RESPIRONICS®

BiPAP Vision Ventilatory Support System

SERVICE MANUAL

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Chapter 1. Introduction and Intended Use

The BiPAP Vision Ventilatory Support System (BiPAP Vision) is a microprocessor-controlled, positive pressure ventilatory assist system. The BiPAP Vision (Figure 1-1) user interface includes multi-function keys, real time graphic displays, and integral patient and system alarms.

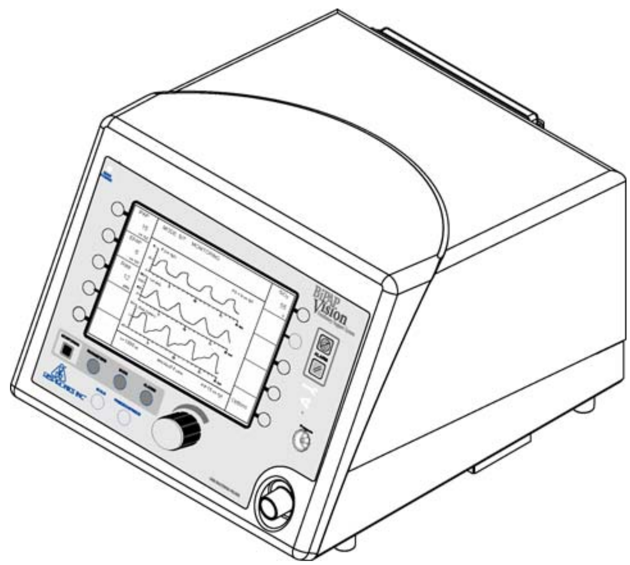

Figure 1-1: BiPAP Vision

The BiPAP Vision features a centrifugal blower to generate airflow and internal oxygen module, allowing single or combined gas therapy. The system operates in these modes:

- continuous positive airway pressure (CPAP) mode
- spontaneous/timed pressure support (S/T) mode
- proportional assist ventilation/timed (PAV/T) mode (international models only).

Integrated safety and self-diagnostic features check all system functions at start-up and during operation. Visual and/or audible indicators report any errors.

The BiPAP Vision regulates pressure by monitoring proximal airway pressure and adjusting flows accordingly to ensure that the proximal pressure equals the set pressure.

1.1 Service Notice

Read this manual thoroughly prior to performing service or maintenance on the BiPAP Vision. 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 BiPAP Vision.

1.2 Tools and Equipment

Table 1-1 lists the recommended tools, test equipment, and materials required to service and maintain the BiPAP Vision.

Table 1-1: Service Tools and Equipment

Description	**Manufacturer and model**
Common hand tools: • Flat-blade screwdrivers, small (long shaft) and medium • Phillips screwdriver, medium • Nut drivers, 1/4-in., 5/16-in., 11/32-in., and 7/16-in. • 1/4-in. wrench • Needle-nose pliers, medium	Local supplier
Antistatic workstation, including grounded mat and wrist strap	Local supplier
Electrical safety analyzer • Earth resistance: Range 0 to 19.99 ohms. Resolution 0.01 ohms. Accuracy ± 5% ± 1 digit. • Leakage current: Range 0 to 19.99 uA. Resolution 1 uA. Accuracy ± 1% ± 1 digit (2.5 to 1 kHz); ± 1 digit (1 kHz to 1 MHz	• Dale Model LT544D • Any commercially available electrical safety analyzer that meets these specifications
Digital manometer • Range of at least 0 to 40 cmH_2O • Accuracy of at least ± 1.0% of reading.	• Certifier FA Plus Ventilator Gas Analyzer with high-flow module and oxygen sensor kit (P/N 1040311) • Certifier FA Plus with high- and low-flow modules and oxygen sensor kit (P/N 1040312) • Any commercially available digital manometer that meets these specifications.

Table 1-1: Service Tools and Equipment

Description	Manufacturer and model
Flowmeter • Range of at least 0 to 150 L/min • Accuracy of at least ± 1.0% of reading.	• Certifier FA Plus with high-flow module and oxygen sensor kit (P/N 1040311) • Certifier FA Plus with high- and low-flow modules and oxygen sensor kit (P/N 1040312) • Any commercially available flowmeter that meets these specifications.
Digital multimeter • 3 1/2-digit readout	• Fluke 87 digital multimeter • Any commercially available digital multimeter that meets these specifications
Service laptop computer • Windows operating system • HyperTerminal or equivalent software	Any commercially available laptop computer that meets these specifications
Oxygen analyzer • Range 0.0 to 100 $\%O_2$. • Display resolution 0.1 $\%O_2$. • Accuracy ± 2% of full scale.	• Certifier FA Plus with high-flow module and oxygen sensor kit (P/N 1040311) • Certifier FA Plus with high- and low-flow modules and oxygen sensor kit (P/N 1040312) • Any commercially available oxygen analyzer that meets these specifications
Oxygen tank, medical grade oxygen, and regulator	Local supplier
Mechanical test lung • Lung capacity of at least 1.2 L	• Ingmar Medical QuickLung test lung • Michigan Instruments Model 1601 or 4600 test lung • Any commercially available test lung that meets these specifications
BiPAP Vision service kit (P/N 1021276)	• Adjustable flow valve (P/N 1006120) • Cable, D9 M/F (P/N 600075) • Extraction tool (P/N 1006874) • Oxygen enrichment kit (P/N 312710) • RS-232 harness, MC, J3 to back panel (P/N 1004699) • Silicone tube, 5-in. x 1/8-in. ID (x3) • Tee fitting, 1/8 in. OD • Test cable (P/N 582161) • Test cable for s/n 106000 and above (P/N 1004823) • Test orifice, 0.25 in.(P/N 332353) • Whisper Swivel II assembly (P/N 332113)

Table 1-1: Service Tools and Equipment

Description	**Manufacturer and model**
Respironics test cable(s)	BiPAP Vision s/n 105999 and under: • P/N 582161 (no upgrade) • P/Ns 1004823 and P/N 1004699 (ribbon cable) (upgraded, new PC/MC boards installed) BiPAP Vision s/n 106000 and higher: • P/N 1004823 NOTE: These test cables are included in BiPAP Vision service kit P/N 1021276.
Pressure tubing, 1/8-in. ID • 6 in. • 6 ft. • Other miscellaneous lengths as required	Local supplier
Loctite® 222 liquid threadlock	Local supplier
Tubing, smooth inner lumen • 6-ft. length • 18-in. length • Other miscellaneous lengths as required	• P/N 301016 • P/N 100060
Service flow valve	Respironics P/N 1037985 NOTE: This item can be used instead of the clamping-type variable flow resistor P/N 1002160.
Isopropyl alcohol	Local supplier
Cleaner such as *Fantastik®* or *409®*	Local supplier
Cleaning cloth	Local supplier
Bacteria filter, 22 mm ID x 22 mm OD	Local supplier
Mild detergent	Local supplier

1.3 Technical Support

Respironics is committed to customer satisfaction. Contact Respironics with questions or for technical support:

U.S. and Canada:
Phone: 1-800-345-6443
Fax: 1-800-866-0245

International:
Phone: 1-724-387-4000
Fax: 1-724-387-5012

E-Mail: service@respironics.com
For Customer Service and Product Support contact:

Online: http://www.respironics.com

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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 device.

NOTE: Important information concerning the device.

2.1 Warnings

- Do not use the BiPAP Vision in the presence of a flammable anesthetic mixture with air, oxygen, or nitrous oxide.
- Oxygen supports combustion. Do not use oxygen while smoking or in the presence of an open flame.
- The BiPAP Vision does not provide an oxygen sensor to monitor oxygen concentrations delivered to the patient circuit. Use oximetry to monitor the use of oxygen with the BiPAP Vision.
- If the *Vent Inop* (wrench) icon lights, see Chapter 6 of this manual for troubleshooting information.
- Never attach oxygen tubing or any positive pressure source to the pressure port on the front panel of the BiPAP Vision.
- Do not attempt to use the RS-232 connector on the back panel of the device to obtain repair information during operation on a patient.
- To ensure personal safety and correct device performance, only qualified technicians are to perform repairs to the BiPAP Vision. Contact Respironics for service training and authorization information.
- High voltages are present inside this device. To avoid electrical shock, disconnect the electrical supply before attempting any repairs on the device.
- For continued protection against risk of fire, replace fuses with those of the same type and rating only.
- To avoid electric shock, unplug the BiPAP Vision before cleaning.

2.2 Cautions

- Do not allow any liquid to enter the cabinet or the inlet filter during cleaning.
- If the BiPAP Vision is exposed to temperatures near the specified limits for operating, storage, or transport temperatures, allow the device to acclimate to room temperature before use.
- Position the unit on its base for proper operation.
- Always use the BiPAP Vision with an inlet filter installed.
- Do not exceed 100 psig oxygen supply pressure when using the oxygen module.
- Electronic components used in this device are subject to electrostatic discharge (ESD) damage. Perform all repairs to this device in an antistatic, ESD-protected environment.
- Use only Respironics-approved repair parts.

2.3 Notes

- Refer to the BiPAP Vision *Clinical Manual* for guidelines on applications and operation, and for a complete list of operational warnings, cautions, and notes.
- This device contains a rechargeable nickel-cadmium (NiCAD) battery which is used by the alarms in the event of a power failure.
- A non-rechargeable lithium ion (Li-ion) battery on the MC board powers the real-time clock (RTC) circuit when the device is off.
- Batteries must be replaced by an authorized service technician using Respironics-approved batteries.
- Dispose of batteries according to manufacturer's instructions and institutional procedures. Follow all applicable regulations regarding environmental protection.
- These boards are generally abbreviated as follows:

  Display control (DC) board
  Main control (MC) board
  Pressure control (PC) board.

  However, these abbreviations refer *specifically* to older boards in non-upgraded units (built s/n 105999 and below):

  Display control subsystem (DCS) board
  Main control subsystem (MCS) board
  Pressure airflow subsystem (PAS) board.
- Additional warnings, cautions, and notes appear in this manual.

Chapter 3. Theory of Operation

The BiPAP Vision is a microprocessor-controlled, positive pressure ventilatory assist system. The system's integral air intake filter draws in ambient air which is then pressurized by the system's centrifugal blower assembly. In the blower discharge airway, the in-line flow restrictor (ILFR) valve and pressure regulation valve (PRV) regulate total flow and pressure from the blower. The oxygen module adds a controlled source of supplemental oxygen, up to 100%, to the patient.

To ensure that the device delivers gas according to settings, the pressure control (PC) board continuously monitors airflow module (AFM) readings for total gas flow, temperature, generated pressure, and patient circuit pressure. The PC board transmits process data to the main control (MC) board, which then provides overall control of the BiPAP Vision and sends instructions to the PC board regarding required ILFR-PRV valve stem positions and blower speed.

The unique design and operation of the device makes it suitable for mask applications. Designed with the BiPAP Auto-Trak Sensitivity feature that automatically adjusts to changing circuit conditions, the device can ensure optimum patient-ventilator synchronicity despite changes in breathing patterns and circuit leaks. (Refer to the BiPAP Vision *Clinical Manual*.)

A liquid crystal display (LCD) screen is mounted on the front enclosure. The LCD and the display control (DC) board provide the primary user interface to the BiPAP Vision. The user interface displays data, provides controls, and visual and audible alarm indicators. The user uses the touch pad and rotary encoder to provide input, and the display confirms the input. Display information varies according to the state of the ventilator and operations being performed.

The BiPAP Vision incorporates these safety features and self-diagnostic systems:

- The device automatically checks internal system functions at startup and periodically throughout normal operation.
- Audible and visual alarms occur in the event of principal subsystem failures.
- Audible and visual patient alarms occur during normal operation.

Ventilator settings are saved in case of AC power loss. The ventilator software revision determines how operation resumes following an AC power loss:

- Software versions 11.0 - 11.11, 12.0 - 12.7, and 13.0 - 13.7: If AC power is lost for approximately 10 seconds or less and the power switch remains ON, the ventilator performs a system self test and returns to normal operation using the same settings that were in effect before the AC power loss.
  If the AC power loss is longer than approximately 10 seconds and the power switch remains ON, the ventilator performs a system self test, displays the Exhalation Port Test screen, and does not resume ventilation.
- Software versions 11.12, 12.8, 13.8 and higher: If AC power is lost for any length of time and the power switch remains ON, the ventilator resumes operation that was in effect at the time of the AC power loss.
- For all software versions, if the power switch is turned OFF after AC power is lost, when AC power is restored and the power switch is turned ON: the ventilator performs the system self test, displays the Exhalation Port Test screen, and does not automatically resume ventilation.

Table 3-1 summarizes the major BiPAP Vision subsystems.

Table 3-1: BiPAP Vision Subsystems

Subsystem	Function
Power supply subsystem (PSS)	Provides the bulk supply DC voltage to the BiPAP Vision subsystems.
Main control (MC) board	Performs all control, data acquisition, and calculations required for user-selected parameters. The MC board also performs the start-up test and reports all errors. (Abbreviated as *MCS board* when referring specifically to older boards in non-upgraded units built s/n 105999 and below.)
Pressure control (PC) board	Controls the blower and valves to generate and regulate system pressure. The PC board senses outlet pressure and patient pressure and regulates outlet pressure to the patient circuit. (Abbreviated as *PAS board* when referring specifically to older boards in non-upgraded units built s/n 105999 and below.)
Display control (DC) board	Evaluates user inputs from the touch pad and passes valid parameters to the MC board. The DC board receives display data from the MC board. The DC board also has its own internal functions, whose results are reported to the MC board. (Abbreviated as *DCS board* when referring specifically to older boards in non-upgraded units built s/n 105999 and below.)
Airflow module (AFM)	Includes the mass airflow sensor in the airstream, and provides an airflow measurement interface to the PC board, allowing the PC board to measure total flow, temperature, and system pressure.
In-line flow restrictor (ILFR)	Regulates the total flow from the blower discharge.
Pressure regulation valve (PRV)	Opens during exhalation to allow patient flow exhaust.
Oxygen module (OM)	Regulates the oxygen released into the air from the blower according to the set oxygen concentration level.

Figure 3-1 shows the BiPAP Vision block diagram.

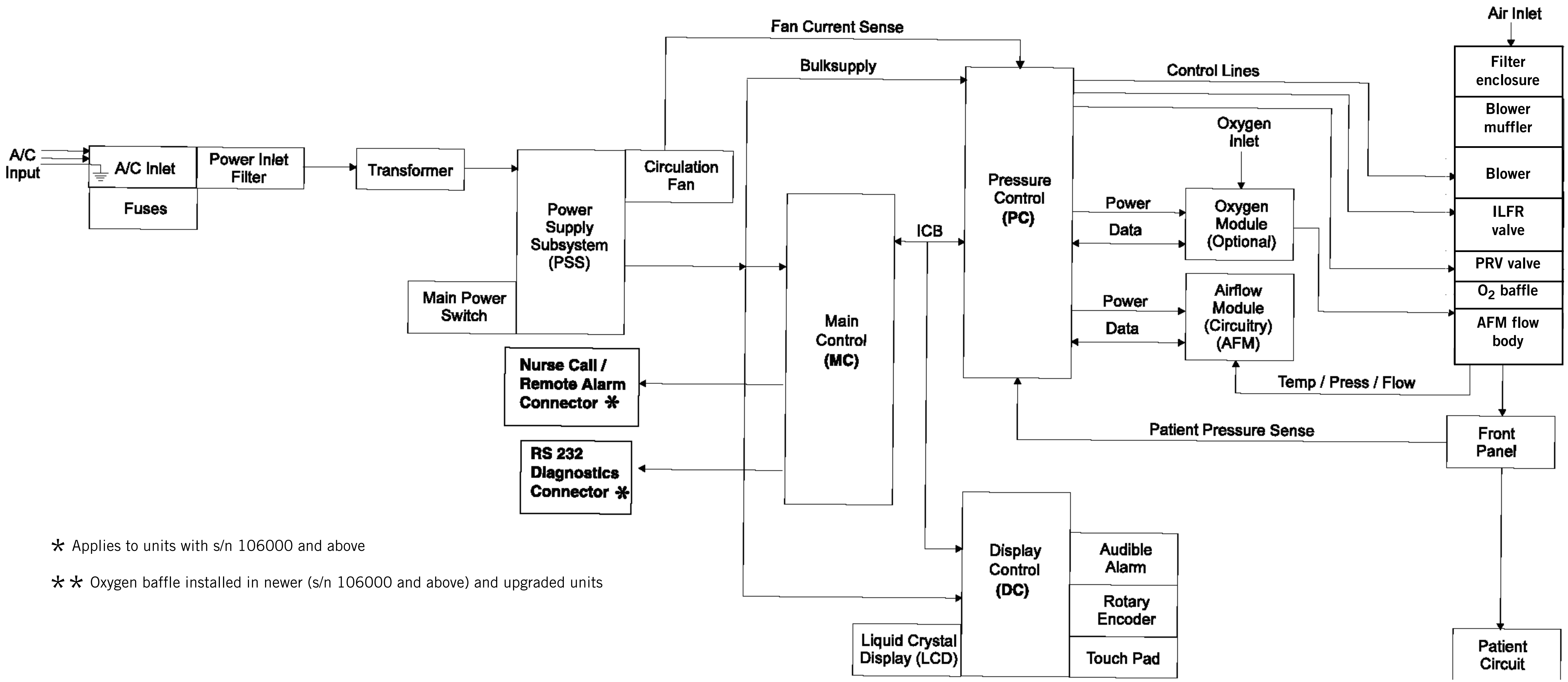

Figure 3-1: BiPAP Vision Block Diagram

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Figure 3-2 shows the BiPAP Vision pneumatic block diagram.

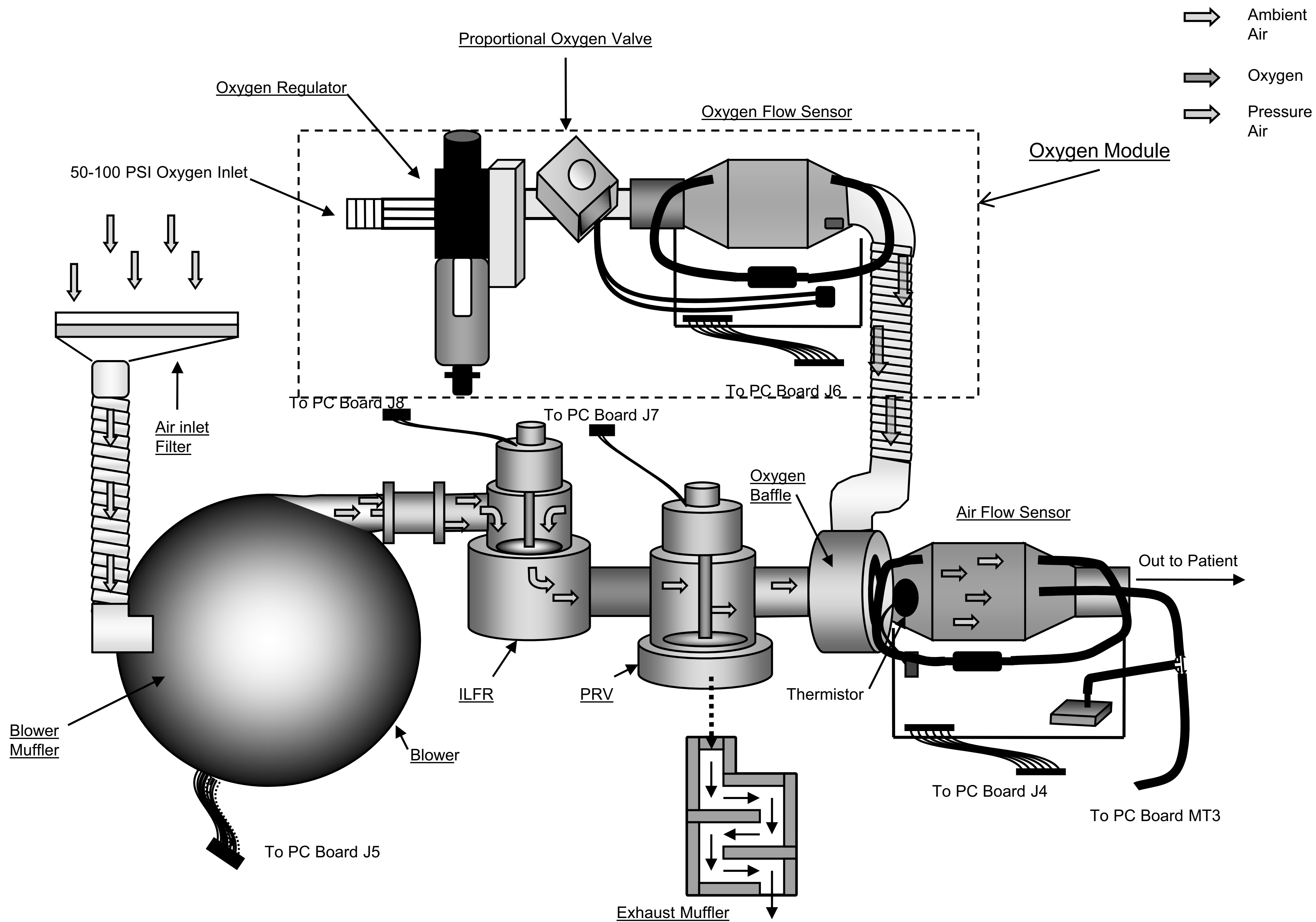

Figure 3-2: BiPAP Vision Pneumatic Block Diagram

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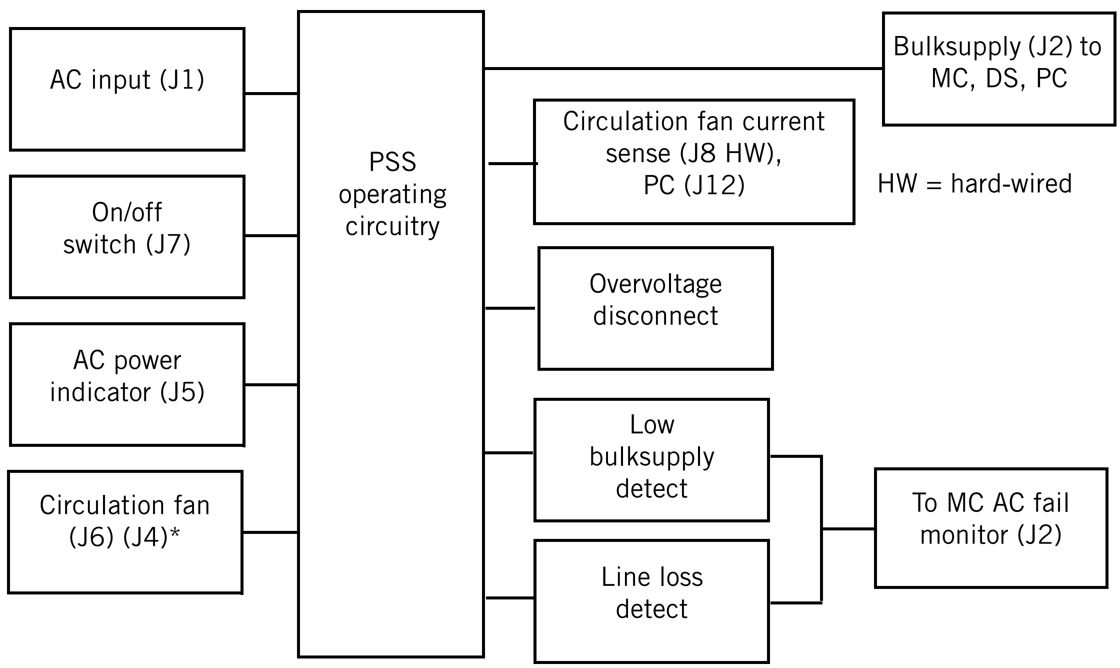
3.1 PSS Board

The PSS board (Figure 3-3) supplies the MC, PC, and DC boards with the correct DC supply voltage. Safety features designed into the circuitry include an overvoltage disconnect, low voltage supply detect, and line loss detect. Other features include power on indicator voltage, circulation fan power, and an on/off switch connection.



* For fans with older style 2-pin connector. Note that current version of PSS board still includes the J4 header.

Figure 3-3: PSS Block Diagram

3.1.1 Input Range

The BiPAP Vision can operate with an input of 100, 120, 230, or 240 VAC (±10%) depending on the model.

3.1.2 DC Supply

The output DC supply is fused at 30 amps (A) and delivers between 20.6 VDC and 35 VDC with a maximum ripple of 1 Vpp (peak-to-peak voltage) to the MC, PC, and DC boards.

3.1.3 Overvoltage Disconnect

The overvoltage disconnect removes the DC supply output when it exceeds 36 VDC and reconnects the DC supply output when the level returns to an acceptable value.

3.1.4 AC Fail Detection

The MC board monitors the level of DC supply voltage and the AC voltage output from the transformer supply winding to determine if an AC fail condition exists.

- Low DC supply detect: if the DC supply voltage drops to 19.38 VDC or lower (nominal), an AC fail condition is triggered.
- Line loss detect: the AC voltage output from the transformer supply winding is monitored for a loss-of cycle condition. Both legs of the winding are input to the monitoring circuitry. Whenever AC is lost, the AC fail signal is activated.

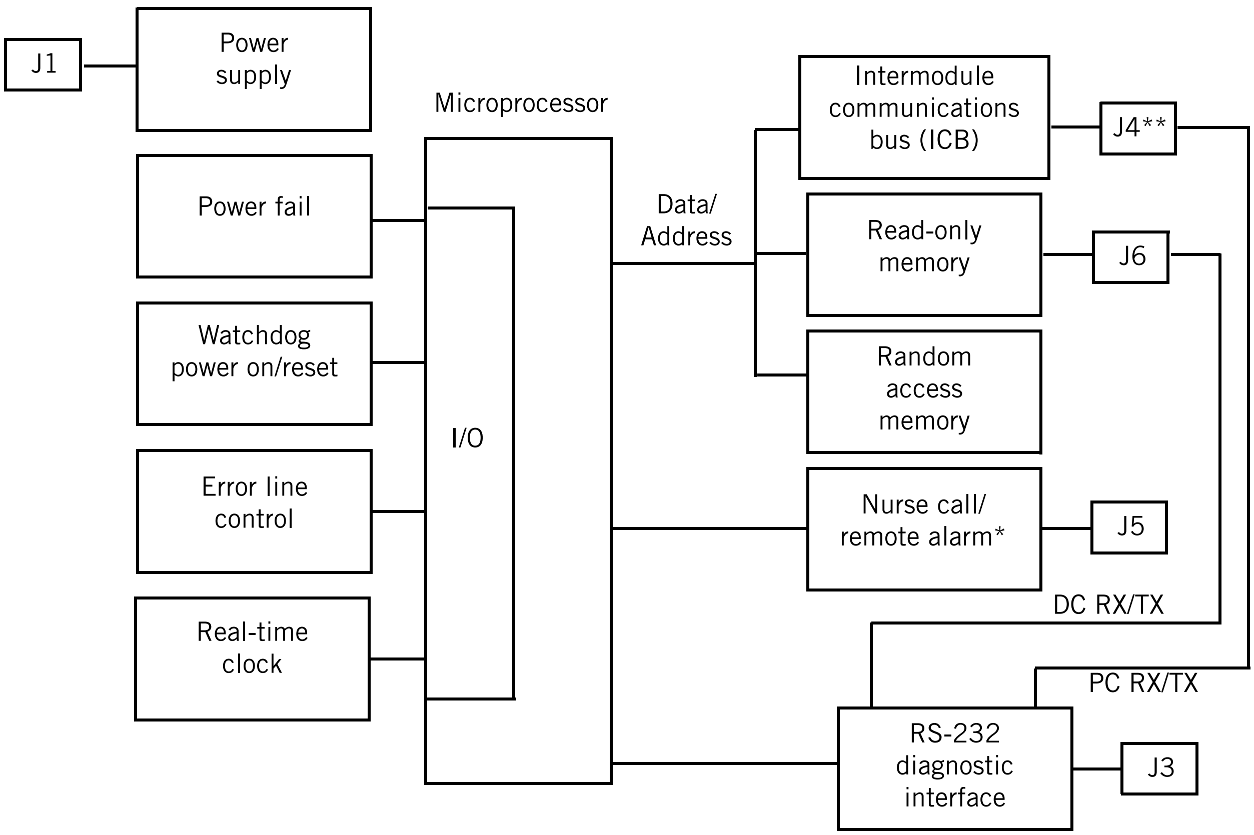
3.1.5 Outputs

The PSS module also includes the following:

- Front panel AC power on indicator voltage (J5).
- Circulation fan power (J6) or (J4) * (J4 for use with older style fan connectors).
- On / Off switch (state of switch high-low signal sent through J2 pin 6 to the MC board).
- Circulation fan current sense information (hard-wired at J8) connects to (J12) on the PC board.

3.2 MC Board

The microcontroller-based MC board (Figure 3-4) provides overall system control. The MC board monitors the activity of all the other system modules and provides commands to these modules based on user and system input. The MC board also acts as the bus controller for all subsystem communications using the intermodule communications bus (ICB).



* For units built s/n 106000 and above.

** J4 on units built s/n 106000 and above, J2 on non-upgraded units built s/n 105999 and below.

Figure 3-4: MC Board Block Diagram

NOTE: The main control board is generally abbreviated as the *MC board*. When referring specifically to older boards in non-upgraded units (built s/n 105999 and below), it is called the *main control subsystem (MCS) board*.

3.2.1 Power Circuitry

Input protection: the power supply is protected by a switch that increases its resistance in case of an overcurrent condition. The switch automatically resets when the overcurrent condition is corrected. A transient voltage suppressor protects the power supply against power spikes.

Power fail: software monitors power fail signals, and notifies the microcontroller if those signals become active. When the circuit detects that power is applied, it clears the power fail signal.

3.2.2 Error LED

The microcontroller turns on an error LED to indicate certain failure conditions.

3.2.3 Real-Time Clock Circuit

The real-time clock circuit includes a systole oscillator and a timekeeper chip. The timekeeper chip contains a clock/calendar and static RAM, and communicates with the microcontroller using a serial peripheral interface. The real-time clock provides seconds, minutes, hours, day, date, month, and year information.

Backup battery: a 3-V lithium battery supplies operating voltage to the real-time clock during the power down state. A diode prevents the +5 V source from charging the battery, and a resistor protects the circuit from inadvertent high discharge or charge current. Another diode at the +5 V source blocks battery voltage from other MC circuitry. Static RAM supplies power to the backup battery circuit at all times. The backup battery does not recharge.

- For MCS boards built s/n 105999 and below, the backup battery (P/N 1001988) is soldered to B1 on the MCS board.
- For MC boards built s/n 106000 and above, the backup battery (P/N 1006005) is snap-fitted to U3 on the MC board.

Removing the battery from the MC board erases the operational hours, which must then be reprogrammed (section 7.3 describes how to reprogram operational hours). Backup battery monitor: an open collector comparator circuit monitors backup battery voltage. If that voltage drops below a reference signal, the comparator output goes low. A resistor provides hysteresis on the comparator, and a signal is sent to the microcontroller to indicate that battery backup voltage is functional.

3.2.4 Watchdog and Power On Reset Circuit

The microcontroller generates pulses that toggle the watchdog timer circuit when the system is running. If watchdog circuit is not toggled within a 70-ms period, the microcontroller resets. The microcontroller monitors watchdog status, and clears the reset when it receives a watchdog timer reset signal. The system does not shut down in case of a watchdog timeout.

The power on reset circuit monitors the logic supply voltage through a voltage divider circuit. A separate 1.3-V threshold detector for this power fail warning. If a low supply voltage level is detected, the microcontroller resets.

3.2.5 Error Line Control Circuit (ELC)

The ELC includes ELC #1, ELC #2, and a 2.38-V reference monitor.

- ELC #1 is designed to allow normal operation only when the PC and DC boards are connected. Removing either board or a microcontroller error signal cause an ELC fault condition.
- ELC #2 includes pulse generators and pulse detectors on the PC and DC boards, and an ELC fault condition occurs if a minimum number of missing pulses occur.
- The 2.38-V reference monitor includes a window comparator that monitors the reference signal and alerts the microcontroller if the signal is out of tolerance.

3.2.6 Microcontroller Interface

The microcontroller interface includes:

- Microcontroller: the MC board uses a microcontroller with a crystal oscillator. A phase-locked loop in the microcontroller generates an internal clock signal that helps to reduce EMI interference. The microcontroller includes 7 interrupt lines and 7 chip select lines.
- Memory: a memory decoder PAL decodes the microcontroller chip selects. Program code is stored in EPROM and data is stored in nonvolatile, static RAM.
- ICB interface: a PAL provides the logic that controls the ICB interface
- Serial interface: +5 V logic voltage is converted into ±10-V RS-232 voltages through transmit (TXD) and receive (RXD) lines.

3.3 PC Board

The PC board functions through a microcontroller to:

- Communicate with the MC board
- Communicate to a service laptop computer for diagnostics
- Acquire sensor data through an analog-to-digital converter (ADC)
- Control valves and the blower motor through a digital-to-analog converter (DAC)
- Respond to or invoke an error signal

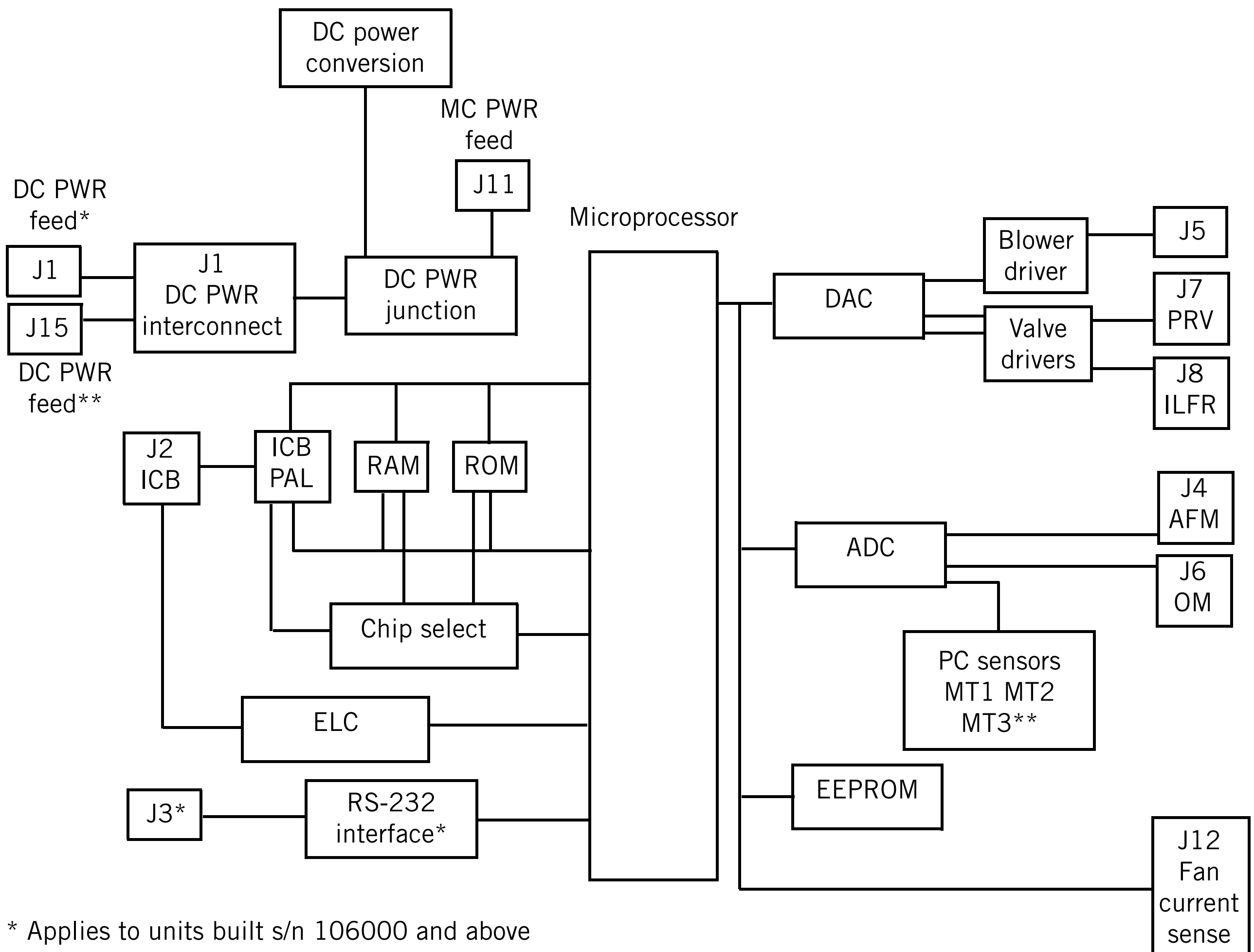


Figure 3-5: PC Board Block Diagram

NOTE: The pressure control board is generally abbreviated as the *PC board*. When referring specifically to older boards in non-upgraded units (built s/n 105999 and below), it is called the *pressure airway subsystem (PAS) board*.

3.3.1 Microcontroller Interface

A programmable array logic (PAL) memory device decodes the chip selects to retrieve program code from the EEPROM and data from RAM. An additional PAL provides the interface for the ICB. The microprocessor monitors:

- Oxygen and gas temperatures
- AFM and OM detection
- ILFR, PRV, and oxygen valve DAC control voltages
- Blower DAC control voltage
- Power supply and reference voltages.

3.3.2 Blower Motor Drive

The complete motor controller uses analog circuitry to provide closed loop speed control. The processor adjusts the speed by increasing or decreasing the DAC converter output to achieve proper pressure and flow.

3.3.3 PRV and ILFR Drives

The microprocessor provides closed loop control of the valve drives. The microprocessor reads seven pressure, flow, and temperature sensors through PC board hardware, and receives target parameters from the MC board. The microprocessor then adjusts analog DAC voltages to control the PRV and ILFR valves as required to meet the target values.

3.3.4 Pressure Sensors

The PC board has two dual-pressure sensors (MT1 and MT2) and a single-pressure sensor (MT3). The pressure sensors measure patient pressure, unit outlet pressure, and barometric pressure. These sensors are subject to calibration with their calculated slope and intercept values stored in the on-board EEPROM. MT3 is a backup outlet pressure sensor that provides a redundant check of the primary outlet sensor located on the AFM. Pressure sensors are factory-calibrated and are not field-adjustable.

3.3.5 Error Line Control (ELC) Circuit

The ELC circuit detects or signals failures to/from the MC and DC boards. If the ELC line activates, only a power on/off can clear the latched circuit state.

3.3.6 RS-232 Connector

Using terminal commands, the RS-232 connector interfaces with the microprocessor to view PC functions and system errors (J3 on PAS boards built s/n 105999 and below, unless upgraded; for units built s/n 106000 and above, the RS-232 connector is on the rear of the unit).

3.4 DC Board

The DC board controls the display of the operating mode, measured and calculated operating parameters, parameter set points, alarm limits, real-time graphics, and general status information. The DC board also controls the user interface that allows the user to:

- Modify the operating mode, parameter set points, alarm limits, and graphic scales
- Reset or silence the audible alarm
- Freeze or unfreeze graphics

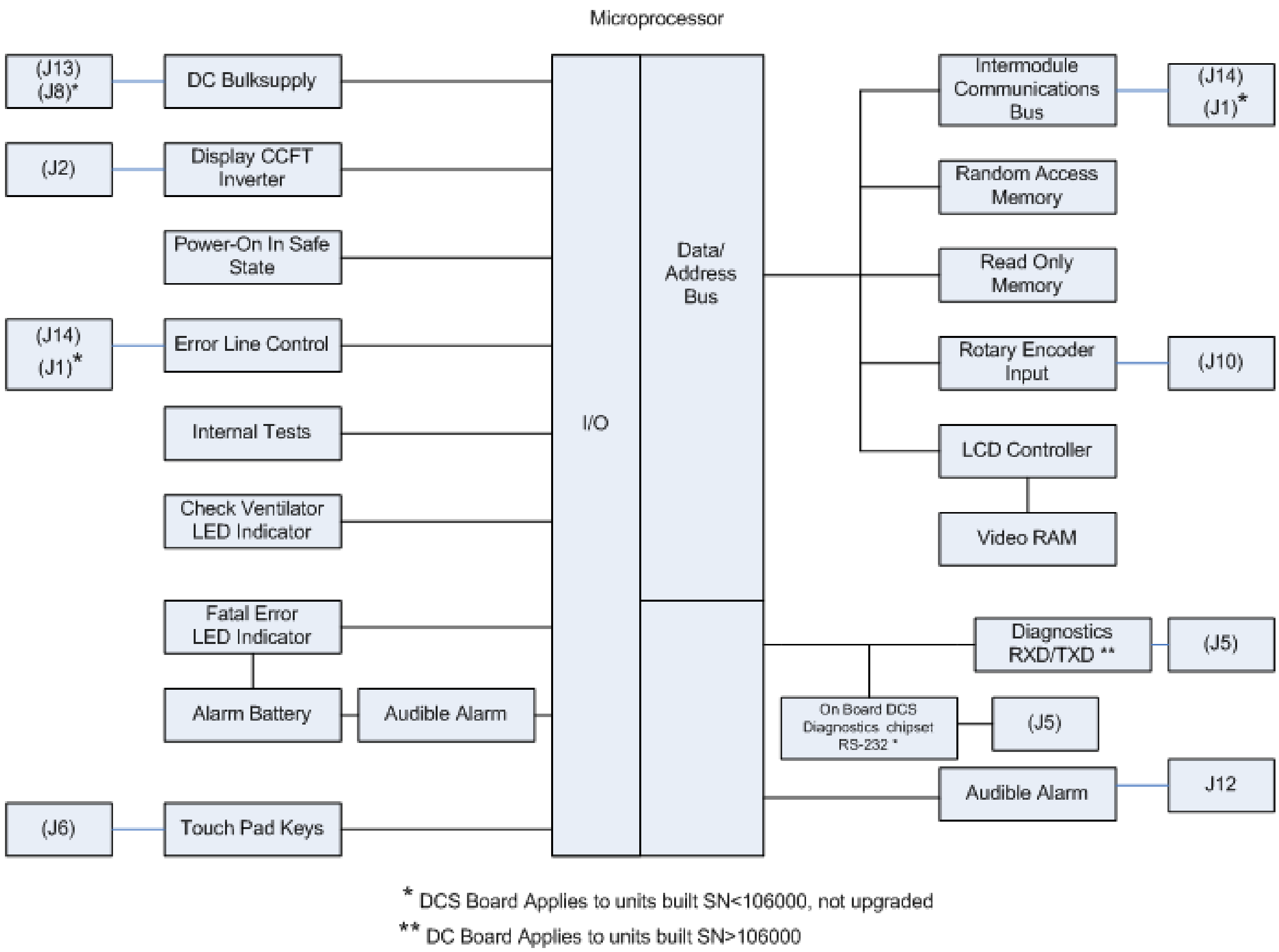


Figure 3-6: DC Board Block Diagram

NOTE: The display control board is generally abbreviated as the *DC board*. When referring specifically to older boards in non-upgraded units (built s/n 105999 and below), it is called the *display control subsystem (DCS) board*.

3.4.1 DC/DC Converter

The DC/DC converter reduces the +24 VDC bulk supply to a +5 VDC logic level. (s/n 105999 and below).

3.4.2 Display Backlight and Contrast Adjustment

A serial 8-bit DAC provides two 0 to +5 VDC signals for these controls.

3.4.3 Display Voltage DC/DC Converter

This adjustable negative voltage converter reduces the level of bulk supply voltage needed to operate the liquid crystal display (LCD) contrast control.

3.4.4 Cold Cathode Fluorescent Tube (CCFT) Inverter

A DC to AC inverter that typically provides 390 VAC to the fluorescent tube in the display through (J2). The current varies to adjust the brightness of the fluorescent tube.

3.4.5 Reference Voltage Checks

This circuit compares reference voltages to determine if they are at the appropriate level.

3.4.6 Power Failure Alarm Battery Enable

This control detects a power failure from the DC bulk supply.

3.4.7 Alarm Battery Voltage Cutout/Check

The battery voltage cutout/check monitors the battery voltage level and cuts it out if it drops to a level of approximately 3 VDC.

3.4.8 Backup Battery/Charger

A 3.6 V nickel cadmium rechargeable battery that operates the audible and visual alarm indicators for at least 20 minutes, when fully charged, when the ELC is active and the DC supply voltage is absent. The battery output is compared to a reference voltage and the battery is recharged as required through a charging circuit. Chapter 4 describes how to recharge the battery.

3.4.9 *Check Vent* LED Enable Current Check

An internal test verifies that the *Check Vent* LED current is acceptable.

3.4.10 Vent Inop LED Current Check

An internal test verifies that the *Vent Inop* LED current is acceptable.

3.4.11 Error Line Control (ELC) Circuits

Redundant error signaling circuitry communicates error conditions among the subsystems to minimize the chance of communication failures.

3.4.12 Error LED

The error LED lights to indicate that an error condition has been detected.

3.4.13 Diagnostic Interface

The diagnostic connector (J5) interfaces with the microprocessor so the DCS board can download its diagnostic data to a service laptop computer for units built s/n 105999 and below. For units built s/n 106000 and above, J5 sends TDS/RDS data to J6 of the MC board, which processes the information then sends it to the RS-232 connector on the back of the unit.

3.4.14 EEPROM

A serial EEPROM stores the set points for the backlighting and contrast, and for the appropriate diagnostic data.

3.4.15 LCD Controller

The LCD controller interfaces with the display.

3.4.16 Debouncing/Keypad Matrix

The matrix keys are debounced and the microprocessor scans the matrix to determine what key was pressed.

3.4.17 Rotary Encoder Control

The rotary encoder control circuit detects the following within one detent of movement: relative position, direction, and speed of the rotary encoder.

3.4.18 Audible Alarm Activation

The audible alarm is activated by either an input from the ELC, the power fail circuitry, or the test alarm signal from the MC board. An audible alarm also occurs when an incorrect key is pressed, an adjustable parameter has reached its limit, or the error signal has been activated.

3.4.19 Audible Alarm Current Check

An internal test verifies that the audible alarm current is acceptable.

3.4.20 Safe State Power On

The DC board contains circuitry that power on the hardware in a safe state. In a safe state, the backlight is off, the display is off, and the ICB is terminated. When the MC board determines that no Vent Inop error exists, it allows the device to resume operation under normal operating conditions.

3.4.21 Watchdog and Low Voltage Reset

The watchdog function must be periodically reset by the microprocessor if a time-out period has been exceeded. This function resets the processor if the software stops functioning correctly. When a low logic level is detected, the ELC is activated and the system shuts down.

3.5 Airflow Module (AFM)

The AFM (Figure 3-7) is a submodule of the PC board. The AFM is powered by the PC board and provides analog signals that indicate gas flow, pressure, and temperature.

To provide accurate indications, the AFM must be calibrated. Calibration data is stored in nonvolatile memory that is part of the AFM. The flow, pressure, and temperature indications are for the ventilator gas stream flowing through a flow body attached to the AFM circuit board.

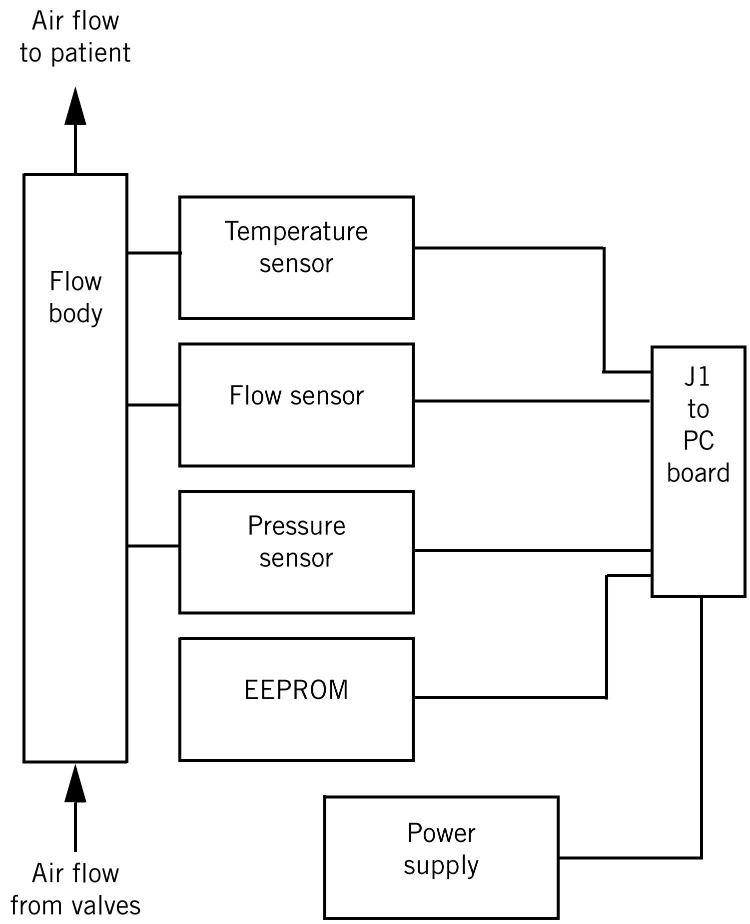


Figure 3-7: AFM Block Diagram

3.5.1 Flow Body

The flow body is attached to the AFM board and includes a laminar flow element. Its position in the ventilator gas stream creates a small pressure differential and diverts the flow through the AFM sensor. The flow body includes inlet, outlet, and pressure ports to allow tubing attachment to the AFM electronic sensors. A hole is molded into the flow body positions the temperature sensor.

3.5.2 Analog Reference

The PC board provides the AFM with power in the form of +12 VDC, –12 VDC, analog ground, +5 VDC, and digital ground. An analog voltage reference supply is derived from the +12 VDC to power the pressure and flow sensors so that their bridge outputs can be factory-calibrated.

3.5.3 Flow Indication

The MT1 sensor indicates total gas flow, which is then amplified by an instrumentation amplifier, low-pass filtered, and sent to the PC board for conversion.

3.5.4 Pressure Indication

MT2, a precision-compensated pressure sensor, indicates unit outlet pressure. The sensor signal is followed by a low-pass filter and a differential amplifier, and then sent to the PC board for conversion.

3.5.5 Temperature Measurement

The temperature sensor in the flow body measures gas temperature. This measurement allows correction for air density and detecting undesirable temperature rises in the patient circuit.

3.5.6 Calibration

The AFM uses a PC-based data acquisition system as the control platform for temperature, pressure, and flow calibration. Correction factors are derived and stored in the AFM EEPROM. Calibration is accomplished by balancing the flow transducer bridge with an EEPOT. The PC board uses temperature, pressure, and flow to correct for actual operating conditions. Once calibrated, the AFM is interchangeable with other AFM assemblies. The AFM is factory-calibrated, and is not field-adjustable.

3.5.7 Module Detection

For normal operation of the device, the PC board must confirm that the AFM is connected. An extra line pulls a PC microcontroller line near 0 V. Line voltage above 2 V indicates that the AFM is not connected, and the PC board enters the error state.

3.6 Oxygen Module (OM)

The OM (Figure 3-8) is a submodule of the PC board. The OM receives power from the PC board and provides an analog signal to the PC board to indicate oxygen flow. Oxygen flow is the flow of oxygen through a flow body on the OM board. To provide accurate indications, the OM must be calibrated. Calibration data is stored in nonvolatile memory that is part of the OM.

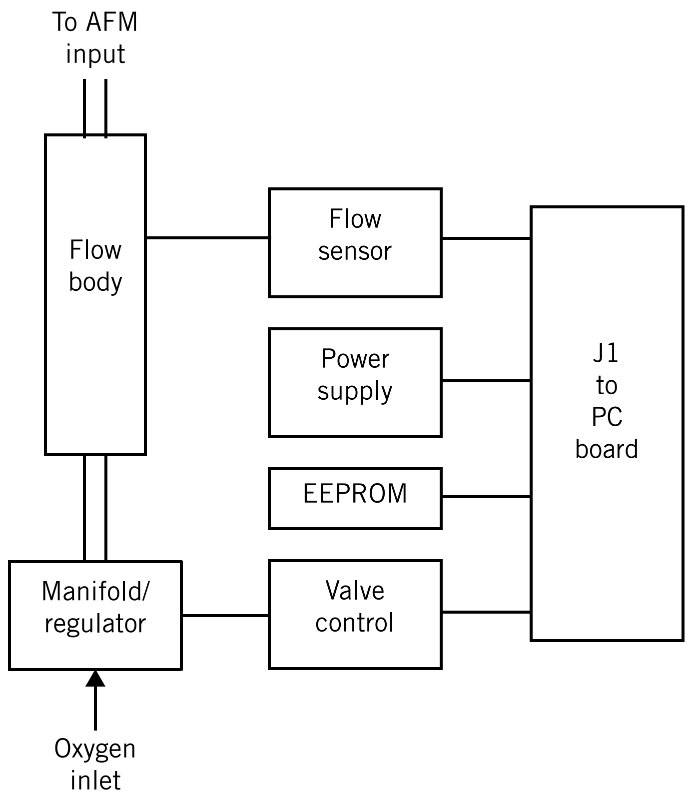


Figure 3-8: OM Block Diagram

3.7 Ventilator Modes

The BiPAP Vision comes standard with continuous positive airway pressure (CPAP) and spontaneous/timed (S/T) modes. A third optional mode, proportional assist ventilation/timed (PAV/T), is also available internationally.

3.7.1 CPAP

CPAP delivers a constant level of positive over the entire patient spontaneous breath cycle. Pressure is controlled and maintained, and flow varies as needed to meet patient demand and compensate for leaks. The mode delivers the set CPAP pressure from 4 to 20 cmH_2O).

3.7.2 Spontaneous/Timed (S/T)

S/T mode provides pressure support during spontaneous breaths, and time-triggered, pressure-limited, time-cycled machine breaths.

Spontaneous breaths:

Spontaneous breaths have two pressure level settings:

- Expiratory positive airway pressure (*EPAP*) establishes the baseline pressure (range: 4 to 20 cmH_2O).
- Inspiratory positive airway pressure (*IPAP*) determines the level of pressure support delivered during inspiration (range: 4 to 40 cmH_2O). Pressure support = IPAP – EPAP).

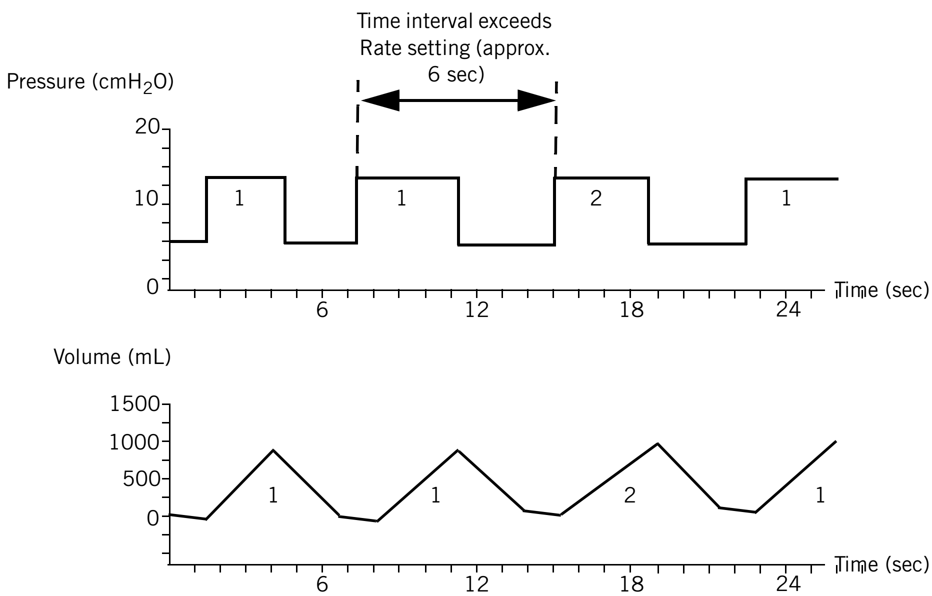
During the inspiratory phase, the device responds as necessary to satisfy the patient's flow requirements while maintaining the preset IPAP level. Patient demand determines inspiratory time and tidal volume. The delivered tidal volume depends on the difference between IPAP and EPAP levels, patient effort, and the combined resistance and compliance of the circuit and the patient. If the patient does not actively participate, the device delivers a timed breath.

Timed breaths:

S/T mode delivers timed breaths when the spontaneous respiratory rate drops below the Rate setting.

If the device does not detect a spontaneous trigger within the interval determined by the Rate setting, it delivers a time-triggered machine breath at the IPAP level. Machine breaths are not synchronized with patient effort, and the length of inspiration is determined by the Timed Inspiratory setting (up to a maximum 3.0 seconds, as long as the I:E ratio does not exceed 1:1, as determined by the Rate setting).

For example (Figure 3-9), if the Rate setting is 10 breaths per minute (BPM), the total respiratory cycle is 6 seconds. If a spontaneous trigger occurs before the inspiratory cycle is complete, the BiPAP Vision delivers a spontaneous breath, and a timed trigger does not occur. The timer resets, and if a 6-second interval elapses without a spontaneous trigger, a timed breath is triggered and the ventilator delivers a timed breath (IPAP delivered for 6 seconds).



1 = Spontaneous-triggered pressure support breath

2 = Time-triggered pressure-limited, time-cydled breath

Figure 3-9: Timed Breath Example

3.7.3 Proportional Assist Ventilation / Timed Mode (PAV/T)

PAV/T incorporates some features of S/T mode and is a software enhancement only. The appropriate *BiPAP Vision Clinical Manual* describes PAV/T in detail.

3.8 Nurse Call/ Remote Alarm (s/n 106000 and above only)

The ventilator activates a nurse call/remote alarm signal in case therapy is interrupted (for example, system shutdowns, patient alarms, and *Loss of AC Power*). However, *Check Vent* does not activate the nurse call/remote alarm. The Alarm silence key silences the nurse call/remote alarm signal for 2 minutes. The Alarm reset key clears the nurse call/remote alarm signal, and the signal automatically terminates when a patient alarm self-cancels. The nurse call/remote alarm is intended as a backup to the main (primary) alarm system.

The nurse call/remote alarm signal is generated on the MC board, and can be connected to a hospital nursing station. This signal is opto-isolated and used to switch a relay to provide open or closed contacts to the remote station circuit. The arrangement of the two jumpers (JP1 and JP2) on the MC board determine the output configuration that is used by a common connector on the rear panel of the ventilator. Use the nurse call adapter (P/N 1014280) and nurse call cable (P/N 1003742) to connect the ventilator to a normally open or normally closed nurse call system.

Select the MC board jumper configuration as required (Table 3-1). Figure 3-10 shows the MC board jumper locations.

Table 3-1: MC Board Jumper Configurations

Remote alarm system and output	JP1 jumper	JP2 jumper	Notes
Respironics remote alarm, 51.1K output	2, 3	2, 3	Respironics remote alarm system P/N 34003 or equivalent
Central alarm system, normally closed output	2, 3	1, 2	Closed contacts = no alarm. Default factory configuration for s/n 106001 - 106368.
Central alarm system, normally open output	1, 2	1, 2	Open contacts = no alarm. Default factory configuration for s/n 106369 and above.

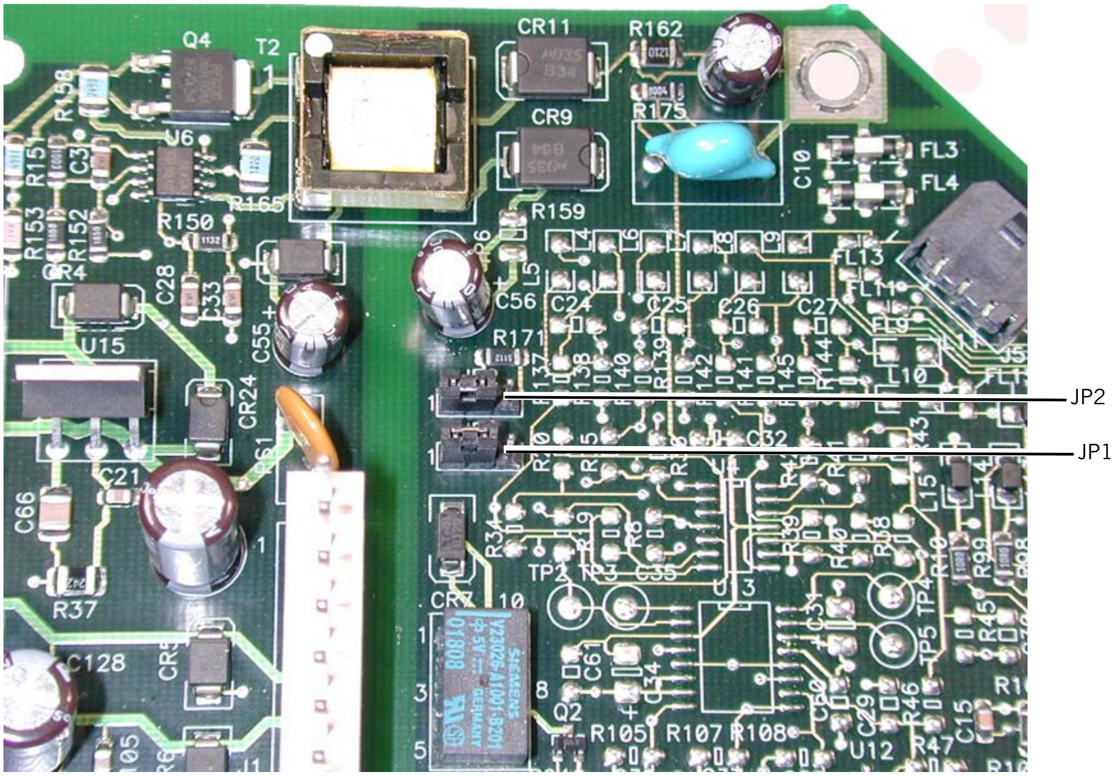


Figure 3-10: MC Board Jumper Locations

CAUTION: The BiPAP Vision nurse call/remote alarm port must be connected to nurse call systems that meet relevant local safety standards.
The nurse call port must be connected to a low voltage circuit ($\leq$ 42.4 Vpeak AC or 50 VDC). Leakage currents from the low voltage circuit must not cause the device leakage current to exceed acceptable levels. The rated output current of the low voltage circuit must not exceed 1 A.

Chapter 4. Periodic Maintenance

Table 4-1 summarizes BiPAP Vision periodic maintenance procedures.

Table 4-1: Periodic Maintenance

Frequency	Component	Maintenance
As required	BiPAP Vision ventilator	Clean exterior surfaces (section 4.1).
	Power cord	Inspect and replace if damage or wear is visible.
	Air inlet filter element	Replace (section 4.2).
	Nylon mesh inlet filter	Clean/replace (section 4.3).
	Oxygen regulator filter	Replace (section 4.4).
	Fuses	Replace (section 4.5).
	Internal alarm battery	Recharge (section 4.6)
Annually	Audible alarm	Activate Test Alarms (Chapter 7) to verify audible and visual function.
	Blower	Perform blower valve calibration (Chapter 7).
	BiPAP Vision ventilator	Clean ventilator interior and exterior as required (section 4.1). Complete system final test (Chapter 7).

Record maintenance activities on the periodic maintenance log (section 4.7).

4.1 Cleaning

Before cleaning, turn the ventilator off and disconnect the power cord from the back of the unit and the wall outlet.

Front panel	Clean as needed by wiping with water or 70% isopropyl alcohol.
Enclosure	Clean exterior as needed by wiping with any antibacterial agent. Clean the Auto-Trak sticker with mild soap and water.
Interior	Carefully clean accessible interior areas with and ESD-safe vacuum cleaner.

CAUTION: Do not immerse the device in water or allow any liquid to enter the enclosure or inlet filter. These instructions are for the BiPAP Vision ventilator only. To clean accessories, see the applicable instructions.

4.2 Air Inlet Filter Element

A dirty filter element can cause high operating temperatures and affect ventilator performance. Examine the filter element (Figure 4-1) and if necessary see Chapter 5 for component removal/installation instructions.

- Inspect the foam lining of the filter cover, and use a vacuum to thoroughly clean any visible lint or dust. Replace the cover if hinge damage prevents the cover from closing properly.
- Remove the old air inlet filter element from the filter housing and discard.
- With the air filter element removed, inspect the filter housing nylon mesh filter for lint, dust, or damage. Use a vacuum (*not* a compressed air source) to remove lint or dust.
- Install a new air inlet filter element (white side facing out) into the filter housing, then reinstall the air inlet filter cover.
- The air inlet filter element is a single-use part. Do not attempt to clean or reuse. Use only Respironics-approved parts.

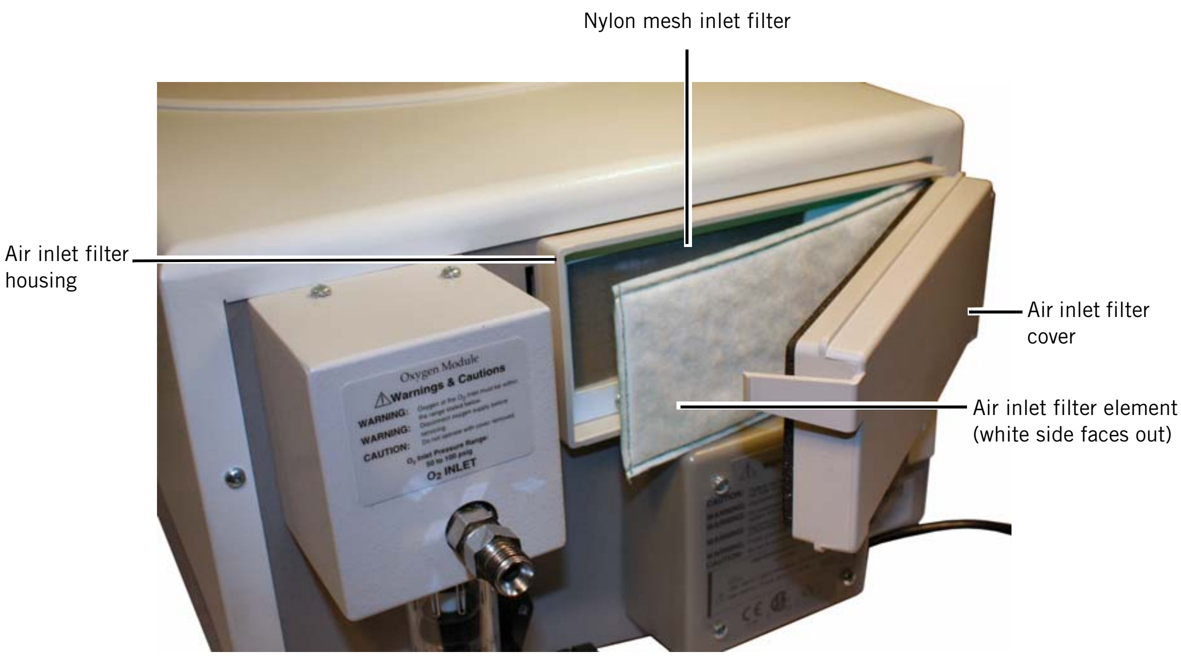


Figure 4-1: Replacing the Inlet Filter

4.3 Nylon Mesh Inlet Filter

A dirty nylon mesh inlet filter can cause high operating temperatures and affect ventilator performance. A damaged mesh filter can allow lint and dust from a damaged or missing air inlet filter element into the ventilator, which can contaminate the internal air pathways. Examine the filter for cleanliness and damage before each use and as required during operation. Replace the nylon mesh inlet filter (Figure 4-2) as required.

The nylon mesh inlet filter can be cleaned and reused or replaced, depending on its condition. See Chapter 5 for component removal/installation instructions.

- inspect the filter housing nylon mesh filter for lint, dust, or damage. Use a vacuum (*not* a compressed air source) to remove lint or dust.
- *If cleaning the filter*: use a solution of mild soap and water to clean, then rinse thoroughly. Ensure that the filter is completely dry before reinstalling.
- *If replacing the filter:* remove the paper backing from the new nylon mesh inlet filter. Align the new, clean filter with its filter enclosure, then press the edges firmly in place to ensure adhesive bond.
- When cleaning the nylon mesh inlet filter, use care not to damage the adhesive on the edges of the filter. If the adhesive is damaged, the filter may not seal correctly when reinstalled.
- Use only Respironics-approved parts.

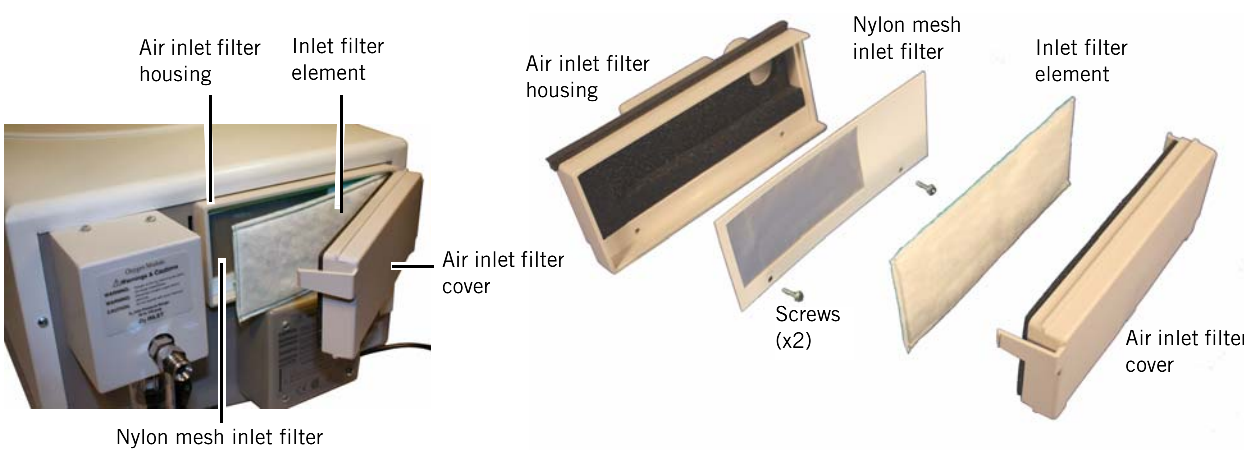


Figure 4-2: Replacing the Nylon Mesh Inlet Filter

4.4 Oxygen Regulator Filter

A dirty oxygen regulator filter can affect ventilator performance. Examine the filter for cleanliness and damage before each use and as required during operation. Replace the oxygen regulator filter (Figure 4-3, Figure 4-4) as required. See Chapter 5 for component removal/installation instructions.

- If needed, clean the regulator bowl with mild soap and water, then rinse and dry completely.

Figure 4-3: Removing the Oxygen Regulator Bowl and Filter (OM s/n 299999 and below)

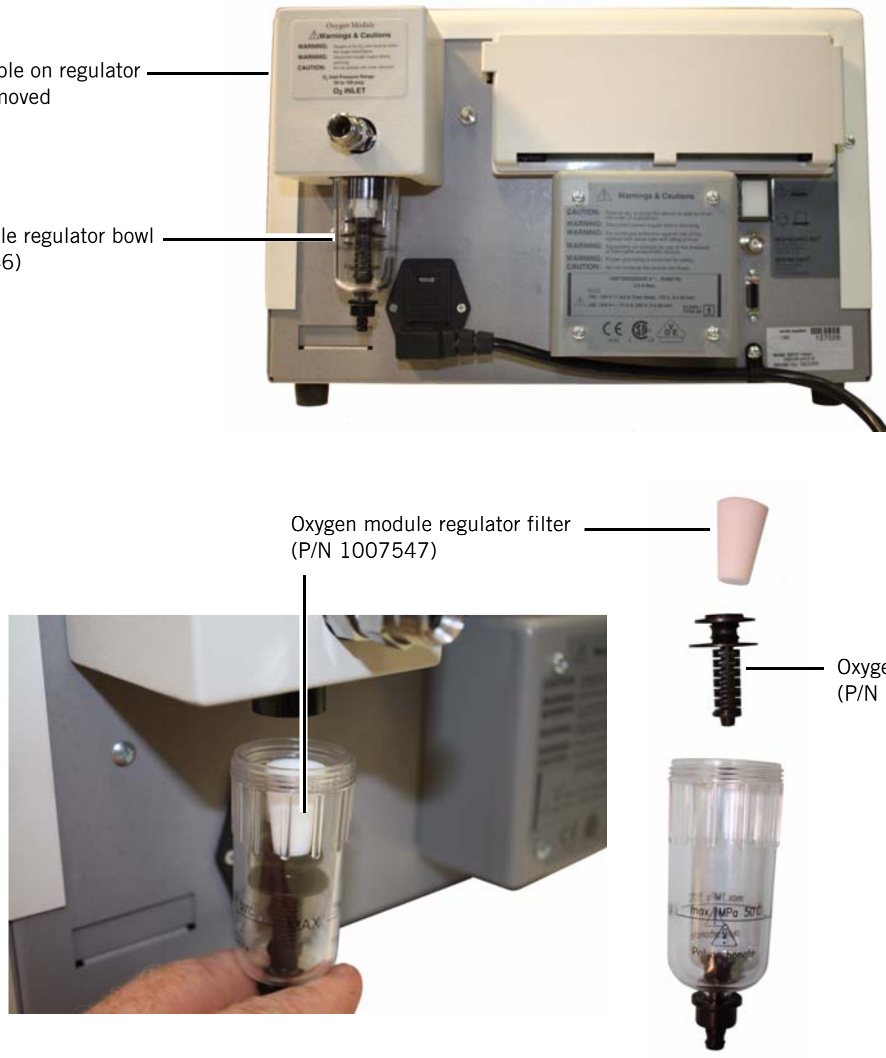


Figure 4-4: Removing the Oxygen Regulator Filter and Bowl (OM s/n 300000 and above)

4.5 Fuses

Replace the ventilator fuses (Figure 4-5, Figure 4-6) as required. See Chapter 5 for component removal/installation and voltage selection instructions.

- Replace both fuses at the same time.
- Reinstall the fuse drawers into the power entry module with arrows on the front of the drawers pointing to the right.

Ventilator s/n 100500 and above	• Use P/N 1041196 (100 and 120 VAC) • Use P/N 1000750 (230 and 240 VAC)
NOTE:	The original 3.5-A fuse (100-120 VAC) is now obsolete, and has been replaced with 4.0-A fuse (P/N 104196), starting with units built s/n 126396 and above. Because the circulation fan muffler is labeled with the fuse rating, a replacement circulation fan muffler (P/N 1041193) is labeled with the 4.0 A rating. When replacing the 100-120 V, 4.0 A fuse and/or the circulation fan muffler, verify that the fuses and muffler have the same fuse value. If the value of the fuses and the muffler labeling do not match, install both the 100-120 V, 4.0 A fuse (P/N 104196) and the 4.0 A circulation fan muffler (P/N 1041193).
Ventilator s/n 100499 and below	• Use P/N 582100 (115 VAC) • Use P/N 1000750 (220 and 240 VAC)

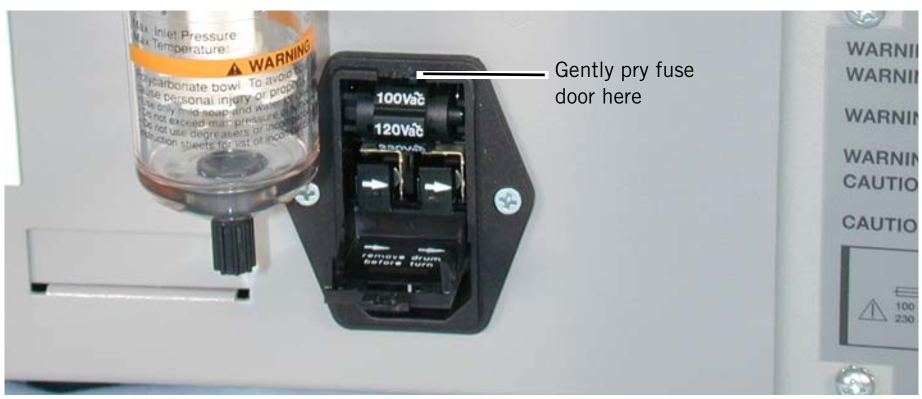


Figure 4-5: Opening the Fuse Door

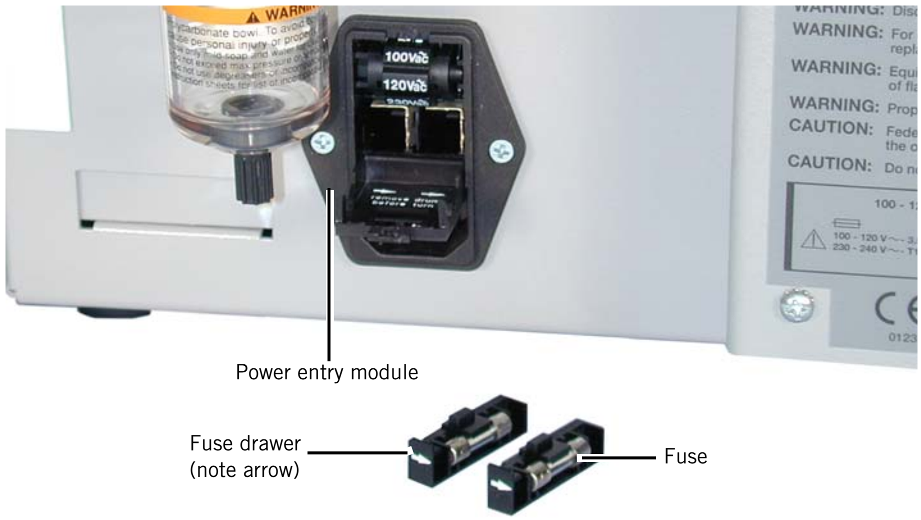


Figure 4-6: Replacing the Fuses

4.6 Internal Alarm Battery

The internal nickel cadmium (NiCAD) battery on the DC board activates the audible and visual *Vent Inop* alarm indicators if an error occurs. A fully-charged battery can maintain the audible alarm for up to 20 minutes.

The NiCAD battery can lose its charge if the ventilator is not used for an extended time. In a typical environment, a fully charged battery can be stored approximately 6 months before losing its charge, but the discharge rate depends heavily on temperature.

CAUTION: Prolonged storage of the BiPAP Vision at high temperatures, above 80 ºF (27 ºC) can result in premature battery failure. Failure to recharge a battery when in storage for long periods reduces battery life, activates the *Check Vent* alarm, and generates error code 205.

NOTE: Charge the internal alarm battery before use if it has been stored for over 3 months. If the battery voltage is too low to support the alarm indicators, the *Check Vent* visual (Eye icon) and audible alarm indicators activate. Low battery voltage may shorten the time that an audible alarm can operate.

4.6.1 Low Internal Alarm Battery Error Code

Low battery voltage generates error code 205. Follow these steps to check the error code:

1. Use the Alarm reset key to silence the audible alarm (the audible alarm does not sound again).
2. View the Monitoring screen (press the Monitoring hard key if necessary).
3. Press the Options soft key.
4. On the Options screen, press the Error soft key. Error codes are displayed in the top line of the Options/Message area.

4.6.2 Recharging the Internal Alarm Battery

There are two methods for recharging the internal alarm battery:

- Fast charge: use this method if the *Check Vent* indicator lights and error code 205 occurs.
- Normal: use this method if the *Check Vent* indicator does *not* light and error code 205 does *not* occur.

Fast charge:

A fast charge initiates at first time initialization and when a low internal battery error is detected. Fast charging is available when the device is in the Setup screen. Fast charge time is 6 hours (this charges the battery enough to power the audible alarm for 20 minutes).

If the unit is powered off during a fast charge sequence, the sequence resumes where it left off when the unit is powered back on. However, the fast charge restarts from the beginning if the device was off long enough to discharge the battery. The 205 error code can be cleared approximately 1 minute after the status indicates a good battery.

NOTE: If the battery cannot be recharged, the fast charge runs continuously and error code 205 cannot be cleared after a full fast charge cycle.

Follow these steps to perform a fast charge:

1. Remove the ventilator from patient use.
2. Connect to AC power and power up: self diagnostics begin.
3. During the fast charge, the ventilator can remain in the Exhalation Port/Language screen, the initial startup screen, or can be placed in Standby mode.
4. If the fast charge is successful, the battery is fully recharged after 6 hours.

Normal charge:

If there is no error code 205, the ventilator continues to charge the battery regularly. It takes approximately 24 hours to fully charge the battery (this charges the battery enough to power the audible alarm for 20 minutes).

Follow these steps to perform a normal charge:

1. Remove the ventilator from patient use.
2. Connect to AC power and power up: self diagnostics begin.
3. During the normal charge, the ventilator can remain in the Exhalation Port/Language screen, in Standby mode, or in Diagnostic mode. Press Alarm reset to silence audible alarms.
4. If the fast charge is successful, the battery is fully recharged after 24 hours.

4.6.3 Verifying the Charge

At least two hours is required to charge a fully discharged battery to a voltage to a level that does not activate a low voltage alarm. After 2 hours, the ventilator can be operated and continues to trickle-charge the battery during operation.

1. Press Monitoring to begin operation.

2. Wait 2 minutes to determine if the *Check Vent* alarm activates and an error code 205 is displayed in the Error Message screen. If not, then the unit is ready for use.

4.7 Periodic Maintenance Log

Use this log to record maintenance activities. Service intervals may vary according to institutional protocol, and comply with any applicable regulations that deviate from this schedule.

Model no. ______________________ Serial no. _______________________

Maintenance activity	Frequency	Date
BiPAP Vision ventilator: clean exterior.	As required	
Power cord: inspect for damage.		
Inlet filter: replace.		
Nylon mesh air inlet filter: clean/replace.		
Oxygen regulator filter: replace.		
Audible alarms: activate Test Alarms to verify.	Annually	
Blower: perform blower valve calibration.		
BiPAP Vision ventilator: • Clean exterior. • Vacuum dust/lint from interior. • Complete system final test.		
Record hours of operation (displayed on Options screen)		

Tested by: ________________________________ Date: _______________

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Chapter 5. Component Removal/Installation

This chapter describes how to remove and replace components of the BiPAP Vision ventilator.

WARNING: Electrical shock hazard. Disconnect the electrical supply before attempting any repairs.

CAUTION: Electronic components used in this device are subject to damage from static electricity. Perform all repairs in an antistatic, ESD-protected environment.

5.1 Major Components

Figure 5-1 shows an exploded view of the BiPAP Vision ventilator, and Figure 5-2 shows an exploded view of the front panel assembly.

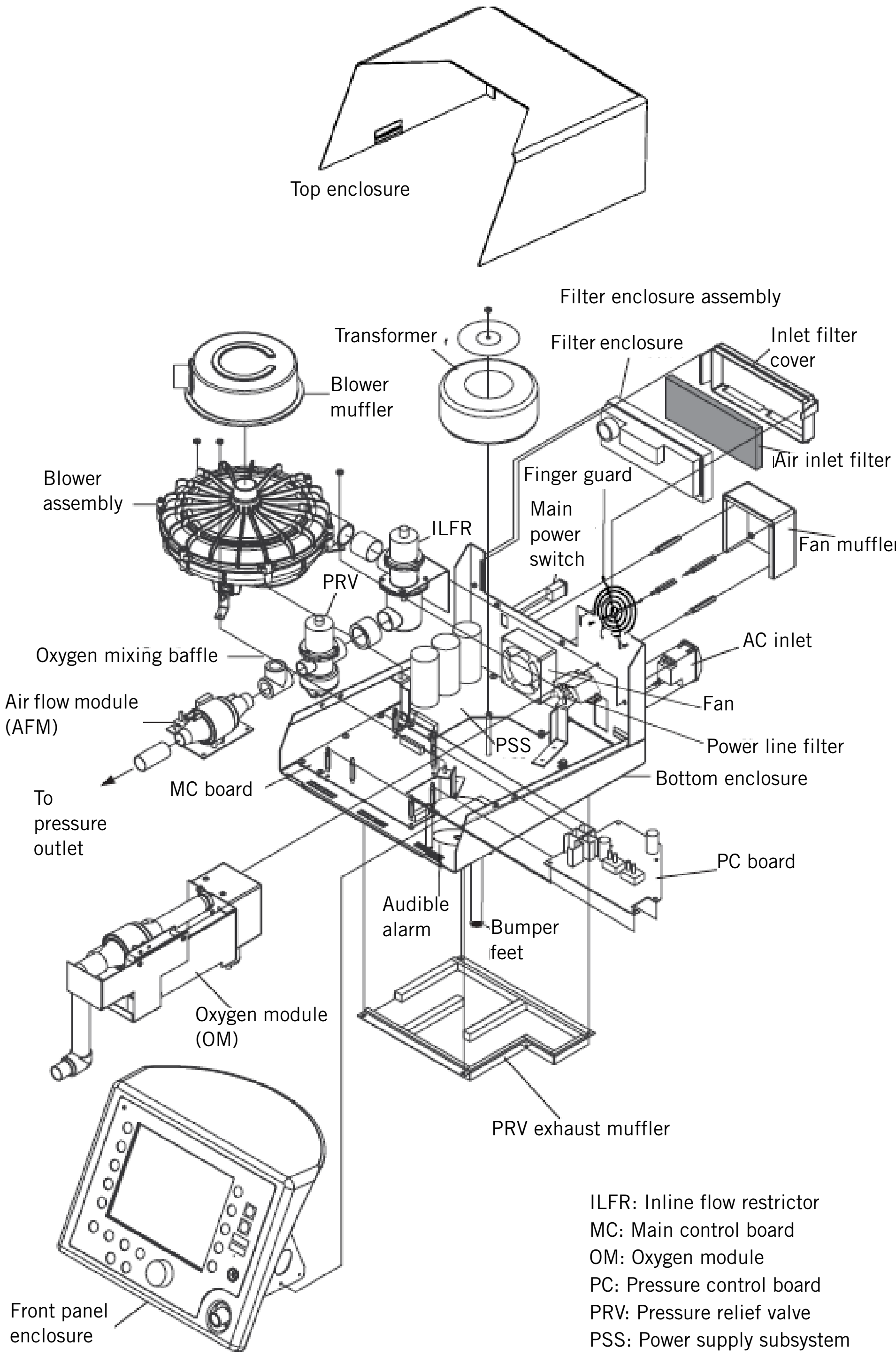

Figure 5-1: BiPAP Vision Ventilator Exploded View

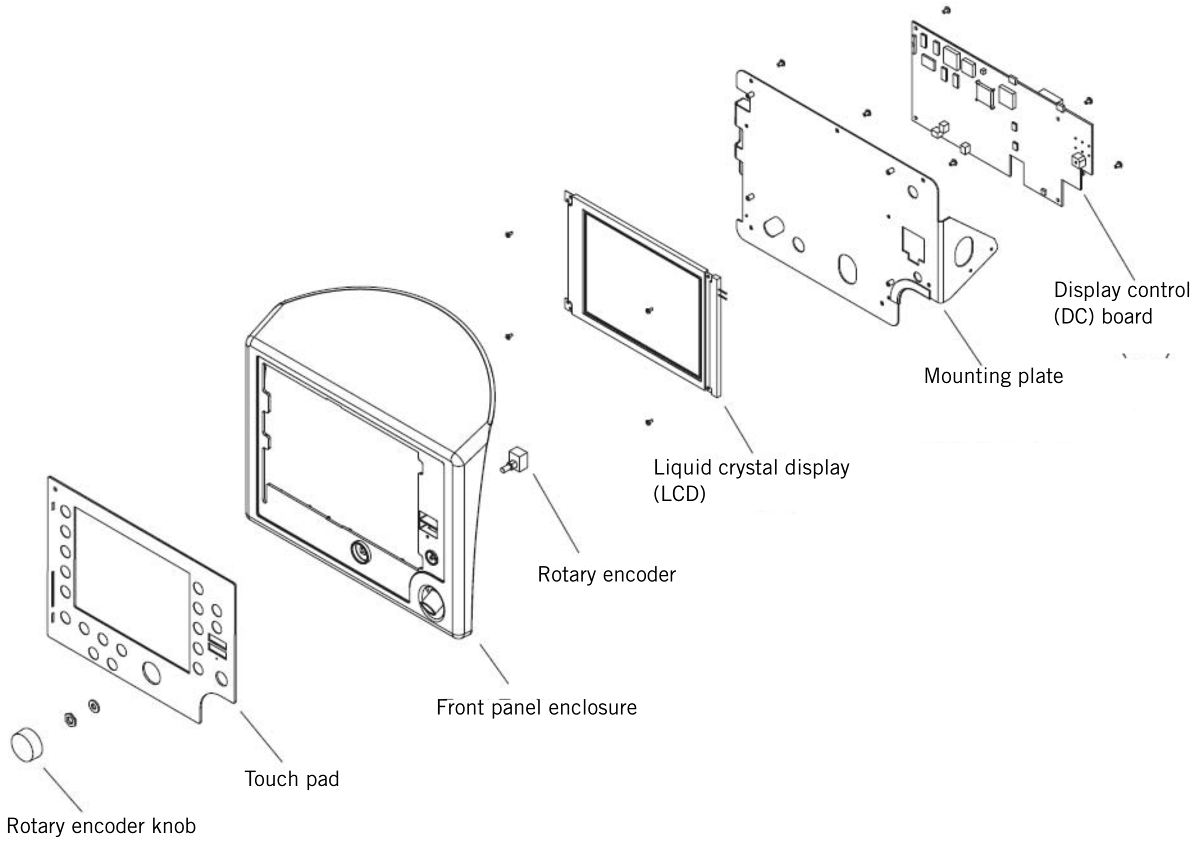

Figure 5-2: BiPAP Vision Front Panel Assembly Exploded View

5.2 Air Inlet Filter Element

Follow these steps to replace the inlet filter element (Figure 5-3):

1. Turn the ventilator off and disconnect the power cord from the back of the unit and the wall outlet.
2. Remove the inlet filter cover from the filter housing: pinch the latch and remove the cover. Inspect the foam lining of the filter cover, and use a vacuum to thoroughly clean any visible lint or dust. Replace the cover if hinge damage prevents the cover from closing properly.
3. Remove the air inlet filter element from the housing and discard.
4. With the air filter element removed, inspect the filter housing nylon mesh filter for lint, dust, or damage. Use a vacuum (*not* a compressed air source) to remove lint or dust. See section 5.3 for instructions on cleaning or replacing the nylon mesh filter.
5. Install a new air inlet filter element (white side facing out) into the filter housing, then reinstall the air inlet filter cover.

NOTE: The air inlet filter element is a single-use part. Do not attempt to clean or reuse. Use only Respironics-approved filters.

Figure 5-3: Replacing the Air Inlet Filter Element

5.3 Cleaning/ Replacing the Nylon Mesh Inlet Filter

Follow these steps to clean/replace the nylon mesh inlet filter (Figure 5-4):

1. Turn the ventilator off and disconnect the power cord from the back of the unit and the wall outlet.
2. Remove the top enclosure (section 5.6).
3. Remove the air inlet filter cover and inlet filter element (section 5.2).
4. Use a medium Phillips screwdriver to remove the two screws that hold the nylon mesh inlet filter to the air inlet filter housing, and pull up to remove the housing from the bottom enclosure.
5. Use a small flat-bladed screw driver to pry the nylon mesh filter from the housing.

NOTE: The nylon mesh inlet filter can be cleaned and reused or replaced, depending on its condition. Use only Respironics-approved filters.

6. *If cleaning the filter*: use a solution of mild soap and water to clean, then rinse thoroughly. Ensure that the filter is completely dry before reinstalling.
   If replacing the filter: remove the paper backing from the new nylon mesh inlet filter. Align the new, clean filter with its filter enclosure, then press the edges firmly in place to ensure adhesive bond.

NOTE: When cleaning the nylon mesh inlet filter, use care not to damage the adhesive on the edges of the filter. If the adhesive is damaged, the filter may not seal correctly when reinstalled.

7. Reinstall the filter housing to the lower enclosure and reinstall the two screws.

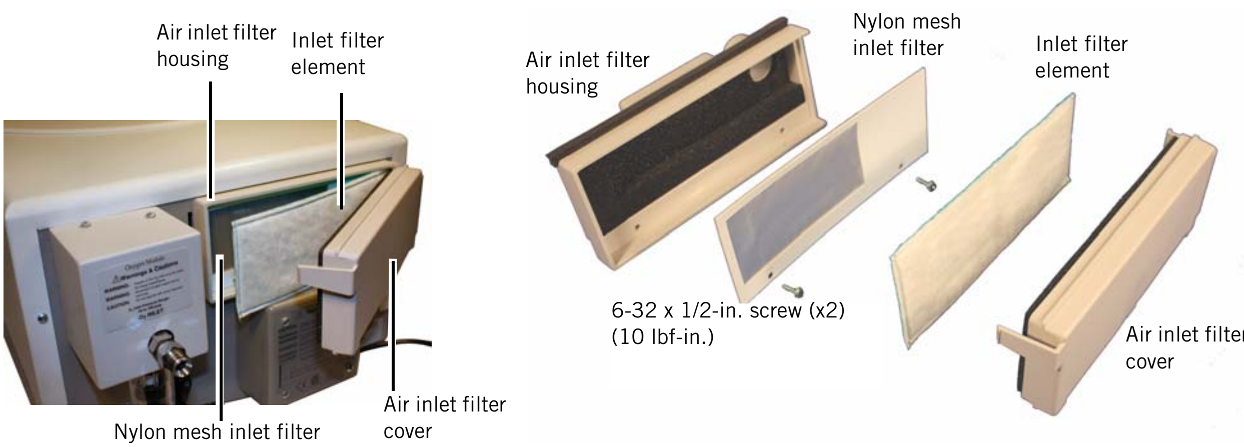

Figure 5-4: Replacing the Nylon Mesh Inlet Filter

5.4 Oxygen Regulator Filter and Bowl

Follow these steps to replace the oxygen regulator filter (Figure 5-5, Figure 5-6):

1. Turn the ventilator off and disconnect the power cord from the back of the device and the wall outlet.

2. Remove the oxygen hose from the oxygen module (OM) inlet on the back of the device, if attached.

3. Rotate the plastic body of the regulator bowl counterclockwise to remove it.

Figure 5-5: Removing the Oxygen Regulator Bowl and Filter (OM s/n 299999 and below)

4. Rotate the oxygen regulator filter counterclockwise to remove it.

5. Install a new oxygen regulator filter, then rotate clockwise to tighten.

6. If needed, clean the regulator bowl with mild soap and water, then rinse and dry completely.
7. Reinstall the regulator bowl, then rotate clockwise to tighten.
8. Reconnect the oxygen hose to the OM inlet.

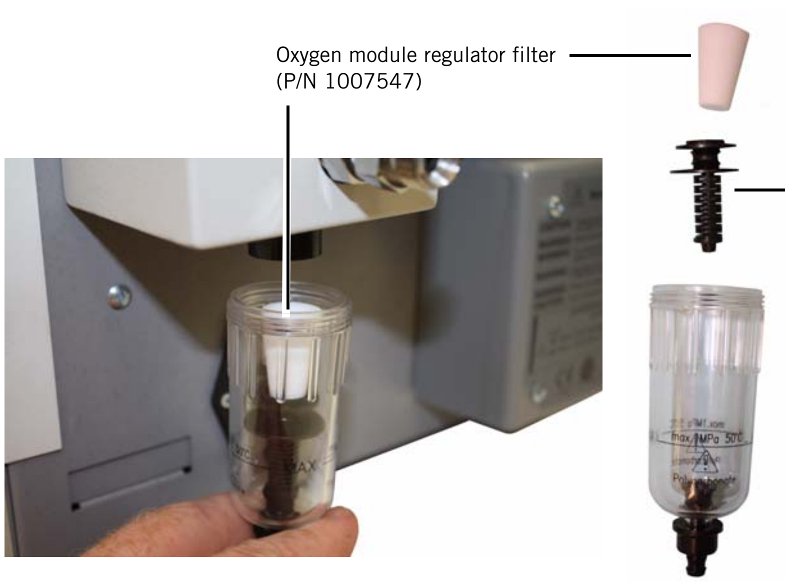

Figure 5-6: Removing the Oxygen Regulator Filter and Bowl (OM s/n 300000 and above)

5.5 Fuses

Follow these steps to replace ventilator fuses (Figure 5-7, Figure 5-8):

Ventilator s/n 100500 and above	• Use P/N 1000749 (100 and 120 VAC) • Use P/N 1000750 (230 and 240 VAC)
Ventilator s/n 100499 and below	• Use P/N 582100 (115 VAC) • Use P/N 1000750 (220 and 240 VAC)

1. Turn the ventilator off and disconnect the power cord from the back of the device and the wall outlet.

2. Gently pry open the top of the fuse holder door. The door hinges downward.

Figure 5-7: Opening the Fuse Door

3. Pry the fuse drawers from the power entry module.

Figure 5-8: Replacing the Fuses

4. Remove and replace both fuses.

5. Reinstall the fuse drawers into the power entry module with arrows on the front of the drawers pointing to the right.

6. Shut the fuse holder door and snap into place.

7. Reinstall the power cord.

5.5.1 Voltage Selection

The voltage selection is originally set at the factory. Follow these steps to select ventilator voltage (Figure 5-9):

1. Turn the ventilator off and disconnect the power cord from the back of the device and the wall outlet.

2. Gently pry open the top of the fuse holder door. The door hinges downward.

3. Remove the drum from the power entry module, and reinsert so that the selected voltage is visible.

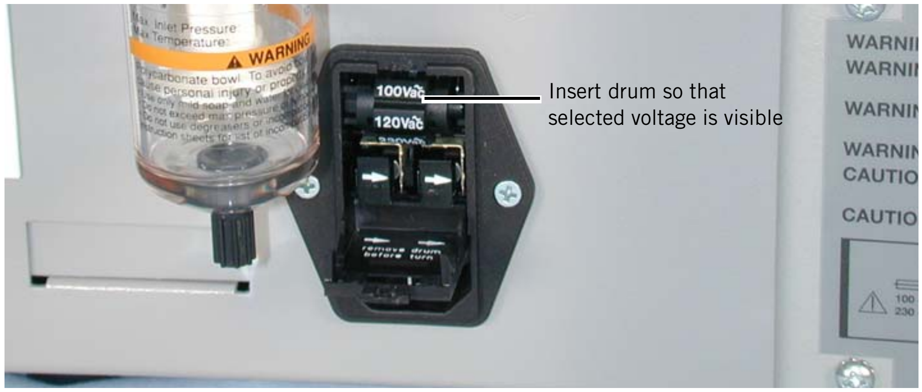

Figure 5-9: Selecting the Voltage

5.6 Top Enclosure

Follow these steps to remove the top enclosure (Figure 5-10). Reverse to install.

NOTE: Apply a small amount of threadlock reinstalling the top enclosure screws to the back panel.

1. Turn the ventilator off and disconnect the power cord from the back of the device.
2. Remove the 2 screws that attach the top enclosure to the bottom enclosure.
3. Slide the enclosure straight back, then lift slightly to clear oxygen module screws.
4. Pull the enclosure back to disengage the latch that attaches the top enclosure to the bottom enclosure, then lift the top enclosure away from the device.

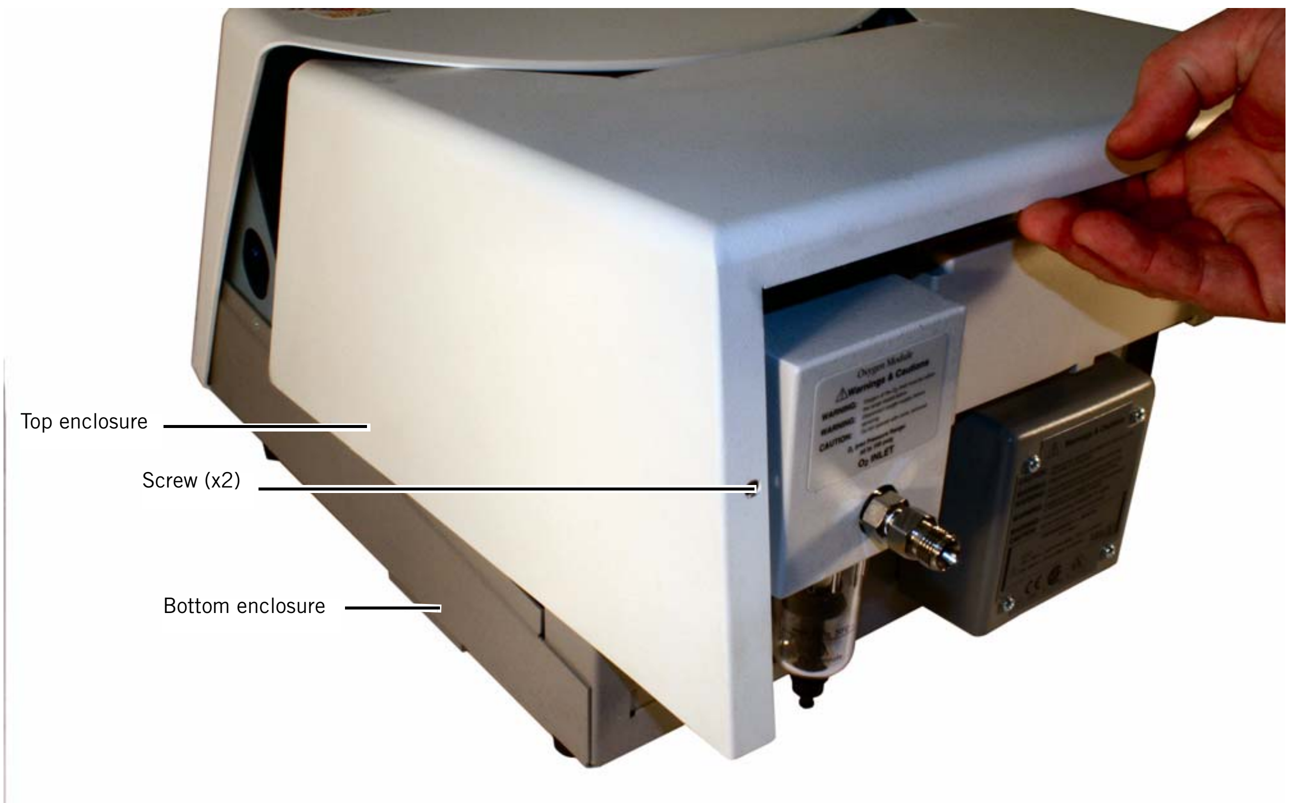

Figure 5-10: Removing the Top Enclosure

5.7 Front Panel Enclosure

Follow these steps to remove the front panel enclosure (Figure 5-11, Figure 5-12). Reverse to install.

NOTE: Apply a small amount of threadlock when reinstalling the front panel enclosure screws to the bottom enclosure.

1. Remove the top enclosure (section 5.6).
2. Remove the 4 screws (2 at each side) that attach the front panel enclosure to the bottom enclosure.
.

Figure 5-11: Removing the Front Panel Enclosure

3. Disconnect the braided tube from the patient outlet port.
4. Tilt the front panel enclosure back and remove these cables:
   - Power harness (DC J13)
   - Power supply harness (Mains ON LED cable)
   - Error LED cable (DC J5)
   - Intermodule communications bus (ICB) cable (ribbon cable)
   - Alarm cable (DC J12)

CAUTION: To avoid damaging the front panel or bottom enclosures, do not tilt the front panel beyond 45 degrees while attached to the bottom enclosure.

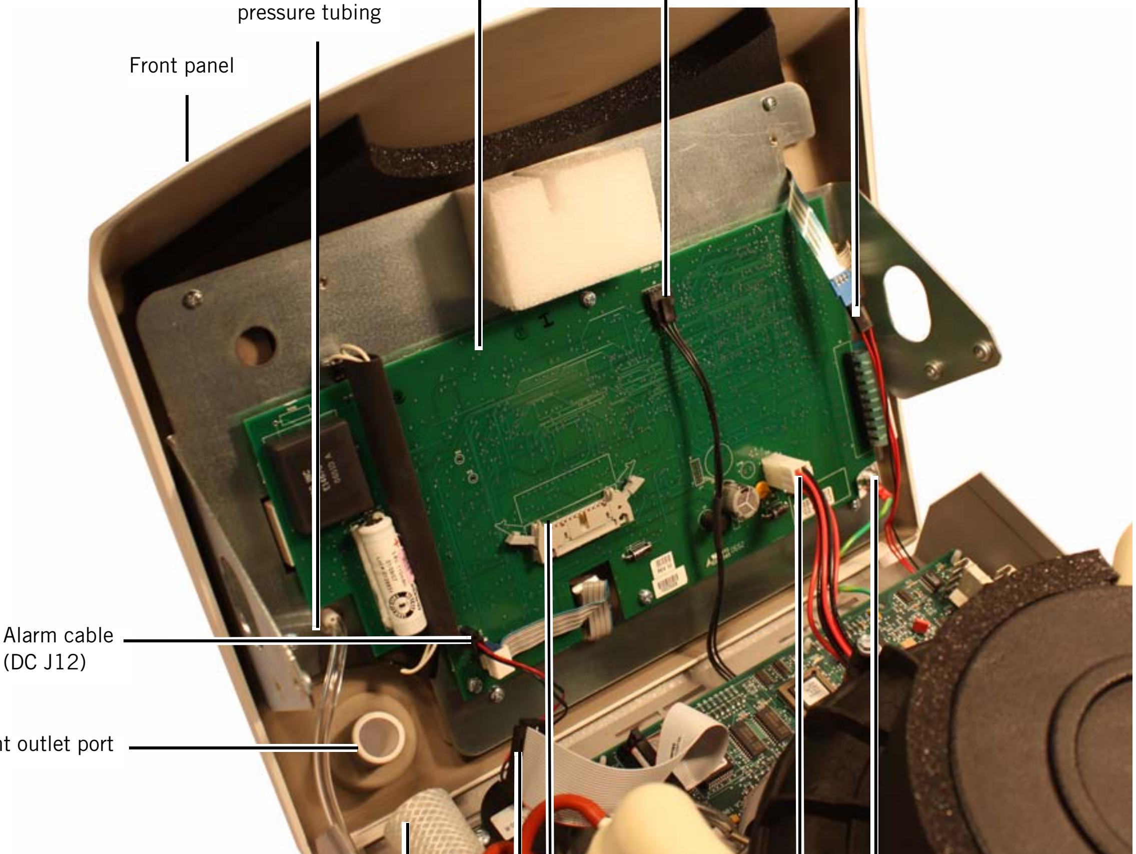

Figure 5-12: Front Panel Enclosure: Disconnecting the Cables and Proximal Pressure Tubing

5. Remove the proximal line tubing from the front panel enclosure.
6. Lift the front panel slightly to remove it from the tabs on the bottom enclosure.
7. Set the front panel enclosure face down and remove the screw that attaches the ground wire and shielding foil to the DC board.

5.8 Display Control (DC) Board

Follow these steps to remove the DC board (Figure 5-13). Reverse to install.

1. Remove the front panel enclosure (section 5.7).
2. Remove these cables:
   - Backlight inverter cable (DC J2)
   - Touch pad ribbon cable (DC J6)
   - Rotary encoder cable (DC J10)
3. Remove the remaining 4 screws that attach the DC board to the mounting plate (ground wire removed when removing front enclosure).
4. On the side of the DC board facing the mounting plate, remove the LCD cable from DC J9.

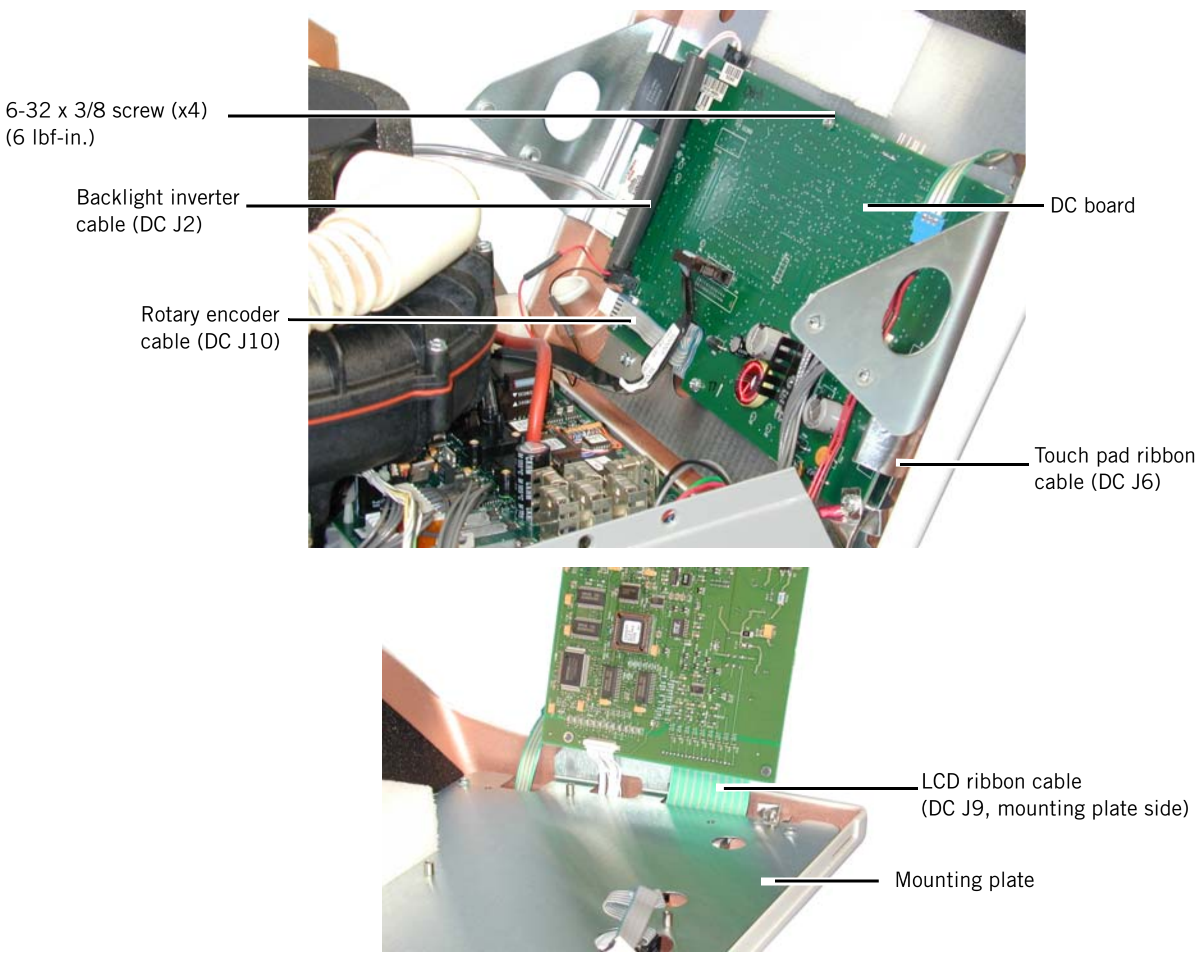

Figure 5-13: Removing the DC *Board*

5.9 Rotary Encoder

Follow these steps to replace the rotary encoder (Figure 5-14).

1. Remove the front panel enclosure (section 5.7).
2. Remove the rotary encoder cable from DC J10.
3. Pull to remove the rotary encoder knob from its shaft.
4. Remove the 7/16-in. nut and washer that attach the rotary encoder to the front panel.
5. When reinstalling the rotary encoder, install the shaft through the inside of the front panel enclosure (align the flat sides of the shaft with the cutout). Ensure that the rotary encoder cable faces the top of the enclosure, then fold the cable downward as shown.

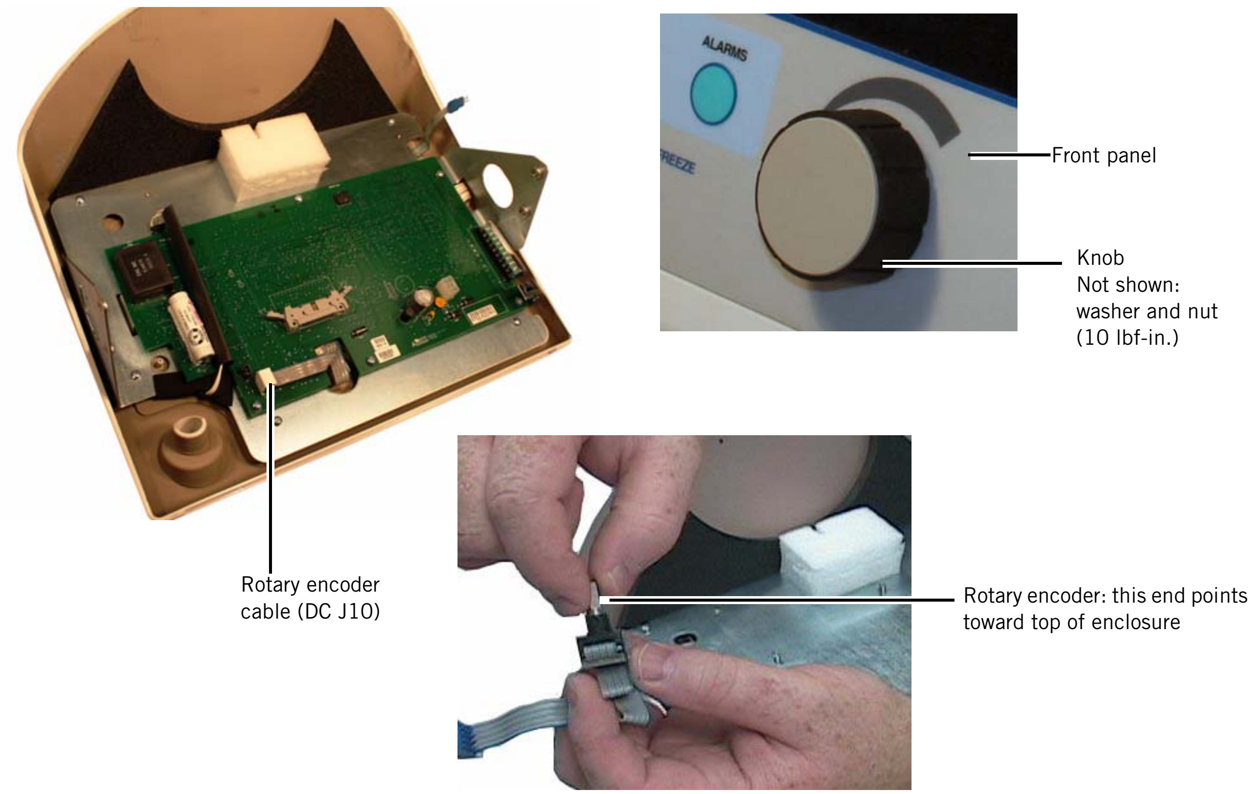

Figure 5-14: Replacing the Rotary Encoder

6. From the front of the enclosure, install the washer and nut onto the shaft and tighten the nut.
7. Reinstall the knob onto the shaft.
8. Reinstall the rotary encoder cable to DC J10.

5.10 Touch Pad

Follow these steps to replace the touch pad (Figure 5-15).

1. Remove the front panel enclosure (section 5.7).
2. Pull to remove the rotary encoder and knob from its shaft.
3. Place the front panel enclosure face down on a protected surface, and gently remove the touch pad ribbon cable from DC connector J6 (Figure 5-13).
4. Gently pry the touch pad from the front panel, starting at a corner. Pry one edge completely from the surface of the front panel, then pull to remove the touch pad.
5. Place the front panel face up, and use isopropyl alcohol to clean any remaining glue from the front panel enclosure surface.
6. Remove the paper backing from the new touch pad, and remove the protective film on the inside (LCD side) of the touch pad lens.
7. Insert the ribbon cables and ground shields through the appropriate slots in the front panel enclosure, ensuring that no cables or wires are pinched.
8. Align the touch pad with its position on the front panel, then carefully apply pressure to adhere the touch pad. Press all touch pad buttons to ensure that they function correctly.

   NOTE: If the touch pad is adhered out of position, use a small amount of isopropyl alcohol to remove the touch pad, allow it to dry, and then re-align the touch pad with the front panel.

Figure 5-15: Feeding Touch Pad Cables Through the Front Panel

9. Replace the mounting plate to the front panel enclosure, ensuring that all cables are properly routed, and reinstall the 6 mounting screws.
10. Reinstall the rotary encoder knob to its shaft.
11. Insert the touch pad ribbon cable completely into DC J6.

5.11 LCD Assembly

Follow these steps to remove the LCD assembly (Figure 5-16, Figure 5-17). Reverse to install.

1. Remove the touch pad (section 5.10), and install a new touch pad following LCD installation.

2. Remove these cables from the DC board:
   - Backlight inverter cable (DC J2)
   - Touch pad ribbon cable (DC J6)
   - LCD ribbon cable (DC J9)
   - Rotary encoder cable (DC J10)

3. Remove the 6 screws that hold the mounting plate to the front panel enclosure.

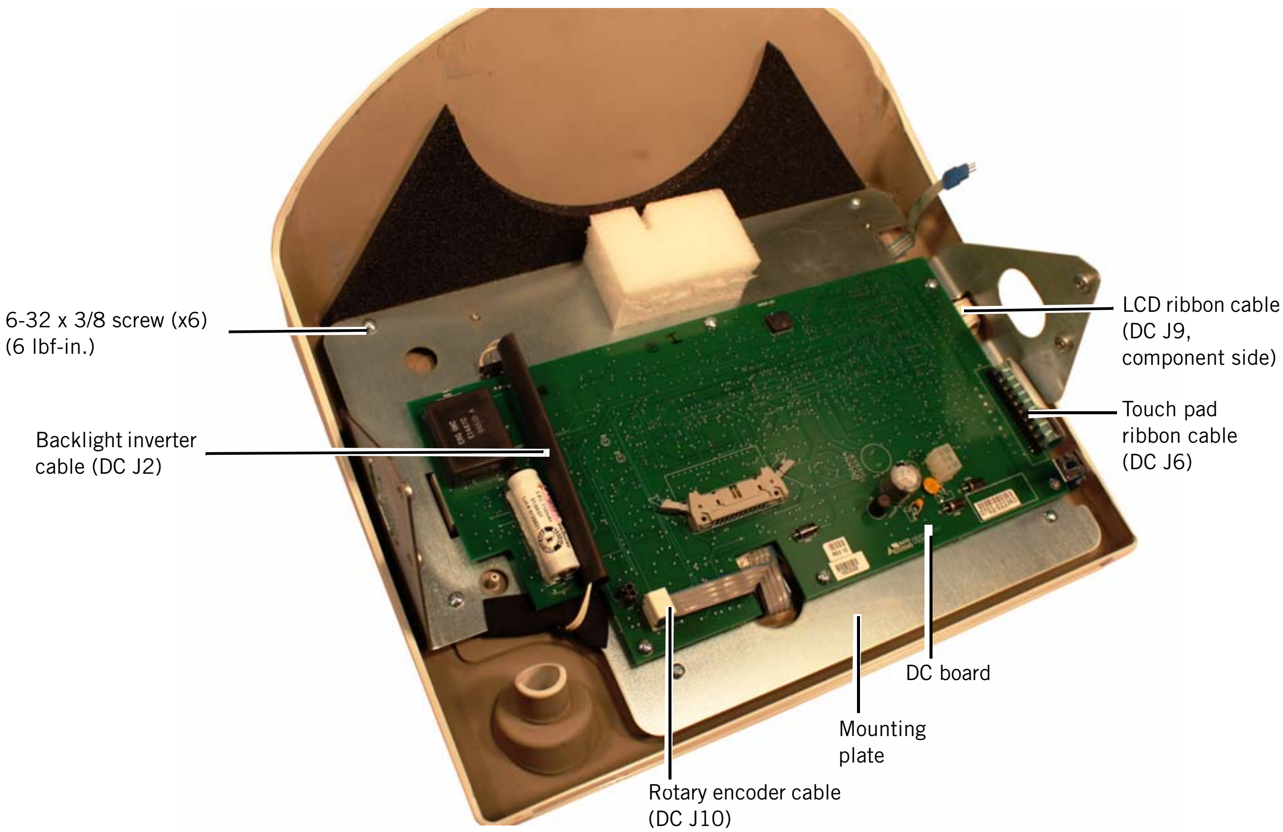

Figure 5-16: Removing the Mounting Plate

4. Tilt the mounting plate back, and remove the four screws that attach the LCD to the mounting plate.

5. Gently wipe the LCD with a soft cloth and isopropyl alcohol.

   NOTE: When reinstalling the LCD, feed the cables through their cutouts in the mounting plate. When reinstalling the front panel enclosure, take care not to pinch the LCD wires.

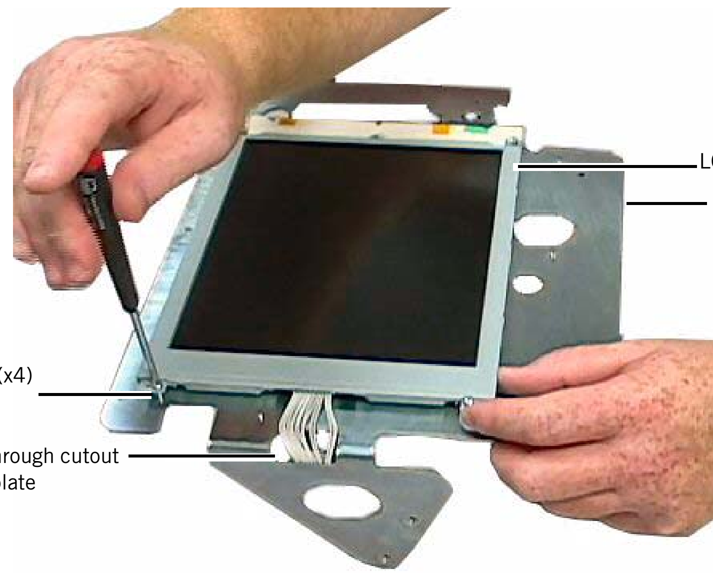

Figure 5-17: Removing the LCD Assembly

5.12 Blower

Follow these steps to remove the blower (Figure 5-18). Reverse to install.

NOTE: When removing the blower motor cable, pull the connector (not the cable) from the PC board, using needle nose pliers if necessary.

1. Remove the front panel enclosure (section 5.7).
2. Pull to remove the air inlet hose from inside the back panel and from the muffler inlet.

NOTE: When replacing the air inlet hose, take care not to push the hose in too far. Use the groove on the hose connector as a reference to ensure correct alignment.

3. Pull up on the muffler to remove it from the blower.

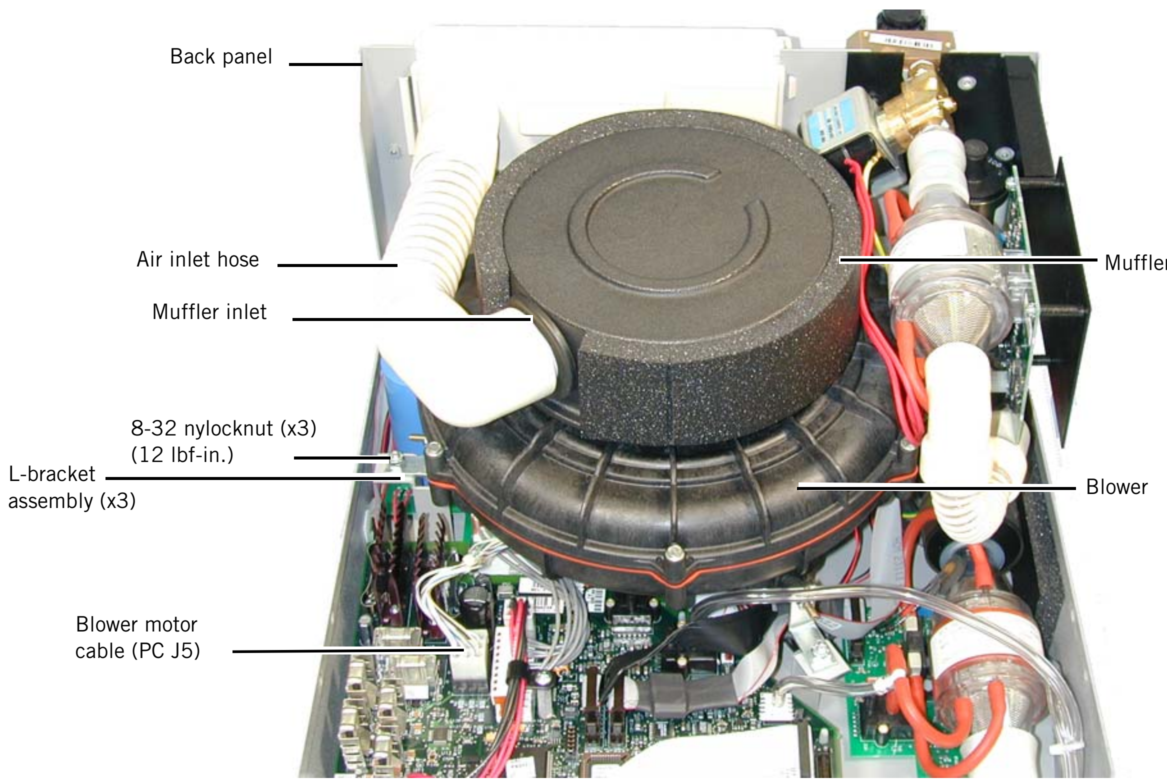

Figure 5-18: Removing the Muffler and Blower

4. Remove the three nuts that attach the blower assembly to the standoffs.
5. Disconnect the blower motor cable from the PC board (PC J5).
6. Lift the blower up and then pull to remove from the silicone coupling.

NOTE: If necessary, use isopropyl alcohol to lubricate the muffler grommet when reinstalling the muffler.

5.13 Oxygen Module (OM) Assembly

Follow these steps to remove the OM (Figure 5-19, Figure 5-20, Figure 5-21). Reverse to install.

1. Remove the front panel enclosure (section 5.7).
2. Remove the 2 screws that attach the oxygen cover, then pull the cover away from the back panel.

Figure 5-19: Removing the Oxygen Cover

3. Remove the ribbon cable from the OM flow sensor (ribbon cable connects to PC J6).
4. Pull the hose from the flow sensor outlet.

5. Remove the nut that attaches the oxygen control valve ground wire from the enclosure ground point.

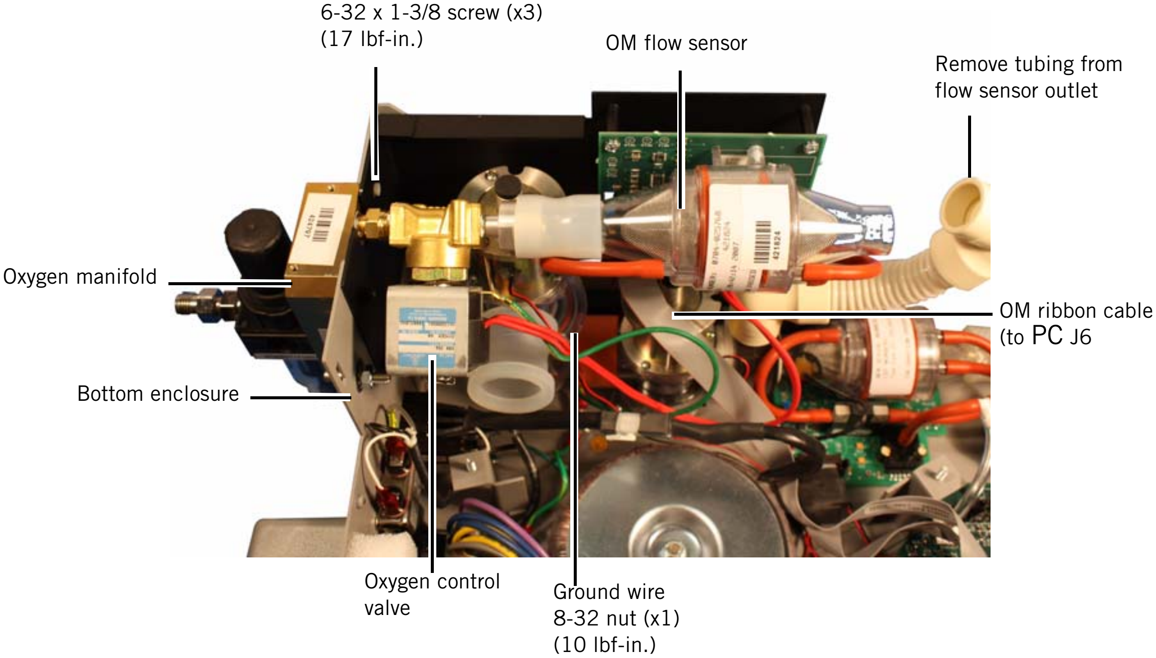

Figure 5-20: Disconnecting the OM from the Bottom Enclosure

6. From the back panel, loosen (but do not remove) the two upper screws on the oxygen manifold. Remove the lower screw completely from the manifold.

7. Lift the OM from the bottom enclosure.

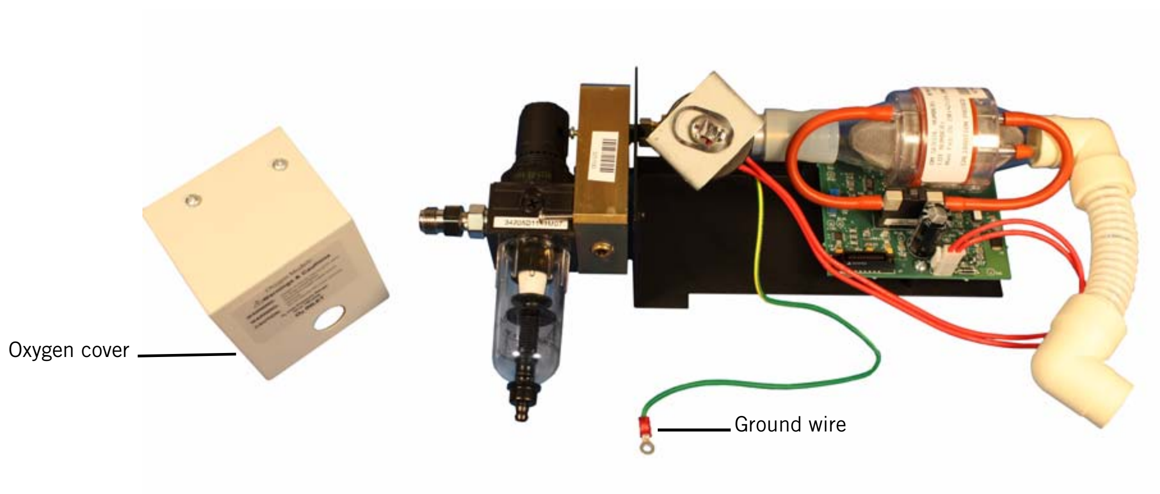

Figure 5-21: The OM

5.14 Air Flow Module (AFM), Oxygen Baffle

Follow these steps to remove the AFM (Figure 5-22). Reverse to install.

1. Remove the OM (section 5.13).
2. Remove the ribbon cable from the AFM.
3. Release the standoffs that attach the AFM to the bottom enclosure.
4. Disconnect the AFM tubing from the tee that connects to the pressure transducer on the PC board.
5. Lift the AFM and attached oxygen baffle from the bottom enclosure.

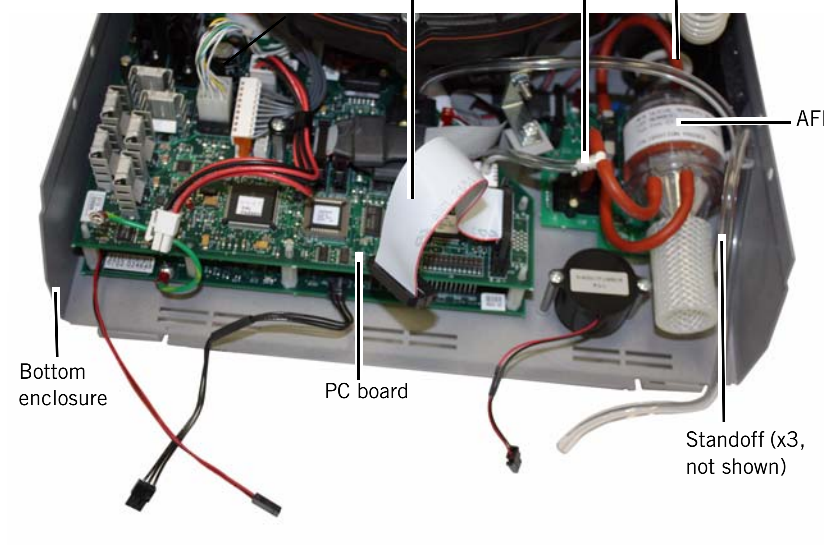

Figure 5-22: Removing the AFM and Oxygen Baffle

6. Pull to remove the oxygen baffle from the AFM inlet.

NOTE: The oxygen baffle is standard on units built s/n 106000 and above. Although not standard, the oxygen baffle can be installed in units built s/n 105999 and below.

5.15 Pressure Relief Valve (PRV)

Follow these steps to remove the PRV (Figure 5-24). Reverse to install.

NOTE: To minimize the possibility of inadvertent leaks, reinstall the PRV so that it is flush with the chassis floor.

1. Remove the AFM (section 5.14).
2. Remove the two 5/16-in. nuts that attach the PRV to the bottom enclosure.
3. Disconnect PRV cable from PC board J7.
4. Gently lift up and away from the inline flow restrictor (ILFR) valve.

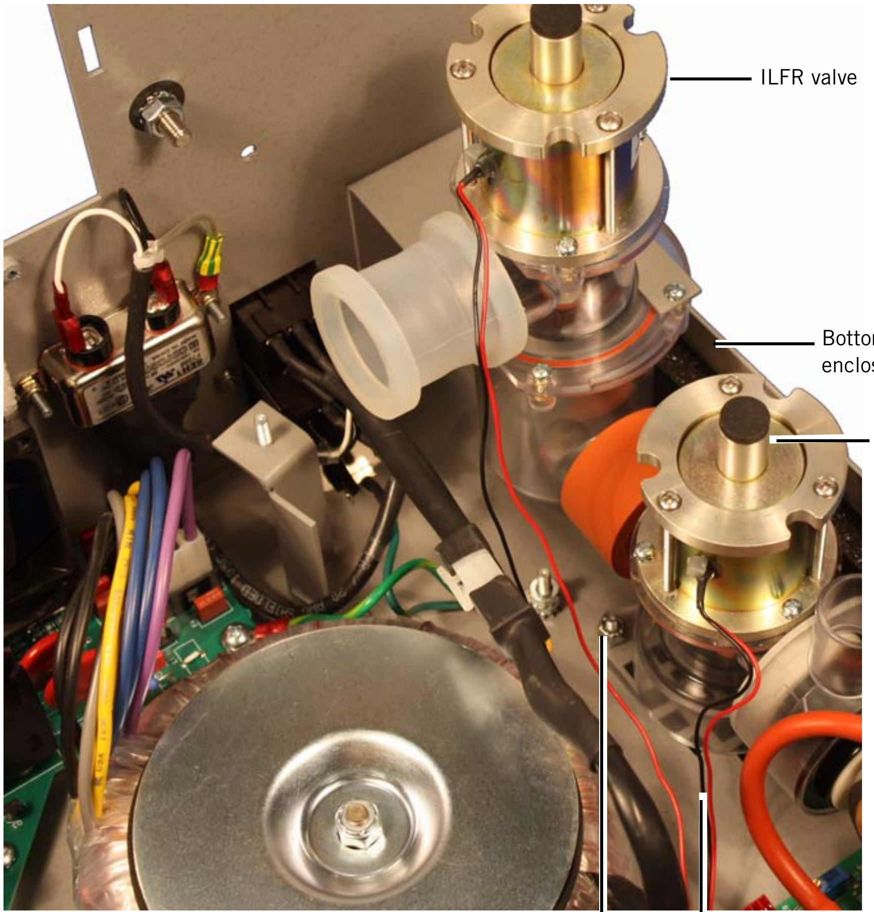

Figure 5-23: Removing the PRV

5.16 Inline Flow Restrictor (ILFR) Valve

Follow these steps to remove the ILFR valve (Figure 5-24). Reverse to install.

1. Remove the PRV (section 5.15).
2. Remove the screw from outside the back panel that retains the ILFR valve bracket.
3. Open the cable retainer and remove ILFR cable.
4. Disconnect ILFR cable from PC board J8.
5. Gently lift up and away from the blower.

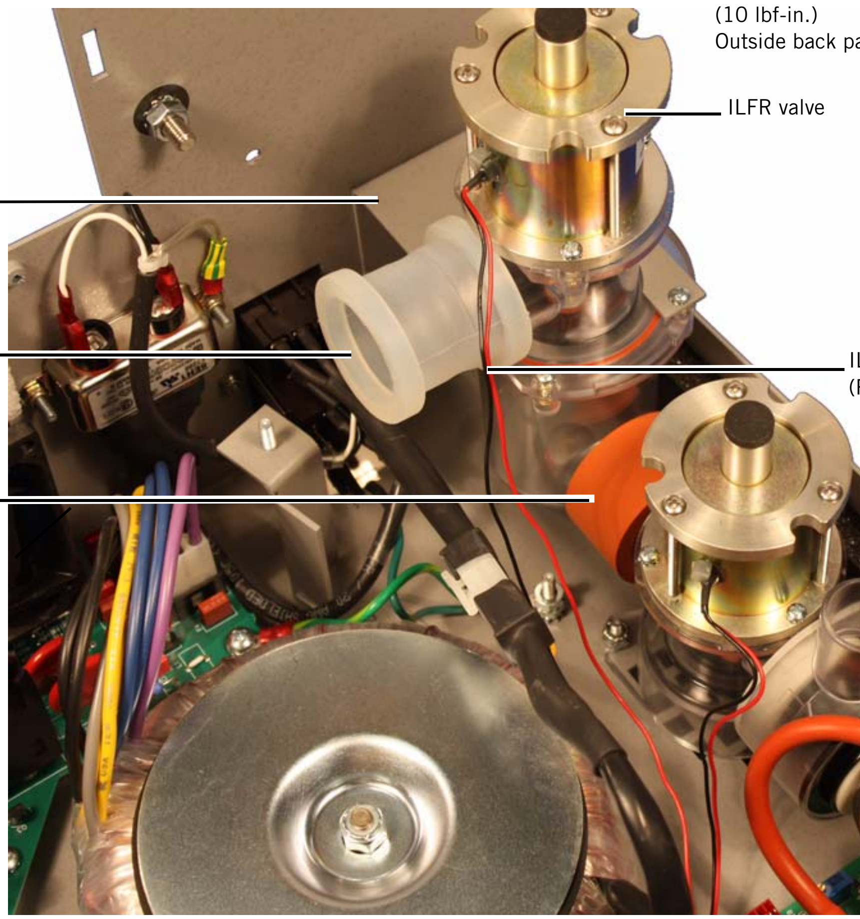

Figure 5-24: Removing the ILFR Valve

5.17 Main Power Switch

Follow these steps to remove the main power switch (Figure 5-27). Reverse to install.

1. Remove the blower (section 5.12).
2. Disconnect the main power switch cable from its connector on the power supply subsystem (PSS J7).
3. Pull the switch away from the back panel, feeding its cable through the back panel cutout.

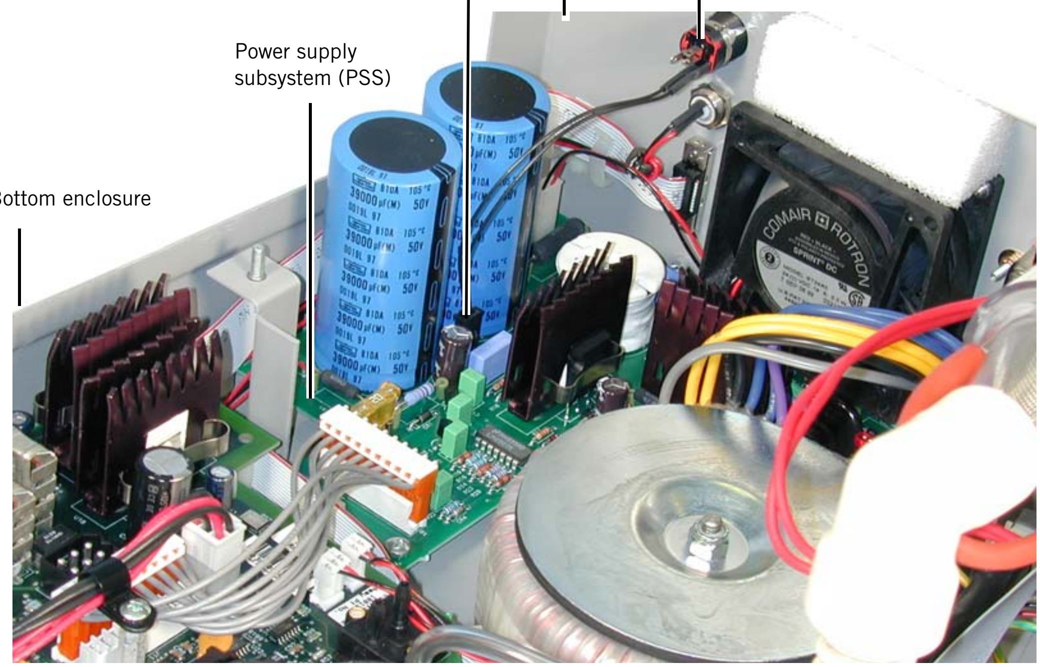

Figure 5-25: Removing the Main Power Switch

5.18 Fan

Follow these steps to remove the fan (Figure 5-27). Reverse to install.

NOTE: When reinstalling fan, ensure that the fan harness is at the lower left of the fan and route the harness over the capacitor.

1. Remove the main power switch (section 5.17).
2. Remove the fan cable from the PSS (PSS J6, PSS J4 for units built s/n 105999 and below).
3. Remove the 4 screws that attach the fan outlet cover to the back panel.
4. Unscrew the 4 standoffs from the back panel, then remove the standoffs and finger guard.
5. From inside the back panel, lift the fan away from the bottom enclosure.

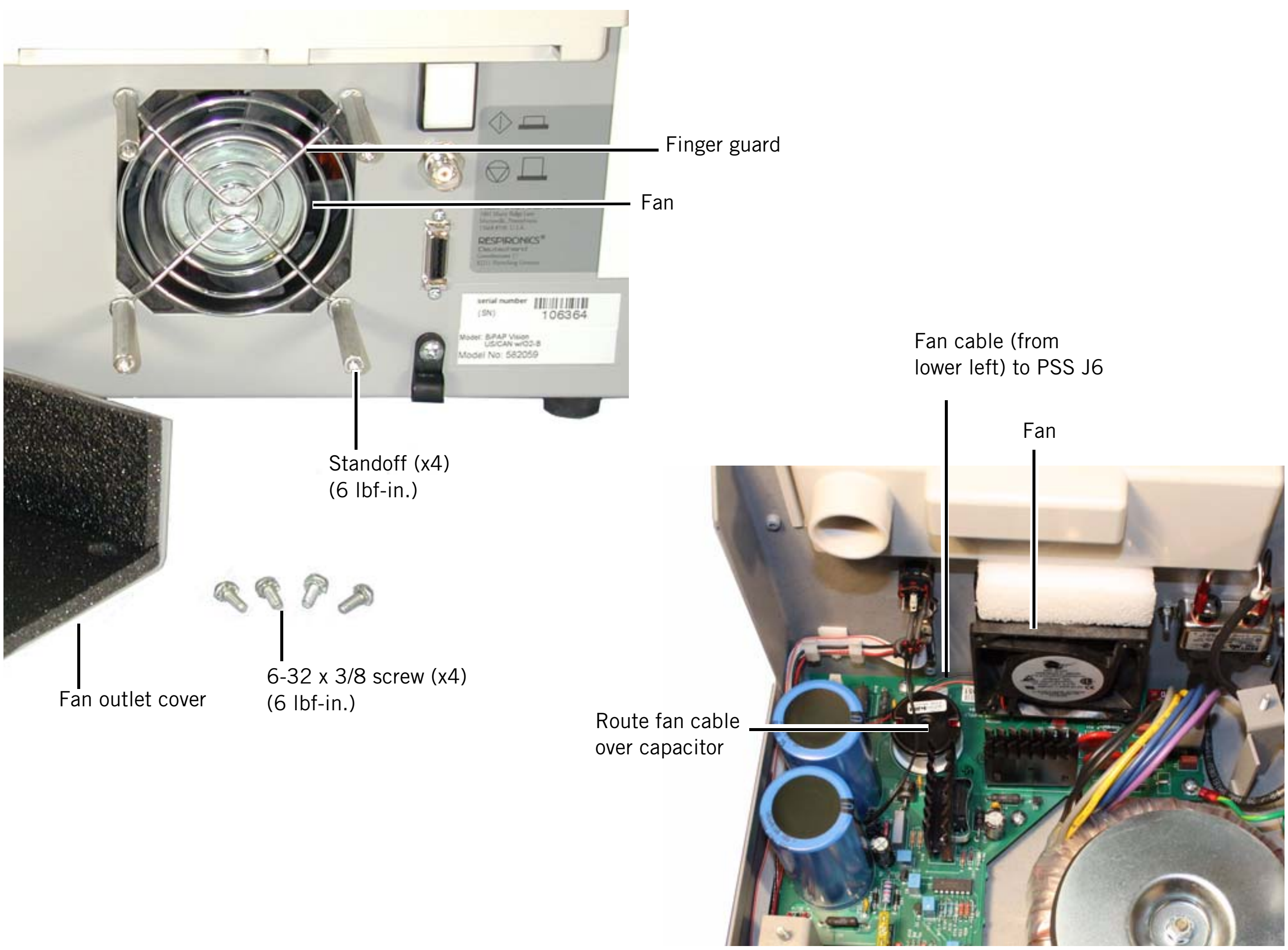

Figure 5-26: Removing the Fan

5.19 Pressure Control (PC) Board

Follow these steps to remove the PC board (Figure 5-27). Reverse to install.

1. Remove the blower (section 5.12).

2. Remove the screw that attaches the cable retainer to the PC standoff. Note that this step does not apply to older boards (called PAS boards) in non-upgraded units (built s/n 105999 and below).

3. Remove the aluminum standoff from the PC board. Note that this step does not apply to older boards (called PAS boards) in non-upgraded units.

4. Remove these cables from the PC board:
   - PSS-PC cable (PC J1-PSS J2).
   - ICB cable (PC J2-DC J14).
   - OM ribbon cable (PC J6-OM).
   - Blower harness (PC J5-blower).
   - AFM ribbon cable (PC J4-AFM).
   - PRV cable (PC J7-PRV).
   - ILFR cable (PC J8-ILFR).
   - PSS voltage monitoring cable (PC J12-PSS J8)

   NOTE: Although the OM and AFM ribbon cables are interchangeable, they are designed so that the shorter cable connects to the AFM and longer cable connects to the OM.

5. Remove the pressure tubing from pressure transducers MT1 and MT3. To reinstall pressure tubing:
   - Connect front panel proximal pressure port tubing to MT1 (port closest to OM/AFM).
   - Connect AFM tubing to MT3 (if transducer has two ports, connect tubing to port closest to “MT3” on PC board).

   CAUTION:To avoid damaging pressure transducers, avoid using excessive pressure to remove tubing. Carefully twist the tubing slightly to break the seal, the continue to rotate the tubing as you lift it away from the transducer.

6. Release the tabs on the 7 nylon standoffs that retain the PC board.

7. Lift the PC board away from the bottom enclosure.

CAUTION: When reinstalling the PC board, use care to align the connector on the underside of the board with the corresponding pins on the main control (MC) board.

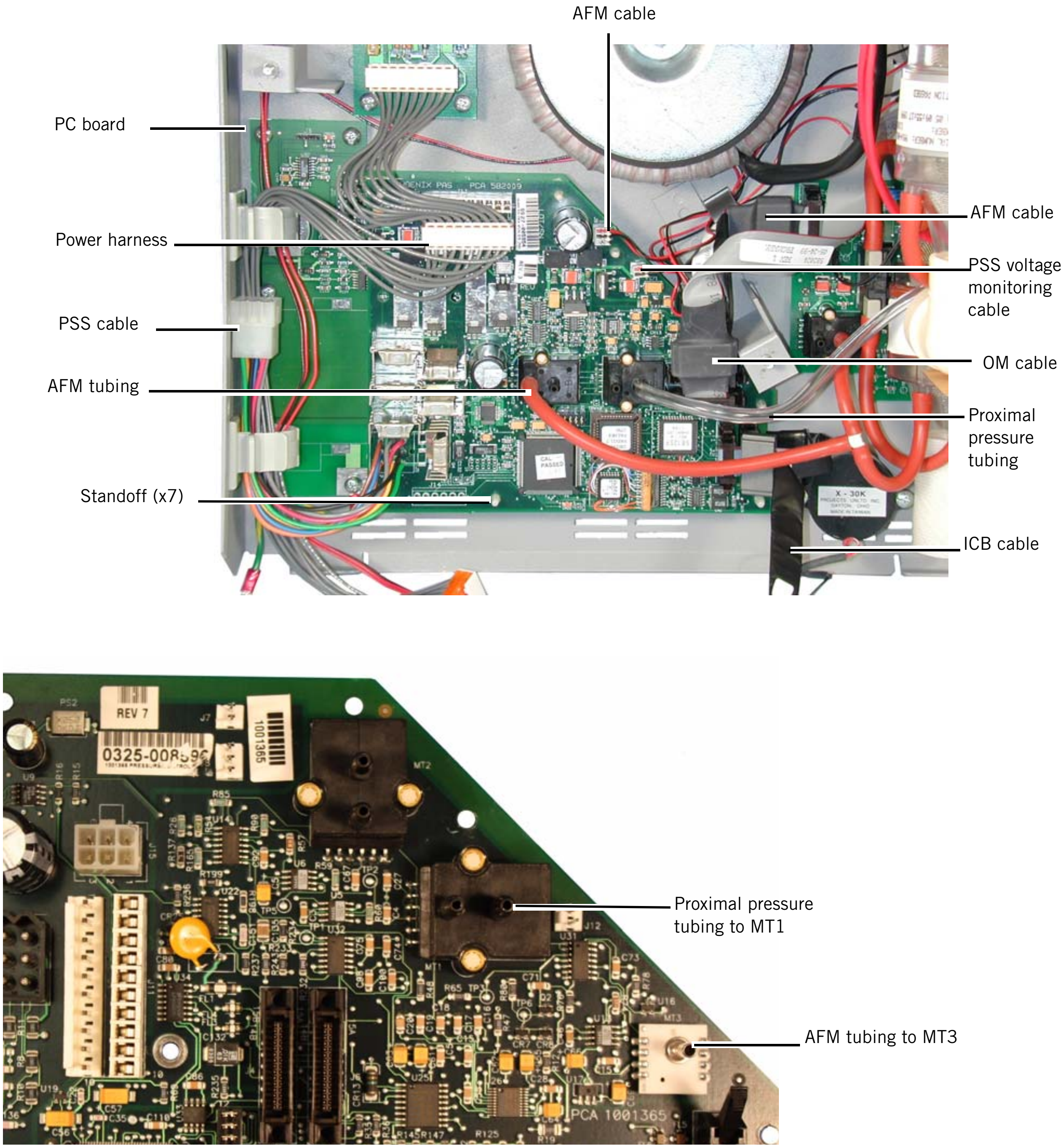

Figure 5-27: The PC Board

5.20 Main Control (MC) Board

Follow these steps to remove the MC board (Figure 5-28). Reverse to install.

1. Remove the PC board (section 5.19).
2. If necessary, remove nylon standoffs from the MC board.
3. Remove the aluminum standoff from the MC board.
4. Remove these cables from the MC board:
   - RS-232 cable from back panel (MC J3-RS 232 port).
   - Nurse call/remote alarm cable (MC J5-remote alarm connector).
   - RS-232 to DC harness (MC J6-DC J5).
5. Remove the 2 screws that attach the MC board from the bottom enclosure.
6. Lift the MC board from the bottom enclosure.

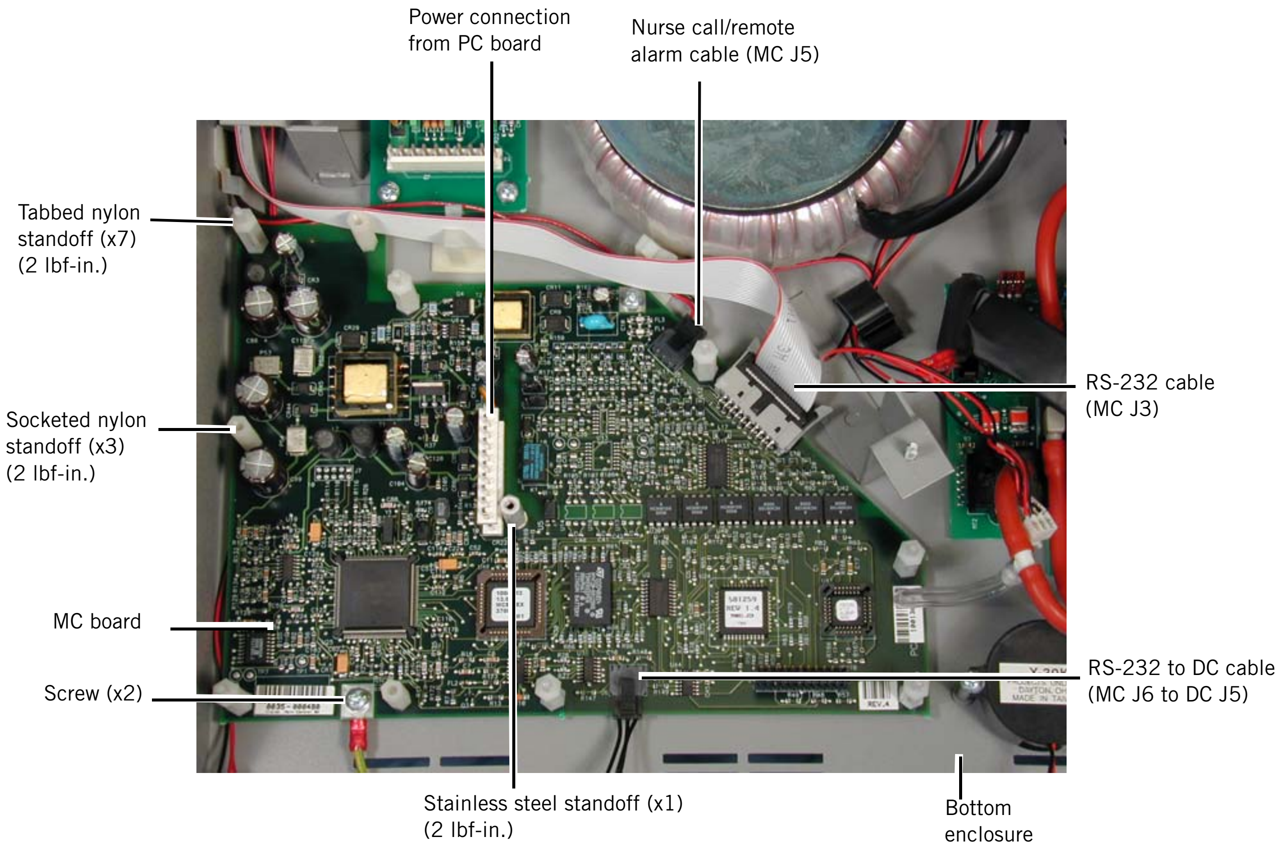

Figure 5-28: Removing the MC Board

5.21 Alarm

Follow these steps to remove the alarm (Figure 5-29). Reverse to install.

1. Remove the front panel enclosure (section 5.7).
2. Disconnect the alarm cable from the display control (DC) board connector J12.
3. Remove the 2 screws that attach the alarm to the bottom enclosure.
4. Lift the alarm from the bottom enclosure.

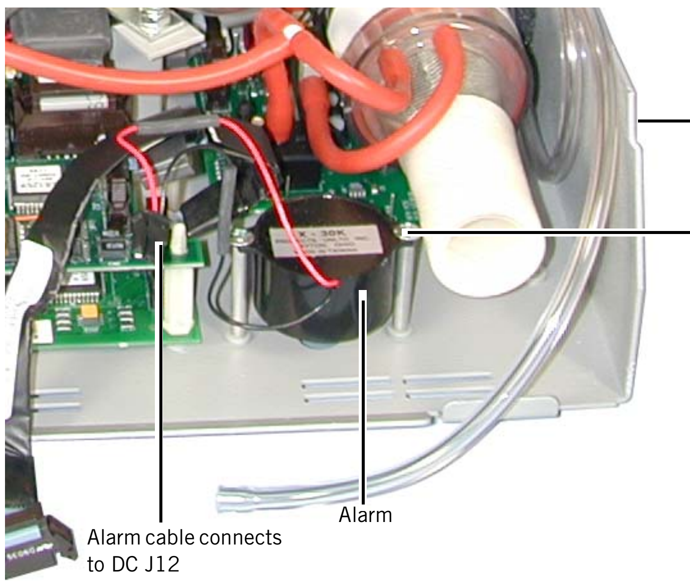

Figure 5-29: Removing the Alarm

5.22 Power Supply Subsystem (PSS)

Follow these steps to remove the PSS (Figure 5-29). Reverse to install.

1. Remove the blower (section 5.12).

2. Disconnect these cables:
    - Power on LED cable (attached to PSS J5)
    - Transformer cable (PSS J1)
    - PSS/PC power cable (PSS J2-PC J1)
    - Fan cable (PSS J6)
    - Power switch cable (PSS J7)
    - Voltage monitoring cable (PSS J8-PC J12)
    - PSS ground wire

3. Remove the 6 screws that attach the PSS to the bottom enclosure.

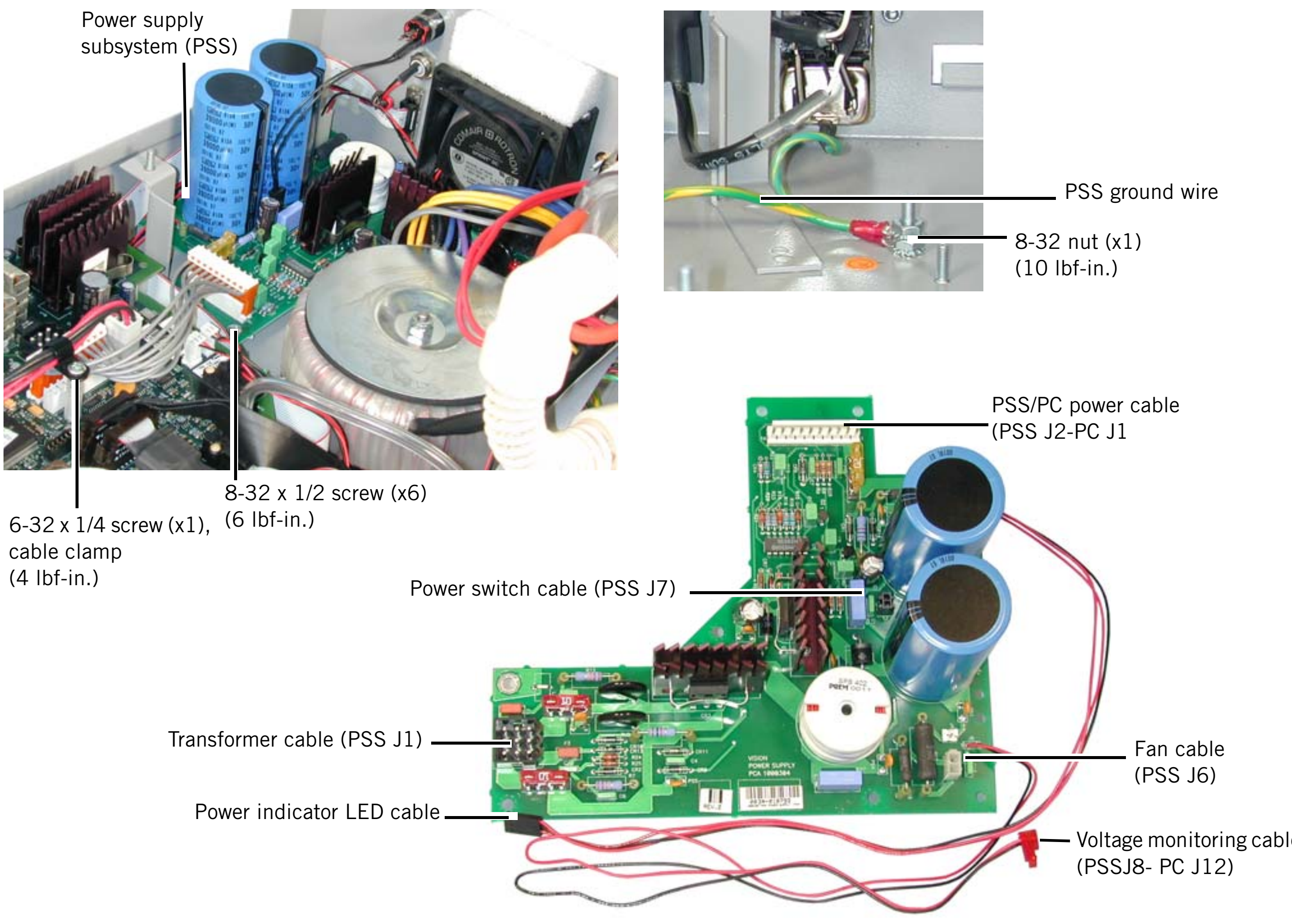

Figure 5-30: Removing the PSS

5.23 RS-232 Connector

Follow these steps to remove the RS-232 connector (Figure 5-31). Reverse to install.

NOTE: This procedure applies only to units built s/n 106000 and above (units built s/n 105999 and below do not include an RS-232 connector).

1. Remove the blower (section 5.12).
2. Remove the RS-232 cable from MC J3.
3. Remove the 2 screws that attach the RS-232 connector to the outside of the back panel.
4. Feed the connector and cable through the cutout in the back panel.

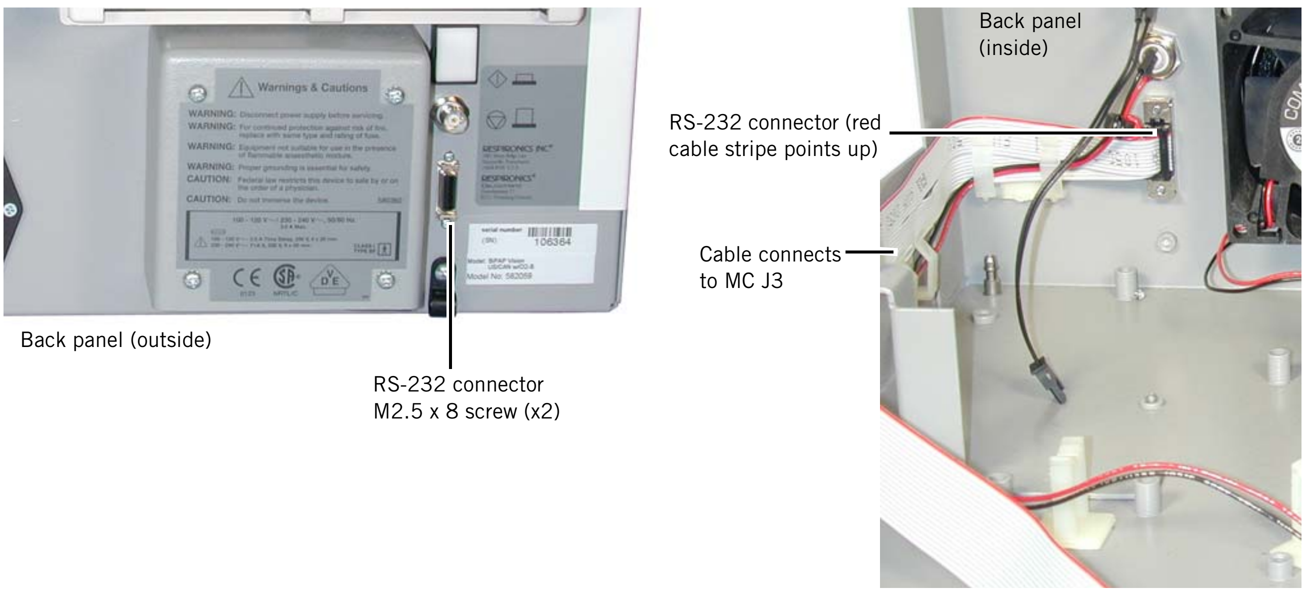

Figure 5-31: Removing the RS-232 Connector

5.24 Nurse Call/ Remote Alarm Connector

Follow these steps to remove the nurse call/remote alarm connector (Figure 5-32). Reverse to install.

NOTE: This procedure applies only to units built s/n 106000 and above (units built s/n 105999 and below do not include a nurse call/remote alarm connector).

1. Remove the blower (section 5.12).
2. Remove the nurse call/remote alarm cable from MC J5.
3. Remove the 9/16-in. nut that attaches the nurse call/remote alarm connector to the inside of the back panel.
4. Feed the connector and cable through the cutout in the back panel.

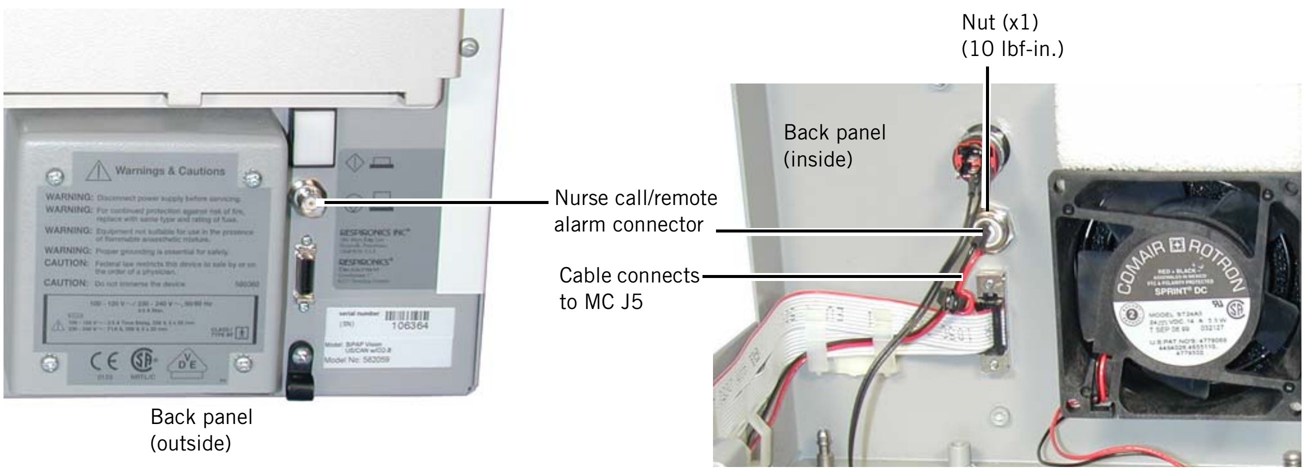

Figure 5-32: Removing the Nurse Call/Remote Alarm Connector

5.25 AC Inlet Assembly

Follow these steps to remove the AC inlet assembly (Figure 5-33). Reverse to install.

1. Remove the blower (section 5.12).
2. Remove the screws and nuts that attach the AC inlet and power line filter to the back panel.
3. Disconnect the transformer cable.
4. Remove the nut that attaches the ground wires from the bottom enclosure.

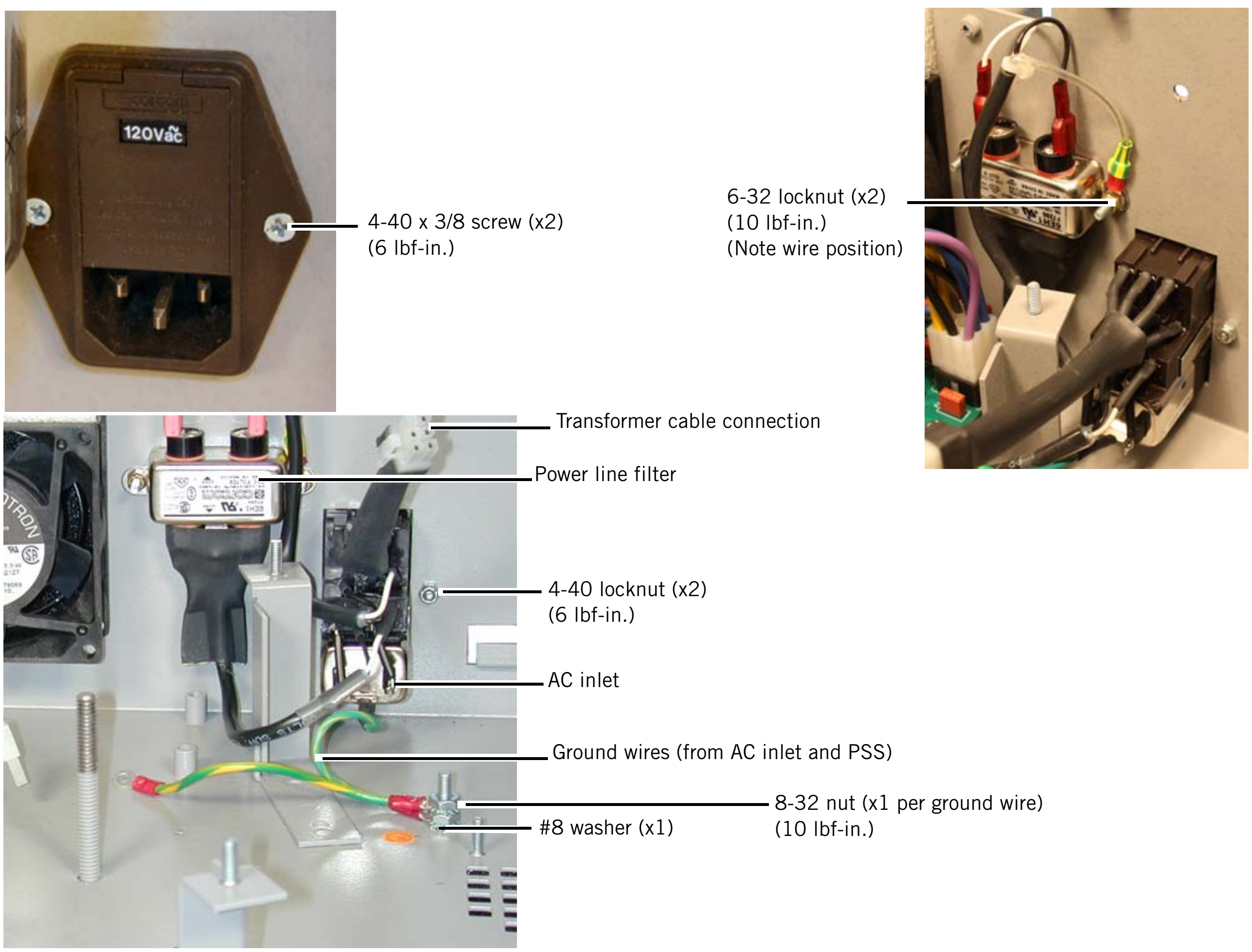

Figure 5-33: Removing the AC Inlet Assembly

5.26 Transformer

Follow these steps to remove the Transformer (Figure 5-34). Reverse to install.

1. Remove the blower (section 5.12).
2. Remove the retaining nut and plate at the top of the transformer.
3. Disconnect the transformer cables from the PSS J1 and AC inlet assembly.

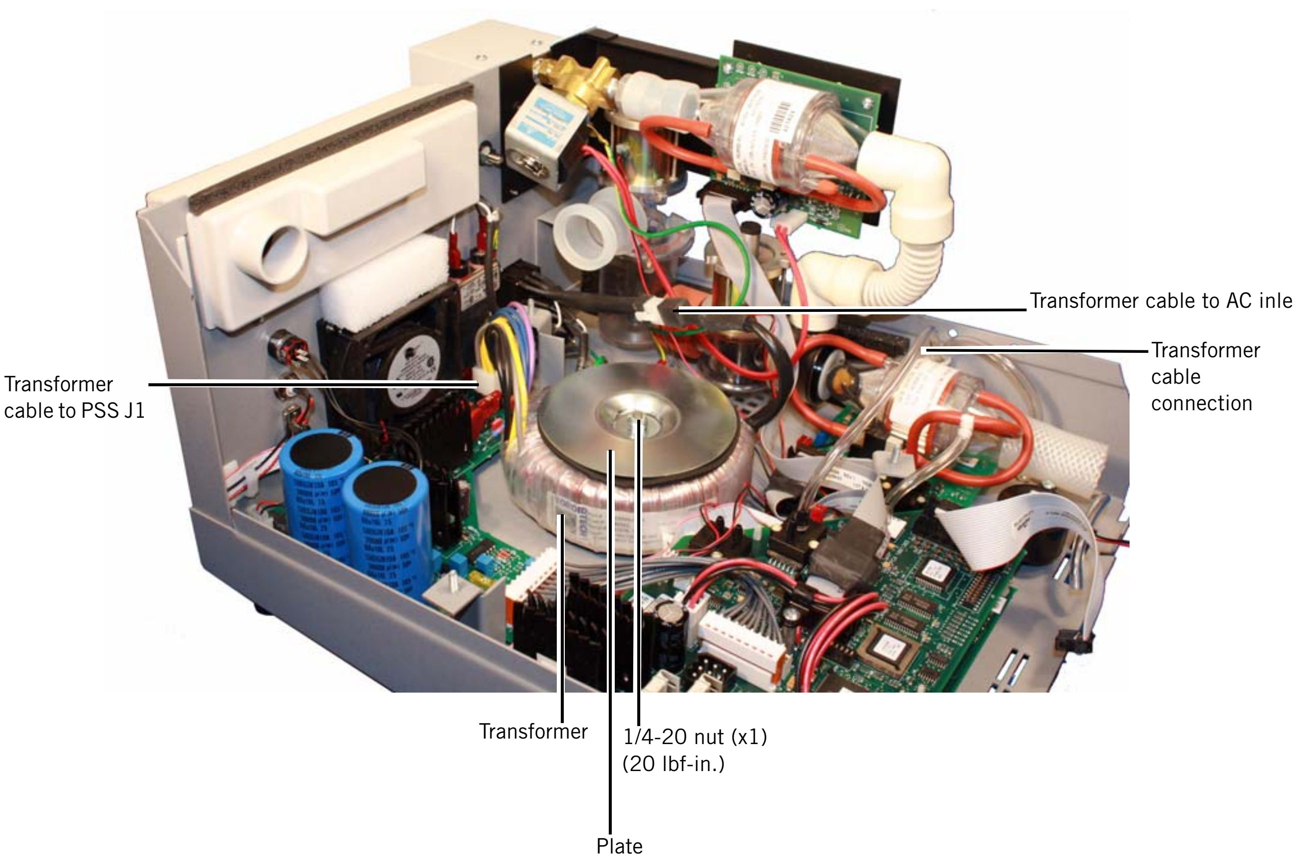

Figure 5-34: Removing the Transformer

5.27 Pressure Relief Valve (PRV) Enclosure

Follow these steps to remove the PRV enclosure (Figure 5-35). Reverse to install.

NOTE: Apply a small amount of threadlock when reinstalling the PRV enclosure screws to the bottom enclosure.

1. From the underside of the bottom enclosure, remove the four screws that attach the PRV enclosure.

2. Remove the PRV enclosure.

Figure 5-35: Removing the PRV Enclosure

5.28 Back Panel Strain Relief

Follow these steps to remove the back panel strain relief (Figure 5-35). Reverse to install.

1. Remove the screw that attaches the back panel strain relief.
2. Remove the strain relief.

Figure 5-36: Back Panel Strain Relief

5.29 Bumper Feet

Follow these steps to remove the bumper feet (Figure 5-11). Reverse to install.

NOTE: Apply a small amount of threadlock when reinstalling the bumper feet screws to the bottom enclosure.

1. Turn the ventilator off and disconnect the power cord from the back of the device.
2. Remove the screw that attaches each bumper foot from the bottom enclosure.

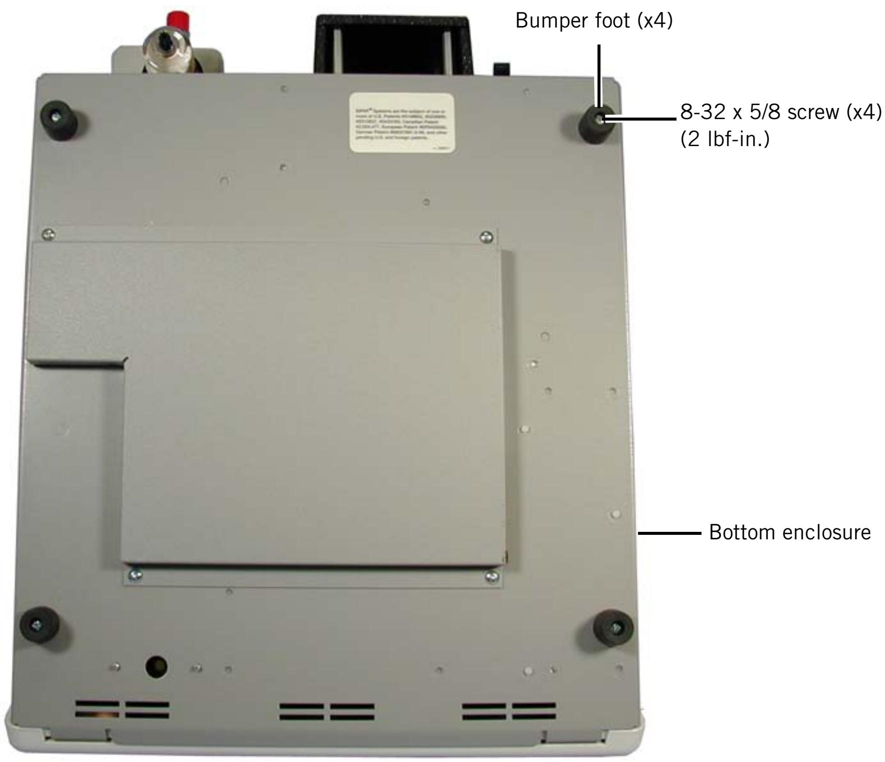

Figure 5-37: Bumper Feet

CAUTION: To avoid contacting the power supply, do not over-tighten the left rear bumper foot.

NOTE: When installing the ventilator to the universal cart, replace the rear bumper foot with the cart's captive hardware.

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Chapter 6. Troubleshooting

This chapter describes how to troubleshoot symptoms that may occur.

- See Section 6.1 to diagnose and correct common problems.
- See Section 6.3 to diagnose and correct alarms.
- See Section 6.4 to diagnose and correct *Check Vent* error codes.
- See Section 6.5 to diagnose *Vent Inop* error codes.
- Section 6.6 describes how to interpret error codes and determine which one is the primary fault.
- Section 6.7 describes how to perform service if the ventilator continues operating when both a *Vent Inop* and a *Check Vent* (error code 201) occur.

6.1 Troubleshooting Common Problems

Table 6-1 describes common problems, possible causes, and corrective actions.

Table 6-1: Troubleshooting Common Problems

Symptom	Possible cause	Corrective action
Outlet air temperature too warm	High ambient temperature	Reduce ambient temperature or relocate ventilator.
	Defective inlet filter, blower, transformer, or PC board.	Replace each part separately to see if problem is resolved. If not, reinstall and try replacing another part.
Noise	Blower out of calibration.	Perform blower/valve calibration (Chapter 7).
	Defective inlet filter, blower, transformer, or PC board.	Replace each part separately to see if problem is resolved. If not, reinstall and try replacing another part.
Touch pad does not respond to selection	Defective touch pad or DC board.	1. Check connections. 2. Replace touch pad. 3. Replace DC board.
Rotary encoder does not adjust selection	Defective rotary encoder or DC board.	1. Replace rotary encoder. 2. Replace DC board.
Ventilator operation is interrupted, then resumes.	AC power restored after power loss. For software versions 11.12, 12.8, 13.8 and higher: normal operation resumes following power loss of any length of time when the power switch remains ON. For earlier software (versions 11.0 - 11.11, 12.0 - 12.7, and 13.0 - 13.7): normal operation resumes following a power loss of approximately 10 seconds or less.	Check power source and power cord connections.
Ventilator operation is interrupted, the display shows the Exhalation Port Test screen.	AC power restored after power loss of approximately 10 seconds or longer, for software versions 11.0 - 11.11, 12.0 - 12.7, and 13.0 - 13.7.	1. Exit screen and restart normal operation. 2. Check power source and power cord connections.

Table 6-1: Troubleshooting Common Problems

Symptom	Possible cause	Corrective action
Check Vent icon lights, audible alarm sounds	See Section 6.4.	
Vent Inop icon lights, audible alarm sounds	See Section 6.5.	

6.2 Alarm Indicators

The BiPAP Vision checks its function at startup and periodically during operation. Ventilator microprocessors continuously monitor internal sensor readings and evaluate operation. The ventilator analyzes and reports any discrepancies according to the level of severity.

- The *Check Vent* and *Vent Inop* indicators can be activated at any time during ventilator operation, and signal a device malfunction.
- Patient-related alarms are displayed on the screen.

6.2.1 *Check Vent* and *Vent Inop* Indicators

Check Vent indicator

Check Vent indicator: notifies users of potentially abnormal operation. When active, the yellow eye icon lights and an audible alarm sounds. Pressing Alarm silence temporarily silences the audible alarm. The visual indicator cannot be reset, and remains lit until the error is corrected. The ventilator continues operation during a *Check Vent* condition.

Vent Inop indicator

Vent Inop indicator: notifies users of a system malfunction or loss of AC power. When active, the red wrench icon lights and an audible alarm sounds. The audible and visual alarms remain active and cannot be silenced or reset until the on/off switch is set to the off position. The ventilator immediately powers down and opens its internal valves to allow spontaneous breathing.

6.2.2 Patient Alarm Indicators

Patient alarms include audible and visual indicators. When an alarm is active, the audible alarm sounds and the display shows the alarm condition in the mode/message area (Figure 6-1).

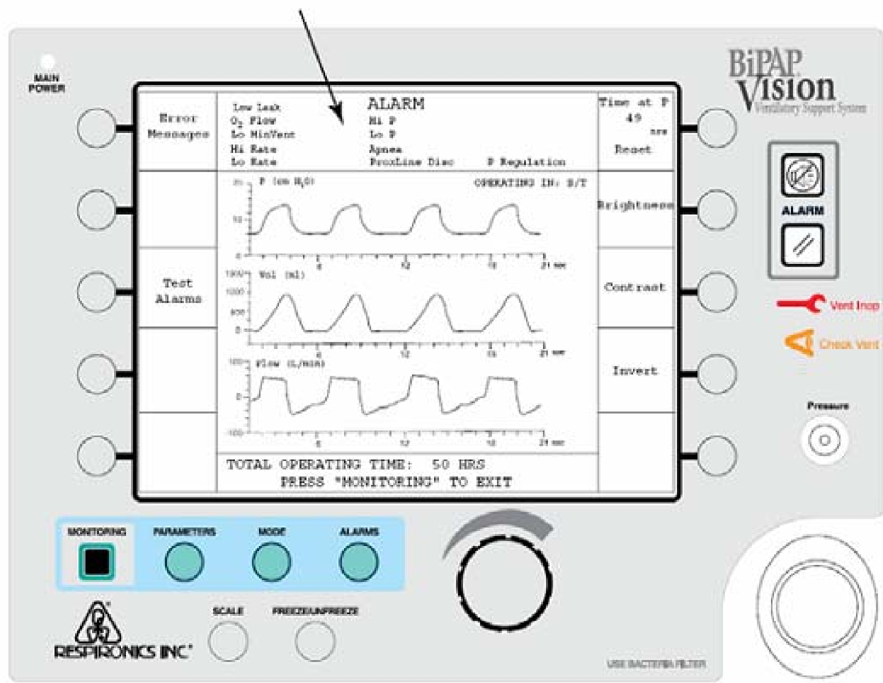

Figure 6-1: Example Patient Alarm in Mode/Message Area

6.2.3 Alarm Silence and Alarm Reset

The ventilator turns off the audible indicator for most patient alarms if the alarm condition is corrected. An operator can press the Alarm silence key to turn off the audible alarm for 2 minutes (subsequent presses have no effect on the alarm).

During the 2-minute alarm silence, the message *Alarm Silenced* appears in the mode/message area. Except for an apnea alarm, any new alarm that occurs during the 2-minute alarm silence is displayed but an audible alarm does not sound.

If an alarm condition is corrected, the audible alarm turns off. The only way to clear a visual patient alarm indicator is to press the Alarm reset key. If the alarm condition is not corrected, the audible and visual alarm indicators immediately turn on.

6.2.4 Flow Limit Control (FLC) State

The ventilator enters the flow limit control (FLC) state when a disconnect alarm occurs.

Detecting a disconnect condition:

The device determines that a patient is not connected to the circuit based on flow for a given pressure (as defined in a lookup table that includes a flow entry for every generated pressure). The range of flows is 95 to 180 LPM, with 180 LPM the low limit for any pressure above 9 cmH_2O. If the unit detects flow greater than the threshold at any given pressure for more than 10 seconds (3 seconds in for software versions earlier than 13.2), it enters the FLC state.

In the FLC state, the ventilator attempts to limit the flow from the mask to make putting the mask back on the patient easier and more comfortable for the patient. The oxygen valve closes to discontinue oxygen delivery. Pressing the Standby key also causes the ventilator to enter the FLC state, regardless of the flow at the time.

During FLC the ventilator drops the pressure to 4 cmH_2O. A full face mask has a flap that closes the patient circuit and opens the mask to atmosphere upon loss of flow and pressure. The 4-cmH_2O pressure keeps the flap open during FLC to avoid occluding the patient circuit. When the ventilator detects that the patient is reconnected, it slowly increases pressure to maintain a the flow of 160-170 LPM. Circuit pressure is limited to 10 cmH_2O (software version 11.2 and 11.3) or 15 cmH_2O (software version 11.3a and higher), regardless of how much flow is generated. This means that the ventilator delivers 160-170 LPM within the specified pressure range, or is limited to a lower flow at 10 or 15 cmH_2O (depending on the software version).

Terminating the FLC state:

FLC terminates if the ventilator detects negative flow (that is, the patient breathes back into the device) as pressure increases from 4 cmH_2O to its maximum of 10 or 15 cmH_2O (depending on software version).

For software versions earlier than 13.2, this pressure increase takes about 10 to 12 seconds (¼ cmH_2O per 40 ms), depending on how soon the flow set point is reached. The ventilator increases pressure more quickly (1 cmH_2O per 40 ms) for software versions 13.2 and later.

For software versions earlier than 13.2, when pressure drops to 4 cmH_2O and the flow is above 160-170 LPM, the flow limit algorithm decreases the pressure to reduce the flow to 160-170 LPM. For software versions 13.2 and later, FLC terminates immediately pressure drops to 4 cmH_2O and the flow is above 160-170 LPM.

Once either the flow target or the maximum pressure is reached, the ventilator automatically terminates FLC if:

- negative flow is detected, or
- flow varies from the current flow by over 40 LPM (software versions earlier than 13.2) or 20 LPM (software versions 13.2 and later).

Example: if 160-170 LPM is reached, the ventilator terminates FLC if:

- flow is below 120 LPM or above 210 LPM (older software)
- flow is below 140 LPM or above 190 LPM (newer software)

If the flow target is not reached, the ventilator targets the maximum pressure instead (10 cmH_2O for software version 11.2 and 11.3, or 15 cmH_2O for software version 11.3a and higher).

Example: if the ventilator can only reach 80 LPM at 10 cmH_2O (older software) or 15 cmH_2O (newer software), FLC terminates if of

- flow is below 40 LPM or above 120 LPM (older software)
- flow is below 60 LPM or above 100 LPM (newer software)

This allows FLC to terminate when the mask is refitted to the patient, without requiring the patient to breathe back into the ventilator.

To terminate Standby manually (which is also terminated automatically as described above), methods, select the highlighted Standby soft key on the Monitoring screen.

When FLC is terminated during a Disconnect alarm, the alarm self-cancels (that is, the audible alarm is silenced but the visual alarm remains). To clear the alarm, press the Alarm reset key.

NOTE: During FLC oxygen concentration is 21%, regardless of the setting.

6.3 Alarm Troubleshooting

Table 6-2 describes alarms, including possible causes and corrective actions.

Table 6-2: Troubleshooting Alarms

Alarm display	Description	Possible cause	Corrective action
	Check ventilator indicator: audible and visual indicators active, ventilator continues operation.	System error	See Section 6.4 for *Check Vent* troubleshooting information.
	Ventilator inoperative indicator: system failure (device malfunction) or AC power failure (power is lost when the power switch is ON). Device shuts down, valves open to atmosphere to permit spontaneous breathing, audible and visual indicators active, audible alarm cannot be silenced.	Failure that impairs ventilator performance.	See Section 6.5 for *Vent Inop* troubleshooting information.
		AC power failure	1. Verify input power. 2. Check fuses.
		Thermal fuse activated (non-resettable).	Replace transformer.
		No bulk supply voltage.	Replace PSS.
Apnea	No spontaneous breath triggered within set apnea interval. Cancels when patient triggers 2 consecutive spontaneous breaths. Apnea alarm can be disabled.	Patient not breathing or cannot trigger a spontaneous breath.	1. Check patient. 2. Check patient circuit. 3. Review apnea alarm limit.
Disconnect	Mask removed or excessive leak. Cancels if leak is corrected.	Mask or circuit removed or dislodged	Check patient circuit and mask.
Exh. Port	Low leak during exhalation: activates when leak during exhalation falls to 5 L/min or 50% of alarm limit for 1 minute.	Air flow path blocked or restricted.	Check air flow path.
Hi P	High pressure: proximal pressure exceeds the high pressure alarm limit for over 0.5 s. Ventilator terminates inspiration. Cancels if pressure during a subsequent breath is below the high pressure limit.	• Patient coughs during inspiration. • High pressure alarm limit set below pressure setting.	1. Check patient. 2. Review high pressure alarm limit.

Table 6-2: Troubleshooting Alarms

Alarm display	Description	Possible cause	Corrective action
Hi Rate	High total respiratory rate: the number of mandatory and spontaneous breaths exceeds the high rate alarm limit. Cancels if the measured rate drops below the alarm limit.	• Patient's respiratory rate increases. • High rate alarm limit set too low for patient.	1. Check patient. 2. Review high rate alarm limit.
Lo P	Low pressure: proximal pressure below the low pressure limit for a time that exceeds the low pressure delay setting. Cancels if pressure rises above the low pressure limit.	• Patient disconnect or large leak. • Patient inspiratory demand exceeds delivered flow. • Low pressure delay setting too low, or low pressure limit set above pressure setting.	1. Check patient. 2. Check patient circuit and inlet filter. 3. Review low pressure delay setting. 4. Review low pressure alarm limit.
Lo Rate	Low total respiratory rate: the number of mandatory and spontaneous breaths below the low rate alarm limit. Cancels if the measured rate rises above the alarm limit.	• Patient's respiratory rate decreases. • Patient cannot trigger breaths. • Low rate alarm limit set too high for patient.	1. Check patient. 2. Review low rate alarm limit.
LoMin Vent	Delivered minute volume is below the low minute volume alarm limit (alarm can be disabled). Cancels if minute volume rises above the alarm limit.	• Patient disconnect or large leak. • Patient's respiratory rate or tidal volume decreases. • Low minute volume alarm limit set too high for patient.	1. Check patient. 2. Check patient circuit and patient connection. 3. Review low minute volume alarm limit.
O_2 Flow	Oxygen supply pressure drop. Ventilation continues. Alarm does not self-cancel.	• Insufficient or disconnected oxygen supply. • Blocked oxygen regulator inlet filter.	1. Check oxygen supply and connections. 2. Check oxygen regulator inlet filter and replace if necessary.

Table 6-2: Troubleshooting Alarms

Alarm display	Description	Possible cause	Corrective action
P Regulation	Loss of pressure regulation: measured proximal pressure is more than 5 cmH_2O above or below the set pressure for over 5 seconds. Cancels if measured pressure returns to within 5 cmH_2O of pressure setting. Alarm automatically cancelled if ventilator enters flow limit control (FLC) state.	• Large leak. • Occluded patient circuit.	Check the patient circuit for leaks, kinks, or obstructions.
ProxLine Disc	Proximal pressure line disconnect: measured proximal pressure is less than 1 cmH_2O for over 1 s. Cancels if proximal pressure rises above 1 cmH_2O. Alarm automatically cancelled if ventilator enters flow limit control (FLC) state.	• Proximal pressure line disconnected or blocked.	Check proximal pressure line for leaks or obstructions.

6.4 Troubleshooting *Check Vent* Error Codes

This flow chart (Figure 6-2) summarizes the troubleshooting sequence to follow if the *Check Vent* indicator lights.

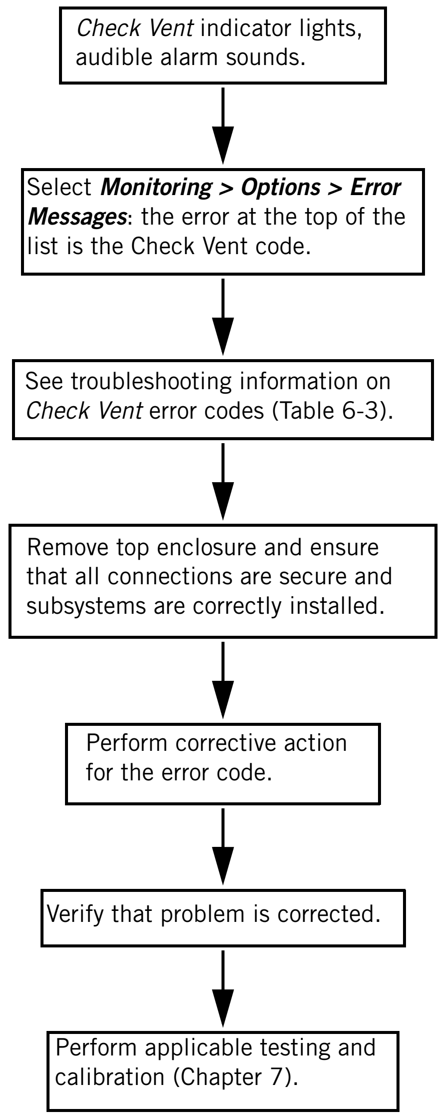

Figure 6-2: Check Vent Troubleshooting Flow Chart

Table 6-3 describes *Check Vent* error codes, including possible causes and corrective actions.

Table 6-3: Troubleshooting *Check Vent* Error Codes

Error code	Description	Corrective action
100	Real-time clock (RTC) error on the MC.	Replace MC board.
101	MC nonvolatile RAM (NVRAM) cyclic redundancy (CRC) error	Replace MC board.
102	MC backup battery error.	1. Replace lithium battery. 2. Replace MC board.
103	MC reference voltage (Vref) error	Replace MC board.
200	DC voltage error.	Replace MC board.
201 with *Vent Inop*	The ventilator continues operating when both a *Vent Inop* and a *Check Vent* (error code 201) occur.	Perform service described in Section 6.7.
201	DC audible alarm error.	Replace DC board.
202	DC *Check Vent* indicator current error.	Replace DC board.
203	DC *Vent Inop* indicator current error.	Replace DC board.
204	DC backlight voltage error.	Replace DC board.
205	Low DC alarm battery voltage.	1. Recharge battery (Chapter 4). 2. Replace DC board.
206	Touch pad error.	1. Recharge touch pad. 2. Replace DC board.
300	Circulation fan error.	Replace circulation fan.
301	Invalid PC calibration data.	1. Calibrate blower valve. 2. Replace PC board.
303	Blower speed exceeds 16500 revolutions per minute (RPM) limit.	1. Replace blower. 2. Replace PC board.
306	Oxygen module (OM) disconnected from PC board.	1. Replace OM cable. 2. Replace OM. 3. Replace PC board.

6.5 Troubleshooting *Vent Inop* Error Codes

This flow chart (Figure 6-3) summarizes the troubleshooting sequence to follow if the *Vent Inop* indicator lights.

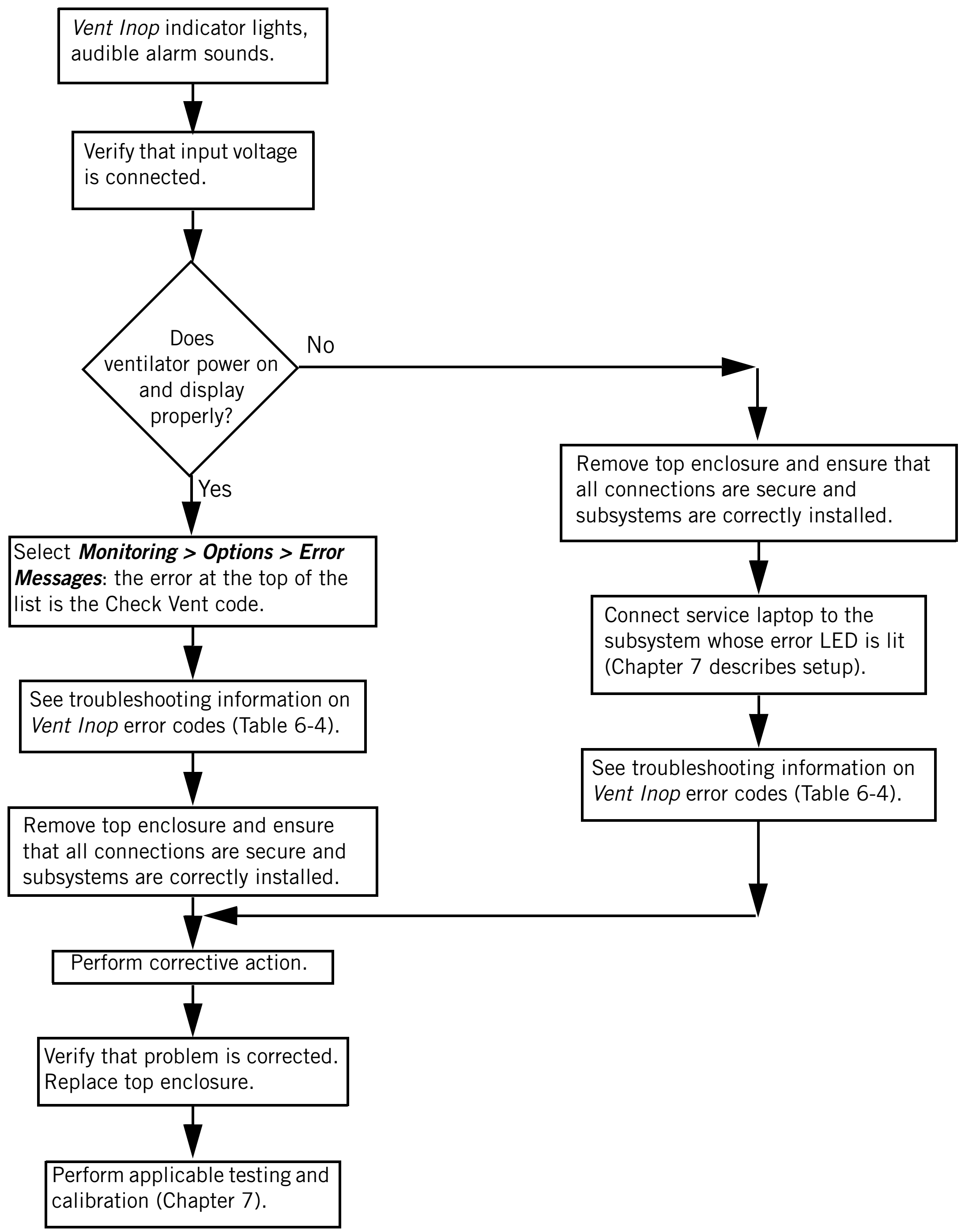

Figure 6-3: Vent Inop Troubleshooting Flow Chart

Table 6-4 describes *Vent Inop* error codes that apply to the MC, DC, and PC boards.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
Vent Inop errors common to all subsystems:		
Vent Inop with *Check Vent* error code 201	The ventilator continues operating when both a *Vent Inop* and a *Check Vent* (error code 201) occur.	Perform service described in Section 6.7.
0 (MC, DC, PC)	Hardware error.	See error reported for a specific subsystem.
601 (MC) E01 (DC) 1601 (PC)	Microcontroller unit (MCU) detects spurious interrupt.	Replace subsystem with lit error LED.
602 (MC) E02 (DC) 1602 (PC)	MCU detects unassigned interrupt.	Replace subsystem with lit error LED.
603 (MC) E03 (DC) 1603 (PC)	MCU detects bus interrupt.	Replace subsystem with lit error LED.
604 (MC) E04 (DC) 1604 (PC)	MCU detects illegal instruction execution.	Replace subsystem with lit error LED.
605 (MC) E05 (DC) 1605 (PC)	MCU detects breakpoint error.	Replace subsystem with lit error LED.
606 (MC) E06 (DC) 1606 (PC)	MCU detects divide by zero error.	Replace subsystem with lit error LED.
607 (MC) E07 (DC) 1607 (PC)	MCU detects municipalized interrupt.	Replace subsystem with lit error LED.
608 (MC) E08 (DC) 1608 (PC)	MCU detects software interrupt execution.	Replace subsystem with lit error LED.
609 (MC) E09 (DC) 1609 (PC)	MCU detects unused interrupt execution.	Replace subsystem with lit error LED.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
60A (MC) E0A (DC) 160A (PC)	Corrupt EPROM CRC error.	Replace subsystem with lit error LED.
60C (MC) N/A (DC) N/A (PC)	Invalid data on *MC state* signal.	Replace subsystem with lit error LED.
60E (MC) E0E (DC) 160E (PC)	Watchdog error (software continues after long delay in watchdog timer test).	Replace subsystem with lit error LED.
614 (MC) E14 (DC) 1614 (PC)	RAM hardware error: pattern read doesn't match written pattern.	Replace subsystem with lit error LED.
616 (MC) E16 (DC) 1616 (PC)	Power on reset occurred after watchdog test.	1. Replace subsystem with lit error LED. 2. Replace alarm PAL chip on MC board.
617 (MC) E17 (DC) 1617 (PC)	Serial interface (SCI) error: SCI register not ready for character output.	Replace subsystem with lit error LED.
700 (MC) F00 (DC) 1700 (PC)	CRC error: calculated CRC does not match sent CRC on third send to DC-MC.	1. Replace intermodule communications bus (ICB) cable. 2. Replace DC board. 3. Replace MC board. 4. Replace PC board.
701 (MC) F01 (DC) 1701 (PC)	Negative acknowledgment (NAK) received on third send to DC-MC.	1. Replace ICB cable. 2. Replace DC board. 3. Replace MC board. 4. Replace PC board.
702 (MC) F02 (DC) 1702 (PC)	Acknowledge timer (Tack) timeout on third send to DC-MC: Tack not received within last 750 usec of last byte sent.	1. Replace ICB cable. 2. Replace DC board. 3. Replace MC board. 4. Replace PC board.
703 (MC, DC, PC)	Reply timer (Trply) timeout on third send to DC-MC: slave did not respond within 1 msec of last byte sent from MC.	1. Replace ICB cable. 2. Replace DC board. 3. Replace MC board. 4. Replace PC board.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
N/A (MC) F04 (DC) 1704 (PC)	MC timeout from slave: MC did not request data from slave within 15 msec.	1. Replace ICB cable. 2. Replace DC board. 3. Replace MC board. 4. Replace PC board.
705 (MC) E05 (DC) 1705 (PC)	Packet does not fit in message: buffer in *Move Packet to Message* is full.	Replace subsystem with lit error LED.
706 (MC) E06 (DC) 1706 (PC)	Invalid timer value: timers not initialized or invalid data on timer parameter.	Replace subsystem with lit error LED.
707 (MC) F07 (DC) 1707 (PC)	Invalid delay value: timers not initialized or requested delay is greater than 1 minute (prevents rollover).	Replace subsystem with lit error LED.
708 (MC) F08 (DC) 1708 (PC)	Invalid delay (usec): timers not initialized or requested delay is greater than 85 usec (use *Delay* for longer delays).	Replace subsystem with lit error LED.
709 (MC) F09 (DC) 1709 (PC)	General purpose timer (GPT) not initialized before *Initiate Timers* call.	Replace subsystem with lit error LED.
70A (MC) F0A (DC) 170A (PC)	Invalid usec ticks: timers not initialized or *PCsed* is too large (>62499 prevents rollover).	Replace subsystem with lit error LED.
70B (MC) F0B (DC) 170B (PC)	Invalid priority level: *PCsed* priority level value is invalid.	Replace subsystem with lit error LED.
70C (MC) N/A (DC) N/A (PC)	CRC error on third send to PC: calculated value does not match sent value on third send.	1. Replace ICB cable. 2. Replace PC board. 3. Replace DC board. 4. Replace MC board.
70D (MC) N/A (DC) N/A (PC)	NAK received on third send to PC.	1. Replace ICB cable. 2. Replace PC board. 3. Replace DC board. 4. Replace MC board.
70E (MC) N/A (DC) N/A (PC)	Tack timeout on third send to PC: Tack not received within 750 usec of last byte sent.	1. Replace ICB cable. 2. Replace PC board. 3. Replace DC board. 4. Replace MC board.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
70F (MC) N/A (DC) N/A (PC)	Trply timeout on third send to PC: Trply not received within 1 msec of last byte sent.	1. Replace ICB cable. 2. Replace PC board. 3. Replace DC board. 4. Replace MC board.
FFFF (MC, DC, PC)	Illegal error report: software detected an extra data bit.	No action required.
Vent Inop errors specific to DC board:		
B00	Bad ICB message from MC: self test status message data invalid, message byte count >125, or command ID not recognized.	1. Replace ICB cable. 2. Replace DC board. 3. Replace MC board. 4. Replace PC board.
B01	Bad download sequence from MC: DC received unexpected download message.	1. Replace ICB cable. 2. Replace DC board. 3. Replace MC board. 4. Replace PC board.
B02	Invalid mode: invalid data in *test mode* signals or mode-specific message received in incorrect mode.	Replace DC board.
B03	Hard key table decoding error: invalid ICB message for selected hard key.	Replace DC board.
B04	Screen state error: invalid soft key selection for mode, illegal entry into process key stroke function.	Replace DC board.
B09	Simultaneous failure of *Vent Inop* LED and audible alarm, alarm and system error LED indicated by hardware.	Replace DC board.
B0A	MC startup error: MC did not send status request within 30 s of DC startup.	1. Replace MC board. 2. Replace DC board.
B0B	Font type error: invalid data on the *G screen font type* signal.	Replace DC board.
B0C	Video memory address error: invalid calculation for screen pixel to start writing to (off screen).	Replace DC board.
B0D	DC queue overflow: no room in display queue for incoming MC message, background not running often enough.	Replace DC board.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
B0E	Graph size error: invalid X or Y length (≤0).	Replace DC board.
B0F	Graph structure unavailable: attempt to initialize a fourth graph.	Replace DC board.
B10	Spurious key pad interrupts: more than 10 interrupts in a row with no key press.	1. Replace touch pad. 2. Replace DC board.
11D1	Touch pad error: key press during startup tests or held down for longer than 10 s.	1. Replace touch pad. 2. Replace DC board.
11D7	Invalid startup test: invalid test case data.	Replace DC board.
11D8	Invalid BIST test: invalid built-in self test (BIST) case data.	Replace DC board.
Vent Inop errors specific to MC board:		
206	Real time clock (RTC) error: invalid data on *RTC case* signal or serial peripheral interface (SPI) timeout when attempting to get time.	Replace MC board.
207	Illegal operational test: test does not exist.	Replace MC board.
209	+12 V out of range: ADC voltage test.	Replace MC board.
20A	-12 V out of range: ADC voltage test.	Replace MC board.
20B	+24 V out of range: ADC voltage test.	Replace MC board.
20C	Reference voltage (Vref) out of range: ADC voltage test.	Replace MC board.
20D	ADC could not return + 12 V value: ADC voltage test.	Replace MC board.
20E	ADC could not return -12 V value: ADC voltage test.	Replace MC board.
20F	ADC could not return +24 V value: ADC voltage test.	Replace MC board.
210	ADC could not return Vref value: ADC voltage test.	Replace MC board.
211	Power failure without AC failure: loss of bulk supply without loss of AC input caused by PSI trip.	1. Replace MC board. 2. Replace PSS. 3. Replace PC board.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
301	Invalid byte count in DC message.	1. Replace ICB cable. 2. Replace PC board. 3. Replace MC board.
304	Divide by zero error in total breaths calculation.	Replace MC board.
305	Divide by zero error in baseline calculation: clock cycle times per breath = 0.	Replace MC board.
306	Divide by zero error in breaths per minute (BPM)/minute ventilation (Min Vent) calculation: sum total time = 0.	Replace MC board.
307	Divide by zero error in Ti/Ttot calculation: clock cycle time per breath = 0.	Replace MC board.
30A	MC scan overrun error: response task could not complete processing before 10-msec interrupt occurred again for 3 seconds.	1. Replace ICB cable. 2. Replace DC board. 3. Replace PC board.
30B	Invalid CPAP command: received S/T or PAV/T command ID from PC.	1. Replace DC board. 2. Replace MC board.
30C	Invalid S/T command: received CPAP or PAV/T command ID from PC.	1. Replace DC board. 2. Replace MC board.
30D	Invalid PAV/T command: received CPAP or S/T command ID from PC.	Replace DC board.
30E	Dispatch function error: command ID from DC not recognized.	Replace DC board.
310	MC scan overrun error: response task did not complete processing before 10-msec interrupt occurred again 10% of the time in one hour.	Replace MC board.
311	Illegal alarm module: hardware does not return built-in module B.	Replace MC board.
312	MC scan overrun error: response task did not complete processing before 10-msec interrupt, 3 times in one hour.	1. Replace ICB cable. 2. Replace DC board. 3. Replace PC board. 4. Replace MC board.
313	PAV/T security failure: software implementation not possible.	Contact Respironics technical support.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
314	PC self test error: PC fails to respond to test complete status within 45 s of startup.	1. Replace PC board. 2. Replace ICB cable.
315	DC self test error: DC fails to respond to test complete status within 45 s of startup.	1. Replace DC board. 2. Replace ICB cable.
332	Pressure regulation error: cannot regulate to 2 cmH_2O in pressure out or flow limit control (FLC).	1. Replace ILFR valve. 2. Replace PRV valve. 3. Replace blower. 4. Replace PC board. 5. Replace AFM. 6. Replace MC board.
333	Invalid S/T state: invalid data on *system status state* signal: not BPM, IPAP, or EPAP.	Replace MC board.
334	Invalid S/T state: invalid data on *system status state* signal: not BPM, IPAP, EPAP, or To inspiratory.	Replace MC board.
335	Invalid mode: invalid mode on *active mode* signal: not standby, CPAP, or PAV/T.	Replace MC board.
Vent Inop errors specific to PC board:		
1201	ADC timeout: incomplete conversion after a 173 usec delay following an ADC read (*ILFR*, *O*, *ANA ground*, *Vref*).	Replace PC board.
1202	Blower speed test error: invalid data in *blower test status* signal.	Replace PC board.
1203	Test control error: invalid data in the *test case primary* and *test case secondary* signals.	Replace PC board.
1204	Multiplexer (MUX) voltage error: invalid data in *MUX channel* parameter.	Replace PC board.
1205	Other voltage error: invalid data in *channel* parameter.	Replace PC board.
1206	Internal ADC (IADC) error: IADC did not complete sequence before background sensor are read.	Replace PC board.
1207	MC communication error: MC did not request status within 30 seconds of startup.	1. Replace ICB cable. 2. Replace MC board. 3. Replace PC board. 4. Replace DC board.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
1208	Operational 12 V voltage reference test error: 12 V signal read from MUX <11 V or >13 V.	Replace PC board.
120A	Operational bulk supply voltage reference test error: bulk supply signal read from MUX <20 V or >38.88 V.	Replace PC board.
120B	Operational -12 V voltage reference test error: 12 V signal read from MUX <-13 V or >-12 V.	Replace PC board.
120C	Operational -5 V voltage reference test error: 12 V signal read from MUX <-5.425 V or >-4.547 V.	Replace PC board.
120D	Operational Vref test error: Vref signal read from MUX <3.749 V or >4.445 V.	Replace PC board.
120E	Queued serial module (QSM) error.	Replace PC board.
120F	Rise rate processing error: rise rate information in MC to PC message out of range (0-4).	1. Replace ICB cable. 2. Replace PC board. 3. Replace MC board. 4. Replace DC board.
1210	Blower voltage error, in safe state: blower drive voltage read from MUX is >15 MV.	Replace PC board.
1211	Pressure release valve (PRV) error, in safe state: PRV drive voltage read from internal ADC >15mV.	Replace PC board.
1212	In-line flow restrictor (IFLR) error, in safe state: IFLR drive voltage read from internal ADC >15mV.	Replace PC board.
1213	Oxygen valve error, in safe state: oxygen valve drive voltage read from internal ADC >15mV.	Replace PC board.
1214	Startup tests control error: invalid data in *test case*.	Replace PC board.
1215	Startup +12 V voltage reference test error: signal from MUX <10.12 V or > 14.04 V.	Replace PC board.
1216	Startup analog (ANA) ground voltage reference test error: signal from MUX <0 mV or >500 mV.	Replace PC board.
1217	Startup bulk supply voltage reference test error: signal from MUX <18.4 V or >38.88 V.	Replace PC board.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
1218	Startup -12 V voltage reference test error: signal from MUX <-14.04 V or >-10.12 V.	Replace PC board.
1219	Startup -5 V voltage reference test error: signal from MUX <-5.833 V or >-4.467 V.	Replace PC board.
121A	Startup Vref voltage reference test error: signal from MUX <3.749 V or >4.445 V.	Replace PC board.
121B	Startup blower voltage reference test error: signal from MUX >100 mV.	Replace PC board.
121C	Startup ILFR voltage reference test error: signal from internal ADC >100 mV.	Replace PC board.
121D	Startup oxygen valve voltage reference test error: OM drive voltage from internal ADC >100 mV.	Replace PC board.
121E	Operational PRV voltage reference test error: PRV drive voltage from internal ADC >100 mV.	Replace PC board.
121F	Operational blower voltage reference test error: blower drive voltage from MUX >40 mV on second try, immediately following first try.	Replace PC board.
122A	Corrupt resistance table: software error, invalid data.	Replace PC board.
122B	Invalid mode: software error, selected mode not supported in software.	Install PAV/T EPROM on PC board.
122C	Blower error: overcurrent, undervoltage, shutdown.	1. Replace PC board. 2. Replace blower.
122D	Backup outlet pressure sensor error: data cannot be read from sensor.	Replace PC board.
122E	Outlet difference error: excessive discrepancy between outlet and backup outlet pressure sensor readings	1. Replace PC board. 2. Replace air flow module (AFM). 3. Replace PSS.
122F	Backup outlet pressure sensor stuck: faulty pressure sensor or ADC.	Replace PC board.
1220	Operational IFLR voltage reference error: drive voltage read from internal ADC >40 MV on the second try, immediately following first try.	Replace PC board.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
1221	Operational oxygen valve voltage reference test error: drive voltage from internal ADC >40 MV on the second try, immediately following first try.	Replace PC board.
1222	Operational PRV voltage reference test error: drive voltage from internal ADC >40 MV on the second try, immediately following first try.	Replace PC board.
1225	Internal ADC calibration divide by zero error: analog Vref signal = analog ground.	Replace PC board.
1226	Oxygen temperature sensor error: OM temperature out of range (40-160 °F) for 2500 counts, conversion did not complete.	Replace PC board.
1227	Blower error: blower out of calibration or stuck motor, blower speed 750 RPM above or below setting for 12 s.	1. Replace blower. 2. Replace PC board.
1228	Pressure setpoint calculation error: low PC filter (LPF) of pressure setpoint in rate rise calculation is out of range.	Replace PC board.
1300	AFM calibration error: CRC error or data all zeros.	Replace AFM.
1301	OM calibration error: CRC error or data all zeros.	Replace oxygen module (OM).
1302	PC calibration error: CRC error or data all zeros.	Replace PC board.
1304	QSM timeout: queued serial peripheral interface (QSPI) not finished after 100 usec following EEPROM selection.	Replace PC board.
1305	No AFM present: AFM detection signal >300 mV.	1. Replace AFM cable 2. Replace AFM 3. Replace PC board.
1308	MC pressure setpoint message error: value in message >40 cmH_2O.	1. Replace ICB cable. 2. Replace MC board. 3. Replace PC board. 4. Replace DC board.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
1309	MC rise rate message error: value in message >4.	1. Replace ICB cable. 2. Replace MC board. 3. Replace PC board. 4. Replace DC board.
130A	MC IPAP setpoint message error: value in message >40 cmH_2O (non-PAV) or >50 cmH_2O (PAV).	1. Replace ICB cable. 2. Replace MC board. 3. Replace PC board. 4. Replace DC board.
130B	MC oxygen concentration message error: value in message <21% or >100%.	1. Replace ICB cable. 2. Replace MC board. 3. Replace PC board. 4. Replace DC board.
130C	MC message error: message byte count does not equal expected byte count.	1. Replace ICB cable. 2. Replace MC board. 3. Replace PC board. 4. Replace DC board.
1312	AFM detect conversion error: ADC read not complete in time for AFM detection read.	1. Replace AFM cable. 2. Replace AFM. 3. Replace PC board.
1313	OM detect conversion error: ADC read not complete in time for OM detection read.	1. Replace OM cable. 2. Replace OM. 3. Replace PC board. 4. Replace AFM.
1316	Absolute atmospheric pressure sensor error: sensor reading <20 in.Hg or >40 in.Hg for 2.5 s.	Replace PC board.
1317	Outlet pressure sensor error: sensor reading <-5 cmH_2O or >70 cmH_2O for 2.5 s.	1. Replace AFM cable. 2. Replace AFM.
1318	Patient pressure sensor error: <-5 cmH_2O or >50 cmH_2O for 2.5 s.	Replace PC board.
1319	Total flow sensor error: sensor reading <-200 L/min or >300 L/min.	1. Replace AFM cable. 2. Replace AFM.
131A	Oxygen flow sensor error: sensor reading >120 L/min for 2.5 s.	1. Replace OM cable. 2. Replace OM.

Table 6-4: Troubleshooting *Vent Inop* Error Codes

Error code	Description	Corrective action
131B	Air temperature sensor error: temperature out of range (40-160 °F) for 2500 counts, conversion did not complete	1. Replace AFM cable. 2. Replace AFM. 3. Replace PC board.
131C	Outlet pressure sensor error, atmospheric pressure (ATM): (high ATM - low ATM) x 100 $\geq$ (5 x high ATM).	Replace PC board.
131D	PC calibration data error: 2 CRC calibration data contains default values or calculated data.	Replace PC board.
131E	PC calibration data error: 3 CRC calibration data contains default values.	Replace PC board.
131F	Drift test error: invalid data in *drift test case*.	Replace PC board.
1320	AFM drift calibration error: 1 CRC calibration data contains default values or calculated data.	1. Replace AFM cable. 2. Replace AFM. 3. Replace PC board.
1321	PC calibration error: 4 CRC calibration data filled with default values or calculated data.	Replace PC board.
1322	Sensor drift error: outlet or pressure sensor out of range (tolerance = $\pm$ 2 cmH_2O of nominal).	1. Replace AFM cable. 2. Replace AFM. 3. Replace PC board.
1323	PC calibration error: 6 CRC drift data cannot be updated.	Replace PC board.
1324	OM drift calibration error: 1CRC calibration data filled with default values or calculated data.	1. Replace OM cable. 2. Replace OM. 3. Replace PC board.
1325	Total flow sensor drift error: excessive total flow sensor drift.	1. Replace AFM cable. 2. Replace AFM. 3. Replace PC board.
1326	Oxygen flow sensor drift error: excessive total flow sensor drift.	1. Replace OM cable. 2. Replace OM. 3. Replace PC board.

6.6 Interpreting Error Codes

To interpret error codes, start by looking at all error codes and their definitions. If one of the error codes indicates a hardware fault, this may be the “primary” fault.

For example, if these error codes occur:

MC = 70E (Tack timeout)

PC = 0 (hardware failure)

DC = 11D1 (touch pad error)

In this example, the error code *11D1* indicates a touch pad error, and may be the primary fault. This *Vent Inop* error powers down the ventilator.

The error code *70E* indicates a timeout, because the MC is not receiving communication from the PC.

The error code *0* indicates a hardware failure, because the ventilator is powering down.

6.7 *Vent Inop*, *Check Vent* Error Code 201, Ventilation Continues

This section describes how to repair a ventilator that indicates a *Vent Inop* and a *Check Vent* (error code 201), while continuing to operate. This error may be due to tarnishing on the power connectors between MC board (connector J1) and the PC board (connector J11).

NOTE: These instructions ***only*** apply to ventilators whose MC and PC board power connectors made of ***tin***. The power connectors on the MC and PC boards must both be the *same material*: ***both tin or both gold***.

NOTE: Later versions of the MC and PC boards (and ventilators with s/n 114455 and above) use non-oxidizing gold connectors. These instructions do not apply to boards with gold connectors.

Follow these steps to clean the connectors and minimize future oxidation:

Required equipment: NyoGel 760G contact grease (P/N 1013213)

1. To help remove oxidation from connector pins, remove and reinstall the PC board from the MC board at least three times.

   CAUTION: Do not attempt to clean oxidation by using a pencil eraser. Erasers are very abrasive and can leave a residue, further damaging the connection.

2. With the PC board removed, use a cotton swab and isopropyl alcohol to clean the pins of MC board connector J1.

3. Insert each of the J1 pins (MC board) into a tube of NyoGel contact grease (Figure 6-4). Inspect pins to ensure that each is covered.

Figure 6-4: Applying Contact Grease to MC Board J1 Connector Pins

4. Reinstall the PC board into the MC board.

5. Perform a run-in cycle and system final test (see Chapter 7) before returning the ventilator to service.

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Chapter 7. Testing and Calibration

This chapter describes how to test and calibrate the BiPAP Vision following service. These procedures include:

- Exhalation port test (Section 7.1): characterizes the circuit and leak rate of the exhalation port. Perform at each circuit change.
- Service laptop computer setup (Section 7.2): instructions for setting a service laptop computer for testing or to display Vent Inop error codes.
- Transferring total operating hours (Section 7.3): reenters the total hours of operation for a ventilator after replacing the MC board or memory battery.
- Blower/valve calibration (Section 7.4): instructions for calibrating the blower and valves after replacing major components.
- Performance verification (Section 7.5): confirms that the ventilator user interface is functioning properly, and does not verify specifications.
- Run-in cycle (Section 7.6): a procedure that cycles the ventilator for 30 minutes with specified parameters to qualify a repair after part replacement.
- System final test (Section 7.7): verifies that the ventilator operates within specifications.
- Oxygen module (OM) test (Section 7.8):

Table 7-1 summarizes which tests must be performed following parts replacement.

Table 7-1: Test Requirements Following Part Replacement

Replacement part	Blower valve calibration	Run-in cycle	Performance verification	System final test
Air flow module (AFM)	X	X		X
Alarm “B” option		X		X
Blower	X	X		X
Blower muffler	X			
Bottom enclosure	X	X		X
Cables (any internal)			X	
Circulation fan	X	X		X

Table 7-1: Test Requirements Following Part Replacement

Replacement part	Blower valve calibration	Run-in cycle	Performance verification	System final test
DC board		X		X
AC power cord		X	X	
Fan muffler	Not required			
Filter enclosure	X	X	X	
Filter	Not required			
Front panel enclosure		X	X	
Fuses			X	
Hoses (any internal)	X	X	X	
ICB cable			X	
Inline flow restrictor (ILFR)	X	X		X
AC inlet	X	X		X
LCD			X	
MC board	X	X		X
Oxygen module (OM)	X	X		X
OM regulator bowl	Not required			
OM regulator filter	Not required			
Main power switch			X	
PC board	X	X		X
PSS board	X	X		X
Pressure relief valve (PRV)	X	X		X
PRV muffler	X		X	
Rotary encoder		X	X	
Rotary encoder knob	Not required			
Rubber feet	Not required			
Top enclosure	Not required			
Touch pad		X	X	
Transformer	X	X		X

Table 7-1: Test Requirements Following Part Replacement

Replacement part	Blower valve calibration	Run-in cycle	Performance verification	System final test
Power line filter		X		X
Audible alarm		X	X	
EPROMs (including PAV/T)		X		X
Oxygen manifold/regulator	X	X		X
Oxygen flow module	X	X		X

7.1 Exhalation Port Test

The exhalation port test characterizes the patient circuit and exhalation port leak rate. This test is recommended before each use, before using a new patient circuit, following changes to the exhalation port, and following service.

The exhalation port test measures the intentional exhalation port leak over the entire pressure range, and is used to perform leak calculations. This allows the ventilator to display accurate patient data (patient leak, minute ventilation, and tidal volume). This test also helps ensure the accuracy of the low minute ventilation when the alarm limit is less than 3 L/min. If the test is not performed, only the total leak can be displayed.

Required equipment:

- Smooth inner lumen tubing, 6-foot length
- Whisper Swivel (P/N 332113)
- Pressure pick-off port

Follow these steps to perform the exhalation port test:

1. Install the smooth lumen tubing, Whisper Swivel, and pressure pick-off port to the ventilator outlet (Figure 7-1), then occlude the outlet.

Figure 7-1: Exhalation Port Test Setup

2. Turn the main power switch ON, and wait for the unit to perform the system self test (about 5 to 15 seconds).

3. At the exhalation port test screen (Figure 7-2), press **Test Exh Port**.

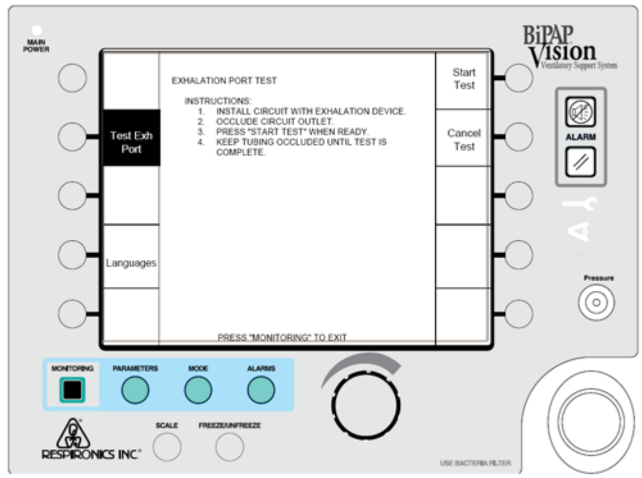


Figure 7-2: Exhalation Port Test Screen

4. Follow the onscreen instructions then press the **Start Test** soft key. To cancel the test at any time, press **Cancel Test**.

5. When the test is complete, the screen shows one of these results:

Table 7-2: Exhalation Port Test

Message	**Description**	**Corrective action (repeat test after each step)**
TEST COMPLETE	Normal leak conditions at the exhalation port.	Not required.
LOW FLOW, CHECK CIRCUIT, REPEAT TEST	Lower than normal leak rate at the exhalation port.	1. Check that exhalation port vents are not blocked, and that the circuit is connected properly. Repeat test. 2. Replace these parts in order: PC board, AFM, PRV, and ILFR. Repeat test after each replacement.
EXCESSIVE FLOW, CHECK CIRCUIT, REPEAT TEST	Higher than normal leak rate at the exhalation port.	1. Check that internal circuit is assembled properly. Repeat test. 2. Replace these parts in order: PC board, AFM, PRV, and ILFR. Repeat test after each replacement.
OCCLUDED EXHALATION PORT, CHECK CIRUIT, REPEAT TEST	Leak rate less than predicted.	1. Check that exhalation port is not blocked. Repeat test. 2. Replace these parts in order: PC board, PRV, and ILFR. Repeat test after each replacement.

Table 7-2: Exhalation Port Test

Message	**Description**	**Corrective action (repeat test after each step)**
PROX LINE DISCONNECTED, CHECK CIRCUIT, REPEAT TEST	Proximal pressure line is disconnected.	1. Check that internal and external proximal pressure lines are connected and not blocked. 2. Repeat test.
PRESSURE REGULATION ERROR, CHECK CIRCUIT, REPEAT TEST	Leak test pressures cannot be reached.	1. Check that internal proximal pressure line is connected and not blocked. Repeat test. 2. Replace these parts in order: AFM, PC board. Repeat test after each replacement.
INTERMITTENT EXCESSIVE FLOW, CHECK CIRCUIT, REPEAT TEST	Intermittently high leak rates during test.	1. Check that internal and external circuits are properly sealed. Repeat test. 2. Replace these parts in order: PRV, PC board. Repeat test after each replacement.

7.2 Service Laptop Setup

This section describes how to set up a service laptop for testing and troubleshooting the BiPAP Vision. The ventilator includes all necessary software to work with a service laptop, and does not require additional software.

7.2.1 Selecting the Test Cable

Select the cable(s) for service laptop setup (Table 7-3) according to the serial number and upgrade status of the ventilator:

Table 7-3: Test Cables for Service Laptop

Ventilator serial number/upgrade	**Required cables**
Ventilators s/n 105999 and below, no upgrades (original MCS, PAS, and DCS boards installed)	• Test cable *582161*
Ventilators s/n 105999 and below, upgraded (new PC and MC boards installed)	• Test cable *1004823* • Ribbon cable *1004699* • Standard RS-232 serial cable
Ventilators s/n 105999 and below (upgraded) with original DCS board installed	• Test cable *1004823* • Test cable *582161* connected to DCS board • Ribbon cable *1004699* • Standard RS-232 serial cable
Ventilators s/n 106000 and above	• Test cable *1004823* • Standard RS-232 serial cable

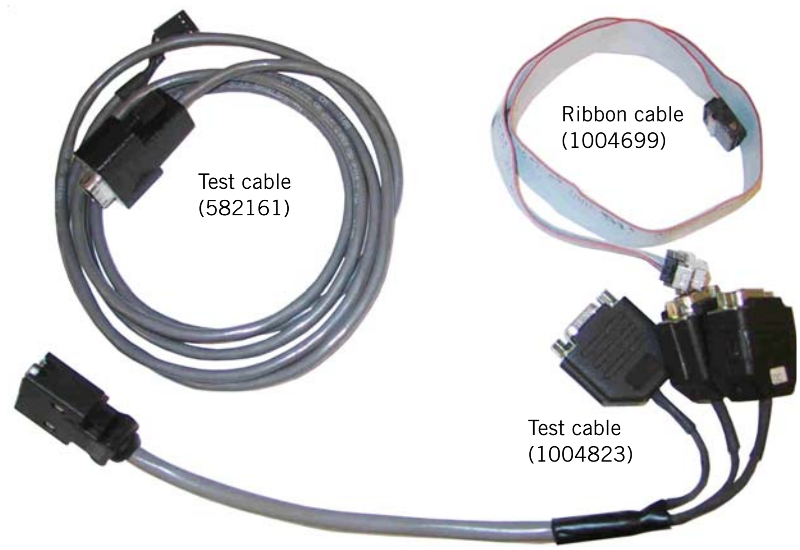


Figure 7-3: Test Cables

NOTE: The ribbon cable is temporarily installed at MC J3, and then removed after testing. Ensure that the metal connector housing does not contact any components within the ventilator during use.

7.2.2 Setting Up the Equipment

Required equipment:
- Service laptop computer
- RS-232 serial cable
- Test cable(s) (see Section 7.2.1 for cable information)

Follow these steps:

1. Connect the test cable to the RS-232 port on the service laptop.

2. Connect cable(s) to the ventilator:
   - Non-upgraded s/n 105999 and below: connect test cable (582161) to the selected subsystem: *J3* on the PAS and MCS boards, or *J5* on the DCS board.
   - Upgraded s/n 105999 and below: connect ribbon cable (1004699) to the appropriate connector on the test cable (1004823).
   - s/n 106000 and above: connect the other end of the test cable (1004823) to the back panel of the ventilator, and the RS-232 serial cable to the appropriate connector on the test cable.

3. Turn on the service laptop.

7.2.3 Operating System Setup

Follow these steps to set up Microsoft Windows with HyperTerminal:

1. From the service laptop, select: **Start > Programs > Accessories > HyperTerminal > HyperTerminal**.

2. At the *Connection Description* window, name the file if it is to be saved, select the umbrella/phone icon, then click **OK**.

3. At *Connect To*, select **COM1** (or available RS-232 serial port) in *Connect Using*, then click **OK**.

4. At *COM1 Properties, Port Settings* set:
   Bits per second: **19,200**

Data bits: **8**	*Stop bits:* **1**
Parity: **None**	*Flow control:* **Xon/Xoff**

5. Click **OK** to activate the settings: a blinking cursor appears on the screen.
   To check ASCII settings (if necessary), select: **File > Properties > Settings > ASCII Setup**.

6. Enter the appropriate command (Table 7-4): the command does not appear on the laptop screen, but requested data appears after entering the command.

   NOTE: If there is an existing Vent Inop condition, the MC, DC, and PC output error information without any command. (The MC and DC output a full screens of information, and the PC outputs one line of error information.) During normal operation (no Vent Inop condition), you must enter a command to view error information.

   If the screen display is "rolling," select: **File > Properties > Settings > Emulation > VT52 > OK**.

7. At the top of the HyperTerminal screen, select: **File > Properties > Settings**, then click **ASCII Setup**.

8. Click **Echo typed characters locally > OK > OK** to return to the HyperTerminal screen.

9. Select **File > Save As**, and save this session of HyperTerminal to the desktop.

Table 7-4: HyperTerminal Commands

Command	Description
SJO	Transfer total operating hours (MC connection)
SJB	Blower/valve calibration (PC calibration).
SJL	System final test and limited PC function (PC connection).
SJP	PC error code information, including operating parameters (PC connection). If the ventilator is in a Vent Inop condition, the current error appears automatically.
SJM	MC error code information (MC connection). If the ventilator is in a Vent Inop condition, the current error appears automatically.
SJD	DC error code information (DC connection). If the ventilator is in a Vent Inop condition, the current error appears automatically.
SJE	Check vent error code history (MC connection).
SJC	Check type of breath triggering (MC connection).
NOTE:	Enter commands in all capital letters, and no carriage return.

7.3 Transferring Total Operating Hours

This section tells you how to transfer a ventilator's total operating hours to the service laptop computer. This is used primarily after replacing the MC board or the real-time clock (RTC) lithium battery.

Required equipment:

- Service laptop computer
- Test cable:
  P/N 582161 for non-upgraded ventilators (units bult s/n 105999 or below with original MCS, PAS, and DCS boards)
  P/N 1004823 for newer ventilators (units built s/n 106000 or above) *or* upgraded ventilators (units built s/n 105999 or below)

Follow these steps to transfer the total operating hours:

1. Power on the ventilator.

   NOTE: If powering on is not possible, approximate the number of hours based on previously-documented hours and estimated additional running time.

2. Record the ventilator's total operating hours from the Setup or Options screen.

3. Use the test cable to connect the service laptop RS-232 port to the MC board as shown in Figure 7-4 or Figure 7-5. (If necessary, see Section 7.2 for more information on laptop setup.)

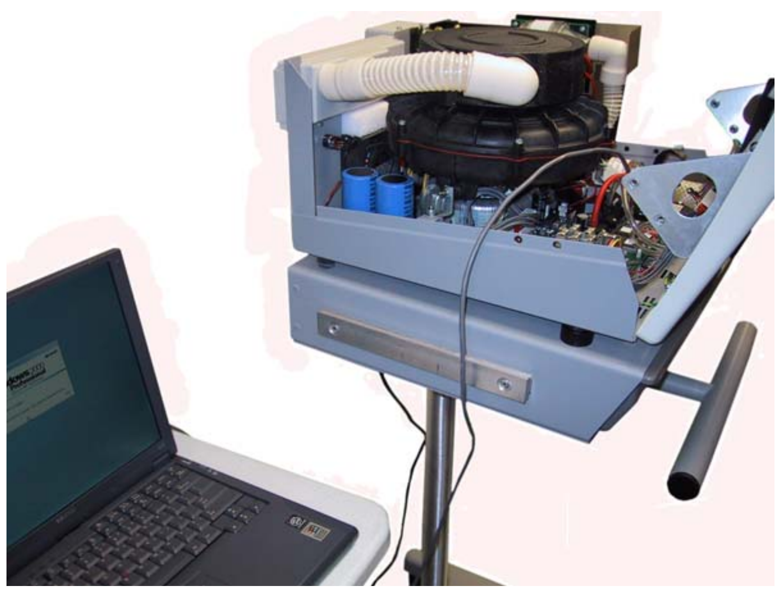


Figure 7-4: Setup for Transferring Total Hours for Non-Upgraded Ventilator (s/n 105999 and below)

Figure 7-5: Setup for Transferring Total Hours for Newer or Upgraded Ventilator (s/n 106000 and above)

4. Leave the ventilator in the Setup screen.
5. Enter **SJO** (all capital letters) at the PC keyboard.
6. At the Operating Time Modify screen, follow the onscreen instructions to enter the recorded value for Total Operating Time.
7. Turn the power switch OFF and remove the service laptop from the ventilator. Reassemble the ventilator or continue testing.

7.4 Blower/Valve Calibration

Calibrating the blower and valves for the BiPAP Vision takes about 10 minutes or less, depending on the installed software version. Perform the blower/valve calibration as required after replacing certain major components.

During the calibration, the blower DAC voltage is increased while pressure and blower speed are monitored to characterize blower performance. Next, operating data for the ILFR and PRV valves is collected. Finally, calibration information is stored in memory to ensure that the blower and valves meet specified requirement.

NOTE: Before performing the blower/valve calibration, ensure that software version 11.8, 12.4, 13.4, or later is installed on the ventilator.

Required equipment:

- Service laptop computer
- Test cable:
  P/N 582161 for non-upgraded ventilators (s/n 105999 and below with original MCS, PAS, and DCS boards installed)
  P/N 1004823 for newer ventilators (s/n 106000 and above) *or* upgraded ventilators (s/n 105999 and below)
- 0.25-in. test orifice (P/N 332353)
- Phillips screwdriver

Follow these steps:

1. Verify that the ventilator is powered off.
2. For ventilators s/n 105999 and below, remove the top enclosure.
3. Depending on the test cable required, connect one side of the test cable to J3 on the PAS board, or connect a standard RS-232 serial cable to the RS-232 connector on the back of the ventilator. Connect the other end to the service laptop.
4. Install the test orifice and pressure line to the ventilator outlet. Turn on the ventilator and laptop.

   NOTE: Do *not* connect the Whisper Swivel for the blower/valve calibration.

   NOTE: If necessary, see Section 7.2 for more information on service laptop setup, including HyperTerminal settings.
5. The Test exhalation port/language screen appears: do *not* select Monitoring.
6. Ensure that the test orifice and PRV exhaust are not obstructed.
7. Enter **SJB** (all capital letters, no carriage return) at the laptop keyboard to begin the calibration.

8. When the terminal stops updating information, the cursor blinks, and the message *Valve Calibration Successful*, the calibration is complete.

9. Unless the test cable is required for further testing, return the ventilator to its normal configuration:
   - Power off and disconnect the power cord.
   - Unplug the test cable and remove the test orifice.
   - Reinstall the top enclosure.

7.5 Performance Verification

Performance verification confirms that the ventilator is operating correctly, and does not verify performance according to specifications (see Section 7.7 for the system final test procedure, which verifies performance according to specifications).

Required equipment:

- 0.25-in. test orifice (P/N 332353)
- Pressure tubing
- Smooth inner lumen tubing
- Whisper Swivel (P/N 332113)
- Performance Verification Form

NOTE: Tubing lengths between circuit components can vary. However, the maximum length of the entire circuit should not exceed 72 inches.

Follow these steps to perform the performance verification:

NOTE: Ventilator settings are saved in case of power loss. The ventilator software revision determines how operation resumes following a power loss:

- Software versions 11.0 - 11.11, 12.0 - 12.7, and 13.0 - 13.7: If AC power is lost for approximately 10 seconds or less and the power switch remains ON, the ventilator performs a system self test and returns to normal operation using the same settings that were in effect before the AC power loss.
  If the AC power loss is longer than approximately 10 seconds and the power switch remains ON, the ventilator performs a system self test, displays the Exhalation Port Test screen, and does not resume ventilation.
- Software versions 11.12, 12.8, 13.8 and higher: If AC power is lost for any length of time and the power switch remains ON, the ventilator resumes operation that was in effect at the time of the AC power loss.
- For all software versions, if the power switch is turned OFF after AC power is lost, when AC power is restored and the power switch is turned ON: the ventilator performs the system self test, displays the Exhalation Port Test screen, and does not automatically resume ventilation.

1. Connect to the ventilator outlet in this order: smooth inner lumen tubing, Whisper Swivel, test orifice, and pressure tubing.

2. *Vent Inop test:*
   Power on the ventilator. When the Test exhalation port/language screen appears, remove the AC power cord from the back of the ventilator, and confirm that the *Vent Inop* indicator (wrench) lights and the audible alarm sounds.

3. Turn the ventilator off and verify that the audible and visual alarm indicators turn off.

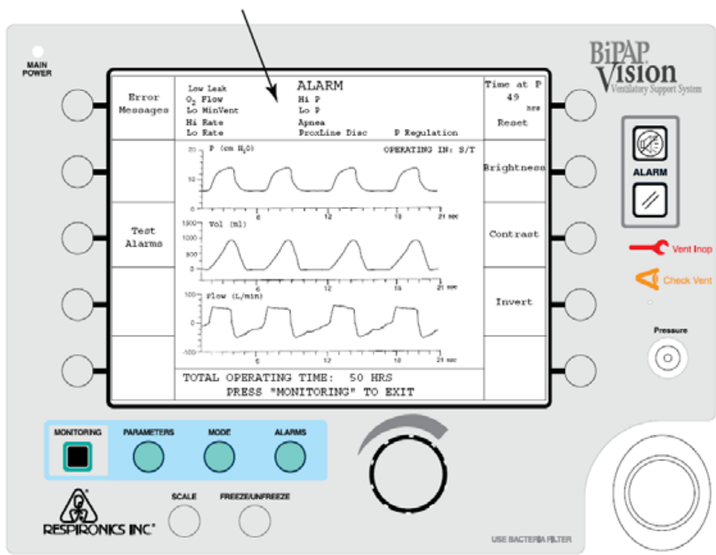
4. After at least 15 seconds, reinstall the power cord and power on the ventilator. If the Loss of AC power symbol flashes in the display area (software versions 11.2 - 11.11, 12.7, and 13.7), press Alarm reset and continue.

5. *Exhalation port test:*
   Perform the exhalation port test (Section 7.1). After successful completion, press **MONITORING** to go to the Monitoring screen.

6. Select **Options** to go to the Options screen. If an alarm is active, press Alarm reset.

7. *Test alarms test:*
   Select **Test Alarms** to verify that the audible and visual indicators activate for each available alarms (if either the audible or visual does not activate, service is required).
   Verify that the *Vent Inop* and *Check Vent* indicators light. Section 7-6 shows how the display should look. (If the OM and optional alarms are installed, O_2 Flow, Lo MinVent, Hi Rate, and Lo Rate also appear.)

Alarm messages in mode/message area



Vent Inop and *Check Vent* indicators light

Figure 7-6: Alarm Test Screen

8. Press **MONITORING**, then select these settings in S/T mode:

   IPAP = 15 cmH_2O *Timed Insp* = 1.0 s
   EPAP = 5 cmH_2O *IPAP Rise Time* = 0.1 s
   Rate = 15 BPM

9. Press **ALARMS**, then select these alarm limits:

   Hi P = 20 cmH_2O *Lo MinVent* = Disabled
   Lo P = 10 cmH_2O *Hi Rate* = 40 BPM
   Lo P Delay = 20 s *Lo Rate* = 10 BPM
   Apnea = Disabled

10. *Monitoring screen parameters test:*
    Press **MONITORING** to go to the Monitoring screen, and verify the following:

    Rate soft key indicator flashes when each timed breath is activated.
    Each timed breath lasts approximately *1 s*.
    IPAP during a timed breath is 15 cmH_2O.
    EPAP during a timed breath is 5 cmH_2O.
    Timed breath rate is 15 BPM (timed breath indicator display).

11. *Spontaneous breath test:*
    Occlude the test orifice for a few seconds. View the pressure waveform, and create a small leak at the orifice to simulate a spontaneous trigger (you might need to repeat this process a few times).
    Verify that the ventilator cycles to IPAP and that the Rate indicator does not flash. Once a spontaneous breath is triggered, unblock the test orifice.

12. *High pressure alarm test:*
    Press **ALARMS** to go to the Alarms screen, then set *Hi P* to 10 cmH_2O. Wait for audible and visual alarms indicating a High Pressure alarm. Return *Hi P* to 20 cmH_2O and press Alarm reset to clear the alarm.

13. *Low pressure alarm test:*
    Open the circuit to atmosphere for about 20 seconds to verify that the Disconnect alarm activates after a few seconds. Press Alarm silence.

14. Verify that the Lo P alarm is activated. Occlude the ventilator outlet and press Alarm reset to clear the alarm.

15. *Apnea alarm test:*
Set *Apnea* to 20 s. Keep the outlet occluded for at least 20 seconds to verify that audible and visual alarms are activated.

16. Set *Apnea* to Disabled and press Alarm reset to clear the alarm.

17. *Earth resistance and leakage current test:*
    a. Measure and record the *earth resistance* using a test current of 25 A, and verify that measured value for earth resistance is *< 0.20 Ohms*.
    b. Electrical safety analyzer settings: neutral: closed; polarity: normal; leakage current: earth leakage.
    c. Measure and record the *normal pole, no earth, L2 earth leakage current* and verify that the measured value is *< 300 uA*.
    d. Electrical safety analyzer settings: neutral: closed; polarity: reversed; leakage current: earth leakage.
    e. Measure and record the *reverse pole, no earth, L2 earth leakage current* and verify that the measured value is *< 300 uA*.
    f. Power off the ventilator, disconnect the test circuit, and disconnect AC power.
    g. Electrical safety analyzer settings: neutral: open; polarity: reversed; leakage current: earth leakage.
    h. Measure and record the *reverse pole, no earth, no L2 earth leakage current* and verify that the measured value is *< 1000 uA*.
    i. Electrical safety analyzer settings: neutral: open; polarity: normal; leakage current: earth leakage.
    j. Measure and record the *normal pole, no earth, no L2 earth leakage current* and verify that the measured value is *< 1000 uA*.

11. Record results on the Performance Verification Form that follows.

BiPAP Vision Performance Verification Form

Use this form to record the results of the performance verification.

Ventilator serial no. ______________________

Service notification (Respironics use only) ______________

Model no. ______________________

Total operating time ______________

Results:

Test	**Pass/Fail (circle one)**	
Vent Inop alarm	Pass	Fail
Exhalation port test	Pass	Fail
Test alarms	Pass	Fail
Monitoring screen parameters	Pass	Fail
Spontaneous breath	Pass	Fail
High pressure alarm	Pass	Fail
Low pressure alarm	Pass	Fail
Apnea alarm	Pass	Fail

Earth Resistance and Leakage Current Test

Test	*DMM reading*	*Specification*	*Pass/Fail*	
Earth resistance		< 0.20 Ohms	Pass	Fail
Normal pole, no earth, L2		< 300 uA	Pass	Fail
Reverse pole, no earth, L2		< 300 uA		
Reverse pole, no earth, no L2		< 1000 uA		
Normal pole, no earth, no L2		< 1000 uA		

Tested by: Date:

______________________ ______________________ ______________

(Print name) (Signature)

7.6 Run-in Cycle

The run-in cycle qualifies a repair after component replacement, and cycles the ventilator for 30 minutes according to specified operating parameters.

Required equipment:

- 0.25-in. test orifice (P/N 332353)
- Pressure tubing

Follow these steps to perform the run-in cycle:

1. Connect the test orifice to the ventilator outlet, and then connect the pressure tubing between the orifice port to the ventilator pressure input.

2. Power up the ventilator and select these settings in S/T mode:

   IPAP = 40 cmH_2O *Timed Insp* = 0.5 s
   EPAP = 4 cmH_2O *IPAP Rise Time* = 0.1 s
   Rate = 20 BPM

3. Select these alarm limits:

   Hi P = 50 cmH_2O *Lo P Delay* = 60 s
   Lo P = Disabled *Apnea* = Disabled

   Lo MinVent = Disabled *Lo Rate* = 4 BPM
   Hi Rate = 50 BPM *%O_2* = 21%

4. Verify that the displayed values on the Monitoring screen match the set values.

5. Run the ventilator for 30 minutes using the selected settings: during this time, verify that displayed values match set values and that no alarms occur.

6. If an alarm occurs, see Chapter 6 for troubleshooting information. Repeat the run-in cycle as needed until successful completion.

7.7 System Final Test

The system final test verifies that the ventilator operates to specifications. This test check the accuracy of sensor measurements, pressures, and flow rates in various operating modes. The system final test also tests user controls and alarm functions. Table 7-5 summarizes the major components of the system final test procedure.

Table 7-5: System Final Test Procedures

Procedure	Description
System final test setup	Section 7.7.1
Power indicator and LCD controls test	Section 7.7.2
Pressure accuracy test	Section 7.7.3
Flow accuracy test	Section 7.7.4
Dynamic pressure regulation test	Section 7.7.5
S/T mode performance test	Section 7.7.6
Options and controls	Section 7.7.7
Alarms test	Section 7.7.8
Oxygen module (OM) test	Section 7.7.9
PAV/T mode test (if installed)	Section 7.7.10
Earth resistance and leakage current	Section 7.7.11
Nurse call/remote alarm test (if applicable)	Section 7.7.12

Required equipment (see Section 1 for a complete list of service equipment, including specifications):

- BiPAP Vision service kit (P/N 1021276)
- Flexible smooth inner lumen tubing (P/N 301016)
- Flowmeter
- Digital manometer
- Service laptop computer
- Mechanical test lung
- Medical grade oxygen and regulator
- Oxygen analyzer
- Variable flow restrictor (P/N 1006120)
- Whisper Swivel (P/N 332113)
- Phillips screwdriver
- Pressure tubing
- Electrical safety analyzer
- Test cable: P/N 582161 for non-upgraded ventilators (s/n 105999 and below), P/N 1004823 for newer (s/n 106000 and above) or upgraded ventilators.
- Multiple-outlet power strip
- Plug, cap, or stopper
- Pressure pick-off port for oxygen port (P/N 312710)
- 0.25-in. test orifice (P/N 332353)
- Pressure tubing

NOTE: Tubing lengths between circuit components can vary. However, the maximum length of the entire circuit should not exceed 72 inches.

7.7.1 System Final Test Setup

CAUTION: To avoid damage to static-sensitive components, perform this procedure an ESD-approved workstation. Ensure that trained service personnel perform the system final test.

Figure 7-7 shows the initial equipment setup for the system final test. This setup varies according the equipment used.

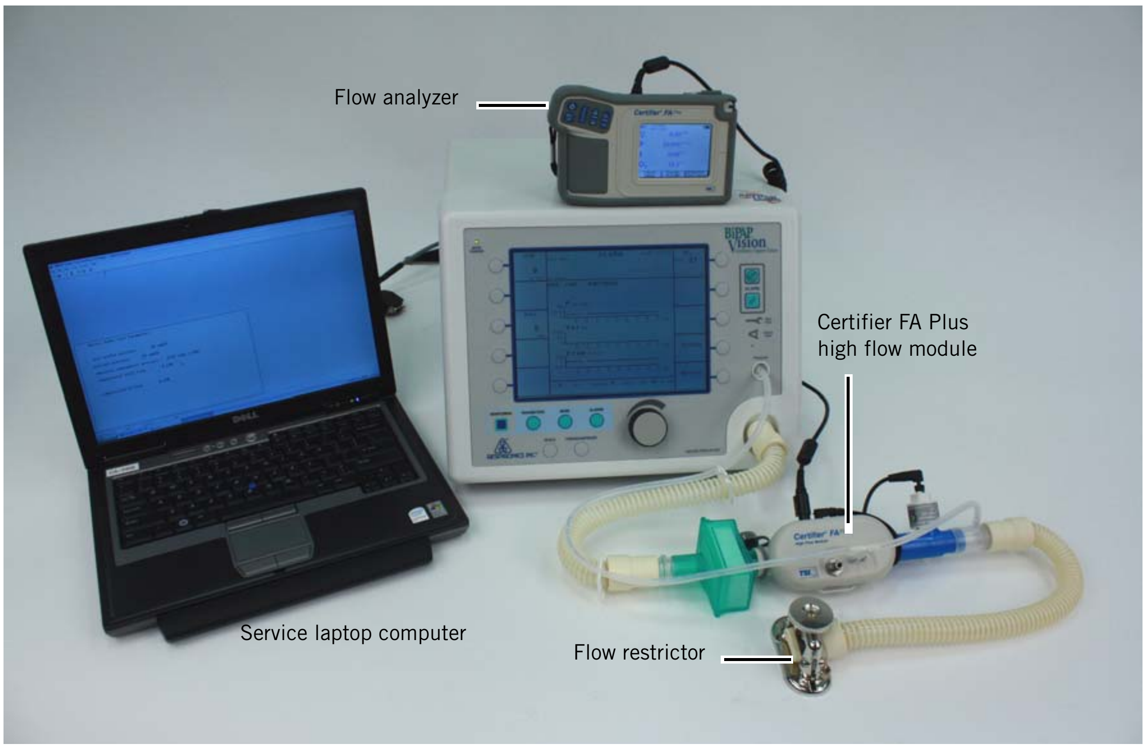


Figure 7-7: Initial Equipment Setup for System Final Test

1. Non-upgraded ventilators s/n 105999 and below: remove the ventilator top enclosure, then connect the test cable from the service laptop RS-232 port to the ventilator PCS connection (J3 on the PCS board or the test cable labeled “PC”).
   Newer (s/n 106000 and above) or upgraded ventilators: connect test cable from service laptop to the RS-232 connector on the ventilator back panel.

2. Connect patient tubing to the ventilator outlet. Connect a pressure pick-off port to the tubing, then connect a flowmeter. Use another length of patient tubing to connect the flowmeter outlet to a restrictor valve. Adjust restrictor valve to create a small amount of circuit leak.

3. Use a tee fitting to connect the manometer, pressure pick-off port, and ventilator pressure port together.

7.7.2 Power Indicator and LCD Controls Test

1. Connect the AC power cord and verify that the MAIN POWER indicator is lit.
2. Power up the ventilator. Once the system self test is complete, record the total operating time displayed at the bottom of the Test exhalation port/language screen.
3. Press **MONITORING** and select Options. Verify that the adjustment knob controls Brightness and Contrast.
4. Press **MONITORING** to exit.

7.7.3 Pressure Accuracy Test

NOTE: When the Low rate alarm occurs during this test, press Alarm silence.

1. Select the following:

Alarms:	
Hi P alarm	50
Lo P alarm	Disabled
Lo P delay	60
Apnea	Disabled

Alarm module B:	
Lo MinVent	Disabled
High rate	50
Low rate	4

Scale:	
P	45 cmH_2O
Vol	1500 mL
Flow	100 L/min
Time base	9 s

2. Set CPAP pressure and activate CPAP mode:
   - In CPAP mode: select **PARAMETERS**, **Set CPAP**, **5 cmH_2O**.
   - In S/T mode: select **MODE**, **CPAP**, **5 cmH_2O**, **Activate new mode**.
   - In PAV/T mode: select **MODE**, **CPAP**, **5 cmH_2O**, **Activate new mode**.
3. Enter **SJL** (all capital letters, no carriage return) at the service laptop keyboard to view the ventilator system parameters (when you enter the command the display shows only a blinking cursor). (If necessary, see Section 7.2 for more information on service laptop setup.)
4. Adjust the flow restrictor to a flow of 0 LPM ($\pm$ 0.5 LPM).
   If there is oscillation, open the flow restrictor slightly until the oscillation stops, then slowly close the valve.

	CPAP
Set pressure	set 5
Outlet pressure	5
	cmH_2O

5. Record these values on the System Final Test Form:
   - *Set* pressure (shown on ventilator display)
   - *Outlet* pressure (shown on ventilator display)
   - *Unit outlet pressure* (shown on service laptop display)
   - *Patient pressure* (shown on service laptop display)
   - Manometer pressure (shown on manometer)

6. Verify that all readings are within ± 2 cmH_2O of the manometer reading.

7. Set *CPAP* to 10 cmH_2O and repeat.

8. Set *CPAP* to 20 cmH_2O, adjust flow restrictor to 30 LPM (± 3 LPM) and repeat.

7.7.4 Flow Accuracy Test

1. Leave *CPAP* set to 20 cmH_2O, and adjust flow restrictor to each of these flow settings in order:
   - 0 LPM ± 0.5 LPM (specified: -5 to 5 LPM)
   - 10 LPM ± 1 LPM) (specified: 4.2 to 15.8 LPM)
   - 60 LPM ± 1 LPM) (specified: 50.2 to 69.8 LPM)
   - 120 LPM ± 1 LPM) (specified: 105.6 to 134.4 LPM)

2. For each flow setting, record:
   - Flowmeter reading
   - *Compensated total flow* shown on the service laptop display.
   - Verify that *Compensated total flow* value is within specification for that flow

3. At 120 LPM, verify that outlet pressure shown on the ventilator is 18.0 to 22.0 cmH_2O.

7.7.5 Dynamic Pressure Regulation Test

1. Power off the ventilator.

2. Disconnect the flow restrictor from the flowmeter. The test lung should not be connected at this point.

3. Connect a Whisper Swivel to the patient tubing at the output of the flowmeter and plug the end.

4. Power on the ventilator.

5. At the Test exhalation port screen, select **Test Exh Port**, then **Start Test**. Do not block the Whisper Swivel vents while the test is in progress. Follow onscreen instructions until the *Test complete* message appears.

6. Press **MONITORING** to exit, then press **PARAMETERS**.

7. Ensure that the ventilator is in CPAP mode, and set CPAP = 20 cmH_2O.

8. Unblock the Whisper Swivel (do not remove) and connect the test lung (Figure 7-8).
   - Set test lung to a parabolic resistance (Rp) of 20 $cmH_2O/L/s$ and set compliance (C) to a setting of 0.04 mL/cmH_2O if using the TTL mechanical lung.
   - If using the Ingmar QuickLung, set (C) to 50 mL/cmH_2O, no springs connected.

Figure 7-8: Dynamic Pressure Regulation Test Setup

9. Press **MONITORING** and verify that ventilator displays the Waveform screen.

10. Manually operate the test lung to create a uniform waveform on the flow display. The waveforms should have peaks of about 100 L/min and a rate of about 30 BPM (about one breath every 2 seconds).

11. Verify that the manometer measures a pressure within 2 cmH_2O of the set value (18 to 22 cmH_2O).

7.7.6 S/T Mode Performance Test

1. Select **MODE**, then **S/T**. Leave the test lung connected.

2. Select these settings:

   IPAP = 35 cmH_2O *Timed Insp* = 2.5 s
   EPAP = 5 cmH_2O *IPAP Rise Time* = 0.05 s
   Rate = 10 BPM

3. Select **Activate new mode** and allow the ventilator to cycle several times.

4. Verify that the rate is 9.3 to 10.8 BPM, and record the reading.

7.7.7 Options and Controls

1. Press **MONITORING**, then select **Options**.

2. Select **Invert**, verify function, and press **Invert** again.

3. Select **Bar Graph**, verify that bar graphs display, then press **Bar Graph** again to return to Waveform.

4. Press **Test Alarms**, and verify that audible alarm sounds, alarm messages are displayed briefly at the top of the screen, and that the *Check Vent* and *Vent Inop* indicators light.

5. Press **Error Messages**, and record the any error codes that are displayed. Press **Clear Error Messages**. Press **Time at P** to reset.

6. Press **System Info**, and record the displayed software version and whether the oxygen module or alarm module is installed.

7. Press **MONITORING**, then select **FREEZE/UNFREEZE**. Verify that graphic displays stop updating, then select to **FREEZE/UNFREEZE** resume.

8. Select **SCALE**, then press **P** and turn the knob to change the scale. Verify that the waveform display changes to reflect the scale changes.

9. Reset scale to 45 cmH_2O and press **MONITORING** to exit.

7.7.8 Alarms Test

1. Disconnect the manometer tubing from the ventilator pressure port: after a few seconds, verify that the audible alarm sounds and that alarm messages (*ProxLine* and/or *Lo P Disc*) appear in the alarm message window at the top of the screen.

2. Replace pressure tubing, and verify that audible alarm is silent. Press Alarm reset to clear the alarm message.

3. Remove the AC power cord from the ventilator, and verify that the audible alarm sounds and the *Vent Inop* (wrench) indicator lights.

4. Power off the ventilator, wait for the audible alarm to silence, then wait at least 10 seconds.

5. Reinstall AC power cord and power up the ventilator.

6. Verify that the ventilator powers up without alarming.

   NOTE: For software versions 11.2 and above, the *Loss of AC Power* message flashes in the display area upon startup: this does not mean the test fails. Press Alarm reset to clear.

7. Power off the ventilator.

7.7.9 Oxygen Module (OM) Test

This test requires that the ventilator under test have software version 11.8 or above installed.

WARNING: **Oxygen supports combustion: Do not use oxygen while smoking or in presence of an open flame.**

WARNING: **Never use the oxygen analyzer to measure gas with a high oxygen content after using the analyzer to measure gas with any oil vapor content. Oil vapor contaminates tubing and can cause fire on contact with high concentrations of oxygen.**

1. Inspect the internal components of the oxygen delivery system to verify that no damage is visible.
2. Figure 7-9 shows the test setup for the OM test.

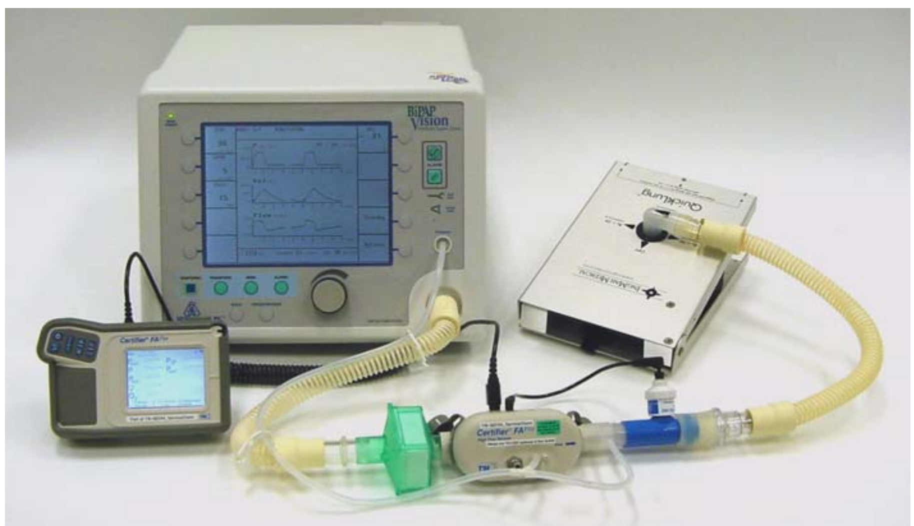


Figure 7-9: Oxygen Module Accuracy Test Setup

3. Set the test lung to a compliance of 50 mL/cmH_2O and a parabolic resistance of 20.
4. Power up the ventilator.
5. Select these settings:

IPAP = 20 cmH_2O	*Timed Insp* = 1.0 s
EPAP = 4 cmH_2O	*IPAP Rise Time* = 0.05 s
Rate = 15 BPM	*O_2%* = 21%

NOTE: Throughout this test, ensure that the ventilator display shows a tidal volume of 480 to 520 mL. If not, adjust *IPAP* to obtain a tidal volume within the correct range before taking the *%O_2* reading.

6. Connect the oxygen line to the OM, and open the oxygen cylinder valve. Ensure that the oxygen regulator is set to 50 to 100 psi.
7. Wait for the oxygen analyzer to stabilize, and verify that the reading is 18 to 24%.

NOTE: It usually takes about 8 to 10 breaths for the analyzer to reach a steady reading. The reading may vary depending on the quality of the analyzer.

8. Select %O_2 to 30%. Once the analyzer has stabilized, verify that the measured oxygen concentration is 27 to 33%.
9. Set %O_2 to 100%, close the oxygen cylinder valve, and disconnect the oxygen hose from the back of the ventilator.
10. Verify that the ventilator activates a No oxygen alarm within 15 or fewer breaths. Press Alarm reset to clear.
11. Reconnect the oxygen hose, open the oxygen cylinder valve, and set %O_2 to 40%. Verify that there is no alarm after 8 breath cycles.
12. Once the analyzer has stabilized, verify that the measured oxygen concentration is 36 to 44%.
13. Set %O_2 to 60%. Once the analyzer has stabilized, verify that the measured oxygen concentration is 54 to 66%.
14. Set %O_2 to 80%. Once the analyzer has stabilized, verify that the measured oxygen concentration is 72 to 88%.
15. Set %O_2 to 100%. Once the analyzer has stabilized, verify that the measured oxygen concentration is 90 to 109%.
16. Close the oxygen cylinder valve and disconnect the oxygen input line.
17. If this test fails, perform the OM calibration (Section 7.8) and repeat this test.

7.7.10 PAV/T Mode Test (if installed)

1. Select **Mode**, then select **PAV/T**, then **Activate New Mode**.
2. Verify that the screens displays PAV/T mode features and that no errors or alarms occur.

   NOTE: No further PAV/T testing is required, because the mode function is directly linked to S/T mode through software, and S/T specifications have already been verified in the system final test.
3. Power off the ventilator, disconnect the test circuit, and disconnect AC power.
4. Reinstall the top enclosure.

7.7.11 Earth Resistance and Leakage Current Test

1. Power on the ventilator if not already on.
2. Measure and record the *earth resistance* using a test current of 25 A, and verify that measured value for earth resistance is *< 0.20 Ohms*.
3. Electrical safety analyzer settings: neutral: closed; polarity: normal; leakage current: earth leakage.
   Measure and record the *normal pole, no earth, L2 earth leakage current* and verify that the measured value is *< 300 uA*.
4. Electrical safety analyzer settings: neutral: closed; polarity: reversed; leakage current: earth leakage.
   Measure and record the *reverse pole, no earth, L2 earth leakage current* and verify that the measured value is *< 300 uA*.
5. Power off the ventilator, disconnect the test circuit, and disconnect AC power.
6. Electrical safety analyzer settings: neutral: open; polarity: reversed; leakage current: earth leakage.
   Measure and record the *reverse pole, no earth, no L2 earth leakage current* and verify that the measured value is *< 1000 uA*.
7. Electrical safety analyzer settings: neutral: open; polarity: normal; leakage current: earth leakage.
   Measure and record the *normal pole, no earth, no L2 earth leakage current* and verify that the measured value is *< 1000 uA*.

7.7.12 Nurse Call/Remote Alarm Test (if applicable)

NOTE: This test applies only to ventilator s/n 106000 and above. This optional test provides a way to verify the nurse call/remote alarm connector as required by institutional protocol.

This test allows testing for the nurse call/remote alarm connector when configured as:

- Remote alarm (option 1)
- Nurse call, normally closed (option 2)
- Nurse call, normally open (option 3), the factory-set configuration.

Jumpers on the MC board configure the nurse call/remote alarm connector (Figure 7-10):

Nurse call/remote alarm configuration	JP1	JP2
Remote alarm (option 1)	2,3	2,3
Nurse call, NC (option 2)	2,3	1,2
Nurse call, NO (option 3)	1,2	1,2

NOTE: Before testing, ensure that MC board jumpers are set correctly.

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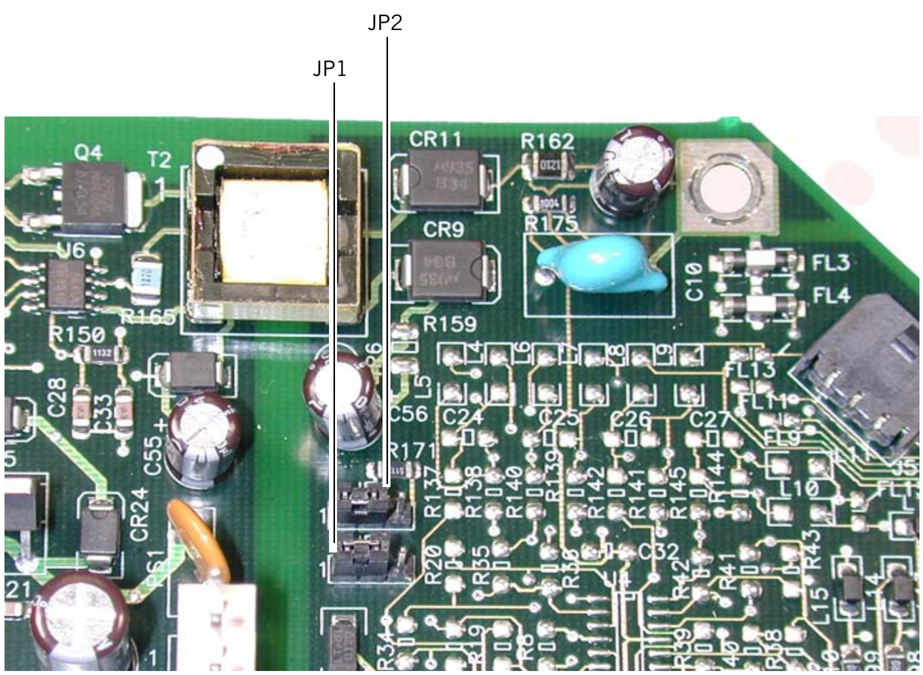


Figure 7-10: MC Board Jumpers

Required equipment:

- 0.25-in. test orifice (P/N 332353) or occluded patient circuit
- Fluke 87 digital multimeter (DMM) or equivalent (3 1/2-digit readout)

Option 1 (remote alarm):

1. With ventilator power off, use the DMM to measure the continuity between the high and low of the connector, and verify that the measurement is approximately 48.6 to 53.7 kOhms.
2. Install a test orifice to the ventilator outlet and power on.
3. Activate a patient alarm (for example, set Apnea = 20 seconds).
4. When the alarm occurs, repeat the connector measurement and verify that it indicates an open circuit.
5. Power off the ventilator.

Option 2 (nurse call, normally closed):

1. With ventilator power off, use the DMM to measure the continuity between the high and low of the connector, and verify that the measurement indicates a closed circuit.
2. Install a test orifice to the ventilator outlet and power on.
3. Activate a patient alarm (for example, set Apnea = 20 seconds).
4. When the alarm occurs, repeat the connector measurement and verify that it indicates an open circuit.
5. Power off the ventilator.

Option 3 (nurse call, normally open):

1. With ventilator power off, use the DMM to measure the continuity between the high and low of the connector, and verify that the measurement indicates an open circuit.
2. Install a test orifice to the ventilator outlet and power on.
3. Activate a patient alarm (for example, set Apnea = 20 seconds).
4. When the alarm occurs, repeat the connector measurement and verify that it indicates a closed circuit.
5. Power off the ventilator.

BiPAP Vision System Final Test Form

Ventilator serial no. ____________________ Service notification (Respironics use only) ____________________

Model no. ____________________ Total operating time ____________________

Power Indicator and LCD Controls Test

Power indicator lights	Pass	Fail
Brightness control function	Pass	Fail
Contrast control function	Pass	Fail

Pressure Accuracy Test

CPAP setting	*Set*	*Outlet*	*Unit*	*Patient*	*Manometer*	*Specification*	*Pass/Fail*	
5 cmH_2O						3-7 cmH_2O	Pass	Fail
10 cmH_2O						8-10 cmH_2O	Pass	Fail
20 cmH_2O						18-22 cmH_2O	Pass	Fail

Flow Accuracy Test

Flow setting	*Flowmeter*	*Compensated total flow*	*Pressure*	*Specification*	*Pass/Fail*	
0 LPM				-5 to 5 LPM	Pass	Fail
10 LPM				4.2-15.8 LPM	Pass	Fail
60 LPM				50.2-69.8 LPM	Pass	Fail
120 LPM				105.6-134.4 LPM	Pass	Fail
120 LPM				18-22 cmH_2O	Pass	Fail

Dynamic Pressure Regulation Test

Exhalation port test complete	Pass	Fail
Flow waveforms created (peak flow ~ 100 LPM, rate ~ 30 BPM)	Pass	Fail
Manometer reading = 18-22 cmH_2O	Pass	Fail

S/T Mode Performance Test

Vent cycles between low and high pressure	Pass	Fail
IPAP = 33-37 cmH_2O, EPAP = 3-7 cmH_2O	Pass	Fail
Rate = 9.3-10.8 BPM	Pass	Fail
Rate reading:		

Options and Controls

Invert, **Bar Graph**, and **Test Alarms** function correctly	Pass	Fail
Record displayed error messages, if any:	Pass	Fail
Record MC board error codes, if any:		
Record PC board error codes, if any:		

Record DC board error codes, if any:		
Record software version:		
Oxygen module installed?	Yes / No	
Alarm module installed?	Yes / No	
FREEZE/UNFREEZE functions correctly	Pass	Fail
SCALE functions correctly, waveform display changes	Pass	Fail

Alarms Test

Alarm occurs upon tubing disconnect, alarm message displayed	Pass	Fail
After reconnecting tubing Alarm reset clears alarm	Pass	Fail
Alarm sounds and wrench icon lights when AC cord removed	Pass	Fail
When powered up with AC cord installed, no audible alarm	Pass	Fail

Oxygen Module (OM) Test

%O_2 setting	*O_2 analyzer reading*	*Specification*	*Pass/Fail*	
21%		18.0 - 24%	Pass	Fail
30%		27.0 - 33%	Pass	Fail
O_2 cylinder valve closed, O_2 flow alarm active within 15 breaths			Pass	Fail
40%		36 - 44%	Pass	Fail
60%		54 - 66%	Pass	Fail
80%		72 - 88%	Pass	Fail
100%		> 90%	Pass	Fail

PAV/T Mode Test

PAV/T mode features displayed correctly, no alarms occur	Pass	Fail	N/A

Earth Resistance and Leakage Current Test

Test	*DMM reading*	*Specification*	*Pass/Fail*	
Earth resistance		< 0.20 Ohms	Pass	Fail
Normal pole, no earth, L2		< 300 uA	Pass	Fail
Reverse pole, no earth, L2		< 300 uA		
Reverse pole, no earth, no L2		< 1000 uA		
Normal pole, no earth, no L2		< 1000 uA		

Nurse Call/Remote Alarm Test

Correct continuity with ventilator off and with active alarm	Pass	Fail

Tested by: Date:

(Print name) (Signature)

7.8 Oxygen Module (OM) Calibration

The OM calibration adjusts the zero voltage on the OM assembly main board. Perform this calibration on any OM module that is suspected to be out of tolerance, then perform the complete system final test on the ventilator.

NOTE: Perform OM calibration on the existing OM before replacing any of its components. If it is necessary to replace an OM component, test the OM using the system final test (Section 7.7). If OM testing fails, perform OM calibration then repeat the system final test.

NOTE: If the OM still does not pass the system final test, follow standard repair procedures.

Required equipment: Fluke 87 digital multimeter (DMM) or equivalent (3 1/2-digit readout)

1. Remove the complete OM assembly except for its ground wire and ribbon cable, and set next to the ventilator.
2. Connect the DMM to TP9 and TP13 (ground).
3. Power on the ventilator and allow it to complete its system self test. Do *not* enter Monitoring.
4. Adjust R41 on the OM so that the DMM measures 0.225-0.235 VDC.
5. Reassemble the ventilator.

Chapter 8. Options and Upgrades

This chapter describes how to install ventilator options and summarizes upgrade information.

WARNING: Electrical shock hazard: disconnect the electrical supply before attempting to make any repairs to the device.

CAUTION: Electrical components used in this device are subject to damage from static electricity. Perform all repairs in an antistatic, ESD-protected environment.

8.1 Options

This section describes how to install these options:

- Section 8.1.1: proportional assist ventilation/timed (PAV/T) mode.
- Section 8.1.2: oxygen baffle, an enhancement for ventilator s/n 105999 and below.

8.1.1 PAV/T Mode

Required equipment:

- Phillips screwdriver
- Small, long-shaft flat-blade screwdriver
- EPROM extraction tool

The PAV/T option kit includes:

- EPROM for DC board
- ERPOM for PC board
- EPROM for MC board
- *Alarm B* PAL (MC board)

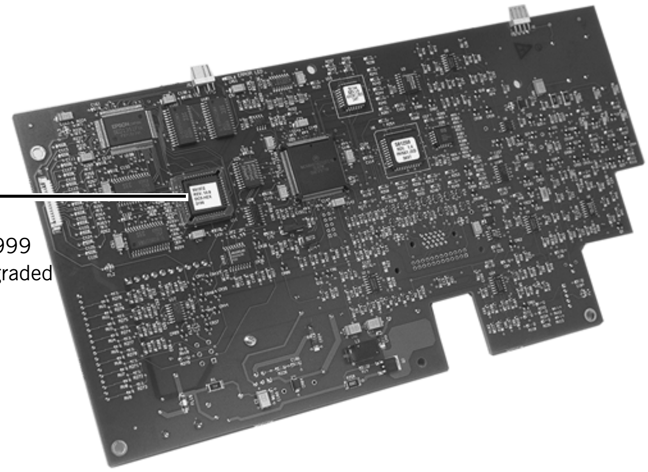
CAUTION: To ensure proper ventilator operation, the EPROMs (DC, PC, and MC) *must* have the same revision.

1. Remove the DC board from the ventilator. It is possible to remove the retaining screws and pull the DC board from the enclosure while leaving the touch pad and LCD connections attached.

2. Use the extraction tool to remove the existing EPROM (Figure 8-1 shows the EPROM location on the board) and store in an antistatic container if required.

DC EPROM

Ventilator s/n 105999
and below, not upgraded



DC EPROM

Ventilator s/n 106000
and above

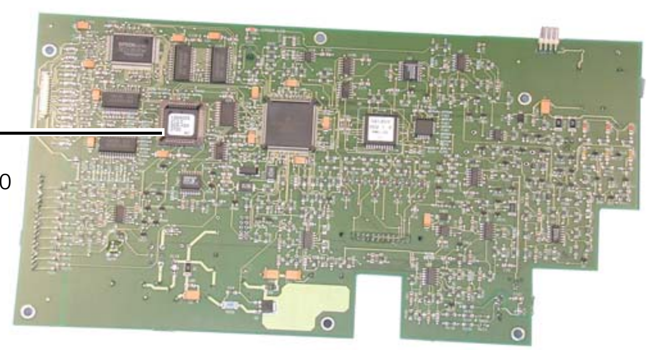


Figure 8-1: DC Board EPROM Location

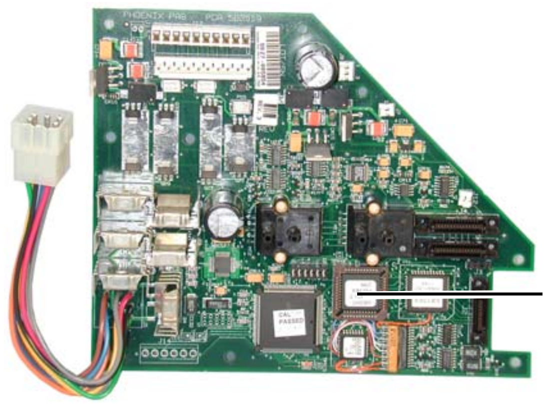
3. Carefully install the new DC EPROM, aligning the flat edges of the EPROM and the socket.

4. Reinstall the DC board.

5. Remove the PC board from the ventilator.

CAUTION: To avoid damaging pressure transducers, avoid using excessive pressure to remove tubing. Carefully twist the tubing slightly to break the seal, the continue to rotate the tubing as you lift it away from the transducer.

6. Use the extraction tool to remove the existing EPROM (Figure 8-2 shows the EPROM location on the board) and store in an antistatic container if required.



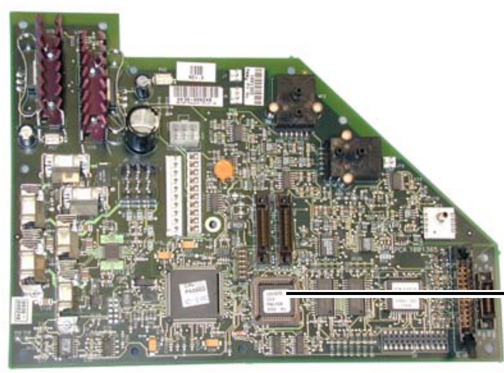


Figure 8-2: PC Board EPROM Location

7. Carefully install the new PC EPROM, aligning the flat edges of the EPROM and the socket.

8. Use the extraction tool to remove the existing EPROM and alarm PAL, if installed, and store in an antistatic container if required (Figure 8-3 shows the location of the EPROM and alarm PAL on the board).

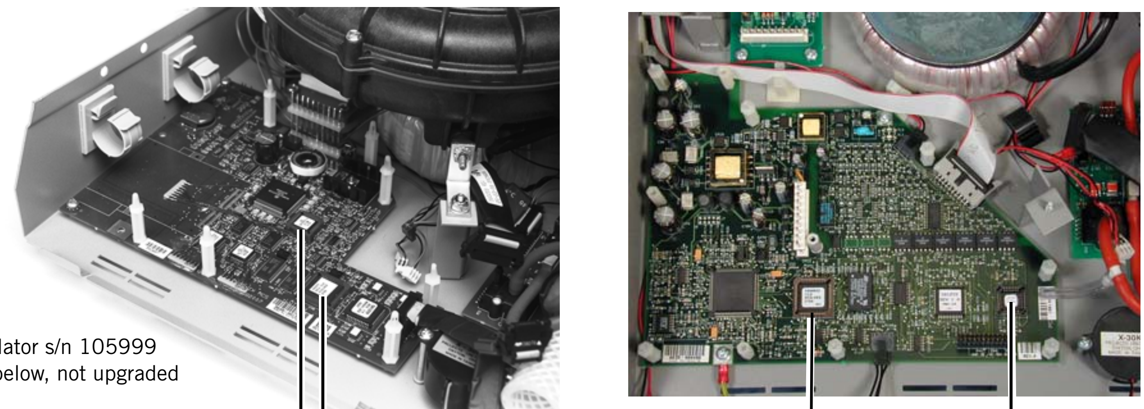


Figure 8-3: MC Board EPROM and Alarm PAL Locations

9. Carefully install the new MC EPROM and alarm PAL, aligning the flat edges of the EPROM and the socket.

10. Reassemble the ventilator.

11. Perform the run-in cycle and system final test (described in Chapter 7) before returning the ventilator to use.

8.1.2 Oxygen Baffle

This section describes how to install the oxygen baffle, an enhancement for ventilator s/n 105999 and below, that improves air and oxygen mixing and airflow module (AFM) operation.

Figure 8-4: Oxygen Baffle

1. Remove the top enclosure and front panel.
2. Remove the following oxygen module (OM) components (Figure 8-5):
   - AFM
   - OM outlet tubing support bracket (no longer needed)
   - T connection (no longer needed)
   - 22-mm coupling at OM outlet (no longer needed)

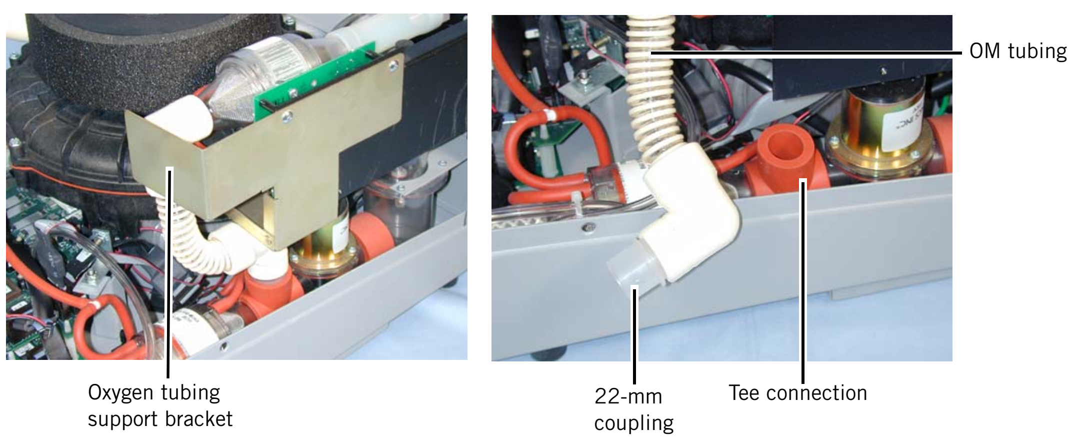


Figure 8-5: Removing OM Components

3. Remove the 2 mounting screws that attach the flow body to the circuit board, using care not to damage the thermistor wire connection (Figure 8-6).

4. Align the nylon washers over the screw holes. The washers provide the necessary clearance for installing the baffle.

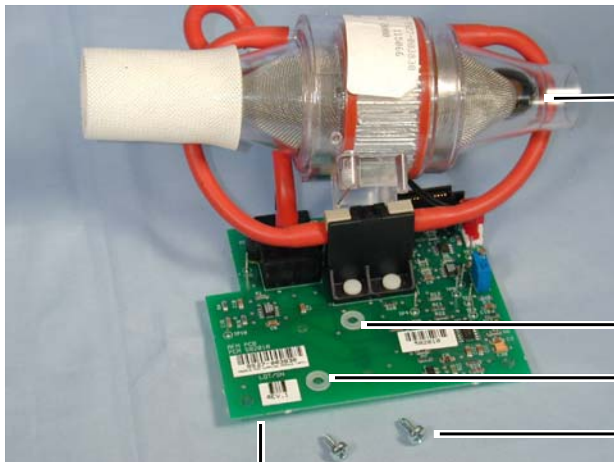


Figure 8-6: Installing Nylon Washers under AFM Mounting Screws

5. Replace the flow body and fasten the screws (Figure 8-7).

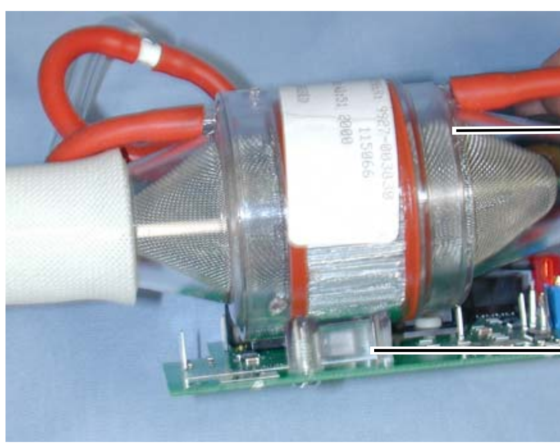


Figure 8-7: Reassembled AFM

6. Install the oxygen baffle onto the ILFR as far as possible, so that the oxygen port points directly up with the flow direction arrow pointing to the front of the ventilator (Figure 8-8).

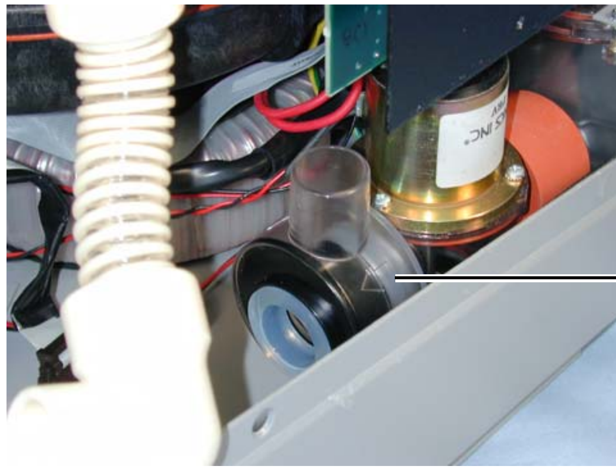


Figure 8-8: Installing the Oxygen Baffle onto the ILFR

7. Carefully insert the AFM into the oxygen baffle outlet until the AFM is aligned with its three mounting posts on the bottom enclosure, then press on the AFM circuit board to secure the AFM in place (Figure 8-9).

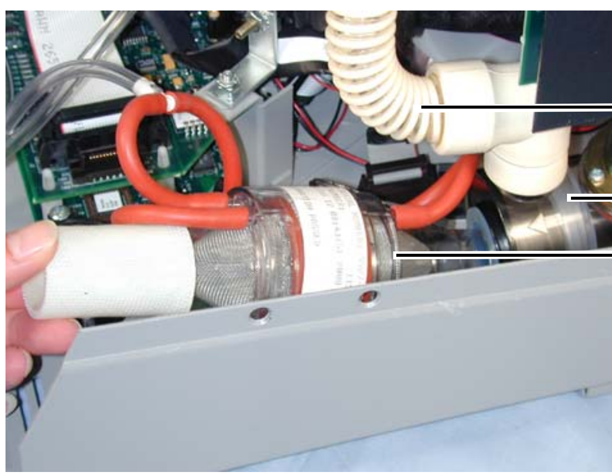


Figure 8-9: Installing the AFM

8. Reinstall:
   - connections to the AFM
   - oxygen tubing to the baffle
   - front enclosure
   - top enclosure

   NOTE: Ensure that AFM tubing is not kinked.

9. Perform the system final test (described in Chapter 7) before returning the ventilator to use.

8.2 Upgrades

This section summarizes the upgrade history for BiPAP Vision ventilators.

8.2.1 Serial Number 105999 and Below

The following upgrades (Table 8-1) do not include these updated items:

- Nurse call/remote
- RS-232 serial port
- Oxygen baffle
- Ground stud

Existing touch pads and labeling are not affected. Language versions are available for software version 13.0 and above only.

Table 8-1: Upgrades for s/n 105999 and Below

Upgrade	Part number	Description
RP-Vision DC Upgrade, non-PAV	1004714	Replaces DC, PC, and MC boards for ventilators without PAV. Adds languages. May also require new test cable (P/N 1004823) and RS-232 serial cable (P/N 1004699). Includes: • DC board and version 13 EPROM • PC board and version 13 EPROM • MC board and version 13 EPROM • Updated (longer) AFM cable • Power cable, PSS to PC • Power cable, PC to DC • ICB cable • PC/MC board spacers • Nut for MC center board spacer • Pressure tubing • Cable clamps • Screw for center cable clamp • MC ground screw • Top cover screws
RP-Vision DC Upgrade, PAV	1004707	Replaces DC, PC, and MC boards for ventilators with PAV. Adds languages. May also require new test cable (P/N 1004823) and RS-232 serial cable (P/N 1004699). Includes: • DC board and version 13 EPROM • PC board and version 13 EPROM • MC board and version 13 EPROM • Updated (longer) AFM cable • Power cable, PSS to PC • Power cable, PC to DC • ICB cable • PC/MC board spacers • Nut for MC center board spacer • Pressure tubing • Cable clamps • Screw for center cable clamp • MC ground screw • Top cover screws

Table 8-1: Upgrades for s/n 105999 and Below

Upgrade	Part number	Description
RP-EPROM Upgrade Kit, non-PAV	1000286	Software-only update with these features: O_2% parameter retained when switching modes, pressure increase from 10 to 15 cmH_2O during Disconnect alarm condition, revised alarm sounds (5-beep sequence for patient alarms, 3-beep sequence for *Check Vent* alarms, soft click for out of range setting attempt, original tone for *Vent Inop* alarms). Includes: • DC board Version 11 EPROM • PC board Version 11 EPROM • MC board Version 11 EPROM
RP-EPROM Upgrade Kit, PAV	1003524	Software-only update with these features: O_2% parameter retained when switching modes, pressure increase from 10 to 15 cmH_2O during Disconnect alarm condition, revised alarm sounds (5-beep sequence for patient alarms, 3-beep sequence for *Check Vent* alarms, soft click for out of range setting attempt, original tone for *Vent Inop* alarms). Includes: • DC board Version 11 EPROM • PC board Version 11 EPROM • MC board Version 11 EPROM • Alarm B option PAL (not used for ventilators that already have PAV)

8.2.2 Obsolete Repair Kits

lists repair kits that are no longer available and what repair kits should be used instead.

Table 8-2: Obsolete Repair Kits

Obsolete kit	Substitution repair kit
Circulation fan muffler French (P/N 1000741) Spanish (P/N 1000738) German (P/N 1000729)	Circulation fan muffler, international (P/N 1005618)
Circulation fan muffler, English, 3.5 A rating (P/N 582155)	Circulation fan muffler, English, 4.0 A rating (P/N 1041193) Install when replacing 3.5-A fuses with 4.0-A fuses.
EPROM upgrade kit (P/N 582180)	EPROM upgrade kit, non-PAV, s/n 105999 and below
Fuse, international (P/N 582099)	Fuse, international (P/N 1000750)

Table 8-2: Obsolete Repair Kits

Obsolete kit	Substitution repair kit
Fuse, 100-120 V, 3.5 A (P/N 1000749)	Fuse, 100-120 V, 4.0 A (P/N 1041196) If current fan muffler is labeled with 3.5-A rating, also install 4.0-A rating circulation fan muffler (P/N 1041193).
MCS board (P/N 582140)	MC upgrade kit, non-PAV (P/N 1004713) MC upgrade kit, PAV (P/N 1000356)
OM assembly, French (P/N 582254) Spanish (P/N 582255) Italian (P/N 1003547) German (P/N 582220)	OM assembly, international (P/N 1004977)
PAV/T option kit (P/N 1000747)	EPROM kit with PAV for s/n 105999 and below not previously upgraded (P/N 1003254)
Power line filter (P/N 1000745)	AC inlet (P/N 582138)
Pressure airflow subsystem (PAS) board (P/N 582146)	PC upgrade kit, non-PAV (P/N 1004714GL) PC upgrade kit, PAV (P/N 104707GL)
Touch pad French (P/N 582257) Spanish (P/N 582256)	Touch pad, international (P/N 1004712)

8.3 PC/MC/DC Upgrade Installation

This section describes how to install these upgrades for ventilator s/n 105999 and below:

- PC/MC/DC three-board upgrade, PAV (P/N 104707GL)
- PC/MC/DC three-board upgrade, non-PAV (P/N 1004714GL)

CAUTION: Perform this repair according to proper ESD guidelines.

NOTE: Record the total operating hours to enter onto the ventilator when the upgrade is complete.

Required equipment:

- Ribbon cable, test (P/N 1004699)
- Test cable (P/N 582161)
- Test cable (P/N 1004823)

Before installing the upgrade kit, remove these items from the ventilator:

- Top cover
- Front panel
- DCS board
- Inlet tubing, blower muffler and blower (it may be necessary to partially remove the oxygen module (OM) to access all blower mounting screws)
- PAS board
- MCS board
- Cable clamps (2) that attach blower power supply, and main power indicator wiring to the left side of the ventilator.

These items from the ventilator are no longer used:

- Gray power cable that originally connected to PSS, PAS, and DCS
- ICB cable
- AFM to PCS cable
- 4 of the 5 screws used to secure the MCS
- PAS, including software
- MCS, including software
- DCS, including software
- 2 top cover screws

Follow these steps to install the upgrade kit:

1. Install the version 13 EPROMs into the sockets on the MC and PC boards.

2. For non-PAV: remove original alarm PAL from U41 on the MCS and install it onto the new MC board.
   For PAV: install the alarm PAL provided in the upgrade kit into U41 on the new MC board.

3. Install the DC EPROM provided in the upgrade kit onto the DC board.

4. Install the DC board to the front enclosure.

5. On the new MC board, install the 6-32 nut and aluminum spacer (spacer on the component side, nut on the reverse side) over the mounting hole near the power cable connection at the center of the board.

6. Install the MC board into the bottom enclosure, using the nylon “snap” standoffs where the original standoffs were removed. Install the 8-32 x 3/8 screw into the mounting hole surrounded by the ground plane (along the transformer edge).

7. Install new nylon standoffs on the MC board mounting holes (front left and back left), then install another standoff between them. Install 2

more standoffs: behind the power supply connector, and in front of the MC board.

8. Install the original DC ground wire and screw to the mounting hole on the MC board (the hole at the left front side surrounded by the ground plane).

9. Temporarily install the RS-232 ribbon cable for testing. It must be removed after testing is complete.

10. Install the new PC board onto the MC board standoffs, ensuring that the power connection (center of the board) and the test/error connection (front right of the board) are fully seated. Verify that all nylon snap-locks are fully engaged.

11. Mount a second aluminum spacer onto the PC board (near the center).

12. Connect the blower, valves, circulation fan current sense, OM ribbon cable, and the new ICB cable to their connections on the PC board.

13. Install the new AFM to PC cable (from J4 on the PC board to the AFM and J6 on the OM).

14. Install the new power supply cable to the PSS, and connect the middle cable connector to the PC board power connection. Make a counter-clockwise loop with the remaining cable length, and connect it to the DC board.

15. Use the 6-32 x 1/4 screw and cable clamp provided in the kit to attach the power supply cable to the center aluminum spacer in the center of the PC board.
(This secures the cable while allowing some cable movement when the front panel is removed.)

16. Remove the 7-inch pressure tubing from the AFM tee fitting (this tube originally connected to the pressure sensor on the PAS board). Attach the 3-inch pressure tubing provided in the kit to connect the AFM tee fitting and the pressure sensor closest to the AFM.

17. Reinstall the blower, blower muffler, and inlet tubing, if any were removed. Connect the blower connector to the PC board.

18. Reinstall the front enclosure, ensuring that all connections are secure. The patient pressure tubing connects from the front enclosure to the middle pressure sensor port on the right side.

19. Perform the following procedures as described in Chapter 7:
    - Transfer the total operating hours to the upgraded ventilator.
    - Blower/valve calibration.
    - Run-in cycle.
    - System final test.

    NOTE: When you power up the upgraded ventilator, a *Check Vent* error 301 may occur. Running a blower/valve calibration and cycling power will clear this error.

20. When testing is complete, remove the test ribbon cable from MC board, and install the top enclosure using the two 6-32 x 1/2 screws provided in the upgrade kit.

Appendix A Parts List

Table A-1 lists replacement parts for the BiPAP Vision ventilator.

WARNING: To reduce the risk of explosion, replace batteries only with the same or equivalent type recommended by the manufacturer, and dispose of battery according to manufacturer instructions.

NOTE: Please contact Respironics customer service (1-800-345-6443) for specific AC power cord ordering information.

Table A-1: BiPAP Vision Replacement Parts

Description	**Part number**
AC inlet (includes power inlet filter)	582138
AC power cord (North America)	362435
AC power cord clamp	1000751
Adapter, nurse call, Executon/Hill-Rom connector	1014280
Adapter plate, Universal Roll Stand, BiPAP Vision	1048872
Airflow module (AFM)	582127
Alarm module (optional)	582158
Audible alarm	1000743
Backlight	1014432
Baffle, oxygen	1004705
Base assembly, Universal Roll Stand	1048900
Basket, Universal Roll Stand	1005839
Battery, alarm, DC board	1012819
Battery, MCS board (s/n 105999 and below, battery soldered to MCS board)	1001988
Battery, MC board (s/n 106000 and above, battery *not* soldered to MC board)	1006005
Blower assembly	582128
Bowl, manifold/regulator, OM (OM s/n 299999 and below)	582154

Table A-1: BiPAP Vision Replacement Parts

Description	Part number
Bowl, manifold/regulator, OM, (OM s/n 300000 and above)	1007546
Bracket, humidifier, Mobile Stand III	1005101
Bracket, mounting, E cylinder	1011949
Bracket, mounting, patient support arm	1002497
Cable, AFM/PC	1041313
Cable kit (includes all interconnecting cables)	582131
Cable, DC/LCD ribbon	1016457
Cable, ICB (s/n 105999 and below)	582159
Cable, ICB (s/n 106000 and above)	1004695
Cable, MC/DC (s/n 106000 and above)	1004698
Cable, OM/PC (included in cable kit P/N 582131)	--
Cable, nurse call	1003742
Cable, ribbon (for RS-232 and with test cable for upgraded s/n 105999 and below)	1004699
Cable, test (s/n 105999 and below)	582161
Cable, test (s/n 106000 and above and upgraded s/n 105999 and below)	1004823
Caster kit, Mobile Stand II, locking	1001921
Caster kit, Mobile Stand II, non-locking	1001922
Caster kit, Universal Roll Stand, locking	1048898
Caster kit, Universal Roll Stand, non-locking	1048897
Circulation fan kit (includes fan and 4 standoffs, P/N 581526)	582132
Connector, DC	1007206
Cover, inlet filter	1003444
Cover, oxygen	1040859
Display control (DC) board (s/n 106000 and above)	1004709

Table A-1: BiPAP Vision Replacement Parts

Description	Part number
DCS board (s/n 105999 and below) NOTE: P/N 582133 is now obsolete. Replace as follows: • Ventilator s/n 105999 and below with original boards and version 11 software: install DC/PC/MC upgrade kit P/N 1004714G. • Ventilator s/n 105999 and below with upgraded MC and PC boards and version 12 software, install: - DC board (P/N 1004709) - MC/DC cable (P/N 1004698) - PC/DC power harness (P/N 1004696) - PSS/PC power harness (P/N 1004706) - EPROM, v13 software (P/N 1000353)	582133
Door, Plexiglas, Mobile Stand II	1001920
Enclosure, bottom (s/n 105999 and below)	582130
Enclosure, bottom (s/n 106000 and above)	1004700
Enclosure, front panel	582135
Enclosure, inlet filter (also order inlet filter foam strip P/N 1004493)	582134
Enclosure, top	582150
EPROM extraction tool kit	1006874
EPROM kit, v11 (s/n 105999 and below)	1000286
EPROM kit, v11 with PAV (s/n 105999 and below)	1003524
EPROM kit, v12 (s/n 105999 and below)	1000351
EPROM kit, v12 with PAV (s/n 105999 and below)	1000349
EPROM kit, v13 (s/n 106000 and above)	1000353
EPROM kit, v13 with PAV (s/n 106000 and above)	1000354
Feet, drawer, Mobile Stand III	1009745
Feet, rubber	582149
Feet, storage tray, Mobile Stand III	1009745
Filter kit, OM manifold/regulator (OM s/n 299999 and below) (package of 5)	582153
Filter kit, OM manifold/regulator (OM s/n 300000 and above) (package of 5)	1007547

Table A-1: BiPAP Vision Replacement Parts

Description	Part number
Foam strip, inlet filter	1004493
Fuse kit, 3.5 A, 100-120 VAC (s/n 105000 and above) (also part of upgrade kit P/N 1004713)	1000749
Fuse kit, 4.0 A, 100-120 VAC (replaces 3.5-A fuse kit P/N 1000749) Also install circulation fan muffler kit (P/N 1041193) if labeling does not match fuse rating	1041196
Fuse kit, 115 VAC (s/n 100499 and below)	582100
Fuse kit, 230-240 VAC (also part of upgrade kit P/N 1000356)	1000750
Ground post hand punch tool	1002991
Grounding post	1002902
Handle, circuit support arm, Mobile Stand II	1006501
Hanger, oxygen hose assembly, Mobile Stand III	1007903
Hardware kit, Universal Roll Stand	1048896
Harness, nurse call (s/n 106000 and above)	1004697
Harness, power, PC/DC (s/n 106000 and above)	1004696
Harness, power, PSS/PC (s/n 106000 and above)	1004706
Hose kit (includes all internal tubing)	582136
Humidifier bracket, Fisher & Paykel, Universal Roll Stand	1049677
Humidifier bracket, Pacifico Medico, Universal Roll Stand	1049679
Inlet filter, nylon mesh	1000747
Inlet filter, replacement (package of 6)	582101
Inlet fitting, oxygen, DISS	1014805
Inline flow restrictor (ILFR) assembly	582137
Knob, rotary encoder	582157
Label, BiPAP Auto-Trak Sensitivity	1031502
Label, diagnostic/nurse call (s/n 105999 and below)	1004703
LCD assembly	582139

Table A-1: BiPAP Vision Replacement Parts

Description	Part number
Main control (MC) board (s/n 106000 and above) (remove EPROM from original board and install into new board unless upgrading s/n 105999 and below) NOTE: The MC and PC boards are now manufactured with gold contacts. If replacing the MC board, the PC board must also be replaced if it has the original tin contacts: order MC/PC boards (P/N 1018548).	1004711G
MC and PC boards only (for ventilator s/n 106000 and above, and s/n 114455 and below) NOTE: The MC and PC boards in this kit are now manufactured with gold contacts.	1018548G
Mount, patient support arm, Mobile Stand II	1002310
Muffler, blower	582129
Muffler, circulation fan, English, 3.5 A rating	582155
Muffler, circulation fan, English, 4.0 A rating	1041193
Muffler, circulation fan, international	1005618
Muffler, PRV	582156
Orifice, test, 0.25 in.	332353
Oxygen flow module	1014433
Oxygen Module (OM) assembly, English	582142
Oxygen Module (OM) assembly, international	1004977
Oxygen regulator/manifold	1014434
Pole, Mobile Stand II	1001923
Pole, oxygen analyzer, Mobile Stand III	1011515
Post, oxygen analyzer, Universal Roll Stand	1048899
Power cord wrap, Universal Roll Stand	1049636
Power supply subsystem (PSS) board	582145

Table A-1: BiPAP Vision Replacement Parts

Description	Part number
Pressure control (PC) board (s/n 106000 and above) (remove EPROM from original board and install into new board unless upgrading s/n 105999 and below) NOTE: The MC and PC boards are now manufactured with gold contacts. If replacing the MC board, the PC board must also be replaced if it has the original tin contacts: order MC/PC boards (P/N 1018548).	1004710G
Pressure regulation valve (PRV) assembly	582147
Repair kit, caster wheel, Mobile Stand III (includes two locking casters and two non-locking casters)	1017814
Repair kit, side rail, Mobile Stand III (includes instructions, side rails, and hardware)	1020266
Repair kit, storage compartment, Mobile Stand III (includes instructions, storage compartment, and hardware)	1015386
Rotary encoder	582148
Service kit, BiPAP Vision, includes: • Adjustable flow valve (P/N 331461) • Cable, D9 M/F (P/N 600075) • Extraction tool (P/N 1000852) • Oxygen enrichment kit (P/N 312002) • RS-232 harness, MC/front panel (P/N 1003446) • Silicone tube, 5-in. x 1/8-in. ID (P/N 580046) • Tee fitting, 1/8 in. OD (P/N 311105) • Test cable (P/N 580236) • Test cable, s/n 106000 and above (P/N 1004823) • Test orifice, 0.25 in. (P/N 332353) • Whisper Swivel II assembly (P/N 302398)	1021276
Shipping kit, Vision ventilator (includes all necessary packaging material)	1002424
Shipping kit, Mobile Stand II	1002425
Shipper (packaging kit), Universal Roll Stand	1049903
Side rail, Universal Roll Stand	1049678
Spring, oxygen inlet	1030632
Standoff, male/female, 6-32 x 1.75 (package of 4, included in circulation fan kit P/N 582132)	581526

Table A-1: BiPAP Vision Replacement Parts

Description	Part number
Storage tray, Mobile Stand III	1007905
Strike/catch kit, Mobile Stand II	1002151
Switch, main power, with cover	582141
Thumbwheel, Universal Roll Stand, BiPAP Vision	1049862
Top assembly, Universal Roll Stand	1048902
Touch pad, English	582151
Touch pad, German	582221
Touch pad, universal	1004712
Transformer assembly	582152
Tubing, coiled pressure tube, 28-in.	1000752
Universal Roll Stand (replaces Mobile Stand III)	1041139
Upgrade kit, DC/MC/PC (s/n 105999 and below) NOTE: The MC and PC boards in this kit are now manufactured with gold contacts.	1004714GL
Upgrade kit, DC/MC/PC, with PAV (s/n 105999 and below) NOTE: The MC and PC boards in this kit are now manufactured with gold contacts.	1004707GL
Upgrade kit, PC/MC (s/n 105999 and below) NOTE: This kit is now obsolete. Install P/N 1004714GL.	1004713GL
Upgrade kit, PC/MC with PAV (s/n 105999 and below) NOTE: This kit is now obsolete. Install P/N 104707GL.	1000356GL
Valve coupler, blower	1003728
Vibration isolator, blower (package of 3)	1003893

A.1 Replacement Part Photos

This section includes photos of the major components of the BiPAP Vision ventilator.

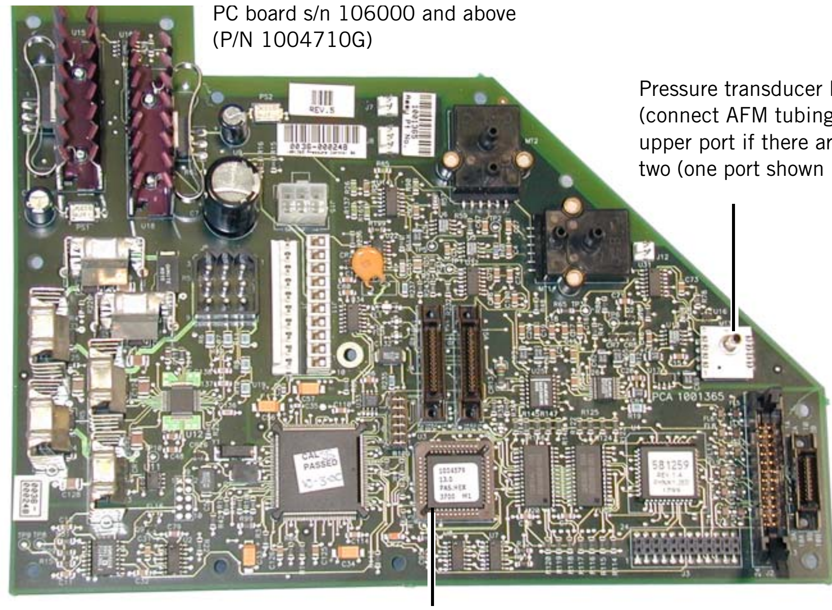
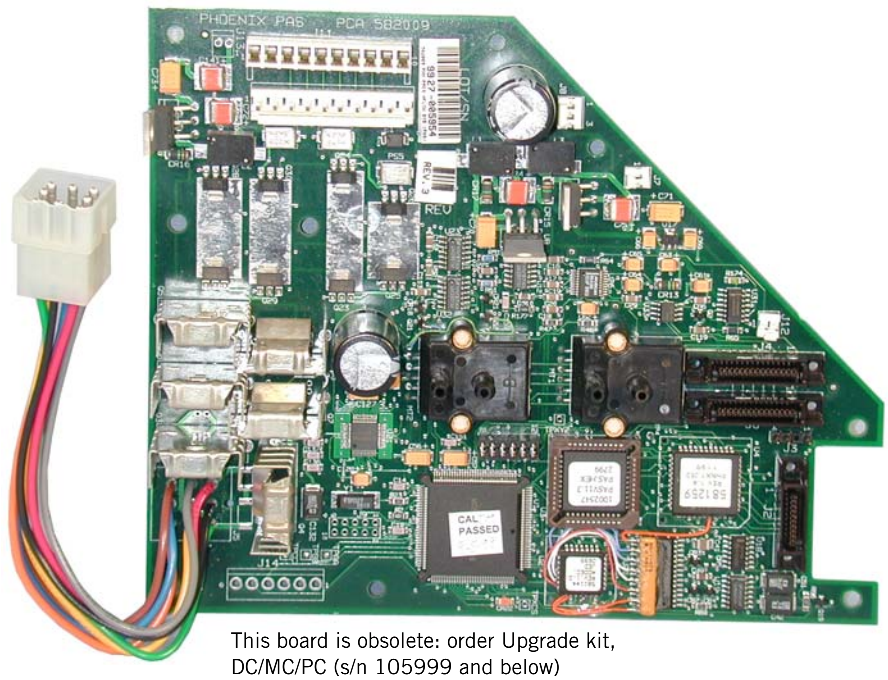


Figure A-1: PC *Board, s/n 106000 and above*

NOTE: The PC board has gold contacts. If replacing the PC board and the MC board has original tin contacts, you must replace the PC and MC boards.

NOTE: The PC board includes pressure transducer MT3. MT3 may include either one or two pick-off ports; if MT3 has two pick-off ports, connect tubing from the AFM module to the port closest to the "MT3" on the board.



This board is obsolete: order Upgrade kit, DC/MC/PC (s/n 105999 and below)

Figure A-2: PAS (PCS) *Board (Obsolete)*

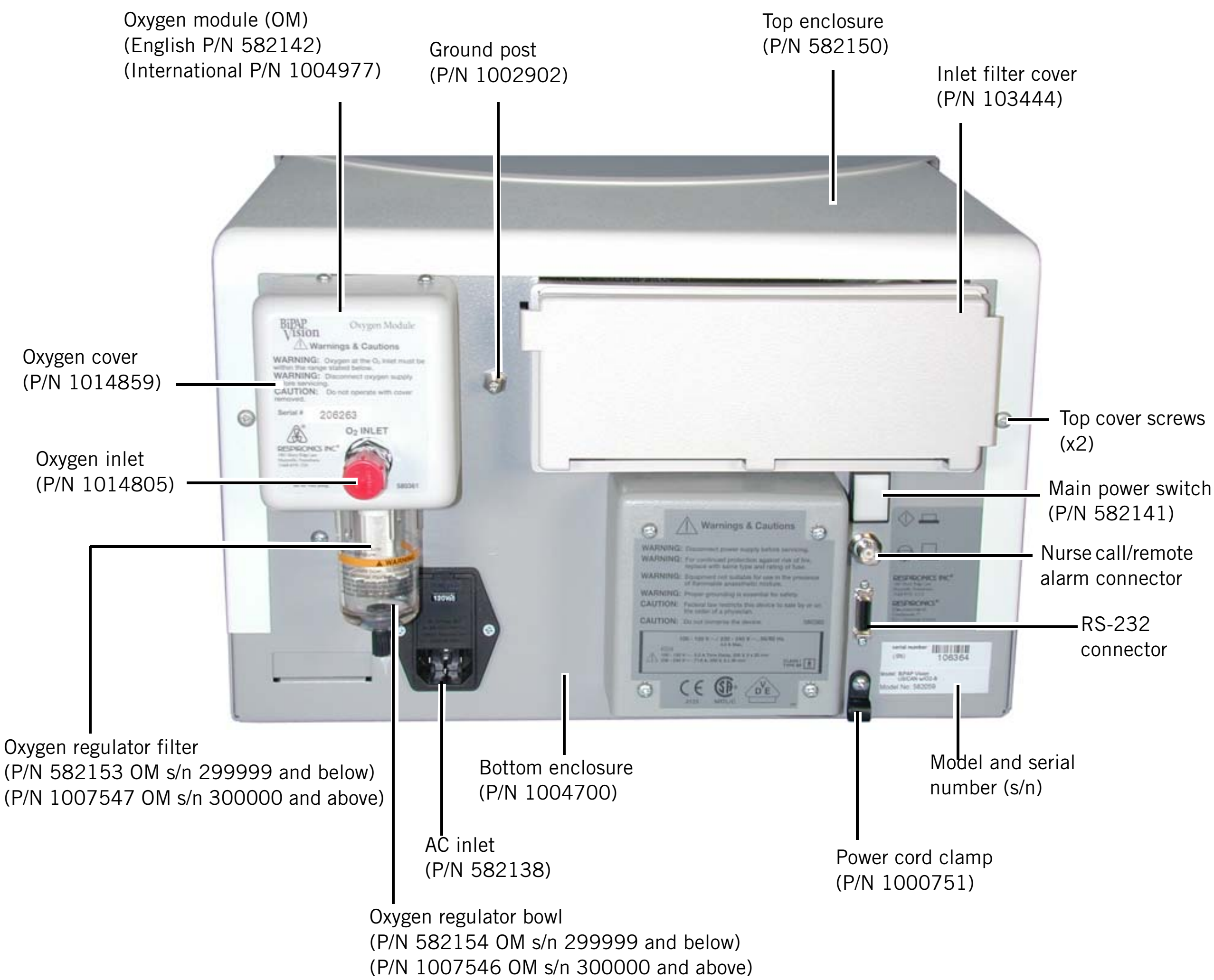


Figure A-3: Back Panel Components, s/n 106000 and above

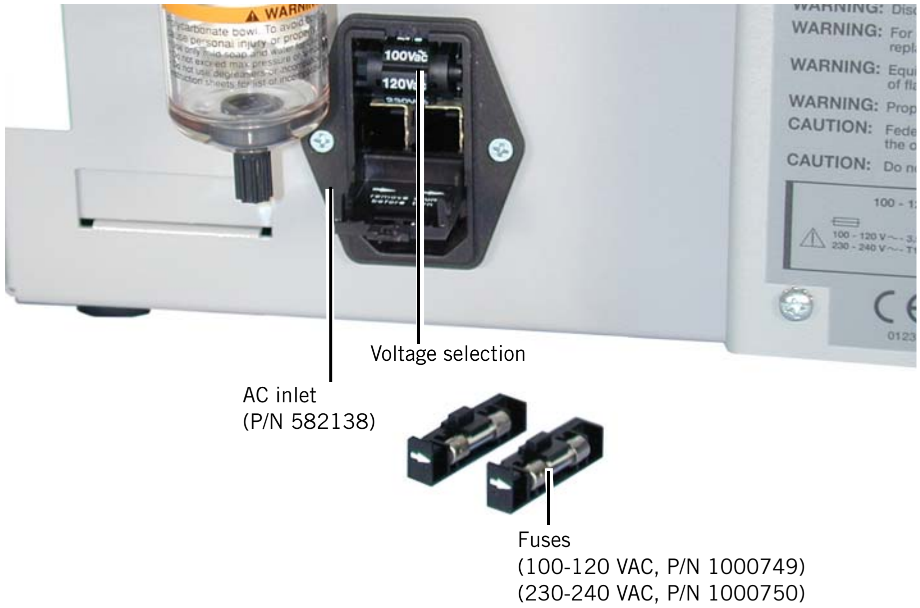
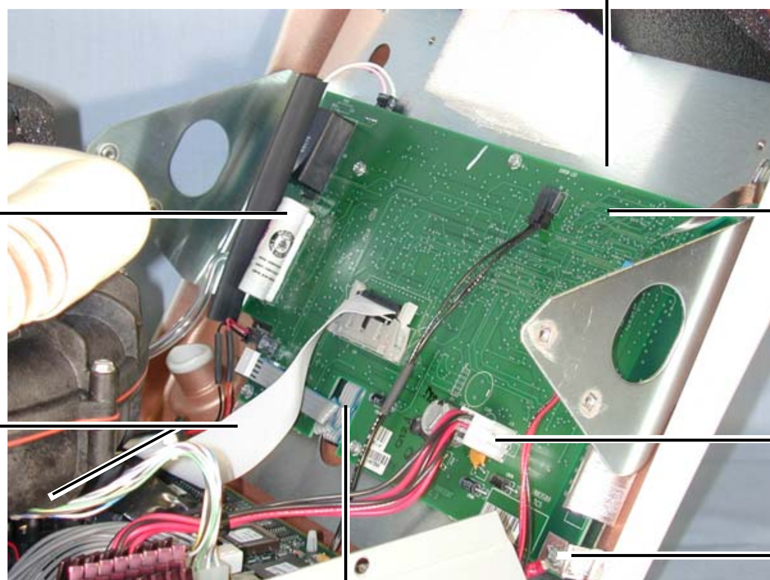


Figure A-4: Fuses

Figure A-5: Inlet Filter Enclosure

Figure A-6: Circulation Fan Muffler



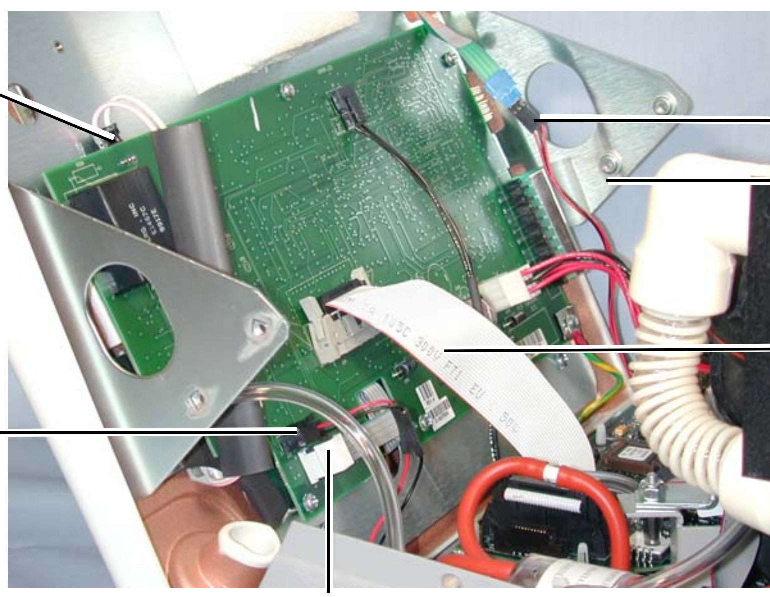


Figure A-7: DC *Board, s/n 106000 and above*

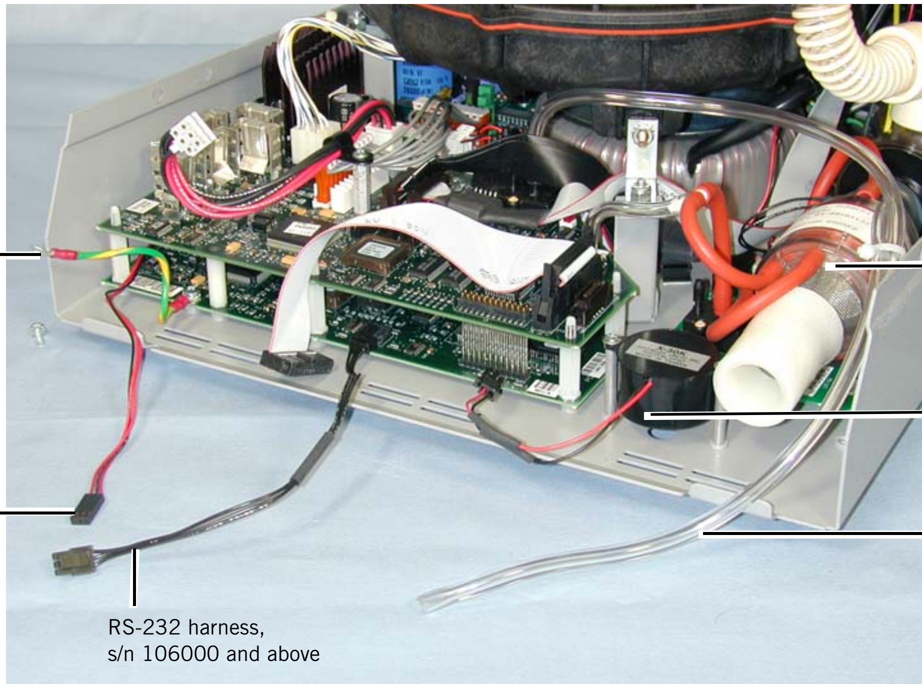


Figure A-8: Component Identification (AFM side)

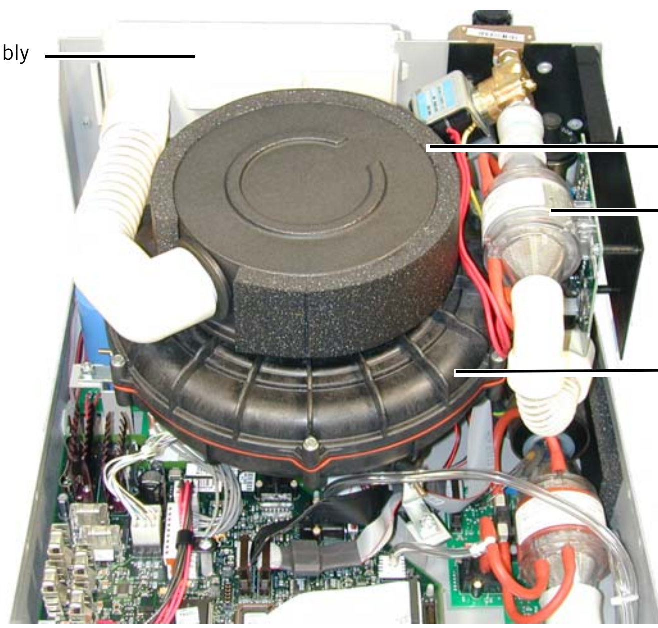


Figure A-9: Component Identification (Blower)

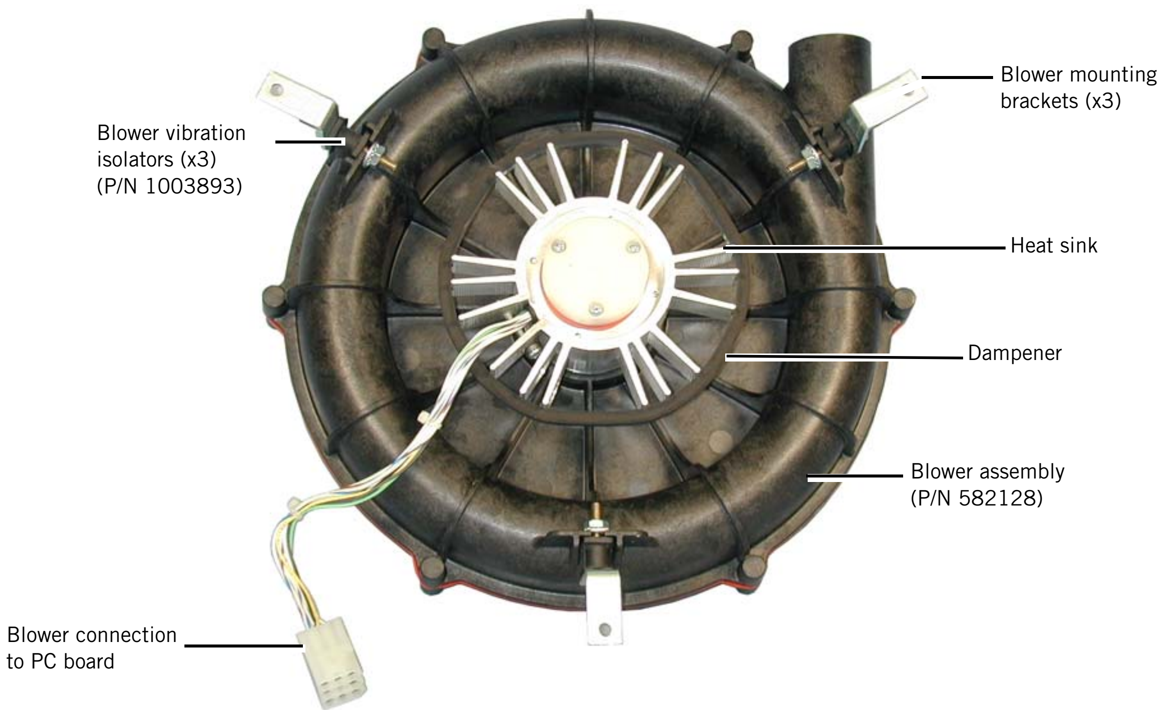


Figure A-10: Blower Assembly

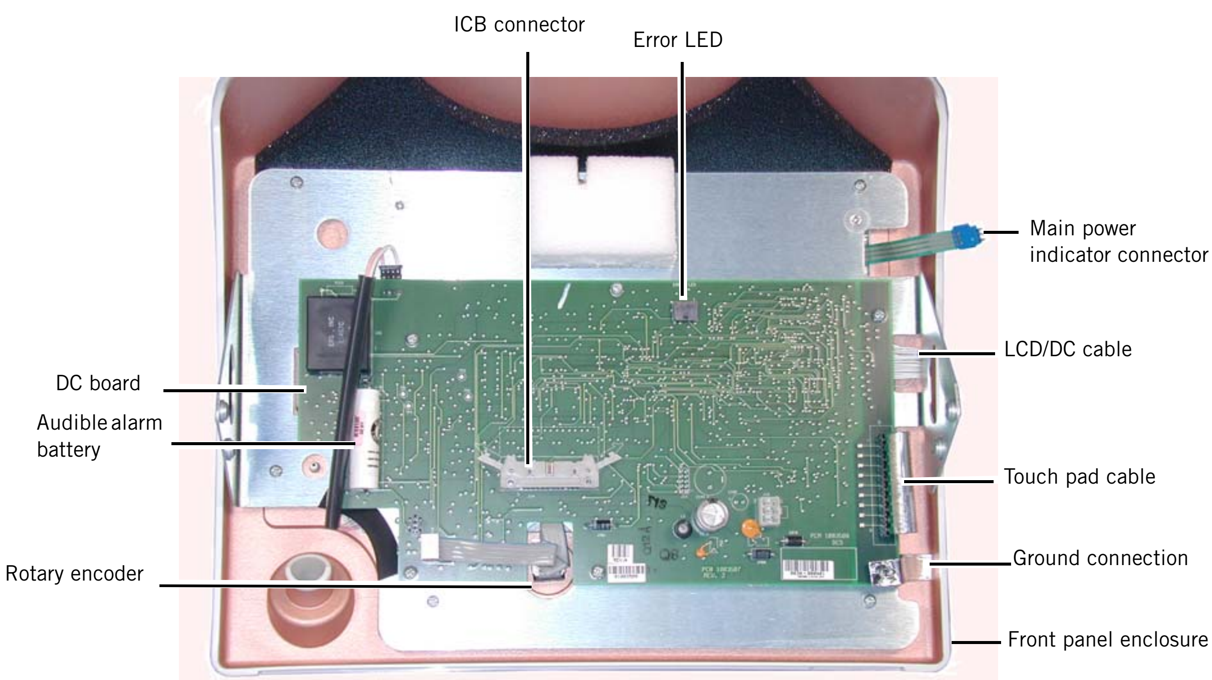


Figure A-11: Front Panel Assembly

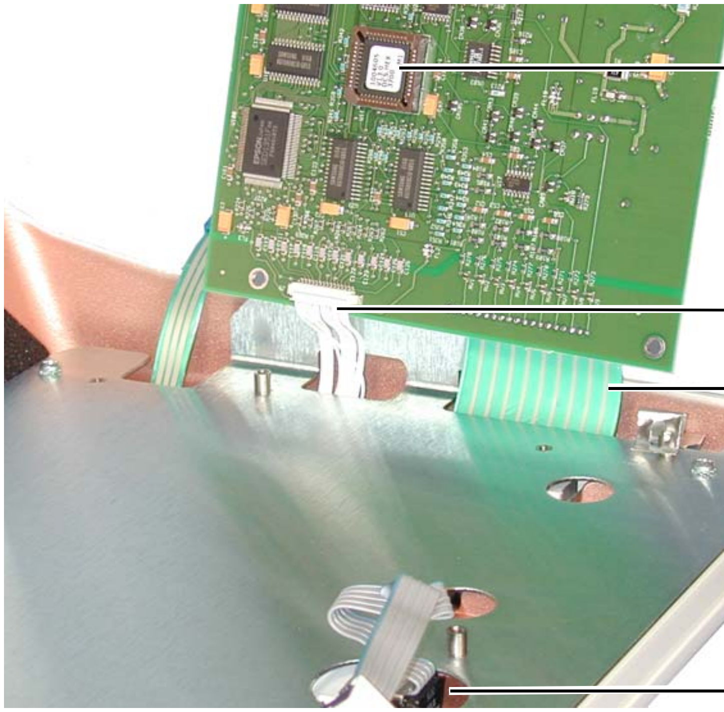
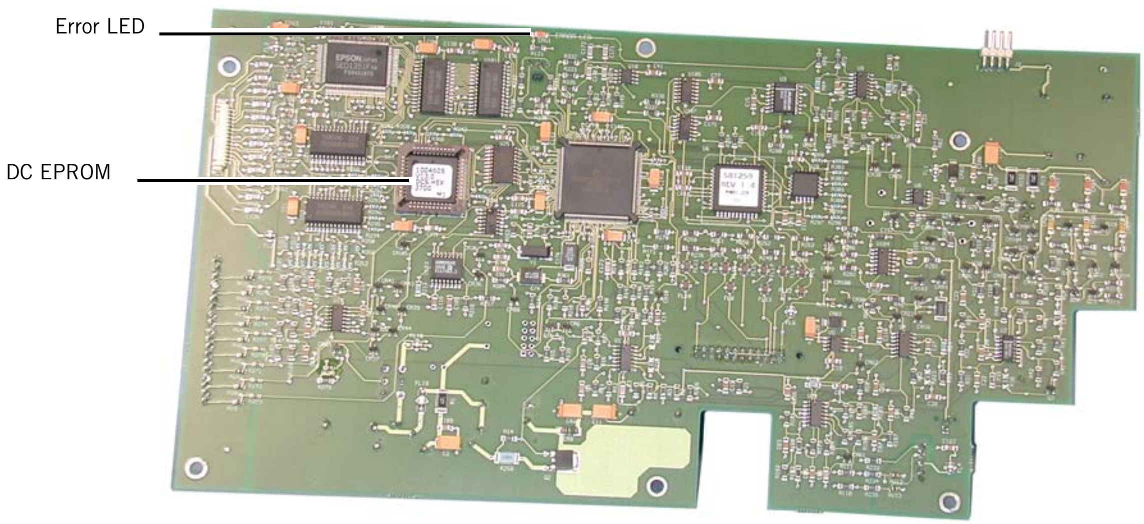


Figure A-12: DC *Cable Connections*

(DC board component side)



DC board (P/N 1004709)

(DC board back view)

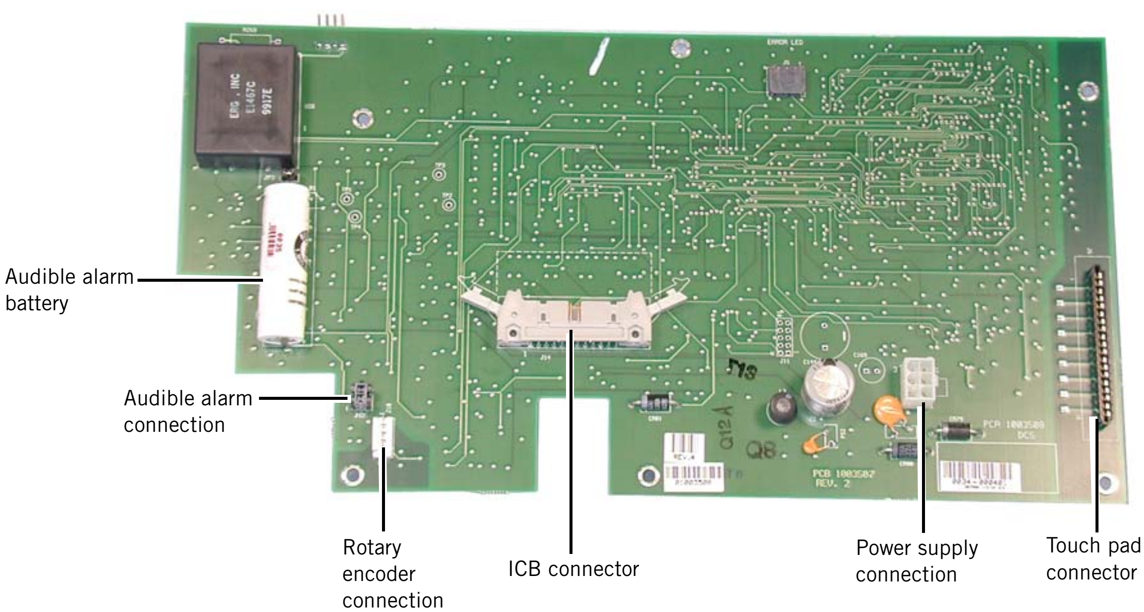


Figure A-13: DC *Board*

Figure A-14: Component Identification (Inside Back Panel)

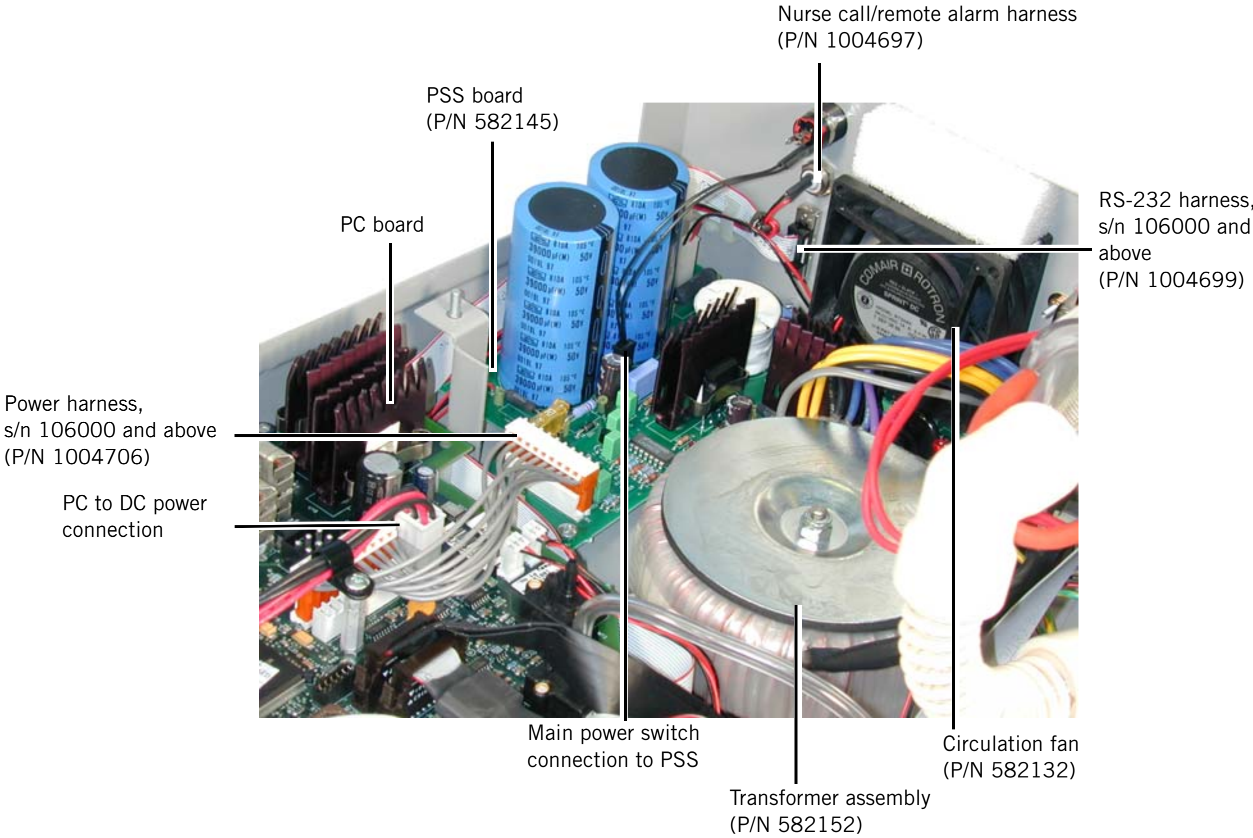


Figure A-15: Component Identification (PSS)

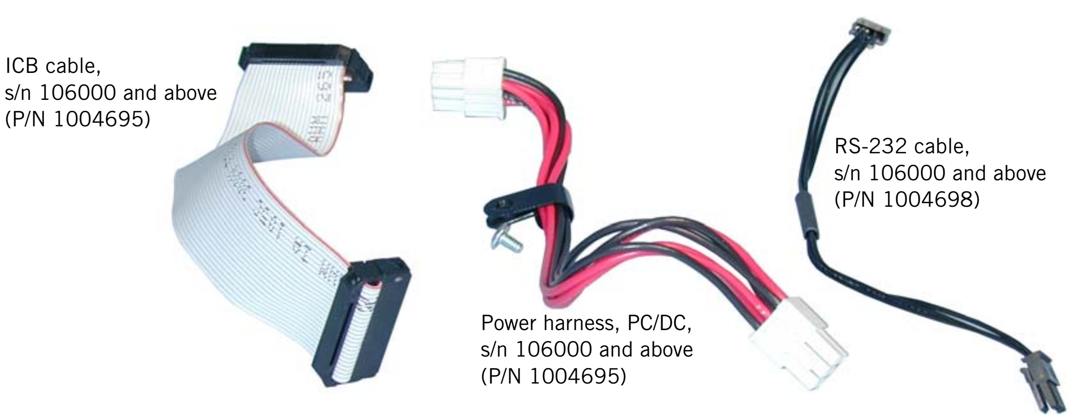


Figure A-16: DC *Cables*

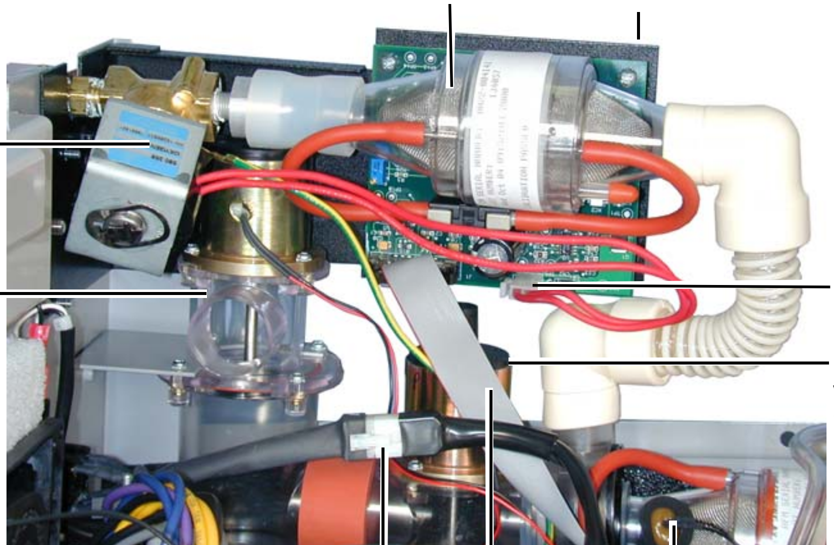


Figure A-17: Component Identification (OM and Pneumatics)

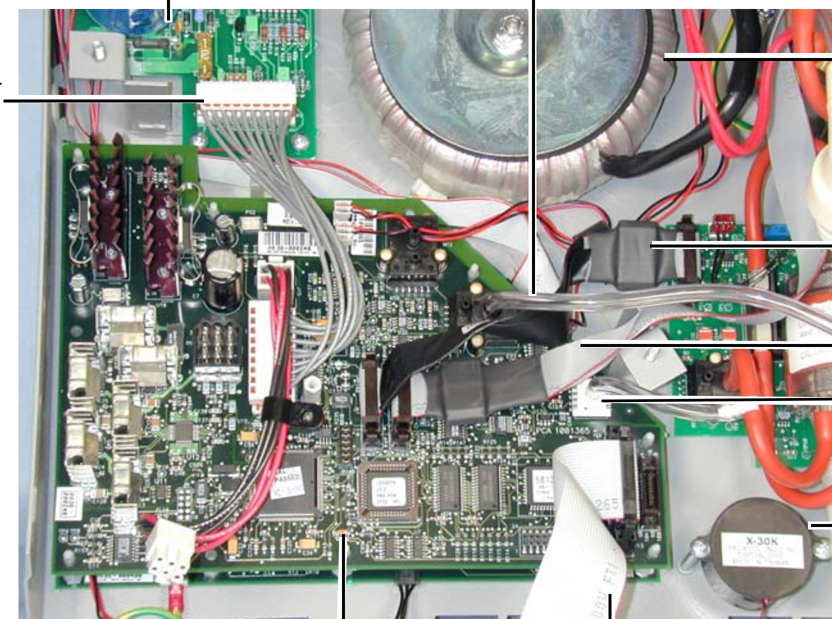


Figure A-18: Component Identification (PC Board)

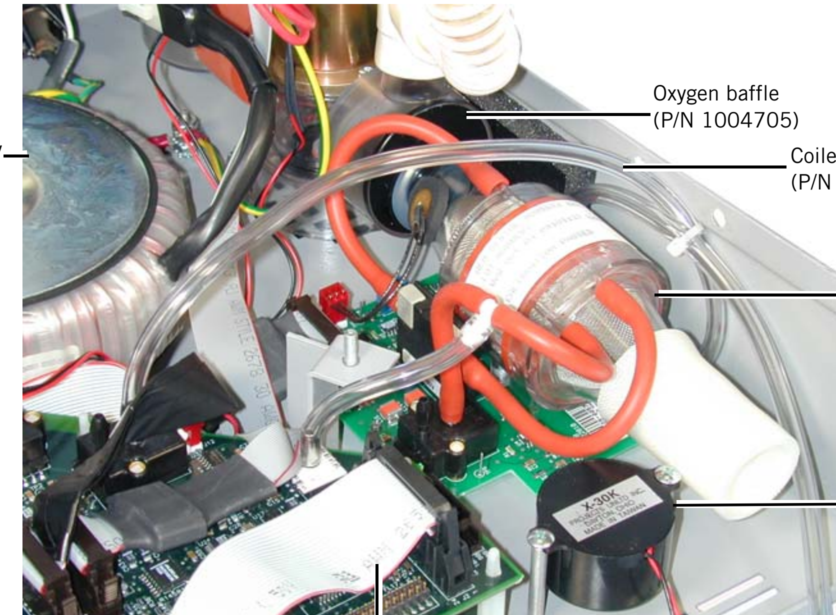


Figure A-19: Component Identification (AFM, Oxygen Baffle, Audible Alarm)

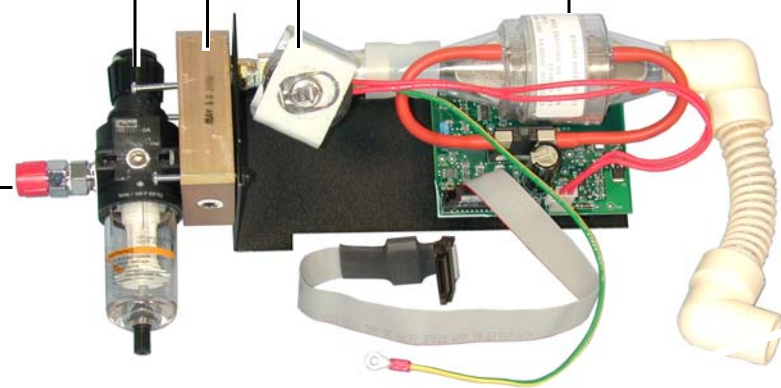


Figure A-20: Oxygen Module (OM) Assembly

PC board s/n 106000 and above
(P/N 1004710)

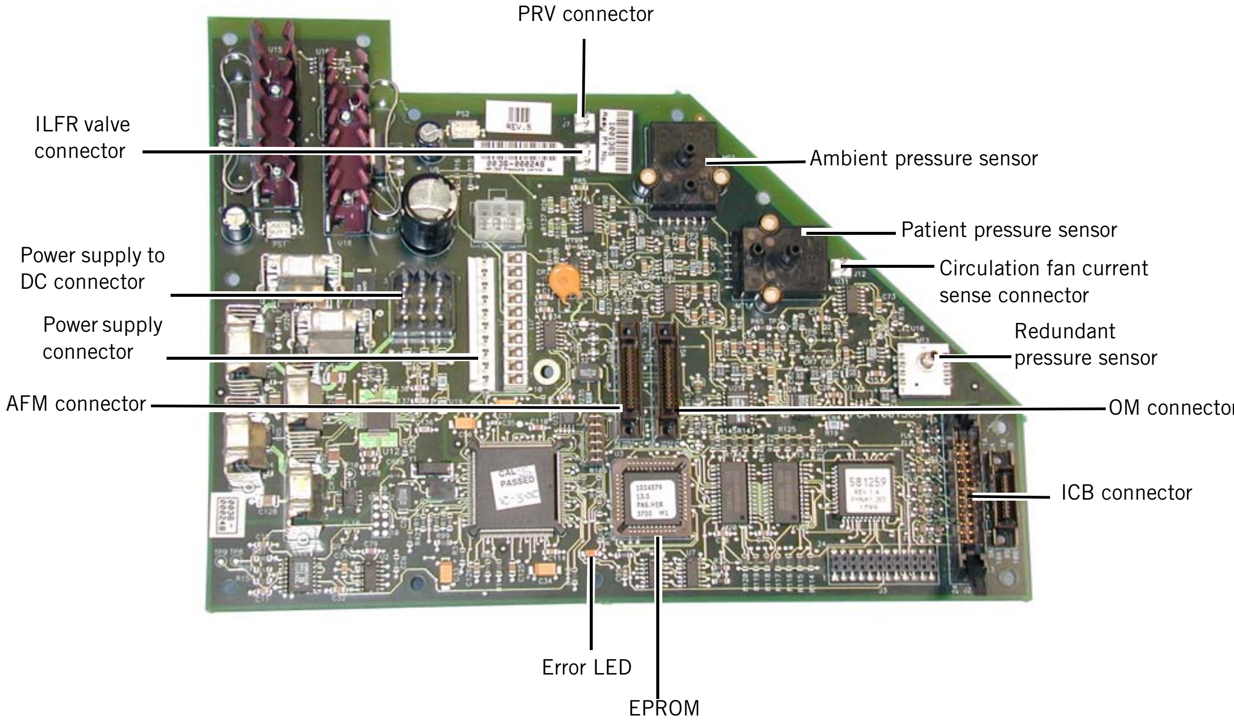


Figure A-21: PC *Board*

MC board s/n 106000 and above
(P/N 1004711)

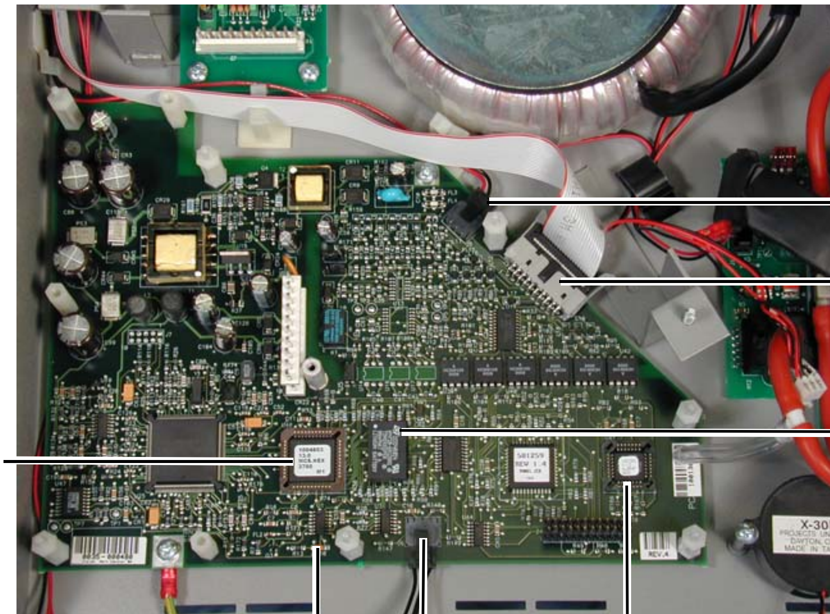


Figure A-22: MC *Board*

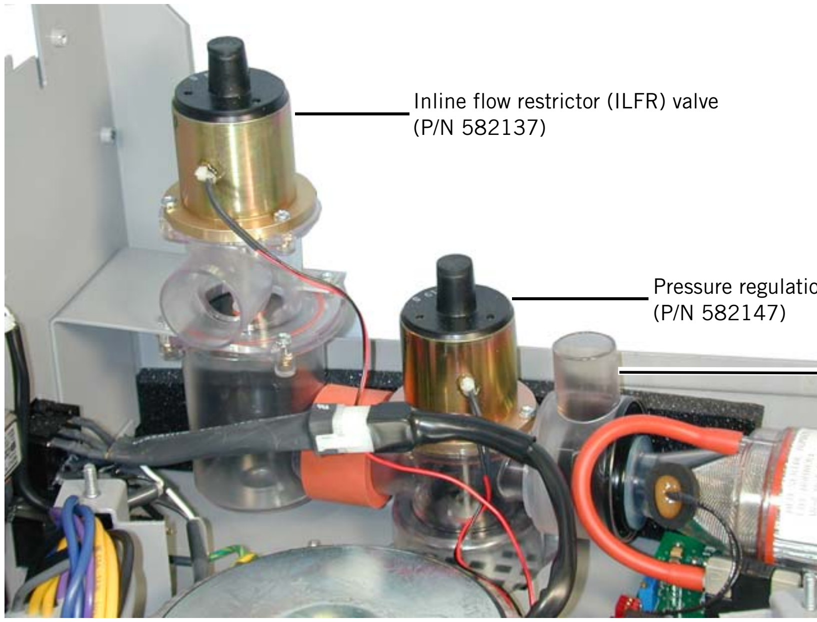


Figure A-23: IFLR Valve, PRV, Oxygen Baffle

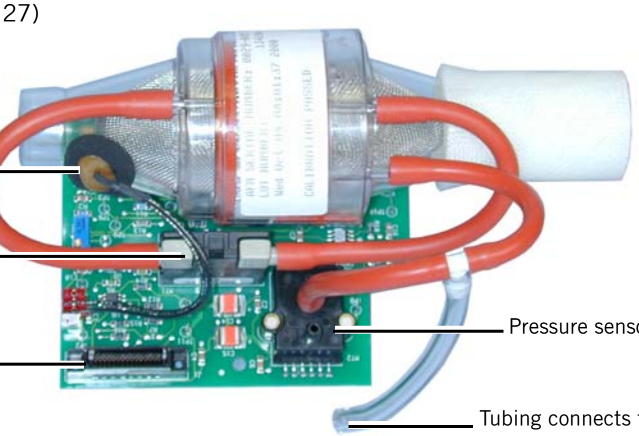


Figure A-24: Air Flow Module (AFM)

Figure A-25: Oxygen Baffle

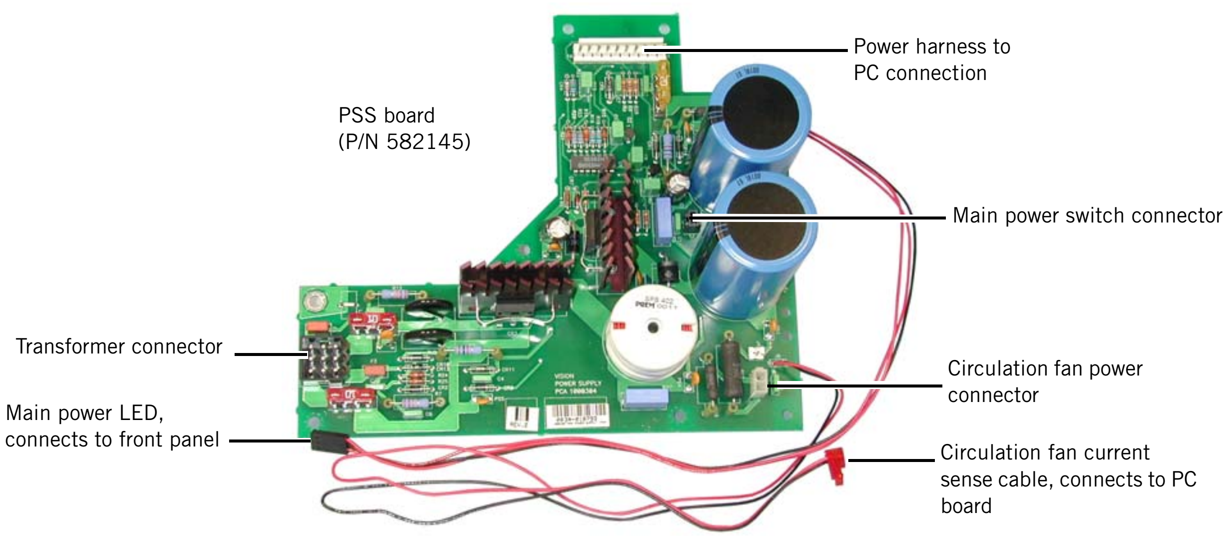


Figure A-26: PSS Board

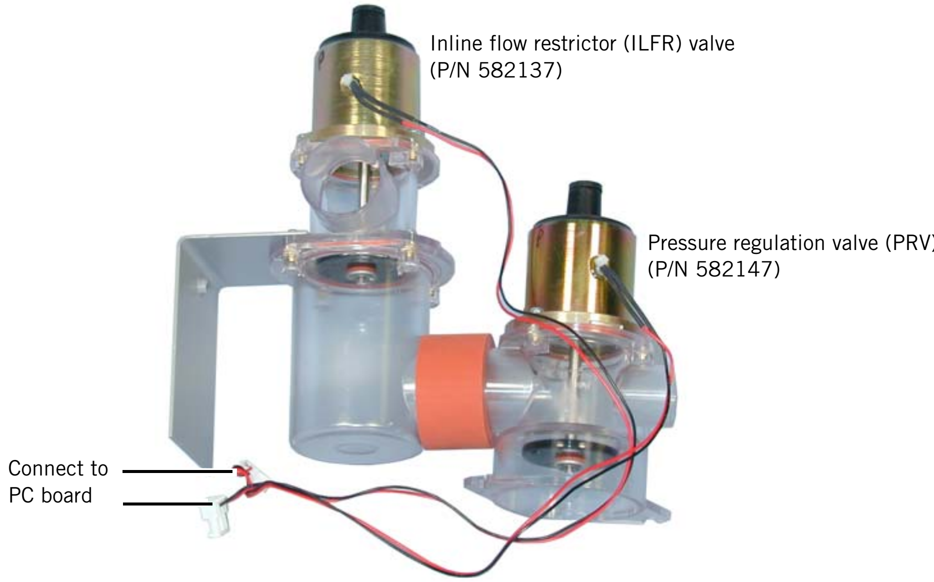


Figure A-27: Valve Identification (IFLR and PRV)

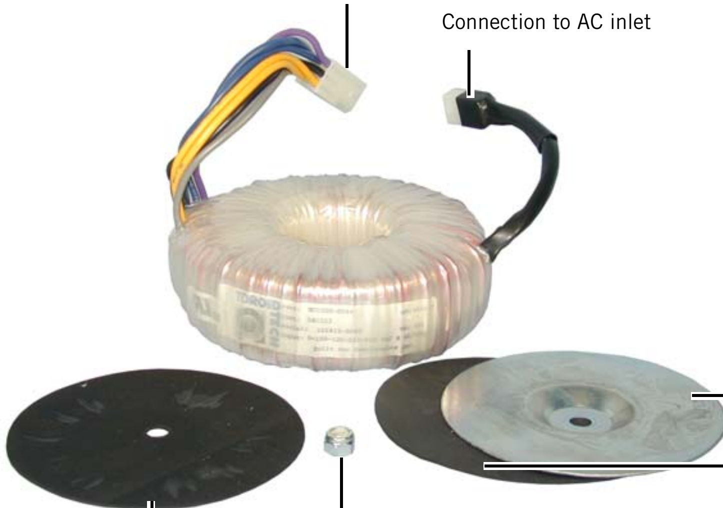


Figure A-28: Transformer Assembly

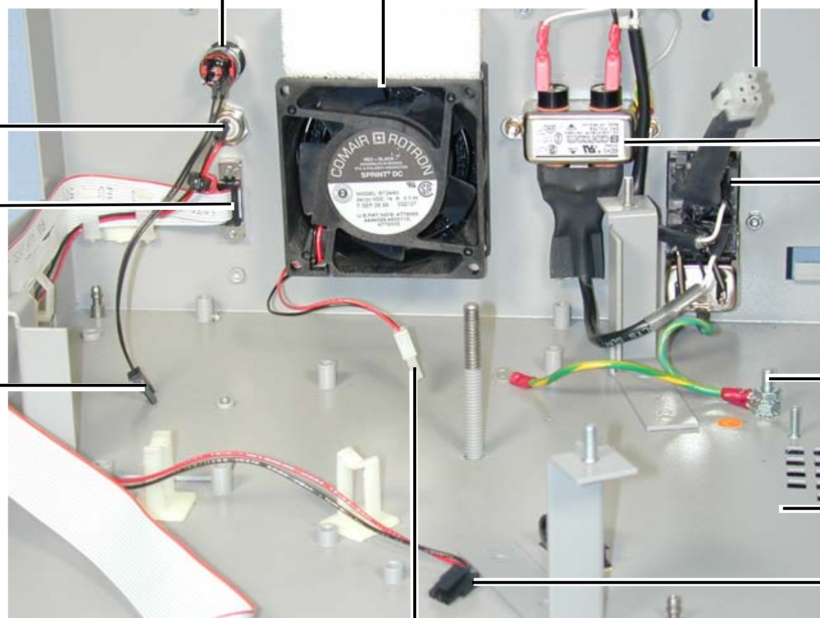


Figure A-29: Inside Back Panel

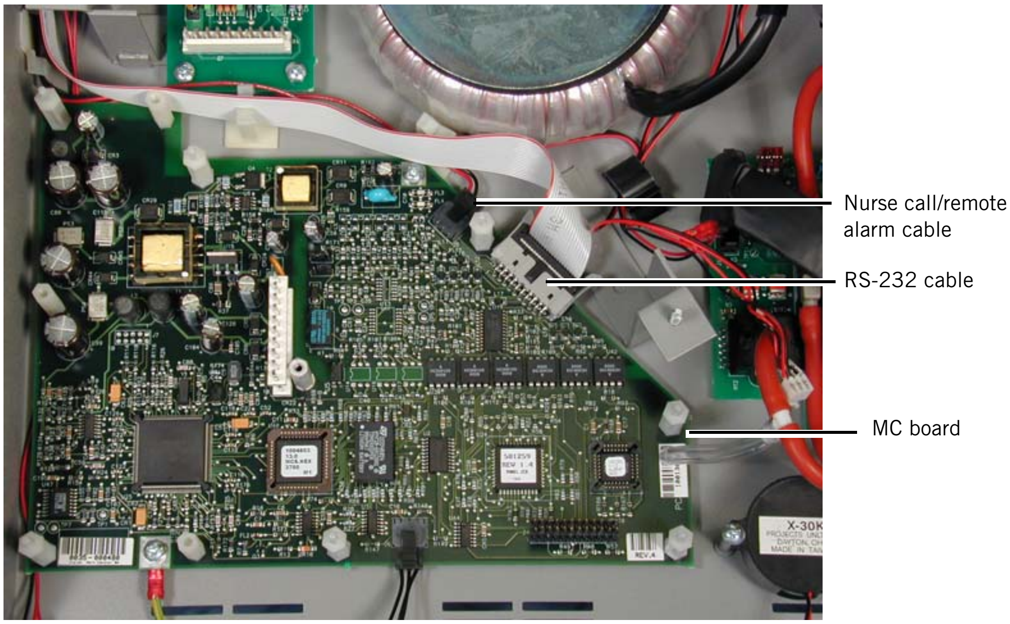
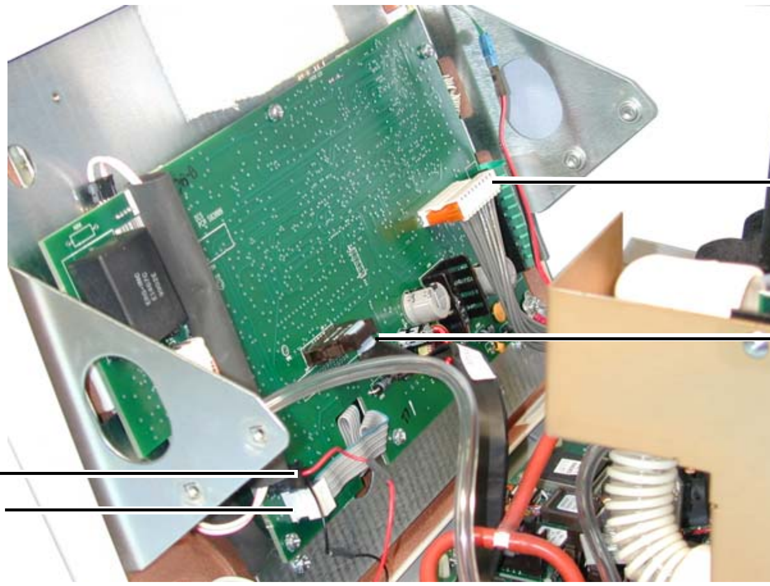


Figure A-30: Nurse Call/Remote Alarm Cable Routing

Figure A-31: Back Panel, s/n 105999 and Below



DCS board, s/n 105999 and below
(obsolete P/N 582133)

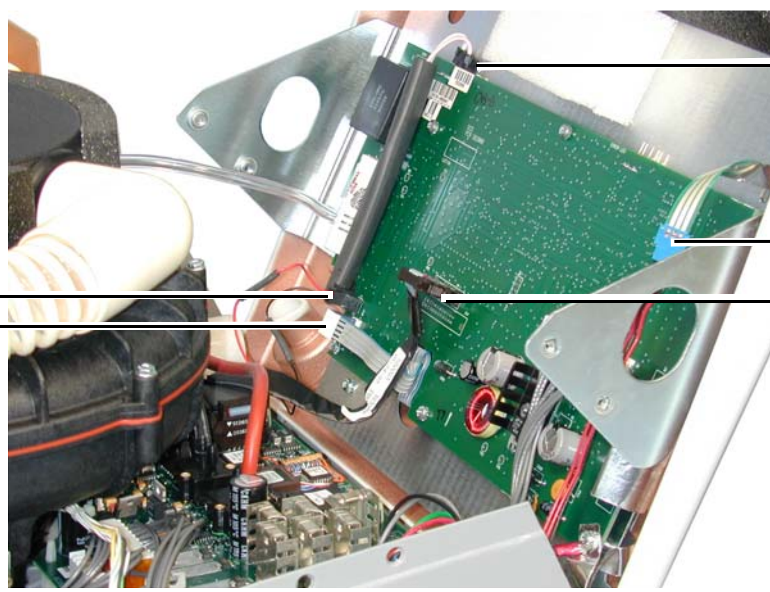


Figure A-32: DCS *Board, s/n 105999 and Below*

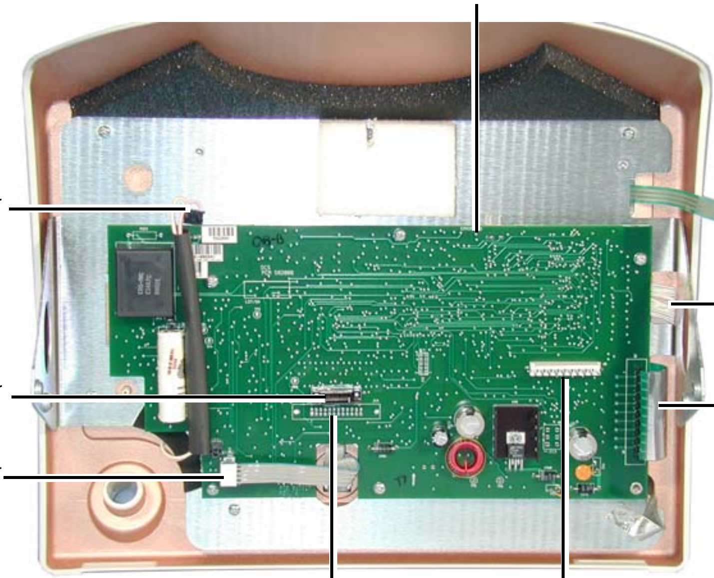
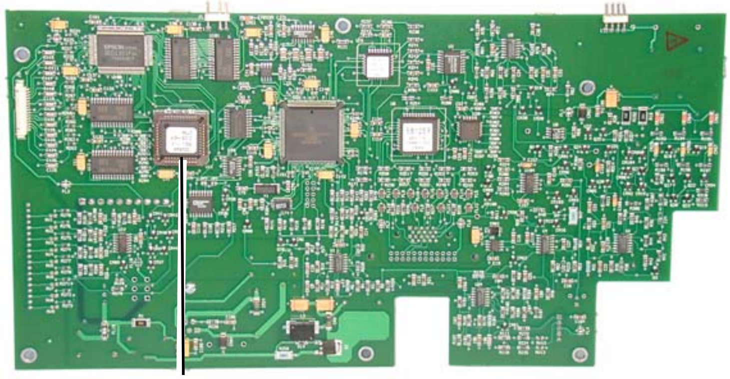


Figure A-33: DCS *Board in Front Panel Enclosure, s/n 105999 and Below*

DCS board, s/n 105999 and below
(obsolete P/N 582133)



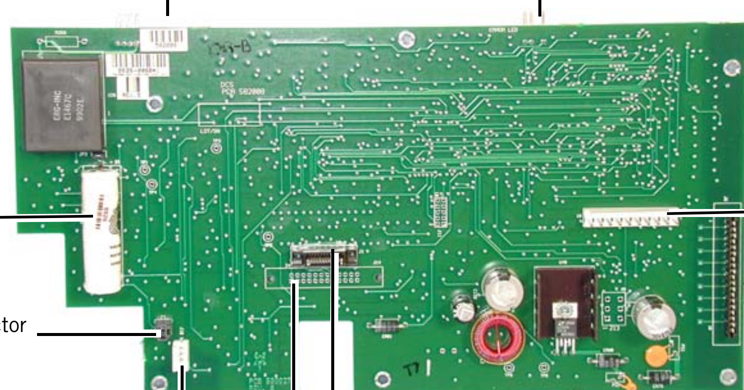
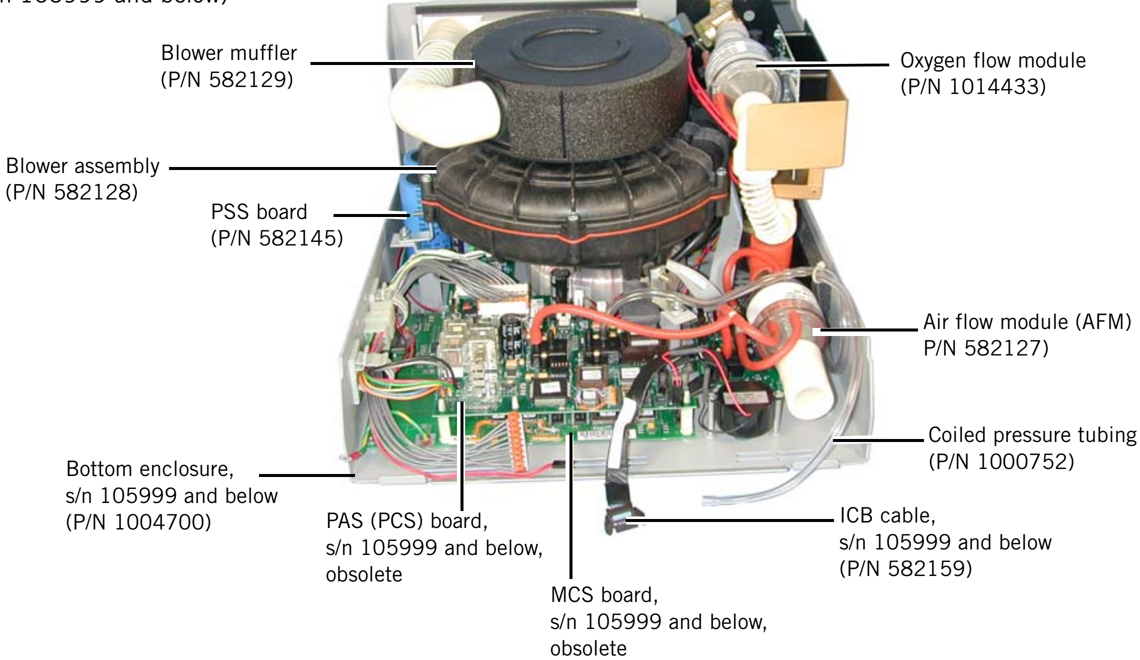


Figure A-34: DCS *Board Connectors, s/n 105999 and Below*

Older units
(s/n 105999 and below)



Newer units
(s/n 106000 and above)

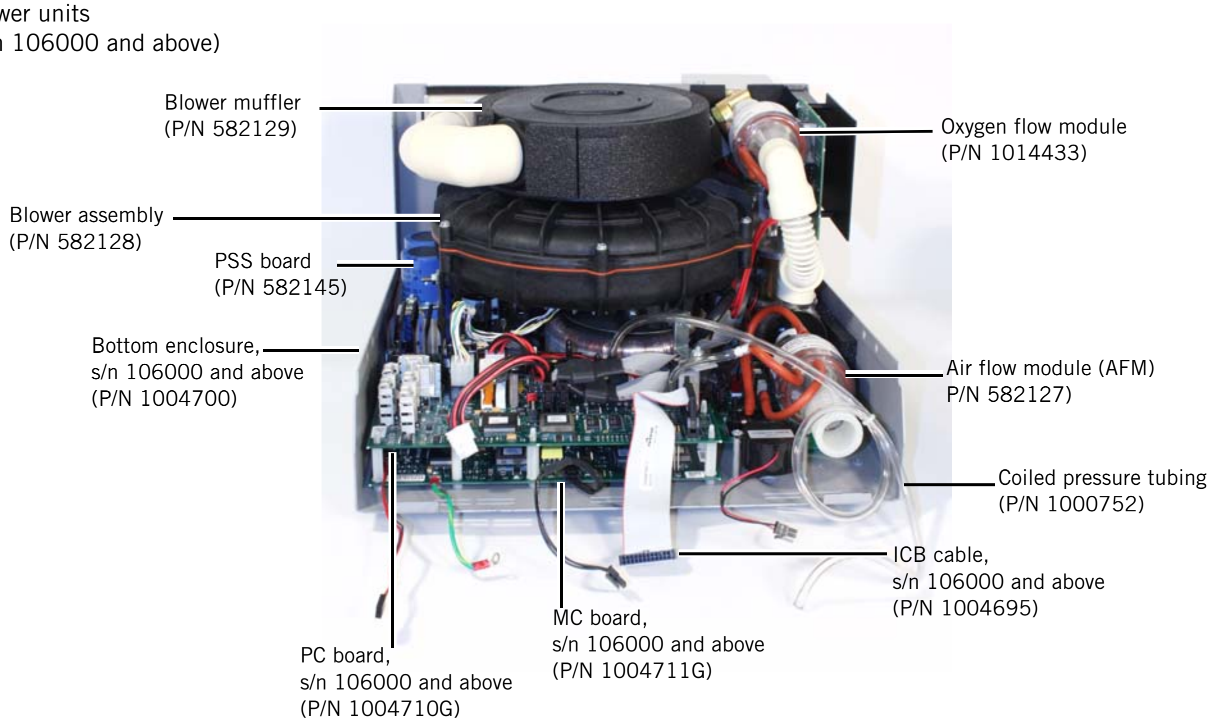


Figure A-35: Component Identification (Blower)

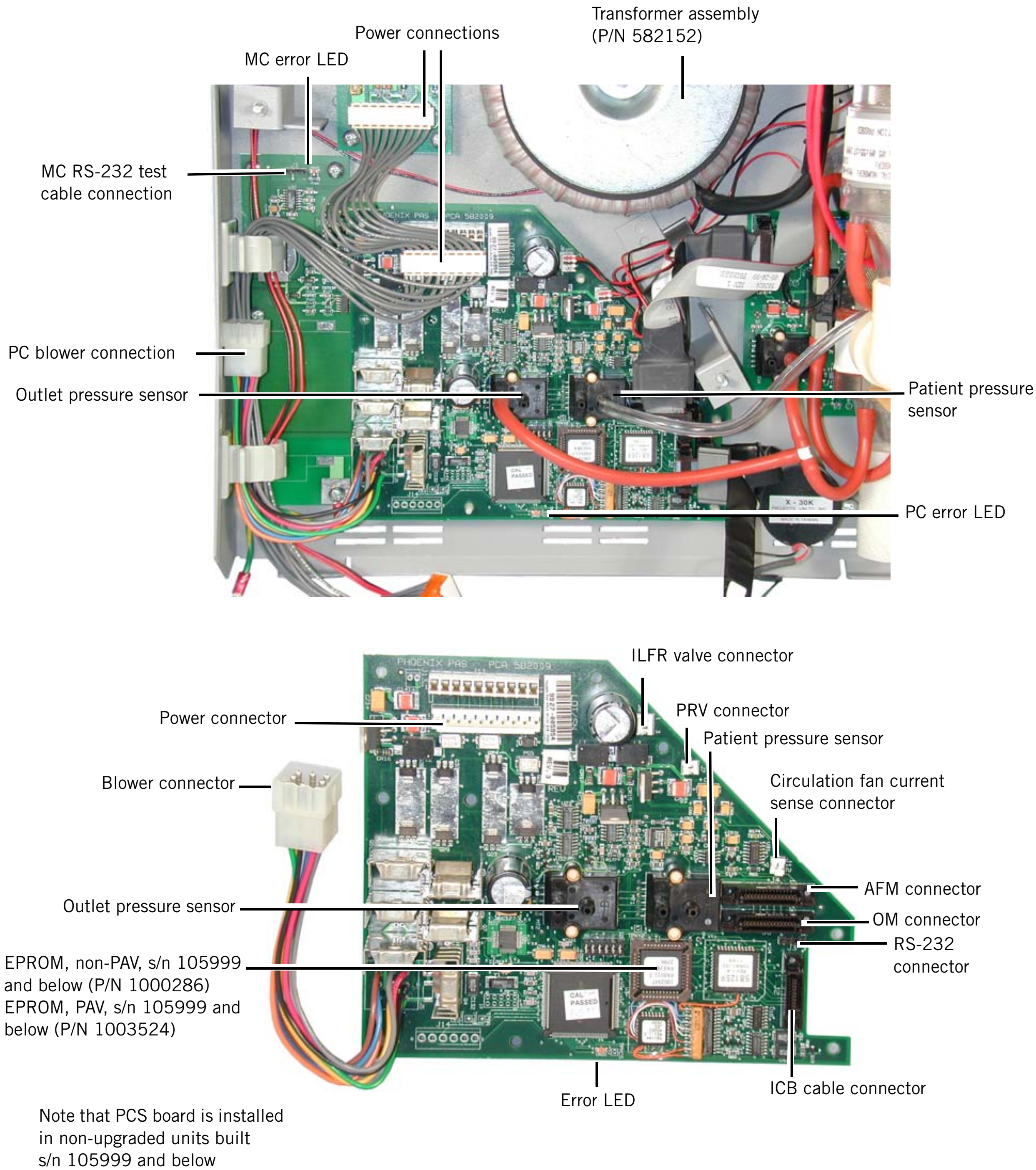


Figure A-36: PCS *Board*

Figure A-37: Inlet Foam Strip

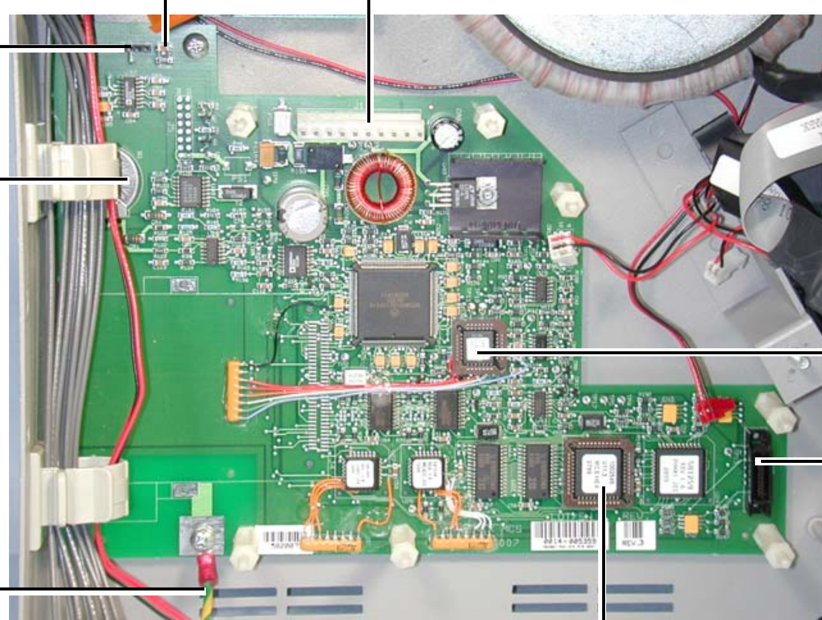


Figure A-38: MC *Board*

Figure A-39: BiPAP Vision Front View

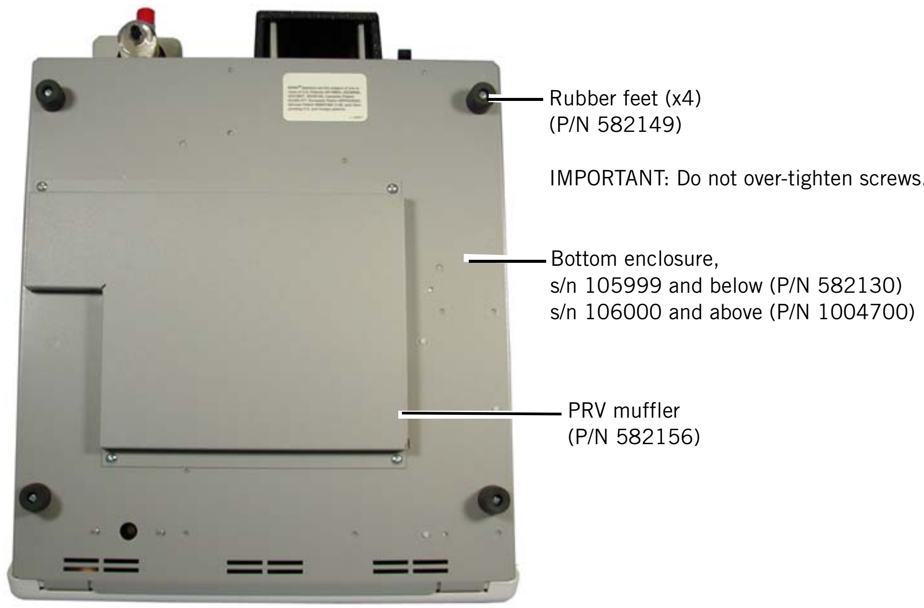


Figure A-40: Bottom Enclosure

Figure A-41: LCD Assembly

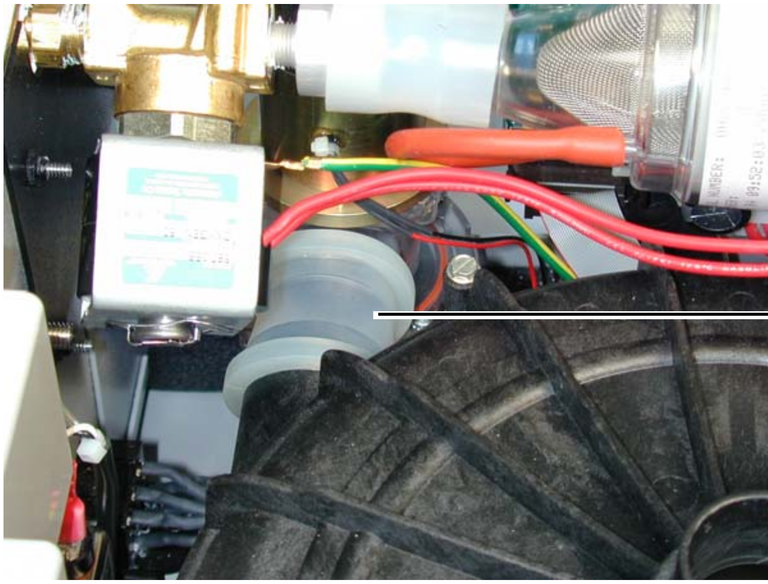


Figure A-42: Blower Valve Coupler

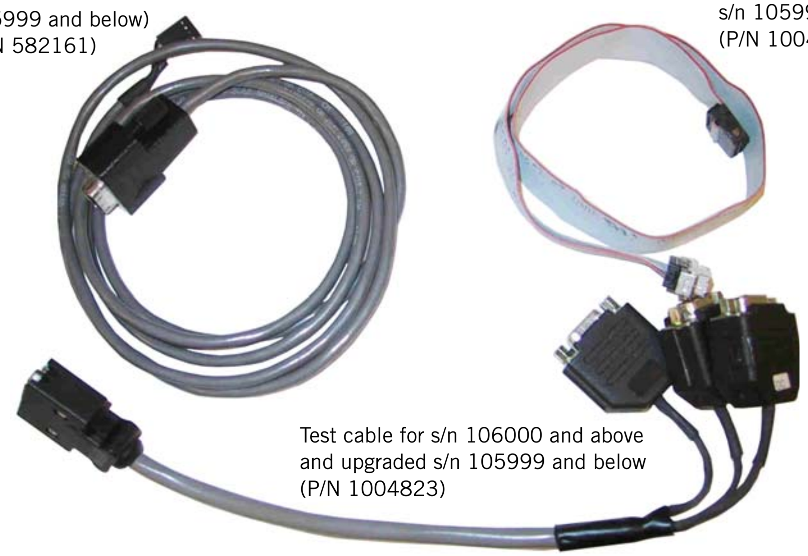


Figure A-43: Test Cables

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Appendix B Specifications

B.1 Environmental

Operating temperature	40 to 104 °F (4.4 to 40 °C)
Transport/storage temperature	–4 to 140 °F (–20 to 60 °C)
Humidity (operating and storage)	0 to 95% relative humidity

B.2 Physical

Base dimensions	16 in. L × 14-3/8 in. W × 10-5/8 in. H (40.6 cm L x 36.5 cm W x 27 cm H)
Weight	34 lbs (15.4 kg)

B.3 Electrical

AC Input Voltage (VAC)	100/120/230/ 240 VAC single phase ±10%
Fuses	100 – 120 VAC ~ T 4.0 A, 5 × 20 mm, time lag (all s/n, P/N 1041196, replaces P/N 1000749) 100 – 120 VAC ~ T 3.5 A, 5 × 20 mm, time lag (×2) (for s/n 100500 and above, P/N 1000749) 115 VAC ~ T 3.0 A, 250 V, ¼ in. × 1¼ in. (for s/n 100499 and below, P/N 582100) 220 VAC, 230 VAC and 240 VAC ~ T 1.6 A, 250 V, 5 × 20 mm (all s/n, P/N 1000750)
Power consumption	300 VA maximum
AC current	3.0 A maximum
AC frequency	50/60 Hz

Protection against electrical shock	Class I
Type	BF
Degree of protection against harmful ingress of water	Ordinary equipment, IPX0
Electromagnetic compatibility	Meets requirements of IEC 601-1-2
Earth resistance	< 0.10 ohms
Earth leakage current	Normal pole, no earth, L2: < 300 μA Reverse pole, no earth, L2: < 300 μA Reverse pole, no earth, no L2: < 1000 μA Normal pole, no earth, no L2: < 1000 μA
Insulation resistance	> 2 megaOhms
Alarm sound	70 to 85 dBA peak at a distance of 1 meter
Noise	No specification: various test instruments, test procedures, and device operating conditions produce varying results.

B.4 Pressure

Output	4 to 40 cmH_2O
Dynamic regulation	$\pm$ 2 cmH_2O at sinusoidal flow at $\pm$ 100 L/min
Static regulation	$\pm$ 2 cmH_2O from -60 to 120 L/min
Elevation	0 to 5000 ft. above sea level

B.5 Control Accuracy

Timed inspiration	Setting ± 2 s
Rate	Setting ± 1 BPM
Oxygen concentration	Setting ± 3% or ± 10% of setting, whichever is greater

B.6 Display Accuracy

Pressure	± 1 cmH_2O
Volume	± 10% during stable conditions
Flow	± 10% during stable conditions

B.7 Trigger Sensitivity

Spontaneous trigger	Shape trigger, leak flow volume 6 cc or above
Spontaneous cycle	Spontaneous expiratory threshold (SET), shape cycle, IPAP maximum 3.0 s, flow reversal

NOTE: See the BiPAP Vision *Clinical Manual* for more Auto-Trak details.

B.8 Oxygen Module Inlet

Pressure range	50 to 100 psig
Inlet fitting	DISS male oxygen connector

B.9 Internal Batteries

Alarm battery	Nickel cadmium (NiCAD), 3.6 VDC, 110 mAh, rechargeable Located on DCS board, P/N 1012819)
Data retention battery (original MCS board)	Lithium cell, 3 VDC, 300 mAh, non-rechargeable, P/N 1001988 Located on MCS board
Data retention battery (current MC board)	Lithium cell, 3 VDC, 300 mAh, non-rechargeable, P/N 1006005 Located on MC board

B.10 Settings

NOTE: See the BiPAP Vision *Clinical Manual* for PAV/T information.

Parameter	Range	Increments
IPAP	4 to 40 cmH_2O	1 cmH_2O
EPAP	4 to 20 cmH_2O	1 cmH_2O
CPAP	4 to 20 cmH_2O	1 cmH_2O
Rate	4 to 40 BPM	1 BPM
Timed inspiration	0.5 to 3.0 s	0.1 s
IPAP rise time	0.05 to 0.4 s	0.05, 0.1, 0.2, or 0.4 s
Oxygen concentration ($\%O_2$) (if oxygen module is installed)	21 to 100%	21 to 25%: 4% 25 to 100%: 5%

Alarm	Range	Increments
High pressure	5 to 50 cmH_2O	1 cmH_2O
Low pressure	0 (disabled) to 40 cmH_2O	1 cmH_2O
Low pressure delay	0 to 60 s	1 s
Apnea	0 (disabled), 20 to 40 s	0 (disabled), 20, 30, 40 s
Low minute ventilation (if alarm module is installed)	0 (disabled) to 99 L/min	1 L/min
High rate (if alarm module is installed)	4 to 120 BPM	1 BPM
Low rate (if alarm module is installed)	4 to 120 BPM	1 BPM

B.11 Display Data

Display data	Range	Resolution
IPAP	0 to 50 cmH_2O	1 cmH_2O
EPAP	0 to 50 cmH_2O	1 cmH_2O
CPAP	0 to 50 cmH_2O	1 cmH_2O
Rate	0 to 150 BPM	1 BPM
Exhaled tidal volume (VT)	0 to 4000 mL	1 mL
Minute ventilation (MIN VENT)	0 to 99 L/min	1 L/min
Total leak (TOT LEAK)	0 to 300 L/min	1 L/min
Patient leak (PT. LEAK)	4 to 120 BPM	1 BPM
Peak inspiratory pressure (PIP)	0 to 50 cmH_2O	1 cmH_2O
Percent of patient-triggered breaths (PT. TRIG)	0 to 100%	1%
TI/TTOT	0 to 100%	1%

Appendix C Schematics

This manual includes schematics to satisfy administrative requirements only. They are not intended for use in component-level testing and repair. Repairs and testing are supported only at the complete board level.

CAUTION: To avoid damaging circuit boards, do not attempt component-level repairs. The multilayer circuit boards and surface-mount components require specialized equipment to manufacture and repair.

NOTE: These schematics are proprietary and confidential. Do not copy or disclose to third parties beyond the purpose for which they are intended. Patents are pending.

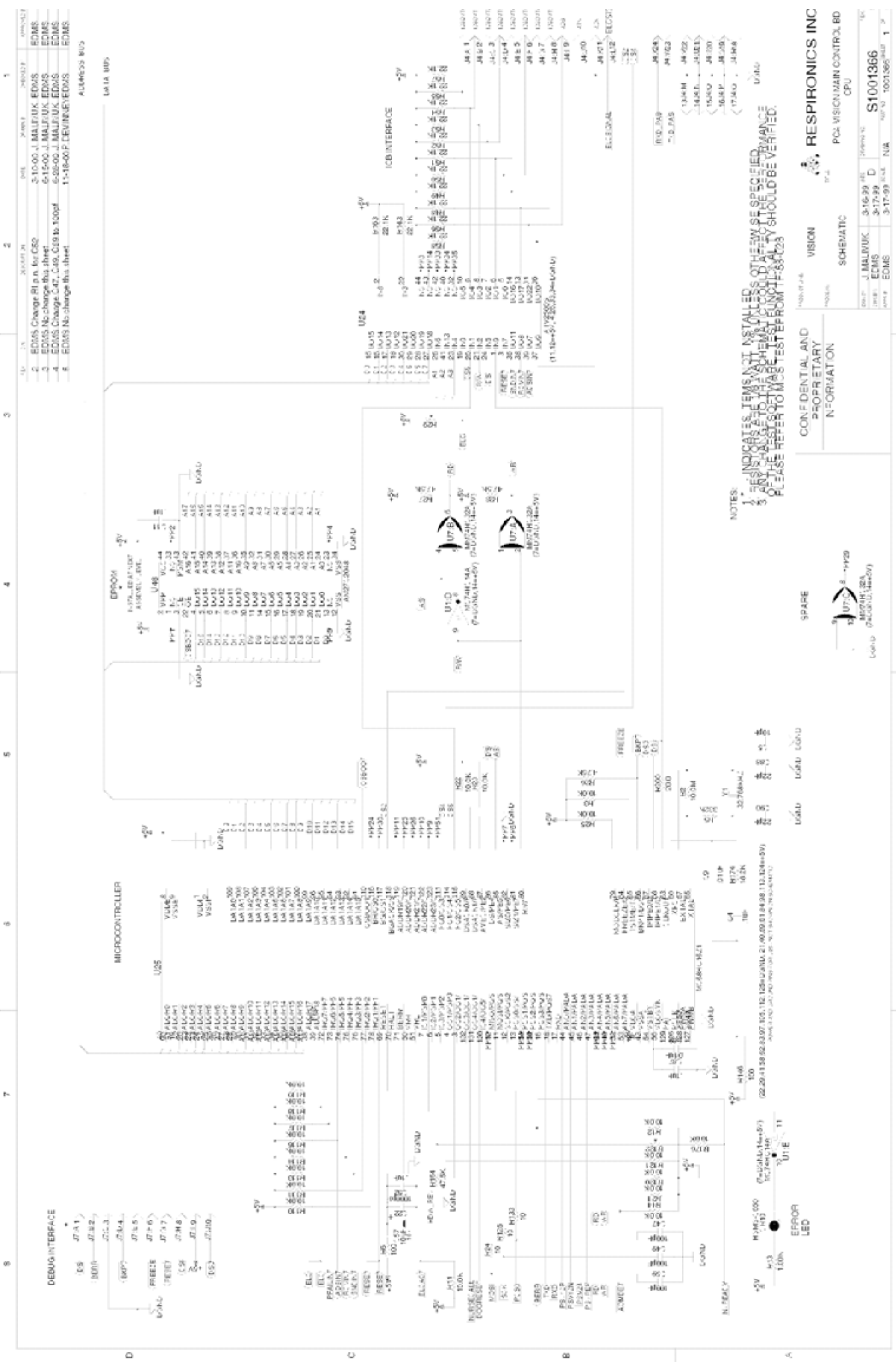

*Figure C-1: Main Control (*MC*) Board Microcontroller Interface*

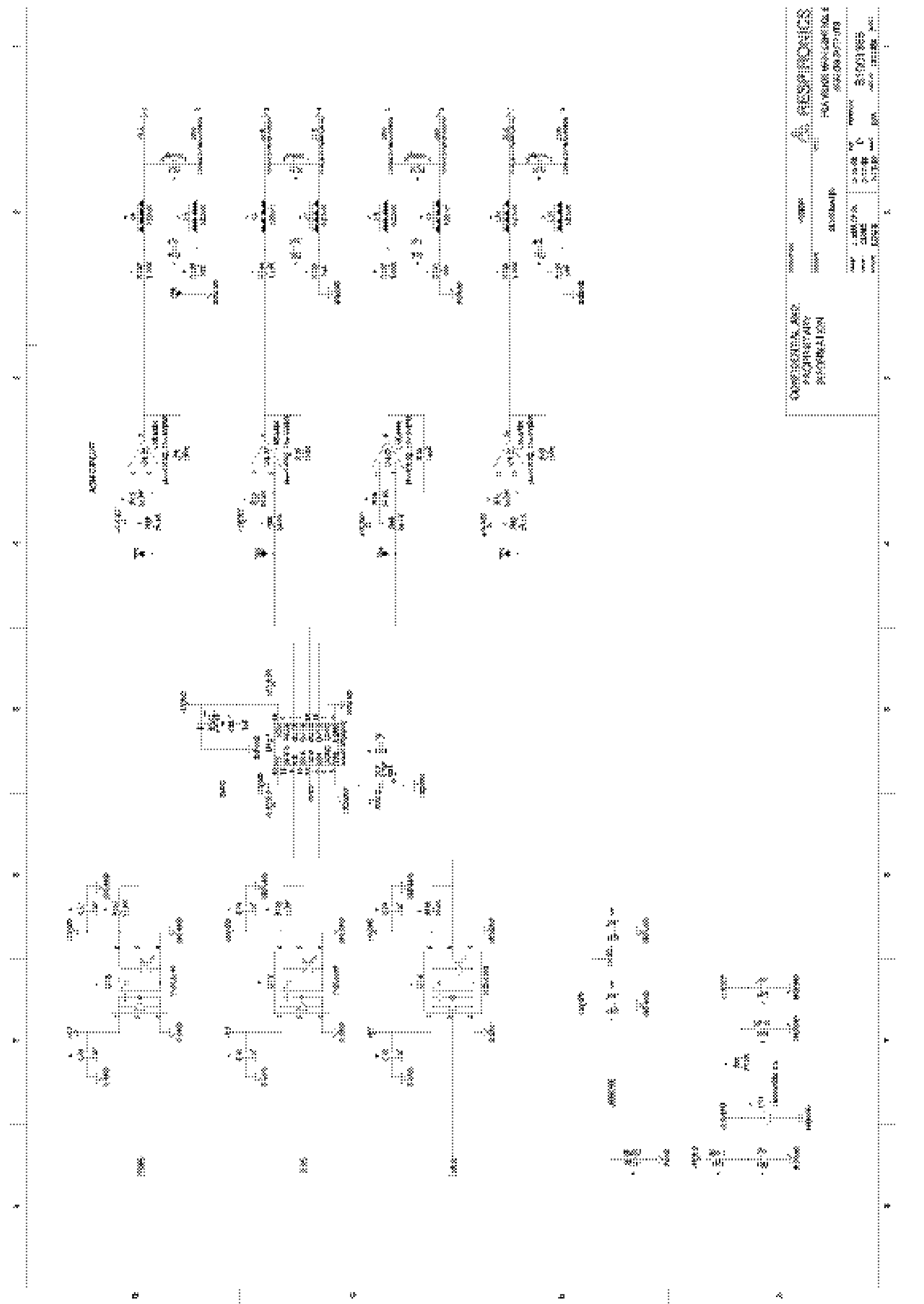

Figure C-2: MC *Board Analog Outputs*

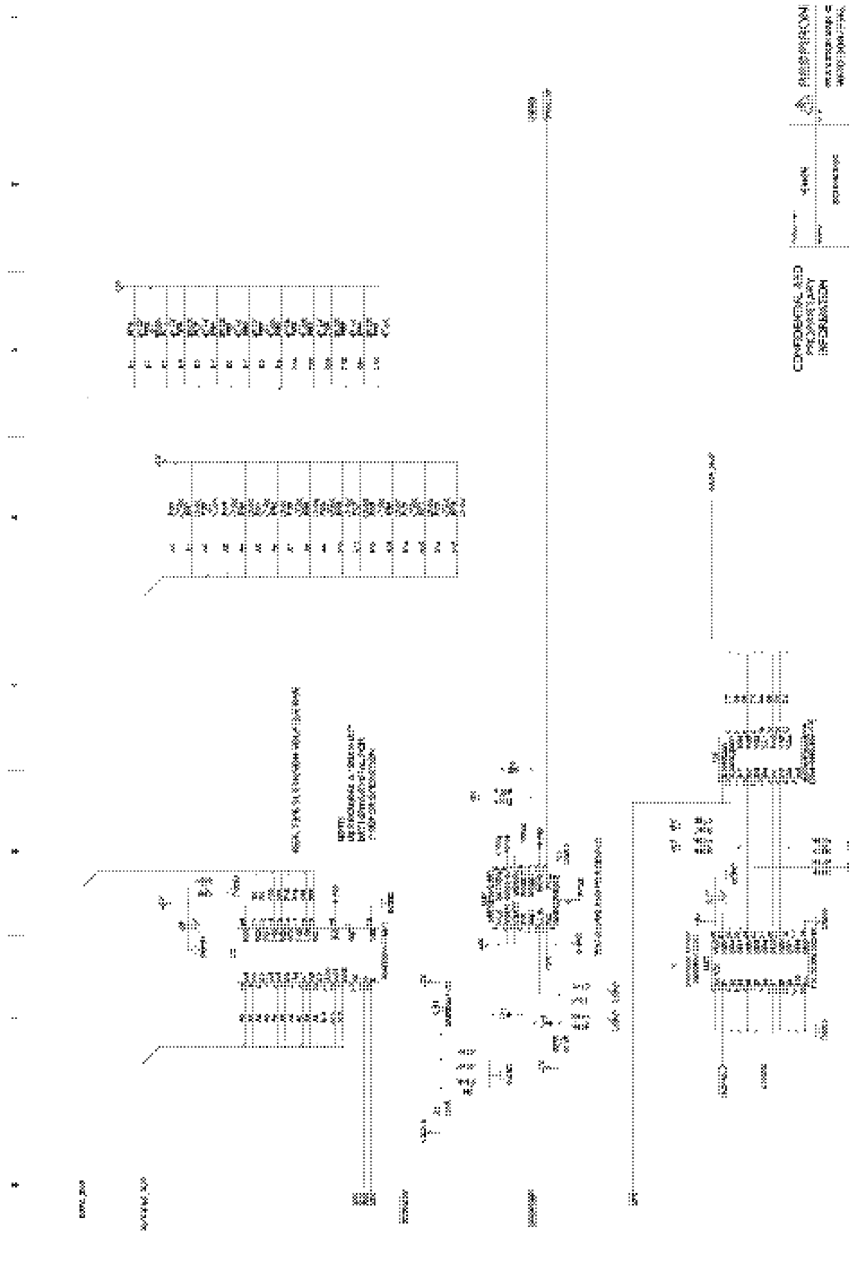

Figure C-3: MC *Board Watchdog/Real Time Clock*

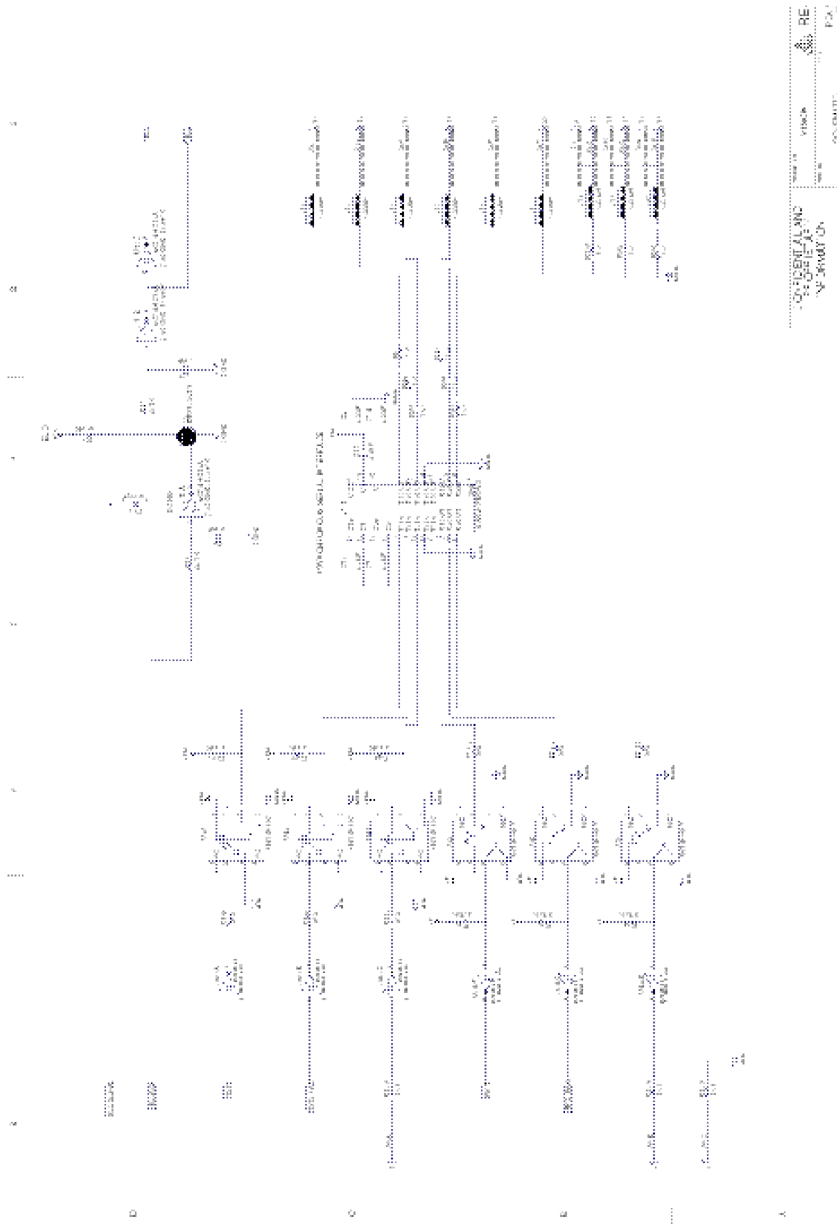

Figure C-4: MC *Board Error Line Control (ELC)/Serial Interface*

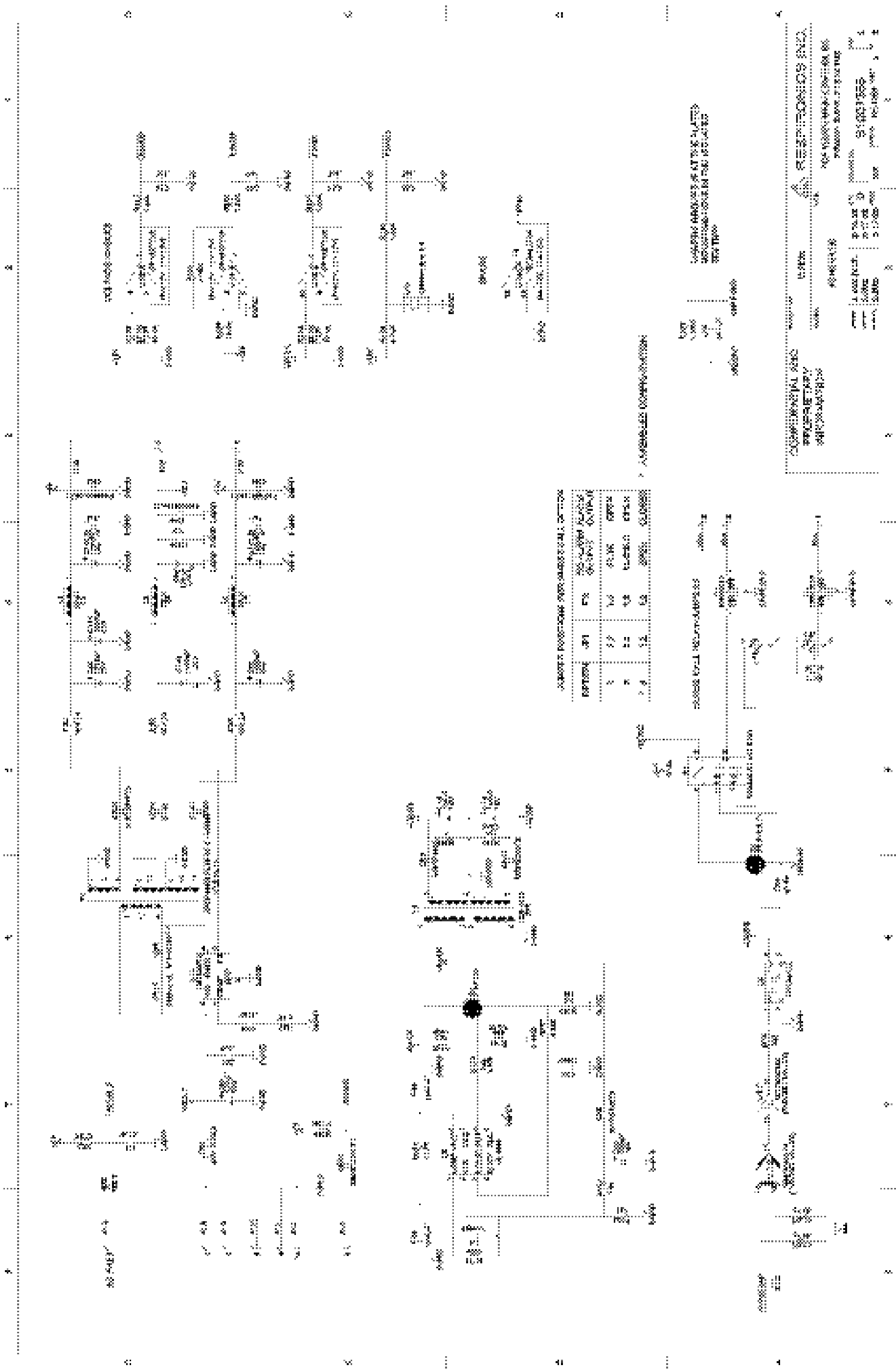

Figure C-5: MC *Board Power Supply/Status*

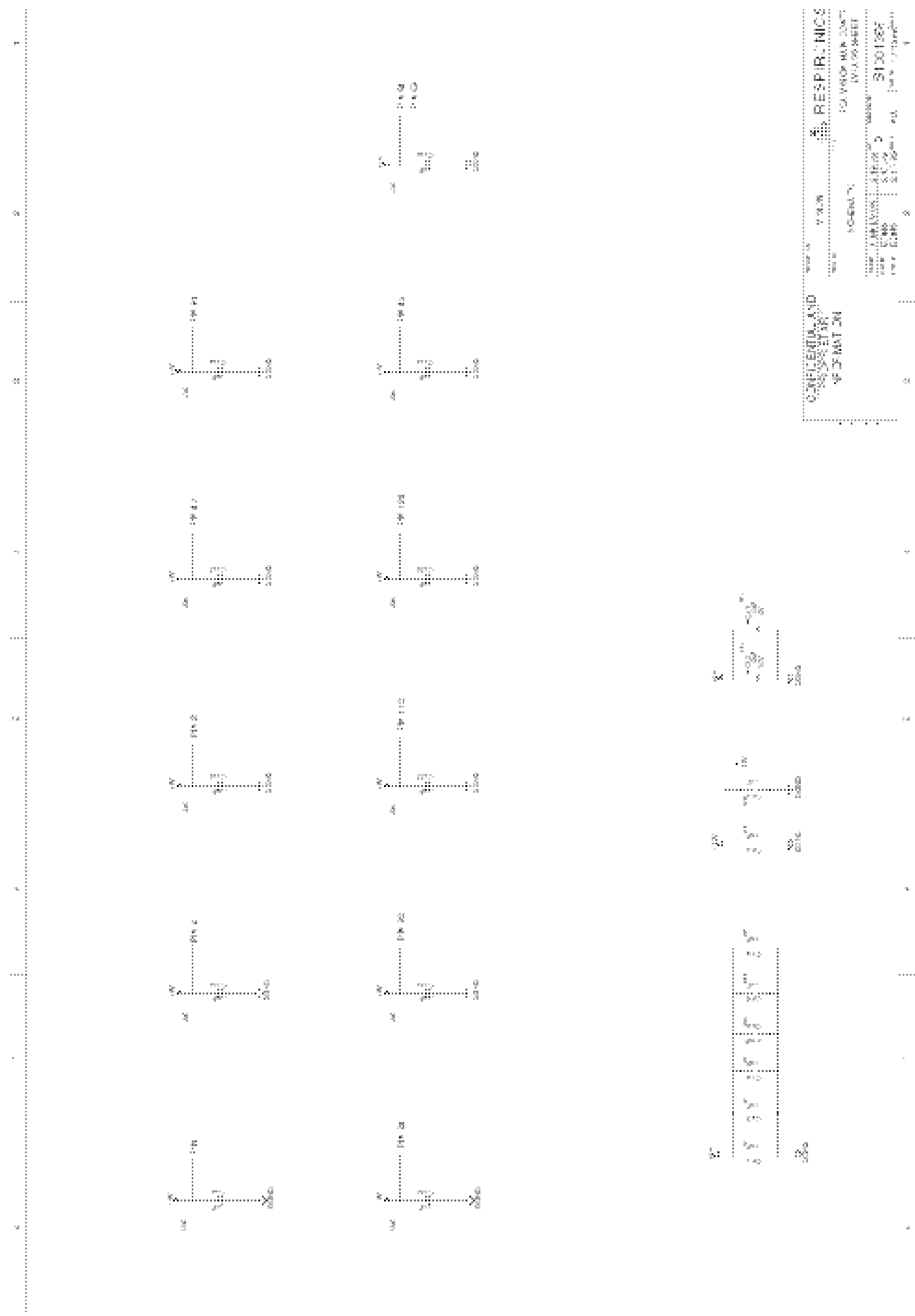

Figure C-6: MC *Board Bypass Circuitry*

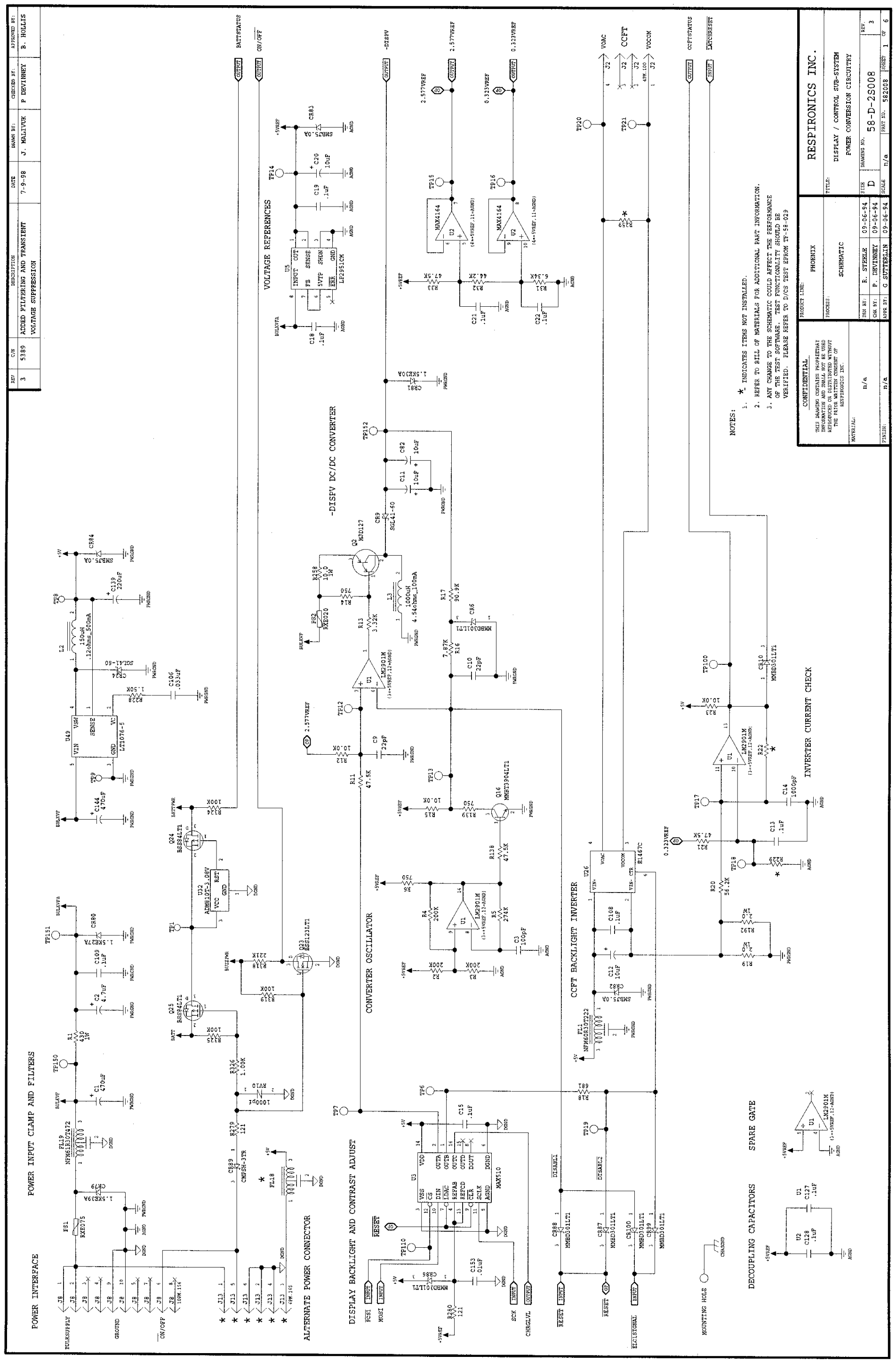

Figure C-7: Display Control (DC) Power Conversion Circuitry

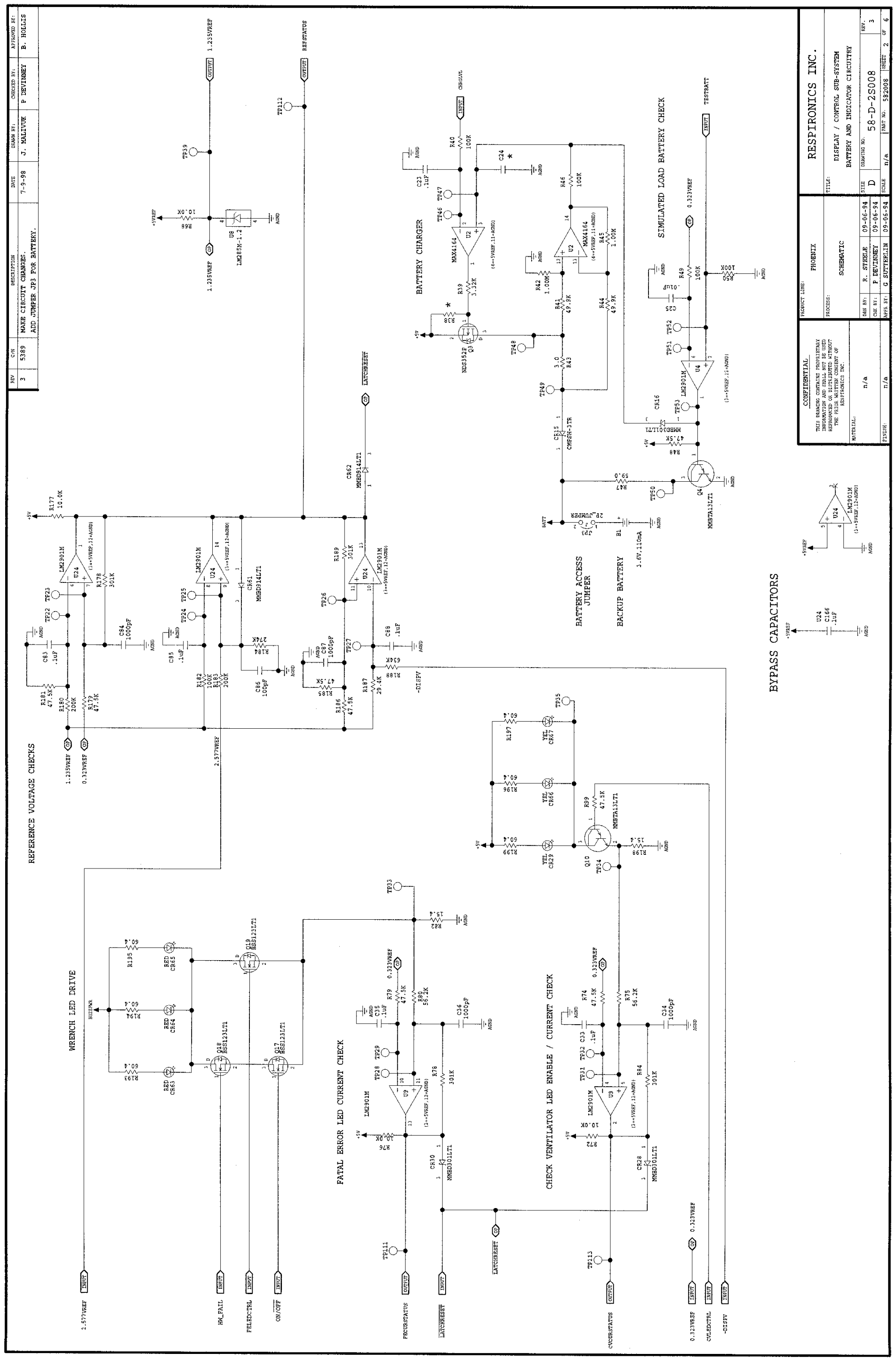

Figure C-8: DC *Battery and Indicator Circuitry*

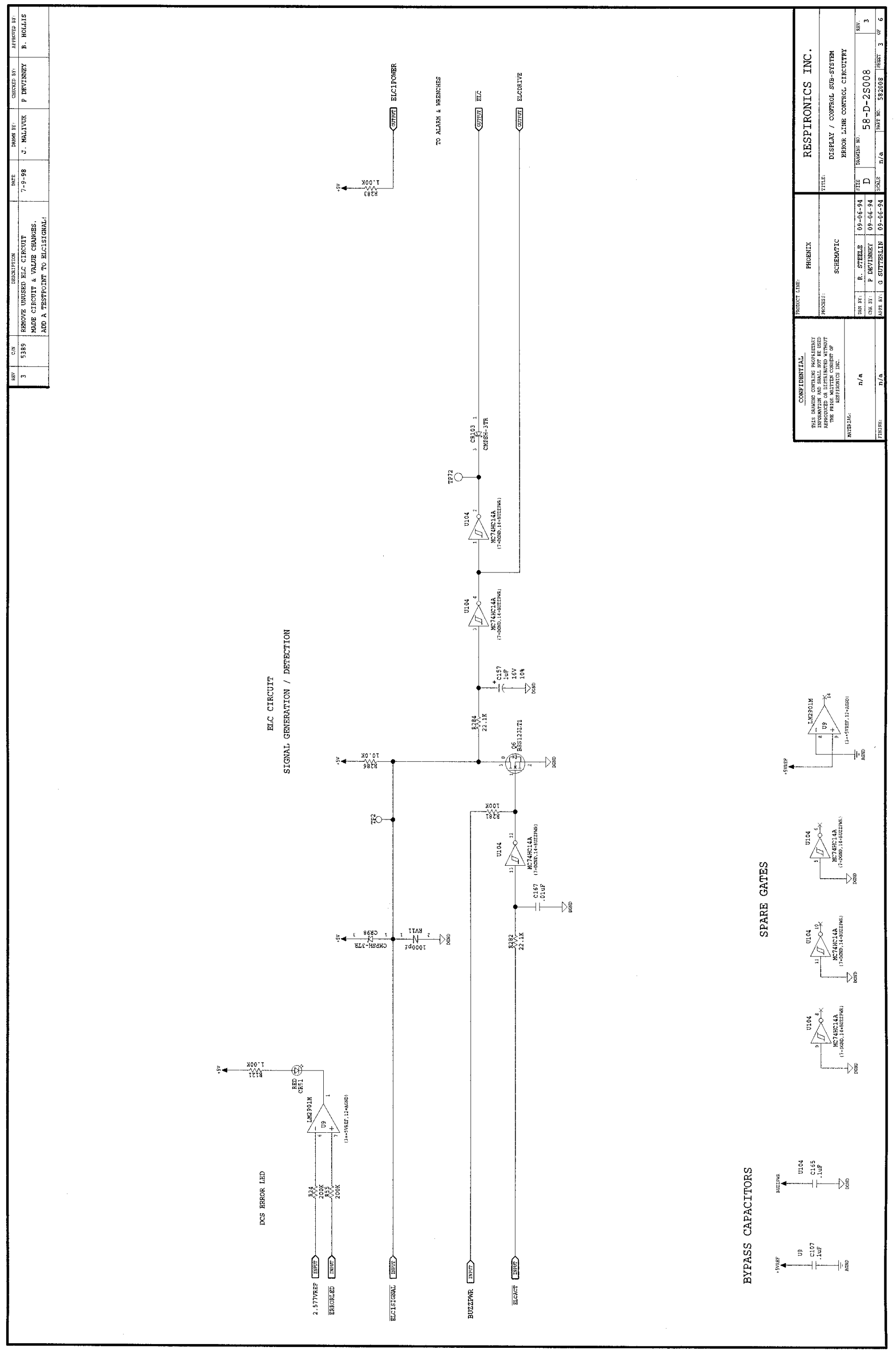

Figure C-9: DC *ELC Circuitry*

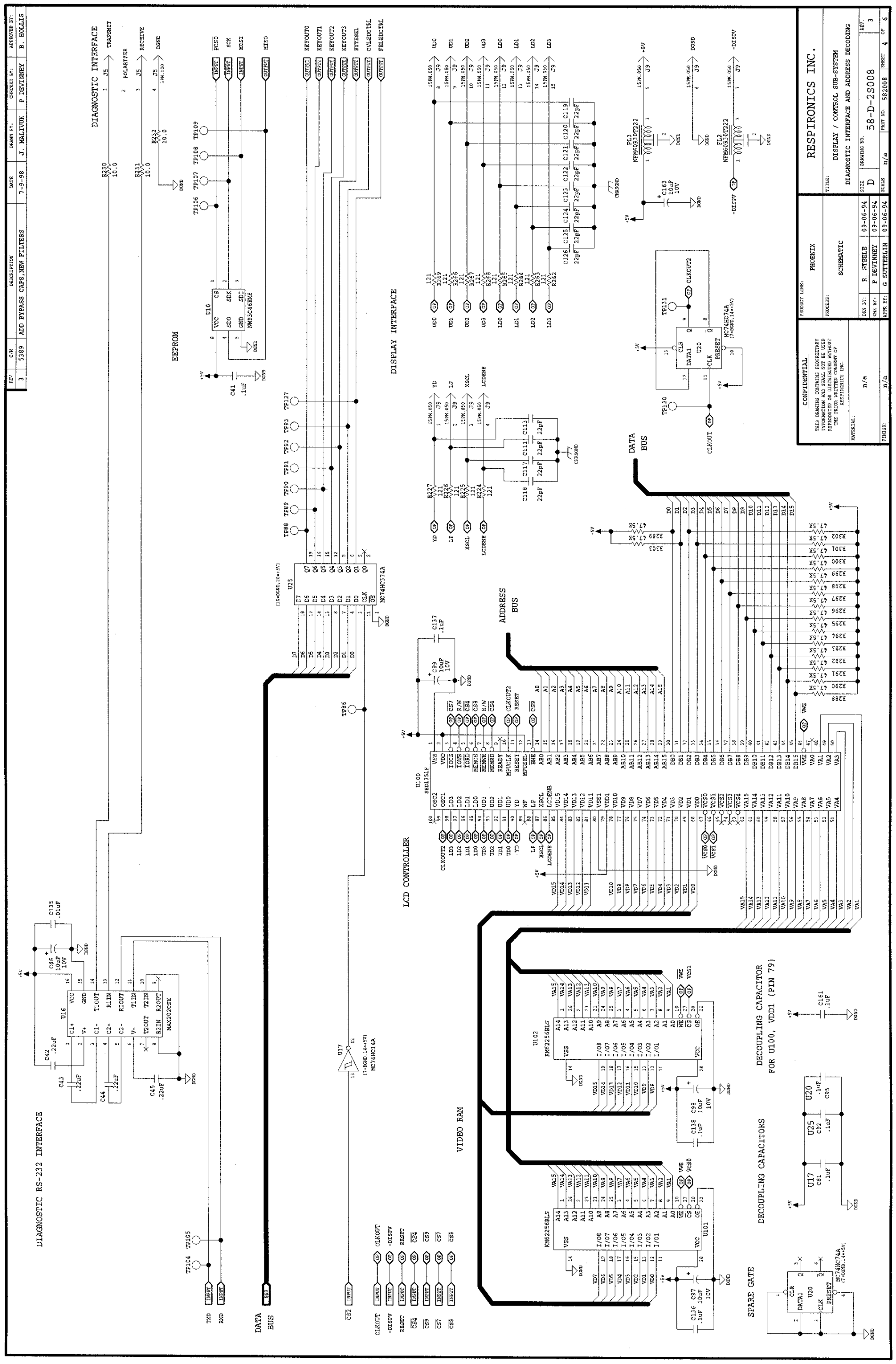

Figure C-10: DC *Diagnostic Interface and Address Decoding*

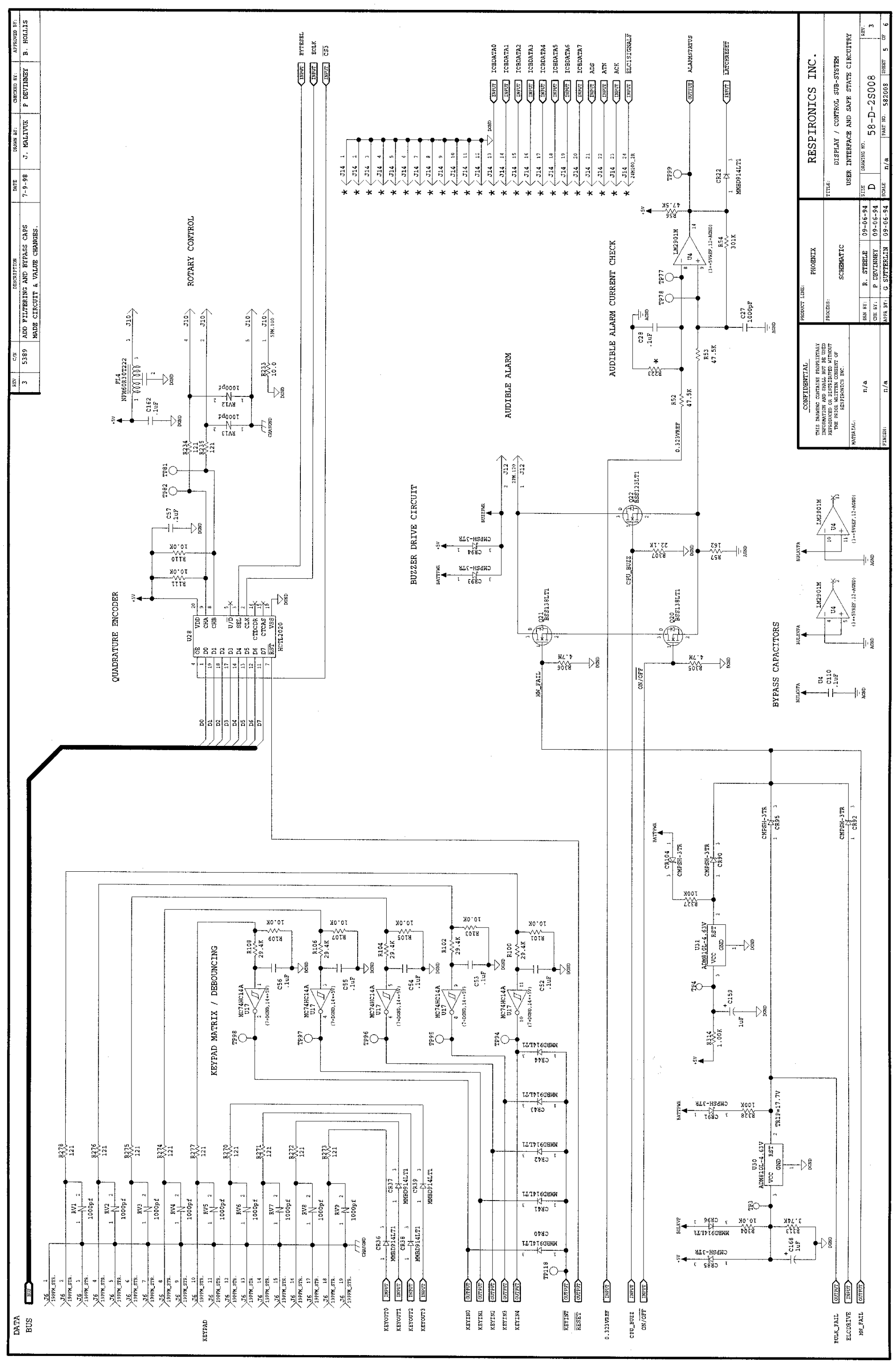

Figure C-11: DC *User Interface and Safe State Circuitry*

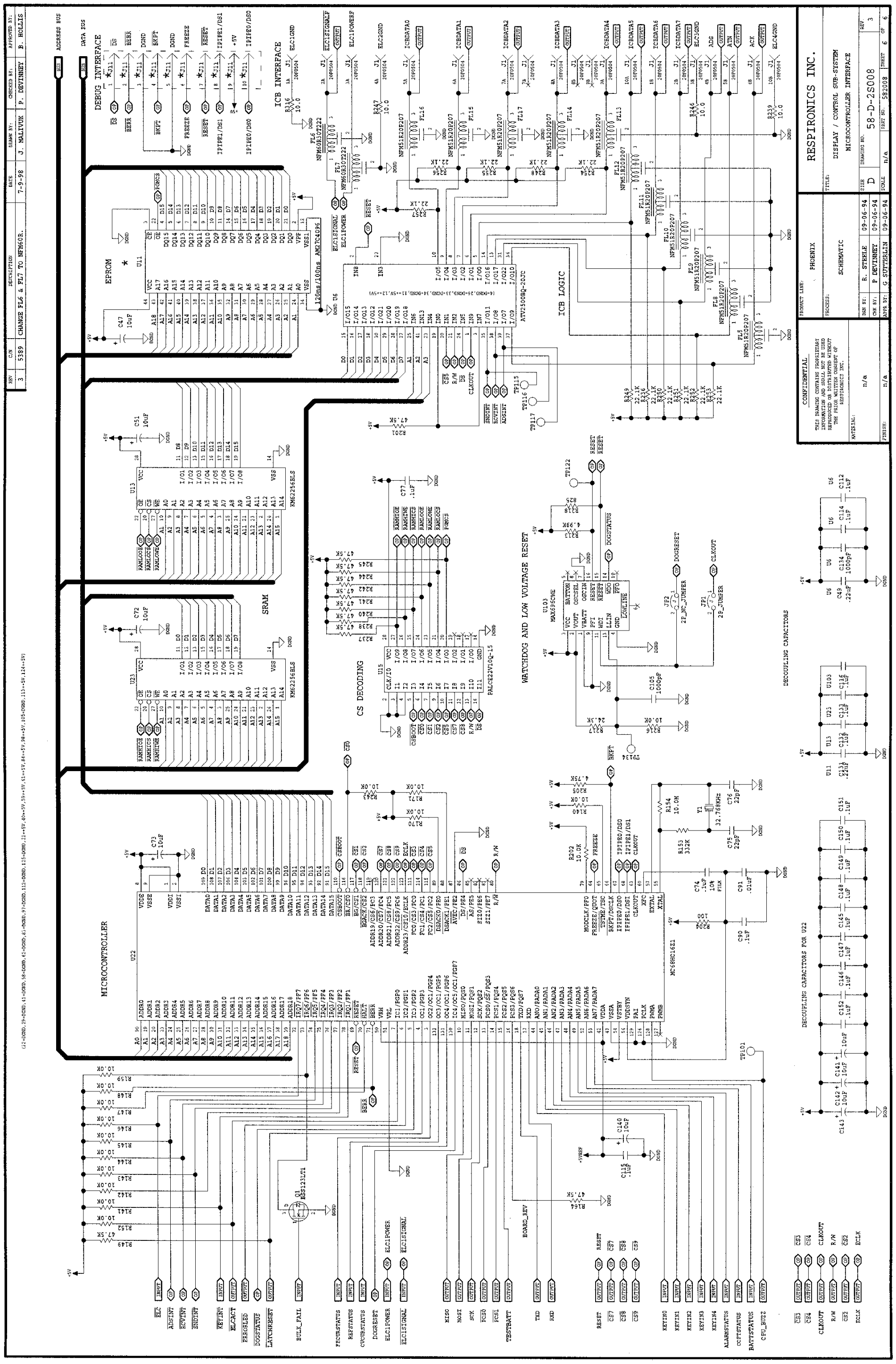

Figure C-12: DC *Microcontroller Interface*

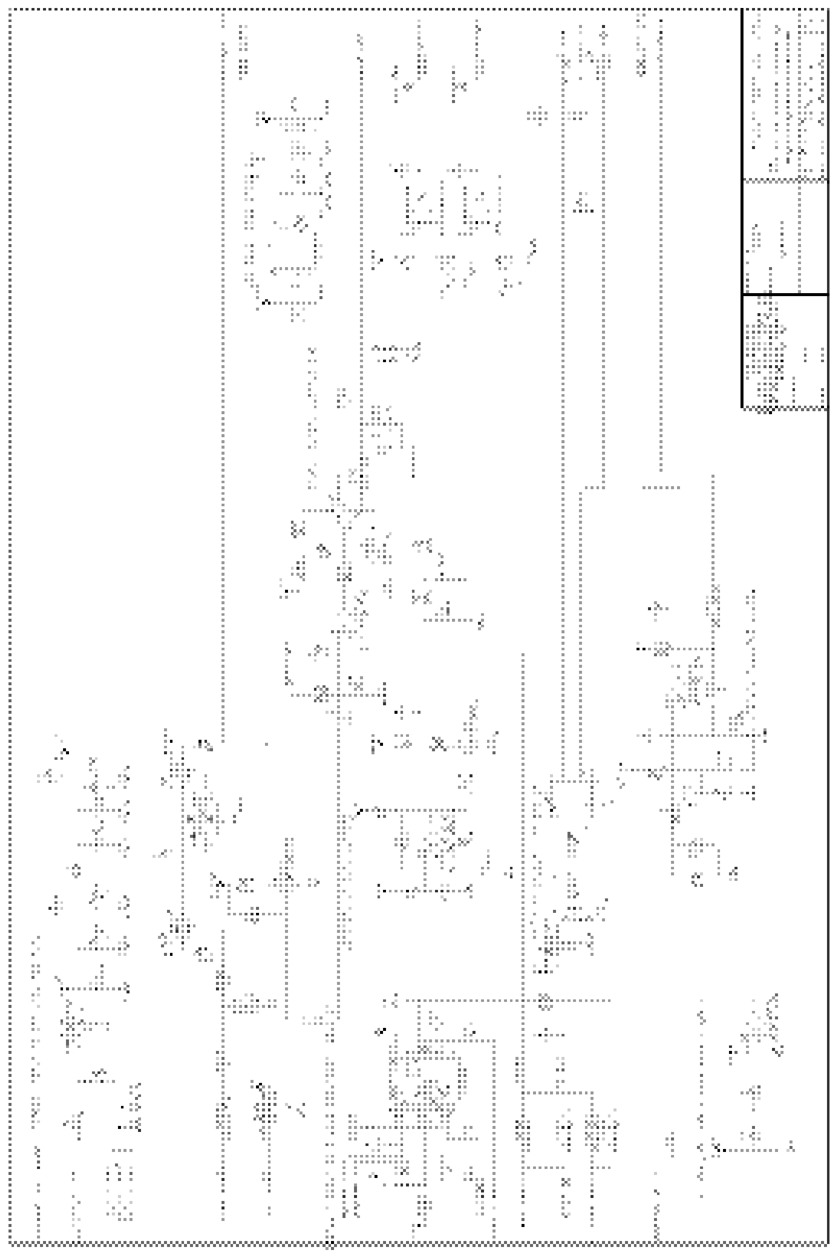

Figure C-13: DC *Board Power Conversion Circuitry*

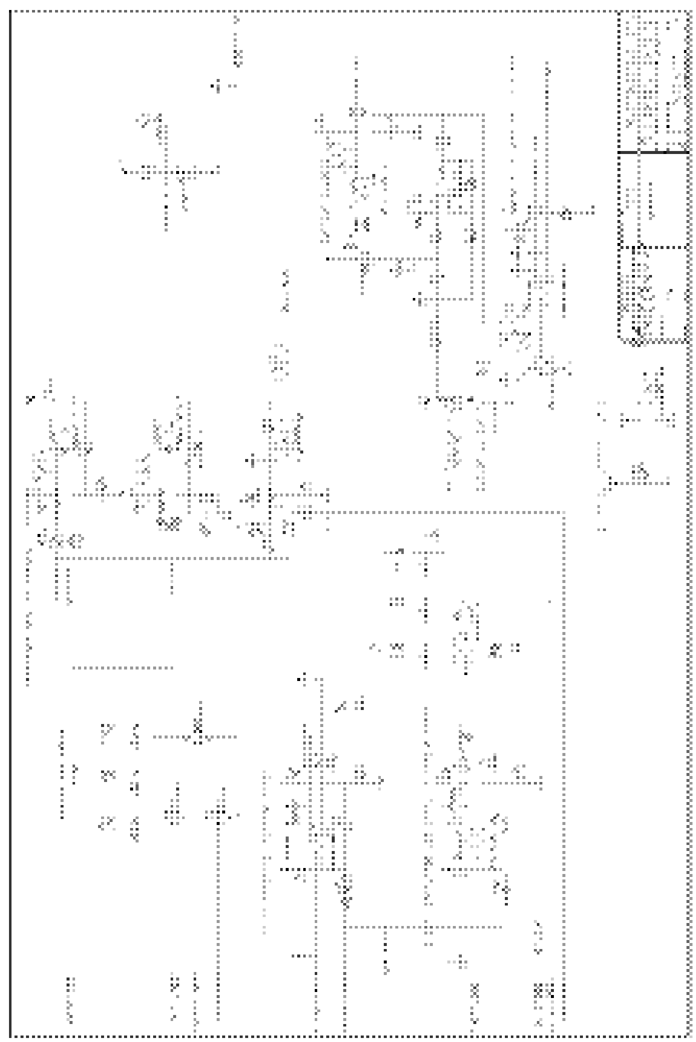

Figure C-14: DC *Board Battery and Indicator Circuitry*

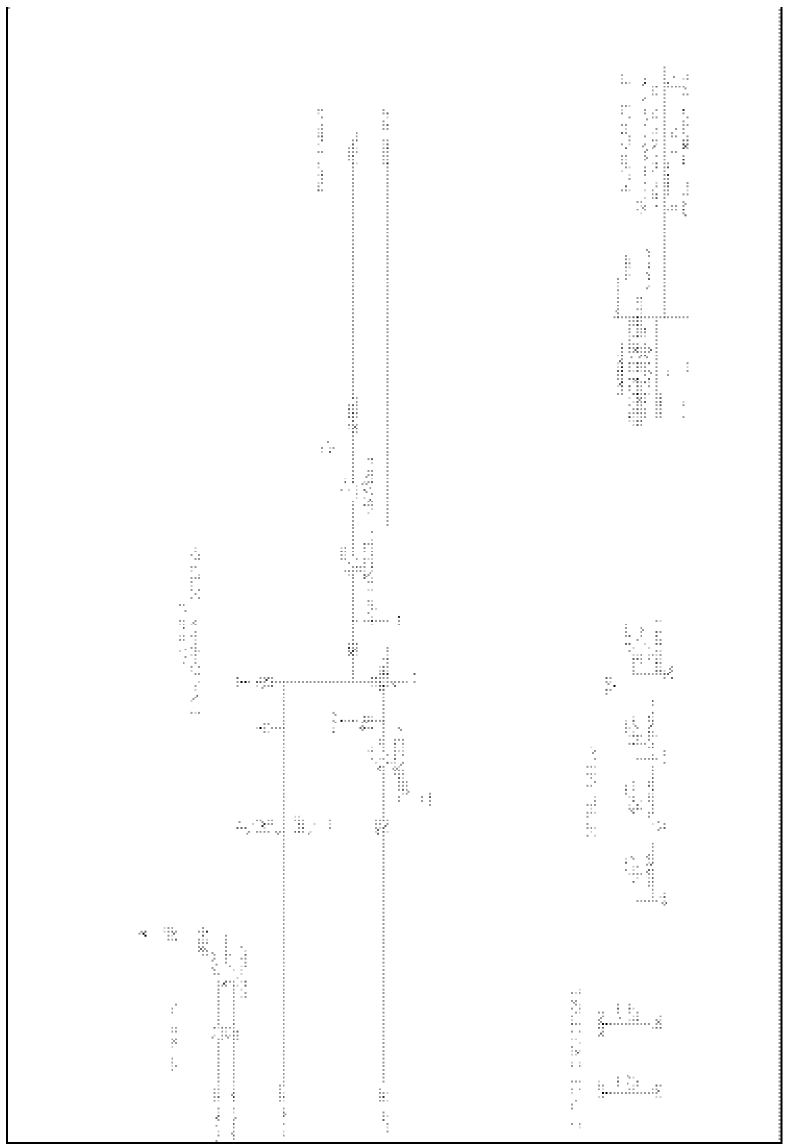

Figure C-15: DC *Board ELC Circuitry*

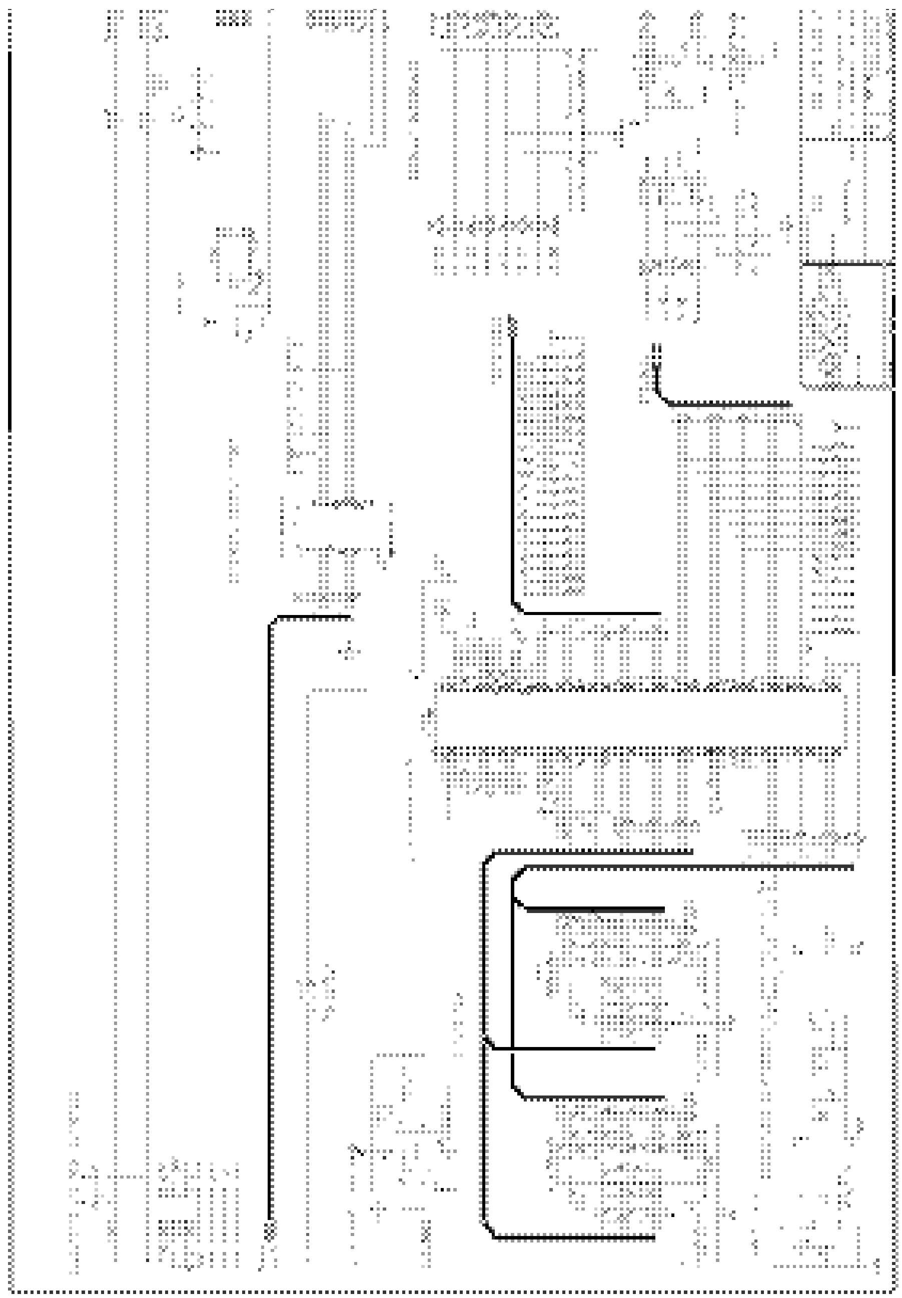

Figure C-16: DC *Board Diagnostic Interface and Address Decoding*

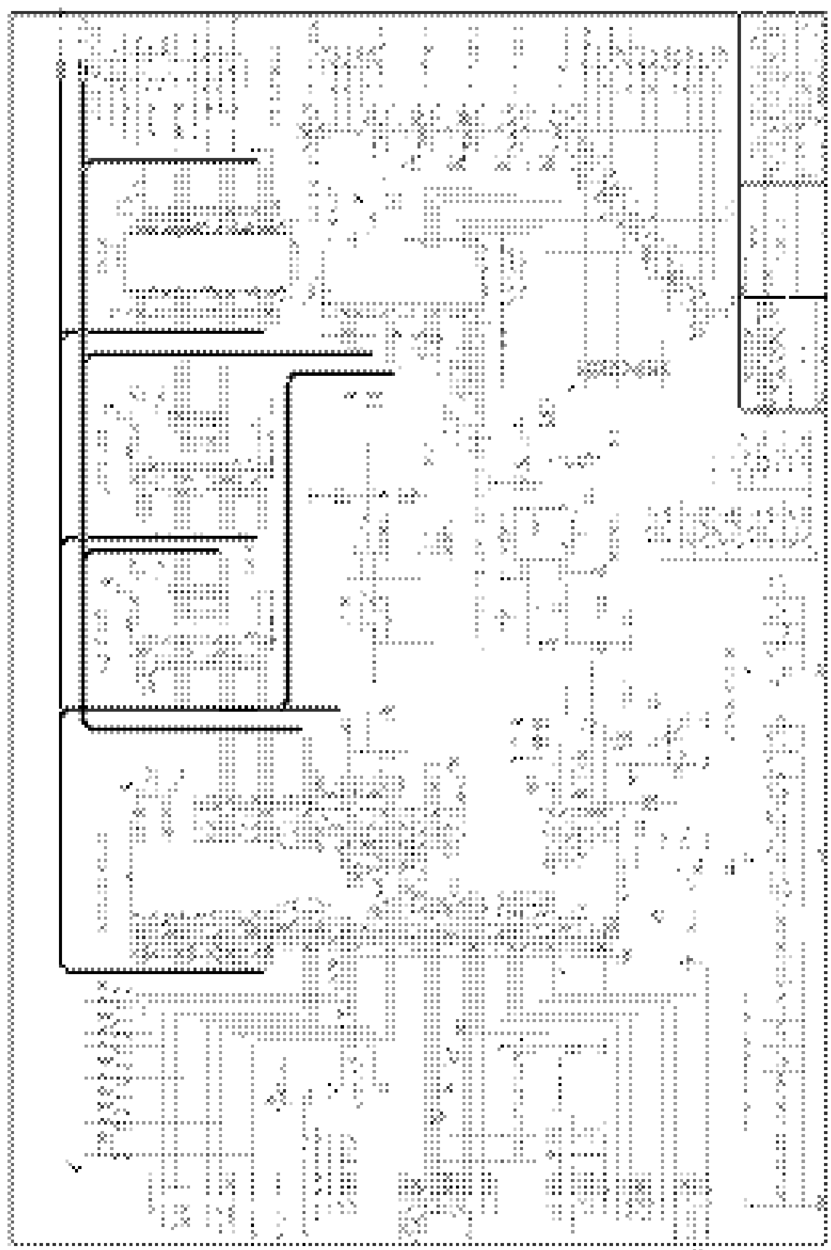

Figure C-17: DC *Board Microcontroller Interface*

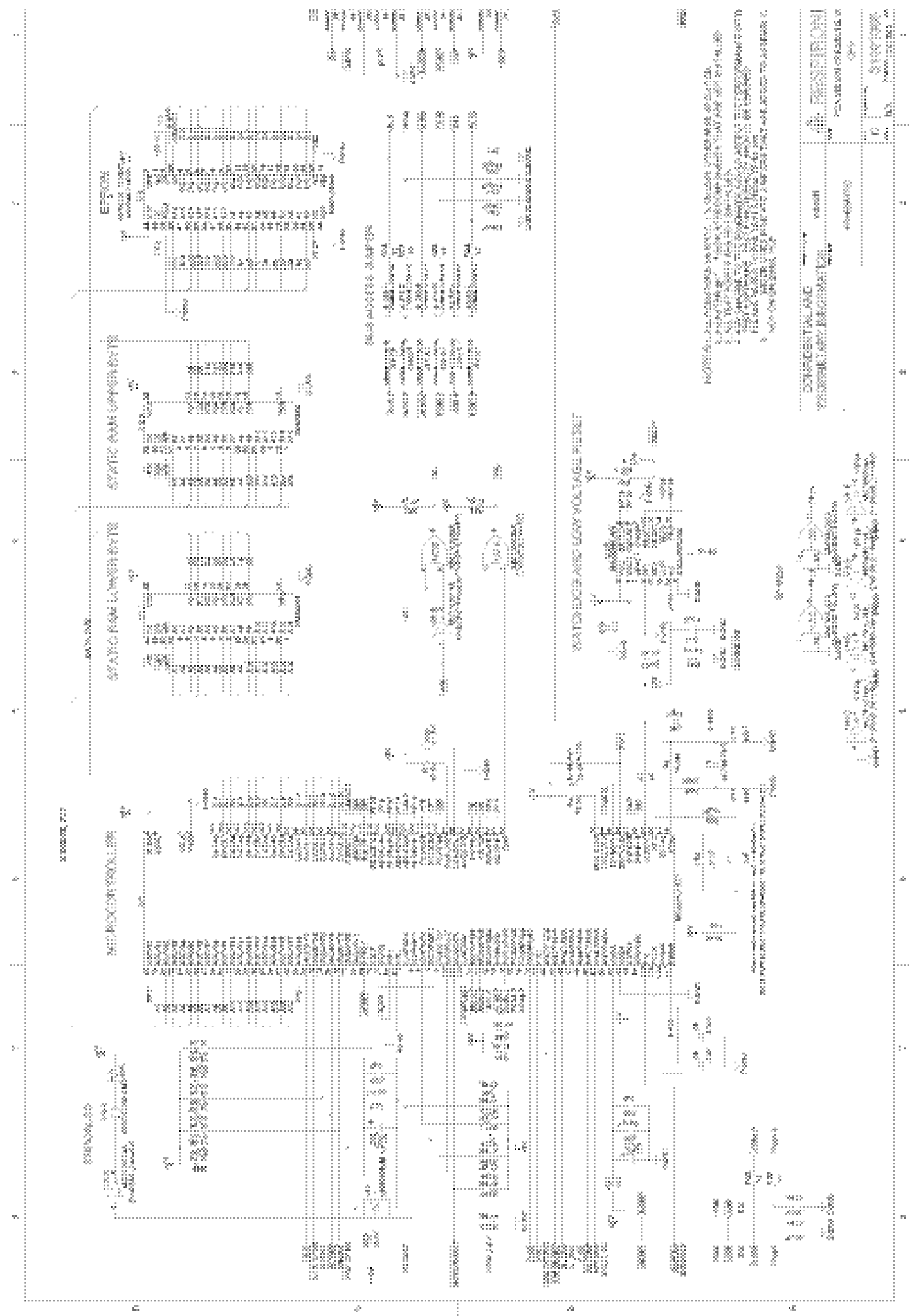

*Figure C-18: Pressure Control (*PC*) Board CPU*

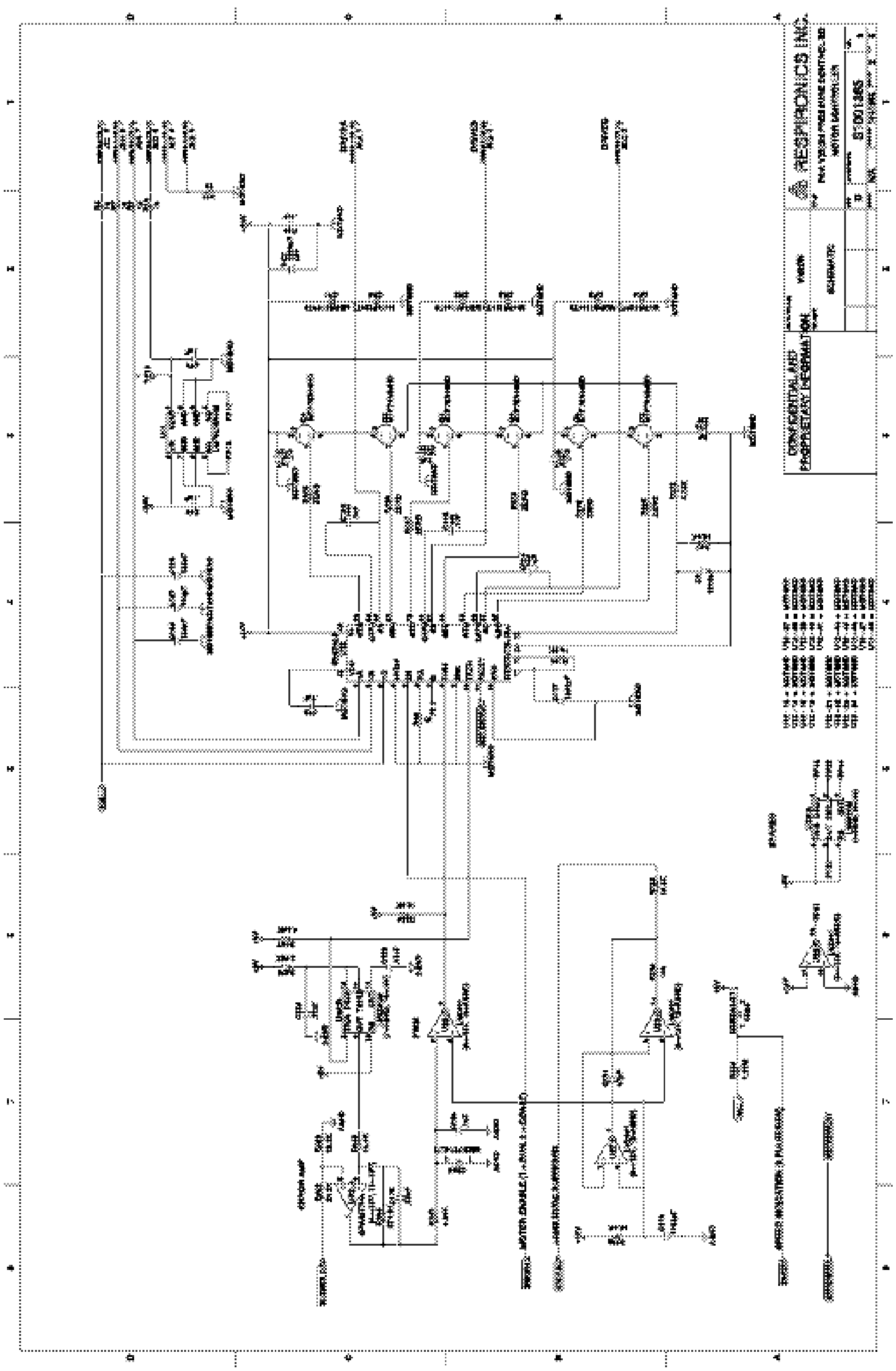

Figure C-19: PC *Board Motor Controller*

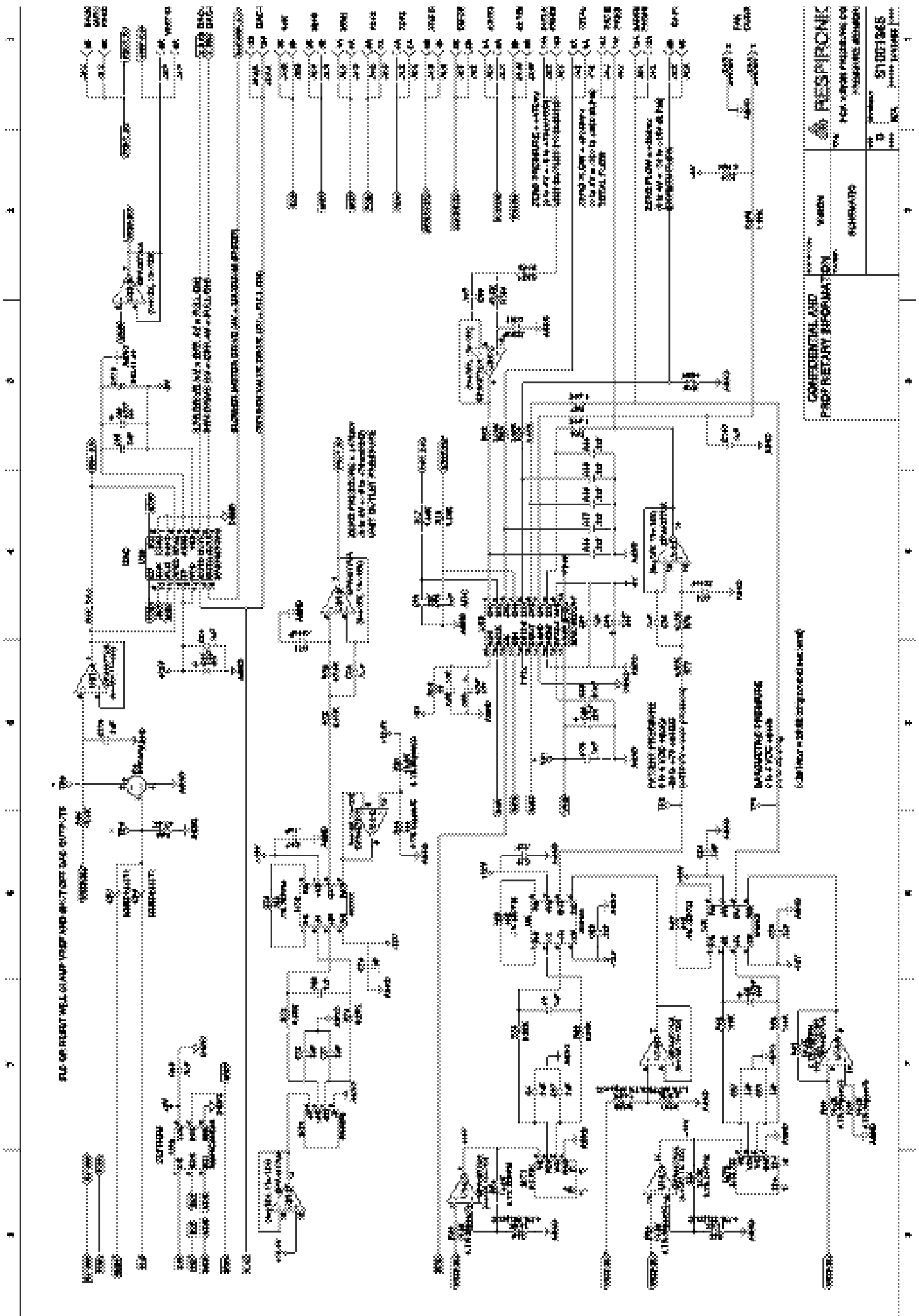

Figure C-20: PC *Board Pressure Sensors*

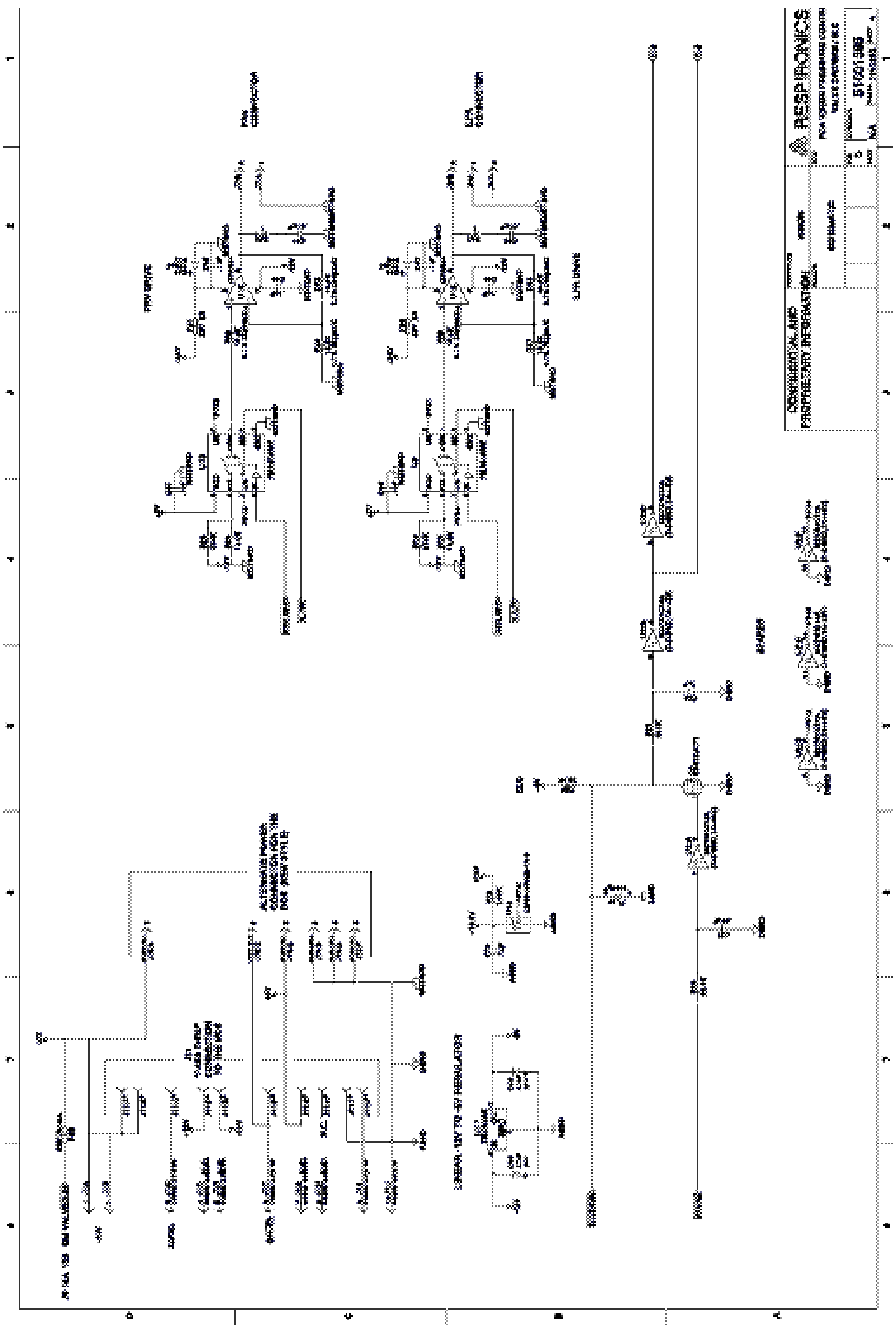

Figure C-21: PC *Board Valve Drivers/ELC*

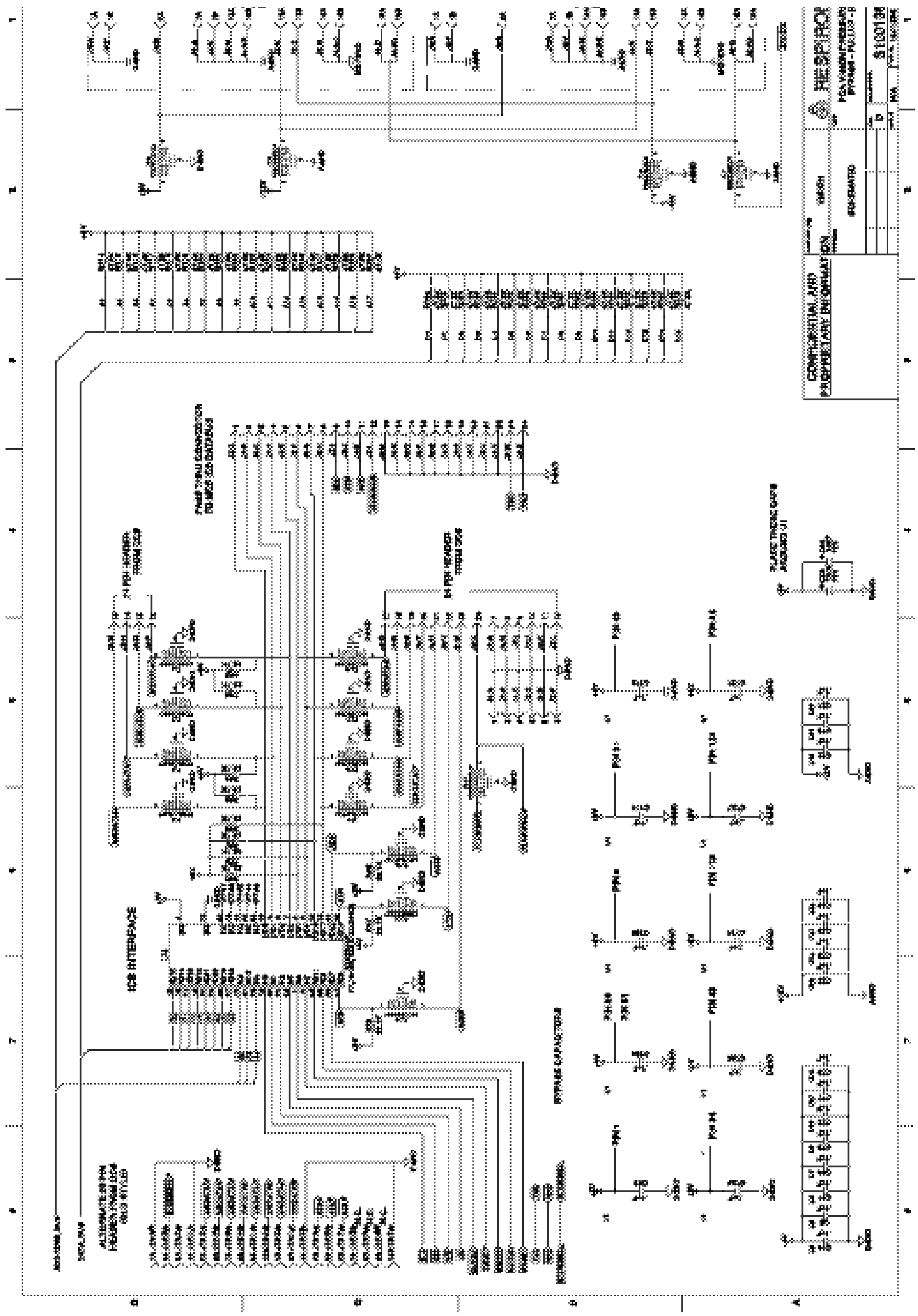

Figure C-22: PC *Board Bypass/Pullup/ICB Databus*

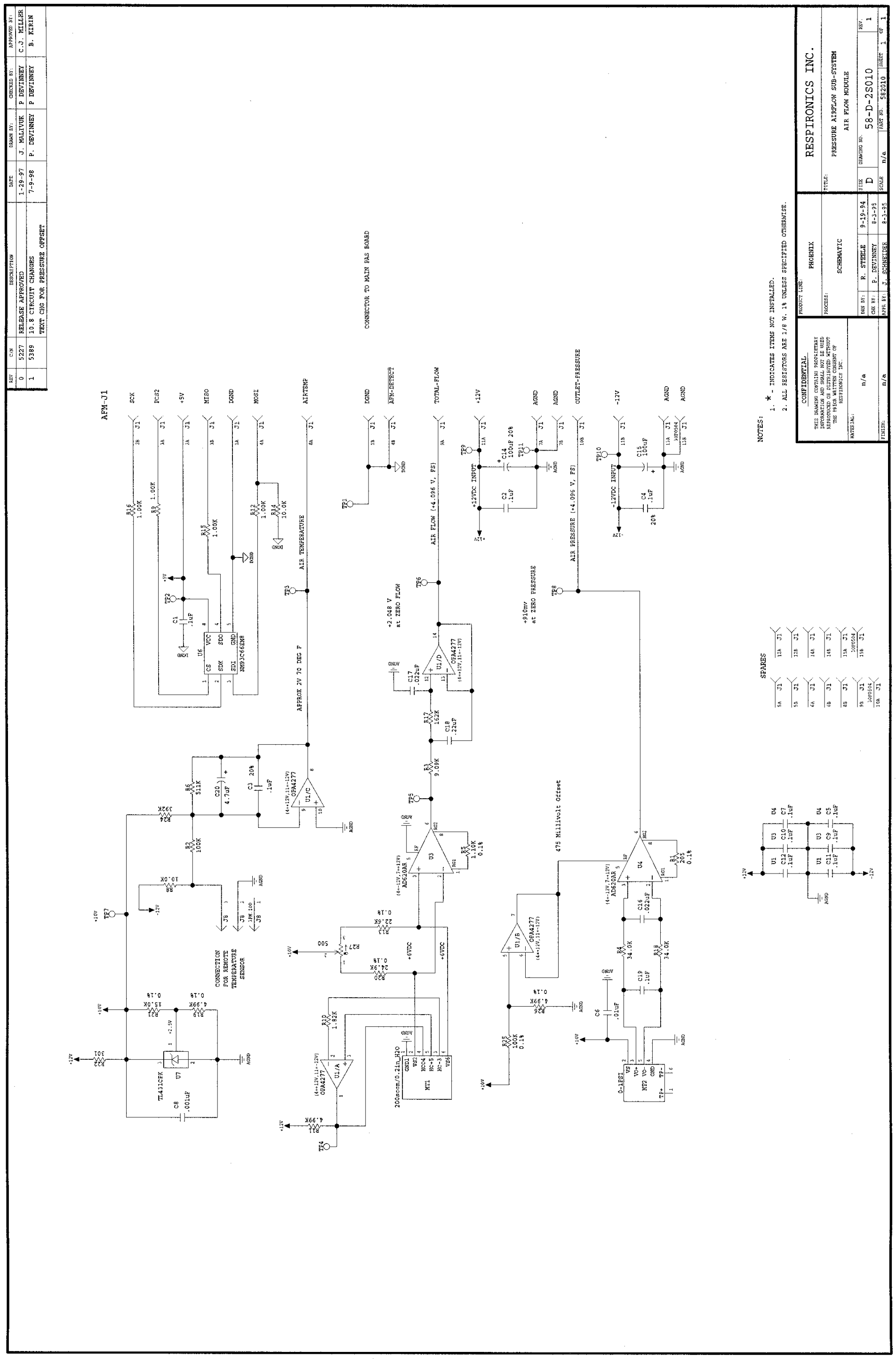

Figure C-23: Air Flow Module (AFM)

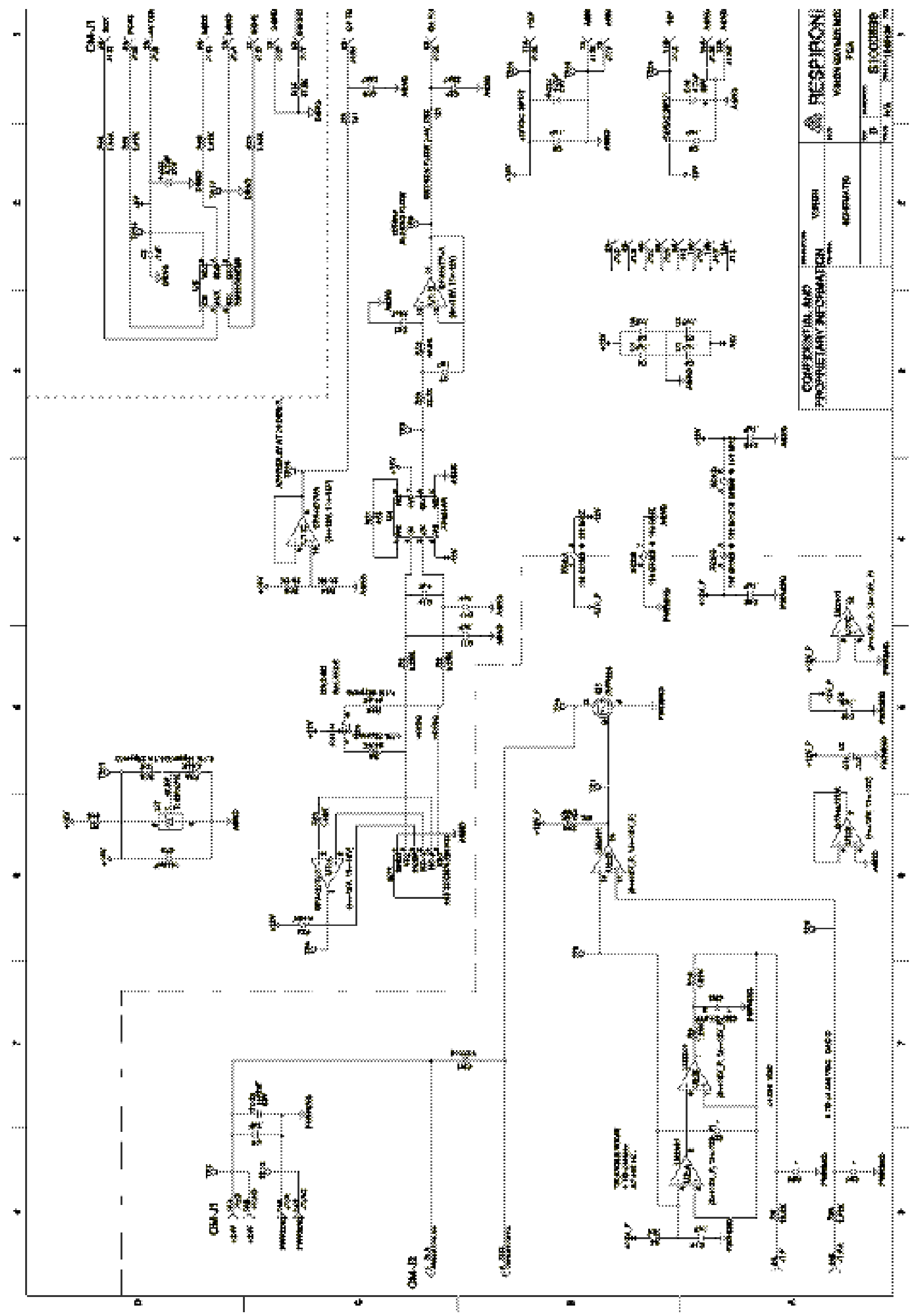

Figure C-24: Oxygen Module (OM)

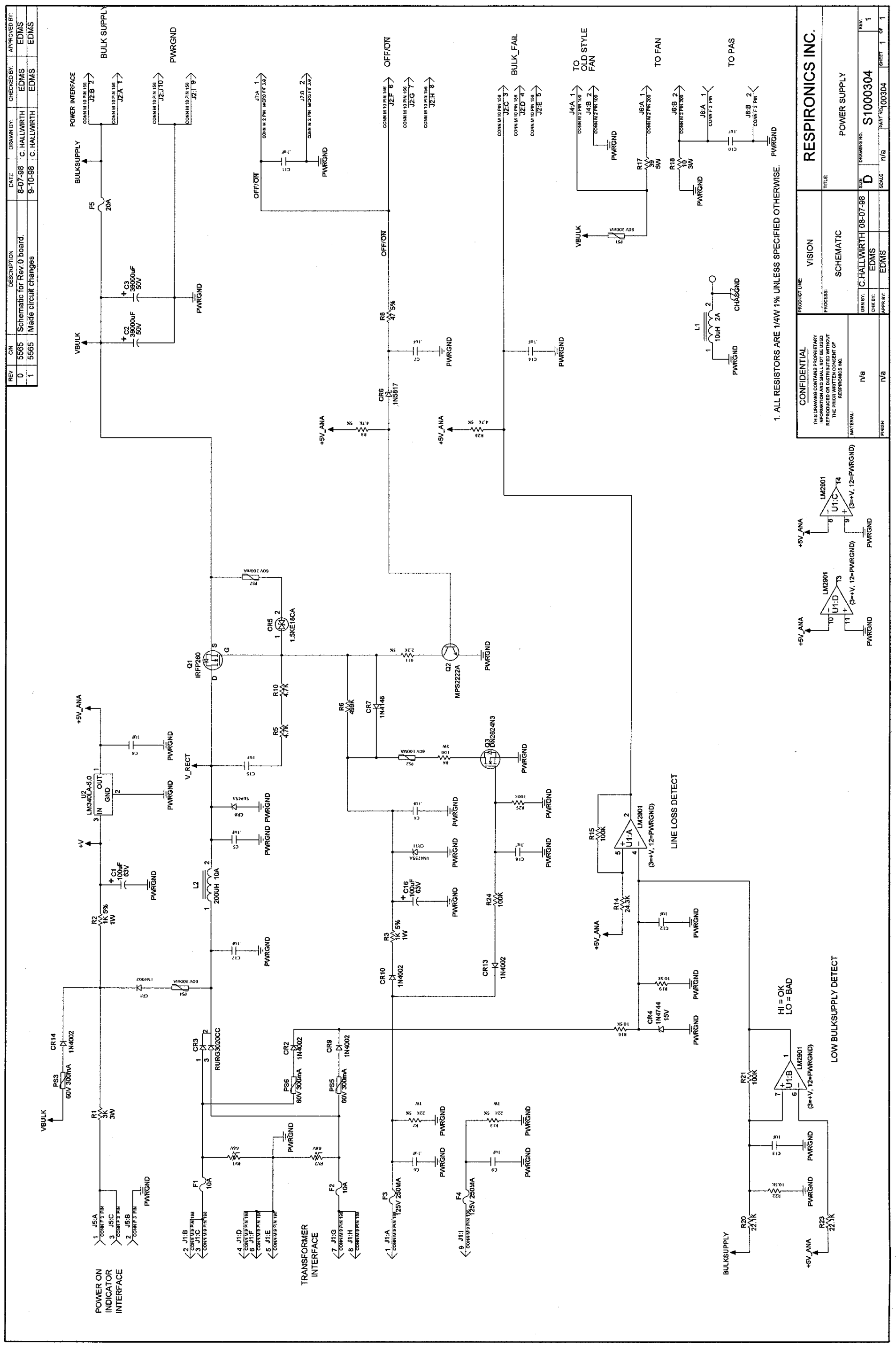

Figure C-25: Power Supply Subsystem (PSS)