



Oxygen System

SERVICE MANUAL

MODEL 4000



CAIRE Inc.

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Ball Ground, GA 30107

www.caireinc.com

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MN260 D



	WARNING: DO NOT OPERATE THIS EQUIPMENT WITHOUT FIRST READING AND UNDERSTANDING THIS MANUAL. IF YOU ARE UNABLE TO UNDERSTAND THE WARNINGS AND INSTRUCTIONS, CONTACT YOUR EQUIPMENT PROVIDER BEFORE ATTEMPTING TO USE THIS EQUIPMENT; OTHERWISE, INJURY OR DAMAGE MAY RESULT.
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DEFINITION OF SYMBOLS PAGE / WARNING PAGE

	WARNING: INDICATES A HAZARDOUS SITUATION THAT, IF NOT AVOIDED, COULD RESULT IN DEATH OR SERIOUS INJURY.
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	CAUTION: Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.
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NOTE: Indicates information considered important, but not hazard-related (e.g. messages relating to property damage).	
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SYMBOLS USED IN THE OPERATION OF SAROS

Symbols are frequently used on equipment in preference to words with the intention of reducing any possibility of misunderstanding caused by language differences. Symbols can also permit easier comprehension of a concept within a restricted space.

ISO 7000: GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT—INDEX AND SYNOPSIS	
	Portable operating temperature is -10C to 40C. Base operating temperature range is 10C-40C. Reg. # 0632
	Portable humidity range is 15 to 90%. Base humidity range is 30 to 75%. Reg. #2620
	Atmospheric pressure limitation. Reg. # 2621
	Keep away from rain, keep dry. Reg. # 0626
	Name and address of manufacturer. Reg. # 3082
	Date of Manufacture. Reg. #2497
	Caution, consult accompanying documents. Reg. # 0434A
	Catalog Number. Reg. # 2493
	Serial Number. Reg. # 2498
	This way up. Reg. # 0623
	Fragile, handle with care. Reg. # 0621
	Stacking height. Reg #2403

ISO 7010: GRAPHICAL SYMBOLS—SAFETY COLORS AND SAFETY SIGNS—REGISTERED SAFETY SIGNS	
	Keep away from open flame, fire, sparks. Open ignition source and smoking prohibited. Reg. # P003
	Do not smoke near unit or while operating unit. Reg. # P002
	Type BF applied part (degree of protection against electric shock). Reg. # 5333
	Warning. Reg. # W001
	The instruction manual must be read. Reg. # M002
IEC 60417: GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT	
	IEC Icon for DC Power (Input) Indicates equipment providing a particular degree of protection against electric shock, particularly regarding: Allowable leakage current; Reliability of a proper ground connection. Reg. #5031
	Alternating Current (AC). Reg # 5032
COUNCIL DIRECTIVE 93/42/EEC; CONCERNING MEDICAL DEVICES	
	If the product unique device identifier (UDI) label has the CE#### symbol on it, the device complies with the requirements of Directive 93/42/EEC concerning medical devices. The CE#### symbol indicates notified body number.

INTERNAL SYMBOLS	
	Keep away from flammable materials, oil and grease.
O ₂	Oxygen Output; The port from which the Oxygen flows and where the tubing or interface(standard nasal cannula) is connected.
A	Amperes (Current)
	Alert (Yellow) Indicator*: When illuminated, this indicates an awareness condition or Caution.
	ON/OFF (Standby); Powers the device ON or OFF, but does not directly disconnect the main power.
	Increase Flow Setting; Increases the flow setting by 1.0 LPM increments or by 1 pulse setting each time the button is pressed.
	Decrease Flow Setting; Decreases the flow setting by 1.0 LPM increments or by 1 pulse setting each time the button is pressed.
	Activates either Continuous Flow Mode or Pulse Flow Mode Operation.
	Utility; The Button that activates a utility menu to access information or to change settings.
	External Power is Present Indicator; Indicates the presence of external power.
	Battery Status Indicator; Shows the amount of charge remaining in the battery. When charging, battery displays as a “Waterfall” Effect.
	“Alarm Off” indicator displayed during Tactical Mode.
21 CFR 801.15: CODE OF FEDERAL REGULATIONS TITLE 21	
RX ONLY	Federal law restricts this device to sale by or on the order of a physician.

COUNCIL DIRECTIVE 2012/19/EU: WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE)


WEEE

IEC 60601-1: MEDICAL ELECTRICAL EQUIPMENT - PART 1: GENERAL REQUIREMENTS FOR BASIC SAFETY AND ESSENTIAL PERFORMANCE


Classification; Class II Equipment, double insulated.

IP33

Protected from tools and wires greater than 2.5 millimeters, Protected from water spray less than 60 degrees from vertical.

*Alarms for the SAROS are considered information-only signals.

This product may be covered by one or more patents, US and international. Please visit our website below for the listing of applicable patents. Pat.: www.caireinc.com/corporate/patents/.

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INDICATIONS FOR USE







SAROS oxygen system is indicated for the administration of supplemental oxygen. The device is not intended for life support nor does it provide any patient monitoring capabilities. The SAROS can be used in the Military Medical Service that is operationally used for medical assemblages, such as the Expeditionary Medical Support (EMEDS) and En-Route Patient Staging System (ERPSS), in deployed scenarios, including wartime operations, deterrence and humanitarian and contingency operations.

The SAROS is used by patients suffering from discomfort due to ailments which affect the efficiency of one's lungs to transfer the oxygen in air to their bloodstream. The device will be operated by a trained medical technician or clinician with a working knowledge of oxygen concentrators. A physician has prescribed a specific oxygen flow setting to meet an individual's needs. Oxygen flow should be adjusted only under the direction of a physician.

The SAROS uses a vacuum pressure adsorbent process to separate oxygen from the air and deliver oxygen rich gas to a patient through a nasal cannula.

	WARNING: FEDERAL U.S. LAW RESTRICTS THIS DEVICE TO SALE BY OR ON THE ORDER OF A PHYSICIAN.
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INDICATIONS

















	<p>WARNING: IN CERTAIN CIRCUMSTANCES, THE USE OF NON-PRESCRIBED OXYGEN CAN BE HAZARDOUS. THIS DEVICE SHOULD ONLY BE USED UNDER THE DIRECTION OF A PHYSICIAN OR QUALIFIED CLINICIAN.</p> <p>NOT FOR USE IN THE PRESENCE OF FLAMMABLE ANESTHETICS.</p> <p>AS WITH ANY ELECTRICALLY POWERED DEVICE, THE USER MAY EXPERIENCE PERIODS OF NON-OPERATION AS A RESULT OF ELECTRICAL POWER INTERRUPTION, OR THE NEED TO HAVE THE SAROS SERVICED BY A QUALIFIED TECHNICIAN. SAROS IS NOT APPROPRIATE FOR ANY PATIENT WHO WOULD EXPERIENCE ADVERSE HEALTH CONSEQUENCES AS THE RESULT OF SUCH TEMPORARY INTERRUPTION.</p> <p>USE OF AN OXYGEN MASK IS CONTRAINDICATED DUE TO THE POSSIBILITY OF REBREATHING EXHALED CARBON DIOXIDE.</p>
	WARNING: EXHAUST GAS MAY REACH HIGH TEMPERATURES DURING NORMAL OPERATIONS. USE CAUTION TO AVOID TOUCHING THE EXHAUST PORT OF THE SAROS WHILE IN USE.
	WARNING: THERE IS A RISK OF FIRE ASSOCIATED WITH OXYGEN THERAPY. DO NOT USE CONCENTRATOR OR ACCESSORIES NEAR SPARKS OR OPEN FLAMES.
	WARNING: SMOKING DURING OXYGEN THERAPY IS DANGEROUS AND IS LIKELY TO RESULT IN SERIOUS INJURY OR DEATH OF THE PATIENT AND OTHERS FROM FIRE.
	WARNING: OPEN FLAMES DURING OXYGEN THERAPY ARE DANGEROUS AND IS LIKELY TO RESULT IN FIRE OR DEATH. DO NOT ALLOW OPEN FLAMES WITHIN 2 METERS OF THE OXYGEN CONCENTRATOR OR ANY OXYGEN CARRYING ACCESSORIES.
	WARNING: SMOKING DURING OXYGEN THERAPY IS DANGEROUS AND IS LIKELY TO RESULT IN FACIAL BURNS OR DEATH. DO NOT ALLOW SMOKING WITHIN THE SAME ROOM WHERE THE OXYGEN CONCENTRATOR OR ANY OXYGEN CARRYING ACCESSORIES ARE LOCATED. IF YOU INTEND TO SMOKE, YOU MUST ALWAYS TURN THE OXYGEN CONCENTRATOR OFF, REMOVE THE CANNULA AND LEAVE THE ROOM WHERE EITHER THE CANNULA OR MASK OR THE OXYGEN CONCENTRATOR IS LOCATED. IF UNABLE TO LEAVE THE ROOM, YOU MUST WAIT 10 MINUTES AFTER YOU HAVE TURNED THE OXYGEN CONCENTRATOR OFF BEFORE SMOKING.











NOTE: Auditory alarms may not be heard in noisy environments and/or in tactical mode. Care providers must rely on visual indications to determine if there are any alarms or other system malfunctions. Care providers should monitor the SAROS for any alarm conditions.

CONTRAINDICATIONS

SAFETY GUIDELINES

These are Warnings and Cautions that apply to hazards or unsafe practices that could result in serious injury or property damage.

	WARNING: FEDERAL U.S. LAW RESTRICTS THIS DEVICE TO SALE BY OR ON THE ORDER OF A PHYSICIAN.
	WARNING: DO NOT USE SAROS IF IT HAS A DAMAGED POWER CORD OR PLUG.
	WARNING: DO NOT DROP OR INSERT ANY OBJECTS INTO ANY OPENING ON THE DEVICE.
	WARNING: DO NOT BLOCK THE AIR INLET OR THE EXHAUST VENT OF THE SAROS WHEN IT IS ON A SOFT SURFACE, SUCH AS A LITTER, BED, CHAIR, CARPET, COUCH OR VEHICLE SEAT.
	WARNING: DO NOT COVER THE DEVICE WITH A BLANKET, TOWEL OR SHEET, ETC.
	WARNING: DO NOT STORE THE SAROS WITH THE BATTERY INSTALLED IN THE UNIT.
	WARNING: DO NOT REMOVE THE COVER. THERE ARE NO USER-SERVICEABLE PARTS INSIDE THE DEVICE. ONLY QUALIFIED SERVICE PERSONNEL SHOULD REMOVE THE COVER OF THE DEVICE.
	WARNING: DO NOT MODIFY THIS EQUIPMENT WITHOUT AUTHORIZATION OF THE MANUFACTURER.
	WARNING: DO NOT OPERATE THE DEVICE, COMPONENTS OR ACCESSORIES ON WET SURFACES OR IN STANDING WATER AND DO NOT SUBMERSE IN WATER.
	WARNING: GERIATRIC, PAEDIATRIC OR ANY OTHER PATIENT UNABLE TO COMMUNICATE DISCOMFORT CAN REQUIRE ADDITIONAL MONITORING AND OR A DISTRIBUTED ALARM SYSTEM TO CONVEY THE INFORMATION ABOUT THE DISCOMFORT AND OR THE MEDICAL URGENCY TO THE RESPONSIBLE CARE GIVER TO AVOID HARM.
	WARNING: OXYGEN MAKES IT EASIER FOR A FIRE TO START AND SPREAD. DO NOT LEAVE THE NASAL CANNULA OR MASK ON BED COVERINGS OR CHAIR CUSHIONS, IF THE OXYGEN CONCENTRATOR IS TURNED ON, BUT NOT IN USE; THE OXYGEN WILL MAKE THE MATERIALS FLAMMABLE. TURN THE OXYGEN CONCENTRATOR OFF WHEN NOT IN USE TO PREVENT OXYGEN ENRICHMENT.
	WARNING: IF YOU FEEL DISCOMFORT OR ARE EXPERIENCING A MEDICAL EMERGENCY WHILE UNDERGOING OXYGEN THERAPY, SEEK MEDICAL ASSISTANCE IMMEDIATELY TO AVOID HARM.
	WARNING: WIND OR STRONG DRAUGHTS, INCLUDING AN OPEN WINDOW OR FAN, CAN ADVERSELY AFFECT ACCURATE DELIVERY OF OXYGEN THERAPY.
	WARNING: THE SETTINGS OF OTHER MODELS OR BRANDS OF OXYGEN THERAPY EQUIPMENT DO NOT CORRESPOND WITH THE SETTINGS OF THE SAROS MODEL 4000.
	WARNING: IN THE EVENT THERE IS A SERIOUS INCIDENT OCCURRING WITH THIS DEVICE, THE USER SHOULD IMMEDIATELY REPORT THE INCIDENT TO THE PROVIDER AND/OR THE MANUFACTURER. A SERIOUS INCIDENT IS DEFINED AS AN INJURY, DEATH, OR POTENTIAL TO CAUSE INJURY/DEATH SHOULD THERE BE A REOCCURRENCE OF THE INCIDENT. THE USER CAN ALSO REPORT THE INCIDENT TO THE COMPETENT AUTHORITY IN THE COUNTRY WHERE THE INCIDENT OCCURRED.
	WARNING: THIS PRODUCT CAN EXPOSE YOU TO CHEMICALS INCLUDING NICKEL, WHICH IS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER. FOR MORE INFORMATION, GO TO WWW.P65WARNINGS.CA.GOV.

	CAUTION: INDICATES A HAZARDOUS SITUATION THAT, IF NOT AVOIDED, COULD RESULT IN MINOR OR MODERATE INJURY.
	CAUTION: KEEP SAROS AND THE POWER CORD AWAY FROM HOT SURFACES OR OPEN FLAMES.
	CAUTION: SAROS SHOULD BE LOCATED IN A WELL-VENTILATED AREA TO ALLOW FOR ADEQUATE AIR INTAKE.
	CAUTION: AVOID THE INTAKE OF AIRBORNE POLLUTANTS, SMOKE AND FUMES.
	CAUTION: ONLY USE THIS DEVICE WITH ACCESSORIES SPECIFIED BY, OR RECOMMENDED BY CAIRE INC.
	CAUTION: IF SAROS HAS BEEN DROPPED, DAMAGED OR EXPOSED TO WATER, PLEASE CONTACT A QUALIFIED TECHNICIAN FOR INSPECTION OR POSSIBLE REPAIR OF THE DEVICE.
	CAUTION: WHEN USING SAROS IN ANY VEHICLE, BE SURE IT IS PROPERLY SECURED, BELTED OR RESTRAINED.
	CAUTION: LOCATE OXYGEN SUPPLY TUBING AND ALL POWER CORDS IN A MANNER TO PREVENT TRIPPING HAZARDS.
	CAUTION: DO NOT PLACE THE SAROS IN A SMALL, ENCLOSED SPACE, SUCH AS A BATHROOM, CLOSET, BAG OR BOX WITH THE OXYGEN CANNULA OR TUBING LEADING OUT OF THE ENCLOSED SPACE.
	CAUTION: DO NOT EXPOSE THE DEVICE TO TEMPERATURES OUTSIDE OF THE SPECIFIED RANGE OF OPERATING OR STORAGE TEMPERATURES AS THIS MAY DAMAGE THE DEVICE.

NOTE: THIS DEVICE MUST COOL FROM THE MAXIMUM STORAGE TEMPERATURE BETWEEN USES UNTIL IT IS READY FOR TEMPERATURES FOR INTENDED USE.

NOTE: SAROS UNIT MUST BE CONSTRAINED OR MOUNTED TO PREVENT DAMAGE TO UNIT OR INJURY TO USER WHILE IN USE.



NOTE: THIS DEVICE DOES EXHAUST NITROGEN GAS. HOWEVER, THIS EXHAUST IS NOT SUFFICIENT TO DISPLACE OXYGEN IN THE OPERATING ENVIRONMENT. NO ADDITIONAL SAFETY PRECAUTIONS NEED TO BE TAKEN TO ACCOUNT FOR THE NITROGEN EXHAUST.








NOTE: PROTECT ELECTRICAL POWER CORDS FROM SHARP EDGES OR ELECTRICAL SHOCK AND SERIOUS PHYSICAL INJURY MAY OCCUR.

NOTE: ONLY USE THE CAIRE INC. SUPPLIED AC POWER ADAPTER AND 24 VDC CABLE WITH THE SAROS. USE OF ANY OTHER AC POWER ADAPTER OR DC CABLE MAY BE HAZARDOUS, CAUSE SERIOUS DAMAGE TO THE SAROS AND WILL VOID THE WARRANTY.

NOTE: AVAILABILITY OF AN ALTERNATE, OR BACK-UP, SOURCE OF SUPPLEMENTAL OXYGEN IS RECOMMENDED IN CASE OF A POWER OUTAGE OR A MECHANICAL FAILURE OF THE DEVICE.

BATTERY SAFETY

	WARNING: DO NOT DISASSEMBLE, PUNCTURE, OR CRUSH THE BATTERY. BATTERY ELECTROLYTES MAY BE TOXIC IF SWALLOWED AND CAN BE HARMFUL TO SKIN AND EYES. KEEP THE BATTERY AWAY FROM CHILDREN.
	WARNING: DO NOT SHORT-CIRCUIT THE BATTERY'S METAL CONTACTS WITH METALLIC OBJECTS, SUCH AS KEYS OR COINS. THIS MAY CAUSE SPARKS OR EXCESSIVE HEAT TO BE GENERATED.

	WARNING: USE OF A DAMAGED BATTERY MAY CAUSE PERSONAL INJURY.
	WARNING: THE BATTERY MAY EXPLODE AND CAUSE POTENTIAL INJURY IF EXPOSED TO A FIRE, OR DISPOSED OF IN A FIRE.
	WARNING: EXPOSING THE BATTERY TO WATER OR OTHER LIQUIDS MAY CAUSE PERSONAL INJURY.
	CAUTION: DO NOT EXPOSE THE BATTERY TO TEMPERATURES ABOVE 140° F (60°C), SUCH AS IN A VEHICLE PARKED IN THE SUN ON A HOT DAY.
	CAUTION: IT IS NOT RECOMMENDED THAT THE BATTERY IS CHARGED BELOW 41° F (5° C) OR ABOVE 104° F (40° C).
	CAUTION: ONLY USE THE BATTERY FOR ITS INTENDED PURPOSE.
	CAUTION: PUSH LOCKING/UNLOCKING BUTTON BEFORE BATTERY INSTALLATION.

Reference SAROS 4000 User Manual for additional information, warnings, and specifications.

1.0 THEORY OF OPERATION

BASIC THEORY OF OPERATION

SAROS Oxygen System uses a variable speed compressor to provide both positive and negative air pressure and is driven by a Brushless DC Motor (BLDC) and drive system.

The ATF® Concentrator Module accepts positively and negatively pressurized air and extracts oxygen from this air using the Pressure Swing Adsorption (PSA) process. The ATF module sub-components consist of patented rotary valves, manifold, housing, sieve beds, and a stepper motor / gear drive system. The rotary valve system channels the gas in a sequential manner to each of the sieve beds. Each bed is pressurized to force the oxygen through the sieve and into the product tank while most of the nitrogen is separated and remains in the sieve. Once the process is maximized then the sieve beds are purged of the nitrogen. The purged nitrogen is then vented to atmosphere through the exhaust vent. The process is continuously repeated in each sieve bed.

The flow of produced oxygen passes from the product tank to a flow and concentration monitoring and control system which utilizes a proprietary ultrasonic flow and concentration sensor. It then continues through a flow control valve to accurately control the flow of oxygen in continuous and pulse flow modes. The oxygen then passes through a HEPA filter and is delivered to the oxygen outlet port.

The oxygen flow rate and mode are selected by the user. In continuous flow mode, oxygen is delivered continuously at rates of 1, 2, and 3 LPM and, in pulse flow mode; a bolus is delivered at the beginning of each inspiration with selectable volume delivery approximately equivalent to rates between 16 and 96 mL.

The SAROS electronic system, together with embedded operational firmware, provide the means to manage power, control oxygen production, monitor safety functions and interface with the user. Power management functions include switching between various power inputs, driving the compressor, ATF stepper motor, and proportional valve, monitoring battery status and charging when power is available from an external source. System management functions include monitoring all flow, pressures, concentrations and safety functions. User Interface components such as buttons, illuminated indicators, LCD display and audio transducer are also monitored or controlled. The User Interface informs the user of the system status, allows the user to select a continuous flow or pulse mode flow setting and the ability to set the desired flow rate. The Utility Button on the User Interface also allows the User to obtain information about the system – hours of operation, software version and 9V battery status - or make selections on various features such as Tactical or Normal Mode, Trigger Sensitivity Adjustments, and LCD Brightness and Contrast.

ATF® CONCENTRATOR MODULE

The SAROS Oxygen System, Model 4000 with autoSAT Technology uses a passive system to separate oxygen from air. Air flows into the SAROS where it is filtered and then enters the compressor. Pressurized air flows from the compressor into the ATF Concentrator Module where it is separated into oxygen and nitrogen components. The air separation process uses a rotary valve system to force air through a series of pressurized sieve beds. Through a process known as “pressure swing adsorption,” nitrogen molecules are collected on an adsorbent material or zeolite allowing the concentrated oxygen to be forced through a sieve bed into the product tank. The nitrogen molecules are then purged from the adsorbent material using a vacuum pressure cycle.

Oxygen flows from the product tank through a sensor that measures flow and concentration and then through a HEPA filter. A flow control valve regulates the flow of concentrated oxygen. The process is continuously repeated during operation.

COMPRESSOR

The SAROS compressor is a two-head variable speed compressor driven by a highly efficient Brushless DC (BLDC) motor. When air flows into the compressor, it passes through an air inlet filter that filters out impurities. Using one head, the compressor takes in filtered air, compresses it and channels the compressed gas to the ATF Module. The second head pulls a vacuum on the ATF module and exhausts nitrogen rich gas through an exhaust outlet muffler to suppress the noise and then to the exhaust vent at the bottom of the device.

BRUSHLESS COMPRESSOR MOTOR DRIVER (BCMD)

The BCMD drives the compressor motor based on the input power from either the battery, the AC Power Adapter or the 24 VDC Cable.

COOLING FAN

A cooling fan is installed in the SAROS to provide forced air cooling to the various components in the system that generate heat.

POWER BOARD

The Power Board takes external power that comes into the SAROS from the AC Power Adapter, 24 VDC Cable or Battery and monitors and controls power distribution to the rest of the SAROS system. The Power Board also drives the cooling fan.

SYSTEM BOARD

The System Board is the center of nearly all the SAROS functions. The System Board is a micro controller-based system that monitors system dynamics such as temperatures, pressures, ATF stepper motor and proportional valve, product flow and concentration, and the Users' input, indicators and buzzer operation and external communications. It measures temperature of the oxygen, compressor motor, ambient temperature, and ATF temperature, BCMD, Power Board and the Battery.

The System Board utilizes a proprietary ultrasonic flow and concentration sensor and a flow control valve to accurately control the flow oxygen in the various flow delivery modes.

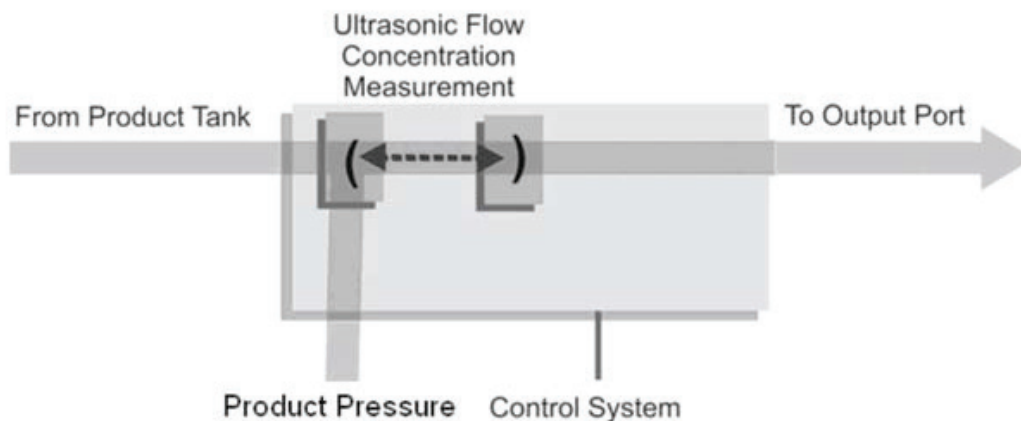


Figure 1-1. System Board Diagram

CONTROL PANEL

The Control Panel provides a user interface consisting of a membrane panel keyboards, Liquid Crystal Display (LCD), external power present indicator, Battery capacity indicator, alarm status indicators, and a buzzer. The user interface informs the user of the system status and allows the user to set the desired flow modes and flow rate – continuous or pulse, display mode – normal or tactical, set up system parameters and acquire system information.



CONTINUOUS FLOW MODE

The user may set the SAROS oxygen flow rate and mode. Continuous Flow Mode delivers a constant flow of oxygen to the Oxygen Outlet Port at settings of 1, 2, and 3 LPM. Within the SAROS, concentrated oxygen is stored in a product tank at pressures in the range of 5 – 9 psi and is back-pressure compensated. This pressure gives Continuous Flow Mode the capability to deliver the indicated flow rate to the patient even if extension tubing is used, up to 50 feet long. In addition, the SAROS Continuous Flow Mode is fully compatible with humidifier use.

PULSE FLOW MODE WITH autoSAT TECHNOLOGY



The SAROS Pulse Flow Mode with autoSAT Technology delivers a high flow of oxygen at the very beginning of each inspiratory effort. The approach is based on the manner in which gas is delivered into a patient's airway. The user may select pulse volume delivery rates between 16 and 96 ml. Pulse durations vary between 100 milliseconds and 500 milliseconds due to dead space considerations. Maximum cannula length is 7 feet.

The fundamental approach to triggering and controlling the oxygen bolus in Pulse Flow Mode is: The user may select pulse trigger sensitivity in settings 1 (most sensitive), 2, or 3 (least sensitive). The pulse will be triggered when the system meets all the following criteria: The cannula pressure has dropped below the trigger point (typically between 0.15 and 0.45 cm H₂O). At least 1.25 seconds has passed since the last pulse began.

The SAROS autoSAT Technology consistently maintains the FiO₂ by adjusting to the patient's respiratory rate. As their rate increases, the autoSAT feature servo controls the device to automatically increase oxygen output to ensure uninterrupted delivery of the set bolus volume. autoSAT provides the patient with unparalleled performance without limiting available oxygen, enabling the system to automatically adjust to increased oxygen demands that often occur.

NOTE: To Equipment Provider: The following oxygen administration accessories are recommended for use with the Oxygen Concentrator:

- Nasal Cannula with 7 feet (2.1 m) of tubing: PN 5408-SEQ

UTILITY MODE

A User or Service Technician can access the Utility Mode function by pressing using the Utility Button on the control panel. All information is displayed on the LCD. Advance to the next feature in the Utility Mode by depressing the Utility Button. The “+” or “-“ button is used to toggle when a feature is selected. Pressing the Flow Mode button takes you back one step.

SERVICE MODE FUNCTIONS

Factory maintenance or service updates may sometimes be required on the SAROS. Factory and qualified factory-trained technicians can access service mode software functions by using the Service Port located on the top of the unit.

POWER SUPPLIES



SAROS may operate from either an AC Power Adapter, 24 VDC Cable or Battery. When power is available from an external supply, the SAROS will draw from the external source rather than depleting the Battery. Connection to external power is indicated when the External Power Present Indicator located on the Control Panel is illuminated.

AC POWER ADAPTER

The AC Power Adapter is a universal input type, capable of accepting 100 – 240 VAC, 50/60 Hz. It is capable of delivering up to 200W at 24 VDC output. The input cord requires a grounded receptacle. Country specific cords may be used with the AC Power Adapter, as the supply is equipped with a universal input receptacle. When used in a medical care facility, international safety standards require the use of hospital grade AC power cord with the SAROS.

The AC Power Adapter contains protection circuits for output over-current, input over-voltage, and internal over-temperature conditions. If any of these conditions exist, output power will be a Loss of Power Alarm. Refer to Alert, Alarms and Troubleshooting Table. These three conditions are self-resetting, such that output power will resume when protection circuits fall back into acceptable operating ranges.

To adapt the SAROS to 220 VAC, just utilize the country cord or a plug adapter. An inverter to step up voltage/current is not needed.



24 VDC CABLE

The 24 VDC Cable is intended for use with 24 volt power sources, such as those found in various vehicles.



RECHARGEABLE BATTERY

The Battery allows operating the SAROS away from AC or DC power. The Battery used with the SAROS contains Lithium Ion battery cells, similar to those used in laptop computers and cell phones. The SAROS battery is approximately 84.2 W-hours in capacity and provides an output voltage of 12V to 16.6V. The battery connects to the bottom of the SAROS and is secured by a mechanical latching mechanism. The battery can be recharged when the SAROS is connected to the AC Power Adapter or the 24 VDC Cable. The battery gauge indicator on the SAROS LCD will have a “waterfall” effect when the battery is charging. The fastest way to recharge the battery is using the AC Power Adapter.



The Battery has an integral safety circuit that prevents over charge, over discharge or damage due to an external short circuit of the pack. An Integral fuel gauge communicates battery voltage, current, charge state, and temperature. Based on the voltage supplied by the Battery, the system is configured to optimize battery charging by regulating the charging voltage and current as follows:

Battery Pack Output Voltage (VDC)	Charging Voltage (VDC)	Charging Current (A)
< 10.0	FAULT	FAULT
10.0 – 11.9	16.6	0.55 to 0.70
> 12.0	16.6	5.60

Table 1-1. Battery Pack

When the SAROS is operating on Battery power, the LCD displays an estimate of the amount of time the unit can operate at the current settings, within +/- 5 minutes. When the SAROS is operating on Battery and the time on battery falls below 15 minutes, the LCD time on battery characters will flash to indicate a low battery condition.

The capacity of the SAROS Battery is determined by electronics and software. While the SAROS Battery allows the concentrator to operate at its full range of capabilities, the primary purpose of the Battery is to allow an autonomous system while moving between AC or DC power sources. The SAROS’s Battery, like all lithium ion batteries, is susceptible to permanent damage from excessive heat. Exposure to excessive heat may shorten the Battery’s service life. Other than excessive heat, other factors influence Battery life, such as the number of Charges/Discharges that the battery has been undergone. CAIRE Inc. advises that a typical service life of a battery is 80% Nominal Capacity after 200 Charge/Discharge cycles.

The Battery contains multiple temperature sensors to monitor battery cell temperature. The amount of heat the Battery can safely endure varies depending on how the Battery is being used. During discharge, the SAROS software will shut the system down if internal battery cell temperature exceeds 59°C. While the Battery is charging, software will interrupt charger operation when the internal battery temperature exceeds 40°C or temperature is less than 5°C. In both of these cases, when internal battery cell temperature returns within these limits, the SAROS will resume normal operation. Operation near these temperature limits will not damage the Battery, but are in place to ensure that the service life of the Battery is preserved.

Heat in the Battery is generated during discharge, and can also be the result of operating the SAROS in high ambient temperatures. The amount of internally generated heat varies with the flow setting – higher flows induce greater Battery heating. While high ambient temperatures are typically the result of operation on a hot day, running the SAROS with inadequate ventilation can also cause additional heat. Always ensure that the SAROS is operated in a well-ventilated space, the Air Inlet Filter is clean, and intake and exhaust vents are unobstructed.

CHARGING ALGORITHM






The charging algorithm is performed by the Power Board software and involves three basic decisions:

1. When to start charging
2. How fast to charge
3. When to stop charging

Charging begins when Battery voltage falls below 90% relative capacity. The charging current is limited by the charger capability and the rated capacity of the Battery. Under certain conditions, the SAROS may not have enough external power available to charge the batteries at the full rate. In this case, the charging rate will be limited to the available power. As the Battery accumulates charge, the charging current required will eventually fall. Battery charging will cease when the Battery voltage is greater than 16V, charge current is less than 0.66A, and relative charge is greater than 93%.

The software will only charge when the Battery temperature is at or below 40°C. The software will always run the cooling fan whenever the charger is enabled. The Battery Charger is disabled and the cooling fan is set to maximum whenever the Battery temperature exceeds 40°C. The Battery charger is disabled when temperature is less than 5°C.

All lithium ion batteries self-discharge at very low rates when not in use. SAROS Batteries are shipped from CAIRE Inc. in a partially charged state (nominally 30%). Do not store the SAROS with the battery installed in the unit. Remove the battery from the unit when storing to prevent damage to the battery and the unit. CAIRE Inc. recommends a first in, first out rotation of Battery inventory for maximum service life.

	WARNING: INDICATES A HAZARDOUS SITUATION THAT, IF NOT AVOIDED, COULD RESULT IN DEATH OR SERIOUS INJURY.
	WARNING: DO NOT OPEN OR HANDLE EXCEPT AT A STATIC FREE WORKSTATION. DO NOT REMOVE COVER WITHOUT ESD PROTECTION.
	WARNING: DO NOT STORE THE SAROS WITH THE BATTERY INSTALLED IN THE UNIT.
	WARNING: WHEN PERFORMING SERVICE AND REPAIR PROCEDURES DO NOT TOUCH EXPOSED CIRCUITS DURING THE MAINTENANCE. DO NOT TOUCH MOVING PARTS.
	CAUTION: The SAROS contains electrostatic sensitive components.

2.0 OPERATOR MAINTENANCE & SERVICE

2.1 CLEANING THE SAROS

Use mild detergent solution to clean the sleeve, control panel and power supplies. Turn OFF the SAROS and disconnect from AC or DC power before any cleaning or disinfection activity. DO NOT spray the sleeve, control panel or power supplies. Use a damp (not soaking wet) cloth or sponge. Spray the cloth or sponge with mild detergent solution to clean the sleeve, control panel or power supplies. To disinfect the SAROS, use only Lysol Brand II disinfectant (or equivalent). Proceed as directed by the manufacturer.



WARNING: USE ONLY SPARE PARTS RECOMMENDED BY THE MANUFACTURER TO ENSURE PROPER FUNCTION AND TO AVOID THE RISK OF FIRE AND BURNS.

Cleaning the SAROS Battery

The Battery in the SAROS requires special care to assure a longer life and the highest level of performance. The CAIRE Inc. Battery is the only approved Battery recommended for use with the SAROS.

Use a damp (not soaking wet) cloth or sponge. First spray the cloth or sponge with a mild detergent and then clean the Battery case and the latch.

Cannula Replacement

Replace your supply tubing and cannula on a regular basis as recommended by the cannula manufacturer's instructions.

2.2 ROUTINE MAINTENANCE

Maintenance Step	Frequency	Performed By
Clean Air Inlet Filter	weekly (If in use, not required if in storage.)	User
Run device and fully drain SAROS battery	3 months*	User, Distributor, or Authorized Service Center
Replace 9-volt battery	as needed	User, Distributor, or Authorized Service Center
Air Inlet Filter Replacement	6 months, or as needed	User, Distributor, or Authorized Service Center
HEPA Filter	6 months, or as needed	User, Distributor, or Authorized Service Center
Performance Verification Check**	Recommended every 6 months, or as needed	Distributor or Authorized Service Center

Table 2-1. Routine Maintenance

*Three month recommendation is based on a climate-controlled storage environment.

** Contact Distributor to schedule

Tools Required

The following section lists procedures that are necessary to maintain the SAROS. Service should only be performed by a qualified technician. To perform periodic maintenance, the only tools that should be necessary are:

- #1 Phillips Screwdriver
- 3/8" open end wrench
- Oxygen Analyzer that includes the capability to measure both flow rate (LPM and mL) and Oxygen concentration/purity %.
- Tubing to connect the SAROS to the Oxygen Analyzer for testing.

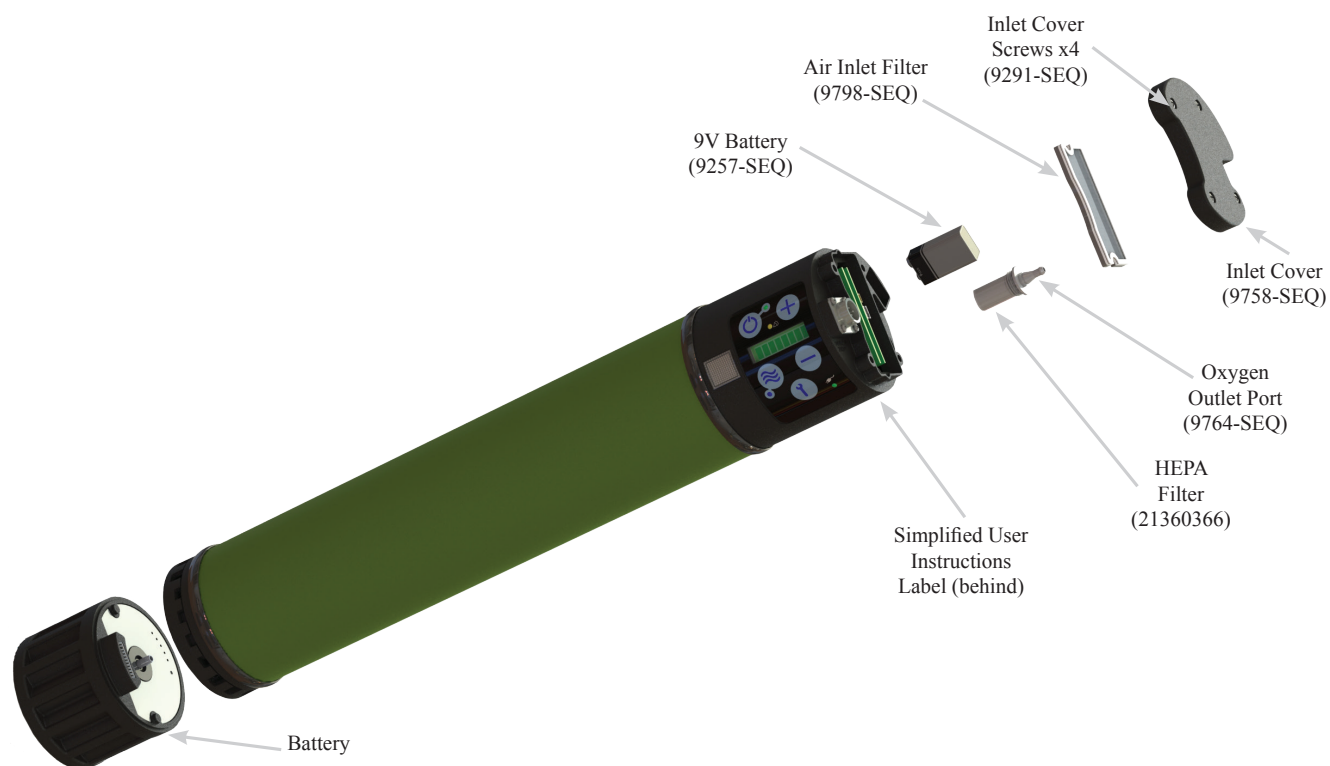


Figure 2-1. SAROS Components

See User Manual for the following procedures: Cleaning or Replacing Air Inlet Filter, Replacing the HEPA Filter, Run Device and Fully Drain SAROS Battery, Replacing the 9V Battery.

2.3 SAROS PERFORMANCE VERIFICATION TEST

NOTE: The entire verification procedure is recommended to be completed after repairs to verify overall functionality of the unit.

Verify functionality of the SAROS using the following procedures. The performance verification test shall be performed upon initial receipt of the SAROS, any time a problem is suspected, and at regular 6 month intervals. It may be performed at more frequent intervals if required by the equipment provider. It is suggested that these steps be performed in the order listed for efficiency and accuracy.

2.3.1 General Operation Test

1) Install the SAROS battery.

2) Use an external (AC or DC) power cord to connect the SAROS to external power. Verify the power cord connects securely to the receptacle on the SAROS.

NOTE: The battery is not fully charged upon initial receipt of the SAROS. If testing a new unit, this will begin the battery charging process. Reference steps 7-8 to verify proper battery charging.

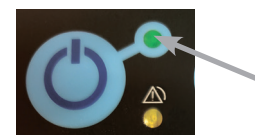
3) Press and hold the "ON/OFF" button for 3 seconds to power on the SAROS.



NOTE: Before powering on, ensure the SAROS is in the well-ventilated area and that the air inlet and exhaust vent are not obstructed.

4) Verify the audible alarm sounds upon start-up and the screen defaults to display a flow setting of C3.

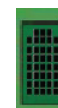
5) Allow the unit to run for a minimum of 5 minutes to reach its performance specifications. After the warm-up period, verify that only the green light remains illuminated and there are no audible alarms.



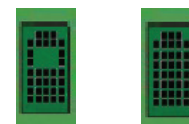
6) Press the utility button once and verify that there are no active alarms. The display screen will read "AC = NONE" if no alarms are active.



7) Verify that the battery icon is visible on the right side of the screen.



8) Verify that the battery is charging. The battery icon bars will move in a waterfall fashion while charging. If the battery icon is not moving, verify if the battery is already fully charged. A fully charged battery will have a completely dark icon with all bars filled.



Half Charged Fully Charged

9) Verify the functionality of the increase and decrease flow buttons. Starting at flow setting C3, press the decrease flow button and verify the screen reads C2. Press the increase flow button and verify the screen changes back to C3.

NOTE: It is normal for the motor to speed up or slow down with each flow adjustment.



Decrease flow button



Increase flow button

10) Verify the functionality of the pulse dose mode button. Press the button and verify the device toggles between a continuous flow setting (C) and pulse dose setting (P). The C & P are displayed on the far left side of the screen.



11) Verify the functionality of the no breath alarm. Switch to a pulse dose setting and do not attach any tubing to the outlet. An alarm will be present after 15 sec of no breath. Within 60 seconds of no breath detected, verify the system automatically changes to continuous flow. This is a patient safety measure.

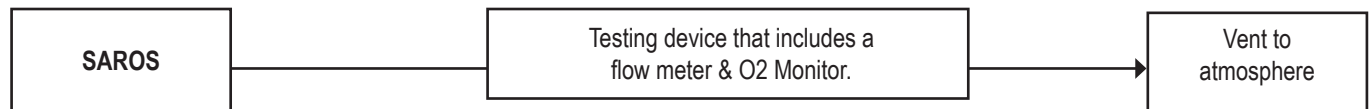
12) Verify the unit runs on battery power. Disconnect the AC power supply and allow the SAROS to run for approximately 60 seconds. Verify the unit continues to run without interruption and that the battery icon is still displayed on the screen.

13) Verify the no battery alarm. Remove the battery and verify that an audible alarm sounds and the yellow light is visible.

14) Within 5-10 seconds, reinstall the battery and verify the SAROS restarts automatically. Once the SAROS restarts, re-connect the external power as well to resume battery charging.

2.3.2 Flow and O₂ Concentration Test

Connect the SAROS to a testing station per the diagram shown below:



NOTE: If testing concentration or flow rate at multiple settings, allow a 5 minute stabilization period between changing the flow rate prior to taking any test readings.

NOTE: The SAROS is BTP compensated. If measuring concentration and/or flow with a device that is non-Argon compensated and non-BTP compensated, an additional 0.10 LPM should be added to the flow rate recorded by the testing equipment.

NOTE: Be sure to use standard oxygen-compatible tubing. The tubing from SAROS to the testing device should be a single continuous piece with no restrictions in line.

1) Verify continuous flow settings C3 and C2 using the following procedure:

- a) Turn on the SAROS and set the flow to C3 (3.0 LPM). Allow the unit to run for a minimum of 5 minutes to stabilize before testing.
- b) Verify the O₂ concentration is within 90-96% and record the reading.
- c) Record a 60 second running average for the flow rate. If recording measurements manually, record 10 readings over the course of 60 seconds and calculate the average. Verify the 60 second average is within 2.70 - 3.30 LPM. If using a non-Argon or Non-BTP compensated measuring device, verify the 60 second average is within 2.60 – 3.20 LPM.
- d) Adjust the flow setting to C2 (2.0 LPM). Allow the unit to run for a minimum of 5 minutes to stabilize before testing.
- e) Verify the O₂ concentration is within 90-96% and record the reading.
- f) Record a 60 second running average for the flow rate. Verify the 60 second average is within 1.80 - 2.20 LPM. If using a non-Argon or Non-BTP compensated measuring device, verify the 60 second average is within 1.70 - 2.10 LPM.

2) Verify functionality of the device in pulse dose mode using the following procedure:

- a) Adjust the SAROS to a setting of P48 (48mL).
- b) Complete this step using one of the methods below:
 - i) If using test equipment that automatically triggers a breath, follow the manufacturer's instructions for operation of the test equipment. Verify the breath is triggered by the light blinking adjacent to the pulse flow mode button.
 - ii) If manually triggering breaths, trigger a simulated breath by folding and pinching the tubing* running from the SAROS to the testing device. Verify the breath is triggered by the light blinking adjacent to the pulse flow mode button.

*Other acceptable procedures to trigger a breath may include connecting a tee to a breath simulator (syringe, jet venturi, nasal cannula, etc.). If you are using a tee, the tubing to the breath simulation device should not exceed 2 inches in length.

c) Complete this step using one of the methods below:

- i) If using test equipment that automatically triggers a breath follow the manufacturer's instructions for operation of the test equipment. Record the average bolus reading.
- ii) If manually triggering breaths, note and record the bolus size in mL of each breath. Repeat 5 times. Average the five bolus measurements and record the average reading. You may need to "zero" the testing device between triggering a simulated breath.

d) Adjust the SAROS to a setting of P96 (96mL).

e) Repeat steps B & C for the P96 testing.

3.2.3 Battery Run Time Test

1) Test battery run time using the following procedure:

- a) Fully charge the battery via AC power by leaving it connected to AC power for a minimum of 1 hour. After 1 hour, verify the power cartridge status indicator is fully illuminated and no longer displays a waterfall motion.
- b) Disconnect the AC power. Power the SAROS on at C3 (3.0 LPM) and start a timer.
- c) Allow the unit to continue to run until it shuts off.
- d) Once the unit shuts off completely, stop the timer and record the battery duration.
- e) Verify that the time recorded is >24 minutes

NOTE: The nominal capacity of a new battery is 30 minutes at setting C3. A battery is considered within its useful life if its duration is 80% of the nominal capacity of a new battery (24 minutes at C3).

3.0 ALERTS, ALARMS, AND TROUBLESHOOTING TABLE

The tables show the possible audible and visual alerts and alarms, their conditions and suggest appropriate troubleshooting responses. The SAROS runs functional verification on alarm system as part of its operation. If you are unsure about any alerts or alarm conditions, or responses please contact an authorized service technician or go to www.caireinc.com.

Alarm levels

Type	Level	Yellow LED	Audio Alarm	LCD	Description
Alarm	1	ON	1 beep 200ms only or repeats every 20 seconds for 120 seconds depending on the alarm	Displays Alarm Category	Attention is required
Status	0	OFF	OFF	NC (No Change)	All OK

Table 3-1. Alarm Levels

	WARNING: AVAILABILITY OF A BACK-UP SOURCE OF OXYGEN IS RECOMMENDED IN CASE OF POWER OUTAGE OR A DEVICE FAILURE. CONSULT YOUR PROVIDER FOR BACK-UP OXYGEN SYSTEM.
	WARNING: DO NOT Ignore Alarms. System will attempt to produce oxygen under fault condition but may not be at purity or flow.

3.1 SYSTEM TROUBLESHOOTING GUIDE

SYMPTOM	PROBABLE CAUSE	REMEDY
SAROS does not power on when ON/OFF button is pressed (constant tone)	No Battery installed	Install Battery or plug into external power
	Battery is discharged or no external power is present	Plug into external power
	Other	Contact an authorized Service Technician
No Oxygen	Air Inlet or HEPA Filter Blocked	Clean Air Inlet Filter or replace HEPA Filter
	SAROS not ON	Power SAROS ON
	Tubing or cannula is not properly connected or is kinked	Check tubing, cannula and connections
	Other	Contact an authorized Service Technician
Low Oxygen Concentration	Restriction in tubing	Repair or replace tubing.
	Air Inlet or HEPA Filter restricted	Clean air inlet filter or replace HEPA Filter. Place your SAROS so there is adequate air flow.
	Inadequate Ventilation	Place your SAROS so that there is adequate air flow, i.e. not covered by a blanket or a poncho.
	Hot environment	Allow SAROS to cool
	Other	Contact an authorized Service Technician
Low Oxygen Flow	Restriction tubing	Repair or replace tubing.
	Air Inlet or HEPA Filter Blocked	Clean Air Inlet Filter or replace HEPA Filter
	Other	Contact an authorized Service Technician
No Oxygen delivered in Pulse Flow Mode	Tubing/cannula longer than 7 feet (2.1m)	Attach 7 foot (2.1m) tubing/cannula
	No inspiration detected	Contact an authorized Service Technician
Battery Status Gauge never indicates fully charged	Battery is aging	Contact an authorized Service Technician to replace Battery
Heat related failures, i.e. Compressor too hot	Ambient condition is too hot	Place unit in cool environment or out of direct sunlight, if possible.
Battery will not latch onto SAROS	Battery Latching Pin Release is stuck in the wrong position	Press the Latching Pin Release Button inward to free the latch mechanism and re-install Battery
Oxygen production is limited due to power limitations	External power source cannot supply enough power	Check air inlet filter and check the external power source

Table 3-2. System Troubleshooting Guide

4.0 REPROGRAMMING/CALIBRATION

All reprogramming of the circuit boards shall be performed by CAIRE, Inc or by a factory authorized service center. Flow calibration is required whenever replacing an ATF, control board, compressor, or proportional valve. Flow calibration can be done at a CAIRE authorized service center or in the field using item T-10560. See manual MN053 for details on performing flow calibration and firmware updates in the field using item T-10560.

5.0 SHIPPING AND TRANSPORTING THE SAROS

When shipping the SAROS use original packaging if possible. Always remove the Battery from the SAROS before shipping.

If original packaging material is available repack the SAROS, Battery and power supplies in the designated packaging area.

If original packaging material or other CAIRE Inc. authorized shipping container is not available, contact CAIRE Inc. for replacement shipping container.

6.0 STORING AND DISCARDING THE SAROS



WARNING: Do not expose the SAROS to water. The SAROS enclosure does not provide protection against the harmful effects of liquid ingress. Electrical shock or damage to the unit may result.

STORING THE SAROS

Heat and humidity may degrade the performance or severely damage the SAROS. Store the device in a cool, dry protected area away from high temperatures, moisture and humidity. Remove the Battery when storing the device.

Ensure that all recommended maintenance procedures in section 1.0 are performed while the device is in storage. It is especially important that the 3-month requirement to run the device and fully drain the SAROS battery be performed while the unit is in storage to ensure proper operation.

Discarding the SAROS

Battery Disposal: Your Battery is rechargeable and can be recycled. Always return it to an authorized service center or CAIRE Inc. for proper disposal. You can also contact your local city or town offices for instructions on proper disposal of the Battery.

SAROS: Local environmental laws may prohibit disposal of electrical and/or electronic equipment such as the SAROS and AC Power Adapter. Contact the local city, town or country offices for instructions on proper disposal of electrical or electronic equipment. Alternately, CAIRE Inc. may be contacted for disposal information at 1-800-482-2473.

7.0 OVERHAUL & REPAIR

7.1 TOOLS AND TEST EQUIPMENT

- #1 Phillips Screwdriver
- #1 Flathead Screwdriver
- Needle nose pliers
- Wire cutting pliers
- 3/8" open end wrench
- Oxygen analyzer that includes the capability to measure both flow rate (LPM and mL) and Oxygen concentration/purity %.
- Tubing to connect the SAROS to the Oxygen analyzer for testing.
- ESD mat or approved ESD system.

7.2 MAINTENANCE AND SERVICE PARTS

NOTE: Incompatible parts or accessories can result in degraded performance. Do not use accessories that contain phthalates, which can leak into the gas pathway. Consult manual 9735-SEQ for SAROS 3000 parts and accessories.

Maintenance Parts			
Description	Part Number		
9V Battery	9257-SEQ		
Air Inlet Filter	9798-SEQ		
HEPA Filter	21360366		
HEPA Filter O-Ring (Large)	9251-SEQ		
HEPA Filter O-Ring (Small)	9250-SEQ		
Accessories			
Description	Part Number		
AC Power Supply	9726-1-SEQ		
AC Power Cord (North America)	4997-SEQ		
AC Power Cord (Europe)	4998-SEQ		
24VDC Cable	9727-SEQ		
Battery Pack (packaged 9723-SEQ)	20952897		
Nasal Cannula	5408-SEQ		
Repair & Overhaul Parts			
Description	Part Number		
9V Battery Foam	9256-SEQ		
Air Inlet Cover	9758-SEQ		
ATF Bulkhead	9922-SEQ		
ATF Exhaust Filter	9221-SEQ		
ATF Exhaust Tubing	9227-SEQ		
ATF Module Assembly	SP9729-SEQ		
ATF Muffler To Rain Guard Tubing	9390-SEQ		
ATF Muffler Assembly	SP9314-SEQ		
ATF To Product Pipe Elbow	9797-SEQ		
ATF To Product Tank Pipe	9342-SEQ		
Product Tank Pipe to Product Tank Tubing	SP6981-SEQ		
Battery Bridge Board	21494868		
Battery Bridge Board Screws (2)	9960-15-SEQ		
Battery Bridge Board Wire Harness	21494875		

Battery Interface Plate	SP9939-1-SEQ
Battery Interface Plate Screws (3)	9914-12-SEQ
Cable Ties	6968-SEQ
Compressor Assembly	SP9238-SEQ
Compressor & Product Tank Assembly	SP9240-SEQ
Compressor Fan	9767-SEQ
Compressor Fan Screws (4)	9913-10-SEQ
External Power Connector	9766-1-SEQ
External Power Connector Screws (4)	9203-2-SEQ
Hose Clamp	9369-SEQ
Inlet Cap Assembly	SP9756V2-SEQ
Inlet Cap Mounting Screws (3)	9914-11-SEQ
Inlet Cover Screws (4)	9291-SEQ
Kapton Tape (1/2 in Width)	2696-SEQ
Left Strut	9779-SEQ
Loctite Adhesive	1405-SEQ
Membrane Panel	9731-1-SEQ
O2 Outlet Port	9764-SEQ
O-Ring For External Power Connector	9916-3-SEQ
Oxygen Outlet Tubing	SP6981-SEQ
PCB Circuit Board Assembly	SP9710V2-SEQ
Proportional Valve	5293-SEQ
Proportional Valve Screws (2)	9203-7-SEQ
Bottom Rain Guard	21494877
Sleeve Ring (2)	9928-SEQ
Sleeve O-rings (4)	9374-SEQ
Right Strut	9780-SEQ
SAROS Sleeve	21341894
Strut Screws (13)	9912-1-SEQ
Top Strut	9778-SEQ

Table 7-1. Maintenance and Service Parts

7.3 REPROGRAMMING AFTER OVERHAUL AND REPAIR PROCEDURES

A flow calibration procedure is required after replacing any of the following components or assemblies: ATF Module, Compressor and Product Tank, PCB Circuit Board, Proportional Valve. If any of these components are replaced, flow calibration is required. Flow calibration can be done at a CAIRE authorized service center or in the field using item T-10560. See manual MN053 for details on performing flow calibration and firmware updates in the field using item T-10560. Equipment or procedures to perform a flow calibration are not contained in this manual.

NOTE: Further damage to the SAROS or other components is possible if the flow calibration is not performed.

7.4 SAROS MAIN COMPONENTS

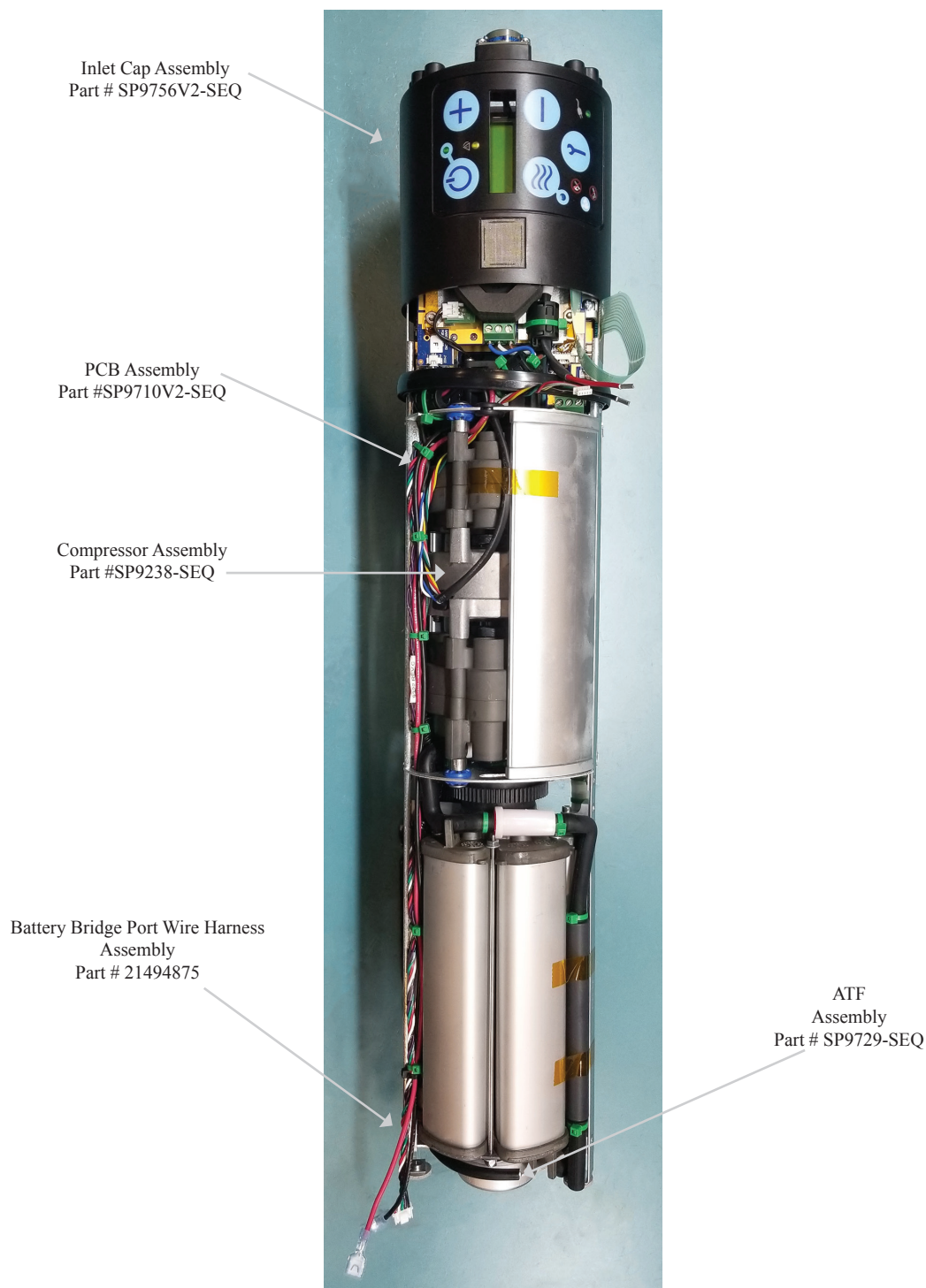


Figure 7-1. Inside SAROS

7.5 COMPREHENSIVE TROUBLESHOOTING GUIDE

Indications		Code	Possible Cause	Remedy
	During start up or stabilization period when a control panel (flow) setting has been changed:		5 minutes before alert conditions will sound or code	Alert condition will be silent until the warm up period or stabilization period is over, 5 minutes.
2	At start up, 2 lights are on (green & yellow)	0800	Device warming up - >85% O ₂	Normal condition
3	At start up, 1 light remains (green)	0000	Device warmed up, Within spec 93 +/-3% O ₂	Ready to use
	After Start Up conditions:		Front panel setting change—alerts will be reset for 5 minute stabilization.	Follow numerically until resolved.
4	Continuous mode: Low O ₂ : below 85 * (yellow light is on)	0800	Low Flow for extended periods of time, filters occluded. ATF gear motor slow or not turning, ATF has moisture. Compressor slow or not working PCB set not calibrated, malfunctioning	1) Clean or replace filters; 2) If device has been in storage, attempt to run for 24 hours continuously to bring up the purity; 3) Check gear motor on ATF is turning, replace ATF if needed (PN: SP9729-SEQ); 4) Check Compressor is not labored, squeaking; replace if not working (PN: SP9238-SEQ); 5) Replace PCB set (PN: SP9710V2-SEQ).
6	Loss of Power	4000	Power has been lost to the SAROS (unit beeps for 2 sec, and switches to attached battery - if present)	1) Check if the front panel power verification LED is lit; 2) Check the power source for proper voltage, review spec chart to details; 3) Check/replace External power supply for functionality (PN: 9726-1-SEQ or PN: 9727-SEQ); 4) replace External power connector (PN: 9766-1-SEQ) 5) Replace PCB set (PN: SP9710V2-SEQ).
7	Flow Rate error Yellow LED will be flashing	2000	A block to flow greater than 10% is detected for more than 60 sec, unit beeps and yellow light is on. Unit will establish normal use after 30 seconds of unblocked patient circuit.	1) Find tubing blockage and remove; 2) if blockage is within SAROS device - remove tubing and investigate filters.
8	Compressor too hot	9100	Environment too hot, Compressor too hot	1) Allow device to cool; 2) Check the cooling fan, replace Compressor cooling fan if not rotating smoothly or at all (PN: 9767-SEQ) 3) If after cooling, the Compressor is damaged or squeaking, replace Compressor (PN: SP9238-SEQ).
9	Caution LED is on. The buzzer beeps once for 200ms.	9110	Compressor Temperature Sensor cable connected to J402 on system board may be damaged or loose. The Compressor Temperature Sensor is bad.	1) Remove and reconnect sensor cable. 2) Repair sensor cable. 3) Replace compressor.

Indications		Code	Possible Cause	Remedy
10	Breath rate malfunction (Pulse Mode only)	A200	While in Pulse mode, the breath rate was not sensed for more than 60 sec.	1) Press Mode button to re-establish Pulse Mode, if SAROS switched to Continuous; 2) Ensure patient is breathing through their nose, not their mouth; 3) Adjust Pulse Sensitivity to a more sensitive setting. See menu options for adjustment; 4) Ensure the SAROS does not have a humidifier attached. Acts as a water block to negative inspiration; 5) Ensure tubing length does not exceed 7 ft.
11	Battery communication error	9500	Battery is not communicating with the SAROS. Battery indicator is flashing, or not there when battery is connected.	1) Re-connect the battery; 2) Test the Battery on another unit to ensure the same code, replace battery; 3) Check the bridge pcb connector for damage, replace BBB wiring harness if needed (PN: 21494875); 4) Replace the PCB set (PN: SP9710V2-SEQ).
12	Battery too HOT	9510	Battery indicator not scrolling - waterfalling (scroll bottom to top)	1) Remove battery and allow to cool; 2) Replace with cool Battery.
13	Battery too Hot to Charge	1030	Battery will not waterfall (scroll bottom to top)- indicates not charging (no code expected)	1) Check battery connection is proper; 2) Reset battery connection locking pin brass barrel; 3) check condition of Battery wiring harness, replace if damaged (PN: 21494875); 4) Replace PCB set (PN: SP9710V2-SEQ).
14	Power Board too Hot	9200	Charging has stopped, Device shut down, the alarm is on, and the ambient temp is above temp limits.	1) Allow PCB set / Device to cool in the shade or A/C environment 2) Once cooled, check functionality to spec.
15	Motor Driver Board too Hot	9300	Charging has stopped, Device Shut down, the alarm is on, and the ambient temp is above temp limits.	1) Allow PCB set / Device to cool in the shade or A/C environment; 2) Once cooled check functionality to spec; 3) Replaced Failed PCB set (PN: SP9710V2-SEQ).
16	Battery is too Cold	95C0	No waterfall effect (scroll bottom to top) on display.	1) Remove Battery from device. Position battery in an environment above 40 degrees (F); 2) Allow to warm to in-spec temperature internal to the battery. Re-insert Battery; 3) Replace with warmer battery.
17	Low Battery Condition	9540	Battery Icon is blinking, Yellow light is on, Device is beeping (2 beeps at 119 sec), <= 6 minutes remaining.	1) Plug into External power; 2) Replace with fully charged Battery.
18	Front Panel Key Stuck	8110	A key is stuck for more than 7 seconds. (NOTE: Utility or tool button/key will not activate this alarm.)	1) Remove and replace front membrane panel (PN: 9731-1-SEQ).

Table 7-2. Troubleshooting Guide (continued)



WARNING: DO NOT Ignore Alarms. System will attempt to produce oxygen under fault condition but may not be at purity or flow.

7.6 REMOVAL PROCEDURES

7.6.1 BATTERY INTERFACE PLATE, RAIN GUARD, AND SLEEVE

7.6.1.1 Remove the three screws (Part# 9914-12-SEQ) and remove the Battery Interface Plate (Part# SP9939-1-SEQ).

Screws
Part# 9914-12-SEQ

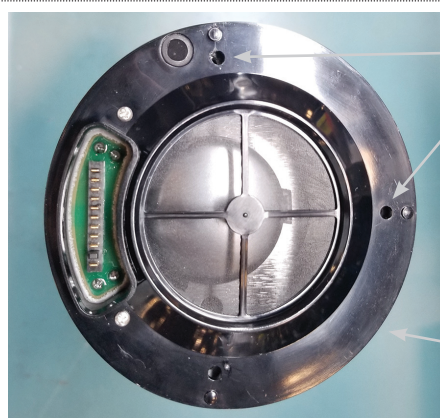


Battery Interface
Plate Part
SP9939-1-SEQ

Figure 7-2. Removal of the three BIP screws

7.6.1.2 Removing the two screws (Part# 9960-15-SEQ) from the Rain Guard (Part# 21494877)

Screws
Part#
9960-15-SEQ



Rain Guard
Part# 21494877

Figure 7-3. Removal of the three Rain Guard Screws

7.6.1.3 Disconnect wires from battery bridge board and detach the Rain Guard (Part# 21494877) from the Alignment Ring

Rain Guard
Part# 21494877

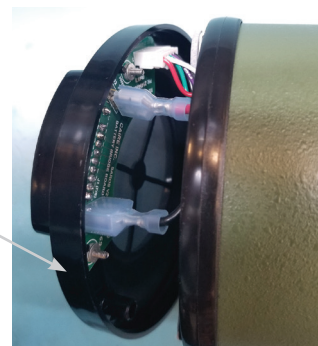


Figure 7-4. Removal of the Rain Guard

7.6.1.4 Remove the Ring SLEEVE (Part# 9928-SEQ) to expose wiring.

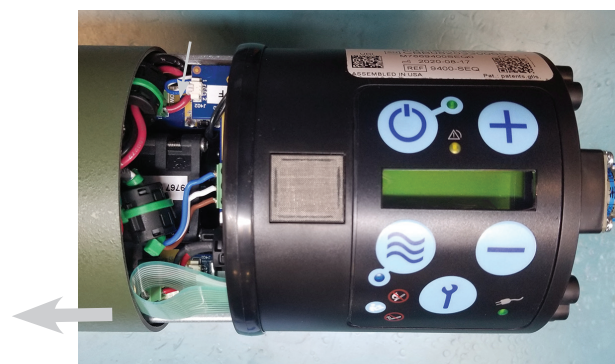
NOTE: Ensure both O-Rings (Part # 9374-SEQ) remains with the Ring Sleeve.

9374-SEQ 9928-SEQ



Figure 7-5. Removal of Sleeve Alignment Ring

7.6.1.5 Remove Fiberglass Sleeve (Part# 21341894) from the rails



Sleeve: 21341894

Figure 7-6. Fiberglass Sleeve

7.7.2 INLET CAP REMOVAL

NOTE: Use ESD Controls when removing the Inlet Cap.

7.7.2.1 Loosen the four CAPTIVE screws (Part# 9291-SEQ) and remove the Air Inlet Cover (Part# 9758-SEQ).

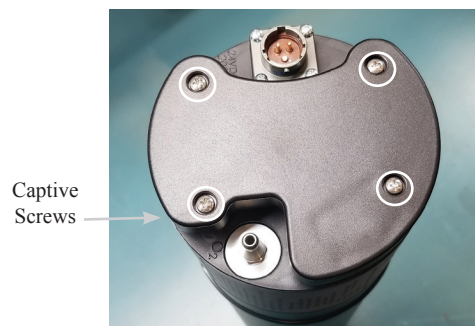


Figure 7-7. Air Inlet Cover Removal

7.7.2.2 Remove and disconnect the 9V Battery (Part# 9257-SEQ) and the Air Inlet Filter (Part# 9798-SEQ).



Figure 7-8. Filter Screen and 9V Removal

7.7.2.3 Remove three Inlet Cap Mounting screws (Part# 9914-11-SEQ).

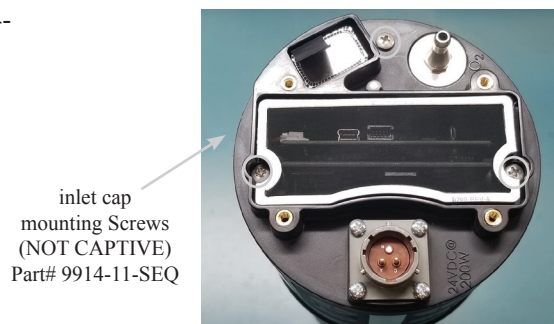


Figure 7-9. Inlet Cap Screw Removal

7.7.2.4 Move sleeve ring aside and cut green cable tie and disconnect the Oxygen Outlet Tube from the Flow Valve.

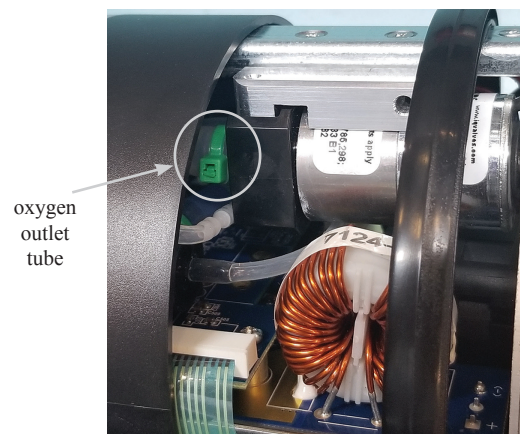


Figure 7-10. Oxygen Outlet Tube Disconnect.

7.7.2.5 Remove tape (Part# 2696-SEQ) from Front Panel Flex Cable and Top Mounting Struts (Part# 9778-SEQ). Lift up locking connector and disconnect the Front Panel Flex cable.

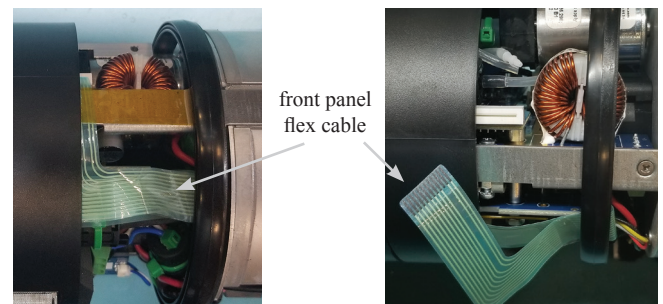


Figure 7-11. Front Panel Flex Cable Disconnect

7.7.2.6 Disconnect the Ambient Air Thermistor Connector and 9V Battery Connector.

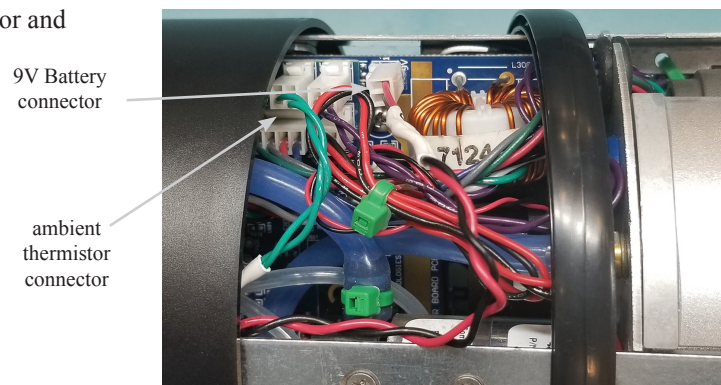


Figure 7-12. Thermistor Connector and 9V Battery Connector

7.7.2.7 Loosen the screws for the AC Power Connector and remove the wires.

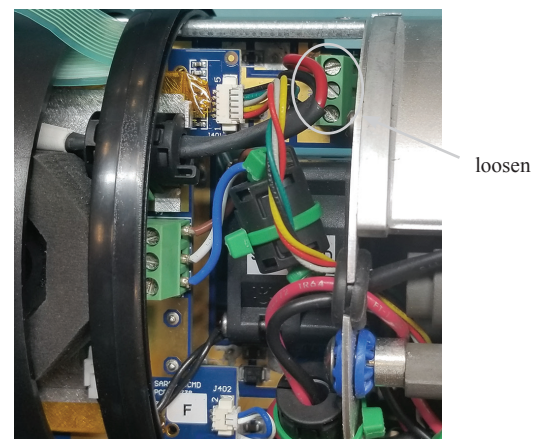


Figure 7-13. Inlet Cap Power

7.7.2.8 Disconnect the Breath Detect Tube.

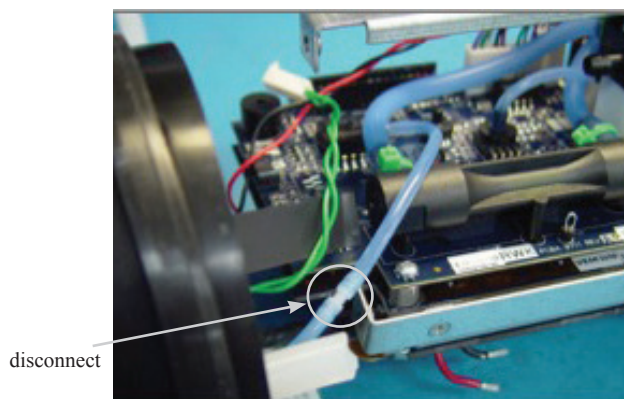


Figure 7-14. Tube Disconnect

7.7.2.9 Remove the Extended Top Cap (Part# SP9756V2-SEQ) and guide AC Power Cable under the frame of the PCB Assembly. Remove and set aside speaker foam.

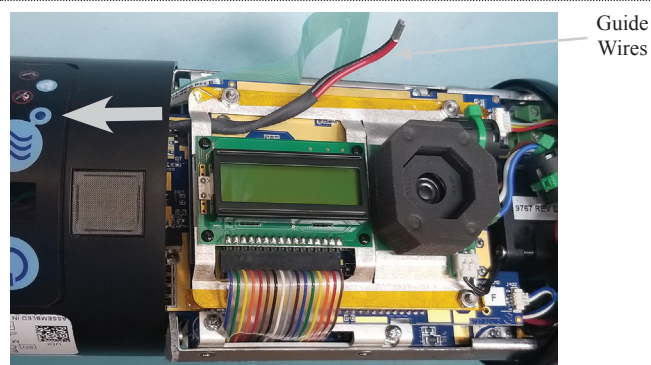


Figure 7-15. Inlet Cap Removal

7.7.3 REMOVE PCB ASSEMBLY

NOTE: Always use ESD Controls when handling the PCB Assembly.

7.7.3.1 Cut zip tie and remove ferrite clamp from Battery Power Wire.

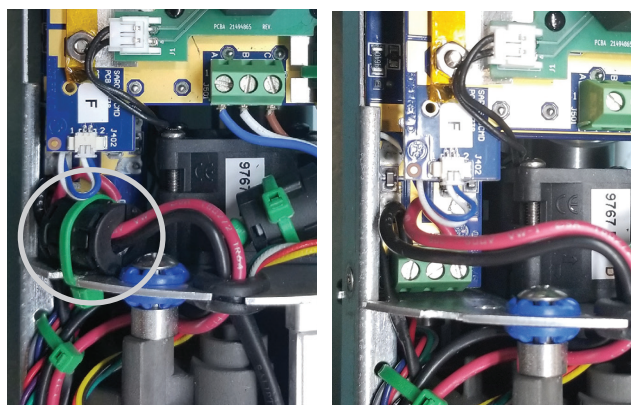


Figure 7-16. Removal of Ferrite from Battery Power Wire

7.7.3.2 Loosen the Battery Power Wire screws and remove wires.

7.7.3.3 Disconnect the Compressor Thermistor wires.

7.7.3.4 Disconnect the Halls Effect wire.

7.7.3.5 Loosen the Compressor Power screws and remove the wires.

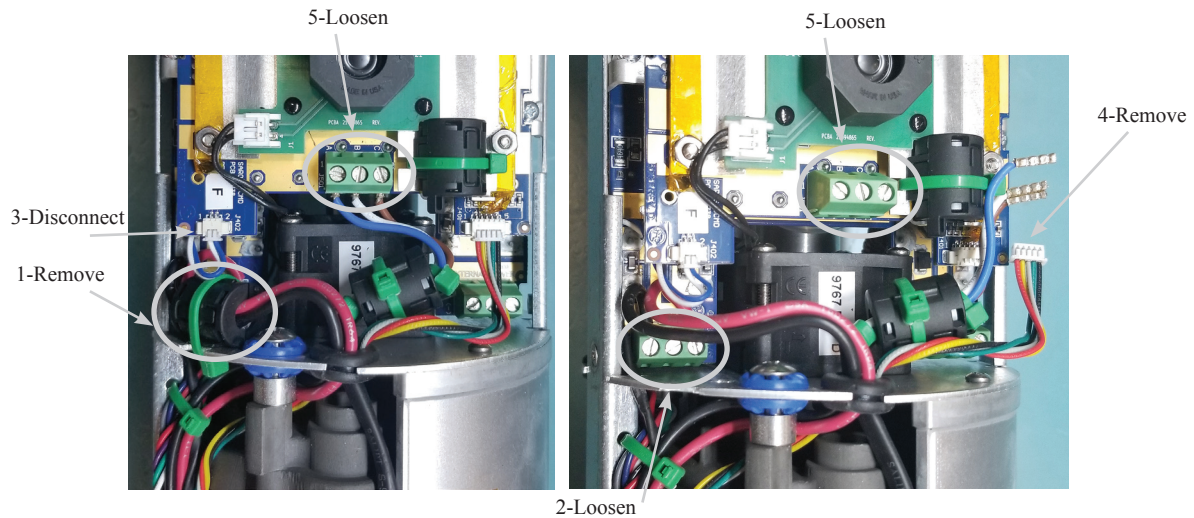


Figure 7-17. Battery Power Wires for Battery Interface

7.7.3.6 Disconnect Battery Communication Connector.

7.7.3.7 Disconnect the ATF Stepper Motor Connector from the PCB.

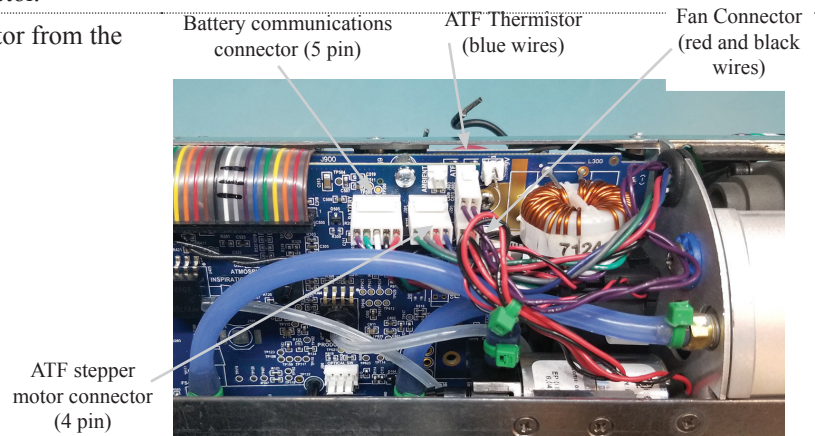


Figure 7-18. Communication Connector for Battery Interface
ATF Stepper Motor Power, Fan Disconnect, ATF Thermistor

7.7.3.9 Cut the cable tie and remove the Flow Tube from the Product Tank.

NOTE: It is recommended to cap this outlet using a piece of tape during the repair process. Do not leave the plug open to atmosphere longer than it takes to preform the repair process. If this port is exposed longer than 24 hours, it must be completely sealed to prevent damage to the ATF. If just exposed during repair, tape is sufficient to prevent any damage.

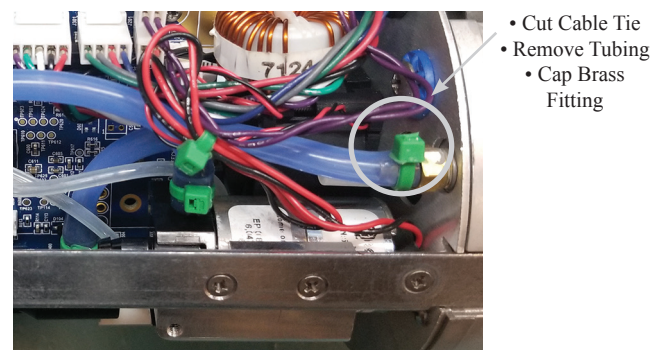


Figure 7-19. ATF Thermistor Disconnect

7.7.3.10 Remove 2 screws on the Left STRUT (9779-SEQ).

7.7.3.11 Remove 2 screws on the Right STRUT (9780-SEQ).

7.7.3.12 Slide the PCB Assembly away from the struts. (Place in ESD bag.)

NOTE: Always use ESD Control when handling the PCB Assembly.

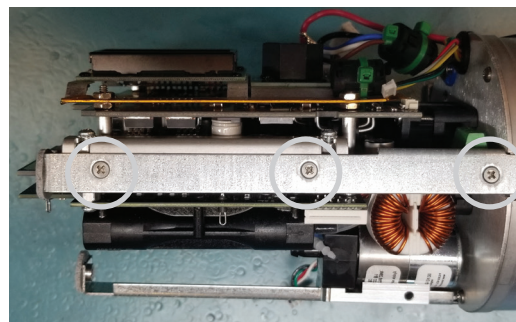


Figure 7-20. PCB Assembly

7.7.3.13 Place PCB Set in ESD Protective Bag.

7.7.4 PROPORTIONAL VALVE REMOVAL (5293-SEQ)

7.7.4.1 Remove Proportional Valve wire from PCB Assembly (if not done so already).

proportional
valve connector

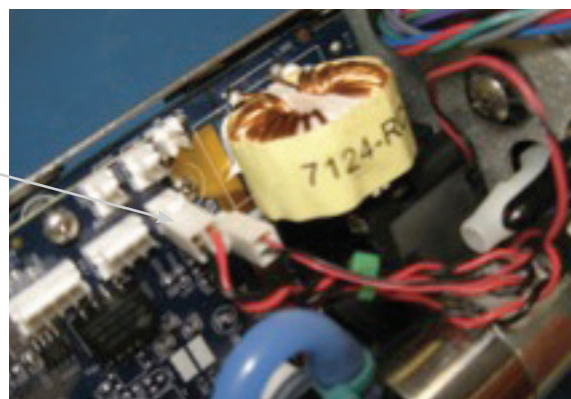


Figure 7-21. Proportional Valve Wire

7.7.4.2 Remove the two screws from the Proportional valve mounting block.

NOTE: If Removing the Compressor Fan go to 6.7.5

7.7.4.3 Cut and remove Cable Tie from Proportional valve and remove tubing.

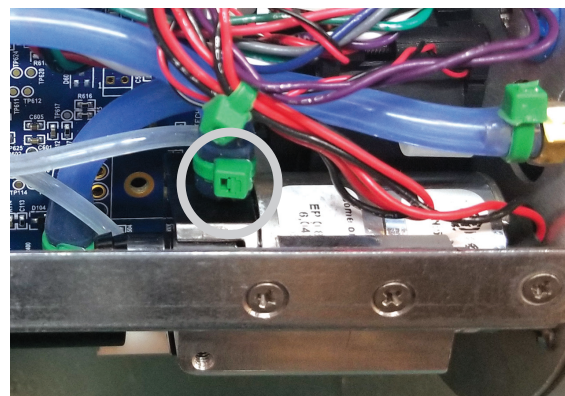


Figure 7-22. Proportional Valve Tube

7.7.4.4 Remove the Proportional Valve (5293-SEQ) from the Proportional Valve Block and replace.



Figure 7-23. Replace Proportional Valve

7.7.5 COMPRESSOR FAN REMOVAL (9767-SEQ)

7.7.5.1 Remove Compressor Fan wire from PCB Assembly (if not done so already).

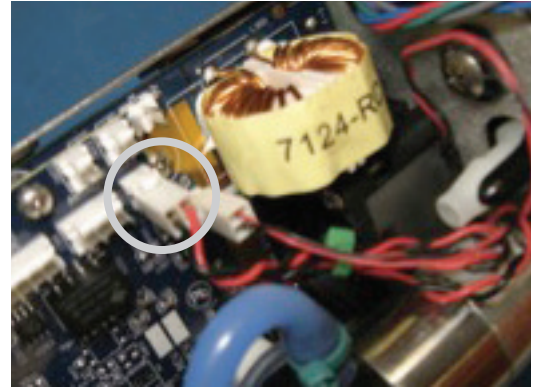


Figure 7-24. Remove Compressor Fan wire

7.7.5.2 Lift the Proportional Valve out of the way (See Proportional Valve Removal Step.)

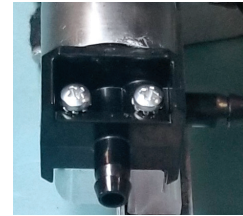


Figure 7-25. Lift the Proportional Valve

7.7.5.3 Loosen Compressor Fan screws (9913-10-SEQ) Remove the Fan subassembly (9767-SEQ) from the Compressor Bulk-head.

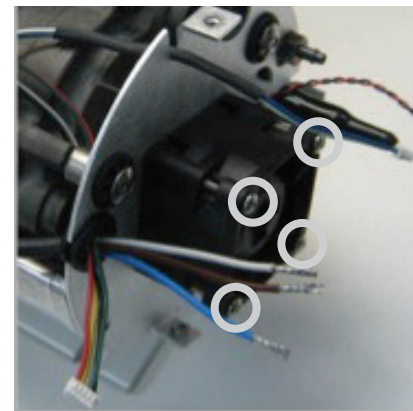


Figure 7-26. Compressor Fan

7.7.6 BATTERY CABLE REMOVAL (21494875)

7.7.6.1 Pull out the wires from the grommets on the bulkhead of the Compressor as shown in figure below.

Hall Effect
Sensor

Hall Effect
Sensor

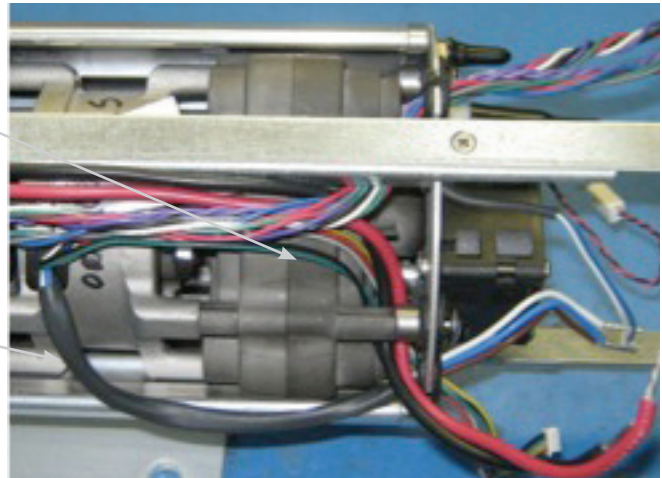


Figure 7-27. Hall Effect Sensor

7.7.6.2 Remove the two large wires (Battery Connector Cable) thru the middle Bulkhead as shown in figure below.

7.7.6.3 Remove the Wire Sleeve with the wires thru the Bulkhead.

ATF power & ATF
thermistor wire
connector cable

Battery Connector
Cable (21494875)

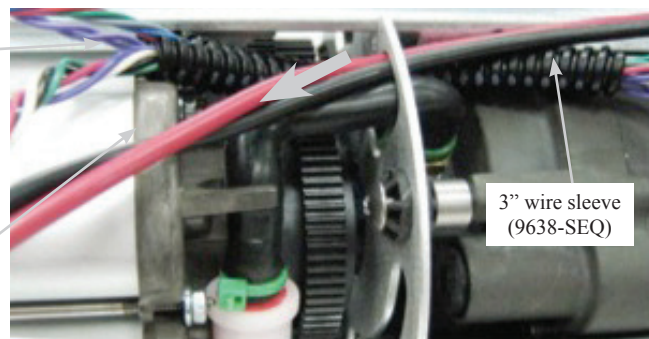


Figure 7-28. Remove Wire Sleeve

7.7.6.4 Cut and remove the 6 Cable Ties (part# 6968-SEQ) on the Side Rail & Cable Ties that group the Cable bundle together.



CAUTION: Do not cut wires.

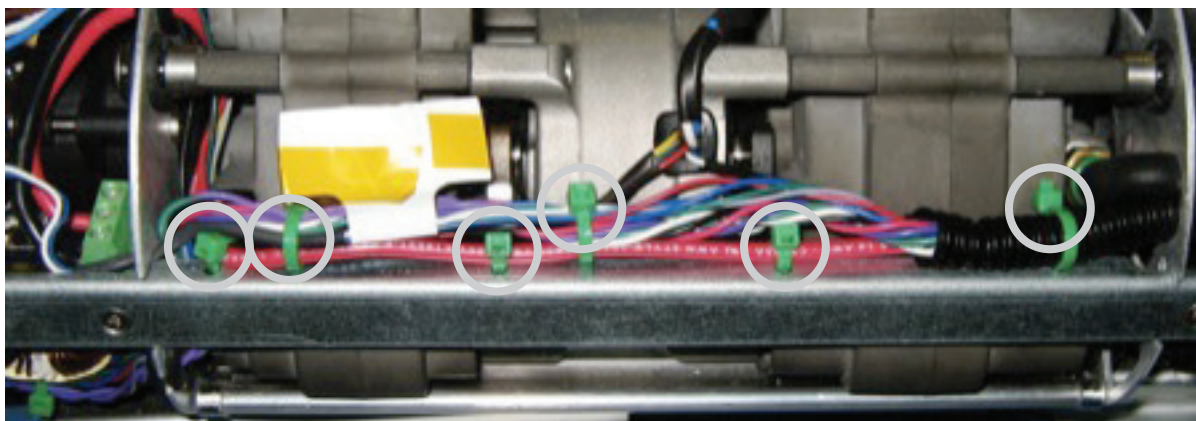


Figure 7-29. Cable Ties and Rails

7.7.6.5 Cut and remove all four Cable Ties between the STRUT (9779-SEQ) and the ATF Assembly.



CAUTION: Do not cut wires or damage insulation.

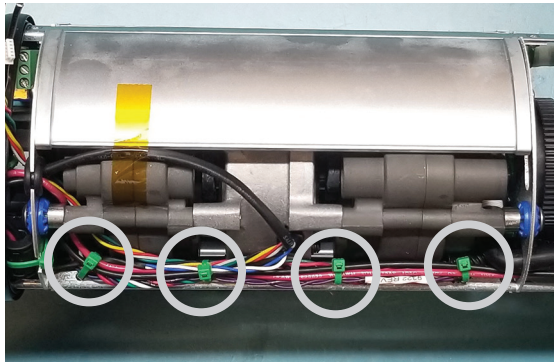


Figure 7-30. Cable Ties and Struts

7.7.7 RAIL REMOVAL

7.7.7.1 Remove five screws (part# 9912-1-SEQ) from left strut (9779-SEQ).

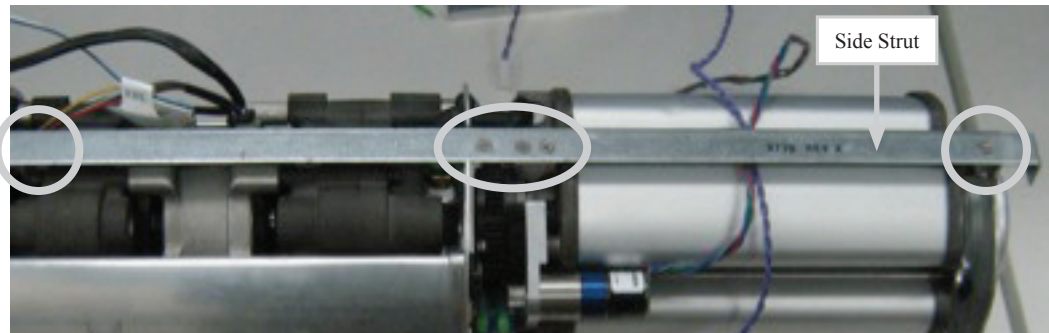


Figure 7-31. Left Strut

7.7.7.2 Remove five screws (part# 9912-1-SEQ) from right strut (9780-SEQ).

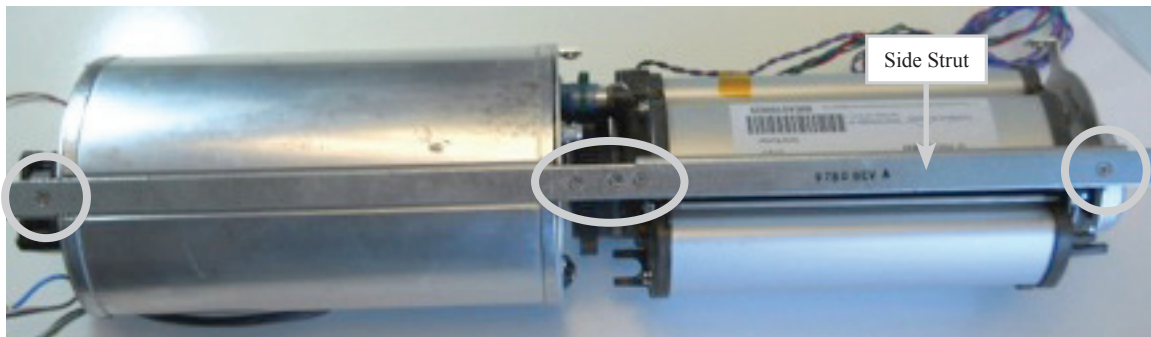


Figure 7-32. Right Strut

7.7.8 ATF & COMPRESSOR / TANK ASSEMBLY REMOVAL

7.7.8.1 Remove Kapton Tape (2696-SEQ) from the Muffler Assembly and left strut (9779-SEQ), as shown in figure.

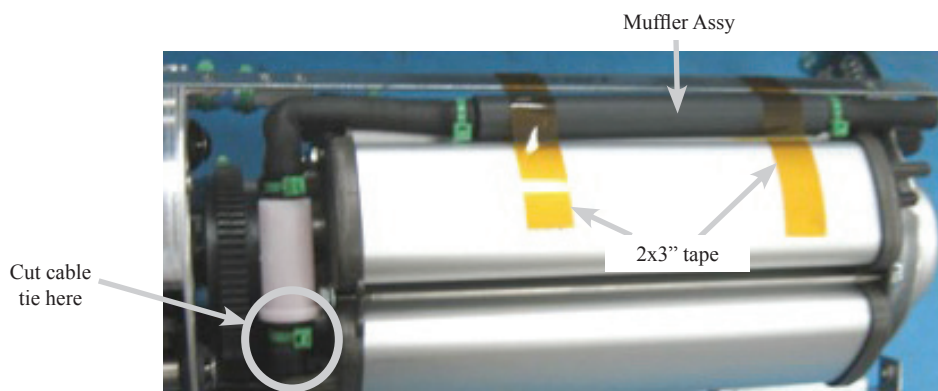


Figure 7-33. Kapton Tape

7.7.8.2 Remove exhaust tube and ATF to product tank tubing. Cap the connection port on the ATF that is exposed when the tubing is removed.



Figure 7-34. Exhaust tube

7.7.8.3 Cut and remove 2 Cable Ties (6968-SEQ) as shown on figure below.

NOTE: Leave the cable tie closest to the Compressor/Product Tank Assembly Intact.

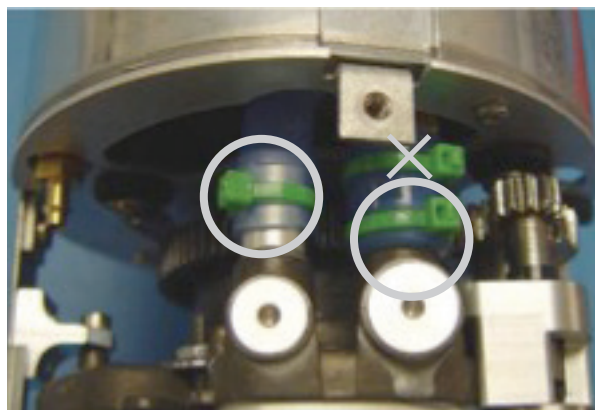


Figure 7-35. Cable Ties

7.7.8.4 Remove the silicone tubing from the ATF, leaving the tubing attached to the Compressor Assembly.

NOTE: May need to carefully pry tubing from ATF ports with a tool.

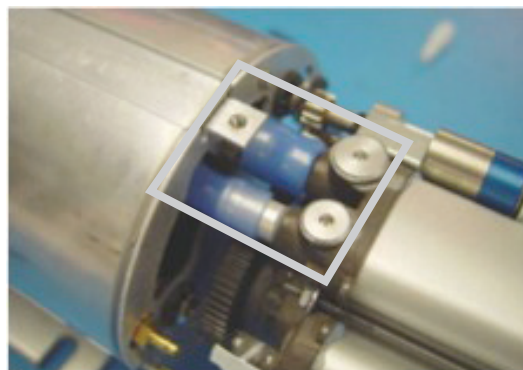


Figure 7-36. Silicone tubing

7.7.8.5 Cap both ATF ports (Feed and Vacuum ports).

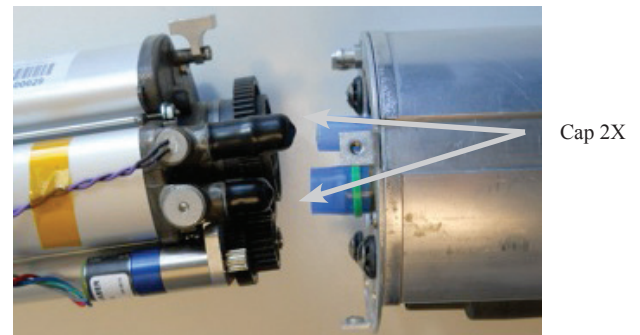


Figure 7-37. ATF ports

7.7.8.6 Remove the ATF Bulkhead FROM the bottom of the ATF Module Assembly as shown in figure below.

NOTE: Mark the position for installation.

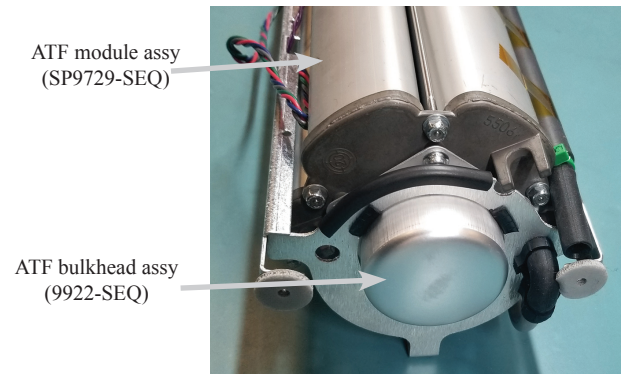


Figure 7-38. ATF bulkhead

7.8 INSTALLATION PROCEDURES

7.8.1 GENERAL PROCEDURE

7.8.1.1 Thread Locking Procedure: When applying thread locker to screws, apply 1 drop of the appropriate thread locking fluid to the first four threads of the screw/standoffs as show in the figure below. The Loctite 222MS will be used unless specified otherwise.

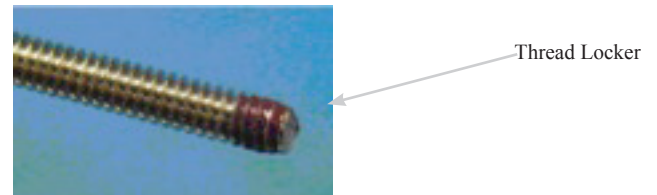


Figure 7-39. Thread Locking Procedure

7.8.1.2 CABLE TIE INSTALLATION PROCEDURE: All cable ties will be installed using cable tie gun unless specified otherwise.



Figure 7-40. Cable tie installation

7.8.2 ATF & COMPRESSOR/PRODUCT TANK INSTALLATION

NOTE: A flow calibration procedure is required after replacing the ATF or Compressor, the PCB Circuit Board, the Proportional Valve. If any of these components are replaced, flow calibration is required. Flow calibration can be done at a CAIRE authorized service center or in the field using item T-10560. See manual MN053 for details on performing flow calibration and firmware updates in the field using item T-10560.

7.8.2.1 Install the ATF Bulkhead Assembly onto the bottom of ATF Module Assembly as shown in figures below.

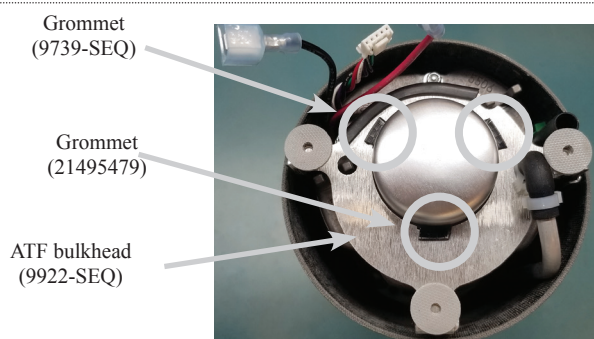


Figure 7-41. ATF Bulkhead

7.8.2.2 Place the ATF Assembly and Compressor Assembly next to each other and align as shown in figure below.

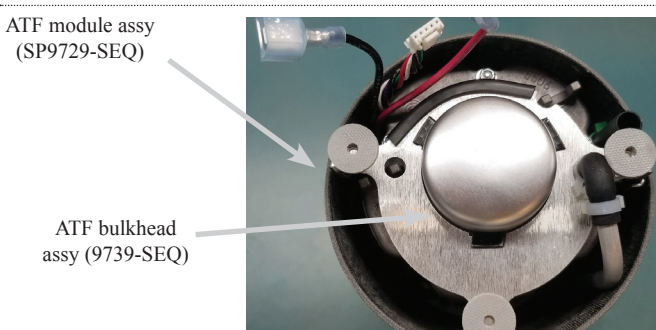


Figure 7-42. Align

7.8.2.3 Remove Caps (3575-SEQ) from the ATF. Insert the Ports from the ATF into the tubes on the Compressor /Tank Assembly. Press the ATF & Compressor together and ensure that the hoses are positioned properly.

NOTE: Pre-wet inner tubing on compressor with alcohol. Also, wet metal barbs on the ATF.

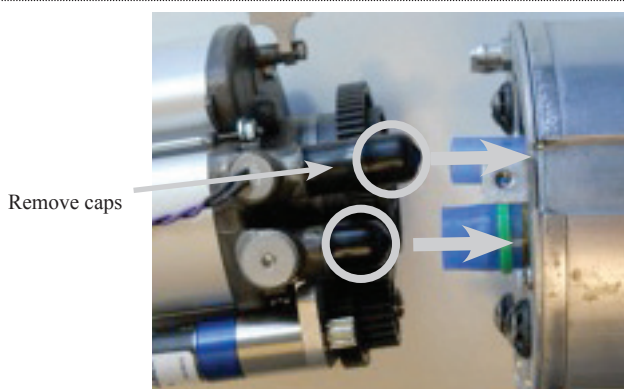


Figure 7-43. ATF caps

NOTE: Use Isopropyl Alcohol to lubricate the Tube and the Barb and use a Mechanics Grabber Pliers to attach the down pipe hose from the Compressor Assembly to the fitting on the ATF Module Assembly.

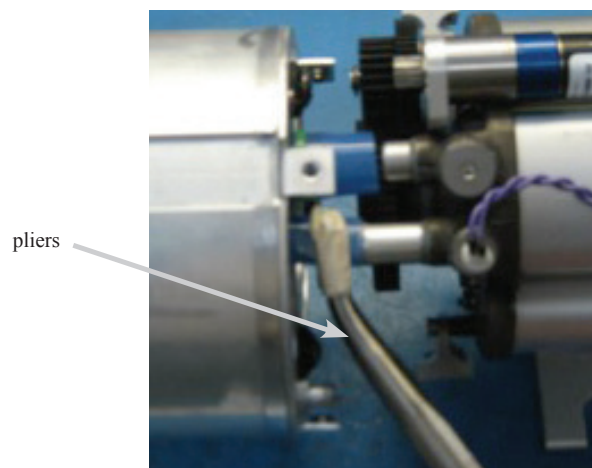


Figure 7-44. Down pipe Hose

7.8.2.4 Apply cap (1137-SEQ) to Product Tank outlet fitting to prevent ATF desaturation.

cap off
fitting

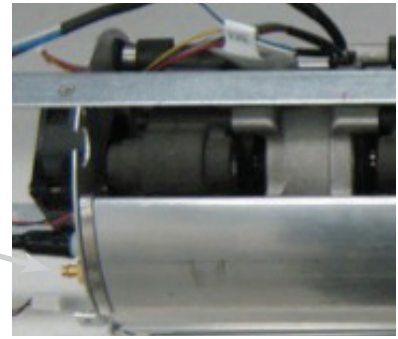


Figure 7-45. Cap

7.8.2.5 Apply 2 Cable Ties as shown on figure.

NOTE: Pre Loop Zip Ties.

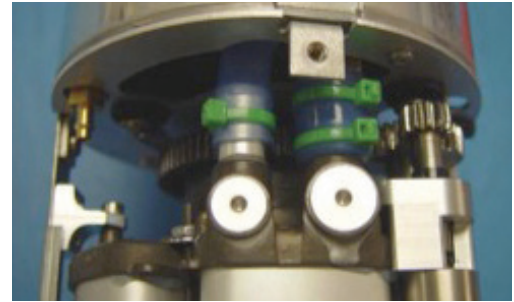


Figure 7-46. Cable Ties

7.8.2.6 Attach the Exhaust Filter, Tube, Muffler Assembly and Tube, Muffler as shown in figure below.

NOTE: Ensure Arrow on Filter points in the correct direction. Install Cable Ties (6968-SEQ) as shown in figure below. Ensure the compressor exhaust elbow tubing is through the bulkhead before/during assembly.

While applying Kapton tape, pull muffler tube to establish clearance. Make sure that tube, muffler, and muffler tube are laying down on ATF surface.

NOTE: Pulling too hard on the Exhaust Tube may cause the tube to tear.

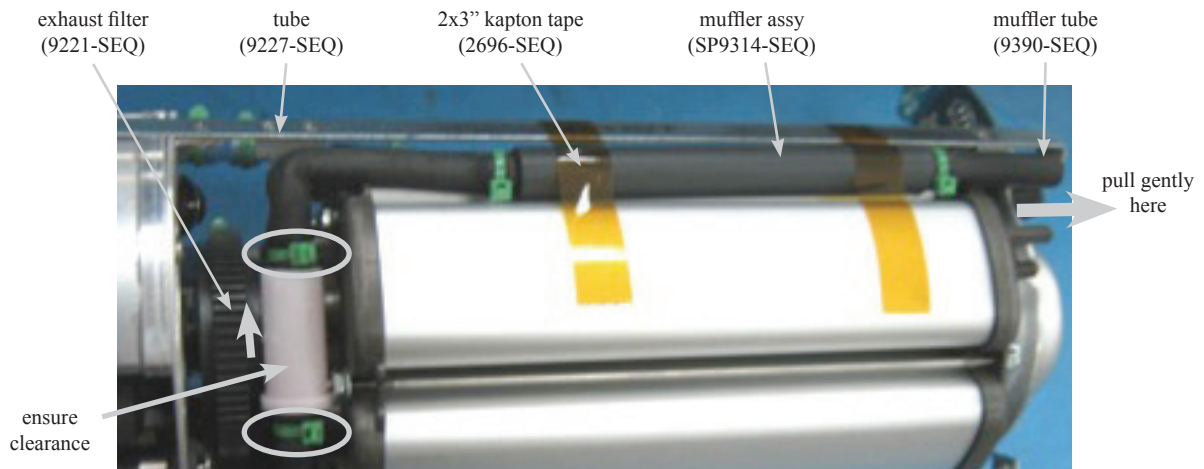


Figure 7-47. Open SAROS

7.8.2.7 Install the ATF Product Pipe onto the Product Tank with Silicone tubing and secure with Cable ties. Install the other end onto the ATF with the Product Tube and Clamp as shown in figure below.

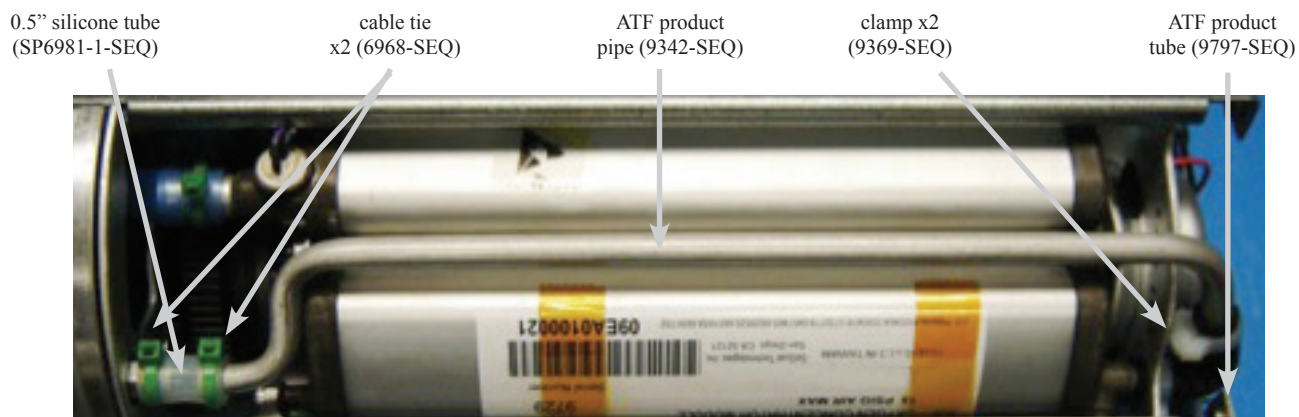


Figure 7-48. Open SAROS

7.8.3 RAIL INSTALLATION

7.8.3.1 Attach RIGHT STRUT (9780-SEQ) with five screws (9912-1-SEQ) with and torque to 6.0 in-lbs.

NOTE: Top bulkhead screw not shown.

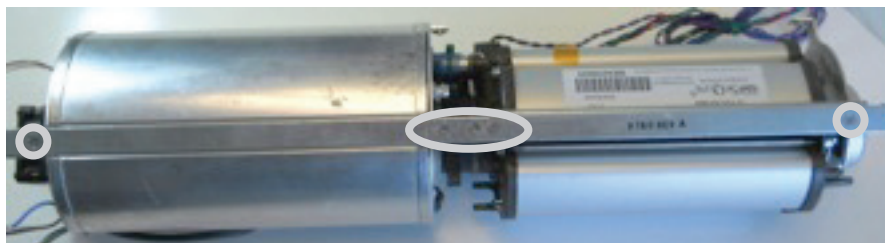


Figure 7-49. Right Strut

7.8.3.2 Rotate assembly, route the ATF wires (stepper motor and ATF thermistor wires) under the slot of the LEFT STRUT (9779-SEQ).

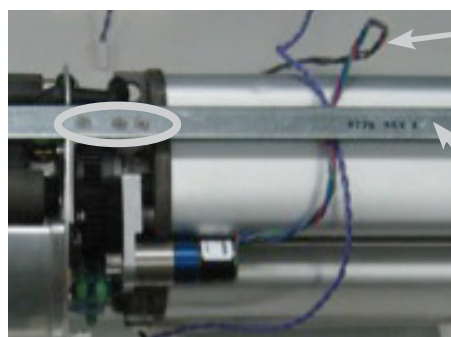
NOTE: Pre-install cable ties in rail holes prior to installation.

Slot in rail



Figure 7-50. Route ATF wires

7.8.3.3 Secure the STRUT (9779-SEQ) with five screws and torque the screws to 6.0 in-lb.



ATF wires, verify loop for proper length

LEFT STRUT (9779-SEQ)

Figure 7-51. Secure

7.8.4 BATTERY CABLE INSTALLATION

7.8.4.1 Secure two Cable Ties through the holes in LEFT STRUT (9779-SEQ) and round all wires. Secure two Cable Ties around all wires (battery cables & ATF Bundle). Apply one Cable Tie around all battery cables, close to the battery board, as in Figure below.

NOTE: Leave the Cable Ties loose in case slack is needed at the PCBA assembly.

NOTE: Ensure slack to wires where indicated.

Orient the Cable Tie knots towards the Compressor.

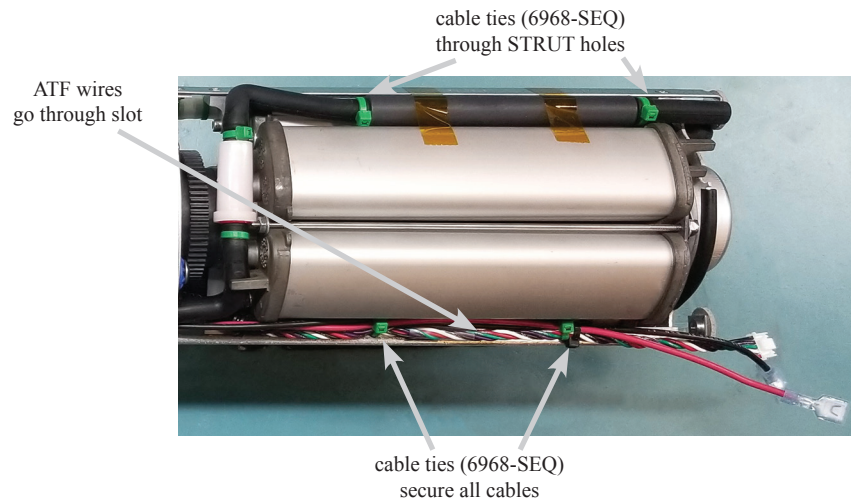


Figure 7-52. Cable Tie Knots

7.8.4.2 Wrap the Wire Sleeve around the ATF wires and pass thru the Bulkhead. Pass the two Battery wires from the Battery Connector thru the Bulkhead as shown in figure below.



Figure 7-53. Wire Sleeve

7.8.4.3 Secure the Battery Power wires on the LEFT STRUT (9779-SEQ) with Cable Tie.

NOTE: Leave the Cable Ties loose in case slack is needed at the PCBA assembly.

NOTE: Ensure slack to wires where indicated.

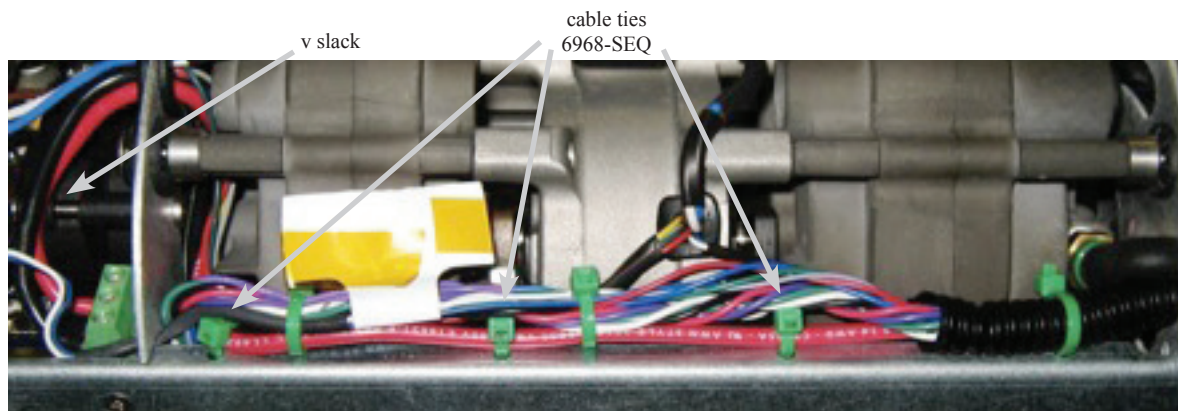


Figure 7-54. Secure Battery Wires

Orient the Cable Tie knots towards the Compressor.

7.8.4.4 Secure the ATF Bundled wires to the Battery Power Cables with cable ties.

NOTE: Leave the Cable Ties loose in case slack is needed at the PCBA assembly.

7.8.4.5 Ensure that there is slack on the wires on the areas indicated.

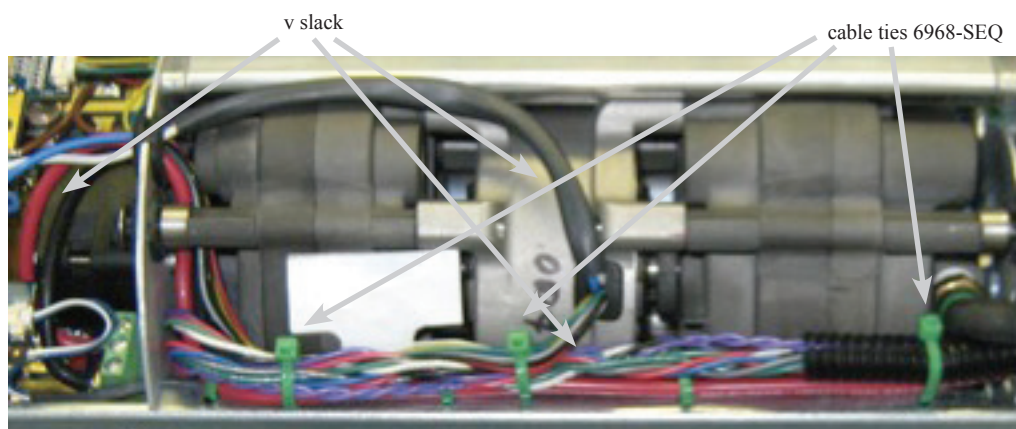


Figure 7-55. Slack

7.8.4.6 Install the Grommet onto the Bulkhead to secure the ATF and Battery wires.

Route the Battery Power wires and Hall Effect wire under the mounting Compressor screw and through the Bulkhead grommet as shown in figure below.

Route the ATF wire bundle under the STRUTS prior to rail installation and through the Bulkhead grommet as shown in figure below.

NOTE: Do not pinch Thermistor Cable in bulk head.

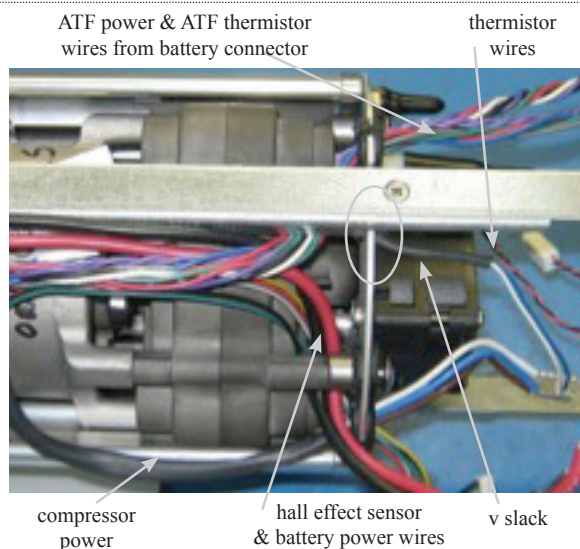


Figure 7-56. Secure ATF

7.8.5 COMPRESSOR FAN REPLACEMENT

7.8.5.1 Attach the Fan subassembly (9767-SEQ) with the flow arrows towards the Bulkhead as shown on figure. Apply Loctite 222MS (1405-SEQ) on the screws and torque to 2.0 in-lbs.

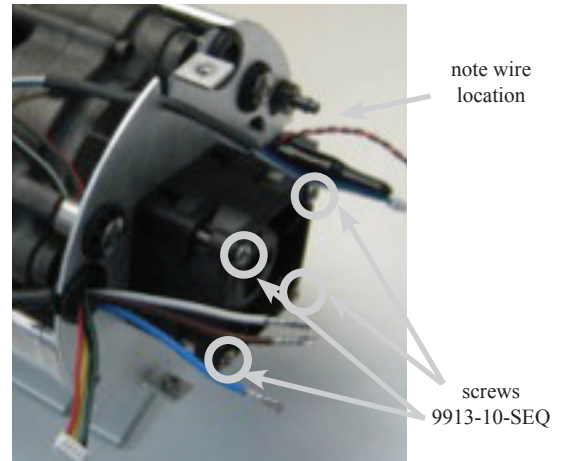


Figure 7-57. Fan

7.8.5.2 Connect the Compressor Fan wire to the PCB Assembly (If PCBA Assembly is connected)

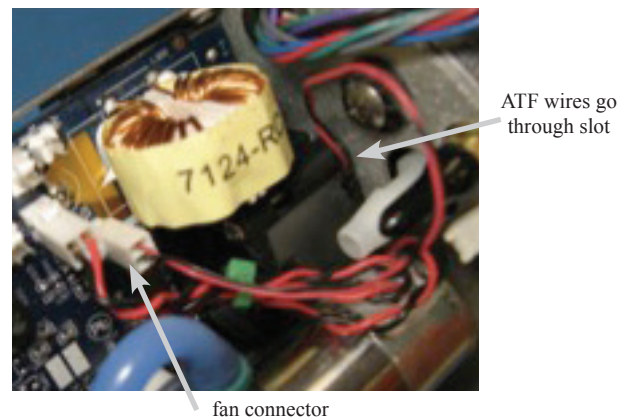


Figure 7-58. Compressor Fan Wire

7.8.6 PROPORTIONAL VALVE REPLACEMENT (5293-SEQ)

NOTE: A flow calibration procedure is required after replacing the ATF or Compressor, the PCB Circuit Board, the Proportional Valve. If any of these components are replaced, flow calibration is required. Flow calibration can be done at a CAIRE authorized service center or in the field using item T-10560. See manual MN053 for details on performing flow calibration and firmware updates in the field using item T-10560.

7.8.6.1 Attach the two screws (9203-7-SEQ) from the Proportional valve in to the Proportional Block below it and Torque to 3 in-lbs.



Figure 7-59. Proportional Valve

7.8.6.2 Secure the Flow Tube with a Cable Tie to the Proportional valve. Install mounting block to rails with two screws (9912-1-SEQ).

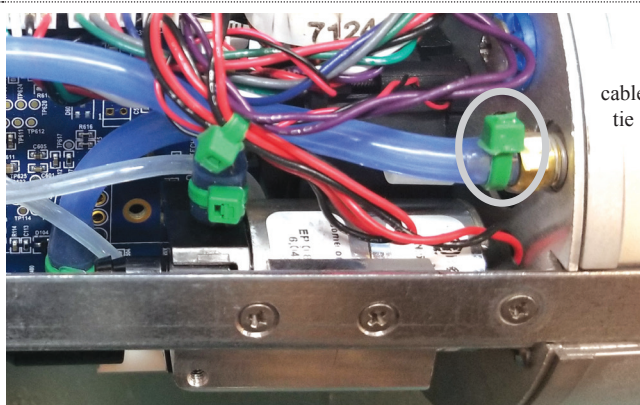


Figure 7-60. Secure

7.8.7 INSTALLATION OF PCB ASSEMBLY

NOTE: A flow calibration procedure is required after replacing the ATF or Compressor, the PCB Circuit Board, the Proportional Valve. If any of these components are replaced, flow calibration is required. Flow calibration can be done at a CAIRE authorized service center or in the field using item T-10560. See manual MN053 for details on performing flow calibration and firmware updates in the field using item T-10560.

7.8.7.1 Position the PCB Assembly between the 2 STRUTS (9779-SEQ & 9780-SEQ). Install 2 Screws on each side and torque the Screws to 6.0 in-lbs.

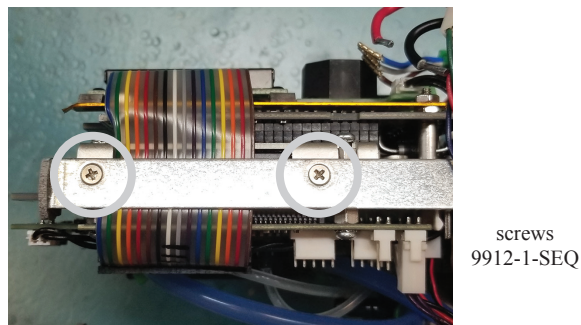


Figure 7-61. Screws

7.8.7.2 Insert and secure the Battery Power and Compressor Power Wires where shown. Use a flat blade screwdriver to tighten and torque the screws to 4.4 in-lbs.

NOTE: Battery wire polarity indicated on the PCBA. Red is (+) and Black is (-).

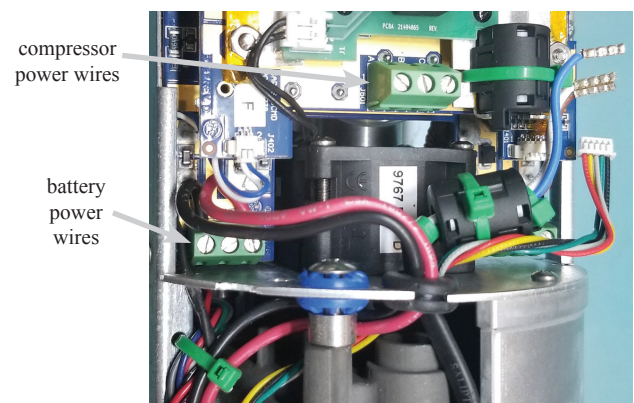


Figure 7-62. Secure Wires

7.8.7.3 Connect the Thermistor Connector to the PCBA

7.8.7.4 Secure Ferrites to the Compressor Wires.

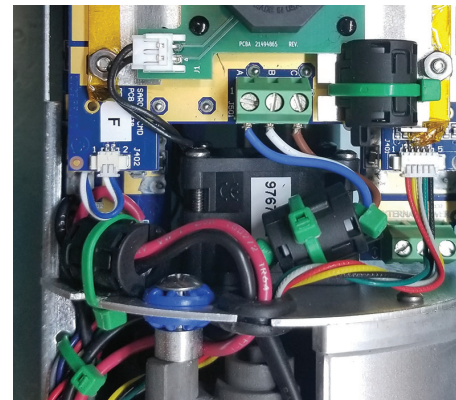


Figure 7-63. Secure Ferrites

7.8.7.5 Connect the Hall Effect Connector to the PCBA

NOTE: Ensure there is enough slack to the Hall Effect Wire

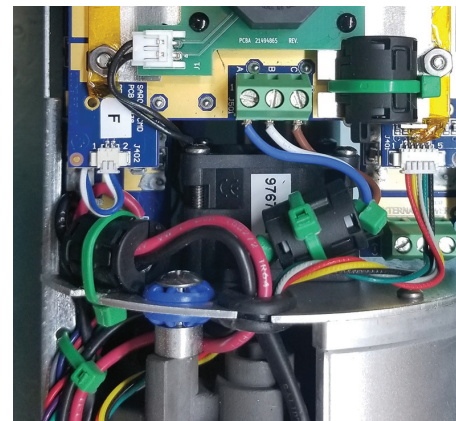


Figure 7-64. Connect

7.8.7.6 Connect the Fan Connector to the PCB and connect flow tubing.

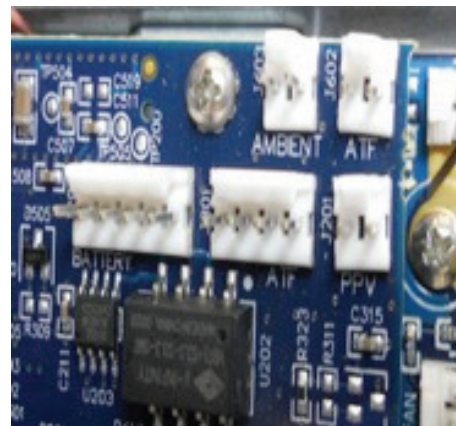


Figure 7-65. Fan Connector

7.8.7.7 Attach the Flow Tube into the Product Tank. Secure the Flow Tube with Cable tie.

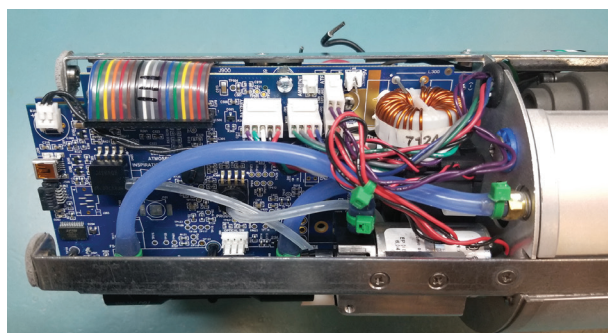


Figure 7-66. Flow Tube

7.8.7.8 Tighten and secure all wires with Cable Ties.

NOTE: Orient ALL Cable Tie knots towards the Compressor.



Figure 7-67. Tighten

7.8.7.8 Tighten and secure all wires with Cable Ties.

NOTE: Orient ALL Cable Tie knots towards the Compressor.

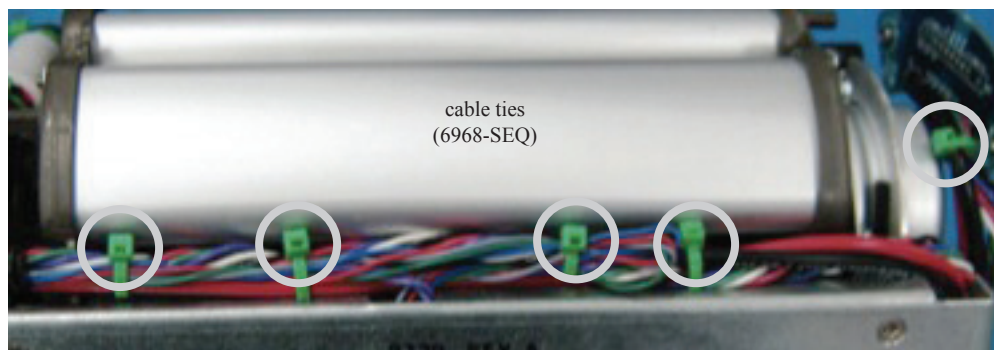


Figure 7-68. Tighten

7.8.7.9 Add Cable Tie to hold wires away from the coil. Hand-tighten loose as in Figure below.

cable tie
(6968-SEQ)



Figure 7-69. Cable Ties

7.8.7.10 Attach Top STRUT (9778-SEQ) with 5 screws as shown on figure below. Torque the screws to 6.0 in-lbs.

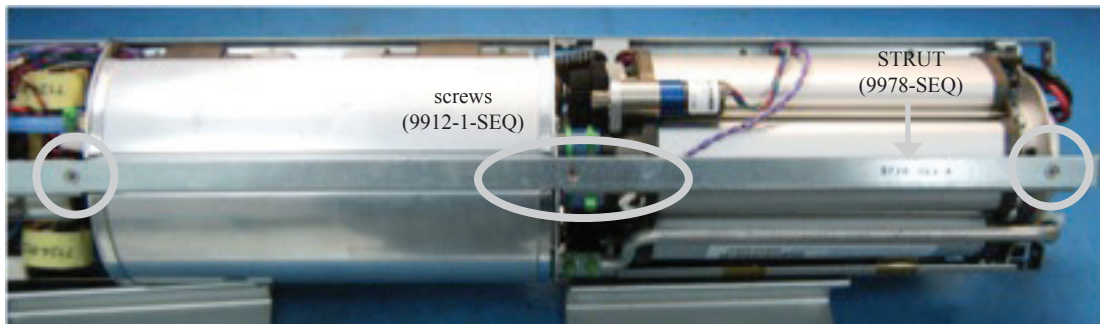


Figure 7-70. Top strut

7.8.8 POWER CONNECTOR REPLACEMENT (9766-1-SEQ)

7.8.8.1 After performing steps 6.7.1.1 thru 6.7.1.8 from “INLET CAP REMOVAL”

7.8.8.2 Remove the four screws (9203-2-SEQ) and remove the Power Connector (9766-1-SEQ).

power connector
(9766-1-SEQ)

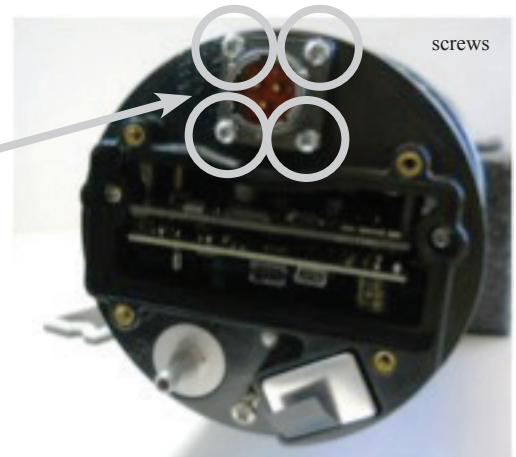


Figure 7-71. Remove screws

7.8.8.3 Install new Power Connector (9766-1-SEQ). Use Loctite 222 on the four mounting screws. Replace O-Ring (9916-3-SEQ) if necessary.



Figure 7-72. Power Connector

7.8.8.4 Perform steps 7.8.10.4 – 7.8.10.11 from section “Inlet Cap Installation”.

7.8.9 MEMBRANE PANEL REPLACEMENT (9731-1-SEQ)

7.8.9.1 After performing steps 7.7.1.1 thru 7.7.1.8 from “INLET CAP REMOVAL”.

7.8.9.2 Peel off the User Panel (9731-1-SEQ) as shown in the figure below.



Figure 7-73. Peel

7.8.9.3. Clean the surface shown in the figure with isopropyl alcohol before re-applying the new User Panel.

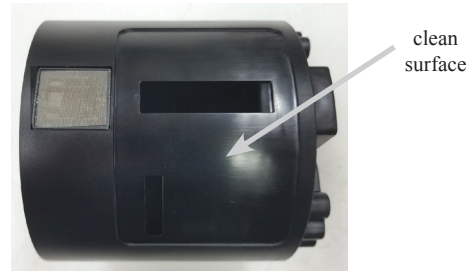


Figure 7-74. Clean

7.8.9.4 Remove the PSA protective cover from the new User Panel (9731-1-SEQ). Insert the Flex Cable as shown in the figure below.



Figure 7-75. Remove PSA cover

7.8.9.5 Position and apply the new User Panel as shown in the figures below. Press firmly on the entire surface of the new User Panel to insure that it is bonded correctly.



Figure 7-76. Apply new User Panel

7.8.9.6 Reconnect the small tube (4056-SEQ [2.3’’]).

7.8.9.7 Perform steps 6.8.10.4 - 6.8.10.11 from section “INLET CAP INSTALLATION”.

7.8.10 INLET CAP INSTALLATION (SP9756V2-SEQ)

7.8.10.1 Place O-Ring in the Ring Sleeve.

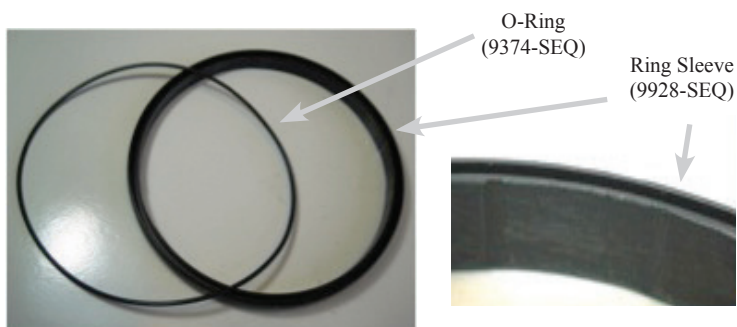


Figure 7-77. O-ring attached

7.8.10.2 Align and slide the three O-Rings in the Ring Sleeve over the three struts.

NOTE: Verify arrow points towards the inlet cap.

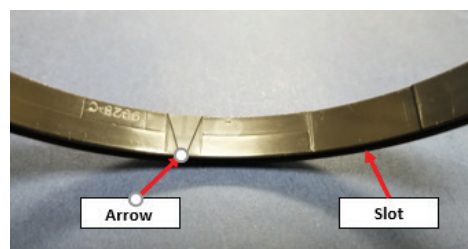


Figure 7-78. Arrows on O-ring

7.8.10.3 Place the Extended Top Cap (SP9756V2-SEQ) over the STRUTS so that the LCD Display is lined up with the Membrane Panel Window.



Figure 7-79. Inlet Caps

7.8.10.4 Connect the Breath Detect Tube.

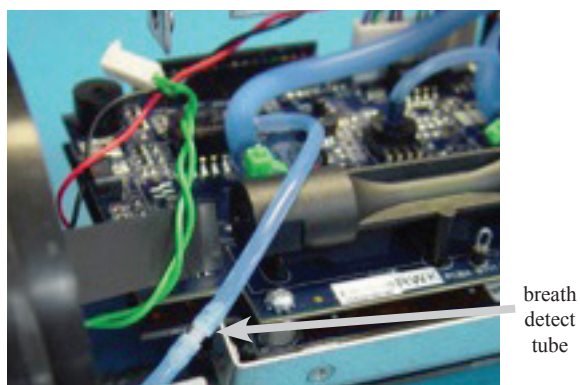


Figure 7-80. Breach Tube

7.8.10.5 Insert Power Harness wires from the Extended Top Cap and tighten the screws to 4.4 in-lbs. Route AC power wires through ferrite attached to board.

NOTE: Battery wire polarity indicated on the PCBA. Red is (+) and Black is (-).

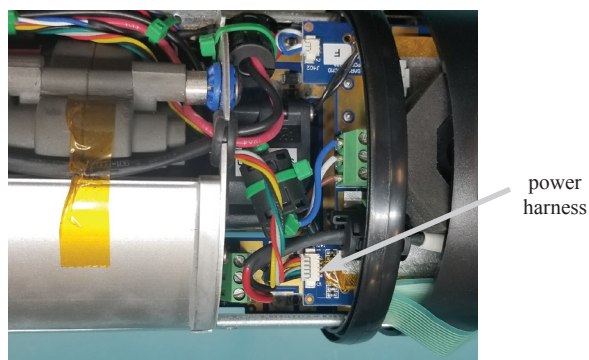


Figure 7-81. Power Harness Wires

7.8.10.6 Insert Front Panel Flex cable flush with locking connector. Apply 2" of Kapton Tape (2696-SEQ) on the Mounting STRUT.

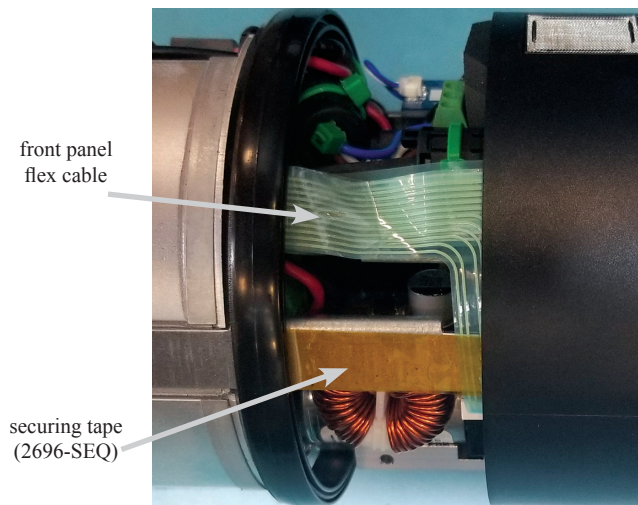


Figure 7-82. Flex cable

7.8.10.7 Connect the Ambient Air Thermistor and connect 9V Battery Connector as shown.

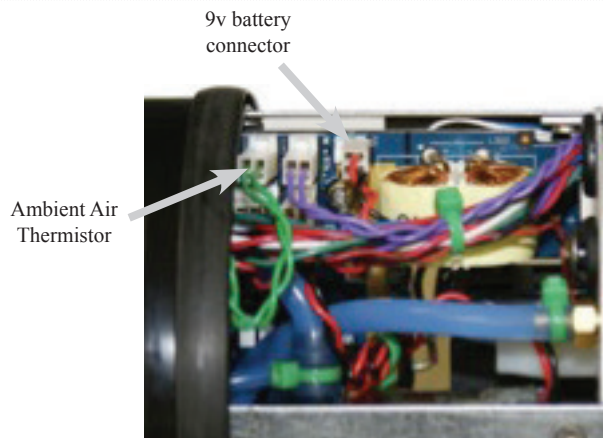


Figure 7-83. Ambient Air Thermistor

7.8.10.8 Attach the Oxygen Outlet Tube (6981-SEQ) to the Flow Valve outlet port and secure with a cable tie.

NOTE: If flow valve is not installed, refer to Flow Valve Replacement Procedure.

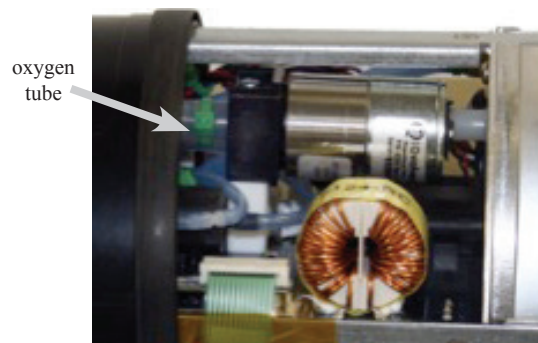


Figure 7-84. Oxygen Outlet Tube

7.8.10.9 Secure the three Inlet Cap Mounting screws (9914-11-SEQ) to each STRUT.

inlet cap
mounting screws
9914-11-SEQ

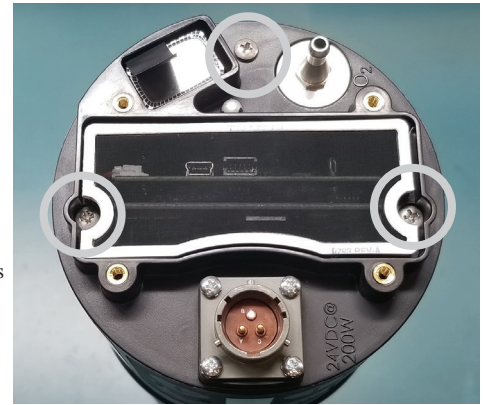


Figure 7-85. Inlet Cap mounting screws

7.8.10.10 Insert and connect the 9V Battery (9257-SEQ) and the Filter (9798-SEQ).

filter



Figure 7-86. 9V battery

7.8.10.11. Align the Air Inlet Cover (9758-SEQ) to the top of the SAROS and tighten the four screws (9291-SEQ).

tighten
screws

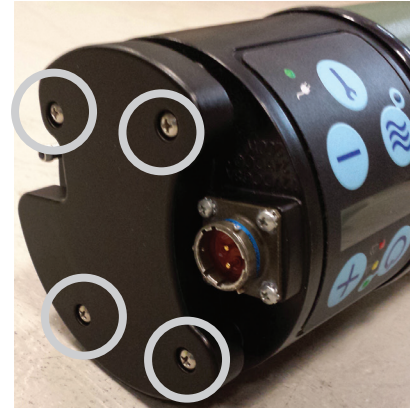


Figure 7-87. Align covers and tighten

7.8.11 INSTALLATION OF THE SLEEVE & BATTERY INTERFACE PLATE

7.8.11.1 Slide Sleeve (21341894) and Ring sleeve with O-Rings (9928-SEQ) over struts, and insert it into Aligning Ring that is attached to the Inlet Cap.

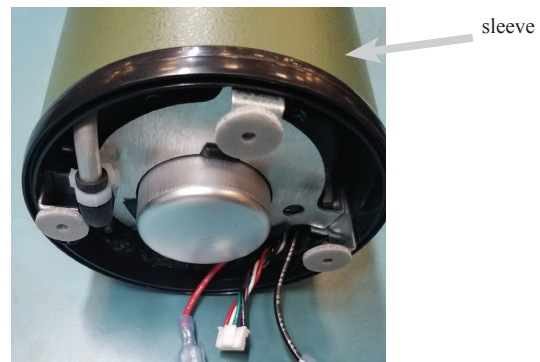


Figure 7-88. Slide Sleeves

7.8.11.2 Align second Sleeve (21341894) AND O-RING (9928-SEQ) over the STRUTS, to the Sleeve leaving the Battery board exposed.

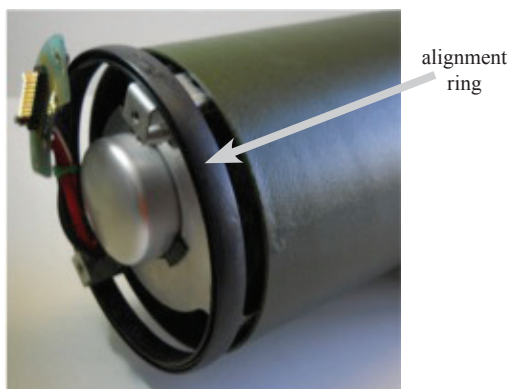


Figure 7-89. Second sleeve

7.8.11.3 Attach the Battery Interface Assembly (21494877) to the Rain Guard by attaching the two screws (9960-15-SEQ). Torque to 3.5 in-lb.

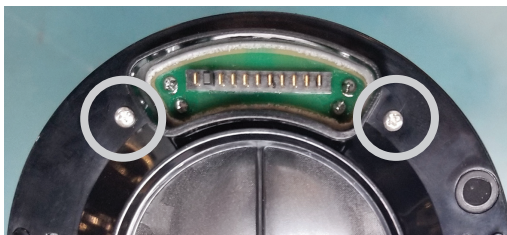


Figure 7-90. Battery Interface Assembly

7.8.11.4 Connect battery wires to battery bridge board assembly. Align and attach the Exhaust tube to the Exhaust port on the Rain Guard.

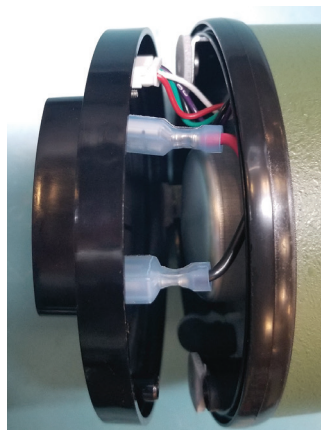


Figure 7-91. Attach

7.8.11.5 Align the three screws (9914-12-SEQ) of the Battery Interface Plate (SP9939-1-SEQ) to the Rain Guard. Torque to 15 in-lb.



Figure 7-92. Align

8.0 CLASSIFICATION

Type of protection against electric shock:

Class II Protection from electric shock is achieved by double insulation.

Degree of protection against electric shock:

Type BF Equipment providing a particular degree of protection against electric shock regarding

- 1) allowable leakage current;
- 2) reliability of protective earth connection (if present).

Not intended for direct cardiac application.

Independent testing for Medical Electrical Equipment Standard:

Tested to be in compliance with

- IEC 60601-1 edition 3.1: Medical Electrical equipment - Part 1 General Requirements for safety.

Protection against potential electromagnetic or other interference between the equipment and other devices.

- Tested to be in compliance with EN 60601-1-2/IEC 60601-1-2: 4th Edition.
- Tested to be in compliance with RTCA/DO160 Section 21 Category M.
- CISPR 11 / EN 55011 Class B Group 1, “Industrial, Scientific, and Medical (ISM) Equipment”
- FCC Part 15, Subpart B – Class B Unintentional Radiators

IP33 – Protection against ingress of tools, thick wires, etc. > 2.5mm. Water falling as a spray at any angle up to 60° from the vertical shall have no harmful effect.

Method of cleaning and infection control allowed: Please refer to “Cleaning, Care, and Proper Maintenance” section of this FreeStyle User Manual.

Degree of safety of application in the presence of flammable anesthetic gases: Equipment not suited for such application.

Mode of operation: Continuous duty.

9.0 SERVICE RECORDS & RETENTION

9.1 RECORD HOURS OF OPERATION AND SOFTWARE VERSION

To help maintain the SAROS, you may obtain the Total Hours of Operation and software version numbers for the Control Board.

To obtain system information, follow these steps:

Press the “Utility” Button on the control panel and advance to the following display mode for each time the icon is depressed:

- | | | | |
|-----------------|---------------------|-------------------------|---------------------------|
| • Tactical Mode | • Pulse Sensitivity | • Tactical Brightness | • Hour of Operation |
| • Alarm Code | • LCD Contrast | • Normal Brightness | • System Software Version |
| | • Tactical Volume | • 9-volt Battery Status | • Motor Software Version |

Total Hours of Operation	
Alarm Code	
Pulse Sensitivity	
LCD Contrast	
Tactical Volume	
Tactical Brightness	
Normal Brightness	
9-Volt Battery Status	
Hour Meter	
System Software Version	
Motor Software Version	

Table 9-1. Log the Results

Whenever maintenance or service is performed on an SAROS unit, an entry should be made in the service log for that concentrator or recorded in accordance with your company's standard procedure. Whenever the sleeve of the SAROS is removed, the flow rate, purity, and alarm status should be verified per the Test Procedures in this manual.

[illegible]

Table 9-2. Sample SAROS Maintenance Record

APPENDIX A

A.1 SAROS PERFORMANCE VERIFICATION CHECKLIST

SAROS Serial Number:											
Hours of Operation:					Date of Testing:						
A. General Operation Test			Pass			Fail					
1) Battery installs properly											
2) External power cord (AC or DC) connects securely											
3) Unit powers on after holding ON/OFF button for 3 seconds											
4) Audible alarm sounds upon start-up											
5) 5-minute warm up period complete with no audible alarm											
6) Utility Mode shows no active alarms after 5-minute warm up											
7) Battery icon visible on screen											
8) Battery is charging or already fully charged											
9) Increase and decrease flow buttons are functional											
10) Pulse flow mode button is functional											
11) No breath alarm is functional											
12) Unit runs on battery power											
13) No battery alarm is functional											
14) Automatic re-start when power is reconnected											
B. Flow and O₂ Concentration Test			Acceptable Range			Recorded Reading					
1) Continuous Flow Setting Verification											
C3 (3.0 LPM)) O ₂ Concentration			90 - 96 %								
C3 (3.0 LPM) flow -- 60 second average reading ¹			Argon-Compensated Testing Device: 2.70 - 3.30 LPM			Non Argon-Compensated Testing Device: 2.60 - 3.20 LPM					
C2 (2.0 LPM)) O ₂ Concentration			90 - 96 %								
C2 (2.0 LPM) flow -- 60 second average reading ¹			Argon-Compensated Testing Device: 1.80 - 2.20 LPM			Non Argon-Compensated Testing Device: 1.70 - 2.10 LPM					
2) Pulse Flow Mode Verification (only one method below required)											
P48 (48 mL) -- 5 bolus average reading (if manually recording measurements)			40.8 - 55.2 mL			1:	2:	3:	4:	5:	Avg:
P96 (96 mL) -- 5 bolus average reading (if manually recording measurements)			81.6 - 110.4 mL			1:	2:	3:	4:	5:	Avg:
P48 (48 mL) -- average reading (if tester records readings)			40.8 - 55.2 mL			1: NA	2: NA	3: NA	4: NA	5: NA	Avg:
P96 (96 mL) -- average reading (if tester records readings)			81.6 - 110.4 mL			1: NA	2: NA	3: NA	4: NA	5: NA	Avg:
C. Battery Run Time Test			Acceptable Range			Recorded Reading					
C3 (3.0 LPM)			> 24 min								

Table A-1. SAROS Performance Verification Checklist

Footnotes: (1) The SAROS is BTP compensated. If measuring concentration and/or flow with a device that is non-Argon compensated and non-BTP compensated, the acceptable range of the device readings will be reduced by 0.1 LPM.

Technician Name (print): _____

Technician Signature: _____

Date: _____

NOTES

NOTES



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15 Dec 2022 MN260-D