
BiPAP[®] System

Service Manual

For Models S, S/T, S-D, and S/T-D



RESPIRONICS INC.[®]

BiPAP systems are the subject of U.S. Patents #5148802, #523995, #5313937, #5433193, Canadian Patent #2,024,477, European Patent #EP0425092, German Patent #69021681.5-08, and other pending U.S. and foreign patents. BiPAP is a registered trademark of Respironics, Inc.

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Chapter 1 Warnings, Cautions, and Notes

1.1 Warnings

1.2 Cautions

1.3 Notes

Chapter 1: Warnings, Cautions, and Notes



WARNING:	Indicates the possibility of injury to the patient or the operator.
CAUTION:	Indicates the possibility of damage to the device.
NOTE:	Places emphasis on an operating characteristic.

1.1 Warnings

General

- This is a service manual. It does not provide adequate information to allow proper operation of the device for use in treating patients. Please refer to the device Clinical, Dealer, and/or Patient Manuals for clinical use.
- This manual serves as a reference. It should be used in conjunction with the instructions and protocol set by the physician at the institution where the device is being used. The instructions in this manual are not intended to supersede established medical protocols regarding the use of assist ventilators.

Safety

- The information contained in this section is supplemental to the warnings, cautions, and notes contained in the Clinical, Dealer, and/or Patient Manuals for each device. Please read the appropriate device manuals prior to servicing the unit.
- The BiPAP System is intended for use on adult patients (≥ 30 kg) only.
- The BiPAP System is intended for use with a Respirationics, Inc. approved patient circuit only. A Respirationics approved circuit consists of:
 - smooth inner lumen tubing;
 - an exhalation device such as the Whisper Swivel® or Respirationics Disposable Exhalation Port Assembly; and
 - a noninvasive patient interface (nasal mask, mouthpiece, or full face mask).

Additional accessories may be added to the circuit to meet specific needs. Every time changes are made to the circuit configuration, the delivered pressures must be monitored at the patient connection with the unit cycling.

- When operating the BiPAP S/T-D System with the Detachable Control Panel (DCP), the DCP settings override the settings on the BiPAP S/T-D System's control panel. DO NOT connect the DCP to the BiPAP S/T-D System while the unit is turned on.
- Explosion Hazard - Do not use the BiPAP System in the presence of flammable anesthetics.
- Oxygen supports combustion. Oxygen should not be used while smoking or in the presence of an open flame.
- DO NOT add oxygen to the front of a BiPAP unit (at the inlet filter opening).

Warnings *continued*

Operation

- BiPAP System performance should be verified, as described in the Clinical Manual, before each new patient is placed on the system.
- The addition of accessories to the patient circuit (e.g., heated humidifier, bacteria filter, water traps, and additional tube lengths) degrades pressure and flow delivery at the patient connection. Confirm that the delivered pressures and flows are adequate for patient management when circuit accessories are used. It may be necessary to increase pressure delivery to compensate for the increased resistance of the circuit.
- When the BiPAP System is used with a heated humidifier, that manufacturer's specifications should be checked to confirm that the humidifier will function correctly in the presence of the continuous flow from the BiPAP System. Always position the humidifier lower than both the BiPAP unit and the patient.
- Never attach oxygen tubing or any positive pressure source to the Pressure Port on the front panel of the BiPAP S/T-D unit.

Service

- Wiring connections and adjustments should be performed by authorized service personnel ONLY.
- Repairs and adjustments **MUST** be performed by experienced personnel who are fully acquainted with this equipment. Service done by inexperienced, unqualified personnel or installation of unauthorized parts could cause personal injury, invalidate the warranty, or result in costly damage. Contact Respironics, Inc. or your health care dealer if the unit fails to meet performance specifications.
- To avoid electrical shock, disconnect the electrical supply before changing the fuses.
- Replace fuses with those of the same type and rating only.

Cleaning

- To avoid electrical shock, unplug the BiPAP unit before cleaning it.

1.2 Cautions

CAUTION: Federal law restricts this device to sale by or on the order of a physician.

- The DCP cable connector port is NOT a standard computer communications port. Connecting the output port to a computer could damage the computer and the BiPAP unit.
- On BiPAP S/T-D models, output signal pin connections are active. Care must be exercised to prevent electrical shorting between the pin connections.
- Only Respironics cables should be used. Use of any other cable types may cause damage to the BiPAP S/T-D System.
- For pressure monitoring, use only tubing with a smooth inner lumen.
- When transporting or storing the BiPAP System, precautions should be taken to avoid exposure to temperature extremes. If exposure to such temperatures has occurred, the unit should be allowed to come to room temperature before being turned on.
- The unit should be positioned on its base or rear panel for proper operation.
- The voltage selector switch must be set according to local line voltage and the proper fuses used.
- When using Respironics smooth inner lumen tubing without a heated humidifier, the overall length of the tubing should not exceed twelve feet.
- Regularly inspect the DCP cable.
- **Electromagnetic emissions:** BiPAP Systems have been tested and shown to comply with FCC Class B Subpart 15.J requirements and the IEC 601-1-2 requirements for electromagnetic compatibility.
- Operational verification of medical monitoring equipment used near the BiPAP System is recommended to assure that any electromagnetic interference produced by the System unit does not affect the function of the monitoring equipment.

1.3 Notes

- The Inspiratory Positive Airway Pressure (IPAP) and Expiratory Positive Airway Pressure (EPAP) controls are electrically coupled. The unit will not deliver an EPAP level that is higher than the set IPAP level. If the EPAP control is set higher than IPAP, the unit will be locked to the IPAP setting and the IPAP Light Emitting Diode (LED) will remain lit.
- Circuit tubing with a smooth inner lumen and a nominal diameter of 22 mm is recommended. Tubing with a corrugated inner lumen will cause a pressure drop from the blower outlet to the patient connection. This may affect the unit's ability to deliver the maximum pressure.
- Heat and moisture exchangers should not be used with the BiPAP System. Testing has shown that the ability of the unit to maintain the prescribed pressure is significantly affected by the addition of a heat and moisture exchanger to the patient circuit.

Additional Warnings, Cautions, and Notes are located throughout this manual.

Chapter 2 BiPAP System

2.1 Identifying the BiPAP System Unit

2.2 BiPAP System Specifications

2.3 System Description

2.4 System Components

2.1 Identifying the BiPAP System Unit

Respironics identifies units with two numbers: the Model Number and the Part Number.

The **Model Number** is printed on a label on the bottom left of the rear end cap.

The **Part Number** (also known as the finished goods number) is indicated on this list by model number. The Part Number is the number used to order the BiPAP system, and is the number that must be used if a unit is returned to Respironics.

<u>Part Number</u>	<u>Product Description</u>
Model 332003	
332110	BiPAP S/T-D — US/CAN Clinical System
332098	BiPAP S/T-D — US/CAN Research Demo
332105	BiPAP S/T-D — US/CAN Clinical Demo
332268	BiPAP S/T-D — US/CAN Hospital Core Package
332305	BiPAP S/T-D — CSA Clinical System with DCP
Model 332083	
332407	BiPAP S/T-D — Australian System
332055	BiPAP S/T-D — International Clinical System
332266	BiPAP S/T-D — LGA Hospital Core Package
332099	BiPAP S/T-D — International Clinical Sample
332392	BiPAP S/T-D — International Hospital Core Package
Model 332109	NOTE: As of S/N 28235, Model 332109 is obsolete
332074	BiPAP S/T Home Starter Kit — US Home System
	NOTE: As of S/N 28235, Part Number 332074 becomes US/CAN Home System; see Model Number 332203
Model 332203	
332056	BiPAP S/T — CAN Home System
	NOTE: As of S/N 28235, Part Number 332056 is obsolete
332074	BiPAP S/T — US/CAN Home System — As of S/N 28235
Model 332108	
332054	BiPAP S/T — International Home System
332406	BiPAP S/T — Australian Home System
Model 332408	
332409	BiPAP S/T — LGA Home System

<u>Part Number</u>	<u>Product Description</u>
Model 332092	
332069	BiPAP S-D — US/CAN Clinical System
332146	BiPAP S-D — US/CAN Sample
332212	BiPAP S-D — Unit Sample
332262	BiPAP S-D — US/CAN Sample
332303	BiPAP S-D — US/CAN Clinical System with DCP
332298	BiPAP S-D — Clinical Sample with DCP
Model 332095	
332023	BiPAP S-D — International Clinical System
332304	BiPAP S-D — TUV Clinical System with DCP
332405	BiPAP S-D — Australian Diagnostic System
Model 332019	NOTE: As of S/N 28329, Model 332019 is obsolete
332100	BiPAP S — US Home System
	NOTE: As of S/N 28329, Part Number 332100 becomes US/CAN Home System; see Model 332202
Model 332079	
332073	BiPAP S — International Home System
332404	BiPAP S — Australian Home System
Model 332202	
332072	BiPAP S — CAN Home System
	NOTE: As of S/N 28329, Part Number 332072 is obsolete
332100	BiPAP S — US/CAN Home System — As of S/N 28329
Model 332252	
332231	BiPAP S/T — International Xemko Home System
Model 332201	
332197	BiPAP S — International Xemko Home System

2.2 BiPAP System Specifications

MODELS:	S/T, S/T-D, S, S-D
<p>FUNCTIONS:</p> <p>IPAP</p> <p>EPAP</p> <p>Modes</p> <p>Zero</p> <p>Cal.</p>	<p>Delivers set pressure continuously. (IPAP-Inspiratory Positive Airway Pressure)</p> <p>Delivers set pressure continuously. (EPAP-Expiratory Positive Airway Pressure)</p> <p>The IPAP and EPAP controls are electrically coupled. The unit will not deliver an EPAP level that is higher than the set IPAP level. If the EPAP control is set higher than IPAP, the unit will be locked to the IPAP setting and the IPAP Light Emitting Diode (LED) will remain lit.</p> <p>Spontaneous Mode (all models) Spontaneous/Timed Mode (S/T and S/T-D models only) Timed Mode (S/T and S/T-D models only)</p> <p>(S/T-D and S-D models with DCP only): Provides "0" reference signal to the \dot{V}_{tot}, \dot{V}_{est}, and V_T channels. Circuit pressure is controlled by the EPAP setting.</p> <p>(S/T-D and S-D models only): Provides an alternating square wave signal with a period of four seconds and an amplitude of $\pm 0.5V$ to the \dot{V}_{tot} and \dot{V}_{est} channels. Sends a corresponding triangular wave volume signal of $0.5V_{pp}$ to the V_T channel. Circuit pressure is controlled by the EPAP setting.</p>
<p>PRESSURES AND FLOW CHARACTERISTICS (all models):</p> <p>Pressure range for IPAP or EPAP</p> <p>Pressure Calibration Accuracy</p> <p>Pressure Setting Stability</p>	<p>4 cm H₂O to 20 cm H₂O at ± 60 L/min flow* Pressure controls are electronically coupled so that the unit will not deliver a higher EPAP than IPAP level.</p> <p>± 2 cm H₂O of the indicated control setting.</p> <p>± 1 cm H₂O over 8 hours.</p> <div style="border: 1px solid black; border-radius: 15px; padding: 10px; margin: 10px 0;"> <p>NOTE: All pressure measurements were made at the blower outlet unless stated otherwise.</p> </div> <p>*Measured at the end of a six-foot section of smooth inner lumen tubing.</p>

<p>CYCLING:</p> <p>Breaths Per Minute</p> <p>Breathing Rate Accuracy</p> <p>% IPAP</p> <p>% IPAP Setting Accuracy</p> <p>Minimum IPAP Time</p> <p>Maximum IPAP Time</p> <p>Minimum EPAP Time</p> <p>Spontaneous Inspiratory Effort Threshold</p>	<p>(S/T and S/T-D units only): 4 to 30 BPM.</p> <p>(S/T and S/T-D units only): ±10% or 2 BPM of indicated reading, whichever is greater.</p> <p>(S/T and S/T-D units only): 10 to 90%.</p> <p>(S/T and S/T-D units only): ±10% of indicated setting.</p> <p>(all units): Approximately 200 msec (Spontaneous and Spontaneous/Timed modes only).</p> <p>(all units): 3 seconds ±0.5 second at a constant flow rate condition of 100 liters/min (Spontaneous and Spontaneous/Timed modes only).</p> <p>(all units): 500 msec ±75 msec (Spontaneous and Spontaneous/Timed modes only).</p> <p>(all units): 47.5 cc/sec above the average leak flow rate of 14L/min, maintained for 30 msec (Spontaneous and Spontaneous/Timed modes only).</p>										
<p>PATIENT CIRCUIT:</p> <p>Whisper Swivel Continuous Leak Rate</p>	<table border="0"> <thead> <tr> <th style="text-align: center;"><u>Pressure</u></th> <th style="text-align: center;"><u>Nominal Leak</u></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">5 cm H₂O</td> <td style="text-align: center;">14 L/min (nominal)</td> </tr> <tr> <td style="text-align: center;">10 cm H₂O</td> <td style="text-align: center;">21 L/min (nominal)</td> </tr> <tr> <td style="text-align: center;">15 cm H₂O</td> <td style="text-align: center;">26 L/min (nominal)</td> </tr> <tr> <td style="text-align: center;">20 cm H₂O</td> <td style="text-align: center;">30 L/min (nominal)</td> </tr> </tbody> </table>	<u>Pressure</u>	<u>Nominal Leak</u>	5 cm H ₂ O	14 L/min (nominal)	10 cm H ₂ O	21 L/min (nominal)	15 cm H ₂ O	26 L/min (nominal)	20 cm H ₂ O	30 L/min (nominal)
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15 cm H ₂ O	26 L/min (nominal)										
20 cm H ₂ O	30 L/min (nominal)										
<p>ELECTRICAL REQUIREMENTS:</p> <p>Current Consumptions:</p> <p>Electromagnetic Emissions:</p> <p>Fuse Ratings: Serial Numbers <200,000</p> <p style="padding-left: 100px;">Serial Numbers >200,000</p>	<p>100-130 VAC (60Hz) or 200 to 260 VAC (50Hz). (Voltage range set by voltage selector switch on rear panel.)</p> <p>800mA max. for 100 to 130 VAC 400mA max for 200 to 260 VAC</p> <p>Designed to ECRI Electrical Safety Specifications. Ground Continuity: <500 milliohms (45 typical) Current Leakage: <100 microamps (8.2 typical)</p> <p>BiPAP Systems have been tested and shown to comply with FCC Class B Subpart 15.J requirements and the IEC 601-1-2 requirements for electromagnetic compatibility.</p> <p>1A Fuses -- 115 Volt Electrical Systems 500mA Fuses -- 230 Volt Electrical Systems</p> <p>800mA Fuses --115 Volt Electrical Systems 400mA Fuses -- 230 Volt Electrical Systems</p>										
<p>OPTIONAL DCP CABLES:</p>	<p>26 AWG (minimum) tinned copper, shielded, insulated wire.</p>										

PHYSICAL CHARACTERISTICS:

Unit dimensions.....	7 ¾ x 9 x 12 ¾ inches (20 x 23 x 31 cm). 850 cubic inches (13,931 cubic cm).
Weight.....	9.5 lbs (4.3 kg).
Operating Temperature.....	50 to 100 °F (10 to 38 °C).
Storage Temperature.....	-20 to 140 °F (-30 to 60 °C).
Outlet Temperature.....	It is normal for the pre-foam BiPAP unit to have an outlet air temperature that is 10 to 12 °F warmer than room temperature, especially after running all night. A difference between room temperature and air outlet temperature greater than 18 °F is an indication for a service check. Foamed units (serial numbers 052000 or greater) can be expected to have an outlet air temperature that is 18 to 25 °F warmer than room temperature, especially after running all night. A difference between room temperature and air outlet temperature greater than 25 °F is an indication for a service check on a foamed BiPAP unit. The air temperature at the end of a patient circuit will always be lower than the temperature measured at the outlet and is typically 5 to 10 °F above ambient.
Noise Level.....	Variables associated with noise measurement are numerous and therefore no specification is provided.

2.3 System Description

This BiPAP unit provides bi-level positive airway pressure, through a nasal or nasal /oral mask, to assist patient ventilation. An integral flow transducer senses whether the patient is inhaling or exhaling by constantly monitoring the amount of air flowing through the system. The system then provides the appropriate amount of positive air pressure for the function, i.e., more pressure during inhalation (IPAP), less pressure during exhalation (EPAP).

The unit is available in four models: BiPAP S, BiPAP S/T, BiPAP S-D, BiPAP S/T-D.

The BiPAP S unit offers two modes of operation:

- CPAP (Continuous Positive Airway Pressure) - When the control is set to either IPAP or EPAP, the unit provides continuous pressure at the level you set for that function.
- SPONTANEOUS - The unit cycles between inhalation (IPAP) and exhalation (EPAP) levels as triggered by patient breathing.

The BiPAP S/T offers four modes of operation:

- CPAP (Continuous Positive Airway Pressure) - When the control is set to either IPAP or EPAP, the unit provides continuous pressure at the level you set for that function.
- SPONTANEOUS - The unit cycles between inhalation (IPAP) and exhalation (EPAP) levels as triggered by patient breathing.
- SPONTANEOUS/TIMED - As with the SPONTANEOUS mode, the unit cycles between IPAP and EPAP levels as sensed from patient breathing, but if the patient does not inhale within a preset time interval, the unit cycles to IPAP. The time interval is determined by the BPM (breaths per minute) setting on the control panel.
- TIMED - The unit cycles between IPAP and EPAP levels at preset time intervals, determined by the BPM and % IPAP (percent of breath cycle spent in IPAP settings on the control panel).

The BiPAP S-D unit offers the same operating modes as the BiPAP S, but all functions can be controlled by a Detachable Control Panel (DCP). In addition, the following DC analog output signals are provided for a recorder or oscilloscope:

- P (Pressure) - The signal from the internal pressure transducer indicates IPAP and EPAP levels (in cm H₂O at the measure point in the patient circuit).
- V_T (Estimated Tidal Volume) - Signal from the internal flow transducer indicates volume of air (in liters) inhaled or exhaled with each breath during quiet breathing.
- \dot{V}_{tot} (Total Flow Rate) - The signal from the internal flow transducer indicates total air flow rate (in L/min) through the unit to the patient circuit. Total air flow consists of the air flow necessary to satisfy circuit leaks (\dot{V}_{leak}), and patient breathing (\dot{V}_{est}).
- \dot{V}_{est} (Estimated Patient Flow Rate) - The signal from the internal flow transducer indicates patient flow rate (in L/min). The data is based on Total Flow Rate (\dot{V}_{tot}) minus Estimated Leak Flow Rate (\dot{V}_{leak}).

The BiPAP S/T-D unit offers the same operating modes as the BiPAP S/T, but all functions can be controlled by a DCP. In addition, it provides the same recorder output signals (V_{Tr} , V_{Iot} , V_{est} , and P) as the BiPAP S-D.

The Airway Pressure Monitor is designed to supplement patient monitoring during ventilation with the BiPAP S/T-D System. Its purpose is to notify medical personnel and/or user of undesirably LOW (as in a disconnect situation) or HIGH pressures at a specific point in the breathing cycle.

Optional Detachable Control panels (DCP) are available for the BiPAP S/T-D and the BiPAP S-D units. They allow all control settings to be made and/or adjusted remotely. Some units may use the Remote Control Unit (RCU). All information relating to the DCP is applicable to the RCU.

Feature	Model			
	S	S-D	S/T	S/T-D
CPAP	Y	Y	Y	Y
Spontaneous	Y	Y	Y	Y
Spontaneous/Timed	N	N	Y	Y
Timed	N	N	Y	Y
DCP Control	N	Y	N	Y

The table above indicates which features are present in the BiPAP model you are using. A "Y" in the column means that feature is present in that model. A "N" means that that feature is not present in that model.

2.4 System Components

Figure 2-1 shows the main system components, and Figure 2-2 shows the system air flow.

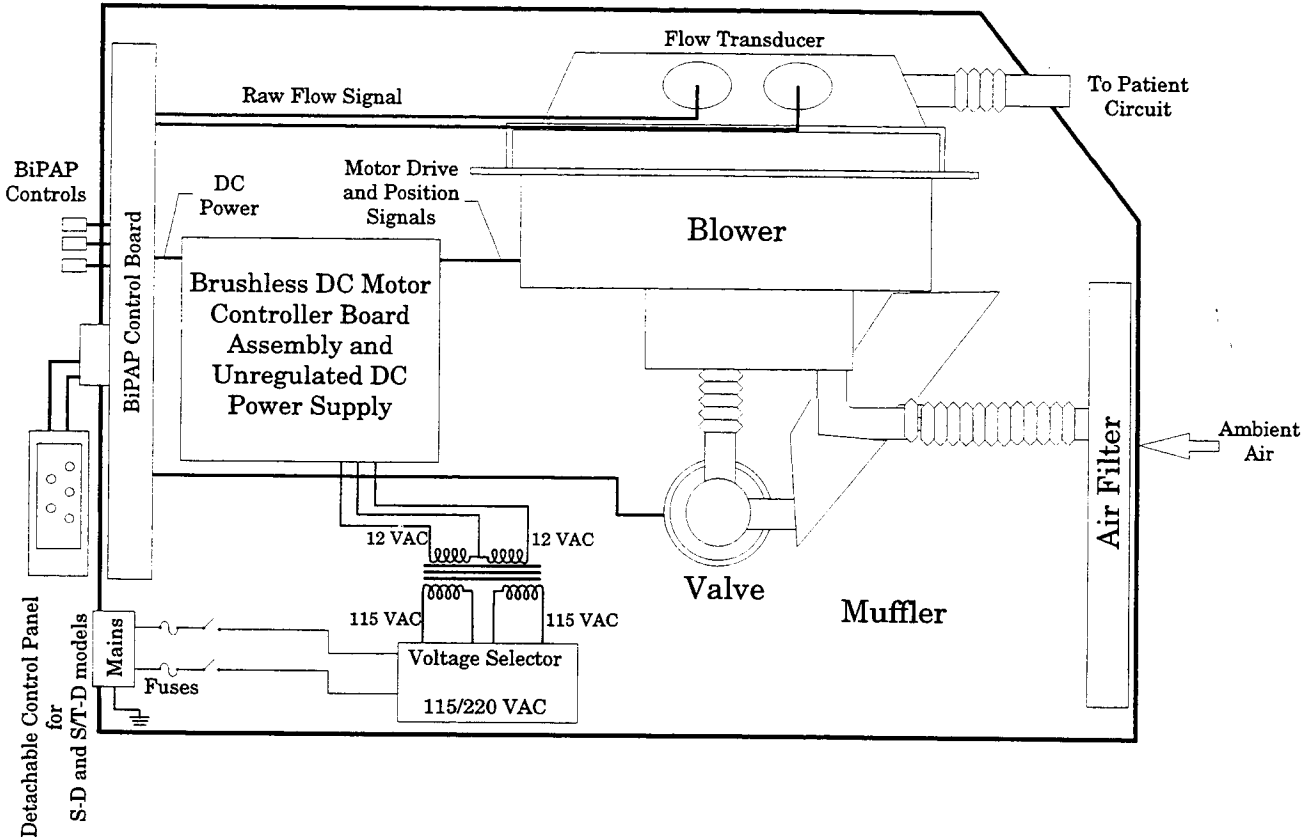


Figure 2-1. System Components.

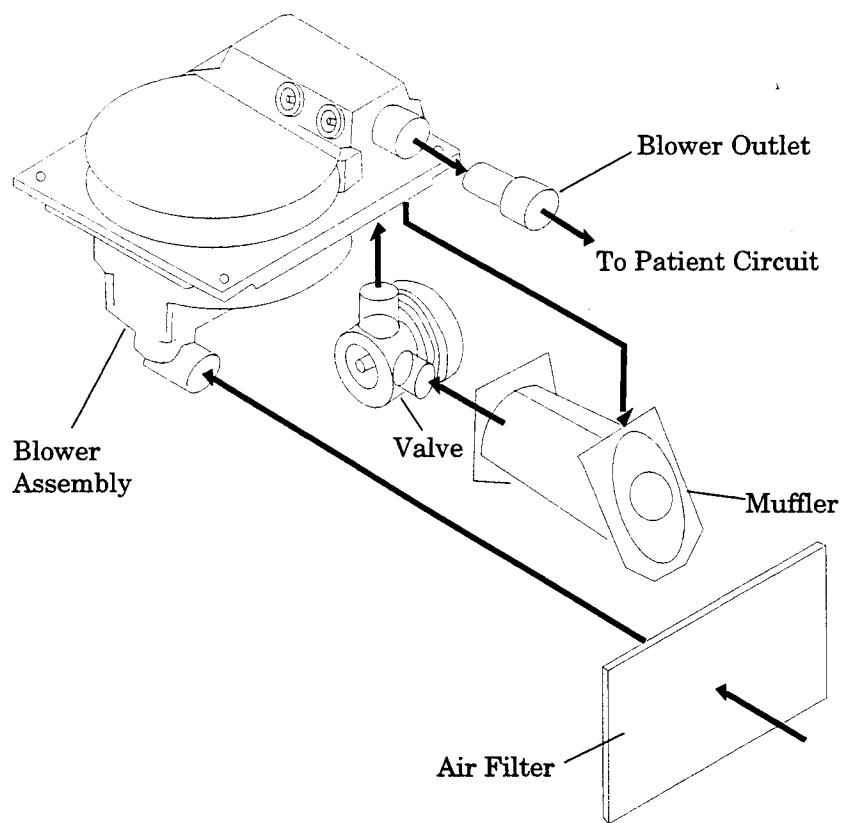


Figure 2-2. System Air Flow.

Chapter 3 Controls and Set-up

3.1 Controls

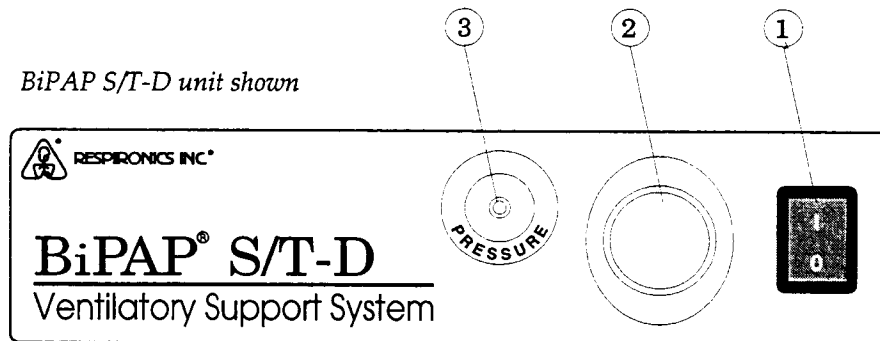
3.2 Setting Up the BiPAP System

3.3 Detachable Control Panel (DCP)

3.4 DCP Set-up

3.1 Controls

3.1.1 Front Panel



① Power Switch

The power switch turns the electrical power to the BiPAP unit ON (I) and OFF (O).

② Tubing Connector

The tubing connector accepts 22 mm I.D. tubing with a smooth inner lumen and accepts a mainflow bacteria filter.

③ Pressure Port (S/T-D and S-D units only)

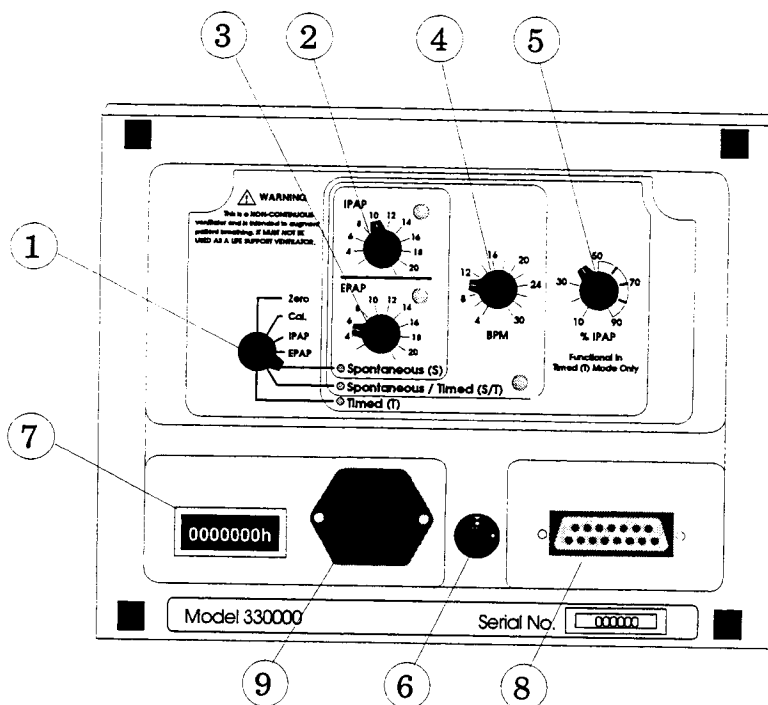
The pressure port accepts manometer tubing with a smooth inner lumen. The port interfaces with an internal pressure transducer and allows in-line pressure monitoring with output to a recorder. The pressure port is the source of the pressure display for the Detachable Control Panel (DCP).

Range = 0 to 20 cm H₂O.

CAUTION: Never add oxygen or any positive pressure source to this connection.

3.1.2 Rear Panel Controls

BiPAP S/T-D unit shown



① Function Selector Knob

The position of the knob indicator determines which function or mode is active. The S/T-D and S-D models function selection knobs have seven discrete positions. The S/T models function selection knobs have five discrete positions.

Zero Position — S/T-D and S-D models only: For use in recorder calibration. Sends a "0" reference signal to the Estimated Tidal Volume (\dot{V}_T), Total Flow rate (\dot{V}_{tot}), and Estimated Patient Flow Rate (\dot{V}_{est}) channels. Pressure in the patient circuit is controlled by the EPAP setting.

Cal. Position — S/T-D and S-D models only: For use in recorder calibration. Sends an alternating square wave signal of +0.5 V (+30 L/min) and -0.5 V (-30 L/min) to the \dot{V}_{tot} and \dot{V}_{est} channels. Sends a corresponding triangular wave volume signal of $0.5 V_{pp}$ to the \dot{V}_T channel. Pressure in the patient circuit is controlled by the EPAP setting.

IPAP Position: Inspiratory Positive Airway Pressure. With the Function Selector Knob in this position, the set pressure is delivered continuously at the IPAP level. The EPAP setting is not active.

EPAP Position: Expiratory Positive Airway Pressure. With the Function Selector Knob in this position, the set pressure is delivered continuously at the EPAP level. The IPAP setting is not active.

Spontaneous (S) Mode: When set at this mode, the adjacent LED is illuminated. Active controls are IPAP and EPAP.

Spontaneous/Timed (S/T) Mode: When set at this mode, the adjacent LED is illuminated. Active controls are IPAP, EPAP, and BPM.

Timed (T) Mode: When set at this mode, the adjacent LED is illuminated. Active controls are IPAP, EPAP, BPM, and % IPAP.

② IPAP Control

Active when the Function Selector Knob is in any of these four positions:

IPAP, S, S/T, or T.

When the BiPAP unit is delivering IPAP, the adjacent LED is illuminated.
Range = 4 to 20 cm H₂O.

③ EPAP Control

Active when the Function Selector Knob is in any of these four positions:

EPAP, S, S/T, or T.

When the BiPAP unit is delivering EPAP, the adjacent LED is illuminated.
Range = 4 to 20 cm H₂O.

NOTE: The IPAP and EPAP controls are electrically coupled. The unit will not deliver an EPAP level that is higher than the IPAP level. If the EPAP control is set higher than IPAP, the BiPAP unit is locked to the IPAP setting and the IPAP LED remains lit. This is active throughout the S, S/T and T settings on the Function Selector Knob.

④ BPM Control

Active when the Function Selector Knob is positioned in either the S/T or the T mode.
Range = 4 to 30 BPM.

S/T Mode: The BPM control sets a time interval for delivery of a breath by the BiPAP System. If the patient initiates a spontaneous breath, the BPM timer is reset. If the patient does not initiate a spontaneous IPAP trigger within the interval set by the BPM control, the BiPAP unit initiates a time-triggered breath. The BPM timer is reset with each transition from EPAP to IPAP whether the transition is triggered by the patient or by the BPM control setting. The adjacent LED illuminates to indicate timer-initiated IPAP transitions.

T Mode: All breathing cycle changes (e.g. IPAP to EPAP) are controlled by the BPM timer. The BPM LED is not active. The % IPAP control must also be set.

⑤ % IPAP Control

Active when the Function Selector Knob is in the T mode. This control works in conjunction with the BPM control and determines the fraction of the respiratory cycle spent in IPAP.

Range = 10 to 90%

NOTE: For % IPAP values greater than 50%, time spent at IPAP will exceed the time spent at EPAP.

⑥ Voltage Selector Switch

Set this switch to the appropriate line voltage:

United States and Canada — 115 Volts

European and other countries — Check the country's line voltage requirements for the correct setting.

⑦ **Elapsed Time Indicator**

Provides resolution to 0.1 hour. Runs only when the main power switch is turned on.

⑧ **DCP Cable Connector**

S-D and S/T-D units only: DB15 female connector interfaces to an optional Detachable Control Panel (DCP) that duplicates the BiPAP S/T-D control panel.

CAUTION: The DCP connector is NOT a standard computer communications port. Connecting the connector to a computer could damage the computer and the BiPAP Unit.

⑨ **AC Inlet/Fuse Holder**

Electrical input for the power cord.

Holds two fuses of appropriate rating for the country of operation. See Section 2.2 for fuse ratings.

3.2 Setting Up the BiPAP System

Step 1 See Figure 3-1. Connect the inlet of a bacteria filter to the airflow outlet port on the front of the BiPAP unit. Connect one end of the tubing to the outlet of the bacteria filter.

To help protect the unit from contamination, place a low resistance main flow bacteria filter on the outlet of the blower. The filter must be positioned in the circuit so that it is filtering air directly from the unit. It should not be placed in the circuit between the outlet of the humidifier and the patient, since this can cause an increase in filter resistance.

The addition of a low resistance main flow bacteria filter does not have any effect on the trigger sensitivity of the system. Dependent upon the degree of resistance imposed by the filter, the pressure stability (the ability of the unit to maintain the delivered pressure within specified tolerances) may be affected. The filter must remain clean and dry to minimize the circuit effects. The dirty main flow bacteria filter should be replaced in accordance with the manufacturer's specifications and instructions.

The bacteria filter should be in-line when the pressure settings are determined. If a filter is added to a system already in use, observe the patient pressure to determine whether the settings should be adjusted to compensate for any effect of the filter.

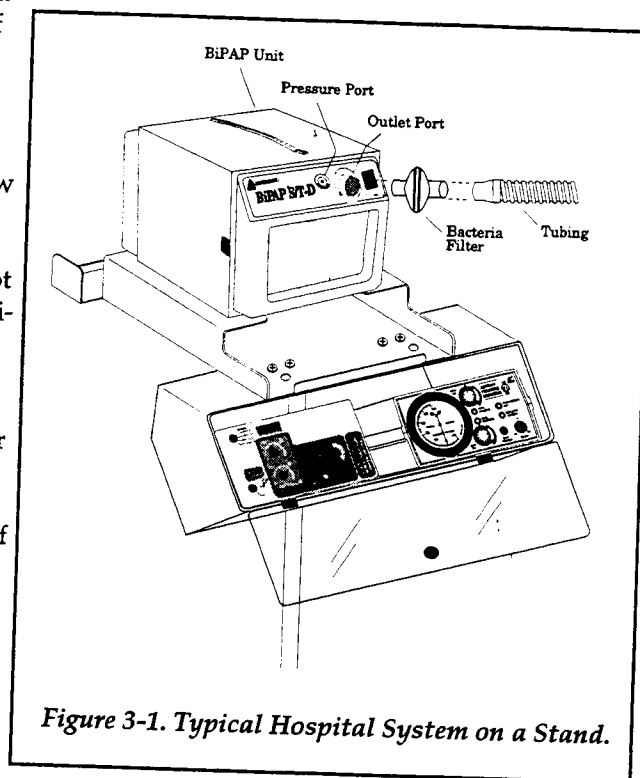
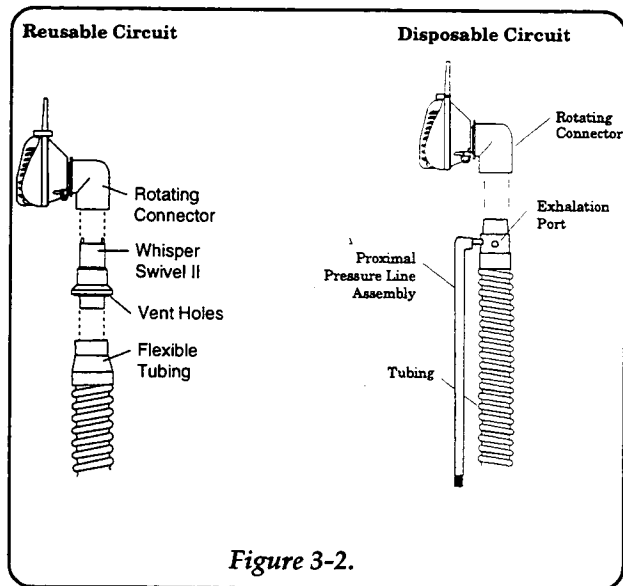


Figure 3-1. Typical Hospital System on a Stand.

Step 2 Assemble the patient circuit as shown in Figure 3-2. Position the circuit so that the gas vents on the side of the swivel (or exhalation port) are facing away from the patient's face.

WARNING: The continuous flow exhalation port (i.e., Whisper Swivel) is designed to exhaust CO₂ from the patient circuit. Continuous flow is required for safe operation. **DO NOT BLOCK OR OTHERWISE TRY TO SEAL THE GAS VENTS OR THE EXHALATION PORT.**



WARNING: Each time changes are made to the circuit configuration, confirm that delivered pressures are adequate for patient management.

WARNING: The addition of accessories to the patient circuit (i.e., heated humidifier, bacteria filter, water traps, and additional tube lengths) degrades pressure and flow delivery at the patient connection. Clinical assessment must confirm that the delivered pressures and flows are adequate for patient management when circuit accessories are used. It may be necessary to increase pressure delivery to compensate for the increased resistance of the circuit.

NOTE: The Whisper Swivel has evolved through several designs, including:

- 3 slots cut at an angle
- 3 slots cut at an angle with 2 raised ridges perpendicular to the slots
- over-lapping collar

All of these designs are acceptable to use.

NOTE: Heat and moisture exchangers should not be used with the BiPAP System. Testing has shown that the ability of the unit to maintain the prescribed pressure is significantly impacted by the addition of a heat moisture exchanger to the patient circuit.

Step 3 Plug the electrical cord into the power connector on the back of the unit. Figure 3-4.

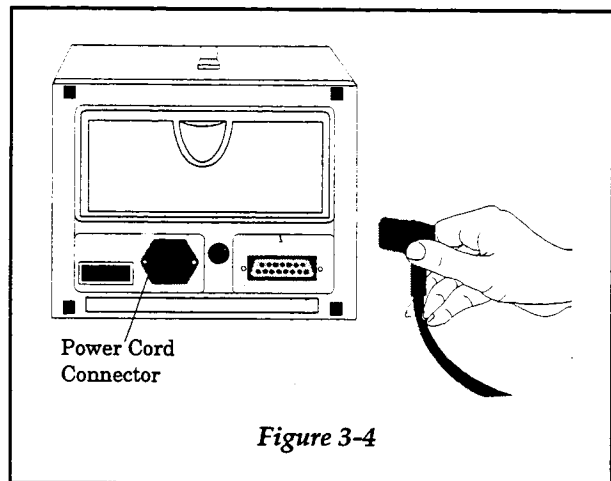


Figure 3-4

Step 4 Make sure the voltage selector switch on the back of the unit is set correctly. Figure 3-5.

United States and Canada setting: 115 V
 Europe and other countries: Check the country's line voltage requirements for the correct setting.

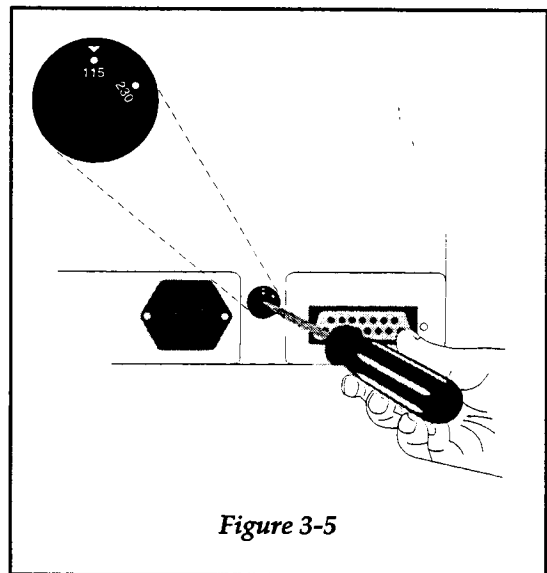


Figure 3-5

Step 5 Make sure the ON/OFF switch is OFF (0), then plug the electrical cord into a three-prong outlet. Figure 3-6.

NOTE: In the United States and Canada, the use of a three-prong to two-prong adapter or extension cord is not recommended.

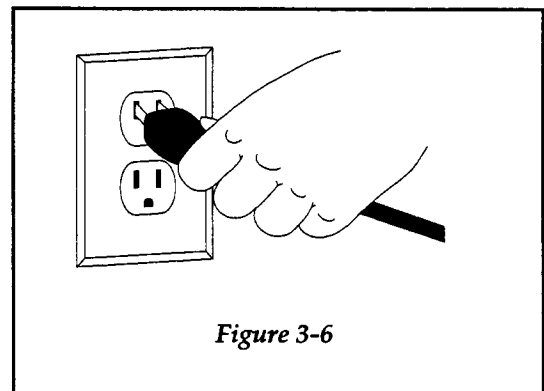


Figure 3-6

Step 6 S/T-D units only—Connecting a Recorder:

If you are using a Detachable Control Panel (DCP), refer to the DCP instruction manual for details on connecting a recorder.

Step 7 Turn the unit on, occlude the outlet port, and confirm the presence of flow from the exhalation port.

3.3 Detachable Control Panel (DCP) (Optional)

The DCP is an optional accessory available for use with the BiPAP S-D and S/T-D units. The DCP combines all the functional controls found on the rear of the BiPAP unit, and includes a selectable display that provides pressure, estimated exhaled tidal volume, and estimated circuit leak data. The DCP allows the operator to make adjustments to settings from a remote location. Output connectors that allow the Patient Output Signals to be displayed on a recorder can be found on the side of the DCP. Some units may use the Remote Control Unit (RCU). All connection information regarding the DCP is applicable to the RCU.

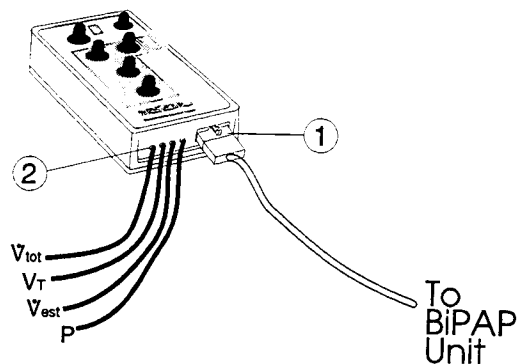


Figure 3-7. Detachable Control Panel.

① DCP Cable Connector

Accepts the BiPAP System Remote cable from the unit. When the BiPAP unit is plugged in and turned on, electrical power is provided to the DCP via the cable.

CAUTION: Do not connect or disconnect the DCP into the BiPAP unit while the unit is turned on.

The DCP control settings override the BiPAP unit settings.

CAUTION: The BiPAP DCP cable connector port is NOT a standard computer communications port. Connecting the output port to a computer could damage the computer and the BiPAP System.

Adjust the control settings appropriately before placing the patient on the BiPAP circuit.

② Output Jack

Transmits Patient Output Signals from the BiPAP unit to a recorder. Four separate recorder cables are available so that only the desired signals need to be accessed. One end of the cable is equipped with a sub-miniature phone plug that connects to the Output Jack. On the other end, cable terminations appropriate for your equipment are available from Respirationics.

CAUTION: Wiring connections and adjustments should be performed by authorized hospital personnel only.

Pressure (P) Signal: $0.10 \text{ V} = 1 \text{ cm H}_2\text{O}$ Range: 0 to 25 cm H₂O

Estimated Patient Flow Rate (V_{est}) Signal: $1.0 \text{ V} = 60 \text{ L/min}$ Range = $\pm 150 \text{ L/min}$

Estimated Tidal Volume (V_T) Signal: $1.0 \text{ V} = 2 \text{ liters}$ Range = 0 to 4 liters

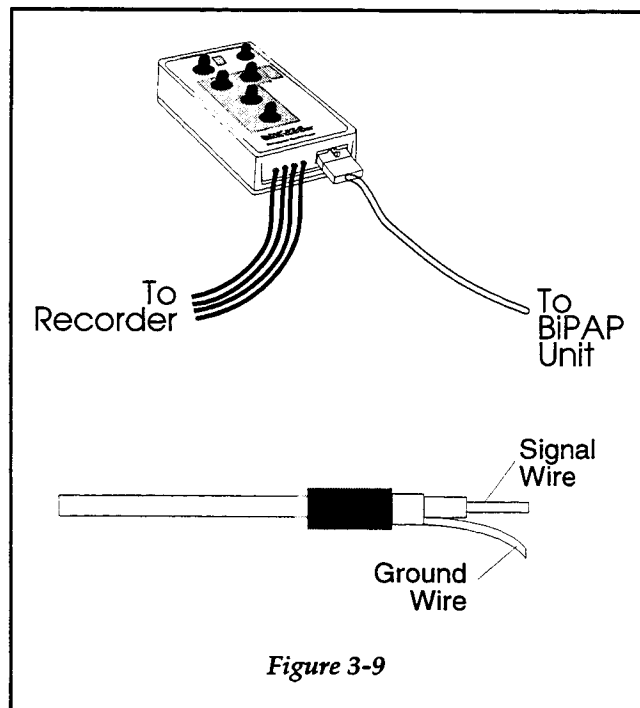
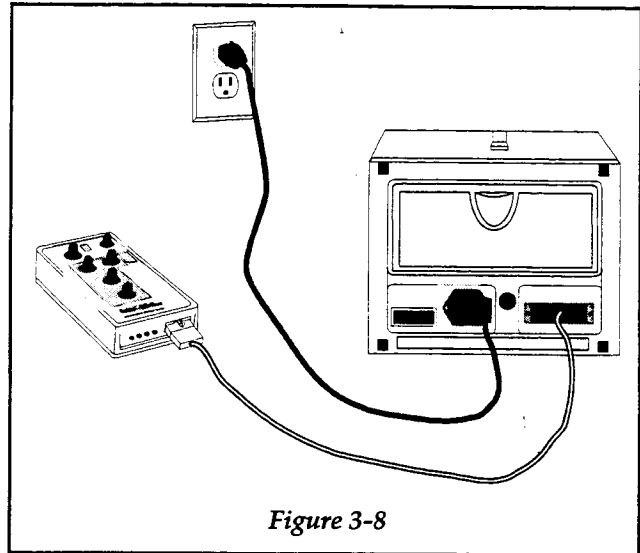
Total Flow Rate (V_{tot}) Signal: $1.0 \text{ V} = 60 \text{ L/min}$ Range = $\pm 150 \text{ L/min}$

3.4 DCP Set-up

NOTE: Refer to the DCP Instruction Manual for detailed set-up and operation instructions.

- Step 1** Make sure that the main power switch is set to OFF (0), then attach the DB15 male connector end of the BiPAP/DCP cable to the DCP cable connector on the back of unit. Attach the other end of the cable to the DCP as shown in Figure 3-8.
- Step 2** Attach the patient circuit to the unit as explained in Section 3.2.
- Step 3** To obtain output signals to a recorder, connect the DCP/recorder cables to the output jacks on the DCP as shown in Figure 3-9. Connect the other ends of the cables to the recorder according to recorder manufacturer's instructions.
- Step 4** If a pressure (P) output signal is desired, connect a length of smooth inner lumen manometer tubing, equal in length to the patient circuit tubing, to the port provided on the patient mask. Attach the other end of the tubing to the pressure port on the front of the BiPAP unit.

CAUTION: The DCP settings (S/T-D and S-D units only) override the settings on the BiPAP unit's control panel. Adjust the DCP settings approximately before setting up the patient on the BiPAP circuit. **DO NOT** connect the DCP unit to the BiPAP while the unit is turned on.



Chapter 4 Maintenance

4.1 Maintenance Schedule

4.2 Maintenance Procedures

Chapter 4: Maintenance

4.1 Maintenance Schedule

The Maintenance Schedule on page 4-2 lists the items that must be periodically inspected or replaced. Use the Log to record the dates you perform the maintenance items. You may photocopy the Maintenance Log for each unit you service.



BiPAP Preventive Maintenance Schedule
(Factory Recommended)

Patient _____ Servicing Agent _____

Address _____ Address _____

Phone _____ Phone _____

Model _____ Serial# _____ Date Purchased _____

Refer to Section 4.2 of this manual for maintenance and service instructions.

Maintenance Item	Service Interval	Date				
Record hours on meter. See 4.2.1.	At set-up, maintenance, or service					
Verify voltage selector switch. See 4.2.2	At set-up					
Test Unit Control Functions See 4.2.4	Annually					
Inspect fuses. See 4.2.3	Annually					

4.2 Maintenance Procedures

4.2.1 Recording the Hours on the Time Meter

See Section 3.1 for the location and description of the Time Meter.

4.2.2 Verifying the Voltage Selector Switch Setting

See Section 3.1 for the location and description of the Voltage Selector Switch.

4.2.3 Changing the Fuses

Inspect the fuses yearly. Check for blackened areas on the glass. If the fuses appear blackened, or if the unit fails to run when the switch is on, change the fuses. Verify that the value of the fuse meets the specification.

The fuses are located in the back of the unit under the AC connector. See section 2.2 for fuse ratings.

WARNING: To avoid electrical shock, disconnect the electrical supply before changing the fuses.

- Step 1 Remove the fuse holder by pushing in on the small tabs on the sides of the holder as shown in Figure 4-1. (Or pushing down from the top. See Figure 4-3.)
- Step 2 Pull the fuse holder completely out of the unit as shown in Figure 4-2.
- Step 3 Replace the old fuses with new fuses of the same type and rating.
- Step 4 Insert the fuse holder back into the unit as shown in Figure 4-2

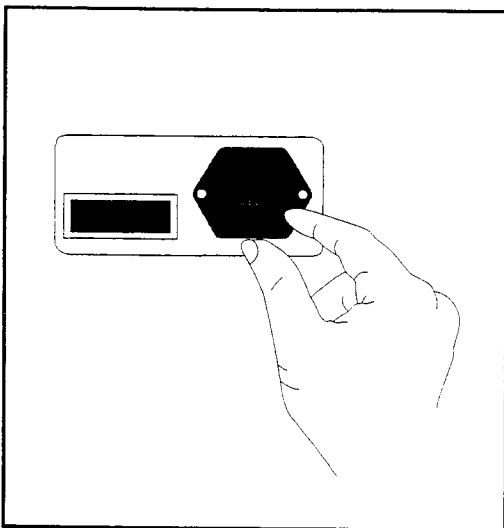


Figure 4-1

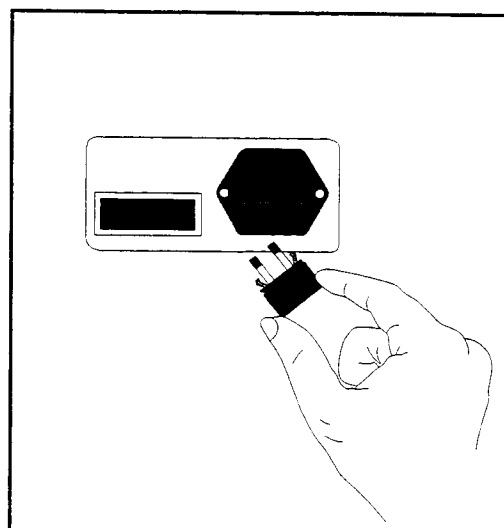
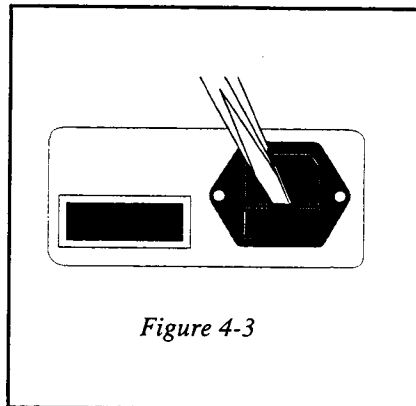


Figure 4-2

Some BiPAP units have an AC Inlet Fuse Drawer without side clips, to remove it, use a straight head screw driver rather than squeezing the side clips on the drawer. For most units use the following steps:

- Step 1 Use a flatblade screwdriver to pry the fuse holder out of the retainer. See Figure 4.3.
- Step 2 Grasp the exposed sides of the fuse holder and pull it completely out of the unit.
- Step 3 Replace the old fuses with new fuses of the same type and rating.
- Step 4 Push the fuse holder back into the unit until it snaps into place. See Figure 4.2.



4.2.4 Test Control Functions

As a minimum test, perform the BiPAP 20 System Screening Procedure in Appendix C. As a more rigorous test, you may choose to perform the System Test in Chapter 7. Perform only the Final Test, in which only measurements are taken and no adjustments are made.

4.2.5 Notes to Maintenance Procedures

Section 4.2.1 to 4.2.4 are preventive maintenance procedures for the BiPAP 20 unit only. There are user care activities that the user or caregiver may do but are not specifically required as part of the preventive maintenance schedule. For more information, see the BiPAP 20 User Guide. These activities include:

- Cleaning the exterior of the unit when visibly dirty. See Section 4.2.6 of this manual.
- Replacing the disposable filter every 30 days of use, or when visibly dirty. See Section 4.2.7 of this manual.
- Clean and inspect the mask, tubing, and accessories daily according to their individual instruction sheets.
- Clean and inspect Softcap®, chin strap, and headgear weekly according to their individual instruction sheets.

For more information about these accessories, refer to the individual instruction sheets or to the User Circuit Accessories Guide.

4.2.6 Cleaning the BiPAP 20 Unit

CAUTION: Do not clean any parts of the system with alcohol or cleaning solutions containing alcohol. These cleaning processes may harden or deform the flexible plastic parts of the system and adversely affect their function. Do not clean the system by steam autoclave or gas sterilization methods.

CAUTION: Unplug the BiPAP 20 before cleaning it. Do not immerse it in water or allow any liquid to enter the cabinet. Do not get the filter wet.

Step 1 Using a cloth slightly dampened with water and a mild dish detergent and standard hospital-grade disinfectant, wipe the outside of the BiPAP 20 enclosure.

Step 2 Let the BiPAP 20 dry before plugging it in again.

4.2.7 Changing the Filter

CAUTION: Failure to replace a dirty filter may cause high operating temperatures in the BiPAP unit, may reduce the flow, and may reduce the output pressure.

The white filter on the front of the BiPAP is disposable and should be replaced after thirty days of use or sooner if it is especially dirty. One extra filter is included with the clinical system.

- Step 1 Turn the BiPAP unit OFF (0) and unplug the electrical cord from the wall outlet and from the back of the unit.
- Step 2 See Figure 4-4. Press down (1) and pull out (2) on the top of the Whisper Cap. You need to press down only about 1/8" to allow the top lip of the Whisper Cap to clear the filter retainer.
- Step 3 Pull up (3) on the bottom of the Whisper Cap until the bottom lip clears the filter retainer.
- Step 4 See Figure 4-5. Locate the button in the center of the filter holder beneath the surface of the filter. Push in on the button and pull the filter out from all four sides of the filter holder.
- Step 5 Throw away the dirty filter. The filter is not washable.
- Step 6 Center a new filter over the filter holder. Carefully push in on the center button and tuck the filter in on all four sides as shown in Figure 4-6.
- Step 7 Release the button. The filter should be intact and fit securely, covering the entire holder. Remove and readjust the filter if necessary.
- Step 8 Insert the bottom lip of the Whisper Cap behind the inner bottom edge of the filter retainer.
- Step 9 Simultaneously press down on the top of the Whisper Cap and push in until the top lip of the Whisper Cap snaps into place behind the inner top edge of the filter retainer.

The filter should be in place at all times when the BiPAP unit is being used. A clean filter protects the patient from breathing irritating airborne particles.

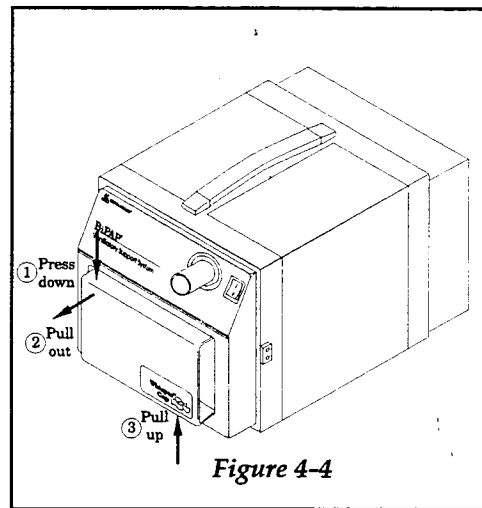


Figure 4-4

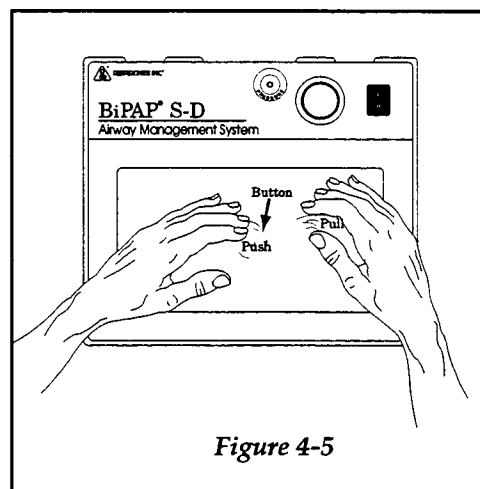


Figure 4-5

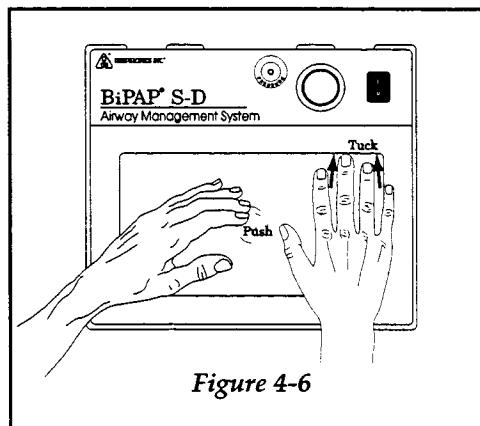


Figure 4-6

Chapter 5 Troubleshooting

5.1 Troubleshooting

5.2 Wiring Diagram

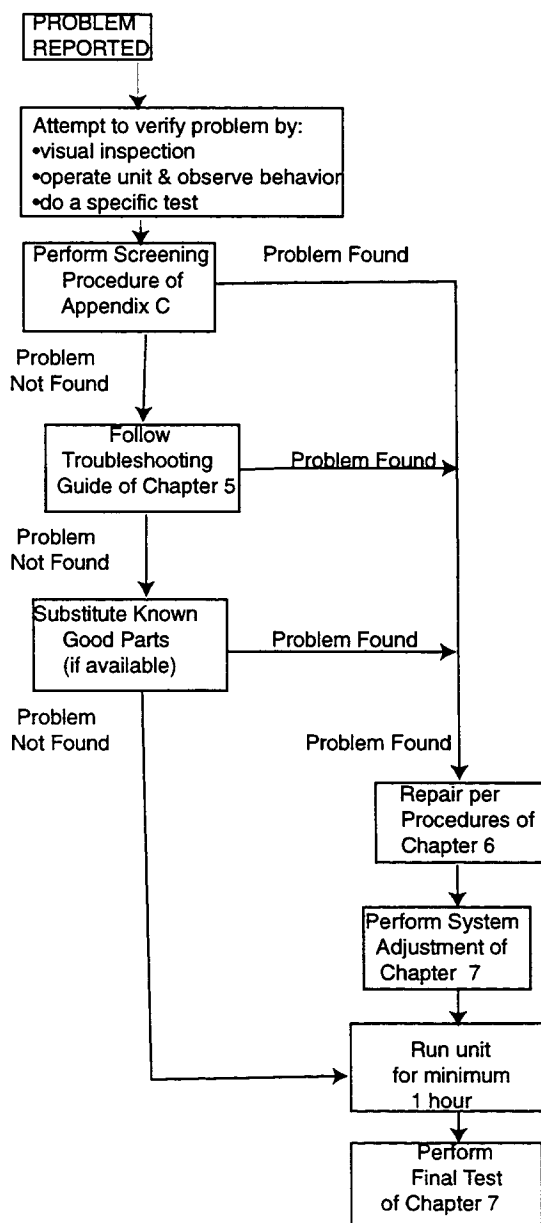
Chapter 5: Troubleshooting

5.1 Troubleshooting

WARNING: Electrical Shock Hazard: Disconnect the electrical supply before repairing the unit.

CAUTION: Electronic components used in this unit are subject to damage by static electricity. Use proper static discharge equipment and grounding precautions when servicing the equipment. Service only at a static-free workstation.

This section describes some unit problems that might occur, the possible causes, and the corrective actions that can be taken.



5.1.1 Troubleshooting Guide

PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION
The unit does not turn on.	The power cord is not securely attached to the unit or wall outlet.	Check that the power cord is plugged into the unit and into the wall outlet.
	The unit is not connected to a live outlet.	Check that the wall outlet has power. Check the circuit breaker.
	The unit fuse(s) is blown.	Replace fuse(s). See Section 4.2.3. If new fuses continue to blow out, follow Procedure 5.1.5, then Procedure 5.1.3 if necessary.
	Main power switch malfunction.	Remove the power cord from the wall outlet and the unit. With an ohmmeter, check between the top and bottom connections on each side of the switch. When the switch is "OFF," the connections should be open. When the switch is "ON," the connections should be closed (0 Ω).
	The fuse drawer is damaged or installed incorrectly.	Remove the fuse drawer from the AC Inlet. See Section 4.2.3. Inspect the drawer for damaged springs.
	The voltage selector switch is set to wrong voltage.	Verify the proper setting of the voltage selector switch on the back of the unit. If the unit is set at 230 V but plugged into a 115 V line, the unit will not operate. If the unit is set at 115 V but plugged into a 230 V line, the unit may operate intermittently.
	The motor wire is not securely plugged into the J1 position on the motor control board.	Check that the terminal is oriented properly and securely fastened to the board pins.
	Faulty transformer.	Follow Procedure 5.1.5.

PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION
The unit does not turn on. (Continued)	Faulty jumper wires on the primary side of the transformer.	Check the continuity of the jumper wires between transformer terminals T1-T3 and between T4-T5. Replace the jumpers if necessary.
	Faulty wiring; overcrimped or broken terminals.	Follow Procedure 5.1.2.
	Motor control board (MCB) is malfunctioning.	Follow Procedure 5.1.3.
The unit starts and stops.	Loose power cord connection at the unit or the wall outlet.	Check that the power cord connections (at the unit and at the wall) are firmly in place.
	Intermittent connection at the main power switch.	Follow Procedure 5.1.2.
	Blower overheating.	Replace the blower assembly. See Section 6.2.2.
	The voltage selector switch is set to wrong voltage.	Verify the proper setting of the voltage selector switch on the back of the unit. If the unit is set at 230 V but plugged into a 115 V line, the unit will not operate. If the unit is set at 115 V but plugged into a 230 V line, the unit may operate intermittently.
Incorrect pressure when checked with a water column or digital manometer.	Blower malfunctioning.	If the blower displays any vibration or rumbling noise, replace the blower assembly. See Section 6.2.2.
NOTE: Pressure readings may deviate ± 2 cm H ₂ O from specified levels.	Motor control board (MCB) malfunctioning.	Follow Procedure 5.1.3.
	A leak in the system.	Visually inspect the flex connector, bellows, and pressure tubing for cracks or splits. Inspect the hose clamps and nylon tie wraps. Inspect the bellows or tubing under the clamps. Check that all fittings are tight and that the mask is not leaking.

PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION
Incorrect pressure when checked with a water column or digital manometer. (Continued)	The blower or the pressure controller is malfunctioning.	Perform the calibration (see Chapter 7) without making any adjustments to the trimpots, and record the data. Compare the test data with the specifications; if the unit does not meet the specs, perform the full calibration and readjust the trimpots where needed. If the unit fails, then replace the part indicated by the test.
No difference between IPAP and EPAP pressures. NOTE: Pressure readings may deviate ± 2 cm H ₂ O from specified levels.	Improper control settings. Defective valve. Blown crowbar fuse on Bipap Control Board. Defective Bipap Control Board.	Adjust the control settings. Re-check with a manometer. Follow Procedure 5.1.6. Remove the fuse and check the continuity. Replace fuse if necessary. Follow Procedure 5.1.7.
Pressure fluctuations during IPAP or EPAP modes.	Defective blower assembly. Defective motor control board. Defective Bipap Control Board.	Follow Procedure 5.1.8. Follow Procedure 5.1.3. Perform the calibration (see Chapter 7). If the unit cannot be adjusted to meet specs, replace the control board.
Low flow and/or pressure.	Defective valve. Defective Bipap Control Board. Defective blower assembly. Filter dirty or clogged.	Follow Procedure 5.1.6. Follow Procedure 5.1.7. Follow Procedure 5.1.8. Replace the intake filter. See Section 4.2.7.

PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION
Low flow and/or pressure. (Continued)	Leak in system.	Visually inspect the flex connector, bellows, and pressure tubing for cracks or splits. Inspect the hose clamps and nylon tie wraps. Inspect the bellows or tubing under the clamps. Check that all fittings, both internal and external, are tight and that the mask is not leaking.
Unit operates "warm."	The filter has become obstructed or dirty.	Replace the filter. See Section 4.2.7.
	Defective blower.	Check the motor balance. If it is out of balance, replace the blower assembly as described in Section 6.2.2.
	Defective motor control board.	Follow Procedure 5.1.3.
	Leak in system.	Visually inspect the flex connector, bellows, and pressure tubing for cracks or splits. Inspect the hose clamps and nylon tie wraps. Inspect the bellows or tubing under the clamps. Check that all fittings, both internal and external, are tight and that the mask is not leaking.
Excessive noise or chattering.	Loose wraparound fit.	Replace the wraparound. See Section 6.2.1.
	The unit is operating without a filter—the plenum rattles.	Install a filter. See Section 4.2.5.
	The wiring harness vibrates against the blower assembly.	Manipulate the wiring assembly away from the blower assembly.
	The blower assembly is damaged.	Replace the blower assembly. See Section 6.2.2.

PROBLEM	POSSIBLE CAUSES	CORRECTIVE ACTION
Excessive noise or chattering. (continued)	The blower pressure is excessively high.	Perform the Calibration and Calibration Checks(see Chapter 7) without making any adjustments to the trimpots; record the data. Compare the test data with the specifications. If the unit does not meet the specs, perform the System Set-up and Final Test and readjust the motor speed as needed.
	Whisper Cap is missing.	Replace Whisper Cap.
The time meter is not functioning.	Motor control board malfunctioning.	Measure the voltage at the motor control board connector J2, between pins 9 and 10, with pin 9 as ground. The voltage should be +5 VDC ± 0.5 V. If no voltage is measured, replace the motor control board. See Section 6.2.3.
	Time meter malfunctioning.	Measure the voltage between J2-9 and J2-10 as described above. If 5 VDC ± 0.5 V is measured, replace the time meter. See Section 6.2.16.
The unit "breathes" on its own. IPAP/EPAP lights flicker erratically.	The pressure transducer tubing is disconnected.	Check the integrity of the tubing from the flow transducer to the Bipap Control Board. Reconnect the tubing if necessary.
	The tubing is routed incorrectly.	Check the routing of the tubing from the flow transducer to the Bipap Control Board for proper orientation.
The DCP does not work with the unit.	Faulty DCP.	Try a new DCP with the unit.
	Faulty DCP cable.	Perform a continuity check on the cable or substitute with a known good cable.
	Bipap Control Board (BCB) malfunction.	Check the DCP terminals. Replace the control board. See Section 6.2.4.
Unit does not trigger in S/T Mode.	Faulty BCB.	Change BCB. See Section 6.2.4.

5.1.2 Power Switch Wiring

- Step 1 Turn the unit off, disconnect the power cord from the wall and the unit, and remove the wraparound (see 6.2.1).
- Step 2 Check the continuity of the wires from the switch to the primary side of the transformer. The top white wire on the switch is connected to transformer terminal T3. The top red wire on the switch is connected to transformer terminal T4.

If either wire shows an open circuit, it may indicate a more serious problem. Return the unit to Respirationics.

5.1.3 Motor Control Board (MCB) Checks

NOTE: The following voltage measurements were made on a new unit set to the IPAP mode. The outlet circuit consisted of the hose with a 0.250 inch orifice on the outlet end. The pressure was set to 10 cm H₂O, measured with a digital manometer. The input voltage was 110 VAC.

- Step 1 Turn the unit off, disconnect the power cord from the wall and the unit, and remove the wraparound (see 6.2.1).
- Step 2 Connect a DC voltmeter negative lead to J2 pin 6. Connect the positive lead to J2 pin 5. Reconnect the power cord and turn the unit on; the voltmeter should read +14 to +18 VDC.
- Step 3 Connect a DC voltmeter negative lead to J2 pin 6. Connect the positive lead to J2 pin 7. The voltage should be -14 to 18 VDC.
- Step 4 Place the negative lead on J1 pin 2 (ground). Re-connect the power cord and turn the unit on. The following voltages should be present with respect to ground:

J1 pin 1:	6.25 VDC \pm 0.5 VDC	} These voltages should be uniform, with a variation of less than \pm 0.5 VDC.
J1 pin 3:	3 VDC	
J1 pin 4:	3 VDC	
J1 pin 5:	3 VDC	
J1 pin 6:	7 VDC	
J1 pin 7:	7 VDC	} These voltages should be uniform, with a variation of less than \pm 0.5 VDC.
J1 pin 8:	7 VDC	

The voltages measured on pins 4 through 8 represent the DC component of a complex AC waveform. The voltages may vary depending on the age of the unit, condition of the blower, etc. The main requirement of the measurements is that the voltages on pins 3, 4, and 6 are within 0.5 VDC, and the voltages on pins 6, 7, and 8 are within 1.0 VDC. If the voltages on pins 1, 3, 4, and 5 deviate beyond \pm 0.5 VDC, or if the voltages on pins 6 to 8 do not match each other, replace the MCB. See Section 6.2.3.

NOTE: The position of pin J1-1 is as marked on the board, and connects to the yellow wire from the blower. Disregard any numbers molded on the wire connector on the wires from the blower.

5.1.4 Blower Assembly Checks

- Step 1 Turn the unit off, disconnect the power cord from the wall and the unit, and remove the wrap-around (See Section 6.1.1).
- Step 2 Disconnect all leads from terminal J1 on the Motor Control Board.
- Step 3 Use the table below to verify resistances between the blower assembly connector leads.

NOTE: The position of pin J1-1 is as marked on the board, and connects to the yellow wire coming from the blower. Disregard any numbers molded on the wire connector on the wires coming from the blower.

Pin	1	2	3	4	5	6	7	8
1		4M	D16M	D16M	D16M	∞	∞	∞
2	4M		D4M	D4M	D4M	∞	∞	∞
3	D16M	D4M		∞	∞	∞	∞	∞
4	D16M	D4M	∞		∞	∞	∞	∞
5	D16M	D4M	∞	∞		∞	∞	∞
6	∞	∞	∞	∞	∞		1	1
7	∞	∞	∞	∞	∞	1		1
8	∞	∞	∞	∞	∞	1	1	

The table indicates the correct readings. "4M" indicates $4 \pm 1.5 \text{ M}\Omega$. " ∞ " indicates infinite resistance (an open circuit). "1" means less than 1Ω . "D" means that the resistance changes depending upon placement of the "+" and "-" leads due to the diode effect. In one direction, you should measure an open. In the other direction you should measure $16 \pm 6 \text{ M}\Omega$, for older units or $11 \pm 3 \text{ M}\Omega$ where the table indicates "D16M," and $4 \pm 1.5 \text{ M}\Omega$ where the table indicates "D4M"

If these resistance readings are incorrect, change the blower assembly. See Section 6.2.2.

5.1.5 Transformer Checks

- Step 1 Turn the unit off, disconnect the power cord from the wall and the unit, and remove the AC inlet fuses (see Section 4.2.3).
- Step 2 Remove the wraparound as shown in Section 6.2.1, Steps 1 to 4.
- Step 3 Connect an ohmmeter across transformer terminals T5 and T6. The resistance should be $10.6 \Omega \pm 10\%$ when the voltage selector switch is set to 230 V, and should be approximately $5.3 \Omega \pm 10\%$ when the voltage selector switch is set to 115 V.
- Step 4 Repeat Step 3 with the ohmmeter across transformer terminals T1 and T2.

If the resistance readings are not correct, replace the transformer sub-assembly. See Section 6.2.5.

5.1.6 Valve Checks

- Step 1 Turn the unit off, disconnect the power cord from the wall and the unit, and remove the wrap-around (see 6.2.1).
- Step 2 Check the integrity and orientation of the J1 connector on the Bipap BCB.
- Step 3 Connect a DC voltmeter from J1-1 (ground) to J1-2.
- Step 4 Reconnect the power cord and turn the unit on.

If the voltmeter measures 0.0 VDC, replace the valve. See 6.2.7.

5.1.7 BiPAP Control Board (BCB) Checks

- Step 1 Turn the unit off, disconnect the power cord from the wall and the unit, and remove the wrap-around as described in 6.2.1.
- Step 2 Check the integrity and orientation of the J1 connector on the BCB.
- Step 3 Connect a DC voltmeter from J1-1 (ground) to J1-2.
- Step 4 Reconnect the power cord and turn the unit on.

If the voltmeter measures greater than 5.0 VDC, replace the BCB. See 6.2.4.

5.1.8 Blower Pressure Check

- Step 1 Turn the unit off, disconnect the power cord from the wall and the unit, and remove the wrap-around as described in 6.2.1.
- Step 2 Reconnect the power cord to the unit and the wall. Monitor the pressure at the outlet with a manometer.
- Step 3 Turn the unit on and hold the valve shut. If the outlet pressure is not steady, replace the blower assembly as described in 6.2.2.

5.1.9 Temperature Guidelines

Use this procedure when troubleshooting a complaint that the unit is running hot: either the unit feels hot to the touch, or the air is hot on the face. Like any electrical appliance, heat is emitted when a BiPAP unit runs. Also, for some units, the higher the pressure setting, the more electrical energy is required; therefore, there is more heat expelled.

It is normal for the pre-foam BiPAP unit to have an outlet air temperature that is 10 to 12 °F warmer than room temperature, especially after running all night. A difference between room temperature and air outlet temperature greater than 18 °F is an indication for a service check. Foamed units (serial number 052000 or greater) can be expected to have an outlet air temperature that is 18 to 25 °F warmer than room temperature, especially after running all night. A difference between room temperature and air outlet temperature greater than 25 °F is an indication for a service check on a foamed BiPAP unit. The air temperature at the end of a patient circuit will always be lower than the temperature measured at the outlet and is typically 5 to 10 °F above ambient.

To test a unit, run the unit at the patient's prescription setting. It is recommended to run the unit overnight. Measure the room temperature near the center of the unit's inlet filter. Measure the temperature of the air at the outlet of the unit. A thermometer may be mounted in a standard Respironics test adaptor.

Some normal causes of elevated temperatures are:

- The room temperature or humidity has risen.
- The air inlet filter has become obstructed.
- The air filter has become dirty.
- The patient's condition has changed (e.g., running a fever).
- The unit is malfunctioning.

5.2 Wiring Diagram

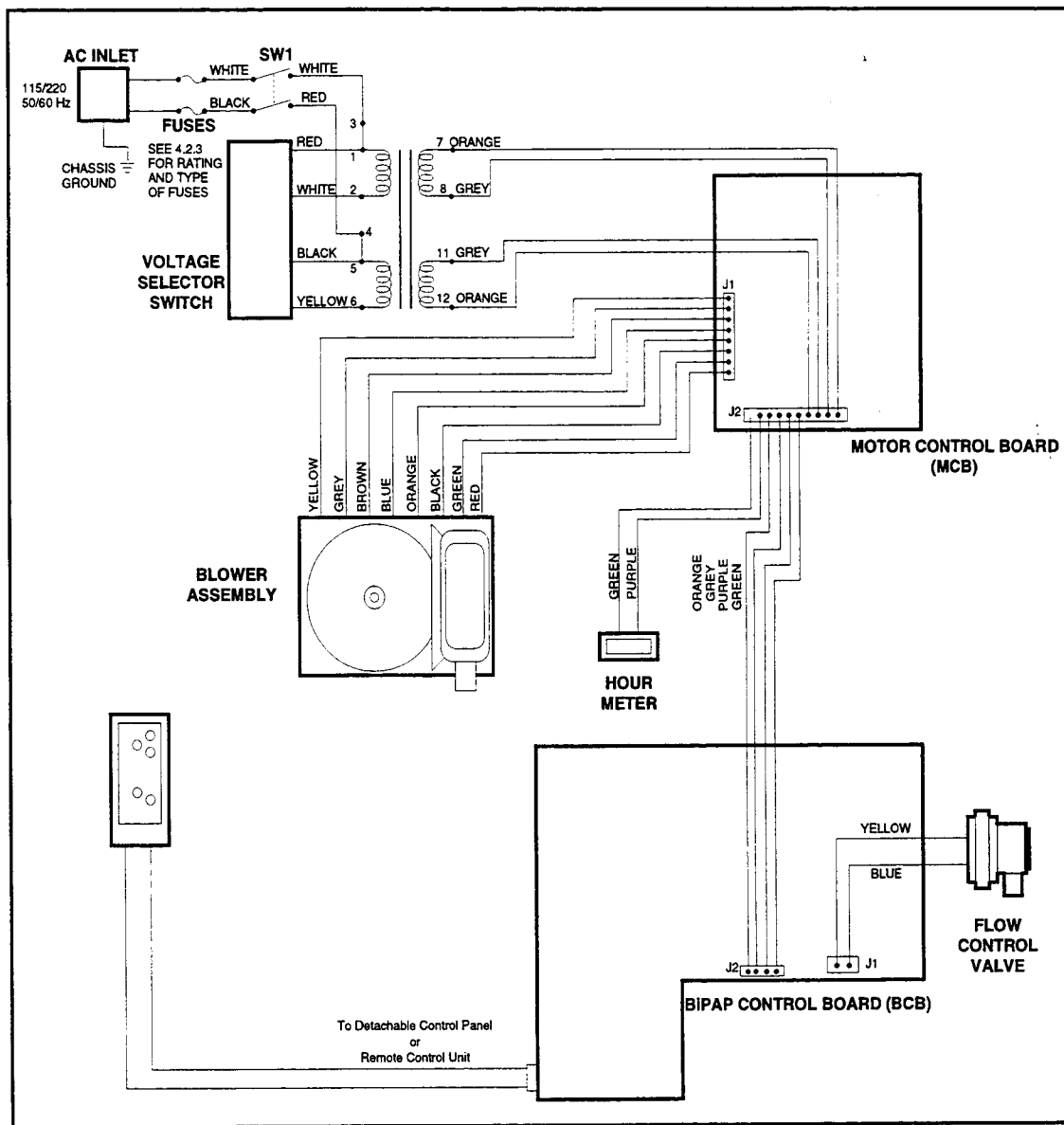


Figure 5-1

NOTE:

Do not connect the DCP port to any other type of electronic equipment, computer interface, etc. Damage to the system may result.

Chapter 6 Repair and Replacement

6.1 Repair Information

6.2 Replacement Guide

6.1 Repair Information

WARNING: All repairs must be accomplished in a manner that maintains traceability of the components assembled in each unit. All replacement parts must be identified by Part Number and Lot Number, and a Repair Work Order must be forwarded to Respironics at the following address:

1001 Murry Ridge Lane
Murrysville, PA 15668-8550
Domestic/Canada Fax: 800/422-5816 • International Fax: 412/472-5012

WARNING: Adjust the unit as outlined in Chapter 7 if any repairs are made that replace major subassemblies (such as the blower, valve, circuit boards) or which affect the air stream integrity (such as the muffler or flow tubes).

WARNING: Electrical shock hazard. Disconnect the electrical supply before making repairs to the BiPAP 20 unit.

CAUTION: Electronic components used in this unit are subject to damage by static electricity. Use proper static discharge and grounding precautions when servicing the equipment. Service only at a static-free workstation.

CAUTION: Units with serial numbers less than 1724 must be returned to the factory for repairs. DO NOT attempt to repair these units.

NOTE: Use Loctite® small screw thread locker 222 (Purple Dot) for small screws where designated.

NOTE: If you require technical assistance during any of these replacement procedures, call,

Respironics Technical Service Department
Phone: 800/345-6443 (US and Canada) or 412-731-2100
FAX: 1-800-422-5816 (US and Canada) or 412-473-5012

If you need replacement kit information, call:

Respironics Customer Satisfaction Department
Phone: 1-800-345-6443 (US and Canada) or 412-731-2100
FAX: 1-800-886-0245 (US and Canada) or 412-473-5012

NOTE: Visit Respironics' Home page on the World Wide Web
<http://www.respironics.com>

6.1.1 Preparing the Unit for Service

Tools Required:

#2 Phillips screwdriver

Refer to Figure: 6-1

Procedure:

- Step 1 Make sure that the work area is clean and static free.
- Step 2 Remove the patient circuit from the unit. Remove the DCP and the pressure port hose (S/T-D and S-D units only).
- Step 3 Unplug the unit from the wall outlet and disconnect the electrical plug from the back of the unit.
- Step 4 Remove the wraparound as follows:
 - a. Tip the unit so that it rests on the rear end cap.
 - b. Remove the four screws on the bottom of unit. The screws attach the feet (A) to the wrap-around (B) and the wrap-around to the unit frame.
 - c. Tip the unit upright. Push down on the edges of the wraparound (B) until it is free. Pull the unit up out of the wraparound.

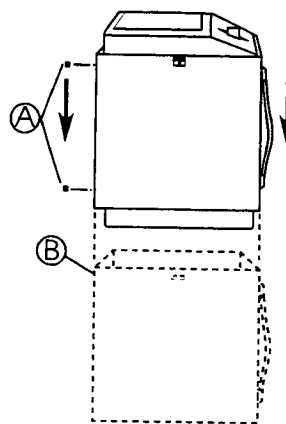


Figure 6-1

6.1.2 Releasing Cable Clips

Figure 6-2 shows how to release cable clips. Insert a slotted screwdriver between the upper and lower tabs. Twist the screwdriver to push down on the lower tab and up on the upper tab.

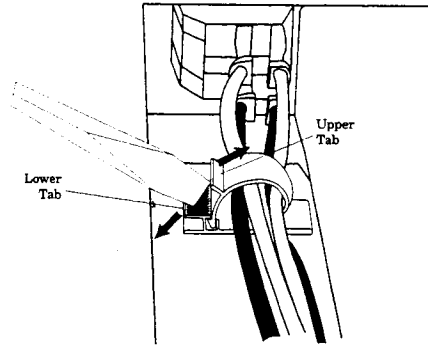


Figure 6-2

6.1.3 Releasing Hose Clamps

Figure 6-3 shows the process to release the hose clamps that hold the bellows and flex connector to their respective ports. Insert a slotted screwdriver where indicated and twist to release the ratchets; pull the hose clamp apart. Normally, the replacement kit contains new hose clamps if the old ones are removed.

NOTE: Disconnecting the bellows could change the leak characteristics and the System adjustment and Final Test in Chapter 7 of this manual must be repeated.

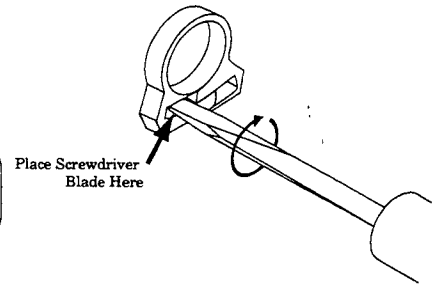


Figure 6-3

6.2 Replacement Guide

6.2.1 Wraparound Replacement

Repair Kit Number: 332183 for all S and all S/T units
 332183 for S-D and S/T-D, S/N > 30000
 332345 for S-D and S/T-D, S/N < 30000

Repair Kit Contents	Tools Required
BiPAP Wraparound (1) Screw-on feet (4)	Torque screwdriver set to 4 in-lb

Refer to Figure: 6-1

Procedure:

- Step 1 Remove the wraparound assembly as described in Section 6.1.1.
- Step 2 Install the new wraparound and insert the four new screw-on feet in the unit bottom.

NOTE: For S-D and S/T-D models with serial numbers less than 30000, you must replace the wraparound with Replacement Kit number 332345. The wraparound is an EMI-shielded wraparound. For units with serial numbers greater than 30000, a new multi-layered board eliminates the need for the new wraparound. These models will use Replacement Kit number 332183.

Acceptable Combinations:

	<u>Old Wraparound</u>	<u>New Wraparound</u>
BiPAP S-D, S/T-D, S/N <30000	Replace with new wraparound	OK
BiPAP S-D, S/T-D, S/N >30000	OK	OK

NOTE: The old 332183 wraparound has a $\frac{3}{4}$ " square molded in the bottom. The new 332345 wraparound has both the $\frac{3}{4}$ " square and a $\frac{5}{8}$ " circle inside the square.

6.2.2 Blower Assembly Replacement

Repair Kit Number: 332181

Repair Kit Contents	Tools Required
Blower module S/A (1) Tie wraps, ET-7 (4) Cable clip (1) Tie wrap, ET-3 (1) Hose clamps (2) 8-position PC male mount conn. (1) Nylon standoffs (2) 0.1 μ f capacitor (1)	Needle nose pliers Cutting pliers Manual Nut Driver set at 4 in-lb Torque Nut Driver set capable of 4 in-lb and 10 in-lb

Refer to Figures: 6-4, 6-5, 6-6

NOTE: If a new blower has been installed in a unit with an old BCB which has R91, you may not be able to perform the flow calibration; the board, in about 10% of the cases, does not have enough gain. If this occurs, Respironics recommends that you install a new board to ensure the successful calibration of the transducer, but you may try another old board.

NOTE: The blower assembly (A) includes the blower impeller and motor. The unit must be replaced as an assembly.

Disassembly:

Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.

NOTE: For BiPAP units with Serial Numbers greater than 52000, substitute Steps 2 to 5 in Section 6.2.21 for Step 2.

Step 2 With the torque screwdriver, remove the four Phillips head screws holding the two end cap cross bars (B) to the front (C) and rear (D) end caps. Rotate the cross bars slightly and lift them up and out of the unit.

CAUTION: The system tubing is held tightly on the connectors. Do not pull the tubes from side to side; use a straight, firm pull to break the seal. Label the tubes for proper reconnection.

Step 3 Disconnect the flow pick-up tubes (E) from the top of the blower assembly.

Step 4 Turn the unit upside down.

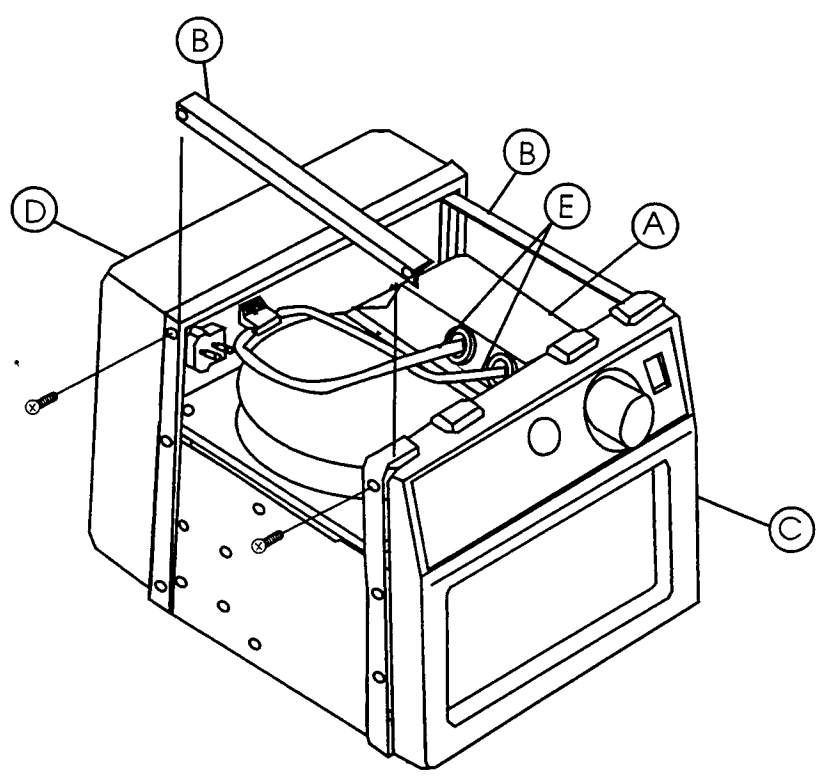


Figure 6-4

NOTE: For BiPAP units with serial numbers greater than 52000, perform Steps 3 to 4 of Section 6.2.22 before proceeding to Step 5.

CAUTION: Before disconnecting the blower wire plug (F) from the Motor Controller Board (MCB) (G), note the proper orientation of the plug and label it for reconnection.

Pull the plug gently away from the MCB to prevent damage to the wires.

Step 5 Disconnect the blower wire plug (F) from the MCB (G). The plug is a white 8-pin connector. With a slotted screwdriver, open the wire retaining clip on the bottom of the blower cover and remove the wires from the clip.

NOTE: The hose clamps ratchet together. Use a slotted screwdriver to open the clamps.

Step 6 Remove the tube clamp on the blower inlet port (H) and discard the clamp. Carefully slide the bellows away from the blower inlet port.

Step 7 Remove the four remaining Phillips screws (I) that attach the front end cap to the chassis.

NOTE: For BiPAP units with serial numbers greater than 52000, these screws were removed prior to Step 2.

Step 8 Turn the unit right-side up.

Step 9 Remove the tube clamp on the blower exit port (J) and discard the clamp. Slide the flexible connector off of the exit port.

Step 10 Open the wire retaining clips on the outside of the blower housing, remove the wire bundles from the clip, and move the wires away from the blower housing.

Step 11 Place the unit on its side with the transducer side of the blower facing up. Move the end cap out of the way.

Step 12 Using a torque nut driver set to 10 in-lb, remove the four nuts (K) holding the blower assembly to the rubber shock mounts (L).

NOTE: For units with serial numbers greater than 80691, there is no bellows on the muffler connection.

Step 13 Slowly pull the transducer side of the blower assembly until you expose the tie wraps retaining the valve and muffler bellows. Cut and discard the tie wraps (M—two are used on each bellows), being careful not to cut the bellows. Side cutters are recommended for cutting the wraps.

NOTE: If a valve coupling(O) is used between the blower and valve then pull to remove it.

Step 14 Remove the blower assembly from the BiPAP chassis.

Step 15 Examine the replacement blower: verify that all screws securing the two parts of the blower assembly are in place and tight.

Step 16 Remove the protective tape cover from the wire retaining clip in the replacement kit. Secure the clip on the blower cover bottom in approximately the same position and orientation as on the original blower assembly.

NOTE: Valve/Muffler is shown detached for clarity only.
You will not remove the Valve or Muffler for Blower Assembly Replacement.

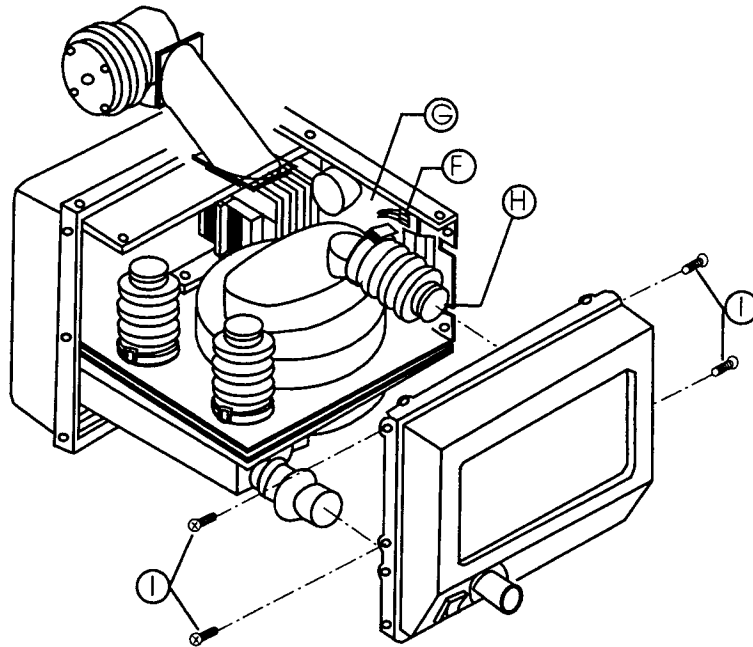


Figure 6-5

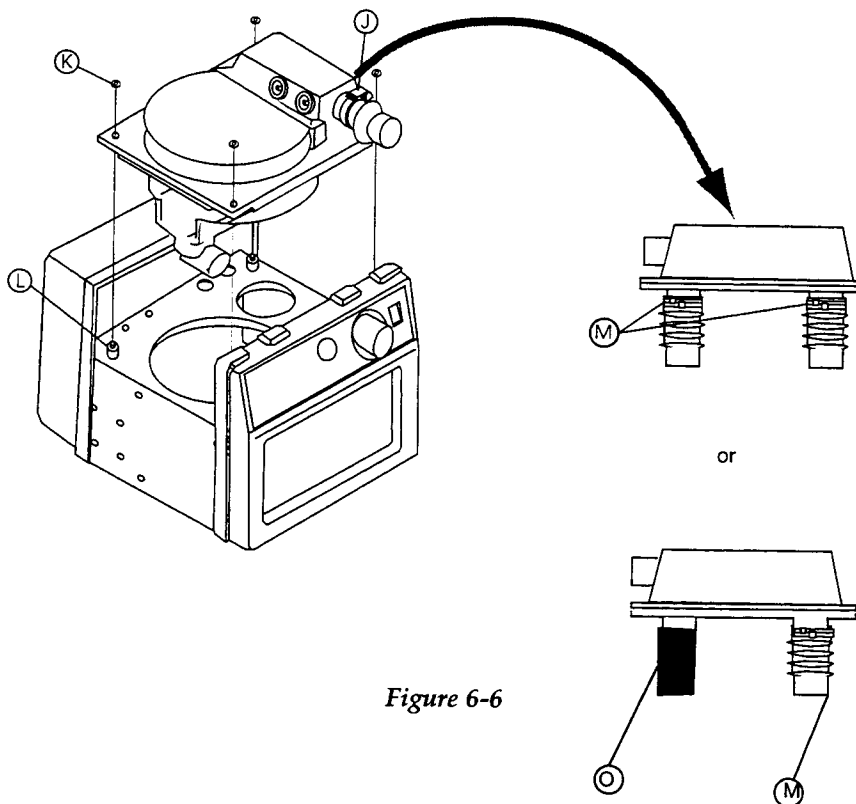


Figure 6-6

NOTE: Some older boards have a 0.1 μ f capacitor located on the trace side of the MCB, soldered between pins 1 and 2 of the header connector (J1). If the board you are working on has this capacitor, discard it when you remove the old header and replace it with the new one included in the kit. If this capacitor does not exist on the MCB under repair, discard the capacitor which is included in the kit.

CAUTION: The replacement blower motor connector is gold-plated. The 8-position PC mount connector (J1) on the Motor Control Board (MCB) must also be gold-plated. Inspect J1 on your MCB: if it is not gold-plated, you must replace it with the PC mount connector supplied in this kit. To remove and replace the board, follow the procedures of Section 6.2.3 to remove and replace the board. This kit contains two nylon standoffs if you need to replace the standoffs on the board.

Reassembly:

NOTE: For units with serial numbers greater than 80691, the muffler does not require a bellows. The blower port inserts directly into the muffler.

NOTE: Any unit can accept a coupling between the blower and the valve instead of the bellows. When installing a coupling between the valve and blower, hose clamps and tie-wraps are not required. Apply a light mist of alcohol on the valve and muffler blower port when installing the coupling.

Step 1 Apply a light mist of alcohol on the valve and muffler blower ports. Gently lower the new blower assembly onto the rubber shock mounts, making sure the valve and muffler bellows fit over the blower ports. Install two tie wraps on each bellows.

NOTE: To install the tie wraps on the valve and muffler bellows, start to make the loop in one of the tie wraps, and place it on the bellows. After the bellows is in place, tighten the tie wrap with a tie wrap gun. Assemble the second tie wrap around the bellows and tighten. Be sure the tie wraps are on the portion of the bellows that overlaps the blower port. Repeat for the other bellows. The knuckles of the two tie wraps should be at least 90° apart.

Step 2 Replace the four nuts onto the shock mounts and tighten with the torque nut driver set to 10 in-lb.

Step 3 Place the front end cap at the front of the chassis.

Step 4 Apply a light mist of alcohol on the blower exit port and slip the flexible connector over the port. Secure the connector with a tubing clamp.

Step 5 Reconnect the flow pick-up tubes to the flow transducer ports. Push the tubes all the way onto the ports.

Step 6 Turn the unit upside down.

CAUTION: Be sure to replace the wire plug in its proper orientation.

Step 7 Route the system wiring through the wire retaining clip on the bottom of the blower assembly and reconnect the blower wire plug to the MCB. Close the retaining clip.

Step 8 Apply a light mist of alcohol on the blower intake port and slip the intake bellows over the port.

Secure the bellows with a tubing clamp.

NOTE: For BiPAP units with serial numbers greater than 52000, do not perform Step 9.

Step 9 Use the torque screwdriver to replace and tighten the four Phillips screws that attach the front end cap to the chassis.

NOTE: For BiPAP units with serial numbers greater than 52000, perform the Reassembly Steps 1 to 3 of Section 6.2.22 before proceeding to Step 10.

Step 10 Turn the unit right side up.

NOTE: For BiPAP units with serial numbers greater than 52000, substitute reassembly steps 1 to 5 of Section 6.2.21 for Step 11.

Step 11 Replace the cross bars.

Step 12 Replace the wraparound and rubber feet.

Step 13 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

6.2.3 Motor Controller Board (MCB) Replacement

Replacement Kit Number: 332172 for serial numbers less than 200,000
332553 for serial numbers 200,000 or greater

CAUTION: The electronic components used in the MCB are subject to damage by static electricity. Use the proper static discharge and grounding precautions when servicing the equipment. Service only at a static-free work station.

CAUTION: The appropriate Replacement Kit must be used for repairs based on the serial number of the unit. The changes that occurred to the unit can be found in Appendix F of this manual.

Repair Kit Contents	Tools Required
Motor controller board (1) Tie wraps, ET-7 (4) Nylon standoffs (2) Tie wrap, ET-3 (1) 6 x 1/4" screws (2) 8-position PC cable mount female (1)	Needle nose pliers Cutting pliers Torque screw driver capable of 4 in-lb and 10 in-lb AMP connector tool-head #58246-1

Refer to Figures: 6-7

Disassembly:

Step 1 Remove the blower assembly as described in Section 6.2.2, Blower Assembly Replacement.

Step 2 Turn the unit upside down.

CAUTION: Be sure to note the proper position and orientation of the plugs. Label the plugs to ensure proper reconnection.

Step 3 Remove all of the wire plugs from the MCB.

Step 4 Use the torque screwdriver to remove the two machine screws and nuts (B) holding the MCB to the frame (C).

Step 5 The MCB is mounted on its left side on two nylon standoffs (D). Hold the standoffs with a pair of needle-nosed pliers and remove the screws from the outside of the chassis. New standoffs and screws are provided in the kit.

CAUTION: The header connector (J1) on the replacement MCB is gold-plated. The motor connector on the blower must also be gold-plated. Inspect the blower connector on your blower: if it is not gold-plated, you must replace it with the connector supplied in this kit. To remove and replace the blower, follow the procedures of Section 6.2.2.

Reassembly:

Step 1 Insert the new standoffs from the rear of the MCB. Align the standoff holes with the appropriate chassis holes and insert the two 6 x 1/4" screws. Tighten with the torque screwdriver set to 4 in-lb.

CAUTION: For proper heat sinking of the board components, the nuts holding the heat sink (E) to the unit frame must be tightened securely.

Step 2 Insert the two Phillips head machine screws through the unit frame and through the MCB mounting holes. Replace the hex head nuts. Tighten with the torque screwdriver set to 10 in-lb.

Step 3 Connect the wire plugs to the new board, being careful to connect the plugs in the same position and orientation as on the original board. If there is any doubt about the wiring connections, refer to Figure 5-1, System Wiring Diagram.

Step 4 Replace the blower assembly as described in Section 6.2.2, Blower Assembly Replacement.

NOTE: For units with serial numbers less than 52000, substitute Reassembly Steps 1-5 of Section 6.2.21 for Step 5.

Step 5 Replace the cross bars.

Step 6 Replace the wraparound and feet.

Step 7 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

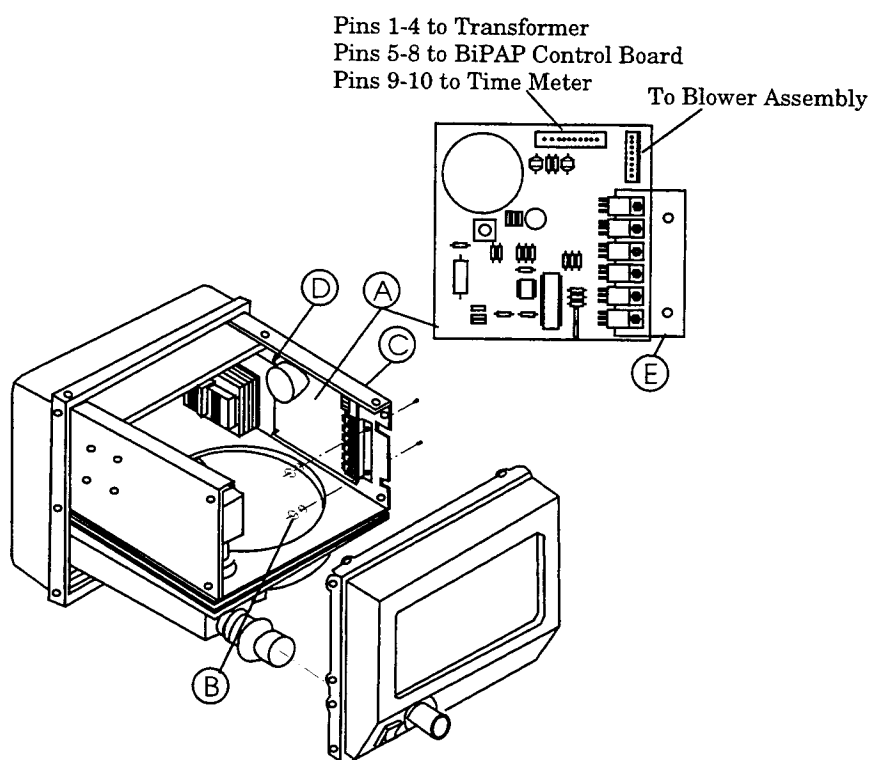


Figure 6-7

6.2.4 BiPAP Control Board (BCB) Replacement

Replacement Kit Number: S= 332168; S/T= 332169; S/T-D= 332170; S-D= 332171

CAUTION: The electronic components used in the BCB are subject to damage by static electricity. Use the proper static discharge and grounding precautions when servicing the equipment. Service only at a static-free work station.

Repair Kit Contents	Tools Required
BiPAP controller board (1) Tie wraps, ET-3 (3) 6-32 latch-type fasteners (2)	Needle nose pliers Cutting pliers Torque screw driver capable of 4 in-lb and 6 in-lb Torque nut driver capable of 4 and 6 in-lb Manual screwdriver set to 6 in-lb

Refer to Figures: 6-8, 6-9

Disassembly:

- Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.
- Step 2 Open the control panel door and remove the control knobs (A). For older units, use a 0.050" Allen Wrench to loosen the set screws (B) holding the control knobs to the potentiometers. For newer units, pull the knobs off the potentiometer shafts. Remove the knobs and note which knob is used on which potentiometer.
- Step 3 Use a 4 in-lb torque nut driver to remove the hex nuts (C) from the potentiometers. The function selector pot has a $\frac{3}{8}$ " nut; the rest of the control pots have $\frac{5}{16}$ " nuts.
- Step 4 **S-D and S/T-D units only** — Use the 6 in-lb manual screwdriver to remove the two screws (D) from the DCP cable connector.

NOTE: For units with serial numbers greater than 52000, perform Steps 2-4 of Section 6.2.20 before Step 5.

- Step 5 Cut the nylon ET-3 wire ties from the flow pick-up tubes (E) at the BCB ports. Discard the wire ties. Label the tubes to ensure proper replacement, then remove them from the ports. **For S-D and S/T-D units only** — Cut the nylon wire tie from the tube at the pressure transducer (F); discard the wire tie; and remove the pressure port tube.
- Step 6 With the torque screwdriver set to 6 in-lb, remove the six Phillips head screws (G) holding the rear end cap (H) in place. Note that two of the six screws retain the cross bar.
- Step 7 Move the end cap away from the unit. The wires to the power connector, voltage selector switch, elapsed time indicator, and DCP cable connector will limit the distance you can move the endcap.
- Step 8 Remove the three connectors on the BCB: The valve connector (I) which consists of two wires; the motor control board connector (J) which consists of four wires; and the ground wire (K). Be sure to note the location and orientation of the connectors; label them if necessary. The ground wire is removed by removing the flat head screw and nylon washer.
- Step 9 Remove the six flat head screws (L) with nylon washers that hold the BCB to the end cap.
- Step 10 Remove the BCB from the unit.

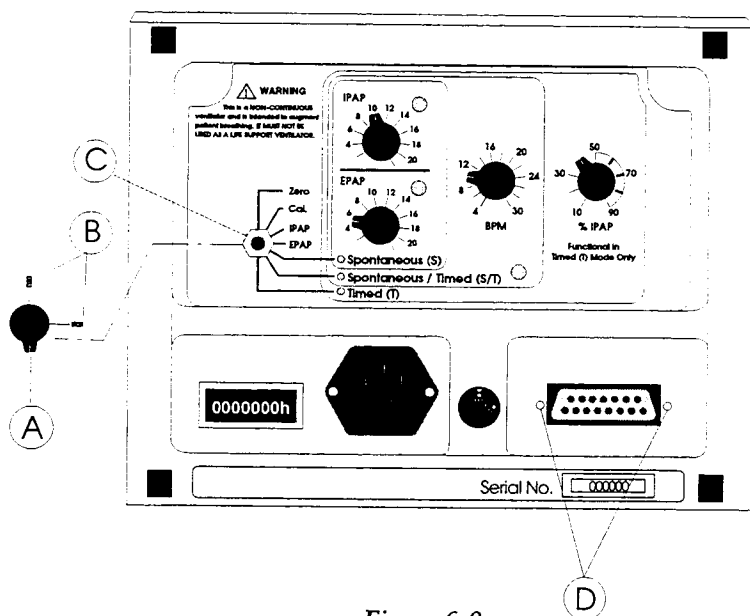


Figure 6-8

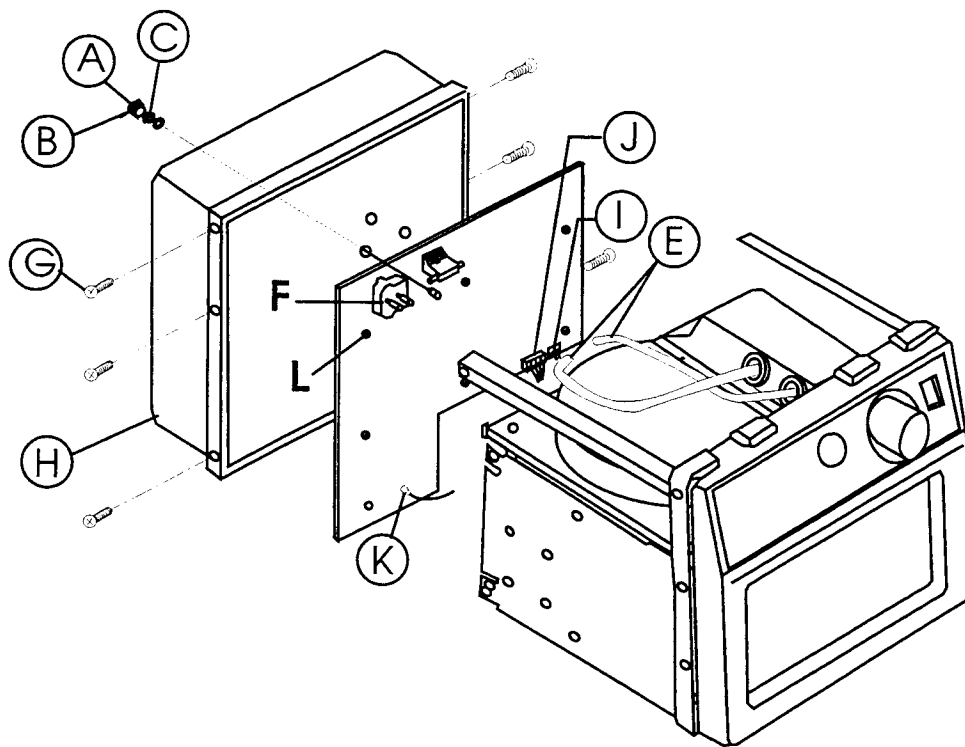


Figure 6-9

Reassembly:

CAUTION: Be certain that the nylon washers are in place before you tighten the screws.

- Step 1 Place the new BCB on the end cap, aligning the six holes in the board with the six threaded mounts in the end cap. Insert the six flat head screws and tighten them with the torque screwdriver set to 6 in-lb.
- Step 2 Connect the ground wire, the motor control board connector, and the valve connector to the BCB. Make certain that the nylon washer is positioned between the ground connector and the board.
- Step 3 Slide the end cap back into position, aligning the six screw holes. Insert the six Phillips head screws and tighten them with the torque screwdriver set to 6 in-lb.
- Step 4 **For S-D and S/T-D units** — replace the two flat head screws that secure the DCP cable connector.
- Step 5 Replace the hex nuts onto the potentiometers and tighten. Turn the potentiometer shafts fully clockwise, then install the control knobs onto the shafts with the knob pointers at their maximum positions.
- Step 6 Replace the flow pick-up tubes and the pressure port tube. Make certain that the tubes are fully engaged on the ports to which they are attached, tighten the connection with the supplied nylon wire ties.

NOTE: For units with serial numbers less than 52000, perform Reassembly Steps 1-3 of Section 6.2.20 before proceeding to Step 7.

- Step 7 Replace the wraparound and feet.
- Step 8 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

6.2.5 Transformer Replacement

Replacement Kit Number: 332180 for serial numbers less than 200,000
332554 for serial numbers 200,000 or greater

CAUTION: The appropriate Replacement Kit must be used for repairs based on the serial number of the unit. The changes that occurred to the unit can be found in Appendix F of this manual.

Repair Kit Contents	Tools Required
BiPAP transformer assembly (1) Tie wraps, ET-3 (3) 6-32 x 1/4" screws (6)	Needle nose pliers Cutting pliers Torque screw driver set at 4 in-lb Loctite 222

Refer to Figures: 6-10, 6-11, 6-12

Disassembly:

Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.

CAUTION: The system tubing is tight. Be careful not to break the tubing ports. Use a straight firm pull to break the seal. Label the tubing to ensure proper reconnection.

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 4 of Section 6.2.20 before proceeding to Step 2.

Step 2 Remove the flow pick-up tubes (A) from the top of the blower assembly.

Step 3 **For S-D and S/T-D models only** — cut the nylon tie wrap that holds the pressure port tube on the BiPAP Control Board (BCB) pressure transducer (B). Discard the nylon tie wrap and remove the pressure port tube.

Step 4 Turn the unit upside down.

Step 5 With the torque screwdriver, remove the six Phillips head screws (C) holding the rear end cap (D) in place.

Step 6 Tilt the rear end cap away from the unit frame.

NOTE: For units with serial numbers greater than 52000, perform steps 2 to 4 of Section 6.2.22 before Step 7.

Step 7 Remove the four Phillips head screws (E) that hold the bottom plate (F) to the frame. Slide the plate out from the frame. Bottom plates on newer chassis will simply lift off the frame.

CAUTION: Before removing any wire plugs from the transformer, note the proper position of the plugs and label them for reconnection.

Step 8 Disconnect all wire plugs from the transformer (G).

Step 9 Turn the unit on its side.

Step 10 Remove the six 6-32 x 1/4" screws (H) holding the transformer bracket to the frame (two screws from the top of the frame and four screws from the side of the frame).

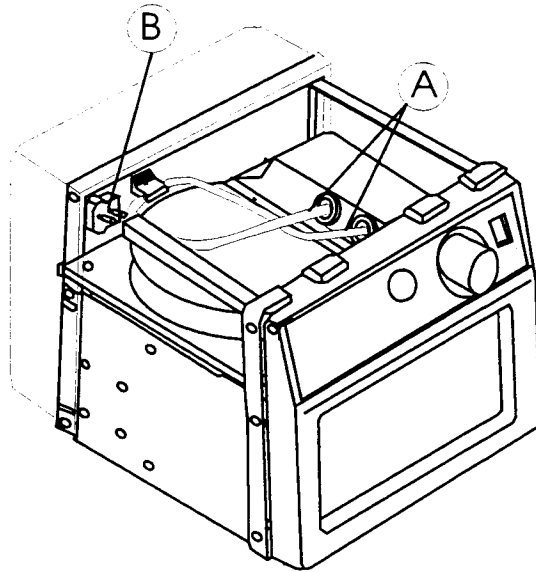


Figure 6-10

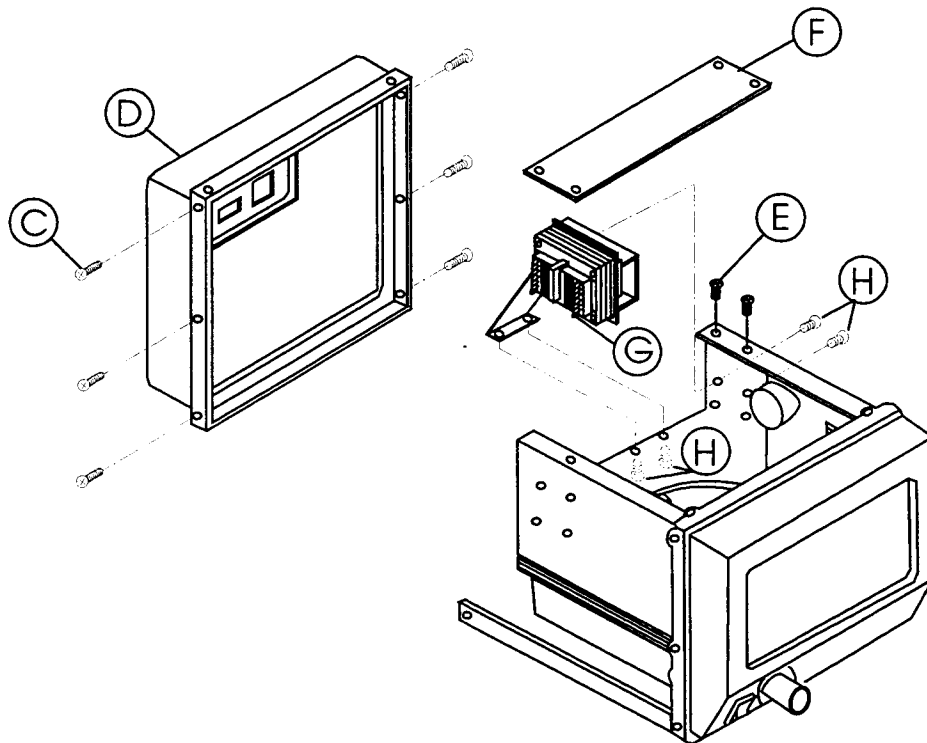


Figure 6-11

Step 11 Lift the transformer subassembly out of the unit.

Reassembly:

Step 1 Attach the new transformer subassembly to the frame using six new screws with a drop of thread sealer on the threads of the screws.

Step 2 Connect the wire plugs to the terminal, being careful to connect the plugs to the same terminals as on the original transformer. See Figure 6-12.

Step 3 Reattach the bottom plate to the unit frame with the four (six for units with serial numbers greater than 52000) Phillips head screws.

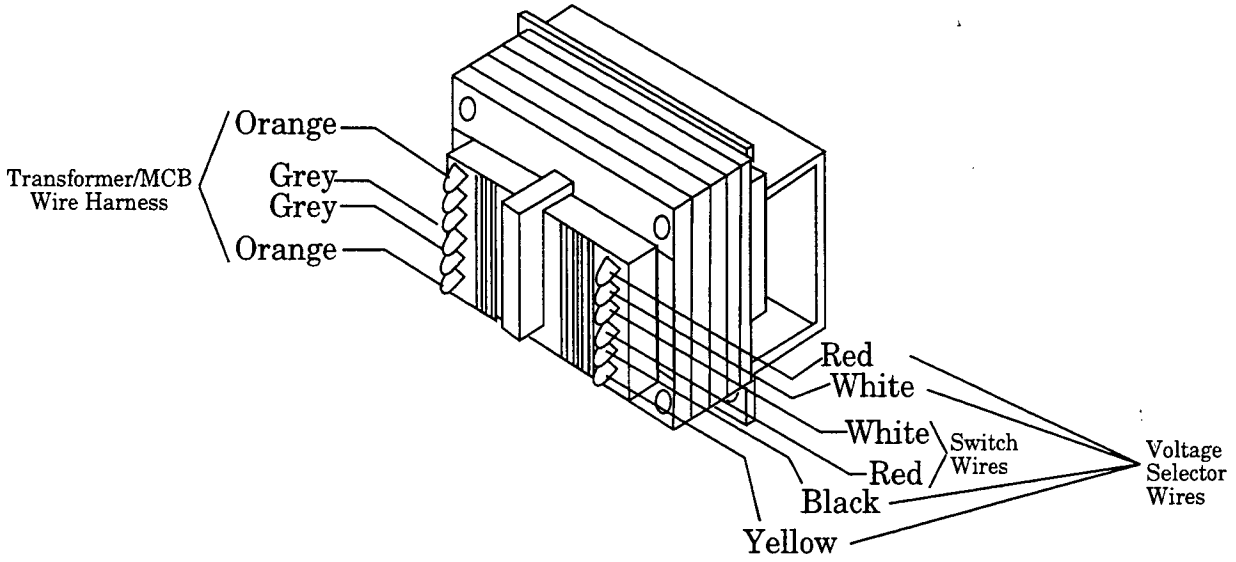
Step 4 Use the torque screwdriver to reattach the rear end cap with the six Phillips head screws.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 1 to 3 of Section 6.2.20 before proceeding to Step 5.

Step 5 Replace the wraparound and feet.

Step 6 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

For serial numbers greater than 200,000.



For serial numbers less than 200,000.

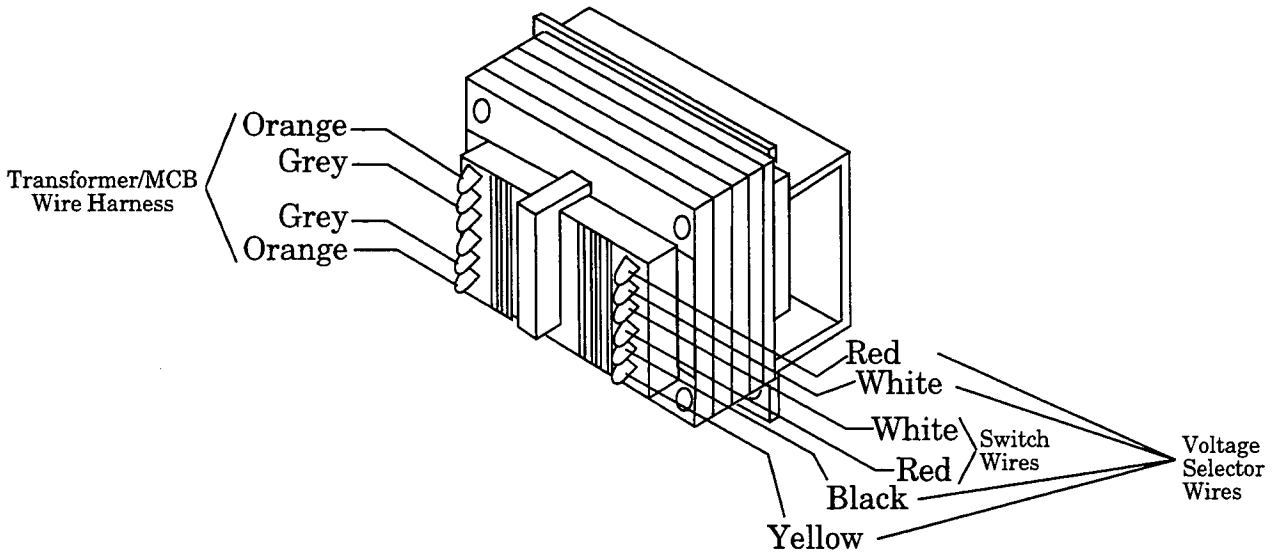


Figure 6-12

6.2.6 Muffler Replacement

Replacement Kit Number: 332471

Repair Kit Contents	Tools Required
BiPAP tube muffler assembly (1) Muffler Grommets (2) Hose clamps (2)	Needle nose pliers Cutting pliers Torque screw driver set at 4 in-lb

NOTE: Units with serial numbers greater than 80961 contain the new "tube" muffler. Replacement parts kits now contain the new tube muffler, which will replace the old square muffler. No adjustments are required to accommodate the new muffler.

Disassembly: Refer to Figures: 6-13, 6-14

Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 4 of Section 6.2.20 before proceeding to Step 2.

Step 2 With the torque screwdriver, remove the six Phillips head screws (A) that hold the front end cap (B) in place.

NOTE: The hose clamps ratchet together. Use a slotted screwdriver to open the hose clamps.

Step 3 Remove the hose clamp from the flex connector on the blower outlet (C) and discard the clamp. Slide the flex connector off of the blower outlet.

Step 4 Loosen the two nuts on the shock mounts that hold the blower down on the same side as the muffler.

Step 5 Turn the unit upside down.

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 4 of Section 6.2.22 before proceeding to Step 5.

Step 6 Remove and discard the hose clamp from the bellows at the blower inlet (D). Slide the bellows off the blower inlet.

Step 7 Move the front end cap out of the way.

Step 8 **Units with serial numbers less than 80691:** Cut, remove, and discard the tie wraps (E) on the bellows between the muffler (F) and the blower assembly.

Units with serial numbers greater than 80691: The muffler (F) does not require a bellows.

CAUTION: Use caution when removing the muffler from the valve port. Rough handling may damage the valve.

Step 9 If you are servicing an older unit, carefully separate the vibration-absorbent tape from the frame. On newer units, single-face foam is used and need not be removed.

Step 10 Slowly slide the muffler out of the valve, then slide the bellows off of the blower port. For units with serial numbers greater than 80691, the muffler does not require a bellows.

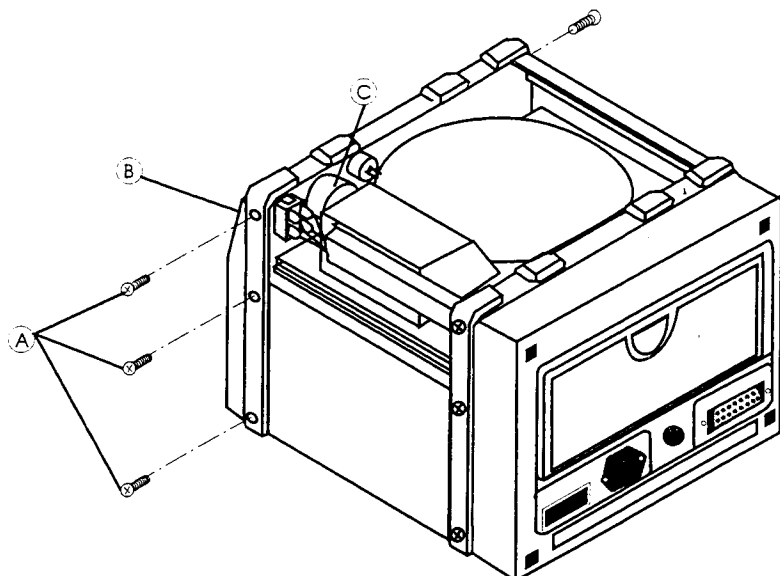
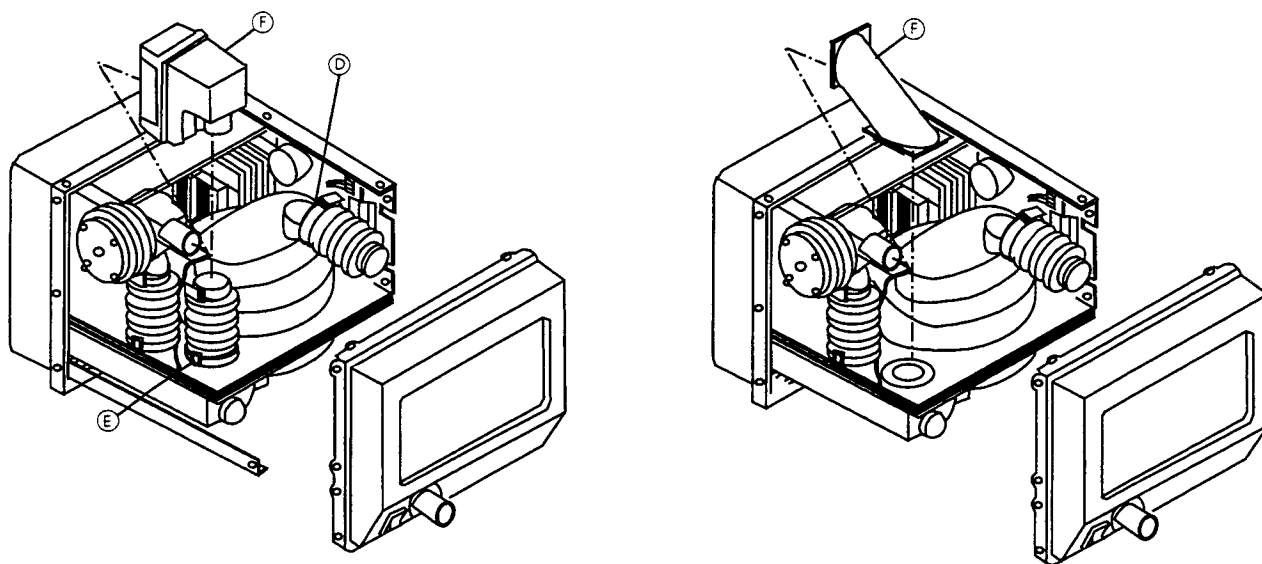


Figure 6-13



Units with serial numbers <80691

Units with serial numbers >80691

Figure 6-14

Reassembly:

- Step 1 Insert the neck of one muffler grommet into each hole on the muffler. A light mist of alcohol may be used for lubrication if necessary.
- Step 2 Gently push the blower away from the mounting plate to create more clearance for the muffler installation. Push the muffler onto the blower port until it is $3/16" \pm 1/8"$ from the mounting plate. This space is necessary for proper flow.
- Step 3 Attach the other end of the muffler to the valve outlet. Push the muffler onto the valve until it is $3/16" \pm 1/8"$ from the mounting plate. This space is necessary for proper flow.
- Step 4 Place blower onto the shock mounts and tighten the nuts.
- Step 5 Place hose clamps on the flexible connector at the blower outlet port and on the bellows at the inlet. Ratchet the clamps until they stop clicking.
- Step 6 Position the front end cap so that the flexible connector slides onto the pressure transducer and the inlet bellows slides over the blower inlet port. Apply a light mist of alcohol on the ports to ease the installation.
- Step 7 Tighten both the flexible connector hose clamp and the blower inlet hose clamp.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 1 to 3 of Section 6.2.22 before proceeding to Step 7.

Step 8 Place the unit right side up.

Step 9 Reattach the front end cap by tightening the six screws with the torque screwdriver.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 1 to 3 of Section 6.2.20 before proceeding to Step 9.

Step 10 Replace the wraparound and feet.

Step 11 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

6.2.7 Valve Replacement

Replacement Kit Number: 332167

Repair Kit Contents	Tools Required
Electronic control valve subassembly (1) Screws, 6-32 x 1/4 Phillips truss head(4) Coupling (1)	Torque screw driver capable of 4 and 10 in-lb Loctite 222 Pliers Needle nose pliers

NOTE: The Coupling Replacement Kit, number 332533, can be used to replace the bellows between the valve and blower.

Refer to Figure: 6-15

Disassembly:

- Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.
- Step 2 Turn the unit upside down.
- Step 3 With the torque screwdriver set to 4 in-lb, remove the six Phillips head screws (A) that hold the rear end cap (B) in place.
- Step 4 Tilt the rear end cap away from the unit frame (C).

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 4 of Section 6.2.22 before proceeding to Step 5.

- Step 5 Remove the four Phillips head screws (D) that hold the bottom plate (E) to the unit frame. Slide the bottom plate back and out of the frame. Bottom plates on newer chassis will simply lift off the frame.

CAUTION: Before you remove the valve BCB wire plug, note the proper position and orientation of the plug. Label the plug for reconnection.

- Step 6 Disconnect the valve wire plug (F) from the BiPAP Control Board (BCB) (G).

NOTE: The hose clamps ratchet together. Use a slotted screwdriver to open the clamps.

NOTE: If the coupling was used no hose clamp will be present.

- Step 7 For units with serial numbers greater than 153045, remove and discard the hose clamp (H) from the bellows at the valve outlet (I) and discard the hose clamp and bellows.

- Step 8 Remove the four 6-32 x 1/4" Phillips head screws (J) that attach the valve (K) to the unit frame.

- Step 9 Carefully pull the valve away from the muffler until the valve port is clear of the muffler, then pull the valve up and away from the bellows or coupling.

NOTE: To replace the bellows with the coupling remove the bellows by cutting the tie-wraps and pulling the bellows off the blower. Tie-wraps and hose clamps are not necessary when using the coupling.

Reassembly:

- Step 1 Apply a light mist of alcohol on the new valve's outlet port and slide the coupling onto the port.
- Step 2 Apply a light mist of alcohol on the blower bottom and slide the other end of the coupling onto the blower bottom.
- Step 3 Carefully slide the valve inlet port into the muffler.
- Step 4 Attach the valve to the unit frame with four new 6-31 x 1/4" screws, with a drop of Loctite 222® thread sealer on the screw threads. Tighten with the torque screwdriver set to 10 in-lb.

NOTE: Check the connections from the valve to the muffler and from the valve to the blower. These connections must be leak-free.

- Step 5 Connect the valve wire plug to the BiPAP Control Board, being careful to connect the plug in the same location and orientation as before.
- Step 6 Reattach the bottom plate to the unit frame with four (six for units with serial numbers greater than 52000) Phillips head screws.
- Step 7 Replace the rear end cap and fasten it in place with six Phillips head screws. Tighten the screws with the torque screwdriver set to 4 in-lb.
- Step 8 Replace the wraparound and feet.
- Step 9 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

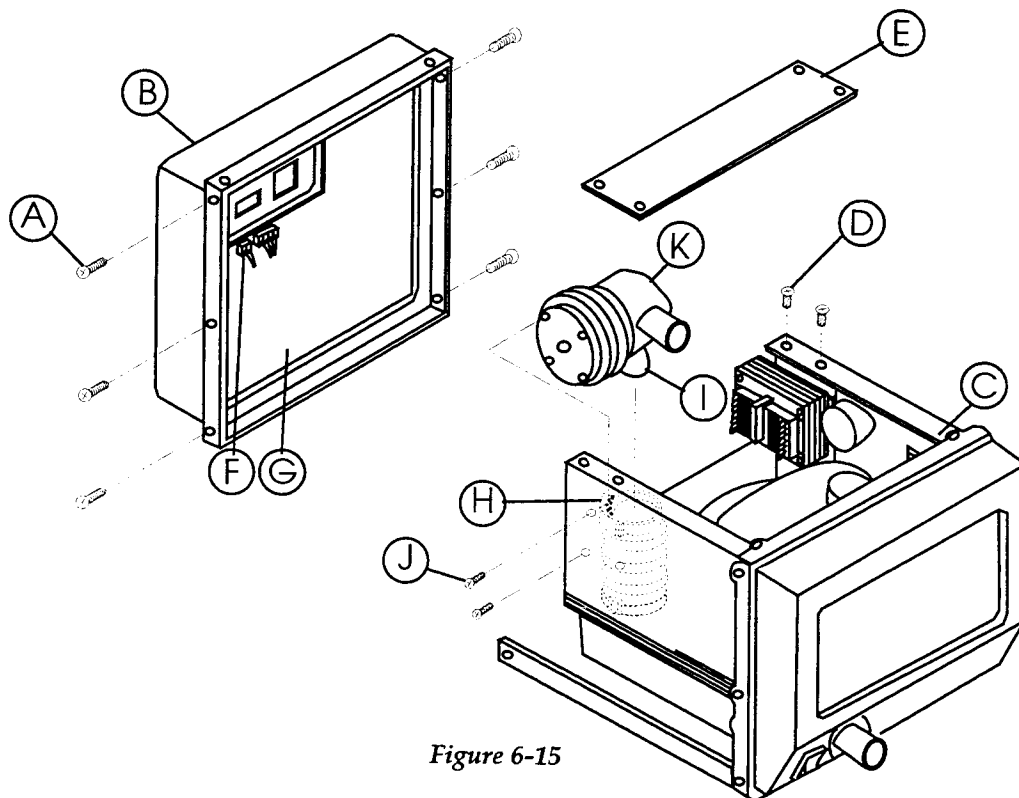


Figure 6-15

6.2.8 Flow Tube Pick-Up Tube Replacement

Replacement Kit Number: 332185

Repair Kit Contents	Tools Required
Flow pick-up tubes (2) Wire ties, ET-3 (2)	#2 Phillips screwdriver Cutting pliers

Refer to Figures: 6-16, 6-17

Disassembly:

Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 4 of Section 6.2.20 before Step 2.

CAUTION: The system tubing fits tightly on the ports. Be careful not to break the tubing ports. Use a straight firm pull to break the seal. Label the tubing to ensure proper reconnection.

Step 2 Disconnect the defective flow tube (A) from the top of the blower assembly (B). If you are replacing both flow tubes, change one tube at a time to prevent replacing the tubes at the wrong position.

Step 3 Cut the nylon wire tie (C) that secures the tube to the pressure transducer on the BiPAP Control Board (BCB); discard the tie wrap. Pull the tube off of the transducer and discard the tube.

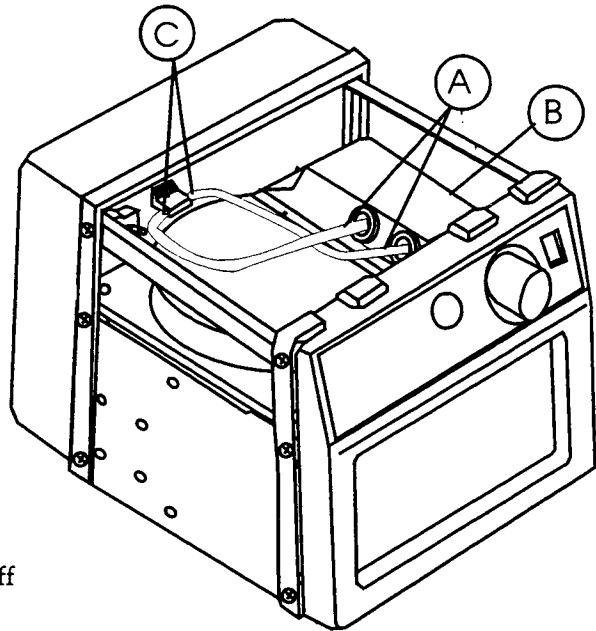


Figure 6-16

Reassembly:

Step 1 Connect the new flow pick-up tube to the BCB.

Step 2 Place a wire tie around the connection and tighten the wrap.

Step 3 Connect the other end of the tube to the top of the blower assembly.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 1 to 3 of Section 6.2.20 before Step 4.

Step 4 Replace the wraparound and the feet.

Step 5 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

6.2.9 Main Power Switch Replacement

Replacement Kit Number: 332163 (lighted) or 552127 (non-lighted)

Repair Kit Contents	Tools Required
Main power switch (1)	#2 Phillips screwdriver Needle nose-pliers

Refer to Figures: 6-16

Disassembly:

Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.

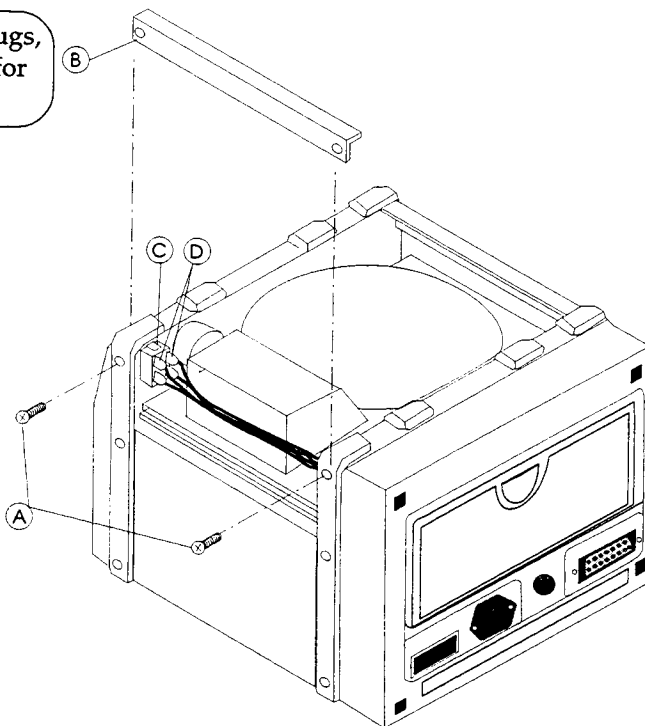
NOTE: For units with serial numbers greater than 52000, replace Step 2 with Steps 2 to 5 of Section 6.2.21, but only remove Side Panel "E."

Step 2 Remove the Phillips screws (A) that retain the cross bar (B) that is nearest the main power switch (C). Remove the bar.

CAUTION: Before disconnecting the switch wire plugs, note the position of the plugs and label for reconnection.

Step 3 Disconnect the switch wire plugs (D) from the switch using needle-nosed pliers.

Step 4 Depress the mounting tabs on the top and bottom of the switch and push the switch out of the front end cap.



Reassembly:

Step 1 Push the new switch into the front end cap from the front. Be sure to orient the switch such that the "I" is on the top.

Step 2 Reconnect the switch wires to the power switch.

NOTE: For units with serial numbers greater than 52000, replace Step 3 with Reassembly Steps 1 to 5 of Section 6.2.21.

Figure 6-17

Step 3 Replace the cross bar and secure it with the two Phillips head screws.

Step 4 Replace the wraparound and feet.

Step 5 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

6.2.10 Front End Cap Replacement

Replacement Kit Number: S=332222; S-D= 332224; S/T= 332161; S/T-D= 332160

Repair Kit Contents	Tools Required
Front end cap (1) Hose clamps (2) Tie wrap (1)—S-D and S/T-D Front End Caps only 6-32 Latch-type fasteners (4)	Torque screwdriver set to 4 in-lb Needle nose pliers Cutting pliers for S-D and S/T-D only

Refer to Figures: 6-18, 6-19

Disassembly:

Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.

NOTE: For units with serial numbers greater than 52000, complete Steps 2 to 5 of Section 6.2.21 before Step 2, but remove side panel "E" only.

Step 2 Remove the six Phillips head screws (A) that hold the front end cap (B) in place.

NOTE: The hose clamps ratchet together. Use a slotted screwdriver to open the clamp.

Step 3 Remove and discard the hose clamp from the flex connector (C).

NOTE: For units with serial numbers greater than 52000, Step 4 is unnecessary.

Step 4 Remove the remaining Phillips head screw (D) that retains the switch-side crossbar (E) and remove the crossbar.

CAUTION: Before you remove the switch wires from the main power switch, be sure to note their proper location and label them for reconnection.

Step 5 Disconnect the switch wire plugs (F) from the main power switch (G).

Step 6 Depress the mounting tabs on the top and bottom of the switch and push the switch out of the front end cap. You must re-use the main power switch.

Step 7 **For S-D and S/T-D models only** — cut the nylon tie wrap that holds the pressure port tube on the pressure port (H). Pull the tube off of the pressure port.

Step 8 Turn the unit upside down.

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 4 of Section 6.2.22 before Step 9.

Step 9 Remove and discard the hose clamp on the blower inlet port (I) and slide the bellows off the blower inlet port.

Step 10 Move the front end cap away from the unit.

Step 11 Locate the lot number label inside the old front end cap. Transfer any lot numbers on the old label to the appropriate lines on the label of the new front end cap.

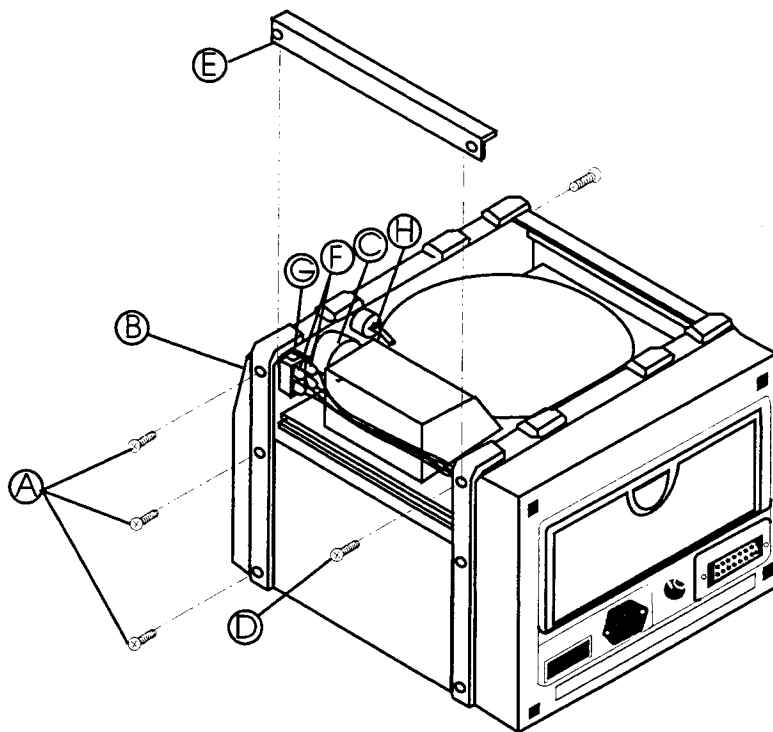


Figure 6-18

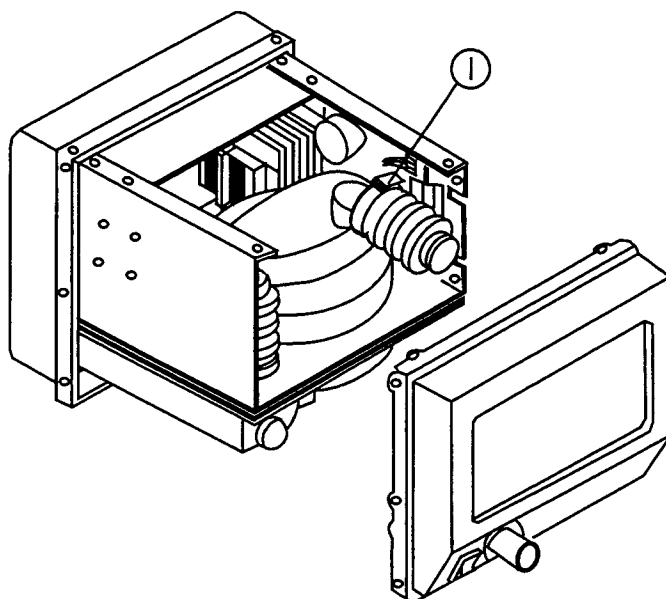


Figure 6-19

Reassembly:

- Step 1 Place the new front end cap near the front of the unit. Place a new hose clamp over the inlet bellows and tighten it by one or two ratchets. Apply a fine mist of alcohol on the blower inlet port and slide the inlet bellows over the port. Tighten the hose clamp over the bellows and the inlet port.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 2 to 3 of Section 6.2.22 before proceeding to Step 2.

- Step 2 Turn the unit right side up.

- Step 3 Place a new hose clamp over the flexible connector and tighten it by one or two ratchets. Apply a fine mist of alcohol on the blower outlet port and slide the flexible connector onto the port. Tighten the hose clamp around the connector and blower outlet port.

- Step 4 Push the main power switch into the front end cap. Be sure to orient the switch so that the "I" is on top and the "O" is on the bottom.

- Step 5 Reconnect the switch wires to the power switch.

- Step 6 **For S-D and S/T-D models** — push the pressure port tube onto the pressure port and tighten with a small nylon tie wrap.

- Step 7 Align the six holes of the front end cap with the holes in the cross bars (side panels for serial numbers greater than 52000) and chassis. Replace and tighten the six Phillips head screws with the torque screwdriver set to 4 in-lb.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 1 to 3 in Section 6.2.20 before proceeding to Step 9.

- Step 8 Replace the wraparound and feet.

- Step 9 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

6.2.11 Blower Shock Mount Replacement

Replacement Kit Number: 332173

Repair Kit Contents	Tools Required
Blower shock mounts (4) Hose clamps (2) Tie wrap, ET-3 (1) 8-32 Locking nuts (4)	Torque screwdriver set to 4 in-lb Torque nut driver ($1\frac{1}{32}$ "") set to 10 in-lb Needle nose pliers Cutting pliers Loctite 222

Refer to Figures: 6-20, 6-21, 6-22

Disassembly:

Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 5 of Section 6.2.21 instead of Step 2.

Step 2 Remove the four Phillips head screws (A) holding the two end cap cross bars (B) to the front (C) and rear (D) end caps. Rotate the cross bars slightly and lift them up and out of the unit.

CAUTION: The system tubing is held tightly on the connectors. Do not pull the tubes from side to side; use a straight, firm pull to break the seal. Label the tubes for proper reconnection.

Step 3 Note the position of the flow pick-up tubes (E), label them, and disconnect them from the top of the blower assembly.

Step 4 Turn the unit upside down.

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 4 of Section 6.2.22 before proceeding to Step 5.

NOTE: The hose clamps ratchet together. Use a slotted screwdriver to open the clamps.

Step 5 Remove and discard the hose clamp (F) on the blower inlet port (G) and slide the bellows off the blower inlet port.

Step 6 Turn the unit right side up.

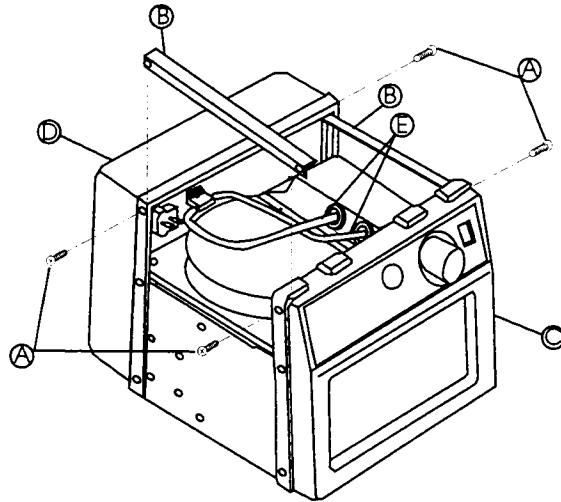


Figure 6-20

NOTE: The front end cap is shown detached for clarity only. It is not removed at this stage of disassembly.

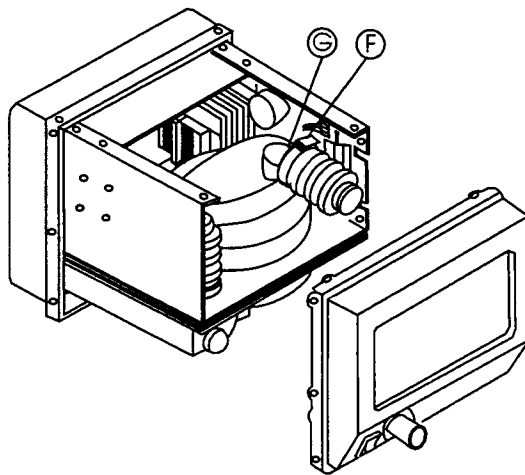


Figure 6-21

Step 7 Remove the remaining four Phillips head screws (H) that hold the front end cap in place.

NOTE: For units with serial numbers greater than 52000, the four screws (H) are already removed.

NOTE: The hose clamps ratchet together. Use a slotted screwdriver to open the clamp.

Step 8 Remove and discard the hose clamp from the flex connector (I).

Step 9 Move the front end cap out of the way.

Step 10 Remove the four Phillips head screws (J) that attach the rear end cap to the unit.

Step 11 Tilt the rear end cap away from the unit.

Step 12 With the nut driver, remove the four locking nuts (K) that hold the blower assembly to the rubber shock mounts.

Step 13 With the nut driver, remove the four locking nuts (L) that fasten the rubber shock mounts to unit.

Step 14 Carefully lift one side of the blower assembly and remove the two rubber shock mounts (M). Insert two new rubber shock mounts in their place.

Step 15 Repeat Step 14 for the opposite side of the blower assembly.

Reassembly:

Step 1 Replace and tighten the four 8-32 locking nuts that retain the rubber shock mounts on the unit. Use the torque nut driver set to 10 in-lb.

Step 2 Replace and tighten the four locking nuts that retain the blower assembly on the rubber shock mounts. Use the torque nut driver set to 10 in-lb.

Step 3 Replace the rear end cap and insert and tighten the two lower Phillips head screws on each side.

Step 4 Place a hose clamp over the flex connector, apply a light mist of alcohol on the blower outlet port, and slide the flex connector over the blower outlet port. Tighten the hose clamp over the connector and outlet port.

NOTE: For units with serial numbers greater than 52000, skip Step 5.

Step 5 Insert and tighten the four Phillips head screws that hold the front end cap to the unit. Use the torque screwdriver set to 4 in-lb.

Step 6 Turn the unit upside down.

Step 7 Place a hose clamp over the inlet bellows collar, apply a light mist of alcohol on the blower inlet port, and slip the intake bellows over the port. Tighten the hose clamp over the inlet port.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 1 to 3 in Section 6.2.22 before proceeding to Step 8.

Step 8 Turn the unit right side up.

Step 9 Reconnect the pressure port tube to the pressure port. Secure the connection with a nylon tie wrap.

Step 10 Reconnect the flow pick-up tubes to the top of the blower assembly.

Step 11 Reconnect the power switch wires to the main power switch.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 1 to 5 in Section 6.2.21 in place of Step 12.

Step 12 Replace the front-rear cross bars.

Step 13 Replace the wraparound and feet.

Step 14 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

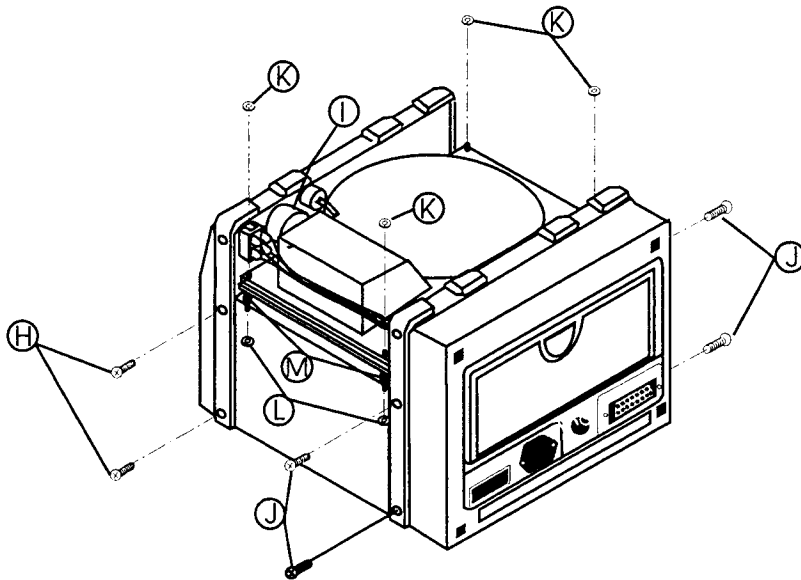


Figure 6-22

6.2.12 Flex Connector Replacement

Replacement Kit Number: 332165

Repair Kit Contents	Tools Required
Flex connector (1) Hose clamps (3) Tie wrap, ET-3 (1)	Torque screwdriver set to 4 in-lb Cutting pliers Razor blade knife to remove flex connector with glued connection.

Refer to Figures: 6-23, 6-24

Disassembly:

Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 4 in Section 6.2.20 before proceeding to Step 2.

Step 2 Remove the six Phillips head screws (A) that hold the front end cap (B) in place.

NOTE: The hose clamps ratchet together. Use a slotted screwdriver to open the clamp as shown in Section 6.1.3.

Step 3 Remove and discard the hose clamp from the blower side of the flex connector (C).

Step 4 Remove the remaining Phillips head screw (D) that retains the switch-side crossbar (E) and remove the crossbar (or side panel for units with serial numbers greater than 52000).

Step 5 Turn the unit upside down.

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 4 of Section 6.2.22 before proceeding to Step 6.

Step 6 Remove and discard the clamp on the blower inlet port (F); slide the bellows off the blower inlet port.

Step 7 Move the front end cap away from the unit.

Step 8 **For glued flex connectors:** Using a razor blade knife, lightly score the flex connector end that is glued to the air outlet port on the front end cap. Cut through the "doughnut" portion of the flex connector, splitting the flex in half.

For clamped flex connectors: Remove and discard the hose clamp from the front end cap side of the flex connector.

Step 9 Peel the flex connector off of the air outlet. Be sure not to leave any excess flex on the outlet.

Step 10 Clean any flex connector or glue remnants from the blower outlet surface.

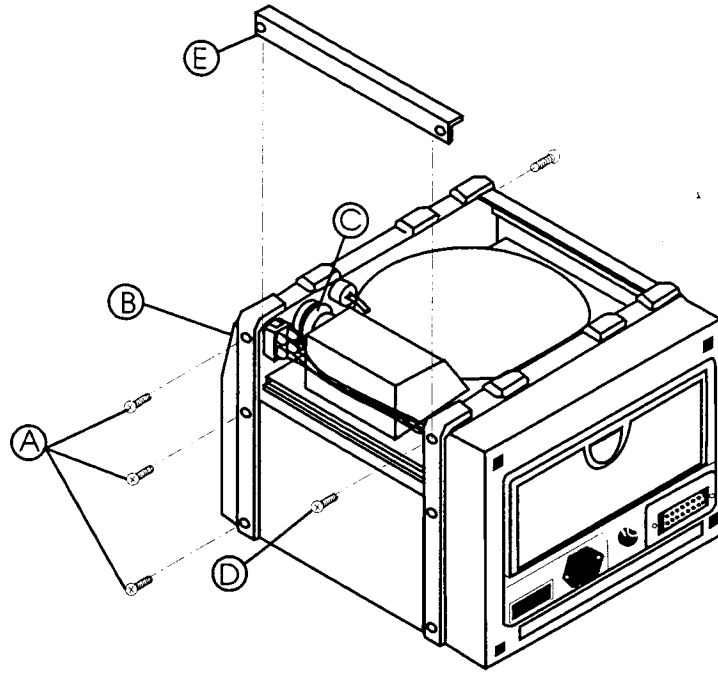


Figure 6-23

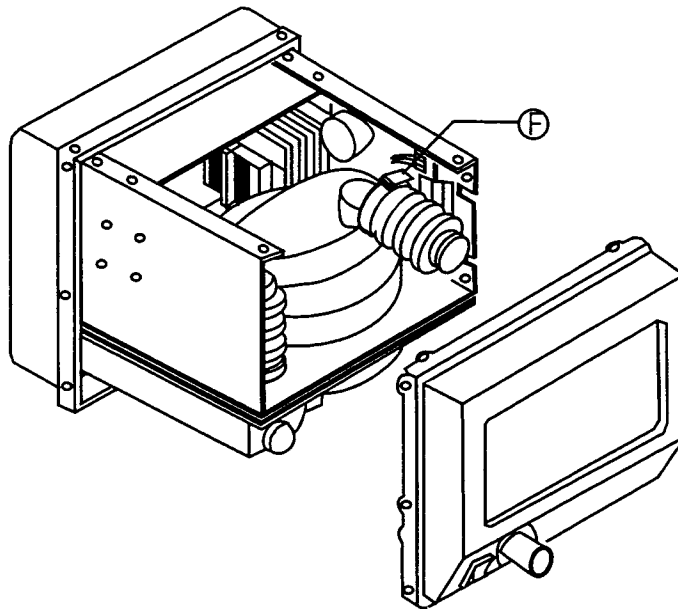


Figure 6-24

Reassembly:

- Step 1 Place a new hose clamp over the flex connector on the side to be placed over the outlet port. Apply a fine mist of alcohol on the front cap outlet port, then slide the new flex connector onto the outlet. Tighten the hose clamp over the connector and port.
- Step 2 Place the front end cap near the front of the unit. Place a new hose clamp over the inlet bellows and tighten it by one or two ratchets. Apply a fine mist of alcohol on the blower inlet port and slide the inlet bellows over the port. Tighten the hose clamp over the bellows and the inlet port.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 1 to 3 of Section 6.2.22 before proceeding to Step 3.

- Step 3 Turn the unit right side up.
- Step 4 Place a new hose clamp over the blower end of the flexible connector and tighten it by one or two ratchets. Apply a fine mist of alcohol on the blower outlet port and slide the flexible connector onto the port. Tighten the hose clamp around the connector and blower outlet port.
- Step 5 Attach the front end cap to the unit, but leave out the top screw for the crossbar, if applicable. Use the power screw driver set to 4 in-lb.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 1 to 5 of Section 6.2.21 in place of Step 6.

- Step 6 Replace the switch-side crossbar.
- Step 7 Replace the wraparound and feet.
- Step 8 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

6.2.13 AC Inlet Connector w/Fuse Drawer Replacement

Replacement Kit Number: 332214 for serial numbers less than 150,000
332556 for serial numbers 150,000 or greater

Repair Kit Contents	Tools Required
AC inlet with fuse drawer (1) 4-40 x $\frac{3}{8}$ " machine screws (2) Wire tie, ET-3 (1) 6 x $\frac{3}{8}$ " thread cutting screws (2) 4-40 locking nuts (2)	Torque screwdriver capable of 4 and 6 in-lb Needle nose pliers Cutting pliers

Refer to Figures: 6-25, 6-26

Disassembly:

- Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.
- Step 2 Remove the six Phillips head screws (A) that fasten the rear end cap (B) to the unit.
- Step 3 Turn the unit upside down.
- Step 4 Pull back the rubber boot (C) that covers the AC inlet wire connections (D).

CAUTION: Before you remove the wire connectors on the AC inlet, label the connectors for proper reconnection.

- Step 5 Remove the wire connectors on the AC inlet (E).
- Step 6 On the back panel remove the two Phillips head screws (F) that attach the AC inlet connector to the rear end cap. Remove the AC inlet connector/fuse drawer assembly (G).

NOTE: On older units, the AC inlet connector is attached with two Phillips head machine screws with locking nuts on the inside. Use an $\frac{1}{32}$ " nutdriver to hold the nuts while removing the machine screws.

- Step 7 Remove the fuses from the fuse drawer (H) and insert them into the new fuse drawer. See section 4.2.7.

Reassembly:

- Step 1 Insert the AC inlet connector/fuse drawer assembly into the rear end cap. Be sure that the fuse drawer is oriented on the lower side of the assembly. Insert and tighten the two 6 x $\frac{3}{8}$ " Phillips head screws that attach the AC inlet to the rear end cap. Use the torque screwdriver set to 6 in-lb.

NOTE: For older units, insert the two 4-40 x $\frac{3}{8}$ " Phillips machine screws through the rear end cap and place 4-40 locking nuts on the inside.

- Step 2 Reconnect the wire connections to the AC inlet and slide the rubber boot over the connections.
- Step 3 Turn the unit right side up.
- Step 4 Align the rear end cap mounting holes with the chassis holes; insert and tighten the six Phillips head screws that attach the rear end cap to the unit. Use the torque screwdriver set to 4 in-lb.

Step 5 Replace the wraparound and feet.

Step 8 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

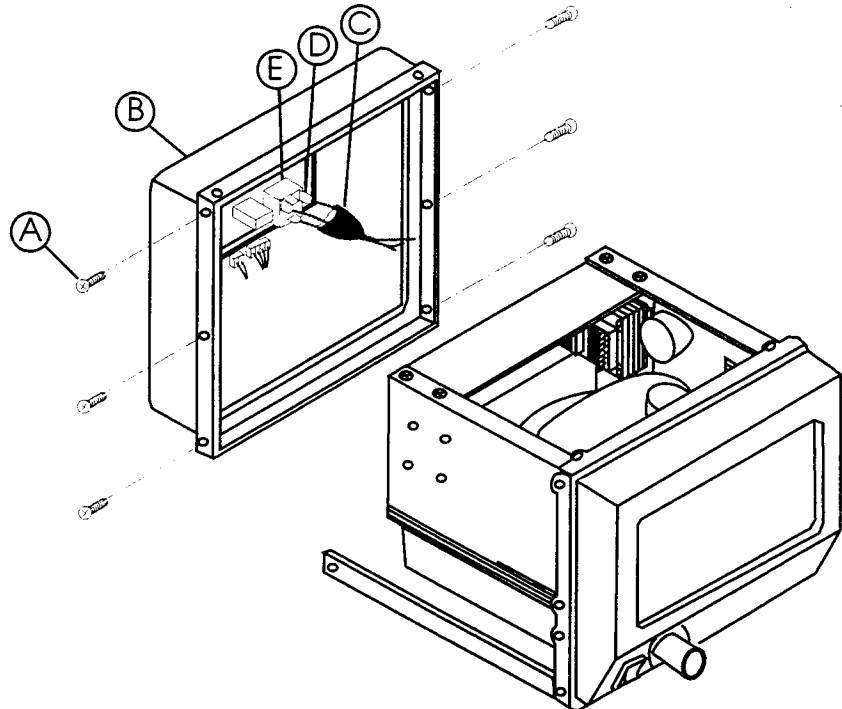


Figure 6-25

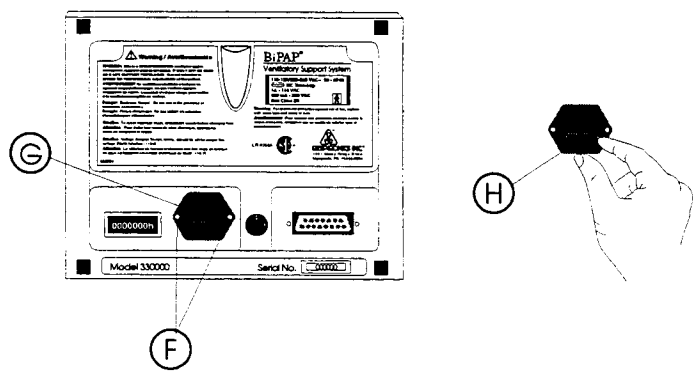


Figure 6-26

6.2.14 Control Knob Replacement

Replacement Kit Number: 332177 D SHAFT (Pull-off knobs)

Repair Kit Contents	Tools Required
Control knobs (5)	None

Refer to Figures: 6-27

Disassembly:

Step 1 Open the cover door on the back panel.

Step 2 Turn all the control knobs (A) to their extreme clockwise positions.

CAUTION: When pulling the control knobs off the shafts, use a straight, firm pull to prevent damage to the potentiometer shafts. If a shaft is damaged, you must replace the BiPAP Control Board (BCB).

Step 3 Remove the knobs by pulling them straight off the shafts.

NOTE: If the knobs don't come off of the shafts, they are the style knobs that were previously used and have set screws (B) that must be removed before removing the knobs. These knobs can be replaced by knobs without screws.

CAUTION: Before replacing the control knobs, visually check the shafts for cracks; if cracks are discovered, you must replace the BCB.

Reassembly:

Step 1 Verify that the shafts are turned to their extreme clockwise positions; replace the control knobs by aligning the indicator line on the knob with the highest setting on the panel label.

Step 2 Push the new control knobs onto the shafts.

Step 3 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

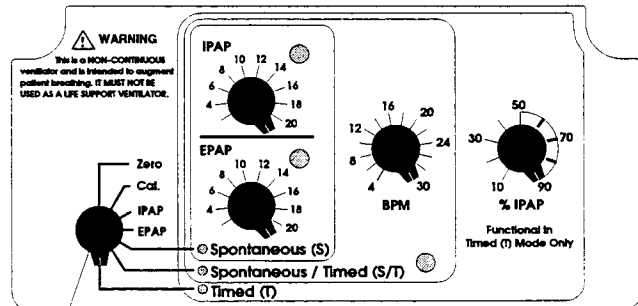


Figure 6-27

6.2.15 Voltage Selector Switch Replacement

Replacement Kit Number: 332175 for serial numbers less than 200,000
332555 for serial numbers 200,000 or greater

Repair Kit Contents	Tools Required
Voltage selector switch (1) Tie wraps, ET-3 (3)	Torque screwdriver set to 4 in-lb Needle nose pliers

Refer to Figures: 6-28

Disassembly:

- Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.
- Step 2 Remove the six Phillips head screws (A) holding the rear end cap (B) in place.
- Step 3 Turn the unit upside down.
- Step 4 Tilt the rear end cap away from the unit frame.

CAUTION: Before removing the voltage selector switch wires from the transformer, note the proper position of the wires and label them for reconnection.

- Step 5 Remove the voltage selector switch wires (C) from transformer terminals 1, 2, 5, and 6 (D). Cut the nylon wire tie that holds each pair of wires.
- Step 6 With a pair of needle nose pliers, remove the nylon nut (E) that secures the voltage selector switch (F) to the rear end cap.
- Step 7 When the nut is removed, feed the wires, one at a time, through the nut.
- Step 8 Remove the voltage selector switch.

Reassembly:

- Step 1 Place the new voltage selector switch in the rear end cap and feed its wires through the nylon nut, one at a time.
- Step 2 With a pair of needle nose pliers, tighten the nylon nut against the rear end cap. **DO NOT OVERTIGHTEN.** Be sure that the tab on the voltage selector switch aligns with the notch in the selector hole in the chassis.
- Step 3 Reconnect the voltage selector switch wires to transformer terminals 1, 2, 5, and 6. Group the red and white wire together and secure them together with a nylon wire tie near the transformer. Repeat for the black and yellow wire.
- Step 4 Replace the rear end cap and tighten with six Phillips head screws. Use the torque screwdriver set to 4 in-lb.
- Step 5 Turn the unit right side up.
- Step 6 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

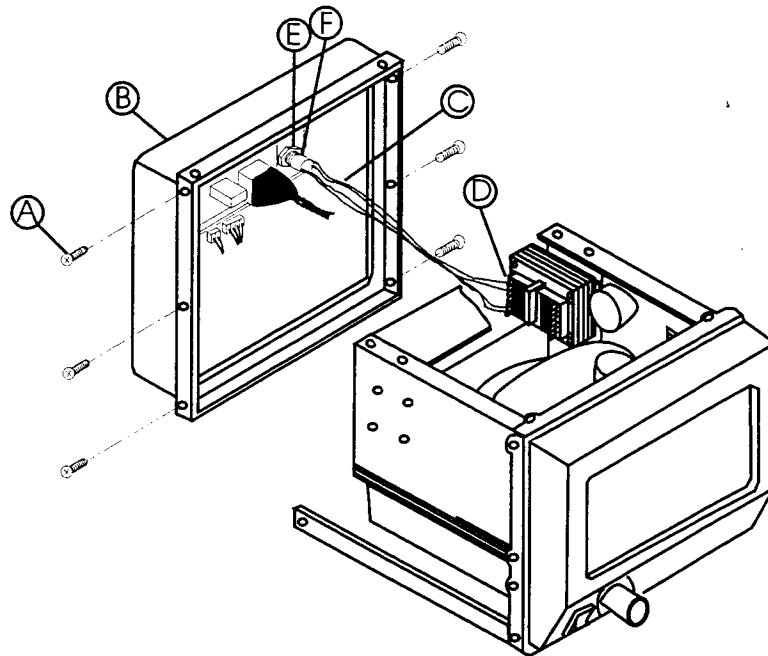


Figure 6-28

6.2.16 Time Meter Replacement

Replacement Kit Number: 332176

Repair Kit Contents	Tools Required
Time meter (1) Tie wrap, ET-3 (1) Time meter labels (2)	Torque screwdriver set to 4 in-lb Hot glue gun Razor blade knife Denatured alcohol

Refer to Figures: 6-29

Disassembly:

- Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.
- Step 2 Remove the six Phillips head screws (A) holding the rear end cap (B) in place.
- Step 3 Turn the unit upside down.
- Step 4 Tilt the rear end cap away from the unit frame.

CAUTION: Before removing the time meter wire plug from the Motor Controller Board, note the proper position and orientation of the plug.

- Step 5 Remove the time meter wires (C) from the Motor Controller Board. The time meter wires are the last set to the right of the connector (purple and green wires).
- Step 6 With a slotted screwdriver, release the wire retaining clip (D) on the bottom of the blower assembly and remove the wires.
- Step 7 Apply some alcohol to the hot melt glue that secures the time meter (E) to the rear end cap. You may have to lightly score the glue as well. Peel the glue away from the rear end cap and the time meter.
- Step 8 Push the time meter out of the rear end cap and remove any excess glue from the rear end cap.

Reassembly:

- Step 1 Place the new time meter in the rear end cap.
- Step 2 Apply hot melt glue around the outside of the time meter, securing the meter to the rear end cap.
- Step 3 Reconnect the time meter wires to the Motor Controller board. Secure the time meter wires with nylon tie wraps at 2 places along the length of the wires.
- Step 4 Replace the rear end cap and tighten the six Phillips head screws. Use the torque screwdriver set to 4 in-lb.
- Step 5 Turn the unit right side up.

- Step 6 Take out the two labels that are supplied in the replacement kit. Write the hours of the old meter and the date it was replaced on both labels. Apply one label on the paperwork. To apply the second label to the BiPAP unit, turn the unit so that the rear end cap is facing up. Place the label on the bottom of the rear end cap, adjacent to the Model Number.
- Step 7 Replace the wraparound and feet.
- Step 8 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

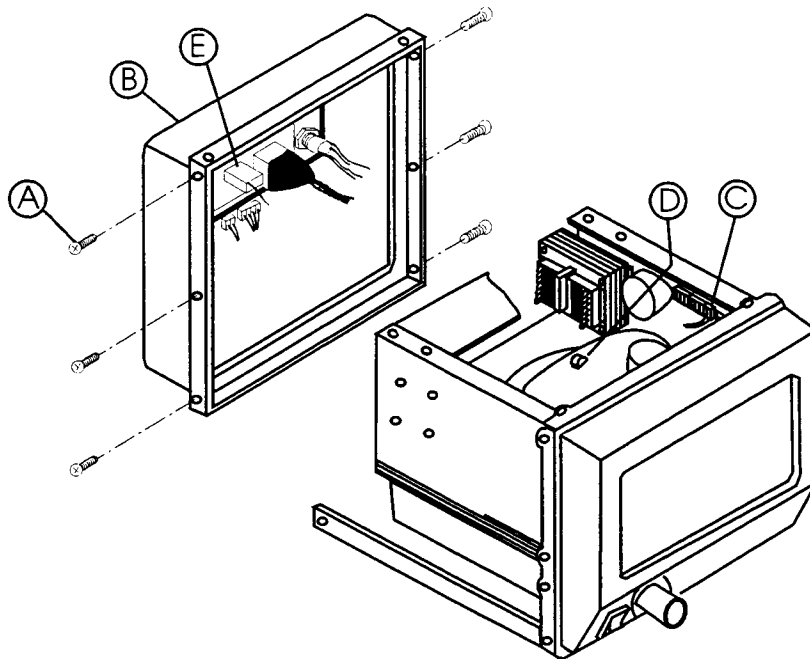


Figure 6-29

6.2.17 Pressure Port Replacement (S-D and S/T-D Models Only)

Replacement Kit Number: 332162

Repair Kit Contents	Tools Required
Pressure port (1) Tie wrap, ET-3 (1) Pressure port label (1) Hose clamps (2)	Torque screwdriver set to 4 in-lb Cutting pliers Medium slotted screwdriver $\frac{13}{16}$ " socket

Refer to Figures: 6-30

Disassembly:

Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.

Step 2 Remove the six Phillips head screws (A) that hold the front end cap (B) in place.

NOTE: For units with serial numbers greater than 52000, perform Steps 2 to 4 of Section 6.2.20 before proceeding to Step 3.

NOTE: The hose clamps ratchet together. Use a slotted screwdriver to open the clamp.

Step 3 Remove and discard the hose clamp (C) from the flex connector.

Step 4 Cut the nylon tie wrap that holds the pressure port tube (D) on the pressure port. Pull the tube off of the pressure port.

Step 5 Tilt the front end cap away from the unit.

Step 6 Remove the pressure port retaining ring from the inside of the front end cap. Use wire cutters to cut the ring.

Step 7 Remove the pressure port from the front end cap.

Reassembly:

Step 1 Apply the "PRESSURE" label to the new pressure port as follows:

- Hold the port with the flat portion on top.
- Peel the backing off the label and place it on the front bottom center of the port.

Step 2 Slide the port into the front end cap. The hole is flattened on top to match the flat portion of the port.

Step 3 Place the retaining ring onto the inside of the pressure port. Place a $\frac{13}{16}$ " socket over the retaining ring, put pressure on the front of the front end cap and push the retaining ring until it is against the inside of the front end cap.

Step 4 Place a new hose clamp over the flexible connector and tighten it by one or two ratchets. Apply a fine mist of alcohol on the blower outlet port and slide the flexible connector onto the port. Tighten the hose clamp around the connector and blower outlet port.

Step 5 Push the pressure port tube onto the pressure port and tighten with a nylon tie wrap.

NOTE: For units with serial numbers greater than 52000, perform Reassembly Steps 1 to 3 of Section 6.2.20 before proceeding to Step 6.

- Step 6 Attach the front end cap to the unit with six Phillips head screws. Use the torque screwdriver set to 4 in-lb.
- Step 7 Replace the wraparound and feet.
- Step 8 Perform the System Adjustment and Final Test procedures in Chapter 7 of this manual.

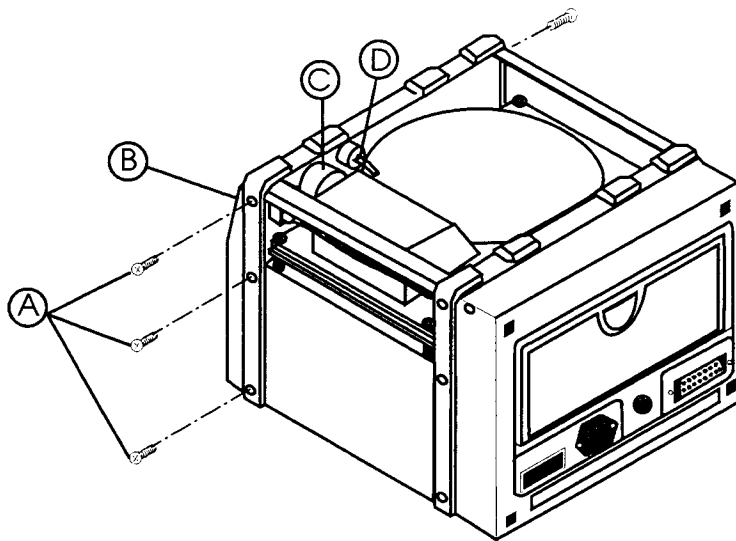


Figure 6-30

6.2.18 Crowbar Fuse Replacement

Replacement Kit Number: 332302

Repair Kit Contents	Tools Required
500 mA time delay fuses (2)	Needle nose pliers Cutting pliers Torque screw driver capable of 4 in-lb and 6 in-lb Torque nut driver capable of 4 and 6 in-lb Manual screwdriver set to 6 in-lb .050" Allen wrench (for models with set-screw control knobs)

Refer to Figures: 6-31

Disassembly:

- Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.
- Step 2 Remove the BiPAP Control Bard (BCB) as described in Section 6.2.4.
- Step 3 Turn the BCB with the component side toward you. Carefully remove the fuse (A) from its holder.

Reassembly:

- Step 1 Insert a new time delay fuse into the fuse holder.
- Step 2 Replace the BCB as described in Section 6.2.4.

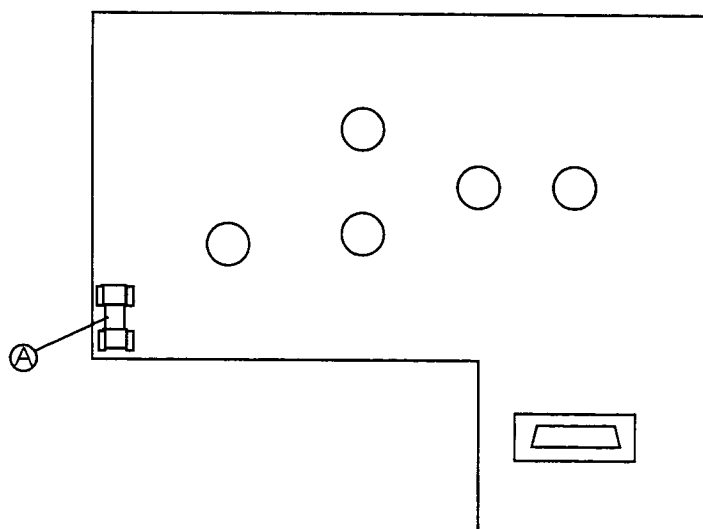


Figure 6-31

6.2.19 Latch Replacement

Replacement Kit Number: 332221

Repair Kit Contents	Tools Required
BiPAP latches (2) BiPAP latch keeper (2) 4-40 x $\frac{3}{8}$ " Phillips screws (4) 4-40 x $\frac{5}{16}$ " Phillips screws (4) 4-40 Locking nuts (4)	Power screw driver set to 4 in-lb

Refer to Figures: 6-32

Disassembly:

- Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.
- Step 2 Remove the four $\frac{5}{16}$ " Phillips screws (A) from the latches (B) on the accessory cap (C).
- Step 3 Remove the four $\frac{3}{8}$ " Phillips screws (D) from the latch keepers (E) on either side of the wraparound (F).

Reassembly:

- Step 1 Align the holes of the new latch keeper with the holes on the wraparound. Secure the latch keeper with two $\frac{3}{8}$ " Phillips screws. Use the torque screwdriver set to 4 in-lb.
- Step 2 Align the holes of the new latch with the holes on the accessory cap. Secure the latch with two $\frac{5}{16}$ " Phillips screws and two locking nuts (on the inside of the accessory cap). Use the torque screw
- Step 3 Replace the wraparound and feet.

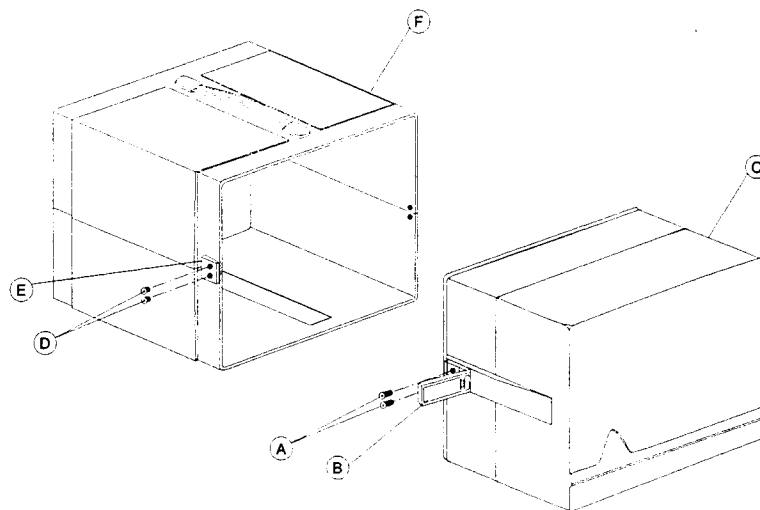


Figure 6-32

6.2.20 Top Plate Replacement

Replacement Kit Number: 332440

NOTE: This kit cannot be installed in BiPAP units with serial numbers less than 52000.

Repair Kit Contents	Tools Required
BiPAP top plate (1)	Torque screwdriver set to 4 in-lb

Refer to Figures: 6-33, 6-34

Disassembly:

- Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.
- Step 2 Remove the four Phillips head screws (A) that secure the top plate (B) to the side plates (C).
- Step 3 Lift the top plate off the BiPAP unit. Pull the front and back edges of the top plate from under the edges of the front and rear end caps.
- Step 4 Note the position of the foam (D) that is attached to the inside of the top plate. The plate must be positioned in the same way when you reassemble the BiPAP unit.

Reassembly:

- Step 1 Position the top plate on the top of the BiPAP unit. Ensure that the foam on the plate is inserted over the blower side of the unit.
- Step 2 Align the four holes in the top plate with the four holes in the tops of the side panels.
- Step 3 Insert and tighten the four Phillips screws that secure the top plate to the side panels. Use the torque screwdriver set to 4 in-lb.
- Step 4 Replace the wraparound and feet.

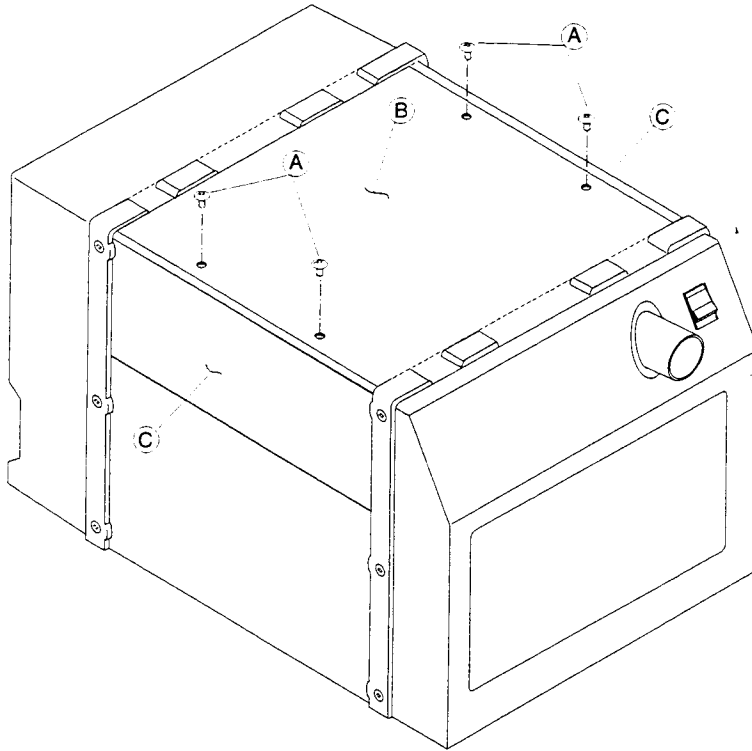


Figure 6-33

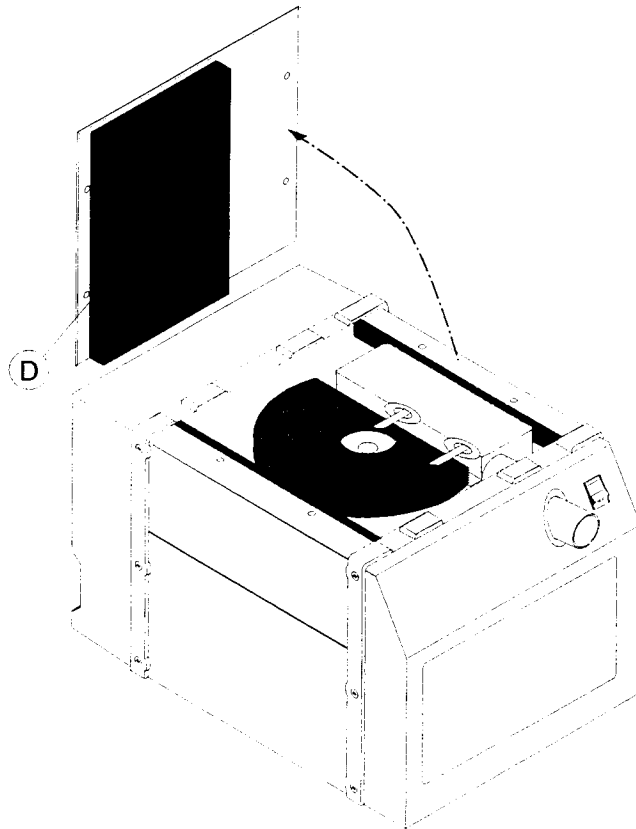


Figure 6-34

6.2.21 Side Panel Replacement

Replacement Kit Number: 332443

Repair Kit Contents	Tools Required
BiPAP side panel (2)	Torque screwdriver set to 4 in-lb

Refer to Figure: 6-35

Disassembly:

- Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.
- Step 2 Remove the top plate as described in Section 6.2.20.
- Step 3 Remove the six Phillips head screws (A) that secure the front end cap (B) to the frame. You will have to move the front end cap slightly away from the frame to facilitate the removal of the side plates.
- Step 4 Remove the two Phillips head screws (C) that secure the rear end cap to side panels.
- Step 5 Slide the Side Panels (D) and (E) out from the unit. Be sure to note from which side the panels are removed; they are not interchangeable.

Reassembly:

- Step 1 Place the side panels into their original positions and align the holes through the front and rear end caps.
- Step 2 Insert and slightly tighten the two rear end cap screws and the six front end cap screws.
- Step 3 When all the side panel and end cap screws are inserted, tighten all the screws with the torque screwdriver set to 4 in-lb.
- Step 4 Return the top plate to its original position and align the holes in the plate with the holes in the side panels.
- Step 5 Insert and tighten the four screws that secure the top panel to the side plates. Use the torque screwdriver set to 4 in-lb.
- Step 6 Replace the wraparound and feet.

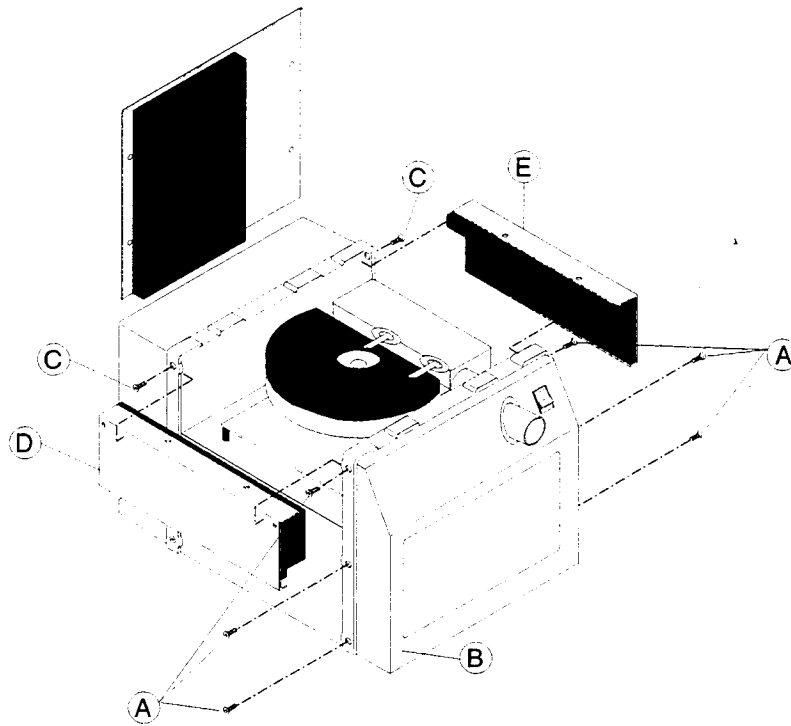


Figure 6-35

6.2.22 Bottom Plate Replacement

NOTE: This kit cannot be installed in BiPAP units with serial numbers less than 52000.

Replacement Kit Number: 332445

Repair Kit Contents	Tools Required
BiPAP bottom plate (1)	Torque screwdriver set to 4 in-lb

Refer to Figures: 6-36, 6-37

Disassembly:

- Step 1 Remove the wraparound as described in Section 6.1.1, Preparing the Unit for Service.
- Step 2 Turn the BiPAP unit over so that it is resting on its top.
- Step 3 Remove the six Phillips head screws (A) that secure the bottom plate (B) to the frame.
- Step 4 Remove the bottom plate, noting the orientation of the plate.

Reassembly:

- Step 1 Place the bottom plate on the frame. Be sure that the plate is oriented so that the hole in the foam (C) is over the BiPAP valve.
- Step 2 Align the six holes in the bottom plate with the six holes in the frame.
- Step 3 Insert and tighten the six Phillips screws that secure the bottom plate to the frame. Use the torque screwdriver set to 4 in-lb.
- Step 4 Replace the wraparound and feet.

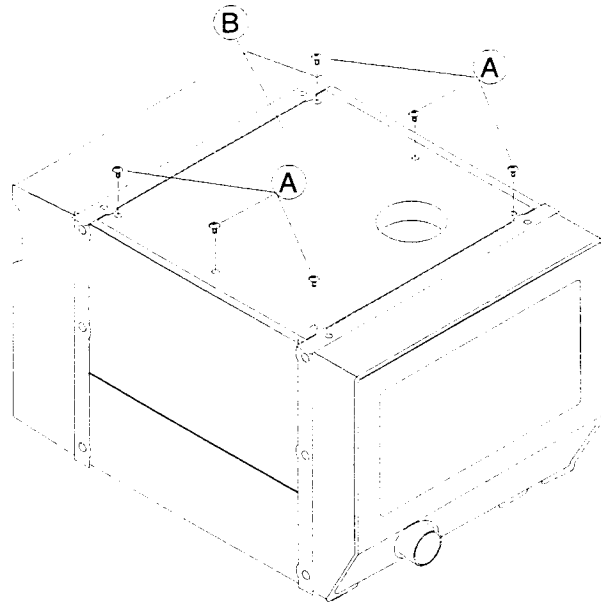


Figure 6-36

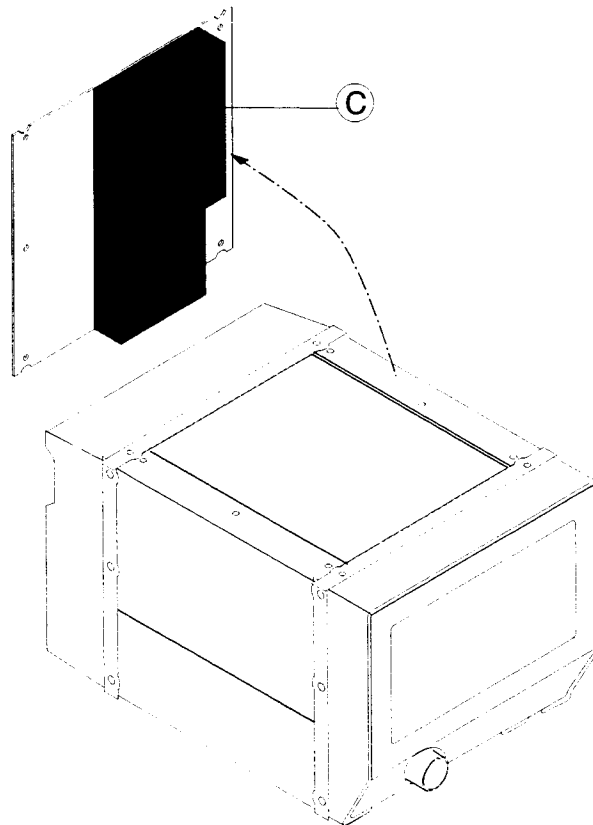


Figure 6-37

Chapter 7 System Adjustment and Final Tests

7.1 Requirements

7.2 Initial Equipment Set-up

7.3 Selector Switch Movement Test

7.4 Blower Pressure Adjustment

7.5 Flow Transducer Calibration

7.6 Valve Control Calibration

7.7 Pressure Monitor Calibration

7.8 Pressure Monitor Calibration Using DCP

7.9 Blocked and Unblocked Watts

7.10 Trigger Level Verification

7.11 Overnight Run/Morning Check

7.12 System Final Test

7.13 Spontaneous Mode Verification

7.14 Spontaneous/Timed Mode Verification

7.15 Timed Mode Verification

7.16 Verify Zero Function

7.17 Verify Calibrate Function

7.18 DCP Verification

7.19 Corrective Actions

CAUTION: Electronic components used in this unit are subject to damage by static electricity. Use proper static discharge and grounding precautions when servicing the equipment. Service only at a static-free workstation.

NOTE: The procedures in this chapter are used for both the adjustment and final test. The only difference is that during adjustment the trim pots are adjusted to specifications and measurements are recorded. During the final test, trim pots are not adjusted and measurements are verified to specifications and recorded.

7.1 Requirements

7.1.1 Equipment

Major Items:

- Oscilloscope
- Multimeters
- Electronic Manometer
- Watt Meter (150W full scale, 1W resolution) with unit power cord
- Flow Meter System
- DCP (S-D and S/T-D units only)
- Trigger Level Test Fixture — Respironics #332300
- BiPAP Small Tool Kit — Respironics #332301
- Air pressure source capable of delivering 50 psi.
- Manometer tubing with smooth inner lumen

See Appendix A for a complete list and a list of acceptable alternate equipment.

7.1.2 Data Sheet

You must complete a System Data Sheet for each test you perform. Appendix B contains the sheet, which you may copy for each test you perform. The sheet is two-sided; one side of the System Data Sheet may be used for the adjustment, and the other side for the final test.

7.1.3 Required Tests

The chart below indicates which procedures you must use for the BiPAP model you are testing. A "Y" in the column means you must perform the test; an "N" indicates the test is not applicable to the model.

Procedure	Model			
	S	S/T	S-D	S/T-D
7.3	Y	Y	Y	Y
7.4	Y	Y	Y	Y
7.5	Y	Y	Y	Y
7.6	N	N	Y	Y
7.7	N	N	Y	Y
7.8	Y	Y	Y	Y
7.9	Y	Y	Y	Y
7.10	Y	Y	Y	Y
7.11	Y	Y	Y	Y
7.12	Y	Y	Y	Y
7.13	N	Y	N	Y
7.14	N	Y	N	Y
7.15	N	N	Y	Y
7.16	N	N	Y	Y
7.17	N	N	Y	Y
7.18	Y	Y	Y	Y

7.1.4 Test Sequence

The required tests are performed twice. The first time, called the adjustment, is used to make adjustments to the unit. The second run is called the final; you simply record the measurements. The system adjustment and final are to be performed as followed:

1. Perform the system adjustments.
2. Run the unit for a minimum of 1 hour (8 hours overnight suggested).
3. Check the outlet temperature.
4. Perform the final tests.

7.2 Initial Equipment Set-up

Figure 7-1 shows the initial equipment set-up.

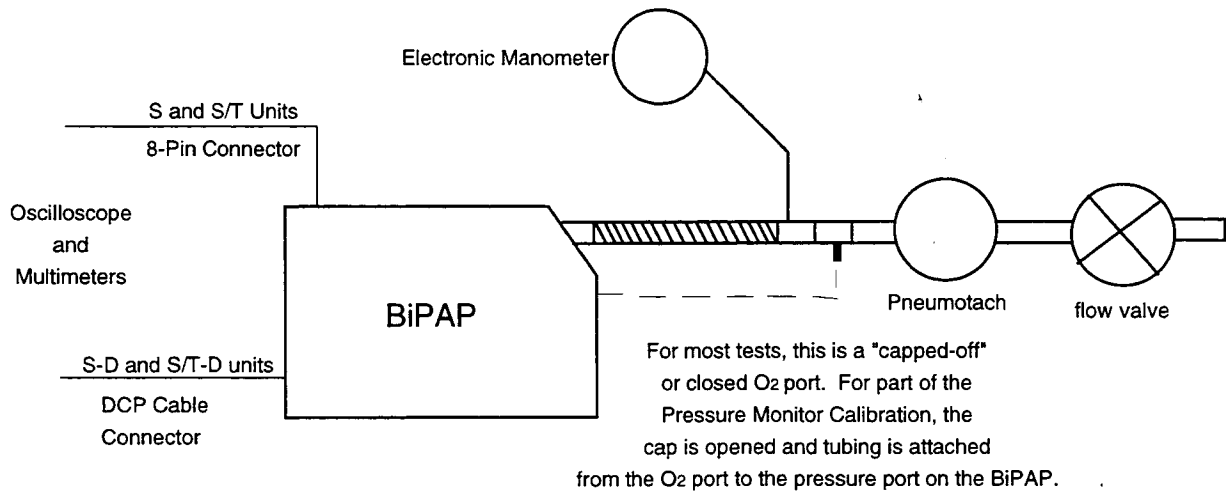
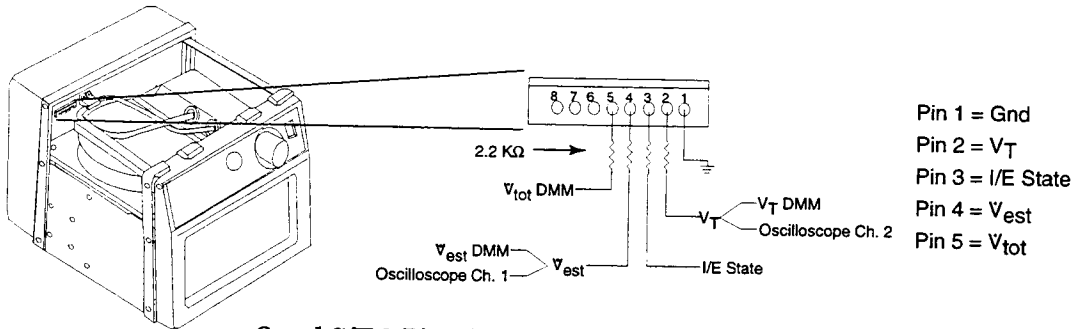
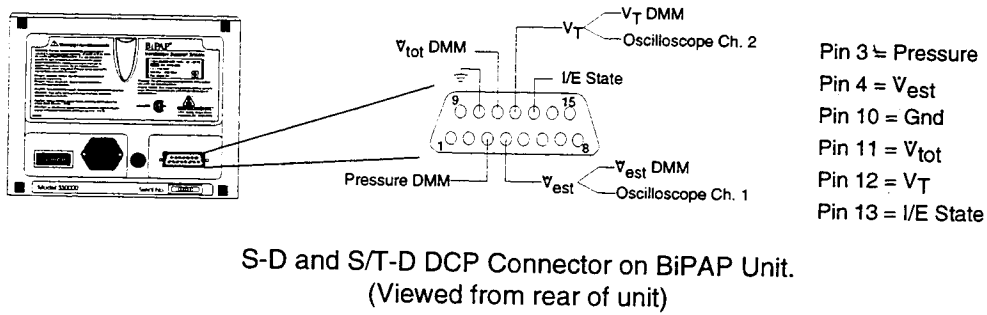


Figure 7-1. Initial Equipment Set-up.

1. Plug the BiPAP unit to be tested into the watt meter. Plug the watt meter into a power source.
2. Attach one end of the 6 ft. tubing, with a smooth inner lumen, to the outlet of the BiPAP unit.
3. Insert two O₂ ports into the other end of a 6 ft. tube.
4. Attach a length of tubing from the first O₂ port to a calibrated or electronic manometer.
5. "Cap-Off" the second O₂ port.
6. Attach the "Up-Stream" end of a pneumotach (i.e. flow tube part of a flowmeter) to the second O₂ port.
7. Attach a flow valve to the "down-stream" end of the pneumotach.

You will access six electrical signals (five for S and S/T units) from the BiPAP unit. These signals may be obtained from the DCP cable connector for the S-D and S/T-D units, or from the 8-pin connector on the BiPAP Control Board (BCB) on S and S/T units. Figure 7-2 shows the pin assignments for the DCP cable connector and the 8-pin connector.



Note: You must remove the cover to access the connector.

It is suggested that you add a 2.2kΩ resistor in series with each output except the ground. (this reduces the 'noise' on the signals).

Note: You must remove the cover to access the connector.

Figure 7-2. Pin Assignments.

The system is ready to be tested. Follow any additional set-up procedures for each test function as required.

NOTE: If at any time during the following tests the unit fails to meet the specifications as stated, repeat the test for the appropriate specification. If the unit fails a second time, mark in the comment area what the problem is, record the hour meter reading, sign and date the history papers, and prepare the unit for repair. See Section 7.18 for corrective actions to take for a failure in any test.

CAUTION: Wear a grounding wrist strap to prevent static electric damage any time a unit is being handled or tested.

7.3 Blower Pressure Adjustment (all units)

7.3.1 Test Equipment Set-up

The test equipment remains the same from the Initial Set-up, Section 7.2.

7.3.2 BiPAP Set-up

- Step 1 Close the flow valve.
- Step 2 Set the BiPAP selector switch to IPAP mode.
- Step 3 Set the IPAP control knob to maximum (full clockwise).

Figure 7-3 shows the location of the trimpot R6 on the motor control board.

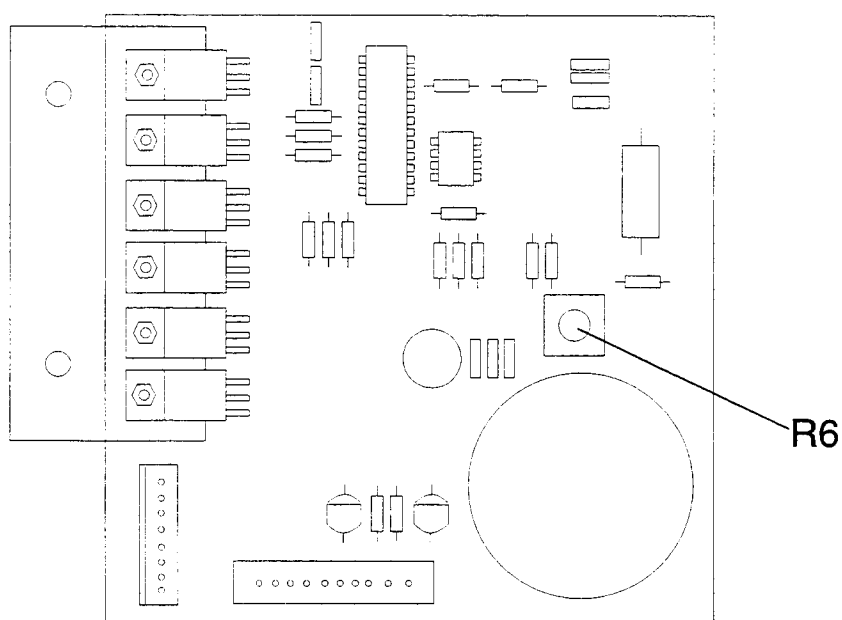


Figure 7-3

7.3.3 Test Procedure

- Step 1 Hold the BiPAP valve completely shut.
- Step 2 Adjust the flow valve for 100 L/min flow (± 2 L/min).
- Step 3 Adjust R6 on the motor control board to obtain 20 cm H₂O on the manometer.
- Step 4 Re-adjust the flow valve if necessary to maintain 100 L/min flow.
- Step 5 Re-adjust R6 for 20 cm H₂O (± 1 cm). Record the blower pressure.
- Step 6 Momentarily block the flow valve and hold the BiPAP valve shut to attain zero flow (± 1 L/min).
- Step 7 Measure and record the dead-head pressure.
- Step 8 Unblock the flow valve and verify 20 cm H₂O (± 1 cm) pressure at 100 L/min flow.
- Step 9 Stop holding the BiPAP valve shut.

7.4 Flow Transducer Calibration (all units)

NOTE:

As of February, 1992, Respironics began using a new flow transducer/BiPAP Control Board (BCB) combination. Since the flow transducer calibration differs between the transducers, two calibration sections (7.5.3 and 7.5.4) are now presented. You must identify the part number of the transducer in the unit you are calibrating, and select the appropriate procedure. The Test Equipment and BiPAP set-ups are identical. The old transducer number is 332046. The board used with this transducer includes trimpot R91. The new transducer number is 332290. The board used with the new transducer does not have trimpot R91. You can find the transducer number on the Blower S/A label located on top of the flow transducer. (If there is no transducer number, then the flow transducer is the new number 332290.)

If a new blower has been installed in a unit with an old BCB which has R91 then, you may not be able to perform the flow calibration; the board, in about 10% of the cases, does not have enough gain. If this occurs, Respironics recommends that you install a new board to ensure the successful calibration of the transducer, but you may try another old board.

7.4.1 Test Equipment Set-up

The test equipment remains the same from the Initial Set-up, Section 7.2.

7.4.2 BiPAP Set-up

- Step 1 Close the flow valve.
- Step 2 Set the BiPAP selector switch to IPAP mode.
- Step 3 Set the IPAP control knob to maximum (full clockwise).
- Step 4 Access the \dot{V}_{tot} (total flow) signal with a multimeter. (Example: read millivolts DC mV range 2000 on Amprobe.)

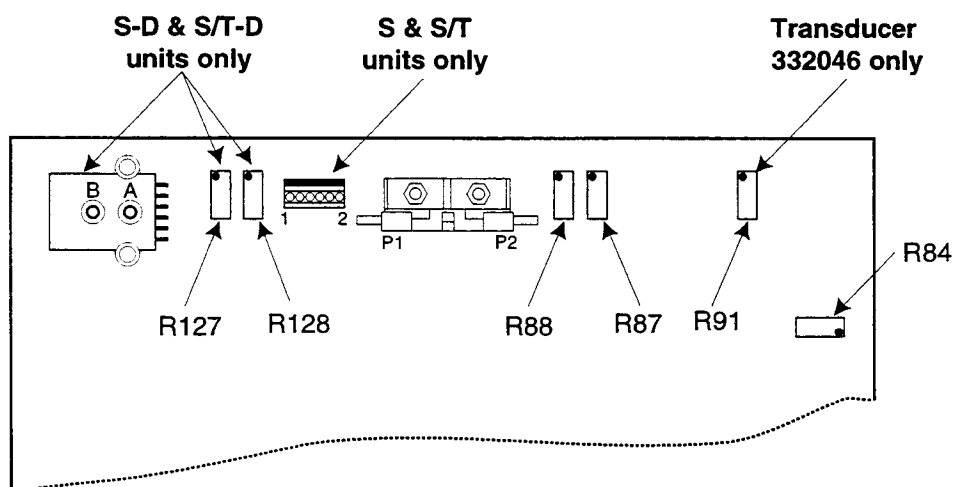


Figure 7-4 shows the location of the trimpots on the BCB.

Figure 7-4

7.4.3 Test Procedure for Transducer 332046 (Trimpot R91)

Adjust Flow Transducer:

- Step 1 Adjust R88 for 0 VDC on the \dot{V}_{tot} meter (± 5 mV). Remove the adjustment tool from the trimpot and allow the setting to stabilize before continuing.
- Step 2 Adjust the flow valve for 60 L/min (± 1) on the pneumotach.
- Step 3 Measure the \dot{V}_{tot} signal in a to DCV range such as 20
- Step 4 Adjust R91 to obtain the maximum voltage output on the \dot{V}_{tot} meter (i.e. until the voltage just stops increasing i.e. just 'levels off' i.e. 'just plateau's'). The maximum voltage can be from 1.2 V to 2.5 V, and typically is 1.4 V to 1.6 V.
- Step 5 Adjust R87 for 1.50 V (± 30 mV) output of the \dot{V}_{tot} signal.
- Step 6 Re-adjust R91 for 1.00 V (± 20 mV) output on the \dot{V}_{tot} meter.
- Step 7 Block the outlet and verify that zero flow produces 0 VDC (± 30 mV) of the \dot{V}_{tot} signal. Record the voltage on the System Data Sheet for 0 L/min if it is within specification.
- Step 8 If the zero flow voltage is not within specification, repeat Steps 1-7.

Record Flow Transducer:

- Step 1 Unblock the outlet and adjust the flow valve for 30, 60, 90, and 120 L/min flow and record the \dot{V}_{tot} reading for each step.

7.4.4 Test Procedure for Transducer 332290 (no Trimpot R91)

Adjust Flow Transducer:

- Step 1 Adjust R88 for 0 VDC of the \dot{V}_{tot} signal (± 5 mV). Remove the adjustment tool from the trimpot and allow the setting to stabilize before continuing.
- Step 2 Adjust the flow valve for 60 L/min (± 1) on the pneumotach.
- Step 3 Measure the \dot{V}_{tot} signal in a DCV range, such as 20.
- Step 4 Adjust R87 for 1.00 V (± 20 mV) output of the \dot{V}_{tot} signal.
- Step 5 Block the outlet and verify that zero flow produces 0 VDC (± 10 mV) of the \dot{V}_{tot} signal. Record the voltage on the System Data Sheet for 0 L/min if it is within specification.
- Step 6 If the zero flow voltage is not within specification, repeat Steps 1-5.

Record Flow Transducer:

- Step 1 Unblock the outlet and adjust the flow valve for 30, 60, 90, and 120 L/min flow and record the \dot{V}_{tot} reading for each step.

7.5 Valve Control Calibration (all units)

7.5.1 Test Equipment Set-up

The test equipment remains the same from the Initial Set-up, Section 7.2.

7.5.2 BiPAP Set-up

Step 1 Close the flow valve. Set the BiPAP selector switch to IPAP mode.

7.5.3 Test Procedure

Calibrate Valve Control:

- Step 1 Turn the IPAP control knob to 20 cm.
- Step 2 Adjust R84 for 20.5 cm H₂O (± 0.2 cm) on the manometer.
- Step 3 Record the pressure on the manometer for each control knob setting: 20, 18, 12, 6, and minimum (usually about 1.4).
- Step 4 Turn the function selector knob to the EPAP mode and repeat Step 3 using the EPAP control knob.

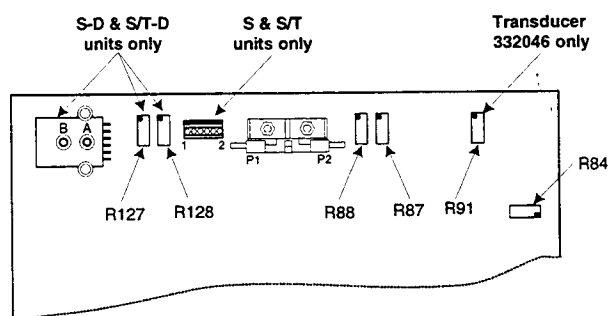


Figure 7-5

Pressure vs. Flow:

- Step 1 Verify the flow valve is still closed. The flowmeter should read 0 flow.
- Step 2 Turn the function selector knob to the IPAP mode and adjust the IPAP control knob until 18 cm H₂O is obtained on the manometer.
- Step 3 Open the flow valve to 50 and 100 L/min and record the pressure for each setting.
- Step 4 Close the flow valve.
- Step 5 Adjust the IPAP control knob until 12 cm H₂O is obtained on the manometer.
- Step 6 Open the flow valve for 50 and 100 L/min and record the pressure for each setting.
- Step 7 Close the flow valve.
- Step 8 Adjust the IPAP control knob until 6 cm H₂O is obtained on the manometer.
- Step 9 Open the flow valve for 50 and 100 L/min and record the pressure for each setting.

NOTE: Some RT-200's may not be able to measure 6cm H₂O at 10L/min., i.e. only 60-70 L/min. can get through.

NOTE: The unit is not required to meet specifications at 150 L/min. The measurement was made for engineering purposes only. Older service manual, and System Test Data Sheets may mention 150L/min flow valve settings.

7.6 Pressure Monitor Calibration (S/T-D and S-D units)

NOTE: Use this procedure when only the BiPAP unit itself is being calibrated.

7.6.1 Test Equipment Set-up

The test equipment remains the same from the Initial Set-up, Section 7.2.

7.6.2 BiPAP Set-up

- Step 1 Close the flow valve.
- Step 2 Set the BiPAP selector switch to IPAP mode.
- Step 3 Set the IPAP control knob to maximum (full clockwise).

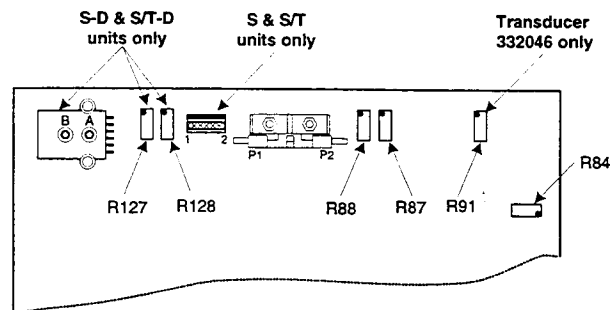


Figure 7-6

Figure 7-6 shows the location of the trim pots on the BCB.

7.6.3 Test Procedure

Calibrate Pressure Monitor:

- Step 1 Set R127 for 0 VDC (0.0 to 0.1) on the Pressure signal.
- Step 2 Uncap the capped O₂ port pressure pick-off and attach manometer tubing from the O₂ port to to the pressure port on the BiPAP.
- Step 3 Adjust the IPAP control knob for 10 cm H₂O (\pm .1 cm) on the manometer.
- Step 4 Adjust R128 for 1.0 VDC (\pm 0.1) on the Pressure signal.
- Step 5 Remove the tubing from BiPAP pressure port and record zero 0 VDC (0.0 to 0.1). Reattach the tubing.
- Step 6 Verify that the Pressure meter reads 1.0 VDC (\pm 0.1).
- Step 7 Set the IPAP control knob for pressures of 5, 10, 15, 20 cm H₂O on the manometer, and record the Pressure signal voltage for each setting.

7.7 Pressure Monitor Calibration (Using the DCP)

NOTE: Use this procedure if both a BiPAP and specific DCP are being calibrated together.

7.7.1 Test Equipment Set-up

The test equipment remains the same from the Initial Set-up, Section 7.2, except for connecting a DCP to the BiPAP.

7.7.2 BiPAP Set-up

- Step 1 Close the flow valve.
- Step 2 Set the DCP function selector knob to the IPAP mode.
- Step 3 Set the DCP IPAP control knob to minimum (full clockwise).
- Step 4 Set the DCP display selector knob to IPAP.

Figure 7-6 shows the location of the trimpots on the BiPAP BCB.

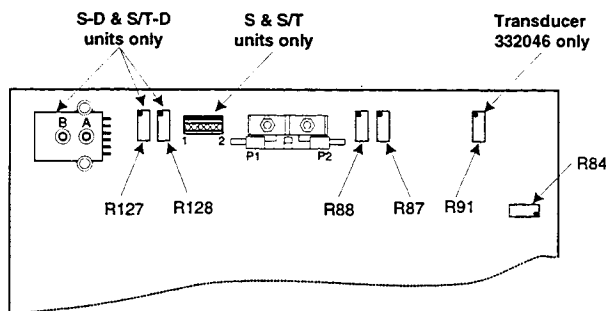


Figure 7-6

7.7.3 Test Procedure

Calibrate Pressure Monitor:

- Step 1 Uncap the capped O₂ port pressure pick-off and attach manometer tubing to the O₂ port and to the pressure port on the BiPAP.

NOTE: Use a "T" to connect a calibrated manometer to the pressure port for reference.

- Step 2 Set R127 so that the DCP display matches a calibrated reference manometer reading (typically about 1.5 cm H₂O.)
- Step 3 Adjust the DCP IPAP control knob for maximum on the manometer.
- Step 4 Adjust R128 on the pressure monitor board so the DCP reading matches a calibrated reference manometer reading.
- Step 5 Set the DCP IPAP control knob for 5, 10, 15, and 20 cm H₂O and record the DCP display reading for each setting pressure setting.

This procedure is accurate to within 1.2 cm H₂O.

7.8 Blocked and Unblocked Watts (all units)

7.8.1 Test Equipment Set-up

The test equipment remains the same from the Initial Set-up, Section 7.2.

7.8.2 BiPAP Set-up

- Step 1 Close the flow valve.
- Step 2 Set the BiPAP selector switch to IPAP mode.
- Step 3 Set the IPAP control knob to maximum (full clockwise).

7.8.3 Test Procedure

- Step 1 Record the blocked AC Watts on the System Data Sheet.
- Step 2 Remove the tubing from the outlet and record the unblocked AC watts. The unblocked watts must be less than 85 watts.
- Step 3 Record the hour meter reading on the System Data Sheet.

7.9 Trigger Level Verification (all units)

7.9.1 Test Equipment Set-up

- Step 1 Remove the BiPAP from the equipment set-up in section 7.2. It requires both an electrical power supply and an air pressure source greater than 50 psi.
- Step 2 Set up the Trigger Test Fixture. Connect the output hose of the fixture to the pressure pickoff of the dual O₂ port.
- Step 3 Install the dual O₂ port on the outlet of the BiPAP unit. Do not block the second port.
- Step 4 Optional: Access the \dot{V}_{tot} and \dot{V}_{est} signals if desired. Use a DCV range of 20.

7.9.2 BiPAP Set-up

- Step 1 Set the BiPAP selector switch to SPONTANEOUS mode.
- Step 2 Set the IPAP control knob to 12.
- Step 3 Set the EPAP control knob to 5.

7.9.3 Test Procedure

- Step 1 Turn on the trigger level test fixture. The ball should indicate 3 L/min flow.
- Step 2 Block the 0.25" orifice of the test fixture.
- Step 3 Wait until the \dot{V}_{est} reading stabilizes (approximately 15 to 30 seconds).
- Step 4 Turn off the trigger level test fixture. The unit should trigger 1 to 5 times.
- Step 5 Unblock the 0.25" orifice. The unit should trigger 6 to 12 times.
- Step 6 Turn on the trigger level fixture. The ball should indicate 3 L/min flow.
- Step 7 Wait until the \dot{V}_{est} reading stabilizes (approximately 15 to 30 seconds).
- Step 8 Turn off the trigger level test fixture. The unit should trigger 1 to 5 times.
- Step 9 Turn on the trigger level test fixture. The ball should indicate 3 L/min flow.
- Step 10 Block the 0.25" orifice of the test fixture.
- Step 11 Wait until the \dot{V}_{est} reading stabilizes (approximately 15 to 30 seconds).
- Step 12 Turn off the trigger level test fixture. The unit should trigger 1 to 5 times.

7.10 Overnight Run/Morning Check

All units which have been repaired must be run for 1 hour before final testing. If the unit has been repaired due to an issue related to time or temperature then a 8 hour run-in time is required. The following procedure outlines the settings for the run in.

The wraparound should be in place. Install a 0.25 " test adaptor when performing this test.

7.10.1 BiPAP S and S-D Set-up

Step 1 **With test adaptor** — set the mode to Spontaneous, the IPAP control to 8, and the EPAP control to its minimum setting.

7.10.2 BiPAP S/T and S/T-D Set-up

Step 1 **With test adaptor** — set the mode to Spontaneous/Timed, the IPAP control to 8, the EPAP control to 4, the BPM control to 12, and the %IPAP control to 50.

7.10.3 Test Procedure

Step 1 Make sure the wraparound is in place. Plug in the AC cord, turn the unit on, and allow it to run overnight (for a minimum of 8 hours), if the repair was due to a time or temperature issue. Allow the unit to run for a minimum of 1 hour for any other repair. After the unit has run in, check the outlet air temperature and the unblocked watts (set the IPAP control to maximum).

The outlet air temperature should be no more than 25°F above ambient temperature.

The unblocked watts should be less than 85 Watts.

7.11 System Final Test

When the system adjustments and overnight run-in/morning checks are complete, perform the system final test.

NOTE: All equipment remains the same as in section 7.2.

Step 1 Repeat sections 7.3 to 7.10 without making any adjustments. Record the measurements on the data sheet.

Step 2 Remove any tubing or test equipment and install a 0.25" test adaptor.

7.12 Spontaneous Mode Verification (all units)

7.12.1 Test Equipment Set-up

- Step 1 Connect Channel 1 of the oscilloscope to the V_T signal (Pin 12 of the DCP cable, connector or Pin 2 of the 8-pin connector) and Channel 2 of the scope to the V_{est} signal (Pin 4 of the DCP cable connector or Pin 4 of the 8-pin connector).
- Step 2 Set up the scope channels as follows:
- Timebase: 1 sec/div
 - Sensitivity: Channel 1—500 mV/div
Channel 2—500 mV/div
 - Measure: none
- Step 3 Remove the tubing from the outlet and install the 0.25" orifice on the outlet.

7.12.2 BiPAP Set-up

- Step 1 Set the BiPAP selector switch to the SPONTANEOUS mode.
- Step 2 Set the IPAP control knob to 12.
- Step 3 Set the EPAP control knob to 4.

7.12.3 Test Procedure

- Step 1 Block and unblock the orifice with a finger and note how the unit switches between EPAP and IPAP.
- Step 2 Observe that the EPAP and IPAP LED's illuminate accordingly.
- Step 3 Block and hold the orifice closed and observe that the V_{est} signal starts to ramp toward 0 V after a short delay, and that the V_T signal also goes to 0 V. Be sure that V_{est} is at 0 V before continuing. See Figure 7-7.
- Step 4 See Figure 7-8 for oscilloscope traces. Unblock the orifice and watch the V_T signal ramp for approximately 1.0 seconds, then block the orifice.
- Step 5 The V_T signal should reset after 1.18 to 1.40 seconds. Shortly after the V_T resets, stop the scope trace near the edge of the screen (press Run/Stop).
- Step 6 Measure the time between blocking the orifice (V_{est} reset) and V_T reset. Record the measurement on the data sheet.
- Step 7 Verify that if EPAP is set higher than IPAP, only IPAP works.

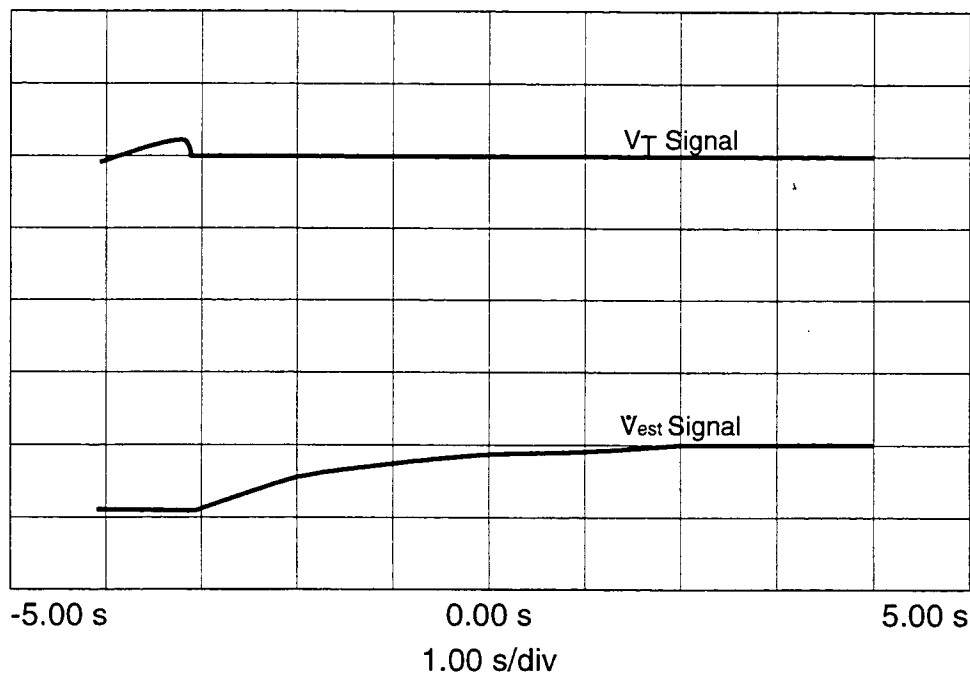


Figure 7-7. Spontaneous Mode, Ramp Up.

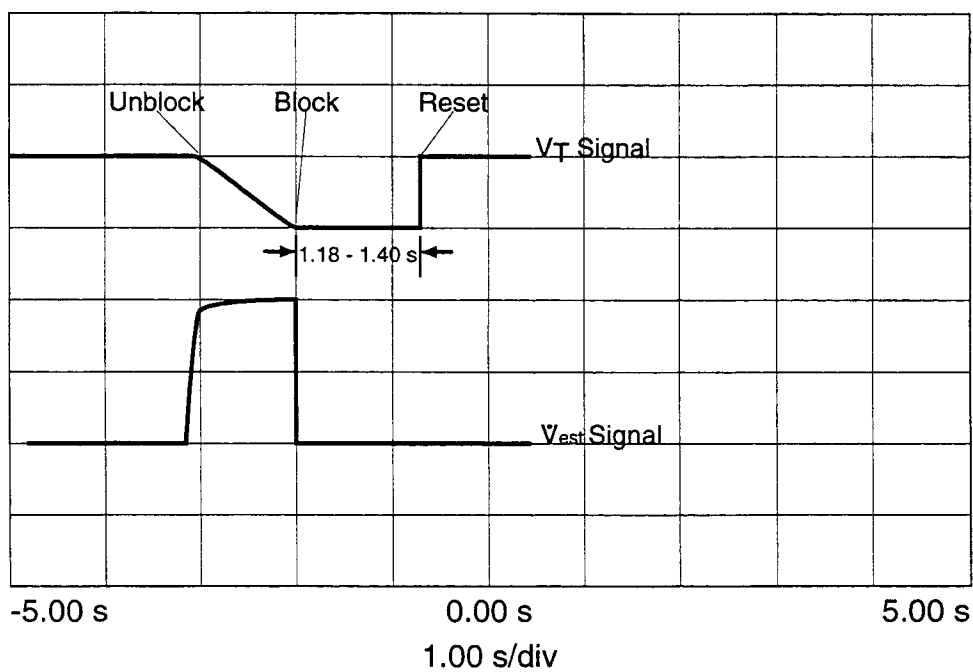


Figure 7-8. Spontaneous Mode.

NOTE: Traces shown are for BiPAP S and S/T. The plateau on the V_T signal goes upward on BiPAP S-D and S/T-D. The short plateau on the \dot{V}_{est} signal goes upward on all units.

7.13 Spontaneous/Timed Mode Verification (S/T & S/T-D)

7.13.1 Test Equipment Set-up

- Step 1 Connect Channel 1 of the oscilloscope to the I/E state signal (Pin 13 of the DCP cable connector or Pin 3 of the 8-pin connector) and Channel 2 of the scope to the V_{est} signal (Pin 4 of the DCP cable connector or Pin 4 of the 8-pin connector).
- Step 2 Set up the scope channels as follows:
- Timebase: 5 sec/div
 - Sensitivity: Channel 1—5 V/div
Channel 2—500 mV/div
 - Measure: period, duty cycle on Channel 1
- Step 3 Remove the tubing from the outlet and install the 0.25" orifice on the outlet.

7.13.2 BiPAP Set-up

- Step 1 Set the BiPAP selector switch to SPONTANEOUS/TIMED mode.
- Step 2 Set the IPAP control knob to 12.
- Step 3 Set the EPAP control knob to 4.
- Step 4 Set the BPM control knob to 16.

7.13.3 Test Procedure

- Step 1 Block and unblock the orifice faster than the BPM setting and note how the BiPAP unit switches between EPAP and IPAP respectively. The operation should be the same as in the Spontaneous mode.
- Step 2 Block and hold the orifice closed and note that the unit automatically cycles. See Figure 7-9 for oscilloscope traces. Observe that a spike occurs in the I/E state signal when the timed pulse occurs and that the Spontaneous/Timed LED illuminates.
- Step 3 The unit should continue to pulse the IPAP every 3.5 seconds \pm 0.5 seconds as long as the orifice is blocked.
- Step 4 Unblock and block the orifice more rapidly than the BPM rate (3.5 seconds) and note that the unit again operates the same as in the Spontaneous mode and that the Spontaneous/Timed LED is off.
- Step 5 Observe that a timed pulse does not occur as long as the orifice is being blocked and unblocked faster than the BPM rate (3.5 seconds).
- Step 6 Block the orifice and allow the unit to pulse.
- Step 7 Store the display on the oscilloscope when it looks like Figure 7-9. Measure the distance between 2 timed pulses (spikes). The time should be $3.55 \pm 0.5s$.
- Step 8 Mark pass or fail (P or F) on the data sheet.

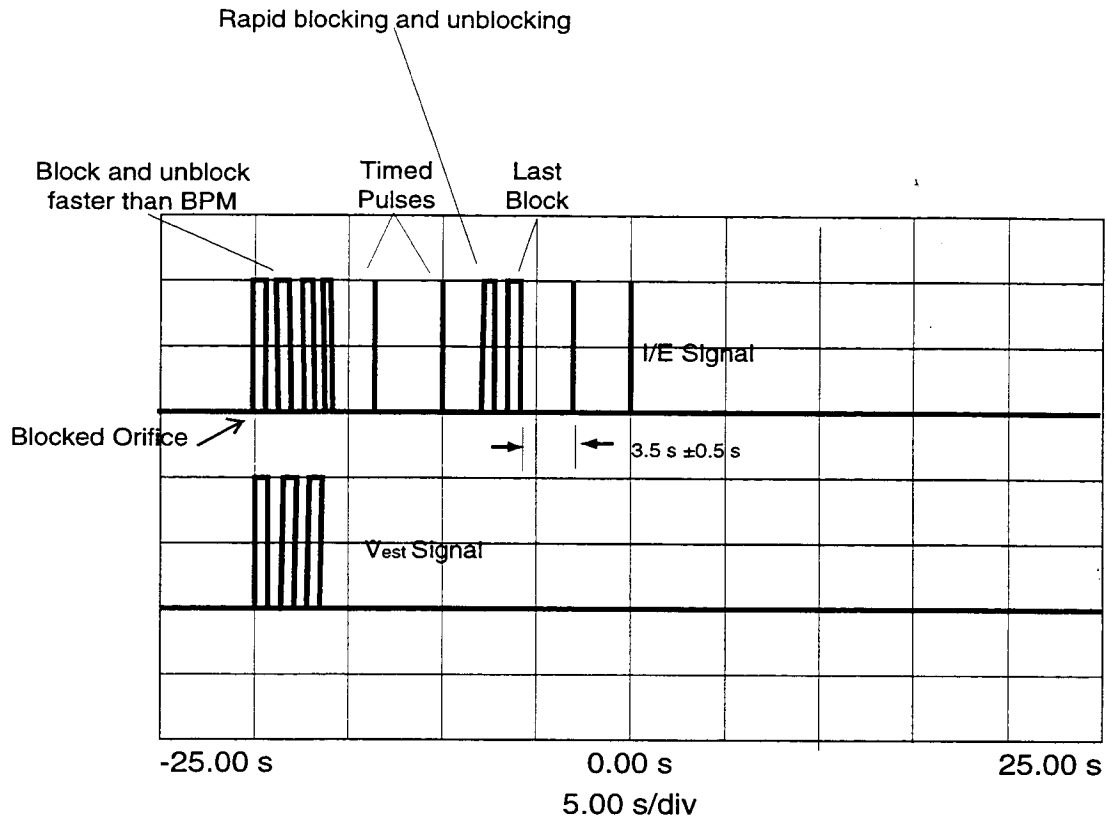


Figure 7-9. Spontaneous/Timed Mode.

7.14 Timed Mode Verification (S/T and S/T-D)

7.14.1 Test Equipment Set-up

- Step 1 Connect Channel 1 of the oscilloscope to the I/E state signal (Pin 13 of the DCP cable connector or Pin 3 of the 8-pin connector).
- Step 2 Set up the scope channel as follows:
- Timebase: 5 sec/div
 - Sensitivity: Channel 1—5 V/div
 - Measure: period, duty cycle on Channel 1
- Step 3 Remove the tubing from the outlet and install the 0.25" orifice on the outlet.

7.14.2 BiPAP Set-up

- Step 1 Set the BiPAP selector switch to TIMED mode.
- Step 2 Set the IPAP control knob to 12.
- Step 3 Set the EPAP control knob to 6.
- Step 4 Set the % IPAP control knob to 50%.
- Step 5 Set the BPM control knob to minimum (full counter-clockwise).

7.14.3 Test Procedure

- Step 1 Verify and record that the I/E signal has a period of approximately 10 to 30 seconds.
- Step 2 Adjust BPM to maximum.
- Step 3 Change the timebase on the oscilloscope to 1 sec./div. (press "timebase"; "1"; "s/v")
- Step 4 Press "Clear Display."
- Step 5 Verify and record that the I/E signal has a period of approximately 1.8 to 2.2 seconds. See Figure 7-11.
- Step 6 Adjust BPM to 16 and press "Clear Display."
- Step 7 Set % IPAP to 10% (minimum setting) and verify and record that the I/E state has a duty cycle of approximately 10% ($\pm 5\%$). See Figure 7-13.
- Step 8 Set % IPAP to 90% (maximum setting) and verify and record I/E state has a duty cycle of approximately 90% ($\pm 5\%$). See Figure 7-12.
- Step 9 Verify that the control panel LEDs switch on and off as the unit switches between IPAP and EPAP.
- Step 10 Mark pass or fail (P or F) on the data sheet.

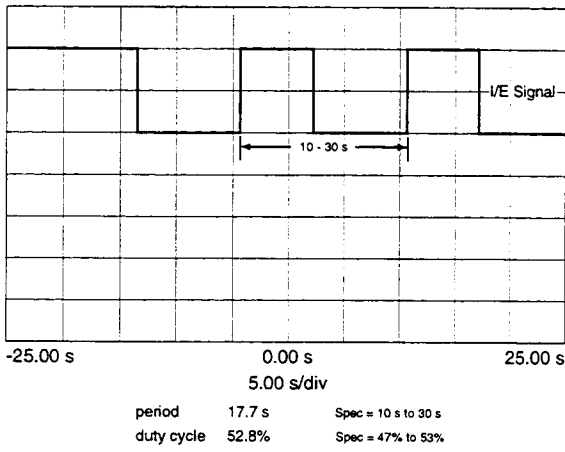


Figure 7-10. Timed Mode, BPM Min., %IPAP: 50%

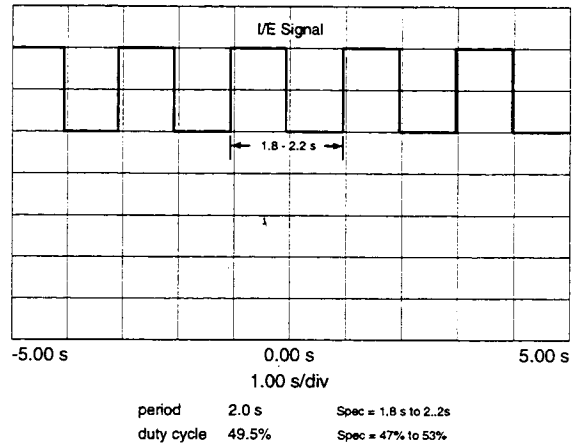


Figure 7-11. Timed Mode, BPM Max, %IPAP: 50%

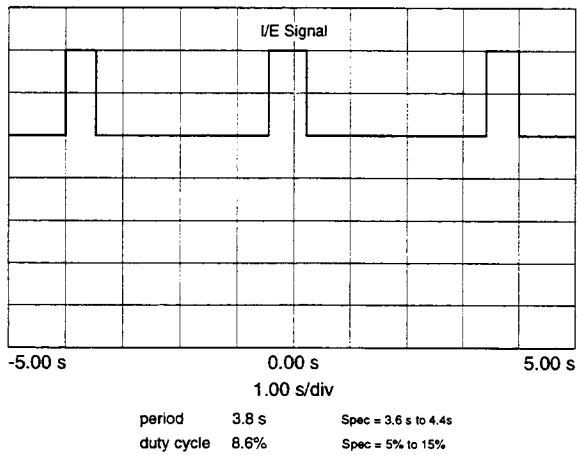


Figure 7-13. Timed Mode, BPM: 16, %IPAP: 10% (Min)

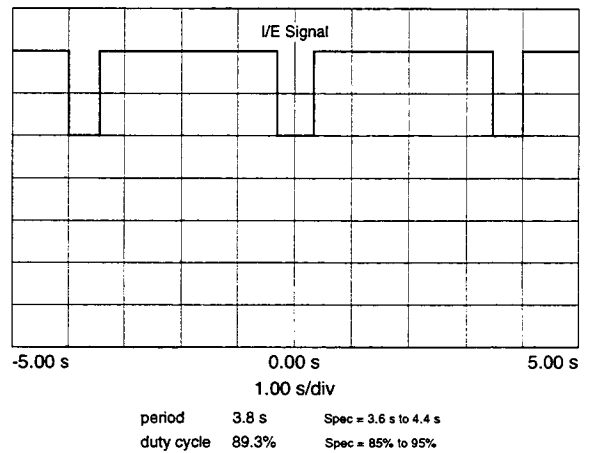


Figure 7-12. Timed Mode, BPM: 16, %IPAP: 90% (Max)

7.15 Verify Zero Function (S-D and S/T-D)

7.15.1 Test Equipment Set-up

- Step 1 Connect Channel 1 of the oscilloscope to the \hat{V}_{est} signal (Pin 4 of the DCP cable connector). Connect Channel 2 of the oscilloscope to the V_T signal (Pin 12 of the DCP cable connector).
- Step 2 Set up the scope channel as follows:
- Timebase: 1 sec/div
 - Sensitivity: Channel 1—500 mV/div
Channel 2—500 mV/div
 - Measure: Period, duty cycle on both channels

7.15.2 BiPAP Set-up

- Step 1 Set the BiPAP selector switch to ZERO.

7.15.3 Test Procedure

- Step 1 Verify that the \hat{V}_{est} signal and V_T signal are at 0 VDC $\pm 0.01V$.
- Step 2 Disconnect channel 1 from \hat{V}_{est} . Connect channel 1 to the Pressure signal. Disconnect channel 2 from V_T . Connect channel 2 to the \hat{V}_{tot} signal.
- Step 3 Verify that the pressure signal and V_T signal are at 0 VDC $\pm 0.01V$.
- Step 4 Mark pass or fail (P or F) on the data sheet.

NOTE: The I/E signal does not go to zero in this mode.

7.16 Verify Calibrate Function (S-D and S/T-D)

7.16.1 Test Equipment Set-up

Step 1 All test equipment should be the same as for 7.15.

7.16.2 BiPAP Set-up

Step 1 Unblock the outlet.

Step 2 Set the Selector knob to IPAP for 2 seconds ± 0 seconds, then switch to CALIBRATE.

7.16.3 Test Procedure

- Step 1 Watch V_{est} and V_T traces as they adjust toward a steady state (the triangle wave must not have any 'breaks' in the trace).
- Step 2 When a steady state is attained in approximately 20 seconds, V_{est} should be a square wave of $+0.5V$ to $-0.5V$ amplitude, 50% duty cycle, 4 sec. period; V_T should be a triangle wave of $0.5 V_{pp}$ with 50% duty cycle and 4 sec. period. See Figure 7-14.
- Step 3 Mark pass or fail (P or F) on the data sheet.

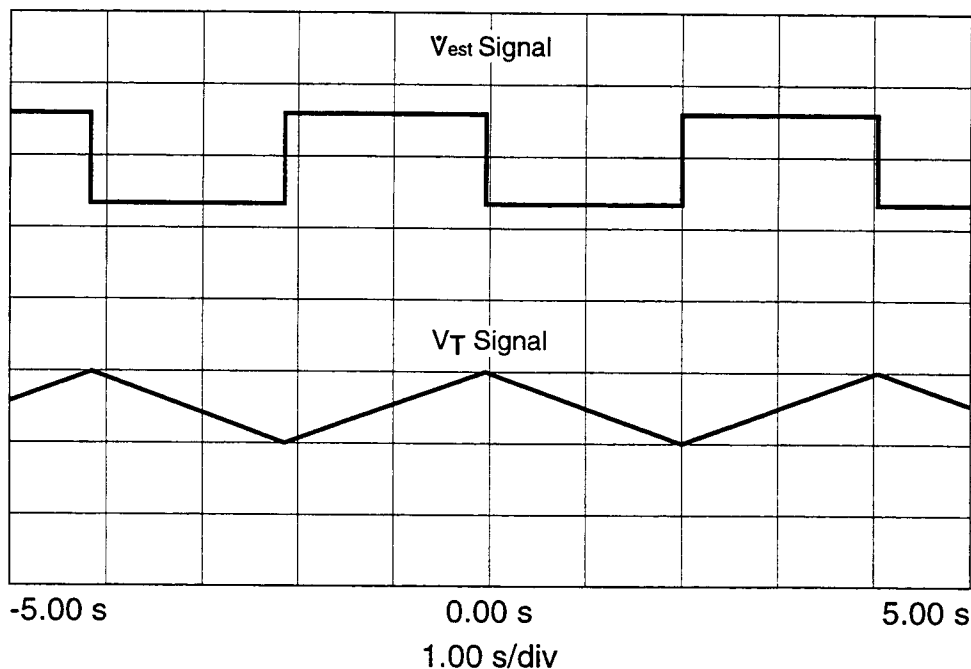


Figure 7-14. Calibration Signals.

7.17 DCP Verification (S-D and S/T-D)

7.17.1 Test Equipment Set-up

Step 1 All test equipment should be the same as for 7.13.

7.17.2 BiPAP Set-up

Step 1 Connect the BiPAP unit to the Detachable Control Panel with the proper cable.

7.17.3 Test Procedure

- Step 1 Verify that the Rear Panel Controls are inactive.
- Step 2 Verify that the DCP Zero sets all signals to 0V.
- Step 3 Verify that the DCP Cal. sets Flow, Flow est to $\pm 0.5V$ square waves and volume to $0.5V_{pp}$ triangle wave.
- Step 4 Verify that the IPAP mode allows the IPAP control to operate and that the IPAP LED illuminates.
- Step 5 Verify that the EPAP mode allows the EPAP control to operate and that the EPAP LED illuminates.
- Step 6 Verify that the SPONTANEOUS mode operates by blocking and unblocking the orifice.
- Step 7 Verify that the SPONTANEOUS/TIMED mode operates like the Spontaneous mode by blocking the orifice and verifying that the unit emits timed pulses.
- Step 8 Verify that the TIMED mode allows BPM and %IPAP controls to operate with IPAP at 12 and EPAP at 6.
- Step 9 Mark pass or fail (P or F) on the data sheet.
- Step 10 Turn off the unit and disconnect the power cord test cable and any tubing or test orifice.

NOTE: Some units may use the Remote Control Unit (RCU). All information regarding the DCP is applicable to the RCU.

7.18 Corrective Actions

In case of a failure during the System Set-up or Final, use the following table for corrective actions.

TEST FAILURE	CORRECTIVE ACTIONS
Blower Pressure (Section 7.3)	<ol style="list-style-type: none"> 1. Check for air leaks. 2. Try resetting the motor speed per the calibration procedure 7.3. 3. If you are unable to set the motor speed, replace the Motor Control Board (See Section 6.2.3).
Flow Calibration (Section 7.4)	<ol style="list-style-type: none"> 1. Reset the flow calibration. 2. If the flow calibration fails after resetting then replace the blower assembly (See Section 6.2.2).
Valve Calibration (Section 7.5)	<ol style="list-style-type: none"> 1. Reset R84 for 20.5 cm H₂O per the calibration procedure for the valve calibration. 2. Retest. 3. If the valve calibration fails again, replace the BiPAP Control Board (BCB) (See Section 6.2.4).
Pressure vs. Flow (Section 7.5)	<ol style="list-style-type: none"> 1. If the test fails at 18 cm H₂O at 100 L/min flow, replace the valve (See Section 6.2.7). 2. If the test fails at all 100 L/min settings, then check the flow calibration. If the flow calibration is within specs, replace the BCB (See Section 6.2.4).
Pressure monitor (Section 7.6)	<ol style="list-style-type: none"> 1. Reset per calibration procedure (7.6). 2. If the unit still fails, replace the BCB (See Section 6.2.4).
Trigger (Section 7.9)	<ol style="list-style-type: none"> 1. Check for leaks anywhere in the system. 2. Replace the Valve (See Section 6.2.7) 3. Replace the BCB (See Section 6.2.4). 4. Replace the Blower (See Section 6.2.2).
Spontaneous (Section 7.12), Spontaneous/Timed (Section 7.13), Timed (Section 7.14), Zero Tests (Section 7.15), or Calibrate (Section 7.16).	Replace the BCB (See Section 6.2.4).

Chapter 8 Parts List and Exploded View

8.1 Wraparound Assembly

8.2 Exploded View

8.3 Exploded View—Foam Panels

8.1 Wraparound Assembly

See Figure 8-1 for corresponding Index numbers. Replacement kits contain the described part and ancillary parts.

Index # From Dwg.	Reorder RP Kit Number	Description
1	332183	BiPAP Wraparound, Repair Kit
2	332184	Molded Accessory Cap
3	362358	Screw-on Feet, Recessed
4	332221	Accessory Cap Latches, Repair Kit

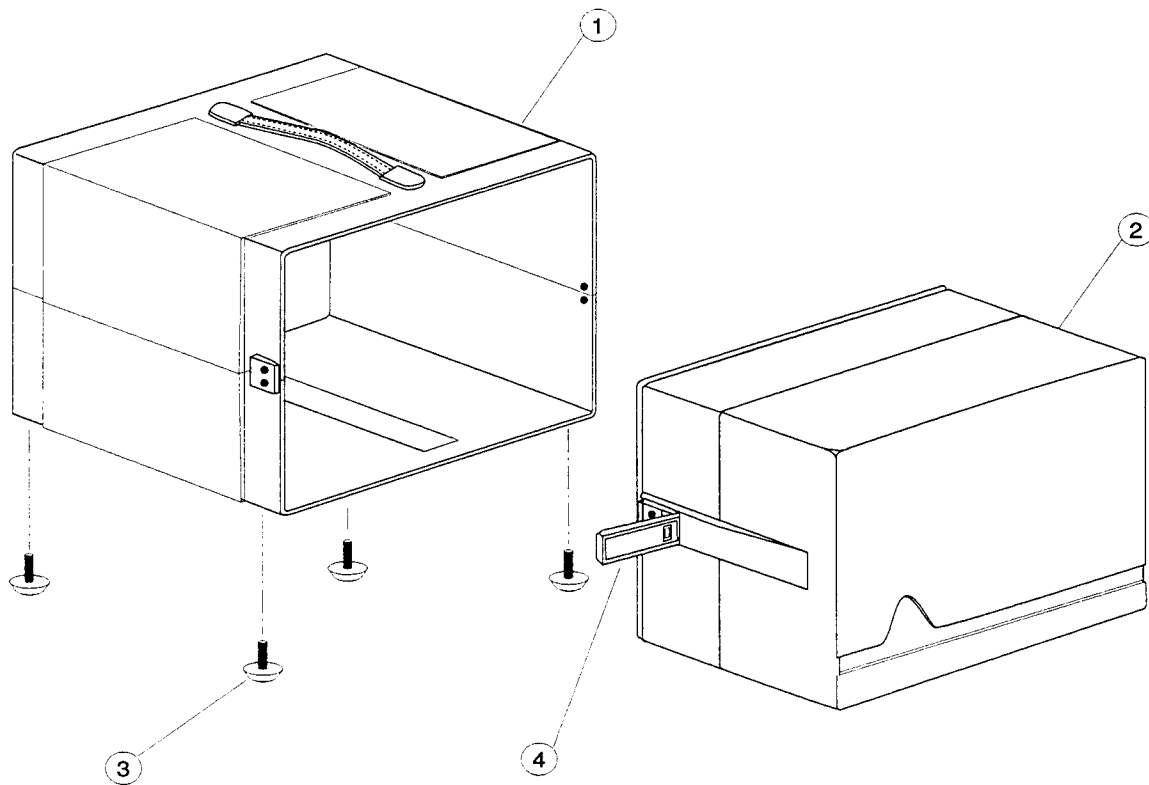


Figure 8-1

8.2 Exploded View

Refer to Figure 8-2 for corresponding Index numbers. Replacement kits contain the described part and ancillary parts. Replacement kits are shown in bold.

Index # From Dwg.	Reorder RP Kit Number	Description
1	302064	Filter, Disposable (Pkg. of 6)
2	332160	Front End Cap, S/T-D Units, Repair Kit
2	332161	Front End Cap, S/T Units, Repair Kit
2	332224	Front End Cap, S-D Units, Repair Kit
2	332222	Front End Cap, S Units, Repair Kit
3	332162	Pressure Port, Repair Kit
4	332163	Main Power Switch, Repair Kit (green, translucent, lighted)
4	552127	Main Power Switch, Repair Kit (black, opaque, non-lighted)
5		Tubing Clamp (2 in flex connector)
6		Tie Wraps (in various kits as needed)
7	332165	Flexible Connector, Repair Kit
8	332471	Muffler, Repair Kit (tubular replaces tan box)
9	332167	Pressure Control Valve, Repair Kit
10	332170	BiPAP Control Board S/T-D Unit, Repair Kit (BCB)
10	332141	BiPAP Control Board S-D Unit, Repair Kit (BCB)
10	332169	BiPAP Control Board S-T Unit, Repair Kit (BCB)
10	332168	BiPAP Control Board S Unit, Repair Kit (BCB)
11	332172, 332553	BiPAP Control Board Repair Kit (MCB)
12	332175, 332555	Voltage Selector Switch, Repair Kit
13	332176	Time Meter, Repair Kit
14	332214, 332556	AC Inlet with Fuse Drawer, Repair Kit
15	332120	115 VAC Applications (pkg. of 2)
	362523	Fuse, 1A, 240V, 5mm x 20mm Time Lag for SN <200,000 or Fuse, 800mA, 250V, 5mm x 20mm Time Lag for SN >200,000
15	332121	230 VAC Applications (pkg. of 2)
	532163	Fuse, 500mA, 240V, 5mm x 20mm, Time Lag - SN <200,000 or Fuse, 400mA, 250V, 5mm x 20mm Time Lag for SN >200,000
16	332177	Control Knobs, D Shaft (Set of 5), Repair Kit
16	332218	Control Knobs, Round Shaft (set of 5), Repair Kit
17	332533	Coupling Kit
18	332180, 332554	Transformer, Repair Kit
19	332181	Blower Assembly, Repair Kit
20		Air Bellows (in various kits)
21	332173	Blower Shock Mount, Repair Kit (pkg of 4)
22	332174	Feet, stick-on (pkg. of 4)
23	332185	Flow Pick-up Tube, Repair Kit
24		Rear End Cap*
25	332302	Crowbar Fuse, 500mA Slo-Blo, Repair Kit (pkg of 2)
Not Shown	332422	Blower Connector, Repair Kit (connector and leader)
Not Shown	332302	Fuse, Internal Crowbar (2/pk)
Not Shown	332204	Service Manual
Not Shown	332301	Small Tool Kit
Not Shown	332353	"T" and Adaptor
Not Shown	332300	Trigger Test Fixture
Not Shown	332389	Whisper Cap _{TMS}

* Due to labeling considerations, contact our Customer Service Department for units that require end cap replacement.

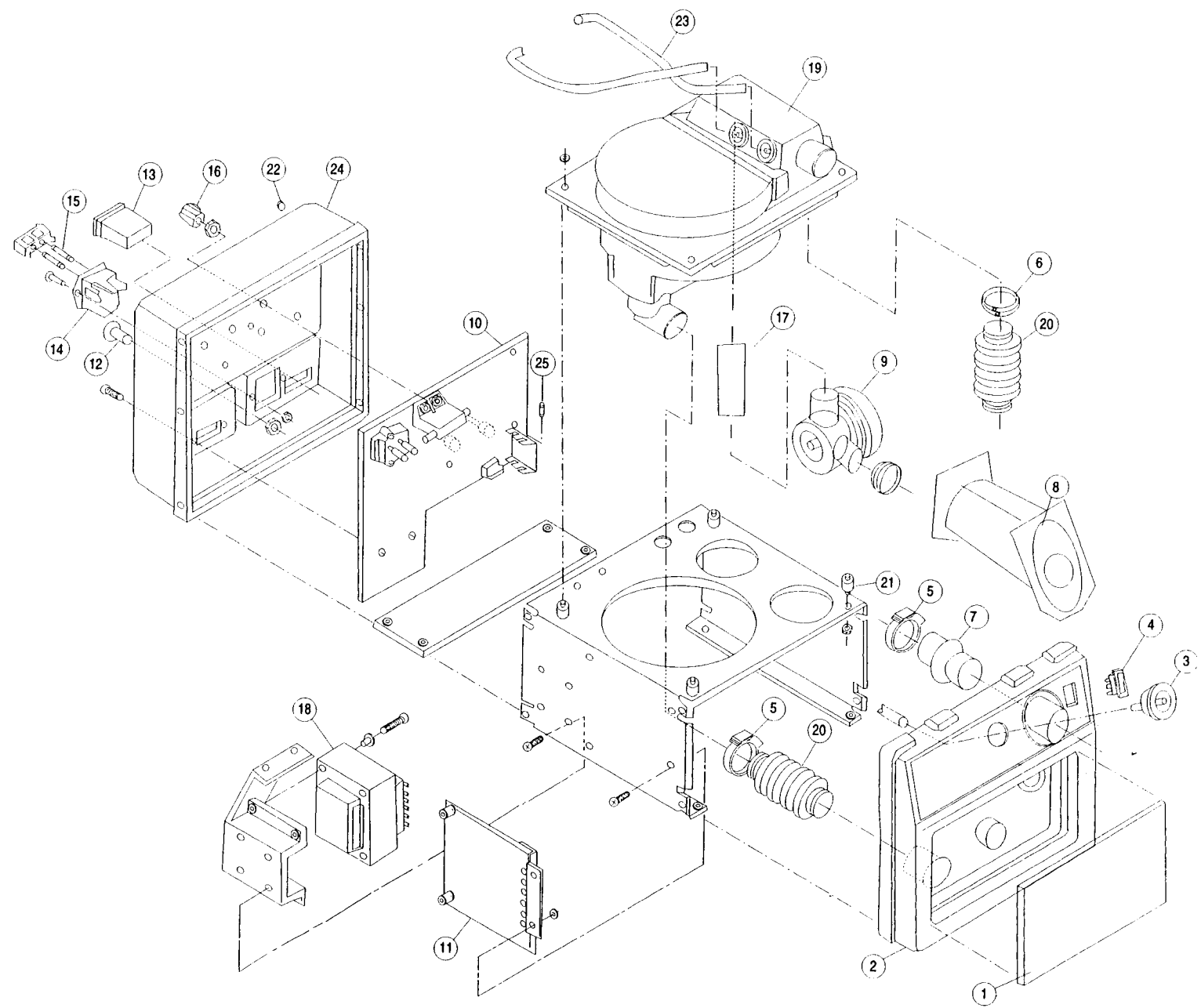


Figure 8-2

8.3 Exploded View—Foam Panels

Refer to Figure 8-3 for Index numbers corresponding to the numbers in the following table. Replacement kits contain the described part and hardware as necessary. See Chapter 6 for the complete kit contents.

Index # From Dwg.	Reorder RP Kit Number	Description
1	332440	BiPAP Top Plate
2	332443	BiPAP Side Panels (Reminder: These side panels replace the cross bars in older units.)
3	332445	BiPAP Bottom Plate

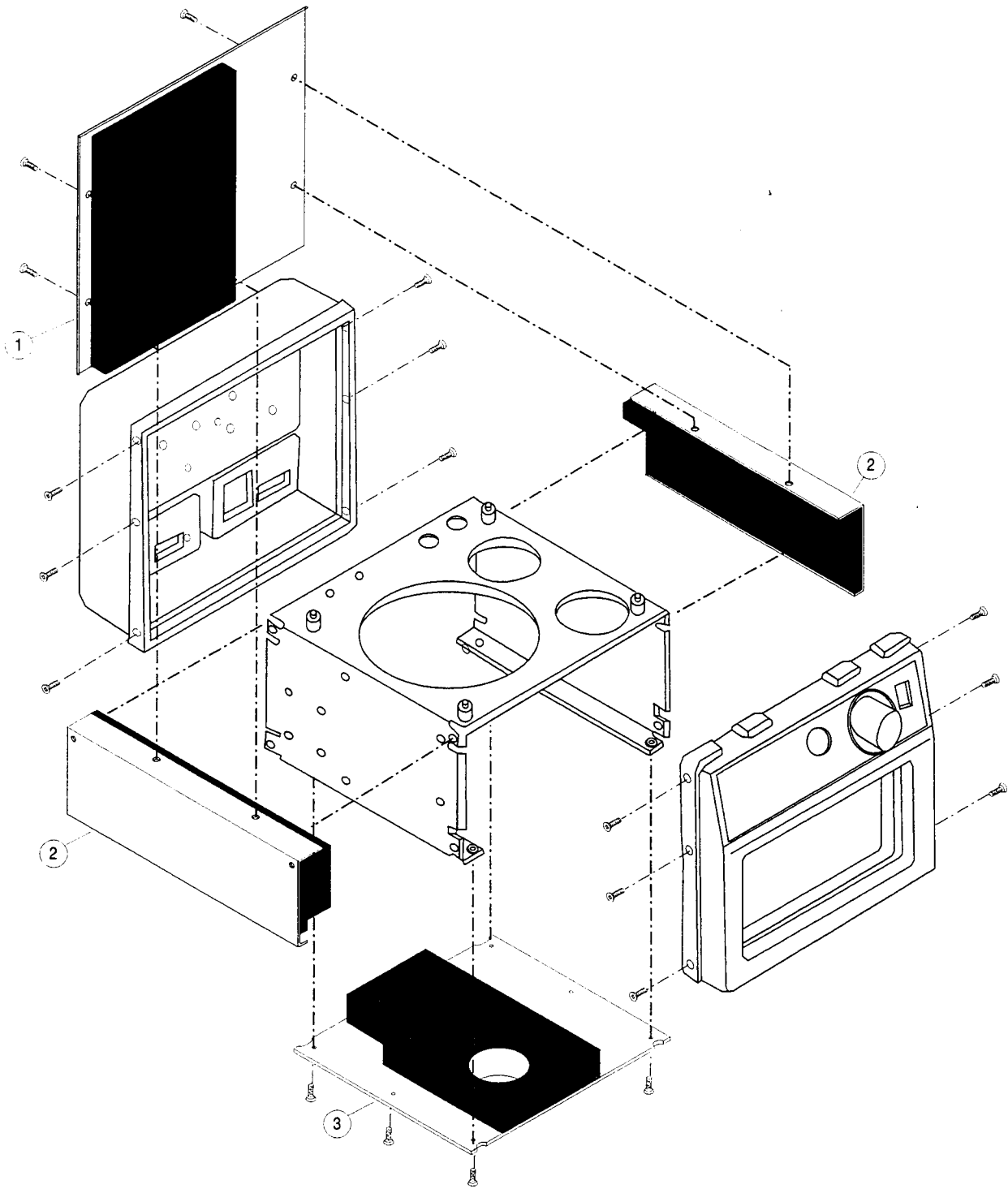


Figure 8-3

Appendix A Required Tools and Equipment

A.1 Service Tools

A.2 Service Supplies

A.3 Acceptable Electronic Test Equipment

A.1 Service Tools

You should have the following tools available for troubleshooting, testing, and repairing the BiPAP unit.

- Common hand tools:
 - Flat-blade screwdrivers — at least a small, medium, and large
 - Phillips screwdrivers— at least a small and medium
 - Nut driver set — $\frac{3}{16}$ " to $\frac{1}{2}$ "
 - Hex wrench set — $\frac{1}{16}$ " to $\frac{1}{2}$ "
 - Putty knife, 1" to 2" wide, with sharp edge, for scraping foam
 - Straight/open end wrench set, $\frac{3}{16}$ " to $\frac{1}{2}$ "
 - Scissors
 - Needle-nose pliers, at least small, medium, and large
 - Diagonal cutters, at least small, medium, and large
 - Vise-grip set, at least small, medium, and large
 - Razor blade knife
- Water column manometer with at least 6' of tubing (optional for trouble-shooting)
- Thermometer — 32°F to 110°F, readable to 0.5°F
- Ruler
- Tie wrap gun
- Anti-static work station — Minimum requirement is a grounded mat and wrist strap
- Digital manometer — Capable of making required measurements.
- Hot melt glue gun
- Watt meter — See Section A.3
- Digital multimeter — Amprobe AM12 or equivalent
- Flowmeter — See Section A.3
- Oscilloscope — See Section A.3
- Trigger test fixture (requires 50+ psi external air source) — Respiroics part number 332300
- Tubing, 6' smooth inner lumen — Respiroics part number 301016
- BiPAP small tool kit — Respiroics part number 332301—including:
 - Adjustable valve (Respiroics part number 331461)
 - Tubing coupler (Respiroics part number 300176)
 - Two O₂ enrichments (Respiroics part number 312710)
 - Test adaptor — 0.25" (Respiroics part number 332353)
 - Allen wrench (0.050) (Respiroics part number 331462)

A.2 Service Supplies

You should have the following supplies available:

- Paper towels
- Disposable gloves
- Cleaner (i.e. Fantastik®, 409®, etc.)
- Denatured alcohol
- Loctite 222® removable thread locker
- Sicomet® 8300 glue
- Hot melt glue
- Tie wraps (3" x 1/8" and 6" x 3/16")
- Cable clips (Stick-on base 1" x 1/2" holds cable up to 1/2" diameter)

A.3 Acceptable Electronic Test Equipment

A.3.1 Flowmeter

Specifications: 0 to 150 L/min
3% accuracy
1 L/min resolution

Acceptable options:

1. Respironics System (RI in-house and limited field use only)
2. CME 422-5-200A (SP-1)
3. RT-200 with some limitations

A.3.2 Oscilloscope

Specifications: 2 Channel
Storage
Timebases with 1 sec/div and 5 sec/div
Sensitivities of 500 mV/div and 5 V/div

Acceptable options:

Any commercially available oscilloscope that meets the above specifications

A.3.3 Digital Manometer

Specifications: 0 to 35 cm H₂O
±0.3 cm H₂O accuracy
±0.1 cm H₂O resolution

Acceptable options:

1. Respironics 302227 Digital Manometer
2. Mercial DP2001
3. Sensym PDM 200CD
4. RT-200
5. Any commercially available manometer that meets the above specifications

A.3.4 Wattmeter

Specifications: 0 to 100 W
3% accuracy
1 W resolution

Acceptable options:

1. Yokogawa 2355 (digital)
2. Simpson, Analog 0 to 150 W
3. Extech DW 6060
4. Any commercially available manometer that meets the above specifications

Appendix B Data Sheets

This Appendix contains the Respironics forms that you must fill out as part of various tasks. The following forms are included:

1. System Data Sheet — Use one side for adjustment and the second side for the Final
2. Respironics Recommended Preventative Maintenance Schedule

These forms may be reproduced as needed for servicing a unit.

BiPAP 20 System Data Sheet (Adjustment)

Blower Pressure
 100 lpm Flow @ 20 cm H₂O ±2
 Dead Head Pressure

Flow Calibration

LPM	0	30	60	90	120
V (Vdc)					
Specs	(-).035-.034V	.350-.640V	.850-1.14V	1.15-1.85V	1.55-2.44V

Valve Calibration

IPAP
 EPAP
 Specs

Minimum	6	12	18	20
<2.5 cm H ₂ O	3.5-8.4 cm H ₂ O	9.5-14.4 cm H ₂ O	15.5-20.4 cm H ₂ O	17.5-22.4cm H ₂ O

Pressure vs. Flow

IPAP Control	50 LPM	100 LPM
6 4.5-6.75 cm H ₂ O		
12 10.5-12.75 cm H ₂ O		
18 16.5-18.75 cm H ₂ O		

Pressure Monitor
 S-D, S/T-D

Pressure (cmH ₂ O)	0	5	10	15	20
P- meter (Vdc)					
Specs (Vdc)	0.0 -.14	.35-.64	.85-1.14	1.35-1.64	1.85-2.14

AC
 Watts

Blocked		Watts
Unblocked		Watts(<85)
Hour Meter		Hours

Comments:



RESPIRONICS INC.®

Serial No.:

Tested By:

Date Tested:

BiPAP 20 System Data Sheet (Final)

Blower Pressure
 100 lpm Flow @ 20 cm H₂O ±2
 Dead Head Pressure

Flow Calibration	LPM	0	30	60	90	120
V (Vdc)						
Specs		(-).035-.034V	.350-.640V	.850-1.14V	1.15-1.85V	1.55-2.44V

Valve Calibration	IPAP	EPAP	Specs			
	Minimum	6	12	18	20	
		<2.5 cm H ₂ O	3.5-8.4 cm H ₂ O	9.5-14.4 cm H ₂ O	15.5-20.4 cm H ₂ O	17.5-22.4cm H ₂ O

Pressure vs. Flow	IPAP Control	50 LPM	100 LPM
6	4.5-6.75 cm H ₂ O		
12	10.5-12.75 cm H ₂ O		
18	16.5-18.75 cm H ₂ O		

Pressure Monitor S-D, S/T-D	0	5	10	15	20
	Pressure (cmH ₂ O)				
P- meter (Vdc)					
Specs (Vdc)	0.0 - .14	.35-.64	.85-1.14	1.35-1.64	1.85-2.14

AC Watts	
Blocked	Watts
Unblocked	Watts(<85)
Hour Meter	Hours

Spontaneous	Timed			
1.18-1.40sec	BPM Min. (10-30)sec	BPM Max. (1.8-2.2 sec)	% IPAP Min. (5-15%)	% IPAP Max. (85-95%)
<input type="text"/>				

Pass or Fail	S	S/T	S/T - D	S - D
	Trigger	Pass/Fail	Pass/Fail	Pass/Fail
Spon. Timed				
Timed				
Zero				
Calibrate				
Remote				

Comments:



Serial No.: _____
 Tested By: _____
 Date Tested: _____

Appendix C BiPAP Screening Procedure

NOTE: This procedure and worksheet are optional. As explained during BiPAP service training, they can be used for:

1. Training people on how the unit is supposed to function.
2. "Screening" or checking a new unit that has just been received. (Some hospitals use this procedure as their "check-out" procedure. Some international dealers use this procedure as their "import check-out.")
3. A quick troubleshooting guide. The procedure can be performed with just the unit and a hook-up to a manometer. (The cover does not have to be removed, an anti-static work station is not needed, and special test equipment is not needed.)
4. As a preventative maintenance test.

- Step 1 Verify that the voltage selector switch is set for the available line voltage.
- Step 2 Verify that the fuses are the correct value.
- Step 3 Plug the unit into a wall outlet, turn it on, and allow it to warm up for a few minutes.
- Step 4 This step verifies the basic IPAP mode function. Set the unit to the IPAP mode. Set the IPAP control to the lowest setting. Connect a water column manometer to any combination of fittings, hoses, etc. that allows the measurement of deadhead pressure. Slowly and smoothly adjust the IPAP pressure upward. The pressure on the manometer should be ± 2 cm H₂O of the pressure setting on the control panel. When the entire range from 4 to 20 cm H₂O has been verified, reduce the IPAP pressure to minimum.
- Step 5 This step verifies the basic EPAP mode function. Repeat Step 4 using the EPAP control instead of the IPAP control.
- Step 6 Remove the fittings, hoses, and manometer.
- Step 7 This step verifies the basic triggering and "lock-out" features of the Spontaneous mode. Set the unit to the Spontaneous mode. Set the IPAP control to 8 and the EPAP control to 4. Use your hand to open and close the outlet port several times, simulating a person breathing. Observe the IPAP and EPAP lights to verify that the unit is following the breathing pattern that your hand is creating. While continuing the breathing pattern, gradually turn the EPAP control to 12. Verify that as the EPAP value becomes higher than the IPAP value, the unit locks out; i.e., defaults to the lower pressure value, which is now IPAP, and no longer follows the breathing pattern.

Continue the breathing pattern and gradually turn the IPAP control to 16. Verify that as the IPAP value exceeds the EPAP value, the unit once again follows the breathing pattern. The exact point of the lock-out can vary, since the pressure controls are specified to be ± 2 cm H₂O. The lock-out feature may also be observed at other pressure control settings, within the specified 4 to 20 cm H₂O BiPAP operating range (i.e., the units may be capable of lower and/or higher pressures, but the units' triggering, lock-out, and other behaviors are not assured outside of that range).

Step 8 This step verifies the default and restart of the Spontaneous mode. Set the unit to the Spontaneous mode. Set the IPAP control to 12 and the EPAP control to 5. Use your hand to open and close the outlet port, simulating a person breathing. Stop the pattern with the port closed. The unit should stop at the EPAP pressure. Restart the pattern of opening and closing. The unit should once again follow the breathing pattern within 3 cycles of the restart.

NOTE: If you stop the pattern with the outlet open, the unit may self-cycle and eventually stop at the EPAP pressure, or the unit may stop at the IPAP pressure. Either behavior is acceptable, since operation in the Spontaneous mode when there is no spontaneous triggering, and with a wide-open leak, does not occur in actual use of the system.

Step 9 **S/T or S/T-D units only** — This step verifies the basic function of the Spontaneous/Timed mode. Set the unit to the S/T mode. Set the IPAP control to 12, the EPAP control to 5, and the BPM to 20. Use your hand to open and close the outlet port several times. Stop this cycling and leave the port closed. The unit should default to the EPAP pressure; after 3 seconds (corresponding to 20 BPM) the unit should produce an assist "shot" of air. Keep the outlet closed. The unit should remain at the EPAP pressure, producing a shot of air every 3 seconds. Check this operation at several BPM settings.

Step 10 **S/T or S/T-D units only** — This step verifies the basic function of the Timed mode. Set the unit to the Timed mode. Set the IPAP control to 12, the EPAP control to 5, the BPM to 20, and the % IPAP to 50. The unit should cycle between IPAP and EPAP based strictly on the BPM and % IPAP settings. The BPM should be $\pm 10\%$ or $\pm 2\%$, whichever is greater. % IPAP should be $\pm 5\%$. Verify the operation at several IPAP, EPAP, BPM, and % IPAP settings. Use your hand to close and open the outlet port. Occluding and opening the port should not affect the cycling.

BIPAP 20 SCREENING PROCEDURE WORKSHEET

Serial No. _____ Date: _____

Comments: _____

Hour meter reading: _____ Unit Model (circle): S S/T S-D S/T-D

Normal Unit Settings:

Mode: _____

IPAP: _____ BPM: _____

EPAP: _____ % IPAP: _____

Initial Checks:

Steps 4 and 5 Pressures:

	IPAP and EPAP Control Settings				
	4	8	12	16	20
Manometer Readings					
IPAP					
EPAP					

Basic function of each mode:

- Step 7. Spontaneous, Lock-out of IPAP, EPAP
- Step 8. Spontaneous, default to EPAP, restart ≤3 cycles ...
- Step 9. S/T, cycles, assist shot of air
- Step 10. T, indep. switching, approx. BPM and % IPAP ..

Further checks, tests, and comments: _____

Date: _____ Initials: _____

Appendix D DC Operation

D.1 D C Operation

D.2 Specifications

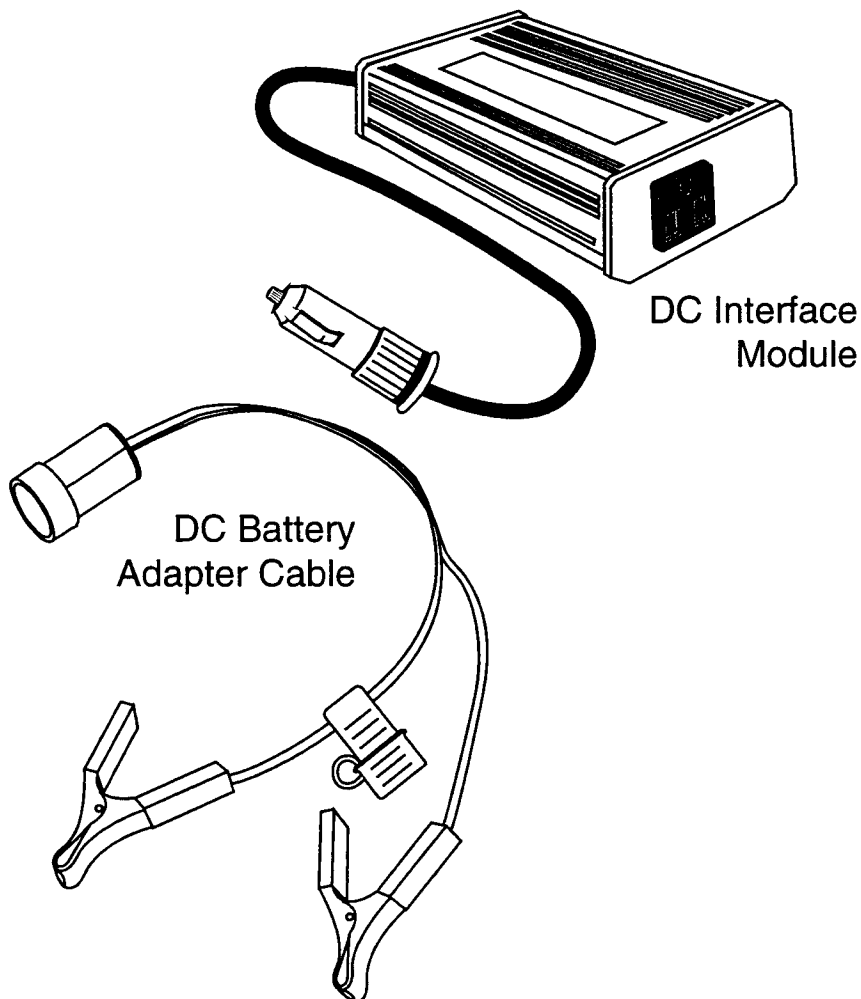
D.1 DC Operation

The BiPAP 20 System may be used with a Respironics DC Interface Module, Part Numbers:

<u>Part #</u>	<u>Description</u>
552097	DC Interface Module
532209	Battery Adapter Cable
532105	DC Interface System, North American
Includes:	1 ea. DC Interface Module 1 ea. Battery Adapter Cable

NOTE: For a 220 volt DC System, contact Customer Service

The figures below illustrate the interface module electrical connection to a battery and to an automobile cigarette lighter. The specifications for the module and for the battery required for operation are on the following page.



D.2 Specifications

Voltage In: 11.5 - 15 VDC

Voltage Out: 115 VAC rms $\pm 5\%$

When measuring the output voltage, use a true rms-indicating voltmeter to obtain an accurate reading.

Continuous Power: 150 watts

Output Frequency: 60 Hz $\pm 1\%$

Efficiency: 90%

Battery Use: Recommend a 12 VDC 100 amp-hour deep cycle marine type battery.

System	Pressure Setting	Battery Size	Length of Operation	Approximate Current Draw
BiPAP 20 System	all pressures	100 amp-hr	up to 8 hrs.	7.2 - 9.5 amps

NOTE: Length of operation times are based on normal operating conditions from a fully charged, deep cycle marine-type battery. Battery age, number of recharging cycle, and recharging rates may affect the actual length of operating times.

Appendix E: BiPAP 20 System Schematics

E.1 Wiring Diagram

E.2 Schematic Statement

E.1 Wiring Diagram

Section 5.2 of this manual contains a wiring diagram that shows the major subassemblies of the BiPAP System. This is the level to which service is performed.

E.2 Schematic Statement

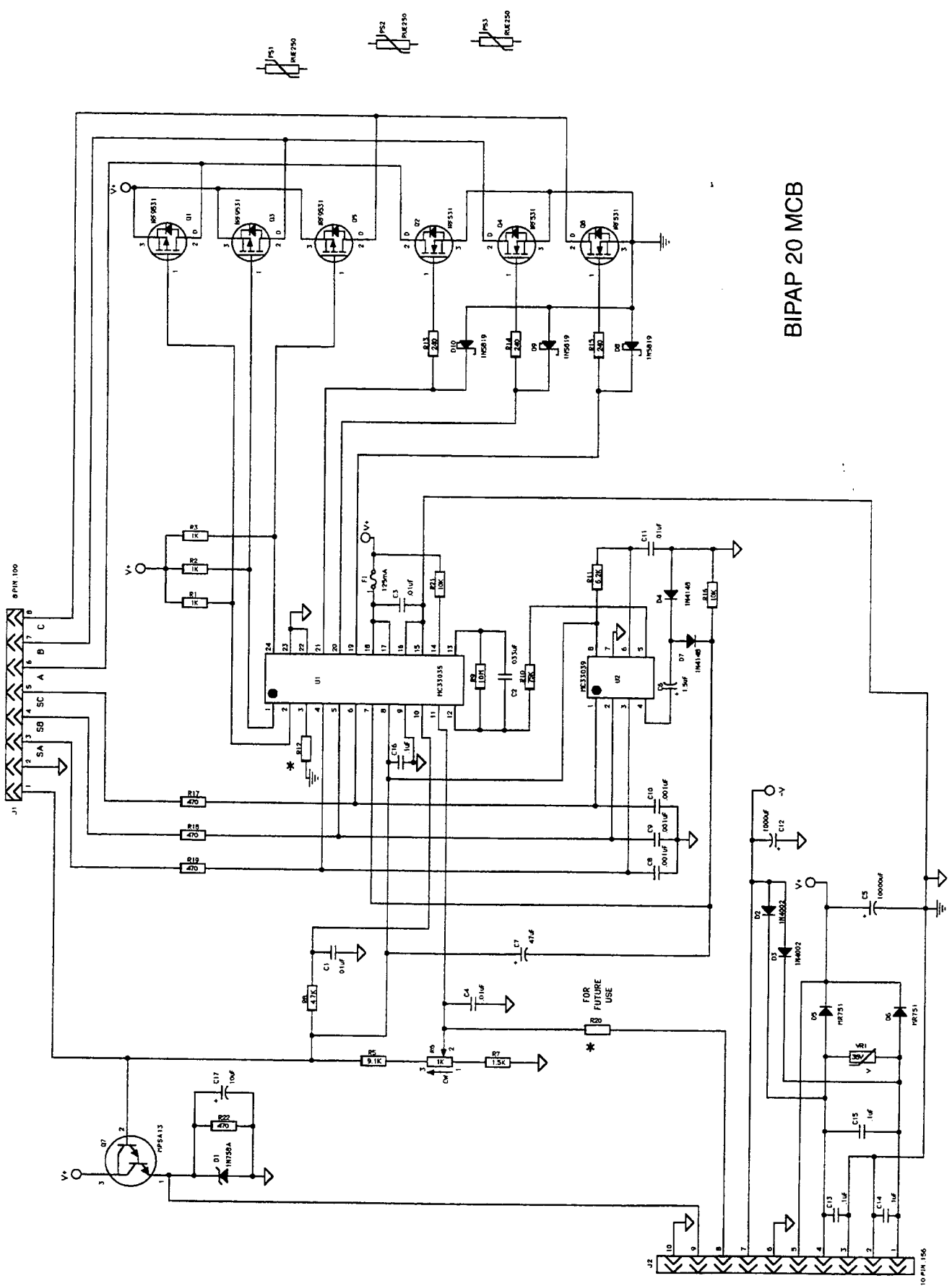
Schematics are supplied with this manual in direct support of the sale and purchase of this product.

The schematics are *proprietary* and *confidential*. Do not copy the schematics or disclose them to third parties beyond the purpose for which they are intended.

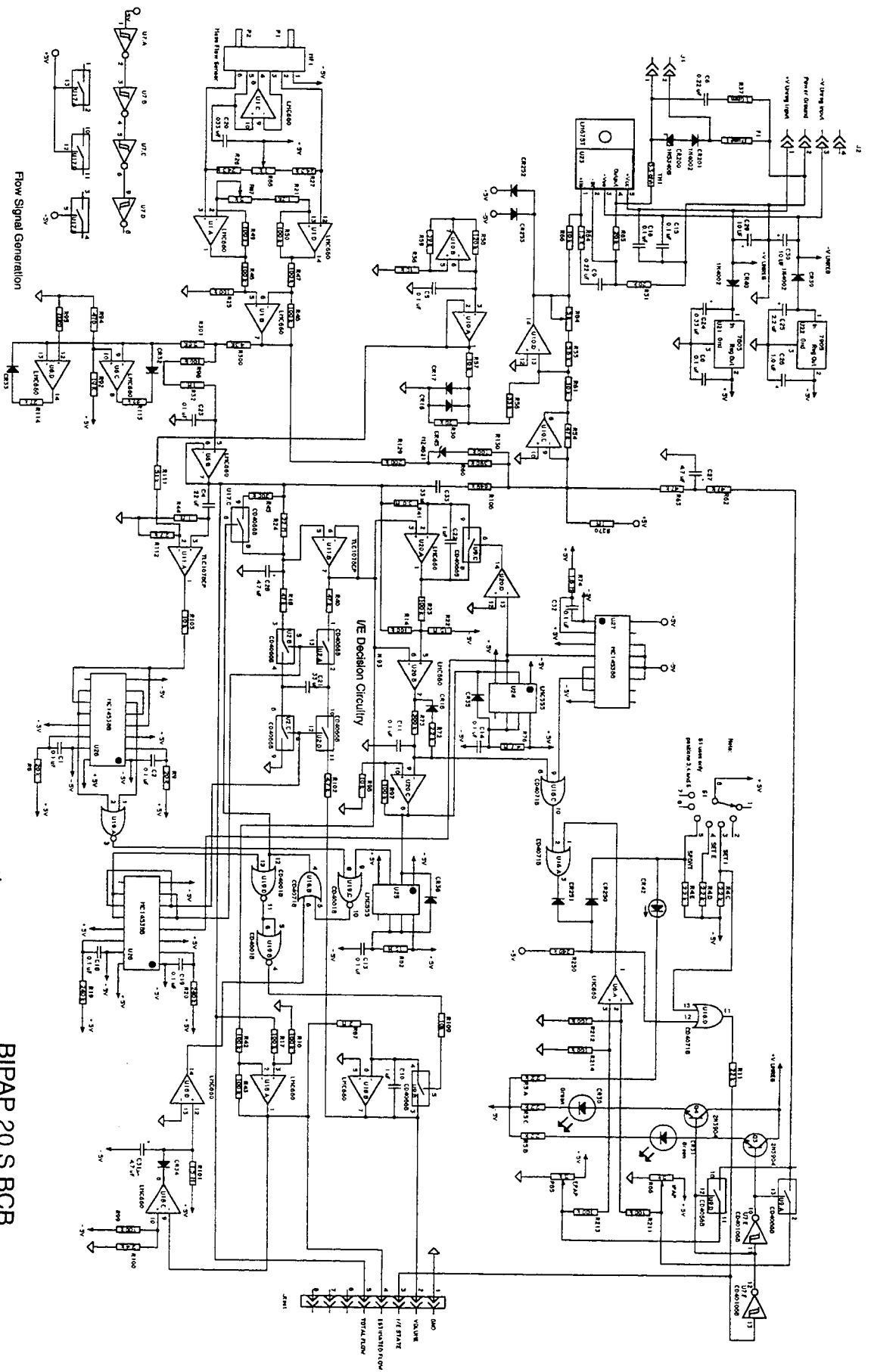
The schematics are intended to satisfy administrative requirements only. They are not intended to be used for component level testing and repair. Any changes of components could affect the reliability of the device, prohibit lot tracking of electronic components, and void warranties. Repairs and testing are supported only at the complete board level.

The schematics are of the revision level in effect at the time that this manual was last revised. New revisions may or may not be distributed in the future.

The schematics are presented in the following order: BiPAP 20 MCB, BiPAP 20 S BCB, BiPAP 20 S/T BCB, BiPAP 20 S/T-D BCB.

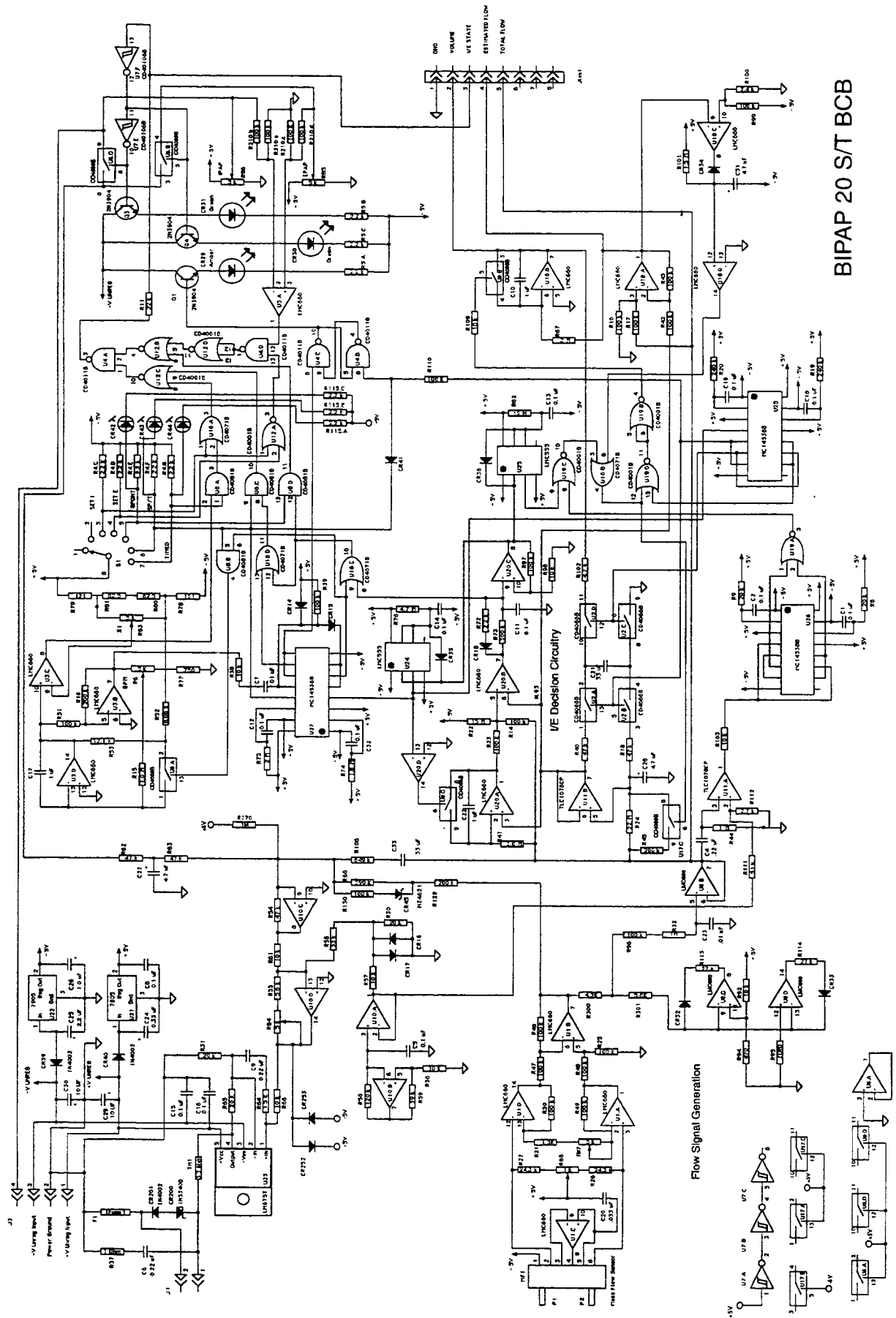


BIPAP 20 MCB

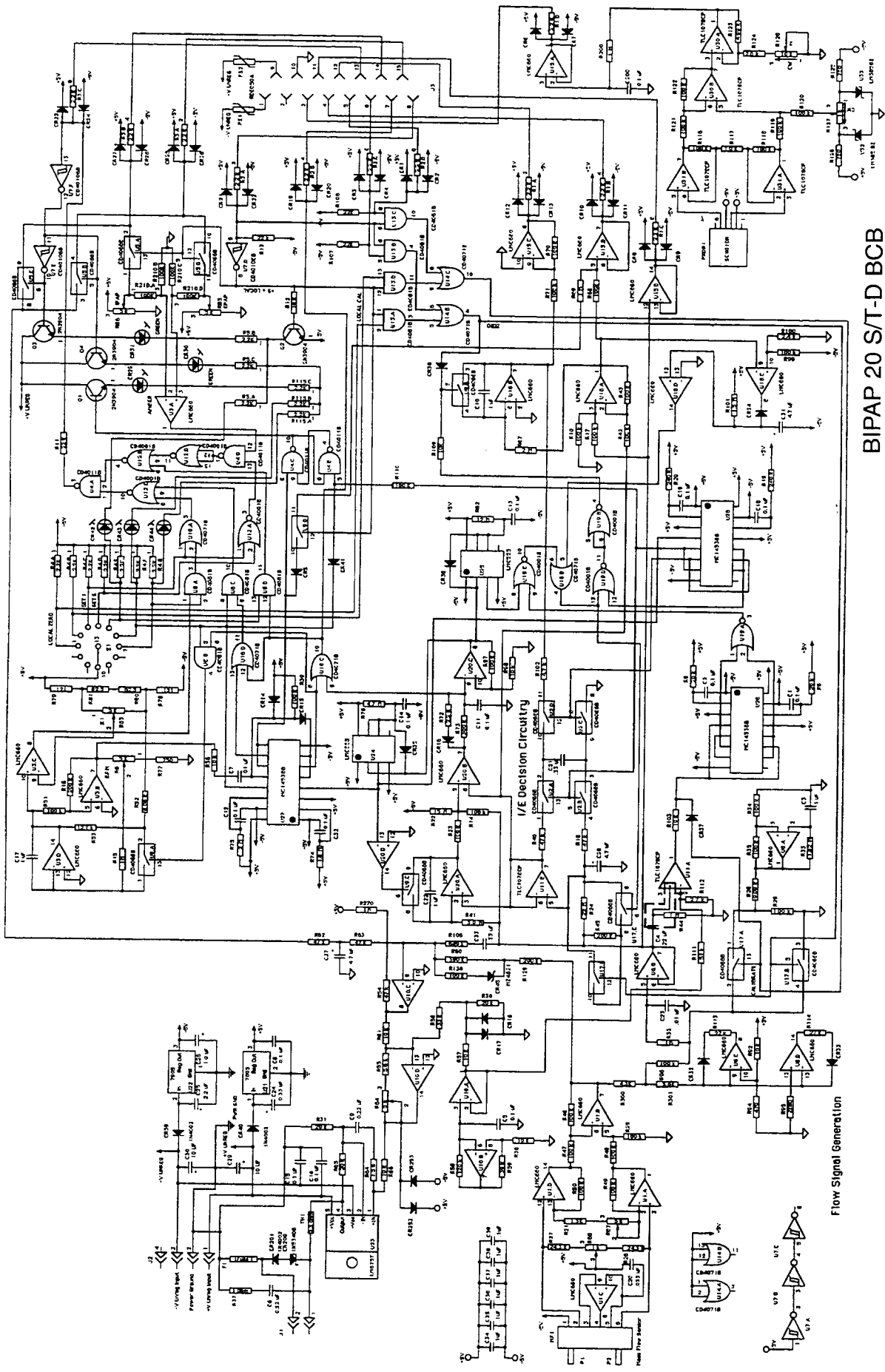


BIPAP 20 S BCB





BIPAP 20 S/T BCB



BIPAP 20 S/T-D BCB

Flow Signal Generation



Appendix F: Changes

CHANGE: New Flow Transducer
New Main Control Board

AFFECTED: Blower Assembly
Manual Sections 7.5.3, 7.5.4

STATUS: In effect
Manual is changed

DESCRIPTION:

As of February, 1992, Respironics began using a new flow transducer/main control board combination. As a result, the flow transducer calibration differs for the different transducers. Two calibration sections (7.5.3 and 7.5.4) are now presented. You must identify the part number of the transducer in the unit you are calibrating, and select the appropriate procedure. The Test Equipment and BiPAP setups for the procedures are identical.

The old transducer number is 332046. The new transducer number is 332290. The board used with the new transducer does not have trimpot R91. You can find the transducer number on the Blower subassembly label located on top of the flow transducer.

ACCEPTABLE COMBINATIONS:

	<u>Old Transducer, 332046</u>	<u>New Transducer, 332290</u>
Old Board, has R91	OK	Caution*
New Board, no R91	OK	OK

*If the unit has been repaired and contains a new transducer with an old board, you may not be able to perform the flow calibration; the old board, in about 10% of the cases, does not have enough gain. If this occurs, Respironics recommends that you install a new board to ensure the successful calibration of the transducer, but you may try another old board.

Changes

CHANGE: New EMI Wraparound
New Main Control Board

AFFECTED: Wraparound
Manual Section 6.2.1

STATUS: In effect
Manual is changed

DESCRIPTION:

For S-D and S/T-D models with serial numbers less than 30000, you must replace the wraparound with Replacement Kit number 332345. The wraparound is an EMI-shielded wraparound. For S-D and S/T-D units with serial numbers greater than 30000, a new multi-layered board eliminates the need for the new wraparound. These models will use Replacement Kit number 332183.

Acceptable Combinations:

	<u>Old Wraparound</u>	<u>New Wraparound</u>
BiPAP S-D, S/T-D, S/N <30000	Replace with new wraparound	OK
BiPAP S-D, S/T-D, S/N >30000	OK	OK

NOTE: The old 332183 wraparound has a 3/4" square molded in the bottom. The new 332345 wraparound has both the 3/4" square and a 5/8" circle inside the square.

CHANGE: NewAC Inlet

AFFECTED: AC Inlet
Manual Section 4.2.3, 6.2.13

STATUS: In effect
Manual is changed

DESCRIPTION:

For units with serial numbers less than 150,000, you must replace the AC Inlet with Replacement Kit Number 332214. This AC Inlet has a fuse drawer with side clips for removal. For serial numbers 150,000 or greater, you must replace the AC Inlet with Replacement Kit Number 332556. This AC Inlet has a fuse drawer without clips and is filtered with a lug insulator.

CHANGE: Transformer Change
(Fuses, Transformer, MCB,
Voltage Selector Switch)

AFFECTED: Fuses
Manual Section 2.2 BiPAP System Specifications
Transformer - Manual Section 6.2.5
Motor Controller Board - Manual Section 6.2.3
Voltage Selector Switch - Manual Section 6.2.15

STATUS: In effect
Manual is changed

DESCRIPTION:

As of serial number 200,000 the BiPAP 20 units have been assembled using new fuses, transformers, motor controller boards, and voltage selector switches. The new components are required for any repairs on units with serial numbers 200,000 or greater. Any units under serial number 200,000 must be repaired using the version of components that were originally used in those units.

Component	Serial Numbers <200,000	Serial Numbers > 200,000
Fuses- 115 VAC Applications	1A Fuses (PN 332120)	800mA Fuses (PN 362523)
Fuses- 230 VAC Applications	500mA Fuses (PN 332121)	400mA Fuses (PN 532163)
Transformer	PN 332180	PN 332554
Motor Controller Board (MCB)	PN 332172	PN 332553
Voltage Selector Switch	PN 332175	PN 332555

CHANGE: Muffler Change

AFFECTED: Muffler

STATUS: In effect
Manual is changed

Manual Section: 6.2.6 Muffler Replacement

DESCRIPTION:

Units with serial numbers greater than 80961 contain the new "tube" muffler. Replacement parts kits now contain the new tube muffler, which will replace the old square muffler. No adjustments are required to accommodate the new muffler.

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