ZOLL®

731 Series Ventilator Service Manual

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



906-0731-04-01 Rev. D

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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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Chapter 1
General Information

Overview

This chapter provides general information about the 731 Series 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 731 Series Ventilator Service Manual provides information that trained service technicians need for the safe and effective repair of ZOLL ventilators. It is important that all persons servicing these devices 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 Operator's Guides, RCS Operator's Guide, and operator's guides for the devices they will use to perform electrical safety testing of the ventilator. ZOLL product documentation is available 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 letter (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 to ensure you're referencing the latest revision.

Service Manual Feedback Survey

In an effort to continuously improve the efficacy of our product documentation, ZOLL Medical Corporation invites you to participate in a short survey regarding your experience using this manual. The responses collected from the survey will contribute directly to improving future revisions of this manual. Participation in the survey is voluntary and survey responses are made anonymous by default.

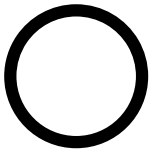
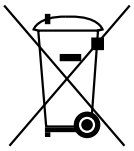
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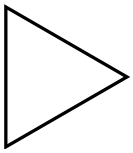
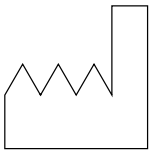
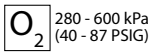
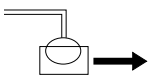
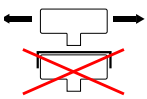
Acronyms and Abbreviations

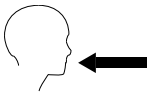
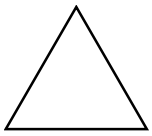
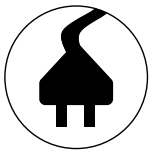
Acronym	Definition
A/C	Assist/Control
ACLS	Advanced Cardiac Life Support
ACV	Assist Control Ventilation
AEV	Automatic Electrical Ventilator
ALS	Advanced Life Support
AMC	Alarm Message Center
APOD	Advanced Probe Off Detection
ATLS	Advanced Trauma Life Support
ATPD	Atmospheric Temperature and Pressure Dry
b/min	Beats Per Minute
B/V	Bacterial/Viral Filter
BiPAP	Bilevel positive airway pressure
BPM	Breaths per Minute
cm H2O	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
FIO2	Fraction of Inspired Oxygen
HME	Heat and Moisture Exchanger
HMEF	Heat and Moisture Exchanger/Bacterial Viral filter combined
HP O2	High Pressure Oxygen
Hz	Hertz (as in frequency, cycles per second)
I:E	Inspiratory to Expiratory time ratio

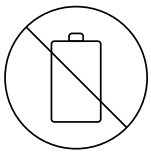
Acronym	Definition
ID	Inner Diameter
L	Liters
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LPM	Liters Per Minute
ml	Milliliters
mm	Millimeter
MRI	Magnetic Resonance Imaging
NPPV	Noninvasive Positive Pressure Ventilation
OD	Outer Diameter
O2	Oxygen
Paw	Airway Pressure
PEEP	Positive End Expiratory Pressure
PIP	Peak Inspiratory Pressure
PPV	Positive Pressure Ventilation
PS	Pressure Support
PSI	Pounds per Square Inch
RF	Radio Frequency
RTC	Real Time Clock
RTV	Room Temperature Vulcanizing
SIMV	Synchronized Intermittent Mandatory Ventilation
SPM	Smart Pneumatic Module
UIM	User Interface Module
USP	United States Pharmacopeia
VAC	Volts AC
VDC	Volts DC
VT	Tidal Volume
WOB	Work Of Breathing

Device Symbols

Symbol	Description
	OFF
	ON
	Direct Current: Identifies the location to connect external DC power.
	Electrostatic Discharge (Esd) Warning: Indicates a component should not be touched.
	Do Not Reuse: Indicates an item should not be reused.
	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.

Symbol	Description
	Power Input Orientation: Locates the DC input identifying its point of insertion.
	Manufacturer: Identifies the name and address of the manufacturer (found adjacent to where the symbol is found).
	Manufacturer Date: Identifies the device's date of manufacture (found adjacent to where the symbol is found).
	Refer to instruction manual.
	Menu icon. This symbol identifies the button that, when pressed, displays a menu of options that you can select to configure the ventilator.
	High Pressure O2 Connector (Top Faceplate) **NOTE** The appearance of this label may differ depending on the age of the ventilator.
	Exhalation Valve (Top Faceplate) **NOTE** The appearance of this label may differ depending on the age of the ventilator.
	Exhaust, Do Not Occlude (Top Faceplate)

Symbol	Description
	Transducer (Top Faceplate) NOTE The appearance of this label may differ depending on the age of the ventilator.
	Gas Output Patient Circuit Connector (Top Faceplate)
	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.

Symbol	Description
	Internal Battery: Provides indication of battery state of charge and charging status.
	No Internal Battery: Indicates when internal battery is not an available power source.

Conventions

⚠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 ventilator.

ⓘ NOTE

A Note provides additional information intended to avoid inconvenience or otherwise provide relevant and useful information 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 nor 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.	Military Customers
Phone: 1-800-348-9011 1-978-421-9655 Email: techsupport@zoll.com	Call the nearest authorized ZOLL Medical Corporation representative. To locate an authorized service center, contact intlservice@zoll.com	Phone: 1-800-348-9011 1-978-421-9655 Email: milsupport@zoll.com

When contacting support, please have the following information ready for the support representative to expedite your experience:

- 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, as 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.

Refer to the following table to determine where to ship the ventilator needing service.

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) Phone: 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) Phone: 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 intlservice@zoll.com

Chapter 2
Device Overview & Architecture

Overview

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

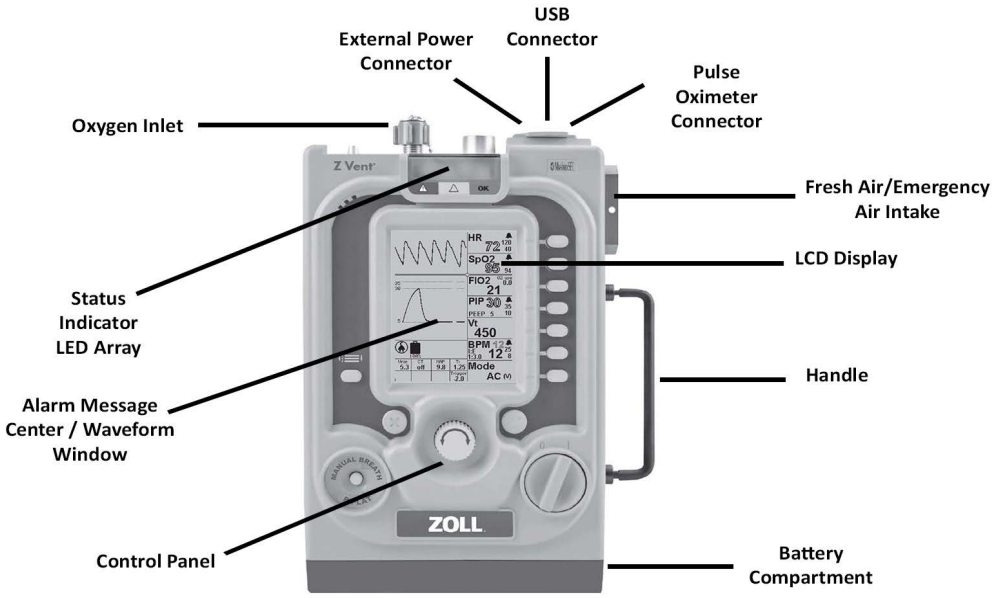
NOTE

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

Model	Description
	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.
	Designed to meet military and civilian transport standards, the versatile EMV+R 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 runtime and multisource power system allow operation and rapid charging with any power source of ground vehicles and aircrafts.
	The Eagle II model 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.
	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

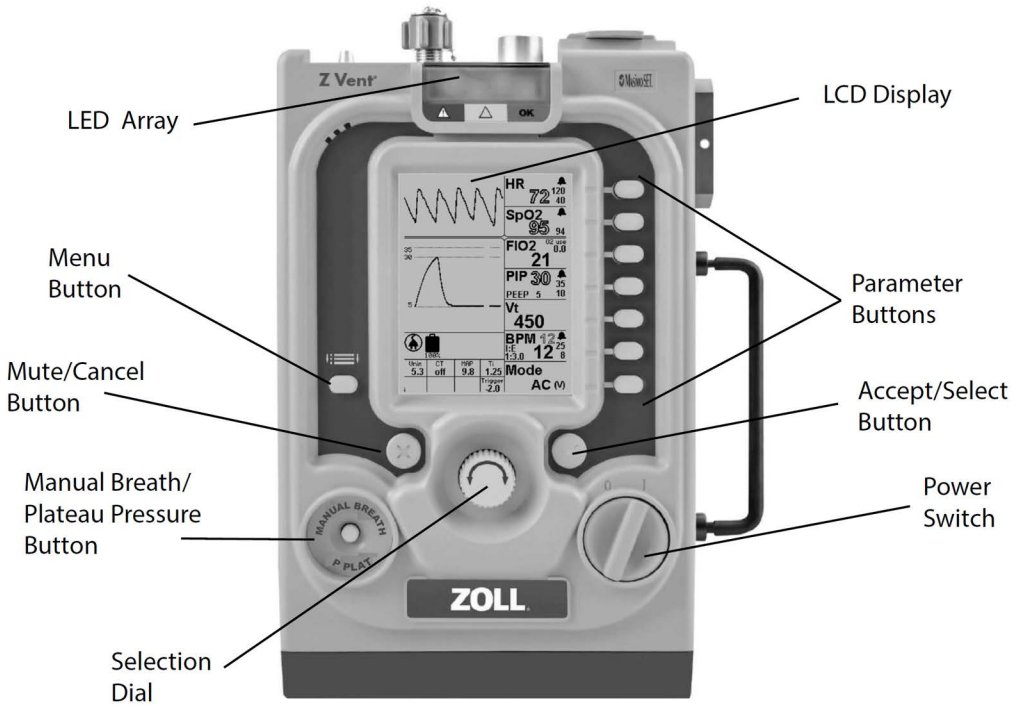
The figure below shows the ventilator's main features.



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.
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	Provides a convenient and comfortable way to carry the ventilator.

Controls and Indicators

The ventilator controls and indicators shown in the below figure facilitate ease of use and visibility in all operating environments.



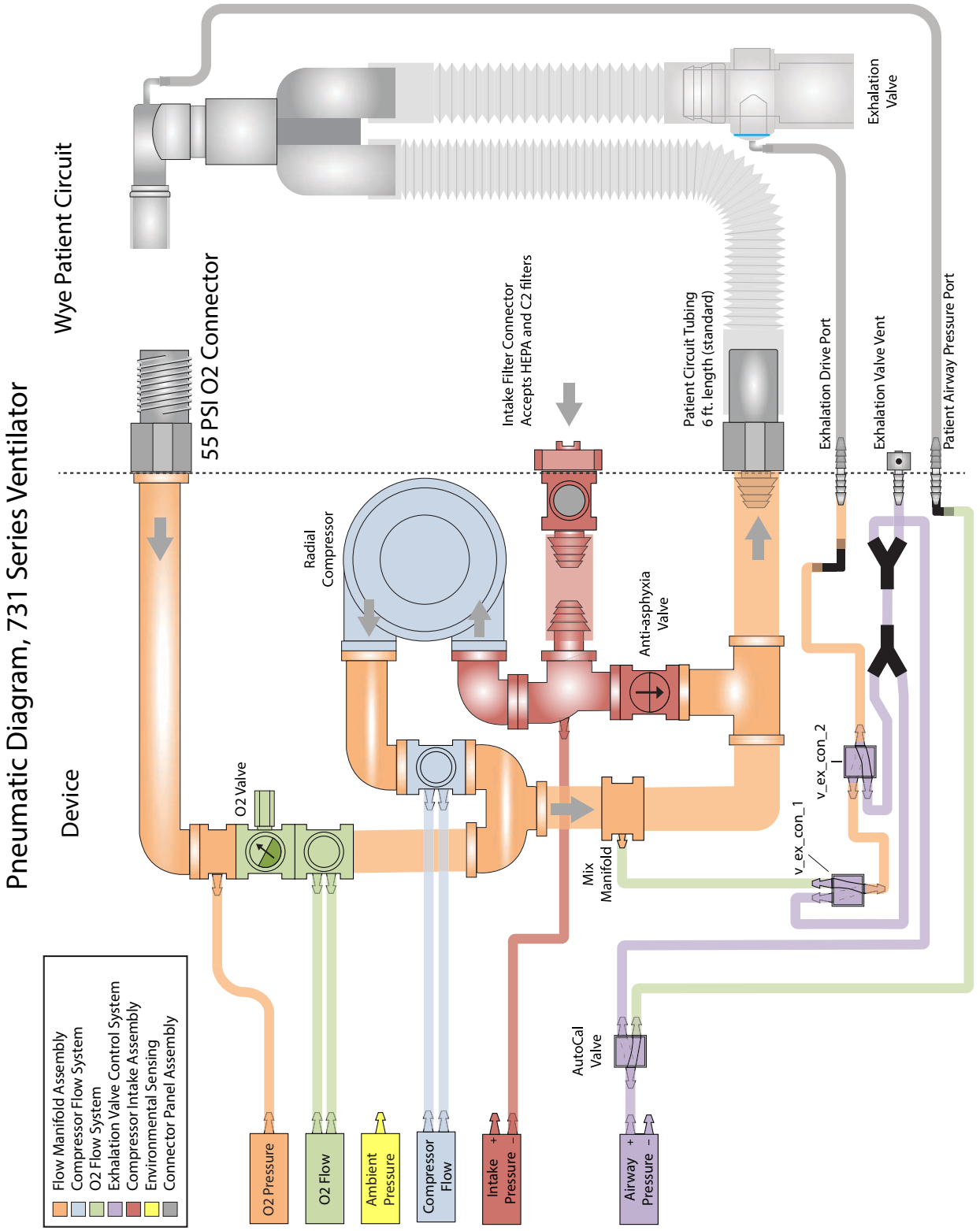
Control	Function
Power Switch	Provides the user to turn the ventilator ON and OFF.
Parameter Buttons	Provides the user to access primary parameters, secondary parameters and context menus associated with a primary parameter (if applicable), and then modify settings using the Selection Dial).
Menu Button	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.
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. 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. A primary purpose of the flow manifold is to route and mix, if needed, the two 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.

O2 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 filtering system is used to clean air entrained by the compressor. The assembly houses a disk 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 ZOLL 731 Series Ventilator Operator’s 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

Overview

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. 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 Remote Calibration System (RCS), refer to the *RCS Operator's Guide* (REF 9650-000859-01).

731 Series Ventilator Maintenance Schedule

The table below 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 feature which generates 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.

	Years After Initial Purchase of Ventilator*							
	1	2	3	4	5	6	7	8
Replace the high pressure oxygen inlet with integrated filter and the Fresh Gas Intake disk filter	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, and o-rings that show signs of wear				x				x

NOTE

* 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.

Annual & 4 Year Service Kits

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

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, is needed to complete the PM process and reset the PM/Calibration Due alarm (#3120). The RCS can be purchased from ZOLL Medical. However, its sale is restricted to only authorized customers and service partners. The RCS is intended for use by biomedical professionals who have been trained on its 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 to do so.

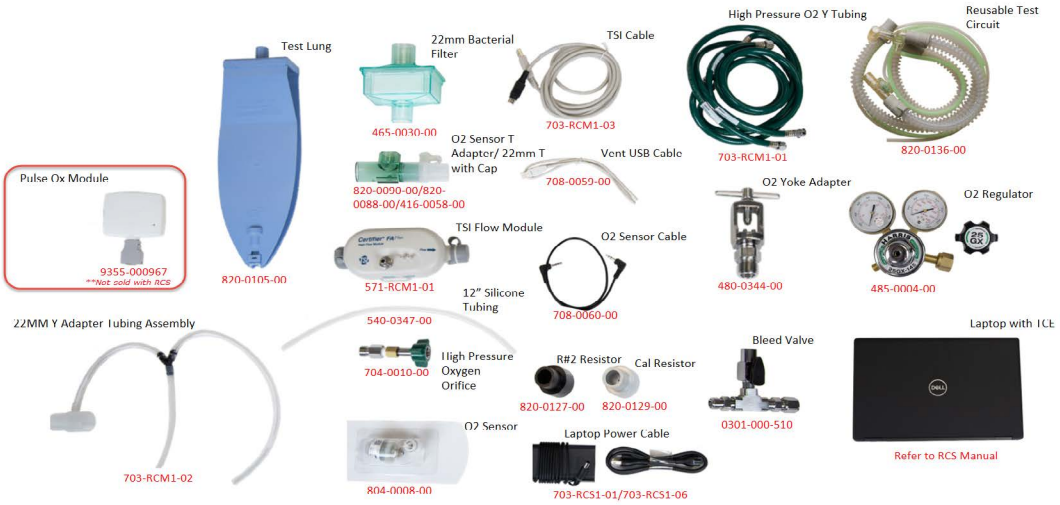
The RCS performs both testing and calibration of the ventilator by processing the ventilator through a series of discrete tests. Discrete tests may be performed individually to aid in troubleshooting, or in part of a larger sequence such as:

- Calibrations
- System Tests

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* (REF 9650-000859-01).

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 instructions below provide a technical overview of the calibration and testing process. If a device is being removed from long term storage or a stockpile, it is recommended to first complete the "Stockpile Warm-Up Procedure" on page 3-8.

NOTE

The order of the steps below may change depending on individual circumstances.

⚠ CAUTION ⚠

Follow electrostatic discharge (ESD) precautions at each workstation throughout the calibration and testing process.

Step 1: Occlusion Test

1. Remove external power from the device and power it 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.

Step 2: Physical Inspection

1. Perform Device Inspection as outlined in RCS Operator's Guide, Chapter 4.

NOTE

The device is expected to be at room temperature (16–28 °C/60–82 °F).

Step 3: Connect Device

1. Connect to device via USB Port (see RCS Operator's Guide).
2. Connect the TSI High Flow Module to PC.
3. Launch RCS Software.
4. Select Get TSI.
5. Once TSI check is complete, select 731 Series Ventilator and Proceed.
6. Select the Service Sequence, then Proceed.

Step 4: Read Vent

1. Select the "Read Vent" button at the top right side of the screen. Follow any on-screen messages that may appear.

Step 5: Read Forensic Memory

1. From the Service Actions list, select and run "Read Forensic Memory".

Step 6: RCS 9.1 (System Tests)

1. From the Service Actions list, select and run "System Tests".
2. If a test fails, check your set up and re-try. Review "Ventilator & Calibration Troubleshooting" on page 6-1 to address failures. Use the Discrete Test drop down list, or the Troubleshooting section, to identify any failure, then confirm that the failed result has been addressed prior to running the Calibrations.

NOTE

This test is only required in the case of a reported complaint or identified failure.

NOTE

Do NOT retry more than 3 times. Call ZOLL Technical Service for support.

Step 7: Device Service or PM Kit Installation

1. Service the device to address issues identified during testing.
2. Install 1 Year or 4 Year PM Kit per the kit's instructions.

Step 8: RCS 9.1 (Calibrations)

1. From the Service Actions list, select and run “Calibrations”.

NOTE

The "Calibrations" sequence must PASS without any failures to apply the calibration to the ventilator.

Step 9: RCS 9.1 (System Tests)

1. From the Service Actions list, select and run “System Tests”.

NOTE

Do NOT retry more than 3 times. Call ZOLL Technical Service for support.

NOTE

System Test sequence must be completed within 5 days from successful completion of the Calibrations sequence.

Step 10: Erase Forensic Memory

1. From the Service Actions list, select and run “Erase Forensic Memory”.
2. Once completed, disconnect the ventilator from the RCS laptop and from AC power. Power it on, and wait for the first breath. Verify no alarms are triggered.

Step 11: Test Records & Calibration Reports

1. Upon completion of the testing and calibration sequences, ensure calibration reports are printed, signed, and filed.

Stockpile Warm-Up Procedure

For ventilators not in regular continued use, it is recommended to use the following settings to exercise the electromechanical 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.

1. Connect ventilator to AC power.
2. Connect ventilator to a 55 PSI Oxygen supply.
3. Switch ventilator to On.
4. Connect RCS Patient Circuit and Test Lung with the black resistor (R2).
5. Exercise ventilator using the following parameters:
   Mode: AC(V)
   I:E = 1:20.0
   High Breath Rate alarm: 90
   60 BPM
   Vt 50 ml
   PEEP 25
   High Pressure alarm: 50
   FiO2 at 100% for 15 minutes, followed by FiO2 at 60% for an additional 15 minutes.

Discrete Tests Overview

The table below provide a technical overview of the individual discrete tests performed during routine maintenance. The order of these tests may vary by sequence.

Test Name	Description
Airway Pressure Calibration	The PGA is adjusted at no flow and ambient pressure until the analogue to digital converter reads approximately 100 counts. The compressor is run until a pressure of approximately 100cm of H2O is indicated. The duty cycle that achieves that pressure is recorded for future use. Actual vs. indicated flow data is gathered for 0 and 100 cmH2O set points and recorded.
Breath Performance Check	The RCS verifies functionality of all the major pneumatic components working together via a matrix of breath and lung settings.
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
Buzzer Check	Operator confirms the buzzer is audible.
Calibration Check 02 Kickstart	The RCS performs the Calibration Check to evaluate the breath volume to determine a PASS/FAIL result for the O2 Kickstart.
Calibration Check 02 System	RCS perform the Calibration Check to determine a PASS/FAIL result for the O2 system
Calibration Check Airway Pressure	The RCS performs the Calibration Check to determine a PASS/FAIL result for the Airway Pressure System.
Calibration Check Barometric Pressure	The RCS checks to see that the barometric pressure sensor in the device is accurate.
Calibration Check Compressor System	The RCS performs the Calibration Check to evaluate the Airflow, Intake and RPM to determine a PASS/FAIL result for the Compressor System.
Comm RAM and Bootloader Check	The RCS 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).
Compressor Bypass Protection	The RCS verifies that the compressor bypass protection mechanism is functional by imposing the fault condition and then verifying recovery from the fault condition.

Test Name	Description
Compressor Calibration	Tests and records the effort required of the compressor to produce a target flow. Using different gain values, the SPM drives the compressor while the TSI Flow Module measures the output flow and communicates it to the RCS. The RCS adjusts the gain values which results in the creation of the calibration table.
Conditional PM Due Reset	The RCS resets the PM due date, if the calibration and functional checks are successful.
Date and Time Check	The RCS verifies functionality of date and time in the device vs. laptop time.
Date and Time Set	The RCS sets the date and time in the device to the laptop time.
EMV Self Check	Check of the ventilator's core hardware, software and communications during power up.
Encoder Check	The RCS 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.
Exhalation Backup and Autocal Valve	The RCS verifies that the Exhalation Valve, Backup Valve and Autocal Valve are tubed correctly can switch completely and can switch with an acceptable delay.
Final Configuration	Downloads the selected configuration into the ventilator and confirms firmware revisions.
LCD Contrast Set	The RCS confirms contrast adjustability by prompting the operator to adjust the contrast.
LCD Visual Inspection	The RCS guides an operator through a visual inspection of the LCD and acquire operator confirmation that the display is defect free.
LED Check	The RCS checks that all Front Panel LEDs are functional and the correct color by sending test mode commands to the device to selectively illuminate the LED being tested
Li-Ion Battery Check	This test verifies that the device can charge and discharge the Li-Ion battery. The test will prompt the user to provide the proper test setup configuration. The test reads the device alarms to ensure there aren't any active power related alarms reported from the device.
Manifold Leak Check	The RCS 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.

Test Name	Description
O2 Leak Filter and Pressure Cal. Check	The RCS 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.
Power Switch Check	The RCS checks the functionality of the power switch. The switch is double pole, double throw, so each pole will be checked.
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 Blink	Operator confirmation that Alarm #1173, Red LEDs and buzzer are activated within 15 seconds.
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 RCS indicates a failure.
Total Power Failure Alarm Check	The RCS verifies the 120s total power failure alarm circuitry.
TSI Calibration Check	The date of the last calibration, the ambient temperature and the altitude of test are all properties checked for this test.
Verify UUT and Reference device	The RCS checks for reference device and UUT serial numbers during a test to ensure the UUT and/or reference device are not swapped.

Test Sequences, RCS 9.1

Service Actions

	Read Forensic Memory	Calibrations	System Tests	Erase Forensic Memory	Final Configuration
Power Switch Check			•		
EMV Self Check			•		
LCD Contrast Set			•		
LCD Visual Inspection			•		
Button 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		•			

	Read Forensic Memory	Calibrations	System Tests	Erase Forensic Memory	Final Configuration
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			•		
Erase Forensic Memory				•	
Final Configuration					•

Troubleshooting

	Calibration Checks	SPM Functional Checks	Battery and Power System Tests	Front Case Tests	Pulse Ox Test
Comm RAM and Boot-loader Checker				•	
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 Self Check	•	•			
SPM Blink		•			
TSI Calibration Check	•	•			
Exhalation Backup and Autocal Valve		•			
Calibration Check Baro-metric Pressure	•	•			
Compressor Calibration		•			
Calibration Check Com-pressor System	•	•			
Airway Pressure Cali-bration		•			
Calibration Check Air-way Pressure	•	•			

	Calibration Checks	SPM Functional Checks	Battery and Power System Tests	Front Case Tests	Pulse Ox Test
O2 Kickstart Calibration		•			
Calibration Check O2 Kickstart	•	•			
O2 Flow Calibration		•			
Calibration Check O2 System	•	•			
O2 Leak Filter and Pressure Cal. Check		•			
Manifold Leak Check		•			
Compressor Bypass Protection		•			
Breath Performance Check		•			
Download Calibration Tables		•			
Verify UUT and Reference Device		•			

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. See “Annual & 4 Year Service Kits” on page 3-3 for additional information, or contact ZOLL 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 Inlet with 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 anti-static 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

The Oxygen Inlet is fastened by three screws located on the Top Connector Panel. The filter is embedded within the Oxygen Inlet.

NOTE

The Oxygen Filter requires annual replacement.

Scan or click QR code to watch a video walk-through of this procedure	

Required Equipment

- 1 Year Service Kit
- #2 Phillips screwdriver
- torque driver

Removal Procedure

1. 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 top connector panel of the ventilator.
3. Lift and remove the Oxygen Inlet fitting.

Replacement Procedure

1. Before replacing the Oxygen Inlet fitting, 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 its screw holes properly aligned with the holes in the ventilator's top connector panel. **Ensure the chain is facing the gas output fitting.**
3. Using a torque driver set to 19 in-lbs (2.14 newton meters), fasten the three 8-32 flathead screws which secure the Oxygen Inlet fitting to the ventilator's top connector panel.

Disk Filter Replacement

The Fresh Gas/Emergency Air Intake Disk Filter is located behind the B/V filter holder. This filter provides 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 Fresh Gas/ Emergency Air Intake Disk Filter becomes 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.

NOTE

The Disk Filter requires annual replacement.

Scan or click QR code to watch a video walk-through of this procedure	

Required Equipment

- 1 Year Service Kit
- Tweezers or hemostats
- #2 Phillips screwdriver
- torque driver

Removal Procedure

1. Position the ventilator on its side so that the Fresh Gas/Emergency Air Intake is facing upward.
2. Using a #2 Phillips screwdriver, remove the four 8-32 flathead screws securing the Fresh Gas/ Emergency Air Intake to the ventilator chassis.
3. Lift and remove the Fresh Gas/Emergency Air Intake.
4. Using tweezers, grasp the disk filter and lift to remove it.

Replacement Procedure

1. Using tweezers, lower the disk filter into place and ensure it is properly seated.
2. Insert the Fresh Gas/Emergency Air 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 meters), replace the four 8-32 flathead screws.
4. Ensure there is no foam filter in the Fresh Gas pathway.

Main Battery Replacement

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

New batteries are shipped at 30% state of charge in compliance with IATA/DOT UN 38.3 mandates.

Scan or click QR code to watch a video walk-through of this procedure	

Required Equipment

- 4 Year Service Kit or Battery Replacement Kit
- torque driver with #1 and #2 Phillips head bits

Removal Procedure

For complete written instructions, refer to the section “4 Year Maintenance Kit” on page 4-30 within the service kits chapter.

RTC Battery Replacement

The Real-time Clock (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 device at start up if the RTC battery is less than or equal to 2.5 VDC.

NOTE

If Service Code #3110 “RTC Battery Low” displays at device start up, device functionality and performance are unaffected. However, the RTC battery should be replaced as soon as possible.

Scan or click QR code to watch a video walk-through of this procedure	

Required Equipment

- 4 Year Service Kit
- #1 and #2 Phillips head screwdriver bits
- 3/8 inch Keps nut bit
- torque driver

Removal Procedure

For complete written instructions, refer to the section “4 Year Maintenance Kit” on page 4-30 within the service kits chapter.

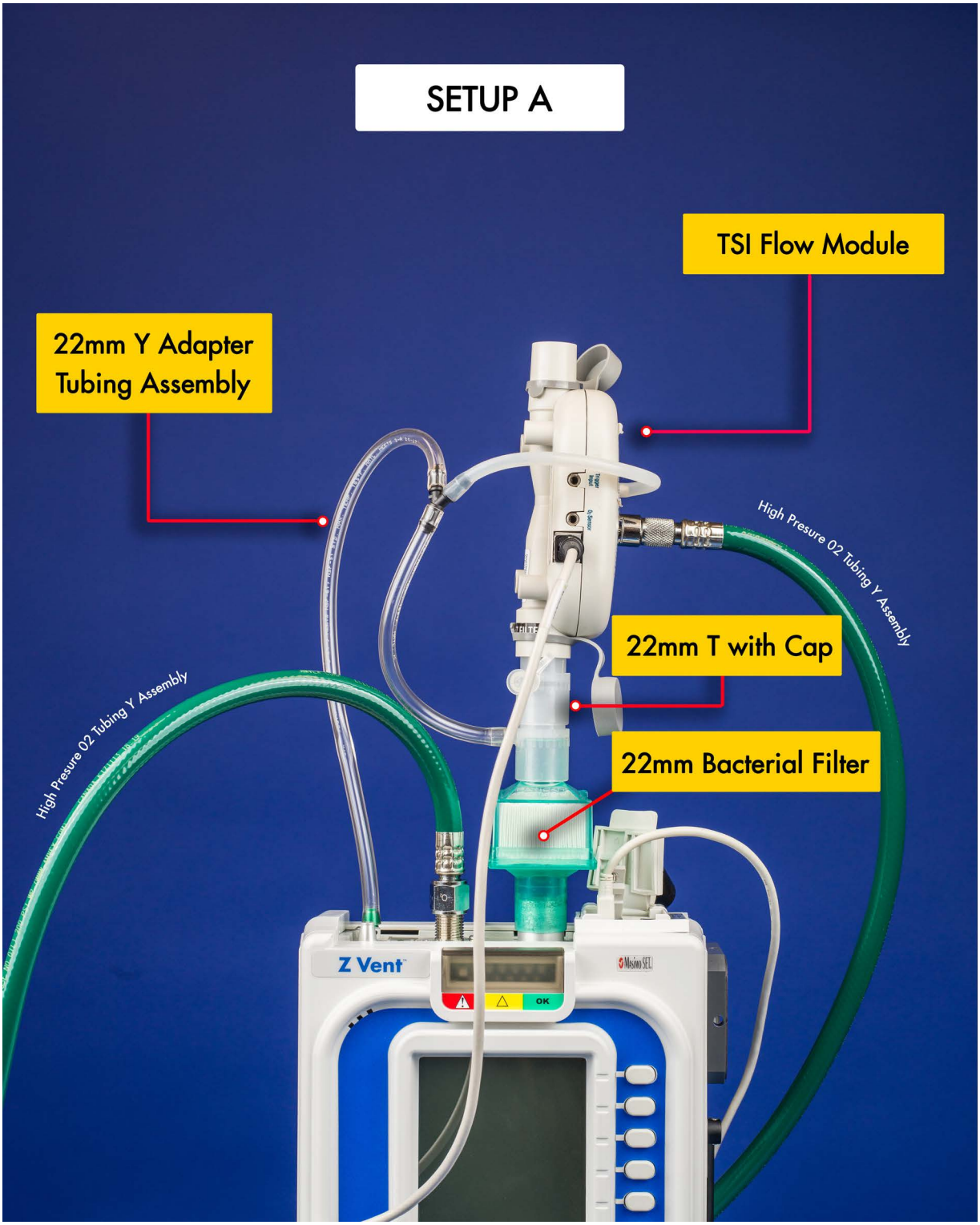
RCS Setups

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 use.

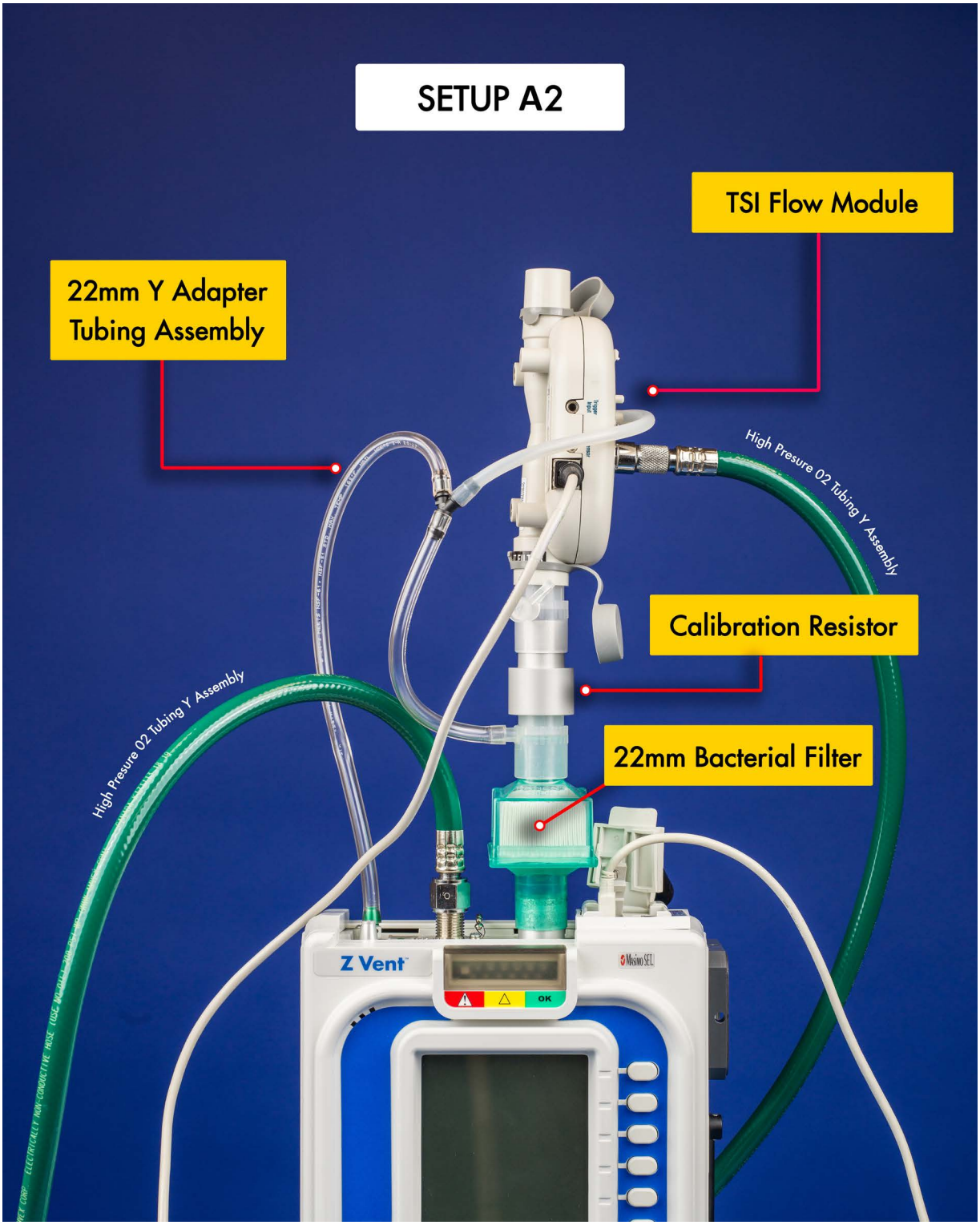
The following setup illustrations are listed below:

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

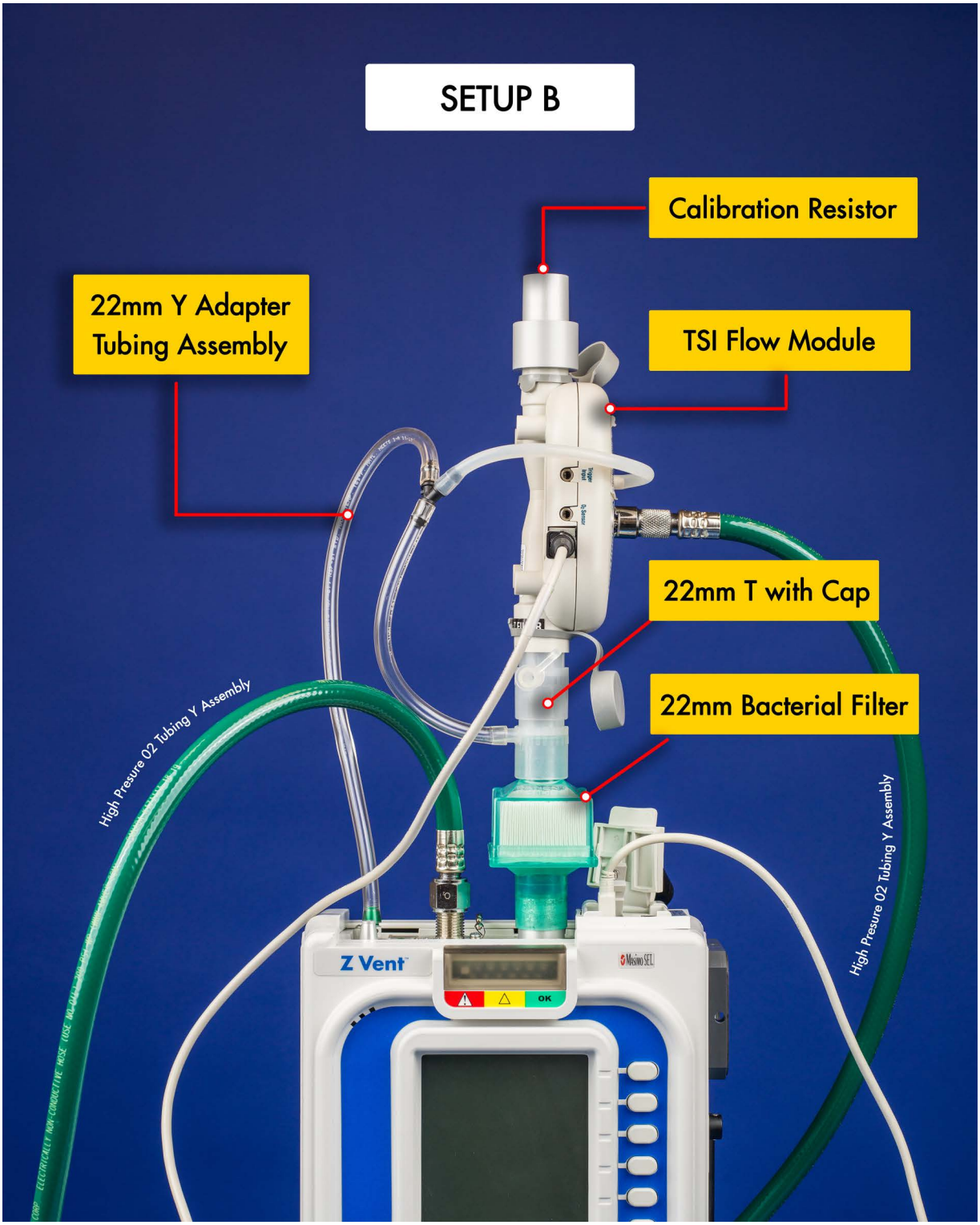
Setup A


SETUP A
TSI Flow Module
22mm Y Adapter Tubing Assembly
High Presure 02 Tubing Y Assembly
22mm T with Cap
22mm Bacterial Filter
High Presure 02 Tubing Y Assembly
Z Vent
OK

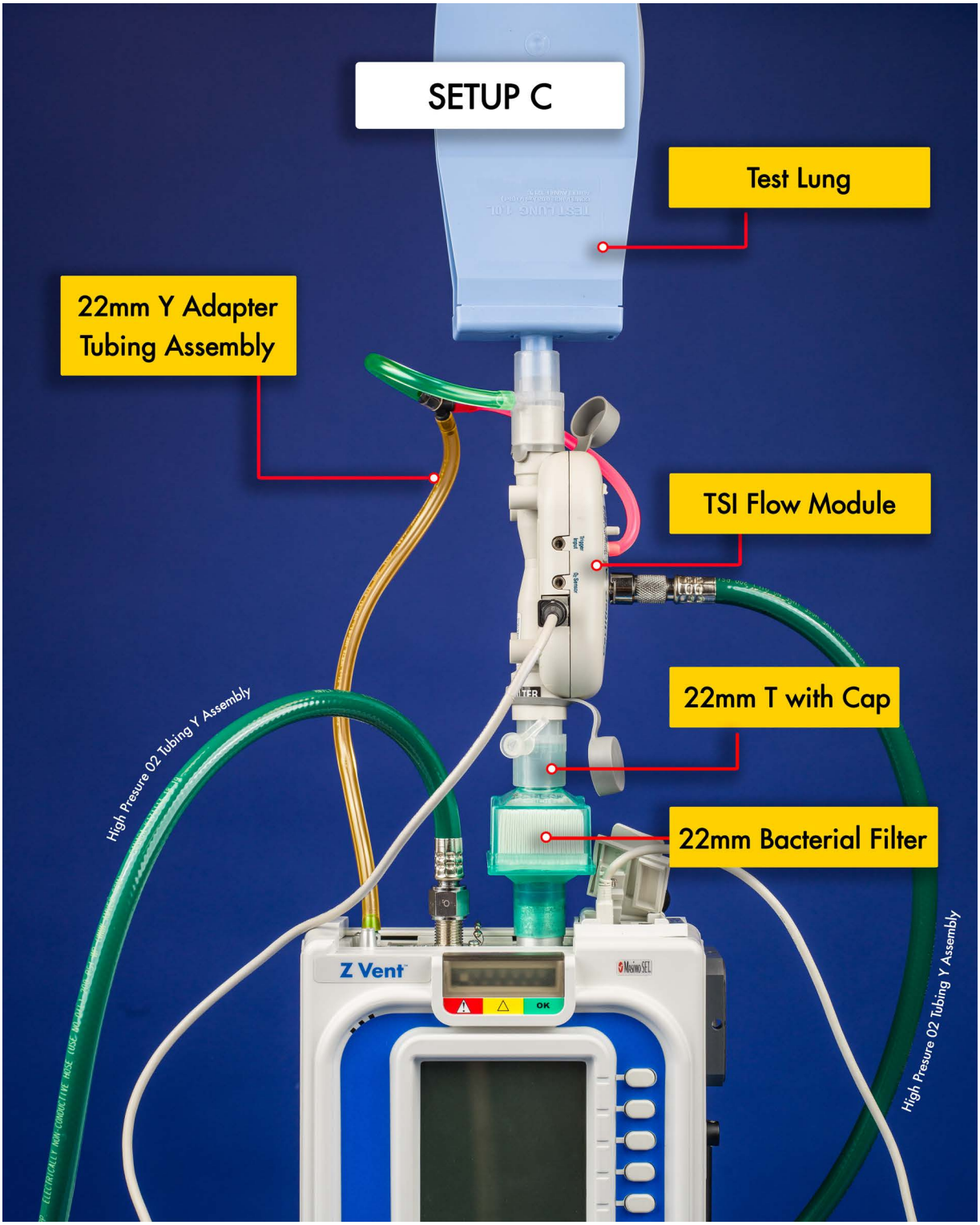
Setup A2


SETUP A2
TSI Flow Module
22mm Y Adapter Tubing Assembly
High Presure 02 Tubing Y Assembly
Calibration Resistor
High Presure 02 Tubing Y Assembly
22mm Bacterial Filter
Z Vent
OK

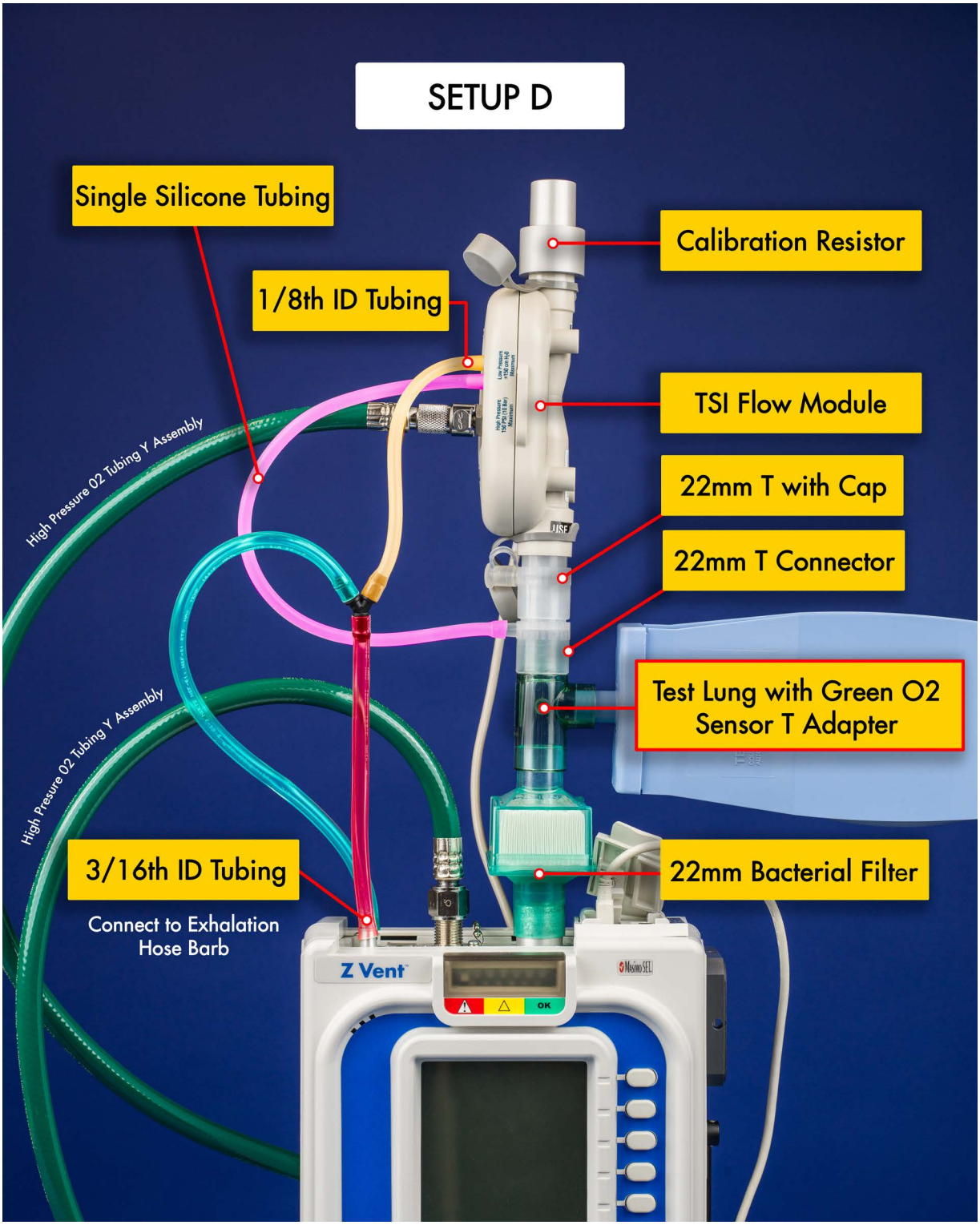
Setup B


SETUP B
Calibration Resistor
22mm Y Adapter Tubing Assembly
TSI Flow Module
22mm T with Cap
22mm Bacterial Filter
High Presure 02 Tubing Y Assembly
High Presure 02 Tubing Y Assembly
Z Vent
OK

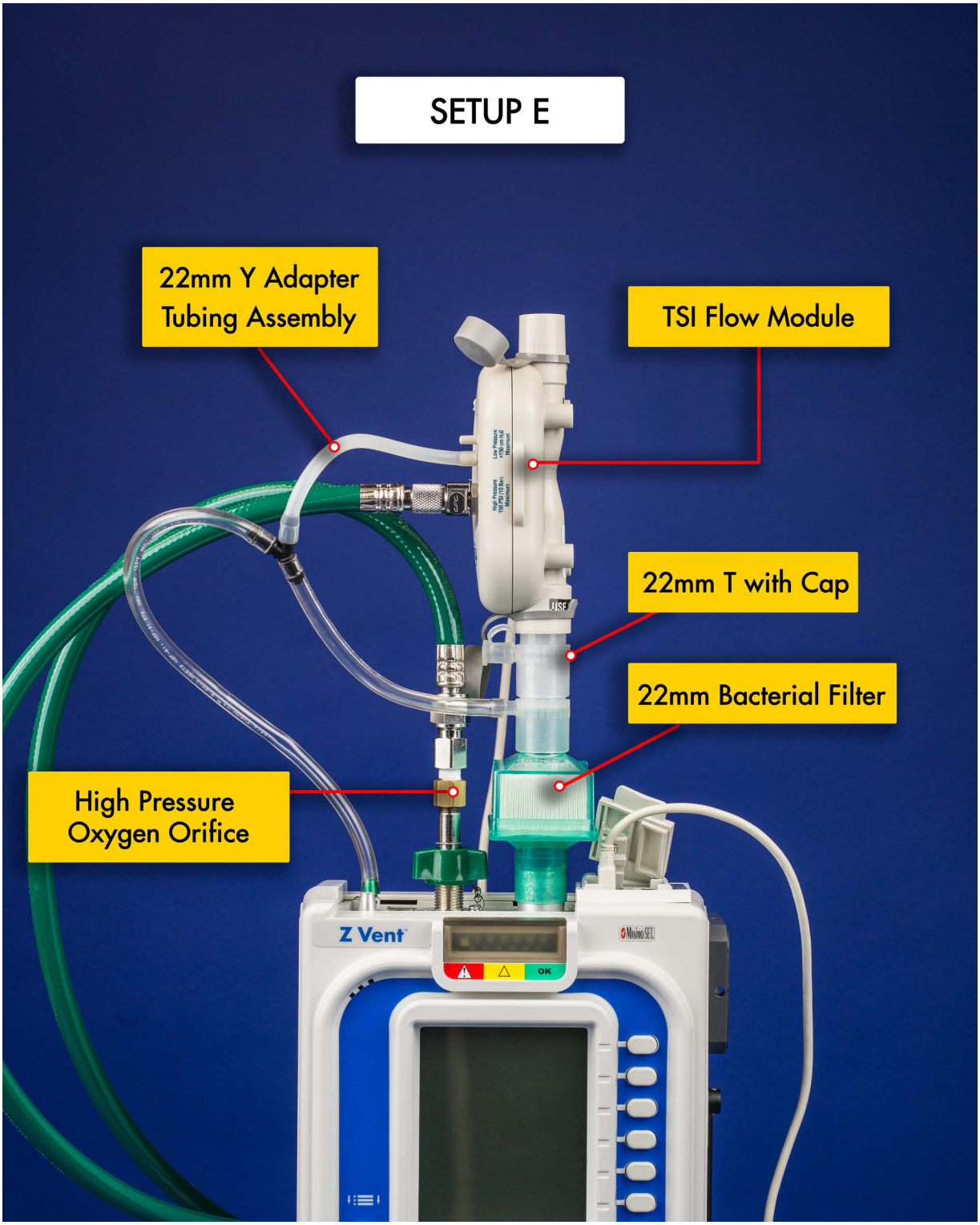
Setup C


SETUP C
Test Lung
22mm Y Adapter Tubing Assembly
TSI Flow Module
22mm T with Cap
22mm Bacterial Filter
High Presure 02 Tubing Y Assembly
High Presure 02 Tubing Y Assembly
Z Vent

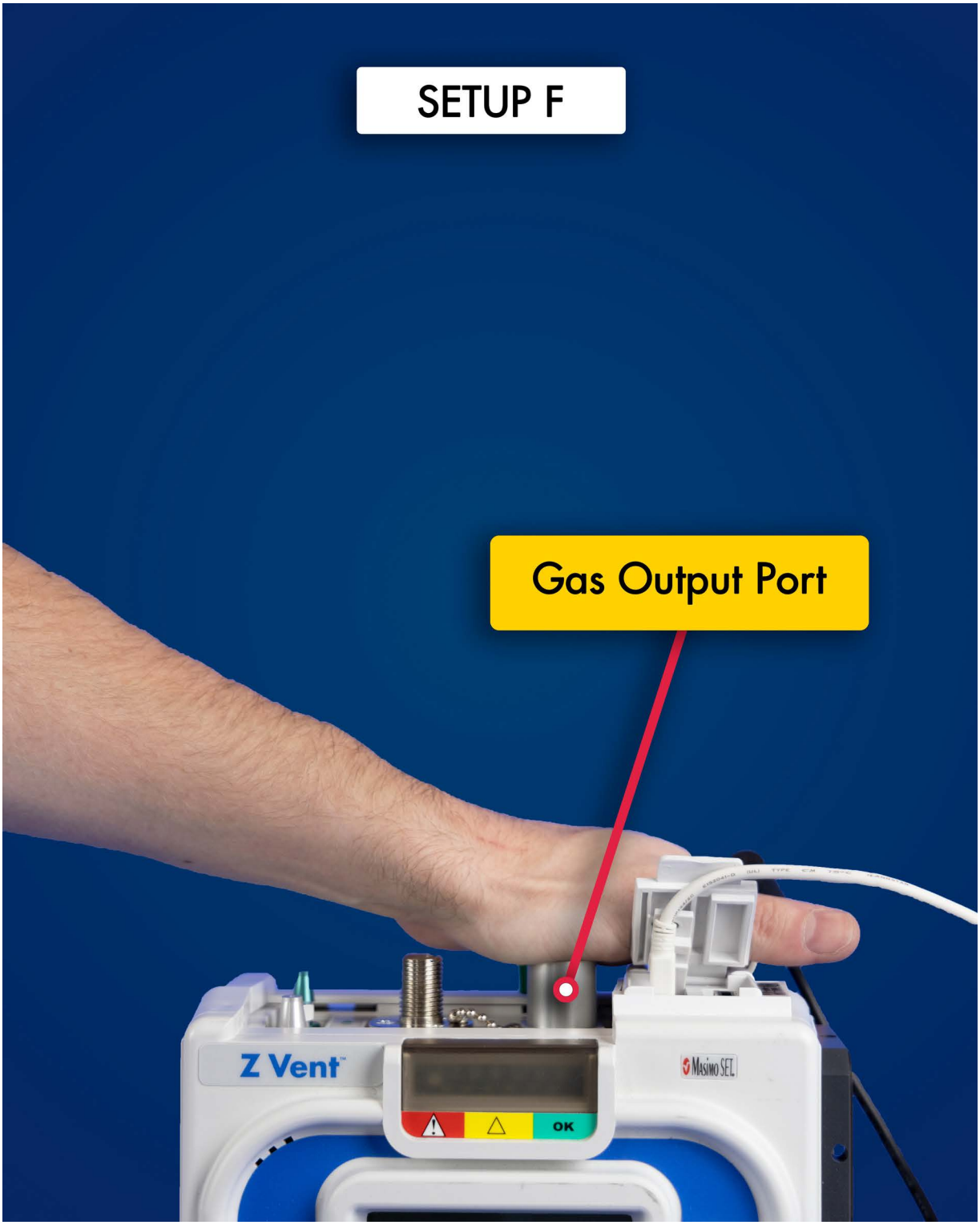
Setup D


SETUP D
Single Silicone Tubing
1/8th ID Tubing
Calibration Resistor
TSI Flow Module
22mm T with Cap
22mm T Connector
Test Lung with Green O2 Sensor T Adapter
22mm Bacterial Filter
3/16th ID Tubing
Connect to Exhalation Hose Barb
High Pressure O2 Tubing Y Assembly
High Presure O2 Tubing Y Assembly
Z Vent
OK

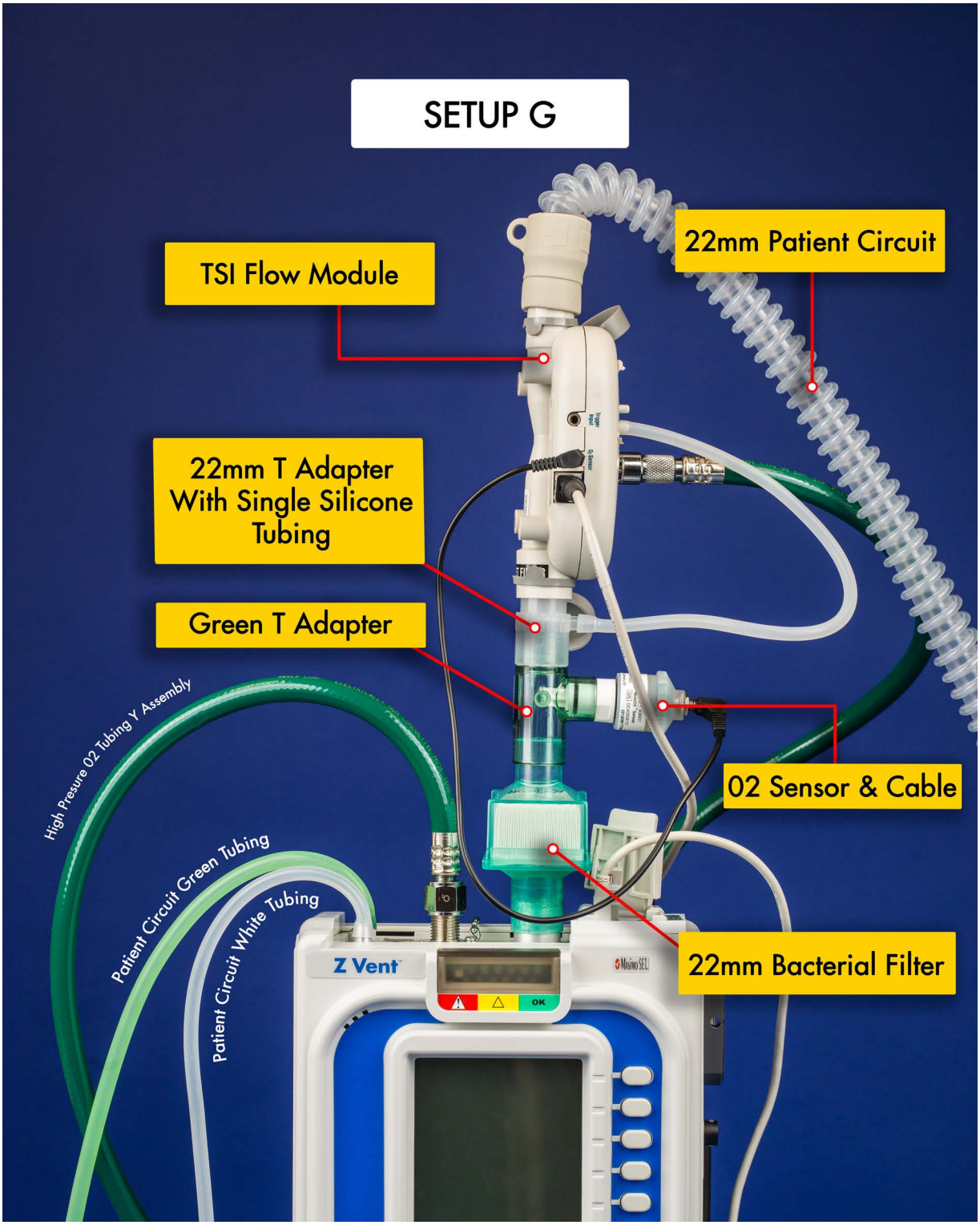
Setup E


SETUP E
22mm Y Adapter Tubing Assembly
TSI Flow Module
22mm T with Cap
22mm Bacterial Filter
High Pressure Oxygen Orifice
Z Vent
OK

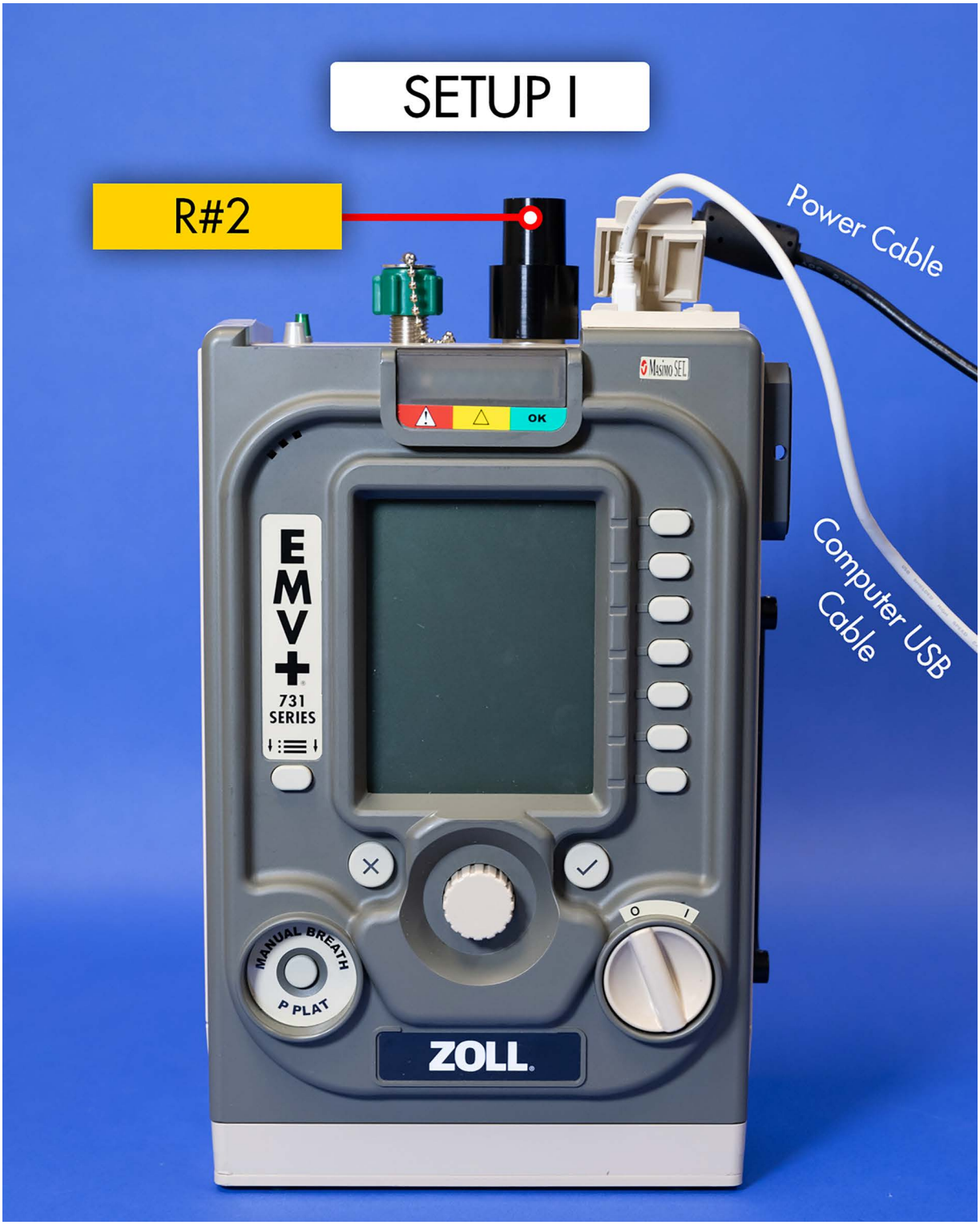
Setup F



Setup G


SETUP G
TSI Flow Module
22mm Patient Circuit
22mm T Adapter With Single Silicone Tubing
Green T Adapter
02 Sensor & Cable
22mm Bacterial Filter
High Presure 02 Tubing Y Assembly
Patient Circuit Green Tubing
Patient Circuit White Tubing
Z Vent
OK

Setup I


SETUP I
R#2
Power Cable
Computer USB Cable
OK
EMV+
731 SERIES
MANUAL BREATH
P PLAT
ZOLL

Setup K


Setup K
Pulse Oximeter Module
Power Cable
Computer USB Cable
OK
EMV+
731 SERIES
MANUAL BREATH
P PLAT
ZOLL

Setup L


SETUP L
Power Cable
RCS Laptop
Computer USB Cable
DELL
ZOLL
EMV+
731 SERIES

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 trained and certified service personnel. For information on the 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
- Service Kit installation instructions, warnings, and cautions

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 Guide

⚠ 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, wipe them clean and then reapply the anti-vibration compound (Part No. 602-0006-00). Some kits require the RTV silicone sealant be reapplied (ZOLL PN: 0550-0099).

Service Kits Requiring Electrical Safety Testing

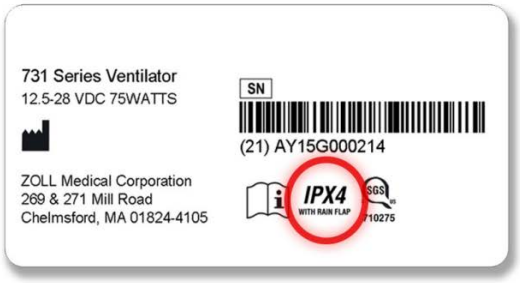
Per the NFPA 99 standard, any service kit installation procedure which requires opening the device should be followed by electrical safety testing. However, this **does not** apply to replacing

the filter in the Fresh Gas pathway nor does it apply to removing the main battery compartment cover. For further instruction, see “Electrical Safety Testing Procedure” on page 5-3.

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 between 3rd and 4th generation devices.

3rd Edition



4th Edition



Service Kits — EMV+ NON-MRI Version

Kit	EMV+	EMV+ V5	EMV+ V5 4th Edition	
			Non-RoHS	RoHS
4 Year PM Kit	712-0731-21	712-0731-35	712-0731-35	
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 Case Bottom Cover Kit	712-0731-09	712-0731-09	712-0731-09	
Battery Compartment Kit	712-0731-03	712-0731-03	712-0731-03	
Battery Replacement Kit	703-0731-01-01	703-0731-01-01	703-0731-01-01	
Bezel Assembly Kit	712-0731-28	712-0731-28-LL	712-0731-28-LL	712-0731-28-LL
Compressor Assembly	7772-000037-01	7772-000037-01	7772-000037-01	712-1731-26-01
Connector Panel Kit	712-0731-11	712-0731-31	712-0731-31-04	712-1731-03-00
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14	712-0731-14-04	712-1731-06-00
EMV Chassis Kit	712-0731-10	712-0731-10	712-0731-10	
Flow Screen Kit	712-0731-41	712-0731-41	712-0731-41	
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	712-1731-13-00
Gas Output Kit	712-0731-16	712-0731-16	712-0731-16	
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 Input Kit	712-0731-17	712-0731-17	712-0731-17-04	712-1731-07-00

Kit	EMV+	EMV+ V5	EMV+ V5 4th Edition	
			Non-RoHS	RoHS
Power Interface Module Kit	702-0731-02	702-0731-02	702-0731-02	
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	712-1731-01-00
SPM Board With Tubing	7772-000038-01	7772-000038-01	7772-000038-01	712-1731-25-01
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	
			Non-RoHS	RoHS
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	712-0731-12-LL
Battery Case Bottom Cover Kit	712-0731-09	712-0731-09	712-0731-09	
Battery Compartment Kit	712-EGL2-13	712-EGL2-13	712-EGL2-13	
Battery Replacement Kit	703-0731-01-01	703-0731-01-01	703-0731-01-01	
Bezel Assembly Kit	712-0731-28	712-0731-28-LL	712-0731-28-LL	712-0731-28-LL
Compressor Assembly	7772-000037-01	7772-000037-01	7772-000037-01	712-1731-26-01
Connector Panel Kit	712-0731-11	712-0731-31	712-0731-31-04	712-1731-03-00
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14	712-0731-14-04	712-1731-06-00
EMV Chassis Kit	712-0731-10	712-0731-10	712-0731-10	
Flow Screen Kit	712-0731-41	712-0731-41	712-0731-41	
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	712-1731-13-00
Gas Output Kit	712-0731-16	712-0731-16	712-0731-16	
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 Input Kit	712-0731-17	712-0731-17	712-0731-17-04	712-1731-07-00

Kit	EMV+ MRI	EMV+ MRI V5	EMV+ MRI V5 4th Edition	
			Non-RoHS	RoHS
Power Interface Module Kit	702-0731-02	702-0731-02	702-0731-02	
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	712-1731-01-00
SPM Board With Tubing	7772-000038-01	7772-000038-01	7772-000038-01	712-1731-25-01
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 Case Bottom Cover Kit	712-0731-09	712-0731-09
Battery Compartment Kit	712-0731-03	712-0731-03
Battery Replacement Kit	703-0731-01-01	703-0731-01-01
Bezel Assembly Kit	712-AEV1-06	712-AEV1-06-LL
Compressor Assembly	7772-000037-01	7772-000037-01
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
Flow Screen Kit	712-0731-41	712-0731-41
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
Oxygen Inlet Fitting Kit	712-0731-34	712-0731-34
Oxygen Valve Assembly Kit	712-0731-42	712-0731-42
Power Input Kit	712-0731-17	712-0731-17
Power Interface Module Kit	702-0731-02	702-0731-02
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
SPM Board With Tubing	7772-000038-01	7772-000038-01
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
Compressor Assembly	7772-000037-01	7772-000037-01
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
SPM Board With Tubing	7772-000038-01	7772-000038-01
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
Compressor Assembly	7772-000037-01	7772-000037-01
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
SPM Board With Tubing	7772-000038-01	7772-000038-01
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	
			Non-RoHS	RoHS
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	712-EMBP-28-LL
Compressor Assembly	7772-000037-01	7772-000037-01	7772-000037-01	712-1731-26-01
Connector Panel Kit	712-EMBP-31	712-EMBP-31	712-EMBP-31-04	712-1731-04-00
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14	712-0731-14-04	712-1731-06-00
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	712-1731-13-00
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	

Kit	Z-Vent NON MRI Basic	Z-Vent NON MRI	Z-Vent NON MRI 4TH EDITION	
			Non-RoHS	RoHS
Power Input Kit	712-0731-17	712-0731-17	712-0731-17-04	712-1731-07-00
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-EMBP-02-04	712-1731-02-00
SPM Board With Tubing	7772-000038-01	7772-000038-01	7772-000038-01	712-1731-25-01
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

Kit	Z-Vent MRI	Z-Vent MRI 4TH EDITION	
		Non-RoHS	RoHS
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	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	712-EMBP-28-LL
Compressor Assembly	7772-000037-01	7772-000037-01	712-1731-26-01
Connector Panel Kit	712-EMBP-31	712-EMBP-31-04	712-1731-04-00
CPU/UIM and SpO_2 Stack Kit	712-0731-14	712-0731-14-04	712-1731-06-00
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	712-1731-13-00
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	712-1731-07-00
Power Knob Kit	392-0071-02	392-0071-02	
Selector Knob Kit	712-EMBP-27	712-EMBP-27	

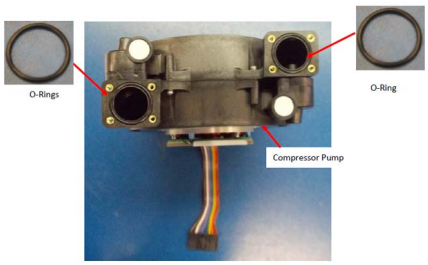
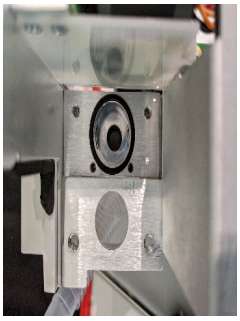
Kit	Z-Vent MRI	Z-Vent MRI 4TH EDITION	
		Non-RoHS	RoHS
Smart Pneumatic Module (SPM)/Vent Assembly Kit	712-EMBP-02-01	712-EMBP-02-04	712-1731-02-00
SPM Board With Tubing	7772-000038-01	7772-000038-01	712-1731-25-01
UIM Adapter PCB Assembly Kit	712-0731-38	712-0731-38-04	
USB Connector Kit	712-0731-15	712-0731-15	
USB Connector Plate Kit	712-EMBP-07	712-EMBP-07	

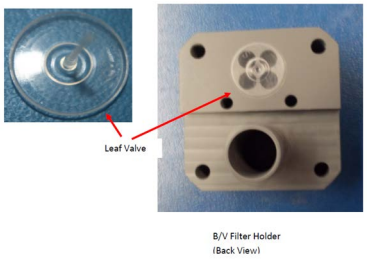
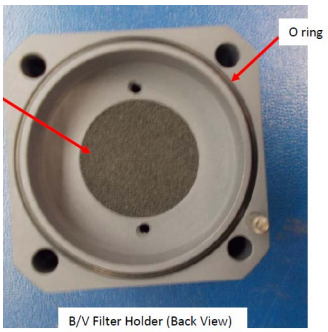
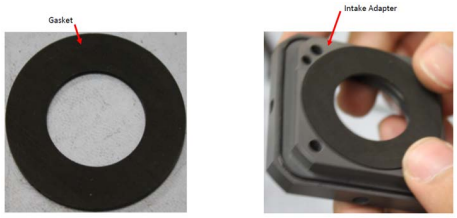
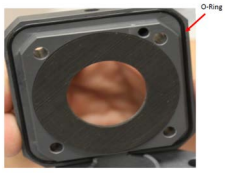
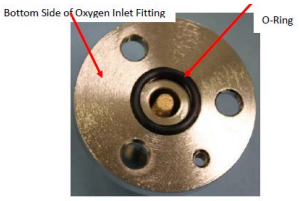
Bulk Supplies

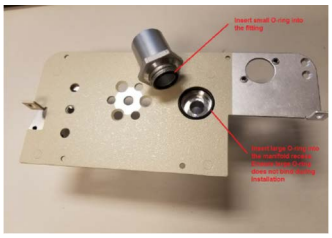
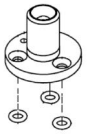
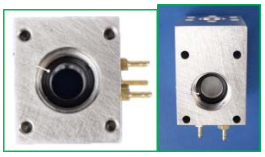
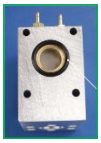
Refer to the table below for a list of supplies to have on hand if regularly servicing 731 series ventilators.

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, 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

Bulk Supplies - Screws & Nuts			
PN	Qty	Location	Type
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	

Bulk Supplies - Components				
Part Number	Qty	Part Type	Location	Picture
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 Adap-tor	
340-0055-00	1	O-Ring	Intake Adap-tor	
340-0023-00	2	O-Ring	Manifold/ Connector Panel	 

Bulk Supplies - Components				
Part Number	Qty	Part Type	Location	Picture
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 sealant	All Screws	
600-0005-00	AR	Loctite	High Pressure O2 Hose	

Bulk Supplies - Components				
Part Number	Qty	Part Type	Location	Picture
0550-0099	AR	RTV silicone sealant	SPO2/USB Connectors	
540-0215-00	AR	High Pressure O2 Tubing	O2 Manifold/ O2 Tank XDCR	
465-0027-00	1	FILTER, DISK, FRESH GAS/ EMERGENCY AIR INTAKE,INDIVIDUALLY BAGGED	Fresh Gas/ Emergency Air Intake	
8731-000001	1	Red Dust Cap	Gas Out	

Torque Specification Guide

Refer to the torque specifications listed 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

Screw/Nut/ Component	Quantity	Screw/Nut Size	Maximum Torque (in-lb)	Maximum Torque (Nm)
USB Cable	2	4-40 X 3/16"	2.5	0.3
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 bot-tom	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/Spac-ers	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 stiff-ener 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

Screw/Nut/ Component	Quantity	Screw/Nut Size	Maximum Torque (in-lb)	Maximum Torque (Nm)
B/V Filter Holder Base to Mix Manifold	2	6-32 X 1/2"	5	0.6
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
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

Screw/Nut/ Component	Quantity	Screw/Nut Size	Maximum Torque (in-lb)	Maximum Torque (Nm)
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

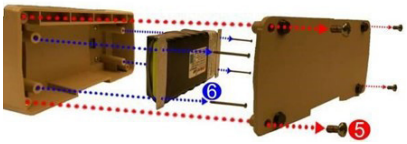
Required Tools and Materials

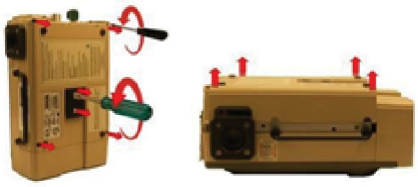
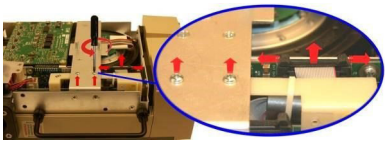
- Torque driver with #1 and #2 Phillips bits
- Nut driver set

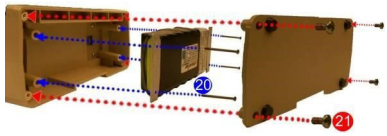
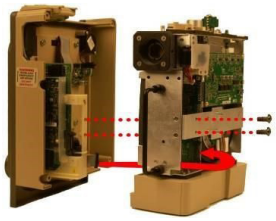
Kit Contents

- (1) Smart Pneumatic Module/Vent Assembly

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake. **NOTE** Additional loosening may cause the filter disk to slip out of place.	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch. Save these screws.	
4	Remove the (4) 6-32 x 5/16 Phillips screws to remove the battery compartment case. Save these screws.	

Step	Action	
5	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator. **NOTE** You may need to cut through stickers/labels that are holding the case halves together.	
6	Remove the (2) 4-40 x 1/4 pan head screws securing the CPU Stack Frame to 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.	
7	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
8	Rotate battery compartment to mate with upper and lower case cutouts and press firmly into place. Secure it with the (4) 6-32 x 5/16 screws provided.	
9	Reassemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it is locked in place), then tighten the (4) 6-32 x 2-1/4 screws.	

Step	Action	
10	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	
11	Place the front case assembly over the ventilator module and tighten the (2) 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.	
12	Attach the back case to the ventilator module and align cover with handle, air intake housing and dovetail mounting studs. Insert and tighten the (4) 6-32 x 2” screws and then the (2) 10-32 Keps nuts (provided in the kit).	
13	Tighten the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake.	
14	Use the RCS "Write" function to update the new part's serial number.	
15	Re-certify the ventilator using the RCS.	

Battery Replacement Service Kit Installation Instructions

Scan or click QR code to watch a video walk-through of this procedure	

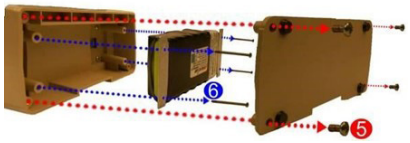
Required Tools

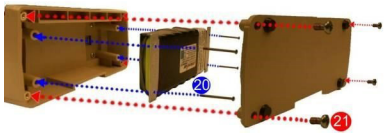
- Torque driver with #1 and #2 Phillips bits

Kit Contents

- (1) ASSY, BATTERY PACK, 6.6 AH, 14.8V, LITHIUM-ION, 12- CELL CONDITIONED

Instructions

Step	Action	
1	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
2	Remove the battery by removing the (4) 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 (4) 6-32 x 2-1/4 screws.	

Step	Action	
4	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	
5	Re-certify the ventilator using the RCS	

Annual Maintenance Kit

Required Tools

- Torque driver with #1 and #2 Phillips bits

Kit Contents

Quantity	Description	Part Number
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	O2 INLET FITTING	712-0731-34
1	FILTER, DISK, FRESH GAS/EMERGENCY AIR INTAKE,INDIVIDUALLY BAGGED	465-0027-00

Instructions

Disk Filter Replacement	Oxygen Inlet Fitting Replacement
Scan or Click for Video	Scan or Click for Video

4 Year Maintenance Kit

Kit Numbers

See Service Kits table.

Required Tools

- Torque driver with #1 and #2 Phillips bits

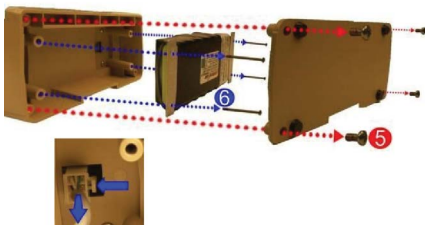
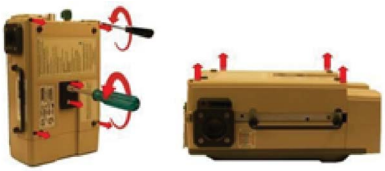
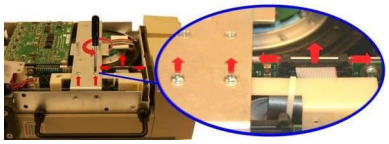
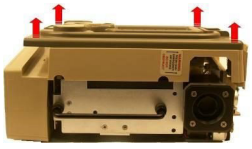
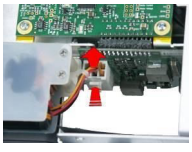
Kit Contents

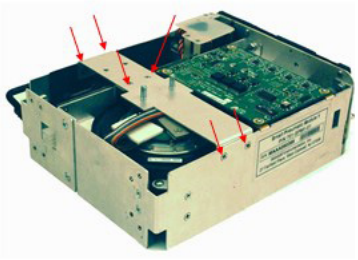
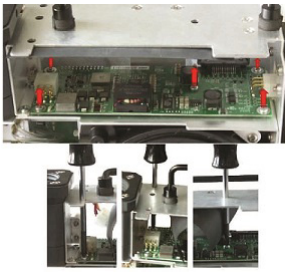
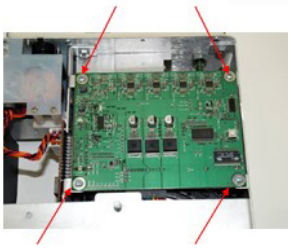
Quantity	Description	Part Number
1	BATTERY, COIN TYPE, 3.0V, 560 mAh, 23MM DIA, LITHIUM	021-0023-00
1	ASSEMBLY,BATTERY PACK,6.6 AH,14.8V,LITHIUM-ION,12- CELL CONDITIONED	703-0731-01-01
1	Annual Maintenance Kit	712-0731-35

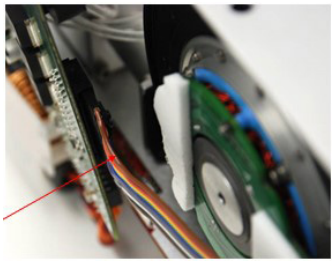
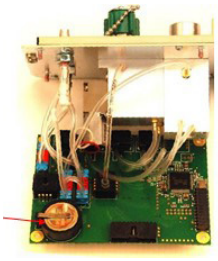
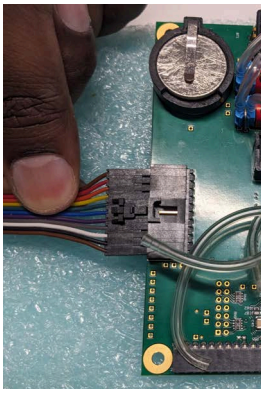
Instructions (see also “Annual Maintenance Kit” on page 4-29)

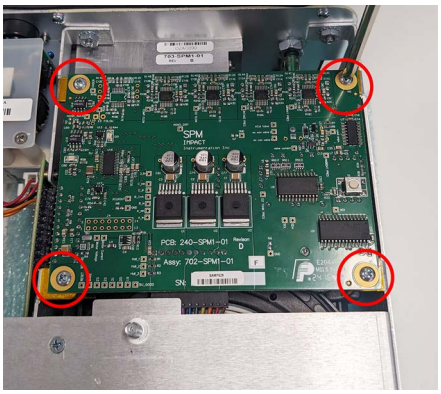
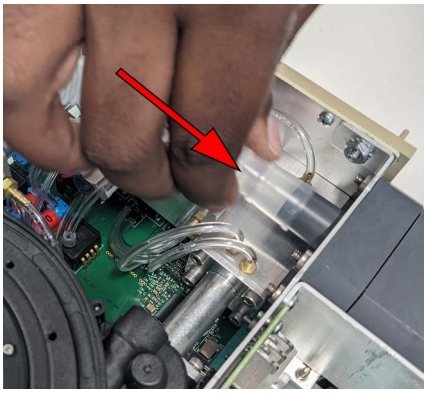
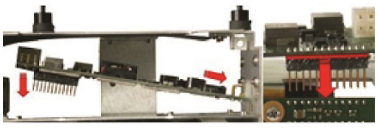
Main Battery Replacement		
1	See “Battery Replacement Service Kit Installation Instructions” on page 4-27.	Scan or Click for Video
RTC Battery Replacement		
2	See instructions that follow, or scan/click the QR Code to watch a video of this procedure.	Scan or Click for Video

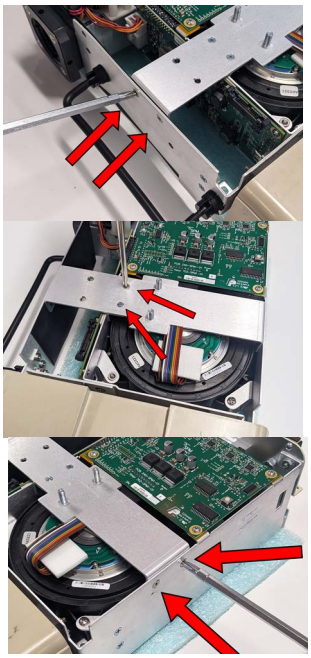
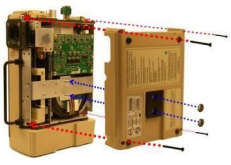
RTC Battery Replacement Instructions

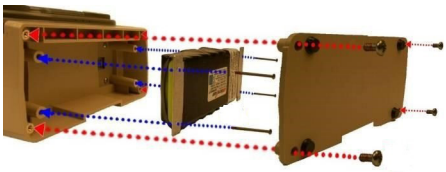
Step	Action	
1	Loosen by 1 full turn and do not remove the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake. **NOTE** Additional loosening may cause the filter disk to slip out of place.	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch. Save these screws.	
4	Position the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Remove the back case by lifting it from the ventilator.	
5	Remove the (2) 4-40 x 1/4 pan head screws securing the CPU Stack Frame to the Dovetail Mounting Bracket. Do not remove the two flathead screws. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
6	Flip the ventilator over and remove the front case assembly by lifting it straight up and away from the ventilator module.	
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	Action	
8	Remove the Dovetail Mounting Bracket by removing the (4) 6-32 x 1/4 flathead screws on the ends, and the (2) 4-40 x 1/4 flathead located near the middle of the bracket.	
9	Remove the (5) 4-40 x 1/4 screws holding the PIM board to the ventilator module. Save these screws. Move the SpO2 Insulator out of the way and insert screwdriver through the holes to aid in removing screws. Do not fold the SpO2 Insulator.	
10	Lift the PIM Board out of the ventilator module.	
11	Remove the corrugated hose connecting the Fresh Gas Intake to the Compressor intake port.	
12	Remove the (4) 4-40 x 1/4 screws fastening the SPM PCB to the SPM.	

Step	Action	
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. Then, without using tools, reload the tension on the battery well's retention clip. After that, slide the new RTC battery into place and ensure it is seated firmly in position. **NOTE** An RTC battery which is not seated firmly may result in ventilator errors.	 
16	Reconnect the Compressor cable to the SPM PCB and verify that it is locked in place.	

Step	Action	
17	Reattach the (4) 4-40 x 1/4 screws fastening the SPM PCB to the SPM.	
18	Verify all tubes are properly connected without loose ends or kinks. Then, reattach the corrugated hose to the Fresh Gas Intake base and the compressor intake port.	
19	Reposition the PIM Board. **NOTE** Make sure male header pins are inserted correctly into the mating header on the SPM PCB.	

Step	Action	
20	Reattach the Dovetail Mounting Bracket using the (4) 6-32 x 1/4 flathead screws on the ends and the (2) 4-40 x 1/4 flat-head located near the middle of the bracket. **NOTE** Make sure to insert the SPO2 insulator *between* the chassis and Dovetail Support bracket.	
21	Secure the PIM board to the SPM with the (5) 4-40 x 1/4 screws. Do not over-tighten the screws. (Maximum torque: 3.5 in-lb)	
22	Connect the Power Input Cable to the PIM board. Ensure the locking latch is secured.	
23	Place the front case assembly over the ventilator module and tighten the (2) 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.	
24	Attach the back case to the ventilator module and align cover with handle, air intake housing and dovetail mounting studs. Insert and tighten the (4) 6-32 x 2” screws and then the (2) 10-32 Keps nuts (provided in the kit).	

Step	Action	
25	Tighten the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake.	
26	Reassemble the battery by connecting its cable to the connector (pull lightly on the cable to ensure it is locked in place) then tighten the (4) 6-32 x 2-1/4 screws.	
27	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	
28	Power cycle the ventilator three times and verify the RTC Battery Low Alarm (#3110) is not triggered. Then, re-certify the ventilator using the RCS. **NOTE** Additional power cycles may be needed to clear a false RTC Battery Low Alarm. **NOTE** A PM Due Alarm (#3120) may occur and will be reset when the device is recalibrated.	

Battery Compartment Service Kit Installation Instructions

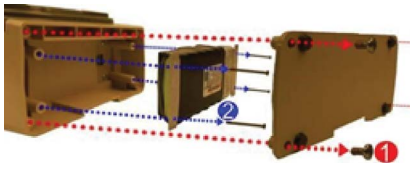
Required Tools

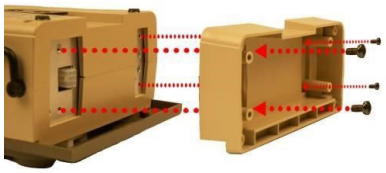
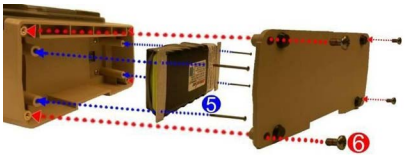
- Torque driver with #1 and #2 Phillips bits

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 removing the (4) 6-32 x 5/16 screws. Save these screws.	
2	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch. Save these screws.	

Step	Action	
3	Remove the (4) 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 (4) 6-32 x 5/16 screws provided.	
5	Reassemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it is locked in place) then tightening the (4) 6-32 x 2-1/4 screws.	
6	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	
7	Re-certify the ventilator using the RCS.	

USB Connector Plate Service Kit Installation Instructions

Required Tools

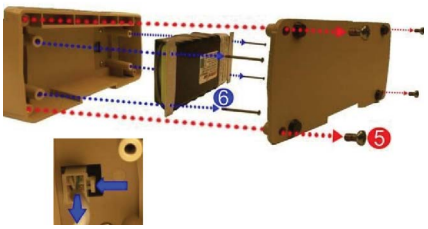
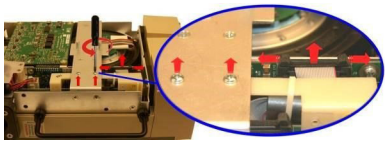
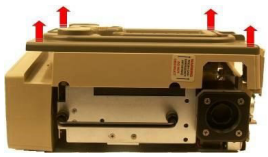
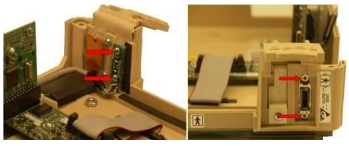
- Torque driver with #1 and #2 Phillips bits
- Nut driver set
- Small utility knife
- RTV silicone sealant

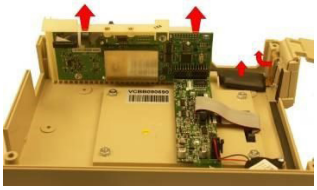
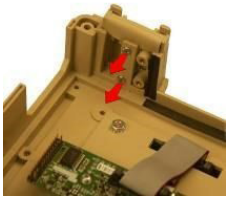
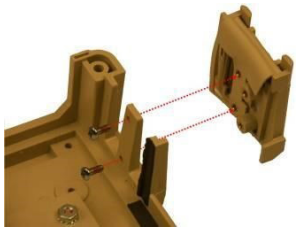
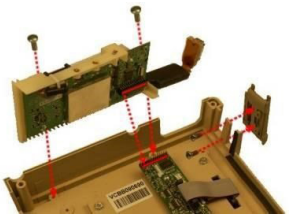
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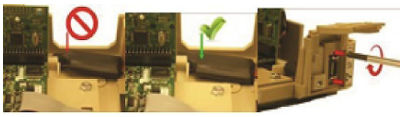
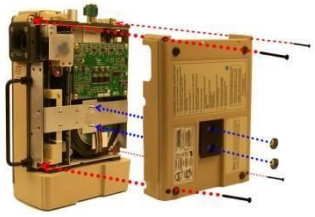
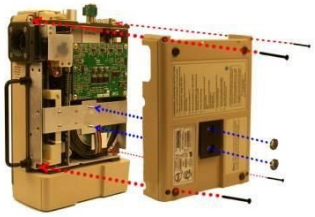
Quantity	Description	Depiction
1	USB Connector Plate Assembly	
2	Screw, Phillips, Pan Head, Zinc Plated 4-40 x 5/16	

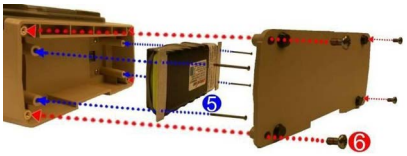
Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake. **NOTE** Additional loosening may cause the filter disk to slip out of place.	

Step	Action	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch. Save these screws.	
4	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator.	
5	Remove the (2) 4-40 x 1/4 screws securing the CPU Stack Frame to the Dovetail Mounting Bracket. Then, disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
6	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
7	Using a sharp knife, carefully cut the RTV sealant around the USB Printed Circuit Board and around the SpO2 Connector. Exercise caution not to cut either cable.	
8	Remove the (2) 4-40 x 3/16 screws fastening the Mini USB Cable Assembly to the front case. Remove the (2) M2.5 x 5mm screws holding the SpO2 connector to the front case.	

Step	Action	
9	Remove the (2) 6-32 x 5/16 screws that hold the CPU/UIM and SpO2 Stack to the front case.	
10	Lift the CPU/UIM and SpO2 Stack up from the front case. Handle the SpO2 cable with extreme care. Do not pull on the cable.	
11	Remove the (2) 4-40 x 5/16 screws holding the damaged USB Connector Plate to the front case.	
12	Insert and tighten the (2) 4-40 x 5/16 screws (provided in the kit) while holding the replacement USB Connector Plate to the front case. **NOTE** Note the proper position of the rubber SpO2 cover before tightening the screws.	
13	Carefully position the CPU/SPO2 Stack in place, ensuring that all the pins on the header mate correctly with the UIM header. Ensure the SPO2 ribbon cable is not pulled or tangled. Tighten the (2) 6-32 x 5/16 screws that fasten the CPU/SPO2 Stack to the Front Case.	

Step	Action	
14	Ensure the SpO2 Flex Cable lies flat against the front case, and verify it is assembled correctly into the UIM Bracket and SpO2 Isolation Shield. Insert and tighten the (2) M2.5 x 5mm screws holding the SpO2 cable to the front case.	
15	Remove any excess RTV sealant from the SpO2 flex cable and USB board. Tighten the (2) 4-40 x 3/16 screws holding the USB board to the front case. Apply RTV sealant to USB board and SpO2 flex cable. Allow to dry/cure.	
16	Place the front case assembly over the ventilator module and tighten the (2) 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.	
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 (4) 6-32 x 2” screws and then the (2) 10-32 Keps nuts.	
18	Tighten the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake.	

Step	Action	
19	Reassemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it is locked in place) then tightening the (4) 6-32 x 2-1/4 screws.	
20	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	
21	Perform PM process testing then re-certify the ventilator using the RCS	

Battery Case Bottom Cover Service Kit Installation Instructions

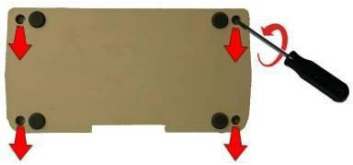
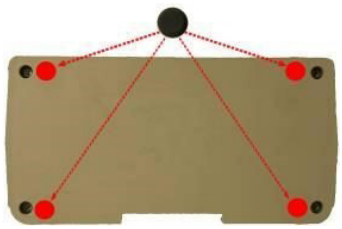
Required Tools

- 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 removing the (4) 6-32 x 5/16 screws.	
2	Remove backing from the bumper feet, then place one at each corner of the battery case bottom cover.	

Step	Action	
3	Rotate cover to align with the battery compartment, then insert and tighten the (4) 6-32 x 5/16 screws.	

EMV Chassis Service Kit Installation Instructions

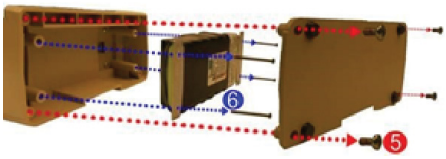
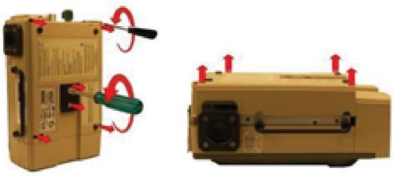
Required Tools

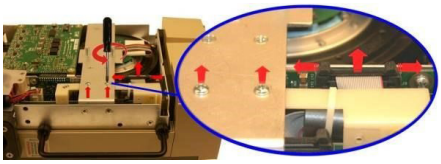
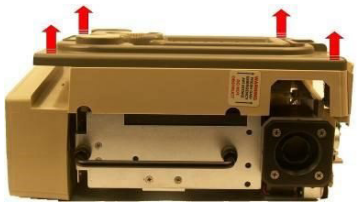
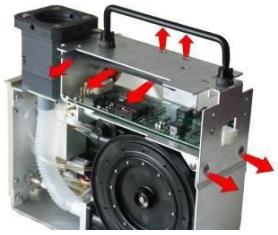
- Torque driver with #1 and #2 Phillips bits
- Nut driver set

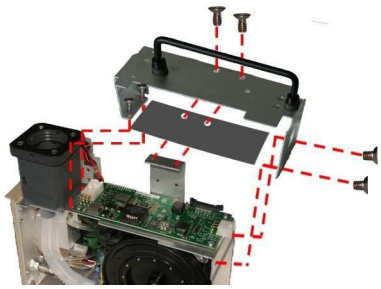
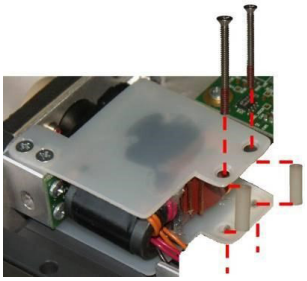
Kit Contents

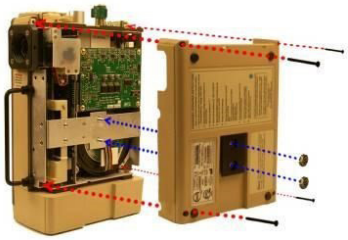
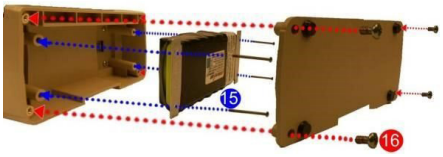
Quantity	Description	Depiction
1	EMV Chassis Assembly	
2	Screw, Phillips, Pan Head, SS, 6-32 x 5/16	
2	Screw, Phillips, Flat Head, 8-32 x 1/4, Undercut, ZP	
2	Screw, Phillips, Flat Head, 6-32 x 1/4, Undercut	
1	SpO_2 Insulator	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake. **NOTE** Additional loosening may cause the filter disk to slip out of place.	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch. Save these screws.	
4	Remove the (4) 6-32 x 5/16 Phillips screws to remove the battery compartment case. Save these screws.	
5	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator. **NOTE** You may need to cut through stickers/ labels that are holding the case halves together.	

Step	Action	
6	Remove the (2) 4-40 x 1/4 screws securing the CPU Stack Frame to the Dovetail Mounting Bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
7	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
8	Remove the (2) 4-40 x 1-1/4 screws and nylon spacers supporting the Power Input assembly unto the chassis. Save these screws and spacers.	
9	Remove the (2) 6-32 x 1/4 screws holding the chassis to the Dovetail Mounting Bracket and remove the SpO_2 insulator. Remove the (2) 8-32 x 1/4 screws holding the chassis to the ventilator module.	
10	Insert screwdriver through the holes in the chassis to remove the (2) 6-32 x 5/16 screws holding the chassis to the ventilator module.	

Step	Action	
11	Lift the damaged chassis from the ventilator module.	
12	Secure the replacement Chassis to the ventilator module using the (2) 6-32 x 1/4 screws (provided in the kit) with the SpO_2 insulator, the (2) 8-32 x 1/4 screws, and the (2) 6-32 x 5/16 screws.	
13	Secure the Power Input assembly to the Chassis using the two spacers and (2) 4-40 x 1-1/4 screws. Do not overtighten 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 (4) 6-32 x 5/16 screws provided.	
15	Place the front case assembly over the ventilator module and tighten the (2) 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	
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 (4) 6-32 x 2” screws and then the (2) 10-32 Keps nuts.	
17	Tighten the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake.	
18	Reassemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it is locked in place) then tightening the (4) 6-32 x 2-1/4 screws.	
19	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	
20	Re-certify the ventilator using the RCS.	

Connector Panel Service Kit Installation Instructions

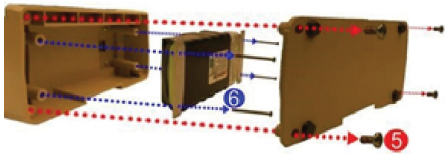
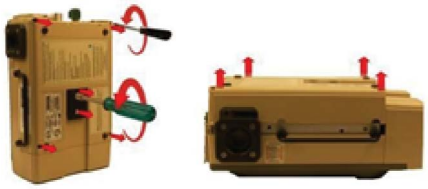
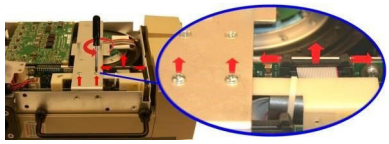
Required Tools

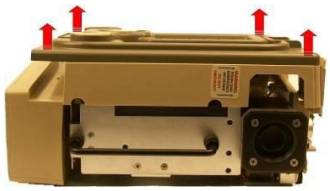
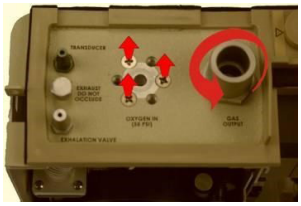
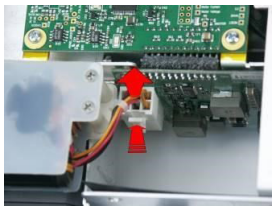
- Torque driver with #1 and #2 Phillips bits
- Nut driver set
- Needle-nosed pliers
- 5/16” open-ended wrench

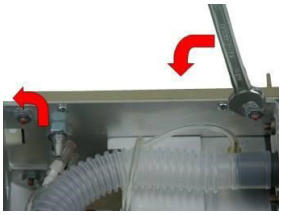
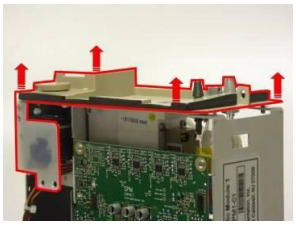
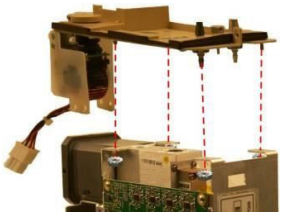
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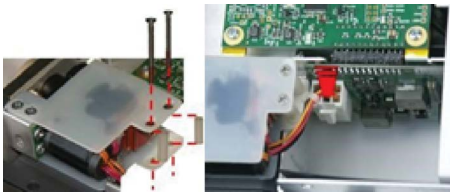
Quantity	Description	Depiction
1	Connector Panel Assembly	
3	8-32 x 1/4 Screw	
4	6-32 Keps Nut	
2	O-Ring 1/2” OD x 3/8” ID	

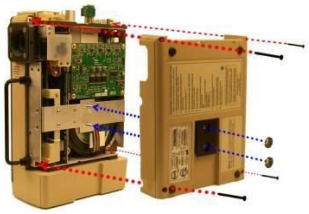
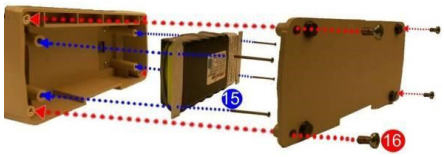
Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake. **NOTE** Additional loosening may cause the filter disk to slip out of place.	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch. Save these screws.	
4	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator. **NOTE** You may need to cut through stickers/ labels that are holding the case halves together.	
5	Remove the (2) 4-40 x 1/4 screws securing the CPU Stack Frame to 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	
6	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
7	Remove the oxygen inlet fitting (OXYGEN IN) by removing the dust cap and then removing the (3) 8-32 x 7/16 screws. Save these screws and o-rings.	
8	Remove the (3) 8-32 x 1/4 screws. Remove the gas output fitting (GAS OUT-PUT) using a socket wrench that has a 1 in. deep well socket. Save the fitting.	
9	Disconnect the Power Input cable by pressing on the locking latch and pulling the cable straight up from the connector.	
10	Remove the (2) 4-40 x 1-1/4 screws and nylon spacers supporting the Power Input assembly unto the chassis. Save these screws and spacers.	
11	Remove the (2) 6-32 Keps nuts using a 5/16 open-end wrench.	

Step	Action	
12	Using smooth jaw needle nose pliers, carefully remove the tubes on the following fittings: • "Transducer" • "Exhaust Do not Occlude" • "Exhalation Valve" Do not discard the tubing. **NOTE** It is advisable to mark each tube for easy identification during reassembly.	
13	Remove the (2) 6-32 Keps nuts using a 5/16 open-end wrench.	
14	Lift the damaged connector panel assembly out from the SPM.	
15	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.	
16	Position the replacement Connector Panel over the SPM.	

Step	Action	
17	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.	
18	Place the fitting and O-ring on the gas output (GAS OUTPUT) but do not tighten.	
19	Insert the 3 tubing to their correct connectors. • “V_BACKUP” to “Exhalation Valve” • “V_ACAL” to “Transducer” • “Exhaust Do Not Occlude” (smallest tubing)	
20	Place the oxygen inlet (OXYGEN IN) fitting over the connector panel, and then insert and tighten with the (3) 8-32 x 7/16 screws.	
21	Tighten the Gas Output with a socket wrench that has a 1 in. deep socket. Torque to 75 in-lbs. Do not cross thread.	
22	Secure the Connector Panel with (4) 6-32 Keps nuts (provided in the kit).	
23	Secure the Power Input assembly to the Chassis using the two spacers and (2) 4-40 x 1-1/4 screws. Do not overtighten the screws. (Maximum torque: 3.5 in.- lb.) Connect the Power Input cable by inserting into connector. Ensure that locking latch engages.	
24	Secure the connector panel to the ventilator module using the (3) 8-32 x 1/4 screws (provided in the kit).	

Step	Action	
25	Place the front case assembly over the ventilator module and tighten the (2) 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.	
26	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 (4) 6-32 x 2” screws and then the (2) 10-32 Keps nuts.	
27	Tighten the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake.	
28	Reassemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it is locked in place) then tightening the (4) 6-32 x 2-1/4 screws.	
29	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	
30	Re-certify the ventilator using the RCS.	

Back Case Service Kit Installation Instructions

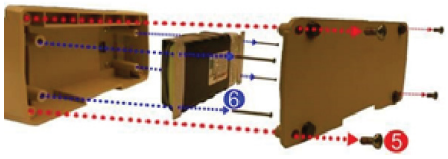
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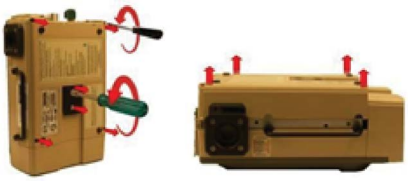
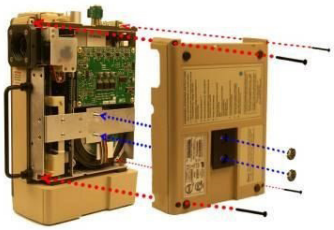
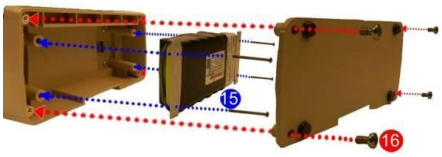
- Torque driver with #1 and #2 Phillips bits
- Nut driver set

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 (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake. **NOTE** Additional loosening may cause the filter disk to slip out of place.	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	

Step	Action	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch. Save these screws.	
4	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator. **NOTE** You may need to cut through stickers/ labels that are holding the case halves together.	
5	Place the replacement cover over ventilator. Then, align the cover with the handle, the air intake housing, and the dovetail mounting studs. Insert and tighten the (2) 10-32 Keps nuts (provided in the kit) and the (4) 6-32 x 2" screws.	
6	Tighten the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake.	
7	Reassemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it is locked in place) then tightening the (4) 6-32 x 2-1/4 screws.	
8	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	

Step	Action	
9	Re-certify the ventilator using the RCS.	

Power Interface Module Service Kit Installation Instructions

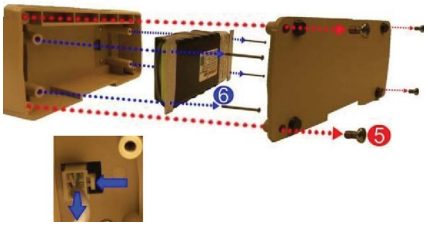
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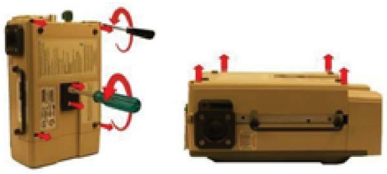
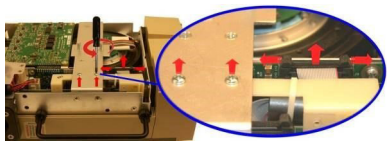
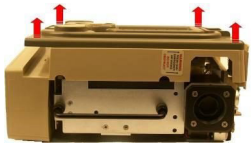
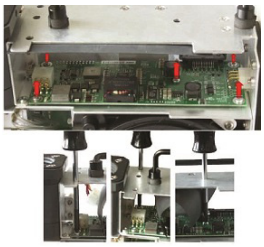
- Torque driver with #1 and #2 Phillips bits
- Nut driver set

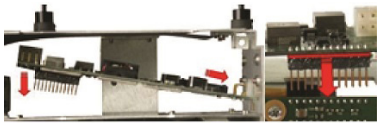
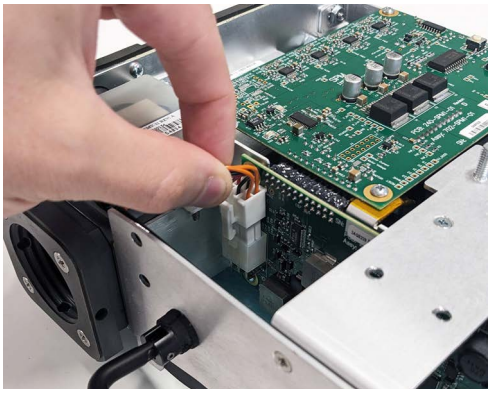
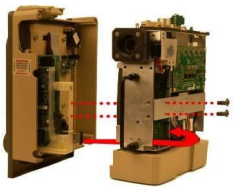
Kit Contents

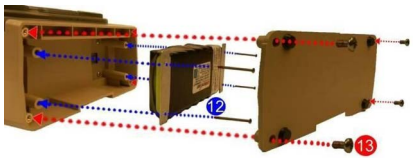
Quantity	Description	Depiction
1	PIM Board (PCB)	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake. ⓘ NOTE Additional loosening may cause the filter disk to slip out of place.	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch. Save these screws.	

Step	Action	
4	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator. **NOTE** You may need to cut through stickers/ labels that are holding the case halves together.	
5	Remove the (2) 4-40 x 1/4 screws securing the CPU Stack Frame to the Dovetail Mounting Bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
6	Flip the ventilator over and remove the front case assembly by lifting it straight up and away from the ventilator module.	
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	Remove the (5) 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. Do not fold the SpO_2 Insulator.	
9	Lift the defective PIM Board out of the ventilator module.	

Step	Action	
10	Place the new PIM Board **NOTE** Ensure male header pins are inserted correctly into the mating header on the SPM board.	
11	Secure the PIM board to the new SPM with the (5) 4-40 x 1/4 screws. Caution: Do not overtighten the screws. (Maximum torque: 3.5 in.- lb.)	
12	Insert the Power Input cable into the mating connector on the PIM board. Ensure that the locking latch engages.	
13	Place the front case assembly over the ventilator module and tighten the (2) 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.	
14	Attach the back case to the ventilator module and align cover with handle, air intake housing and dovetail mounting studs. Insert and tighten the (2) 10-32 Keps nuts (provided in the kit) and the (4) 6-32 x 2” screws.	
15	Tighten the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake.	

Step	Action	
16	Reassemble the battery by connecting its cable to the connector (pull lightly on the cable to ensure it is locked in place) then tighten the (4) 6-32 x 2-1/4 screws.	
17	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	
18	Use the RCS "Write" function to update the new part's serial number.	
19	Re-certify the ventilator using the RCS.	

CPU/UIM and SPO2 Stack Service Kit Installation Instructions

Required Tools

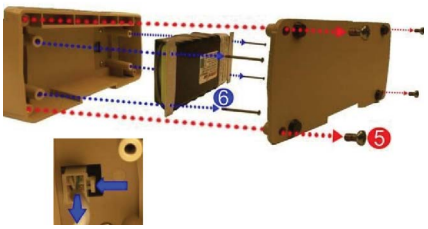
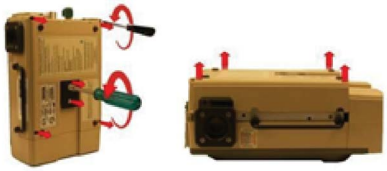
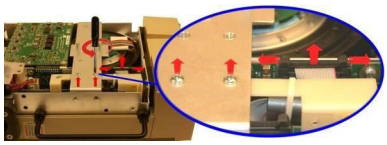
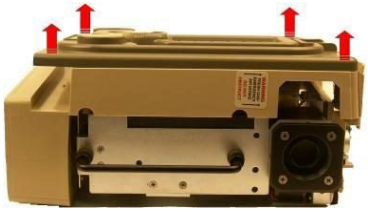
- Torque driver with #1 and #2 Phillips bits
- Nut driver set
- Small utility knife
- RTV sealant

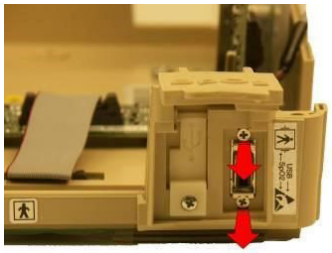
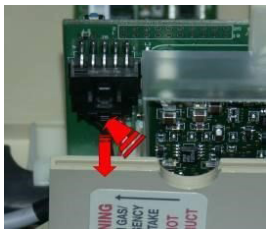
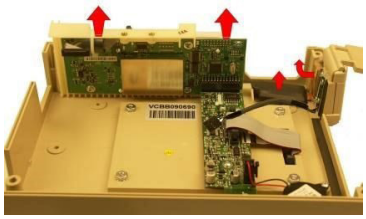
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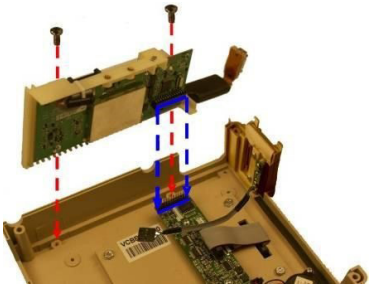
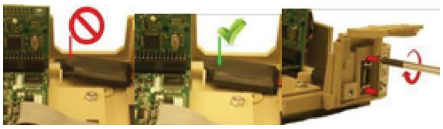
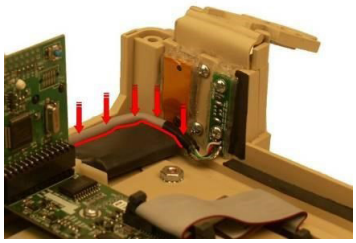
Quantity	Description	Depiction
1	CPU/UIM & SpO_2 Stack	
2	Screw, Phillips, Pan Head, SS, 6-32 x 5/16	
2	Screw, Metric, Phillips, Flat Head, M2.5 x 5mm Stainless Steel	

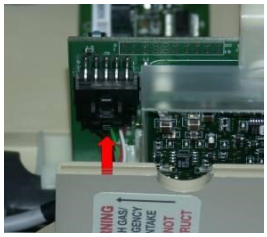
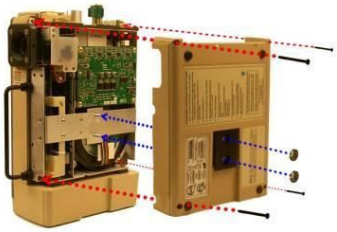
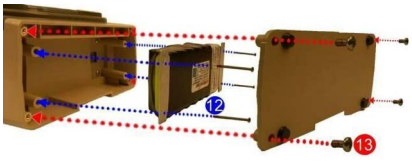
Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake. **NOTE** Additional loosening may cause the filter disk to slip out of place.	

Step	Action	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch. Save these screws.	
4	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator. **NOTE** You may need to cut through stickers/ labels that are holding the case halves together.	
5	Remove the (2) 4-40 x 1/4 screws securing the CPU Stack Frame to the Dovetail Mounting Bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
6	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
7	Using a sharp knife, carefully cut the RTV sealant around the SpO_2 cable.	

Step	Action	
8	Remove the (2) M2.5 x 5mm screws fastening the SpO2 cable to the front case.	
9	Disconnect the USB cable by pressing on locking tab and pulling cable downwards.	
10	Remove the (2) 6-32 x 5/16 screws that hold the CPU/UIM and SpO2 Stack to the front case.	
11	Lift the CPU/UIM and SpO2 Stack up from the front case. Handle the SpO2 cable with extreme care. Do not pull on the cable.	

Step	Action	
12	Position the new CPU/SPO2 Stack in place carefully connecting it to the UIM board. Then, tighten the (2) 6-32 x 5/16 screws that secure the new CPU/UIM and SPO2 Stack to the front case. **NOTE** Handle the SPO2 cable with extreme care. Do not pull or twist the cable. **NOTE** Make sure that all the pins on the header mate correctly.	
13	Ensure the SpO2 Flex Cable lays flat against the front case and is routed correctly into the UIM Bracket and SpO2 Isolation Shield. Insert and tighten the (2) M2.5 x 5mm screws holding the SpO2 cable to the front case.	
14	Apply RTV sealant around the SpO_2 Flex Cable and allow to dry.	
15	Route the USB Connector cable along the case and over the SpO_2 flex cable.	

Step	Action	
16	Attach USB Connector cable to its mating connector on the CPU board. Make sure tab locks the cable in place.	
17	Place the front case assembly over the ventilator module and tighten the (2) 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.	
18	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 (4) 6-32 x 2” screws and then the (2) 10-32 Keps nuts.	
19	Tighten the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake.	
20	Reassemble the battery by connecting its cable to the connector (pull lightly on the cable to ensure it is locked in place) then tighten the (4) 6-32 x 2-1/4 screws.	
21	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	

Step	Action	
22	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.	
23	Re-certify the ventilator using the RCS.	

USB Connector Service Kit Installation Instructions

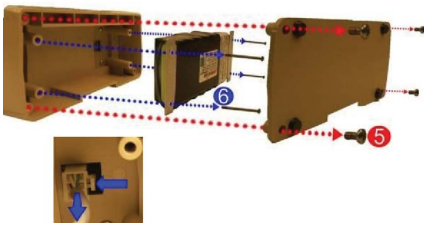
Required Tools

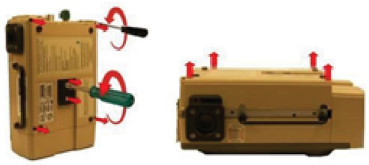
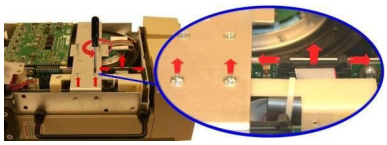
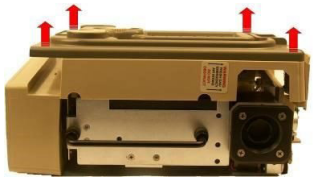
- Torque driver with #1 and #2 Phillips bits
- Nut driver set
- Small utility knife
- RTV silicone sealant

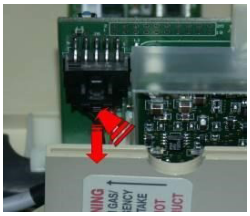
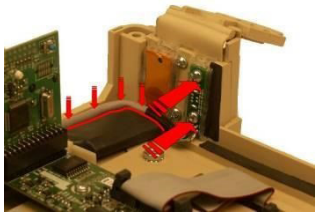
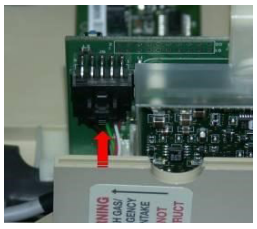
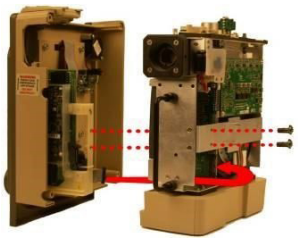
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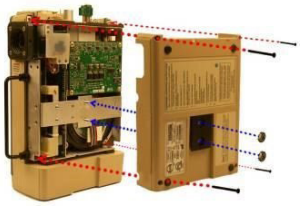
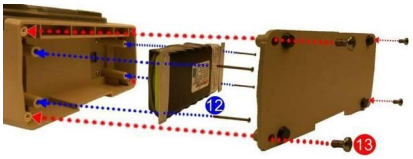
Quantity	Description	Depiction
1	USB Connector Assembly	
2	Screw, Phillips, Pan Head, Zinc Plated, 4-40 x 3/16	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the (4) 8-32 x 3 screws on the Fresh Gas Intake. **NOTE** Additional loosening may cause the filter disk to slip out of place.	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch. Save these screws.	

Step	Action	
4	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator. **NOTE** You may need to cut through stickers/ labels that are holding the case halves together.	
5	Remove the (2) 4-40 x 1/4 screws securing the CPU Stack Frame to the Dovetail Mounting Bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
6	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
7	Using a sharp knife, carefully cut the RTV sealant around the USB Printed Circuit Board.	
8	Remove the (2) 4-40 x 3/16 screws holding the Mini USB Cable Assembly to the front case.	

Step	Action	
9	Remove the damaged cable by pressing on locking tab and pulling cable downwards.	
10	Remove any excess RTV sealant from the case. Insert and tighten the (2) 4-40 x 3/16 screws (provided in the kit) holding the new USB Connector to the front case. Route the USB Connector cable along the case and over the SpO_2 flex cable. **NOTE** Exercise caution not to damage the SPO2 flex cable with the sharp knife.	
11	Attach USB Connector cable to its mating connector on the CPU board. Make sure tab locks the cable in place.	
12	Apply RTV sealant around USB board and allow to dry.	
13	Place the front case assembly over the ventilator module and tighten the (2) 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	
14	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 (2) 10-32 Keps nuts (provided in the kit) and the (4) 6-32 x 2” screws.	
15	Tighten the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake.	
16	Reassemble the battery by connecting its cable to the connector (pull lightly on the cable to ensure it is locked in place) then tighten the (4) 6-32 x 2-1/4 screws.	
17	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	
18	Re-certify the ventilator using the RCS.	

Gas Output Service Kit Installation Instructions

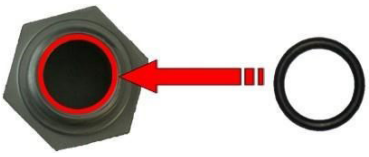
Required Tools

- 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 removing it 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. Do not cross thread.	
4	Re-certify the ventilator using the RCS.	

Power Input Service Kit Installation Instructions

Required Tools

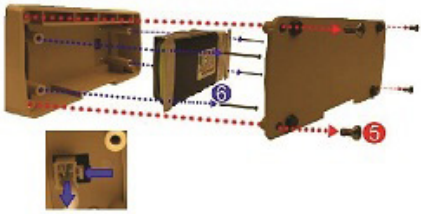
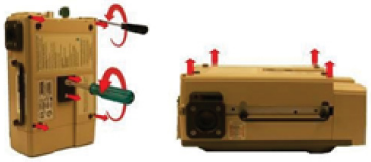
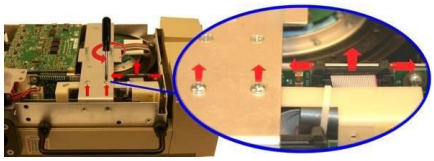
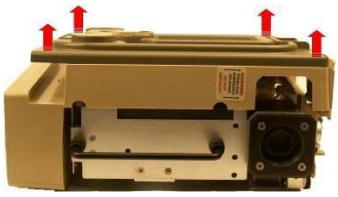
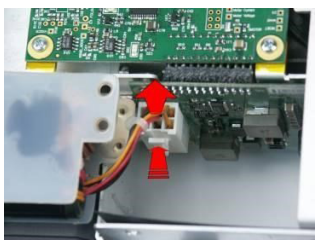
- Torque driver with #1 and #2 Phillips bits
- Nut driver set

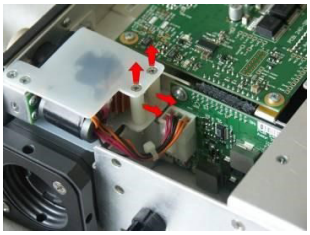
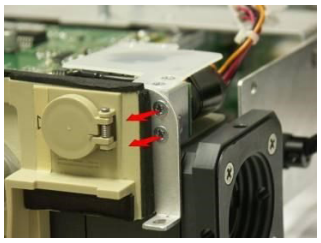
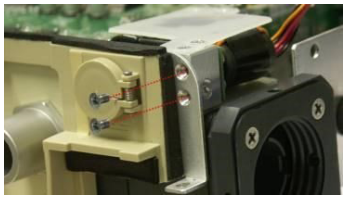
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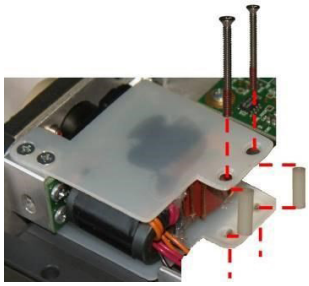
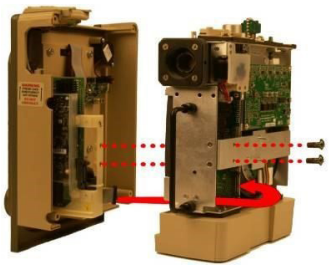
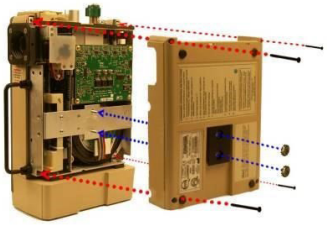
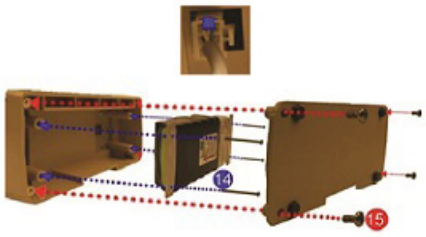
Quantity	Description	Depiction
1	Power Input Assembly	
2	Screw, Phillips, Flat Head, Zinc Plated, 4-40 x 1/4	
2	Screw, Phillips, Flat Head, 4-40 x 1-1/4	
2	Spacer, Nylon, #4, x 812 Long	

Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the (4) 8-32 x 3 screws on the Fresh Gas Intake. **NOTE** Additional loosening may cause the filter disk to slip out of place.	

Step	Action	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch.	
4	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator. **NOTE** You may need to cut through stickers/ labels that are holding the case halves together.	
5	Remove the (2) 4-40 x 1/4 screws securing the CPU Stack Frame to the Dovetail Mounting Bracket. Save these screws. Disconnect the ribbon cable on the PIM board by simultaneously applying pressure on the two ejector latches.	
6	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
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	Action	
8	Remove the (2) 4-40 x 1-1/4 Screws and nylon spacers supporting the Power Input assembly unto the chassis.	
9	Remove the (2) 4-40 x 1/4 screws fastening 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.	
12	Secure the Power Input assembly to the Connector Panel using the (2) 4-40 x 1/4 screws (provided in the kit).	

Step	Action	
13	Secure the Power Input assembly to the Chassis using the two spacers and the (2) 4-40 x 1-1/4 screws (provided in the kit). Do not overtighten the screws. (Maximum torque: 3.5 in-lb.)	
14	Place the front case assembly over the ventilator module and tighten the (2) 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.	
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 (4) 6-32 x 2” screws and then the (2) 10-32 Keps nuts (provided in the kit).	
16	Tighten the (4) 8-32 x 3 screws on the exterior of the Fresh Gas Intake.	
17	Reassemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it s locked in place) then tightening the (4) 6-32 x 2-1/4 screws.	
18	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	

Step	Action	
19	Re-certify the ventilator using the RCS.	

Oxygen Inlet Fitting Service Kit Installation Instructions

⚠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. **Do not attempt to clean it.**

Required Tools

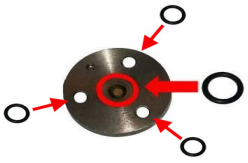
- Torque driver with #1 and #2 Phillips bits

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)	

Quantity	Description	Depiction
3	O-Ring, Buna-N 5/16 OD X 3/16	

Instructions

Step	Action	
1	Remove the damaged oxygen inlet (OXY-GEN IN) fitting by removing the dust cap. Then, remove the (3) 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 and #2 Phillips bits
- Nut driver set

⚠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:

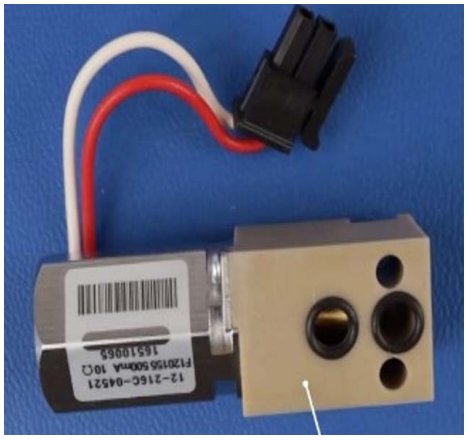
Never touch the components with your bare hands as oils and residue may contaminate the component.

Keep all Oxygen Clean parts in their protective packaging prior to installation.

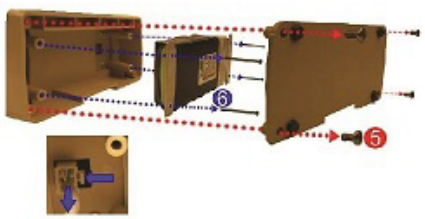
Do not keep sources of contaminate on the workbench such as soldering material.

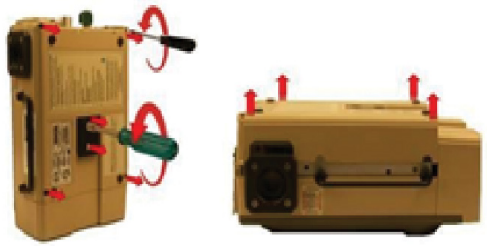
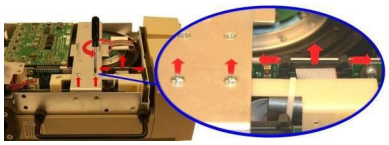
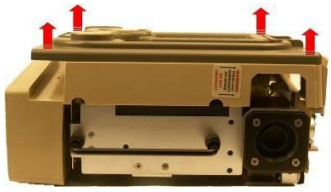
If an oxygen clean part becomes contaminated, replace the part. **Do not attempt to clean it.**

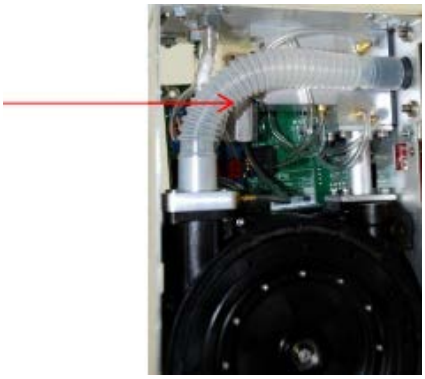
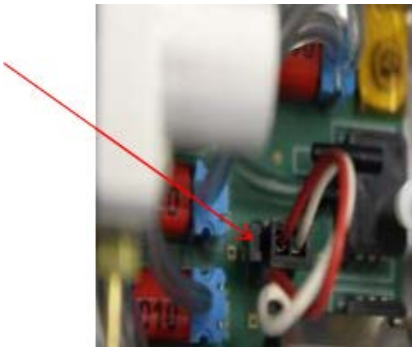
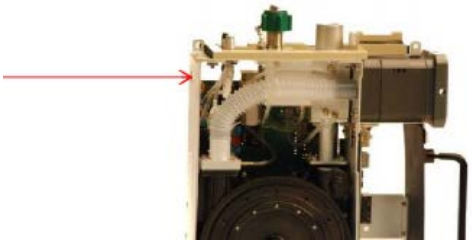
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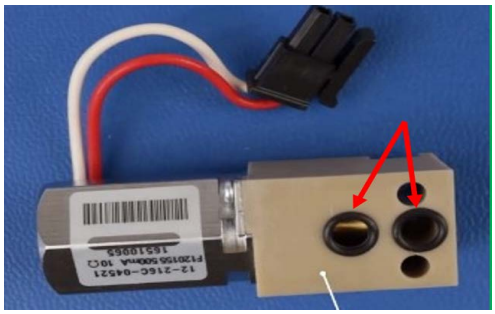
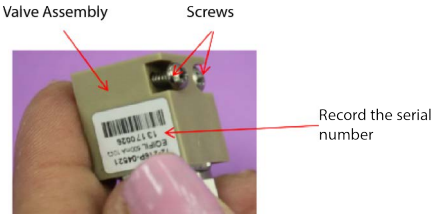
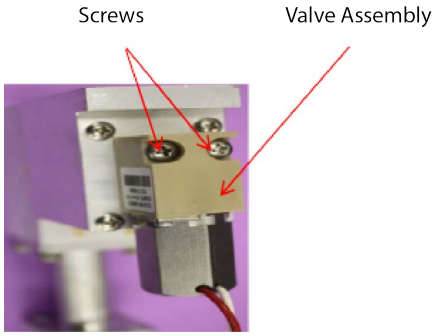
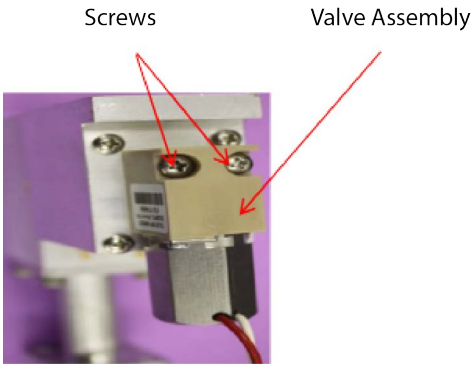
Quantity	Description	Depiction
2	SCREW, PHILIPS, PAN HEAD, 4-40 x 1-3/4, RoHS	
1	Assembly, Valve with O Rings.	

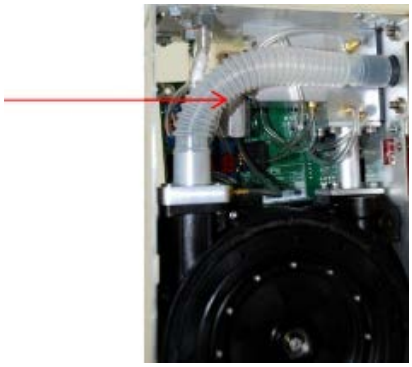
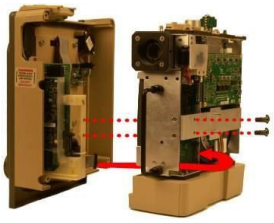
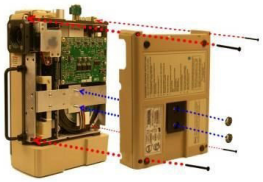
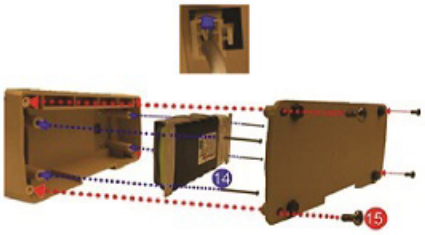
Instructions

Step	Action	
1	Loosen by 1 full turn and do not remove the (4) 8-32 x 3 screws on the Fresh Gas Intake. **NOTE** Additional loosening may cause the filter disk to slip out of place.	
2	Remove the battery compartment cover by removing the (4) 6-32 x 5/16 screws. Save these screws.	
3	Remove the battery by removing the (4) 6-32 x 2-1/4 screws and detaching the plug from its locking latch.	

Step	Action	
4	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator. **NOTE** You may need to cut through stickers/ labels that are holding the case halves together.	
5	Remove the (2) 4-40 x 1/4 pan head screws securing the CPU Stack Frame to 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.	
6	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	
7	The O2 valve is located on the SPM Assembly.	

Step	Action	
8	The 6" corrugated tubing can be removed for easier viewing and access to the O_2 Valve.	
9	Note orientation of Oxygen valve cable. Disconnect Oxygen valve cable from J2 of SPM PCB by pinching on the locking latch and pulling up on the connector.	
10	Access to the O2 Valve screws is through the cutout of the SPM chassis. Using a small point Philips screwdriver, remove the (2) 4-40 x 11/16 screws from the O2 valve. Remove the O2 valve with its two O-rings from the SPM assembly.	 

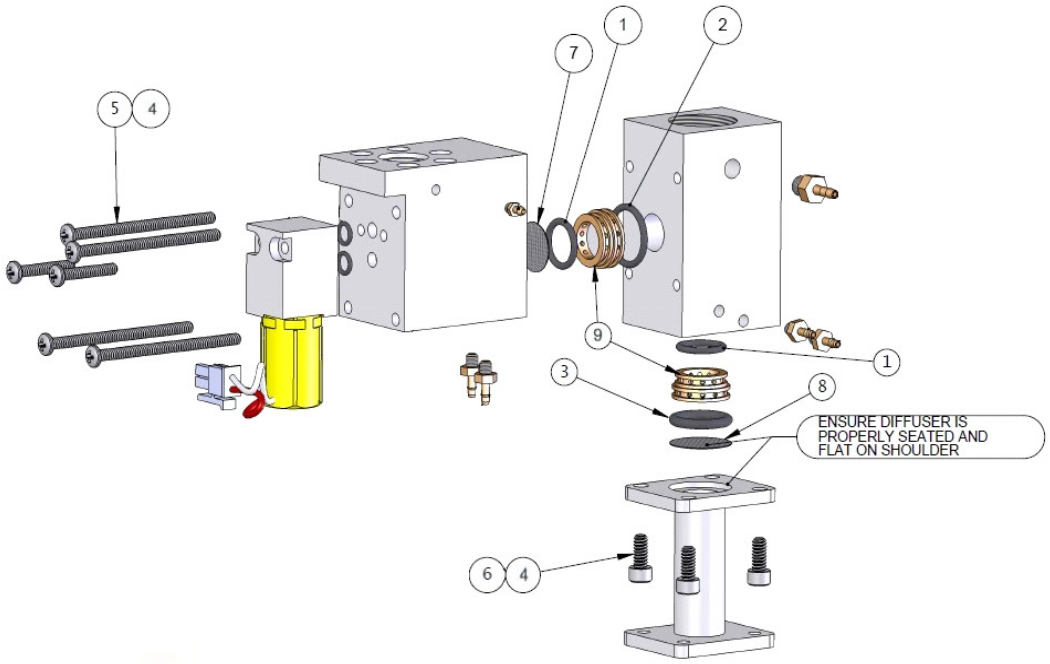
Step	Action	
11	With the new valve kit, insert two O-Rings into the Valve Assembly. **NOTE** Ensure that the O-Rings stay firmly in place.	
12	Hold Valve Assembly with the O-Rings attached and insert the (2) 4-40 x 11/16 Phillips pan head screws (P/N 358-0440-11). Record serial number used in your service records.	
13	Attach Valve Assembly to the Oxygen Inlet Manifold in the orientation as shown and tighten with (2) 4-40 x 11/16) screws. **NOTE** Make sure the O-rings stay in place.	
14	Note orientation of Oxygen valve cable. Connect Oxygen valve cable to J2 of SPM PCB. Ensure that the connector is locked in place by gently pulling up on the connector.	

Step	Action	
15	Reconnect the 6-inch corrugated tubing (if it was previously disconnected).	
16	Place the front case assembly over the ventilator module and tighten the (2) 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.	
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 (4) 6-32 x 2” screws and then the (2) 10-32 Keps nuts (provided in the kit).	
18	Reassemble the battery by connecting its cable to the connector (pull lightly on cable to ensure it s locked in place) then tightening the (4) 6-32 x 2-1/4 screws.	
19	Reassemble the battery compartment cover by tightening the (4) 6-32 x 5/16 screws.	
20	Use the RCS "Write" function to update the O2 valve's serial number on the respective field.	

Step	Action	
21	Re-certify the ventilator using the RCS.	

Flow Screen Service Kit Installation Instructions

Manifold Diagram

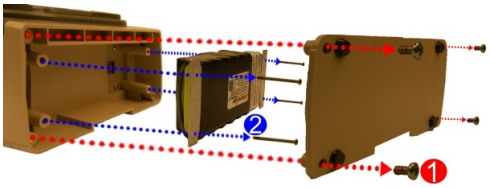
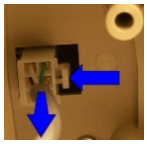


Kit Number (ALL MODELS)	SCAN OR CLICK FOR VIDEO
712-0731-41	Compressor Flow Screen O2 Flow Screen

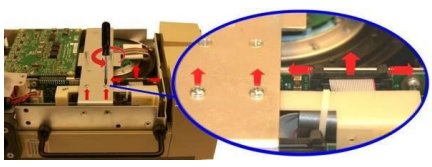
Kit Contents			
Item	Part Number	Quantity	Description

1	340-0023-00	2	O-Ring 1/2” OD X 3/8” ID
2	340-0059-00	1	O-Ring 5/8” OD X 1/2” 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 3/4 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

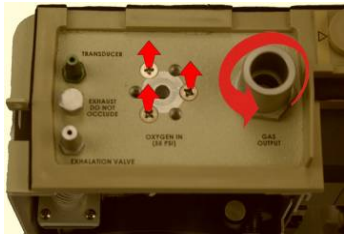
Step	Action	
1	Remove the battery compartment cover by removing the (4) 6-32 X 5/16 screws.	
2	Remove the battery by removing the (4) 6-32 X 2-1/4 screws and detaching the plug from its locking latch.	

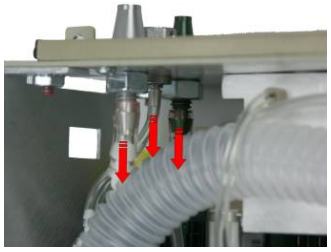
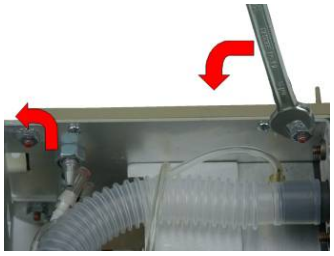
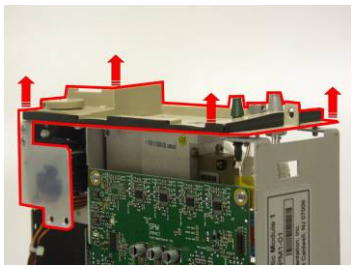
Remove the Fresh Gas/Emergency Air Intake, Back Cover and Front Case Assembly

Step	Action	
1	Remove the (4) 8-32 X 3 screws on the exterior of the Fresh Gas Intake. Remove the entire Fresh Gas/Emergency Air Intake assembly including disk filter.	
2	Lay the ventilator face down on a cushioning anti-static material. Remove the two Dovetail 10-32 Keps nuts and the four Back Cover 6-32 x 2 screws. Save these screws and Keps nuts. Remove the back case by lifting from the ventilator. **NOTE** You may need to cut through stickers/labels that are holding the case halves together.	
3	Remove the (2) 4-40 X 1/4 screws securing the CPU Stack Frame to the Dovetail Mounting Bracket and disconnect the ribbon cable on the PIM PCB by simultaneously applying pressure on the two ejector latches.	

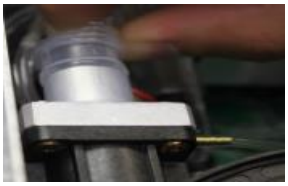
4	Flip the ventilator over and remove the front case assembly by lifting it straight up away from the ventilator module.	

Remove the Connector Panel Assembly

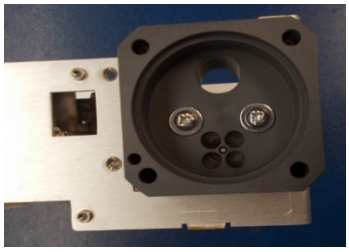
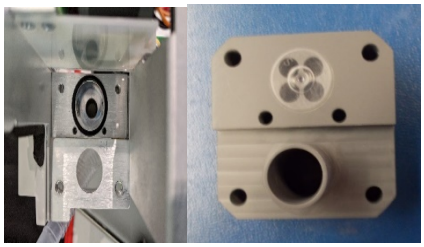
Step	Action	
1	Remove the O2 Inlet fitting by removing the dust cap and then removing the (3) 8-32 X 7/16 screws. Remove and keep the O-ring(s).	 
2	Remove the (3) 8-32 X 1/4 screws. Remove the Gas Output fitting using a 1-inch deep-socket wrench. Remove and keep the O-ring(s).	
3	Disconnect the Power Input cable by pressing on the locking latch and pulling the cable straight up from the connector.	
4	Remove the (2) 4-40 X 1-¼ screws and nylon spacers supporting the Power Input assembly unto the chassis. Save the screws and spacers.	
5	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 tubes on these fittings: • "Transducer" • "Exhaust Do not Occlude" • "Exhalation Valve" Do not discard the tubing. **NOTE** It is advisable to mark each tube for easy identification during reassembly.	
7	Remove the (2) 6-32 Keps nuts using a 5/16 open-end wrench.	
8	Lift the Connector Panel assembly out from the SPM.	

Remove the Compressor Intake Corrugated Hose

Step	Action	
1	Remove the corrugated hose from the Compressor Intake. **NOTE** Cover the Compressor Inlet to avoid any screws/particles from falling in.	
2	Remove the corrugated hose from the BV Holder base.	

Remove the BV Holder Base

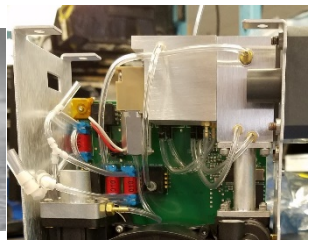
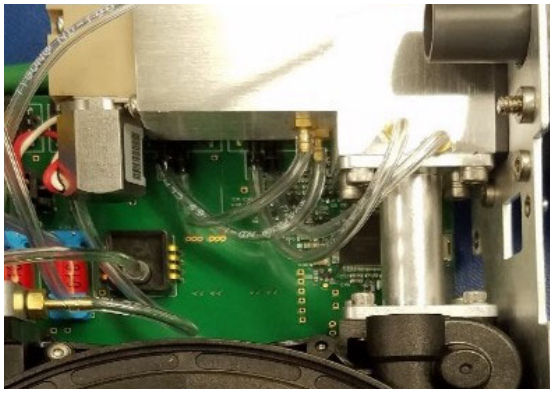
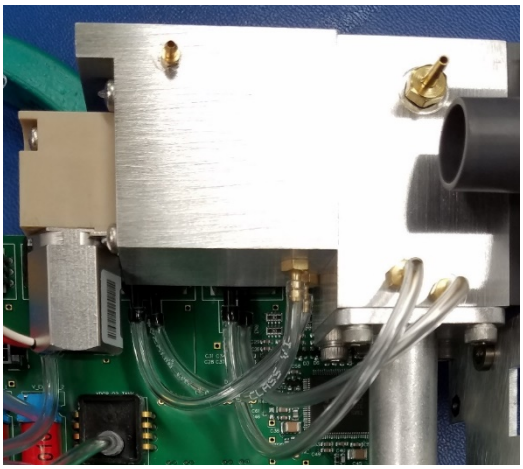
Step	Action	
1	Remove the 2 screws (with washers) fastening the BV Holder base.	
2	Remove the BV Holder Base. Pay attention to the integrity of the anti-asphyxia valve and the O-ring behind it.	

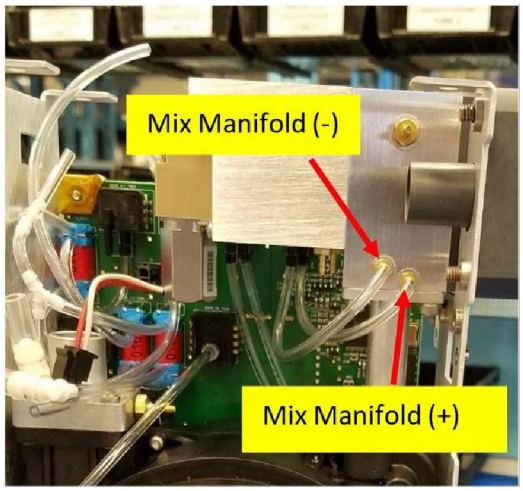
Disconnect the 02 Valve Cable from the SPM PCB

Step	Action	
1	Note the orientation of the O2 valve connector. Disconnect the O2 valve cable from J2 of SPM PCB by depressing the locking latch and pulling up on the connector.	

Disconnect the Hoses (6) from the Flow Manifold Assembly

Step	Action	

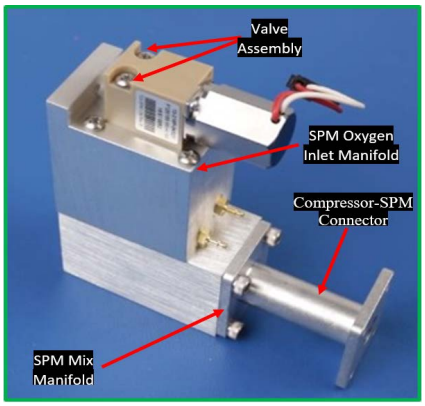
1	Raise the sleeve clamp and disconnect tubing from the Oxygen Inlet Manifold. **NOTE** Exercise caution not to break the hose barb on the manifold. Gently pull the tubing off the barb in a straight movement. Do not tilt the tubing sideways. **NOTE** During reassembly, connect tubing and sleeve clamp and push both all the way down on the hose barb.	 
2	Disconnect tubing from the Mix Manifold Pressure fitting. **NOTE** Exercise caution not to break the hose barb on the manifold. Gently pull the tubing off the barb in a straight movement. Do not tilt the tubing sideways. **NOTE** During reassembly, connect tubing from Exhalation Control Valve to Mix Manifold Pressure fitting.	
3	Disconnect tubing from the O2 Inlet Manifold (+). **NOTE** It is advisable to mark the (+) port on the manifold for easy identification during reassembly.	
4	Disconnect tubing from the O2 Inlet Manifold (-). **NOTE** It is advisable to mark the (-) port on the manifold for easy identification during reassembly.	

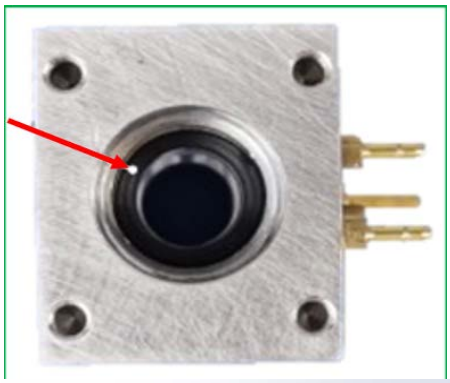
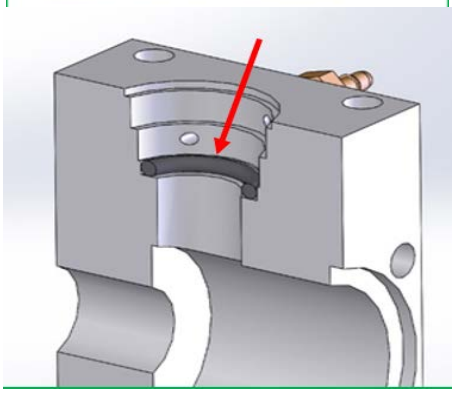
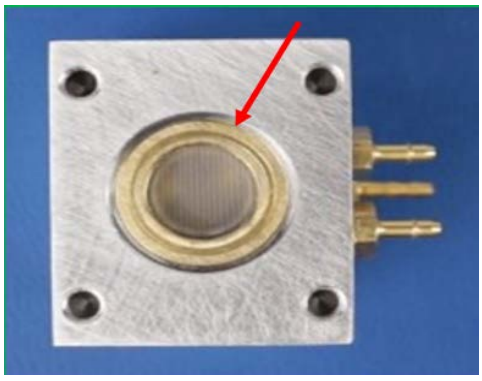
5	Disconnect tubing from the Mix Manifold (-). **NOTE** It is advisable to mark the (-) port on the manifold for easy identification during reassembly.	
6	Disconnect tubing from the Mix Manifold (+). **NOTE** It is advisable to mark the (+) port on the manifold for easy identification during reassembly.	

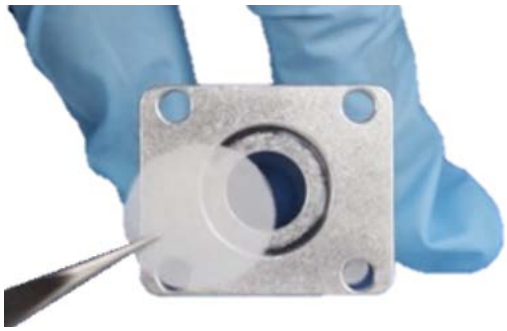
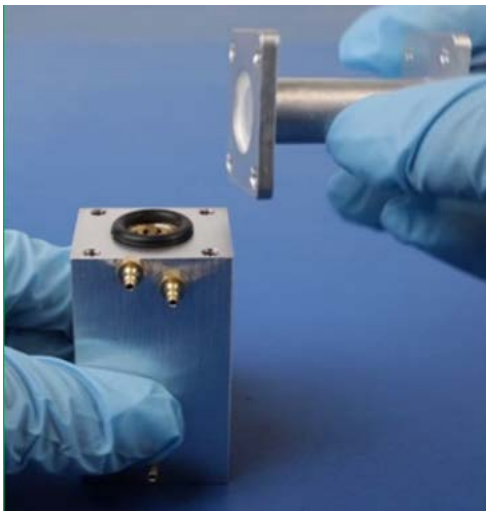
Disconnect the Flow Manifold from the Compressor

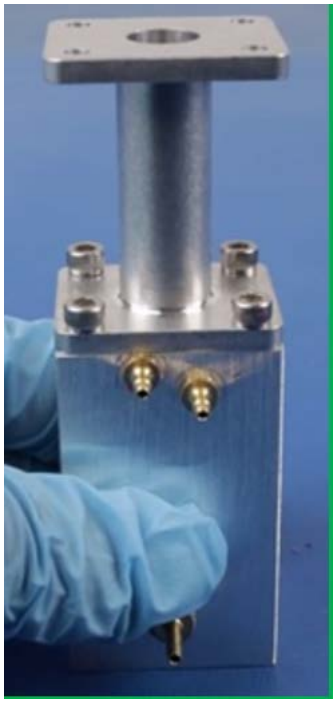
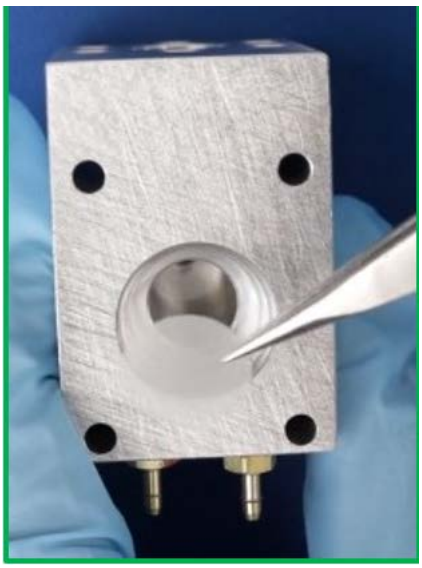
Step	Action	
1	Remove the 4 hex screws (with washers) fastening the Flow Manifold to the Compressor outlet. **NOTE** Cover the Compressor Outlet to avoid any screws/particles from falling in.	

General instruction set resumes...

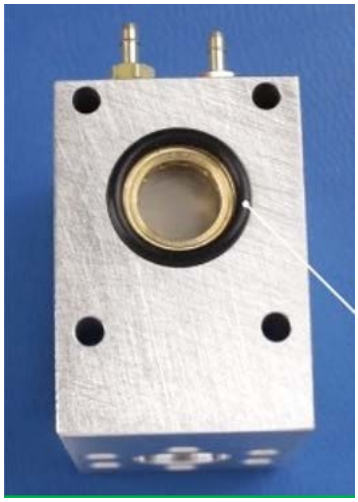
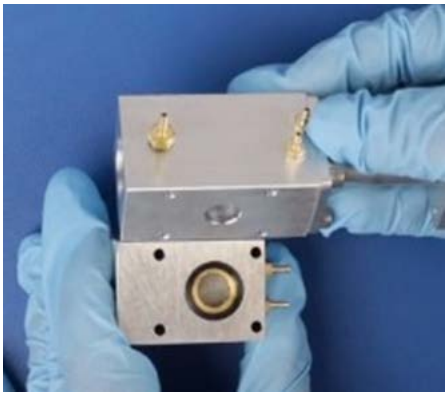
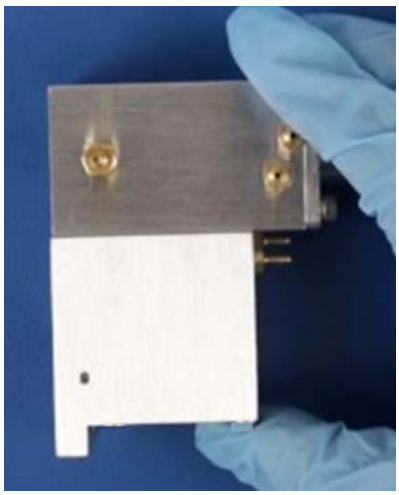
Step	Action	
1	Remove 4 screws at SPM Oxygen Inlet Manifold to separate it from the SPM Mix Manifold. Using tweezers, carefully remove the existing O2 Flow Screen, both O-rings, and diffuser. Set them aside until reassembly is completed and the ventilator is re-certified. Remove 4 screws at SPM Mix Manifold to separate it from the Compressor-SPM Connector. Using tweezers, carefully remove the existing Compressor Flow Screen, both O-rings, and diffuser. Set them aside until reassembly is completed and the ventilator is re-certified.	

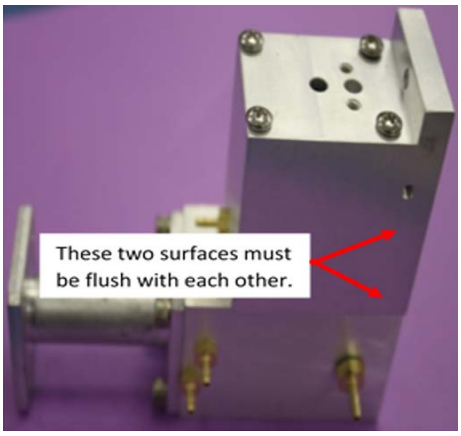
Step	Action	
2	On the SPM Mix Manifold, insert the O-ring 1/2" OD X 3/8" ID (P/N 340-0023-00). **NOTE** Ensure that the O-ring sits fully in the counter bore of the bottom. **NOTE** Exercise caution not to pinch or damage the O-ring.	 
3	Insert the Transducer, Screen, 400 Mesh (P/N 804-0006-00) with its smaller diameter side into the SPM Mix Manifold. **NOTE** Ensure that it sits properly in the counter bore. **NOTE** Exercise caution not to touch or damage the screen surface.	

Step	Action	
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. **NOTE** Do not pinch or fold the diffuser.	
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 or become pinched during this operation. Failure to do so will cause the device to fail.	

Step	Action	
7	Insert (4) Screw, Cap, Socket, 6-32 X 5/16 (P/N 360-0632-05) through the Compressor-SPM Connector into the SPM Mix Manifold. Using a 7/64 ball driver hex bit, tighten the four screws in a crossing pattern. Torque screws to 9 in-lbs. **NOTE** Ensure the thread does not get stripped.	
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. **NOTE** Do not pinch or fold the diffuser.	

Step	Action	
9	Insert the O-Ring 1/2" 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. **NOTE** Do not pinch or damage the O-ring.	
10	Insert the Transducer, Screen, 400 Mesh with its smaller diameter side into the SPM Oxygen Inlet Manifold. **NOTE** Ensure that it sits properly in the counter bore. **NOTE** Exercise caution not to touch or damage the screen surface.	

Step	Action	
11	Insert the O-Ring 1/2" 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. **NOTE** Do not pinch or damage the O-ring.	
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.	 

Step	Action	
13	Insert (4) Screw, Phillips, Pan Head, 4-40 X 1-3/4 (P/N 358-0440-28) into the SPM Oxygen Inlet Manifold and tighten in a crossing pattern with #1 Phillips head screwdriver. Torque to 5 in-lbs.	
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 reassembly is completed you must calibrate and test the ventilator with the RCS.	

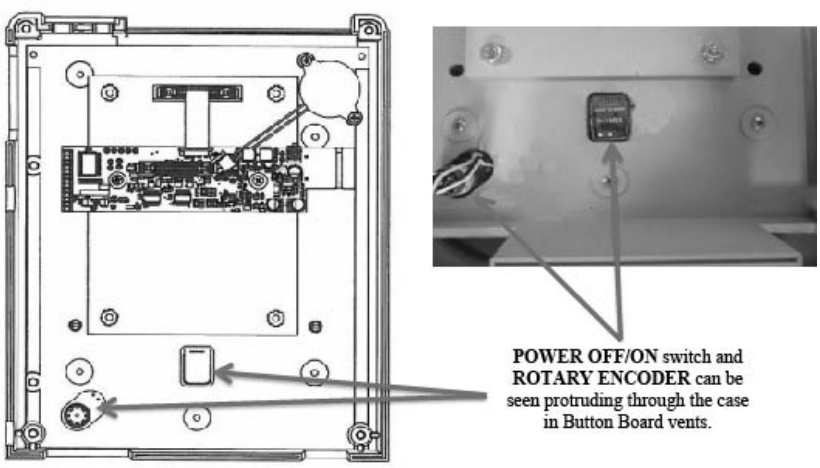
Servicing Membrane Panels and Button Boards

NOTE

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

The figure below shows how to identify 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, use the replacement kit number(s) listed.

Description	EMV(P)/AEV		Eagle II	
	Picture	Kit Part Number	Picture	Kit Part Number
Membrane Panel Kit		Convert ventilator to Button Board with kits: EMV+: 712-0731-23 and 712-0731-28 AEV: 712-0731-23 and 712-AEV1-06		Convert ventilator to Button Board with kit: 712-EGL2-18.
Bezel Assembly Kit		Convert ventilator to Button Board with kits: EMV+: 712-0731-23 and 712-0731-28 AEV: 712-AEV1-06		Convert ventilator to Button Board with kit: 712-EGL2-18
Power Knob Kit		Convert ventilator to Button Board with kits: EMV+: 712-0731-23 and 712-0731-28 AEV: 712-0731-23 and 712-AEV1-06		Convert ventilator to Button Board with kit: 712-EGL2-18
Front Case Assembly Kit		Use the Button Board kits listed below: EMV+: 712-0731-29 AEV: 712-AEV1-04		Use Button Board Kit: 712-EGL2-16

Selector Knob Kit		Convert ventilator to Button Board with kits: EMV+: 712-0731-23 and 712-0731-28 AEV: 712-0731-23 and 712-AEV1-06		Convert ventilator to Button Board with kit 712-EGL2-18

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

Description	Picture	Kit Part Number	Picture	Kit Part Number
Button Board Kit		712-0731-23		Not available
Bezel Assembly Kit		EMV+: 712-0731-28 AEV: 712-AEV1-06		712-EGL2-18
Front Case Assembly		EMV+: 712-0731-29 AEV: 712-AEV1-04		712-EGL2-16
Selector Knob Kit		712-0731-27		Not available

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 Medical Corporation 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 ⚠

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 ⚠

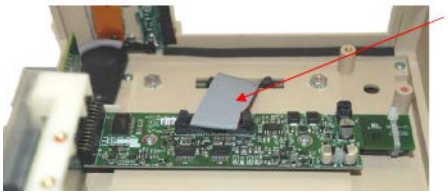
The SPO2 insulator is a critical component and its correct assembly is required for the safety of both the patient and the operator. Ensure there are no tears or physical damage to the insulator and verify it is installed correctly before reassembly.

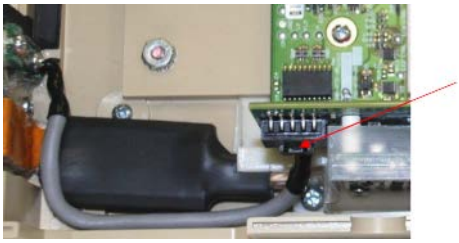
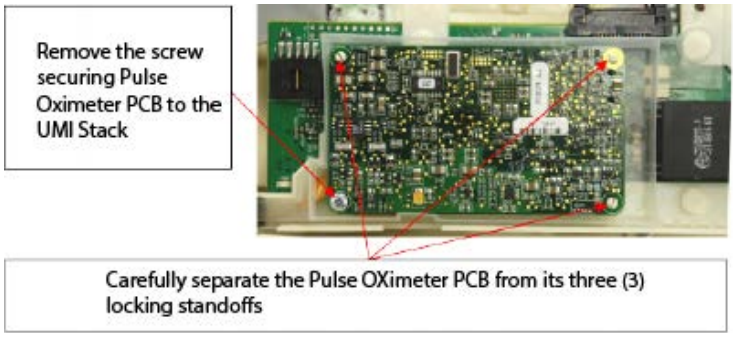
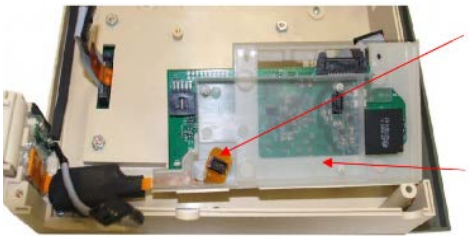
Disassembly/Assembly Procedure for Front Case Kits

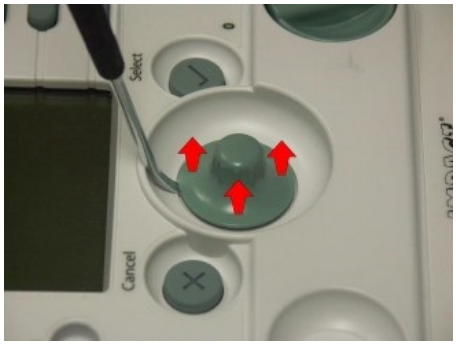
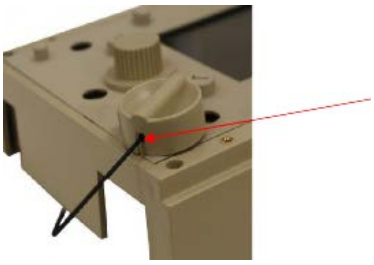
Follow the steps below to disassemble and reassemble the front case assembly. Kit numbers available are referenced throughout the procedure. RCS testing **must** be performed after reassembly of the ventilator.

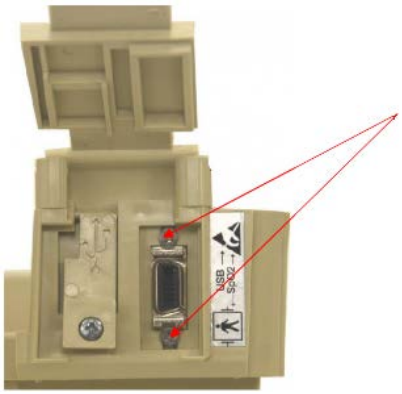
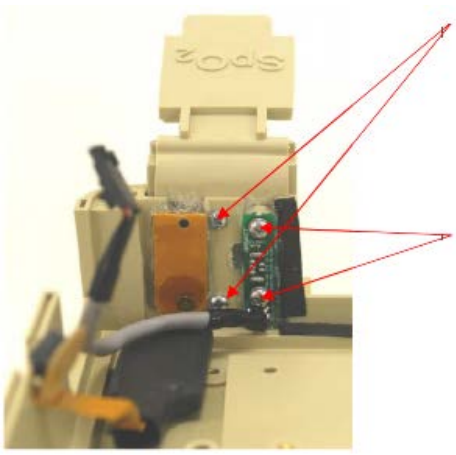
Tools/Supplies Required

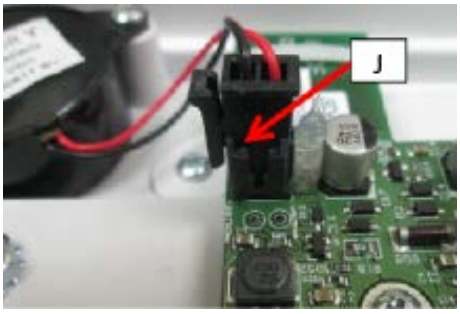
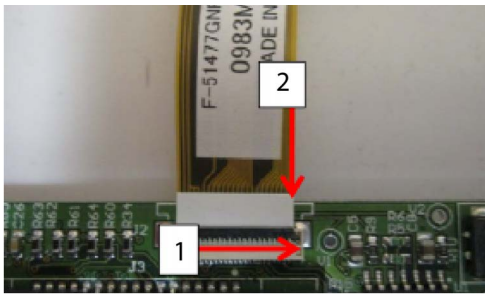
- Philips Head Screwdriver, small point
- 5/16” Nut Driver
- 1/16” Ball Hex Driver
- pen knife or similar
- RTV sealant (ZOLL PN: 0550-0099)

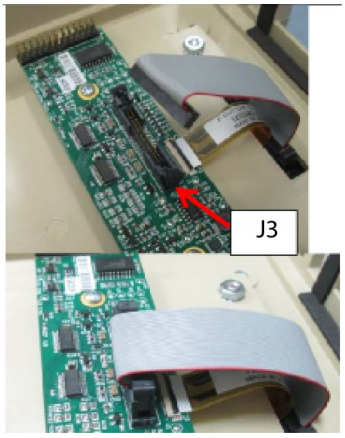
Step	Action	
1	Buzzer - Kit #: 712-0731-37 Remove the (2) 4-40 x 1/4 Phillips pan head screws that fasten the Buzzer to the Front. Depress the locking tab, and then remove the Buzzer's 2-pin connector located at the UIM Adapter Printed Circuit Board (PCB).	
2	UIM Adapter, CPU w/Bracket and Pulse Oximeter PCBs	
	Disconnect the gray ribbon connector from the Membrane Panel located at the UIM PCB by exerting outward pressure on the ejector latches.	
3	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.	

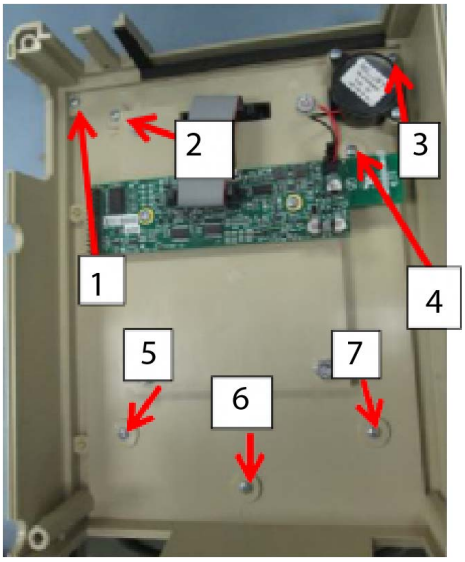
Step	Action	
4	Remove the (2) 6-32 x 1/4 Philips pan head screws securing the UIM Stack to the Front Case.	
5	Release cable from USB connector at the CPU PCB. Press tab to unlock then slide cable out.	
6	Remove the UIM Stack from the UIM Adapter PCB (pull to separate).	
7	Remove the (2) 4-40 x 1/4 Philips pan head screws securing the UIM PCB to the Front Case.	
8		
9	Carefully disconnect the Pulse Oximeter ribbon cable from Pulse Oximeter PCB. Separate the UIM Bracket from the Pulse Oximeter plastic housing.	

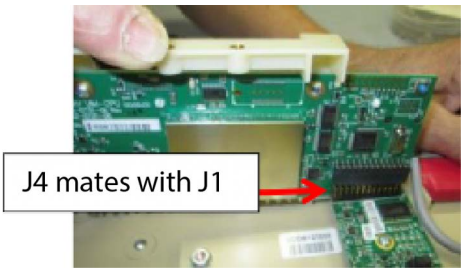
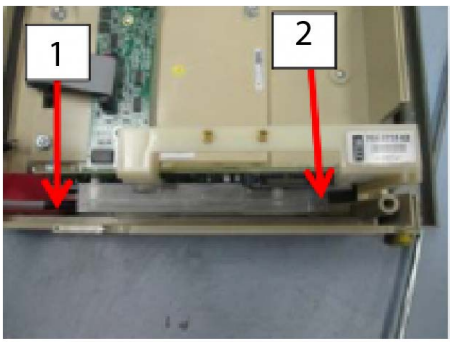
Step	Action	
10	Slide the Pulse Oximeter plastic housing away from the ribbon cable.	
11	Membrane Panel/Button Board: 712-0731-35 Kit, Membrane Panel, Tan	
	For Eagle II ventilators start by removing the Selector knob by prying the knob up from the case.	
12	Remove the (7) 4-40 x 1/4 Philips pan head screws securing the Front Case to the Front Panel.	
13	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.	

Step	Action	
14	Remove the (2) M2.5 Phillips flat head screws that fasten the Pulse Oximeter connector to the USB Connector Plate Assembly.	
15	Remove the (2) 4-40 x 5/16" Philips pan head screws that fasten the USB Connector Plate Assembly to the Front Case. Remove the (2) 4-40 x 3/16" Philips pan head screws that fasten the USB Adapter PCB to the USB Connector Plate Assembly and remove the cable. Remove the USB Connector Plate from the Front Case.	
	Reassembly	
16	Install buzzer using (2) 4-40 X 1/4 screws.	

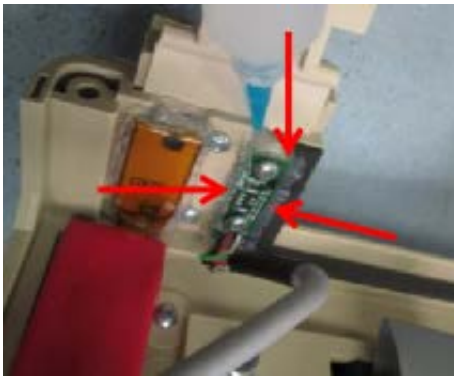
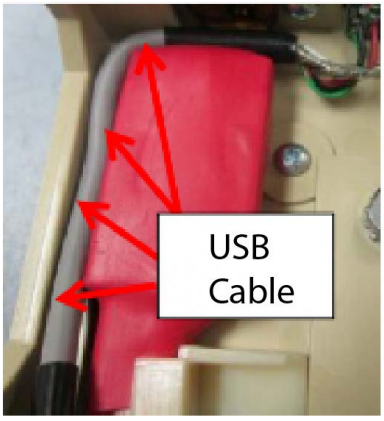
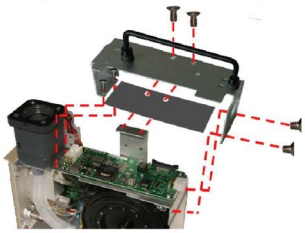
Step	Action	
17	Install UIM adapter using (2) 4-40 X 1/4 screws.	
18	Ensure proper connector key orientation and attach buzzer cable to connector J4 of UIM adapter.	
19	Make sure flex cable is aligned with the right side of J2 on UIM adapter board. Insert flex cable into J2.	
20	Paying attention to key orientation, attach ribbon cable to back of membrane panel assembly.	

Step	Action	
21	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 picture. Do not allow any bulging of the ribbon cable, as it may interfere with tubing.	
22	Ensure proper key orientation and install power knob to assembly.	
23	Ensure proper key orientation and install selector knob to assembly. **NOTE** Eagle II units will have the selector knob installed during front case assembly.	
24	Carefully unplug membrane panel/button board ribbon cable from J3 of UIM adapter board.	

Step	Action	
25	Ensure proper key orientation and connect membrane panel/button board ribbon cable to J3 of UIM adapter.	
26	Fasten the Front Bezel to the front case using quantity 7 of 4-40 X 1/4 screws in locations indicated.	
27	Prepare connector plate assembly for installation.	

Step	Action	
28	Hold cap and plate together and insert into case as shown.	
29	Fasten assembly to front case using (2) 4-40 x 5/16" Phillips pan head screws.	
30	Ensure proper mating connector alignment (J4 connector of UIM/CPU board mates with J1 connector of UIM Adapter), and install UIM Stack into Front Case.	
31	Fasten UIM Stack to Front Case using (2) 6-32 x 5/16" Philips pan head screws.	

Step	Action	
32	Fasten USB connector board onto case using (2) 4-40 x 3/16" Philips.	
33	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.	
34	Perform after successful Pre-Test (#35) Apply a bead of RTV sealant around the perimeter of the Masimo connector board to create a seal between Front Case and board.	

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

Chapter 5
Electrical Safety Testing

Overview

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. An electrical safety testing device must only be operated by a skilled worker trained on its use.

⚠WARNING⚠

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

⚠WARNING⚠

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

⚠WARNING⚠

DO NOT wear an ESD wrist strap.

⚠WARNING⚠

Before and after testing, handle test clips by insulation only. Never touch clips directly.

⚠WARNING⚠

Do NOT touch the ventilator, the electrical safety testing device, high voltage test lead, alligator clip, or clip insulator once testing starts.

⚠WARNING⚠

Remove all metal jewelry, watches, rings, etc. that could accidentally complete a circuit.

⚠WARNING⚠

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.

⚠WARNING⚠

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

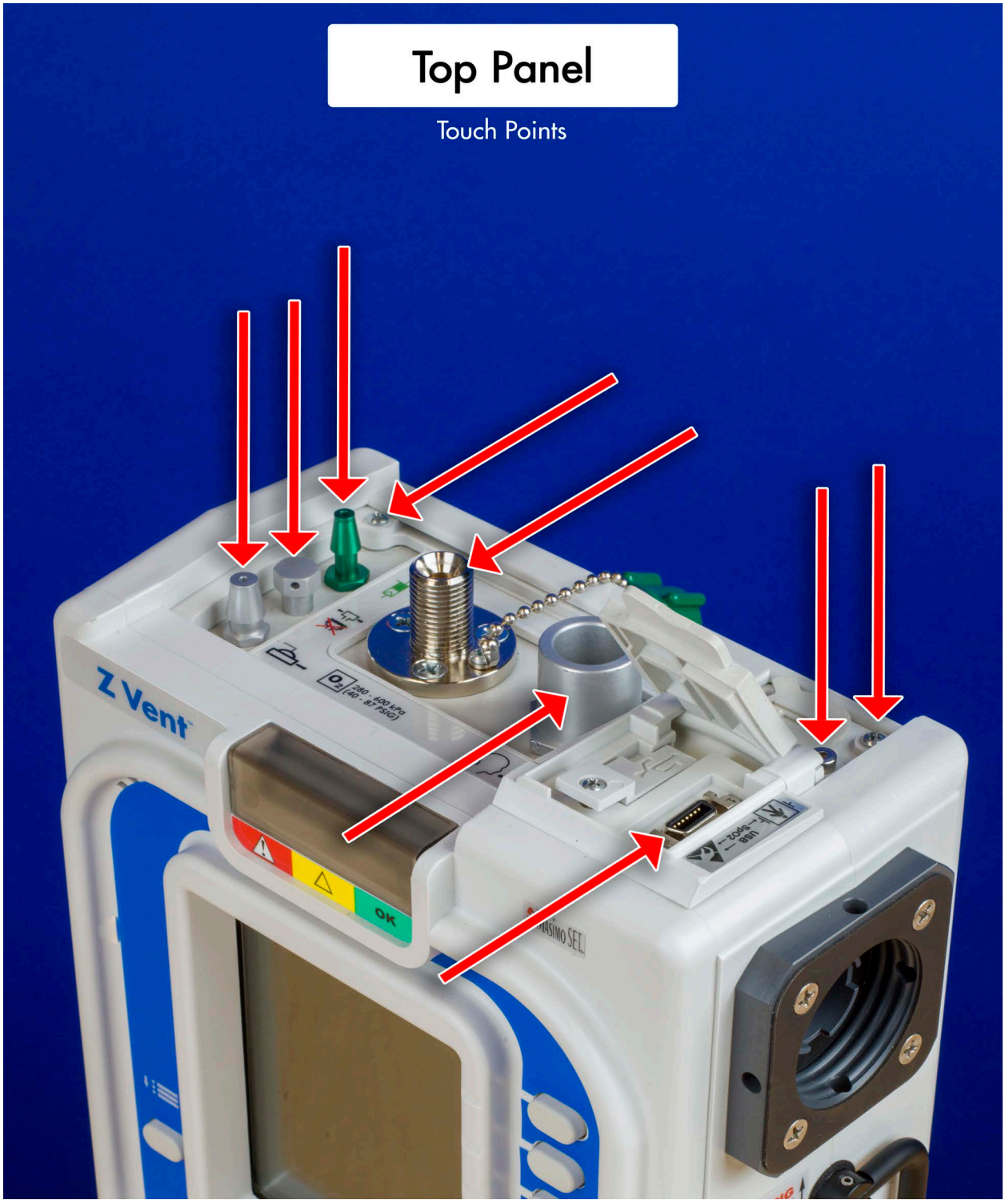
NOTE

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.

Touch Points for Electrical Leakage Testing




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 Netherlend
GTIN
(01) 0 0847946 02420 8
SN
(21) AY19A007442
IPX4
This device is covered under one or more of the following U.S.A. Patents: 5,758,644, 5,8
6,011,986, 6,157,850, 6,263,222, 6,501,975 and other
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 9.1.

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 to. 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 and stockpile removal procedure found in Chapter 3: Maintenance Schedule & Procedures.

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

The following tables identify and describe each discrete test and the associated subsystems tested.

System Tests

The System Tests sequence ensures the device hardware meets all functional and performance specifications. After troubleshooting or repair, the System Tests sequence 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 ZOLL 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 condi-

tion. For additional information on device alarms and service codes, see “Part III — Service Codes” on page 6-38.

Device alarms which indicate a hardware problem are identified in “Part II — Ventilator Troubleshooting” on page 6-8.

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.

Service Kits and Replacement Parts

For service kit and replacement part information, refer to “About Service Kits” on page 4-1.

Test Sequences, RCS 9.1

Service Actions

	Read Forensic Memory	Calibrations	System Tests	Erase Forensic Memory	Final Configuration
Power Switch Check			•		
EMV Self Check			•		
LCD Contrast Set			•		
LCD Visual Inspection			•		
Button 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		•			

	Read Forensic Memory	Calibrations	System Tests	Erase Forensic Memory	Final Configuration
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			•		
Erase Forensic Memory				•	
Final Configuration					•

Troubleshooting

	Calibration Checks	SPM Functional Checks	Battery and Power System Tests	Front Case Tests	Pulse Ox Test
Comm RAM and Boot-loader Checker				•	
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 Self Check	•	•			
SPM Blink		•			
TSI Calibration Check	•	•			
Exhalation Backup and Autocal Valve		•			
Calibration Check Baro-metric Pressure	•	•			
Compressor Calibration		•			
Calibration Check Com-pressor System	•	•			
Airway Pressure Cali-bration		•			
Calibration Check Air-way Pressure	•	•			

	Calibration Checks	SPM Functional Checks	Battery and Power System Tests	Front Case Tests	Pulse Ox Test
O2 Kickstart Calibration		•			
Calibration Check O2 Kickstart	•	•			
O2 Flow Calibration		•			
Calibration Check O2 System	•	•			
O2 Leak Filter and Pressure Cal. Check		•			
Manifold Leak Check		•			
Compressor Bypass Protection		•			
Breath Performance Check		•			
Download Calibration Tables		•			
Verify UUT and Reference Device		•			

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.

Troubleshooting — Communication & Preventive Maintenance Alarms

Remote Calibration System		
Discrete Tests	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		

Technical Related 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 timeout condition.	Hardware Problem: Change the SPM Board.
Preventive Maintenance Alarms			
PM Due	3120	This is triggered one year after service unless otherwise noted.	Perform 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 performed prior to calibrating and testing the device.

RTC Battery Low	3110	Indicates when the RTC battery is low to prevent loss of date/time, forensic memory, and custom and last settings	• Hardware Problem: Change Battery • Check battery is properly seated, and the retention clip secures the battery in its location. • May occur after replacing RTC battery. Run device for 2 minutes while connected to AC power, then power cycle device. Repeat twice. If alarm persists, verify RTC battery's voltage.
Power Cycle Needed	3121	Triggered when the device has been in operation for over 30 days.	NOTE This is not an indication of a hardware problem. The start up self-check alarm will trigger if device servicing is required.

Observations		
Summary	Description	Resolution
Device Hardware COMM Problem	Some 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 setup • Return the device to service to evaluate the FTDI component.
External Power		The RCS requires External Power to operate. Connect External Power.

LCD is 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. This is expected behavior.	When using the RCS, 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, and 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
Date or PM Due Date resetting	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. A 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	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 USB – Hardware COMM • Check TSI COMM (see Test Station) • Retry to check if communication is established. • The log files store the status window content.
USB – Cable	With high use, the USB cable can degrade over time due to wear and tear.	• When multiple devices at a station fail due to communication with the device, check 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).	Choose another USB port on the PC.
User prompt hidden/not appearing	User expects to see a prompt pop-up but none are visible.	Prompt may be hidden by application. Minimize window to see prompt.
FAILED TO WRITE TESTLOAD.BOOTLOADER.BIN	This message may appear when initiating testing. The RCS 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. • Check for Device Hardware COMM

Troubleshooting — Front Panel

Remote Calibration System		
Discrete Tests	Purpose	Troubleshooting
Comm RAM and Bootloader Check	Verifies functionality of EMV COMM interface (RX & TX signals),	• CPU & RAM function, bootload interface as well as communication to SPM (SPM RX & TX, boot-select, 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 RCS 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 the contrast is able to be adjusted.	• The ribbon cable from the LCD to the button board may not be seated correctly. Try re-seating the cable. • If this test fails, 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 malfunctions, and contrast issues.	Replace the Front Panel Assembly kit.
Button Check	Verifies the proper functionality of each button on the device.	Replace the Front Panel Assembly kit.
Total Power Failure Alarm Check	Tests the power failure circuit, which in the event of a total power failure will pulse the buzzer and LEDs to indicate the failure. 120 second Total Power Failure alarm triggers (fast beep and red alarm LED blink pattern) and lasts for at least 10 seconds.	• 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	Verifies 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 an audible alarm.	Replace the Front Panel Assembly kit.

Troubleshooting — Pulse Oximeter Subsystem

Remote Calibration System		
Discrete Tests	Purpose/ Definition	Troubleshooting
Pulse Oximeter SpO2 and Heart Rate	A Masimo tester is used to verify 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 • Check the SPO2 simulator connections and settings • If above 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	Purpose	Troubleshooting
Li-Ion Battery Check	Evaluate the device's ability to discharge and charge the Li-Ion battery and read battery status. 1) Discharge Check: discharge current >= 2000mA for 120 seconds or battery state of charge 30 seconds < 80% and discharge current >= 2000mA for 30 seconds 2) Charge Check: charge current > 150mA for 30 seconds in total (does not have to be a continuous 30 seconds)	• Review active service codes. Refer to the Service code troubleshooting sheet • When conducting this test, unplug the external power from the connector at the ventilator.

Ventilator Alarms			
Title	Service Code	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 will 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 PIM board connections. • Ensure thermal gap pads are under PIM. • PIM board may need to be replaced.
Self Check: Power System Fault/Failure			

5V Bus Compromised	1172	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. • To repair, replace the PIM board and verify functionality. The connection between the boards may be damaged.
Input Protection Circuit Failure	2421	Indicates a damaged fuse on the PIM board.	Replace PIM and check SPM (as they are connected and my also be damaged).
Internal COMM Battery Faults	2455	Indicates a communication failure to the device's main battery (without external power).	• Check connection from main battery to PIM board • Replace battery or PIM
	3455	Indicates a communication failure to the device's main battery while operating on external power.	• Check connection from main battery to PIM board. • Replace battery or PIM
Internal COMM Power Components Fault	3470	Indicates a communication error with the PIM.	• Check the connection from the PIM to the SPM and check connection from the PIM to CPU. • To 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 verify the hardware has not failed. The SPM software checks for alarms. In the event an alarm is active, and the RCS indicates a failure.	Review active service codes refer to the Service code troubleshooting section.
SPM Blink	Verifies the SPM is able to drive the LEDs and buzzer in the event the EMV is not functioning. Operator confirmation that Red LEDs 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. 1. Input pressure limit is +/- 1 psi at 90 psi and +/- 10% at 70 psi 2. Leak rate <= 2000 ml/hour at 55 psi 3. Sintered bronze filter resistance measured at 100 LPM, and flow is between 0.01–0.06 psi/LPM. 4. Reported O2 supply pressure limit is < 2 psi for zero, and < 7 psi for 70 psi. 5. Reported O2 Leak through valve limit is <= 0.3 LPM	1. If this fails, 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 fails, check tubing. Check O-ring on O2 inlet assembly, O2 manifold, and O2 valve. Replace O2 manifold and O-rings. 3. If this fails, replace the sintered bronze filter assembly. 4. If this fails, check O2 supply. Check for kinked or damaged tubing. Replace the Smart Pneumatic Module (SPM)/Vent Assembly Kit. 5. If this fails, check for kinked or damaged tubing, and 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. • Check for loose Gas Output • Check if anti-asphyxia valve has become hardened or contaminated • 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 < 150 ms 3. Exhalation valve rise delay < 45 ms 4. Exhalation valve fall delay < 45 ms 5. Backup valve rise delay < 45 ms 6. Backup valve fall delay < 45 ms 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 or SPM Board kit. • Check exhaust valve for leak.

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 O2 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 22 ml 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 retrying, recalibrate the O2 sensor. • Replace the O2 sensor if FIO2 issues persist • If the ventilator 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 power cycling the device clears the alarm condition. Additionally, verify there are no compressor control faults with the power on self-check.	• Loose intake assembly or incomplete blockage. • No Alarm: Follow RCS prompt for setup, check intake pressure tubing, and ensure correct installation. • 3030 alarm: Partial blockage, ensure full occlusion • 2030 alarm: Partial blockage, ensure full occlusion

Date and Time Set	The RCS 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 RCS verifies functionality of date and time in the device vs. PC.	• Review active service codes. Refer to the service code troubleshooting sheet. • Retry setting the date and time • 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 issue persists after RTC battery replacement.

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
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 RCS 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	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	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: 25563 - 50104)	• 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. Tighten intake assembly. • Replace disk filter • RPM (caused by a leak during calibration) fails. Check Anti-Asphyxia valve (replacing if faulty), then recalibrate. • Low flow may indicate a leak • If high flow, recalibrate. • Filters may be dirty. Replace filters. • Check test setup for leaks • Compressor flow failures require recalibration. Ensure correct setup 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 have condensed 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.
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 Filter needs to be replaced • Flow screen is dirty. Clean or replace flow screen. • 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 properly
Devices are returned with “compressor failures” that are resolved with replacement of a disk filter.	• 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 disk filter.
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.
User prompt hidden/not appearing User expects to see a prompt pop up but none are visible.	• Prompt may be hidden by application. Minimize window to see prompt.

Troubleshooting — Oxygen System Calibrations

Remote Calibration System		
Discrete Tests	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 are 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 or tighter to allow for drift.	

Ventilator Alarms			
Title	Service Code	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 < 87 psig.
High 02 Supply Failure	1041 2041	Oxygen tank pressure is excessive (> 87 psig)	• Reduce O2 Supply Pressure • Power cycle device • Check Oxygen Regulator • Replace SPM if Supply Pressure is verified to be < 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 it will 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. Clean or replace flow screen. • O2 Valve: leaky valve/debris or 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.	• 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.
User prompt hidden/not appearing User expects to see a prompt pop up but none are visible.	• Prompt may be hidden by application. Minimize window to see prompt.

Troubleshooting — Test Station

Remote Calibration System		
Discrete Tests	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 specification

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 with Quality System.

PC Setup	• If this is a new installation and if the drivers did not register properly, 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 an incompatible open source driver (BOSSA). To fix, reinstall the RCS 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 second 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 Operator's Guide).
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
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 as they may be damaged if overtightened. • Debris may become lodged in the tubing from damage to the O-rings. • Inspect hoses to ensure O-rings are in place and not damaged
User prompt hidden/not appearing User expects to see a prompt pop up but none are visible.	• Prompt may be hidden by application. Minimize window to see prompt.

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 after successful completion of all tests. It is recommended to perform a complete power cycle of the device after erasing the forensic memory to reset the device. Please note that erasing the Forensic Memory will erase the user's "Custom Settings".

RCS Software 9.1	
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 .csv 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.

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

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 5 ventilators can be found below. The list is divided into the following three categories:

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

NOTE

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

Codes	Associated Alarm 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	**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. **Presents at power up** • Check tubing. If tubing kinked or disconnected, correct tubing • Check compressor cable is properly seated. If connector dislodged, re-seat connector. • Check diffuser screen. Check flow screen. If 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. If tubing kinked or disconnected, correct tubing. • Check Flow transducer. If bad flow transducer, replace Smart Pneumatic Module (SPM)/ Vent Assembly Kit.

Codes	Associated Alarm Name	Description / Possible Cause	Actions
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	• If calibration error, calibrate. • Check diffuser screen. Check flow screen. If collapsed diffuser screen, foreign substances contamination, or wet flow screen, replace screen. • If bad flow transducer, replace SPM Module.
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. If debris on the O2 input filter and manifold, replace O2 input filter. • Exercise ventilator at 100% FIO2, 50BPM for 5 minutes • Replace O2 valve

Codes	Associated Alarm Name	Description / Possible Cause	Actions
1011 2011 3011	O2 Flow Path (Failure/ Faults)	Description: Loss of O2 Flow control Possible Cause: • O2 valve cable faulty • loose, tubing kinked/damaged/disconnected • faulty valve drive circuit	• Check O2 Valve cable. If O2 valve cable faulty or loose, correct cable or replace O2 valve. • Check O2 Flow transducer tubing. If 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 O2 Flow transducer tubing. If kinked or disconnected tube, correct tubing. • Check SPM board. If SPM contamination near O2 flow transducer, replace SPM Module.

Codes	Associated Alarm 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. If O2 supply leak, correct O2 supply. • Check O2 regulator. If O2 supply regulator failure, replace O2 regulator. • Check High Pressure inlet. If debris in the high pressure O2 inlet, remove debris from high pressure inlet. • Check internal high pressure tubing. If internal tube disconnect, correct tubing. • Check High Pressure O2 barb. If 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. The disk filter may be installed incorrectly. Reinstall. • Check fresh gas intake filters. If dirty or wet, replace filters.

Codes	Associated Alarm Name	Description / Possible Cause	Actions
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	• If O2 reservoir in use, select Reservoir in use from the O2 sub menu. • Check fresh gas intake assembly. The disk filter may be installed incorrectly. Reinstall. • Check Fresh gas intake for partial occlusions. If occluded, correct occlusions. • Check filters. If dirty/wet filters, replace filters. • Check filters. If installed improperly, reinstall. • Check intake transducer tubing. If kinked tubing, correct or 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. If kinked tubing, correct tubing. • Replace SPM Module
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. If supply pressure too high, decrease O2 supply pressure. • Check O2 regulator. If faulty, replace O2 regulator on O2 inlet. • Replace SPM Module

Codes	Associated Alarm Name	Description / Possible Cause	Actions
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	To check for kinked tube or Auto Cal valve: **If failure occurs at startup:** this implicates transducer or kinked CF/OF/Auto Cal pathway hose. Correct hose. **If failure occurs at runtime**: this implicates Auto Cal valve. Replace SPM Module. To check valves: 1. Run exhalation, backup, and Auto Cal valve check to make sure valves are good. If valve failure, replace SPM Module. To check calibration: 1. If valves are good, run calibration checks for O2 flow, compressor flow, and airway pressure to see if one is out of specification. If calibration error, calibrate. 2. Rerun calibration for failing calibrations (if successful, it means a transducer offset shifted since device was last calibrated). If 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. If calibration drift, recalibrate. • Check AW Pressure/Auto Cal pathway tubing. If kinked tubing, correct tubing. • If bad airway pressure transducer, replace SPM module. • Check SPM PCB for contamination. If contaminated, replace SPM module.

Codes	Associated Alarm 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. If kinked tubing, correct tubing. • Check drive and exhalation tubing ports. If debris/blockage in exhalation drive or exhaust port, correct tubing or clean ports. • Check exhalation valve. If occluded exhalation valve, replace patient circuit. • Check patient circuit. If pinched patient circuit tubing, correct pinch. • Check exhalation/backup valve with RCS. If faulty exhalation/backup valve (EX_CON_1, EX_CON_2), replace SPM Module.

Codes	Associated Alarm Name	Description / Possible Cause	Actions
1061	Exhalation System Failure	Description: (Airway Pressure > 70 cmH2O for 1.5 seconds) 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. If blocked Exhalation Drive or exhaust tubing/port, correct blockage. • Check patient circuit exhalation valve. If blocked exhalation valve, replace exhalation valve patient circuit. • Check AW Pressure/Auto Cal pathway for kinked tubing. If kinked tubing, correct tubing. • If 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. If blocked Exhalation Drive or exhaust tubing/port, correct blockage. • Check patient circuit exhalation valve. If blocked exhalation valve, replace exhalation valve patient circuit. • Check AW Pressure/Auto Cal pathway for kinked tubing. If kinked tubing, correct tubing. • If none of the above, replace faulty SPM Module.
3110	RTC Battery Low	Description: RTC alarm at start up, date and time returned to default Possible Cause: • RTC battery is drained •	• Check RTC Battery. If RTC battery is drained, replace RTC battery. • If poor battery contact due to damaged retention clip, replace SPM Module.

Codes	Associated Alarm Name	Description / Possible Cause	Actions
3120	Calibration Due	Description: Calibration Due Possible Cause: • Calibration exceeds interval • RTC battery is drained • Intermittent RTC battery contact	• Check calibration date. If date exceeds interval, calibrate. • Check RTC Battery. If RTC battery is drained, replace RTC battery. • If poor battery contact due to damaged retention clip, 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 Barometric Pressure Sensor. If Altitude reads < 0.1 ATM or > 1.9 ATM, replace SPM Module. • If Transducer output stuck ATM, replace SPM Module.

Codes	Associated Alarm Name	Description / Possible Cause	Actions
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 25,000 feet: Faulty Barometric Pressure Sensor	• Check the barometric pressure sensor by bringing the ventilator to a stable altitude below 25,000 feet. The alarm condition should clear. If the alarm condition 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 by bringing the ventilator to a stable altitude above -2000 feet. The alarm condition should clear. If the alarm condition does not clear, the barometric transducer may be stuck. Replace the SPM Module.

Codes	Associated Alarm 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	• Power cycle device. If alarm condition does not clear, power cycle again. If alarm condition 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 LED **is not** blinking, replace SPM Module. If LED **is** blinking, 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/improper seating of the PIM to CPU cable. If the cable is damaged, replace cable. • If issue persists after replacing PIM to CPU cable, the CPU Module is faulty. Replace Front Panel Assembly.

Codes	Associated Alarm Name	Description / Possible Cause	Actions
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 if the transducer tubing is kinked. If tubing is kinked, correct tubing. • Check if the calibration has drifted by recalibrating. If the issue is resolved, the cause was transducer drift. If the issue persists, replace the SPM Module. • Check for contamination on the SPM Module or for a bad transducer. If SPM board is contaminated or transducer is 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
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 if the calibration table has been corrupted by recalibrating (do not write defaults). If the issue is resolved, the cause was the calibration table. If the issue persists, replace the SPM Module.

Codes	Associated Alarm Name	Description / Possible Cause	Actions
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 if the Masimo board has become dislodged. If it has, reseat the Masimo board. • Check if the Masimo board is damaged. If it is, replace CPU/SPO2 Stack kit. • If the above actions do not resolve the issue, the Front Panel Module is faulty. 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 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	Associated Alarm 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 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. If 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 if the battery pack is missing. If it is, replace battery pack. • Check if the battery pack is unplugged. If it is, plug in the battery pack. • Check if the battery cable is damaged. If it is, replace battery pack. • Check if the battery pack is malfunctioning. If it is, replace battery pack. • If none of the above resolve the issue, the cause is PIM board failure. Replace the PIM board.

Codes	Associated Alarm Name	Description / Possible Cause	Actions
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 the applied voltage is in specified range. If so, external power supply is faulty. Replace external power supply. • If the above does not resolve the issue, the cause is a faulty PIM board. Replace the PIM board.
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 the applied voltage is in specified range. If so, external power supply is faulty. Replace external power supply. • If the above does not resolve the issue, the cause is a 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 the applied voltage is in specified range. If so, external power supply fault or DC to DC converter fault. Replace external power supply or DC to DC converter. • If the above does not resolve the issue, the cause is a faulty PIM board. Replace the PIM board.

Codes	Associated Alarm Name	Description / Possible Cause	Actions
2450 3450	Battery Discharge Fault	Description: The battery pack has reported an internal temperature of ≥ 70 °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 °C. Possible Cause: • The internal temperature of the battery pack is too high and external power is plugged in	• Replace Battery Pack

Codes	Associated Alarm Name	Description / Possible Cause	Actions
3452	Battery Charging Fault	Description: External power present AND battery temperature ≥ 45 °C NOTE The battery pack will continue charging up to 50 °C if it was charging before 45 °C, but must be below 45 °C to re-initiate charging once 50 °C 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

Codes	Associated Alarm Name	Description / Possible Cause	Actions
3453	Battery Charging Fault	Description: External power present AND battery temperature ≤ 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. If cable loose or dislodged, re-seat battery cable. • Check battery pack. If faulty battery pack, replace battery pack. • If the above does not resolve the issue, the cause is a faulty PIM board. Replace the PIM board.
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 or improper seating of the PIM to CPU cable. If damaged or loose, replace the PIM to CPU cable. • If the above does not resolve the issue, the cause is a faulty PIM board. Replace the PIM board.

Codes	Associated Alarm Name	Description / Possible Cause	Actions
1471	Self Check Failure	Description: cannot communicate with IO expander responsible for sampling buttons and driving LEDs Possible Cause: • Stuck I2C bus • dislodged CPU to UIM connection • faulty UIM adapter or CPU board	• Check if the I2C bus is stuck by power cycling the device. If the issue is resolved, the cause was stuck I2C bus. No further action required. • Check the CPU to UIM connection. If CPU(J4) to UIM(J1) connection dislodged, correct dislodged connection. • If none of the above resolves the issue, the cause is a 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 for damage or improper seating of the PIM to CPU cable. If damaged or loose, replace the PIM to CPU cable. • If the above does not resolve the issue, a possible cause is 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 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. If faulty or loose, replace PIM to CPU cable. If the LED **is not** blinking, the SPM firmware may be corrupt. If corrupt firmware, reprogram SPM. • If the above does not resolve the issue, the cause is a faulty SPM Module. Replace SPM Module.

Codes	Associated Alarm 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 if the I2C bus is stuck by power cycling the device. If the issue is resolved, the cause was stuck I2C bus. No further action required. • If this does not resolve the issue, the cause is a 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? If so, use RCS to Write "SPM SN" and "SPM Model" in "SN To Update" fields • Is it possible that assemblies have been accidentally swapped? If so, correct the assemblies. • Did this happen during an upgrade? Incomplete upgrade possible. Re-conduct upgrade and use RCS to Write "SPM SN" and "SPM Model" in "SN To Update" fields. • Did this happen during programming? Incorrect programming possible. Re-conduct programing, and use RCS to Write "SPM SN" and "SPM Model" in "SN To Update" fields.

Service Codes - Version 4

A list of all ventilator service codes for Version 4 ventilators can be found below. The list is divided into the following three categories:

- High Priority
- Medium Priority
- Low Priority

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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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
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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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 O2 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 O2 by setting the FIO2 to 100%. At this time, the priority changes to low priority. While operating in this state, the user should ensure an adequate supply of O2. Failure to maintain the O2 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 O2 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 FIO2 to 21%. At this time, the alarm priority changes to low. While operating in this state, the user should monitor the SpO2 to ensure that adequate oxygenation is maintained. If low flow O2 is available, it can be entrained through the Fresh Gas/Emergency Air Intake port using the optional O2 reservoir. Maintain an acceptable SpO2 by adjusting the O2 supply up or down to increase or decrease the amount of O2 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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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
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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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
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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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
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 SpO2 value drops below the Low SpO2 Limit. The default value for the limit is 94%. Corrective actions are increasing oxygenation by increasing the FIO2 or PEEP settings. PEEP should only be changed based on consultation with the attending physician. When using low flow O2 the user should increase the flow of O2 to the low flow O2 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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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
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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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
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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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
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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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
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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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
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

Service Code	Associated Alarm Name	Description	Service Kit/ Resolution
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

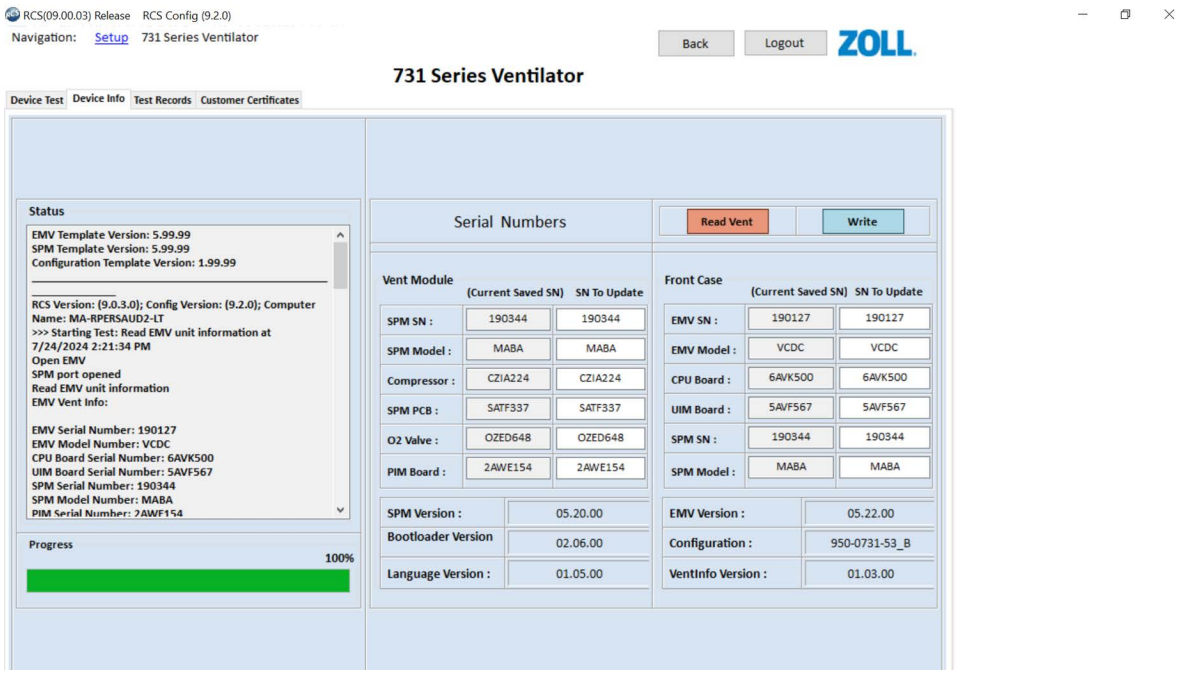
Writing Serial Numbers to the Ventilator

The Remote Calibration System (RCS) provides the user the ability to write serial numbers to a 731 Series ventilator. This is required in the following instances:

- When installing new *serialized* parts/components inside the ventilator
- When recovering from corrupted data on the ventilator

To write serial numbers to a ventilator, perform the following:

1. Power on the RCS laptop and launch the RCS software application.
2. Connect the laptop to the ventilator using the Setup L configuration (as depicted in “RCS Set-ups” on page 3-21).
3. On the RCS user interface, click “Read Vent” to establish communication between the RCS application and the ventilator.
4. Click on the “Device Info” tab to view the serial numbers for the ventilator.



5. For each new serial number needing to be written to the ventilator, enter the new part/component’s serial number into the corresponding “SN To Update” field.
6. Once finished entering the new serial number(s), click on the “Write” button to write the serial numbers to the respective boards within the ventilator. Acknowledge and proceed through the prompts which appear.
7. Click “Read Vent” to verify the serial numbers were written to the SPM and CPU/UIM boards within the ventilator.

NOTE

Writing serial numbers to the ventilator will set the calibration date to January 1, 2001 (2001-01-01). In some instances, a default calibration table will be saved to the device.

8. Click the “Device Test” tab and complete the Calibrations/System Tests to set the correct PM Due date.