731 Series Ventilator Service Manual

Models: Z Vent, EMV+, Eagle II, and AEV

906-0731-04-01 Rev. C

The issue date for the *ZOLL Ventilator Service Manual* (**REF** 906-0731-04-01 Rev. C) is **April 2024**.

Masimo Pulse Oximeter

This device uses Masimo SET® technology to provide continuous pulse oximeter and heart rate monitoring and is covered under one or more of the following U.S.A. patents: 5,758,644, 5,823,950, 6,011,986, 6,157,850, 6,263,222, 6,501,975 and other applicable patents listed at www.masimo.com/patents.htm.

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Table Of Contents

Chapter 4 Service Kit Installation Procedures

Service Kits

Chapter 5 Electrical Safety Testing

Chapter 6 Ventilator & Calibration Troubleshooting

Chapter 1
General Information

Introduction

This chapter provides general information about the ZOLL Ventilator Service Manual. Specifically, this chapter provides:

- A description of this manual.
- A List of Acronyms, Abbreviations and Device Symbols.
- A list of warnings and cautions regarding the servicing of ZOLL ventilators.
- Technical Support contact information.

The *ZOLL Ventilator Service Manual* provides information that ZOLL-trained service technicians need for the safe and effective repair of ZOLL ventilators. It is important that all persons servicing this device read and understand all information contained within. Before performing service procedures, please thoroughly read the information found in this manual related to the following topics.

- All Warnings, Cautions, and Guidelines
- Preventive Maintenance Procedures
- Service Codes
- Service Kit installation Procedures
- Electrical Safety Procedures

Related Publications

Service Technicians should obtain and be familiar with the relevant release 4 (V4) or release 5 (V5) Ventilator Operators Guides, RCS Operators Guide, and operators guides for the devices they will use to perform Electrical safety testing of the ventilator. Product documentation is available through the ZOLL website at www.zoll.com.

Covered Products

This service manual covers the following Ventilator Models:

- EMV+ (MRI & NON-MRI)
- Z-Vent (MRI & NON-MRI)
- Eagle II (MRI & NON-MRI)
- AEV

Service Manual Updates

A revision level (A, B, C, ...) and publication date (month/year) for this manual appears on the inside of the front cover. Contact ZOLL to determine the latest manual release and make sure to use the latest revision.

Acronyms and Abbreviations

A/C- Assist/Control

AEV- Automatic Electrical Ventilator

ACLS- Advanced Cardiac Life Support

ALS- Advanced Life Support

ATLS- Advanced Trauma Life Support

ACV- Assist-Control Ventilation

AMC- Alarm Message Center

APOD- Advanced Probe Off Detection

ATPD - Atmospheric Temperature and Pressure Dry

b/min- Beats Per Minute

B/V - Bacterial/Viral Filter

BiPAP- Bilevel positive airway pressure

BPM - Breaths per Minute

cm H_2O - Centimeters of Water

CPAP- Continuous Positive Airway Pressure

CPR - Cardiopulmonary Resuscitation

CPU- Central Processor Unit

dBA- Decibel

DISS - Diameter Index Safety System

EMC- Electromagnetic Compatibility

EMV- Emergency Medical Ventilator

ESD- Electrostatic Discharge

FIO_2 - Fraction of Inspired Oxygen

HME - Heat and Moisture Exchanger

HMEF - Heat and Moisture Exchanger/Bacterial Viral filter combined

HP O_2- High Pressure Oxygen

Hz – Hertz (as in frequency, cycles per second)

I:E- Inspiratory to Expiratory time ratio.

ID - Internal Diameter

L - Liters

LCD- Liquid Crystal Display

LED - Light Emitting Diode

LPM - Liters Per Minute

ml - Milliliters

mm - Millimeter

MRI- Magnetic Resonance Imaging

NPPV – Noninvasive Positive Pressure Ventilation

O_2- oxygen

P_{aw} - Airway Pressure

PEEP - Positive End Expiratory Pressure

PIP - Peak Inspiratory Pressure

PPV- Positive-Pressure Ventilation

PS- Pressure support

psi - Pounds per Square Inch

RF- Radio Frequency

RTC- Real time clock

SIMV - Synchronized Intermittent Mandatory Ventilation

SPM- Smart Pneumatic Module

UIM - User Interface Module

USP - United States Pharmacopeia

VAC - Volts AC

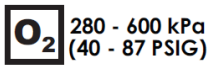
VDC - Volts DC

V_T - Tidal Volume

WOB – Work Of Breathing

Device Symbols

SYMBOL	DESCRIPTION
	OFF
	ON
	DIRECT CURRENT: Identifies the location to connect external DC Power.
	ESD: Warns that connector pins should not be touched.
	Do Not Re-Use: This item should not be re-used.
	Do Not Discard: Follow all governing regulations regarding the disposal of any part of this medical device.
	Defibrillation Proof: Indicates the degree of protection against electrical shock.
	BF Symbol: Protection against electric shock, Type B with floating (F-type) parts.

	Power Input Orientation: Locates the DC input identifying its point of insertion.
	Manufacturer: This symbol identifies the name and address of the manufacturer.
	Manufacturer Date: Manufacturer Date Symbol identifies the device's date of manufacture.
	Refer to instruction manual.
	Menu icon. This icon identifies the button that, when pressed, displays a menu of options that you can select to configure the ventilator.
	High Pressure 02 Connector (Top Faceplate, Note: The appearance of this label may be different depending on ventilator age).
	Exhalation Valve (Top Faceplate, Note: The appearance of this label may be different depending on ventilator age).
	Exhaust Do Not Occlude (top faceplate icon).

	Transducer (Top Faceplate, Note: The appearance of this label may be different depending on ventilator age).
	Gas Output -- Patient Circuit Connector (top faceplate icon).
	Non-Sterile
	High Priority Alarm
	Medium Priority Alarm
	Low Priority Alarm
	External Power: Indicates the device is operating using an external power source.
	No External Power: Indicates the device is operating without an external power source.

	Internal Battery: Provides indication of battery capacity and charging.
	No Internal Battery: Indicates when internal battery is not an available power source.

Conventions

This manual uses the following conventions:

- Within text, the names and labels for physical buttons and soft-keys appear in **boldface** type (for example, “Press the **ACCEPT** button”). This guide uses uppercase italics for text messages displayed on the screen.

WARNING:
Warning statements within this manual alert technicians to conditions or actions that can result in personal injury or death.

CAUTION:
Caution statements alert you to conditions or actions that can result in damage to the unit.

NOTE:
A Note provides additional information intended to avoid inconvenience when servicing a ventilator.

General Warnings

- The information contained herein is restricted for use by personnel trained by ZOLL Medical Corporation in the care and servicing of this product. ZOLL does not authorize or assume any obligations resulting from unauthorized servicing of its products nor will it be held liable for any injuries or damages incurred therefrom.
- This device has been classified “life supporting” and “life sustaining” by the United States Food & Drug Administration. If you have not been trained directly by ZOLL Medical Corporation in the care and servicing of this product, DO NOT attempt to service this device.

Service Technician Safety Warnings

Be attentive to these warnings when servicing a ventilator.

- Possible explosion hazard if used in the presence of flammable anesthetics or other flammable substances in combination with air, oxygen-enriched environments, or nitrous oxide.
- This ventilator is not intended for use in explosive atmospheres.
- Pins of connectors identified with the ESD warning symbol should not be touched.
- Always use precautionary procedures with ESD-sensitive connections.
- Internal components are susceptible to damage from static discharge. All servicing operations must be done in an ESD controlled environment, with the exception of electrical safety testing.
- Oxygen Clean Parts should never be handled with bare hands. Use caution not to contaminate any oxygen clean parts during servicing of the equipment as explosion hazards exist.

Contacting Technical Support

If the ventilator requires service, contact one of the following ZOLL Technical Support Departments.

Customers In the U.S.A.		**Customers outside the U.S.A.**
Telephone	1-800-348-9011 1-978-421-9655	Call the nearest authorized ZOLL Medical Corporation representative.
Email	techsupport@zoll.com	To locate an authorized service center, contact: tservice_master@zoll.com

Military Customers	
Telephone	1-800-348-9011 1-978-421-9655
Email	milsupport@zoll.com

When requesting support, please provide the following information to the support representative:

- Ventilator serial number
- Description of the problem, and service code if available
- Department using the equipment and name of the person to contact
- Purchase order to allow tracking of loan equipment
- Purchase order for a device with an expired warranty

Returning A Ventilator For Service

Before sending a ventilator to the ZOLL Technical Support Department for repair, obtain a service request (SR) number from a service representative.

The Li-ion battery should remain secured inside the ventilator. Follow any additional local or international shipping protocols regarding Lithium Ion batteries if required.

Pack the ventilator with its power supply in the original shipping containers
(if available) or equivalent packaging. Be sure the assigned service request (SR) number appears on each package

Return the device to:

For customers	Return the device to
In the U.S.A.	ZOLL Medical Corporation 269 Mill Road Chelmsford, MA 01824 Attention: Technical Support Department (*SR number)* Telephone: 1-978-421-9655
In Canada	ZOLL Medical Canada 405 Britannia Road East, units 17-19 Mississauga, Ontario, L4Z3E6, Canada Attention: Technical Support Department (*SR number*) Telephone: 1-866-442-1011
In other locations	The nearest authorized ZOLL Medical Corporation representative. To locate an authorized service center, contact ZOLL International technical support at: **tservice_master@zoll.com**

Chapter 2
Device Overview & Architecture

Introduction

This chapter provides a general overview of the various models within the 731 Series of ventilators along with detailed information covering system and pneumatic architectures.

The below list of topics are covered in the following pages:

- **Ventilator Models**
- **Main Features**
- **Controls and Indicators**
- **Pneumatic Diagram**
- **Functional Descriptions**

Ventilator Models

NOTE:

Z Vent, EMV+, and Eagle II models have MRI-compatible versions not shown.

Ventilator Model	Description
 Z Vent	The Z Vent® ventilator is easy to use, portable, durable, and rugged. Designed to be lightweight and energy-efficient, Z Vent is ideal for all types of transport: ground ambulances, critical care transports, and air transports.
 EMV+	Designed to meet military and civilian transport standards, the versatile EMV+® portable ventilator is ideal for air medical and ambulance transport of infants (≥5 kg), pediatric patients, and adults. Only 9.7 pounds (4.4 kg), EMV+ is lightweight yet rugged and features an energy-efficient integrated, high-flow compressor and oxygen system. The unprecedented 10-hour battery run-time and multisource power system allow operation and rapid charging with any power source of ground vehicles and aircrafts.
 Eagle II	The Eagle II model's adapts the design of the EMV+ for use by emergency departments and intra-hospital transport. Its design also allows it to be mounted onto walls or onto specified boom arms and roll stands as well as gurneys.
 AEV	The AEV model's is designed for managing ventilator support patients during ambulance transport. Its ventilation modes (AC, CPAP with PS, and BL) are specifically chosen to be consistent with pre-hospital care provider's operating procedures.

Main Features

Figure 2-1 shows the ventilator's main features.

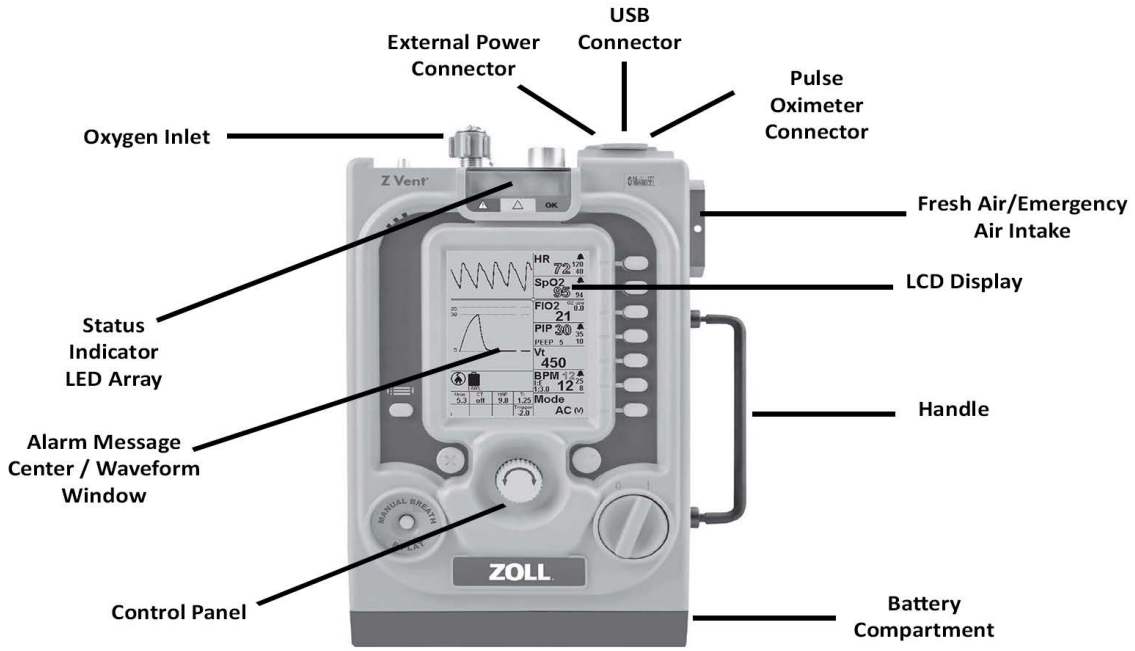


Figure 2-1 Main Features

Item	Location	Description
Oxygen Inlet	Top	Enables connection to an external high pressure oxygen source.
Status Indicator LED Array	Top	Lights to indicate ventilator status and a visible alarm indicator.
External Power Input Connector	Top	Enables connection to an external power source.
USB Connector	Top	Enables connection to a USB compatible device for servicing the ventilator.

Item	Location	Description
Pulse Oximeter Connector	Top	Enables connection to Masimo LNCS Sensors
LCD Display	Front	Displays settings, ventilation data, and alarm information.
Alarm Message Center	LCD Screen	Displays active alarms and alarm mitigation information.
Control Panel	Front	Provides user access to the ventilator settings.
Battery Compartment	Bottom	Holds the ventilator's rechargeable Li-ion battery.
Fresh Gas/Emergency Air Intake	Side	Enables the ventilator internal compressor to use ambient air and acts as an anti-asphyxia valve.
Handle	Side	

Controls and Indicators

The ventilator controls and indicators (shown in Figure 2-2) facilitate ease of use and visibility in all operating environments.

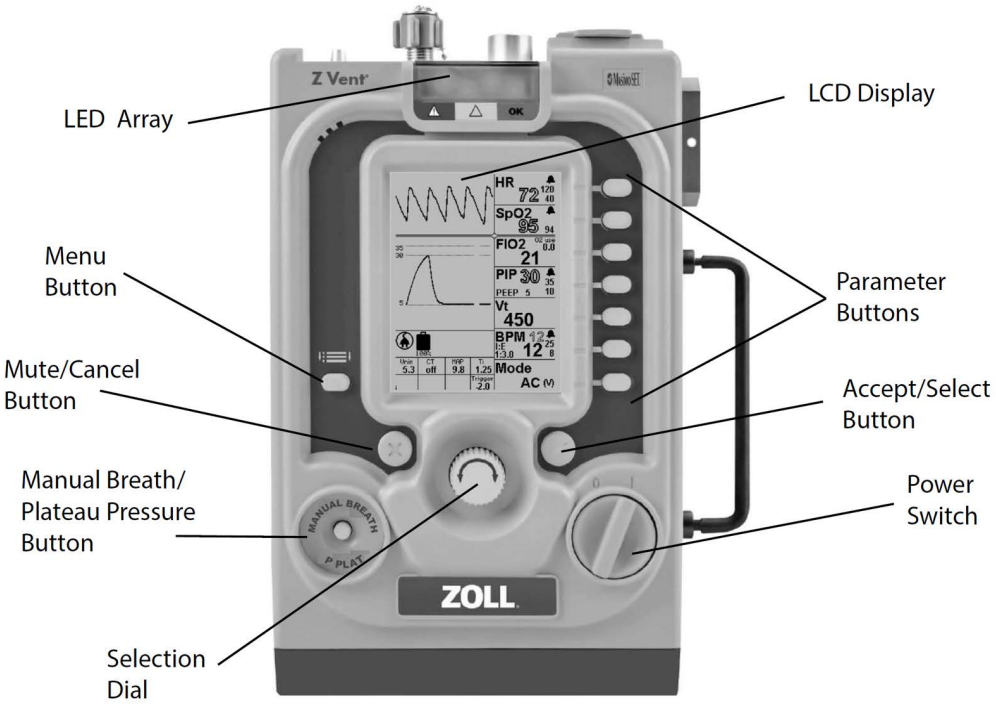


Figure 2-2 Controls and Indicators

Controls

The ventilator's controls consist of the following:

Control	Function
Power Switch	Provides the user to turn the ventilator ON and OFF.
Parameter Buttons	Provides the user to access primary parameters, secondary parameters and context menus associated with a primary parameter (if applicable), and then modify settings using the Selection Dial).
Menu Button	Provides the user to access the Menu.
Selection Dial	Allows the user to set values for a chosen (highlighted) Primary Parameter, Secondary Parameter, Context Menu item, and Menu item. Values accelerate with speed of turning.
Mute/Cancel button	The Mute/Cancel button mutes the audible alarm allowing the user time to change parameters. It can also be used to cancel parameter entries.

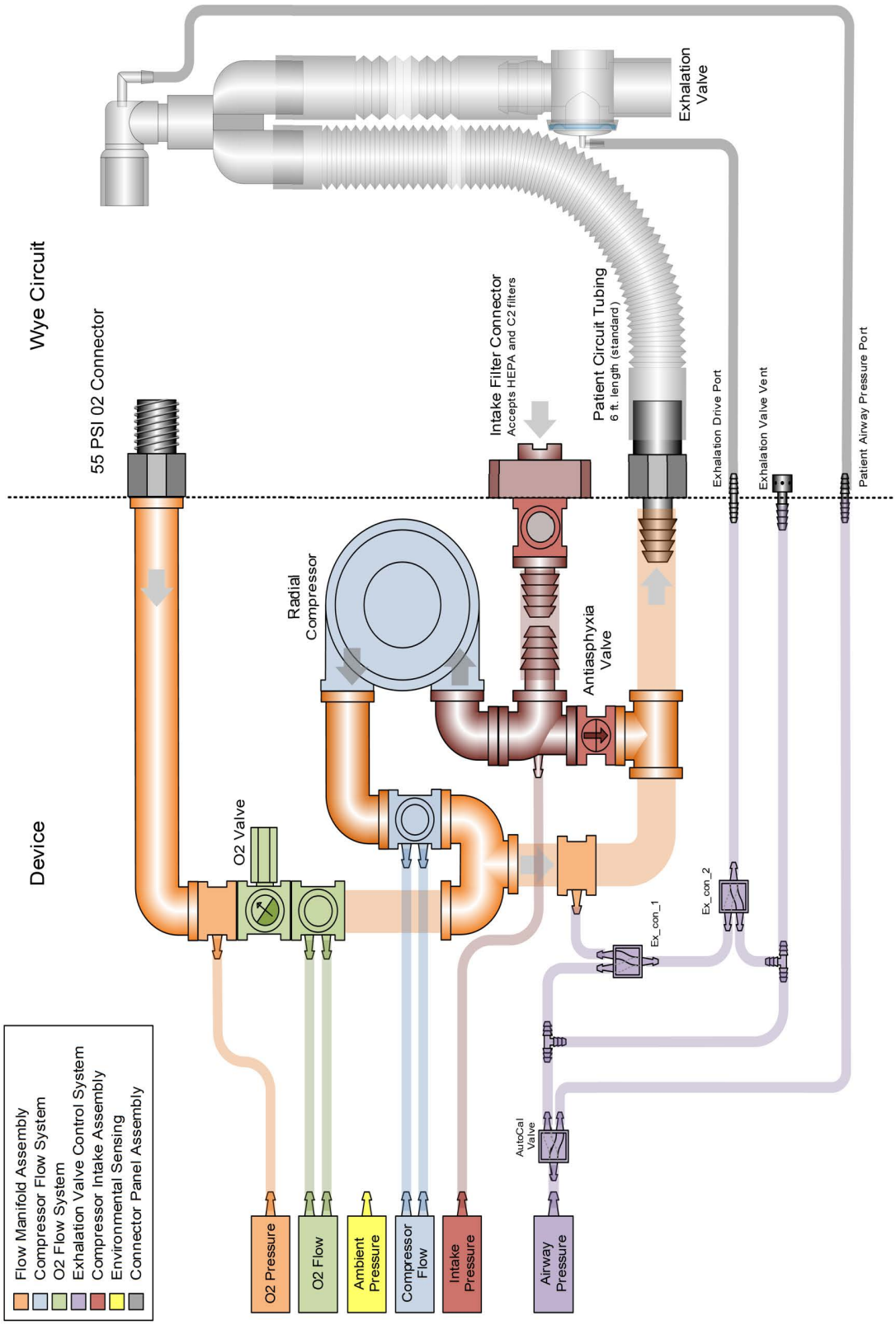
Control	Function
Accept/Select button	The Accept/Select button allows the user to accept parameter value settings, acknowledge popup messages, and accept menu choices
Manual Breath Button/ Plateau Pressure	Enables the user to deliver a manual breath and measure Plateau Pressure Note: Plateau Pressure is an optional ventilator control.

Indicators

The ventilator's indicators consist of the following:

Indicator	Description
LCD Display	Displays settings, patient data, and alarm information.
LED Array	Indicates operational status (Red, Yellow, or Green).

Pneumatic Diagram



Functional Descriptions

Flow Manifold Assembly

The flow manifold assembly comprises of the O2 flow system, the mix manifold and the compressor connector. Directly attached to the flow manifold are the Connector panel, O2 filter assembly, the gas outlet fitting, compressor assembly and the Fresh Gas/Emergency Air Intake assembly. One of flow manifold's main purpose is to route and mix, if needed, the 2 primary gas sources (oxygen and air) to the patient. The assembly also houses the pneumotach components necessary to measure the two gas flows. Sensors (oxygen flow, oxygen pressure and compressor flow) and the exhalation control valves are connected to the flow manifold via tubing.

Compressor Flow System

The compressor flow system includes the Fresh Gas/Emergency Air Intake assembly, Compressor assembly, flow sensor, motor drive circuitry, diffuser and pneumotach. During compressor operation, room air (or a combination of room air with low flow oxygen) is entrained and cleaned through a 2-stage filtering process in the Fresh Gas / Emergency Air intake assembly. A sensor measures the incoming pressure to determine if any blockage is present. The flow rate is controlled by adjusting the compressor motor speed using hardware on the SPM board. The air flow is then diffused and measured using a pneumotach connected to a differential pressure transducer. A calibration table is used to determine and adjust the required flow rate as determined by the user configured respiratory parameters.

02 Flow System

The oxygen flow system includes the oxygen filter, proportional/variable orifice valve, oxygen manifold, flow and pressure sensors, diffuser and pneumotach. High pressure oxygen coming from an in-wall or regulated cylinder source is connected to the Oxygen filter. A sensor measures the incoming oxygen pressure for an acceptable usable range. Once filtered the pressure is routed to the proportional valve which controls the flow rate. The flow is then diffused and measured using a pneumotach connected to a differential pressure transducer. A calibration table is used to determine and adjust the required flow rate as determined by the user configured respiratory parameters.
.

Exhalation Valve Control System

To deliver fresh gas to the patient, the ventilator will pressurize the exhalation valve located on the Wye circuit. The system uses pressure from the flow that is routed through the mix manifold to a series of 3-way valves located on the SPM board. The valves act as gates to allow a pressure build up on the exhalation valve's diaphragm during inhalation and will allow the pressure to exhaust to atmosphere for exhalation. The valves are also used to perform the PEEP feature.

Fresh Gas / Emergency Air Intake Assembly

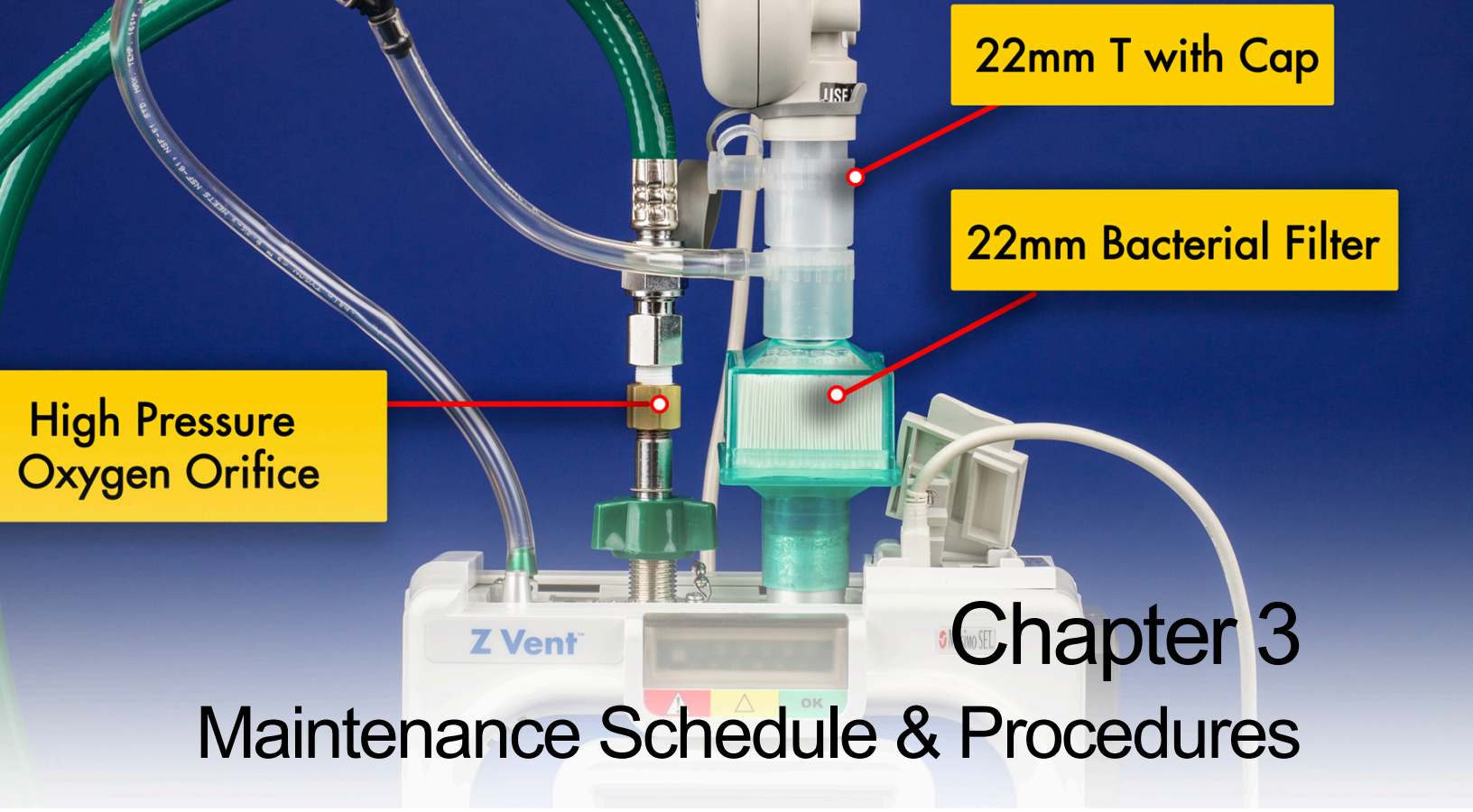
A two-stage filtering system is used to clean air entrained by the compressor. The assembly houses a disk and foam filter. There is an anti-asphyxia valve connected to the intake assembly to allow a patient to breathe ambient air should the ventilator fail. The intake is designed to accept additional filters through an integrated 22mm connection and also incorporates a connection for a C2A1 style chemical/biological filter. The assembly acts as a means to entrain supplemental low flow oxygen using ZOLL's O2 Reservoir kit. See the Operators guide for detailed use.

Environmental Sensing

The 731 ventilator incorporates sensors for ambient and device temperatures and barometric pressure/altitude. These sensors are located on the SPM board. The temperature sensors are used to alert the user if operating conditions are drifting out of specified range. The barometric pressure sensor is monitored to continuously correct the output of the ventilator parameters for changes in altitude.

Connector Panel Assembly

The Connector Panel Assembly is a user interface that allows for connection of the patient circuit's main hose, patient airway monitoring hose and exhalation drive hose. The panel also has the high pressure oxygen connection attached. The panel is the pathway for the exhalation valve's pressure to exhaust to atmosphere. Power input and power filtering are connected to the control panel. Located to the front and right of the Control Panel is the USB port for calibration and diagnostics and the pulse oximeter connector.



Chapter 3
Maintenance Schedule & Procedures

Introduction

The ventilator should be incorporated into a regular maintenance program to ensure safe and effective operation. Electro-mechanical and pneumatic components are subject to wear and fatigue over time and components deteriorate more quickly when used continuously.

Scheduled replacement of filters, batteries, seals and mechanical/pneumatic moving parts ensures that the ventilator is always operating at peak performance.

This chapter will cover the following aspects of routine maintenance:

- **Maintenance Schedules**
- **Annual and 4 year PM Kits**
- **Stockpile Warm-Up Procedure**
- **Discreet Test Overview**
- **Annual Hardware Maintenance Procedures**
- **4 Year Hardware Maintenance Procedures**
- **Setup Diagrams**

NOTE:

This chapter does not cover the detailed calibration process or provide step by step instruction for the calibration of ventilators. Rather, this chapter provides a general overview for reference purposes. For additional information and instruction on using the RCS refer to the RCS Operator's guide.

Table 1 on the following page outlines the scheduled interval for routine parts replacement, calibration and testing. Ventilators used in extreme environments may warrant earlier or more frequent maintenance scheduling.

The ventilator has a built in function generating an alarm to remind the user of the PM/Calibration Due date (#3120). Refer to the respective alarm codes in the troubleshooting section of this manual.

731 Series Ventilators Maintenance Schedule

Maintenance Schedule	Year After Initial Purchase of Ventilator *							
	1	2	3	4	5	6	7	8
Replace the high pressure oxygen inlet and compressor foam and disk filters	X	X	X	X	X	X	X	X
Perform a periodic maintenance check using the RCS tool.	X	X	X	X	X	X	X	X
Replace the main battery				X				X
Replace the Real Time Clock (RTC) battery				X				X
Inspect and replace if necessary any internal tubing, gaskets, O-Rings, that show signs of wear				X				X

*** Ventilators with Stockpile configurations may require annual maintenance to be conducted every other year if the total run time of the ventilator is less than 5 hours for Stockpile I configuration, or less than 50 hours for Stockpile II configuration. Stockpile configurations do not impact or change the 4 year maintenance schedule.**

Table 1

Annual & 4 Year Service Kits

The following tables provide part numbers for PM kits across the line of 731 Series ventilators. See the Service Kits chapter for information on additional kit options. (**Click to Jump**)

Kit	Z Vent, EMV+, Eagle II, and AEV
4 Year PM Kit	712-0731-21
Annual PM Kit	712-0731-35

RCS Procedures (Remote Calibration System)

ZOLL's ventilator service tool, the Remote Calibration System (Figure 1) is needed to complete the PM process, and thereby reset the PM/Calibration Due alarm (#3120). The RCS can be purchased from ZOLL Medical, however it's sale is restricted to only authorized customers and service partners. The RCS is intended for use by biomedical professionals who have been trained on it's use by ZOLL Medical.

In addition to automating and documenting the PM process, the RCS is capable of calibrating the ventilator and installing and verifying software upgrades and updates. If you have not been trained on the RCS procedures, or do not have access to an RCS, ventilators can be returned to ZOLL for calibration or calibration may be performed on-site by a field service technician. Contact ZOLL Technical support in order to inquire.

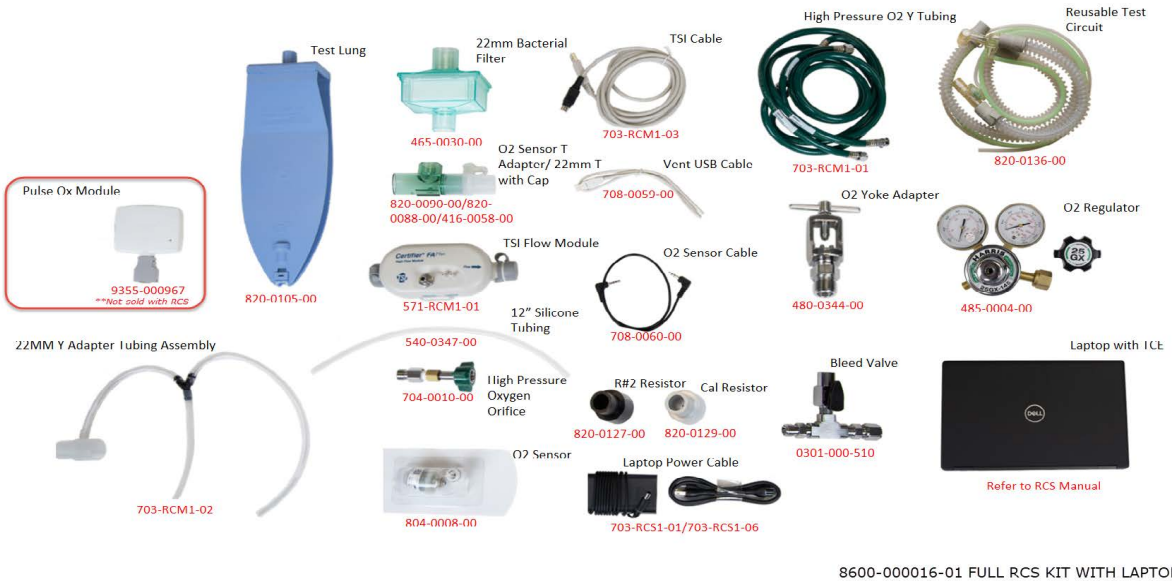
The RCS performs both testing and calibration of the ventilator by processing the ventilator through a series of discrete tests. Discrete tests may be performed individually to aid in troubleshooting, or in part of a larger sequence such as:

- **Incoming System Testing**
- **Complete Calibration**
- **Outgoing System Testing**

A description of each discrete test along with an overview of the 13 step calibration and testing process can be found on the following pages.

NOTE:
The TSI Flow Module requires yearly calibration. Do not attempt to start ventilator calibration without first checking the last calibration date for the TSI Flow Module. For additional information on RCS inspection, storage and maintenance see the chapter titled "RCS Maintenance" within the RCS Operator's Guide.

Figure 1- RCS Kit. Note: Depending on the RCS Kit configuration, the Laptop is an optional component. The Masimo tester is not included in either configuration and must be purchased separately.



Process Overview

The table below provides a technical overview of the 13 step calibration & testing process. If a device is being removed from long term storage or a stockpile, you must first complete the "**Stockpile Warm-Up Procedure"** found following this table.

NOTE:

The below outline provides a general overview of the calibration and testing procedure. The order of the steps may change, depending on individual circumstances.

Step		Description & Notes
1	**"Occlusion Test" – Compressor bypass protection**  **Scan or click to watch a video of this procedure.**	1. Remove external power from the device and power off 2. Occlude the Gas Output Port of the Device 3. Power on the device, continue to occlude until the device displays a high priority alarm (SC 1001 or 1030). 4. Power off the device, install the Calibration Resistor to the Fresh Gas Intake Port of the device. 5. Occlude the Resistor and power on the device. 6. Once the High priority alarm SC 1030 occurs, the device may be powered off. 7. Remove Calibration Resistor from the Fresh Gas Intake Port 8. Switch on the ventilator and ensure that the compressor cycles.
2	**Workstation (RCS Operators Manual: Chapter 3)**	9. Follow ESD Precautions at each workstation. 10. Ensquipmenure all et is calibrated.
3	**Physical Inspection** **(RCS Operators Manual: Chapter 4)**	Perform Device Inspection as outlined in RCS User Manual Note: The device is expected to be at the same temperature as the lab environment.
4	**Connect Device**	11. Launch RCS Software 12. Connect the TSI High Flow Module to PC 13. Select Get TSI 14. Once TSI check is complete, select 731 Series Ventilator and Proceed 15. Select the Service Sequence, then proceed. 16. Connect to device via USB service Port (See RCS User Manual)
5	**Read (TCE 7.X)** **Read Vent (RCS 8.X)**	**TCE 7.X** - Select the "Read" button. If TCE displays popups asking if you would like to program the various components, Select "Yes" for all. **RCS 8.X** - Select the "Read Vent" button. Program a version 5 configuration if required.
6	**Read Forensic Memory**	From the Sequence list, Select & Run "Read Forensic Memory"

Step		Description & Notes
7	**Note: This test is only required in the case of a reported complaint or identified failure.** **TCE 7.X Incoming System Tests** **RCS 8.X (System Tests)**	**TCE 7.X** - From the Sequence list, select & run “Incoming System Tests” **RCS 8.X** - From the Service Actions list, select and run “System Tests” If the test fails, check your set up and re-try. Review Troubleshooting guide to address failures. Use the Discrete Test drop down to confirm that the failed result has been addressed Prior to running the calibration and outgoing system test. Do NOT retry more than 3 times. Call for support. **Note**: Completion of the Incoming System Test Sequence is not required. Verify failures have been corrected using the discrete tests.
8	**Device Service or PM Kit Installation**	Service the device to address issues identified during testing. Install 1 Year or 4 Year PM Kit per instructions.
9	**TCE 7.X - Complete Calibration** **RCS 8.X - Calibration**	**TCE 7.X** - From the Sequence list, Select & Run “Complete Calibration” Note: Complete Calibration must complete without any failures to apply the calibration to the device. **RCS 8.X**- From the Service Actions list, Select & Run “Calibration” **Note**: Calibration must complete without any failures to apply the calibration to the device.
10	**TCE 7.X - Outgoing System Test** **RCS 8.X (System Tests)**	**TCE 7.X** - From the Sequence list, select & run “Outgoing System Tests” **RCS 8.X** - From the Service Actions list, select and run “System Tests” Do NOT retry more than 3 times. Call for support. **Note:** Outgoing System Tests / System Tests must be completed without any failures to update the PM due date and generate the customer certificate.
11	**Erase Forensic Memory**	From the Sequence or Service Actions list, Select & Run “Erase Forensic Memory”
12	**Final Configuration**	**TCE 7.X** - From the Sequence List, select and run “Final Configuration”, select the appropriate configuration file. **RCS 8.X** - Final Configuration is only required only when a change in the current configuration is necessary. Note: Do NOT change the original configuration without prior authorization. Contact technical support to change configuration or for authorization.
13	**Test Records & Calibration Reports**	Upon completion of the testing and calibration sequences, ensure calibration reports are printed, signed and filed.
Table 3		

Stockpile Warm-Up Procedure

It is recommended for ventilators not in regular continued use to use the following settings to exercise the electro-mechanical components prior to connecting the device to the RCS system. Failure to complete this warm-up procedure may result in testing or calibration failures of the device.

Step	Instructions
1.	Connect 55 PSI O2 to the ventilator.
2.	Connect the patient circuit to the vent, the circuit's patient connection end to resistor R#2 then add the test lung.
3.	On the vent set Mode: AC(V), Breath Rate= 20 BPM, Vt= 450ml, PIP High alarm=50cmH2O, FIO2=60% run for 5 minutes.
4.	Set FIO2 to 100%. Run for 5 minutes.
End of Procedure	

An Overview of Discrete Tests

The tables below provide a technical overview of the individual discrete tests performed during routine calibration. The order of these tests may vary both by sequence and RCS software version. Note there are separate tables for RCS software version 7 and version 8.

Test Name	Description
Comm RAM and Bootloader Check	The TCE verifies functionality of the EMV Communication Interface (Rx and Tx signals), CPU RAM interface and RAM functionality (address and data lines), and the Bootload interface (boot select, reset and watchdog disable), as well as the ability to communicate with the SPM through the CPU board (SPM Rx, Tx, bootselect, and reset).
Power Switch Check	The TCE checks the functionality of the power switch. The switch is double pole, double throw, so each pole will be checked.
EMV Self Check	Check of the ventilator's core hardware, software and communications during power up.
LCD Contrast Set	The TCE confirms contrast adjustability by prompting the operator to adjust the contrast.
LCD Visual Inspection	The TCE guides an operator through a visual inspection of the LCD and acquire operator confirmation that the display is defect free.
Button Check	Ability to verify functionality of all the buttons by having the operator physically press the buttons and using the device communication interface to detect and indicate the button is being pressed
Total Power Failure Alarm Check	The TCE verifies the 120s total power failure alarm circuitry.
LED Check	The TCE checks that all Front Panel LED's are functional and the correct color by sending test mode commands to the device to selectively illuminate the LED being tested
Encoder Check	The TCE checks that the rotary dial is functional by having the operator physically turn the dial and using the device communication interface to detect and indicate encoder increment and decrement.
Buzzer Check	Operator confirms the buzzer is audible:
Pulse Ox Sp02 & Heart Rate	Masimo Tester Model # 1593 (or equivalent simulator) is used to test the Pulse Oximeter SpO2 and Heart Rate on the 731 series ventilator.
SPM Self Check	The device software continuously checks to see that the hardware has not failed. The SPM software checks for presence of specific alarms, in event an alarm is active, and the TCE indicates a failure.
SPM Blink	Operator confirmation that Alarm #1173, Red LED's and buzzer are activated within 15 seconds.
TSI Calibration Check	The date of the last calibration, the ambient temperature and the altitude of test are all properties checked for this test.
Calibration Check Barometric Pressure	The TCE checks to see that the barometric pressure sensor in the device is accurate.
Calibration Check Compressor System	The TCE performs the Calibration Check to evaluate the Airflow, Intake and RPM to determine a PASS/FAIL result for the Compressor System.

Test Name	Description
Calibration Check Airway Pressure	The TCE performs the Calibration Check to determine a PASS/FAIL result for the Airway Pressure System.
Calibration Check 02 Kickstart	The TCE performs the Calibration Check to evaluate the breath volume to determine a PASS/FAIL result for the O2 Kickstart.
Calibration Check 02 System	TCE perform the Calibration Check to determine a PASS/FAIL result for the O2 system
O2 Leak Filter and Pressure Cal. Check	The TCE verifies that there is no leak in the high pressure O2 supply interface, the sintered bronze filter is present and not clogged, and the O2 supply pressure calibration meets specification.
Manifold Leak Check	The TCE verifies that the manifold (everything pneumatically connected to the gas output port) has an acceptable leak rate when tested at 5 cmH2O and 25 cmH2O.
Exhalation Backup and Autocal Valve	The TCE verifies that the Exhalation Valve, Backup Valve and Autocal Valve are tubed correctly can switch completely and can switch with an acceptable delay.
Compressor Bypass Protection	The TCE verifies that the compressor bypass protection mechanism is functional by imposing the fault condition and then verifying recovery from the fault condition.
Breath Performance Check	The TCE verifies functionality of all the major pneumatic components working together via a matrix of breath and lung settings.
Date and Time Set	The TCE set the date and time in the device to the laptop time.
Date and Time Check	The TCE verifies functionality of date and time in the device vs. laptop time.
Verify UUT and Reference device	The TCE checks for reference device and UUT serial numbers during a test to ensure the UUT and/or reference device are not swapped.
Conditional PM Due Reset	The TCE resets the PM due date, if the calibration and functional checks are successful.
End of Discrete Test List	

Table 1 - Test Sequences RCS 7.X	<------ RCS RELEASE 7 ------>		
Discrete Test	***Incoming System Testing***	***Complete Calibration***	***Outgoing System Testing***
Comm RAM and Bootloader Check	●		●
Power Switch Check	●		●
EMV Self Check	●		●
LCD Contrast Set	●		●
LCD Visual Inspection	●		●
Button Check	●		●
Total Power Failure Alarm Check	●		●
LED Check	●		●
Encoder Check	●		●
Buzzer Check	●		●
Li-Ion Battery Check	●		●
Pulse Oximeter SpO2 and Heart Rate	●		●
SPM Communication		●	
SPM Self Check	●	●	●
SPM Blink	●		●
TSI Calibration Check	●	●	●
Calibration Check Barometric Pressure	●		●
Compressor Calibration		●	
Incoming Calibration Check Compressor System	●		
Calibration Check Compressor System			●
Airway Pressure Calibration		●	
Incoming Calibration Check Airway Pressure	●		
Calibration Check Airway Pressure			●
O2 Kickstart Calibration		●	
Calibration Check O2 Kickstart	●	●	●
O2 Flow Calibration		●	
Incoming Calibration Check O2 System	●		
Calibration Check O2 System			●
O2 Leak Filter and Pressure Cal. Check	●		●
Manifold Leak Check	●		●
Exhalation Backup and Autocal Valve	●		●
Compressor Bypass Protection	●		●
Breath Performance Check			●
Date and Time Set			●
Date and Time Check			●
Download Calibration Tables		●	
Verify UUT and Reference Device	●	●	●
Conditional PM Due Reset			●

Table 2 - Test Sequences RCS 8	RCS RELEASE 8 SEQUENCES								
Discrete Test Name	*Calibration*	*System Tests*	*Battery and Power System Tests*	*Front Case Tests*	*Calibration Checks*	*SPM Functional Check*	*Pulse Ox Test*	*Erase Forensic Memory*	*Final Configuration*
Comm RAM and Bootloader Check				●					
Power Switch Check		●		●					
EMV Self Check		●		●					
LCD Contrast Set		●		●					
LCD Visual Inspection		●		●					
Button Check		●		●					
Total Power Failure Alarm Check			●						
LED Check		●		●					
Encoder Check		●		●					
Buzzer Check		●		●					
Li-Ion Battery Check		●	●						
Pulse Oximeter SpO2 and Heart Rate		●					●		
SPM Communication									
SPM Self Check	●	●			●	●			
SPM Blink		●				●			
TSI Calibration Check	●	●			●	●			
Calibration Check Barometric Pressure	●				●	●			
Compressor Calibration	●					●			
Calibration Check Compressor System	●				●	●			
Airway Pressure Calibration	●					●			
Incoming Calibration Check Airway Pressure									
Calibration Check Airway Pressure	●				●	●			
O2 Kickstart Calibration	●					●			
Calibration Check O2 Kickstart	●				●	●			
O2 Flow Calibration	●					●			
Incoming Calibration Check O2 System									
Calibration Check O2 System	●				●	●			
O2 Leak Filter and Pressure Cal. Check		●				●			
Manifold Leak Check		●				●			
Exhalation Backup and Autocal Valve		●				●			
Compressor Bypass Protection		●				●			
Breath Performance Check		●				●			
Date and Time Set		●							
Date and Time Check		●							
Download Calibration Tables	●					●			
Verify UUT and Reference Device	●	●				●			
Conditional PM Due Reset		●							
Erases Forensic Memory								●	
Final Configuration									●

Hardware Maintenance Routines

The following pages cover the required annual hardware replacement procedures. Service kits for annual and 4 year cycles can be purchased from ZOLL medical. See the section above titled “Annual & 4 year service kits” for additional information, or contact ZOLL Medical technical support.

Written instructions are accompanied by detailed videos which can be accessed by either scanning or clicking on the QR code included within each instruction set.

The following filters should be changed annually on all 731 Series ventilators.

- Oxygen Filter
- Foam Filter
- Disk Filter

CAUTION:
PERFORM THESE PROCEDURES IN AN ESD CONTROLLED ENVIRONMENT. TAKE ALL NECESSARY ESD PRECAUTIONS TO PREVENT DAMAGE TO THE UNIT!
Always wear a properly grounded anti-static wrist strap when handling exposed electrical components.
Use grounded mats on workbenches, and grounded floor mats in work areas.
Never let exposed PCBs come in contact with clothing. Ground straps cannot dissipate static charges from fabrics.
Keep all components in antistatic bags until you are ready to install them.
Failure to follow accepted ESD handling practices could cause damage to sensitive electronic components.

Oxygen Filter Replacement (Annual)

The Oxygen Filter is held on by three screws located on the top connector panel. It is embedded within the oxygen inlet filter.

Required Annually		
Oxygen Filter Replacement Instructions		**Scan Or Click To Watch Video**
Required Equipment:	• 1 Year Service Kit (See Service Kits Chapter) • #2 Phillips Head Screw Driver • Torque Driver	

Step	Removal Instructions
1.	To begin, unscrew the oxygen inlet cap.
2.	Using a #2 Phillips head screwdriver remove the three 8-32 flat head screws securing the oxygen inlet fitting to the ZOLL 731 Ventilator.
3.	Next, lift and remove the oxygen inlet fitting.

Step	Replacement Instructions
1.	Before replacing the oxygen inlet fitting, be sure to insert the center rubber O ring into its recess.
NOTE	There may be an additional 3 rubber O rings that need to be inserted. Check the requirement for your ventilator before beginning.
2.	Lower the oxygen inlet fitting into position with the screw holes properly aligned.
NOTE	Ensure the chain is facing the gas output fitting.
3	Next, using a torque driver set to 19 in lbs/2.14 newton meters replace the three 8-32 flathead screws.
4	To complete, screw on the oxygen inlet cap.

Foam Filter Replacement (Annual)

The Removable Foam Filter is located on the right side of the ventilator. It should be inspected and replaced if needed every 1,000 hours of operation or more frequently if used in dusty environments.

Required Annually		
Foam Filter Replacement Instructions		**Scan Or Click To Watch Video**
Required Equipment:	• 1 Year Service Kit (See Service Kits Chapter) • Tweezers/hemostats	

Step	Removal Instructions
1.	To begin, using tweezers, reach into the compressor intake housing and grasp the foam filter.
2.	Lift and remove the foam filter.

Step	Replacement Instructions
1.	Lower the foam filter into the compressor intake housing.
2.	To complete, lightly tap the foam filter into place, allowing it to expand into the fresh gas intake housing.

Disk Filter Replacement (Annual)

The Fresh Gas/Emergency Air Intake Disk Filter is located behind the Removable Foam Filter. This filter provides a second level of filtration to the ambient air that is delivered to the patient. This filter must be checked periodically and replaced when necessary. The device triggers an alarm when the combination of Removable Foam Filter and Fresh Gas/Emergency Air Intake Disk Filter become dirty. This alarm signifies that the device is still able to deliver the correct tidal volume but one or more of its filters need replacement. The Fresh Gas/Emergency Air Intake Disk Filter can be visually inspected after the Fresh Gas Intake assembly is removed. If the filter appears discolored it must be replaced.

Required Annually		
Disk Filter Replacement Instructions		**Scan Or Click To Watch Video**
Required Equipment:	• 1 Year Service Kit (See Service Kits Chapter) • Tweezers/hemostats • #2 Phillips Head Screwdriver • Torque Driver	

Step	Removal Instructions
1.	To begin place the ventilator on it's side so that the fresh gas intake faces up. Using a #2 Phillips head screwdriver loosen the four Phillips 8-32 flathead screws securing the fresh gas intake to the chassis.
2.	Lift and remove the fresh gas intake.
3.	Using tweezers, grasp the disk filter and lift to remove it from the BV filter holder.

Step	Replacement Instructions
1.	Using tweezers lower the disk filter into the BV filter holder, ensuring it is properly seated.
2.	Insert the fresh gas intake into the device, making sure that its alignment pin mates. The O-Ring and gasket should be checked and replaced if damaged.
3.	Using a torque driver set to 14 in lbs/1.58 newton meter replace the four 8-32 flathead screws.

Main Battery Replacement (Every 4 Years)

ZOLL 731 Series Ventilators are internally powered by a 6.6 Ah, 14.8 V, Lithium-Ion Battery. Only trained technicians should replace the Main battery within the unit. Note that new batteries are shipped at a 30% charge per IATA/DOT UN 38.3 mandates.

Required Every 4 Years		
Main Battery Replacement Instructions		**Scan Or Click To Watch Video**
Required Equipment:	• 4 Year Service Kit, or Battery Replacement Kit (See Service Kits Chapter) • Torque driver with #1 and #2 Phillips bits.	

Step	Removal Instructions
1.	For complete written instructions, refer to the section “4 Year Maintenance Kit” within the service kits chapter. (**Click to Jump**)

RTC Battery Replacement (Every 4 Years)

The RTC Battery within ZOLL 731 Series ventilators should be replaced Every 4 years, or when prompted by the device. Service Code 3110 “RTC Battery Low” will display on start up if the RTC battery is less than or equal to 2.5 VDC. The ventilator will remain fully functional when this occurs.

Required Every 4 Years		
RTC Battery Replacement Instructions		**Scan Or Click To Watch Video**
Required Equipment:	• 4 Year Service Kit. • #1 and #2 Phillips bits. • 3/8th” Keps Nut bit • Torque Driver	

Step	Removal Instructions
1.	For complete written instructions, refer to the section “4 Year Maintenance Kit” within the service kits chapter. (**Click to Jump**)

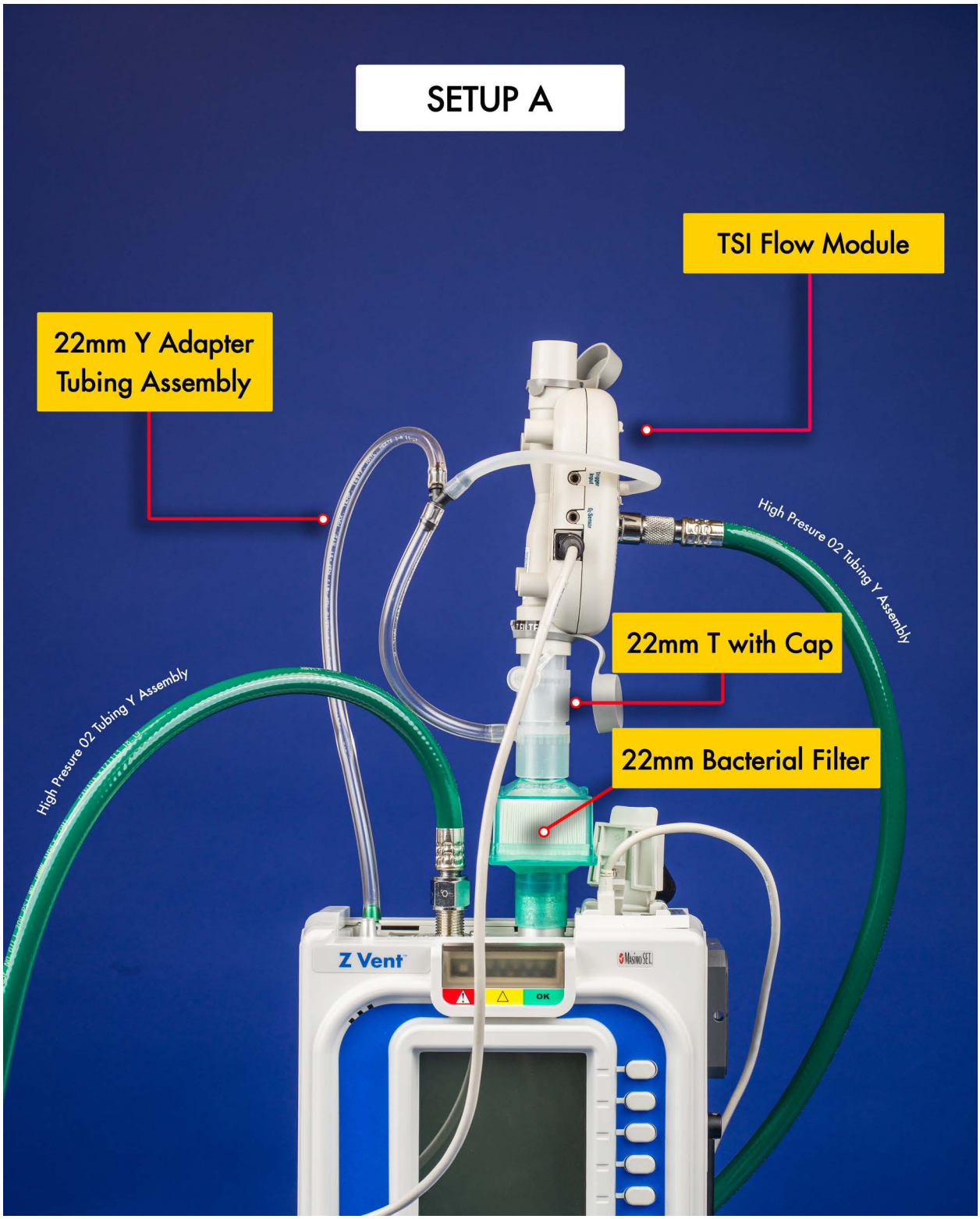
RCS Setups

The RCS setups illustrated on the following pages provide a visual overview of the various setups required during testing and calibration of the ventilator. You may find it valuable to print the following pages for quick reference during RCS usage.

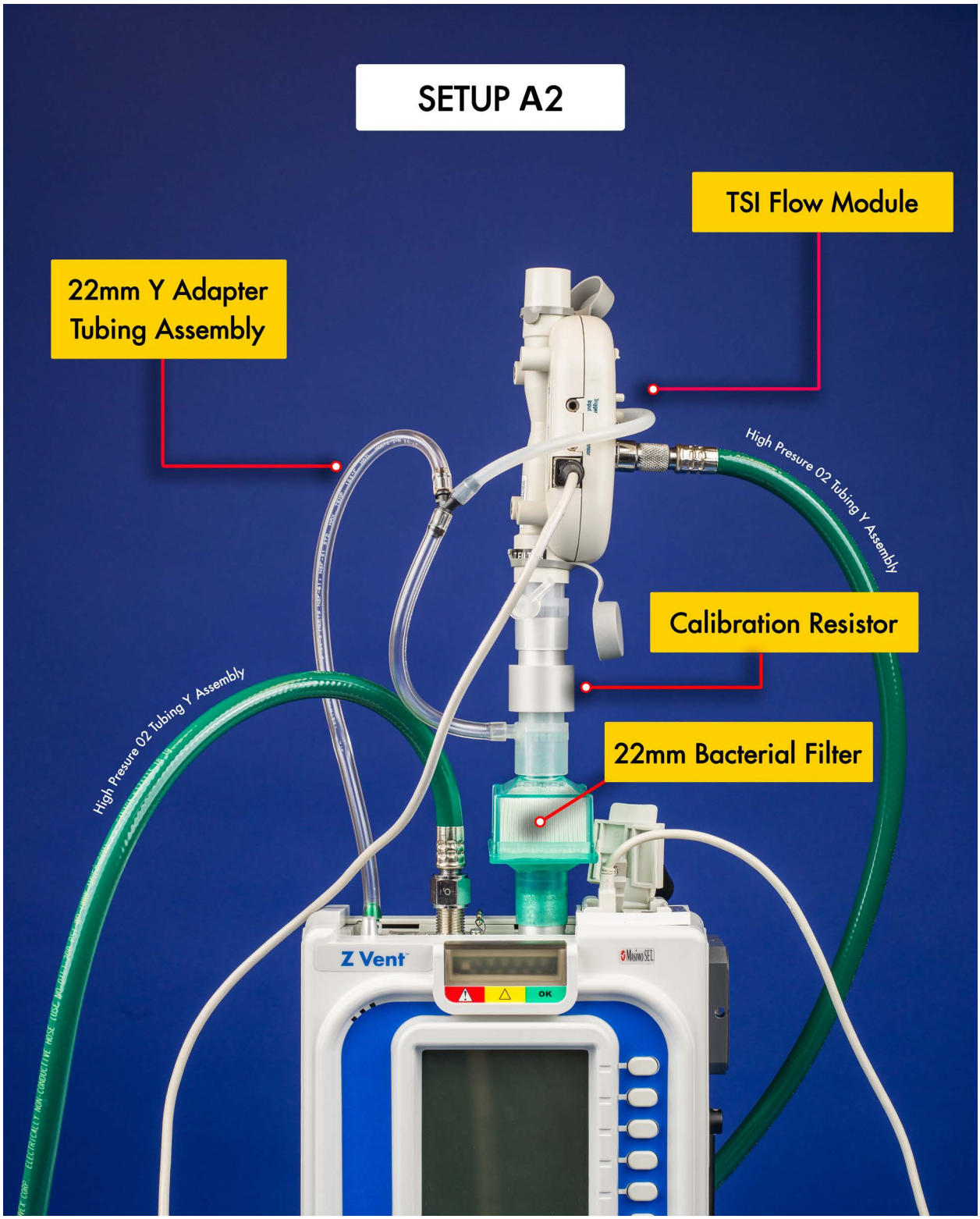
The following setup illustrations are listed below:

- **Setup A**
- **Setup A2**
- **Setup B**
- **Setup C**
- **Setup D**
- **Setup E**
- **Setup F**
- **Setup G**
- **Setup I**
- **Setup K**

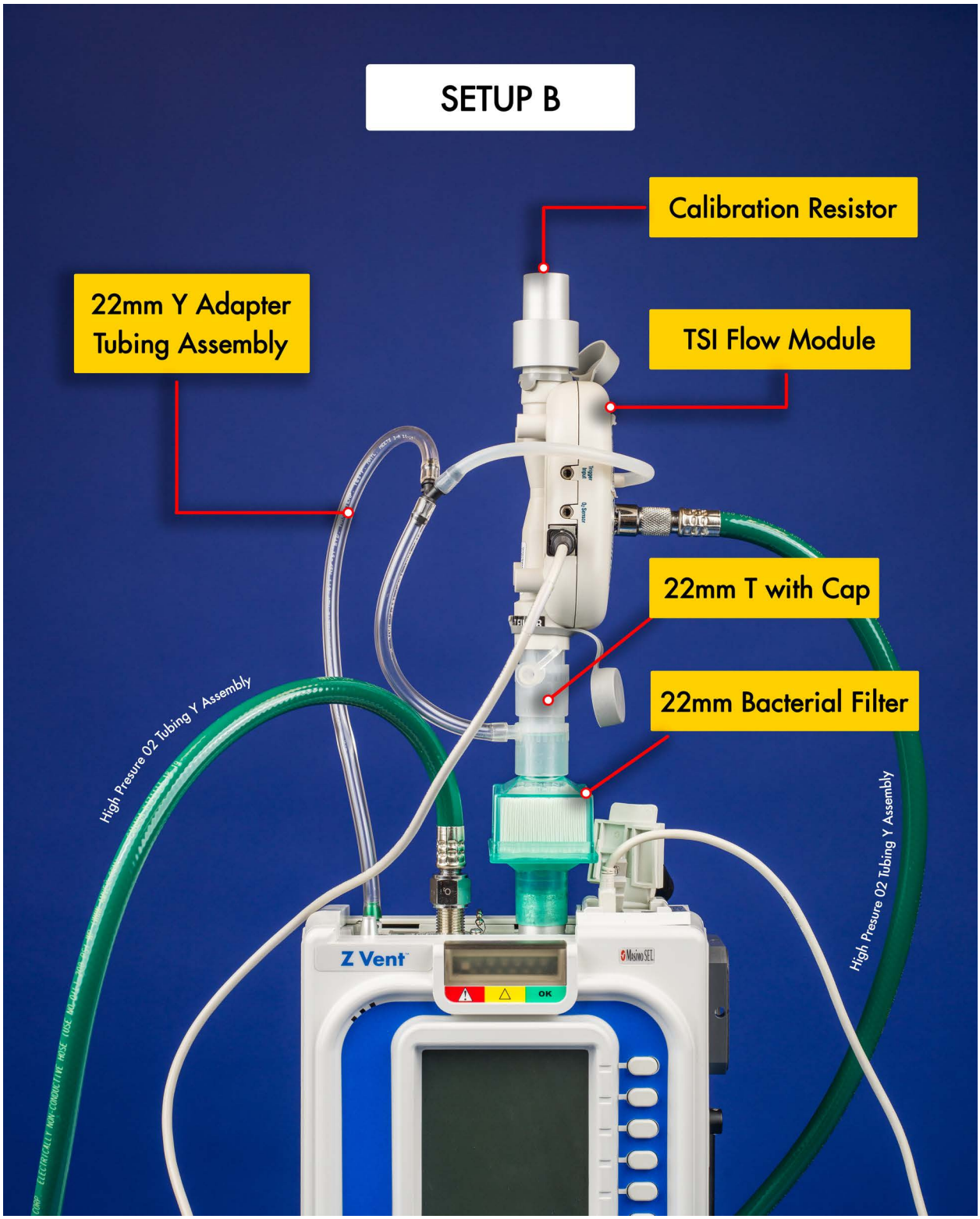
Setup Diagram A



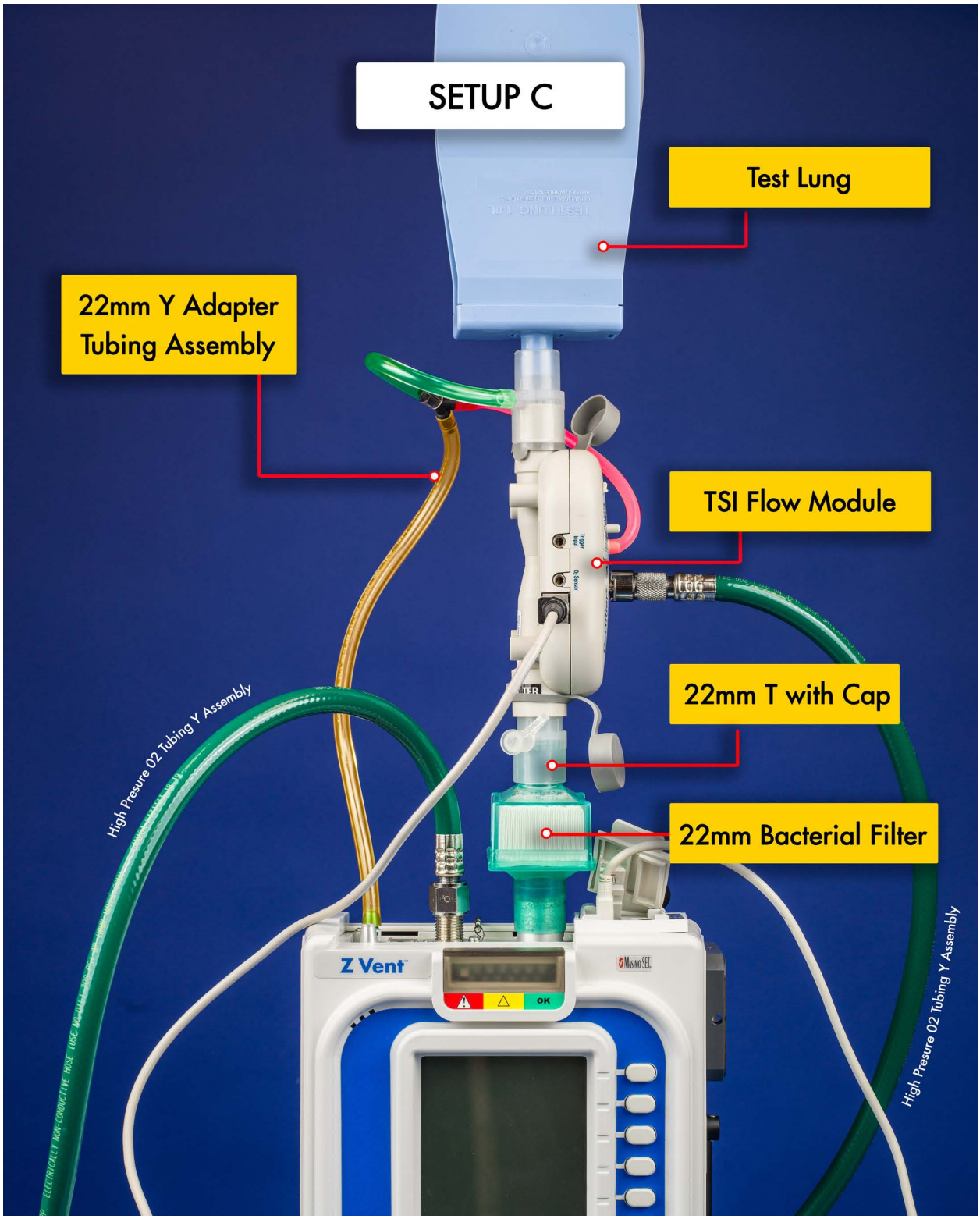
Setup Diagram A2



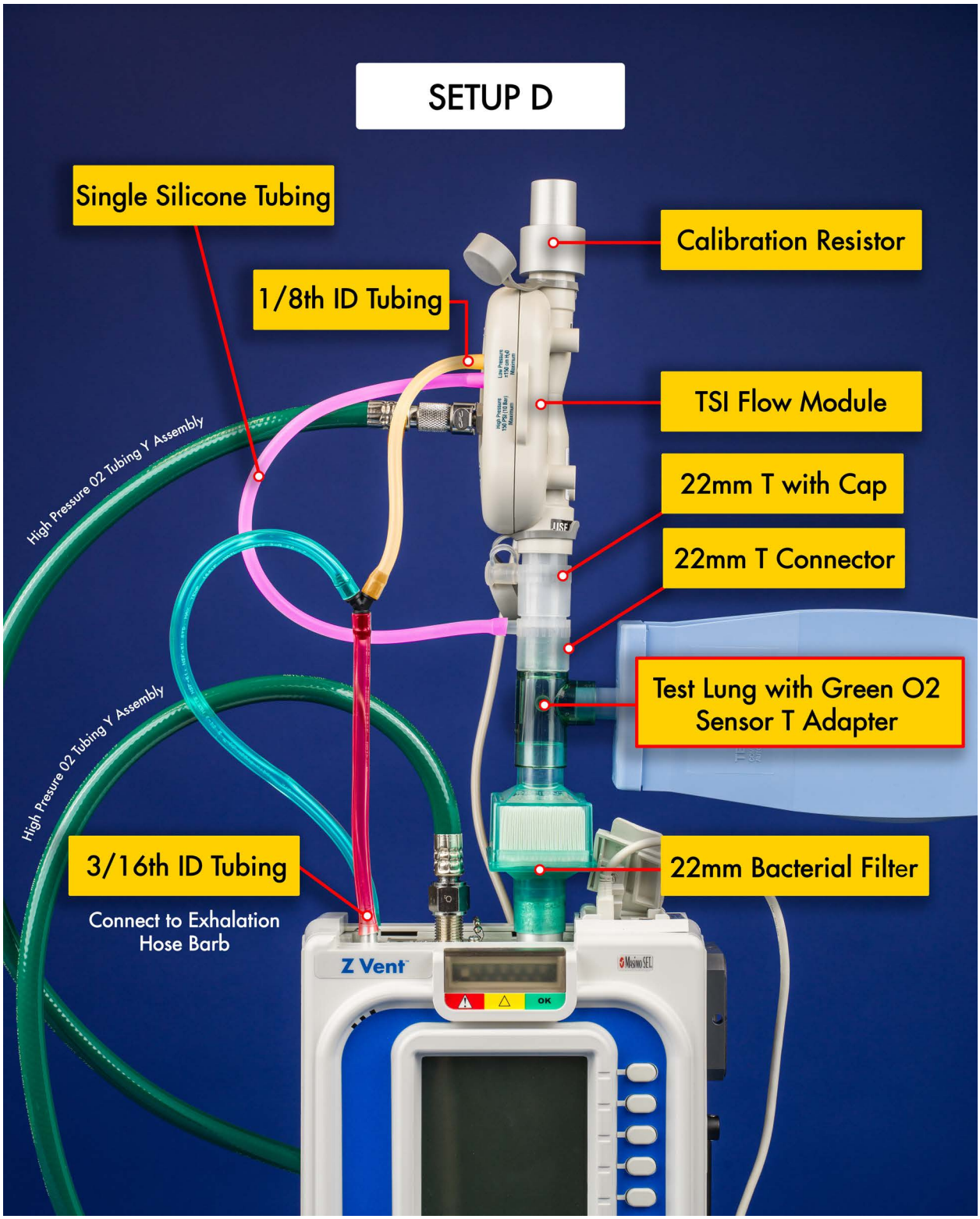
Setup Diagram B



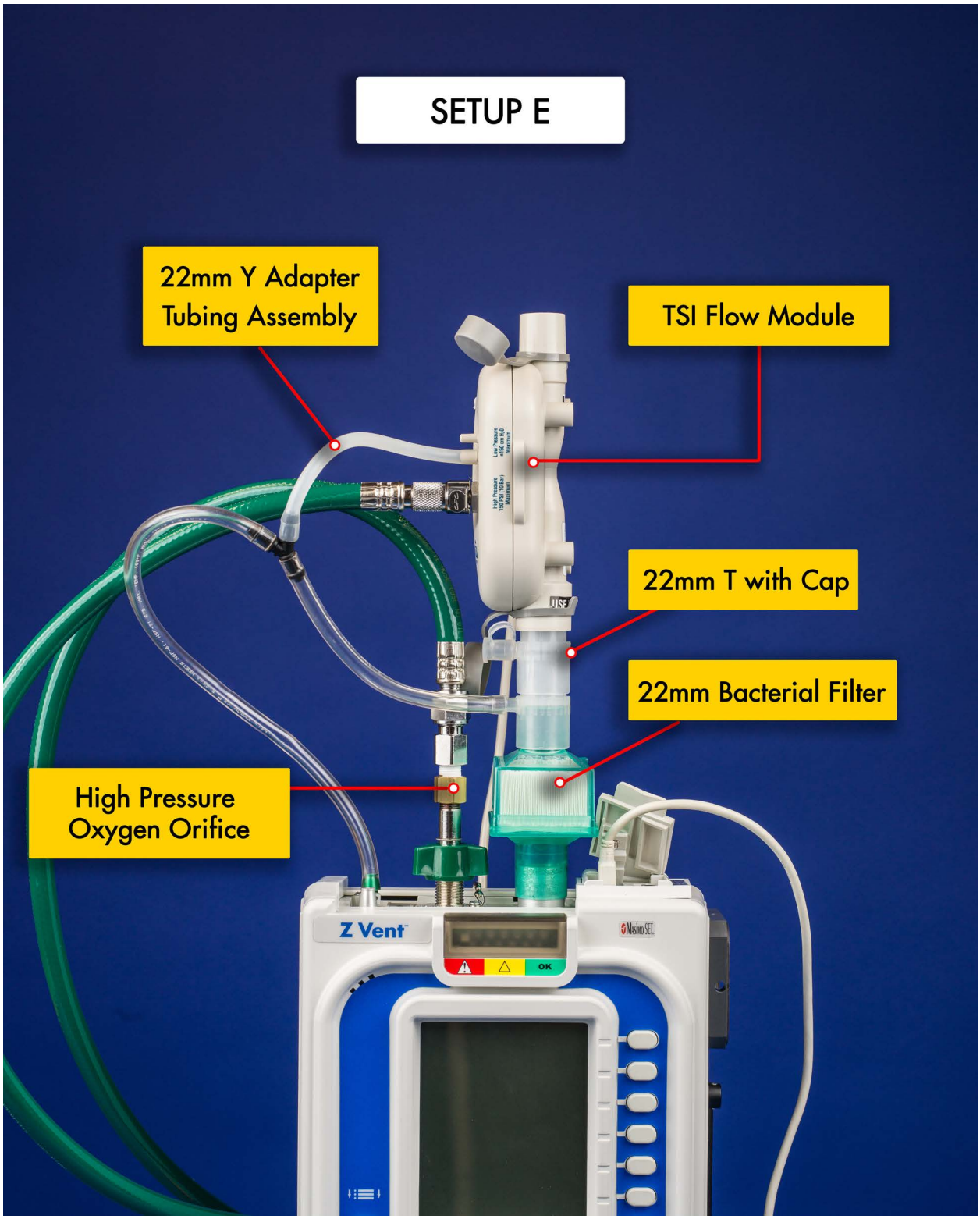
Setup Diagram C



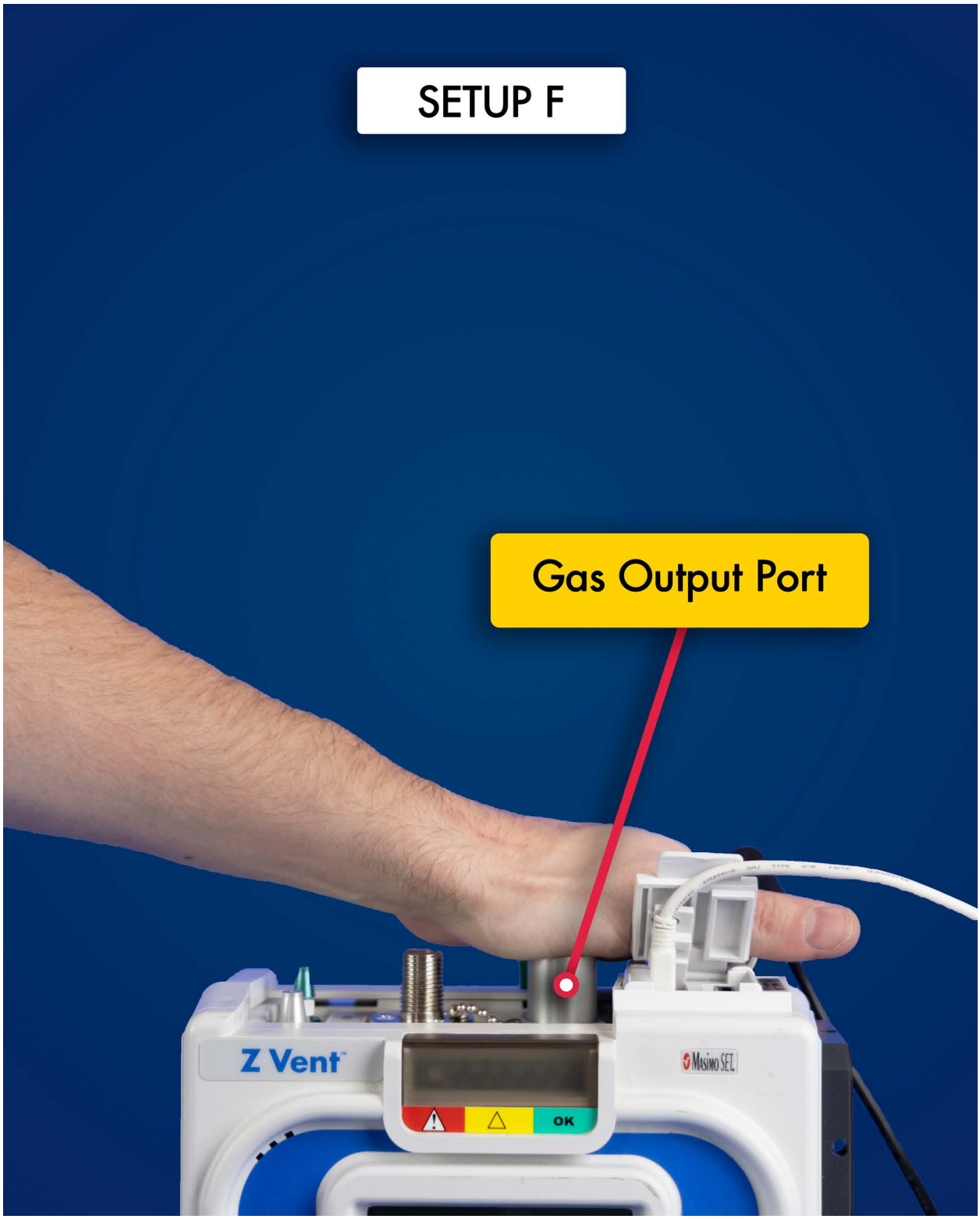
Setup Diagram D



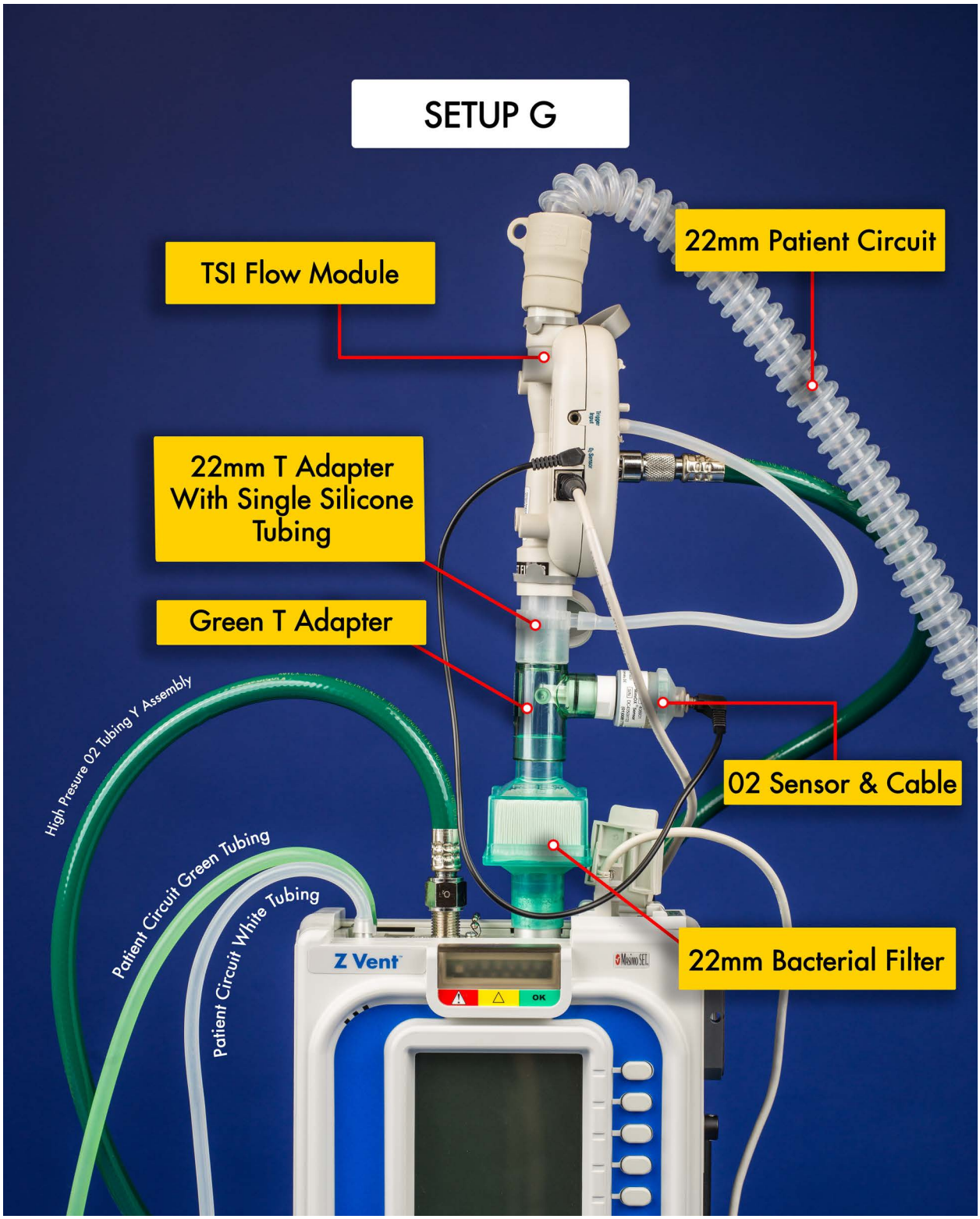
Setup Diagram E



Setup Diagram F

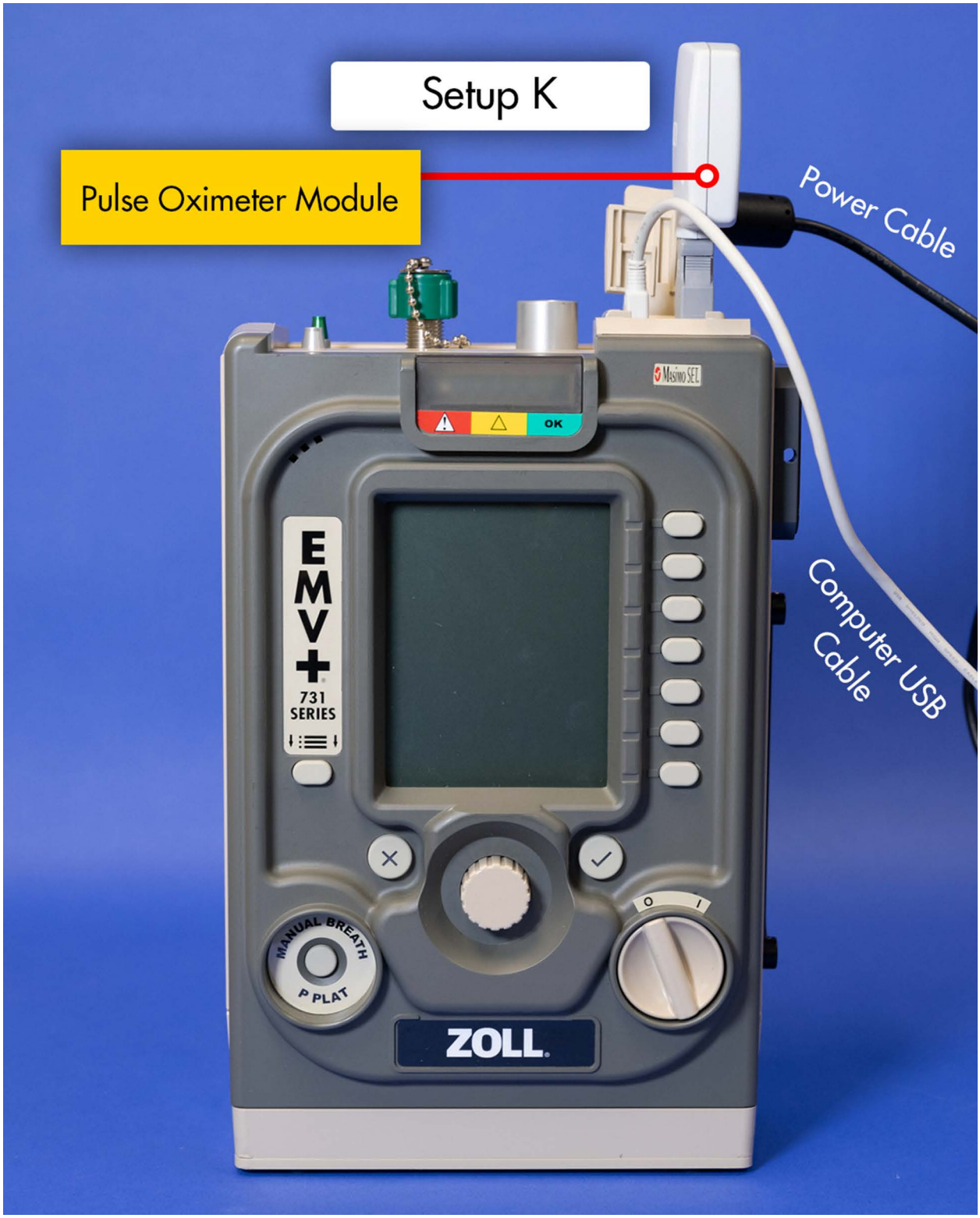


Setup Diagram G



Setup Diagram I

Setup Diagram K



Setup Diagram L

Chapter 4
Service Kit Installation Procedures

About Service Kits

Service kits are factory-tested sub-assemblies used to facilitate ventilator servicing and repair. Service kits are available only to ZOLL trained and certified service personnel. For additional information on availability of ZOLL Technical training programs, please contact **techtraining@zoll.com.**

This chapter provides information on Ventilator Service Kits, including:

- **A list of Service Kits available**
- **A list of supplies to stock on-hand.**
- **Torque Specification Guide**
- **General Service Kit installation instructions, warnings, and cautions**
- **Service Kit installation instructions**

Service Kit Installation Guidelines, Cautions and Warnings

Observe the following guidelines, cautions and warnings before installing any Service Kit.

- Ensure that the problem is not accessory-related. Check the integrity of all tubing, fittings, and verify that tubing is not crimped or cracked.
- Be aware of potentially dangerous operating voltages.
- Disconnect the power supply and internal battery prior to servicing.
- Please review all warnings listed in the following documents:
- Service Kits requiring electrical safety testing
- ZOLL Ventilator Operator's Guide
- RCS Operator's Manual

CAUTION

Replacement of the Oxygen Valve Assembly requires the handling of Oxygen Clean Parts. When handling any metal components within the ventilator which are responsible for transporting oxygen, take the following precautions:

- Never touch the components with your bare hands as oils and residue may contaminate the component.
- Keep all Oxygen Clean parts in their protective packaging prior to installation.
- Do not keep sources of contaminate on the workbench such as soldering material.
- If an oxygen clean part becomes contaminated, replace the part and do not attempt to clean it.

CAUTION

Follow torque specifications listed to avoid damage to the device. Refer to the Torque Specification Guide section of this chapter.

WARNING:

For Service Kit installations requiring electrical safety testing, electrical safety testing should NOT be performed in or around ESD testing areas. ESD protocols (methods) should NOT be enforced during electrical safety testing, since they could cause a hazardous condition for equipment and test operators.

WARNING:

Service kit installations should be done in an ESD controlled environment.

Remove all jewelry and keep liquids away from the ventilator when servicing it. Always safeguard your personal well-being when troubleshooting electronic circuitry.

Make sure to take the necessary precautions when working with static sensitive units. For example, you must wear a conductive wrist strap (which touches your skin) connected to a grounding mat and to the earth ground.

NOTE:

Screws are coated with anti-vibration compound. When reusing screws clean, then reapply the anti-vibration compound (Part No. 602-0006-00). Some kits require the RTV silicone sealant be reapplied (Part No. 602-0001-00)

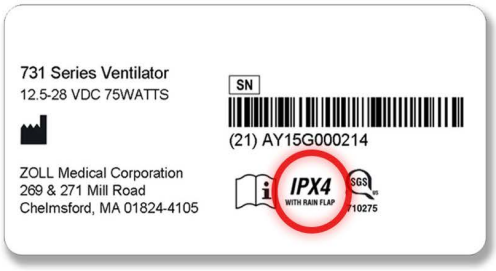
Service Kits Requiring Electrical Safety Testing

Any service kit which requires opening of the device should be followed by electrical safety testing. For further instruction see the chapter titled "**Electrical Safety Testing**" within this manual.

Identifying 3rd and 4th Edition Ventilators.

When servicing 731 series ventilators, it is important to differentiate between 3rd and 4th edition devices. The tables on the following pages identify service kits for each product along with specific columns for 3rd and 4th edition kits. The illustrations below, reflect changes to the regulatory labeling which can be used as a reference. The device IP rating as shown on the labeling is one way to easily differentiate.

3rd Edition



4th Edition

Service Kits — EMV+ NON-MRI Version

Kit	EMV+	EMV+ V5	EMV+ V5 4th Edition
4 Year PM Kit	712-0731-21	712-0731-21	712-0731-21
Annual PM Kit	712-0731-35	712-0731-35	712-0731-35
Back Case Kit	712-0731-12	712-0731-12-LL	712-0731-12-LL
Battery Replacement Kit	703-0731-01-01	703-0731-01-01	703-0731-01-01
Battery Compartment Kit	712-0731-03	712-0731-03	712-0731-03
Battery Case Bottom Cover Kit	712-0731-09	712-0731-09	712-0731-09
Bezel Assembly Kit	712-0731-28	712-0731-28-LL	712-0731-28-LL
Connector Panel Kit	712-0731-11	712-0731-31	712-0731-31-04
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14	712-0731-14-04
EMV Chassis Kit	712-0731-10	712-0731-10	712-0731-10
Front Case Assembly	712-0731-29	712-0731-29-LL	712-0731-49-LL
Front Panel Kit	712-0731-23	712-0731-23-LL	712-0731-43-LL
Gas Output Kit	712-0731-16	712-0731-16	712-0731-16
Flow Screen Kit	712-0731-41	712-0731-41	712-0731-41
Oxygen Inlet Fitting Kit	712-0731-34	712-0731-34	712-0731-34
Oxygen Valve Assembly Kit	712-0731-42	712-0731-42	712-0731-42
Power Interface Module Kit	702-0731-02	702-0731-02	702-0731-02
Power Input Kit	712-0731-17	712-0731-17	712-0731-17-04
Power Knob Kit	392-0071-00	392-0071-00	392-0071-00
Selector Knob Kit	712-0731-27	712-0731-27	712-0731-27
Smart Pneumatic Module (SPM)/ Vent Assembly Kit	712-0731-02	712-0731-02-01	712-0731-02-04
UIM Adapter PCB Assembly Kit	712-0731-38	712-0731-38	712-0731-38-04
USB Connector Kit	712-0731-15	712-0731-15	712-0731-15
USB Connector Plate Kit	712-0731-07	712-0731-07	712-0731-07

Service Kits — EMV+ MRI Version

Kit	EMV+ MRI	EMV+ MRI V5	EMV+ MRI V5 4th Edition
4 Year PM Kit	712-0731-21	712-0731-21	712-0731-21
Annual PM Kit	712-0731-35	712-0731-35	712-0731-35
Back Case Kit	712-0731-12	712-0731-12-LL	712-EGL2-12-LL
Battery Replacement Kit	703-0731-01-01	703-0731-01-01	703-0731-01-01
Battery Compartment Kit	712-EGL2-13	712-EGL2-13	712-EGL2-13
Battery Case Bottom Cover Kit	712-0731-09	712-0731-09	712-0731-09
Bezel Assembly Kit	712-0731-28	712-0731-28-LL	712-0731-28-LL
Connector Panel Kit	712-0731-11	712-0731-31	712-0731-31-04
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14	712-0731-14-04
EMV Chassis Kit	712-0731-10	712-0731-10	712-0731-10
Front Case Assembly	712-0731-29	712-0731-29-LL	712-0731-49-LL
Front Panel Kit	712-0731-23	712-0731-23-LL	712-0731-43-LL
Gas Output Kit	712-0731-16	712-0731-16	712-0731-16
Flow Screen Kit	712-0731-41	712-0731-41	712-0731-41
Oxygen Inlet Fitting Kit	712-0731-34	712-0731-34	712-0731-34
Oxygen Valve Assembly Kit	712-0731-42	712-0731-42	712-0731-42
Power Interface Module Kit	702-0731-02	702-0731-02	702-0731-02
Power Input Kit	712-0731-17	712-0731-17	712-0731-17-04
Power Knob Kit	392-0071-00	392-0071-00	392-0071-00
Selector Knob Kit	712-0731-27	712-0731-27	712-0731-27
Smart Pneumatic Module (SPM)/ Vent Assembly Kit	712-0731-02	712-0731-02-01	712-0731-02-04
UIM Adapter PCB Assembly Kit	712-0731-38	712-0731-38	712-0731-38-04
USB Connector Kit	712-0731-15	712-0731-15	712-0731-15
USB Connector Plate Kit	712-0731-07	712-0731-07	712-0731-07

Service Kits — AEV

Kit	AEV	AEV V5
4 Year PM Kit	712-0731-21	712-0731-21
Annual PM Kit	712-0731-35	712-0731-35
Back Case Kit	712-0731-12	712-0731-12-LL
Battery Replacement Kit	703-0731-01-01	703-0731-01-01
Battery Compartment Kit	712-0731-03	712-0731-03
Battery Case Bottom Cover Kit	712-0731-09	712-0731-09
Bezel Assembly Kit	712-AEV1-06	712-AEV1-06-LL
Connector Panel Kit	712-0731-11	712-0731-31
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14
EMV Chassis Kit	712-0731-10	712-0731-10
Front Case Assembly	712-AEV1-04	712-AEV1-04-LL
Front Panel Kit	712-AEV1-23	712-AEV1-23-LL
Gas Output Kit	712-0731-16	712-0731-16
Flow Screen Kit	712-0731-41	712-0731-41
Oxygen Inlet Fitting Kit	712-0731-34	712-0731-34
Oxygen Valve Assembly Kit	712-0731-42	712-0731-42
Power Interface Module Kit	702-0731-02	702-0731-02
Power Input Kit	712-0731-17	712-0731-17
Power Knob Kit	392-0071-00	392-0071-00
Selector Knob Kit	712-AEV1-27	712-AEV1-27
Smart Pneumatic Module (SPM)/ Vent Assembly Kit	712-0731-02	712-0731-02-01
UIM Adapter PCB Assembly Kit	712-0731-38	712-0731-38
USB Connector Kit	712-0731-15	712-0731-15
USB Connector Plate Kit	712-0731-07	712-0731-07

Service Kits — EAGLE II - NON MRI

Kit	EAGLEII NON-MRI	EAGLE II NON-MRI V5
4 Year PM Kit	712-0731-21	712-0731-21
Annual PM Kit	712-0731-35	712-0731-35
Back Case Kit	712-EGL2-12	712-EGL2-12-LL
Battery Replacement Kit	703-0731-01-01	703-0731-01-01
Battery Compartment Kit	712-EGL2-03	712-EGL2-03
Battery Case Bottom Cover Kit	712-EGL2-09	712-EGL2-09
Bezel Assembly Kit	712-EGL2-18	712-EGL2-18-LL
Connector Panel Kit	712-EGL2-11	712-EGL2-31
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14
EMV Chassis Kit	712-EGL2-10	712-EGL2-10
Front Case Assembly	712-EGL2-16	712-EGL2-16-LL
Front Panel Kit	712-EGL2-15	712-EGL2-15
Gas Output Kit	712-0731-16	712-0731-16
Flow Screen Kit	712-0731-41	712-0731-41
Oxygen Inlet Fitting Kit	712-0731-34	712-0731-34
Oxygen Valve Assembly Kit	712-0731-42	712-0731-42
Power Interface Module Kit	702-0731-02	702-0731-02
Power Input Kit	712-0731-17	712-0731-17
Power Knob Kit	392-0071-01	392-0071-01
Selector Knob Kit	712-EGL2-27	712-EGL2-27
Smart Pneumatic Module (SPM)/ Vent Assembly Kit	712-EGL2-02	712-EGL2-02-01
UIM Adapter PCB Assembly Kit	712-0731-38	712-0731-38
USB Connector Kit	712-0731-15	712-0731-15
USB Connector Plate Kit	712-EGL2-07	712-EGL2-07

Service Kits — EAGLE II - MRI

Kit	EAGLE II MRI	EAGLE II MRI V5
4 Year PM Kit	712-0731-21	712-0731-21
Annual PM Kit	712-0731-35	712-0731-35
Back Case Kit	712-EGL2-12	712-EGL2-12-LL
Battery Replacement Kit	703-0731-01-01	703-0731-01-01
Battery Compartment Kit	712-EGL2-13	712-EGL2-13
Battery Case Bottom Cover Kit	712-EGL2-09	712-EGL2-09
Bezel Assembly Kit	712-EGL2-18	712-EGL2-18-LL
Connector Panel Kit	712-EGL2-11	712-EGL2-31
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14
EMV Chassis Kit	712-EGL2-10	712-EGL2-10
Front Case Assembly	712-EGL2-16	712-EGL2-16-LL
Front Panel Kit	712-EGL2-15	712-EGL2-15
Gas Output Kit	712-0731-16	712-0731-16
Flow Screen Kit	712-0731-41	712-0731-41
Oxygen Inlet Fitting Kit	712-0731-34	712-0731-34
Oxygen Valve Assembly Kit	712-0731-42	712-0731-42
Power Interface Module Kit	702-0731-02	702-0731-02
Power Input Kit	712-0731-17	712-0731-17
Power Knob Kit	392-0071-01	392-0071-01
Selector Knob Kit	712-EGL2-27	712-EGL2-27
Smart Pneumatic Module (SPM)/ Vent Assembly Kit	712-EGL2-02	712-EGL2-02-01
UIM Adapter PCB Assembly Kit	712-0731-38	712-0731-38
USB Connector Kit	712-0731-15	712-0731-15
USB Connector Plate Kit	712-EGL2-07	712-EGL2-07

Service Kits — Z-Vent - NON MRI

Kit	Z-Vent NON MRI Basic	Z-Vent NON MRI	Z-Vent NON MRI 4TH EDITION
4 Year PM Kit	712-0731-21	712-0731-21	712-0731-21
Annual PM Kit	712-0731-35	712-0731-35	712-0731-35
Back Case Kit	712-EMBP-12-LL	712-EMBP-12-LL	712-EMBP-12-LL
Battery Replacement Kit	703-0731-01-01	703-0731-01-01	703-0731-01-01
Battery Compartment Kit	712-EMBP-03	712-EMBP-03	712-EMBP-03
Battery Case Bottom Cover Kit	712-EMBP-09	712-EMBP-09	712-EMBP-09
Bezel Assembly Kit	712-EMBP-28-LL	712-EMBP-28-LL	712-EMBP-28-LL
Connector Panel Kit	712-EMBP-31	712-EMBP-31	712-EMBP-31-04
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14	712-0731-14-04
EMV Chassis Kit	712-0731-10	712-0731-10	712-0731-10
Front Case Assembly	712-EMBP-29-LL	712-EMBP-29-LL	712-EMBP-49-LL
Front Panel Kit	712-EMBP-23-LL	712-EMBP-23-LL	712-EMBP-43-LL
Gas Output Kit	712-0731-16	712-0731-16	712-0731-16
Flow Screen Kit	712-0731-41	712-0731-41	712-0731-41
Oxygen Inlet Fitting Kit	712-0731-34	712-0731-34	712-0731-34
Oxygen Valve Assembly Kit	712-0731-42	712-0731-42	712-0731-42
Power Interface Module Kit	702-0731-02	702-0731-02	702-0731-02
Power Input Kit	712-0731-17	712-0731-17	712-0731-17-04
Power Knob Kit	392-0071-02	392-0071-02	392-0071-02
Selector Knob Kit	712-EMBP-27	712-EMBP-27	712-EMBP-27
Smart Pneumatic Module (SPM)/ Vent Assembly Kit	712-EMBP-02-01	712-EMBP-02-01	712-EMB4-02-04
UIM Adapter PCB Assembly Kit	712-0731-38	712-0731-38	712-0731-38-04
USB Connector Kit	712-0731-15	712-0731-15	712-0731-15
USB Connector Plate Kit	712-EMBP-07	712-EMBP-07	712-EMBP-07

Service Kits — Z-Vent - MRI Version

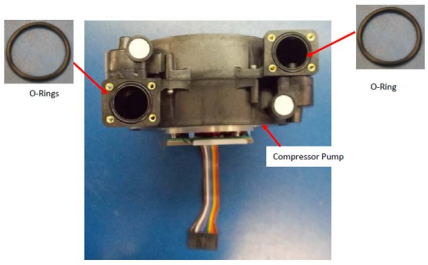
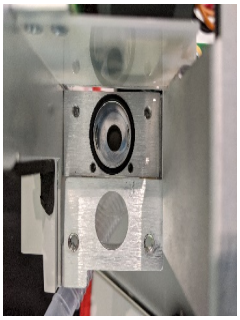
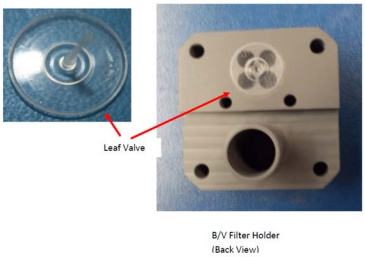
Kit	Z-Vent MRI	Z-Vent MRI 4TH EDITION
4 Year PM Kit	712-0731-21	712-0731-21
Annual PM Kit	712-0731-35	712-0731-35
Back Case Kit	712-EMBP-12-LL	712-EMBP-12-LL
Battery Replacement Kit	703-0731-01-01	703-0731-01-01
Battery Compartment Kit	712-EMBP-13	712-EMBP-13
Battery Case Bottom Cover Kit	712-EMBP-09	712-EMBP-09
Bezel Assembly Kit	712-EMBP-28-LL	712-EMBP-28-LL
Connector Panel Kit	712-EMBP-31	712-EMBP-31-04
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14-04
EMV Chassis Kit	712-0731-10	712-0731-10
Front Case Assembly	712-EMBP-29-LL	712-EMBP-49-LL
Front Panel Kit	712-EMBP-23-LL	712-EMBP-43-LL
Gas Output Kit	712-0731-16	712-0731-16
Flow Screen Kit	712-0731-41	712-0731-41
Oxygen Inlet Fitting Kit	712-0731-34	712-0731-34
Oxygen Valve Assembly Kit	712-0731-42	712-0731-42
Power Interface Module Kit	702-0731-02	702-0731-02
Power Input Kit	712-0731-17	712-0731-17-04
Power Knob Kit	392-0071-02	392-0071-02
Selector Knob Kit	712-EMBP-27	712-EMBP-27
Smart Pneumatic Module (SPM)/ Vent Assembly Kit	712-EMBP-02-01	712-EMB4-02-04
UIM Adapter PCB Assembly Kit	712-0731-38	712-0731-38-04
USB Connector Kit	712-0731-15	712-0731-15
USB Connector Plate Kit	712-EMBP-07	712-EMBP-07

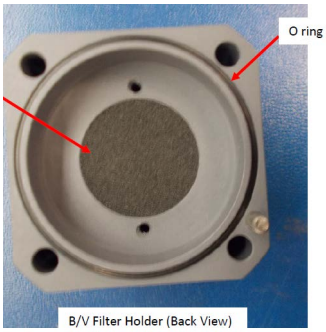
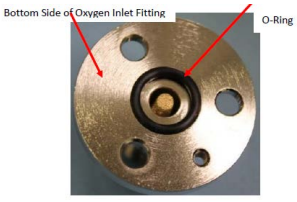
Bulk Supplies

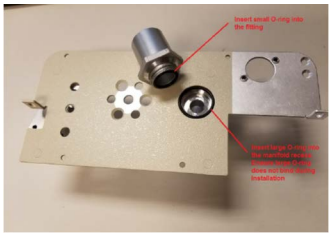
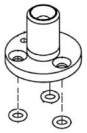
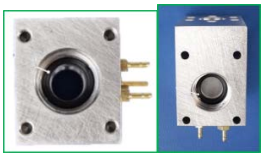
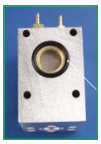
Refer to the table below for a list of supplies to have on hand if regularly servicing 731 series ventilators.

Bulk Supplies - Screws & Nuts			
PN	**Qty**	**Location**	**Type**
0163-000460	1	Z-Vent Power Input Plug	Hex Socket Shoulder
346-0632-01	4	Connector Panel to Flow Manifold Keps Nuts	KEPS Nut
346-1032-01	2	Back Cover Keps Nut	KEPS Nut
355-0632-04	4	Dovetail Mounting bracket (Left and Right sides)	Flat Head
355-0832-04	2	Chassis to SPM bottom	Flat Head
357-0440-04	4	Power Input to Connector Panel, Dovetail Stiffener Bracket	Flat Head
357-0440-20	2	Power Input Assembly w/Spacers	Flat Head
357-0632-04	4	Pump Bracket to Chassis	Flat Head
357-0632-05-2	2	Back Cover to Dovetail Bracket	Flat Head
357-0832-04	3	Connector Panel to Flow Manifold Screws	Flat Head
357-0832-07	3	O2 Fitting	Flat Head
357-0832-48	4	Fresh Gas Air Intake Assembly	Flat Head
358-0440-03	7	USB Cable, Green cap & chain to O2 Fitting, Connector Snap Cover Assembly to connector panel	Pan Head
358-0440-04	28	Front Case Assembly to Vent Module , Front Bezel, Buzzer, UIM Adapter Board, CPU to UIM Bracket, PIM board to SPM Assy, SPM PCB to SPM,Foam Filter Holder Screen to B/V Holder	Pan Head
358-0440-05	2	USB Connector Plate	Pan Head
358-0440-08	4	15mm Compressor Input Port to Compressor	Pan Head
358-0440-11	2	O2 Valve	Pan Head
358-0440-28	4	Oxygen Inlet Manifold to Mix Manifold	Pan Head
358-0632-05	16	Battery Cover, LCD, UIM Stack to Front Case, Batt Compartment, Inside by Air Intake	Pan Head
358-0632-08	2	B/V Filter Holder Base to Mix Manifold	Pan Head
358-0632-24	2	Compressor to Pump Bracket	Pan Head
358-0632-32	4	Back Cover	Pan Head
358-0632-36	4	Battery	Pan Head
360-0440-05	4	Flow Manifold to Compressor Output	Hex Socket
360-0632-05	4	Compressor Connector to Mix Manifold	Hex socket

363-0006-00	2	Masimo Plug (SPO2 Cable)	Flat Head
366-0400-05	1	SPO2 PCB to UIM Bracket	Self Tapping
376-0007-00	2	BV Holder to Mix Manifold	#6 Flat washer
376-0079-00	4	Flow Manifold to Compressor Output	#4 Split ring washer

Bulk Supplies - Components				
Part Number	**Qty**	**Part Type**	**Location**	**Picture**
340-0106-00	2	O-Ring	Compressor Inlet/Outlet	
340-0020-00	1	O-Ring	Snap Cover	
340-0113-00	1	O-Ring	Mix Manifold	
490-0005-00	1	Leaf Valve	BV Filter Holder Base	

340-0118-00	1	O-Ring	BV Filter Holder	
340-0107-00	1	Gasket	Intake Adaptor	 
340-0055-00	1	O-Ring	Intake Adaptor	
340-0023-00	2	O-Ring	Manifold/ Connector Panel	 
340-0059-00	1	O-Ring	Gas Out	

0310-000381	1	O-Ring	Gas Out/Conn Panel	
0310-000380	3	O-Ring	Oxygen Inlet	
340-0023-00	2	O-Ring	Mix Manifold, O2 Manifold	
340-0061-00	1	O-Ring	Mix Manifold	
340-0059-00	1	O-Ring	O2 Manifold	
450-0008-00	8	Bumper Foot	Back Cover / Battery Cover	
602-0006-00	AR	Vibratite	All Screws	
600-0005-00	AR	Loctite	High Pressure O2 Hose	
602-0001-01	AR	RTV Silicone	SPO2 / USB Connectors	
540-0215-00	AR	High Pressure O2 Tubing	O2 Manifold / O2 Tank XDCR	

540-0217-00	AR	SPM Tubing	SPM Board	

Torque Specification Guide

Refer to the torque specifications that we list in the following table when performing service kit installations to avoid damage to the device

Screw/Nut/Component	Quantity	Screw/Nut Size	Maximum Torque (in-lb)	Maximum Torque (Nm)
ANNUAL PM				
O2 Fitting	3	8-32 X 7/16	19	2.0
Fresh Gas Air Intake Assembly	4	8-32 X 3"	14	1.6
4 YEAR PM				
O2 Fitting	3	8-32 X 7/16	19	2.0
Fresh Gas Air Intake Assembly	4	8-32 X 3"	14	1.6
Battery Cover	4	6-32 X 5/16"	9	1.0
Battery	4	6-32 X 2.25"	9	1.0
Back Cover	4	6-32 X 2"	9	1.0
Back Cover Keps Nut	2	10-32	18	2.0
Front Case Assembly to Vent Module	2	4-40 X 1/4"	5	0.6
Dovetail Mounting Bracket Left and Right sides	4	6-32 X 1/4"	3.5	0.4
To dovetail stiffener bracket	2	4-40 X 1/4"	5	0.6
SPM PCB to SPM	4	4-40 X 1/4"	5	0.6
FRONT CASE				
Front Bezel	7	4-40 X 1/4"	5	0.6
Buzzer	2	4-40 X 1/4"	3.5	0.4
Masimo Plug (SPO2 Cable)	2	M2.5 X 5mm	0.5	0.1
UIM Stack to Front Case	2	6-32 X 5/16"	5	0.6
UIM Adapter Board	2	4-40 X 1/4"	3.5	0.4
USB Cable	2	4-40 X 3/16"	2.5	0.3

Screw/Nut/Component	Quantity	Screw/Nut Size	Maximum Torque (in-lb)	Maximum Torque (Nm)
USB Connector Plate	2	4-40 X 5/16"	2.5	0.3
LCD	4	6-32 X 5/16" Screws, 6-32 Keps Nuts	9	1.0
CPU to UIM Bracket	4	4-40 X 1/4"	4.5	0.5
SPO2 PCB to UIM Bracket	1	#4-5/16"	Tap @ 5 then loosen and re-tighten to 3.5	0.4
USB Connector Cover	1	4-40 X 3/16”	3.5	0.4
CHASSIS ASSEMBLY				
Inside by Air Intake	2	6-32 X 5/16"	9	1.0
Chassis to SPM bottom	2	8-32 X 1/4"	19	2.0
Chassis to dovetail mounting bracket	2	6-32 X 1/4"	3.5	0.4
Power Input Assembly w/Spacers	2	4-40 X 1.25"	3.5	0.4
DOVETAIL MOUNTING BRACKET				
Dovetail Mounting Bracket Left and Right sides	4	6-32 X 1/4"	3.5	0.4
To dovetail stiffener bracket	2	4-40 X 1/4"	5	0.6
SPM				
PIM board to SPM Assy	5	4-40 X 1/4"	3.5	0.4
Fresh Gas Air Intake Assembly	4	8-32 X 3"	14	1.6
B/V Filter Holder Base to Mix Manifold	2	6-32 X 1/2"	5	0.6
Foam Filter Holder Screen to B/V Holder	2	4-40 X 1/4"	5	0.6
Green cap & chain to O2 Fitting	1	4-40 X 3/16	5	0.6
O2 Fitting	3	8-32 X 7/16	19	2.0
Gas Output Fitting	N/A	N/A	75	8.5

Screw/Nut/Component	Quantity	Screw/Nut Size	Maximum Torque (in-lb)	Maximum Torque (Nm)
Gas Output Fitting (Z-Vent)	N/A	N/A	75	8.5
Connector Panel to Flow Manifold Screws	3	8-32 X 1/4"	19	2.0
Connector Panel to Flow Manifold Keps Nuts	4	6-32	9	1.0
Power Input to Connector Panel	2	4-40 X 1/4"	5	0.6
Connector Snap Cover Assembly to connector panel	4	4-40 X 3/16"	5	0.6
Z-Vent Power Input Plug	1	4-40 X 5/32"	5	0.6
SPM PCB to SPM	4	4-40 X 1/4"	5	0.6
O2 Valve	2	4-40 X 11/16"	4.5	0.5
Oxygen Inlet Manifold to Mix Manifold	4	4-40 X 1.75"	5	0.6
Compressor Connector to Mix Manifold	4	6-32 X 5/16"	9	1.0
Flow Manifold to Compressor Output	4	4-40 X 5/16"	5	0.6
15mm Compressor Input Port to Compressor	4	4-40 X 1/2"	5	0.6
Back Cover to Dovetail Bracket	2	6-32 X 5/16"	9	1.0
Compressor to Pump Bracket	2	6-32 X 1.5"	9	1.0
Pump Bracket to Chassis	4	6-32 X 1/4"	9	1.0

Smart Pneumatic Module/Vent Assembly Service Kit Installation Instructions

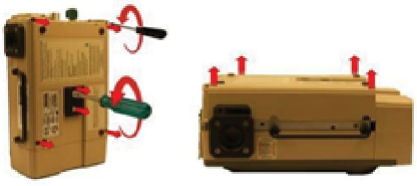
Required Tools and Materials

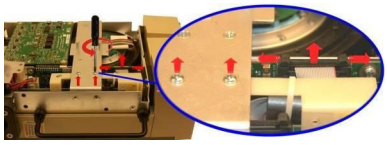
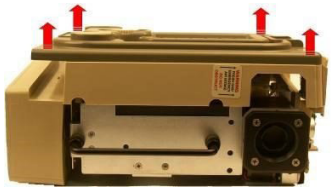
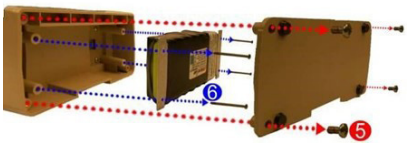
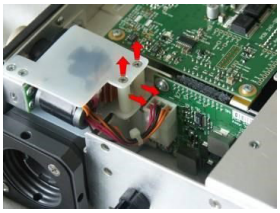
- Torque driver with #1 and #2 Phillips bits
- Nut driver set

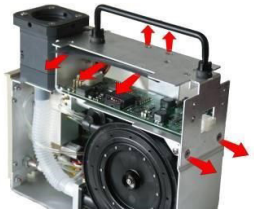
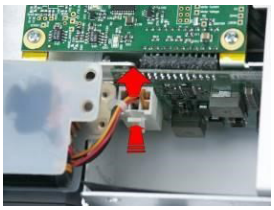
Kit Contents

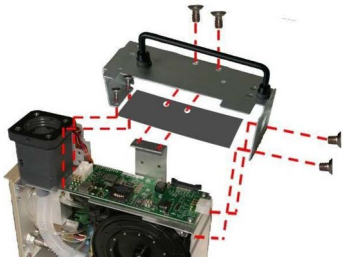
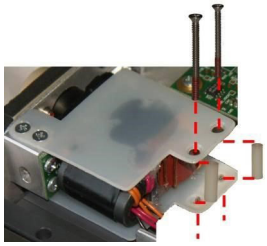
Quantity	Description	Depiction
1	Smart Pneumatic Module/Vent Assembly	

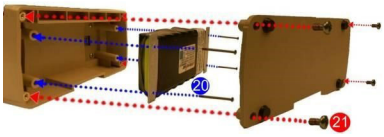
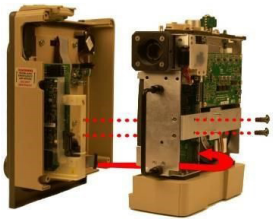
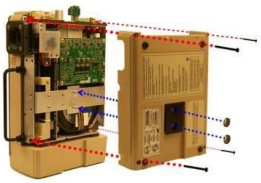
Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	
2	Loosen and remove the two 10-32 Keps nuts and the four 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator.	

Step	Action	
3	Remove the two Pan Head 4-40 x 1/4 screws on the dovetail mounting bracket but do not remove the two flat head screws. Disconnect the ribbon cable on the Power Interface Module (PIM) board by simultaneously applying pressure on the two tabs. Save these screws.	
4	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
5	Remove the battery compartment cover by unscrewing the four 6-32 x 5/16 screws. Save these screws.	
6	Remove the battery by unscrewing the four 6-32 x 2 1/4 screws and detaching the plug from its locking latch. Save these screws.	
7	Unscrew the four 6-32 x 5/16 Phillips screws to remove the battery compartment case. Save these screws.	
8	Loosen and remove the two 4-40 x 1 1/4 screws and nylon spacers that support the Power Input assembly within the chassis. Save these screws and spacers.	

Step	Action	
9	Loosen and remove the two 6-32 x 1/4 screws holding the chassis to the dovetail mounting bracket and remove the SpO_2 insulator. Loosen and remove the two 8-32 x 1/4 screws holding the chassis to the ventilator module.	
10	Insert screwdriver through the holes on the chassis to loosen and remove the two 6-32 x 5/16 screws holding the chassis to the ventilator module.	
11	Lift the chassis from the ventilator module.	
12	Disconnect the Power Input cable from the PIM board by pressing on the locking latch and pulling the cable straight up from the connector.	
13	Remove the PIM board by loosening the five 4-40 x 1/4 screws.	

Step	Action	
14	Remove the dovetail stabilizer bracket by loosening and removing the two 6-32 x 1/4 and the two 4-40 x 1/4 screws.	
15	Install the dovetail stabilizer bracket onto the new SPM assembly by tightening the two 6-32 x 1/4 and two 4-40 x 1/4 screws.	
16	Secure the PIM board to the new SPM with the five 4-40 x 1/4 screws. Caution: Do not over-tighten the screws. (Maximum torque - 3.5 in.- lb.)	
17	Secure the chassis to the ventilator module using the two 6-32 x 1/4 screws with SpO_2 insulator, the two 8-32 x 1/4 and the two 6-32 x 5/16 screws.	
18	Secure the Power Input assembly to the Chassis using the two spacers and two 4-40 x 1 1/4 screws. **Note:** Do not over-tighten the screws. (Maximum torque - 3.5 in.- lb.)	

Step	Action	
19	Rotate battery compartment to mate with upper and lower case cutouts and press firmly into place. Secure it with the four 6-32 x 5/16 screws provided.	
20	Re-assemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it is locked in place), then tighten the four 6-32 x 2 1/4 screws.	
21	Re-assemble the battery compartment cover by tightening the four 6-32 x 5/16 screws.	
22	Place the front case assembly over the ventilator module and tighten the two 4-40 x 1/4 screws to the dovetail mounting bracket. Reconnect the ribbon cable unto the PIM board. Make sure ejector latches are secured.	
23	Attach the back case to the ventilator module and align cover with handle, air intake housing and dovetail mounting studs. Insert and tighten the four 6-32 x 2” screws and then the two 10-32 Keps nuts (provided in the kit).	
24	Tighten the four 8-32 x 3 screws on the outer air intake.	

Step	Action	
25	Use the RCS "Write" function to update the new part's serial number.	
26	Re-certify the ventilator using the RCS tool	

Battery Replacement Service Kit Installation Instructions

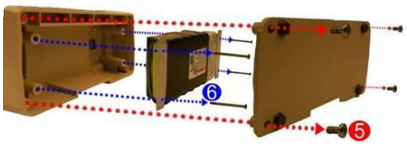
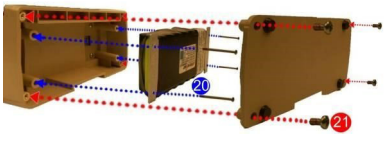
Required Tools

- Torque driver with #1 and #2 Phillips bits

Kit Contents

Quantity	Description
1	ASSY, BATTERY PACK, 6.6 AH, 14.8V, LITHIUM-ION, 12- CELL CONDITIONED

Instructions

1	Remove the battery compartment cover by unscrewing the four 6-32 x 5/16 screws. Save these screws.	
2	Remove the battery by unscrewing the four 6-32 x 2 1/4 screws and disconnecting the plug from its locking latch. Save these screws.	
3	Connect the new battery by connecting its cable to the connector (pull lightly on cable to ensure it is locked in place), then tighten the four 6-32 x 2 1/4 screws.	
4	Re-assemble the battery compartment cover by tightening the four 6-32 x 5/16 screws.	
5	Re-certify the ventilator using the RCS tool	

Annual Maintenance Kit

Required Tools

- Torque driver with #1 and #2 Phillips bits

Kit Contents

Quantity	Description	PN
1	OIL-RESISTANT BUNA-N MULTIPURPOSE O-RING 1/2" OD X 3/8" ID	340-0023-00
3	O RING BUNA-N SOFT	0310-000380
3	SCREW, PHILLIPS, FLAT HEAD, 8-32 x 7/16, STEEL, ZINC PLATED, RoHS	357-0832-07
1	SCREW, PHILLIPS, PAN HEAD, 4-40 x 3/16, STEEL, ZINC PLATED, RoHS	358-0440-03
1	FILTER, SINTER BRONZE, 0.250" X 0.125" X 0.705"	465-0015-00
1	FITTING, DISS MALE, O2 INLET	
1	DUST CAP ASSY, DISS 1240	480-0325-00
1	FILTER, DISK, FRESH GAS/EMERGENCY AIR INTAKE,INDIVIDUALLY BAGGED	465-0027-00
1	FILTER, FOAM INLET	465-0028-00

Instructions

Disk Filter Replacement	Oxygen Filter Replacement	Foam Filter Replacement
Scan or Click for Video	Scan or Click for Video	Scan or Click for Video

4 Year Maintenance Kit

Kit Numbers

- See Service Kit Tables

Required Tools

- Torque driver with #1 and #2 Phillips bits

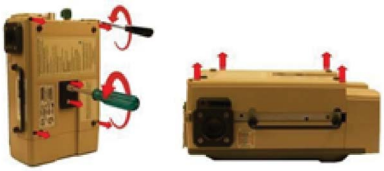
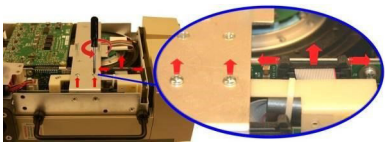
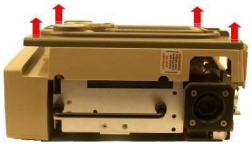
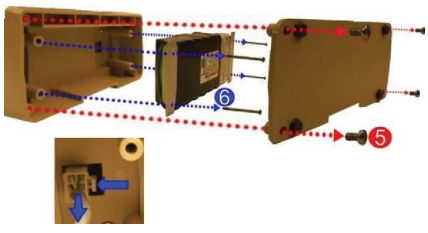
Kit Contents

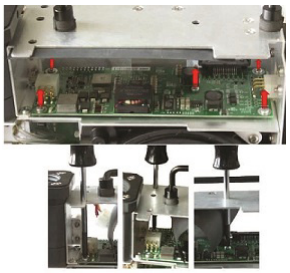
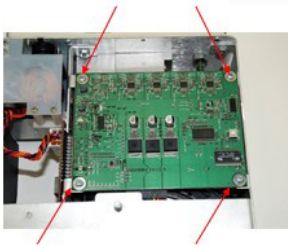
Quantity	Description	PN
1	BATTERY, COIN TYPE, 3.0V, 560 mAh, 23MM DIA, LITHIUM	021-0023-00
1	ASSEMBLY,BATTERY PACK,6.6 AH,14.8V,LITHIUM-ION,12- CELL CONDITIONED	703-0731-01-01
1	Annual Maintenance Kit	712-0731-35

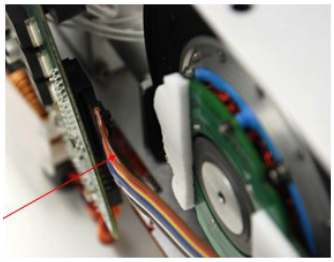
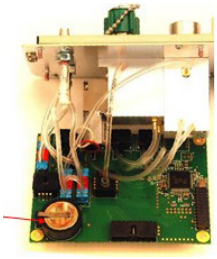
Instructions

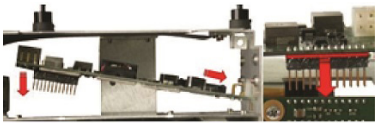
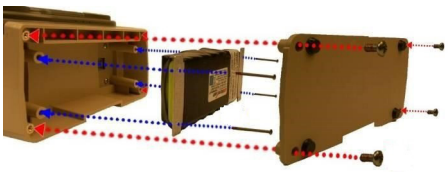
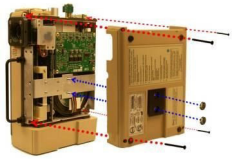
Main Battery Replacement		
1	See instructions under “Battery Replacement Service Kit” within this Chapter. **(Click to Jump)**	Scan or Click for Video
RTC Battery Replacement		
2	See instructions below on the following pages, or scan / click the QR Code to watch a video of this procedure.	Scan or Click for Video

RTC Battery Replacement Instructions

Step	Procedure	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	
2	Loosen and remove the two 1032 Keps nuts and the four 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting it from the ventilator.	
3	Remove the two pan head 4-40 x 1/4 screws on the dovetail mounting bracket, do not remove the two flat head screws. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
4	Flip the ventilator over and remove the front case assembly by lifting it straight up and away from the ventilator module.	
5	Remove the battery compartment cover by unscrewing the four 6-32 x 5/16 screws. Save these screws.	
6	Remove the battery by unscrewing the four 6-32 x 2 1/4 screws and detaching the plug from its locking latch. Save these screws.	
7	Disconnect the Power Input Cable from the PIM board by pressing on the locking latch and pulling the cable straight up from the connector.	

Step	Procedure	
8	Loosen and remove the five 4-40 x 1/4 screws holding the PIM board to the ventilator module. Save these screws. Move SpO_2 Insulator out of the way and insert screwdriver through the holes to aid in removing screws. **Note:** Do not fold the SpO_2 Insulator.	
9	Lift the PIM Board out of the ventilator module.	
10	Remove the Dovetail Mounting Bracket (Loosen and remove the 4 6-32 x 1/4" flathead screws on the ends and 2 4-40 x ¼" flathead located towards the middle of the bracket.	
11	Remove the corrugated hose connecting the Compressor Air Intake Base to the Compressor intake port.	
12	Remove the 4 4-40 x ¼" screws holding the SPM PCB to the SPM.	

Step	Procedure	
13	Remove the compressor cable from the bottom of the SPM PCB by pressing the locking tab and pulling the cable away from the board	
14	Carefully rotate the SPM PCB until the RTC battery extends past the chassis.	
15	Remove the RTC battery, reload the tension on the holding clip on the battery holder and insert the new RTC battery.	 
16	Reconnect the Compressor cable to the SPM PCB and verify that it is locked in place.	
17	Reattach the 4 screws 4-40 x ¼" screws holding the SPM PCB to the SPM.	
18	Reattach the corrugated hose to the Compressor Air Intake base and the compressor intake port.	
19	Reattach the Dovetail Mounting Bracket using the 4 6-32 x 1/4" flathead screws on the ends and 2 4-40 x ¼" flathead located towards the middle of the bracket. **Caution:** Make sure to insert the SPO_2 insulator between the chassis and Dovetail Support bracket.	

Step	Procedure	
20	Reposition the PIM Board **Note:** Make sure male header pins are inserted correctly into the mating header.	
21	Secure the PIM board to the new SPM with the five 4-40 x 1/4 screws. Caution: Do not over-tighten the screws. (Maximum torque - 3.5 in.- lb.)	
22	Re-assemble the battery by connecting its cable to the connector (pull lightly on the cable to ensure it is locked in place) then tighten the four 6-32 x 2 1/4 screws.	
23	Re-assemble the battery compartment cover by tightening the four 6-32 x 5/16 screws.	
24	Place the front case assembly over the ventilator module and tighten the two 4-40 x 1/4 screws to the dovetail mounting bracket. Reconnect the ribbon cable unto the PIM board. Make sure the two ejector latches are secured.	
25	Attach the back case to the ventilator module and align cover with handle, air intake housing and dovetail mounting studs. Insert and tighten the four 6-32 x 2” screws and then the two 10-32 Keps nuts (provided in the kit).	
26	Tighten the four 8-32 x 3 screws on the outer air intake.	

Step	Procedure	
27	Power cycle the ventilator three times, and then re-certify the ventilator using the RCS. Note: A PM Due Alarm (SC#3120) may occur and will be reset when the device is recalibrated.	

Battery Compartment Service Kit Installation Instructions

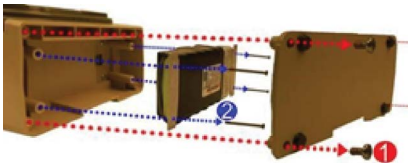
Required Tools

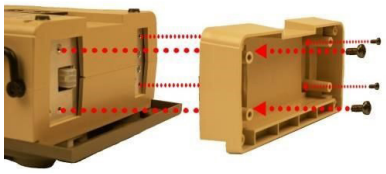
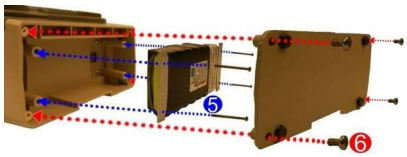
- Torque driver with #1 and #2 Phillips bits

Kit Contents

Quantity	Description	Depiction
1	Battery Compartment Case with Gaskets	
4	Screw, Phillips, Pan Head, SS, 6-32 x 5/16	

Instructions

Step	Action	
1	Remove the battery compartment cover by unscrewing the four 6-32 x 5/16 screws. Save these screws.	
2	Remove the battery by unscrewing the four 6-32 x 2 1/4 screws and detaching the plug from its locking latch. Save these screws.	

Step	Action	
3	Unscrew the four 6-32 x 5/16 Phillips screws to remove the damaged battery compartment case. Save these screws.	
4	Rotate the battery compartment to mate with upper and lower case cutouts and press firmly into place. Secure with four 6-32 x 5/16 screws provided.	
5	Re-assemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it is locked in place) then tightening the four 6-32 x 2 1/4 screws.	
6	Re-assemble the battery compartment cover by tightening the four 6-32 x 5/16 screws.	
7	Re-certify the ventilator using the RCS.	

USB Connector Plate Service Kit Installation Instructions

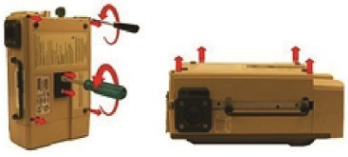
Required Tools

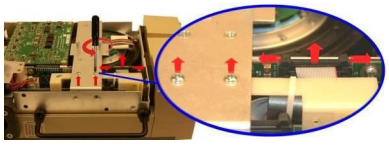
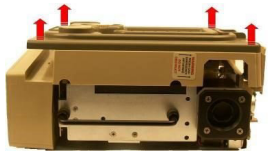
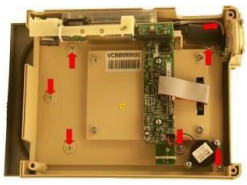
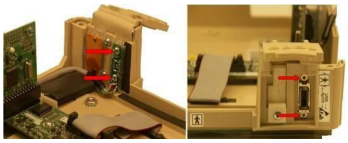
- Torque driver with #1 and #2 Phillips bits
- Nut driver set
- Small utility knife
- RTV sealant

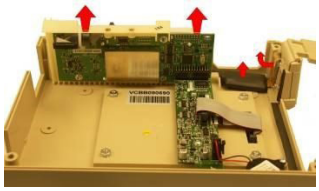
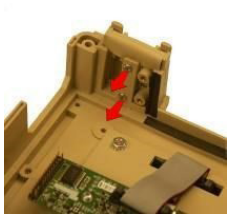
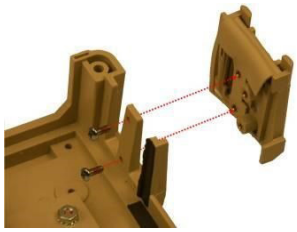
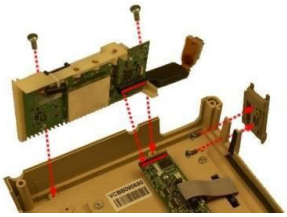
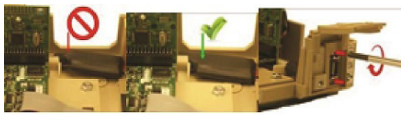
Kit Contents

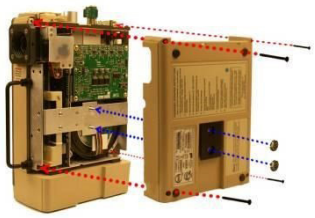
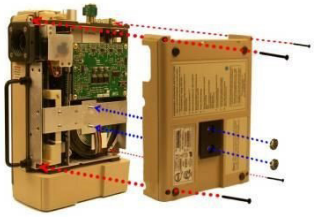
Quantity	Description	Depiction
1	USB Connector Plate Assembly	
2	Screw, Phillips, Pan Head, Zinc Plated 4-40 x 5/16	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	
2	Loosen and remove the two 10-32 Keps nuts and the four 6-32 x 2 screws. Remove the back case by lifting from the ventilator.	

Step	Action	
3	Remove the two 4-40 x 1/4 screws on the dovetail mounting bracket, then disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
4	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
5	Remove the bezel by loosening and removing the seven 4-40 x 1/4 screws that hold the bezel to the front case.	
6	Using a sharp knife, carefully cut the RTV sealant around the USB Printed Circuit Board and around the SpO_2 Connector. **Note:** Take precaution not to cut either cable.	
7	Loosen and remove the two 4-40 x 3/16 screws holding the Mini USB Cable Assembly to the front case. Loosen and remove the two M2.5 x 5mm screws holding the SpO_2 cable to the front case.	
8	Loosen and remove the two 6-32 x 5/16 screws that hold the CPU/UIM & SpO_2 Stack to the front case.	

Step	Action	
9	Lift the CPU/UIM & SpO_2 Stack up from the front case. Handle the SpO_2 cable with extreme care. Do not pull on the cable.	
10	Loosen and remove the two 4-40 x 5/16 screws holding the damaged USB Connector Plate to the front case.	
11	Insert and tighten the two 4-40 x 5/16 screws (provided in the kit) while holding the replacement USB Connector Plate to the front case.	
12	Tighten the two 6-32 x 5/16 screws that hold the CPU/UIM & SpO_2 Stack to the front case. Make sure that all the pins on the header mate correctly.	
13	Make sure the SpO_2 Flex Cable lays flat against the front case and is assembled correctly into the UIM Bracket and SpO_2 Isolation Shield. Insert and tighten the two M2.5 x 5mm screws holding the SpO_2 cable to the front case.	

Step	Action	
14	Remove any excess RTV sealant from the SpO_2 flex cable and USB board. Tighten the two 4-40 x 3/16 screws holding the USB board to the front case. Apply RTV sealant to USB board and SpO_2 flex cable. Allow to dry/cure.	
15	Place the front case assembly over the ventilator module and tighten the two 4-40 x 1/4 screws to the dovetail mounting bracket. Reconnect the ribbon cable to the PIM board. Make sure the two ejector latches are secured.	
16	Attach the back case to the ventilator module and align cover with handle, air intake housing and dovetail mounting studs. Insert and tighten the four 6-32 x 2” screws and then the two 10-32 Keps nuts.	
17	Tighten the four 8-32 x 3 screws on the outer air intake.	
18	Perform PM processPM process testing then re-certify the ventilator using the RCS	

Battery Case Bottom Cover Service Kit Installation Instructions

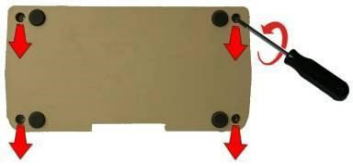
Required Tools

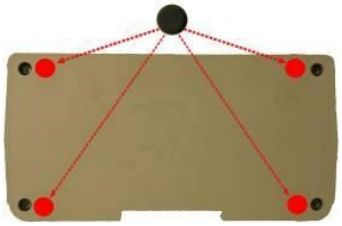
- Torque driver with #1 and #2 Phillips bits

Kit Contents

Quantity	Description	Depiction
1	Battery case bottom cover	
4	Screw, Phillips, Pan Head, SS, 6-32 x 5/16	
4	Bumper, Rubber, Foot, P/S, Round, 1/2" Dia. x 1/8", Blk	

Instructions

Step	Action	
1	Remove the damaged cover by unscrewing the four 6-32 x 5/16 screws.	

Step	Action	
2	Remove backing from the bumper feet, then place one at each corner of the battery case bottom cover.	
3	Rotate cover to align with the battery compartment, then insert and tighten the four 6-32 x 5/16 screws.	
4	Re-certify the ventilator using the RCS.	

EMV Chassis Service Kit Installation Instructions

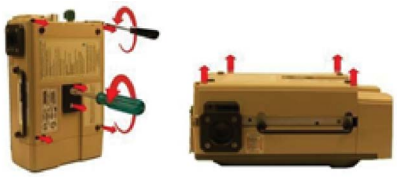
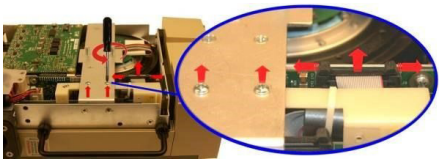
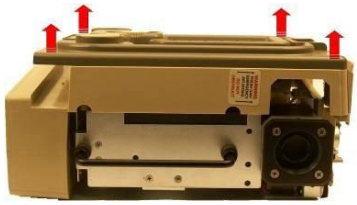
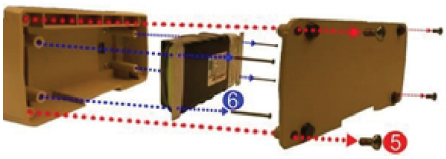
Required Tools

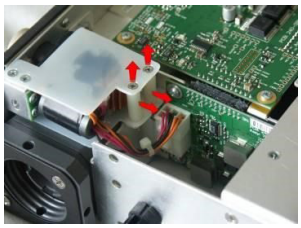
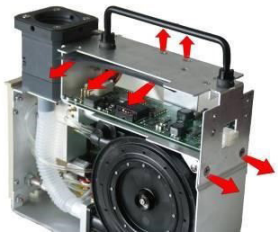
- Torque driver with #1 and #2 Phillips bits
- Nut driver set

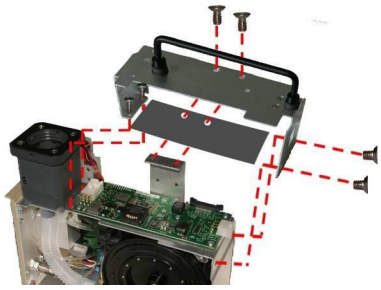
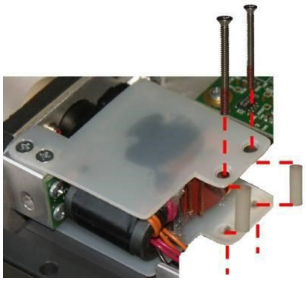
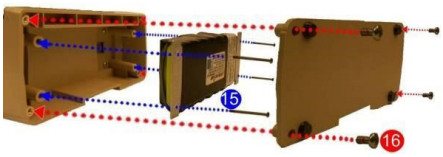
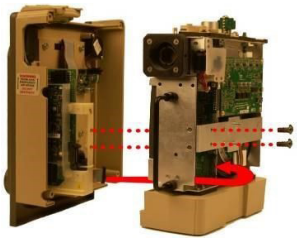
Kit Contents

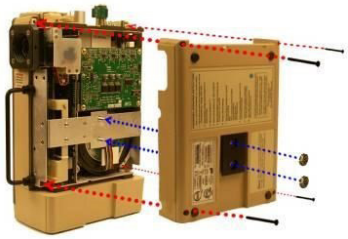
Quantity	Description	Depiction
1	EMV Chassis Assembly	
2	Screw, Phillips, Pan Head, SS, 6-32 x 5/16	
2	Screw, Phillips, Flat Head, 8-32 x 1/4, Undercut, ZP	
2	Screw, Phillips, Flat Head, 6-32 x 1/4, Undercut	
1	SpO_2 Insulator	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	
2	Loosen and remove the two 10-32 Keps nuts and the four 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator.	
3	Remove the two 4-40 x 1/4 screws on the dovetail mounting bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
4	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
5	Remove the battery compartment cover by unscrewing the four 6-32 x 5/16 screws. Save these screws.	
6	Remove the battery by unscrewing the four 6-32 x 2 1/4 screws and detaching the plug from its locking latch. Save these screws.	

Step	Action	
7	Unscrew the four 6-32 x 5/16 Phillips screws to remove the battery compartment case. Save these screws.	
8	Loosen and remove the two 4-40 x 1 1/4 screws and nylon spacers supporting the Power Input assembly unto the chassis. Save these screws and spacers.	
9	Loosen and remove the two 6-32 x 1/4 screws holding the chassis to the dovetail mounting bracket and remove the SpO_2 insulator. Loosen and remove the two 8-32 x 1/4 screws holding the chassis to the ventilator module.	
10	Insert screwdriver through the holes on the chassis to loosen and remove the two 6-32 x 5/16 screws holding the chassis to the ventilator module.	
11	Lift the damaged chassis from the ventilator module.	

Step	Action	
12	Secure the replacement Chassis to the ventilator module using the two 6-32 x 1/4 screws (provided in the kit) with the SpO_2 insulator, the two 8-32 x 1/4, and the two 6-32 x 5/16 screws.	
13	Secure the Power Input assembly to the Chassis using the two spacers and two 4-40 x 1 1/4 screws. **Note:** Do not over-tighten the screws. (Maximum torque - 3.5 in.- lb.)	
14	Rotate battery compartment to mate with upper and lower case cutouts and press firmly into place. Secure with four 632 x 5/16 screws provided.	
15	Re-assemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it is locked in place) then tightening the four 6-32 x 2 1/4 screws.	
16	Re-assemble the battery compartment cover by tightening the four 6-32 x 5/16 screws.	
17	Place the front case assembly over the ventilator module and tighten the two 4-40 x 1/4 screws to the dovetail mounting bracket. Reconnect the ribbon cable unto the PIM board. Make sure the two ejector latches are secured.	

Step	Action	
18	Attach the back case to the ventilator module and align cover with handle, air intake housing and dovetail mounting studs. Insert and tighten the four 6-32 x 2” screws and then the two 10-32 Keps nuts.	
19	Tighten the four 8-32 x 3 screws on the outer air intake.	
20	Re-certify the ventilator using the RCS.	

Connector Panel Service Kit Installation Instructions

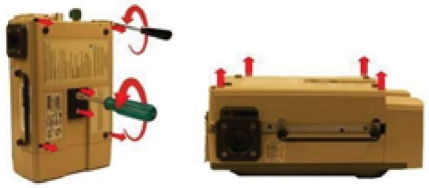
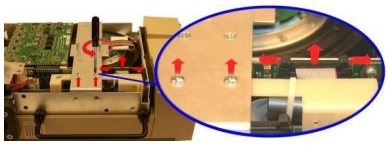
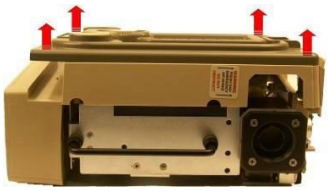
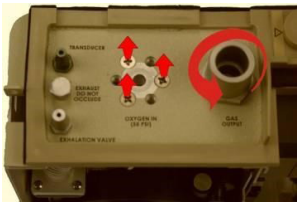
Required Tools

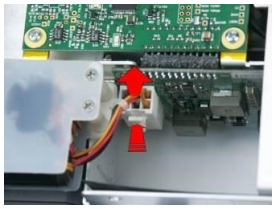
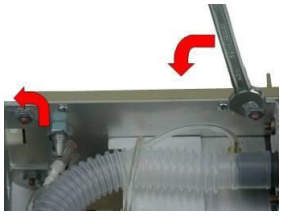
- Torque driver with #1 and #2 Phillips bits
- Nut driver set
- Needle-nosed pliers
- 5/16” open-ended wrench

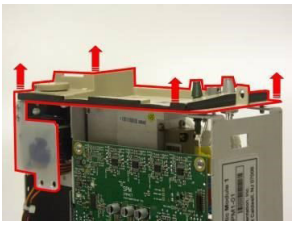
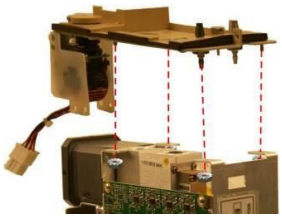
Kit Contents

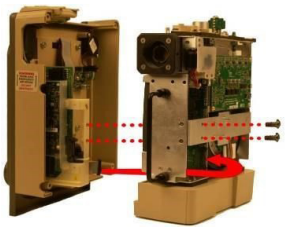
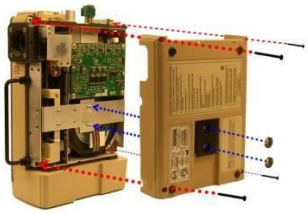
Quantity	Description	Depiction
1	Connector Panel Assembly	
3	8-32 x 1/4 Screw	
4	6-32 Keps Nut	
2	O-Ring ½” OD x 3/8” ID	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	
2	Loosen and remove the two 10-32 Keps nuts and the four 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator.	
3	Remove the two 4-40 x 1/4 screws on the dovetail mounting bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
4	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
5	Remove the oxygen inlet fitting (**OXYGEN IN**) by unscrewing the dust cap then unscrewing the three 8-32 x 7/16 screws. Save these screws.	
6	Loosen and remove the three 8-32 x 1/4 screws. Loosen and remove the gas output fitting (**GAS OUTPUT**) using a socket wrench that has a 1 in. deep well socket. Save the fitting.	

Step	Action	
7	Disconnect the Power Input cable by pressing on the locking latch and pulling the cable straight up from the connector.	
8	Loosen and remove the two 4-40 x 1 1/4 screws and nylon spacers supporting the Power Input assembly unto the chassis. Save these screws and spacers.	
9	Loosen and remove the two 6-32 Keps nuts using a 5/16 open-end wrench.	
10	Using smooth jaw needle nose pliers, carefully remove the 3 tubing on these fittings: • "Transducer" • "Exhaust Do not Occlude" • "Exhalation Valve" Do not discard the tubing.	
11	Loosen and remove the two 6-32 Keps nuts using a 5/16 open-end wrench.	

Step	Action	
12	Lift the damaged connector panel assembly out from the SPM.	
13	Remove and discard the 1/2" OD x 3/8" ID O-ring from the Oxygen Inlet manifold. Place the new 1/2" OD x 3/8" ID O-ring in the Oxygen Inlet manifold.	
14	Position the replacement Connector Panel over the SPM and secure with the four 6-32 Keps nuts (provided in the kit).	
15	Secure the Power Input assembly to the Chassis using the two spacers and two 4-40 x 1 1/4 screws. **Note:** Do not over-tighten the screws. (Maximum torque - 3.5 in.- lb.) Connect the Power Input cable by inserting into connector. Insure that locking latch engages.	
16	Insert the 3 tubing to their correct connectors. • “V_BACKUP” to “Exhalation Valve” • “V_ACAL” to “Transducer” • “Exhaust Do Not Occlude” (smallest tubing)	

Step	Action	
17	Secure the connector panel to the ventilator module using the three 8-32 x 1/4 screws (provided in the kit).	
18	Insert the 1/2" OD x 3/8" ID O-ring (provided in the kit) into the oxygen inlet (OXYGEN IN) fitting and the existing 5/8" OD x 1/2" ID O-ring into the Gas Output adapter.	
19	Place the oxygen inlet (**OXYGEN IN**) fitting over the connector panel, then insert and tighten with the three 8-32 x 7/16 screws. Place the fitting and O-ring to the gas output (**GAS OUTPUT**) and tighten with a socket wrench that has a 1 in. deep socket. Torque to 75 in-lbs. **Note:** Do not cross thread.	
20	Place the front case assembly over the ventilator module and tighten the two 4-40 x 1/4 screws unto the dovetail mounting bracket. Reconnect the ribbon cable unto the PIM board. Make sure the two ejector latches are secured.	
21	Attach the back case to the ventilator module, then align the cover with the handle, air intake housing and dovetail mounting studs. Insert and tighten the four 6-32 x 2” screws and then the two 10-32 Keps nuts.	

Step	Action	
22	Tighten the four 8-32 x 3 screws on the outer air intake.	
23	Re-certify the ventilator using the RCS.	

Back Case Service Kit Installation Instructions

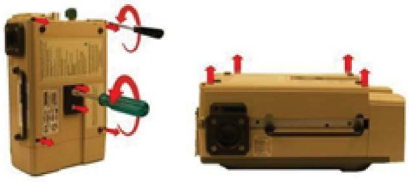
Required Tools

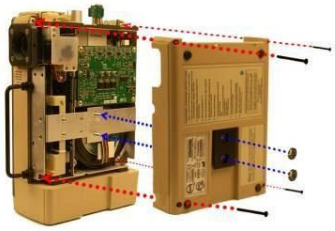
- Torque driver with #1 and #2 Phillips bits
- Nut driver set

Kit Contents

Quantity	Description	Depiction
1	Back Case Assembly	
4	Screw, Phillips, Pan Head, SS, Black Oxide, 6-32 x 2	
2	Nut, Keps, 10-32	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	
2	Loosen and remove the two 10-32 Keps nuts and the four 6-32 x 2 screws. Remove the case by lifting from the ventilator. Save these screws.	

Step	Action	
3	Place the replacement cover over ventilator, then align the cover with the handle, air intake housing and dovetail mounting studs. Insert and tighten the two 10-32 Keps nuts (provided in the kit) and the four 6-32 x 2” screws.	
4	Tighten the four 8-32 x 3 screws on the outer air intake.	
5	Re-certify the ventilator using the RCS.	

Power Interface Module Service Kit Installation Instructions

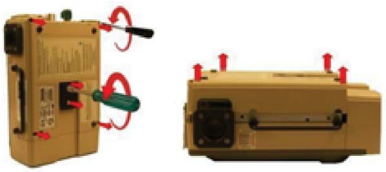
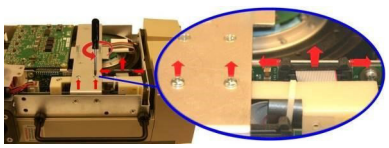
Required Tools

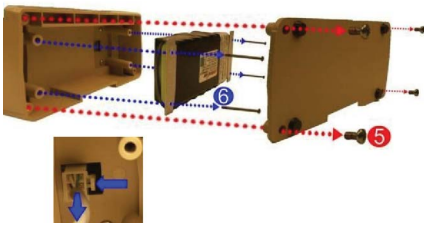
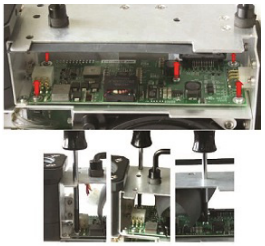
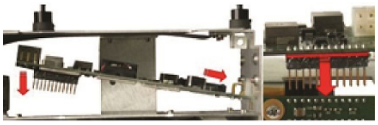
- Torque driver with #1 and #2 Phillips bits
- Nut driver set

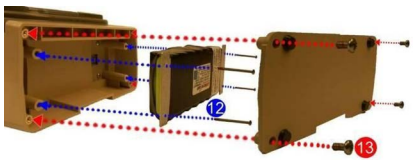
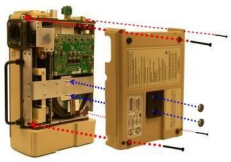
Kit Contents

Quantity	Description	Depiction
1	PIM Board (PCB)	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	
2	Loosen and remove the two 1032 Keps nuts and the four 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting it from the ventilator.	
3	Remove the two 4-40 x 1/4 screws on the dovetail mounting bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	

Step	Action	
4	Flip the ventilator over and remove the front case assembly by lifting it straight up and away from the ventilator module.	
5	Remove the battery compartment cover by unscrewing the four 6-32 x 5/16 screws. Save these screws.	
6	Remove the battery by unscrewing the four 6-32 x 2 1/4 screws and detaching the plug from its locking latch. Save these screws.	
7	Disconnect the Power Input Cable from the PIM board by pressing on the locking latch and pulling the cable straight up from the connector.	
8	Loosen and remove the five 4-40 x 1/4 screws holding the PIM board to the ventilator module. Save these screws. Move SpO_2 Insulator out of the way and insert screwdriver through the holes to aid in removing screws. **Note:** Do not fold the SpO_2 Insulator.	
9	Lift the defective PIM Board out of the ventilator module.	
10	Place the new PIM Board **Note:** Make sure male header pins are inserted correctly into the mating header.	

Step	Action	
11	Secure the PIM board to the new SPM with the five 4-40 x 1/4 screws. Caution: Do not over-tighten the screws. (Maximum torque - 3.5 in.- lb.)	
12	Re-assemble the battery by connecting its cable to the connector (pull lightly on the cable to ensure it is locked in place) then tighten the four 6-32 x 2 1/4 screws.	
13	Re-assemble the battery compartment cover by tightening the four 6-32 x 5/16 screws.	
14	Place the front case assembly over the ventilator module and tighten the two 4-40 x 1/4 screws to the dovetail mounting bracket. Reconnect the ribbon cable unto the PIM board. Make sure the two ejector latches are secured.	
15	Attach the back case to the ventilator module and align cover with handle, air intake housing and dovetail mounting studs. Insert and tighten the two 10-32 Keps nuts (provided in the kit) and the four 6-32 x 2” screws.	
16	Tighten the four 8-32 x 3 screws on the outer air intake.	
17	Use the RCS "Write" function to update the new part's serial number.	
18	Re-certify the ventilator using the RCS tool	

CPU/UIM and SPO Stack Service Kit Installation Instructions

Required Tools

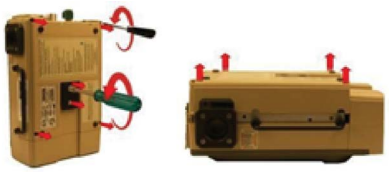
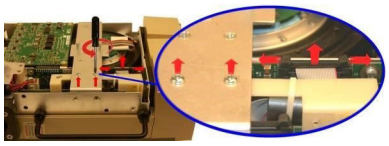
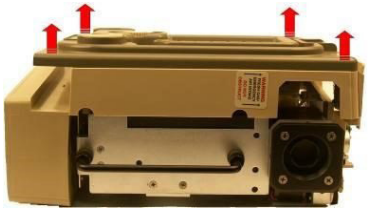
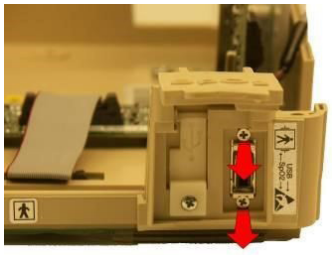
- Torque driver with #1 and #2 Phillips bits
- Nut driver set
- Small utility knife
- RTV sealant

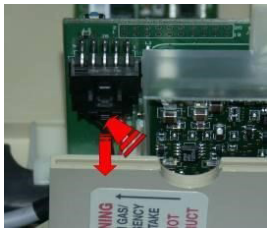
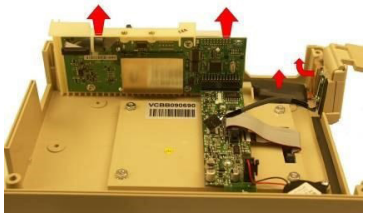
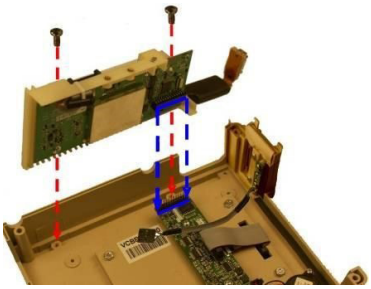
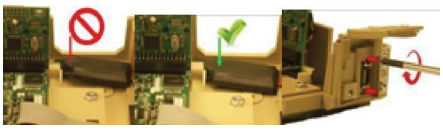
Kit Contents

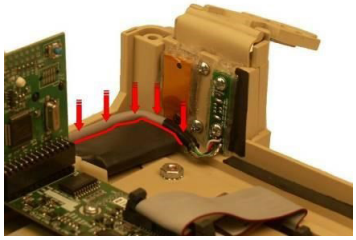
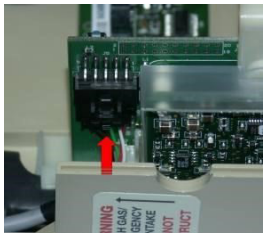
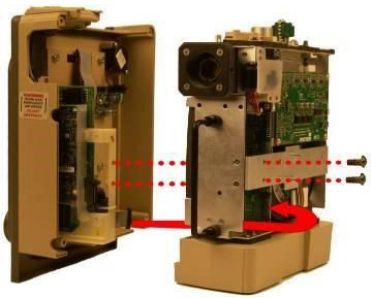
Quantity	Description	Depiction
1	CPU/UIM & SpO_2 Stack	
2	Screw, Phillips, Pan Head, SS, 6-32 x 5/16	
2	Screw, Metric, Phillips, Flat Head, M2.5 x 5mm Stainless Steel	

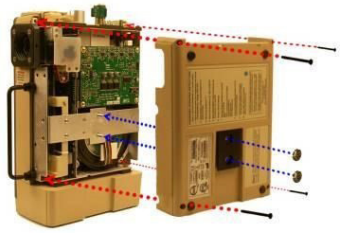
Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	

Step	Action	
2	Loosen and remove the two 10-32 Keps nuts and the four 6-32 x 2 screws. Save these screws. Remove the back case by lifting from the ventilator.	
3	Remove the two 4-40 x 1/4 screws on the dovetail mounting bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
4	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
5	Using a sharp knife, carefully cut the RTV sealant around the SpO_2 cable.	
6	Loosen and remove the two M2.5 x 5mm screws holding the SpO_2 cable to the front case.	

Step	Action	
7	Disconnect the USB cable by pressing on locking tab and pulling cable downwards.	
8	Loosen and remove the two 6-32 x 5/16 screws that hold the CPU/UIM & SpO_2 Stack to the front case.	
9	Lift the CPU/UIM & SpO_2 Stack up from the front case. **Note:** Handle the SpO_2 cable with extreme care. Do not pull on the cable.	
10	Tighten the two 6-32 x 5/16 screws that hold down the new CPU/UIM & SPo2 Stack to the front case. **Note:** Make sure that all the pins on the header mate correctly.	
11	Make sure the SpO_2 Flex Cable lays flat against the front case and is routed correctly into the UIM Bracket and SpO_2 Isolation Shield. Insert and tighten the two M2.5 x 5mm screws holding the SpO_2 cable to the front case.	

Step	Action	
12	Apply RTV Sealant around the SpO_2 Flex Cable and allow to dry.	
13	Dress the USB Connector cable along the case and over the SpO_2 flex cable.	
14	Attach USB Connector cable to its mating connector on the CPU board. Make sure tab locks the cable in place.	
15	Place the front case assembly over the ventilator module and tighten the two 4-40 x 1/4 screws unto the dovetail mounting bracket. Reconnect the ribbon cable unto the PIM board. Make sure the two ejector latches are secured.	

Step	Action	
16	Attach the back case to the ventilator module and align cover with the handle, the air intake housing, and the dovetail mounting studs. Insert and tighten the four 6-32 x 2” screws and then the two 10-32 Keps nuts.	
17	Tighten the four 8-32 x 3 screws on the outer air intake.	
18	Use the RCS "Write" function to update all serial numbers on the "Front Case" fields, and the PIM board's serial number on the respective field.	
19	Re-certify the ventilator using the RCS tool.	

USB Connector Service Kit Installation Instructions

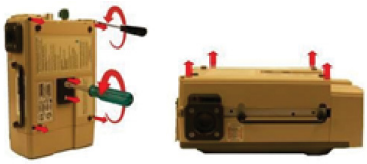
Required Tools

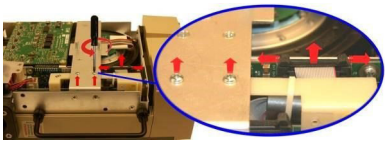
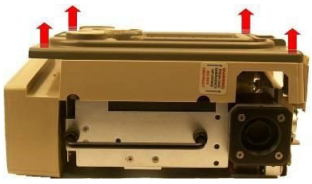
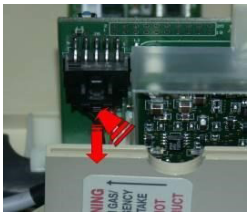
- Torque driver with #1 and #2 Phillips bits
- Nut driver set
- Small utility knife
- RTV sealant

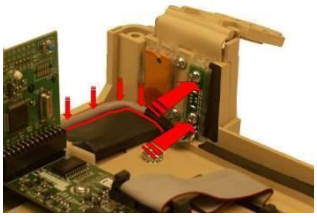
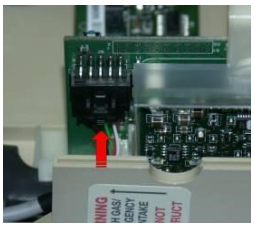
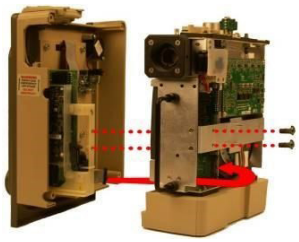
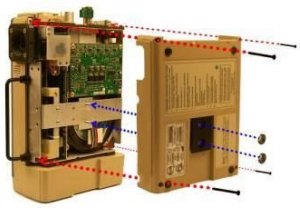
Kit Contents

Quantity	Description	Depiction
	USB Connector Assembly	
	Screw, Phillips, Pan Head, Zinc Plated, 4-40 x 3/16	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	
2	Loosen and remove the two 10-32 Keps nuts and the four 6-32 x 2 screws. Save these screws. Remove the back case by lifting from the ventilator.	

Step	Action	
3	Remove the two 4-40 x 1/4 screws on the dovetail mounting bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
4	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
5	Using a sharp knife, carefully cut the RTV sealant around the USB Printed Circuit Board.	
6	Loosen and remove the two 4-40 x 3/16 screws holding the Mini USB Cable Assembly to the front case.	
7	Remove the damaged cable by pressing on locking tab and pulling cable downwards.	

Step	Action	
8	Remove any excess RTV from the case. Insert and tighten the two 4-40 x 3/16 screws (provided in the kit) holding the new USB Connector to the front case. Dress the USB Connector cable along the case and over the SpO_2 flex cable.	
9	Attach USB Connector cable to its mating connector on the CPU board. Make sure tab locks the cable in place.	
10	Apply RTV Sealant around USB board and allow to dry.	
11	Place the front case assembly over the ventilator module and tighten the two 4-40 x 1/4 screws to the dovetail mounting bracket. Reconnect the ribbon cable unto the PIM board. Make sure the two ejector latches are secured.	
12	Attach the back case to the ventilator module and align cover with the handle, air intake housing, and dovetail mounting studs. Insert and tighten the two 10-32 Keps nuts (provided in the kit) and the four 6-32 x 2” screws.	

Step	Action	
13	Tighten the four 8-32 x 3 screws on the outer air intake.	
14	Re-certify the ventilator using the RCS.	

Gas Output Service Kit Installation Instructions

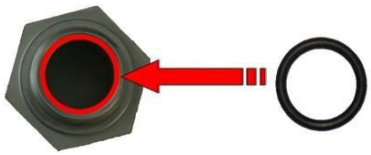
Required Tools

- Socket wrench with a 1 inch deep well socket

Kit Contents

Quantity	Description	Depiction
1	Fitting, Patient, Outlet, SPM	
1	O-Ring, Neoprene, 1/2" ID	

Instructions

Step	Action	
1	Remove the damaged fitting by unscrewing with a socket wrench that has a 1-inch deep well socket.	
2	Place O-ring unto underside of outlet fitting	

Step	Action	
3	Place fitting and O-ring unto Gas Output and tighten with a socket wrench that has a 1 in. deep well socket. Torque to 75 in-lbs. **Note:** Do not cross thread.	
4	Re-certify the ventilator using the RCS.	

Power Input Service Kit Installation Instructions

Required Tools

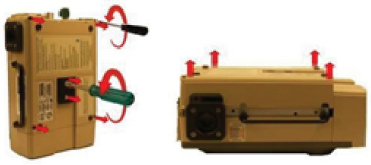
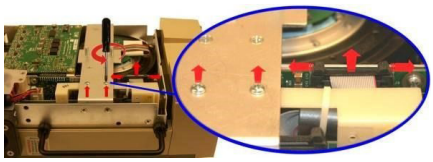
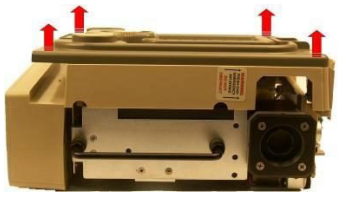
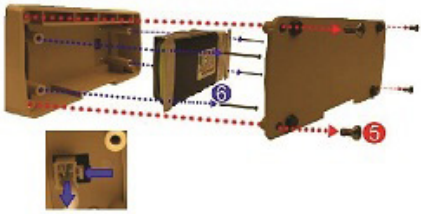
- Torque driver with #1 and #2 Phillips bits
- Nut driver set

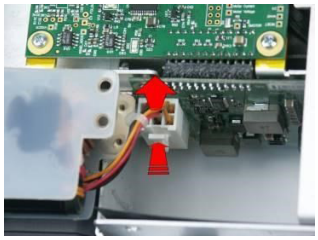
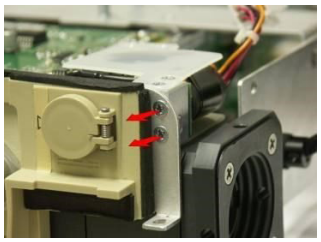
Kit Contents

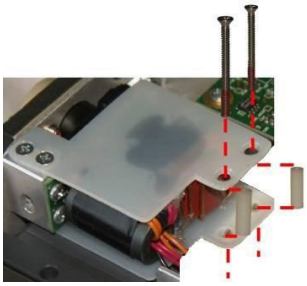
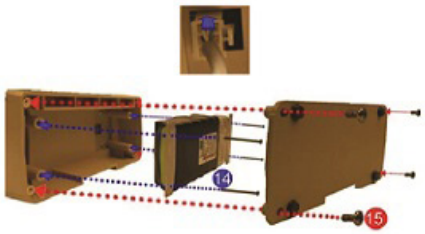
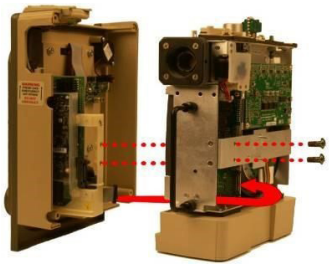
Quantity	Description	Depiction
1	Power Input Assembly	
2	Screw, Phillips, Flat Head, Zinc Plated, 4-40 x 1/4	
2	Screw, Phillips, Flat Head, 4-40 x 1 1/4	
2	Spacer, Nylon, #4, x 812 Long	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	

Step	Action	
2	Loosen and remove the two 10-32 Keps nuts and the four 6-32 x 2 screws. Save these screws. Remove the back case by lifting from the ventilator	
3	Remove the two 4-40 x 1/4 screws on the dovetail mounting bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
4	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
5	Remove the battery compartment cover by unscrewing the four 6-32 x 5/16 screws. Save these screws.	
6	Remove the battery by unscrewing the four 6-32 x 2 1/4 screws and detaching the plug from its locking latch.	
7	Loosen and remove the two 4-40 x 1 1/4 Screws and nylon spacers supporting the Power Input assembly unto the chassis.	

Step	Action	
8	Disconnect the Power Input cable from the PIM board by pressing on the locking latch and pulling the cable straight up from the connector.	
9	Loosen and remove the two 4-40 x 1/4 screws holding the Power Input to the connector panel.	
10	Using two small flat blade screwdrivers, separate the two locking tabs on the power plug and pull the power input assembly away from the connector panel.	   Unobstructed View 
11	Insert the new power input assembly into the connector panel socket and pull on the assembly to ensure the locking tabs have engaged.	

Step	Action	
12	Secure the Power Input assembly to the Connector Panel using the two 4-40 x 1/4 screws (provided in the kit).	
13	Secure the Power Input assembly to the Chassis using the two spacers and the two 4-40 x 1 1/4 screws (provided in the kit). **Note:** Do not over-tighten the screws. (Maximum torque - 3.5 in.- lb.)	
14	Re-assemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it s locked in place) then tightening the four 6-32 x 2 1/ 4 screws.	
15	Re-assemble the battery compartment cover by tightening the four 6-32 x 5/16 screws.	
16	Place the front case assembly over the ventilator module and tighten the two 4-40 x 1/4 screws unto the dovetail mounting bracket. Reconnect the ribbon cable unto the PIM board. Make sure the two ejector latches are secured.	
17	Attach the back case to the ventilator module and align cover with handle, air intake housing and dovetail mounting studs. Insert and tighten the four 6-32 x 2” screws and then the two 10-32 Keps nuts (provided in the kit).	

Step	Action	
18	Tighten the four 8-32 x 3 screws on the outer air intake.	
19	Re-certify the ventilator using the RCS.	

Oxygen Inlet Fitting Service Kit Installation Instructions

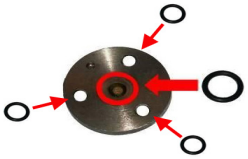
Required Tools

- Torque driver with #1 and #2 Phillips bits

Kit Contents

Quantity	Description	Depiction
1	Oxygen inlet fitting with filter, cap and chain	
3	Screw, Phillips, Flat Head, 8-32 x 7/16, ZP	
1	O-Ring, Black, Neoprene, 1/2"O.D.x 3/8"I.D. (Nominal)	
3	O-Ring, Buna-N 5/16 OD X 3/16	

Instructions

Step	Action	
1	Remove the damaged oxygen inlet (**OXYGEN IN**) fitting by unscrewing the dust cap then unscrewing the three 8-32 x 7/16 screws.	
2	Install the O-Rings (provided in the kit) into grooves on underside of inlet fitting.	
3	Place oxygen inlet fitting over the ventilators connector panel then insert and tighten the 3 supplied 8-32 x 7/16 screws.	
4	Re-certify the ventilator using the RCS.	

Oxygen Valve Assembly Service Kit Installation Instructions

Kit Numbers (ALL MODELS)

- 712-0731-42

Required Tools

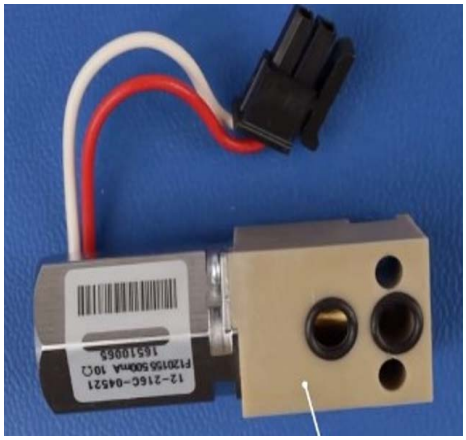
- Torque driver with #1 Phillips bit

CAUTION / WARNING!

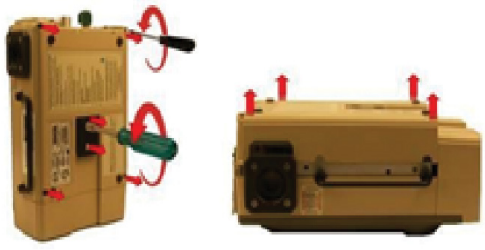
Replacement of the Oxygen Valve Assembly requires the handling of **Oxygen Clean Parts.** When handling any metal components within the ventilator which are responsible for transporting oxygen, take the following precautions:

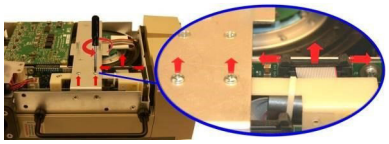
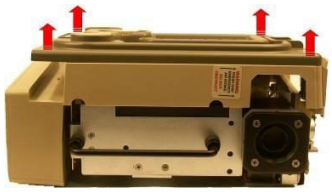
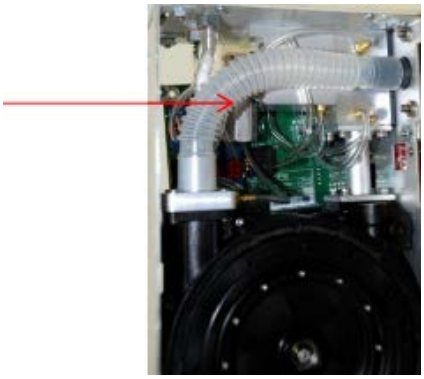
- Never touch the components with your bare hands as oils and residue may contaminate the component.
- Keep all Oxygen Clean parts in their protective packaging prior to installation.
- Do not keep sources of contaminate on the workbench such as soldering material.
- If an oxygen clean part becomes contaminated, replace the part and do not attempt to clean it.

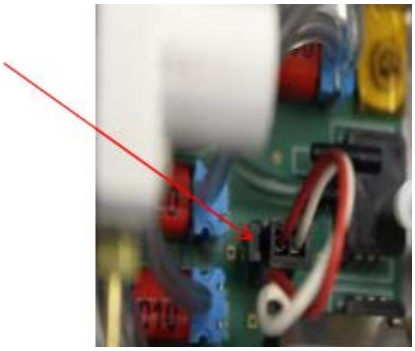
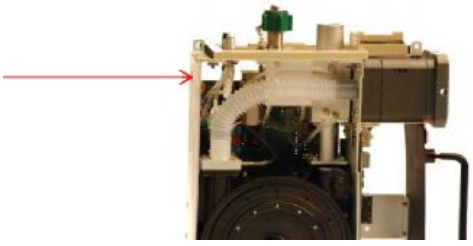
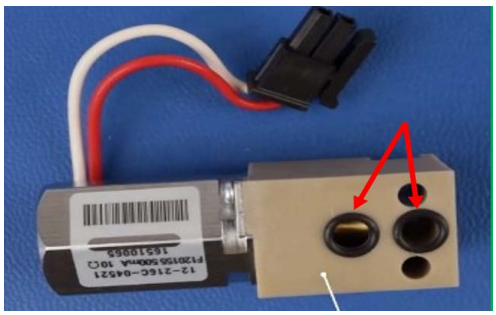
Kit Contents

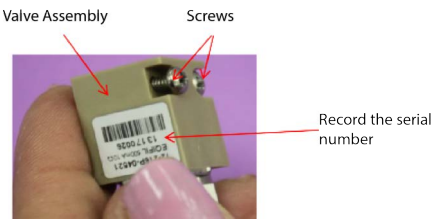
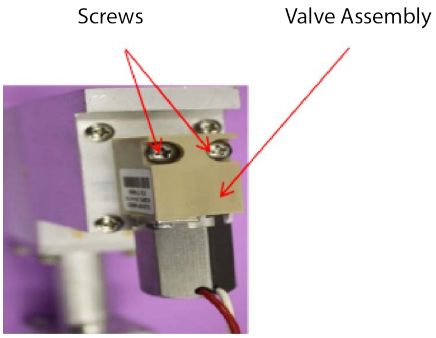
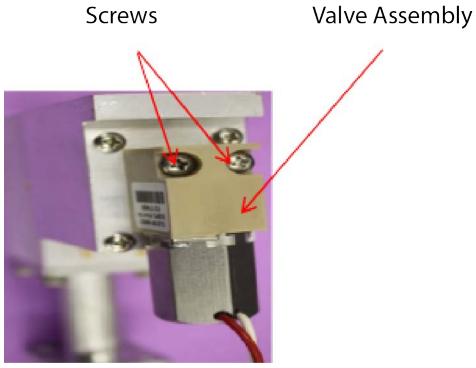
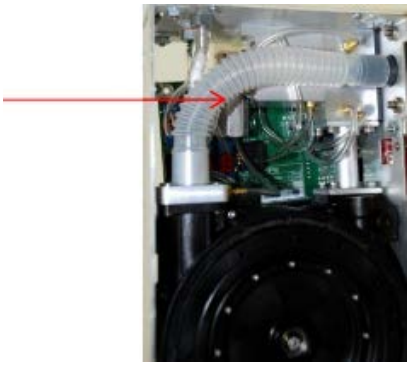
Quantity	Description	Depiction
2	SCREW, PHILIPS, PAN HEAD, 4-40 x 1 3/4, RoHS	
1	Assembly, Valve with O Rings.	

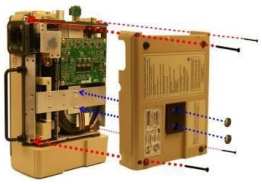
Instructions

Step	Procedure	
1	Loosen by 1 full turn and do not remove the four 8-32 x 3 screws on the outer air intake. (Additional loosening may cause the filter disk to slip out of place)	
2	Loosen and remove the two 10-32 Keps nuts and the four 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator.	

Step	Procedure	
3	Remove the two Pan Head 4-40 x 1/4 screws on the dovetail mounting bracket but do not remove the two flat head screws. Disconnect the ribbon cable on the Power Interface Module (PIM) board by simultaneously applying pressure on the two ejector latches. Save these screws.	
4	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
5	The O2 valve is located on the ventilator module.	
6	The 6" corrugated tubing can be removed for easier viewing and access to the O_2 Valve.	

Step	Procedure	
7	Note orientation of Oxygen Flow valve cable. Disconnect Oxygen Flow Valve cable from J2 of SPM PCB by pinching on the locking latch and pulling up on the connector.	
8	Access to the O_2 Valve screws is through the cutout of the SPM chassis. Using a small point Philips screwdriver, loosen and remove the two screws (4-40 x 11/16) from the O_2 Valve. Remove the O_2 Valve with its (2) O-rings from the SPM assembly.	 
9	With the new valve kit, insert two O-Rings into the Valve Assembly. Note: Ensure that the O-Rings stay firmly in place.	

Step	Procedure	
10	Hold Valve Assembly with the O-Rings attached and insert the 2 screws. **Phillips, Pan Head, 4-40 x 11/16 (P/N 358-0440-11)** Record serial number used in your service records.	
11	Attach Valve Assembly to the Oxygen Inlet Manifold in the orientation as shown and tighten with 2 screws (4-40 x 11/16). Note: Make sure the O-rings stay in place.	
12	Note orientation of Oxygen Flow valve cable. Connect Oxygen Flow Valve cable to J2 of SPM PCB. Test that the connector is locked in place by gently pulling up on the connector.	
13	Re-attach the 6" corrugated tubing if it was previously removed.	

Step	Procedure	
14	Place the front case assembly over the ventilator module and tighten the two 4-40 x 1/4 screws to the dovetail mounting bracket. Reconnect the ribbon cable unto the PIM board. Make sure the two ejector latches are secured.	
15	Attach the back case to the ventilator module and align cover with handle, air intake housing and dovetail mounting studs. Insert and tighten the four 6-32 x 2” screws and then the two 10-32 Keps nuts (provided in the kit).	
16	Re-certify the ventilator using the RCS.	

Flow Screen Service Kit Installation Instructions

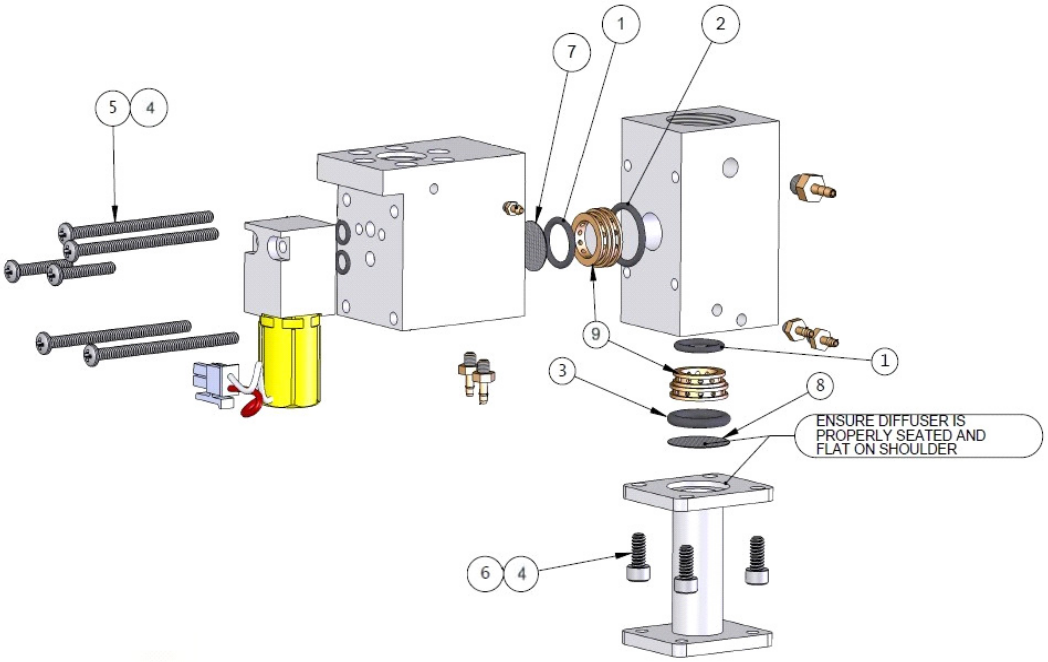
Kit Number (ALL MODELS)	SCAN OR CLICK FOR VIDEO
712-0731-41	Compressor Flow Screen O2 Flow Screen

CAUTION / WARNING!

Replacement of the Flow Screen requires the handling of **Oxygen Clean Parts.** When handling any metal components within the ventilator which are responsible for transporting oxygen, take the following precautions:

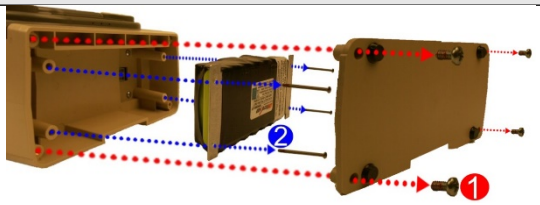
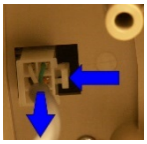
- Never touch the components with your bare hands as oils and residue may contaminate the component.
- Keep all Oxygen Clean parts in their protective packaging prior to installation.
- Do not keep sources of contaminate on the workbench such as soldering material.
- If an oxygen clean part becomes contaminated, replace the part and do not attempt to clean it.

Manifold Diagram

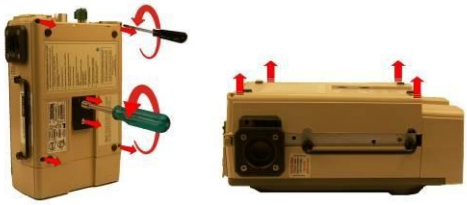
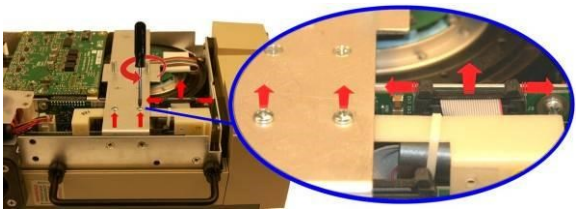


Kit Contents			
ITEM	PN	QTY	DESCRIPTION
1	340-0023-00	2	O-Ring ½" OD X 3/8" ID
2	340-0059-00	1	O-Ring 5/8" OD X ½" ID
3	340-0061-00	1	O-Ring 5/8" OD X 7/16" ID
5 + 4	358-0440-28 602-0006-00	4 As Required	SCREW, PHILIPS, PAN HEAD, 4-40 x 1 ¾ Vibratite
6 + 4	360-0632-05 602-0006-00	4 As Required	SCREW, CAP, SOCKET, 6-32 x 5/16 Vibratite
7	465-0013-00	1	Diffuser 0.484 Diameter
8	465-0029-00	1	Diffuser 0.615 Diameter
9	804-0006-00	2	Flow Screen, 400 Mesh

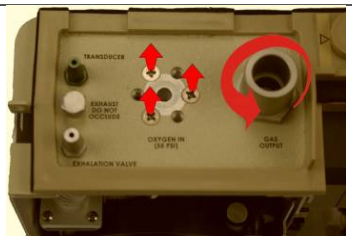
Remove the Main Battery

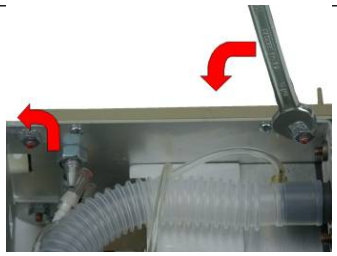
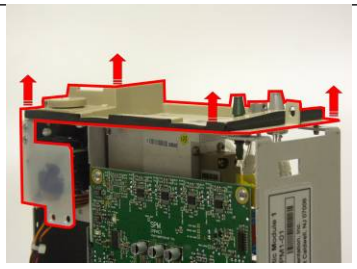
STEP	ACTION	
1		Remove the battery compartment cover by unscrewing the (4) 6-32 X 5/16 screws.
2		Remove the battery by unscrewing the (4) 6-32 X 2 ¼ screws and detaching the plug from its locking latch.

Remove the Fresh Gas/Emergency Air Intake, Back Cover and Front Case Assembly.

STEP	ACTION	
1		Loosen and remove the (4) 8-32 X 3 screws on the outer air intake. Remove the entire Fresh Gas Emergency Air Intake assembly including foam and disk filters.
2		Loosen and remove the (2) 10-32 Keps nuts and the (4) 6-32 X 2 screws. Remove the back case by lifting from the ventilator.
3		Remove the (2) 4-40 X ¼ screws on the Dovetail Mounting Bracket and disconnect the ribbon cable on the PIM PCB by simultaneously applying pressure on the two ejector latches.
4		Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.

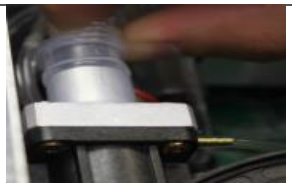
Remove the Connector Panel Assembly

STEP	ACTION	
1		Remove the O2 Inlet fitting by unscrewing the dust cap then unscrewing the (3) 8-32 X 7/16 screws. Remove and keep the O-ring(s)
2		Loosen and remove the (3) 8-32 X ¼ screws. Loosen and remove the Gas Output fitting using a 1-inch deep-socket wrench. Remove and keep the O-ring(s)

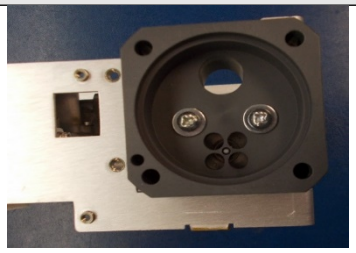
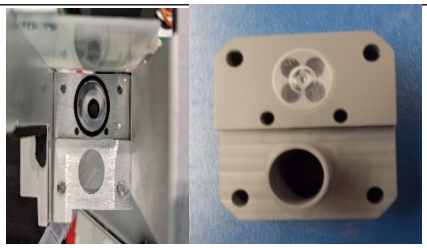
3		Disconnect the Power Input cable by pressing on the locking latch and pulling the cable straight up from the connector.
4		Loosen and remove the (2) 4-40 X 1 ¼ Screws and nylon spacers supporting the Power Input assembly unto the chassis. Save the screws & spacers.
5		Loosen and remove the (2) 6-32 Keps nuts using a 5/16 open-end wrench.
6		Using smooth jaw needle nose pliers, carefully remove the 3 tubing on the “Transducer”, “Exhaust Do not Occlude”, and “Exhalation Valve” fittings.
7		Loosen and remove the (2) 6-32 Keps nuts using a 5/16 open-end wrench.
8		Lift the damaged connector panel assembly out from the SPM.

Remove the Compressor Intake Corrugated Hose

STEP	ACTION

1		Remove the hose from the Compressor Intake. Note: Cover the Compressor Inlet to avoid any screws/particles from falling in.
2		Remove the hose from the BV Holder base.

Remove the BV Holder Base

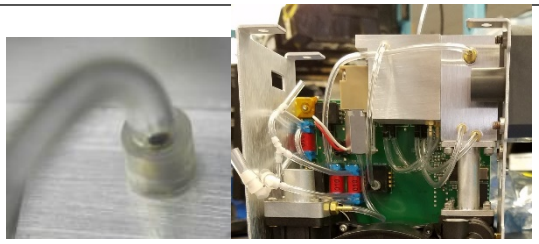
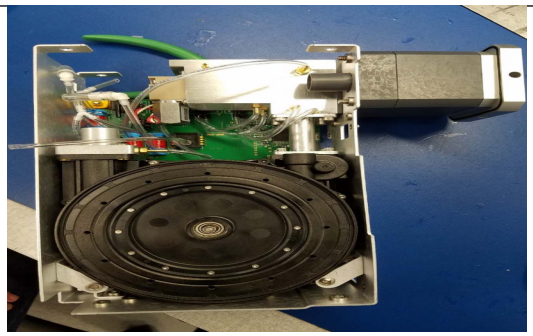
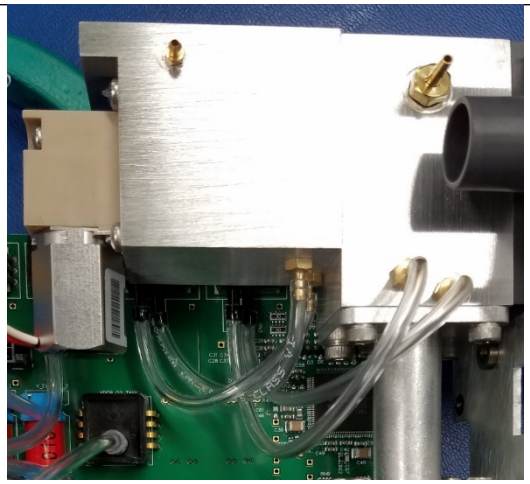
STEP	ACTION	
1		Unscrew the 2 screw (with washers) holding the BV Holder base. .
2		Remove the bacterial filter housing. Pay attention to the integrity of the Anti-asphyxia valve and the O-ring behind it.

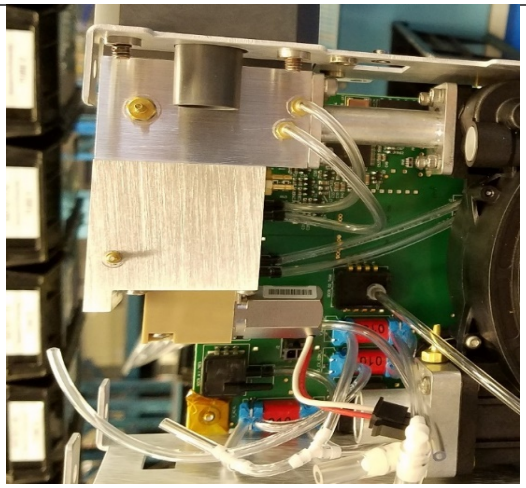
Disconnect the 02 Valve Cable from the SPM PCB

STEP	ACTION	
1		Note orientation of Oxygen Flow valve cable. Disconnect Oxygen Flow Valve cable from J2 of SPM PCB by pinching on the locking latch and pulling up on the connector.

Disconnect the Hoses (6) from the Flow Manifold Assembly

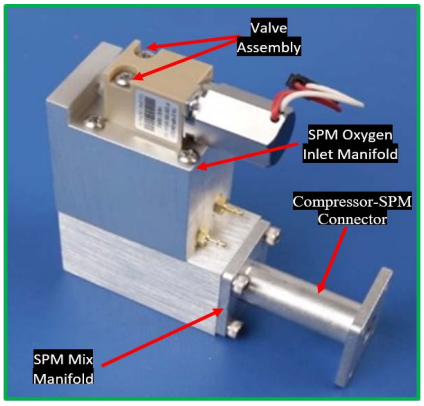
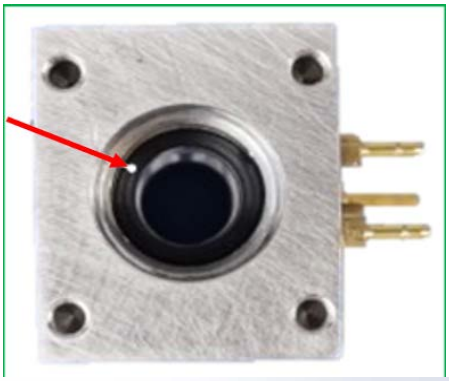
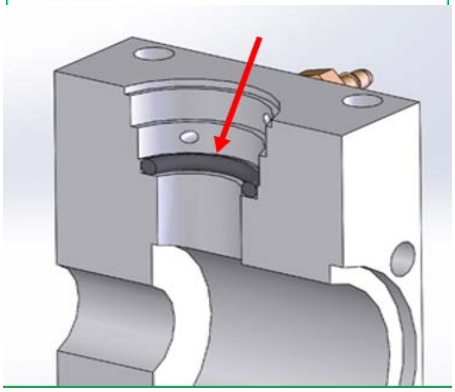
STEP	ACTION

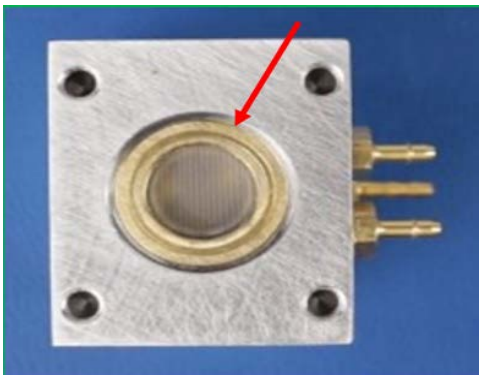
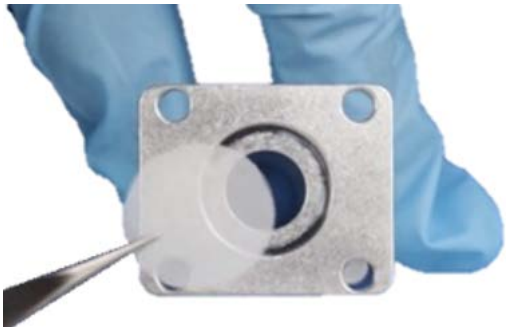
1		Raise sleeve clamp and disconnect tubing from the Oxygen Inlet Manifold. For re-assembly: Connect tubing and sleeve clamp. Push both all the way down on hose barb.
2		Disconnect tubing from the Mix Manifold Pressure fitting. For re-assembly: Connect tubing from Exhalation Control Valve to Mix Manifold Pressure fitting.
3	 O2	Disconnect tubing from the O2 Inlet Manifold (+). For re-assembly: Connect tubing from XDCR_O2_FLOW (-) to the O2 Inlet Manifold (-).
4		Disconnect tubing from the O2 Inlet Manifold (-). For re-assembly: Connect tubing from XDCR_O2_FLOW (+) to the O2 Inlet Manifold (+).

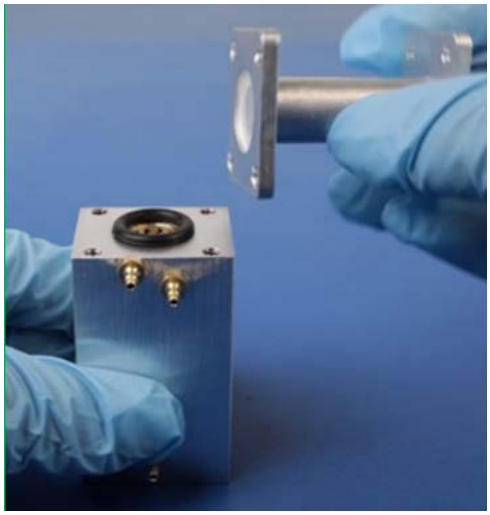
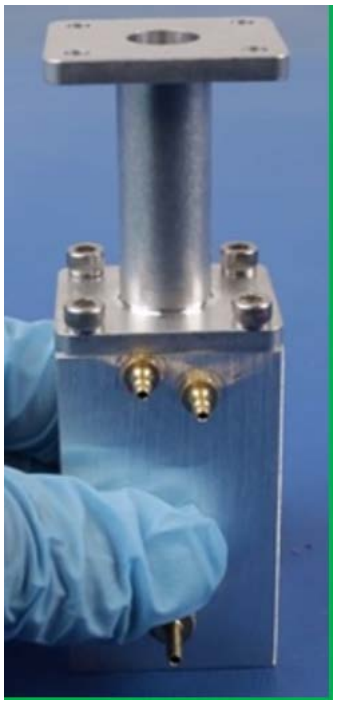
5	 Mix	Disconnect tubing from the Mix Manifold (-). For re-assembly: Connect tubing from XDCR_COMP_FLOW (-) to the Mix Manifold (-).
6		Disconnect tubing from the Mix Manifold (+). For re-assembly: Connect tubing from XDCR_COMP_FLOW (+) to the Mix Manifold (+).

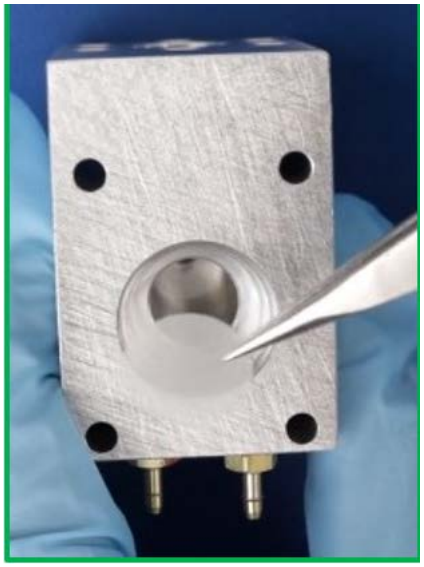
Disconnect the Flow Manifold from the Compressor

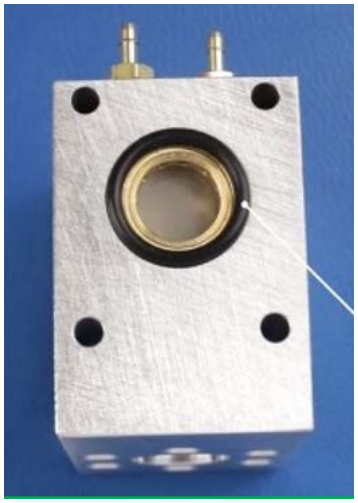
STEP	ACTION	
1		Loosen and remove the 4 hex screws (with washers) holding the Flow Manifold to the Compressor outlet.

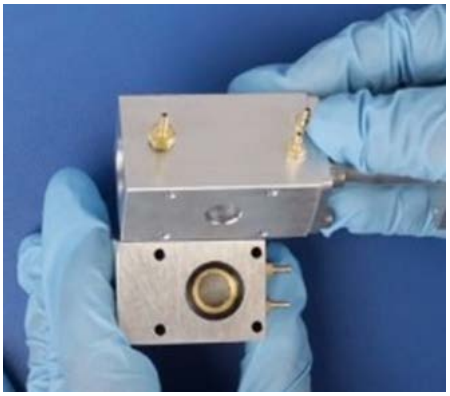
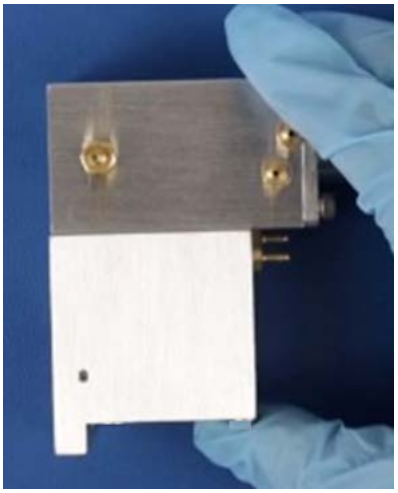
Step	Action	
1	Remove the Manifold Assembly from the Top Panel Connector and the Compressor Pump. Remove 4 screws at SPM Oxygen Inlet Manifold to separate it from the SPM Mix Manifold. Remove 4 screws at SPM Mix Manifold to separate it from the Compressor-SPM Connector.	
2	On the SPM Mix Manifold, insert the O-Ring ½" OD X 3/8" ID (P/N 340-0023-00). NOTE: Ensure that it sits fully in the counter bore of the bottom.	 

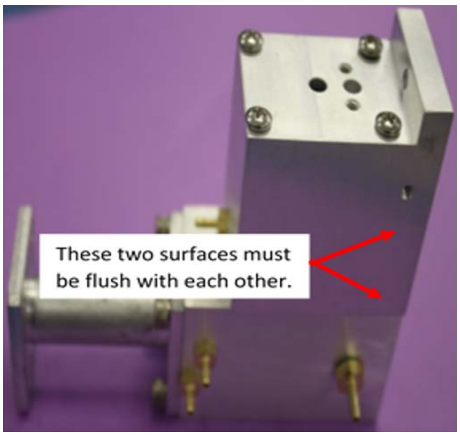
Step	Action	
3	Insert the Transducer, Screen, 400 Mesh (P/N 804-0006-00) with smaller diameter into the SPM Mix Manifold. NOTE: Ensure that it sits properly in the counter bore.	
4	Insert the larger O-Ring, 5/8" OD X 7/16" ID (P/N 340-0061-00) on top of the 400 Mesh Screen Transducer and into the SPM Mix Manifold. NOTE: Ensure that it sits properly in the counter bore.	
5	Insert the Filter, Diffuser, .615 DIA (P/N 465-0029-00) into the shoulder of the Compressor-SPM Connector. NOTE: Ensure that it sits properly and flat on the shoulder.	

Step	Action	
6	Secure the bottom of Compressor-SPM Connector to the SPM Mix Manifold. NOTE: Ensure the .615 Diffuser Filter and O-Ring do not move during this operation. Failure to do so will cause the device to fail.	
7	Insert four of Screw, Cap, Socket, 6-32 X 5/16 (P/N 360-0632-05) through the Compressor-SPM Connector into the SPM Mix Manifold. NOTE: Ensure the thread does not get stripped. Torque four screws in a crossing pattern to 9 in-lbs with a 7/64 ball driver hex bit.	

Step	Action	
8	On the SPM Oxygen Inlet Manifold, insert the Filter, Diffuser, .484 Dia. (P/N 465-0013-00). NOTE: Ensure that it sits properly and flat on the shoulder.	
9	Insert the O-Ring ½" OD X 3/8" ID (P/N 340-0023-00) into the SPM Oxygen Inlet Manifold with tweezers. NOTE: Ensure that it sits properly in the counter bore.	

Step	Action	
10	Insert the Transducer, Screen, 400 Mesh with the smaller diameter into the SPM Oxygen Inlet Manifold. NOTE: Ensure that it sits properly in the counter bore.	
11	Insert the O-Ring ½" ID X 5/8" OD X .0629 (P/N 340-0059-00) into the SPM Oxygen Inlet Manifold. NOTE: Ensure that it sits properly in the counter bore.	

Step	Action	
12	Secure the SPM Mix Manifold to the SPM Oxygen Inlet Manifold. Ensure that the O-Ring does not move while completing this operation. Failure to do so will cause the device to fail. NOTE: SPM Mix Manifold must be flush with the SPM Oxygen Inlet Manifold.	 
13	Insert four of Screw, Phillips, Pan Head, 4-40 X 1 ¾ (P/N 358-0440-28) into the SPM Oxygen Inlet Manifold and torque in a crossing pattern to 5 in-lbs with #1 Phillips head.	

Step	Action	
14	Check to ensure that the surfaces between SPM Mix Manifold, SPM Oxygen Inlet Manifold, and Compressor-SPM Connector are flushed before re-install the whole Manifold Assembly to the Top Panel Connector and Compressor Pump.	
NOTE	Once re-assembly is completed you must calibrate and test the ventilator with the RCS.	

Cleaning Instructions - Mesh Screen

- You may wash the Flow Screen with a Liquinox or equivalent solution.
- You may use an ultrasonic bath with Liquinox or equivalent solution. See information here: https://alconox.com/liquinox/
- Allow the Flow Screens to air dry before re-inserting them into the Manifold. DO NOT use compressed air from an oil-based compressor.
- Inspect the screen against a light to verify cleanliness before re-inserting them into the manifold

Servicing Membrane Panels and Button Boards

NOTICE: There has been a design change in ZOLL Ventilators. The user interface has been changed from a Membrane Panel (MP) to Button Board (BB). The Button Board components (including knobs and bezels) are not interchangeable with the older Membrane Panel components. The new Button Board can be easily identified (see below). Membrane Panel parts are now obsolete. Refer to the information below to convert Membrane Panel vents to Button Board design should parts be required.

How to Identify a Button Board

Figure A-1 shows how to identify a button board.

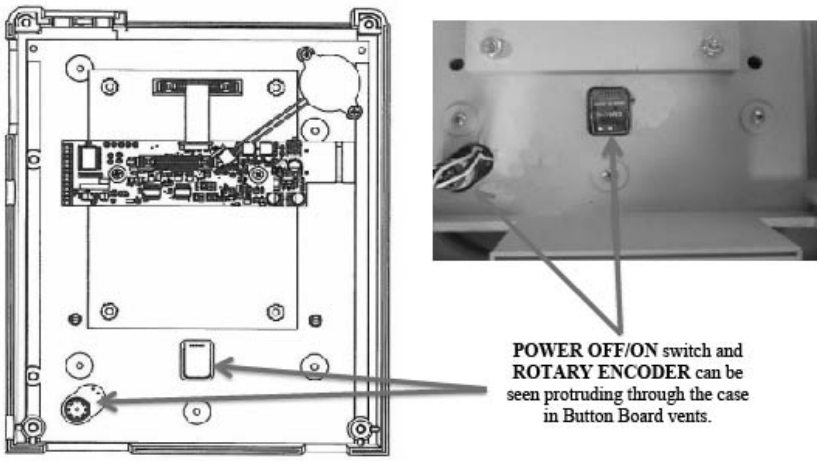


Figure 4-1 Identifying a Button Board

Below is a list of Membrane Panel kits affected and their replacement numbers for commercial ventilators. If the ventilator has been identified as a Membrane Panel ventilator then use the replacement kit number(s) listed.

Description	EMV(P)/AEV		Eagle II	
	Picture	Kit #	Picture	Kit#
Membrane Panel Kit		712-0731-01 Convert ventilator to Button Board with kits: EMV+: 712-0731-23 and 712-0731-28 AEV: 712-0731-23 and 712-AEV1-06		712-EGL2-01 OBSOLETE and NOT available. Convert ventilator to Button Board with kits: 712-EGL2-15 and 712-EGL2-18.
Bezel Assembly Kit		712-0731-05 (EMV+) 712-AEV1-01 (AEV) Convert ventilator to Button Board with kits: EMV+: 712-0731-23 and 712-0731-28 AEV: 712-0731-23 and 712-AEV1-06 AEV-IDF: 712-AEV1-07		712-EGL2-05 Near end of life. Available until Zoll inventory is depleted. After that convert ventilator to Button Board with kits: 712-EGL2-15 and 712-EGL2-18.

Power Knob Kit		712-0731-06 Convert ventilator to Button Board with kits: EMV+:712-0731-23 and 712-0731-28 AEV: 712-0731-23 and 712-AEV1-06		712-EGL2-06 NEAR END OF LIFE Available until Zoll inventory is depleted. After that convert ventilator to Button Board with kits: 712-EGL2-15 and 712-EGL2-18
Front Case Assembly Kit		712-0731-08 (EMV+) Use the Button Board kits listed below: EMV+: 712-0731-29 AEV: 712-AEV1-04 AEV-IDF: 712-AEV1-05		712-EGL2-08 OBSOLETE and NOT Available. Use Button Board Kit 712-EGL2-16
Selector Knob Kit		712-0731-19 Convert ventilator to Button Board with kits: EMV+: 712-0731-23 and 712-0731-28 AEV: 712-0731-23 and 712-AEV1-06		712-EGL2-19 NEAR END OF LIFE Available until Zoll inventory is depleted. After that convert ventilator to Button Board with kits: 712-EGL2-15 and 712-EGL2-18

If the ventilator has been identified as one using a Button Board then use the kit listed number(s) listed.

Description	Picture	Kit #	Picture	Kit#
Button Board Kit		712-0731-23		712-EGL2-15
Bezel Assembly Kit		EMV+: 712-0731-28 AEV: 712-AEV1-06		712-EGL2-18
Power Knob Kit		712-0731-26		712-EGL2-17
Front Case Assembly		EMV+: 712-0731-29 AEV: 712-AEV1-04		712-EGL2-16
Selector Knob Kit		712-0731-27		712-EGL2-20

Procedure for Front Case Kits

This section provides instructions for the disassembly and assembly of the front case assembly of 731 Series ventilators.

Before Performing the Procedures

Before performing the Disassembly/Assembly Procedure for the Front Case Kit read the following Warnings, Cautions, and Notes.

To distinguish between a Membrane Panel and Button Board ventilator and to also determine replacement kit number needed refer to, “How to Identify a Button Board for the 731 Series Ventilator” earlier in this appendix.

Note: Plastic case, Membrane Panel and Button Boards are not interchangeable.

Caution	Internal components are susceptible to damage from static discharge. All servicing operations MUST be done in an ESD controlled environment.

Caution	Use only manufacturer supplied parts in the servicing and maintenance of the ventilator.

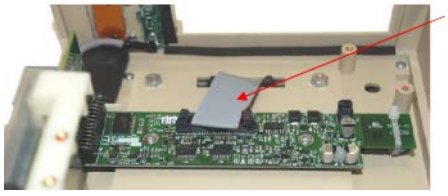
Warning!	This device has been classified "life supporting" and "life sustaining" by the United States Food & Drug Administration. If you have not been trained and certified by Zoll Instrumentation, Inc. in the care and servicing of this product, DO NOT attempt to service this device. Should factory based servicing become necessary, or technical assistance is required, please have the device Model and Serial Number available and contact ZOLL Technical Support.

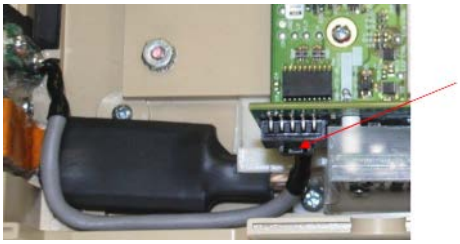
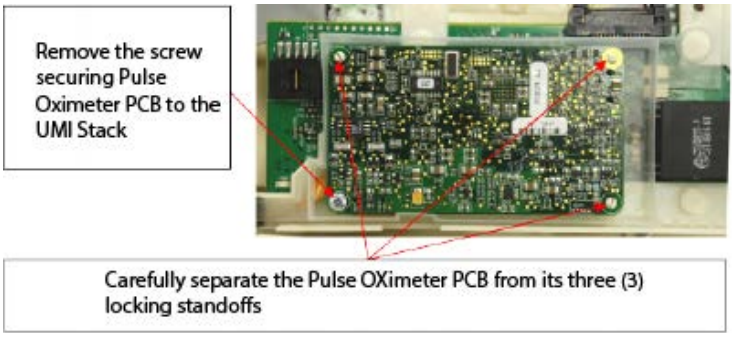
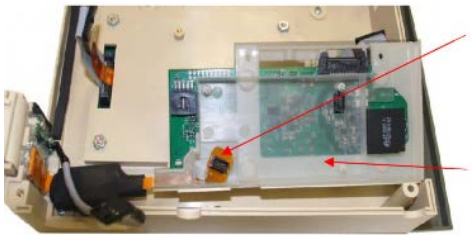
Warning!	WARNING: Service personnel should be familiar with the contents and instructions contained within this service manual. Review all Cautions and Warnings before you begin. Failure to do so may cause injury to the service personnel or damage to the device.

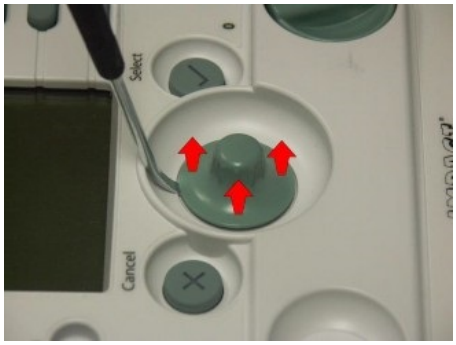
Warning!	WARNING: The SPO_2 insulator is a critical component and its correct assembly is required for the safety of both the patient and the operator. Insure there are no tears or physical damage to the insulator and verify it is installed correctly before re-assembly.

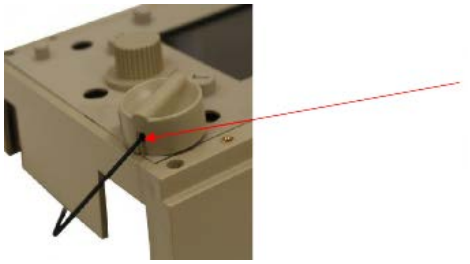
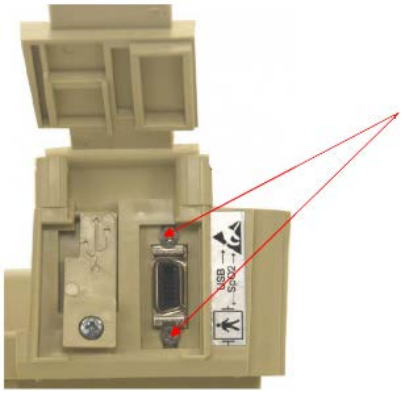
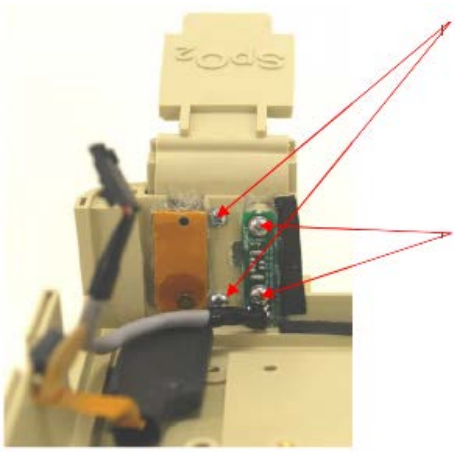
Disassembly/Assembly Procedure for Front Case Kits

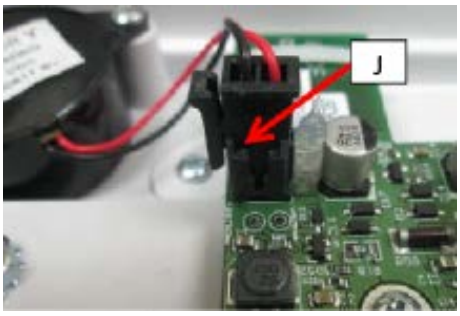
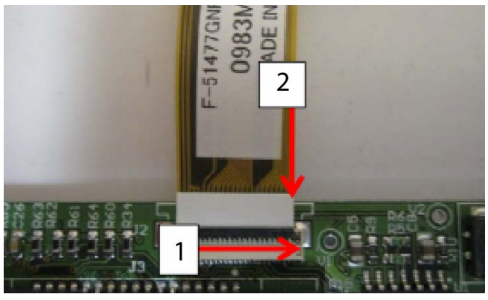
Follow the procedures below to disassemble and reassemble the front case assembly. Kit numbers available are referenced throughout the procedure. RCS testing **must** be performed after re-assembly of the ventilator.

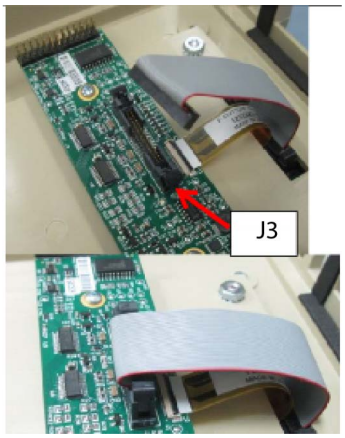
Step	Procedure	
1		Tools/Supplies needed: • Philips Head Screwdriver, small point • 5/16” Nut Driver • 1/16” Ball Hex Driver • X-Acto® Knife • RTV- Zoll #s • 602-0001-01(3oz) • 602-0001-02(10oz)
2		Buzzer - Kit#:712-0731-37 Remove two (2) 4-40 x ¼" Philips Pan Head screws that secure the Buzzer to the Front Pinch locking tab then remove the Buzzer's 2- Pin connector located at the UIM Adapter Printed Circuit Board (PCB).
3	UIM Adapter, CPU w/Bracket and Pulse Oximeter PCB's	
		Disconnect the gray ribbon connector from the Membrane Panel located at the UIM PCB by exerting outward pressure on the ejector latches.
4		Disconnect the small ribbon cable beneath the gray ribbon cable located at the UIM PCB by carefully lifting its locking bar to release the cable.

Step	Procedure	
5		Remove two (2) 6-32 x ¼" Philips Pan Head screws securing the UIM Stack to the Front Case.
6		Release cable from USB connector at the CPU PCB. Press tab to unlock then slide cable out.
7		Remove the UIM Stack from the UIM Adapter PCB (pull to separate).
8		Remove two (2) 4-40 x ¼" Philips Pan Head screws securing the UIM PCB to the Front Case.
9		
10		Carefully disconnect the Pulse Oximeter ribbon cable from Pulse Oximeter PCB. Separate the UIM Bracket from the Pulse Oximeter plastic housing.

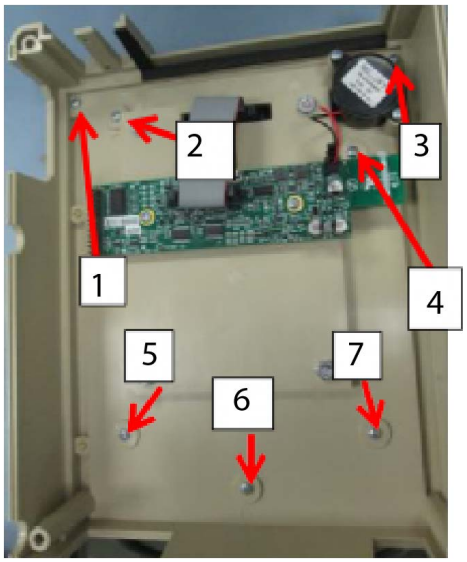
Step	Procedure	
11		Slide the Pulse Oximeter plastic housing away from the ribbon cable.
12	Membrane Panel/Button Board: • 712-0731-35Kit, Membrane Panel, Tan • 712-0731-36Kit, Button Board Assembly, Tan • 712-EGL2-22Kit, Button Board Assembly, Teal LCD: • 712-0731-39Kit, LCD Display	
		For Eagle II ventilators start by removing the Selector knob by prying the knob up from the case.
13		Remove the seven (7) (4) 4-40 x ¼" Philips Pan Head screws securing the Front Case to the Front Panel.

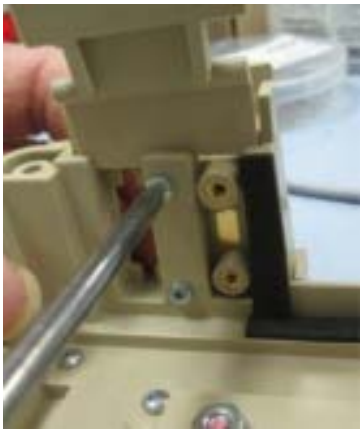
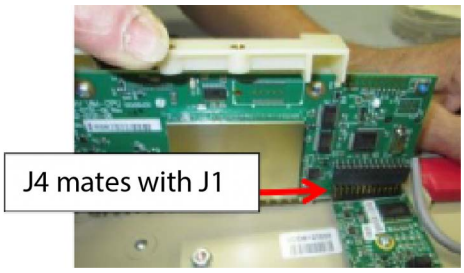
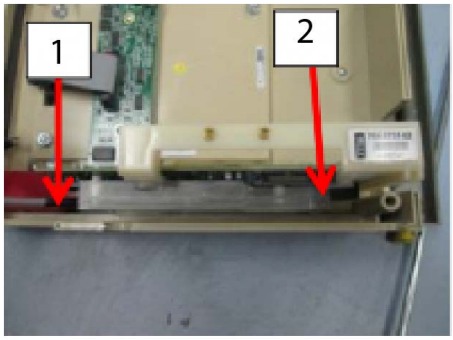
Step	Procedure	
14		If present loosen the set screw in the Power Switch knob then remove the knob using the 1/16" Ball Hex Driver. Discard the set screw - It is no longer necessary.
15		Remove the two (2) metric M2.5 Phillips Flat Head screws that secure the Pulse Oximeter connector to the USB Connector Plate Assembly.
16		Remove the two (2) 4-40 x 5/16" Philips Pan Head screws that attach the USB Connector Plate Assembly to the Front Case. Remove the two (2) 4-40 x 3/16" Philips Pan Head screws that attach the USB Adapter PCB to the USB Connector Plate Assembly and remove the cable. Remove the USB Connector Plate from the Front Case.
	Reassembly	

Step	Procedure	
17		Install buzzer using two 4-40 X ¼ screws.
18		Install UIM adapter using two 4-40 X ¼ screws.
19		Ensure proper connector key orientation and attach buzzer cable to connector J4 of UIM adapter.
20		1.) Make sure flex cable is aligned with the right side of J2 on UIM adapter board. 2.) Insert flex cable into J2.

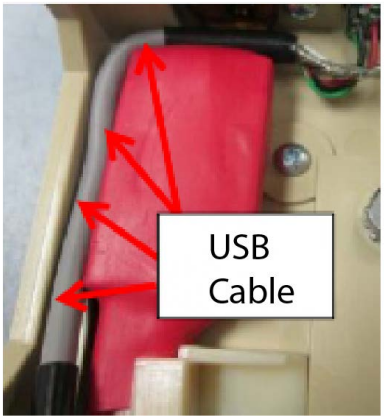
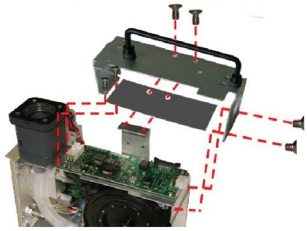
Step	Procedure	
21		Paying attention to key orientation, Attach ribbon cable to back of membrane panel assembly.
22		Ensure proper key orientation and attach membrane panel ribbon cable to J3 connector on UIM adapter. Ensure that the ribbon cable is pushed down to be flattened as shown in the photo. Do not allow any bulging of the ribbon cable, as it may interfere with tubing.
23		Ensure proper key orientation and install power knob to assembly.

Step	Procedure	
24		Ensure proper key orientation and install selector knob to assembly. Note: Eagle II units will have the selector knob installed during front case assembly.
25		Carefully unplug membrane panel/button board ribbon cable from J3 of UIM adapter board.
26		Ensure proper key orientation and connect membrane panel/button board ribbon cable to J3 of UIM adapter.

Step	Procedure	
27		Fasten the Front Bezel to the front case using quantity 7 of 4-40 X ¼" screws in locations indicated.
28		Prepare connector plate assembly for installation.
29		Hold cap and plate together and insert into case as shown.

Step	Procedure	
30		Fasten assembly to front case using quantity (2) 4-40 x 5/16" Phillips pan head screws
31		Ensure proper mating connector alignment (J4 connector of UIM/CPU board mates with J1 connector of UIM Adapter), install UIM Stack into Front Case.
32		Fasten UIM Stack to Front Case using quantity (2) 6-32 x 5/16" Philips pan head screws.

Step	Procedure	
33		Fasten USB connector board onto case using quantity (2) 4-40 x 3/16" Philips
34		Install Masimo plug into recess on Front Case as indicated. Fasten the Masimo plug to Front Case using quantity (2) M2.5 x 5mm Philips flat head screws.
35		Perform after successful Pre-Test (#35) Apply a bead of RTV around the perimeter of the Masimo connector board to create a seal between Front Case and board.

Step	Procedure	
36		Perform after successful Pre-Test (#35) Apply a bead of RTV around the perimeter of the USB connector board to create seal between Front Case and board.
37		Position USB cable as indicated.
38	  CAUTION: Ensure the presence and correct positioning of the SPO2 Isolator upon re-assembly.	Re-assemble ventilator per instructions, and test/ calibrate using the RCS.

Chapter 5
Electrical Safety Testing

This chapter provides information on the following:

- **About Electrical Safety Testing**
- **Warnings**
- **Electrical Safety Testing Procedure**
- **Touch Point Diagrams**

About Electrical Safety Testing

Electrical safety testing is non-destructive testing that confirms the suitability of electrical insulation. Electrical safety testing is helpful for discovering damaged insulation, stray wire strands or damaged braided shielding.

Refer to the manufacturer's instructions or supplied specifications for the leakage tester you use. Read the electrical safety testing device user and operator's manuals to become familiar with the device (safety warnings, cautions, safety markings) and to confirm that the testing area (station) where the electrical safety testing device operates conforms to all guidelines, safety warnings, and cautions.

NOTE:
Due to the wide variety of electrical safety test equipment on the market, it is not possible to provide detailed step by step instructions for this procedure.

Perform these tests at the line-power voltage and frequency used in your installation. The 731 Series Ventilator

is a Class 1 medical device, certified to IEC 60601-1 with BF applied parts.

The ZOLL 731 series ventilators have been certified as Class 1 ME externally powered per IEC/EN 60601-1 Standards.

The device meets the class 1 standard when operating on battery as the device is internally powered, and again when operating on AC due to the presence of a protective earth connection.

The design of these products comply with IEC standards, which allow for various methods of protection.

Subclause 8.6 of IEC 60601-1 states the following:

"Typically, metal ACCESSIBLE PARTS of CLASS I ME EQUIPMENT are PROTECTIVELY EARTHED. However, they could be separated by other MEANS OF PROTECTION, in accordance with 8.5."

Subclause 8.5.1 details the following example:

"PATIENT CONNECTIONS and other ACCESSIBLE PARTS are separated from parts different from earth potential by DOUBLE or REINFORCED INSULATION."

731 Series ventilators comply with Subclause 8.5.1 as the external power supply is double insulated, and therefore provides protection to the entire rest of the system. Further, an isolation transformer within the external power supply also provides a reduction in voltage from the AC input to 24Vdc.

Per the standard, a protective earth connection is not required to be carried through to the chassis. Any exposed metal components on the chassis, are not to be considered protective. Exposed metal components in the chassis of the ventilator can however be used for enclosure leakage measurements or “Touch current” testing.

Warnings:

WARNING:
Electrical safety testing produces voltages and currents that can cause harmful or fatal electric shock. To prevent accidental injury or death, safety procedures must be strictly observed when handling and using the electrical safety testing device.

Electrical safety testing should NOT be performed in or around ESD testing areas.

ESD protocols (methods) should NOT be enforced during electrical safety testing, since they could cause a hazardous condition for equipment and test operators.

- A electrical safety testing device generates voltages and currents that can cause harmful or fatal electric shock and must only be operated by a skilled worker trained in its use.
- DO NOT wear an ESD wrist strap. ESD protocols (methods) should NOT be followed when electrical safety testing.
- Before and after testing, handle test clips by insulation only, never touch clips directly.
- Do NOT touch the ventilator, the electrical safety testing device, high voltage test lead, alligator clip, or clip insulator once testing starts.

- Remove all metal jewelry, watches, rings that could accidentally complete a circuit.
- Persons with heart ailments or devices such as pacemakers should be informed that the voltages and currents generated by the electrical safety testing device are very dangerous. If contacted, the electrical safety testing device may cause heart-related problems. An affected test operator should consult a physician for recommendations.
- Do not attempt to operate the electrical safety testing device if impaired for any reason including medication, illness, alcohol, mental stress, etc.

Electrical Safety Testing Procedure

NOTE:
Perform this procedure in accordance with your local protocols and standards. The leakage limits provided below are taken from the IEC 60601-1 for reference.

Visual Inspection of the device:

- Review all labeling to ensure that any safety or classification markers are legible and in-tact.
- Ensure that housing shows no signs of excessive damage, cracks or structural compromise.
- Inspect all cables, including the external power supply looking for signs of excessive wear or damage to the cable integrity.

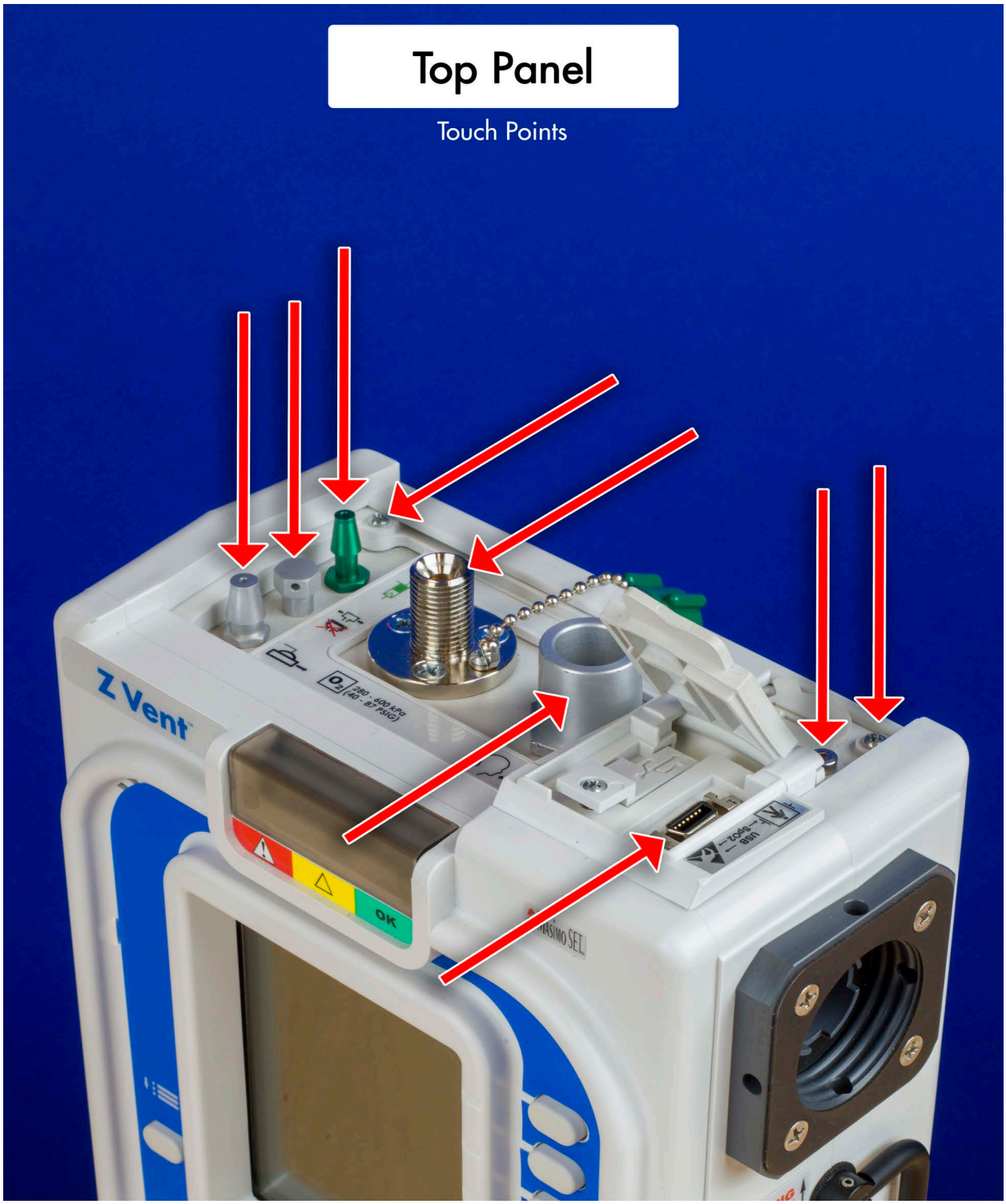
Leakage Testing :

- The chassis of the 731 Series ventilator is electrically isolated from AC power. Enclosure leakage testing of all exposed metal components on the device should be utilized in order to verify the device remains properly insulated. Use the following values for enclosure leakage in accordance with IEC 60601-1.

IEC 60601-1 LEAKAGE TEST LIMITS		
	Normal Condition	**Single Fault Condition**
Enclosure Leakage	100 µA	500 µA

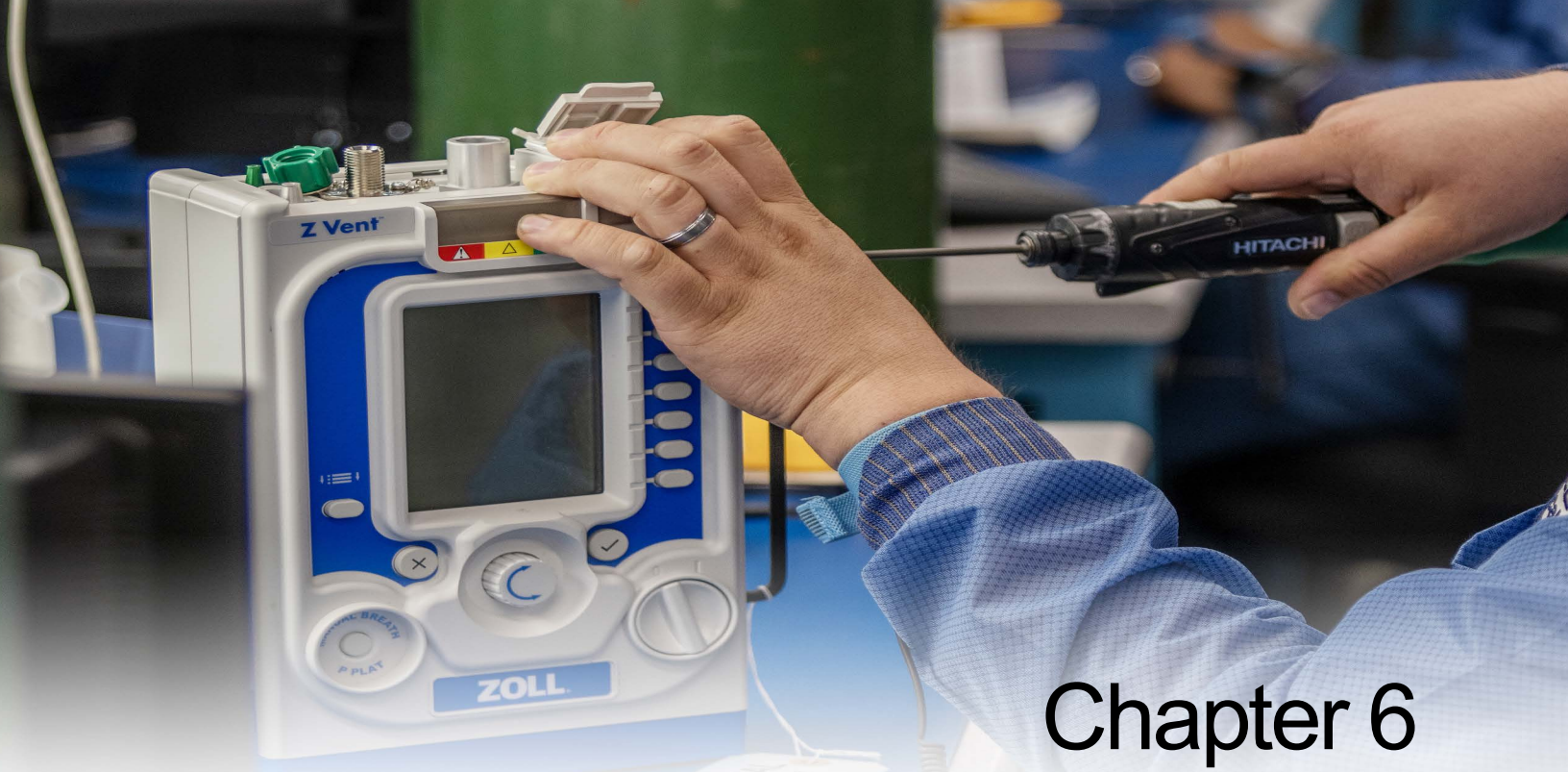
NOTE:
A diagram of all exposed touch points can be found on the following page.

NOTE:
The SPO2 sensor is optically isolated from the system with no exposed metal components in contact with the patient. It is not a requirement to test the SPO2 sensor as an applied part during this procedure.


Top Panel
Touch Points
Z Vent
OK


Right Side
Touch Points
WARNING
FRESH GAS/
EMERGENCY
AIR INTAKE
DO NOT
OBSTRUCT
Service Loaner
ZOLL ZOLL Medical Corporation


Rear Panel
Touch Points
Condensed Operating Instructions
1. Connect:
• Compressed O2: 55 psig (380 kPa)
• Ventilator Circuit
• Pulse Oximeter
2. Ensure that all hoses and connections are secure.
3. Verify power source (internal battery or external power source).
4. Turn on ventilator (Power Switch to "I").
5. Allow ventilator to perform initial Self Check.
6. Use default settings or configure ventilator parameters for the patient.
7. Perform Operational Test.
8. Attach patient to ventilator circuit to begin ventilation.
WARNING! DO NOT leave patient unattended.
9. Configure alarms for the patient.
For complete details on operating the ventilator, refer to the Z Vent™ Ventilator Operator's Guide.
WARNING! Possible explosion hazard if used in the presence of flammable anesthetics.
WARNING! DO NOT remove covers. Only ZOLL- Authorized Service Centers can perform maintenance.
Federal law restricts this device to sale by or on the order of a physician.
731 Series Ventilator
12.5-28 VDC 75WATTS
ZOLL Medical Corporation
269 Mill Road
Chelmsford, MA 01824-4105
ZOLL International Holding B.V.
Newtonweg 18
6662 PV ELST, The Netherland
GTIN
(01) 0 08479 46 02420 8
SN
(21) AY19A007442
IPX4
This device is covered under one or m of the following U.S.A. Patents: 5,758,644, 5,6 150. 6,011,986, 6,157,850, 6,263,222, 6,501,975 and othe applicable patents listed at: www.masimo.com/patents.



Chapter 6
Ventilator & Calibration Troubleshooting

Introduction

The purpose of this chapter is to provide additional support when encountering potential conditions and issues that have been observed during recent field testing and calibration.

Part I - Troubleshooting Overview:
This section provides an overview section which addresses RCS Test Setup, preparation of the ventilator and discrete test tables for RCS release 7 and 8.

Part II - Ventilator Troubleshooting:
This section provides a troubleshooting information which addresses servicing the device and various subsystems using the RCS tool. Each subsystem section contains an explanation of each discrete test and troubleshooting steps, along with:

- Device alarms as relevant to the service provider
- Observations and resolution for the RCS user.

Part III - Service Codes:
This section provides a numerical list of service codes for both V4 and V5 ventilators. Each code contains relevant mitigation/resolution strategies along with service kit information.

Part I — Troubleshooting Overview

Test Setup

The maintenance chapter of this manual provides detailed diagrams and instruction on various setup configurations which must be strictly adhered too. Failure to follow the correct setup instructions will result in a test failure.

Compressor Preparation

Ventilator design includes components which need to be exercised as part of the maintenance procedure. It is possible that the device being tested may have been stored for a long period of time. Before connecting the ventilator to the RCS, exercise the compressor as detailed in both the occlusion test & stockpile removal procedure, found within the maintenance chapter of this manual. (**Click to Jump**)

Connecting the Ventilator

Ensure that the USB connection between the ventilator and the computer is secure. Position the USB cable away from other components during testing to minimize the possibility of disconnection.

Do not power on the ventilator unless instructed by the prompts in the RCS. Not correctly following the power prompts during RCS procedures will cause failures during testing.

Ventilator RCS Testing Overview

The RCS employs discrete tests to evaluate a subsystem function and hardware. A process is built by constructing a sequence of these discrete test as explained below. (RCS prompts, titles, and status messages are noted with bold italic font throughout this document)

Discrete Tests

Table 1 (RCS Release 5) & Table 2 (RCS Release 8) identify each discrete test and the associated subsystems tested during the Incoming System Test, Complete Calibration and Outgoing System Test phases of the calibration cycle. Please refer to Table 1 & Table 2 at the end of this section, along with the Ventilator Troubleshooting Section for potential solutions to Error Messages.

System Test (Incoming System Test - RCS 7.X)

The System Test phase evaluates the performance of the device relative to its specifications. It evaluates the device in its current state before applying a new calibration.

Ventilators that have not been operated in the interval since the previous calibration cycle do not need to have the Incoming System Test run, since nothing has changed in the system performance.

NOTE:
Failures can be expected during the Incoming System Test; the report is used to direct the service program. When the identified problem has been fixed, use the discrete test to confirm that the fault has been corrected.

Calibration (Complete Calibration RCS 7.X)

The Complete Calibration cycle evaluates hardware for its ability to be calibrated. This test identifies device hardware faults, if they exist. Once all calibrations are completed successfully, the calibration table is applied to the device.

Hardware faults indicate maintenance is required to apply a calibration.

System Tests (Outgoing System Tests RCS 7.X)

The Outgoing System Test ensures the device hardware meets all functional and performance specifications. After troubleshooting or repair, the outgoing system test will confirm that the ventilator is operating within expected tolerances.

The calibration tables for the device are tested and performance specifications are confirmed. The number of re-tries is limited to three. If the issue persists, record the fault and contact technical support.

Device Alarms

Each alarm is assigned a service code which reflects its priority. All alarms are grouped into general categories (Patient Safety, Environment and Use, Self-Check) to help resolve the alarm condition. For additional information on device alarms and service codes, see section III of this chapter. (**Click to jump**).

Determining which components or sub systems require attention is accomplished by reviewing service codes, incoming system test results and maintenance records for the device.

Device alarms which indicate a hardware problem are identified in the subsection of this chapter “Ventilator Troubleshooting” (**Click to jump**).

NOTE:
The use of RCS with the device may generate alarm conditions that are expected as part of the testing procedure. Typically, this is to ensure proper function of the alarms.
High Priority Communication Alarms may occur at various points in the testing and may require a power cycle to clear the alarm condition.
The alarm history menu, available on devices configured with Release 5, indicates alarms that have occurred during operation, including use with RCS. The review of this file may indicate hardware faults or failures that occurred in recent service operations.

Observations

Observations are identified in the troubleshooting section which are derived from review of tool users in both manufacturing and service. Resolutions are provided to direct the technical actions taken by all technicians.

Service Kits and Replacement Parts

The service kits and replacement parts are listed in Chapter 4 of this Service Manual. Please refer to Chapter 4 for Part Number and ordering information.

Table 1 - Test Sequences RCS 7		***RCS RELEASE 7 SEQUENCES***		
Discrete Test Name	**Sub System**	***Incoming System Testing***	***Complete Calibration***	***Outgoing System Testing***
Comm RAM and Bootloader Check	Front Case – CPU	●		●
Power Switch Check	Front Case – I/O & UIM Board	●		●
EMV Self Check	Front Case – CPU	●		●
LCD Contrast Set	Front Case – LCD, UIM & CPU Board	●		●
LCD Visual Inspection	Front Case – LCD	●		●
Button Check	Front Case – I/O & UIM Board	●		●
Total Power Failure Alarm Check	Front Case – UIM	●		●
LED Check	Front Case – I/O, UIM & CPU	●		●
Encoder Check	Front Case – I/O	●		●
Buzzer Check	Front Case – UIM	●		●
Li-Ion Battery Check	Battery	●		●
Pulse Oximeter SpO2 and Heart Rate	Pulse Oximeter	●		●
SPM Communication	SPM		●	
SPM Self Check	SPM	●	●	●
SPM Blink	SPM – Board	●		●
TSI Calibration Check	Test Station	●	●	●
Calibration Check Barometric Pressure	SPM – Board	●		●
Compressor Calibration	SPM – Compressor System		●	
Incoming Calibration Check Compressor System	SPM – Compressor System	●		
Calibration Check Compressor System	SPM – Compressor System			●
Airway Pressure Calibration	SPM – Board		●	
Incoming Calibration Check Airway Pressure	SPM	●		
Calibration Check Airway Pressure	SPM			●
O2 Kickstart Calibration	SPM – O2 System		●	
Calibration Check O2 Kickstart	SPM – O2 System	●	●	●
O2 Flow Calibration	SPM – O2 System		●	
Incoming Calibration Check O2 System	SPM – O2 System	●		
Calibration Check O2 System	SPM – O2 System			●
O2 Leak Filter and Pressure Cal. Check	SPM – Manifold and Board	●		●
Manifold Leak Check	SPM – Manifold	●		●
Exhalation Backup and Autocal Valve	SPM – Board	●		●
Compressor Bypass Protection	SPM – Compressor	●		●
Breath Performance Check	SPM – O2 & Compressor Systems			●
Date and Time Set	SPM – Board			●
Date and Time Check	SPM – Board			●
Download Calibration Tables	Test Station		●	
Verify UUT and Reference Device	Test Station	●	●	●
Conditional PM Due Reset	Test Station/Device			●

Table 2 - Test Sequences RCS 8	***RCS RELEASE 8 SEQUENCES***								
Discrete Test Name	*Calibration*	*System Tests*	*Battery and Power System Tests*	*Front Case Tests*	*Calibration Checks*	*SPM Functional Check*	*Pulse Ox Test*	*Erase Forensic Memory*	*Final Configuration*
Comm RAM and Bootloader Check				●					
Power Switch Check		●		●					
EMV Self Check		●		●					
LCD Contrast Set		●		●					
LCD Visual Inspection		●		●					
Button Check		●		●					
Total Power Failure Alarm Check			●						
LED Check		●		●					
Encoder Check		●		●					
Buzzer Check		●		●					
Li-Ion Battery Check		●	●						
Pulse Oximeter SpO2 and Heart Rate		●					●		
SPM Communication									
SPM Self Check	●	●			●	●			
SPM Blink		●				●			
TSI Calibration Check	●	●			●	●			
Calibration Check Barometric Pressure	●				●	●			
Compressor Calibration	●					●			
Calibration Check Compressor System	●				●	●			
Airway Pressure Calibration	●					●			
Incoming Calibration Check Airway Pressure									
Calibration Check Airway Pressure	●				●	●			
O2 Kickstart Calibration	●					●			
Calibration Check O2 Kickstart	●				●	●			
O2 Flow Calibration	●					●			
Incoming Calibration Check O2 System									
Calibration Check O2 System	●				●	●			
O2 Leak Filter and Pressure Cal. Check		●				●			
Manifold Leak Check		●				●			
Exhalation Backup and Autocal Valve		●				●			
Compressor Bypass Protection		●				●			
Breath Performance Check		●				●			
Date and Time Set		●							
Date and Time Check		●							
Download Calibration Tables	●					●			
Verify UUT and Reference Device	●	●				●			
Conditional PM Due Reset		●							
Erases Forensic Memory								●	
Final Configuration									●

Part II — Ventilator Troubleshooting

Part II of this chapter addresses troubleshooting of the various device subsystems and calibration components. Each section contains a list of service relevant alarm codes, troubleshooting actions and resolutions.

See the table below for a list of troubleshooting sections:

Sections	Component(s)
Communication & Preventive Maintenance Alarms	
Device Subsystems	
Front Case Assembly,	I/O, CPU, Adapter
Pulse Oximeter Subsystem,	Masimo Embedded Module
Power Subsystem	PIM
Smart Pneumatic Module	SPM Board
Calibration	
Airway Pressure Calibration	
Compressor System Calibration	
Oxygen Systems Calibrations	
Test Station	

Troubleshooting — Communication & Preventive Maintenance Alarms

Remote Calibration System		
Discrete Tests	Test Purpose	Troubleshooting
Read	Reads the device serial numbers.	• This is where most connection issues are seen. (see Observations table)
Comm RAM and Bootloader Check	CPU – Board Problem	• Check USB connections. • Power cycle • Replace Front Panel assembly kit.
SPM Communication	SPM – (Board Problem)	• Check Data connection to device. (See Test Station) • Power cycle
EMV Self Check	The device continuously monitors components and issues alarm with hardware failures that do not clear with a power cycle	• See the Service Code tables
SPM Self Check	The device continuously monitors components and issues alarm with hardware failures that do not clear with a power cycle	• See the Service Code tables

Ventilator Alarms			
Title	Service Code	Alarm Purpose	Troubleshooting
Start Up – Self Check	N/A	When the device is turned ON it will perform a self-diagnosis and indicate and indicate a self-check failure and identify the component that requires to be serviced.	• Self Check Failures are identified by Service Code (SC) numbers. The device will display the service code, alarm title and mitigation.
Self- Check: Communication			
Internal COMM CPU-SPM	1473	The CPU monitors the SPM.	• Hardware Problem: Determine if the SPM is property connected or if the assembly/board may need to be replaced.
Internal COMM CPU	1471	The CPU can no longer communicate with the UIM adapter board.	• Hardware Problem with CPU or UIM. • Check connections between UIM and CPU. • Consider replacement of the CPU/UIM
	1475	The contrast fault indicates when the LCD Is not visible	• Replace LCD/PIM board or replace the LCD front panel both are viable.

Internal COMM SPM	1175	The alarm indicates a I2C fault condition in which the device cannot communicate with the PGA's or RTC.	• Expected: Caused by Software Asserts used in the RCS (clears with power cycle). • Hardware Problem: A problem with the SPM board needs to be addressed when there is a persistent condition that does not clear with a power cycle
	1472	CPU monitoring the SPM issues a communication failure due to too many CRCs.	• Hardware Problem: Change the SPM Board.
	1474	CPU monitoring the SPM issues a communication failure due to time – out condition.	• Hardware Problem: Change the SPM Board.
Preventive Maintenance Alarms			
PM Due	3120	This is triggered one year after service unless otherwise noted.	• Execute annual PM as indicated in the Service Manual.
SPM Serial Number Mismatch	3480	Alarm indicates when the serial number written to the SPM does not match the serial number expected by the EMV.	• Using RCS, program the device with the correct serial numbers. This is typically seen after the SPM has been replaced. Correction of the serial number should be prior to calibration and testing the device.
RTC Battery Low	3110	Indicate when the RTC battery is low to prevent loss of date/ time, forensic memory, as well as custom & last settings	• Hardware Problem: • Change Battery. • Check battery is properly seated, and the clip secures the battery in its location.
Power Cycle Needed	3121	Triggered when the device has been in operation for over 30 days.	• NOTE: This is <u>not</u> an indication of a hardware problem. • (The start up self-check alarm will be trigger if device service is required.)

Observations	
Observation	Resolution
Device Hardware COMM Problem Note that at subpopulation of older devices may need an updated CPU board due to a hardware problem with the FTDI component on the board.	• Check device hardware. • The USB connector panel, and USB cable may need to be changed. • For older devices, the USB revision may not be compatible. • On the PC check the Device Manager and verify connection to both CPU and DSP. • On the PC verify Load VCP box is unchecked. • Check USB-PC Set UP • Return the device to service to evaluate the FTDI component.

External Power	• The RCS requires External Power to operate. • Connect External Power.
It is expected that the LCD will be dark ("GUI is blank") The device is not working because the GUI is blank Programming the device puts the device in a "reset" state in which a vertical line is present and the screen is otherwise blank.	• When using the TCE the LCD remains "OFF" and the GUI is not shown.
Power Cycle When the device is left in an intermediated state. (e.g., held in reset).	• Unplug External Power, turn off the device, plug the device back in. • This is the only way to completely reset the device and its connection with the test tool. • Rapid cycling of the switch does **not** allow for system to reset.
Hardware Problem – Alarm Condition Self Check Alarms / Start Up Self Check	• See Ventilator Alarms Section.
Self –Check Alarm (Service Code # 1175) – Internal COMM occurs during service. Although this alarm is typical during service, it is not common during operational use.	• Expect to see SC1175 alarms. These are typically due to intermittent conditions. • Power Cycle
After RTC Battery replacement, device frequently resets date or PM Due alarm returns	• During the battery replacement, the retaining clip may be bent. Be careful to gently replace this battery without displacing the clip. The bent clip may cause an intermittent connection when the device is transported causing momentary power interruptions, which reset the date and trigger a PM due alarm condition.
Multiple RCS applications: Another RCS application running in the background may already have an active/open connection to the device.	• Close all applications. • Restart PC.
Status Window Use the status window to troubleshoot communication problems. The window will indicate a device has been connected: Open Port Close Port The window will indicate when power is applied: …	• Power Cycle needed • Check USB – PC • Check USB – Cable • Check USB – Hardware • Check TSI COMM (See Test Station) • Retry to check if communication is established.
USB – Cable With high use, the USB Cable can degrade due to wear and tear.	• When multiple devices at a station fail due to communication with the device, check if the USB cable for wear and tear. • Replace USB Cable
USB – PC Setup: Older devices are compatible with USB 2.0. But on newer PCs, USB 3.0 ports are preferred over a USB 2.0. port (if available on the PC).	• Choose another USB port on the PC
Multiple RCS applications: Another TCE running in the background may already have an active/open connection to the device	• Close all applications. • Restart PC.
Hidden Pop Up. Users waiting for Prompt.	• Prompt is hidden by application. • Minimize Window to see Pop UP.

Status Window The window will indicate a device has been connected: Open Port Close Port The window will indicate when power is applied:	• Use the status window to troubleshoot communication problems. • Power Cycle needed • Check USB – PC • Check USB – Cable • Check Hardware COMM • Check TSI COMM (See Test Station) • Retry to check if communication is established. • The log files store the status window content.
When initiating the testing, there is a persistent message: *FAILED TO WRITE TESTLOAD.BOOTLOADER.BIN* The RCS does cannot read the device Serial Numbers, and the test load cannot be installed on the device.	• If multiple failures occur at one station: • Check USB Cable. • OR • Check USB-PC • Check for Device Hardware COMM

Troubleshooting — Front Panel

Remote Calibration System		
Discrete Tests	Test Purpose	Troubleshooting
Comm RAM and Bootloader Check	Verify functionality of EMV COMM interface (RX & TX signals),	• CPU & RAM function, bootload interface as well as communication to SPM (SPM RX & TX, bootselect, reset). • Replace the front panel assembly kit.
Power Switch Check	Verify functionality of Power Switch, each pole must be checked. 1. Unit fully shuts off with no external power - Off and No External Power = Pass/Fail. 2. Unit turns on from battery -- On and No External Power = Pass/Fail. 3. Unit displays proper ON/OFF state with external power -- On&Off with External Power	• Repeat the test, be sure to unplug the external power from the 731, not the wall • Replace the CPU to PIM ribbon cable • Replace the front panel assembly kit.
EMV Self Check	The TCE checks for active alarms on the EMV that indicate problems with the power system, communications, or the pulse oximeter.	• Review active service codes refer to the Service code troubleshooting sheet • Note service codes expressed by the 731 due to the presence of a fault condition • Check all connections. • Solution: Front panel assembly.
LCD Contrast Set	The test reads and confirms contrast adjustability.	• The ribbon cable from the LCD to the button board may not be seated correctly, try re-seating the cable • If these test fail, replace the front panel assembly kit.
LCD Visual Inspection	The test is intended to guide the operator through the inspection of the LCD to ensure it is free of defects such as stuck pixels, blemishes, back light function and contrast.	• Replace the front panel assembly kit.
Button Check	Checks the function of each button on the device. Ensures each button is properly functioning.	• Replace the front panel assembly kit.
Total Power Failure Alarm Check	This is a test of the power failure circuit, which in the event of a total power failure will pulse the buzzer and LED's to indicate the failure. 120s Total Power Failure alarm triggers (fast beep and red alarm LED blink pattern) and lasts for at least 10s.	• Repeat the test, with careful attention to prompts • If this test fails Change the front panel assembly kit
LED Check	Verifies the operation of device LEDs. 4 green, 4 yellow, 4 red and 1 IR LED.	• Replace the front panel assembly kit.
Encoder Check	The test is to verify the functionality of the rotary encoder in both directions.	• Replace the front panel assembly kit.
Buzzer Check	Verifies the capability of the device to sound and audible alarm.	• Replace the front panel assembly kit.

Troubleshooting — Pulse Oximeter Subsystem

Remote Calibration System		
Discrete Tests	Test Purpose/ Definition	Troubleshooting
Pulse Oximeter SpO2 and Heart Rate	A Masimo tester is used to confirm SpO2 and HR measurements are within the limits specified below: 1) Waveform data is present. 2) Heart Rate is 61 BPM ± 1 BPM 3) SpO2 is 81% ± 3%.	• Review active service codes refer to the Service code troubleshooting sheet • 1) Waveform data is present • Check the SPO2 simulator connections and settings. • 2) Heart Rate is 61 BPM ± 1 BPM • Check the SPO2 simulator connections and settings • 3) SpO2 is 81% ± 3%. • Check the SPO2 simulator, connections and settings • If these items fail the front panel assembly kit may be faulty

Ventilator Alarms			
Title	Service Code	Alarm Purpose	Troubleshooting
Self-Check: Pulse Ox - Module Failure			
Internal OEM Board	2300 3300	The Masimo board indicates a failure.	• Replace CPU/SPO2 Stack kit or Front Panel Assembly.
Internal COMM	2301 3301	2301: Masimo comm has a tread out or is damaged. 3301: Alarm priority, depending if the Masimo sensor is in use.	• Check Masimo cable or board. • Disable and enable spo2 functionality

Observations	
Observation	Resolution
SPO2 readings are not displayed or SPO2 sensor LEDs do not illuminate.	• Replace sensor and cable with a <u>new</u> and known working cable/sensor set. • Replace Masimo board.

Troubleshooting — Power and Battery

Remote Calibration System		
Discrete Tests	Test Purpose	Troubleshooting
Li-Ion Battery Check	Evaluate the devices ability to discharge and charge the Li-Ion battery and read battery status. 1) Discharge Check: discharge current >= 2000mA for 120 sec or battery state of charge 30s < 80% and discharge current >= 2000mA for 30 sec 2) Charge Check: charge current > 150mA for 30s in total (does not have to be a continuous 30s)	• Review active service codes refer to the Service code troubleshooting sheet • When conducting this test, be sure to unplug the external power from the connector at the ventilator.

Ventilator Alarms			
Title	Service Code	Alarm Purpose	Troubleshooting
Complete Power Failure	1420	When power is lost from both the internal battery and an external source during operation. The device alarms for approximately two minutes. When this occurs, the LCD turns OFF; the audible alarm will pulse rapidly, and the LED shall flash rapidly.	• Apply external power to the device. • Check battery is connected and charging. • If external power is applied and battery does not charge, or device does not power on, inspect connections made to the PIM board. • Ensure thermal gap pads are under PIM. • PIM board may need to be replaced.
Self Check: Power System Fault/Failure			
5V Bus Compromised	1172	Error indicates a self check failure of the 5V bus.	• 5v bus originates from the power interface module. Check the PIM board connection to the SPM board. • Repair: replace the PIM board, and verify. (connection between the boards may be damaged)
Input Protection Circuit Failure	2421	Error indicates a damaged fuse on the PIM board.	• Replace PIM, check SPM as they are connected and my also be damaged.
Internal COMM Battery Faults	2455	communication to the devices main battery has failed. (Without external power)	• Check connection from main battery to PIM board. • Replace battery or PIM
	3455	Communication to the device's main battery has failed while operating on external power.	• Check connection from main battery to PIM board. • Replace battery or PIM
Internal COMM Power Components Fault	3470	The system has identified a communication error with the PIM.	• Check the connection from the PIM to the SPM and check connection from the PIM to CPU. • Repair: replace PIM or Connector cable to CPU.
EXT BATT	N/A	Indicates Possible faulty wiring of the external power connector.	• Disconnect external power, and verify the icon disappears. Try replacing your external power cable.

Troubleshooting — Smart Pneumatic Module (SPM) Hardware

Remote Calibration System		
Discrete Tests	Purpose	Troubleshooting
SPM Communication	The test confirms communication signals (RX & TX), bootload and toggle (set/reset) are functional prior to calibration.	• Review active service codes refer to the Service code troubleshooting section.
SPM Self Check	The device software continuously checks to see that the hardware has not failed. The SPM software checks for alarms. In event an alarm is active, and the TCE indicates a failure.	• Review active service codes refer to the Service code troubleshooting section.
SPM Blink	Confirms the SPM is able to drive the LED's and Buzzer in the event the EMV is not functioning. Operator confirmation that Red LED's and buzzer were driven within 15 seconds (Test Passed = Pass), otherwise Test Passed = Fail	• Failure of this test may be the SPM board faulty or connections to the SPM • Check the SPM to UIM cable, the PIM to CPU cable, PIM to SPM cable. • Change the *SPM Assembly*.
O2 Leak and Filter Check	The O2 system is checked for leaks. • Input pressure limit is +/- 1 psi at 90 psi • Input pressure limit is +/- 10% at 70 psi • Leak rate is less than or equal 2000 ml/ hour at 55 psi. • Sintered bronze filter resistance measured at 100 LPM flow is between 0.01 and 0.06 psi/LPM. • Reported O2 supply pressure limit is <2 psi for zero, and <7 psi for 70 psi. • Reported O2 Leak through valve limit is less than or equal 0.3 LPM	1. If this is a failure, verify the O2 supply pressure. Check O2 input barb. Check internal O2 tubing. Check for damage or debris at the input filter. 2. If this is a failure check tubing. Check O-ring on O2 inlet assembly, O2 manifold, and O2 valve. Replace O2 manifold and O-rings 3. If this is a failure, replace the sintered bronze filter assembly 4. Check O2 supply, If this is a failure, check for kinked or damaged tubing. Replace the Smart Pneumatic Module (SPM)/ Vent Assembly Kit. 5. If this test fails check for kinked or damaged tubing, Check for audible leak. Change the O2 valve.
Manifold Leak Test	The system is pressurized (within specification) to determine if there are any leaks in the manifold connection or tubing. The slope of the airway pressure during simulated expiratory phase (no flow) shall be less than 0.5 cmH2O per second at 5 cmH2O and 25 cmH2O.	• Check test setup for leaks, check for deformation of the test lung • Checks for leaks between compressor/O2 Valve output and gas output port. • See the manifold calibration sheet.

Exhalation Backup and Autocal Valve	Control Valves are exercised to ensure they open and close as expected. For both 4 cmH2O and 25 cmH2O pressure targets, normalize waveforms and verify the following: 1) Autocal rise settling time < 30ms 2) Autocal fall settling time < 30ms (<150ms RCS 8) 3) Exhalation valve rise delay < 45ms 4) Exhalation valve fall delay < 45ms 5) Backup valve rise delay < 45ms 6) Backup valve fall delay < 45ms 7) Pressure difference between exhalation valve drive port and airway pressure < 2.0 cmH2O.	• Check setup for leaks or assembly error check lung. • Change the *SPM Assembly*.
Breath Performance Testing	Checks ventilator tidal volume and selected parametric values. **Target Settings:** VT=700; FIO2=21; BPM=20; Itime=1000; PEEP=0 VT=100; FIO2=21; BPM=30; Itime=667.67; PEEP=5 VT=700; FIO2=60; BPM=20; Itime=1000; PEEP=0 VT=100; FIO2=60; BPM=30; Itime=667.67; PEEP=5 VT=700; FIO2=100; BPM=20; Itime=1000; PEEP=0 VT=100; FIO2=100; BPM=30; Itime=667.67; PEEP=5 **Tolerances:** VT: ± (5ml + 8% of setting) PEEP: ± (2cmH2O + 7.5% of setting) PIP: ± (2 cm H2O + 7.5% of setting) BPM: ±1 FIO2: ± (3% + 8% of setting) I Time: ± (100ms) NOTE: For mixed flows, only FIO2 is checked due to calibration issue with TSI	• Check Set Up • Remove Resistor from compressor intake. • Remove High Pressure 02 Orifice / Resistor left on the device. • Check test lung for proper inflation and uniformity • Check O2 cell for leaks, it's a two piece assembly which may unscrew or leak • Check 22ml bacterial filter for cracks, leaks • ensure that the circuit is laying flat on the work bench, with the exhalation valve in the upright position • flush the o2 circuit before any retry, recal the O2 sensor. • Replace the O2 sensor if FIO2 issues persist. • If the vent can't capture PEEP, check the Anti-Asphyxia valve for damage or debris • Recalibrate the ventilator

Compressor Bypass Protection	Monitors the device for alarms when the fresh gas intake on the device is occluded. Verify that the intake blocked alarm (1030) triggers during fault condition and that cycling power clears the alarm condition and there are no compressor control faults with the power on self-check	• Loose intake assembly or incomplete blockage. • No Alarm: Follow TCE prompt for setup, check intake pressure tubing, insure correct installation • 3030 alarm: Partial blockage, ensure full occlusion • 2030 alarm: Partial blockage, ensure full occlusion
Date and Time Set	The TCE set the date and time in the device.	• Review active service codes refer to the Service code troubleshooting sheet. • A failure in this sequence may indicate a depleted RTC battery. • Replace the RTC battery
Date and Time Check	The TCE verifies functionality of date and time in the device vs. PC	• Review active service codes refer to the Service code troubleshooting sheet. • Try again to set the time and date • A failure in this sequence may indicate a depleted RTC battery. • Replace the RTC battery • Potential faulty battery connector. • Replace the Smart Pneumatic Module (SPM)/ Vent Assembly Kit if RTC battery replacement does not solve the issue.

Ventilator Alarms			
Title	Service Code	Alarm Purpose	Troubleshooting
Self-Check: Sensor/Transducer Faults			
	1051	Autocal triggered if after 10 breaths: The valve does not open, or only opens part way, or if the readings are too noisy	• Autocal valve not responding as expected. Change SPM.
	3143	Internal temperature sensor failure	• Change SPM board.
	3130	Ambient pressure transducer fails	• Change SPM board / transducer replacement.
Self Check: Internal COMM – Corrupt file			
	1176	Checks for a corrupted calibration file.	• Calibration required. • Attempt recalibration. • Note: You may need to use the write function if the default cal table is loaded.

Observations	
Observation	Resolution

Breath performance test failed due to setup issue and is now saturated with O2.	• Purge patient circuit of O2 with the following method: • Power on device. • Select mode button. • Press Accept/Confirm button. • Note: The device will start ventilating, alarms may occur. • Allow the device to deliver several breaths, this should flush any O2 out of the patient circuit. • Power off device. • Retry the Breath Performance Test.
The RCS is used to calibrate the device on an annual basis.	• The ***Incoming System Test*** confirms the device meets specification (as defined in the operation manual). • The ***Outgoing System Test*** confirms the device can operate at a tighter tolerance to ensure the device can maintain operational specifications for the PM cycle.
Autocal Valve failures: Release 4 vs. Release 5. Continues to monitors the autocal valve's ability to manage the transducer drift across environments.	• The RCS now confirms the valve is behaving as expected at each annual PM. Expect reduced rate of field failure.
Majority of pneumatic test issues are due to Set Up and Test Station issues. This calibration is based on the measurements of the reference device (TSI).	• Check Set-Up • test apparatus is not removed from the device before the next test step. • Check Test Station • O2 Regulator • TSI Connections
The TCE detects a corrupt calibration file and prompts: Do you want to upload a default cal file?	• Respond to Prompt: • Select: ***No*** • Attempt to perform a calibration. Selecting "Yes" will overwrite the SPM serial numbers and Write will need to be done.

Troubleshooting — Airway Pressure Calibration

Remote Calibration System		
Discrete Tests	Test Purpose	Troubleshooting
Airway Pressure Calibration	Airway PGA Fine Offset within range: 28668-37914 Airway PGA Fine Gain within range: 22867 - 27669 Airway PGA Coarse Gain within range: 38675 (fixed)	• Carefully check the setup • Review active service codes refer to the Service code troubleshooting sheet
Calibration Check Airway Pressure	Evaluates the accuracy of the airway pressure calibration across the measurement range of the transducer. Calibration Data is within limit ± (0.2 cmH2O + 7.5% of UUT).	• Check the setup per Cal Check Airway Press sheet • Incorrect resistor at setup • correct resistor • setup leak (filter cracked, gas output port not connected) • Replace filter Correct output port connection

Ventilator Alarms			
Title	Service Code	Alarm Purpose	Troubleshooting
Self-Check: Sensor/Transducers/ Calibration Files			
Self Check Failure	1052	Airway pressure transducer is not behaving as expected.	• Change SPM board.
Self Check Fault	3172	Airway pressure transducer cannot zero.	• Hardware Problem: • Change SPM Board/ transducer replacement • Environmental Use • Rapid temperature change, high vibration.
Self Check: Internal COMM – Corrupt file			
Self Check Failure	1176	Checks for a corrupted calibration file.	• Calibration required. • Perform WRITE function to eliminate error and perform calibration sequence.

Troubleshooting — Compressor System Calibration

Remote Calibration System		
Discrete Tests	Test Purpose/ Definition	Troubleshooting
Note: Within the status area or log file, the middle number indicates measured gain. Ex: 22588 < **29266** < 41168		
Intake Pressure Calibration	***IP_Offset*** (range: 22588 - 41168) ***IP_Gain*** (range: 28045 - 54968)	• Check set up • Gain Too Low – check assembly for restrictions or damaged filters. Check torque used in assembly of intake. • Gain Too High – check assembly to ensure all intake components (filters, O-rings, etc.) have been installed. • Check for damaged fresh gas intake filters.
Compressor Flow Calibration	***CF_Offset*** (range: 26823 - 35474) ***CF_Gain*** (range: 23322 - 33584)	• Check set up • Gain Too Low – clean flow screens and re-install. • Gain Too High – check test setup and assembly for leaks, then recalibrate.
Calibration Check Compressor System	Compares selected flow values to published specifications (incoming), or tighter (outgoing) limits to allow for drift. Also Checks Intake Pressure, Compressor RPM, Airway Pressure to ensure correct compressor performance. Airflow tolerance ± (0.1 LPM + 5% of setting) Intake tolerance ± 15% of ADC target values (Note: ADC target values are altitude compensated) RPM tolerance ± 15% of RPM target.	• Review active service codes refer to the Service code troubleshooting sheet • Intake assembly may not be tight replace disk filter) • Tighten intake assembly • RPM (caused by a leak during calibration) fails check Anti-Asphyxia valve, then recalibrate • low flow may be leak • High flow, recalibrate • filters may be dirty • Replace filters • anti-asphyxia valve may be faulty • Replace ant-asphyxia valve • Check test setup for leaks • Compressor flow failures require re-calibration. Ensure setup is correct during calibration.

Ventilator Alarms			
Title	Service Code	Alarm Purpose	Troubleshooting
Self-Check: Transducers/ Calibration Files			
Self Check Failure / Self Check Fault	1001 2001	Indicates a compressor control fault.	• Cycle Power • Wet/dirty flow screen • If the device was used in a high humidity environment, moisture may condense on the flow screen. • Loose compressor connection (electrical)
Self Check Failure / Self Check Fault	1002 2002	PGA or ADC faults detected for Compressor System.	• Recalibrate Device • Replace SPM
Self Check Failure	1003	Alarm occurs if low RPM is detected.	• Clean or change flow screen • Check compressor flow
Gas Intake Failure	1030	Gas intake failure, prevents device from delivering sufficient flow.	• Check intake assembly for blockage • Replace filters
Self Check Failure	1174	Flow transducers are not behaving as expected.	• Change SPM board

Self Check Fault	3032	Inlet pressure transducer failed	• Change SPM board/ transducer replacement.
Self Check: Internal COMM – Corrupt file			
Self Check Failure	1176	Checks for a corrupted calibration file.	• Calibration required.

Observations	
Observation	Resolution
Device Hardware Problems – Compressor Flow A successful calibration harmonizes a signal chain comprising electrical components (e.g. PGA) mechanical components (e.g. flow screen).	• More than one component may change and then allow for a successful calibration. • Air Intake Filters need to be replaced • Flow Screen is dirty. Needs to be cleaned/replaced. • Compressor Failure • Pop-Off valves not exercised prior to testing. • Cracked compressor case • When the identified problem has been fixed, use the discrete test to confirm that the device hardware can now calibrate
Flow measurement is lower than expected.	• Anti-asphyxia valve may not be seated
Devices are returned with "compressor failures" that are resolved with replacement of disk and particulate filters.	• The RCS reports the intake pressure calibration failures as a failed compressor system (because the filter is part of the compressor intake assembly). • The intake pressure calibration can be addressed with maintenance of the disc and particulate filters.
TSI Measurements (Flow and Low Pressure)	• The most common faults are related to equipment/ setup mistakes. • Check Set Up • Check TSI Connection
Multiple RCS applications: Another RCS application running in the background may already have an active/open connection to the device.	• Close all applications • Restart PC
Status Window This window should always be reviewed prior to attempting to correct setup issues or re-try a test.	• Faults are indicated in the scrolling text window of the application and are available in the Log files.
Hidden Pop Up. Users waiting for Prompt.	• Prompt is hidden by application. • Minimize Window to see Pop UP

Troubleshooting — Oxygen System Calibrations

Remote Calibration System		
Discrete Tests	Test Purpose/ Definition	Troubleshooting
O2 Kickstart Calibration	Calibrates near zero flow target used for fine flow control after opening valve. (range: 50 - 900)	• Typical failures are with the Oxygen Delivery System. Gas flow is critical. • If gas flow is restricted this test may not successfully calibrate. • Check the gas regulator to ensure tank is fully open. • Check set up • Replace Oxygen valve assembly kit.
O2 Kick Start Check	Deliver 50 ml breath using 100% FiO2	
O2 Flow Calibration	• ***OF_Offset*** • (range: 26053 - 37516) • ***OF_Gain*** • (range: 12727 - 34650)	• Check set up • Gain Too Low – clean flow screens and re-install. Check diffuser screen is present in assembly. • Gain Too High – check test setup and assembly for leaks, then recalibrate. If issue persists, check assembly to ensure O-rings were installed on either side of the flow screen and diffuser screen is properly installed. • Replace the SPM/Vent assembly kit.
Flow Calibration Check	Compares selected flow values to published specifications (incoming), or tighter (outgoing) to allow for drift.	

Ventilator Alarms			
Title	Service Code	Alarm Purpose	Troubleshooting
Self-Check: Transducers/ Calibration Files			
Self Check Failure / Self Check Fault	1010 2010	O2 Valve Stuck Open	• Connect O2, listen for flow. • If no flow can be heard, recalibrate device. • Replace O2 Valve
Self Check Failure / Self Check Fault	1011 2011	Control fault to indicate Insufficient O2 Flow rate.	• Recalibrate device • Check manifold for leaks • Replace O2 Valve • Check Flow Screen Assembly, clean and replace.
Self Check Failure	1012	PGA or ADC faults detected for O2 System.	• Recalibrate Device • Replace SPM
Low 02 Supply Failure / Low 02 Supply Fault	1020 2020	Oxygen Tank Pressure low (less than 35 psig)	• Reduce O2 Supply Pressure • Power Cycle Device • Check Oxygen Regulator • Replace SPM if Supply Pressure is verified to be below 87 psig.
High 02 Supply Failure	1041 2041	Oxygen tank pressure is excessive (greater than 87 psig)	• Reduce O2 Supply Pressure • Power Cycle Device • Check Oxygen Regulator • Replace SPM if Supply Pressure is verified to be below 87 psig.
Self Check Failure	1174	Flow transducers are not behaving as expected.	• Change SPM board
Self Check Failure	1176	Checks for a corrupted calibration file.	• Calibration required.

Observations	
Observation	Resolution

Device Hardware Problems – O2 Flow A successful calibration harmonizes a signal chain comprising electrical components (e.g. PGA) mechanical components (e.g. flow screen). Note: Changing the O2 Valve may resolve the failure, but not address the root cause.	• More than one component may change and then allow for a successful calibration. • Intake Gas Port (and sintered bronze filter). • Flow Screen is dirty. Needs to be cleaned/replaced. • O2 Valve - Leaky valve / debris - Broken apparatus • When the identified problem has been fixed, use the discrete test to confirm that the device hardware can now calibrate
TSI Measurements (Flow and Low Pressure)	• The most common faults are related to equipment/ setup mistakes. • Check Set Up • Check TSI Connection
Faulty O2 Regulator Problems are common with the gas supply during calibration. In the event a calibration fails, the corresponding pneumatic system may require maintenance prior to being able to be calibrated.	• It is important to regularly inspect log and study files to ensure proper function. (See Test Station and Diagnostic) • Check Faulty O2 Regulator • Check O2 Supply • Check TSI Data Cables
Multiple RCS applications: Another RCS application running in the background may already have an active/open connection to the device.	• Close all applications. • Restart PC.
Status Window This window should always be reviewed prior to attempting to correct setup issues or re-try a test.	• Faults are indicated in the scrolling text window of the application and are available in the Log files.
Hidden Pop Up. Users waiting for Prompt.	• Prompt is hidden by application. • Minimize Window to see Pop UP.

Troubleshooting — Test Station

Remote Calibration System		
Discrete Tests	Test Purpose	Troubleshooting
TSI Cal Check	Confirm the TSI calibration, Used within temperature and altitude range. 1) TSI Barometric Pressure: 69kPa < reading < 102kPa (~10,000 ft. to -200 ft.), 2) TSI Temperature: 16C < reading < 32C, 3) TSI Calibration: current date does not exceed due date.	• Return to main menu, select "Get TSI Flow Module" information button and confirm operating conditions • Swap-out to new module; • Use notes to justify usage when out of spec.

Observations	
Observation	Resolution
Prior to servicing the device, ensure equipment and technician safety.	• Use proper ESD precautions at all test stations when opening the device. • Follow proper safety precautions as noted in the Service Manual
The tool is not compliant to FDA Part 11	• Print hard copy of each record, sign and maintain in accordance to Quality System.
PC Setup	• If this is a new installation and if the drivers did not register properly then the user will be unable to read/write to the ventilator's firmware. • If connected to the Internet the Atmel driver may be replaced by windows automatically to a non-compatible open-sourced driver (BOSSA). Fix: Reinstall the TCE software. • With unit plugged in, verify "Load VCP" is unchecked for both USB Serial Converter properties advanced tab.
Note: To uncheck the "Load VCP" option, follow the below steps: • Navigate to: device manager > universal serial bus controllers > USB serial converter • Right click and choose properties, and select the advanced tab. • Verify that Load VCP is unchecked. • Repeat these steps for the 2nd USB serial converter.	
TSI flow modules need to be calibrated on a yearly basis	• Contact TSI and calibrate module on an annual basis. (See RCS manual)
The TSI may not maintain calibration for the year.	• Establish a monthly flow check. • Properly store and protect the TSI module.
TSI Cables	• Inspect the TSI data cable to avoid data interruptions. • TSI Data Cable • O2 Cable
O2 Cell	• Calibrate when prompted
Faulty O2 Regulators The O2 regulators need to be properly used to ensure proper flow.	• Oxygen Regulators may be damaged due to improper use. • Always close the tank and relieve pressure from both sides of the regulator when not in use. • Always open the tank slowly with the regulator in the completely closed position (0 PSI). Turn the regulator handle fully counter clockwise.

O2 Supply The oxygen supply used with RCS is critical to the ability to calibrate and test devices.	• It is recommended to perform frequent checks. • Confirm O2 regulated supply (see Diagnostics Section below) • The supplied O2 hoses use DISS 1240 fittings and O ring seal. • It is recommended to hand tighten the O2 Fittings, they do not need to be tightened with a wrench and may be damaged if overtightened. • Debris may become lodged in the tubing from damage to the O-rings. • Inspect hoses to ensure O-rings is in place and not damaged
Hidden Pop Up. Users waiting for Prompt.	• Prompt is hidden by application. • Minimize Window to see Pop UP.

Troubleshooting — Diagnostics

Identify Trends

Each device that is used with RCS has an associated log file. The log file contains all of the information presented on the scrolling application window that is populated during testing and calibration.

Confirm Regulated O2 Supply

Inspection of the "TCE_Study" file "O2_Kickstart_Calibration_O2Valve" provides detailed information about the gas supply used with the device during calibration. The file contains columns for the Device flow, TSI flow, Duty Cycle, Current, and Supply pressure. During the test, the device should be capable of reaching peak flow rates of approximately 103 LPM. The supply pressure should be maintained within 10-15 psig of the starting pressure. Issues with either of these may indicate problems with the Oxygen supply (restricted flow) or regulator (slow response).

Forensic Memory - Erase

Prior to releasing the device for field use, it is recommended to erase the forensic memory. This may be performed with RCS prior to performing "Final Config". It is recommended to perform a complete power cycle of the device after erasing the forensic memory to reset the device. Failure to power cycle the device may cause unsuccessful programming of the EMV when proceeding to "Final Config".

RCS Software 8.XXX	
Folder Name	Description
RCS Application Logs: Documents\ZOLL\RCS_Application_Logs	Contains detailed log of transactions between the application and the device. Record of commands sent and received. Typically used to diagnose issues with PC or drivers.
RCS Study: Documents\ZOLL\RCS_Study\Ventilator\ServiceActions	Contains .cvs files for each discrete test. Tests typically have 2 files associated with them, a "VV" and a "DB" file. The "VV" file is a condensed, more readable format. The "DB" file, while less readable contains information in a database format. Typically, "VV" files are used to assess the calibration applied to the device and assist in understanding device/Test station behavior

Ventilator Memory Logs: Documents\ZOLL\Ventilator_Forensic_Logs	This folder will contain several files and is created when the forensic memory is read from the ventilator. This folder is only present after the read forensic memory is executed. The files document device settings and conditions as well as all alarms active on the device at the time of each entry. Device logging is cyclic, meaning once the forensic memory is full on the device, it will continue to log overwriting the oldest data first. The log does not discriminate against alarms generated by use of RCS vs. those generated on the device while it is in use and all time is formatted in UTC time. The log may contain alarms that were not present on the display when used with RCS, which is expected behavior. When communicating with the SPM, communication is broken with the EMV. The opposite is also true. Therefore, it is common and expected to have communication alarms present in forensic memory after conducting tests with RCS.
RCS Logs: Documents\ZOLL\RCS_Logs\Ventilator\ServiceActions	Text file, uses the EMV Model & Serial Number (Ex. VCDB123456) as the file name. Contains all of the information displayed in the application window during testing & calibration. Records Pass/Fail criteria. Typically used to diagnose issues with process or review specific failure criteria post-test.

TCE Software 7.XXX	
Folder Name	Description
TCE_Application_Logs Documents\ZOLL\TCE_Aplication_Logs\	Contains detailed log of transactions between the application and the device. Record of commands sent and received. Typically used to diagnose issues with PC or drivers.
TCE_Logs Documents\ZOLL\TCE_Logs\Ventilator\Service\	Text file, uses the EMV Model & Serial Number (Ex. VCDB123456) as the file name. Contains all of the information displayed in the application window during testing & calibration. Records Pass/Fail criteria. Typically used to diagnose issues with process or review specific failure criteria post-test.
TCE_Study Documents\ZOLL\TCE_Study\Ventilator\EMV Model & SN\	Contains .cvs files for each discrete test. Tests typically have 2 files associated with them, a “VV” and a “DB” file. The “VV” file is a condensed, more readable format. The “DB” file, while less readable contains information in a database format. Typically, “VV” files are used to assess the calibration applied to the device and assist in understanding device/Test station behavior.

Ventilator_Memory_Logs Documents\ZOLL\Ventilator_Memory_Logs\"EMV Model & SN"\	This folder will contain several files and is created when the forensic memory is read from the ventilator. This folder is only present after the read forensic memory is executed. The files document device settings and conditions as well as all alarms active on the device at the time of each entry. Device logging is cyclic, meaning once the forensic memory is full on the device, it will continue to log overwriting the oldest data first. The log does not discriminate against alarms generated by use of RCS vs. those generated on the device while it is in use and all time is formatted in UTC time. The log may contain alarms that were not present on the display when used with RCS, which is expected behavior. When communicating with the SPM, communication is broken with the EMV. The opposite is also true. Therefore, it is common and expected to have communication alarms present in forensic memory after conducting tests with RCS.

Part III — Service Codes

This section provides a list of Version 5 and Version 4 service codes of service related alarms, their associated alarm description and their resolution for restoring proper ventilator operation.

A service Code is a four-digit number associated with each ventilator alarm.

The code appears at the bottom of the Alarm Message Center (AMC). In Release 5.x ventilators the Service Code is also listed on the Alarm History.

Retrieving Service Codes

Version 5 Ventilators only

Retrieving Service Codes (Alarm History) is accomplished by the Read Forensic Memory sequence on RCS software. Running this sequence will read the alarm history data from the ventilator and parse that data into five files. The five files are:

- Alarms
- Breaths
- Conditions
- Settings
- Summary (AllData - RCS 8.X)

The files are written in CSV (comma separated values) format and can be viewed through any text editor or spreadsheet application.

There will be sub-folders named with the embedded serial number of the vent (EMV Model + EMV SN) ex. VCDB123456.

Each time the Read Forensic Memory is run, five additional files will be written to the directory location. The file names will include the current date and time to prevent overwriting previously read Forensic Memory files.

Service Codes - Version 5

A list of all ventilator Service Codes for Version 5follows and is divided into three categories:

- High Priority (1XXX)
- Medium Priority (2XXX)
- Low Priority (3XXX)

Service Codes in each category are provided in numerical order.

NOTE:

Before ordering a service kit, ensure that all troubleshooting steps listed earlier in this chapter have been followed.

CODES	NAME	Description /Possible Cause	Actions
1001 **2001** **3001**	**Compressor Flow Path / Failure**	**Description:** Compressor does NOT respond to control signals **Possible Cause:** • Blocked output • Tubing kinked • Connector loose • Diffuser or flow screen issue	1. Does not present at power up • Use Conditions (Possible settings conflict or the output was blocked during operation): • Download forensic memory using RCS consult technical support; possibly the output was blocked. 2. Presents at power up • Check tubing -> tubing kinked or disconnected-> Correct tubing • Check compressor cable is properly seated -> dislodged connector -> re-seat connector • Check diffuser screen, check flow screen ->collapsed diffuser screen or wet flow screen - replace Flow Screen Kit
1002 **2002** **3003**	**Internal communication Compressor (Failure/Faults)**	**Description:** Compressor flow signal - High, Low, or Stuck **Possible Cause:** • Tubing kinked or disconnected • Faulty compressor flow transducer	• Check tubing -> tubing kinked or disconnected-> Correct tubing • Check Flow transducer -> Bad flow transducer -> Replace Smart Pneumatic Module (SPM)/ Vent Assembly Kit
1003	**Sensor/ Transducers/Cal file Failures**	**Description:** Fails power-on self check breath **Possible Cause:** • Calibration error • Foreign substances in screen • Faulty compressor flow transducer	• calibration Error -> Calibrate • check diffuser screen check flow screen ->collapsed diffuser screen, foreign substances contamination or wet flow screen - replace screen • Bad flow transducer -> Replace SPM Module

CODES	NAME	Description /Possible Cause	Actions
1010	**O2 Valve Failure**	**Description:** O2 Valve Failure (O2 Valve Failed Open) The O2 Valve fails in the open position which results in flow even during expiratory phase. When this occurs, the unit automatically opens the exhalation valve to prevent pressure from building in the patient circuit and ventilation stops. **Possible Cause:** • Debris on the O2 input filter and manifold • O2 valve / debris on the valve seat	• Check O2 input filter and manifold -> Debris on the O2 input filter and manifold -> Replace O2 input filter • Exercise ventilator at 100% FIO2, 50BPM for 5 minutes. • Replace O2 valve
1011 **2011** **3011**	**O2 Flow Path (Failure/Faults)**	**Description:** Loss of O2 Flow control **Possible Cause:** • O2 valve cable faulty or loose Tubing kinked/ damaged/ disconnected • Faulty valve drive circuit	• Check O2 Valve Cable -> O2 valve cable faulty or loose -> Correct cable or replace O2 valve • Check 02 Flow transducer tubing -> Tubing kinked/ damaged/disconnected -> Correct tubing • Replace SPM Module
1012 **2012** **3012**	**Internal communication Valve (Failure/ Faults)**	**Description:** The signal from the O2 flow sensor to the SPM fails. **Possible Cause:** • Kinked or disconnected tube • SPM contamination near O2 flow transducer • Faulty O2 flow transducer	• Check 02 Flow transducer tubing ->Kinked or disconnected tube -> correct tubing • Check SPM board ->SPM contamination near O2 flow transducer-> Replace SPM Module

CODES	NAME	Description /Possible Cause	Actions
2020	**Low O2 Supply Fault**	**Description:** O2 supply pressure < 35 psi **Possible Cause:** • O2 supply leak • O2 supply regulator failure • Debris in the high pressure O2 inlet • Internal hose disconnect • Clogged or damaged high pressure O2 barb	• Check the O2 supply for leaks -> O2 supply leak -> Correct O2 supply • Check O2 regulator -> O2 supply regulator failure -> Replace O2 regulator • Check High Pressure inlet -> debris in the high pressure O2 inlet -> Clear high pressure inlet • Check internal high pressure tubing ->Internal tube disconnect -> Correct tubing • Check High Pressure O2 barb -> Clogged or damaged high pressure O2 barb-> Replace SPM Module
1030 **2030** **3030**	**Gas Intake (Failure/Faults)**	**Description:** Insufficient flow or blocked fresh gas intake **Possible Cause:** • Fresh gas intake assembly error • Dirty/wet filters	• Check fresh gas intake assembly -> fresh gas intake assembly the disk filter may be incorrectly installed -> Correct error • Check fresh gas intake filters -> Dirty/wet filters -> Replace filters
3031	**Intake Restricted**	**Description:** Insufficient flow from fresh gas intake **Possible Cause:** • O2 reservoir in use • Fresh gas intake assembly error • Intake partially occluded • Dirty/wet filters • Improperly installed filter • Kinked tubing	• Is the O2 reservoir in use ->O2 reservoir in use -> Select Reservoir in use from the O2 sub menu • Check fresh gas intake assembly -> fresh gas intake assembly the disk filter may be incorrectly installed -> Correct error • Check Fresh gas intake for partial occlusions ->Intake partially occluded -> Correct occlusions • Check filters ->Dirty/wet filters -> Replace filters • Check filters ->improperly installed filter -> Correct filters • Check intake transducer tubing ->Kinked tubing-> Correct/replace tubing
3032	**Sensor and Transducer Faults**	**Description:** Signal from the Fresh Gas/ Intake pressure sensor is stuck High or Low **Possible Cause:** • Kinked tubing • Faulty intake pressure transducer	• Check intake transducer tubing -> Kinked tubing -> correct tubing • Replace SPM Module

CODES	NAME	Description /Possible Cause	Actions
1041 **3041**	**High O2 Supply (Failure/Fault)**	**Description:** O2 input pressure too high **Possible Cause:** • O2 supply pressure too high • Faulty regulator • Faulty O2 Pressure Transducer	• Check O2 supply-> O2 supply pressure too high->Decrease O2 supply • Check O2 regulator ->Faulty regulator -> Replace O2 regulator on O2 inlet • Faulty SPM Module>Replace SPM Module
1051	**Self Check Failure**	**Description:** Run-Time Calibration Failure **Possible Cause:** • Kinked hose • Auto Cal valve • Ventilator needs calibration • Faulty transducer • Persistent high vibration or electrically noisy environment	1. To Check for kinked tube or auto Cal valve Does it occur at startup, or does it occur after running for some time? **A**. At startup implicates transducer or kinked CF/OF/ Auto Cal pathway hose->Correct hose **B**. Runtime implicates auto Cal valve->Replace SPM Module To Check Valves 2. Run exhalation, backup and auto Cal valve check to make sure valves are good-valve failure->replace SPM Module 3. To Check Calibration 4. If valves are good, run calibration checks for O2 flow, compressor flow, and airway pressure to see if one is out of spec->Calibration error->Calibrate 5. Rerun calibration for failing calibrations (if this works, it means a transducer offset shifted since device was last calibrated)->unable to calibrate->replace SPM Module
1052	**Self Check Failure**	**Description:** Airway pressure signal is stuck high or stuck low or is unchanging. **Possible Cause:** • Calibration drift • Kinked tubing • Bad airway pressure transducer • Contamination on PCB near airway pressure transducer / PGA	• Check calibration -> calibration drift ->recalibrate • Check AW Pressure/Auto Cal pathway tubing ->kinked tubing -> Correct tubing • Bad airway pressure transducer -> Replace SPM module • Check SPM PCB for contamination -> Replace SPM module

CODES	NAME	Description /Possible Cause	Actions
1060	**Exhalation System Failure**	**Description:** PEEP higher than greater of PIP high limit - 5 cmH2O or PEEP + 2.5 cmH2O for 3 consecutive breaths **Possible Cause:** • Kinked tubing • debris/blockage in exhalation drive or exhaust port • Blocked/occluded exhalation valve • Pinched patient circuit line • Faulty exhalation/ backup valve (EX_CON_1, EX_CON_2)	• Check AW Pressure/Auto Cal pathway for kinked tubing -> Kinked tubing -> correct tubing • Check drive and exhalation tubing ports -> debris/ blockage in exhalation drive or exhaust port -> correct tubing / clean ports • Check exhalation valve -> Blocked/occluded exhalation valve ->replace patient circuit • Check patient circuit ->Pinched patient circuit tubing ->correct pinch • Check exhalation/backup valve with RCS -> Faulty exhalation/backup valve (EX_CON_1, EX_CON_2) -> replace SPM Module
1061	**Exhalation System Failure**	**Description:** (Airway Pressure > 70 cmH2O for 1.5s) OR (Airway Pressure > greater of 35 cmH2O or PIP High Limit for 5s) **Possible Cause:** • Blocked Exhalation drive or exhaust port • Blocked exhalation valve • Kinked tubing • Faulty airway pressure transducer	• Check Exhalation Drive or Exhaust tubing ports -> Blocked Exhalation drive or exhaust tubing/port ->Correct blockage • Check patient circuit exhalation valve -> Blocked exhalation valve ->Replace exhalation valve patient circuit • Check AW Pressure/Auto Cal pathway for kinked tubing -> Kinked tubing -> Correct tubing • Faulty airway pressure transducer -> Replace SPM Module
2062	**Exhalation System Fault**	**Description:** PEEP measured > PEEP setting + 5 cmH2O **Possible Cause:** • Blocked Exhalation drive or exhaust port • Blocked exhalation valve • Kinked tubing • Faulty SPM Module	• Check Exhalation Drive or Exhaust tubing/ports -> Blocked Exhalation drive or exhaust tubing/port ->Correct blockage • Check patient circuit exhalation valve -> Blocked exhalation valve ->Replace exhalation valve patient circuit • Check AW/ Pressure/Auto Cal pathway for kinked tubing -> Kinked tubing -> Correct tubing • None of the above -> Faulty SPM Module -> Replace SPM Module
3110	**RTC Battery Low**	**Description:** RTC alarm at start up, date and time returned to default **Possible Cause:** • RTC battery is drained • RTC battery contact is intermittent	• Check RTC Battery -> RTC battery is drained -> Replace RTC battery • Check RTC Battery Contact -> Retention battery holder clip -> RTC battery contact is intermittent -> Replace SPM Module

CODES	NAME	Description /Possible Cause	Actions
3120	**Calibration Due**	**Description:** Calibration Due **Possible Cause:** • Calibration exceeds interval • RTC battery is drained • RTC battery contact is intermittent	• Check date ->Calibration exceeds interval -> Calibrate • Check RTC Battery -> RTC battery is drained -> Replace RTC battery • Check RTC Battery Contact -> Retention battery holder clip -> RTC battery contact is intermittent -> Replace SPM Module
3130	**Self Check Fault**	**Description:** Ambient Pressure sensor reads near zero or full scale **Possible Cause:** • Vent's altitude sensor reads < 0.1 ATM • Vent's altitude sensor reads > 1.9 ATM • Transducer output stuck • Faulty Barometric Pressure Sensor	• Check for a faulty or stuck Faulty Barometric Pressure Sensor-> Altitude (TCE Log UUT Pressure) reads <0.1 ATM -> Replace SPM module • Check for a faulty or stuck Faulty Barometric Pressure Sensor-> Altitude (TCE Log UUT Pressure) reads >1.9 ATM -> Replace SPM module • Check for a faulty or stuck Faulty Barometric Pressure Sensor-> Transducer output stuck ATM -> Replace SPM module
3131	**Excessive Altitude**	**Description:** Ambient Pressure < 0.36 ATM (greater than 25,000 ft. altitude) **Possible Cause:** • If this error is displayed at an altitude below 25000 feet: • Faulty Barometric Pressure Sensor	• Check the barometric Pressure sensor, bring the ventilator to a stable altitude below 25000 feet, the alarm should clear, if the alarm does not clear -> the barometric transducer may be stuck -> Replace the SPM module
3132	**Low Altitude**	**Description:** Ambient Pressure > 1.1 ATM (below -2000 feet) **Possible Cause:** • If this error occurs at altitudes that are above -2000 feet: • Faulty Barometric Pressure Sensor	• Check the barometric Pressure sensor -> Bring the ventilator to a stable altitude above -2000 feet if the alarm does not clear -> Replace the SPM module

CODES	NAME	Description /Possible Cause	Actions
3143	**Self Check Fault**	**Description:** Temperature Sensor Fault displayed Possible Cause: • 1 of the 4 PGA's temperature measurements beyond threshold • SPM Module is faulty	• Check to see if the error clears on power cycle ->Power Cycle device if the error persists -> Replace SPM Module
1172	**Self Check Failure**	**Description:** 5V Self Check Failure Possible Cause: • PIM Board malfunction • Any board in the front panel assembly or SPM module	• Check to see if the problem is within the SPM assembly by disconnecting the front panel and powering up the SPM, look for a blinking LED on the SPM PCB if no blinking LED-> replace SPM Module • Check to see if the problem is within the SPM assembly by disconnecting the front panel and powering up the SPM, look for a blinking LED on the SPM PCB if the SPM LED is blinking, then the problem resides within the front panel assembly-> replace front panel assembly
1173	**Self Check Failure**	**Description:** Communication Failure **Possible Cause:** • PIM to CPU ribbon damage • CPU Module faulty	• Check for damage/seating of the PIM to CPU cable -> if the cable is damaged -> Replace PIM to CPU cable • Replace the PIM to CPU cable and the problem persists - . CPU Module faulty-> Replace Front Panel Assembly
1174	**Self Check Failure**	**Description:** Unable to zero/null transducer offset on one or more transducers **Possible Cause:** • kinked tubing • transducer offset drift (new offset too far from calibrated offset) • board contamination / bad transducer	• Check to see if the transducer(s) tubing is kinked -> tubing kinked -> Correct tubing • Check to see if the calibration has drifted by recalibrating-> if the problem has resolved the issue was transducer drift if the problem persists -> Replace the SPM Module • Check for contamination on the SPM Module or bad transducer -> SPM board contaminated/ Transducer bad -> Replace SPM Module
1175	**Self Check Failure**	**Description:** Loss of communication with any I2C device for 4 consecutive attempts (on the SPM) **Possible Cause:** • Stuck I2C bus	• Check to see if the problem will clear on power cycle by power cycling the unit-> if the problem has resolved the I2C was stuck, if the problem persists -> Replace SPM Module

CODES	NAME	Description /Possible Cause	Actions
1176	**Self Check Failure**	**Description:** Any of the calibration tables has a bad CRC or the calibration header has a bad CRC **Possible Cause:** • Calibration table corrupted	• Check to see if the calibration table has been corrupted by recalibrating (do not write defaults) -> if the problem has resolved the issue was the calibration table if the problem persists -> Replace the SPM Module
2300 **3300**	**Self Check Fault**	**Description:** The Masimo board indicates a failure **Possible Cause:** • SPO2 Failure	• Replace CPU/SPO2 Stack kit or front panel assembly.
2301 **3301**	**Self Check Fault**	**Description:** Communication from the Masimo board has timed out **Possible Cause:** • Board has become dislodged • Masimo board is damaged • Faulty Front Panel Module	• Check to see if the Masimo board has become dislodged -> the Masimo board has become dislodged -> reseat the Masimo board • Check to see if the Masimo board is damaged -> Masimo board damaged -> Replace CPU/SPO2 Stack kit • If the above actions do not resolve the issue -> Faulty Front Panel Module ->Replace Front Panel Assembly
3311	**Defective Pulse Ox Sensor**	**Description:** Alarm occurs when the pulse oximeter cannot identify the connected sensor or the sensor has failed. **Possible Cause:** • Masimo Flex Cable fault • Internal Masimo board fault	• Check to see if Masimo Flex Cable is bad or the Internal Masimo board is bad-> if the Masimo Flex Cable is bad or the Internal Masimo board is bad -> Replace CPU/ SPO2 Stack kit or the front panel assembly

CODES	NAME	Description /Possible Cause	Actions
3316	**Invalid Pulse Ox Sensor**	**Description:** Alarm occurs does when the pulse oximeter does not recognize the connected sensor. **Possible Cause:** • Bad sensor, incompatible sensor • Masimo Flex Cable is bad • Masimo board	• Check for a bad sensor or incompatible sensor -> if the sensor is incompatible or bad -> Replace Sensor • Check to see if Masimo Flex Cable is bad or the Internal Masimo board is bad-> if the Masimo Flex Cable is bad or the Internal Masimo board is bad -> Replace CPU/ SPO2 Stack kit or the front panel assembly
2421	**Self Check Fault**	**Description:** Input Circuit protection failed **Possible Cause:** • Permanent fuse on PIM is blown	• Check the PIM fuse -> the PIM fuse is blown -> Replace the PIM Board • Even if the PIM fuse is not blown if this error should persist -> Replace PIM Board
3422	**Battery Fault**	**Description:** The device is unable to detect a battery pack **Possible Cause:** • The battery pack is missing • The battery pack is unplugged • The battery cable is damaged • The battery pack is malfunctioning • PIM board failure	• Check to see if the battery pack is missing->battery pack missing -> replace battery pack • Check to see if the battery pack is unplugged -> battery is unplugged -> plug in the battery pack • Check to see if the battery cable is damaged -> the battery cable is damaged -> replace battery pack • Check to see if the battery pack is malfunctioning-> the battery pack is malfunctioning-> replace battery pack • If none of the above->PIM board failure -> Replace the PIM board
2423 **3423**	**Self Check Fault/ Battery Charging**	**Description:** Power system failure **Possible Cause:** • Faulty PIM Board	• Replace the PIM board
3441	**External Power Fault**	**Description:** The input voltage is too high; > 33 VDC after the fuse **Possible Cause:** • faulty external power supply • faulty PIM board	• Confirm that the applied voltage is in specified range -> External Power Supply Fault -> Replace external Power Supply • If the above does not resolve the issue -> Faulty PIM board ->Replace the PIM board

CODES	NAME	Description /Possible Cause	Actions
3442	**External Power Fault**	**Description:** The input voltage is too low; < 11.5 VDC after the fuse **Possible Cause:** • faulty external power supply or damaged connector • faulty PIM board	• Confirm that the applied voltage is in specified range -> External Power Supply Fault -> Replace external Power Supply • If the above does not resolve the issue -> Faulty PIM board ->Replace the PIM Board
3444	**External Power Fault**	**Description:** Voltage in at <-1 VDC **Possible Cause:** • faulty external power supply • faulty PIM board	• Confirm that the applied voltage is in specified range -> External Power Supply Fault or DC to DC converter at fault -> Replace external Power Supply or DC to DC converter • If the above does not resolve the issue -> Faulty PIM board ->Replace the PIM Board
2450 **3450**	**Battery Discharge Fault**	**Description:** The battery pack has reported an internal temperature of ≥ 70 degrees C **Possible Cause:** • The internal temperature of the battery pack is too high	• Replace Battery Pack
3451	**Battery Discharge Fault**	**Description:** The battery pack has reported an internal temperature of ≥ 75 degrees C **Possible Cause:** • The internal temperature of the battery pack is too high and external power is plugged in	• Replace Battery Pack

CODES	NAME	Description /Possible Cause	Actions
3452	**Battery Charging Fault**	**Description:** external power present AND battery temp ≥ 45C **Note:** The battery pack will continue charging up to 50C if it was charging before 45C, but must be below 45C to re-initiate charging once 50C is exceeded. This is logic in the battery pack, not the EMV CPU **Possible Cause:** • The internal temperature of the battery pack is too high and external power is plugged in, unable to charge the battery	• Replace Battery Pack
3453	**Battery Charging Fault**	**Description:** external power present AND battery temp ≤ 0 °C **Possible Cause:** • The internal temperature of the battery pack is too low	• Replace Battery pack
2455 **3455**	**Battery Fault**	**Description:** System powered by battery AND battery communication. **Possible Cause:** • Cable loose or wire dislodged • faulty Battery Pack • faulty PIM board	• Check Battery cable -> Cable loose or wire dislodged -> Reseat battery cable • Check Battery Pack -> faulty Battery Pack -> Replace battery pack • If the above do not resolve the issue -> faulty PIM board-> Replace the PIM board

CODES	NAME	Description /Possible Cause	Actions
3470	**Self Check Fault**	**Description:** too many consecutive NACKS for any combination of LTC1760, LTC4260, or AN1112 (Note: PIM communication. Failure) **Possible Cause:** • faulty or loose PIM to CPU cable • faulty PIM board	• Check for damage/seating of the PIM to CPU cable -> faulty or loose PIM to CPU cable -> Replace the PIM to CPU cable • If the above does not resolve the problem -> faulty PIM board -> Replace the PIM Board
1471	**Self Check Failure**	**Description:** cannot communicate with IO expander responsible for sampling buttons and driving LED's **Possible Cause:** • Stuck I2C bus • dislodged CPU to UIM connection • faulty UIM adapter or CPU board	• Check to see if the I2C bus is stuck by power cycling the device if the problem clears ->Stuck I2C bus -> No further action required • Check the CPU to UIM connection ->dislodged connection on CPU(J4) to UIM(J1) connection -> resolve issue • If none of the above-> faulty UIM adapter or CPU board-> replace UIM Adapter or CPU/SPO2 Stack Kit
1472	**Self Check Failure**	**Description:** rate of corrupted packets from SPM is too high **Possible Cause:** • faulty or loose PIM to CPU cable • electrical interference	• Check damage/seating of the PIM to CPU cable->faulty or loose PIM to CPU cable -> replace the PIM to CPU cable • if the above does not resolve the issue possible cause ->electrical interference -> replace SPM Module
1474	**Self Check Failure**	**Description:** CPU and PIM communication gaps **Possible Cause:** • faulty or loose PIM to CPU cable • SPM application corrupted	• check to see if the SPM is operating by looking for a blinking LED (DS1) on the SPM PCB If the LED is blinking, Check for a faulty or loose PIM to CPU cable-> faulty or loose PIM to CPU cable -> replace PIM to CPU cable • check to see if the SPM is operating by looking for a blinking LED (DS1) on the SPM PCB If the LED is Not blinking, the SPM firmware may be corrupt-> corrupt SPM firmware -> reprogram SPM • If the above do not resolve the issue-> Faulty SPM Module-Replace SPM module

CODES	NAME	Description /Possible Cause	Actions
1475	**Self Check Failure**	**Description:** cannot communicate with the LCD contrast control circuit **Possible Cause:** • Stuck I2C bus • Faulty UIM Adapter	• Check to see if the I2C bus is stuck by power cycling the device if the problem clears ->Stuck I2C bus -> No further action required • If this does not resolve the issue-> faulty UIM adapter > replace the UIM adapter board
1480 **3480**	**Self Check Failure /** **Self Check Fault**	**Description:** CPU and SPM software revisions are not compatible (1480), or the SPM serial number stored in CPU does not match what is reported by the SPM (3480) **Possible Cause:** • Newly combined front case and SPM module • Accidentally swapped assemblies • Incomplete upgrade • incorrect programming	• Is this a newly combined front case and SPM module->Newly combined front case and SPM module->Use RCS to Write "SPM SN" and "SPM Model" in "SN To Update" fields • is it possible that assemblies have been accidentally swapped ->>Accidentally swapped assemblies -> Correct the assemblies • Did this happen during an upgrade -> possible incomplete upgrade -> re-conduct upgrade, Use RCS to Write "SPM SN" and "SPM Model" in "SN To Update" fields • Did this happen during programming -> possible incorrect programming -> re-conduct programing -> Use RCS to Write "SPM SN" and "SPM Model" in "SN To Update" fields

Version 4 Service Code List

A list of all ventilator Service Codes for Version 4 follows and is divided into three categories:

- High Priority
- Medium Priority
- Low Priority

Service Codes in each category are provided in numerical order.

NOTE:

Before ordering a service kit, ensure that all troubleshooting steps listed earlier in this chapter have been followed.

High Priority Service Codes - Version 4

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
1001	**Self Check Failure** Compressor Failure Alarm triggers when the compressor fails to operate or fails to provide the flow required to deliver a breath and high pressure O_2 is not available to provide ventilation.	Smart Pneumatic Module/ Vent Assembly Service Kit
1002	Self Check Failure Compressor Fault Alarm triggers when communication between the compressor controller and the Smart Pneumatic Module (SPM) is lost and high pressure O_2 is not available to provide ventilation.	Smart Pneumatic Module/ Vent Assembly Service Kit
1003	Self Check Failure Alarm triggers when the flow from the first breath is ± 20% of the expected flow for the tidal volume at start up. This unusually low compressor speed is a symptom of a dirty flow screen.	Smart Pneumatic Module/ Vent Assembly Service Kit
1010	Self Check Failure O2 Valve Failure Alarm triggers when the O_2 valve fails in the open position, which results in continuous Inspiratory flow. When this occurs, the device automatically opens the exhalation valve to prevent pressure from accumulating in the circuit and ventilation stops.	Smart Pneumatic Module/ Vent Assembly Service Kit
1011	**Self Check Failure** O2 Valve Failure Alarm occurs when the signal to the O_2 valve is not delivering the required flow rate and the compressor is not available to provide ventilation.	Smart Pneumatic Module/ Vent Assembly Service Kit

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
1012	**Self Check Failure** O2 Valve Failure Alarm occurs when the communication between the O_2 valve and the SPM fails and the compressor is not available to provide ventilation.	Smart Pneumatic Module/ Vent Assembly Service Kit
1020	**Low O2 Supply Failure** Alarm occurs when the O_2 supply pressure is < 35 psig (241 kPa) and the compressor is not available to support ventilation.	Smart Pneumatic Module/ Vent Assembly Service Kit
1030	**Gas Intake Failure** Alarm occurs when the Fresh Gas/Emergency Air Inlet is blocked so that the compressor is not able to deliver flow sufficient for the current settings and high pressure O_2 is not available to support ventilation.	Smart Pneumatic Module/ Vent Assembly Service Kit
1041	**High O2 Supply Failure** Alarm triggers when the O_2 supply pressure is > 80 psig (552 kPa).	Lower oxygen input pressure
1051	**Self Check Failure** Run-Time Calibration Failure Alarm triggers when the autocal procedure is not able to zero the airway pressure transducer to ambient pressure.	Smart Pneumatic Module/ Vent Assembly Service Kit
1052	**Self Check Failure** Communication between the airway pressure sensor and the SPM is lost.	Smart Pneumatic Module/ Vent Assembly Service Kit
1060	**Exhalation System Failure** Alarm occurs when the PIP fails to return to the baseline pressure for 3 consecutive breaths, indicating that the exhalation control valve has failed. When triggered, the device stops ventilating and attempts to discharge the pressure in the breathing circuit to atmosphere. A significant blockage of the exhalation valve or an occlusion/kink in the exhalation valve tube mat cause this failure.	Smart Pneumatic Module/ Vent Assembly Service Kit
1061	**Exhalation System Failure** The airway pressure, PIP, is > 40 cm H_2O, the PIP High Limit (when PIP High Limit is < 35 cm H_2O) for > 5 seconds, or when the PIP is > 75 cm H_2O for > 1.5 seconds. When this happens, the device stops ventilating and attempts to discharge the pressure in the breathing circuit to atmosphere. A significant blockage of the exhalation valve or an occlusion/kink in the exhalation valve tube may cause this failure.	Smart Pneumatic Module/ Vent Assembly Service Kit
1172	**Self Check Failure** Alarm occurs when the 5 volt power bus fails to provide the required voltage.	Smart Pneumatic Module/ Vent Assembly Service Kit

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
1173	**Self Check Failure** Alarm occurs when communication fails between one of the subcomponents and the host processor.	Check cable from PIM board to CPU Smart Pneumatic Module/ Vent Assembly Service Kit
1174	**Self Check Failure** Failure of PGA offset control detected during startup Alarm occurs when the device is not able to calibrate the one or more transducers and is no longer able to operate safely.	Smart Pneumatic Module/ Vent Assembly Service Kit
1175	**Self Check Failure** Alarm triggers when the internal communication bus and the host are not able to communicate with the sub-assemblies. If this failure occurs, the user should manually ventilate the patient, replace the ventilator, and contact the ZOLL Technical Service Department for additional information.	Smart Pneumatic Module/ Vent Assembly Service Kit
1176	**Self Check Failure** Alarm triggers when the calibration file fails its integrity check.	Smart Pneumatic Module/ Vent Assembly Service Kit
1420	**Self Check Failure** Complete Power Failure Alarm triggers when power is lost from both the internal battery and an external source during operation. When this occurs, the LCD blanks (no power for operation), the audible alarm pulses rapidly, and the visual alarm flashes rapidly. This alarm will last approximately two minutes. If the device can be recharged after the failure and there are no other issues, you can return the ventilator.	Smart Pneumatic Module/ Vent Assembly Service Kit
1430	**Drained Battery** Alarm triggers when the internal battery power drops below the amount required to provide ventilation and external power is not connected. When this occurs there is enough power to operate the user interface and provide information to the user.	Battery Replacement Service Kit
1471	**Self Check Failure** Alarm triggers when the device is no longer able to communicate with the User Interface Module (UIM) and the interface controls.	Check Flex cable to LCD CPU/UIM and SPO Stack Service Kit
1472	**Self Check Failure** Alarm triggers when the device is no longer able to communicate with the Smart Pneumatic Module (SPM).	Check cable from PIM board to CPU Power Interface Module Service Kit
1473	**Self Check Failure** Alarm triggers when no valid data is sent from the SPM within 1 second.	Check cable from PIM board to CPU Power Interface Module Service Kit

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
1474	**Self Check Failure** Alarm triggers when cyclic redundancy checking between the device and the SPM fails. When this occurs, ventilation continues at the current setting or the backup mode settings and the high priority alarm sounds. The user should manually ventilate the patient, replace the ventilator, and contact the ZOLL Technical Service Department for additional information.	Check cable from PIM board to CPU. Power Interface Module Service Kit
1475	**Self Check Failure** Alarm triggers when the device has lost communication with the contrast control and in most instances the content of the LCD is not visible. When this occurs, ventilation continues at the current settings or the backup mode setting and the high priority alarm sounds. The user should manually ventilate the patient, replace the ventilator, and contact the ZOLL Technical Service Department for additional information.	Check Cable from PIM board to CPU 712-0731-02
1480	**Self Check Failure** Alarm triggers when the device and the SPM software loads are not compatible. This alarm is typically associated with an SPM change where the technician failed to update the device and the SPM to the current software revision.	Recalibrate using the RCS

Medium Priority Service Codes - Version 4

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
2001	**Self Check Fault** Alarm triggers when the communication between the compressor and the SPM fails and high pressure O_2 is available to provide ventilation. The alarm will continue to sound as a medium priority alarm until the user acknowledges that ventilation is being provided using O_2 by setting the FIO_2 to 100%. At this time, the priority changes to low priority. While operating in this state, the user should ensure an adequate supply of O_2. Failure to maintain the O_2 supply will result in a high priority alarm. *Mitigation/Info: Pneumatic System: Compressor, Operation Switched to O2 Supply, Set FIO2 to 100%, Monitor O2 Supply, **Contact Service Center*****	Check cable from compressor to PIM board Smart Pneumatic Module/ Vent Assembly Service Kit
2002	**Self Check Fault** Alarm triggers when the communication between the O_2 valve and the SPM fails and the compressor is available to provide ventilation. The alarm will continue to sound as a medium priority alarm until the user acknowledges that ventilation is being provided using the compressor by setting the FIO_2 to 21%. At this time, the alarm priority changes to low. While operating in this state, the user should monitor the SpO_2 to ensure that adequate oxygenation is maintained. If low flow O_2 is available, it can be entrained through the Fresh Gas/Emergency Air Intake port using the optional O_2 reservoir. Maintain an acceptable SpO_2 by adjusting the O_2 supply up or down to increase or decrease the amount of O_2 delivered to the patient. *Mitigation/Info: Pneumatic System: Compressor, Operation Switched to O2 Supply, Set FIO2 to 100%, Monitor O2 Supply, **Contact Service Center*****	Check cable from O2 valve to the SPM board. Oxygen Valve Assembly Kit Smart Pneumatic Module/ Vent Assembly Service Kit
2011	**Self Check Fault** Alarm triggers when the signal to the O_2 valve is outside of the calibration range for the required flow rate and the compressor is available to provide ventilation.	Smart Pneumatic Module/ Vent Assembly Service Kit
2012	**Self Check Fault** Alarm triggers when the communication between the O_2 valve and the SPM fails and the compressor is available to provide ventilation.	Smart Pneumatic Module/ Vent Assembly Service Kit
2020	**Low O2 Supply Fault** Alarm triggers when the O_2 supply pressure is < 35 psig (241 kPa) and the compressor is able to support ventilation.	Check O2 regulator output pressure Smart Pneumatic Module/ Vent Assembly Service Kit

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
2030	**Gas Intake Fault** Alarm triggers when the Fresh Gas/Emergency Air Inlet is blocked so that the compressor is not able to deliver a breath within ± 10% of the current settings and high pressure O_2 is available to support ventilation.	Smart Pneumatic Module/ Vent Assembly Service Kit
2053	**Self Check Fault** Alarm triggers when the expiratory time is < 170 ms for 3 consecutive breaths.	Smart Pneumatic Module/ Vent Assembly Service Kit
2062	**Exhalation System Fault** Alarm triggers when the airway pressure, PIP, measured at the end of expiration is > 5 cm H_2O above the baseline pressure, PEEP. This is typically caused by a restriction of the exhalation valve or an occlusion/kink in one or more of the breathing circuit tubes or hose. If the breathing circuit tubes appear to be intact, you should replace the circuit to eliminate the possibility of a bad exhalation valve.	Smart Pneumatic Module/ Vent Assembly Service Kit
2070	**Airway Pressure High** Alarm triggers when the airway pressure, PIP, is greater than the high airway pressure limit for 2 consecutive breaths. When the limit is reached, the flow decelerates to keep the PIP below the airway pressure for the duration of the breath (Inspiratory time).	Smart Pneumatic Module/ Vent Assembly Service Kit
2071	**Low Airway Pressure** Alarm triggers when the airway pressure, PIP, is less than the low airway pressure limit for 2 consecutive breaths.	Smart Pneumatic Module/ Vent Assembly Service Kit
2072	**High Tidal Volume** Alarm triggers during pressure targeted ventilation when the delivered tidal volume exceeds the user defined limit for 2 consecutive breaths. This can be caused by a leak in the patient connection or breathing circuit.	Check internal/external tubing connections
2073	**Low Tidal Volume** Alarm triggers during pressure targeted ventilation when the delivered tidal volume does not reach the user-defined limit for 2 consecutive breaths.	Check internal/external tubing connections
2074	**High Breath Rate** Alarm triggers when the actual breathing rate (set rate plus spontaneous patient rate) exceeds the high alarm limit.	Check internal/external tubing connections
2075	**Low Breath Rate/Apnea** Alarm triggers when the actual breathing rate (set rate plus spontaneous patient rate) is less than the low alarm limit.	Check internal/external tubing connections
2076	**Apnea** Alarm triggers when the spontaneous breathing rate is less than the low alarm limit. This alarm only occurs in noninvasive ventilation, CPAP and BL modes.	Check internal/external tubing connections

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
2090	**PEEP Leak** Alarm triggers when the airway pressure drops below the PEEP setting by 2 cm H_2O during the expiratory phase of the breath. This can be caused by a leak in the breathing circuit, exhalation valve or patient airway.	Check internal/external tubing connections
2095	**Insufficient Flow** Alarm triggers when the pressure target is not reached during the Inspiratory period during pressure targeted ventilation. Typically this can occur when the Rise Time is set too low for the patient and their respiratory mechanics.	Check internal/external tubing connections
2100	**Patient Disconnect** Alarm triggers when the airway pressure fails to exceed the PEEP setting by ~7 cm H_2O.	Check internal/external tubing connections
2110	**Patient Detected** An alarm triggers when you connect the patient to the ventilator while the Start Menu is still active. To resolve the alarm, you must select a mode of ventilation and configure the device appropriately for the patient. In addition, you should perform the Operational Test procedure before reconnecting the patient to the device. *Mitigation/Info: Backup Ventilation Started, Set Mode (AC, SIMV, CPAP, BL), Configure Other Settings, **Manually Ventilate Patient and Restart***	Select a mode of ventilation. Configure appropriate settings
2170	**Spont. Breath PIP High** Alarm triggers when the airway pressure, PIP, exceeds the High PIP Limit Setting during 2 consecutive spontaneous breaths.	Check accuracy of Paw Smart Pneumatic Module/ Vent Assembly Service Kit
2171	**Spont. Breath PIP Low** Alarm triggers when the airway pressure, PIP, exceeds the Low PIP Limit Setting during 2 consecutive spontaneous breaths.	Check accuracy of Paw Smart Pneumatic Module/ Vent Assembly Service Kit
2172	**Spont. Breath Vt High** Alarm triggers when the high VT Limit is exceeded during 2 consecutive spontaneous breaths.	Smart Pneumatic Module/ Vent Assembly Service Kit
2173	**Spont. Breath Tt Low** Alarm triggers when the Low VT Limit Setting is not achieved during 2 consecutive spontaneous breaths.	Smart Pneumatic Module/ Vent Assembly Service Kit
2300	**Self Check Fault** Alarm triggers when the pulse oximeter module fails while in use. When the alarm is active "-- --" appears in the HR and SpO_2 windows. Pressing the Mute/Cancel button silences the audible alarm for 30 seconds.	CPU/UIM and SPO Stack Service Kit
2301	**Self Check Fault** Alarm triggers when the communication between the pulse oximeter module and device fails.	CPU/UIM and SPO Stack Service Kit

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
2314	**Pulse Ox Sensor Off Patient** Alarm triggers when an operating sensor loses the patient signal. The most common cause is when the sensor disconnects from the patient or is misaligned with the sensor site. This alarm can also be caused by poor perfusion at the sensor site which doesn't provide an adequate signal. In these cases try another site. Replace the sensor if another sensor is available. If the alarm condition cannot be resolved the user should remove the sensor from the patient and put the pulse oximetry monitor in standby "stby". *Mitigation/Info: Check Pulse Ox Sensor Site, Check Patient for Peripheral Pulse, Change Placement, Check Sensor Operation, Replace Sensor,**Turn Off Pulse Ox Monitoring***	CPU/UIM and SPO Stack Service Kit
2401	**SpO2 Low** Alarm triggers whenever the SpO_2 value drops below the Low SpO_2 Limit. The default value for the limit is 94%. Corrective actions are increasing oxygenation by increasing the FIO_2 or PEEP settings. PEEP should only be changed based on consultation with the attending physician. When using low flow O_2 the user should increase the flow of O_2 to the low flow O_2 reservoir. *Mitigation/Info: SpO2 Below Limit, Increase FIO2, Check O2 Supply, Increase PEEP Per Physician, **Consult Physician***	CPU/UIM and SPO Stack Service Kit
2410	**Heart Rate High** Alarm triggers when the heart rate is greater than the High Heart Rate Limit. The default value for the limit is 120 beats/minute. The user should consult with the attending physician on how best to reduce the heart rate to an acceptable level. *Mitigation/Info: Heart Rate Above Limit, Check High Limit Setting, **Consult Physician***	CPU/UIM and SPO Stack Service Kit
2411	**Heart Rate Low** Alarm triggers when the heart rate is less than the Low Heart Rate Limit. The default value for the limit is 40 beats/minute. The user should consult with the attending physician on how best to increase the heart rate to an acceptable level. *Mitigation/Info: Heart Rate Below Limit, Check Low Limit Setting, **Consult Physician***	CPU/UIM and SPO Stack Service Kit
2421	**Self Check Fault** Alarm triggers when there is a failure of the input protection circuit and the device is able to operate.	Power Interface Module Service Kit
2423	**Self Check Fault** Alarm triggers when the internal power circuit has failed and external power is connected but cannot be used.	Power Interface Module Service Kit

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
2430	**Nearly Drained Battery** Alarm triggers when the device detects that there is ≤ 5 minutes of battery operation remaining and external power is not connected.	4 Year Maintenance Kit
2450	**Battery Discharge Fault** Alarm triggers when the battery temperature reaches 70 °C (158 °F) which is 5 °C from its maximum operating temperature using the internal battery and external power is not connected. When the battery temperature reaches 75 °C (167 °F) the battery will shut down to prevent failure and the device will sound a high priority alarm and shutdown.	4 Year Maintenance Kit
2455	**Battery Fault** Alarm triggers when the device is not able to communicate with the internal battery. When this occurs the device does not know the current charge of the battery and operation could stop at any time.	4 Year Maintenance Kit

Low Priority Service Codes - Version 4

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
3001	**Self Check Fault** Alarm triggers when the compressor fails to operate or fails to provide the flow required to deliver a breath within ± 10% of the current settings, high pressure O_2 is available to provide ventilation and the user has set the FIO_2 to 100%.	Smart Pneumatic Module/ Vent Assembly Service Kit
3002	**Self Check Fault** Alarm triggers when communication between the compressor controller and the SPM is lost, high pressure O_2 is available to provide ventilation and the user has set the FIO_2 to 100%.	Smart Pneumatic Module/ Vent Assembly Service Kit
3011	**Self Check Fault** Alarm triggers when the signal to the O_2 valve is outside of the calibration range for the required flow rate, the compressor is available to provide ventilation and the user has acknowledged that ventilation is being provided using the compressor by setting the FIO_2 to 21%.	Smart Pneumatic Module/ Vent Assembly Service Kit
3012	**Self Check Fault** Alarm triggers when communication between the O_2 valve and the SPM is lost, the compressor is available to provide ventilation and the user has set the FIO_2 to 21%.	Smart Pneumatic Module/ Vent Assembly Service Kit
3030	**Gas Intake Fault** Alarm triggers when the Fresh Gas/Emergency Air Inlet is blocked so that the compressor is not able to deliver breaths within ± 10% of the current settings, high pressure O_2 is available to support ventilation and the user has set the FIO_2 to 100%.	Smart Pneumatic Module/ Vent Assembly Service Kit
3031	**Intake Restricted** Alarm triggers when the Fresh Gas/Emergency Air Inlet is blocked but is still capable of delivering breaths within ± 10% of the current settings. This could be caused by an external blockage or a dirty/wet external or internal filter.	Smart Pneumatic Module/ Vent Assembly Service Kit
3032	**Self Check Fault** Alarm triggers when communication between the Fresh Gas/Emergency Air Inlet pressure sensor is lost.	Smart Pneumatic Module/ Vent Assembly Service Kit
3041	**High O2 Supply Fault** Alarm triggers when the high pressure O_2 supply is ≥75 psig (517 kPa) and < 80 psig (552 kPa).	Lower oxygen input pressure
3073	**Tubing Compliance Fault** Alarm is triggered when the tubing compliance correction shows that it is greater than the set tidal volume, indicating that the patient may not be receiving the appropriate tidal volume.	Check internal/external tubing connections

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
3091	**AutoPEEP** Alarm triggers when the exhaled flow from the patient continues throughout the expiratory period causing the expiratory control valve to cycle throughout the period to maintain the baseline pressure.	Check external/internal tubing connections Smart Pneumatic Module/ Vent Assembly Service Kit
3092	**Inspiratory Demand** Alarm triggers when the end-Inspiratory pressure is < -1.0 cm H_2O for 3 consecutive breaths.	Check internal/external tubing connections
3110	**RTC Battery Low** Alarm triggers when the real-time clock (RTC) battery is less than ~2.5 volts.	Smart Pneumatic Module/ Vent Assembly Service Kit
3120	**PM Due** Alarm triggers at start up when the preselected number of days has elapsed since the last calibration.	Smart Pneumatic Module/ Vent Assembly Service Kit
3121	**Power Cycle Need** This alarm occurs when the device has been running continuously for 30 days.	Smart Pneumatic Module/ Vent Assembly Service Kit
3130	**Self Check Fault** Alarm triggers when the ambient pressure transducer fails. When this occurs, the device is no longer able to automatically compensate for changes in altitude especially in situations where the ambient pressure could change rapidly as during transport by air.	Smart Pneumatic Module/ Vent Assembly Service Kit
3131	**Excessive Altitude** Alarm triggers when the ambient pressure transducer detects an altitude > 25,000 feet (7620 meters). Beyond this altitude, compensation remains fixed at the 25,000 ft compensation level.	Ventilator being used outside of specification limits
3132	**Low Altitude** Alarm triggers when the ambient pressure transducer detects an altitude < -2,000 feet below sea level (610 meters, 15.8 psig or 103 kPa). This can be caused by use in subterranean rescue operation or mistaken use in a hyperbaric chamber. Beyond this pressure level, compensation remains fixed at the -2,000 ft level.	Ventilator being used outside of specification limits
3140	**Ambient Temperature Fault** Alarm triggers when the ambient temperature exceeds the normal operating range, > 131 °F (55 °C) for the ventilator.	Ventilator being used outside of specification limits
3141	**Ambient Temperature Fault** Alarm triggers when the ambient temperature falls below the normal operating range < 14 °F (-10 °C) for the ventilator.	Ventilator being used outside of specification limits

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
3143	**Self Check Fault** Alarm triggers when there is failure of the internal temperature sensors. When this occurs the device is no longer able to detect if it is operating outside of the allowable temperature range.	Smart Pneumatic Module/ Vent Assembly Service Kit
3172	**Self Check Fault** Alarm triggers when the device is not able to zero the airway pressure transducer during the autocal cycle. When this occurs the device is still able to monitor the airway pressure safely. Large changes in temperature should be avoided which can affect the calibration of the transducer. This alarm can also be triggered when the device is exposed to excessive vibration and/or is mounted in a vehicle in a manner that increases its exposure to vibration. If the alarm continues, replace the ventilator and contact the service center for additional information. *Mitigation/Info: Pneumatic Sensor: Autocal, Reduce Vibration if Possible, Avoid Temperature Changes, Autocal Suspended, **Contact Service Center***	Smart Pneumatic Module/ Vent Assembly Service Kit
3300	**Self Check Fault** Alarm triggers when the pulse oximeter module fails and the user has turned off pulse oximeter monitoring acknowledging the condition.	CPU/UIM and SPO Stack Service Kit
3301	**Self Check Fault** Alarm triggers when the communication between the pulse oximeter module and device fails and the user has turned off pulse oximeter monitoring acknowledging the condition.	CPU/UIM and SPO Stack Service Kit
3310	**Pulse Ox Sensor Not Connected** Alarm triggers when the pulse oximeter detects that no SpO_2 sensor is connected after a period of successful operation.	CPU/UIM and SPO Stack Service Kit
3311	**Defective Pulse Ox Sensor** Alarm triggers when the pulse oximeter cannot identify the connected sensor or the sensor has failed. Causes for this alarm include: broken sensor cable, inoperative sensor LEDs and/or faulty detector.	CPU/UIM and SPO Stack Service Kit
3312	**Pulse Search** Alarm triggers when the pulse oximeter is searching for a pulse signal.	CPU/UIM and SPO Stack Service Kit
3313	**Pulse Ox Signal Interference** Alarm triggers when an outside signal or energy source prevents accurate reading by the device.	CPU/UIM and SPO Stack Service Kit
3315	**Ambient Light Fault** Alarm triggers when there is too much ambient light on the SpO_2 sensor or there is inadequate tissue covering the sensor detector.	CPU/UIM and SPO Stack Service Kit

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
3316	**Invalid Pulse Ox Sensor** Alarm triggers when the pulse oximeter does not recognize the connected sensor, i.e. a non-Masimo sensor. The alarm can also occur when there is a broken sensor cable, inoperative LEDs, a fault is detected, and/or the sensor has failed.	CPU/UIM and SPO Stack Service Kit
3317	**Low SpO2 Perfusion** Alarm triggers whenever the amplitude of the arterial pulsation is weak.	CPU/UIM and SPO Stack Service Kit
3318	**Low SpO2 Perfusion** Alarm triggers when the pulse oximeter determines the quality of the input signal is low due to excessive motion or artifact.	CPU/UIM and SPO Stack Service Kit
3421	**External Power Low /Disconnect** Alarm triggers when the external power (either AC or DC) drops below minimum level (~11 VDC as supplied by either the AC/DC Power Supply or a direct DC source) or power is intentionally disconnected.	Power Interface Module Service Kit
3422	**Battery Fault** Alarm triggers when the internal battery has been removed or communication between the battery and CPU has failed. When external power is applied the device is capable of operation however, loss of external power will result in loss of ventilation and a high priority alarm.	4 Year Maintenance Kit Power Interface Module Service Kit
3423	**Battery Charging Fault** Alarm triggers when the battery charging circuit fails. When this alarm is active, the battery cannot be charged. The device can only run with external power. If power is lost, ventilator will stop and a high priority alarm will trigger.	Power Interface Module Service Kit
3430	**Low Battery** Alarm triggers when the device detects that there is < 30 minutes of battery operation remaining and no external power is connected.	4 Year Maintenance Kit
3431	**Low Battery** Alarm triggers when external power is connected to a device that has an internal battery that has drained to low battery status. The device is warning the user that in the event of an external power failure the device has < 30 minutes of backup.	4 Year Maintenance Kit
3441	**External Power Fault** Alarm triggers when the supplied DC power is > 33 VDC. When this occurs, the device automatically switches to operation using the internal battery. If the supplied voltage drops to < 30 VDC, the device automatically returns to operation using external power. If the external power source is known to be good, then the AC/DC Power Supply may be faulty and need replacement.	Power Interface Module Service Kit
3442	**External Power Fault** Alarm triggers when the external power supply has insufficient current. When this occurs, the device automatically switches to operation using the internal battery. If the external power source is known to be good, then the AC/DC Power Supply may be faulty and need replacement.	Power Interface Module Service Kit

Service Code	Associated Alarm Name/Description	Service Kit/Resolution
3450	**Battery Discharge Fault** Alarm triggers when the battery temperature reaches 70 °C (158 °F) which is 5 °C from its maximum operating temperature and external power is connected.	4 Year Maintenance Kit
3451	**Battery Discharge Fault** Alarm triggers when the battery temperature reaches ≥75 °C (167 °F) and external power is connected.	4 Year Maintenance Kit
3452	**Battery Charging Fault** Alarm triggers when the battery temperature is > 45 °C (122 °F).	4 Year Maintenance Kit
3453	**Battery Charging Fault** Alarm triggers when the battery temperature is ≤ 0 °C (32 °F).	4 Year Maintenance Kit
3455	**Battery Fault** Alarm triggers when the device is not able to communicate with the internal battery and external power is connected.	Power Interface Module Service Kit 4 Year Maintenance Kit
3470	**Self Check Fault** Alarm triggers when the device is no longer able to communicate with the Power Interface Module (PIM).	Check cable from PIM board to CPU Power Interface Module Service Kit
3480	**Self Check Fault** Alarm triggers when the device software detects that it has not been calibrated with the SPM that is inside the device.	Recalibrate using the RCS