HAMILTON-C2

Intelligent Ventilation

Service Manual

PN 624165/03
October 2010

HAMILTON MEDICAL

This document may be revised or replaced by HAMILTON MEDICAL AG at any time and without notice. You should ensure that you have the most current applicable version of this document; if in doubt, contact the technical support department of HAMILTON MEDICAL AG, Switzerland. While the information set forth is believed to be accurate, it is not a substitute for the excercise of professional judgement.

Nothing in this document shall limit or restrict in any way HAMILTON MEDICAL AG's right to revise or otherwise change or modify the equipment (including its software) described herein, without notice. In the absence of an express, written agreement to the contrary, HAMILTON MEDICAL AG has no obligation to furnish any such revisions, changes, or modifications to the owner or user of the equipment (including software) described herein.

The equipment must be operated, serviced or upgraded only by trained professionals. HAMILTON MEDICAL's sole responsibility with respect to the equipment and its use is as stated in the limited warranty provided in the operator's manual.

HAMILTON MEDICAL AG will make available on request, component parts lists, descriptions, calibration instructions, or other information that will assist the user's appropriately trained personnel to repair those parts of the equipment designated by HAMILTON MEDICAL AG to be repairable.

Manufacturer
HAMILTON MEDICAL AG
Via Crusch 8
CH-7402 Bonaduz
Switzerland
Phone: (+41) 81 660 60 10
Fax: (+41) 81 660 60 20

info@hamilton-medical.com
www.hamilton-medical.com

Representative in USA
HAMILTON MEDICAL Inc.
4990 Energy Way
Reno, NV 89502
PO Box 30008
Reno, NV 89520
Phone: (775) 858-3200
Toll-free: (800) HAM-MED 1
Or: (800) 426-6331
Fax: (775) 856-5621

Table of Contents

Part 2: Preventive Maintenance and Testing

Part 3:
Component Technical faults

Conventions

Notes, Cautions and Warnings

Note
This format emphasizes information of particular importance.

CAUTION
This format alerts the user to the possibility of a problem with the device associated with its use or misuse, such as device malfunction, device failure, damage to the device, or damage to other property.

WARNING
This format alerts the user to the possibility of injury, death, or other serious adverse reactions associated with the user or misuse of the device.

Note
The HAMILTON-C2 needs a warm-up period. Make sure it was running for at least 20 minutes in the ventilation software.

Typographic Conventions

Effect	Example	Function
`Courier, bold`	**`Configuration`**	Marks text quoted directly from the HAMILTON-C2 screen.
Italic	*HAMILTON-C2 Ventilator Operator's Manual*	Marks the names of other documents.
	Appendix C, *Upgrade paths*, on page C-1	Marks text that is a quotation from within the manual. In this example, it is part of a cross-reference.
	Tank	Marks a term that is in the glossary. If you are using a PDF file to view this, you can hyperlink to the glossary by clicking on these items.
Bold	**TRIGGER**	Marks text that is quoted directly from: • The HAMILTON-C2 case • A touch key • A printed circuit board
Bold, italic	Select ***only the first*** column.	Emphasizes important text.
Number Sequence	1. Step one in a sequence 2. Step two in a sequence	Organizes the performance of actions into steps.
Letter Sequence	A. Identifies part A B. Identifies part B	Used in photos and illustrations to identify the topic being discussed and relates to specific text.

Expressions

Expression	Example	Explanation
Activate	Activate **`LED ON/OFF`**.	Using the Control Knob, you must first select the **`LED ON/OFF`** Button on the HAMILTON-C2's screen, and then press the Control Knob. The button on the screen changes its appearance, so that it looks "pressed". It now performs its function (turning the LED ON in this case). Sometimes you are told to "activate and set" a field. In this case you first activate the field, and then turn the P&T Control Knob to set a value.
Deactivate	Deactivate **`LED ON/OFF`**.	With **`LED ON/OFF`** still selected and activated, you must press the Control Knob again. The button on the screen changes its appearance, so that it looks "unpressed". It stops performing its function (turning the LED OFF in this case).
Select	Select **`LED ON/OFF.`**	Pressing the Touchscreen to select the LED ON/OFF Button.
De-select	De-select **`LED ON/OFF.`**	Pressing the Touchscreen to de-select the LED ON/OFF Button.
Pressure	Patient Pressure is 80 mbar.	Pressure refers to the amount of pressure above ambient pressure. If the Patient Pressure (Ppat) is 80 mbar, it means the pressure is 80 mbar above the ambient (room) pressure.
Software version	0.6.0	The HAMILTON-C2 contains a memory device that hold software identified by a version number.
Update	This kit enables an update to an existing function.	An update is an improvement to an existing function. An update normally involves only software. A software update is generally a revision number increment in a digit after the decimal point.
Upgrade	This kit enables an upgrade to implement a new function.	An upgrade is the addition of new functions to a device. There are three ways to perform an upgrade: • Add a hardware item that offers additional functions. • Upgrade to a higher software revision. This is indicated by a higher value before the decimal point. • Upgrade to a higher type of software.
*	With this kit, you can update or upgrade from software version.	Unless otherwise stated, a syntax variable ("wild card") indicates the use of any alpha-numeric character.

Foreword

WARNING

- ***Service the HAMILTON-C2 only as described in this manual, using only parts approved or supplied by HAMILTON MEDICAL AG. Incorrectly parts, components or assemblies could result in patient injury. See available spare parts in Appendix B, Spare Parts, on page B-1.***
- ***For incorrectly used parts HAMILTON MEDICAL doesn't takes any warranty.***

The HAMILTON-C2 Service Manual is for:

Engineers who have successfully completed a HAMILTON MEDICAL AG Service Training Course for the HAMILTON-C2.

Training courses are held regularly in Bonaduz, Switzerland, at HAMILTON MEDICAL's headquarters, and at other locations throughout the world. For more information, visit the partner section of the HAMILTON MEDICAL AG Web Site (http://www.hamilton-medical.com).

Note

If you have questions about testing or any part of this manual, contact HAMILTON MEDICAL AG (techsupport@hamilton-medical.ch).

The HAMILTON-C2 Service Manual contains:

The architecture and components of the HAMILTON-C2.

In addition, information on testing, troubleshooting and repairing the HAMILTON-C2.

Appendices.

The HAMILTON-C2 Service Manual does not contain:

Information about operating the HAMILTON-C2. See the HAMILTON-C2 Operator's Manual for operating instructions.

This HAMILTON-C2 Service Manual covers:

The HAMILTON-C2 Software version 1.1.1 and higher versions.

The HAMILTON-C2 Service Manual Structure:

Section	Function	Your responsibility
Section 1, *HAMILTON-C2 Overview*	This section explains the theory behind the HAMILTON-C2.	***You should fully understand this section.***
Section 2, *Pneumatics: Overview and Theory of Operation*	This section explains each component and the gas flows, flow measurements and pressure measurements in the pneumatic circuits.	***You should be able to name and explain the functions of all the major components.***
Section 3, *Electronics: Component Functions*	This section explains the basic functions of the printed circuit boards, Printed circuit boards are not repaired in the field.	***You should be able to identify all circuit boards, and know where they are positioned in the HAMILTON-C2.***
Section 4, *Lithium Ion Battery*	This section explains the use, care and maintenance of the Lithium Ion Battery Pack.	***You have to understand the safety concerns and hazards, and know how to perform charging and calibration of the Lithium Ion Battery Pack.***
Section 5, *Preventive Maintenance and Testing Overview*	This section gives a schedule for maintenance.	***You have to be familiar with the maintenance schedule for the HAMILTON-C2.***
Section 6, *Hospital Preventive Maintenance*	This section gives the Hospital Preventive Maintenance details.	***You should be able to perform this maintenance and assertain if this maintenance is being performed regularly.***
Section 7, *Engineer Preventive Maintenance*	This section gives maintenance details.	***You have to be able to perform all the tasks in this section.***
Section 8, *Electrical Safety Tests*	This section lists further tests you must perform on the HAMILTON-C2 before you start the Service Software tests.	***You have to be able to use this section to test the HAMILTON-C2.***
Section 9, *Service Software*	This section explains how you perform the tests that are built into the software of the HAMILTON-C2.	***You have to know how to perform all the appropriate tests.***
Section 10, *Technical faults*	This section gives an overview of the alarm indications	--
Section 11, *Components Removal/Assembly*	This section explains how to remove and assemble each major component.	***You have to be able to use this section to make repairs***.
Appendix A, *Maintenance Tools and Test Equipment*	This appendix lists the equipment you require to work on the HAMILTON-C2.	Check this appendix to make sure you have the correct tools and test equipment.
Appendix B, *Spare Parts*	Information resource.	You only require this section when you must order spare parts.
Appendix C, *Schematics*	This section includes many of the schematics produced by HAMILTON MEDICAL AG for internal use.	You are sometimes directed to this section when reading in other parts of the manual.

Section	Function	Your responsibility
Appendix D, *Software revisions, features and compatibility*	This section explains many of the expressions used in the manual.	You should know how to find information in this section.
Appendix E, *Hardware revisions, features and compatibility*	This section explains many of the expressions used in the manual.	You should know how to find information in this section.
Appendix F, *Glossary*	This section explains many of the expressions used in the manual.	You should know how to find information in this section.
Appendix G, *Knowledgebase*	This section explains many of the expressions used in the manual.	You should know how to find information in this section.
HAMILTON-C2 Test Report	Test Report pages for the Service Software section.	Complete the report when using the Service Software tests.

Part 1:
General Description

Section

1 HAMILTON-C2 Overview

1.1 Front Components Overview

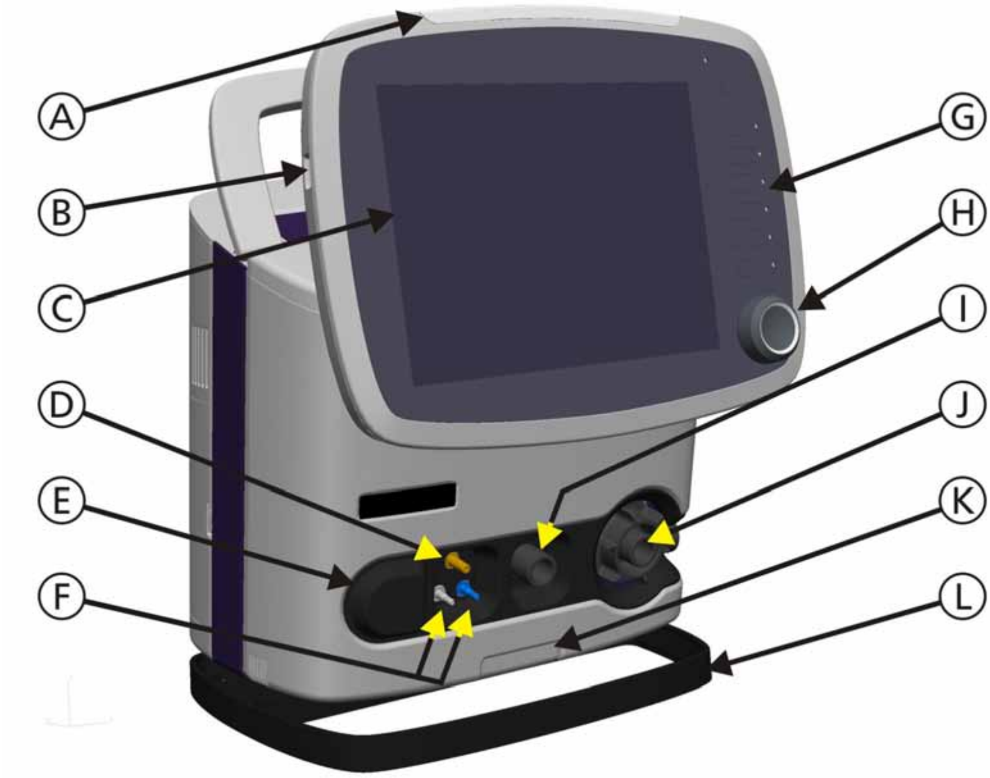


Figure 1-1. Front Panel Components Overview

A. Alarm Lamp
- Yellow - Medium and Low Priority Alarms
- Red - High Priority Alarms and Technical Faults

B. USB Socket

C. 10.4” TFT Display with Touchscreen and Backlight

D. Nebulizer Connection

E. Oxygen Cell Sensor and Cover (O2 cell not shown)

F. Flow Sensor Connections

G. Front Panel Keys

H. P&T (Press and Turn) Control Knob

I. Patient Breathing Circuit Connection to the Patient

J. Patient Breathing Circuit Connection from the Patient

K. Quick lock to remove Hamilton-C2 from the trolley.

L. Shelf Stand

1.2 Rear Components Overview

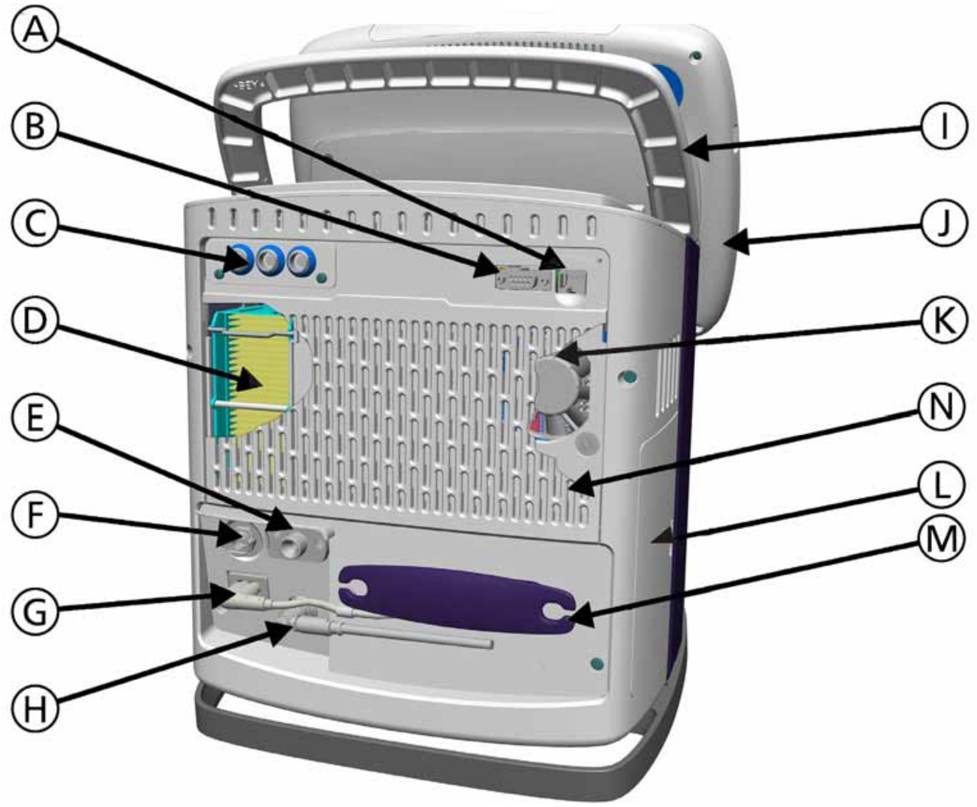


Figure 1-2. Rear Panel Components Overview

A. Ethernet Connection
B. RS232 Interface Connection
C. Option slot for future options
D. Dust Air Filter and HEPA Filter Element
E. High Pressure Oxygen DISS or NIST Connection
F. Low Pressure Oxygen Connection
G. Mains Power Inlet
H. DC input
I. Lift Handle
J. Interaction Panel
K. Cooling Fan
L. Battery Compartment
M. Cable Holder
N. Ventilation Unit Filter Cover

1.3 Interaction Panel Internal Components Overview

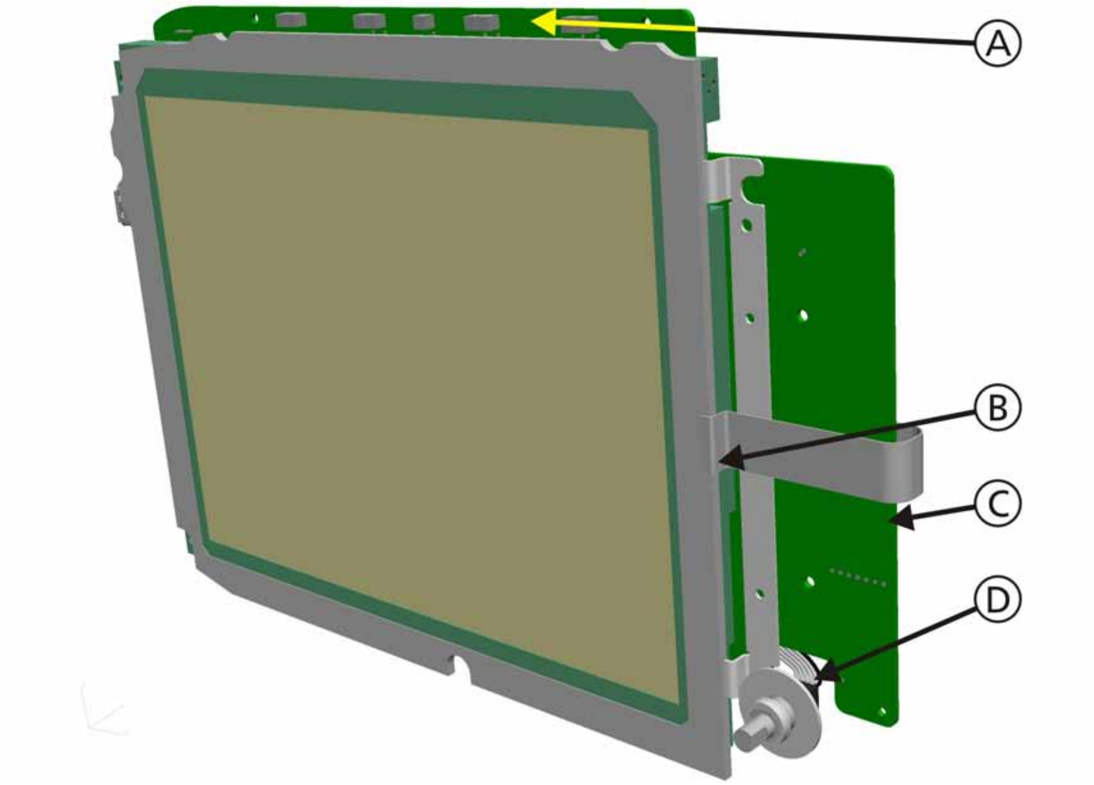


Figure 1-3. Interaction Panel Internal Components Front Overview

A. Alarm Lamp LED's

B. 10.4" TFT Display with Backlight

C. IP Board

D. P&T (Press and Turn) Control Knob Encoder

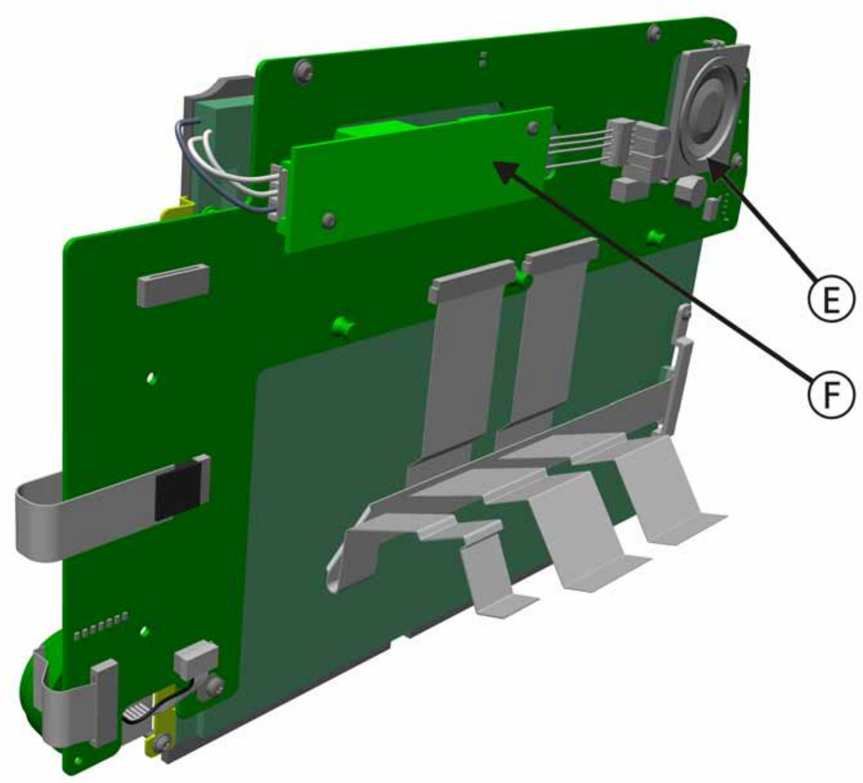


Figure 1-4. Interaction Panel Internal Components Rear Overview

E. Loudspeaker

F. Backlight Converter Board

1.4 Ventilation Unit Internal Components Overview

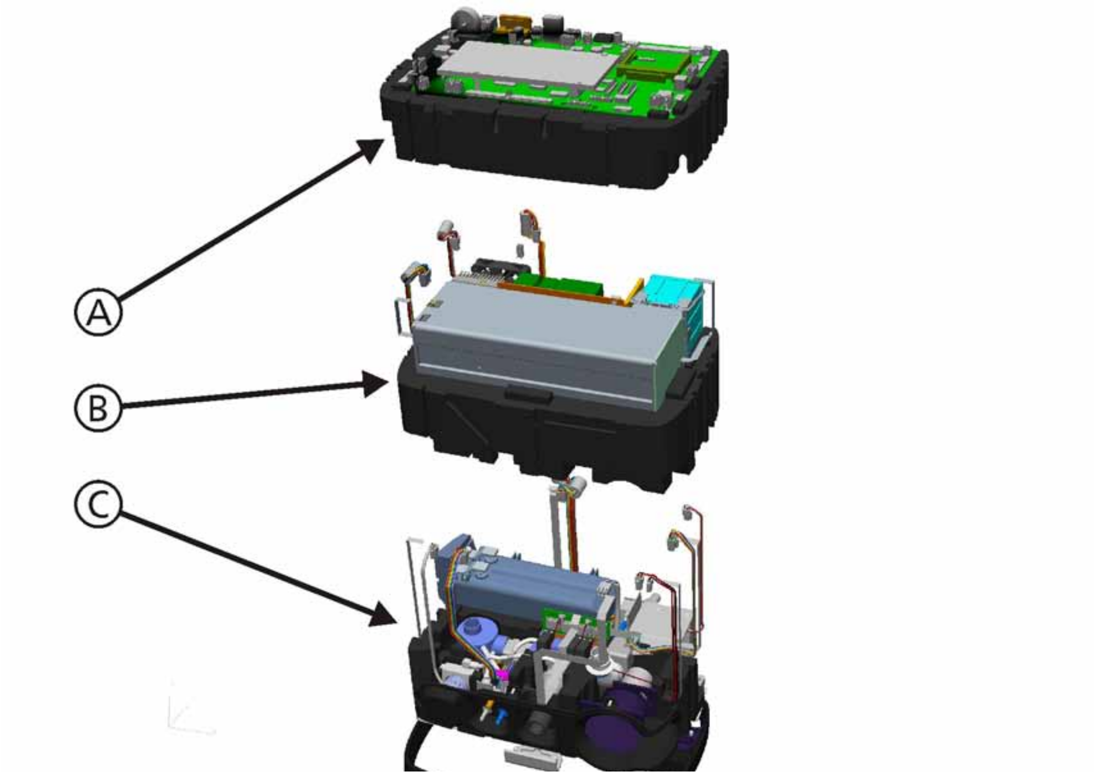


Figure 1-5. Ventilation Unit Internal Components Overview

The Ventilation Unit is divided into 3 sections:

A. Top Section

B. Middle Section

C. Bottom Section

1.5 Top Section

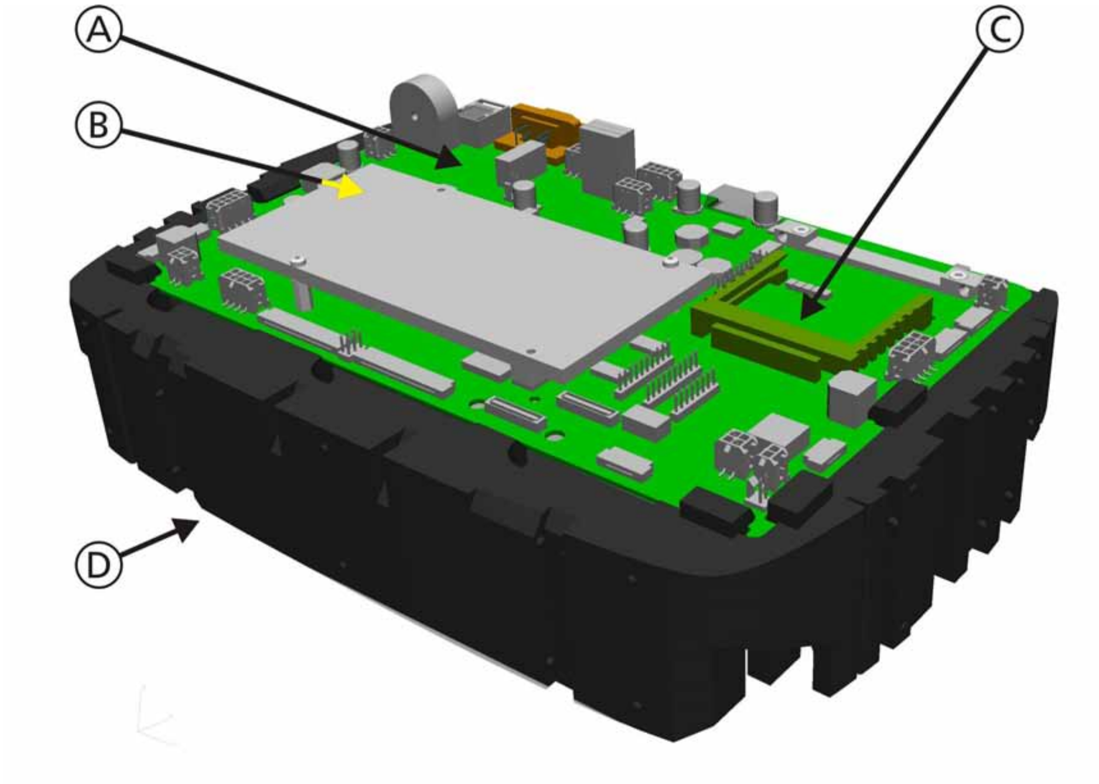


Figure 1-6. Ventilation Unit Internal Components Top Section Front Overview

A. Mainboard

B. ESM (Embedded System Module)

C. Options Slot

D. Top Foam Section

1.6 Middle Section

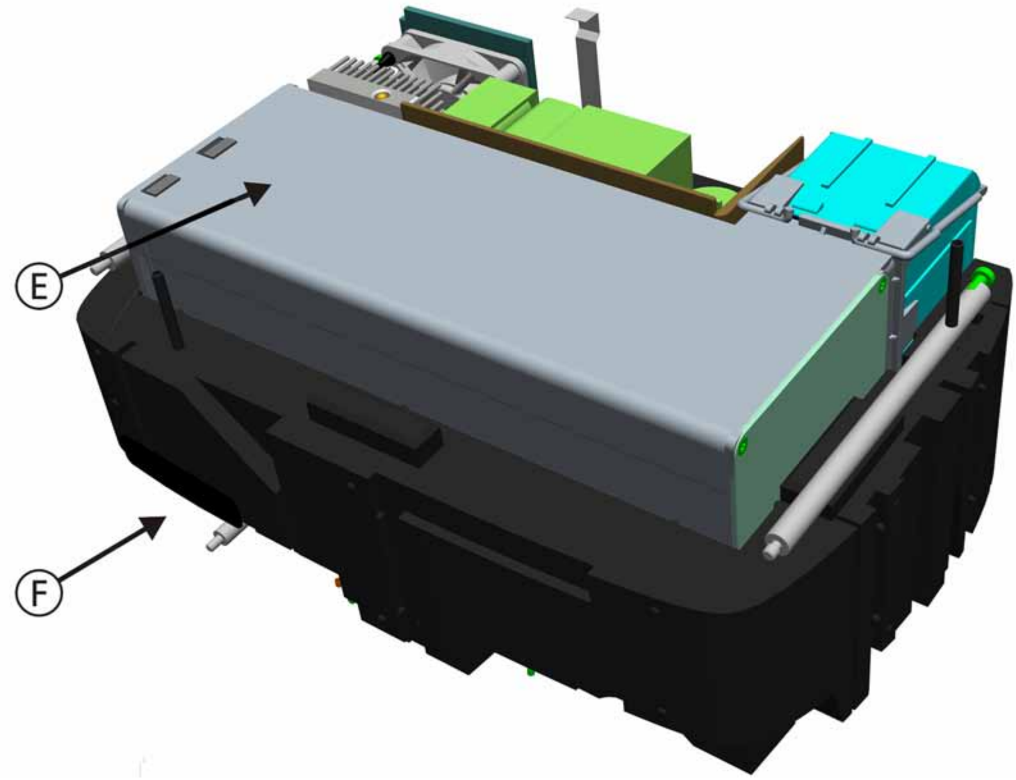


Figure 1-7. Ventilation Unit Internal Components Middle Section Front Overview

E. Blower Assembly

F. Middle Foam Section

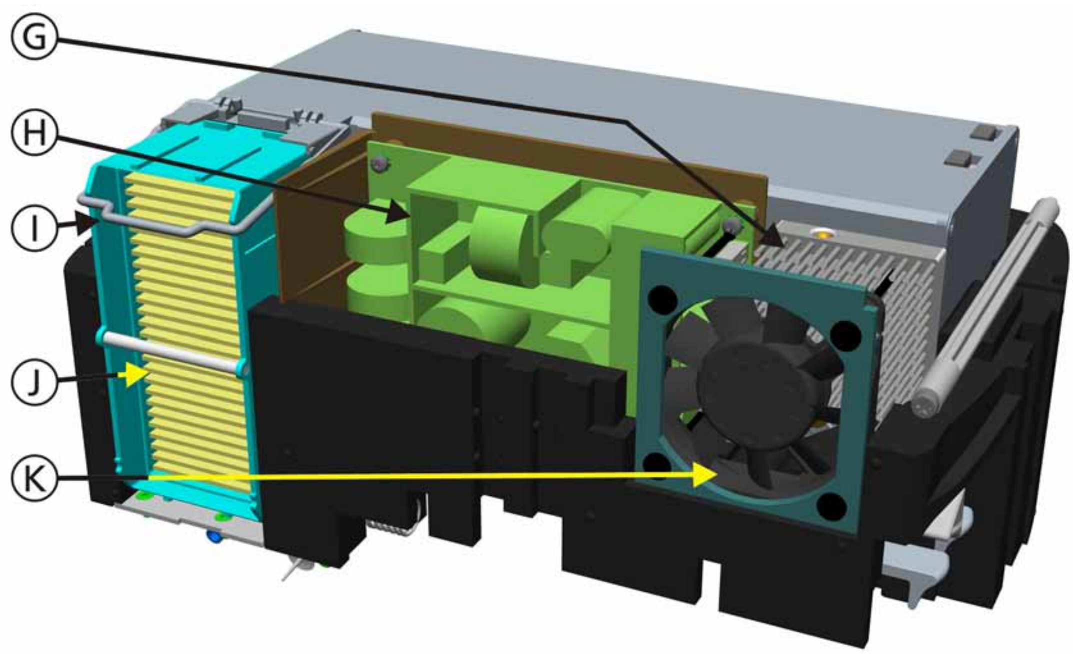


Figure 1-8. Ventilation Unit Internal Components Middle Section Rear Overview

G. Heat Exchanger
H. Power Supply
I. HEPA Filter Latch
J. HEPA Filter
K. Cooling Fan

1.7 Bottom Section

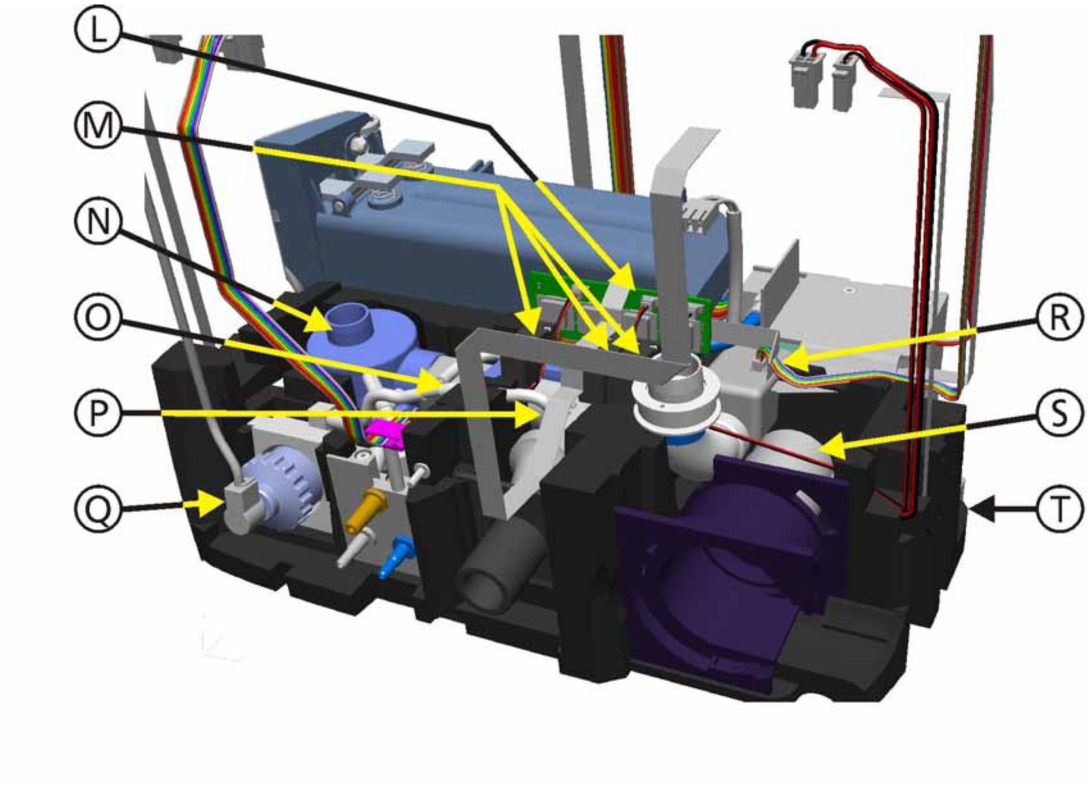


Figure 1-9. Ventilation Unit Internal Components Bottom Section Front Overview

L. Pressure Sensor Assembly

M. Autozero Valves

N. Inspiratory Valve

O. Qvent Flow Sensor

P. Ambient Valve

Q. O_2 Cell

R. QO_2 Flow Sensor

S. Expiratory Valve

T. Bottom Foam Section

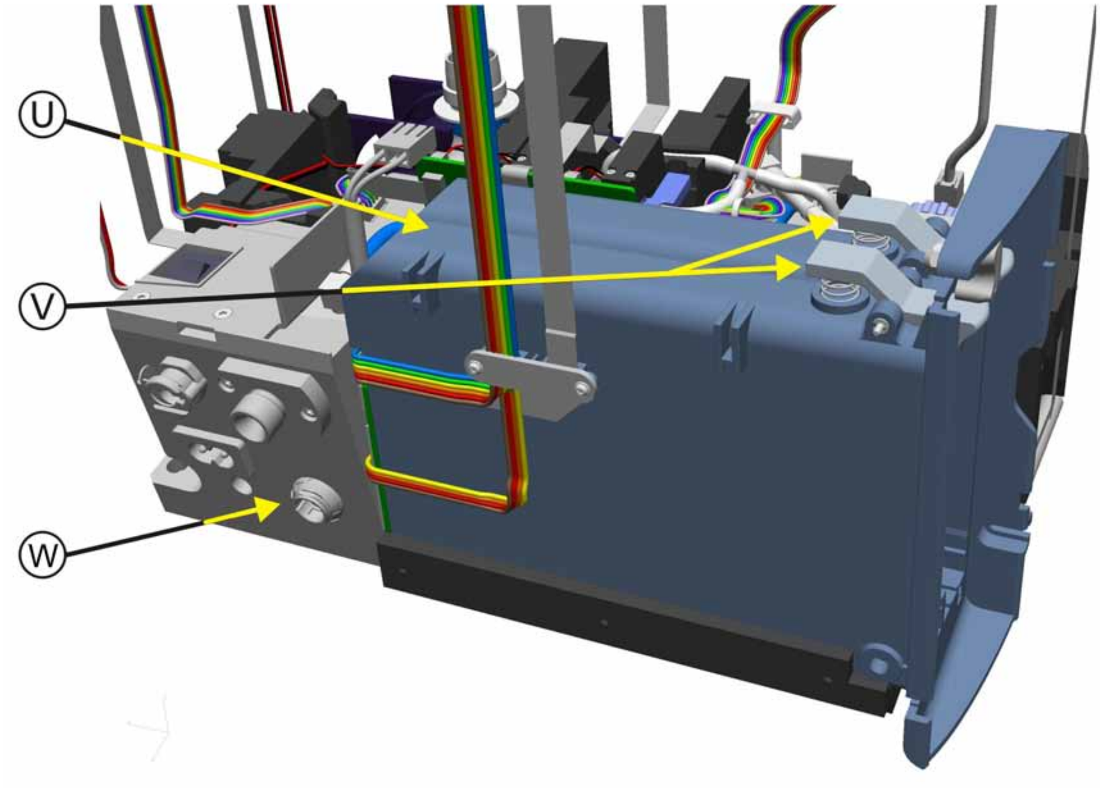


Figure 1-10. Ventilation Unit Internal Components Bottom Section Rear Overview

U. Battery Module

V. Battery Release Latches

W. Oxygen Mixer Block

Section

2 Pneumatics: Overview and Theory of Operation

2.1 Overview

This section introduces all the major pneumatic components in the HAMILTON-C2. In addition, the gas flows and theory of operation are explained.

Note

The figures in this section show exploded and transparent views of the HAMILTON-C2 components. The exploded diagrams may not always show components in their correct positions.

WARNING

Repair of parts, components or assemblies is not permitted by HAMILTON MEDICAL AG, as incorrectly repaired parts, components or assemblies could result in patient injury. See available spare parts in Spare Parts.

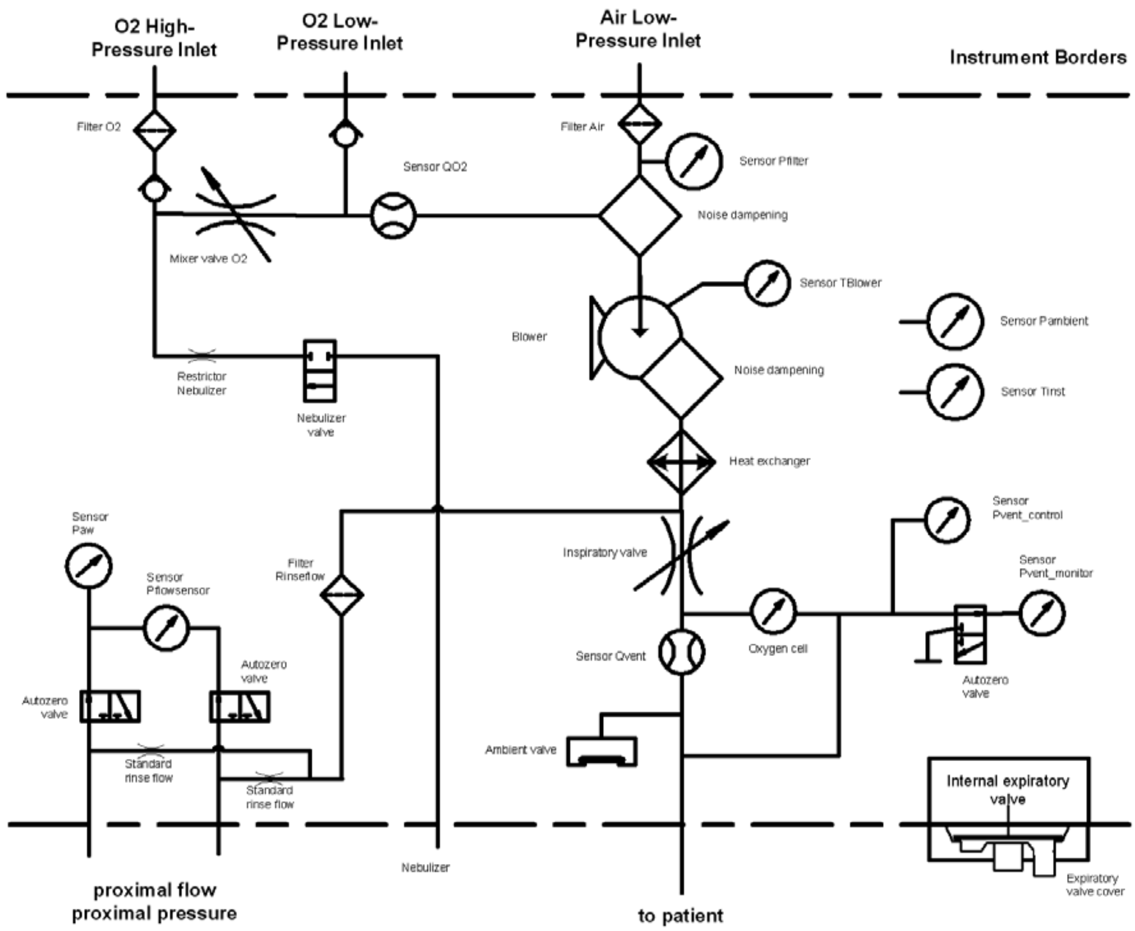


Figure 2-1. Pneumatic System Drawing

2.1.1 Blower Assembly Overview

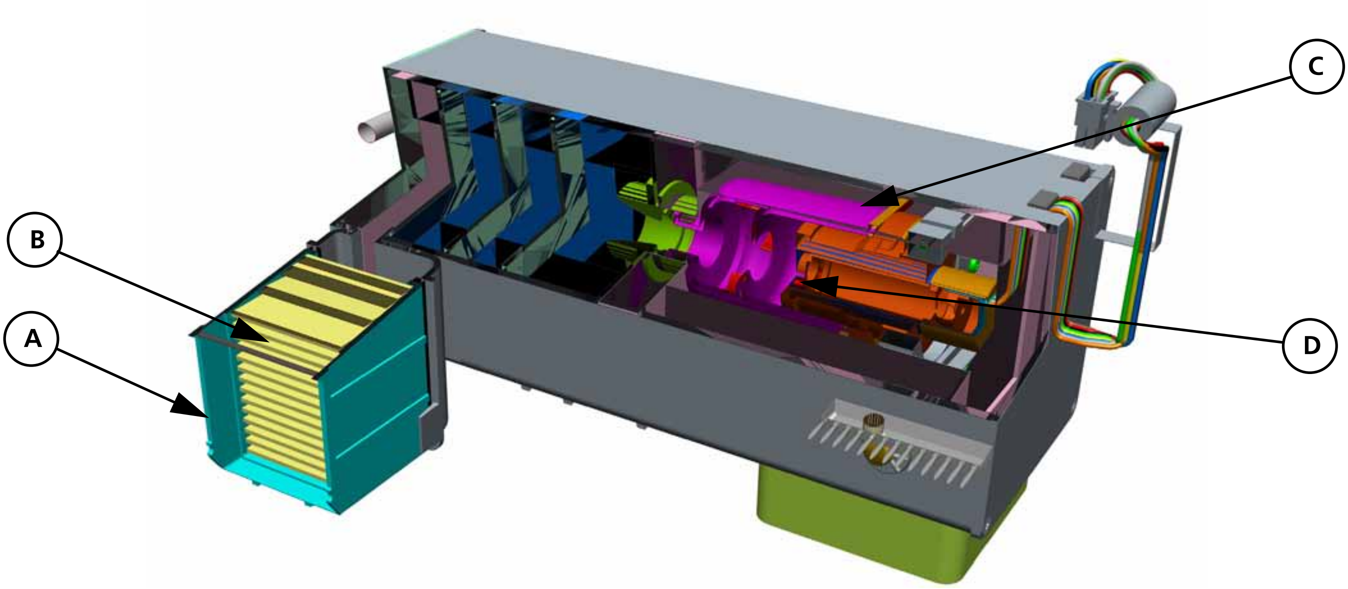


Figure 2-2. Blower Assembly Overview

The Blower Assembly supplies the air and oxygen mixture for patient inspiration.

A. Dust Air Filter

B. HEPA Filter Element

C. Blower Module

D. Blower and Motor

2.1.2 Oxygen Mixer Block Assembly Overview

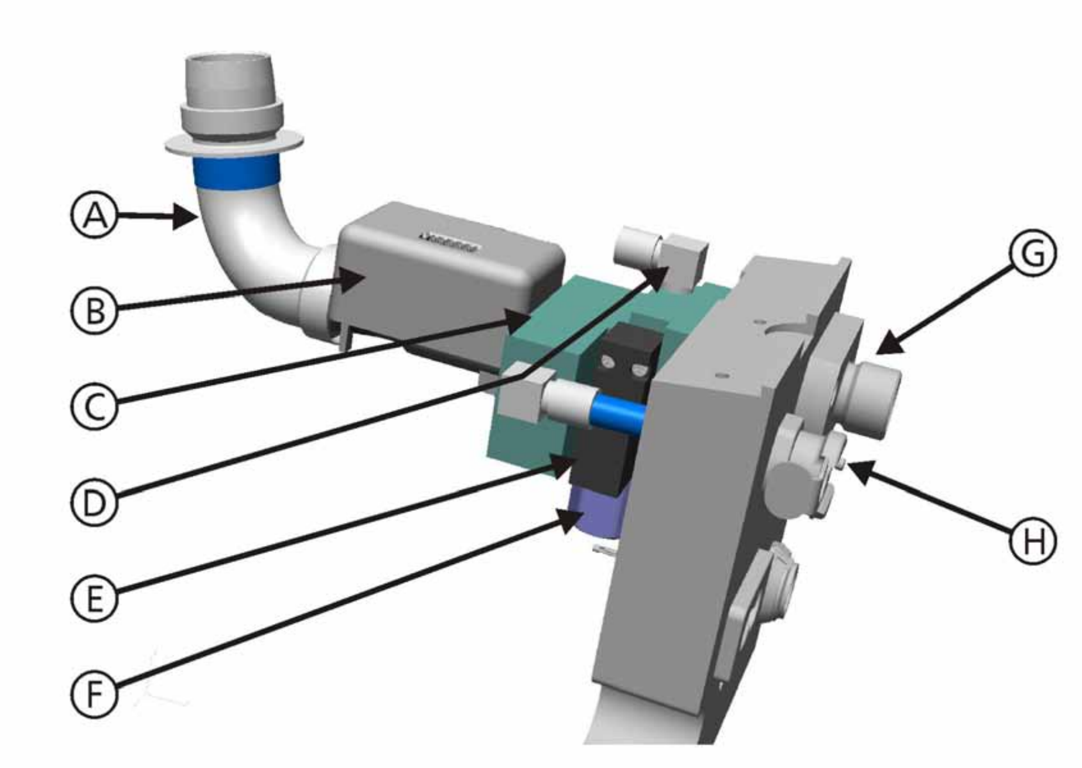


Figure 2-3. Oxygen Mixer Block Assembly Overview

The Oxygen Mixer Block Assembly controls the flow of oxygen into the Blower Assembly.

A. Shaped Tube from the QO_2 Flow Sensor to the Blower Assembly

B. QO_2 Flow Sensor

C. Oxygen Mixer Block Assembly

D. Outlet to supply Oxygen to the Front Panel Nebulizer Connection

E. Nebulizer Valve

F. High Pressure Oxygen Control Valve

G. High pressure Oxygen DISS or NIST Connection

H. Low pressure Oxygen Connection

2.1.3 Inspiratory Valve Overview

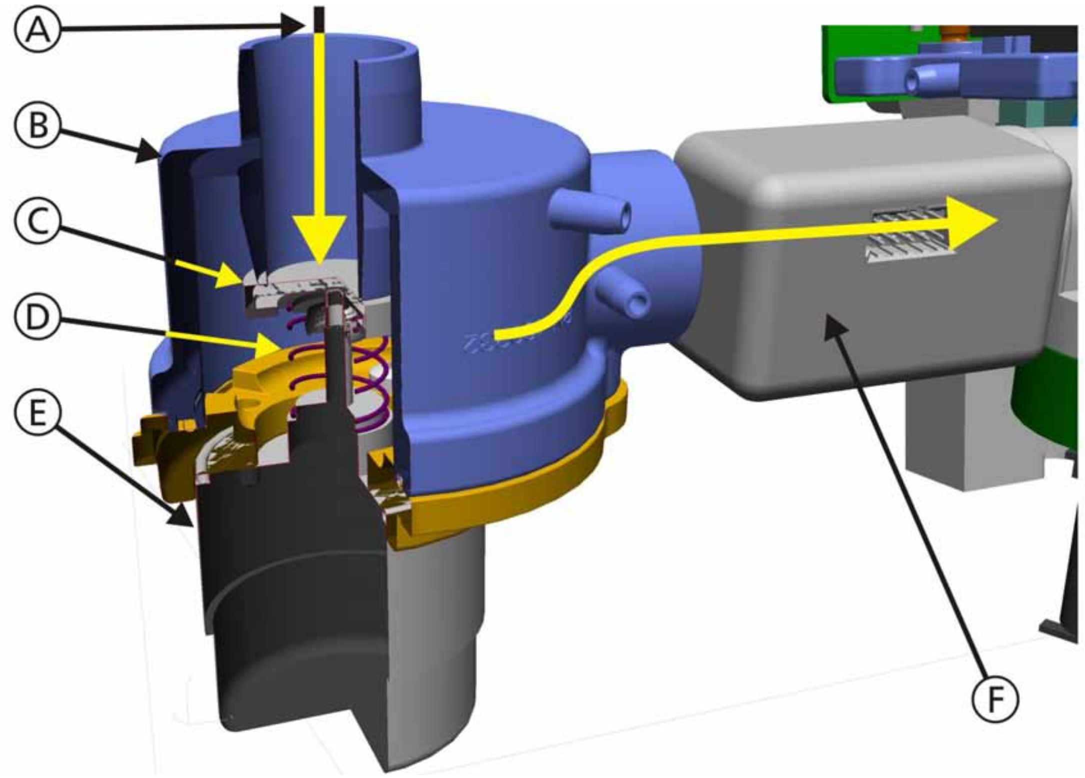


Figure 2-4. Inspiratory Valve Overview

The Inspiratory Valve precisely controls the volume and pressure of the air/oxygen mixture from the Blower Assembly to the Patient Breathing Circuit.

The Inspiratory Valve contains the following components:

A. The Air/Oxygen Mixture from the Blower Assembly
B. Inspiratory Valve
C. Control Valve
D. Pressure Spring
E. Inspiratory Valve Voice Coil Assembly
F. Qvent Flow Sensor

2.1.4 Ambient Valve Overview

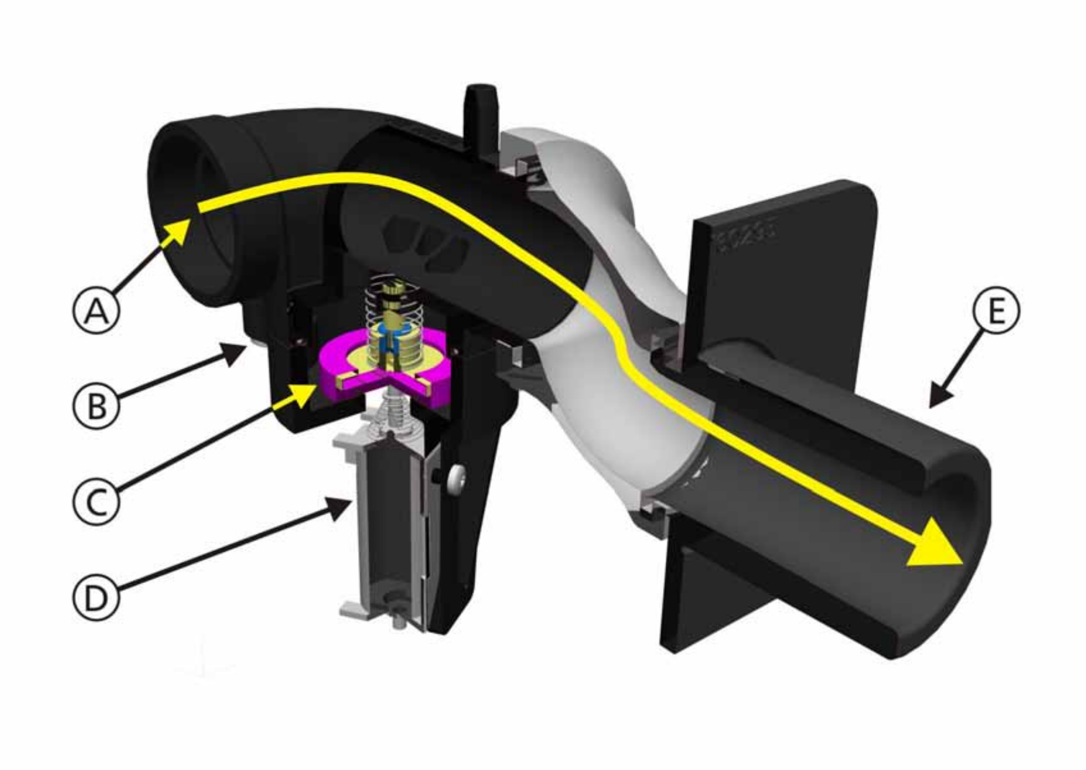


Figure 2-5. Ambient Valve Overview

The Ambient Valve enables the patient to inhale ambient air, if there is a fatal failure on the HAMILTON-C2 (Ambient Mode). It is opened when unpowered, allowing the patient to inspire ambient air.

The Ambient Valve Assembly consists of:

A. The Air/Oxygen Mixture from the Inspiratory Valve to the Patient Breathing Circuit
B. Ambient Valve Assembly
C. Ambient Valve
D. Ambient Valve Solenoid
E. Outlet connection to the Patient Breathing Circuit

2.1.5 Expiratory Valve Overview

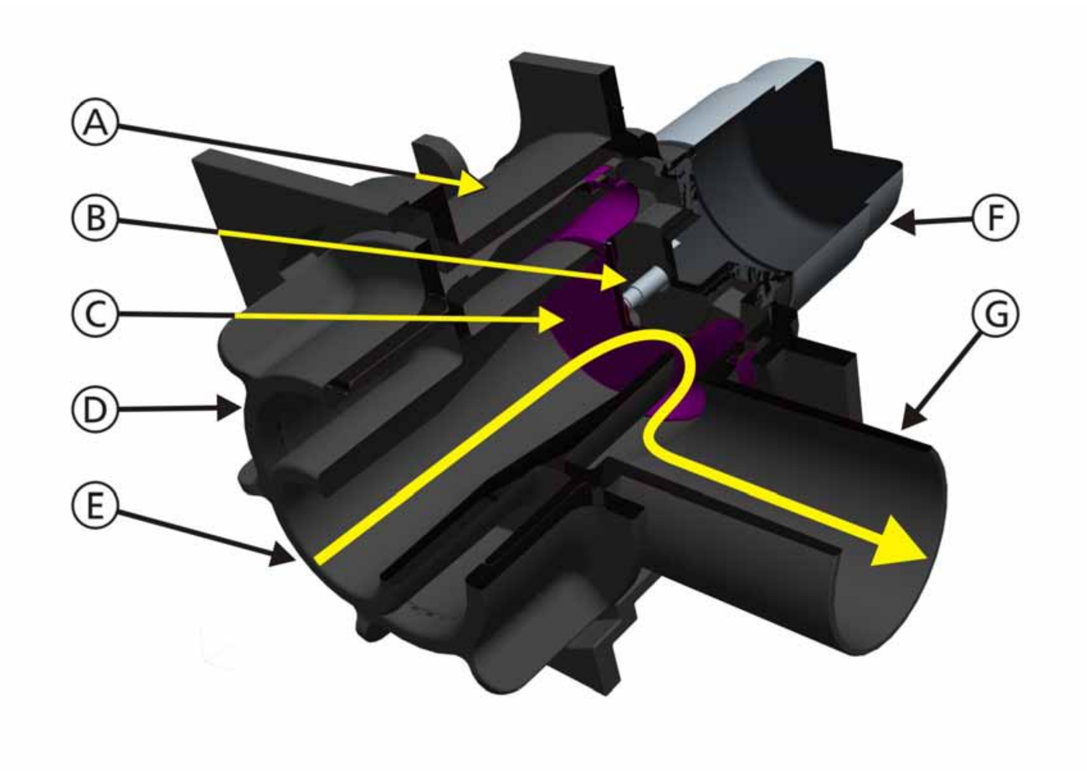


Figure 2-6. Expiratory Valve Overview

The Expiratory Valve enables gas to escape from the Patient Breathing Circuit in a controlled manner, allowing the patient to exhale.

The Expiratory Valve consists of:

A. Expiratory Valve Assembly

B. Plunger

C. Silicon Membrane

D. Inlet connection from the Patient Breathing Circuit

E. Expired gas from the Patient Breathing Circuit

F. Expiratory Valve Voice Coil Assembly

G. Expiratory Valve Exhaust

The Expiratory Valve:

- Maintain PEEP/CPAP if required - To do this, the action of the Expiratory Valve is closely synchronized with the action of the Inspiratory Valve
- In ambient state the Expiratory Valve is open.

WARNING

Never attach a Spirometer or any other device or tube to the exhaust port of the Expiratory Valve. This can cause the HAMILTON-C2 to lose full control of PEEP/CPAP.

2.1.6 Patient Flow Sensor Overview

Figure 2-7. Flow Sensor Overview

The Patient Flow Sensor is used to calculate the Gas Flow to and from the patient and measure the Gas Pressure at a point near (proximal) to the patient's airway.

The Patient Flow Sensor generates a pressure difference which is measured by the Pflowsensor Pressure Sensor located on the Pressure Sensor Assembly.

A. Blue Tube - Proximal side measured Pflowsensor Pressure and Paw Pressure

B. Clear Tube - Distal side measures Pflowsensor Pressure

C. Variable Orifice Membrane

D. Two-way Gas Flow connection on the Distal side of the Patient Flow Sensor

E. Two-way Gas Flow connection on the Proximal side of the Patient Flow Sensor

Note

Ventilation is not totally dependent on the Flow Sensor. If the Flow Sensor malfunctions, patient ventilation continues. The HAMILTON-C2 has an internal flow measurement at the Inspiratory Valve for Inspiratory Flow.

2.1.7 Oxygen Cell Overview

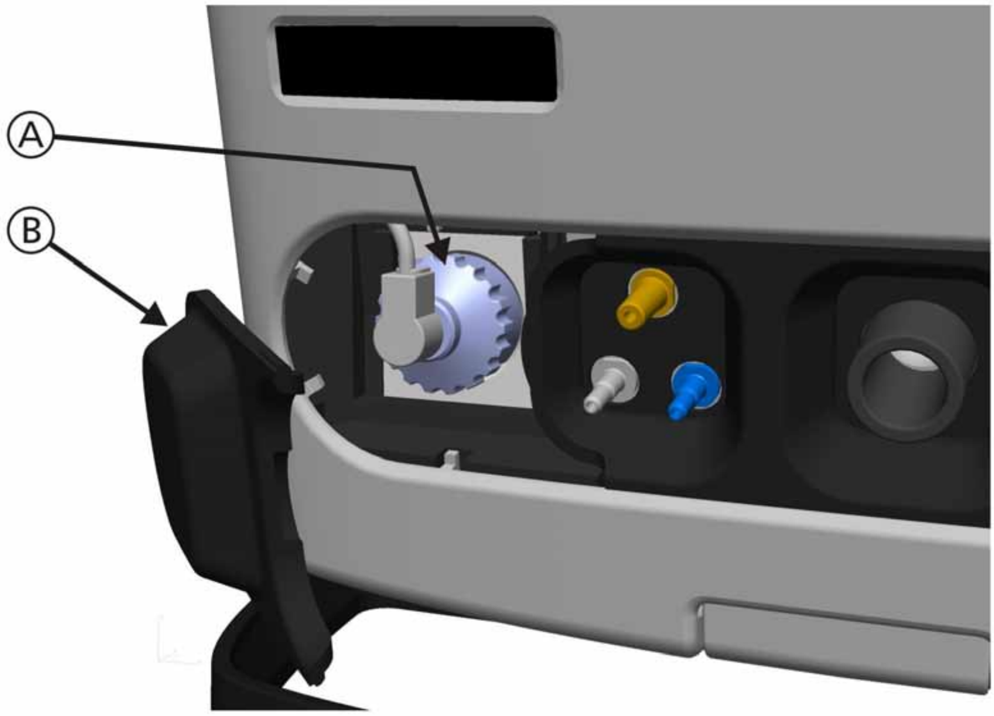


Figure 2-8. Oxygen Cell Overview

The Oxygen Cell (A) is attached to the front left side of the HAMILTON-C2 behind the Oxygen Cell Cover (B). It is used to monitor the oxygen concentration in the gases delivered to the patient. The Oxygen Cell performs only a monitoring function, and can be disabled by the user, if required.

- HAMILTON MEDICAL Oxygen Cells are available from HAMILTON MEDICAL AG only.

WARNING

The HAMILTON-C2 should never be used for ventilating a patient without some means of monitoring the oxygen content in the gas mixture delivered to the patient. The HAMILTON-C2 can not be operated without O_2 cell installed.

The HAMILTON MEDICAL Oxygen Cell produces a voltage between 11 and 13mV at 21%O_2 which changes with oxygen concentration. Each unit comprises a teflon-bonded gold cathode and a lead anode, submerged in a liquid electrolyte solution. When oxygen diffuses through the flouropolymer membrane, the electrochemical reduction of oxygen on the cathode and the corresponding oxidation of the anode generates an electrical current that is proportional to the concentration of oxygen.

2.2 Principal Gas Flow

The HAMILTON-C2 regulates the flow of gases at three points, as represented in the diagram in Figure 2-9.

Room air (A) is aspirated, mixed with compressed oxygen (C) from an external high or low pressure supply (B) and compressed in the Blower Assembly (D). The flow of the air/oxygen mixture is regulated at three points:

- Air and oxygen mixture in the Blower Assembly (D - regulation point 1).
- Air and oxygen mixture through the Inspiratory Valve and Flow Sensor (E - regulation point 2).
- Expired gas from the patient through the Expiratory Valve (F - regulatoin point 3).

Expired gases from the patient are allowed to escape into the room.

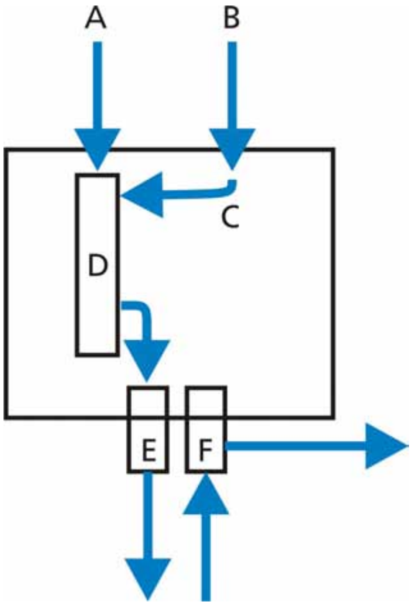


Figure 2-9. Principal Gas Flow

The “Principal Gas Flow” is the flow of air and oxygen into the HAMILTON-C2, out to the patient and directly at the Expiratory valve back to the room.

This flow is managed by components that regulate the gases at three points:

- Room air and oxygen into the Blower Assembly
- Gas to the patient at the Inspiratory Valve
- Gas from the patient at the Expiratory Valve

The following section provides details of the components that manage the “Principal Gas Flow”.

2.2.1 Components that manage the Principal Gas Flow

The main components that control the flow of gases through the HAMILTON-C2 are shown in Figure 2-10.

The components have the following functions:

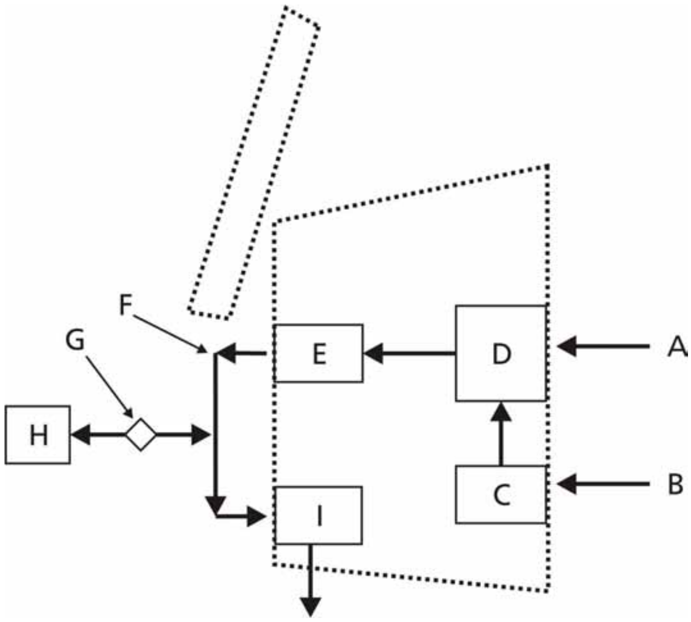


Figure 2-10. Components that Manage the Principal Gas Flow

A. Room Air	Room air.
B. Oxygen	Oxygen from an external high or low pressure source.
C. Mixer Block	Measures and Regulates the flow of the high pressure oxygen (B) into the Blower Assembly.
D. Blower Assembly	Compresses the air and oxygen mixture with a Turbine Blower.
E. Inspiratory Valve and Qvent Flow Sensor	Measures and Regulates the flow of the air/oxygen mixture to the patient and the pressure during inspiration. It regulates the Base Flow during expiration.
F. Patient Circuit	Supplies air/oxygen gas mixture to the patient, and removes exhalation gases from the patient.
G. Patient Flow Sensor	The Flow Sensor monitors the flow of gases to and from the patient's airway.
H. Patient	The patient breathes in and out (inhales and exhales) with the assistance of the ventilator.
I. Expiratory Valve	Regulates the flow of expiratory gases from the patient. The Expiratory Valve is nearly closed during inspiraton and regulates PEEP during expiration.

2.2.2 Principal Gas Flow in the HAMILTON-C2

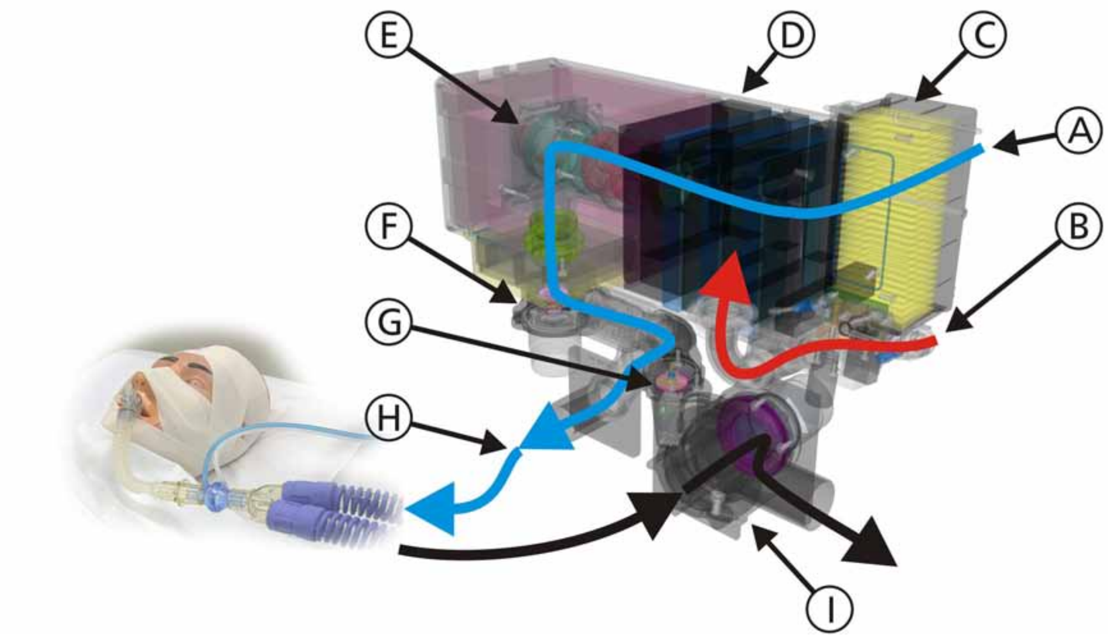


Figure 2-11. Principal Gas Flow in the HAMILTON-C2

The following flow occurs in the “Principal Gas Flow”:

A. Room Air

B. High or Low Pressure Oxygen Supply

C. HEPA Filter Assembly

D. Air and oxygen mixed in the Blower Assembly

E. Air/Oxygen Mixture flows through the Turbine Blower

F. From the Turbine Blower to the Inspiratory Valve

G. Passes the Ambient Valve

H. Air/Oxygen Mixture into the Patient Breathing Circuit

I. Expired gas to the Expiratory Valve

2.2.3 Components for the Ambient State Gas Flow

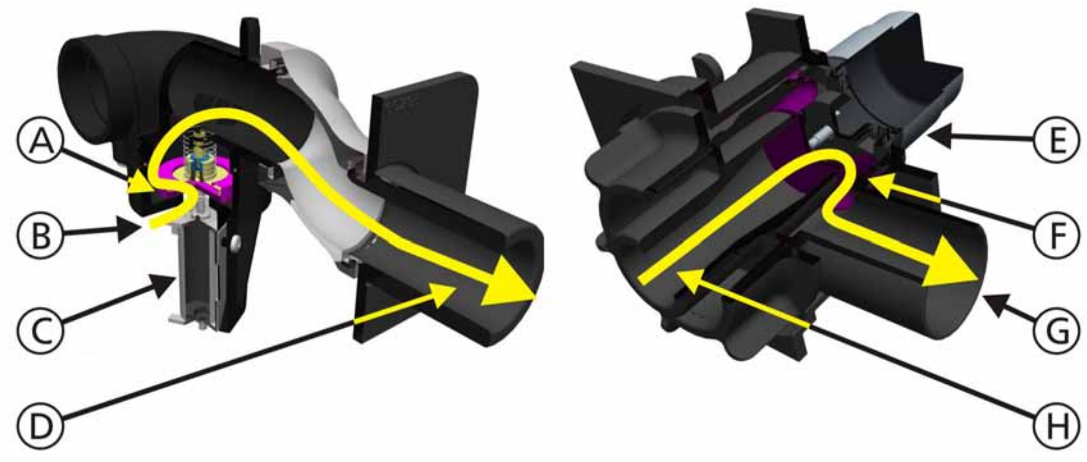


Figure 2-12. Components for the Ambient State Gas Flow

If there is a total breakdown of ventilation, the HAMILTON-C2 goes into Ambient State.

In the Ambient State, the Ambient Valve is unpowered, allowing the patient to inspire ambient air thru the Ambient Disc.

In the Ambient State, the Expiratory Valve is also unpowered, enabling gas to escape from the Patient Breathing Circuit in a controlled manner, allowing the patient to exhale into the room. The Expiratory Valve Silicon Membrane has a one-way flow from the Patient Breathing Circuit.

The one-way function of the Expiratory Valve make sure the patient does not inhale his exhaled CO_2 (rebreathing).

A. Ambient Valve Disc

B. Ambient air from the room

C. Ambient Valve Solenoid

D. Into Patient Breathing Circuit

E. Expiratory Valve

F. Expiratory Valve Membrane

G. Expired gas to the room

H. From the Patient Breathing Circuit

2.2.4 Components for the Overpressure Relief Gas Flow

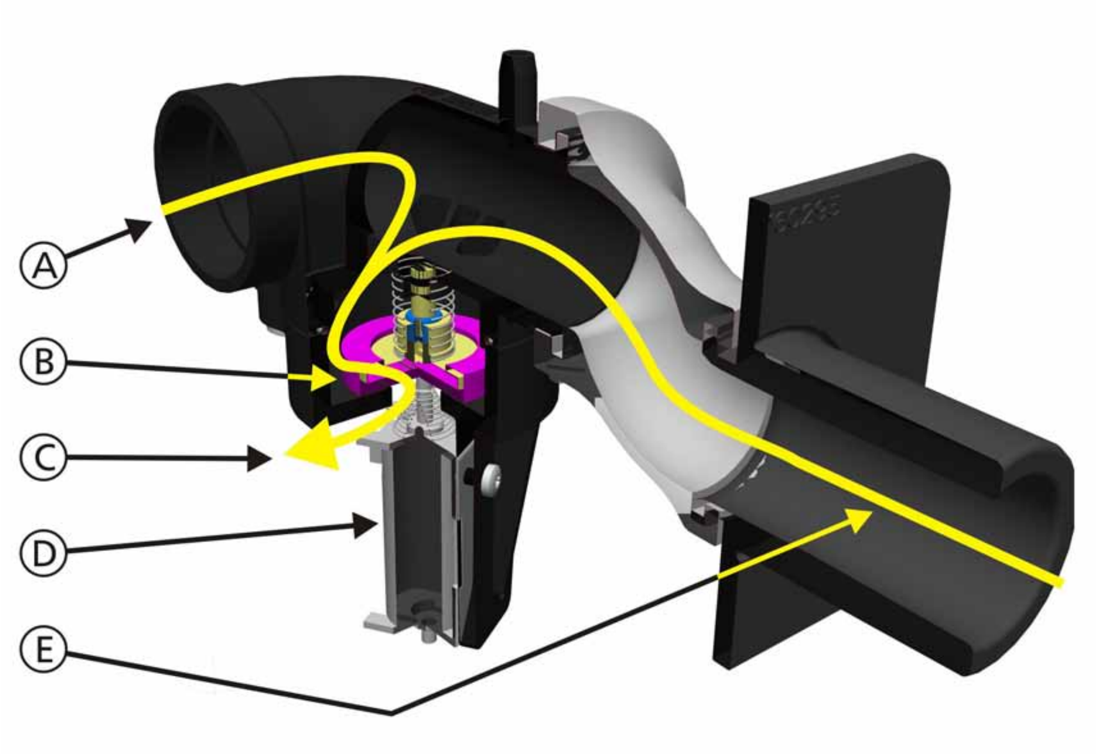


Figure 2-13. Components for the Patient Overpressure Gas Flow

If the pressure from the Inspiratory Valve for the Patient Breathing Circuit is too high (15 mbar above Pmax), the Ambient Valve is driven to an open position to relieve the excess pressure to the room.

Functions as an additional backup to the pressure limit set by the user for the Patient Circuit.

A. Overpressure from the Inspiratory Valve

B. Ambient Valve Disc

C. Excess pressure to the room

D. Ambient Valve Solenoid

E. Overpressure from the Patient Breathing Circuit

2.2.5 Components for the Nebulizer Gas Flow

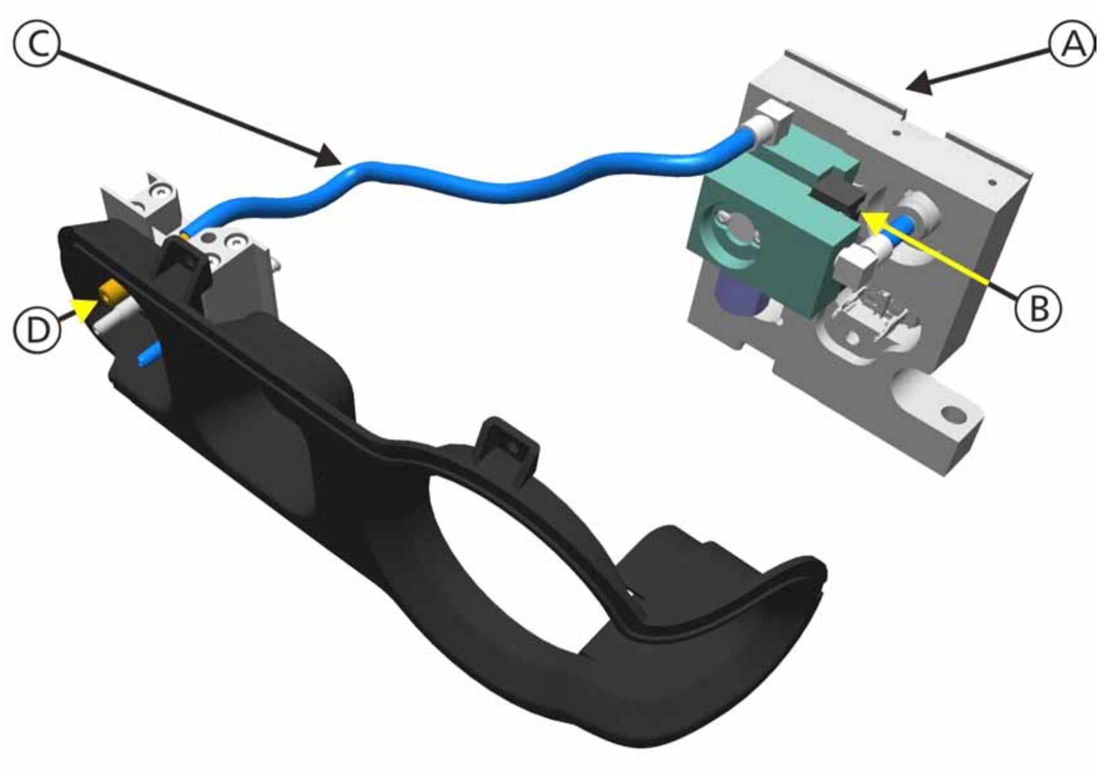


Figure 2-14. Nebulizer Output Overview

The HAMILTON-C2 provides Oxygen with sufficient pressure to drive the Nebulizer Jar. The Oxygen flow is reduced to approximately 8 liters/minute by means of an internal flow restrictor in the Oxygen Mixer Block Assembly. A valve attached to the Oxygen Mixer Block Assembly switches the flow of Oxygen to the Nebulizer Jar through the output connection at the Front Panel.
The pneumatic nebulizer is inactive when low-pressure oxygen is used.

A. High Pressure Oxygen Inlet

B. Nebulizer Valve

C. Tubing from Oxygen Mixer Block Assembly to the Nebulizer Front Panel connection

D. Nebulizer Front Panel connection

2.3 Pressure Control

The HAMILTON-C2 is a pressure controlled ventilator. This means that the applied volume is controlled by a specific calculated pressure and not by a setted, permanently volume only. The HAMILTON-C2 does not contain a tank. The required pressure is generated by a turbine, known as blower module, which turns with approximately 35000 RPM during normal ventilation. This pressure source provides a pressure always at least 10mbar above the required ventilation pressure, e.g. PEEP+Pcontrol+10mbar = Pblower. To get the certain pressure in the breathing circuit the outlet pressure of the inspiration valve is observed with a 1000 measurement per second so the inspiration valve can react within in a fraction of a second. The expiration valve on the other hand manages the outflow of the gas. It applies a known force by the membrane which has a direct effect on the gas in the breathing circuit (back pressure). It does never close completely the outlet of the breathing circuit during ventilation, so the membrane is floating all the time. The correct ventilation pressure is given by the close collaboration of the inspiration valve, that applies the pressure into to the breathing circuit and the expiration valve that stabilize it by a controlled releasing of the gas.

2.3.1 Pressure Sensor Assembly

The HAMILTON-C2 has four pressure sensors over all to apply, control and monitor the airway pressure and proximal flow.
Detailed description see *Pressure Sensor Assembly Components Overview* on page 3-10

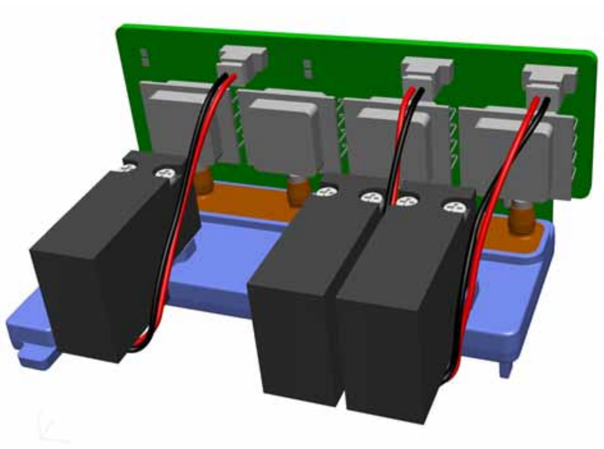


Figure 2-15. Pressure Sensor Assembly

2.3.2 Flow Sensors used for Flow Measurement Overview

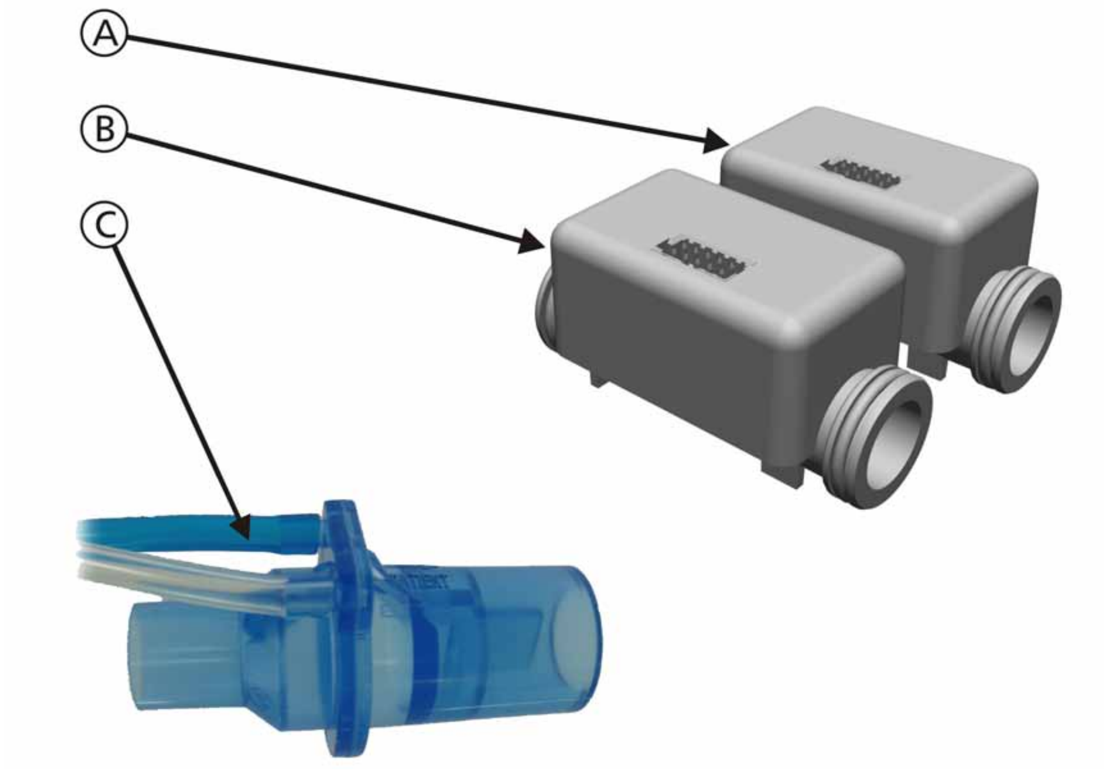


Figure 2-16. Flow Sensors used for Flow Measurement Overview

Flow Sensors used for flow measurement are:

A. The QO_2 Flow Sensor measures the flow of the Oxygen into the Blower Assembly. Works with the Qvent Flow Sensor to control the Air/Oxygen Mixture.

B. The Qvent Flow Sensor measures the flow of the Air/Oxygen Mixture into the Patient Breathing Circuit.

C. Patient Flow Sensor with a flap. The flap works as a very flexible resistance to make flow/pressure relation proportional.

This Flow Sensor is used to messure the inspiration and expiration flow from/to the patient.

2.3.3 Flow Restrictors used for Flow Reduction Overview

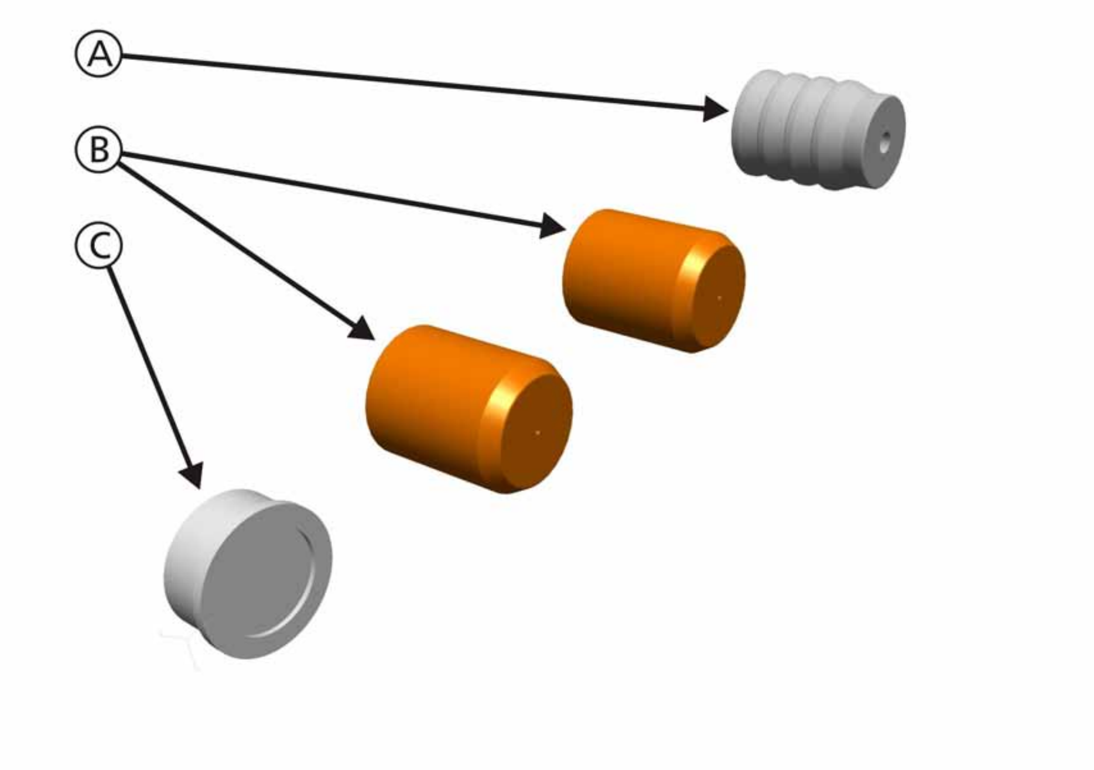


Figure 2-17. Flow Restrictors for Flow Reduction Overview

Flow Restrictors for the purpose of reducing flow are:

A. A Restrictive “Orifice” for the Oxygen Flow to the Nebulizer Valve.

B. Two precisely matched “Orifice” Restrictors for the Flow Sensor Rinse Flow.

C. A Restrictive “Screen” for the Flow Sensor Rinse Flow supply from the Inspiratory Valve.

2.4 Gas Rinse Flows

2.4.1 Components that generate the Flow Sensor Rinse Flow

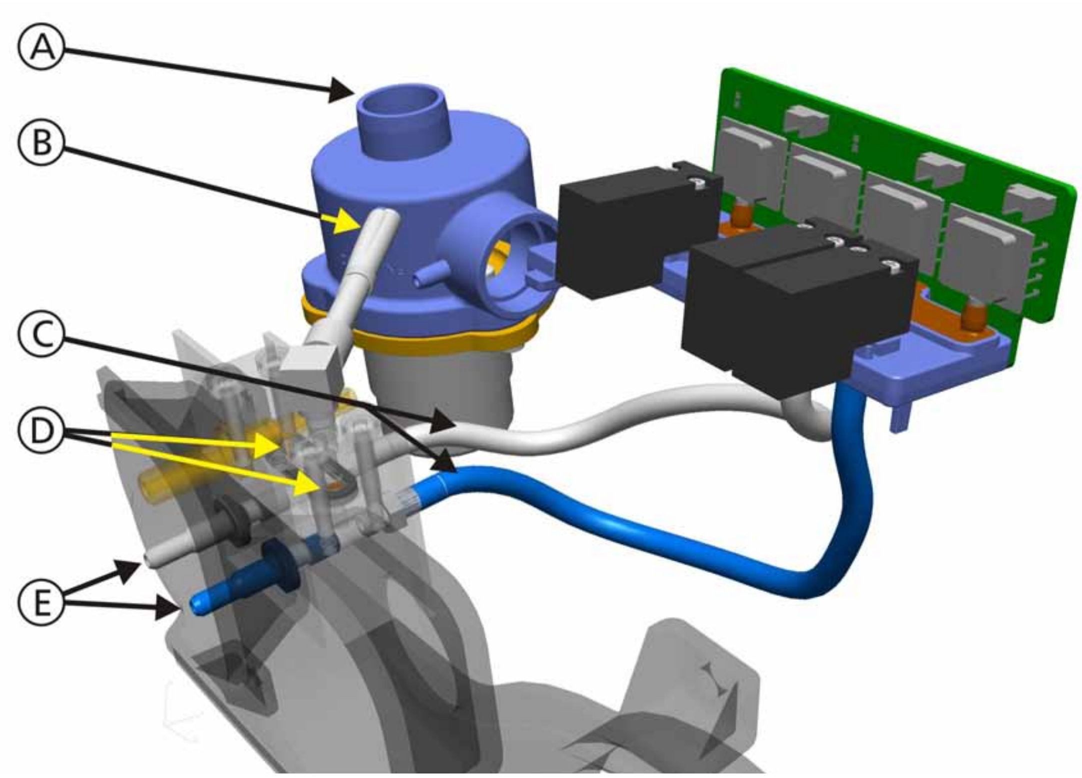


Figure 2-18. Components that Generate the Flow Sensor Rinse Flow

The Rinse Flow is provided on the Blower side of the Inspiratory Block Assembly. A constant small flow of gas (approximately 11.5 ml/min @ 35mbar Blower Pressure) is provided through both tubes to the Flow Sensor. The difference between the Proximal and Distal Rinse Flows is ±10%. The Rinse Flow eliminates the possibility of contamination from the patient, condensing humidity in the measuring tubes and cross-contamination to other patients.

A. Gas from the Blower Assembly
B. Outlet from the Blower side of the Inspiratory Valve
C. Pflowsensor Sensor Connections
D. Flow Restrictors
E. Front Panel Connections for the Flow Sensor

2.5 Measurements

2.5.1 Overview of Pneumatic Sensors

The following table lists all the pneumatic sensors in the HAMILTON-C2:

Name	Location	Comment
Pvent_control	Pressure Sensor Assembly	• Measures pressure at the *Inspiratory Valve* outlet for controlling.
Pvent_monitor	Pressure Sensor Assembly	• Measures pressure at the *Inspiratory Valve* outlet for monitoring.
Paw	Pressure Sensor Assembly	• Measures pressure at the proximal side of the *Flow Sensor*.
Pflowsensor	Pressure Sensor Assembly	• Measures differential pressure across the *Flow Sensor*.
Pambient	Mainboard	• Measures *Ambient Pressure* or the room pressure.
Pfilter	Blower module	• Measures pressure after the Filter; used to indicate if the HEPA Filter needs to be replaced.
Qvent	Ventilation Flow Sensor	• Measures the Air/Oxygen Flow in the Patient Breathing Circuit.
QO_2	Oxygen Flow Sensor	• Measures the Oxygen Flow into the Blower Assembly.

Table 2-1. Sensors in the HAMILTON-C2

2.5.2 Components that measure Gas Flow and Pressure

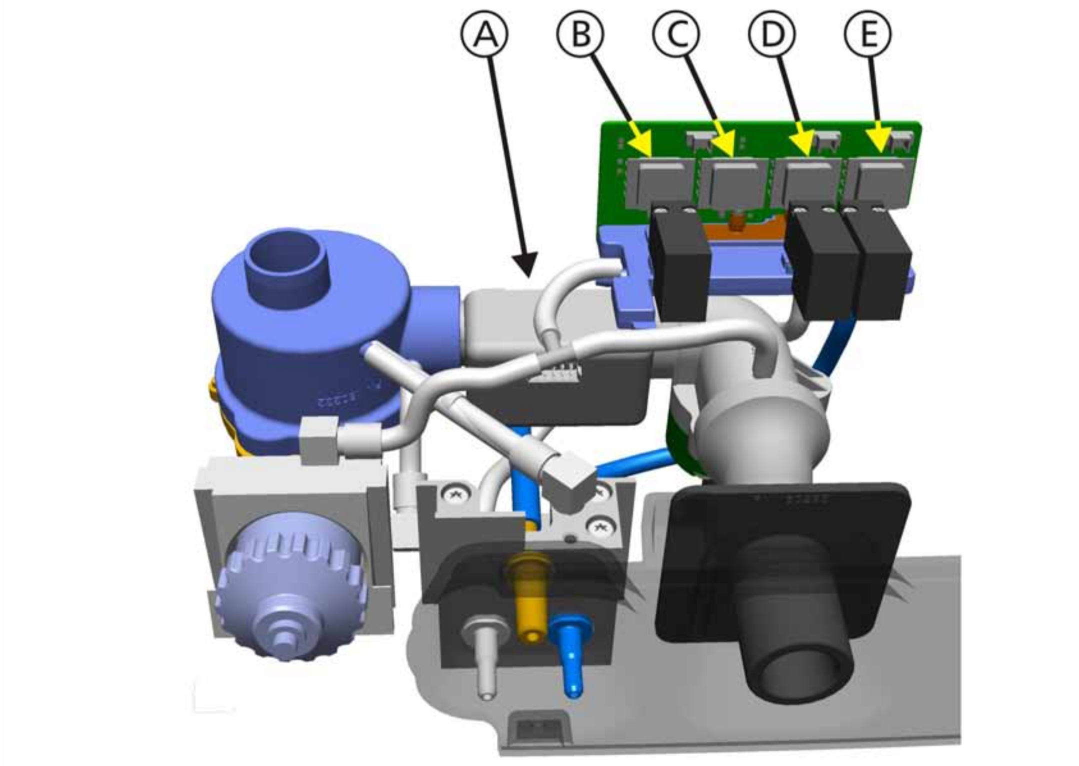


Figure 2-19. Components that measure Gas Flow and Pressure in the Patient Circuit

The Flow Sensor Qvent measures the flow of Air/Oxygen in the Patient Breathing Circuit. The Pvent_control measurement is used to control the Inspiratory Valve. The Pvent_monitor Sensor measures the pressure in the patient circuit.

A. Flow Sensor Qvent - measures the flow of Air/Oxygen to the Patient Breathing Circuit.

B. Pvent_monitor Pressure Sensor - monitor the pressure in the Patient Breathing Circuit.

C. Pvent_control Pressure Sensor - used to control the Inspiratory Valve.

D. Pflowsensor Pressure Sensor - measures the pressure difference between the two chambers of the Patient Flow Sensor, and enables the flow of gas to and from the patient to be calculated.

E. Paw Pressure Sensor - measures the pressure on the proximal side of the Patient Flow Sensor.

During normal ventilation, the Flow Sensor Autozero Valves open at calculated intervals to expose the Pflowsensor Pressure Sensor to ambient air for the Autozero offset compensation.

Note

During the Autozero procedure, which occurs in a fraction of a second, the patient is ventilated normally. Since parameters such as expired tidal volume, resistance, compliance, and PEEP cannot be measured or monitored, the HAMILTON-C2 uses the most recently measured values until the procedure is complete.

Section

3 Electronics: Component Functions Overview

3.1 Overview

This section introduces the major electronic components in the HAMILTON-C2. Where you require more information, cross-references direct you to other parts of this manual.

This section does not include a theory of operation, because engineers do not require a detailed knowledge of board-level electronics to service and maintain the HAMILTON-C2. All electronic failures are dealt with by replacing complete circuit boards. Any repairs at a lower level than the spare parts provided in Appendix B, *Spare Parts*, on page B-1 is not permitted.

WARNING

Service the HAMILTON-C2 only as described in this manual, using only parts approved or supplied by HAMILTON MEDICAL AG. Incorrectly repaired parts, components or assemblies could result in patient injury. See available spare parts in Appendix B, Spare Parts, on page B-1.

Note

Always send defective Printed Circuit Boards to HAMILTON MEDICAL AG with a completed *Returned Goods ID Tag*.

3.2 Ventilation Unit Electronics Components

3.2.1 Ventilation Unit Mainboard

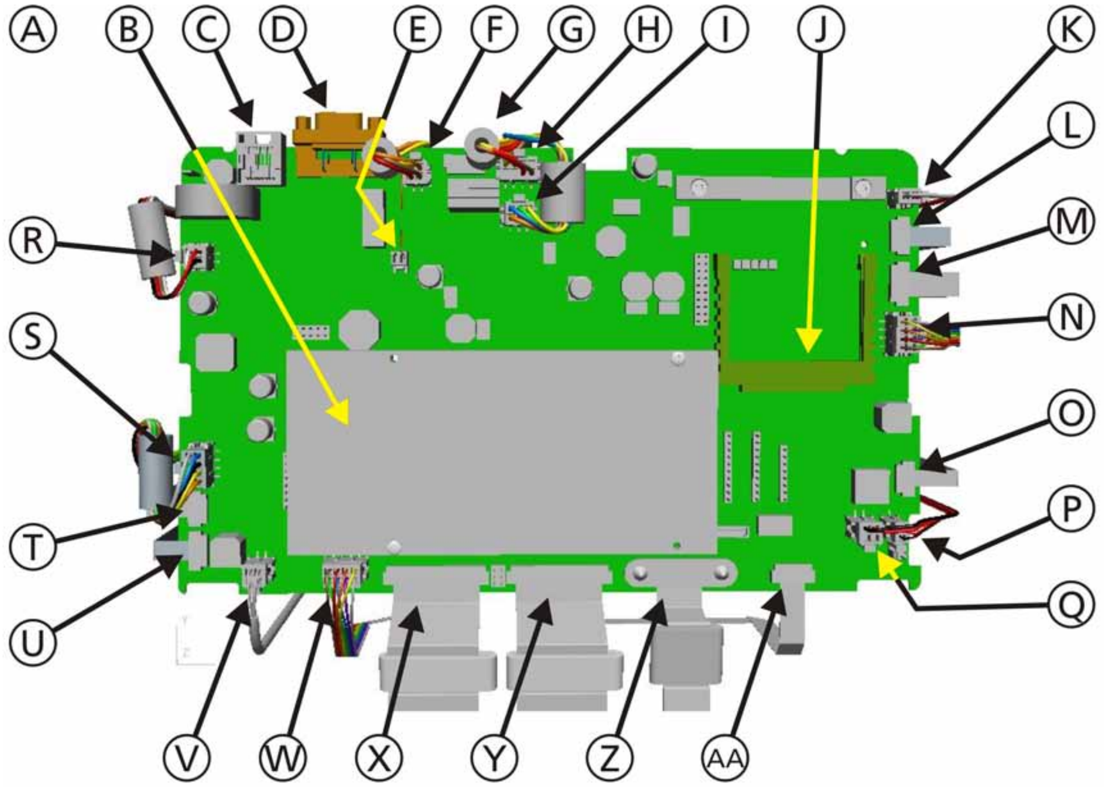


Figure 3-1. Ventilation Unit Mainboard Overview

A. Ventilation Unit Mainboard

- Serves as the Carrier Board for the Processor Board, Power Management System and a Connector Board for all Sensors, Valves and Periphery Components
- The Motherboard controls:
  - Blower
  - ON/OFF Key
  - Hardkey and Lamps
  - Touch Panel
  - TFT Display
  - Ambient Valve
  - Expiratory Valve
  - Mixer Valves
  - Nebulizer Valve
  - Emergency Status Indicator
- Interfaces with the following Ventilation Unit boards:
  - Power Supply
  - Pressure Sensor Assembly
  - Filter Board
  - Smart Batteries
- Sensor Monitoring:
  - Blower Temperature
  - Instrument Temperature
  - Pvent_control
  - Pvent_monitor
  - Paw
  - Pflowsensor
  - Pambient
  - O_2 Flow Sensor
  - Qvent Flow Sensor
  - Proximal Flow Sensor
  - O_2 Cell
- Input Voltage supplied from the Power Supply:
  - 24VDC ±5% 6.6A/150W (Range 22.8V...25.2V)
- Output Voltages created by Switching Regulators on the Ventilation Unit Mainboard:
  - 3.3VDC - Ventilation Flow Sensor, O_2 Flow Sensor, USB Port, Pressure Sensors, P&T Control Knob, ESM Module, Blower Temperature Sensor and HEPA Filter Temperature Sensor
  - 5VDC - Ventilation Flow Sensor, O_2 Flow Sensor , DC/AC Backlight Converter and USB Port
  - 12VDC - Autozero Valves, Inspiratory Valve, Expiratory Valve, O2 Inlet Proportional Valve, Ambient Valve, Nebulizer, Valve, Alarm Lamps (IP), Speaker and the Cooling Fan
  - 24 VDC - Blower

B. ESM Module

- Embedded System Microprocessor Module
  - Power PC MPC5200 Processor

C. J1 Connector

- Ethernet Connection

D. J2 Connector	• RS232 Connection
E. P25 Connector	• Cable from Power Supply for Fan Supply
F. P3 Connector	• Cable from Power Supply 24VDC (PN 160371)
G. J4 Connector	• FCC to Battery Data (PN 160351)
H. P5 Connector	• Cable to DC Input (PN 160372)
I. P6 Connector	• Cable to Battery Power (PN 160351)
J. P60 Connector	• Options Slot (VGA interface for beamer)
K. P7 Connector	• Cable to O_2 Valve
L. J9 Connector	• Cable to Filter Pressure Board
M. J8 Connector	• FFC to Binary Valves (PN 160359)
N. P10 Connector	• Cable to Flow Sensor O_2 (PN 160373)
O. J11 Connector	• Cable to Expiratory Valve
P. P12 Connector	• Cable to Ambient Valve
Q. P13 Connector	• Cable to Nebulizer Valve
R. P28 Connector	• Cable to Fan 12V (PN 160346)
S. P23 Connector	• Cable to Blower
T. J22 Connector	• Cable to Inspiratory Valve
U. J21 Connector	• FFC to Temperature Sensor (PN 160353)
V. P20 Connector	• Cable to O_2 Cell (PN 160354)
W. P19 Connector	• Cable to Flow Sensor Ventilation (PN 160373)
X. J18 Connector	• FFC to Key Panel for Backlight, Speaker and Microphone (PN 160356)
Y. J17 Connector	• FFC to Key Panel for P&T and Key Panel (PN 160356)
Z. P16 Connector	• FDC to Display (PN 160357)
AA.J14 Connector	• FFC to Pressure Sensor Assembly (PN 160355)

Mainboard Voltage inputs:

Signal Name	Voltage Level	Voltage Range	Current	Watts
+24V_PS (from Power Supply)	**24VDC**	**21.6 - 26.4**	**7A at 21.6V 5.7 at 26.4**	**150W**
+24V_DcIn (from DC Input)	**12-24VDC**	**11.0 - 27.0**	**9.1A at 11V 5A at 20V**	**100W**
			7.5A at >20V* 5.6A at 27V*	**150W**
Battery 1 (Primary Battery)	**14.4VDC**	**12.0 - 16.8**	**6A at 16.8V 8.3A at 12V**	**100W**
Battery 2 (Optional Battery)	**14.4VDC**	**12.0 - 16.8**	**6A at 16.8V 8.3A at 12V**	**100W**

Table 3-1. Mainboard Voltage Inputs

Note

*Battery starts charging from DC inlet if voltage is above 20V .

Mainboard Supply Voltages:

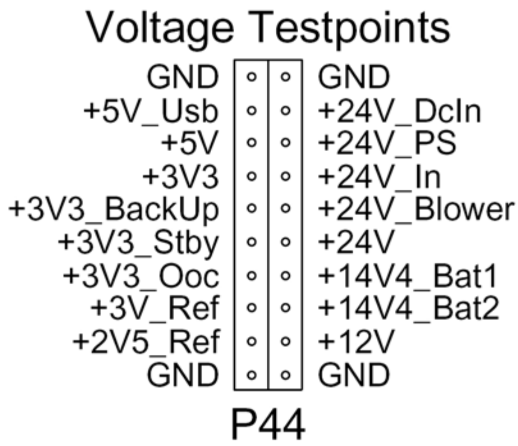
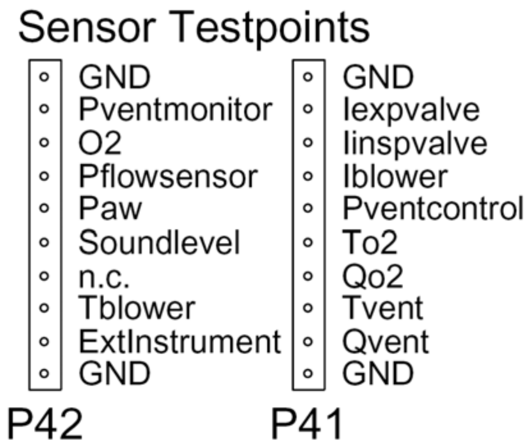


Table 3-2. Mainboard Voltage Outputs

Signal Name	Voltage Level	Voltage Range
+3V_Ref	**3.0VDC**	**2.91 - 3.09**
+3V3	**3.3VDC**	**3.10 - 3.60**
+3V3 Ooc	**3.3VDC**	**3.00 - 4.20**
+3V3_BackUp	**3.3VDC**	**3.00 - 3.60**
+3V3_Stby	**3.3VDC**	**3.00 - 4.20**
+5V	**5.0VDC**	**4.60 - 5.40**
+5V_USB	**5.0VDC**	**4.75 - 5.25**
+12V	**12VDC**	**9.00 - 13.2**
+24V	**26.80VDC**	**24 - 29**



Signal Name	Voltage Level	Voltage Range
Pventmonitor	0.472	**0.372 - 0.572**
O2	0.227*	**0.223 - 0.231**
Pflowsensor	1.25	**1.15 - 1.35**
Paw	0.472	**0.372 - 0.572**
Soundlevel	1.15	**1.11 - 1.19**
Tblower	0.5V	**+ 10mV/°C**
ExtInstrument	not used	
Iexpvalve	1.25	**1.05 - 1.45**
Iinspvalve	not used	
Iblower	not used	
Pventcontrol	0.472	**0.372 - 0.572**
To2	1.25	**1.15 - 1.35**
Qo2	0.25	**0.05 - 0.45**
Tvent	1.25	**1.15 - 1.35**
Qvent	0.25	**0.05 - 0.45**

* when O2 cell is disconnected

3.2.2 Power Supply Components Overview

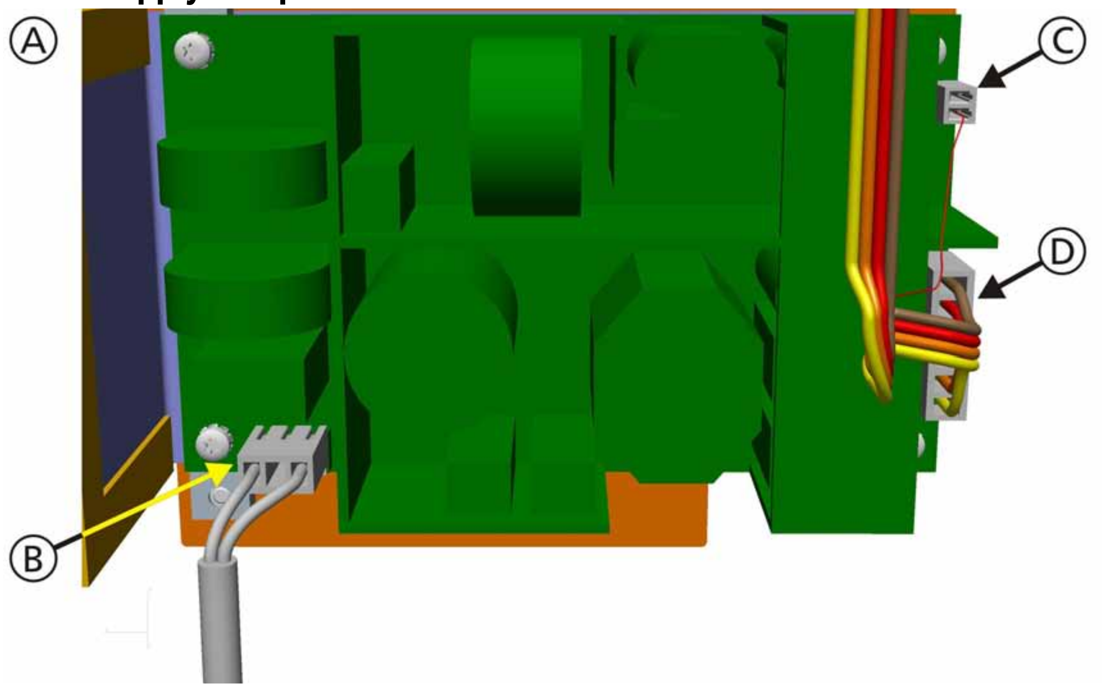


Figure 3-2. Power Supply Overview

A. Power Supply
- Provides power conversion for the Mains Power
- Input Power:
  - 100 to 240VAC
  - 50 to 60Hz
- Output Voltage:
  - +24VDC ± 10%

B. Power Inlet Connector
- Cable from AC Power Inlet

C. Power Outlet Connector
- Cable for Fan Supply from the Power Supply to the Mainboard P25 Connector

D. Power Outlet Connector
- Cable for 24VDC Supply from the Power Supply to the Mainboard P3 Connector

Power Supply Voltage input and output:

Signal Name	Voltage Level	Voltage Range
Mains Input Voltage	**100 - 240VAC** **50 - 60Hz**	**90 - 264**
Output Voltage	**+24VDC**	**21.6 - 26.4**

Table 3-3. Power Supply Voltage Input and Output

3.2.3 Pressure Sensor Assembly Components Overview

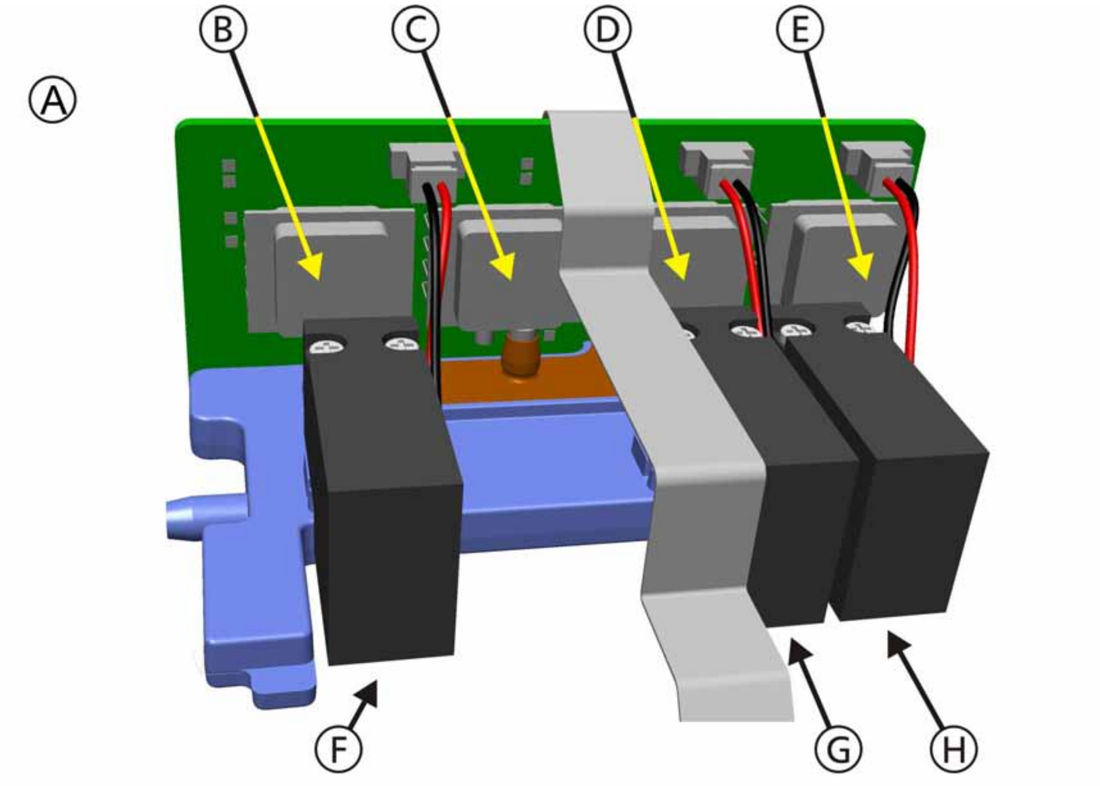


Figure 3-3. Pressure Sensor Assembly Components Overview

A.)Pressure Sensor Assembly	• Provides components for pressure measurements.
B.)Pvent_monitor Pressure Sensor	• Monitors the pressure in the ventilation circuit.
C.) Pvent_control Pressure Sensor	• Controls the pressure in the ventilation circuit.
D.) Pflowsensor Pressure Sensor	• A measurement of the pressure difference between the front and rear chambers of the Flow Sensor.
E.) Paw Pressure Sensor	• A measurement of the pressure in the patient breathing circuit as measured at the Flow Sensor, in the chamber attached to the blue (patient side) pressure-sensing tube.
F.) Pvent_monitor Autozero Valve	• Switches the Pvent_monitor Air Way Pressure Messured at the proximal Flow Sensor to allow for offset re-calculation to compensate for sensor drift for Pvent_control and Pvent_monitor.
G.).Distal Autozero Valve	• Switches the Pflowsensor Pressure Sensor to Ambient Air to allow for offset re-calculation to compensate for sensor drift.
H.) Proximal Autozero Valve	• Switches the Pflowsensor and Paw Pressure Sensor to Ambient Air to allow for offset re-calculation to compensate for sensor drift.

3.3 Interaction Panel Electronics Components

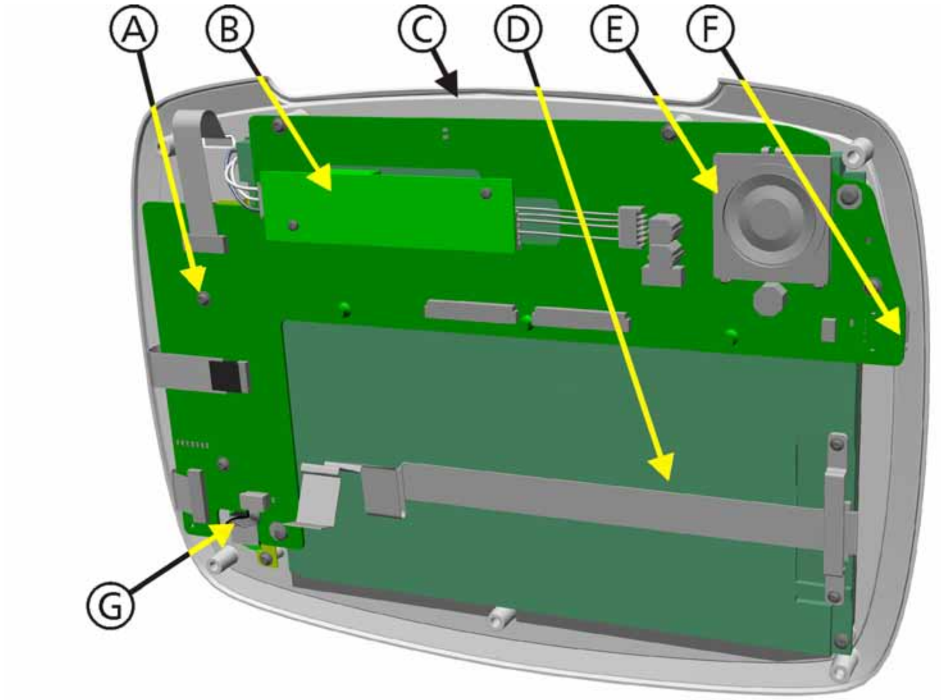


Figure 3-4. Interaction Panel Components Overview

A. Front Panel Board	• Provides 7 Hard Keys for the operator with LED Indicators
	• Interfaces the P&T Control Knob Encoder
	• LED Colors available:
	  • Red
	  • Green
	  • Yellow
	• Voltage inputs:
	  • 12VDC for the Key and LED Communications Board
	  • 5VDC for the Backlight Inverter Board
	  • 3.3VDC for the P&T Control Knob Encoder and USB

B. Backlight Inverter Board	• Converts 5VDC (Input Voltage) to 1100VAC for the 10.4” TFT LCD Display Backlight

C. Alarm Lamp LEDs	• Indicates Alarm Conditions:
	  • Yellow - Medium and Low Priority Alarms
	  • Red - High Priority Alarms and Technical Faults

D. 10.4” TFT LCD Display with Frontpanel and Backlight	• Graphical User Interface (GUI)

E. Loudspeaker and Microphone	• Audible indication of alarms
	• Microphone:
	  • The Microphone monitors the operation of the Loudspeaker
	  • If the Loudspeaker does not function, audible alarm indication is transferred to the Buzzer

F. USB Socket	• Used to:
	  • Download software from a USB Stick
	  • Export Data to a USB Stick

G. P&T Control Knob Encoder	• Provides additional controls for interaction with various screen functions
	• Functions:
	  • -16 Encoder positions from center
	  • +16 Encoder positions from center
	  • Switch activation when the P&T Control Knob is depressed

H. RS232 interface (not shown)	• Used to • communicate information about the patient and about the ventilator settings to peripherals such as a computer or monitor.

Section

4 Lithium Ion Battery

4.1 Lithium Ion Battery Handling Precautions

Note

Before using Lithium Ion Batteries for the first time, carefully study this section, including all Cautions and Warnings. Keep this section for future reference.

4.1.1 Cautions

CAUTION

1. **If you find rust, a bad odor, overheating and/or other irregularities when using the Battery for the first time, return it to HAMILTON Medical.**
2. **If acid leaking from the Battery comes into contact with your skin or clothing, immediately wash it away with running water. Otherwise, skin inflammation can occur.**
3. **The Battery incorporates built-in safety devices. Do not use it in a location where static electricity (greater than the manufacturer's guarantee) may be present. Otherwise, the safety devices can be damaged, possibly leading to acid leakage, overheating, smoke emission, bursting and/or ignition.**
4. **Do not use or subject the Battery to intense sunlight or hot temperatures such as in a car in hot weather. Otherwise, acid leakage, overheating and/or smoke emission can occur. Also, its guaranteed performance will be lost and/or its service life will be shortened.**
5. **The guaranteed recharging temperature range is 0°C to +55°C. A recharging operation outside this temperature range can lead to acid leakage and/or overheating of the Battery and may cause damage to it.**
6. **Store the Battery in a location where children cannot reach it. Also, make sure that a child does not take the Battery out of the Battery Charger or equipment.**

4.1.2 Warnings

WARNING

1. **Do not use the Battery for a purpose other than those specified. Otherwise, its guaranteed performance will be lost and/or its service life will be shortened. Depending on the equipment in which the Battery is used, excessively high current can flow through the Battery , possibly damaging it and leading to acid leakage, overheating, smoke emission, bursting and/or ignition.**
2. **Do not use the Battery in combination with primary Batteries (such as Dry-Cell Batteries) or Batteries of different capacities or brands. Otherwise, the Battery can be overdischarged during use or overcharged during recharging, abnormal chemical reactions may occur, possibly leading to acid leakage, overheating, smoke emission, bursting and/or ignition.**
3. **Do not use or leave the Battery near a heat source such as a fire or a heater (+80°C or higher). If the resin separator should be damaged owing to overheating, internal short-circuiting may occur to the Battery, possibly leading to acid leakage, smoke emission, bursting and/or ignition of the Battery.**
4. **Do not put the Battery into a microwave oven or pressurized container. Rapid heating or disrupted sealing can lead to acid leakage, overheating, smoke emission, bursting and/or ignition.**
5. **Do not discard the Battery into fire or heat it. Otherwise, its insulation can melt down, its gas release vent or safety features will be damaged and/or its electrolyte can ignite, possibly leading to acid leakage, overheating, smoke emission, bursting and/or ignition on it.**
6. **Do not immerse the Battery in water or seawater and do not allow it to get wet. Otherwise, the protective features in it can be damaged, it can be charged with extremely high current and voltage, abnormal chemical reactions may occur in it, possibly leading to acid leakage, smoke emission, bursting and/or ignition.**
7. **Do not pierce the Battery with a nail or other sharp objects, strike it with a hammer, or step on it. Otherwise, the Battery will become damaged and deformed, internal short-circuiting can occur, possibly leading to acid leakage, overheating, smoke emission, bursting and/or ignition.**
8. **Do not strike or throw the Battery. The impact might cause leakage, overheating, smoke emission, bursting and/or ignition. Also, if the protective feature in it becomes damaged, it could become charged with an extremely high current and voltage, abnormal chemical reactions can occur, which can lead to acid leakage, overheating smoke emission, bursting and/or ignition.**
9. **Do not disassemble or modify the Battery. The Battery is equipped with built-in safety/protection features. Should these features be disabled, the Battery can leak acid, overheat, emit smoke, burst and/or ignite.**
10. **If the Battery leaks and the electrolyte gets into the eyes, do not rub them. Instead, rinse the eyes with clean running water and immediately seek medical attention. Otherwise, eye injury may result.**
11. **Do not use an apparently damaged or deformed Battery. Otherwise, acid leakage, overheating, smoke emission, bursting and/or ignition of the Battery may occur.**
12. **Do not directly solder the Battery. Otherwise, heat can melt down its insulation, damage its gas release vent or safety features, possibly leading to acid leakage, overheating, smoke emission, bursting and/or ignition.**
13. **If the Battery leaks or gives off a bad odor, remove it from any exposed flame. Otherwise, the leaking electrolyte may catch fire and the Battery may emit smoke, burst or ignite.**
14. **If the Battery gives off an odor, generates heat, becomes discolored or deformed, or in any way appears abnormal during use, recharging or storage, immediately remove it from the equipment or Battery Charger and stop using it. Otherwise, the problematic Battery can develop acid leakage, overheating, smoke emission, bursting and/or ignition.**
15. **Do not reverse the positive (+) and negative (-) terminals. Otherwise, during recharging, the Battery will be reverse-charged, abnormal chemical reactions then may occur, or excessively high current can flow during discharging, leading to acid leakage, overheating, smoke emission, bursting and/or ignition.**
16. **The positive (+) and negative (-) terminals are arranged in a particular orientation. Do not force**

the connection if you cannot easily connect the Battery terminals to the Battery Charger or other equipment. Confirm that the terminals are correctly oriented. Reversing the terminals will result in reverse-charging, possibly leading to acid leakage, overheating, smoke emission, bursting and/or ignition of the Battery.

17. **Do not connect the positive (+) and negative (-) terminals with a metal object such as wire. Do not transport or store the Battery together with metal objects such as necklaces, hair pins, etc. Otherwise, short-circuiting will occur, over-current will flow, causing the Battery to leak acid, overheat, emit smoke, burst and/or ignite, or the metal object such as wire, necklace or hair pin can generate heat.**
18. **Do not connect the Battery to an electrical outlet, vehicle cigarette lighter, etc. When subjected to large voltage, over-current can flow on the Battery, possibly leading to acid leakage, overheating, smoke emission, bursting and/or ignition.**
19. **Do not recharge the Battery near fire or in extremely hot weather. Otherwise, hot temperatures can trigger its built-in protective features, inhibiting recharging, or can damage the built-in protective features, causing it to be charged with an extremely high current and voltage and, as a result, abnormal chemical reactions can occur in it, possibly leading to acid leakage, overheating, smoke emission, bursting and/or ignition.**
20. **To recharge the Battery, use the Battery Charger specifically designed for the purpose and observe the recharging conditions specified in the *Section 4.3 Battery Charger / Calibrator*. A recharging operation under non-conforming recharging conditions (higher temperature and larger voltage/current than specified, modified Battery Charger, etc.) can cause the Battery to be overcharged, or charged with extremely high current, abnormal chemical reaction can occur in it, possibly leading to acid leakage, overheating, smoke emission, bursting and/or ignition.**
21. **If recharging operation fails to complete even when a specified recharging time has elapsed, immediately stop further recharging. Otherwise, acid leakage, overheating, smoke emission, bursting and/or ignition can occur.**

4.2 Rechargeable Lithium Ion Battery

The Rechargeable Lithium Ion Batteries utilized in the HAMILTON-C2 are manufactured by Inspired Energy. The Backup Battery provides backup power to the HAMILTON-C2.

CAUTION

It is mandatory that the HAMILTON-C2 is operated with at least one battery installed.

Note

- The Backup Battery is intended for short-term use only. It is not intended to be a primary power source.
- HAMILTON MEDICAL recommends that the Ventilator's Batteries be fully charged before you ventilate a patient. If the Batteries are not fully charged and the AC power fails, always pay close attention to the level of Battery Charge.

4.2.1 Introduction

Two Backup Batteries, one standard and the other optional, protect the HAMILTON-C2 from low, or failure of, the primary power source. When the primary power source (either AC Mains Power or a DC Power Supply) fails, the ventilator automatically switches to Backup Battery operation with no interruption in ventilation. An alarm sounds to signal the switchover. You must silence the alarm to confirm notification of the power system change; this resets the alarm. If the optional Battery (Battery 2) is available and adequately charged, the ventilator switches to this Battery first. When Battery 2 is depleted or not installed, the ventilator switches to the standard Battery (Battery 1). The Batteries power the ventilator until the primary power source is again adequate or until the Battery is depleted. Each Battery powers the ventilator typically for 3 hours or a minimum of 2.5 hours.

As a further safeguard, the HAMILTON-C2 provides a low battery alarm. It also has a capacitor-driven backup buzzer that sounds continuously for at least 2 minutes when Battery Power is completely lost.

The ventilator recharges the Batteries whenever the ventilator is connected to either AC or >20VDC, with or without the ventilator power switched on. The battery charge indicator (Figure 2-13) lights to show that the Batteries are being charged.

The power source symbols in the bottom right-hand corner of the screen show the available power sources. A frame around a symbol indicates the current ventilator power source. Green indicates the level of battery charge.

Check the battery charge level before putting the ventilator on a patient and before unplugging the ventilator for transport or other purposes. A green symbol indicates a fully charged battery. A red and green symbol indicates a partially charged battery. If battery symbol 1 is crossed out, the standard battery is is not installed or defective. If battery symbol 2 is not shown, the optional battery is not installed. If a battery is not fully charged, recharge it by connecting the ventilator to the primary power source for a minimum of 3h for one battery and 5h charging time for two batteries until the battery charge level is 80 to 100%. If the battery is not fully charged at this time, have the ventilator serviced.

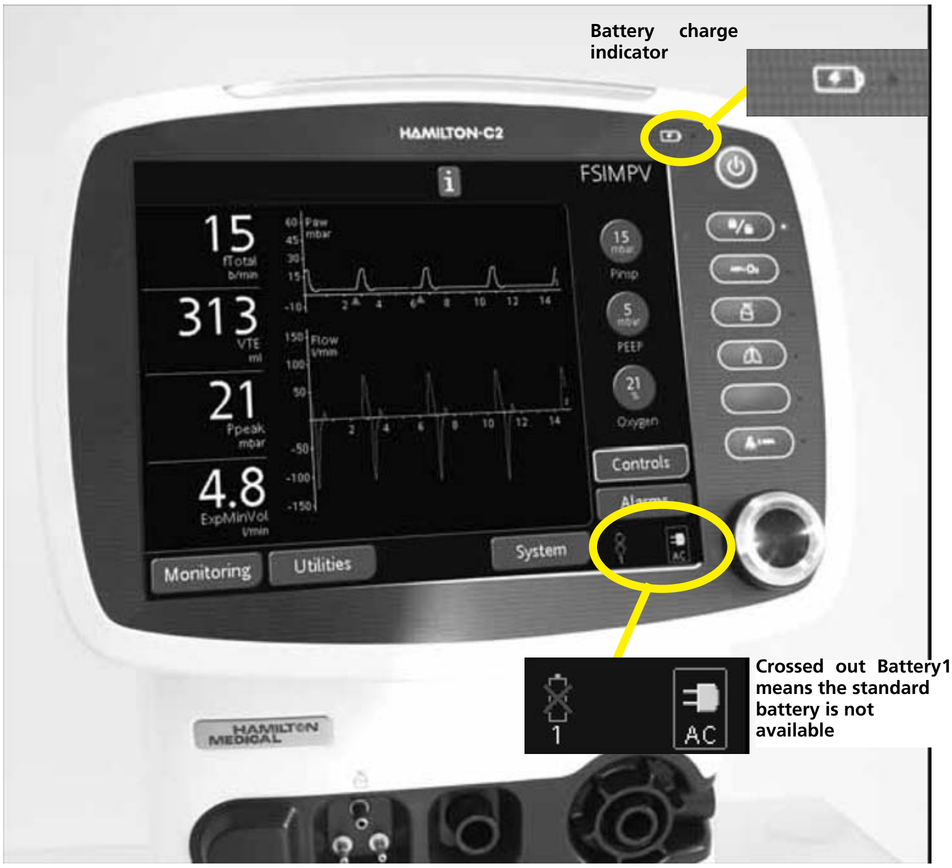


Figure 4-1. Power Source Symbols and Battery Charge Indicator

4.2.2 Replacing the Batteries

The Batteries are hot-swappable; that is, they can be replaced while the ventilator is operating. Replace with a newly charged Battery. For Battery replacement, See *Section 11.4.3* ***Backup Battery Pack Removal/Assembly***.

4.3 Battery Charger / Calibrator

The Battery Charger / Calibrator (PN 369104) is a standalone desktop Battery Charger with the added ability to Recalibrate the Fuel Gauge on Smart Batteries. It works with all Moltech Power Systems or Inspired Energy® Brand Smart Batteries and hybrids irrespective of size, shape, voltage, cell chemistry or capacity.

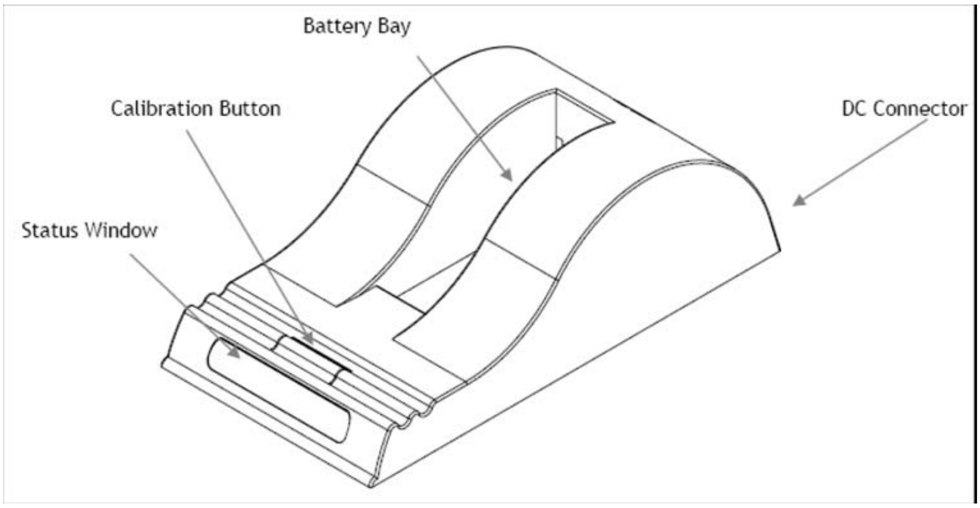


Figure 4-2. Battery Charger/Calibrator

4.3.1 Package Contents

1. One Desktop Charger/Calibrator (PN 369104)
2. Three plastic spacers to modify the battery recess to suit your battery size.
3. One 24V 2.5A AC:DC Power Supply, Universal Mains Input.

Note
Chargers shipped with medical grade power supplies carry the suffix “M” – eg. CH5000AM

4. One Mains Cable.
   a. European Chargers (CH5000E) are packed with a European 2-pin Mains Power Cord
   a. UK Chargers (CH5000U) are packed with a UK 3-pin Mains Power Cord
5. Instuction Manual.

4.3.2 Warnings and Cautions

WARNING

1. **Do not expose the charger or power supply to water or conductive liquids, this is not a sealed case.**
2. **Do not open the charger or power supply case. There are no user serviceable parts inside.**
3. **Do not cover the fan exhaust or obstruct the airflow, as this will cause overheating.**
4. **Use only the manufacturer's 24V 2.5A power supply and observe terminal polarity.**
5. **Place the charger in a cool spot, away from external heat sources**

CAUTION

During recalibration, the battery connector and base of the charger may become warm.

4.3.3 Battery Charger/Calibrator Installation

Place the Charger Unit on a flat, level surface away from sources of heat and moisture. Plug the DC Connector from the Power Supply into the back of the charger and connect the Power Supply to the AC Mains Supply using the supplied cable.

4.3.4 Battery Charging

Place the Battery into the Battery Bay making sure that the 5-way connector is fully seated. The LEDs in the status window will provide status information as detailed below, and the charger will automatically begin to charge the Battery.

4.3.5 LED Indications

The status of the Battery is indicated by the LEDs visible in the status window:

Green Flashing	**Charging**
Green Solid	**Fully Charged**
Blue Flashing	**In Calibration Mode**
Blue Solid	**Calibration Complete**
Red Flashing	**Fuel Gauge Calibration Required**
Red Solid	**Error**

Table 4-1. Charger LED Status Indicator Descriptions

4.3.6 Battery Recharge Time

The times given below are for a full charge from 0% to 100% state of charge.

Battery Chemistry	Battery Model	Typical Recharge Time
Li Ion	NL2024	4 1/2 hours

Table 4-2. Battery Charge Time

4.3.7 Battery Recalibration

If the Battery is in need of Fuel Gauge Recalibration, the red LED will flash upon insertion of the Battery into the Battery Charger. This indicator provides feedback to the user on the accuracy of the fuel gauge and avoids unnecessary Battery Calibration Cycles.

The user has the option to calibrate the fuel gauge and charge the Battery, or to only charge the Battery. This option is given because a recalibration cycle is longer than a charge cycle.

To recalibrate the Battery, press the calibrate button on the front of the charger.

Note
No action is required if only a recharge is required, as the charger will automatically begin to charge the battery.

The blue calibration LED will flash to indicate that the Battery is undergoing the recalibration cycle. There may be a short delay before the calibration begins. During calibration the discharge resistors will heat up and the fan will operate to maintain temperature within acceptable limits.

At the end of this procedure the blue LED will stay constant indicating a fully charged, fully calibrated Battery.

Note
The most common cause of calibration failure is overheating of the Battery during discharge. Please keep the charger away from direct sunlight or heat sources.

4.3.8 Recalibration Time

The Recalibration Cycle begins by discharging away any residual capacity. Then a Calibration Charge is delivered to the Battery. This is followed by a Calibration Discharge. Finally the Battery is given a regular charge. A Calibration Cycle will be faster if the Battery is fully discharged to begin with. Recalibration Time is governed by the battery voltage and capacity. Larger Batteries, and lower voltage Batteries will take longer to recalibrate.

Calibration is initiated each time the Recalibration Button is pressed, so it is not recommended to press the Recalibration Button part way through the recalibration cycle.

Battery Chemistry	Battery Model	Min. Recalibration Time	Max. Recalibration Time
Li Ion	NL2024	14.6 hours	19.2 hours

Table 4-3. Battery Recalibration Times

4.3.9 Recalibration Description

The Fuel Gauge in the Battery uses a highly accurate voltmeter, amperemeter and time clock to measure actual charge in and out of the Battery. In addition, there are algorithms to compensate for the effects of discharge rate, discharge temperature, self-discharge and charging efficiency etc.

All this combines to provide a highly accurate Fuel Gauging System. What is also required is the means to ensure the continued reliability of this system throughout the life of the Battery.

Even with all this technology, the only time at which the Battery is absolutely certain of its real capacity is when it is either completely full or completely empty. Anywhere in between is a calculated estimate - albeit a highly accurate calculated estimate.

Also, as the Battery ages, the amount of available capacity shrinks - so each cycle the "full" point gets a little bit lower.

What's more, if the Battery only sees partial charges and discharges during its application, then it may not get the benefit of a "full" or "empty" reference point for some time and must rely more and more on its calculated figure. The Fuel Gauging System may be subject to drift during use.

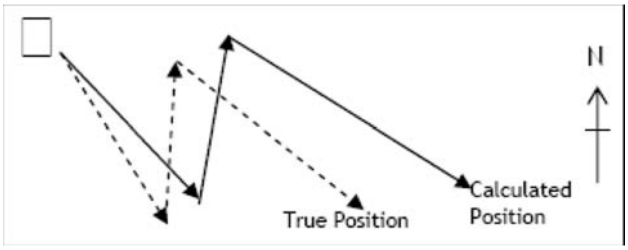


Figure 4-3. Battery Capacity Graph

In use, as the Fuel Gauge mathematically works out the Batteries remaining capacity. It will also work out an estimated accuracy figure known as the "Max Error". This keeps track of the overall accuracy of the system. In this way, the Battery can tell the device not only how much capacity is remaining, but also how reliable this estimate is. When a Moltech Power Systems or Inspired Energy battery achieves a max. error of 10% the recalibration bit is set.

Some devices use this recalibration bit to trigger a note on the device screen to tell the user to recalibrate their Battery. The Battery Charger/Calibrator uses the recalibration bit to tell the user if recalibration is necessary and flashes the red LED if the Battery Fuel Gauge is becoming inaccurate.

The recalibration is used to re-set the Fuel Gauge algorithms, re-establish the full and empty points, and re-calculate the actual capacity in the Battery. In this way, even as the Battery ages and things change, the accuracy and reliability of the Fuel Gauge can be retained throughout the life of the Battery.

In order to carry out a full recalibration the following must occur:

- Either; begin with a fully discharged Battery, or discharge away any residual capacity.
- Fully charge the Battery (this tells the system how much charge has been put into the battery to take it from 0% to 100% charged, and establishes the current "Full" point.)
- Fully discharge the Battery (This tells the system how much of the full charge input is available for discharging, and re-sets the Max Error)

At this point the Battery is calibrated, but it is also empty - so it needs a full recharge to return it to use.

This process can be achieved inside the device (e.g. you leave the device on until it shuts down, fully charge it, leave it on until it shuts down again and then fully charge it again) but this can be time consuming and inconvenient. Also many devices operate a device shut-down before the Battery is discharged to the point at which the fully-discharged bit is set. These devices will not be capable of recalibration Smart Batteries and an external device such as the Battery Charger/Calibrator must be used instead.

A desktop device like the Battery Charger/Calibrator, which automatically takes the Batteries through this process, is a useful alternative, ensuring accuracy and reliability of the fuel gauge throughout the life of the battery. As the process of recalibration includes the charging process it is most convenient to build in this functionality into a charger and give the user the option of a regular charge or a recalibration with a charge.

Part 2: Preventive Maintenance and Testing

Section

5 Preventive Maintenance and Testing Overview

WARNING

- **To prevent disease transmission, you must use personal protective equipment when handling contaminated bacterial filters or other patient accessories. Refer to the HAMILTON-C2 operator's manual for instructions on sterilizing patient system parts.**
- **You must complete a service training course for the HAMILTON-C2 with HAMILTON MEDICAL before undertaking the maintenance and testing procedures described in this manual.**

CAUTION

Make sure to take full ESD (ElectroStatic Discharge) precautions before handling any EEPROM, or before opening the HAMILTON-C2. For more information, see Appendix A, *Maintenance Tools and Test Equipment*, on page A-1.

5.1 Introduction

All preventive maintenance and testing must be performed:

- After replacing any component.
- Once a year or once every 5000 operating hours, whichever comes first.

To perform preventive maintenance, perform all the steps shown in Table 5-2.

5.2 Checking the Software Level

In general, HAMILTON MEDICAL AG recommends updating to the latest Software available. See the HAMILTON MEDICAL AG Partner Web Site (http://www.hamilton-medical.com).

5.3 Items Required for Preventive Maintenance and Testing

<table>
<tr><th>Step</th><th>Items required, or possibly required</th></tr>
<tr><td>• Section 6, Hospital Preventive Maintenance
• Section 7, Engineer Preventive Maintenance</td><td>• The HAMILTON-C2 Operator's Manual or local-language equivalent
• HEPA Filter (PN 160216)
• Filter set (each set has 2 Dust Air Filter and 1 Fan Filter (PN 160215)
• Backlight (PN 380030)
• Blower Module (PN 160250)
• Lithium Ion Battery Pack(s) (PN 369106)
• Battery Charger / Calibrator (PN 369104)
• HAMILTON-C2 Oxygen Cell (PN 396200)
• O_2 Inlet filter kit (PN 160497)
• Complete Breathing Circuit (Adult) (PN 260086):
  • Flow sensors. Any of the following:
    • Pediatric/Adult (PN 155362), reusable or
    • Pediatric/Adult (PN 279331), Single-Patient use
  • Test Lung with ET-Tube (PN 151815) and adapter (PN 281420)
  • Filter Inspiratory (PN 279204)
  • Short Silicone tube (PN 260100)

Note
Details of parts are shown in Appendix B, Spare Parts, on page B-1.</td></tr>
<tr><td>• Section 8, Electrical Safety Tests
• Section 9, Service Software</td><td>• Test equipment for HAMILTON-C2; see HAMILTON MEDICAL website: Partner-net -> Technial support -> recommended spare part list -> Test equipment (complete)

Note
Details of tools are shown in Appendix A, Maintenance Tools and Test Equipment, on page A-1.</td></tr>
</table>

Table 5-1. Items Required for Preventive Maintenance and Testing

5.4 Procedure

Work methodically through the sections shown in Table 5-2.

Maintenance and testing is not complete until all steps are successfully performed.

Step	Task	Where Found	Time Required
1.	Perform (or confirm it has been performed) the Hospital Preventive Maintenance.	Section 6, *Hospital Preventive Maintenance*	5-15 min.
2.	Perform the Engineer Preventive Maintenance.	Section 7, *Engineer Preventive Maintenance*.	10 min.
3.	Perform parts replacements as necessary.[a]	Section 11, *Components Removal/Assembly*	N/A
4.	Perform the Electrical Safety Tests.	Section 8, *Electrical Safety Tests*	10 min
5.	Perform the Service Software.	Section 9, *Service Software*	40 min
6.	Finish the testing by completing the tasks documented in the *Tests, Calibrations and utilities* section of the *HAMILTON-C2 Operator's Manual*.	The *HAMILTON-C2 Operator's Manual* or local-language equivalent.	10 min

Table 5-2. Overview of Preventive Maintenance and Testing

a. If you make a replacement, you must go back to step (3).

Section

6 Hospital Preventive Maintenance

Table 6-1 shows the maintenance tasks that hospital staff must perform. It is copied from the English version of the HAMILTON-C2 Operator's Manual.

Examine each HAMILTON-C2 for which you are responsible, and satisfy yourself that hospital staff are regularly performing these tasks. If necessary:

- Perform the tasks yourself.
- Train staff how to perform these tasks.

Interval	Part/Accessory	Procedure
Between patients and according to hospital policy.	Breathing circuit (including Mask, Inspiratory Filter, Flow Sensor, Nebulizer Jar, Expiratory Valve and Membrane).	Replace with sterilized or new single-use parts. Run the Tightness Test and the Flow Sensor Calibration as shown in the HAMILTON-C2 Operator's Manual.
	Entire ventilator.	Run the pre-operational check as shown in the HAMILTON-C2 Operator's Manual.
Every 2 days or according to hospital policy	Breathing Circuit.	Empty any water from breathing tubes or water traps. Inspect parts for damage. Replace as necessary.
Every month (or more often, if required).	Air intake Dust Filter and Fan Filter set (5 pieces)(rear panel).	Check for dust and lint. If needed, clean or replace as shown in the HAMILTON-C2 Operator's Manual.
Every 6 months (while the Ventilator is in storage)	Battery	Recharge battery by plugging the Ventilator into AC Power for at least 4 hours.

Table 6-1. Hospital Preventive Maintenance Schedule

Section

7 Engineer Preventive Maintenance

WARNING

This section is not a stand-alone, independent part of the manual. Perform the tasks detailed here only as a part of, and as instructed by, Section 5, *Preventive Maintenance and Testing Overview*.

Perform the Engineer Preventive Maintenance, according to the table below:

Interval	Part/accessory	Procedure
Yearly or every 5000 Hours, whichever comes first, or as necessary	Ventilator	Check internal connections of cables. Check for proper installation of components. Perform service-related Preventive Maintenance.
	Tests	Perform complete Service Software checks as described in **Section 9, *Service Software***, on page 9-1**.**
	Pre-Operational Checks	Perform the Pre-Operational Checks as shown in the HAMILTON-C2 Operator's Manual, Section 3.2 Preoperational Checks.
	Test and Calibration Procedure	Perform the Test and Calibration Procedure as shown in the HAMILTON-C2 Operator's Manual, Section 3.3.2 Test & Calib.
	Alarm Tests	Perform the Alarm Checks as shown in the HAMILTON-C2 Operator's Manual, Section 3.5 Alarm Tests.
	HEPA Filter	Replace.
	O2 inlet filter	Replace
	Oxygen Cell	Replace if depleted as shown in the HAMILTON-C2 Operator's Manual.
	Mainboard	Check screw nut at RS232 connector. If necessary tighten and fix with Loctite 638.
	Note Oxygen Cell life specifications are approximate. The actual cell life depends on the operating environment. Operation at higher temperatures, higher oxygen concentrations shorten cell life.	
Cycles to be checked > 500	Lithium Ion Battery	Replace the Lithium Ion Battery. Also reference **Section 4, *Lithium Ion Battery***, on page 4-1.

Table 7-1. Engineer Preventive Maintenance

Interval	Part/accessory	Procedure
Every 20,000 hours or as required by service timer.	Ventilator	Replace the Blower Module as described in *Section 11.4.9, Blower Module Removal/Assembly*, on page 11-27
Every 5 years (30,000 Hours)	LCD display backlight.	Replace as described in *Section 11.3.7, LCD Display Removal/Assembly*, on page 11-13.

Table 7-1. Engineer Preventive Maintenance

Section

8 Electrical Safety Tests

WARNING

Electrical Safety Tests detailed in this section must be performed as part of, or as instructed by, Section 5, *Preventive Maintenance and Testing Overview*, on page 5-1.
In addition, to comply with IEC 60601-1 the Electrical Safety Tests must be performed after:

- **the Power Supply is replaced**
- **the Mainboard is replaced**
- **removing any ground contact from the HAMILTON-C2**
- **when performing Preventive Maintenance**

8.1 Overview

HAMILTON MEDICAL performs a set of Electrical Safety Tests, as specified in IEC 60601-1, on all the ventilator and compressor units that it manufactures. HAMILTON MEDICAL performs these tests automatically, using the RIGEL 288.

As stated in the warning above, it is a legal necessity that, after performing a repair or adjustment that includes replacing the Power Supply, replacing the Mainboard or by removing any of the internal connectors, you must perform the Electrical Safety Tests. In addition, HAMILTON MEDICAL recommends that even if a repair is not made, the Electrical Safety Tests are performed during Preventive Maintenance.

8.2 Preparation for test

See „Short description RIGEL 288 PN 612175".

- Multimeter

- Safety Analyzer

- EST Cable

Figure 8-1. RIGEL 288

8.3 Perform the test

The Electrical Safety Tests you must perform are explained in this section. If you have an automated safety device such as the Metron Safety Analyzer used by HAMILTON MEDICAL, perform the automated tests ***in addition to the tests shown in this section***.

8.4 Device Type

For the IEC 60601-1 Regulations concerning medical devices, the HAMILTON-C2 is a Class: 2 Type: B device.

8.5 Internal Cable Checks

For these tests, a Digital Voltmeter is required, as specified in Appendix A.3.1, *Digital Voltmeter*, on page A-1.

Check the resistance between the ground (earth) pin on the HAMILTON-C2’s DC Power Inlet Socket with the Test Connector, and other components, as shown in Table 8-1.

Check	Mimimal acceptable resistance	Figure
A. Ground (earth) pin to: Communications Interface Connector	> 2.4MΩ	Figure 8-2
B. Ground (earth) pin to: Interaction Panel	> 2.4MΩ	Figure 8-3
C. Ground (earth) pin to: Oxygen High Pressure	> 2.4MΩ	Figure 8-4
D. Ground (earth) pin to: Oxygen Low Pressure	> 2.4MΩ	Figure 8-5

Table 8-1. Electrical Tests

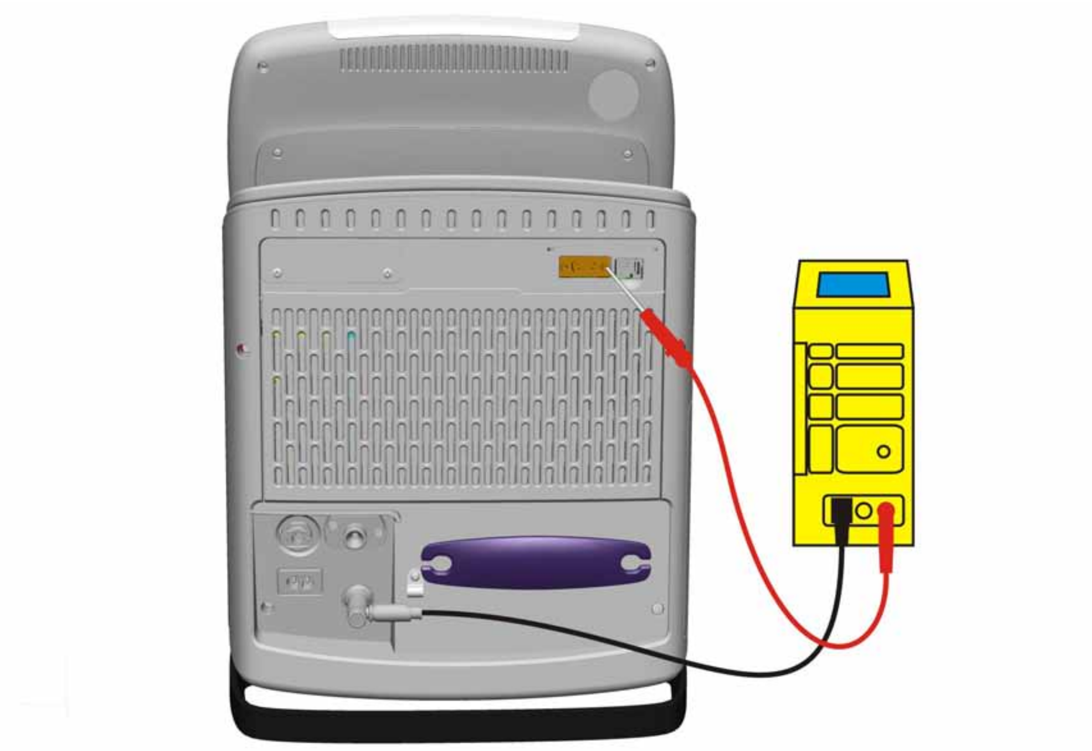


Figure 8-2. Checking the Earth Ground to the Communication Interface Connector Resistance

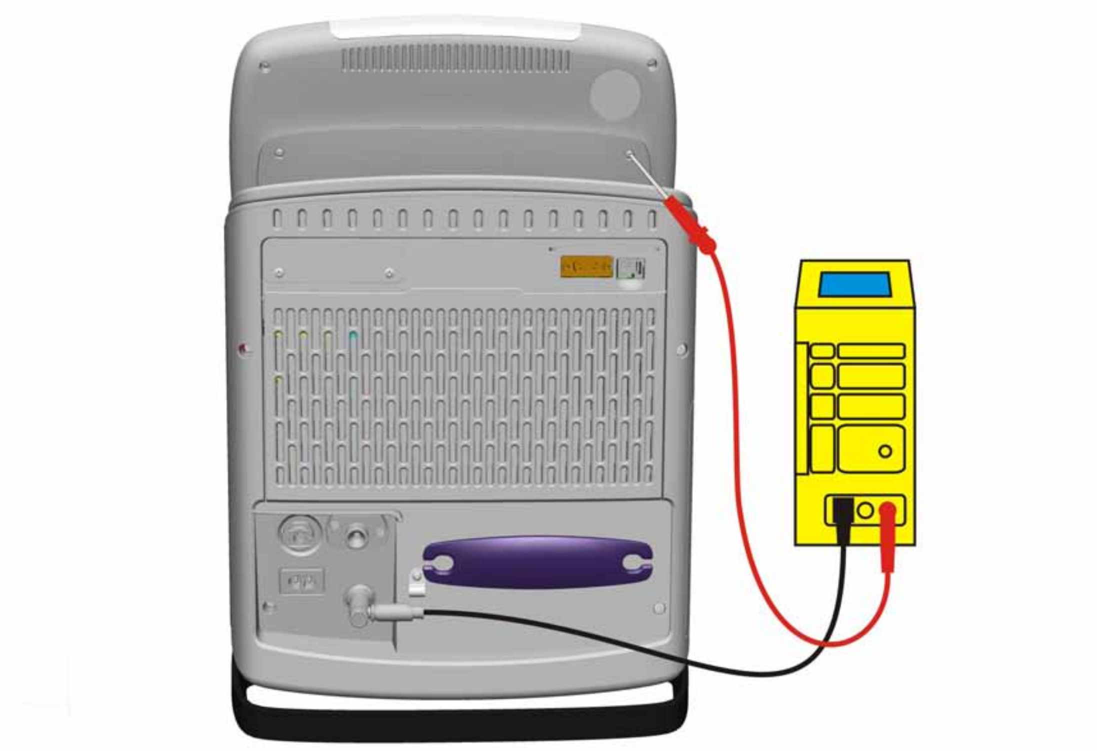


Figure 8-3. Checking the Earth Ground to the Interaction Panel Resistance

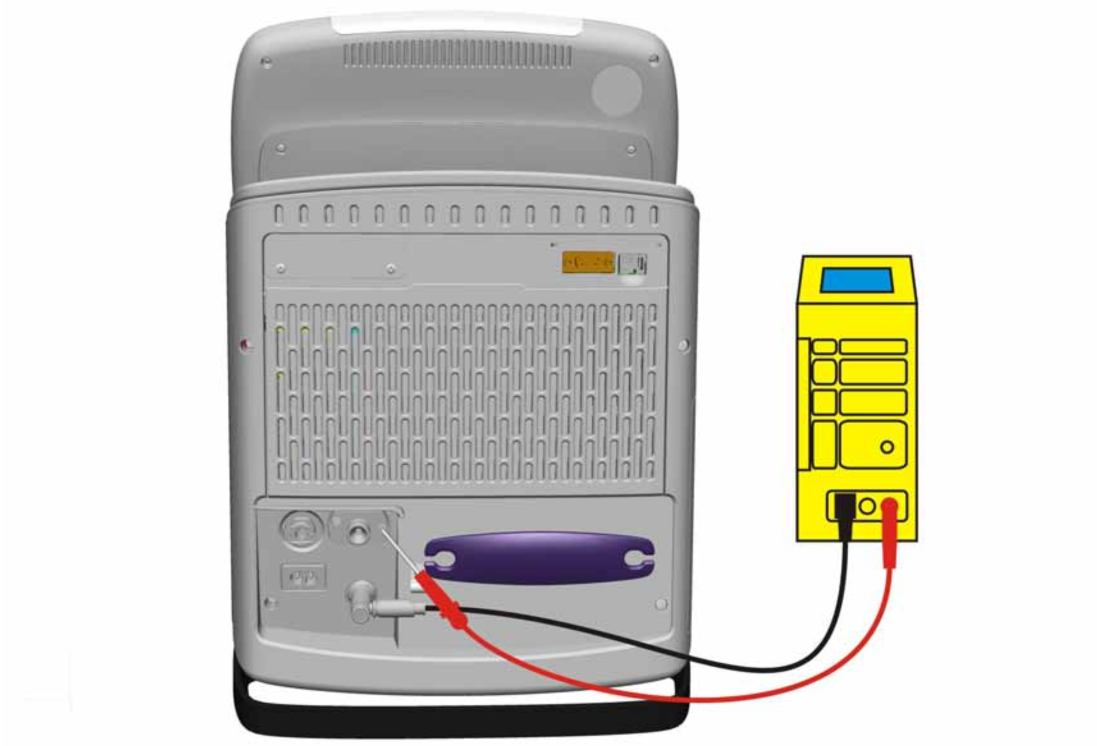


Figure 8-4. Checking the Earth Ground to the High Pressure Oxygen Resistance

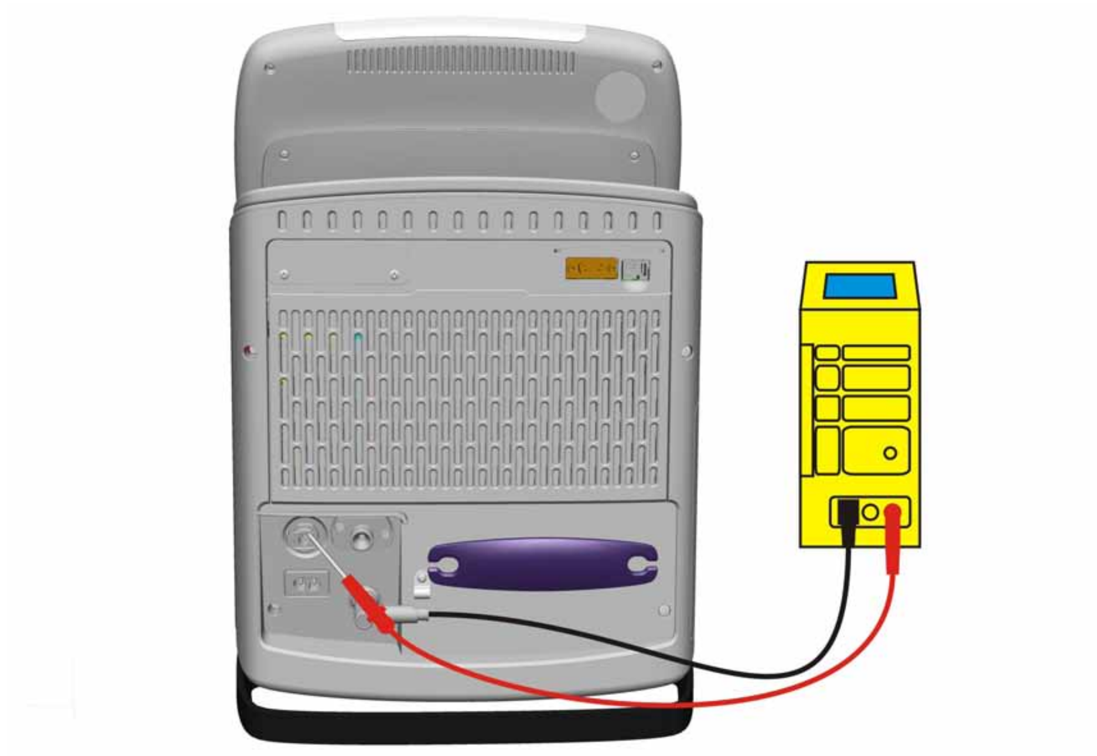


Figure 8-5. Checking the Earth Ground to the Low Pressure Oxygen Resistance

8.6 Electrical Safety Tests - IEC 60601-1

HAMILTON MEDICAL performs an Electrical Safety Test, according to IEC 60601-1, on all ventilator and compressor units it manufactures.

It is a legal necessity, after a repair or adjustment that includes replacing the Power Supply, Mainboard or removing any of the internal earth connectors, perform an Electrical Safety Test on the HAMILTON-C2.

The Electrical Safety Test is performed with suitable equipment such as the RIGEL 288.

Because details of these Automated Electrical Safety Tests depend on the test equipment used, it is impossible to offer any detailed descriptions.

Figure 8-6. RIGEL 288

8.6.1 Specifications

Current / Value		Type B		Type BF	
		N.C.	S.F.C.	N.C.	S.F.C.
Enclosure Leakage Current / mA		0.1 mA	0.5 mA	0.1 mA	0.5 mA
Patient Leakage Current / mA	DC	0.01 mA	0.05 mA	0.01 mA	0.05 mA
	AC	0.1 mA	0.5 mA	0.1 mA	0.5 mA
Insulating Resistance / Mohms		>200 MΩ		>200 MΩ	

Table 8-2. IEC 60601-1 Specifications for the Class 2 Type B Device

8.6.2 Setup for the RIGEL 288 Safety Tests

1. Attach the Ground Cable from the DC Input of the HAMILTON-C2 to the Ground of the RIGEL 288.
2. Connect the AC Mains Cable from the HAMILTON-C2 to the AC Connection at the front of the RIGEL 288.

Figure 8-7. RIGEL 288 Rear Connections

3. Attach a Patient lead from the Patient Lead 1 Connection on the top of the RIGEL 288 to one of the Nebulizer outlet on the front of the HAMILT0N-C2.

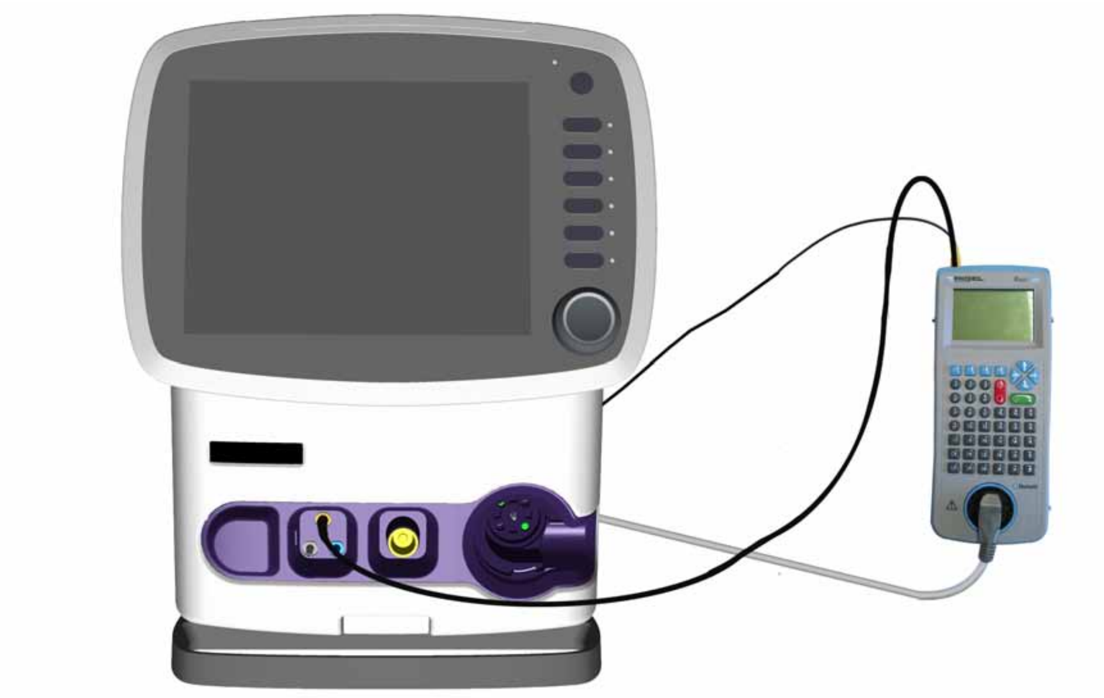


Figure 8-8. RIGEL 288 Front Connections

Section

9 Service Software

WARNING

- **Read Section 5 *Preventive Maintenance and Testing Overview*, before performing any of the tests in this section.**
- **If one of the tests indicates that you must replace a part, do so immediately and update the service entry (see Section 9 *Service Entry*) and then repeat the complete series of tests. See Section 11 *Contents in this Section*.**

CAUTION

To prevent patient or ventilator contamination, always use a Bacterial Filter between the HAMILTON-C2 and the Inspiratory Limb of the Patient Breathing Circuit.

- For Troubleshooting see Knowledge base.
- Record all results on the HAMILTON-C2 Test report.
- Confirm that the technical state is updated and that the device has been restarted after technical state modifications. see Service *Service Entry* on page 9-12. Always use a Adult Breathing Circuit, if a circuit is required during the tests.

Note

The HAMILTON-C2 needs a warm-up period. Make sure it was running for at least 20min in the ventilation software.

9.1 Introduction

This section describes each of the Units comprising the HAMILTON-C2 Service Software.

Before starting, be sure that you are familiar with *Typographic Conventions* on page *Conventions-1*, and *Expressions* on page *Conventions-2*.

The *HAMILTON-C2 Test Report Form* is the standard form to be used and must be completed each time the Service Software is performed. If you do not have a suitable form, you can photocopy and use the form named *HAMILTON-C2 Test Report Form* at the back of this manual.

9.2 Functions of the Service Software

Units in the Service Software perform the following functions:

- Enables display information (concerning revisions and versions of the HAMILTON-C2 Hardware and Software)
- Enables checks on the HAMILTON-C2 Hardware and Software
- Enables calibration of the HAMILTON-C2 Hardware
- Enables viewing and exporting of the Event Log and Service Log
- Enables software upgrades

9.3 Structure of the Service Software

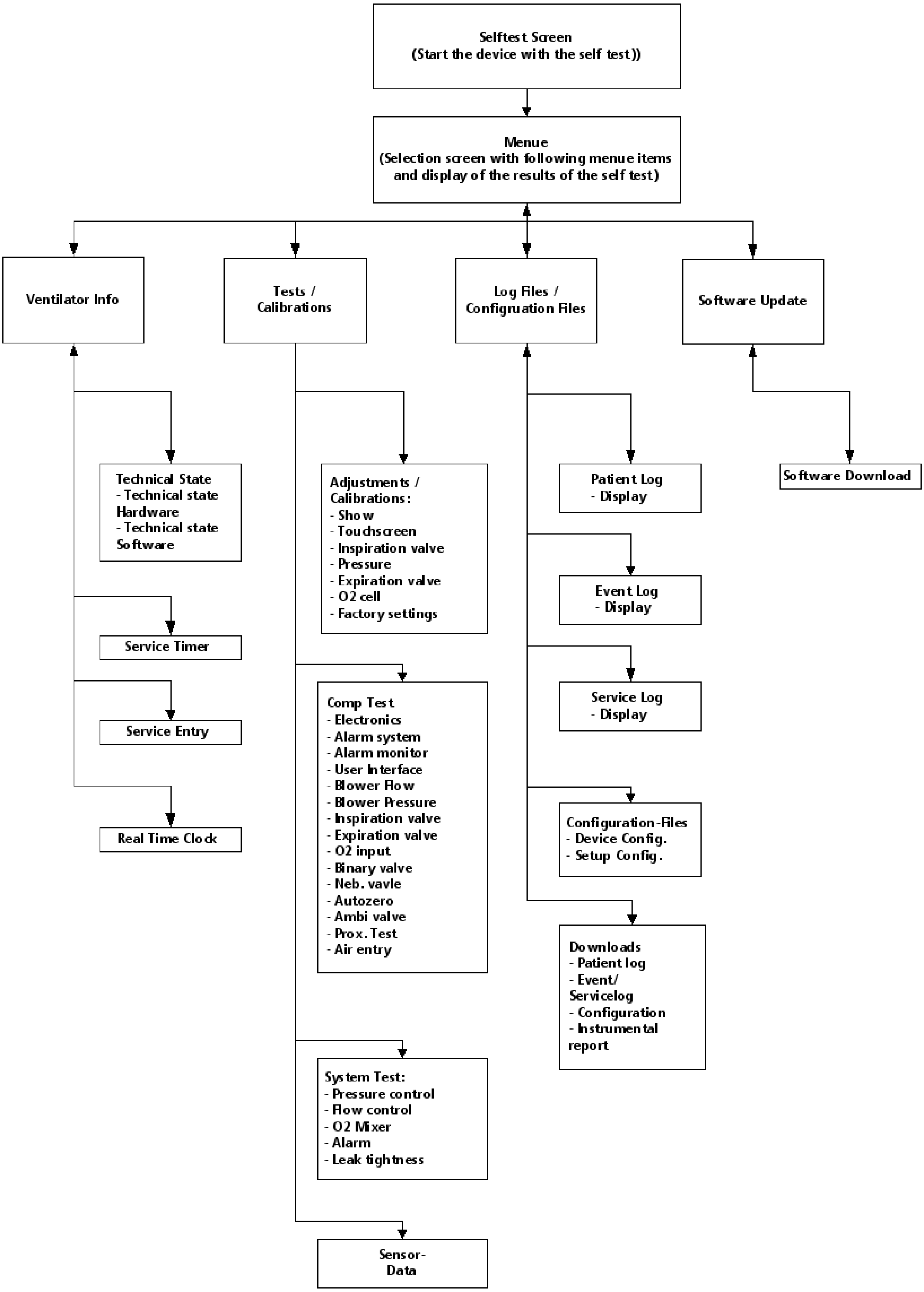


Figure 9-1. **Menue structure**

9.4 Service Software Screen Layout

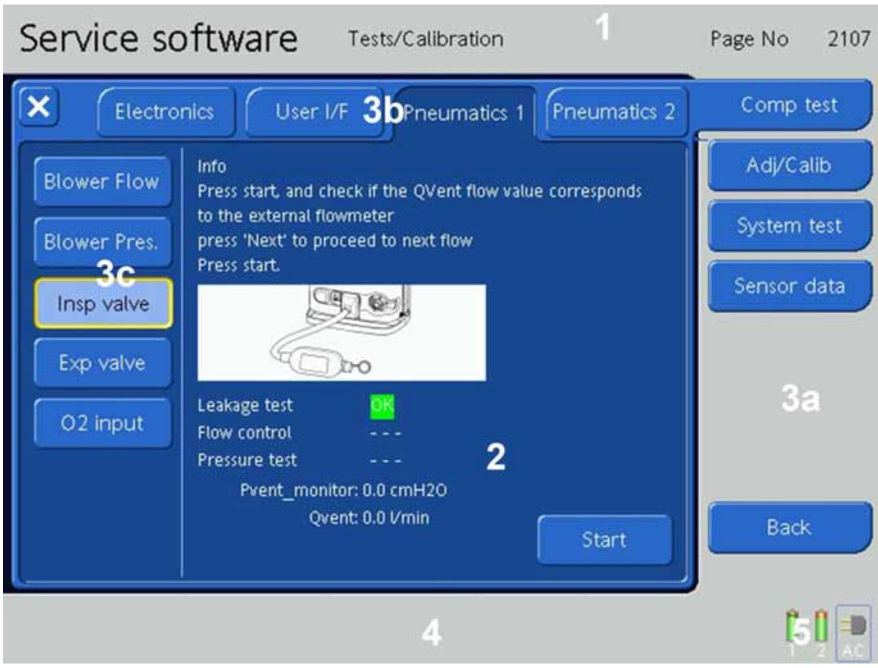


Figure 9-2. The HAMILTON-C2 Service Software Screen Layout

1. Header Window
2. Test Window including Dialogs

3a. Menu Tab Layer 1

3b. Optional Menu Tab Layer 2

3c. Optional Menu Tab Layer 3

4. Alarm Window
5. Energy State Window

9.5 Starting the Service Software

To start the Service Software, you must place the HAMILTON-C2 into the Service Software Mode.

1. Connect the HAMILTON-C2 to Mains Power.
2. Switch the **ON** (A) Button located on the HAMILTON-C2 Interaction Panel and then press and hold the **100% O_2** (B) and **Manual Breath** (B) **Buttons** at the same time.

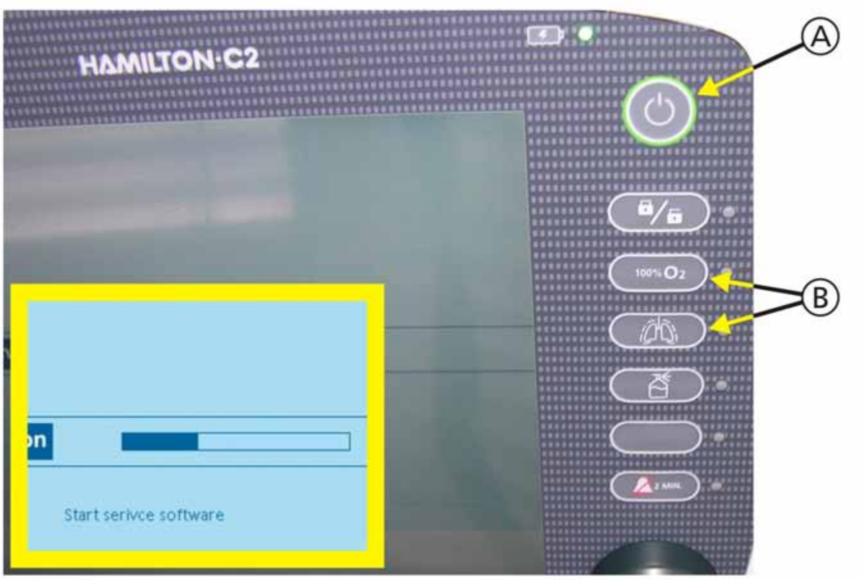


Figure 9-3. Starting the HAMILTON-C2 Service Software

3. After the Service Software starts, the Main Service Software Screen is displayed.

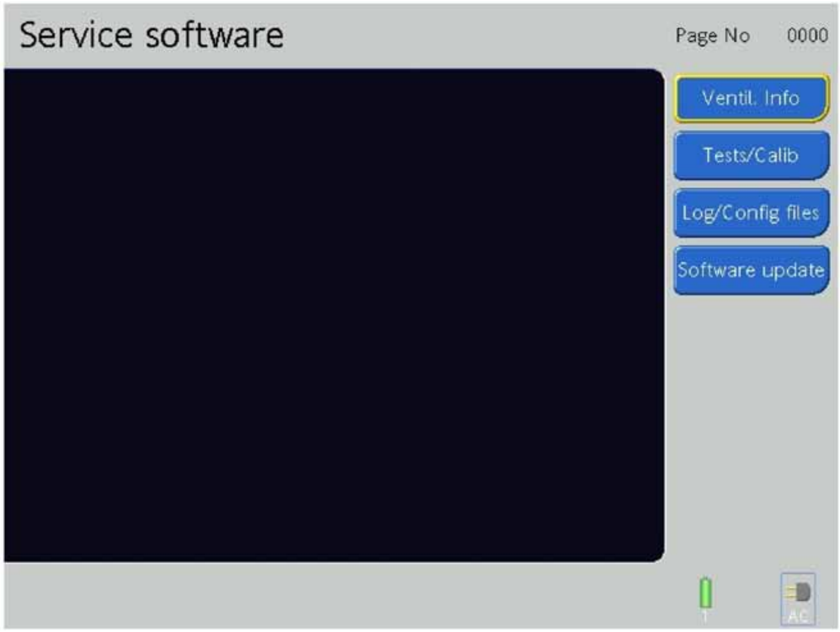


Figure 9-4. The HAMILTON-C2 Main Service Software Screen

4. To exit the Service Software, switch OFF the HAMILTON-C2.

9.6 Making screenshots

1. Create a file folder on the USB Stick called „screenshots".
2. Connect the **USB Stick** (B) (PN 396207) with the HAMILTON-C2 and press the (A) for 1 second..

Figure 9-5. Making screenshots

Note
Screenshots are only in the Service Software possible. For the Print Screen Button test, press the empty button for 1 second.

9.7 Ventilator Info Screens

From the Main Service Software Screen, press the **Ventilator Info Button**.

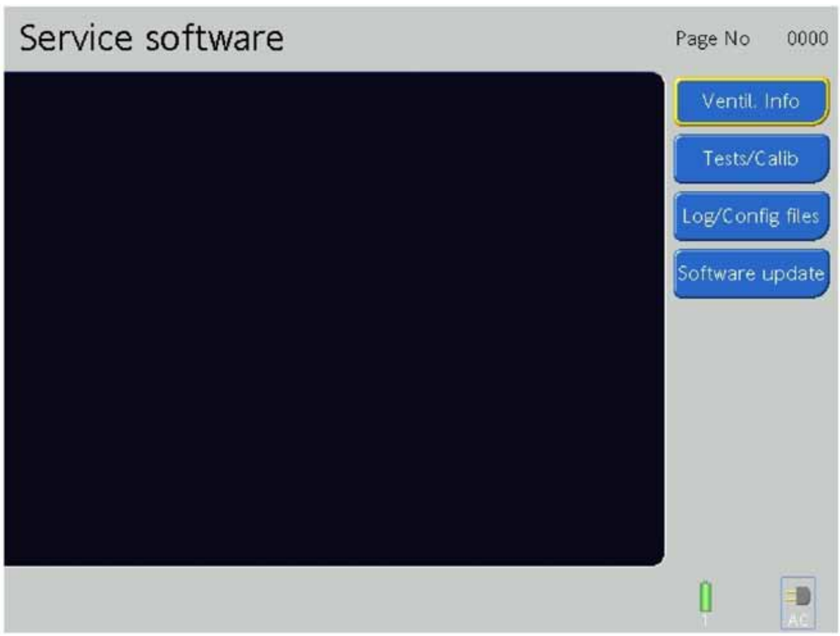


Figure 9-6. The Main Service Software Screen

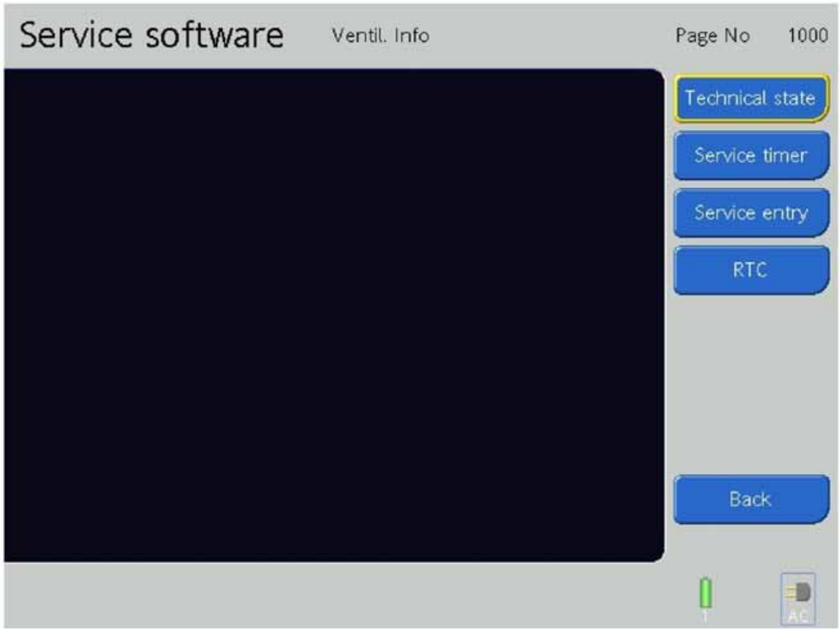


Figure 9-7. The Ventilator Info Screen

On the Ventilator Info Screen are the:

- *Technical State* Button
- *Service Timer* Button
- *Service Entry* Button
- *Real Time Clock (RTC)* Button
- Back Button (go back to the main menu)

9.7.1 Technical State

Press the **Technical State Button** to open the Hardware (HW) Version and Software (SW) Version Tabs.

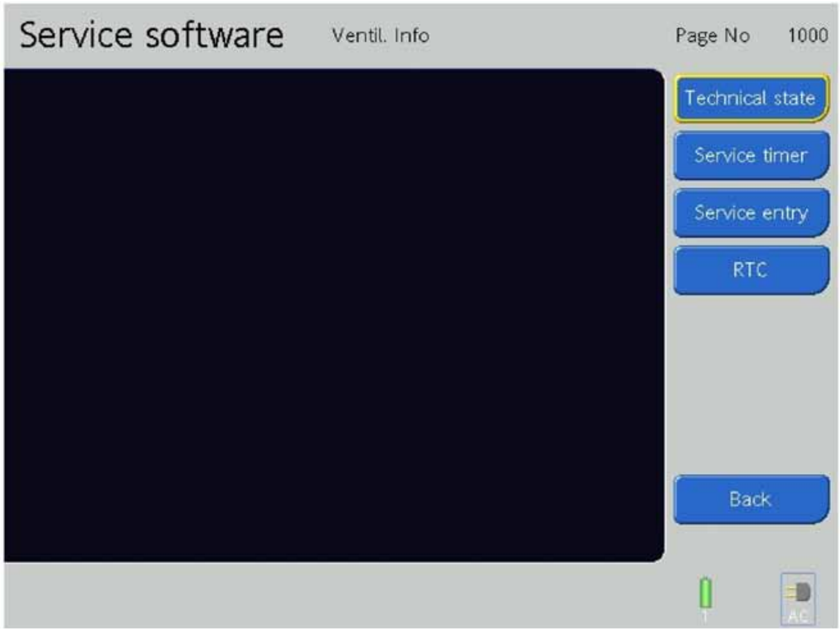


Figure 9-8. The Instrument State Screen

9.7.1.1 Hardware Version Tab

1. Press the **HW Version Tab**. The Hardware Version Tab displays the Device Name, Part Number, Revision, Serial Number and Timing Information.

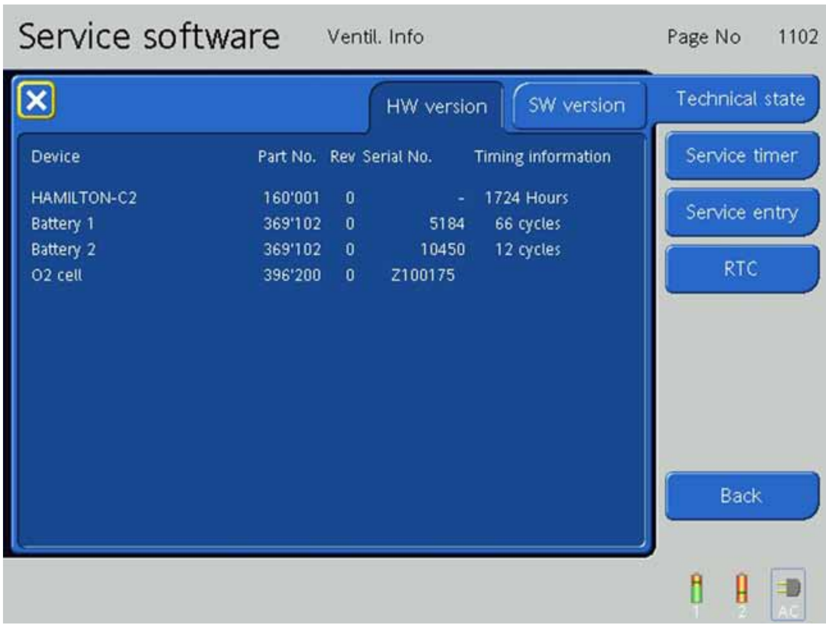


Figure 9-9. The Hardware Version Tab

2. Record the Hardware Version Information on the **HAMILTON-C2 Test Report**.

9.7.1.2 Software Version Tab

1. Press the **SW Version Tab**. The Software Version Tab displays the Device Names and Revisions of the operating software.

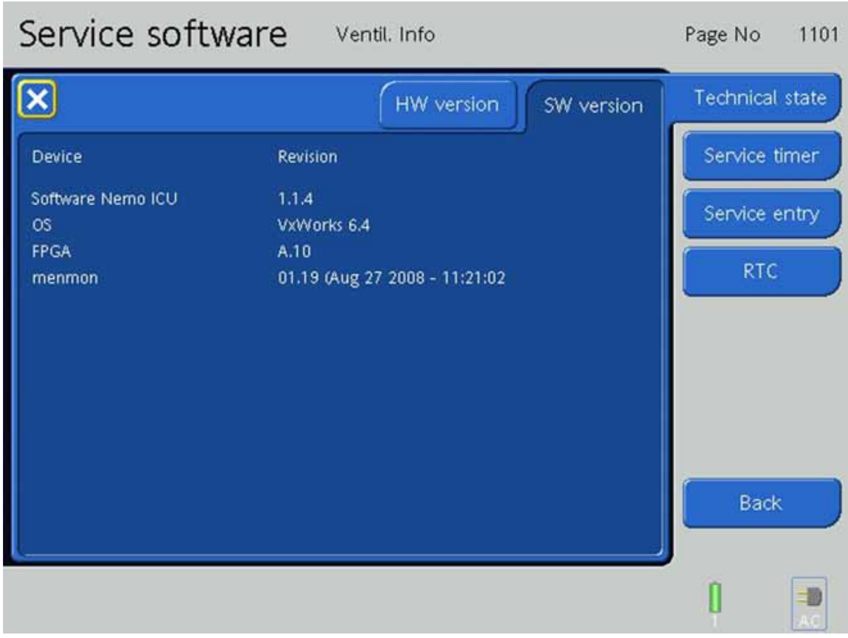


Figure 9-10. The Software Version Tab

2. Record the Software Version Information on the HAMILTON-C2 Test Report.

9.7.2 Service Timer

Press the **Service Timer Button**.

9.7.2.1 Service Timer Tab

1. Press the **Service Timer Tab**. On the Service Timer Tab, the total Operating hours are displayed and the Service Timer hours are displayed since the last time the Service Timer was previously Reset.

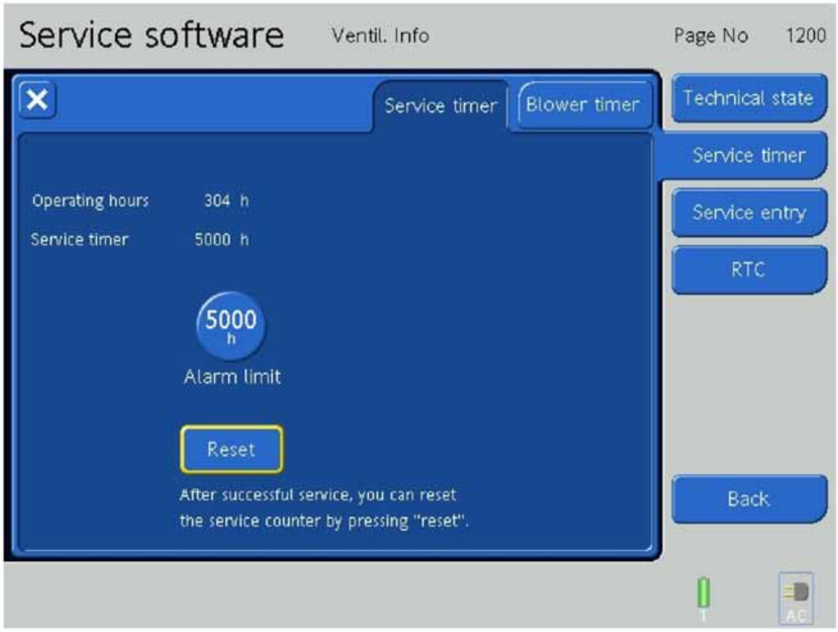


Figure 9-11. The Service Timer Tab

2. Record the Operating hours and the Service Timer Hours on the **HAMILTON-C2 Test Report**.
3. After successful service, ‘Reset’ the service counter by pressing the **Reset Button**.

4. The **Alarm Limit Button** allows the set number of hours between service intervals to be changed.

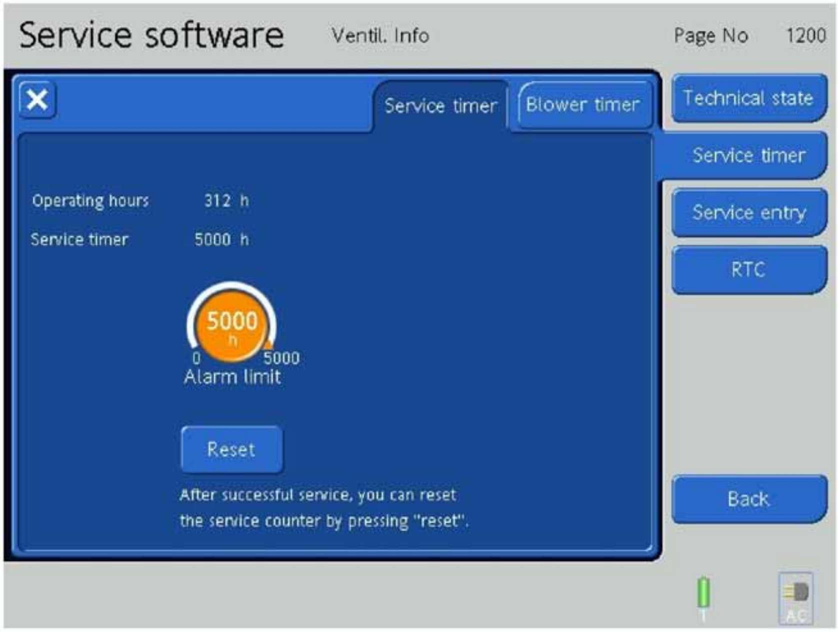


Figure 9-12. Setting the Alarm Limit

a. Press the **Alarm Limit Button** or rotate the P&T Control Knob until the Alarm Limit Rotary Screen Button is highlighted, then press the P&T Control Knob.

b. The number of hours can be changed by rotating the P&T Control Knob.

c. Press the **Alarm Limit Button** again or press the P&T Control Knob to save the new value.

d. Press RESET

9.7.2.2 Blower Timer Tab

1. Press the **Blower Timer Tab**. On the Blower Timer Tab, the total Blower Time hours are displayed in percentage.

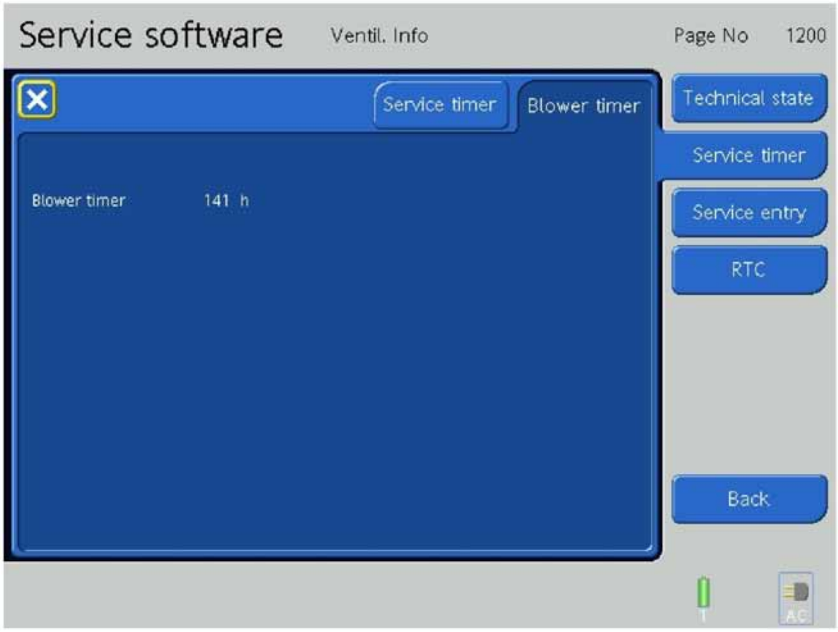


Figure 9-13. The Blower Timer Tab

2. Record the Blower Timer Hours on the **HAMILTON-C2 Test Report**.

9.7.3 Service Entry

Press the **Service Entry Button**.

9.7.3.1 Service Entry Show Tab

The Service Entry Show Tab displays all the major components by Device Name and their Part Number, Revision Number and Serial Number. Service Entry Modify Tab

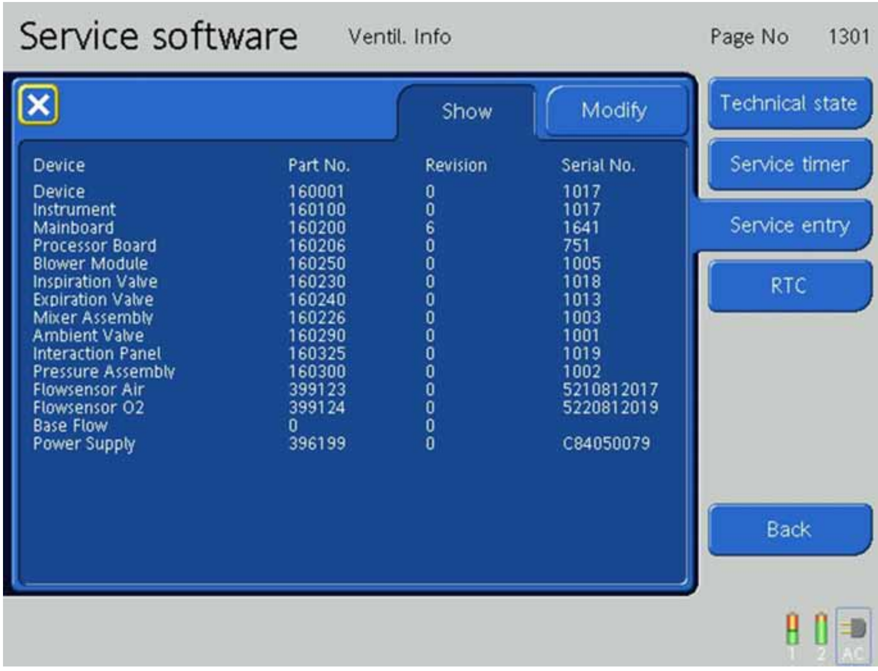


Figure 9-14. The Service Entry Show Tab Screen

9.7.3.2 Service Entry Modify Tab

Note
Always complete, actualize the Service Entry Modifications and restart the device before you perform the Service Software Tests and Calibrations.

The Service Entry Modify Tab allows updating information when a part has been replaced.

1. Press the **Modify Button** and select the part which has been replaced.

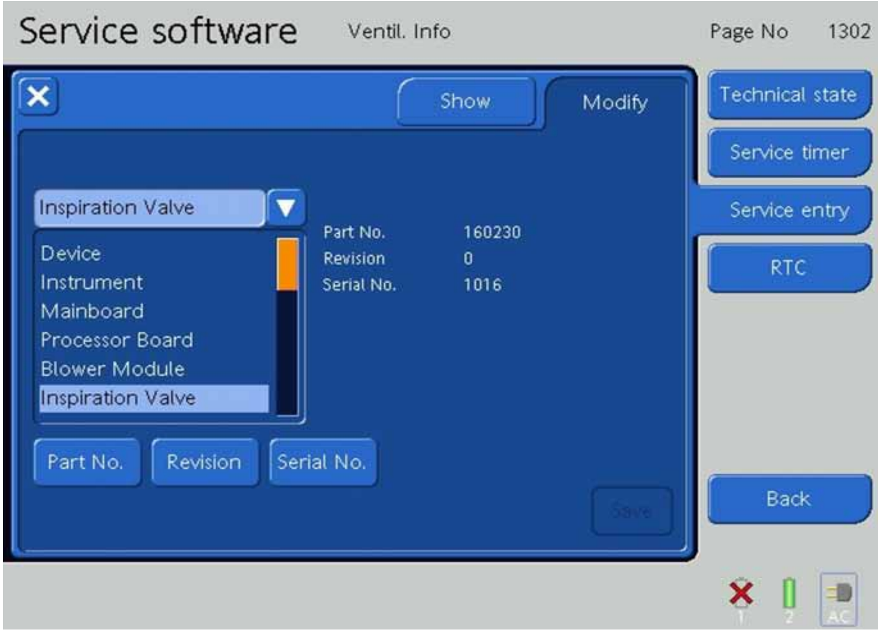


Figure 9-15. The Service Entry Modify Tab Screen, Step 1

2. To change the Serial- or Partnumber or Revision press one of these buttons.

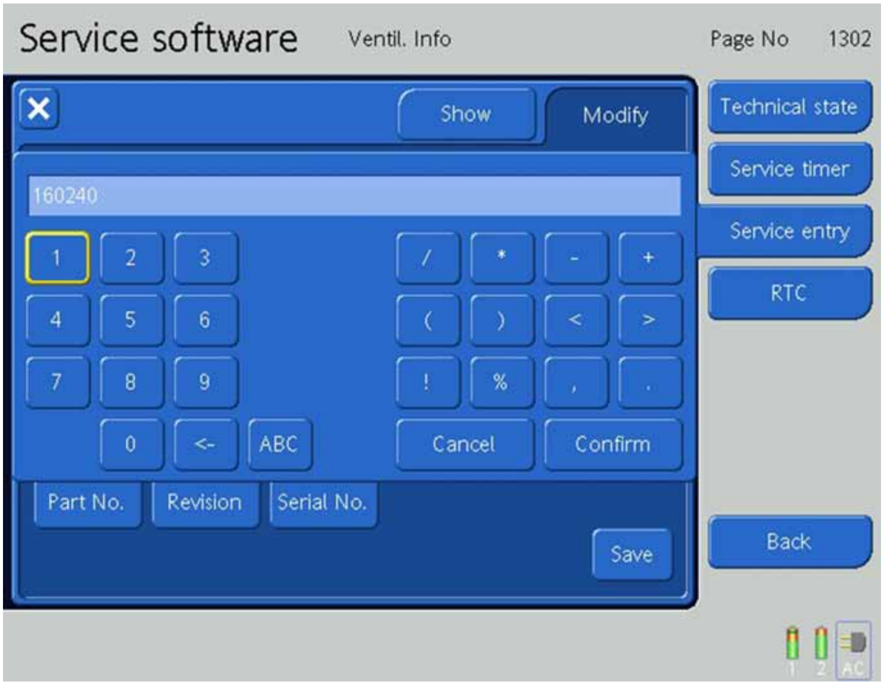


Figure 9-16. The Service Entry Modify Tab Screen, Step 2

3. Confirm and press the **Save Button**.

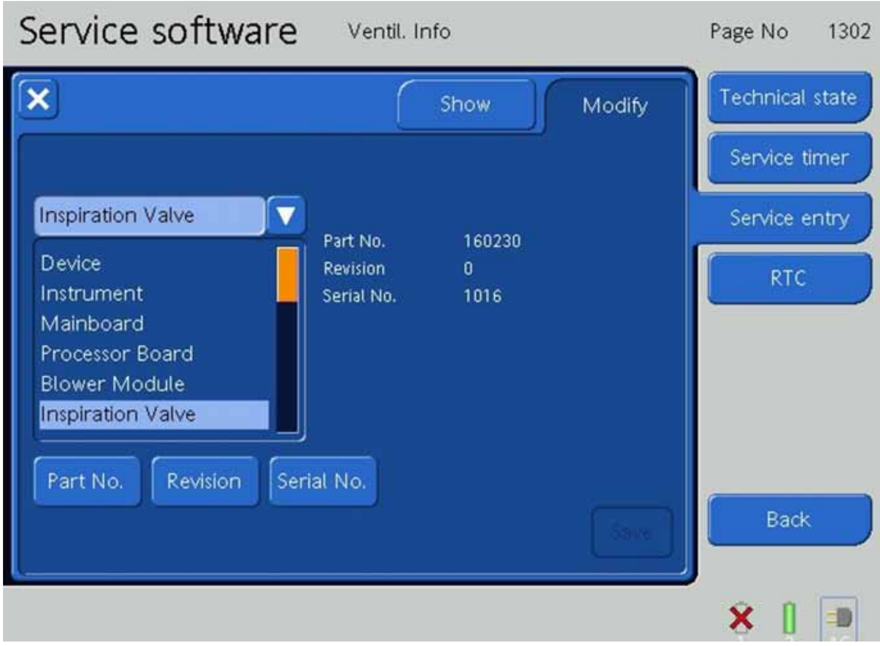


Figure 9-17. The Service Entry Modify Tab Screen, Step 3

9.7.3.3 Data Transfer with Software 2.0.0 or higher

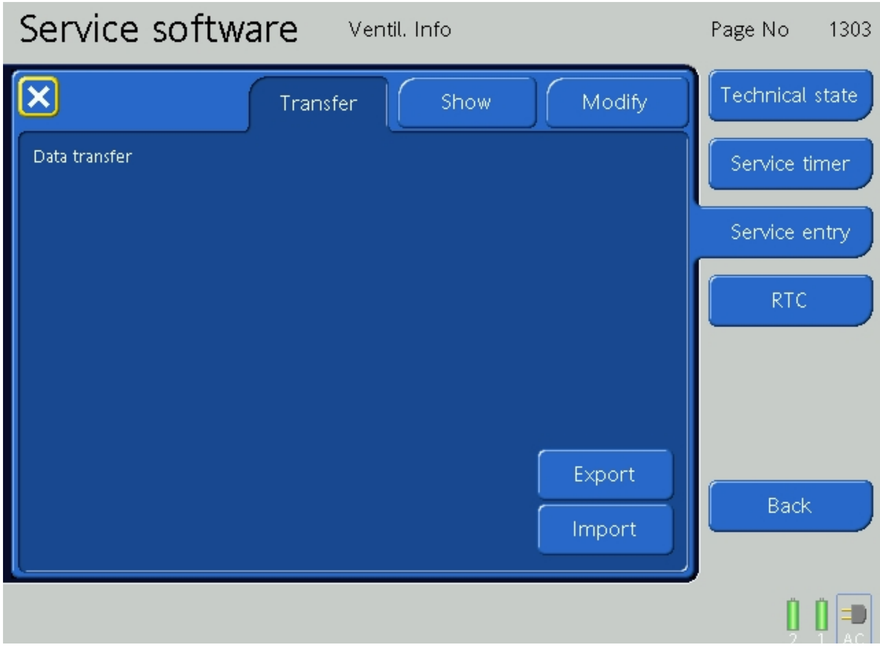


Figure 9-18. The Service Entry Modify Tab Screen, Step 3

9.7.4 Real Time Clock (RTC)

1. Check the current Date and Time:

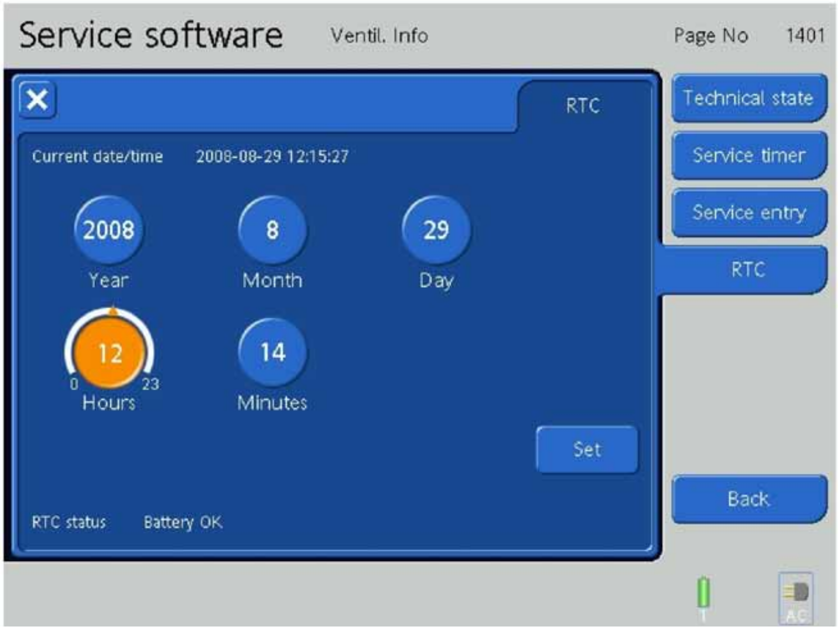


Figure 9-19. Current Date and Time Reset, Step 1

   a. Press the **Screen Button(s)** that need to be changed, or rotate the P&T Control Knob until the desired Button is highlighted, then press the P&T Control Knob.
   b. Change the number displayed by rotating the P&T Control Knob.
   c. Press the **Screen Button** again or press the P&T Control Knob to keep the new value.

2. When all selections are complete, press the **Set Button**.

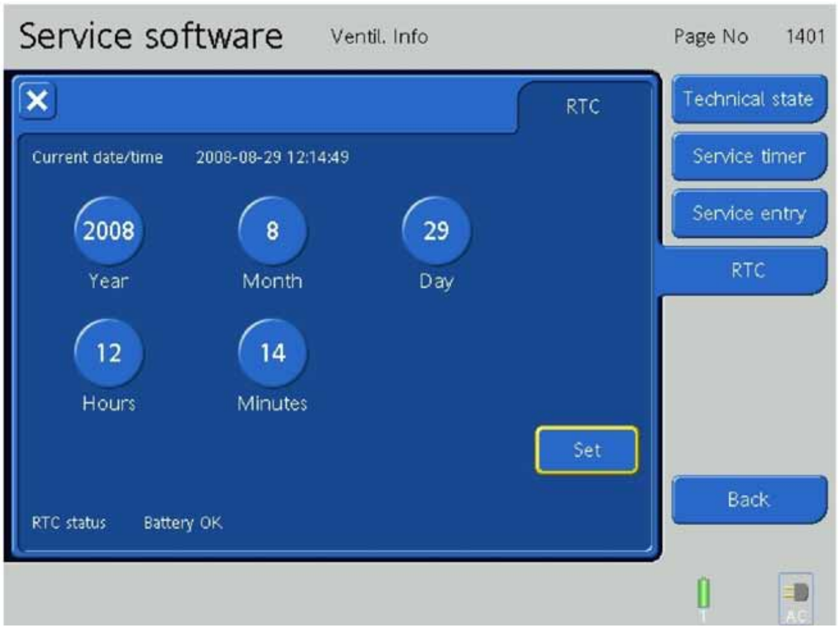


Figure 9-20. Current Date and Time Reset, Step 2

3. To change to the **Main Menu**, press the **Back Button**.

9.8 Test overviews

Adjustments/Calibrations		
Tests	**Screenshots**	**Page No**
Touchscreen	Page No 2321	page 9-23
Pressure	Page No 2341	page 9-19
Inspiratory Valve	Page No 2342	page 9-74
Expiratory Valve	Page No 2343	page 9-39
O2 Cell	Page No 2346	page 9-22

Components Tests		
Tests	**Screenshots**	**Page No**
Alarm System	Page No 2102	page 9-52
Alarm Monitor 1	Page No 2113	page 9-57
Alarm Monitor 2	Page No 2114	page 9-64
User Interface Tab	Page No 2115	page 9-68
Blower Flow	Page No 2104	page 9-70
Blower Pressure	Page No 2105	page 9-72
Inspiratory Valve	Page No 2107	page 9-74
Expiratory Valve	Page No 2111	page 9-39
O2 Input	Page No 2112	page 9-79
Binary Valve	Page No 2106	page 9-83
Nebulize valve	Page No 2116	page 9-85
Autozero	Page No 2109	page 9-86
Ambient Valve	Page No 2108	page 9-88
Proximal Test	Page No 2110	page 9-91
HEPA Filter Test	Page No 2117	page 9-95

System Test		
Tests	**Screenshots**	**Page No**
Pressure	Page No 2201	page 9-96
Leakage Test	Page No 2204	page 9-99
Alarming	Page No 2205	page 9-101

9.9 Test / Calibration Screens

From the Main Service Software Screen, press the **Tests / Calibration Button**.

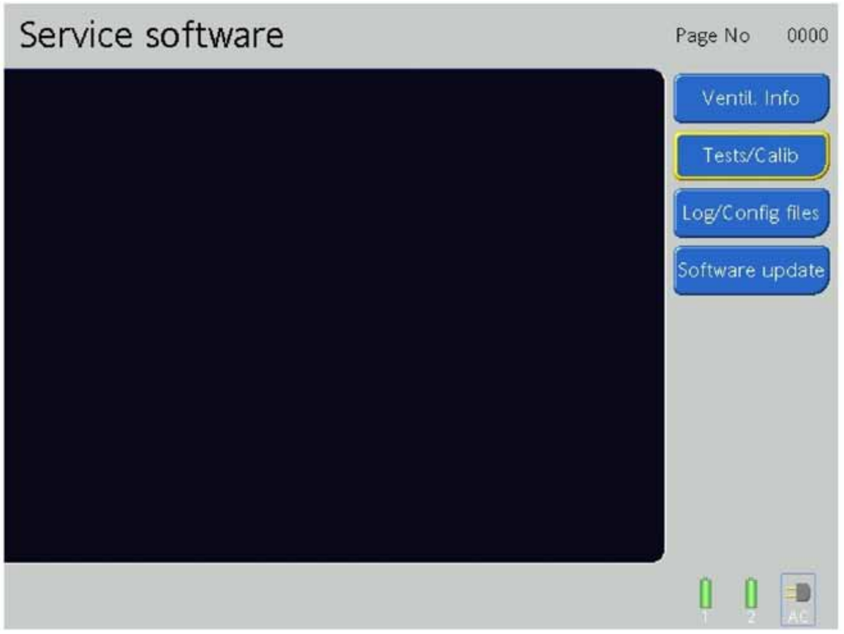


Figure 9-21. The Main Service Software Screen

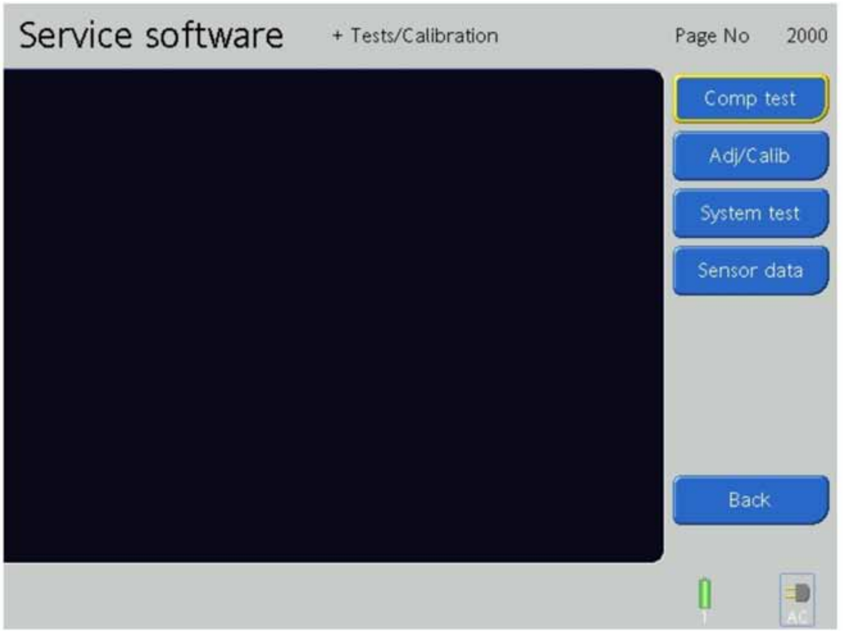


Figure 9-22. The Test / Calibration Screen

On the Test / Calibration Screen are the:

- *Component Test* Button
- *Adjustment / Calibration* Button
- *System Test* Button
- *Sensor Data* Button
- Back Button

9.9.1 Adjustment / Calibration

Press the **Adjustment / Calibration Button**.

9.9.1.1 Show Tab

Press the **Show Tab**.

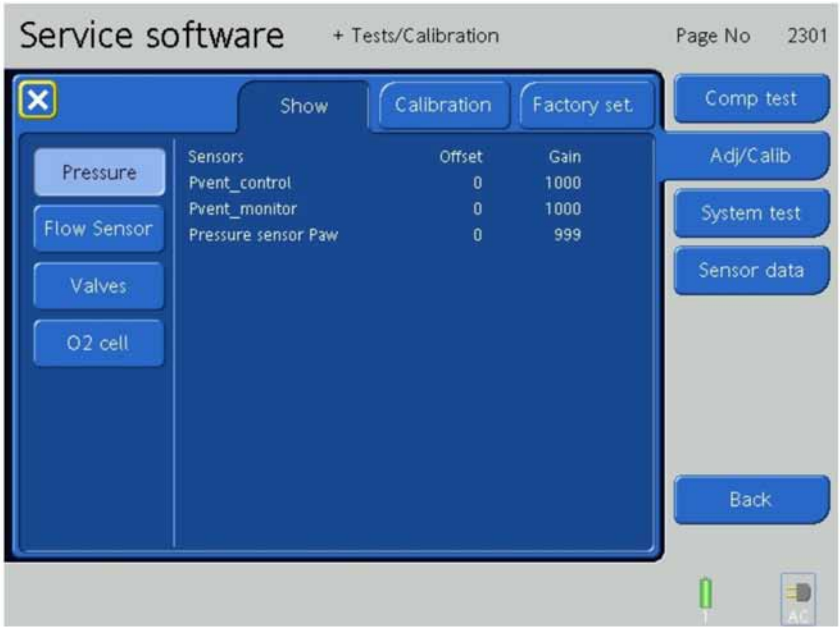


Figure 9-23. The Adjustment / Calibration Show Tab Screen

Pressure

1. Press the **Pressure Button**.

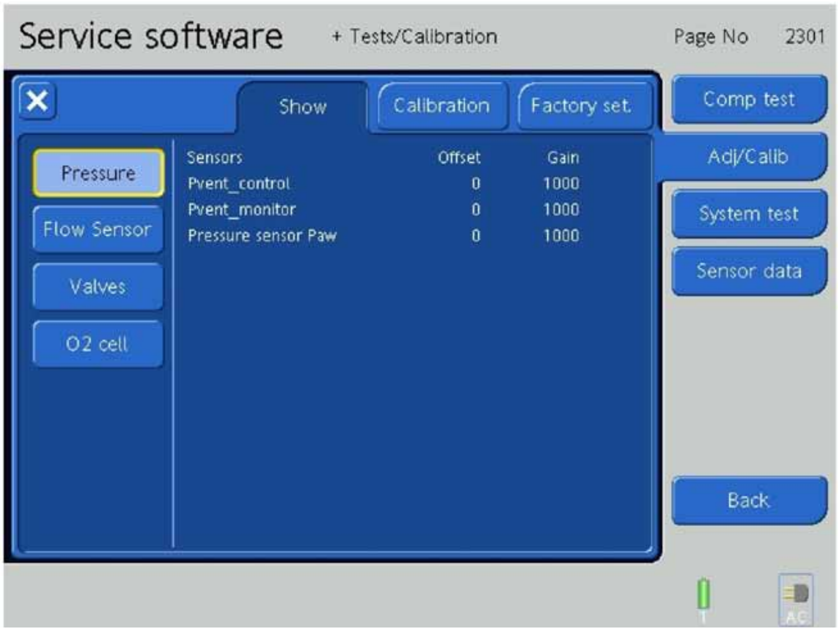


Figure 9-24. The Adjustment / Calibration Pressure Sensors Screen

2. Displays the Pvent_control, Pvent_monitor and Paw Pressure Sensor Offset and Gain values.

Flow Sensor

1. Press the **Flow Sensor Button**.

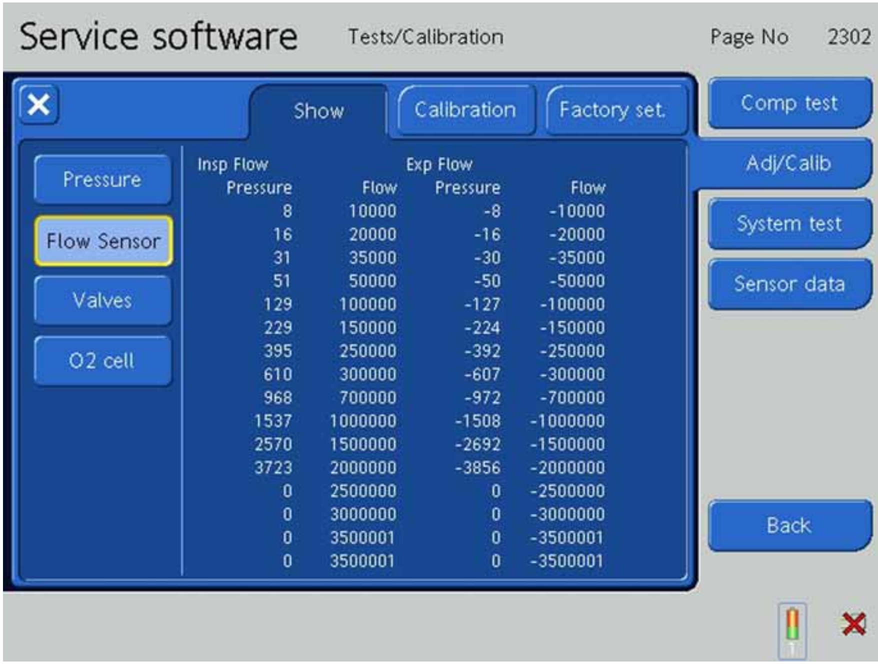


Figure 9-25. The Adjustment / Calibration Flow Sensor Screen

2. Displays the Inspiratory Flow and Expiratory Flow values at different pressures.

Note
Not required on the HAMILTON-C2 Service Report.

Valves

1. Press the **Valves Button**.

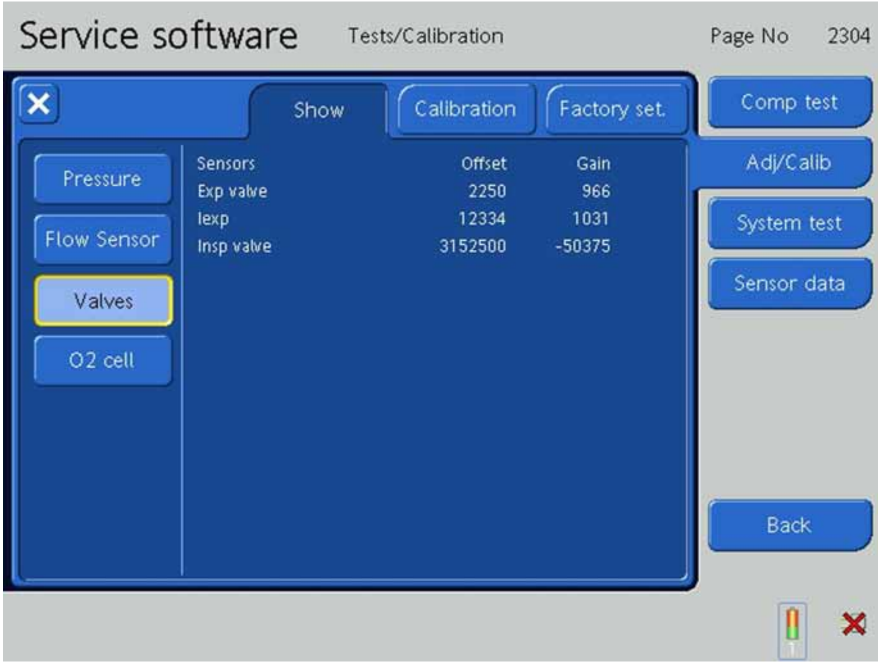


Figure 9-26. The Adjustment / Calibration Valves Screen

2. Displays the Expiratory Valve Offset and Gain values.

O_2 Cell

1. Press the **O_2 Cell Button**.

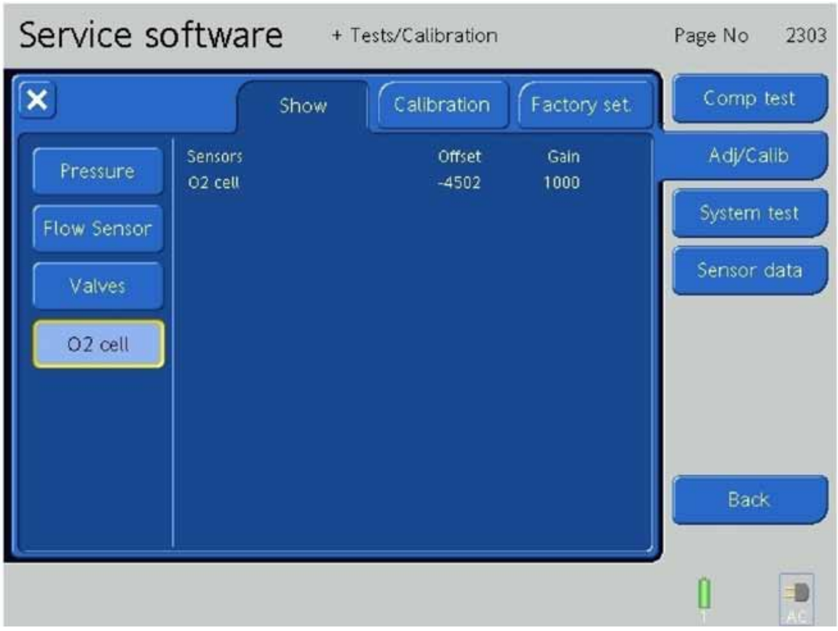


Figure 9-27. The Adjustment / Calibration O_2 Cell Screen

2. Displays the O_2 Cell Offset and Gain values.

9.9.1.2 Calibration Tab

Press the **Calibration Tab**.

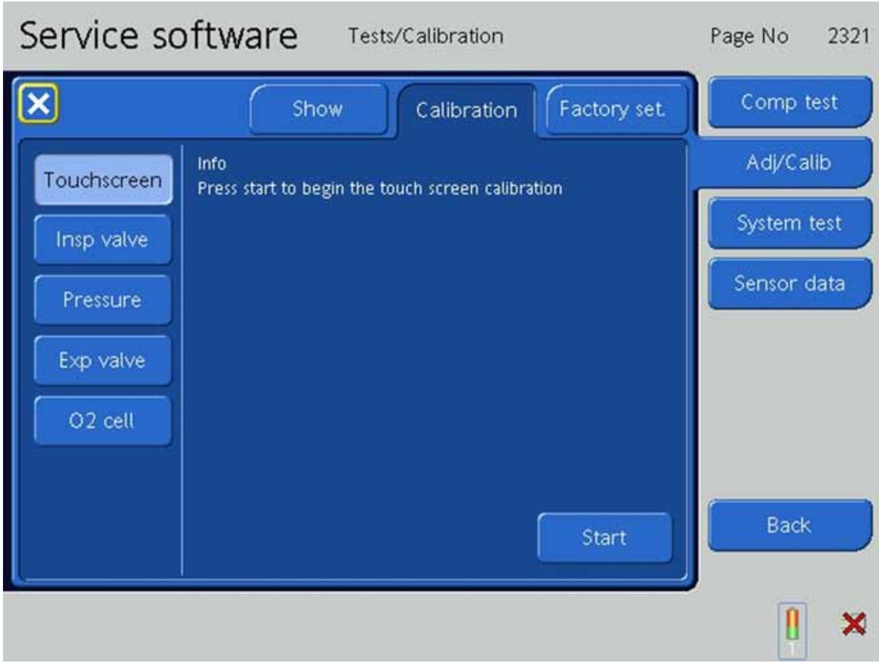


Figure 9-28. The Calibration Tab

Touchscreen

1. Press the **Touchscreen Button**.

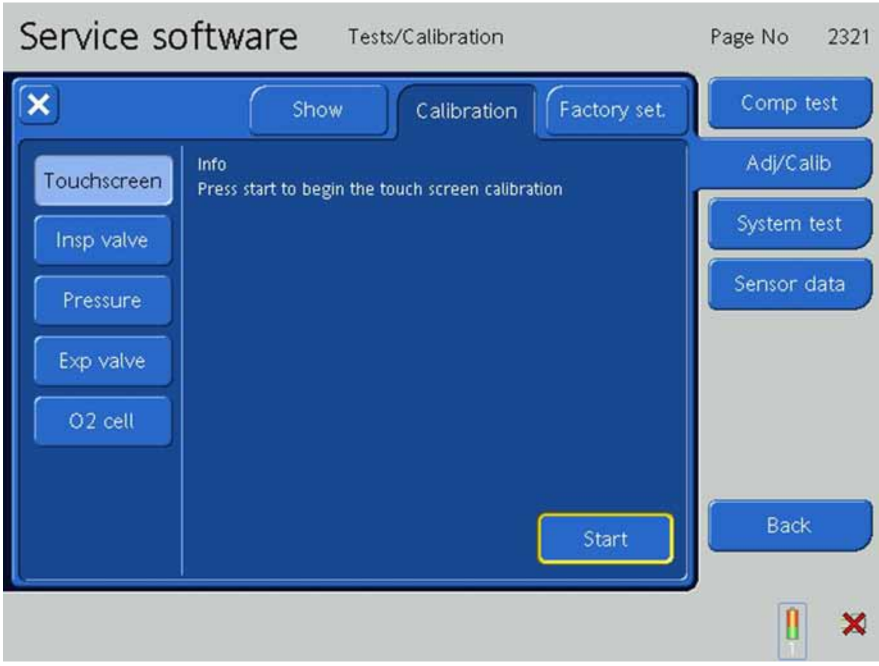


Figure 9-29. The Touch Screen Calibration, Step 1

2. Press the **Start Button** to begin the Touch Screen Calibration.

3. The test begins automatically indicated by **Touch Screen Calibration is Running** on the screen.

Figure 9-30. The Touch Screen Calibration, Step 2

4. You are instructed to touch the cross located on the top left of the screen with your finger.

Figure 9-31. The Touch Screen Calibration, Step 3

5. Next, you are then instructed to touch the cross located on the bottom right of the screen with your finger.

Figure 9-32. The Touch Screen Calibration, Step 4

6. Next, you are instructed to touch the Test Button in the middle of the screen with your finger.

Figure 9-33. The Touch Screen Calibration, Step 5

7. The Touch Screen Calibration is complete. Press **Apply** to accept the new Touch Screen Calibration or **Cancel**.

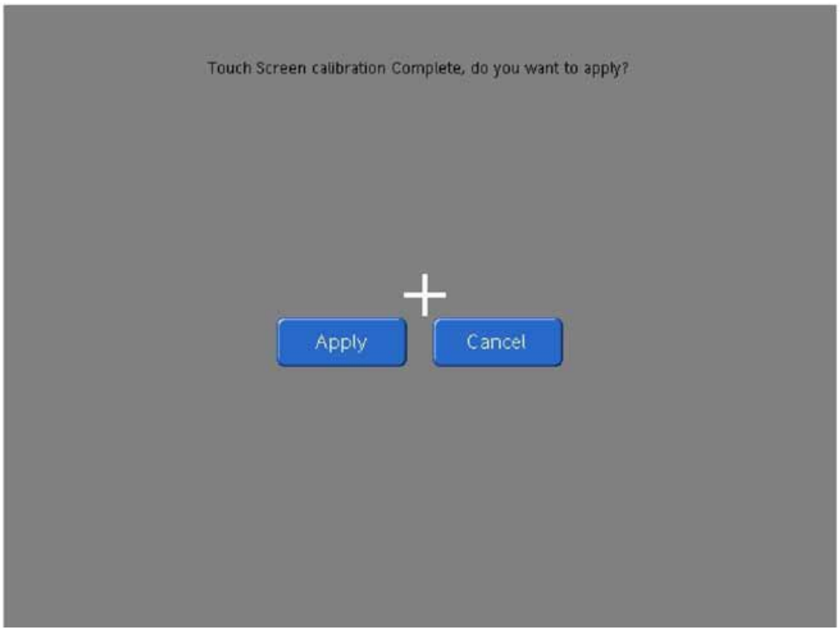


Figure 9-34. The Touch Screen Calibration, Step 6

8. Press **Apply** to accept the new Touch Screen Calibration.

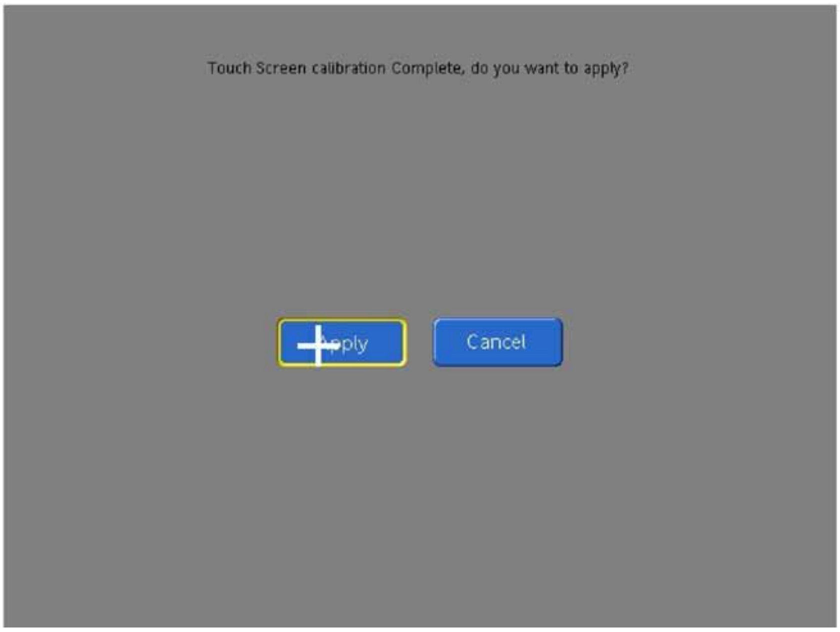


Figure 9-35. The Touch Screen Calibration, Step 7

9. The Touch Screen Calibration is complete indicated by **Touch screen calibration values saved** on the screen.

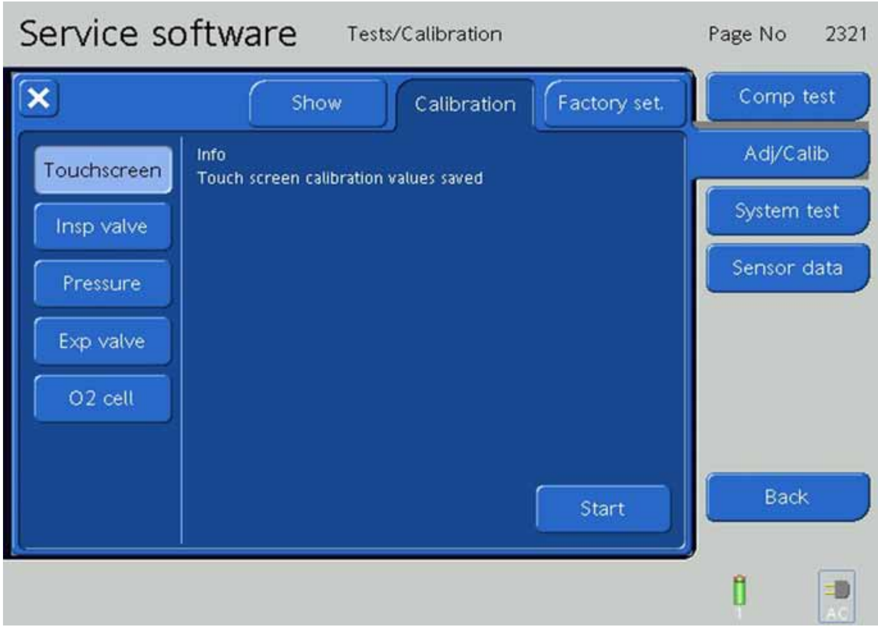


Figure 9-36. The Touch Screen Calibration, Step 8

Inspiratory Valve

Note

- To adjust in small steps use the P&T Control Knob to set the step width on 5mV.
- Confirm that the technical state is updated with the fitted inspiration valve serial number AND revision, see *Service Entry* on page 9-12. The calibration values depends on software version. But the calibration process is the same.
- The HAMILTON-C2 needs a warm-up period. Make sure it was running for at least 20min in the ventilation software.

Software 2.0.0 or higher

10. With software version 2.0.0 the calibration of the inspiration valve is fully automated.

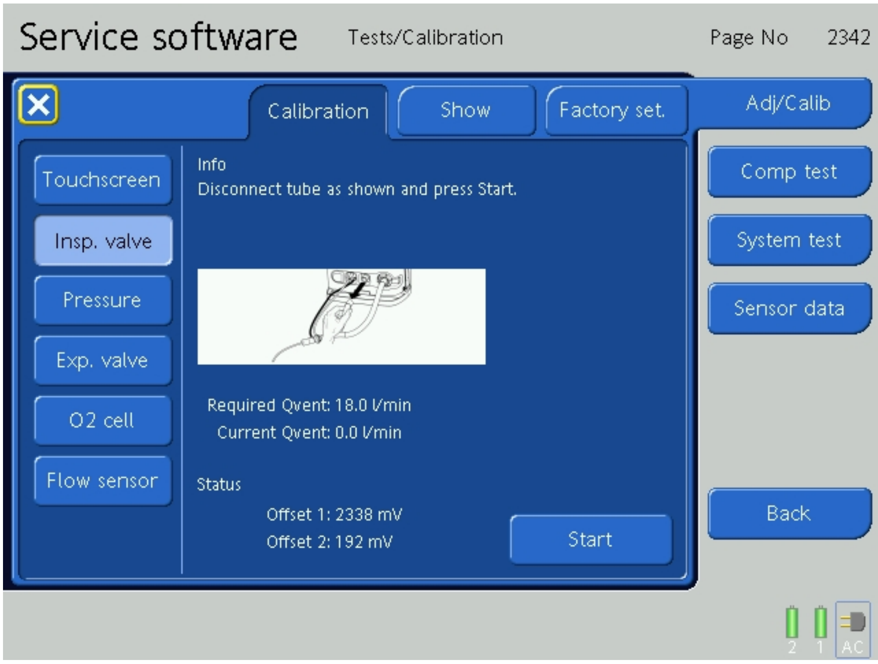


Figure 9-37. The Inspiratory Valve Adjustment / Calibration

11.

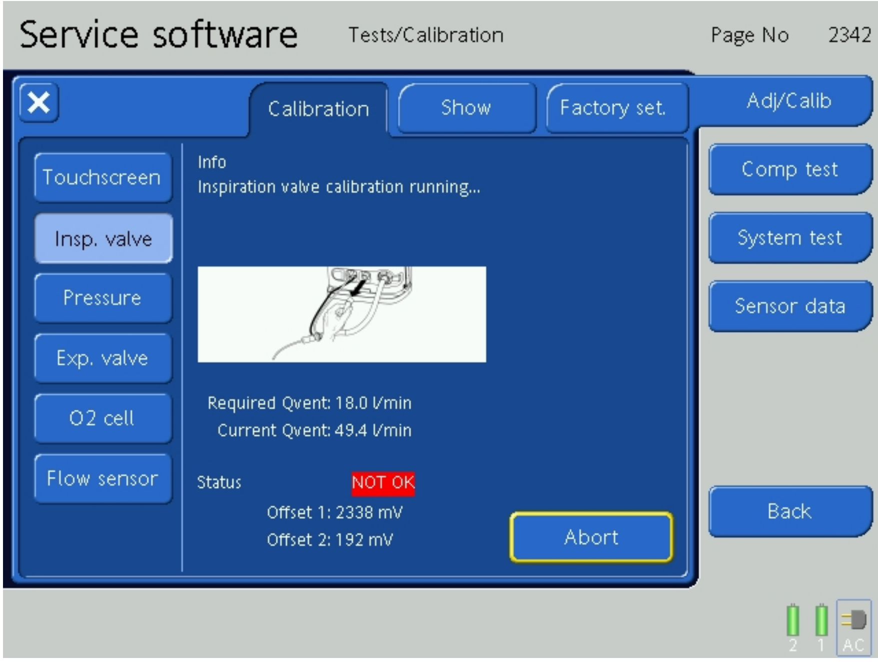


Figure 9-38. The Inspiratory Valve Adjustment / Calibration

12.

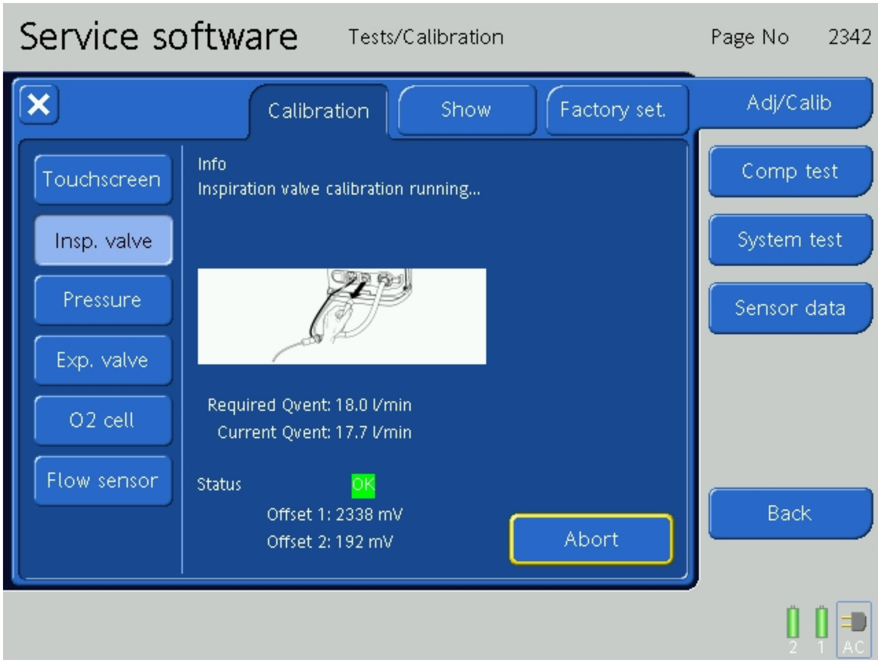


Figure 9-39. The Inspiratory Valve Adjustment / Calibration

13.

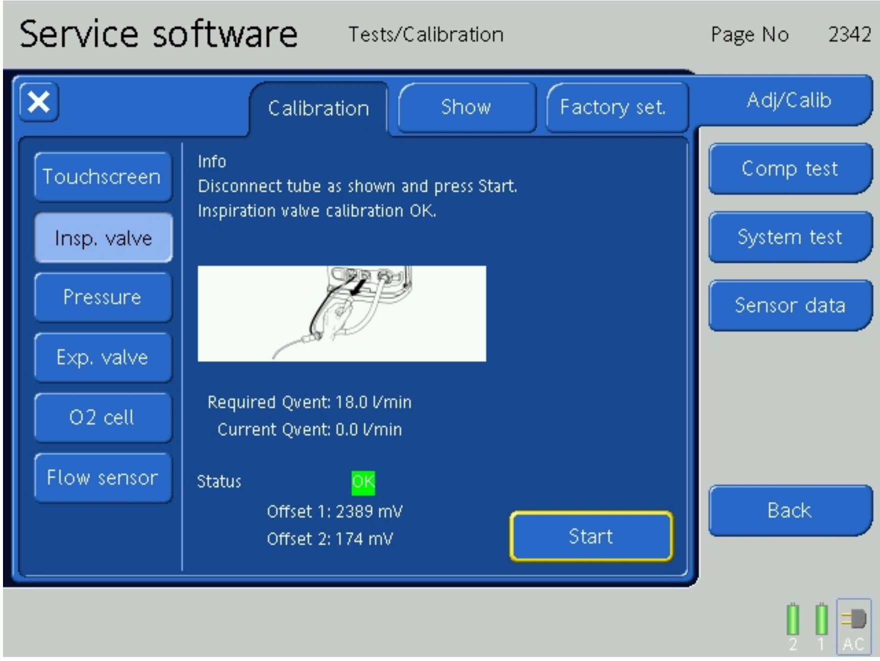


Figure 9-40. The Inspiratory Valve Adjustment / Calibration

Software 1.1.4 or lower

Regarding the fact that the inspiration valve has a flow-voltage-hysteresis in other words the valve open characteristic is different from the close characteristic, the valve needs to be calibrated with either the closing process or opening process. Based on the design and pressure control mechanism, the inspiration valve is calibrated by the closing characteristic.

For a better understanding, how to calibrate the inspiratory valve correctly, please find a flow chart of the calibration process on the next page:

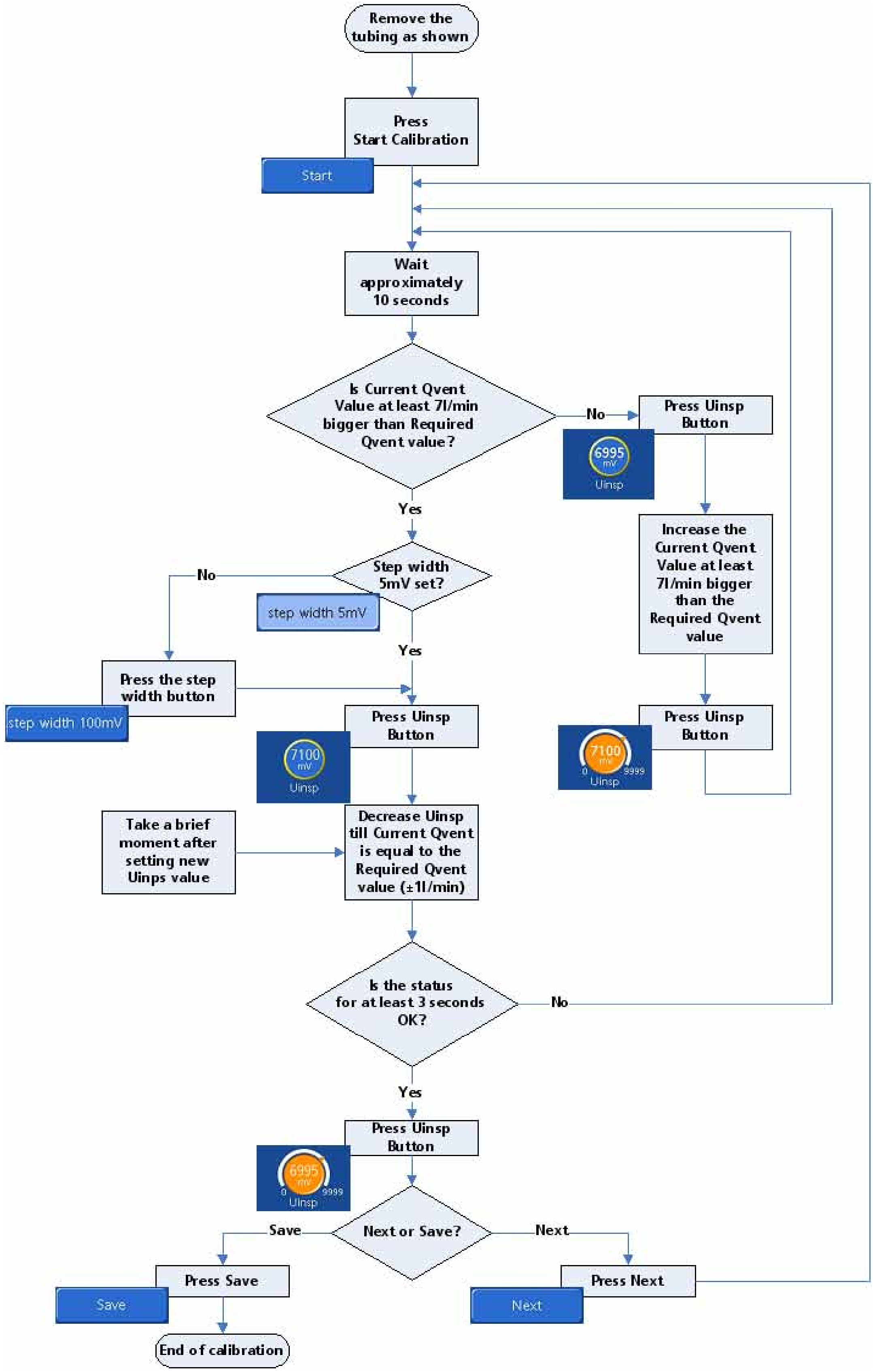


Figure 9-41. Inspiration calibration overview

1. Disconect the inspiration tube as shown.
2. Press the **Start Button**. Wait approximately 10 seconds till the flow has stabilised.

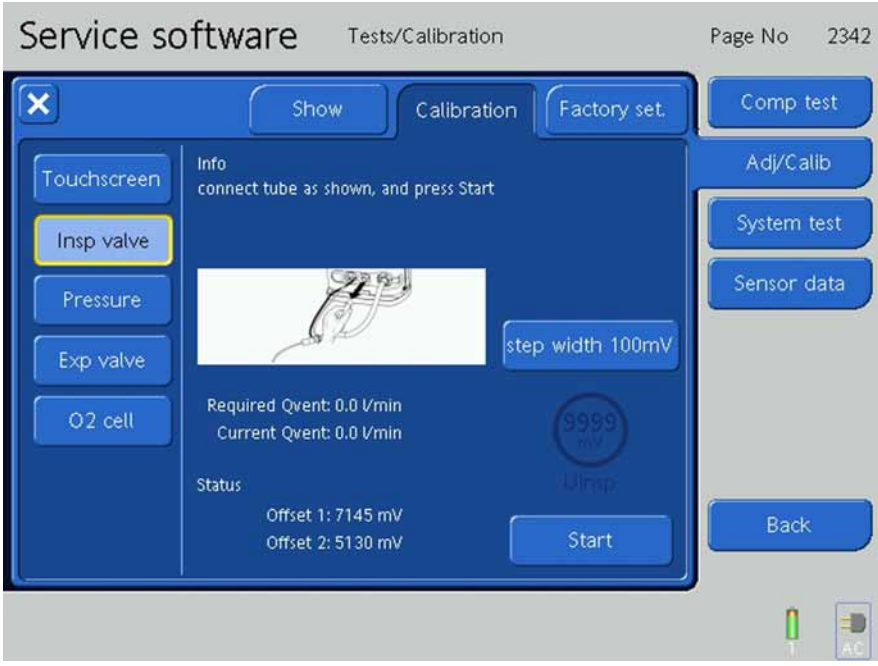


Figure 9-42. The Inspiratory Valve Adjustment / Calibration

3. Press the Uinsp button to adjust Current Qvent flow step by step to a value which is at least 7l/min bigger than Required Qvent.

Figure 9-43. The Inspiratory Valve Adjustment / Calibration

4. Change the step width to 5mV and decrease smoothly the Uinsp value till the Required Qvent value (±1l/min) is reached.

5. The Inspiratory Valve Test is complete when **OK** is indicated for 3-4 seconds.

Figure 9-44. The Inspiratory Valve Adjustment / Calibration

6. Press **Next** to calibrate the Offset 2 value, please proceed with this calibration as before mentioned.

7. Press save to complete Inspiration Valve Calibration.

Note

If you restart the test make sure the 5mV step width is activated, otherwise the calibration values will not be taken over correctly as a start value.

Pressure with Software 2.0.0 or higher

1. Press the **Pressure Button**.

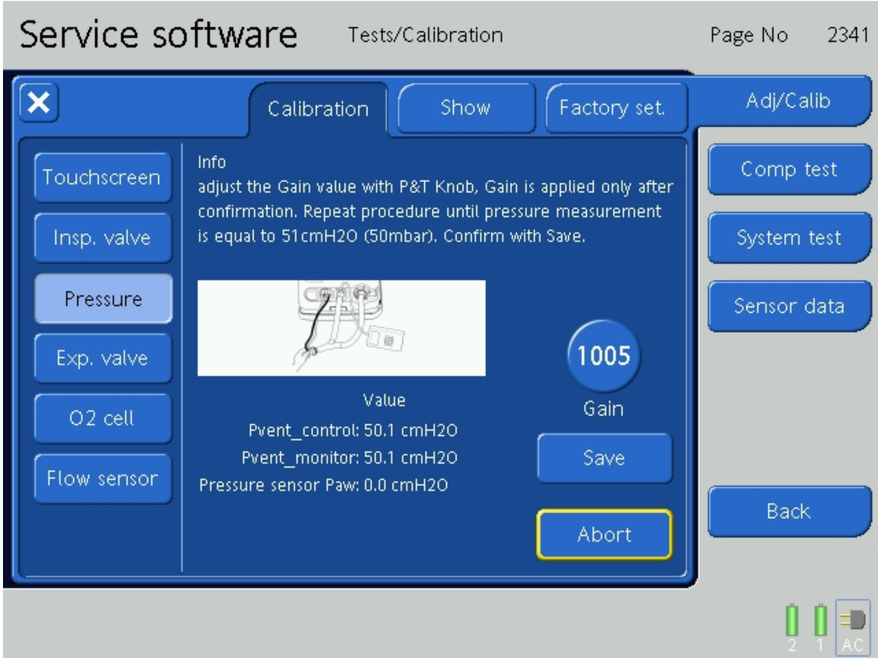


Figure 9-45. The Pressure Adjustment / Calibration, Step 1

Pressure with Software 1.1.4 or higher

1. Press the **Pressure Button**.

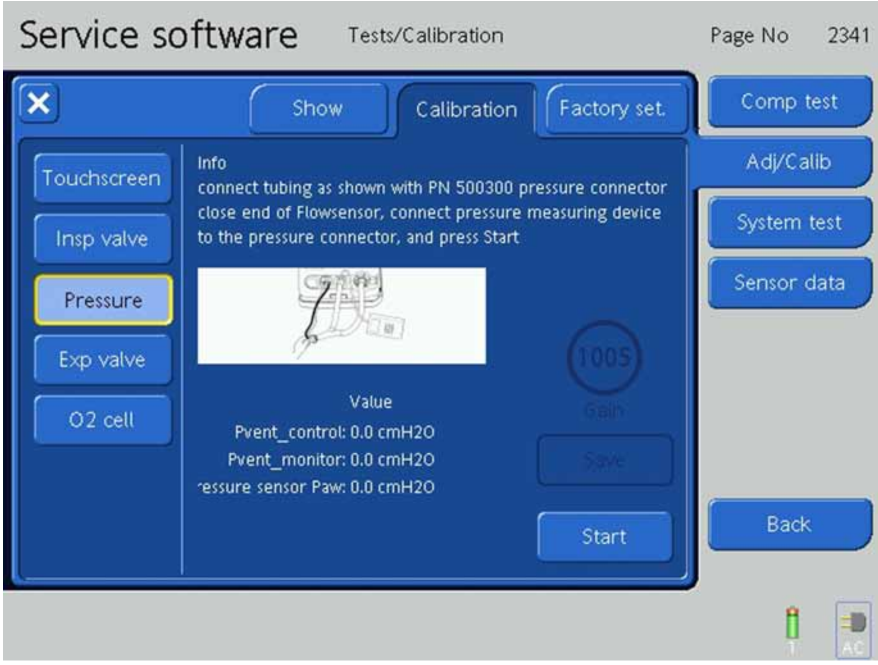


Figure 9-46. The Pressure Adjustment / Calibration, Step 1

2. Attach a Pressure Connector to the Patient Connection.
3. Attach the Tube System to the Pressure Connector and the Expiratory Connection.
4. Attach an external Pressure Gauge to the Pressure Connector.
5. Close the Flow Sensor outlet.
6. Press the **Start Button**.
7. The Values on the screen should equal the value on the Pressure Gauge.

8. If adjustment is necessary, adjust the Gain by using the P&T Control Knob. Make the adjustment with the P&T Control Knob, then, press the P&T Control Knob for the change in Gain to be applied. Adjust the Gain to equal the measurement of the external Pressure Gauge. The pressure must be 50 mbar, +/- 0.5 mbar.

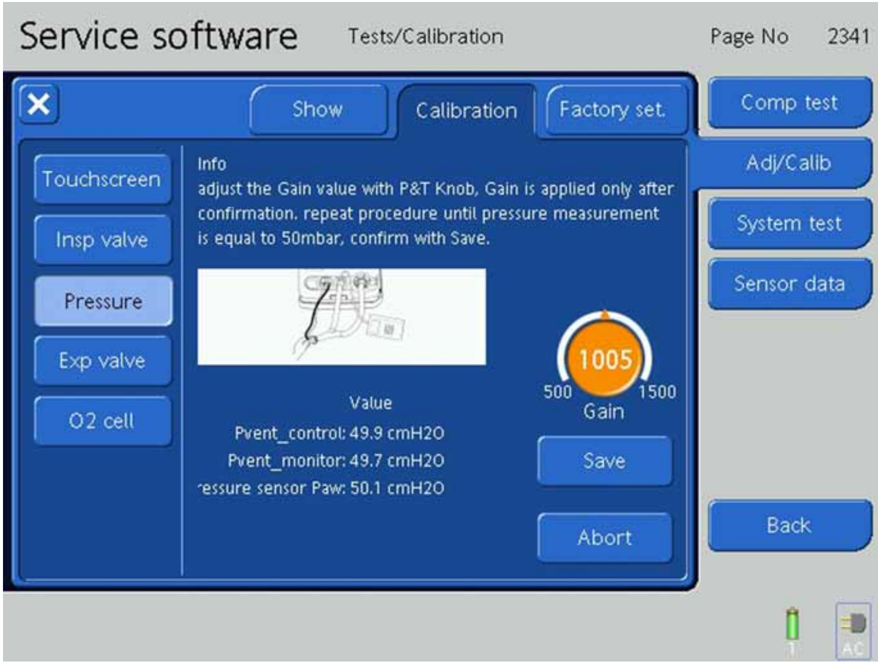


Figure 9-47. The Pressure Adjustment / Calibration, Step 2

9. After completion, press **Save** to save the changes.

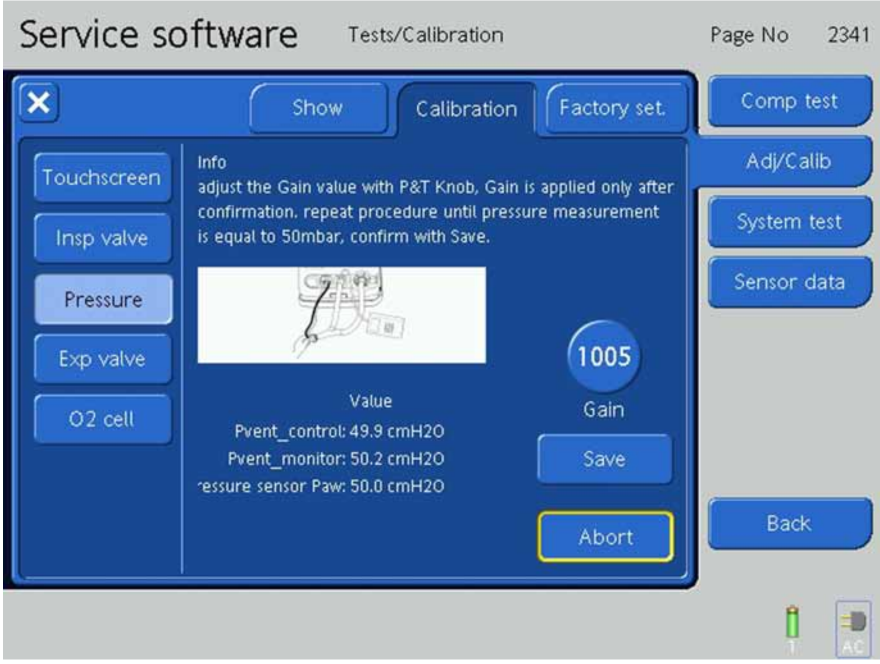


Figure 9-48. The Pressure Adjustment / Calibration, Step 3

Note

If the test can not be performed, check the hole setup for leakages. Furthermore the flow, out of the expiration outlet should be next to nothing.

If you perform this test more than ones, please close and reopen the pressure calibration window.

Expiratory Valve

1. Press the **Expiratory Valve Button**.

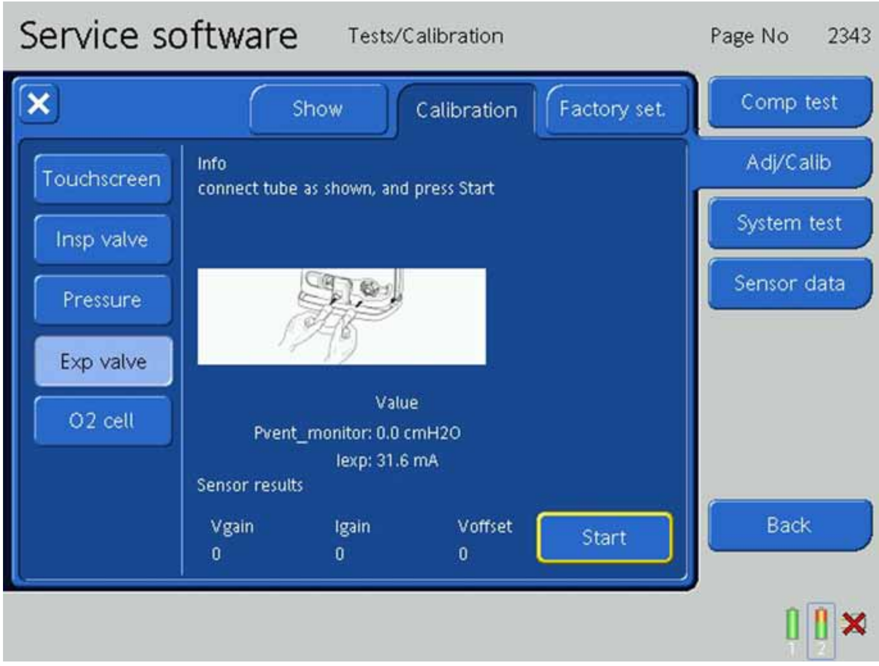


Figure 9-49. The Expiratory Valve Tests, Step 1

2. Connect a short tube with a filter (PN 279204) as shown on the screen.
3. Press the **Start Button**.
4. The calibration runs automatically indicated by the Pvent_monitor and Iexp. values changing during the calibration process.

5. The calibration is complete when **Calibration Successfully Finished** is displayed on the screen.

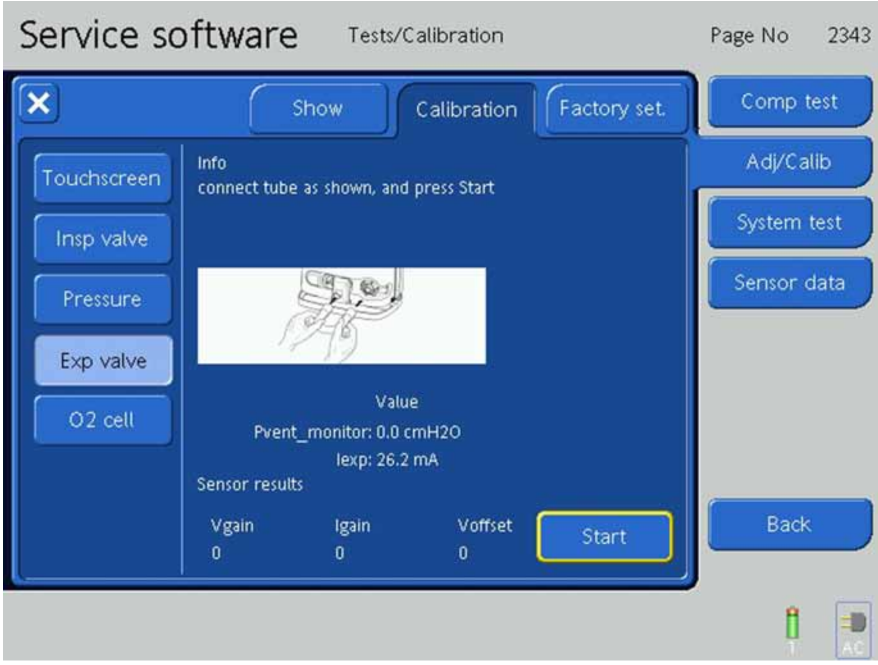


Figure 9-50. The Expiratory Valve Adjustment / Calibration, Step 4

Note
If the test takes more than 3 minutes or if calibration is not ok replace the membrane.

O_2 Cell

Note
Confirm that the technical state is updated see Section 9.7.3, *Service Entry*, on page 9-12.

Note
With mainboard **Revision 1-5** perform the test as shown in figures 9-45 to 9-48 and with **Revisions 6** and higher perform it as shown in figures 9-49 to 9-52.

Revisions 1-5

1. Connect the device to HP **O_2**.
2. Press the **O_2 Cell Button**.
3. Disconnect the O_2 Cell cable from the O_2 Cell and connect the O_2 cell calibration tool (PN 160967).

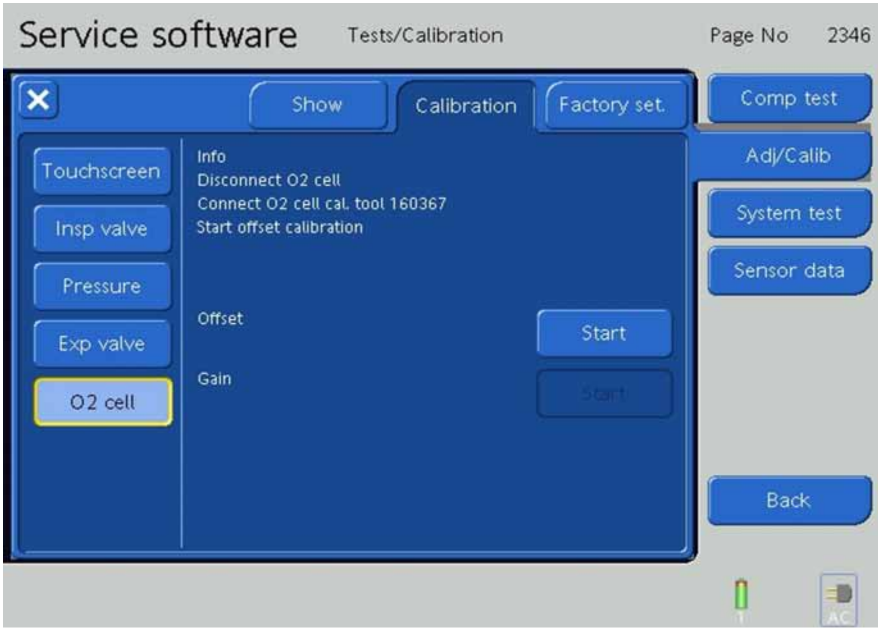


Figure 9-51. The O_2 Cell Adjustment / Calibration, Step 1

4. Press the **Start Button**.

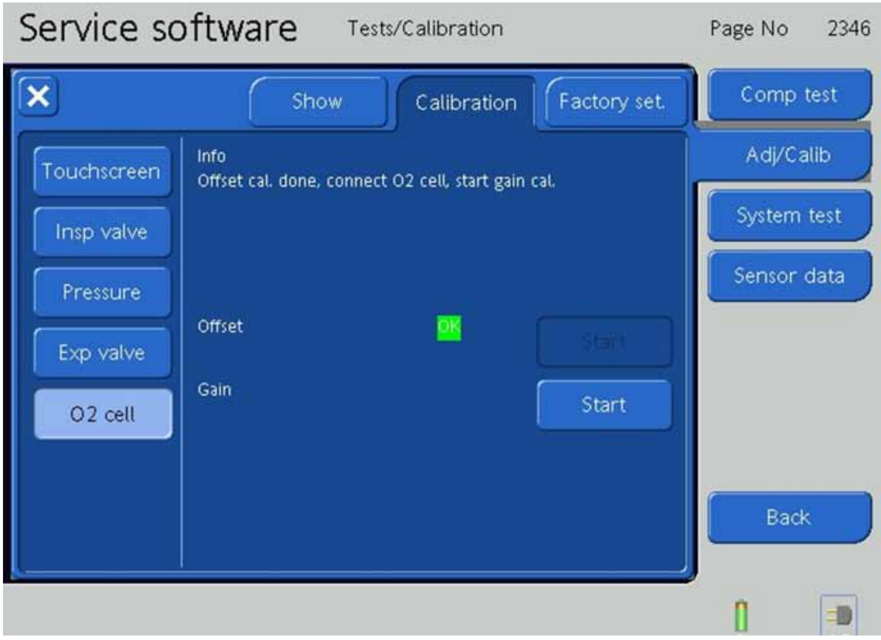


Figure 9-52. The O_2 Cell Adjustment / Calibration, Step 2

5. The O_2 Cell Offset Calibration runs automatically until **Offset Calibration done OK** appears on the screen.
6. Connect the O_2 Cell cable to the O_2 Cell.
7. Press start to begin the Gain Calibration.

8. The O_2 Cell Gain Calibration runs automatically indicated **Oxygen cell Calibration Running** on the screen.

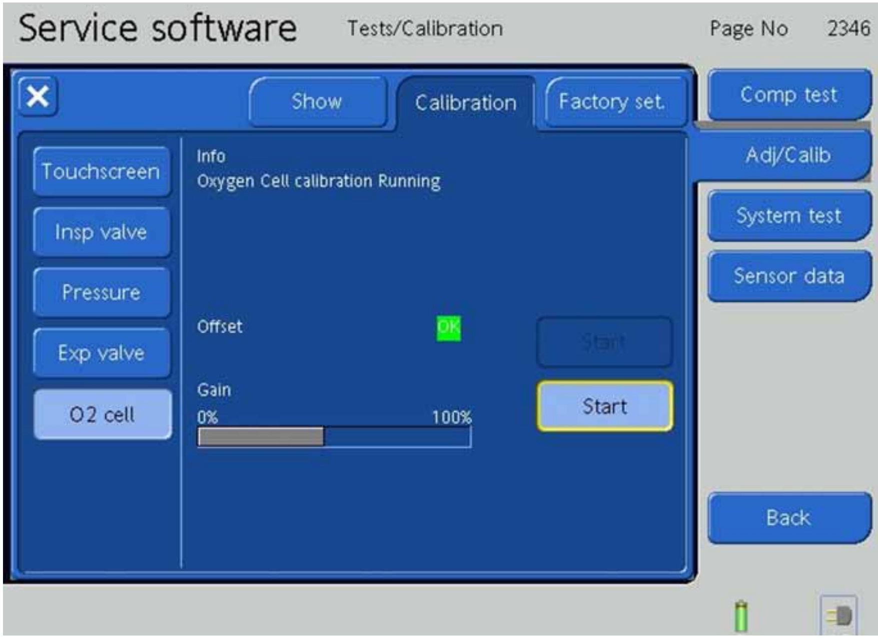


Figure 9-53. The O_2 Cell Adjustment / Calibration, Step 3

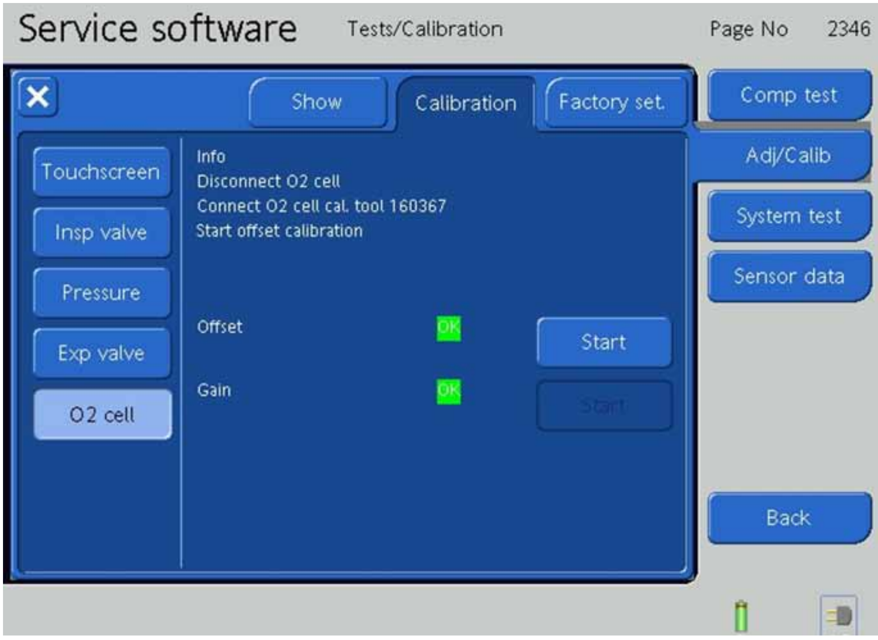


Figure 9-54. The O_2 Cell Adjustment / Calibration, Step 4

9. The calibration is complete when **OK** is displayed on the screen.

Revision 6

For Mainboard PN 160200/06 and higher.

1. Press the **O_2 Cell Button**.
2. Disconnect the O_2 Cell cable from the O_2 Cell. Make sure the O_2 Cell connector is free-hanging.

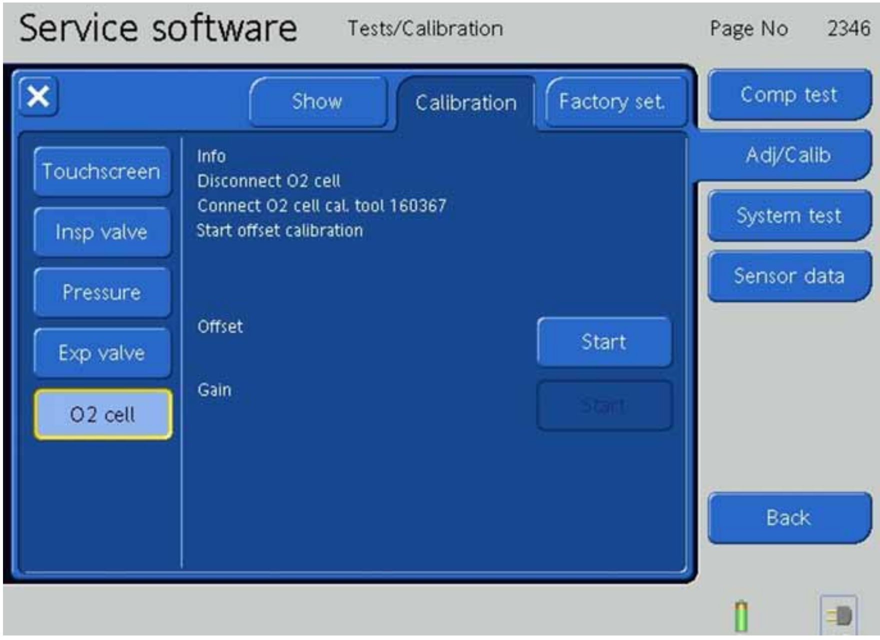


Figure 9-55. The O_2 Cell Adjustment / Calibration, Step 1

3. Press the **Start Button**.

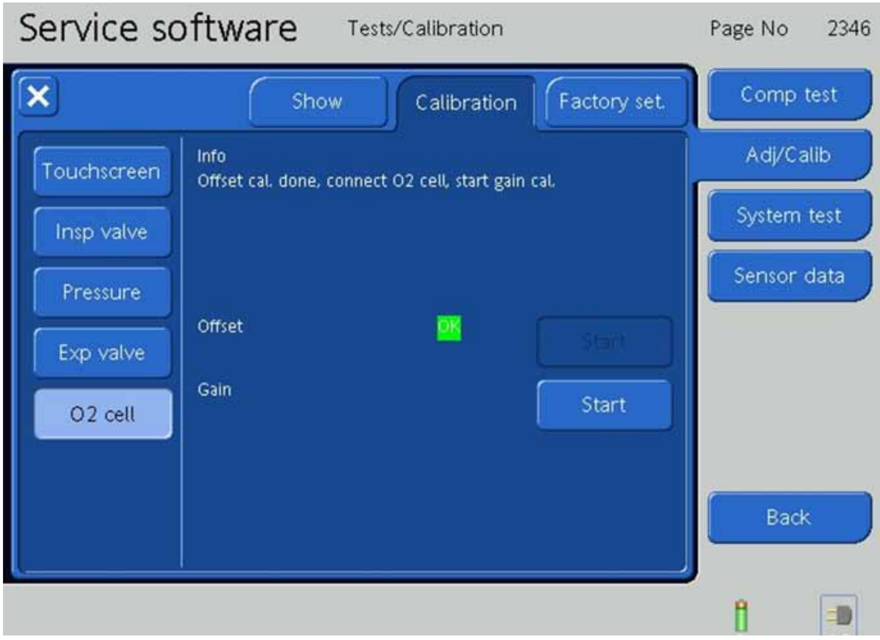


Figure 9-56. The O_2 Cell Adjustment / Calibration, Step 2

4. The O_2 Cell Offset Calibration runs automatically until **Offset Calibration OK** appears on the screen.
5. Connect the O_2 Cell cable to the O_2 Cell.

6. Press start to begin the Gain Calibration.
7. The O_2 Cell Gain Calibration runs automatically indicated **Oxygen Cell calibration Running** on the screen.

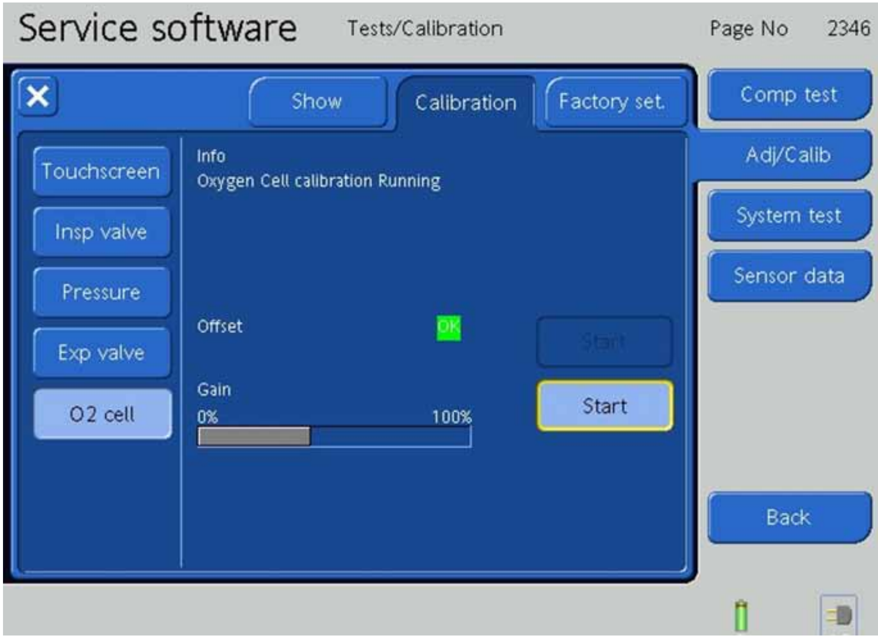


Figure 9-57. The O_2 Cell Adjustment / Calibration, Step 3

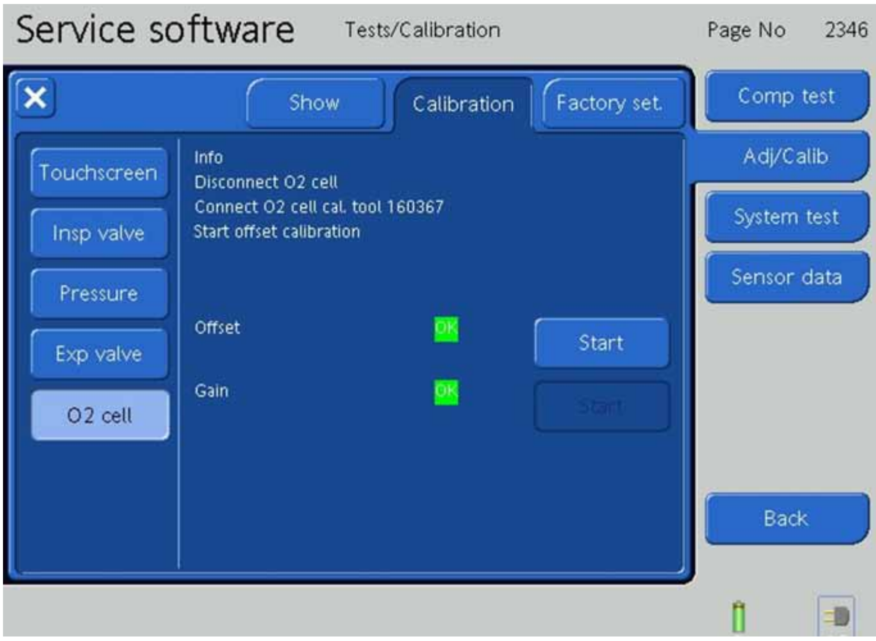


Figure 9-58. The O_2 Cell Adjustment / Calibration, Step 4

8. The calibration is complete when **OK** is displayed on the screen.

Flow Sensor Calibration with Software 2.0.0 or higher

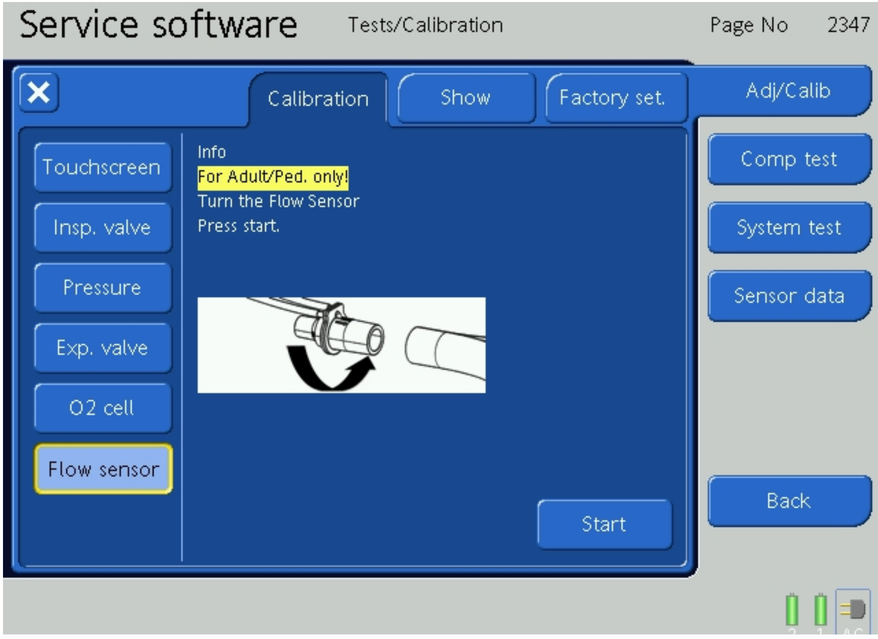


Figure 9-59. Flow Sensor Calibration

To be clear, the flow sensor as to be turned for the flow sensor calibration.

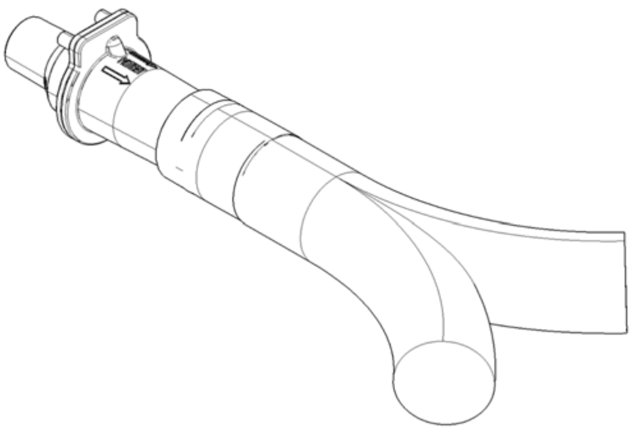


Figure 9-60. Set up for Flow Sensor Calibration

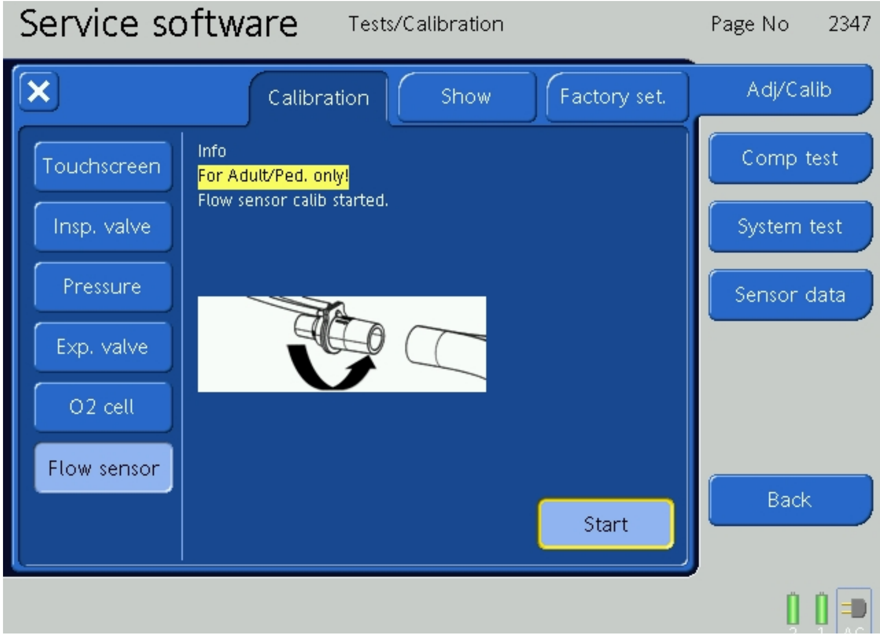


Figure 9-61. Flow Sensor Calibration

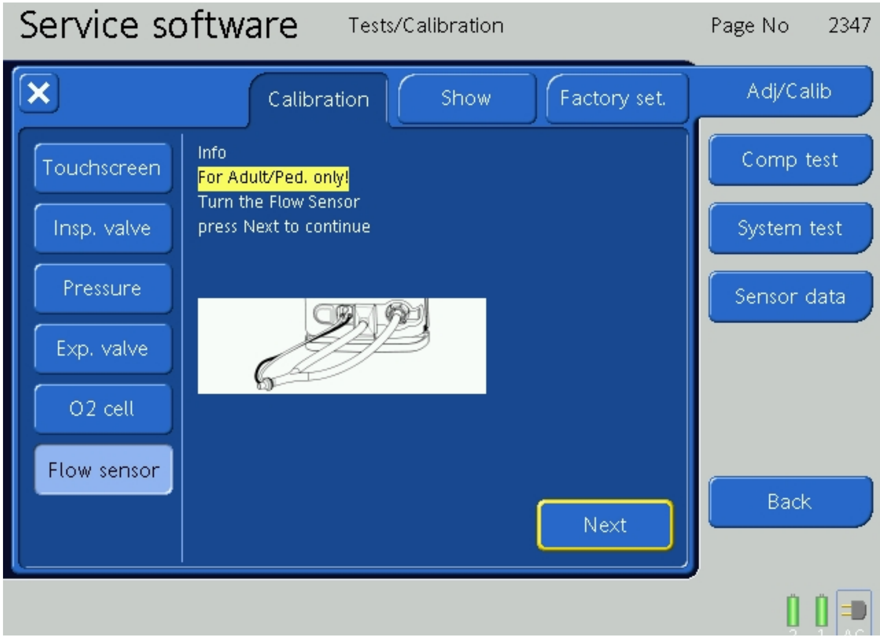


Figure 9-62. Flow Sensor Calibration

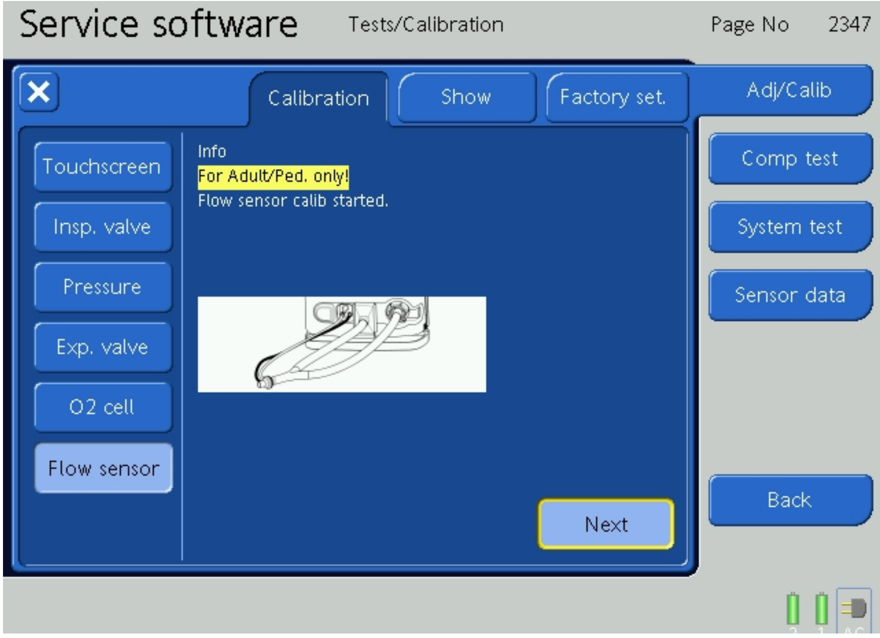


Figure 9-63. Flow Sensor Calibration

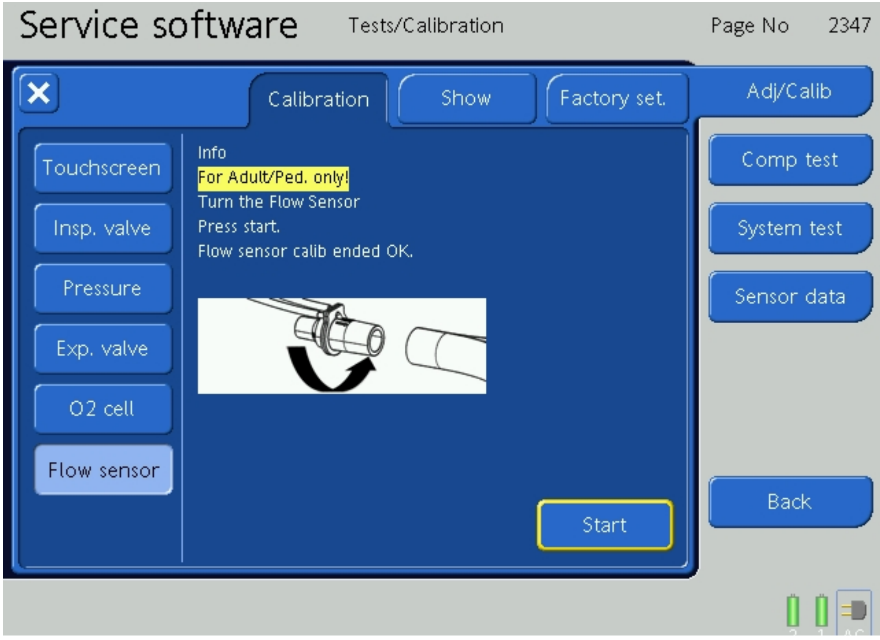


Figure 9-64. Flow Sensor Calibration

Factory Settings Tab

CAUTION

If calibration is not possible due to a corrupted calibration file, press the Factory Settings Tab. Therefore the Service software has to be passed through again.

1. Press the **Factory Settings Tab**.

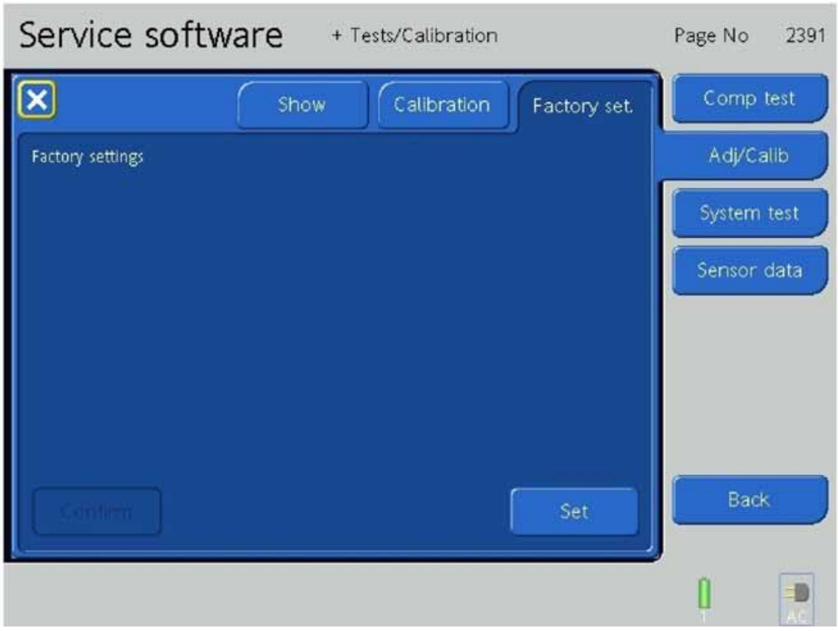


Figure 9-65. The Factory Settings Reset, Step 1

2. The Factory Settings Tab provides a method to reset or set all the values to a pre-determined Factory Default Setting.
3. To reset the values, press the **Set Button**.

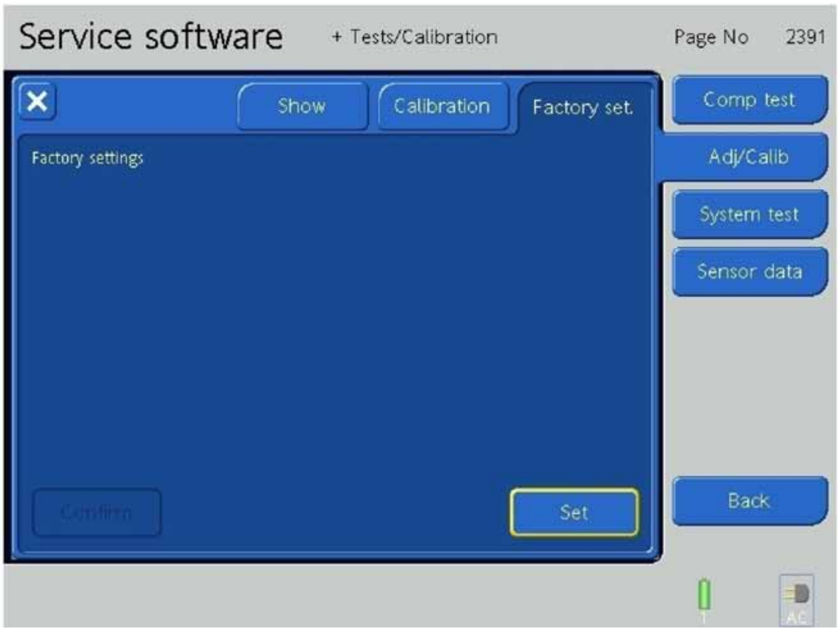


Figure 9-66. The Factory Settings Reset, Step 2

4. When the **Set Button** is pressed, a **Warning:** is displayed with the **Cancel Button** highlighted.

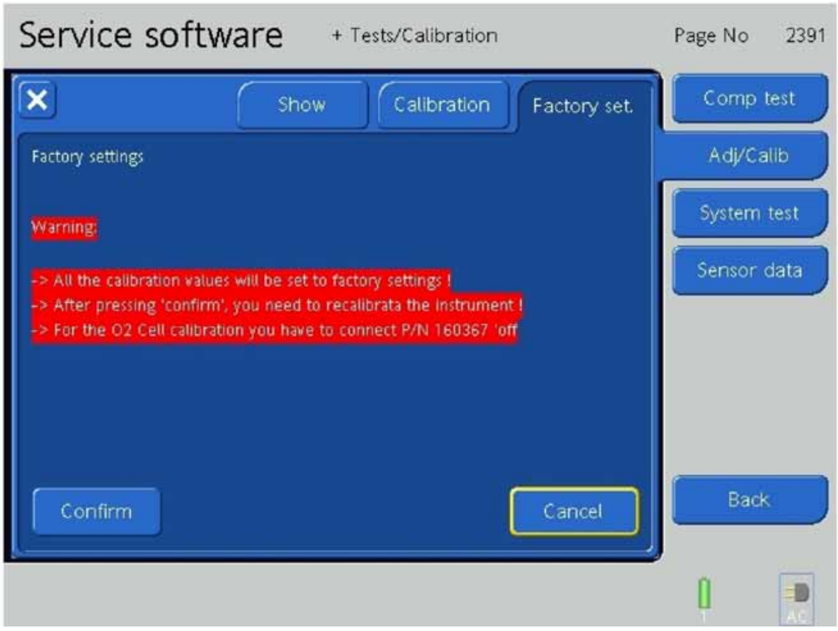


Figure 9-67. The Factory Settings Reset, Step 3

5. You must press the **Confirm Button** to reset to the Factory Settings.

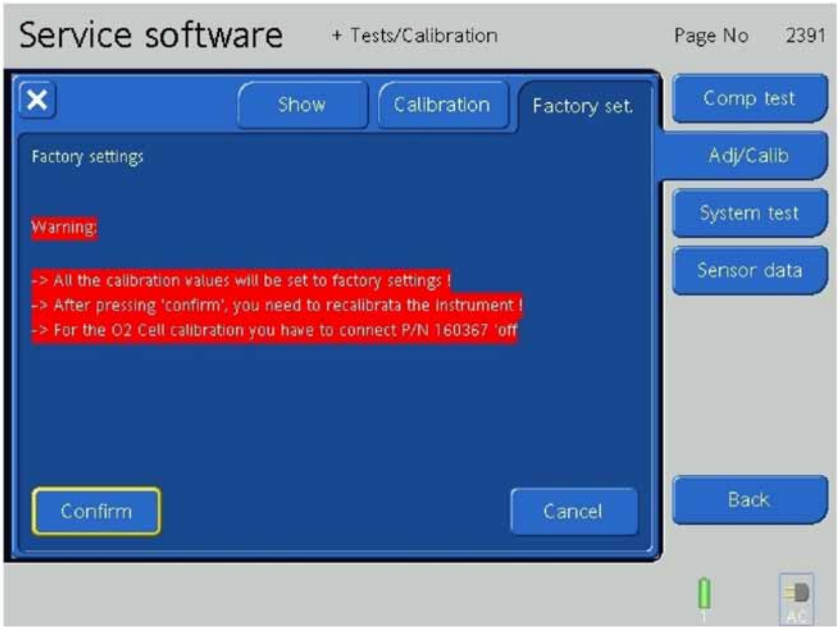


Figure 9-68. The Factory Settings Reset, Step 4

9.9.2 Component Test

Press the **Component Test Button**.

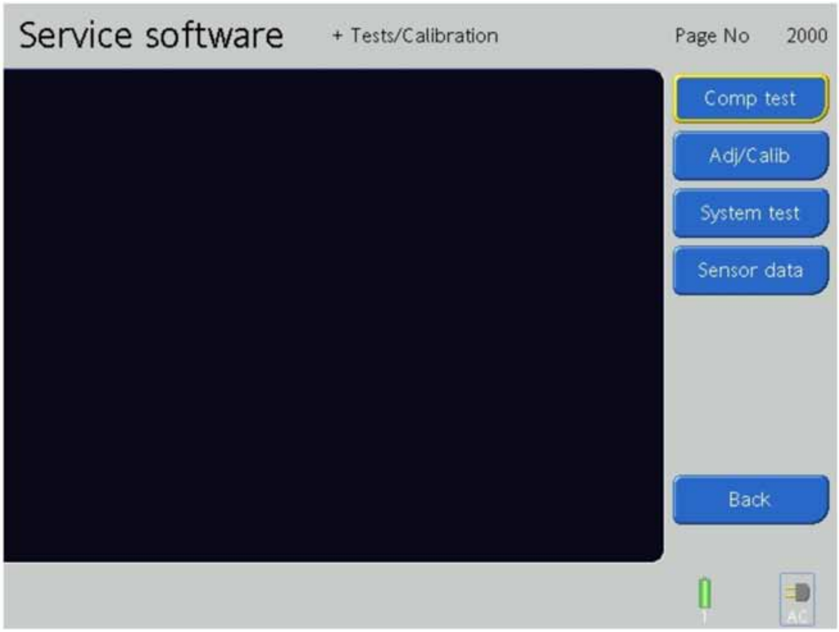


Figure 9-69. The Test / Calibration Screen

9.9.2.1 Electronics Tab

Press the **Electronics Tab**.

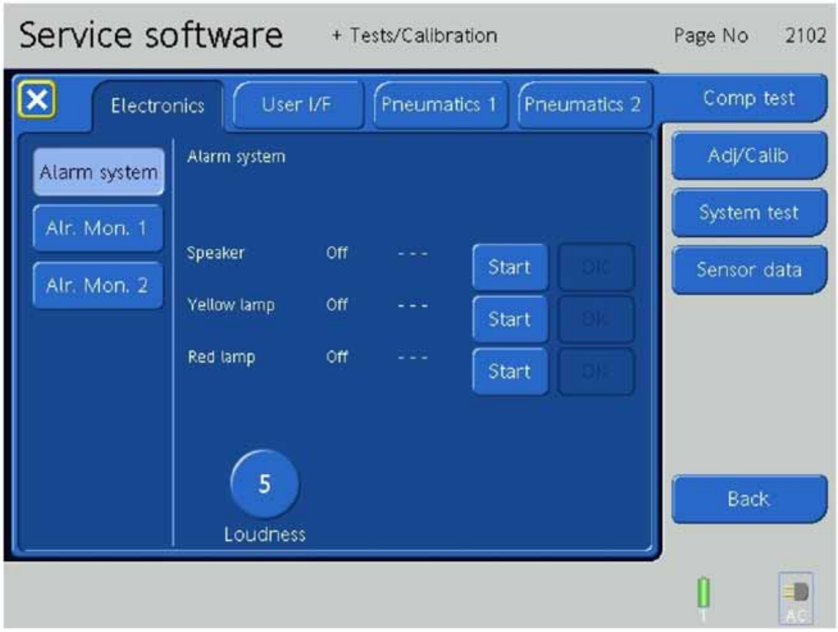


Figure 9-70. The Component Test, Electronics Tab Screen

Alarm System

1. Press the **Alarm System Button**.

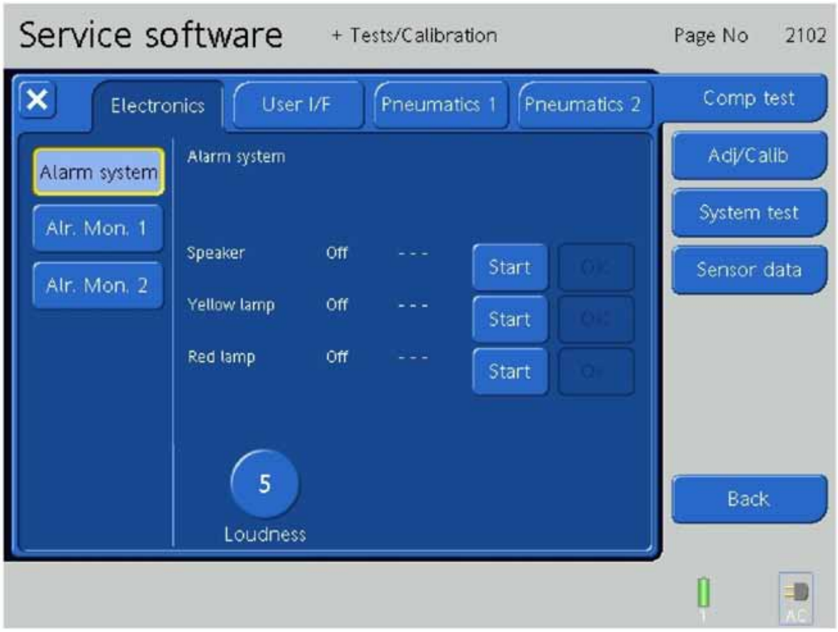


Figure 9-71. The Alarm System Tests, Step 1

2. Press the **Speaker Start Button**.

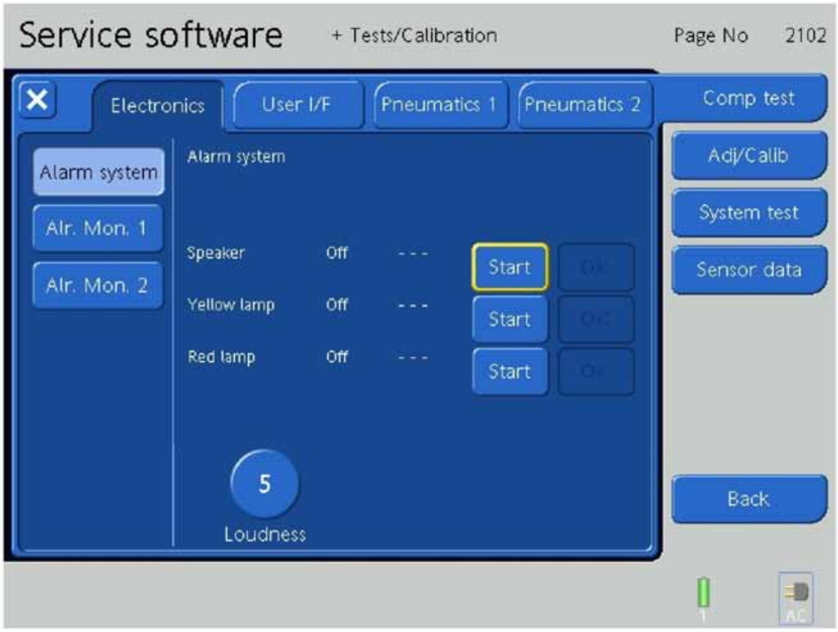


Figure 9-72. The Alarm System Tests, Step 2

3. Observe that the Speaker makes an audible sound.

4. The Speaker Volume can be adjusted with the screen adjustment knob.Check that the volume changes to minimum and maximum.

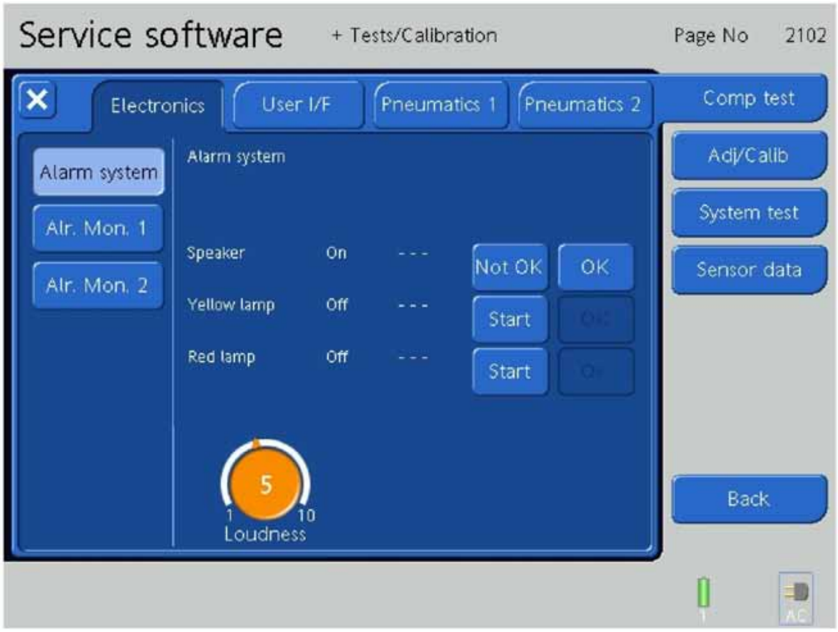


Figure 9-73. The Alarm System Tests, Step 3

5. Indicate on the screen if the Speaker is operating properly by pressing **OK** or **Not OK**.

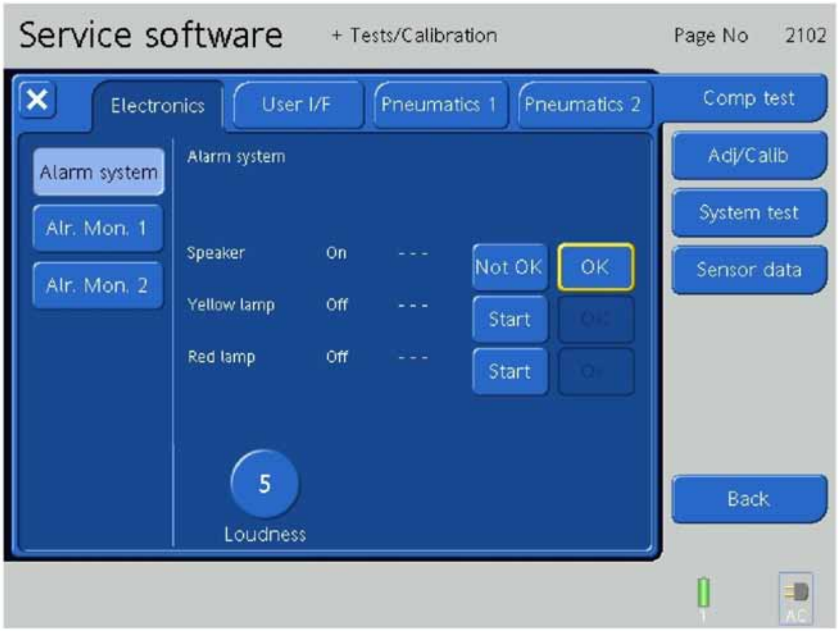


Figure 9-74. The Alarm System Tests, Step 4

6. If **OK** is pressed, the Speaker will switch OFF, the Speaker Start Button will switch to Start and OK will be indicated on the screen.

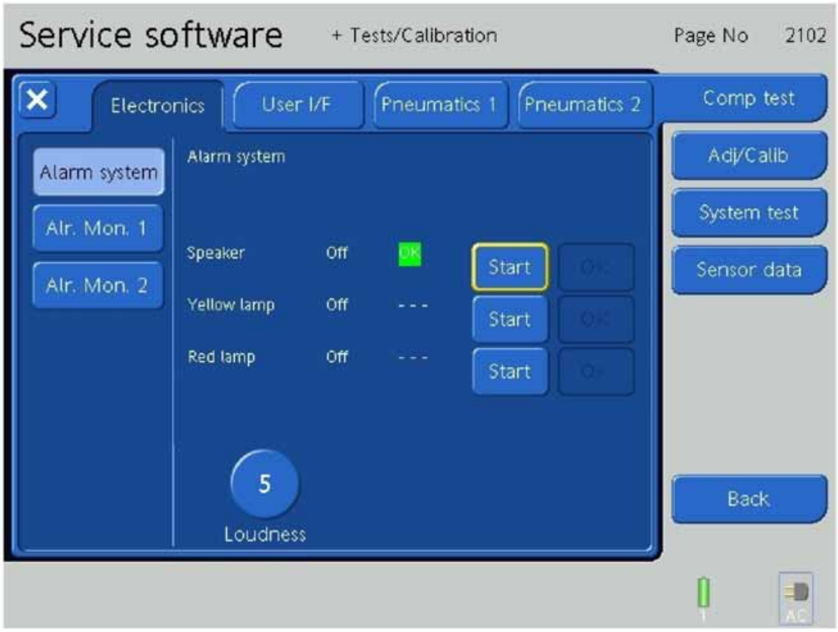


Figure 9-75. The Alarm System Tests, Step 5

7. Press the **Yellow Lamp Start Button**.

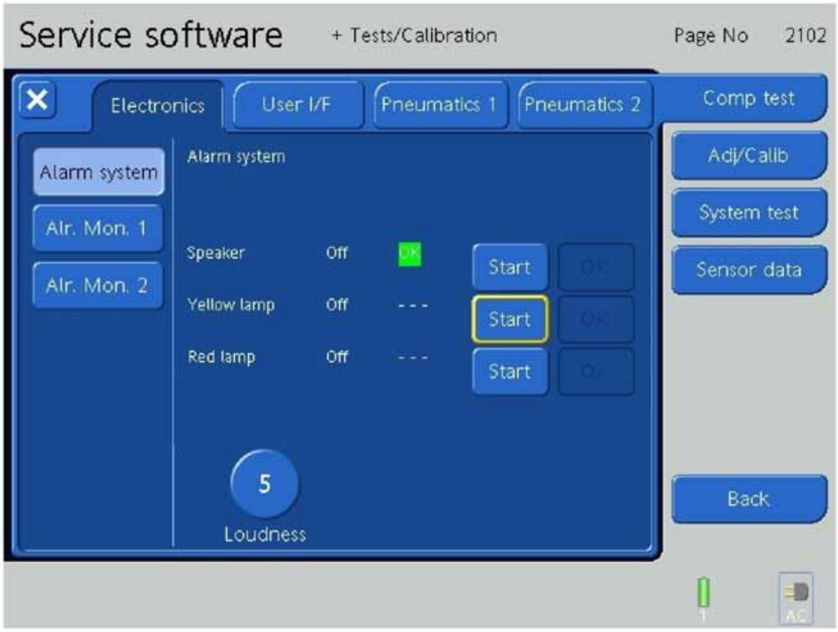


Figure 9-76. The Alarm System Tests, Step 6

8. Observe that the Yellow Lamp is switched ON.

9. Indicate on the screen if the Yellow Lamp is operating properly by pressing **OK** or **Not OK**.

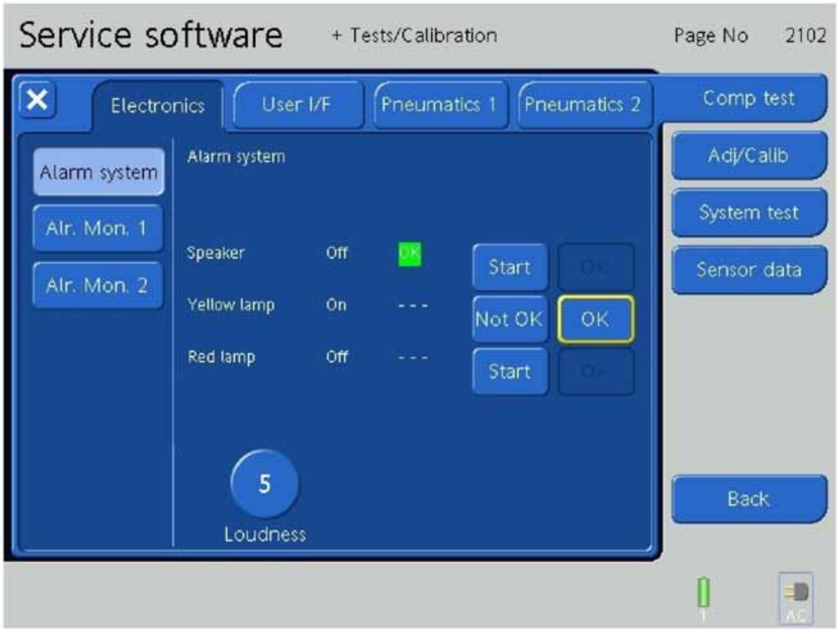


Figure 9-77. The Alarm System Tests, Step 7

10. If **OK** is pressed, the Yellow Lamp will switch OFF, the Yellow Lamp Start Button will switch to Start and OK will be indicated on the screen.

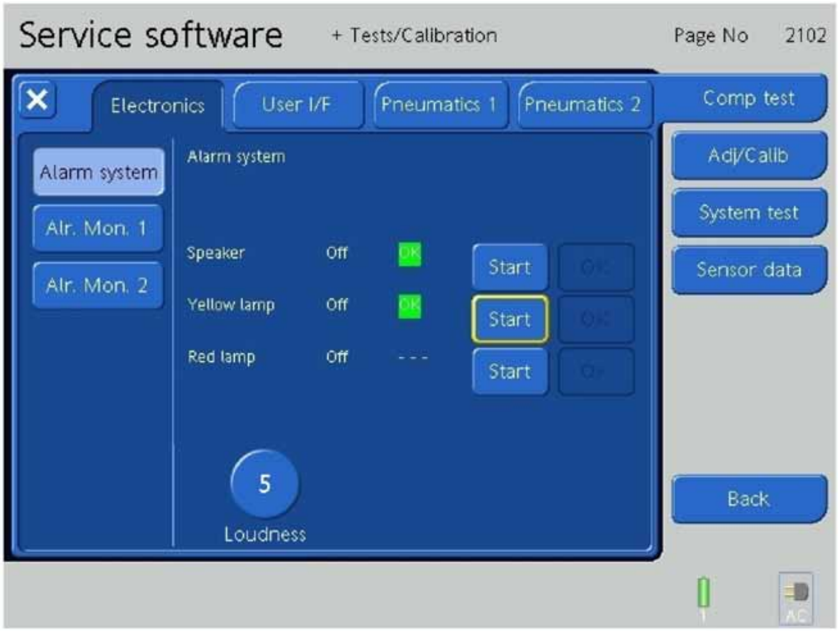


Figure 9-78. The Alarm System Tests, Step 8

11. Press the **Red Lamp Start Button**.

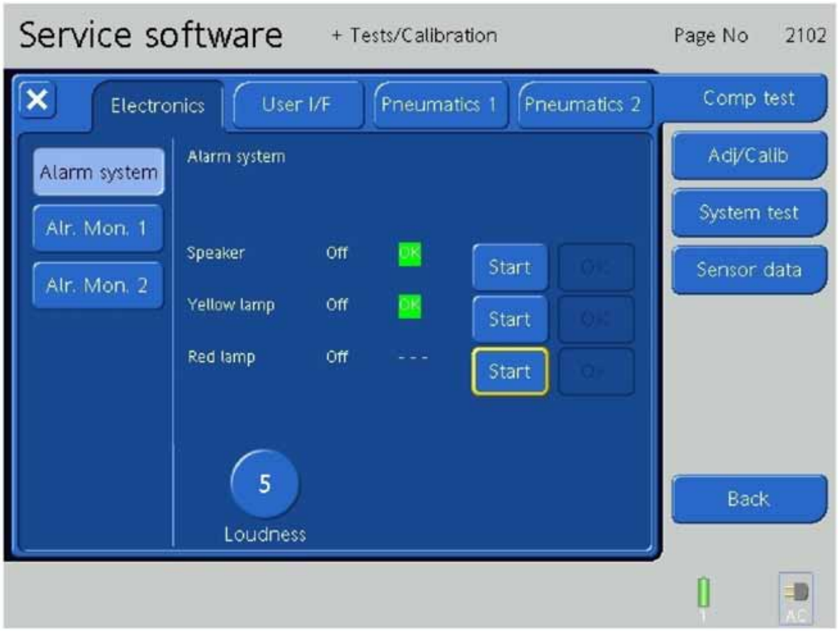


Figure 9-79. The Alarm System Tests, Step 9

12. Observe that the Red Lamp is switched ON.
13. Indicate on the screen if the Red Lamp is operating properly by pressing **OK** or **Not OK**.

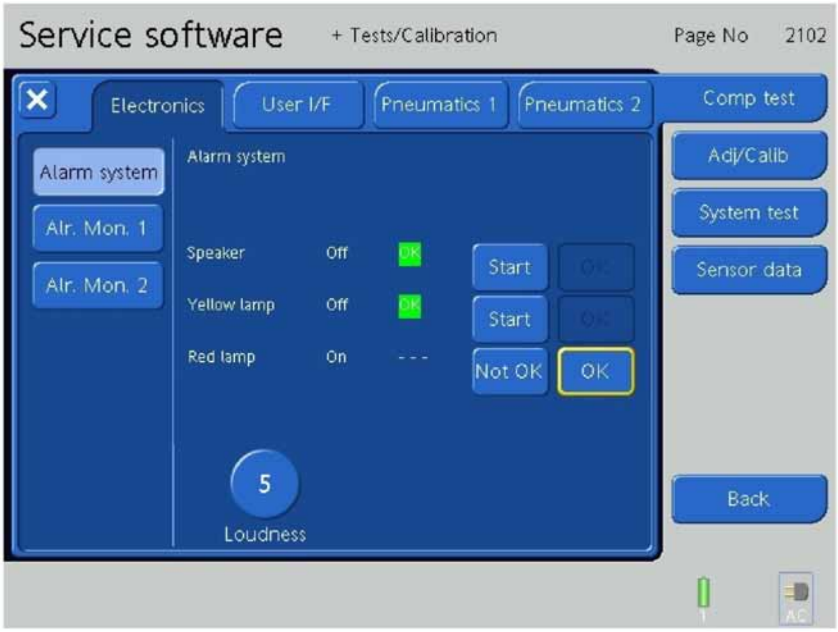


Figure 9-80. The Alarm System Tests, Step 10

14. If **OK** is pressed, the Red Lamp will switch OFF, the Red Lamp Start Button will switch to Start and OK will be indicated on the screen.

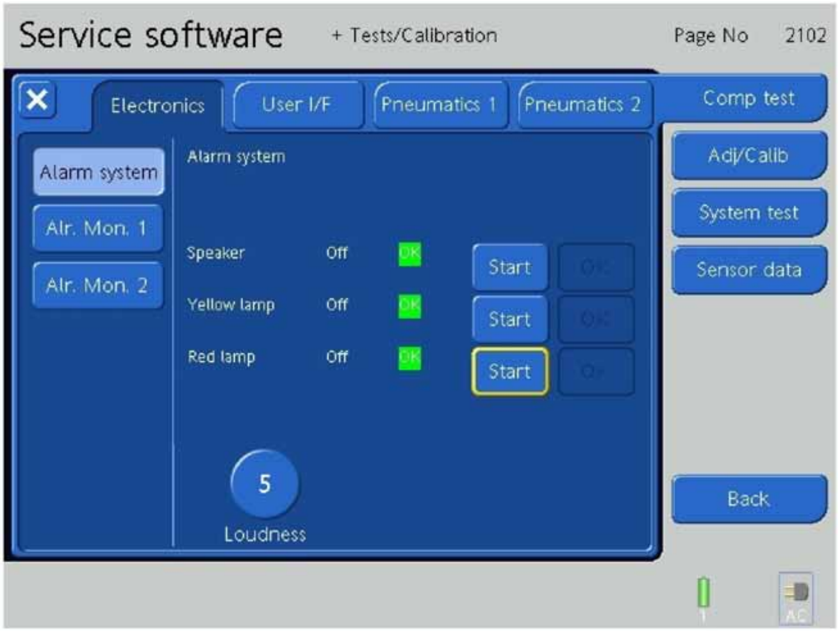


Figure 9-81. The Alarm System Tests, Step 11

15. After completion of the Alarm System Tests, the results are indicated on the screen.

Alarm Monitor 1

1. Press the **Alarm Monitor 1 Button**.

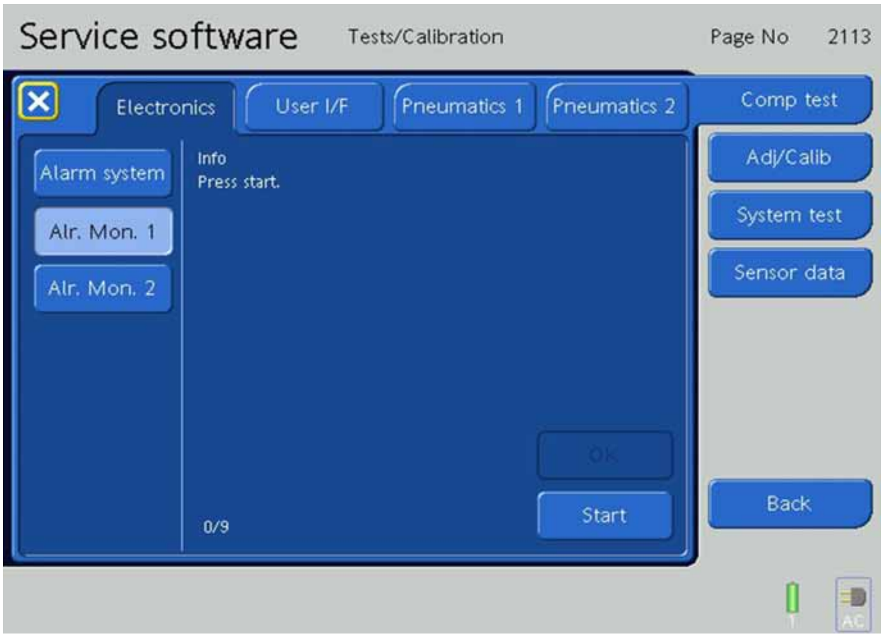


Figure 9-82. The Alarm Monitor 1 Screen

2. Press the **Start Button**.

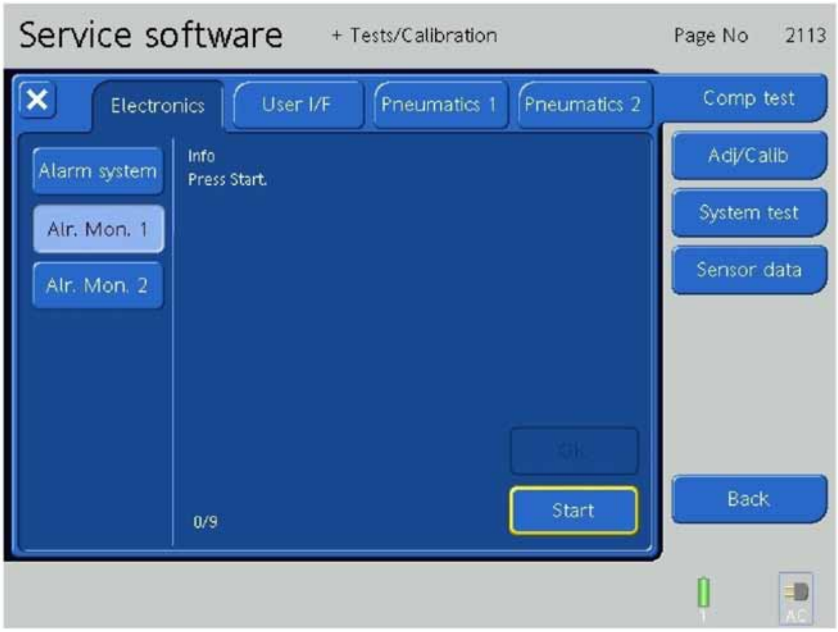


Figure 9-83. The Alarm Monitor 1 Tests, Step 1

3. Indicate on the screen if the Alarm Light and the Alarm Silence LED is blinking by pressing **OK** or **Not OK**.

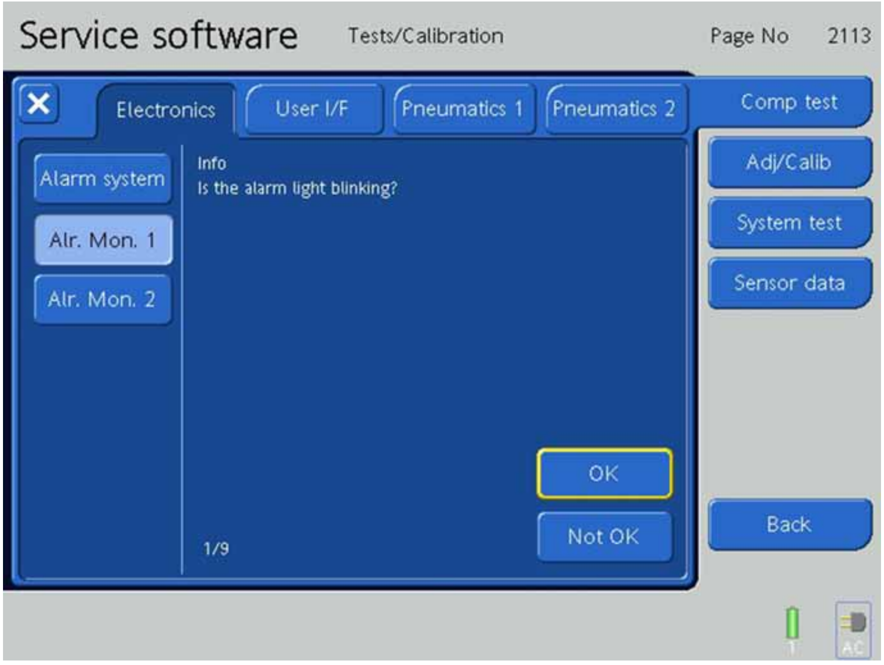


Figure 9-84. The Alarm Monitor 1 Tests, Step 2

4. Record the results on the HAMILTON-C2 Test Report.

5. Next, indicate on the screen if the Alarm Light and the Alarm Silence LED is ON by pressing **OK** or **Not OK**.

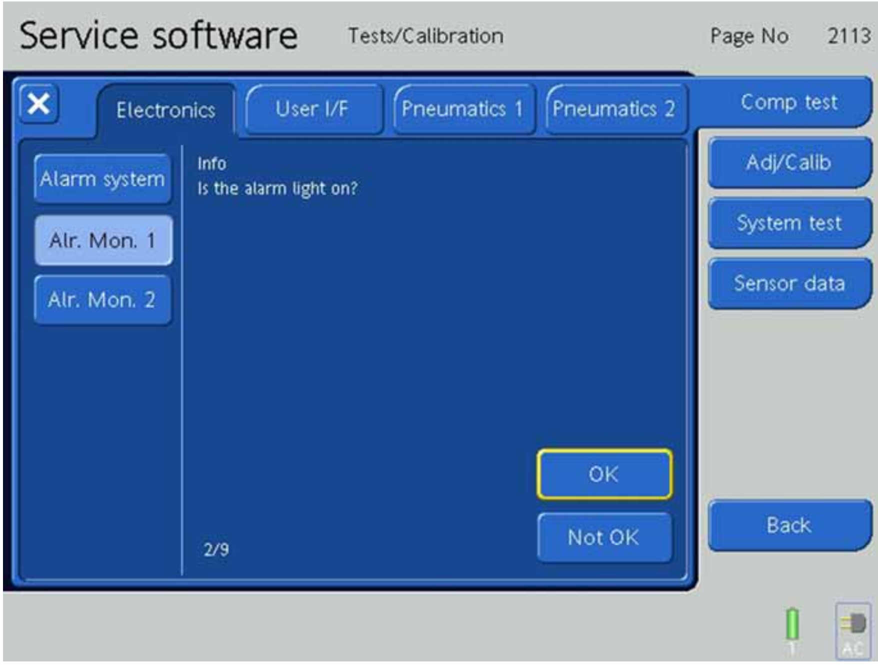


Figure 9-85. The Alarm Monitor 1 Tests, Step 3

6. Next, press the Alarm Silence Button then indicate on the screen if the Alarm Light is ON by pressing **OK** or **Not OK**.

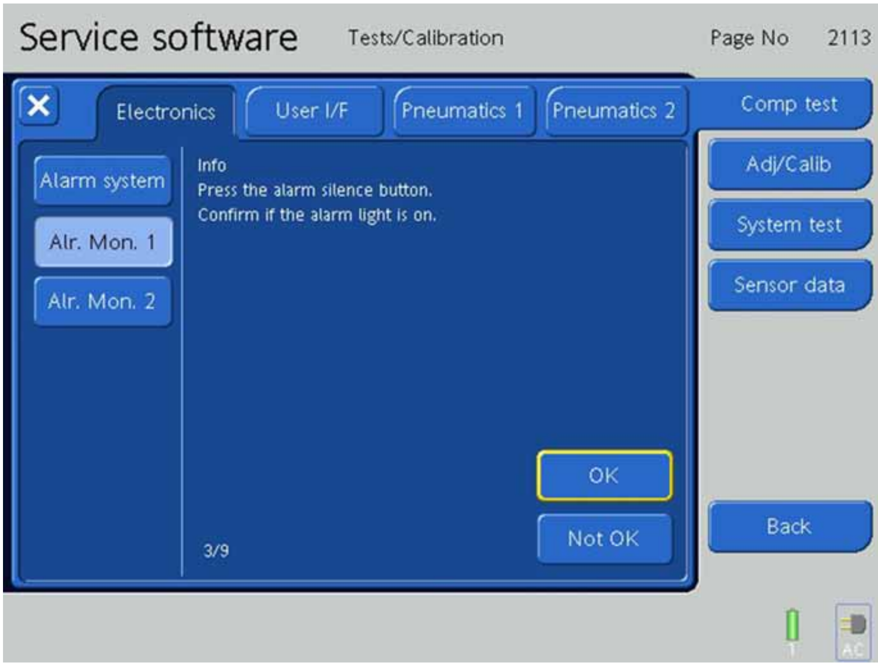


Figure 9-86. The Alarm Monitor 1 Tests, Step 4

7. Next, indicate on the screen if the Alarm Light is OFF by pressing **OK** or **Not OK**.

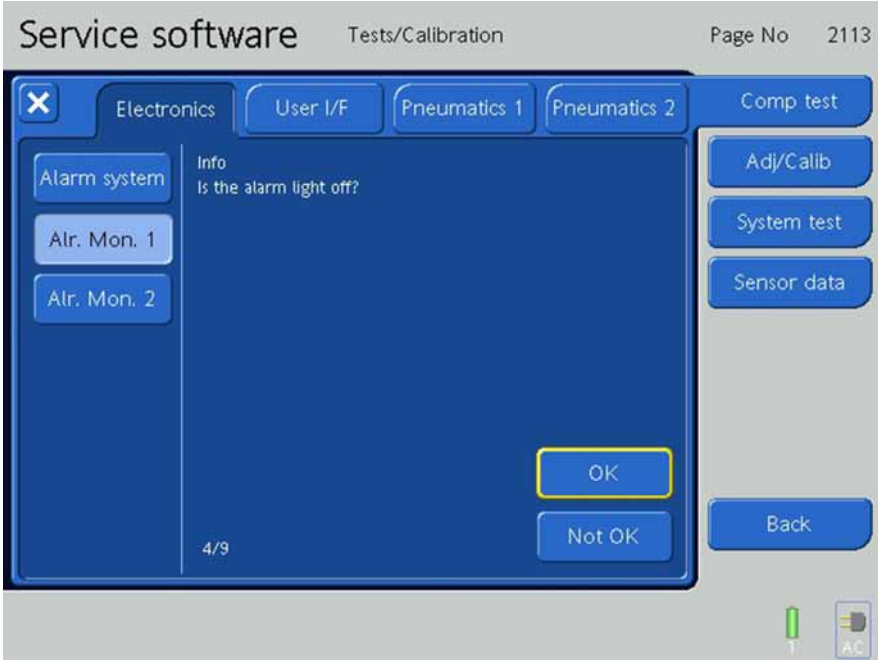


Figure 9-87. The Alarm Monitor 1 Tests, Step 5

8. Next, press the Alarm Silence Button then indicate on the screen if the Alarm Light is OFF by pressing **OK** or **Not OK**.

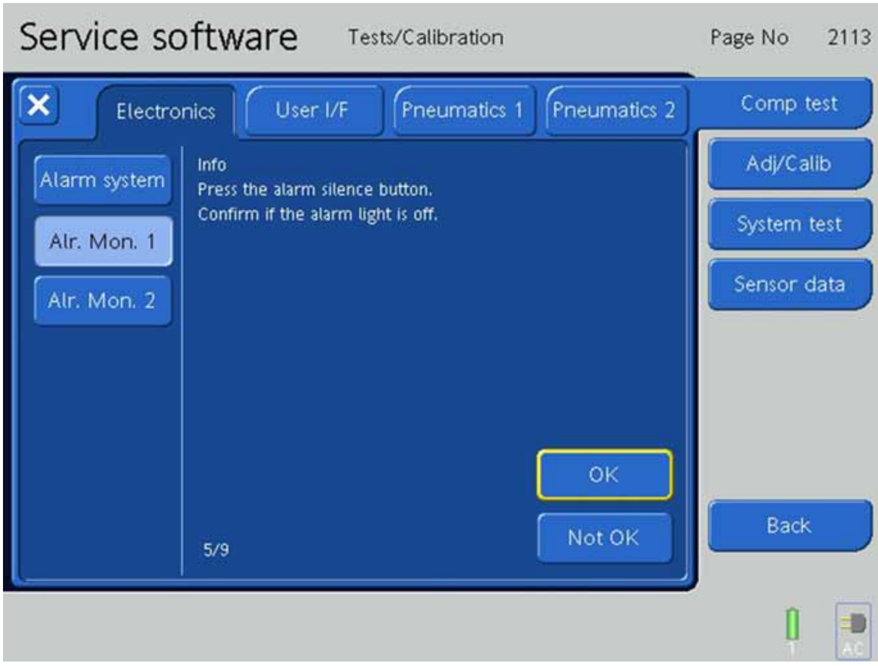


Figure 9-88. The Alarm Monitor 1 Tests, Step 6

9. Press the Alarm Silence Button and wait 5 seconds.

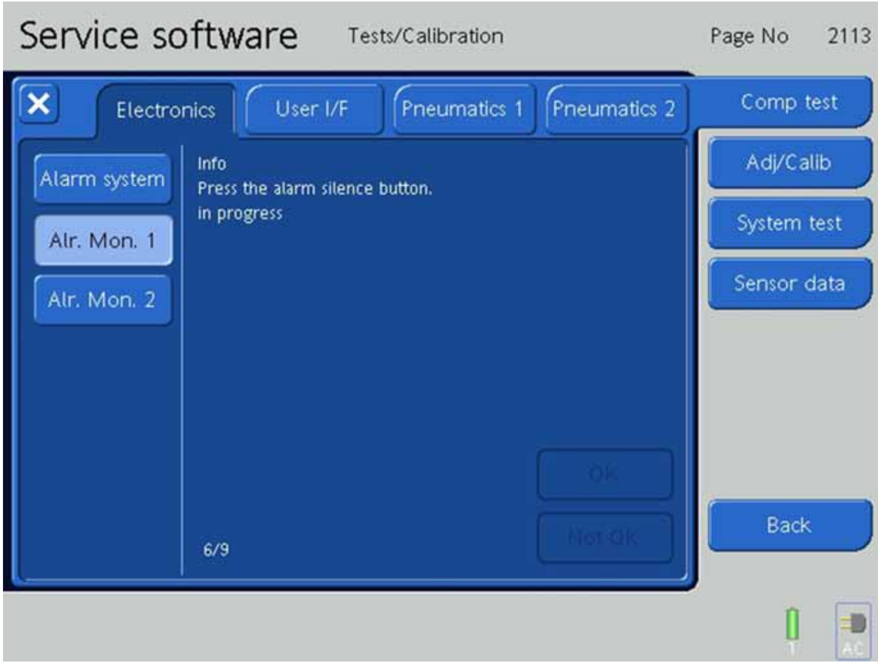


Figure 9-89. The Alarm Monitor 1 Tests, Step 7

10. Indicate on the screen if the Expiratory Valve Plunger can be moved by hand by pressing **OK** or **Not OK**.

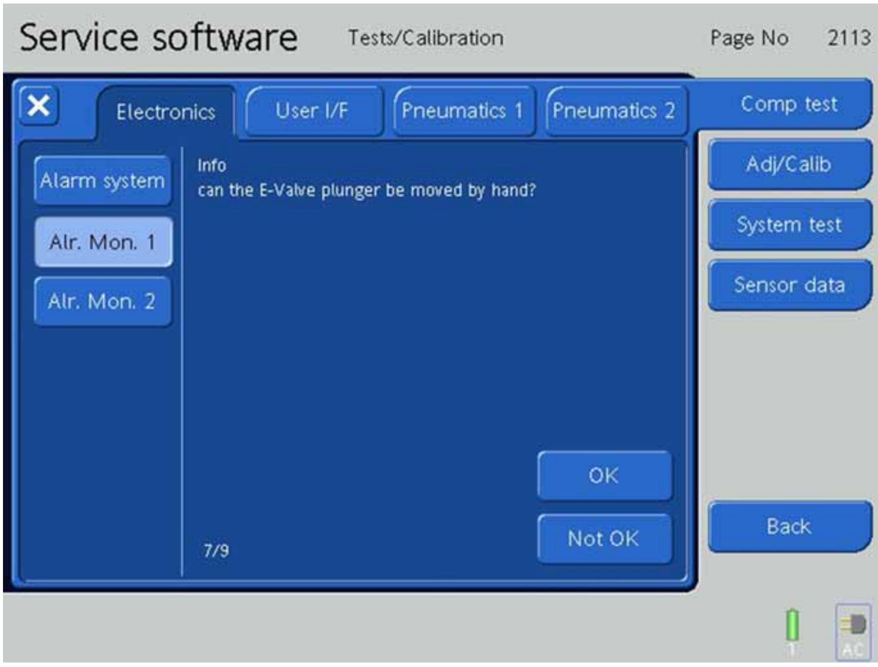


Figure 9-90. The Alarm Monitor 1 Tests, Step 8

11. Indicate on the screen if the Alarm Silence LED is ON and the Buzzer Sounds by pressing **OK** or **Not OK**.

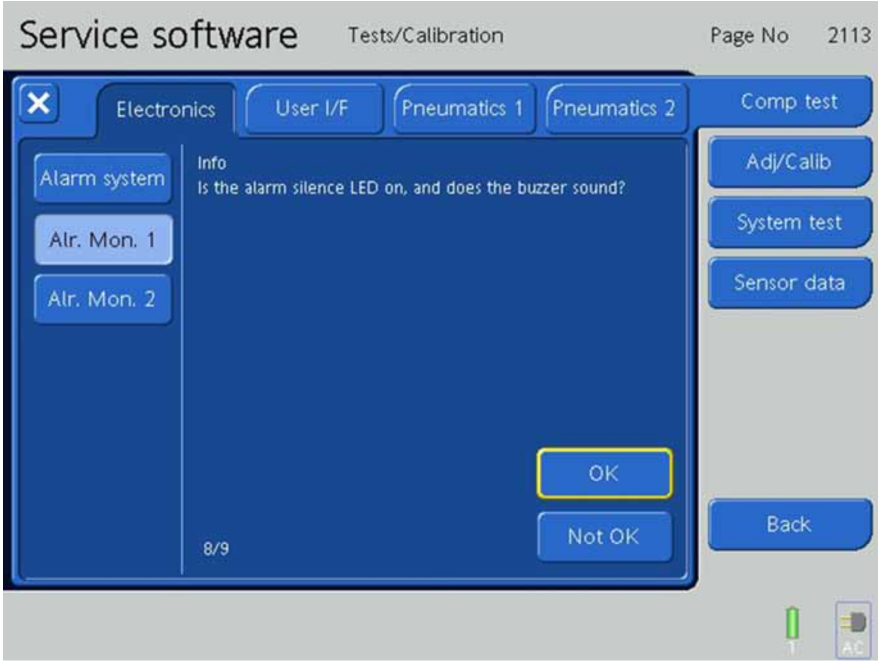


Figure 9-91. The Alarm Monitor 1 Tests, Step 9

12. Next, remove the Rear Cover and Fan Filter, then physically STOP the Cooling Fan by Hand until the alarm is shown on the screen.

CAUTION

Be careful when stopping the Cooling Fan by Hand.

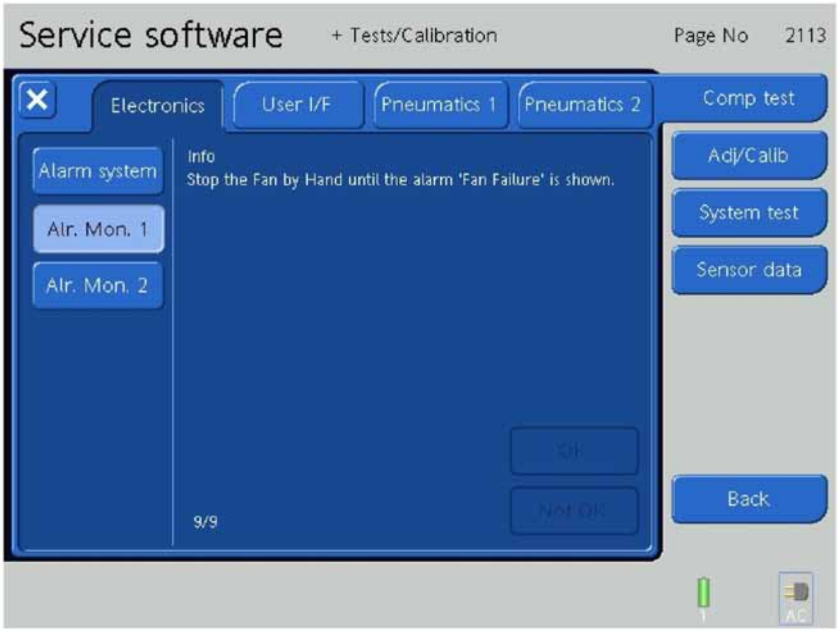


Figure 9-92. The Alarm Monitor 1 Tests, Step 10

13. After the Fan Failure Alarm is displayed, release the Fan.

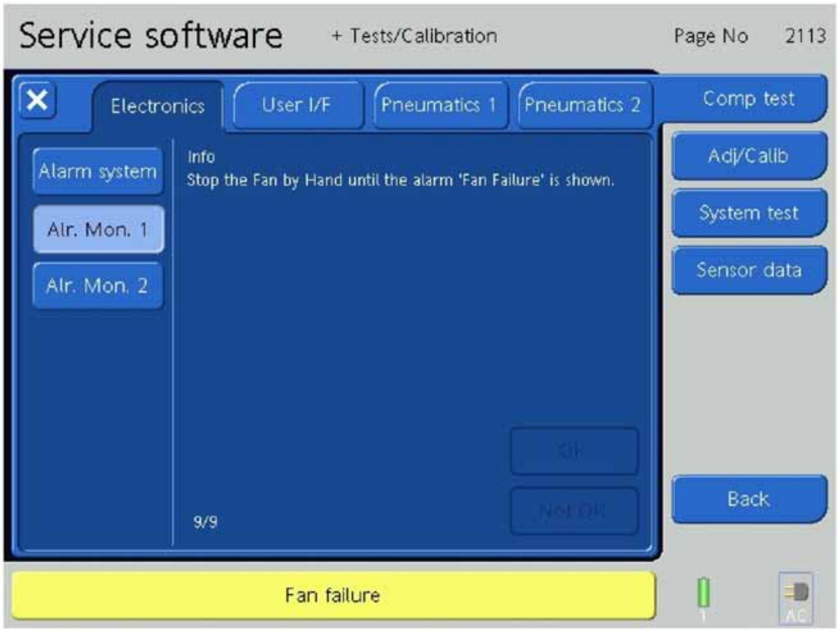


Figure 9-93. The Alarm Monitor 1 Tests, Step 11

14. Verify that the message “Test completed successfully” is displayed on the screen.

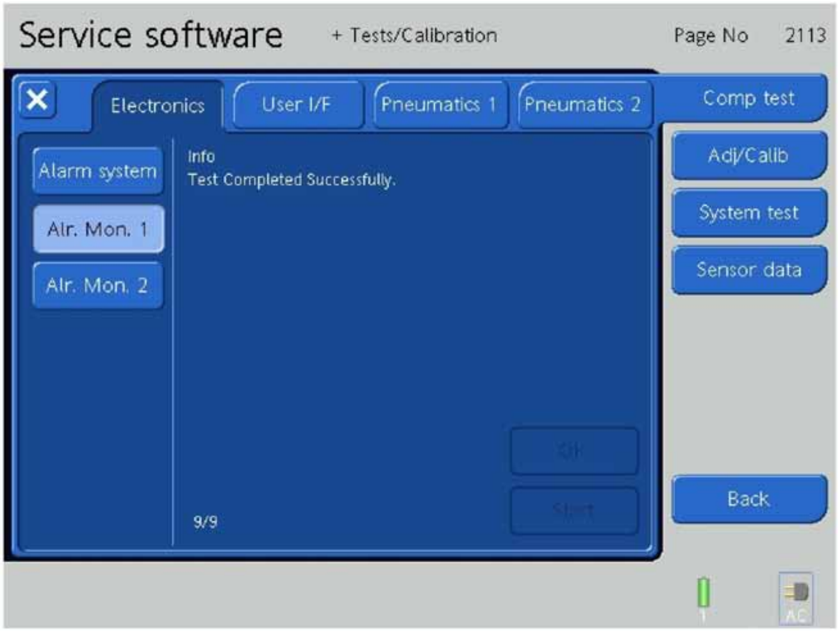


Figure 9-94. The Alarm Monitor 1 Tests, Step 12

15. Re-install the Fan Filter and Rear Cover.

Alarm Monitor 2

1. Press the **Alarm Monitor 2 Button**.

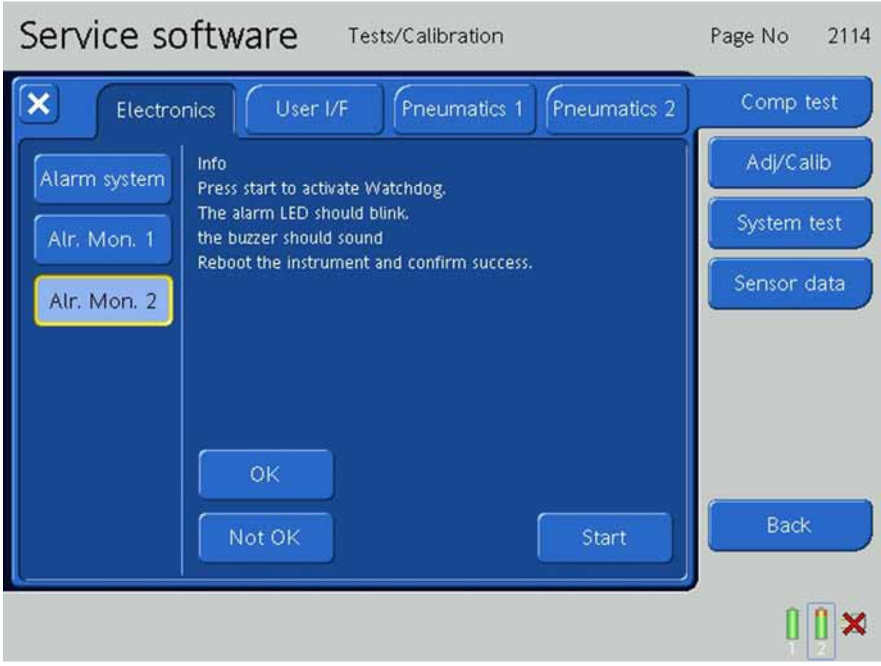


Figure 9-95. The Alarm Monitor 2 Screen

2. Press the **Start Button** to activate the Watchdog.

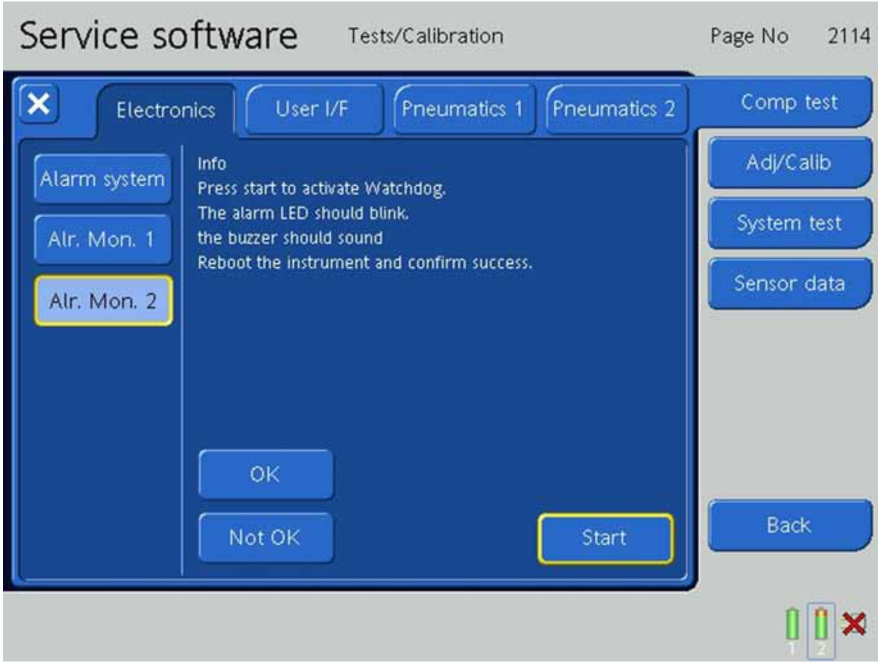


Figure 9-96. The Alarm Monitor 2 Tests, Step 1

- The Alarm LED should blink.
- The Buzzer should sound.

3. Reboot the instrument by switching **OFF** the Power Button (A) on the front of the HAMILTON-C2 Interaction Panel. Wait 15 seconds, switch **ON** the Power Button (A) on the front of the HAMILTON-C2 Interaction Panel and then press and hold the **100% O_2 (B)** and **Manual Breath (B) Buttons** at the same time.

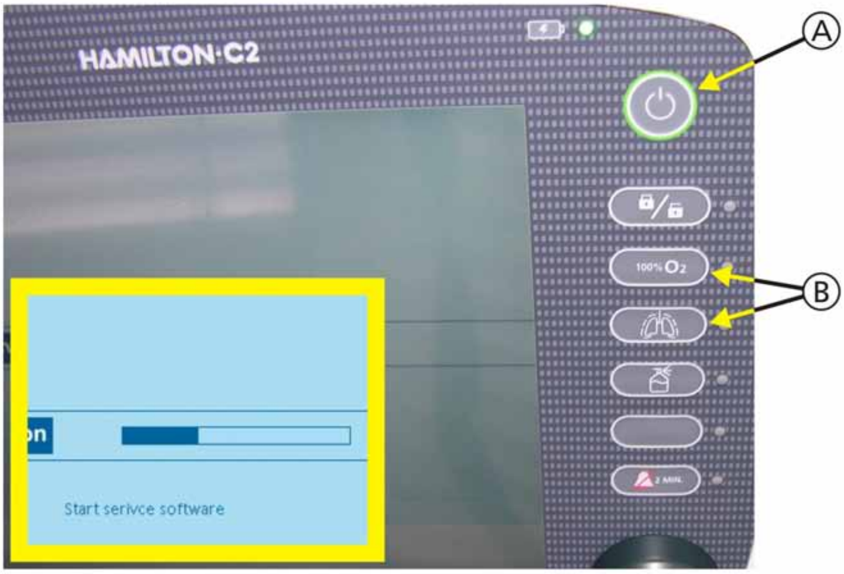


Figure 9-97. The Alarm Monitor 2 Tests, Step 2

4. From the Main Service Software Screen, press the **Test /Calibration Button**.

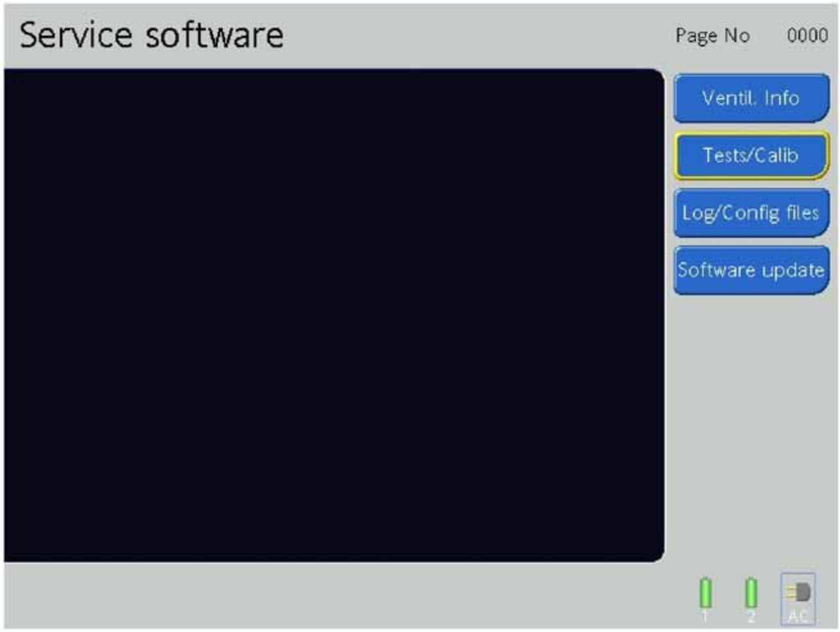


Figure 9-98. The Alarm Monitor 2 Tests, Step 3

5. From the Test / Calibration Screen, press the **Component Test Button**.

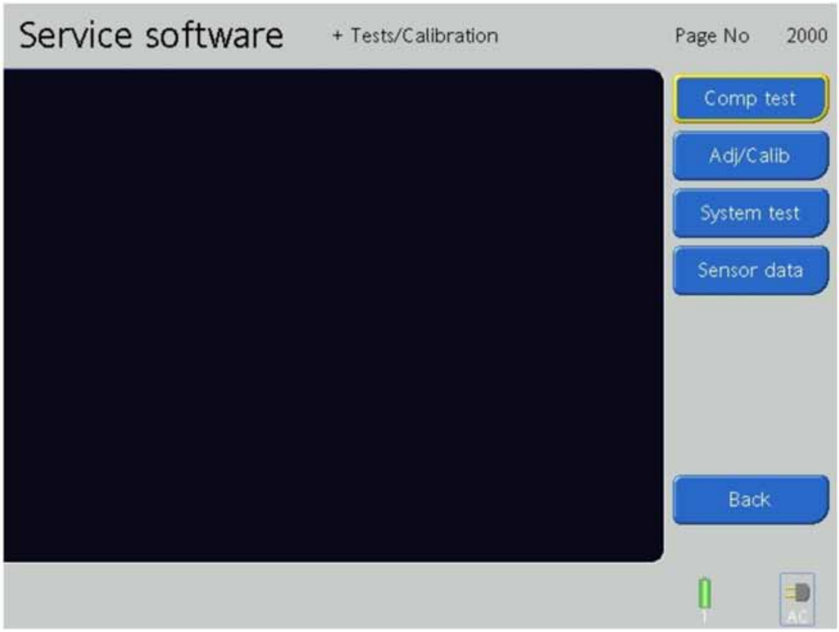


Figure 9-99. The Alarm Monitor 2 Tests, Step 4

6. On the Electronics Tab, press the **Alarm Monitor 2 Button**.

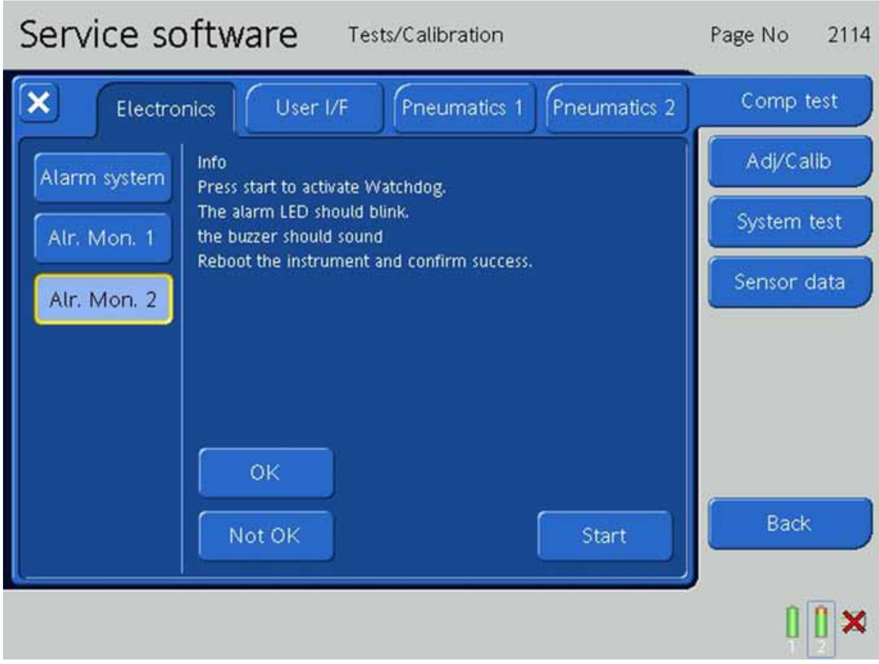


Figure 9-100. The Alarm Monitor 2 Tests, Step 6

7. **DO NOT** press Start again.
8. Indicate on the screen if the Alarm LED and the Buzzer functioned as expected by pressing **OK** or **Not OK**.

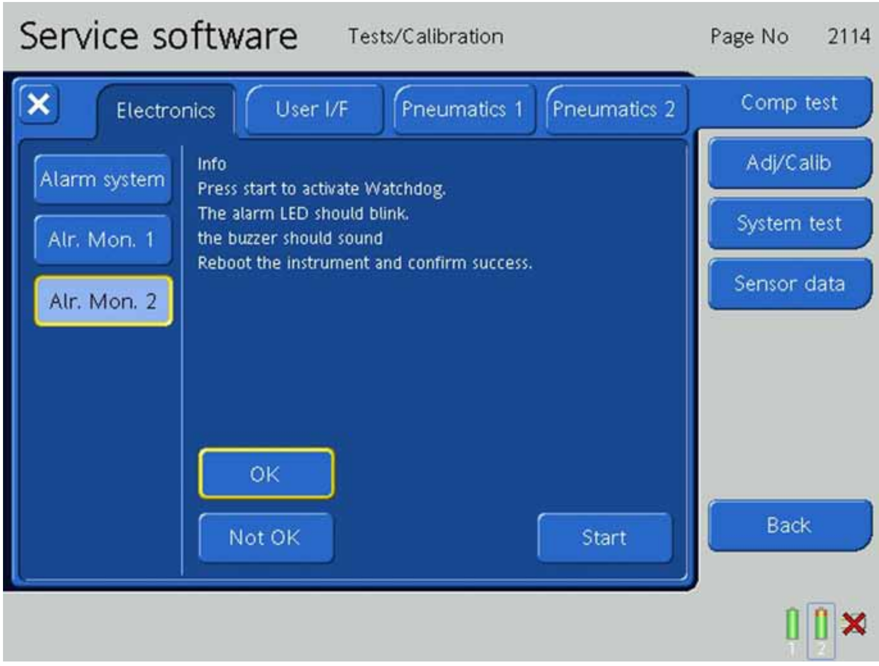


Figure 9-101. The Alarm Monitor 2 Tests, Step 7

9.9.2.2 User Interface Tab

1. Press the **User Interface Tab**

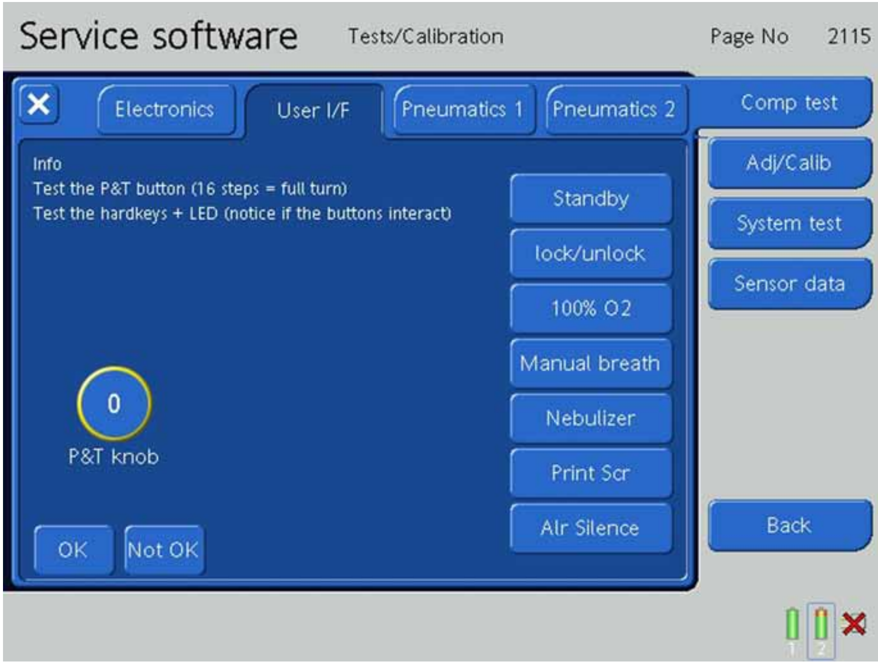


Figure 9-102. The User Interface Tab Screen

2. Test the P&T Control Knob Encoder by selecting the P&T Control Knob on the screen and rotating the knob. Observe there are 16 steps in 1 full turn of the P&T Knob.

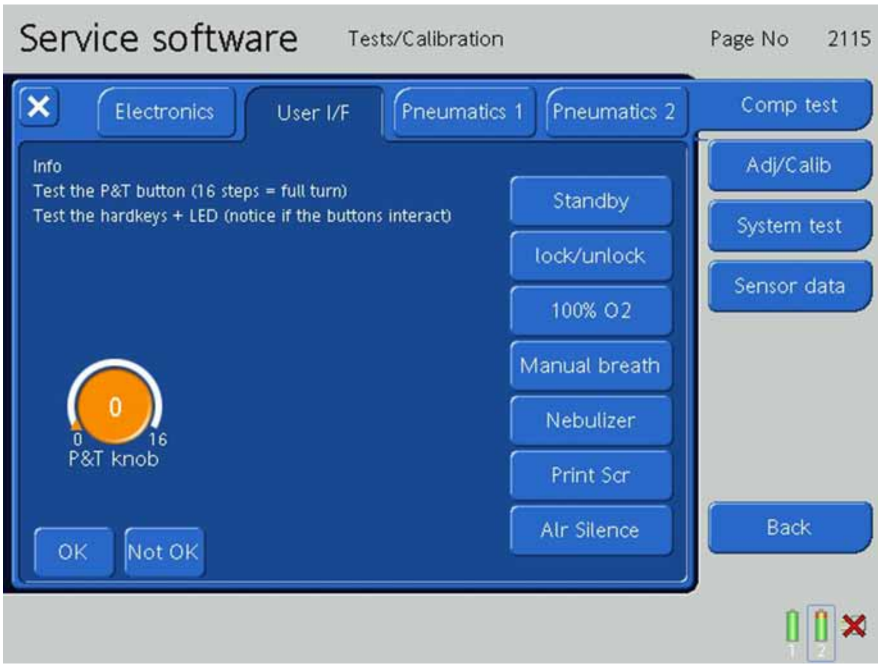


Figure 9-103. The User Interface Tests, Step 1

3. Press each button on the Interaction Panel and observe the reaction to the button pressed on the screen.

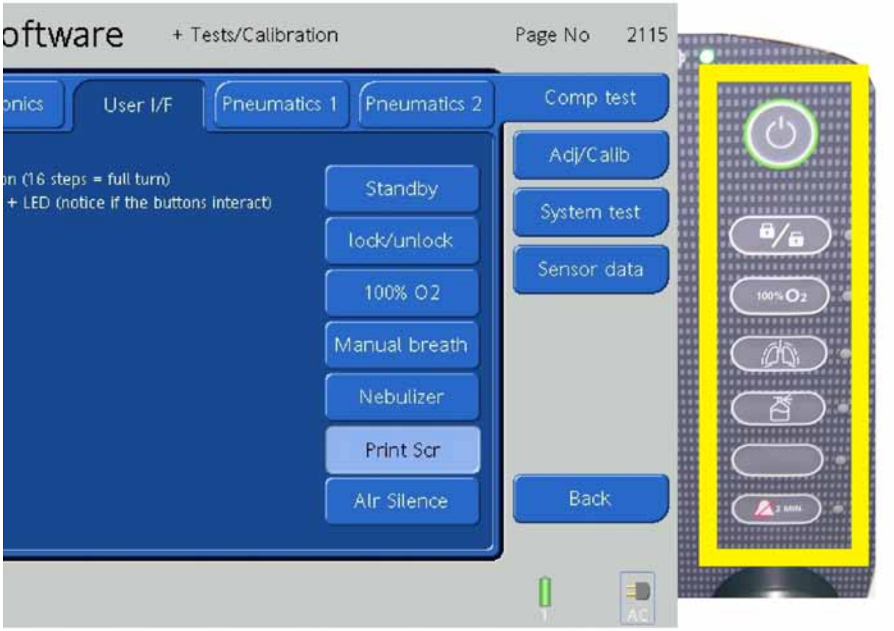


Figure 9-104. The User Interface Tests, Step 2

9.9.2.3 Pneumatics 1 Tab

Binary Valve in Software 2.0.0

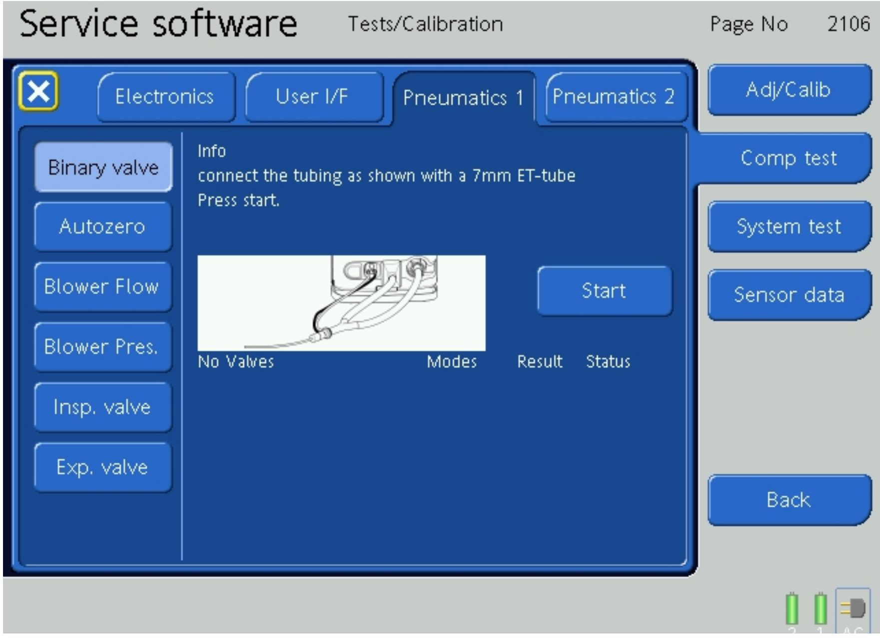


Figure 9-105. The Pneumatics 1 Screen

1. Press the **Pneumatics 1 Tab**.

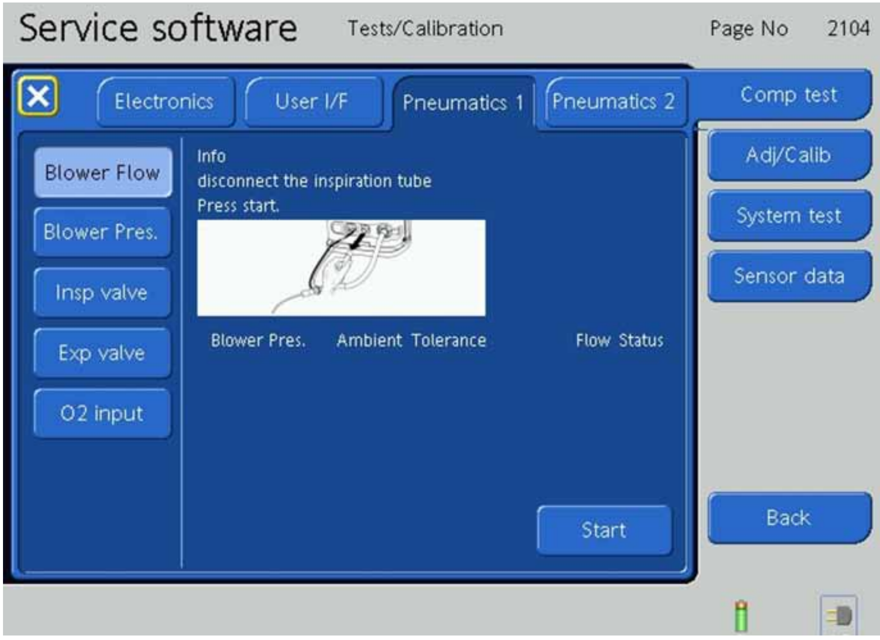


Figure 9-106. The Pneumatics 1 Screen

2. Connect a complete Patient Breathing Circuit before starting the test.

Blower Flow

1. Press the **Blower Flow Button**.
2. Disconnect the Inspiration Tube.

3. Press the **Start Button**.

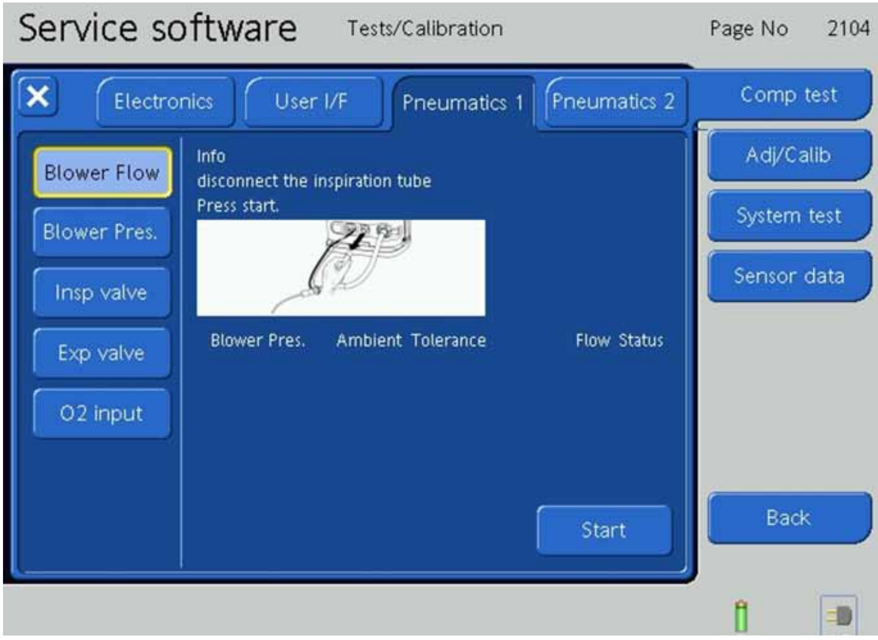


Figure 9-107. The Blower Flow Tests, Step 1

4. The test runs automatically indicated by **Component Test Blower Flow Running** on the screen.

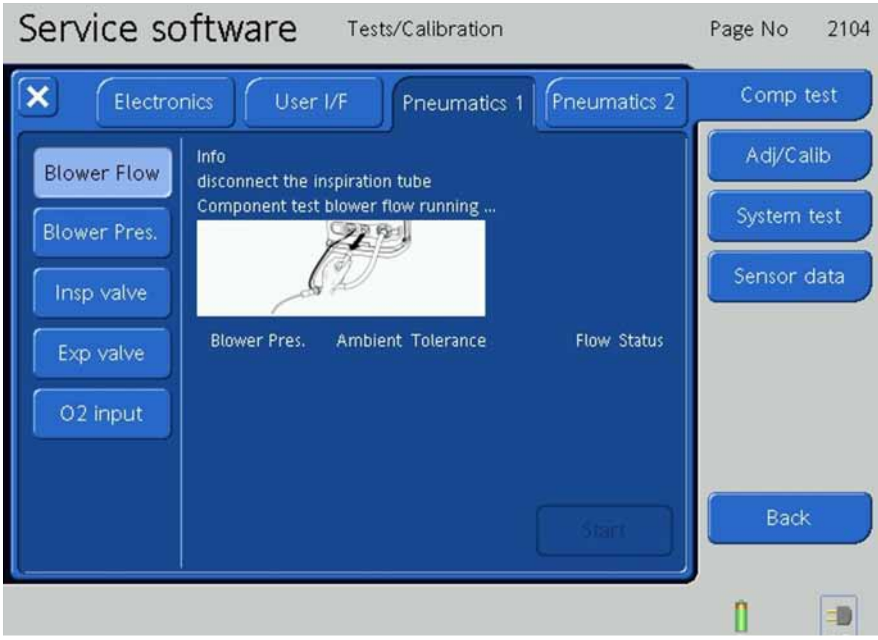


Figure 9-108. The Blower Flow Tests, Step 2

5. The test is complete when **Component Test Blower Flow Done** is displayed on the screen and the results are displayed with **OK** or **Not OK**.

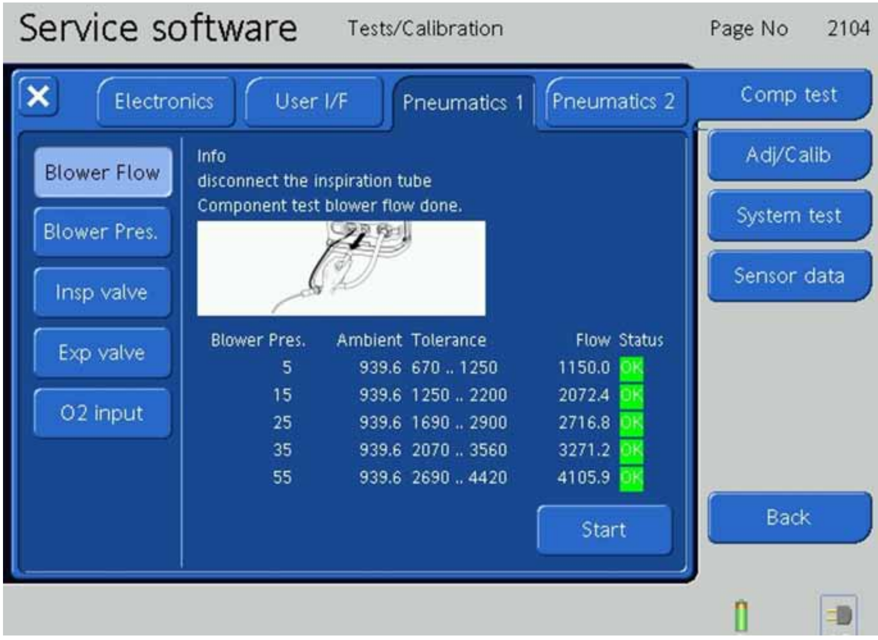


Figure 9-109. The Blower Flow Tests, Step 3

Note
The Blower Pressure values are in **mbar** and the Flow values are in **ml/minute**.

Blower Pressure

1. Press the **Blower Pressure Button**.
2. Disconnect the Inspiration Tube and seal the Patient Outlet with a stopper.

3. Press the **Start Button**.

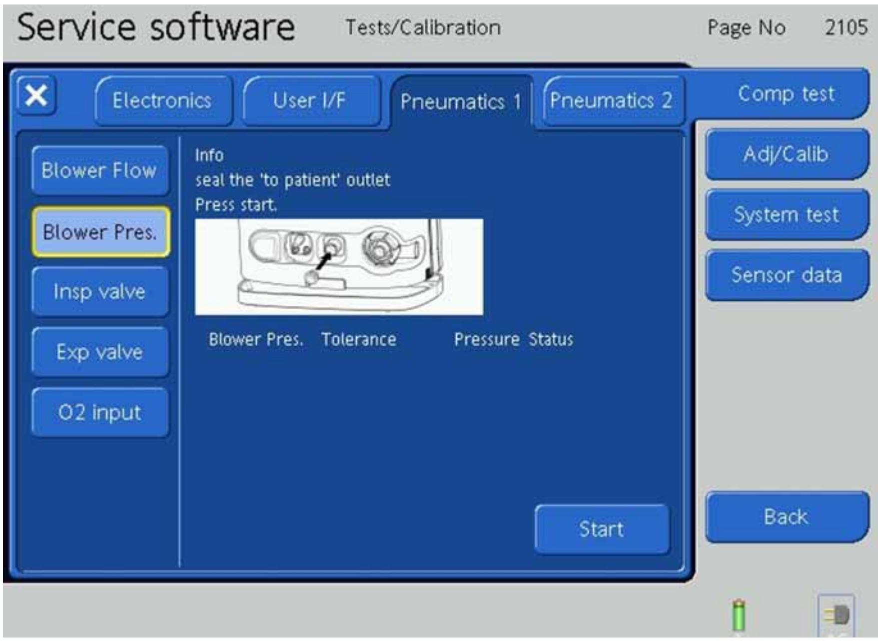


Figure 9-110. The Blower Pressure Tests, Step 1

4. The test runs automatically indicated by **Component Test Blower Pressure Running** on the screen.

Figure 9-111. The Blower Pressure Tests, Step 2

5. The test is complete when **Component Test Blower Flow Done** is displayed on the screen and the results are displayed with **OK** or **Not OK**.

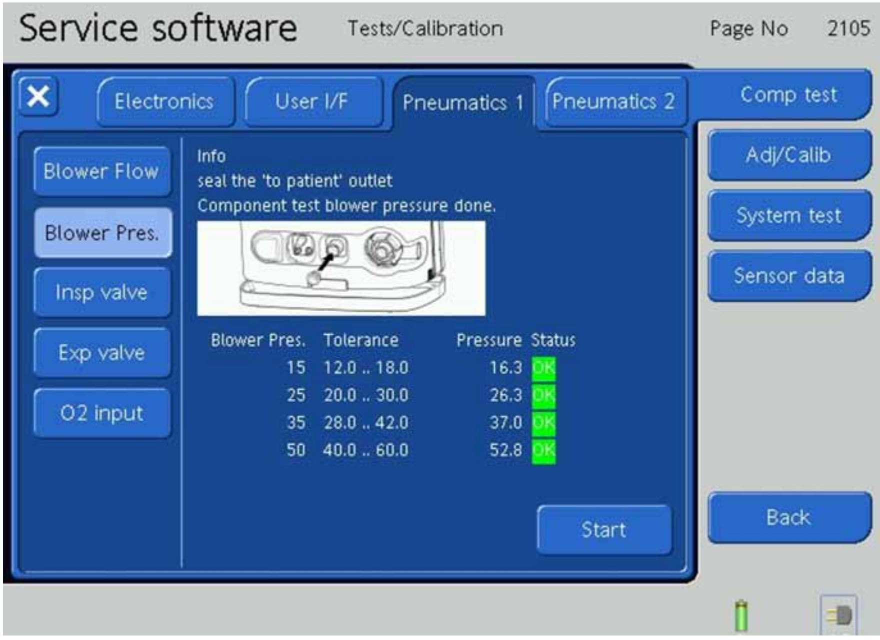


Figure 9-112. The Blower Pressure Tests, Step 3

Note

The Blower Pressure values are in **mbar**.

Inspiratory Valve

1. Press the **Inspiratory Valve Button**.

Figure 9-113. The Inspiratory Valve Tests, Step 1

2. Connect an Adult 22mm Tube (PN 260100) and a filter (PN 279211) to the Instrument and attach the Flow Analyzer (as shown in the picture on the screen).
3. Press the **Start Button**.
4. The test runs automatically indicated by **Test Leakage Test in Progress** on the screen.

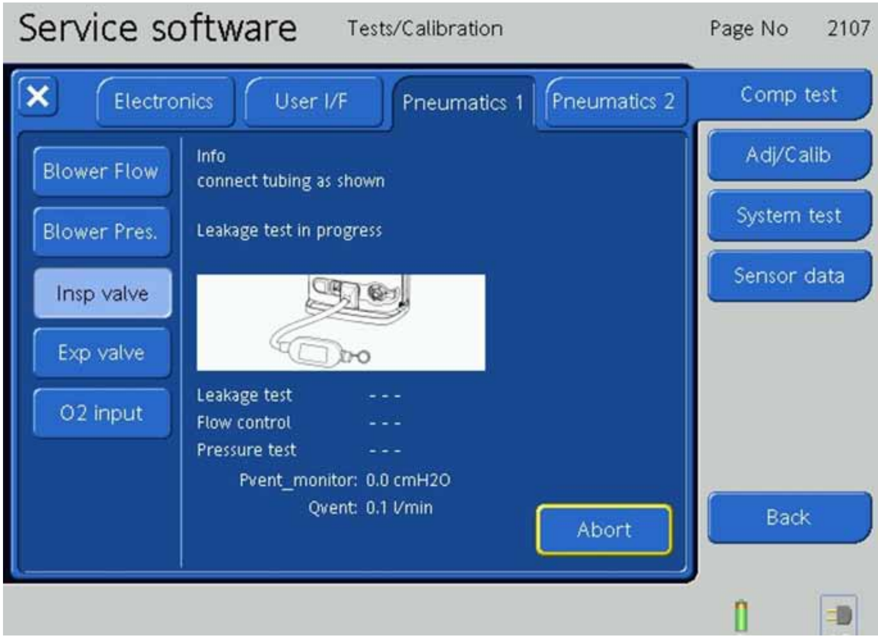


Figure 9-114. The Inspiratory Valve Tests, Step 2

5. The Inspiratory Valve Leakage Test is complete when **OK** is indicated on the screen.

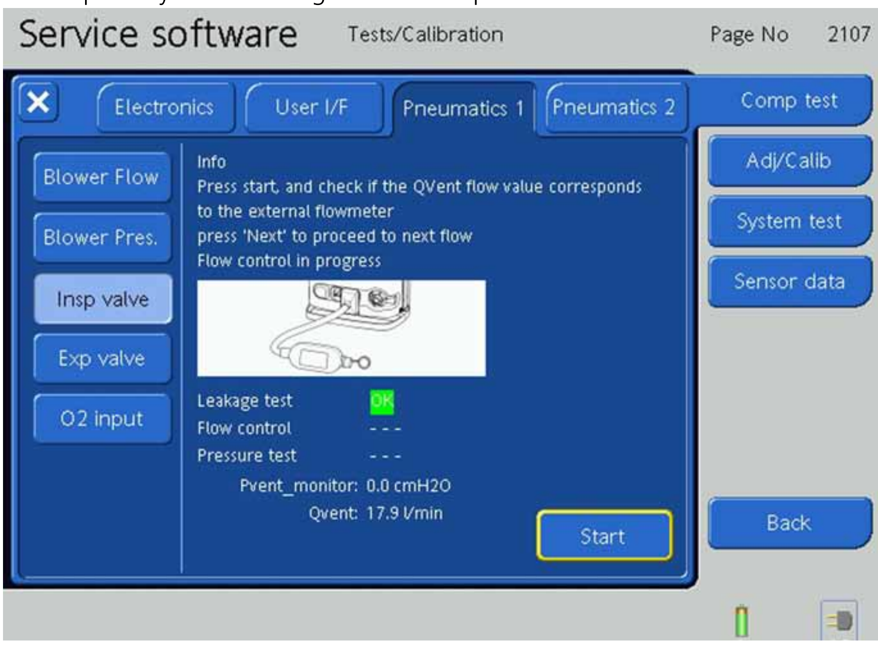


Figure 9-115. The Inspiratory Valve Tests, Step 3

6. Press the **Start Button** to begin the Flow Control Tests.
7. Pass through the Flow control test with the values of 0 l/min., 3 l/min., 18 l/min. and 150 l/min. Only verify the 18 l/min. value with external flow analyser. It must be in tolerance of +/- 8% (16.5 - 19.5 l/min).
8. The Inspiratory Valve Flow Control Test is complete when **OK** is indicated on the screen.

9. The test runs automatically indicated by **Test Pressure Control in Progress** on the screen.

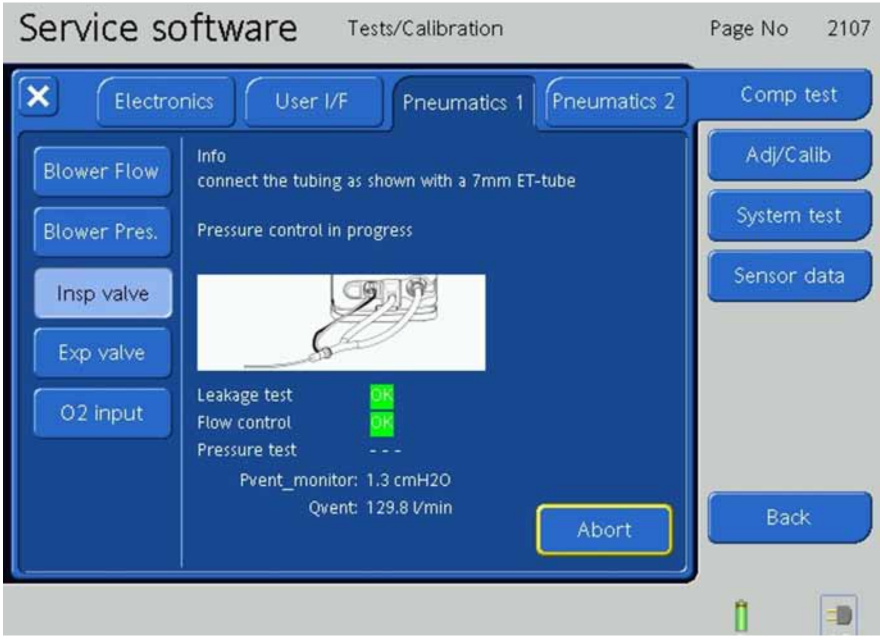


Figure 9-116. The Inspiratory Valve Tests, Step 8

10. The Inspiratory Valve Pressure Control Test is complete when **OK** is indicated on the screen.

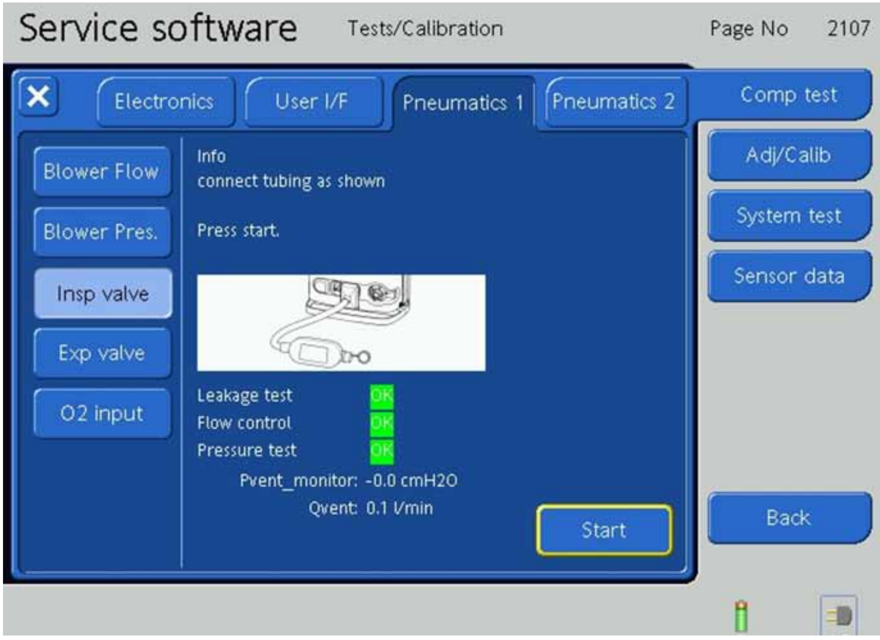


Figure 9-117. The Inspiratory Valve Tests, Step 9

11. Connect the tubing as shown and close the end of the Flow Sensor.

12. Press the **Start Button** to begin the Expiratory Valve Leakage and Pressure Tests.

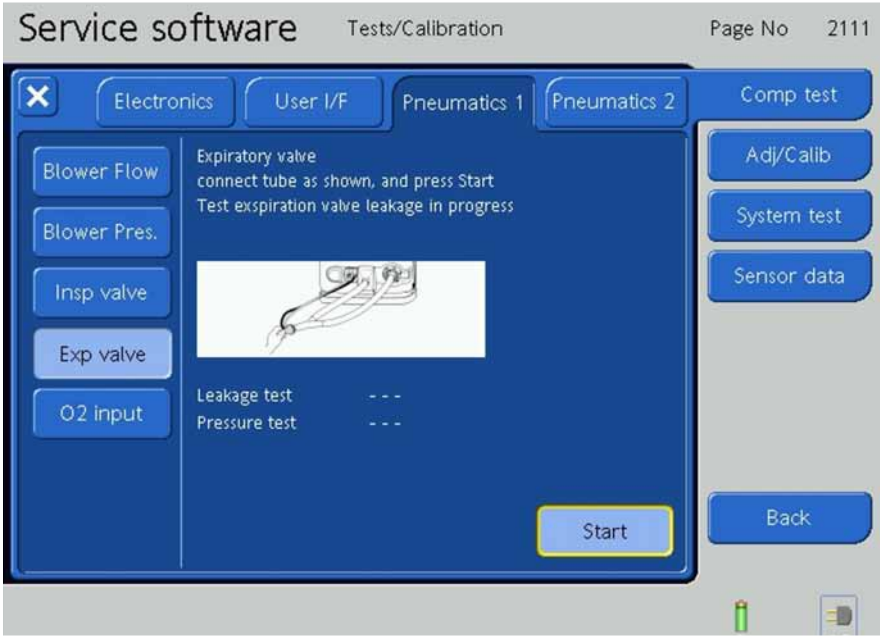


Figure 9-118. The Expiratory Valve Tests, Step 2

13. The test runs automatically indicated by **Test Expiration Valve Leakage in Progress** on the screen.

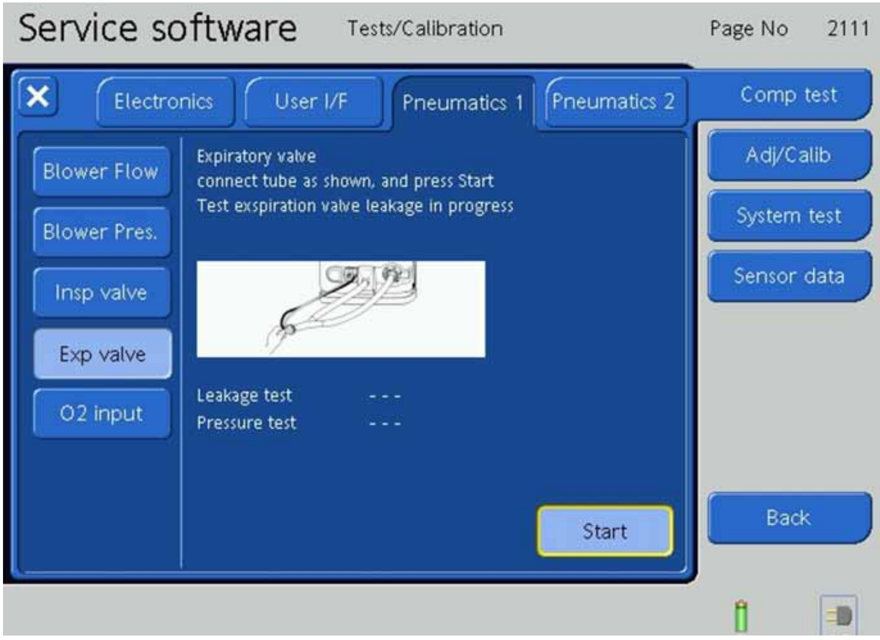


Figure 9-119. The Expiratory Valve Tests, Step 3

14. The Test Expiration Valve Leakage Test is complete when **OK** is indicated on the screen.

Figure 9-120. The Expiratory Valve Tests, Step 4

15. The next test runs automatically indicated by **Test Expiration Valve Pressure in Progress** on the screen.

Figure 9-121. The Expiratory Valve Tests, Step 5

16. The Test Expiration Valve Pressure Test is complete when **OK** is indicated on the screen.

Figure 9-122. The Expiratory Valve Tests, Step 6

O_2 Input

1. Press the **O_2 Input Button**.

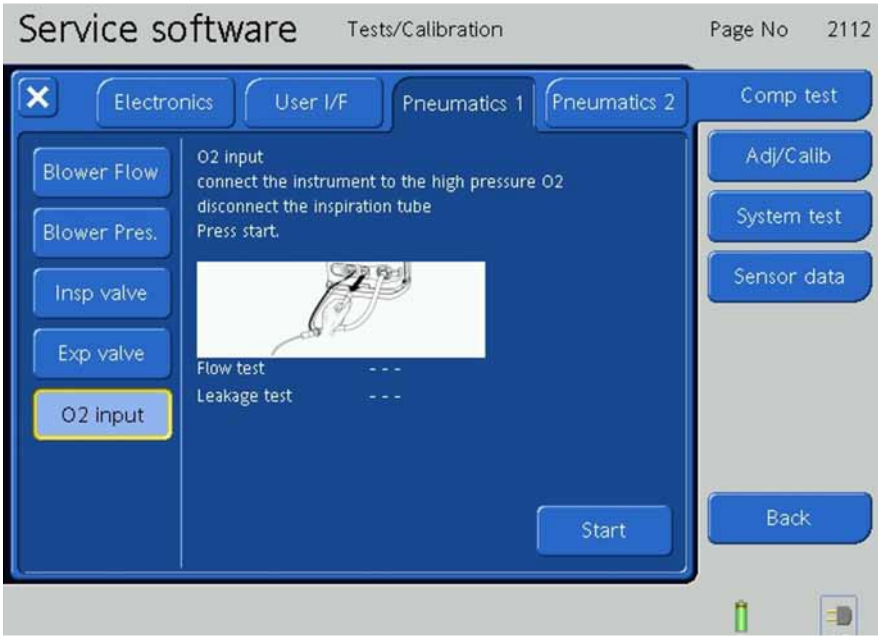


Figure 9-123. The O_2 Input Tests, Step 1

2. Connect the Instrument to the High Pressure O_2 of 2-6 bar.
3. Disconnect the Inspiration Tube.

4. Press the **Start Button** to begin the O_2 Input Flow and Leakage Tests.

Figure 9-124. The O_2 Input Tests, Step 2

5. The test runs automatically indicated by **Test O_2 Valve Flow in Progress** on the screen.

Figure 9-125. The O_2 Input Tests, Step 3

6. The O_2 Valve Flow Test is complete when **OK** is indicated on the screen.

Figure 9-126. The O_2 Input Tests, Step 4

7. The next test runs automatically indicated by **Test O2 Valve Leakage in Progress** on the screen.

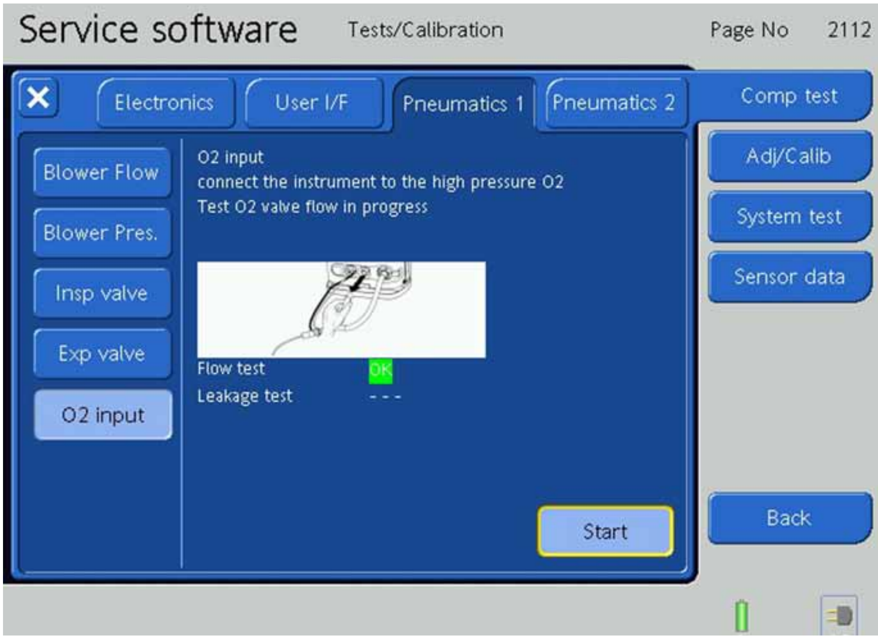


Figure 9-127. The O_2 Input Tests, Step 5

8. The O_2 Valve Leakage Test is complete when **OK** is indicated on the screen.

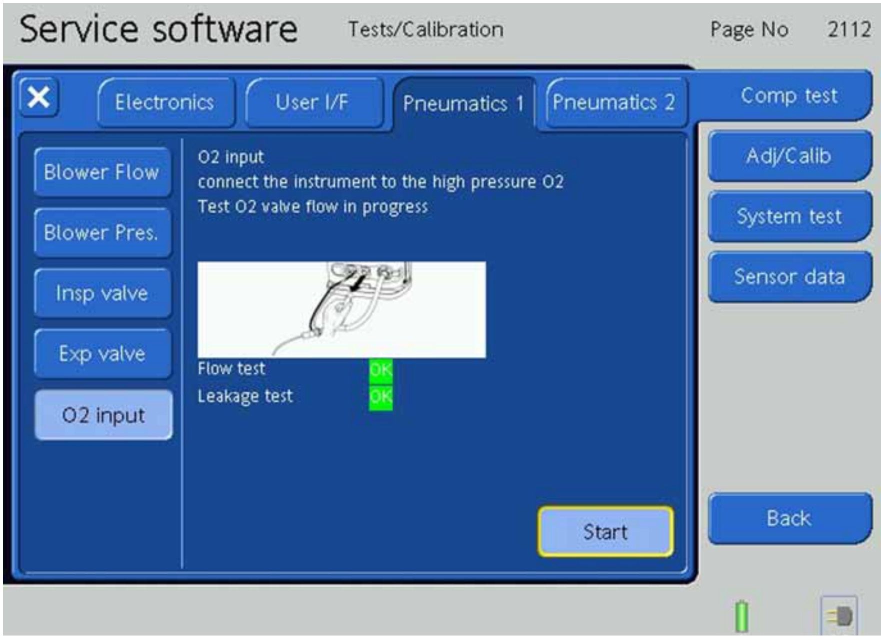


Figure 9-128. The O_2 Input Tests, Step 6

9.9.2.4 Pneumatics 2 Tab

Press the **Pneumatics 2 Tab**.

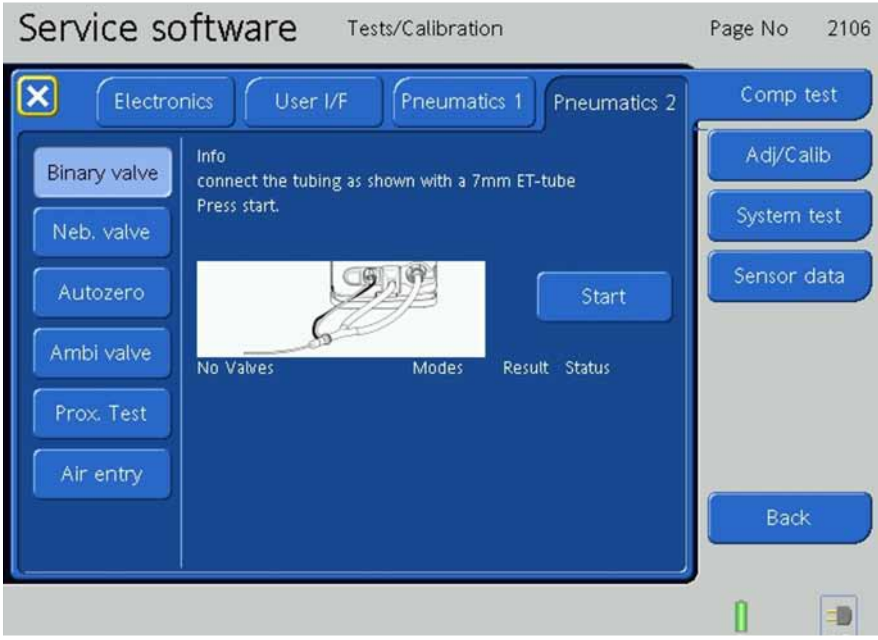


Figure 9-129. The Pneumatics 2 Screen

Binary Valve

1. Press the **Binary Valve Button**.

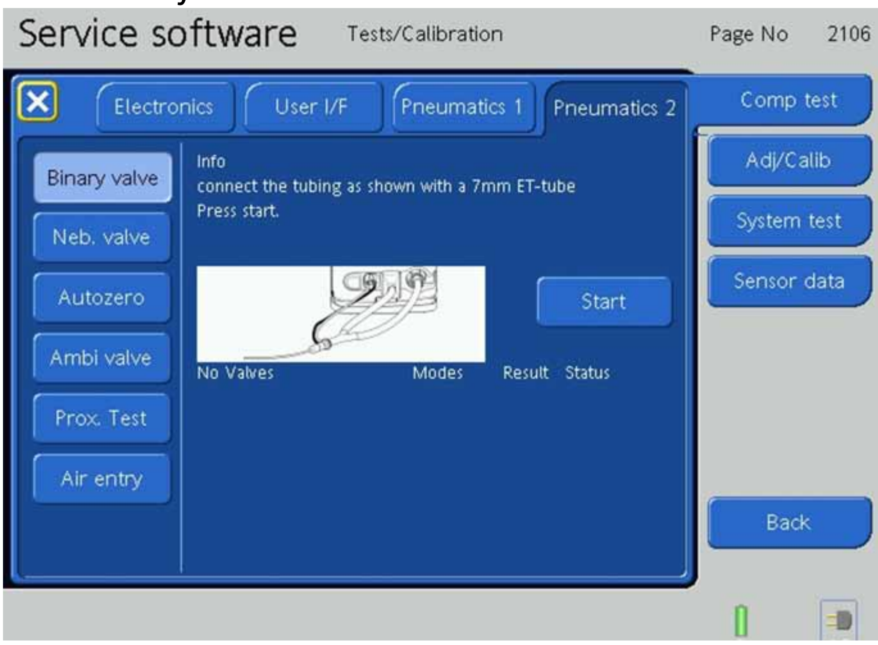


Figure 9-130. The Binary Valve Tests, Step 1

2. Connect the tubing as shown with a 7mm ET Tube to the Flow Sensor.

3. Press the **Start Button** to begin the Binary Valve Test.

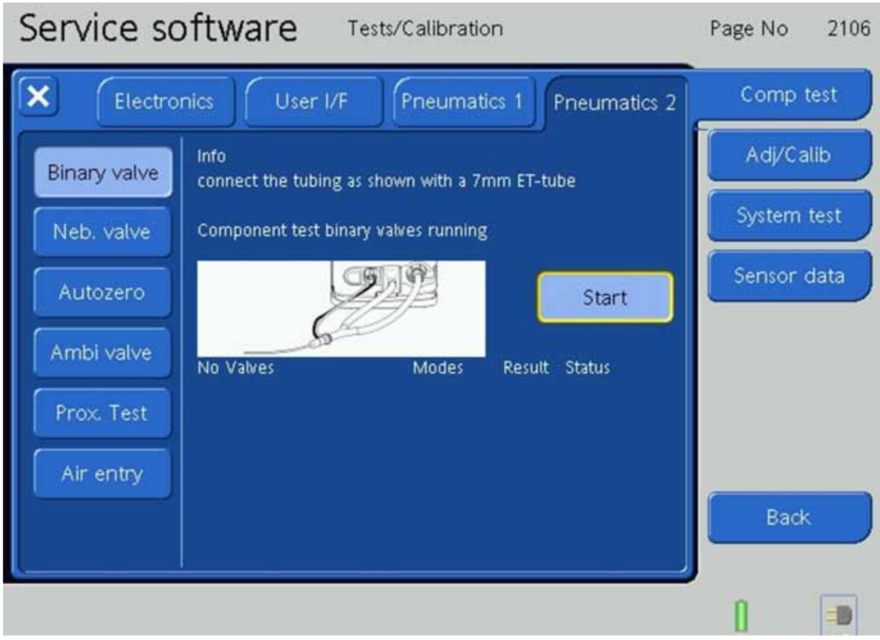


Figure 9-131. The Binary Valve Tests, Step 2

4. The test runs automatically indicated by **Component Test Binary Valves Running** on the screen.

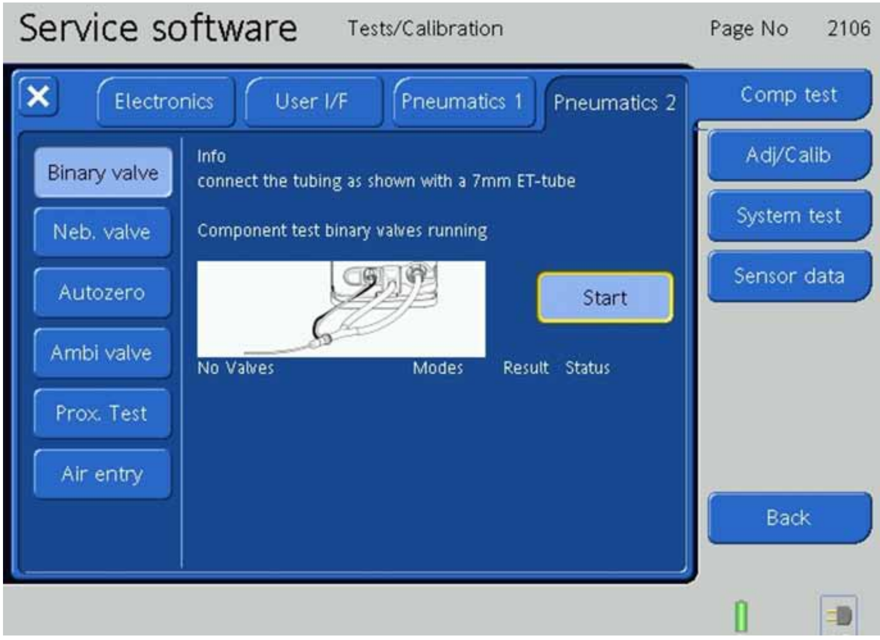


Figure 9-132. The Binary Valve Tests, Step 3

5. The Component Test Binary Valves is complete when **OK** is indicated on the screen.This means that the internal sensor checks are ok.

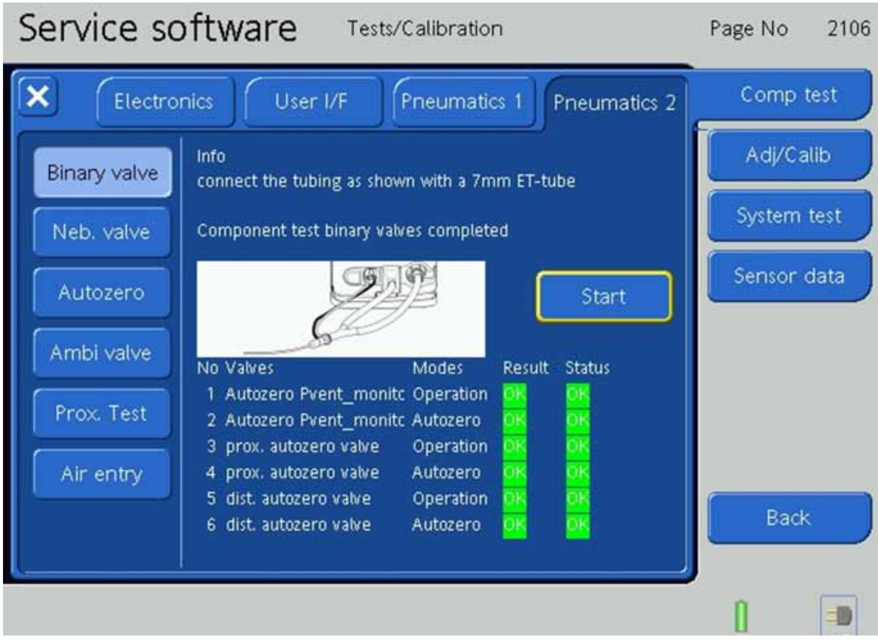


Figure 9-133. The Binary Valve Tests, Step 4

Nebulize valve

1. Press the **Nebulize Button**

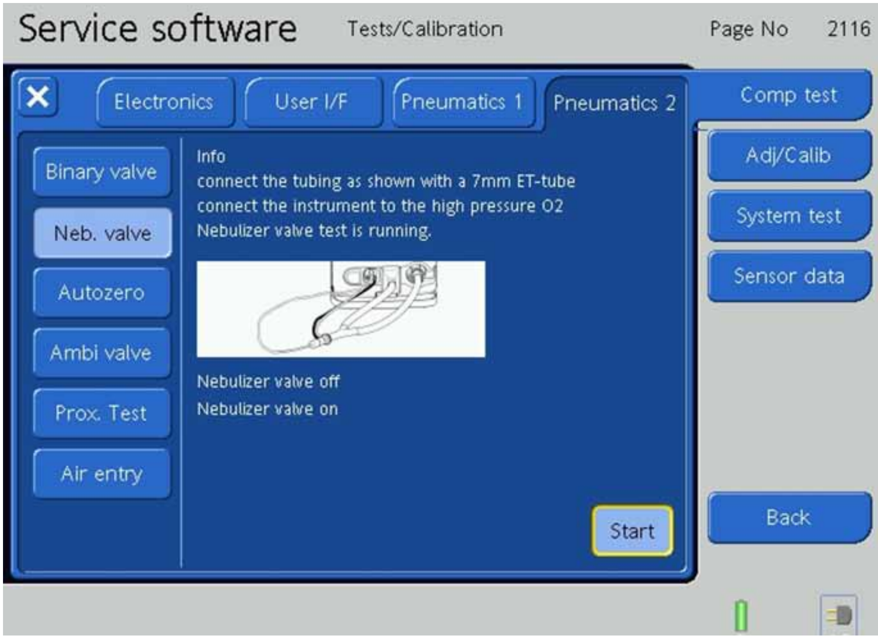


Figure 9-134. The Nebulizer Valve Tests, Step 1

2. Press the **Start Button** to start running the Nubulizer valve test with high inlet O2 pressure min 2.8 bar max. 6.0 bar (41-86psi).

3. The adjustment is complete when **OK** is indicated on the screen.

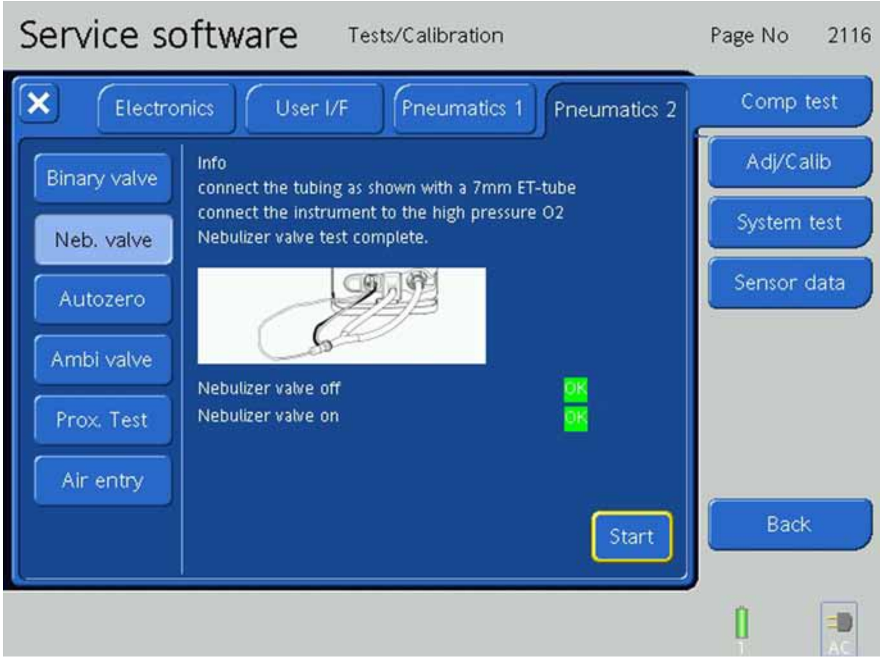


Figure 9-135. The Nebulizer Valve Tests, Step 2

Autozero

1. Press the **Autozero Button**.

Figure 9-136. The Autozero Valves Tests, Step 1

2. Press the **Start Button** to Autozero the Paw Pressure Sensor and Qaw Proximal Flow Sensor.

Figure 9-137. The Autozero Valves Tests, Step 2

3. The Paw Pressure Sensor and Qaw Flow Sensor Autozero adjustment is complete when **OK** is indicated on the screen.
4. Press the **Start Button** to Autozero the Pvent_monitor and Pvent_control Pressure Sensors.

Figure 9-138. The Autozero Valves Tests, Step 3

5. The Pvent_monitor and Pvent_control Autozero adjustments are complete when **OK** is indicated on the screen.
6. The Autozero Tests are complete when **OK** for both tests is indicated on the screen.

Ambient Valve

1. Press the **Ambient Valve Button**.

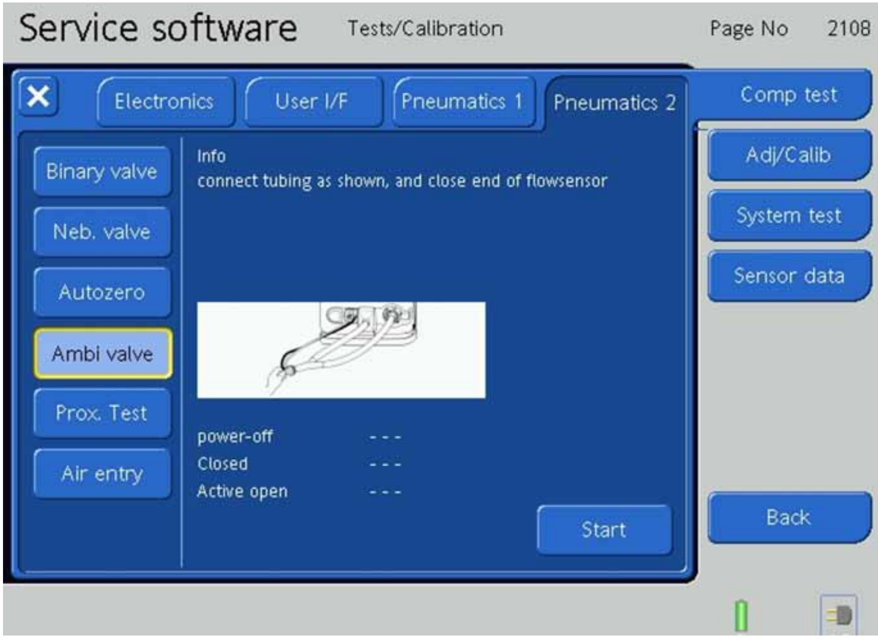


Figure 9-139. The Ambient Valve Tests, Step 1

2. Connect the Tube System as shown and close the Flow Sensor outlet.
3. Press the **Start Button**.

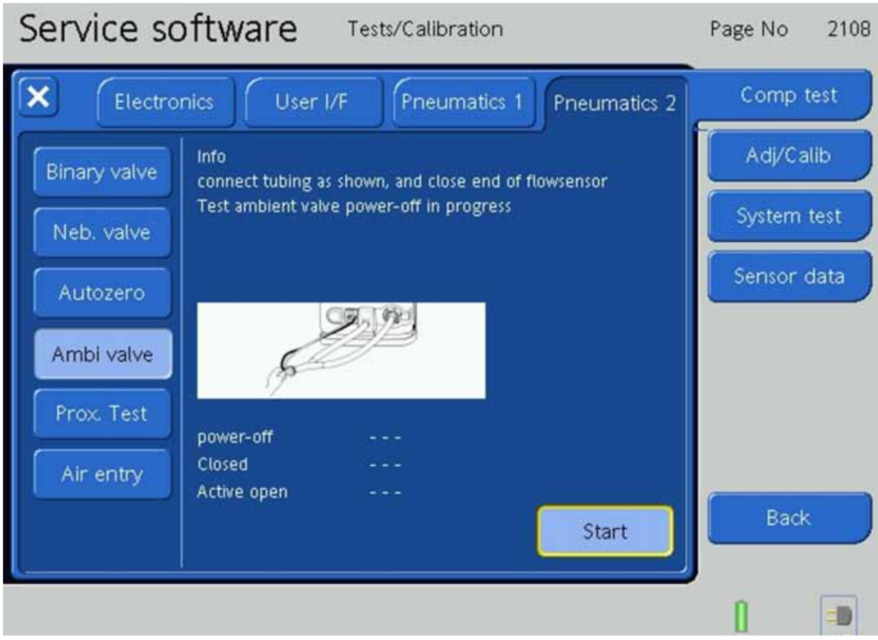


Figure 9-140. The Ambient Valve Tests, Step 2

4. The test runs automatically indicated by **Test Ambient Valve Power-Off in Progress** on the screen.

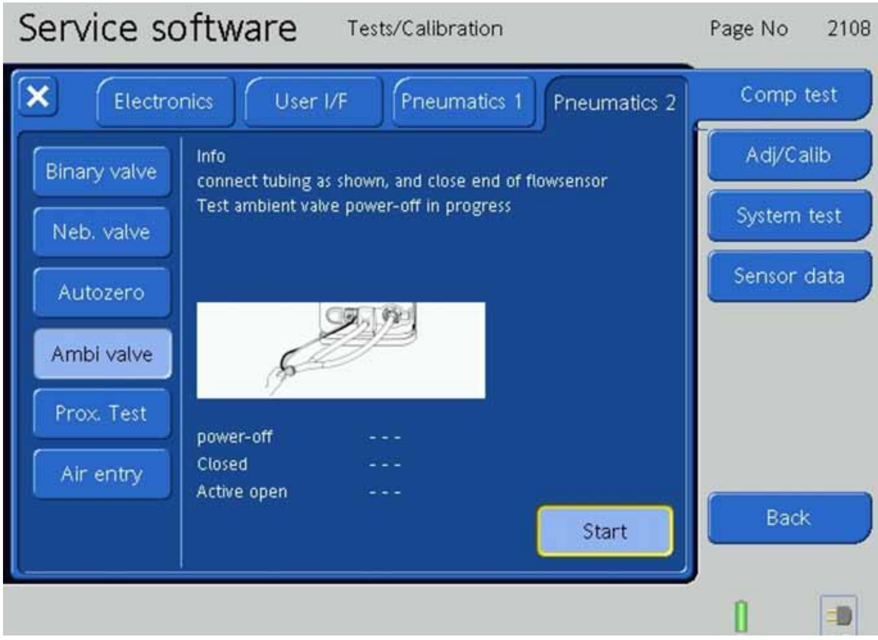


Figure 9-141. The Ambient Valve Tests, Step 3

5. The Ambient Valve Power-Off Test is complete when **OK** is indicated on the screen.

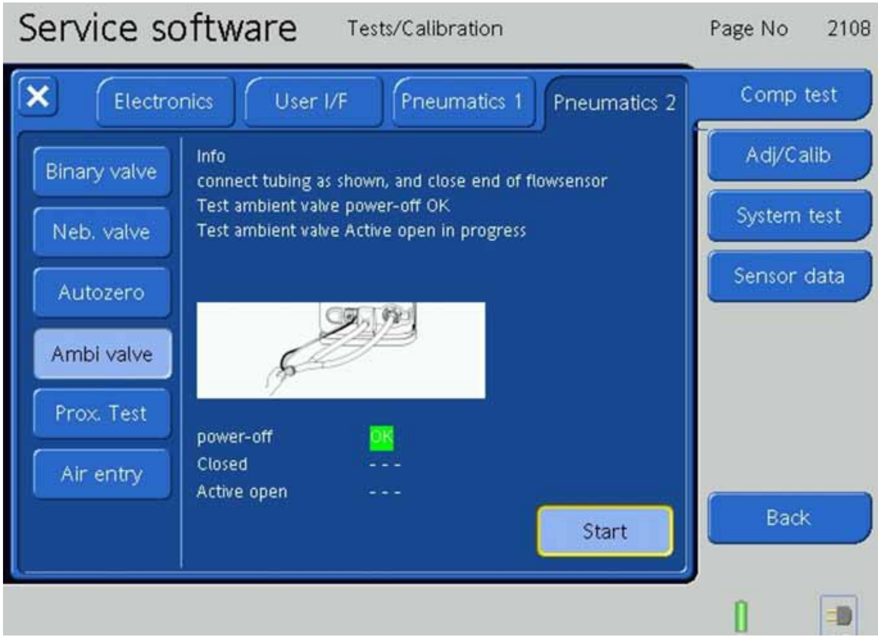


Figure 9-142. The Ambient Valve Tests, Step 4

6. The next test runs automatically indicated by **Test Ambient Valve Closed in Progress** on the screen.

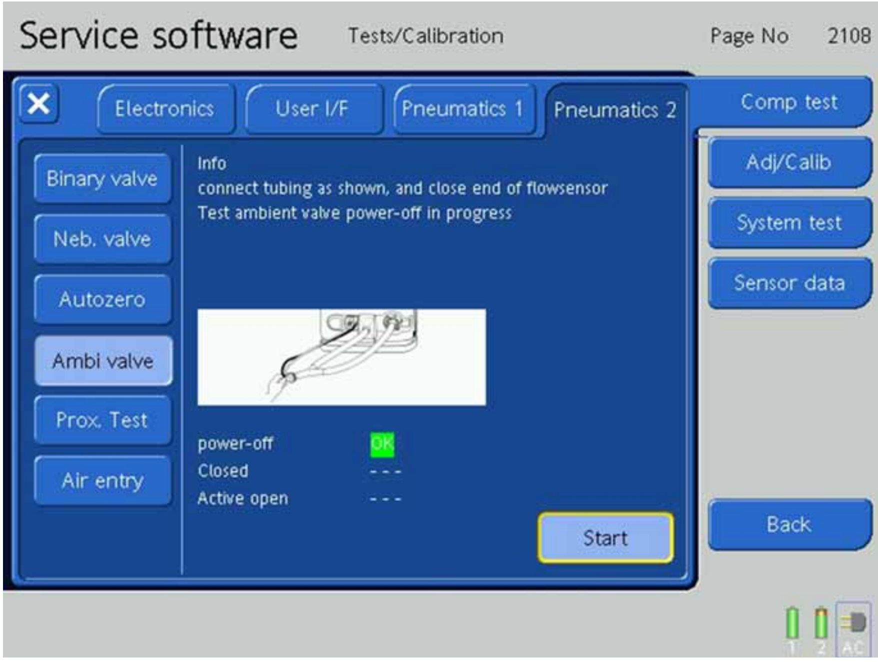


Figure 9-143. The Ambient Valve Tests, Step 5

During this Test there must appear the Technical event 231003.

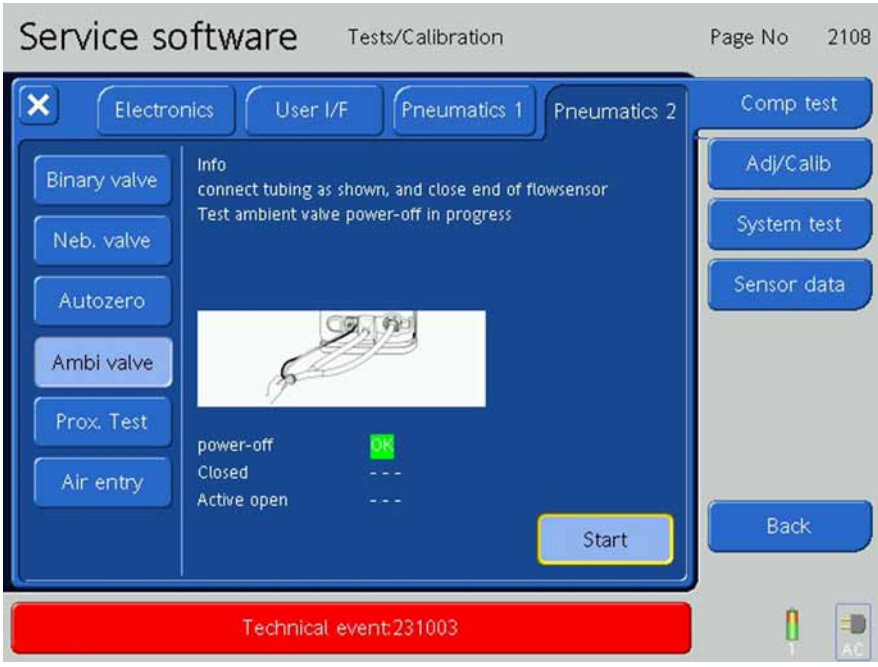


Figure 9-144. The Ambient Valve Tests, Possible Technical event

7. The Ambient Valve Closed Test is complete when **OK** is indicated on the screen.
8. The next test runs automatically indicated by **Test Ambient Valve Active Open in Progress** on the screen.

9. The Ambient Valve Active Open Test is complete when **OK** is indicated on the screen.

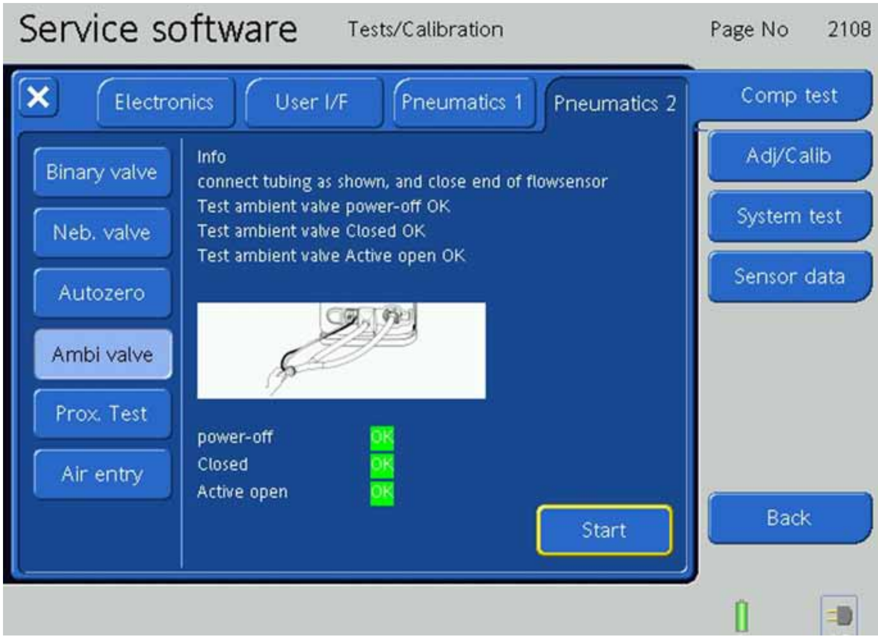


Figure 9-145. The Ambient Valve Tests, Step 7

Proximal Test

1. Press the **Proximal Test Button**.

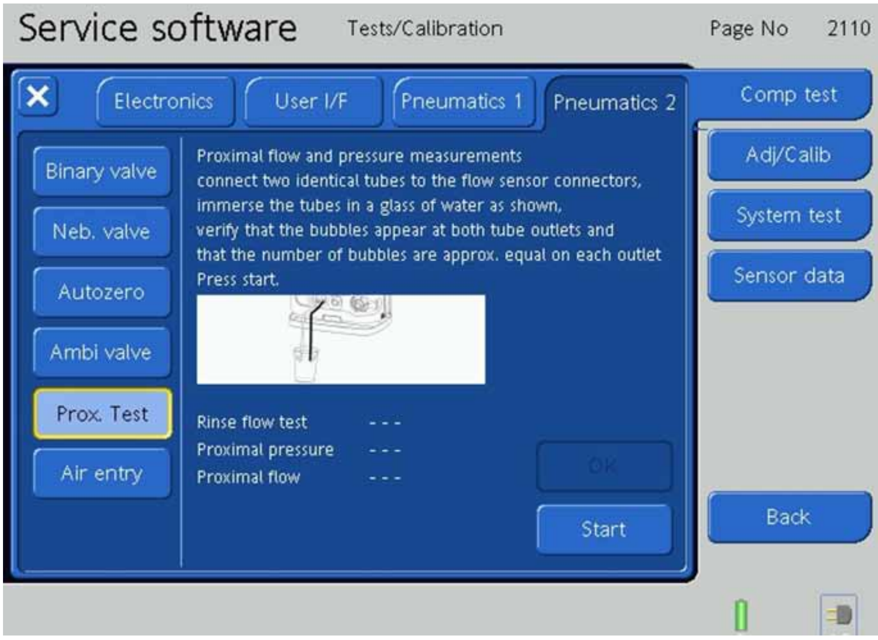


Figure 9-146. The Proximal Tests, Step 1

2. Attach 2 identical length tubes to the Flow Sensor connectors, immerse the tubes in a glass of water. Verify that the bubbles appear at both tube outlets and that the number of bubbles are approximately equal on each outlet.
3. Press the **Start Button**.

4. Indicate on the screen if the Rinse Flow Test passed by pressing **OK** or **Not OK**.

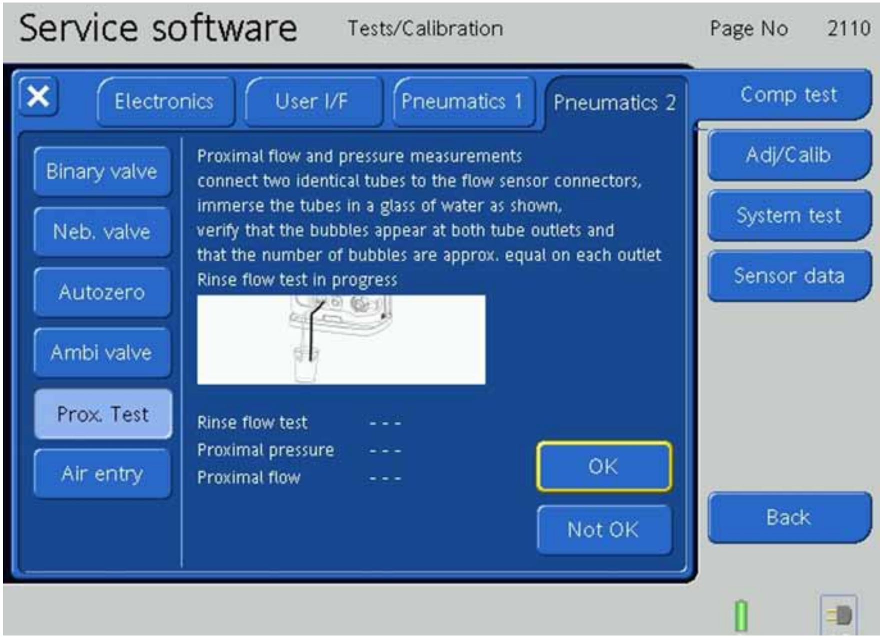


Figure 9-147. The Proximal Tests, Step 2

5. The Rinse Flow Test is complete when **OK** is displayed on the screen.

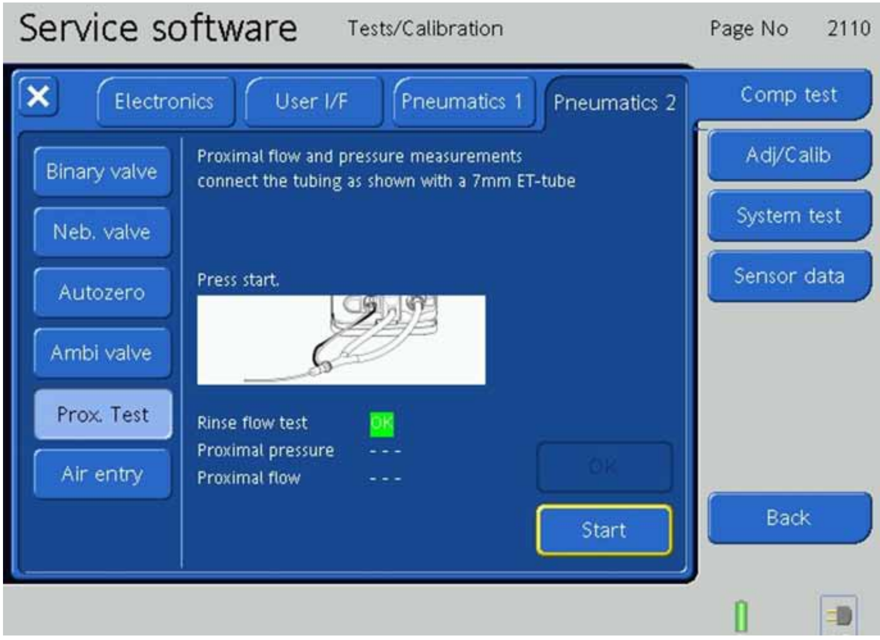


Figure 9-148. The Proximal Tests, Step 3

6. Connect the Adult Tube System to the Instrument with a 7mm ET Tube.
7. Press the **Start Button** to begin the Proximal Pressure Test.

8. The test runs automatically indicated by **Test Proximal Pressure in Progress** on the screen.

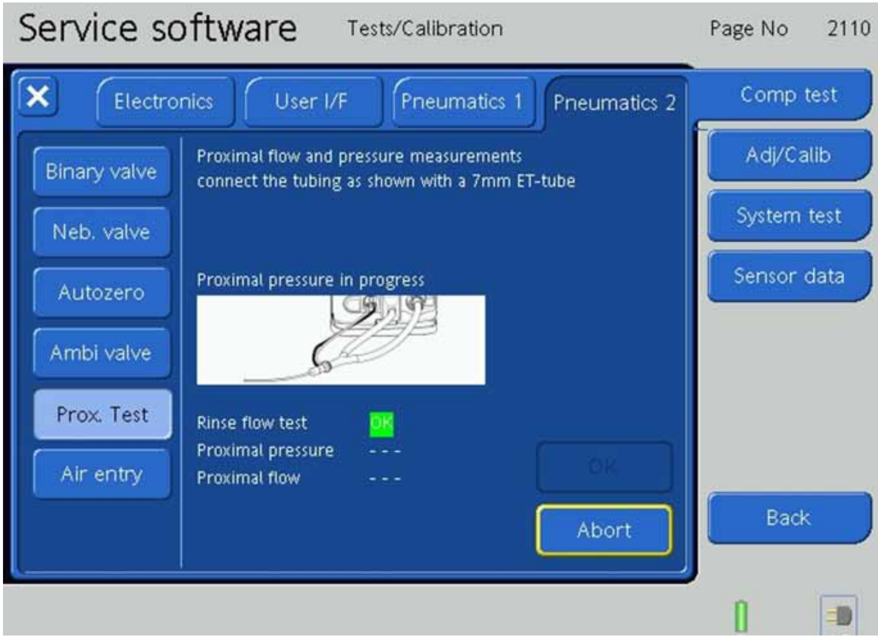


Figure 9-149. The Proximal Tests, Step 4

9. The Proximal Pressure Test is complete when **OK** is indicated on the screen.

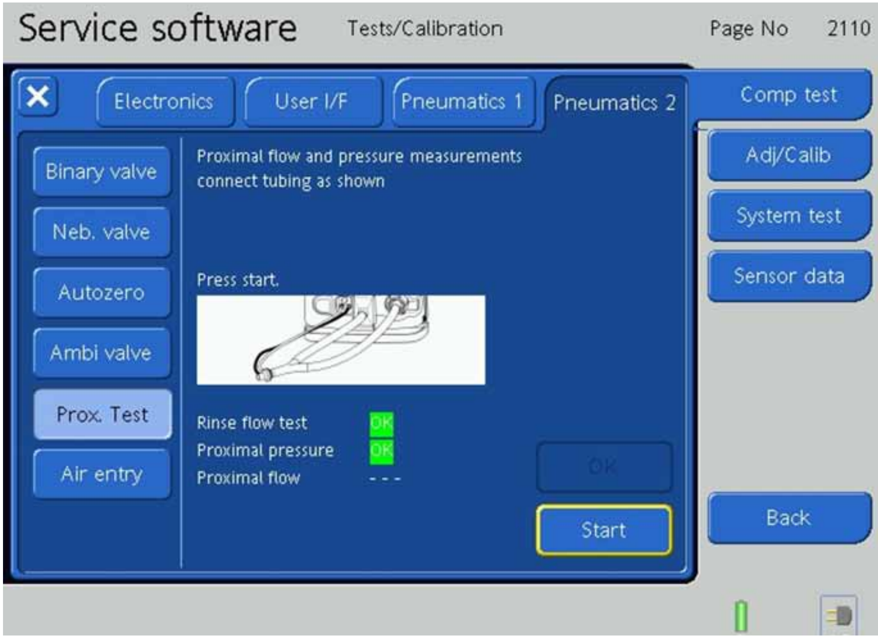


Figure 9-150. The Proximal Tests, Step 5

10. Remove the 7mm ET Tube from the Adult Tube System.
11. Press the **Start Button** to begin the Proximal Flow Test.

12. The test runs automatically indicated by **Test Proximal Flow in Progress** on the screen.

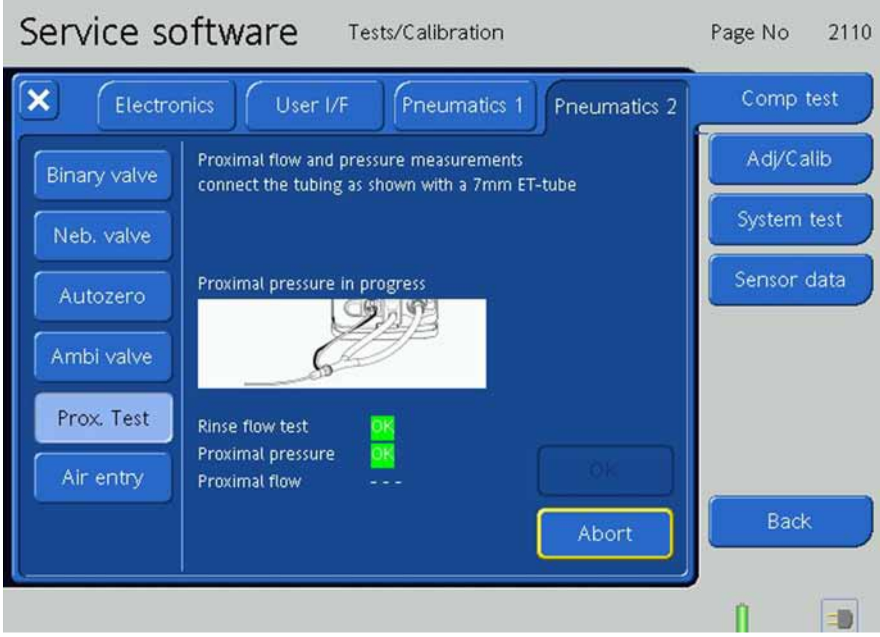


Figure 9-151. The Proximal Tests, Step 6

13. The Proximal Flow Test is complete when **OK** is indicated on the screen.

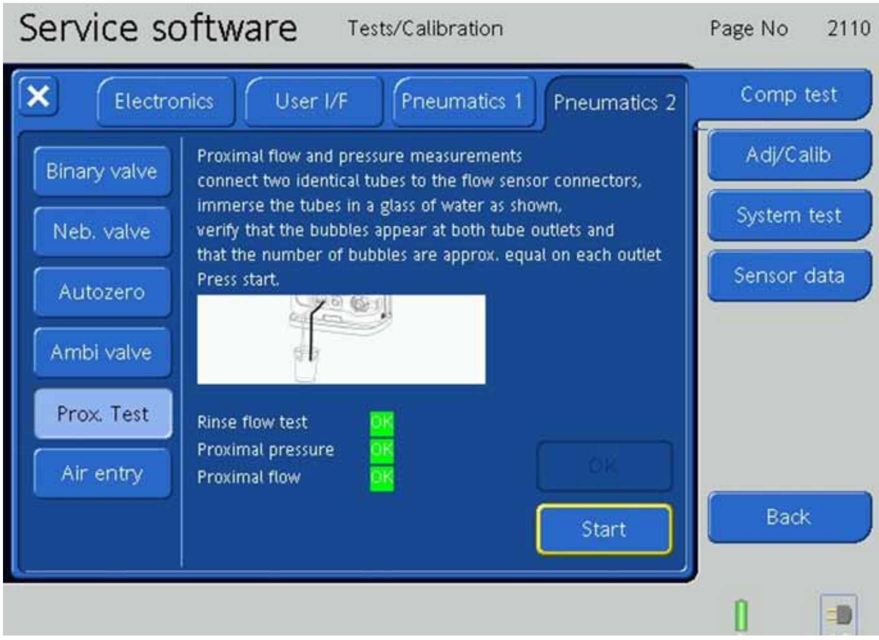


Figure 9-152. The Proximal Tests, Step 7

HEPA Filter Test

Note
If the test is not **OK** restart the HAMILTON-C2 Service software and perform the test again.

1. Press the **Air entry Test Button** and then start.

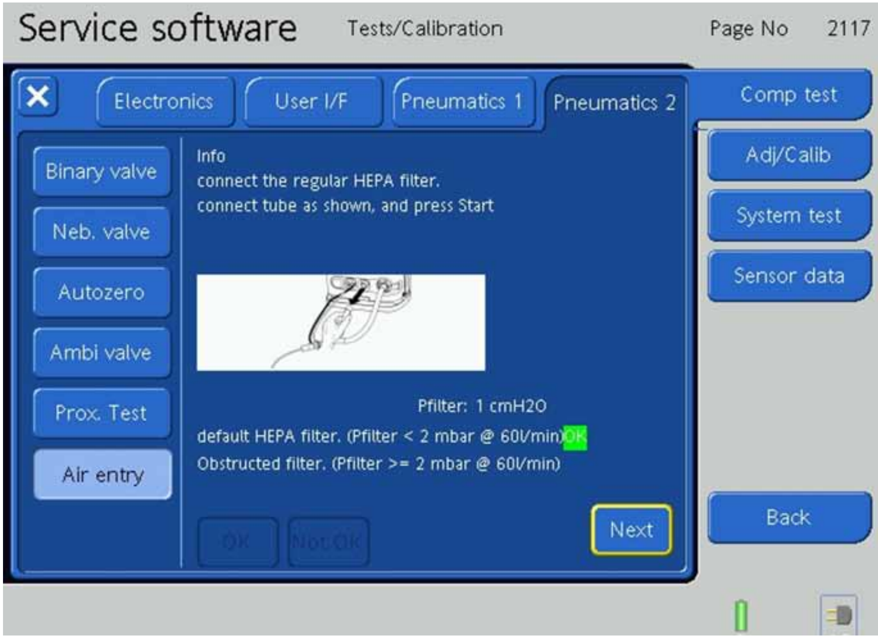


Figure 9-153. The Air entry Tests, Step 1

2. Obstruct HEPA filter with a piece of paper with a small hole.
3. Connect the obstructed HEPA filter and press start. The pressure must be higher than 2 mbar as shown.

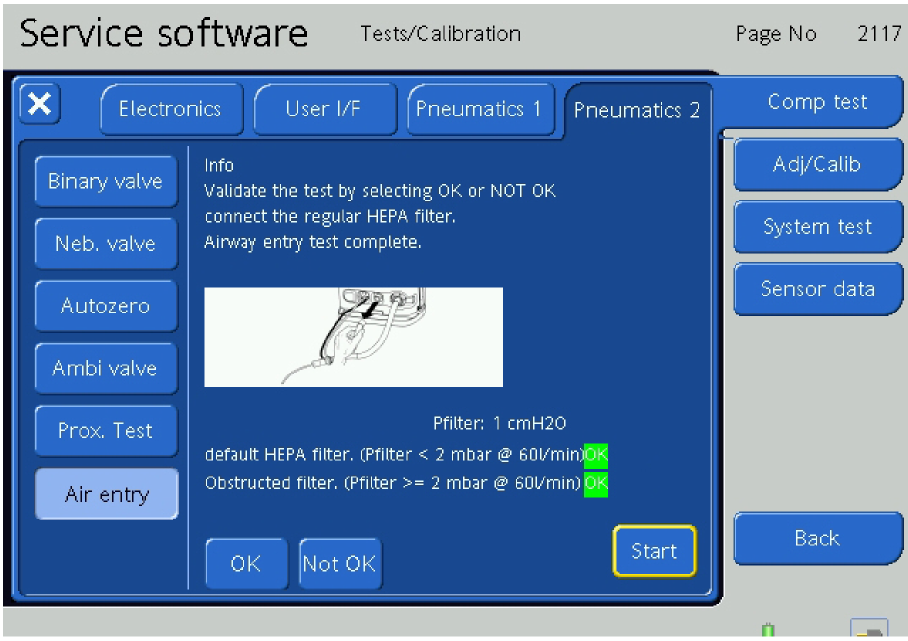


Figure 9-154. The Air entry Tests, Step 2

4. The test is complete when **OK** is indicated twice on the screen.

9.9.3 System Test

Press the **System Test Button**.

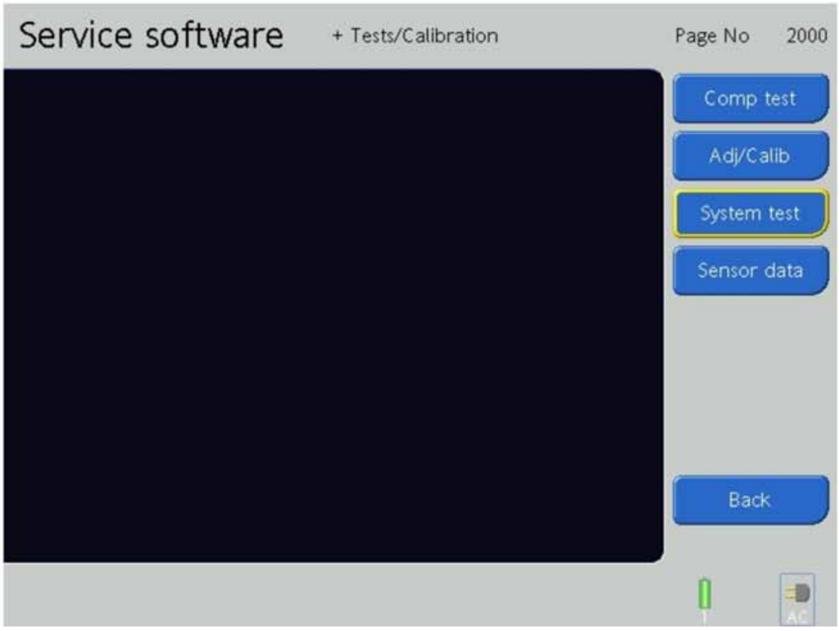


Figure 9-155. The Tests / Calibration Screen

Pressure

1. Press the **Pressure Button**.

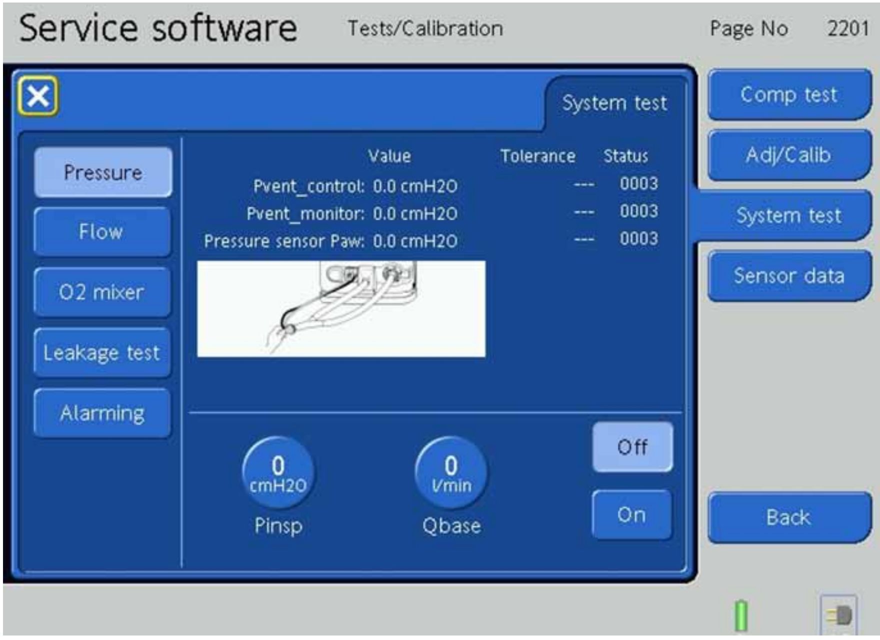


Figure 9-156. The Pressure System Tests, Step 1

2. Attach the Tube System.

3. Press the **ON Button**.

4. Set Pinsp to **5, 25 and 50cmH2O**. Press the Pinsp Button with the P&T Control Knob. Press the P&T Control Knob and rotate the setting to these values. Press the P&T Control Knob to activate the setting.

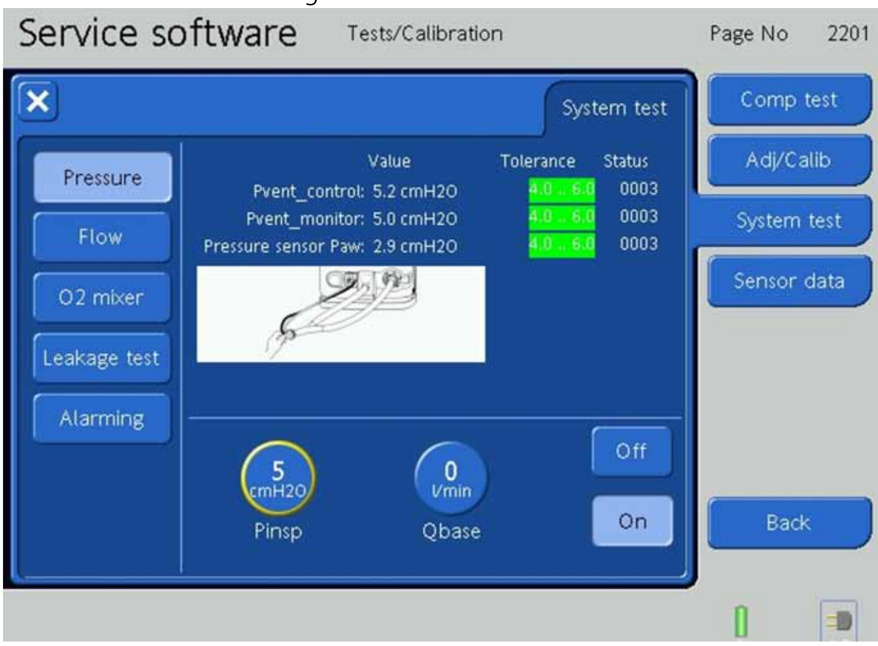


Figure 9-157. The Pressure System Tests, Step 3

5. All values should read **5cmH2O ±1.0, 25cmH2O ±1.2 and 50cmH2O ±2.5**.
6. The test is OK, If the tolerance buttons are green.

7. Then, press the **Off Button**.

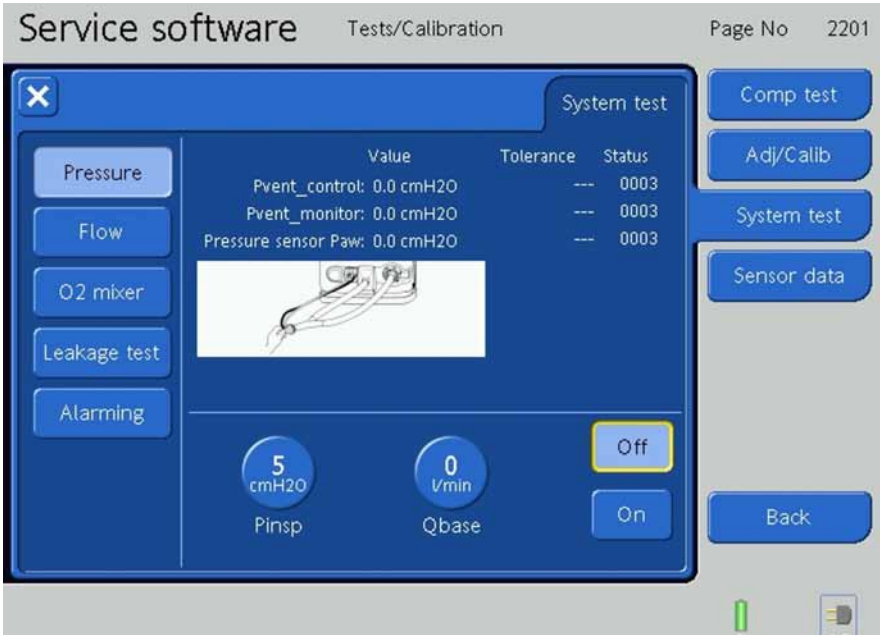


Figure 9-158. The Pressure System Tests, Step 6

Note
Flow test only for internal use.

O2 Mixer

1. Connect the instrument to the high pressure O2.
2. Press the **O2 Mixer Button** and then **On**.

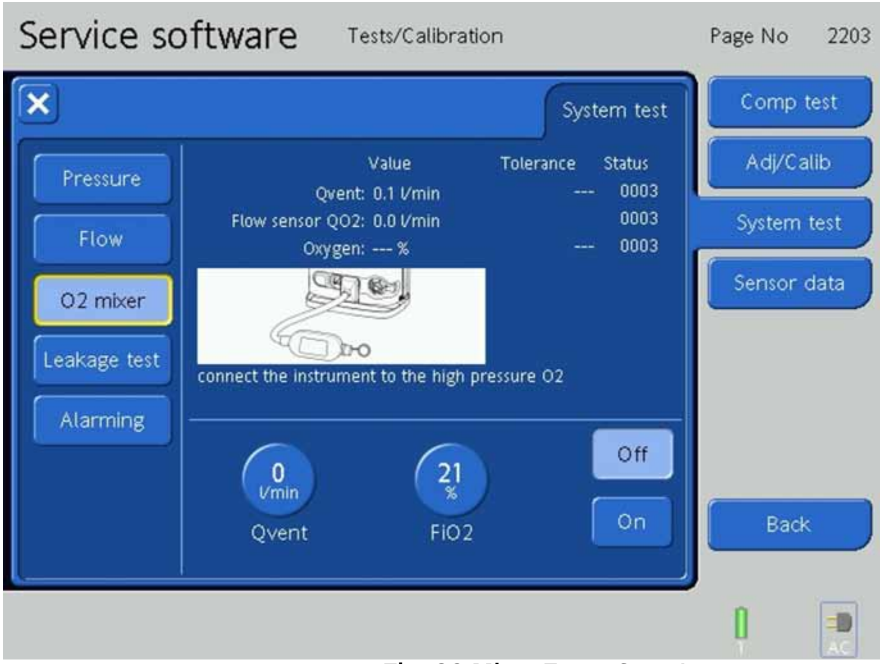


Figure 9-159. The O2 Mixer Tests, Step 1

3. If the green lights appear, the test is complete.

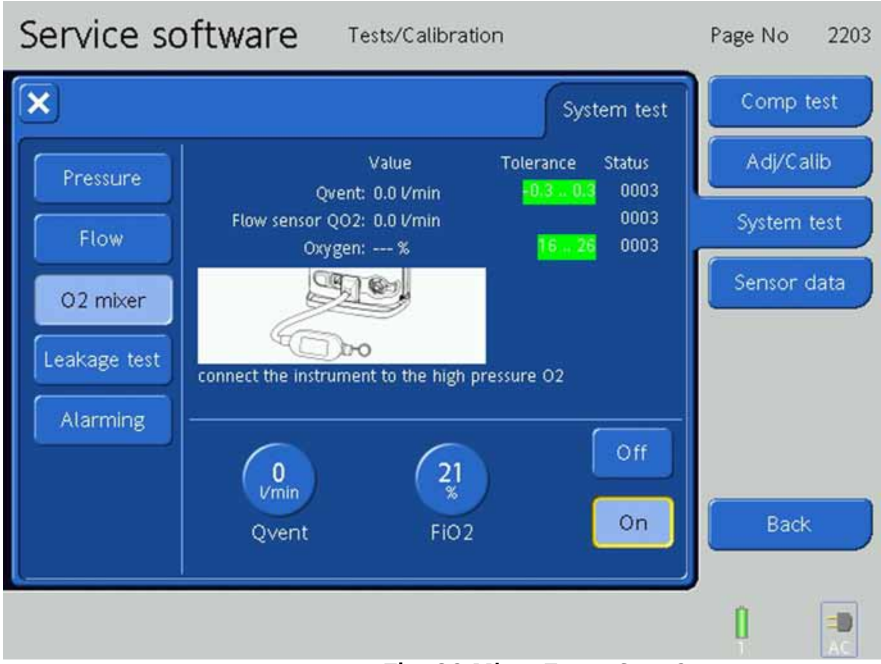


Figure 9-160. The O2 Mixer Tests, Step 2

4. Check for the following concentrations: 21%, 90%, 61%.

Leakage Test

1. Press **Leakage Test Button**.

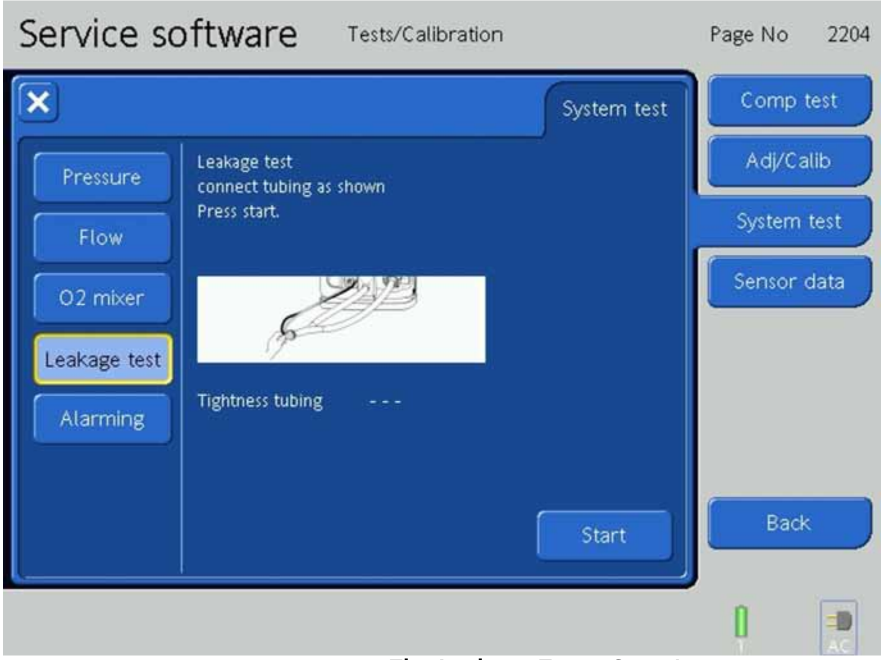


Figure 9-161. The Leakage Tests, Step 1

2. Press **Start Button**.

3. The test runs automatically indicated by **Tightness tubing in progress** on the screen.

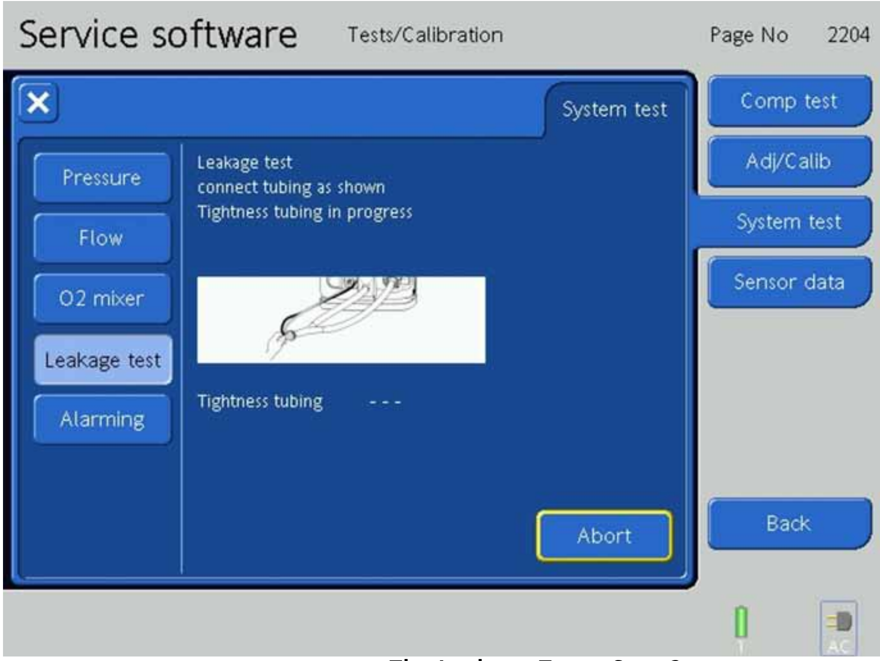


Figure 9-162. The Leakage Tests, Step 2

4. The Leakage Test is complete when **OK** is indicated on the screen.

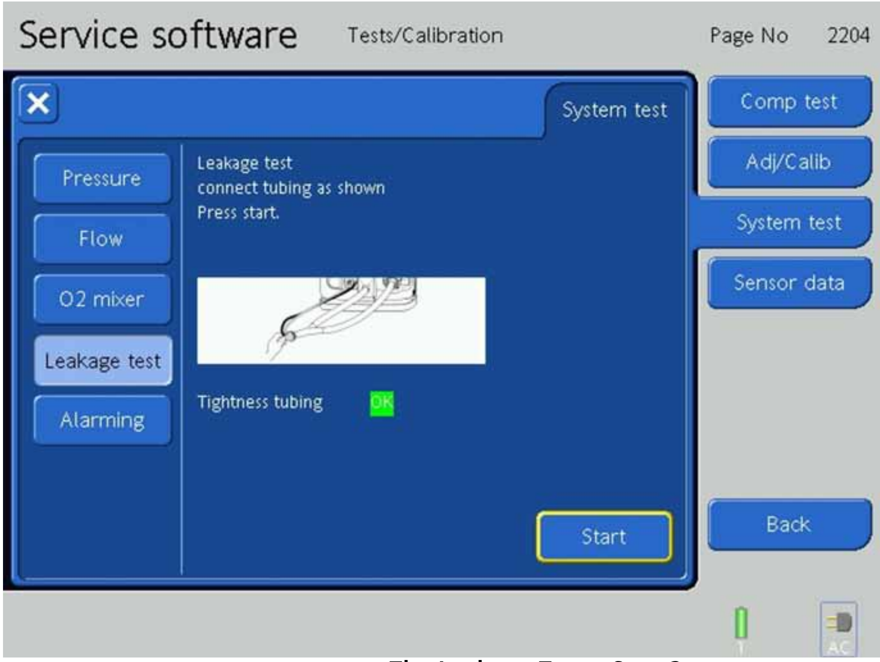


Figure 9-163. The Leakage Tests, Step 3

Alarming

1. Press the **Alarming Button**.

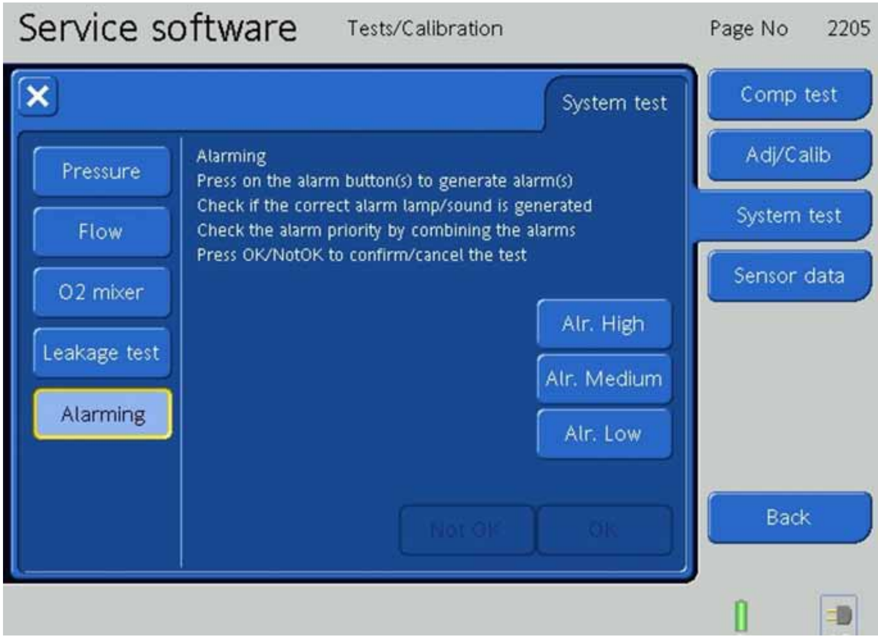


Figure 9-164. The Alarming Screen Tests, Step 1

2. Press the **Alarm High**, **Alarm Medium** and **Alarm Low** Buttons to generate Alarm(s).
3. Check if the correct Alarm Lamp and Alarm Sounds are generated.
4. Check the Alarm Priority by combining the Alarms.
5. **Alarm High Button**.

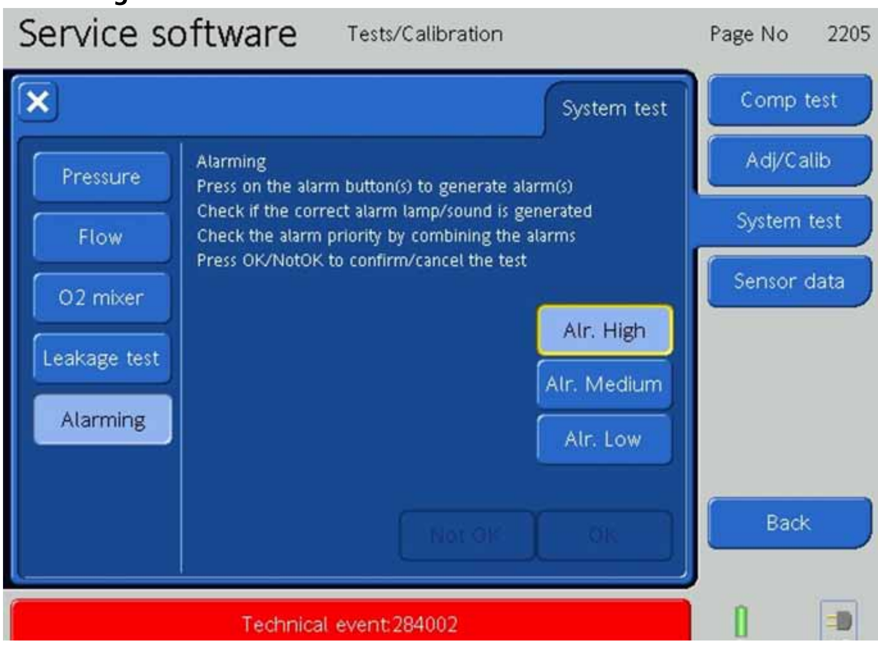


Figure 9-165. The Alarming Screen Tests, Step 2

6. **Alarm Medium Button**.

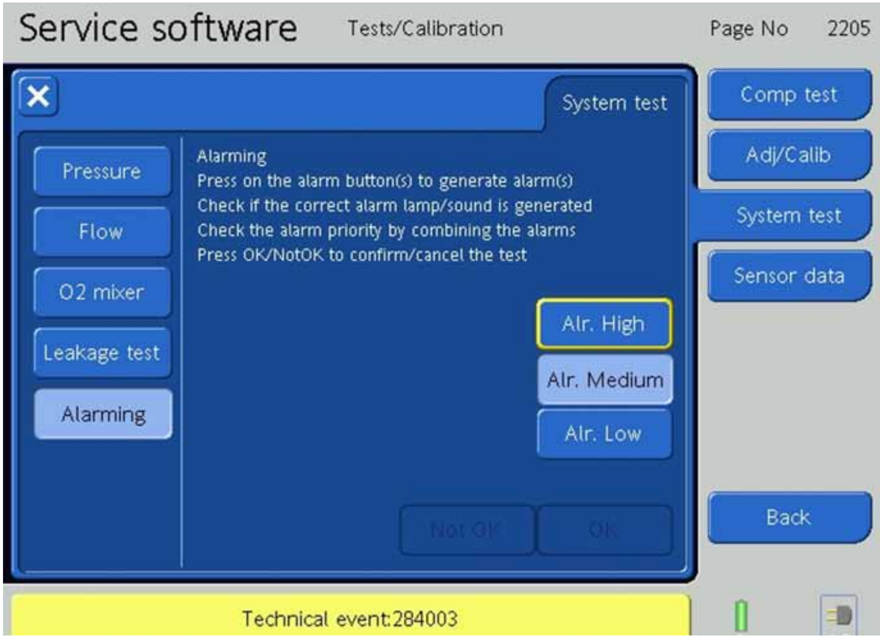


Figure 9-166. The Alarming Screen Tests, Step 3

7. **Alarm Low Button**.

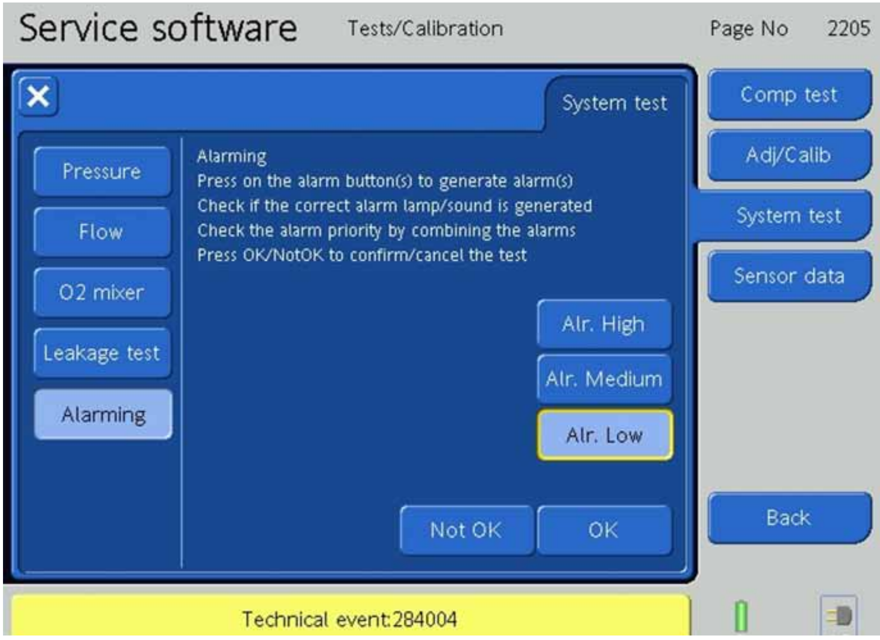


Figure 9-167. The Alarming Screen Tests, Step 4

8. Press **OK / Not OK** to confirm / cancel the Test.

Figure 9-168. The Alarming Screen Tests, Step 4

9.9.4 Sensor Data

Note
Only for internal use.

9.10 Log/Config Files

Note
This capture is only a description, not a test.

From the Main Service Software Screen, press the **Log/Config Files Button**.

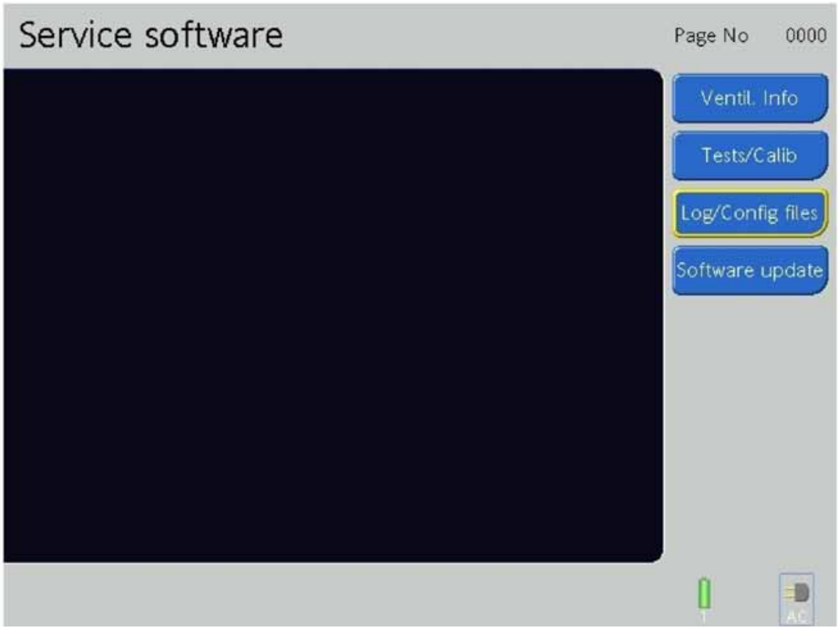


Figure 9-169. The Main Service Software Screen

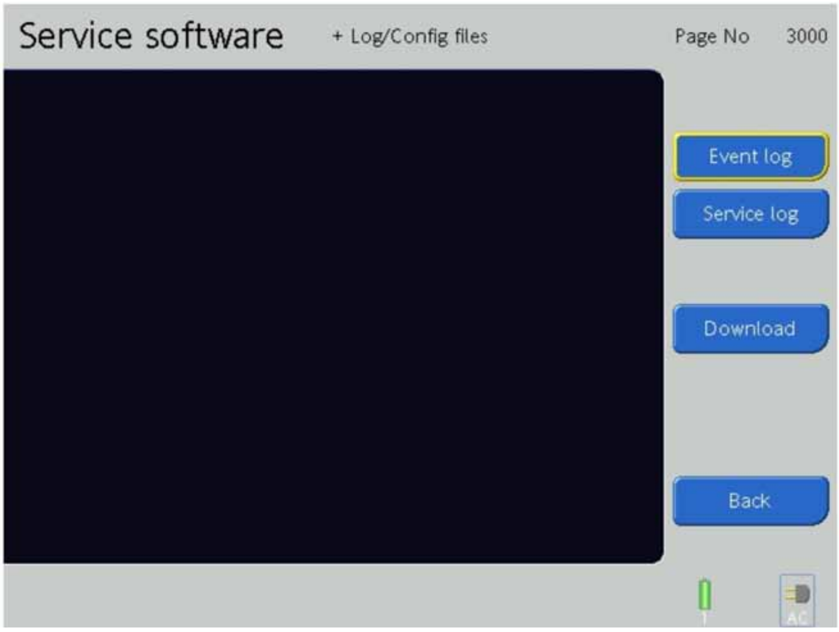


Figure 9-170. The Log / Config Files Screen

On the Log/Config Files screen are the:

- *Event Log* Button

- *Service Log* Button
- *Download (Instrument report and Events)* Button
- Back Button

9.10.1 Event Log

Press the **Event Log Button** to open the Event Log.

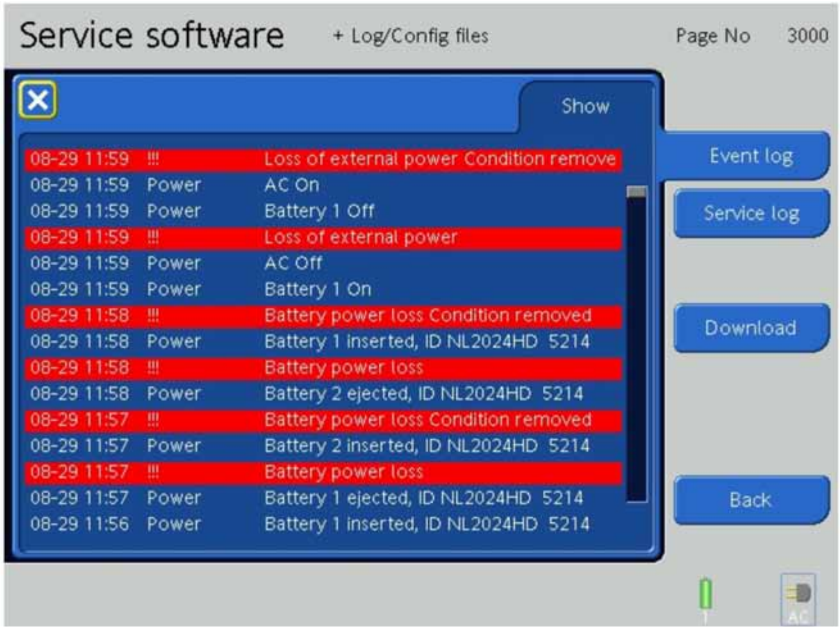


Figure 9-171. Viewing the Event Log, Step 1

1. The Event Log displays the Technical Events which have occurred with the Date, Time, Device Affected and a Description of the Technical Event.
2. To view another section of the Event Log listing, rotate the P&T Control Knob to select the slider on the right side of the screen.

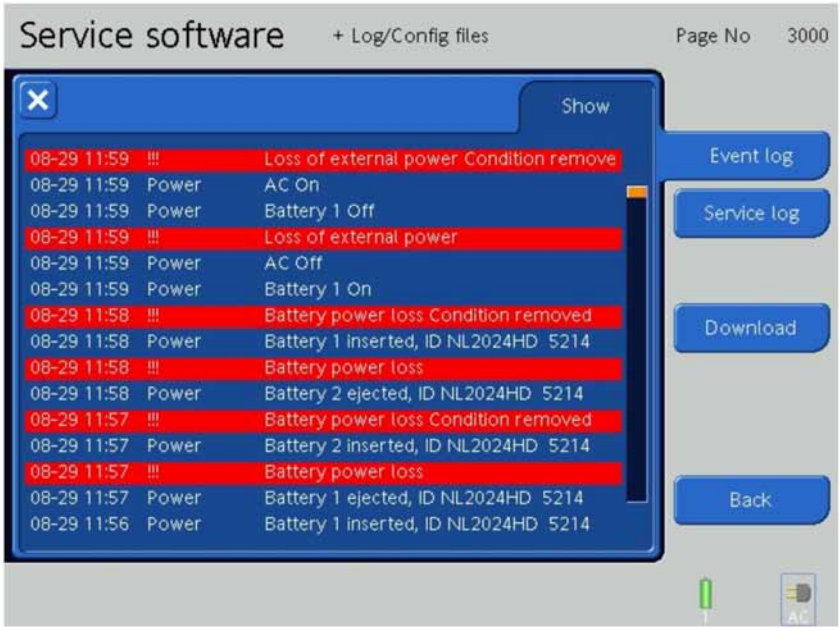


Figure 9-172. Viewing the Event Log, Step 2

3. Press the P&T Control Knob to activate the slider, then rotate the P&T Control Knob to move the slider up or down.

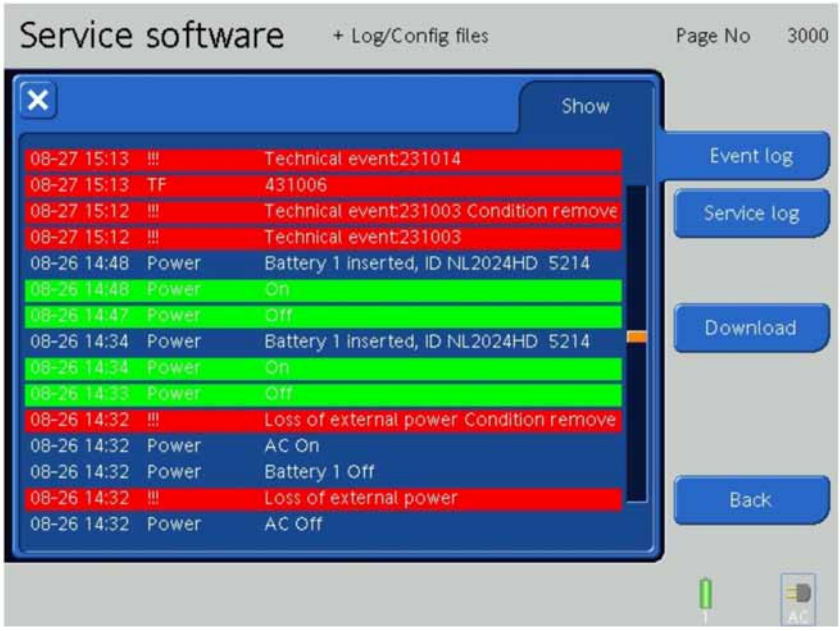


Figure 9-173. Viewing the Event Log, Step 3

9.10.2 Service Log

Press the **Service Log Button** to open the Service Log.

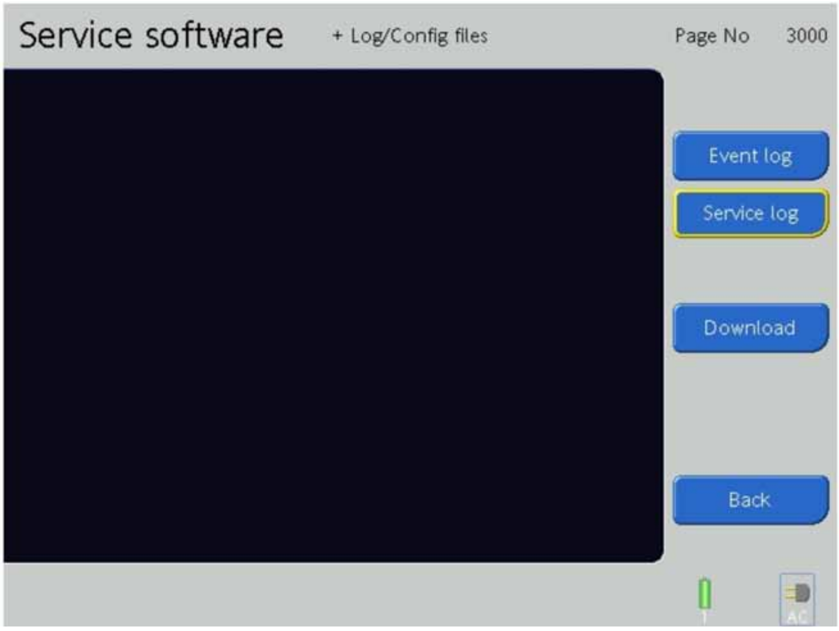


Figure 9-174. The Service Log Screen, Step 1

1. The Service Log displays the Test and Calibration results with the Date, Time and a Description of the results.

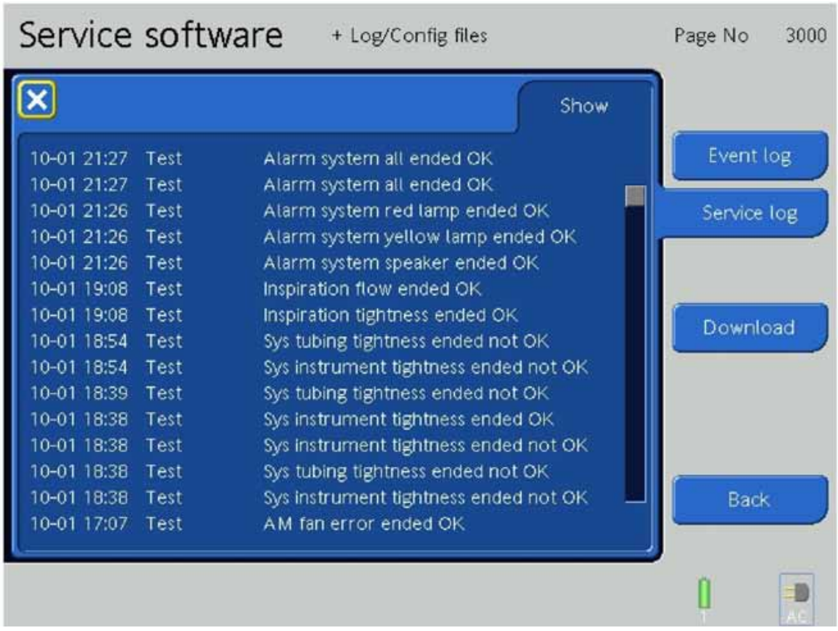


Figure 9-175. The Service Log Screen, Step 2

1. To view another section of the Service Log listing, rotate the P&T Control Knob to select the slider on the right side of the screen.
2. Press the P&T Control Knob to activate the slider, then rotate the P&T Control Knob to move the slider up or down.

9.10.3 Download (Instrument report and Events)

1. The Download Tab allows downloading the Service Log / Instrument Report to a USB Memory Stick.
2. Insert a USB Memory Stick (PN 396207) into the USB connection on the side of the Interaction Panel.

9.10.3.1 Download Events

1. Press the **Download Button**.

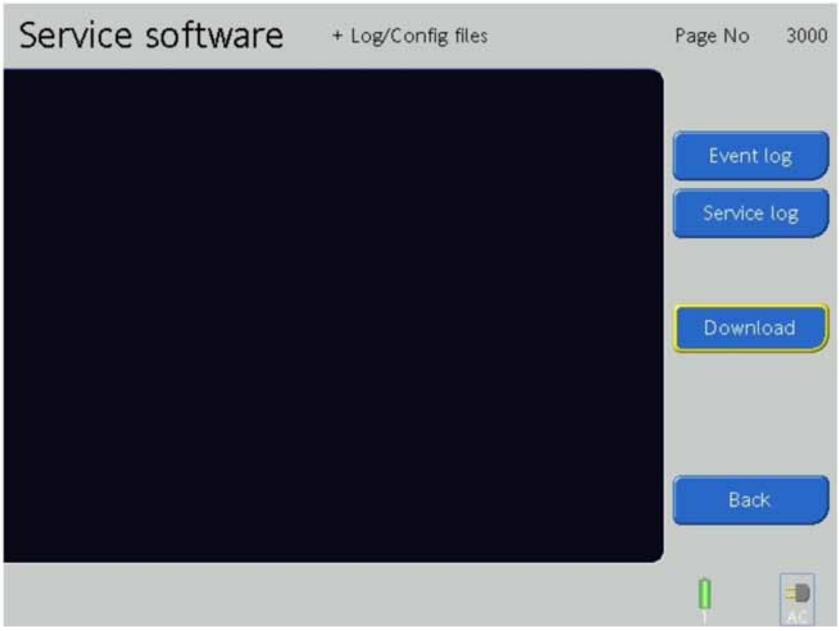


Figure 9-176. The Download Screen, Step 1

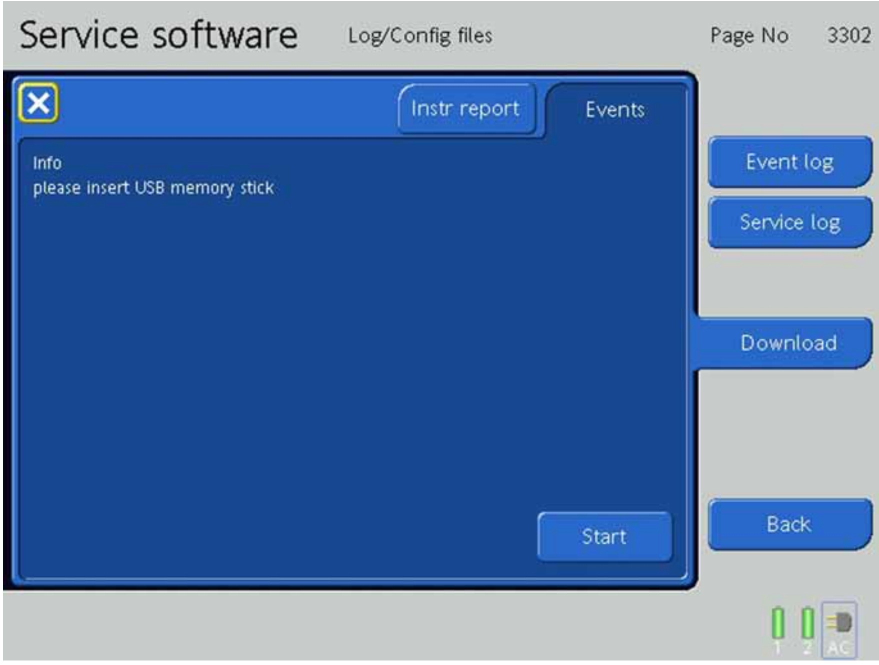


Figure 9-177.

2. **Press Start**.
3. The download is performed automatically.

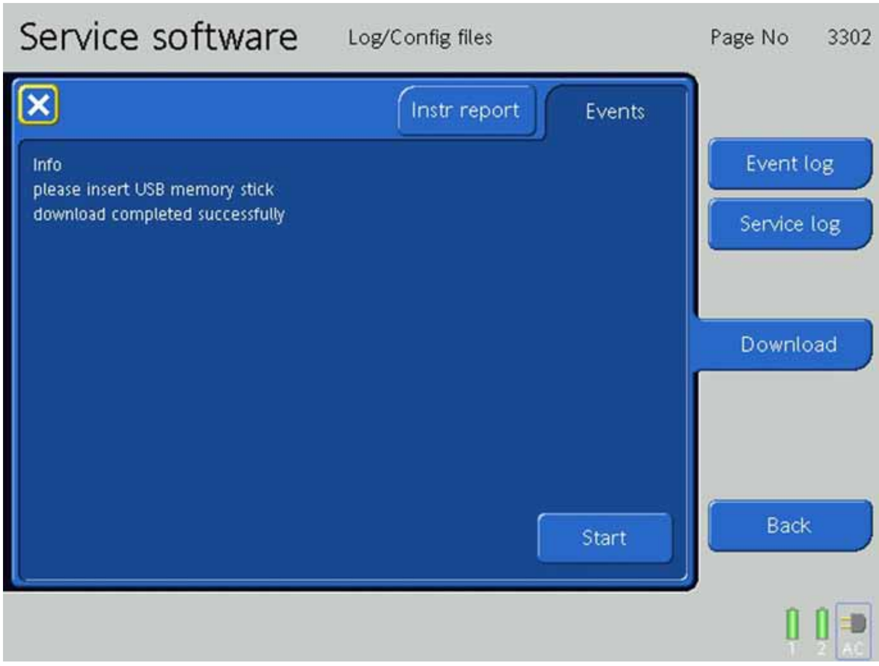


Figure 9-178.

4. The Eventfile is downloaded in a folder named as c2-sn##### (##### device serial number). In this folder is a file named year-month-day_hour-minute-second_serviceLog_enGB.txt

Note

If you have to send log files to HAMILTON MEDICAL for further investigation, please send all files which are created in the specific folder (error.log, eventLog.txt, serviceLog.txt, etcetera).

9.10.3.2 Download Instrument report

1. Press the **Download Button.**

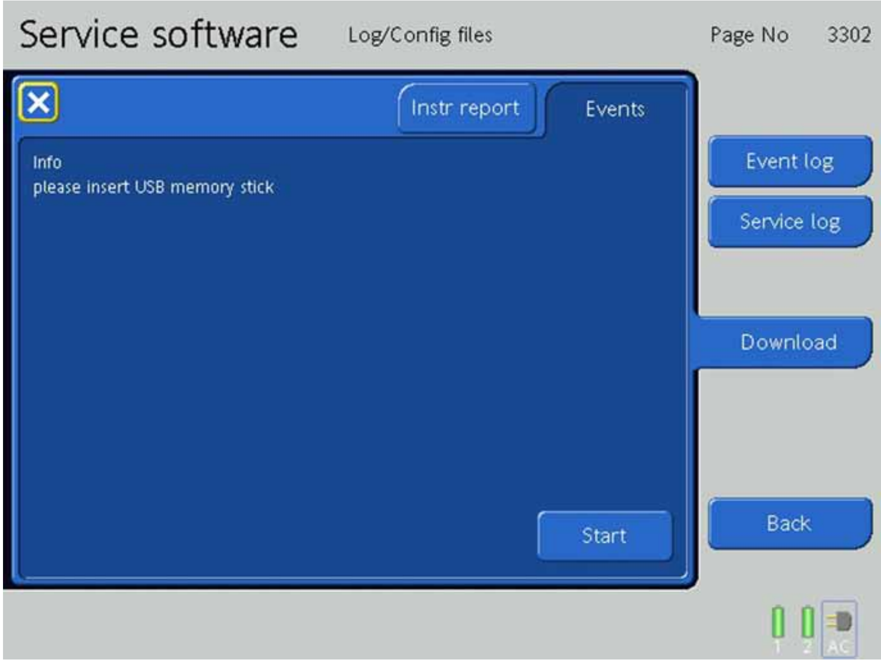


Figure 9-179.

2. Activate the **Instr report** Tab.

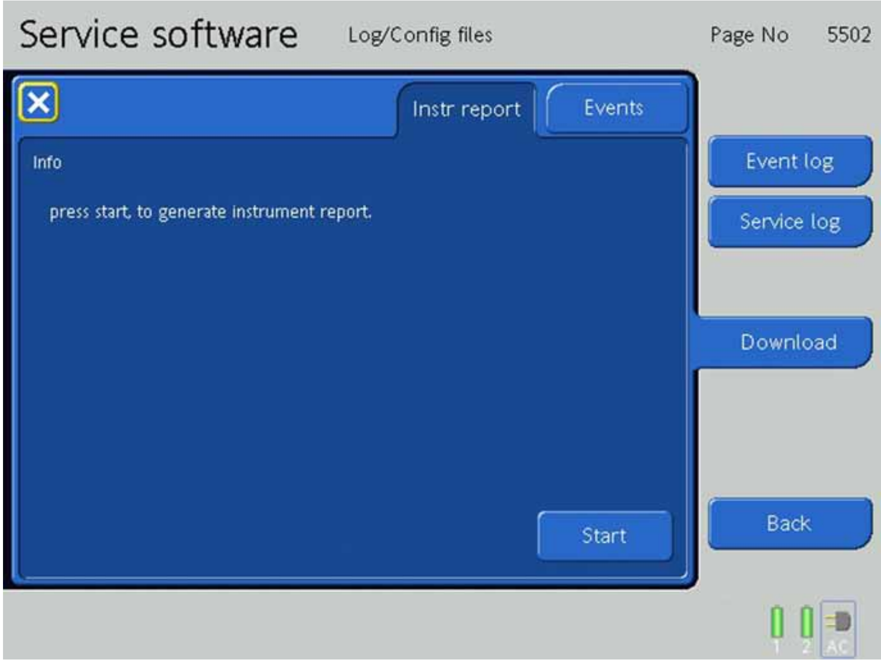


Figure 9-180.

3. Press **Start**
4. The download is performed automatically.

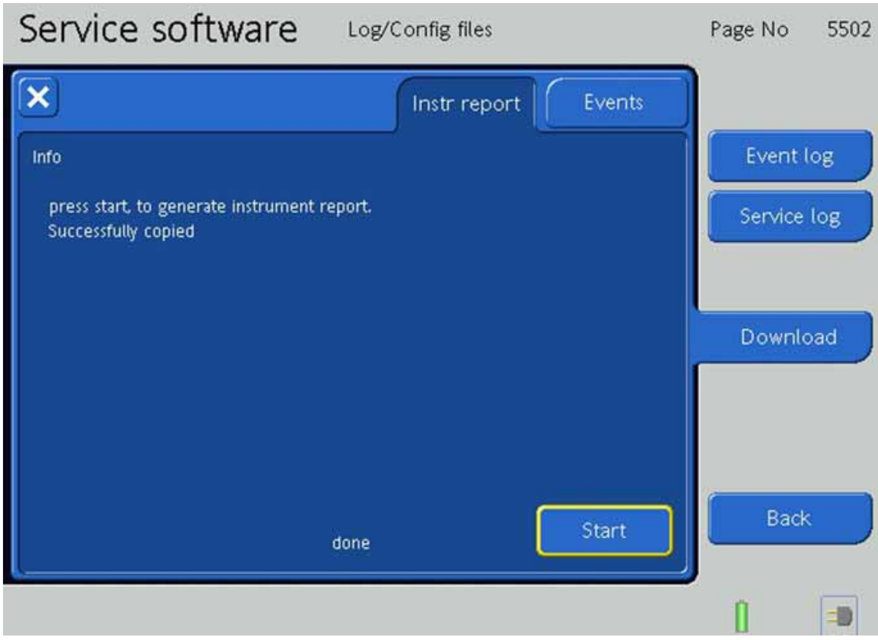


Figure 9-181.

The Instrument report is downloaded in a folder named as c2-sn##### (##### device serial number). In this folder is a file named year-month-day_hour-minute-secondInstrumentRepport.txt.

9.11 Software Update

CAUTION

Software downgrade is not allowed/possible, because this will corrupt the unit and the ESM module will need to be exchanged.

1. From the Main Service Software Screen, press the **Software Update Button**.

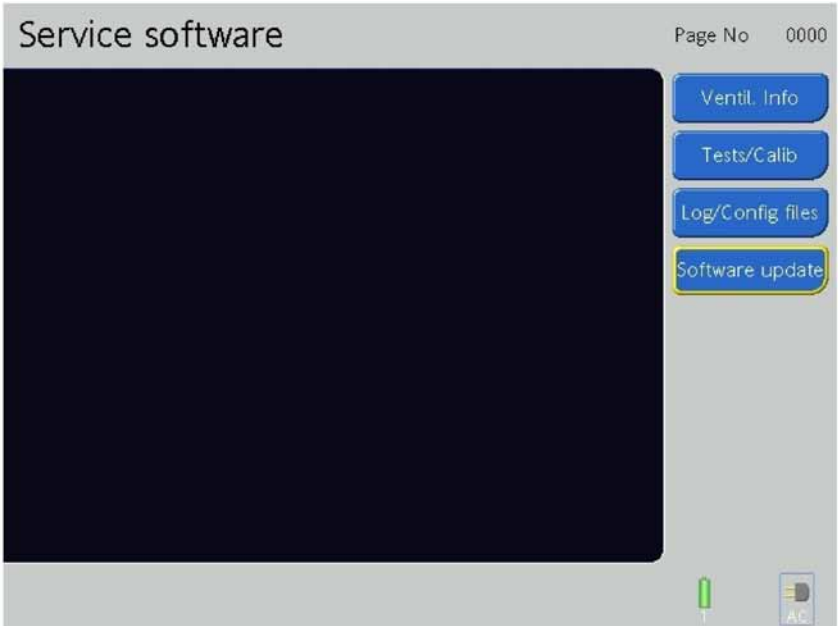


Figure 9-182. The Main Service Software Screen

2. The Software Update Screen allows update or upgrade of the HAMILTON-C2 software.
3. Press the **SW Download Button**.

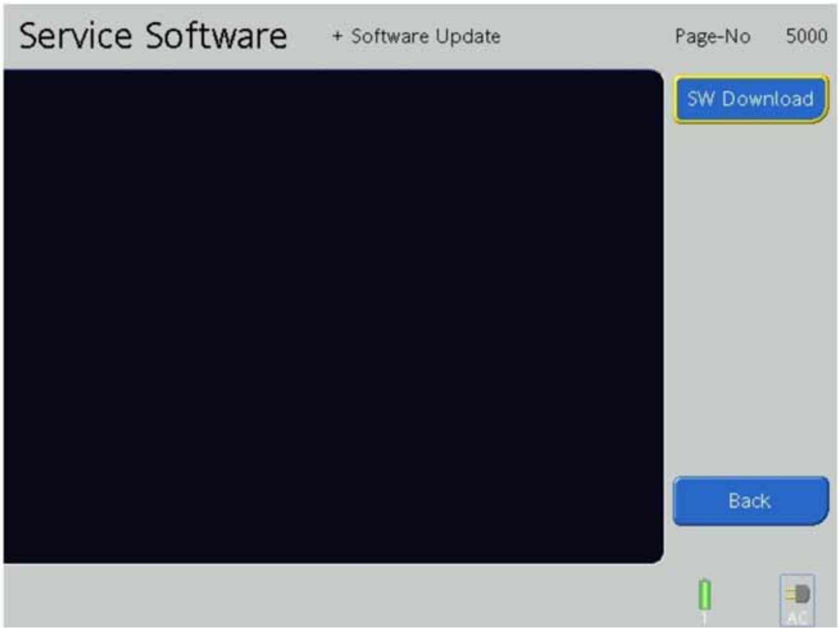


Figure 9-183. The Software Download, Step 1

4. If the USB Memory Stick is not inserted into the USB Connector or no software is available on the USB Memory Stick, the message “No Update Tarball File is available...” is displayed.

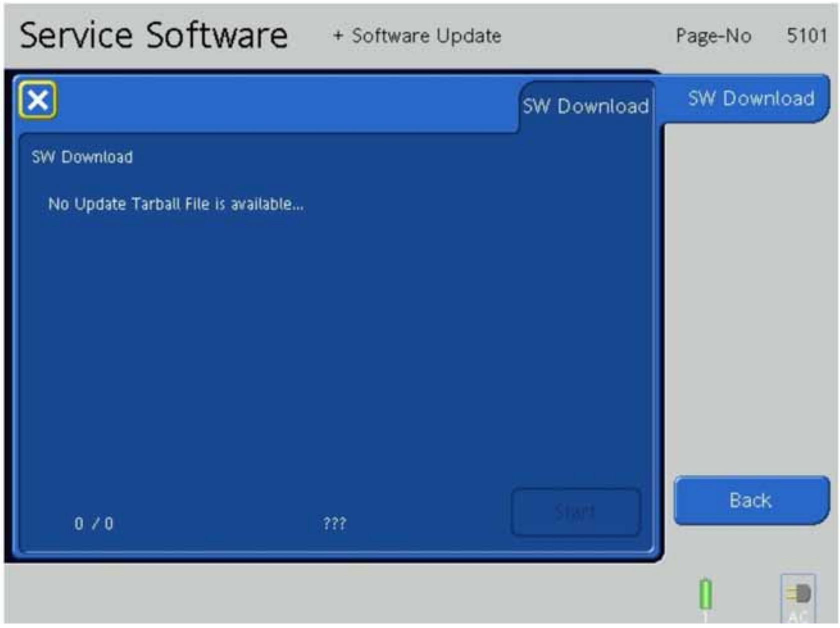


Figure 9-184. The Software Download, Step 2

5. If the correct file is available on the USB Memory Stick, the message appears indicating the update version.

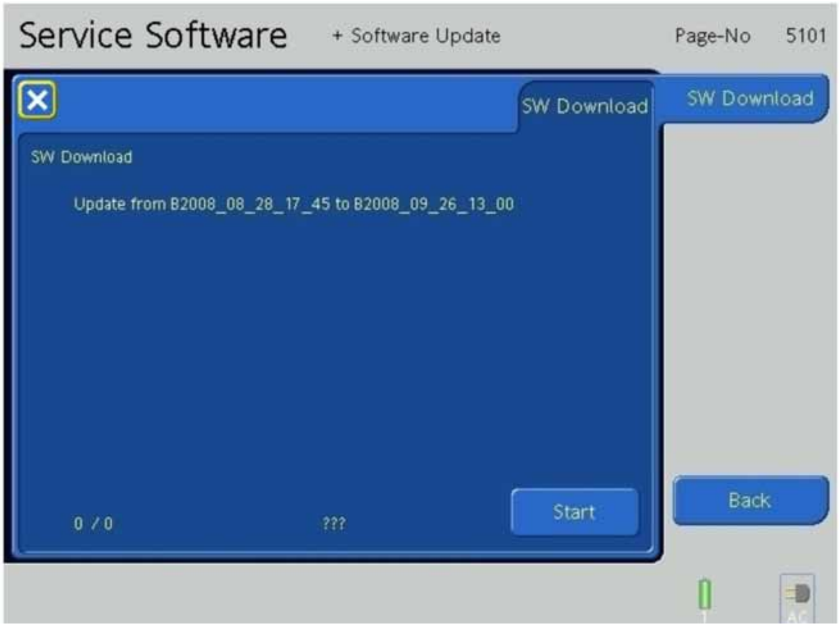


Figure 9-185. The Software Download, Step 3

6. To begin the software update, press the **Start Button**.

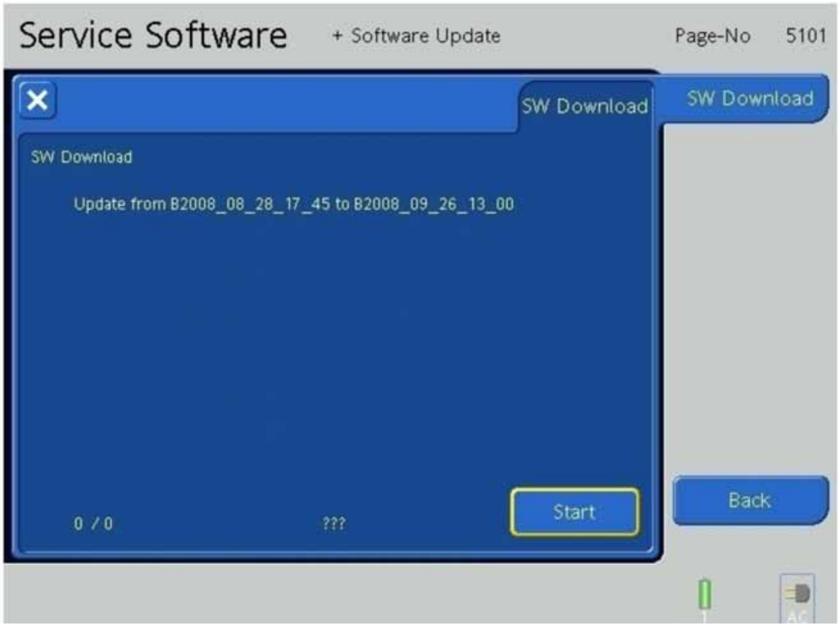


Figure 9-186. The Software Download, Step 4

7. A progress bar is shown indicating the progress of the update.

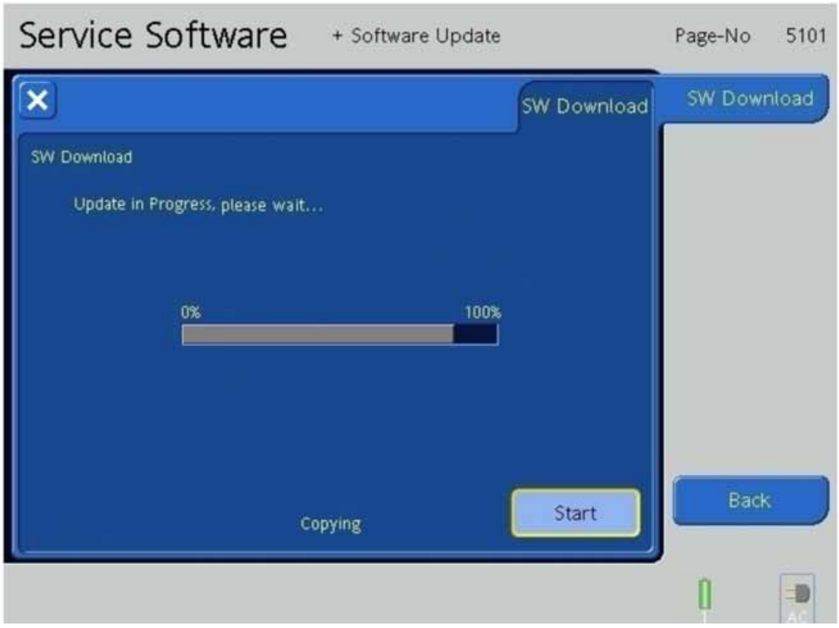


Figure 9-187. The Software Download, Step 5

8. After the software update, the message “Update Successfully Finished” is displayed on the screen.

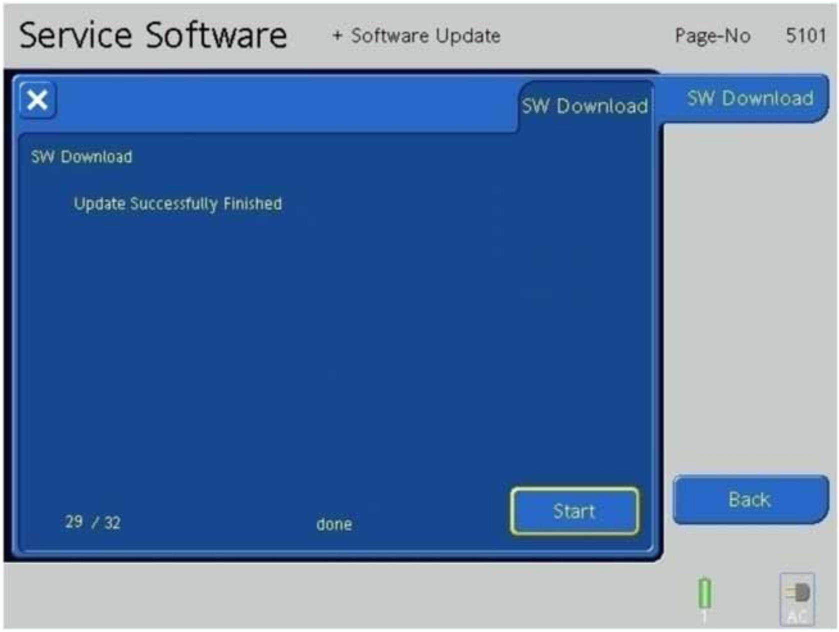


Figure 9-188. The Software Download, Step 6

9.12 Preoperational Check

Perform the preoperational checks as decribed in the HAMILTON-C2 Operator’s Manual.

9.13 General tests

1. Connect the HAMITLON-C2 to the mains AC and to the DC power supply.
2. Switch on the HAMILTON-C2 and stay in Stand-by.
3. Perform following tests:

   AC – DC Tests
   Disconnect the AC mains power supply. Verify that the unit continues to run on DC power supply and that the DC symbol is displayed at the screen.

   DC - Battery Test
   Disconnect now the DC power. Verify that the unit continues to run on battery power and that the battery symbol is displayed at the screen.

   Power Loss Test
   Remove now the batteries. Verify that the unit alarms. Connect the batteries again and very that the unit starts up again.

   Communication interface RS232 Test

Note
All devices connected to the HAMILTON-C2 must be for medical use and meet the requirements of standard IEC 60601-1.

Connect a patient monitoring system. Verify that the communication with the patient monitoring communicate properly.

9.14 Final Tests

1. Install a USB stick to the HAMILTON-C2.
2. Switch on the unit to get into Service Software mode.
3. Select the menu Download and then Instr Report.
4. Start the Instr Report download.
5. Check if the download completed to verify the USB function.

Finish this unit test by saving the instrument report at your documentation.

9.15 Set the Service Timer

Set the *Service Timer*.

Part 3: Component Technical faults and Repairs

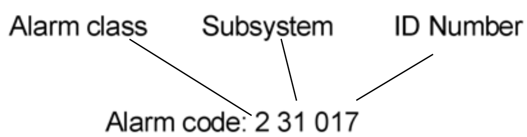
Section
10 Technical faults

10.0.1 Alarm Indications in the HAMILTON-C2

Alarm type	Message bar[a]	Alarm lamp	Audio	Action required
High-priority alarm	Red, with alarm message	Red	A sequence of 5 beeps, repeated until the alarm is reset. If the audible alarm is not silenced during the first minute, the continuous-tone buzzer also sounds.	The patient's safety is compromised. The problem needs immediate attention.
Medium-priority alarm	Yellow, with alarm message	Yellow	A sequence of 3 beeps, repeated periodically. If the audible alarm is not silenced during the first minute, the continuous-tone buzzer also sounds.	The patient needs prompt attention.
Low-priority alarm	Yellow, with alarm message	Yellow	Two sequences of beeps. This is not repeated.	Operator awareness is required.
Technical fault	Red, with **`Safety ventilation:`** *xxxxxx* or **`Technical fault:`** *xxxxxx*	Red	Same as for high-priority alarm, if technically possible. At the minimum a continuous buzzer tone. The buzzer cannot be silenced.	The ventilator enters the safety mode, or, if it cannot safely ventilate, the ambient state. Provide alternative ventilation. Turn off the ventilator. Have the ventilator serviced.

a. If more than one alarm is active, the associated alarm messages alternate in the message bar.

10.0.2 Alarm class



Alarm Codes	Alarm Class
100000	Patient Alarms
200000	Technical Alarms
300000	Technical Failures resulting in the HAMILTON-C2 switching to the Safety Mode
400000	Technical Failures resulting in the HAMILTON-C2 switching to the Ambient Mode
500000	System Failures; invisible TF for user, no Action required

10.0.3 Patient-/ Technical alarms

Patient alarms: (Alarm code 100000)

- High priority alarms
- Medium priority alarms
- Low priority alarms

Alarms related to : Pressure, flow, volume, apnea

Technical alarms: (Alarm code 200000)

- High priority alarms
- Medium priority alarms
- Low priority alarms

Alarms related to: Temperature, battery, valves, sensors

10.0.3.1 Technical Faults

Technical faults end up in one of the following states:

Fatal -> safety mode: (Alarm code 300000)

In this mode the ventilator is placed into a safety mode, which ensures a basic minute ventilation while giving the user time for corrective actions. A constant blower speed helps maintain the default inspiratory pressure.

Fatal -> ambient mode: (Alarm code 400000)

If the alarm is serious enough to possibly compromise safe ventilation, the HAMILTON-C2 is placed into the ambient state.
The inspiratory valve is closed and the ambient and expiratory valves are opened, letting the patient breathe room air unassisted.

10.0.4 *100000 Alarm Code - Patient Alarms Section*

10.0.5 *200000 Alarm Code - Technical Alarms Section*

10.0.6 *300000 Alarm Code - Technical failure ending in safety mode*

10.0.7 *400000 Alarm Code - Technical failure ending in ambient mode*

10.0.8 *500000 Alarm Codes*

For Detaildescreption go to Appendix - *Alarm overview* F-8

Section

11 Components Removal/Assembly

WARNING

You must perform the repairs detailed in this section only as instructed in Section 5, *Preventive Maintenance and Testing Overview*, on page 5-1.

11.1 Overview

This section provides:

- General information about all major components in the HAMILTON-C2
- Maintenance or replacement information about many components

11.2 Notes on Maintenance and Replacement

CAUTION

After performing Maintenance or Replacement of a component or module, perform the necessary Service Software checks, calibrations and Safety Tests to ensure the HAMILTON-C2 is performing properly.

HAMILTON MEDICAL AG does not permit repairs to parts that are supplied as an assembly.

For example:

- You have to replace the *Blower Module* as a complete assembly
- You have to replace the *Inspiratory Valve* as a complete assembly
- You have to replace the *Expiratory Valve* as a complete assembly
- You have to replace the *Ambient Valve* as a complete assembly
- You have to replace the *Mixer* as complete assemblies
- You have to replace HAMILTON MEDICAL Printed Circuit Boards only

WARNING

Service the HAMILTON-C2 only as described in this manual, using only parts approved or supplied by HAMILTON MEDICAL AG. Incorrectly repaired parts, components or assemblies could result in patient injury. See available spare parts in Appendix B, Spare Parts.

Note

Always send defective parts, components or assemblies to HAMILTON MEDICAL AG with a completed Return Good Authorization (RGA) Request.

CAUTION

Make sure to take full ESD (Electro Static Discharge) precautions before opening the HAMILTON-C2. See Appendix A.3.3, *ESD (ElectroStatic Discharge) Protection*, on page A-2.

CAUTION

When the HAMILTON-C2 is switched ON, even when not connected to the external Mains Power, the Battery Pack(s) supply power. Therefore, a short circuit is possible when the HAMILTON-C2 is switched ON.

WARNING

- **Always switch the HAMILTON-C2 off disconnect the HAMILTON-C2 from the external Mains Power and remove the Battery Pack(s), before opening the Cover**
- **Never use any kind of lubrication on any part of the HAMILTON-C2**

Note

Before making any repairs, remove from the HAMILTON-C2:

- External Mains Power Supply or Portable Power Supply and Battery Pack(s)
- Oxygen Supply
- Patient Breathing Circuit (if not needed)
- Flow Sensor Tubing (if not needed)
- Batteries

Note

Update the technical state if necessary after exchanging the parts and restart the machine. This must be done before performing the service software.

11.2.1 Contents in this Section

  - Section 11.4.24, *Bottom Foam Section Removal/Assembly*, on page 11-50

11.2.2 Figures in this Section

11.3 Interaction Panel Components Removal/Assembly

11.3.1 Ventilation Unit Top Cover Removal/Assembly

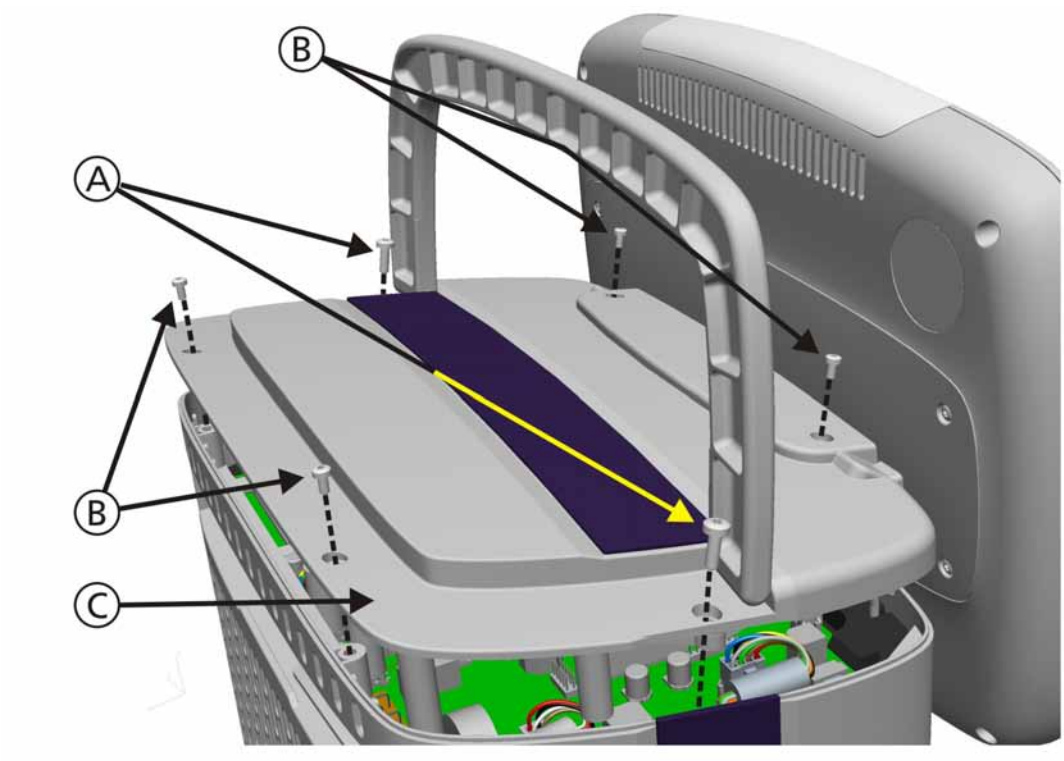


Figure 11-1. Ventilation Unit Top Cover Removal

To remove the Top cover (PN 160325):

Note
Interaction Panel must be tilted to the front completely to remove the Top Cover.

1. Lift the Handle and remove 6 Torx screws from the Top Cover of the Ventilation Unit; 2 Torx screws (A) (PN 420682) and 4 Torx screws (B) (PN 420642), then remove the Top Cover.
2. Remove the Top Cover (C).
3. Assemble in the reverse order of removal.

11.3.2 Interaction Panel Small Rear Cover Removal/Assembly

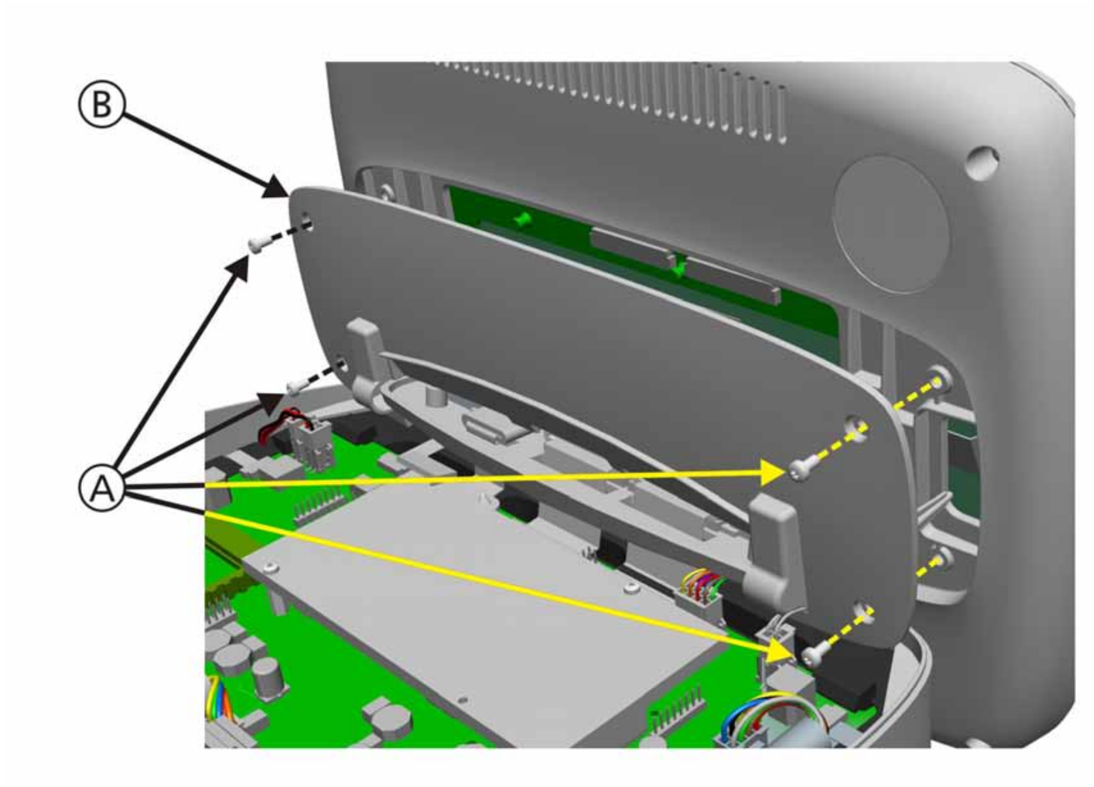


Figure 11-2. Interaction Panel Small Cover Removal

To remove the Interaction Panel Small Rear Cover (PN 160402):

1. Remove the Top Cover from the Ventilation Unit (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove 4 Torx screws (A) (PN 420642) from the Small Rear Cover.

WARNING

Torx screws (A) cannot be any longer than the specified size (M3x6), otherwise, damage can be caused to the Interaction Panel Board.

3. Remove the Small Rear Cover (B).
4. Assemble in the reverse order of removal.

11.3.3 Interaction Panel Removal/Assembly

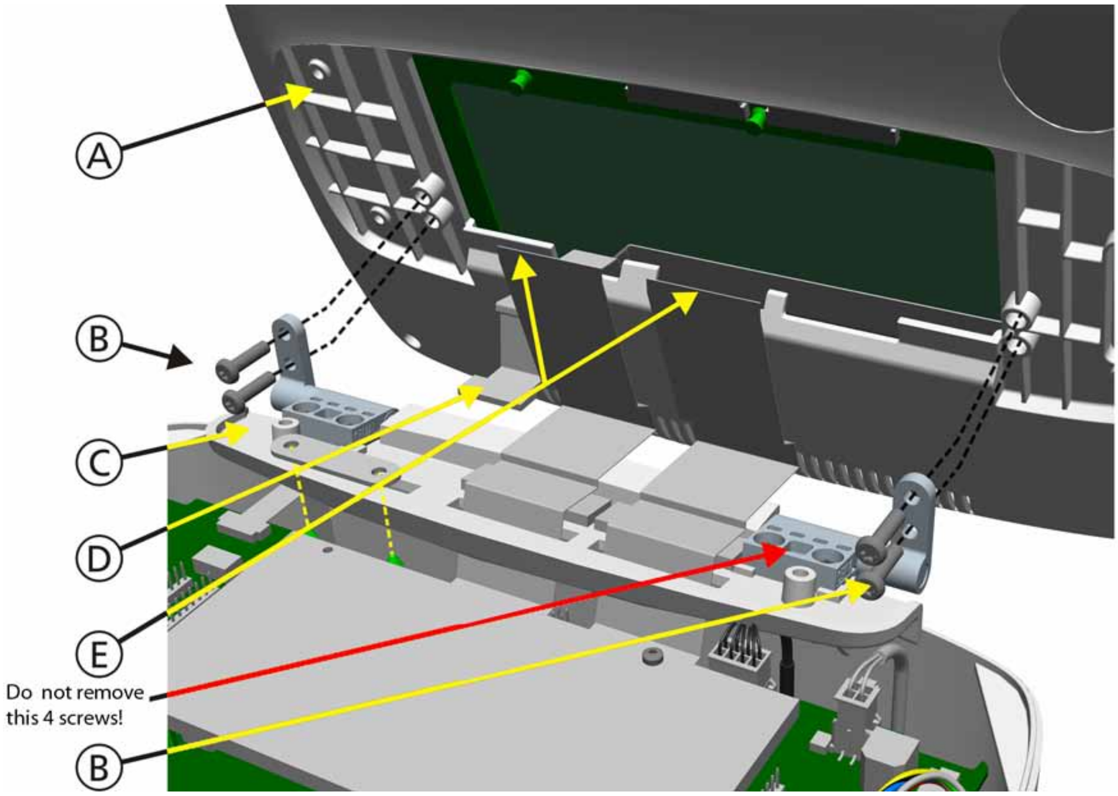


Figure 11-3. Interaction Panel Removal

5. Remove the Security Strap (C) from the 1 Flat Band Cable (D) and disconnect from the Ventilation Unit Mainboard.

6. Disconnect the other 2 Flat Band Cables (E) from the Interaction Panel Board.

Note
The 2 Flat Band Cables (E) can more easily be disconnected from the Interaction Panel Board but can also be disconnected from the Ventilation Unit Mainboard. The Ferrite Cores for these 2 cables are secured to the top of the Front Cover, and are not intended to be removed with the cables.

7. Remove 4 Torx screws (B) (PN 420727) from the Tilt Brackets of the Interaction Panel.

8. Remove the Interaction Panel (A) from the Ventilation Unit.

9. Place aside in a safe location.

10. Assemble in the reverse order of removal.

Note
Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.3.4 Interaction Panel Large Rear Cover Removal/Assembly

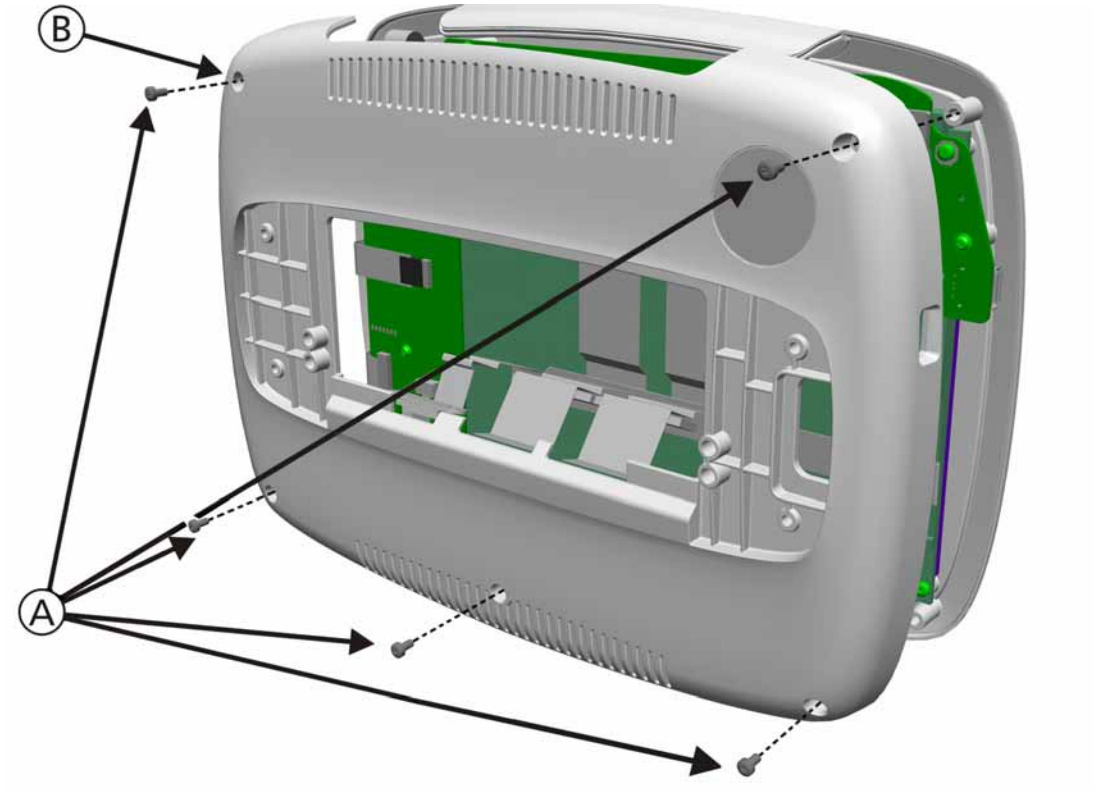


Figure 11-4. Interaction Panel Large Rear Cover Removal

To remove the Interaction Panel Large Rear Cover (PN 160326):

1. Remove the Top Cover and Interaction Panel from the Ventilation Unit (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6 and Section 11.3.2, *Interaction Panel Small Rear Cover Removal/Assembly*, on page 11-7).
2. Remove 5 Torx screws (A) (PN 420642) from the Large Rear Cover.
3. Remove the Large Rear Cover (B).
4. Assemble in the reverse order of removal.

11.3.5 Backlight Converter Board Removal/Assembly

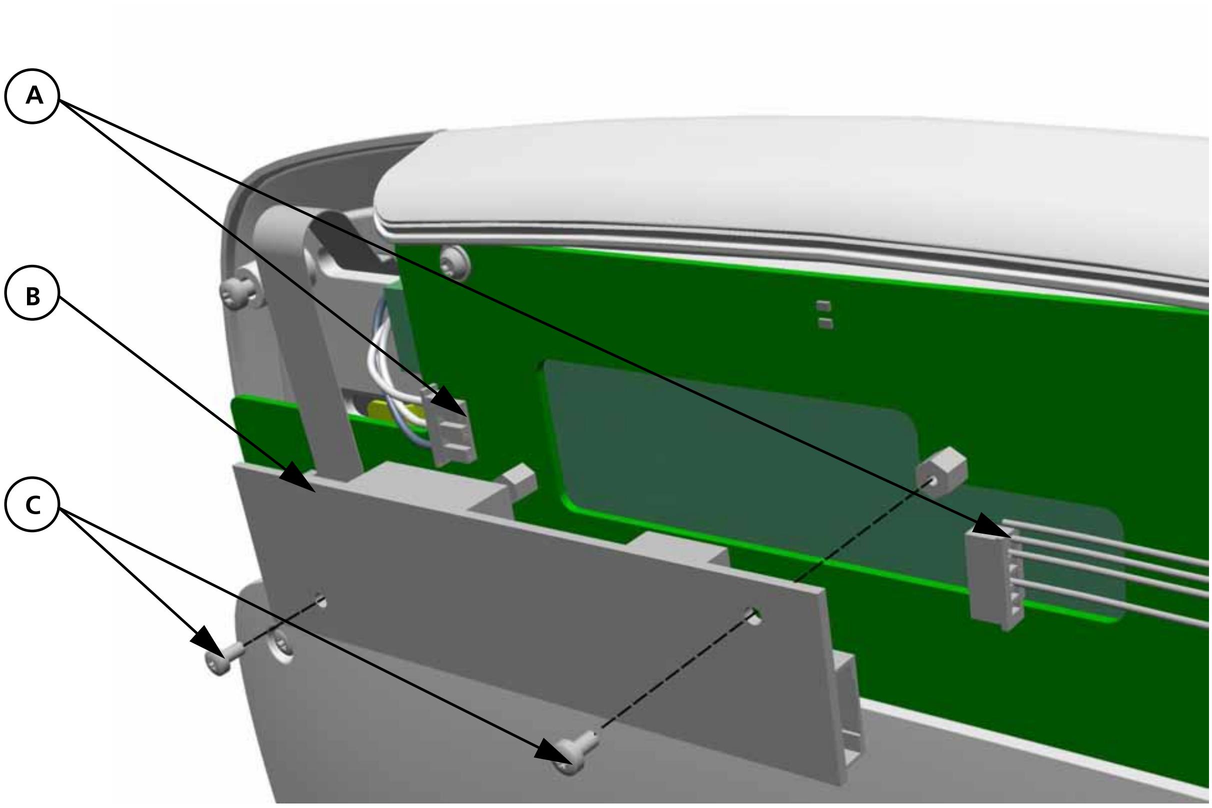


Figure 11-5. Backlight Converter Board Removal

To remove the Backlight Converter Board (PN 396197):

1. Remove the Top Cover and Interaction Panel from the Ventilation Unit (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6 and Section 11.3.2, *Interaction Panel Small Rear Cover Removal/Assembly*, on page 11-7).
2. Remove the Interaction Panel Large Rear Cover (see Section 11.3.4, *Interaction Panel Large Rear Cover Removal/Assembly*, on page 11-9).
3. Disconnect 2 Cables (A) from the Backlight Converter Board (B).
4. Remove 2 Torx screws (C) (PN 420692) from the Backlight Converter Board.
5. Remove the Backlight Converter Board (B).
6. Assemble in the reverse order of removal.

11.3.6 Interaction Panel Board Removal/Assembly

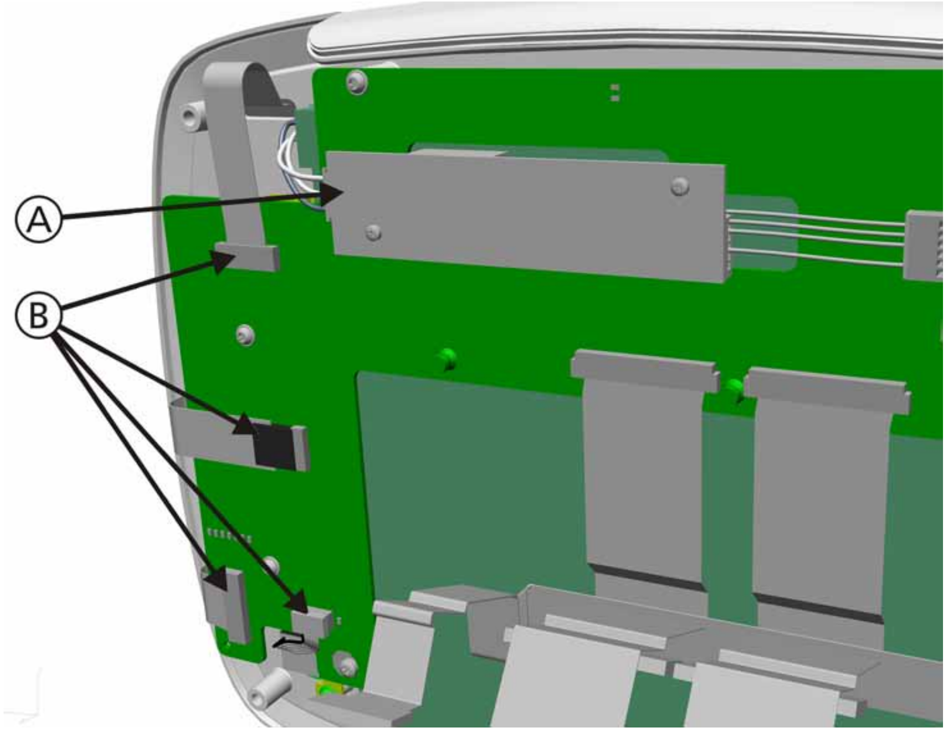


Figure 11-6. Interaction Panel Board Removal, Step 1

To remove the Interaction Panel Board (PN 160196):

1. Remove the Top Cover and Interaction Panel from the Ventilation Unit (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6 and Section 11.3.2, *Interaction Panel Small Rear Cover Removal/Assembly*, on page 11-7).
2. Remove the Interaction Panel Large Rear Cover (see Section 11.3.4, *Interaction Panel Large Rear Cover Removal/Assembly*, on page 11-9).
3. Disconnect 1 Cable (A) from the Backlight Converter Board and 4 Cables (B) from the Interaction Panel Board.

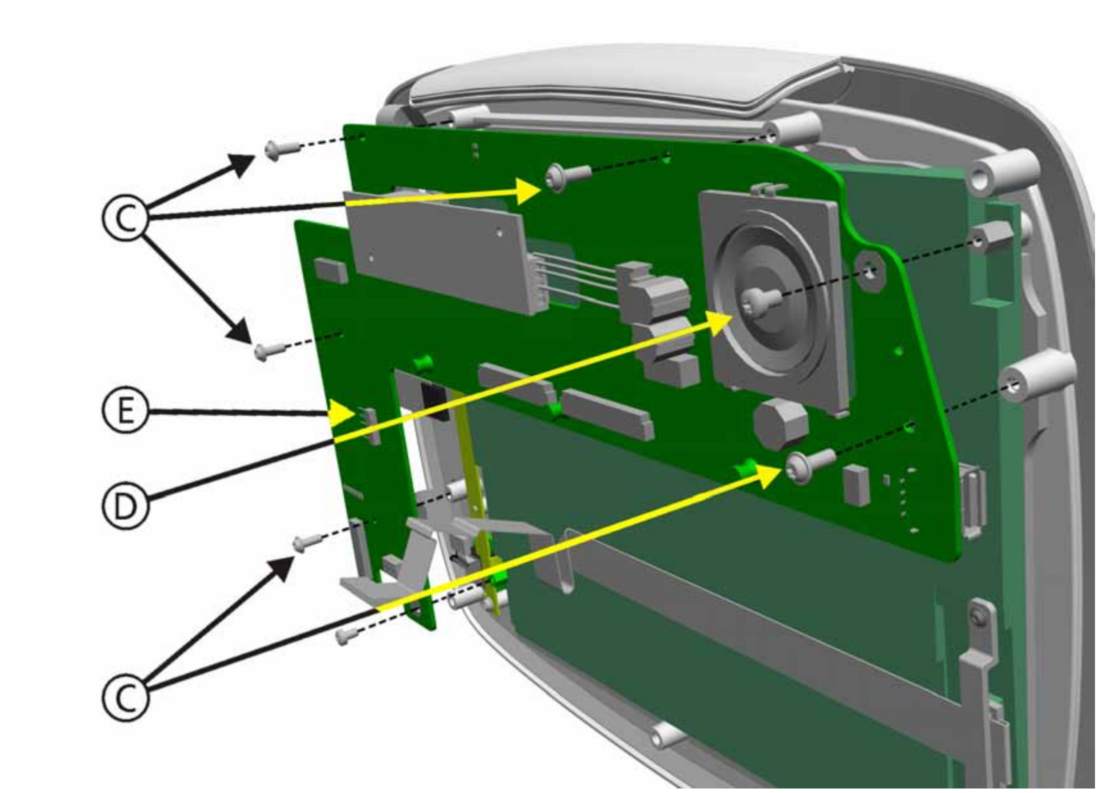


Figure 11-7. Interaction Panel Board Removal, Step 2

4. Remove 5 Torx screws (C) (PN 420724) and 2 Torx screw (D) (PN 420641) from the Interaction Panel Board.
5. Remove the Interaction Panel Board (E).
6. Assemble in the reverse order of removal.

11.3.7 LCD Display Removal/Assembly

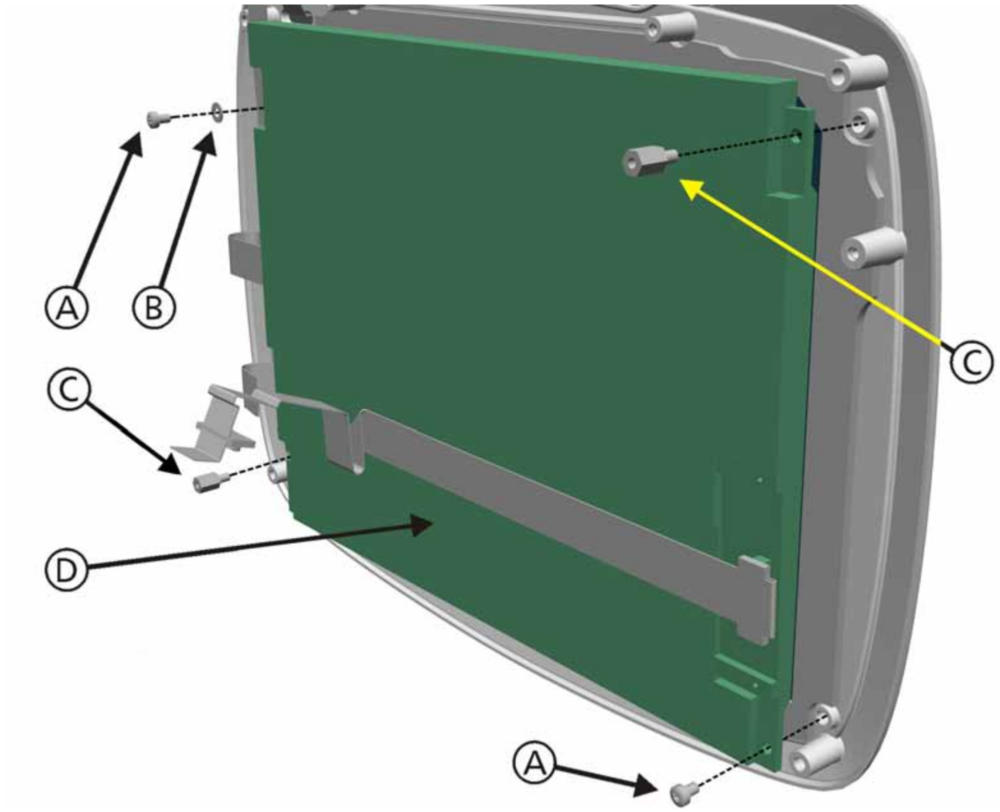


Figure 11-8. LCD Display Removal

To remove the LCD Display (PN 380027):

1. Remove the Top Cover and Interaction Panel from the Ventilation Unit (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6 and Section 11.3.2, *Interaction Panel Small Rear Cover Removal/Assembly*, on page 11-7).
2. Remove the Interaction Panel Large Rear Cover (see Section 11.3.4, *Interaction Panel Large Rear Cover Removal/Assembly*, on page 11-9).
3. Remove the Interaction Panel Board (Section 11.3.6, *Interaction Panel Board Removal/Assembly*, on page 11-11).
4. Remove 2 Torx screws (A) (PN 420641), 1 Washers (B) (PN 409105) and 2 Hex Standoff screw (C) (PN 257038).
5. Remove the LCD Display (D).
6. Assemble in the reverse order of removal.

11.3.8 P&T Control Knob Encoder Removal/Assembly

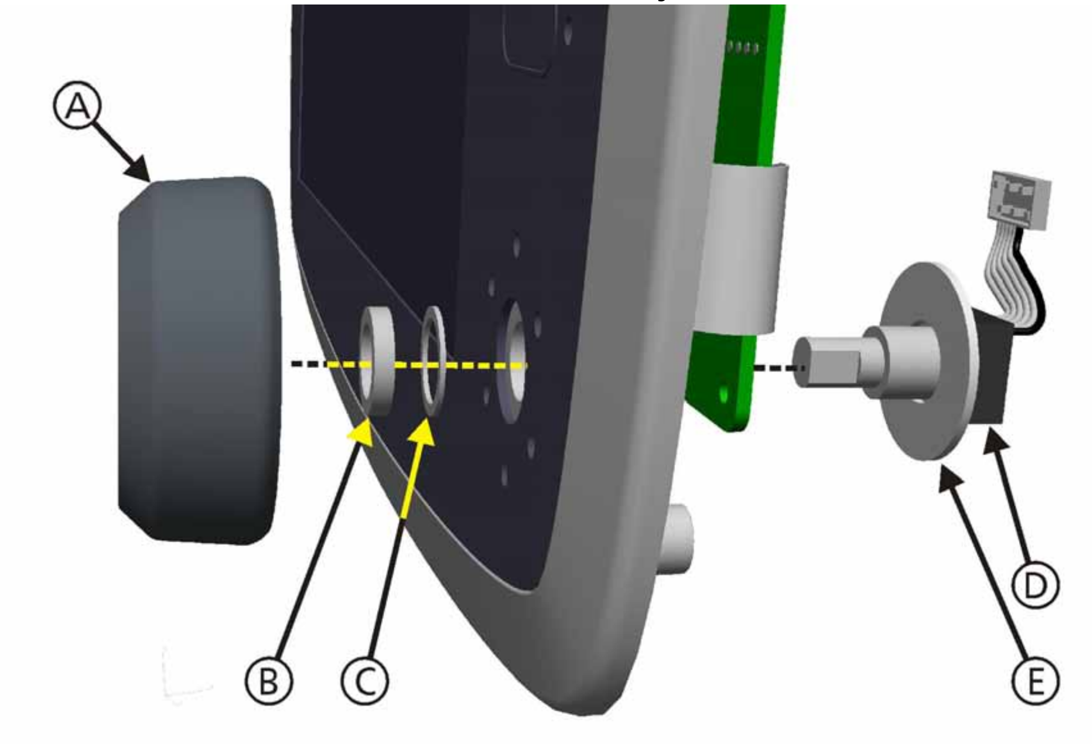


Figure 11-9. P&T Control Knob Encoder Removal

To remove the P&T (Press & Turn) Control Knob Encoder (PN 372036):

1. Remove the Top Cover and Interaction Panel from the Ventilation Unit (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6 and Section 11.3.2, *Interaction Panel Small Rear Cover Removal/Assembly*, on page 11-7).
2. Remove the Interaction Panel Large Rear Cover (see Section 11.3.4, *Interaction Panel Large Rear Cover Removal/Assembly*, on page 11-9).
3. Disconnect the Cable from the Interaction Panel Board.
4. Remove the P&T Control Knob (A) (PN 160328) from the front of the Interaction Panel.
5. Remove the Hex Nut (B) and Washer (C) from the P&T Control Knob Encoder (D).
6. Remove the P&T Control Knob Encoder (D) and Large Washer (PN 409908).
7. Assemble in the reverse order of removal.

CAUTION

Do not remove the P&T Conrol Knob for maintenance. Removal of the P&T Control Knob can damage the P&T Control Knob Encoder. Only remove if necessary to replace a non-functioning P&T Control Knob Encoder.

Note

The Knob must be positioned to allow free movement. Attach so there is a 3 mm gap between the back of the Knob and the face of the Interaction Panel. Test the Knob actions for both Press and Turn.

11.4 Ventilation Unit Components Removal/Assembly

11.4.1 Rear Access Panel Removal/Assembly

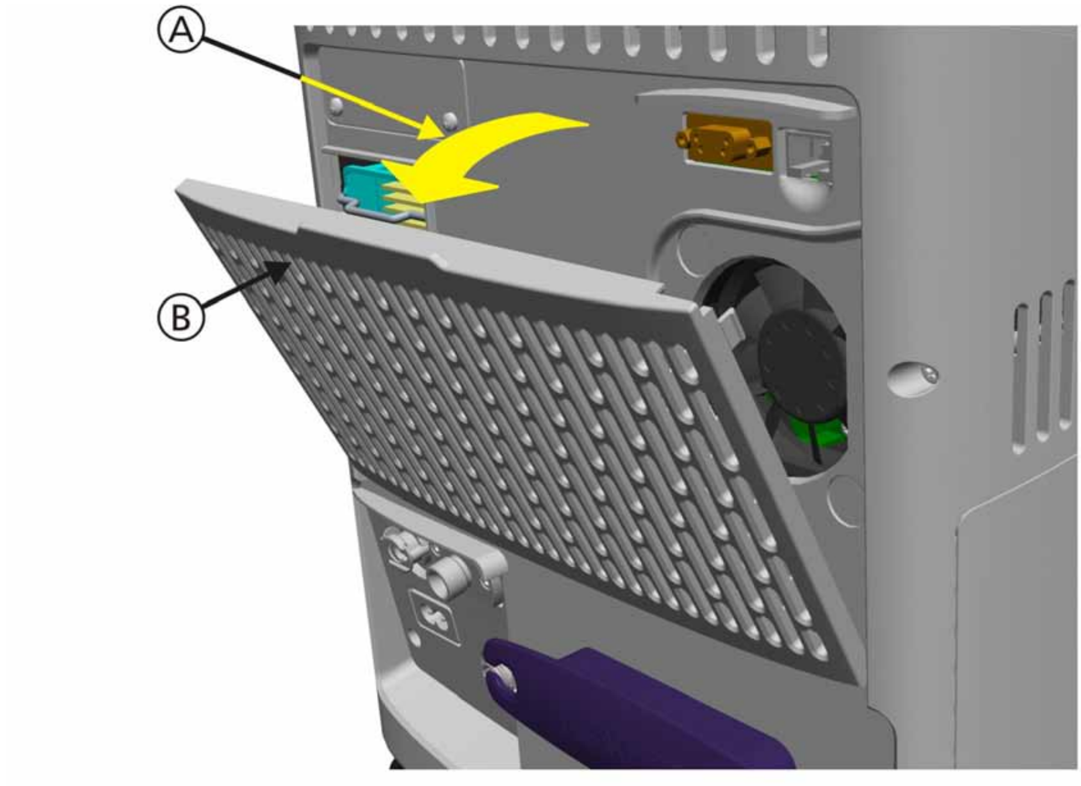


Figure 11-10. Rear Access Panel Removal

To remove the Rear Access Panel (PN 160343):

1. Detach from the top and swivel (A) away from the rear of the Ventilation Unit.
2. Remove the Rear Access Panel (B).
3. Assemble in the reverse order of removal.

11.4.2 HEPA Filter Removal/Assembly

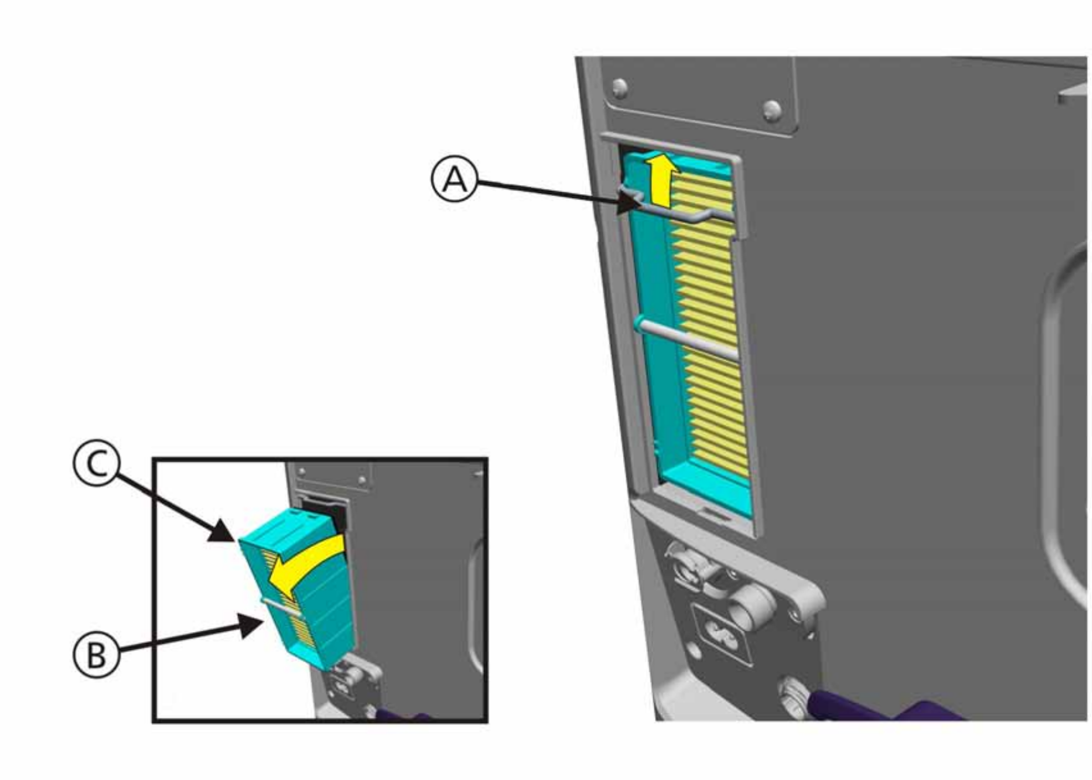


Figure 11-11. Air Filter Removal

To remove the HEPA Filter (PN 160216):

1. Remove the Rear Accesss Panel (see Section 11.4.1, *Rear Access Panel Removal/Assembly*, on page 11-15).

1. Raise the HEPA Filter Latch (A).

2. Use the Handle (B) to pull the HEPA Filter from the holder.

3. Remove the HEPA Filter (C).

4. Assemble in the reverse order of removal.

11.4.3 Backup Battery Pack Removal/Assembly

CAUTION

It is mandatory that the HAMILTON-C2 is operated with at least one battery installed.

The Backup Battery Compartment provides space for 2 Backup Battery Packs. The primary Battery Pack is positioned into the left compartment. An Optional 2nd Battery Pack is positioned into the right compartment.

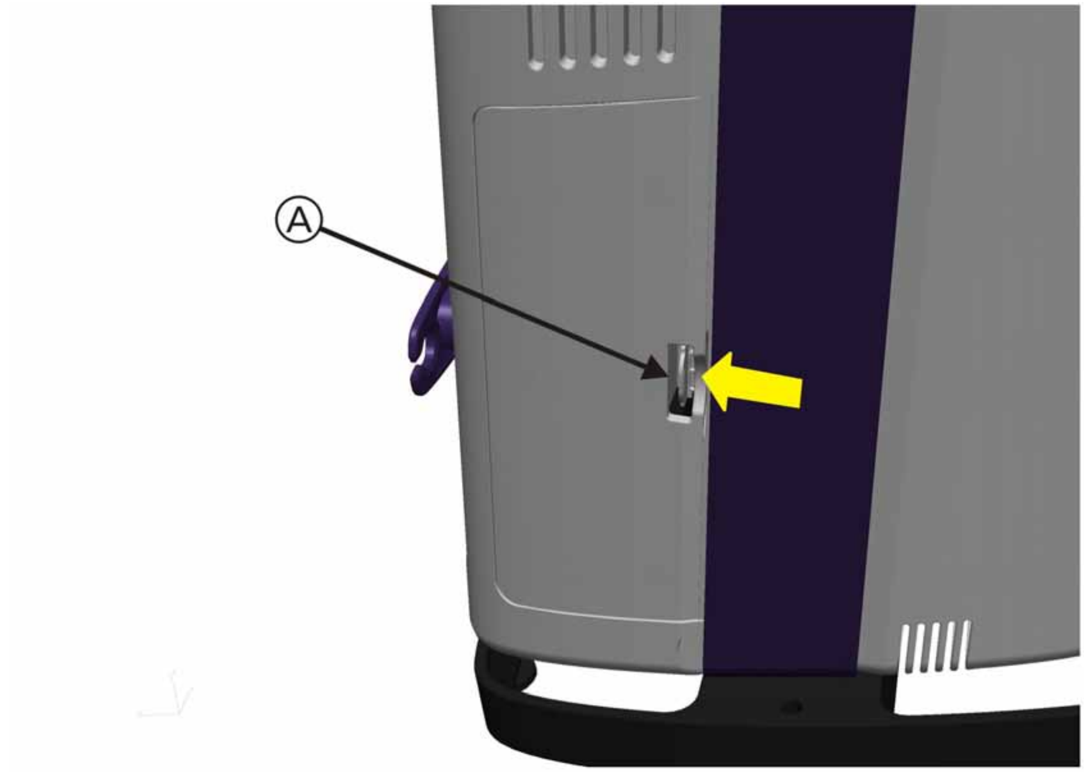


Figure 11-12. Backup Battery Pack Removal, Step 1

To remove the Backup Battery Pack (PN 369106):

1. Open the Backup Battery Door by depressing the Door Latch (A).

Note

A Battery Lock is used to secure the Battery Release Latch. The Battery Release Latch must be in the latched position for the Battery Door to close.

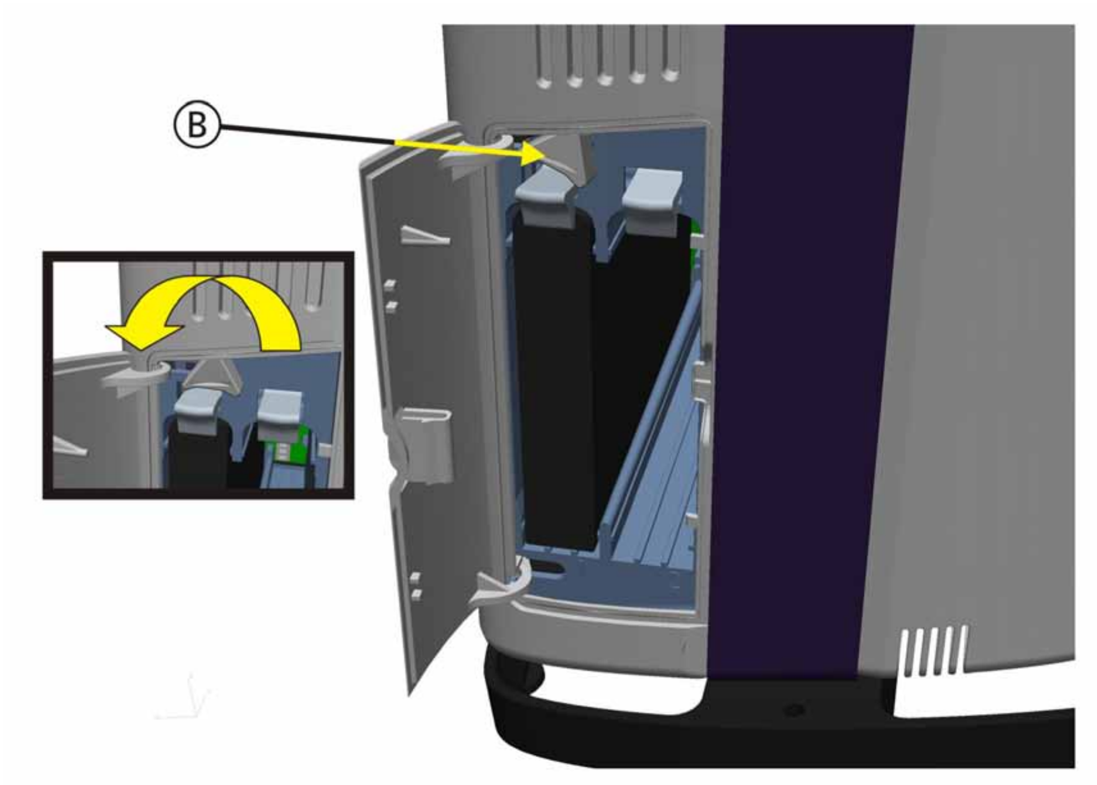


Figure 11-13. Backup Battery Pack Removal, Step 2

2. Open the Battery Lock (B) by rotating the Battery Lock counter-clockwise.

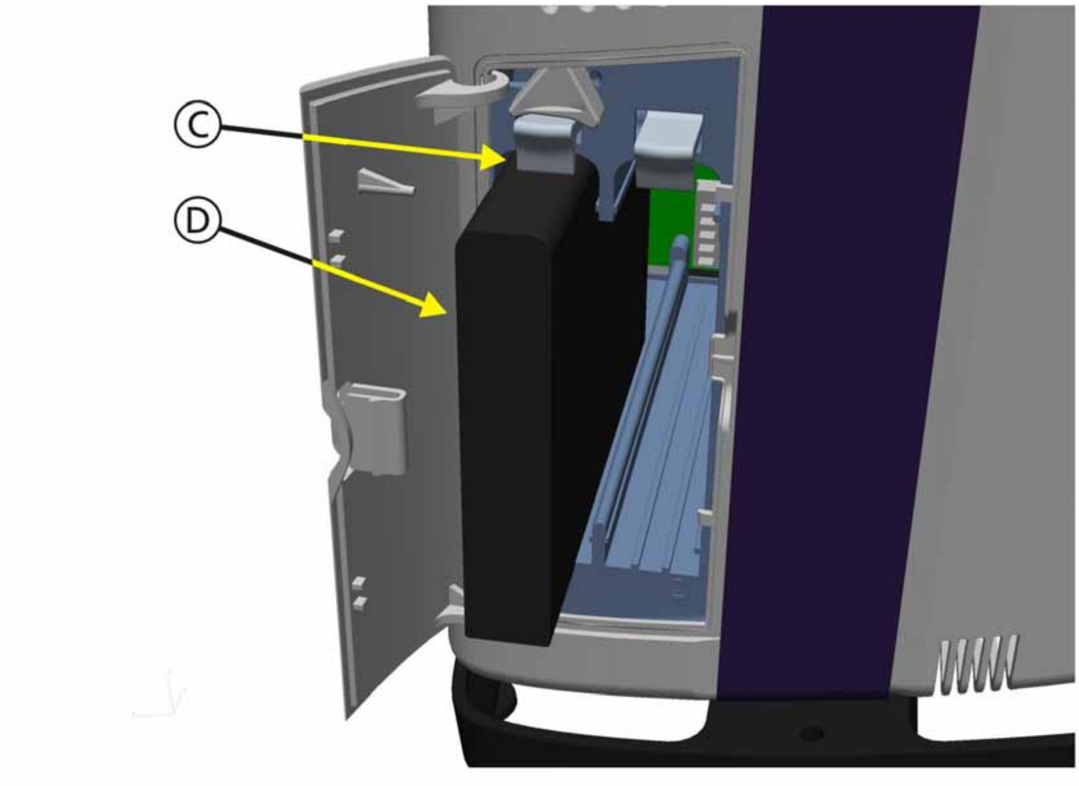


Figure 11-14. Backup Battery Pack Removal, Step 3

3. Raise the Battery Release Latch (C) to release the Battery Pack (D) from the Battery Compartment.
4. Remove the Battery Pack (D).
5. Assemble in the reverse order of removal .

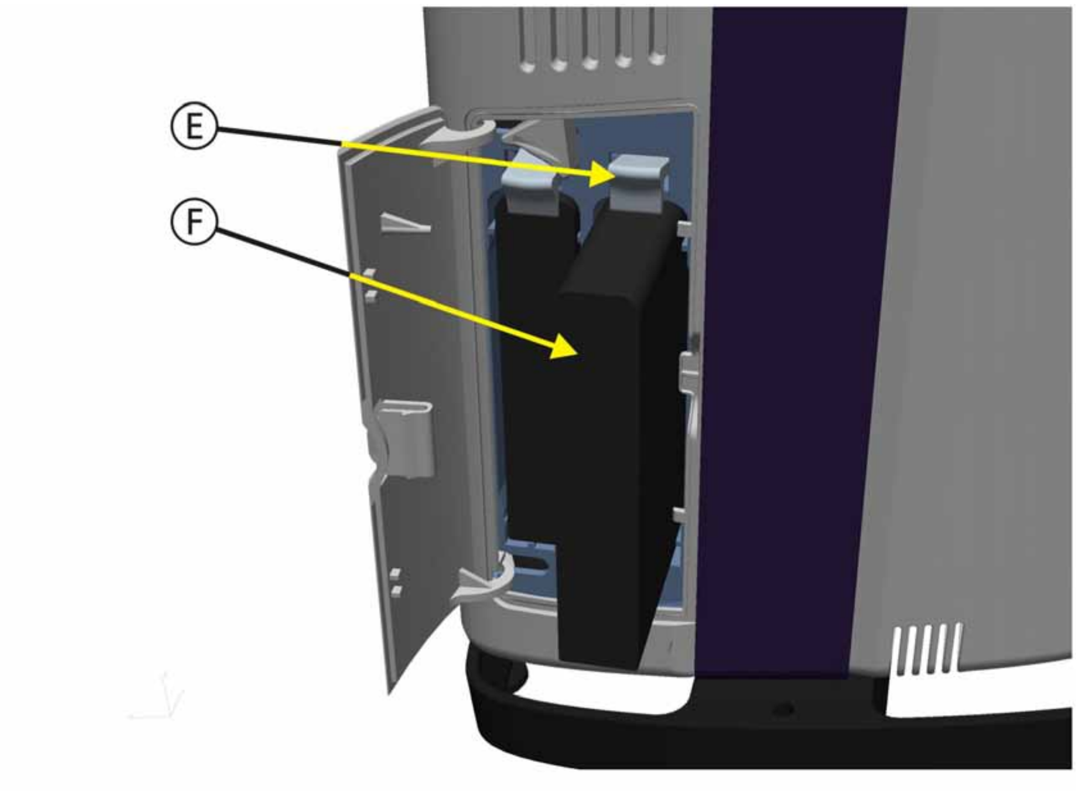


Figure 11-15. Backup Battery Pack Removal, Step 4

6. If a second Battery Pack is used, release the Battery Release Latch (E) and remove the Battery Pack from the Battery Compartment (F).

7. Assemble in the reverse order of removal.

11.4.4 Front and Rear Covers Removal/Assembly

The Front and Rear Covers are attached together and positioned with the support plates on each side of the HAMILTON-C2.

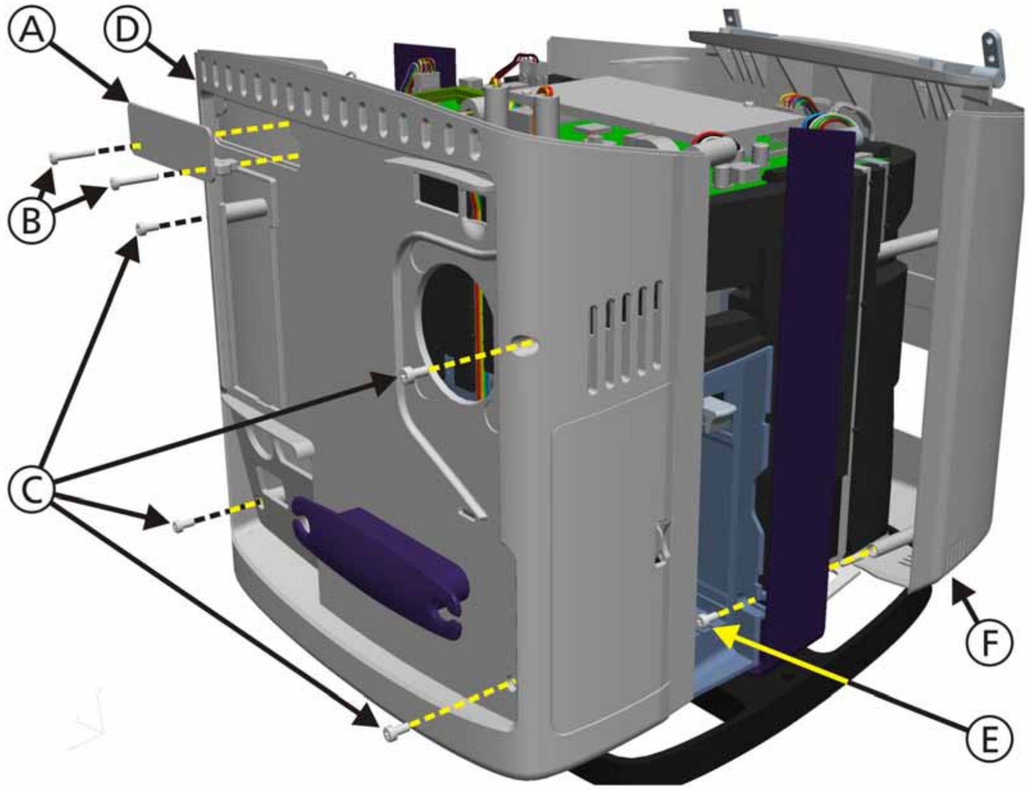


Figure 11-16. Front and Rear Covers Removal

Note
It is not necessary to remove the Interaction Panel for Front Cover Removal.

To remove the Front and Rear Covers (PN 160317):

1. Remove the Top Cover from the Ventilation Unit (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6.
2. Remove 2 Phillips screws (B) (PN 420730) to remove the Options Board Cover (A).
3. Remove 4 Torx screws (C) (PN 420667) from the back of the Rear Cover (D).
4. Remove the Rear Cover (D).
5. Remove 1 Torx screw (E) (PN 420667) from inside the Battery Compartment.
6. Remove the Expiratory Valve Seal.
7. Depress the Trolley Release Front Latch to remove the Front Cover (F).
8. Assemble in the reverse order of removal.

11.4.5 ESM Module Removal/Assembly

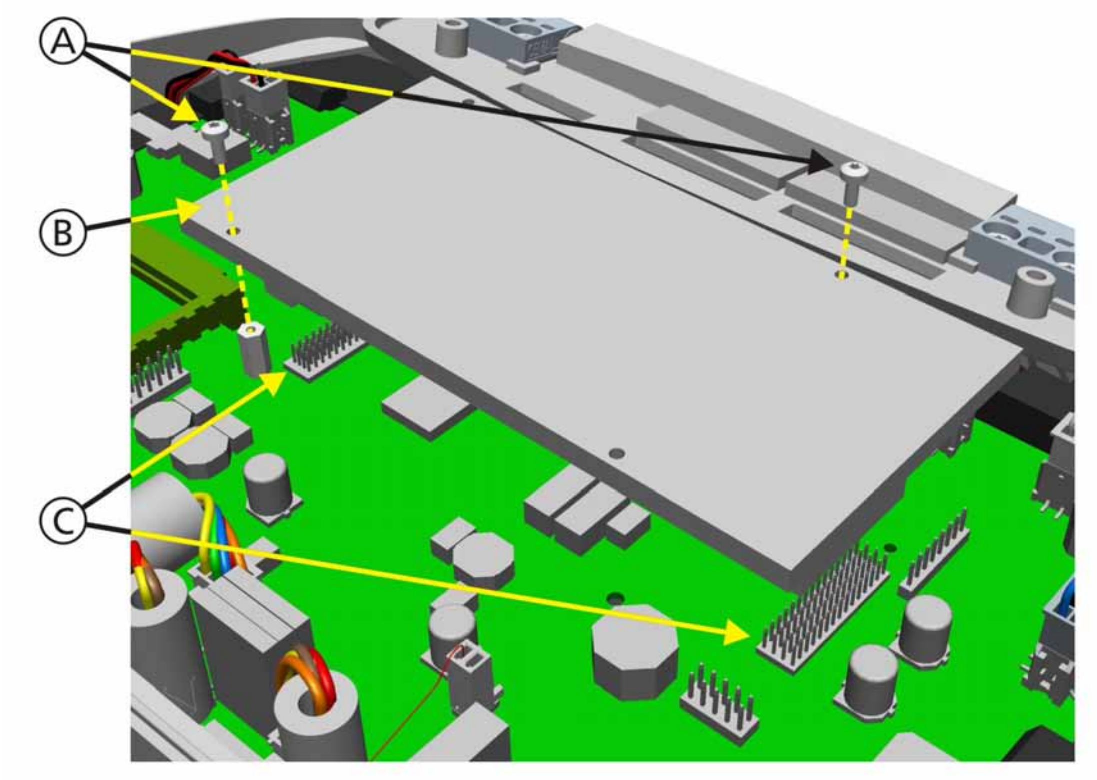


Figure 11-17. ESM Module Removal

To remove the ESM Module (PN 160206):

1. Remove the Top Cover from the Ventilation Unit (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove 2 Torx screws (A) (PN 420638) from the ESM Module (B).
3. Disconnect the ESM Module from 2 connector sockets (C) on the Ventilation Unit Board.
4. Remove the ESM Module (B).
5. Assemble in the reverse order of removal.

Note
Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.4.6 Ventilation Unit Mainboard Removal/Assembly

Note
Backup Technical State (Instrument Report) before removing the Ventilation Unit Mainboard. See *Download (Instrument report and Events)* on page 9-109.

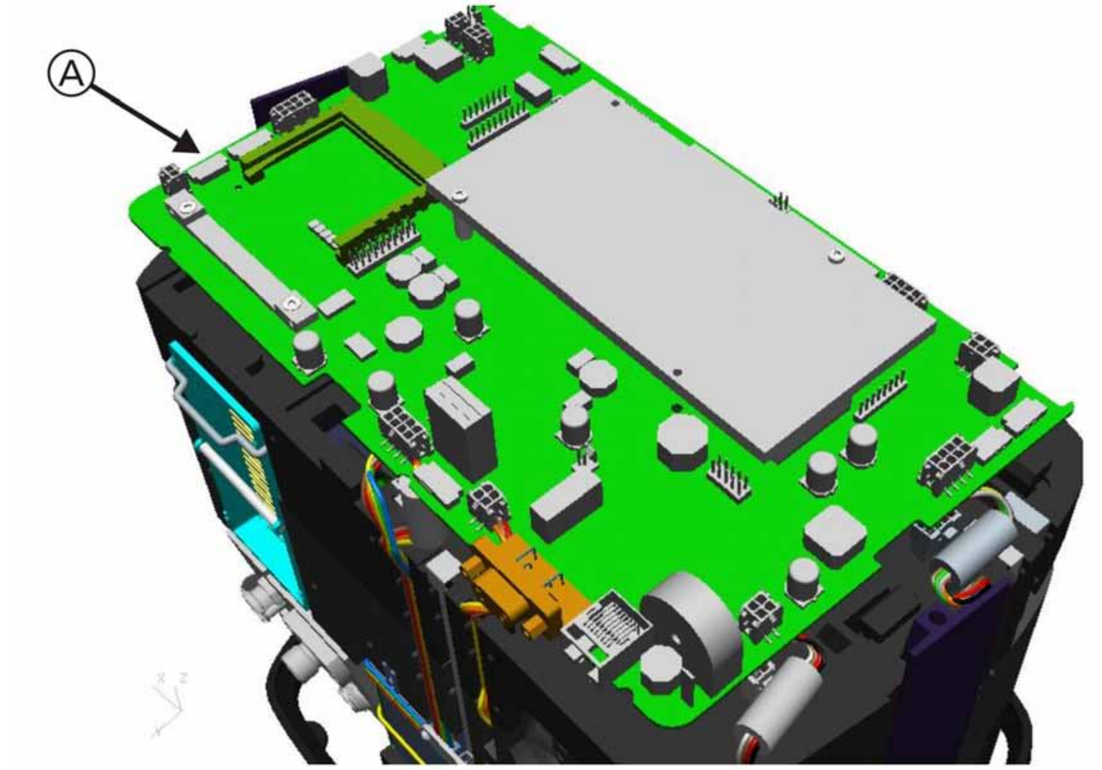


Figure 11-18. Ventilation Unit Mainboard Removal

To remove the Ventilation Unit Mainboard (PN 160200):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6.
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Disconnect all cabling connections from the Ventilation Unit Mainboard.

CAUTION

Take care not to damage the Top Foam Section Latches used to secure the Ventilation Unit Mainboard.

4. Remove the Ventilation Unit Mainboard (A) from the Top Foam Section.
5. Remove the ESM Holder (PN 257080) and LCD Cable lock holder (PN 362051) as well.
6. Assemble in the reverse order of removal (see also Section 11.5, *Ventilation Unit Components, Tubings and Cables Assembly*, on page 11-51).

Note

Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.4.7 Top Foam Section Removal/Assembly

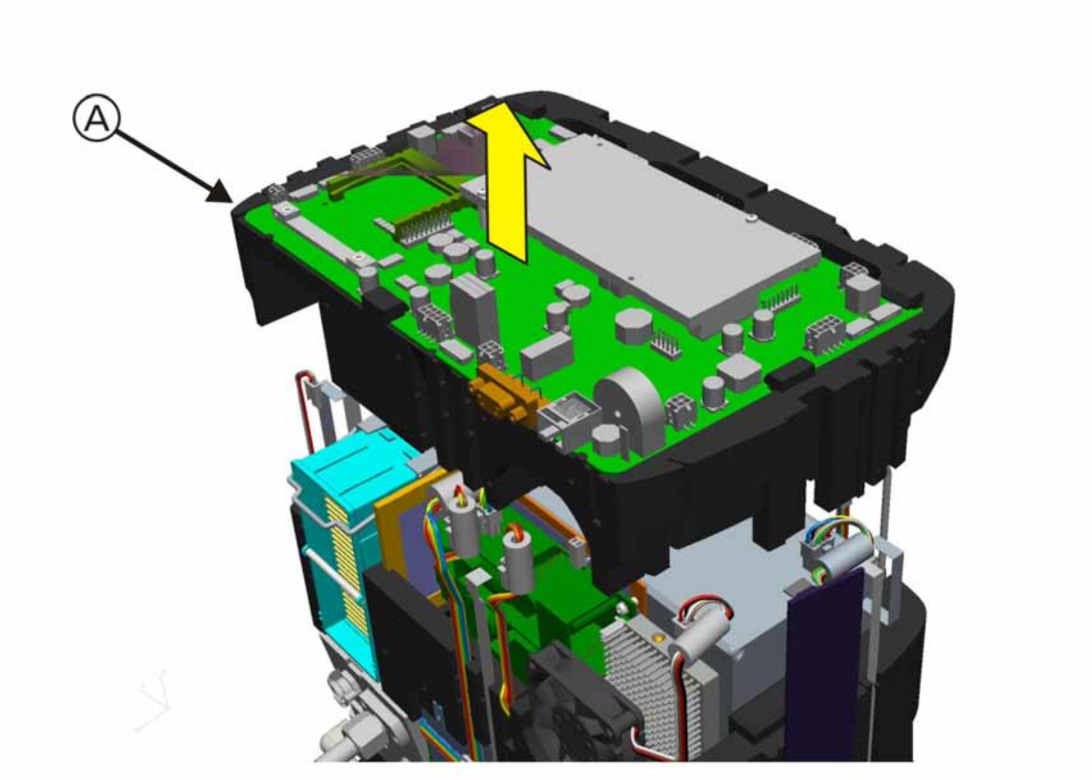


Figure 11-19. Top Foam Section Removal, Step 1

To remove the Top Foam Section (PN 160239):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6.)
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Disconnect all cabling connections from the Ventilation Unit Mainboard.
4. Lift the Top Foam Section (A) from the Ventilation Unit.

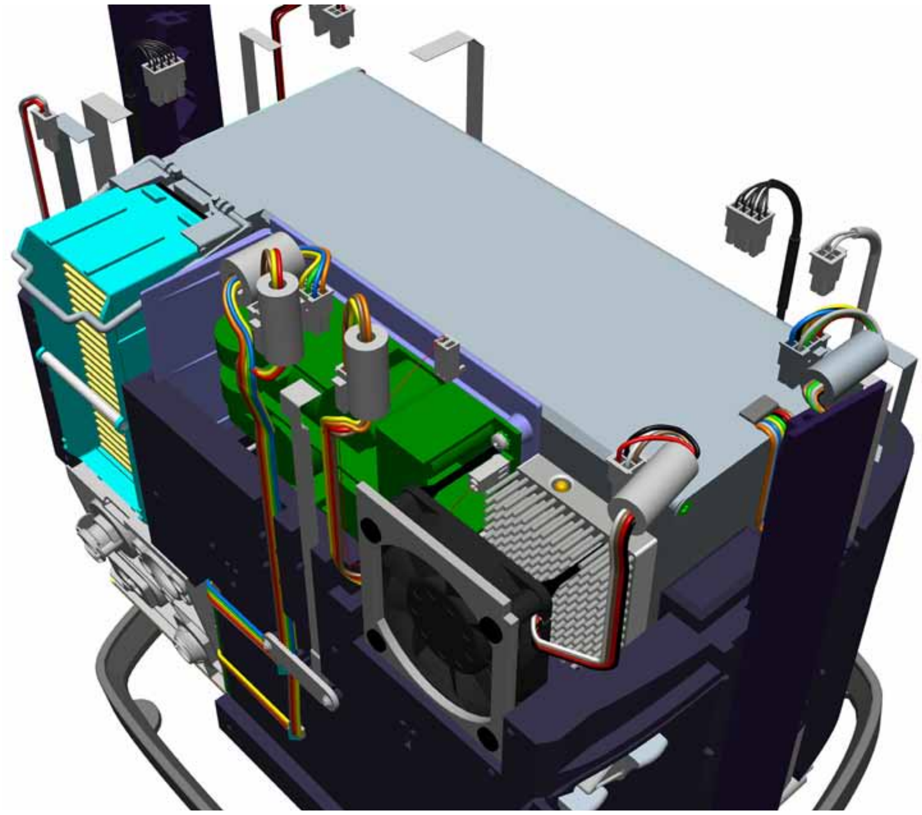


Figure 11-20. Top Foam Section Removal, Step 2

5. Assemble in the reverse order of removal.

11.4.8 Cooling Fan Removal/Assembly

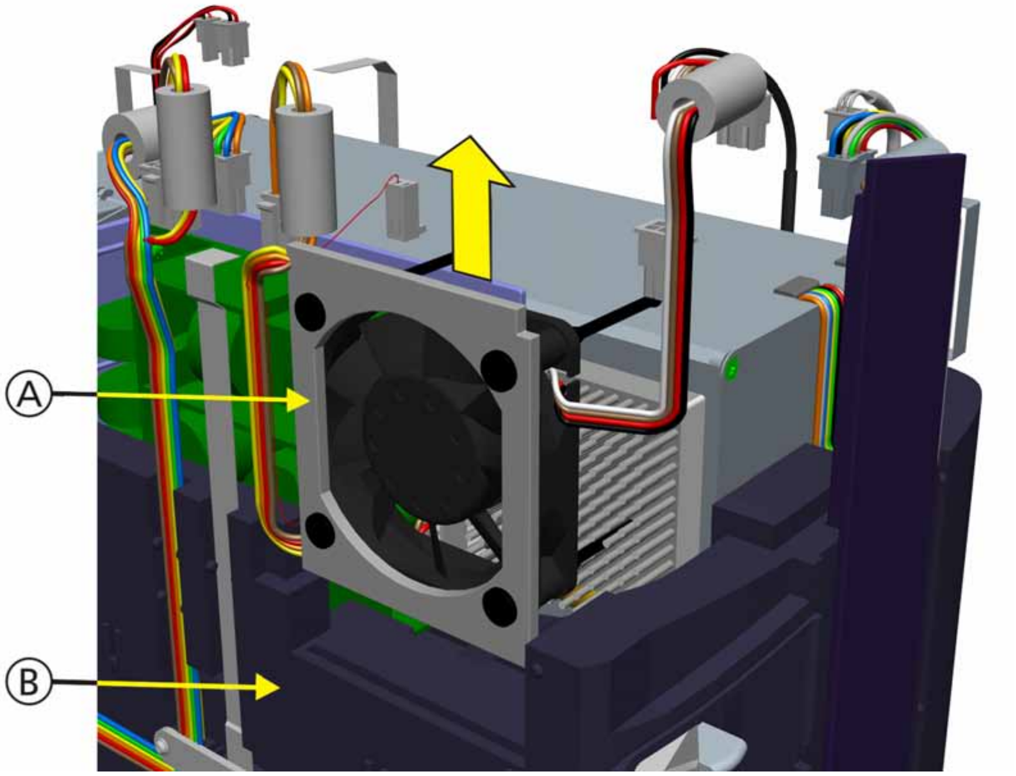


Figure 11-21. Cooling Fan Removal

To remove the Cooling Fan (PN 391165):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Lift the Cooling Fan (A) from the Middle Foam Section (B) of the Ventilation Unit.
5. Assemble in the reverse order of removal. Be careful not to bend the FFCs to hard while reassembling the blower module.

Note
The Fan Air Flow is into the Ventilation Unit. Observe the direction of Air Flow for the Fan.

11.4.9 Blower Module Removal/Assembly

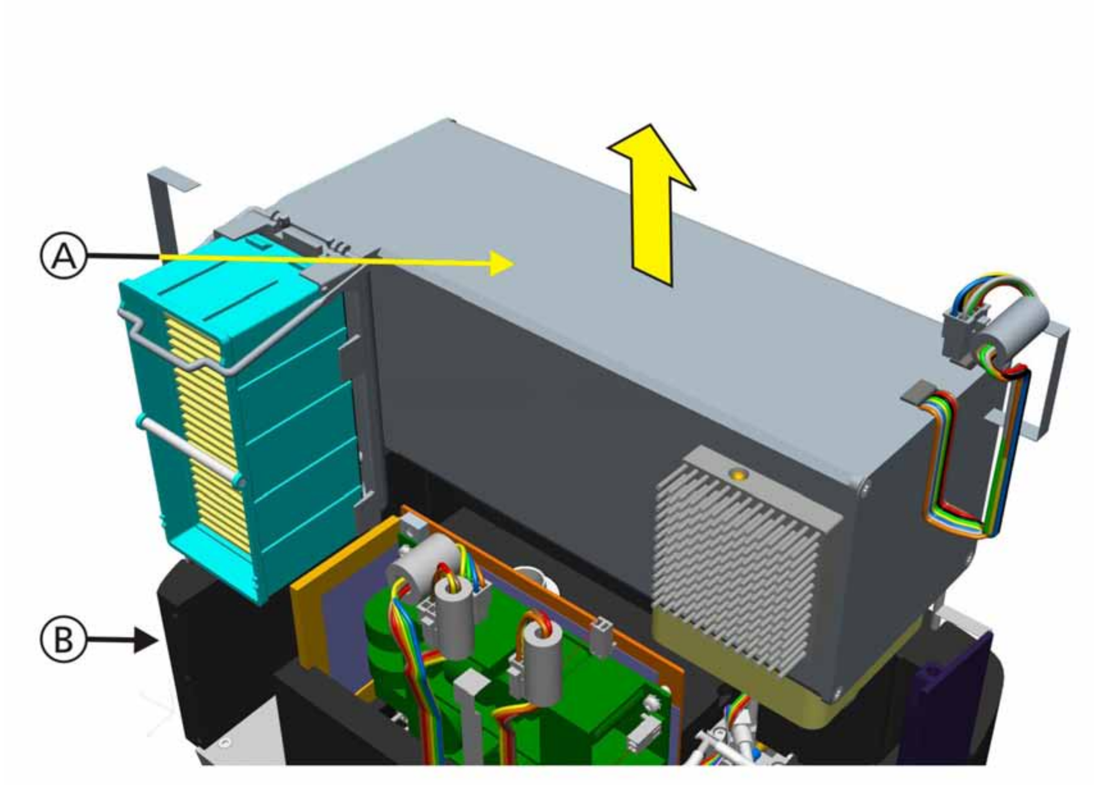


Figure 11-22. Blower Module Removal

To remove the Blower Module (PN 160250):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Lift the Blower Module (A) from the Middle Foam Section (B) of the Ventilation Unit.
5. Assemble in the reverse order of removal.

Note
Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.4.10 Power Supply Removal/Assembly

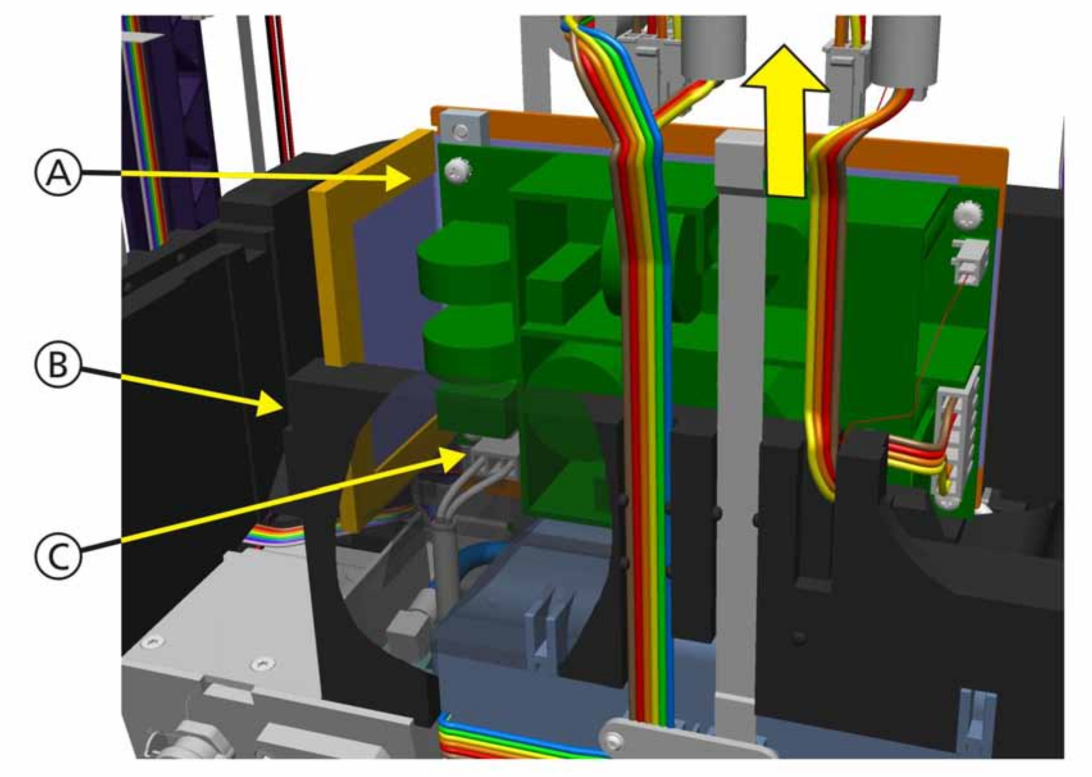


Figure 11-23. Power Supply Removal

To remove the Power Supply (PN 160600):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Lift the Power Supply (A) from the Middle Foam Section (B) of the Ventilation Unit and move away from the back to have access to the AC Mains Power Cable (C).
5. Disconnect the AC Mains Power Cable (C).
6. Remove the Power Supply (A).
7. Assemble in the reverse order of removal.

Note
Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.4.11 Middle Foam Section Removal/Assembly

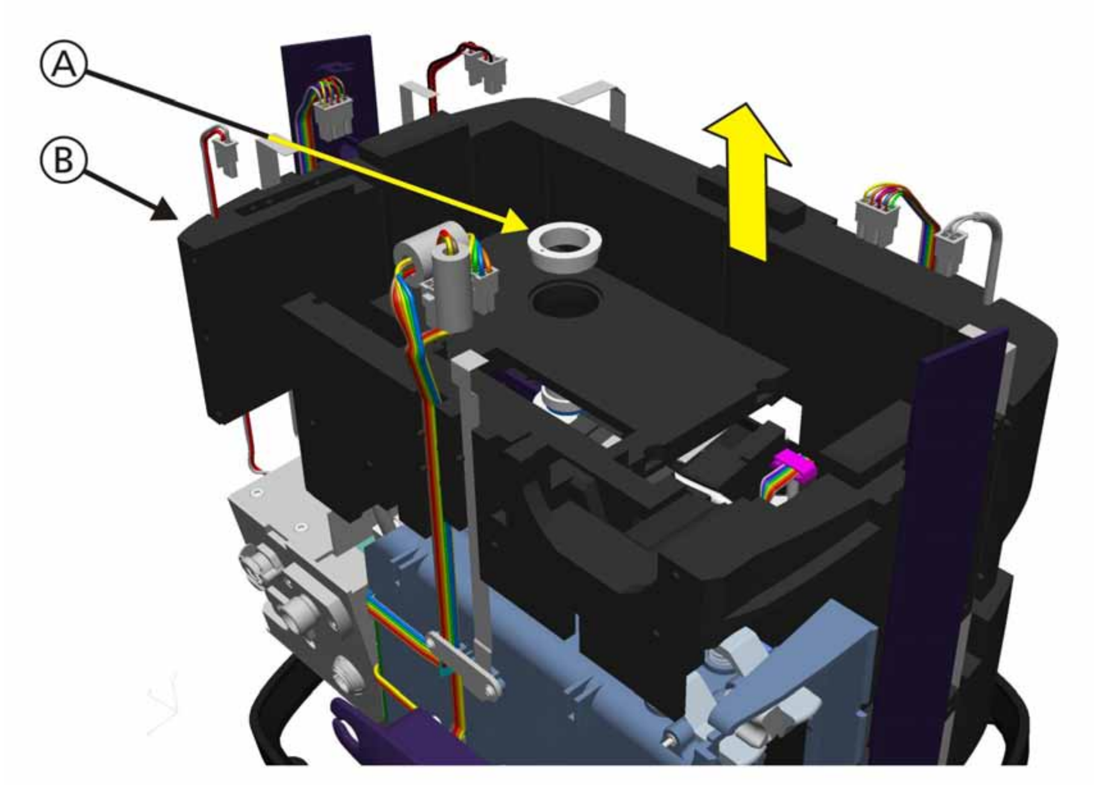


Figure 11-24. Middle Foam Section Removal, Step 1

Note
Be sure that all cables are free from the Middle foam section.

To remove the Middle Foam Section (PN 160238):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Cooling Fan, Power Supply and Blower Module (see Section 11.4.8, *Cooling Fan Removal/Assembly*, on page 11-26, Section 11.4.10, *Power Supply Removal/Assembly*, on page 11-28 and Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Unscrew the Tube Flange (A) used to fit the Blower Module (see Service Tool PN 500314) .
6. Lift the Middle Foam Section (B) from the Ventilation Unit.

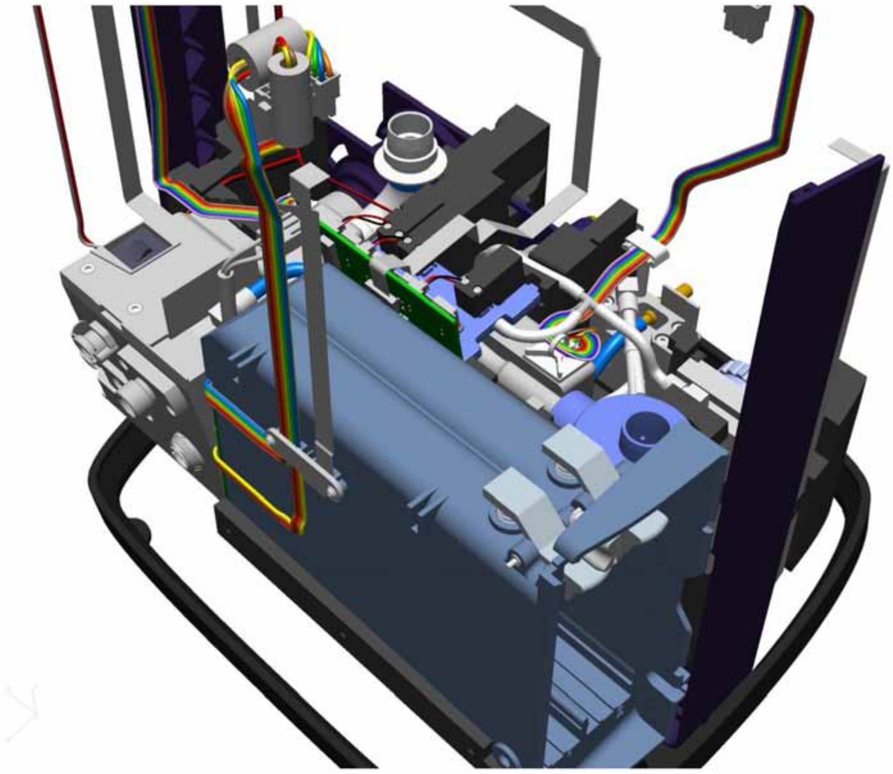


Figure 11-25. Middle Foam Section Removal, Step 2

7. Assemble in the reverse order of removal.

11.4.12 Pressure Sensor Assembly Pressure Sensor Assembly Removal/Assembly

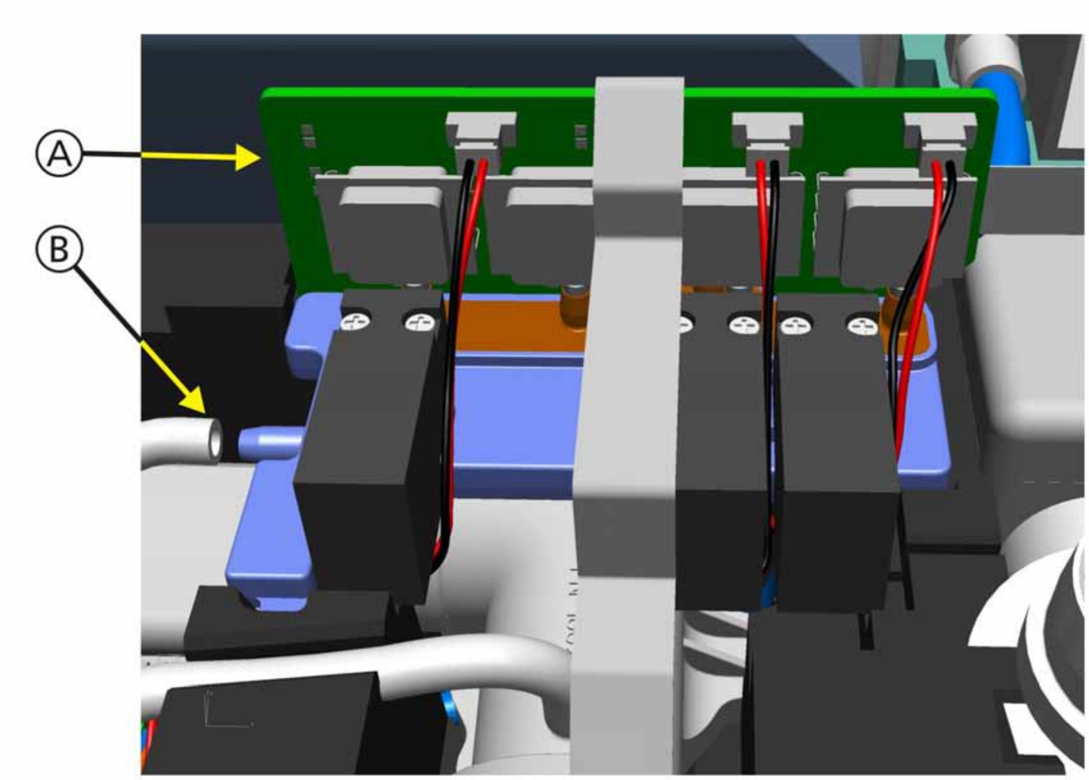


Figure 11-26. Pressure Sensor Assembly Removal, Step 1

To remove the Pressure Sensor Assembly (PN 160300):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Remove the Tubing (B) from the left side of the Pressure Sensor Assembly (A).

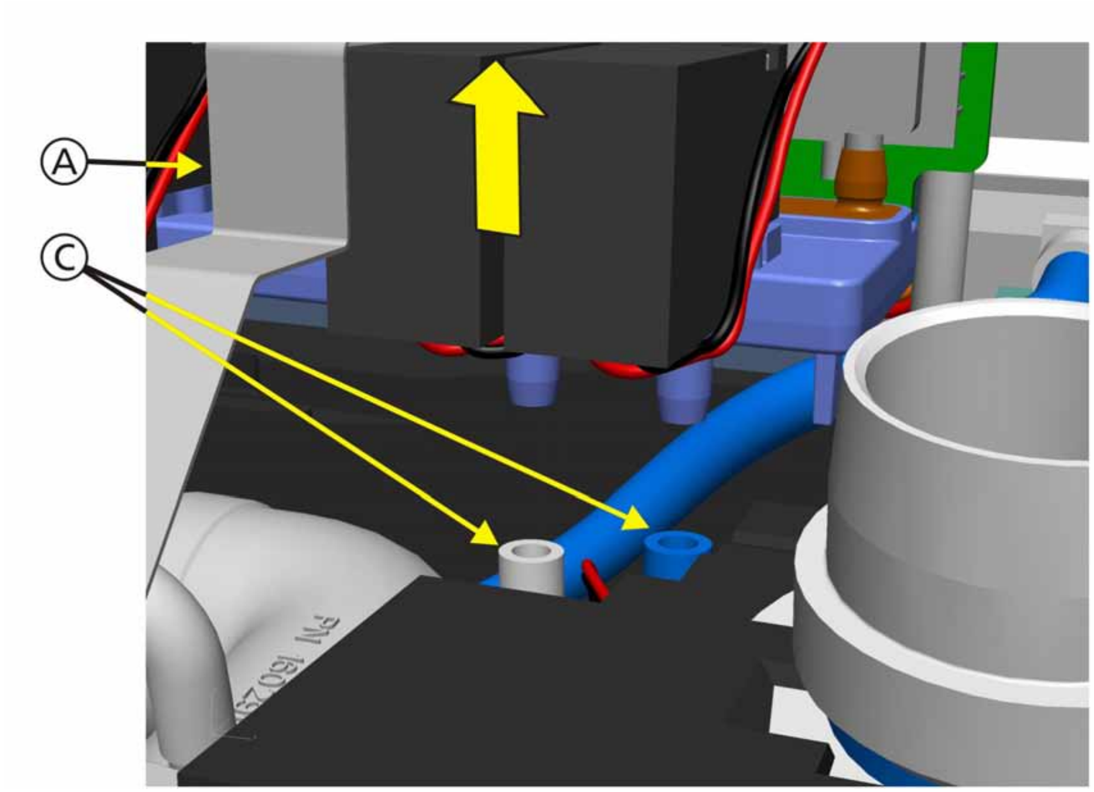


Figure 11-27. Pressure Sensor Assembly Removal, Step 2

6. Lift the Pressure Sensor Assembly (A) slightly to remove the 2 Tubings (C) from the bottom of the Pressure Sensor Assembly (A).

Note

The tubes are color coded.

7. Remove the Pressure Sensor Assembly (A).

8. Assemble in the reverse order of removal.

Note

Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.4.13 Inspiratory Valve Removal/Assembly

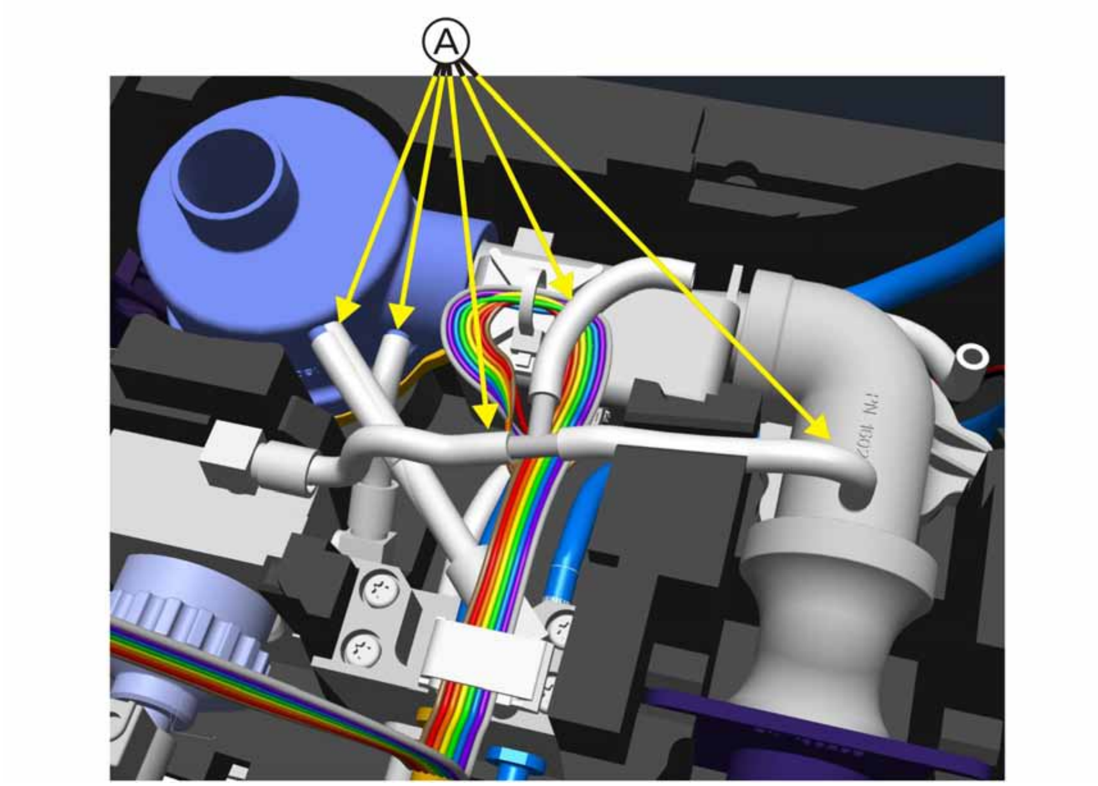


Figure 11-28. Inspiratory Valve Removal, Step 1

To remove the Inspiratory Valve (PN 160230):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Disconnect all Tubings (A) from the Inspiratory Valve.

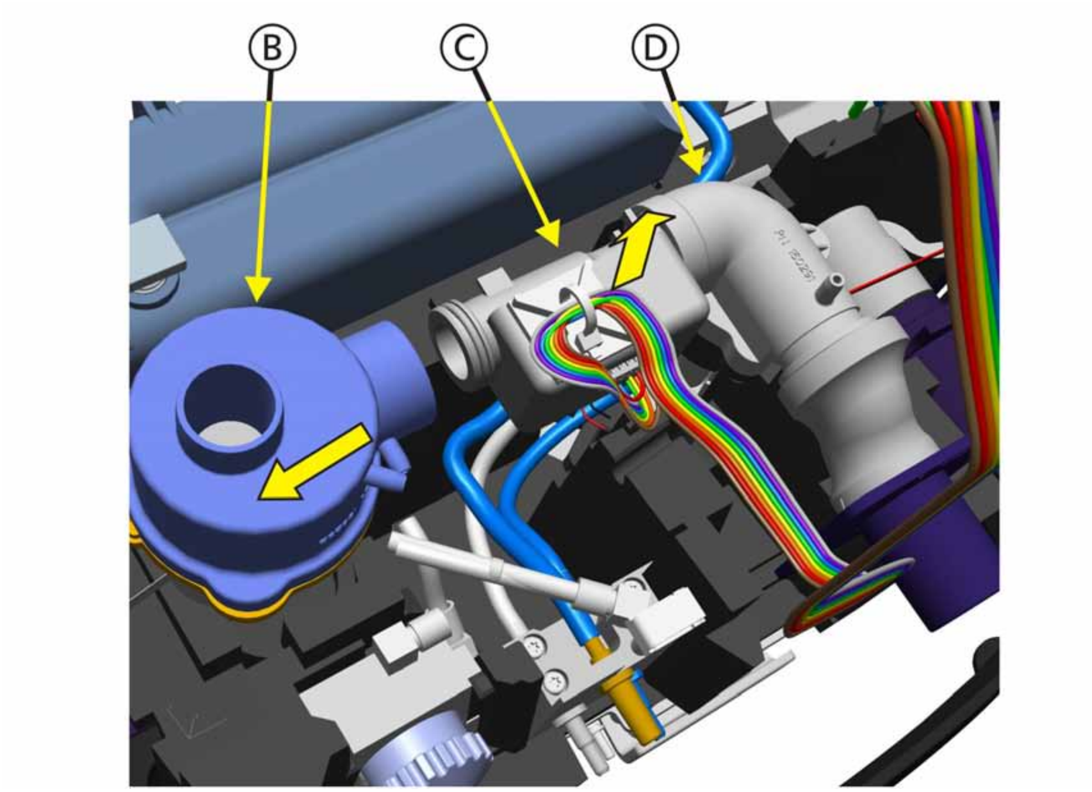


Figure 11-29. Inspiratory Valve Removal, Step 2

6. Lift the Inspiratory Valve (B), Qvent Flow Sensor (C) and Ambient Valve (D) as an assembly from the Bottom Foam Section of the Ventilation Unit.

7. Disconnect the Inspiratory Valve (B) from the Qvent Flow Sensor (C).

8. Assemble in the reverse order of removal.

Note
Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.4.14 Qvent Flow Sensor Removal/Assembly

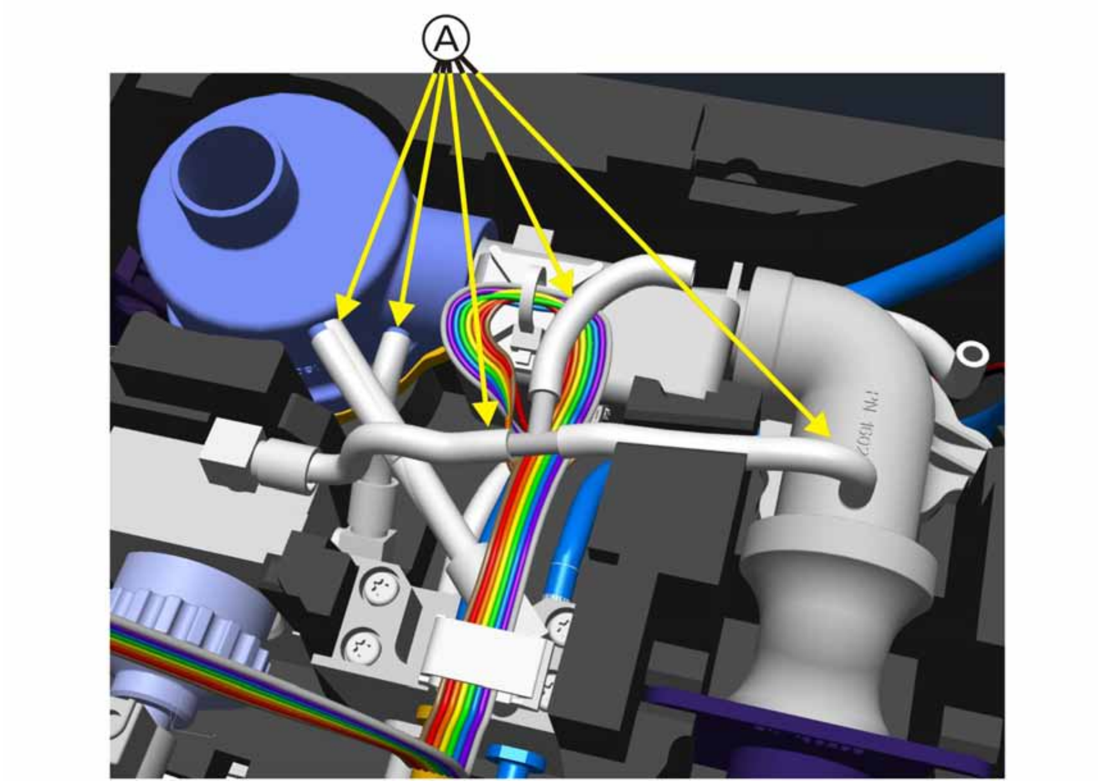


Figure 11-30. Qvent Flow Sensor Removal, Step 1

To remove the Qvent Flow Sensor (PN 399123):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Disconnect all Tubings (A).

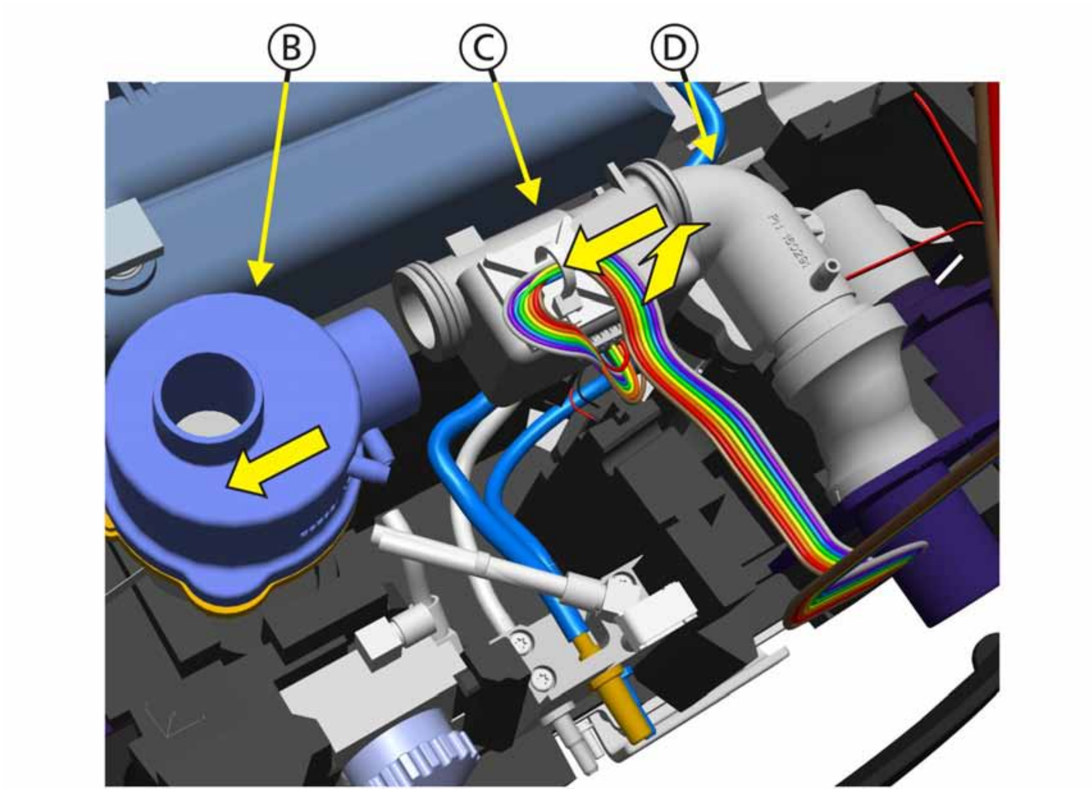


Figure 11-31. Qvent Flow Sensor Removal, Step 2

6. Lift the Inspiratory Valve (B), Qvent Flow Sensor (C) and Ambient Valve (D) as an assembly from the Bottom Foam Section of the Ventilation Unit.
7. Disconnect the Inspiratory Valve (B) from the Qvent Flow Sensor (C).
8. Disconnect the Qvent Flow Sensor (C) from the Ambient Valve (D).
9. Remove the Qvent Flow Sensor (C).
10. Assemble in the reverse order of removal.

Note
Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.4.15 Ambient Valve Removal/Assembly

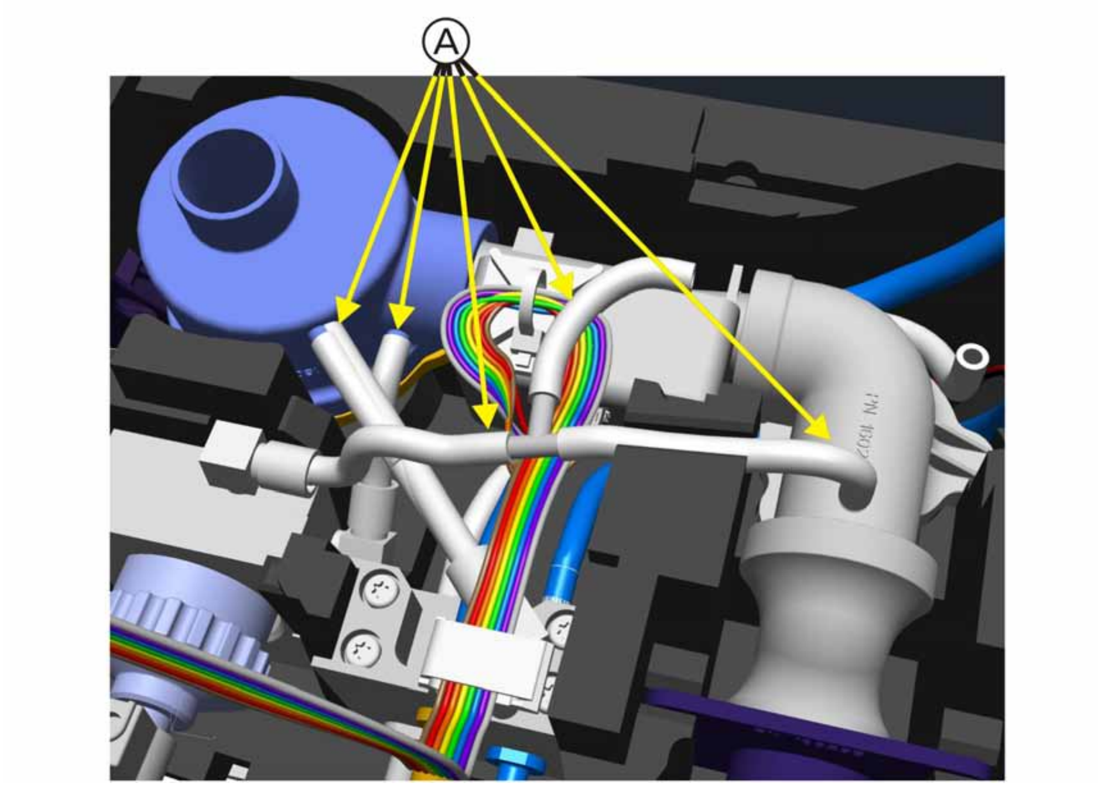


Figure 11-32. Ambient Valve Removal, Step 1

To remove the Ambient Valve (PN 160290):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Disconnect all Tubings (A).

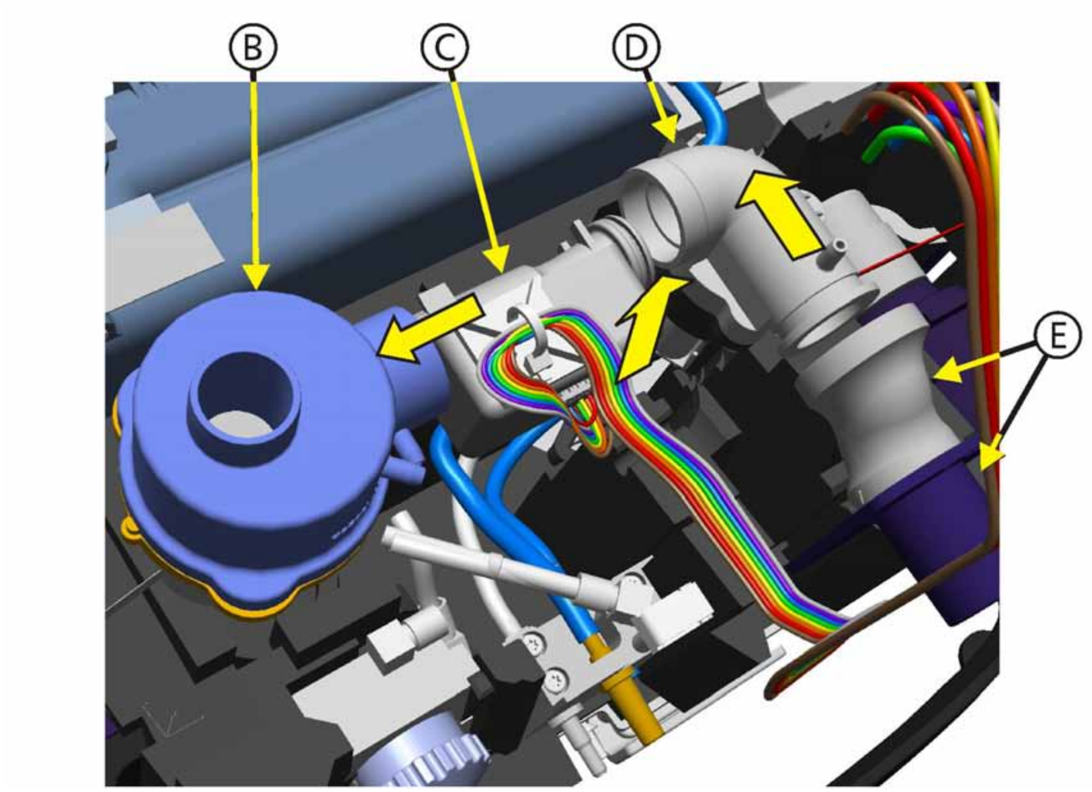


Figure 11-33. Ambient Valve Removal, Step 2

6. Lift the Inspiratory Valve (B), Qvent Flow Sensor (C) and Ambient Valve (D) as an assembly from the Bottom Foam Section of the Ventilation Unit.

7. Disconnect the Inspiratory Valve (B) and the Qvent Flow Sensor (C) from the Ambient Valve (D).

8. Disconnect the Patient Connection Tubes (E) from the Ambient Valve (D).

9. Remove the Ambient Valve (D).

10. Assemble in the reverse order of removal.

Note
Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.4.16 Expiratory Valve Removal/Assembly

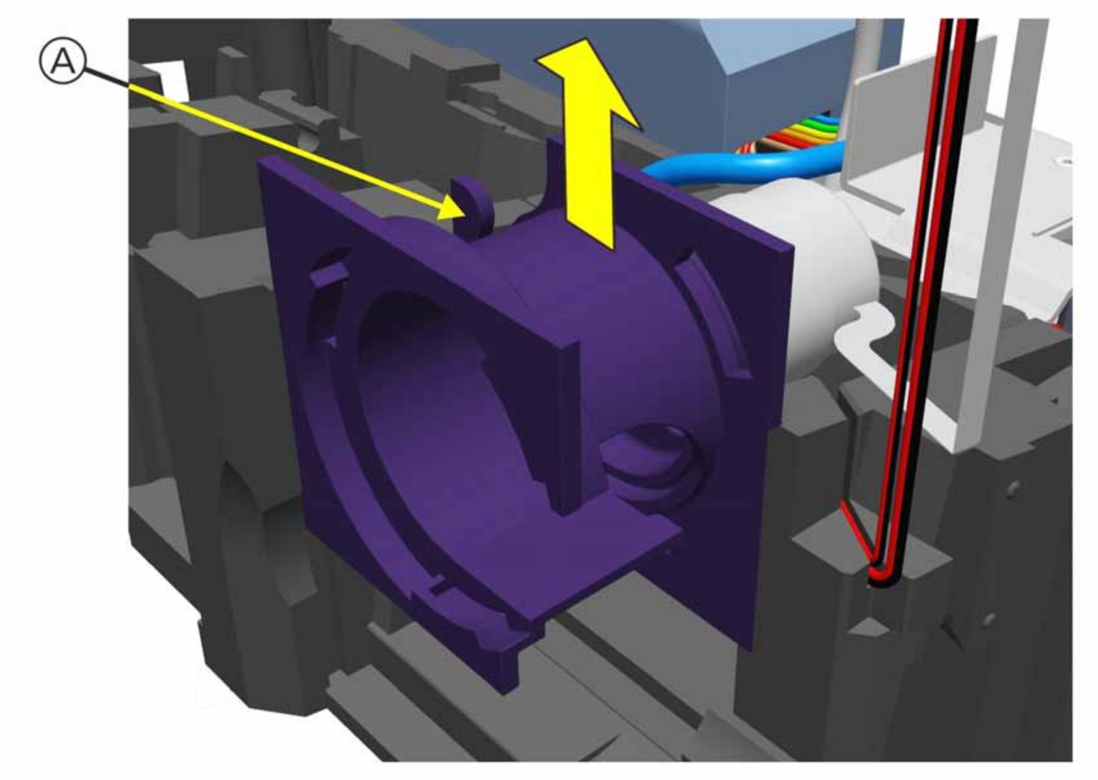


Figure 11-34. Expiratory Valve Removal

To remove the Expiratory Valve (PN 160240):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Lift the Expiratory Valve Assembly (A) from the Bottom Foam Section of the Ventilation Unit.
6. Remove the Expiratory Valve Assembly (A).
7. Assemble in the reverse order of removal.

Note
Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.4.17 Front Panel Connector Block Removal/Assembly

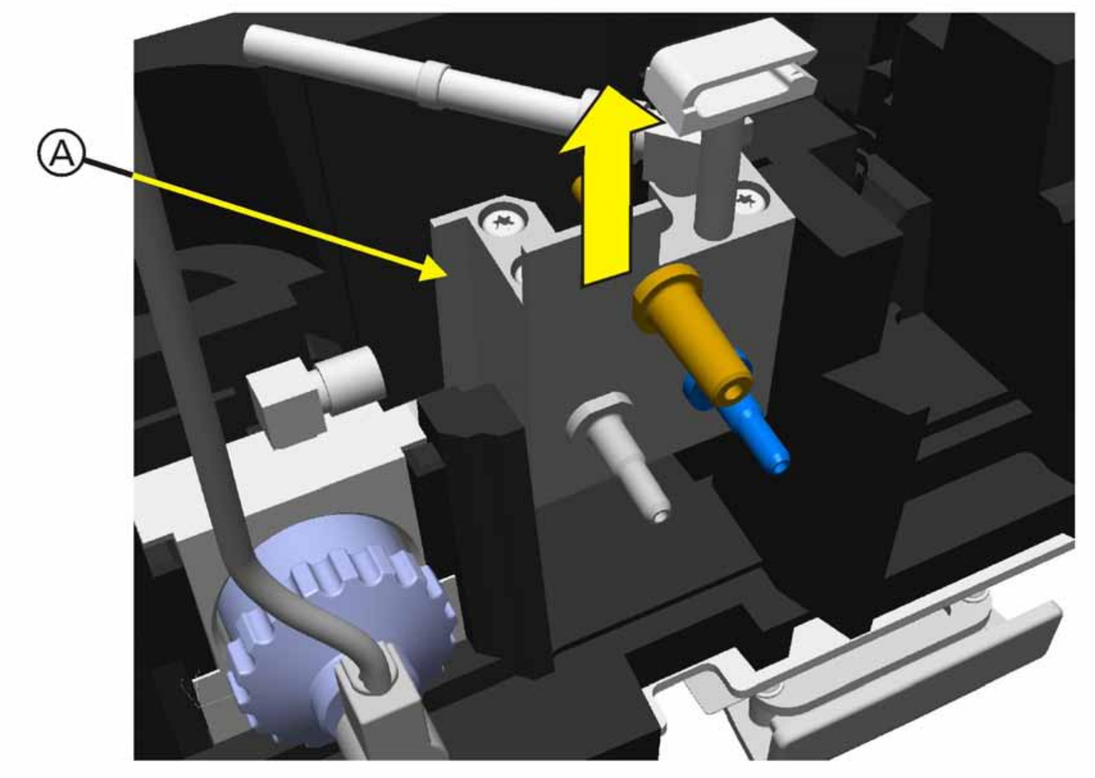


Figure 11-35. Front Panel Connector Block Removal

To remove the Front Panel Connector Block (PN 160472):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Disconnect tubing if not already disconnected.
6. Lift the Front Panel Connector Block (A) from the Bottom Foam Section. Before remove the screws.
7. Remove the Front Panel Connector Block (A).
8. Assemble in the reverse order of removal.

11.4.18 Oxygen Sensor Block Removal/Assembly

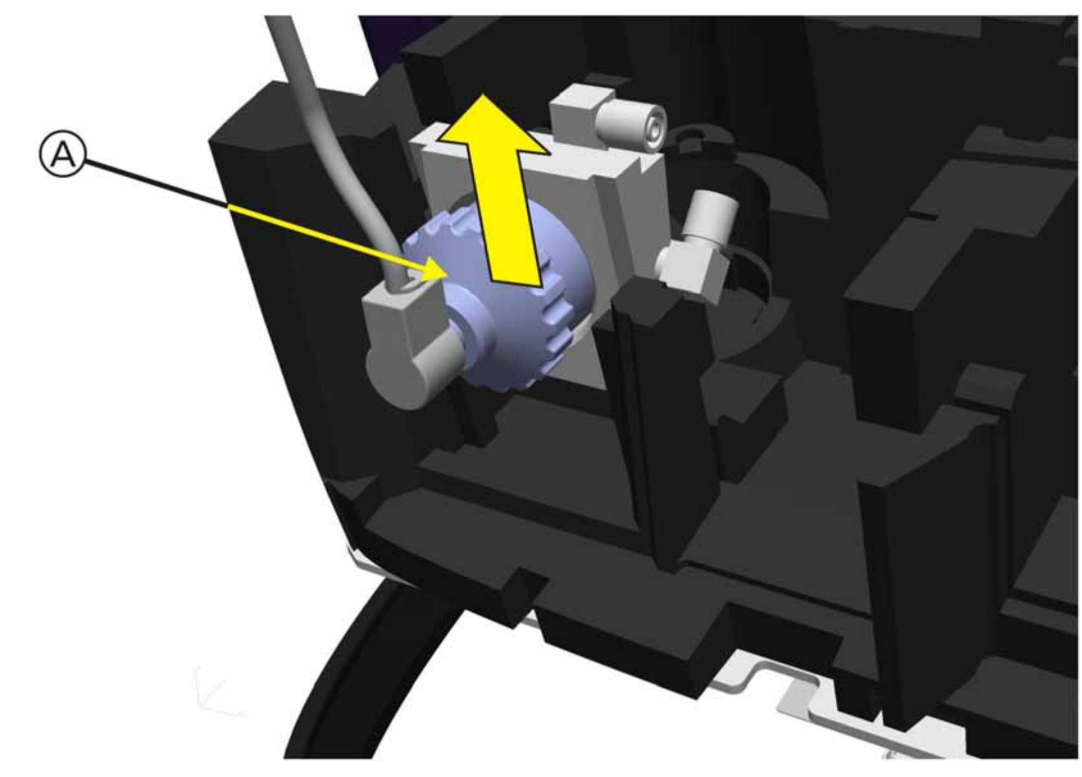


Figure 11-36. Oxygen Sensor Block Removal

To remove the Oxygen Sensor Block (PN 160100):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Lift the Oxygen Sensor Block (A) from the Bottom Foam Section.
6. Remove the Oxygen Sensor Block (A).
7. Assemble in the reverse order of removal.

11.4.19 Battery Compartment Removal/Assembly

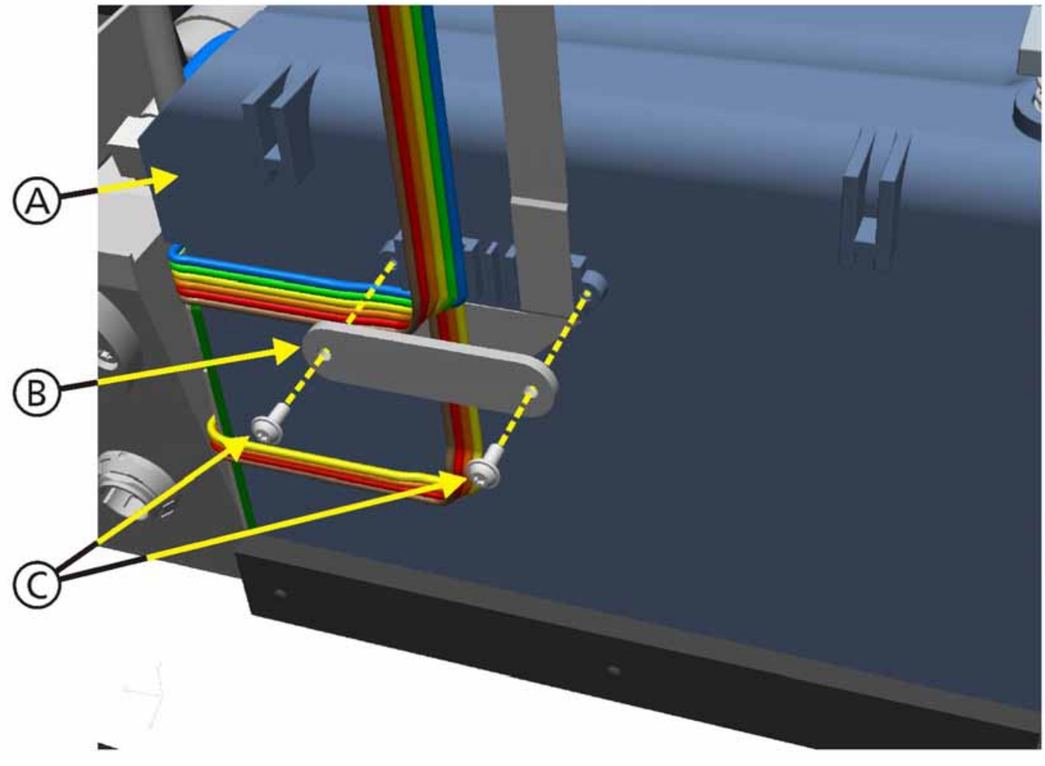


Figure 11-37. Battery Compartment Removal, Step 1

To remove the Battery Compartment (PN 160302):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Remove 2 Torx screws (C) (PN 420699) to remove the Cable Clamp (B) (PN 160405) from the rear of the Battery Compartment (A).

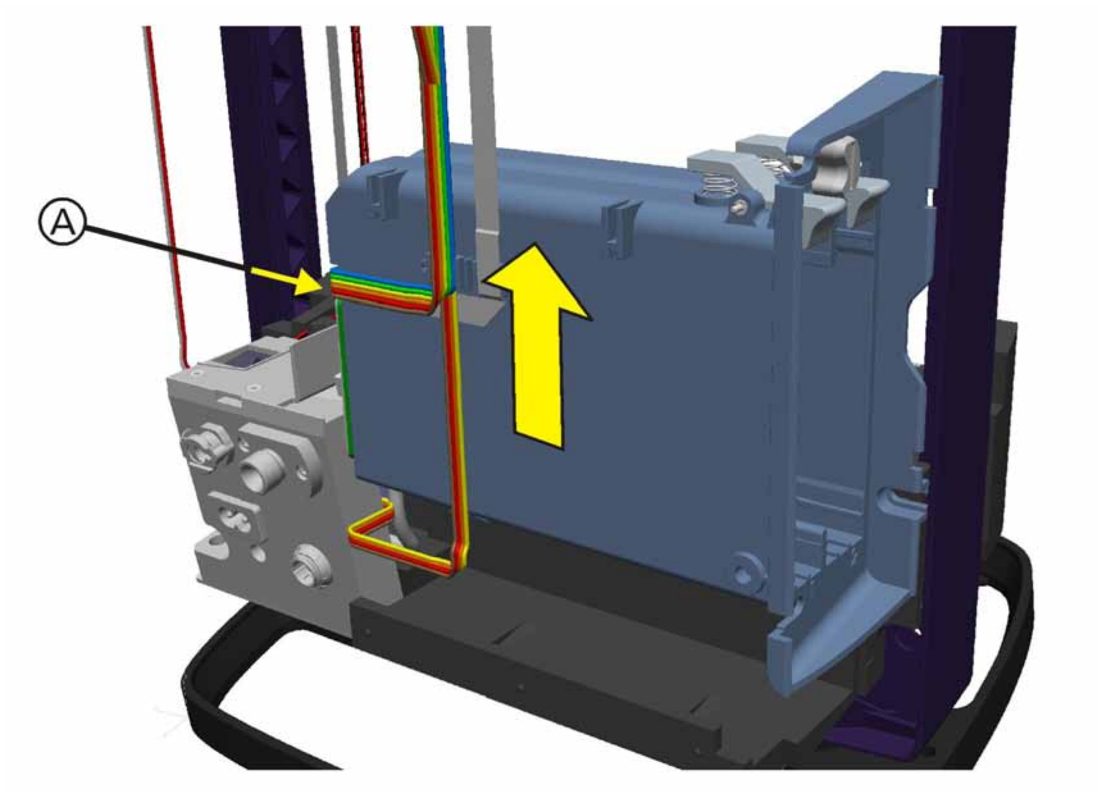


Figure 11-38. Battery Compartment Removal, Step 2

6. Lift the Battery Compartment (A) from the Bottom Foam Section of the Ventilation Unit.
7. Remove the Battery Compartment (A).
8. Assemble in the reverse order of removal.

11.4.20 Mixer Block Module Removal/Assembly

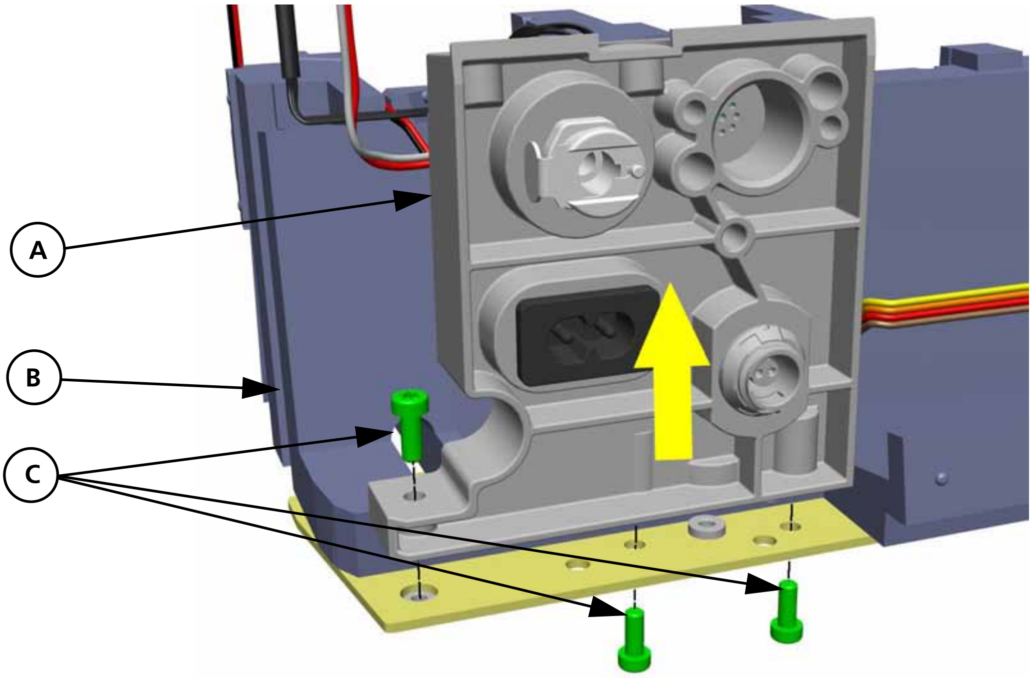


Figure 11-39. Mixer Block Removal

1. To remove the Mixer Block Assembly:
2. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
3. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
4. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
5. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
6. Remove 3 Torx screws (C) (PN 420657) attaching the Mixer Block Assembly (A) to the Base Plate (B).
7. Assemble in the reverse order of removal.

11.4.21 Mixer Block Removal/Assembly

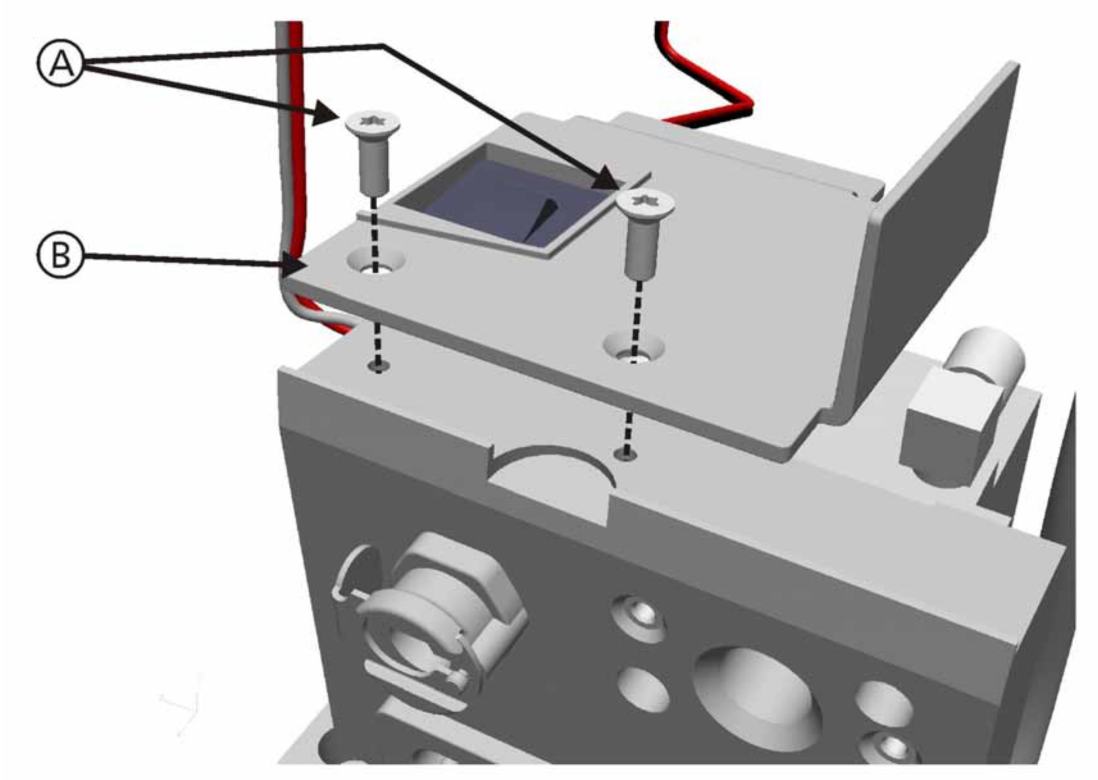


Figure 11-40. Mixer Block Removal, Step 1

1. To remove the Mixer Block Assembly (PN 160226):
2. Disconnect the wiring connections to the 2A Circuit Breaker.
3. Remove 2 Torx screws (A) (PN 420664) to remove the Top Cover (B).

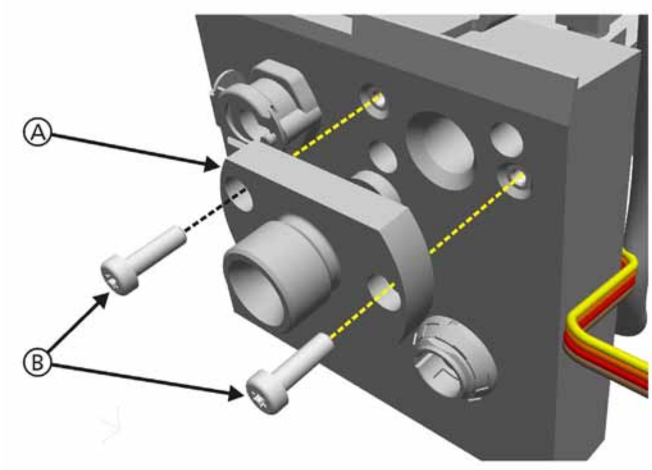


Figure 11-41. Mixer Block Removal, Step 2

4. Remove the High Pressure Oxygen Connector (see Section 11.4.21, *High Pressure Oxygen Connector Removal/Assembly*, on page 11-45).
5. Remove 2 Torx screws (C) (PN 420720) from the Mixer Block.

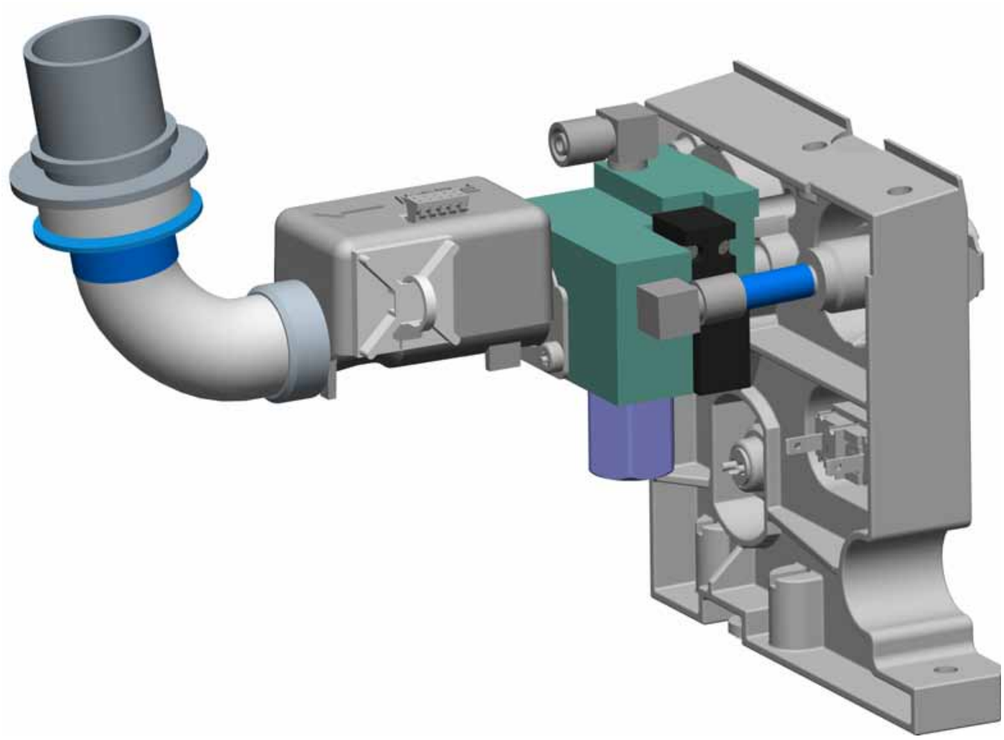


Figure 11-42. Mixer Block Removal, Step 3

6. Remove the Mixer Block Assembly.
7. Assemble in the reverse order of removal.

Note
Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

11.4.22 Pressure Oxygen Connector Removal/Assembly

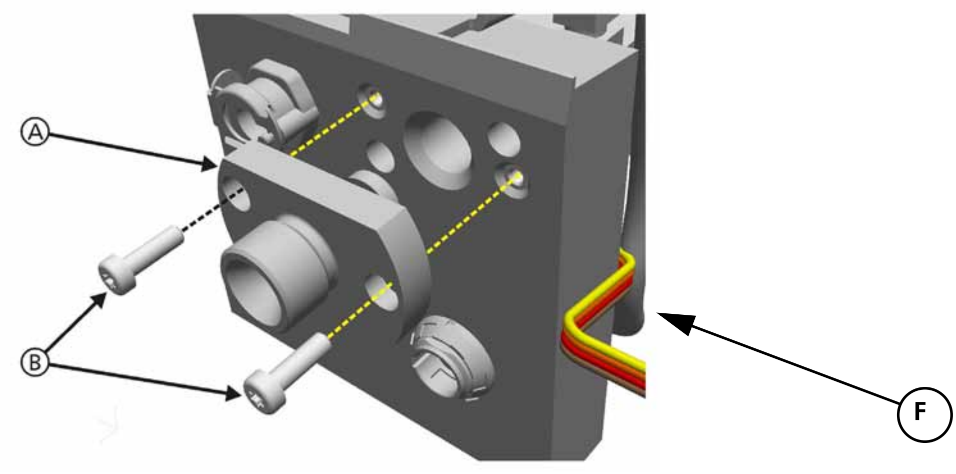


Figure 11-43. High Pressure Oxygen Connector Removal

1. To remove the High Pressure Oxygen DISS (PN 160470) or NIST (PN 160471) Connector:
2. Remove 2 Torx screws (A) (PN 420734) to remove the High Pressure Oxygen DISS or NIST Connector (B).
3. Assemble in the reverse order of removal.

11.4.23 Nebulizer Valve Removal/Assembly

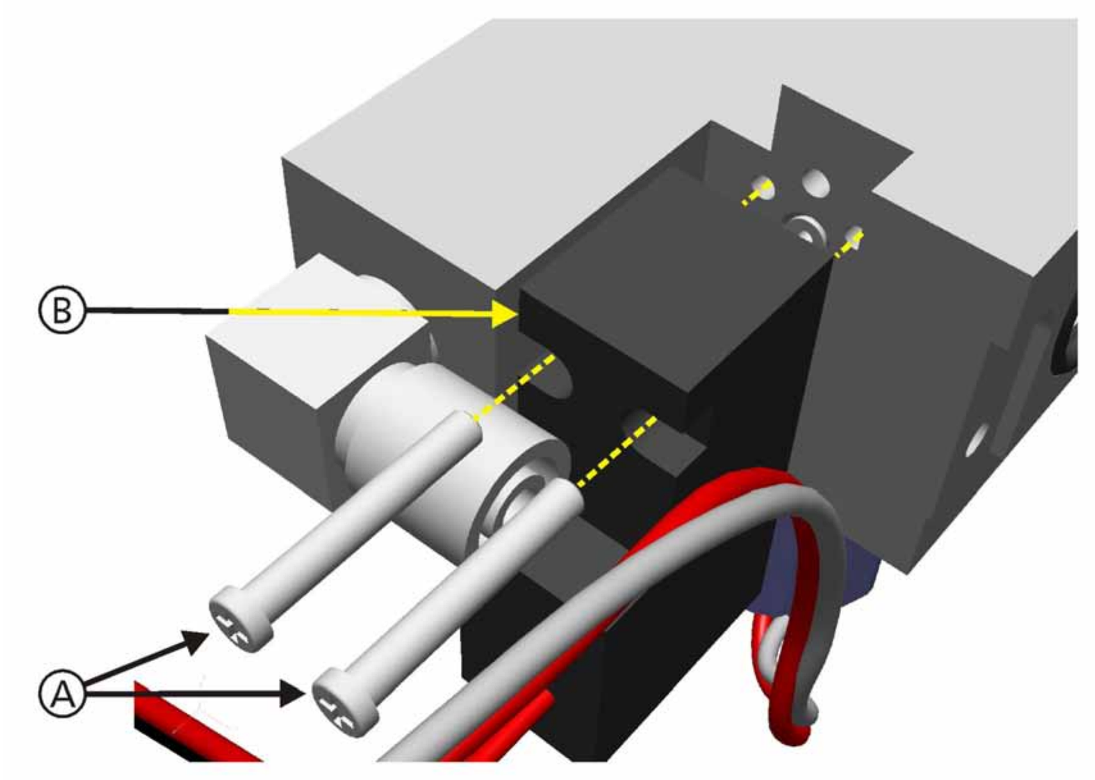


Figure 11-44. Nebulizer Valve Removal

To remove the Nebulizer Valve (PN 160400) from the Mixer Block:

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Remove the Bottom Foam Section (see Section 11.4.20, *Mixer Block Module Removal/Assembly*, on page 11-44).
6. Remove 2 Phillips screws (A) from the Nebulizer Valve (B).
7. Remove the Nebulizer Valve (B).
8. Assemble in the reverse order of removal.

11.4.24 Bottom Foam Section Removal/Assembly

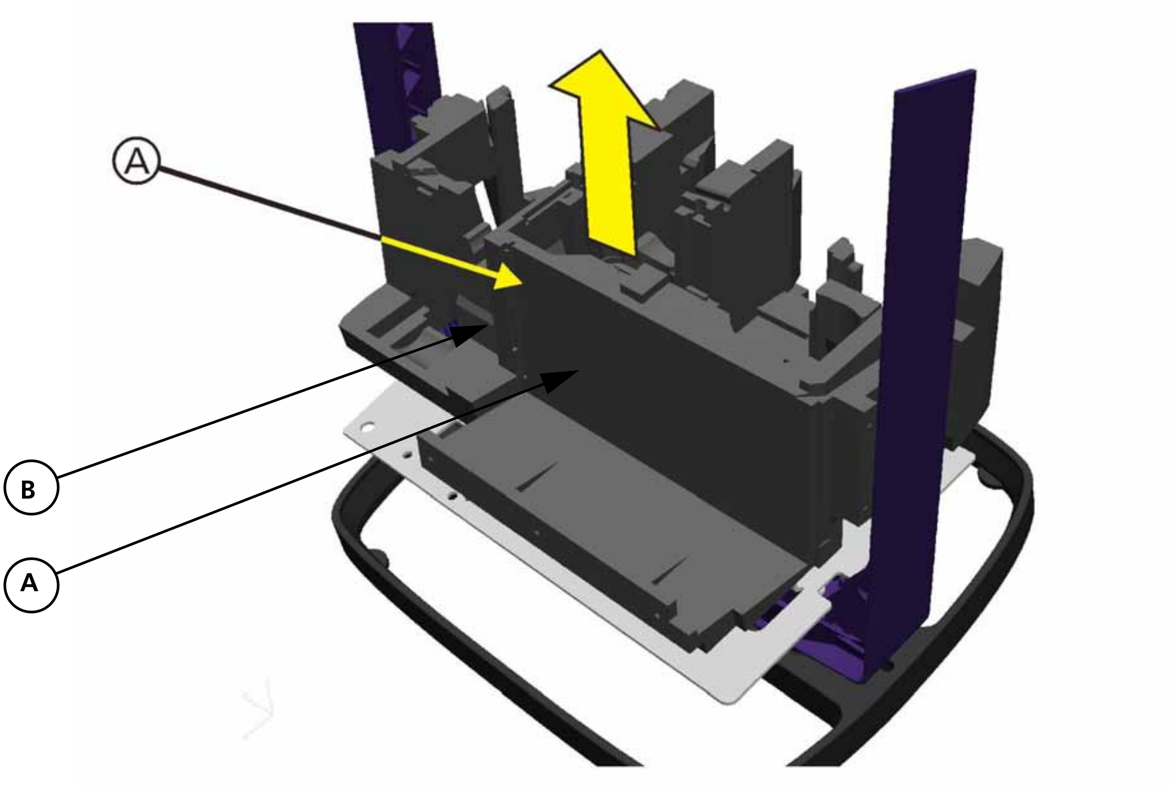


Figure 11-45. Bottom Foam Section Removal

To remove the Bottom Foam Section (PN 160237):

1. Remove the Top Cover (see Section 11.3.1, *Ventilation Unit Top Cover Removal/Assembly*, on page 11-6).
2. Remove the Front and Rear Covers from the Ventilation Unit (see Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21).
3. Remove the Top Foam Section from the Ventilation Unit (see Section 11.4.7, *Top Foam Section Removal/Assembly*, on page 11-24).
4. Remove the Middle Foam Section from the Ventilation Unit (see Section 11.4.11, *Middle Foam Section Removal/Assembly*, on page 11-29).
5. Remove the Bottom Foam Section (A) from the Ventilation Unit Base Frame.
6. Assemble in the reverse order of removal.

11.5 Ventilation Unit Components, Tubings and Cables Assembly

This section is provided to assist in the re-assembly of the HAMILTON-C2 Ventilation Unit. The positioning of Components and Component Assemblies and routing of Tubings and Cables are critical in the assembly.

The Foam Sections (Top, Middle and Bottom) are formed for all the different Components, Tubings and Cables.

11.5.1 Contents in this Section

11.5.2 Figures in this Section

11.5.3 Oxygen Mixer Block Assembly

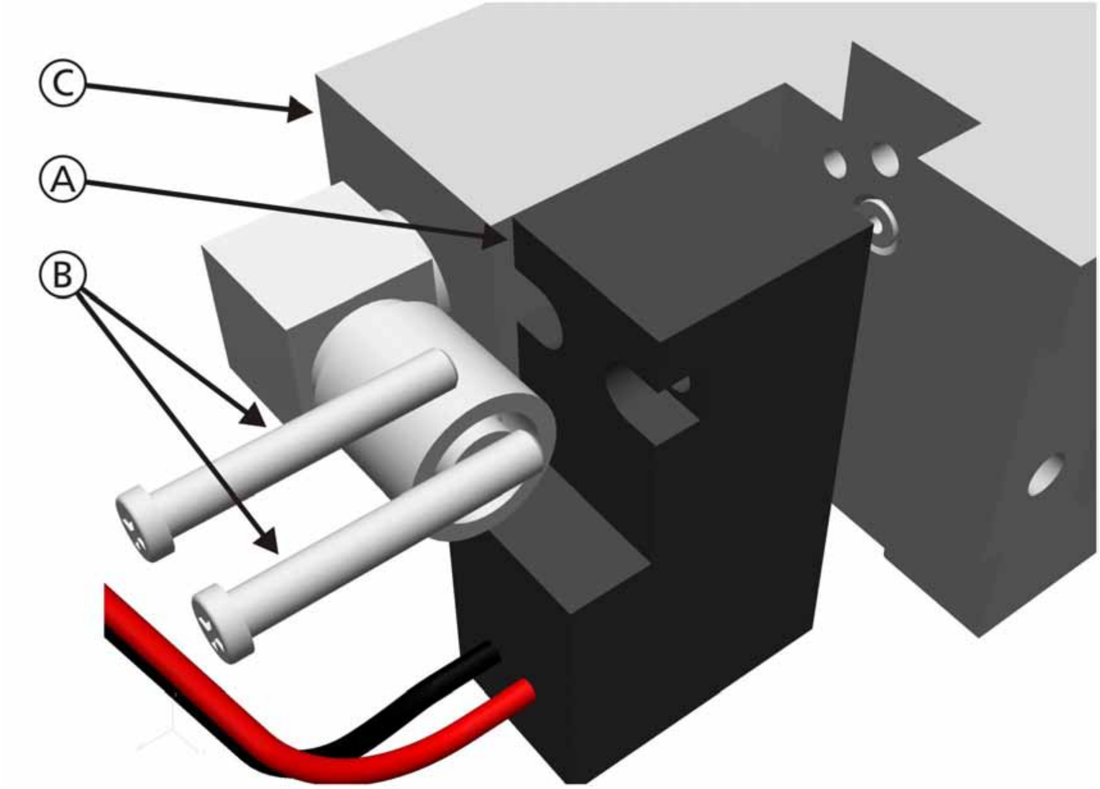


Figure 11-46. Oxygen Mixer Block Assembly, Step 1

1. Attach the Nebulizer Valve (A) (PN 160400) with 2 Phillips Head screws (B) supplied to the Oxygen Mixer Block Assembly (C).

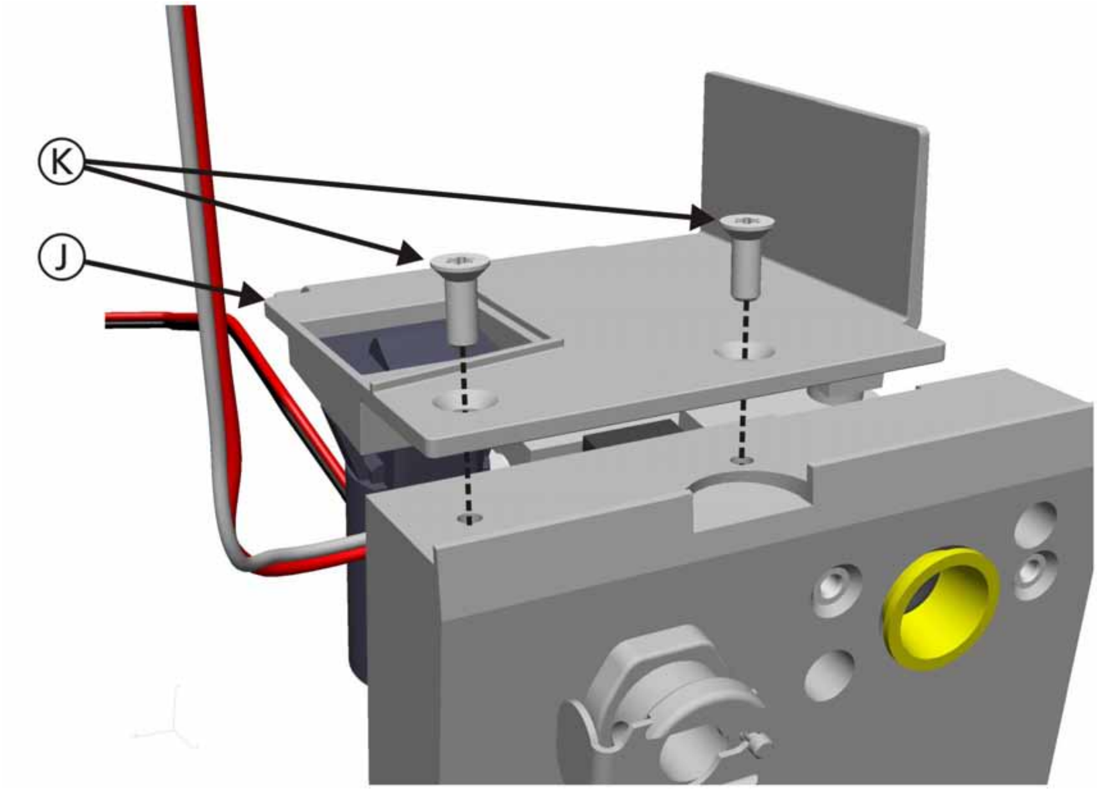


Figure 11-47. Oxygen Mixer Block Assembly, Step 4

2. Attach the Oxygen Mixer Block Assembly Cover Plate (J) (PN 160459) to the Oxygen Mixer Block Assembly with 2 Torx screws (K) (PN 420664).

11.5.3.1 Mains Power Cable Assembly

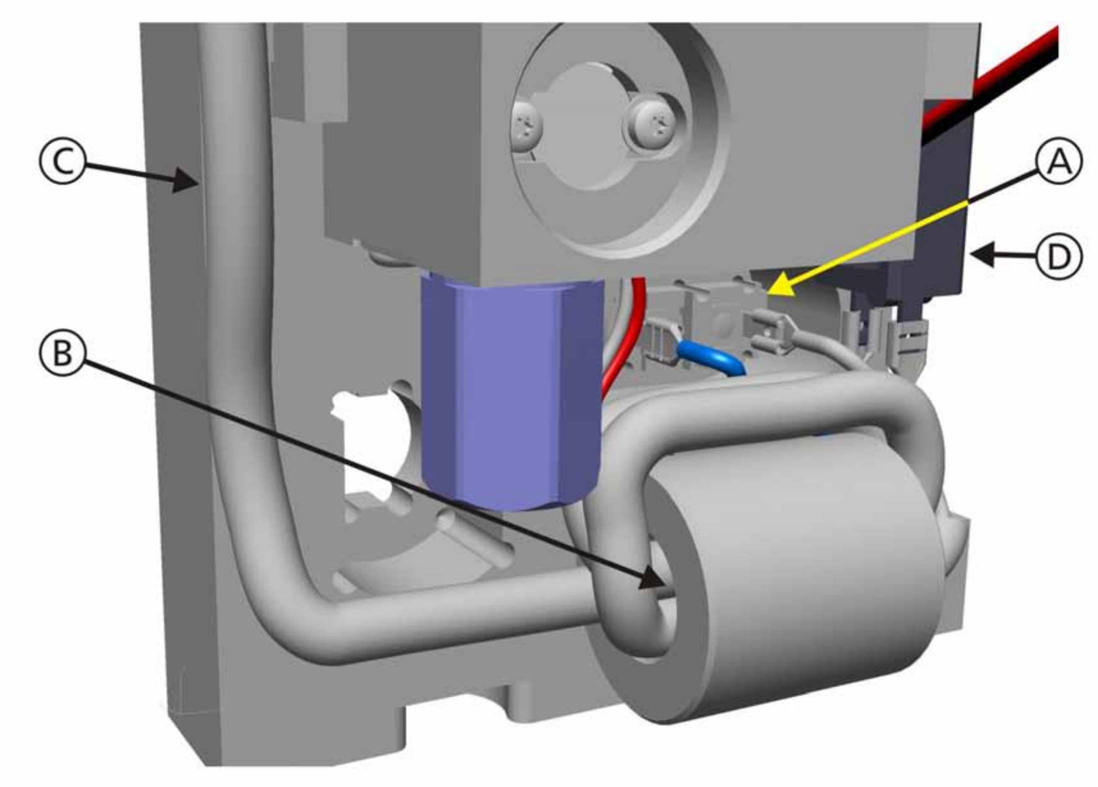


Figure 11-48. Mains Power Cable Assembly

1. The Mains Power Cable (C) (PN 160348) is connected to the Mains Power Connector (A), with one side connected to the 2A Circuit Breaker (D) (PN 378009), then routed thru a Ferrite Core (B) and positioned on the side of the Mixer Block Assembly (C).
2. It will then be connected to the Power Supply when assembled.

11.5.3.2 DC Input Power Cable Assembly

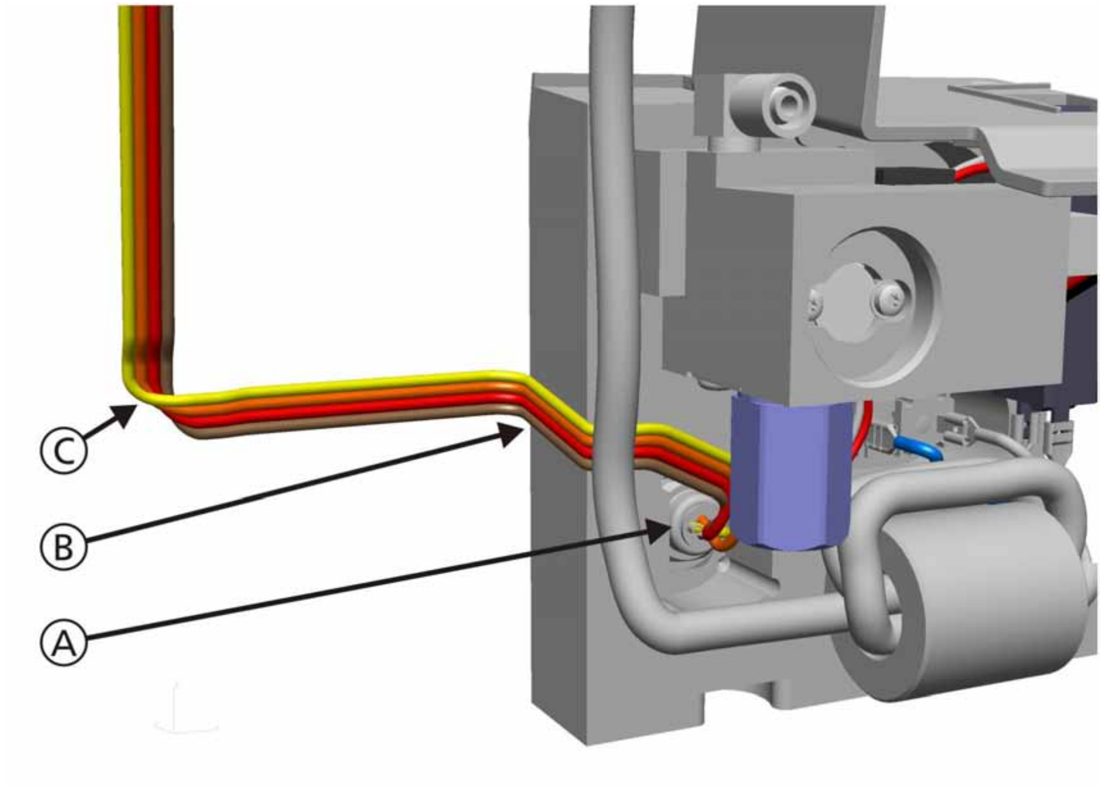


Figure 11-49. DC Input Power Cable Assembly

1. The DC Input Power Cable (B) (PN 160372) from the DC Power Connector (A) is positioned on the side of the Mixer Block Assembly (B) and will be attached to the Battery Compartment (C) when assembled.
2. It will then be connected to the Ventilation Unit Mainboard when assembled.

11.5.4 Bottom Foam Section Assembly

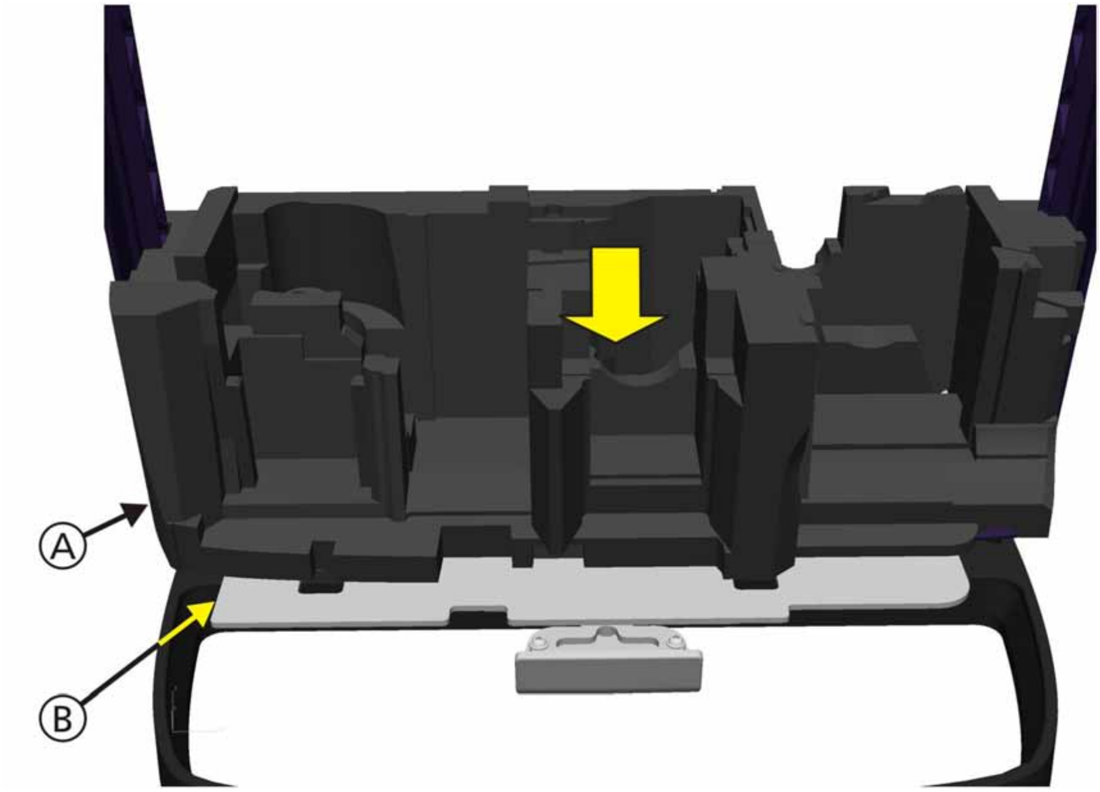


Figure 11-50. Bottom Foam Section Assembly

1. The Bottom Foam Section (A) (PN 160237) is positioned onto the Chassis Frame (B).

11.5.5 Oxygen Mixer Block Assembly Mounting

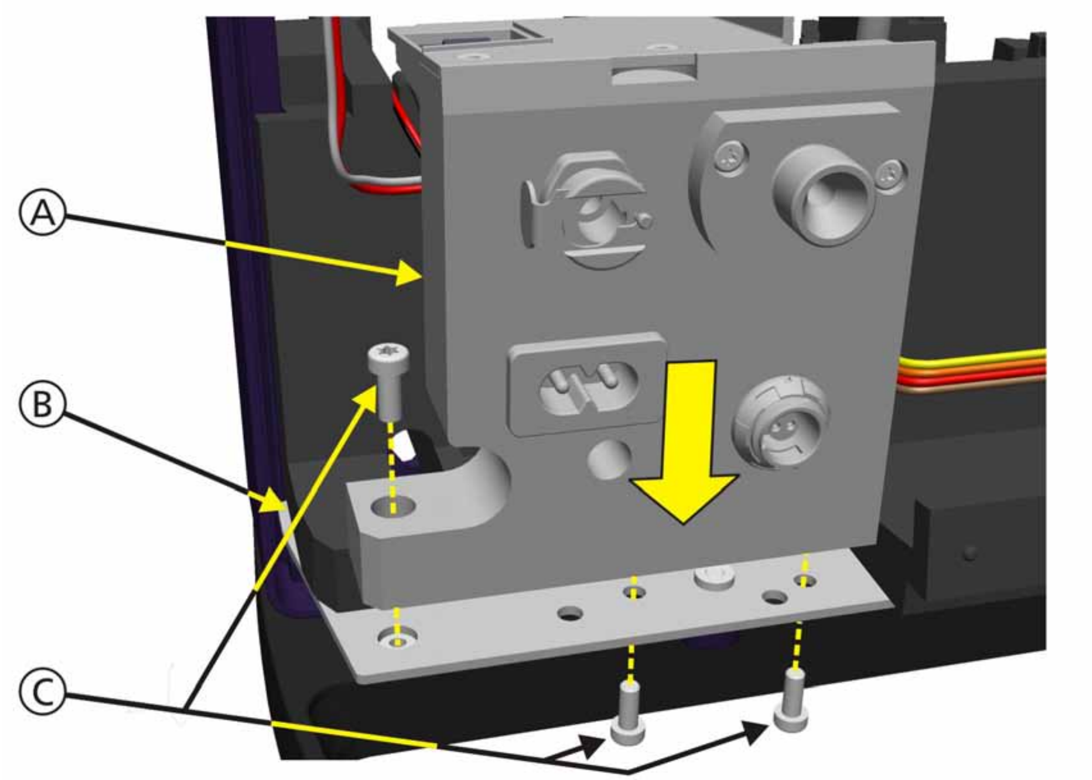


Figure 11-51. Oxygen Mixer Block Assembly Mounting

1. The Oxygen Mixer Block Assembly (A) is mounted to the Chassis (B) with 3 Torx screws (C) (PN 420657).

11.5.6 Oxygen Mixer Valve Cable Assembly

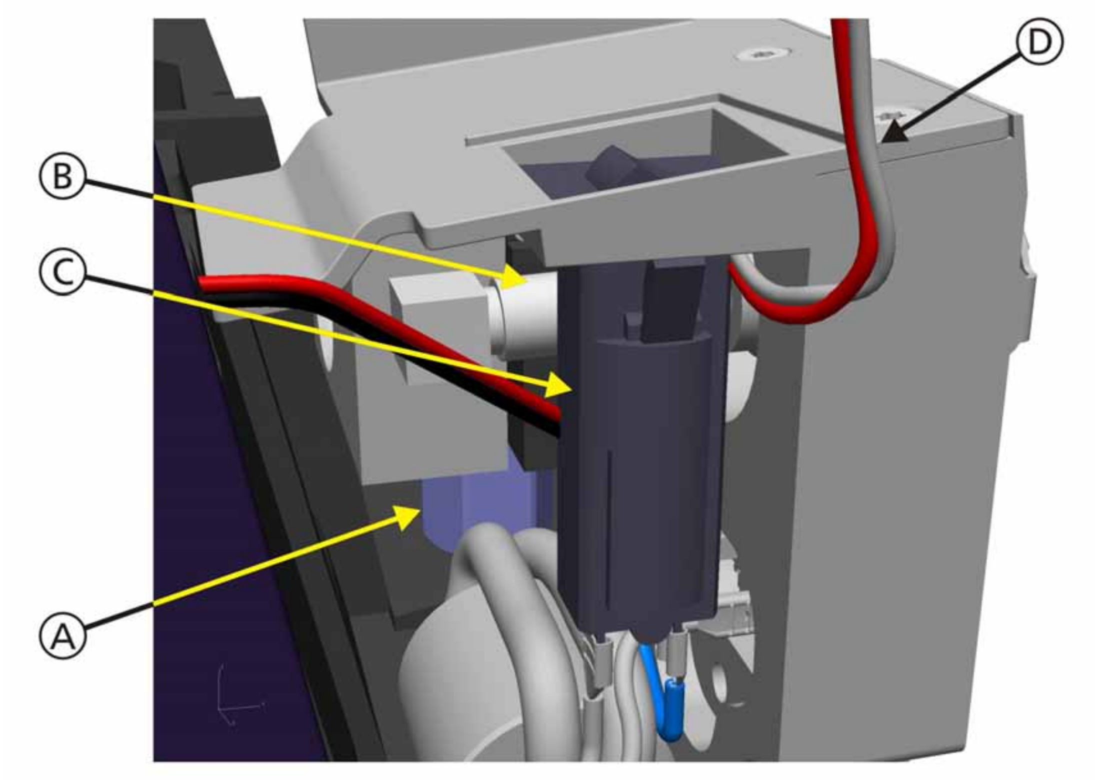


Figure 11-52. Oxygen Mixer Valve Cable Assembly

1. The Oxygen Mixer Valve Cable (D) (part of the Oxygen Mixer Valve, no part number) from the Oxygen Mixer Valve (A) is positioned over the Low Pressure Oxygen Input Tubing (B) and behind the 2A Circuit Breaker (C), then placed to the side of the Mixer Block Assembly (D).
2. The Cable will route on the side of the Middle and Top Foam Sections when assembled.
3. It will then be connected to the Ventilation Unit Mainboard when assembled.

11.5.7 Nebulizer Cable Assembly

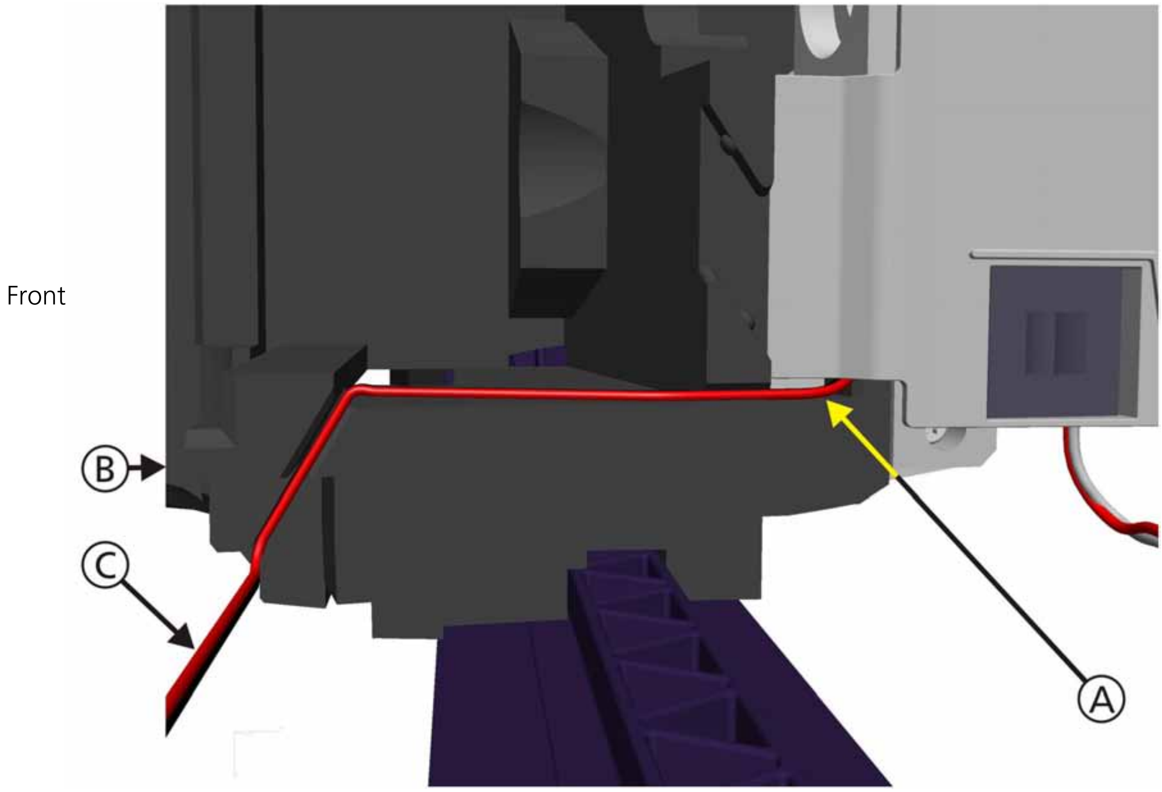


Figure 11-53. Nebulizer Cable Assembly (Top View)

1. The Nebulizer Cable (A) (part of the Nebulizer Valve, no part number) from the Nebulizer Valve is positioined in a channel of the Bottom Foam Section (B) and routed to the right side of the Ventilator (C).
2. The Cable will route on the side of the Middle and Top Foam Sections when assembled.
3. It will then be connected to the Ventilation Unit Mainboard when assembled.

11.5.8 Battery Compartment Assembly

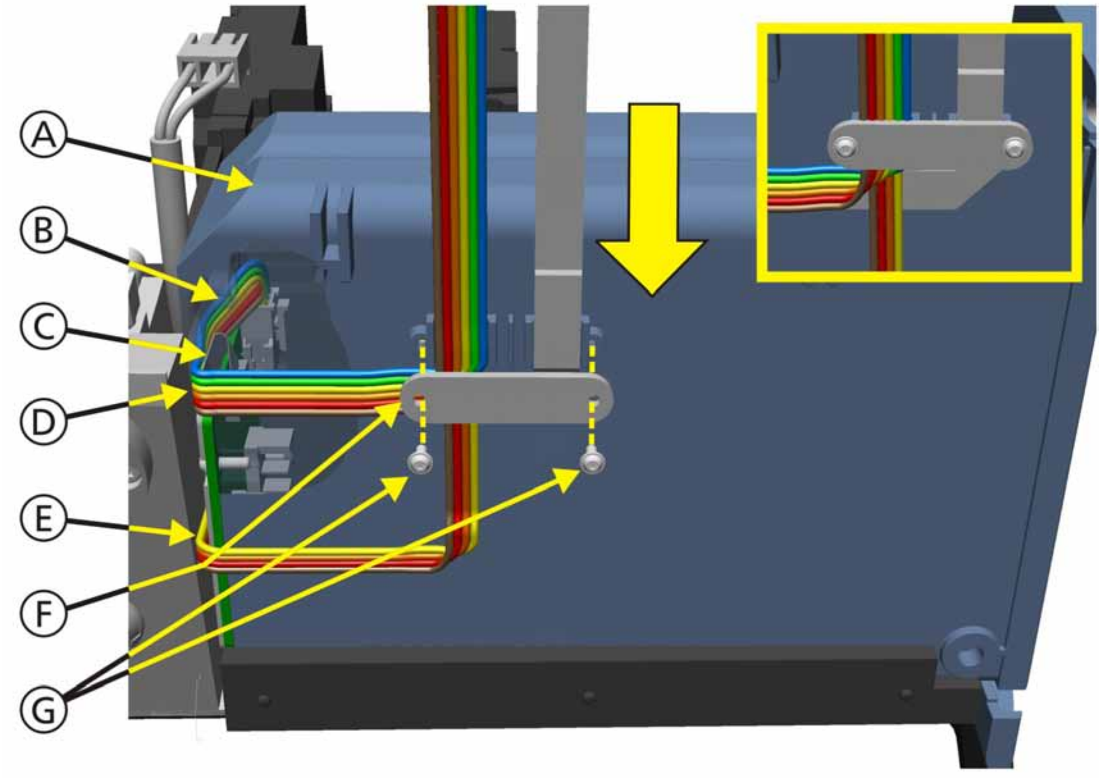


Figure 11-54. Battery Compartment Assembly

1. The Battery Compartment (A) is positioned at the rear of the Bottom Foam Section.
2. The Battery Power Cable (B) (PN 160350) and the Battery Data FFC (C) (PN 160351) are routed to the rear of the Battery Compartment (D). They are secured along with the DC Input Power Cable (E) (PN 160372) to the rear of the Battery Compartment with the Cable Clamp (F) (PN 160405) and 2 Torx screws (G) (PN 420699).
3. It will then be connected to the Ventilation Unit Mainboard when assembled.

11.5.9 Expiratory Valve Assembly

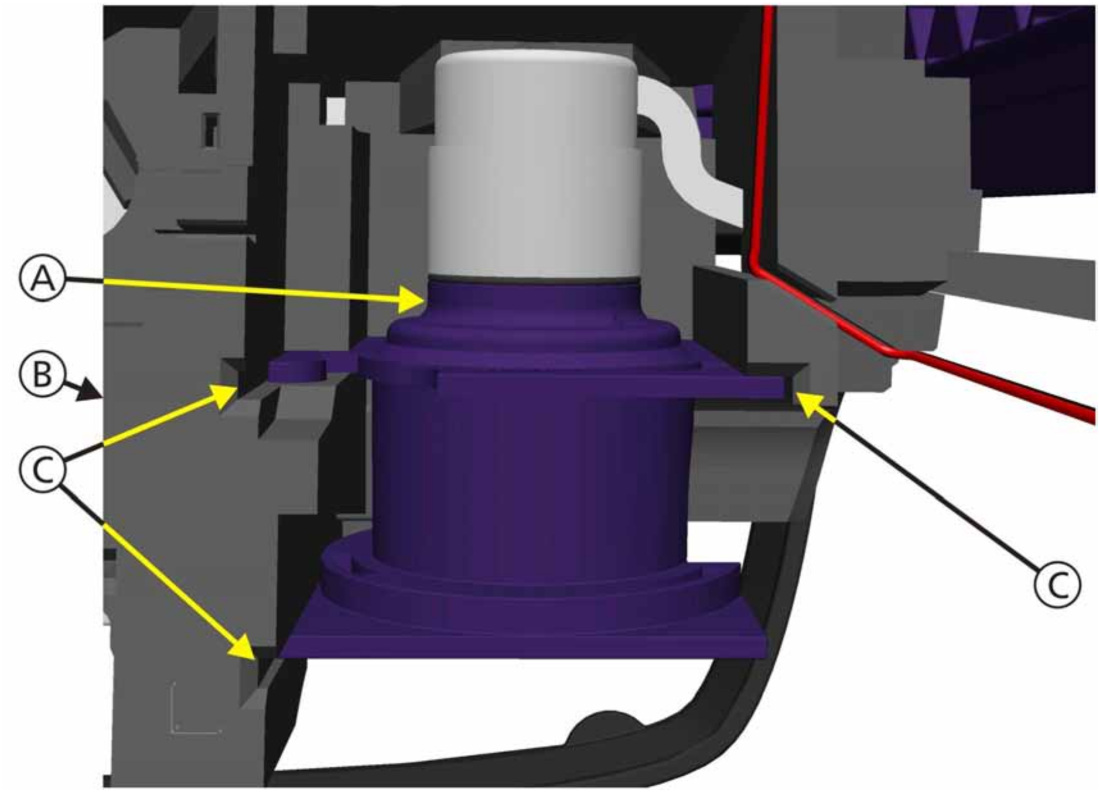


Figure 11-55. Expiratory Valve Assembly, Step 1

1. The Expiratory Valve (A) (PN 160240) is positioned with 3 slots (C) into the Bottom Foam Section (B).

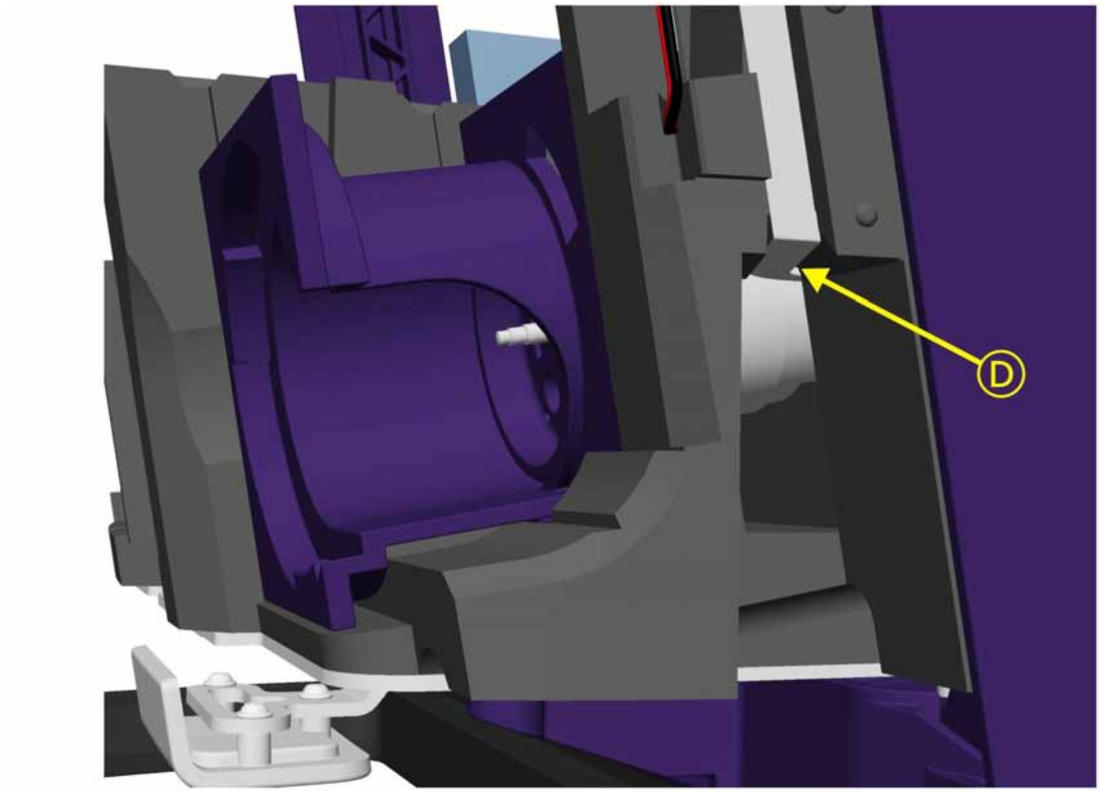


Figure 11-56. Expiratory Valve Assembly, Step 2

2. The Expiratory Valve FFC (D) (part of the Expiratory Valve, no part number) is routed under a channel in the Bottom Foam Section to the side.
3. The Cable will route on the side of the Bottom, Middle and Top Foam Sections when assembled.
4. It will then be connected to the Ventilation Unit Mainboard when assembled.

11.5.10 Front Panel Connector Block and Tubing Assembly

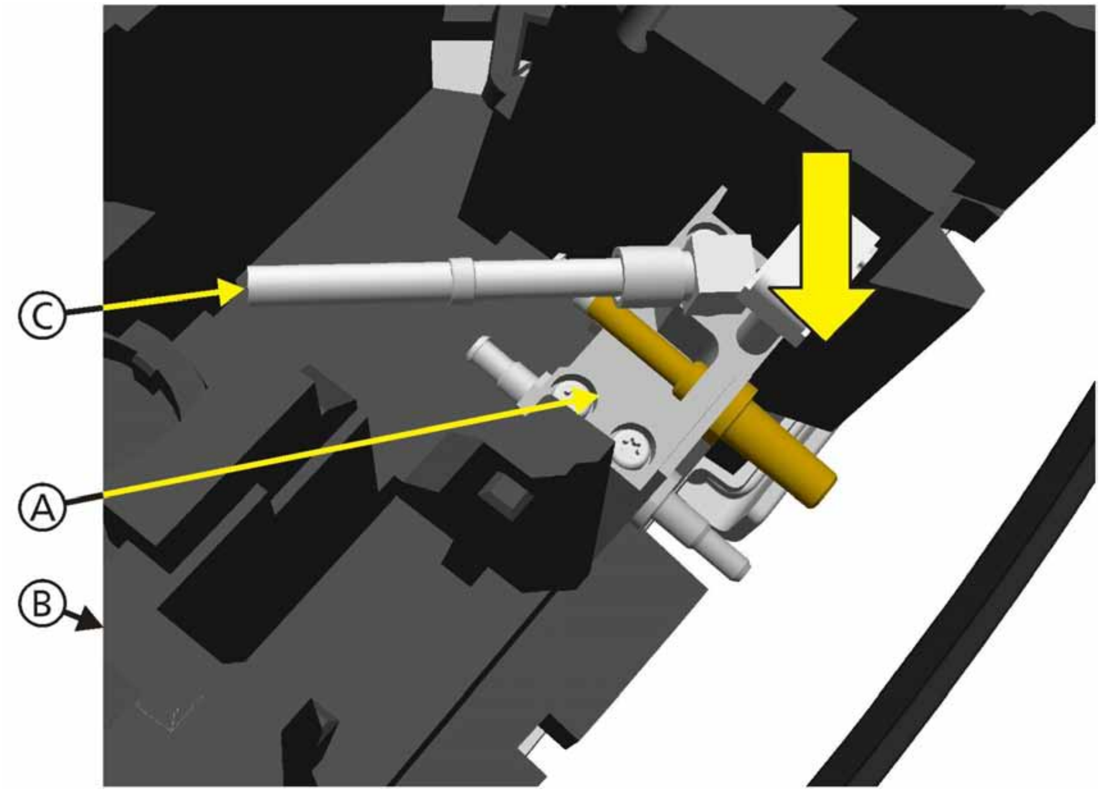


Figure 11-57. Front Panel Connector Block and Tubing Assembly, Step 1

1. Insert the Front Panel Connector Block (A) (PN 160472) into the Bottom Foam Section (B).
2. The Tubing (C) connects to the Inspiratory Valve and contains a Flow Restrictor.

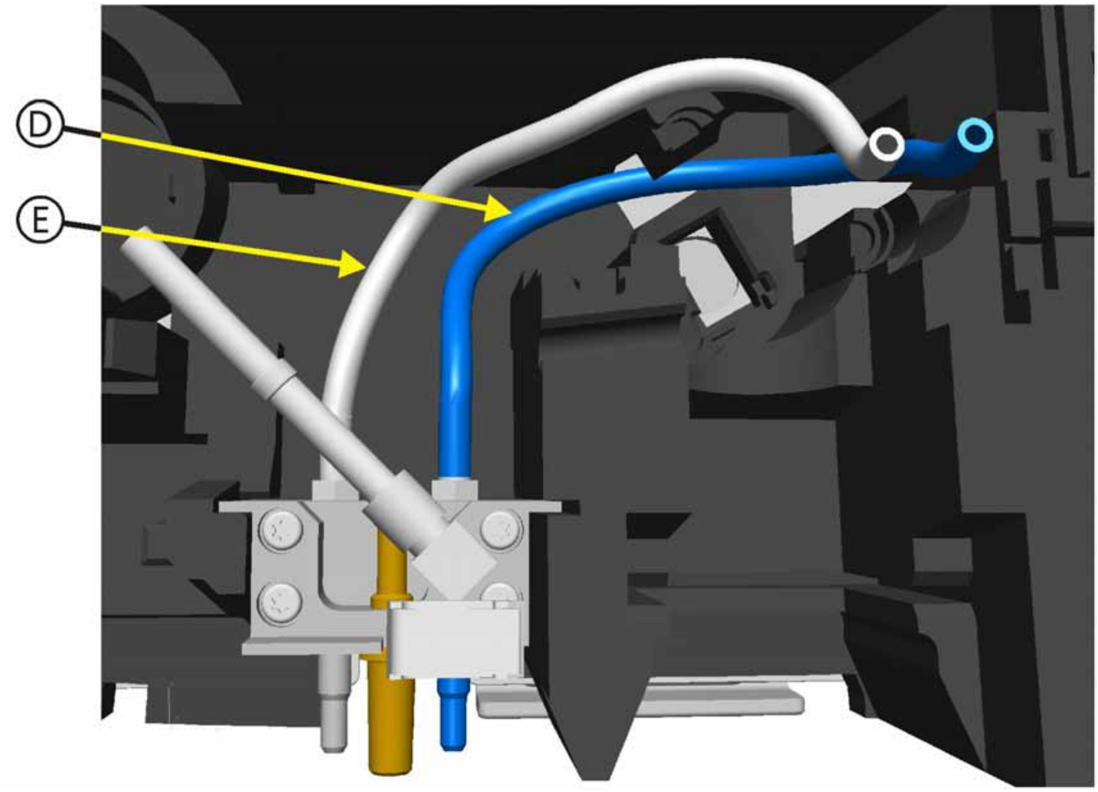


Figure 11-58. Front Panel Connector Block and Tubing Assembly, Step 2

3. Connect the Proximal Flow Sensor Tubing (D) (PN 160476) and Distal Flow Sensor Tubing (E) (PN 160476) to the Front Panel Connector Block.

4. The other Tubing ends will connect to the Pressure Sensor Assembly when assembled.

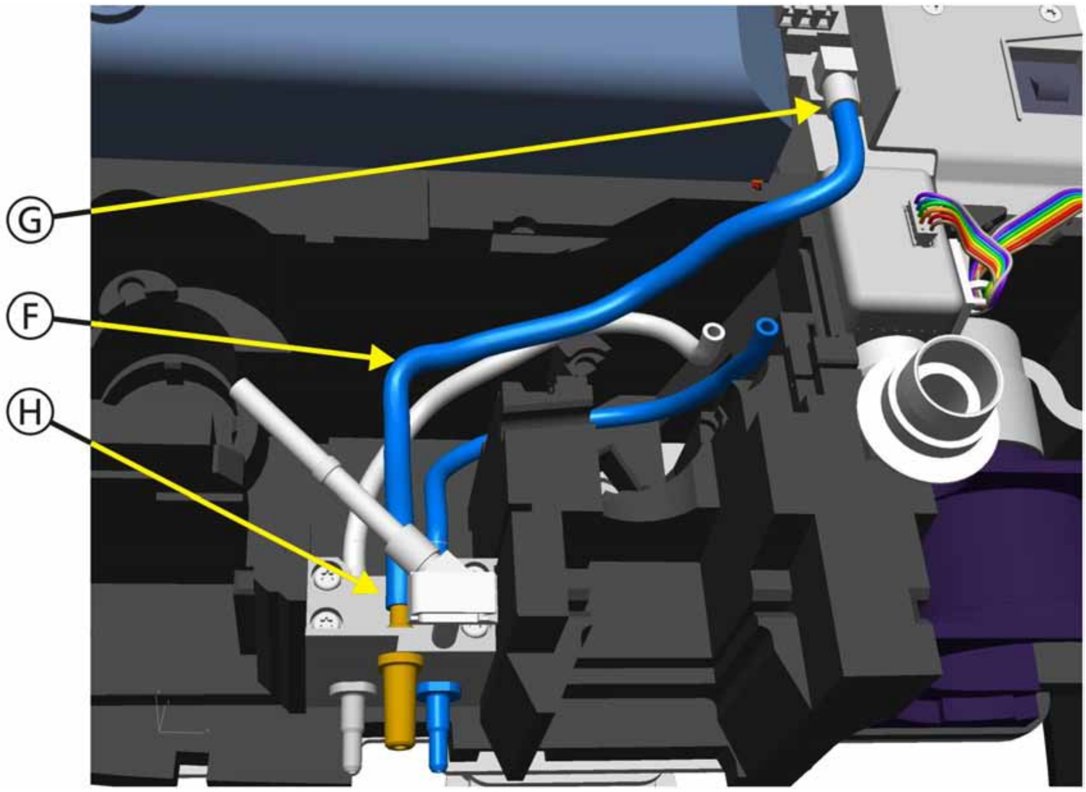


Figure 11-59. Front Panel Connector Block and Tubing Assembly, Step 3

5. Connect the Nebulizer Tubing (F) (PN 160409) from the Mixer Block Fitting (G) and the Nebulizer Connector (H) on the Front Panel Connector Block.

11.5.11 Inspiratory Valve, Qvent Flow Sensor and Ambient Valve Assembly

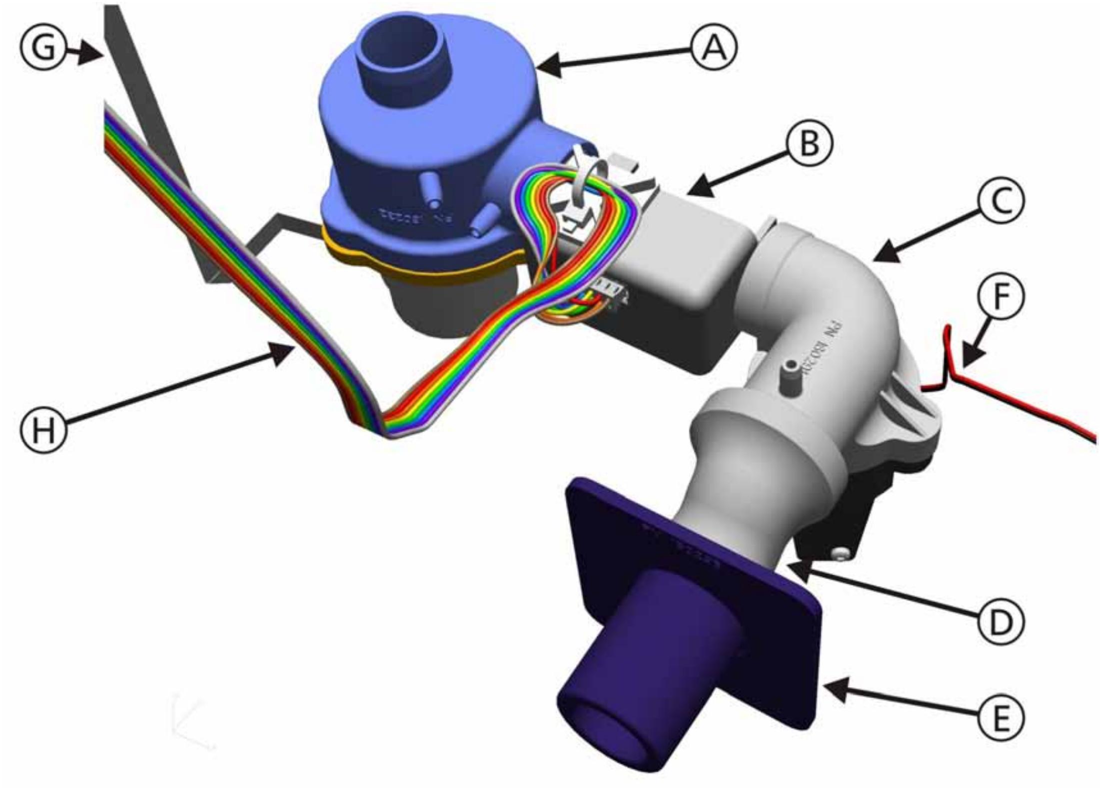


Figure 11-60. Inspiratory Valve, Qvent Flow Sensor and Ambient Valve Assembly, Step 1

1. Pre-assemble the Inspiratory Valve (A) (PN 160230), Qvent Flow Sensor (B) (PN 399123), Ambient Valve (C) (PN 160290), Shaped Tube (D) (PN 160223) and Patient Connection Tube (E) (PN 160295). (The Ambient Valve Cable (F) is part of the Ambient Valve Assembly and has no part number. The Inspiratory Valve FFC (G) is part of the Inspiratory Valve and has no part number.)

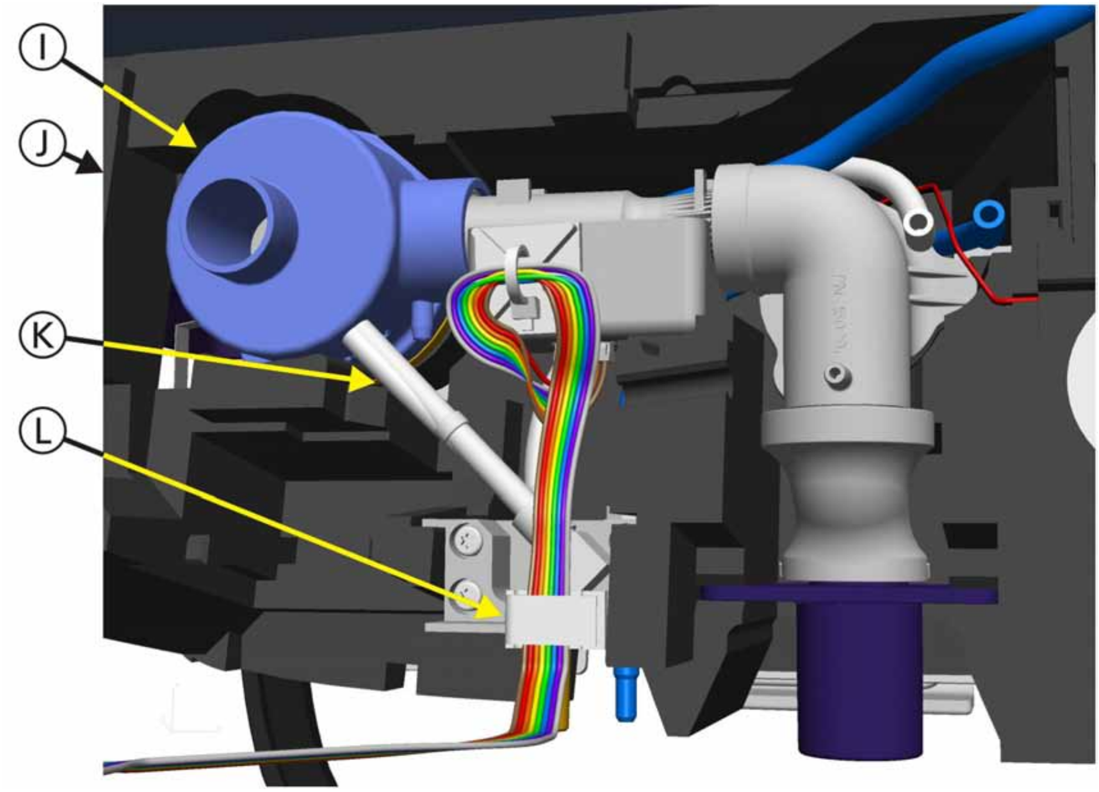


Figure 11-61. Inspiratory Valve, Qvent Flow Sensor and Ambient Valve Assembly, Step 2

2. Insert the complete assembly (I) into the Bottom Foam Section (J).
3. Connect the Tubing (K) from the Front Panel Connector Block to the Inspiratory Valve Assembly.
4. Place the Qvent Flow Sensor Cable into the Cable Holder (L) located on top of the Front Panel Connector Block.
5. The Cable will route on the side of the Middle and Top Foam Sections when assembled.
6. It will then be connected to the Ventilation Unit Mainboard when assembled.

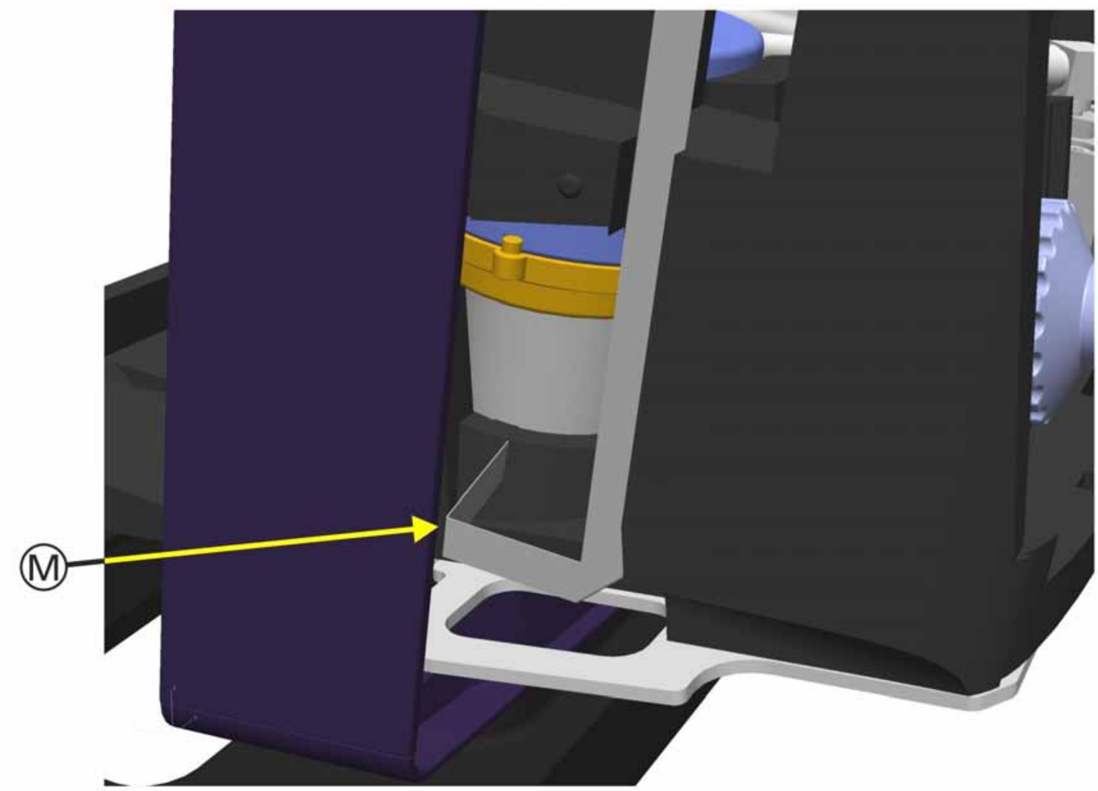


Figure 11-62. Inspiratory Valve, Qvent Flow Sensor and Ambient Valve Assembly, Step 3

7. The Inspiratory Valve FFC (M) (part of the Inspiratory Valve, no part number) is routed under a channel in the Bottom Foam Section to the side.

8. The Cable will route on the side of the Bottom, Middle and Top Foam Sections when assembled.

9. It will then be connected to the Ventilation Unit Mainboard when assembled.

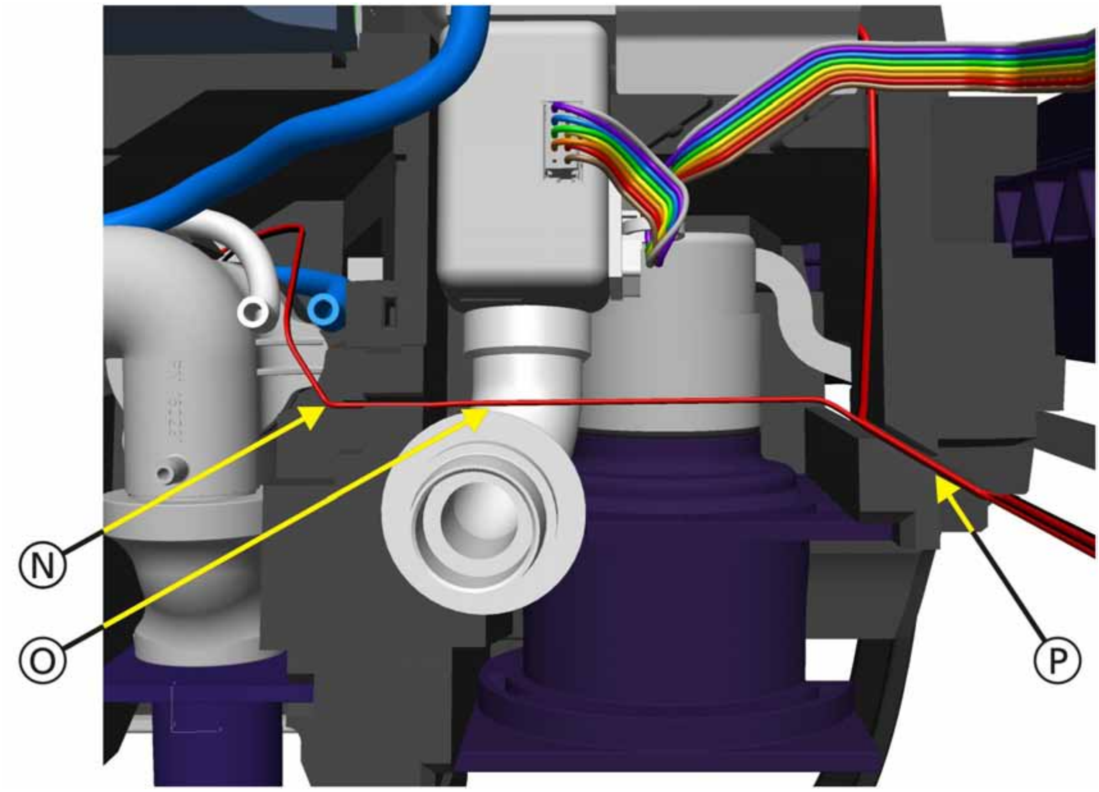


Figure 11-63. Inspiratory Valve, Qvent Flow Sensor and Ambient Valve Assembly, Step 4

10. The Cable from the Ambient Valve Assembly (part of the Ambient Valve, no part number) is routed thru a channel (N) in the Bottom Foam Section, over the Shaped Tube (O) and thru another channel (P) to the side.

11. The Cable will route on the side of the Middle and Top Foam Sections when assembled.

12. It will then be connected to the Ventilation Unit Mainboard when assembled.

11.5.12 Oxygen Sensor Block and Tubing Assembly

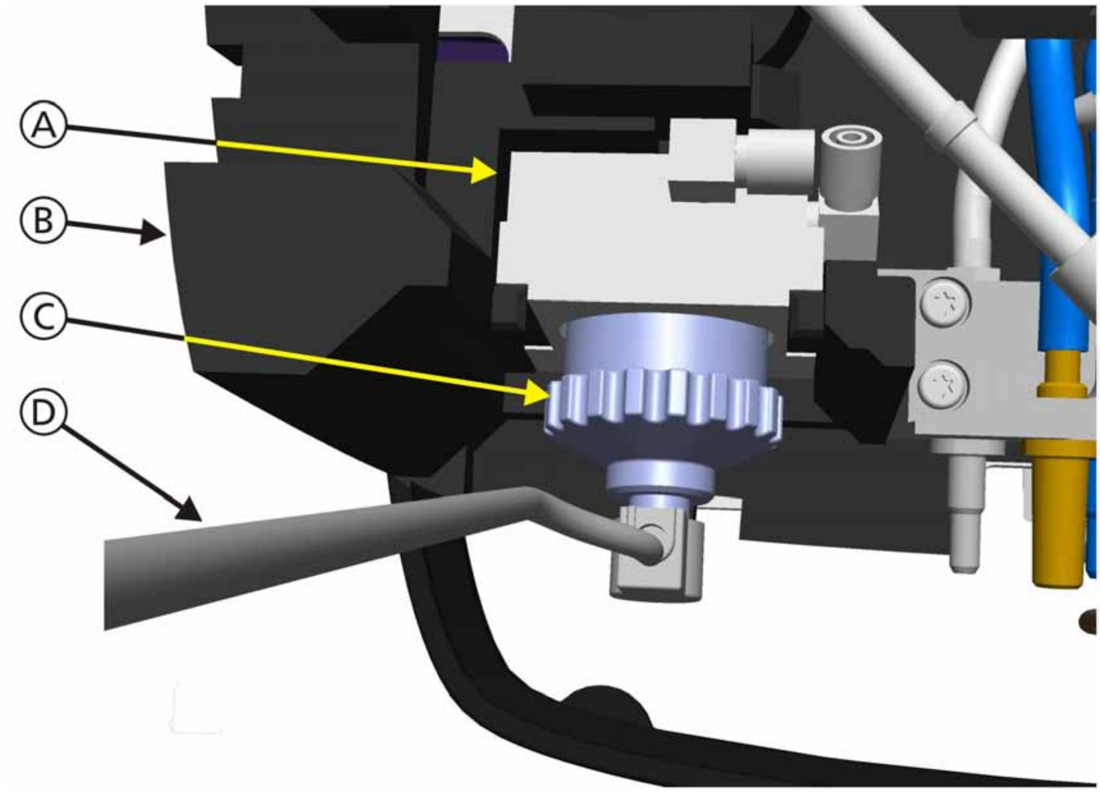


Figure 11-64. Oxygen Sensor Block and Tubing Assembly, Step 1

1. Insert the Oxygen Sensor Block (A) (PN 160100) into the Bottom Foam Section (B).
2. Connect the Oxygen Sensor Cable (D) (PN 160354) to the Oxygen Sensor (C) (PN 396200).
3. The Cable will route on the side of the Middle and Top Foam Sections when assembled.
4. It will then be connected to the Ventilation Unit Mainboard when assembled.

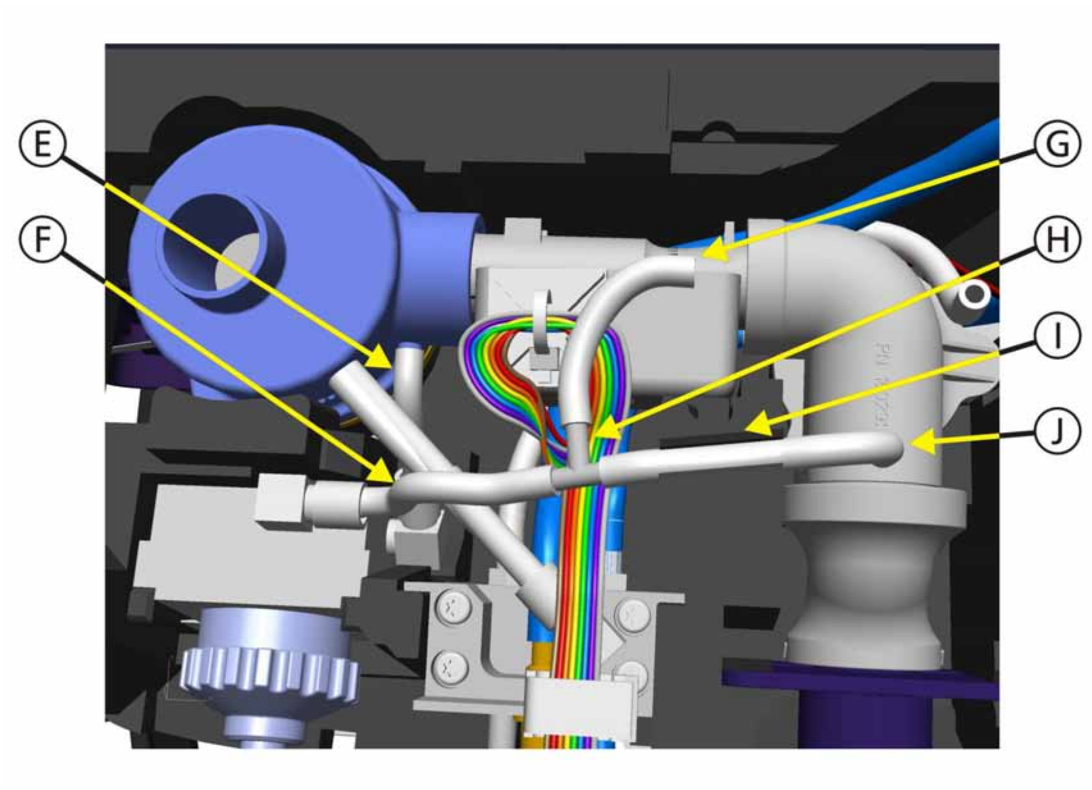


Figure 11-65. Oxygen Sensor Block and Tubing Assembly, Step 2

5. Connect the tubing (E) (PN 160475) from the side of the Oxygen Sensor Block to the Inspiratory Valve.

6. Connect the tubing (F) (PN 160475) from the top of the Oxygen Sensor Block, thru the T-Connector (H) (PN 279865), thru tubing (I) (PN 160475) (routed thru a channel in the Bottom Foam Section) to the top of the Ambient Valve (J).

7. The other side of the T-Connector (H) is connected to a tubing (G) (PN 160475) and will be connected to the Pressure Sensor Assembly when assembled.

11.5.13 Pressue Sensor Module Assembly

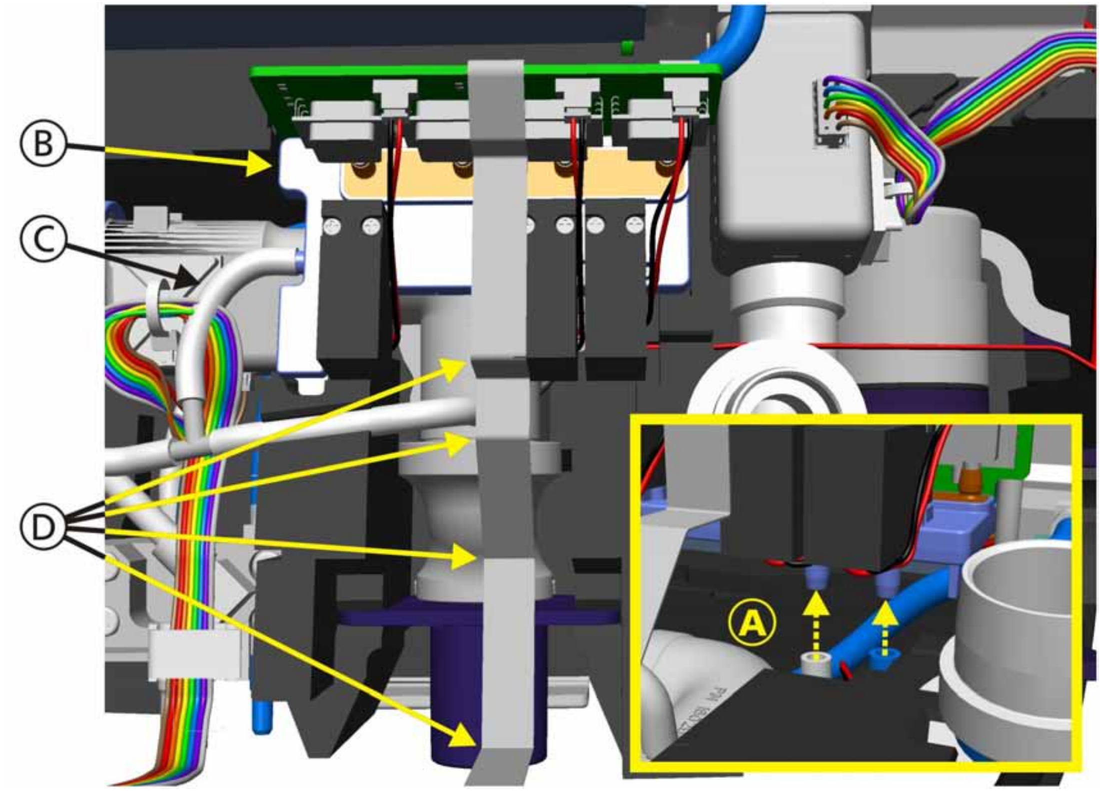


Figure 11-66. Pressure Sensor Assembly Assembly

1. Insert the Pressure Sensor Assembly (B) (PN 160300) above the Ambient Valve.
2. Connect the 2 Pflowsensor tubings (A) to the bottom of the Pressure Sensor Assembly (Tubes are color coded).
3. Connect the tubing (C) from the Y-Connector to the side of the Pressure Sensor Assembly .
4. Position the Pressure Sensor Assembly FFC (D) (PN 160355) along the top of the Shaped Tubes.
5. The Cable will route on the side of the Middle and Top Foam Sections when assembled.
6. It will then be connected to the Ventilation Unit Mainboard when assembled.

11.5.14 Middle Foam Section Assembly

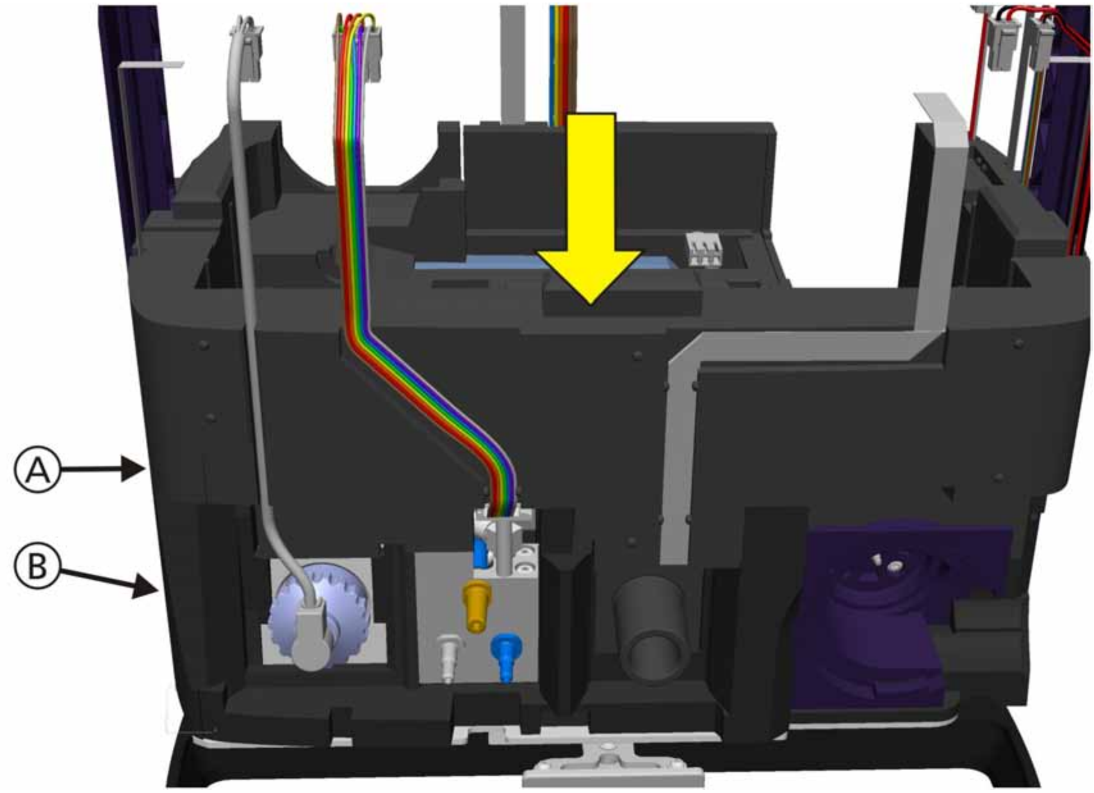


Figure 11-67. Middle Foam Section Assembly, Step 1

1. Position the Middle Foam Section (A) (PN 160238) onto the Bottom Foam Section.

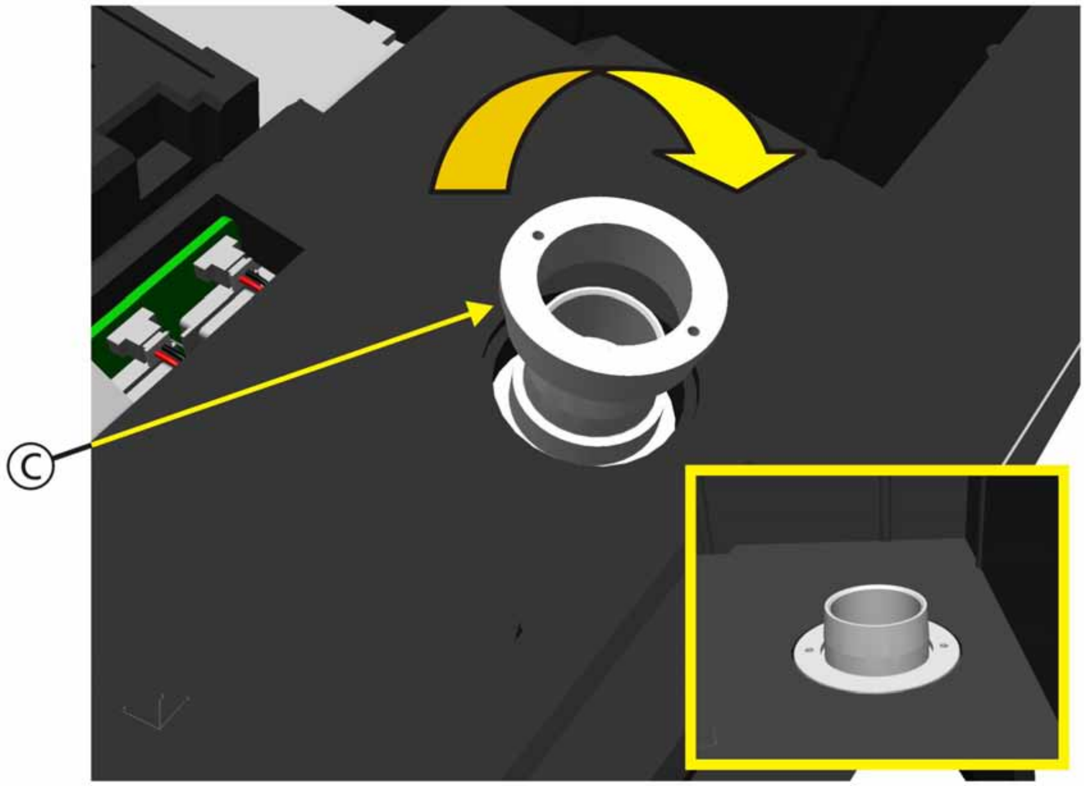


Figure 11-68. Middle Foam Section Assembly, Step 2

2. Assemble the Tube Flange (C) (PN 160287) and screw onto the Shaped Tubes from the QO_2 Flow Sensor.

11.5.15 Power Supply Assembly

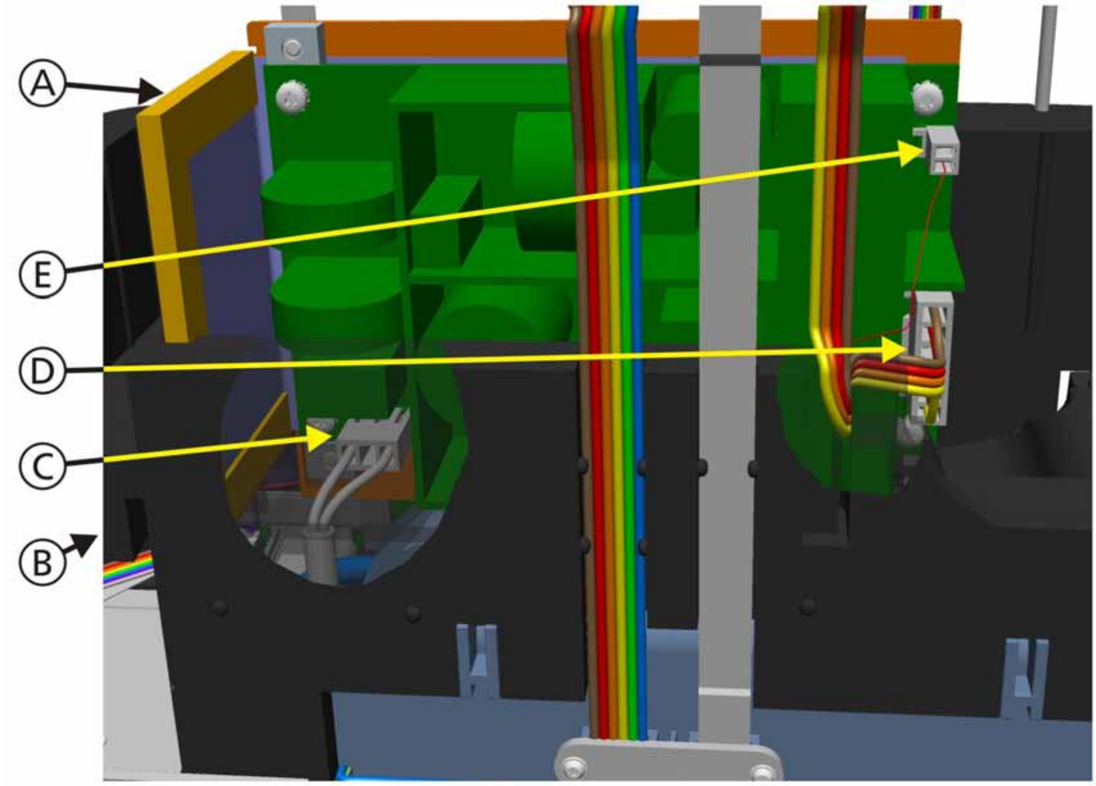


Figure 11-69. Power Supply Assembly

1. Insert the Power Supply (A) (PN 160100) into the rear of the of the Middle Foam Section (B).
2. Connect the Mains Power Cable (C) to the Power Supply.
3. Connect the Power Supply Cable (D) (PN 160371) and the Fan Supply Cable (E) (PN 160365) to the Power Supply.
4. The Cables will route on the side of the Middle and Top Foam Sections when assembled.
5. They will then be connected to the Ventilation Unit Mainboard when assembled.

Note
To prevent noise in operation by vibrations, look out for correct implementation of the Power Supply.

11.5.16 Cooling Fan Assembly

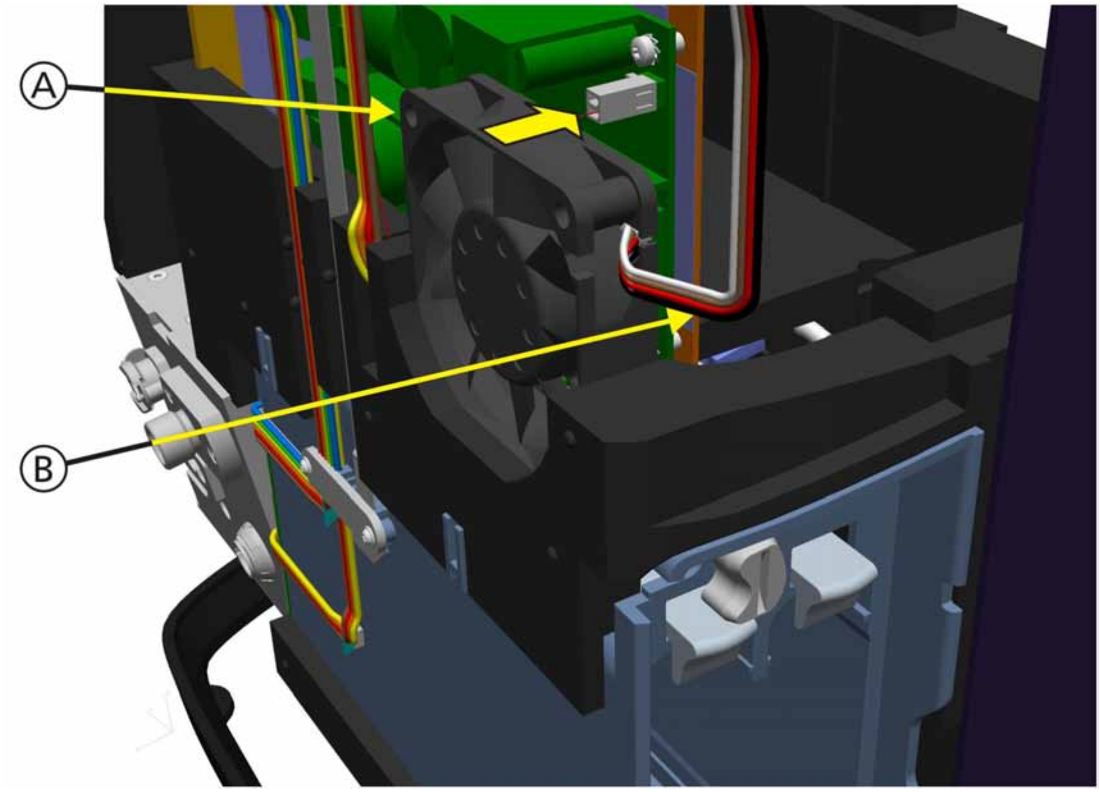


Figure 11-70. Cooling Fan Assembly

1. Insert the Cooling Fan (A) (PN 160346) into the rear of the Middle Foam Section.

Note
Observe the air flow direction of the Fan. Flow direction in to the device.

---

2. Position the Fan 12V Cable to the side.
3. The Cable will route on the side of the Top Foam Section when assembled.
4. It will then be connected to the Ventilation Unit Mainboard when assembled.

11.5.17 Blower Module Assembly

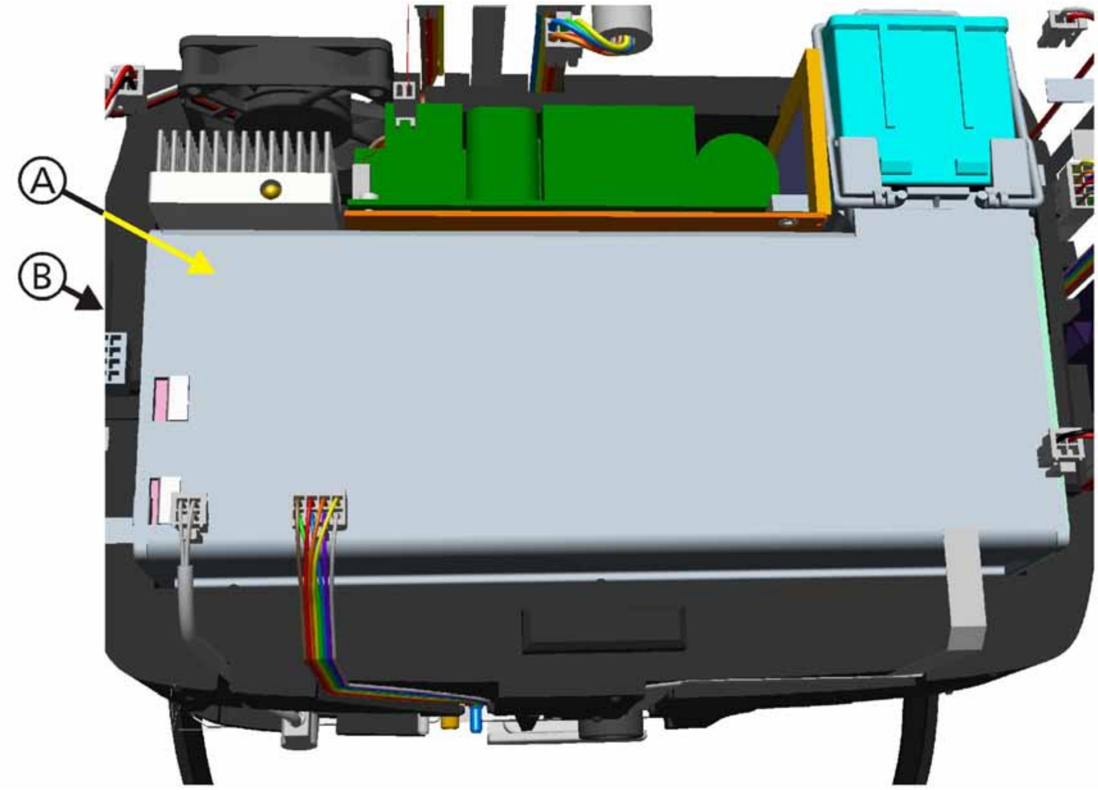


Figure 11-71. Blower Module Assembly, Step 1

1. Insert the Blower Module (A) (PN 160250) into the Middle Foam Section (B).

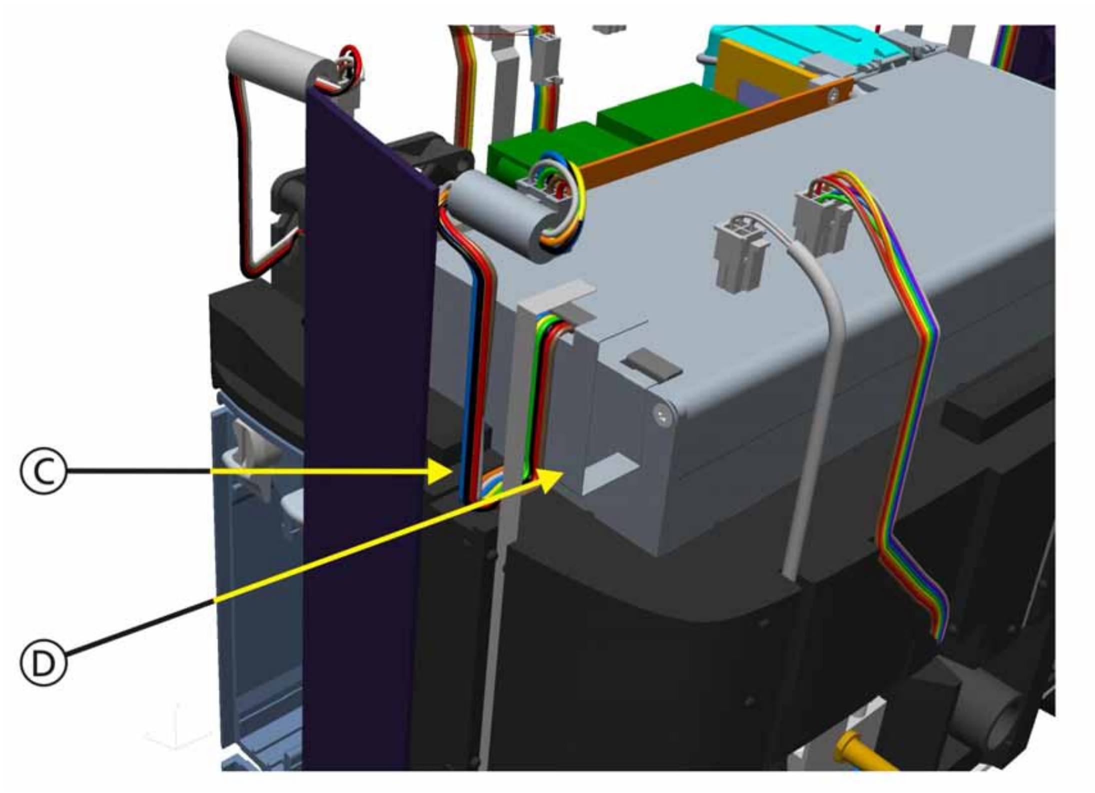


Figure 11-72. Blower Module Assembly, Step 2

2. Position the Blower Cable (C) (part of the Blower Module, no part number) and the Temperature Sensor FFC (D) (PN 160353) to the side.
3. The Cables will route on the side of the Top Foam Section when assembled.
4. They will then be connected to the Ventilation Unit Mainboard when assembled.

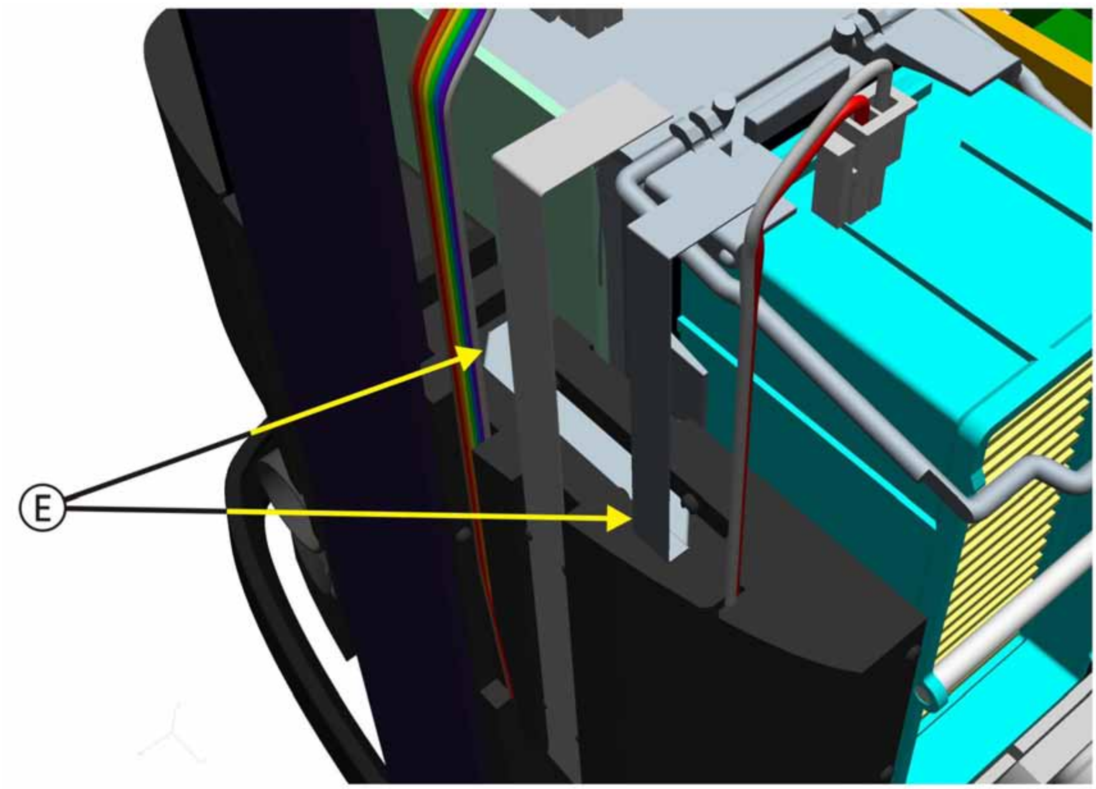


Figure 11-73. Blower Module Assembly, Step 3

5. Position the Filter Pressure Sensor Cable (E) into the cutout of the Middle Foam Section.
6. The Cable will route on the side of the Top Foam Section when assembled.
7. It will then be connected to the Ventilation Unit Mainboard when assembled.

Note

To prevent noise in operation by vibrations, look out for correct implementation of the Power Supply.

11.5.18 Top Foam Section and Mainboard Assembly

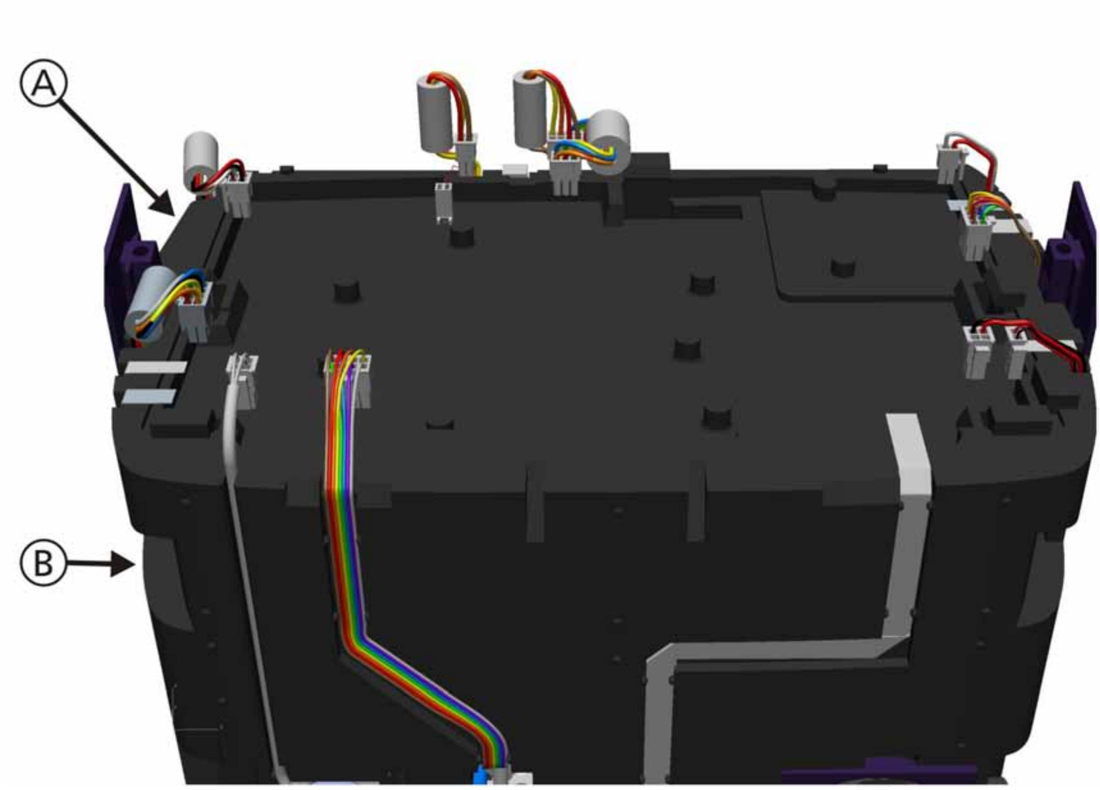


Figure 11-74. Top Foam Section and Mainboard Assembly, Step 1

1. Position the Top Foam Section (A) (PN 160239) onto the Middle Foam Section (B).

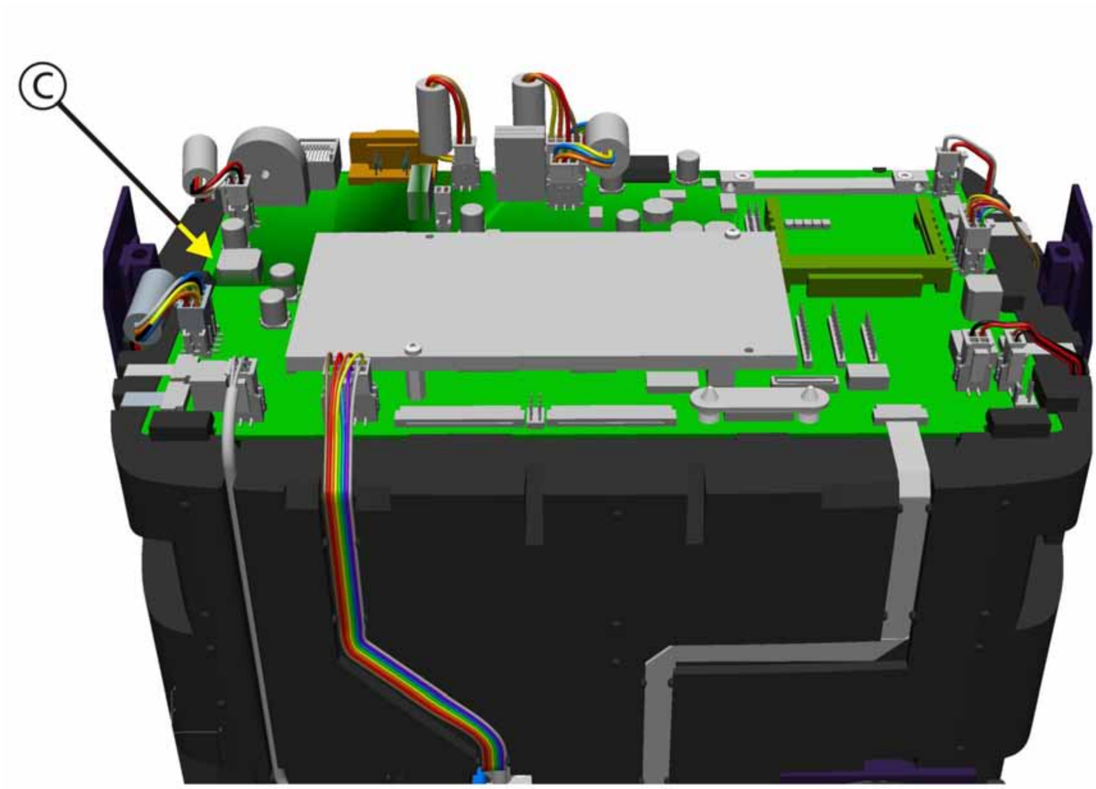


Figure 11-75. Top Foam Section and Mainboard Assembly (Front View), Step 2

2. Insert the Mainboard (C) (PN 160200) onto the Top Foam Section.

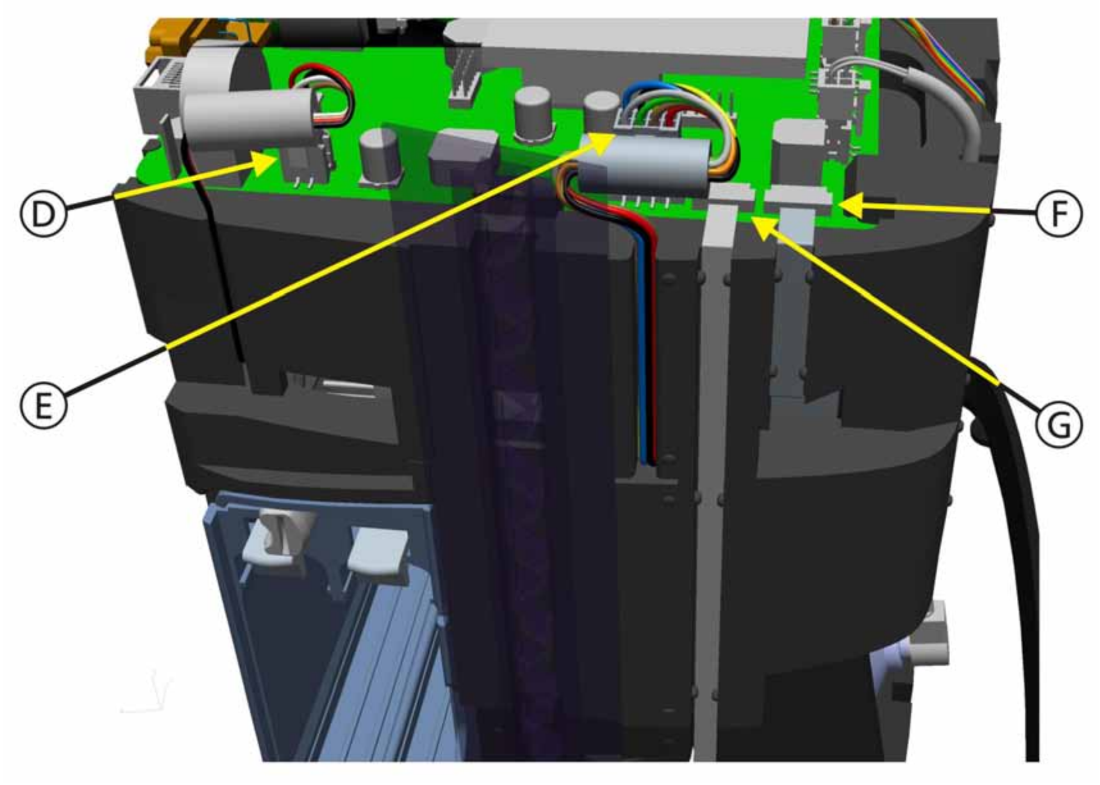


Figure 11-76. Top Foam Section and Mainboard Assembly, Step 3

3. Route the Fan 12V Cable (D) into the side of the Top Foam Section and plug into Connector P28 on the Mainboard.
4. Route the Blower Cable (E) into the side of the Top Foam Section and plug into Connector P23 on the Mainboard.
5. Route the Temperature Sensor FFC (F) into the side of the Top Foam Section and plug into Connector J21 on the Mainboard.
6. Route the Inspiratory Valve FFC (G) into the Bottom, Middle and Top Foam Sections and plug into Connector J22 on the Mainboard.

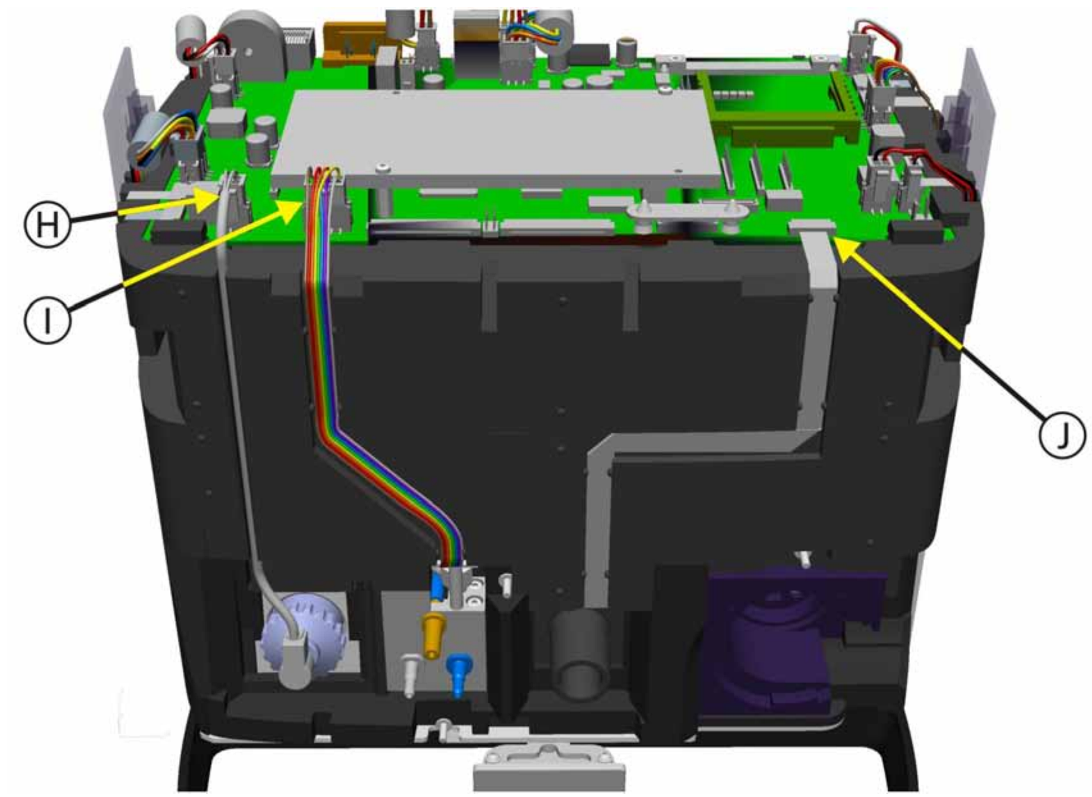


Figure 11-77. Top Foam Section and Mainboard Assembly, Step 4

7. Route the Oxygen Cell Cable (H) into the front of the Middle and Top Foam Sections and plug into Connector P20 on the Mainboard.

8. Route the Qvent Ventilation Cable (I) into the front of the Middle and Top Foam Sections and plug into Connector P19 on the Mainboard.

9. Route the Pressure Sensor Board FFC (J) into the front of the Middle and Top Foam Sections and plug into Connector J17 on the Mainboard.

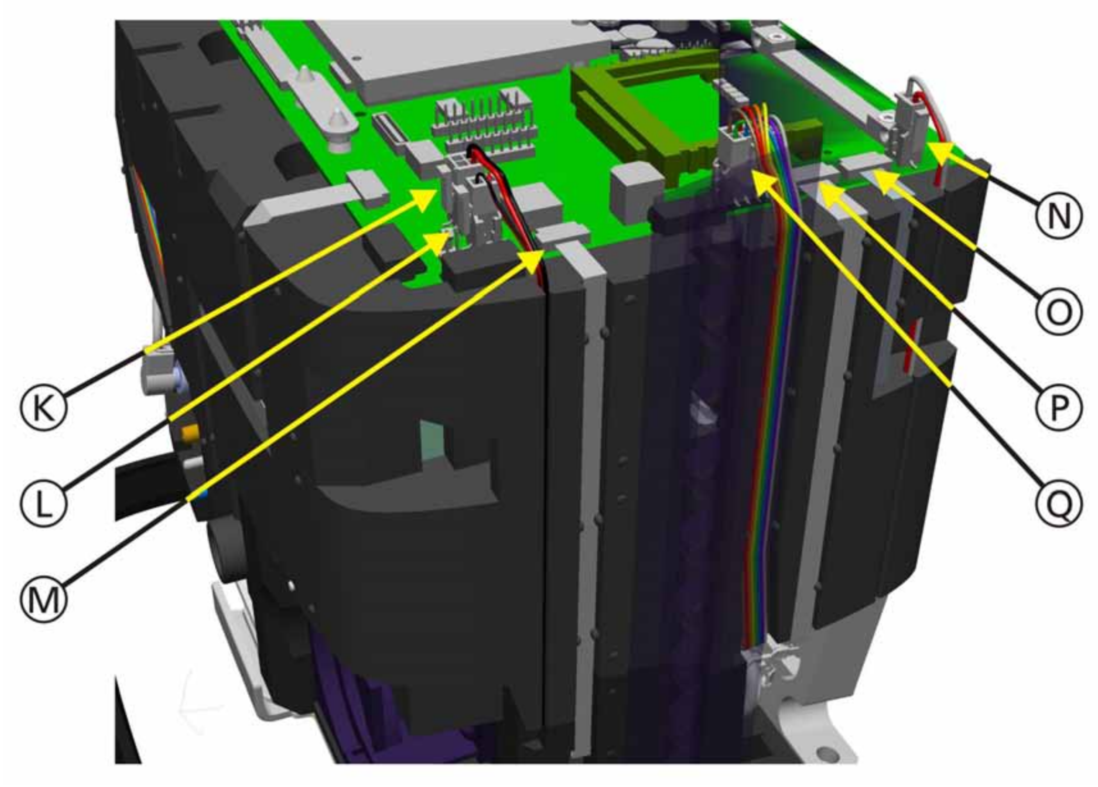


Figure 11-78. Top Foam Section and Mainboard Assembly, Step 5

10. Route the Nebulizer Valve Cable (K) into the side of the Middle and Top Foam Sections and plug into Connector P13 on the Mainboard.
11. Route the Ambient Valve Cable (L) into the side of the Middle and Top Foam Sections and plug into Connector P12 on the Mainboard.
12. Route the Expiratory Valve FFC (M) into the side of the Bottom, Middle and Top Foam Sections and plug into Connector J11 on the Mainboard.
13. Route the O_2 Valve Cable (N) into the side of the Middle and Top Foam Sections and plug into Connector P7 on the Mainboard.
14. Route the Filter Pressure Sensor FFC (O) into the side of the Middle and Top Foam Sections and plug into Connector J9 on the Mainboard.
15. Route the Binary Valve FFC (P) from the Pressure Sensor Assembly into the side of the Middle and Top Foam Sections and plug into Connector J8 on the Mainboard.
16. Route the Flow Sensor O_2 Cable (Q) into the side of the Middle and Top Foam Sections and plug into Connector P10 on the Mainboard.

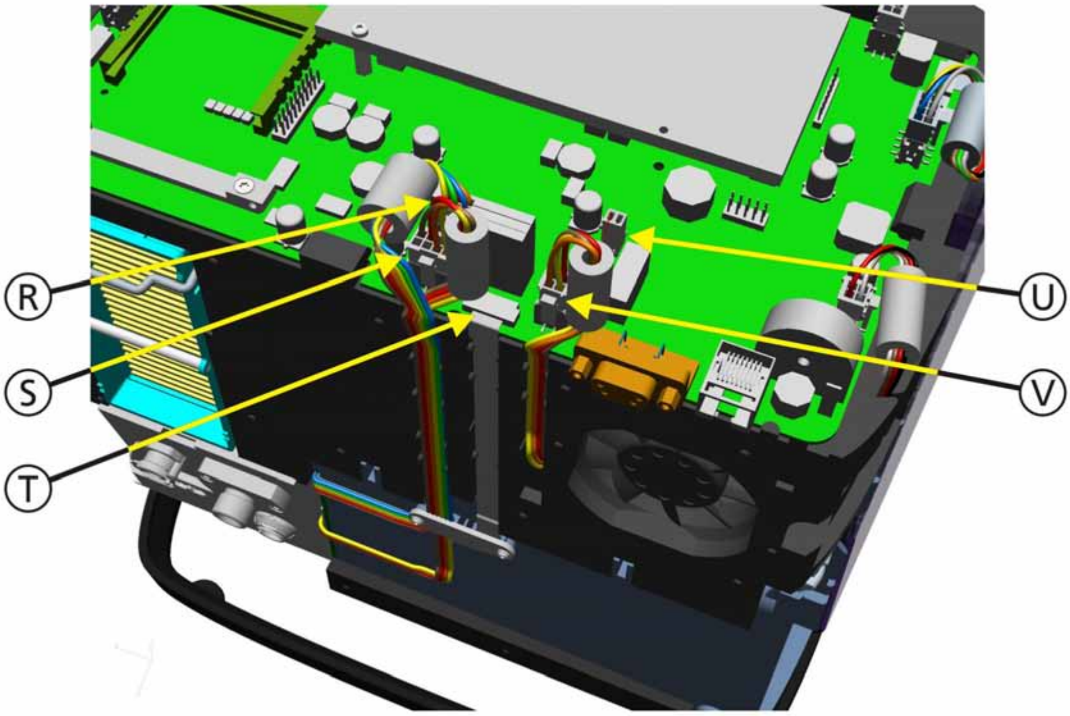


Figure 11-79. Top Foam Section and Mainboard Assembly, Step 6

17. Route the Battery Power Cable (R) into the rear of the Middle and Top Foam Sections and plug into Connector P6 on the Mainboard.
18. Route the DC Input Cable (S) into the rear of the Middle and Top Foam Sections and plug into Connector P5 on the Mainboard.
19. Route the Battery Data FFC (T) into the rear of the Middle and Top Foam Sections and plug into Connector J4 on the Mainboard.
20. Route the Fan Supply Cable (U) into the rear of the Middle and Top Foam Sections and plug into Connector P25 on the Mainboard.
21. Route the Power Supply Cable (V) into the rear of the Middle and Top Foam Sections and plug into Connector P3 on the Mainboard.
22. Assemble the covers as described in Section 11.4.4, *Front and Rear Covers Removal/Assembly*, on page 11-21.

Note

Update the Technical State, see *Service Entry Modify Tab* on page 9-12.

Part 4: Appendices

Appendix

A Maintenance Tools and Test Equipment

A.1 Overview

Standard tools, special tools, ElectroStatic Discharge (ESD) protection and test equipment detailed in the following sections are required to carry out:

- The Preventive Maintenance procedures in Section 7, *Engineer Preventive Maintenance*, on page 7-1
- The Tests Functions in Section 9, *Service Software*, on page 9-1
- The Component Replacemenets in Section 11, *Components Removal/Assembly*, on page 11-1

A.2 Standard Tools

To perform basic maintenance on equipment from HAMILTON MEDICAL AG, you require a range of:

- Screwdrivers (both flat and cross-head)
- Metric Spanners (wrenches)
- Metric Hex (Allen) Keys (wrenches)

A.3 Special Tools

A.3.1 Digital Voltmeter

To perform the tests in Section 8.5, *Internal Cable Checks*, on page 8-3, a Digital Voltmeter (DVM) is required for measuring voltage (to a tolerance of ± 0.5%) or resistance (to a tolerance of ≤1Ω (less than 1 Ohm).

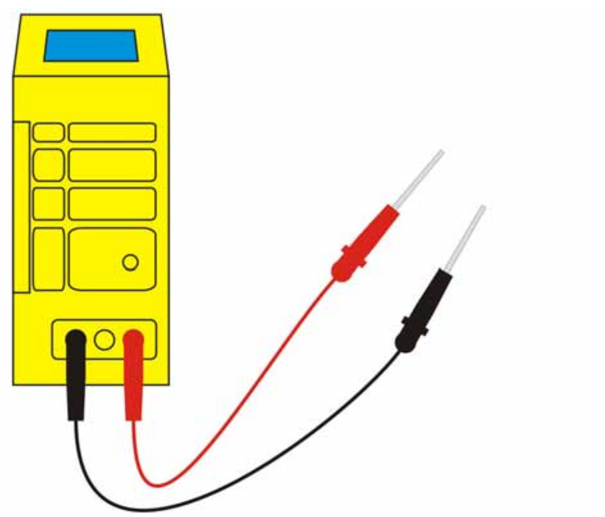


Figure A-1. Digital Voltmeter

A.3.2 Electrical Safety Tester

Electrical Safety Testing is required according to IEC-60601-1. A RIGEL 288, or similar equipment is required.

Figure A-2. The Metron Safety Analyzer

A.3.3 ESD (ElectroStatic Discharge) Protection

ESD (ElectroStatic Discharge) equipment must be used to prevent damage to sensitive electronic circuits. Typically, this comprises:

- ESD grounding (earthing) cable and wrist band connected to the HAMILTON-C2 for use when working inside the HAMILTON-C2
- ESD grounding cable and wrist band connected to the work surface for use when working on an electronic component from the HAMILTON-C2

Figure A-3 shows a wrist band and connecting cable complete with the crocodile clip that must be attached to the ventilator or work surface.

Figure A-3. ESD Wrist Strap and Cable

A.3.4 Test Equipment

The following Test Equipment is required, as well as the tools listed above, to complete the tests and adjustment included in Section 9, *Service Software*, on page 9-1.

Pictures and details of most of these items are in the *Product Catalog*.

Item	Comment
 Coaxial breathing set	PN 260086
 Pressure Connector	PN 500300
 Flow Analyzer	PN 500084 TSI FLOWMETER KIT contains: PN 500085 TSI-FM BATTERY BOX PN 500086 TSI-FM SOFT CARRAYING CASE PN 279204 Bacteria Filter PN 260100 Silicon Tube 35cm 22F PN 500308 TSI Flowmeter
 Pressure Gauge with the following specifications: • Range: 0–400 mbar Accuracy: ≤ 0.5%	A complete WIKA gauge set can be obtained from HAMILTON MEDICAL, PN 500058.
 Tube, silicone, 4 mm ID, 7 mm OD. Order by the length in meters.	PN 7249057
 Stopper for use in creating equipment setups to perform Test Mode.	A suitable stopper is supplied with every HAMILTON-C2 delivered. PN 281717

Item		Comment
	Connector 15M/4M	PN 279913
	Personal Bacteria Filter.	PN 279204
	O_2 cell calibration tool	PN 160367 (for mainboards of the revisions 00 to 05 only)
	EST cable	PN 160368
	Service tool	PN 500314
	USB Stick 4GB	PN 396207 (Specification for the USB stick: - Filesystem: FAT or FAT32 - Unpartitioned memory - No Operating System or Security software installed
	External Battery Charger	PN 369104
	SIL.CORR.TUBE 22MM 22/22F 35CM	PN 260100

Item		Comment
	Adult Demo Lung with 7mm ET tube	PN 151815
	CONNECTOR 22M/15F-22M/15F	PN 281420

A.3.4.1 Calibration of Test Equipment

Some test equipment must be tested and calibrated periodically. HAMILTON MEDICAL recommends the following schedule:

Item	Schedule	Action
Pressure Gauge	As recommended by the manufacturer, or at least once per year	Send the pressure gauge back to the manufacturer for testing. (for example, www.thommenag.ch or www.wika.com for calibration information).
Digital Voltmeter (DVM)	As recommended by the manufacturer	As recommended by manufacturer.
Flow Analyzer	As recommended by the manufacturer	As recommended by manufacturer.

Appendix

B Spare Parts

B.1 Introduction to Major Components

Appendix B lists replacement parts that are available for the HAMILTON-C2.

The first sections of the appendix contains four diagrams that enable you to locate major components. Later sections offer much more detailed listings.

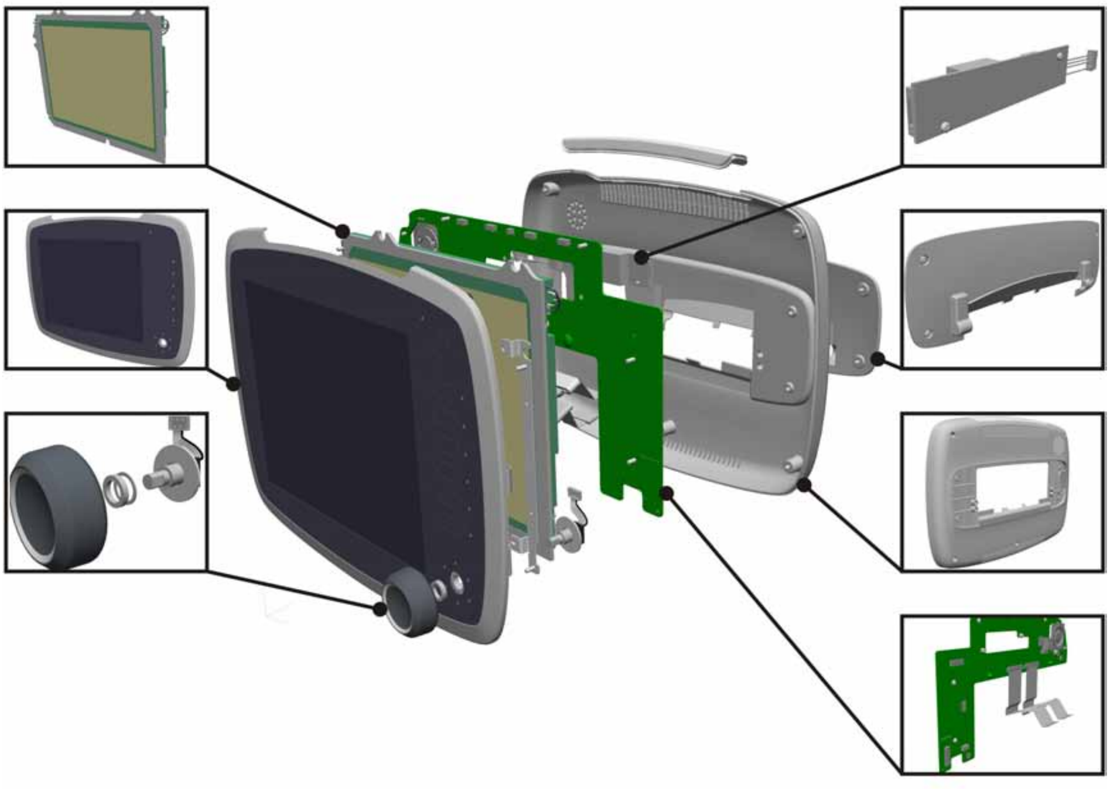
Note

- For information about consumables (such as tubing) and complete assemblies (such as the Patient Tubing Support Arm), see the HAMILTON MEDICAL Product Catalog (PN 689060). It can be located on the HAMILTON MEDICAL AG (http://www.hamilton-medical.com).
- Some photographs shown in later sections may not be displayed to scale.
- Some Spare Parts have a preffix MSP (Medical Spare Part). If you exchange a MSP you usually have to update the technical state of the device with the new serial and revision number.

160150

There are no spare parts for the trolley available.

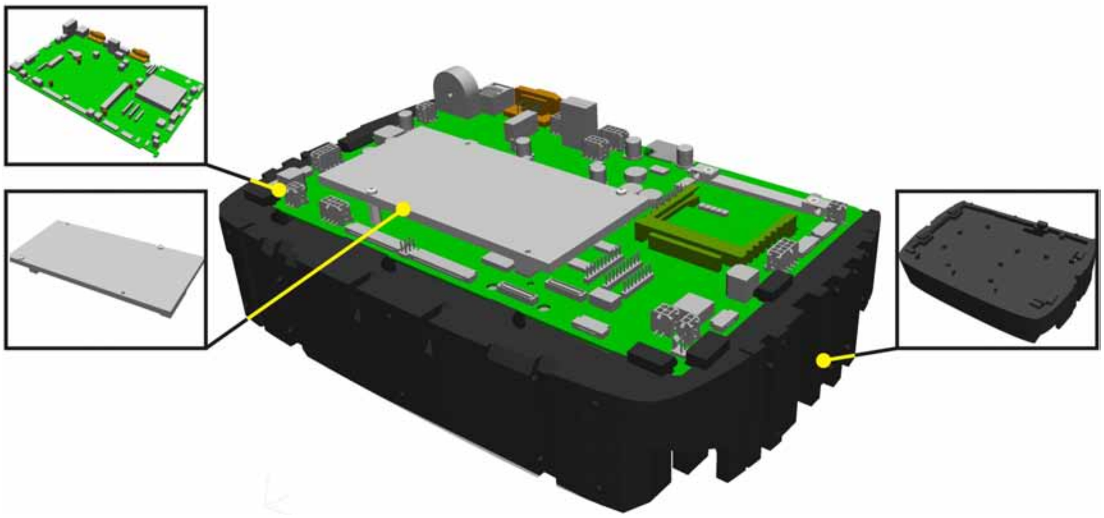
B.2 Major Components of the Interaction Panel



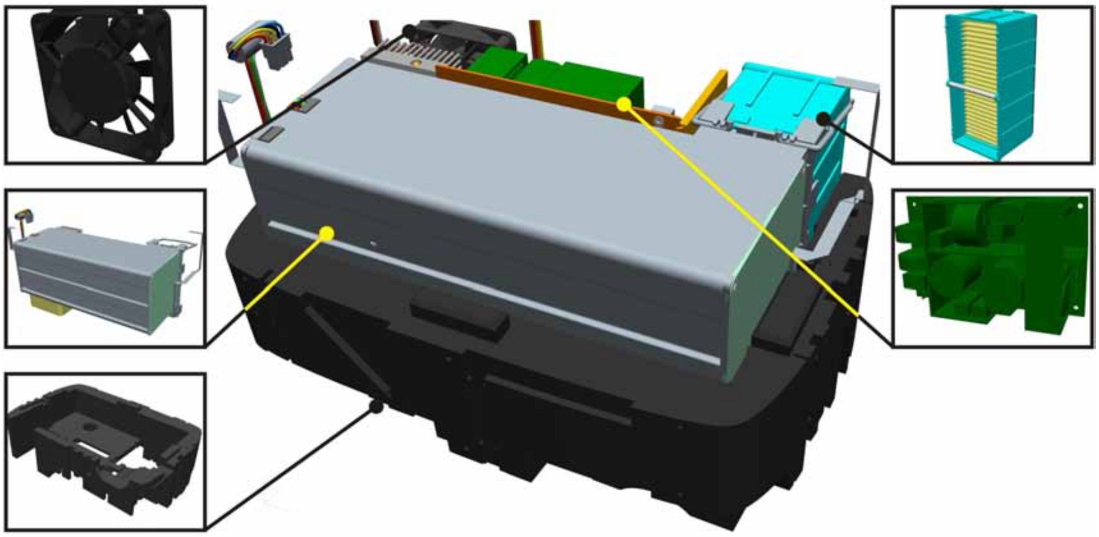
B.3 Major Components of the Ventilation Unit

B.3.1 Ventilation Unit Covers

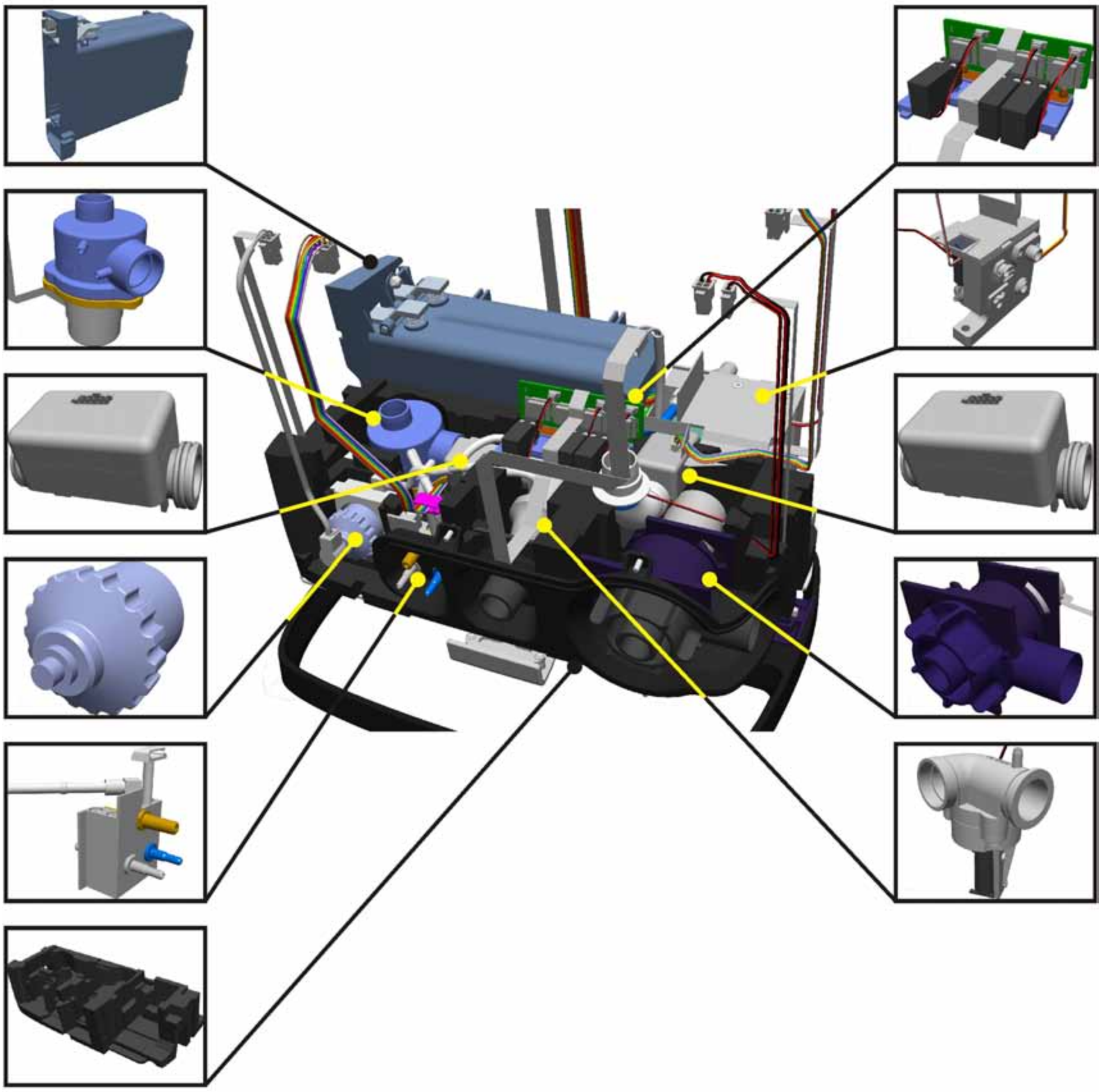
B.3.2 Ventilation Unit Top Section



B.3.3 Ventilation Unit Middle Section



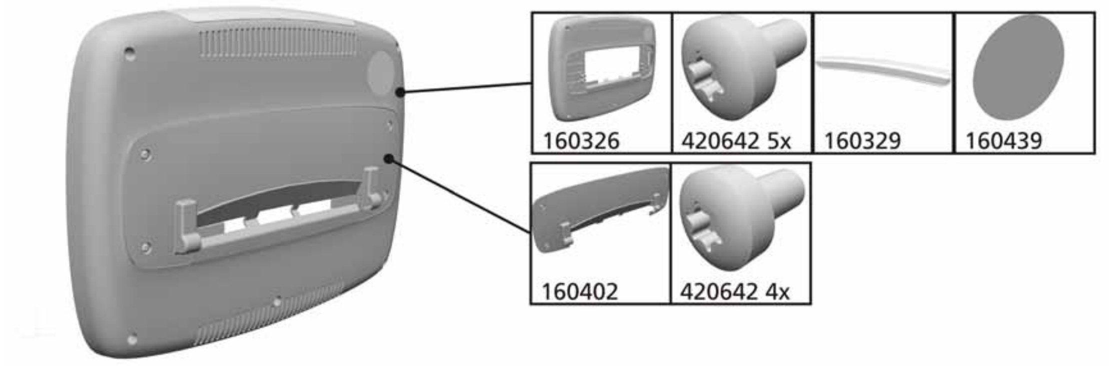
B.3.4 Ventilation Unit Bottom Section



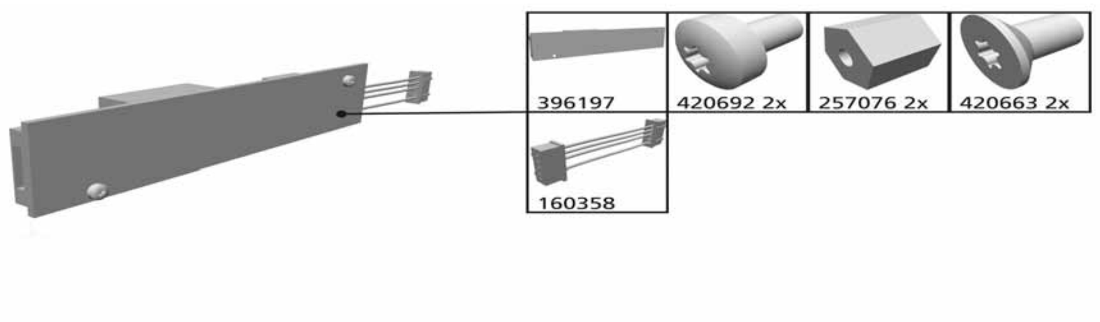
B.4 Interaction Panel Parts Summary

Complete Interaction Panel MSP160325

B.4.1 Interaction Panel Covers

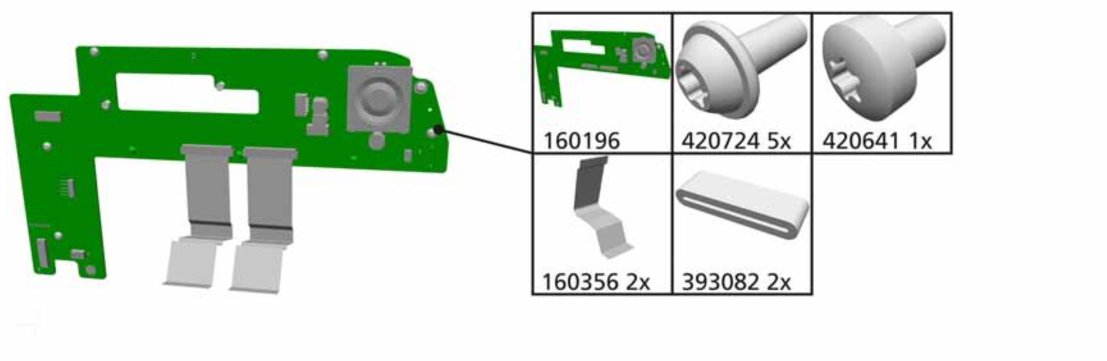


B.4.2 Backlight Converter Board

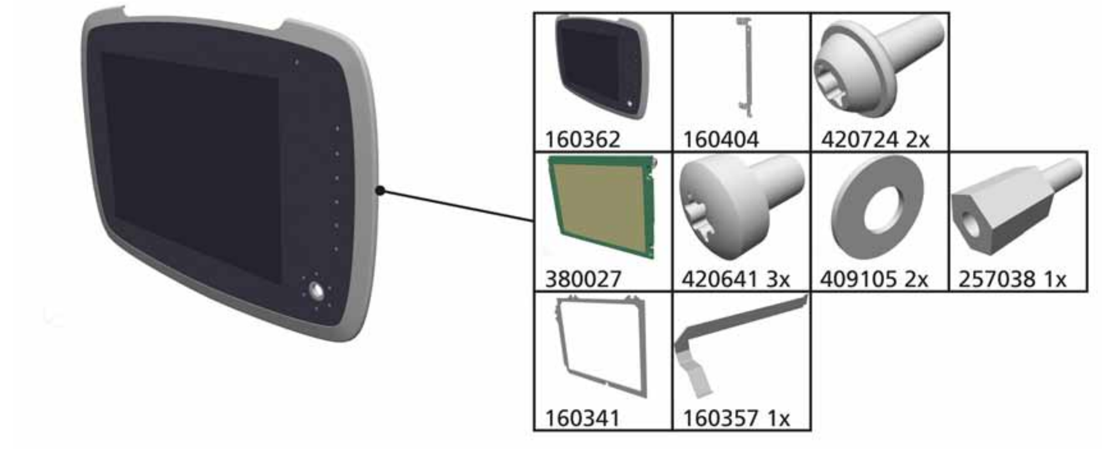


Note
Please check compatibility for HAMILTON-C2 serial number <1676, see E.2.18 *Display modifications* on page E-14.

B.4.3 Front Panel Board



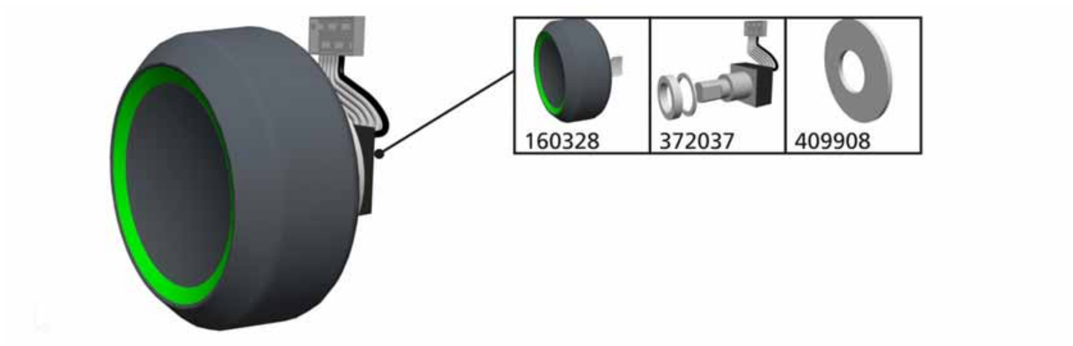
B.4.4 LCD Display and Touchscreen



160467 ESD isolation sticker on monitor
361015 Cable holder

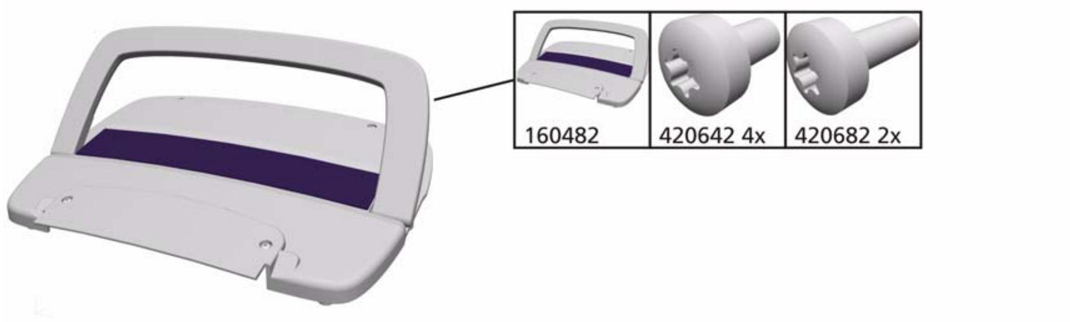
Note
Please order PN 160341 as well if you have to exchange the DISPLAY FRONT PN 160362. Please see *Display modifications* on page E-14 for display compatibility.

B.4.5 P&T Control Knob Encoder

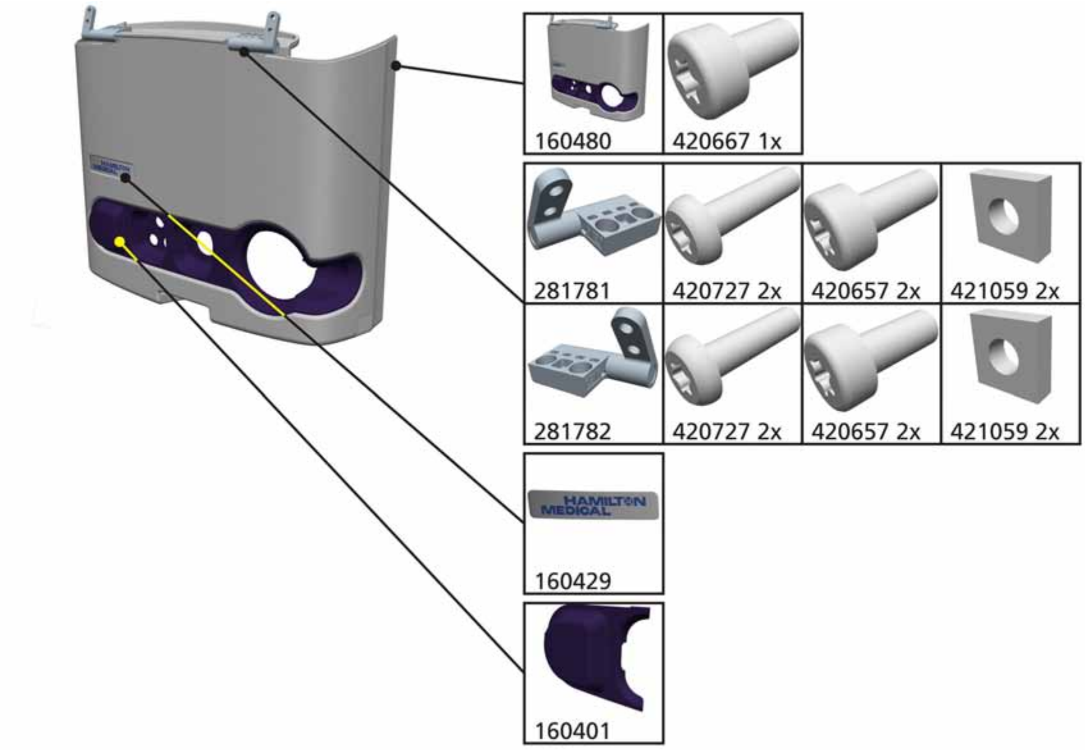


B.5 Ventilation Unit Parts Summary

B.5.1 Top Cover

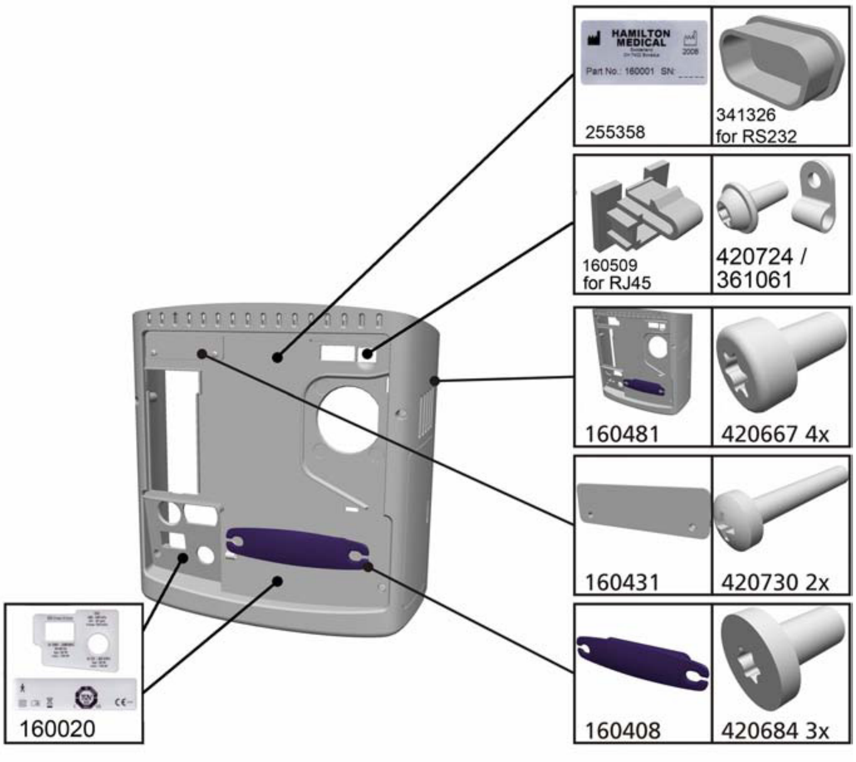


B.5.2 Front Cover



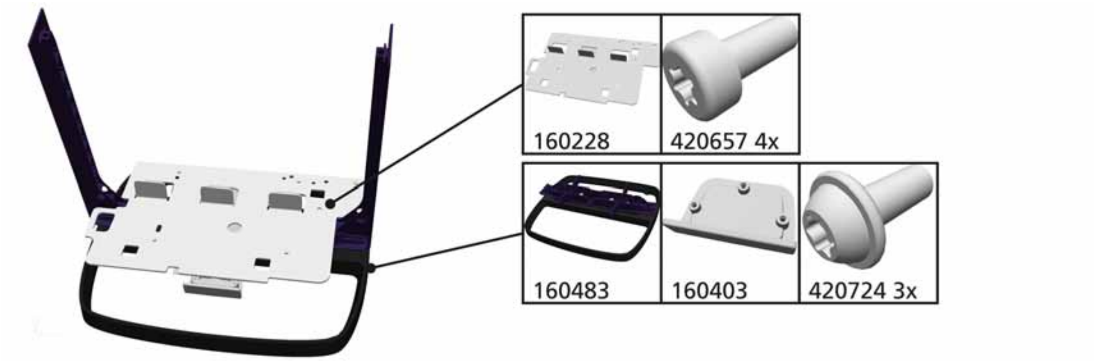
Complete Front Cover with label MSP160480

B.5.3 Rear Cover

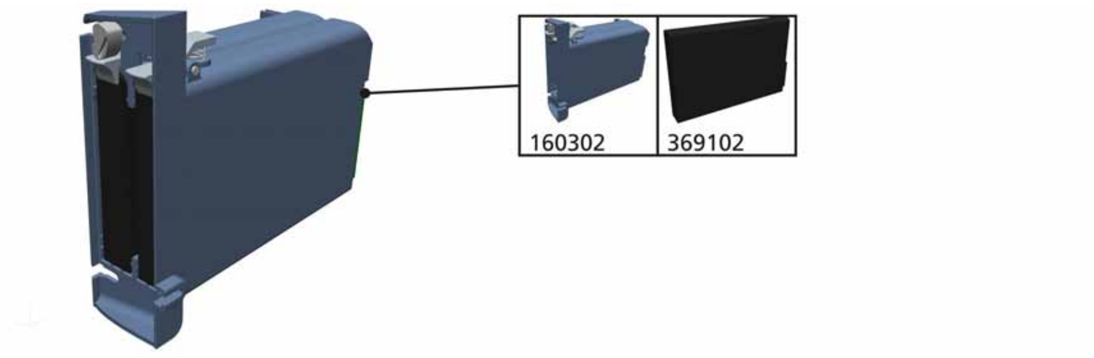


Complete Rear Cover MSP160481

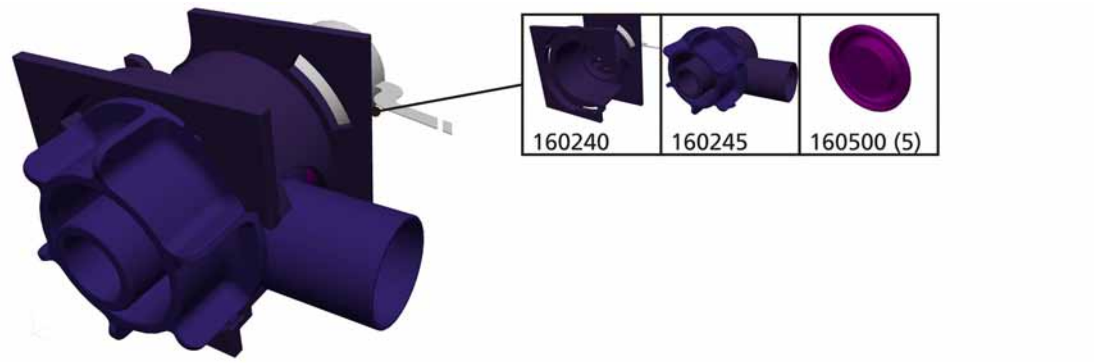
B.5.4 Ventilation Unit Base



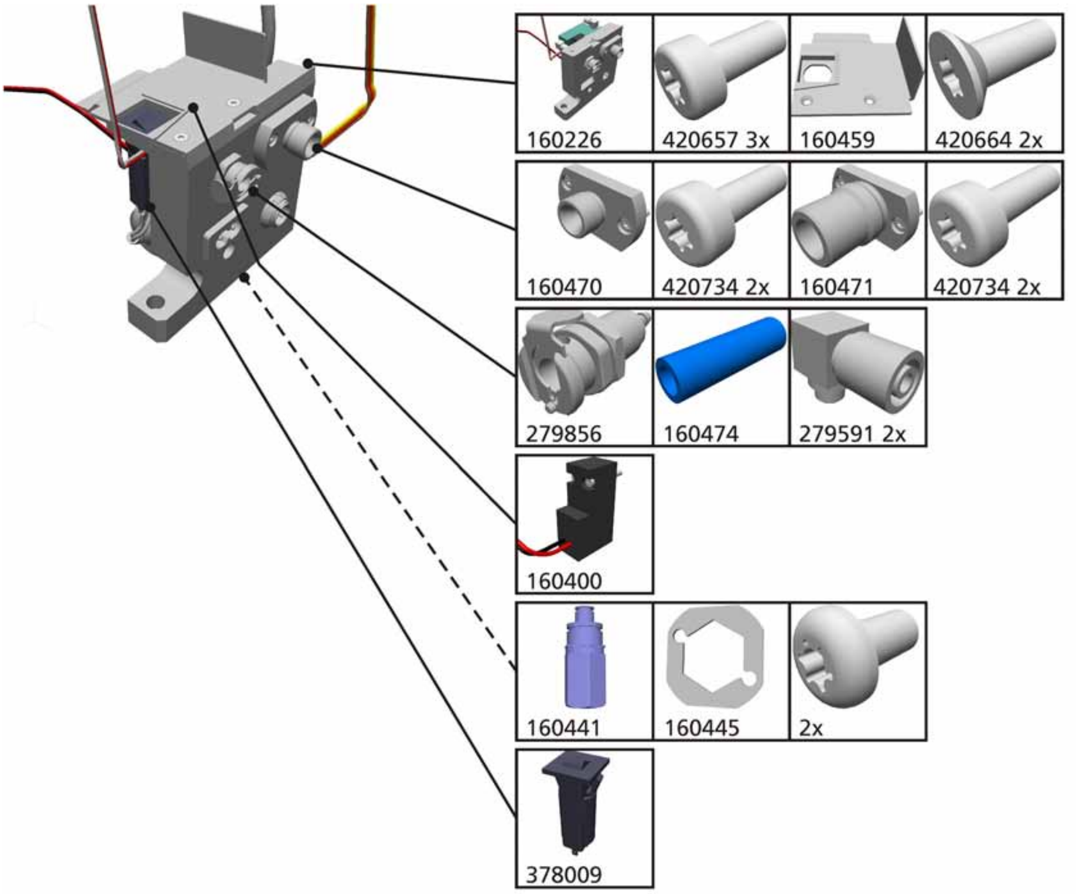
B.5.5 Backup Battery Pack Compartment



B.5.6 Expiratory Valve Assembly

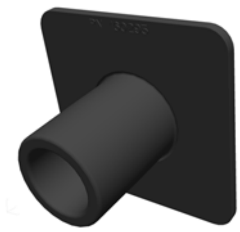
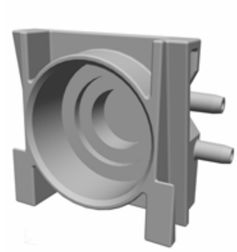


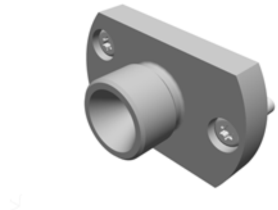
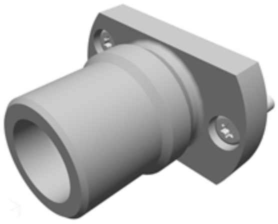
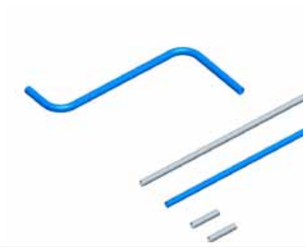
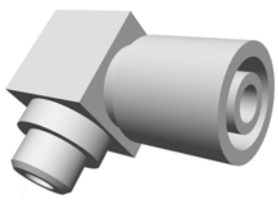
B.5.7 Mixer Block Assembly

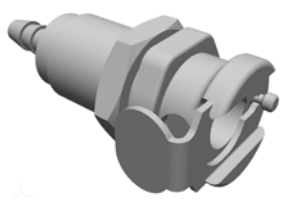


B.6 Detailed Parts Descriptions

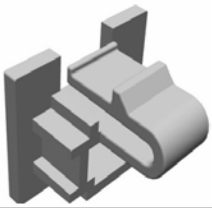
B.6.1 Tubing and Fittings

Part Number	Description	Photo
160223	**FORMED TUBE PATIENT CIRCUIT**	
160285	**FORMED TUBE O_2 HD**	
160287	**TUBE RING NUT FITTING**	
160295	**PATIENT CONNECTION**	
160298	**OXYGEN CELL MOUNTING BLOCK** **(PN 160475 must be ordered as well, if the old OXYGEN CELL MOUNTING BLOCK is made of aluminium)**	

Part Number	Description	Photo
160470	**O_2- DISS CONNECTOR**	
160471	**O_2- NIST CONNECTOR**	
160474	**POLYURETHANE TUBING O_2 BLUE 4x6**	
160475	**TUBING SET (O_2)**	
160476	**TUBING SET (Rinse Flow & Nebulizer)**	
279591	**MINI QUICK DISCONNECT FITTING**	

Part Number	Description	Photo
279856	**OXYGEN QUICK DISCONNECT ID=3.2**	

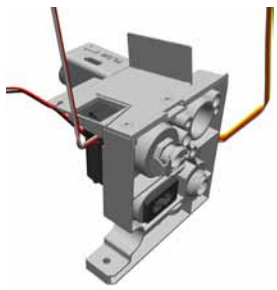
B.6.2 Clamps and Fasteners

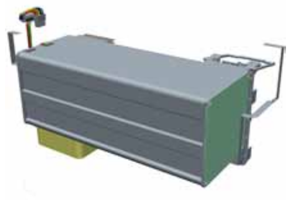
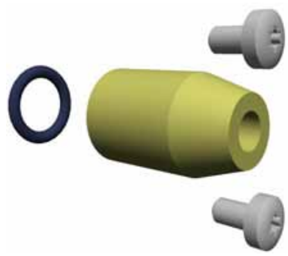
Part Number	Description	Photo
361000	TIE WRAP L=100 B=2.5MM	
361016	CABLE HOLDER 20x20x5MM	
361061	P-CLAMP D=5.0 PA 6	
341458	USB Cover	
341326	RS 232 Cover	
160509	Ethernet Cover	

B.6.3 Stickers and Labels

160020	**Stickers**	
160429	**HAMILTON MEDICAL LABEL**	
255358	**Sticker**	

B.6.4 Pneumatic Parts and Assemblies

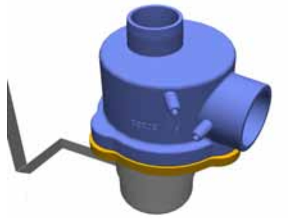
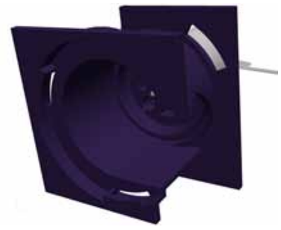
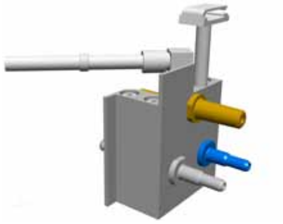
Part Number	Description	Photo
160216	**HEPA FILTER ASSEMBLY**	
MSP160226	**O_2 MIXER ASSEMBLY (complete)**	

Part Number	Description	Photo
MSP160250	BLOWER MODULE	
160497	HAMILTON-C2 INLET Service Kit	

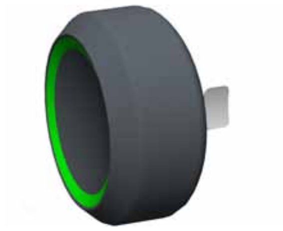
B.6.5 Flow Restrictors and Flow Sensors

Part Number	Description	Photo
MSP399123 521 0836 112	TSI FLOW SENSOR AIR (Qvent) Please order also TIE WRAP L=100 B=2.5MM (PN 361000) and CABLE HOLDER 20x20x5MM (PN 361016)	

B.6.6 Assembled Components

Part Number	Description	Photo
MSP160230	**INSPIRATORY VALVE COMPLETE**	
MSP160240	**EXPIRATORY VALVE COMPLETE**	
160245	**EXPIRATORY VALVE SEAL WITH MEMBRANE**	
MSP160290	**AMBIENT VALVE COMPLETE**	
MSP160325	**INTERACTION PANEL COMPLETE**	
MSP160472	**RINSE FLOW ASSEMBLY** The new Rinse Flow Assembly (made of plastic), does not need a rinse pill any more.	

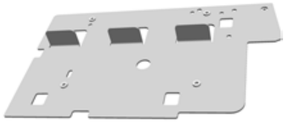
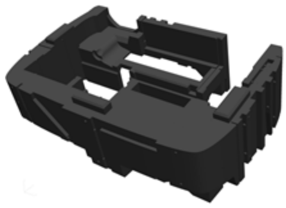
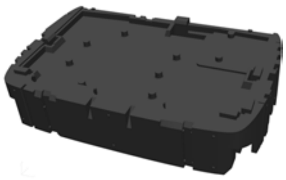
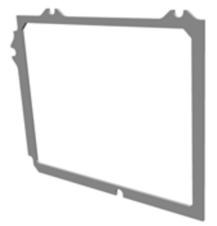
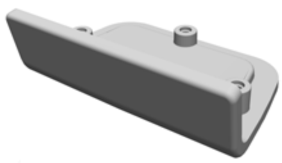
B.6.7 Colored Metal Rings and Controls

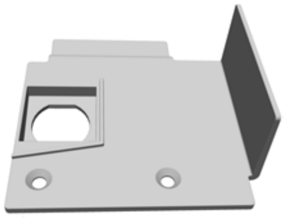
Part Number	Description	Photo
MSP160328	P&T CONTROL KNOB COMPLETE	

B.6.8 Rubber Seals and Grommets

Part Number	Description	Photo
160500	EXPIRATORY VALVE SILICON MEMBRANE 5 PIECES	

B.6.9 Metal Brackets and Frame Components

Part Number	Description	Photo
160228	BASE PLATE	
160237	BOTTOM FOAM	
160238	MIDDLE FOAM	
160239	TOP FOAM	
160341	DISPLAY GASKET	
160403	RELEASE HANDLE	

Part Number	Description	Photo
160404	**DISPLAY MOUNTING BRACKET**	
160426	**LEFT SIDE BRACE**	
160427	**RIGHT SIDE BRACE**	
160459	**MIXER BLOCK COVER PLATE**	
160483	**BASE FRAME**	
281781	**INTERACTION PANEL HINGE TYPE A**	

Part Number	Description	Photo
281782	**INTERACTION PANEL HINGE TYPE B**	

B.6.10 Electrical/Electronic Cables

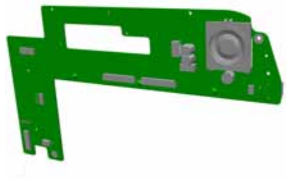
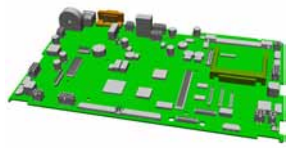
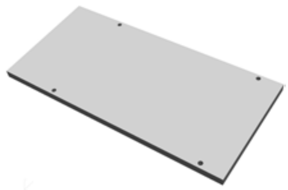
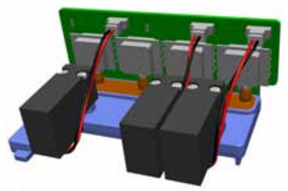
Part Number	Description	Photo
160347	FFC CABLE TO FILTER PRESSURE BOARD	
160348	CABLE TO AC INPUT AND CIRCUIT BREAKER	
160349	CABLE AC INPUT TO CIRCUIT BREAKER	
160370	CABLE TO BATTERY POWER	
160351	FFC CABLE TO BATTERY DATA	
160371	CABLE TO POWER SUPPLY	

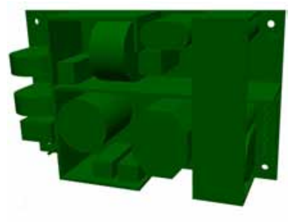
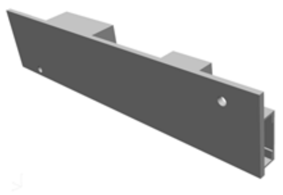
Part Number	Description	Photo
160354	**CABLE TO O_2 CELL**	
160355	**FFC CABLE TO PRESSURE SENSOR BOARD**	
160356	**FFC CABLE TO KEY PANEL**	
160357	**FDC CABLE TO DISPLAY**	
160358	**CABLE TO BACKLIGHT**	
160359	**FFC CABLE TO BINARY VALVES**	

Part Number	Description	Photo
160372	**CABLE DC INPUT**	
160373	**CABLE TO VENTILATION FLOW SENSOR (Qvent)**	
160365	**CABLE TO FAN SUPPLY**	
355198	**USA POWER CABLE 2 POL 3MT C7 G (United States)**	
355199	**GB POWER CABLE 2 POL 3MT C7 G (Great Britain)**	
355200	**EU POWER CABLE 2 POL 3MT C7 G (European)**	

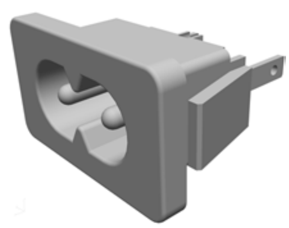
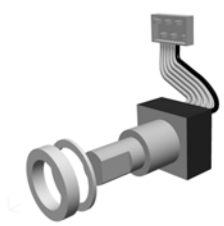
Part Number	Description	Photo
160187	**Car Adapter**	

B.6.11 Electronic Printed Circuit Boards

Part Number	Description	Photo
MSP160196	**FRONTPANEL BOARD**	
MSP160200	**MAINBOARD-C2**	
MSP160206	**EMBEDDED SYSTEM MODULE**	
MSP160300	**PRESSURE SENSOR ASSEMBLY**	
160362	**DISPLAY FRONT** **see B4.4 *LCD Display and Touchscreen*** required: Display Gasket (PN 160341) contains: - Touchscreen - Key Panel - Symbol Insert (PN160376) does not contain: - P&T Knob - LCD - Display - Display Gasket	

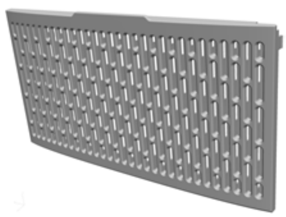
Part Number	Description	Photo
MSP160600	**SERVICE POWER SUPPLY** **Note** MSP160600 is the MSP (Medical Spare Part) for Power Supply (PN 396199) see *Service Entry Show Tab* on page 9-12	
380031	**GRAPHIC LCD TFT VGA 10.4” NEC**	
396197	**DC/AC CONVERTER BOARD** (new Display) for Hamilton-C2 SN>1675 see *Backlight inverter PN 396197 (old) or PN 396229 (New)* on page E-15	

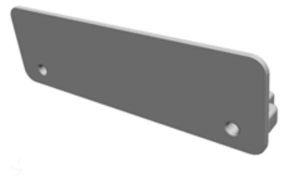
B.6.12 Electrical/Electronic Devices

Part Number	Description	Photo
160302	**BATTERY COMPARTMENT**	
160346	**FAN 12V**	
160400	**2/2 WAY MAGNET VALVE MICRO 10 (NEBULIZER VALVE)**	
340530	**AC ELECTRICAL INLET PLUG SNAP-IN CLASS II**	
369106	**BATTERY LI-ION 14.4V/6.6Ah**	
372036	**P&T CONTROL KNOB ENCODER**	

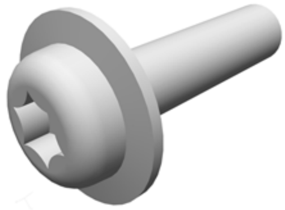
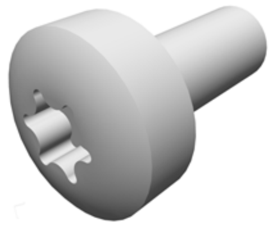
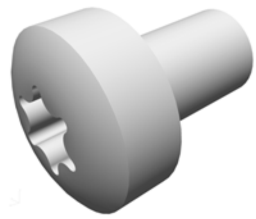
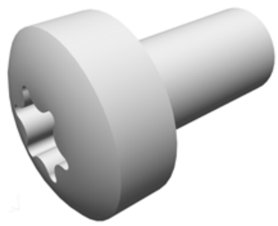
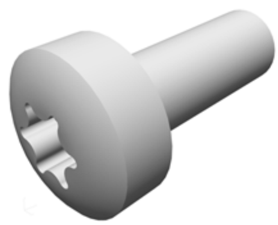
Part Number	Description	Photo
378009	2 AMP CIRCUIT BREAKER	
380030	BACKLIGHT FOR LCD	
396200	O_2 CELL HAMILTON-C2 (coded)	

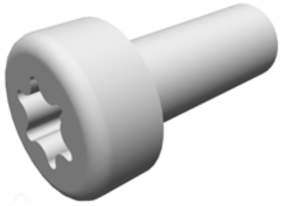
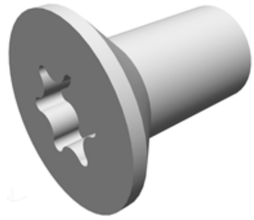
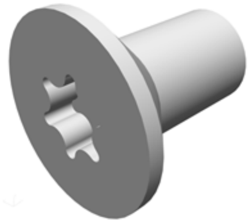
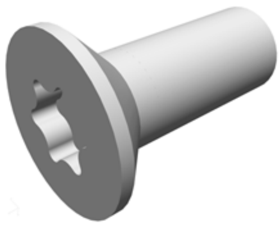
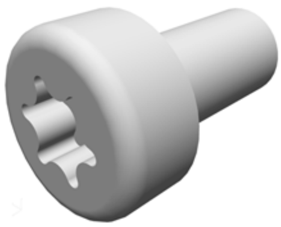
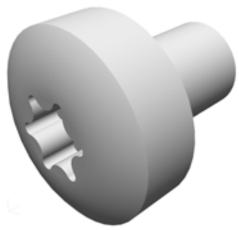
B.6.13 External Covers and External Hardware

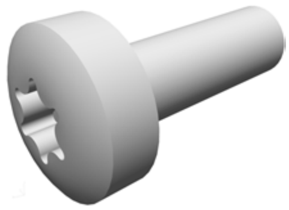
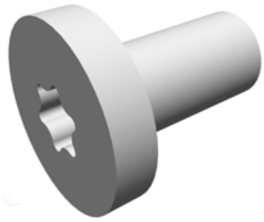
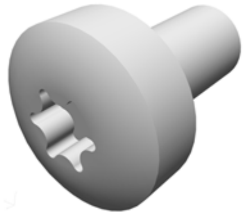
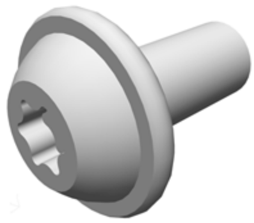
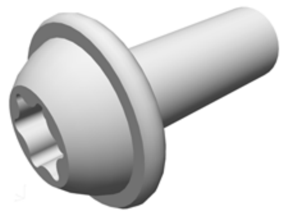
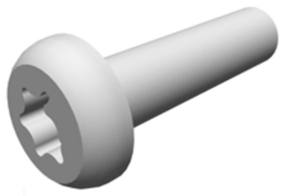
Part Number	Description	Photo
160326	**INTERACTION PANEL LARGE REAR COVER**	
160329	**ALARM LAMP COVER**	
160343	**VENTILATOR UNIT FILTER COVER**	
160506	**BATTERY COVER** cover fits only to latest style of rear cover, see E.2.20 *Battery Door PN 160344 (old) or PN 160506 (new)*	
160401	**O_2 CELL COVER**	
160402	**INTERACTION PANEL SMALL REAR COVER**	

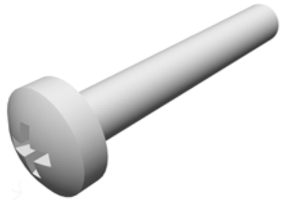
Part Number	Description	Photo
160408	**CABLE SUPPORT**	
160431	**BLANK PLATE FOR OPTIONS BOARD**	
160439	**LOUDSPEAKER FOIL COVER**	
MSP160480	**VENTILATOR UNIT FRONT COVER with Label**	
MSP160481	**VENTILATOR UNIT REAR COVER complete see B.5.3 *Rear Cover***	
160601	**VENTILATOR UNIT TOP COVER**	

B.6.14 Screws

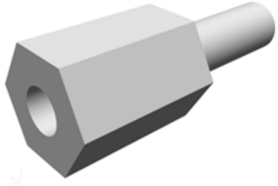
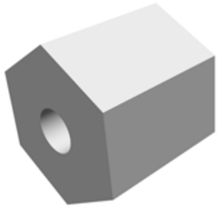
Part Number	Description	Photo
420623	TORX ROUNDHEAD SCREW W/I-6-ROUND M4x16	
420638	TORX ROUNDHEAD SCREW I-6-R M2.5x6 A4	
420641	TORX ROUNDHEAD SCREW I-6-R M3x5 A4	
420642	TORX ROUNDHEAD SCREW I-6-R M3x6 A4	
420643	TORX ROUNDHEAD SCREW I-6-R M3x8 A4	
420654	TORX CYL-SCREW I-6-R NK M3x4 A2	

Part Number	Description	Photo
420657	TORX CYL-SCREW I-6-R NK M4x10 A2	
420659	TORX C-SUNK SCREW I-6-R M3x6 A4	
420663	TORX C-SUNK SCREW I-6-R M2x4 A4	
420664	TORX C-SUNK SCREW I-6-R M3x8	
420667	TORX CYL-SCREW I-6-R M4x8 A2	
420671	TORX ROUNDHEAD SCREW I-6-R M2x3 A2	

Part Number	Description	Photo
420682	**TORX ROUNDHEAD SCREW I-6-R M4x12 A4**	
420684	**TORX CYL-SCREW I-6-R ENK M3x6 A2**	
420692	**TORX ROUNDHEAD SCREW I-6-R M2x4 A4**	
420699	**TORX FILLISTER HEAD SCREW 22x5 D1=2.2, L=5, 6 IP**	
420724	**TORX FILLISTER HEAD SCREW 30x8**	
420727	**TORX SCREW I-6-R M4x16**	

Part Number	Description	Photo
420730	**PHILLIPS HEAD SCREW M3x20 DIN7985 PA6.6**	
420734	**TORX CYL-SCREW I-6-R NK M3x10**	

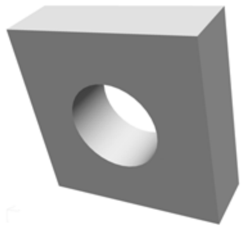
B.6.15 Standoffs

Part Number	Description	Photo
257038	STANDOFF SCREW M3x8	
257076	STANDOFF M2x5	

B.6.16 Washers

Part Number	Description	Photo
409105	WASHER M3 DIN125A	
409908	WASHER M10/1.2 BN735	
411001	STAR WASHER M3 DIN6798	

B.6.17 Screw Nuts

Part Number	Description	Photo
421059	SCREW SQUARE NUT M4	

Appendix

C Schematics

C.1 Block Diagrams

Component	Number/Revision	File Link
Block Diagram HAMILTON-C2 ICU	BD614227/00	BD614227/00

C.2 Wiring Diagrams

Component	Number/Revision	File Link
Wiring Diagram HAMILTON-C2	WD616063/01	WD616063/01

Appendix

D Software revisions, features and compatibility

Note
For actual information and latest software, log in to HAMILTON MEDICAL Partner Web Site (http://www.hamilton-medical.com). There, you can also find information about upgrading and updating a HAMILTON-C2.

D.1 Introduction

The Appendix gives an overview of all published HAMILTON-C2 software. It concludes information about new features introduced with software upgrades and software updates information about compatibility between software of different versions.
The improvement list is not meant to be complete and covers only the most relevant changes.

D.2 Software version 1.0.1 *)

HAMILTON-C2	
Date	From October 2008
Improvements	• SW 1.0.1, ready for software upgrade with USB memory stick

Table D-1. Software version 1.0.1

D.3 Software version 1.0.2 *)

HAMILTON-C2	
Date	From December 2008
Improvements	• Reducing of maximum power consumption during starting the device • Adjusting limits of the buzzer control • New settings of O2 control low alarm • Changing identification algorithm of the O2 cell • Increased the divergence of flow sensor calibration

Table D-2. Software version 1.0.2

Note
*Obsolete software version. Mandatory update must be performed.

D.4 Software version 1.1.0 *)

HAMILTON-C2	
Date	From March 2009
Additional features	• DuoPAP/ APRV • Trend • Loops • Asian languages • Ferrits in Interaction Panel not necessary

Table D-3. Software version 1.1.0

D.5 Software version 1.1.1 *)

HAMILTON-C2	
Date	From May 2009
Improvements	• Internal tightness test applicable • Adjusting alarm limit blower service required • System test O2 mixer implemented • System test flow implemented

Table D-4. Software version 1.1.1

D.6 Software version 1.1.2 *)

HAMILTON-C2	
Date	From August 2009
Improvements	• Technical Fault Handling • Flow sensor calibration • Autotriggering behavior • Power Management (battery power handling) • New Languagefiles; DuoPAP+ to PSIMV+ • Language adaption based on International Standards

Table D-5. Software version 1.1.2

Note
*Obsolete software version. Mandatory update must be performed.

D.7 Software version 1.1.3 *)

HAMILTON-C2	
Date	From December 2009
Improvements	• Labelling of TF 232007: The technical alarm TF 232007 is displayed as "**Check Flow Sensor tubing**" alarm on screen during ventilation in order to give the user a better understanding of the situation. In the event and service log the technical alarm TF 232007 is displayed as Check Flow Sensor tubing alarm. • Autozero procedure: Due to internal investigation the autozero interval takes place more frequently to improve the flow measurement performance. • Event Log: All technical faults generated while performing the Service Software tests will no longer be registered in the user event log as numerical codes.

Table D-6. Software version 1.1.3

Note
*Obsolete software version. Mandatory update must be performed.

D.8 Software version 1.1.4

HAMILTON-C2	
Date	From April 2010
Soft Boot Corrective Action	Every Device in the Field must have a SW Version 1.1.4 or later. The software solves a problem met during extreme stress with an external monitoring system.
Improvements	• A decrease of the blower speed after stand-by prevents the device from false positive "External power loss" alarms. • TF 243005: loudspeaker sounds continually. The alarm rule has been adapted • TF 231008/TF231013: During start-up in LPO mode the false positive TF's 231008/231013 doesn't pop up No false positive TF 485001 during the switch off procedure any more Increased O2 mixer stability • Ready for the new inspiration valve

Table D-7. Software version 1.1.4

D.9 Software version 2.0.0

HAMILTON-C2	
Date	From September 2010
Improvements	• Technical State (Service Entry) can be imported and exported • Fully automated inspiration valve calibration • Flow sensor calibratione can be performed in the Service Software

Table D-8. Software version 2.0.0

D.10 Software version 2.0.1

HAMILTON-C2	
Date	From September 2010
Improvements	• By using the suctioning tool TF 331001(works only with 2.0.0) may appear. With the software 2.0.1 this failure has been eliminated.

Table D-9. Software version 2.0.1

Appendix

E Hardware revisions, features and compatibility

E.1 Introduction

The appendix brings together information found in other parts of the service manual concerning hardware components that have changed over time. The appendix then adds additional information, such as associated HAMILTON-C2 serial numbers and the dates of changes..

E.2 Improvements

E.2.1 Trolley (PN 160150)

To prevent that the threads pull out of the PU foam and the holding device falls down a metal bar (A) is mounted on the trolley. The holding device can be mounted directly to the metal bar. .

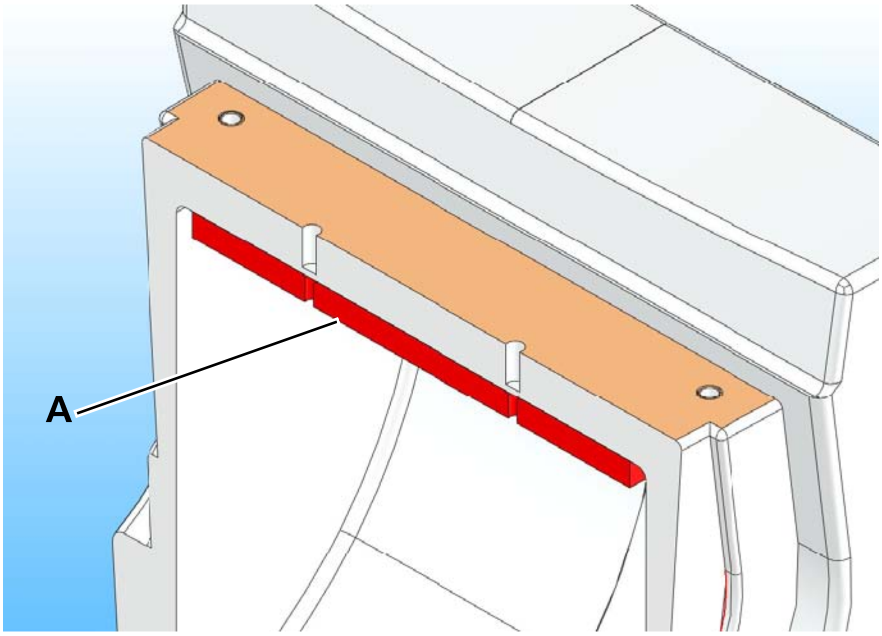
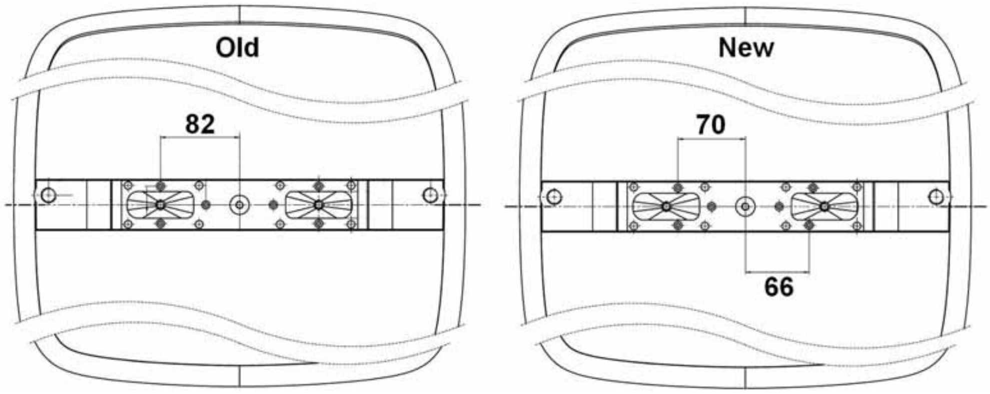


Figure E-1. Trolley

The trolley handle on HAMILTON-C2 has been modified. The trolley handle versions are not compatible to each other. The distance of the drilled holes have been changed from 82 mm to 70 and 66 mm. HAMILTON-C2 devices as far as serial number 1350 use the older trolley version. Individual spareparts for it are not available, the ordering number for the complete trolly is still 160150. For further details please refer to the technical drawings above.



E.2.2 Front Panel Board modifications Revisions 01 to 03 (PN 160196)

Rev 01	First official release
Rev 02	new layout, connector handling
Rev 03	Speaker loudness

E.2.3 Mainboard modifications Revisions 03 to 09 (PN 160200)

Rev 03	First official release
Rev 05	Alarm buzzer loudness
Rev 06	new layout and new firmware O2 - Cell calibration without ext. tool
Rev 07	new layout, blower endstage robustness
Rev 08	new firmware
Rev 09	Qvent sensor precision improved, EMC immunity to 20 v/m increased

General improvements:

- Blower feeding voltage by new logic,
- Buzzer Alarm loudness
- power management

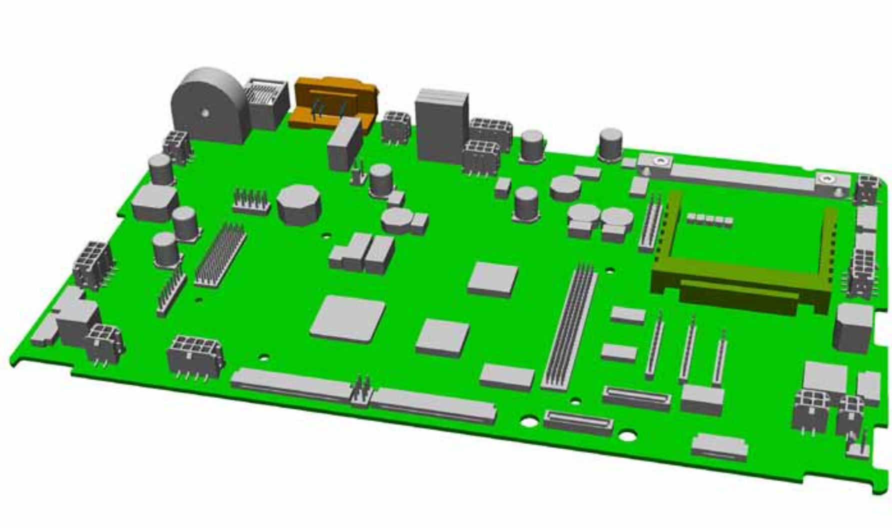


Figure E-2. Mainboard-C2

Note

The oxygen cell calibration tool PN 160367 is no longer required for the mainboard revisions 06 and higher.

E.2.4 ESM Board modifications Revisions 01 to 05 (PN 160206)

Rev 01	First official release
Rev 02	new layout, new firmware, SW 1.0.1, ready for SW upgrade with USB memory stick
Rev 03	not used components droped^
Rev 04	not used components droped
Rev 05	SW 1.0.5, no more loss of technical state due to SW upgrade, not used components droped

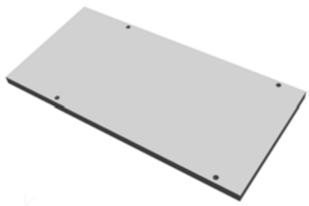


Figure E-3. ESM Board

E.2.5 Mixer Assembly modifications Revisions 00 to 03 (PN 160226)

Rev 00	First official release 1001 to 1271
Rev 01	see Appendix E.2.5.1 from SN 1272 to 1589
Rev 02	see Appendix E.2.5.2 from SN 1590 to 1589
Rev 03	see Appendix E.2.5.3 since SN 1590

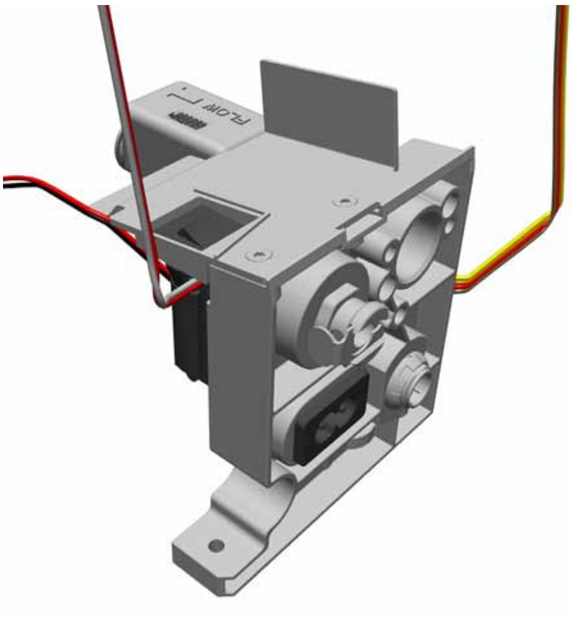


Figure E-4. Mixer Assembly

E.2.5.1 Mixer Assembly modifications Revisions 00 to 01 (PN 160226)

Installed in all HAMILTON-C2 devices from serial number 1001 to SN 1271.

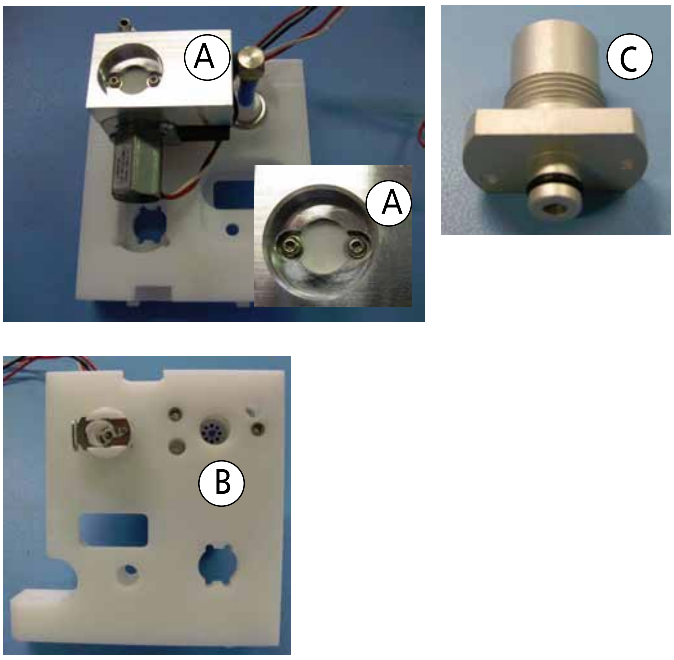


Figure E-5. Mixer Assembly

Features:

- Plastic disk PN 160454 (A)
- Without turbulence screen PN 160489 (A)
- Manufactured with the small O2 connector seat (B) from SN 1001 to 1271 (Refer to section Mounting Plate PN 160458 for further information)
- Manufactured without O2 Inlet Filter (C) (Refer to section O2 Inlet Filter PN 160491)

E.2.5.2 Mixer Assembly modifications Revisions 01 to 02 (PN 160226)

Installed in all HAMILTON-C2 devices from serial number 1272 to 1589.

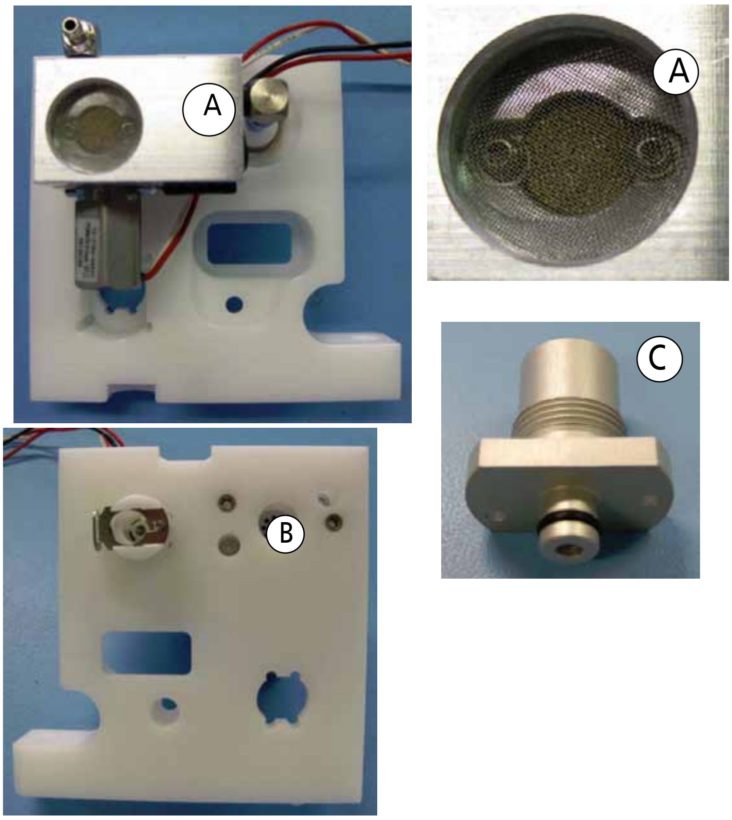


Figure E-6. Mixer Assembly

Features:

- Sinter disk PN 160486 (A)
- Equipped with turbulence screen PN 160489 (B)
- Manufactured with the small O2 connector seat (B) from SN 1272 to 1589 (Refer to section Mounting Plate PN 160458 for further information)
- Manufactured without O2 Inlet Filter (C) (Refer to section O2 Inlet Filter PN 160491)

E.2.5.3 Mixer Assembly modifications Revisions 02 to 03 (PN 160226)

Installed in all HAMILTON-C2 devices from serial number 1590 to 1625.

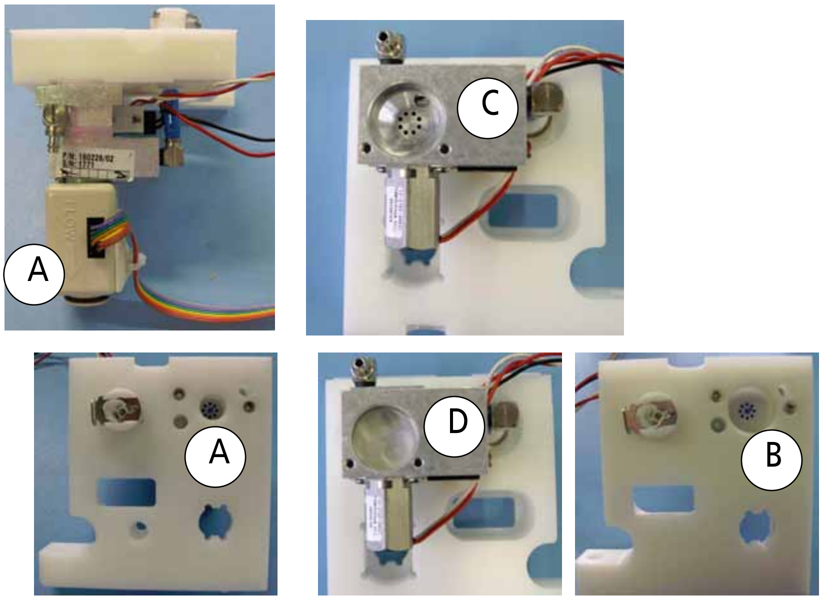


Figure E-7. Mixer Assembly

- The QO2 Flow Sensor PN 399124 is part of the mixer assembly PN 160226. (A)
- Manufactured with the small O2 connector seat (A1) from SN 1590 to 1625
- Manufactured with the large O2 connector seat (B) from SN 1626 on
- Orifice PN 160510 (C)
- Turbulence screen PN 160513 (D)

E.2.6 O2 Inlet Filter PN 160491:

To prevent the Proportional Valve PN 160441 from obstruction caused by particels entering the device, the O2 inlet filter with reference number PN 160491 has been implemented.

The inlet filter PN 160491 is part of the DISS (PN 160470) or NIST (PN 160471) connector.

For devices which do not yet have a O2 inlet filter installed, we strongly do recommend installing the filter to avoid the device from malfunctioning.

For this purpose we do provide the following solutions:

1. Devices with mixer assembly PN 160226 REV 00 and 01

    The following items need to be ordered for the update:

    - PN 160470 O2 DISS connector
    - PN 160496 Mounting kit (Including mounting adaptor PN 160494)

or

    - PN 160471 O2 NIST connector
    - PN 160496 Mounting kit (Including mounting adaptor PN 160494)

2. HAMILTON- C2 with mixer assembly PN 160226 REV 02

    The following items need to be ordered for the update:

- PN 160470 O2 DISS connector

or

- PN 160471 O2 NIST connector

Note

A number of devices with mixer assembly PN 160226 **REV 02** (SN 1590 - 1625) are not equipped with the large O2 connector seat. For these devices it is necessary to order the mounting kit PN 160496 together with the DISS or NIST connector.

Figure E-8. DISS connector with mounting adaptor

Figure E-9. NIST connector with mounting adaptor

The O2 inlet filter is part of the yearly maintenance procedure and can be ordered seperately under reference number PN 160491.

Figure E-10. O2 Inlet filter

E.2.7 Mounting plate Revisions 00 to 01 (PN 160458)

Rev 00 First official release. The mounting plate with the small O2 connector seat is installed in all HAMILTON-C2 devices from SN 1001 to 1625.

Rev 01 The mounting plate with the large O2 connector seat is installed in all HAMILTON-C2 devices from SN 1626 on.

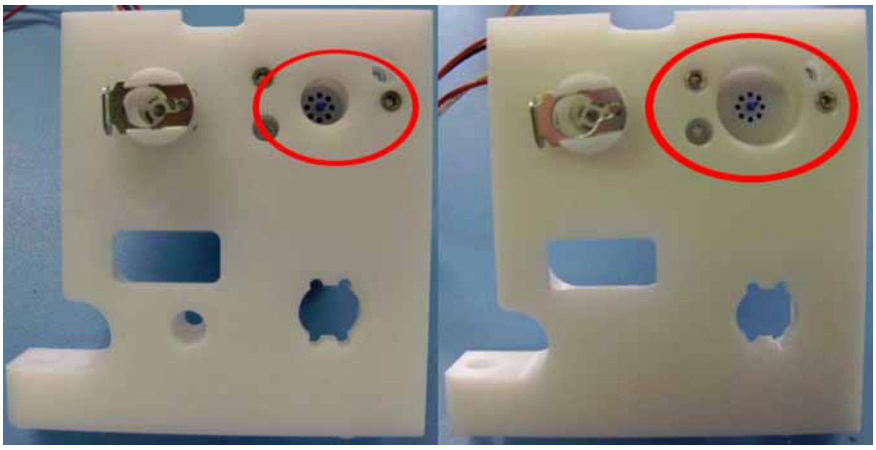


Figure E-11. Mounting plate Rev 00 (left) and Rev 01 (right)

E.2.8 Inspiratory-Valve modifications Revisions 00 to 01 (PN 160230)

Rev 00 First official release

Rev 01 Housing and flow characteristic improved

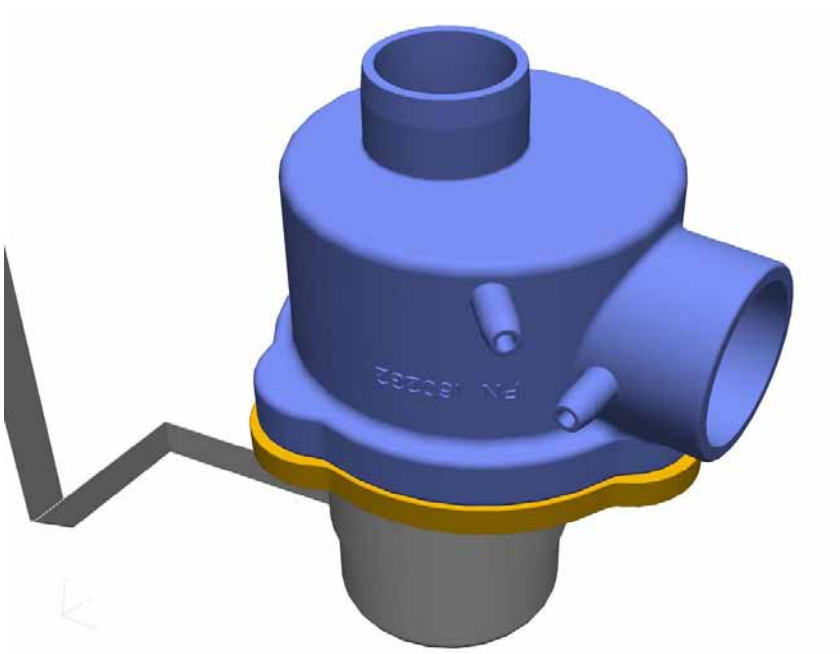


Figure E-12. Inspiratory-Valve

E.2.9 Blower Module modifications Revisions 00 to 02 (PN 160250)

Rev 00	First official Release
Rev 01	Noise reduction and Blower Turbine sealed up
Rev 02	Assembly process improved
Rev 03	Assembly process improved

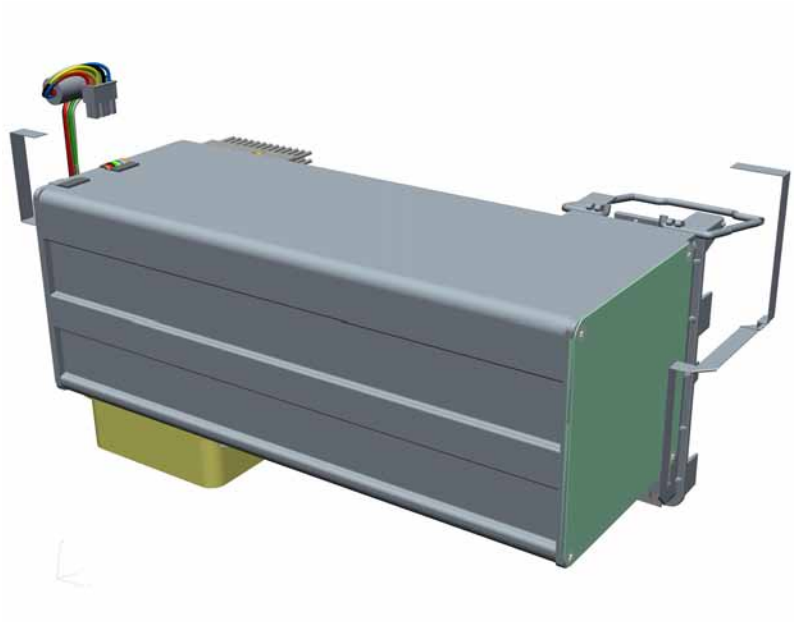


Figure E-13. Blower Module

E.2.10 Pressure Sensor Assembly modifications Revisions 00 to 01 (PN 160300)

Rev 00	First official Release
Rev 01	Design of the Holding Plate improved

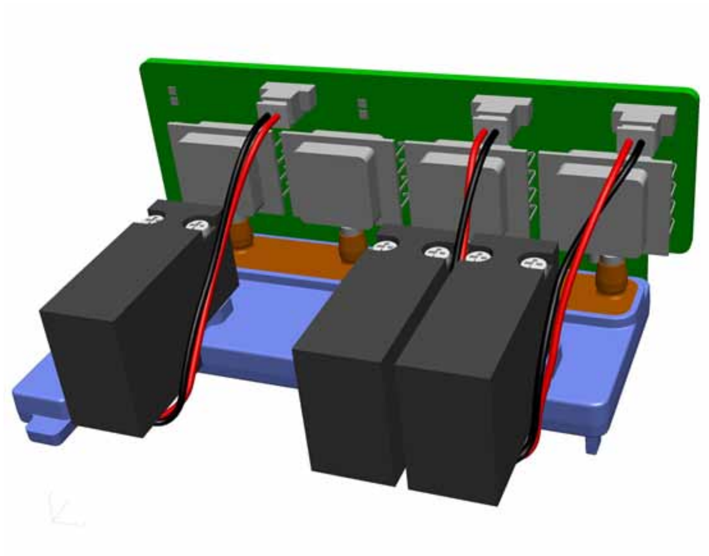


Figure E-14. Pressure Sensor Assembly

E.2.11 Battery fitting (PN 160303)

To prevent an increase of battery temperatures >54 °C 5 vent holes (A) are drilled on the top of the Battery fitting.

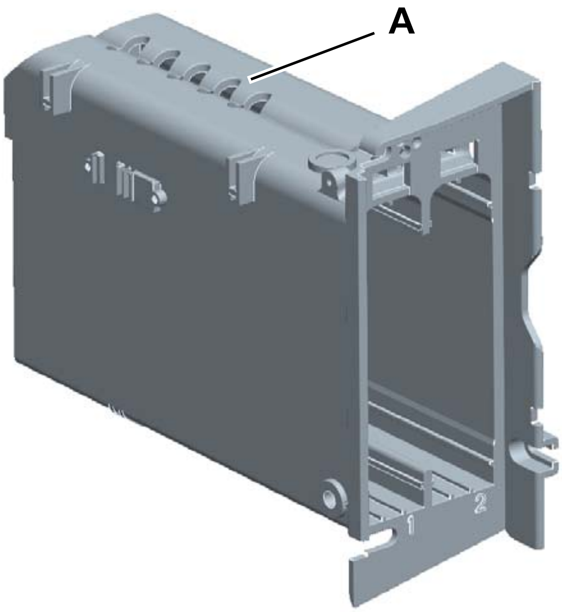


Figure E-15. Battery fitting

E.2.12 Handle (PN 160342)

To prevent a damage of the device the cylinder bolt (A) was extended and locked against removing with a retaining ring (B) inside. The top cover can be replaced with PN 160601.

This improvement is from SN 1271 active.

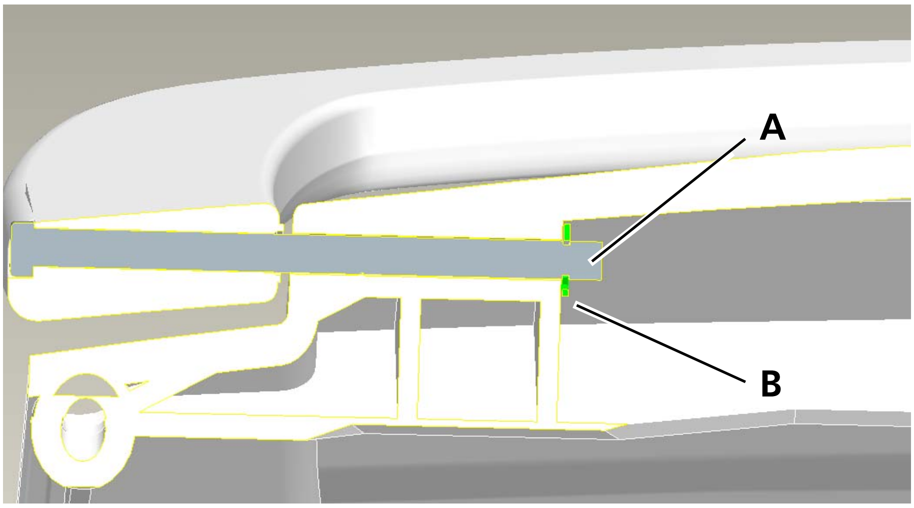


Figure E-16. Handle

E.2.13 O2 Cell Cover modifications Revisions 00 to 02 (PN 160401)

Rev 00	First official release
Rev 01	improved ultraviolet rays resistance
Rev 02	O2-Cell cover improved

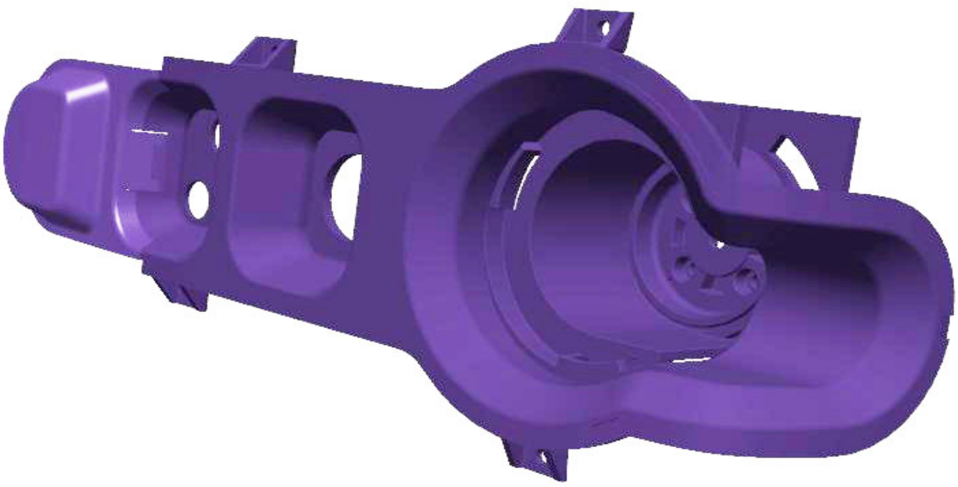


Figure E-17. O2 Cell cover

E.2.14 Front cover modifications Revisions 00 to 02 (PN 160480)

Rev 00	First official release
Rev 01	Improved ultraviolet rays resistance
Rev 02	O2-Cell cover improved

Figure E-18. Front cover

E.2.15 Rear Cover modifications Revisions 00 to 02 (PN 160481)

Rev 00	First official release
Rev 01	Improved ultraviolet rays resistance
Rev 02	Several further improvements like Battery Door.

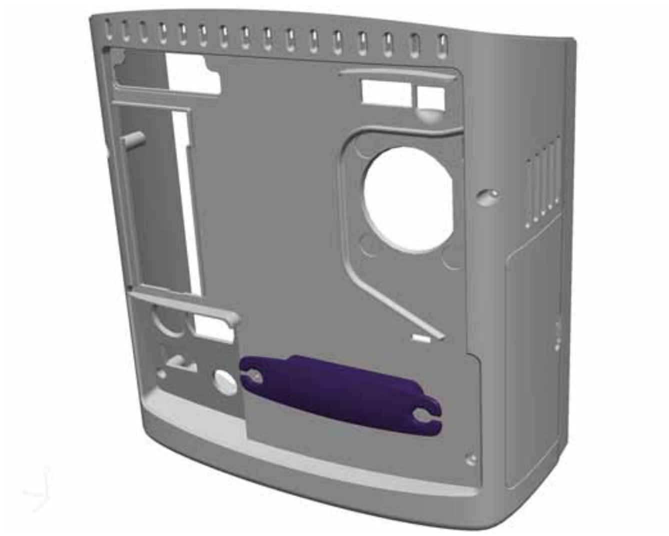


Figure E-19. Rear Cover

E.2.16 Display modifications

Figure E-20. Display

S/N	Display (PN)	Backlight inverter (PN)	Cable PN	Remmarks PN
1001 - 1675	380027	396197	160357	
1676 -	380031	396229	160357	no more Ferrits needed

If the old display (PN 380027) or backlight converter (PN 396197)is no longer available, please order the following parts:

1x Display	PN 380031
1x DC/AC Inverter	PN 396229
1x Cabel	PN 160357
1x Earth contact spacer	PN 257038
1x Earth screw	PN 420641
1x Cable holder	PN 160488
2x Allen screw	PN 420699

E.2.17 Backlight inverter PN 396197 (old) or PN 396229 (New)

For compatibility see Appendix E.2.16, *Display modifications*, on page E-14 PN 396229 (old Display) for Hamilton-C2 SN<1676.

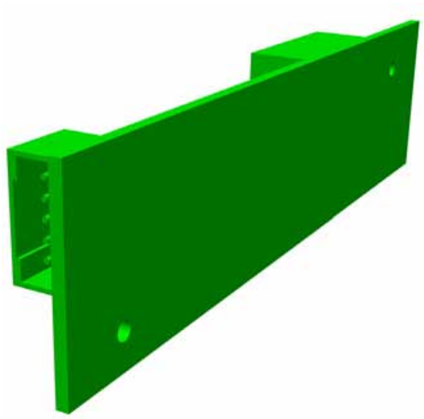


Figure E-21. Backlight inverter

E.2.18 Battery Door PN 160344 (old) or PN 160506 (new)

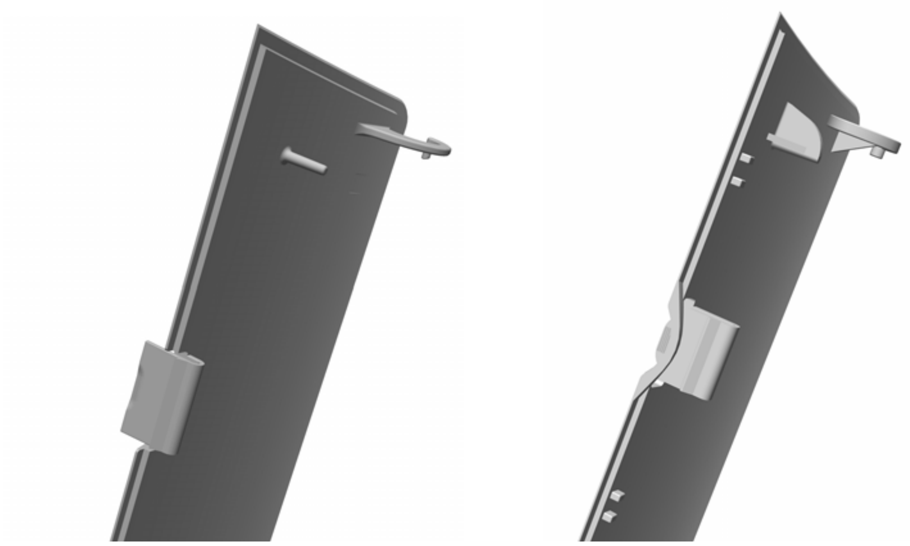


Figure E-22. Battery Door old (left) (PN 160344) and Battery Door new (right) (PN 160506)

Order the complete rear cover MSP160481, see B.5.3 *Rear Cover* on page B-9, if the brocken battery cover is an old one (PN 160344).

Appendix

F Glossary

F.1 Definitions of expression

This glossary offers definitions of expressions not included, or extended definitions of expressions briefly included, in the glossary of the *HAMILTON-C2 Operator's Manual*. It should be used together with the glossary in this guide.

Activate	An action on the Touchscreen or the P&T Control Knob to choose a function or action.
Air	Source used in the HAMILTON-C2
Alarm Buffer	An area of memory containing details of the twenty most recent alarms. The most recent six of the twenty alarms can be accessed by activating the alarm symbol at the bottom left of the screen when the HAMILTON-C2 is in normal operating mode.
Alarm Lamp	Indicates alarm conditions • Red - High Priority Alarms and Technical Faults • Yellow - Medium and Low Priority Alarms
Alarm Status Indicator	An area at the bottom of the Interaction Panel Touch Screen of the HAMILTON-C2 which displays the Alarm Status and Power Status.
Ambient State	A state that the HAMILTON-C2 uses when it cannot function normally because of an internal or external fault. In this state, the *Inspiratory Valve* closes, the *Expiratory Valve* opens and the *Ambient Valve opens.* The patient is not actively ventilated in any way, but is allowed to inhale through the *Ambient Valve*. The Ambient State is often associated with *Technical Faults*, but can also be caused by such things as a air or oxygen supply. It is always accompanied by a high-priority Patient Alarm, sounded by the Loudspeaker or *Buzzer*.
Ambient State Gas Flow	If the HAMILTON-C2 is in Ambient State, the patient breathes unassisted. This flow occurs in the Ambient Valve and the Expiratory Valve.
Ambient Valve	The Ambient Valve when ***not*** activated, enables air in the room to enter the Patient Breathing Circuit. The valve is held closed by a solenoid during normal ventilation, but can open in response to a patient's efforts to inhale, when the HAMILTON-C2 is in the *Ambient State*.
Ambient Valve Membrane	A valve which allows the patient to breathe unattended when unpowered.
Ambient Valve Solenoid	The Ambient Valve Solenoid holds the *Ambient Valve* closed during normal ventilation.
Analog - Digital Conversion (ADC)	Converts an Analog Signal to a Digitized Signal.

Audible Alarm	An alarm sounded when there is a Technical Fault or other error condition. An Audible Alarm is generated through the Loudspeaker in the Interaction Panel. A buzzer is used as a backup if the Audible Alarm through the Loudspeaker does not function.
Autorinse	See *Rinse Flow*.
Autozero	A method to automatically adjust for electronic drift of a device due to temperature and environmental conditions.
Autozero Valves	See *Flow Sensor Autozero Valves*.
Backlight	Lights used to help illuminate the screen.
Backlight Converter	A Printed Circuit Board used to convert 5 VDC to 1100 VAC for the Backlight of the 10.4-in. TFT screen.
Basic Input Output System (BIOS)	The Basic Input Output System for the Central Processing Unit (CPU). This is held on an EPROM or EEPROM mounted on the Motherboards.
Basket	An accessory located on the back of the HAMILTON-C2 Trolley.
Battery Charger	Circuits located in the Mainboard that resupply power to the Primary and Optional Battery Packs when Mains Power is available. • Primary Battery Pack - 14.4 VDC maximum charging voltage. • Optional Battery Pack - 14.4 VDC maximum charging voltage. Both Battery Packs can also be charged using an external charger.
Breathing Circuit	A Patient Breathing Circuit carries the Air/Oxygen Mixture to the patient and carries the expired (exhaust) air from the patient. It may include Tubings, Mask, Inspiratory Filter, Flow Sensor, Nebulizer Jar, Exhalation Valve Cover and Membrane.
Buzzer	A piezoelectric device mounted on the *Mains Board*, used by the HAMILTON-C2 to sound some alarms. It functions independently of the Loudspeaker and the Power Supply, and typically indicates a high-priority Technical Fault that causes the HAMILTON-C2 to go into the Ambient State. **Note** Despite its name, the buzzer makes a high frequency sound.
Communication Interface	The RS232 port and the Ethernet port on the rear of the HAMILTON-C2. The RS232 port is used to communicate with peripherals such as a computer or monitor.
Configuration Menu	A screen used to select ventilation and other operation parameters of the HAMILTON-C2.
Control Knob	Used to select an option on the LCD screen by rotating and can be used to activate a selection on the LCD screen by pressing.
De-activate	An action on the Touchscreen or the P&T Control Knob to clear the selection of a function or action.

De-select	An action on the Touchscreen or the P&T Control Knob to clear the selection of a function or action.
Digital - Analog Converter (DAC)	Converts a Digital Signal to an Analog Signal.
DISS	Diameter index safety standard, a standard connector used for connection of Oxygen to the HAMILTON-C2, designed so the Oxygen supply cannot be connected incorrectly.
dP Flow Sensor	Measures the differential pressure (pressure difference) across the Flow Sensor. The measurement is performed by a pressure sensor inside the HAMILTON-C2, and is used to calculate airway gas flow.
EEPROM	Electrically Erasable Programmable Read Only Memory
Electrical Safety Tests	A set of electrical tests used to check the safety of a device.
Electrostatic Dischage (ESD)	Electrostatic Discharge
Emergency Buzzer Alarm	**Note** The buzzer makes a high frequency sound. It functions independently of the loudspeaker. An alarm that sounds when a Technical Fault occurs that is serious enough to cause the HAMILTON-C2 to switch to Ambient Mode. In Ambient Mode, all valves switch to their unpowered position, and the HAMILTON-C2 is completely passive.
Event Log	A record of most activity in the HAMILTON-C2. This includes user actions and internal activity such as: •Calibration results •Alarms •Technical faults •Controls settings •Configuration, serial numbers, revision numbers •Switch-on times The Event Log always holds a minimum of 4,000 events. Switching OFF and ON the HAMILTON-C2 does not delete the storage of the Event Log. You can access a subset of the event log suited for clinical use by activating the Event Log symbol in the monitoring menu in normal operating mode. Other subsets of the log, or the full contents of the log, are available in *Test Mode*.
Expiration	The act of the patient breathing out.

Expiratory Valve	A valve controlling pressure in the patient circuit, enabling the patient to exhale and the HAMILTON-C2 to maintain PEEP. It comprises a Positioning Coil Membrane and Cover. Its function is synchronized with that of the *Inspiratory Valve*.
Expiratory Valve Block Connection	The plastic connector used to attach the Patient Breathing Circuit on the front of the HAMILTON-C2.
Fan Filter	A filter used to capture dust from the cooling fan.
Flow Restrictor	A device that restricts flow of a gas.
Front Panel Keys	Control buttons at the front of the Interaction Panel.
Galvanic Oxygen Cell	See *Oxygen Cell*.
Gas Inlet	Connections for the inlet of Oxygen to the HAMILTON-C2.
Gold Cap	Provides power for emergency buzzer alarm for 3 months when no power source is provided from Mains Power or Batteries.
Ground	Refers to the 0 electrical potential of a device.
Ground (GND)	Ground
Hamilton-C2	Product Name.
Hand Pump	Used in Test Configurations to induce and control a pressure for adjustments of the sensors.
HEPA	High efficiency particle air filter
High Voltage Converter Board	A Printed Circuit Board used to convert 5 VDC to 1100 VAC to power the Backlight of the Display.
Hot Swappable	A term used to indicate a device can be disconnected without removing power.
Inspiration	The act of the patient breathing in.
Inspiratory Valve	A valve controlling the pressure or flow (depending on mode) of the air/oxygen mixture to the Patient Breathing Circuit. Its function is synchronized with that of the *Expiratory Valve*.
Interaction Panel (IP)	Part of the HAMILTON-C2 containing the user interface for interaction with the ventilator; LCD Display, Hard Keys and a USB port for software download and event log export.
Internal Temperature	The HAMILTON-C2 contains devices to measure the internal operating temperatures.
Light Emitting Diode (LED)	Light Emitting Diode

Loudspeaker	A speaker used to indicate alarm conditions from either the Interaction Panel or the Ventilation Unit.
Main Power Switch	Powers the HAMILTON-C2 ON and OFF.
Metron EST Tester	Automated device used to perform the electrical safety test.
Microphone	In the HAMILTON-C2, a microphone is positioned near the Loudspeaker as a feedback circuit to determine that the Loudspeaker is operating properly.
Nebulizer Connection	Connection on the front of the HAMILTON-C2 to attach tubing for the Nebulizer output.
Nebulizer Valve	Valve used to control the flow of Oxygen to the Nebulizer Jar.
NIST	Noninterchangeable screw thread, a standard connector used for connection of Oxygen to the HAMILTON-C2, designed so the Oxygen supply cannot be connected incorrectly.
O_2 Cell Calibration	A procedure which supplies a controlled flow of Air, Oxygen and Air/Oxygen mixture to the Oxygen Cell for calibration.
One-Way Check Valve	Used to restrict gas flow to only one direction.
Orifice Flow Restrictor	A device with an fixed opening which restricts the flow of a gas.
Orifice Tube	Used in the Test Configuration to perform adjustments in the Service Software.
Oxygen Cell	A small, replaceable, plastic unit used by the HAMILTON-C2 to measure Oxygen Concentration. (Also known as an O_2 Cell.) The Oxygen Cell reacts to the presence of Oxygen, producing a voltage output in proportion to the Oxygen Concentration. The Oxygen Cell must be replaced after a period of service, when it can no longer be calibrated. Typically, about one year.
Pambient	A sensor which measures the Ambient Pressure or the room pressure.
Patient Alarms	An alarm indicating that there is a problem or potential problem in ventilating the patient. There are three levels of patient alarms: high, medium and low. They are indicated by beeps on the loudspeaker, messages on the display and the Alarm Lamp.
Patient Breathing Circuit	A Patient Breathing Circuit carries the Air/Oxygen Mixture to the patient and carries the expired (exhaust) air from the patient. It may include Tubings, Mask, Inspiratory Filter, Flow Sensor, Nebulizer Jar, Exhalation Valve Cover and Membrane.
Paw	A sensor which measures the pressure at the proximal side of the Flow Sensor.

Pfilter	A sensor which measures the pressure after the HEPA Filter; used to indicate if the HEPA Filter needs to be replaced.
Pflowsensor	A sensor which measures the differential pressure across the Patient Airway Flow Sensor.
Portable Tank	Oxygen Tanks used for supply in a portable environment when the facility source is not available.
Press and Turn Control Knob (P&T)	A button on the front of the Interaction Panel used to select and activate screen functions.
Press and Turn Encoder (P&T Encoder)	An electrical device which provides input signals for control of screen functions.
Pressure Gauge	A mechanical device used to measure gas pressure.
Pressure Regulator	A device that regulates the pressure and restricts the flow of a gas.
Pressure Sensor Assembly	Provides components for pressure measurments used to monitor ventilation.
Preventive Maintenance (PM)	A term used for periodic maintenance of a device with specific planned tasks and items to check, adjust and replace.
Principal Gas Flow	The main gas flow through the HAMILTON-C2 from the HEPA Fileter for air and the Oxygen inlets to the patient, and then from the patient through the Expiratory Valve.
Pvent_control	A sensor which measures the pressure at the Inspiratory Valve outlet.
Pvent_monitor	A sensor which measures the pressure at the Inspiratory Valve outlet.
QO_2 Flow Sensor	Used to measure the Oxygen Flow into the Blower Assembly.
Qvent Flow Sensor	Used to measure the Air/Oxygen Flow in the Patient Breathing Circuit
Rinse Flow	A very small, continuous flow of gas through both the blue (patient side) and clear (ventilator side) Flow Sensor tubes to the Flow Sensor. The flow minimizes the possibility of tube blockage, and hinders the potential migration of bacteria and viruses from the patient's expired gases through the tubes, towards the pressure sensors inside the ventilator.
Safety mode	An emergency state that ensures a basic minute ventilation while giving the user time for corrective actions in case of some technical fault alarms. The default inspiratory pressure is maintained, the expiratory valve opens as needed to switch system pressure levels between PEEP and inspiratory pressure, and patient sensing is nonfunctional.
Select	An action on the Touchscreen or the P&T Control Knob to choose a function or action.
Smart Battery Pack	Li-Ion Battery, Hot Swappable which monitors and communicates the battery condition.

T-Fitting	A type of tubing connector in the shape of a T.
Technical Events	A minor fault or event recorded by the HAMILTON-C2 in the *Event Log*.
Technical Faults	An alarm condition indicating a major malfunction of the HAMILTON-C2. (This contrasts with an alarm, that indicates a problem with the status of a patient.) Technical Faults are intended to alert users and engineers of the need for intervention, and are recorded in the *Event Log*.
Test Configuration (TC)	A particular configuration of devices and tubings use to perform the Test Units of the Test Mode.
Test Mode	A special mode in the HAMILTON-C2 that aids in performing operational check and calibrations. Also enables viewing and exporting data from the *Event Log*. For more information about Test Mode, attend a HAMILTON MEDICAL AG service training course for the HAMILTON-C2.

WARNING

The HAMILTON-C2 cannot be used for patient ventilation when in Test Mode.

Service Software	The software used to perform tests, adjustments and calibrations of the HAMILTON-C2.
Service Software Mode	The operational status of the HAMILTON-C2 when in the Service Software.
Test Unit	A step in the process of adjustment and calibration of the HAMILTON-C2.
Touchscreen	An interaction method where the LCD Display Screen can be touched with a finger to activate or select a function.
Trolley	A part of the HAMILTON-C2 on which the ventilator is mounted for transport within the customer location.
Update	An update is an improvement to an existing function. An update normally involves only software. A software update is generally a revision number increment in a digit after the decimal point: for example, from 3.2 to 3.3.
Upgrade	An upgrade is the addition of new functions to a device. There are three ways to perofrm an upgrade: • Add a hardware item that offers additional functions • Upgrade to a higher software revision indicated by a higher value before the decimal point: for example 01.03 to 02.00 • Upgrade to a higher type of software
Variable Orifice Membrance	A variable flow restrictor as used in the Patient Flow Sensor.
Ventilation Unit Mainboard	The HAMILTON-C2 Main Processor. An assembly containing the microprocessor that controls both the user interface and high-level aspects of ventilation, such as tidal volume, minute volume and rate.

Y-Fitting	A type of tubing connector in the shape of a Y.

F.2 Alarm overview

KB-ID Nr.: Knowledgebase ID Number

F.2.1 100000 Alarm Code - Patient Alarms Section

sid number	CSystemConfiguration id	KB-ID Nr.
	Breath Monitoring	
132001	pawPressureLow	
132002	pawTubing	
132003	qawFlowSensorTubing	
132004	qawFlowSensorMissing	
132005	O2SensorDefect	
132006	O2SensorMissing	
132007	O2SensorInvalid	
132008	O2SensorCalibrationNeeded	
132009	exhalationOccluded	
132010	CO2SensorMissing	
132011	CO2SensorDefect	
132012	CO2SensorOverTemperature	
132013	CO2SensorWarmUp	
132014	wrongFlowsensor	
132015	FlowSensorCalibrationNeeded	
	Breath Pattern Generation	
133002	volumeLimitReached	
133003	pressureLimitReached	
	VentModeControl	
141001	pressureLimitation	
141002	VThigh	
141003	VTlow	
141004	expMinVolHigh	
141005	expMinVolLow	
141006	fTotalHigh	
141007	fTotalLow	
141008	oxygenHigh	

sid number	CSystemConfiguration id	KB-ID Nr.
141009	oxygenLow	
141010	apnea	
141011	apneaVentilationEnd	
141012	apneaVentilation	
141013	highPressureDuringSigh	
141014	turnFlowSensor	
141016	disconnectionVentilator	
141017	disconnectionPatient	
141018	exhalationObstructed	
141019	IRV	
141020	ASVunableToReachTarget	
141021	ASVplimitChanged	
141022	instrumentMaybeContaminated	
141023	sensorFailMode	
141024	pressureLow	
141025	paVMC_PetCO2High	
141026	paVMC_PetCO2Low	

F.2.1.1 200000 Alarm Code - Technical Alarms Section

Error No.	Error Description	KB-ID Nr.
	Gas delivery	
231001	pressureControllerPressureLow	
231003	flowControllerFlowLow	
231004	flowControllerFlowHigh	
231005	inspirationValveLeak	
231006	O2ControllerFlowLow	
231007	O2ControllerFlowHigh	*ID 863*
231008	O2ValveLeak	*ID 839*, *ID 947*
231009	blowerControllerSpeedLow	
231010	blowerControllerSpeedHigh	
231011	ventOutputTemperatureHigh	
231012	qventFlowSensorDefect	
231013	qO2FlowSensorDefect	*ID 946*
231014	ambientValveError	*ID 998*
231017	blowerServiceRequired	
231018	selftestWithError	
231019	iInspValveSensorDefect	
231020	regulatorDataLogOn	
232002	pventMonitorSensorDefect	
232003	pawSensorDefect	
232004	pressureNotReleased	
232005	blowerHot	
232006	blowerTemperatureSensorDefect	*ID 1018*
232007	qawFlowSensorDefect	
232008	pambientSensorDefect	
232027	instrumentTemperatureHigh	
232028	pFilterPressureHigh	
232029	tinstSensorDefect	
232030	clockError	

Error No.	Error Description	KB-ID Nr.
232034	O2SensorError	
232035	pfilterSensorDefect	
232038	co2CalibrationNeeded	
232039	co2SensorInvalid	
	Breath Monitoring (SERVICE SOFTWARE)	
233001	autozeroPventMonitorFail	
233002	autozeroPventControlFail	
233003	autozeroPawFail	
233004	autozeroQawFail	
233005	pressureSensorTolerance	
233006	nebulizerValveError	
	Vent mode control	
241001	replaceHEPAfilter	
	Alarming	
243001	alarmSilenceError	
243002	alarmUnknown	*ID 948*
243003	loudspeakerDefect	*ID 924*
243004	buzzerDefectAtStartup	
243005	loudspeakerSoundsContinual	
243006	developSound	
243007	rtcReset	
	Power management	
244001	externalPowerLoss	
244002	taPM_batteryCalibrationRequiredBat1	
244003	taPM_batteryCalibrationRequiredBat2	
244004	TemperatureHighBat1	
244005	TemperatureHighBat2	
244006	PowerLow	
244007	PowerLoss	
244008	1WrongBattery	

Error No.	Error Description	KB-ID Nr.
244009	2WrongBattery	
244010	PowerLowOnPower	
	Low level security	
246001	serviceNeeded	
246002	cpuTemperatureHigh	
246003	fanError	
246004	processorOverload	
246005	alarmMonitorDefect	
246006	eepromDefaults	*ID 949, ID 1015*
246007	eepromWriteFailed	
246008	cpuTemperatureDefect	
246009	devWatchdogDisabled	
246010	hardwareParameterError	
249001	OhOptionFileNotRead	
249002	OhOptionFileNotWritten	
249003	OhOptionFileWrongVersion	
249004	OhOptionFileDefaultGenerated	
249010	DscDeviceConfigFileError	
249011	DscSetupConfigFileError	
249012	DscLastSettingConfigFileError	
281001	SdramError	
281002	EthernetError	
281003	EepromError	
281004	RtcError	
281005	IdeNandError	
281006	TouchError	
	Ventilation GUI	
283001	taVGUI_StartupFailed	
283003	taVGUI_languageNotLoaded	
283004	taVGUI_deviceConfigFileError	*ID 901*

Error No.	Error Description	KB-ID Nr.
283005	taVGUI_setupConfigFileError	
283006	taVGUI_lastSettingConfigFileError	
	Service GUI	
284002	taSGUI_alarmServiceHigh	
284003	taSGUI_alarmServiceMedium	
284004	taSGUI_alarmServiceLow	
	ApplicationGuiLibrary	
285001	taAGL_alarmLampsErrorDefect	
285002	taAGL_alarmLampsWarningDefect	

F.2.2 300000 Alarm Code - Technical failure ending in safety mode

Error No.	Error Description	KB-ID Nr.
	Gas delivery	
331001	pventPressureSensorDefect	
	Breath monitoring	
332001	qawFlowSensorError	
	Vent mode control	
341001	breathSettingsNotAccepted	
341002	returnedBreathSettingsIncorrect	
341003	adaptiveSettingsInvalid	
341004	breathSettingsTimeout	
341005	controllerSettingsInvalid	
343001	tfsALR_communicationTimeout	
344001	tfsPM_SystemManagerBusError	*ID 874*
346002	FailedALR	
346003	FailedALR_MFmeasure	
346004	FailedESL	
346005	FailedESL_MMILog	
346006	FailedESL_ControlLog	
346007	FailedESL_BreathLog	
346008	FailedESL_EventSDRReader	
346009	FailedESL_ServiceSDRReader	
346010	FailedESL_EventSDRWriter	
346011	FailedESL_ServiceSDRWriter	
346012	FailedESL_MFmeasure	
346013	FailedGUIL_Touch	
346014	FailedGUIL_PTKnob	
346015	FailedGUIL_Hardkeys	
346016	FailedGUIL_ScreenShot	
346017	FailedLM	
346019	FailedLLS_HWException	

Error No.	Error Description	KB-ID Nr.
346020	FailedLLS_CommonServer	
346022	FailedLLS_AlarmStatus	
346023	FailedLLS_MFmeasure	
346024	FailedPM	
346025	FailedPM_MFmeasure	
346026	FailedQSPI	
346027	FailedQSPI_MMI_Server	
346028	FailedQSPI_BM_Server	
346029	FailedQSPI_BPG_Server	
346030	FailedQSPI_LLS_Server	
346031	FailedQSPI_QuadSPI	
346032	FailedQSPI_MFmeasure	
346033	FailedRTC_RealTimeClock	
346034	FailedRTC_AlarmClock	
346035	FailedSC	
346036	FailedSGUI	
346037	FailedSTU	
346038	FailedVMC	
346039	FailedVentAlarming	
346040	FailedVentControl	
346041	FailedVentMonitoring	
346042	FailedMFmeasure	
346043	FailedVGUI	
346044	FailedVGUI_ModeControl	
346045	FailedVGUI_MFmeasure	
346046	FailedLLS_eepromWrite	
346047	FailedBM_AlarmingSlow	
346048	FailedSND_SoundControl	
346049	FailedSND_Sound	
346050	FailedVT	

Error No.	Error Description	KB-ID Nr.
346051	CFG_Configuration	
346052	watchdogFailedEXM_ComBase	
	Ventilation GUI	
383001	settingsNotAccepted	
383002	returnedSettingsIncorrect	
383003	settingsValidation	
383004	monitoringChannelObservation	
383005	VMCTimeout	
383006	returnedDeviceSettingsIncorrect	
383007	trendingChannelObservation	
	ApplicationGuiLibrary	
385001	alarmingChannelObservation	
385002	safteyModeObservationFailed (Safety Mode active)	*ID 927, ID 974*
	GuiLibary	
386001	bitmapNotLoaded	

F.2.3 400000 Alarm Code - Technical failure ending in ambient mode

Error No.	Error Description	KB-ID Nr.
431001	GD_blowerFault	*ID 861*, *ID 930*
431002	GD_blowerDisconnected	*ID 846*, *ID 930*, *ID 837*
431004	GD_inspirationValveOverCurrent	
431005	GD_expirationValveDisconnected	*ID 998*
431006	GD_expirationValveOverCurrent	
431007	GD_ventOutputOverTemperature	
431008	GD_qventFlowSensorError	
431009	GD_qO2FlowSensorError	
431010	GD_controlREGSPITimeout	
431011	GD_monitorREGSPITimeout	
431012	GD_flowSensorMeasurementImprecise	
431013	GD_calibrationReadFailed	
431014	GD_iExpValveSensorDefect	
432001	BM_blowerOverTemperature	
432002	BM_instrumentOverTemperature	
433001	BPG_breathMonitoringTickTimeout	
444001	PM_batteriesTotalDischarge	
444002	PM_batteryOverTempBat1	
444003	PM_batteryOverTempBat2	
444004	PM_voltageOutOfTolerance	
444005	PM_shutdownFailed	*ID 911*
446001	cpuTemperatureCritical	
446002	safetyFailed	
446003	watchdogFailedGD	
446004	watchdogFailedGD_ValveRegulator	
446005	watchdogFailedGD_BlowerRegulator	
446006	watchdogFailedGD_Monitoring	
446007	watchdogFailedGD_ValveLog	
446008	watchdogFailedGD_BlowerLog	

Error No.	Error Description	KB-ID Nr.
446009	watchdogFailedGD_MFmeasure	
446010	watchdogFailedGD_GPIOFaultInput	
446011	watchdogFailedBM	
446012	watchdogFailedBM_GasDeliveryCom	
446013	watchdogFailedBM_Hardwarecontrol	
446014	watchdogFailedBM_BPGclientReceiver	
446015	watchdogFailedBM_BPGserverReceiver	
446016	watchdogFailedBM_BreathDataCalc	
446017	watchdogFailedBM_MFmeasure	
446018	watchdogFailedBPG	
446019	watchdogFailedBPG_GDclientReceiver	
446020	watchdogFailedBPG_MFmeasure	
446021	exceptionHappened	
446022	voltageError	*ID 873*, *ID 998*
446023	watchdogFailedFailedLLS_Workload	
446024	Am3v3Error	
446025	AmAdcError	
446026	AmVrefError	
446027	watchdogFailedLLS	
481001	STU_firstRunMigrationError	
481002	STU_crcError	
484001	SGUI_ptError	
485001	AGL_ambientModeObservationFailed (Ambient Mode active)	*ID 998*
485002	AGL_selftest	

F.2.4 500000 Alarm Codes

These are classed as “invisible technical faults” and are not shown on the LCD display during operation. They refer to exception handling performed by HAMILTON-C2 during operation, and are for HAMILTON MEDICAL internal use.

Do not consult HAMILTON MEDICAL technical support concerning these technical faults. They have no significance for hospital workers or field engineers.

Appendix

G Knowledgebase

G.1 Knowledgebase

G.1.1 ID 837

Subject	TF 431002 blower disconnected
Failure Mode Description	TF 431002 blower disconnected occures during start-up. Not achieving blower speed (rpm) during the start-up self test procedure.
Failure Effect	TF 431002 and TF 485001 occures during start-up
Root Cause	Defective mainboard. Wiring not correct.
Correction	Check wiring. Install latest SW Version from the partner net. Install mainboard with revision higher than 6.

G.1.2 ID 839

Subject	TF 231008 O2 valve leak using HPO
Failure Mode Description	TF 231008 alarm message appears on screen
Failure Effect	TF 231008 alarm message appears on screen
Root Cause	1) O2 proportioning valve is damaged caused by impurities inside of the oxygen hose or inside the valve itself. 2) Leak in LPO/HPO inlet
Correction	Check the LPO/HPO inlet for leaks as this could lead to a TF 231008 even though the O2 valve is working properly. If HPO is used then make sure no LPO connector is connected to the LPO inlet. - Update to the latest software version. - Replacement of the O2 mixer assembly MSP160226. - In order to prevent the HAMILTON-C2 from particles entering the high oxygen inlet and causing the oxygen inlet valve to get obstructed, we do provide a new designed NIST and DISS connector kit with a replaceable 25 micron filter mounted: 1) PN 160470 Oxygen connector DISS with inlet filter 2) PN 160471 Oxygen connector NIST with inlet filter

G.1.3 ID 846

Subject	TF 431002 Blower disconnection, TF 431001 Blower fault
Failure Mode Description	TF 431002 or TF 431001 occurs.
Failure Effect	System failure
Root Cause	Blower selftest at start-up not successful. 1. Cables not properly connected. 2. Defective blower driver on mainboard. 3. Defective blower.
Correction	Install latest software from the partner-net. 1. Check blower cables. 2. Replace mainboard (MSP160200) 3. Replace blower (MSP160250) if TF 431001 persist after software update. Note: Never use a Hamilton-C2 without a battery. Update the technical state.

G.1.4 ID 861

Subject	TF 431001 occurs during start-up
Failure Mode Description	TF 431001 (blowerFault) occurs during start-up. Not achieving blower speed (rpm) during the start-up selftest procedure.
Failure Effect	TF 231001 and TF 485001 occurs during start-up
Root Cause	Wiring not correct Defective mainboard
Correction	Install latest software Check wiring Install mainboard revision higher than 06

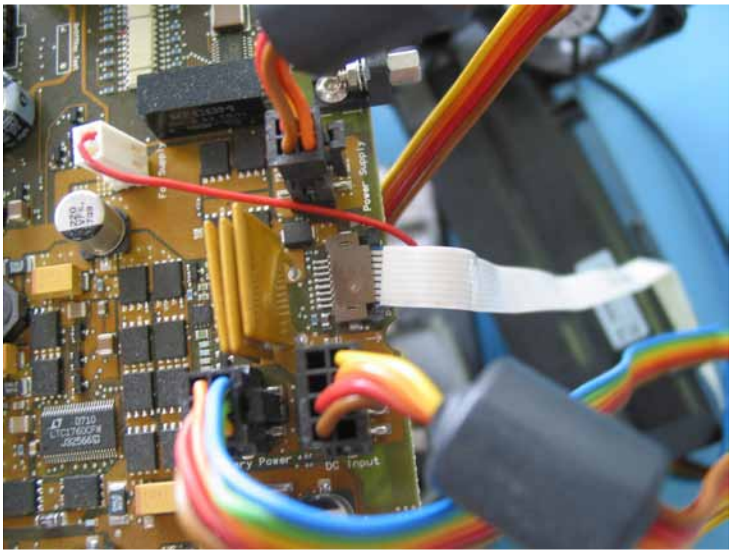
G.1.5 ID 863

Subject	TF 232007 Qaw Flow Sensor defect
Failure Mode Description	TF 232007 Alarm appears
Failure Effect	TF 232007 Alarm appears
Root Cause	-Flowsensor calibration values out of range -defective Flowsensor -defective Pressure Sensor Board
Correction	-Install latest SW Version from the partner net -Perform proximal Flowsensor calibration -Replace proximal Flowsensor -Check pressure sensor board and replace if neccessary -Check wiring to Qvent flow sensor -Replace cable (PN 160373) from Qvent to mainboard -Replace Qvent sensor (PN 399123)

G.1.6 ID 873

Subject	TF 446022
Failure Mode Description	TF 446022 appears (Ambient mode)
Failure Effect	Device stops ventilation. Ambient Mode active.
Root Cause	This failure may have three different, completely independent root causes 1. Real Time Processes overloaded for more than 50ms. 2. Unexpected total power fail. 3. 2.5_Ref_ADC voltage not in range (can not be measured)
Correction	Install latest software from the partner net. 1. Download the eventlogs and send it to HAMILTON-MEDICAL AG. 2. and 3. Check battery cable (PN 160370) for proper connection. Restart the device several times, if the TF appears every time during start up, exchange mainboard (PN MSP160200).

G.1.7 ID 874

Subject	TF 344001 (Battery_System_Manager_Bus_ERROR) , TF385002 (Safety Mode)
Failure Mode Description	TF 344001, TF 385002, Battery 1 ejected ID, Battery power loss
Failure Effect	SafetyMode (TF 385002) and serveral TFs: 344001, 385002, Battery 1 ejected ID, Battery power loss
Root Cause	Communication of the SM Bus from ESM to battery manager and Qvent flowsensor disturbed.
Correction	-Check the cable from/to the Qvent sensor at the mainboard and sensor side -Check the FFC from mainboard to the battery pack compartment PN 160302 (see picture attached). -Temporary solution switch off /on device. -Replace the cable (PN 160373) and/or Qvent sensor (PN MSP399123), if the problem occurs repeatedly.
Attachments	

G.1.8 ID 883

Subject	Loss of external power due to defective power supply
Failure Mode Description	AC power available, but unit switches to battery power during ventilation mode.
Failure Effect	Unit alarms with "Loss of external power" and continous on battery power.
Root Cause	1. Defective power supply.
Correction	Update to the latest software version, available from the partner net. Check if the failure still appears after the update. 1. Defective power supply 24 Volts at mainboard (measured between pin GND_Power and pin +24V_PS) is not in range (21.6 - 26.4V) exchange power supply (PN MSP160600). Note: Update the technical state if the power supply had to be exchanged.

G.1.9 ID 900

Subject	TF 243005 (Loudspeaker Off failed; Loudspeaker sounds continual)
Failure Mode Description	TF243005 Technical Event
Failure Effect	Device displays TF243005
Root Cause	TF243005 (Loudspeaker Off failed; Loudspeaker sounds continual) Sound level never falls below SoundOFF threshold within 10 minutes. Sndlevel ON threshold 1.2V. 1. Microphone on Frontpanelboard or Mainboard defect. 2. Front panel board not properly mounted (loose screws) 3. Voltage SndLevel out of tolerance. 4. Loudspeaker monitoring system influenced by loud environment sound.
Correction	-Install latest SW version. -Check influence by loud environment sound. -Check if heatpipe of the blower module is touching the internal foam material. -Check flatcables from the mainboard to the front panel board for proper connection. -Check the correct mounting of the front panel board-> all screws must be tight. -Check Mainboard voltage on Testpins P42 between pin SndLevel and GND while Loudspeaker is off. Tolerance: Voltage must be lower than 1.2 Volt in a silent environment while loudspeaker is off. If it is out of tolerance: Replace Frontpanelboard (PN MSP160196) for testing. If failure persists, replace Mainboard (PN MSP160200).

G.1.10 ID 901

Subject	TF 283004 (deviceConfigFileError)
Failure Mode Description	TF 283004 is displayed during start-up
Failure Effect	During start-up device alarms with TF 283004
Root Cause	Wrong checksum of Device Configuration File due to a SW Bug in SW 1.1.2 and lower
Correction	Problem fixed with SW Version 1.1.3 Install latest SW Version from the partner net

G.1.11 ID 911

Subject	Loss of external power due to defective power supply or mainboard
Failure Mode Description	AC power available, but unit switches to battery power during ventilation mode.
Failure Effect	Unit alarms with "Loss of external power" and continous on battery power.
Root Cause	1. Defective power supply.
Correction	Update to the latest software version, available from the partner net. Check if the failure still appears after the update. 1. Defective power supply 24 Volts at mainboard (measured between pin GND_Power and pin +24V_PS) is not in range (21.6 - 26.4V) exchange power supply (PN MSP160600). Note: Update the technical state if the power supply had to be exchanged.

G.1.12 ID 924

Subject	TF 243003 Loudspeaker defect
Failure Mode Description	TF 243003 (Technical Event)
Failure Effect	Device alarms with TF 243003
Root Cause	Sound level doesn't reach SoundON threshold due to: -FFC (Flat flex cable) between mainboard and front panel to be not properly connected -defective loudspeaker -defective mainboard (rare)
Correction	-Perform Loudness Test: If loudspeaker is not hearable then check the FFC cables between Mainboard and Front Panel Board and replace Front Panel Board (PN 160196) if necessary. Hint: -Switch off the Unit and measure the loudspeaker resistance on the mainboard at connector J18 between Pin 25/26 (see attachement). Resistance should be 70..130 Ohm otherwise replace Front Panel Board -Measure the voltage (Peak function) on mainboard between Pin Gnd and Pin SndLevel (P42) and replace Mainboard if the voltage < 1.2V while Loudspeaker is on.

G.1.13 ID 927

Subject	TF 341908, TF 385002 (Safety Mode)
Failure Mode Description	Device alarms with TF 341908 and TF 385002 (Safety Mode)
Failure Effect	Unit switchs to Safety Mode
Root Cause	After changing mode from SIMV+ into SPONT or ASV or into Sensor failure without closing the setting window the device fails and switchs to safety mode due to a SW Bug on SW 1.1.2 and lower.
Correction	Install latest SW Version from the partner net (at least Version 1.1.3)

G.1.14 ID 928

Subject	Touchscreen not working
Failure Mode Description	Touchscreen not working
Failure Effect	Touchscreen cannot be used
Root Cause	-Cables not properly connected -Defective Touchscreen, scratch in the top foil. -Defective mainboard
Correction	-Check the connection cables from/to touchscreen (see WD616063): FFC cables 2xPN 160356, PN 160357 from Mainboard to Front Panel (J1, J2) FFC cable from Touchscreen to Frontpanel Board as shown on picture (P8) -Check function of the touchscreen by measuring the resistance on the black connector from the middle pin to the other 4 pins (see picture). While pressing on touchscreen the values of the resistance should be 1..5kOhm. While not pressed the values of the resistance should be over 1MOhm. If the values are out of range: -Replace Touchscreen (Display Front Complete PN 160362 & Display Gasket PN 160341) -Replace Mainboard (MSP160200) if the values are within the given range.

G.1.15 ID 930

Subject	TF 431002 Blower disconnection, TF 431001 Blower fault
Failure Mode Description	TF 431002 or TF 431001 occurs.
Failure Effect	System failure
Root Cause	Blower selftest at start-up not successful. 1. Cables not properly connected. 2. Defective blower driver on mainboard. 3. Defective blower.
Correction	Install latest Software from the partner-net. 1. Check blower cables. 2. Replace mainboard (PN MSP160200) 3. Replace blower (PN MSP160250) if TF 431001 persist after software update. Note: Never use a Hamilton-C2 without a battery. Update the technical state.

G.1.16 ID 944

Subject	Flow sensor calibration fails
Failure Mode Description	Flow sensor calibration fails
Failure Effect	Flow sensor calibration fails, unit cannot be operated.
Root Cause	1. Qvent flow measurement is affected by blower driver. The failure gets bigger as lower the battery capacity is. 2. Defective autozero valves 3. Defective mainboard
Correction	1. Please perform the following test step: Preparation: To perform this test you need the following equipment: HAMILTON-C2 battery PN 369102 or PN 369106 A calibrated flow meter such as TSI flow meter PN 500308 Note: Please make sure that the battery charge level is at 25%. Test steps: 1. Start up the device in Service Software and make sure that the device is running on mains power. 2. Open the Pneumatics 1 window (Page No 2107) ->Tests/Calib->Comp test >Pneumatics 1. 3. Start the Insp valve test. 4. Perform the Flow control test and stay/stop at the 150l/min test step. 5. Make sure that the applied flow is within 150±15 l/min (Reading from the TSI). If not in range check the device for leakage or/and a defective Qvent sensor. 6. Disconnect the HAMILTON-C2 from the mains now. 7. Verify that the measured flow (Reading from the TSI) is within its range of 150±15 l/min. If not in range: Connect and disconnect the mains several times to verify that the flow on battery operation is incorrect. -> An incorrect flow on battery operating indicates a defective main board and must be replaced (PN MSP160200). If in range: Keep the device running on battery for about a minute. After this the flow must be still in range. If it is, then this HAMILTON-C2 is not defective. If not, then the main board (PN MSP160200) must be exchanged. Note: If you get TF 444001 then the battery is fully discharged and it needs to be charged for at least 10 minutes to run the test again. 2. Check the the binary and autozero valves several times. Exchange pressure sensor assembly (PN MSP160300) if the tests can not be passed. 3. Exchange mainboard (PN MSP160200)

G.1.17 ID 946

Subject	TF 231013 QO2 Flow sensor defect. Selftest at start up not passed.
Failure Mode Description	At start up: TF 231013 while using LPO
Failure Effect	Device alarms with TF 231013 (QO2 Flow sensor defect)
Root Cause	-SW Bug in Version 1.1.3 and lower plus device is used in LPO Mode while LPO not activated. -Leaking O2-Valve -QO2 Sensor defect
Correction	Detach LPO and restart the C2. Select LPO Mode and reattach LPO afterwards. Install the latest SW version from Partner-net. If the failure still appears with the latest SW version, exchange mixer assembly (MSP160226)

G.1.18 ID 947

Subject	TF 231008 O2 valve leak. Selftest at start up not successful
Failure Mode Description	TF 231008 O2 valve leak
Failure Effect	Device alarms with TF 231008 O2 valve leak.
Root Cause	1. Software version lower than 1.1.4 and instrument is used in LPO mode. 2. Leaking O2-valve. 3. QO2-Sensor defect
Correction	1: Install latest Software. 2 and 3: Exchange mixer (MSP160226)

G.1.19 ID 948

Subject	TF 243002 is a summery of general errors.
Failure Mode Description	TF 243002 is a summery of general errors.
Failure Effect	TF 243002 registered with the event logs.
Root Cause	This failure occured during Flowsensor calibration due to a Software Bug in US Version 1.0.3 (=European 1.1.1).
Correction	Install latest Software from the partner net.

G.1.20 ID 949

Subject	TF 246006 after installing new mainboard
Failure Mode Description	Technical fault appears after installing mainboard
Failure Effect	The TF 246006 appears after installing new mainboard
Root Cause	A new mainboard shows default values at EEPROM.
Correction	Run complete service software which will solve the issue. No further action required.

G.1.21 ID 954

Subject	Oxygen supply failed Alarm
Failure Mode Description	Oxygen supply failed Alarm, after have set O2 to 100%.
Failure Effect	Device alarms with "Oxygen supply failed"
Root Cause	1. The expected flow values are calculated wrong due to a SW Error in version 1.1.3 and lower 2. Inlet pressure to low and/or gas supply insufficient. Requirement: 280 to 600 kPa (41 to 87 psi), 120 l/min. 3. Defective proportional valve.
Correction	Install Service Software Version from the partner net. 2. Connect the HAMILTON-C2 to a proper gassupply. 3. Exchange mixer (MSP160226)

G.1.22 ID 974

Subject	In service software starting event log download, TF 385002 occurs
Failure Mode Description	In service software starting event log download, TF 385002 occurs
Failure Effect	Starting event log download in service software the TF 385002 occurs. Eventlog cannot be downloaded and the device has to be switched OFF/ON prior to be used.
Root Cause	SW Problem with SW < 2.0
Correction	Eventlog can be downloaded in ventilation software Install SW Version 2.0 (to be released later this summer)

G.1.23 ID 979

Subject	Softboot C2
Failure Mode Description	During in-house stress tests of the RS-232 data interface using a simulation program ventilator it was detected that the ventilator can stop the ventilation and remain in the start-up screen, i.e. the mechanical ventilation can be interrupted without alarming of the operator. However, a spontaneous breathing of the connected patient is always possible. The used simulation program cannot be compared with the patient monitors of patient data management systems (PDMS) mentioned in the HAMILTON-C2 operator's manual which can be connected to the RS-232 data interface, since the simulation program applies a much higher load to the interface and the internal data flow within the instrument, especially with respect to cyclic variability.
Failure Effect	The ventilator can stop the ventilation and remain in the start-up screen, i.e. the mechanical ventilation can be interrupted without alarming of the operator. However, a spontaneous breathing of the connected patient is always possible.
Root Cause	The root cause lies in an overload of an internal interface in the HAMILTON-C2 in case of extremely high data traffic.
Correction	Actions by the distributors: Prompt upgrade of the affected HAMILTON-C2 ventilators with the revised software version 1.1.4 / 1.0.5 (Japan); the update should be performed at latest during the next yearly preventive maintenance.

G.1.24 ID 988

Subject	Exhalation port occluded with SW1.1.4
Failure Mode Description	Device alarms with "Exhalation port occluded". The baseline circuit flow is < 3.5 l/min for a period of 1 min. Active only in NIV and NIV-ST Mode.
Failure Effect	Device alarms with "Exhalation port occluded"
Root Cause	Alarmrule too sensitive with SW 1.1.4 and lower
Correction	Install SW version 2.0 (August 2010)

G.1.25 ID 998

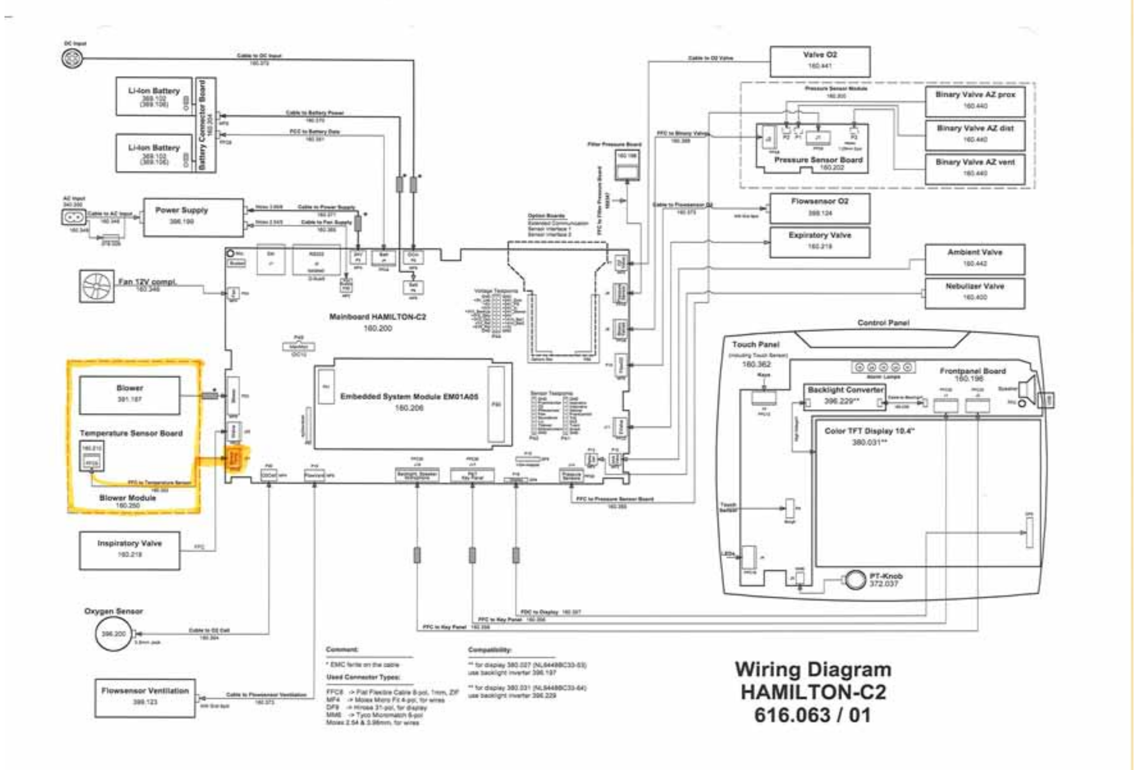
Subject	TF 231014 , TF 431005, TF 446022, TF 485001 due to defective mainboard
Failure Mode Description	Device alarms with: -TF 231014 (Ambient valve error) -TF 431005 (Expiration valve disconnected) -TF 446022 (Voltage Error)
Failure Effect	Device alarms with: -TF 231014 (Ambient valve error) -TF 431005 (Expiration valve disconnected) -TF 446022 (Voltage Error) Device switchs to ambient mode and alarms with TF 485001
Root Cause	Defective Mainboard
Correction	Replace Mainboard MSP160200

G.1.26 ID 1015

Subject	TF 246005 due to defective Mainboard
Failure Mode Description	Device alarms with TF 246005
Failure Effect	Preop check cannot be performed successfully
Root Cause	Defective alarm monitor on mainboard
Correction	Exchange mainboard MSP160200

G.1.27 ID 1018

Subject	TF 232006 (blowerTemperatureSensorDefect) during Start-Up
Failure Mode Description	Device alarms with TF 232006 (blowerTemperatureSensorDefect) during Start-Up
Failure Effect	Device alarms with TF 232006 (blowerTemperatureSensorDefect) during Start-Up
Root Cause	Blower Temperature Sensor cable (FFC6) not properly connected to mainboard (Connector J21).
Correction	Reconnect flat cable FFC6 to Mainboard connector J21.



HAMILTON-C2 SN _ _ _ _ _

HAMILTON-C2 Test Report

Customer Name:	____
Date: (YYYY/MM/DD):	_ _ _ _ / _ _ / _ _
Service Manual Version:	**624165/** _ _

General Maintenance

	Yes	No
Oxygen Cell replaced?	❑	❑
Air Intake Dust Filter cleaned or replaced?	❑	❑
Fan Filter cleaned or replaced?	❑	❑
O2 Inlet Filter replaced	❑	❑
HEPA Filter replaced?	❑	❑
Battery Pack(s) Calibrated (cycles >100)?	❑	❑
Battery Pack(s) Replaced (cycles >500)?	❑	❑
Blower Module Replaced (op hours >20’000h)?	❑	❑
TFT Display w/ Backlight replaced (>20’000)?	❑	❑

Electrical SafetyTest

		Results	
Service Manual Section 7 **Electrical Safety Test**	Electrical Safety Test **OK**?	OK ❑ Not OK ❑	

Ventilator Information

Ventilator Info > RTC > **RTC Tab**	**Page No 1401** Date and Time **OK**? RTC status **Battery OK**?	**Results** OK ❑ Not OK ❑ OK ❑ Not OK ❑		
Ventilator Info > Technical State > **Hardware Version Tab**	**Page No 1102** 1. Hamilton -C2 2. O2 Cell 3. Battery 1 4. Battery 2	**Revision** ____ ____ ____ ____	**Serial Number** ____ ____ ____ ____	
Ventilator Info > Technical State > **Software Version Tab**	**Page No 1101** Software Nemo ICU OS (Operating System) FPGA menmon	**Revision** ____ ____ ____ ____		

Ventilator Info > Service Timer > **Service Timer Tab**	**Page No 1200** Operating Hours Service Timer Setting Service Timer Reset	**Hours** ________ ________ Yes ❑ No ❑		
Instrument State > Service Timer > **Blower Timer Tab**	**Page No 1200** Blower Timer	**Hours** ________	**Percentage** ________	

Adjustments / Calibrations			
Tests/Calibration > Adjustment/Calibration > Calibration Tab > **Touch Screen Button**	**Page No 2321** Is the Touch Screen Calibration **OK**?	**Results** OK ❑ Not OK ❑	
Tests/Calibration > Adjustment/Calibration > Calibration Tab > **Inspiratory Valve Button**	**Page No 2342** Is **'Inspiration valve calibration OK'** displayed on the screen?	**Results** OK ❑ Not OK ❑	
Tests/Calibration > Adjustment/Calibration > Calibration Tab > **Pressure Button**	**Page No 2341** Pressure Sensor Gain Values	**Gain** ________	
Tests/Calibration > Adjustment/Calibration > Calibration Tab > **Expiratory Valve Button**	**Page No 2343** Is **'Calibration Successfully Finished'** displayed on the screen?	**Results** OK ❑ Not OK ❑	
Tests/Calibration > Adjustment/Calibration > Calibration Tab > **O_2 Cell Button**	**Page No 2346** Is **'Oxygen Cell Calibration OK'** displayed on the screen?	**Results** OK ❑ Not OK ❑	
Tests/Calibration > Adjustment/Calibration > Calibration Tab > **Flow Sensor**	**Page No 2347** Is **'Flow sensor calib ended OK'** displayed on the screen?	**Results** OK ❑ Not OK ❑	

Component Tests			
Tests/Calibration > Component Test > Electronics Tab > **Alarm System Button**	**Page No 2102**	**Results**	
	Is the Speaker **ON**?	OK ❑ Not OK ❑	
	Is the Yellow Lamp **ON**?	OK ❑ Not OK ❑	
	Is the Red Lamp **ON**?	OK ❑ Not OK ❑	
	Is the Speaker Loudness min and max **OK**?	OK ❑ Not OK ❑	
Tests/Calibration > Component Test > Electronics Tab > **Alarm Monitor 1**	**Page No 2113**	**Results**	
	Is the Alarm Light and Alarm Silence LED **Blinking**?	OK ❑ Not OK ❑	
	Is the Alarm Light and Alarm Silence LED **ON**?	OK ❑ Not OK ❑	
	Press the Alarm Silence Button - Light **ON**?	OK ❑ Not OK ❑	
	Is the Alarm Light **OFF**?	OK ❑ Not OK ❑	
	Press the Alarm Silence Button - is the Alarm Light is **OFF**?	OK ❑ Not OK ❑	
	Can Expiratory Valve Plunger be moved?	OK ❑ Not OK ❑	
	Is the Alarm Silence LED **ON**?	OK ❑ Not OK ❑	
	Did the Buzzer Sound?	OK ❑ Not OK ❑	
	Fan Failure Alarm displayed?	OK ❑ Not OK ❑	
	Is '**Test completed successfully**' on the screen?	Yes ❑ No ❑	
Tests/Calibration > Component Test > Electronics Tab > **Alarm Monitor 2**	**Page No 2114**	**Results**	
	Did the Alarm Light **Blink**?	OK ❑ Not OK ❑	
	Did the Buzzer Sound?	OK ❑ Not OK ❑	
Tests/Calibration > Component Test > **User Interface Tab**	**Page No 2115**	**Results**	
	Is the P&T Control Knob **OK**?	OK ❑ Not OK ❑	
	Is the Hardkeys + LED's **OK**?	OK ❑ Not OK ❑	
	Are the Hardkey Combinations **OK**?	OK ❑ Not OK ❑	
Tests/Calibration > Component Test > Pneumatics 1 > **Blower Flow Button**	**Page No 2104**	**Results**	
	Is the Blower Pressure at 5mbar **OK**?	OK ❑ Not OK ❑	
	Is the Blower Pressure at 15mbar **OK**?	OK ❑ Not OK ❑	
	Is the Blower Pressure at 25mbar **OK**?	OK ❑ Not OK ❑	
	Is the Blower Pressure at 35mbar **OK**?	OK ❑ Not OK ❑	
	Is the Blower Pressure at 55mbar **OK**?	OK ❑ Not OK ❑	

Tests/Calibration > Component Test > Pneumatics 1 > **Blower Pressure Button**	**Page No 2105**	**Results**	
	Is the Blower Pressure at 15mbar **OK**? Is the Blower Pressure at 25mbar **OK**? Is the Blower Pressure at 35mbar **OK**? Is the Blower Pressure at 50mbar **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑	
Tests/Calibration > Component Test > Pneumatics 1 > **Inspiratory Valve Button**	**Page No 2107**	**Results**	
	Is the Leakage Test **OK**? Is the Flow Control Test **OK**? (16.5 - 19.5 l/min) Is the Pressure Control Test **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑	
Tests/Calibration > Component Test > Pneumatics 1 > **Expiratory Valve Button**	**Page No 2111**	**Results**	
	Is the Leakage Test **OK**? Is the Pressure Test **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑	
Tests/Calibration > Component Test > Pneumatics 1 > **O2 Input Button**	**Page No 2112**	**Results**	
	Is the O_2 Flow Test **OK**? Is the O_2 Leakage Test **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑	
Tests/Calibration > Component Test > Pneumatics 2 > **Binary Valve Button**	**Page No 2106**	**Results**	
	Is the Autozero Pvent_monitor Operation **OK**? Is the Autozero Pvent_monitor Autozero **OK**? Is the Autozero valve 1 Pflow Operation **OK**? Is the Autozero valve 1 Pflow Autozero **OK**? Is the Autozero valve 2 Pflow Operation **OK**? Is the Autozero valve 2 Pflow Autozero **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑	
Tests/Calibration > Component Test > Pneumatics 2 > **Neb. Valve Button**	**Page No 2116**	**Results**	
	Is the Nebulizer valve off **OK**? Is the Nebulizer vavle on **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑	
Tests/Calibration > Component Test > Pneumatics 2 > **Autozero Button**	**Page No 2109**	**Results**	
	Is the Pressure Sensor Paw and Flow Sensor Qaw **OK**? Is the Pvent_monitor and Pvent_control **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑	

Tests/Calibration > Component Test > Pneumatics 2 > **Ambient Valve Button**	**Page No 2108**	**Results**	
	Is the Ambient Valve Power-off **OK**? Is the Ambient Valve Closed **OK**? Is the Ambient Valve Active Open **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑	
Tests/Calibration > Component Test > Pneumatics 2 > **Proximal Test Button**	**Page No 2110**	**Results**	
	Is the Rinse Flow Test **OK**? Is the Proximal Pressure Test **OK**? Is the Proximal Flow Test **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑	
Tests/Calibration > Component Test > Pneumatics 2 > **Air Entry Button**	**Page No 2117**	**Results**	
	Is the default HEPA filter Test **OK**? Is the obstructed filter Test **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑	

System Test			
Tests/Calibration > System Test > System Test Tab > **Pressure Button**	**Page No 2201**	**Results**	
	5cmH2O ±1.0; are all the values **OK**? 25cmH2O ±1.2; are all the values **OK**? 50cmH2O ±2.5; are all the values **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑	
Tests/Calibration > System Test > System Test Tab > **Leakage Test Button**	**Page No 2204**	**Results**	
	Is the Tubing Test **OK**?	OK ❑ Not OK ❑	
Tests/Calibration > System Test > System Test Tab > **Alarming Button**	**Page No 2205**	**Results**	
	Is the Alarm High Test **OK**? Is the Alarm Medium Test **OK**? Is the Alarm Low Test **OK**? Is the Alarm Priority **OK**?	OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑	

General Tests			
Service Manual Section: General Test	Is the AC --> DC Test OK?	OK ❑ Not OK ❑ No DC in use ❑	
Service Manual Section: General Test	Is the DC --> Battery Test OK?	OK ❑ Not OK ❑ No DC in use ❑	
Service Manual Section: General Test	Is the Power (Battery) Loss --> Ambient Mode Test OK?	OK ❑ Not OK ❑	

Service Manual Section: **RS232**	Is the RS232 Test OK?	OK ❑ Not OK ❑ RS232 not in use ❑	

Operator's Manual Checks			
Operator's Manual Section 2.9 **About the batteries**		**Results**	
	Is the battery charge indicator green **OK**?	OK ❑ Not OK ❑	
Operator's Manual section 3.2 **Running the peroperational check**	**Tests, calibrations, and utilities**	**Results**	
	Is the Tightness Test OK? Is the Flow Sensor Calibration OK? Is the O2 cell calibration OK?	OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑	
Operator's Manual Section 3.5 **Alarm Tests**	Is the Oxygen Low Pressure Inlet Test OK?	OK ❑ Not OK ❑ No low O2 pressure availabel ❑	
	Is the Oxygen High Pressure Inlet Test OK?	OK ❑ Not OK ❑ No high O2 pressure availabel ❑	
	Is the Disconnection Test OK? Is the Exhalation Test OK? Is the Trigger Test OK? Is the Apnea Test OK? Is the External Power Loss Test OK?	OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑ OK ❑ Not OK ❑	

Final Tests			
Service Manual Section: **Instrument report**	Instrument report download performed?	performed ❑	
Date and signature	Date: ....Siganture:		

Revision 00	October, 2008: Release of the HAMILTON-C2 Service Manual.
Revision 01	July, 2009: Complete rework and new update.
Revision 02	June, 2010: Service Software adapted, Part History updated, MSP introduced
Revision 03	October, 2010: Service Software adapted, MSP introduced