BiPAP® Synchrony

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Service & Technical Information

Revision History

Section Name (No.)	Rev. #	Date	Description
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Warnings & Cautions (1032408)	*01*		*Initial Revision*
Specifications & System Features (1032409)	*00*		*Initial Revision*
Theory of Operation (1032410)	*00*		*Initial Revision*
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Tools and Equipment (1032448)	*00*		*Initial Revision*
Schematics (1032449)	*01*		*Initial Revision*

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WARRANTY

Respironics, Inc. warrants that the system shall be free from defects of workmanship and materials and will perform in accordance with the product specifications for a period of two (2) years from the date of sale by Respironics, Inc. to the dealer. Respironics warrants that the BiPAP Synchrony units serviced by Respironics will be free from defects in serviced materials for a period of one year and free from defects in workmanship for a period of 90 days from the time of service. Respironics accessories are warranted to be free of defects in materials and workmanship for a period of 90 days from the time of purchase. If the product fails to perform in accordance with the product specifications, Respironics, Inc. will repair or replace – at its option – the defective material or part. Respironics, Inc. will pay customary freight charges from Respironics, Inc. to the dealer location only. This warranty does not cover damage caused by accident, misuse, abuse, alteration, and other defects not related to material or workmanship.

Respironics, Inc. disclaims all liability for economic loss, loss of profits, overhead, or consequential damages which may be claimed to arise from any sale or use of this product. Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty is given in lieu of all other express warranties. In addition, any implied warranties – including any warranty of merchantability or fitness for the particular purpose – are limited to two years. Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

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Introduction

BiPAP Synchrony Ventilatory Support System Overview

The BiPAP Synchrony, shown in Figure A, is a low-pressure, electronically driven ventilator system with electronic pressure control. The device's pressure controls are adjusted to deliver pressure support for patient ventilatory assistance.

Figure A: BiPAP Synchrony Device

The BiPAP Synchrony is intended to augment patient breathing by supplying pressurized air through a patient circuit. It senses the patient's breathing effort by monitoring airflow in the patient circuit and adjusts its output to assist in inhalation and exhalation. This assistance is provided by the administration of two levels of positive pressure. During exhalation, pressure is variably positive or near ambient. During inspiration, pressure is variably positive and always equal to or higher than the expiratory level.

The BiPAP Synchrony responds reliably to patient flow rates that indicate movement to inhalation or exhalation, even in the presence of most normal leaks in the patient circuit. Automatic adjustment of this trigger threshold in the presence of leaks makes the system ideal for mask-applied ventilation assistance. The patient-controllable Rise Time and Bi-Flex features may enhance patient-ventilator synchrony and patient comfort.

The BiPAP Synchrony operates in the following modes: Continuous Positive Airway Pressure (CPAP), Spontaneous (S), Spontaneous/Timed (S/T), Timed (T), and Pressure Control (PC).

In the Continuous Positive Airway Pressure (CPAP) mode, the BiPAP Synchrony delivers continuous pressure support ventilation at one pressure level.

In the Spontaneous (S) mode, the BiPAP Synchrony delivers bi-level pressure support. The device triggers to Inspiratory Positive Airway Pressure (IPAP) in response to spontaneous inspiratory effort and cycles to Expiratory Positive Airway Pressure (EPAP) during exhalation. The level of pressure support delivered is determined by the difference between the IPAP and EPAP settings. The Spontaneous/Timed (S/T) mode of the BiPAP Synchrony is similar to the S mode, except that it also can deliver a machine-triggered breath if the patient does not spontaneously breathe within a set time.

The S/T mode ensures that patients receive a minimum number of breaths per minute based on the Rate setting. If the patient fails to initiate an inspiration within the interval determined by the Rate control, the unit triggers a timed (or machine-triggered) breath resulting in a pressure-control (pressure-limited, time-cycled) breath at the set IPAP level. The rate of timed breaths is adjustable. The duration of each timed breath is controlled by an Inspiratory Time control.

The Timed mode provides mandatory pressure assist. All breaths are machine triggered and machine cycled. The patient breathing has no affect on this machine. The triggering is determined by the Breath Rate control. The cycle time is determined by the Inspiratory Control.

The PC mode is equivalent to the S/T mode except that all breaths are machine cycled and, therefore, have a fixed inspiratory time. This mode is a pressure limited, machine or patient triggered, time cycled mode. The patient may initiate a breath, but all breaths are pressure limited (IPAP) and time-cycled. The cycle time is determined by the Inspiratory Time control setting.

AVAPS is available in the S, S/T, Timed and PC modes. AVAPS provides dynamic IPAP control. The IPAP pressure is dynamically controlled so that exhaled tidal volumes approach the Vte control value. AVAPS provides gradual pressure changes to compensate for the tidal volume error observed over several preceding breaths.

The BiPAP Synchrony provides the Bi-Flex feature in S mode. The Bi-Flex attribute adjusts therapy by inserting a small amount of pressure relief during the latter stages of inspiration and during active exhalation (the beginning part of exhalation).

The device incorporates a user interface made up of a Ramp Button, Humidifier Button, Alarm Reset Button, Alarm Silence Button, Scroll Button, and Liquid Crystal Display (LCD). A pressure On/Off push-button is located on the side of the unit.

Service Notice

This service manual was prepared by Respironics primarily for use by technicians to service the BiPAP Synchrony Ventilatory Support System. The individuals using this manual to service the BiPAP Synchrony should have prior training or experience servicing ventilatory devices.

Technical Support Statement

Respironics is committed to customer satisfaction and may be contacted with any questions or for product support. For product assistance or replacement part ordering information, contact Respironics Customer Service.

US and Canada

Phone:1-800-345-6443

Fax:1-800-866-0245

Email: service@respironics.com

International

Phone:1-724-387-4000

Fax:1-724-387-5012

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Training

Respironics offers service training for BiPAP and CPAP systems. For more information, Email Respironics at:

service.operations@respironics.com

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Warnings, Cautions, and Notes

Chapter Overview

Warnings, Cautions, and Notes are used throughout this manual to identify possible safety hazards, conditions that may result in equipment or property damage, and important information that must be considered when performing service and testing procedures on the BiPAP Synchrony.

Please read this section carefully before servicing the BiPAP Synchrony.

WARNING

Warnings indicate the possibility of injury to the patient, operator, or technician.

CAUTION

Cautions indicate the possibility of damage to the device

NOTE

Notes are used to emphasize a characteristic or important consideration.

Warnings

WARNINGS

- *The service technician should read and understand this entire manual before servicing the BiPAP Synchrony. Ensure that all warnings, cautions, and notes cited in the BiPAP Synchrony Provider manual are read and understood prior to servicing this device.*
- *To assure the safety of the service technician and the specified performance of the device, Respironics recommends that only technicians having prior training or experience servicing ventilatory devices perform any repairs or adjustment to the BiPAP Synchrony.*
- *High voltages are present inside this device. To avoid electrical shock, disconnect the electrical supply before attempting any repairs on the device.*
- *DO NOT immerse this device into any fluids.*

Cautions

CAUTIONS
• *Electronic components used in this device are subject to damage from static electricity. Repairs made to this device must be performed only in an anti-static, Electro-static Discharge (ESD)-protected environment.* • *Care should be taken to avoid exposure of the BiPAP Synchrony to temperatures at or near the extremes of those specified in Chapter 3. If exposure to such temperatures has occurred, the device should be allowed to return to room temperature before being turned on.* • *Never place liquids on or near the BiPAP Synchrony.* • *The information in this manual is provided for service personnel reference.*

Notes

NOTES
• *Additional Warnings, Cautions, and Notes are located throughout this manual.* • *Refer to the BiPAP Synchrony User and Provider Manual for product use, additional Warnings, Cautions and Notes.*

Specifications, & System Features

Overview

This chapter describes the specifications and system features for the BiPAP Synchrony Ventilatory Support System.

Specifications

Environmental	
Operating Temperature	*5 °C to 35 °C*
Storage Temperature	*-20 °C to 60 °C*
Humidity	*15 - 95% non-condensing*
Atmospheric Pressure	*83 - 102 kPascals* *(Storage: 50 - 102 kPascals)*
Elevation	*0 - 5,600 ft. with automatic altitude adjustment*
Noise Level	*No specification is given because various test instruments, test procedures, and unit operating conditions produce varying results.*

Fuses	
Fuses	*There are no replaceable fuses in this device.*

Electrical	
AC Voltage Source	*90 - 264 VAC; 47/70 Hz**
DC Input Voltage	*9.8-17.0 VDC***
AC Current Consumption	*1.25 A maximum*
DC Current Consumption	*3.0 A maximum*
Protection Against Electric Shock	*Class II*
Degree of Protection Against Electric Shock	*Type BF Applied Part*
Degree of Protection Against Harmful Ingress of Water	*Device:* *Ordinary Equipment, IPX0* *External AC and External DC Power Supply:* *Drip Proof, IPX1*
** When used with an external AC/DC power converter.*	
***When used with an external DC boost converter and $\geq$ 10.5 VDC to start.*	

Mode of operation
Continuous

Functions	
Modes	*Continuous Positive Airway Pressure (CPAP)* *Spontaneous (S)* *Timed (T)* *Spontaneous/Times (S/T)* *Pressure Control (PC)*

Pressure	
IPAP	*4 to 30 cm H_2O**
EPAP	*4 to 25 cm H_2O*
CPAP	*4 to 20 cm H_2O*
V_{te} Setpoint	*200mL to 1500mL*
Low MinVent Alarm	*0.0 LPM to 99.0 LPM*
Flex Setpoint	*0 to 3*
Breath Rate	*0 to 30 BPM*
Timed Inspiration	*0.5 to 3.0 seconds*
Ramp Duration	*0 to 45 minutes*
*Rise Time***	*1 to 6 (0.1 to 0.6 seconds)*
** Limited to 25 cmH_2O when using the Bi-Flex feature in S mode.*	
*** The range of values correspond to tenths of seconds (e.g., a setting of 4 indicates a Rise Time of 0.4 seconds). When in BiFlex Mode, the unit shall always use a rise time of 3 regardless of this setpoint.*	

Physical	
Dimensions	*9.8"(L) x 6.6"(W) x 4.4"(H)*
Weight	*Less than 7 lbs. without the humidifier*

EMC Normative Documents	
This product is designed to conform to the following standards:	
IEC 60601-1	*Medical Electrical Equipment, Part 1 General Requirements for Safety and essential performance.*

System Features

System Features	
AC Power Connector	*AC power supply connection.*
Air Outlet Port	*Flexible tubing/patient circuit connection.*
DC Power Connector	*Optional DC power connection.*
AC Power Indicator	*LED Display for AC power.*
DC Power Indicator	*LED Display for DC power.*
High Priority Alarm Indicator	*LED Display for High Priority Alarms. (RED)*
Low/Medium Priority Alarm Indicator	*LED Display for Low/Medium Priority Alarms. (YELLOW)*
Display Screen	*Liquid Crystal Display where all device settings appear.*
Pressure On/Off	*Starts or stops the devices airflow.*
Bi-Flex Feature	*Available in S Mode.*
AVAPS Feature	*Available in S, S/T, and PC and T Modes.*
Heat	*Controls the optional Heated Humidifier.*
Ramp	*Lowers the airflow pressure allowing the patient to fall asleep more easily.*
User Buttons	*Navigate the display screen.*
Alarm Silence Button	*Temporarily silences the audible portion of the alarm.*
Reset	*Acknowledges an alarm and resets the device for alarm detection.*
Scroll Button	*Allows for the user to scroll through monitoring parameters on the display.*
Filter Cap and Filters	*The pollen filter screens out normal household dust and pollens. This must be in place at all times when the BiPAP Synchrony is operating. An optional, ultra-fine filter is also included for more complete filtration of very fine particles. The filter cap can be positioned to direct the air flow away from your device.*

RAMP FEATURE

BiPAP Synchrony is equipped with a linear ramp function. The ramp feature will reduce the pressure and then gradually increase (ramp) the pressure to the prescription pressure setting so patients can fall asleep more comfortably.

DIGITAL AUTO-TRAK SENSITIVITY

An important characteristic of the BiPAP Synchrony is its ability to recognize and compensate for unintentional leaks in the system and to automatically adjust its trigger and cycle algorithms to maintain optimum performance in the presence of leaks. This feature is known as Digital Auto-Trak Sensitivity. The following sections examine this function in detail by describing the leak tolerance function and sensitivity.

LEAK TOLERANCE

A microprocessor monitors the total flow of the patient circuit and calculates patient flow values. The BiPAP Synchrony uses two leak estimation algorithms. A conservation of mass algorithm is used to compute the average leak for a given pressure support relationship. This average leak is a high estimate during EPAP pressure and a low estimate during IPAP pressure.

A better leak estimate, enabled by the digital system, is the parabolic leak algorithm. Parabolic leak is proportional to the square of the patient pressure; therefore, the leak estimate is correlated to the changing patient pressure. Both algorithms include unintentional circuit leak and are averaged over several breaths.

The total circuit flow is comprised of the circuit leak and the patient flow. The calculated patient flow is the circuit flow minus the circuit leak. Patient flow is a primary input into the triggering and cycling mechanisms.

SENSITIVITY

An essential feature of the BiPAP Synchrony while operating in the S and S/T modes is its ability to effectively sense spontaneous breathing efforts, which causes the unit to trigger IPAP and cycle to EPAP. Because no preset sensitivity threshold can assure patient and machine synchrony with changing breathing efforts and circuit leaks, the BiPAP Synchrony continuously tracks patient breathing patterns and automatically adjusts sensitivity thresholds to ensure optimum sensitivity as breathing patterns change or as circuit leaks change. The algorithms used to ensure optimum sensitivity are the Volume Trigger/Cycle, Shape Trigger, Flow Reversal and Spontaneous Expiratory Threshold (SET).

The shape trigger/cycle is another method used to trigger IPAP and/or cycle from IPAP to EPAP during spontaneous breathing in the S and S/T modes. This method continuously tracks patient inspiratory and expiratory flow and adjusts the spontaneous trigger and cycle thresholds for optimum sensitivity. The Shape Signal appears as a shadow image of the patient's actual flow. The shape signal functions as a sensitivity threshold at either inspiration or expiration. When the patient's flow rate crosses the shape signal, the unit changes pressure levels. The shape signal is created by offsetting the signal from the actual patient flow by 15 lpm and delaying it for a 300 ms period. This intentional delay causes the shape signal to be slightly behind the patient's flow rate. A sudden change in patient flow will cross the shape signal, causing the pressure level to change.

A second method used to cycle off IPAP during spontaneous breathing in the S and S/T modes is called Spontaneous Expiratory Threshold (SET). The SET rises in proportion to the inspiratory flow rate on each breath. When the SET and actual patient flow value are equal, the unit cycles to EPAP.

A maximum IPAP time of 3.0 seconds acts as a safety mechanism to limit the time spent at the IPAP level during spontaneous breathing in the S and S/T modes. Once the time limit is reached, the unit automatically cycles off IPAP to the EPAP level.

As flow begins to decrease during IPAP, a flow reversal can occur due to a large leak around the mask or because the patient's mouth is open. When the BiPAP Synchrony unit senses this flow reversal, the unit automatically cycles to the EPAP level.

Symbols for Device and Power Supply

Symbols and Meanings	
	*Attention, consult accompanying documents*
	*DC Power*
	*Pressure On/Off*
	*Type BF Applied Part*
	*Class II (Double Insulated)*
	*European CE Declaration of Conformity*
	*Canadian/US Certification*

Symbols and Meanings Cont.	
	*Electrostatic Discharge*
	*Ordinary Equipment*
	*UL Recognized for Canada and the United States*
	*TUV Safety Standard Compliance*
	*No User Serviceable Parts*
	*WEEE/RoHS Symbol*

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THEORY OF OPERATION

OVERVIEW

This chapter describes the operation of the BiPAP Synchrony Printed Circuit Assembly (PCA). Operation of the various circuits on the board are explained.

MAIN PRINTED CIRCUIT ASSEMBLY (PCA)

The Main PCA is the computer control center of the BiPAP Synchrony. A microcontroller reads and writes to various I/O devices such as the control pad, LCD, memory chips, pressure and flow sensors and motor control circuitry. The microcontroller will make appropriate adjustments to the valve and blower using this information to deliver the desired therapy to the patient.

POWER DISTRIBUTION

There are two 3 pin power din connectors on the back of the BiPAP Synchrony. They will accept the bulk voltage on pin 1 from either an external AC/DC 60W Respironics' power supply or an external DC/DC Respironics' power supply with the mating connector. Pin 2 is the return on both connectors. Pin 3 is a multi-purpose pin. It is floating when the AC/DC converter is connected. It is connected to the battery voltage to read on internal ADC channel 0. When the AC/DC converter is used, the bulk voltage will range from 24 to 28 VDC (read on internal ADC channel 4). When the DC/DC converter is used, the voltage will be less than 23 VDC.

5 VOLT SWITCHING POWER SUPPLY

5 Volts is needed throughout the Main PCA for logic circuits. U16 is a simple switcher which produces a 5V output from the bulk voltage. The input cap, C45, is oversized and serves both as an input filter for the bulk voltage at the input connector and the high frequency input cap for this switcher. The output cap, C79, maintains the output ripple voltage below 50 mV. L2 allows 2A output currents comfortably due to its size.

+12V REGULATOR

U18 produces the 12 Volts needed to bias the flow sensor and it is also used as the positive rail for the analog circuitry and the operational amplifiers of the valve controller.

-15V SWITCHING CIRCUIT

A negative power supply is created by using an output from the microcontroller switching current through resistor R186 and capacitor C80. This negative voltage is used as the negative rail for the analog circuitry and valve controller operational amplifiers.

+3.3V REGULATOR

The core and I/O of the microcontroller are driven by 3.3 volts. Voltage regulator U12 creates this voltage from the 5V power supply.

DIGITAL CIRCUITRY

MICROCONTROLLER U2

The microcontroller, U2, has a high-performance 32 bit RISC architecture. The 176 pin device contains an external address and data bus interface, an eight level external interrupt controller, 58 programmable I/O lines, six 16 bit timers, 3 UARTs, a 3 wire SPI interface, an eight channel 10 bit ADC, a two channel 10 bit DAC, an on chip oscillator and PLL for multiplication, a real time clock, a

JTAG interface for boundry scans and a power management controller for sleep and wakeup operations.

The core and I/O ports of the microcontroller use 3.3 V connected at several pins shown on the schematic.

There is an eight channel successive approximation Analog to Digital Converter (ADC) on this microcontroller. Channels AD0 through AD7 are all in use.

When power is initially supplied to the chip, the main oscillator is off until the PLL is enabled. Until this is done, the chip is clocked off of the 32.768 kHz crystal, Y2. The main oscillator takes the output from fundamental crystal, Y1 and is capable of multiplying this frequency up to 33 MHz.

The computer uses the watch crystal (Y2) and a lithium battery (B1) to maintain an internal clock that consumes very little power. The lithium coin cell battery (B1) provides a minimum of 17 years of battery life for the Main PCA.

The main board uses both channels of the two channel 10 bit DAC to control motor speed and set the output pressure controlled by the valve sleeve. The range of the output voltage is 0 to 3.3V. The motor speed command is a calibrated non-linear relationship between RPM and DAC counts.

This device features a Serial Peripheral Interface (SPI) that communicates with external devices in either master or slave mode. Two external devices on the board use this type of communication, the EEPROM (U1) and the ADC (U11). The microcontroller provides three universal sychronous/ asynchronous receiver/transmitters. The zero transmitter, TXD0, is used for communication with the humidifier. TXD1 and RXD1 are used for two way communications with a PC via the SleepLink card or to communicate with an external smart modem.

IR Communication Link for the Integrated Humidifier

The BiPAP Synchrony communicates serially via an infrared LED with the integrated humidifier that cradles the enclosure. The LED (CR3) transmits 2 wire serial commands to an IR detector inside the humidifier to turn on, turn off and adjust the water temperature in the humidifier.

8Kbit EEPROM

Eight thousand bits of memory are provided on this board for the storage of therapy parameters in U1.

4Mbits of Program Flash Memory

IC, U4 contains 512 kbytes of non-volatile Flash memory that is programmed and operated with 3.3V. This chip contains the application software.

128 kbytes of Asynchronous SRAM

U5 has 128 kbytes of static ram which allows for the freedom and complexity of the application code. This chip is designed for 3V operation.

Watchdog Supervisor

An external supervisory chip, U3, monitors the 3.3 Volts. When the voltage approaches 2.93 V the chip will protect the Flash Chip by resetting the processor before the voltage reaches a level too low for the Flash and also shuts down the processor while the core voltage is dropping.

Analog Devices

Pressure Sensors

The main control board uses two sensors to monitor pressure amplitudes, MT4 or MT5 and MT3 or MT1. MT4 or MT5 is connected to the outlet pressure and MT3 or MT1 is connected at the blower. (Type of sensor used on the PCA will determine the MT locations used.)

Barometric Pressure Sensor

The BiPAP Synchrony uses a 15psia pressure sensor. The sensor, MT6, is used to provide altitude compensation for volumetric flow calculations. It is a 0 to 15 psia sensor with temperature compensation and calibrated zero and span.

Bi-Directional Mass Flow Sensor

The main board uses mass flow sensor (MT2). The sensor uses the thermal properties of air to qualify the mass of a gas passing through the element. The sensing elements are seated on a heater element and are normally at some temperature above the ambient. As flow passes over the first element, which can be called the upstream element, it cools this element and at the same time picks up heat. Between the two elements the gas picks up more heat as it traverses the heater and finally adds its newly acquired heat to the downstream element. The two elements are thermistors that when placed in a Wheat-stone bridge configuration, produce an output voltage proportional to the mass of the airflow.

Electro-Mechanical

A brushless DC motor is used in the BiPAP Synchrony to spin the impeller used to generate the pressure for therapy. The BiPAP Synchrony uses a valve to control the patient pressure but the blower provides a deadhead pressure above the maximum pressure setpoint.

Sensorless motor controller

The motor control chip (U9) runs off of the regulated +12 Volt power. When a motor speed command voltage is present and the BRAKE signal goes from high to low, the unit aligns the motor, ramps the motor in open loop control mode and then senses crossing from the phase windings to commutate the motor at the command speed.

Motor Speed Control

The DAC command from the microcontroller is a 0 to 3.3 volt signal and the signal is doubled by the Op-amp (U7). It is filtered by R85 and C39 to prevent noise on the signal. The speed command is virtually linear up until the command voltage reaches 6 volts and then it begins to flatten (less speed for changing voltage). The range of speed commands is from zero to the 6.9V reference voltage.

Braking and Starting Circuitry

The BRAKE output from the microcontroller commands both the BRAKE and the reset (CRST) pins. When the brake is released, Q10 and Q11 are both switched off. When these two pins are left floating, the chip enters the reset state by turning on two of the high side drivers (Q8 and Q21) and one of the low side drivers (Q9). This has the effect of aligning the motor 30 degrees before the first commutation state. While this is happening, the unit is switching in and out of current limit and the capacitor C40 is charging up by a small output current from the CRST pin and the additional current supplied by +12 Volts through R89. When the voltage on C40 exceeds 1.5 Volts, the chip enters the ramp mode. In ramp mode, the chip begins the commutation sequence and increases the rate of the sequence while charging both the ramp capacitor, and the PLL filter components. When the ramp capacitor, C38 reaches 1.5 Volts, the motor has enough speed for sensing and closed loop control.

Sleeve Valve

The sleeve valve of the BiPAP Synchrony controls with good response time and stability. The valve is a linear DC motor with a slitted sleeve sliding over ports in the stationary barrel. One of the ports is pneumatically connected to the blower pressure and the other is an exhaust outlet. There is always a nominal flow through the annulas between the two concentric parts that provides additional stability and an air bearing. The sleeve is wound with copper wire and a magnet is attached to the inner diameter of the barrel to provide a perpendicular bi-directional force.

Valve Controller

The command is a voltage generated from the microcontroller DAC channel 1. When a pressure is requested, the voltage generated from the DAC is multiplied by 1.499 by the amp, U23 with R146 and R147. MT4 or MT3 produces a pressure feedback signal through an amplifier U28. This signal is subtracted from the command pressure with U22A and the difference or error signal U22 pin 1 is the input to the sleeve controller. The output of the controller network is delivered to the valve driver/ amplifier U24. U24 takes a 5V analog input signal and drives a voltage out that can swing from -5V to 5V across the valve coil. 2.5V corresponds to zero voltage and current.

User Interface

Soft Key with Push Buttons

The board has seven pills to detect keypresses. The pull-up resistors, R20, R22, R23, R24, R41, R129, and R130 are used for this circuit. The BiPAP Synchrony has a Scroll key that allows the user to scroll through different measured parameters. The pullup resistor for the Scroll key is R41. Four white LED's CR1, CR2, CR10, and CR11 are illuminated by switching Q1. All four are turned on and off together.

Display Driver and LCD

The backlighting for the display is switched on through Q27 and the current is set by R227. All displays are driven by display drives U6 and U15. Both chips run off of 3.3 Volts. The clock output can be found on pin 4.

Power Fail Circuitry

When power is removed from the unit, but the on/off button remains in the on position, the unit will enter power fail mode. Voltage is held up by C57. This voltage is boosted and regulated by U15 to provide a fixed loudness. As the capacitor drains, Q26 and Q25 with the surrounding circuitry provide an astable vibrator to provide a 2 second on / 2 second off alarm. The red LED remains on continuously. Power fail on the board is detected by the existence or lack of +5 Volts.

System Setup Procedures

Overview

This section provides an overview of the system setup, including detailed instructions on how to access the Therapy settings.

NOTE

This section provides directions for accessing the Therapy settings. To prevent patients from tampering with these settings, the directions to access the therapy settings should not be revealed to the patient.

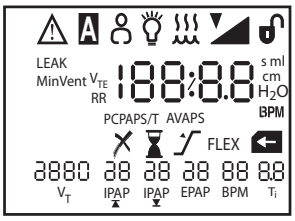
CAUTION

If the BiPAP Synchrony has been exposed to either very hot or very cold temperatures, allow it to adjust to room temperature (approximately two hours) before beginning startup.

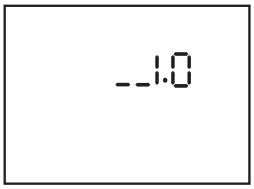
Figure A: BiPAP Synchrony Display

System Setup

Plug the external power supply into the connector in the back of the BiPAP Synchrony. The BiPAP Synchrony will sound a confirmation alarm, and the control panel buttons light up. The first screen to appear is the Self Test screen

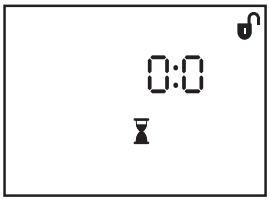


The next screen that will appear will display the software version of the device

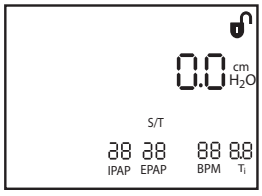


The Blower Hours Screen will then appear, which displays the Blower Hours Time Meter:

The next screen that will appear will be the Standby Screen:



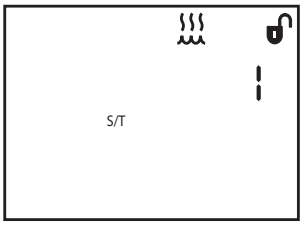
The Standby Screen appears when the BiPAP Synchrony is in the Standby state. Pressing the Pressure On/Off button in puts the BiPAP Synchrony in the Operate state. The Monitoring Screen will then appear:



Both the Monitoring and the Standby screens display the Patient, Apnea, and Light icons if these features are enabled. Likewise, the Card icon displays if a SmartCard is inserted, and the Setup icon

displays if the access level is set to Provider mode. The monitoring screen also displays the actual measured pressure and the Flex icon if Flex is enabled.

When in the Standby or Monitoring screens, you can modify the humidifier setting by pressing and holding the Heat button until the following screen appears:



You can increase or decrease the humidifier setting from 1 to 5 in increments of 1. The setting changes immediately as you adjust it.

Provider Mode

There are two ways to access Provider mode:

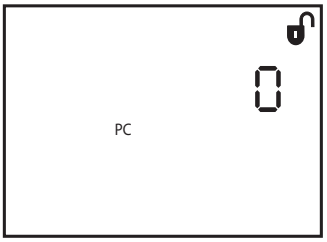
1. When the access level parameter is set to 1, the BiPAP Synchrony will be in Provider mode when power is supplied to the unit. The only way to exit this mode is to change the access level parameter to 0.
2. Simultaneously hold down the right user button and the alarm silence button for approximately 2 seconds while supplying power to the unit until the device beeps. Pressing the alarm silence button at any time will exit you from the Provider mode.

NOTE

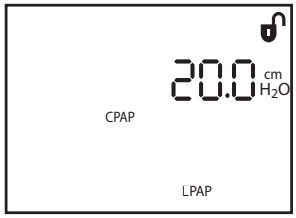
In order to scroll through the different menus, you must use the left and right user buttons along with the ramp and heat buttons.

Setting up the BiPAP Synchrony

1. Enter the Provider Mode. The first screen is the Mode setting screen. To change the selection, press the Heat or Ramp button until the correct setting appears. Available modes are PC, CPAP, S, S/T, and T. Press the right user button once the desired setting is reached.

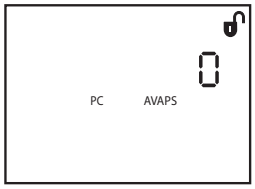


2. If CPAP is chosen, the CPAP setting screen will appear next.



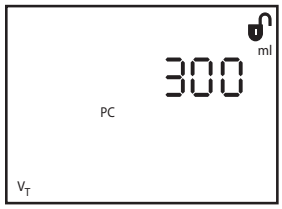
Increase or decrease the CPAP pressure by pressing the Heat and Ramp buttons until the desired pressure appears. You can adjust the pressure from 4 to 20 cm H_2O in 1 cm H_2O increments. Press the right user button to move to the next screen. If CPAP is the chosen mode, proceed to Step 10 for next screen.

If PC, S, S/T, or T mode is chosen, the AVAPS screen will appear next.



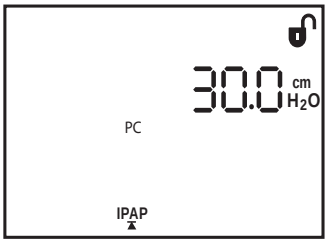
Turn the AVAPS on or off by pressing the Heat or Ramp buttons until the correct number appears. A One (1) on the display screen indicates that AVAPS is enabled and a Zero (0) indicates that the AVAPS feature is disabled. Press the right user button to move to the next screen. If AVAPS is not chosen proceed to Step 6.

3. The Target Tidal Volume screen will appear next.



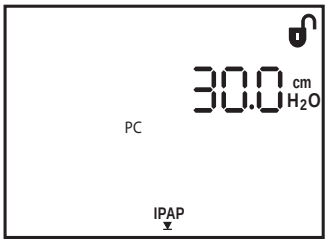
Increase or decrease the Target VT pressure by pressing the Heat or Ramp buttons until the correct pressure appears. You can adjust Target VT from 200 mL to 1500mL in increments of 10mL. Press the right user button to move to the next screen.

4. The IPAP max screen will appear next.



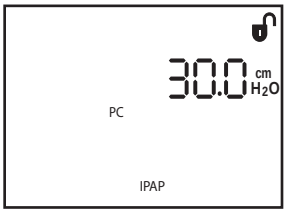
Increase or decrease the IPAP max pressure by pressing the Heat or Ramp buttons until the correct pressure appears. You can adjust the pressure from 4 to 30 cm H_2O in 1 cm H_2O increments. The IPAP max pressure setpoint cannot be set lower than the IPAP min pressure setting. Press the right user button to move to the next screen.

5. The IPAP min screen will appear next.



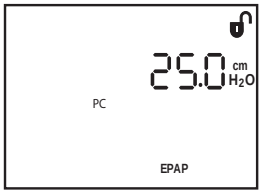
Increase or decrease the IPAP min pressure by pressing the Heat or Ramp buttons until the correct pressure appears. You can adjust the pressure from 4 to 30 cm H_2O in 1 cm H_2O increments. The IPAP min pressure setpoint cannot be set lower than the EPAP setting. Press the right user button to move to the next screen.

6. If AVAPS is not enabled the IPAP screen will appear next.



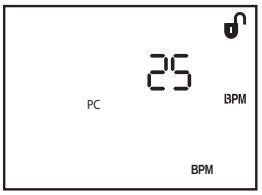
Increase or decrease the IPAP pressure by pressing the Heat or Ramp buttons until the correct pressure appears. You can adjust the pressure from 4 to 30 cm H_2O in 1 cm H_2O increments. The IPAP pressure setpoint cannot be set lower than the EPAP setting. Press the right user button to move to the next screen.

7. The EPAP screen will appear next.



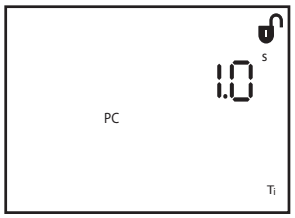
Increase or decrease the EPAP pressure by pressing the Heat or Ramp buttons until the correct pressure appears. You can adjust the pressure from 4 to 25 cm H_2O in 1 cm H_2O increments. The EPAP pressure cannot be set higher than the IPAP setting. If the EPAP is set to less than the ramp start pressure, the ramp start pressure automatically sets to the EPAP. Press the right user button to move to the next screen.

8. If the unit is set to PC, S/T, or T mode, the next screen will be the Breath Rate Mode. (For CPAP, proceed to step 11 and S mode, proceed to step 10.)



Increase or decrease the breath rate by pressing the Heat or Ramp buttons until the correct setting appears. You can adjust the breath rate from 0 to 30 in 1 BPM increments. Press the right user button to move to the next screen.

9. The next screen will be the Inspiratory Time Setting screen. (For CPAP, proceed to step 11 and S mode, proceed to step 10.)

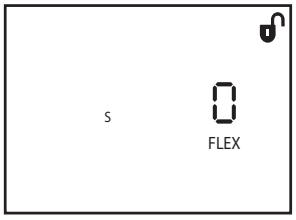


Increase or decrease the inspiratory time by pressing the Heat and Ramp buttons until the correct setting is reached. You can adjust the inspiratory time from 0.5 to 3 seconds in 0.1 second increments. Press the right user button to move to the next screen.

NOTE:

The inspiratory time and breath rate controls are linked so the inspiratory time never exceeds the expiratory time. If the breath rate or inspiratory time are set to values that would cause the IE ratio to exceed 1:1, the inspiratory time is automatically reduced to maintain a IE ratio of 1:1.

10. When in S mode the next screen will be the Flex Setting screen. (All other modes should proceed to Step 11.)

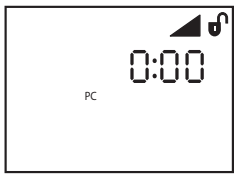


NOTE

The Flex Setting is not available if the IPAP at 26 cm H_2O or higher.

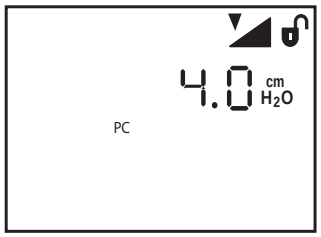
This screen allows you to adjust the level of air pressure relief that the patient feels when he or she exhales during therapy. To change the selection, press the Heat or Ramp buttons until the correct setting appears. The Flex set point is adjustable from 0-3 in increments of 1. Press the right user button to move to the next screen.

11. The next screen is the Ramp Length Setting. This allows you to change the ramp time.



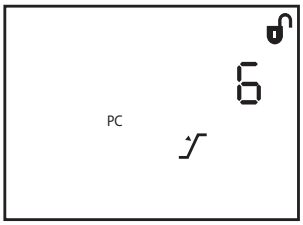
To change the ramp time, press the Heat and Ramp buttons until the correct time appears. The setting increases or decreases from 0 to 45 minutes in 5 minute increments. If you do not want to ramp, set the time to zero. Press the right user button to move to the next screen.

12. The next screen is the ramp setting pressure. This screen will only display if the ramp length setting is greater than zero.



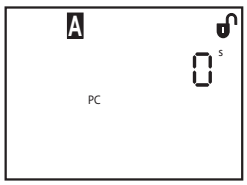
To change the ramp setting pressure, press the Heat and Ramp buttons until the correct pressure appears. The setting increases or decreases in 1.0 cmH_2O increments. The user can adjust the setting from 4 cmH_2O to the EPAP/CPAP pressure setting. Press the right user button to move to the next screen.

13. The Rise Time is the next screen that will appear. In S mode, this screen will only display if the Flex setting is equal to zero.



Rise Time is the time it takes for the BiPAP Synchrony to change from EPAP to IPAP. This screen allows you to adjust the rise time so you can find the most comfortable setting for the patient. To change the rise time setting, press the Heat and Ramp buttons until you find the right setting. The rise time can be set from 1 to 6. The rise time of 1 to 6 corresponds to tenths of a second. When in Bi-Flex mode, the BiPAP Synchrony will use a rise time of 3 regardless of the setpoint. Press the right user button to move to the next screen.

14. The next screen is the Apnea Alarm Setting. This screen will allow you to enable or disable the audible alert (a beeping sound) when an apnea is detected.

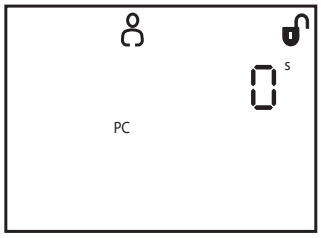


Change the apnea setting by pressing the Heat and Ramp buttons until the desired setting is reached. You can increase the time from 0 to 30 seconds in 10 second increments.

- 0 will disable the apnea alarm.
- 10 means that the alarm sounds if the time between spontaneous breaths exceeds 10 seconds.
- 20 means that the alarm sounds if the time between spontaneous breaths exceeds 20 seconds.
- 30 means that the alarm sounds if the time between spontaneous breaths exceeds 30 seconds.

Press the right user button to move to the next screen.

15. The next screen is the Patient Disconnect Alarm Setting.



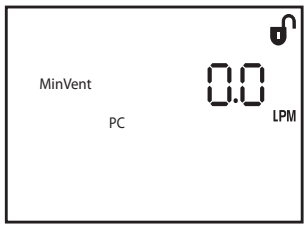
This setting enables or disables the audible alert (a beeping sound) when a large, continuous air leak (such as mask removal) has been detected in the circuit.

To change the patient disconnect alarm setting, press the Heat and Ramp buttons until the correct setting appears. You can increase or decrease the setting between 0, 15, and 60 seconds.

- 0 disables the patient disconnect alarm.
- 15 means that the alarm sounds after the patient has been disconnected for 15 seconds.
- 60 means that the alarm sounds after the patient has been disconnected for one minute.

Press the right user button to move to the next screen.

16. The Next Screen is the Low Minute Ventilation Alarm Setpoint.

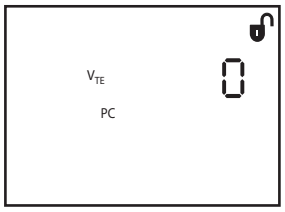


This setting enables or disables the audible alert (a beeping sound) when a low minute ventilation event is detected.

To change the low minute ventilation alarm setting, press the Heat and Ramp buttons until the correct setting appears. You can increase or decrease the setting from 0 to 99 LPM in increments of 1 LPM.

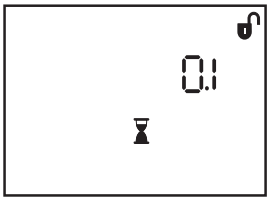
Press the right user button to move to the next screen.

17. When in PC, S, S/T, and T mode and AVAPS is enabled, the next screen to appear is the Low Tidal Volume Alarm Setpoint. (For CPAP mode proceed to step 18.)



This screen turns on/off the Low Vte alarm. A 1 on the display window turns the alarm on and a zero indicates that the alarm is off. This alarm will sound when the measured tidal volume is less than 90% of the target tidal volume setpoint.

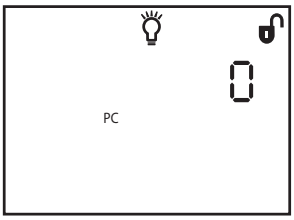
18. The Reset Therapy Meter Setting screen is the next screen that will appear.



This screen displays the number of hours that the BiPAP Synchrony delivered therapy to the patient. The decimal digit displays with a 0.1 hour resolution if the therapy time is less than 1000 hours. Otherwise, the decimal digit does not display so values between 1000 and 19999 hours can display.

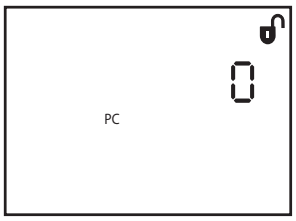
To erase the totals and go back to zero, press and hold the Ramp or Heat buttons. The Erase Hours icon displays on the screen. Hold the button down until the time changes to zero and the icon disappears. Press the right user button to move to the next screen.

19. The next screen is the LED Backlight Setting Screen.



The LED Backlight Setting screen allows you to have the control pad lights behind the buttons on or off while the airflow is turned on and the unit is in the Operate state. To change the LED backlight setting, press the Heat and Ramp button until the correct setting appears. 1 means the light is on, while 0 means the light is off. Press the right user button to move to the next screen.

20. The next and final screen is the Access Level Setting screen.



This screen allows you to select Provider mode or User mode access. Press the Heat or Ramp buttons to select the appropriate access level. 0 indicates that the BiPAP Synchrony is in User mode, and 1 indicates that the unit is in Provider mode.

The Provider mode settings are complete. Press the Alarm Silence button to exit the settings menu or continue pressing the right and left user buttons to navigate the Provider mode screens.

Required, Alternate, and Optional Accessories

This section addresses the required, alternate, and optional circuit accessories that can be used with the BiPAP Synchrony. For additional information, refer to the literature supplied with the accessory

WARNING

The BiPAP Synchrony requires an intentional leak port, either built into the mask or on a separate exhalation device (e.g., Whisper Swivel II, Disposable Exhalation Valve) to remove exhaled air from the circuit. Therefore, specific masks and circuits using an intentional leak port are required for normal operation. The pressurized air from the BiPAP Synchrony causes a continuous flow of air to exhaust from the leak port to flush the exhaled air from the circuit. The BiPAP Synchrony should be turned on and the intentional leak port should be checked before using the device.

WARNING

At low CPAP and bi-level pressures, the air flow through the exhalation ports may not be enough to clear all of the exhaled gas (CO_2) from the mask. Patients may breathe in some of the air that they exhaled. DO NOT block or try to seal the exhalation ports in the circuit.

Circuit Configurations

The BiPAP Synchrony is intended for use with Respironics-approved patient circuits. Typical components are:

- Bacteria Filter (Optional)
- 22 mm reusable circuit tubing
- Exhalation Device
- Respironics Patient Interface (e.g., mask)
- Respironics Pressure Valve (RI p/n 302418, required), if using supplemental oxygen
- Humidifier (Optional)

Additional accessories may be added to the circuit to meet specific needs.

Circuits and Accessories

Reusable or Disposable Circuit

- Reusable smooth inner lumen circuit tubing and exhalation port
- Disposable smooth inner lumen circuit tubing and exhalation port

Circuit Accessories

- 6” disposable circuit tubing
- 18” disposable circuit tubing
- 72” disposable circuit tubing
- O_2 enrichment attachment
- Bacteria Filter

BiPAP Synchrony Accessories

- DC/DC Power Adapter
- Respironics Communication Cable
- Remote Alarm
- Respironics Portable Battery Pack (RI p/n 1028869)

Masks, Exhalation Ports, and Related Accessories

Masks

- Respironics mask with built-in exhalation port
- Respironics mask with separate exhalation device

Accessories

- Disposable Headgear
- Reusable Headgear
- Chin Strap

Humidifiers

- Respironics REMstar Heated Humidifier
- Respironics Pass-over Humidifier
- Respironics H2 Heated Humidifier

Software

- Respironics Encore Pro Data Management software for reading compliance data.

DC Power Accessories

The BiPAP Synchrony can be used in a stationary recreational vehicle, boat, or motor home when powered by the DC/DC power adapter.

The Respironics DC/DC power adapter and cord enables the BiPAP Synchrony to be operated from a 12 VDC free-standing battery, or a portable battery pack from Respironics (RI p/n 1028869).

CAUTIONS

- *Only use the Respironics DC Power Accessories. Use of any other system may cause damage to the BiPAP Synchrony.*
- *DC Power is not intended to be used as battery back-up. DO NOT connect the DC Power while the BiPAP Synchrony is operating on AC Power. System damage may occur.*

Adding a Humidifier

When using a humidifier, always disconnect the humidifier tubing from the BiPAP Synchrony system when it is turned off. DO NOT use a room humidifier within 6 ft. of the BiPAP Synchrony. Moisture can build up in the system and cause damage. Follow the instructions included with the humidifier.

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Routine Maintenance

Chapter Overview

This chapter provides guidelines and illustrates the cleaning and maintenance procedures for the BiPAP Synchrony system.

Cleaning the System

WARNING

To avoid electrical shock, disconnect the electrical supply before attempting to clean the BiPAP Synchrony. DO NOT immerse the device in water or allow any liquid to enter the cabinet or the filter intake.

Wipe the outside of the device with a cloth slightly dampened with water and a mild detergent. Let the device dry before reconnecting the electrical supply.

Cleaning/Replacing the Intake Filter

The gray pollen filter is a reusable filter that screens out pollens and some household dust. This filter should be cleaned at least once every two weeks under normal usage, or as required, and replaced with a new one every six months. One additional pollen filter is included with the system. The pollen filter must be in place at all times when the unit is operating.

CAUTION

Failure to replace a dirty filter may cause the device to operate at higher than normal temperatures and damage the device.

Removing, Cleaning, and Replacing the Filter

1. With the airflow turned off, disconnect the AC power cord from the back of the unit.
2. Remove the filter cap by gently lifting up on the bottom of the filter cap, then pull it away from the back of the device.

Figure A BiPAP Synchrony System with Filters and Cap

3. Remove the pollen filter by gently pulling the edges of the filter. Rinse the filter in a steady stream of running water. Squeeze out the water, and repeat. Allow the pollen filter to air dry for 8 to 12 hours, or in a clothes dryer on low heat for 15 to 20 minutes.
4. If using the optional ultra-fine filter, place it into the filter area in the back of the BiPAP Synchrony. Then place the pollen filter in line with the ultra-fine filter. Place the filter cap onto the back of the unit.

CAUTIONS

The pollen filter must be completely dry before use. Never place a wet filter into the device. Respironics recommends that you clean the filter in the morning and alternate using the two pollen filters provided with the system to ensure enough drying time for the cleaned filter.

DO NOT place both pollen filters into the device at the same time. One pollen filter and one ultra-fine filter or one pollen filter may be used.

Preventive Maintenance Schedule

The following Preventive Maintenance Schedule lists the items that must be inspected or tested periodically, or after service is performed. Use the Preventive Maintenance Schedule to record the dates on which the maintenance items are performed.

The Preventive Maintenance Schedule may be copied for each device serviced.

BiPAP Synchrony System Preventive Maintenance Schedule (Factory Recommended)

Model Number:_____

Serial Number:_____

Date:_____/_____/_____

Technicians Name:_____

Maintenance Item	Verification Reference	Service Invoice	Date
Record Blower Hours	*Displayed on LCD Screen*	*As Desired*	
Clean/Replace Pollen Filters	*Routine Maintenance Section*	*Clean every two weeks, or as required; Change every six months*	
Perform Testing Process	*Testing Section*	*After service is performed*	
Cleaning	*Routine Maintenance Section*	*As required*	

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TROUBLESHOOTING AND DIAGNOSTICS

CHAPTER OVERVIEW

WARNING

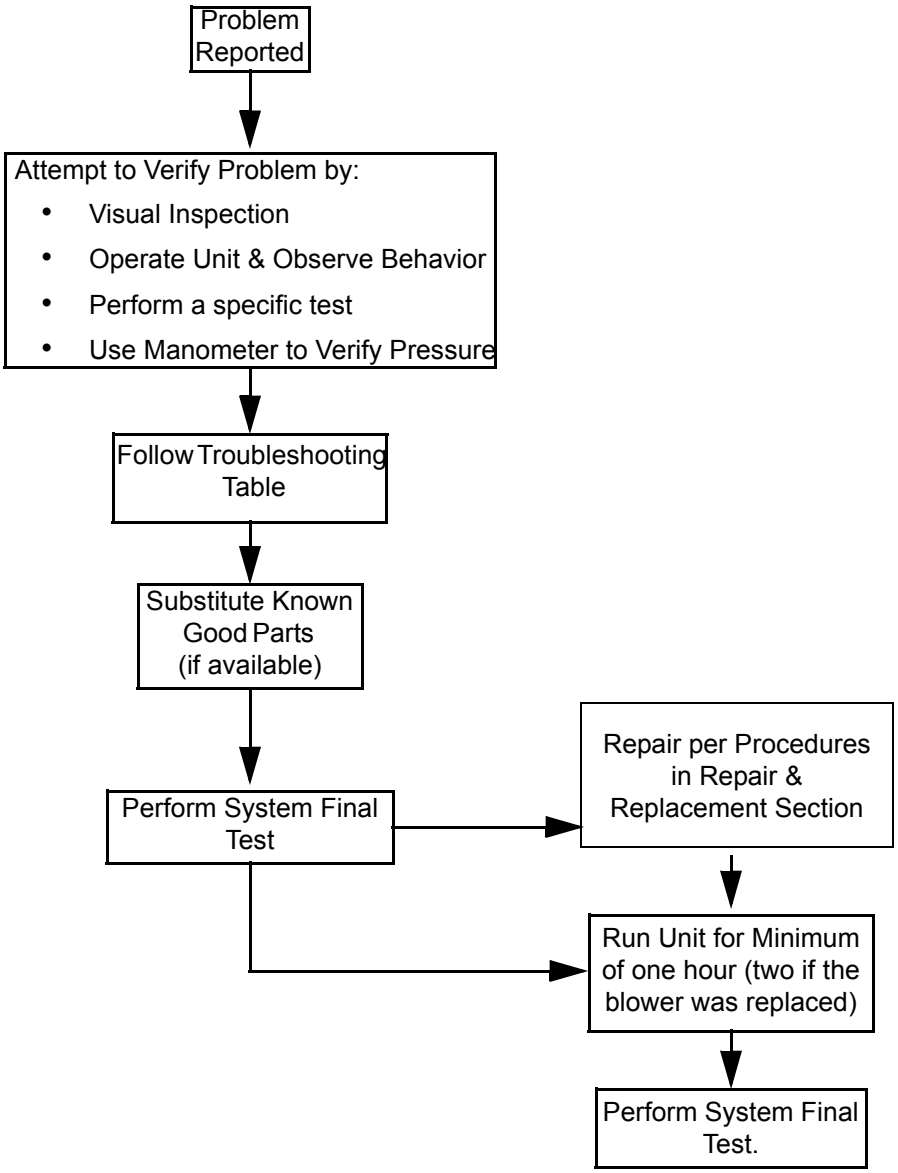
Disconnect the electrical supply before repairing the device.

CAUTION

Electrical components used in this device are subject to damage by static electricity. Use the proper static discharge equipment and grounding precautions when servicing the equipment. Service only in an ESD-protected environment.

This section contains information necessary to troubleshoot and diagnose problems with the BiPAP Synchrony. It provides a summary of common system problems as well as a flow chart and table to simplify the troubleshooting process. The error code chart lists all error codes, the associated problem, and suggested corrective action to be taken.

Troubleshooting Flow Chart



Alarm Introduction

This section describes the BiPAP Synchrony alarms, how to set them, and what corrective actions to take for the alarm conditions.

The BiPAP Synchrony provides three alarm levels: high, medium, and low priority.

High Priority: These alarms require immediate operator response. The alarm signal consists of a red LED and a high priority sound. The display has the message ALARM at the top of the screen.

Medium Priority: These alarms require prompt operator response. The alarm signal consists of a yellow LED and a medium priority sound. The display has the message ALARM at the top of the screen.

Low Priority: These alarms require operator awareness. The alarm signal consists of a yellow LED and a low priority sound. The display has the message ALARM at the top of the screen.

Figure A: BiPAP Synchrony Alarm LEDs and Buttons

Overview of Alarm Behavior

Alarm conditions are signalled by the BiPAP Synchrony in three ways: sound, an LED, and a display message. Each signal type behaves differently depending on the type of alarm.

Alarm Sound Behavior

High Priority Sounds

The BiPAP Synchrony has two possible high priority sounds.

- **High Priority** - The sound repeats a pattern of three beeps followed by a pause and then two more beeps until the **Silence** or **Reset** button is pressed. The silence period is one minute. This pattern is indicated as ••• ••
- **Loss of Power** - The sound repeats a pattern of one beep followed by a two second pause periodically without user intervention. The **Pressure On/Off** button silences this alarm. The **Silence** and **Reset** buttons and the LED control panel backlight do not apply to this alarm. This pattern is indicated as: ▬ ▬

Medium Priority Sound

The medium priority sound repeats a pattern of three beeps every 20 seconds until the **Silence** or **Reset** button is pressed. The silence period is one minute. This pattern is indicated as •••

Low Priority Sound

The low priority sound repeats a pattern of two beeps every 30 seconds until the **Silence** or **Reset** button is pressed. The audible alarm will not reoccur. This pattern is indicated as ••

Silence Period

The silence period for all applicable alarms is one minute. When the alarm sound is silenced, a flashing LED becomes continuous. If the alarm condition is not corrected by the end of the silence period, the alarm sound is repeated; the LED will flash again. If a new high or medium priority alarm condition occurs during this time, the appropriate LED flashes. New low priority alarms do not cause the LED to flash.

NOTE

Pressing the Silence button while the silence period is active does not restart the silence period.

Alarm LED Behavior

Red Alarm LED

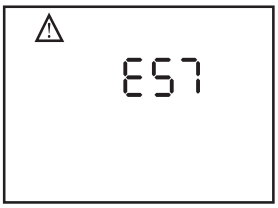
The red alarm LED indicates high priority system and patient alarms. The LED flashes when a new high priority alarm is detected. It changes from flashing to continuous when the alarm sound is silenced or the alarm condition is corrected. The LED resumes flashing when the silence period expires or if a new alarm occurs. The LED turns off when all high priority alarms with an automatic reset method end and there are no high priority alarms with a manual reset method are active. Additionally, the red LED turns off when you press the **Reset** button.

Yellow Alarm LED

The yellow alarm LED indicates medium or low priority system and power alarms. The LED flashes when a new medium priority alarm is detected. It changes from flashing to continuous when the alarm sound is silenced or if the alarm condition is corrected. The LED resumes flashing when the silence period expires or if a new alarm occurs. The LED turns off when all medium and low priority alarms with an automatic reset method end and there are no medium or low priority alarms with a manual reset method active. Additionally, the yellow alarm LED turns off when you press the **Reset** Button.

Display Behavior

For high, medium, and low priority alarms the display shows ALARM and the name of the alarm.



System Alarms

The BiPAP Synchrony has several system alarms:

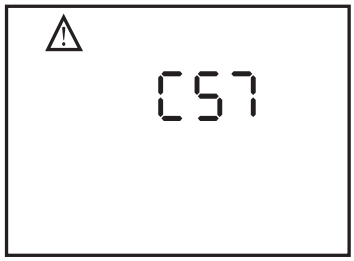
- System Error
- Card Error
- Pressure Regulation High
- Pressure Regulation Low
- Low Pressure Support

System Error Alarm

The System Error Alarm is a high priority alarm. It indicates that there is a problem with the device. Unlike other high priority alarms, the red LED cannot be turned off because the alarm does not stop until the power shuts down and is then restored. A three digit error code displays on the screen, indicating the type of error (e.g., error code 57 displays as E57). When a system error occurs, the BiPAP Synchrony's LCD backlight is turned on and the blower and humidifier are off. Pressing the **Reset** button only shuts off the audible alarm.

Card Error Alarm

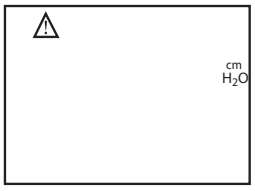
The Card Error alarm is a low priority alarm. It indicates that a problem exists with the SmartCard inserted in the device. Removing the SmartCard automatically resets this alarm. Additionally, pressing the Reset button stops the alarm until another valid SmartCard is inserted and detected.



A three digit error code displays on the screen, indicating the type of error (e.g., error code 57 displays as C57). When a card error occurs, the BiPAP Synchrony's LCD backlight is turned on. Pressing either the **Reset** button or **Silence** button exits this screen and returns to the previous screen.

Pressure Regulation High Alarm

The Pressure Regulation High alarm is a high priority alarm. It indicates that the outlet pressure is greater than 5 cmH_2O above the IPAP setpoint. This alarm does not reset automatically. Press the **Reset** button to manually reset this alarm. The Pressure Regulation High, Pressure Regulation Low, and Low Pressure Support alarms both display the following screen.



When this screen displays a Pressure Regulation High alarm, the **cm H_2O** and **ALARM** icons flash and the LCD backlight is turned on. Pressing either the Silence or Reset button exits this screen and returns to the previous screen. If the condition occurs for 0.5 seconds, the device cycles to EPAP. After 3 seconds, if the condition continues, a high priority alarm is generated, but the device still operates. If the condition is still detected after 10 seconds, the device shuts down.

Pressure Regulation Low Alarm

The Pressure Regulation Low alarm is a high priority alarm that indicates when the patient is not receiving adequate pressure therapy (the outlet pressure is 5 cm H_2O below the IPAP set point). This alarm does not reset automatically. Press the Reset button to manually reset this alarm. When the Pressure Regulation Low alarm screen appears, the **cmH_2O,** and **Alarm** icons flash and the LCD backlight is turned on. Pressing either the **Silence** or **Reset** button exits this screen and returns to the previous screen.

Low Pressure Support Alarm

The Low Pressure alarm is a high priority alarm that indicates that a low pressure support condition has been detected for 60 seconds. This alarm does not reset automatically. Press the reset button to manually reset this alarm. Pressing either the **Silence** or **Reset** button exits this screen and returns to the previous screen.

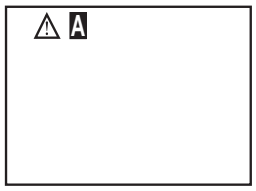
Patient Alarms

The BiPAP Synchrony has the following patient alarms:

- Apnea
- Patient Disconnect
- Low Minute Ventilation
- Low Tidal Volume

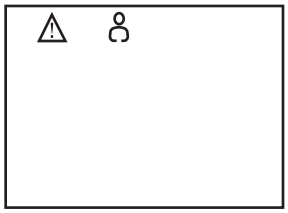
Apnea Alarm

The Apnea Alarm is a high priority alarm that detects the sensation of spontaneous breathing. It occurs when the time between spontaneous breaths exceeds the Apnea alarm time setting (10, 20, or 30 seconds). A setting of zero disables the Apnea Alarm. When an apnea alarm occurs, the **APNEA** and **ALARM** icons flash on display and the LCD backlight is turned on. This alarm does not automatically reset. Press the **Reset** button to manually reset the alarm.



Patient Disconnect alarm

The Patient Disconnect Alarm is a high priority alarm. It occurs when the patient is disconnected from the BiPAP Synchrony for the time specified in the Patient Disconnect alarm time setting (0, 15,or 60 seconds). When a patient disconnect alarm occurs, the Patient and ALARM icons flash on the display and the LCD backlight is turned on. A setting of zero disables the Patient Disconnect alarm. This alarm does not automatically reset. Press the Reset button to manually reset the alarm.



Low Minute Ventilation

The Low Minute Ventilation alarm is a high priority alarm. It occurs when the calculated minute ventilation is less than or equal to the alarm setting. When a Low Minute Ventilation alarm occurs, the **Alarm** and **Min Vent** icons flash on the display and the LCD backlight is turned on. This alarm does not automatically reset. Press the reset button to manually reset the alarm.

NOTE
A setting of zero disables the Low Minute Ventilation alarm.

Low Tidal Volume Alarm

The Low Tidal Volume alarm is a high priority alarm. IT occurs when the calculated tidal volume is less than 90% of the target tidal volume setting. When a Low Tidal Alarm occurs, the **Alarm** and $\mathbf{V_{TE}}$ symbols flash on the display and the LCD backlight is turned on. This alarm does not automatically reset. Press the reset button to manually reset the alarm

NOTE
A setting of zero disables the Low Tidal Volume alarm.

Power Alarms

The BiPAP Synchrony power alarms are described below.

External Battery Discharged

This alarm occurs when the external battery is below 9.8V. This alarm does not occur if AC power is available, but the Low External Battery alarm remains active. The red alarm LED flashes when this alarm occurs and the power failure audible alarm beeps. The **Silence** and **Reset** buttons do not apply to this alarm.

Loss of Input Power

This alarm occurs when AC and DC power is lost while the unit is in the Operate state, or AC and DC power is not available when the Pressure On/Off button is pressed. The red alarm LED flashes when this alarm occurs and the power failure audible alarm beeps. The **Silence** and **Reset** buttons do not apply to this alarm.

Low External Battery

This alarm occurs when the external battery is below 10.3V. It is a medium priority alarm. When this alarm occurs, the yellow LED and the DC power LED flash upon detection. When the alarm is reset or the battery is replaced, the yellow LED goes away and the DC power LED stops flashing (but remains on to indicate that DC power is being used). The medium priority audible alarm sounds. This alarm automatically resets when the external battery is replaced. Additionally, you can press the Reset button to reset this alarm; however, the alarm will recur unless the external battery is replaced.

AC to DC Power Switchover

This alarm occurs when the BiPAP Synchrony switches from AC to DC power. It is a low priority alarm. When this alarm occurs, the yellow LED is on and the DC power LED flashes upon detection. When the alarm is reset, the yellow LED goes away and the DC power LED stops flashing (but remains on to indicate that DC power is being used). The low priority audible alarm sounds. This alarm automatically resets when AC power is restored. Additionally, you can use the **Reset** button to manually reset this alarm.

Battery in Use

This alarm occurs only upon startup, to notify the user that the battery power is being used. This is a low priority alarm.

When this alarm occurs, the yellow LED is on and the DC Power LED flashes. The low priority audible alarm sounds. This alarm automatically resets when AC power is provided. Additionally, you can use the **Reset** button to manually reset this alarm.

AC Power Supply Alarm

This alarm may indicate two issues, depending on which power supply is connected. If only the DC power adapter is connected, the alarm indicates that the power supply has a defective battery sense line. If only the AC power supply is connected or if both the AC power supply and DC power adapter are connected, this alarm indicates that the AC power supply is out of specification (less than 22V). You can press the **Reset** button to reset the alarm. However, the AC power LED continues to flash after a manual reset.

Troubleshooting Table

Symptom	Cause	Verification	Corrective Action
Display Indicator- LED or other indicator not working	*Main printed circuit assembly (Main PCA).*	*Perform BiPAP Synchrony Performance Verification (8.5)*	*If device fails user interface checkout procedure, replace Main PCA*
Display- Display is blank or contains erroneous information.	*Display Assembly* *Main PCA*	*Inspect solder joints between display and Main PCA.*	*Replace Main PCA.*
Intermittent Power Supply Problem- An intermittent on/off condition exists, unit alarms randomly, or indicator lights blink sporadically.	*Power cord, Power Supply, AC inlet, Main PCA, loose connections.*	*Inspect power cord and power supply for fraying at cable ends.* *Inspect all connections on the Main PCA.*	*Replace Power Supply* *Replace Main PCA.*
Noise-	*Missing or damaged rubber feet on bottom of device, blower malfunctioning. Blower impeller imbalance.*	*Turn over and inspect the bottom for missing or damaged rubber feet. Place hand on device, if vibration is detected, then replace blower S/A.*	*If rubber feet are missing replace rubber feet. Tighten any loose screws.* *Resolve any air leaks.* *Replace Blower*

Symptom	Cause	Verification	Corrective Action
Humidifier will not turn on.	*Humidifier not turned back on after BiPAP Synchrony was turned off*	*Inspect main power cord for fraying at cable ends.*	*Replace Power Cord.*
	Faulty Power Cord	*Inspect power cord between BiPAP Synchrony and Humidifier base.*	*Replace Main PCA in humidifier base.*
	Broken or damaged Light Pipe	*Inspect Light Pipe inside BiPAP Synchrony for misalignment.*	*Realign or replace light pipe.*
	No infrared connection	*Make sure receiver on Humidifier base is not damaged.*	*Replace Humidifier Main PCA.*
	Humidifier Main PCA	*Make sure BiPAP Synchrony is seated properly on the humidifier base.*	*Reset BiPAP Synchrony on humidifier base.*
	BiPAP Synchrony Main PCA	*Inspect BiPAP Synchrony Main PCA for damage to the Humidifier On/Off button.*	*Replace BiPAP Synchrony Main PCA.*
	Humidifier Heater Plate	*Inspect Heater Plate to see that it is connected to the humidifier Main PCA and that it is not damaged.*	*Replace Heater Plate in humidifier base.*
Pressure Offset- Static pressure fluctuates from -2.0 cm to +2.0 cm H_2O of set pressure	*The delivered pressure is higher or lower than the set value by more than - 2.0 cm to +2.0 cm H_2O.*	*Perform power up process.*	*Check internal tubing for kinks.* *Check Valve* *Replace Main PCA.*

Symptom	Cause	Verification	Corrective Action
No Stored Therapy Data	*SmartCard not installed*	*No therapy data after usage*	*Depress the blower on/off button before disconnecting the Main PCA.*
	Not a Respironics SmartCard (error code displayed)		*Replace SmartCard.*
	SmartCard not formatted or faulty SmartCard (error code displayed)		*Format SmartCard.*
Device LCD or Backlight Failure	*Damage to LCD or backlight*	*Remove power from unit and retry.*	*Replace Main PCA.*
Device On, displays pressure setpoint, No airflow	*Loose Connection*	*Check motor plug/ PCA connections.*	*Ensure connections are secure.*
	Blower/motor failure	*Troubleshoot by substitution with a known good Blower S/A.*	*Replace the blower assembly.*
	Main PCA failure		*Replace the Main PCA.*
Pressure check out of range	*Occluded or restricted pressure tube*	*Check pressure with calibrated Manometer.*	*Replace pressure tubing.*
	Defective Valve		*Check/Replace valve*
	Defective pressure sensor		*Calibrate Main PCA.*
	Blower speed regulation		*Replace Main PCA.*
	Leaks in flow path		*Check or replace flow element.*
Odor-	*Tubing smells new, device new, airborne residue buildup.*	*Visually inspect patient tubing for contamination.*	*Run device in a clean environment for a few hours to eliminate new smell. Wash tubing with soap and water. To clear residue buildup, replace all subassemblies in the patient air stream (blower, filters, patient circuit).*

Symptom	Cause	Verification	Corrective Action
Outlet air temperature- The outlet air temperature is too warm.	*Filters dirty, blower, Main PCA.*	*Ensure the filter is clean and not restricting airflow. Monitor the outlet temperature at the end of the six foot patient tubing. A rise in temperature can be expected (See Chapter 3 for Operating Temperature).*	*Replace in order until solved:* *Filters* *Blower* *Main PCA*
Pressure Related Problem- The outlet pressure does not change or properly adjust.	*Pressure tubing has been blocked, disconnected, or kinked. Valve malfunctioning Main PCA or blower malfunction.*	*Inspect pressure tubing for secure connections and kinks.* *Check blower for leaks.*	*Secure pressure tubing connections.* *Check/Replace Valve* *Replace blower, pressure tubing, or Main PCA.*
Audible Alarm- During audible alarm condition, the alarm is not audible.	*Audible Alarm cable not connected to Main PCA.* *Buzzer Assembly.* *Main PCA.*	*Perform power up sequence. Visually verify the LEDs and display illuminate. Re-establish original alert conditions. Listen for audible alarm.* *Verify with known good buzzer.*	*Check that audible alarm cable is connected to Main PCA.* *Replace Buzzer Assembly* *If Audible alarm does not work, replace Main PCA.* *If visual indicators are not present at power up, perform user checkout procedure.* *If device fails user interface checkout procedure, replace Main PCA.* *If alarm is audible during both tests, no corrective action is required.*

Symptom	Cause	Verification	Corrective Action
Device does not operate from the 12 VDC power source-	*Faulty DC plug, low DC voltage, fuse in DC cord is blown.* *Main PCA.*	*Ensure DC voltage supply is a minimum of 11.5 VDC. Ensure the DC voltage is stable. Monitor the voltage at the back of the DC connector mounted on the Main PCA. If DC voltage is below 11.5 VDC, replace or recharge DC source. If there is no DC measured at the Main PCA, then check the DC adapter cord for continuity.*	*If DC source is not at 11.5 VDC or higher, replace or recharge power source as required.* *If 12 VDC supply and DC cords are okay, replace Main PCA.*
Ramp Pressure- The pressure does not ramp correctly.	*No ramp time prescribed in the CPAP mode.* *Ramp minimum pressure has to be lower than CPAP pressure.* *Main PCA.* *Ramp button not functioning.*	*Verify the patient's prescription specified ramp. Make sure unit was set for ramp.* *Perform the Performance Verification Testing Procedure (Section 8.5).*	*Set device for ramp.* *Replace Main PCA.* *If device fails the Performance Verification, replace KeyPad or Main PCA.*
Pressure Variation- The pressure varies around the set value, pressure fluctuates greater than 2.0 cm H_2O.	*Internal Air Leak.* *Filters Dirty.* *Main PCA, blower, valve.* *Air path blocked.*	*Replace Filter.* *Perform Testing Process in Chapter 8.*	*Replace Blower.* *If pressure still drifts, then replace Main PCA, valve.* *Check internal tubing.*

BiPAP Synchrony System Error Code Retrieval

The BiPAP Synchrony Ventilatory Support System stores error codes that may aid the technician in troubleshooting. The following instructions aid in the retrieval of those error codes. The BiPAP Synchrony can store up to 10 error codes at a time. Once this limit is reached, the error codes will be overwritten, beginning with the first error code.

Installing the Software

1. Go to http://servicesoftware.respironics.com on the internet.
2. Download the Utility Software to your computer.

Connecting the BiPAP Synchrony to your Computer

1. Connect the Sleep Link interface card and cable between the BiPAP Synchrony and the computer serial port.
2. Connect the BiPAP Synchrony to the proper power source.

Retrieving the Error Codes

1. With your mouse, click on the **Start Button** of your computer.
2. Select:
   - Programs
   - Respironics
   - Tools
   - Read Error Logs
3. The software will load automatically.
4. With your mouse, click on the Run Arrow located in the upper left corner of the computer screen.
5. Choose System Error Log or Patient Alarm Log.
6. The software will automatically read and display any error codes stored in the unit along with the time the error occurred.
7. To close the software select exit from the file menu.
8. Disconnect the Power Cord and the Sleep Link communications cable from the BiPAP Synchrony.

System Error Codes List (Patient Action)

Error Code	Description of Error	Device Action
E0	*No Error*	*Reserved*
E1	*Generic Software Error*	*REBOOT*
E2	*Software Corrupt*	*STOP*
E3	*External RAM Failure*	*STOP*
E4	*FIQ Stack Overflow*	*REBOOT*
E5	*FIQ Stack Underflow*	*REBOOT*
E6	*Nested IRQ Stack Overflow*	*REBOOT*
E7	*Nested IRQ Stack Underflow*	*REBOOT*
E8	*IRQ Stack Overflow*	*REBOOT*
E9	*IRQ Stack Underflow*	*REBOOT*
E10	*Timer Stack Overflow*	*REBOOT*
E11	*Timer Stack Underflow*	*REBOOT*
E12	*Service Stack Overflow*	*REBOOT*
E13	*Service Stack Underflow*	*REBOOT*
E14	*Thread Stack Overflow*	*REBOOT*
E15	*Undefined Instruction*	*REBOOT*
E16	*Unexpected Software Interrupt*	*REBOOT*
E17	*Microprocessor Prefetch Exception*	*REBOOT*
E18	*Data Access Exception*	*REBOOT*
E19	*Reserved Exception*	*REBOOT*
E20	*Spurious Default Interrupt*	*REBOOT*
E21	*Spurious Interrupt*	*REBOOT*
E22	*Corrupt Calibration Table*	*STOP*
E23	*Invalid Zero Flow Value in Calibration Table*	*Not Used*
E24	*Unrecognized Version of Calibration Table*	*STOP*

Error Code	Description of Error	Device Action
E25	*Excessive Drift on Flow Sensor*	*STOP*
E26	*Communications Failure with LCD Driver Chip*	*STOP*
E27	*Excessive Drift on Outlet Pressure Sensor*	*STOP*
E28	*Empty Calibration Table*	*Not Used*
E29	*Excessive Drift on Blower Pressure Sensor*	*STOP*
E30	*Unrecognized Version of Parameter Storage*	*STOP*
E31	*Un-repairable Parameter Storage*	*STOP*
E32	*Corrupt Parameter Storage*	*STOP*
E33	*Excessive Parameter Storage Size*	*STOP*
E34	*Unable to Queue Data to Parameter Storage*	*REBOOT*
E35	*Unable to write to parameter storage*	*STOP*
E36	*Parameter Out of Range*	*STOP*
E37	*Corrupt Real-Time Clock Value*	*CONTINUE*
E38	*Real-Time Clock not Ticking*	*CONTINUE*
E39	*Unable to Queue Data to User Interface*	*REBOOT*
E40	*Invalid Built-in Self Test Call*	*Not Used*
E41	*Over Pressure Condition*	*STOP*
E42	*Operating System not Responding to Software*	*REBOOT*
E43	*Insufficient Voltage for Audible Alarm*	*STOP*
E44	*12V Reference Out of Range*	*STOP*
E45	*5V Reference Out of Range*	*STOP*
E46	*Bulk Voltage Out of Range*	*STOP*
E47	*-15V Reference Out of Range*	*STOP*
E48	*Railed Flow Sensor*	*STOP*
E49	*Blower Pressure Sensor Failure*	*STOP*
E50	*Flash Memory Failure*	*Not Used*
E51	*Unrecognized Main PCA*	*STOP*
E52	*Blower Failure*	*STOP*
E53	*Blower Speed Out of Tolerance*	*STOP*

Error Code	Description of Error	Device Action
E54	*Motor Current High While Blower Off*	*STOP*
E55	*Buffer Overflow*	*REBOOT*
E56	*Motor Current High While Blower On*	*STOP*
E57	*Unable to Queue Data to Provide Therapy*	*REBOOT*
E58	*Stuck Key*	*CONTINUE*
E59	*Outlet Pressure Sensor Railed*	*STOP*
E60	*Blower Pressure Sensor Railed*	*STOP*
E61	*Real-time Clock's Battery Dead*	*CONTINUE*
E62	*Blower Speed Exceeds Maximum Limit*	*STOP*
E63	*Internal Watchdog Failure*	*STOP*
E64	*External Watchdog failure*	*STOP*
E65	*Unexpected Watchdog Reset*	*REBOOT*
E66	*Reserved for Future Use*	*REBOOT*
E67	*Operating System Failed Initialization*	*REBOOT*
E68	*Unable to Queue Data for Communication*	*REBOOT*
E69	*Sampling Thread Locked*	*REBOOT*
E70	*Execution Thread Locked*	*REBOOT*
E71	*Internal RAM Failure*	*STOP*
E72	*Unable to Queue Data for logging*	*REBOOT*
E73	*Reserved for Future Use*	*REBOOT*
E74	*Reserved for Future Use*	*REBOOT*
E75	*Incorrect Display Tape*	*STOP*
E76	*Failure in Loss of Power Battery*	*STOP*
E77	*High Pressure Condition*	*LOGGED*
E78	*Low Pressure Condition*	*LOGGED*
E79	*Unable to Maintain Pressure Support*	*LOGGED*
E80	*Barometric Pressure Sensor Failure*	*LOGGED*
E81	*Barometric Sensor Failure*	*STOP*
E82	*Invalid Error Code*	*RESERVED*

NOTE

The error conditions are categorized into three groups:

CONTINUE/LOGGED: *This group contains error conditions in which there is reasonable expectation that the device will operate within published specification and not cause an unacceptable level of risk.*

REBOOT: *This group contains error conditions in which there is a reasonable expectation that the error was a transient and the device will perform properly after a system reboot.*

STOP: *This group contains error conditions in which there is a low confidence in the ability of the device to operate within specification or may cause unacceptable level of risk. Additionally, any three (3) Reboot errors within a 24-hour period as referenced from the last error shall constitute a Stop error.*

User will only see STOP errors displayed.

BiPAP Synchrony System Error Codes (Corrective Action)

Error Code	Description of Error	Probable Cause	Corrective Action
E0	*No Error*	*Reserved*	*Replace Main PCA*
E1	*Generic Software Error*	*Defective RAM chip*	*Replace Main PCA*
E2	*Software Corrupt*	*Defective FLASH chip*	*Replace Main PCA*
E3	*External RAM Failure*	*Defective RAM chip*	*Replace Main PCA*
E4	*FIQ Stack Overflow*	*Defective RAM chip*	*Replace Main PCA*
E5	*FIQ Stack Underflow*	*Defective RAM chip*	*Replace Main PCA*
E6	*Nested IRQ Stack Overflow*	*Defective RAM chip*	*Replace Main PCA*
E7	*Nested IRQ Stack Underflow*	*Defective RAM chip*	*Replace Main PCA*
E8	*IRQ Stack Overflow*	*Defective RAM chip*	*Replace Main PCA*
E9	*IRQ Stack Underflow*	*Defective RAM chip*	*Replace Main PCA*
E10	*Timer Stack Overflow*	*Defective RAM chip*	*Replace Main PCA*
E11	*Timer Stack Underflow*	*Defective RAM chip*	*Replace Main PCA*
E12	*Service Stack Overflow*	*Defective RAM chip*	*Replace Main PCA*
E13	*Service Stack Underflow*	*Defective RAM chip*	*Replace Main PCA*
E14	*Thread Stack Overflow*	*Defective RAM chip*	*Replace Main PCA*
E15	*Undefined Instruction*	*Defective FLASH chip*	*Replace Main PCA*
E16	*Unexpected Software Interrupt*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E17	*Microprocessor Prefetch Exception*	*Defective FLASH chip*	*Replace Main PCA*
E18	*Data Access Exception*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E19	*Reserved Exception*	*Defective FLASH chip* *Defective Microprocessor*	*Replace Main PCA*
E20	*Spurious Default Interrupt*	*Defective FLASH chip*	*Replace Main PCA*
E21	*Spurious Interrupt*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E22	*Corrupt Calibration Table*	*Improper Calibration* *Defective FLASH chip*	*Recalibrate* *Replace Main PCA*

Error Code	Description of Error	Probable Cause	Corrective Action
E23	*Invalid Zero Flow Value in Calibration Table*	*Improper Calibration Occluded or Restricted Flow Tube Defective Flow Sensor*	*Recalibrate Replace Flow Tube Replace Main PCA*
E24	*Unrecognized Version of Calibration Table*	*Improper Calibration Defective FLASH chip*	*Recalibrate Replace Main PCA*
E25	*Excessive Drift on Flow Sensor*	*Improper Calibration Occluded or Restricted Flow Tube Defective Flow Sensor*	*Recalibrate Replace Flow Tube Replace Main PCA*
E26	*Communications Failure with LCD Driver Chip*	*Defective LCD Driver Chip*	*Replace Main PCA*
E27	*Excessive Drift on Outlet Pressure Sensor*	*Occluded or Restricted Pressure Tube Defective Pressure Sensor*	*Replace Pressure Tubing Replace Main PCA*
E28	*Empty Calibration Table*	*Improper Calibration Defective FLASH Chip*	*Recalibrate Replace Main PCA*
E29	*Excessive Drift on Blower Pressure Sensor*	*Occluded or Restricted Pressure Tube Defective Pressure Sensor*	*Replace Pressure Tubing Replace Main PCA*
E30	*Unrecognized Version of Parameter Storage*	*Normal for First Time Power Up Defective EPROM*	*Remove and Restore Power Replace Main PCA*
E31	*Un-repairable Parameter Storage*	*Defective EPROM*	*Replace Main PCA*
E32	*Corrupt Parameter Storage*	*Normal for First Time Power Up Defective EPROM*	*Remove and Restore Power Replace Main PCA*
E33	*Excessive Parameter Storage Size*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E34	*Unable to Queue Data to Parameter Storage*	*Defective EPROM, FLASH, or RAM chip*	*Replace Main PCA*
E35	*Unable to write to parameter storage*	*Defective EPROM*	*Replace Main PCA*
E36	*Parameter Out of Range*	*Defective EPROM*	*Replace Main PCA*
E37	*Corrupt Real-Time Clock Value*	*Defective Microprocessor*	*Replace Main PCA*

Error Code	Description of Error	Probable Cause	Corrective Action
E38	*Real-Time Clock not Ticking*	*Defective Microprocessor* *Defective Crystal*	*Replace Main PCA* *Replace Main PCA*
E39	*Unable to Queue Data to User Interface*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E40	*Invalid Built-in Self Test Call*	*Invalid RASP command*	*Reissue RASP Command*
E41	*Over Pressure Condition*	*Occluded or Restricted Pressure Tube* *Defective Pressure Sensor* *Defective Motor Drive chip* *Defective Valve*	*Replace Pressure Tubing* *Replace Main PCA* *Replace Main PCA* *Replace Valve*
E42	*Operating System not Responding to Software*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E43	*Insufficient Voltage for Audible Alarm*	*Defective PCA*	*Replace Main PCA*
E44	*12V Reference Out of Range*	*Defective Power Supply*	*Replace Main PCA*
E45	*5V Reference Out of Range*	*Defective Power Supply*	*Replace Main PCA*
E46	*Bulk Voltage Out of Range*	*Defective Power Supply*	*Replace Main PCA*
E47	*-15V Reference Out of Range*	*Defective Power Supply*	*Replace Main PCA*
E48	*Railed Flow Sensor*	*Occluded or Restricted Flow Tube* *Defective Flow Sensor*	*Replace Flow Tube* *Replace Main PCA*
E49	*Blower Pressure Sensor Failure*	*Occluded or Restricted Pressure Tube* *Defective Blower Pressure Sensor*	*Replace Pressure Tubing* *Replace Main PCA*
E50	*Flash Memory Failure*	*Defective FLASH chip*	*Replace Main PCA*
E51	*Unrecognized Main PCA*	*Needs New Software* *Defective PCA*	*Replace Main PCA* *Replace Main PCA*
E52	*Blower Failure*	*Stalled or Locked Blower* *Defective Motor Drive Chip*	*Replace Blower* *Replace Main PCA*
E53	*Blower Speed Out of Tolerance*	*Stalled or Locked Blower* *Defective Motor Drive Chip*	*Replace Blower* *Replace Main PCA*
E54	*Motor Current High While Blower Off*	*Stalled or Locked Blower* *Defective Motor Drive Chip*	*Replace Blower* *Replace Main PCA*

Error Code	Description of Error	Probable Cause	Corrective Action
E55	*Buffer Overflow*	*Defective PCA*	*Replace Main PCA*
E56	*Motor Current High While Blower On*	*Stalled or Locked Blower* *Defective Motor Drive Chip*	*Replace Blower* *Replace Main PCA*
E57	*Unable to Queue Data to Provide Therapy*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E58	*Stuck Key*	*Verify all keys protrude through top* *Defective Keypad* *Defective Pad on PCA*	*Replace Main PCA* *Align keys with top* *Replace Keypad*
E59	*Outlet Pressure Sensor Railed*	*Occluded or restricted pressure tube* *Defective pressure sensor*	*Replace Main PCA* *Replace Pressure Tube*
E60	*Blower Pressure Sensor Railed*	*Occluded or restricted pressure tube* *Defective pressure sensor*	*Replace Main PCA* *Replace Pressure Tube*
E61	*Real-time Clock's Battery Dead*	*Dead Battery*	*Replace Main PCA*
E62	*Blower Speed exceeds maximum limit*	*Defective Motor Drive chip*	*Replace Main PCA*
E63	*Internal Watchdog Failure*	*Defective RAM chip*	*Replace Main PCA*
E64	*External Watchdog failure*	*Defective Microprocessor*	*Replace Main PCA*
E65	*Unexpected Watchdog Reset*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E66	*Reserved for Future Use*	*Defective RAM chip*	*Replace Main PCA*
E67	*Operating System Failed Initialization*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E68	*Unable to Queue Data for Communication*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E69	*Sampling Thread Locked*	*Defective PCA*	*Replace Main PCA*
E70	*Execution Thread Locked*	*Defective PCA*	*Replace Main PCA*
E71	*Internal RAM Failure*	*Defective Microprocessor*	*Replace Main PCA*
E72	*Unable to Queue Data for logging*	*Defective FLASH or RAM chip*	*Replace Main PCA*
E73	*Reserved for Future Use*	*Defective RAM chip*	*Replace Main PCA*

Error Code	Description of Error	Probable Cause	Corrective Action
E74	*Reserved for Future Use*	*Defective RAM chip*	*Replace Main PCA*
E75	*Incorrect Display Tape*	*Incorrect LCD setup on Main PCA*	*Replace Main PCA*
E76	*Failure in Loss of Power Battery*	*Defective PCA*	*Replace Main PCA*
E77	*Invalid Error Code*	*Reserved*	*Replace Main PCA*
E78	*Low Pressure Condition*	*Defective Motor Drive Chip* *Defective Valve* *Defective PCA* *Excessive leak in patient circuit*	*Replace Main PCA* *Replace Valve* *Replace Main PCA* *Correct leak in patient circuit*
E79	*Unable to Maintain Pressure Support*	*Defective Valve* *Defective PCA* *Excessive leak in patient circuit*	*Replace Valve* *Replace Main PCA* *Correct leak in patient circuit*
E80	*Barometric Pressure Sensor Failure*	*The raw value from the barometric pressure sensor A/D converter is outside its valid range of values*	*Replace Main PCA*
E81	*BarometricSensor Failure*	*The barometric pressure reading is outside its acceptable range.*	*Replace Main PCA*
E82	*Invalid Error Code*	*Reserved*	*Replace Main PCA*

BiPAP Synchrony SmartCard Error Codes

Error Code	Description of Error	User Action
C1	*Unable to Write to SmartCard*	*Card inserted Upside-down. Remove card and reinsert properly. Otherwise, card is damaged and should be replaced.*
C2, C3	*Card is Corrupt*	*Erase or reprogram card.*
C4	*Card contains a prescription and was inserted while the unit was in a parameter screen.*	*Remove Card. Exit parameter screen. Then reinsert card.*
C5	*Card inserted while the unit was in calibration mode*	*Remove Card. Exit Calibration mode. Then reinsert card.*
C6	*Card is Corrupt*	*Erase or reprogram card.*
C7	*Reserved*	*N/A*
C8	*Unable to Read from SmartCard*	*Card inserted Upside-down. Remove card and reinsert properly. Otherwise, card is damaged and should be replaced.*
C9, C10 C100, C101	*Card is Corrupt*	*Erase or reprogram card.*
C103-C105	*Card Contains an Unknown Prescription*	*Card contains a prescription that is not supported by this unit. Perhaps card is intended for another unit.*
C106-C109, C200	*Card is corrupt*	*Erase or reprogram card.*
C201	*Card Contains an Unknown Logging Format*	*Card contains a logging format that is not supported by this unit. Perhaps card is intended for another unit.*
C202-C207, C300-C303, C400-C409, C500-C506	*Card is Corrupt*	*Erase or reprogram card.*

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REPAIR AND REPLACEMENT

CHAPTER OVERVIEW

This chapter illustrates the names and locations of the replaceable components in the BiPAP Synchrony system. This chapter provides a quick reference and overview of the unit. Within each replacement section, more detailed support information is provided to illustrate the exact component location and replacement procedure(s).

NOTE
Refer to the Repair Kits Section for proper repair part identification.

For technical assistance or replacement part ordering information, contact Respironics Product Support.

USA and Canada

Phone: 1-800-345-6443
Fax: 1-800-866-0245
Email: service@respironics.com

International

Phone: 1-724-387-4000
Fax: 1-800-387-5012

Visit Respironics Home Page on the World Wide Web at:

www.respironics.com

WARNINGS AND CAUTIONS

WARNING

To prevent electrical shock, disconnect the electrical supply before attempting to make any repairs to the BiPAP Synchrony Ventilatory Support System.

CAUTION

Electromagnetic components used in this unit are subject to damage from static electricity. Repairs made to this unit must be performed only in an antistatic, Electro-Static Discharge (ESD) protected environment.

REPLACEMENT INSTRUCTIONS

Refer to Figure A and Figure B before removing or installing any components. These figures will detail the order in which each item must be removed or installed and should be used as a guideline for quick reference.

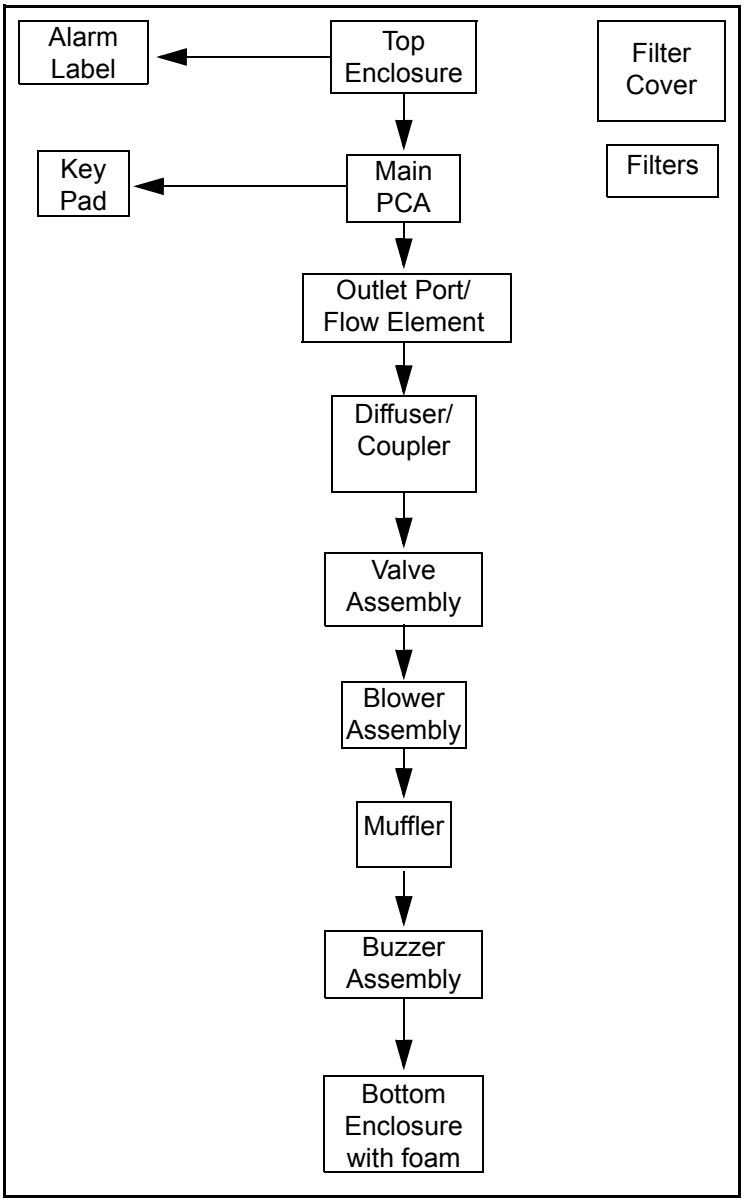


Figure A: Removal Flow Chart

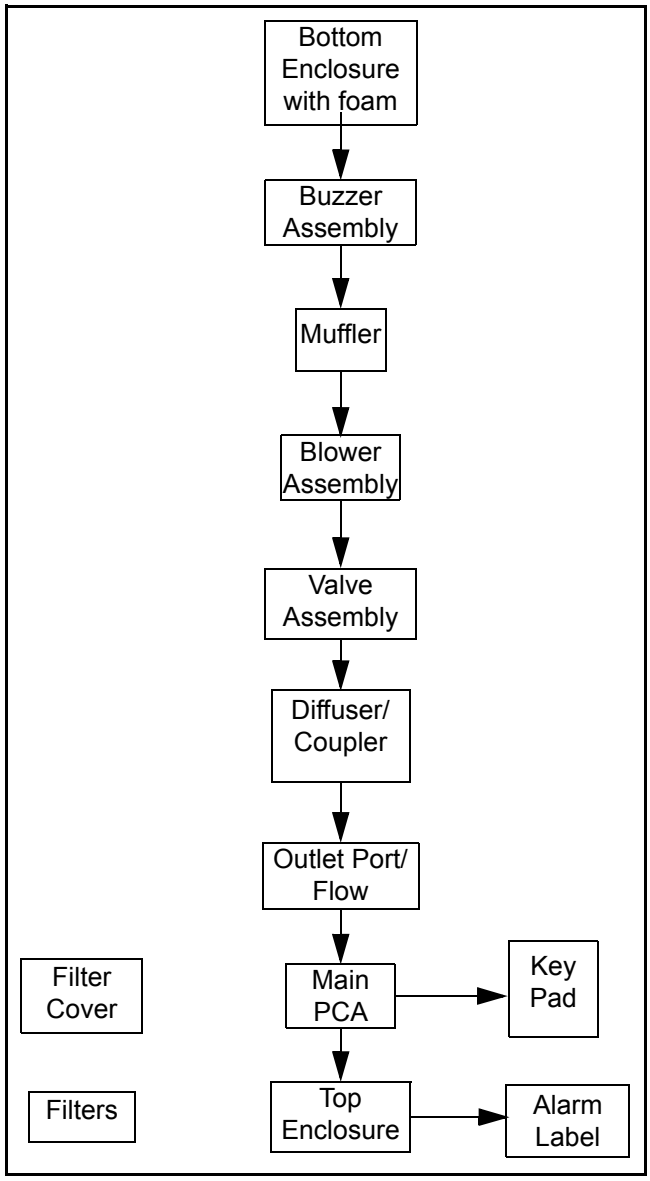


Figure B: Installation Flow Chart

Top Enclosure Replacement

Procedure

Removed/Installed During Process:

- Top Enclosure

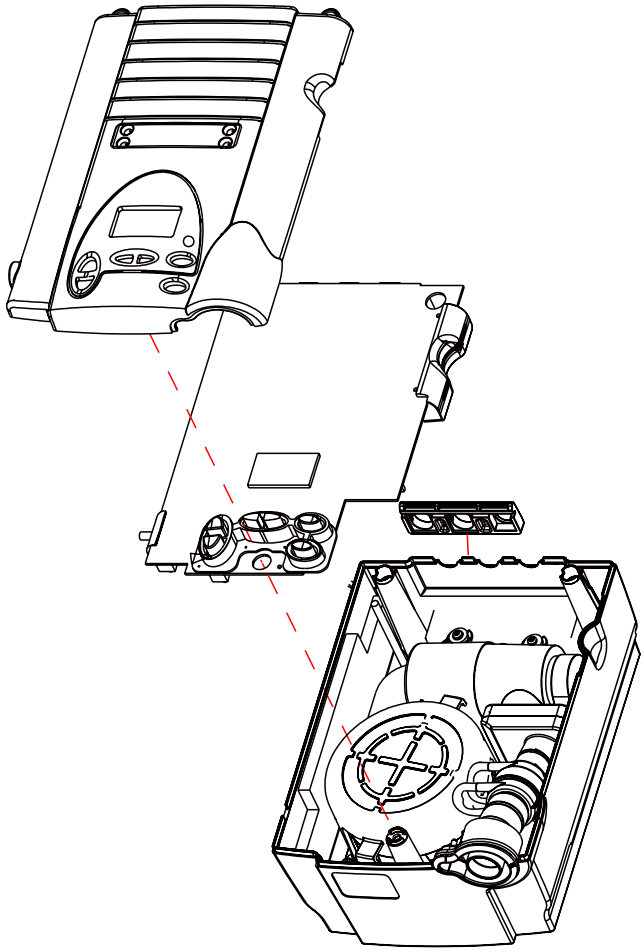


Figure C: Removal and Installation of the Top Enclosure

To remove the Top Enclosure:

1. Place the device on a protected work surface and carefully turn it over, exposing the bottom enclosure.
2. Using a Phillips screwdriver, remove the three screws that secure the top enclosure to the bottom enclosure.

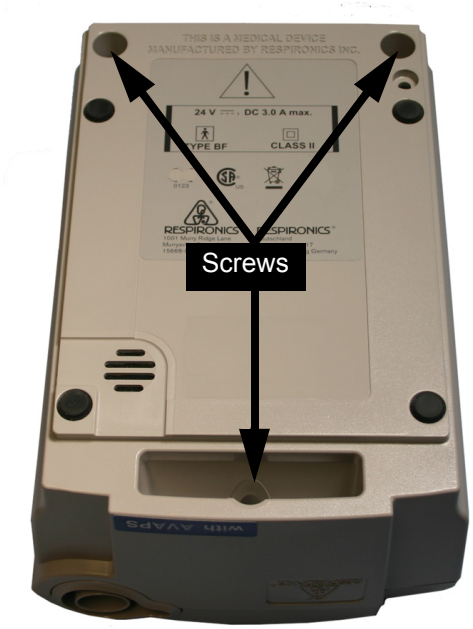


Figure D: Screw Locations

3. While securely holding the top and bottom enclosure together, carefully return the device to its upright position.
4. Lift the top enclosure up and away from the bottom enclosure.

To Install the Top Enclosure

1. Place the new top enclosure down over the key pad and Main PCA.
2. While securely holding the top enclosure and bottom enclosure together, carefully turn the device upside down.
3. Insert and tighten the three Phillips screws to secure the top and bottom enclosure together.

Main Printed Circuit Assembly (PCA) Replacement

Procedure

Removed/Installed During Process:

- Top Enclosure (Refer to page 5 for detailed instructions.)
- Main PCA

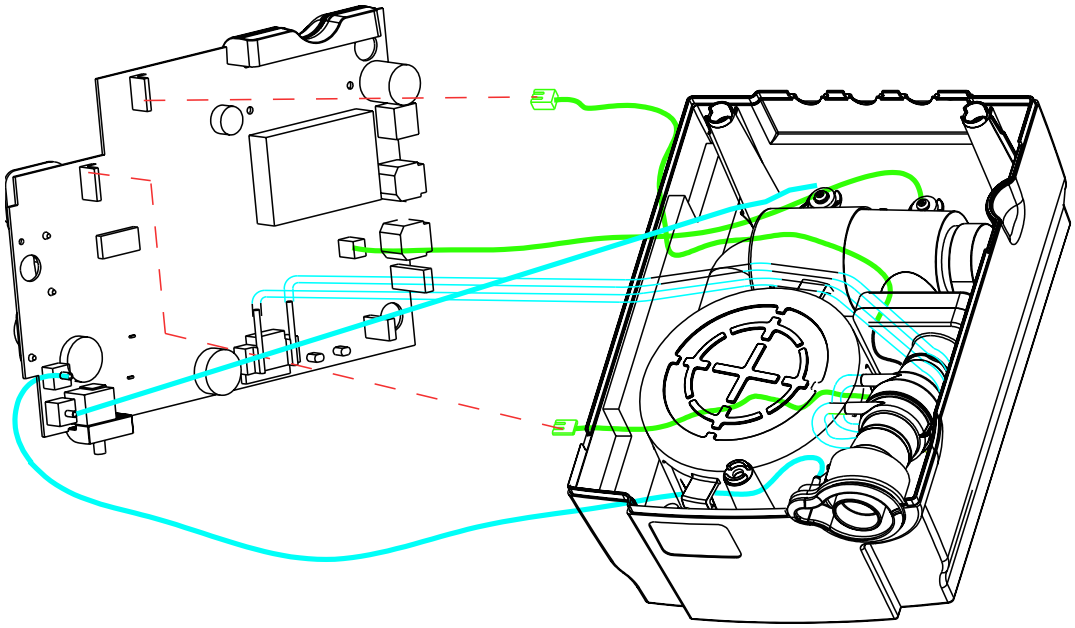


Figure E: Removal and Installation of the Main Printed Circuit Assembly

To remove the Main PCA:

1. Remove the Top Enclosure (Refer to page 5 for more detailed instructions on removing the Top Enclosure).
2. Lift the Main PCA and hold it slightly above the Blower Assembly to provide access to the blower cable connector and buzzer connector.
3. Disconnect the blower connector from the Main PCA.
4. Disconnect the buzzer from the Main PCA.
5. Disconnect the pressure tubing and flow sensor tubing from the Main PCA.
6. Disconnect the Valve Assembly connector from the Main PCA.

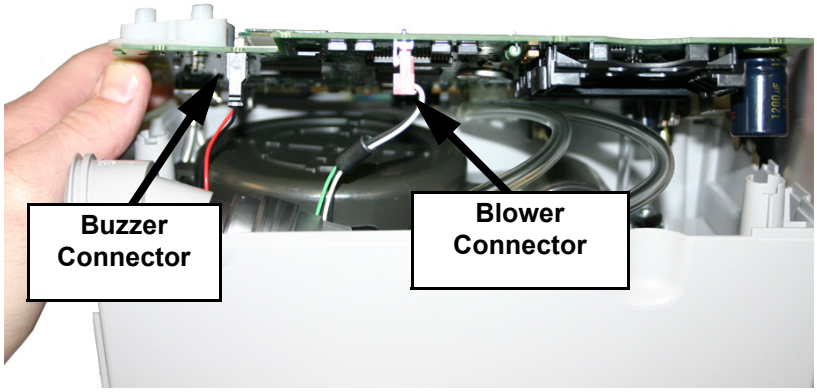


Figure F: Location of blower cable connector and Buzzer connector

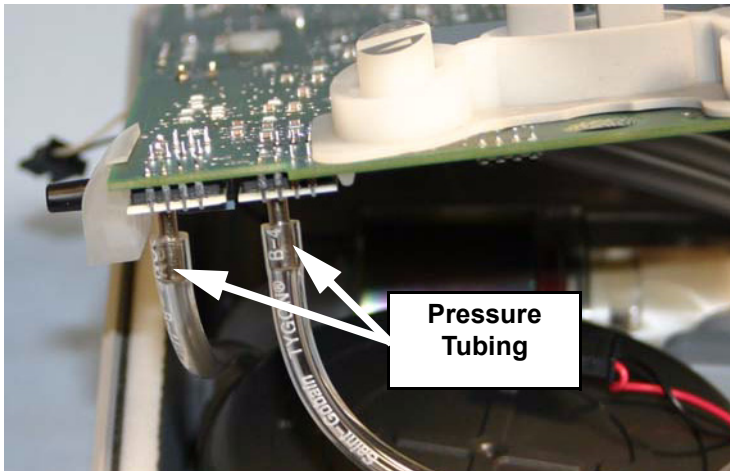


Figure G: Pressure Tubing

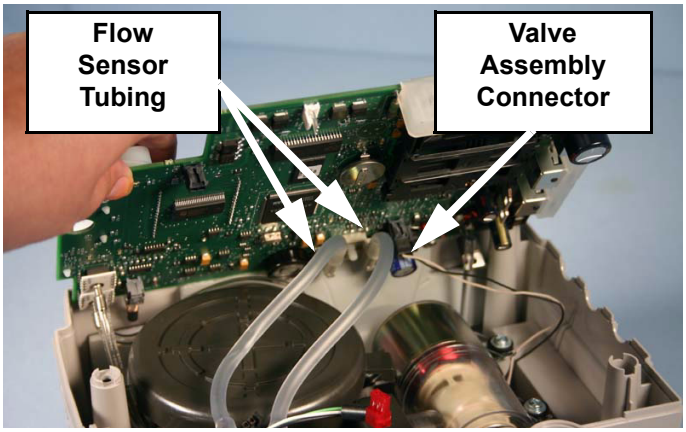


Figure H: Flow Sensor Tubing and Valve Assembly

7. Remove the Key Pad (Refer to page 10 for more detailed instructions on removing the Key Pad).

NOTE
The display assembly is soldered to the Main PCA.

To install the Main PCA:

1. Install the Key Pad (Refer to page 10 for more detailed instructions on installing the Key Pad).
2. While holding the Main PCA over the bottom enclosure assembly, attach the flow sensor tubing closest to the outlet port to P1 on MT2. Attach the flow sensor tubing closest to the valve assembly to P2 on MT2.
3. Attach the valve assembly connector to J9 on the Main PCA.
4. Attach the pressure tubing from the outlet port to the flow sensor marked “Outlet” on the Main PCA.
5. Attach the pressure tubing from the blower to the sensor marked “Sensor” on the Main PCA.
6. Attach the blower connector to J5 on the Main PCA.
7. Attach the buzzer connector to J6 on the Main PCA. Ensure that the wires are positioned between the two ports on the Flow Element.
8. Gently set the Main PCA down on the three stands that will hold the Main PCA in place.
9. Install the Top Enclosure (Refer to page 5 for more detailed instructions on installing the Top Enclosure).

KeyPad Replacement

Procedure

Removed/Installed During Process:

- Top Enclosure (Refer to page 5 for more detailed instructions.)
- Main PCA (Refer to page 7 for more detailed instructions.)
- Key Pad

Figure I: Key Pad

To remove the Key Pad:

1. Remove the Top Enclosure (Refer to page 5 for more detailed instructions on removing the Top Enclosure).
2. Remove the Main PCA (Refer to page 7 for more detailed instructions on removing the Main PCA).
3. Carefully lift the Key Pad from the Main PCA. There are three locking pins that hold the key pad to the Main PCA.

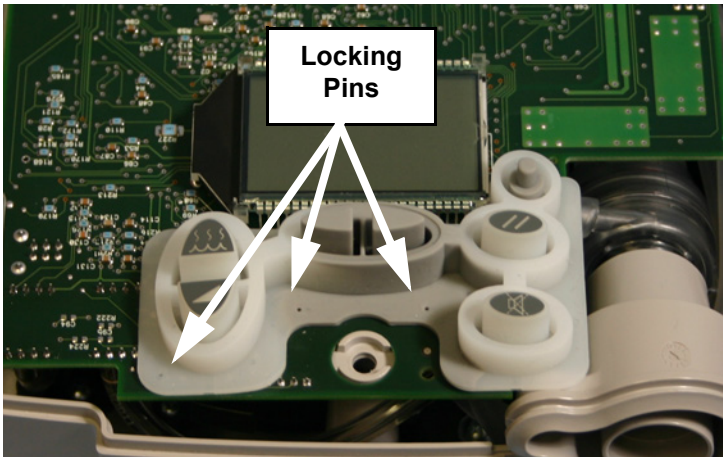


Figure J: Key Pad

To install the Key Pad:

1. Place the key pad on the Main PCA. Align the locking pins with the three holes on the display assembly. Press down on the locking pins until they snap into place.

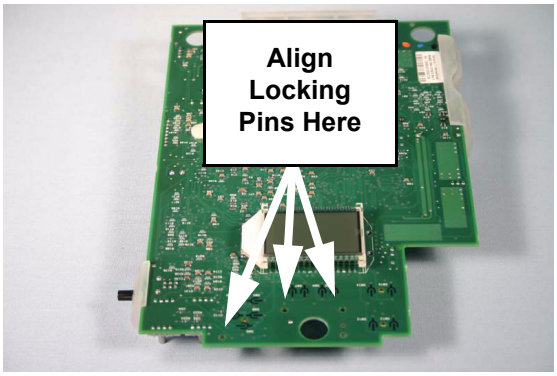


Figure K: Pin Location

2. Install the Main PCA (Refer to page 7 for more detailed instructions on installing the Main PCA).
3. Install the Top Enclosure (Refer to page 5 for more detailed instructions on installing the top enclosure).

Outlet-Flow-Tubing Replacement

NOTE

This kit comes pre-assembled for easy installation in the device.

Procedure

Removed/Installed During Process:

- Top Enclosure (Refer to page 5 for more detailed instructions.)
- Main PCA (Refer to page 7 for more detailed instructions.)
- Outlet-Flow-Tubing Assembly

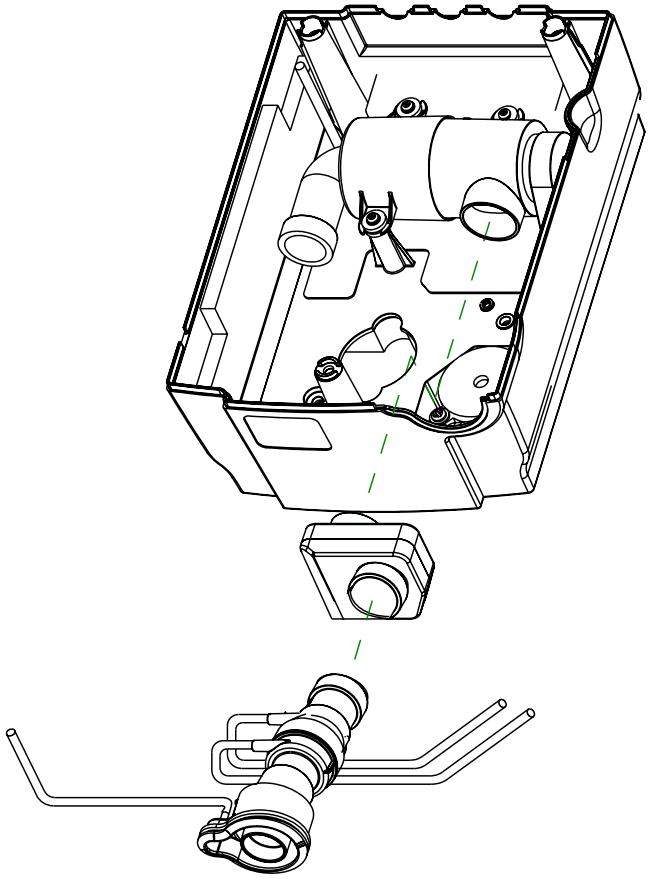


Figure L: Removal and Installation of the Outlet-Flow Tubing

To remove the Outlet-Flow-Tubing Kit:

1. Remove the Top Enclosure (Refer to page 5 for more detailed instructions on removing the top enclosure).
2. Remove the Main PCA (Refer to page 7 for more detailed instructions on removing the Main PCA).
3. Disconnect the Flow Element from the Coupler and remove the Flow Element, Outlet Port, and Tubing from the unit.

To install the Outlet-Flow-Tubing:

CAUTION
Twisting and/or turning the Flow Element or Outlet Port may cause improper alignment.

1. Position the Outlet Port in its mounting location in the Bottom Enclosure.
2. Connect the Flow Element to the Coupler.
3. Route the Flow Sensor Tubing underneath the Outlet Port and on the outside of the Coupler as Shown in Figure L.
4. Connect all Tubing to the Main PCA.
5. Install the Main PCA (Refer to page 7 for more detailed instructions on installing the Main PCA).
6. Install the Top Enclosure (Refer to page 5 for more detailed instructions on installing the top enclosure).

Diffuser Assembly Replacement

Procedure

Removed/Installed During Process:

- Top Enclosure (Refer to page 5 for more detailed instructions.)
- Main PCA (Refer to page 7 for more detailed instructions.)
- Outlet-Flow-Tubing (Refer to page 12 for more detailed instructions.)
- Diffuser Assembly

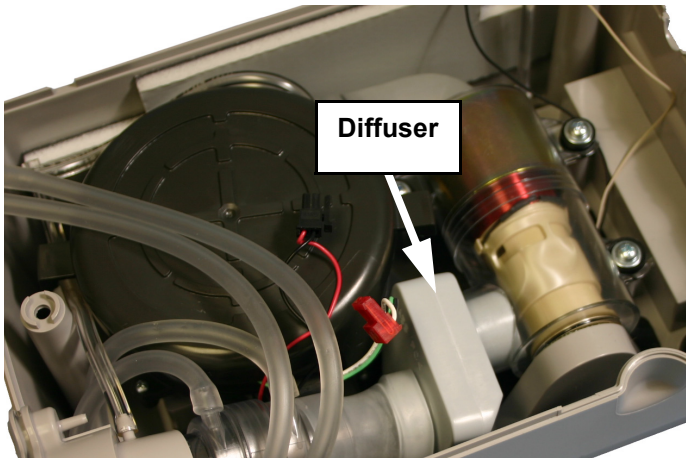


Figure M: Diffuser Assembly

To remove the Diffuser Assembly:

1. Remove the Top Enclosure (Refer to page 5 for more detailed instructions on removing the Top Enclosure).
2. Remove the Main PCA (Refer to page 7 for more detailed instructions on removing the Main PCA).
3. Remove the Outlet-Flow Tubing (Refer to page 12 for more detailed instructions on removing the Outlet-Flow-Tubing).
4. Slide the Coupler off the Diffuser Assembly.
5. Slide the Diffuser out of the Valve Assembly.

To install the Diffuser Assembly:

1. Slide the Diffuser into the Valve Assembly
2. Slide the Coupler onto the other end of the Diffuser.
3. Install the Outlet-Flow-Tubing (Refer to page 12 for more detailed instructions on installing the Outlet-Flow-Tubing).
4. Install the Main PCA (Refer to page 7 for more detailed instructions on installing the Main PCA).
5. Install the Top Enclosure (Refer to page 5 for more detailed instructions on installing the Top Enclosure).

Valve Assembly Replacement

Procedure

Removed/Installed During Process:

- Top Enclosure (Refer to page 5 for more detailed instructions.)
- Main PCA (Refer to page 7 for more detailed instructions.)
- Outlet-Flow-Tubing (Refer to page 12 for more detailed instructions.)
- Diffuser Assembly (Refer to page 14 for more detailed instructions.)
- Valve Assembly

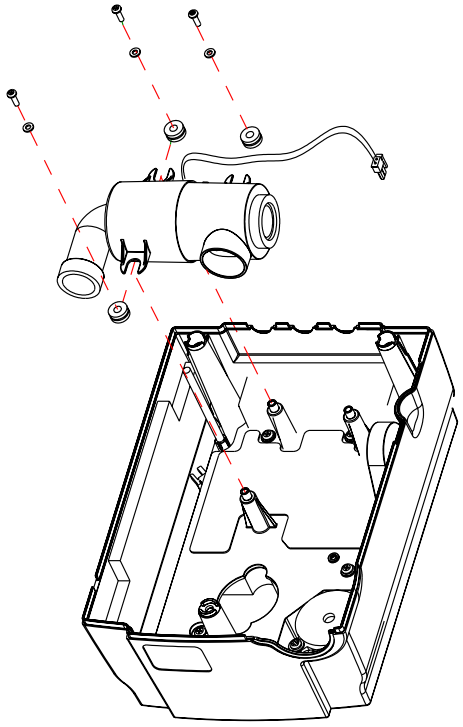


Figure N: Removal and Installation of Valve Assembly

To remove the Valve Assembly:

1. Remove the Top Enclosure (Refer to page 5 for more detailed instructions on removing the Top Enclosure).
2. Remove the Main PCA (Refer to page 7 for more detailed instructions on removing the Main PCA).
3. Remove the Outlet-Flow Tubing (Refer to page 12 for more detailed instructions on removing the Outlet-Flow-Tubing).
4. Remove the Diffuser Assembly (Refer to page 14 for more detailed instructions on removing the Diffuser Assembly).
5. Remove the three screws and washers that hold the Valve Assembly onto the bottom enclosure stands.

NOTE
Do not remove tubing from the Valve Assembly.

6. Slide the elbow off of the blower outlet.
7. Lift the Valve Assembly up and away from the bottom enclosure.

To install the Valve Assembly:

1. Place the Valve Assembly onto the Bottom Enclosure standoffs making sure the grommets do not cover the holes and the foam gasket on the valve assembly exhaust outlet is properly seated in the muffler exhaust port.
2. Route the valve wires towards the rear of the unit.
3. Fasten the Valve Assembly to the Bottom Enclosure standoffs using the three screws and washers.
4. Slide the elbow over the blower outlet.
5. Install the Diffuser Assembly (Refer topage 14 for more detailed instructions on installing the Diffuser Assembly).
6. Install the Outlet-Flow-Tubing (Refer to page 12 for more detailed instructions on installing the Outlet-Flow-Tubing).
7. Install the Main PCA (Refer to page 7 for more detailed instructions on installing the Main PCA).
8. Install the Top Enclosure (Refer to page 5 for more detailed instructions on installing the Top Enclosure).

Blower Assembly

Procedure

Removed/Installed During Process:

- Top Enclosure (Refer to page 5 for more detailed instructions.)
- Main PCA (Refer to page 7 for more detailed instructions.)
- Blower Assembly

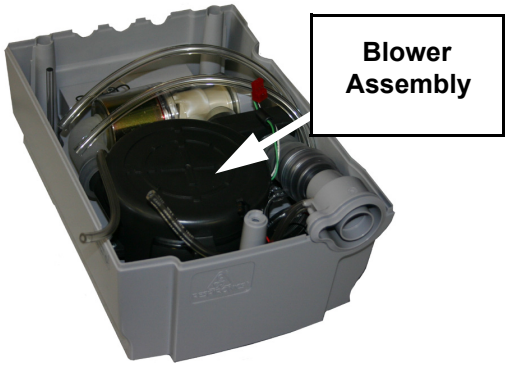


Figure O: Blower Assembly

To remove the Blower Assembly:

1. Remove the Top Enclosure (Refer to page 5 for more detailed instructions).
2. Remove the Main PCA (Refer to page 7 for more detailed instructions).
3. Remove the two screws that hold the damper strap to the Bottom Enclosure.
4. Lift the damper strap up and away from the blower.
5. Gently pull the pressure tubing from the blower outlet pickoff.
6. Slide the Valve Assembly elbow off of the blower outlet.
7. Lift the Blower Assembly up and away from the Bottom Enclosure. The blower doughnut may not come out of the Bottom Enclosure with the blower. If this is the case, remove the doughnut.

To install the Blower Assembly:

1. Place the blower doughnut onto the bottom of the Blower Assembly. Ensure the keys on the blower bottom are aligned with the slots in the doughnut.

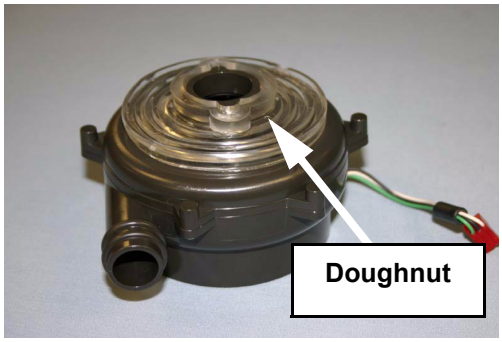


Figure P: Blower Doughnut

2. Align the Blower Assembly with the doughnut into the slot in the Bottom Enclosure.

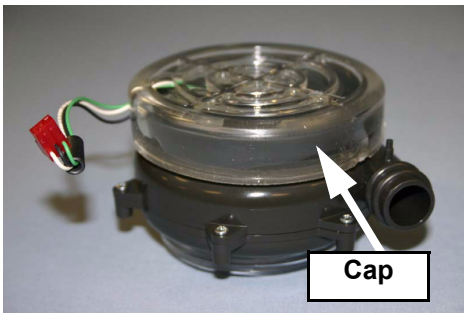


Figure Q: Blower Cap

3. Place the blower cap on top of the Blower Assembly. Make sure the blower wires and connector are aligned with the cut-out in the blower top and the slot in the top of the Blower Assembly.
4. Place the damper strap onto the blower assembly.
5. Align the damper strap with blower assembly with the screw holes in the Bottom Enclosure.
6. Fasten the damper strap down to the Bottom Enclosure with the two screws.
7. Slide the Valve Assembly elbow onto the blower outlet.
8. Attach the pressure tubing to the blower outlet pickoff.
9. Install the Main PCA (Refer to page 7 for more detailed instructions).
10. Install the Top Enclosure (Refer to page 5 for more detailed instructions).

Muffler Replacement

Procedure

Removed/Installed During Process:

- Top Enclosure (Refer to page 5 for more detailed instructions.)
- Main PCA (Refer to page 7 for more detailed instructions.)
- Outlet-Flow-Tubing (Refer to page 12 for more detailed instructions.)
- Diffuser Assembly (Refer to page 14 for more detailed instructions.)
- Valve Assembly (Refer to page 15 for more detailed instructions.)
- Blower Assembly (Refer to page 17 for more detailed instructions.)
- Muffler

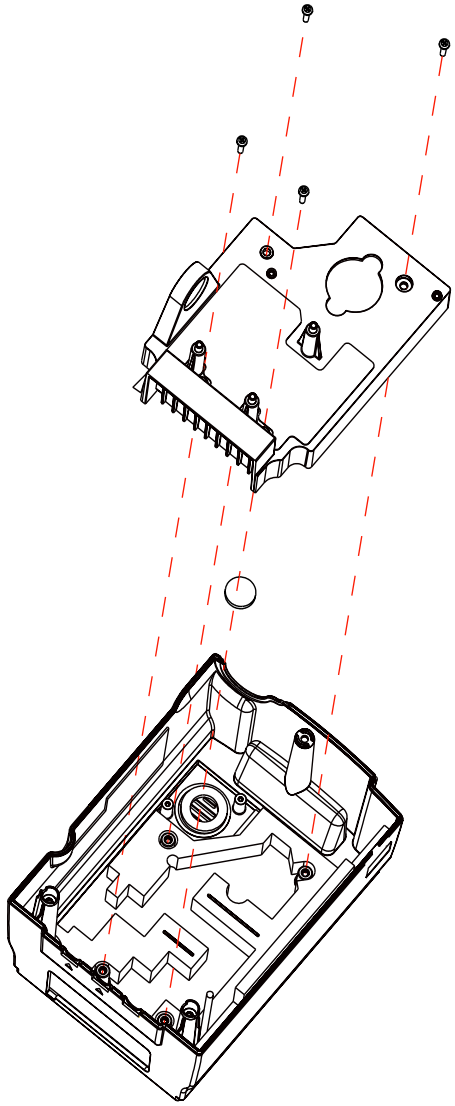


Figure R: Removal and Installation of the Muffler

To remove the Muffler:

1. Remove the Top Enclosure (Refer to page 5 for more detailed instructions).
2. Remove the Main PCA (Refer to page 7 for more detailed instructions).
3. Remove the Outlet-Flow-Tubing Assembly (Refer to page 12 for more detailed instructions).
4. Remove the Diffuser assembly (Refer to page 14 for more detailed instructions).
5. Remove the Valve Assembly (Refer to page 15 for more detailed instructions).
6. Remove the Blower Assembly (Refer to page 17 for more detailed instructions).
7. Remove the four screws that fasten the Muffler to the Bottom Enclosure.
8. Lift the Muffler up and away from the Bottom Enclosure.

To install the Muffler:

1. Place the Muffler onto the Bottom Enclosure.
2. Ensure the exhaust air path foam and the inlet air path foam are aligned properly.
3. Fasten the Muffler down to the bottom with four screws.
4. Install the Blower Assembly (Refer to page 17 for more detailed instructions).
5. Install the Valve Assembly (Refer to page 15 for more detailed instructions).
6. Install the Diffuser Assembly (Refer to page 14 for more detailed instructions).
7. Install the Outlet-Flow Tubing Assembly (Refer to page 12 for more detailed instructions).
8. Install the Main PCA (Refer to page 7 for more detailed instructions).
9. Install the Top Enclosure (Refer to page 5 for more detailed instructions).

Buzzer Assembly

Procedure

Removed/Installed During Process:

- Top Enclosure (Refer to page 5 for more detailed instructions.)
- Main PCA (Refer to page 7 for more detailed instructions.)
- Outlet-Flow-Tubing (Refer to page 12 for more detailed instructions.)
- Buzzer Assembly

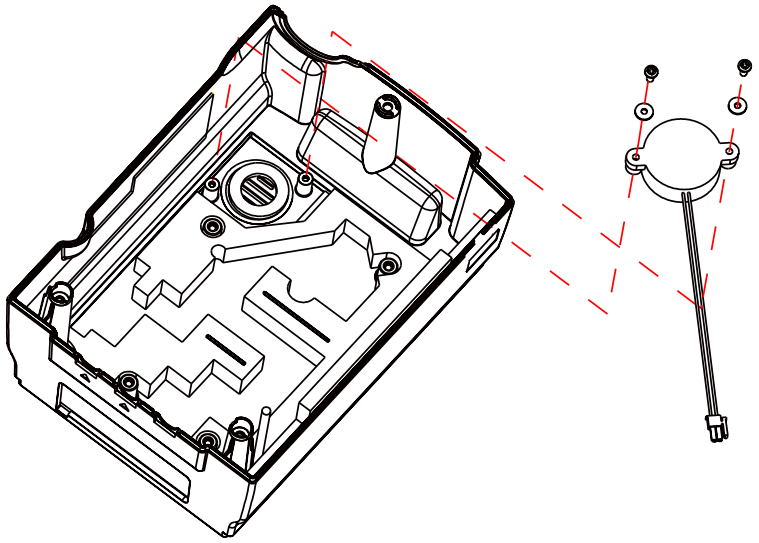


Figure S: Removal and Installation of the Buzzer Assembly

To remove the Buzzer Assembly:

1. Remove the Top Enclosure (Refer to page 5 for more detailed instructions).
2. Remove the Main PCA (Refer to page 7 for more detailed instructions).
3. Remove the Outlet-Flow-Tubing Assembly (Refer to page 12 for more detailed instructions).
4. Remove the two screws and washer that fasten the buzzer assembly to the Bottom Enclosure and lift the buzzer up and away from the Bottom Enclosure.

To install the Buzzer Assembly:

1. Place the buzzer in the Bottom Enclosure and fasten it down using two screws and washers. Ensure that the buzzer wire is positioned towards the rear of the unit.
2. Install the Outlet-Flow Tubing Assembly (Refer to page 12 for more detailed instructions).
3. Install the Main PCA (Refer to page 7 for more detailed instructions).
4. Install the Top Enclosure (Refer to page 5 for more detailed instructions).

Bottom Enclosure

Procedure

Removed/Installed During Process:

- Top Enclosure (Refer topage 5 for more detailed instructions.)
- Main PCA (Refer to page 7 for more detailed instructions.)
- Outlet-Flow-Tubing (Refer topage 12 for more detailed instructions.)
- Diffuser Assembly (Refer to page 14 for more detailed instructions.)
- Valve Assembly (Refer to page 15 for more detailed instructions.)
- Blower Assembly (Refer to page 17 for more detailed instructions.)
- Muffler (Refer to page 19 for more detailed instructions.)
- Buzzer (Refer to page 21 for more detailed instructions.)
- Bottom Enclosure

Figure T: Bottom Enclosure

To remove the Bottom Enclosure:

1. Remove the Top Enclosure (Refer to page 5 for more detailed instructions).
2. Remove the Main PCA (Refer to page 7 for more detailed instructions).
3. Remove the Outlet-Flow-Tubing Assembly (Refer to page 12 for more detailed instructions).
4. Remove the Diffuser Assembly (Refer to page 14 for more detailed instructions).
5. Remove the Valve Assembly (Refer to page 15 for more detailed instructions).
6. Remove the Blower Assembly (Refer to page 17 for more detailed instructions).
7. Remove the Muffler (Refer to page 19 for more detailed instructions).
8. Remove the Buzzer (Refer to page 21 for more detailed instructions).
9. Remove Light Pipe from Bottom Enclosure.

To install the Bottom Enclosure:

1. Remove the backing from the AVAPS Label. Place the label on the front of the unit, in the bottom right-hand corner.
2. Remove the backing from the Pressure On/Off Sticker. Center the sticker under the cut-out for the On/Off button.

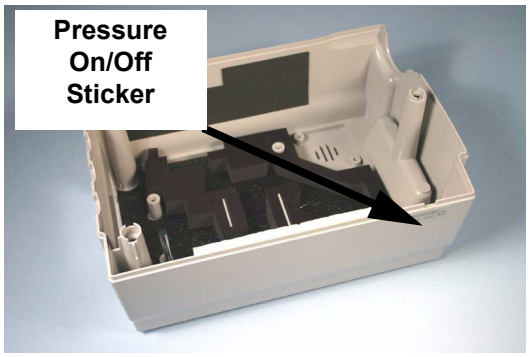


Figure U: Pressure On/Off Sticker Placement

3. Position the end of the light pipe with the notch in it towards the Bottom Enclosure.
4. Insert the Light Pipe into the Bottom Enclosure until the Light Pipe snaps in the mating feature in the bottom.

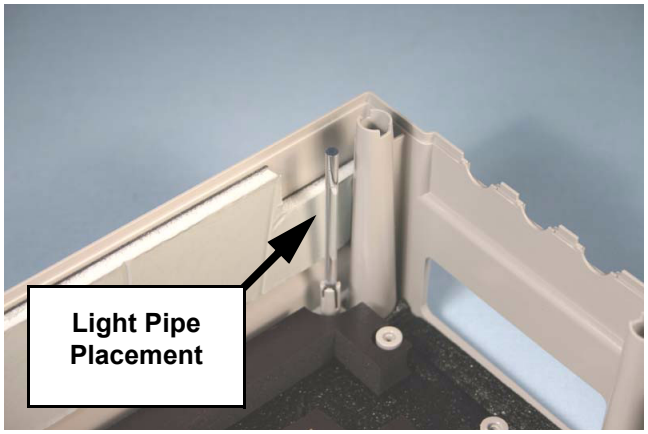


Figure V: Light Pipe Placement

5. Place the Exhaust Air Path Foam onto the Bottom Enclosure (Refer to Figure W).
6. Place the Inlet Air Path Foam onto the Bottom Enclosure (Refer to Figure W).

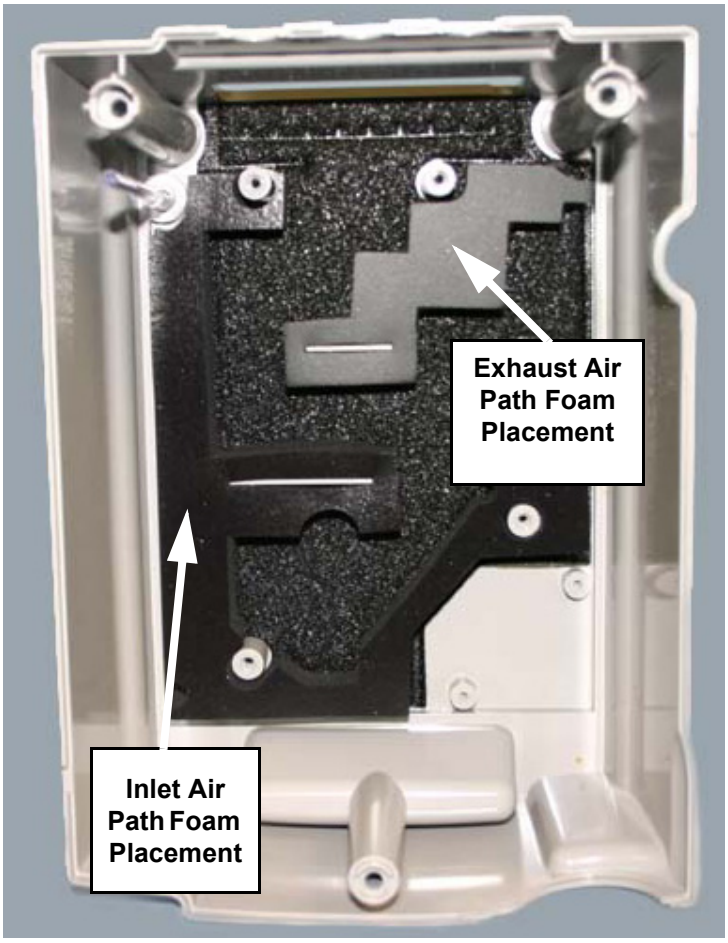


Figure W: Foam Placement

7. Install the Buzzer (Refer to page 21 for more detailed instructions).
8. Install the Muffler (Refer topage 19 for more detailed instructions).
9. Install the Blower Assembly (Refer to page 17 for more detailed instructions).
10. Install the Valve Assembly (Refer to page 15 for more detailed instructions).
11. Install the Diffuser Assembly (Refer to page 14 for more detailed instructions).
12. Install the Outlet-Flow Tubing Assembly (Refer to page 12 for more detailed instructions).
13. Install the Main PCA (Refer to page 7 for more detailed instructions).
14. Install the Top Enclosure (Refer to page 5 for more detailed instructions).

Repair Kits

Chapter Overview

This chapter illustrates the names and components for each of the repair kits for the BiPAP Synchrony system.

For technical assistance or replacement part ordering information, contact Respironics Product Support.

USA and Canada

Phone: 1-800-345-6443
Fax: 1-800-866-0245
Email: service@respironics.com

International

Phone: 1-724-387-4000
Fax: 1-800-387-5012

Visit Respironics Home Page on the World Wide Web at:

www.respironics.com

Repair Kit Reference Table

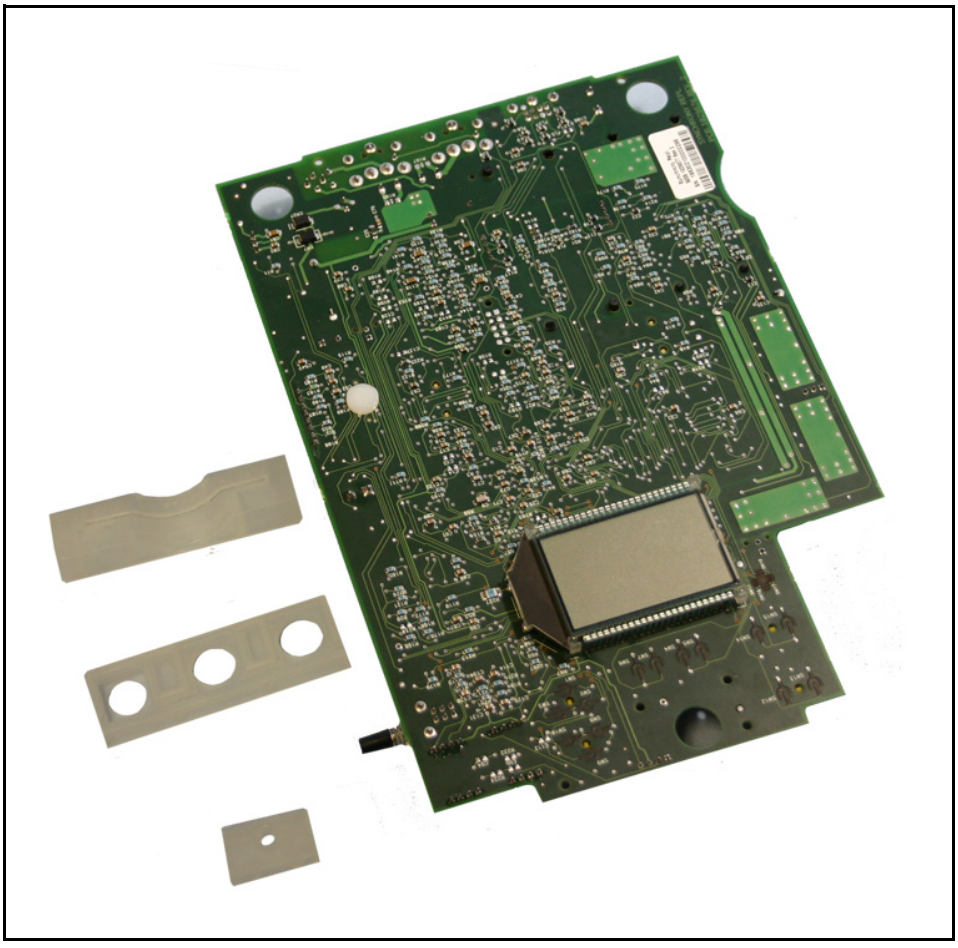
PART NUMER	REPAIR KIT NAME	PAGE IDENTIFIER
1031394	*Top Enclosure*	*Page 3*
1031732	*Main PCA*	*Page 4*
1031731	*KeyPad*	*Page 5*
1025184	*Outlet-Flow-Tubing Assembly*	*Page 6*
1018156	*Diffuser*	*Page 7*
1017912	*Valve Assembly*	*Page 8*
1023818	*Blower Assembly*	*Page 9*
1017913	*Muffler*	*Page 10*
1018163	*Buzzer Assembly*	*Page 11*
1032132	*Bottom Enclosure*	*Page 12*
1017937	*Warning Label*	*Page 13*
1005945	*Ultra Fine Filter*	*Page 14*
1005964	*Pollen Filter*	*Page 15*
1019523	*Filter Cap*	*Page 16*
1012832	*60 Watt Power Supply*	*Page 17*
1018160	*Alarm Label*	*Page 18*
1007492	*SleepLink Communication Cable*	*Page 19*
1031099	*SmartCard Seal*	*Page 20*
1032896	*Tubing Kit*	*Page 21*

Top Enclosure Repair Kit

PART NUMBER: 1031394	
Included in Kit	**Tools Required**
Top Enclosure	Phillips Screwdriver (No. 2 Medium)

Main Printed Circuit Assembly (PCA) Repair Kit

PART NUMBER:1031732	
Included in Kit	**Tools Required**
Main PCA	Phillips Screwdriver (No. 2 Medium)
SmartCard Seal	
Power Switch Seal	
Connector Seal	



KeyPad Repair Kit

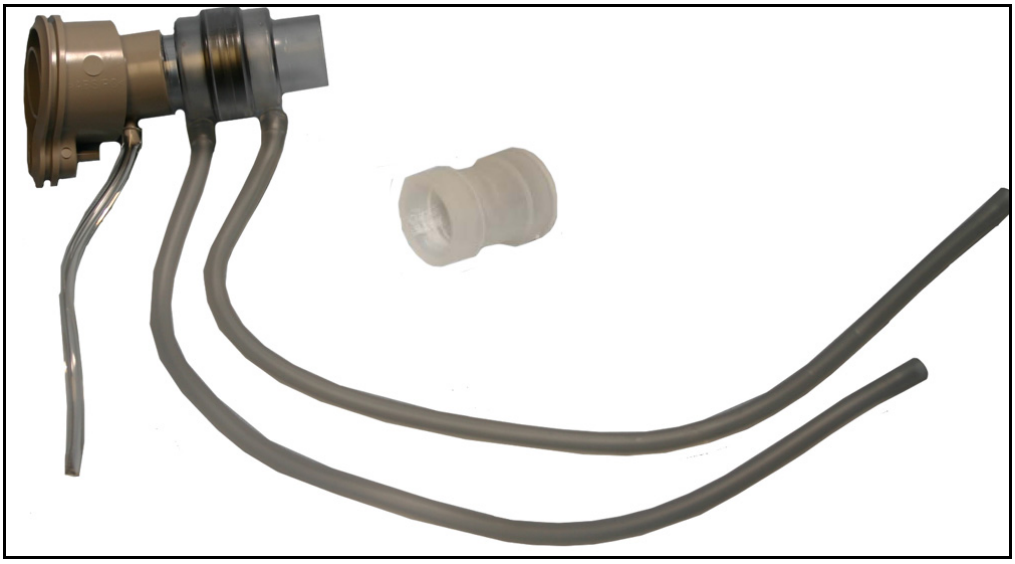
PART NUMBER: 1031731	
Included in Kit	**Tools Required**
KeyPad	Phillips Screwdriver (No. 2 Medium)

Outlet-Flow-Tubing Repair Kit

PART NUMBER: 1025184	
Included in Kit	**Tools Required**
Flow Element	Phillips Screwdriver (No. 2 Medium)
Outlet Port	
Flow Sensor Tubing (x2)	
Pressure Tubing (x2)	
Coupler	

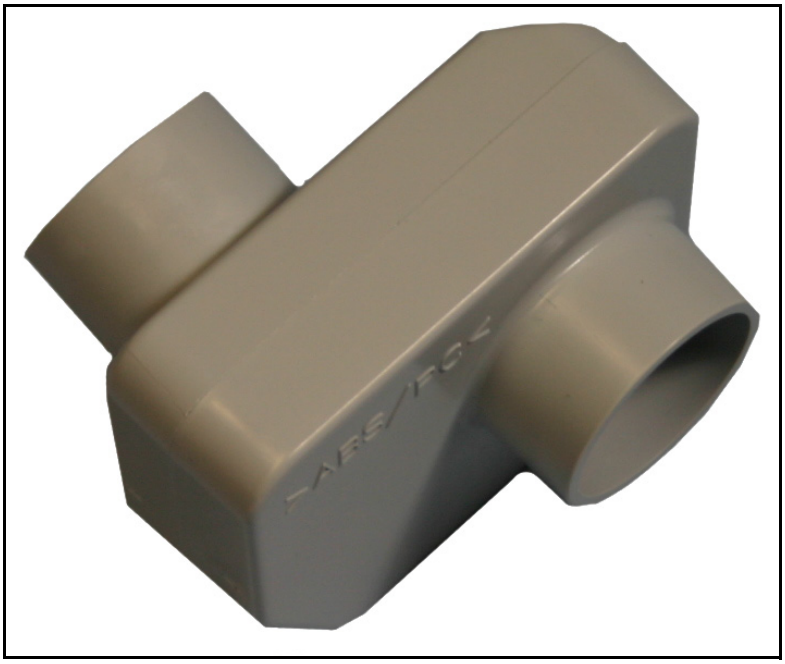
NOTE

This kit comes pre-assembled for easy installation in the device.



Diffuser Assembly Repair Kit

PART NUMBER: 1018156	
Included in Kit	**Tools Required**
Diffuser	Phillips Screwdriver (No. 2 Medium)



Valve Assembly Repair Kit

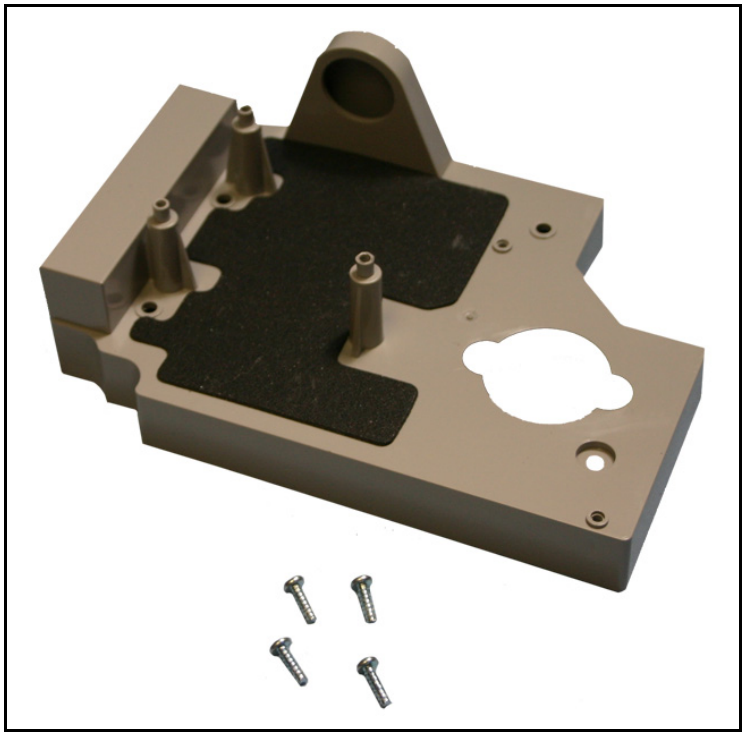
PART NUMBER: 1017912	
Included in Kit	**Tools Required**
Valve Assembly	Phillips Screwdriver (No. 2 Medium)
Grommets (x3)	
Screws (x3)	
Washers (x3)	

Blower Assembly Repair Kit

PART NUMBER: 1023818	
Included in Kit	**Tools Required**
Blower Assembly	Phillips Screwdriver (No. 2 Medium)
Blower Cap	
Damper Strap	
Doughnut	
Screws (x2)	

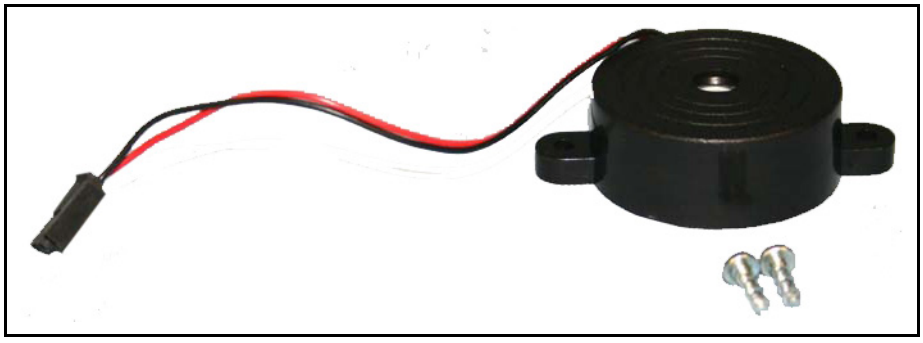
Muffler Repair Kit

PART NUMBER: 1017913	
Included in Kit	**Tools Required**
Muffler	Phillips Screwdriver (No. 2 Medium)
Screws (x4)	



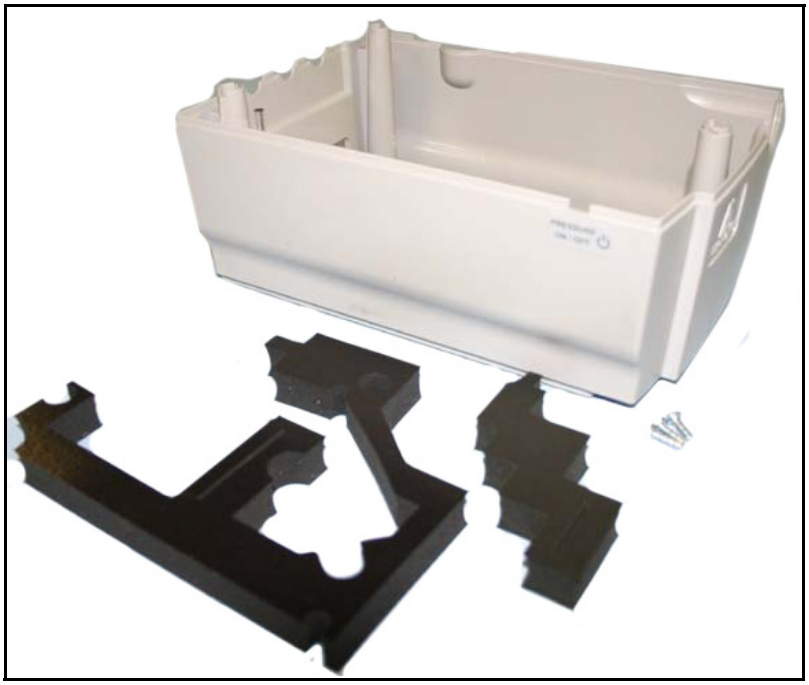
Buzzer Assembly Repair Kit

PART NUMBER: 1018163	
Included in Kit	**Tools Required**
Buzzer Assembly	Phillips Screwdriver (No. 2 Medium)
Screws (x2)	
Washers (x2)	



Bottom Enclosure Repair Kit

PART NUMBER: 1032132	
Included in Kit	**Tools Required**
Bottom Enclosure	Phillips Screwdriver (No. 2 Medium)
Light Pipe	
AVAPS Label	
Pressure On/Off Label	
Exhaust Air Foam	
Inlet Air Foam	
Screws (x3)	

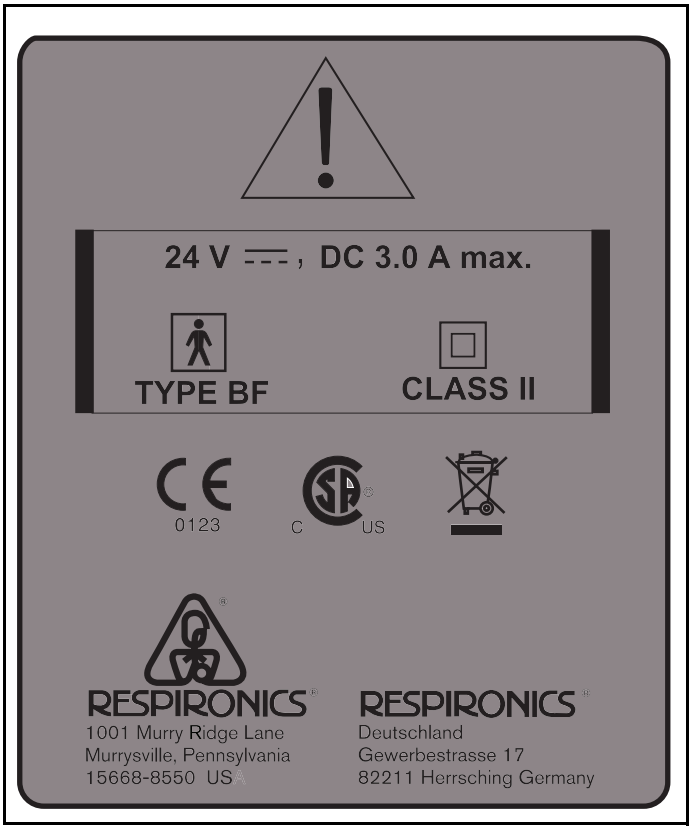


NOTE

Contact Respironics Product Support for the proper labeling when replacing the bottom enclosure

Warning Label Repair Kit

PART NUMBER: 1017937	
Included in Kit	**Tools Required**
Warning Label	None



Ultra Fine Filter Repair Kit

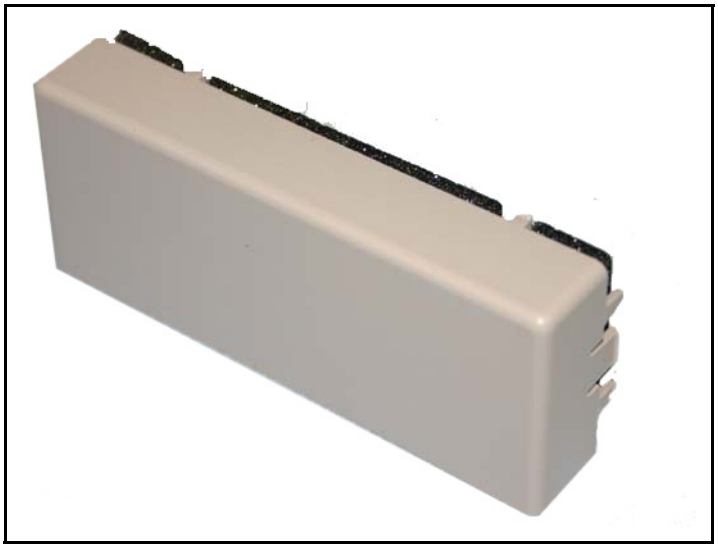
PART NUMBER: 1005945	
Included in Kit	**Tools Required**
Ultra Fine Filter	None

Pollen Filter Repair Kit

PART NUMBER: 1005964	
Included in Kit	**Tools Required**
Pollen Filter	None

Filter Cap Repair Kit

PART NUMBER: 1019523	
Included in Kit	**Tools Required**
Filter Cap	None



60 Watt Power Supply Repair Kit

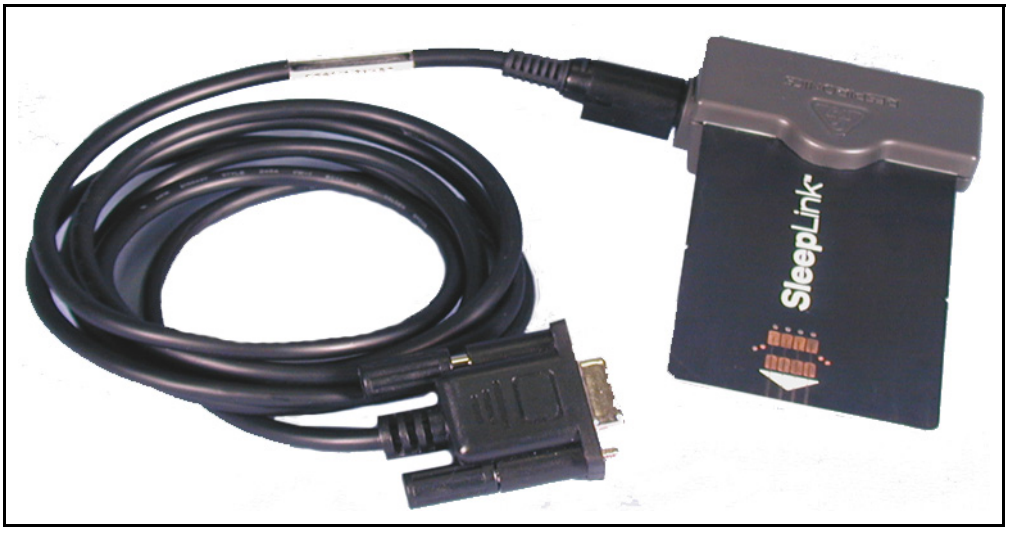
PART NUMBER: 1012832	
Included in Kit	**Tools Required**
Power Supply	None

Alarm Label Repair Kit

PART NUMBER: 1018160	
Included in Kit	**Tools Required**
Alarm Label	None

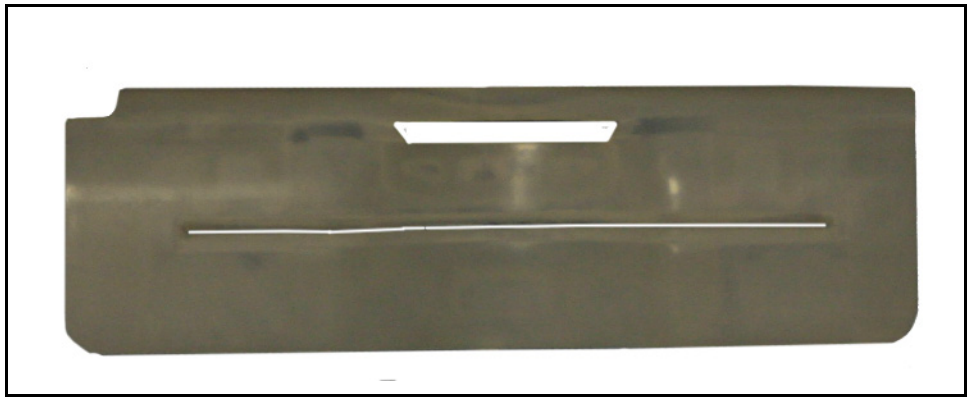
SleepLink Communication Cable Repair Kit

PART NUMBER: 1007492	
Included in Kit	**Tools Required**
SleepLink Communication Cable	None



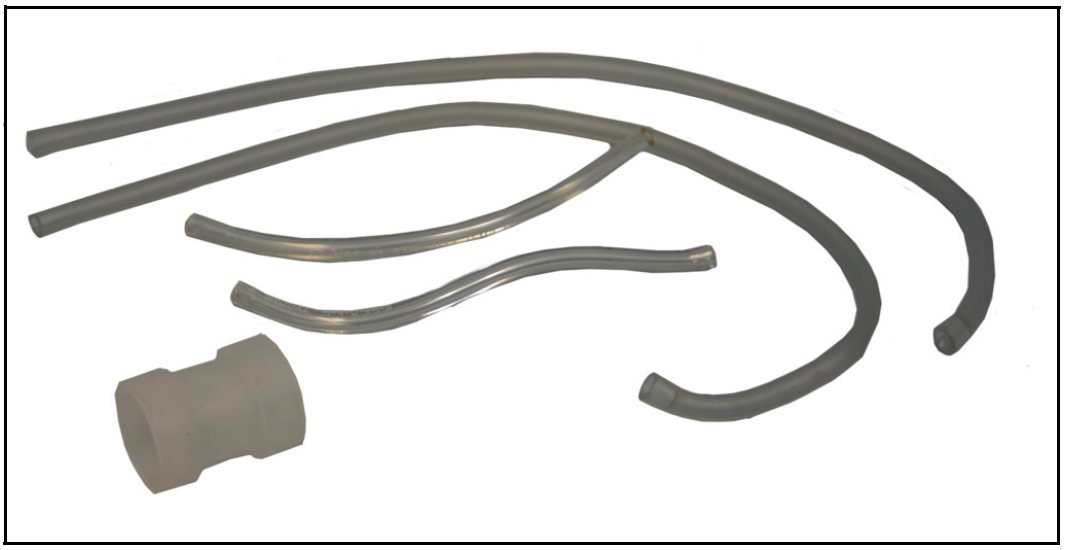
SmartCard Seal Repair Kit

PART NUMBER: 1031099	
Included in Kit	**Tools Required**
SmartCard Seal	None



Tubing Repair Kit

PART NUMBER: 1032896	
Included in Kit	**Tools Required**
Pressure Tubing (x2)	None
Flow Tubing (x2)	
Coupler	



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TESTING

TESTING PROCESS

This chapter provides run-in, calibration, AC current draw testing, and performance verification procedures for the BiPAP Synchrony. Calibration and AC current draw testing are necessary only when a repair has been made to the BiPAP Synchrony. However, these procedures may be used in conjunction with the performance verification to determine that the BiPAP Synchrony is functioning properly. Verification shall be performed at periodic intervals commensurate with hospital or home care provider guidelines for preventive maintenance, between rentals or during normal patient usage.

Calibration and testing of the BiPAP Synchrony requires the use of Respironics Utility Software. Before proceeding, log on to http://servicesoftware.respironics.com and download the Utility Software onto your PC.

Calibration and testing can also be performed on the Multi-function Test Station at service locations equipped with this device.

BiPAP SYNCHRONY SYSTEM RUN-IN

Before the BiPAP Synchrony can be calibrated, the device must be run-in for at least 2 hours to avoid possible calibration failures.

EQUIPMENT REQUIRED

- 0.25” Test Orifice (RI p/n 332353)

PROCEDURE

1. Connect the test orifice to the outlet port of the unit.
2. Enter the therapy setup menu (refer to the System Setup Porcedures Section for detailed instructions). Set the unit to CPAP mode and set the pressure to 20 cm H_2O.
3. Run the unit for at least 2 hours before performing the calibration.

PERFORMANCE VERIFICATION

This procedure provides guidelines to verify the performance of the BiPAP Synchrony.

PROCEDURE

1. Record the Serial Number and Model Number of the unit located on the bottom enclosure on the test data sheet (refer to page 22).
2. Plug the BiPAP Synchrony power source in and record the line voltage used for testing and the blower hours on the test data sheet (refer to page 22).
3. Place the BiPAP test orifice (RI p/n 332353) on the outlet of the unit. Connect a Digital Manometer to the test orifice.
   a. Enter the provider menu of the BiPAP Synchrony.
   b. Set the BiPAP Synchrony to the CPAP mode and the pressure to 4 cm H_2O. Verify the pressure reading and record it on the test data sheet.
   c. Set the BiPAP Synchrony to 20 cm H_2O. Verify the pressure reading and record it on the test data sheet.

d. Set the BiPAP Synchrony to the S mode and set the IPAP pressure to 10 cm H_2O and EPAP pressure to 5 cm H_2O.

e. Using your finger, occlude and unocclude the outlet and verify that the BiPAP Synchrony is switching between IPAP and EPAP mode on the display screen. Record results on the test data sheet.

f. Set the BiPAP Synchrony to the S/T mode and set the IPAP pressure to 10 cm H_2O, EPAP pressure to 5 cm H_2O, BPM to 10 and the Ti time to 2.0.

g. Verify that the BiPAP Synchrony is switching between IPAP and EPAP mode on the display screen and record the results on the test data sheet.

h. While still in the provider menu, activate the ramp mode.

i. Once the BiPAP Synchrony has achieved the set IPAP and EPAP pressure, press the ramp button.

j. Observe the display and the manometer reading until the pressure increases at least 1 cm H_2O in approximately 1 minute. Record results on test data sheet.

Real-time Clock Calibration

The BiPAP Synchrony will record and track several different parameters (e.g. patient pressures, apnea events, when and how the device is used, error codes, etc.). To do this in a logical manner and for a technician or therapist to know exactly when a certain event has occurred, the BiPAP Synchrony runs and records events in real-time. This time is checked and compared to your computers time when running the calibration software. If the time does not match, the calibration will fail. Therefore, you must perform the real-time clock calibration before you proceed with the BiPAP Synchrony calibration.

Equipment Required

- SleepLink Interface Card w/Cable (RI p/n 1007492)
- Utility Software

Procedure

1. Ensure AC power is connected to the BiPAP Synchrony
2. Connect the SleepLink cable to communication port (1) of your computer. Connect the other end of the cable to the SleepLink card.
3. Log onto **http://servicesoftware.respironics.com**.
4. Click on the **Respironics Utility Tools Software** link. Refer to Figure A.

:

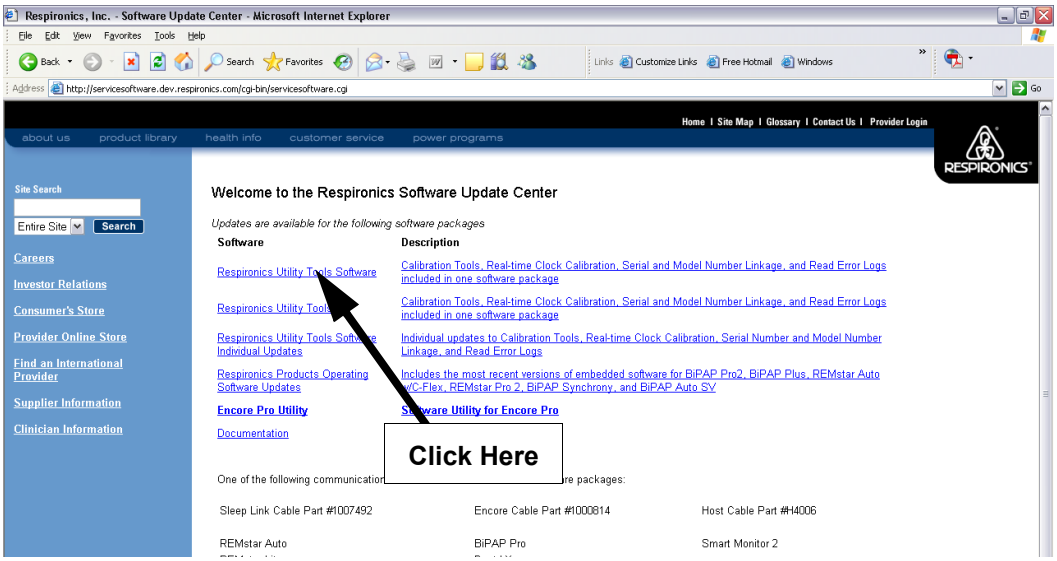

FIGURE A: RESPIRONICS SERVICE SOFTWARE WEB PAGE

5. Click on the **Download** button adjacent to **Service Center Tools Suite**. Refer to Figure B.

:

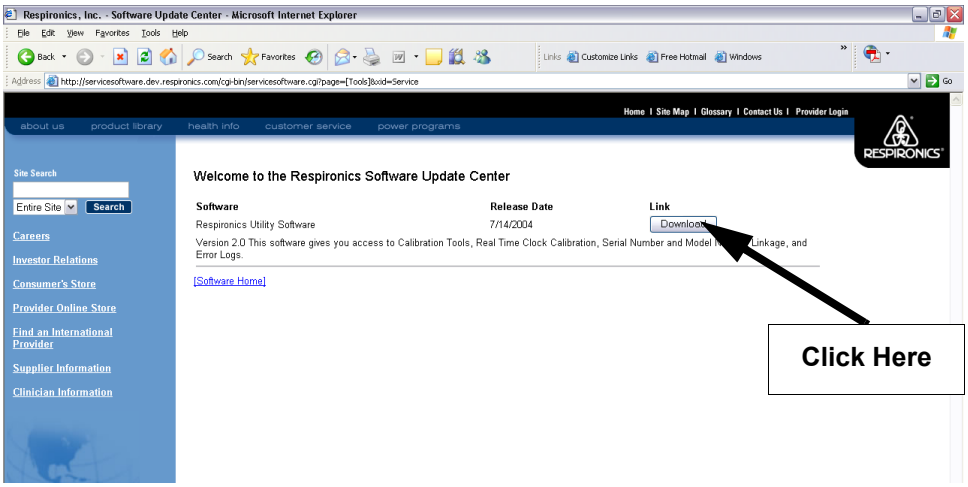

FIGURE B: UTILITY TOOLS WEB PAGE

6. When you click on the **Download** button, the following window will appear:

:

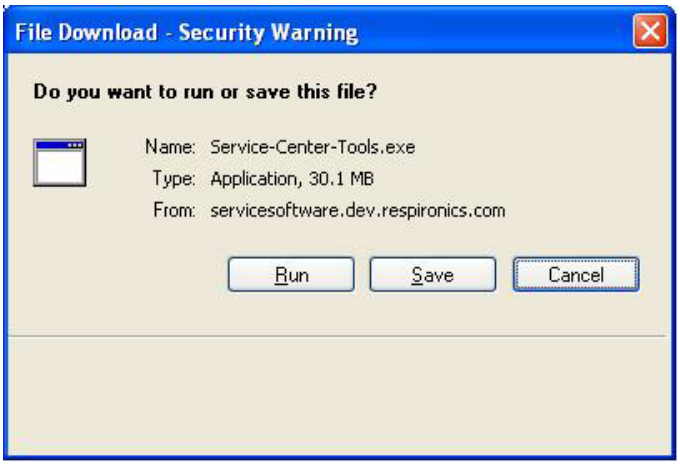

Figure C: Run or Save Window

7. Click on **Run** to install the software on your PC, or click on **Save** to download the software and save it to a specific location on your PC. Click Save if you wish to copy the software to a CD_ROM and install it on other PCs.

NOTE
Clicking on “Run” installs the software onto your PC. The program will be accessible from the **Start** menu in your Windows Task bar.

NOTE
Remember to periodically log onto **http://servicesoftware.respironics.com** and check the site for software updates.

8. Once you have installed the software, open *Service Center Tools* from the *Start* menu.

:

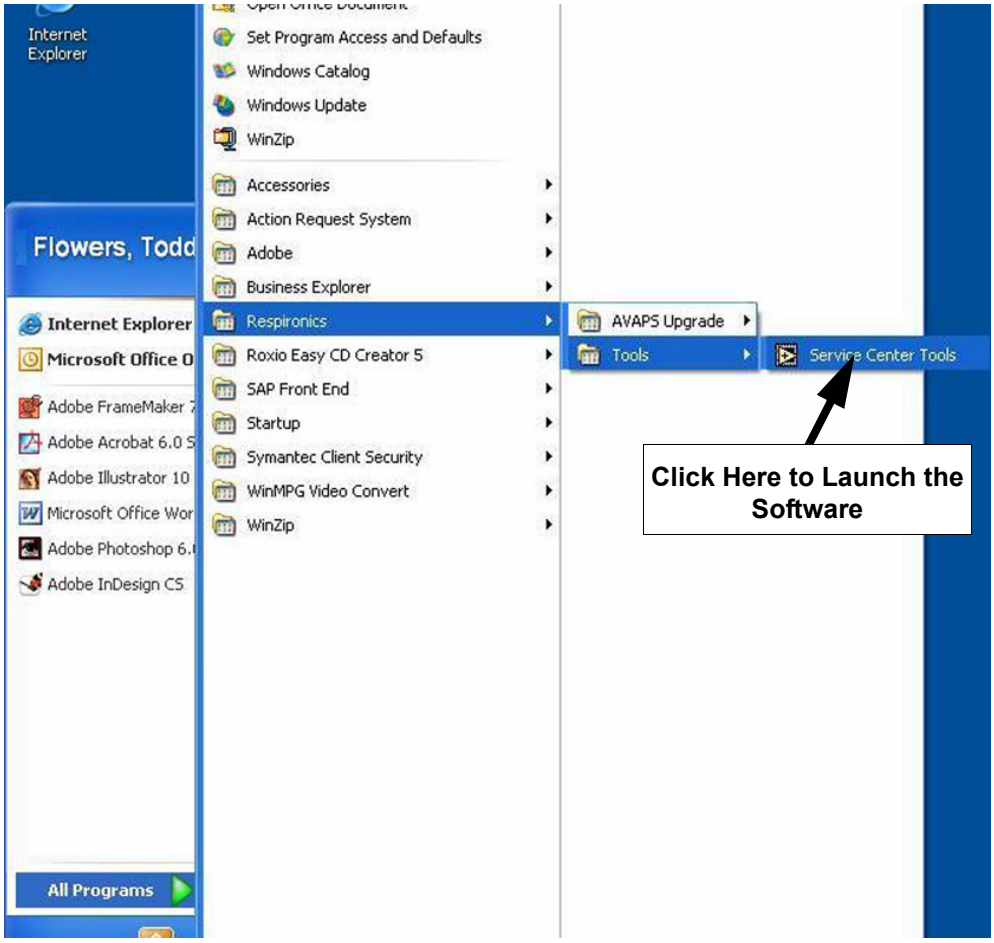

FIGURE D: START MENU

9. Once you launch the software click on the Drop Down Menu and select **"Real-Time Clock Calibration"**. Refer to Figure E.

FIGURE E: DROP DOWN MENU

10. Click the **"Execute Tool"** button. Refer to Figure F.

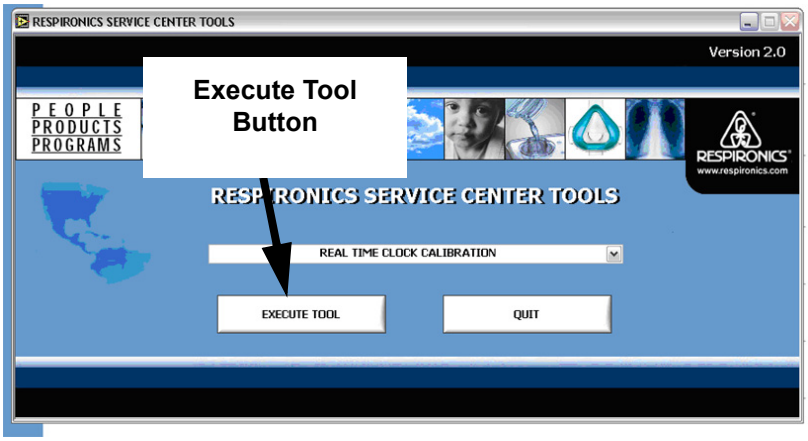

Figure F: Execute Tool Button

11. When the program has finished, a "Success" screen will appear. Click the "OK" button.

Figure G: Real-time Clock Calibration Complete

BiPAP Synchrony Calibration

This procedure provides remote instructions for the calibration of the BiPAP Synchrony. The results of this calibration can be printed to a local printer and used as a final test data sheet that can be retained as part of the device history record.

Equipment Required

- Utility Software (http://servicesoftware.respironics.com)
- Digital Manometer (Refer to Testing Section)
- Windows® - compatible personal computer running Windows 95 or higher version software.
- Printer
- SleepLink Card with cable (RI p/n 1007492)
- Flow Meter (Refer to Testing Section)
- Flow control valve (RI p/n 1006120)
- O_2 Enrichment Adapter (RI p/n 312710)
- Barometer
- Pressure Tubing
- Negative Flow Source (CPAP capable of 60 lpm)
- Smooth Bore Patient Tubing for intradevice connection
- REMstar Heated Humidifier (optional)

Procedure

1. Connect the RS-232 connector of the SleepLink cable to the communication port (1) of your computer. Connect the other end to the cable to the SleepLink card. Slide the card into the SmartCard slot on the BiPAP Synchrony (the card must be inserted with the words “SleepLink” facing upwards).
2. Connect the external power supply to the BiPAP Synchrony.
3. Set the BiPAP Synchrony on the Remstar Heated Humidifier and connect the AC power cord to the Humidifier.
4. Connect the O_2 adapter to the outlet of the BiPAP Synchrony and occlude the adapter.

NOTE

Remove the humidifier’s water chamber if connected. All connections must be made to the outlet port of the BiPAP Synchrony.

5. Connect the pressure tubing from the O_2 port of the O_2 adapter to the digital manometer. Refer to Figure K for setup.
6. Log onto **http://servicesoftware.respironics.com**.

7. Click on the **Respironics Utility Tools Software Individual Updates** link.

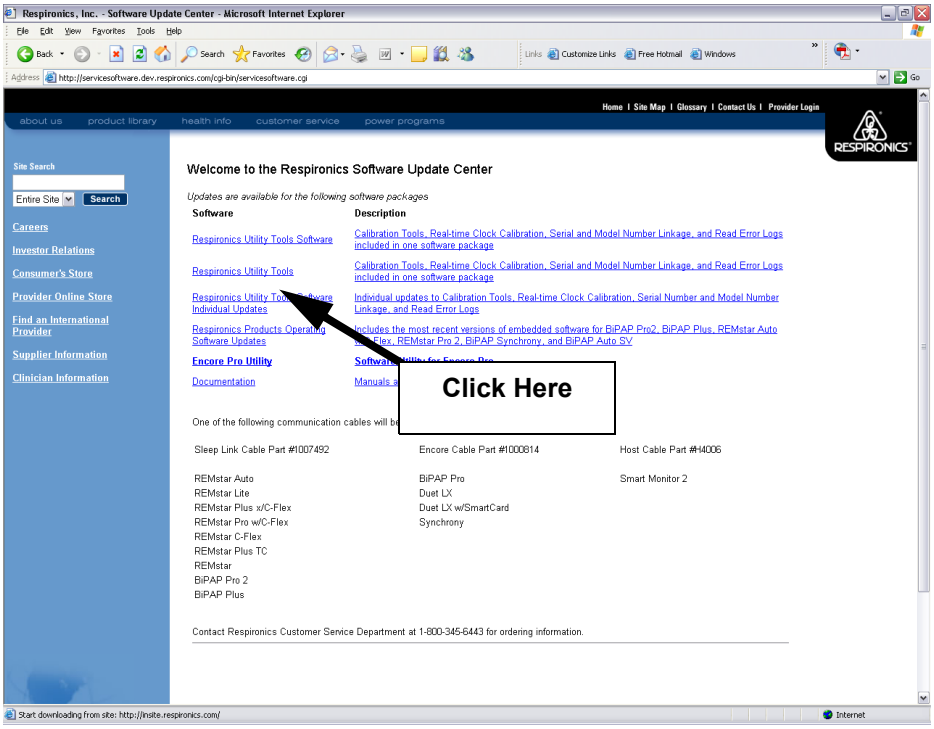

FIGURE H: RESPIRONICS SERVICE SOFTWARE PAGE

8. Click on the **Download** button adjacent to **Service Center Calibration**.

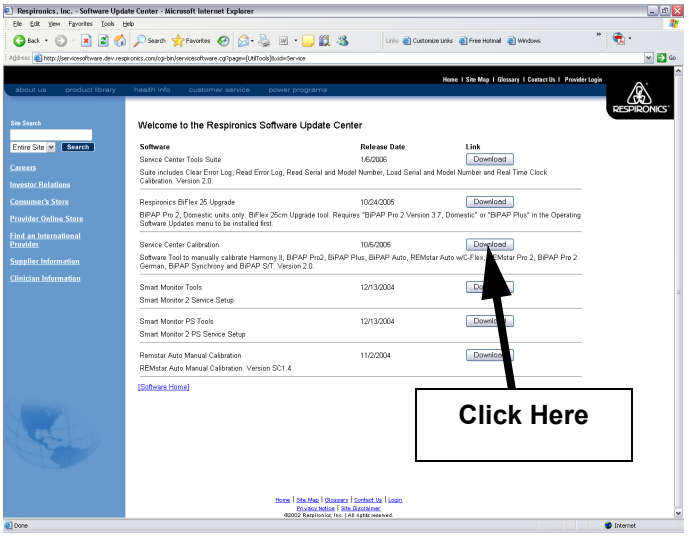

FIGURE I: UTILITY TOOLS SOFTWARE INDIVIDUAL PAGE

9. When you click on the **Download** button, the following window will appear:

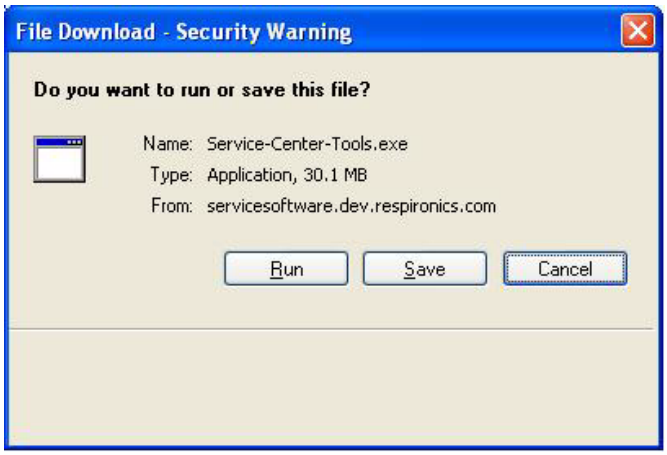

FIGURE J: RUN OR SAVE WINDOW

10. Click on **Run** to install the software on your PC, or click on **Save** to download the software and save it to a specific location on your PC. Click Save if you wish to copy the software to a CD_ROM and install it on other PCs.

NOTE

Clicking on "Run" installs the software onto your PC. The program will be accessible from the **Start** menu in your Windows Task bar.

NOTE

Remember to periodically log onto **http://servicesoftware.respironics.com** and check the site for software updates.

11. Once you have installed the software, open *Service Center Calibration Software* from the *Start* menu. Refer to Figure D.
12. Start the calibration by clicking on the white run time arrow in the upper left hand corner of the window.

Figure K: Pressure Setup

Figure L: System Setup

13. The program will then prompt the user to enter the serial number. After typing in the serial number, click "OK". The program will ask you to enter the model number. Then, click "OK". Enter the user name and hit "ENTER" on the keyboard.

NOTE
Click the appropriate button in Figure M. You may run the Calibration Software with or without a humidifier.

14. The program will then run through a series of humidifier (optional), lighting, alarm, and display tests. Follow the on screen instructions.

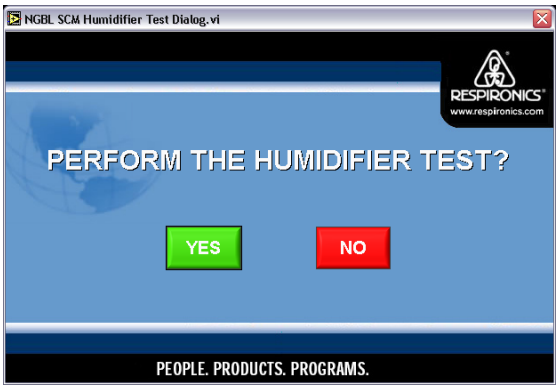

Figure M: Humidifier Test Screen

15. When the prompt in Figure N appears, the program is ready to start sensor calibration. Click on the "OK" button.

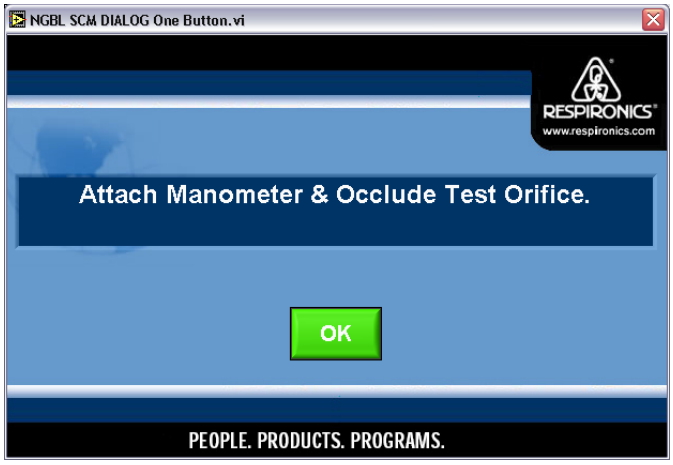

Figure N: System Calibration

16. Observe the manometer. If the pressure is higher than 4.00 cm H_2O, click on the red button to decrease the blower speed. If the pressure on the manometer is lower than 4.00 cm H_2O, click on the green button to increase blower speed. Each time a button is clicked, the pressure will change by approximately 0.2 cm H_2O. When 4.00 cm H_2O is achieved, click "DONE" on the screen.

NOTE

Let the pressures stabilize for at least one minute before making any adjustments during the calibration.

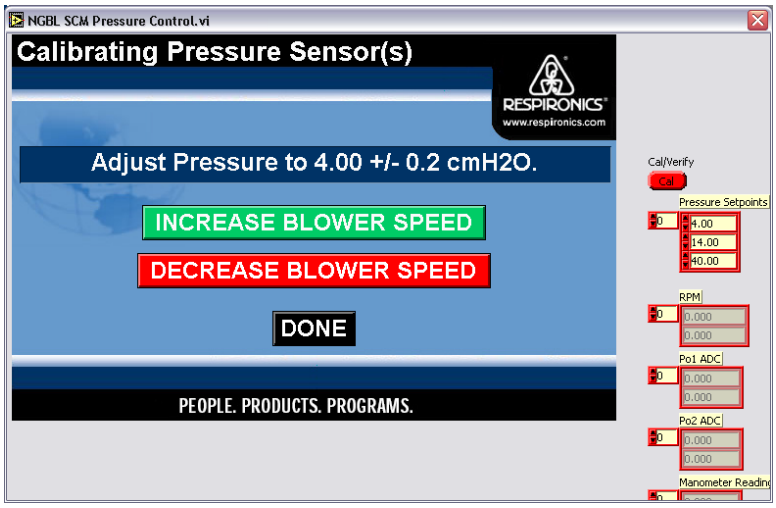

FIGURE O: INCREASE/DECREASE BLOWER SPEED

17. Type in the pressure reading from the manometer and press “ENTER” on the keyboard.

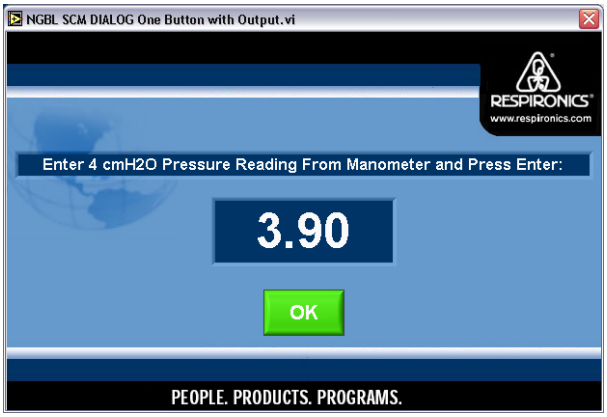

FIGURE P: ENTERING MANOMETER READING

18. The program will now request calibration at several higher pressures. Perform the same procedure for the remaining different settings.
19. After the last pressure calibration is performed, the following prompt will appear, indicating the program is about to start the flow element calibration. The program will first calibrate positive flow.

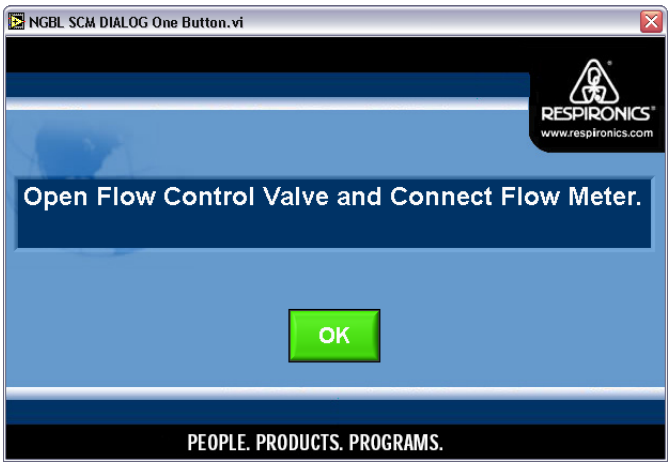

Figure Q: Flow Element Calibration

20. Unblock the end of the O_2 adapter. Connect a section of patient tubing between the O_2 adapter and the inlet of the flow meter. Connect another section of patient tubing from the outlet of the flow meter to the control valve (completely open the flow valve). Click on the green "OK" button on the program window.

Figure R: Calibration Circuit

21. Observe the flow meter. If the flow is greater than 160 lpm, click on the red button to decrease the flow. If the flow is less than 150 lpm, click on the green button to increase the flow. When the BiPAP Synchrony is delivering between 150-160 lpm, click on the "DONE" button.

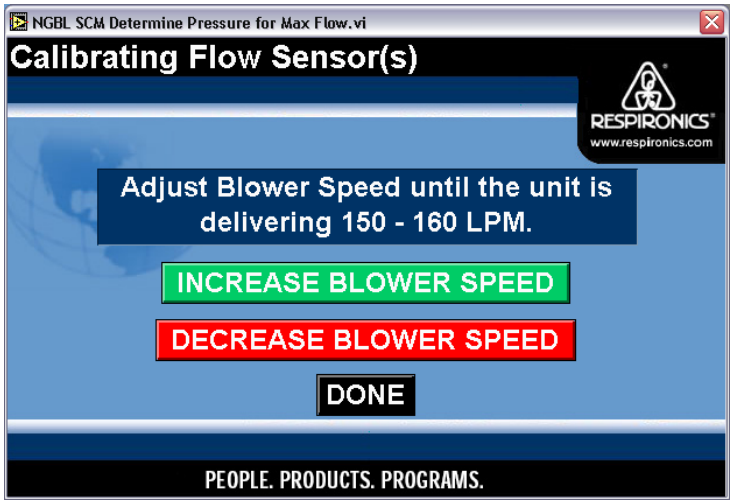

Figure S: Increase/Decrease Flow

22. Observe the flow meter and adjust the flow control valve until 146 lpm of flow is achieved. Click on the green 'OK" button.

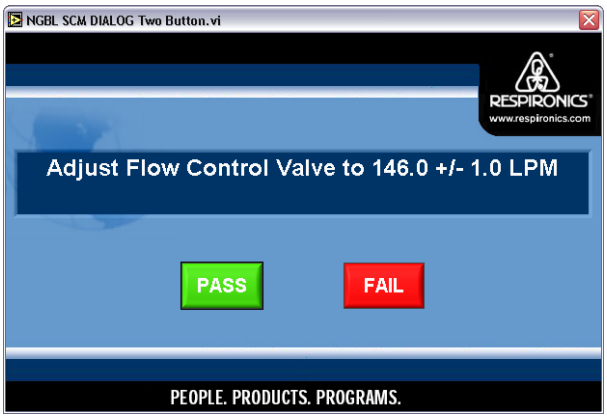

Figure T: Flow Element Calibration

23. Type in the flow reading from the flow meter and press “ENTER” on the keyboard.

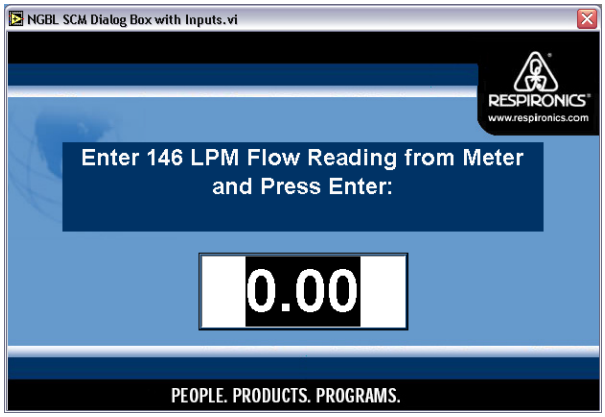

Figure U: Entering the Flow Meter Reading

24. The program will now request several different flow settings decreasing in value down to and including zero flow. For each setting, raise the flow control valve to set the flow and then type in each value. After zero flow is confirmed, the following prompt will appear.

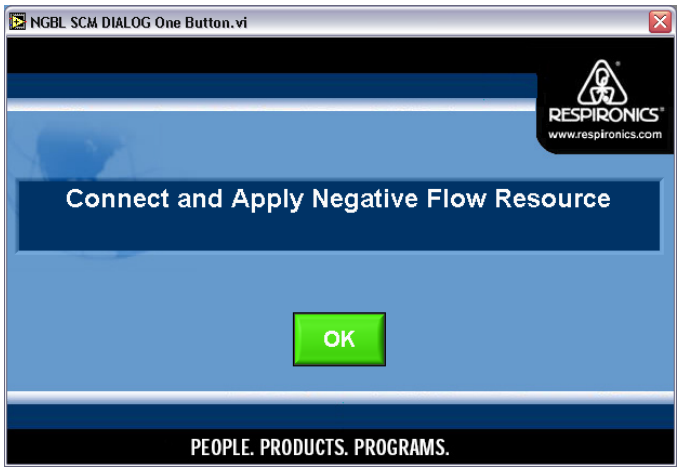

Figure V: Zero Flow Confirmation

25. The program will now calibrate negative flow. Connect another section of patient tubing between the outlet of the flow control valve and the outlet of the negative flow source. Turn on the negative flow source and click on the green “OK” button.

NOTE

For the negative flow source, a REMstar device may be used with the pressure set at 20 cm H_2O.

Figure W: System Calibration with Negative Flow Source

26. The program will now calibrate the negative portion of the flow table. Although the flow meter may not display a negative flow, pressure against the normal direction of flow of the device is considered a negative flow. Adjust the flow control valve until 10 lpm is displayed on the flow meter and click "OK".

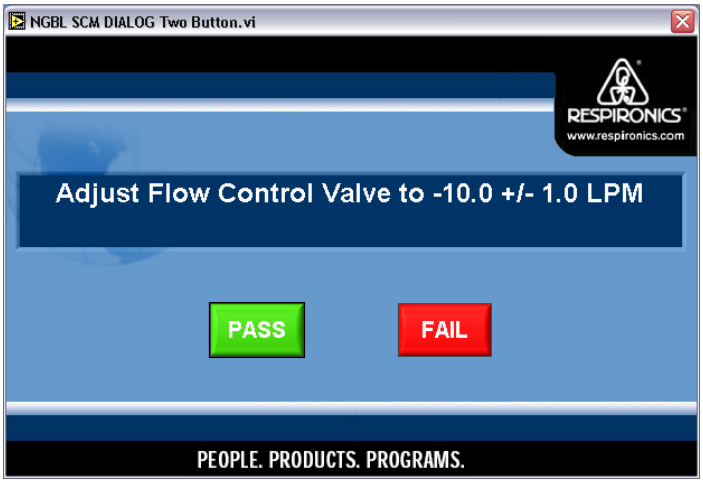

Figure X: Negative Flow Value Display

27. Before entering the flow value, ensure that the negative or minus symbol is typed in first. The software will reject a positive value here.

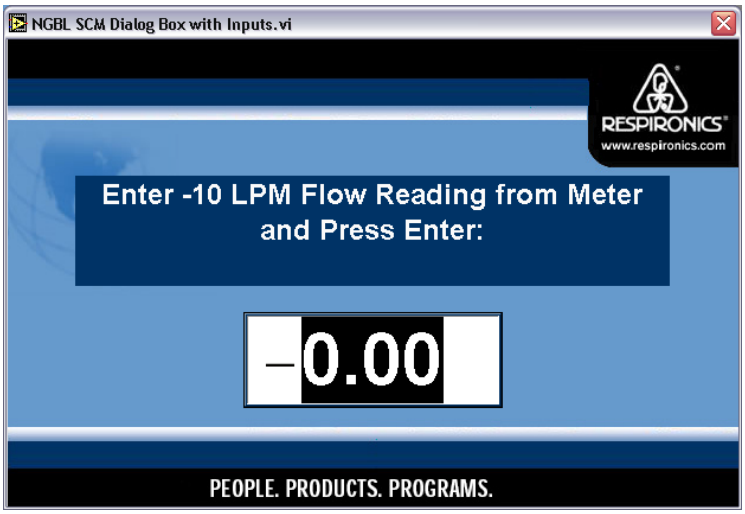

Figure Y: Entering the Negative Flow Value

28. Once again, use the flow control valve to set the negative flows that the program requests and enter the values.
29. The program has now completed calibrating the flow and pressure sensor.
30. The program will now ask for the barometric pressure reading. Using your barometer enter the value in iniches.

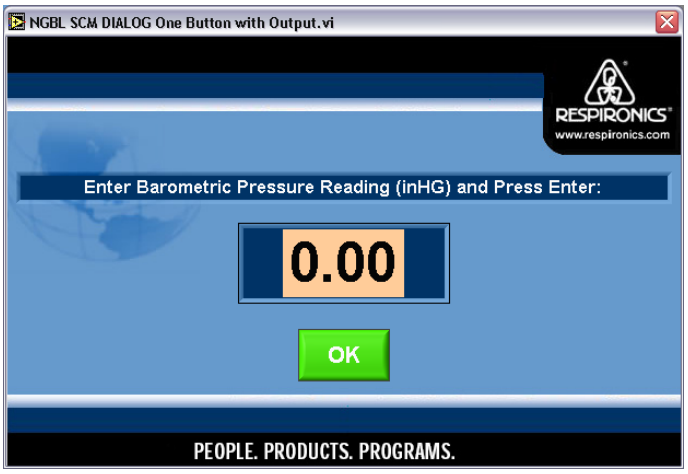

Figure Z: Entering the Barometric Pressure

31. Pressure and flow accuracy of the device must now be verified. The program will now read the pressure and flow parameters from the device and compare these reading to the pressure and flow values that the user will enter.
32. The program will first verify positive flows. Turn off the negative flow source and disconnect the patient tubing from between the negative flow source and the flow valve. Completely open the flow valve. Follow the prompts on the screen for the flow settings.

33. After zero flow is confirmed, the program will verify negative flow. Connect the patient tubing between the outlet of the flow valve and the negative flow source. Turn on the negative flow source and follow the prompts.
34. After completion of the negative flow verification, pressure accuracy will be checked. Turn off the negative flow source. Disconnect the patient tubing and occlude the O_2 port at the BiPAP Synchrony outlet port.
35. The program will now verify the barometirc pressure. Enter the value, in inches of mercury, displayed on the barometer.
36. When the pressure verification is complete, the program will request a button test for the BiPAP Synchrony. Press the buttons on the device in the order that they are numbered on the program screen.

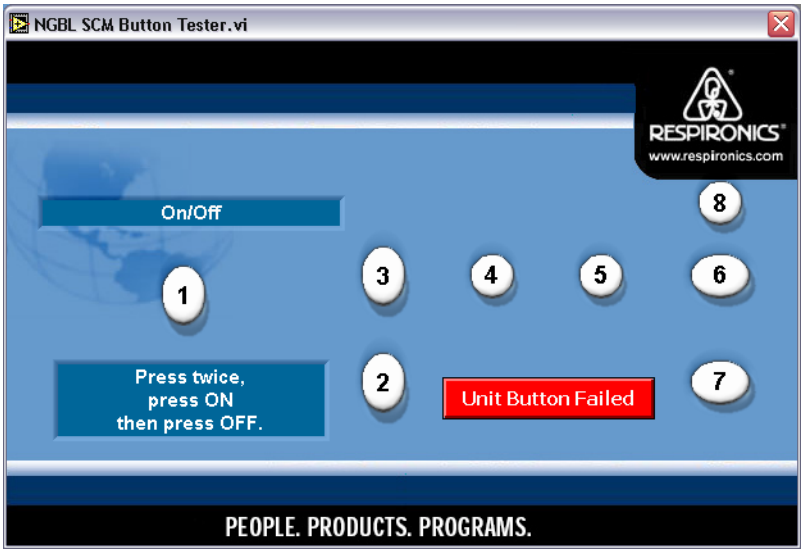

Figure AA: Button Test

37. When the button test has been completed and the BiPAP Synchrony has successfully passed all tests, a green “PASS” prompt will appear on the computer screen. Click the “OK” button to view the test data sheet. Click “OK” on the print results button to print the test data sheet.

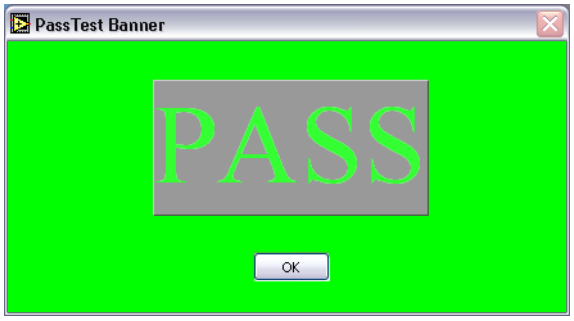

Figure AB: Pass Screen

Printing of the Final Test Data Sheet

38. Sign the sheet and retain as part of a device history record. Refer toFigure AC. This completes the calibration procedure. The BiPAP Synchrony Current Draw Test must now be performed.

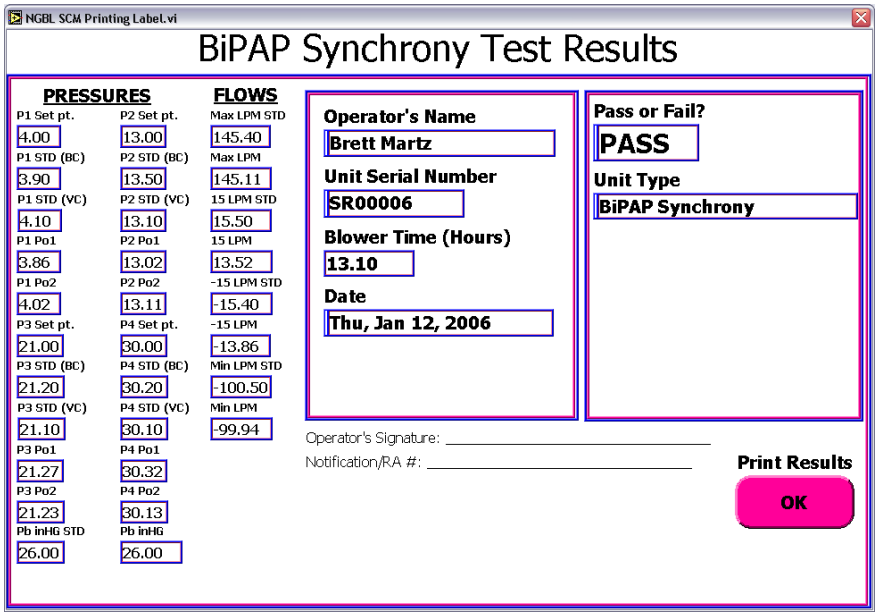

Figure AC: Test Data Sheet

Current Draw Test

This procedure provides instructions for testing the current draw on the BiPAP Synchrony System.

Equipment Required

- 0.25” Test Adapter (RI p/n 332353)
- Multimeter
- Test Leads

NOTE

*It is recommended to use an adapted, spare BiPAP Synchrony Power cord, in conjunction with an Amprobe for measuring the current draw of the unit. The spare BiPAP Synchrony power cord can be adapted by separating the two insulated sides of the power cord, taking extra care **NOT** to remove any insulation, thus exposing the bare wires.*

Alternatively, the technician may use whichever method they are comfortable with to complete the current draw test.

Procedure

1. Connect the adapted, spare BiPAP Synchrony Power cord to the BiPAP Synchrony Unit and the other end to an AC outlet. Attach the Amprobe to the hot side of the adapted, spare BiPAP Synchrony Power cord.
2. Place the test adapter on the outlet of the BiPAP Synchrony. Enter the Setup menu and set the IPAP pressure to 25 cm H_2O and EPAP to 25 cm H_2O.
3. Turn on the BiPAP Synchrony and allow the device to stabilize for at least one minute.
4. Record the current readings from the Amprobe in the space provided on the Test Data Sheet. Sign and date the test data sheet and retain for a device history record. This concludes the BiPAP Synchrony Current Draw Test.

NOTE

Refer to the REMstar Heated Humidifier Service Manual (Reorder Number: 1015720) for steps to perform current draw test with a heated humidifier.

BiPAP Synchrony Current Draw Test Data Sheet

Serial No._____

Model No._____

Tolerance

Current Draw @ 25 cm H_2O (_____)<1.25 Amps

Name (print)_____

Signature (In Ink)_____ Date:_____/_____/____

NOTE
Attach this form to print out from BiPAP Synchrony System calibration.

Performance Verification Data Sheet

NOTE

You should record all information on this data sheet after each test has been completed. Data sheet must then be signed in ink and dated by the technician performing the test.

Serial No: _____

Model Number:_____

Line Voltage: _____

Blower Hours:_____

CPAP Mode Pressure Settings:

3b) 4 cm H_2O_____(3-5 cm H_2O)

3c) 20 cm H_2O_____(18-22 cm H_2O)

3e) Synchrony Mode Trigger Performance: Pass/Fail_____

3j) Ramp Performance Bi-Level: Pass/Fail_____

3g) S Mode Trigger Performance: Pass/Fail_____

Humidifier Testing: Pass/Fail_____

Name (print)_____

Signature (In Ink)_____ Date:_____/_____/____

Tools and Equipment

Service Tools and Supplies

You should have the following hand tools and supplies available for troubleshooting, testing, and repairing the BiPAP Synchrony Ventilatory Support System.

- Common Hand Tools
  - Flat-Blade Screwdriver - small
  - Phillips Screwdriver - medium
- Antistatic, Electro-Static Discharge (ESD)-protected work station - minimum requirement is a grounded mat and wrist strap
- Windows®-compatible personal computer running Windows 95, 98, 2000, NT with a CD-ROM drive and internet access
- SleepLink Cable (RI p/n 1007492)
- Cleaning Cloth
- Digital Manometer - Refer to page 2.
- Digital Multimeter - Refer to page 2.
- Flow Meter - Refer to page 2.
- Barometer - Refer to page 3.
- Test Leads
- Isopropyl Alcohol
- Mild Detergent
- Pressure Tubing
- Test Orifice (RI p/n 332353)
- Whisper Swivel II (RI p/n 332113)
- Flow Control Valve (RI p/n 1006120) or any commercially available flow control valve.
- CPAP (for negative flow)
- O_2 Enrichment Port (RI p/n 312710)

Acceptable Test Equipment

Digital Manometer

Specifications:

- 0 - 45 cmH_2O (or better)
- ± 0.3 cmH_2O accuracy
- ± 0.1 cmH_2O resolution

Acceptable Options:

- Respironics Digital Manometer
- Merical DP2001
- Sensym PDM 200CD
- TSI Certifier (RI p/n 1012598)
- Any commercially available digital manometer that meets the above specifications.
- A water column manometer may also be used.

Digital Multimeter

Specifications:

- 2.5 digit readout minimum
- 0.0 - 20.0 VDC
- 0.0 - 25.0 VAC

Acceptable Options:

- Fluke 83 or better model
- any commercially available multimeter that meets the above specifications.

Flow Meter

Specifications:

- Range: +180 to -180 LPM
- ± 2% Accuracy
- ± 1 LPM Resolution

Acceptable Options:

- Certifier (RI p/n 1012598)
- TSI 4000 Series Flow Meter
- Time Meter RT-200
- Any commercially available flowmeter that meets the above specifications.

Barometer

Specifications:

- Range: 83-102 kPa

Acceptable Options:

- Any commercially available barometer that meets the above specifications.

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SCHEMATICS

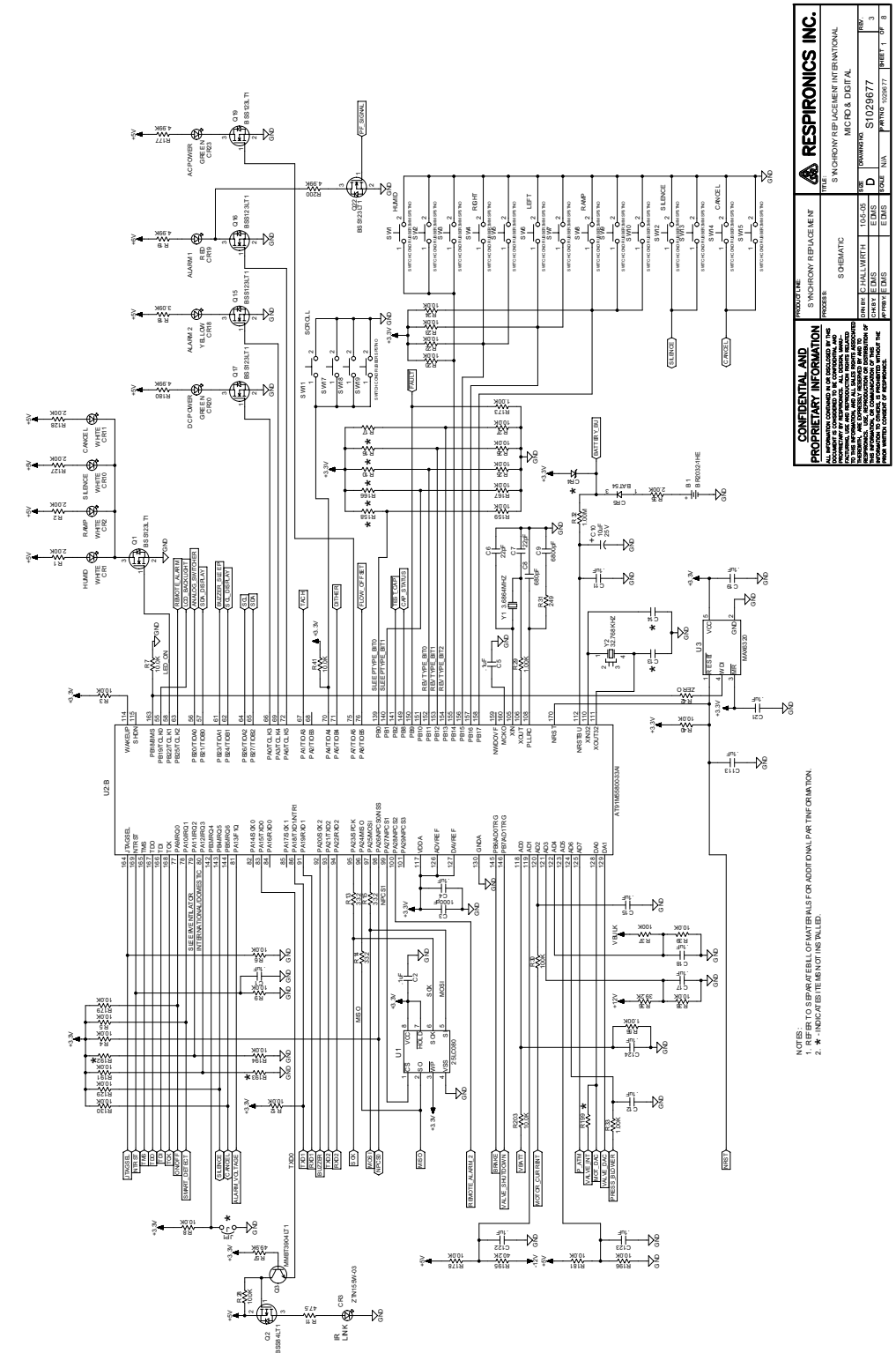
SCHEMATICS STATEMENT

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. Patents are pending.

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 effect 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 this manual was last revised. New revisions may or may not be distributed in the future.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MICRO & DIGITAL
SCHEMATIC
S1029677
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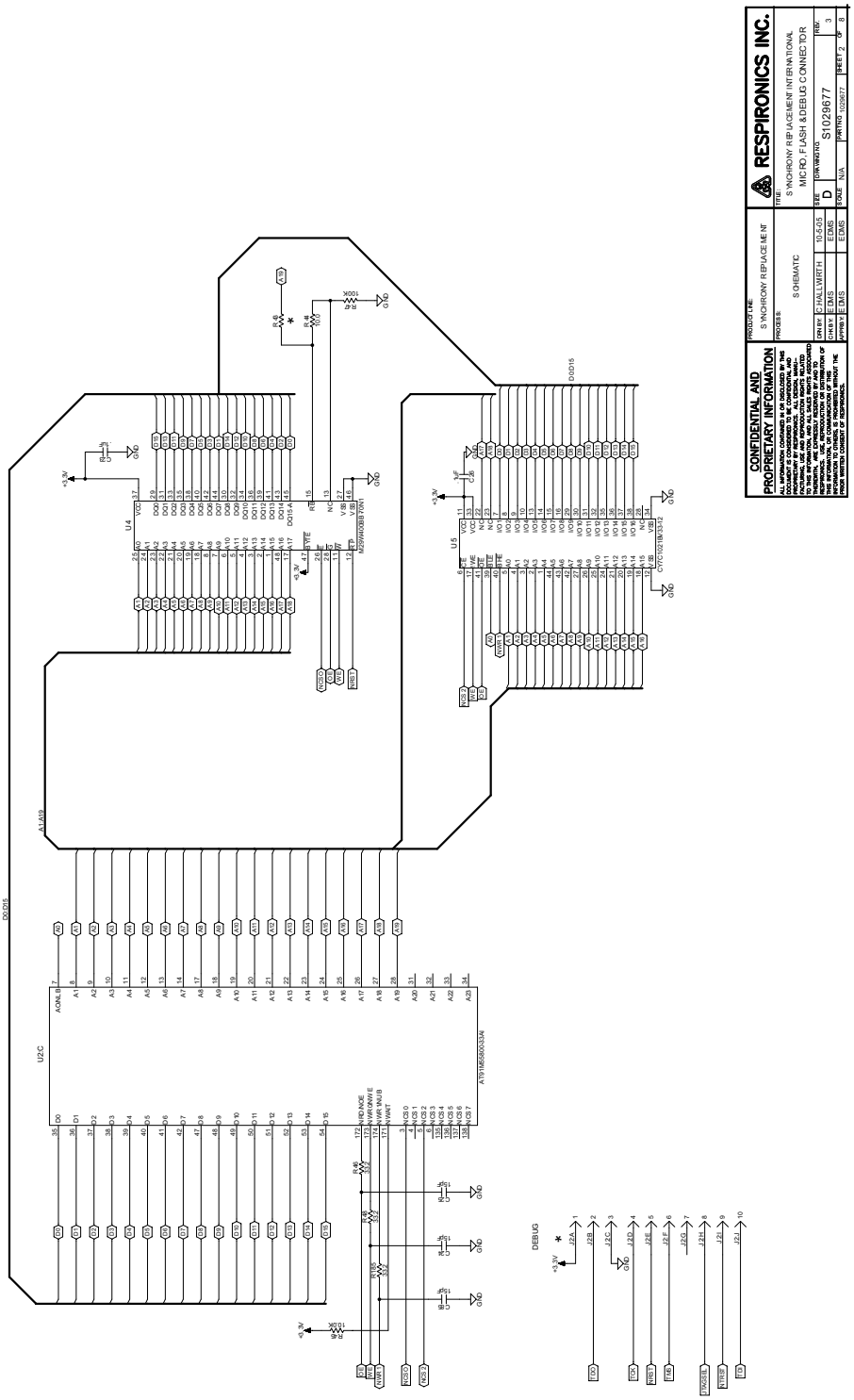
1. REFER TO SEPARATE BILL OF MATERIALS FOR ADDITIONAL PART INFORMATION.
2. ★ - INDICATES ITEM IS NOT INSTALLED.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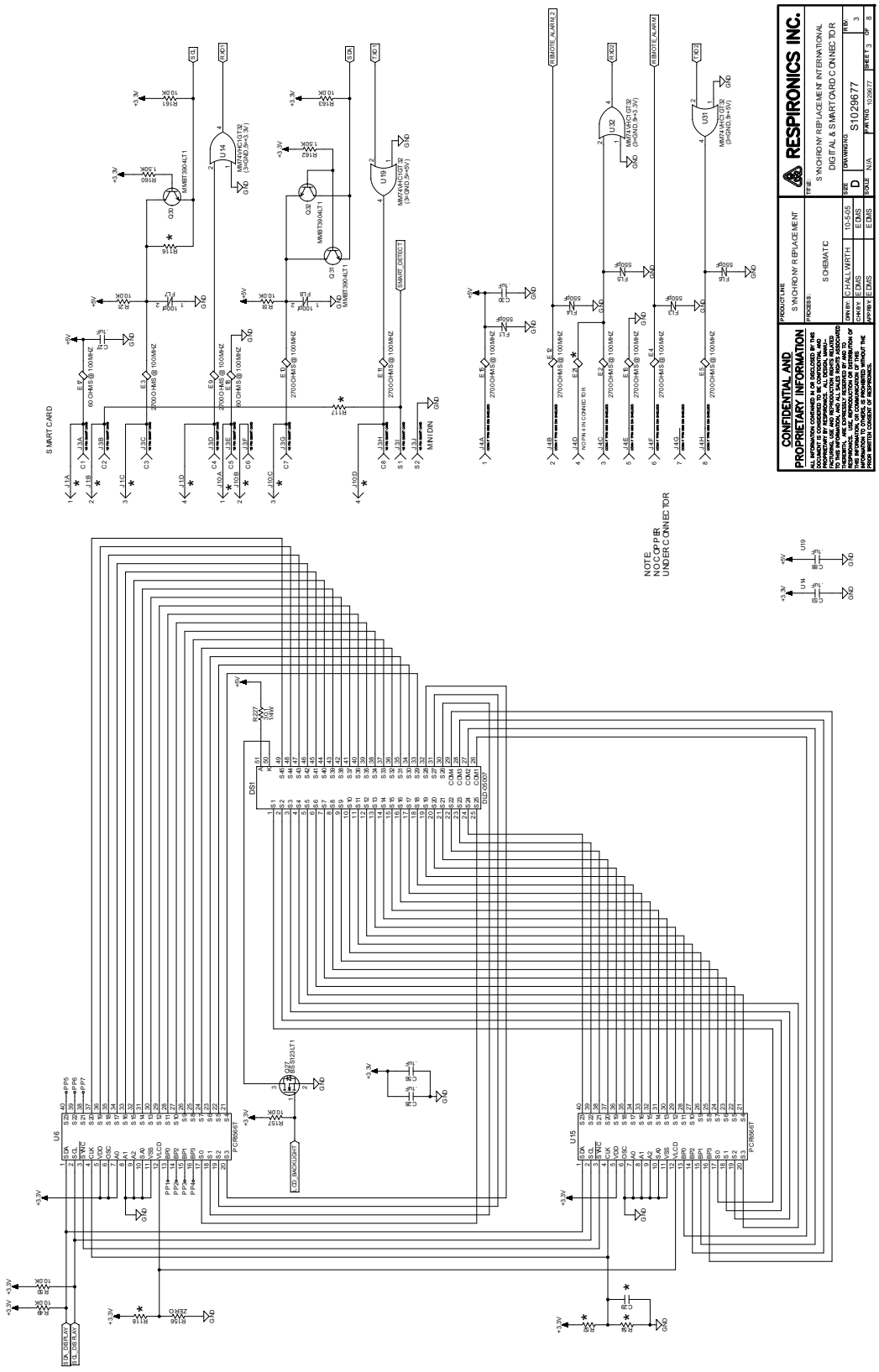
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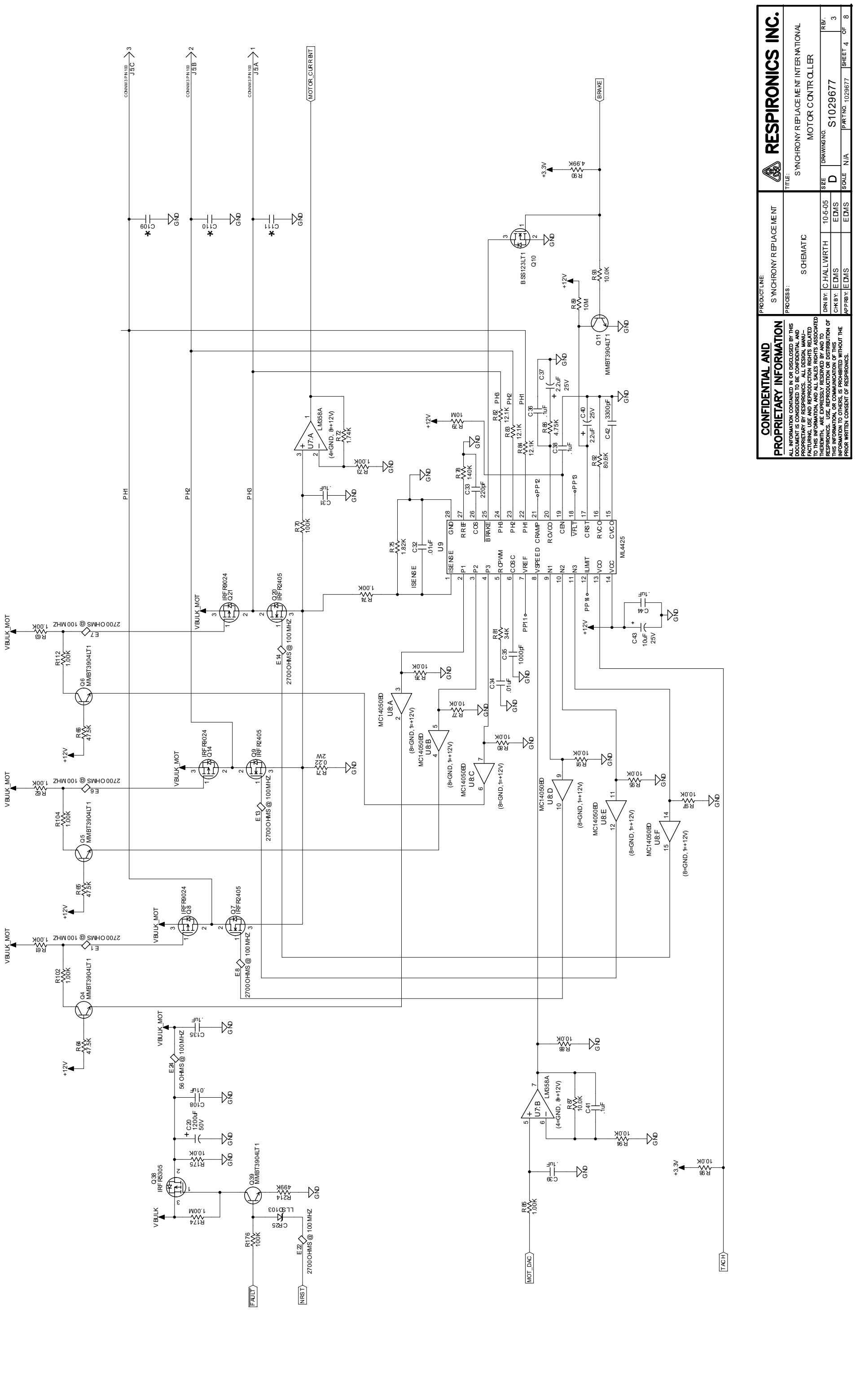
UNDER CONNECTOR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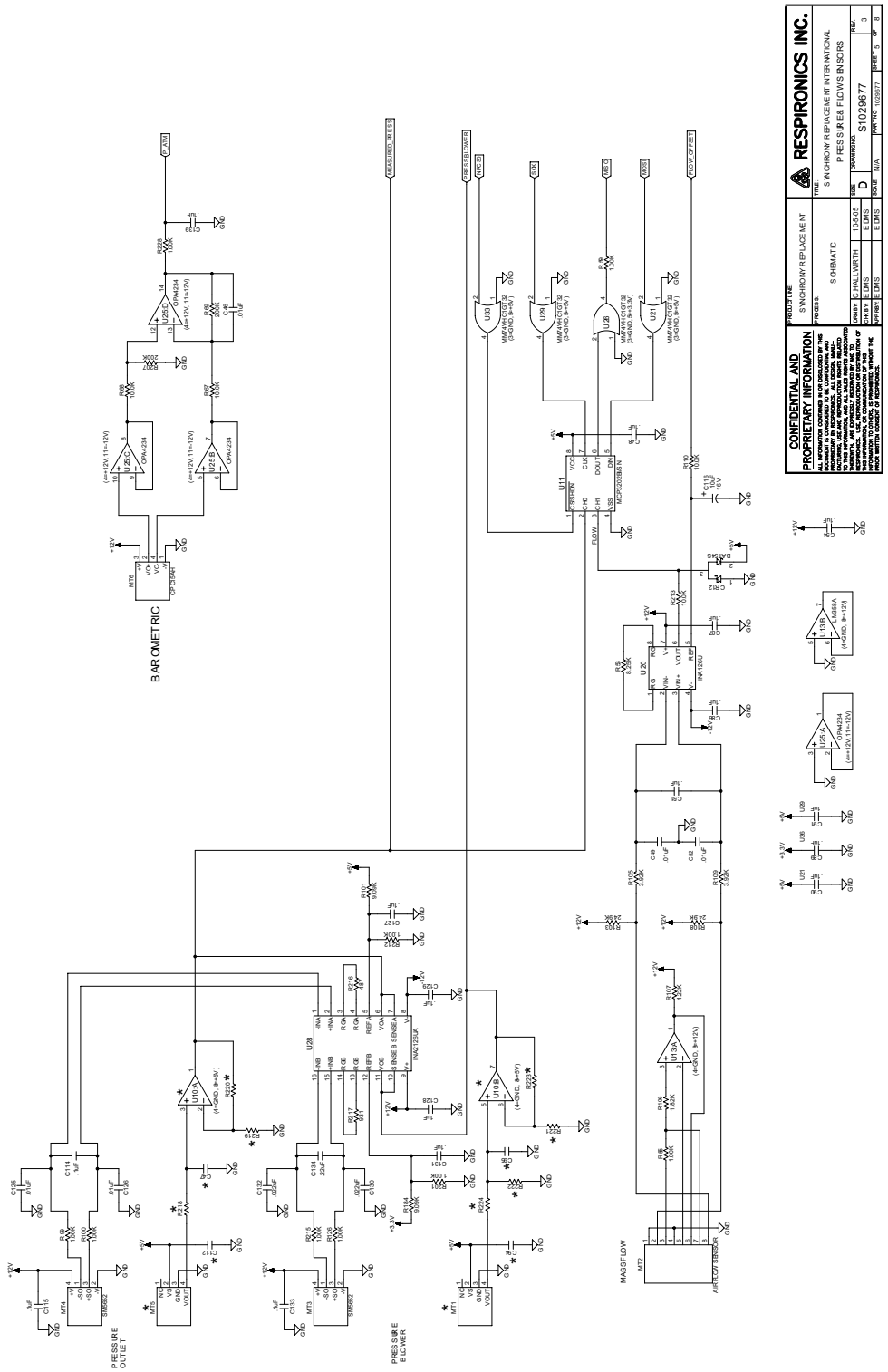
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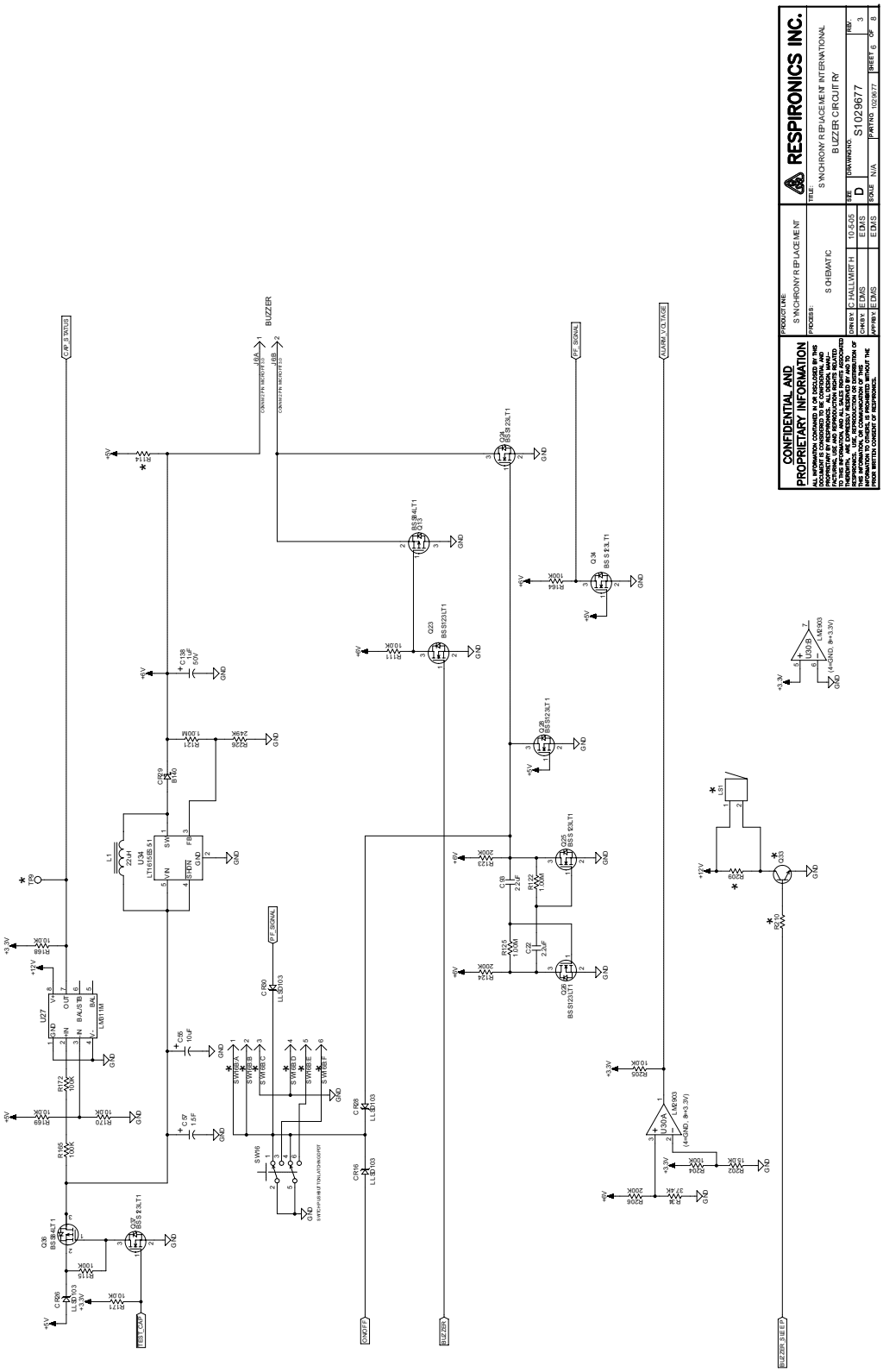
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SCALE: N/A
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+5V
+12V
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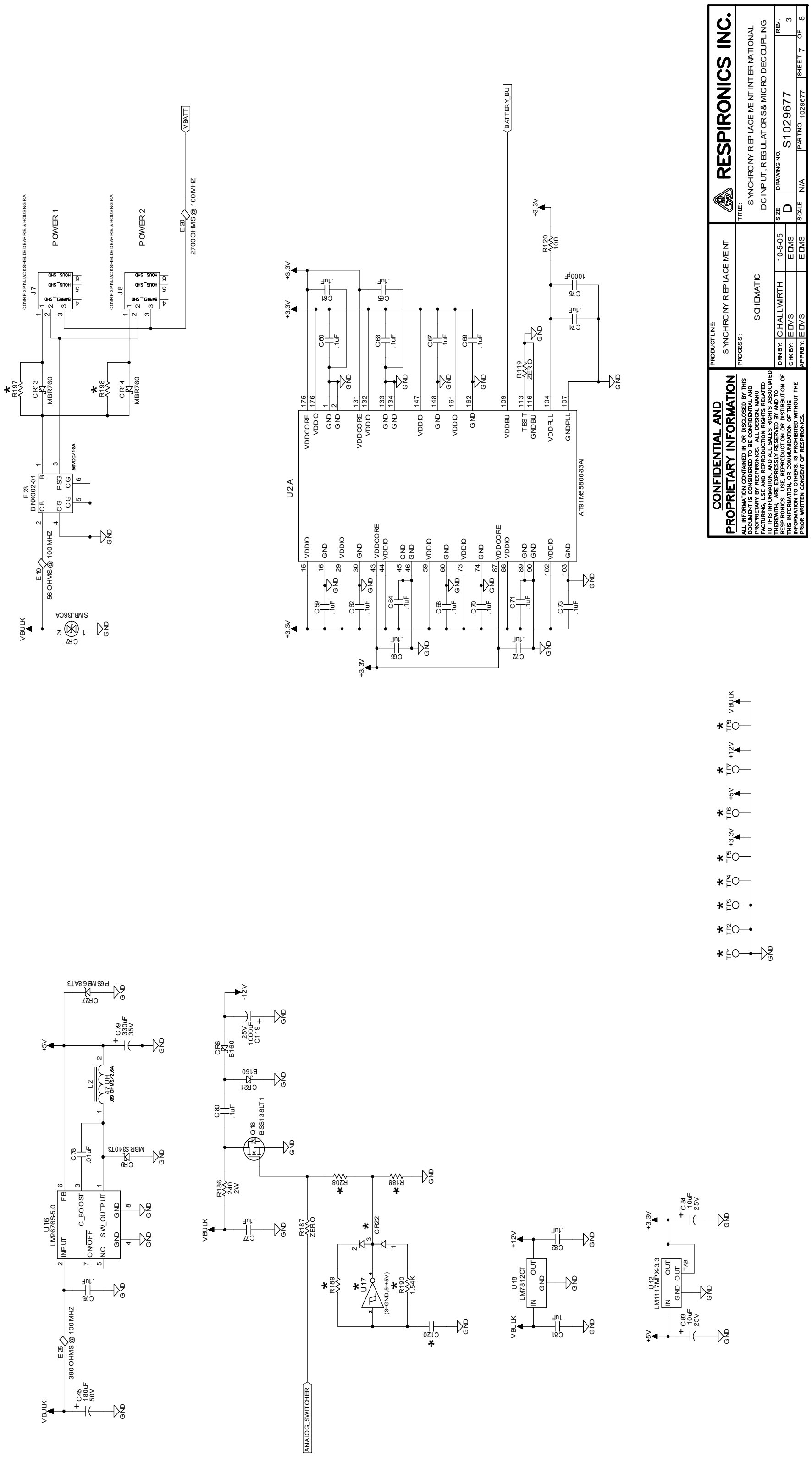
BUZZER
ON/OFF
BUZZER_SLEEP
MSV_CAP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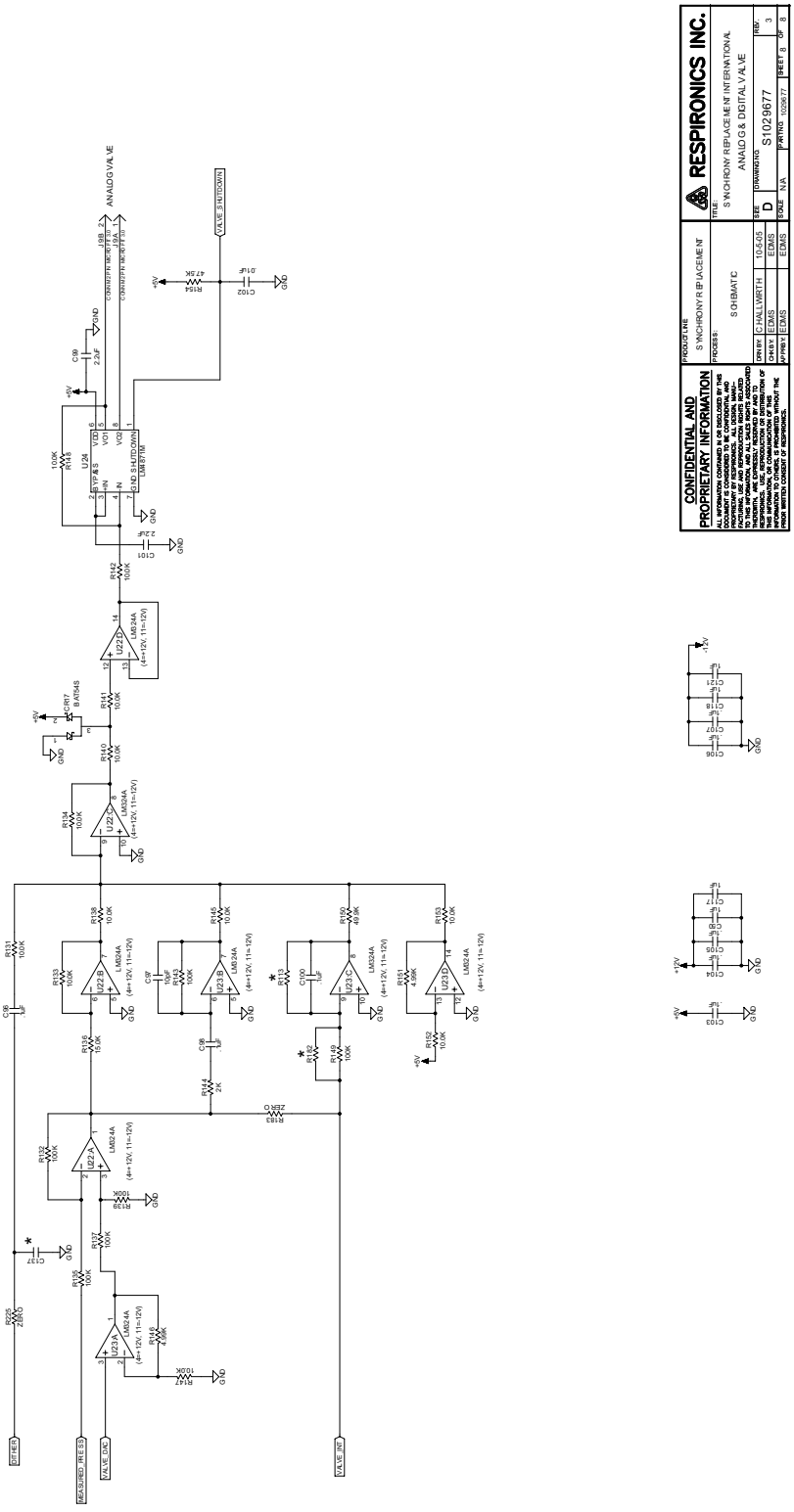
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CHK BY: EDMS EDMS
APPRV: EDMS EDMS
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DRAWING S1029677
SCALE N/A
P/ATRG 1029677
REV 3
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ANALOG VALVE
VALVE SHUTDOWN
+5V
+12V
GND
VALVE_INT
VALVE_DAC
PRESSURE_RESET

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