Respironics V200/Esprit Ventilator

Service Manual

REF 580-1000-02 H

PHILIPS

For Technical support, contact:
Respironics, Inc. Customer Service
Within the U.S.A. **1-800-345-6443**
Outside the U.S.A. **724-387-4000**
Facsimile **724-387-5012**
service@respironics.com

United States of America
Respironics California, Inc.
2271 Cosmos Court
Carlsbad, CA 92011
USA
1-800-345-6443
or 724-387-4000

CE
0086

Authorized Representative
Respironics Deutschland, Inc.
Gewerbestrasse 17
D-82211 Herrsching Deutschland
+49-8-15-29-30-60

Table of Contents

Chapter 1. Introduction and Intended Use

The Esprit and Respironics V200 ventilators are microprocessor-controlled, electrically powered mechanical ventilators. They are intended for use by qualified medical personnel to provide continuous or intermittent ventilatory support for adult, pediatric, and neonatal patients as prescribed by a physician. They are intended for use in either invasive or non-invasive applications in institutional environments.

The Esprit and Respironics V200 ventilators meet or exceed all applicable safety requirements, consensus guidelines, U.S. regulatory statutes, and international regulatory standards for life support/mechanical ventilation devices.

Read this manual thoroughly prior to performing service or maintenance on the ventilators. This manual contains advanced troubleshooting, calibration, and maintenance instructions. 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 and Respironics V200 ventilators.

Review the *Esprit* or *Respironics V200 Operator's Manual* and become familiar with the operation before running tests, checking operational readiness, or initiating patient use. The operator's manual includes important information about ventilator safety and operation.

Schematic diagrams of the Esprit and Respironics V200 ventilators are available upon request.

For additional information about accessories or related equipment, such as humidifiers and remote alarm systems, refer to the appropriate instruction manual prior to operating the 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. Heed all appropriate alarms and follow the instructions and warnings in this service manual and the operator's manual. Always check life-support equipment for proper operation before use.

NOTE: The *Esprit* or *Respironics V200 Operator's Manual* lists all applicable warnings and cautions. Review these notices thoroughly before operating the ventilator.

1.1 Recommended Tools and Test Equipment

The following table lists the recommended tools, test equipment, and materials required for ventilator service and maintenance (Table 1-1). Test equipment must meet the requirements in Table 1-2.

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

Description	Manufacturer and Model
Test Equipment	
Adapter, USB to serial	Respironics P/N 1022895
Analog output port signal selector	Respironics P/N 1010891
Digital multimeter (DMM) and frequency counter accurate to three decimal places	Local supplier
Electrical safety analyzer	Dale LT 544D or equivalent
Pneumatic calibration analyzer capable of measuring low pressure (cmH_2O), high pressure (PSI), flow rate (LPM), volume (liters), and oxygen concentration (accuracy ± 2%)	Certifier FA Plus Ventilator Gas Analyzer with oxygen sensor kit (Respironics P/N 1040311 or 1040312) or equivalent
Syringe, 10-mL calibrated (neonatal testing)	Hans Rudolph 5220 or equivalent
Service kit (*included in the kit)	Respironics P/N 1021670
Adapter, oxygen regulator test *	Respironics P/N 1001376
Adapter, parallel port *	Respironics P/N 1004644
Cable, remote alarm test *	Respironics P/N 1027818
Cable adapter, remote alarm test	Respironics P/N 1027817
Cable assembly, null modem *	Respironics P/N 1022815 or equivalent
Cork, silicone *	Respironics P/N 1001735 or equivalent
Test lung, 1 L *	Respironics P/N 1021671 or equivalent
Ventilator Accessories	
Adapter, oxygen sensor	Respironics P/N 1001736 or equivalent
Connector, plastic, 22mm OD	Respironics P/N C06335 or equivalent
Coupling, silicone rubber	Respironics P/N C06348 or equivalent
Patient circuit tubes, adult, 42-in. smooth bore (2 each)	Respironics P/N 1003643 or equivalent
Tee, plastic with silicone rubber coupling	Respironics P/N C06260 or equivalent
Tubing, silicone, 3/16 in. ID x 6.5 ft., PAP	Respironics P/N C06686 or equivalent
Wye, reusable, 22mm OD/15mm ID	Respironics P/N 1003070 or equivalent
Hand Tools and Materials	
ESD-safe field service vacuum cleaner	3M model 497-AJM or equivalent
Hex key set, metric (rounded ends), 1.5 to 4 mm	Local supplier
Hex key set, standard (rounded ends), 0.050 to 5/32 in.	Local supplier

Table 1-1: Recommended Test Equipment, Tools, and Materials (Continued)

Description	Manufacturer and Model
Loctite 222	Respironics P/N 200-1000-00
Lubricant, Dupont Krytox GPL226 Res	pironics P/N 100-1012-00
Mild detergent or antiseptic wipes	Local supplier
PC or laptop (for downloading software) with Windows 95 or later, serial port and CD ROM drive	Local supplier
Pliers	Local supplier
Pliers, needle nose	Local supplier
Ratchet, box, 8 mm	Local supplier
Screwdriver, flat head, #2	Local supplier
Screwdriver, flat head, #3	Local supplier
Screwdriver, Phillips head, #2	Local supplier
Screwdriver, pen size flat head	Local supplier
Screwdriver, pen size Phillips head	Local supplier
Static dissipative field service kit	Local supplier
Thread tape	Local supplier
Tie wraps, 3 in. length	Respironics P/N 500-1000-66 or equivalent
Tie wraps, 8 in. length	Respironics P/N 500-1000-62 or equivalent
Tie wrap gun	Local supplier
Torque driver capable of 5 to 25 in.-lbs.	Local supplier
Tweezers, angled	Local supplier
Wire cutters	Local supplier
Wrench, open end, 7/32 in.	Local supplier
Wrench, open end, 1/4 in.	Local supplier
Wrench, open end, 5/16 in.	Local supplier
Wrench, open end, 7/16 in.	Local supplier
Wrench, open end, 1/2 in.	Local supplier
Wrench, open end, 11/16 in.	Local supplier
Wrench, open end, 5.5 mm	Local supplier
Wrench, open end, 7 mm	Local supplier
Wrench, open end or box, #10	Local supplier
Wrench, open end or socket, 3/16 in.	Local supplier
Wrench, socket, 9/32 in. with removable 6-in. extension bar	Local supplier
Wrench, socket, #10	Local supplier

Table 1-2: Test Equipment Specifications

Unit of Measurement	Range	Accuracy
Pressure	-25 to 150 cmH_2O 0 to 100 psi	± 1% of reading or ± 0.20 cmH_2O (whichever is greater). ± 2% of reading @ -1 to 38ºC (30 to 100ºF)
Flow (standard)	0 to 300 SLPM	± 2% of reading ± 0.20 SLPM (whichever is greater)
Torque	5 to 25 in-lb.	± 1 in-lb. of reading
Volume (STP)	0 to 10 L STP	± 2% of reading ± 0.20 L STP
Voltage	DC: ± 5 to 50 V AC: 2 to 300 V	± 2% of reading

Chapter 2. Warnings, Cautions, and Notes

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/Respironics V200 Ventilator.

2.1 General Warnings

WARNING: Do not obstruct the emergency air intake near the oxygen water trap/inlet filter assembly.

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

WARNING: If the ventilator has been operating, the exhalation filter heater conductor may be hot. Use caution when removing the filter.

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

WARNING: To avoid personal injury, always disconnect external AC and DC power sources and high-pressure oxygen sources from the ventilator before servicing.

WARNING: Explosion hazard. Do no operate the ventilator in the presence of flammable anesthetic agents.

2.2 General Cautions

CAUTION: Troubleshooting and repair should be performed only by a qualified service technician. Respironics Factory Service Training is highly recommended prior to performing service procedures on the Respironics Ventilator. Contact Customer Service at 1-800-345-6443 or 724-387-4000 for more information.

CAUTION: Use only Respironics ventilator repair/service parts. Only Respironics parts are designed for use in this ventilator. Use of non-Respironics repair parts may alter ventilator reliability resulting in damage. Use of non-Respironics repair parts will affect your warranty. Contact Customer Service at 1-800-345-6443 or 724-387-4000 for more information.

CAUTION: Do not modify oxygen diameter index safety systems (DISS) connector on rear panel. Use only medical grade oxygen.

CAUTION: Always ensure that you are following proper electrostatic discharge (ESD) grounding procedures before handling static-sensitive devices.

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

2.3 General Notes

NOTE: This manual covers multiple versions of the Esprit and Respironics V200 Ventilators. The information given may not exactly match your own ventilator.

Chapter 3. Theory of Operation

The Esprit and Respironics V200 ventilators are microprocessor-controlled devices that can deliver 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 uses electromechanical control circuits, flow and pressure monitors, and software programs to deliver breaths as a flow or pressure controller.

The ventilators include a graphic user interface (GUI), internal blower, and inspiratory module that mixes air and oxygen. The ventilators can operate from a 40 to 90 psig (276 to 620 kPa) medical grade oxygen source for enriched oxygen operation. It also includes multiple communications interfaces and an internal power supply that can run from a 100 to 240 V AC 50/60 Hz or 24 V DC power sources.

Schematic diagrams of the Esprit and Respironics V200 ventilators are available upon request.

3.1 Pneumatic System

The pneumatic system consists of these subsystems (see Figure 3-1):

- Internal blower (air source)
- Oxygen regulator (oxygen source)
- Inspiratory module
- Heated exhalation filter assembly
- Exhalation valve assembly
- Expiratory flow sensor

The internal blower generates the air pressure necessary for breath delivery, eliminating the need for an external source of medical-grade compressed air. An internal oxygen regulator controls wall oxygen pressure. The ventilator mixes air and oxygen in the inspiratory module before delivery to the patient.

Based on operator settings, the central processing unit (CPU) controls the air valve, oxygen valve, and exhalation valve through stepper motor controller printed circuit boards (PCBs). As flow is delivered to the patient, the air and oxygen flow sensors and two pressure sensors provide feedback to the CPU.

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

The exhalation filter reduces the risk of contamination or component damage due to bacteria or moisture in expired gases. The exhalation filter is housed in a heated sleeve, which reduces the relative moisture condensation in the exhalation filter, exhalation valve, and expiratory flow sensor. Exhaled gas is then vented to atmosphere.

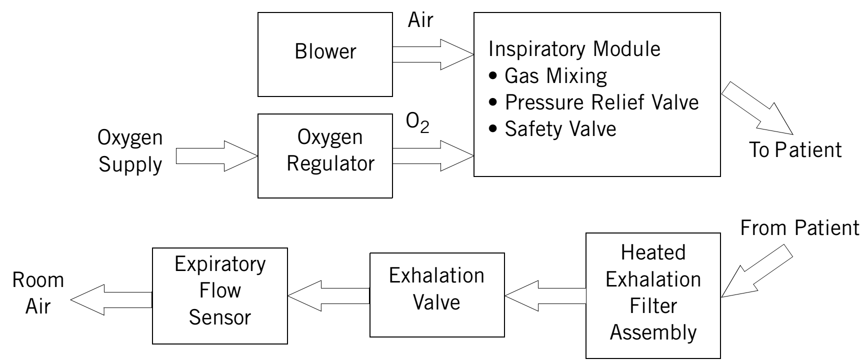


Figure 3-1: Pneumatic System Block Diagram

Figure 3-2 shows the pneumatic system and its components.

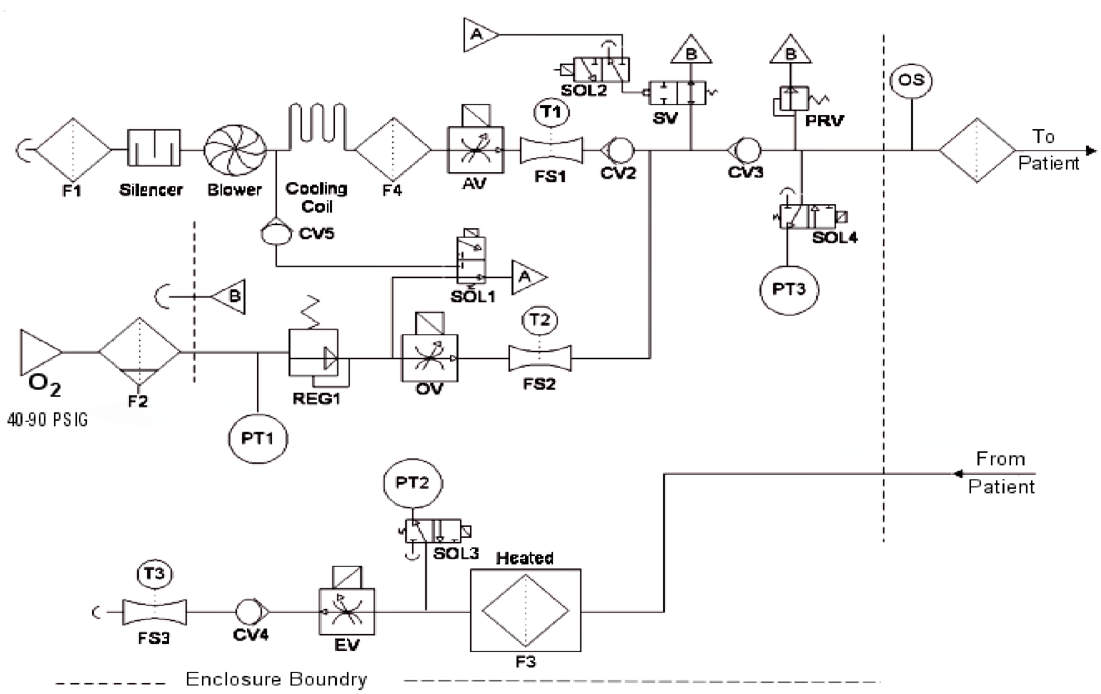


Figure 3-2: Pneumatic Schematic

3.1.1 Blower Inlet Filter (F1)

The blower draws room air through the blower inlet filter (F1) and the muffler (silencer) and outputs flow to the air valve assembly (AV). The blower inlet filter removes coarse particulate from ambient air as it is entrained into the blower assembly. See Chapter 4 for periodic maintenance information.

3.1.2 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.

3.1.3 Blower

The blower draws room air though the air inlet filter and outputs the air that is delivered to the patient, and provides the pilot pressure that can actuate the safety valve. The blower contains a DC motor and a series of stator and impeller assemblies. It can provide 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 Diagnostics mode. The high pressure alarm limit setting also affects blower speed.

3.1.4 Cooling Fan Filter

The cooling fan filter removes coarse particulate from ambient air entrained by the cooling fan. See Chapter 4 for periodic maintenance information.

3.1.5 Cooling Coil

The cooling coil is a copper tube connected to the outlet of the blower dissipate heat from gas leaving the blower before it reaches the air valve.

3.1.6 Cooling Coil Fan

The 24 V DC cooling coil fan removes the heat dissipated by the cooling coil and blower.

3.1.7 Air Valve Assembly (AV)

The air valve assembly includes a stepper motor that meters air flow from the blower to achieve the target flow under CPU control, based on operator selected parameters. It can deliver up to 200 LPM of flow.

3.1.8 Air Flow Sensor (FS1)

The air flow sensor measures flow from the air valve. The ventilator uses this measurement to provide closed loop control of the air valve and to compute the flow and volume delivered to the patient. A thermistor in the flow sensor measures the temperature of the air and provides the microprocessor with information to compensate the delivered flow.

3.1.9 Oxygen Water Trap/Inlet Filter Assembly (F2)

The oxygen water trap/inlet filter assembly consists of a 5-micron (μ) 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.

3.1.10 Oxygen Inlet Connector (O_2)

The oxygen inlet connector provides a country-specific connection point for an external oxygen gas supply of 40 to 90 psig (276 to 620 kPa).

3.1.11 Oxygen Supply Pressure Switch (PS1)

The oxygen supply pressure switch is part of the oxygen regulator. PS1 is a normally open (NO) switch that monitors oxygen supply pressure by closing when measured pressure is over 40 psig (276 kPa), and sends a signal to the sensor PCB to indicate if supply pressure is adequate at the oxygen inlet.

PS1 opens if measured pressure is less than 35 psig (241.3 kPa). If the oxygen supply pressure switch opens during normal ventilation (at O_2 > 21%), a low oxygen supply alarm results.

3.1.12 Oxygen Regulator (REG 1)

The oxygen regulator reduces the oxygen supply pressure to the proper inlet pressure for the oxygen valve (22-24 psig, or 152-165 kPa @ 180 LPM) and supplies the regulated pressure to the crossover solenoid, which pilots the safety valve.

3.1.13 Oxygen Valve (OV)

The oxygen valve assembly contains a stepper motor that meters flow from the oxygen regulator to achieve the target flow under CPU control, based on operator-selected parameters. It can deliver up to 200 LPM of flow.

3.1.14 Oxygen Flow Sensor (FS2)

The oxygen flow sensor measures the flow from the oxygen valve. The ventilator uses this measurement to provide closed loop control of the oxygen valve and to compute the flow and volume delivered to the patient. A thermistor contained in the flow sensor measures the temperature of the oxygen and provides temperature compensation information to the microprocessor for delivered flow.

3.1.15 Crossover Solenoid (SOL1)

The crossover solenoid is a three-way valve that supplies either air or oxygen pressure to pilot (hold) the safety valve closed during normal ventilation. In its normal state, SOL1 is normally de-energized to pilot the safety valve with oxygen. If oxygen pressure is lost, SOL1 is energized and air (rather than oxygen) controls the safety valve.

3.1.16 Cross-Contamination Check Valve (CV5)

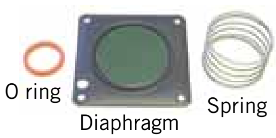
The cross-contamination check valve prevents the oxygen supply from entering the air delivery system (blower) in the event of a crossover solenoid leak.

3.1.17 Safety Valve Pilot Solenoid (SOL2)

SOL2 directs the output of the crossover solenoid to the safety valve or vents the pilot pressure line to atmosphere.

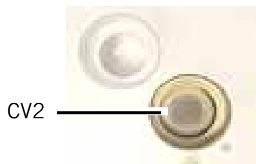
During normal operation, SOL2 is energized and directs pressure from the crossover solenoid to close the safety valve. During a high priority alarm condition such as an occlusion or ventilator failure (VENT INOP) mode, SOL2 is deenergized, the safety valve opens, and the patient can breathe room air.

3.1.18 Safety Valve (SV)



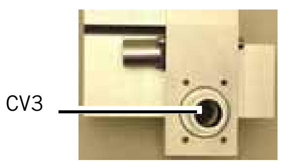
The safety valve contains a spring-loaded diaphragm that is controlled by safety valve pilot solenoid (SOL2). Under normal conditions the safety valve is closed, allowing delivered flow to reach the patient. In the event of a safety valve open (SVO) condition, pilot pressure is vented to atmosphere, which opens the safety valve and allows the patient to breathe room air through the safety port at the back of the ventilator.

3.1.19 Air System Check Valve (CV2)



CV2 prevents oxygen from entering the air delivery system in the event of a blower failure.

3.1.20 Inspiratory Non-Rebreathing Check Valve (CV3)



CV3 prevents the patient from exhaling through the inspiratory limb during a safety valve open condition, which prevents the patient from rebreathing exhaled gas.

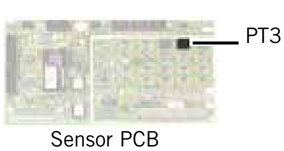
3.1.21 Pressure Relief Valve (PRV)

The pressure relief valve provides a backup to the operator adjustable high-pressure alarm and prevents excessive pressures in the patient circuit. The pressure relief valve is spring-loaded to limit the maximum circuit pressure to 130 to 140 cmH_2O.

3.1.22 Oxygen Sensor (OS)

The optional oxygen sensor is installed between the 22-mm inspiratory port and the inspiratory bacteria filter. The galvanic oxygen sensor measures the oxygen concentration of the blended gas as it leaves the inspiratory manifold. The output signal from the sensor is used to determine whether measured oxygen concentration is within 6% of the $\%O_2$ setting. If not, a high or low oxygen concentration alarm occurs.

3.1.23 Inspiratory Pressure Transducer (PT3)



PT3 on the sensor PCB monitors system pressure from the inspiratory side of the patient circuit during exhalation pressure transducer autozeroing, ensuring uninterrupted pressure monitoring. PT3 is also used with the exhalation pressure transducer (PT2) to detect patient circuit occlusions.

3.1.24 Inspiratory Pressure Transducer Solenoid (SOL4)

SOL4 periodically vents the inspiratory pressure transducer to atmosphere and makes a measurement at zero (atmospheric) pressure. Periodically autozeroing the transducer allows it to correct the slight zero voltage drift that can occur over time, and improves the overall accuracy of the pressure measurement.

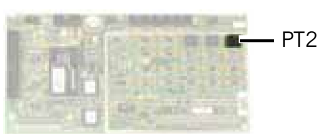
During normal operation, SOL4 is de-energized and applies patient circuit pressure to the inspiratory pressure transducer. During an autozero, SOL4 is energized, venting the transducer to atmosphere. This occurs during power on self test (POST), at the beginning of a breath one minute after POST, six minutes after POST, eleven minutes after POST, and hourly thereafter.

3.1.25 Heated Exhalation Filter (F3)

The heated exhalation filter includes a heated filter sleeve and a bacteria filter. The heater protects the exhalation flow sensor and exhalation system components from condensation by heating exhaled gas (which has cooled in the exhalation limb) above its dew point.

The exhalation bacteria filter protects the exhalation flow sensor and exhalation system component from contaminants and filters exhaled gas before it is vented to atmosphere.

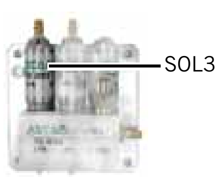
3.1.26 Exhalation Pressure Transducer (PT2)



Sensor PCB

The exhalation pressure transducer on the sensor PCB measures patient circuit pressure from the exhalation side of the patient circuit. During normal operation PT2 is the primary transducer for measuring patient pressures, including peak inspiratory pressure (PIP), mean airway pressure (MAP), end inspiratory pressure, and auto-PEEP. The exhalation pressure transducer provides monitoring data for closed loop control.

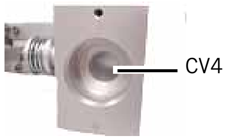
3.1.27 Exhalation Pressure Transducer Solenoid (SOL3)



The exhalation pressure transducer solenoid periodically vents the exhalation pressure transducer to atmosphere and measures zero (atmospheric) pressure. Periodically autozeroing the transducer allows it to correct the slight zero voltage drift that can occur over time, and improves overall pressure measurement accuracy.

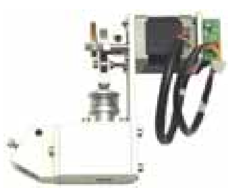
During normal operation, SOL3 is de-energized and applies patient circuit pressure to the exhalation pressure transducer. During an autozero, SOL3 is energized, venting the transducer to atmosphere. This occurs during POST, at the beginning of a breath one minute after POST, six minutes after POST, eleven minutes after POST, and hourly thereafter.

3.1.28 Exhalation Non-Rebreathing Check Valve (CV4)



CV4 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.

3.1.29 Exhalation Valve (EV)



The exhalation valve is controlled by a stepper motor. At the beginning of an inspiration, the exhalation valve shuts to create a closed circuit and allow the patient system to pressurize. The exhalation valve opens at the beginning of exhalation, allowing system pressure to vent to atmosphere.

The exhalation valve also regulates positive end expiratory pressure (PEEP) and expiratory positive airway pressure (EPAP) levels during exhalation.

3.1.30 Exhalation Flow Sensor (FS3)

The exhalation flow sensor measures the flow leaving the ventilator, which includes gas exhaled by the patient, tubing compliance volume, and bias flow (if flow triggering or Auto-Trak triggering is selected). The ventilator uses the exhaled flow measurement to compute flow and volume coming from the patient and the circuit.

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

3.2 Ventilator System Electronics

Figure 3-3 shows the electronic system. Schematics are available upon request.

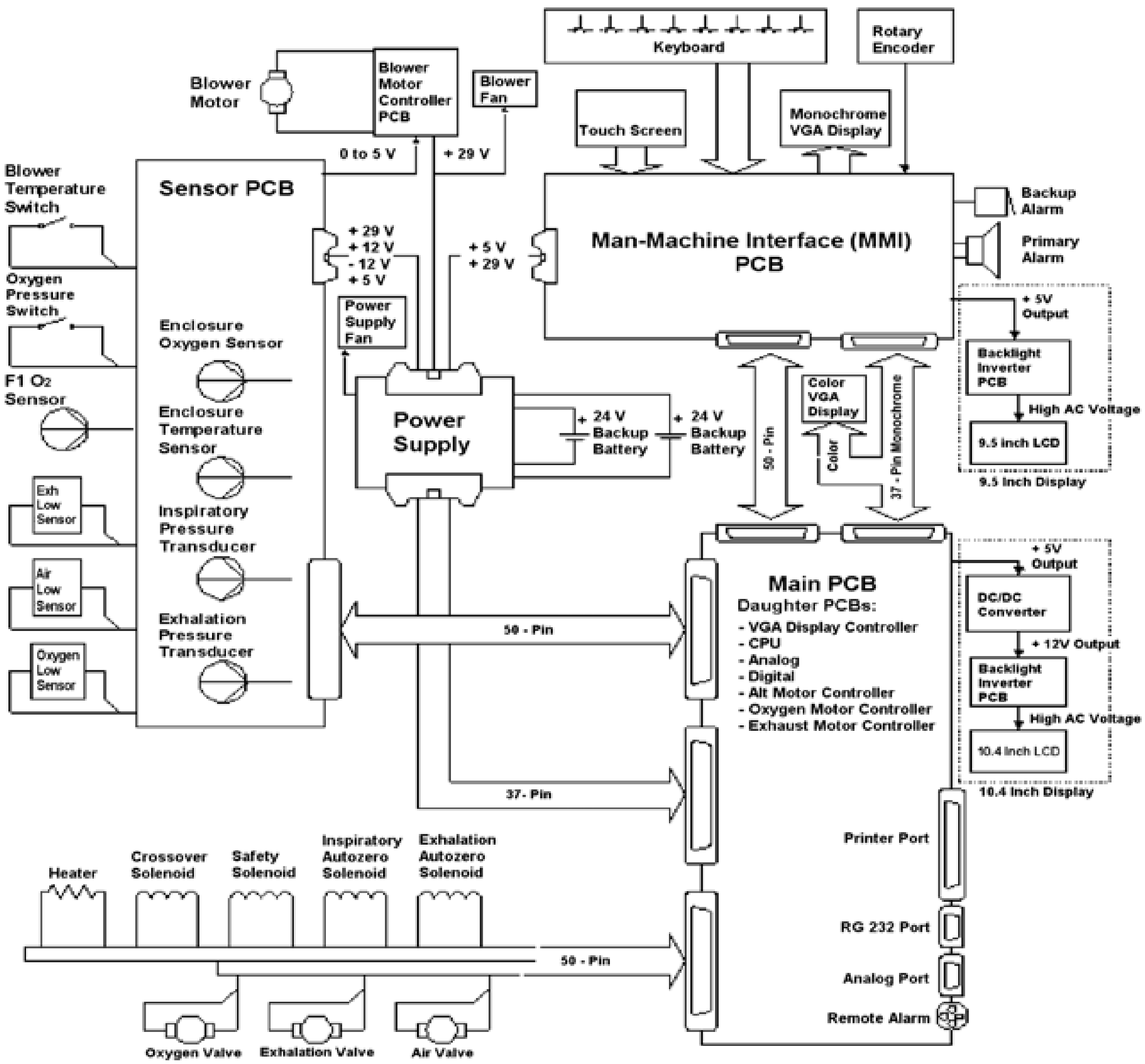


Figure 3-3: Electronic System Diagram

The ventilator can be powered by a 100 to 240 VAC 50/60 Hz or external 24 V DC power source (backup battery or external battery). The power supply conditions the input voltage and distributes +5 V, +12 V, -12 V, and +29 V to the main PCB and blower motor controller to power digital electronics, electropneumatic components, and displays. AC power to the humidifier port can be used on 100-120 V units only.

The microprocessor on the CPU PCB and programs stored in memory control the interaction of the pneumatic and electronic subsystems. Using inputs from electropneumatic sensors and the operator, the CPU controls the flow, pressure, and volume of air and oxygen to be delivered to the patient. The CPU also monitors alarms and independently monitors software execution.

The the CPU PCB, digital PCB, analog PCB, VGA controller PCB, and three stepper motor controller PCBs are vertically mounted on the main PCB.

Digital control signals from the CPU are sent to the analog PCB, where they are converted into analog signals that control blower speed and chart recorder outputs (pressure, flow, and volume). The sensor PCB conditions and converts analog data from the flow, pressure, and oxygen sensors, then sends the data to the analog PCB, where it is read by the CPU.

Ventilator data from the CPU is conditioned by the VGA and man-machine interface (MMI) PCBs, then displayed on an LCD.

Table 3-1 summarizes the electronic signal path sequences for the ventilator components.

Table 3-1: Signal Path Sequences

Component	Signal Path Sequence
100% O_2 indicator	Front panel overlay, MMI PCB, main PCB, digital PCB, CPU PCB
29 V enable	Main PCB, CPU PCB, power supply
Air (AV), oxygen (OV), exhalation (EV) valves	Main PCB, motor controller PCB, CPU PCB
Air (FS1), oxygen (FS2), exhalation (FS3) flow sensors	Sensor PCB, main PCB, analog PCB, CPU PCB
Alarm High indicator	Front panel overlay, MMI PCB, main PCB, CPU PCB
Alarm Med/Low indicator	Front panel overlay, MMI PCB, main PCB, CPU PCB
Alarm Silence indicator	Front panel overlay, MMI PCB, main PCB, digital PCB, CPU PCB
Backlight (9.5 in display, standard on Esprit ventilator)	Backlight inverter PCB, DC/DC converter PCB, main PCB, backlight control potentiometer
Backlight (10.4-in display, optional on Esprit ventilator, standard on Respironics V200 ventilator)	Backlight inverter PCB, DC/DC converter PCB, main PCB, backlight control potentiometer

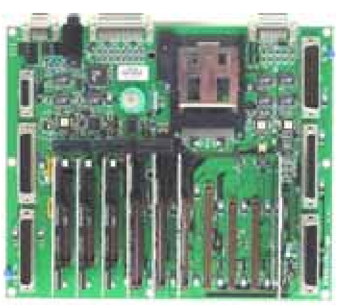
Table 3-1: Signal Path Sequences (Continued)

Component	Signal Path Sequence
Backup alarm	MMI PCB, main PCB, digital PCB, CPU PCB
Battery/Charging indicator	Front panel overlay, MMI PCB, power supply, main PCB, CPU PCB
Battery/In Use indicator	Front panel overlay, MMI PCB, main PCB, digital PCB, CPU PCB
Battery/Low indicator	Front panel overlay, MMI PCB, digital PCB, CPU PCB
Blower DAC	Blower controller PCB, sensor PCB, main PCB, analog PCB, CPU PCB
Blower on/off	Blower controller PCB, sensor PCB, main PCB, CPU PCB
Blower temperature switch	Sensor PCB, main PCB, digital PCB, CPU PCB
Console: all keys	Front panel overlay, MMI PCB, main PCB, CPU PCB
Crossover solenoid (SOL1)	Main PCB, CPU PCB
Enclosure temperature sensor	Sensor PCB, main PCB, analog PCB, CPU PCB
Exhalation pressure transducer (PT2)	Sensor PCB, main PCB, analog PCB, CPU PCB
Exhalation pressure transducer solenoid (SOL3)	Main PCB, CPU PCB
External backup battery	Power supply
External Battery indicator	Front panel overlay, MMI PCB, power supply
Heater	Main PCB, CPU PCB
Inspiratory pressure transducer (PT3)	Sensor PCB, main PCB, analog PCB, CPU PCB
Inspiratory pressure transducer solenoid (SOL4)	Main PCB, CPU PCB
Mains indicator	Front panel overlay, MMI PCB, power supply
Nonmaskable interrupt (NMI) signal	Sensor PCB, main PCB, CPU PCB
Normal indicator	Front panel overlay, MMI PCB, main PCB, CPU PCB
Oxygen Sensor (OS)	Sensor PCB, main PCB, analog PCB, CPU PCB
Oxygen supply pressure switch (PS1)	Sensor PCB, main PCB, digital PCB, CPU PCB
Primary alarm	MMI PCB, main PCB, digital PCB, CPU PCB
Primary alarm potentiometer	MMI PCB
Printer	Main PCB, CPU PCB
Remote alarm (nurse call)	Main PCB, CPU PCB
Rotary encoder	MMI PCB, main PCB, digital PCB, CPU PCB
Safety Valve indicator	Front panel overlay, MMI PCB, main PCB, CPU PCB
Safety valve pilot solenoid (SOL2)	Main PCB, CPU PCB
Screen Lock indicator	Front panel overlay, MMI PCB, main PCB, CPU PCB
Touch screen	MMI PCB, main PCB, digital PCB, CPU PCB
Vent Inop indicator	Front panel overlay, MMI PCB, main PCB, CPU PCB

Table 3-1: Signal Path Sequences (Continued)

Component	Signal Path Sequence
VGA backlight intensity potentiometer (9.5 in display, standard on Esprit ventilator)	MMI PCB, backlight inverter PCB
VGA backlight intensity potentiometer (10.4-in display, optional on Esprit ventilator, standard on Respironics V200 ventilator)	Backlight inverter PCB
VGA display (9.5 in display, standard on Esprit ventilator)	MMI PCB, main PCB, VGA controller PCB, CPU PCB
VGA display (10.4-in display, optional on Esprit ventilator, standard on Respironics V200 ventilator)	Main PCB, VGA controller PCB, CPU PCB

3.2.1 Main PCB



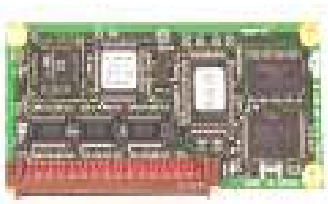
The CPU and other ventilator logic interact through the system data, address, and control buses on the main PCB. The main PCB receives input signals from various keys on the console or touch screen display and sends them to the CPU. The main PCB also contains signal inputs for non-maskable interrupt,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

The main PCB receives control signals from the CPU and outputs them to various pneumatic components and console indicators. The main PCB receives signals from the digital PCB to turn on the indicators for alarm silence, 100% oxygen, AC power, external battery power, and backup battery status. The main PCB receives signal from the CPU PCB to turn on the backup alarm, enable 24V, and the *Screen Lock*, *Battery/Charging*, and *Vent Inop* indicators. The CPU PCB reads the *Accept* key from the main PCB.

The main PCB includes a normal open and normal closed relay that can trigger the remote nurse call alarm. The main PCB also includes the RS-232, parallel printer, analog output, and remote alarm connectors.

The main PCB also routes these signals: reset, MMI PCB reset, sensor PCB reset, primary alarm, primary alarm failure detection logic, backup alarm, remote alarm, printer, POST timer, clocked serial interface (CSI) signals, and the battery backed +3.6 V.

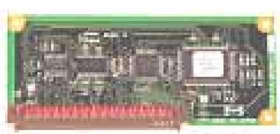
3.2.2 CPU PCB



The CPU PCB contains the microprocessor, memory, I/O ports, and associated control circuitry that controls the ventilator:

- V851 microprocessor with a 25-MHz clock
- Static RAM that stores ventilator data
- EEPROM that stores patient settings
- Flash memory that contains ventilator operating software
- One time programmable (OTP) memory that stores the POST routine
- Internal RS-232 port that receives ventilator data from the touch screen
- Nonmaskable interrupt that tells the CPU a power source has been lost or interrupted
- 5-msec bus timer that monitors hardware operation
- 169-msec watchdog timer that monitors software operation
- Data address and control bus to the main PCB
- 2-MB memory capacity

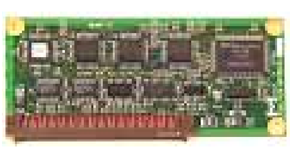
3.2.3 Analog PCB



The analog PCB converts digital signals to analog signals to the blower controller PCB and analog output port. The analog PCB connects directly to the system bus on the main PCB, and includes these functional circuits:

- An eight-bit digital to analog converter (DAC) that converts digital signals from the CPU to analog for the blower and external devices such as chart recorders and bedside monitors
- Clocked serial interface (CSI), a high-speed communication link between the air, oxygen, and exhalation motor controllers and flow sensor lookup tables contained on the CPU and the voltage monitor register
- A circuit that retrieves converted data from the sensor PCB

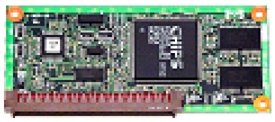
3.2.4 Digital PCB



The digital PCB conditions serial port signals coming from and going to the CPU PCB. It also contains control circuitry for the power fail alarm, primary alarm, backup alarm, RS-232 port, and rotary encoder.

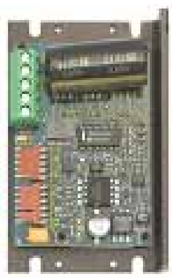
Digital inputs include analog-to-digital converter (ADC) out of range, compressor temperature switch, and oxygen present. Digital outputs include the alarm silence indicator, 100% oxygen indicator, running on AC indicator, running on external battery indicator, backup battery status indicators, printer ready signal, and printer direction.

3.2.5 VGA Controller PCB



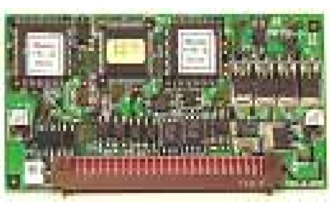
The VGA controller PCB contains the date and real time clock and LCD VGA display controller drivers.

3.2.6 Blower Controller PCB



The blower motor controller PCB controls the speed of the blower motor based on analog input conditioned by the sensor PCB. It includes a lockup sensing circuit, which monitors sensors in the blower motor to detect a locked rotor condition. If the blower motor stops running, the lockup sensing circuit shuts off power to the blower.

3.2.7 Motor Controller PCBs

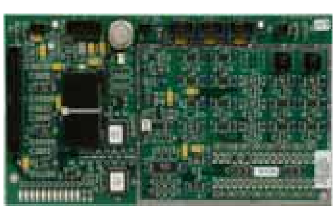


There are three motor controller PCBs for the air valve, oxygen valve, and exhalation valve. The three boards are physically the same and are differentiated by the slot they occupy on the main PCB:

- Exhalation valve motor controller PCB: slot CN11
- Oxygen valve motor controller PCB: slot CN12
- Air valve motor controller PCB: slot CN13

Each motor controller PCB includes a microprocessor dedicated to controlling the corresponding motor and driving the step positions of the motor based on input from the CPU.

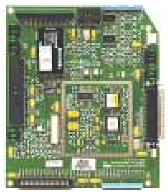
3.2.8 Sensor PCB



The sensor PCB contains an analog to digital converter (ADC) that converts analog signals from various pneumatic components and the power supply into digital signals for the CPU. Signals include: air flow and temperature, oxygen flow and temperature, exhalation flow and temperature, inspiratory and exhalation pressure, battery voltage, FIO_2, enclosure temperature, and enclosure oxygen concentration.

The sensor PCB conditions blower speed analog input and the on/off control to the blower controller PCB. It also routes signals for the oxygen pressure and blower temperature switches.

The sensor PCB also includes voltage LEDs that light to indicate under- and over-voltage conditions.



3.2.9 Man-Machine Interface (MMI) PCB

The MMI PCB interfaces the front panel overlay, VGA display, rotary encoder, and touch screen to the CPU via the main PCB. The MMI PCB contains control circuitry for the primary and back-up alarms, and includes the hard keys and LEDs on the front panel membrane keypad.

3.2.10 Power Supply

The power supply converts AC voltage to DC voltage to be used by the system electronics. The switching power supply can accept voltage from 100 to 240 V AC (50/60 Hz), and converts it to +5 V, + 12 V, and +29 V DC voltages. In the absence of AC voltage, the power supply converts the +24V DC input voltage from an external DC power source (Backup Battery or External Battery). The power supply also includes power fail logic and charging circuitry for the backup battery.

The power supply is cooled by a 24 VDC fan housed in a shroud covering the power supply PCB.

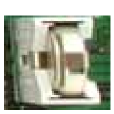
3.2.11 Backlight Inverter PCB

The backlight inverter PCB converts 12 V to approximately 500 V to drive the backlight on the VGA display assembly.

WARNING: The backlight inverter PCB generates high voltage. To avoid personal injury, verify that the AC and external DC power sources (backup battery or external battery) are disconnected from the ventilator.

3.2.12 Real-Time Clock Battery

3.6-V lithium battery (original Esprit ventilator)



3.2-V button battery (current Esprit/ Respironics V200 ventilator)

The Esprit ventilator originally included a 3.6-V lithium real-time clock/backup alarm battery. The Esprit/Respironics V200 ventilators currently use a 3.2-V button battery installed on the main PCB.

3.2.13 Backup Battery

Esprit ventilator backup battery

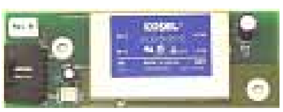
Respironics V200 ventilator backup battery

The 24-V backup battery can power the ventilator for approximately 30 minutes at nominal settings in case of AC power loss.

3.2.14 External Battery

The optional external battery supplements the backup battery, and can provide an additional two hours of ventilator operation (depending on ventilator settings). The ventilator runs on AC power when available, then external battery power if installed, and then backup battery power.

3.2.15 DC/DC Converter PCB



The DC/DC converter PCB converts a 5-V input to a 12-V output for the original 10.4-inch display backlight inverter PCB. This PCB is not used in current displays.

3.2.16 Optical Rotary Encoder

The optical rotary encoder converts the mechanical position of the user interface knob into a representative electrical signal using a patterned disk or scale, a light source, and photosensitive elements.

3.2.17 Graphic User Interface (GUI)

Respironics V200 ventilator GUI

Esprit ventilator GUI

The GUI includes an infrared (IR) touchframe that contains 24 vertical and 32 horizontal IR emitter detector pairs, each of which is sequenced at a high frequency. When the screen is touched, breaking the IR beam, the x and y coordinates that correspond to the position on the screen are communicated to the microprocessor.

The GUI on Esprit ventilators is equipped with a 9.5-inch monochrome or a 10.4-in. color-capable liquid crystal display (LCD). The GUI on Respironics V200 ventilators is equipped with a 10.4-inch color-capable LCD. The 10.4-inch color-capable LCD is a 640 x 480 active matrix display.

3.2.18 Remote Alarm (Nurse Call)

The remote alarm contacts provide remote alarm capability, allowing the ventilator to annunciate an active medium or high priority alarm at a location away from the ventilator. Pressing Alarm Silence mutes the remote alarm.

The ventilator signals an alarm condition using normally open (NO) or normally closed (NC) relay contacts, where the deenergized state indicates an active alarm. The remote alarm port is a standard ¼-in. phone jack (ring, tip, sleeve) connector (Figure 3-4).

- When the ring and sleeve are used, the relay is open during normal ventilator operation and closed when an alarm is active or the ventilator is off.
- When the tip and sleeve are used, the relay is closed during normal operation and open when an alarm is active or the ventilator is off.

CAUTION: The remote alarm port is intended to connect only to SELV (safety extra low voltage and ungrounded system with basic insulation to ground), in accordance with IEC 60601-1. To prevent damage to the remote alarm, the signal input should not exceed the maximum rating of 24 VAC or 36 VDC at 500mA with a current of 1mA.

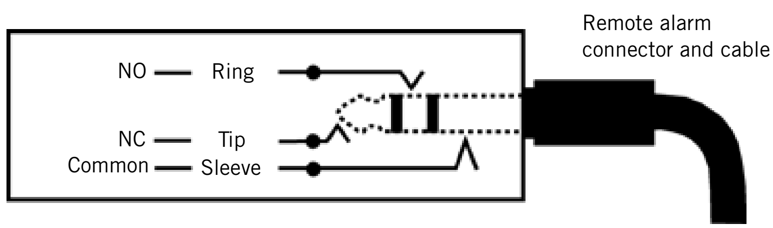


Figure 3-4: Remote Alarm (Nurse Call) Connector

The 15-pin analog output (chart recorder) port of the ventilator can also be used to connect to the Respironics Lifecare remote alarm system. The Lifecare remote alarm sounds under these conditions:

- A high or medium priority alarm condition is active
- Ventilator power is turned off or disconnected.
- The Respironics Lifecare remote alarm system is disconnected from the ventilator
- The ventilator runs POST

NOTE: To connect the Lifecare remote alarm system to the ventilator, a DB15 to BNC cable adapter must be installed into the analog output port.

(This page is intentionally blank.)

Chapter 4. Periodic Maintenance

Perform periodic maintenance (PM) procedures (Table 4-1) to ensure consistent optimal ventilator operation. The annual and 12,500-hour PM kits are intended to be installed only by a qualified service technician. The *Esprit* or *Respironics V200 Ventilator Operator's Manual* summarizes the PM schedule.

Table 4-1: Periodic Maintenance Schedule

Frequency	Component	Maintenance
During ventilator setup	• Inspiratory bacteria filter	• Check filter for occlusions, cracks, and tears.
	• Inspiratory and expiratory filters	• Ensure that the ventilator functions normally with both filters in place.
	• Ventilator and patient circuit components	• Perform Short Self-Test (SST) whenever circuit components are changed (Chapter 5). • Perform Extended Self-Test (EST) between patient uses (Chapter 5).
At least daily, and as recommended by filter manufacturers	• Inspiratory and expiratory filters	• Monitor filter performance and replace as needed. Changes in expiratory resistance that can indicate expiratory filter damage. • Follow filter manufacturer recommendations regarding duration of use, maintenance (for reusable filters), and disposal. Note that high humidity and aerosol medications can reduce expiratory filter life, increase expiratory resistance, or cause filter damage. CAUTION: Do not operate the ventilator without a properly functioning expiratory filter and heater. Doing so may cause damage to delicate ventilator components, such as the expiratory flow sensor, which may lead to inaccurate spirometry or a Vent Inop condition. **WARNING: Vent Inop is a serious condition which is indicated by both visual and audible alarms. If the ventilator is attached to a patient when Vent Inop occurs, the patient must be supported with another means of life support ventilation.**
At least daily	• Oxygen supply water trap and filter	• Check and empty as required every shift.
At least every 250 hours	• Air inlet and fan filters	• Inspect and clean. Lint and dust can accumulate more quickly in some environments: inspect and clean more frequently if required.
Annually	• Annual PM kit (P/N 1034840).	• Clean ventilator interior and exterior (section 4.1). • Install annual PM kit (section 4.2). • Complete performance verification procedure (Chapter 8). CAUTION: The annual preventive maintenance procedure is to be performed only by a qualified service technician.

Table 4-1: Periodic Maintenance Schedule (Continued)

12,500 hours	• 12,500-hour PM kit (P/N 1001733).	• Clean ventilator interior and exterior (section 4.1). • Install the12,500-hour PM kit (section 4.3). • Complete performance verification procedure (Chapter 8). CAUTION: The 12,500-hour preventive maintenance procedure is to be performed only by a qualified service technician.
As required	• External oxygen sensor	• Replace and run EST to recalibrate new sensor (Chapter 5).
	• Backup battery	• If the backup battery option is installed, charge and maintain according to instructions in the *Operator's Manual*.

4.1 Cleaning the Ventilator

Clean the ventilator before installing a PM kit:

1. Generate a ventilator diagnostic report (DRPT) (Chapter 7).
2. Perform an extended self-test (EST) (Chapter 5.)
3. Turn the ventilator off, disconnect all power sources (AC and battery), and disconnect oxygen.
4. If required, remove the ventilator from its cart.
5. Separate the top and bottom enclosures.
6. Remove the power supply shroud.
7. Use an ESD-safe vacuum to remove dust or debris from the top and bottom enclosures, then inspect for any signs of corrosion or damage:
   - Ensure that the exhalation flow sensor tube is clean, clear, and moisture-free.
   - Check for loose cables, screws, or pneumatic lines.
   - Remove any dust from the power supply PCB, power supply fan housing, and power supply fan.
8. Reinstall the power supply shroud, including electrical connections to the GUI and fan.
9. Use a clean, lint-free cloth and vacuum to remove dust from the interior of the power supply air inlet hose, then reinstall to the power supply shroud.
10. Clean the GUI as described in the *Operators Manual*. If required, also use an ESD-safe vacuum to clean the interior components.
11. Reassemble the top and bottom enclosures, then clean the ventilator exterior as described in the *Operator's Manual*.

NOTE: For component removal/installation instructions, see Chapter 9 (Esprit ventilator), or Chapter 10 (V200 ventilator).

4.2 Annual PM

Follow these steps to install the annual PM kit:

1. Clean the ventilator (section 4.1).
2. Replace these PM kit components:
    - Air inlet filter.
    - Blower inlet filter.
    - Oxygen water trap filter.
3. Complete a performance verification (Chapter 8).
4. Apply these labels:
    - PM label: complete and apply to upper right center of blower shroud exterior
    - Clear chemical-resistant label: apply to cover PM label
    - Electrical safety label: apply to upper left center of blower shroud exterior or as required.

4.3 12,500-Hour PM

Follow these steps to install the 12,500-hour PM kit:

1. Clean the ventilator (section 4.1).
2. With the top and bottom enclosures separated and the power supply shroud removed, check the power supply to blower motor harness (Figure 4-1):
    - If the harness has a white terminal block, do *not* replace.
    - If the harness does not have a white terminal block, replace the harness.

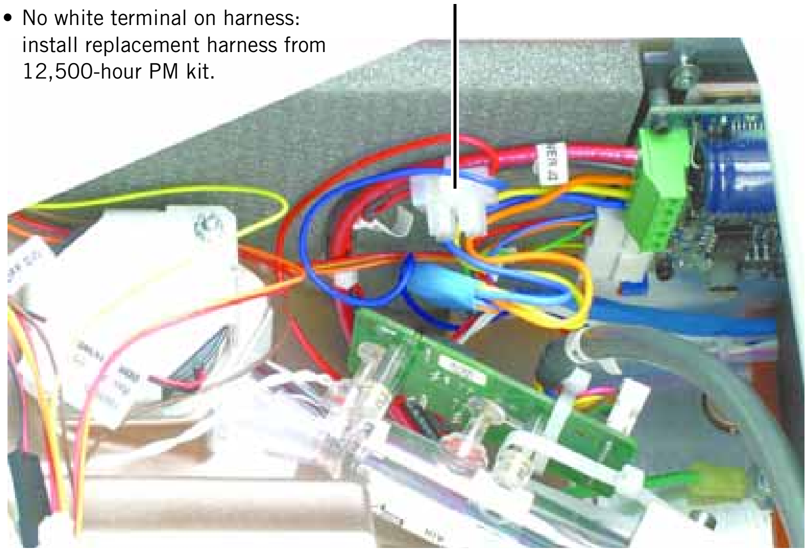
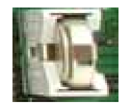


Figure 4-1: Power Supply to Blower Motor Harness Versions

3. Determine whether the real-time clock battery must be replaced (Figure 4-2):
   - If the power supply shroud includes a 3.6-V lithium battery, install the replacement battery from the 12,500-hour PM kit.
   - If a main PCB with the 3.2-V button battery is installed, do *not* replace the battery.

3.6-V lithium battery (original Esprit ventilator): if present on power supply shroud, install replacement battery from 12,500-hour PM kit.



3.2-V button battery (current Esprit/ Respironics V200 ventilator): if present on main PCB, do *not* replace battery.

Figure 4-2: Real-Time Clock Battery Versions

4. Remove the power supply fan from the shroud and install the replacement fan from the PM kit.
5. Reinstall the power supply fan shroud and its connections.
6. Remove the blower, cooling coil, cooling coil fan and mesh cup.
7. Install these replacement components from the PM kit:
   - Cooling coil fan
   - Blower assembly
   - Mesh cup
8. Reassemble the ventilator and install these replacement components from the PM kit:
   - Air inlet filter.
   - Blower inlet filter.
   - Oxygen water trap filter.
9. Complete a performance verification (Chapter 8).
10. Apply these labels:
    - PM label: complete and apply to upper right center of blower shroud exterior
    - Clear chemical-resistant label: apply to cover PM label
    - Electrical safety label: apply to upper left center of blower shroud exterior or as required.

Chapter 5. Diagnostic Mode and Troubleshooting

Use diagnostic mode to:

- Set the date and time, set the correct altitude, enable or disable automatic patient circuit compliance, select a 12 or 24 hour clock, and enable or disable backup battery confirmation at startup (section 5.2).
- Run a short self test (SST) (section 5.3).
- Run an extended self test (EST) (section 5.4).
- View the software revision of the ventilator and installed options (section 5.5).
- View diagnostic codes (section 5.6).
- Control and monitor pneumatic components and voltages for troubleshooting in case the ventilator fails SST, EST, or performance verification (section 5.7).
- Check bacteria filter resistance (section 5.9).

WARNING: Diagnostic mode suspends normal ventilation: disconnect the patient from the ventilator before entering diagnostic mode.

CAUTION: Troubleshooting and repair should be performed only by a qualified service technician. Respironics Factory Service Training is highly recommended prior to performing service procedures on Esprit or Respironics V200 Ventilator. Contact Customer Service at 1-800-342-6443 or 724-387-4000 for more information.

5.1 Entering Diagnostic Mode

To start ventilator diagnostics, simultaneously press the **ALARM RESET** and **100% O_2** keys on the front panel for approximately five seconds while turning ventilator power on. At the prompt, touch **OK** to enter diagnostic mode (Figure 5-1).

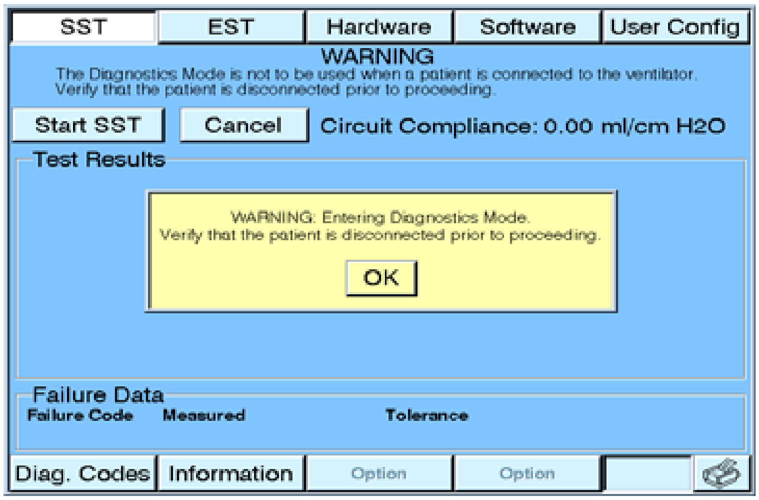


Figure 5-1: Entering Diagnostic Mode

5.2 User Configuration

Use the user configuration screen (Figure 5-2) to:

- Set the date and time (section 5.2.1)
- Set the correct altitude (section 5.2.2)
- Enable or disable automatic patient circuit compliance compensation (section 5.2.3)
- Select a 12 or 24 hour clock (section 5.2.4)
- Enable or disable backup battery confirmation at ventilator startup (section 5.2.5).

To view the user configuration screen, touch **User Config** on the diagnostic screen.

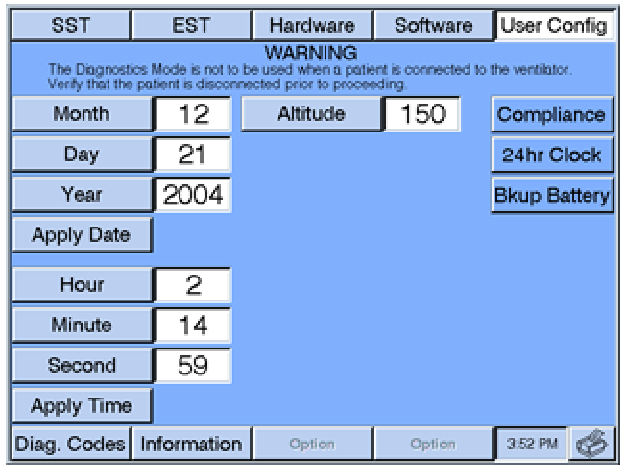


Figure 5-2: User Configuration Screen

5.2.1 Setting the Date and Time

1. Touch the button for the value you want to change.
2. Touch the **Increase** or **Decrease** bar or turn the knob to adjust the value.
3. Press **Accept** (onscreen button or offscreen key) to confirm the change.
4. Touch **Apply Date** or **Apply Time** to apply the change (changes do not take effect until you touch the button).

5.2.2 Setting Altitude

Setting altitude to the correct value allows the ventilator to deliver tidal volumes at optimal accuracy.

WARNING: Reenter the correct altitude setting whenever upgrading software. The altitude setting reverts to the default setting (9999 feet, displayed as ----) at every software upgrade.

1. Verify the altitude using an altimeter if available, or estimate altitude in feet or meters above sea level.
2. Touch **Altitude**.
3. Touch the **Increase** or **Decrease** bar or turn the knob to adjust the value.
4. Press **Accept**.

5.2.3 Enabling Circuit Compliance

The ventilator can use compliance correction to compensate for volume loss in the patient breathing circuit due to the compressible volume of the tubing.

Touch **Compliance** to enable or disable compliance correction:

- Enabled: the ventilator adds the compliance volume measured during SST or EST to delivered volume, and improves the accuracy of volume delivery during normal operation.
- Disabled: the ventilator does not add compliance volume to delivered volume. Compliance correction is typically disabled during performance testing.
- After downloading software, you must disable then re-enable compliance correction (even though compliance correction appears enabled) to put compliance into effect.

5.2.4 Selecting 12 or 12 Hour Clock

Touch **24hr Clock** to toggle between standard 12-hour and 24-hour time format. The lower right corner of the diagnostic screen shows the selected format.

5.2.5 Confirm Backup Battery

Touch **Bkup Battery** to enable or disable backup battery confirmation at ventilator startup.

When enabled, ventilator startup is normal if the backup battery is connected. If the backup battery is *not* connected, the ventilator displays a message at startup (Figure 5-3) and logs a 5002 diagnostic code.

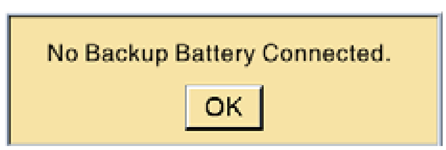


Figure 5-3: No Backup Battery Connected message

5.3 Short Self Test (SST)

SST verifies the integrity of the patient circuit tubing by measuring its leak rate and compliance. SST also tests some hardware, including the safety valve (SV), flow sensor tables, autozero solenoids and the inspiratory non-rebreathing check valve (CV3). Perform SST after every patient circuit change.

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.**

Required equipment: the intended patient circuit assembly and a rubber cork.

Follow these steps to run SST:

1. Connect the intended patient circuit to the ventilator.
2. Touch **SST** on the diagnostic screen (Figure 5-4).
3. Touch **Start SST** to begin the test.
4. When prompted, unblock the wye and touch **OK**.
5. When prompted, block the wye and touch **OK**.
6. When SST is completed successfully, touch **OK**. The SST screen shows the results of each test. Diagnostic code 2000 indicates that SST was successfully completed.

If any SST tests fail, the screen displays failure data, including diagnostic code, measured value, and passing values.

- Touch **RETEST** to repeat the test.
- Touch **CONTINUE** to skip the failed test.
- Touch **CANCEL** to exit EST.

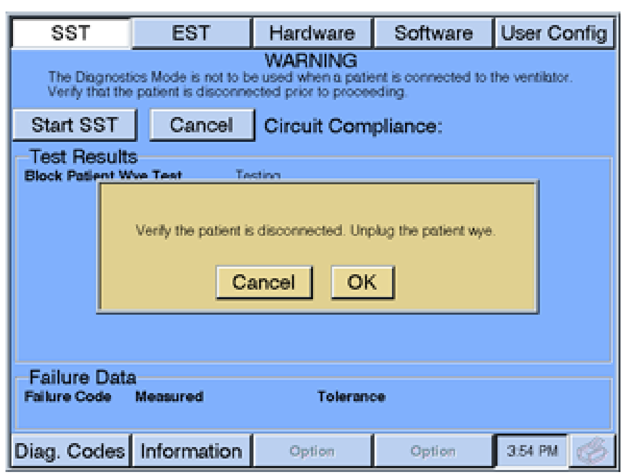


Figure 5-4: Starting SST

5.4 Extended Self Test (EST)

EST verifies the functional integrity of the ventilator by testing its hardware subsystems and components. Perform EST between patients, during preventive maintenance, performance verification, for oxygen sensor calibration, or if ventilator operation is questionable.

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.

Required equipment:

- Reusable adult patient circuit assembly
- Rubber cork
- Regulated oxygen source
- Optional: an external oxygen sensor to perform the automatic oxygen sensor test and calibration
- Optional: a remote alarm

Follow these steps to run EST:

1. Verify that the bacteria filters and oxygen sensor are connected to the ventilator.
2. Connect the patient circuit to the ventilator.
3. Touch **EST** on the diagnostic screen (Figure 5-5).
4. Touch **Start EST** to begin the test. Follow the onscreen prompts and touch **OK** to go to the next step.

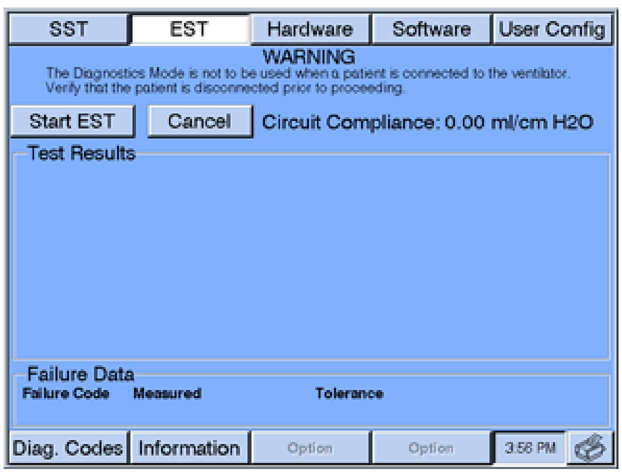


Figure 5-5: Starting EST

5. Unblock wye and touch **OK**, then block the wye with the cork and touch **OK**. Unblock wye at the prompt and touch **OK**.

6. If prompted, connect oxygen to the ventilator and touch **OK**. (This prompt does not appear if oxygen is already connected.) Disconnect oxygen and touch **OK**, then reconnect oxygen when prompted and touch **OK**.
7. Disconnect the patient circuit from the heated exhalation filter and touch **OK**, then reconnect and touch **OK**.

   NOTE: For neonatal circuits, touch **OK** to proceed through this step without disconnecting the circuit.
8. At these messages, touch **YES** or **NO** to answer each question:

   Is the primary audio alarm active?

   Is the backup audio alarm active?

   Is the remote alarm connected?

   Is the remote alarm active?
9. At the prompts, touch **YES** or **NO** to indicate whether each front panel LED lights.
10. Press the front panel keys as prompted.
11. When EST is completed successfully, touch **OK**. The EST screen shows the results of each test. Diagnostic code *3000* appears in the diagnostic log each time EST is successfully completed.

If any EST tests fail, the screen displays failure data, including diagnostic code, measured value, and passing values.

- Touch **RETEST** to repeat the test.
- Touch **CONTINUE** to skip the failed test.
- Touch **CANCEL** to exit EST.

5.5 Software Screen

To view the software screen, touch **Software** on the diagnostic screen (Figure 5-6). The software screen displays:

- Ventilator serial number
- 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
- Air, oxygen, and exhalation flow sensor part numbers
- Options installed, if any.

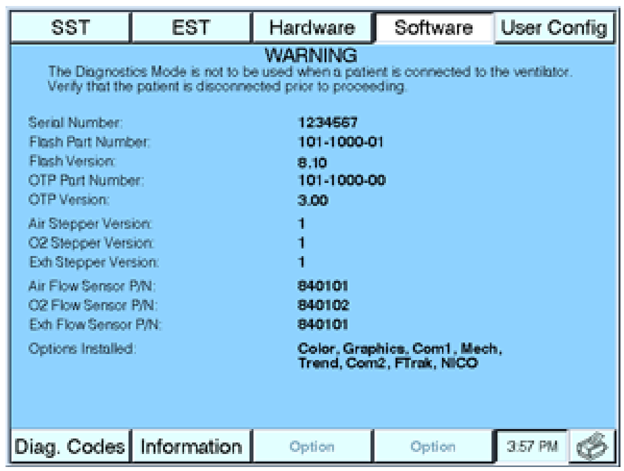


Figure 5-6: Diagnostic Mode Software Screen

5.6 Diagnostic Codes

The Esprit and V200 ventilators generate diagnostic codes when the microprocessor detects a fault during normal operation, or if a failure occurs during SST or EST. Chapter 6 lists diagnostic codes and recommended repair procedures for each code.

To view the diagnostic code screen, touch **Diag. Codes** on the diagnostic screen (Figure 5-7).

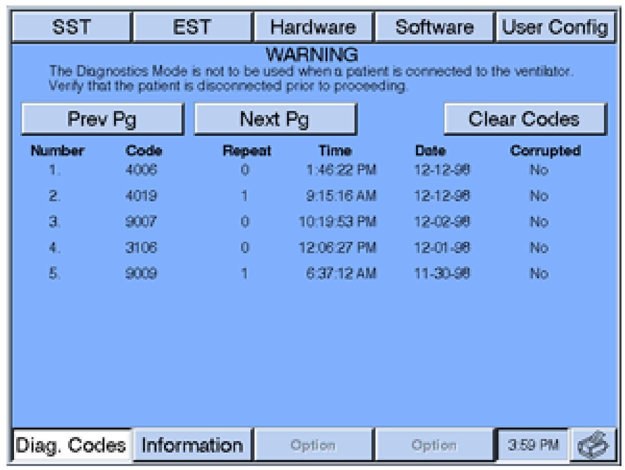


Figure 5-7: Diagnostic Code Screen

The diagnostic code screen displays the following information:

1. *Number*: Diagnostic codes are numbered in reverse order of occurrence, with the most recent code first.
2. *Code*: The number assigned to a specific failure, which can help determine the cause of a failure. The first digit of the four-digit diagnostic codes indicates the type of fault:

   1xxx: Failure during power on self test (POST).

   2xxx: Failure during short self test (SST).

   3xxx: Failure during extended self test (EST).

   4xxx: Continuous built-in test failure (during normal ventilation).

   5xxx: Safety valve open/Backup battery not connected.

   6xxx: Not used.

   7xxx: Power supply failure.

   8xxx: Software diagnostic information.

   9xxx: Sensor/internal communication fault.
3. *Repeat*: If the same code occurs consecutively, the repeat column is incremented (rather than displaying the code again). For example, if code 1002 occurs three consecutive times, it is logged as code *1002* with *2* in the repeat column. The repeat column increments (up to a maximum of 255) until a different code occurs.

4. *Time*: Diagnostic codes are time-stamped in hour/minute/second format (for example, 09:15:23). The time is that of the most recent occurrence of the code.
5. *Date*: Diagnostic codes are date-stamped in a month/day/year format (for example, 09/12/01) to indicate the most recent occurrence of the code.
6. *Corrupted*: The microprocessor regularly cross checks the data in memory. If it determines that the diagnostic code in memory has been corrupted, a *Yes* entry indicates that its validity is suspect.
7. ***Next Pg** and **Prev Pg** buttons*: The ventilator can log up to 20 error codes but can only display 10 on a screen. Touch the **Next Pg** button to view the next group of codes, or **Prev Pg** to view the previous group.
8. ***Clear Codes** button*: Allows you to delete diagnostic codes.

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

   To delete diagnostic codes, touch **Clear Codes** and at the following prompt:

   Are you sure you want to clear the codes?

   Touch **YES** to clear the codes or **NO** to retain the codes.

5.7 Hardware Diagnostics

The hardware screen (Figure 5-7) verifies components in case of a failure during SST, EST, or performance verification. Use the hardware screen to:

- Set specific air and oxygen valve flow rates and step positions.
- Incrementally open and close the exhalation valve.
- Set various analog and digital voltages.
- Control power to the blower, filter heater, and 24-V components.
- Exercise the solenoids.
- View hardware status.

NOTE: On the hardware screen, a white background indicates that the button is enabled or energized, and a gray background indicates that a button is disabled or de-energized.

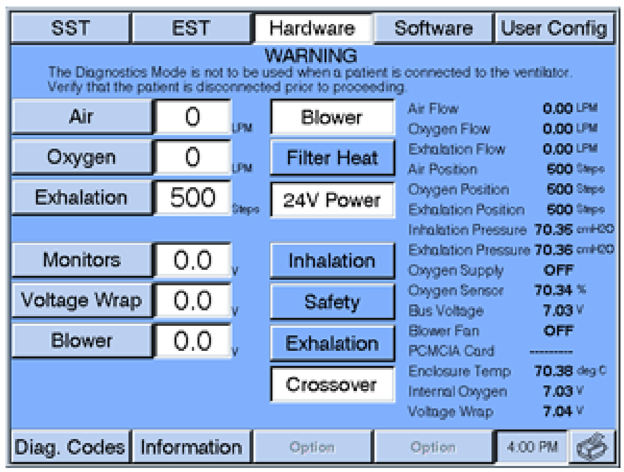


Figure 5-8: Diagnostic Mode Hardware Screen

Table 5-1 summarizes the hardware screen functions.

Table 5-1: Hardware Screen Functions

Button/Display	Function
Air button	Sets air flow from 0 to 200 LPM or step position from 0 to 2000 steps.
Oxygen button	Sets oxygen flow from 0 to 200 LPM or step position from 0 to 2000 steps.
Exhalation button	Opens or closes the exhalation valve from 0 (fully open) to 2000 (fully closed) steps. (Although the exhalation stepper motor can be commanded to 2000 steps, a maximum of 1800 steps is displayed.)
Monitors button	Simulates voltages for pressure, volume, and flow analog output voltages. The selected voltage (from 0 to 5 V) is sent to the analog output port (the DB15 connector on the ventilator back panel).
Voltage Wrap button	Adjusts blower DAC voltage from 0 to 5 V, and compares it to the ADC output voltage shown in the Voltage Wrap status display.
Blower button	Adjusts blower voltage from 0 to 5 V.
Blower on/off button	Turns the blower on and off.

Table 5-1: Hardware Screen Functions (Continued)

Button/Display	Function
Filter Heat on/off button	Turns the filter heater on and off.
24V Power on/off button	Turns all pneumatic components on and off simultaneously without disturbing the display.
Inhalation button	Toggles SOL4 between circuit pressure and atmospheric pressure.
Safety button	Opens and closes SOL2, which controls the source pressure that opens or closes the safety valve.
Exhalation button	Toggles SOL3 between circuit pressure and atmospheric pressure.
Crossover button	Toggles SOL1, which determines which gas provides source pressure to SOL2. SOL1 uses air to provide source pressure to SOL2 when energized, and uses oxygen when de-energized.
Air Flow status display	Displays the measured flow passing through the air flow sensor.
Oxygen Flow status display	Displays the measured flow passing through the oxygen flow sensor.
Exhalation Flow status display	Displays the measured flow passing through the exhalation flow sensor.
Air Position status display	Displays the step position of the air valve stepper motor for a specified flow rate or air valve step position.
Oxygen Position status display	Displays the step position of the oxygen valve stepper motor for a specified flow rate or oxygen valve step position.
Exhalation Position status display	Displays the step position of the exhalation valve.
Inhalation Pressure status display	Displays the pressure measured by the inhalation pressure sensor.
Exhalation Pressure status display	Displays the pressure measured by the exhalation pressure sensor.
Oxygen Supply status display	Displays whether the oxygen inlet pressure switch detects an external oxygen source is connected.
Oxygen Sensor status display	Displays the oxygen concentration measured by the external oxygen sensor.
Bus Voltage status display	Displays the measured voltage of the +29 V output (if AC is connected) or the +24 V output from the backup or external battery.
Blower Fan status display	Displays the status of the thermal switch attached to the blower housing, and is ON during normal operation. A switch status of OFF indicates a switch is malfunction or that the cooling fan is malfunctioning and temperature has risen to 125 °C.
PCMCIA Card status display	Displays dashes when a PCMCIA card is not installed. If a PCMCIA card is installed, displays *SDP*.
Enclosure Temp status display	Displays the temperature inside the ventilator enclosure measured by the temperature sensor on the sensor PCB. Typical temperature range is approximately 35 to 50 °C.
Internal Oxygen status display	Displays the oxygen concentration within the enclosure in volts as measured by the oxygen sensor located on the sensor PCB. Acceptable voltage is between 0.52 to 0.62 V.
Voltage Wrap status display	Displays the ADC input voltage for comparison to the voltage wrap DAC output voltage.

5.8 Pneumatic Component Troubleshooting

This section tells you how to perform component troubleshooting in case of a failure during SST, EST, or performance verification. Perform these tests as needed, rather than in consecutive order.

WARNING: Troubleshooting suspends normal ventilation, and should never be performed while a patient is connected to the ventilator.

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

NOTE: These troubleshooting procedures assume that all hardware begins in an initialized state (all adjustable parameters set to zero), including Blower voltage set to 4 V (blower voltage may vary depending on the altitude setting), Blower on, Filter Heat off, 24V Power on, Crossover solenoid energized (white background), and all other solenoids de-energized (gray background).

NOTE: At the end of each test, return the hardware screen to its initialized state.

NOTE: The pneumatic calibration analyzer should always be in BTPS when measuring volume, and in ATP when measuring flow.

NOTE: Use a known-good reusable patient tubing circuit and reliable exhalation bacteria filter.

Perform all troubleshooting from the hardware screen in diagnostic mode. Follow these steps to view the hardware screen:

1. Simultaneously press the **Alarm Reset** and **100% O_2** keys on the ventilator front for five seconds while turning ventilator power on.
2. When prompted, touch **OK** to enter diagnostics mode.
3. Perform EST and log the diagnostic codes, or create a ventilator diagnostic report (DRPT) (Chapter 7).
4. Touch the **Hardware** button to view the hardware screen.

5.8.1 Oxygen Valve

1. Connect the oxygen source to the ventilator.
2. Disconnect the bacteria filter, patient circuit tube, and oxygen sensor tee from the ventilator inspiratory outlet.
3. Touch **User Config** and note the altitude.
4. Touch **Hardware**.
5. Touch **Safety** to energize (white background) the safety solenoid.

   NOTE: The sensor readings on an actual Hardware screen vary from those shown in Figure 5-9.

6. Touch **Oxygen** and set the flow to 1 LPM.
7. Check that the *Oxygen Position* display is between 185 and 525 steps.
8. Touch **Oxygen** and set the flow to 180 LPM. Verify that the *O2 Position* display corresponds to the set altitude:

Ventilator Altitude Setting	*Oxygen Position* Display
0 - 2000 ft.	1175 - 1575 steps
2001 - 4000 ft.	1145 - 1540 steps
4001 - 6000 ft.	1120 - 1505 steps
6001 - 8000 ft.	1090 - 1470 steps
8001 - 10,000 ft.	1060 - 1435 steps

   Verify that the oxygen source is disconnected from the ventilator, and verify that *Oxygen Supply* reads *OFF*.

9. Return the hardware screen to its initialized state.

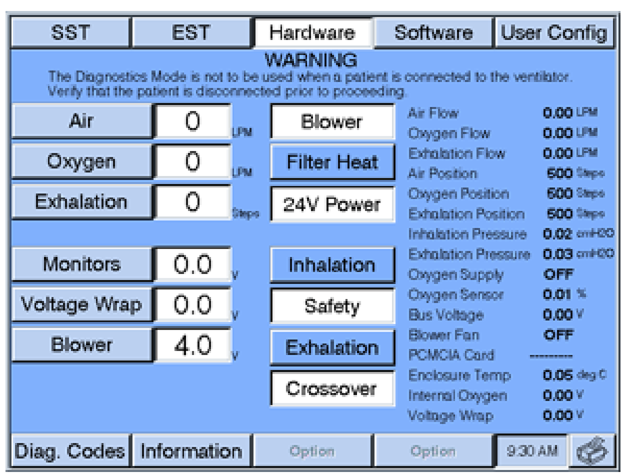


Figure 5-9: Diagnostic Mode - Hardware Screen (Safety Solenoid Energized)

5.8.2 Oxygen Flow Sensor

1. Connect the oxygen source to the ventilator.
2. Connect a tube from the ventilator main outlet to the high flow port of a calibrated analyzer (Figure 5-10).

Figure 5-10: Flow Sensor Troubleshooting Setup

3. Set the analyzer to read *LPM*.
4. Set the analyzer's gas flow to oxygen.
5. Touch **Safety** to energize (white background) the safety solenoid.
6. Check that set oxygen flow corresponds to measured flow:

Touch *Oxygen* and Set the Flow to:	Check that *Analyzer* and *Oxygen Flow* Displays Read:
5 LPM	4.5 to 5.5 LPM
10 LPM	9 to 11 LPM
20 LPM	18 to 22 LPM
50 LPM	45 to 55 LPM
100 LPM	90 to 110 LPM
120 LPM	108 to 132 LPM
165 LPM	148.5 to 181.5 LPM
0 LPM	0 ± 0.1 LPM

7. Disconnect the oxygen source from the ventilator.
8. Return the hardware screen to its initialized state.

5.8.3 Oxygen Regulator

1. Disconnect the bacteria filter, patient circuit tube, and oxygen sensor tee from the ventilator inspiratory outlet.
2. Connect the oxygen source to the ventilator.
3. Use a pressure gauge capable of measuring 100 PSI, and set the pressure range to 100 PSI. Zero the gauge.
4. Connect the gauge to the oxygen valve pressure port (Figure 5-11).

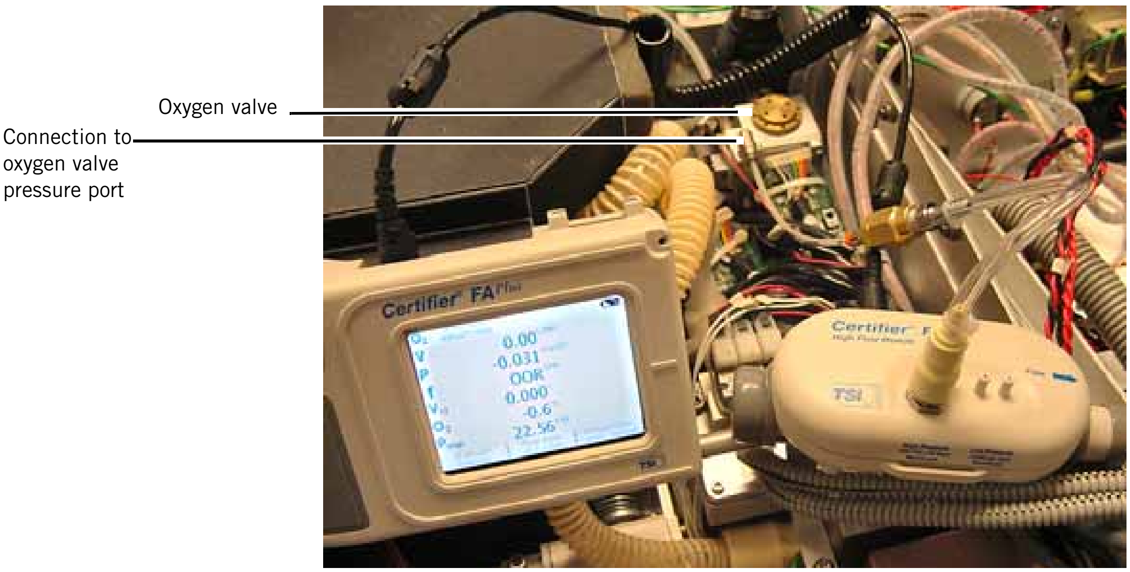


Figure 5-11: Oxygen High Pressure Connection

5. Touch **Blower** and **Crossover** to de-energize (gray backgrounds) the blower and crossover solenoid.
6. Touch **Oxygen** and set the flow to 180 LPM.
7. Check that the gauge 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 so the gauge reads 23 ± 1 PSI, then tighten the locking nut.
   c. Touch **Oxygen** and set the flow to 0 LPM and then back to 180 LPM.
   d. Check that the gauge still reads 23 ± 1 PSI. Repeat steps *a* to *d* if necessary.
8. Disconnect the oxygen source from the ventilator.
9. Return the hardware screen to its initialized state.
10. Remove the gauge and reconnect tubing to the safety valve solenoid tubing connection.

5.8.4 Air Valve

1. Disconnect the bacteria filter, patient circuit tube, and oxygen sensor tee from the ventilator inspiratory outlet.
2. Touch **User Config** and note the altitude.
3. Touch **Hardware**.
4. Touch **Safety** to energize (white background) the safety solenoid.
5. Touch **Air** and set the flow to 1 LPM.
6. Check that the *Air Position* display is between 215 and 525 steps.
7. Touch **Air** and set the flow to 180 LPM.
8. Check that the *Air Position* display corresponds to the set altitude:

Ventilator Altitude Setting	*Air Position* Display
0 - 2000 ft.	930 - 1215 steps
2001 - 4000 ft.	910 - 1190 steps
4001 - 6000 ft.	890 - 1165 steps
6001 - 8000 ft.	875 - 1145 steps
8001 - 10,000 ft.	855 - 1125 steps

9. Return the hardware screen to its initialized state.

5.8.5 Air Flow Sensor

1. Connect a tube from the ventilator main outlet to the high flow port of a calibrated analyzer (Figure 5-14).
2. Set the analyzer to read LPM.
3. Set the analyzer's gas flow to air.
4. Touch **Safety** to energize (white background) the safety solenoid.
5. Check that set air flow corresponds to measured flow:

Touch *Air* and Set the Flow to:	Check that *Analyzer, Air Flow* and *Exhalation Flow* Displays Read:
5 LPM	4.5 to 5.5 LPM
10 LPM	9 to 11 LPM
20 LPM	18 to 22 LPM
50 LPM	45 to 55 LPM
100 LPM	90 to 110 LPM
120 LPM	108 to 132 LPM
165 LPM	148.5 to 181.5 LPM
0 LPM	0 ± 0.1 LPM

6. Return the hardware screen to its initialized state.

5.8.6 Inhalation and Exhalation Solenoids

NOTE: If pressure displays do not drop to 0 ± 0.1 cmH_2O, cycle power to the ventilator to enter normal ventilation mode. After the ventilator completes POST, cycle power to the ventilator to enter diagnostic mode and re-run the test.

1. Connect the patient circuit to the ventilator and block the wye.
2. Touch **Safety** to energize (white background) the safety solenoid.
3. Touch **Exhalation** and set it to 2000 steps.
4. Touch **Air** and set the flow to 1 LPM.
5. Check that the *Inhalation Pressure* and *Exhalation Pressure* displays on the hardware screen are greater than 30 cmH_2O.
6. Touch **Inhalation** to energize (white background) the inhalation solenoid.
7. Check that the *Inhalation Pressure* display reads 0 ± 0.1 cmH_2O.
8. Touch **Exhalation** to energize (white background) the exhalation solenoid.
9. Check that the *Exhalation Pressure* display reads 0 ± 0.1 cmH_2O.
10. Return the hardware screen to its initialized state.

5.8.7 Safety Valve and Safety Solenoid

NOTE: If pressure displays do not drop to 0 ± 0.1 cmH_2O, cycle power to the ventilator to enter normal ventilation mode. After the ventilator completes POST, cycle power to the ventilator to enter diagnostic mode and re-run the test.

1. Connect the patient circuit to the ventilator and block the wye.
2. Touch **Exhalation** and set it to 2000 steps.
3. Touch **Air** and set the flow to 1 LPM.
4. Check that the *Inhalation Pressure* display reads 0 ± 0.1 cmH_2O.
5. Touch **Safety** to energize (white background) the safety solenoid.
6. Check that the *Inhalation Pressure* display is greater than 30 cmH_2O.
7. Return the hardware screen to its initialized state.

5.8.8 Pressure Relief Valve

1. Set the analyzer to read cmH_2O.
2. Connect the analyzer's positive low pressure port to the patient circuit (Figure 5-12).

Figure 5-12: Pressure Relief Valve Troubleshooting Setup

3. Touch **Safety** to energize (white background) the safety solenoid.
4. Touch **Exhalation** and set it to 2000 steps.
5. Touch **Air** and set the flow to 1 LPM.
6. Check that the analyzer reads 130-140 cmH_2O. If not, adjust the relief pressure (Figure 5-13):
    a. Turn the pressure relief valve hex cap clockwise to decrease or counterclockwise to increase, so that analyzer reads 130-140 cmH_2O.
    b. Touch **Safety** to relieve system pressure, then Touch **Safety** to re-pressurize.
    c. Check that the analyzer reads 130-140 cmH_2O. Repeat steps *a* to *c* if necessary.

7. Return the hardware screen to its initialized state.

Figure 5-13: Pressure Relief Valve Hex Cap

5.8.9 Crossover Solenoid

1. Disconnect the oxygen source from ventilator.
2. Touch **Oxygen** and set the flow to 100 LPM, then back to 0 LPM to relieve any trapped oxygen pressure.
3. Connect patient circuit to ventilator and block wye with a cork.
4. Touch **Safety** to energize (white background) the safety solenoid.
5. Touch **Exhalation** and set it to 2000 steps.
6. Touch **Air** and set the flow to 1 LPM.
7. Check that the *Inhalation Pressure* display on the hardware screen reads greater than 30 cmH_2O.
8. Remove cork from the wye.
9. Touch **Crossover** to de-energize (gray background) the crossover solenoid, then block the wye.
10. Check that the *Inhalation Pressure* display reads 0 ± 0.1 cmH_2O.
11. Return the hardware screen to its initialized state.

5.8.10 Exhalation Flow Sensor

1. Connect the patient tubing from the ventilator to the high flow port of a calibrated analyzer (Figure 5-14).

Figure 5-14: Exhalation Flow Sensor Troubleshooting Setup

2. Set analyzer to read LPM.
3. Set analyzer's gas flow to air.
4. Touch **Safety** to energize (white background) the safety solenoid.
5. Check that the set air flow corresponds to measured flow:

Touch *Air* and Set the Flow to:	Check that *Analyzer, Air Flow* and *Exhalation Flow* Displays Read:
5 LPM	4.5 to 5.5 LPM
20 LPM	18 to 22 LPM
50 LPM	45 to 55 LPM
100 LPM	90 to 110 LPM
120 LPM	108 to 132 LPM
165 LPM	148.5 to 181.5 LPM
0 LPM	0 ± 0.1 LPM

6. Return the hardware screen to its initial state.

5.8.11 Check Valve 2

1. Connect the oxygen source to the ventilator.
2. Connect patient circuit to the ventilator, then block the wye.
3. Touch **Safety** to energize (white background) the safety solenoid.
4. Touch **Crossover** to de-energize (gray background) the crossover solenoid.
5. Touch **Blower** to de-energize (gray background) the blower.
6. Touch **Exhalation** and set it to 2000 steps.
7. Touch **Oxygen** and set flow to 1 LPM.
8. Touch **Air** and set flow to 200 LPM.
9. Check that *Inhalation Pressure* display on the hardware screen reads greater than 30 cmH_2O.
10. Check that the *Air Flow* display on the hardware screen reads 0 ± 0.1 LPM.
11. Return the hardware screen to its initialized state.

5.8.12 Check Valve 3

1. Disconnect the oxygen source to the ventilator.
2. Connect the patient circuit to the ventilator, then block the wye.
3. Touch **Safety** to energize (white background) the safety solenoid.
4. Touch **Exhalation** and set it to 2000 steps.
5. Touch **Air** and set flow to 1 LPM.
6. Check that *Inhalation Pressure* display on the hardware screen reads greater than 30 cmH_2O.
7. Touch **Air** and set flow to 0 LPM.
8. Touch **Oxygen** and set flow to 200 LPM.
9. Check that the *Oxygen Flow* display on the hardware screen reads 0 ± 0.1 LPM.
10. Return the hardware screen to its initialized state.

5.8.13 Check Valve 4

WARNING: To prevent contamination, use two clean filters to perform this test.

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

1. Install a new, clean exhalation bacteria filter to the exhalation port of the ventilator.
2. Connect an adult patient tube between the just-installed exhalation filter end and a second bacteria filter.

   NOTE: Install filters so that their flow arrows point away from the ventilator.
3. *Gently* inhale from the bacteria filter.
4. Check that the *Exhalation Flow* display on the hardware screen reads 0 ± 0.1 LPM.
5. Return the hardware screen to its initialized state.

5.8.14 Filter Heater

WARNING: If the ventilator has been operating, the filter heater sleeve may be hot.

1. Touch **Filter Heat** on the hardware screen to turn the filter heater on (white background). Skip this step if the ventilator has been operating in ventilation mode.
2. Wait 15 minutes. Skip this step if the ventilator has been operating in ventilation mode.
3. Remove the exhalation filter and verify that it is very warm to the touch.
4. Reinstall the filter and heater.
5. Return the hardware screen to its initialized state.

5.8.15 Blower

1. Connect a tube from the ventilator main outlet to the high flow port of pneumatic calibration analyzer (Figure 5-15).
2. Set the analyzer's peak/continuous function to *continuous*.
3. Set analyzer's gas flow to measure 180 LPM air. Zero the analyzer.
4. Touch **Safety** to energize (white background) the safety solenoid.
5. Touch **Air** and set the flow to 165 LPM.
6. Check that the analyzer reads 148.5 to 181.5 LPM.
7. Touch **Blower** to turn off the blower (gray background).
8. Check that the blower stops and the analyzer reads 0 ± 0.1 LPM.
9. Return the hardware screen to its initialized state.

Figure 5-15: Blower Troubleshooting Setup

5.8.16 Inhalation/ Exhalation Pressure Transducers and Exhalation Valve

1. Connect patient circuit with tee to the ventilator.
2. Connect the analyzer's positive low pressure port to the patient circuit (Figure 5-16).

Figure 5-16: Inhalation and Exhalation Pressure Transducer Troubleshooting Setup

3. Set the analyzer to read cmH_2O.
4. Touch **Safety** to energize (white background) the safety solenoid.
5. Touch **Exhalation** and set it to 1470 steps.
6. Touch **Air** and set the flow to 1 LPM.
7. Touch **Exhalation** and adjust the steps until the analyzer pressure reads 100 ± 5 cmH_2O.
8. Check that the *Inhalation Pressure* and *Exhalation Pressure* displays on the hardware screen read within ± 10% of the analyzer display.
9. Unblock the tee and verify that the inhalation, exhalation, and analyzer pressure displays read 0 ± 0.1 cmH_2O.
10. Return the hardware screen to its initialized state.

5.8.17 Oxygen Pressure Switch

1. Connect a wall or bottled oxygen source to the ventilator. The *Oxygen Supply* display on the hardware screen should read *ON*.
2. Disconnect the oxygen source from the ventilator.
3. Touch **Oxygen** and set the flow to 100 LPM, and then back to 0 LPM to relieve any trapped oxygen pressure.
4. The *Oxygen Supply* display should read *OFF*.
5. Return the hardware screen to its initialized state.

5.8.18 External Oxygen Sensor

Perform the performance verification oxygen accuracy test (Chapter 8).

5.8.19 High Internal Oxygen Alarm Test

Follow these steps if a *High Internal* O_2 alarm occurs:

1. Disconnect oxygen from the ventilator and wait 5 minutes to allow the internal oxygen percentage to stabilize.
2. Power up the ventilator in diagnostic mode and touch the **Hardware** button to view the Hardware screen.
3. Confirm that the Internal Oxygen display on the Hardware screen is between 0.52 to 0.62 V. If the display is outside this range, replace the sensor PCB.

5.8.20 Sensor PCB Voltage Indicators

The sensor PCB includes LEDs (Figure 5-17) that indicate uner- and overvoltage conditions, as summarized in Table 5-2.

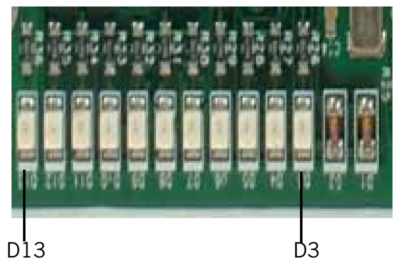


Figure 5-17: Sensor PCB LEDs

Table 5-2: Sensor PCB Voltage LEDs

Sensor PCB LED	Voltage Condition	Recommended Repair
D3	Power supply: -12 V under	Replace power supply.
D4	Power supply: +12 V under	Replace power supply.
D5	Power supply: +24 V under	Replace power supply.
D6	Sensor PCB: +5 V under	Replace sensor PCB.
D7	Sensor PCB: +5 V over	Replace sensor PCB.
D8	MMI PCB: +5 V under	Replace MMI PCB.
D9	MMI PCB: +5 V over	Replace MMI PCB.
D10	Power supply: +10 V under	Replace power supply.
D11	Power supply: +10 V over	Replace power supply.
D12	Main PCB: +5 V over	Replace main PCB.
D13	Main PCB: +5 V under	Replace main PCB.
D49	Power Fail	Replace power supply.

5.9 Bacteria Filter Back Pressure Test

Follow these steps to check the resistance of any bacteria filter:

1. Power up the ventilator in diagnostic mode and touch the **Hardware** button to view the Hardware screen.
2. Use the default settings in the hardware screen *EXCEPT:*
   - Set an air flow rate of 100 LPM
   - Energize the safety solenoid
3. Connect a tube from the inspiratory gas outlet to the heated bacteria filter's inlet. **Important:** Do *not* connect anything to the filter outlet.
4. The displayed *Inhalation Pressure* is the measured back pressure of the bacteria filter. The back pressure for a new filter is typically 2.5 cmH_2O.

   A back pressure over 4 cmH_2O indicates an occluded filter. The filter fails the test if the back pressure is greater than 4 cmH_2O.

Chapter 6. Diagnostic Codes

The ventilator generates diagnostic codes when the microprocessor detects a fault during normal operation, or if a failure occurs during SST or EST.

Table 6-1 lists diagnostic codes, and recommended repair procedures for each code. Perform the repair procedures in the order listed until the problem is resolved.

- See Chapter 5 describes how to use diagnostic mode for troubleshooting.
- See Chapter 8 for performance verification procedures.
- See Chapter 9 for Esprit component replacement procedures.
- See Chapter 10 for Respironics V200 component replacement procedures.
- See Appendix A for EST pneumatic schematics by test number.

NOTE: Because the troubleshooting procedures for two diagnostic codes (1012 and 5000) are more detailed, they are described in section 6.1 and section 6.2.

The first digit of the four-digit diagnostic codes indicates the type of fault:

1xxx: Failure during power on self test (POST).
2xxx: Failure during short self test (SST).
3xxx: Failure during extended self test (EST).
4xxx: Continuous built-in test failure (failures during normal ventilation).
5xxx: Safety valve open/Backup battery not connected.
6xxx: Not used.
7xxx: Power supply failure.
8xxx: Software diagnostic information.
9xxx: Sensor/internal communication fault.

Diagnostic Code	Code Description	Recommended Repair
1	Ventilator normal mode startup. Air/ O_2 valve liftoff positions logged.	Occurs when ventilator is ON: no action required.
3	Diagnostic startup. Air/O_2 liftoff positions logged.	Occurs when diagnostics invoked: no action required.
4	Unknown restart. Indicates uncontrolled shutdown of the system. Possible causes include watchdog/bus activity timeout, main PCB +5VDC failure, or loss of AC power while in diagnostic mode.	1. Verify AC connection at wall and ventilator, check circuit breaker. 2. Replace CPU PCB. 3. Replace sensor PCB. 4. Replace main PCB. 5. Replace power supply.

Diagnostic Code	Code Description	Recommended Repair
5	Depleted backup battery. Battery depleted dialog displayed on the screen.	1. Connect AC power cord and allow battery to charge. 2. Replace backup battery. 3. Replace power supply.
1xxx: Failures During Power On Self Test (POST)		
1001	Bus activity monitor test failure.	1. Replace CPU PCB. 2. Replace main PCB.
1002	Watchdog timer test failure.	1. Replace CPU PCB. 2. Replace main PCB.
1003	Processor test failure.	Replace CPU PCB.
1004	OTP cyclic redundancy check (CRC) failure.	Replace CPU PCB.
1005	Flash CRC failure.	1. Repeat software download. 2. Replace CPU PCB.
1006	Internal RAM test failure.	Replace CPU PCB.
1007	External RAM test failure.	Replace CPU PCB.
1008	Maximum system resets exceeded: ventilator has reset 3 times within 2 hours.	Review the diagnostics log: the code in memory prior to the 1008 occurrence indicates the root cause.
1009	POST inhalation autozero test failure. Possible causes include crimped tube or transducer failure.	1. Check for crimped tube between three-station solenoid and the sensor PCB. 2. Replace sensor PCB. 3. Replace analog PCB.
1010	POST exhalation autozero test failure. Possible causes include crimped tube or transducer failure.	1. Check for crimped tube between the three-station solenoid and the sensor PCB. 2. Replace sensor PCB.
1011	POST OTP flash compatibility test failure.	1. Repeat software download. 2. Replace CPU PCB.
1012	Air valve liftoff failure: measured liftoff < 180 or > 500 steps (default = 280 steps).	See section 6.1.
1013	Oxygen valve liftoff failure: measured liftoff < 150 or > 500 steps (default = 280 steps).	1. Use RS-232 diagnostic report (DRPT) command to obtain detailed information. 2. If step position during liftoff is outside range, replace oxygen valve. 3. Replace oxygen motor controller PCB.

Diagnostic Code	Code Description	Recommended Repair
1014	POST timer/24V failure: system has reset 3 times within the first 30 seconds of operation. Once this code occurs, it recurs at every power up or reset until the ventilator enters diagnostic mode.	Review the diagnostic log: the code in memory before or after the 1014 occurrence indicates the root cause. *If this code is not 4, 7xxx, or 8001:* 1. Replace power supply. 2. Replace main PCB. 3. Replace CPU PCB. 4. Replace BMC PCB
2xxx: Failures During Short Self Test (SST)		
2000	SST passed.	No action required.
2100	Cancelled by user.	No action required.
2106	Patient circuit leak. Patient circuit test (test 11): this code indicates that the ventilator could not pressurize the tubing circuit to 50 cmH_2O with a 5 LPM air flow and the safety and exhalation valves closed.	1. Remove inspiratory bacteria filter and external oxygen sensor and try another patient circuit. 2. Block outlet of exhalation flow sensor while running leak test. If leak stops, replace exhalation valve. 3. Verify that connection between the oxygen flow sensor and oxygen valve is tight.
2107	Low inhalation pressure. Patient circuit test (test 11): this code indicates that circuit pressure dropped from 50 cmH_2O to <45 cmH_2O after exactly 100 ms.	1. Check for patient circuit leaks. 2. Verify that O-ring is present in external oxygen sensor or bypass oxygen sensor. 3. Check inhalation pressure transducer. 4. Check the connection between the inspiratory manifold and inspiratory autozero solenoid. 5. Check for kinks or cuts in the tube between inhalation autozero solenoid and inhalation pressure sensor. 6. Replace sensor PCB. 7. Replace three-station solenoid.
2110	Check valve 3 (CV3) leak. Patient circuit test (test 11): the circuit is pressurized to 50 cmH_2O with the exhalation valve closed, then the safety valve opens. After two seconds, circuit pressure should not drop below 35 cmH_2O. This code indicates that circuit pressure was <35 cmH_2O.	1. Check for patient circuit leaks. 2. Verify that O-ring is present in external oxygen sensor or bypass oxygen sensor. 3. Verify that CV3 is undamaged and in 12:00 position. 4. Check CV3. Replace as necessary. 5. Check tubing from inspiratory solenoid to inspiratory manifold.
2125	Inhalation and exhalation pressure transducer disagreement. Patient circuit test (test 11): the difference between the inhalation and exhalation pressure transducers is >3 cmH_2O.	1. Check patient circuit for leaks. 2. Replace sensor PCB. 3. Replace analog PCB. 4. Replace main PCB.

Diagnostic Code	Code Description	Recommended Repair
2128	Circuit compliance out of range. Patient circuit test (test 11): circuit compliance is calculated by measuring the time required to achieve 50 cmH_2O at 5 LPM. This code indicates that calculated compliance is < 0.50 ml/cmH_2O or >9.0 ml/cmH_2O.	1. Remove inspiratory bacteria filter and external oxygen sensor and try another patient circuit. 2. Replace sensor PCB. 3. Replace analog PCB.
2129	Pressure leak out of range. Patient circuit test (test 11): the patient circuit leak rate (based on calculated compliance value) is determined by measuring the decrease in circuit pressure from 50 cmH_2O after one second. This code indicates that the pressure leak was out of range, based on the calculated compliance value.	1. Remove inspiratory bacteria filter and external oxygen sensor and try another patient circuit. 2. Rerun leak test while blocking exhalation flow sensor outlet. If leak stops, replace exhalation valve. 3. Replace sensor PCB. 4. Replace analog PCB.
2130	Safety valve cannot open. Safety valve test (test 2): the exhalation valve is opened then closed to vent circuit pressure. The safety valve solenoid (SOL2) is then deenergized to open the safety valve, and a 10 LPM air flow starts while monitoring the inspiratory pressure transducer (PT3). This code indicates that PT3 is measuring >5 cmH_2O.	1. Check safety valve and safety valve solenoid. 2. Check for blocked vent tube between the inspiratory manifold and the back of the ventilator. 3. Replace three-station solenoid assembly. 4. Install safety valve kit. 5. Replace inspiratory manifold assembly. 6. Replace main PCB. 7. Replace CPU PCB.
2131	Patient wye not blocked. Block patient wye (test 1): after the prompt to block the wye, the safety valve and exhalation valves close. The ventilator starts a 5 LPM air flow, and the inspiratory pressure transducer (PT3) should measure $\geq$10 cmH_2O. This code indicates that PT3 is measuring <10 cmH_2O.	1. Check that patient wye is blocked and circuit is tightly connected. 2. Ensure that exhalation filter door is securely closed. 3. Replace exhalation filter and rerun test. 4. Replace 3-station solenoid assembly.
2134	Cannot read air flow sensor. This code indicates that system cannot read EEPROM from the air flow sensor (FS1).	1. Enter diagnostic mode, then turn ventilator off and on. 2. Verify air flow sensor cable connections. 3. Replace air flow sensor. 4. Replace CPU PCB. 5. Replace sensor PCB. 6. Replace analog PCB. 7. Replace main PCB.

Diagnostic Code	Code Description	Recommended Repair
2135	Cannot read oxygen flow sensor. This code indicates that system cannot read EEPROM from the oxygen flow sensor (FS2).	1. Enter diagnostic mode, then turn ventilator off and on. 2. Verify oxygen flow sensor cable connections. 3. Replace oxygen flow sensor. 4. Replace CPU PCB. 5. Replace sensor PCB. 6. Replace analog PCB. 7. Replace main PCB.
2136	Cannot read exhalation flow sensor: This code indicates that system cannot read EEPROM from the exhalation flow sensor (FS3)	1. Enter diagnostic mode, then turn ventilator off and on. 2. Verify exhalation flow sensor cable connections. 3. Replace exhalation flow sensor. 4. Replace sensor PCB. 5. Replace CPU PCB. 6. Replace analog PCB. 7. Replace main PCB.
2137	Air flow sensor (FS1) failure. This code indicates that information stored on FS1 cannot be read.	1. Enter diagnostic mode, then turn ventilator off and on. 2. Replace CPU PCB. 3. Replace air flow sensor. 4. Replace sensor PCB. 5. Replace analog PCB. 6. Replace main PCB.
2138	Oxygen flow sensor (FS2) failure. This code indicates that information stored on FS2 cannot be read.	1. Enter diagnostic mode, then turn ventilator off and on. 2. Replace CPU PCB. 3. Replace oxygen flow sensor. 4. Replace sensor PCB. 5. Replace analog PCB. 6. Replace main PCB.
2139	Exhalation flow sensor (FS3) failure. This code indicates that information stored on FS3 cannot be read.	1. Enter diagnostic mode, then turn ventilator off and on. 2. Replace CPU PCB. 3. Replace exhalation flow sensor. 4. Replace sensor PCB. 5. Replace analog PCB. 6. Replace main PCB.
2140	Flow sensors cannot erase table. This code indicates that flow sensor calibration tables stored on the CPU PCB cannot be erased.	Replace CPU PCB.

Diagnostic Code	Code Description	Recommended Repair
2141	Inhalation autozero solenoid cannot open. Block patient wye (test 1): patient circuit pressurized to 50 cmH_2O, then inhalation autozero solenoid commanded to energize (open), and inspiration pressure transducer (PT3) should measure 0 cmH_2O. This code indicates that PT3 measured >3 cmH_2O or <-3 cmH_2O.	1. Check inhalation autozero solenoid. 2. Replace three-station solenoid. 3. Replace sensor PCB. 4. Replace main PCB.
2142	Exhalation autozero solenoid cannot open. Block patient wye (test 1): patient circuit pressurized to 50 cmH_2O, then exhalation autozero solenoid commanded to energize (open), and exhalation pressure transducer (PT2) should measure 0 cmH_2O. This code indicates that PT2 measured >3 cmH_2O or <-3 cmH_2O.	1. Check inhalation autozero solenoid. 2. Replace three-station solenoid. 3. Replace sensor PCB. 4. Replace main PCB.
2152	Patient wye not unblocked. Block patient wye (test 1): with the wye unblocked and the safety and exhalation valves closed, a 25-LPM air flow should create a back pressure <10 cmH_2O as measured by inspiratory pressure transducer (PT3). This code indicates that PT3 measured a back pressure ≥10 cmH_2O.	1. Verify that circuit is not a neonatal circuit. 2. Check that patient wye is unblocked. 3. Try new inspiratory bacteria filter. 4. Check for occlusion in the inspiratory limb of the patient circuit.
2156	Inhalation transducer autozero failure. Block patient wye test (test 1): with no pressure in the circuit, the inspiratory pressure transducer (PT3) and exhalation pressure transducer (PT2) are cross-checked. This code indicates that the PT3 measurement was out of range.	1. Check for crimped tube. 2. Check inhalation solenoid. 3. Replace sensor PCB. 4. Replace three-station solenoid.) 5. Replace main to sensor cable. 6. Replace analog PCB. 7. Replace main PCB.
2157	Exhalation transducer autozero failure. Block patient wye test (test 1): with no pressure in the circuit, the inspiratory pressure transducer (PT3) and exhalation pressure transducer (PT2) are cross-checked. This code indicates that the PT2 measurement was out of range.	1. Check for crimped tube. 2. Check exhalation solenoid. 3. Replace sensor PCB. 4. Replace three-station solenoid assembly. 5. Replace main to sensor cable. 6. Replace analog PCB. 7. Replace main PCB.

Diagnostic Code	Code Description	Recommended Repair
3xxx: Failures During Extended Self Test (EST)		
NOTE:	Test numbers refer to tests within EST and are illustrated in the pneumatic schematics in Appendix A of this manual.	
NOTE:	Because EST requires a functioning blower, always verify that the blower is operating before troubleshooting.	
3000	EST passed.	No action required.
3100	Cancelled by user.	No action required
3103	Air flow out of range. Air delivery test (test 8): flow rates of 0 and 3 LPM (±1 LPM), 5, 10, 20, 23, 50, 100, 150 and 200 LPM (±8 LPM) are set through the air valve as measured at the air flow sensor (FS1). This code indicates that FS1 measured out of range flows.	1. Check air flow sensor accuracy. Replace if necessary. 2. Check air valve. 3. Replace air valve assembly. 4. Replace air motor controller PCB.
3104	Oxygen flow out of range. Oxygen delivery test (test 6): flow rates of 0 and 3 LPM (± LPM), 5, 10, 20, 23, 50, 100 and 150 LPM (±8 LPM) are set through the oxygen flow sensor (FS2). This code indicates that FS2 measured out of range flows.	1. Check oxygen valve. 2. Verify adequate source pressure and flow rates. 3. Try another oxygen source: flowmeters or other restrictions can limit flow even with sufficient pressure. 4. Check oxygen flow sensor. 5. Replace oxygen motor controller PCB.
3105	Exhalation flow outside range. Heated filter back pressure test (test 12): a 100 LPM air flow rate is established in the patient circuit with the exhalation valve open. This code indicates that the exhalation flow sensor (FS3) measurement is <90 LPM or >110 LPM, and the FS3 measurement is displayed.	1. Check circuit integrity. 2. Replace exhalation filter. 3. Check exhalation flow sensor. 4. Check orientation of exhalation check valve CV4.
3106	Patient circuit leak. Patient circuit test (test 11): this code indicates that the ventilator could not pressurize the tubing circuit to 50 cmH_2O with a 5 LPM air flow and the safety and exhalation valves closed.	1. Check for leaks at the connections between the circuit, filters, humidifier, and couplings. 2. Remove inspiratory bacteria filter and external oxygen sensor and try another patient circuit. 3. Verify that connection between oxygen flow sensor and oxygen valve is tight.

Diagnostic Code	Code Description	Recommended Repair
3107	Low inhalation pressure. Patient circuit test (test 11): this code indicates that circuit pressure dropped from 50 cmH_2O to <45 cmH_2O after exactly 100 ms.	1. Check for patient circuit leaks. 2. Verify that O-ring is present in external oxygen sensor of bypass oxygen sensor. 3. Check inhalation pressure transducer. 4. Check the connection between the inspiratory manifold and inspiratory autozero solenoid. 5. Check for kinks or cuts in the tube between inhalation autozero solenoid and inhalation pressure sensor. 6. Replace sensor PCB. 7. Replace three-station solenoid.
3108	Exhalation pressure outside range. Exhalation valve test (test 10): the exhalation valve is set to deliver pressures of 0, 5, 10, and 20 cmH_2O (tolerance ±2 cmH_2O), 30 cmH_2O (tolerance ± 3 cmH_2O), and 35 cmH_2O (tolerance ± 3.5 cmH_2O) as measured at the exhalation pressure transducer (PT2). This code indicates that PT2 measured out of range pressures.	1. Replace exhalation bacteria filter. 2. Check exhalation solenoid for operation and leaks. 3. Check exhalation pressure transducer. 4. Check exhalation valve. 5. Check for kinks or cuts in the tube between exhalation solenoid and exhalation pressure sensor. 6. Replace sensor PCB. 7. Replace three-station solenoid.
3109	Check valve 2 (CV2) leak. Crossover circuit test (test 5): the air valve is opened without the blower running and an oxygen flow of 100 LPM is created. The air flow sensor (FS1) should measure a flow of 0 LPM. This code indicates that FS1 measured >3 LPM.	Check CV2. Replace as necessary.
3110	Check valve 3 (CV3) leak. Patient circuit test (test 11): the circuit is pressurized to 50 cmH_2O with the exhalation valve closed, then the safety valve opens. After two seconds, circuit pressure should not drop below 35 cmH_2O in adult or ped mode, or below 41 cmH_2O in Neo mode. This code indicates that circuit pressure was <35 cmH_2O in adult or ped mode, and <41 cmH_2O in Neo mode.	1. Check for patient circuit/filter leaks. 2. Verify that CV3 is in 12:00 position. 3. Verify that there is an O-ring in the oxygen sensor or bypass. 4. Check CV3. Replace as necessary. 5. Check tubing from SOL4 to inspiratory manifold.

Diagnostic Code	Code Description	Recommended Repair
3111	Oxygen not connected. Oxygen supply test (test 4): the oxygen supply pressure switch (PS1) is open when oxygen is not connected. At the prompt to connect oxygen, PS1 should close when 40-90 PSI is connected. This code indicates that PS1 remains open.	1. Check that oxygen (minimum of 40PSI/276 kPa) is connected to the ventilator. 2. Try another oxygen hose, outlet, quick-connect, or external regulator. 3. Check oxygen pressure switch. 4. Check oxygen regulator assembly.
3112	Oxygen not disconnected. Oxygen supply test (test 4): the oxygen supply pressure switch (PS1) is closed when oxygen is connected. At the prompt to disconnect oxygen, the oxygen valve opens and closes to relieve pressure, and PS1 should be open. This code indicates that PS1 remains closed.	1. Check that oxygen is disconnected. 2. Check oxygen pressure switch. 3. Replace oxygen regulator assembly.
3113	Oxygen sensor analog to digital converter (ADC) sample out of range. Oxygen sensor test (test 7): this code indicates that the ADC measurements are out of range and assumes that the oxygen sensor is not connected.	1. Replace external oxygen sensor. 2. Replace oxygen sensor cable. 3. Replace FIO_2 sensor to sensor PCB cable. 4. Replace sensor PCB. 5. Replace analog PCB.
3115	Primary audio not sounding. Audio test (test 13): ventilator activates primary alarm and prompts for a response that alarm is audible. This code indicates that the primary alarm is not working.	1. Verify correct key press. 2. Replace primary alarm. 3. Replace digital PCB. 4. Replace the primary alarm to MMI PCB cable. 5. Replace MMI PCB. 6. Replace main PCB.
3116	Backup audio not sounding. Audio test (test 13): ventilator activates backup alarm and prompts for a response that alarm is audible. This code indicates that the backup alarm is not working.	1. Verify correct key press. 2. Replace the backup alarm. 3. Replace digital PCB. 4. Replace the primary alarm to MMI PCB cable. 5. Replace MMI PCB. 6. Replace main PCB.
3117	Crossover circuit fault. Crossover circuit test (test 5): crossover solenoid (SO1) is energized to supply air source gas to close safety valve, and an air flow rate of 5 LPM is established with the exhalation valve closed. After three seconds, the inspiratory pressure transducer (PT3) should measure a pressure of 50 cmH_2O or greater. This code indicates that PT3 measured <50 cmH_2O.	1. Check for patient circuit leaks, bypass the oxygen sensor, and replace exhalation bacteria filter. 2. Check crossover solenoid. 3. Replace crossover solenoid assembly. 4. Replace main PCB.

Diagnostic Code	Code Description	Recommended Repair
3118	Blower not turned off. Blower test (test 3): turns blower off and opens air valve. Air flow sensor (FS1) should measure flow less than 50 LPM within 20 seconds. This code indicates that FS1 measured $\geq$50 LPM.	1. Check blower. 2. Replace blower controller PCB. 3. Replace sensor PCB. 4. Replace main PCB.
3119	Blower DAC failure. Blower test (test 3): turns blower controller switch on but sets analog voltage that controls blower speed to 0 V. Blower should remain off, and air flow sensor (FS1) should measure flow less than 50 LPM within two seconds. This code indicates that FS1 measured $\geq$50 LPM.	1. Check blower. 2. Replace blower controller PCB. 3. Replace sensor PCB. 4. Replace analog PCB.
3120	Relief valve cracking pressure too high (>170 cmH$_2$O). Pressure relief valve test (test 9): at an oxygen flow of 1 LPM, the exhalation pressure transducer (PT2) should measure a stable pressure of 120-160 cmH2O within 60 seconds. This code indicates that PT2 measured >170 cmH$_2$O.	1. Check pressure relief valve and adjust if necessary. 2. Replace pressure relief valve. 3. Replace sensor PCB.
3121	Relief valve cracking flow not stable. Pressure relief valve test (test 9): the oxygen flow sensor (FS2) should measure 1 LPM during this test. This code indicates that FS2 measured <0.8 LPM or >1.2 LPM.	1. Check pressure relief valve and adjust if necessary. 2. Replace pressure relief valve. 3. Replace sensor PCB.
3122	Relief valve cracking pressure out of range (<120 cmH$_2$O or >160 cmH$_2$O). Pressure relief valve test (test 9): at an oxygen flow of 1 LPM, the exhalation pressure transducer (PT2) should measure a pressure between 120-160 cmH$_2$O. This code indicates that PT2 measured <120 cmH$_2$O or >160 cmH$_2$O (but <170 cmH$_2$O).	1. Check pressure relief valve and adjust if necessary. 2. Replace pressure relief valve. 3. Replace sensor PCB. 4. Replace analog PCB.
3123	Oxygen cracking flow out of range (<0.7 LPM or >1.3 LPM). Pressure relief valve test (test 9): the oxygen flow sensor (FS2) should measure a flow of 1 LPM. This code indicates that FS2 measured <0.7 LPM or >1.3 LPM.	1. Replace oxygen valve assembly. 2. Replace oxygen flow sensor. 3. Replace sensor PCB.

Diagnostic Code	Code Description	Recommended Repair
3125	Difference between air flow sensor and exhalation flow sensor during air delivery test 8. Patient circuit test (test 11): pressure measured by the inspiratory pressure transducer (PT3) and the exhalation transducer (PT2) are sampled, averaged and compared. This code indicates that measurement difference was >3 cmH_2O.	1. Check air and exhalation flows and replace flow sensor(s) as necessary. 2. Replace sensor PCB. 3. Replace analog PCB. 4. Replace main PCB.
3126	Difference (>20 LPM) between oxygen flow sensor and exhalation flow sensor. Oxygen delivery test (test 6): an oxygen flow rate of 150 LPM is established and compared to the exhalation flow sensor (FS3) reading. This code indicates that FS3 measurement difference was >20 LPM.	1. Check oxygen and exhalation flows and replace flow sensor(s) as necessary. 2. Replace sensor PCB. 3. Replace analog PCB. 4. Replace main PCB.
3127	Heated filter back pressure out of range (<5 cmH_2O or >15 cmH_2O). Heated filter test (test 12): at an air flow reading of 100 LPM through the patient circuit, the system calculates the difference between inspiratory pressure transducer (PT3) measurements before and after disconnecting the exhalation limb from exhalation filter. This code indicates that the difference is <5 cmH_2O or >15 cmH_2O.	1. Replace the exhalation bacteria filter. 2. Check of occlusions in the patient circuit. 3. Check CV4.
3128	Circuit compliance out of range. Patient circuit test (test 11): circuit compliance is calculated by measuring the time required to achieve 50 cmH_2O at 5 LPM. This code indicates that calculated compliance is <0.50 ml/cmH_2O or >9.0 ml/cmH_2O.	1. Remove inspiratory bacteria filter and external oxygen sensor and try another patient circuit. 2. Replace sensor PCB. 3. Replace analog PCB.
3129	Pressure leak out of range. Patient circuit test (test 11): the patient circuit leak rate (based on calculated compliance value) is determined by measuring the decrease in circuit pressure from 50 cmH_2O after one second. This code indicates that the pressure leak was out of range, based on the calculated compliance value.	1. Remove inspiratory bacteria filter and external oxygen sensor and try another patient circuit. 2. Rerun leak test while blocking exhalation flow sensor outlet. If leak stops, replace the exhalation valve. 3. Ensure that exhalation filter door is securely closed. 4. Replace sensor PCB. 5. Replace analog PCB.

Diagnostic Code	Code Description	Recommended Repair
3130	Safety valve cannot open. Safety valve test (test 2): the exhalation valve is opened then closed to vent circuit pressure. The safety valve solenoid (SOL2) is then deenergized to open the safety valve, and a 10 LPM air flow starts while monitoring the inspiratory pressure transducer (PT3). This code indicates that PT3 is measuring $\geq$5 cmH_2O.	1. Check safety valve and safety valve solenoid. 2. Check for blocked vent tube between the inspiratory manifold and the back of the ventilator. 3. Replace three-station solenoid assembly. 4. Install safety valve kit. 5. Replace inspiratory manifold assembly.
3131	Patient wye not blocked. Block patient wye (test 1): after the prompt to block the wye, the safety and exhalation valves close. The ventilator starts a 5 LPM air flow and the inspiratory pressure transducer (PT3) should measure $\geq$10 cmH_2O. This code indicates that PT3 is measuring <10 cmH_2O.	1. Check that patient wye is blocked. 2. Check for patient disconnection in patient circuit. 3. Ensure that exhalation filter door is securely closed. 4. Replace exhalation filter and retest. 5. Replace 3-station solenoid assembly.
3132	Keyboard key not responding. Keyboard test (test 15): the operator is prompted to press each hard key on the keyboard. This code indicates an incorrect key response.	1. Check cable connections between front panel overlay and MMI PCB. 2. Slave in replacement front panel overlay and check for proper operation. 3. Replace MMI PCB. 4. Replace CPU PCB.
3133	Rotary encoder failure. Keyboard test (test 15): the operator is prompted to rotate the knob. This code indicates no knob response.	1. Replace rotary encoder. 2. Replace MMI PCB. 3. Replace digital PCB. 4. Replace main PCB to MMI PCB cable. 5. Replace CPU PCB. 6. Replace main PCB.
3134	Cannot read air flow sensor. This code indicates that system cannot read EEPROM from the air flow sensor (FS1).	1. Enter diagnostic mode, then turn ventilator off and on. 2. Verify air flow sensor cable connections. 3. Replace air flow sensor. 4. Replace CPU PCB. 5. Replace sensor PCB. 6. Replace analog PCB.
3135	Cannot read oxygen flow sensor. This code indicates that system cannot read EEPROM from the oxygen flow sensor (FS2).	1. Enter diagnostic mode, then turn ventilator off and on. 2. Verify oxygen flow sensor cable connections. 3. Replace oxygen flow sensor. 4. Replace CPU PCB. 5. Replace sensor PCB. 6. Replace analog PCB.

Diagnostic Code	Code Description	Recommended Repair
3136	Cannot read exhalation flow sensor. This code indicates that system cannot read EEPROM from the exhalation flow sensor (FS3).	1. Enter diagnostic mode, then turn ventilator off and on. 2. Verify exhalation flow sensor cable connections. 3. Replace exhalation flow sensor. 4. Replace sensor PCB. 5. Replace CPU PCB. 6. Replace analog PCB. 7. Replace main PCB.
3137	Air flow sensor (FS1) failure. This code indicates that information stored on FS1 cannot be read.	1. Enter diagnostic mode, then turn ventilator off and on. 2. Replace CPU PCB. 3. Replace air flow sensor. 4. Replace sensor PCB. 5. Replace analog PCB. 6. Replace main PCB.
3138	Oxygen flow sensor (FS2) failure. This code indicates that information stored on FS2 cannot be read.	1. Enter diagnostic mode, then turn ventilator off and on. 2. Replace CPU PCB. 3. Replace oxygen flow sensor. 4. Replace sensor PCB. 5. Replace analog PCB. 6. Replace main PCB.
3139	Exhalation flow sensor (FS3) failure. This code indicates that information stored on FS3 cannot be read.	1. Enter diagnostic mode, then turn ventilator off and on. 2. Replace CPU PCB. 3. Replace exhalation flow sensor. 4. Replace sensor PCB. 5. Replace analog PCB. 6. Replace main PCB.
3140	Flow sensors cannot erase table. This code indicates that flow sensor calibration tables stored on the CPU PCB cannot be erased.	Replace CPU PCB.
3141	Inhalation autozero solenoid cannot open. Block patient wye (test 1): patient circuit pressurized to 50 cmH_2O, then inhalation autozero solenoid commanded to energize (open), and inspiration pressure transducer (PT3) should measure 0 cmH_2O. This code indicates that PT3 measured outside the range from -3 to 3 cmH_2O.	1. Check inhalation solenoid. 2. Replace three-station solenoid assembly. 3. Replace sensor PCB. 4. Replace analog PCB.

Diagnostic Code	Code Description	Recommended Repair
3142	Exhalation autozero solenoid cannot open. Block patient wye (test 1): patient circuit pressurized to 50 cmH_2O, then exhalation autozero solenoid commanded to energize (open), and exhalation pressure transducer (PT2) should measure 0 cmH_2O. This code indicates that PT2 measured outside the range from -3 to 3 cmH_2O.	1. Check inhalation solenoid. 2. Replace three-station solenoid assembly. 3. Replace sensor PCB. 4. Replace analog PCB.
3143	Air stepper motor open position out of range. Air delivery test (test 8): air valve stepper commanded to open position (2000 ± 5 steps). This code indicates that measured position was outside the range of 1995 to 2005 steps.	1. Replace air motor controller PCB. 2. Replace air valve assembly. 3. Replace main to motors cable. 4. Replace CPU PCB. 5. Replace main PCB. 6. Replace analog PCB.
3144	Air stepper motor midpoint position out of range. Air delivery test (test 8): air valve stepper commanded to midpoint position (1000 ± 5 steps). This code indicates that measured position was outside the range of 995 to 1005 steps.	1. Replace air motor controller PCB. 2. Replace air valve assembly. 3. Replace main to motors cable. 4. Replace CPU PCB. 5. Replace analog PCB.
3145	Air stepper motor closed position out of range. Air delivery test (test 8): air valve stepper commanded to closed position (last measured liftoff position ± 5 steps). This code indicates that the measured position was more than 5 steps above or below the liftoff position.	1. Replace air motor controller PCB. 2. Replace air valve assembly. 3. Replace main to motors cable. 4. Replace CPU PCB. 5. Replace analog PCB.
3146	Oxygen stepper motor open position out of range. Oxygen delivery test (test 6): oxygen valve stepper commanded to open position (2000 ± 5 steps). This code indicates that measured position was outside the range of 1995 to 2005 steps.	1. Replace oxygen motor controller PCB. 2. Replace oxygen valve assembly. 3. Replace main to motors cable. 4. Replace CPU PCB. 5. Replace main PCB.

Diagnostic Code	Code Description	Recommended Repair
3147	Oxygen stepper midpoint position out of range. Oxygen delivery test (test 6): oxygen valve stepper commanded to midpoint position (1000 ± 5 steps). This code indicates that measured position was outside the range of 995 to 1005 steps.	1. Replace oxygen motor controller PCB. 2. Replace oxygen valve assembly. 3. Replace main to motors cable. 4. Replace CPU PCB. 5. Replace main PCB.
3148	Oxygen stepper motor closed position out of range. Oxygen delivery test (test 6): oxygen valve stepper commanded to closed position (last measured liftoff position ± 5 steps). This code indicates that the measured position was more than 5 steps above or below the liftoff position.	1. Replace oxygen motor controller PCB. 2. Replace oxygen valve assembly. 3. Replace main to motors cable. 4. Replace CPU PCB. 5. Replace main PCB.
3149	Exhalation stepper motor open position out of range. Exhalation valve test (test 10): exhalation valve stepper commanded to open position (0 ± 5 steps). This code indicates that measured position was outside the range of 1795 to 1805 steps.	1. Replace exhalation motor controller PCB. 2. Replace exhalation valve assembly. 3. Replace main to motors cable. 4. Replace CPU PCB. 5. Replace main PCB.
3150	Exhalation stepper motor midpoint position out of range. Exhalation valve test (test 10): exhalation valve stepper commanded to midpoint position (1000 ± 5 steps). This code indicates that measured position was outside the range of 995 to 1005 steps.	1. Replace exhalation motor controller PCB. 2. Replace exhalation valve assembly. 3. Replace main to motors cable. 4. Replace CPU PCB. 5. Replace main PCB.
3151	Exhalation stepper motor closed position out of range. Exhalation valve test (test 10): exhalation valve stepper commanded to closed position (2,000 ± 5 steps). This code indicates that the measured position was more than 5 steps above or below the closed position.	1. Replace exhalation motor controller PCB. 2. Replace exhalation valve assembly. 3. Replace main to motors cable. 4. Replace CPU PCB. 5. Replace main PCB.

Diagnostic Code	Code Description	Recommended Repair
3152	Patient wye not unblocked. Block patient wye (test 1): with the wye unblocked and the safety and exhalation valves closed, a 25-LPM air flow should create a back pressure <10 cmH_2O as measured by inspiratory pressure transducer (PT3). This code indicates that PT3 measured a back pressure ≥10 cmH_2O.	1. Verify that circuit is not a neonatal circuit. 2. Check that patient wye is unblocked. 3. Try new inspiratory bacteria filter. 4. Check for occlusion in the inspiratory limb of the patient circuit.
3153	Touch screen failure. Keyboard test (test 15): checks touch screen to verify that all emitters, detectors, and the touch screen controller on the MMI PCB are working properly.	1. Clean screen and touch frame assembly. 2. Verify cable connections. 3. Replace IR touch frame or GUI assembly. 4. Replace MMI PCB. 5. Replace digital PCB. 6. Replace main PCB.
3154	LED indicator failure. LED test (test 14): prompts the operator to confirm that each LED on the front panel lights as described (constant or flashing). This code indicates that correct LED response was not received.	1. Verify correct key press. 2. Check ribbon cable connections. 3. Replace front panel overlay. 4. Replace digital PCB. 5. Replace MMI PCB. 6. Replace main PCB.
3155	Remote alarm not sounding. Audio test (test 13): if operator responds that a remote alarm is connected to the ¼ inch phone jack on ventilator back panel, this test activates the nurse call relay. Operator is prompted to confirm remote. This code indicates that confirmation of remote alarm function was not received.	1. Verify correct key press. 2. Check nurse call. 3. Replace CPU PCB. 4. Replace main PCB.
3156	Inhalation transducer autozero failure. Block patient wye test (test 1): with no pressure in the circuit, the inspiratory pressure transducer (PT3) and exhalation pressure transducer (PT2) are cross-checked. This code indicates that the PT3 measurement was out of range.	1. Check for crimped tube. 2. Check inhalation solenoid. 3. Replace sensor PCB. 4. Replace three-station solenoid assembly. 5. Replace main to sensor cable. 6. Replace analog PCB. 7. Replace main PCB.

Diagnostic Code	Code Description	Recommended Repair
3157	Exhalation transducer autozero failure. Block patient wye test (test 1): with no pressure in the circuit, the inspiratory pressure transducer (PT3) and exhalation pressure transducer (PT2) are cross-checked. This code indicates that the PT2 measurement was out of range.	1. Check for crimped tube. 2. Check exhalation solenoid. 3. Replace sensor PCB. 4. Replace three-station solenoid assembly. 5. Replace main to sensor cable. 6. Replace analog PCB. 7. Replace main PCB.
3158	Exhalation Valve Test failure. (Neonatal Option only) This code indicates that the initial pressure is outside of range during exhalation valve test.	1. Check exhalation solenoid for operation and leaks. 2. Check exhalation pressure transducer. 3. Check exhalation valve. 4. Check for kinks in the tube between exhalation solenoid and exhalation pressure sensor. 5. Replace sensor PCB.
3159	Exhalation Valve Test failure. (Neonatal Option only) This code indicates that the final pressure is outside of range during exhalation valve test.	1. Check exhalation solenoid for operation and leaks. 2. Check exhalation pressure transducer. 3. Check exhalation valve. 4. Check for kinks in the tube between exhalation solenoid and exhalation pressure sensor. 5. Replace sensor PCB.
3160	Exhalation Valve Test failure. (Neonatal Option only) This code indicates that the exhalation flow is outside of range during exhalation valve test.	1. Check circuit integrity. 2. Check exhalation filter for occlusion or leaks. 3. Check exhalation flow sensor. 4. Check orientation of exhalation check valve CV4. 5. Replace exhalation flow sensor. 6. Replace sensor PCB.
4xxx: Continuous Built-in Test Failures (*Vent Inop.)		
4002*	RAM test. Memory test on CPU PCB.	Replace CPU PCB.
4003*	ADC/DAC test. The 12-bit analog to digital converter (ADC) and 8-bit digital to analog converter (DAC) on the analog PCB are tested.	1. Replace analog PCB. 2. Replace main to sensor cable. 3. Replace sensor PCB.

Diagnostic Code	Code Description	Recommended Repair
4004*	Inhalation autozero failure. The inspiratory pressure transducer solenoid (SOL4) is energized at regular intervals. This code indicates that the system failed to measure a stable reading. Three consecutive failures result in a *Vent Inop* condition.	1. Check for crimped tubes between inhalation solenoid and transducers on sensor PCBA. 2. Check inhalation solenoid. 3. Replace sensor PCB. 4. Replace three-station solenoid assembly. 5. Replace main to sensor cable. 6. Replace analog PCB. 7. Replace main PCB.
4005*	Exhalation autozero failure. The exhalation pressure transducer solenoid (SOL3) is energized at regular intervals. This code indicates that the system failed to measure a stable reading. Three consecutive failures result in a *Vent Inop* condition.	1. Check for crimped tubes between inhalation solenoid and transducers on sensor PCBA. 2. Check inhalation solenoid. 3. Replace sensor PCB. 4. Replace three-station solenoid assembly. 5. Replace main PCB to sensor PCB cable. 6. Replace analog PCB. 7. Replace main PCB.
4006*	High temperature (>65 °C). Fan(s) not running or blocked air flow. The temperature sensor is on the sensor PCB. A high-priority, non-resettable alarm.	1. Check both cooling fans for proper operation. If there is a fan failure, measure voltage to the fan (it should be 24 VDC). If voltage is correct, replace fan. If voltage is incorrect, replace power supply. 2. Check blower inlet filter and air intake filter, and clean or replace as necessary. 3. Replace sensor PCB.
4007	Exhalation valve stuck open. When the exhalation valve is commanded closed, the exhalation flow sensor (FS3) still measures flow.	1. Check exhalation flow sensor and exhalation valve (test the exhalation valve using the flow transducer test described in Chapter 5). 2. Replace exhalation motor controller PCB. 3. Replace exhalation valve assembly. 4. Replace exhalation flow sensor. 5. Replace exhalation flow sensor cable. 6. Replace main PCB.
4008	Air valve stuck open. When the air valve is commanded closed, the air flow sensor (FS1) still measures flow.	1. Check air valve and air flow sensor. 2. Replace air motor controller PCB. 3. Replace air valve assembly. 4. Replace air flow sensor. 5. Replace air flow sensor cable. 6. Replace main PCB.

Diagnostic Code	Code Description	Recommended Repair
4009*	Oxygen valve stuck open. When the oxygen valve is commanded closed, the oxygen flow sensor (FS2) still measures flow.	1. Check oxygen valve and oxygen flow sensor. 2. Replace oxygen motor controller PCB. 3. Replace oxygen valve assembly. 4. Replace oxygen flow sensor. 5. Replace oxygen flow sensor cable. 6. Replace main PCB.
4010	Air valve stuck closed. When air valve is commanded open, no air flow is detectable.	1. Check air valve and air flow sensor. 2. Replace air flow sensor cable. 3. Replace air flow sensor. 4. Replace air motor controller PCB. 5. Replace air valve assembly. 6. Replace main PCB.
4011	Oxygen valve stuck closed. When oxygen valve is commanded open, no oxygen flow is detected.	1. Check oxygen valve and oxygen flow sensor. 2. Replace oxygen flow sensor cable. 3. Replace oxygen flow sensor. 4. Replace oxygen motor controller PCB. 5. Replace oxygen valve assembly. 6. Replace main PCB.
4013*	CPU memory test. Unable to read POST data on the CPU.	Replace CPU PCB.
4014*	Flash CRC. A memory test on the CPU PCB failed.	1. Repeat software download. 2. Replace CPU PCB.
4015	Primary alarm failure. Electronic pulse detection circuitry unable to confirm a functioning main alarm.	1. Check MMI to primary alarm cable and replace as necessary. 2. Replace primary alarm. 3. Replace digital PCB. 4. Replace MMI PCB. 5. Replace main PCB.
4018*	Flow table CRC. Flow sensor data on the CPU does not match flow sensor installed in ventilator.	Replace CPU PCB.
4019	Air motor error. Unexpected air valve stepper motor reading.	1. Check air valve. 2. Replace air motor controller PCB. 3. Replace main to motors cable. 4. Replace air valve assembly. 5. Replace main PCB.

Diagnostic Code	Code Description	Recommended Repair
4020*	Oxygen motor error. Unexpected oxygen valve stepper motor reading.	1. Check oxygen valve. 2. Replace oxygen motor controller PCB. 3. Replace oxygen valve assembly. 4. Replace main PCB.
4021*	Exhalation motor error. Unexpected exhalation valve stepper motor reading.	1. Replace exhalation motor controller PCB. 2. Replace exhalation valve assembly. 3. Replace main PCB.
4022	Blower fan failure. The thermal switch attached to the blower housing measures 125 °C or there is an open circuit to the sensor PCB.	1. Check that cooling coil fan is working. 2. Check the J3/J4 connections on the sensor PCB. 3. Check for open between thermal switch contacts when temperature is >125 °F. 4. Replace sensor PCB.
5xxx: Status/Miscellaneous Codes		
5000	Occlusion: safety valve open alarm. A pressure difference between inspiratory and expiratory limbs of the circuit was detected.	See section 6.2.
5001	Gas supplies lost: safety valve open alarm. No air flow from the blower detected, and the oxygen source is either disconnected or not detected by the oxygen pressure switch (PS1).	1. Check blower operation in normal and diagnostic modes. 2. Check PS1. 3. Replace the sensor PCB. 4. Replace the CPU PCB.
5002	Backup battery not connected. Backup battery was not detected during power up (POST).	1. If backup battery was not connected during power up, disregard 5002. 2. Verify the backup battery is properly connected to the ventilator. 3. Connect AC power and allow backup battery to charge and perform backup battery test. 4. Replace backup battery.
5003	High internal O_2 alarm	1. Perform High Internal Oxygen Alarm test. 2. With unit open, connect a high pressure oxygen source to the unit (power off). Listen for any pneumatic leaks. Repair as required. 3. Power on unit and confirm both cooling fans are operational. 4. With unit closed, operate in normal mode (use default settings, except set oxygen at 100%) for 20 minutes on a test lung. 5. Replace sensor PCB.

Diagnostic Code	Code Description	Recommended Repair
5004	Exhalation flow sensor thermistor temperature outside range.	1. Perform the air flow accuracy test. 2. Verify cooling fans are functioning and are both installed in the proper orientation. 3. Replace exhalation flow sensor.
7xxx: Power Supply Failures (Vent Inop)		
NOTE:	A 7xxx code that precedes a 1008 or 1014 in the diagnostic log indicates that the power supply output voltage has dropped below tolerance three times. Always confirm fuse integrity before replacing power supply.	
7000	Power failure, power fail.	Replace power supply.
7002	Power failure, power fail.	1. If code 7002 occurs in conjunction with code 1008 or 1014, slave in replacement power switch and replace if the problem is resolved. 2. 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.	1. Confirm power cord is fully connected. 2. Replace power supply.
7032-7062	Sensor PCB +5V failure and/or various combinations of +12V, -12V, 24V, and power fail failures.	1. Replace sensor PCB. 2. Replace power supply.
7064-7094	MMI PCB +5V failure and/or various combinations of +12V, -12V, 24V, and power failures.	1. Replace MMI PCB. 2. Replace power supply.
7096-7126	MMI PCB +5V failure and/or various combinations of sensor PCB +5V, +12V, -12V, 24V, and power fail failures.	1. Replace MMI PCB. 2. Replace sensor PCB. 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 PCB +5V, +12V, -12V, 24V, and power fail failures.	1. Verify power supply harness connections. 2. Replace sensor PCB. 3. Replace power supply.
7192-7222	+10V failure and various combinations of MMI PCB +5V, +12V, -12V, 24V, and power fail failures.	1. Verify power supply harness connections. 2. Replace MMI PCB. 3. Replace power supply.
7224-7254	+10V failure and various combinations of MMI PCB +5V, sensor PCB +5V, +12V, -12V, 24V, and power fail failures.	1. Verify power supply harness connections. 2. Replace sensor PCB. 3. Replace MMI PCB. 4. Replace power supply.

Diagnostic Code	Code Description	Recommended Repair
8xxx: Software Faults		
8001	Recoverable condition. Software has detected an unexpected condition.	Use RS-232 diagnostic report (DRPT) command to obtain detailed information and contact technical support.
8002	Alarm corrupt status.	1. Replace CPU PCB.
8003	Software option button failure or attempt to reuse button.	Use RS-232 diagnostic report (DPRT) command to obtain detailed information and contact technical support.
8004	Insufficient blower current. Blower startup is confirmed by comparing current draw before and after blower startup.	1. If this code is accompanied by a 1012 code in the diagnostic log, see section 6.1. 2. If this code is not accompanied by a 1012 code, disregard.
9xxx: Flow Sensor Faults (Vent Inop)		
9001	Flash programming error. An error occurred while writing flow sensor calibration data to memory.	1. Replace the CPU PCB. 2. Replace the sensor PCB.
9002	Flow sensor mismatch. The calibration (lookup) tables stored on the flow sensor and CPU do not match.	1. Reprogram the CPU flow sensor tables by powering up in diagnostic mode. 2. Slave in a known-good flow sensor and cable to each connector (J10, J11, J12) on the sensor PCB, then power up until diagnostic mode is accessible. 3. Replace the sensor PCB. 4. Replace the CPU PCB. 5. Replace the main PCB.
9003	Flow sensor failure. Flow sensor data is not being communicated to the CPU.	1. Attempt to access diagnostic mode/ EST. 2. Slave in a known-good flow sensor and cable to each connector (J10, J11, J12) on the sensor PCB, then power up until diagnostic mode is accessible. 3. Replace the sensor PCB. 4. Replace the CPU PCB. 5. Replace the analog PCB. 6. Replace the main PCB.
9004	Pressure sensor failure. A/D converter out of range.	1. Replace sensor PCB. 2. Replace analog PCB.

Diagnostic Code	Code Description	Recommended Repair
9005	Sensor failure. Generic sensor failure due to flow sensor, pressure transducer, or communication problem.	1. Slave in a known-good flow sensor and cable to each connector (J10, J11, J12) on the sensor PCB, then power up until diagnostic mode is accessible. 2. Replace the sensor PCB. 3. Replace the CPU PCB. 4. Replace the analog PCB. 5. Replace the main PCB.
9007	Air flow sensor cable misconnected to the oxygen connector (J10) on sensor PCB.	Connect air flow sensor cable to J12 on sensor PCB.
9008	Oxygen flow sensor cable misconnected to the air (J12) or exhalation (J11) connector on sensor PCB.	1. Connect oxygen flow sensor cable to J10 on sensor PCB. 2. Replace sensor PCB.
9009	Flow sensor calibration data out of range or lookup table cannot be read.	1. Check cable connections. 2. Reprogram the CPU flow sensor tables by powering up in diagnostic mode. 3. Slave in a known-good flow sensor and cable to each connector (J10, J11, J12) on the sensor PCB, then power up until diagnostic mode is accessible. 4. Replace the sensor PCB. 5. Replace the CPU PCB. 6. Replace the main PCB.

6.1 Diagnostic Code 1012 Troubleshooting

A 1012 (air liftoff failure) code indicates an out of range air liftoff value. As part of power-on self-test (POST), the microprocessor starts the blower and opens the air valve until the air flow sensor reads a flow rate of 1 LPM. The step position of the air stepper motor is recorded at this point, and is called the liftoff value.

The liftoff value is recorded during normal (diagnostic code 1) and diagnostic mode (diagnostic code 3) startup sequences. The liftoff value (and other diagnostic information) is also recorded when a 1012 code occurs. If the blower fails to start spinning, the difference in current draw is zero, and an 8004 diagnostic code is logged. To view the information recorded during 1012 or 8004 events, generate a ventilator diagnostic report (DRPT) (Chapter 7).

NOTE: Disregard an 8004 code *without* an accompanying 1012 code in the diagnostic log.

Possible causes for a 1012 diagnostic code include:

- The air valve opening position is too low or too high.
- The blower motor has seized or is drawing too much current.
- The blower controller PCB is not operating properly.
- The air flow sensor is not reading accurately.
- The power supply is not providing the 29 VDC (24 VDC if running on battery) output to the blower controller PCB.
- The sensor PCB is not operating properly.
- Faulty harness connections between the blower controller PCB and power supply or sensor PCB.

Follow these steps to determine the cause and repair for a 1012 diagnostic code:

1. Determine if the blower is working: listen for the blower to start spinning at startup, or use the Hardware screen (Chapter 5) to set an air flow: if there is flow, the blower is working.
2. If the blower is not working, determine if the cooling coil fan on the bottom of the unit is operating by looking, feeling for air flow, or carefully probing with a slender flexible object such as a wire or tie wrap. (The blower and this cooling fan share the same output from the power supply.)
3. If both the blower and the fan are not working, check for 29 VDC (24 VDC if running on battery) at the blower controller PCB:
    a. Enter diagnostic mode.
    b. Place DMM leads on the red and black wires on the green terminal block on the blower controller PCB mounted next to the blower.
    c. Make sure the wires to the terminal block are securely connected. Check the other end of this harness and verify it is securely connected to power supply connector J1.

   d. If F1 and/or F2 are open, replace fuses.
   e. If 24/29 VDC is not present, replace the power supply.

4. If the blower is not working but the fan is, check the LED (which indicates an overcurrent condition) on the blower controller PCB during a normal startup attempt. If the LED lights, either the blower motor or the blower controller PCB is not functioning correctly.
   a. If you can hear the blower attempt to start running, and then the LED lights, replace the blower.
   b. If the blower still does not work and the LED still lights, reinstall the original blower and replace the blower controller PCB. You can slave in and connect the replacement blower controller PCB to see if it corrects the problem before replacing the original PCB.
5. If the blower doesn't start, 24/29 VDC is present at the terminal block, and the LED on the blower controller PCB does not light:
   a. Check the continuity and connections of the harness between J9 on the sensor PCB and J3 on the blower controller PCB. If there is a continuity problem, replace the cable.
   b. If the blower still doesn't work, replace the sensor PCB.
6. If the blower is working, check the DRPT liftoff value (Chapter 7).
7. If the liftoff value is below 180 steps, there may be foreign material in the valve that prevents it from closing all the way.
   a. Cycle the air flow rate from closed to fully open several times to expel any foreign material. Use the hardware screen to open the air valve to its maximum position (2,000 steps), then toggle between the hardware screen and any other screen in the diagnostic mode to cycle the valve.
   b. Reattempt normal startup.
   c. If the value is still below 180 steps, replace the air valve.
8. If the value is over 525 steps, either the air valve or the airflow sensor is not functioning correctly, perform the air flow accuracy test of the performance verification (Chapter 8):
   - If the air flow accuracy test passes, replace the air valve.
   - If the test fails, replace the air flow sensor.

6.2 Diagnostic Code 5000 Troubleshooting

A diagnostic code 5000 occurs when a significant pressure differential is detected between the Inspiratory and exhalation sides of the tubing circuit. This pressure differential can be caused by blocked tubing (due to liquid accumulation or a pinched circuit), increased exhalation filter resistance, or increased resistance caused by additional bacteria filters in line for nebulizer treatments.

When the ventilator enters an occlusion state, it opens the exhalation valve and safety valve, then closes them and attempts to deliver a patient breath. If the pressure differential still exists, the ventilator repeats the process (up to 40 times per minute). During an occlusion state, the ventilator enters the safety valve open (SVO) state (not VENT INOP).

NOTE: If pressure displays do not drop to 0 ± 0.1 cmH_2O, cycle power to the ventilator to enter normal ventilation mode. After the ventilator completes POST, cycle power to the ventilator to enter diagnostic mode and re-run the test.

Follow these steps to determine the cause and repair for a 5000 diagnostic code:

1. Connect a patient circuit, including test lung, to the ventilator and turn the ventilator ON in diagnostic mode.
2. Touch **Hardware** to view the Hardware screen, then select these settings:
   - Touch **Air** and set to 1 LPM.
   - Touch **Exhalation** and set to 2000 Steps.
   - Touch **Safety** to energize (white background indicates energized).
3. Block the patient wye, then watch the *Inhalation Pressure* and *Exhalation Pressure* displays on the Hardware screen as they rise from 0 cmH_2O to the highest stable point (the PRV cracking pressure). If the difference between the pressure displays is greater than 2 cmH_2O at any time, note which is higher.
4. Unblock the patient wye to allow pressures to return to 0 ± 0.1 cmH_2O, then repeat for **Air** settings of 2, 3, 4, and 5 LPM.
5. With circuit pressure at the PRV cracking pressure, touch **Inhalation** and verify that the pressure displays drop to 0 ± 0.1 cmH_2O immediately when energized (white background) and returns to circuit pressure when deenergized, without displaying any pressures between 0 cmH_2O and PRV cracking pressure.
6. With circuit pressure at the PRV cracking pressure, touch **Exhalation** and verify that the pressure displays drop to 0 ± 0.1 cmH_2O immediately when energized (white background) and returns to circuit pressure when deenergized, without displaying any pressures between 0 cmH_2O and PRV cracking pressure.

7. If the difference between the *Inhalation Pressure* and *Exhalation Pressure* displays on the Hardware screen is greater than 2 cmH_2O at any time, note which is higher, then swap the INSP and EXH tubes on the sensor PCB and retest.
   - If the pressures are now higher on the opposite pressure display, replace the 3-station solenoid assembly.
   - If pressures remain higher on the same pressure display, replace the sensor PCB.
8. Return the INSP and EXH tubes to their correct positions on the sensor PCB.

(This page is intentionally blank.)

Chapter 7. Ventilator Communications

This section describes ventilator communications functions, including:

- Downloading software
- Programming the serial number
- Enabling options
- Setting up the serial interface to generate a diagnostic report (DRPT)
- Generating a DRPT

7.1 Downloading Software

The CPU PCB in the ventilator contains nonvolatile memory that allows the software to be upgraded electronically using a personal computer (PC) or laptop computer. If the CPU PCB is replaced, the serial number and any installed options (such as color or graphics) must be reprogrammed.

Writing the ventilator's serial number to the CPU disables any installed options. Downloading a new software revision by itself does not disable options. If you are downloading software after replacing the CPU PCB, you can reprogram the ventilator serial number as part of the software download as described in section 7.2.

Follow these steps to download software to the ventilator:

1. Turn PC on and ventilator off.
2. Double-click on **SETUP.EXE** from the software CD to start the program.

NOTE: The software CD is configured to autorun if the PC has autorun enabled. To manually start the software, insert the CD into the tray and click **Start > Run**, then enter the CD drive location (e.g.: **D:\Setup.exe** where *D* is the CD drive letter.)

3. The *Setup* screen appears (Figure 7-1). Click **Next** to continue or **Cancel** to exit.

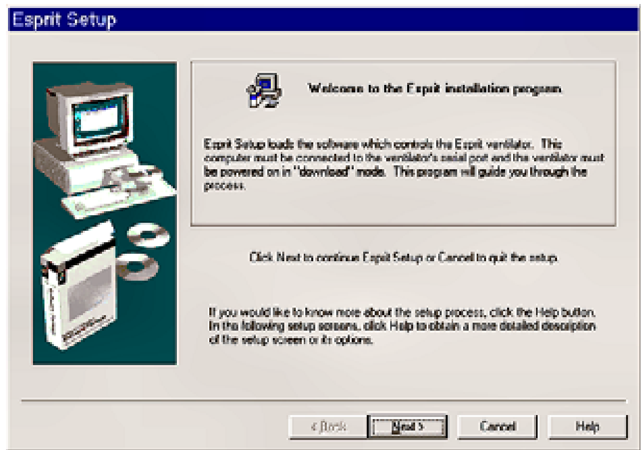


Figure 7-1: Setup Screen

4. The *Select Language* screen (Figure 7-2) appears. Select a language, then click **Next** to continue or **Cancel** to exit.

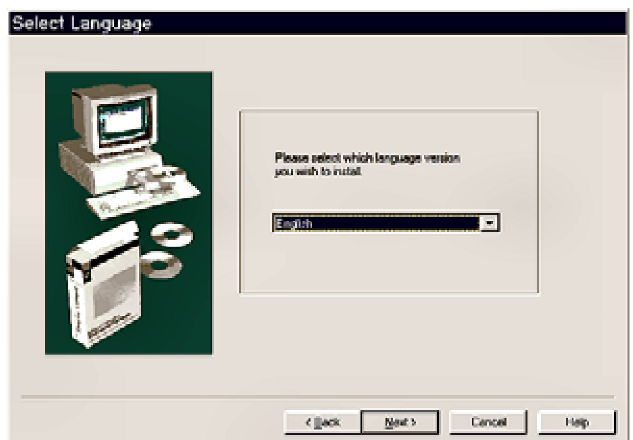


Figure 7-2: Select Language Screen

5. The *Prepare Hardware* screen appears (Figure 7-3). Connect a standard 9-pin male-female RS-232 null modem cable between the PC serial port and the ventilator serial port and select the COM port in use.
6. While turning the ventilator on, simultaneously press the two **Options** keys (the two keys to the left of the **Accept** key) on the ventilator front panel for five seconds. The message *Looking for a download server* appears on the ventilator display, and the backup alarm sounds.

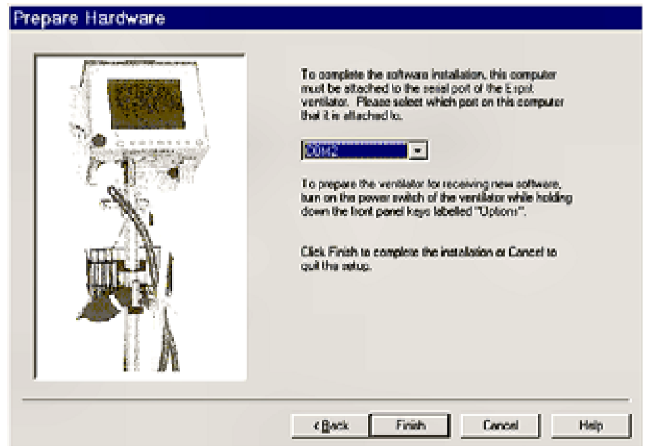


Figure 7-3: Prepare Hardware Screen

7. Click **Finish** on the *Prepare Hardware* screen. The download sequence begins, and after approximately five minutes, the PC displays a message indicating that software has been successfully downloaded.

   If there is a communication problem between the PC and the ventilator, an error message appears (Figure 7-4). Check the cable connection and verify that the correct serial port is selected, then try the download sequence again.

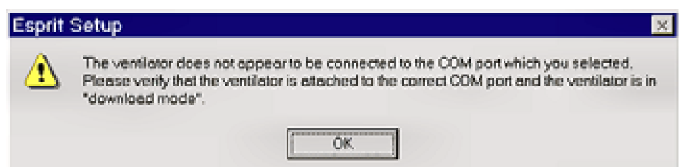


Figure 7-4: Software Download Communication Error

8. If the download is successful, the ventilator displays these messages:

   Initializing memory, please wait

   Initialization Complete

   Programming flow sensor tables, please wait

   Programming Complete

9. When the download is complete, click **OK** on the PC screen. The ventilator automatically reboots in diagnostics mode.
10. Touch the **Software** key on the ventilator screen.
11. Verify that the *Flash Version* is the same as the version on the Respironics software CD-ROM.

IMPORTANT: *Reset the altitude and turn compliance off then back on to reactivate compliance compensation* (use the User Configuration screen in diagnostic mode as described in Chapter 5).

12. Disconnect the null-modem cable from the ventilator.
13. Perform EST (Chapter 5).

7.2 Programming the Ventilator Serial Number

The serial number of each Respironics V200 or Esprit ventilator is stored in nonvolatile memory on its CPU PCB, and must be reprogrammed if you replace the CPU PCB. There are two ways to program the serial number:

- You can program the serial number during a software download (replacement CPU PCBs are shipped without the Respironics V200 Ventilator software installed).
- You can program the serial number without downloading software (use this method to save time if you've already downloaded software but have not yet reprogrammed the serial number).

CAUTION: Programming the ventilator serial number disables any installed options, such as color or graphics. Be sure to program the serial number *before* enabling an option.

To program the serial number during a software download:

1. While turning the ventilator on, simultaneously press the two **Options** keys on the ventilator front panel for five seconds. The message *Looking for a download server* appears on the ventilator display, and the backup alarm sounds.
2. With the Esprit/V200 software installation CD in the CD drive, click on **Start > Run**, then enter **D:\setup.exe -vs** to begin a software download, where *D* is the CD drive letter.

   Enter the command exactly as shown, in lowercase letters with a space between *exe* and *-vs*. (This is the same procedure as described in section 7.1, except that you enter the above command rather than double-clicking on SETUP.EXE.)
3. At the end of the download, a dialog box prompts you to enter the ventilator serial number. Enter the serial number (**VSxxxxxxx**) after the ventilator has restarted in diagnostic mode, where *xxxxxxx* is the seven-digit ventilator serial number. Enter *VS* in uppercase letters.

To program the serial number only (without downloading software):

1. Enter the ventilator diagnostic mode: simultaneously press the **ALARM RESET** and **100% O_2** keys on the front panel for approximately five seconds while turning ventilator power on. A warning to verify that no patient is connected. Touch **OK** to enter diagnostic mode.
2. With the software CD in the CD drive, click on **Start > Run**, then enter **D:\setup.exe -snonly** to begin a software download, where *D:* is the CD drive letter. Enter the command exactly as shown, in lowercase letters with a space between *exe* and *-snonly*.
3. Click **Next** at each of the dialog boxes until you are prompted to enter the serial number.
4. When a dialog box prompts you to do so, enter the ventilator serial number (**VSxxxxxxx**) *after* the ventilator has restarted in diagnostic mode, where *xxxxxxx* is the seven-digit ventilator serial number. Enter *VS* in uppercase letters.

7.3 Enabling Options

CAUTION: Option enable buttons can be used *one time only*: do *not* install options until you have verified that the ventilator serial number is displayed at power up or on the software screen in diagnostic mode. If the serial number must be reprogrammed, be sure to do so *before* enabling an option.

To enable an option, a parallel port adapter (P/N 1004644) and option enable buttons are required. Follow these steps:

1. Insert the option button (label side up) into the parallel port adapter (Figure 7-5), then plug the adapter into the parallel port on the ventilator back panel.
2. Power up the ventilator in diagnostic mode: the ventilator automatically reads the option from the option enable button.
3. To confirm that the option is enabled, verify that the option appears in the software screen.

4. Remove the parallel port adapter from the ventilator back panel.

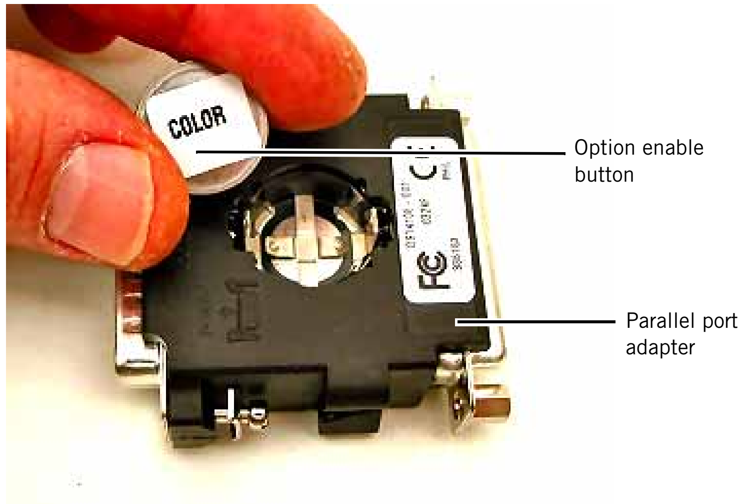


Figure 7-5: Parallel Port Adapter and Option Enable Button

7.4 Setting Up the Serial Interface for DRPT

Follow these steps to connect the ventilator to a PC and create a diagnostic report (DRPT):

1. Connect a 9-pin male-female null modem RS-232 cable between the PC and the ventilator. To verify that the cable is a null modem cable, use a DMM to verify continuity between these DB9 connector pins at opposite ends of the cable:

RS-232 Cable Continuity Check	
Female DB9 Pin	**Male DB9 Pin**
1	4
2	3
3	2
4	1 and 6
5	5
6	4
7	8
8	7
9	Not connected

2. Power up the ventilator in diagnostic mode: simultaneously press the **Alarm Reset** and **100% O_2** keys for approximately five seconds while turning the ventilator power on.

3. Launch the HyperTerminal program on the PC by clicking **Start > Programs > Accessories > Communications > HyperTerminal**, and then double-clicking on the *HYPERTRM.EXE* icon.
4. Enter a name for the connection (*Esprit/Respironics V200 Communications* is entered in Figure 7-6) choose an icon, and then click **OK**).

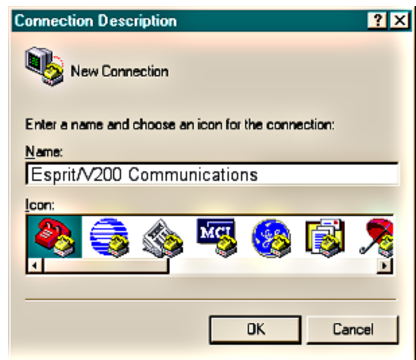


Figure 7-6: Entering a Name for the Connection to the Ventilator

5. Select the appropriate serial port (Figure 7-7 shows *Com1* selected), and then click **OK**.

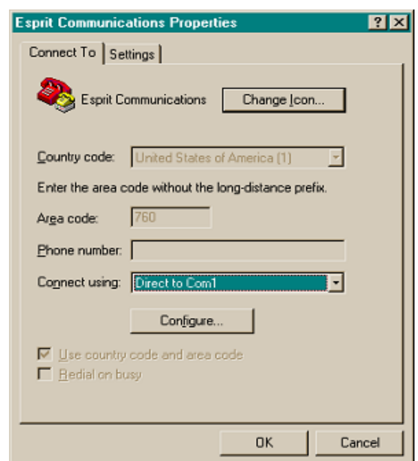


Figure 7-7: Selecting the Serial Port

6. Enter these settings for the serial port (Figure 7-8):

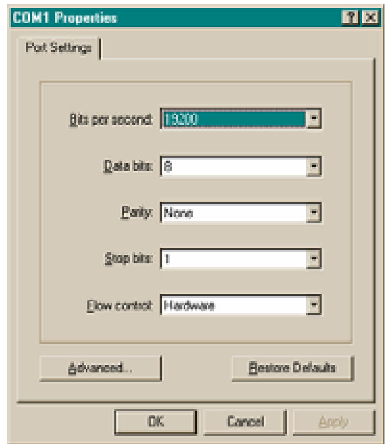


Figure 7-8: Serial Port Settings

7. At the HyperTerminal window, click on **File > Properties**, the **Settings** tab (Figure 7-9), then **ASCII Setup**.

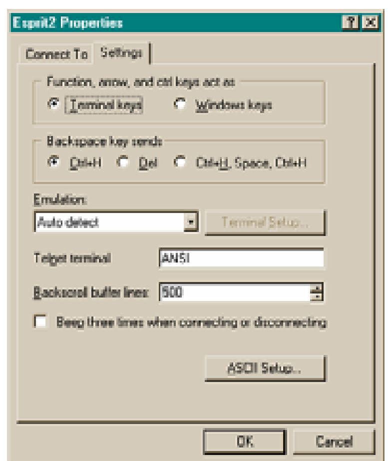


Figure 7-9: HyperTerminal Settings Tab

8. Match the *ASCII Setup* screen (Figure 7-10), and then select **File > Save As** and save to the desktop if you want to create an icon for Communications on the Windows desktop.

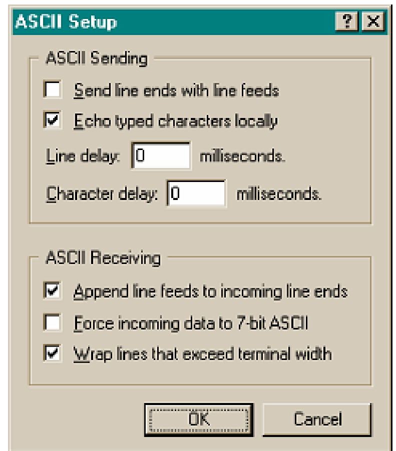


Figure 7-10: ASCII Setup Screen

7.5 Generating a Diagnostic Report (DRPT)

1. With the ventilator in diagnostic mode and the null-modem serial cable connected, start HyperTerminal, open the Communications file, or click on the ventilator Communications icon on the PC (if created).
2. Type **DRPT** (all caps) in the dialog box, and press the **Enter** key.
3. If the ventilator is connected and communication occurs, a response similar to the following appears:

   DRPT,03:44,3,1,03:34.01,10-2-01,AirLiftOff: 310, O2LiftOff: 280

   1,0,11:37.43,8-8-01,AirLiftOff: 320, O2LiftOff: 265

   3000,0,11:04.38,8-8-01,NONE

   3,0,10:58.17,8-8-01,AirLiftOff: 315, O2LiftOff: 250

   1,0,10:57.32,8-8-01,AirLiftOff: 315, O2LiftOff: 275

   3,1,10:52.33,8-8-01,AirLiftOff: 320, O2LiftOff: 265

   1,0,10:40.36,8-8-01,AirLiftOff: 320, O2LiftOff: 255

   4,0,10:40.30,8-8-01,NONE

   3130,0,10:32.06,8-8-01,NONE

4. Figure 7-11 shows how to interpret each line of the DRPT report.

DRPT,03:44,3,1,03:34.01,10-2-01,AirLiftOff: 310, O2LiftOff: 280

AirLiftOff: 310, O2LiftOff: 280 - Air and oxygen liftoff positions

10-2-01 - Date stamp of most recent diagnostic mode occurrence

03:34.01 - Time stamp of most recent diagnostic code occurrence

1 - Number of repeats (ventilator started up in diagnostic mode twice in a row)

3 - Diagnostic code 3 (startup in diagnostic mode)

03:44 - Ventilator time when command received.

DRPT - Command given to ventilator.

Figure 7-11: Interpreting the DRPT Report

The following information may apply to DRPT results:

- If the ventilator is not connected to oxygen at power up, the most recent oxygen liftoff value is used.
- Air and oxygen liftoff values are only logged during normal startup (diagnostic code 1) and diagnostic startup (diagnostic code 3), or if an air or oxygen liftoff failure (diagnostic code 1012 or 1013) occurs.
- Passing ranges for air and oxygen liftoff values are:

  Air liftoff 180 to 500 steps

  Oxygen liftoff 150 to 500 steps
- Certain diagnostic codes include additional debugging data. In case additional data is displayed, contact Respironics Customer Service for more information.

7.6 Analog Output Port (Chart Recorder) Pinout

The Communications Option allows the ventilator to send ventilator data to a chart recorder or compatible patient monitoring systems using the analog output port. Figure 7-12 summarizes the analog output port pinouts.

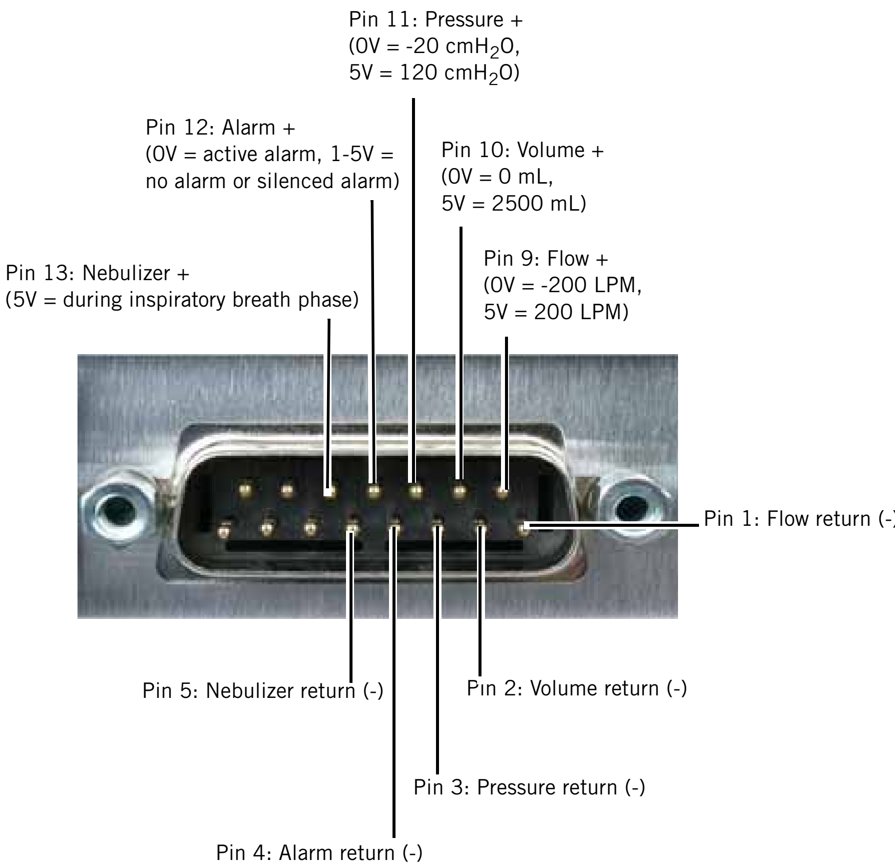


Figure 7-12: Analog Output Port Pinouts

(This page is intentionally blank.)

Chapter 8. Performance Verification

Performance verification verifies the integrity of the sensors and other critical components in the ventilator using external measurement devices. The performance verification consists of several tests (Table 8-1). The type of service performed determines which tests are required (Table 8-2). Run all tests in the order shown.

Table 8-1: Performance Verification Tests

Test Number	Description
1	Electrical safety
2	EST
3	Air flow accuracy
4	Oxygen flow accuracy
5	Pressure accuracy
6	PEEP system
7	Breath rate
8	Alarm output signal, volume, and remote alarm
9	Gas volume accuracy
10	Oxygen accuracy
11	Heated exhalation filter power fail alarm
12	Neonatal option
13	Backup battery and external battery (if installed)

Table 8-2: Performance Verification Test Requirements

Service Performed	Required Tests
Annual preventive maintenance	All
12,500-hour preventive maintenance	All
Installation: Neonatal option	Electrical safety EST Neonatal option testing
Removal/replacement: AC distribution panel	Electrical Safety EST
Removal/replacement: Power supply	Electrical Safety EST Backup battery and external battery

Table 8-2: Performance Verification Test Requirements (Continued)

Service Performed	Required Tests
Removal/replacement: Power supply harness	Electrical safety EST Backup battery and external battery
Removal/replacement: Power switch	Electrical safety EST
Removal/replacement: Rotary encoder	Electrical safety EST
Removal/replacement: Blower	All
Removal/replacement: Sensor PCB	All
Removal/replacement: Main PCB	Electrical safety EST Alarm output signal, volume, and remote alarm Backup battery and external battery
Removal/replacement: MMI PCB	Electrical safety EST Heated exhalation filter and power fail alarm Backup battery and external battery
Removal/replacement: Blower motor controller PCB	All
Removal/replacement: Motor controller(s)	All
Removal/replacement: CPU PCB	Electrical safety EST
Removal/replacement: Digital PCB	Electrical safety EST Heated exhalation filter and power fail alarm
Removal/replacement: VGA PCB	Electrical safety EST
Removal/replacement: Analog PCB	Electrical safety EST Air flow accuracy
Removal/replacement: Air flow sensor	Electrical safety EST Air flow accuracy Gas volume accuracy
Removal/replacement: Air valve	All
Removal/replacement: Oxygen flow sensor	Electrical safety EST Oxygen flow accuracy Gas volume accuracy Oxygen accuracy
Removal/replacement: Oxygen valve	All

Table 8-2: Performance Verification Test Requirements (Continued)

Service Performed	Required Tests
Removal/replacement: Exhalation flow sensor	Electrical safety EST Air flow accuracy Gas volume accuracy
Removal/replacement: Exhalation valve assembly	All
Removal/replacement: Primary alarm	Electrical safety EST Alarm output signal, volume, and remote alarm Heated exhalation filter and power fail alarm
Removal/replacement/adjustment: Pressure relief valve, poppet	Electrical safety EST Pressure accuracy
Removal/replacement: Air system check valve (CV2), inspiratory non-rebreathing check valve (CV3), exhalation non-rebreathing check valve (CV4)	All
Removal/replacement: Crossover solenoid (SOL1), safety valve pilot solenoid (SOL2), exhalation pressure transducer solenoid (SOL3), inspiratory pressure transducer solenoid (SOL4)	Electrical safety EST Pressure accuracy PEEP system
Removal/replacement: Oxygen regulator	Electrical safety EST Oxygen flow accuracy Gas volume accuracy Oxygen accuracy
Removal/replacement: Heated bacteria filter door, heater	Electrical safety EST Heated exhalation filter and power fail alarm
Removal/replacement: 10.4-in. GUI assembly or GUI components	Electrical safety EST
10.4-in. GUI upgrade kit installation	All

8.1 Required Test Equipment

Table 8-3 summarizes the test equipment required, and Table 8-4 summarizes the service accessories required for performance verification. Check the calibration status of all test equipment before use.

Table 8-3: Required Test Equipment for Performance Verification

Description	Recommended Manufacturer/Model
Electrical safety analyzer	Dale LT 544D or equivalent
Pneumatic calibration analyzer(s) capable of measuring low pressure (cmH_2O), flow rate (LPM), volume (Liters BTPS), and respiratory rate	TSI Certifier FA Plus (Respironics P/N 1040311), or equivalent
Oxygen analyzer with accuracy of ± 2%	TSI Certifier FA Plus with oxygen sensor kit or equivalent
Pressure analyzer capable of measuring high pressure (PSI)	TSI Certifier FA Plus or equivalent
Digital multimeter (DMM) and frequency counter accurate to three decimal places	Local supplier
10 mL calibrated syringe (Neonatal testing)	Hans Rudolph 5220 or equivalent
NOTE: An oxygen source capable of delivering 180 LPM (40-90 PSI) is required for oxygen system tests.	

Table 8-4: Required Service Accessories for Performance Verification

Description	Quantity	Part Number
Adult patient circuit tube, 42-in. smooth-bore*	2	P/N 1003643
Patient circuit wye, 22 mm*	1	P/N 1003070
Analog output port signal selector*	1	P/N 1010891
Test lung, 1-liter, hard sided	1	P/N 1021671
Coupling, silicone	2	P/N C06348
Tee, plastic w/silicone coupling	1	P/N C06260 or equivalent
Connector, 22 mm OD	1	P/N C06335 or equivalent
Cork, silicone	1	P/N 1001735 or equivalent
Remote alarm test cable adaptor	1	P/N 1027817
Remote alarm test cable	1	P/N 1027818
Oxygen sensor adapter	1	P/N 1001736
Tubing, silicone, 3/16-in. ID x 6.5 ft. PAP	1	P/N C06686
*Assemble to make an adult patient circuit.		

8.2 Preliminary Cleaning, Inspection and Setup

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

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

- Clean the ventilator exterior as described in the ventilator operator's manual.
- Remove the humidifier from the ventilator, if applicable.
- Visually inspect the exterior of the ventilator for damage. Replace damaged parts as needed.
- Remove and inspect the cooling fan filter and air inlet filter. Clean or replace filter if necessary.
- View and record the ventilator information:
  a. Simultaneously press the **ALARM RESET** and **100% O_2** keys on the front panel for approximately five seconds while turning the ventilator power on.
  b. Touch **OK** to enter diagnostic mode (Figure 8-1).

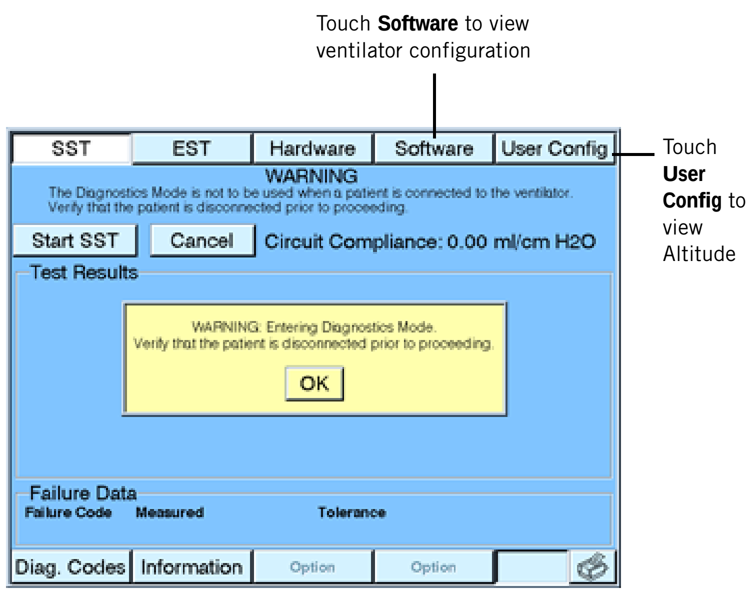


Figure 8-1: Entering Diagnostic Mode

  c. Touch **Software** on the diagnostic screen and record the ventilator configuration information (Figure 8-2) on the Performance Verification Data Form (page 8-52).
  d. Touch **User Config** on the diagnostic screen and record the Altitude (Figure 8-13) on the Performance Verification Data Form (section 8.10).
  e. Record the elapsed time meter reading on the Performance Verification Data Form.
  f. Complete a diagnostic report (DRPT) download (Chapter 7).

g. Turn the ventilator OFF.

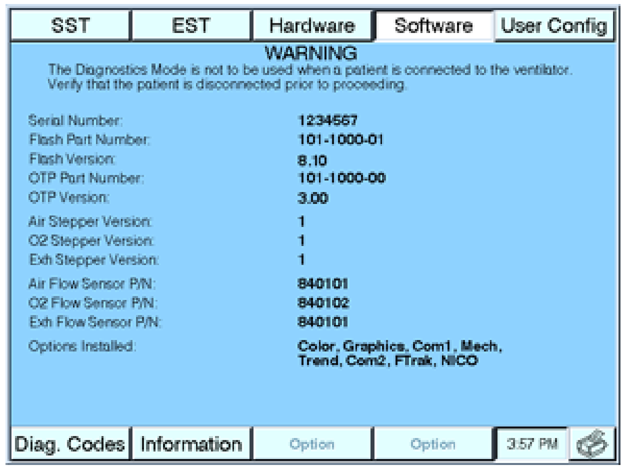


Figure 8-2: Diagnostic Mode - Software Screen

8.3 Preliminary Pneumatic Calibration Analyzer Setup

When using a pneumatic calibration analyzer, remember:

- The analyzer should be in BTPS when measuring volume.
- The analyzer should be in ATP when measuring flow.

8.4 Certifier FA Plus Setup

The following instructions will help guide you through the setup screens of the Certifier FA Plus and select the appropriate parameters and save a configuration for the ventilator.

8.4.1 Measurement Selection Screen

Use this screen to add or remove parameters from the Certifier FA Plus screen.

1. Touch any parameter on the touch screen (refer to Figure 8-3) to display the Measurement Selection screen.

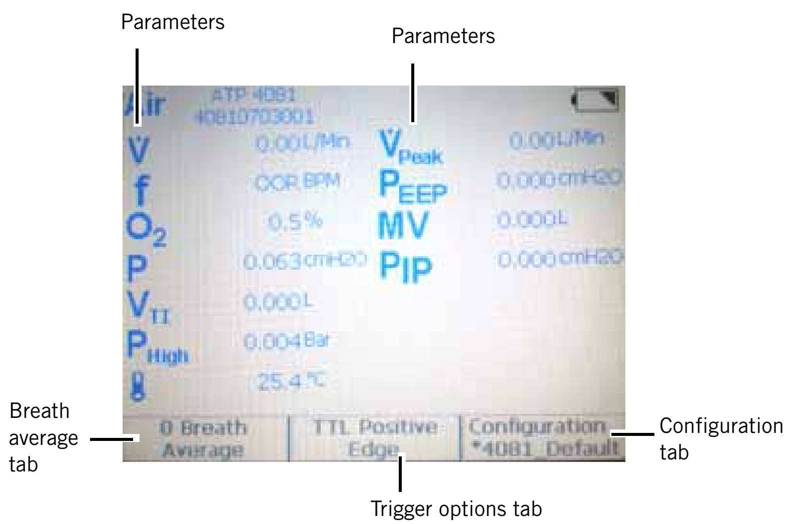


Figure 8-3: Main Screen

2. To add parameters, touch the parameter and then touch the right direction arrow. To remove parameters, touch the left direction arrow (refer to Figure 8-4).

   Recommended parameters:
   - Flow ate
   - Low pressure
   - Frequency
   - Inhaled tidal volume
   - Oxygen concentration
   - High pressure

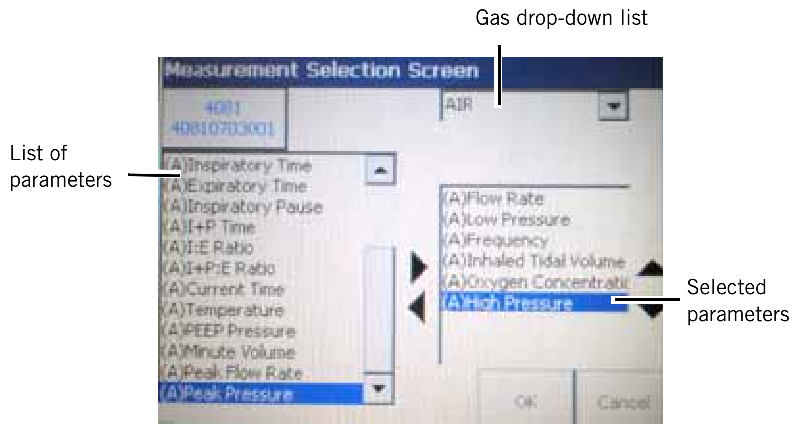


Figure 8-4: Measurement Selection Screen

3. To select or change the gas being measured, touch the gas dropdown list and select the desired gas.
4. When the appropriate parameters are selected and placed in the desired order, touch **OK** (refer to Figure 8-4).

8.4.2 Averaging Setup Menu

Use this screen to select the number of breaths that all breath parameters are averaged over and to select the number of seconds the transducers are averaged over.

1. Touch the Breath Average tab (refer to Figure 8-3) to display the Averaging Setup Menu screen.
2. Use the up or down direction arrows to select *1* for Number of Breaths Averaged and *0.5* for Second average for Real-Time Values (refer to Figure 8-5).

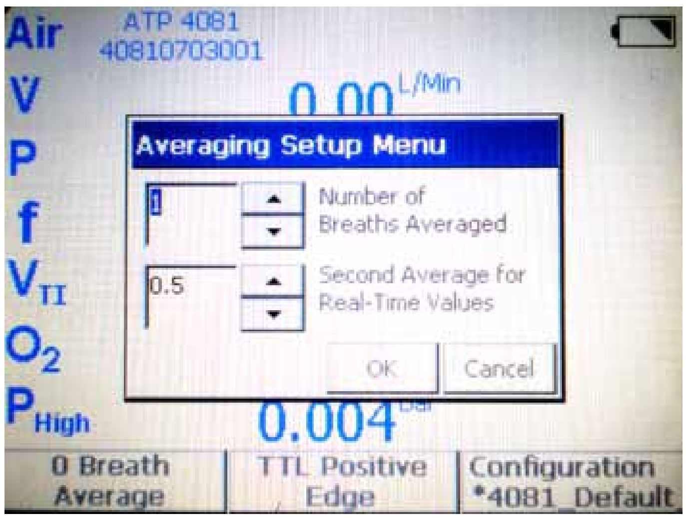


Figure 8-5: Averaging Setup Menu

3. When the appropriate parameters are selected, touch **OK** (refer to Figure 8-5).

8.4.3 Trigger Options Menu

Use this screen to define how the start of the inspiratory breath cycle and expiratory breath cycle is detected.

1. Touch the Trigger Options tab (refer to Figure 8-3) to display the Trigger Options screen.
2. Select Flow Rate (refer to Figure 8-6) and verify Auto-Triggering is ***not*** checked.

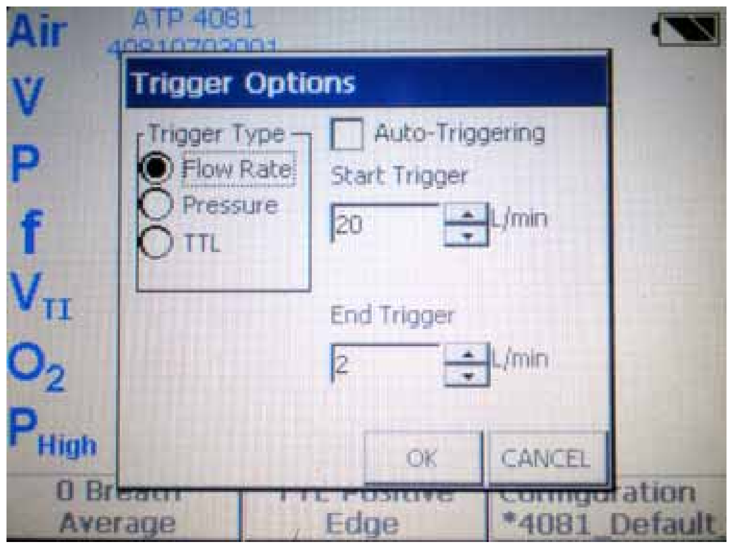


Figure 8-6: Trigger Options Screen

3. Use the up or down direction arrows to select *20* L/min for Start Trigger and *2* L/min for End Trigger (refer to Figure 8-6).
4. When the appropriate parameters are selected, touch **OK** (refer to Figure 8-6).

8.4.4 Configuration Menu

Use this screen to save configurations and switch between different configurations.

8.4.5 Saving Configurations

1. Touch the “Configuration” tab (refer to Figure 8-3).
2. Touch the Save As tab (refer to Figure 8-7).

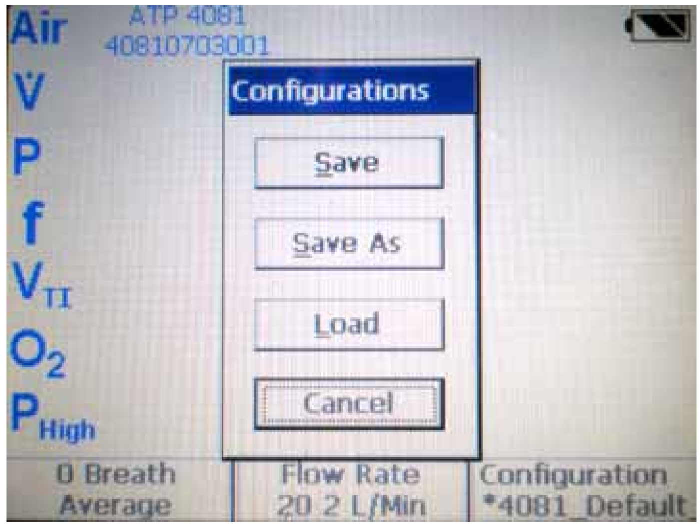


Figure 8-7: Save, Save As, Load screen

3. Touch the New Folder tab (refer to Figure 8-8).

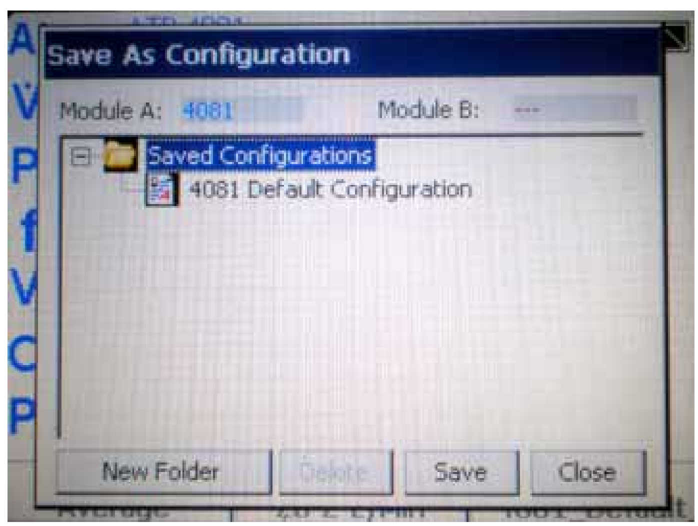


Figure 8-8: Save As Configuration Screen

4. Use the onscreen keyboard to enter **RESPIRONICS** (Figure 8-9), and then touch **OK**.

Figure 8-9: New Folder Screen

5. Verify that *RESPIRONICS* is highlighted and touch **Save** (refer to Figure 8-10).

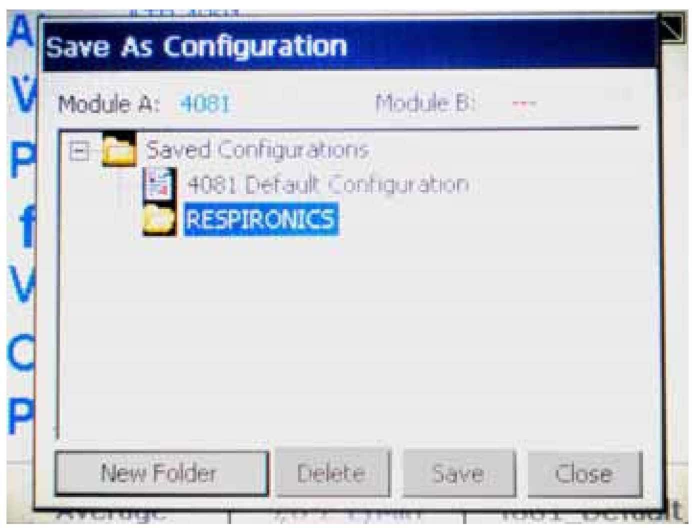


Figure 8-10: Save As Configuration Screen

6. Enter either **Esprit** or **V200**, and then touch OK (refer to Figure 8-11).

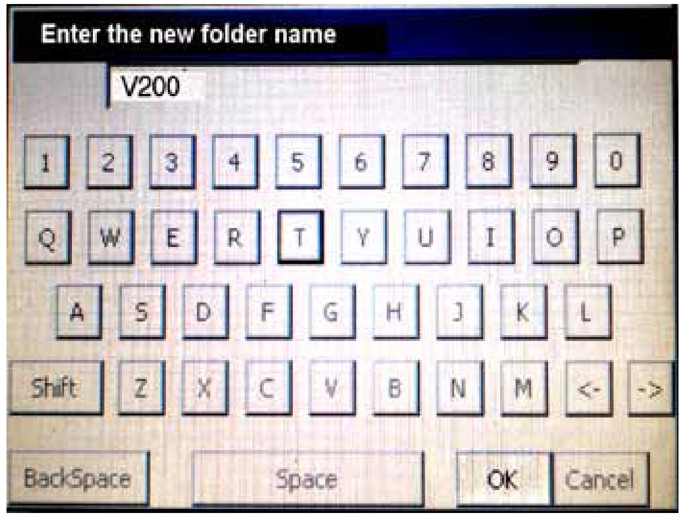


Figure 8-11: New Configuration Screen

8.5 Performance Verification Procedures

When running a complete performance verification, perform the tests in order to ensure logical fault diagnosis. If the ventilator fails any performance verification test, see section 8.7 for troubleshooting instructions. Fill in the applicable parts of the Performance Verification Data Form as each test is completed.

8.5.1 Test 1: Electrical Safety

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

Use the ground lug (equipotential) at the back of the ventilator to connect the electrical safety analyzer to ventilator ground (refer to Figure 8-12). Include the External Battery and Backup Battery (if installed) when performing electrical safety testing.

1. Check that the ground resistance is < 0.2 ohm (Ω).
2. Turn ventilator on and check that the cooling fans are operating properly.
3. Check that the forward and reverse leakage current is < 100 microamperes (µA) for ventilators connected to 100-120 V or < 300 µA for ventilators connected to 220-240 V and/or an external battery.
4. The electrical safety test is complete.

Figure 8-12: Electrical Safety Testing

8.5.2 Test 2: Extended Self Test (EST)

Run EST as described in Chapter 5.

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.**

NOTE: If the ventilator fails EST, repair the unit, then repeat and pass EST before proceeding to another test. See Chapter 6 for recommended repair procedures for diagnostic codes.

NOTE: If the EST fails a test, log the diagnostic code, measurement, and tolerance parameters as displayed in the *Failure Data* window during EST on the Performance Verification Data Form (section 8.10).

1. Run EST as described in Chapter 5.
2. When EST is successfully completed, touch **User Config** to display the *User Configuration* screen (Figure 8-13).

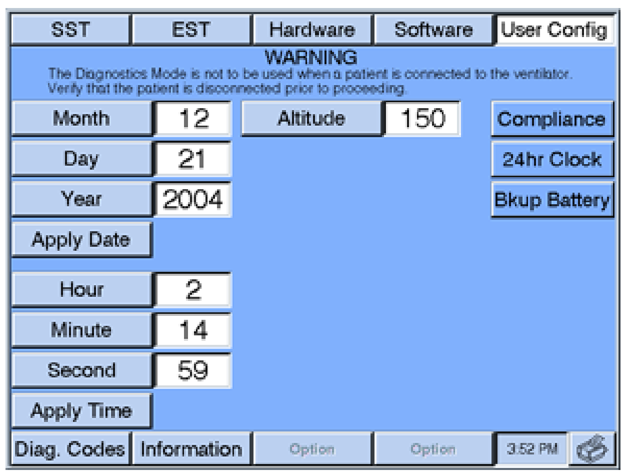


Figure 8-13: Diagnostic Mode - User Configuration Screen

3. If necessary, touch **Compliance** to disable (gray background) the compliance factor.
4. Check the **Altitude** setting and correct it if necessary. *Write down the altitude:* the oxygen flow and pressure accuracy tests require correct altitude information.
5. EST is complete.

8.5.3 Test 3: Air Flow Accuracy

The air flow accuracy test verifies the accuracy of the air and exhalation flow sensors and function of the air valve.

1. If the ventilator is not already in diagnostic mode, simultaneously press the **ALARM RESET** and **100% O_2** keys on the front panel for approximately five seconds while turning ventilator power on, then touch **OK** to enter diagnostic mode.
2. Disconnect the oxygen source from the ventilator.
3. Touch **Safety** on the diagnostic mode Hardware screen to energize (white background) the safety solenoid (Figure 8-14).

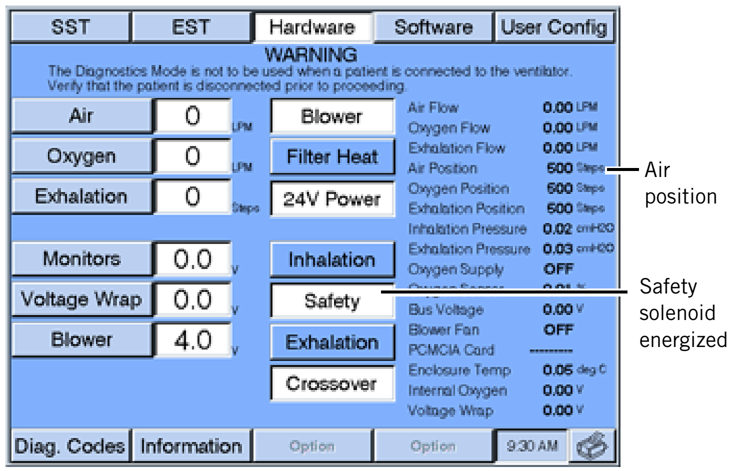


Figure 8-14: Diagnostic Mode - Hardware Screen

4. Touch **Air** on the Hardware screen and set the flow to 1 LPM (Figure 8-15). Verify that the *Air Position* display reads from 185 to 525 steps.

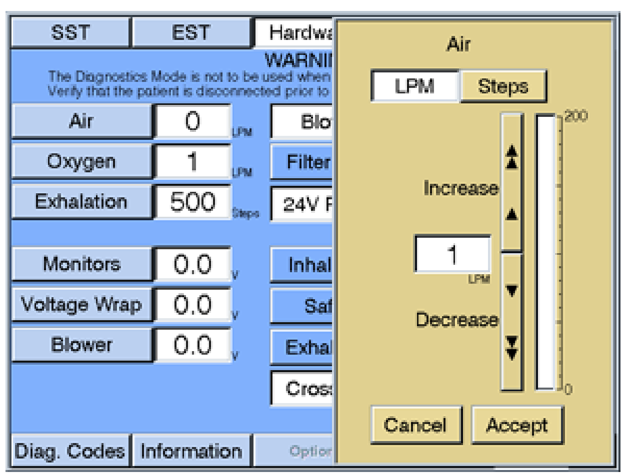


Figure 8-15: Diagnostic Mode - Setting Air Flow

5. Touch **Air** and set the flow to 180 LPM. Check that the *Air Position* display corresponds to the set altitude:

Ventilator Altitude Setting	*Air Position* Display
0 - 2000 ft	930 - 1215 steps
2001 - 4000 ft	910 - 1190 steps
4001 - 6000 ft	890 - 1165 steps
6001 - 8000 ft	875 - 1145 steps
8001 - 10,000 ft	855 - 1125 steps

6. Connect a patient circuit and analyzer to the ventilator as shown in Figure 8-16.
7. Set the analyzer's function to read LPM (set a flow range capable of measuring 180 LPM air).
8. Check that set air flow corresponds to measured flow:

Touch *Air* and set the flow to:	Check that the analyzer and *Air Flow* and *Exhalation Flow* displays read:
5 LPM	4.5 to 5.5 LPM
10 LPM	9 to 11 LPM
20 LPM	18 to 22 LPM
50 LPM	45 to 55 LPM
100 LPM	90 to 110 LPM
120 LPM	108 to 132 LPM
165 LPM	148.5 to 181.5 LPM
0 LPM	0 ± 0.1 LPM

9. The air flow accuracy test is complete.

Figure 8-16: Flow Accuracy Test Configuration

8.5.4 Test 4: Oxygen Flow Accuracy

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

1. If the ventilator is not already in diagnostic mode, simultaneously press the **ALARM RESET** and **100% O_2** keys on the front panel for approximately five seconds while turning ventilator power on, and then touch **OK** to enter diagnostic mode.
2. Reconnect the oxygen source to the ventilator.
3. Touch **Oxygen** on the Hardware screen and set the flow to 1 LPM. Verify that the *O_2Position* display reads from 185 to 525 steps.

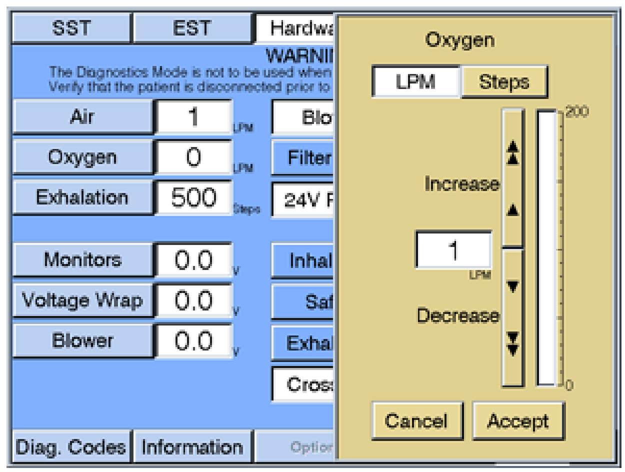


Figure 8-17: Diagnostic Mode - Setting Oxygen Flow

4. Touch **Oxygen** and set the flow to 180 LPM. Check that the *O_2 Position* display corresponds to the set altitude:

Ventilator Altitude Setting	***Oxygen Position* Display**
0 - 2000 ft.	1175 - 1575 steps
2001 - 4000 ft.	1145 - 1540 steps
4001 - 6000 ft.	1120 - 1505 steps
6001 - 8000 ft.	1090 - 1470 steps
8001 - 10,000 ft.	1060 - 1435 steps

5. Connect a patient circuit and analyzer to the ventilator as shown in Figure 8-16.
6. Set the analyzer's function to read LPM mode and gas select to O_2 (set a high flow range capable of measuring 180 LPM oxygen).
7. Check that set oxygen flow corresponds to measured flow:

Touch *Oxygen* and set the flow to:	Check that analyzer and *Oxygen Flow* displays read:
5 LPM	4.5 to 5.5 LPM
10 LPM	9 to 11 LPM
20 LPM	18 to 22 LPM
50 LPM	45 to 55 LPM
100 LPM	90 to 110 LPM
120 LPM	108 to 132 LPM
165 LPM	148.5 to 181.5 LPM
0 LPM	0 ± 0.1 LPM

8. The oxygen flow accuracy test is complete.

8.5.5 Test 5: Pressure Accuracy

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

1. If the ventilator is not already in diagnostic mode, simultaneously press the **ALARM RESET** and **100% O_2** keys on the front panel for approximately five seconds while turning ventilator power on, then touch **OK** to enter diagnostic mode.
2. Connect a patient circuit and analyzer to the ventilator as shown in Figure 8-19.
3. Set the analyzer's function to read cmH_2O (set pressure range to measure at least 120 cmH_2O).
4. Touch **Safety** on the Hardware screen to energize (white background) the safety solenoid.
5. Touch **Exhalation** on the Hardware screen and set it to 1470 steps (Figure 8-18).

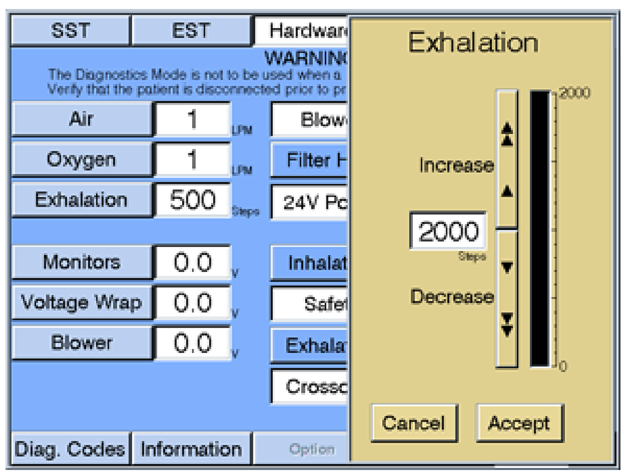


Figure 8-18: Diagnostic Mode - Selecting Exhalation Position

6. Touch **Air** and set the flow to 1 LPM.
7. Touch **Exhalation** and adjust the steps until the analyzer pressure reads 100 ± 5 cmH_2O (95 to 105 cmH_2O).
8. Check that the Inhalation Pressure and Exhalation Pressure displays on the hardware screen read within ± 10% of the analyzer display.

   EXAMPLE: If the analyzer's display reads 98.7 cmH_2O, 10% of the display is 9.87 cmH_2O, and ± 10% of the analyzer display would be 88.83 to 108.57 cmH_2O (-10% = 98.7 - 9.87 = 88.83 cmH_2O, and + 10% = 98.7 + 9.87 = 108.57 cmH_2O).

9. The pressure accuracy test is complete.

Figure 8-19: Pressure Accuracy Test Configuration

8.5.6 Test 6: PEEP System

The PEEP system test verifies the integrity of the PEEP system and checks for autocycling.

1. Connect a patient circuit and analyzer to the ventilator as shown in Figure 8-20.
2. If the ventilator is not already in normal ventilation mode, cycle power to the ventilator to enter normal ventilation mode.

   NOTE: The PEEP system test requires the ventilator to be in Volume Control Ventilation (VCV) and Assist/Control (A/C) mode.

3. Select the following ventilator settings and alarm limits:

Ventilator Settings	Alarm Limits
Mode: VCV-A/C	High Pressure: 105 cmH_2O
Rate: 6 BPM	Low Pressure: 3 cmH_2O
Tidal Volume: 300 mL	Low PEEP: 0 cmH_2O
Peak Flow: 30 LPM	Low Vt Mand: 0 mL
PEEP: 5 cmH_2O	Low Vt Spont: 0 mL
I-Trigger: 2 cmH_2O	High Rate: 150 BPM
O_2: 21%	Low VE: 0.00 L
Insp. Hold: 0.0 sec	Apnea: 60 sec
Apnea rate: 12 BPM	

4. Set the analyzer to measure low pressure (cmH_2O).
5. Touch **Patient Data** to display the patient data screen. Reset any alarms if necessary.
6. Wait for six breaths to complete.
7. During exhalation, check that the analyzer and the *Pe End* display on the patient data screen read 4.0 to 6.0 cmH_2O, and the *Rate* display reads 6 BPM.
8. Touch **VCV Settings** to display the VCV settings screen, then touch **PEEP** and set it to 10 cmH_2O.
9. Touch **Patient Data** to display the patient data screen.
10. Wait for six breaths to complete.
11. During exhalation, check that the analyzer and the *Pe End* display on the patient data screen read 9 to 11 cmH_2O, and the *Rate* display reads 6 BPM.
12. Touch **VCV Settings** to display the VCV settings screen, then touch **PEEP** and set it to 25 cmH_2O.
13. Touch **Patient Data** to display the patient data screen.
14. Wait for six breaths to complete.

15. During exhalation, check that the analyzer and the *Pe End* display on the patient data screen read 22.5 to 27.5 cmH_2O, and the *Rate* display reads 6 BPM.
16. Touch **VCV Settings** to display the VCV settings screen, then touch **I-Trigger**, touch **Flow**, and set it to 4 LPM.
17. Touch **Patient Data** to display the patient data screen.
18. Wait for six breaths to complete.
19. During exhalation, check that the analyzer and the *Pe End* display on the patient data screen reads 22.5 to 27.5 cmH_2O, and the *Rate* display reads 6 BPM.
20. Touch **VCV Settings** to display the VCV settings screen, then touch **PEEP** and set it to 10 cmH2O.
21. Touch **Patient Data** to display the patient data screen.
22. Wait for six breaths to complete.
23. During exhalation, check that the analyzer and the *Pe End* display on the patient data screen read 9 to 11 cmH_2O, and the *Rate* display reads 6 BPM.
24. Touch **VCV Settings** to display the VCV settings screen, then touch **PEEP** and set it to 5 cmH_2O.
25. Touch **Patient Data** to display the patient data screen.
26. Wait for six breaths to complete.
27. During exhalation, check that the analyzer and the *Pe End* display on the patient data screen read 4.0 to 6.0 cmH_2O, and the *Rate* display reads 6 BPM.

28. The PEEP system test is complete.

Figure 8-20: PEEP System and Breath Rate Test Setup

8.5.7 Test 7: Breath Rate

The breath rate test verifies the accuracy of the breath rate setting and to ensure that the ventilator does not autocycle at high respiratory rates.

1. Connect a patient circuit and analyzer to the ventilator as shown in Figure 8-20.
2. If the ventilator is not already in normal ventilation mode, cycle power to the ventilator to enter normal ventilation mode.

   NOTE: The breath rate test requires the ventilator to be in Volume Control Ventilation (VCV) and Assist/Control (A/C) mode.

3. Set the analyzer to display the measured respiratory rate.
4. Select these ventilator settings and alarm limits:

Ventilator Settings	Alarm Limits
Mode: VCV-A/C	High Pressure: 105 cmH_2O
Rate: 60 BPM	Low Pressure: 3 cmH_2O
Tidal Volume: 500 mL	Low PEEP: 0 cmH_2O
Peak Flow: 140 LPM	Low Vt Mand: 0 mL
PEEP: 0 cmH_2O	Low Vt Spont: 0 mL
I-Trigger: 20 cmH_2O	High Rate: 150 BPM
O_2: 21%	Low VE: 0.00 L
Insp. Hold: 0.0 sec	Apnea: 60 sec
Apnea rate: 60 BPM	

5. Touch **Patient Data** to display the patient data screen. Reset any alarms if necessary.
6. Check that the *Rate* display on the analyzer and patient data screen read 59 to 61 BPM.

   NOTE: If using an RT-200 pneumatic tester only, you must remove the test lung so the tester can measure a value for breath rate. It is not necessary to remove the test lung when using other pneumatic testers.

7. The breath rate test is complete.

8.5.8 Test 8: Alarm/Analog Output Signals, Alarm Volume, and Remote Alarm

This test verifies the performance of the alarm volume control, and remote alarm outputs.

1. If the ventilator is not already in normal ventilation mode, cycle power to the ventilator to enter normal ventilation mode.
2. Turn the alarm volume control knob fully counterclockwise.
3. Select the following ventilator settings and alarm limits:

Ventilator Settings	Alarm Limits
Mode: VCV-A/C	High Pressure: 105 cmH_2O
Rate: 12 BPM	Low Pressure: 3 cmH_2O
Tidal Volume: 500 mL	Low PEEP: 0 cmH_2O
Peak Flow: 30 LPM	Low Vt Mand: 0 mL
PEEP: 5 cmH_2O	Low Vt Spont: 0 mL
I-Trigger: 20 cmH_2O	High Rate: 150 BPM
O_2: 21%	Low VE: 0.00 L
Insp. Hold: 0.0 sec	Apnea: 60 sec
Apnea rate: 12 BPM	

4. Connect the adapter's double banana plugs to the DMM with the GND tab to the common jack (Figure 8-21). Set the DMM to measure resistance.

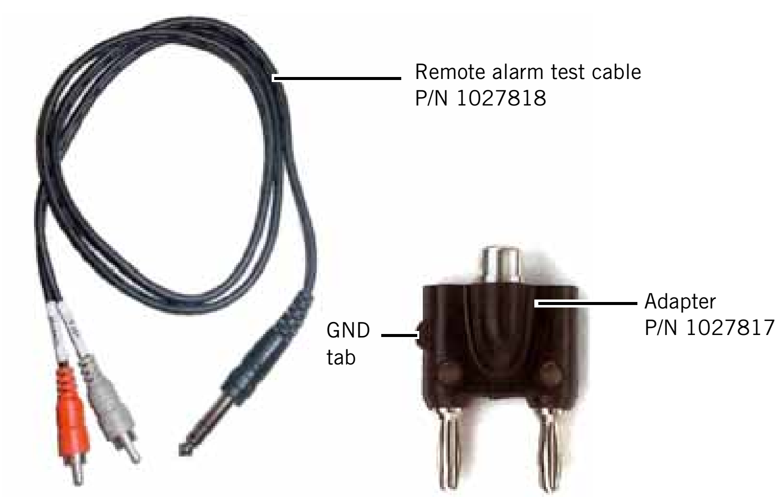


Figure 8-21: Remote Alarm Test Cable and Adapter

5. Connect the black lead of the remote alarm test cable (P/N 1027818) to the common port and the white lead to the Ω port on the DMM.
6. Plug the ¼-in. phono connector into the remote alarm phono jack at the back of the ventilator.
7. Check that no ventilator alarms are active (reset any alarms if necessary) and the DMM reads infinite resistance (open circuit).
8. Remove the white wire from the DMM and connect the red wire in its place.
9. Check that no ventilator alarms are active (reset any alarms if necessary) and the DMM reads 0 ±3 Ω (closed circuit).
10. Disconnect the test lung from the wye to create a Low Pressure alarm.
11. Slowly turn the alarm volume control knob clockwise.
12. Check that the alarm volume steadily increases as you turn the knob.
13. Check that the DMM reads infinite resistance (open circuit).
14. Remove the red lead from the DMM and connect the white lead in its place.
15. Check that the DMM reads 0 ±3 Ω (closed circuit).
16. Remove the adapter from the remote alarm jack.
17. Using either a DMM and test leads, or an Analog Output Port Selector Box, connect a DMM and set to measure DC volts (Figure 8-23).

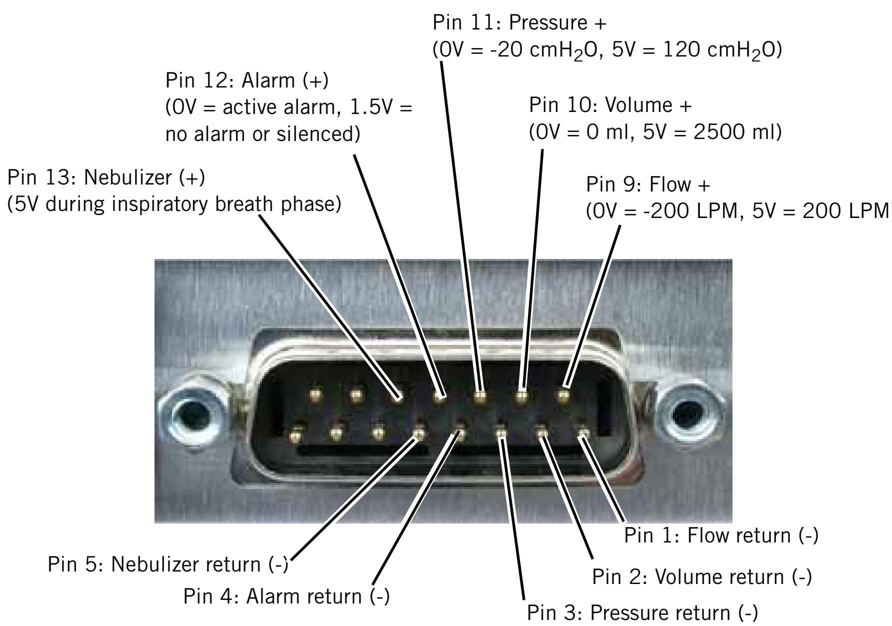


Figure 8-22: Analog Output Port Pinouts

Figure 8-23: Analog Output Port Selector Box Setup

18. Select **ALARM** on the signal selector box or refer to Figure 8-22 for pinouts.
19. With a ventilator alarm active, the DMM should read 0 V (±0.1 V).
20. Replace the test lung to the patient wye: verify that the audible alarm is automatically silenced and the DMM reads 1.25 to 1.75 V.
21. Select **NEBULIZER** on the signal selector box or refer to Figure 8-22 for pinouts.
22. Confirm that the voltage toggles between 0 V (+ 0.1 V) during exhalation and 5 volts (+ 0.6 V) during inhalation.
23. Cycle power and start the ventilator in diagnostic mode by simultaneously pressing the **ALARM RESET** and **100% O_2** keys on the front panel for approximately five seconds while turning ventilator power on, then touch **OK** to enter diagnostics mode.
24. Touch the hardware key, then select **MONITORS** and set the voltage to 2.0 VDC.
25. Select **PRESSURE**, then **VOLUME**, then **FLOW** on the signal selector box or refer to Figure 8-22 for pin outs and verify the DMM reads 2 V (+ 0.3 V) at each setting.
26. Select **MONITORS** and set the voltage to 4.0 VDC.
27. Select **FLOW**, then **VOLUME**, then **PRESSURE** on the signal selector box or refer to Figure 8-22 for pinouts and verify the DMM reads 4 V (+ 0.5 V) at each setting.
28. Disconnect the Analog Output Port Selector Box or DMM test leads from the analog output port.
29. The alarm/analog output signals, alarm volume, and remote alarm test is complete.

8.5.9 Test 9: Gas Volume Accuracy

The gas volume accuracy test verifies the accuracy of the tidal volume delivered to the patient.

1. If the ventilator is not already in normal ventilation mode, cycle power to the ventilator to enter normal ventilation mode.
2. Select the following ventilator settings and alarm limits:

Ventilator Settings	Alarm Limits
Mode: VCV-A/C	High Pressure: 105 cmH_2O
Rate: 12 BPM	Low Pressure: 3 cmH_2O
Tidal Volume: 250 mL	Low PEEP: 0 cmH_2O
Peak Flow: 30 LPM	Low Vt Mand: 0 mL
PEEP: 5 cmH_2O	Low Vt Spont: 0 mL
I-Trigger: 20 cmH_2O	High Rate: 150 BPM
O_2: 21%	Low VE: 0.00 L
Insp. Hold: 0.0 sec	Apnea: 60 sec
Apnea rate: 12 BPM	
Waveform: Square	

3. Connect a patient circuit and analyzer to the ventilator as shown in Figure 8-24. Select *BTPS* mode (set volume range for 3 L air).
4. After six breaths the analyzer should read 225 to 275 mL.
5. Change the flow pattern to Ramp. After three breaths the analyzer should read 225 to 275 mL.
6. Change the Tidal Volume to 500 mL. After six breaths the analyzer should read 450 to 550 mL.
7. Change the flow pattern to Square. After three breaths the analyzer should read 450 to 550 mL.
8. Select these ventilator settings: Peak Flow = 60 LPM, Tidal Volume = 1000 mL. After six breaths the analyzer should read 900 to 1100 mL.
9. Change the flow pattern to Ramp. After six breaths the analyzer should read 900 to 1100 mL.
10. Select these ventilator settings: Peak Flow = 140 LPM, Tidal Volume = 2500 mL. After six breaths the analyzer should read 2250 to 2750 mL.
11. Change the flow pattern to Square. After six breaths the analyzer should read 2250 to 2750 mL.
12. Set the analyzer's volume range for 3 L oxygen. Zero the analyzer during exhalation.
13. Change the O_2 setting to 100%. After six breaths the analyzer should read 2250 to 2750 mL.

14. Change the flow pattern to Ramp. After six breaths the analyzer should read 2250 to 2750 mL.
15. Select these ventilator settings: Peak Flow = 60 LPM, Tidal Volume = 1000 mL. After six breaths the analyzer should read 900 to 1100 mL.
16. Change the flow pattern to Square. After six breaths the analyzer should read 900 to 1100 mL.
17. Select these ventilator settings: Tidal Volume = 500 mL, Peak Flow = 30 LPM. After six breaths the analyzer should read 450 to 550 mL.
18. Change the flow pattern to Ramp. After six breaths the analyzer should read 450 to 550 mL.
19. Change the Tidal Volume to 250 mL. After six breaths the analyzer should read 225 to 275 mL.
20. Change the flow pattern to Square. After five breaths the analyzer should read 225 to 275 mL.
21. The gas volume accuracy test is complete.

Figure 8-24: Gas Volume Accuracy Test Configuration

8.5.10 Test 10: Oxygen Accuracy

The oxygen accuracy test verifies the accuracy of the oxygen percentage 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 (Figure 8-25).
4. If the ventilator is not already in normal ventilation mode, cycle power to the ventilator to enter normal ventilation mode.
5. Select these ventilator settings and alarm limits:

Ventilator Settings	Alarm Limits
Mode: VCV-A/C	High Pressure: 105 cmH_2O
Rate: 12 BPM	Low Pressure: 3 cmH_2O
Tidal Volume: 500 mL	Low PEEP: 0 cmH_2O
Peak Flow: 30 LPM	Low Vt Mand: 0 mL
PEEP: 5 cmH_2O	Low Vt Spont: 0 mL
I-Trigger: 20 cmH_2O	High Rate: 150 BPM
O_2: 21%	Low VE: 0.00 L
Insp. Hold: 0.0 sec	Apnea: 60 sec
Apnea rate: 15 BPM	
Waveform: Square	

6. Check that the set of oxygen percentage corresponds to the measured value:

At this O_2 Setting	The *Patient Data* screen and external O_2 monitor should read:
21%	18 to 24% O_2 (after 12 breaths)
30%	27 to 33% O_2 (after 12 breaths)
60%	57 to 63% O_2 (after 12 breaths)
80%	77 to 83% O_2 (after 12 breaths)
100%	97 to 103% O_2 (after 12 breaths)

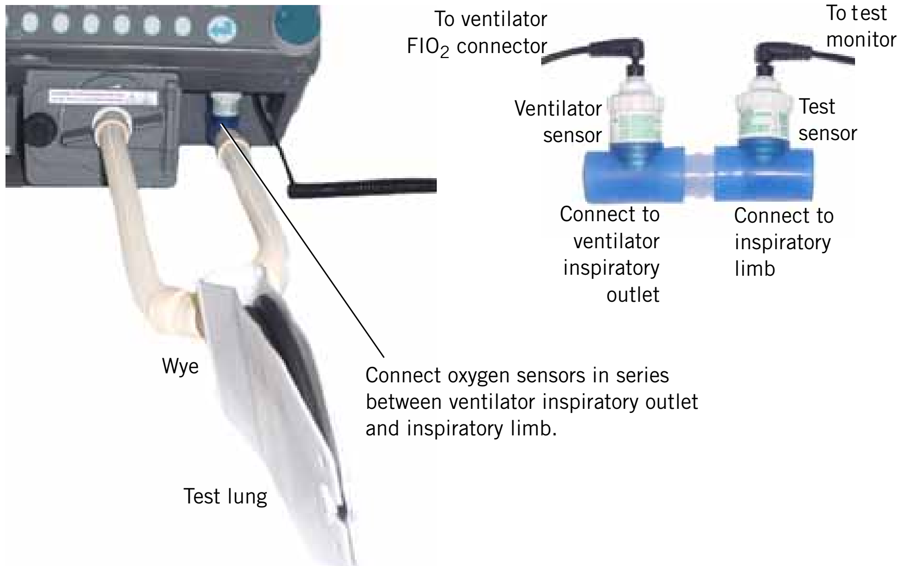


Figure 8-25: External Oxygen Sensor Connection

7. Change the following ventilator settings and alarm limits:

Ventilator Settings		Alarm Limits
Mode: PCV-A/C	PSV: 0 cmH_2O	High Rate: 13 BPM
Rate: 12 BPM	I-Trigger: 2.0 cmH_2O	High VE: 60.0 L
Pressure: 5 cmH_2O	E-Trigger: 25%	Low VE: 1.00 L
I-Time: 1.0 sec	Rise Time: 0.1 sec	
PEEP: 0 cmH_2O	Apnea Rate: 12 BPM	

8. Check that the set oxygen percentage corresponds to the measured value:

At this O_2 Setting	The *Patient Data* screen and external O_2 monitor should read:
96%	93 to 99% O_2 (after 12 breaths)
60%	57 to 63% O_2 (after 12 breaths)
25%	22 to 28% O_2 (after 12 breaths)

9. The oxygen accuracy test is complete.

8.5.11 Test 11: Heated Exhalation Bacteria Filter, Power Fail Alarm, and Display Intensity

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

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

Start here if the optional external battery is installed:

1. Turn ventilator power off.
2. Disconnect the external battery cable from the back panel of the ventilator.
3. Turn the ventilator on.
4. Verify display information is still visible when intensity knob is set at minimum.
5. With the ventilator turned on, unplug the power cord from the AC outlet.
6. Check that the audible alarm sounds and start the stopwatch.
7. Remove the exhalation bacteria filter from the ventilator.
8. Check that it is warm to the touch.
9. Reinstall the exhalation bacteria filter.
10. Check that the audible alarm is still sounding after 2 minutes.
11. Turn ventilator power off.
12. Check that the audible alarm is silenced.
13. Plug the ventilator into an AC outlet.
14. The heated exhalation bacteria filter and power fail alarm test is complete.

Start here if only the backup battery is installed:

1. Turn the ventilator power off.
2. Disconnect the backup battery cable from the back panel of the ventilator.
3. Turn the ventilator on.
4. Verify display information is still visible when intensity knob is set at minimum.
5. With the ventilator turned on, unplug the power cord from the AC outlet.
6. Check that the audible alarm sounds and start the stopwatch.
7. Remove the exhalation bacteria filter from the ventilator.
8. Check that it is warm to the touch.
9. Reinstall the exhalation bacteria filter.

10. Check that the audible alarm is still sounding after 2 minutes.
11. Turn the ventilator power off.
12. Check that the audible alarm is silenced.
13. Plug the ventilator into an AC outlet.
14. The heated exhalation bacteria filter and power fail alarm test is complete.

Start here if no battery is installed:

1. With the ventilator turned on, verify display information is still visible when intensity knob is set at minimum.
2. Unplug the power cord from the AC outlet.
3. Check that the audible alarm sounds and start the stopwatch.
4. Remove the exhalation bacteria filter from the ventilator.
5. Check that it is warm to the touch.
6. Reinstall the exhalation bacteria filter.
7. Check that the audible alarm is still sounding after 2 minutes.
8. Turn ventilator power off.
9. Check that the audible alarm is silenced.
10. Plug the ventilator into an AC outlet.
11. The heated exhalation bacteria filter and power fail alarm test is complete.

8.5.12 Test 12: Neonatal Option Testing

These tests verify pressure accuracy at 5 cmH_2O, low flow, breath rate at 150 BPM, and volume accuracy at 10mL.

If the ventilator is not already in diagnostic mode, simultaneously press the **ALARM RESET** and **100% O_2** keys on the front panel for approximately 5 seconds while turning ventilator power **ON**. Touch **OK** to enter diagnostic mode.

Test 12a: Extended Self Test (EST) in Neonatal Mode

1. Connect a neonatal patient circuit to the ventilator.
2. Select **User Config**, verify **Compliance** is enabled (white background). If not, touch **Compliance** to enable.
3. Touch **EST**, then touch **Start EST**.
4. Select Neonatal patient type and then follow the remaining onscreen instructions.

Test 12b: Pressure Accuracy

1. Remain in diagnostic mode.
2. Block the patient wye.
3. Connect the analyzer to the ventilator (see Figure 8-19).
4. Set the analyzer's pressure range to measure at least 120 cmH_2O.
5. Touch **Hardware**, then touch **Safety** on the Hardware screen to energize (white background) the safety solenoid.
6. Touch **Air** and set the flow to 1 LPM.
7. Touch **Exhalation** and set to 1470 steps, then adjust the steps until the analyzer pressure reads 5 ± 1 cmH_2O (4 to 6 cmH_2O).
8. Verify the *Inhalation Pressure* and *Exhalation Pressure* displays on the hardware screen read within ± 10% of the analyzer display.

Test 12c: Low Flow Test

1. Remove analyzer and reconnect the patient circuit with the wye blocked.
2. Touch **Exhalation** on the Hardware screen and set to 0 steps.
3. Touch **Air** and set the flow to 3 LPM.
4. Verify the displayed exhalation flow is 3 ± 0.5 LPM.

Test 12d: Breath Rate Test

1. Unblock the patient wye and connect a Test Lung.
2. Cycle power to the ventilator to enter normal ventilation mode.
3. Ensure **Neo** patient type is selected.

4. Select the following settings and alarm limits:

Ventilator Settings	Alarm Settings
Mode: PCV - A/C	High Pressure: 105 cmH_2O
Rate: 150 BPM	Low Pressure: 3 cmH_2O
Pressure: 10 cmH_2O	Low PEEP: 0 cmH_2O
I-Time: 0.3 sec	Low Vt Mand: 0 mL
PEEP: 3 cmH_2O	Low Vt Spont: 0 mL
I-Trigger: 10 LPM	High Rate: 150 BPM
E-Cycle: 25%	Low VE: 0.00 L
Rise Time: 0.2 sec	Apnea: 60 sec
O_2: 21%	
Apnea Rate: 20 BPM	

5. Using either a DMM and test leads or an analog output port selector Box, connect a DMM and set to measure frequency.
6. Select NEB on the signal selector box or refer to Figure 8-22 for pinouts.
7. Verify the frequency is between 2.48Hz (149 BPM) and 2.52Hz (151 BPM).

Test 12e: Volume Accuracy

1. Remove test lung from patient wye.
2. Select the following settings and alarm limits:

Ventilator Settings	Alarm Settings
Mode: PCV - A/C	High Pressure: 105 cmH_2O
Rate: 5 BPM	Low Pressure: 3 cmH_2O
Pressure: 10 cmH_2O	Low PEEP: 0 cmH_2O
I-Time: 1.0 sec	Low Vt Mand: 0 mL
PEEP: 3 cmH_2O	Low Vt Spont: 0 mL
I-Trigger: 2.0 LPM	High Rate: 150 BPM
E-Cycle: 25%	Low VE: 0.00 L
Rise Time: 0.2 sec	Apnea: 60 sec
O_2: 21%	
Apnea Rate: 20 BPM	

3. Connect a calibrated 10-mL syringe to the patient wye.
4. During exhalation, pull the syringe all the way out (this should trigger a breath).
5. During the exhalation phase of the triggered breath, push the syringe all the way in.
6. Repeat the previous step ten times, verify the displayed value (V+) on the patient data window is 10 mL ± 5 mL.
7. Remove all test equipment, tools, and materials from ventilator.
8. Turn ventilator **OFF**.
9. Neonatal option testing is complete.

8.5.13 Test 13: Backup Battery and External Battery (If Installed)

This test verifies that the ventilator can transition to and from battery power sources, when these power sources are installed.

NOTE: This test cannot be performed if batteries are not installed.

NOTE: The backup and external batteries (if installed) should be *fully charged* before performing this test. If the backup or external battery is not fully charged, this test may fail. Record the result of this test as (Limited Use) on the Performance Verification Data Form until the Backup Battery is charged and the Backup Battery test passes.

Test 13a: Start here if the optional external battery is installed

1. Make sure the ventilator is connected to AC power.
2. With the external battery plugged in, check that the *Mains* LED is ON (green).
3. Check: amber (charging) LED OFF (indicating battery fully charged).

NOTE: If the amber LED is ON, wait until it is OFF before proceeding.

4. Turn the ventilator power ON, enter diagnostic mode, and select the hardware screen.
5. Verify that the ventilator *Mains* LED is illuminated.
6. Verify that the external battery ON/OFF switch is in the ON position.
7. Unplug the AC power cord and verify that the ventilator front panel *Mains* LED turns OFF and the *External Battery* LED turns ON.
8. Verify that both the *AC* and *Charging* indicators on the External Battery are OFF.
9. Verify that the *Bus Voltage* on the hardware screen is at least 22.3 VDC.
10. Allow the ventilator to run 10 minutes on external battery power.
11. Verify that the *Bus Voltage* on the hardware screen is at least 22.3 VDC.
12. With AC still disconnected, cycle power to the ventilator and allow it to come up in ventilation mode.
13. Verify that the ventilator front panel *External Battery* LED is ON and the *Battery In Use* and *Battery Low* LEDs are OFF.
14. Reconnect the AC power cord. Verify that the ventilator continues operating uninterrupted, the ventilator front panel *Mains* LED turns ON, and the *External Battery* LED turns OFF.
15. Verify that the External Battery *AC* and *Battery Charging* LEDs are ON.
16. Turn the ventilator OFF.
17. The external battery test is complete.

Test 13b: Start here if only the backup battery is installed

1. Connect the ventilator to AC power, enter diagnostic mode, and select the hardware screen.
2. Unplug the AC power cord and verify that ventilator operation continues uninterrupted and the *Bus Voltage* on the hardware screen is at least 22.3 VDC.
3. Allow ventilator to run 5 minutes on backup battery power.
4. Verify the *Bus Voltage* on the hardware screen is at least 22.3 VDC.
5. With AC still disconnected, cycle power to the ventilator and allow it to come up in normal ventilation.
6. Verify that the ventilator operates in normal ventilation, the message *Backup Battery On* is displayed in the Alert window, the *Battery In Use* indicator is on, and the *Battery Low* indicator turns off.
7. Reconnect the AC power cord. Verify that the ventilator continues operating uninterrupted, the *Mains* indicator turns on, and the *Battery In Use* indicator turns off.
8. Verify that the *Battery Charging* indicator lights within 30 seconds.
9. The backup battery test is complete.

8.6 Returning Ventilator to Normal Operation

Follow these steps to return the ventilator to operation after a successful performance verification:

1. Remove all test equipment, tools, and materials from ventilator.
2. Enter diagnostic mode by simultaneously pressing the **ALARM RESET** and **100% O_2** keys on the front panel for approximately five seconds while turning ventilator power ON.
3. Touch **OK**, **User Config**, and then **Compliance** to enable circuit compliance.

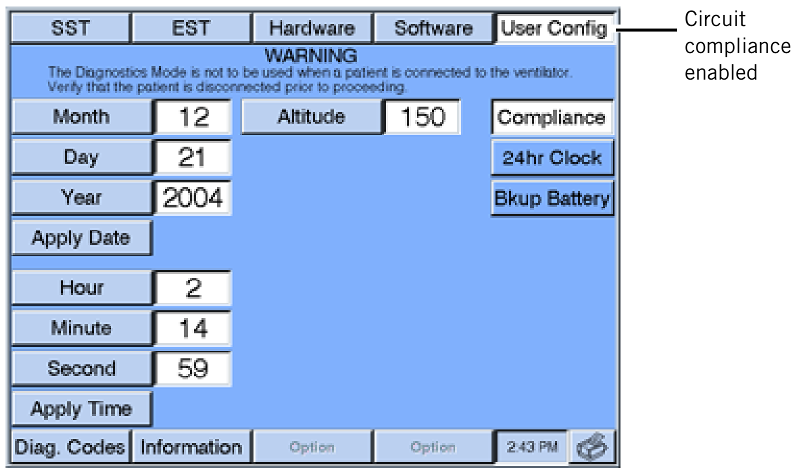


Figure 8-26: User Configuration Screen - Compliance Enabled

4. Touch **Bkup Battery** to enable backup battery confirmation if applicable.
5. Correct the date, time, and altitude if necessary.
6. Rerun electrical safety test if any repairs were made.
7. Reconnect the original patient circuit and inspiratory bacteria filter to the ventilator.
8. Run SST with Adult patient type selected.
9. Turn the alarm volume control knob fully clockwise.
10. Turn ventilator OFF to exit diagnostic mode, then turn ON to enter normal ventilation mode.

11. Verify that the I-Trigger is set to Pressure Triggering with a value of 2.0 cmH_2O (Figure 8-27) before returning the ventilator to use.

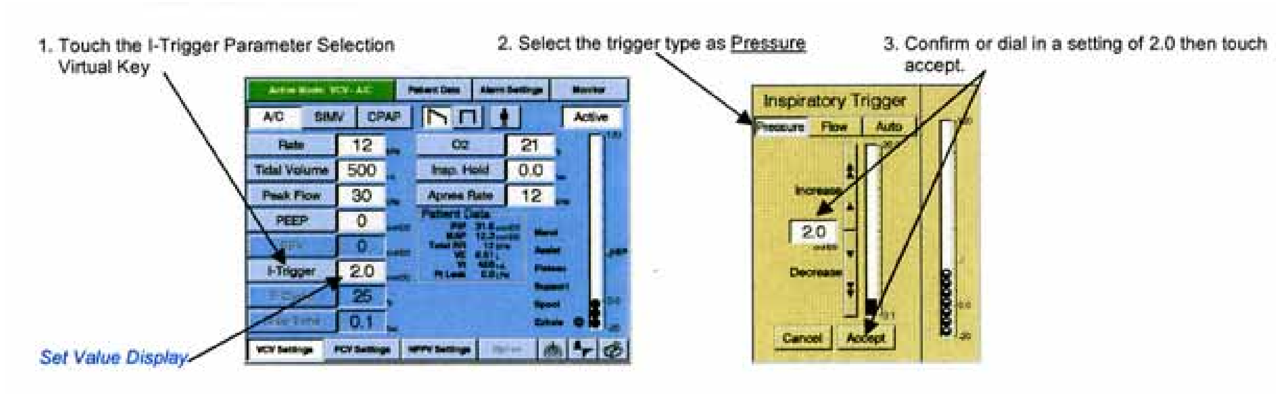


Figure 8-27: I-Trigger Sensitivity Setting

8.7 Performance Verification Troubleshooting/ Repair

Use the following troubleshooting procedures if the ventilator fails a performance verification test. Make sure that the external measurement devices such as the pneumatic calibration analyzer are calibrated and functioning properly.

Perform the repair procedures in the order listed until the problem is resolved. (See Chapter 5 for diagnostic mode procedures, and Chapter 9 for Esprit or Chapter 10 for Respironics V200 component replacement procedures.)

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

8.7.1 Test 1: Electrical Safety

Symptom	Recommended Repair
Ground resistance out of range	1. Verify that the AC outlet is properly grounded. Try another AC outlet. 2. Verify that the AC power cord is completely inserted into the AC inlet. 3. Bypass external battery (if connected). 4. Check for secure connections of AC mains ground wires on the AC distribution panel, power supply, and equipotential ground. 5. Check for visible damage to the power cord. 6. Replace power cord.
Cooling fan(s) not operating	1. Check that the fan wires are properly seated in connector J2 on the blower controller PCB (for the cooling coil fan) and that the power supply shroud fan is connected. 2. Slave in a replacement fan and replace if it is operational. 3. Replace the power supply.
Forward/reverse leakage current out of range	1. Disconnect any devices plugged into the humidifier outlet. 2. Bypass external battery (if connected). 3. Check for missing insulation strips on the power supply shroud. 4. Check for secure connections of AC mains ground wires on the AC distribution panel, power supply, and equipotential ground. 5. Replace power cord and rerun test. 6. Check for pinched cables and harnesses or damaged wire insulation throughout the ventilator. 7. Replace power supply and rerun test.

8.7.2 Test 2: Extended Self Test

See Chapter 5 for EST instructions and Chapter 6 for diagnostic code repair procedures.

8.7.3 Test 3: Air Flow Accuracy

Symptom	Recommended Repair
Measured flow rates out of range	1. Confirm correct altitude setting. 2. Check that safety valve solenoid is energized. 3. Verify calibration analyzer is set to measure air in ATP mode. 4. Check that nothing is obstructing the ventilator inspiratory outlet. 5. Verify that CV3 is correctly positioned and oriented. 6. If air flow sensor reading is within specification of the calibration analyzer, check for exhalation bacteria filter occlusions (perform the back pressure test or replace filter) and confirm CV4 orientation before replacing the exhalation flow sensor. 7. If air flow sensor reading is not within limits as compared to the calibration analyzer, replace the air flow sensor. 8. Slave in a different air flow sensor cable. 9. Replace air motor controller PCB. 10.Replace the sensor PCB. 11.Replace the air valve assembly.

8.7.4 Test 4: Oxygen Flow Accuracy

Symptom	Recommended Repair
Measured flow rates out of tolerance	1. Confirm correct altitude setting. 2. Check that safety valve solenoid is energized. 3. Verify calibration analyzer is set to measure oxygen in ATP mode. 4. Check that nothing is obstructing the ventilator inspiratory outlet. 5. Verify that CV3 is correctly positioned and oriented. 6. If oxygen flow sensor reading is within specification of the calibration analyzer, check for exhalation bacteria filter occlusions (perform the back pressure test or replace filter) and confirm CV4 orientation before replacing the exhalation flow sensor. 7. If oxygen flow sensor reading is not within limits as compared to the calibration analyzer, replace the oxygen flow sensor. 8. Slave in a different oxygen flow sensor cable. 9. Replace oxygen motor controller PCB. 10.Replace the sensor PCB. 11.Replace the oxygen valve assembly.

8.7.5 Test 5: Pressure Accuracy

Symptom	Recommended Repair
Inhalation/exhalation pressure readings out of range at 100 cmH_2O	1. Check for leaks at circuit connections, test lung, filters, etc. 2. Check for kinked or cut tubing from inhalation module to SOL4, and from SOL4 to sensor PCB. 3. Check for kinked or cut tubing from exhalation pressure tap to SOL3, and from SOL3 to sensor PCB. 4. Check for leaks at the oxygen sensor/oxygen valve connection. 5. Replace the sensor PCB. 6. Replace the 3-station solenoid.

8.7.6 Test 6: PEEP System

Symptom	Recommended Repair
Ventilator PEEP below acceptable value	1. Check for leaks at circuit connections, test lung, filters, etc. 2. Check for kinked or cut tubing from inhalation module to SOL4, and from SOL4 to sensor PCB. 3. Check for kinked or cut tubing from exhalation pressure tap to SOL3, and from SOL3 to sensor PCB. 4. Replace sensor PCB. 5. Replace exhalation valve assembly.
Ventilator PEEP above acceptable value	Replace sensor PCB.
Ventilator breath rate outside acceptable value	1. Check for leaks at circuit connections, test lung, filters, etc., and bypass oxygen sensor. 2. Replace patient circuit (including exhalation bacteria filter).

8.7.7 Test 7: Breath Rate

Symptom	Recommended Repair
Ventilator breath rate outside acceptable value	1. Replace CPU PCB. 2. Replace main PCB.

8.7.8 Test 8: Alarm Output Signal, Volume, and Remote Alarm

Symptom	Recommended Repair
Normally open or normally closed relay test failure (continuity check)	1. Verify continuity of remote alarm test cable. 2. Replace main PCB.
Primary alarm volume not adjustable	1. Verify that alarm volume potentiometer is connected to J5 connector on MMI PCB. 2. Slave in another alarm volume potentiometer. 3. Replace MMI PCB.
Analog output port alarm voltage outside acceptable range	1. Replace digital PCB. 2. Replace main PCB.

8.7.9 Test 9: Gas Volume Accuracy

Symptom	Recommended Repair
Measured tidal volume out of tolerance	1. Verify that altitude is correct. 2. Verify that compliance factor is disabled. 3. Verify that calibration analyzer is set to measure the correct gas flow (air or oxygen, depending on which test failed) flow sensor. 4. Replace source gas (air or oxygen, depending on which test failed). 5. Replace source gas motor controller (air or oxygen, depending on which test failed). 6. Replaced source gas valve (air or oxygen, depending on which test failed). 7. Replace sensor PCB. 8. Replace analog PCB.

8.7.10 Test 10: Oxygen Accuracy

Symptom	Recommended Repair
The % O_2 in the *Patient Data* screen is out of tolerance	1. Check that test oxygen monitor is calibrated. 2. Run EST to calibrate the oxygen sensor and verify that the calibration test passes. 3. Verify that the oxygen sensor coupling is directly connected to the main outlet of the ventilator. 4. Verify that the oxygen sensor is oriented with cable connector on top. 5. Verify that the oxygen sensor is positioned in its rectangular recess in the bottom enclosure. 6. Replace the oxygen sensor harness and run EST to recalibrate the sensor. 7. Replace the sensor PCB and run EST to recalibrate the sensor.

8.7.11 Test 11: Heated Exhalation Bacteria Filter, Power Failure Alarm, and Display Intensity

Symptom	Recommended Repair
Backup audible alarm fails to sound	1. Slave in replacement backup alarm. 2. Replace the MMI to backup alarm cable. 3. Replace digital PCB. 4. Replace MMI PCB.
Backup audible alarm fails to sound for at least two minutes	1. Replace main PCB. 2. Replace digital PCB.
Filter heater is not warm to the touch after 20 minutes of operation	1. Verify that the 26-29 VDC is present on heater connector terminals (heater connector is on the main to motor 1, 2, 3 cable). 2. Replace filter heater assembly. 3. Replace the main PCB.
Power switch turned off but backup alarm remains on	1. Slave in replacement power switch. 2. Replace power switch harness. 3. Replace digital PCB.
Display not visible when set to minimum intensity	1. Replace backlight inverter harness. 2. Replace backlight inverter PCB. 3. Replace LCD.

8.7.12 Test 12: Neonatal Option Test

Symptom	Recommended Repair
Inhalation/exhalation pressure readings out of range at 5 cmH_2O	1. Check for leaks at circuit connections, test lung, filters, etc. 2. Check for kinked or cut tubing from inhalation module to SOL4, and from SOL4 to sensor PCB. 3. Check for kinked or cut tubing from exhalation pressure tap to SOL3, and from SOL3 to sensor PCB. 4. Check for leaks at the oxygen sensor/oxygen valve connection. 5. Replace the sensor PCB. 6. Replace the 3-station solenoid.
Low flow rate out of range	1. Confirm correct altitude setting. 2. Check that safety valve solenoid is energized. 3. Verify that CV3 is correctly positioned and oriented. 4. Check for exhalation bacteria filter occlusions (perform the back pressure test or replace filter). 5. Verify that CV4 is correctly positioned and oriented. If not, reposition and re-test. 6. If CV4 is correctly positioned and oriented, replace CV4. 7. Replace the exhalation flow sensor.
Ventilator breath rate outside acceptable value	1. Check for leaks at circuit connections, test lung, filters, etc., and bypass oxygen sensor. 2. Replace patient circuit (including exhalation bacteria filter). 3. Replace CPU PCB. 4. Replace main PCB.
Measured tidal volume out of tolerance	1. Verify the altitude is correct. 2. Verify the compliance factor is disabled. 3. Verify that CV4 is correctly positioned and oriented, if not reposition and re-test. 4. If CV4 is correctly positioned and oriented, replace CV4. 5. Replace the exhalation flow sensor. 6. Replace sensor PCB. 7. Replace analog PCB.

8.7.13 Test 13: Backup Battery and External Battery Test

Symptom	Recommended Repair
Ventilator unable to transition from AC to external battery	1. Verify external battery's power switch is turned on. 2. Verify that battery's harness connections are secure. 3. Check the external battery fuse (see external battery service instructions). 4. Replace the power supply.
Backup battery becomes depleted prematurely	1. If battery had been allowed to fully charge before test, replace the backup battery. 2. Replace the power supply.
Connecting to AC power causes ventilator to reset	Replace the power supply.
Backup battery *Charging* indicator fails to light when connected to AC power following 10 minutes of battery operation	Replace the power supply.
AC disconnect does not cause AC or *Charging* indicator to turn off	Replace external battery charger PCB (see external battery service instructions).
Displayed bus voltage is below 22.3 VDC during external battery operation	1. Allow external battery to fully charge (recharge for 10 to 14 hours if fully depleted). 2. Check the external battery output voltage with a DMM (see external battery service instructions). Replace battery if the output voltage is below 22.3 VDC.
External battery keyboard indicator does not light	1. Verify that ventilator is operating from external battery power. To ensure external battery operation, try turning backup battery power switch off and disconnecting backup battery. 2. Replace the front panel keyboard if the external battery is functional.
Displayed bus voltage for backup battery below 22.3 VDC during backup battery operation	1. Allow backup battery to fully charge (recharge for 8 to 12 hours if fully depleted). 2. Check the backup battery output voltage with a DMM. Replace battery if the output voltage is below 22.3 VDC.
Cycling ventilator power results in diagnostic code or continuous backup alarm condition	1. Allow backup battery to fully charge (recharge for 8 to 12 hours if fully depleted). 2. Slave-in a known-good backup battery. 3. Replace the power supply.

8.8 Neonatal Option Data Form

Complete this form whenever the Neonatal option is added to the ventilator. **Make copies of this form for data collection.**

Date: ____________ **Notification number(s):** ____________________

____

Customer Information

Name: ______________________________

Address: ______________________________

City/State: ______________________________

Account no.: ______________________________

Preliminary ventilator cleaning and inspection	**Circle one**	
Was the ventilator damaged?	YES	NO
If yes, provide a brief description of damage and repair:		
Cleaned ventilator exterior?	YES	NO
Inspected cooling fan filter?	YES	NO
Inspected blower inlet filter?	YES	NO
Inspected O_2 water trap/inlet filter?	YES	NO

	Model:					
	Serial number:		Software (flash) version:			
	Altitude:		Elapsed time meter:			
	Installed options:	❑ ALRM	❑ Auto	❑ Color	❑ COM1	❑ COM2
❑ FTrak	❑ Graphics	❑ Mech	❑ Neonatal	❑ NICO	❑ SM	❑ Trend
❑	❑	❑	❑	❑	❑	❑

Test 1: Electrical safety	**Circle one**		**Passed value**	**Failed value**	**Value after repair**
Proper cooling fan operation?	YES	NO			
GND resistance (<0.2 ohm)			Ω	Ω	Ω
Forward leakage current: ❑ <100 µA (100-120V) ❑ <300 µA (100-120V & external battery) ❑ <300 µA (220-240V)			µA	µA	µA
Reverse leakage current: ❑ <100 µA (100-120V) ❑ <300 µA (100-120V & external battery) ❑ <300 µA (220-240V)			µA	µA	µA

Test 2: Extended self test (EST)	**Circle one**	
Did EST pass?	YES	NO

Test 12: Neonatal option testing

Test 12a: EST in neonatal mode	Circle one	
Did EST pass in neonatal mode?	PASS	FAIL

Test 12b: Pressure accuracy	Initial value	Passed value	Failed value	Value after repair
Analyzer pressure display 4-6 cmH_2O	cmH_2O			
Inhalation Pressure display = analyzer display ± 10%		cmH_2O	cmH_2O	cmH_2O
Exhalation Pressure display = analyzer display ± 10%		cmH_2O	cmH_2O	cmH_2O

Test 12c: Low flow	Passed value	Failed value	Value after repair
Exhalation flow 2.5 - 3.5 LPM	LPM	LPM	LPM

Test 12d: Breath rate test in neonatal mode	Passed value	Failed value	Value after repair
Hz display 2.48 (149 BPM) - 2.52 (151 BPM) after 60 seconds	Hz	Hz	Hz

Test 12e: Volume accuracy in neonatal mode	Passed value	Failed value	Value after repair
Tidal volume display 5 - 15mL	mL	mL	mL

Technician's signature **Date**

8.9 Electrical Safety/ Extended Self Test (EST) Data Form

Complete this form whenever Electrical Safety and Extended Self Test (EST) are performed. **Make copies of this form for data collection..**

Date: ____________ **Notification number(s):** ______________________

____

Customer Information

Name: ______________________________

Address: ______________________________

City/State: ______________________________

Account no.: ______________________________

Preliminary ventilator cleaning and inspection	**Circle one**	
Was the ventilator damaged?	YES	NO
If yes, provide a brief description of damage and repair:		
Cleaned ventilator exterior?	YES	NO
Inspected cooling fan filter?	YES	NO
Inspected blower inlet filter?	YES	NO
Inspected O_2 water trap/inlet filter?	YES	NO

Model:						
Serial number:			Software (flash) version:			
Altitude:			Elapsed time meter:			
Installed options:		❑ ALRM	❑ Auto	❑ Color	❑ COM1	❑ COM2
❑ FTrak	❑ Graphics	❑ Mech	❑ Neonatal	❑ NICO	❑ SM	❑ Trend
❑	❑	❑	❑	❑	❑	❑

Test 1: Electrical safety	**Circle one**		**Passed value**	**Failed value**	**Value after repair**
Proper cooling fan operation?	YES	NO			
GND resistance (<0.2 ohm)			Ω	Ω	Ω
Forward leakage current: ❑ <100 µA (100-120V) ❑ <300 µA (100-120V & external battery) ❑ <300 µA (220-240V)			µA	µA	µA
Reverse leakage current: ❑ <100 µA (100-120V) ❑ <300 µA (100-120V & external battery) ❑ <300 µA (220-240V)			µA	µA	µA

Test 2: Extended self test (EST)	**Circle one**	
Did EST pass?	YES	NO

______________________________ ____________

Technician's signature **Date**

8.10 Performance Verification Data Form

Complete this form at every performance verification. **Make copies of this form for data collection.**

Date: ____________ **Notification number(s):** ____________________

____

Customer Information

Name: ____________________

Address: ____________________

City/State: ____________________

Account no.: ____________________

Preliminary ventilator cleaning and inspection	**Circle one**	
Was the ventilator damaged?	YES	NO
If yes, provide a brief description of damage and repair:		
Cleaned ventilator exterior?	YES	NO
Inspected cooling fan filter?	YES	NO
Inspected blower inlet filter?	YES	NO
Inspected O_2 water trap/inlet filter?	YES	NO

Model:						
Serial number:			Software (flash) version:			
Altitude:			Elapsed time meter:			
Installed options:		❑ ALRM	❑ Auto	❑ Color	❑ COM1	❑ COM2
❑ FTrak	❑ Graphics	❑ Mech	❑ Neonatal	❑ NICO	❑ SM	❑ Trend
❑	❑	❑	❑	❑	❑	❑

Test 1: Electrical safety	**Circle one**		**Passed value**	**Failed value**	**Value after repair**
Proper cooling fan operation?	YES	NO			
GND resistance (<0.2 ohm)			Ω	Ω	Ω
Forward leakage current: ❑ <100 μA (100-120V) ❑ <300 μA (100-120V & external battery) ❑ <300 μA (220-240V)			μA	μA	μA
Reverse leakage current: ❑ <100 μA (100-120V) ❑ <300 μA (100-120V & external battery) ❑ <300 μA (220-240V)			μA	μA	μA

Test 2: Extended self test (EST)	**Circle one**	
Did EST pass?	YES	NO

Test 3: Air flow accuracy	Passed value	Failed value	Value after repair
Air Position display at 1 LPM (185-525 steps)	Steps	Steps	Steps
Air Position display at 180 LPM (refer to altitude table)	Steps	Steps	Steps
Air at 5 LPM			
Analyzer Flow display (4.5-5.5 LPM)	LPM	LPM	LPM
Air Flow display (4.5-5.5 LPM)	LPM	LPM	LPM
Exhalation Flow display (4.5-5.5 LPM)	LPM	LPM	LPM
Air at 10 LPM			
Analyzer Flow display (9-11 LPM)	LPM	LPM	LPM
Air Flow display (9-11 LPM)	LPM	LPM	LPM
Exhalation Flow display (9-11 LPM)	LPM	LPM	LPM
Air at 20 LPM			
Analyzer Flow display (18-22 LPM)	LPM	LPM	LPM
Air Flow display (18-22 LPM)	LPM	LPM	LPM
Exhalation Flow display (18-22 LPM)	LPM	LPM	LPM
Air at 50 LPM			
Analyzer Flow display (45-55 LPM)	LPM	LPM	LPM
Air Flow display (45-55 LPM)	LPM	LPM	LPM
Exhalation Flow display (45-55 LPM)	LPM	LPM	LPM
Air at 100 LPM			
Analyzer Flow display (90-110 LPM)	LPM	LPM	LPM
Air Flow display (90-110 LPM)	LPM	LPM	LPM
Exhalation Flow display (90-110 LPM)	LPM	LPM	LPM
Air at 120 LPM			
Analyzer Flow display (108-132 LPM)	LPM	LPM	LPM
Air Flow display (108-132 LPM)	LPM	LPM	LPM
Exhalation Flow display (108-132 LPM)	LPM	LPM	LPM
Air at 165 LPM			
Analyzer Flow display (148.5-181.5 LPM)	LPM	LPM	LPM
Air Flow display (148.5-181.5 LPM)	LPM	LPM	LPM
Exhalation Flow display (148.5-181.5 LPM)	LPM	LPM	LPM
Air at 0 LPM			
Analyzer Flow display (±0.1 LPM)	LPM	LPM	LPM
Air Flow display (±0.1 LPM)	LPM	LPM	LPM
Exhalation Flow display (±0.1 LPM)	LPM	LPM	LPM

Test 4: Oxygen flow accuracy	Passed value	Failed value	Value after repair
Oxygen Position display at 1 LPM (185-525 steps)	Steps	Steps	Steps
Oxygen Position display at 180 LPM (refer to altitude table)	Steps	Steps	Steps
Oxygen at 5 LPM			
Analyzer Flow display (4.0-6.0 LPM)	LPM	LPM	LPM
Oxygen Flow display (4.0-6.0 LPM)	LPM	LPM	LPM
Oxygen at 10 LPM			
Analyzer Flow display (9-11 LPM)	LPM	LPM	LPM
Oxygen Flow display (9-11 LPM)	LPM	LPM	LPM
Oxygen at 20 LPM			
Analyzer Flow display (18-22 LPM)	LPM	LPM	LPM
Oxygen Flow display (18-22 LPM)	LPM	LPM	LPM
Oxygen at 50 LPM			
Analyzer Flow display (45-55 LPM)	LPM	LPM	LPM
Oxygen Flow display (45-55 LPM)	LPM	LPM	LPM
Oxygen at 100 LPM			
Analyzer Flow display (90-110 LPM)	LPM	LPM	LPM
Oxygen Flow display (90-110 LPM)	LPM	LPM	LPM
Oxygen at 120 LPM			
Analyzer Flow display (108-132 LPM)	LPM	LPM	LPM
Oxygen Flow display (108-132 LPM)	LPM	LPM	LPM
Oxygen at 165 LPM			
Analyzer Flow display (148.5-181.5 LPM)	LPM	LPM	LPM
Oxygen Flow display (148.5-181.5 LPM)	LPM	LPM	LPM
Oxygen at 0 LPM			
Analyzer Flow display (±0.1 LPM)	LPM	LPM	LPM
Oxygen Flow display (±0.1 LPM)	LPM	LPM	LPM

Test 5: Pressure accuracy	Initial value	Passed value	Failed value	Value after repair
Analyzer Pressure display 95-105 cmH_2O	cmH_20			
Inhalation Pressure display = analyzer display ± 10%		cmH_20	cmH_20	cmH_20
Exhalation Pressure display = analyzer display ± 10%		cmH_20	cmH_20	cmH_20

Test 6: PEEP system	Passed value	Failed value	Value after repair
I-Trigger = 2 cmH_20, **PEEP** = 5 cmH_20			
Analyzer pressure display (4.0-6.0 cmH_20)	cmH_20	cmH_20	cmH_20
Pe End display (4.0-6.0 cmH_20)	cmH_20	cmH_20	cmH_20
Rate display (6 BPM)	BPM	BPM	BPM
I-Trigger = 2 cmH_20, **PEEP** = 10 cmH_20			
Analyzer pressure display (9-11 cmH_20)	cmH_20	cmH_20	cmH_20
Pe End pressure display (9-11 cmH_20)	cmH_20	cmH_20	cmH_20
Rate display (6 BPM)	BPM	BPM	BPM
I-Trigger = 2 cmH_20, **PEEP** = 25 cmH_20			
Analyzer pressure display (22.5 - 27.5 cmH_20)	cmH_20	cmH_20	cmH_20
Pe End pressure display (22.5 - 27.5 cmH_20)	cmH_20	cmH_20	cmH_20
Rate display (6 BPM)	BPM	BPM	BPM
I-Trigger = 4 LPM, **PEEP** = 25 cmH_20			
Analyzer pressure display (22.5 - 27.5 cmH_20)	cmH_20	cmH_20	cmH_20
Pe End pressure display (22.5 - 27.5 cmH_20)	cmH_20	cmH_20	cmH_20
Rate display (6 BPM)	BPM	BPM	BPM
I-Trigger = 4 LPM, **PEEP** = 10 cmH_20			
Analyzer pressure display (9-11 cmH_20)	cmH_20	cmH_20	cmH_20
Pe End pressure display (9-11 cmH_20)	cmH_20	cmH_20	cmH_20
Rate display (6 BPM)	BPM	BPM	BPM

Test 6: PEEP system	Passed value	Failed value	Value after repair
I-Trigger = 4 LPM, **PEEP** = 5 cmH_20			
Analyzer pressure display (4.0 - 6.0 cmH_20)	cmH_20	cmH_20	cmH_20
Pe End pressure display (4.0 -6.0 cmH_20)	cmH_20	cmH_20	cmH_20
Rate display (6 BPM)	BPM	BPM	BPM

Test 7: Breath rate test	Passed value	Failed value	Value after repair
Rate display 59 - 61 BPM after 60 s	BPM	BPM	BPM

Test 8: Alarm/analog output signals, alarm volume, and remote alarm	Circle one	
DMM to remote alarm test cable reads infinite resistance, no alarm	PASS	FAIL
DMM reads -3 to 3 Ω with no alarm	PASS	FAIL
Alarm volume steadily increases	PASS	FAIL
DMM reads infinite resistance with alarm	PASS	FAIL
DMM to analog output port reads -3 to 3 Ω with alarm	PASS	FAIL
Audio alarm is automatically silenced	PASS	FAIL
DMM reads 1.25 - 1.75 V with no alarm	PASS	FAIL
Nebulizer signal at 0 V reads -0.1 - 0.1	PASS	FAIL
Nebulizer signal at 5 V reads 4.4 - 5.6 V	PASS	FAIL
Pressure, volume and flow output at 2 V reads 1.7 - 2.3 V	PASS	FAIL
Flow, volume and pressure output at 4 V reads 3.5 - 4.5 V	PASS	FAIL

Test 9: Gas volume accuracy	Passed value	Failed value	Value after repair
Analyzer air reads 225 - 275 mL (square wave)	mL	mL	mL
Analyzer air reads 225 - 275 mL (ramp wave)	mL	mL	mL
Analyzer air reads 450 - 550 mL (ramp wave)	mL	mL	mL
Analyzer air reads 450 - 550 mL (square wave)	mL	mL	mL
Analyzer air reads 900 - 1100 mL (square wave)	mL	mL	mL
Analyzer air reads 900 - 1100 mL (ramp wave)	mL	mL	mL
Analyzer air reads 2250 - 2750 mL (ramp wave)	mL	mL	mL
Analyzer air reads 2250 - 2750 mL (square wave)	mL	mL	mL
Analyzer O_2 reads 2250 - 2750 mL (square wave)	mL	mL	mL

Test 9: Gas volume accuracy	Passed value	Failed value	Value after repair
Analyzer O_2 reads 2250 - 2750 mL (ramp wave)	mL	mL	mL
Analyzer O_2 reads 900 - 1100 mL (ramp wave)	mL	mL	mL
Analyzer O_2 reads 900 - 1100 mL (square wave)	mL	mL	mL
Analyzer O_2 reads 450 - 550 mL (square wave)	mL	mL	mL
Analyzer O_2 reads 450 - 550 mL (ramp wave)	mL	mL	mL
Analyzer O_2 reads 225 - 275 mL (ramp wave)	mL	mL	mL
Analyzer O_2 reads 225 - 275 mL (square wave)	mL	mL	mL

Test 10: Oxygen accuracy	Passed value	Failed value	Value after repair
External O_2 monitor reads 18 - 24% (VCV)	%	%	%
Ventilator O_2 display reads 18 - 24% (VCV)	%	%	%
External O_2 monitor reads 27 - 33% (VCV)	%	%	%
Ventilator O_2 display reads 27 - 33% (VCV)	%	%	%
External O_2 monitor reads 57 - 63% (VCV)	%	%	%
Ventilator O_2 display reads 57 - 63% (VCV)	%	%	%
External O_2 monitor reads 77 - 83% (VCV)	%	%	%
Ventilator O_2 display reads 77 - 83% (VCV)	%	%	%
External O_2 monitor reads 97 - 103% (VCV)	%	%	%
Ventilator O_2 display reads 97 - 103% (VCV)	%	%	%
External O_2 monitor reads 93 - 99% (PCV)	%	%	%
Ventilator O_2 display reads 93 - 99% (PCV)	%	%	%
External O_2 monitor reads 57 - 63% (PCV)	%	%	%
Ventilator O_2 display reads 57 - 63% (PCV)	%	%	%
External O_2 monitor reads 22 - 28% (PCV)	%	%	%
Ventilator O_2 display reads 22 - 28% (PCV)	%	%	%

Test 11: Heated exhalation filter, power fail alarm, and display intensity	Circle one	
Display information still visible with intensity knob set to minimum	PASS	FAIL
Audible alarm sounds	PASS	FAIL
Exhalation bacteria filter is warm to the touch	PASS	FAIL
Audible alarm is still active after two minutes	PASS	FAIL
Audible alarm was silenced	PASS	FAIL

NOTE: Do not perform Test 12 if the Neonatal option is not installed.

Test 12: Neonatal option testing

Test 12a: EST in neonatal mode	**Circle one**	
Did EST pass in neonatal mode?	PASS	FAIL

Test 12b: Pressure accuracy	**Initial value**	**Passed value**	**Failed value**	**Value after repair**
Analyzer pressure display 4-6 cmH_2O	cmH_2O			
Inhalation Pressure display = analyzer display ± 10%		cmH_2O	cmH_2O	cmH_2O
Exhalation Pressure display = analyzer display ± 10%		cmH_2O	cmH_2O	cmH_2O

Test 12c: Low flow	**Passed value**	**Failed value**	**Value after repair**
Exhalation flow 2.5 - 3.5 LPM	LPM	LPM	LPM

Test 12d: Breath rate test in neonatal mode	**Passed value**	**Failed value**	**Value after repair**
Hz display 2.48 (149 BPM) - 2.52 (151 BPM) after 60 seconds	Hz	Hz	Hz

Test 12e: Volume accuracy in neonatal mode	**Passed value**	**Failed value**	**Value after repair**
Tidal volume display 5 - 15mL	mL	mL	mL

Test 13: Backup battery and external battery test	**Circle one**		
Indicators operate correctly on external battery	PASS	FAIL	N/A
Bus voltage ≥ 22.3 VDC on external battery	PASS	FAIL	N/A
Bus voltage ≥ 22.3 VDC after 10 min. on external battery	PASS	FAIL	N/A
Transition from AC to external battery does not interrupt ventilator operation and indicators operate correctly	PASS	FAIL	N/A
Transition from external battery to AC does not interrupt ventilator operation and indicators operate correctly	PASS	FAIL	N/A
External battery fully charged?	PASS	FAIL	N/A
Transition from AC to backup battery does not interrupt ventilator operation and indicators operate correctly	PASS	FAIL	N/A
Bus voltage ≥ 22.3 VDC on backup battery	PASS	FAIL	N/A

Test 13: Backup battery and external battery test	Circle one		
Bus voltage ≥ 22.3 VDC after 5 min. on backup battery	PASS	FAIL	N/A
Ventilator powers up in normal ventilation and indicators operate correctly	PASS	FAIL	N/A
Transition from backup battery to AC does not interrupt ventilator operation and indicators operate correctly	PASS	FAIL	N/A
Backup battery fully charged?	PASS	FAIL	N/A
Backup battery is *not* fully charged if Battery Low indicator lights during normal operation on AC power. Performance verification result is *LIMITED USE*			

Did the performance verification pass? (Circle one)			
YES	**NO**	**LIMITED USE (backup battery)***	**LIMITED USE (external battery)***
* LIMITED USE indicates that the backup battery or external battery operational check failed. Recommend that the operator connect the ventilator to AC power for at least 12 hours and verify battery performance.			

Technician's signature **Date**

(This page is intentionally blank.)

Chapter 9. Esprit Ventilator Component Removal/Installation

WARNING: To avoid personal injury, always disconnect external AC and DC power sources and high-pressure oxygen sources from the ventilator before servicing.

NOTE: Two GUI versions exist in the field: the original monochrome 9.5-in. GUI, and the later 10.4-in. GUI with color capability. Because the 9.5-in. GUI assembly is no longer available, the 10.4-in. GUI upgrade kit must be installed when replacing a VGA display, touch frame, backlight inverter PCB, or keyboard.

These flow charts summarize the disassembly sequence for the top enclosure with the 9.5-in. GUI (Figure 9-1), top enclosure with newer 10.4-in. GUI (Figure 9-2), and the bottom enclosure (Figure 9-3).

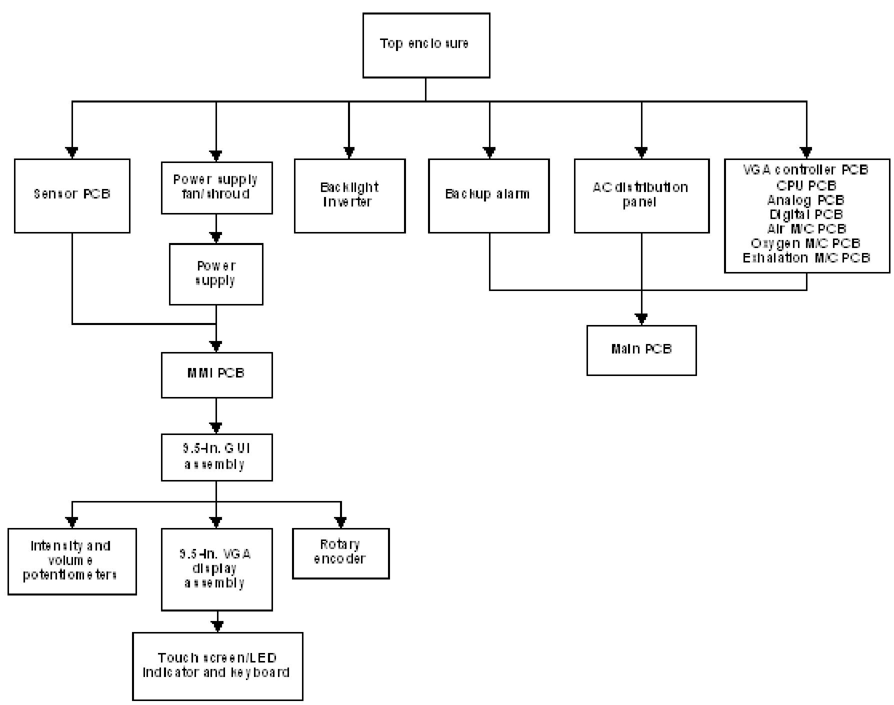


Figure 9-1: Top Enclosure (9.5-in. GUI) Disassembly Flow Chart

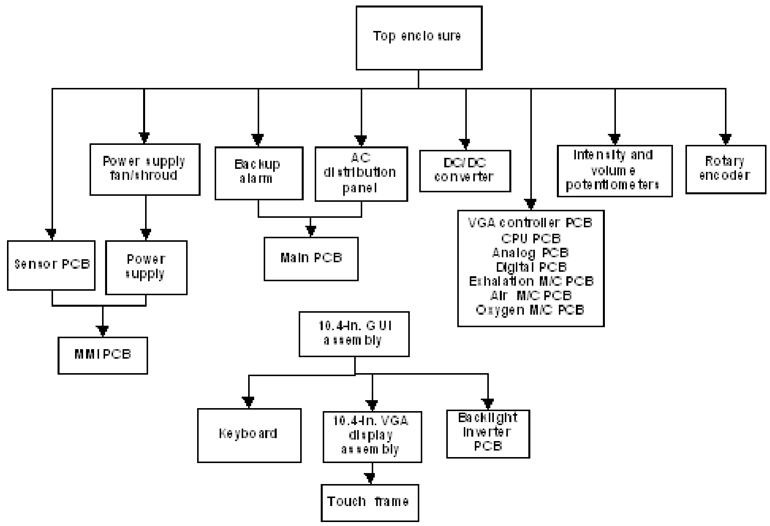


Figure 9-2: Top Enclosure (10.4-in. GUI) Disassembly Flow Chart

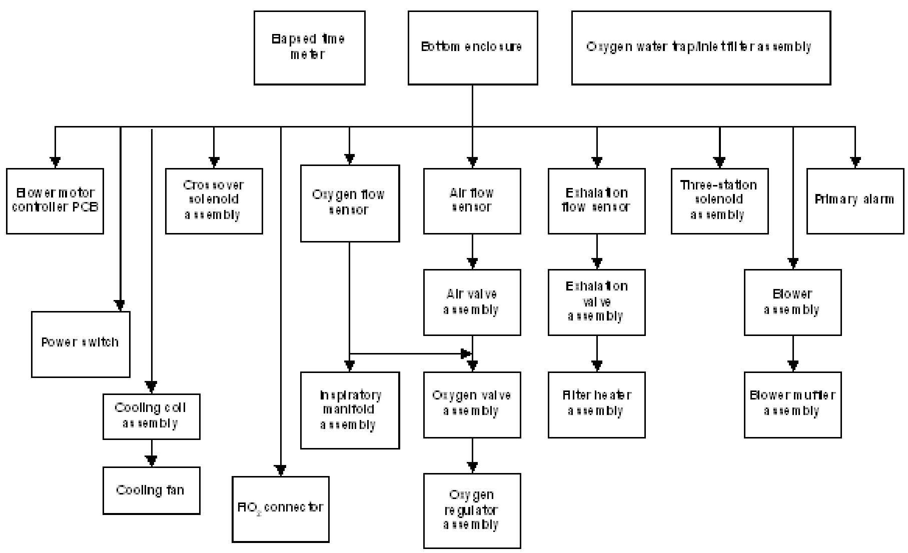


Figure 9-3: Bottom Enclosure Disassembly Flow Chart

9.1 Filter Replacement

To remove the air inlet filter (Figure 9-4), pull to remove outer air inlet filter housing, then remove air inlet filter. *Do not* remove screws that hold inner housing to the back panel. Reverse to install.

Figure 9-4: Air Inlet Filter

To remove the blower inlet filter (Figure 9-5), pull blower inlet filter from blower inlet. Reverse to install, ensuring that the filter is positioned to cover the blower inlet.

Figure 9-5: Blower Inlet Filter

To remove the oxygen water trap filter (Figure 9-6), unscrew the water trap, then unscrew the filter element. Reverse to install a new filter.

Figure 9-6: Oxygen Water Trap Filter

9.2 Top Enclosure

Follow these steps to remove the top enclosure (Figure 9-7). Reverse removal steps to install.

CAUTION: Be careful not to pull or crimp any cables, tubes, or wires during removal or installation.

1. Turn ventilator power OFF, then disconnect AC power and oxygen from the ventilator.
2. Remove all accessories (including humidifiers, flex arms, etc.) and external cables from the ventilator.
3. Remove six screws and washers (three on each side) from the side rails. Two longer screws are closest to the front panel.
4. Remove the four screws and washers from the underside of the bottom enclosure. Hang the enclosure off the work surface to remove the back screws.
5. Carefully lift the top enclosure from the unit.

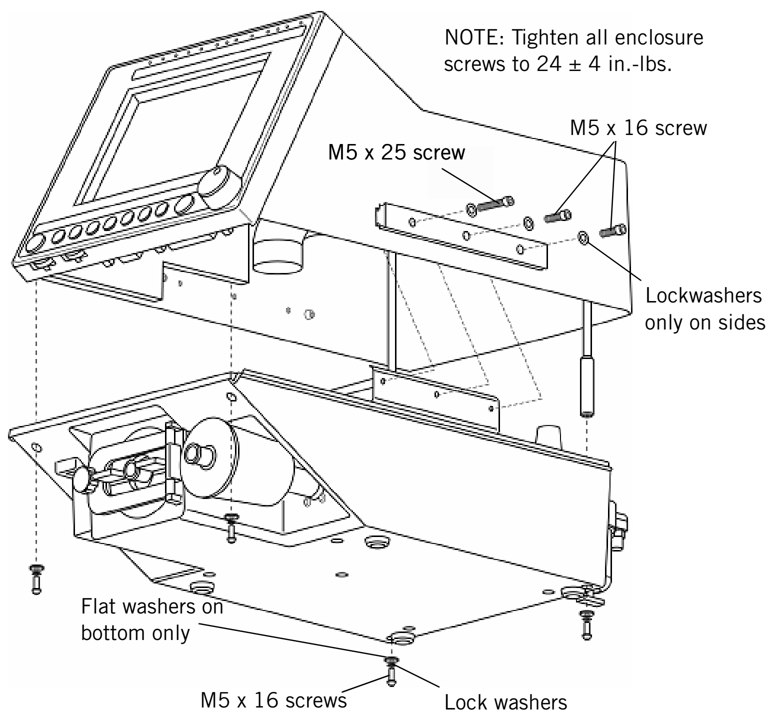


Figure 9-7: Top Enclosure

9.3 Sensor PCB

Follow these steps to remove the sensor PCB (Figure 9-8). Reverse removal steps to install.

CAUTION: When removing or installing the sensor PCB, avoid bumping the R76 potentiometer.

NOTE: For a ventilator with a 9.5-in. display, the GUI and MMI PCB must be installed before reinstalling the sensor PCB.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove all cables from the connectors on the sensor PCB:

Remove this cable:	From this connector on the Sensor PCB:
SEN J1	J1
Black wires from oxygen pressure switch*	J5 and J6
SEN J9	J9
SEN J2	J2
SEN J7	J7
SEN J12	J12
SEN J10	J10
SEN J11	J11
SEN BRD J8	J8
SENSOR BRD J3 & J4*	J3 and J4
*Either wire can be connected to either terminal.	

3. Disconnect the exhalation solenoid tube from pressure sensor U32, and the inhalation solenoid tube from pressure sensor U33 on the sensor PCB.

CAUTION: To avoid damage to sensors, pry (don't pull) tubes from sensors.

4. Unsnap the sensor PCB from the top two posts, then the bottom two posts. Remove the sensor PCB.

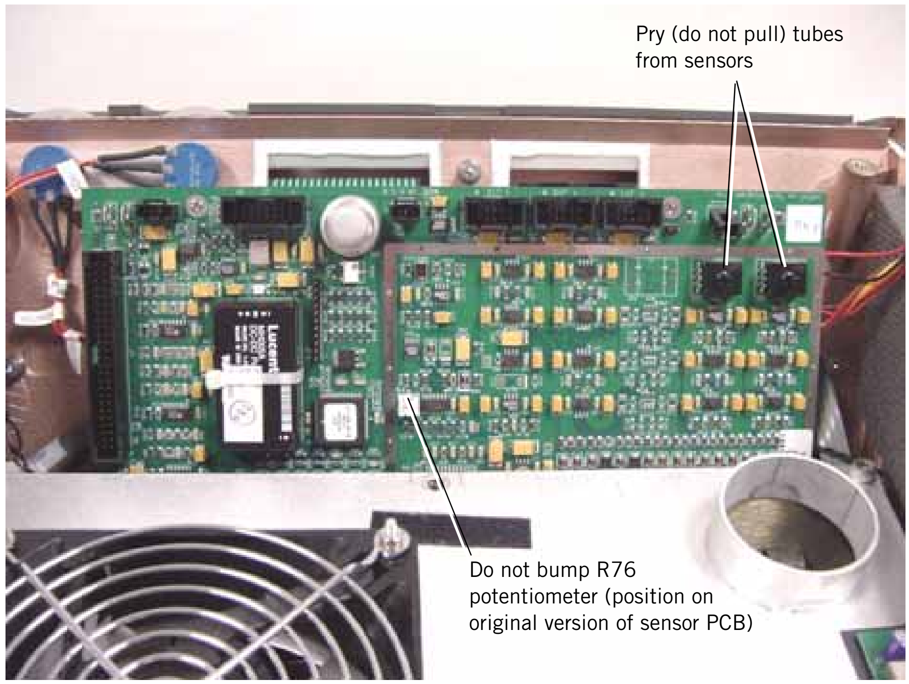


Figure 9-8: Sensor PCB

9.4 Power Supply Fan/Shroud

Follow these steps to remove the power supply fan and shroud (Figure 9-9). Reverse removal steps to install.

NOTE: The fan must be installed with its flow direction arrow pointing *away* from the power supply. When the fan is reinstalled and before reassembling the ventilator, confirm correct air flow: connect AC power, turn on the ventilator, then check that the fan blows air *away* from the power supply.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. For 9.5-in. GUI, disconnect cables from the backlight inverter PCB (see Figure 9-10). For the original 10.4-in. GUI, disconnect cable from the DC/DC converter PCB (see Figure 9-13).
3. Remove the air inlet hose from the power supply shroud, then use a 4-mm Allen wrench to remove the five screws that secure the shroud.
4. If present, disconnect the lithium battery.
5. Tilt the front of the shroud carefully and disconnect the fan harness connector by lifting up on the latch from underneath.
6. To remove the fan from the original shroud, remove the four nuts, screws, and twelve washers that secure the fan to the shroud.
7. To remove the fan from the new shroud, remove the four screws that secure the fan to the shroud.

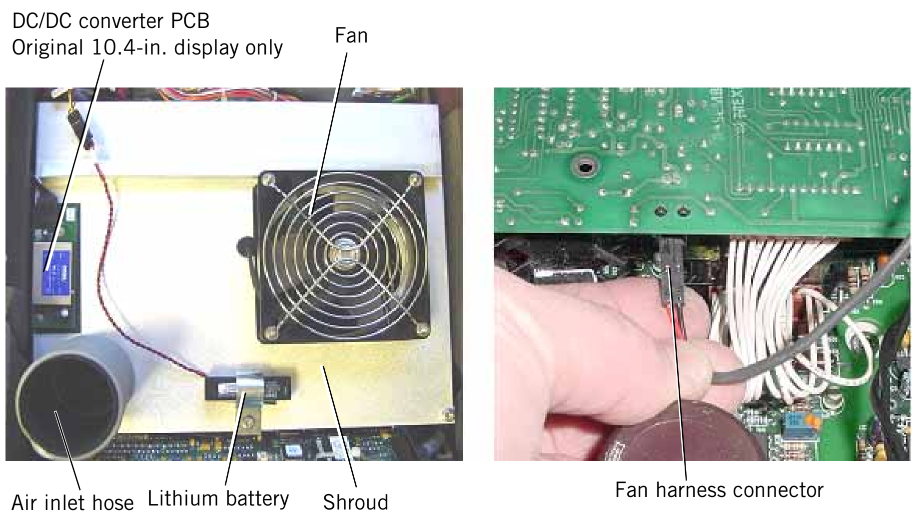


Figure 9-9: Power Supply Fan and Shroud

9.5 Backlight Inverter PCB (9.5-in. GUI)

WARNING: The backlight inverter PCB generates high voltage. To avoid personal injury, verify that the AC and external DC power sources are disconnected from the ventilator.

Follow these three steps to remove the backlight inverter PCB (see Figure 9-10 for 9.5-in. GUI ventilators). Reverse removal steps to install.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Disconnect the cables from CN1 and CN2 on the backlight inverter PCB.
3. Remove the two screws that hold the PCB to the power supply shroud, then remove the backlight inverter PCB.

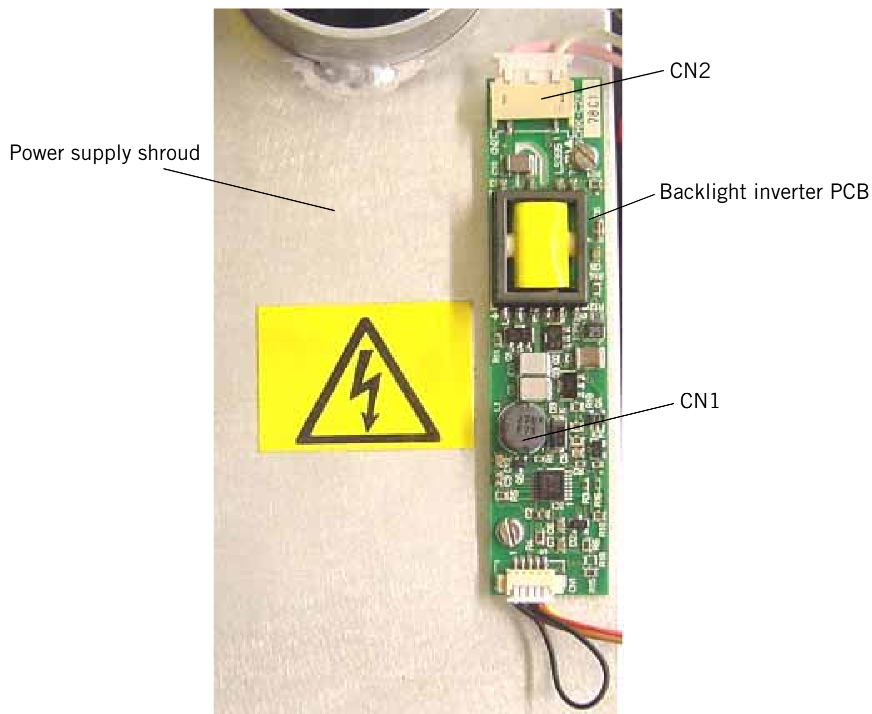


Figure 9-10: Backlight Inverter PCB Connections (9.5-in. GUI)

9.6 Backlight Inverter PCB (Original 10.4-in. GUI only)

WARNING: The backlight inverter PCB generates high voltage. To avoid personal injury, verify that the AC and external DC power sources are disconnected from the ventilator.

Follow these steps to remove the backlight inverter PCB (Figure 9-11, Figure 9-12) for 10.4-in. GUI ventilators. Reverse removal steps to install.

1. Remove the two 2.5-mm screws from the bottom corners of the GUI.
2. Remove the rotary encoder knob cover and loosen the 11-mm nut. Remove the knob.
3. Remove the ½-in. nut and star washer.
4. Carefully separate the GUI from the enclosure. Disconnect the interconnect harnesses and set the GUI face down on a soft, flat surface.
5. Disconnect the harness from the backlight inverter PCB.
6. Remove the two Phillips head screws that hold the backlight inverter PCB to the GUI.

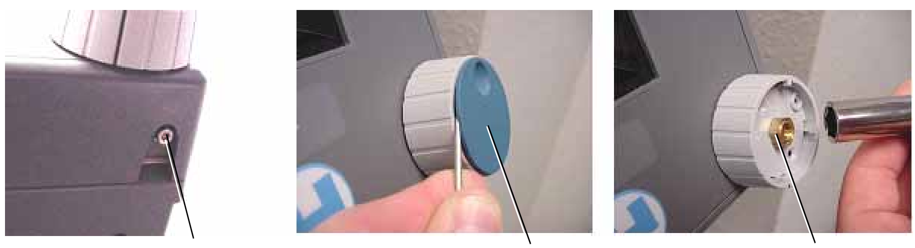


Figure 9-11: Removing/Installing the Rotary Encoder Knob

Figure 9-12: Removing/Installing the Backlight Inverter PCB (10.4-in. GUI)

9.7 DC/DC Converter PCB (Original 10.4-in. GUI only)

Follow these steps to remove the DC/DC converter PCB (Figure 9-13) for 10.4-in. GUI ventilators. Reverse removal steps to install.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Disconnect the harness from the DC/DC converter PCB.
3. Remove the two screws that hold the PCB to the power supply shroud, then remove the DC/DC converter PCB.

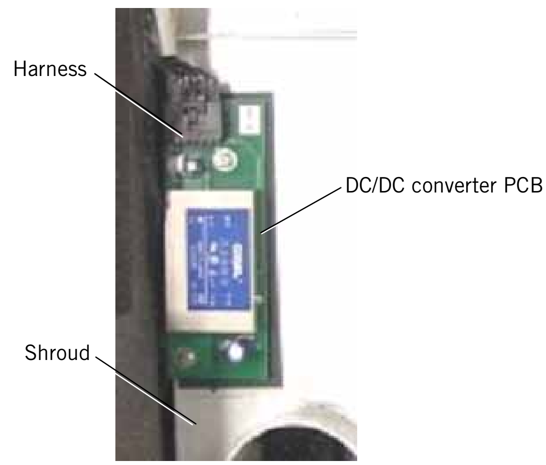


Figure 9-13: DC/DC Converter PCB Connections (10.4-in. GUI)

9.8 Power Supply

WARNING: The power supply generates high voltage. To avoid personal injury, verify that the AC and external DC power sources are disconnected from the ventilator.

Follow these steps to remove the power supply (Figure 9-14, Figure 9-15, Figure 9-16):

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the power supply shroud (see Chapter 9.4 on p. 9-8).
3. Unscrew terminal block screws on power supply connector TB1 and disconnect these wires: brown (pin 1), blue (pin 2), and green (pin 4).
4. Unscrew terminal blockscrews on power supply connector TB2 and disconnect these wires: red (pin 1) and thin black (pin 4). *Do not remove the thin black ground wire from TB3 pin 3.*
5. Unscrew terminal block screws on power supply connector TB3 and disconnect these wires: red (pin 1) and thin black (pin 4). *Do not remove the thin black ground wire from TB2 pin 3.*
6. Use a 4-mm Allen wrench to remove the eight M5 x 12 screws that secure the power supply to the top enclosure.
7. Lift the power supply far enough to disconnect the cables from connectors J1, J2, and J3, then lift the power supply from the top enclosure.

NOTE: The GUI assembly and MMI PCB must be installed before reinstalling the power supply on ventilators with the 9.5-in. GUI. The MMI PCB must be installed on ventilators with the 10.4-in. GUI before reinstalling the power supply. When reinstalling, ensure that no cables are routed underneath the power supply.

Follow these steps to reinstall the power supply:

1. Reinstall the eight screws that hold the power supply to the top enclosure. Do not tighten the screws until all are installed.
2. Connect these cables to the power supply:
   - Cable PSU J1 to connector J1.
   - Cable PSU J2 to connector J2.
   - Cable PSU J3 to connector J3.
3. Install these wires to the power supply, pushing the wires completely into the connectors. No wires should be visible after being tightened at the terminal block.
   - Red and black wires (PSU TB3) to connector TB3.
   - Red and black wires (PSU TB2) to connector TB2.
   - Blue, green, and brown wires from the AC mains panel to connector TB1.
   - Connect the fan harness.

4. Replace the power supply shroud, ensuring that the red and black wires from TB3 rest inside the shroud slots, and that the shroud does not pinch any of these cables. All cable assemblies and wires must be routed between the shroud and the top enclosure wall.

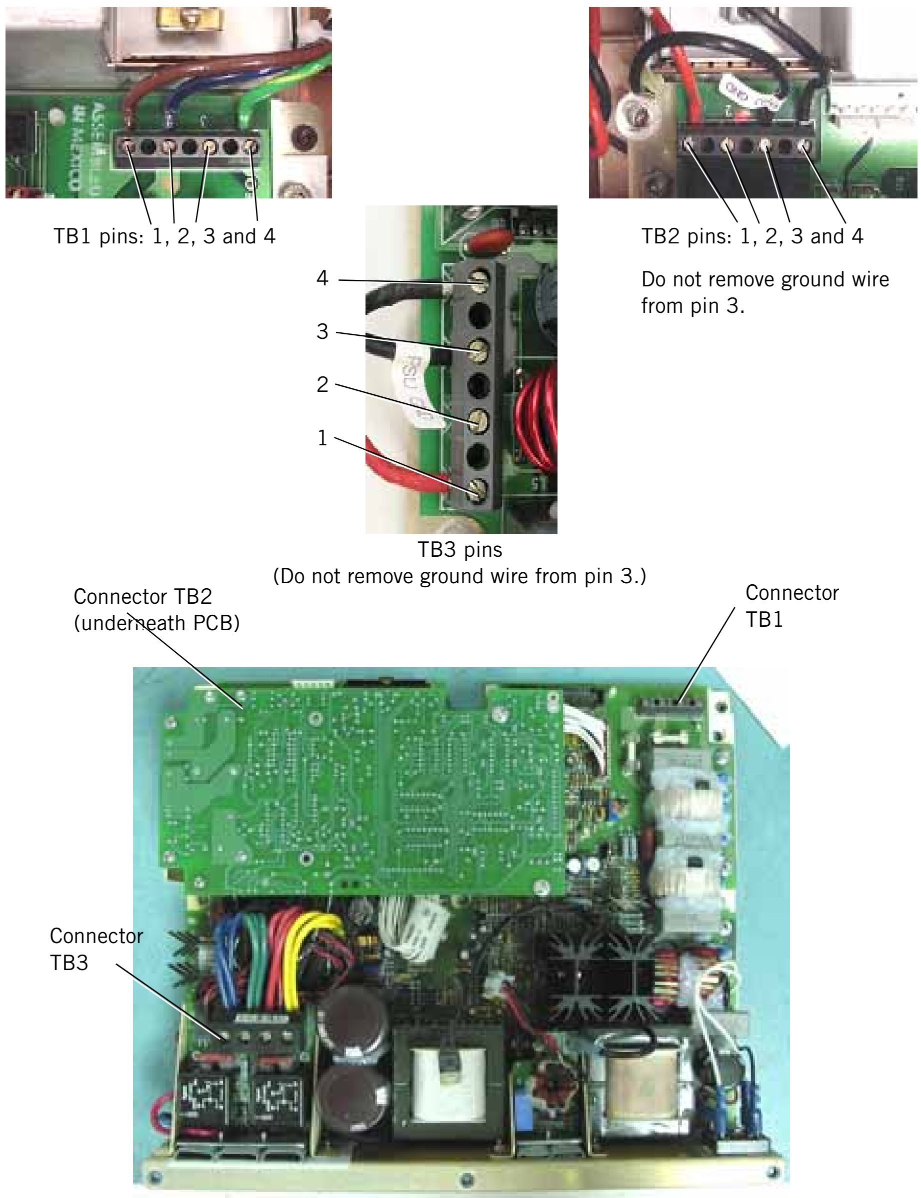


Figure 9-14: Power Supply Wire Connections

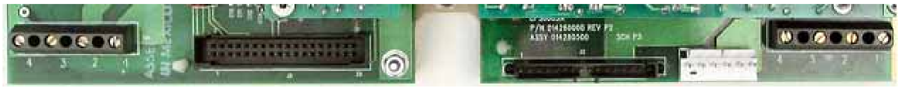


Figure 9-15: Power Supply Connectors

5. Fasten the black ground wire with longer screw (M5 x 10) to the shroud near the TB2 terminal block.

Figure 9-16: Shroud Ground Connection

6. Fasten the shroud with the remaining four M5x6 screws.
7. Connect the cables to the backlight inverter PCB (for the 9.5-in. GUI) or DC/DC converter PCB (10.4-in. GUI).
8. Reinstall the top enclosure (see Chapter 9.2 on p. 9-5).

9.9 Power Supply Fuses

WARNING: The power supply generates high voltage. To avoid personal injury, verify that the AC and external DC power sources are disconnected from the ventilator.

NOTE: F2 fuses will **not** be field replaceable on the power supplies with fuse F2 soldered to the fuse clip (see Figure 9-17). F2 fuses **will** be available for replacement in Esprit ventilators with power supplies without fuse F2 soldered to the fuse clip (see Figure 9-18).

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the power supply shroud (Chapter 9.4 on p. 9-8).
3. Remove the appropriate fuse from its holder (see Figure 9-17).
4. Pinch fuse clips together before inserting replacement fuse (see Figure 9-19).

Figure 9-17: Power Supply Fuses (F2 Soldered)

Figure 9-18: Power Supply Fuses (F2 Not Soldered)

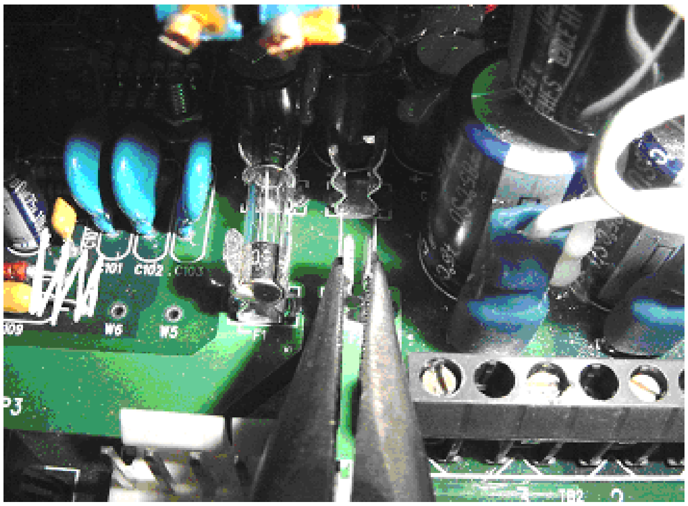


Figure 9-19: Pinch Fuse Clips Together

9.10 MMI PCB (9.5-in. GUI)

Follow these steps to remove the MMI PCB (Figure 9-20) for ventilators with 9.5-in. GUI. Reverse removal steps to install.

NOTE: The GUI assembly must be installed before reinstalling the MMI PCB.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the power supply shroud (see Chapter 9.4 on p. 9-8).
3. Remove the screws securing the power supply to the top enclosure.
4. Move the power supply out of the way to allow access to the MMI PCB mounting screws.
5. Remove the sensor PCB (see Chapter 9.3 on p. 9-6).
6. Remove the cables from the connectors on the MMI PCB:

Remove cables in this order:	**From this MMI PCB connector:**
Ribbon cable from VGA display* *Reinstall with black side facing MMI PCB*	J7
MMI J4 *PRIMARY ALARM*	J4
MMI J8 *MAIN PCB*	J8
MMI J5 *ALARM VOLUME POT*	J5
MMI J9 *LCD BRIGHTNESS POT*	J9
MMI J3 *MAIN HARNESS*	J3
Ribbon cable from overlay LEDs*	J11
Ribbon cable from touch frame*	J12
Ribbon cable from rotary encoder*	J10
MMI J1 *POWER SWITCH*	J1
White ribbon cable from touch frame* *Display top*	J13
MMI J15 *BACKUP ALARM*	J15
* When removing, lift connector lock before pulling cable. Do not use a tool.	

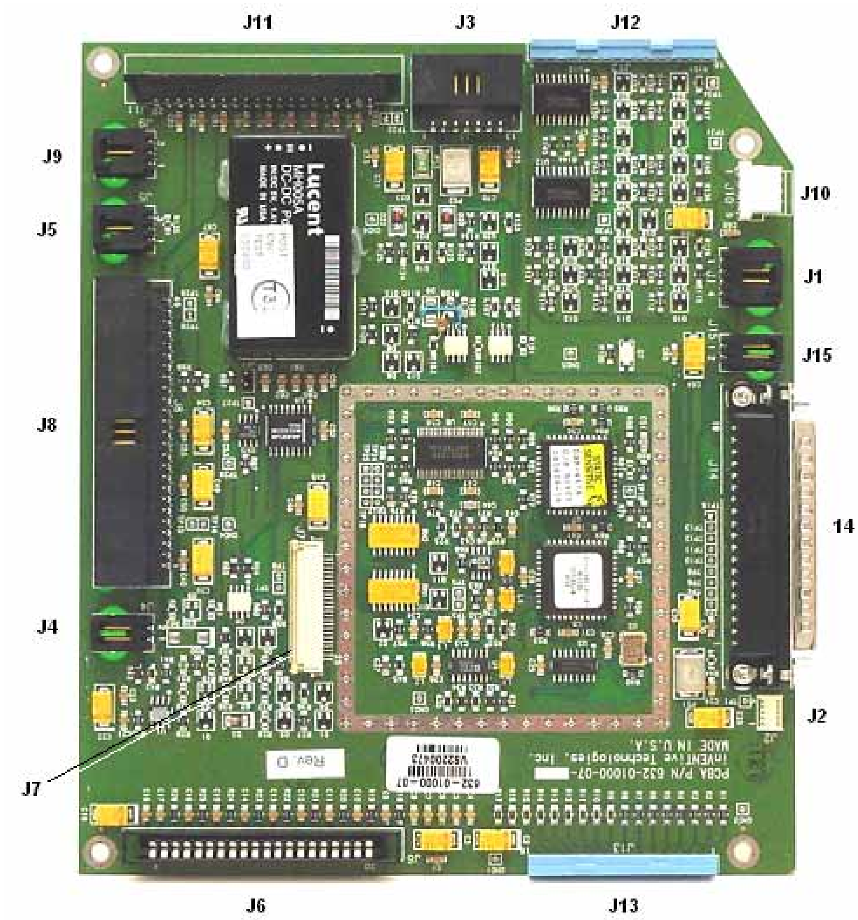


Figure 9-20: MMI PCB Connectors (9.5-in. GUI)

7. Remove the four screws holding the MMI PCB to the mounting plate.
8. Pull the MMI PCB away from the plate just enough to remove the two screws that hold the cable (MMI J14) to connector J14, then disconnect the cable and remove it from the U-brace.
9. Disconnect the cable (MMI J2) from connector J2.
10. Disconnect ribbon cables from the connectors J6 and J13 (touch frame), then pull the MMI PCB completely out of the top enclosure.

NOTE: When reinstalling the ribbon cables to J6 and J11 (overlay LEDs), tug on the cable to ensure that it is properly seated. When reinstalling the ribbon cable to J12 and J13, ensure that no connector pins are visible, then snap cover shut.

NOTE: When you install a new MMI PCB, you must remove the minimum alarm volume harness (Figure 9-21), if installed. Minimum alarm volume circuitry is integrated into the current MMI PCB.

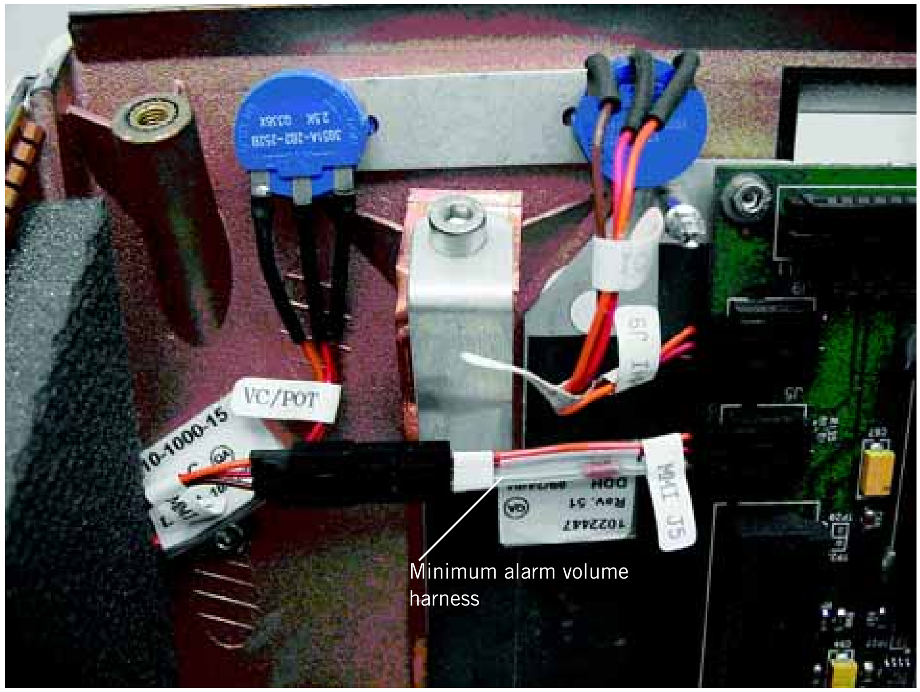


Figure 9-21: Minimum alarm volume harness

9.11 MMI PCB (10.4-in. GUI)

Follow these steps to remove the MMI PCB (Figure 9-22) for ventilators with 10.4-in. GUI. Reverse removal steps to install.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the power supply shroud (see Chapter 9.4 on p. 9-8).
3. Remove the screws securing the power supply to the top enclosure.
4. Move the power supply out of the way to allow access to the MMI mounting screws.
5. Remove the sensor PCB (see Chapter 9.3 on p. 9-6).
6. Remove the cables from the connectors on the MMI PCB:

Remove cables in this order:	From this connector on the MMI PCB (10.4-in. GUI):
MMI J1 *POWER SWITCH*	J1
MMI J3 *MAIN HARNESS*	J3
MMI J4 *PRIMARY ALARM*	J4
MMI J5 *ALARM VOLUME POT*	J5
Ribbon cable from keyboard LEDs*	J11
MMI J8 *MAIN PCB*	J8
Rotary encoder ribbon cable	J10
Ribbon cable from keyboard overlay LEDs* (Newer J11 connectors are a friction fit, therefore a connector lock is not present.)	J11
White ribbon cable from touch frame* *Display bottom*	J6
White ribbon cable from touch frame* *Display top*	J13
MMI J15 *BACKUP ALARM*	J15
* When removing, lift connector lock before pulling cable. Do not use a tool.	

7. Remove the four screws holding the MMI PCB to the plate. Install cables to the MMI PCB first, then insert the cables through the top enclosure.

NOTE: When reinstalling the ribbon cables to J6 and J11 (overlay LEDs), tug on the cable to ensure that it is properly seated. When reinstalling the ribbon cable to J12 and J13, ensure that no connector pins are visible, then snap cover shut.

NOTE: When you install a new MMI PCB, you must remove the minimum alarm volume harness (Figure 9-21), if installed. Minimum alarm volume circuitry is integrated into the current MMI PCB.

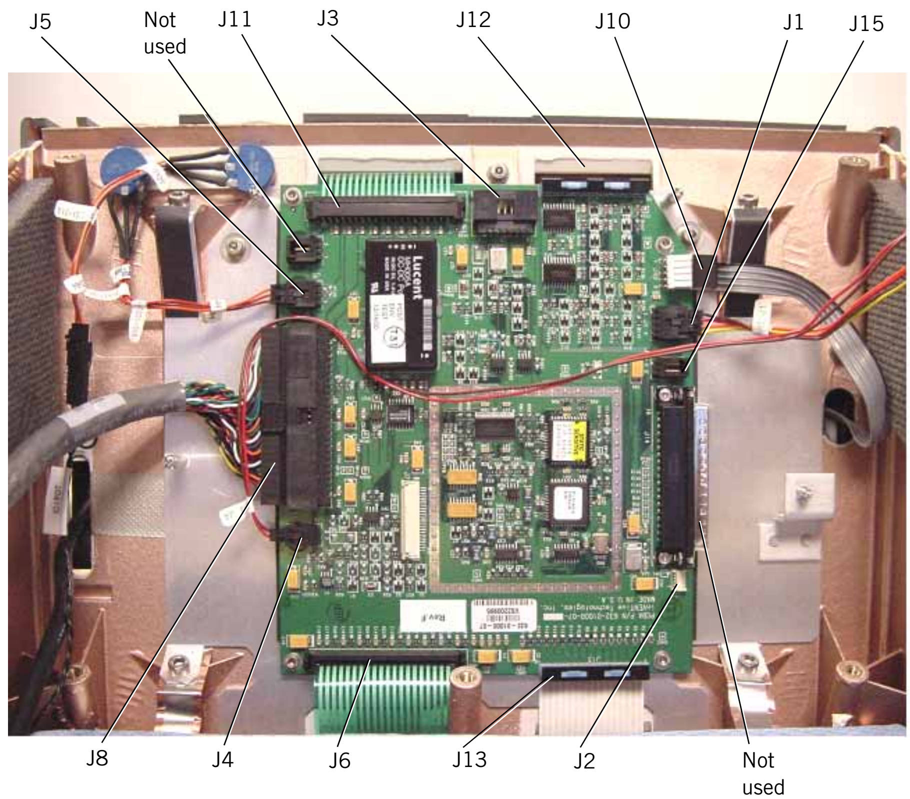


Figure 9-22: MMI PCB Connectors (10.4-in. GUI)

9.12 GUI Assembly (9.5-in. GUI)

NOTE: Because the original 9.5-in. GUI assembly is no longer available, the 10.4-in. GUI upgrade kit must be installed when replacing a VGA display, touch frame, or keyboard.

Follow these steps to remove the 9.5-in. GUI assembly (Figure 9-23):

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the power supply shroud (see Chapter 9.4 on p. 9-8).
3. Remove the screws securing the power supply to the top enclosure.
4. Move the power supply out of the way to allow access to the GUI mounting screws.
5. Remove the sensor PCB (see Chapter 9.3 on p. 9-6).
6. Loosen the set screws (one for each knob) holding the brightness and volume knobs.
7. Remove four 3-mm screws securing the GUI to the top enclosure.
8. Carefully remove the GUI assembly from the top enclosure.

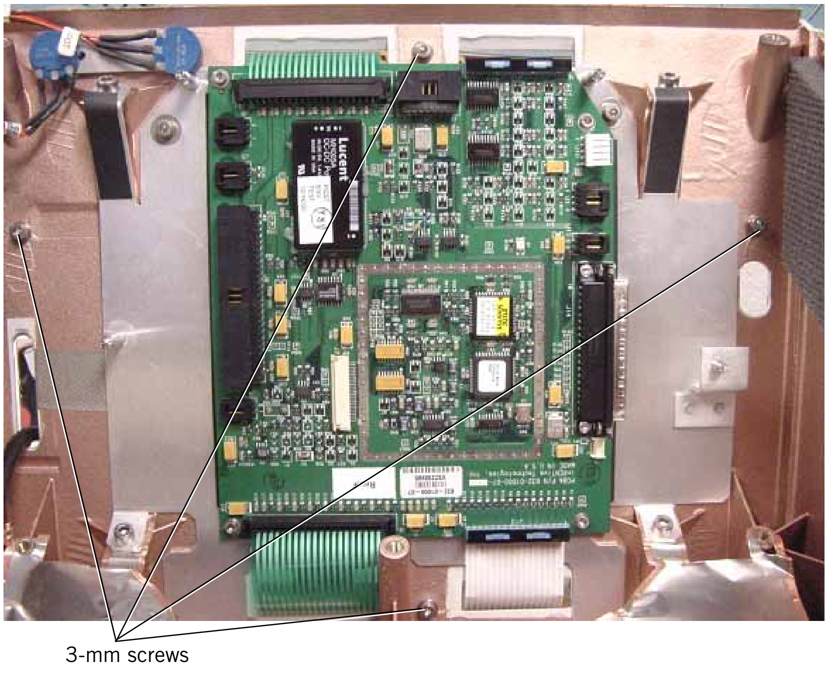


Figure 9-23: 9.5-in. GUI Assembly

Follow these steps to install the 9.5-in. GUI assembly (Figure 9-24):

1. Assemble the knobs to brightness and volume potentiometers so that set screws are closest to potentiometers. On the intensity potentiometer, ensure that the hex screw on the knob makes contact with the flat part of the shaft.

2. Feed cables 1 through 5 through the top enclosure slots, then set the GUI assembly in position onto the top enclosure, ensuring that all ribbon cables are untwisted.
3. Feed ribbon cables 6 and 7 through the remaining top enclosure slots, then set the GUI assembly in position onto the top enclosure, ensuring that all ribbon cables are untwisted.
4. Use the four 3-mm screws to reinstall the GUI to the top enclosure (Figure 9-23).

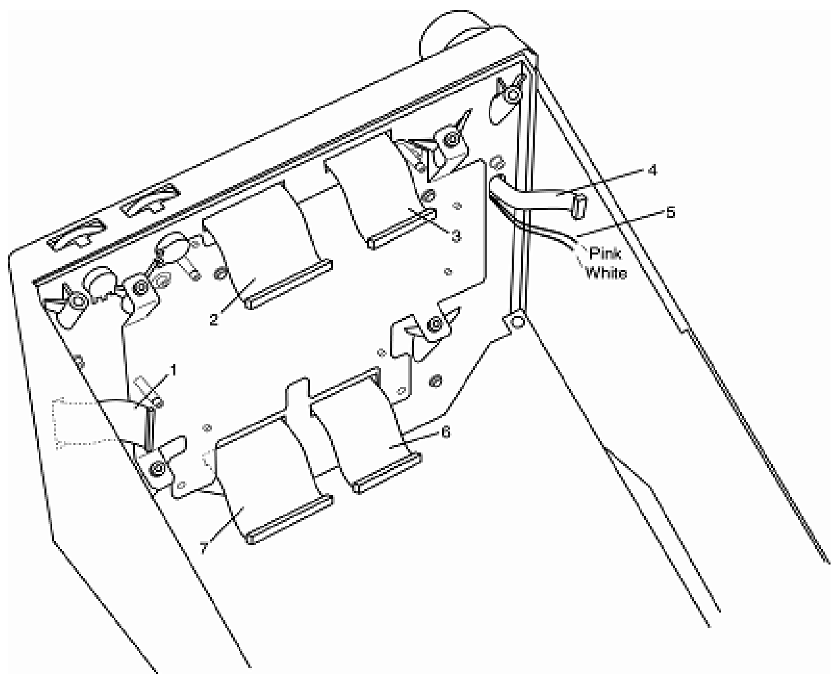


Figure 9-24: GUI Cables

5. Readjust the intensity and volume potentiometers so that knobs can turn freely. Do not overtighten screws.
6. Reposition and secure the power supply (see Chapter 9.8 on p. 9-12).
7. Install the sensor PCB (see Chapter 9.3 on p. 9-6).
8. Install the top enclosure (see Chapter 9.2 on p. 9-5).

9.13 GUI Assembly (Original 10.4-in. GUI)

Follow these steps to remove the 10.4-in. GUI assembly (Figure 9-25, Figure 9-26). Reverse removal steps to install.

1. Unscrew the two 2.5-mm screws from the bottom corners of the GUI.
2. Remove the GUI knob cover, loosen the 11-mm nut, then remove the knob.
3. Remove the ½-in. nut and star washer to the rotary encoder.
4. Carefully separate the GUI from the enclosure enough to gain hand access. Disconnect all interconnect harnesses between the GUI and enclosure.

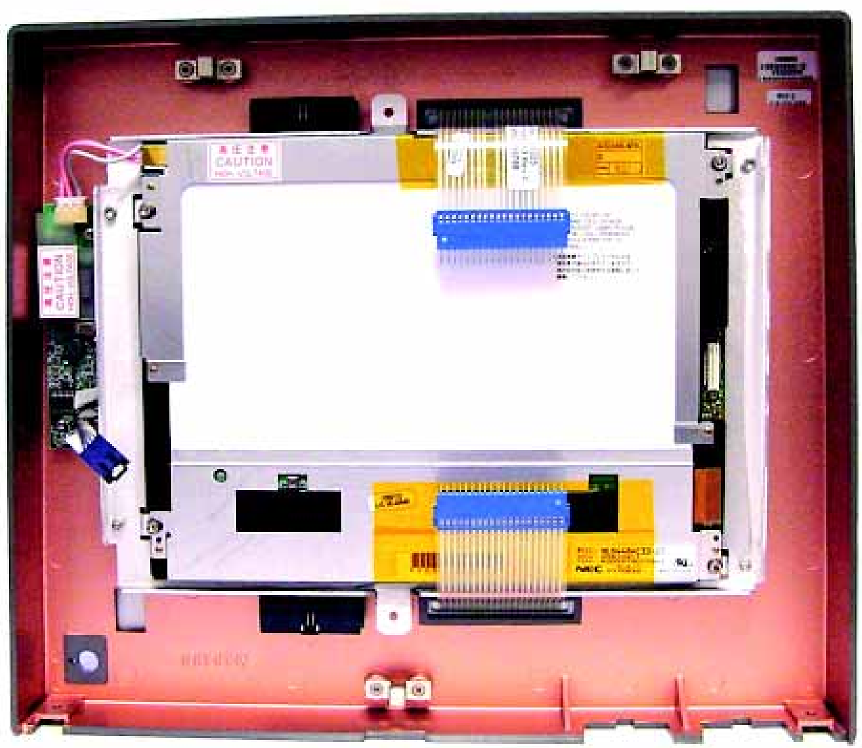


Figure 9-25: 10.4-in. GUI Assembly

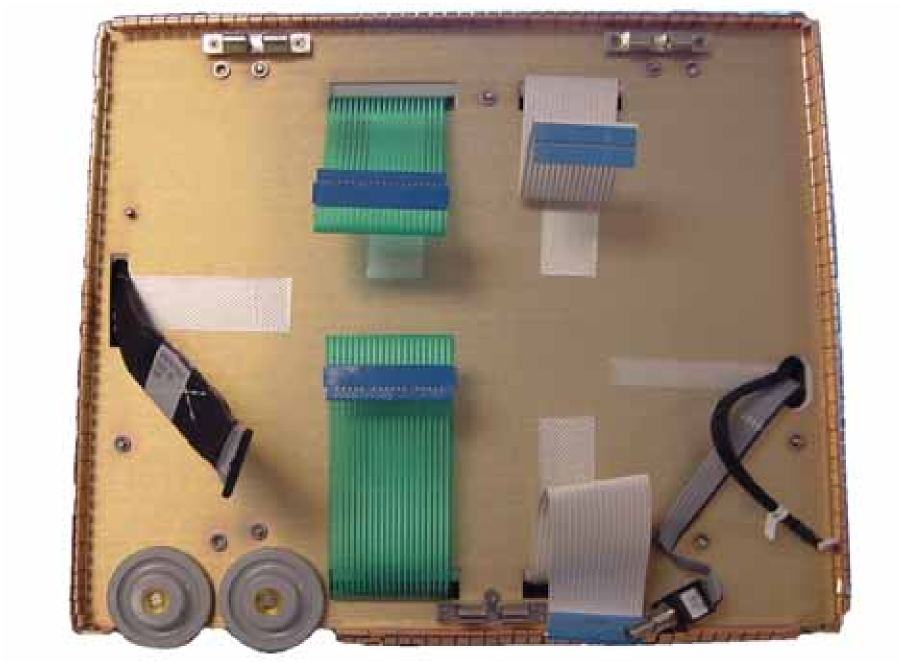


Figure 9-26: Front of Ventilator with 10.4-in. GUI Removed

9.14 GUI Assembly (2nd Generation 10.4-in. GUI)

Follow these steps to remove the 10.4-in. GUI assembly (Figure 9-25, Figure 9-26). Reverse removal steps to install.

1. Unscrew the two 2.5-mm screws from the bottom corners of the GUI.
2. Remove the GUI knob cover, loosen the 11-mm nut, and then remove the knob.
3. Remove the ½-in. nut and star washer to the rotary encoder.
4. Carefully separate the GUI from the enclosure enough to gain hand access. Disconnect all interconnect harnesses between the GUI and enclosure.

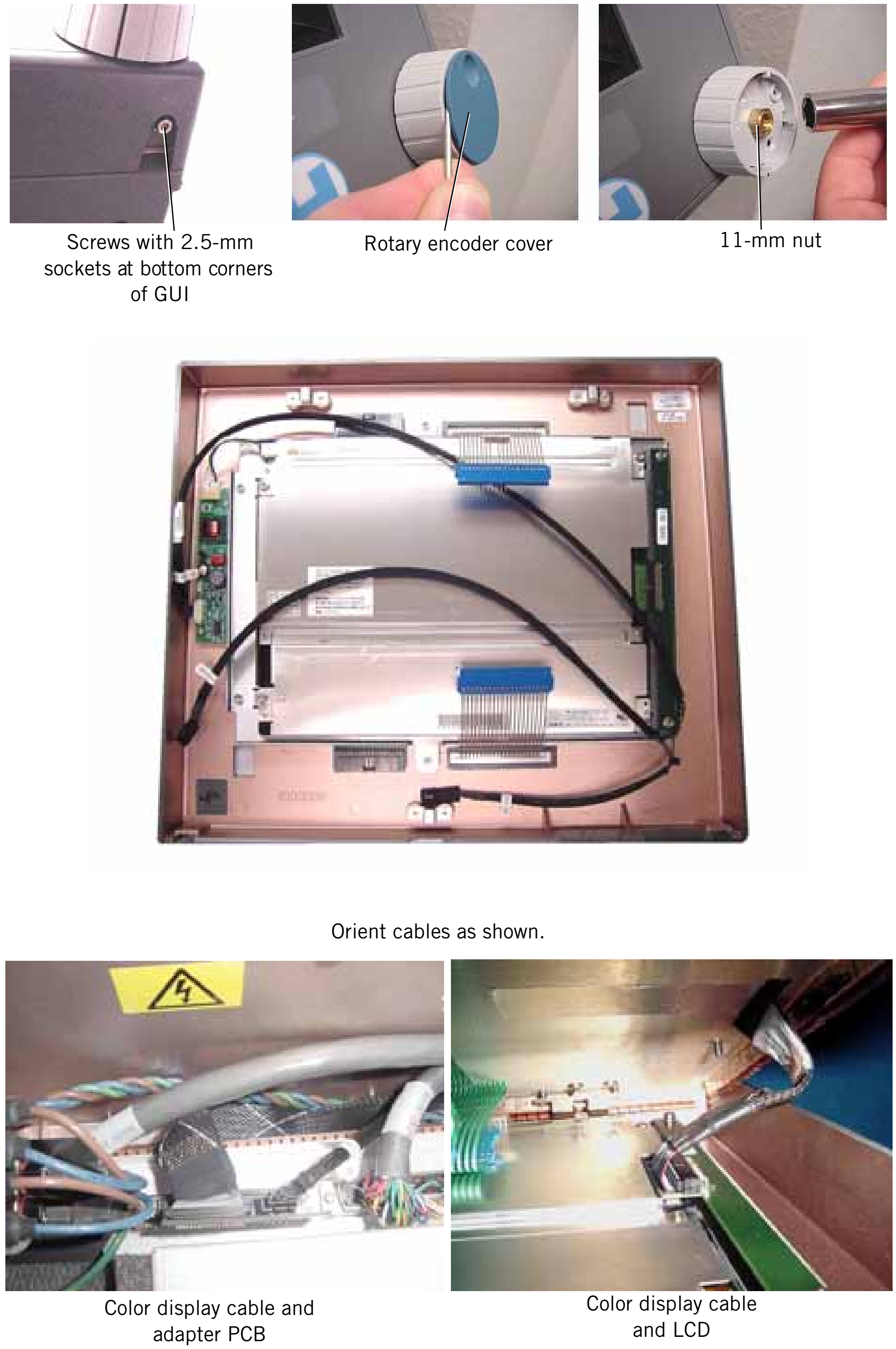


Figure 9-27: 2nd Generation 10.4-in. GUI Assembly

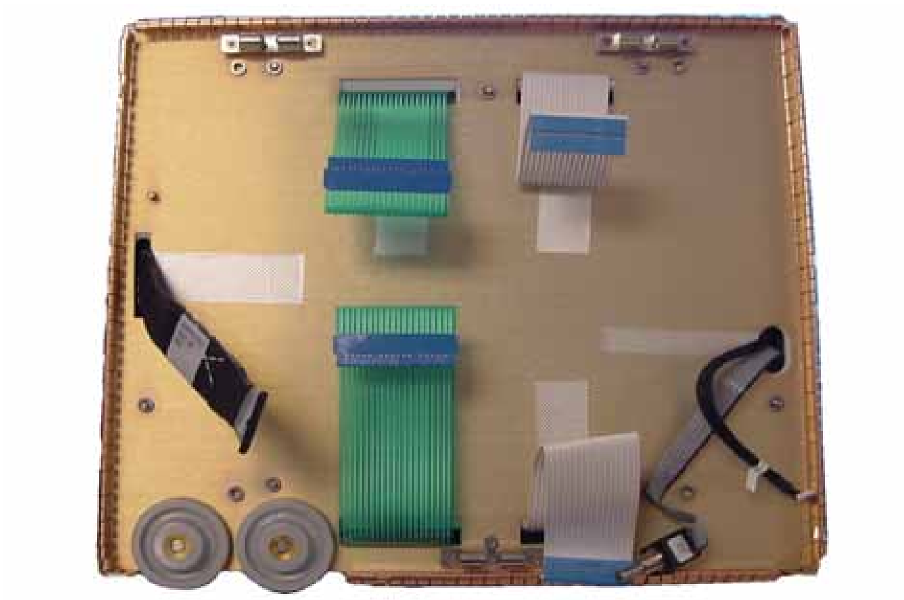


Figure 9-28: Front of Ventilator with 10.4-in. GUI Removed

9.15 Intensity and Volume Potentiometers (9.5-in. GUI)

Follow these steps to remove the intensity and volume potentiometers (Figure 9-29). Reverse removal steps to install as shown.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the sensor PCB (see Chapter 9.3 on p. 9-6).
3. Remove the power supply (see Chapter 9.4 on p. 9-8).
4. Remove the MMI PCB (see Chapter 9.10 on p. 9-17).
5. Remove the GUI assembly (see Chapter 9.12 on p. 9-22).
6. Remove the nut and washer holding each potentiometer, then disconnect the harnesses and remove the potentiometers.

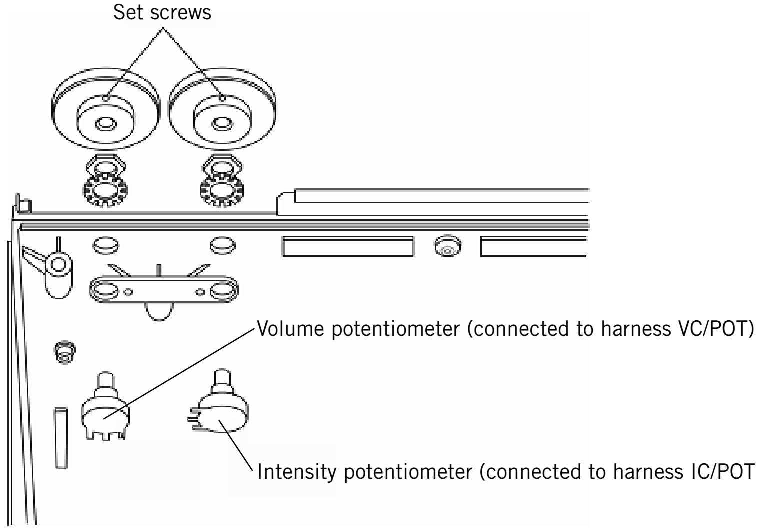


Figure 9-29: Volume and Intensity Potentiometers (9.5-in. GUI)

9.16 Intensity and Volume Potentiometers (10.4-in. GUI's)

Follow these steps to remove the intensity and volume potentiometers (Figure 9-30). Reverse removal steps to install as shown.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Unscrew the two 2.5-mm screws from the bottom corners of the GUI.
3. Remove the GUI knob cover, loosen the 11-mm nut, then remove the knob.
4. Remove the ½-in. nut and star washer to the rotary encoder.
5. Separate the GUI from the enclosure. Disconnect all interconnect harnesses between the GUI and enclosure.
6. Loosen the set screws (one for each knob) holding the brightness and alarm volume knobs.
7. Remove the ½-in. nut and washer holding each potentiometer, then disconnect the harnesses and remove the potentiometers.

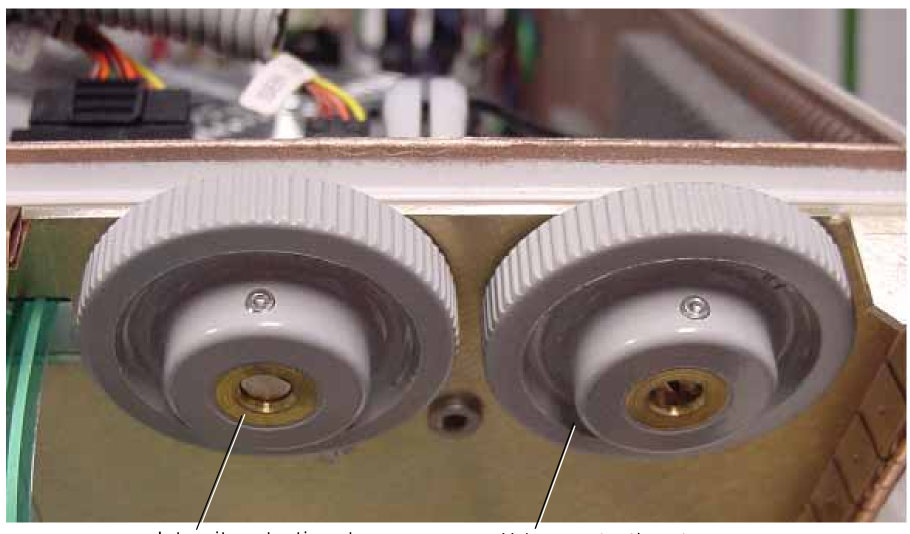


Figure 9-30: Volume and Intensity Potentiometers (10.4-in. GUI)

9.17 Rotary Encoder (9.5-in. GUI)

Follow these steps to remove the rotary encoder (Figure 9-31). Reverse removal steps to install.

NOTE: Reinstall the rotary encoder according to the orientation shown.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the sensor PCB (see Chapter 9.3 on p. 9-6).
3. Remove the power supply (see Chapter 9.4 on p. 9-8).
4. Disconnect the rotary encoder harness from the J10 connector on the MMI PCB (see Chapter 9.10 on p. 9-17).
5. Remove the GUI assembly (see Chapter 9.12 on p. 9-22).
6. Pry the blue cover from the rotary encoder.
7. Loosen the 11-mm nut holding the knob, then remove the knob and washer.
8. Remove the ½-in. nut and star washer holding the rotary encoder to the front panel overlay, then remove the encoder.

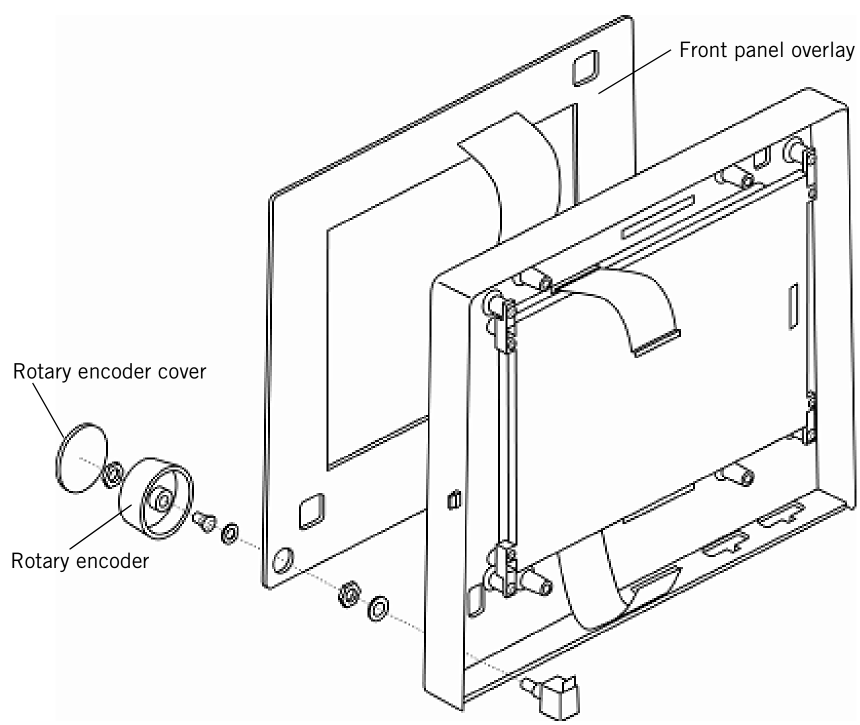


Figure 9-31: Rotary Encoder (9.5-in. GUI)

9.18 Rotary Encoder (10.4-in. GUI's)

Follow these steps to remove the rotary encoder (Figure 9-31). Reverse removal steps to install.

NOTE: Reinstall the rotary encoder according to the orientation shown.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the sensor PCB (see Chapter 9.3 on p. 9-6).
3. Disconnect the rotary encoder harness from the J10 connector on the MMI PCB (see Chapter 9.11 on p. 9-20).
4. Remove the GUI assembly (see Chapter 9.13 on p. 9-24).
5. Remove the ½-in. nut and star washer holding the rotary encoder to the GUI assembly, then remove the encoder.

Rotary encoder from outside GUI assembly

Rotary encoder from inside GUI assembly (note orientation).

Figure 9-32: Rotary Encoder (10.4-in. GUI)

9.19 GUI Front Panel Overlay (10.4-in. GUI's)

Follow these steps to replace the front panel overlay assembly (Figure 9-33, Figure 9-34):

1. Remove the GUI assembly from the enclosure (see Chapter 9.13 on p. 9-24).
2. Remove the language inserts from the front panel. Use a small flat screwdriver to lift the inserts, then pull to remove.
3. Use a small flat head screwdriver to lift the corner of the keyboard assembly, then peel the keyboard from the bezel.
4. Use a soft cloth and isopropyl alcohol to remove any adhesive remaining on the bezel.
5. Peel the backing off the replacement overlay, and remove the small pieces of back behind the ribbon cables.
6. Thread the ribbon cables through the bezel slots, then align the overlay over the bezel and adhere with overlay centered in the bezel frame.
7. Reinstall language inserts. Use a pencil eraser to push the inserts in, then check that inserts are aligned correctly (right side up).

Figure 9-33: Installing GUI Front Panel Overlay (10.4-in. GUI)

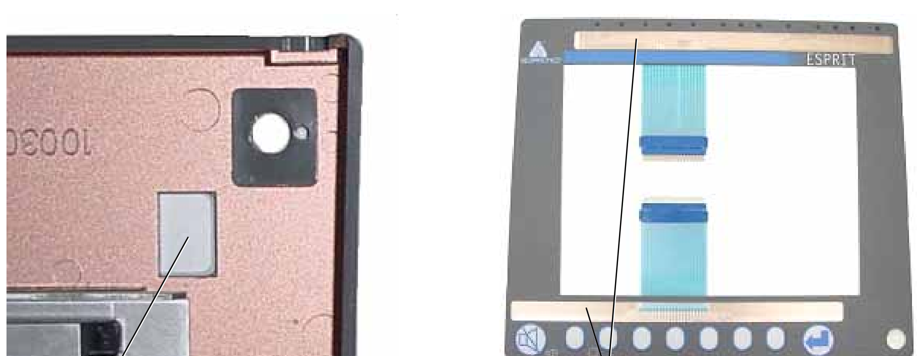


Figure 9-34: Language Inserts

9.20 VGA Display Assembly (9.5-in. GUI)

WARNING: The backlight lamps in the monitor display contain mercury, which must be recycled or disposed of in accordance with local, state, or federal laws.

NOTE: Because the original 9.5-in. is no longer available, the 10.4-in. GUI upgrade kit must be installed when replacing a VGA display, touch frame, or keyboard.

Follow these steps to remove the VGA display assembly (Figure 9-35). Reverse removal steps to install.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the sensor PCB (see Chapter 9.3 on p. 9-6).
3. Remove the power supply (see Chapter 9.4 on p. 9-8).
4. Remove the GUI assembly (see Chapter 9.10 on p. 9-17).
5. Remove four hex screws holding the VGA display assembly to the spacers, then remove the display.

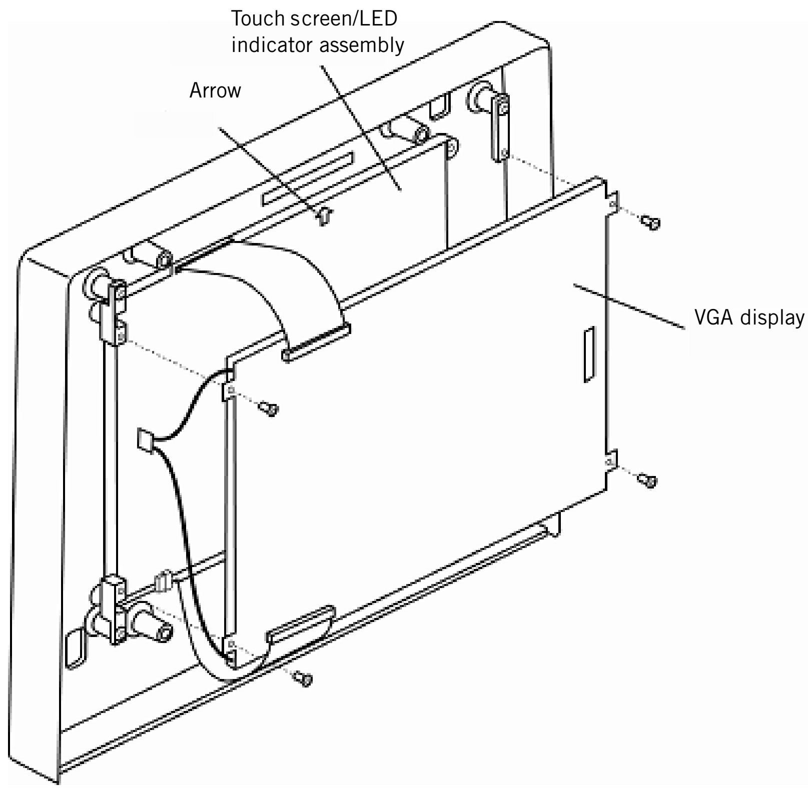


Figure 9-35: VGA Display and Touch Screen Assembly

NOTE: Reinstall the VGA display assembly as shown, noting the display's orientation.

9.21 Touch Screen/ LED Indicator Assembly and Front Panel Overlay (9.5-in. GUI)

Follow these steps to remove the touch screen/LED indicator assembly and front panel overlay (Figure 9-35). Reverse removal steps to install.

NOTE: Because the original 9.5-in. GUI assembly is no longer available, the 10.4-in. GUI upgrade kit must be installed when replacing a VGA display assembly, touch frame, or keyboard.

NOTE: Reinstall the touch screen/LED indicator assembly and front panel overlay as shown, noting the orientation of the cables and the arrow on the touch screen/LED indicator.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the sensor PCB (see Chapter 9.3 on p. 9-6).
3. Remove the power supply (see Chapter 9.4 on p. 9-8).
4. Remove the GUI assembly (see Chapter 9.10 on p. 9-17).
5. Remove VGA display assembly (see Chapter 9.20 on p. 9-33).
6. Carefully pop out the touch screen/LED indicator assembly from the GUI bezel.

9.22 Backlight Inverter PCB, VGA Display, and Touch Frame (Original 10.4-in. GUI)

WARNING: The backlight lamps in the monitor display contain mercury, which must be recycled or disposed of in accordance with local, state, or federal laws.

Follow these steps to remove the backlight inverter PCB, VGA display, and touch frame (Figure 9-36). Reverse removal steps to install.

1. Remove the 2.5-mm screws securing the GUI to the enclosure.
2. Remove the rotary encoder (see Chapter 9.18 on p. 9-31). The rotary encoder has the only harness connector not accessible within the GUI assembly.
3. Gently pry the GUI assembly from the ventilator enclosure enough to access and disconnect the harness connectors.
4. Remove the rotary encoder from the GUI assembly.
5. Disconnect harnesses from the touch frame, VGA display, backlight inverter PCB, and keyboard interconnects.
6. Set the GUI face down on a nonabrasive surface.
7. To remove the VGA display, remove the four 2.5-mm screws that hold it to the GUI.
8. To remove the touch frame, remove the four 2.5-mm screws that hold the VGA display to the GUI, then carefully pop out the touch frame assembly from the bezel.
9. To remove the backlight inverter PCB, remove the two Phillips head screws that hold it to the GUI.

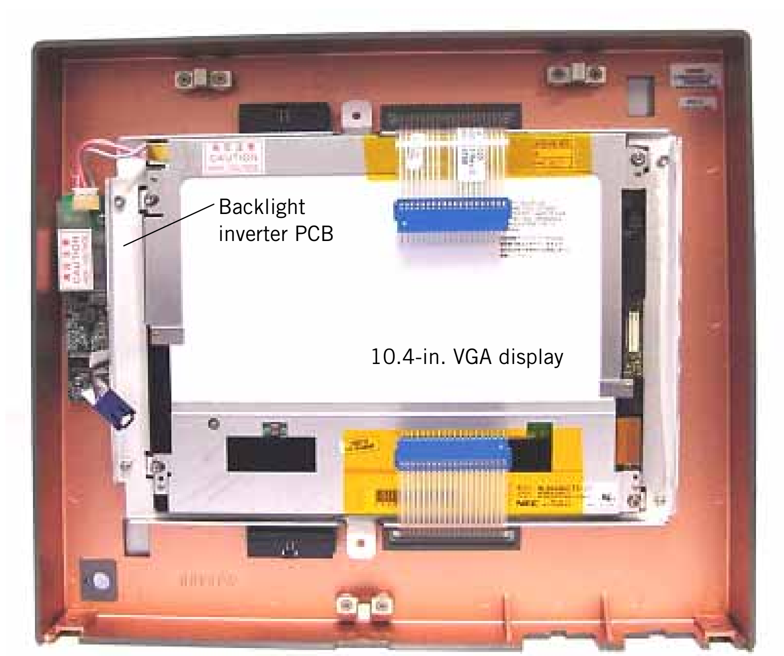


Figure 9-36: Backlight Inverter PCB and VGA Display (10.4-in. GUI)

9.23 Transition PCB, LCD, IR Touch Frame, and Backlight Inverter PCB (2nd Generation 10.4-in. GUI)

WARNING: The backlight lamps in the monitor display contain mercury, which must be recycled or disposed of in accordance with local, state, or federal laws.

Follow these steps to remove the backlight inverter PCB, LCD, and touch frame (Figure 9-37). Reverse removal steps to install.

1. Remove the 2.5-mm screws securing the GUI to the enclosure.
2. Remove the rotary encoder (see Chapter 9.18 on p. 9-31). The rotary encoder has the only harness connector not accessible within the GUI assembly.
3. Gently pry the GUI assembly from the ventilator enclosure enough to access and disconnect the harness connectors.
4. Remove the rotary encoder from the GUI assembly.
5. Disconnect harnesses and cables from the touch frame, transition PCB, backlight inverter PCB, and keyboard interconnects.
6. Set the GUI face down on a nonabrasive surface.
7. To remove the transition PCB, remove the two M3 x 16-mm screws and the two M3 flat washers that hold it to the LCD bracket. Then remove the transition PCB and the two hex spacers (Figure 9-37).
8. To remove the LCD, remove the four M3 x 5-mm screws and four M3 flat washers that hold it to the LCD bracket (Figure 9-37).
9. Set the LCD face up on a nonabrasive surface.
10. To remove the LCD bracket, remove the two 2.5-mm screws that hold the LCD bracket to the bezel. Then carefully remove the LCD bracket from the bezel.
11. To remove the IR touch frame, carefully pop out the IR touch frame assembly from the bezel.

12. To remove the backlight inverter PCB, remove the two Phillips head screws that hold it to the bezel.

Figure 9-37: Transition PCB (2nd Generation)

Figure 9-38: LCD (2nd Generation)

9.24 GUI Cleaning and Dust Gasket Installation (2nd Generation 10.4-in. GUI)

Follow these steps to clean the LCD and IR touch frame.

1. Remove the GUI (see Chapter 9.22 on p. 9-35, steps 1-6).
2. To remove the LCD and transition PCB, remove the two M3 x 16-mm screws and two M3 flat washers that hold the LCD to the LCD bracket (Figure 9-37).
3. Set the LCD face up on a nonabrasive surface.
4. Clean the IR TouchFrame and LCD assemblies with isopropyl alcohol with a soft, lint free cloth.
5. Separate the GUI dust gasket parts (Figure 9-39).
6. Place the four foam pieces on the LCD (Figure 9-40 and Figure 9-41).
7. Verify the two 5/16 hex spacers are aligned on the LCD bracket.
8. Reinstall the LCD and transition PCB onto the bezel. Use four M3 x 5-mm screws and four M3 flat washers to attache the LCD. Then use two M3 x 16-mm screws and two M3 flat washers to attach the transition PCB.
9. Verify the installed foam pieces are not visible from the viewing side of the GUI assembly.
10. Clean all dust from the ventilator bulkhead.
11. Place the two bulkhead foam pieces, the straight piece under the bottom ribbon cable and the other piece above the potentiometer wheels (Figure 9-42).
12. Re-attach the GUI assembly to the ventilator.

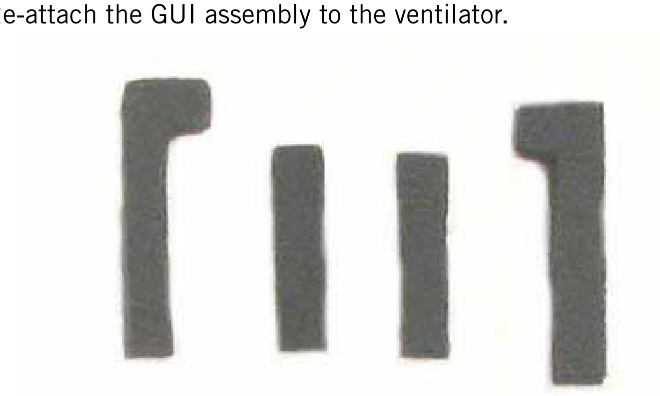


Figure 9-39: GUI Dust Gaskets

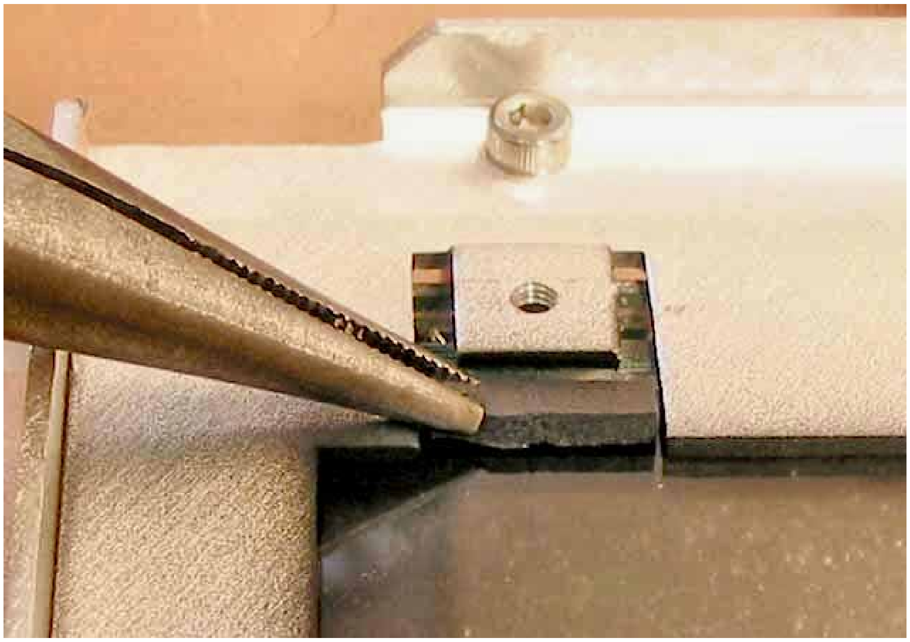


Figure 9-40: Installing the GUI Dust Gaskets

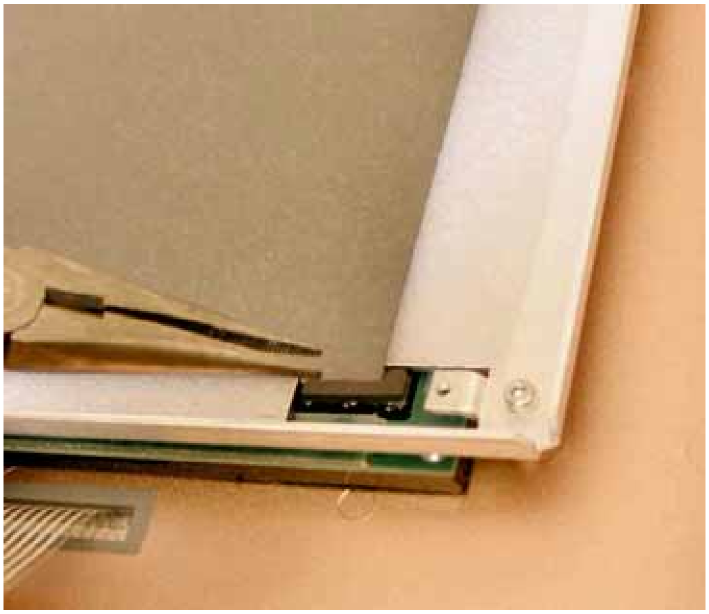


Figure 9-41: Installing the GUI Dust Gaskets

Figure 9-42: Installing the Bulkhead Foam

9.25 Increased Minimum Alarm Volume Harness

Follow these steps to remove the increased minimum alarm volume harness (Figure 9-43). Reverse removal steps to install as shown.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Disconnect the Alarm Volume Potentiometer from the Increased Minimum Alarm Volume Harness.
3. Disconnect the Increased Minimum Alarm Volume Harness from J5 of the MMI PCB.

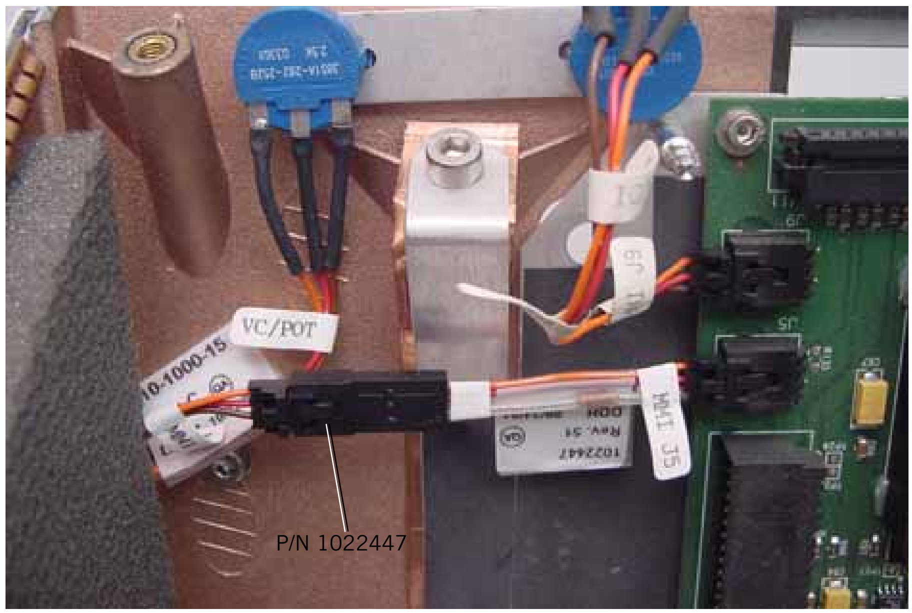


Figure 9-43: Increased Alarm Volume Harness

9.26 Backup Alarm

Follow these steps to remove the backup alarm (Figure 9-44). Reverse removal steps to install.

NOTE: Before reinstalling the backup alarm, inspect the EMI and mesh cooling fan filters. If the filters are dirty, rinse with warm water and wipe or blow dry.

Reinstall the EMI filter in the orientation shown.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the outer filter housing and mesh cooling inlet filter.
3. Remove the four screws that hold the backup alarm bracket, then separate components.
4. Disconnect the backup alarm from the J15 connector on the MMI PCB.
5. Remove the collar from the alarm, then push the alarm from the bracket.

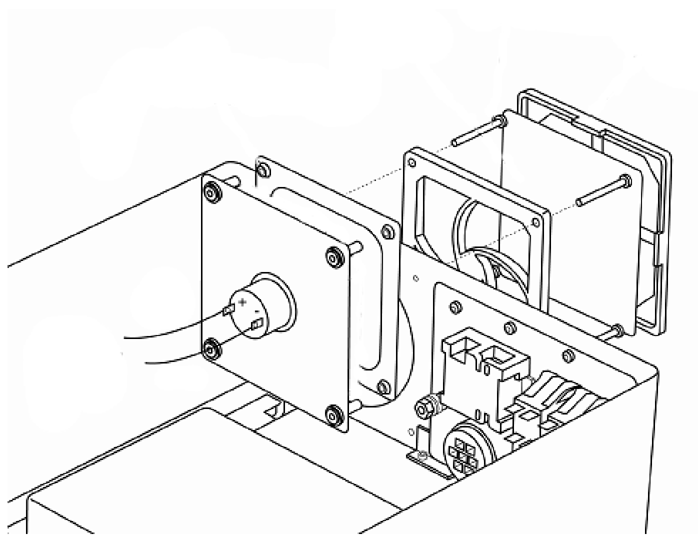


Figure 9-44: Backup Alarm

9.27 AC Distribution Panel

WARNING: The AC distribution panel contains high voltage components. To avoid injury, verify that the AC and external DC power sources are disconnected from the ventilator.

Follow these steps to remove the AC distribution panel (Figure 9-45, Figure 9-46, Figure 9-47). Reverse removal steps to install.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the ten screws and washers that hold the AC distribution panel to the enclosure. Note that one screw is longer (M3x12) and is fastened on the inside of the enclosure with a 5.5-mm nut.
3. Remove the 10-mm nuts and washers holding the ground wires to the ground lug and top enclosure, then remove the lug.
4. Remove the 2.5-mm screw holding the L-bracket, then lift the AC distribution panel away from the top enclosure.

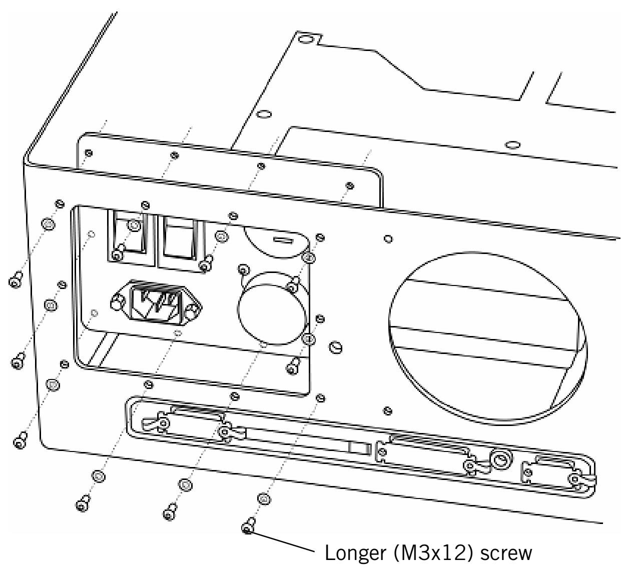


Figure 9-45: AC Distribution Panel (From Outside the Top Enclosure)

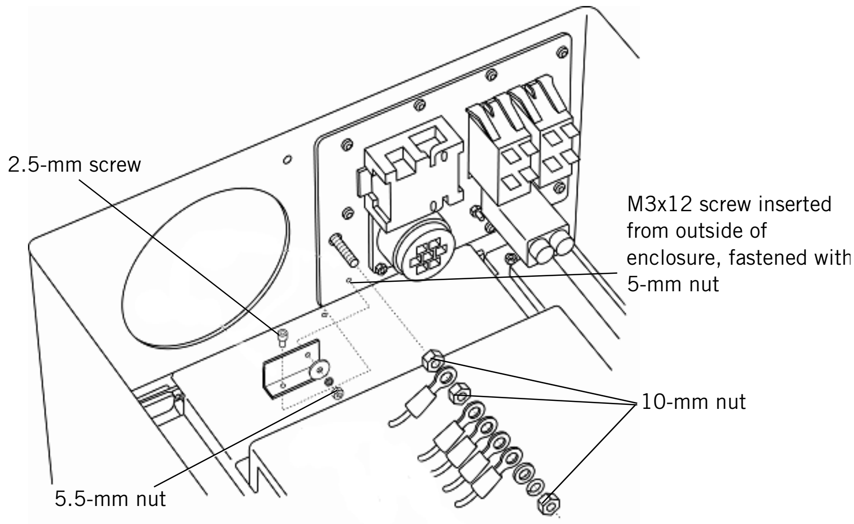


Figure 9-46: AC Distribution Panel (From Inside the Enclosure)

Figure 9-47: Ground Lug and L-Bracket

9.28 AC Cord Bracket

Follow these steps to remove the AC Cord Bracket (Figure 9-48). (Reverse removal steps to install.)

CAUTION: Hardware may fall into the Esprit Ventilator enclosure if the instructions outlined below are not followed.

NOTE: If the AC Cord Bracket is missing, verify the KEP nuts are not inside the Esprit enclosure.

1. Remove the top enclosure (see “Top Enclosure” on page 9-5).
2. Remove the AC Distribution Panel (see “AC Distribution Panel” on page 9-43).
3. Remove the screws, washers, and KEP nuts that hold the AC Cord Bracket to the AC Distribution Panel (Figure 9-48).

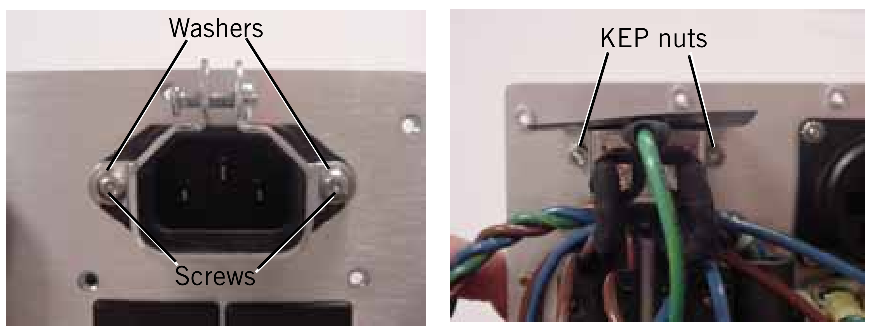


Figure 9-48: AC Cord Bracket (Outside and inside views)

9.29 Humidifier Receptacle Rotation

Rotate the humidifier AC receptacle 180 degrees if necessary to allow right-angle humidifier power cords to connect to the receptacle. Follow these steps to rotate the receptacle (Figure 9-49, Figure 9-50, Figure 9-51, Figure 9-52):

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5) to allow access to the AC distribution panel.
2. From inside the ventilator, unscrew the blue neutral wire from the humidifier circuit breaker.

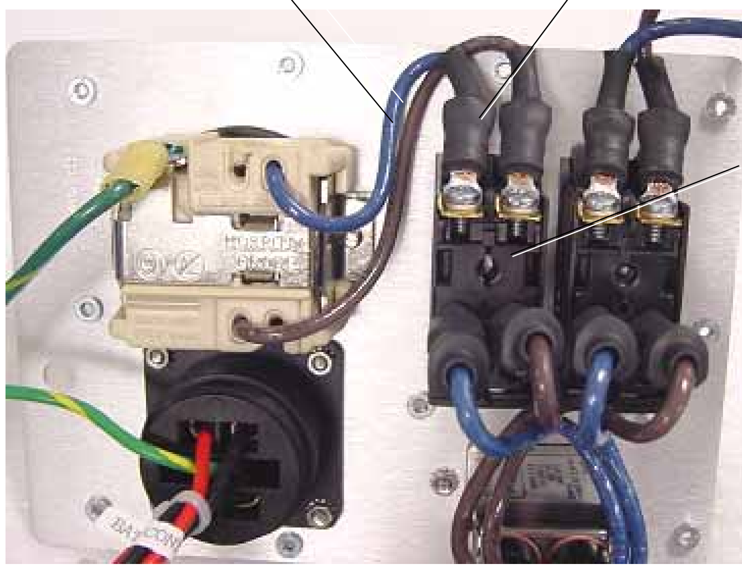


Figure 9-49: Removing the Blue Neutral Wire

3. From outside the ventilator, remove the humidifier outlet cover.

Figure 9-50: Humidifier Outlet Cover

4. Remove the two jackscrews from the outside of the receptacle.

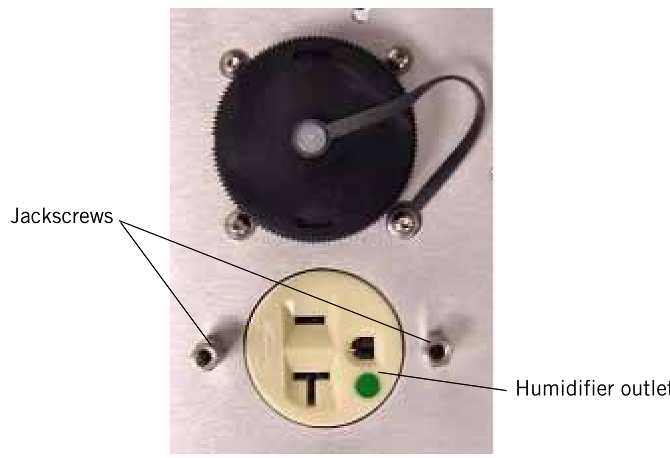


Figure 9-51: Removing AC Receptacle Jackscrews

5. Unscrew the other end of the blue neutral wire from the AC receptacle, and discard the wire.
6. Insert the longer replacement neutral wire (P/N 1012131) into the AC receptacle: twist the wires if necessary, and check that no copper wiring extends outside the receptacle after the wire is inserted.
7. Rotate the receptacle and use the jackscrews to secure it into place.

Rotated humidifier outlet allows connection of right angle power cords

Figure 9-52: Rotated Humidifier AC Receptacle

8. Connect the free end of the replacement neutral wire to the humidifier circuit breaker and screw into place, with the replacement wire in the same orientation as the other circuit breaker connections.
9. Once installed, plug in a humidifier or measure AC voltage to verify that the AC receptacle operates correctly. Perform the electrical safety test and EST as described in Chapter 8.

9.30 Printed Circuit Boards (Daughter PCBs) (Except Main PCB)

Follow these steps to remove the daughter PCBs (Figure 9-53, Figure 9-57). Reverse removal steps to install.

NOTE: NOTE: The main PCB must be installed before reinstalling the other PCBs.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Loosen the three captive screws and remove the screw holding the PCB shroud, then remove the cover.
3. Pull up on the top corners of the daughter PCB you want to remove, using a slight rocking motion as you pull.

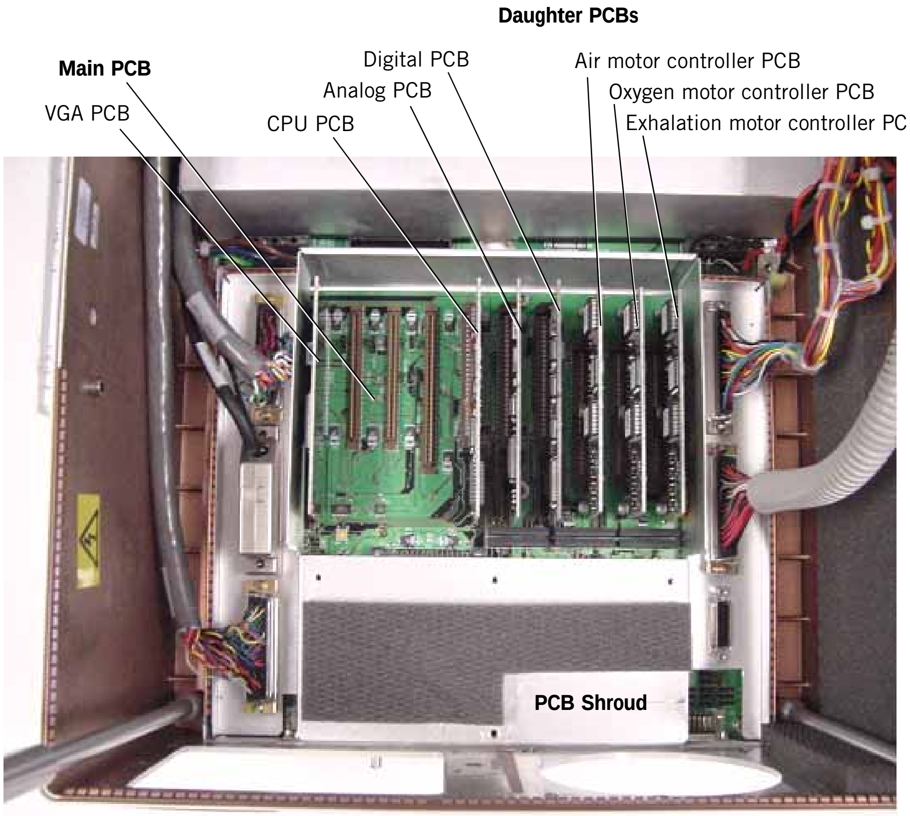


Figure 9-53: Printed Circuit Boards (PCBs)

9.31 CPU PCB with 4.10 or Greater

When installing the new CPU PCB with 4.10 OTP (P/N 1022451), verify the Main PCB is the correct version (P/N 1005947 or P/N 632-01000-03 Rev D or greater), by performing the following step:

1. Verify the checksum on U14 (see Figure 9-54) of the Main PCB is B27A (see Figure 9-55), if not, replace the Main PCB.

Figure 9-54: U14 on Main PCB

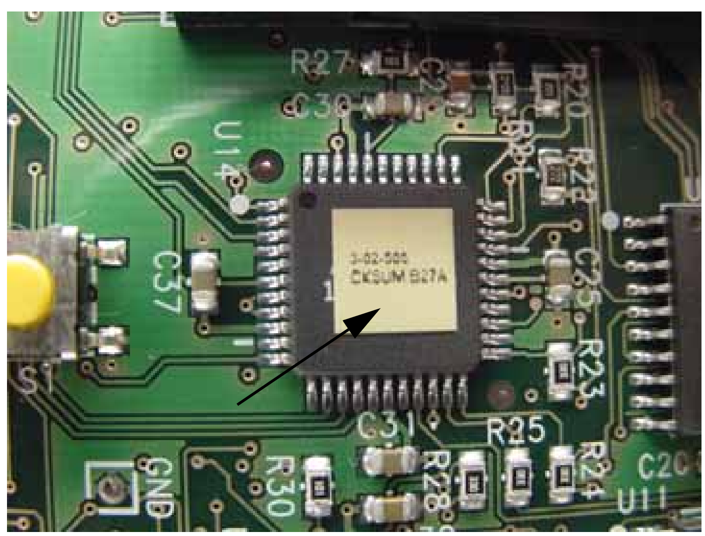


Figure 9-55: CKSUM B27A

9.32 Main PCB

Three main PCBs exist in the field: the original main PCB accommodates the standard alarm, the revised main PCB accommodates the standard alarm, and the high-volume primary alarm. The third version accommodates the standard and high-volume primary alarm, has a lithium battery on the board, and the remote alarm jack is mounted to the top enclosure. Contact technical services for assistance if there is any question regarding the main PCB version.

Follow these steps to remove the main PCB (Figure 9-56, Figure 9-57, Figure 9-58). Reverse removal steps to install.

NOTE: When reinstalling the main PCB, do not tighten jackscrews on the CN connectors until all are assembled.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove all vertically mounted PCBs from the main PCB (see Chapter 9.30 on p. 9-48), and store each PCB in a conductive bag.
3. Remove the backup alarm (see Chapter 9.26 on p. 9-42), 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 backup alarm cover and mesh filter.
6. Remove the AC distribution panel (see Chapter 9.27 on p. 9-43.
7. Remove the ten screws that hold these cables, then disconnect by pulling the connector (not the cable): MAIN *CN7*, MAIN *CN8*, MAIN *CN9*, MAIN *CN10*, and MAIN *CN21*.
8. Remove twelve jackscrews from female connectors on the main PCB.
9. Remove the port covers and six jackscrews that hold the external connectors to the rear of the enclosure.
10. If necessary, remove the remote alarm jack (see Chapter 9.33 on p. 9-53).
11. Remove the nine screws that hold the main PCB to the tray, then remove the main PCB.

Figure 9-56: External Connectors with Port Covers and Jackscrews Removed

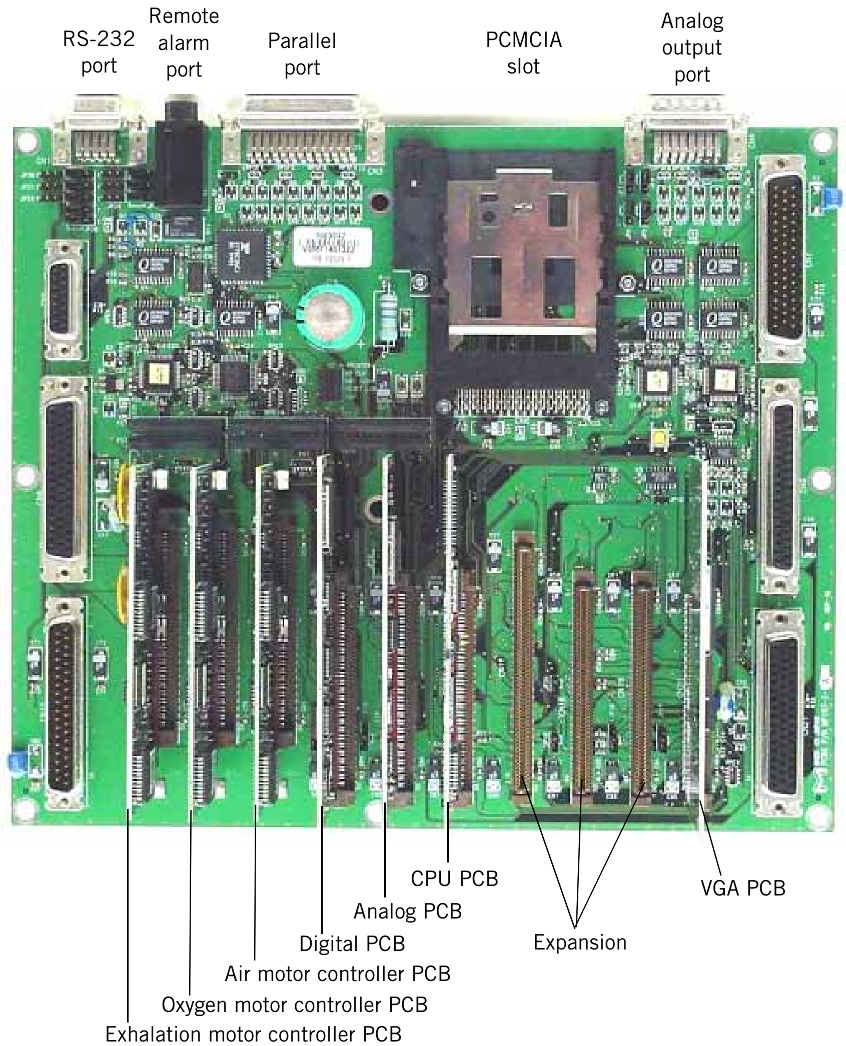


Figure 9-57: Main PCB and Daughter PCBs

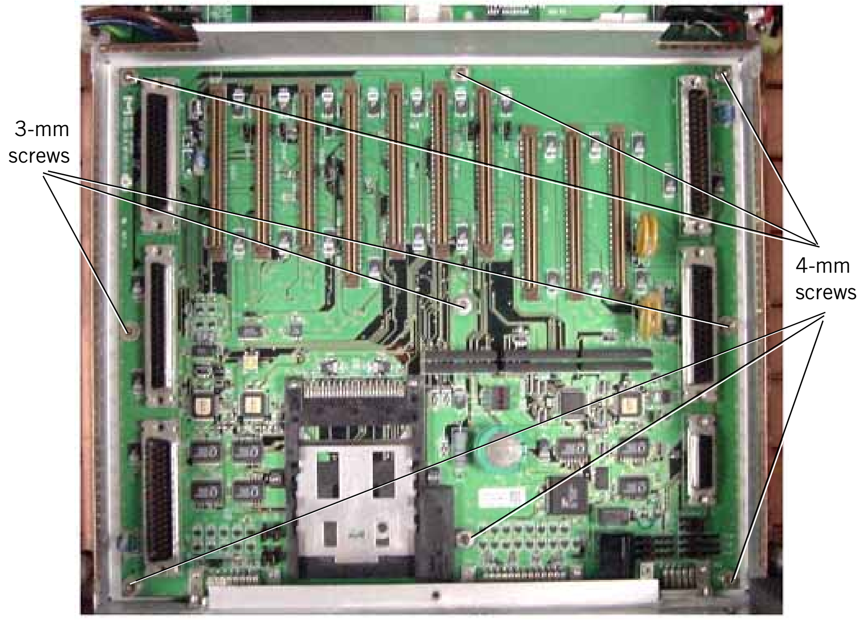


Figure 9-58: Nine Screws Secure Main PCB to Tray

9.33 Remote Alarm Jack

Follow these steps to remove the remote alarm jack (). Reverse removal steps to install.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Loosen the three captive screws and remove the screw holding the PCB shroud, then remove the cover.
3. Remove the nut and washer from the remote alarm jack (Figure 9-59).
4. Disconnect the remote alarm jack harness from CN2 on the Main PCB (Figure 9-60).

Figure 9-59: Remote Alarm Jack (Outside view)

5. Remove the remote alarm jack and washer from the Main PCB/top enclosure.

Figure 9-60: Remote Alarm Jack (Inside view)

9.34 Power Switch

Follow these steps to remove the power switch (Figure 9-61). Reverse removal steps to install.

NOTE: Orient the switch as shown when reinstalling.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Disconnect the spade connectors from the power switch terminals.
3. Press the flex clips on the side of the switch and push down to remove the switch.

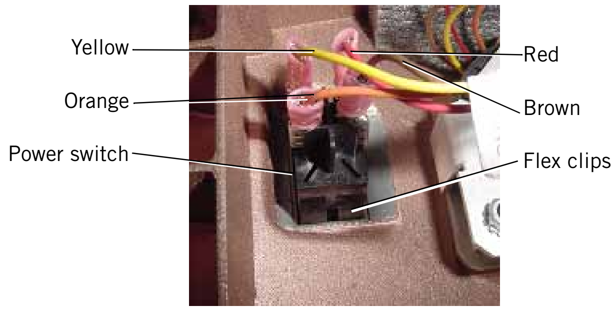


Figure 9-61: Power Switch Wire Connections

NOTE: An improved power switch (P/N 1050831) is terminated with solder connections to a wire harness. When replacing a power switch with terminal spade connectors, remove the switch and the MMI cable. Replace both with the new switch/cable assembly ().

Figure 9-62: Soldered Power Switch/MMI Cable

9.35 FIO_2 Connector

Follow these steps to remove the FIO_2 connector (Figure 9-63). Reverse removal steps to install.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Cut the tie wrap that holds the FIO_2 cable near the sensor PCB.
3. Disconnect cable SEN J7 from the sensor PCB.
4. Remove the 8-mm nut and washer that hold the FIO_2 connector, then remove the connector.

Figure 9-63: FIO_2 Connector

9.36 Exhalation Flow Sensor

Follow these steps to remove the exhalation flow sensor (Figure 9-64, Figure 9-65):

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the enclosure brace.
3. Cut the tie wrap holding the exhalation flow sensor to the exhalation valve, and the tie wrap holding 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 exhalation outlet port to the exhalation valve.
6. Remove the screw holding the outlet port to the bottom enclosure.
7. Push the flow sensor toward the vent port.
8. Wiggle the outlet block to remove from the exhalation manifold, then remove the exhalation flow sensor.

Enclosure brace

Figure 9-64: Enclosure Brace

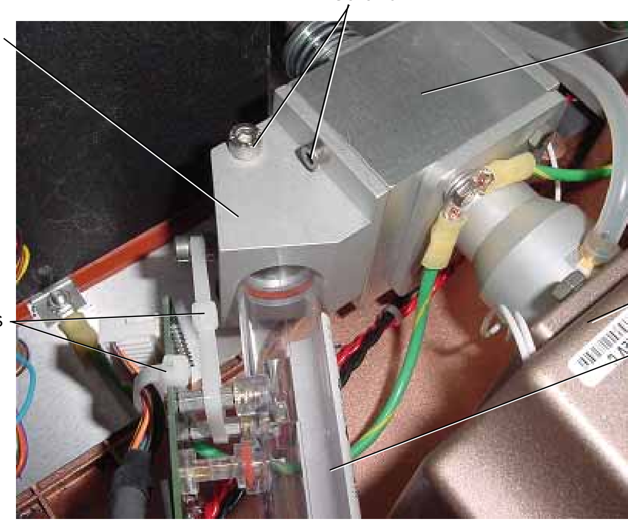


Figure 9-65: Exhalation Flow Sensor

Follow these steps to install the exhalation flow sensor:

NOTE: The filter heater assembly and exhalation valve assembly must be installed before reinstalling the exhalation flow sensor.

1. Inspect the two O-rings on the exhalation output manifold and replace if cracked or deformed. Lightly lubricate the O-rings with Krytox GPL226 lubricant.

NOTE: The CV4 check valve should remain inside the exhalation valve when the outlet manifold is removed. If it falls out, reinstall into the exhalation valve assembly (Figure 9-68).

2. Gently push the exhalation flow sensor through the ventilator output hole vent port. The flow arrow on the sensor must point toward the ventilator outlet hole vent port.
3. Use the screw to fasten the exhalation valve outlet port to the exhalation valve.
4. Use the M5x50 screw to fasten the output manifold to the bottom enclosure.
5. Insert the flow sensor completely into the exhalation valve (use a slight rotating motion) and fasten with a tie wrap. To avoid damaging the flow sensor, hand-tighten only (do not tighten the tie wrap with a tool).
6. Connect cable EXH F/S to the flow sensor and fasten with a tie wrap. To avoid damaging the flow sensor, hand-tighten only (do not tighten the tie wrap with a tool).
7. Install enclosure brace.
8. Install top enclosure (see Chapter 9.2 on p. 9-5).

9.37 Exhalation Valve Assembly

Follow these steps to remove the exhalation valve assembly (Figure 9-66).

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the enclosure brace.
3. Remove the exhalation flow sensor (see Chapter 9.36 on p. 9-56).
4. Disconnect the white and black connectors on the exhalation valve from the MTR EV cable.
5. Disconnect the exhalation pressure tube to the inspiratory manifold.
6. Remove the four 10-mm screws that hold the exhalation valve to the heater outlet port. Move the green ground wires out of the way, then carefully remove the exhalation valve, taking care not to damage the coiled spring.

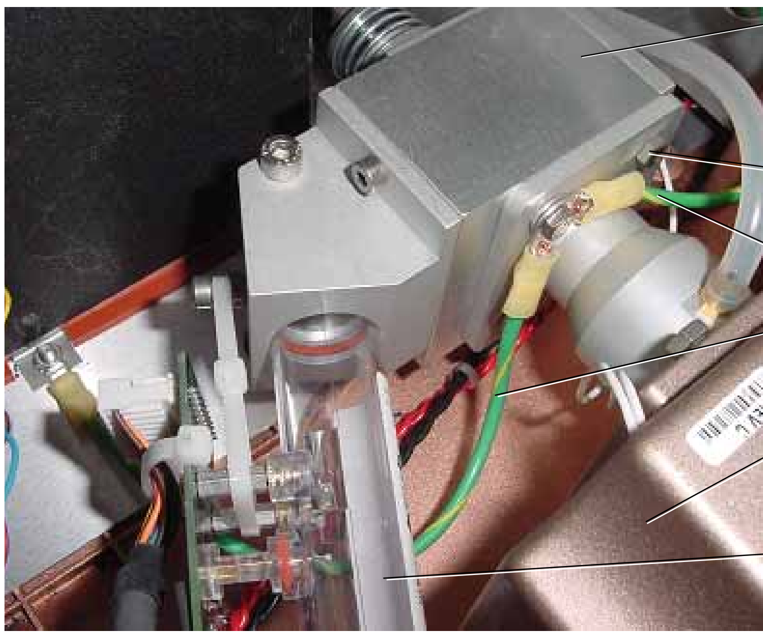


Figure 9-66: Exhalation Valve and Filter Heater Assembly

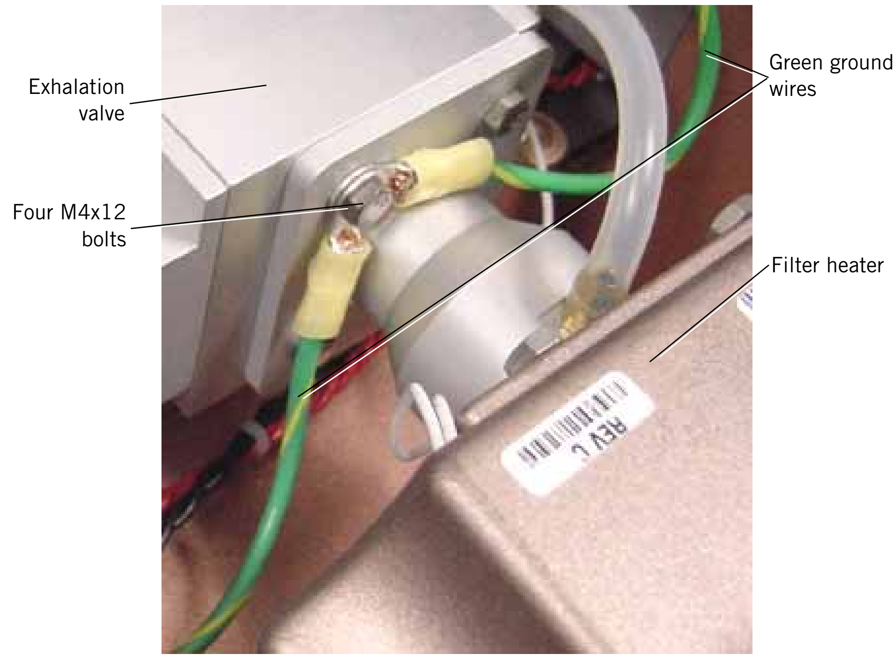


Figure 9-67: Exhalation valve to Filter Heater Connection

Follow these steps to reinstall the exhalation valve (Figure 9-66 and Figure 9-68).

NOTE: The filter heater assembly must be installed before reinstalling the exhalation valve.

1. Inspect the O-ring on the inlet port of the filter heater assembly, and replace if cracked or deformed. Lightly lubricate the O-ring with Krytox GPL226 lubricant.
2. Important: Check that the CV4 check valve is oriented and seated properly (Figure 9-68).

   NOTE: It is not necessary to inspect CV4 if you are installing a new exhalation valve.
3. Use the four M4x12 bolts to fasten the exhalation valve to the filter heater assembly, with the two green ground wires connected (Figure 9-67).
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 Chapter 9.36 on p. 9-56).
7. Install the enclosure brace.

8. Install the top enclosure (see Chapter 9.2 on p. 9-5).

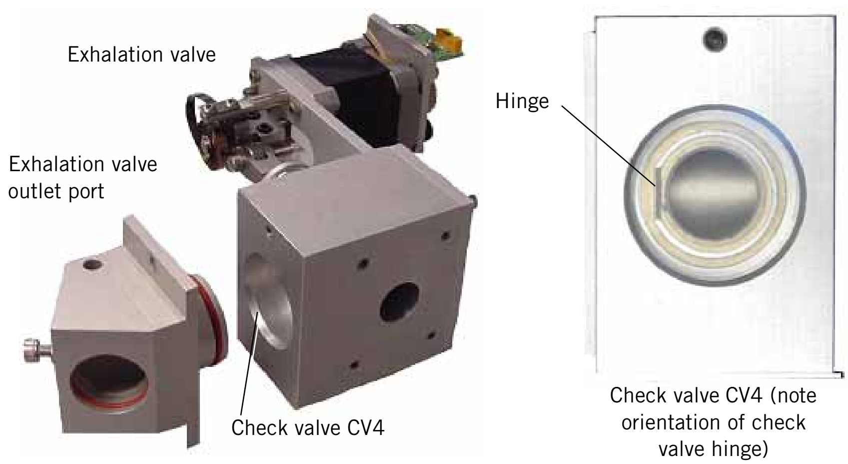


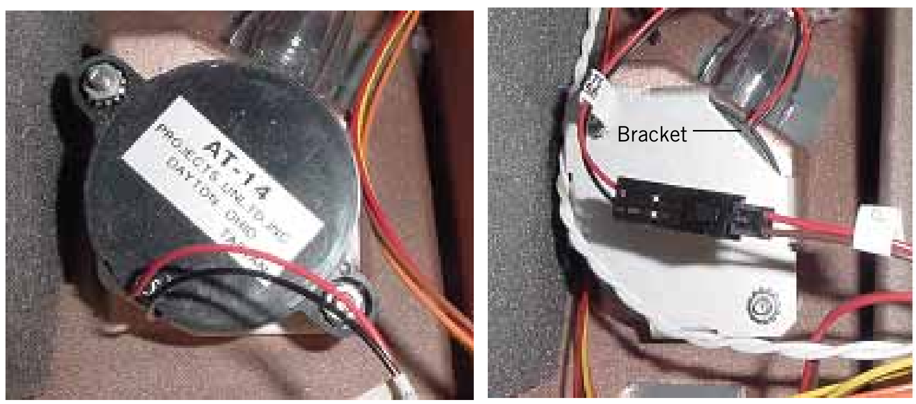
Figure 9-68: CV4 Check Valve Orientation

9.38 Primary Alarm

Follow these steps to remove the primary alarm (Figure 9-69). Reverse removal steps to install.

NOTE: Two versions of the primary alarm exist in the field: the standard alarm and the high-volume primary alarm. The original main and digital PCBs accommodate the standard alarm, and the revised main and digital PCBs accommodate the standard alarm and the high-volume primary alarm.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Disconnect the primary alarm cable from the P ALARM cable.
3. Remove the two 7/32-in. nuts that hold the alarm (for the standard primary alarm) or bracket and alarm (for the high-volume alarm), then remove.



Standard alarm High-volume alarm

Figure 9-69: Primary Alarm

9.39 Filter Heater Assembly

Follow these steps to remove the filter heater assembly (Figure 9-70). Reverse removal steps to install.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove enclosure brace.
3. Disconnect the heater assembly HEATER cable from the mating HEATER cable.
4. Remove the four screws that hold the exhalation valve to the heater assembly (Figure 9-67).
5. Disconnect the silicone tube from the tube nipple, then push the filter heater assembly out through the front of the bottom enclosure.

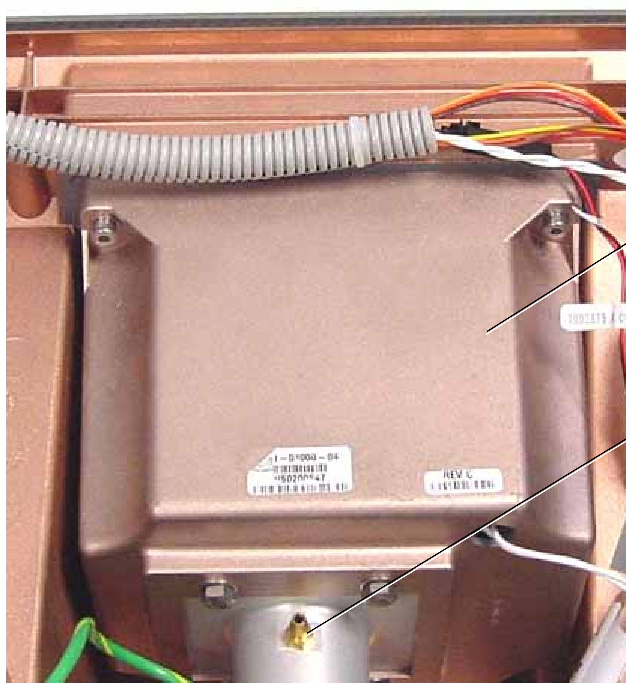


Figure 9-70: Filter Heater Tube Connection

9.40 Oxygen Flow Sensor

Follow these steps to remove the oxygen flow sensor (Figure 9-71):

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the enclosure brace.
3. Completely remove the 4-mm screws and clamp from the oxygen flow sensor.
4. Cut the tie wrap holding cable O_2 F/S to the oxygen flow sensor, then disconnect the cable.
5. Gently push the oxygen flow sensor and the aluminum sleeve toward each other, then tilt the flow sensor up at the oxygen valve and lift out.

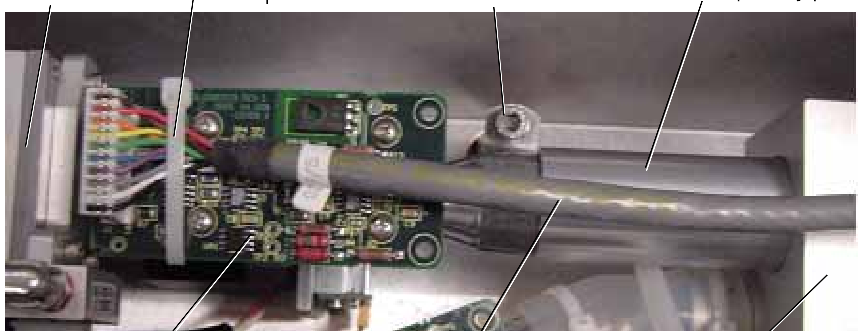


Figure 9-71: Oxygen Flow Sensor

Follow these steps to install the oxygen flow sensor:

NOTE: The oxygen regulator assembly, oxygen module assembly, and inspiratory manifold assembly must be installed before reinstalling the oxygen flow sensor.

NOTE: When reinstalling the oxygen flow sensor, ensure that it is fully installed to the oxygen valve assembly and the oxygen inspiratory port.

NOTE: Always inspect O-rings between interconnecting parts and replace if visibly damaged or rough to the touch. Always use new O-rings supplied with replacement parts. Lightly lubricate O-rings with Krytox GPL226 lubricant when installing, and relubricate at every reinstallation.

1. Slide the aluminum oxygen inspiratory port onto the outlet of the flow sensor.
2. With the flow arrow pointing toward the inspiratory manifold, insert the flow sensor into the oxygen valve outlet port, then push the aluminum sleeve into the inspiratory manifold.
   - The circuit board on the flow sensor must face up.

- Route cables MTR O_2, MTR BV and MTR EV underneath the flow sensor.
- The flow sensor and aluminum sleeve must be pushed *completely* into their respective ports.

3. Place the clamp around the outlet of the flow sensor and fasten with the 4-mm screw.
4. Connect cable O2 F/S to the oxygen flow sensor, then tie wrap it to the circuit board. To avoid damaging the flow sensor, hand-tighten only (do not tighten the tie wrap with a tool).
5. Install the enclosure brace.
6. Install the top enclosure (see Chapter 9.2 on p. 9-5).

9.41 Inspiratory Manifold Assembly

Follow these steps to remove the inspiratory manifold assembly (Figure 9-72, Figure 9-73, Figure 9-74):

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove enclosure brace.
3. Remove the oxygen flow sensor (see Chapter 9.40 on p. 9-63).
4. Remove the air flow sensor (see Chapter 9.44 on p. 9-72).
5. Remove the vent port tubing from the inspiratory manifold.
6. Disconnect the tubes from the inspiratory, exhalation, and safety valve solenoids.
7. Remove the green ground wire from the manifold.
8. Loosen the recessed 2.5-mm hex set screw on the outlet port, but do not remove it. *When re-installing the outlet port, partially set the setscrew into one of the indents. Turn the outlet port left and right to be certain the setscrew is captured by the indent. Next, tighten the setscrew all of the way and confirm the outlet port is tight.*
9. Remove two 4-mm screws holding the inspiratory manifold to the bottom enclosure.
10. Remove four 2.5-mm screws and washers surrounding the inspiratory outlet port. Pull the outlet port from the inspiratory manifold. *Verify check valve orientation at reinstallation.*
11. Disconnect the cables labeled EXHAL SOL, INSP SOL, and SAFETY SOL, and remove the inspiratory manifold.

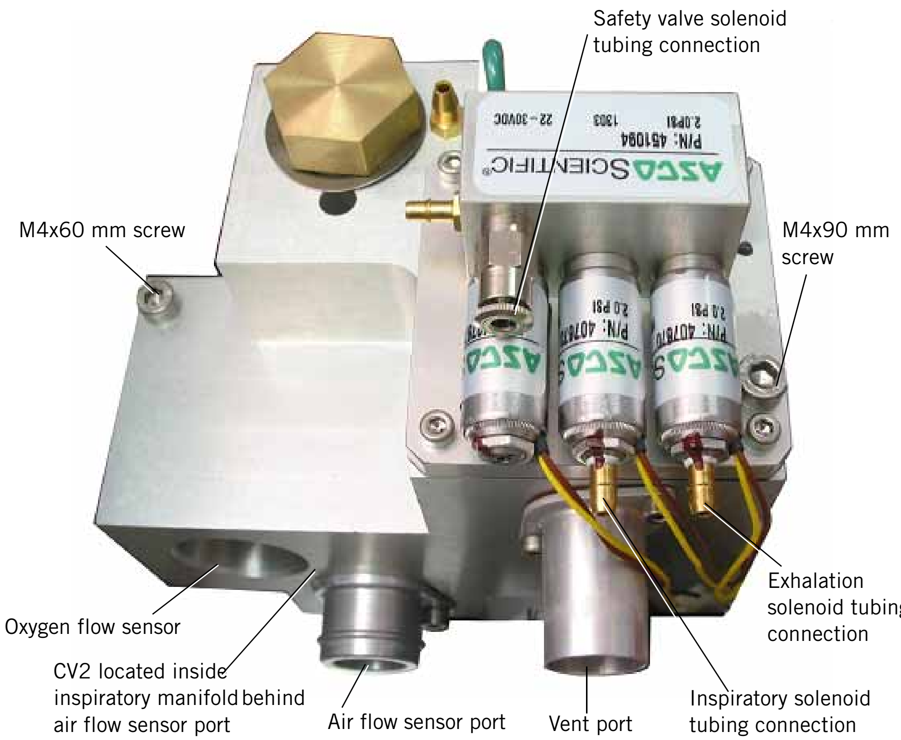


Figure 9-72: Inspiratory Manifold Assembly

Figure 9-73: Recessed 2.5-mm Set Screw Securing Outlet Port

Figure 9-74: Inspiratory Outlet Port and Check Valve CV3 Orientation

Follow these steps to install the inspiratory manifold assembly:

NOTE:

- The oxygen regulator assembly and oxygen module assembly must be installed before reinstalling the inspiratory module assembly.
- Always inspect O-rings between interconnecting parts and replace if visibly damaged or rough to the touch. Always use new O-rings supplied with replacement parts. Lightly lubricate O-rings with Krytox GPL226 lubricant when installing, and relubricate at every reinstallation.
- When replacing original version of inspiratory manifold assembly, use cable extension kit to rework main PCB to motor cable as described in Chapter 9.42 on p. 9-69.

1. Turn the two inspiratory manifold screws (Figure 9-72) a few threads to secure the inspiratory manifold, but do not tighten yet.
2. Connect the silicone tube from the air flow sensor to the male port on the inspiratory manifold. Route cables MTR O2, MTR BV and MTR EV underneath the silicone tube.
3. Install the oxygen flow sensor (see Chapter 9.40 on p. 9-63).
4. Tighten the two inspiratory manifold screws and torque to 5 in-lbs.
5. Reconnect the green ground wire to the inspiratory manifold.
6. Install four screws and washers at the inspiratory outlet port (Figure 9-74), but do not tighten until the outlet port is installed and secured.

7. Inspect the inspiratory outlet:
   - Check the O-ring on the inspiratory outlet, and replace if cracked or deformed. Lightly lubricate the O-ring with Krytox GPL226 lubricant.
   - Check that check valve CV3 in the inspiratory outlet is oriented and seated properly.
8. Insert the inspiratory port completely into the inspiratory manifold and fasten by tightening the locking screw (Figure 9-73). Pull on the inspiratory outlet to ensure it does not come out or rotate.
9. Reconnect the SV, inspiratory, and exhalation tubes to the solenoids (Figure 9-72).
10. Reconnect all remaining tubes to the inspiratory manifold (Figure 9-72).
11. Reconnect the cables labeled EXHAL SOL, INSP SOL and SAFETY SOL (Figure 9-72).
12. Install the enclosure brace and top enclosure (see Chapter 9.2 on p. 9-5).

9.42 Installing the Cable Extension Kit

Updated three-station solenoids and crossover solenoids (SOL1) are used to manufacture Esprit ventilators. Because the electrical connectors on these solenoids differ from the original versions, a cable extension kit (P/N 1010867) must be installed when replacing the original versions of any of these components:

- Three-station solenoid
- Inspiratory module (which includes a three-station solenoid)
- Crossover solenoid
- Oxygen valve assembly (which includes a crossover solenoid)

Install the cable extension kit to the main PCB to motor cable (P/N 610-1000-05) to make the electrical connector(s) compatible with the updated component(s):

1. Use wire cutters to remove electrical connector(s) from the main PCB to motor cable (Figure 9-75). Cut as close to connector as possible, and remove only the connector(s) for the component(s) being replaced. For example, if replacing the crossover solenoid or oxygen valve assembly, only remove the connector on the wire pair labeled “CROSSOVER.”

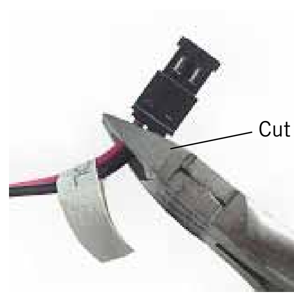


Figure 9-75: Cutting Off Electrical Connector from Main PCB to Motor Cable

2. If necessary, affix the appropriate label from the cable extension kit to identify the individual wire pair(s).

3. Insert the cut wire ends over both contacts in the crimp connector (Figure 9-76) for each cut wire pair.

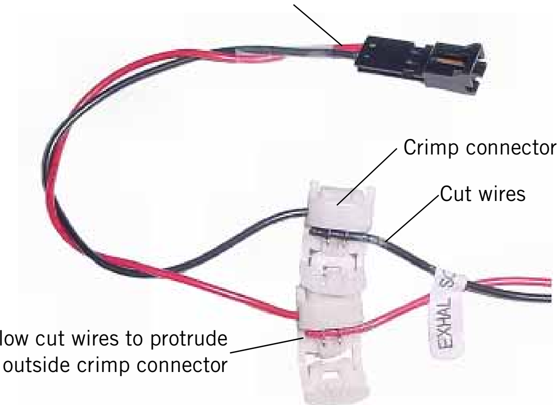


Figure 9-76: Installing Cut Wires into Crimp Connector

4. Fold the crimp connector to close and use pliers to lock the connector together (Figure 9-77). Pull to verify that the connection is tight.

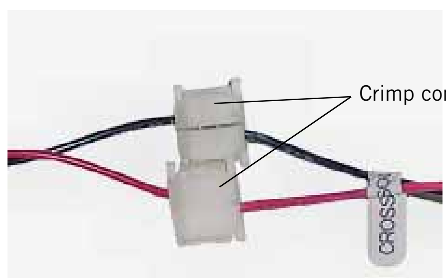


Figure 9-77: Closing the Crimp Connector

5. Test the replaced solenoid as described in Chapter 5.

9.43 Three-Station Solenoid Assembly

NOTE:

- When reinstalling three-station solenoid assembly, orient as shown and install and hand-tighten an 8-in. tie wrap to secure. Do not use tools to tighten the tie wrap.
- Do not remove the diaphragm, spring, or O-ring under the solenoid assembly.
- When reinstalling the screws that hold the solenoid assembly to the inspiratory manifold, torque to 5.5± 1 in.-lbs.
- When replacing original version of three-station solenoid, use cable extension kit to rework the main PCB to motor cable, as described in Chapter 9.42 on p. 9-69.

Follow these steps to remove the three-station solenoid assembly (Figure 9-78). Reverse removal steps to install.

1. Remove top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove enclosure brace.
3. Label the six tubes connected to the solenoid assembly to ensure proper reconnection, then disconnect.
4. Disconnect the harnesses to the three solenoids.
5. Remove the five screws holding the solenoid assembly to the inspiratory manifold, then remove the solenoid assembly.

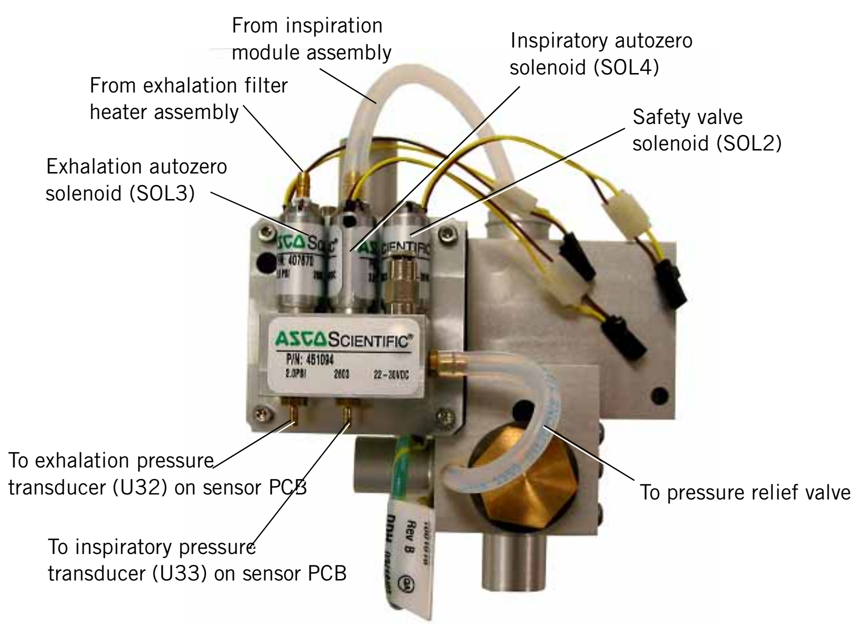


Figure 9-78: Three-Station Solenoid Assembly

9.44 Air Flow Sensor

Follow these steps to remove the air flow sensor (Figure 9-79). Reverse removal steps to install.

NOTE:

- The oxygen regulator assembly and air valve must be installed before reinstalling the air flow sensor.
- When reinstalling the air flow sensor:
  - Install a new mesh cup on the top port of the air valve.
  - The circuit board must face away from the blower with the flow arrow pointing toward the inspiratory manifold.
- To avoid damaging the flow sensor, hand-tighten replacement tie-wraps (do not tighten the tie wrap with a tool).

1. Remove top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove enclosure brace.
3. Disconnect the transfer tube from blower outlet to the top port of the air valve.
4. Disconnect the vent tube from the safety valve port, then fold the tube away from air flow sensor.
5. Cut the tie wraps holding the AIR F/S cable and silicone tubes to the air valve and inspiratory manifold.
6. Remove the screw holding the retaining clamp.
7. Remove the air flow sensor with silicone tubes attached.

NOTE: If replacing the air flow sensor, cut the tie wraps and remove the silicone tubes from the flow sensor. When replacing tie wraps, do not capture the inspiratory pressure tube directly below the air inlet connection to the inspiratory module.

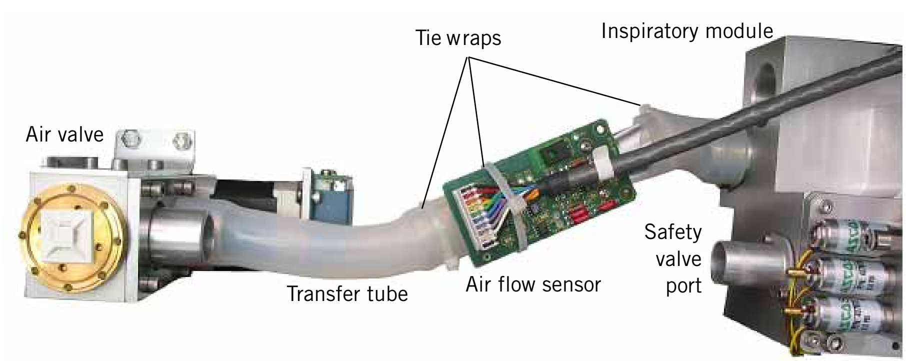


Figure 9-79: Air Flow Sensor

9.45 Air Valve Assembly

Follow these steps to remove the air valve assembly (Figure 9-61). Reverse removal steps to install.

NOTE:

- The oxygen regulator assembly must be installed before reinstalling the air valve.
- Install a replacement mesh cup before reinstalling the air valve inlet tube: place the mesh cup over the air valve inlet port, then insert the blower outlet hose over the mesh cup completely up to the valve body.

1. Remove the top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the enclosure brace.
3. Disconnect the blower outlet tube from the air valve inlet, and remove the mesh cup from inside the tube. Discard mesh cup.
4. Remove the air flow sensor but do not cut the tie wrap or disconnect the AIR F/S cable from the flow sensor (see Chapter 9.44 on p. 9-72).
5. Disconnect the two MTR BV cables on the air valve from the mating cable MTR BV.
6. Disconnect the silicone tube from the blower to the crossover solenoid assembly.
7. Remove two 4-mm screws holding the air valve bracket, then carefully remove the air valve.

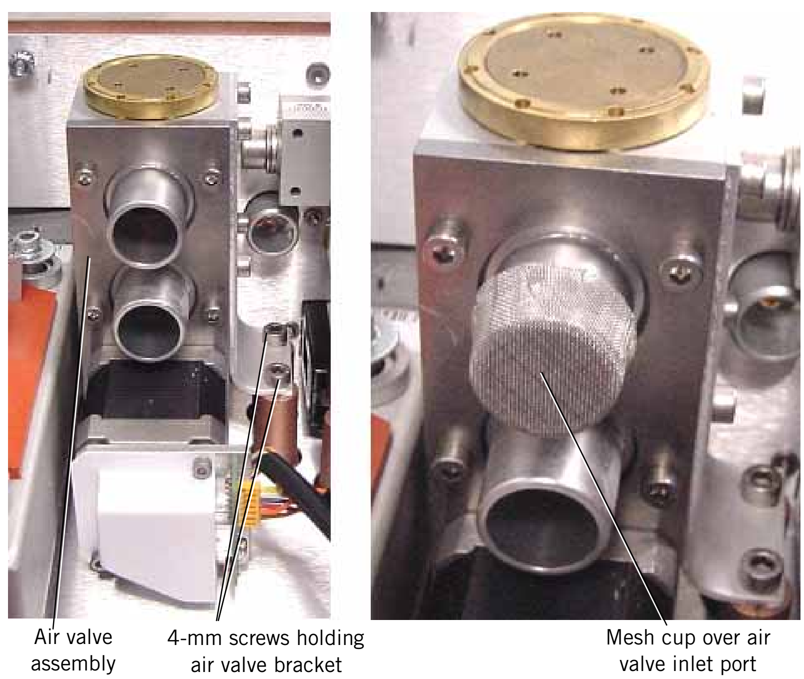


Figure 9-80: Air Valve and Mesh Cup

9.46 Oxygen Valve Assembly

Follow these steps to remove the oxygen valve assembly (Figure 9-81). Reverse removal steps to install.

NOTE:

- The oxygen regulator assembly must be installed before reinstalling the oxygen valve assembly.
- When reinstalling the oxygen valve, ensure that the oxygen regulator and oxygen flow sensor are fully installed to the oxygen valve assembly.
- Always inspect O-rings between interconnecting parts and replace if visibly damaged or rough to the touch. Always use new O-rings supplied with replacement parts. Lightly lubricate O-rings with Krytox GPL226 lubricant when installing, and relubricate at every reinstallation.
- When replacing the original version of the oxygen valve assembly or crossover solenoid, use the cable extension kit to rework the main PCB to motor cable, as described in Chapter 9.42 on p. 9-69.

1. Remove top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove enclosure brace.
3. Remove the oxygen flow sensor (see Chapter 9.40 on p. 9-63), but do not cut the tie wrap or disconnect the O2 F/S cable from the flow sensor.
4. Remove the air flow sensor but do not disconnect the AIR F/S cable from the flow sensor (see Chapter 9.44 on p. 9-72).
5. Remove the air valve assembly (see Chapter 9.45 on p. 9-73).
6. Disconnect the two MTR O2 cables on the oxygen valve from the mating MTR O2 cable.
7. Disconnect the CROSS SOL cable from the crossover solenoid assembly.
8. Use an 8-mm socket with extension to remove the three bolts holding the oxygen valve bracket.

9. Slowly pull the oxygen valve assembly away from the oxygen regulator.

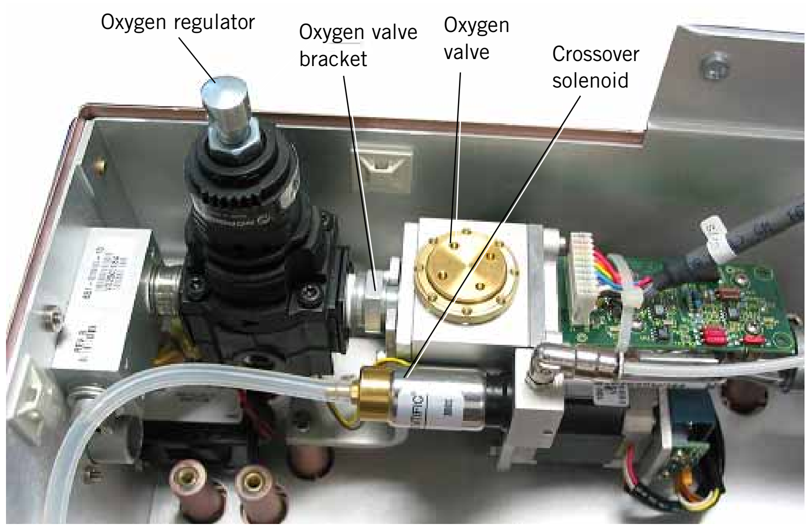


Figure 9-81: Oxygen Valve and Oxygen Regulator

9.47 Oxygen Regulator Assembly (with Oxygen Pressure Switch)

Follow these steps to remove the oxygen regulator assembly (Figure 9-82):

1. Remove top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove enclosure brace.
3. Remove oxygen flow sensor (see Chapter 9.40 on p. 9-63), but do not cut the tie wrap or disconnect the O2 F/S cable from the flow sensor.
4. Remove the air flow sensor but do not cut the tie wrap or disconnect the AIR F/S cable from the flow sensor (see Chapter 9.44 on p. 9-72).
5. Remove the air valve assembly (see Chapter 9.45 on p. 9-73).
6. Remove the oxygen valve assembly (see Chapter 9.46 on p. 9-74).
7. Use a 4-mm hex wrench to remove the two screws holding the oxygen water trap to the bracket.
8. Use a 2.5-mm hex wrench to remove the bracket screw above the water trap.
9. Unscrew the bowl from the oxygen water trap, then unscrew the water trap from the inlet block.
10. Remove the four 2.5-mm screws holding the oxygen regulator assembly to the back plate.
11. From inside the enclosure, disconnect the two black wires from connectors J5 and J6 on the sensor PCB.
12. Carefully cut the tie wraps holding the two black wires near the sensor PCB, then carefully separate these wires all the way back to pressure switch 1.
13. Lift the oxygen regulator assembly away from the enclosure.

Figure 9-82: Oxygen Water Trap and Oxygen Regulator

Follow these steps to install the oxygen regulator assembly:

1. Fasten the plate and the oxygen regulator assembly to the bottom enclosure using four 2.5-mm screws.
2. Connect the two black wires from the oxygen pressure switch to the J5 and J6 connectors on the sensor PCB (polarity is not important).
3. Use two tie wraps to fasten the two black wires to the bundle of cables running across the top of the sensor PCB.
4. Install oxygen valve assembly (see Chapter 9.46 on p. 9-74). Ensure that the oxygen valve is fully installed to the regulator.
5. Install air valve assembly (see Chapter 9.47 on p. 9-76).
6. Install air flow sensor (see Chapter 9.44 on p. 9-72).
7. Install oxygen flow sensor (see Chapter 9.40 on p. 9-63). Ensure that the oxygen flow sensor is fully installed to the oxygen valve assembly.
8. Remove any residual Teflon tape from male and female threads
9. Apply 2¾ turns of Teflon tape to the thread of the inlet block.
10. Screw the oxygen water trap onto the inlet block (clockwise) until one thread is showing and the assembly is perpendicular to the floor.
11. Screw the bowl onto the oxygen water trap.
12. Fasten the bracket to the oxygen water trap and bottom enclosure using two 4-mm screws and one 3-mm screw.
13. Install enclosure brace.
14. Install top enclosure (see Chapter 9.2 on p. 9-5).

9.48 Elapsed Time Meter

NOTE: Record the previous elapsed time meter hours on service documentation: replacement meters always start at 0 hours.

NOTE: Torque the elapsed time meter retaining screws to 4.5 to 6.5 in.-lb.

Follow these steps to remove the elapsed time meter (Figure 9-83). Reverse removal steps to install.

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 2-mm 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.

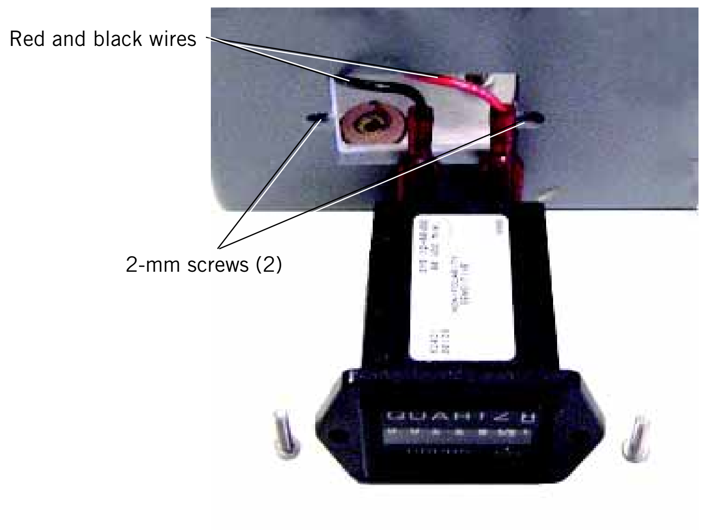


Figure 9-83: Elapsed Time Meter

9.49 Oxygen Water Trap Assembly

Follow these steps to remove the oxygen water trap assembly (Figure 9-84):

1. Disconnect the oxygen hose from the ventilator.
2. Remove three screws holding the bracket to the oxygen water trap/inlet filter and bottom enclosure, then remove the bracket.
3. Unscrew the bowl from the oxygen water trap.
4. Remove the oxygen water trap by unscrewing it (counterclockwise) from the inlet block.

Follow these steps to replace the oxygen water trap:

1. Clean any residual Teflon tape from the threads of the oxygen inlet block
2. Apply 2½ turns of Teflon tape to the threads of the oxygen inlet block.
3. Screw the oxygen water trap 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.
5. Fasten the bracket to the oxygen water trap and bottom enclosure using three screws.

Figure 9-84: Oxygen Water Trap and Oxygen Regulator

9.50 Blower Motor Controller PCB (Original)

Follow these steps to remove the original blower motor controller PCB from the bottom enclosure (Figure 9-85). Reverse to install.

NOTES:

- The original blower motor controller PCB consists of a controller PCB, a smaller blower lockup PCB, and a bracket.
- When installing the PCB, place onto the threaded studs, then install the three nuts and washers.
- Tighten all nuts just until firm: do not over-tighten. (No nut is attached to the bottom rear stud.)

1. Remove top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the enclosure brace.
3. Remove three 5.5-mm nuts and washers holding the blower motor controller PCB bracket, then partially remove the bracket.
4. Disconnect the wires from the green terminal block (connector J2) on the large PCB.
5. Disconnect the cables from the blower and sensor PCB harnesses on the small PCB, then remove the entire bracketed assembly.

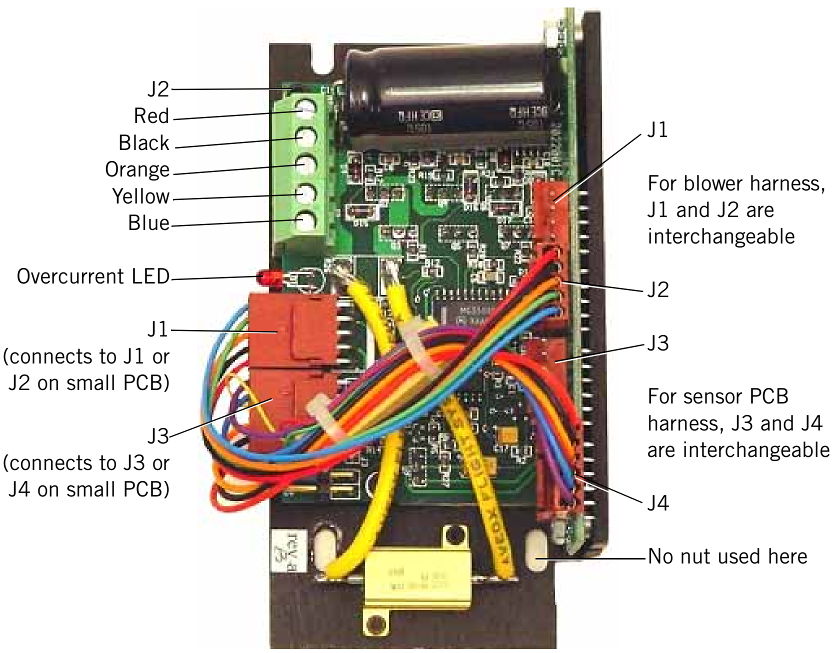


Figure 9-85: Original Blower Motor Controller PCB

9.51 Blower Motor Controller PCB (Updated)

Follow these steps to remove the updated blower motor controller PCB from the bottom enclosure (Figure 9-86). Reverse to install.

1. Remove top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove the enclosure brace.
3. Remove four M3 nuts holding the blower motor controller PCB bracket, then partially remove the bracket.
4. Disconnect the wires from the green terminal block (connector J2).
5. Disconnect the cables from the blower and sensor PCB harnesses.
6. Remove the entire bracketed blower motor controller PCB assembly.

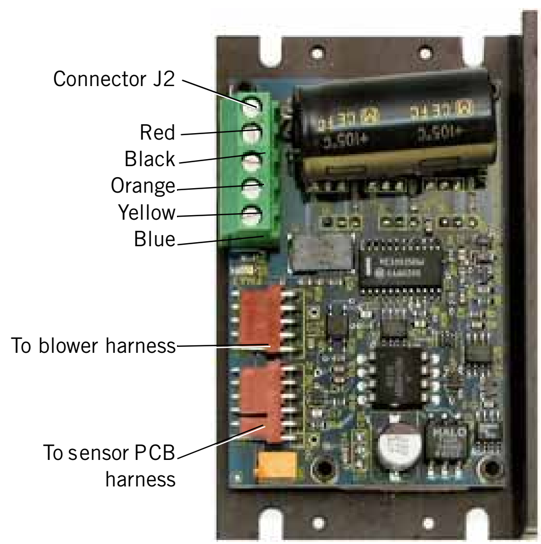


Figure 9-86: Updated Blower Motor Controller PCB

9.52 Blower Assembly

Follow these steps to remove the blower assembly (Figure 9-87, Figure 9-88, Figure 9-73).

1. Remove top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove enclosure brace.
3. Disconnect the blower outlet tube from the top port of the air valve. Remove the mesh cup from inside the tube.
4. Pry the grommet from the blower shroud.
5. Remove four 7-mm lock nuts holding the blower shroud to the bottom enclosure.
6. Partially remove the shroud, pull the transfer tube into the shroud, then completely remove the shroud.
7. Disconnect the silicone tube from the top of the cooling coil.
8. Remove four lock nuts (and L-brackets, for the original blower assembly) holding the blower.
9. Loosen the hose clamp holding the silicone tube to blower outlet, then disconnect the tube.
10. Disconnect the BLOWER cable from its connection on the blower controller PCB.
11. Loosen the screws securing the orange, yellow, and blue wires from the blower harness to the green terminal block connector J2 on the blower motor controller PCB. Disconnect the wires (Figure 9-85, Figure 9-86).
12. Disconnect the thermostat wires from connectors J3 and J4 on the sensor PCB. Cut tie wraps and separate the harness back to the blower.

13. Remove the blower.

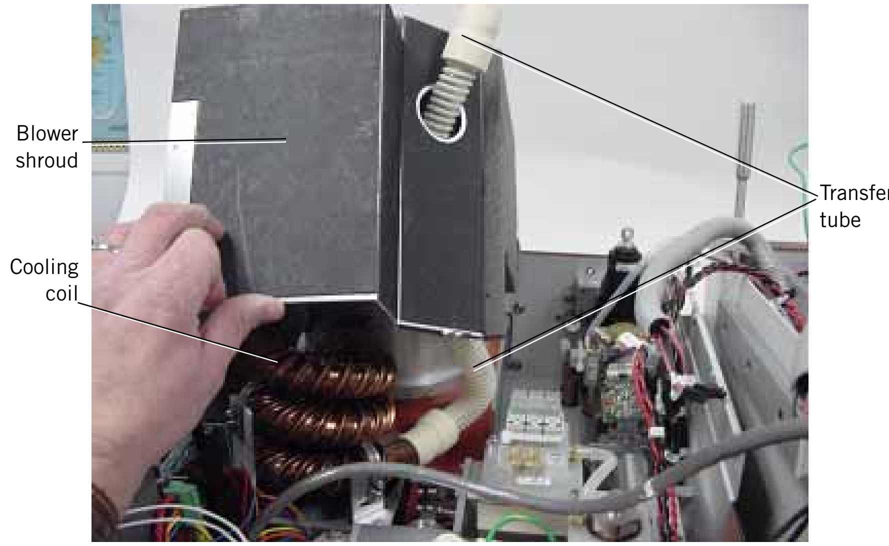


Figure 9-87: Blower Shroud

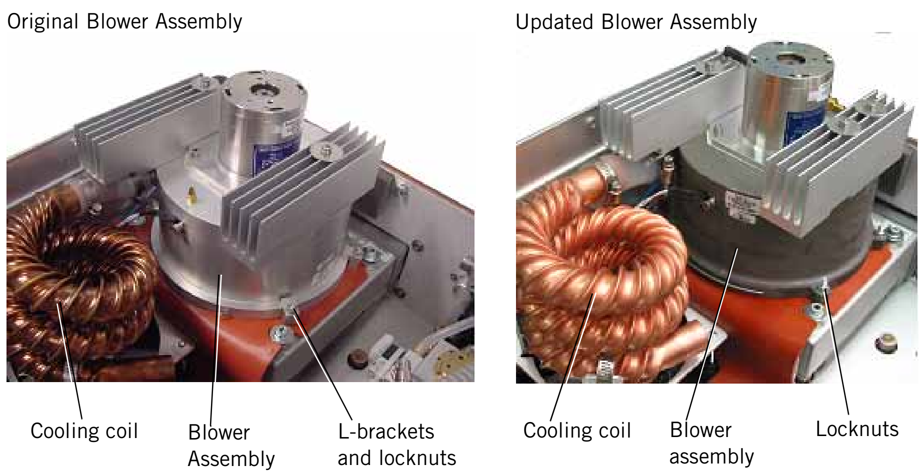


Figure 9-88: Blower Assembly (Original and Updated)

Follow these steps to install the blower assembly (Figure 9-87, Figure 9-89):

NOTE: The muffler assembly must be installed before reinstalling the blower assembly.

1. Connect the transfer tube to the bottom of the cooling coil.
2. Place the blower assembly on the gasket so that blower outlet is parallel to the enclosure wall. Fasten with four lock nuts (and L-brackets, for the original version of the blower assembly).

NOTE: The L-brackets (original blower assembly) should be perpendicular to the blower after tightening. Torque just until firm (do not overtighten).

3. Route the blower cables between the cooling coil and the enclosure wall.
4. Connect the BLOWER J1 cable to connector J1 or J2 on the blower motor controller PCB (Figure 9-85).
5. Connect the blue, yellow and orange wires to the green terminal block connector J2 on the original blower motor controller PCB (Figure 9-85), or to connector J1 on the updated blower motor controller PCB (Figure 9-86).
6. Connect the thermostat wires to connectors J3 and J4 on the sensor PCB (polarity is unimportant).
7. Connect the silicone tube from the top of the cooling coil to the blower, then use the hose clamp to fasten.
8. Connect the silicone tube to the brass barb connector on top of the blower.
9. Place the shroud over the blower while pushing the transfer tube through the hole, then install the grommet.

CAUTION: Route the cables from the blower and fan through the cutout at the bottom corner of the shroud. *Do not pinch wires under the blower shroud*.

10. Use the four 7-mm lock nuts to fasten the shroud. Connect the green ground wire from the exhalation valve to the shroud stud. Torque just until firm (do not overtighten).
11. Connect the small silicone tube from the blower to the crossover solenoid assembly.
12. Install a new mesh cup on the top port of the air valve, then insert the blower outlet hose over the mesh cup completely to the valve body.
13. Install enclosure brace.
14. Install top enclosure (see Chapter 9.2 on p. 9-5).

Figure 9-89: Blower Assembly Position on Gasket

9.53 Blower Muffler Assembly

Follow these steps to remove the blower muffler assembly (Figure 9-90):

1. Remove top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove enclosure brace.
3. Remove blower assembly (see Chapter 9.51 on p. 9-81).
4. Disconnect transfer tube from the bottom of cooling coil.
5. Use a 4-mm hex wrench to remove the four bolts holding the muffler assembly.
6. Use a 2.5-mm hex wrench to remove the rear air intake cover.
7. Peel back the gasket, then remove muffler assembly.

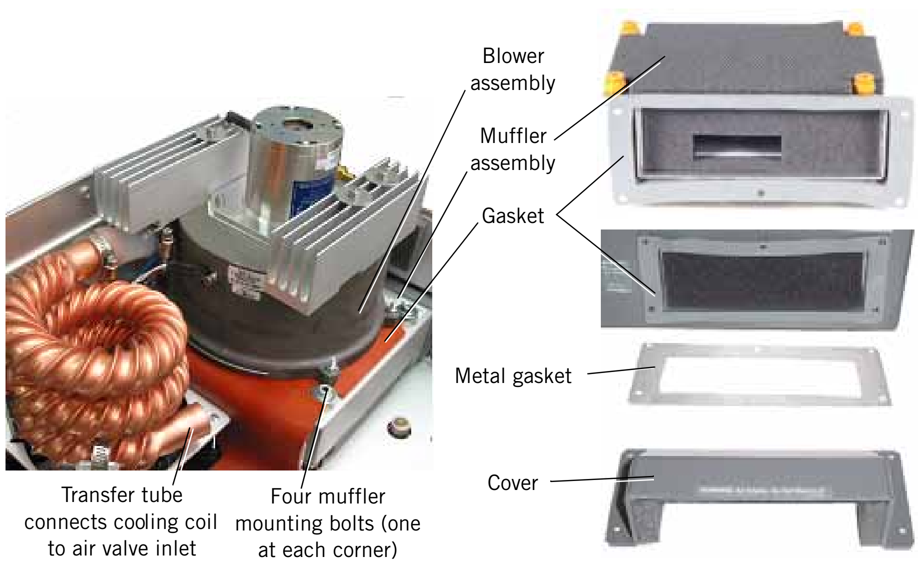


Figure 9-90: Blower Muffler Assembly

Follow these steps to install the blower muffler assembly:

1. Install the muffler assembly, making sure the gasket is on the outside of the bottom enclosure and the air inlet cover holes are aligned.
2. Align the metal inlet gasket over the rubber gasket, then secure the cover with five 2.5-mm screws.
3. Apply one drop of Loctite 222 to the threads of the four muffler mounting bolts.
4. Tighten the bolts until they just touch the muffler, then back off 1¾ turns.
5. Fold the gasket over the threaded studs.
6. Connect the transfer tube to the bottom of the cooling coil.
7. Install blower assembly (see Chapter 9.51 on p. 9-81).
8. Install enclosure brace.
9. Install top enclosure (see Chapter 9.2 on p. 9-5).

9.54 Cooling Fan/ Cooling Coil Assembly

NOTE: It may be convenient to position the bottom enclosure on its side during fan removal and installation.

Follow these steps to remove the cooling fan/cooling coil assembly (Figure 9-91):

1. Remove top enclosure (see Chapter 9.2 on p. 9-5).
2. Remove enclosure brace.
3. Disconnect the transfer tube from the top port of the air valve. Remove the mesh cup from inside the transfer tube.
4. Disconnect the silicone tube from the crossover solenoid assembly.
5. Pry the grommet from the blower shroud.
6. Remove four 7-mm lock nuts holding the blower shroud to the bottom enclosure.
7. Partially remove the shroud, pull the transfer tube into the shroud, then completely remove the shroud.
8. Loosen the hose clamp holding the silicone tube at the blower outlet, then disconnect the tube.
9. Disconnect the transfer tube from the bottom of the cooling coil.
10. Loosen the two top screws in connector J2 on the blower motor controller PCB. Disconnect and separate the black and red wires from the connector (Figure 9-85, Figure 9-86).
11. Remove four screws, washers, and nuts that hold the cooling fan to the enclosure, then remove the cooling coil and fan.

Follow these steps to install the cooling fan/cooling coil assembly:

NOTE: The fan must be installed with its flow direction arrow pointing out of the ventilator. When the fan is reinstalled and before reassembling the ventilator, confirm correct air flow: connect AC power, turn on the ventilator, then check that the fan blows air out of the ventilator.

1. Place the fan on the gasket with the flow arrow on the fan pointing down and the fan cable closest to blower controller PCB. Make sure no wires are pinched under the fan.
2. Place the cooling coil assembly on the fan noting the orientation of the cooling coil inlet, then fasten with four bolts. Torque bolts just until firm (do not over-tighten).
3. Twist the fan’s red and black wires around the large wires from the power supply. Insert them into the J2 connector and tighten. 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 silicone 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 in the shroud.

7. Use the four lock nuts to fasten the shroud.
8. Connect the green ground wires from the exhalation valve and solenoid assembly to the shroud stud. Tighten stud just until firm (do not over-tighten).

NOTE: Route the cables from the blower and fan through the cutout at the bottom corner of the shroud.

9. Connect the silicone tube from the blower to the crossover solenoid (Figure 9-91).
10. Install a new mesh cup over the air valve inlet, then insert the blower outlet tube completely over the port to the valve body.
11. Install enclosure brace.
12. Install top enclosure (see Chapter 9.2 on p. 9-5).

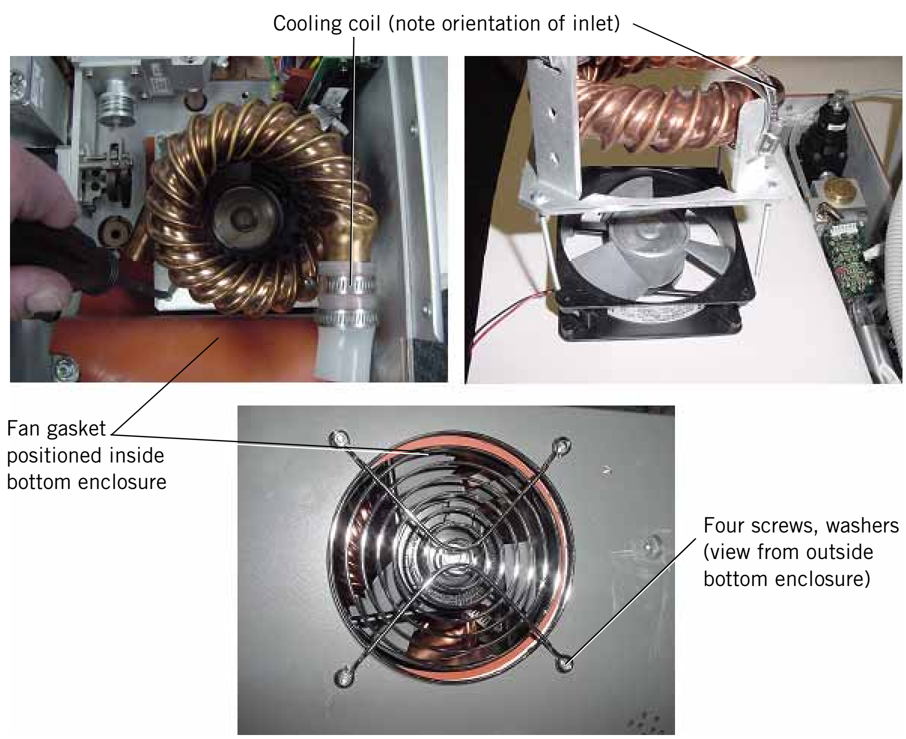


Figure 9-91: Cooling Coil and Fan

9.55 GUI Upgrades

Three GUI versions exist in the field: the original monochrome 9.5-in. GUI, the original 10.4-in. GUI, and the 2nd generation 10.4-in. GUI. Because the 9.5-in. GUI assembly is no longer available, the 10.4-in. GUI upgrade kit must be installed when installing the color upgrade option or replacing a VGA display, touch frame, backlight inverter PCB, or keyboard.

The GUI upgrade procedure includes the following steps, if applicable:

- Replacing the GUI (see page 9-90).
- Installing the upgrade kit CPU and DC/DC converter PCBs (see page 9-93).
- Downloading ventilator software (see page 9-93).
- Calibrating the screen (see page 9-94).
- Enabling the color option (see page 9-94).
- Enabling the graphics option (see page 9-94).
- Final checkout (see page 9-94).

Table 9-1 lists the contents of the GUI upgrade kits.

Description	Part Number Original 10.4-in.	Part Number 2nd Generation 10.4-in.
10.4-in. GUI upgrade kit	1014182	1019370
10.4-in. to 10.4-in. upgrade kit	N/A	1020175
10.4-in. GUI assembly	1014183	1019107
2-Mb CPU PCB	1012273	1018603
DC/DC converter PCB	1004972	N/A
GUI shielding plate	1003194	1003194
Cable, 10.4-in display to main PCB	1016006	1018334
Cable, backlight inverter	N/A	1018336
Transition PCB	N/A	1018752
Adapter PCB	N/A	1018753
Backlight inverter PCB	1005514	1019368
Mounting hardware	Miscellaneous	Miscellaneous

Table 9-1: GUI Upgrade Kits

This upgrade is not mandatory unless the color option or replacement GUI components (display, touch frame, backlight inverter PCB, or keyboard) are installed. If the a 10.4-in. GUI is already installed, do not install the upgrade kit (see Table 9-2 for minimum required parts to complete the repair).

NOTE: NOTE: Before performing the upgrade procedure, verify that the ventilator can power up, pass EST, and operate in normal ventilation mode. Complete the performance verification procedure when the upgrade is complete.

Current Ventilator Configuration	Reason for Service	Minimum Required Replacement Parts
9.5-in. GUI	VGA display failure	• 10.4-in GUI upgrade kit (P/N 1014182 or 1019370) • Software version 8.1 or higher (P/N 1003481)
9.5-in. GUI	Color option upgrade	• 10.4-in. GUI upgrade kit (P/N 1014182 or 1019370) • Software version 8.1 or higher (P/N 1003481)
Original 10.4-in. GUI	VGA display failure (parts required depend on specific reason for failure)	• 10.4-in. VGA display assembly (P/N 1014183) • 10.4-in. LCD assembly (includes the LCD and backlight inverter PCBs) (P/N 1006359) • 10.4-in. touch frame assembly (P/N 1006460) • 10.4-in. keyboard overlay assembly (P/N 1006582) • Cable, MMI PCB to overlay (P/N 1003311) • Cable, MMI PCB to touch frame (P/N 1003310) • Cable, 10.4-in. color display (P/N 1016006)
2nd Generation 10.4-in. GUI	VGA display failure (parts required depend on specific reason for failure)	• 10.4-in. VGA display assembly (P/N 1019107) • 10.4-in. LCD assembly (includes LCD only) (P/N 1019369) • Backlight inverter PCB (P/N 1019368) • 10.4-in. touch frame assembly (P/N 1006460) • 10.4-in. keyboard overlay assembly (P/N 1006582) • Cable, MMI PCB to overlay (P/N 1003311) • Cable, MMI PCB to touch frame (P/N 1003310) • Cable, 10.4-in. color display (P/N 1018334) • Cable, backlight inverter (P/N 1018336) • Transition PCB (P/N 1018752) • Adapter PCB (P/N 1018753)

Table 9-2: Minimum GUI Replacement Parts

9.56 Replacing the GUI (9.5-in. to original 10.4-in.)

1. Disconnect power, unscrew and separate the ventilator top and bottom halves. Set the halves side by side.
2. Disconnect all accessible wiring harnesses to the sensor, MMI, and backlight inverter PCBs.
3. Remove the power supply shroud (see Chapter 9.4 on p. 9-8).
4. Remove the hardware securing the power supply (see Chapter 9.8 on p. 9-12). Disconnect J2 and J3 harness connections to the power supply. Position the power supply and remaining interconnect wires so that they are out of the way.
5. Disconnect the harnesses (not previously accessible) to the MMI PCB. Remove all hardware securing the MMI PCB to the bulkhead bracket, and then remove both the MMI PCB and bulkhead bracket (see Chapter 9.10 on p. 9-17).
6. Remove the J14 harness from the main PCB (it will not be reused).
7. Remove the 9.5-in. GUI assembly (Chapter 9.12 on p. 9-22). Loosen the alarm volume and intensity control potentiometer set screws. Retain the ribbon cable end connectors.
8. Transfer the language inserts, knob, and rotary encoder from the old GUI to the new.
9. Remove the conductive tape from the shielding plate, unscrew all hardware securing the shielding plate to the ventilator housing, and remove the old shielding plate.
10. Use a soldering iron to enlarge the hole in the ventilator enclosure for the new display to main PCB wiring harness (Figure 9-92) to approximately 3/8-in. diameter (Figure 9-93).

CAUTION: Enlarging the enclosure hole for the harness may create excess plastic material: remove all excess enclosure material after enlarging the opening.

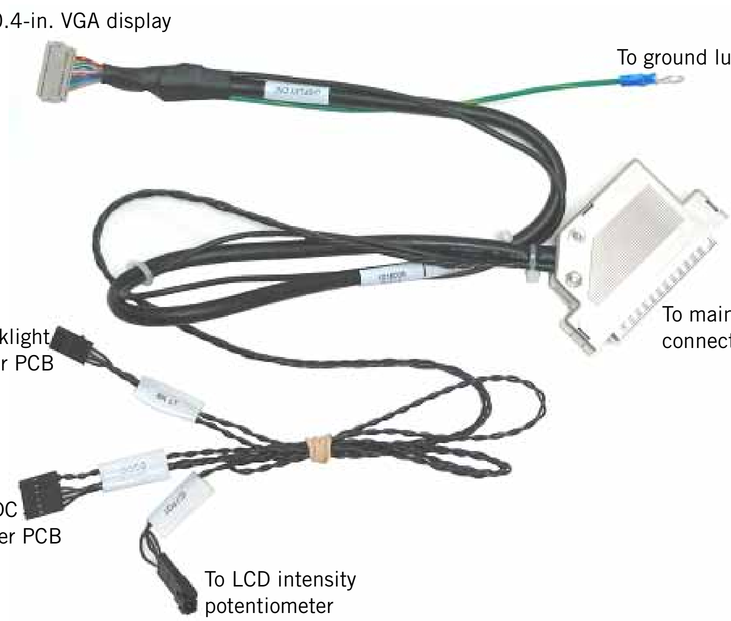


Figure 9-92: Display to Main PCB Wiring Harness

Figure 9-93: Enlarge Hole in Ventilator Enclosure for New GUI Cable

11. Attach the new shielding plate and conductive tape (Figure 9-94).
12. Feed the replacement harness through the enlarged bulkhead hole and connect the ground wire to the threaded stud using the supplied 7-mm nut.

NOTE: NOTE: Each of the three ball catches that hold the GUI to the enclosure has two tension adjustment screws. Adjust the ball catch tension by first tightening the tension screws fully clockwise, then unscrewing counterclockwise one and a quarter turn.

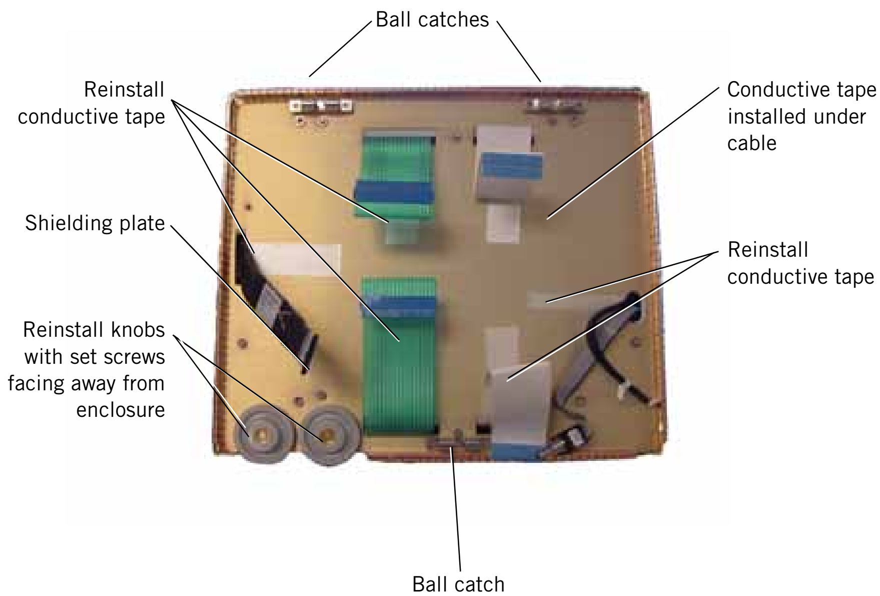


Figure 9-94: Front of Ventilator Before Installing 10.4-in. GUI

13. Position the foil blanket in the enclosure and reattach the bulkhead plate and MMI PCB.
14. Connect all of the interconnect cables to the 10.4-in. GUI and reinstall the potentiometer knobs with the set screws toward the face of the GUI (on 9.4-in. GUIs the knobs were installed with set screws toward the inside of the enclosure). Ensure that the knobs don't bind or rub when turned completely in either direction.
15. Align the foil shield holes with the power supply mounting holes. Reinstall the power supply. Reconnect J2 and J3 harness connections.
16. Reattach the power supply shroud. Replace the backlight inverter PCB with the DC/DC converter PCB on the power supply shroud. Apply the adhesive-backed insulation shield to the power supply shroud before mounting the DC/DC converter PCB (Figure 9-95).

17. Reattach the sensor PCB (see Chapter 9.3 on p. 9-6) and reconnect all remaining interconnect cables.

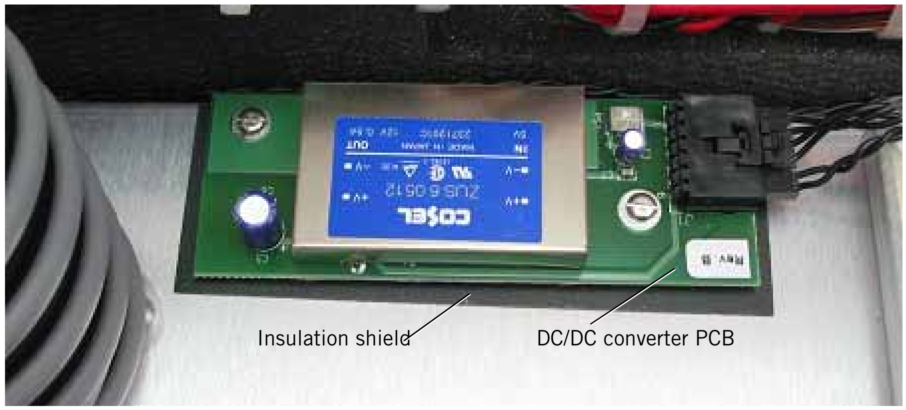


Figure 9-95: Adhesive-Backed Insulation Shield on Power Supply Shroud

9.56.1 Installing the CPU and DC/DC Converter PCBs

Remove the existing PCBs and replace with the PCBs included in the upgrade kit.

- Chapter 9.30 on p. 9-48 describes how to install the CPU PCB.
- Chapter 9.7 on p. 9-11 describes how to install the DC/DC converter PCB.

9.56.2 Downloading Ventilator Software

See Chapter 7 for complete software download instructions.

- Connect the service PC to the ventilator serial port using a null modem cable.
- Insert the field upgrade CD-ROM and follow the on-screen instructions. Use this command to prompt for the ventilator serial number (*x:* is the CD-ROM drive, and a space precedes *-vs*):

  (x:)\setup -vs

9.56.3 Calibrating the Screen

1. Cycle ventilator power while holding down the **Exp. Hold** and left **Options** button.
2. The ventilator prompts you to calibrate the screen. Upon acknowledgement, the software automatically detects and adjusts for the 10.4-in. screen size.
3. After the ventilator confirms the screen calibration is complete, cycle power to the ventilator and enter diagnostic mode.
4. Enter the software screen and confirm that the serial number is correct.
5. Reset the altitude and compliance compensation settings in the user configuration screen.
6. Perform an EST with the top enclosure removed. If the EST passes, install the top enclosure (see Chapter 9.2 on p. 9-5).

9.56.4 Enabling Options

Enable an option (see Chapter 7) only if the option upgrade is being installed at this time.

9.56.5 Final Checkout

Complete the recommended tests in the performance verification procedure (see Chapter 8).

9.57 Replacing the GUI (9.5-in. to 2nd Generation 10.4-in.)

1. Disconnect power, unscrew and separate the ventilator top and bottom halves. Set the halves side by side.
2. Disconnect all accessible wiring harnesses to the sensor, MMI, and backlight inverter PCBs.
3. Remove the power supply shroud (see Chapter 9.4 on p. 9-8).
4. Remove the hardware securing the power supply (see Chapter 9.8 on p. 9-12). Disconnect J2 and J3 harness connections to the power supply. Position the power supply and remaining interconnect wires so that they are out of the way.
5. Disconnect the harnesses (not previously accessible) to the MMI PCB. Remove all hardware securing the MMI PCB to the bulkhead bracket, and then remove both the MMI PCB and bulkhead bracket (see Chapter 9.10 on p. 9-17).
6. Remove the J14 harness from the main PCB (it will not be reused).
7. Remove the 9.5-in. GUI assembly (Chapter 9.12 on p. 9-22). Loosen the alarm volume and intensity control potentiometer set screws. Retain the ribbon cable end connectors.
8. Transfer the language inserts, knob, and rotary encoder from the old GUI to the new.
9. Remove the conductive tape from the shielding plate, unscrew all hardware securing the shielding plate to the ventilator housing, and remove the old shielding plate.
10. Attach the new shielding plate and conductive tape (Figure 9-96).

NOTE: Each of the three ball catches that hold the GUI to the enclosure has two tension adjustment screws. Adjust the ball catch tension by first tightening the tension screws fully clockwise, then unscrewing counterclockwise one and a quarter turn.

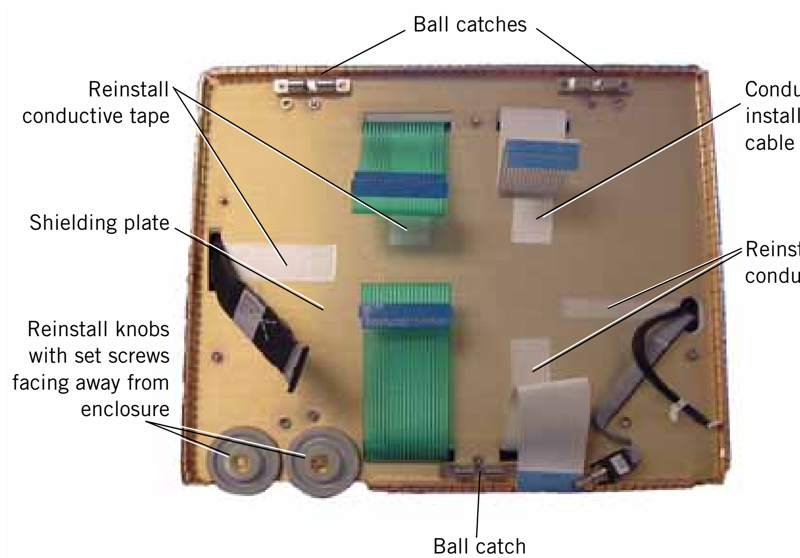


Figure 9-96: Front of Ventilator Before Installing 10.4-in. GUI

11. Position the foil blanket in the enclosure and reattach the bulkhead plate and MMI PCB.
12. Connect all of the interconnect cables to the 10.4-in. GUI and reinstall the potentiometer knobs with the set screws toward the face of the GUI (on 9.4-in. GUIs the knobs were installed with set screws toward the inside of the enclosure). Ensure that the knobs don't bind or rub when turned completely in either direction.
13. Align the foil shield holes with the power supply mounting holes. Reinstall the power supply. Reconnect J2 and J3 harness connections.
14. Reattach the power supply shroud. Remove the backlight inverter PCB from the power supply shroud and discard.
15. Reattach the sensor PCB (see Chapter 9.3 on p. 9-6) and reconnect all remaining interconnect cables.

9.57.1 Installing the CPU PCB

Remove the existing CPU PCB and replace with the CPU PCB included in the upgrade kit. Secnum describes how to install the CPU PCB.

9.57.2 Downloading Ventilator Software

See Chapter 7 for complete software download instructions.

1. Connect the service PC to the ventilator serial port using a null modem cable.
2. Insert the field upgrade CD-ROM and follow the onscreen instructions. Use this command to prompt for the ventilator serial number (*x:* is the CD-ROM drive, and a space precedes *-vs*):
   (x:)\setup -vs

9.57.3 Calibrating the Screen

1. Cycle ventilator power while holding down the **Exp. Hold** and left **Options** button.
2. The ventilator prompts you to calibrate the screen. Upon acknowledgement, the software automatically detects and adjusts for the 10.4-in. screen size.
3. After the ventilator confirms the screen calibration is complete, cycle power to the ventilator and enter diagnostic mode.
4. Enter the software screen and confirm that the serial number is correct.
5. Reset the altitude and compliance compensation settings in the user configuration screen.
6. Perform an EST with the top enclosure removed. If the EST passes, install the top enclosure (see Chapter 9.2 on p. 9-5).

9.57.4 Enabling Options

Enable an option (see Chapter 7) only if the option upgrade is being installed at this time.

9.57.5 Final Checkout

Complete the recommended tests in the performance verification procedure (see Chapter 8).

9.58 Replacing the GUI (Original 10.4-in. to 2nd Generation 10.4-in)

1. Disconnect power, unscrew and separate the ventilator top and bottom halves. Set the halves side by side.
2. Remove the GUI assembly from the enclosure (see Chapter 9.13 on p. 9-24).
3. Remove the four screws and washers securing LCD to the LCD bracket (Figure 9-97).

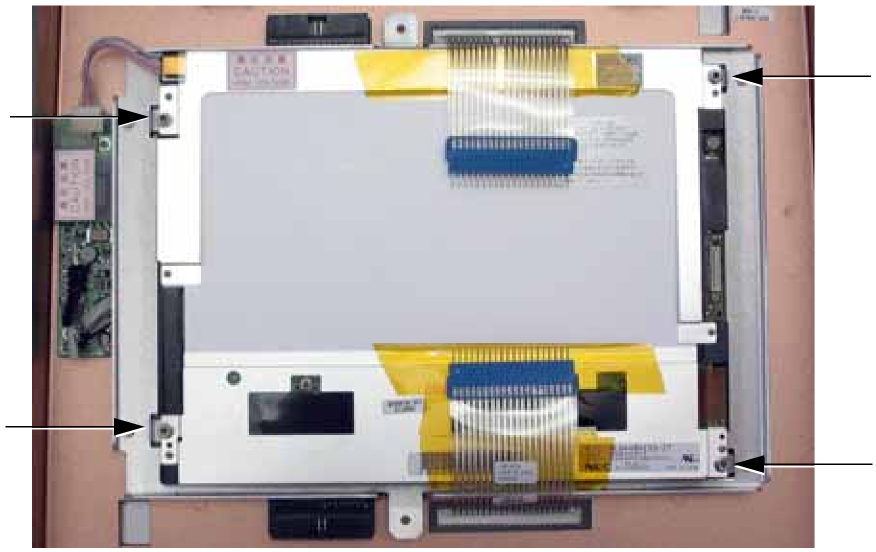


Figure 9-97: Disassembling the LCD

4. Remove the two screws securing the original backlight inverter PCB to the bezel and two of the LCD bracket screws. Discard screws and original backlight inverter PCB (Figure 9-98).

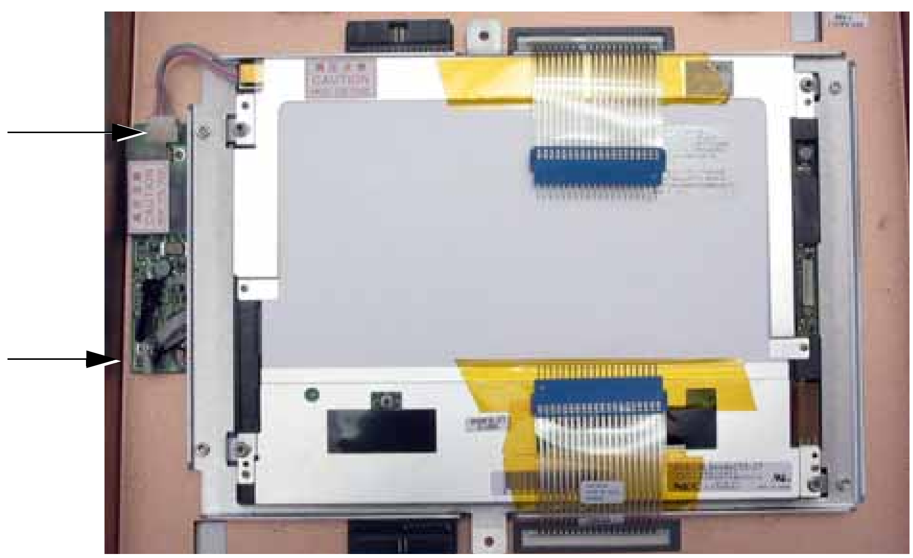


Figure 9-98: Removing the Backlight Inverter

5. Remove the original 10.4-in. LCD and backlight inverter PCB from the GUI assembly.
6. If necessary, clean the inside surface of the touchframe using Isopropyl Alcohol and a soft, lint-free cloth.
7. Connect the 2nd generation backlight inverter cable to the 2nd generation backlight inverter PCB.
8. Install the 2nd generation backlight inverter PCB and secure with two M2 x 0.45 x 6-mm screws (Figure 9-99).
9. Place the 2nd generation LCD onto the LCD bracket and secure with four M3 flat washers and four M3 x 5-mm screws. Tighten screws to 5.5 ± 1 in-lbs. (Figure 9-99).

Figure 9-99: Installing the LCD

10. In the place of the previously removed screws on the LCD bracket, place two 5/16-in. hex spacers (Figure 9-100).

Figure 9-100: Installing the LCD

11. Install the transition PCB onto the LCD and press the connector into place, verify transition PCB is fully seated (Figure 9-101).
12. Insert one M3 x 16-mm screw into one M3 flat washer. Insert the screw through the transition PCB and hex spacer and then tighten screws to 5.5 ± 1 in-lbs. (Figure 9-101).

Figure 9-101: Installing the Transition PCB

13. Install the color display data cable onto the transition PCB. Verify the cable is fully seated (Figure 9-102).

Figure 9-102: Installing the Color Display Cable

14. Disconnect the original color display cable from the DC/DC converter PCB, the intensity control potentiometer, the main PCB, and the ground lug from the shielding plate. Remove and discard the original color display cable.
15. Remove the DC/DC converter PCB from the power supply shroud and discard.
16. Route the color display data cable and the backlight inverter cable through the shielding plate into the top enclosure. Reconnect the remaining ribbon cables to the GUI.
17. Carefully install the GUI onto the top enclosure. Insert one M3 x 8-mm screw into one M3 lock washer. Hand tighten the screws.

18. Install the adapter PCB onto the main PCB. Verify the adapter PCB is fully seated. Insert one screw with lock washer through the adapter PCB. Tighten to 4.0 ± 1 in-lbs. (Figure 9-103).

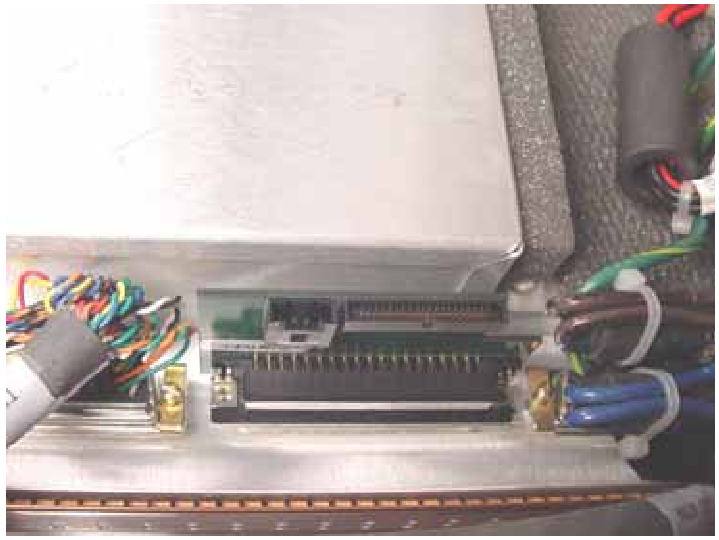


Figure 9-103: Installing the Adapter PCB

19. Connect the backlight inverter cable to the intensity control potentiometer. Verify the cable is fully seated.
20. Install the color display data cable and the backlight inverter cable onto the adapter PCB. Verify the cables are fully seated.

9.58.1 Installing the CPU PCB

Remove the existing CPU PCB and replace with the CPU PCB included in the upgrade kit (see Chapter 9.30 on p. 9-48).

9.58.2 Downloading Ventilator Software

See Chapter 7 for complete software download instructions

1. Connect the service PC to the ventilator serial port using a null modem cable.
2. Insert field upgrade CD-ROM and follow the onscreen instructions. Use this command to prompt for the ventilator serial number (*x:* is the CD-ROM drive, and a space precedes *-vs*):
   (x:)\setup -vs

9.58.3 Calibrating the Screen

1. Cycle ventilator power while holding down the Exp. Hold and left Options button.
2. The ventilator prompts you to calibrate the screen. Upon acknowledgement, the software automatically detects and adjusts for the 10.4-in. screen size.
3. After the ventilator confirms the screen calibration is complete, cycle power to the ventilator and enter diagnostic mode.
4. Enter the software screen and confirm that the serial number is correct.
5. Reset the altitude and compliance compensation settings in the user configuration screen.
6. Perform and EST with the top enclosure removed. If the EST passes, install the top enclosure (see Chapter 9.2 on p. 9-5).

9.58.4 Enabling Options

Enable an option (see Chapter 7) only if the option upgrade is being installed at this time.

9.58.5 Final Checkout

Complete the recommended tests in the performance verification procedure (see Chapter 8).

(This page is intentionally blank.)

Chapter 10. Respironics V200 Ventilator Component Removal/Installation

WARNING: To avoid personal injury, always disconnect external AC and DC power sources and high-pressure oxygen sources from the ventilator before servicing.

NOTE: If your Respironics V200 Ventilator was converted from an Esprit Ventilator, it may include some older-version hardware, which is not shown in this chapter. Consult Chapter 9 for removal and installation details for this older hardware.

Figure 10-1 and Figure 10-2 summarize the disassembly sequence for the bottom and top enclosures of the Respironics V200 Ventilator.

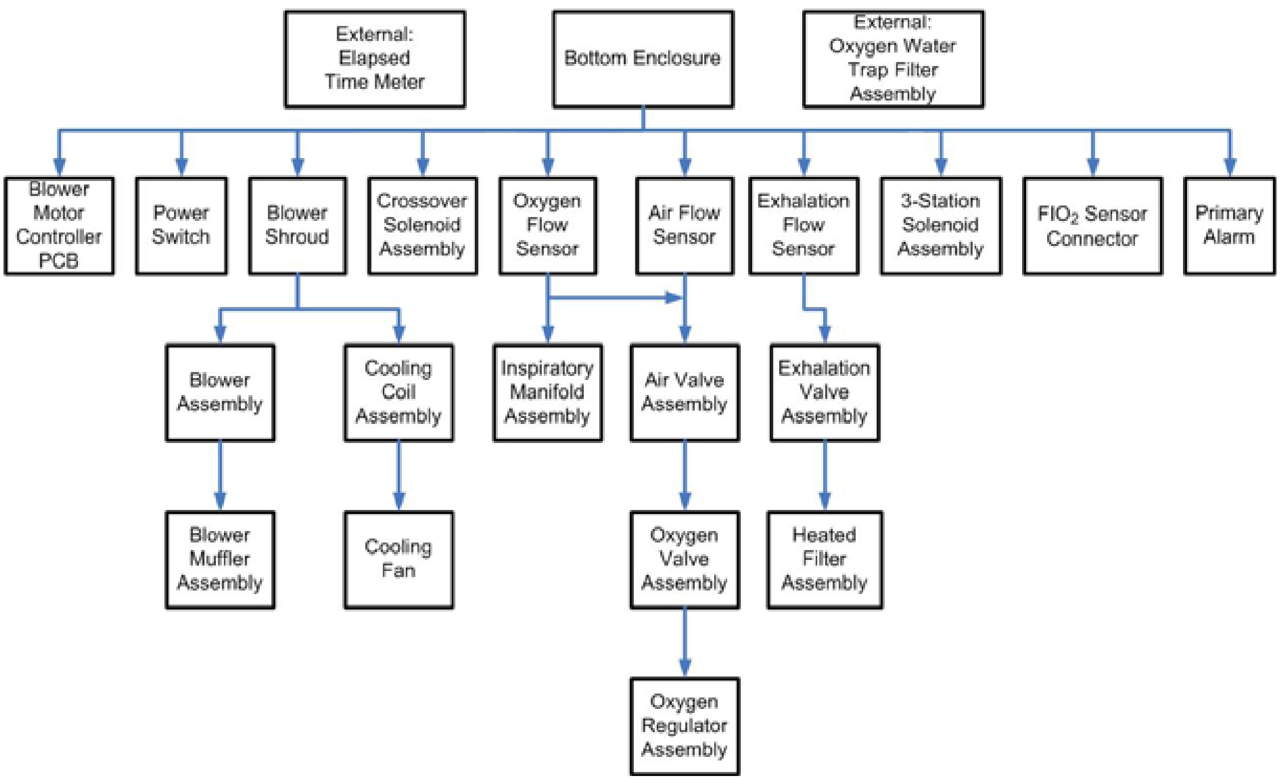


Figure 10-1: Bottom Enclosure Disassembly Flow Chart

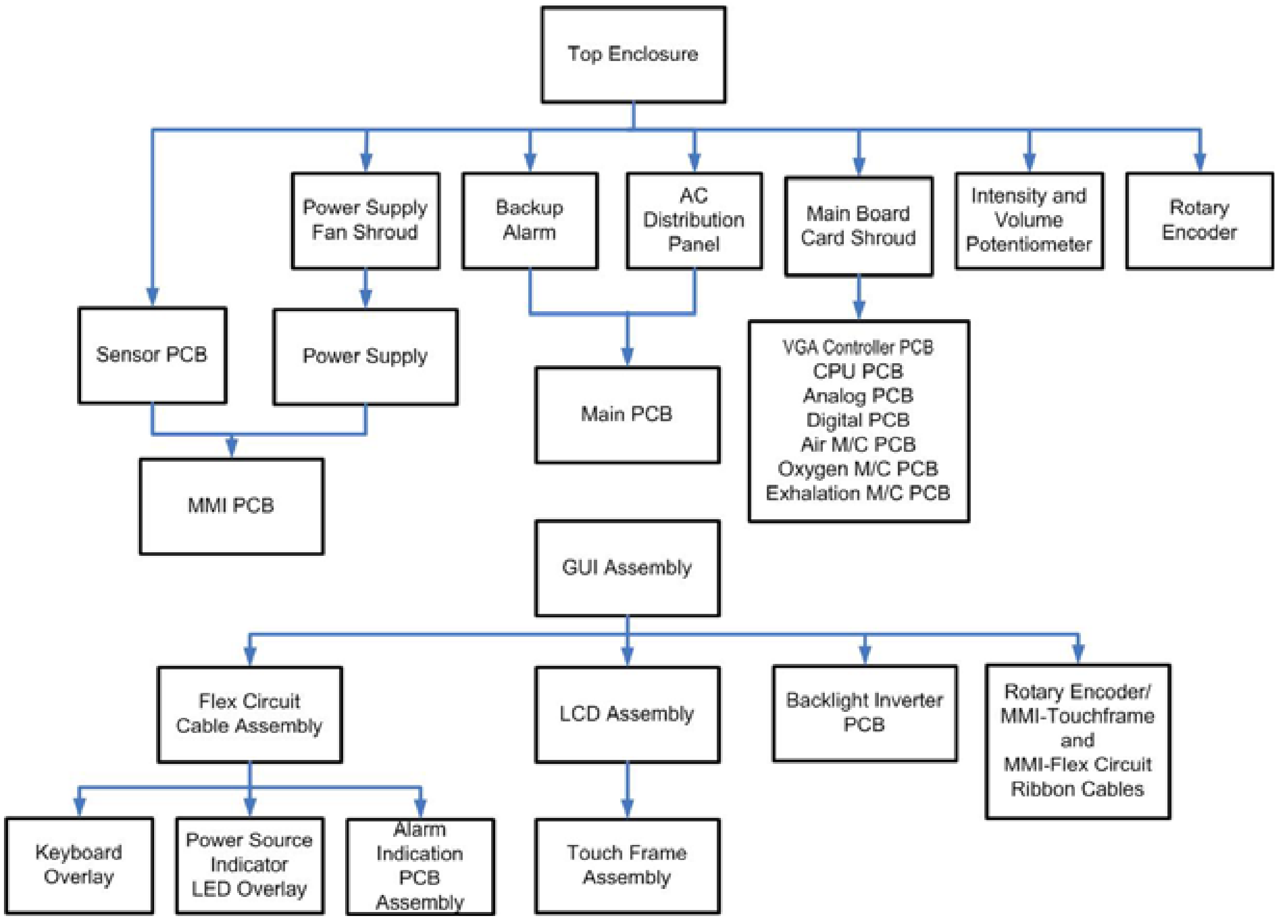


Figure 10-2: Respironics V200 Ventilator Top Enclosure Disassembly Flow Chart

10.1 Inlet Filters

10.1.1 Air Inlet Filter

To remove the air inlet filter (Figure 10-3), pull to remove the outer air inlet filter housing. Remove the filter. *Do not* remove the screws that hold the inner housing to the back panel. Reverse removal procedures to install.

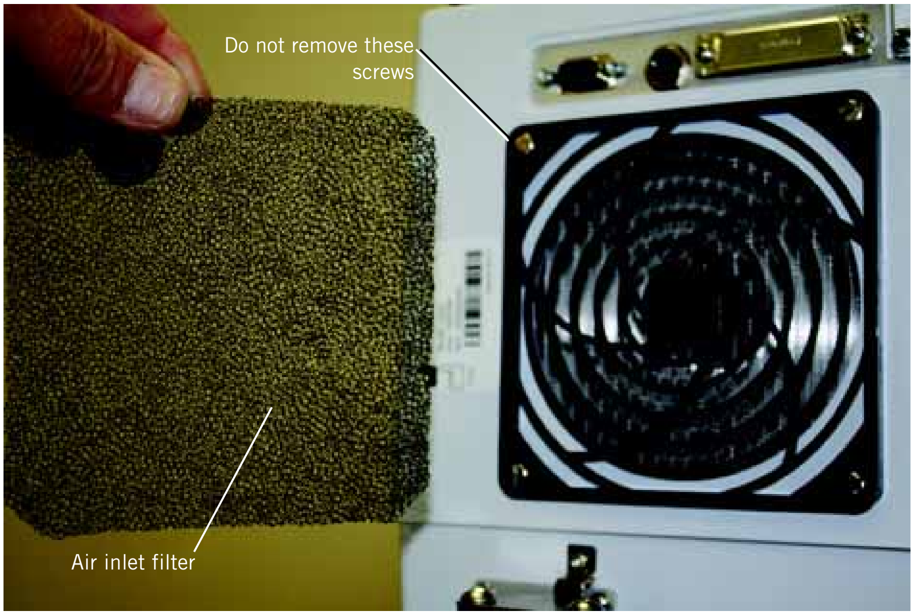


Figure 10-3: Removing Air Inlet Filter

10.1.2 Blower Inlet Filter

To remove the blower inlet filter (Figure 10-4), pull the filter from the blower inlet. Reverse removal procedures to install, ensuring that the filter is positioned to cover the blower inlet.

Figure 10-4: Removing Blower Inlet Filter

10.1.3 Oxygen Inlet Filter

NOTE: Before servicing the oxygen water trap/inlet filter assembly, disconnect the oxygen hose.

To remove the inlet filter (Figure 10-5), unscrew the water trap bowl. Unscrew the filter assembly. Separate the filter element from its black plastic retainer. Reverse removal procedures to install a new filter.

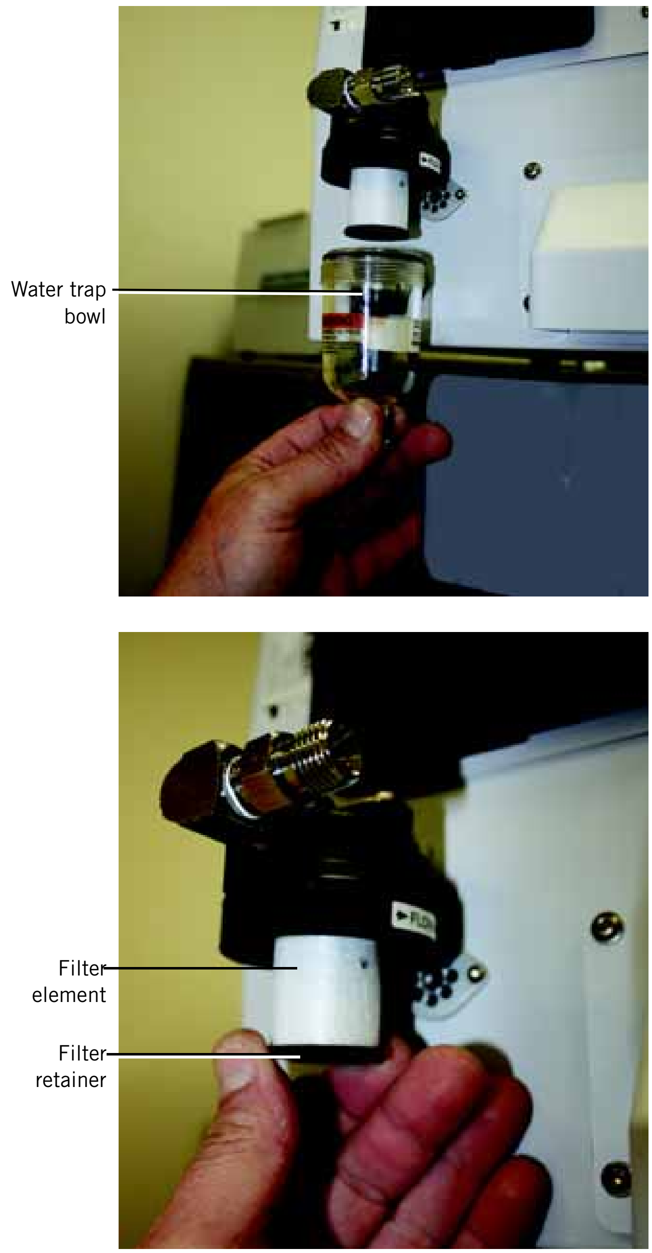


Figure 10-5: Removing Oxygen Inlet Filter

10.2 GUI Assembly

10.2.1 GUI Assembly Removal/Installation

Follow these steps to remove the GUI assembly. Reverse removal steps to install.

1. Using a 2-mm hex driver, remove the four screws and split-ring lockwashers from the bottom and side corners of the GUI bezel (Figure 10-6).

Figure 10-6: Removing GUI - Step 1

2. Remove the rotary encoder knob by gently pulling it away from the GUI. Remove the spacer washer.
3. Remove the 1/2-in. nut and internal lockwasher holding the rotary encoder to the GUI assembly. To gain clearance to finish the removal, push the rotary encoder toward the inside.

4. Carefully separate the GUI bezel from the ventilator. Disconnect the interconnecting cables and harnesses from the GUI in this order (Figure 10-7):
   a. LCD cable
   b. Backlight inverter harness
   c. Upper touch frame/MMI PCB cable
   d. Flex circuit cable (connection to the MMI PCB)
   e. Lower touch frame/MMI PCB cable
   f. Keypad overlay/MMI PCB cable

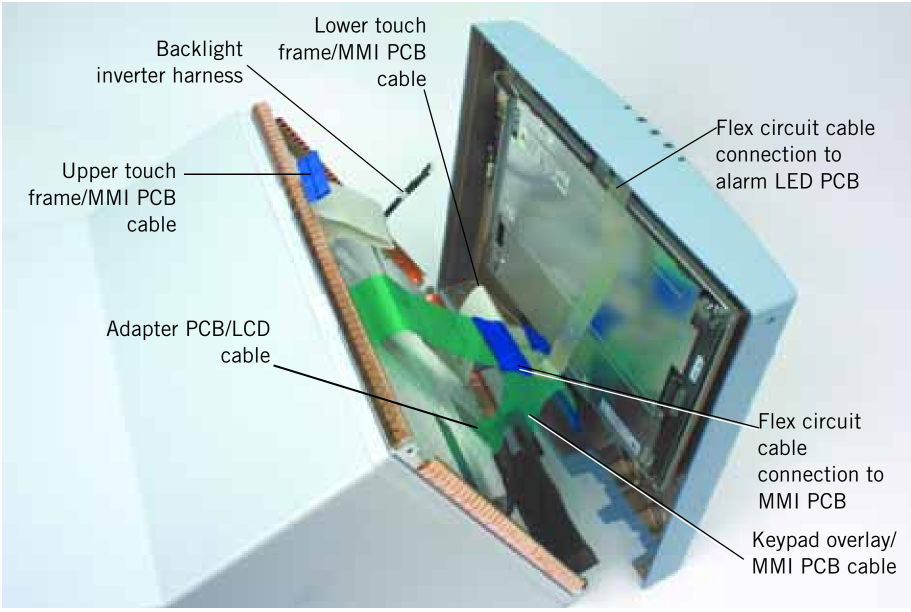


Figure 10-7: Removing GUI - Step 2

5. Set the GUI face down on a soft, flat surface (Figure 10-8).

Figure 10-8: GUI Assembly Removed

10.2.2 Backlight Inverter PCB

Follow these steps to remove the backlight inverter PCB. Reverse removal steps to install.

WARNING: The backlight inverter PCB generates high voltage. To avoid personal injury, verify that the AC and external DC power sources are disconnected from the ventilator.

1. Remove the GUI (Chapter 10.2 on p. 10-6).
2. Disconnect the backlight harness from the backlight inverter PCB (Figure 10-8).
3. Remove the two screws that hold the backlight inverter PCB to the GUI. Remove the backlight inverter PCB.

10.2.3 Transition PCB

Follow these steps to remove the transition PCB (Figure 10-8). Reverse removal steps to install.

1. Remove the GUI (Chapter 10.2 on p. 10-6).
2. Loosen the two M3 x 16 screws that hold the transition PCB to the LCD bracket.
3. Lift the PCB to disengage it from the connector on the LCD panel, and slide it off the screws.

10.2.4 LCD Panel

Follow these steps to remove the LCD panel (Figure 10-8). Reverse removal steps to install.

WARNING: The backlight lamps in the monitor display contain mercury, which must be recycled or disposed of in accordance with local, state, or federal laws.

NOTE: When reconnecting ribbon cables, refer to Figure 10-8 for proper flex circuit cable connector orientation.

1. Remove the GUI (see Chapter 10.2 on p. 10-6).
2. Disconnect the flex circuit cable from the keypad and power status overlays.
3. Disconnect the backlight harness from backlight inverter PCB connector J2.
4. Loosen the two M3 x 16 screws that hold the transition PCB to the LCD bracket.
5. Lift the PCB to disengage it from the connector on the LCD panel, and slide it off the screws.
6. Using a 2.5-mm hex driver, remove the four M3 x 5 screws and M3 flat washers that hold the LCD to the LCD bracket.
7. Lift off the LCD panel, and set it face up on a nonabrasive surface.

10.2.5 Touch Frame and Alarm LED PCB

Follow these steps to remove the touch frame and alarm LED PCB (Figure 10-8). Reverse removal steps to install.

NOTE: When reconnecting ribbon cables, refer to Figure 10-8 for proper flex circuit cable connector orientation.

1. Remove the GUI (see Chapter 10.2 on p. 10-6).
2. Disconnect the flex circuit cable from the keypad and power status overlays and the alarm LED PCB.
3. Disconnect the harness from the backlight inverter PCB connector J2.

4. Using a 2.5-mm hex driver, remove the three M3 x 8 screws that hold the LCD bracket to the bezel at the center and closest to the backlight inverter.
5. Remove the two screws that hold the transition PCB/LCD bracket to the bezel. Carefully remove the LCD bracket from the bezel.

NOTE: Be careful not to lose the screws, flat washers, and spacers that retain the transition PCB/LCD bracket to the bezel.

6. To remove the touch frame, carefully lift it out of the bezel.
7. To remove the alarm LED PCB, remove two M3 x 5 screws and lift the PCB out.

10.2.6 GUI Front Panel Overlays

Follow these steps to remove and install the front panel overlays.

1. Remove the GUI (see Chapter 10.2 on p. 10-6).
2. Disconnect the flex circuit cable from the keypad and power status overlays.
3. Remove the keyboard or LED overlay from the front panel. Use a small flat-blade screwdriver to lift the corner of each overlay, and then peel to remove it from the bezel.
4. Use a soft cloth and isopropyl alcohol to remove any adhesive remaining on the bezel.
5. Peel the backing off the replacement overlay, and remove the small pieces of backing behind the ribbon cables.
6. Thread the ribbon cables through the bezel slots, then align the overlay over the bezel and adhere with overlay centered in the bezel frame. Use a pencil eraser to push the overlays in, and then check that they are aligned correctly (right side up).

10.2.7 GUI Cleaning and Dust Gasket Installation

Follow these steps to clean the LCD panel and touch frame.

1. Remove the LCD panel (Chapter 10.2.4 on p. 10-9).
2. Clean the touch frame and LCD panel assemblies with isopropyl alcohol with a soft, lint-free cloth.
3. Separate the GUI dust gasket parts (Figure 10-9).

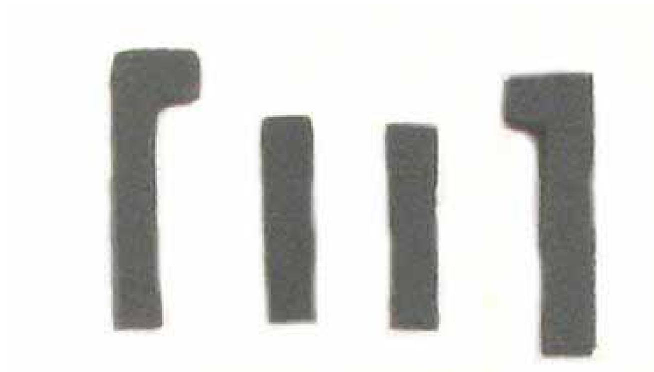


Figure 10-9: GUI Dust Gaskets

4. Place the four foam pieces on the LCD (Figure 10-10 and Figure 10-11).

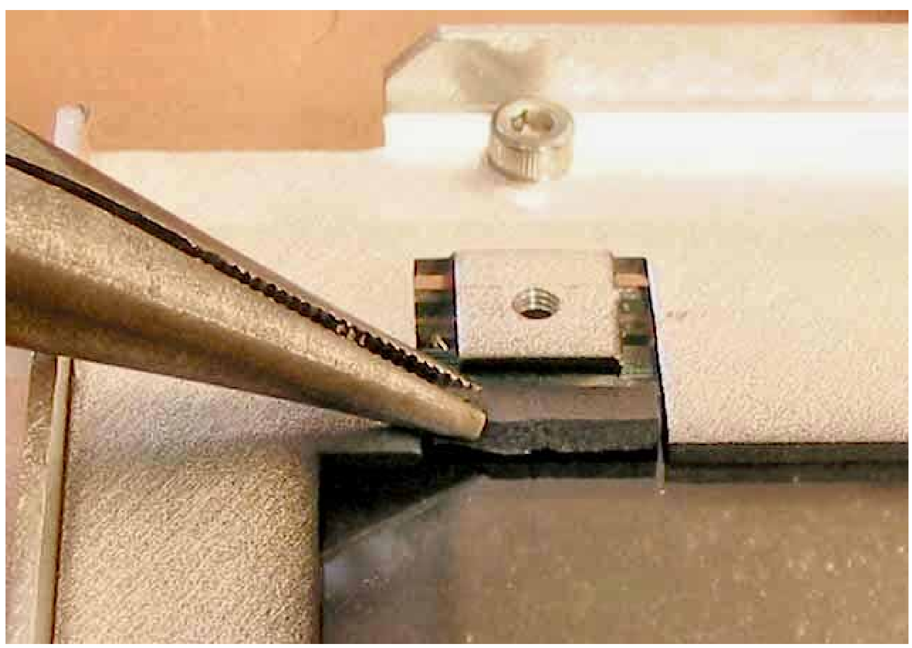


Figure 10-10: Installing the GUI Dust Gaskets

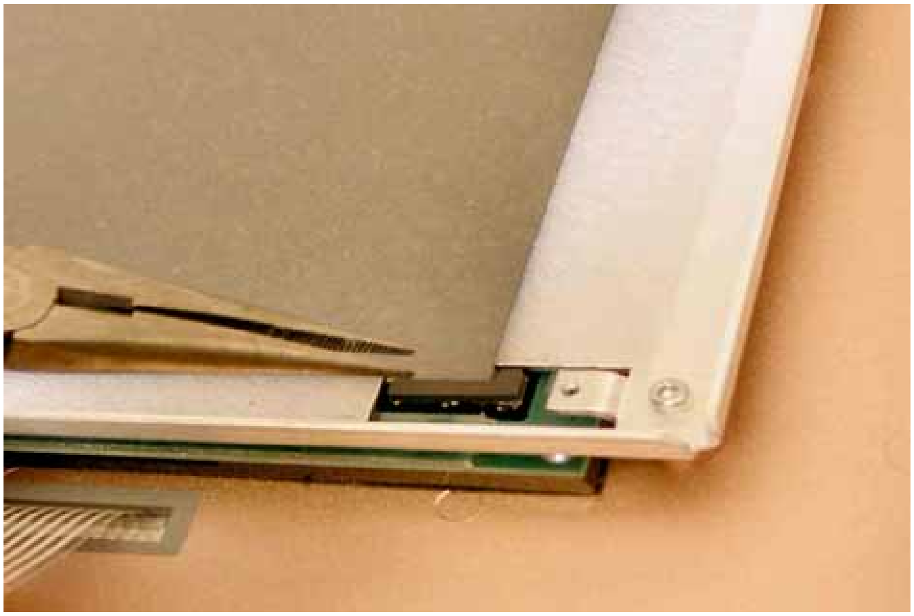


Figure 10-11: Installing the GUI Dust Gaskets

5. Verify the two 5/16 hex spacers are aligned on the LCD bracket.
6. Reinstall the LCD panel.
7. Verify the installed foam pieces are not visible from the viewing side of the GUI assembly.
8. Clean all dust from the ventilator bulkhead.
9. Place the two bulkhead foam pieces, the straight piece under the bottom ribbon cable and the other piece above the potentiometer knobs (Figure 10-12).
10. Reattach the GUI assembly to the ventilator.

Figure 10-12: Installing the Bulkhead Foam

10.3 Separating the Top and Bottom Enclosures

Follow these steps to separate the top enclosure from the bottom enclosure. Reverse steps to reassemble.

CAUTION: Be careful not to pull or crimp any cables, tubes, or wires during removal or installation.

1. Turn ventilator power off, and then disconnect AC power and oxygen from the ventilator.
2. Remove all accessories and external cables from the ventilator.
3. Using a 3-mm hex driver, remove six screws (three on each side) and washers from the side panels (Figure 10-13). Two longer screws are closest to the front panel.
4. Using a 3-mm hex driver, remove the four screws and washers from the underside of the bottom enclosure. Hang the rear side of the ventilator off the work surface to remove the back screws.
5. Carefully lift the top enclosure. With all cables still connected, turn the enclosure upside down and place it beside the bottom enclosure (Figure 10-14).

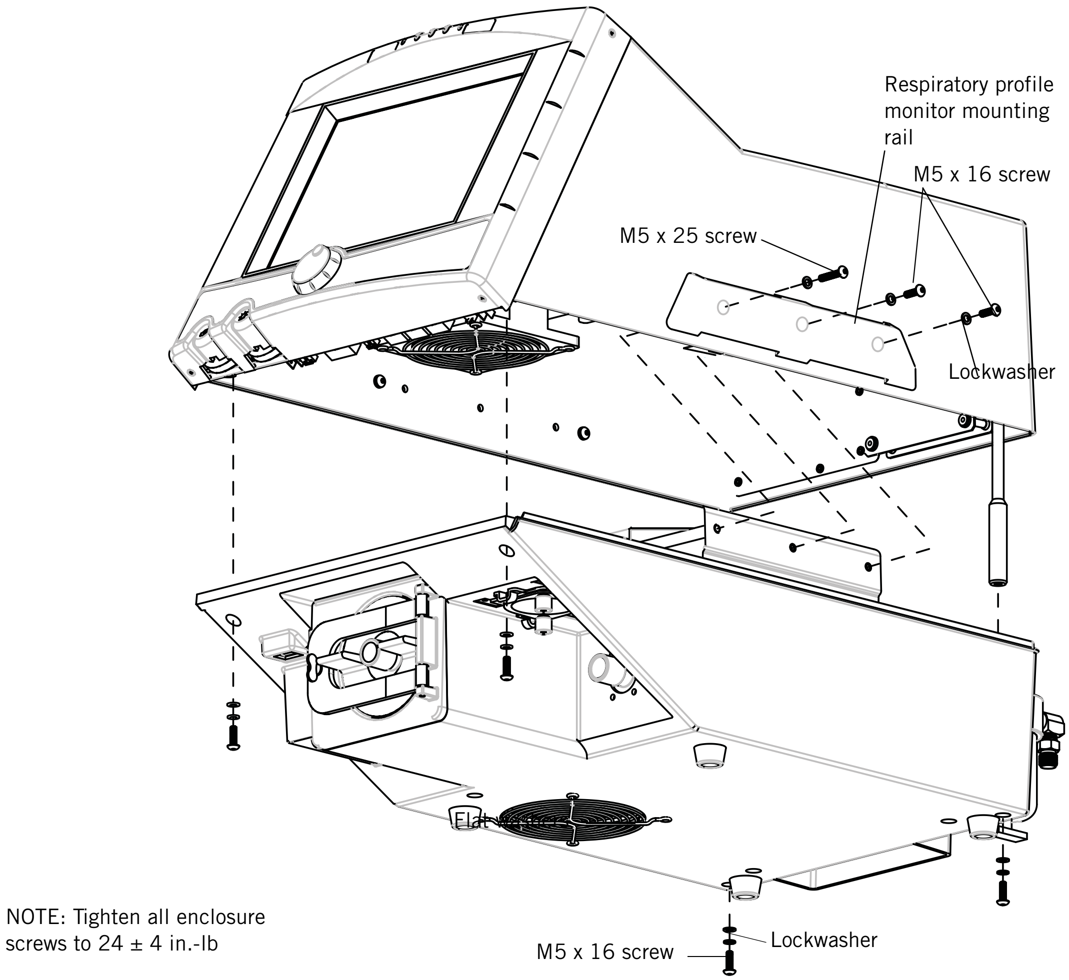


Figure 10-13: Separating the Top and Bottom Enclosures

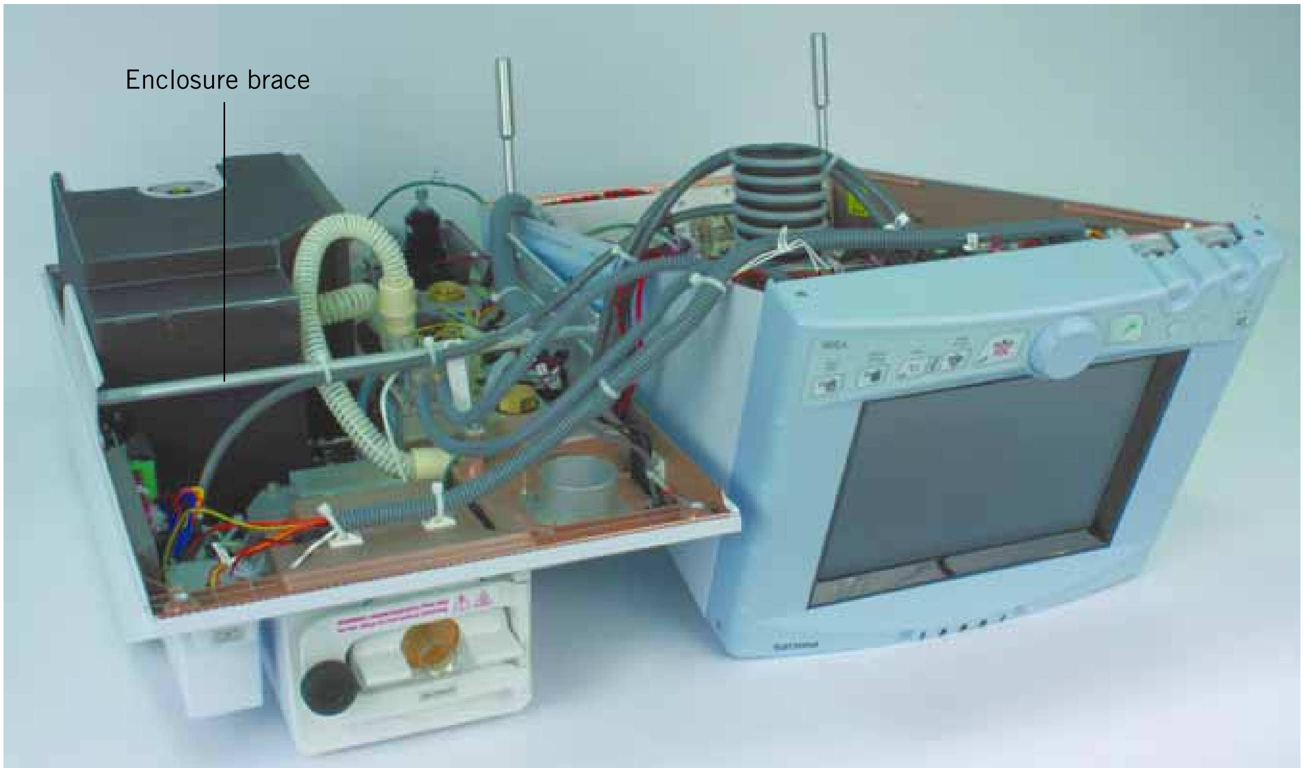


Figure 10-14: Enclosures Separated

10.4 Enclosure Brace

Move the enclosure brace (Figure 10-15) aside by removing the two screws with flat washers and spring washers. To remove the brace completely, cut the tie wraps. Reverse steps to reinstall.

Figure 10-15: Enclosure Brace

10.5 Sensor PCB

Follow these steps to remove the sensor PCB. Reverse removal steps to install.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Disconnect all cables from the connectors on the sensor PCB (Figure 10-16):

Disconnect this cable:	From this connector on the sensor PCB:
SEN J1	J1
Black wires from oxygen pressure switch*	J5 and J6
SEN J9	J9
SEN J2	J2
SEN J7	J7
SEN J12	J12
SEN J10	J10
SEN J11	J11
SEN BRD J8	J8
SENSOR BRD J3 & J4*	J3 and J4
*Either wire can be connected to either terminal.	

3. Disconnect the exhalation solenoid tube from pressure sensor U32, and the inhalation solenoid tube from pressure sensor U33 on the sensor PCB.

CAUTION: To avoid damage to sensors, pry (do not pull) tubes from sensors.

4. Unsnap the sensor PCB from the top two posts and then the bottom two posts. Remove the sensor PCB.

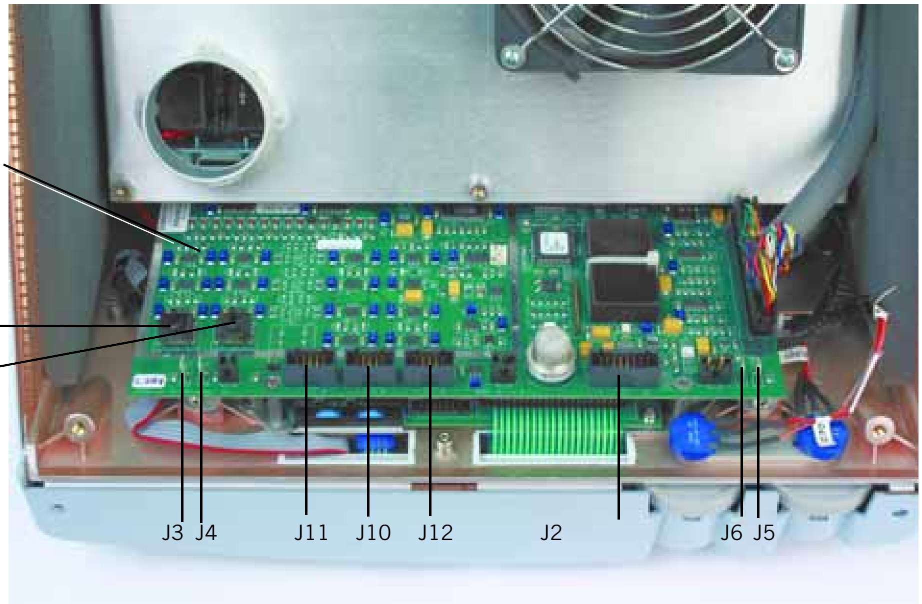


Figure 10-16: Sensor PCB

10.6 Intensity and Volume Potentiometers

Follow these steps to remove the intensity and volume potentiometers (Figure 10-17). Reverse removal steps to install.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Remove the GUI (see Chapter 10.2 on p. 10-6).
3. Loosen the setscrew (one for each knob) holding the brightness or alarm volume knob. Remove the knob.
4. Remove the 1/2-in. nut and washer that hold each potentiometer.
5. Disconnect the harness.
6. Remove the potentiometer.

Figure 10-17: Volume and Intensity Potentiometers

10.7 Rotary Encoder

Follow these steps to remove the rotary encoder. Reverse removal steps to install.

NOTE: Reinstall the rotary encoder ribbon cable according to the orientation shown in Figure 10-18.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Remove the sensor PCB (see Chapter 10.5 on p. 10-18).
3. Disconnect the rotary encoder cable from MMI PCB connector J10 (Figure 10-18).
4. Remove the GUI (see Chapter 10.2 on p. 10-6).
5. Remove the encoder.

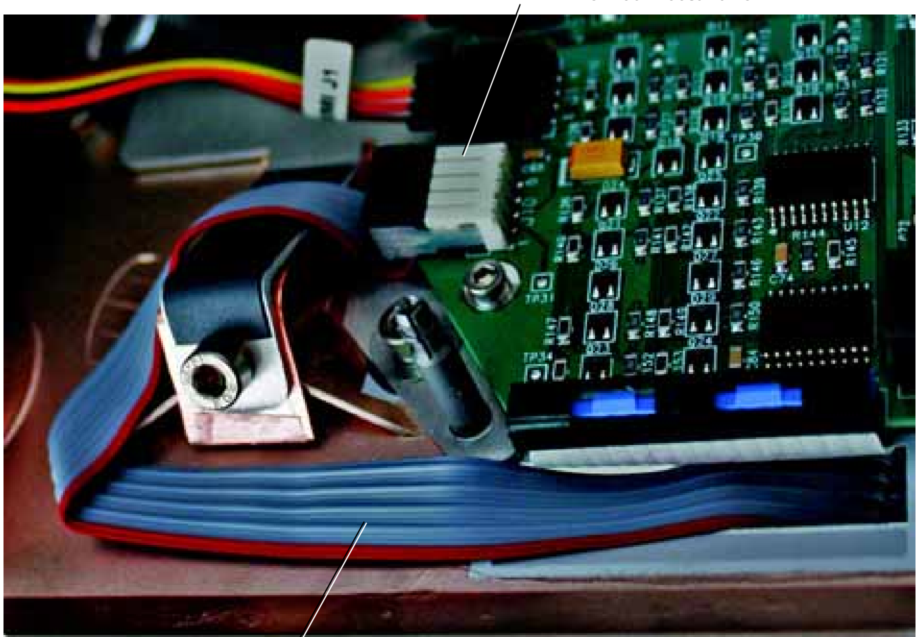


Figure 10-18: Disconnecting the Rotary Encoder

10.8 Power Supply Shroud

Follow these steps to remove the power supply shroud. Reverse removal steps to install.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Remove the air inlet hose from the power supply shroud (Figure 10-19).

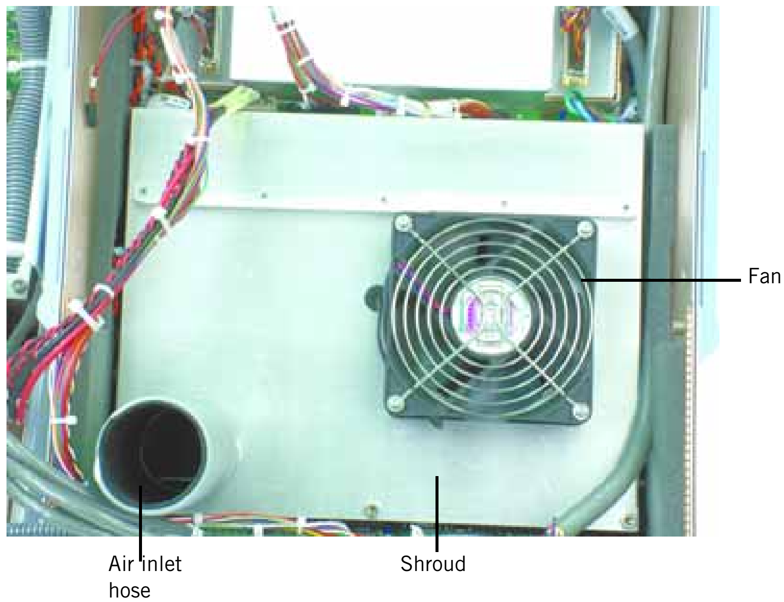


Figure 10-19: Power Supply Fan and Shroud

3. Using a 4-mm hex wrench, remove the five screws that secure the shroud.
4. Slightly lift then tilt the front of the shroud carefully, and disconnect the fan harness connector from the power supply by lifting up on the connector latch from underneath.

NOTE: Make sure the shroud's grommet edging stays in place when you remove the shroud.

10.9 Power Supply Fan

Remove the fan from the shroud by removing four screws (Figure 10-19). Reverse removal steps to install.

NOTE: Install the fan with its flow direction arrow pointing *away* from the power supply. After installing the fan but before reassembling the ventilator, confirm correct air flow: connect AC power, turn on the ventilator, then check that the fan blows air *away* from the power supply.

10.10 Power Supply

WARNING: The power supply generates high voltage. To avoid personal injury, verify that the AC and external DC power sources are disconnected from the ventilator.

10.10.1 Removal

Follow these steps to remove the power supply (Figure 10-20 and Figure 10-21):

1. Remove the power supply shroud (see Chapter 10.8 on p. 10-22).
2. Loosen the screws on power supply connector TB1 and disconnect these wires: brown (terminal 1), blue (terminal 2), and green (terminal 4).
3. Loosen the screws on power supply connector TB2 and disconnect these wires: red (terminal 1) and black (terminal 4). *Do not remove the black ground wire from TB3 terminal 3.*
4. Loosen the screws on power supply connector TB3 and disconnect these wires: red (terminal 1) and black (terminal 2). *Do not remove the black ground wire from TB3 terminal 2.*
5. Using a 4-mm hex driver, remove the eight M5 x 12 screws that secure the power supply to the top enclosure.
6. Lifting the power supply as needed, disconnect cables from connectors J1, J2, and J3.
7. Lift the power supply from the top enclosure.

NOTE: You must install the MMI PCB before installing the power supply.

NOTE: When installing the power supply, make sure no cables are routed underneath the power supply.

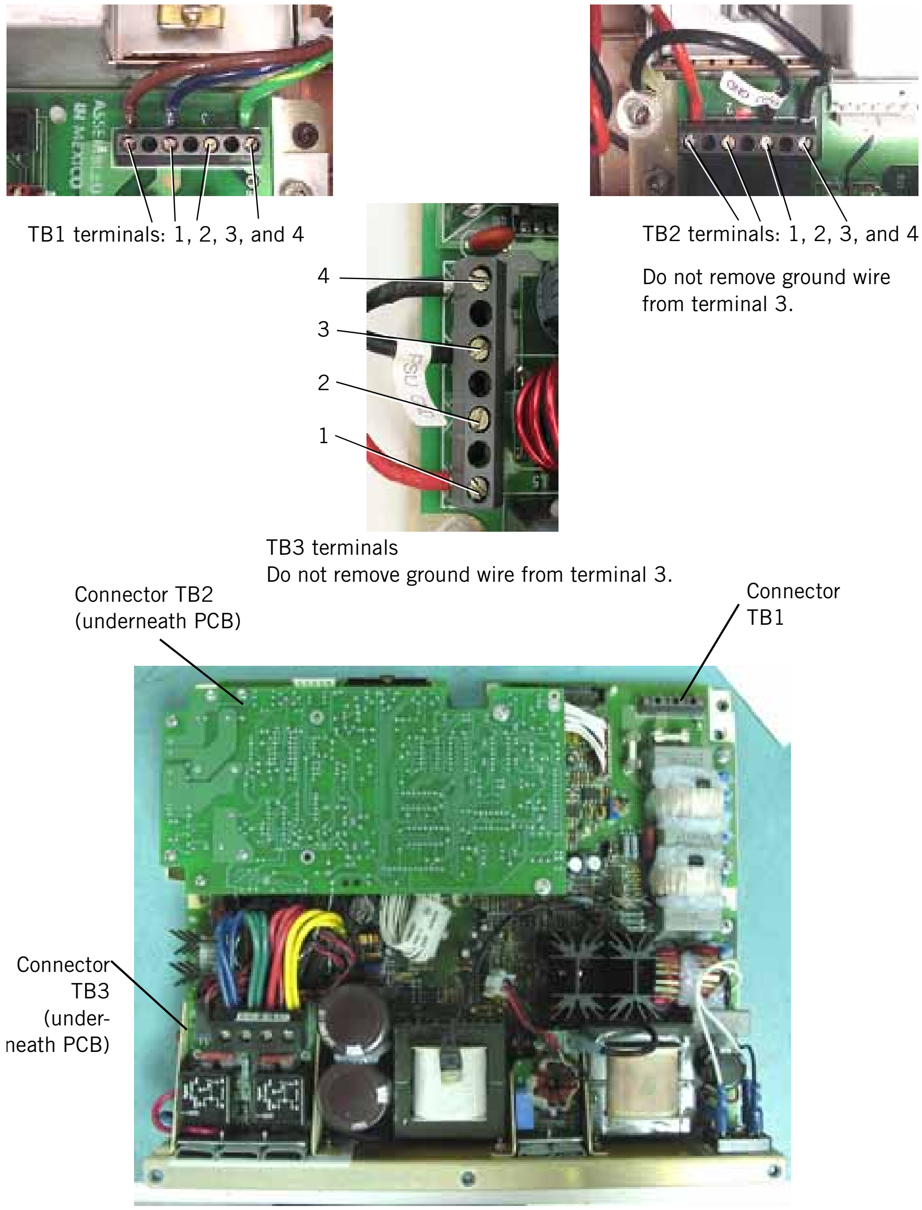


Figure 10-20: Power Supply Wire Connections

Figure 10-21: Power Supply Connectors

10.10.2 Installation

Follow these steps to reinstall the power supply:

1. Reinstall the eight screws that hold the power supply to the top enclosure. Do not tighten the screws until all are installed.
2. Connect these cables to the power supply:
   - Cable PSU J1 to connector J1.
   - Cable PSU J2 to connector J2.
   - Cable PSU J3 to connector J3.
3. Install these wires to the power supply, pushing the wires completely into the connectors. No wires should be visible after being tightened at the terminal block.
   - Red and black wires (PSU TB3) to connector TB3.
   - Red and black wires (PSU TB2) to connector TB2.
   - Blue, green, and brown wires from the AC mains panel to connector TB1.
4. Reinstall the power supply shroud (see Chapter 10.8 on p. 10-22). Make sure the red and black wires from TB3 rest inside the shroud slots, and that the shroud does not pinch any of these cables. All cable assemblies and wires must be routed between the shroud and the top enclosure wall. The black ground wire reattaches to the shroud with the longer screw, near connector TB2 (Figure 10-22).

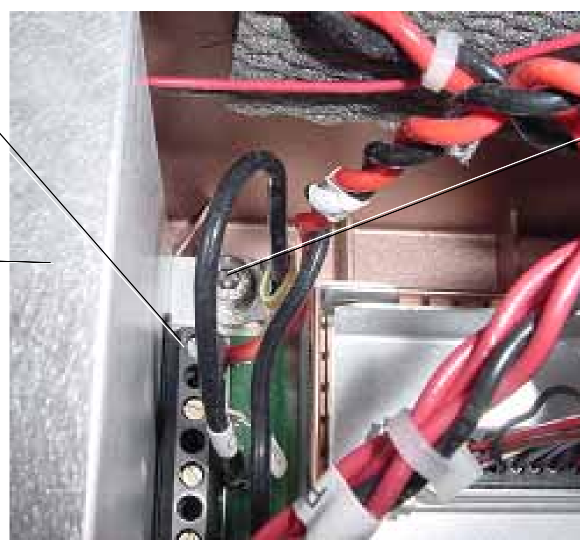


Figure 10-22: Shroud Ground Connection

10.11 Power Supply Fuses

WARNING: The power supply generates high voltage. To avoid personal injury, verify that the AC and external DC power sources are disconnected from the ventilator.

NOTE: F2 fuses are **not** field replaceable on the power supplies with fuse F2 soldered to the fuse clip (Figure 10-23).

1. Remove the power supply shroud (see Chapter 10.8 on p. 10-22).
2. Remove the appropriate fuse from its holder (Figure 10-23).
3. Pinch fuse clips together before inserting replacement fuse.

Figure 10-23: Power Supply Fuses (F2 Soldered)

10.12 MMI PCB

Follow these steps to remove the MMI PCB. Reverse removal steps to install.

NOTE: When installing cables to the MMI PCB, first connect them and then insert them through the top enclosure.

NOTE: When installing the ribbon cables to J6 and J11 (keypad and power status LED overlays), tug on the cables to ensure they are properly seated. When installing the ribbon cables to J12 and J13, ensure that no connector pins are visible, then snap the cover shut.

1. Remove the power supply shroud (see Chapter 10.8 on p. 10-22).
2. Pull the sensor PCB off its standoffs, and move it aside (Figure 10-16).
3. Remove the screws that secure the power supply to the top enclosure.
4. Move the power supply out of the way to allow access to the MMI PCB mounting screws.
5. Disconnect the cables from the connectors on the MMI PCB:

Disconnect cables in this order:	From this connector on the MMI PCB:
MMI J1 *POWER SWITCH*	J1
MMI J4 *PRIMARY ALARM*	J4
MMI J5 *ALARM VOLUME POT*	J5
Ribbon cable from keyboard overlay*	J11
MMI J8 *MAIN PCB*	J8
Rotary encoder ribbon cable	J10
Flex cable from keyboard overlay LEDs, power status overlay LEDs, and alarm LED PCB*	J6
White ribbon cable from touch frame LED connector* *Display bottom edge*	J12
White ribbon cable from touch frame IR detector connector* *Display top edge*	J13
MMI J15 *BACKUP ALARM*	J15
* When removing, lift connector lock before pulling cable. Do not use a tool.	

6. Remove the four screws that hold the MMI PCB to the plate.

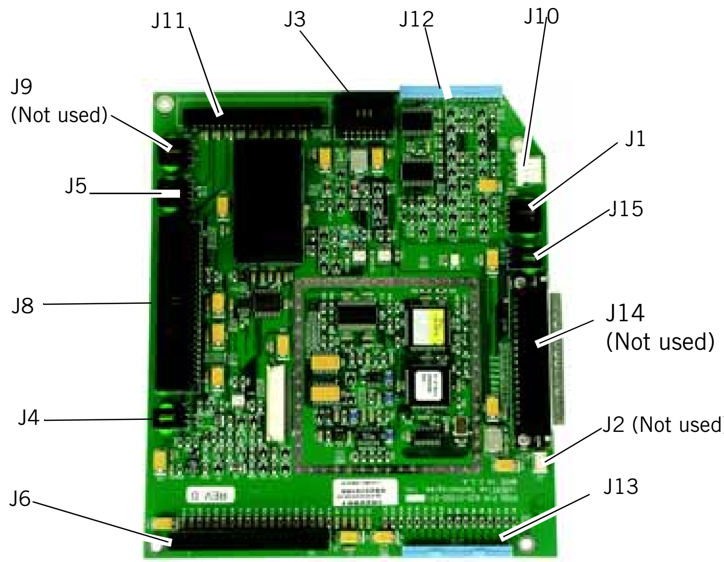


Figure 10-24: MMI PCB Connectors

10.13 Backup Alarm

Follow these steps to remove the backup alarm (Figure 10-25). Reverse removal steps to install.

NOTE: Before reinstalling the backup alarm, inspect the EMI and mesh cooling fan filters. If the filters are dirty, rinse with warm water and wipe or blow dry.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Remove the outer filter housing and mesh cooling fan filter (Figure 10-25).
3. Remove the four screws that hold the backup alarm bracket to the enclosure. Separate the components.
4. Disconnect the backup alarm from MMI PCB connector J15.
5. Remove the collar from the alarm, then push the alarm from the bracket.

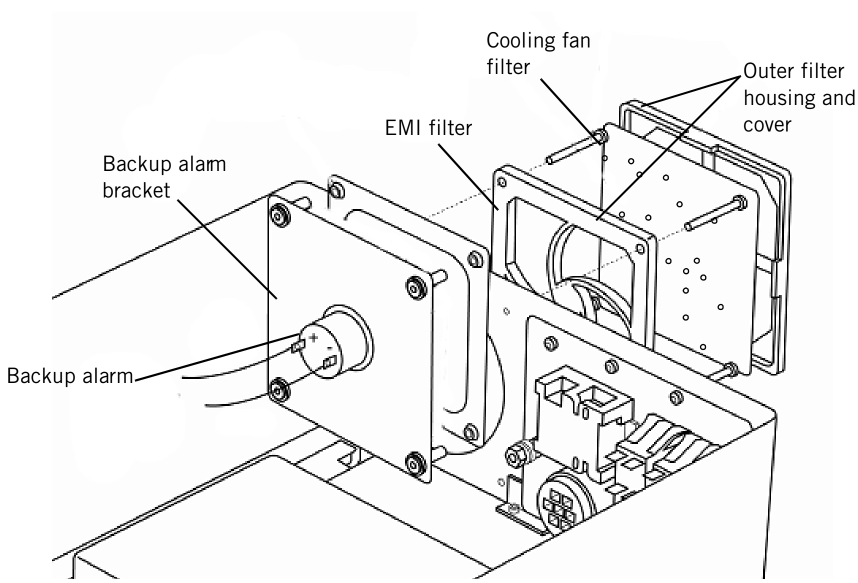


Figure 10-25: Removing the Backup Alarm

10.14 AC Distribution Panel

WARNING: The AC distribution panel contains high voltage components. To avoid injury, verify that the AC and external DC power sources are disconnected from the ventilator.

Follow these steps to remove the AC distribution panel (Figure 10-26 through Figure 10-28). Reverse removal steps to install.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Remove the ten screws and washers that hold the AC distribution panel to the enclosure (Figure 10-26). Note that one screw is longer (M3 x 12) and is fastened on the inside of the enclosure with a 5.5-mm nut.

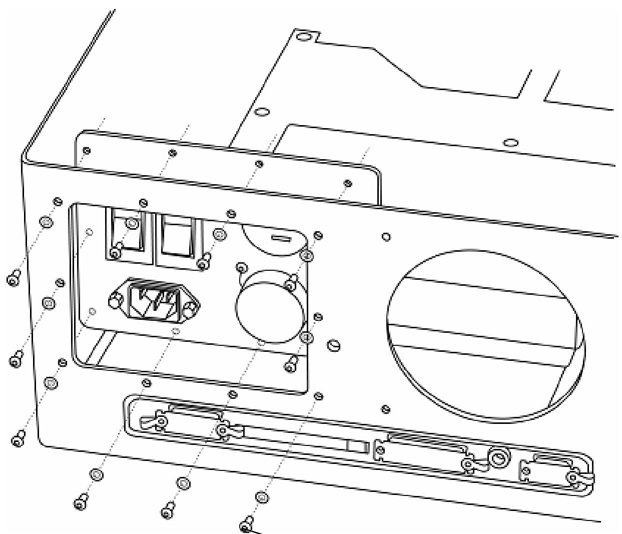


Figure 10-26: AC Distribution Panel (From Outside the Top Enclosure)

3. Remove the 10-mm nuts and washers holding the ground wires to the ground lug and top enclosure (Figure 10-27 and Figure 10-28). Remove the lug.
4. Using a 2.5-mm hex driver, remove the screw that holds the L-bracket to the main PCB tray, and remove the bracket. Lift the AC distribution panel away from the top enclosure.

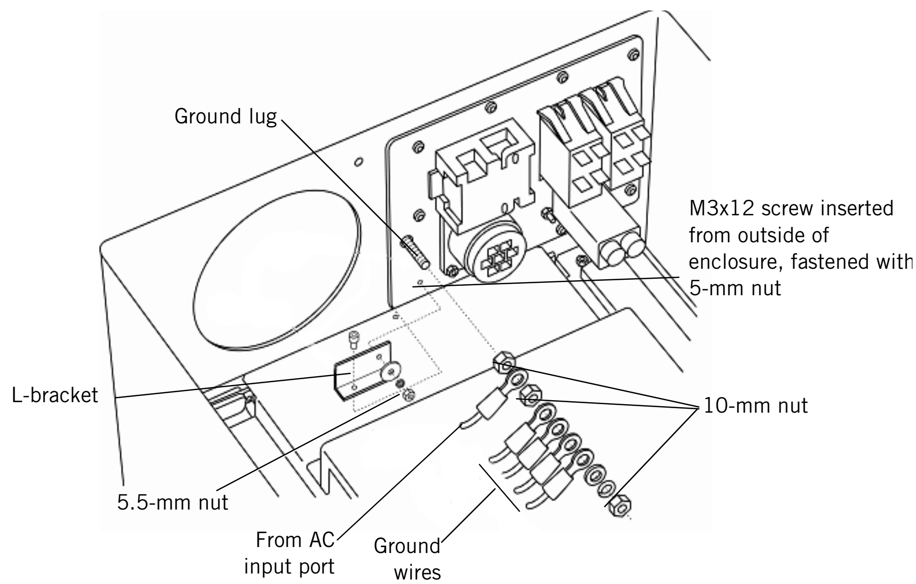


Figure 10-27: AC Distribution Panel (From Inside the Enclosure)

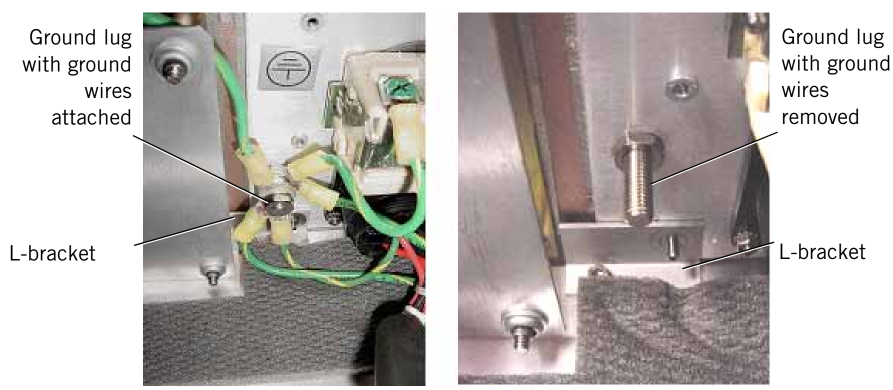


Figure 10-28: Ground Lug and L-Bracket

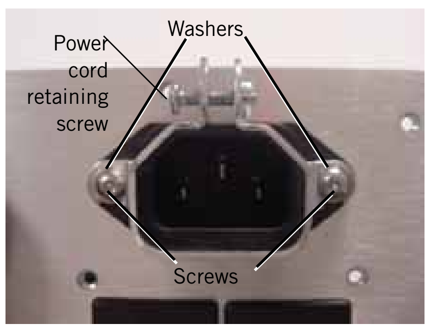
10.15 AC Power Cord Bracket and Power Cord

Follow these steps to remove the AC power cord and power cord bracket. Reverse removal steps to install.

CAUTION: Hardware may fall into the Respironics V200 Ventilator enclosure if the instructions outlined below are not followed.

NOTE: If the AC cord bracket is missing, make sure the KEP nuts are not inside the Respironics V200 enclosure.

1. Loosen the screw that retains the power cord (Figure 10-29). Disconnect the power cord.
2. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
3. If necessary to facilitate removal of the bracket and power cord, remove the AC distribution panel (see Chapter 10.14 on p. 10-30).
4. Loosen the two screws that hold the power cord bracket to the AC distribution panel (Figure 10-29). Slide the bracket downward off the screws.



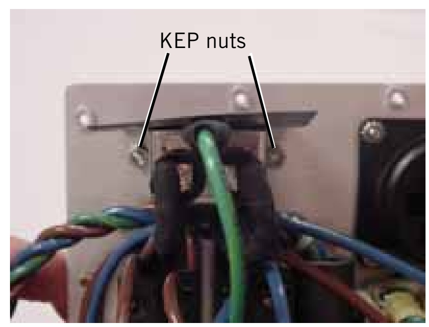


Figure 10-29: AC Cord Bracket (Outside and Inside Views)

10.16 Elapsed Time Meter

Follow these steps to remove the elapsed time meter. Reverse removal steps to install.

NOTE: Record the previous elapsed time meter hours on your service documentation. Replacement meters always start at 0 hours.

NOTE: Torque the elapsed time meter retaining screws to 4.5 to 6.5 in.-lb.

1. Disconnect all oxygen and power sources from the ventilator.
2. Unscrew the bowl from the oxygen water trap/inlet filter assembly.
3. Using a 2-mm hex wrench, remove the two screws that hold the elapsed time meter to the bottom enclosure (Figure 10-30). Slowly pull the time 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.
5. Remove the time meter.

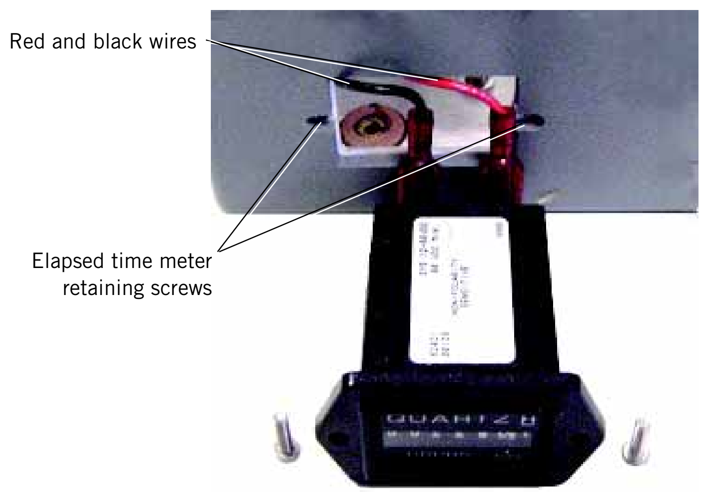


Figure 10-30: Elapsed Time Meter

10.17 Printed Circuit Boards (Daughter PCBs) (Except Main PCB)

Follow these steps to remove the daughter PCBs (Figure 10-31, Figure 10-33). Reverse removal steps to install.

NOTE: You must install the main PCB before installing the other PCBs.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Loosen the three captive thumbscrews and remove the screw that hold the PCB shroud. Remove the shroud.
3. Pull up on the top corners of the daughter PCB you want to remove, using a slight rocking motion as you pull.

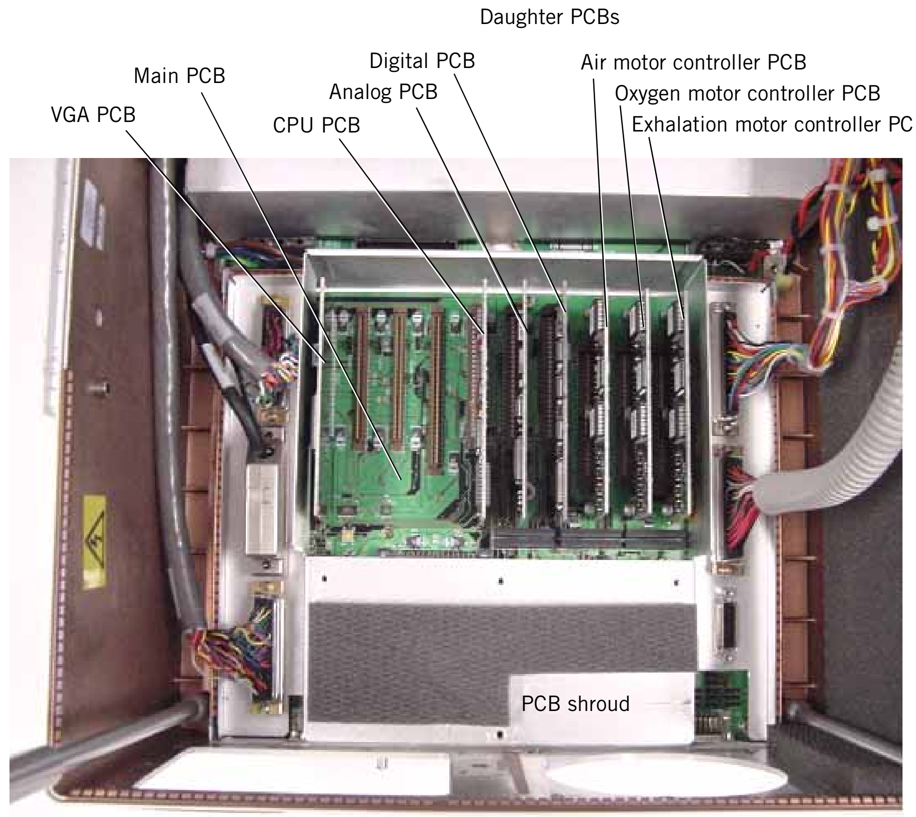


Figure 10-31: Main and Daughter PCBs

10.18 Main PCB

Follow these steps to remove the main PCB (Figure 10-32 through Figure 10-34). Reverse removal steps to install.

NOTE: When reinstalling the main PCB, do not tighten the jackscrews on the CN connectors until all are assembled.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Remove all vertically mounted (daughter) PCBs from the main PCB (see Chapter 10.17 on p. 10-34), and store each PCB in a conductive bag.
3. Remove the backup alarm (see Chapter 10.13 on p. 10-29), but do not disconnect it. Hang the backup alarm over the edge of the bottom enclosure.
4. Remove the AC distribution panel (see Chapter 10.14 on p. 10-30).
5. Loosen the ten screws that hold these cables, then disconnect by pulling the connector (not the cable): MAIN CN7, MAIN CN8, MAIN CN9, MAIN CN10, and MAIN CN21.
6. Remove the 12 jackscrews from the female connectors on the main PCB.
7. Remove the port covers and six jackscrews that hold the external connectors to the rear of the enclosure.
8. If necessary, remove the remote alarm jack (Figure 10-35).
9. Using 3- and 4-mm hex drivers, remove the nine screws that hold the main PCB to the tray. Remove the main PCB.

Figure 10-32: External Connectors with Port Covers and Jackscrews Removed

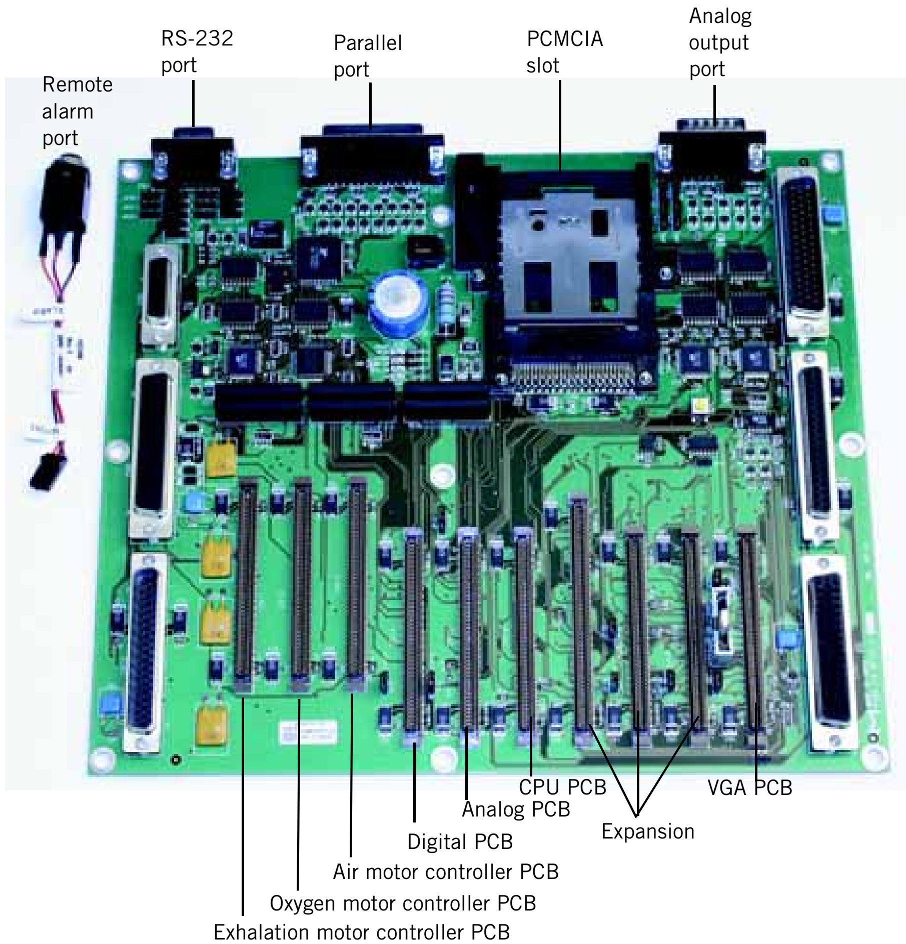


Figure 10-33: Main PCB and Locations of Daughter PCBs

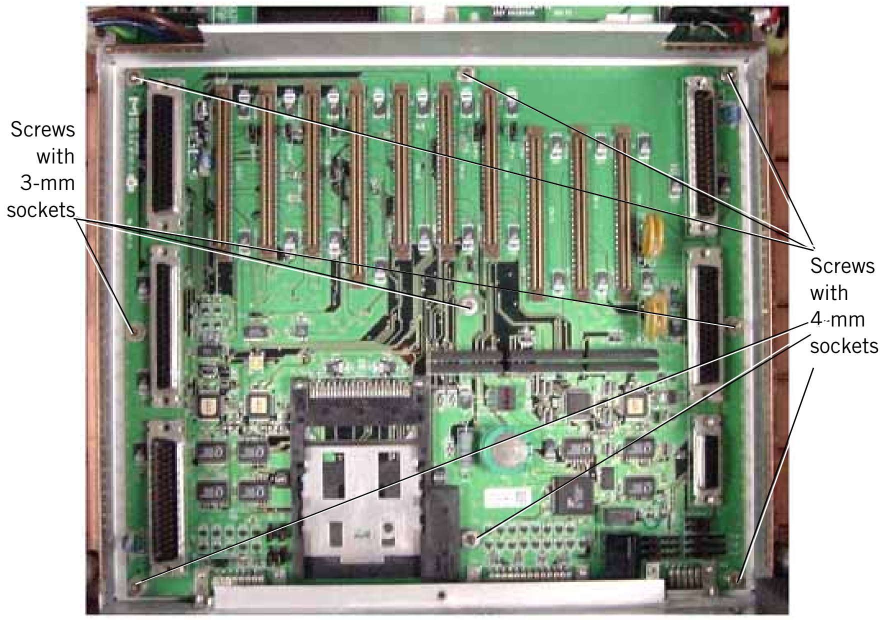


Figure 10-34: Nine Screws That Secure Main PCB to Tray

10.19 Remote Alarm Jack

Follow these steps to remove the remote alarm jack (Figure 10-35). Reverse removal steps to install.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Loosen the three captive thumbscrews and remove the screw that hold the PCB shroud. Remove the shroud.
3. Remove the nut and washer from the remote alarm jack.
4. Disconnect the remote alarm jack harness from CN2 on the main PCB (Figure 10-36).
5. Remove the remote alarm jack and washer from the main PCB/top enclosure.

Figure 10-35: Remote Alarm Jack (Outside View)

Figure 10-36: Remote Alarm Jack (Inside View)

10.20 Power Switch

Follow these steps to remove the power switch (Figure 10-37). Reverse removal steps to install.

NOTE: Orient the switch as shown when reinstalling.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Press flex clips on side of switch, and push down to remove switch.

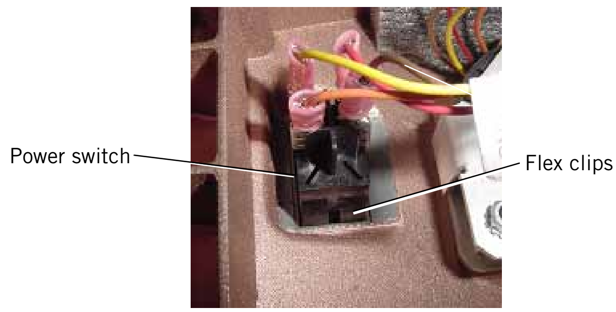


Figure 10-37: Power Switch Installed

10.21 FIO_2 Connector

Follow these steps to remove the FIO_2 connector (Figure 10-38). Reverse removal steps to install.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Cut tie wraps as necessary to free the FIO_2 connector harness (labeled FIO2 at the FIO_2 connector end and SEN J7 at the sensor PCB end).
3. Disconnect the harness from sensor PCB connector J7.
4. Remove the 8-mm nut and washer that hold the FIO_2 connector.
5. Remove the connector.

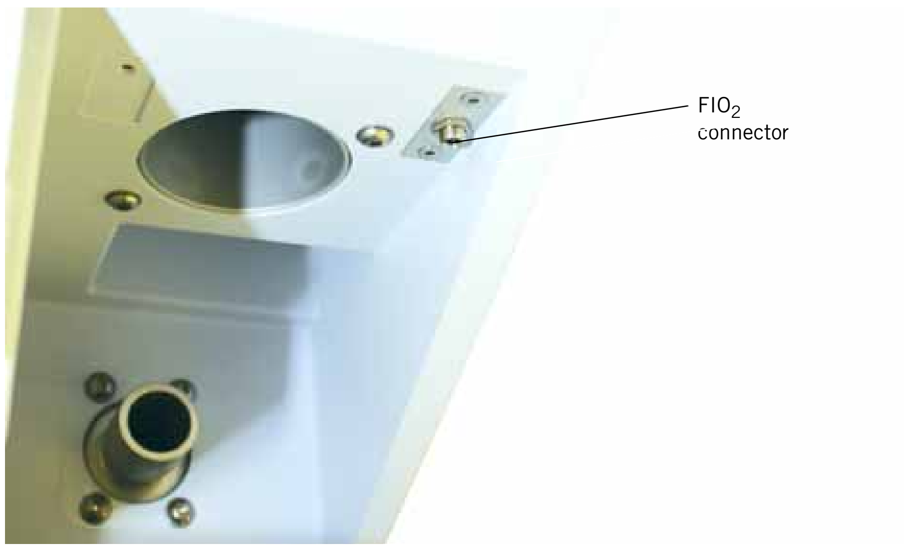


Figure 10-38: FIO_2 Connector

10.22 Exhalation Flow Sensor

10.22.1 Removal

Follow these steps to remove the exhalation flow sensor.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Move the enclosure brace aside (see Chapter 10.4 on p. 10-17).
3. Cut the tie wraps that hold the exhalation flow sensor to the exhalation valve and to the EXH F/S cable (Figure 10-39).
4. Disconnect the EXH F/S cable from the exhalation flow sensor.
5. Using a 3-mm hex driver, remove the screw that holds the exhalation valve outlet port to the exhalation valve.
6. Using a 4-mm hex driver, remove the screw that holds the exhalation valve to the bottom enclosure standoff.
7. Push the flow sensor toward the vent port.
8. Wiggle the outlet port to remove it from the exhalation valve. Remove the flow sensor.

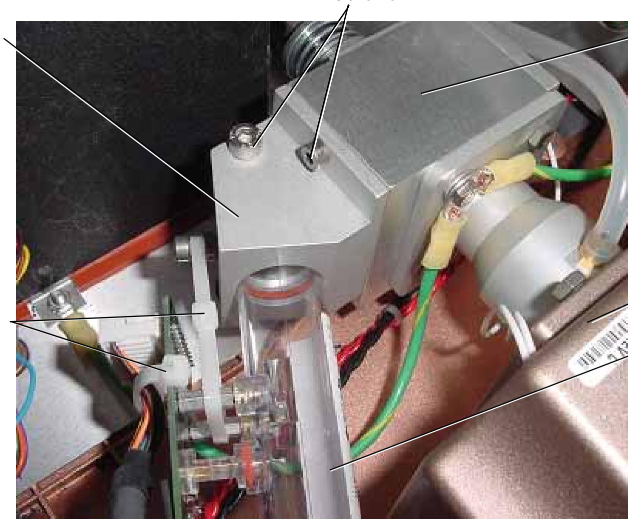


Figure 10-39: Exhalation Flow Sensor

10.22.2 Installation

Follow these steps to install the exhalation flow sensor.

NOTE: You must install the filter heater and exhalation valve assemblies before reinstalling the exhalation flow sensor.

1. Gently push the exhalation flow sensor body through the bottom enclosure vent port. Make sure the flow direction arrow on the sensor points toward the vent port.

2. Verify that check valve CV4 is oriented and seated properly.

NOTE: It is not necessary to inspect CV4 if you are installing a new exhalation valve.

NOTE: Check valve CV4 should remain inside the exhalation valve when the outlet port is removed. If CV4 falls out, reinstall it into the exhalation valve assembly.

3. Inspect the two O-rings on the exhalation valve outlet port (Figure 10-40). Replace the O-rings if they are cracked or deformed. Lightly lubricate O-rings with Krytox GPL226 lubricant.

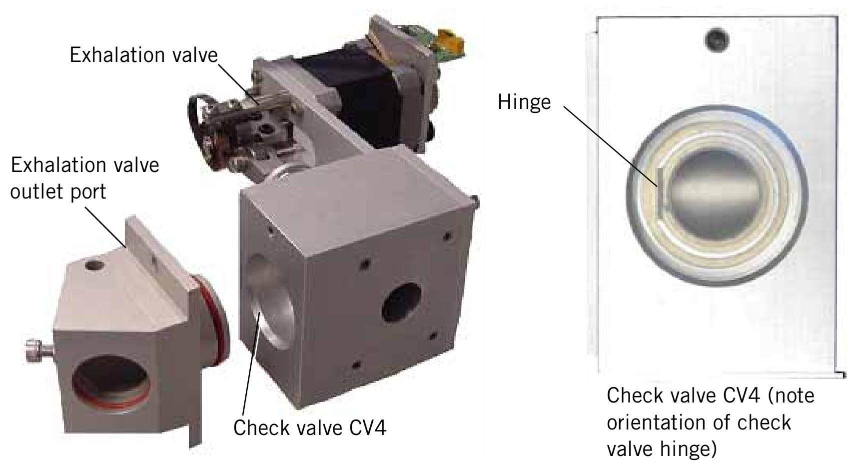


Figure 10-40: Inspecting O-rings in Exhalation Valve Outlet Port and Check Valve CV4 Orientation

4. Squarely position the exhalation valve outlet port to the exhalation valve outlet and fully insert it into the exhalation valve.
5. Using a 3-mm hex driver, install the screw that holds the exhalation valve outlet manifold to the exhalation valve.

CAUTION: To avoid damaging the flow sensor, hand tighten only (do not tighten tie wraps with a tool).

6. Using a 4-mm hex driver, install the screw that holds the exhalation valve outlet port to the bottom enclosure standoff.
7. Insert the flow sensor completely into the exhalation valve outlet port (use a slight rotating motion) and fasten it with a tie wrap.
8. Connect the EXH F/S cable to the flow sensor and fasten it with a tie wrap. See Figure 10-39 for tie wrap positioning.
9. Install the enclosure brace (see Chapter 10.4 on p. 10-17).
10. Install the top enclosure (see Chapter 10.3 on p. 10-14).

10.23 Exhalation Valve Assembly

10.23.1 Removal

Follow these steps to remove the exhalation valve assembly.

1. Remove the exhalation flow sensor (see Chapter 10.22.1 on p. 10-41).
2. Disconnect the MTR EV cable from the white and black connectors on the exhalation valve (Figure 10-41).
3. Disconnect the exhalation pressure tube from the exhalation solenoid.
4. Remove the four M4 x 12 hex bolts that hold the exhalation valve to the heater outlet port.
5. Move the green ground wires out of the way, and then carefully remove the exhalation valve, taking care not to damage the coiled spring on the stepper motor's shaft.

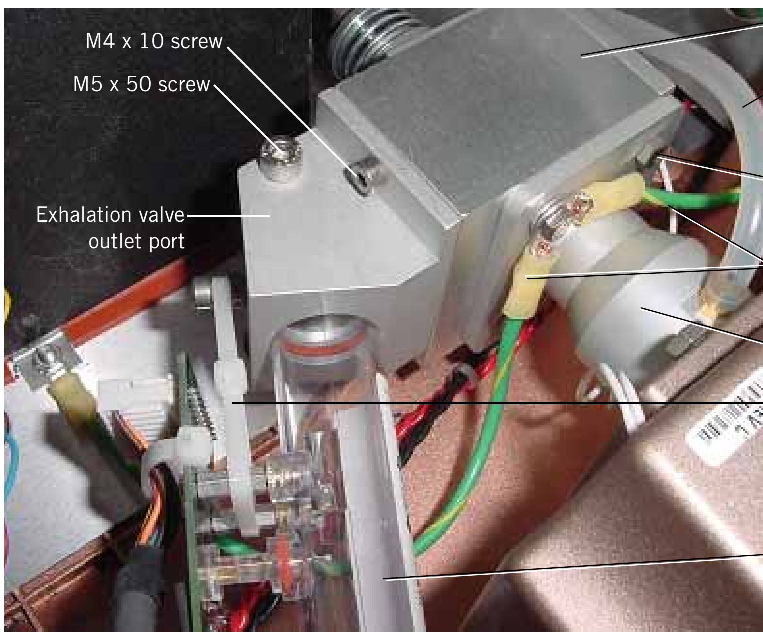


Figure 10-41: Exhalation Valve and Filter Heater Assembly

10.23.2 Installation

Follow these steps to install the exhalation valve (Figure 10-41).

NOTE: You must install the filter heater assembly before reinstalling the exhalation valve assembly.

1. Ensuring the presence and proper position of the O-ring, fasten the exhalation valve to the filter heater outlet port with four M4 x 12 bolts, being sure to attach the two green ground wires (Figure 10-41).
2. Connect the exhalation pressure tube to the exhalation solenoid.
3. Route the two cables (MTR EV) from the exhalation valve under the aluminum oxygen inspiratory port on the oxygen flow sensor, then connect them to the MTR EV cable.
4. Install the exhalation flow sensor (see Chapter 10.22 on p. 10-41).

10.24 Primary Alarm

Follow these steps to remove the primary alarm (Figure 10-42). Reverse removal steps to install.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Disconnect the primary alarm cable from the P ALARM cable.
3. Remove the two M3 nuts that hold the alarm bracket and alarm. Remove the alarm.

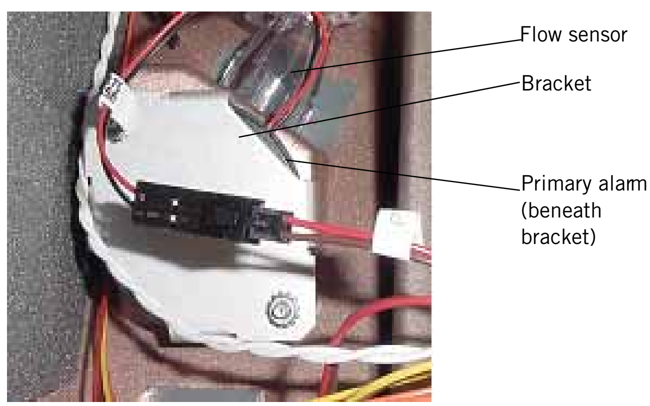


Figure 10-42: Primary Alarm

10.25 Filter Heater Assembly

Follow these steps to remove the filter heater assembly (Figure 10-43). Reverse removal steps to install.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
1. Move the enclosure brace aside (see Chapter 10.4 on p. 10-17).
2. Disconnect the heater assembly HEATER cable from its mating connector.
3. Disconnect the exhalation pressure tube from the barbed fitting at the heater outlet port.
4. Remove the four M4 x 12 hex bolts that hold the exhalation valve to the heater outlet (Figure 10-41).
5. Push the filter heater assembly out through the front of the bottom enclosure.

Figure 10-43: Filter Heater Tube Connector

10.26 Oxygen Flow Sensor

10.26.1 Removal

Follow these steps to remove the oxygen flow sensor (Figure 10-44):

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Move the enclosure brace aside (see Chapter 10.4 on p. 10-17).
3. Using a 4-mm hex driver, remove the M5 x 10 screw and clamp from the oxygen flow sensor at the lower enclosure standoff.
4. Cut the tie wrap that holds the O2 F/S cable to the oxygen flow sensor. Disconnect the cable.
5. Gently push the oxygen flow sensor and aluminum oxygen inspiratory port toward each other to disengage the flow sensor from the oxygen valve and the oxygen inspiratory port from the inspiratory module. Tilt the flow sensor up at the oxygen valve, and lift it out.
6. Remove the oxygen flow sensor from the oxygen inspiratory port by sliding the two apart.

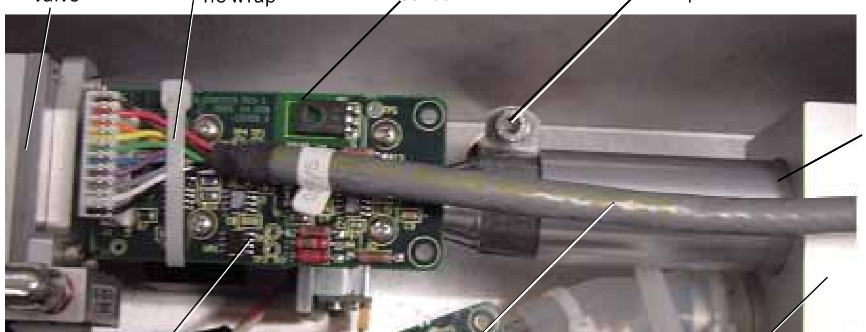


Figure 10-44: Oxygen Flow Sensor

10.26.2 Installation

Follow these steps to install the oxygen flow sensor.

NOTE: You must install the oxygen regulator assembly, oxygen valve assembly, and inspiratory manifold assembly's outlet port before installing the oxygen flow sensor.

NOTE: When installing the oxygen flow sensor, make sure its inlet is fully seated at the oxygen valve assembly and the oxygen inspiratory port is fully inserted and seated at the inspiratory module.

NOTE: Always inspect O-rings between interconnecting parts and replace if visibly damaged or rough to the touch. Always use new O-rings supplied with replacement parts. Lightly lubricate O-rings with Krytox GPL226 lubricant when installing, and relubricate at every reinstallation.

1. Slide the aluminum oxygen inspiratory port onto the flow sensor outlet.
2. With the flow direction arrow pointing toward the inspiratory manifold, insert the flow sensor into oxygen valve outlet port, and then push the aluminum oxygen inspiratory port into the inspiratory manifold.

NOTE: The PCB on the flow sensor must face up and be positioned level with the top of the oxygen valve.

NOTE: Route cables MTR O_2, MTR BV, and MTR EV underneath the flow sensor.

NOTE: The flow sensor and oxygen inspiratory port must be pushed *completely* into their respective ports.

3. Place the clamp around flow sensor outlet. Using a 4-mm hex driver, install the clamp-retaining screw to the bottom enclosure standoff.
4. Connect cable O2 F/S to the oxygen flow sensor. Attach it to the flow sensor PCB with a tie wrap.

NOTE: To avoid damaging the flow sensor, hand tighten tie wrap only (do not tighten it with a tool).

5. Install the enclosure brace (see Chapter 10.4 on p. 10-17).
6. Install the top enclosure (see Chapter 10.3 on p. 10-14).

10.27 Air Flow Sensor

Follow these steps to remove the air flow sensor (Figure 10-45). Reverse removal steps to install.

NOTE: You must install the oxygen regulator assembly and air valve before installing the air flow sensor.

NOTE: Install a replacement mesh cup before installing the air valve inlet tube: place the mesh cup over the air valve inlet port, then insert the blower outlet hose over the mesh cup completely up to the valve body.

NOTE: The circuit board must face up and away from the blower shroud with the flow arrow pointing toward the inspiratory manifold.

NOTE: To avoid damaging the flow sensor, hand-tighten replacement tie-wraps (do not tighten the tie wrap with a tool).

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Move the enclosure brace aside (see Chapter 10.4 on p. 10-17).
3. Disconnect the blower outlet transfer tube from the upper port of the air valve (Figure 10-50).
4. Remove the PRV outlet transfer tube at the safety valve/PRV vent tube tee connection.
5. Disconnect the vent tube with the tee from the safety valve port. Move the two tubes aside to permit access to the air flow sensor.
6. Cut the tie wraps, and disconnect the tubes from the air valve and inspiratory module. Leave tubes connected to the air flow sensor.

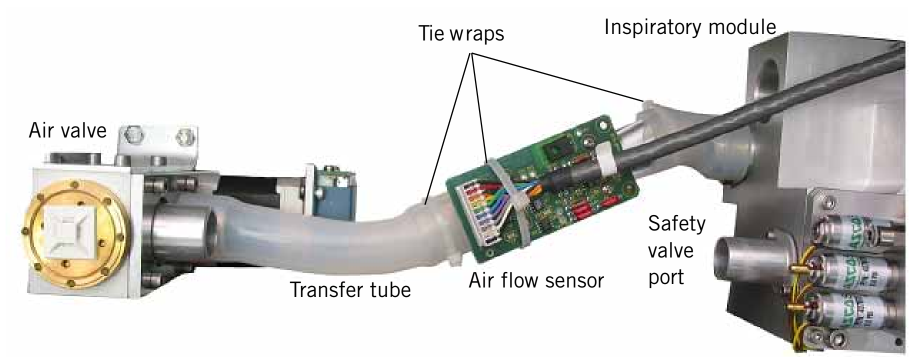


Figure 10-45: Air Flow Sensor

7. Cut the tie wrap that secures the AIR F/S cable.
8. Remove the screw that holds the retaining clamp to the lower enclosure standoff.
9. Remove the air flow sensor with the silicone tubes attached.
10. Cut the tie wraps and remove the silicone tubes from the air flow sensor.

NOTE: When replacing the tie wraps, do not capture the inspiratory pressure tube directly below the air inlet connection to the inspiratory module.

10.28 Inspiratory Manifold Assembly

10.28.1 Removal

Follow these steps to remove the inspiratory manifold assembly (Figure 10-46).

1. Remove the oxygen flow sensor (see Chapter 10.26 on p. 10-46).
2. Remove the air flow sensor (see Chapter 10.27 on p. 10-48).
3. Cut the tie wrap, and remove the tubing from the safety valve vent port of the inspiratory manifold.

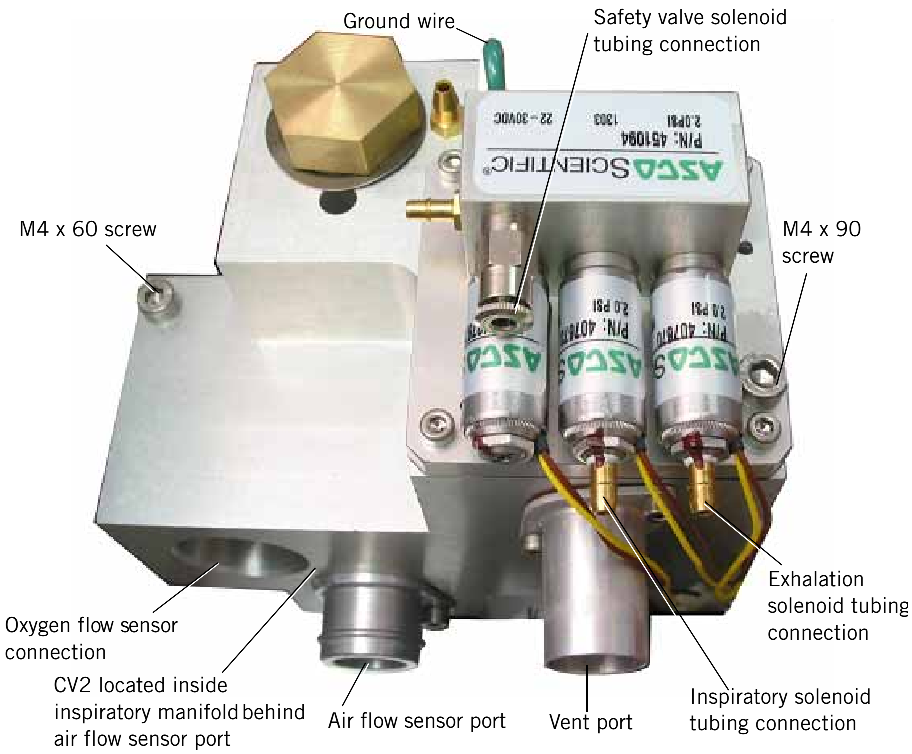


Figure 10-46: Inspiratory Manifold Assembly

4. Label the six tubes connected to the solenoid valve assembly to ensure proper reconnection. Disconnect the tubes.
5. Disconnect the green ground wire from the manifold.
6. Using a 2.5-mm hex driver, loosen the recessed setscrew on the outlet port (Figure 10-47), but do not remove it.

Figure 10-47: Recessed 2.5-mm Setscrew Securing Outlet Port

7. Remove the two screws that hold the inspiratory manifold to the bottom enclosure.
8. Using a 2.5-in. hex driver, remove the four screws and washers that surround the inspiratory gas outlet port (Figure 10-48). Pull the outlet port from the inspiratory manifold.

CAUTION: To avoid scoring the gas outlet port O-rings, push downward on the inspiratory manifold as needed to center the gas outlet port within the cutout of the enclosure. Doing so will also ease removal and installation of the port.

9. Disconnect the three solenoid valve and heater harnesses.
10. Remove the inspiratory manifold.

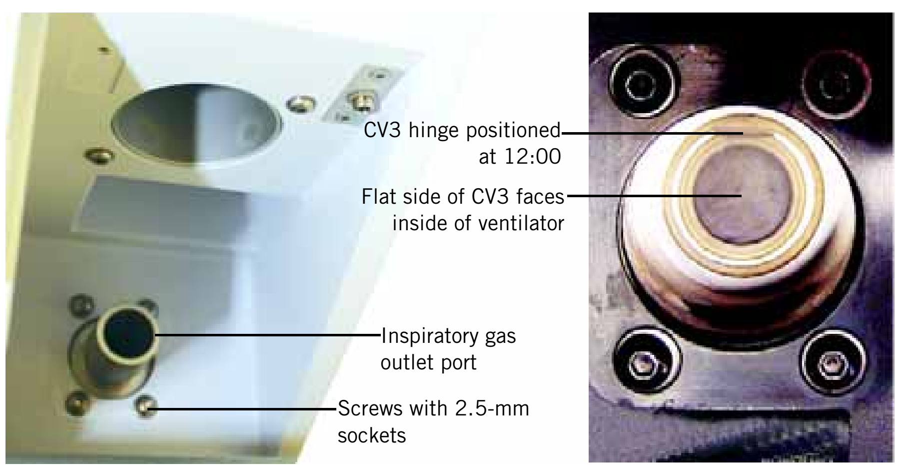


Figure 10-48: Inspiratory Outlet Port and Check Valve CV3 Orientation

10.28.2 Installation

Follow these steps to install the inspiratory manifold assembly:

NOTE: You must install the oxygen regulator assembly and oxygen module assembly before reinstalling the inspiratory manifold assembly.

NOTE: Always inspect O-rings between interconnecting parts and replace if visibly damaged or rough to the touch. Always use new O-rings supplied with replacement parts. Lightly lubricate O-rings with Krytox GPL226 lubricant when installing, and relubricate at every reinstallation.

1. Position the inspiratory manifold in the bottom enclosure. Install two screws, and screw in a few threads to secure the manifold, but do not tighten yet.
2. Connect the silicone tube from the air flow sensor to the male port on the inspiratory manifold. Route cables MTR O2, MTR BV, and MTR EV underneath the silicone tube.
3. Install the oxygen flow sensor (see Chapter 10.26 on p. 10-46).
4. Tighten the two inspiratory manifold screws and torque to 5 in-lb.
5. Reconnect the green ground wire to the inspiratory manifold.
6. Install the four screws and washers at the inspiratory outlet port (Figure 10-48), but do not tighten until the outlet port is installed and secured.
7. Inspect the inspiratory outlet:
   - Check the O-ring on the inspiratory outlet port, and replace it if it is cracked or deformed. Lightly lubricate the O-ring with Krytox GPL226 lubricant.
   - Check that check valve CV3 in the inspiratory outlet is oriented and seated properly.
8. Insert the outlet port completely into the inspiratory manifold and fasten by tightening the setscrew (Figure 10-47). Pull on the inspiratory outlet to ensure it does not come out or rotate.

NOTE: When reinstalling the inspiratory gas outlet port, partially set the set screw into one of the four indents on the port. Turn outlet port left and right to be certain setscrew is captured by indent. Next, tighten setscrew completely and confirm that outlet port is tight.

9. Reconnect the SV, inspiratory, and exhalation tubes to the solenoids (Figure 10-46).
10. Reconnect all remaining tubes to the inspiratory manifold (Figure 10-46).
11. Reconnect the cables labeled EXHAL SOL, INSP SOL, SAFETY SOL, and HEATER.
12. Install the enclosure brace (see Chapter 10.4 on p. 10-17).
13. Install the top enclosure (see Chapter 10.3 on p. 10-14).

10.29 Three-Station Solenoid Valve Assembly

Follow these steps to remove the three-station solenoid valve assembly (Figure 10-49). Reverse removal steps to install.

NOTE: When reinstalling the three-station solenoid valve assembly, orient it as shown.

NOTE: Do not use tools to tighten tie wraps.

NOTE: When reinstalling the screws that hold the solenoid assembly to the inspiratory manifold, torque to 5.5 ± 1 in.-lb.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Move the enclosure brace aside (see Chapter 10.4 on p. 10-17).
3. Label the six tubes connected to the solenoid valve assembly to ensure proper reconnection. Disconnect the tubes.
4. Disconnect the three solenoid valve harnesses.
5. Remove the screws that hold the solenoid valve assembly to the inspiratory manifold. Remove the solenoid valve assembly.

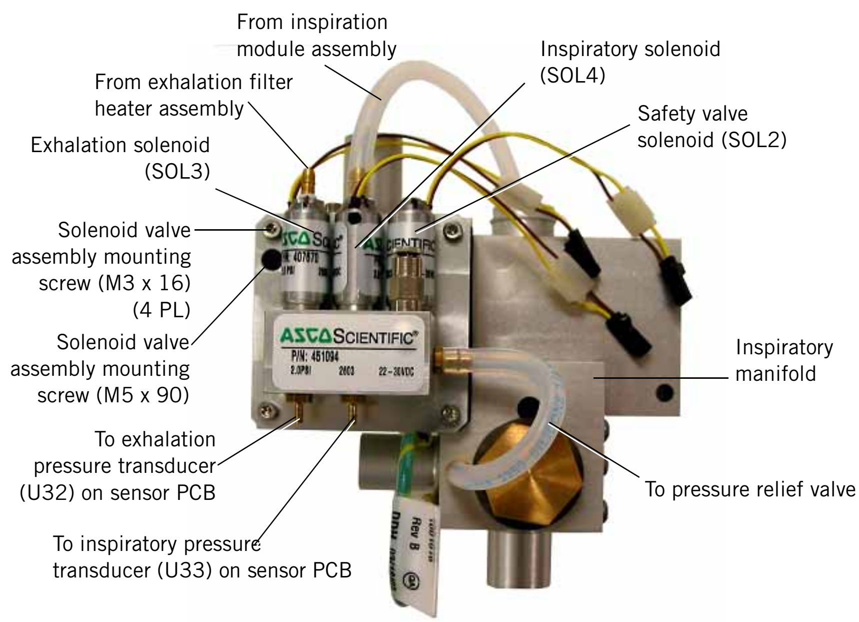


Figure 10-49: Three-Station Solenoid Valve Assembly

10.30 Air Valve Assembly

Follow these steps to remove the air valve assembly. Reverse removal procedures to install.

NOTE: You must install the oxygen regulator assembly before installing the air valve.

NOTE: Install a replacement mesh cup before installing the air valve inlet tube: place the mesh cup over the air valve inlet port, then insert the blower outlet hose over the mesh cup completely up to the valve body.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Move the enclosure brace aside (see Chapter 10.4 on p. 10-17).
3. Cutting the tie wrap, disconnect the blower outlet transfer tube from the upper port of the air valve inlet (Figure 10-50).
4. Carefully remove the mesh cup from inside the transfer tube. Discard the mesh cup.

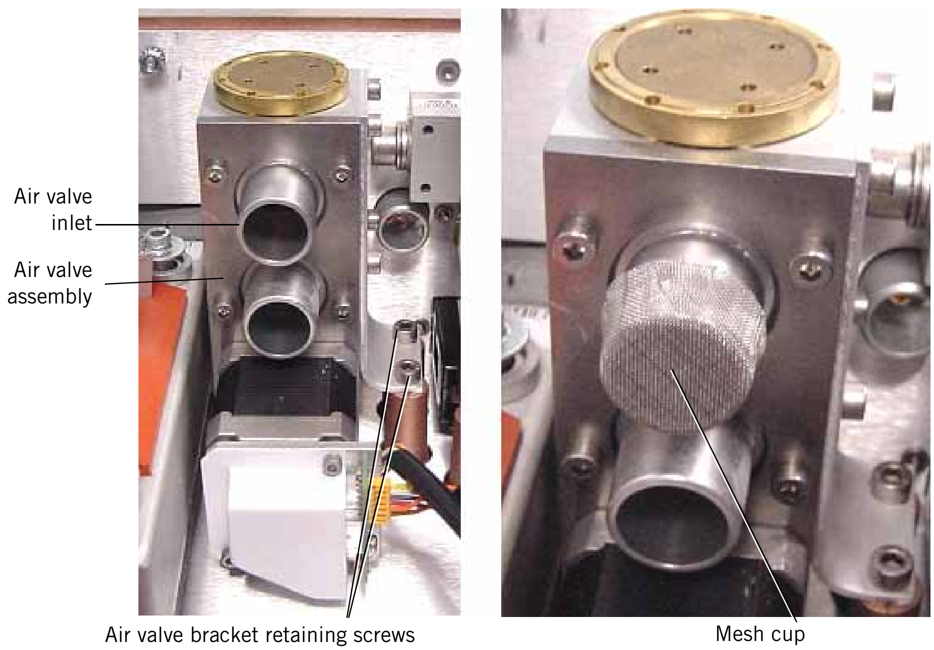


Figure 10-50: Air Valve and Mesh Cup

5. Remove the air flow sensor, but do not cut the tie wrap or disconnect the AIR F/S cable from the flow sensor (see Chapter 10.27 on p. 10-48).
6. Disconnect the two MTR BV cables on the air valve from the mating cable MTR BV.
7. Disconnect the small silicone pilot air supply tube from the brass barb at the top of the blower.

NOTE: Feed the tube through the loop located at the tie wrap mounting pad on top of the air valve.

8. Using a 4-mm hex driver, remove the two M5 x 10 screws that hold the air valve bracket to the bottom enclosure standoffs. Carefully remove the air valve.

10.31 Oxygen Valve Assembly

Follow these steps to remove the oxygen valve assembly (Figure 10-51). Reverse removal steps to install.

NOTE: You must install the oxygen regulator assembly before reinstalling the oxygen valve assembly.

NOTE: When reinstalling the oxygen valve, make sure the oxygen regulator and oxygen flow sensor are fully installed to the oxygen valve assembly.

NOTE: Always inspect the O-rings between interconnecting parts, and replace them if they are visibly damaged or rough to the touch. Always use new O-rings supplied with replacement parts. Lightly lubricate O-rings with Krytox GPL226 lubricant when installing, and relubricate at every reinstallation.

1. Remove the oxygen flow sensor (see Chapter 10.26 on p. 10-46), but do not cut the tie wrap or disconnect the O2 F/S cable from the flow sensor.
2. Remove the air flow sensor (see Chapter 10.27 on p. 10-48), but do not disconnect the AIR F/S cable from the flow sensor.
3. Remove the air valve assembly (see Chapter 10.30 on p. 10-53).
4. Disconnect the two MTR O2 cables on the oxygen valve from the mating MTR O2 cable.
5. Disconnect the CROSS SOL cable from the crossover solenoid valve.
6. Using a 8-mm socket with extension, remove the three bolts that hold the oxygen valve bracket.
7. Slowly pull the oxygen valve assembly away from the oxygen regulator.

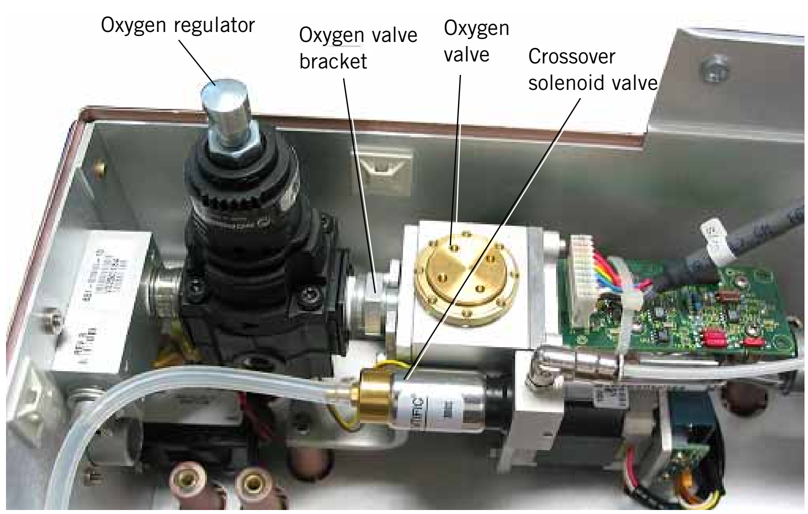


Figure 10-51: Oxygen Valve and Oxygen Regulator

10.32 Oxygen Water Trap/Inlet Filter Assembly

NOTE: Before servicing the oxygen water trap/inlet filter assembly, disconnect the oxygen hose.

10.32.1 Removal

Follow these steps to remove the oxygen filter/water trap assembly (Figure 10-52):

1. Unscrew the bowl.
2. Using a 2.5 mm hex driver, remove the M4 x 10 screw that holds the oxygen filter/water trap assembly bracket to the bottom enclosure.
3. Using a 5/32 hex driver, remove the two 1/4-20 x 3/8 screws that hold the bracket to the oxygen filter/water trap assembly. Remove the bracket.
4. Remove the assembly by unscrewing it (counterclockwise) from the oxygen inlet block.

Figure 10-52: Oxygen Water Trap/Inlet Filter Assembly

10.32.2 Installation

Follow these steps to install the oxygen water trap/inlet filter assembly (Figure 10-52):

1. Clean any residual Teflon tape from the threads of the oxygen regulator inlet block (to which the water trap/inlet filter assembly was installed).
2. Apply 2-1/2 turns of Teflon tape to the threads of the oxygen inlet block.
3. With the water trap bowl removed, screw the assembly into the oxygen inlet block until one thread remains showing and the assembly is perpendicular to the floor.
4. Using a 5/32-in. hex driver, attach the bracket to the oxygen filter/water trap assembly with the two 1/4-20 x 3/8 screws. Torque to 33 to 47 in.-lb.
5. Using a 2.5-mm hex driver, attach the assembly/bracket to the bottom enclosure with one M4 x 10 screw. Torque to 8 to 12 in.-lb.
6. Screw on the bowl.

10.33 Oxygen Regulator Assembly (with Oxygen Pressure Switch)

10.33.1 Removal

Follow these steps to remove the oxygen regulator assembly with oxygen pressure switch:

1. Remove the oxygen flow sensor (see Chapter 10.26 on p. 10-46), but do not cut the tie wrap or disconnect the O2 F/S cable from the flow sensor.
2. Remove the air flow sensor (see Chapter 10.27 on p. 10-48), but do not cut the tie wrap or disconnect the AIR F/S cable from the flow sensor.
3. Remove the air valve assembly (see Chapter 10.30 on p. 10-53).
4. Remove the oxygen valve assembly (see Chapter 10.31 on p. 10-54).
5. Unscrew the oxygen water trap/inlet filter assembly (see Chapter 10.32 on p. 10-56).
6. Using a 2.5-mm hex driver, remove the four M4 x 16 screws and plate that hold the oxygen regulator assembly to the rear of the lower enclosure.
7. From inside the enclosure, disconnect the two black pressure switch wires from sensor PCB connectors J5 and J6 (Figure 10-16).
8. Carefully cut the tie wraps that hold the two black wires near the sensor PCB. Carefully separate these wires all the way back to the pressure switch.
9. Lift the oxygen regulator assembly away from the enclosure (Figure 10-51).

10.33.2 Installation

Follow these steps to install the oxygen regulator assembly with oxygen pressure switch:

1. Using a 2.5-mm hex driver, fasten the plate and the oxygen regulator assembly to the bottom enclosure with four M4 x 16 screws (Figure 10-51).
2. Cleanly route, then connect the two black wires from the oxygen pressure switch to sensor PCB connectors J5 and J6 (polarity is not important) (Figure 10-16).
3. Using two tie wraps, fasten the two black wires to the bundle of cables running across the top of the sensor PCB.
4. Install the oxygen valve assembly (see Chapter 10.31 on p. 10-54). Make sure the oxygen valve is fully installed to the regulator.
5. Install the air valve assembly (see Chapter 10.33 on p. 10-58).
6. Install the air flow sensor (see Chapter 10.27 on p. 10-48).

7. Install the oxygen flow sensor (see Chapter 10.26 on p. 10-46). Make sure the oxygen flow sensor is fully installed to the oxygen valve assembly.
8. Install the oxygen water trap/inlet filter assembly (Chapter 10.32 on p. 10-56).
9. Install the enclosure brace (see Chapter 10.4 on p. 10-17).
10. Install the top enclosure (see Chapter 10.3 on p. 10-14).

10.34 Blower Motor Controller PCB

Follow these steps to remove the blower motor controller PCB. Reverse removal steps to install.

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Move the enclosure brace aside (see Chapter 10.4 on p. 10-17).
3. Remove the four M3 nuts that hold the blower motor controller PCB bracket (Figure 10-53). Partially remove the bracket.

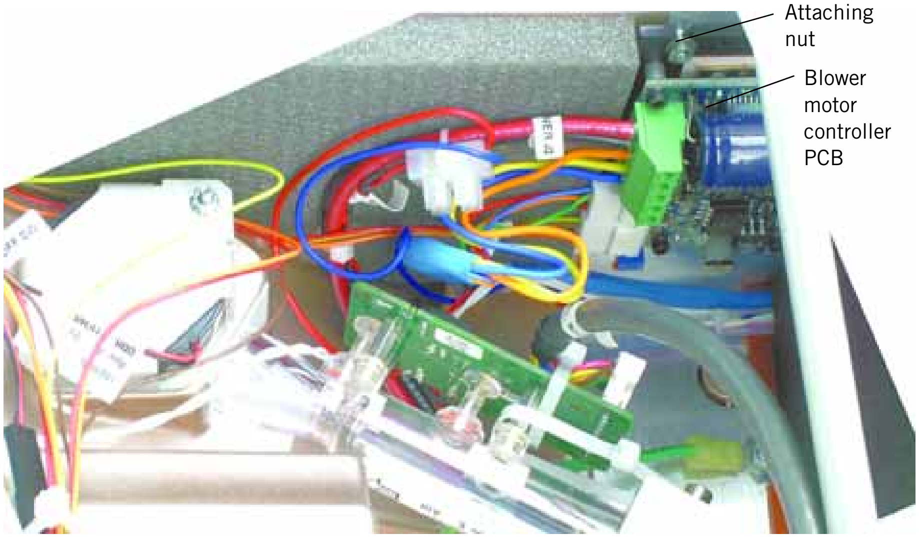


Figure 10-53: Blower Motor Controller PCB Installed

4. Disconnect the wires from the green terminal block (connector J2) (Figure 10-54).

Figure 10-54: Blower Motor Controller PCB

5. Disconnect the blower and sensor PCB harnesses.
6. Remove the entire blower motor controller PCB assembly with bracket.

10.35 Blower Assembly

10.35.1 Removal

Follow these steps to remove the blower assembly:

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
1. Move the enclosure brace aside (see Chapter 10.4 on p. 10-17).
2. Disconnect the blower outlet tube from the upper port of the air valve (Figure 10-50).
3. Remove the mesh cup from inside the tube. Discard the mesh cup.
4. Pry the grommet from the blower shroud (Figure 10-55).

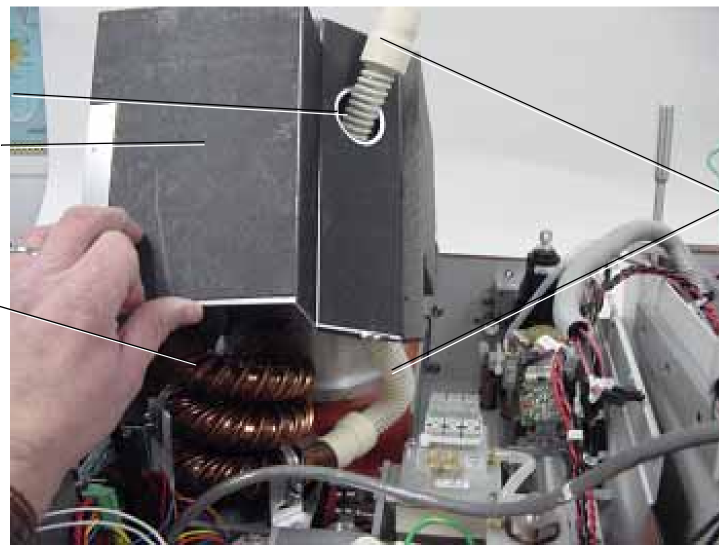


Figure 10-55: Blower Shroud

5. Remove the four 7-mm lock nuts that hold the blower shroud to the bottom enclosure.
6. Partially remove the shroud, pull the transfer tube into the shroud, and then completely remove the shroud.
7. Disconnect the silicone tube from the top of the cooling coil (Figure 10-56).

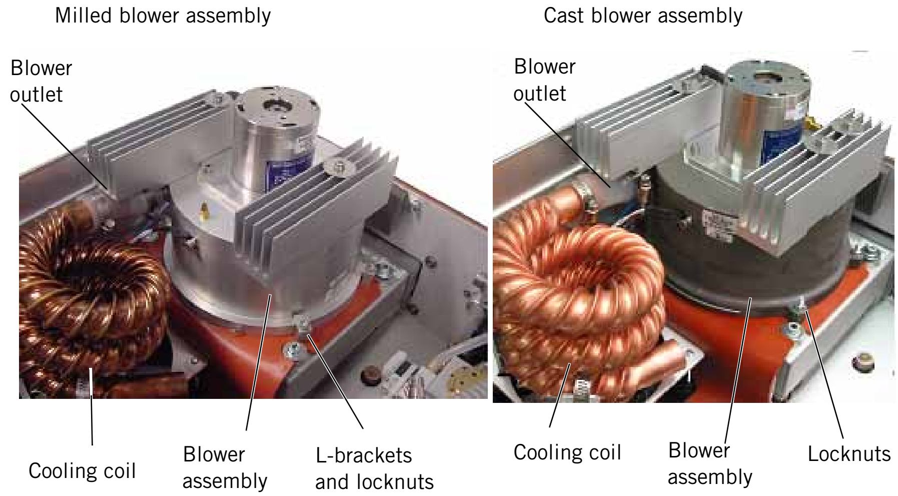


Figure 10-56: Blower Assembly (Milled and Cast)

8. Remove the four lock nuts (and L-brackets for milled housing version of blower assembly) that hold the blower to the muffler assembly.
9. Loosen the hose clamp that holds the silicone tube to the blower outlet. Disconnect the tube.
10. Disconnect the blower harness from its connection on the blower motor controller PCB (Figure 10-54).
11. Loosen the screws that secure the orange, yellow, and blue wires from the blower harness to the green terminal block connector J2 on the blower motor controller PCB. Disconnect the wires.
12. Disconnect the thermostat wires from sensor PCB connectors J3 and J4 (Figure 10-16). Cut the tie wraps and separate the harness back to the blower.
13. Remove the blower.

10.35.2 Installation

Follow these steps to install the blower assembly (Figure 10-57):

NOTE: You must install the muffler assembly before reinstalling the blower assembly.

1. Connect the transfer tube to the bottom of the cooling coil.
2. Place the blower assembly on the gasket so that the blower outlet is parallel to the enclosure wall. Fasten with four lock nuts (and L-brackets, for milled housing version of blower assembly).

NOTE: The L-brackets (milled housing) should be perpendicular to the blower after tightening. Torque just until firm (do not overtighten).

3. Route the blower cables between the cooling coil and the enclosure wall.
4. Connect the BLOWER J1 cable from the sensor PCB to connector J2 on the blower motor controller PCB (Figure 10-54).
5. Connect the blue, yellow, and orange wires to the green terminal block connector J3 on the blower motor controller PCB.
6. Connect the thermostat wires to sensor PCB connectors J3 and J4 (Figure 10-16) (polarity is unimportant).
7. Connect the silicone tube from the top of the cooling coil to the blower (Figure 10-56). Secure the tube with the hose clamp.
8. Place the shroud over the blower while pushing the transfer tube through the hole (Figure 10-55). Install the grommet.

CAUTION: Route the cables from the blower and fan through the cutout at the bottom corner of the shroud. *Do not pinch wires under the blower shroud*.

9. Fasten the shroud with four 7-mm lock nuts. Connect green ground wire from exhalation valve to shroud stud. Torque just until firm (do not over-tighten).
10. Connect the small silicone pilot air supply tube from the crossover solenoid to the brass barb at the top of the blower (Figure 10-56).
11. Install a new mesh cup on the upper port of air valve, and then insert the blower outlet tube over the mesh cup, all the way to the valve body. Fasten the tube in place with a tie wrap.
12. Install the enclosure brace (see Chapter 10.4 on p. 10-17).
13. Install the top enclosure (see Chapter 10.3 on p. 10-14).

Figure 10-57: Blower Assembly Position on Gasket

10.36 Blower Muffler Assembly

10.36.1 Removal

Follow these steps to remove the blower muffler assembly:

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Move the enclosure brace aside (see Chapter 10.4 on p. 10-17).
3. Remove the blower assembly (Chapter 10.35 on p. 10-62).
4. Disconnect the transfer tube from the bottom of the cooling coil (Figure 10-58).
5. Using a 4-mm hex driver, remove the four muffler mounting bolts.
6. Using a 2.5-mm hex driver, remove the six M4 x 12 screws that hold the rear air intake cover.
7. Peel back the gasket. Remove the muffler assembly.

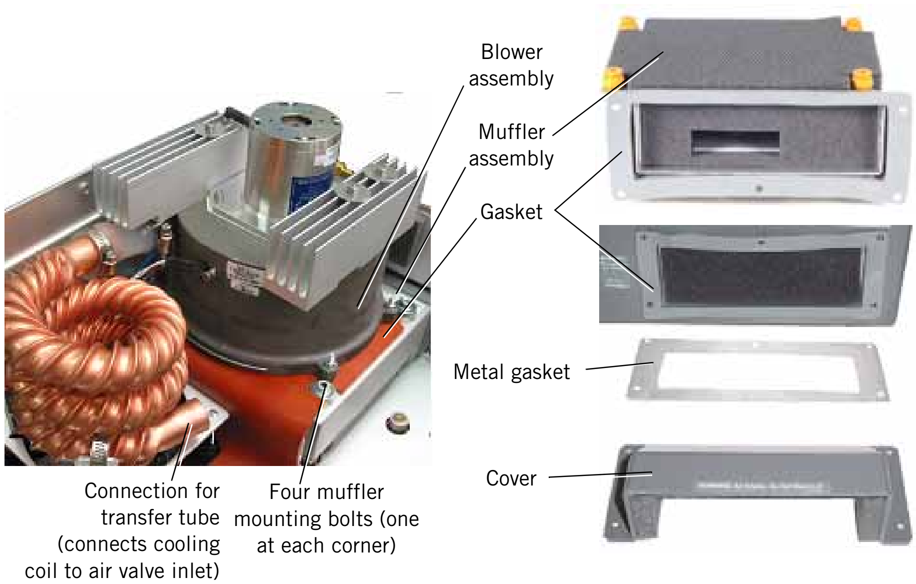


Figure 10-58: Blower Muffler Assembly

10.36.2 Installation

Follow these steps to install the blower muffler assembly (Figure 10-58):

1. Install the muffler assembly, making sure the gasket is on the outside of the bottom enclosure and the air inlet cover holes are aligned.
2. Align the metal inlet gasket over the rubber gasket. Using a 2.5-mm hex driver, secure the cover with five M4 x 12 screws.
3. Apply one drop of Loctite 222 to the threads of the four muffler mounting bolts.

4. Tighten the bolts until they just touch the muffler, then back off 1-3/4 turns.
5. Fold the gasket over the threaded studs.
6. Connect the transfer tube to the bottom of the cooling coil.
7. Install the blower assembly (see Chapter 10.35.2 on p. 10-63).
8. Install the enclosure brace (see Chapter 10.4 on p. 10-17).
9. Install the top enclosure (see Chapter 10.3 on p. 10-14).

10.37 Cooling Fan/ Cooling Coil Assembly

NOTE: It may be convenient to position the bottom enclosure on its side during fan removal and installation.

10.37.1 Removal

Follow these steps to remove the cooling fan/cooling coil assembly (Figure 10-59):

1. Separate the top from the bottom enclosure (see Chapter 10.3 on p. 10-14).
2. Move the enclosure brace aside (see Chapter 10.4 on p. 10-17).
3. Disconnect the blower outlet tube from the upper port of the air valve (Figure 10-50).
4. Remove the mesh cup from inside the tube. Discard the mesh cup.
5. Disconnect the silicone tube from the brass barb at the top of the blower.
6. Pry the grommet from the blower shroud.
7. Remove the four 7-mm lock nuts that hold the blower shroud to the bottom enclosure.
8. Partially remove the shroud, pull the transfer tube into the shroud, then completely the remove shroud.
9. Loosen the hose clamp that holds the silicone tube at the blower outlet. Disconnect the tube.
10. Disconnect the transfer tube from the bottom of the cooling coil.
11. Loosen the two screws securing the fan's positive and negative wires to the terminal block located on the power supply/blower motor controller PCB cable.
12. Remove four M3 x 60 screws, fan guard, M3 snap lockwashers, and M3 nuts that hold cooling fan to enclosure; and then remove cooling coil and fan.

10.37.2 Installation

NOTE: The fan must be installed with its flow direction arrow pointing out of the ventilator. When the fan is reinstalled and before reassembling the ventilator, confirm correct air flow: connect AC power, turn on the ventilator, and then check that the fan blows air out of the ventilator.

Follow these steps to install the cooling fan/cooling coil assembly (Figure 10-59):

1. Place the fan on the gasket with the flow arrow on the fan pointing down and the fan cable closest to the blower controller PCB. Make sure no wires are pinched under the fan.
2. Place the cooling coil assembly on fan, noting orientation of cooling coil inlet; then fasten with four M3 x 60 screws. Torque bolts just until firm (do not over-tighten).
3. Twist the red and black fan wires around the large wires from the power supply. Insert them into connector J2 and tighten. Once the wires are fastened, gently tug on them to ensure a good connection.
4. Connect the transfer tube to the bottom of the cooling coil.
5. Connect the silicone tube to the top of the blower outlet. Fasten it with the hose clamp.
6. Push the transfer tube through the hole in the shroud. Install the grommet in the shroud.
7. Fasten the shroud with four lock nuts.
8. Connect the green ground wires from the exhalation valve and solenoid assembly to the shroud stud. Tighten the stud just until firm (do not over-tighten).

NOTE: Route the cables from the blower and fan through the cutout at the bottom corner of the shroud.

9. Connect the small silicone tube from the blower to the crossover solenoid (Figure 10-56).
10. Install a new mesh cup on the upper port of air valve, and then insert the blower outlet tube over the mesh cup, all the way to the valve body.
11. Install the enclosure brace (see Chapter 10.4 on p. 10-17).
12. Install the top enclosure (see Chapter 10.3 on p. 10-14).

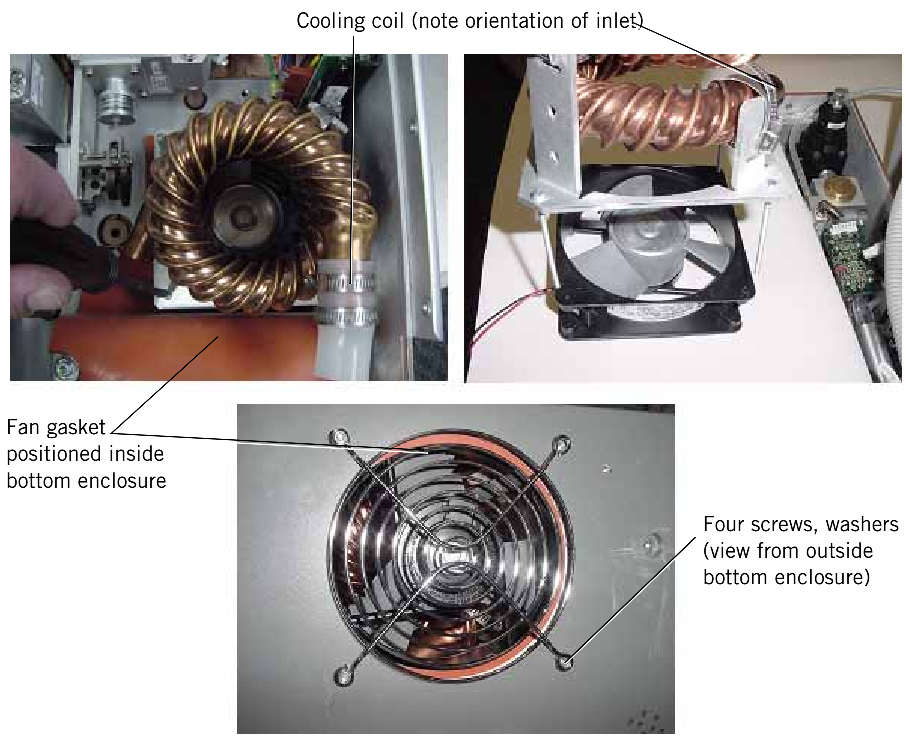


Figure 10-59: Cooling Coil and Fan

10.38 Installing the CPU PCB

Remove the existing CPU PCB and replace with the CPU PCB included in the upgrade kit. Chapter 10.17 on p. 10-34 describes how to install the CPU PCB.

10.38.1 Downloading Ventilator Software

See Chapter 7 for complete software download instructions.

1. Connect service PC to ventilator serial port using a null modem cable.
2. Insert field upgrade CD-ROM, and follow onscreen instructions.

   To prompt for the ventilator serial number use this command:
   (x:)\setup -vs

   where *x:* is the CD-ROM drive, and a space precedes *-vs*

10.38.2 Calibrating the Display Screen

1. Cycle ventilator power while holding down the **Exp. Hold** and the leftmost unlabeled button. The ventilator prompts you to calibrate the screen. Upon acknowledgement, the software automatically detects and adjusts for the 10.4-in. screen size.
2. After ventilator confirms that the screen calibration is complete, cycle ventilator power and enter diagnostic mode.
3. Enter software screen and confirm that serial number is correct.
4. Reset altitude and compliance compensation settings on the user configuration screen.
5. Run EST with top enclosure removed. If EST passes, install the top enclosure (see Chapter 10.3 on p. 10-14).

10.38.3 Enabling Options

Enable an option (see Chapter 7) only if the option upgrade is being installed at this time.

10.38.4 Final Checkout

Complete the recommended tests in the performance verification procedure (see Chapter 8).

Chapter 11. Where to Go for Help

For further information or technical assistance, contact Respironics Customer Service:

- By email: **service@respironics.com**
- In the U.S.: **800-345-6443**
- Outside the U.S.: **724-387-4000** (phone) or **724-387-5012** (fax)

(This page is intentionally blank.)

Chapter 12. Respironics V200/Esprit Ventilator Replacement Parts List

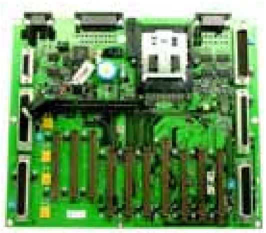
12.1 Major Components

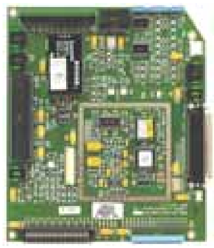
This section illustrates the major components of the Respironics V200 and Esprit Ventilators, including:

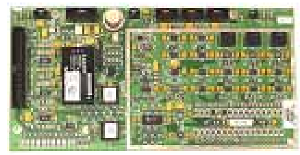
- Electronics (see page 12-2)
- GUI assembly (see page 12-3)
- Oxygen pneumatics (see page 12-7)
- Air pneumatics (see page 12-8)
- Exhalation pneumatics (see page 12-10)
- Inspiration pneumatics (see page 12-11)
- Back panel (see page 12-12)

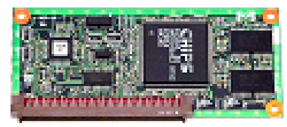
Chapter 12.2 on page 12-15 lists the recommended service part inventory. Chapter 12.3 on page 12-17 lists all repair parts for the two ventilators.

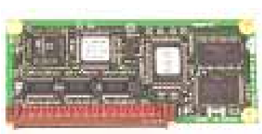
12.1.1 Electronics

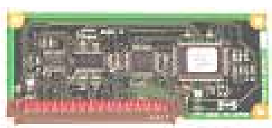

Main PCB
(P/N 1034721)

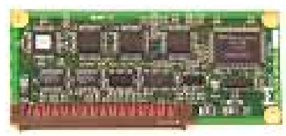

MMI PCB
(P/N 1026559)

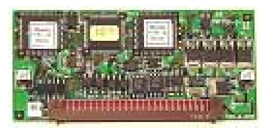

Sensor PCB
(P/N 1001353)

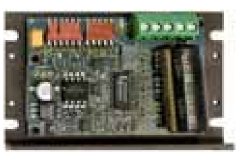

VGA controller PCB
(P/N 1001345)


CPU PCB with 4.10 OTP
(P/N 1022451)
Requires software version
30.10 or higher


Analog PCB
(P/N 1001343)


Digital PCB
(P/N 1005946)


Motor controller PCB
(air, oxygen, exhalation)
(P/N 1063035)

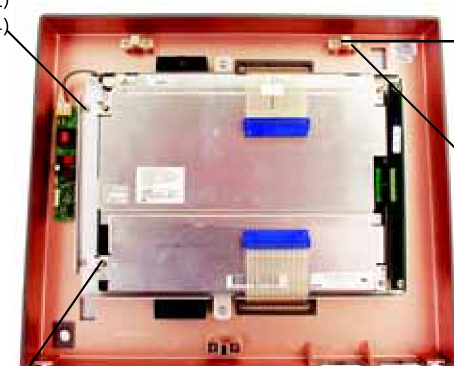

Blower motor controller
PCB
(P/N 1017857)


Power supply assembly
(P/N 1018246)

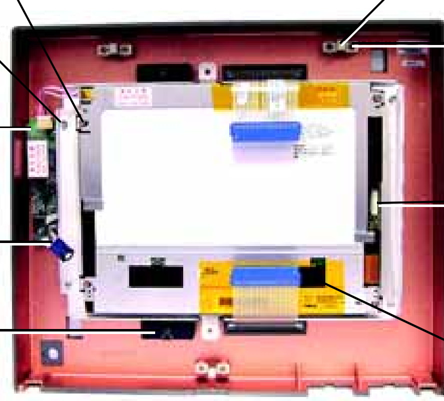
12.1.2 GUI Assembly

Esprit GUI Assembly

GUI assembly
(2nd-generation 10.4-in. - P/N 1019107)
(1st-generation 10.4-in. - P/N 1014183)



2nd-generation 10.4-in. GUI



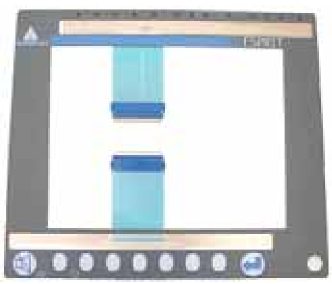
1st-generation 10.4-in. GUI

Esprit GUI Assembly (continued)

DC/DC converter PCB
(For original 10.4-in. display only - P/N 1004972)

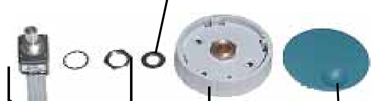
1st-generation 10.4-in. color LCD (with backlight inverter PCB)
(P/N 1006359)

2nd-generation 10.4-in. color LCD
(P/N 1019369)



Overlay assembly
(For 10.4-in. GUI only - P/N 1006582)

Infrared touch frame
(For 10.4-in. GUI only - (P/N 1006460)



Washer
(P/N 550-1000-08)

Optical rotary encoder
(Includes lockwasher and nut)
(P/N 443-1000-00)

Knob cap
(P/N 330-1000-03)

Knob
(P/N 330-1000-01)

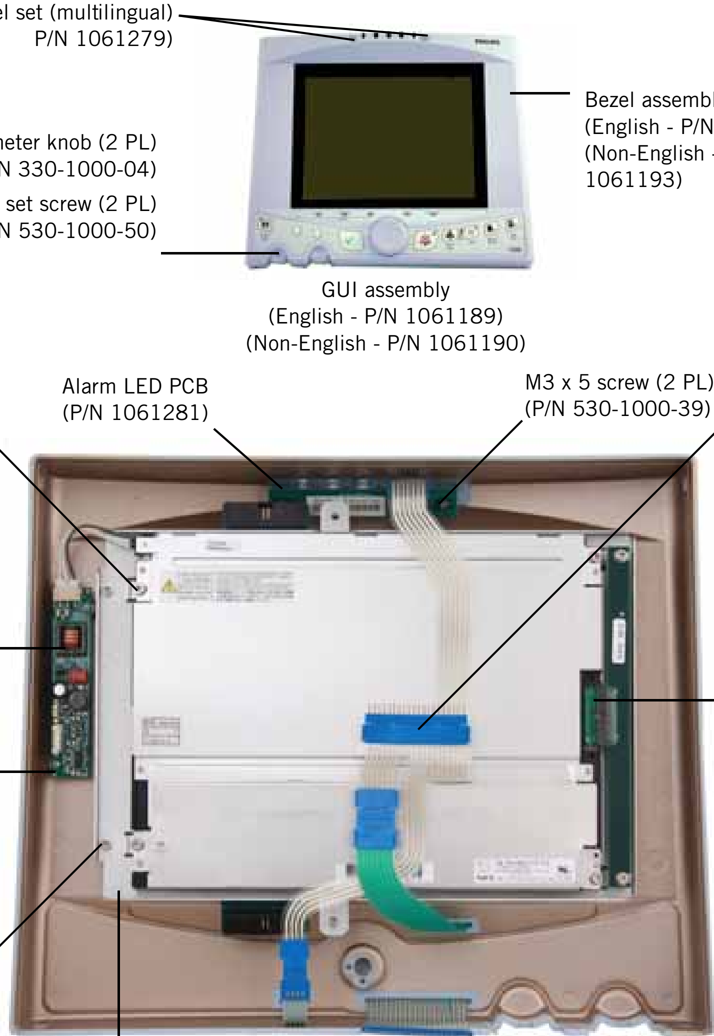
Transition PCB
(For 2nd-generation GUI only - P/N 1018752)

Adapter PCB
(For 2nd-generation GUI only -
P/N 1018753)

Color display cable
(For 2nd-generation GUI only -
P/N 1018334)

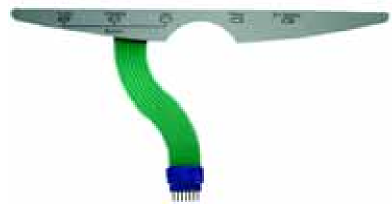
Backlight inverter cable
(For 2nd-generation GUI only -
P/N 1018336)

Respironics V200 GUI Assembly



Respironics V200 GUI Assembly (continued)

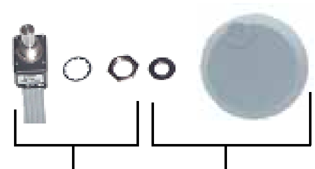
Keypad overlay
(English - P/N 1061196)
(Non-English - P/N 1061277)



Power status LED overlay
(English - P/N 1061194)
(Non-English - P/N 1061195)

Infrared touch frame
(P/N 1006460)

10.4-in. color LCD
(P/N 1019369)



Optical rotary encoder
(Includes internal
lockwasher and nut)
(P/N 1061283)

Rotary encoder knob
with M6 flat washer
(P/N 1061282)

M6 flat washer
(P/N 550-1000-08)

12.1.3 Oxygen Pneumatics

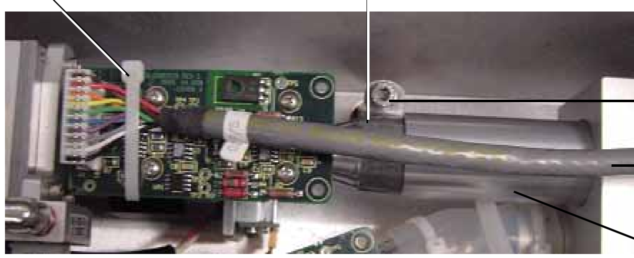
Oxygen regulator assembly
(P/N 1001334)

O-ring
(P/N 500-1000-24)

Crossover solenoid
assembly (SOL1)
(P/N 1011126)

M5 x 12 screw (3 PL)
(Not shown)
(P/N 530-1000-37)

Oxygen valve assembly (P/N 1012087)
(Includes three M5 x 12 attaching screws)



8-in. tie wrap
(P/N 500-1000-62)

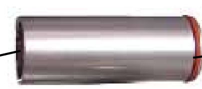
Clamp
(P/N 500-1000-61)

M5 x 10 screw
(P/N 530-1000-29)

Sensor PCB to oxygen flow
sensor cable
(P/N 610-1000-06)

Oxygen inspiratory port
(P/N 261-1001-25)

Oxygen flow sensor
(P/N 1001339)



Internal O-ring
(Not shown)
(P/N 500-1000-14)

External O-ring
(P/N 500-1000-13)

Oxygen inspiratory port
(P/N 261-1001-25)

Plate
(P/N 261-1000-82)

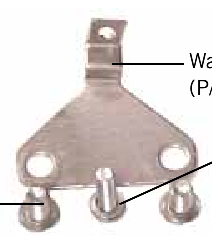
M4 x 16 screw (4 PL)
(P/N 530-1000-60)

Oxygen inlet filter
(P/N 1001311)

Elbow fitting, NPT
(P/N 1002771)

Oxygen adapter, male SIS x 1/4 NPT
(P/N 1002785)

Oxygen water trap/inlet filter
assembly
(P/N 1001336)

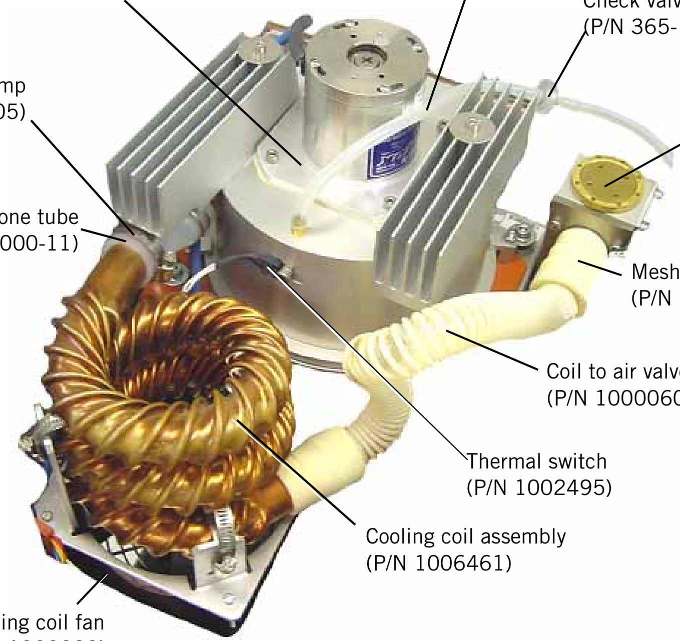


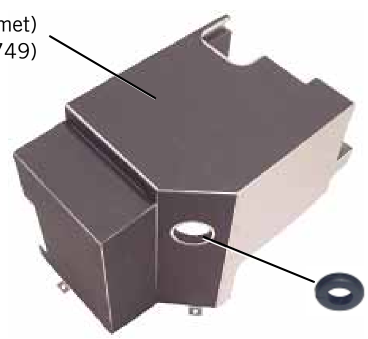
Water trap bracket
(P/N 261-1000-96)

M4 x 10 screw
(P/N 530-1000-47)

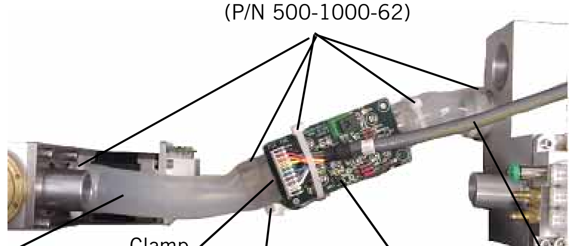
¼-20 x 3/8 screw (2 PL)
(P/N 530-1000-61)

12.1.4 Air Pneumatics





*Sold in 10-ft increments

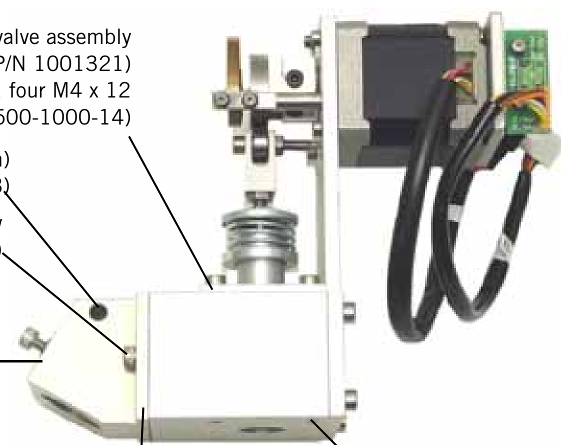


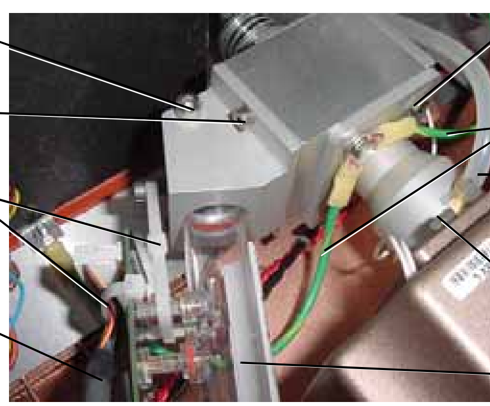
*Sold in 10-ft increments
**Sold by the ft

12.1.5 Exhalation Pneumatics

Heated filter assembly. See Table 12-2 for part numbers.

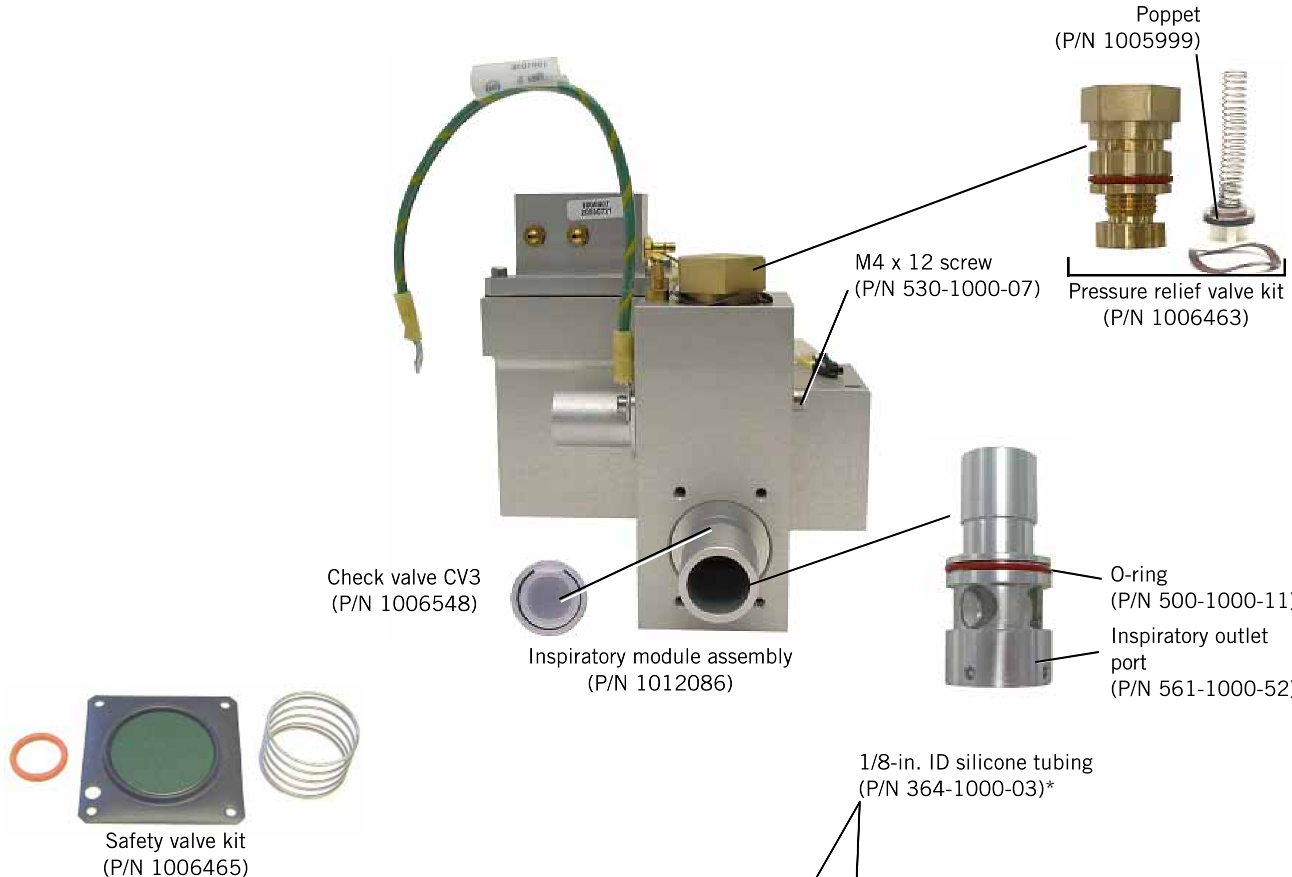
Heated filter sleeve assembly
(Esprit - P/N 1006358)
(Respironics V200 - P/N 1061309)

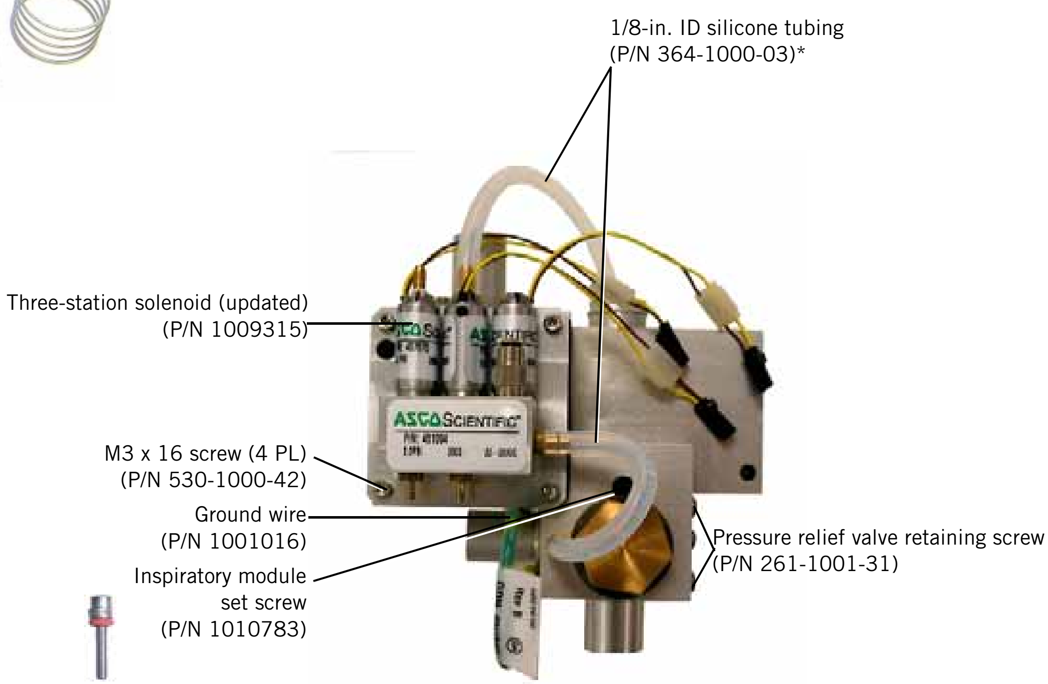





*Sold in 10-ft increments

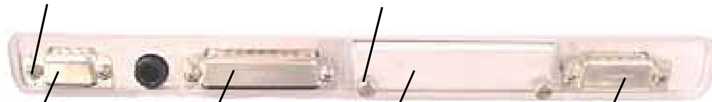
12.1.6 Inspiration Pneumatics

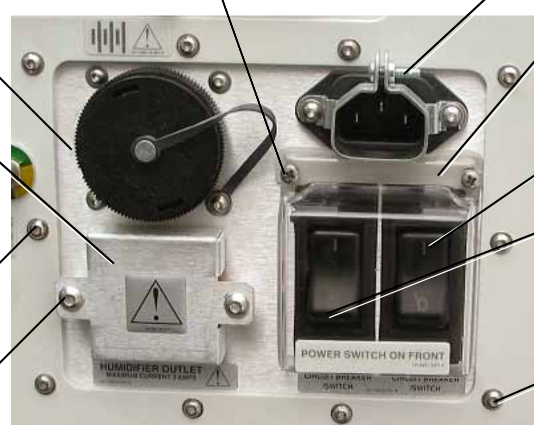




*Sold in 10-ft increments

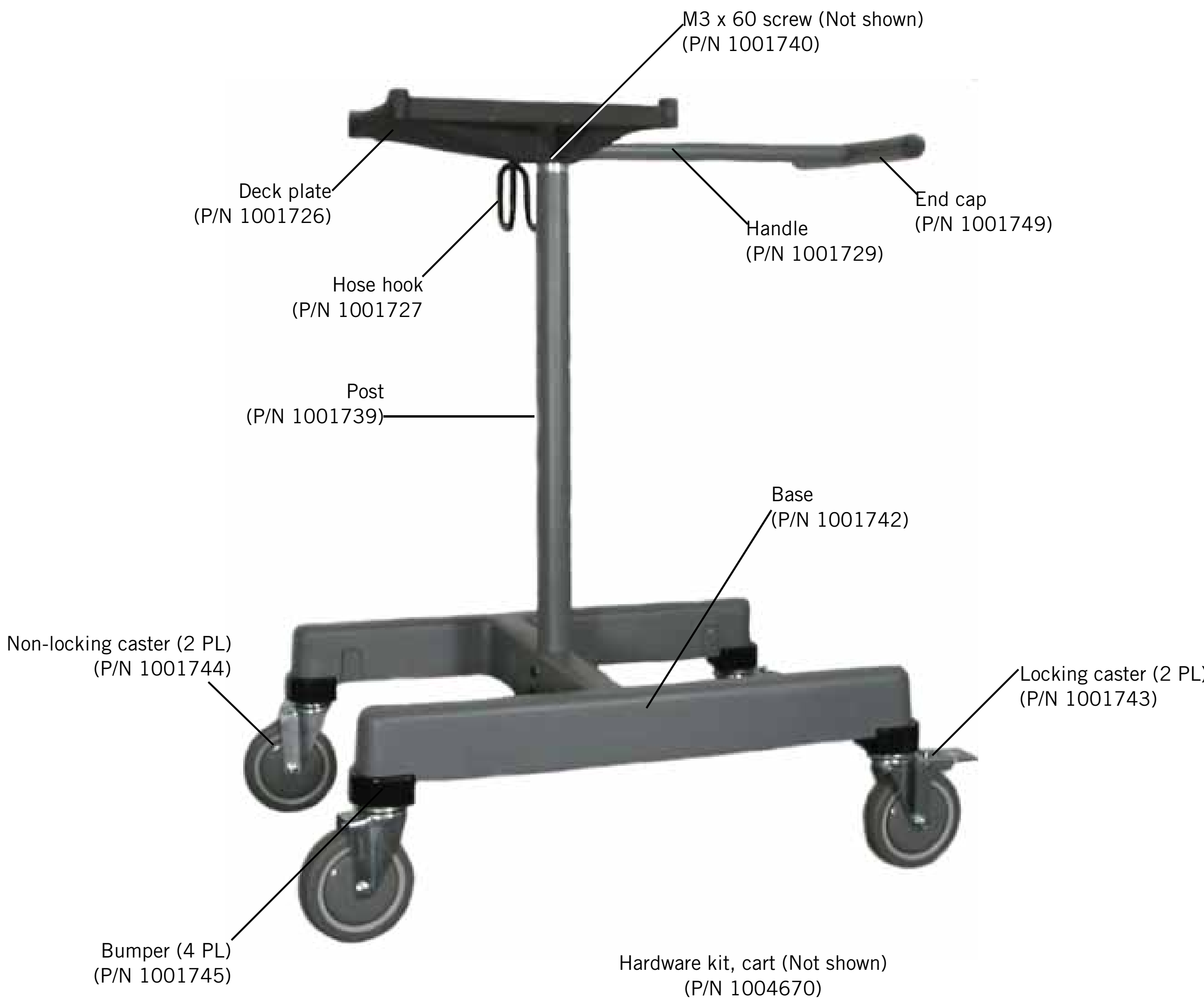
12.1.7 Back Panel



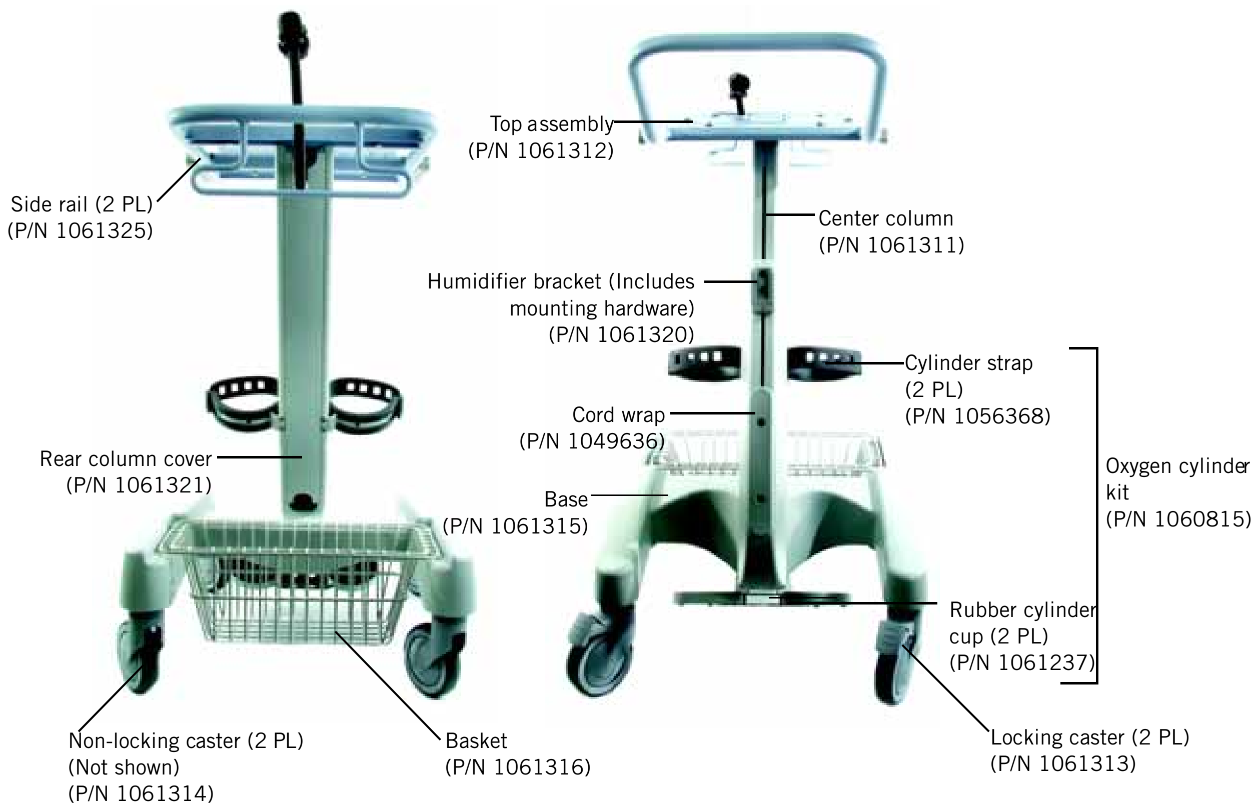


12.1.8 Cart

Esprit Ventilator Cart



Respironics V200 Cart



Backup battery tray (Not shown)
(P/N 1061317)

Backup battery tray strap kit (Not shown)
(P/N 1061318)

Hardware kit, mounting, ventilator-to-cart (Not shown)
(P/N 1061324)

Hardware kit, complete (Not shown)
(P/N 1061322)

12.2 Service Part Inventory List

Table 12-1 lists the recommended service part inventory (see page 12-17 for a complete list of all Esprit repair parts).

CAUTION: Use only Respironics ventilator repair/service parts. Only Respironics parts are designed for use in this ventilator. Use of non-Respironics repair parts may alter ventilator reliability resulting in damage. Use of non-Respironics repair parts will affect your warranty. Contact Customer Service at 1-800-345-6443 or 724-387-4000 for more information.

Table 12-1: Recommended Service Parts Inventory

Description	Esprit Part Number	Respironics V200 Part Number
Adapter, USB to serial	1022895	1022895
Air valve assembly	1001327	1001327
Alarm, backup with cable	1012962	1012962
Alarm, high volume primary	1003875	1003875
Alarm, standard primary	1002511	1002511
Analog PCB	1001343	1001343
Battery, lithium, 3 V, CR2032 (Located on main PCB)	1034865	1034865
Battery, lithium, 3.6 V, 2.1 Ah	1000658	--
Blower assembly (new)	1001328	1001328
Blower assembly (remanufactured)	1007702	1007702
Blower motor controller PCB	1017857	1017857
Cable, 1st-generation 10.4-in. display to main PCB	1016006	--
Cable, MMI PCB to overlay	1003311	1003311
Cable, MMI PCB to primary alarm connector	610-1000-14	610-1000-14
Cable, MMI PCB to touchscreen	1003310	1003310
Cable, sensor PCB to air flow sensor	610-1000-07	610-1000-07
Cable, sensor PCB to exhalation flow sensor	610-1000-04	610-1000-04
Cable, sensor PCB to oxygen flow sensor	610-1000-06	610-1000-06
Check valve 2, 3, or 4	1006548	1006548
Circuit breaker, 10 A, 50/60 Hz	1003733	1003733
Circuit breaker, humidifier, 4 A	1003732	1003732
Color LCD assembly, 1st-generation 10.4-in. display (Includes backlight inverter PCB)	1006359	--
Cooling coil assembly	1006461	1006461
Cover, blower filter	261-1001-19	261-1001-19
CPU PCB w/4.10 OTP (requires 30.10 software or greater)	1022451	1022451
Crossover solenoid assembly (SOL1)	1011126	1011126
Cylinder latch/lock assembly	1005997	--
DC/DC converter PCB	1004972	1004972
Digital PCB	1005946	1005946

Table 12-1: Recommended Service Parts Inventory (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Elapsed time meter	1000291	1000291
Enable button, Color option	1006356	1006356
Enclosure assembly, top, English	1004436	1061289
Exhalation valve assembly	1001321	1001321
Fan, air intake (power supply shroud)	1000040	1000040
Fan, brushless, 24 VDC (cooling coil)	1000022	1000022
Field upgrade software CD	1003481	1003481
Filter, air inlet	1015672	1015672
Filter, air inlet, with housing	500-1000-32	500-1000-32
Filter, blower inlet	261-1001-42	261-1001-42
Filter, oxygen water trap	1001311	1001311
Flow sensor, air/exhalation	1001338	1001338
Flow sensor, oxygen	1001339	1001339
Fuse, power supply F1, 10 A 250 V	1005091	1005091
Fuse, power supply F2, 16 A 250 V	1009110	1009110
GUI upgrade kit (Includes all parts to convert a 9.5-in. display to a 2nd-generation 10.4-in. color display)	1019370	--
GUI upgrade kit (Includes all parts to convert an original 10.4-in. display to a 2nd-generation 10.4-in. color display)	1020175	--
Heated filter assembly, English	1001269	1061294
Heated filter door assembly, English	1004688	1061303
Heated filter sleeve assembly	1006358	1061309
Inspiratory module assembly	1012086	1012086
Main PCB	1034721	1034721
Mesh cup	1009121	1009121
MMI PCB	1026559	1026559
Motor controller PCB	1063035	1063035
Muffler assembly	1006464	1006464
O-ring (exhalation valve outlet port)	500-1000-10	500-1000-10
O-ring, 2-004 (inspiratory module)	500-1000-17	500-1000-17
O-ring, 2-012 (oxygen valve)	500-1000-24	500-1000-24
O-ring, 2-020 (oxygen valve, exhalation valve, flow sensors)	500-1000-14	500-1000-14
O-ring, 2-021 (exhalation valve, flow sensors, inspiratory module, air valve, heated filter assembly)	500-1000-13	500-1000-13
O-ring, 2-023 (inspiratory module)	500-1000-11	500-1000-11
Oxygen regulator assembly	1001334	1001334
Oxygen valve assembly	1012087	1012087

Table 12-1: Recommended Service Parts Inventory (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Oxygen water trap/inlet filter assembly	1001336	1001336
Poppet assembly (pressure relief valve)	1005999	1005999
Power supply assembly	1018246	1018246
Pressure relief valve kit	1006463	1006463
Rotary encoder, optical	443-1000-00	1061283
Safety valve kit	1006465	1006465
Sensor PCB	1001353	1001353
Set screw, inspiratory module	1010783	1010783
Side rail assembly (both sides, complete)	1006462	--
Switch, on/off	440-1000-00	440-1000-00
Three-station solenoid (updated)	1009315	1009315
Tie wrap, 11.4-in.	500-1000-65	500-1000-65
Tie wrap, 3.1-in.	500-1000-66	500-1000-66
Tie wrap, 8-in. (100 per package)	500-1000-62	500-1000-62
VGA controller PCB	1001345	1001345

12.3 Complete Repair Parts List

The following table lists all repair parts for the Esprit and Respironics V200 Ventilators.

NOTE: Though many of the part numbers for the Esprit Ventilator are also listed for the Respironics V200 Ventilator, always order Esprit parts only from the Esprit Part Inventory List.

CAUTION: Use only Respironics ventilator repair/service parts. Only Respironics parts are designed for use in this ventilator. Use of non-Respironics repair parts may alter ventilator reliability resulting in damage. Use of non-Respironics repair parts will affect your warranty. Contact Customer Service at 1-800-345-6443 or 724-387-4000 for more information.

Table 12-2: Complete Repair Parts List

Description	Esprit Part Number	Respironics V200 Part Number
Accessory kit	1005774	1005774
Adapter, 22 mm OD x 22 mm OD	1002505	1002505
Adapter, high pressure oxygen hose (Italy)	1002558	1002558
Adapter, oxygen, male, SIS x ¼ NPT (U.S.)	1002785	1002785
Adapter, oxygen regulator test	1001376	1001376
Adapter, oxygen sensor, silicone	1001736	1001736

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Adapter, parallel port, DS1410E	1004644	1004644
Adapter PCB, Esprit 2nd-generation 10.4-in. display/Respironics V200	1018753	1018753
Adhesive, LOCTITE 222MS thread locker	200-1000-00	200-1000-00
Adhesive, LOCTITE 4013	1002571	1002571
Air valve assembly	1001327	1001327
Alarm LED PCB	--	1061281
Alarm, backup with cable	1012962	1012962
Alarm, high volume primary	1003875	1003875
Alarm, standard primary	1002511	--
Alarm (ALRM) option field upgrade kit	1023193	--
Analog output port selector box	1010891	1010891
Analog PCB	1001343	1001343
Auto-Trak option field upgrade kit, English (Not available in the U.S.)	1010439	--
Auto-Trak option field upgrade kit, Japanese	1010853	--
Auto-Trak option field upgrade kit, Portuguese	1014157	--
Auto-Trak option field upgrade kit, Spanish	1012472	--
Backlight inverter PCB (Used on 2nd-generation 10.4-in. display)	1019368	1019368
Backlight inverter PCB (Used on 1st-generation 10.4-in. display)	1005514	--
Backlight inverter PCB (Used on 9.5-in. display)	1001350	--
Backup battery tray	--	1061317
Backup battery strap kit	--	1061318
Base, LX-200 cart	1001742	--
Base, V200 cart (Includes casters)	--	1061315
Basket, for cart	--	1061316
Battery, backup, English	1001470	1059956
Battery, backup, French	1022652	--
Battery, backup, Japanese	1032021	--
Battery, backup, Portuguese	1001471	--
Battery, backup, Spanish	1024311	--
Battery, external, English, for North America	1001456	--
Battery, lithium, 3 V, CR2032 (Located on main PCB)	1034865	1034865
Battery, lithium, 3.6 V, 2.1 Ah (Located on power supply shroud)	1000658	--
Bezel, 10.4-in. display	1003039	--
Bezel assembly, with overlays, English	--	1061192
Bezel assembly, with overlays, non-English	--	1061193
Blower assembly, new	1001328	1001328

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Blower assembly, remanufactured	1007702	1007702
Blower motor controller PCB	1017857	1017857
Blower muffler assembly	1006464	1006464
Bolt, hex, M4 x 12, stainless steel with Nylok strip (Attaches heated filter assembly to exhalation valve)	1013448	1013448
Bottle, water collection, polysulfone (water collection vial system)	1006244	1006244
Box, shipping, cart	1002472	1062807
Box, shipping, ventilator	1008395	1008395
Brace, enclosure	1000062	1000062
Bracket, 10.4-in. display mounting	1004979	1004979
Bracket, AC cord, with screw	1040817	1040817
Bracket, alarm	1002496	1002496
Bracket, alarm, top	1003878	1003878
Bracket, blower mounting (milled blower only)	261-1001-71	261-1001-71
Bracket, blower valve mounting	261-1001-77	261-1001-77
Bracket, brace anti-rotation (Connects to enclosure brace)	261-1001-72	261-1001-72
Bracket, display knob	261-1000-93	261-1000-93
Bracket, F & P humidifier, LX-200 cart pole-mounting	1002226	--
Bracket, Hudson Concha II humidifier	1002227	--
Bracket, Hudson Concha IV humidifier	1002228	--
Bracket, humidifier, wall/table	1002901	--
Bracket, humidifier (Includes bracket mounting hardware)	--	1061320
Bracket, circuit arm mounting	1002497	1002497
Bracket, oxygen cylinder kit, LX-200 cart mounting	1002241	--
Bracket, oxygen sensor connector	261-1000-89	261-1000-89
Bracket, rear attachment	261-1001-51	261-1001-51
Bracket, side, receiver, left/right, Respironics V200 (Attaches respiratory profile monitor mounting bracket)	--	1061310
Bracket, water trap	261-1000-96	261-1000-96
Bulkhead, front (MMI PCB mounting plate)	261-1000-81	261-1000-81
Bulkhead, lower enclosure	1000063	1000063
Bumper, LX-200 cart base	1001745	--
Bumper foot	1000001	1000001
Cable, increased minimum alarm volume control	1022447	--
Cable extension kit (Used to rework main PCB to motor cable (P/N 610-1000-05) when replacing original versions of inspiratory module, three-station solenoid, crossover solenoid (SOL1), or oxygen valve assembly)	1010867	--
Cable, 10.4-in. display to main PCB (1st-generation 10.4-in. display)	1016006	--

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Cable, 10.4-in display to main PCB (Esprit 2nd-generation 10.4-in. display/ Respironics V200)	1018334	1018334
Cable, adapter, DB15 to BNC (installed into chart recorder port for use with Lifecare remote alarm)	1011533	1011533
Cable, backlight extension (original 10.4-in. display)	1002965	--
Cable, backlight inverter (2nd-generation 10.4-in display)	1018336	1018336
Cable, flex circuit	--	1061280
Cable, ground wire, bottom assembly to top	1001207	1001207
Cable, ground wire, inhalation and exhalation	1001016	1001016
Cable, main BD remote alarm (Phono jack)	1022446	1022446
Cable, main harness	1002160	1002160
Cable, main PCB to motor (use with ASCO solenoids)	1009242	1009242
Cable, main PCB to MMI PCB, 50-pin	610-1000-01	610-1000-01
Cable, main PCB to motor (use with Numatec solenoids)	610-1000-05	--
Cable, main PCB to sensor PCB, 50-pin	610-1000-03	610-1000-03
Cable, MMI PCB to backlight inverter	610-1000-11	--
Cable, MMI PCB to intensity control potentiometer	610-1000-16	610-1000-16
Cable, MMI PCB to on/off switch	610-1000-12	--
Cable, MMI PCB to overlay	1003311	1003311
Cable, MMI PCB to primary alarm connector	610-1000-14	610-1000-14
Cable, MMI PCB to touchscreen	1003310	1003310
Cable, MMI PCB to volume control potentiometer	610-1000-15	610-1000-15
Cable, null modem (9-pin)	1022815	1022815
Cable, null modem (9-pin) (respiratory profile monitor-ventilator interface)	1018292	1018292
Cable, nurse call alarm, Lifecare remote	1003743	1003743
Cable, nurse call alarm, alarm state = closed	1003742	1003742
Cable, nurse call alarm, alarm state = open	1003741	1003741
Cable, nurse call test	1001375	1001375
Cable, oxygen sensor	160-1000-03	160-1000-03
Cable, power supply chassis grounding (short jumper)	610-1000-22	610-1000-22
Cable, power supply to blower controller	610-1000-17	610-1000-17
Cable, sensor PCB to air flow sensor	610-1000-07	610-1000-07
Cable, sensor PCB to blower controller	610-1000-09	610-1000-09
Cable, sensor PCB to exhalation flow sensor	610-1000-04	610-1000-04
Cable, sensor PCB to oxygen flow sensor	610-1000-06	610-1000-06
Cable, sensor PCB to oxygen sensor connector	610-1000-02	610-1000-02
Cable, VGA display to MMI, 25-pin (9.5-in. display only)	610-1000-21	--

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Cable, VueLink to ventilator	1006912	1006912
Cap, battery terminal	1013568	1013568
Cap, end, LX-200 cart tee handle	1001749	--
Cap, GUI knob	330-1000-03	--
Card cage bottom	261-1001-83	261-1001-83
Cart	1001453	1060495
Caster, locking	1001743	1061313
Caster, non-locking	1001744	1061314
Check valve (CV2, CV3, or CV4)	1006548	1006548
Check valve (CV5)	365-1000-00	365-1000-00
Circuit breaker, 10 A, 50/60 Hz	1003733	1003733
Circuit breaker, humidifier, 4 A	1003732	1003732
Circuit breaker cover kit, with label, English	1019130	1019130
Circuit breaker cover kit, without label	1007811	--
Clamp, 0.875-in. diameter, steel zinc alloy	500-1000-61	500-1000-61
Clamp, cable, 0.75 x 0.75, with adhesive	1013388	1013388
Clamp, cooling coil mount	1000013	1000013
Clamp, half, 0.875-in. for 0.281-in. hole	1000630	1000630
Clamp, hose, blower outlet/cooling coil inlet	1022505	1022505
Color display option	1004956	--
Color LCD assembly. 1st-generation 10.4-in. display (Includes backlight inverter PCB)	1006359	--
Column, center, Respironics V200 cart	--	1061311
Communications 2 (COM2) option field upgrade kit (COM1 and COM2 options cannot both be installed on a ventilator at the same time)	1015725	1015725
Communications 1 (COM1) option field upgrade kit (COM1 and COM2 options cannot both be installed on a ventilator at the same time)	1010525	1010525
Conductive foil, top enclosure	261-1001-57	261-1001-57
Connector, 22mm conical x barb, polysulfone (water collection vial system)	1006242	1006242
Connector, barb x barb, polypropylene	1006245	1006245
Connector, tee, silicone rubber (water collection vial system)	1006243	1006243
Cooling coil assembly	1006461	1006461
Cooling coil mounting bracket	261-1001-88	261-1001-88
Cork, silicone	1001735	1001735
Coupling, straight, silicone	500-1000-43	500-1000-43
Cover, blower filter	261-1001-19	261-1001-19
Cover, humidifier outlet	1010785	1010785

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Cover, PCMCIA port	261-1001-60	261-1001-60
Cover, vent manifold	261-1001-48	261-1001-48
Cover, rear, center column, cart	--	1061321
Cup, rubber, E-cylinder bracket base	--	1061327
CPU PCB, with 4.10 OTP (Requires software version 30.10 or higher)	1022451	1022451
Cushion, main PCB	261-1001-69	261-1001-69
Cylinder lock/latch assembly	1005997	--
DC/DC converter PCB (for original 10.4-in. displays only)	1004972	--
Desiccant bag, unit size 1, type 2	1001670	1001670
Digital PCB	1005946	1005946
Distribution panel, interconnection (AC distribution panel assembly)	1000045	1000045
Dust cover, without chain, 9-pin connector	1001211	1001211
Dust cover, without chain, 15-pin connector	1001212	1001212
Dust cover, without chain, 25-pin connector	1001213	1001213
Elapsed time meter	1000291	1000291
Elbow fitting, oxygen	1002771	1002771
EMI screen (air inlet)	485-1000-00	485-1000-00
Enable button, alarm	1023193	1023193
Enable button, Auto-Trak option	1010440	1010440
Enable button, Color option	1006356	1006356
Enable button, COM1 option (COM1 and COM2 options cannot both be installed on a ventilator at the same time)	1010524	1010524
Enable button, COM2 option (COM1 and COM2 options cannot both be installed on a ventilator at the same time)	1015674	1015674
Enable button, Flow-Trak	1019027	1019027
Enable button, Graphics option	1006357	1006357
Enable button, Respiratory Mechanics option	1012205	1012205
Enable button, Trending option	1013445	1013445
Enable button, Neonatal option	1016844	1016844
Enable button, NICO-Esprit interface (NICO-Esprit interface and COM2 options cannot both be installed on a ventilator at the same time)	1022487	1022487
Enclosure assembly, bottom, English	1014970	1061284
Enclosure assembly, bottom, Italian	1014974	1061288
Enclosure assembly, bottom, Japanese	1014973	1061287
Enclosure assembly, bottom, Portuguese	1014972	1061286
Enclosure assembly, bottom, Spanish	1014971	1061285
Enclosure assembly, top, English	1004436	1061289

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Enclosure assembly, top, Italian	--	1061293
Enclosure assembly, top, Japanese	--	1061292
Enclosure assembly, top, Portuguese	--	1061291
Enclosure assembly, top, Spanish	--	1061290
Exhalation valve assembly	1001321	1001321
Exhalation valve outlet port	1007132	1007132
Exhaust port	261-1000-54	261-1000-54
Fan, air intake (power supply shroud)	1000040	1000040
Fan, brushless, 24 VDC (cooling coil)	1000022	1000022
Fan guard	500-1000-58	500-1000-58
Field upgrade software CD (Available to Respironics service personnel only)	1003481	1003481
Filter, air inlet	1015672	1015672
Filter, air inlet, with housing	500-1000-32	500-1000-32
Filter, blower inlet	261-1001-42	261-1001-42
Filter, coalescent (oxygen water trap)	500-1000-29	500-1000-29
Filter, oxygen inlet	1001311	1001311
Fitting, 10-32 to 1/8-in. barb, brass (inspiratory module)	500-1000-08	500-1000-08
Fitting, oxygen, ¼-in. NPT-SIS outlet	1007655	1007655
Fitting, oxygen, Air Liquide	1004727	1004727
Fitting, vent tube tee, 3/4-in.	500-1000-56	500-1000-56
Flex arm, two-section, gooseneck, CE	1003781	1003781
Flow sensor, air/exhalation	1001338	1001338
Flow sensor, oxygen	1001339	1001339
Flow-Trak option field upgrade kit, English	1019026	1019026
Fuse, ceramic, 25 A, 250 V	1013498	1013498
Fuse, power supply F1, 10 A, 250 V, 5 x 20 mm	1005091	1005091
Fuse, power supply F2, 16 A, 250 V, 5 x 20 mm	1009110	1009110
Gasket, blower	261-1001-75	261-1001-75
Gasket, EMI (copper finger strips)	500-1000-41	500-1000-41
Gasket/foam kit, GUI	1022023	1022023
Gasket, humidifier outlet	1002972	1002972
Gasket, switch cover	1007512	1007512
Graphics option field upgrade kit, English	1003772	1003772
Grommet edging (Used to secure harnesses)	1012090	1012090
Grommet, blower shroud	1000010	1000010
Grommet, roll form (top enclosure)	510-1000-00	510-1000-00

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Ground lug	199-1000-00	199-1000-00
GUI assembly, 10.4-in. color display, 2nd-generation	1019107	--
GUI assembly, 10.4-in. color display, 1st-generation	1014183	--
GUI assembly, English	--	1061189
GUI assembly, non-English	--	1061190
GUI upgrade kit (Includes all parts to convert a 9.5-in. display to a 2nd-generation 10.4-in. color display)	1019370	--
GUI upgrade kit (Includes all parts to convert an original 10.4-in. display to a 2nd-generation 10.4-in. color display)	1020175	--
Handle, LX-200 cart	1001729	--
Hanger, adult/pediatric tubing	1003661	1003661
Hardware kit, E-cylinder bracket mounting	--	1061328
Hardware kit, LX-200 cart	1004670	--
Hardware kit, Respironics V200 cart, complete cart	--	1061322
Hardware kit, mounting, ventilator-to-cart	--	1061324
Heated filter assembly, English	1001269	1061294
Heated filter assembly, Italian	--	1061298
Heated filter assembly, Japanese	1004722	1061295
Heated filter assembly, Metran	1004725	--
Heated filter assembly, Portuguese	1004719	1061296
Heated filter assembly, Spanish	1004721	1061297
Heated filter door assembly, English	1004688	1061303
Heated filter door assembly, Italian	--	1061299
Heated filter door assembly, Japanese	1004718	1061301
Heated filter door assembly, Metran	1004726	--
Heated filter door assembly, Portuguese	1004717	1061302
Heated filter door assembly, Spanish	1004716	1061300
Heated filter sleeve assembly	1006358	1061309
Hook, hose, LX-200 cart	1001727	--
Hose, ARH, 2-in. ID (power supply air inlet)	1002821	1002821
Hose, oxygen high pressure, Air Liquide	1001661	1001661
Hose, oxygen high pressure, DISS	1001664	1001664
Hose, oxygen high pressure, DISS 1240, oxygen manifold assembly, 2-ft	1006655	1006655
Hose, oxygen high pressure, SIS (Australia)	1001659	1001659
Hose, oxygen high pressure, USISO (China, Singapore)	1002556	1002556
Inspiratory module assembly	1012086	1012086
Knob, potentiometer (intensity or alarm volume)	330-1000-04	330-1000-04

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Knob, rotary encoder	330-1000-01	1061282
Label, Auto-Trak option (multilingual)	1010403	--
Label, dangerous voltage (multilingual)	1001125	1001125
Label, Communications option (multilingual)	1024910	1024910
Label, Flow-Trak option (multilingual)	1017118	1017118
Label, Graphics option (multilingual)	1004782	1004782
Label, Neonatal option (multilingual)	1025933	1025933
Label, respiratory profile monitor interface option (multilingual)	1058896	1058896
Label, Preventive Maintenance	1011247	1011247
Label, Respiratory Mechanics option (multilingual)	1012331	1012331
Label, Trending option (multilingual)	1013394	1013394
Label assembly, Chinese	1024294	1064672
Label assembly, English	1000531	1062319
Label assembly, French	1022637	1064671
Label assembly, Italian	1000535	1064670
Label assembly, Japanese	1000800	1064669
Label assembly, Portuguese	1000530	1064668
Label assembly, Spanish	1000532	1064667
Label set, backup battery, English	1002120	--
Label set, backup battery, French	1022653	--
Label set, backup battery, multilingual	--	1059994
Label set, backup battery, Portuguese	1002611	--
Label set, backup battery, Spanish	1002605	--
Label set, Vent Inop/Safety Valve (multilingual)	--	1061279
Language insert, bottom row, English	321-1000-01	--
Language insert, bottom row, Italian	1000282	--
Language insert, bottom row, Japanese	1000274	--
Language insert, bottom row, Portuguese	1000284	--
Language insert, bottom row, Spanish	1000278	--
Language insert, bottom row, Chinese	1024310	--
Language insert, bottom row, French	1022636	--
Language insert, top row, English	321-1000-00	--
Language insert, top row, Italian	1000283	--
Language insert, top row, Japanese	1000275	--
Language insert, top row, Portuguese	1000285	--
Language insert, top row, Spanish	1000279	--

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Language insert, top row, Chinese	1024309	--
Language insert, top row, French	1022635	--
LCD assembly, color, for original 10.4-in. display (with backlight inverter PCB)	1006359	--
LCD assembly, color, for Esprit 2nd-generation 10.4-in. display/Respironics V200	1019369	1019369
Lubricant, KRYTOX GPL 226	100-1012-00	100-1012-00
Main PCB	1034721	1034721
Manual, operator’s, English (CD)	1062476	1062476
Manual, operator’s, English (printed)	580-1000-01	1057983
Manual, Esprit Quick Reference, English	1002780	--
Manual, service, English	580-1000-02	580-1000-02
Mesh cup	1009121	1009121
MMI PCB	1026559	1026559
Motor controller PCB	1001341	1001341
Mounting plate, backup alarm	1000047	1000047
Muffler assembly	1006464	1006464
Muffler baffle assembly, English	1011052	1061308
Muffler baffle assembly, Italian	1011056	1061304
Muffler baffle assembly, Japanese	1011055	1061306
Muffler baffle assembly, Portuguese	1011054	1061307
Muffler baffle assembly, Spanish	1011053	1061305
Neonatal option field upgrade kit, English (Neonatal option requires a CPU with OTP 4.10 or greater)	1016851	1016851
NICO-Esprit interface (NICO) option field upgrade kit (NICO-Esprit interface and COM2 options cannot both be installed on a ventilator at the same time)	1022488	1022488
Nut, hex, M3 (Attaches blower motor control PCB, cooling coil fan, AC distribution panel)	520-1000-05	520-1000-05
Nut, hex, M3, with star washer, zinc-plated steel	520-1000-06	520-1000-06
Nut, hex, M4, with star washer (Attaches blower, blower shroud, 10.4-in. harness ground lug, rear air inlet assembly)	520-1000-07	520-1000-07
Nut, hex, M6-1.0 (Attaches ground lug)	520-1000-04	520-1000-04
O-ring, 2-011 (oxygen valve, solenoid 1)	500-1000-37	500-1000-37
O-ring, 2-012 (oxygen valve)	500-1000-24	500-1000-24
O-ring, 2-020 (oxygen valve, exhalation valve, flow sensors)	500-1000-14	500-1000-14
O-ring, 2-021 (exhalation valve, flow sensors, inspiratory module, air valve, heated filter assembly)	500-1000-13	500-1000-13
O-ring, 2-022 (exhalation valve outlet port, air valve)	500-1000-10	500-1000-10
O-ring, 2-023 (inspiratory module)	500-1000-11	500-1000-11

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
O-ring, 2-004 (inspiratory module)	500-1000-17	500-1000-17
O-ring, 60 durometer, silicone (safety valve)	1001384	1001384
O-ring, silicone (heated filter assembly) (filter side)	500-1000-12	500-1000-12
O-ring, size -010, Viton (O_2 transport kit)	1016395	1016395
Overlay, 10.4-in. GUI front panel	1006582	--
Overlay, keypad, English	--	1061196
Overlay, keypad, non-English	--	1061277
Overlay, power status LED, English	--	1061194
Overlay, power status LED, non-English	--	1061195
Oxygen cylinder kit	--	1060815
Oxygen regulator assembly	1001334	1001334
Oxygen sensor kit	1002541	1002541
Oxygen sensor, CE	1001454	1001454
Oxygen valve assembly	1012087	1012087
Oxygen water trap/inlet filter assembly	1001336	1001336
Patient circuit kit, adult disposable	1003698	1003698
Patient circuit kit, adult reusable	1003058	1003058
Patient circuit tubing, Smooth-Bor, 18-in. x 15mm	1003649	1003649
Patient circuit tubing, Smooth-Bor, 18-in. x 22mm	1003660	1003660
Patient circuit tubing, Smooth-Bor, 42-in. x 15mm	1003646	1003646
Patient circuit tubing, Smooth-Bor, 42-in. x 22mm	1003643	1003643
PCMCIA card/adapter kit, Trending option	1014293	1014293
Plate, coalescent filter (oxygen water trap)	261-1000-82	261-1000-82
Plate, deck, LX-200 cart	1001726	--
Poppet assembly (pressure relief valve)	1005999	1005999
Port, inspiratory (safety valve/pressure relief valve, air valve, vent manifold)	261-1001-45	261-1001-45
Port, inspiratory outlet	261-1000-52	261-1000-52
Port, oxygen inlet side	261-1001-25	261-1001-25
Post, LX-200 cart	1001739	--
Power cord, Australia/New Zealand	1002585	1002585
Power cord, Italy	1002589	1002589
Power cord, U.S.	1004981	1004981
Power supply assembly	1018246	1018246
Power supply exhaust port	261-1001-59	261-1001-59
Power supply shroud	1010780	1010780
Pressure relief valve kit	1006463	1006463

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Preventive maintenance kit, 12,500-hour	1001733	1001733
Preventive maintenance kit, annual	1034840	1034840
Respiratory Mechanics option field upgrade kit, English	1006600	--
Respiratory Mechanics option field upgrade kit. Italian	1017050	--
Respiratory Mechanics option field upgrade kit, Portuguese	1017051	--
Respiratory Mechanics option field upgrade kit, Spanish	1017052	--
Retainer spring, pressure relief valve	261-1000-50	261-1000-50
Retaining clip, bow-tie, 4-40 x ¼-in.	500-1000-63	500-1000-63
Retaining clip, bow-tie, 4-40 x ¼-in., steel	500-1000-64	500-1000-64
Retaining ring, 4-mm diameter	500-1000-02	500-1000-02
Rotary encoder, optical (Includes lockwasher and nut)	443-1000-00	1061283
RTV silicone, clear, per MIL A-46106	200-1000-04	200-1000-04
Safety valve kit	1006465	1006465
Screw, button head socket,¼-20 x 3/8 (Attaches oxygen water trap bracket, oxygen manifold bracket)	530-1000-61	530-1000-61
Screw, button head socket, M3 x 6 (Attaches exhalation valve, oxygen valve, display)	530-1000-20	530-1000-20
Screw, button head socket, M3 x 8 (Attaches AC distribution panel)	530-1000-58	530-1000-58
Screw, button head socket, M3 x 12 (Attaches vent port, elapsed time meter, AC distribution panel)	530-1000-59	530-1000-59
Screw, button head socket, M4 x 6, button head (Attaches top enclosure)	1000901	1000901
Screw, button head socket, M4 x 10 (Attaches enclosure brace, inspiratory module to front of ventilator, oxygen water trap bracket, power supply air inlet port)	530-1000-47	530-1000-47
Screw, button head socket, M4 x 12 (Attaches muffler baffle to bottom enclosure)	530-1000-33	530-1000-33
Screw, button head socket, M4 x 16 (Attaches oxygen water trap, backup battery strain relief)	530-1000-60	530-1000-60
Screw, button head socket, M5 x 10 (Attaches enclosure brace, lower bulkhead)	1000135	1000135
Screw, button head socket, M5 x 16 (short screws that attach side rails to top enclosure, bottom enclosure to top enclosure)	530-1000-62	530-1000-62
Screw, button head socket, M5 x 25 (long screws that attach side rails to top enclosure)	530-1000-56	530-1000-56
Screw, captive panel, M3 x 13	530-1000-48	530-1000-48
Screw, cheese head slotted, M3.5 x 10 (heat filter sleeve)	530-1000-41	530-1000-41
Screw, flat head, M2.2 x 6.5	1002507	1002507
Screw, flat head, M2.2 x 9.5 (Attaches alarm bracket, bottom enclosure)	1005864	1005864
Screw, flat head, M3 x 0.5-G x 12 (GUI tension latches)	1004124	1004124
Screw, flat head Phillips, M3 x 5 (Attaches muffler)	1001097	1001097

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Screw, flat head socket, M3 x 10 (Attaches oxygen sensor connector)	530-1000-28	530-1000-28
Screw, hex head, M5 x 12 (Attaches oxygen regulator)	530-1000-37	530-1000-37
Screw, jack, 4-40 x 0.250 (Attaches all DB-style connectors)	530-1000-57	530-1000-57
Screw, pan head Phillips, 4-40 x 0.125 (port covers)	1001206	1001206
Screw, pan head Phillips, M2 x 0.45 x 6 (GUI touch frame, 2nd-generation backlight inverter PCB)	1003466	1003466
Screw, pan head Phillips, M3 x 0.5 x 10 (Attaches circuit breaker cover)	1008011	1008011
Screw, pan head Phillips, M3 x 45 (Attaches power supply fan shroud)	1022461	1022461
Screw, pan head slotted, M2.5 x 4	530-1000-23	530-1000-23
Screw, pan head slotted, M3 x 60, (Attaches cooling coil and fan to bottom enclosure, attaches Esprit cart column to deck plate)	1001740	1001740
Screw, pan head slotted, M4 x 40 (Attaches rear air inlet assembly)	1000036	1000036
Screw, pan head slotted CRES, 4-40 x 3/16 (Attaches 9.5-in. GUI)	1003980	1003980
Screw, pressure relief valve retaining	261-1001-31	261-1001-31
Screw, set, inspiratory module	1010783	1010783
Screw, socket head cap, M3 x 5 (Attaches MMI PCB, AC distribution panel L-bracket, GUI LCD, valve gear covers)	530-1000-39	530-1000-39
Screw, socket head cap, M3 x 6 (Attaches inspiratory module exhaust port)	530-1000-00	530-1000-00
Screw, socket head cap, M3 x 8 (Attaches 10.4-in. GUI, GUI LCD bracket)	530-1000-14	530-1000-14
Screw, socket head cap, M3 x 10 (Attaches GUI LCD)	530-1000-02	530-1000-02
Screw, socket head cap, M3 x 16 (Attaches solenoid 1, three-station solenoid, inspiratory module, pressure relief valve poppet, 2nd-generation color display transition PCB)	530-1000-42	530-1000-42
Screw, socket head cap, M4 x 6 (Attaches air side inspiratory port, blower thermostat)	530-1000-04	530-1000-04
Screw, socket head cap, M4 x 8 (Attaches main PCB)	530-1000-11	530-1000-11
Screw, socket head cap, M4 x 10 (Attaches exhalation valve outlet port)	530-1000-03	530-1000-03
Screw, socket head cap, M4 x 12 (Attaches pressure relief valve slot screen, front bulkhead, GUI shield plate)	530-1000-07	530-1000-07
Screw, socket head cap, M4 x 20 (Attaches bumper feet)	530-1000-01	530-1000-01
Screw, socket head cap, M5 x 6 (Attaches power supply shroud, lithium battery retainer bracket)	530-1000-40	530-1000-40
Screw, socket head cap, M5 x 10 (Attaches air valve, original power supply shroud, front bulkhead, flow sensor clamps, side rails)	530-1000-29	530-1000-29
Screw, socket head cap, M5 x 12 (Attaches main PCB, power supply)	530-1000-19	530-1000-19
Screw, socket head cap, M5 x 50 (Attaches exhalation valve)	530-1000-53	530-1000-53
Screw, socket head cap, M5 x 60 (Attaches inspiratory module)	530-1000-21	530-1000-21
Screw, socket head cap, M5 x 77 (Attaches muffler to enclosure)	1014850	1014850
Screw, socket head cap, M5 x 90 (Attaches inspiratory module)	530-1000-54	530-1000-54

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Screw, socket set, 6-32 x 3/8 (intensity, volume knob set screw)	530-1000-50	530-1000-50
Sensor PCB	1001353	1001353
Service kit	1021670	--
Shield, AC filter	1002441	1002441
Shield, DC/DC converter PCB insulation	1005673	--
Shield, MMI PCB	1001427	1001427
Shield, sensor PCB	1004740	1004740
Shielding plate, 10.4-in. display	1003194	1061191
Shielding, clip-on, perpendicular	1000581	1000581
Shroud, blower	1010749	1010749
Shroud, card cage	261-1001-82	261-1001-82
Side rail, Respironics V200 cart	--	1061325
Side rail assembly, LX-200 cart (both sides, complete)	1006462	--
Side rail cap, left	261-1001-29	--
Side rail cap, right	261-1001-30	--
Solenoid valve assembly, SOL1 (crossover)	1011126	1011126
Solenoid valve assembly, three-station (updated) (Includes safety valve pilot solenoid, SOL2, exhalation pressure transducer solenoid, SOL3, and inspiratory pressure transducer solenoid, SOL4)	1009315	1009315
Spacer, 6 mm round x 20 mm L, aluminum (backup alarm plate)	1000035	1000035
Spacer, GUI, left bottom (9.5-in. display)	261-1000-74	--
Spacer, GUI, left top (9.5-in. display)	261-1001-38	--
Spacer, GUI, right	261-1000-73	261-1000-73
Spacer, hex, 5/16 (2nd-generation color display)	1018992	1018992
Spacer, silicone (PCMCIA port cover)	1014415	1014415
Spring, 3-wave, 22-lb. load (pressure relief valve)	1001210	1001210
Spring, compression, 22-coil, 0. 0.635 diameter wire (pressure relief valve adjustment nut)	1001270	1001270
Standoff, enclosure	261-1000-91	261-1000-91
Standoff, round, M5, 7-mm threaded (heated filter door thumbscrew)	1003528	1003528
Stepper motor encoder cover	261-1001-81	261-1001-81
Strap, E-cylinder bracket, 100-mm OD, Respironics V200	--	1056368
Switch, on/off (1st-generation Esprit only)	440-1000-00	440-1000-00
Switch, on/off (2nd-generation Esprit and Respironics V200)	1050831	1050831
Switch, pressure 27-40 PSIG	500-1000-48	500-1000-48
Tape, EMI/RFI, ½-in. wide, type 1345	1000370	1000370
Tape, EMI/RFI, 1-in. wide, type 1345	1000582	1000582

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Tape, thread-sealing, ¼-in. wide	200-1000-02	200-1000-02
Tension catch	1023168	--
Tension catch, strike	1023167	--
Test lung	1021671	1021671
Tie wrap, 3.1-in.	500-1000-66	500-1000-66
Tie wrap, 8-in.	500-1000-62	500-1000-62
Tie wrap, 11.4-in.	500-1000-65	500-1000-65
Thermostat (blower)	1002495	1002495
Timer, 12-60 VDC system, 100,000 hours	1000291	1000291
Top assembly, Respironics V200 cart	--	1061312
Touch frame, infrared, 10.4-in. display	1006460	1006460
Transition PCB, Esprit 2nd-generation 10.4-in display/Respironics V200	1018752	1018752
Trending option field upgrade kit, English	1013446	1013446
Tube, corrugated (cooling coil to air valve)	1000060	1000060
Tube, corrugated (inspiratory exhaust to tee fitting)	1000015	1000015
Tube, corrugated, silicone, 90-degree, 15 cm (water collection vial system)	1016101	1016101
Tubing, 1/16-in. ID, 1/8-in. OD (transducers)[a]	364-1000-07	364-1000-07
Tubing, 1/8-in. ID, ¼-in. OD, Tygon (inspiratory module, filter heater assembly, muffler screws)*	364-1000-03	364-1000-03
Tubing, 1/8-in. OD, 0.093 ID, nylon (solenoid 1 to solenoid 2)*	364-1000-08	364-1000-08
Tubing, ¼-in. ID, split-loom flexible (wire protection sheath)*	1002822	1002822
Tubing, 3/8-in. ID, split-loom flexible (wire protection sheath)*	1002824	1002824
Tubing, 5/8-in. ID x 1/8-in. wall, natural, silicone (vent manifold)*	364-1000-14	364-1000-14
Tubing, ¾-in. ID x 1/8-in. wall, natural, silicone (blower outlet, air flow sensor)*	364-1000-11	364-1000-11
Tubing, ¾-in. ID, split-loom flexible (wire protection sheath)*	1002823	1002823
VGA controller PCB	1001345	1001345
Washer, 0.070-in. x 0.235-in. x 0.031-in. THK, nylon (GUI touch frame)	1005675	1005675
Washer, 0.133 ID x 0.220 OD x 0.030 THK (inspiratory module)	550-1000-20	550-1000-20
Washer, color-coded (ground lug), green/yellow	550-1000-10	550-1000-10
Washer, flat, 0.130 ID x 0.375 OD x 0.012 THK (top enclosure)	1000910	1000910
Washer, flat, 0.145 ID x 0.500 OD x 0.030 THK (AC distribution panel)	550-1000-15	550-1000-15
Washer, flat, 0.168 ID x 0.500 OD x 0.010 THK (front bulkhead)	550-1000-21	550-1000-21
Washer, flat, for #10 screw	1002951	1002951
Washer, flat, M3, 7-mm OD (blower motor controller PCB, AC distribution panel, GUI LCD, 2nd-generation color display transition PCB)	550-1000-02	550-1000-02

Table 12-2: Complete Repair Parts List (Continued)

Description	Esprit Part Number	Respironics V200 Part Number
Washer, flat, M4, 9-mm OD (power supply air inlet port, enclosure brace, inspiratory module at front of ventilator, heated filter door, muffler baffle, GUI shield plate)	550-1000-11	550-1000-11
Washer, flat, M4, 12.7-mm OD, 4.5 ID (bumper feet)	550-1000-12	550-1000-12
Washer, flat, M5, 10-mm OD (lower bulkhead, enclosure brace, side rails, with four bottom enclosure screws)	550-1000-00	550-1000-00
Washer, flat, M6, DIN 125 (ground lug, GUI knob spacer)	550-1000-08	550-1000-08
Washer, lock, 4-40 (valve or gear covers, all DB-style connectors)	550-1000-23	550-1000-23
Washer, lock, M3 (cooling coil, fan, AC distribution panel, 10.4-in. GUI)	550-1000-14	550-1000-14
Washer, lock, M4 (enclosure brace, GUI shield plate, front bulkhead)	550-1000-17	550-1000-17
Washer, lock, M5 (used with all enclosure screws)	550-1000-24	550-1000-24
Washer, lock, M6 (ground lug)	550-1000-09	550-1000-09
Washer, muffler mounting (Attaches muffler to enclosure)	1014851	1014851
Washer, shoulder, #6 (ground lug, MMI PCB)	550-1000-26	550-1000-26
Washer, split-ring, M3	550-1000-18	550-1000-18
Water collection vial system	1006241	1006241
Water trap	1003648	1003648
Wire, neutral, blue, 6-in. (Install to allow humidifier AC receptacle rotation)	1012131	1012131
Wye connector, reusable	1003070	1003070

a Bulk part. Sold in 10-ft increments.

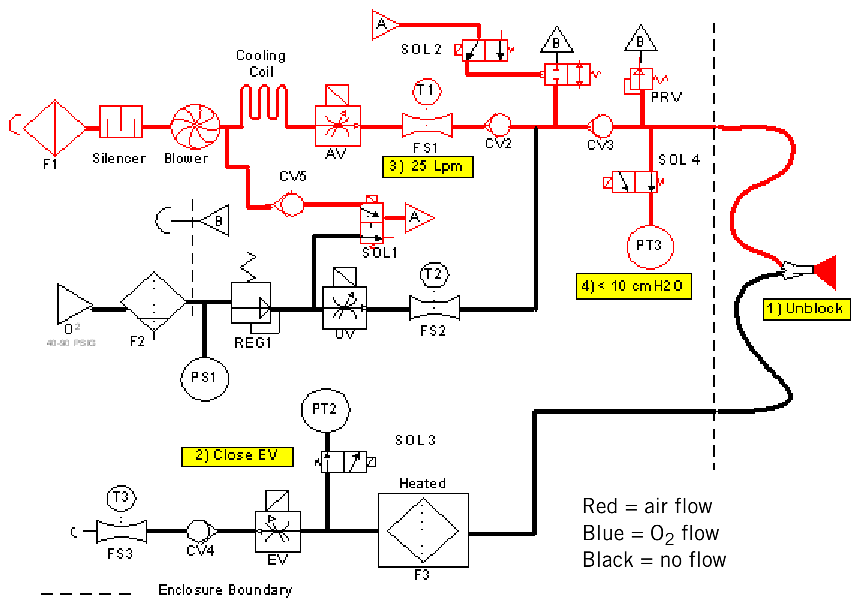
Appendix A Pneumatic Schematics for EST

This appendix illustrates the tests within extended self test (EST).

A.1 Block Patient Wye (Test 1, Step 2)

The purpose of this step is to verify that the patient is not connected.

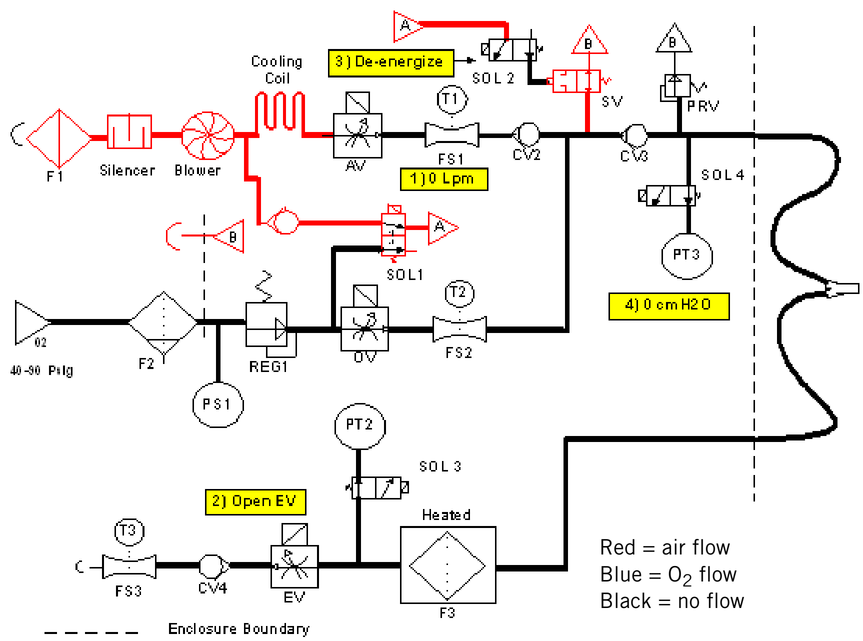
Diagnostic code **3152** could occur if a neonatal circuit is in use.



A.2 Block Patient Wye (Test 1, Step 3)

The purpose of this step is to relieve residual pressure in the system, and is a transparent continuation from step 2.

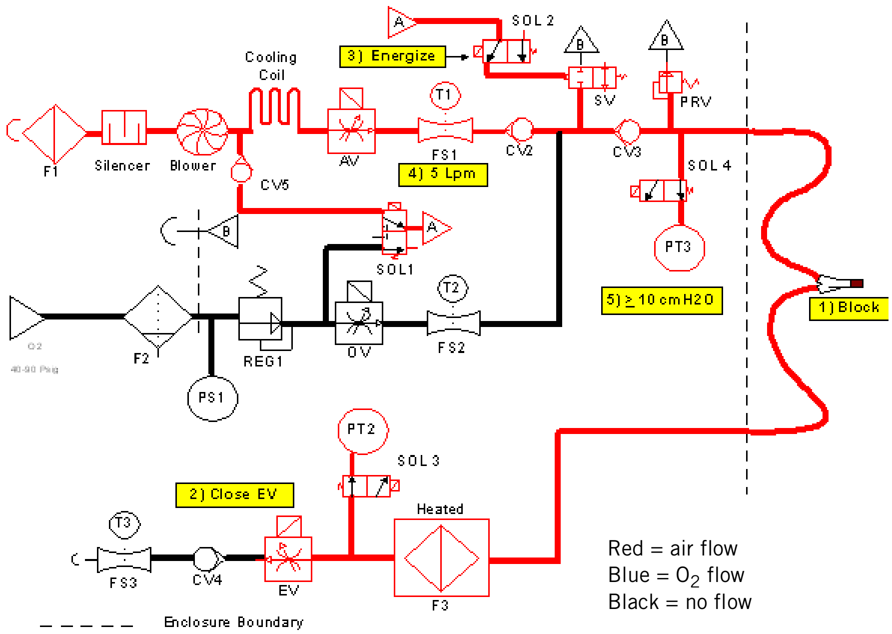
Diagnostic code **3152** could occur if neonatal circuit is in use and the Neonatal Option is not installed, or if Neonatal has not been selected at the start of EST.



A.3 Block Patient Wye (Test 1, Step 4)

The purpose of this step is to verify that the wye is blocked.

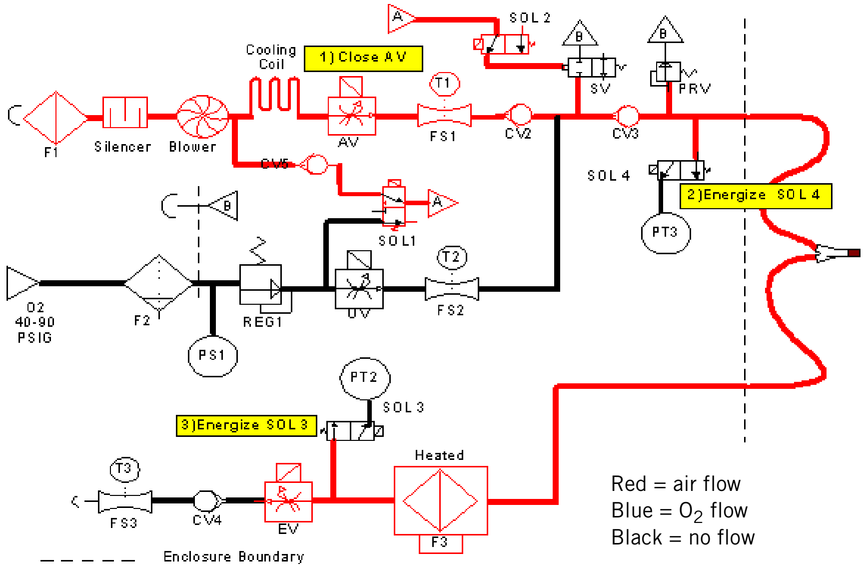
Diagnostic code 3131 indicates that the ventilator cannot pressurize the circuit.



A.4 Block Patient Wye (Test 1, Step 5)

This step energizes inhalation and exhalation solenoids to autozero the inhalation and exhalation pressure transducers at ambient pressure. This step averages eight readings, which must be within 0.8 cmH_2O of each other.

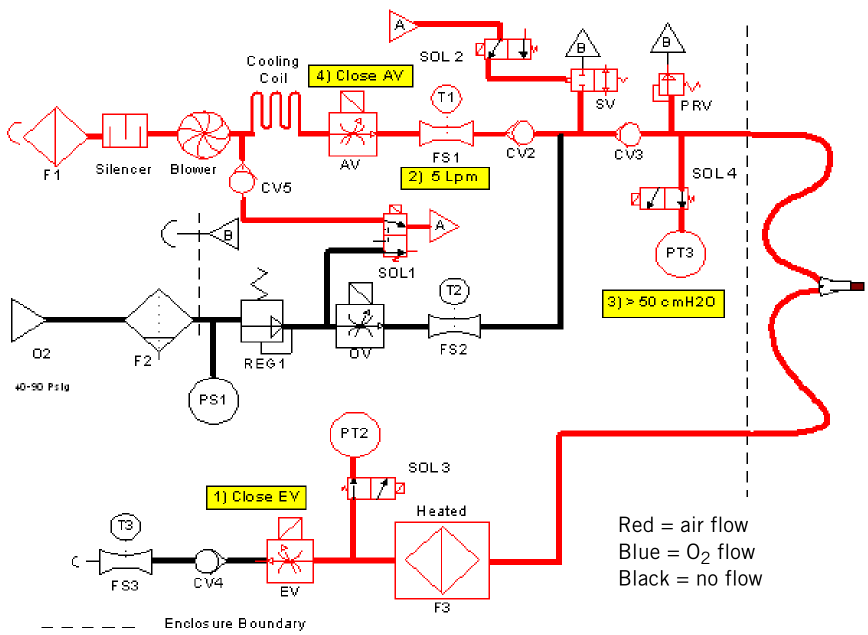
Diagnostic code **3156** indicates an inhalation pressure transducer (PT3) autozero failure. Diagnostic code **3157** indicates an exhalation pressure transducer (PT2) autozero failure.



A.5 Safety Valve (Test 2, Step 1)

This step charges the circuit to verify that the system is closed.

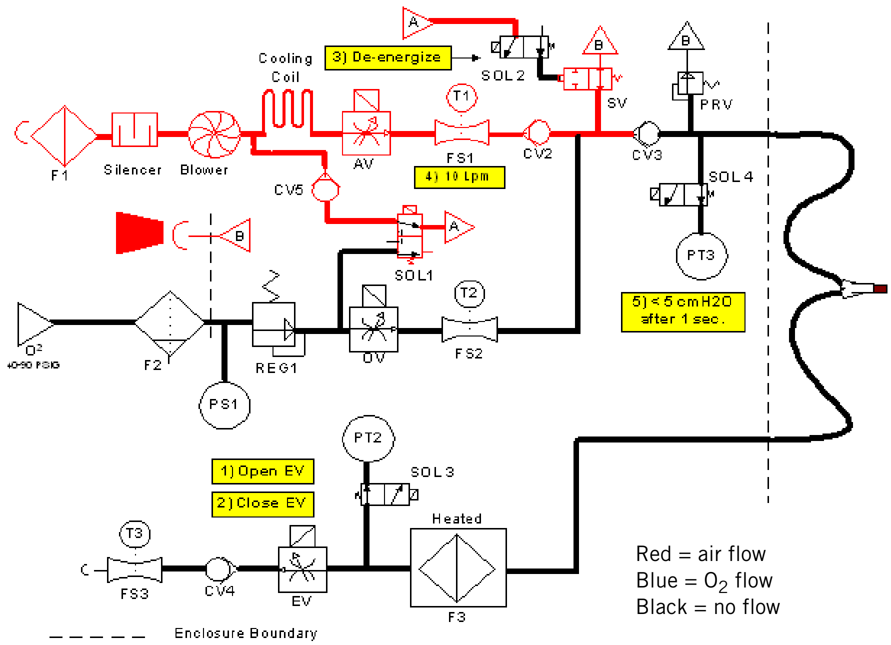
Diagnostic code **3106** occurs if the ventilator cannot pressurize the system to 50 cmH_2O.



A.6 Safety Valve (Test 2, Step 2)

This step de-energizes safety valve pilot solenoid (SOL2) to verify that the safety valve opens.

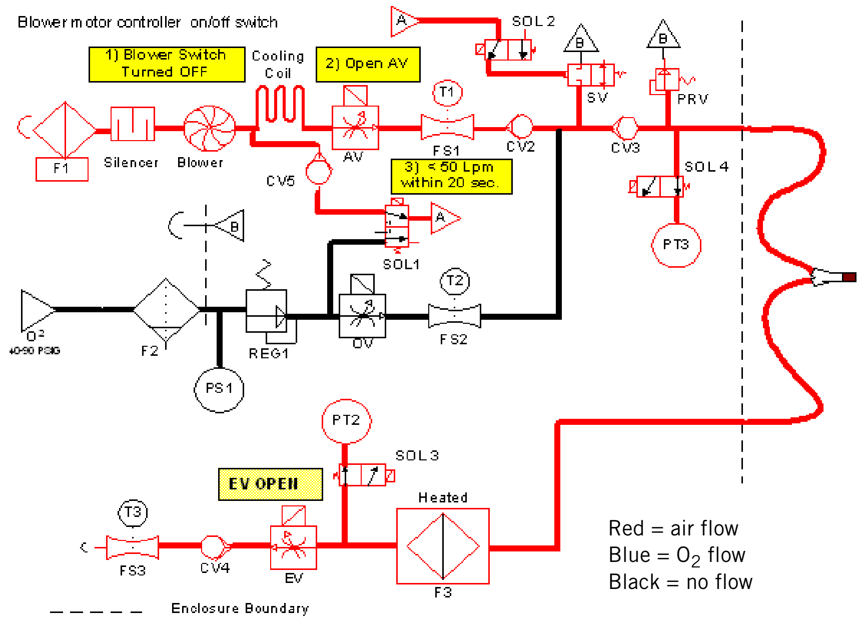
Diagnostic code **3130** indicates that the safety valve did not open.



A.7 Blower (Test 3, Step 1)

This step turns off the blower switch on the blower controller PCB to verify that the blower stops when the switch is turned off.

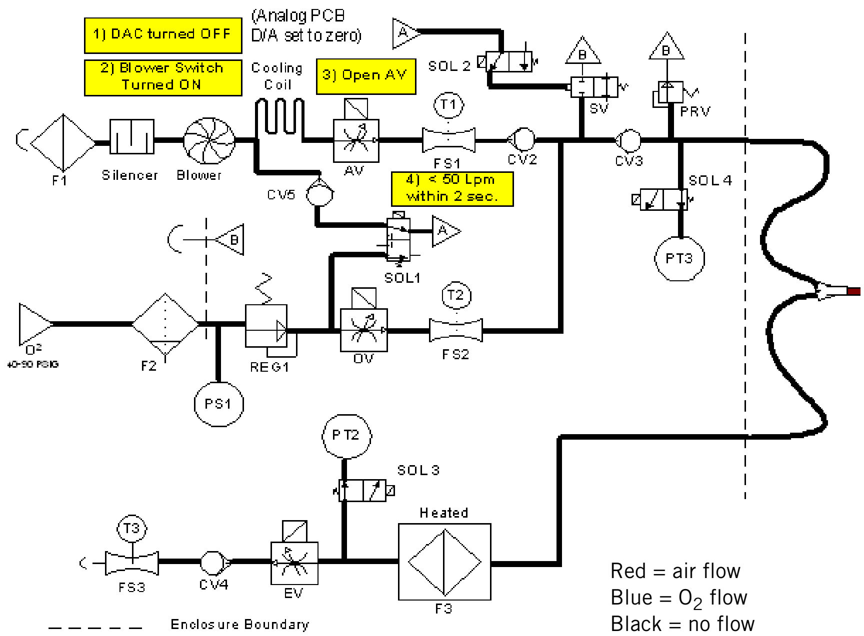
Diagnostic code **3118** occurs if the blower does not stop.



A.8 Blower (Test 3, Step 2)

This step turns the blower switch back on, and the digital to analog converter (DAC) on the analog PCB off, to verify that the blower stays off.

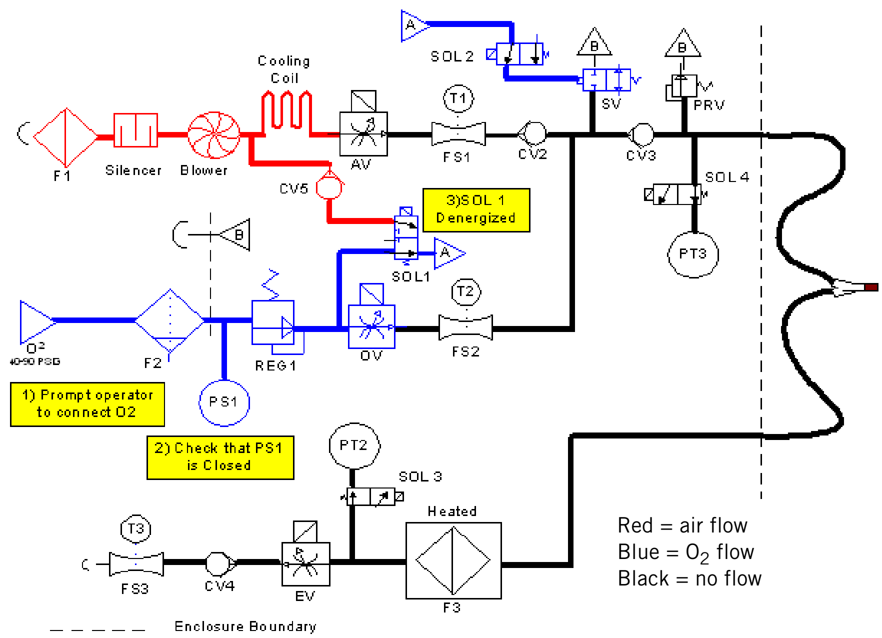
Diagnostic code **3119** indicates a blower DAC failure on the analog PCB.



A.9 Oxygen Supply (Test 4, Step 1)

This step prompts the operator to connect oxygen to check the function of the oxygen pressure switch (PS1).

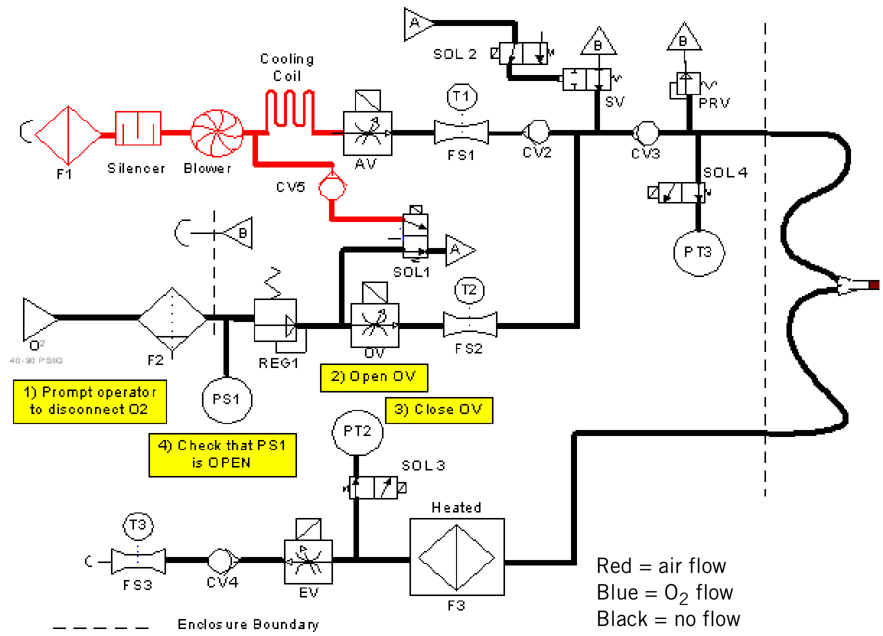
Diagnostic code **3111** indicates that the PS1 is open. This can occur if the PS1 connector on the sensor PCB is faulty.



A.10 Oxygen Supply (Test 4, Step 2)

This step prompts the operator to disconnect oxygen to verify that the oxygen pressure switch (PS1) opens.

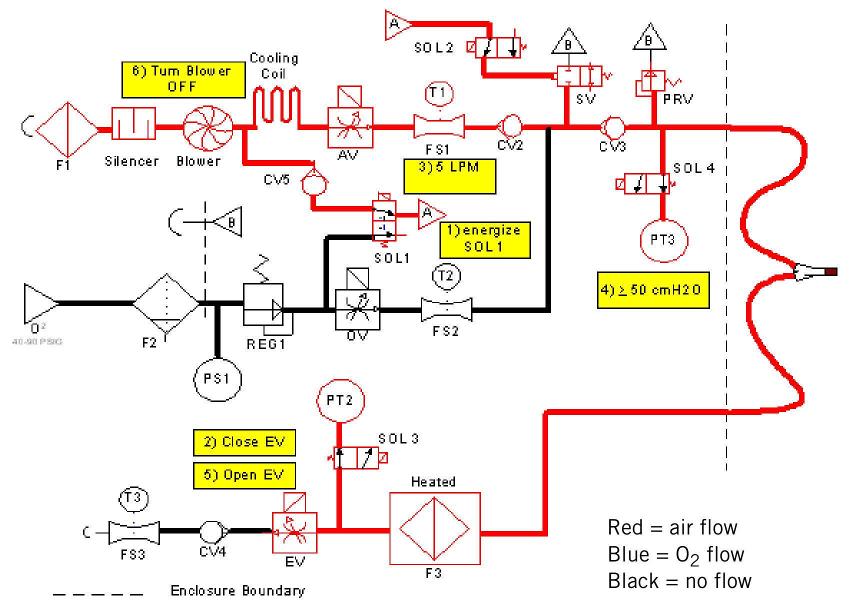
Diagnostic code **3112** indicates that PS1 is closed. This can occur if oxygen is not connected, or if the PS1 connection or the sensor PCB is faulty.



A.11 Crossover Circuit (Test 5, Step 1)

This step pressurizes the circuit with air (oxygen is disconnected) to verify that the crossover solenoid operates properly when energized.

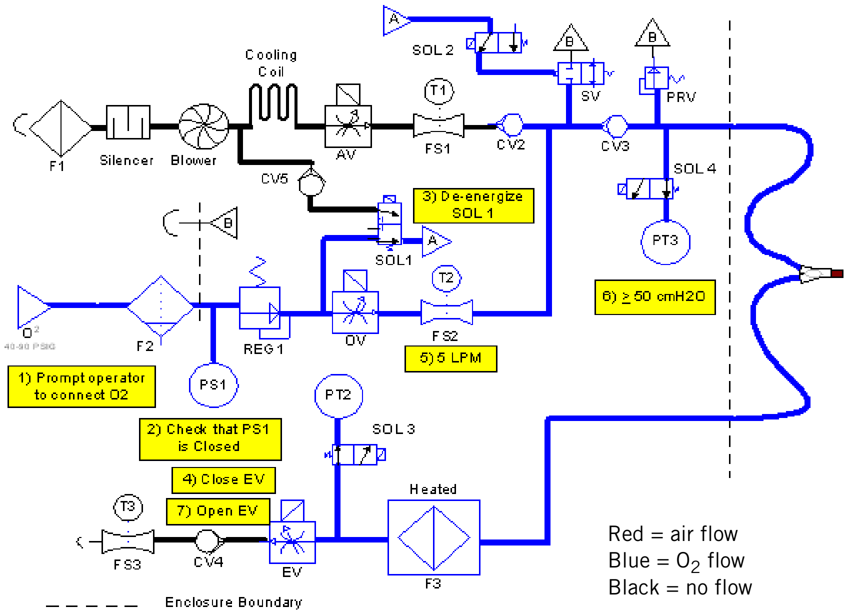
Diagnostic code **3112** occurs if oxygen is not disconnected. Diagnostic code **3117** indicates a crossover circuit fault. Diagnostic code **3119** occurs if the blower does not turn off.



A.12 Crossover Circuit (Test 5, Step 2)

This step pressurizes the circuit with oxygen to verify that the crossover solenoid (SOL1) operates properly when de-energized.

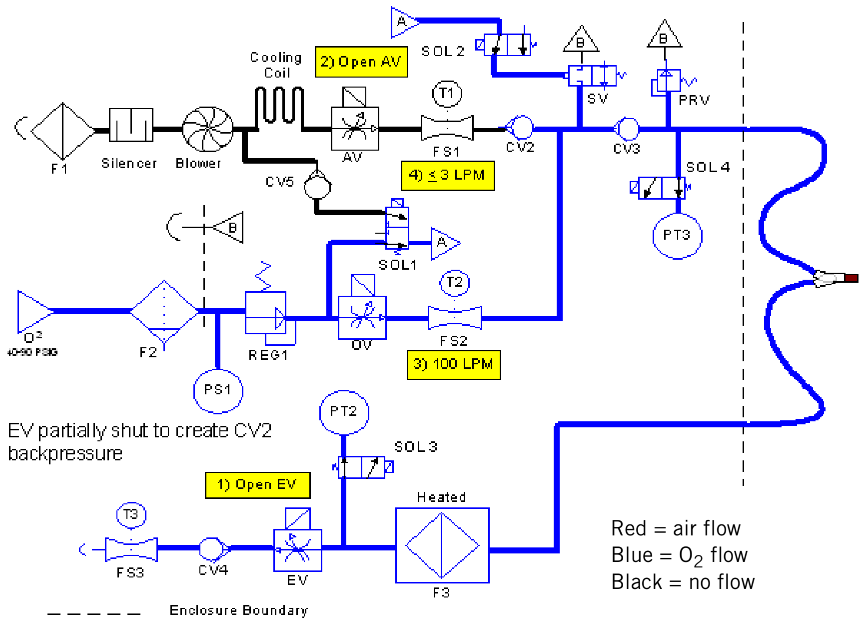
Diagnostic code **3117** indicates a probable SOL1 failure.



A.13 Crossover Circuit (Test 5, Step 3)

This step opens the blower valve and pressurizes the circuit with oxygen to verify that the air system check valve (CV2) functions properly.

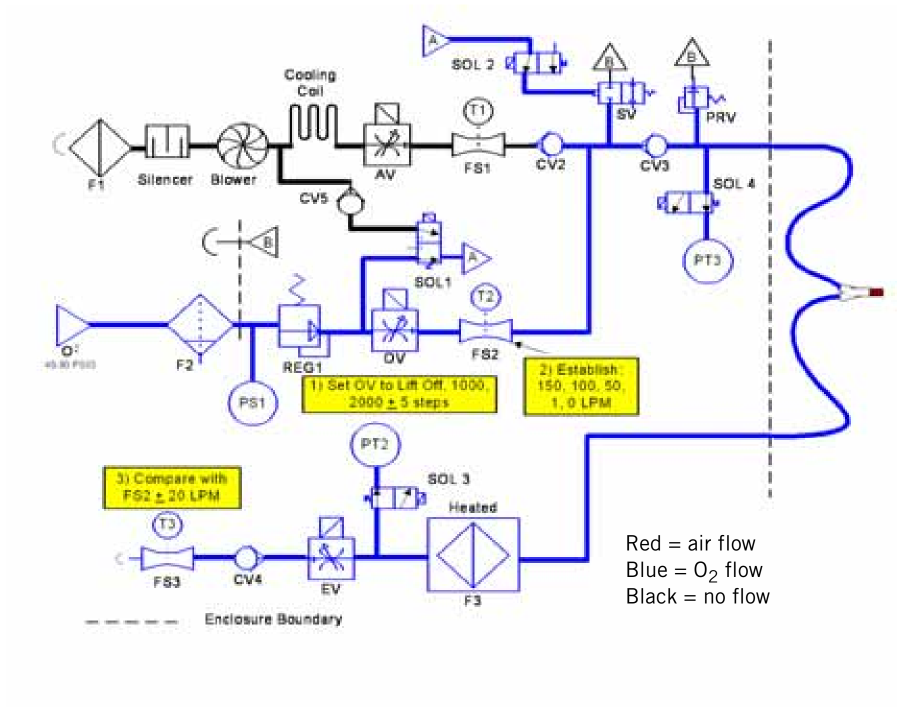
Diagnostic code **3109** indicates a CV2 leak.



A.14 Oxygen Delivery (Test 6, Step 1)

This step sets specific oxygen valve positions and oxygen flows to verify the correct oxygen valve control and the accuracy of oxygen and exhalation flow sensor readings.

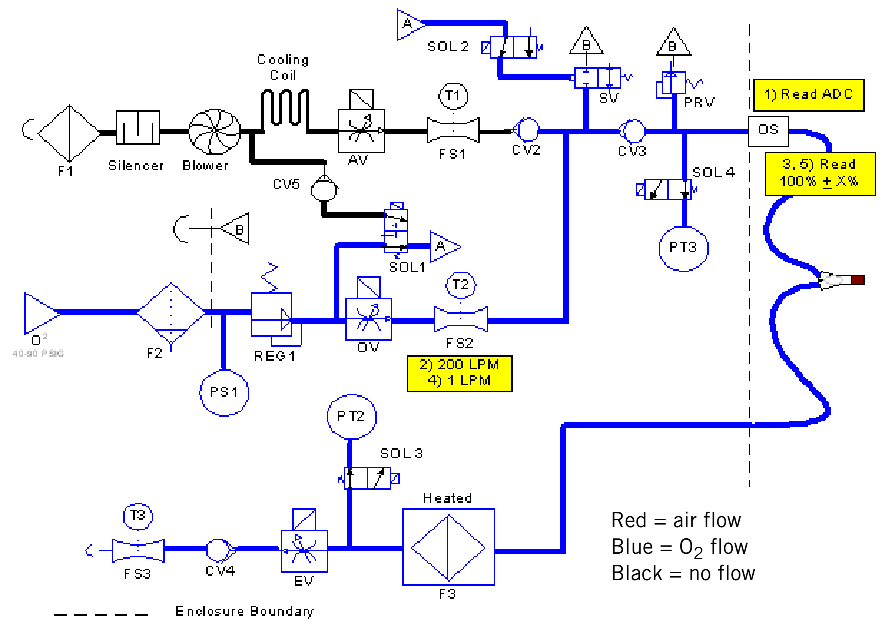
Diagnostic codes **3102**, **3104**, and **3126** indicate that oxygen flow rates are out of range. Diagnostic codes **3146**, **3147**, and **3148** indicate that the oxygen valve stepper motor positions are out of range.



A.15 Oxygen Sensor (Test 7, Step 1)

This step establishes 100% oxygen at 200 LPMfor one second, and 1 LPM for two minutes, to calibrate the oxygen sensor.

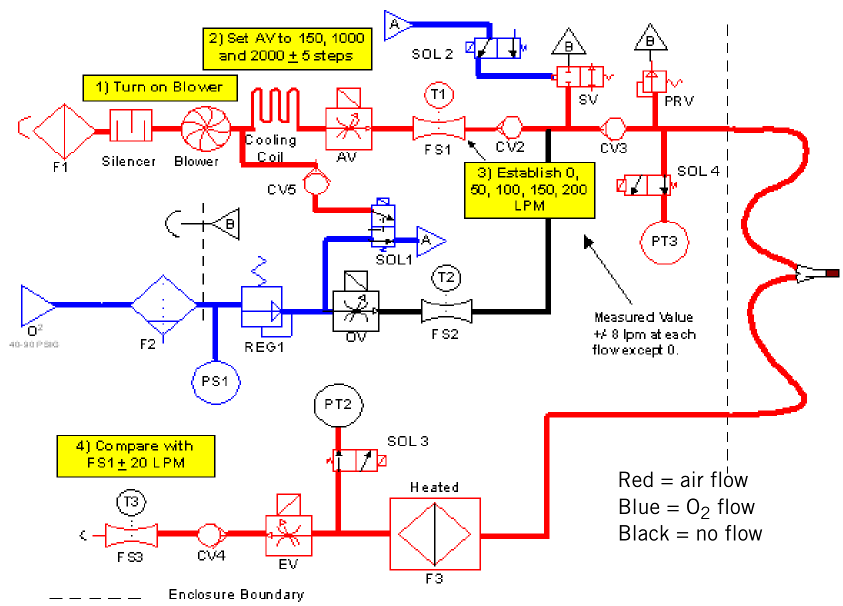
Diagnostic code **3113** indicates a bad oxygen sensor or oxygen sensor cable. *The ventilator must pass EST following oxygen sensor replacement.*



A.16 Air Delivery (Test 8, Step 1)

This step sets specific air valve positions and air flowsto verify correct air valve control and accuracy of air and exhalation flow sensor readings.

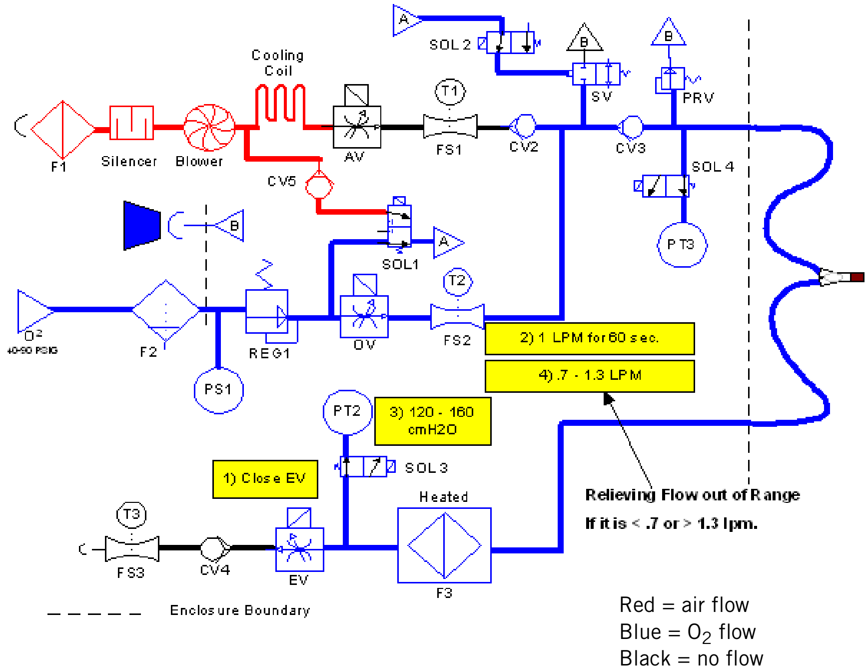
Diagnostic code **3103** indicates that air flow rates are out of range. Diagnostic code **3125** indicates that the air and flow sensor difference is out of range. Diagnostic codes **3143**, **3144**, and **3145** indicate that the air valve stepper motor position is out of range.



A.17 Pressure Relief Valve (Test 9, Step 1)

This step closes the exhalation valve (EV) and establishes oxygen flow to verify that the pressure relief valve (PRV) functions properly.

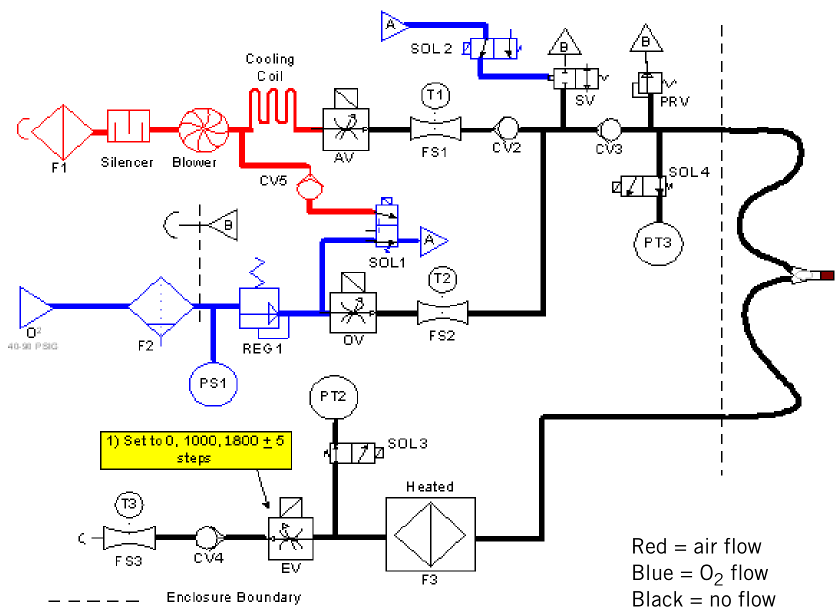
Diagnostic code **3120** indicates that the PRV cracking pressure is too high (>170 cmH_2O). Diagnostic code **3121** indicates that the PRV cracking pressure is unstable (>20 cmH_2O difference between three readings). Diagnostic code **3122** indicates that the PRV cracking pressure is out of range (>160 cmH_2O or <120 cmH_2O).



A.18 Exhalation Valve (Test 10, Step 1)

This step commands the exhalation valve to specific positions to verify accurate control.

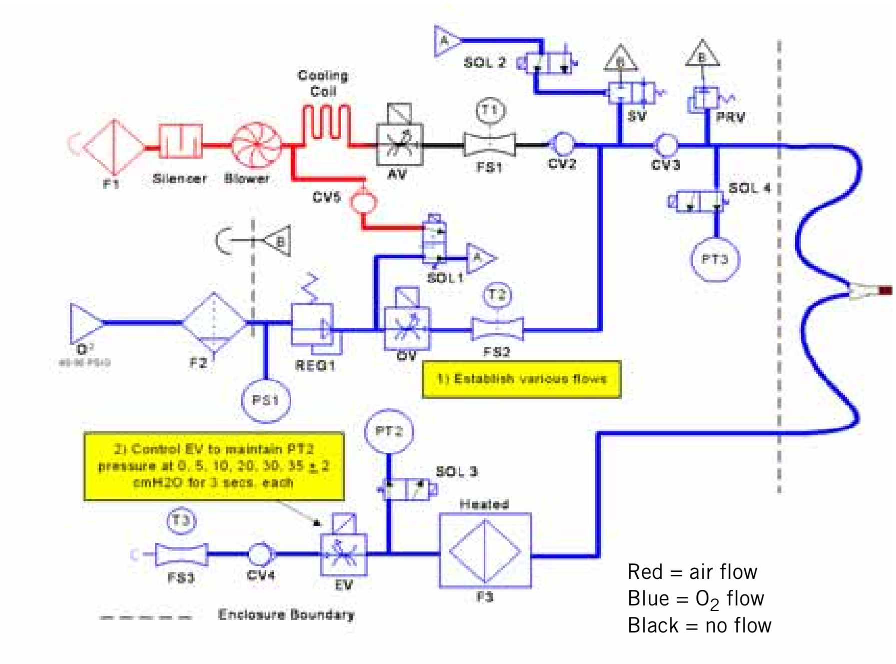
Diagnostic code **3149** indicates that the exhalation valve stepper motor open position is out of range. Diagnostic code **3150** indicates that the exhalation valve stepper motor midpoint position is out of range. Diagnostic code **3151** indicates that the exhalation valve stepper motor closed position is out of range.



A.19 Exhalation Valve (Test 10, Step 2)

This step sets various circuit pressure levels to verify that the exhalation valve can control PEEP accurately.

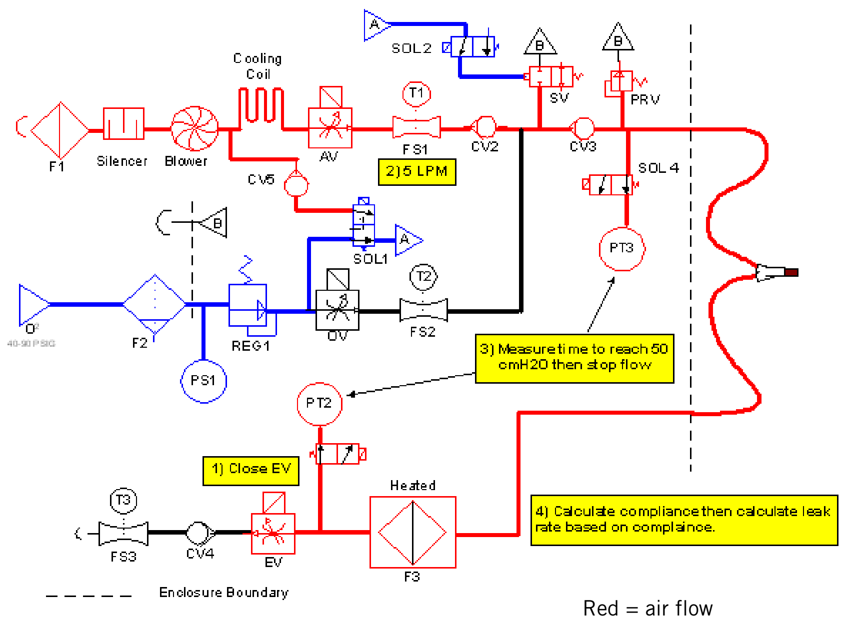
Diagnostic code 3108 indicates that exhalation pressure is out of range. *This can be due to incorrect altitude setting, damaged exhalation filter, nonstandard circuit size, or faulty exhalation valve/stepper motor controller PCB.*



A.20 Patient Circuit (Test 11, Step 1)

This step pressurizes the circuit with air to measure tubing compliance and leak rate, and includes several time-dependent sub-tests.

Diagnostic code **3106** indicates a leak in the circuit that prevents the circuit from being pressurized. Diagnostic code **3107** occurs if a leak rate is excessive. Diagnostic code **3125** occurs if PT2 and PT3 disagree by >3 cmH_2O. Diagnostic code **3128** occurs if calculated compliance is <0.5 or >9.0 mL/cmH_2O. Diagnostic code **3129** indicates a leak in the circuit that is out of range.

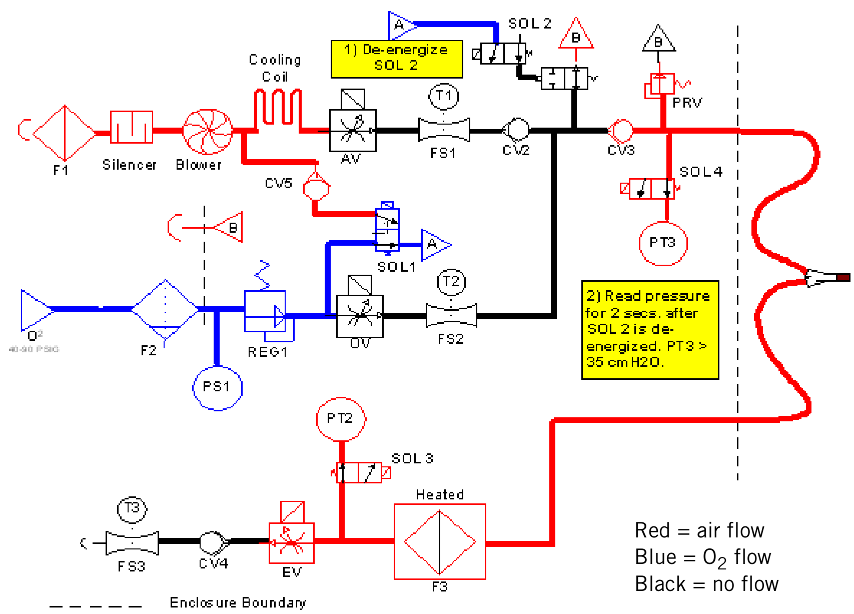


Red = air flow
Blue = O_2 flow
Black = no flow

A.21 Patient Circuit (Test 11, Step 2)

This step opens the safety valve by de-energizing SOL2 to verify that the inspiratory non-rebreathing check valve (CV3) is operating correctly.

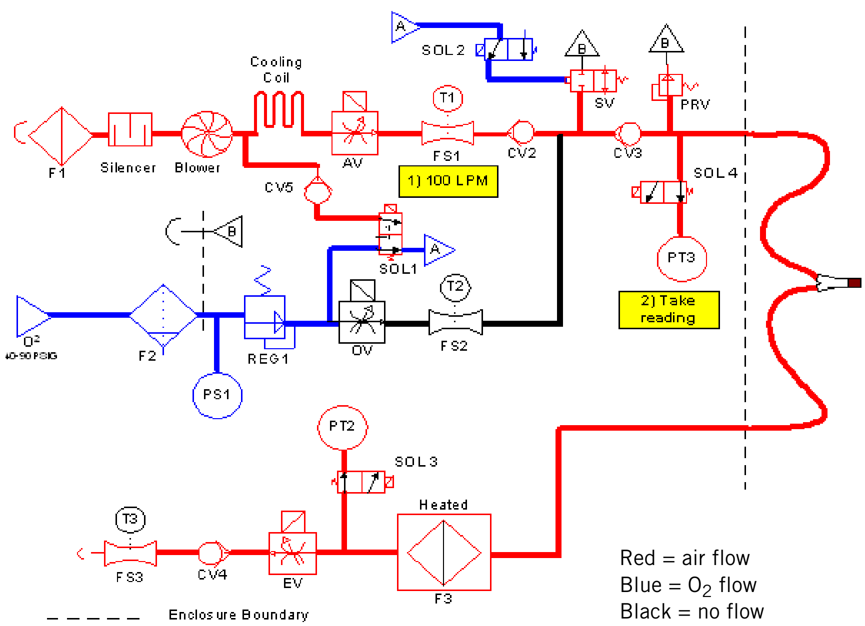
Diagnostic code **3110** indicates a CV3 leak (possibly due to CV3 orientation or a loose outlet port set screw).



A.22 Heated Filter (Test 12, Step 1)

This step establishes 100 LPM air flow and measures pressure at the inspiratory pressure transducer (PT3) to check the back pressure of all components downstream of the inspiratory pressure transducer.

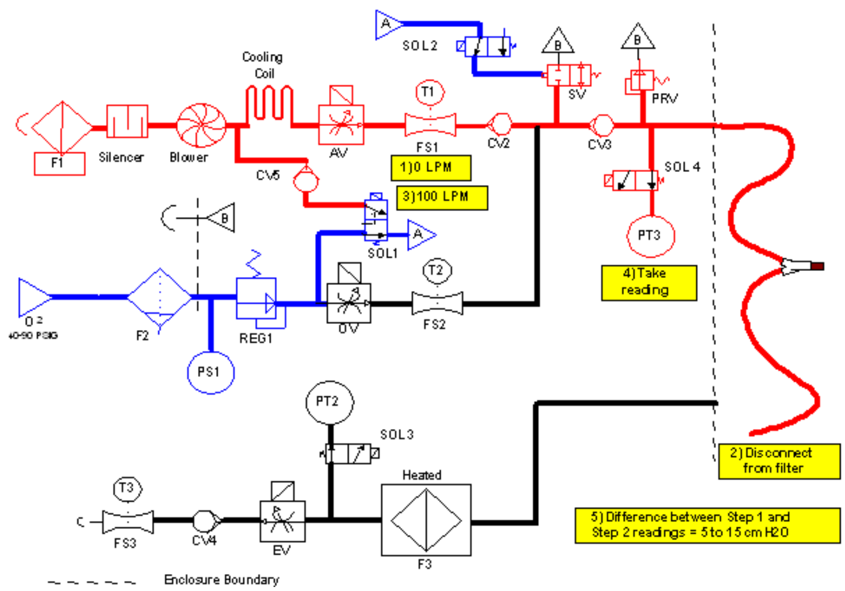
Diagnostic code **3105** indicates that exhalation flow is out of range(<90 LPM or >110 LPM).



A.23 Heated Filter (Test 12, Step 2)

Once the operator acknowledges that the exhalation limb is disconnected, the system establishes 100 LPM air flow, and again measures pressure at PT3. The second reading is subtracted from the first to calculate the back pressure, which must be between 5 and 15 cmH_2O.

Diagnostic code 3127 indicates an out of range back pressure (<5 cmH_2O or >15 cmH_2O difference from reading with exhalation limb attached).



Red = air flow
Blue = O_2 flow
Black = no flow

(This page is intentionally blank.)

Appendix B Field Communications

Save field communications in this section.

(This page is intentionally blank.)

Appendix C. Respi-Link

Save Respi-Link information in this section.

(This page is intentionally blank.)

Index

(This page is intentionally blank.)