Anexa nr.114.3
la Formularul Specificații tehnice
Servicii de mentenanta pentru ventilator Hamilton C3

Specificarea tehnică deplină solicitată, Standarde de referinţă	Specificarea tehnică ofertata
Lucrări necesare de întreținere a dispozitivului conform manualului de service și recomandării producătorului dispozitivului medical. 1. Obligatoriu se va prezenta lista lucrărilor de mentenanță și numărul de intervenții planificate de mentenanță de la producător, care urmeză să fie desfășurată. 2.Prezentarea listei detaliate cu costul fiecărei activități întreprinse. 3.Prezentarea listei cu prețul piese de schimb, kit de mentenanță care urmeză să fie inlocuite în procesul de mentenanță., Numărul de intervenții tehnice asupra dispozitivului medical conform recomandării producătorului dar nu mai puțin decât numărul de intervenții solicitate. Agentul economic v-a asigura lucrări de întreținere a dispozitivului medical solicitat și lucrări pentru toate dispozitivele aferente care sunt în legătură directă cu dispozitivul medical, sau accesorii. Înlăturarea tuturor defecțiunilor depistate, tehnice cât și cele de program. Intervenții de urgență Lucrări de diagnosticare, testare, reparație în cazul defecțiunilor minore neprevăzute (erori tehnice, calibrare, resetare). Intervenții de urgență cu reacționarea în maxim 24 ore de la notificarea defecțiunii, problemei, timpul intervenției telefonică maxim 1 oră, soluționarea problemei nu mai mult de 72 ore de la notificare. Chemarea inginerului companiei poate fi în formă scrisă cât și telefonică. Numărul de intervenții la solicitarea beneficiarului nelimitate pe tot parcursul contractului încheiat.	Lucrări necesare de întreținere a dispozitivului conform manualului de service și recomandării producătorului dispozitivului medical. • Procedura de mentenanță preventivă, pag.65 din manual Hamilton-C3 Prețul prezentat în Anexa 23 pentru o vizită include diagnosticarea, reparația în cazul în care nu este nevoie de piese adiționale și efectuarea procedurii de mentenanță efectuată anual conform manualului de service: 1. Inspecție vizuală 2. Inspecția sistemului respirator 3. Testarea bateriei 4. Testarea surselor de gaze medicale 5. Testarea senzorilor de flux 6. Testarea displayului 7. Calibrarea ventilatorului Analizatoare utilizate: 1. TSI-Flowmeter kit, 500084 2. Pressure controller setl, 500058 Kiturile de mentenanță se vor procura separat, în dependență de starea ventilatorului. Piesele de schimb necesare pentru înlocuire în caz de defecțiune, se vor achiziționa separat conform ofertei prezentate în urma diagnosticului. • Kit de mentenanță (Kitul nu este inclus in oferta de pret!) Cod | Configuratie | Interval de înlocuire

Intervenția trebuie să se soldeze cu dispozitivul reparat sau problema soluționată. Generarea din partea agentului economic a unui raport cu toate acțiunile de reparație, remediere interprinse și indicarea pieselor utilizate. **Controlul prin verificare a dispozitivelor medicale** Verificare stare aparat (să nu aibă lovituri, crăpături, starea şuruburilor şi prinderilor roţilor, etc.); Verificare parametrii tensiune de alimentare (tensiune, împământare, verificare întrerupători, etc.); Verificarea protecţiilor interne care asigură funcţionarea în condiţii de siguranţă ale aparatului; Verificare conectori şi cabluri; Măsurarea tensiunii din sursa de alimentare şi din bateria de back up; Măsurarea rezistenţelor diferitelor ansamble ale aparatului; Verificare şi curăţare filtre; Verificare şi curăţare ventilatoare de răcire; Verificare si calibrare ecran; Descărcare fişiere de logurişi erori; Verificare parametrii de protecție electrică conform EN 60601; Evaluarea parametrilor definitorii de performanță, prin examinare și testare; Verificarea îndeplinirii setului de criterii de acceptabilitate pentru dispozitivul medical (valori impuse, limite specificate, accesorii etc.). Verificarea și reglarea părților mecanice aflate în mișcare; Eliminarea jocurilor la părțile mecanice; Curățarea și gresarea părților mecanice aflate în mișcare; Curățarea plăcilor electronice (dacă este cazul), precum și a altor componente; Verificarea componentelor pneumatice (acolo unde este cazul).	<table><tr><td>160216</td><td>HEPA filter</td><td>Anual</td></tr><tr><td>160215</td><td>Dust filter for HEPA and fan Set of 5</td><td>Anual</td></tr><tr><td>160497</td><td>HPO inlet filter service kit</td><td>Anual</td></tr><tr><td>396200</td><td>O2 sensor</td><td>Anual</td></tr><tr><td>369136</td><td>Battery</td><td>La necesitate</td></tr></table> Se va reacționa în maxim 24 ore de la notificarea defecțiunii. problemei, timpul intervenției telefonică maxim 24 ore, soluționarea problemei nu mai mult de 72 ore de la notificare. Chemarea inginerului companiei poate fi în formă scrisă cât și telefonică. Intervenția trebuie să se soldeze cu dispozitivul reparat în cazul în care nu este nevoie de piese adiționale sau beneficiarul are piesa în stoc. În cazul în care este nevoie de piese adiționale, în urma diagnosticului se face ofertă de preț. În urma intervenției se generează un raport cu toate acțiunile de reparație, remediere interprinse și indicarea pieselor utilizate. **Controlul prin verificare a dispozitivelor medicale** ▪ Verificare stare aparat (să nu aibă lovituri, crăpături, starea şuruburilor şi prinderilor roţilor, etc.);**DA** ▪ Verificare parametrii tensiune de alimentare (tensiune, împământare, verificare întrerupători, etc.); **DA** ▪ Verificarea protecţiilor interne care asigură funcţionarea în condiţii de siguranţă ale aparatului; **DA** ▪ Verificare conectori şi cabluri; **DA** ▪ Măsurarea tensiunii din sursa de alimentare şi din bateria de back up; **DA** ▪ Măsurarea rezistenţelor diferitelor ansamble ale aparatului; **DA** ▪ Verificare şi curăţare filtre; **DA** ▪ Verificare şi curăţare ventilatoare de răcire; **DA** ▪ Verificare si calibrare ecran; **DA** ▪ Descărcare fişiere de logurişi erori; **DA** ▪ Verificare parametrii de protecție electrică conform EN 60601; **DA** ▪ Evaluarea parametrilor definitorii de performanță, prin examinare și testare; ▪ Verificarea îndeplinirii setului de criterii de acceptabilitate pentru dispozitivul medical (valori impuse, limite specificate, accesorii etc.). **DA** ▪ Verificarea și reglarea părților mecanice aflate în mișcare; **DA**

	▪ Eliminarea jocurilor la părțile mecanice; **DA** ▪ Curățarea și gresarea părților mecanice aflate în mișcare; **DA** ▪ Curățarea plăcilor electronice (dacă este cazul), precum și a altor componente; **DA** ▪ Verificarea componentelor pneumatice (acolo unde este cazul). **DA** ***Dacă producător nu prevede alte servicii asupra dispozitivului solicitat***

5.6 Battery Re-calibration

The battery calibration is done automatically.

If the battery fuel gauge needs re-calibrating, the red LED will flash when you put the battery into the battery charger. This indicator provides feedback on the accuracy of the fuel gauge and avoids unnecessary battery calibration cycles.

You have 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.

The blue calibration LED will flash to indicate that the battery is undergoing the re-calibration 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 the temperature within acceptable limits.

At the end of the procedure the blue calibration LED will illuminate indicating a fully charged, fully calibrated battery.

NOTICE

No action is necessary if only a recharge is required. The charger will automatically begin to charge the battery.

The most common cause of calibration failure is overheating of the battery during discharge. Keep the charger away from direct sunlight or heat sources.

⚠ CAUTION

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

5.6.1 General Information

If the battery is in need of fuel gauge re-calibration, 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 only charge the battery. This option is given because a re-calibration cycle is longer than a charge cycle.

For re-calibration of the battery, please press the "calibration button" on the front of the charger.

NOTICE

No additional action is required for re-charging the battery. The process starts automatically.

The blue calibration LED will flash to indicate the re-calibration 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.

⚠ CAUTION

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.

5.6.2 Re-calibration time

The re-calibration cycle begins by discharging the 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.

Re-calibration time (see the table below) is governed by the battery voltage and capacity. Larger batteries, and low voltage batteries will take longer to re-calibrate. Calibration is initiated each time the re-calibration button is pressed, so it is not recommended to press the re-calibration button part way through the re-calibration cycle.

Calibration begins each time the re-calibration button is pressed. Do not press the re-calibration button part way through the re-calibration cycle.

The re-calibration cycle is as follows:

1. Discharge of any residual capacity.
2. A calibration charge is delivered to the battery.
3. Discharge of calibration capacity.
4. The battery is given a regular charge.

Table 5-4. Battery re-calibration times

Battery	Battery model	Minimum re-calibration time	Maximum re-calibration time
Li-ion	MSP369106	14.6 hours	19.2 hours

5.6.3 Re-calibration Description

Impedance tracking fuel gauges retain accuracy longer than coulomb-counters and can even self re-calibrate in use as long as there are periods of inactivity in the cycle so that the impedance measurement can be made more accurately.

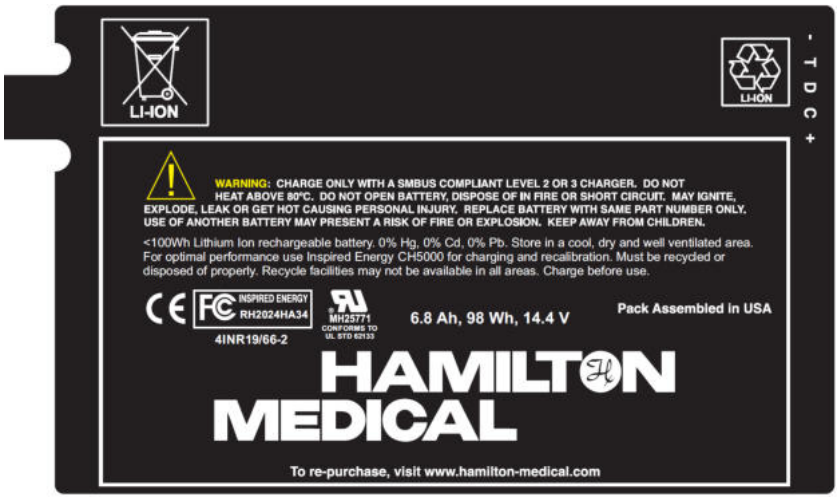
If no periods of rest are present in the cycle then the Impedance tracking fuel gauge will accumulate the Max-Error at a rate of 1% every 20 cycles.

Impedance-Tracking fuel gauge re-calibration is achieved by charging the battery, allowing it to rest, discharging it allowing it to rest again. This algorithm can only be performed on the external charger/calibrator CH5000 (see Section 5.6.2).

So re-calibration is used to re-set the fuel gauge to match 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.

5.6.4 Rechargeable Lithium Ion Battery Capacity

Figure 5-4. Rechargeable Lithium Ion Battery Capacity



The battery can directly display the capacity information. The battery capacity is displayed as the RSoC (Relative State of Charge). Each LED segment represents 25 percent of the full charge capacity. The LED pattern definition is given in the table below. The LED's illuminate for four seconds following switch activation. If the battery voltage is too low, there will be no LED indication.

Table 5-5. Battery Capacity Information

Capacity	LED Indicators #				Note
	1	2	3	4	
At or below 10%	x				Blinks
10% - 25%	x				Lit for 4 seconds.
26% - 50%	x	x			Lit for 4 seconds.
51% - 75%	x	x	x		Lit for 4 seconds.
76% - 100%	x	x	x	x	Lit for 4 seconds.

See the HAMILTON-C3 Operator's Manual --> Electrical Specifications

6

Preventive Maintenance and Testing

6.1 Overview

⚠ WARNING

- To prevent disease transmission, you must use personal protective equipment when handling contaminated bacterial filters or other patient accessories. For instructions on sterilizing patient system parts, see the HAMILTON-C3 Operator's Manual.
- Device is potentially contaminated.
- The device must be cleaned and disinfected to prevent the spread of infections and germs.

⚠ CAUTION

Make sure to take full ESD (ElectroStatic Discharge) precautions before handling any electronic parts, or before opening the HAMILTON-C3. For more information see:

- *Electrical safety overview, Section 8.1.*
- *Standard tools, Section 7.2.*
- *Special tools and test equipment, see Section 7.3.*
- *You must complete a service training course for the HAMILTON-C3 with Hamilton Medical before undertaking the maintenance and testing procedures described in this manual.*

6.1.1 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 the Overview of Preventive Maintenance and Testing, see Section 6.1.4.

6.1.2 Checking the software version

Check the technical state in service software mode to verify if the latest software version is installed on the HAMILTON-C3 ventilator. If not, install the latest software. See Hamilton Medical's Partner-net (https://www.hamilton-medical.com/Partner-Net/)[3] to download the latest software version.

6.1.3 Items required for preventive maintenance and testing

Table 6-1. Items Required for Preventive Maintenance and Testing

Step	Items Required, or Possibly Required
Hospital's Preventive Maintenance. See Section 6.2 Engineer's Preventive Maintenance See Section 6.3	• The HAMILTON-C3 Operator's Manual or local-language equivalent • HEPA Filter (PN 160216) • Filter Set (containing 2 Dust Air Filter and 1 Fan Filter (PN 160215)) • Blower Module (MSP160250) • Lithium Ion Battery Pack(s) (MSP369106) • Battery charger / calibrator (PN 369104, Rev 07 or higher) • O2 sensor (PN 396200) • HPO Inlet filter kit (PN 160497) • Complete patient breathing circuit (Adult, PN 260086): – Test lung with ET-Tube (PN 151815) and Adapter (PN 281420) – Inspiratory filter (PN 279204) – Short silicone tube (PN 260100) **NOTICE!** For more details of parts, see Section 12.

[3] Second-level engineers only.

Step	Items Required, or Possibly Required
Electrical Safety Tests See Section 8.2 Service Software See Section 9	• Test equipment for the HAMILTON-C3. See the Hamilton Medical AG Partner-net[4] --> Technical Support --> Recommended Spare Parts List --> Recommended Test Equipment For more details of Test Equipment see Section7.3.

6.1.4 Overview of Preventive Maintenance and Testing

Work methodically through the sections shown in the table below.

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

If you make a replacement, you must go back to "Step 3" in the table below.

⚠ CAUTION

Check the technical state in service software mode to verify that the latest software version 2.0.11 is installed on the HAMILTON-C3 ventilator. If not, install the latest software. See Hamilton Medical's Partner-net (https://www.hamilton-medical.com/Partner-Net/)[5] to download the latest software version.

Table 6-2. Overview of Preventive Maintenance and Testing

Step	Task	Where Found	Time Required
1.	Perform (or confirm it has been performed) the Hospital's Preventive Maintenance	Hospital preventive maintenance, see Section 6.2	5-15 min.
2.	Check if the latest software version is installed on the HAMILTON-C3 ventilator. Install the latest software on the ventilator if it is not installed.	See the Hamilton Medical´s Partner-net website (https://www.hamilton-medical. com/Partner-Net/)[5] for the latest software version. • Software version (Technical state), see Section 9.8.2 • Software Update from Version < 1.1.0, see Section 9.19	10-15 min.
3.	Perform the Engineer's Preventive Maintenance	Engineer preventive maintenance, see Section 6.3	10 min.
4.	Perform parts replacements as necessary	Components Removal/Installation Section 11	N/A
5.	Perform the Electrical Safety Tests	Electrical Safety Tests, see Section 8.2	15-20 min.
6.	Perform the Service Software Checks	Service Software Section 9	40 min.
7	Finish the testing by completing the tasks documented in the Tests, Calibrations and Utilities Section of the HAMILTON-C3 Operator's Manual	The HAMILTON-C3 Operator's Manual or local language equivalent.	20 min.

[4] Second-level engineers only.
[5] Second-level engineers only.

6.2 Hospital's Preventive Maintenance

The table below shows the maintenance tasks that hospital staff must perform. It is copied from the English version of the Operator's Manual.

Examine each ventilator 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

Table 6-3. Hospital's Preventive Maintenance

Interval	Part/Accessory	Procedure
Between patients and according to hospital policy	Patient 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-C3 Operator's Manual.
	Entire ventilator	Run the pre-operational check as shown in the HAMILTON-C3 Operator's Manual.
Every 2 days or according to hospital policy	Patient 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-C3 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.

6.3 Engineer's 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. See Section 6.1 and Section 6.2.

NOTICE

Check if the latest software version is installed on the HAMILTON-C3. If not installed the latest software, see the Hamilton Medical Partner-Net website https://www.hamilton-medical.com/Partner-Net/)[6] for the latest software version.

Perform the Engineer's Preventive Maintenance according to the table below:

Table 6-4. Engineer's Preventive Maintenance Schedule

Interval	Part/Accessory	Procedure
Yearly or every 5000 hours, whichever comes first, or as necessary	HAMILTON-C3 ventilator	Perform service-related Preventive Maintenance.
	Calibrations and Tests	Perform all calibrations and tests in the Service Software. See Section 9.1.
	Pre-Operational Checks	Perform the Pre-operational Checks as shown in the HAMILTON-C3 Operator's Manual.
	Alarm Tests	Perform the alarm checks as shown in the HAMILTON-C3 Operator's Manual.
	HEPA Filter	Replace as described in the HAMILTON-C3 Operator's Manual.
	HPO Inlet Filter	Replace as described in Section 11.4.4.

[6] Second-level engineers only.

Interval	Part/Accessory	Procedure
Yearly or every 5000 hours, whichever comes first, or as necessary	Oxygen Sensor	Replace if depleted as shown in the HAMILTON-C3 Operator's Manual.
Battery to be checked. Replace battery when (whichever comes first): • MSP369106 when capacity < 5280 mAh • Cycles > 400	Lithium Ion Battery	**Battery handling for all HAMILTON-C3 ventilators** • Replace the battery if the date of manufacture is > 3 years before the serviceable due date. • Replace the lithium-ion battery if it has been in use for 2 years or more. See Section 5.2.2. • Calibrate the lithium-ion battery when the Error is ≥ 5%. **HAMILTON-C3 with SW v ≥ v2.0.6** Additionally, you must check the battery's state of health (SoH) during the yearly preventive maintenance: • Replace the Lithium-ion battery, when the battery's state of health (SoH) is < 20%. (**Battery replacement required** message appears in the user mode). • Consider to replace lithium-ion battery, when battery's state of health (SoH) is < 40%.
When the expected blower timer (ebt) or blower timer is ≥ 100%	Blower Module	Blower timer must be checked during the yearly preventive maintenance. • Replace the Blower Module when the Blower Timer has reached 100%. **NOTICE!** The Dynamic Lifetime Surveillance monitors the service life of the blower module. The blower service life message **Blower service required** is displayed in service software mode, typically after eight years of a blower module in service. • The Blower Module must be replaced if the expected blower timer (ebt) is predicted to reach 100% in the next 6 months. See Section 9.9.2 and Section 11.4.10.
When you do an initial installation/ remove an electrical/electronic part or accessory, or repair/service activity	• HAMILTON-C3 ventilator • Maintenance tools and test equipment, see Chapter 7.	Perform electrical safety tests on the HAMILTON-C3 ventilator and its accessories or peripheral devices. See Chapter 8.

Table 6-5. Software update

Task	Information Reference	Time Required
Check if the latest software version 2.0.11 is installed on the HAMILTON-C3 ventilator. If the latest software is not installed, then you must install the latest software version 2.0.11.	See the Hamilton Medical's Partner-net website (https://www.hamilton-medical. com/Partner-Net/)[6] for the latest software version. • Software version (Technical state), see Section 9.8.2 • Software Update from Version < 1.1.0, see Section 9.19	10-15 min.

7

Maintenance tools and test equipment

7.1 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 the Engineer Preventive Maintenance Section 6.3.
- The Tests Functions in the Service Software Section 9.
- The Component Replacements in the Components Removal/Installation Section 11.

7.2 Standard Tools

To perform basic maintenance on equipment from Hamilton Medical AG, you require a range of:

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

7.3 Test Equipiment

The following test equipment is required, as well as the tools listed above, to complete the tests and adjustments included in the Service Software Section 9.

Pictures and details most of these items are in the product catalog.

Part Number	Description	Photo
500058	Pressure measurement kit • A complete WIKA gauge set can be obtained from Hamilton Medical AG Pressure gauge with the following specifications: • Range: 0 – 400 mbar accuracy: 0.5%	
500084	TSI flow meter kit Contains: • 500308 TSI flow meter • 500085 TSI-Flow meter battery box • 500086 TSI-Flow meter soft carrying case • 279204 Bacteria filter 260100 silicone tube 30cm 22F	
500330	Hand pump	
–	Digital voltmeter With red and black crocodile clips	
260206	Coaxial adult breathing circuit	
281637	Flow sensor pediatric/adult (single Use)	

Part Number	Description	Photo
279928	Adapter for flow sensor calibration adult/pediatric	
281717	Stopper (used for test configurations)	
500300	Pressure connector	
10117779	Pressure connector	
279812	Clamp, flow restrictor	
500077	ESD wrist band	
151815	Adult demo lung with 7 mm ET tube	
281420	Connector 22M/15F-22M/15F	
281803	Adapter (three pieces required for CO2 accuracy check)	
279913	Connector 15M/4M	

Part Number	Description	Photo
7249057	2 Meter silicone tube 4 mm ID, 7 mm OD	
161618	Electrical Safety Test Cable for USB Port	
160368	Electrical Safety Test Cable	
159171	Electrical Safety Test Cable for CO2 Option	
159681	Electrical Safety Test Cable for SpO2 Option	
—	Safety Analyzer (Electric Safety Tester)	
-	Safety Analyzer Hand Held Device (Electric Safety Tester)	
396376	USB memory stick Specification for the USB stick: • File system: Fat or FAT32 • Unpartitioned memory • No operating system or security software installed	
369104	External Battery Charger	

Part Number	Description	Photo
500314	Two-pin cylindrical service tool	

7.4 Calibration of test equipment

Some test equipment must be tested and calibrated periodically. Hamilton Medical recommends the following schedule:

Table 7-1. Calibration of test equipment

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.wika.com for calibration information).
Digital voltmeter	As recommended by the manufacturer.	As recommended by manufacturer.
Flow analyzer	As recommended by the manufacturer.	As recommended by manufacturer.

8

Electrical safety

8.1 Electrical Safety Overview

⚠ WARNING

- Electrical Safety Tests detailed in this section must be performed as part of, or as instructed in the Overview of Preventive Maintenance and Testing Section 6.1.4.
- Disconnect the power cable of the device from the mains power supply if connected before you do the Electrical Safety Tests (IEC 62353) to prevent potential electrical hazards.
- In addition, to comply with IEC 62353, the Electrical Safety Tests must be performed after:
  - The power supply is replaced
  - The mainboard is replaced
  - Removing any ground contact from the HAMILTON-C3 ventilator
  - Performing preventive maintenance
  - Repair or service activity
  - Initial installation of the HAMILTON-C3 ventilator
  - Installation/removal of an electrical/electronic part or option board.

Electrical safety test standard used by Hamilton Medical AG

Hamilton Medical AG performs a set of Electrical Safety Tests, as specified in IEC 60601-1 standard, on all the ventilator units that it manufactures.

Operator's responsibility: performing the electrical safety tests on the device

As stated in the WARNING above, it is a legal necessity that you do the *Electrical Safety Tests* as specified in IEC 62353 standard after performing the initial installation, preventive maintenance, repair/service or an adjustment on the HAMILTON-C3 ventilator.

The device operator is responsible for performing the electrical safety tests during the in-service or use phase of the HAMILTON-C3 ventilator.

For details on how to perform the electrical safety tests, see Section 8.2.4.

Country-specific regulations and test intervals

If IEC 62353 standard has not been adopted by your country, then you must follow your country's standard/norm for performing electrical safety tests on medical devices after installation, routine preventative maintenance, service, or repair.

You must observe the electrical safety tests intervals specified in Section 6.3 or observe the country-specific regulations regarding the electrical safety tests intervals or routine testing.

Connection to the mains power supply: rated supply frequency (50 Hz or 60 Hz)

The *rated* supply frequency for the HAMILTON-C3 therapy device is 50 Hz or 60 Hz. This means that the HAMILTON-C3 therapy device is designed to be connected to a mains power supply having a normal frequency of 50 Hz or 60 Hz.
The electrical safety tests must be conducted by applying a current-limited mains potential sinusoidal 50 Hz signal (60 Hz where this is the mains frequency in the country or region).
For further details on the electrical safety tests standards, see IEC 62353 and IEC 60601-1.

8.2 Electrical Safety Tests

8.2.1 Preparation for Tests

- Multimeter
- Safety Analyzer
- Electrical Safety Test Cables

8.2.2 Perform the Tests

The Electrical Safety Tests you must perform are explained in this section. If you have an Automated Safety Device such as the RIGEL 288 Safety Analyzer used by Hamilton Medical, perform the automated tests in addition to the tests shown in this section.

8.2.3 Device type

For the IEC 60601-1 regulations concerning medical devices, the HAMILTON-C3 is a:

- Class 2
- Type B device
- Type BF, if the extended communication board for capnography is installed

8.2.4 Internal resistance checks

Required measurement instruments and tools:

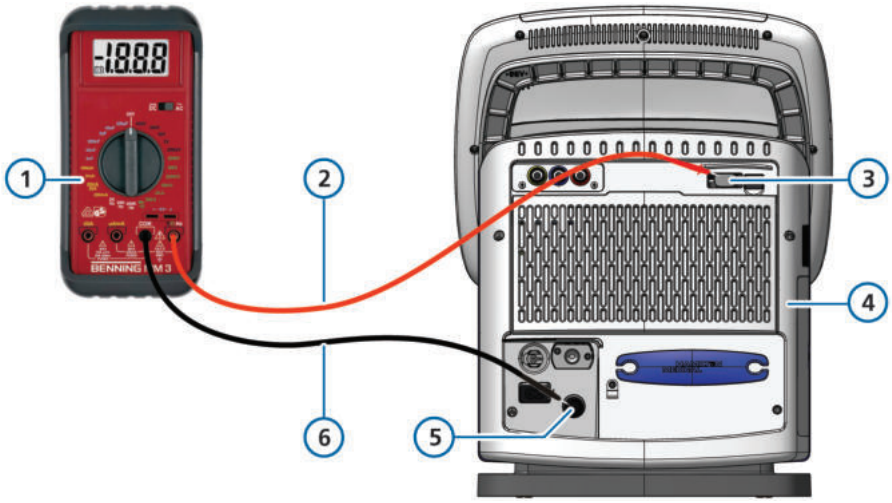
- Digital voltmeter
- Electrical safety test cable (PN 160368)

Check the resistance between the Earth Ground on the HAMILTON-C3 with the Test Connector, and other components as shown in the table below.

Table 8-1. Internal Resistance Checks

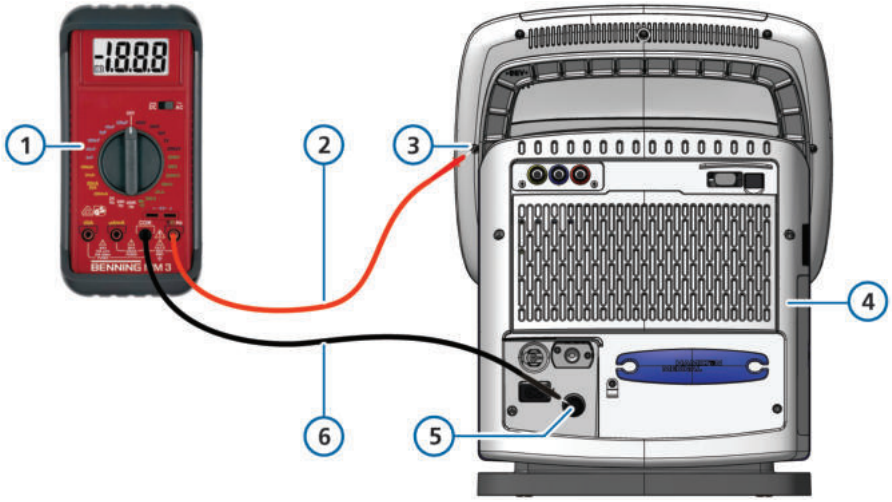
Check	Minimal Acceptable Resistance
A. Ground (earth) pin to: Communications Interface Connector	> 2.4MΩ
B. Ground (earth) pin to: Interaction Panel	> 2.4MΩ
C. Ground (earth) pin to: High Pressure Oxygen	> 2.4MΩ
D. Ground (earth) pin to: Low Pressure Oxygen	> 2.4MΩ

Figure 8-1. Earth ground to the communication interface connector resistance



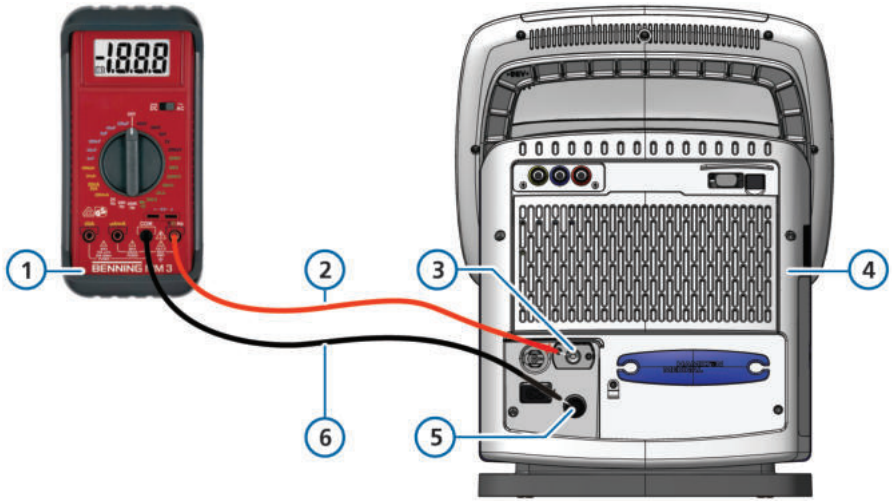
1	Digital multimeter	4	HAMILTON-C3 ventilator
2	Voltage, current and resistance (mAVΩ) probe	5	Earth Ground
3	Communication Interface Connector	6	Ground (earth) probe

Figure 8-2. Earth ground to the interaction panel resistance



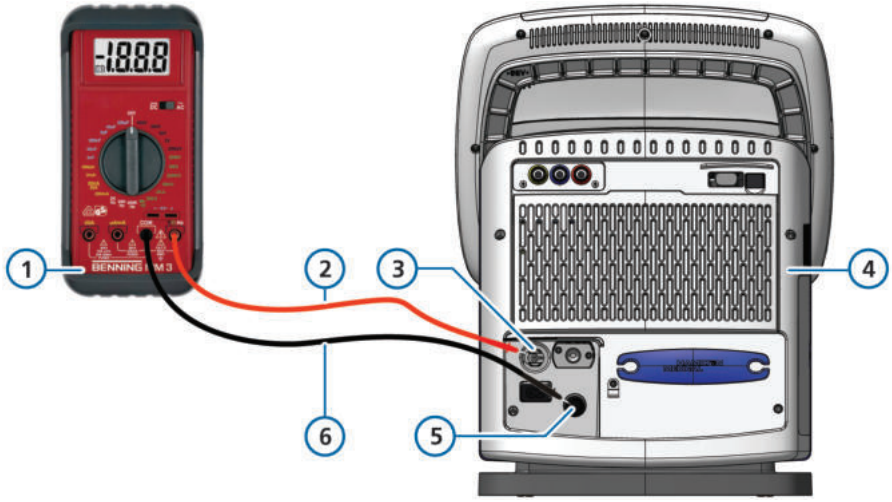
1	Digital multimeter	4	HAMILTON-C3 ventilator
2	Voltage, current and resistance (mAVΩ) probe	5	Earth Ground
3	Any of the Torx screws (PN 420642) from the Large Rear Cover or from the Small Rear Cover	6	Ground (earth) probe

Figure 8-3. Earth Ground to the High Pressure Oxygen Resistance



1	Digital multimeter	4	HAMILTON-C3 ventilator
2	Voltage, current and resistance (mAVΩ) probe	5	Earth Ground
3	High Pressure Oxygen Connector	6	Ground (earth) probe

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



1	Digital multimeter	4	HAMILTON-C3 ventilator
2	Voltage, current and resistance (mAVΩ) probe	5	Earth Ground
3	Low Pressure Oxygen Connector	6	Ground (earth) probe

8.2.5 Electrical Safety Tests - IEC 62353

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 ventilator. The Electrical Safety Test is performed with suitable equipment such as the RIGEL 288 safety analyzer. Details of these automated electrical safety tests depend on the test equipment used, it is impossible to offer any detailed descriptions.

Specifications

Table 8-2. IEC 62353 Specifications for Class II Type B and BF Devices

Current in mA (RMS - Root Mean Square)	Type B	Type BF
Setup	Setup for Type B Device (no Communication Board Installed) Section 8.2.5.1	Setup for Type BF Device (with Communication Board for Capnography) Section 8.2.5.2
Equipment leakage (direct method)*	0.1 mA	0.1 mA
Patient leakage current (direct method) AC*	–	5 mA
* see IEC62353		

All measured values must be documented using the measurement process and are considered reference values. Should the obtained values measured during the next maintenance cycle be within 90 to 100% of the permissible values, the reference values are to be used to evaluate the ventilators electrical safety.

Definition

Applied Parts of the medical device, which are designed to come into physical contact with the patient or parts that are likely to be brought into contact with the patient.

Type B applied parts

Type B applied parts are those parts, which are usually Earth referenced. Type B is used for applied parts that are generally not conductive and can be immediately released from the patient.

Type BF applied parts

Type BF applied parts are generally for devices that have conductive contact with the patient, or having medium or long term contact with the patient. For example, using capnostat and/or SPO2 finger probe on a patient. This applied part complies with a higher degree of protection against electric shock than Type B applied part.

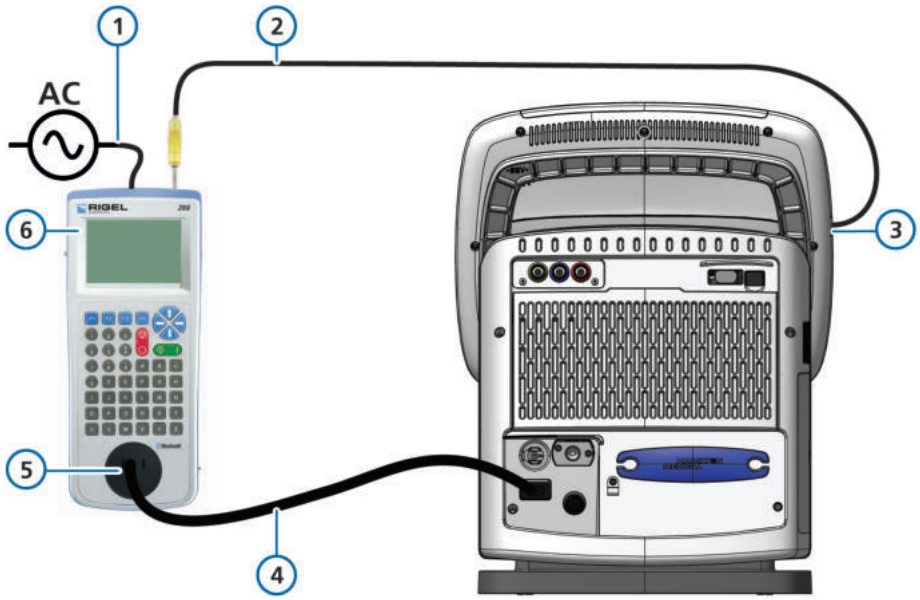
8.2.5.1 Setup for Type B device (no communication board installed)

NOTICE

For detailed information regarding the use of your electrical safety tester, please check the users manual for the device.

1. For setup for the RIGEL 288 safety analyzer tests, attach the ground cable (2) from the USB Port (3) of the HAMILTON-C3 to the 4 mm earth bond probe socket of the RIGEL 288 Safety Analyzer (6).
2. Connect the AC mains cable (1) from the HAMILTON-C3 to the AC connection (5) at the front of the RIGEL 288 safety analyzer (6).
3. Turn on the HAMILTON-C3 (standby mode) for the electrical safety tests.

Figure 8-5. Setup for Type B device (no communication board installed)



1	AC Power Cable Inlet (RIGEL 288 Safety Analyzer)	4	Power Cord (HAMILTON-C3)
2	Electrical Safety Test Cable (PN 161618)	5	EUT Socket (RIGEL 288 Safety Analyzer)
3	USB Port	6	RIGEL 288 Safety Analyzer (Handheld Medical Electrical Safety Tester)

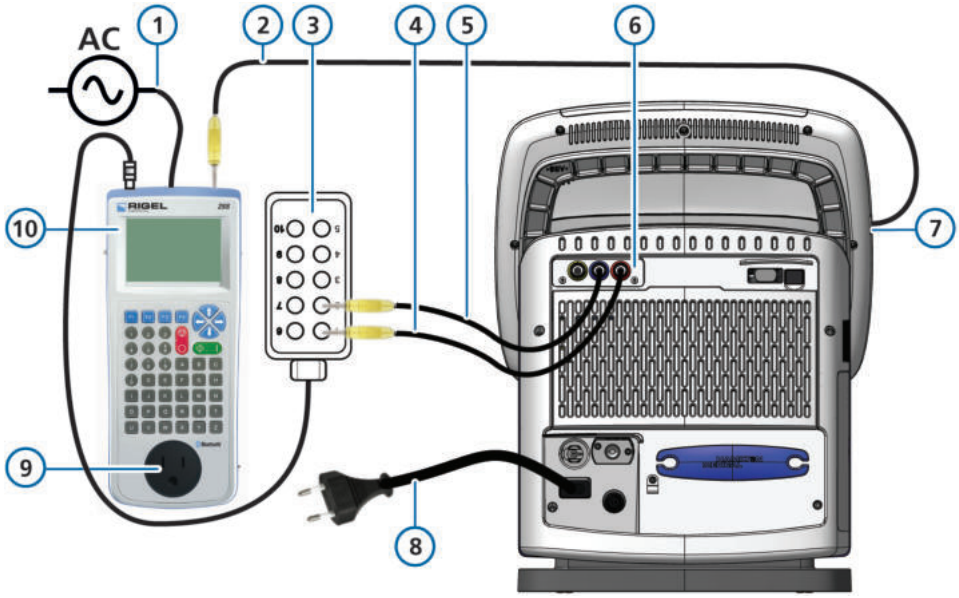
8.2.5.2 Setup for Type BF device (with communication board for capnography)

NOTICE

For detailed information regarding the use of your electrical safety tester, please check the users manual for the device.

1. Connect the RIGEL 288 safety analyzer to the AC power supply.
2. Connect the RIGEL 288 Safety Analyzer and the HAMILTON-C3 to each other as shown below.
3. Turn on the HAMILTON-C3 (Standby mode) for the electrical safety tests.

Figure 8-6. Setup for Type BF device (with communication board for capnography)



1	AC power cable Inlet (Rigel 288 safety analyzer)	6	Communication board
2	Electrical safety test cable (PN 161618)	7	USB port
3	AP-Box 331A700 (RIGEL 288 safety analyzer)	8	Power cord (HAMILTON-C3)
4	CO2 sensor electrical safety test cable (PN 159171)	9	EUT socket (Rigel 288 safety analyzer)
5	SPO2 sensor electrical safety test cable (PN 159681)	10	Rigel 288 safety analyzer (handheld medical electrical safety tester)

9

Service Software

9.1 Introduction

⚠ WARNING

- Before performing any of the tests in this section, read Section 6.1.
- If one of the tests indicates that you must replace a part, do so immediately and update the Service Software Modify Tab (see the Modify Tab Section 9.8.3) and then repeat the complete series of tests. See contents in this section.

⚠ CAUTION

To prevent patient or ventilator contamination, always use a bacterial filter between the HAMILTON-C3 and the Inspiratory Limb of the Patient Breathing Circuit.

- *For troubleshooting see the related Knowledge Base entry[7].*
- *Record all results on the HAMILTON-C3 Summary of Test Report. See Section 17.2.*
- *Confirm that the technical state is updated and that the device has been restarted after technical state modifications. See Section 9.8.3.*
- *Always use an adult breathing circuit, if a circuit is required during the tests.*

NOTICE

The HAMILTON-C3 needs a warm-up period. Make sure it was running for at least 20 minutes in the Ventilation Mode.

This section describes each of the units containing the HAMILTON-C3 Service Software.

Before starting, be sure that you are familiar with Section Typographic Conventions and Section Expressions.

The HAMILTON-C3 Summary of test report 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-C3 Summary of test report. See Section 17.2.

9.2 Functions of the Service Software

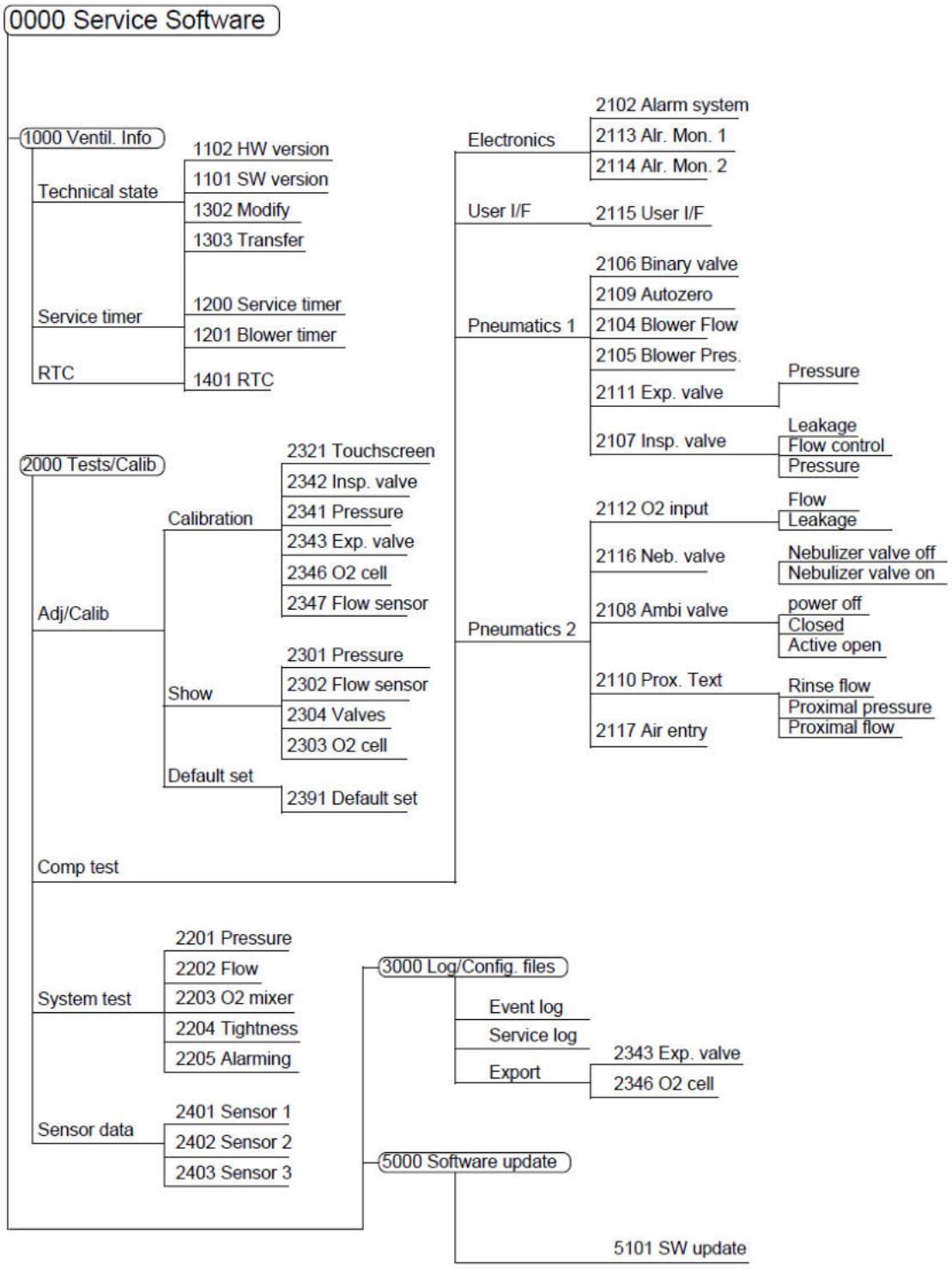
Units in the Service Software perform the following functions:

- Enables display information (concerning Revisions and Versions of the HAMILTON-C3 Hardware and Software)
- Enables checks on the HAMILTON-C3 Hardware and Software
- Enables Calibration of the HAMILTON-C3 Hardware
- Enables viewing and exporting of the Event Log and Service Log
- Enables software upgrades

[7] Second-level engineers only.

9.3 Structure of the Service Software

Figure 9-1. Service Software Structure



9.4 Starting the Service Software

NOTICE

To start the Service Software, you must place the HAMILTON-C3 in the Service Software Mode

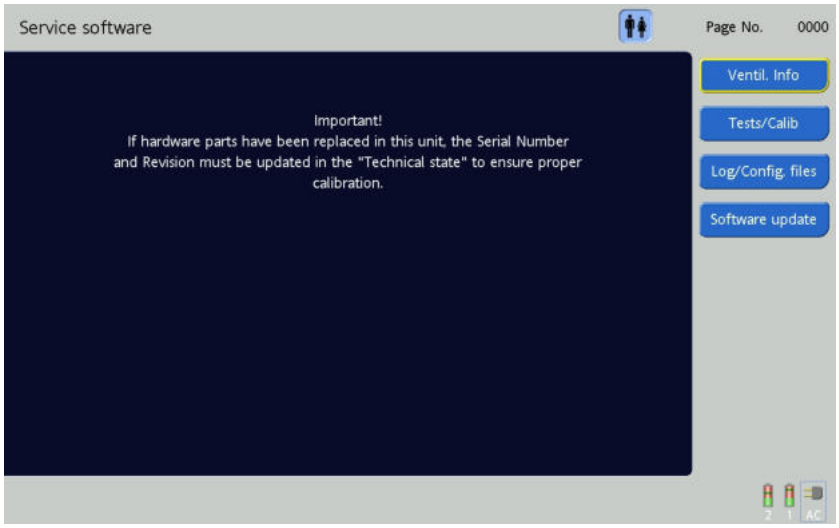
1. Connect the HAMILTON-C3 to mains power.

2. Press the **ON** (A) button located on the HAMILTON-C3 Interaction Panel and then press and hold the **100% O2** (B) and **Manual Breath** (B) buttons at the same time. The 2 buttons can be released as soon as the Alarm Silence Key is illuminated.

Figure 9-2. Starting the Service Software

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

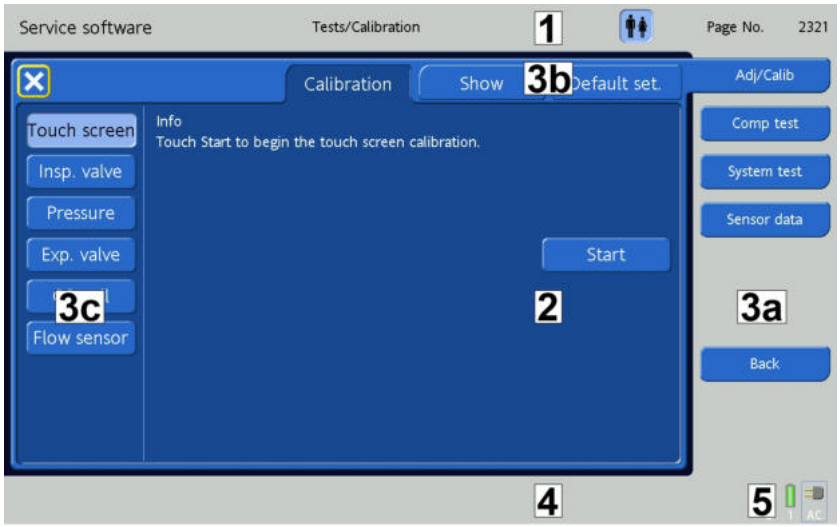
Figure 9-3. Main Service Software Screen



4. To exit the Service Software, switch OFF the HAMILTON-C3.

9.5 Service Software Screen Layout

Figure 9-4. Service Software Screen Layout



1	Header Window	3c	Optional Menu Tab Layer 3
2	Test Window including Dialogs	4	Alarm Window
3a	Menu Tab Layer 1	5	Energy State Window
3b	Optional Menu Tab Layer 2		

9.6 Making screenshots

- Insert the **USB memory stick** (B) into the HAMILTON-C3 USB Slot and press the print screen key (A) for one second until the corresponding LED lights up.

Figure 9-5. Making Screenshots

A	Print screen key	B	USB memory stick (PN 396376)

The print screen function saves a JPG file of the current ventilator screen to a USB memory stick (B).

The USB memory stick can be removed when the Print Screen Key LED is no longer lit.

The filename takes this format: **screenshot_yyyy-mm-dd_HH-MM-ss.jpg**

Where:

- yyyy is the year
- mm is the month
- dd is the day
- HH is the hour (in 24-hour format)
- MM is the minute
- ss is the second

NOTICE

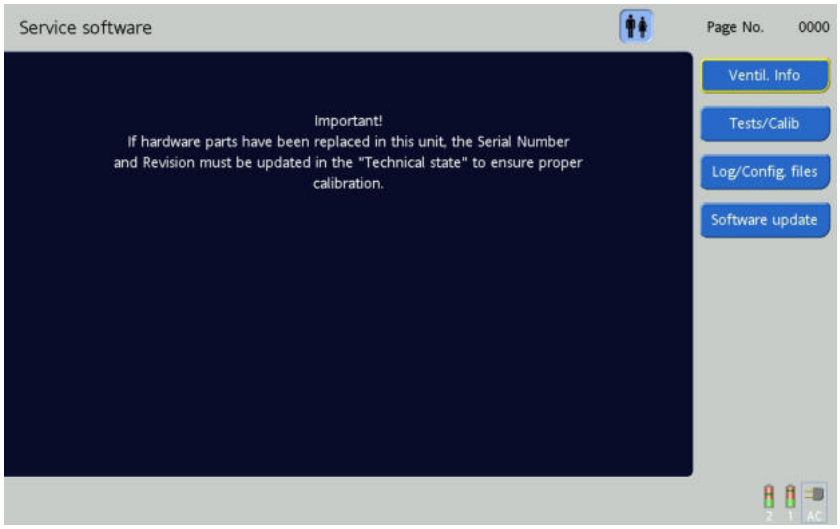
Specification for the USB Flash Drive:

- We recommend that you use an 8 GB USB flash drive (PN 396376), which can be ordered from Hamilton Medical AG
- File system: FAT or FAT32
- Unpartitioned memory
- No operating system or security software installed

9.7 Ventilator Info

1. From the Main Service Software Screen, touch the **Ventil. Info** Button.

Figure 9-6. Main Service Software Screen

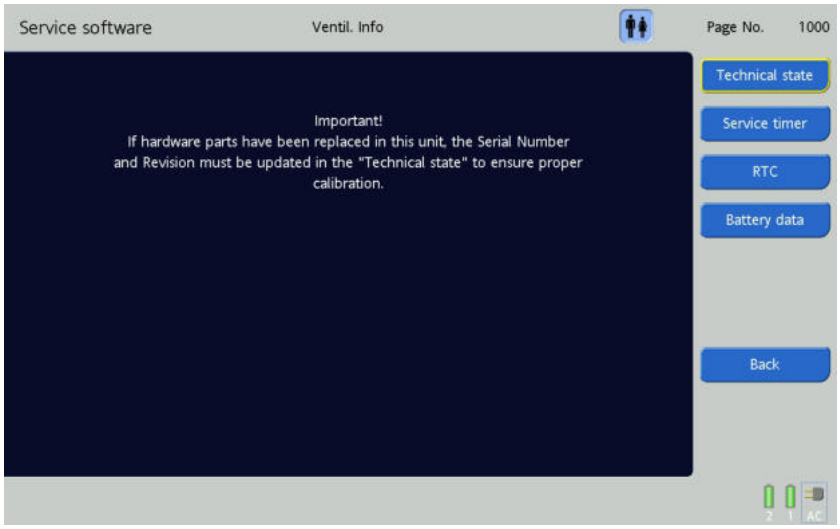


The Main Service Software Screen

2. On the Ventilator Info Screen are the:

- **Technical State** Button
- **Service Timer** Button
- **Real Time Clock (RTC)** Button
- **Battery Data** Button
- **Back** Button (go back to the Main Menu)

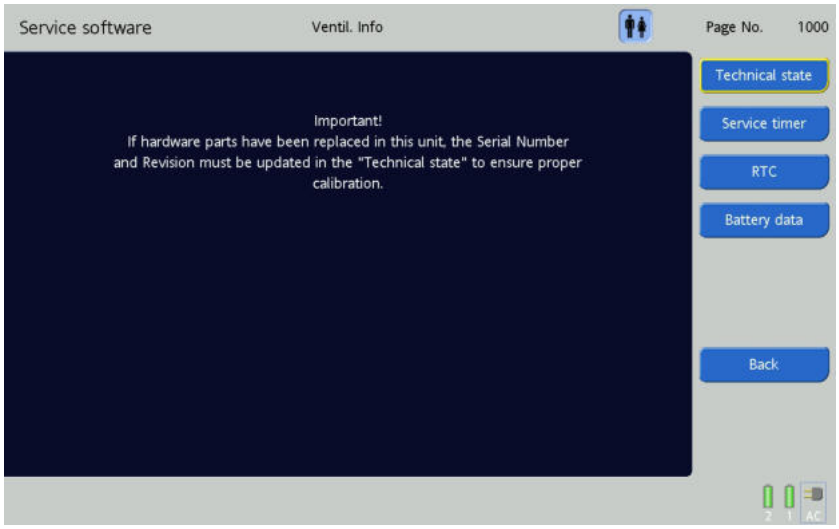
Figure 9-7. The Ventilator Info Screen



9.8 Technical state

Touch the **Technical State** button to enter the technical state section.

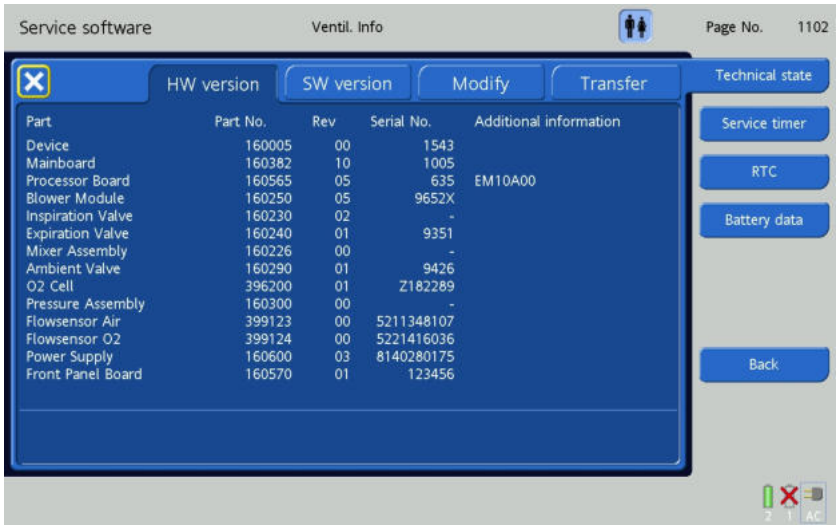
Figure 9-8. Ventilator info screen



9.8.1 Hardware version tab

1. Touch the **HW Version** tab (if not already selected). The hardware version tab displays the Device Name, Part Number, Revision, Serial Number and other information as shown in the figure below.

Figure 9-9. Hardware version tab

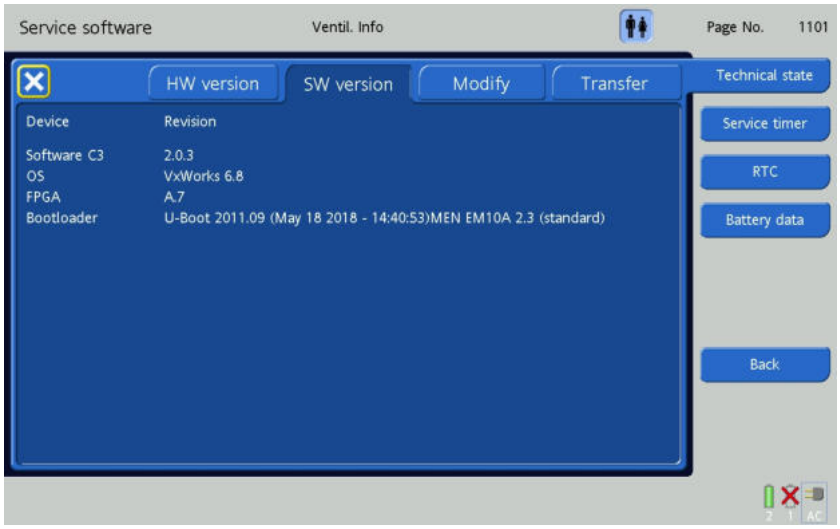


2. The information of the following components will be updated automatically from the HAMILTON-C3 during start-up:
   – Battery 1
   – Battery 2
   – Flow sensor AIR (Qvent)
   – Flow sensor O2 (QO2)
   – O2 sensor
   – Communication Board
3. In case the technical state is corrupt, or after upgrading the software, the **Clean-up** button will appear.
4. In case the technical state cannot be read out from the EEprom of a component, the unit will fail in self-test and alarm with **Technical state failed**. Other technical faults will appear as after effects.
5. Record the hardware version information on the HAMILTON-C3. See Section 17.2.

9.8.2 Software Version Tab

1. Touch the **SW version** Tab. The SW Version Tab displays the device names and revisions of the operating software.

Figure 9-10. Software Version Tab



2. Record the software version Information on the HAMILTON-C3 Test Report. See Section 17.2.

9.8.3 Modify tab

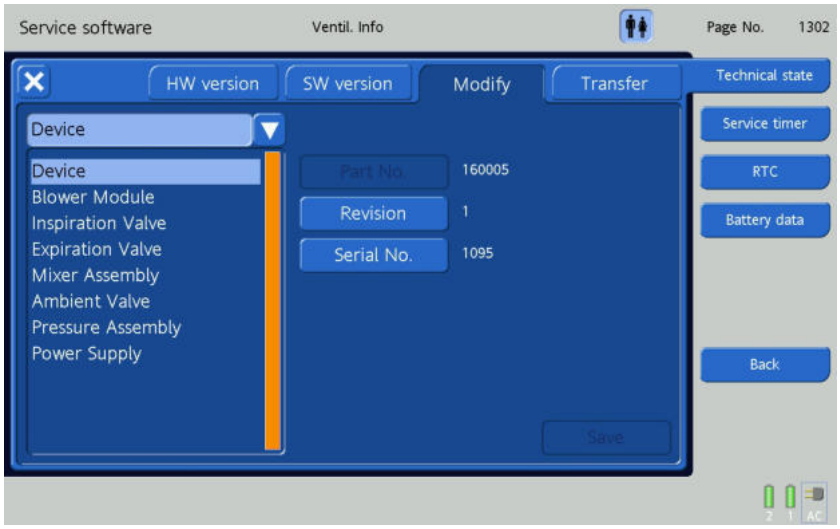
NOTICE

Always update the technical state when an assembly as listed below has been replaced.
Restart the device prior to performing the service software tests and calibrations.

The modify tab allows updating information when a part has been replaced.

1. Touch the **Modify** tab.
2. Select the hardware component you want to modify.
3. To change the serial number or revision number, touch the corresponding button.

Figure 9-11. Modify tab - step 1

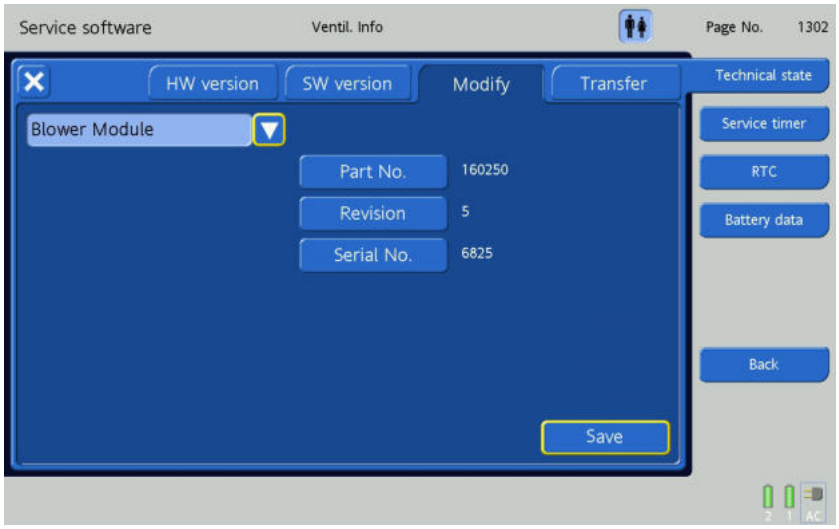


4. Enter the number.

Figure 9-12. Modify tab - step 2

5. Proceed with **Confirm**. When finished, touch the **Save** Button.
6. To change the Part Number, touch the **Part No.** Button and select the correct number.
7. Proceed with **Confirm**. When finished, touch the **Save** Button.

Figure 9-13. Modify tab - step 3



NOTICE

Make sure to select the correct Part Number. Cross check with the label of the Spare Part / Installation Guide of the MSP Spare Part.

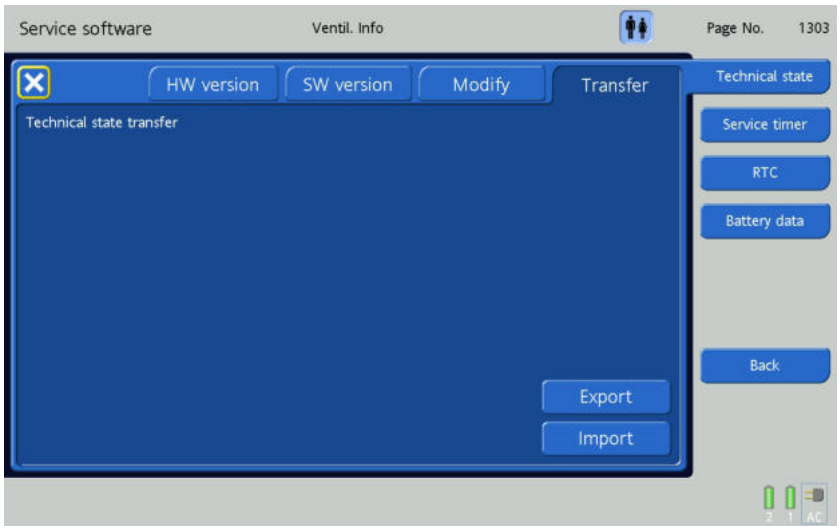
9.8.4 Transfer Tab

The **Transfer** Tab contains 2 buttons:

Export and **Import**

To allow you to export/import the technical state of the device from a USB Memory Stick.

Figure 9-14. Transfer Data Tab



By exporting, the service software creates a directory, if it does not exist, on the USB Memory Stick.

The naming convention of this directory is:

INSTRUMENT-sn#device_serial_number: /myUSBDevice/C3-sn-1010/ the file which is exported is a .csv (comma separated file) file containing the device technical states.

It has the same naming convention as the directory created on the USB Memory Stick:

e.g.: C3-sn-1010.csv

For importing values to the device, be sure that there is a directory following the previous given naming convention and a .csv file having the proper name according to the device serial number.

The technical state can be exported and imported to/from a USB Memory Stick. Ensure the USB Memory Stick is connected to the ventilator, then touch the corresponding button.

NOTICE

Insert USB Memory Stick is visible, as long as there is no memory stick inserted.

NOTICE

The format of the file is .csv (comma separated values) and can be edited with a text editor (e.g. Notepad, Wordpad). Do **not** use Excel to modify the **.csv file**.

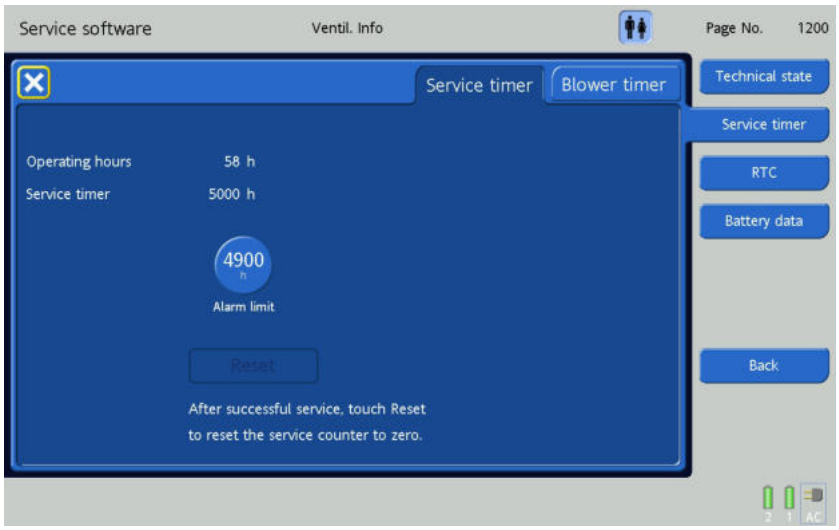
9.9 Service Timer

9.9.1 Service Timer Tab

1. Touch the **Service timer** Tab.

2. 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 9-15. The Service Timer Tab



3. Record the **Operating hours** and the **Service timer** hours on the HAMILTON-C3 Summary of Test Report Section 17.2.

4. After successful service, reset the service counter by touching the **Reset** Button. To enable the reset function, select the **Alarm limit** Timer first.

5. The **Alarm limit** Timer Button allows the set number of hours between service intervals to be changed.

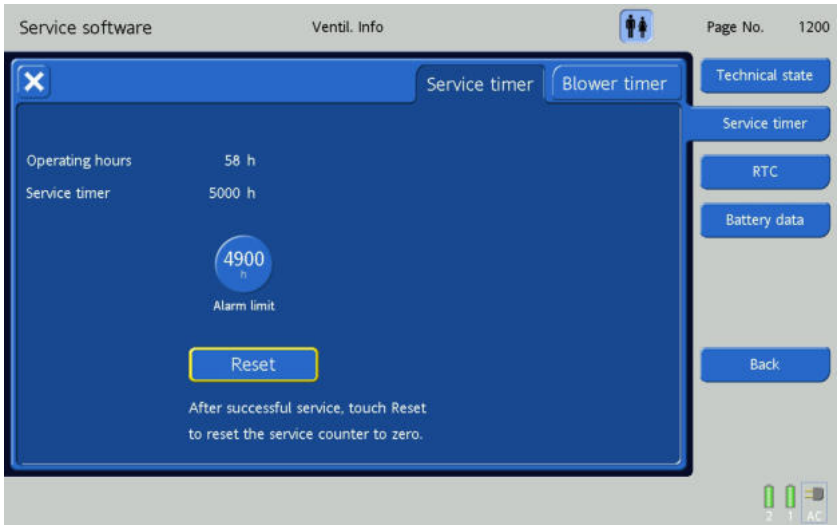
Figure 9-16. Setting the Alarm Limit

6. Touch the **Alarm limit** Timer Button or rotate the P&T Control Knob until the Alarm Limit Rotary Screen Button is highlighted, then press the P&T Control Knob.

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

8. Touch the **Alarm limit** Timer Button again or press the P&T Control Knob to save the new value.

Figure 9-17. Alarm Limit Reset Button



9. Touch **Reset**.

10. After resetting the service timer, the current operating hours will be added to the set alarm limit hours.

9.9.2 Blower timer tab

NOTICE

The expected operation time (100%) is calculated based on the operating hours, temperature and rotation speed of the blower. When 100% is reached, the alarm **Blower service required** appears and the Blower Module needs to be replaced.

Replace the Blower Module when the blower timer **≥ 100%**. Also replace the Blower Module when the **Prediction Blower Timer in the Next 6 Months** reaches **100%**. See prediction calculation formula in the table below.

After replacement of the blower module, enter the serial number and revision number of the new blower module in the technical state. See Section 9.8.3. This will reset the **Blower timer**.

Table 9-1. Prediction of the blower timer in 6 months:

$$ebt = bt + \left(\frac{bt}{y \times 2}\right)$$

Where:

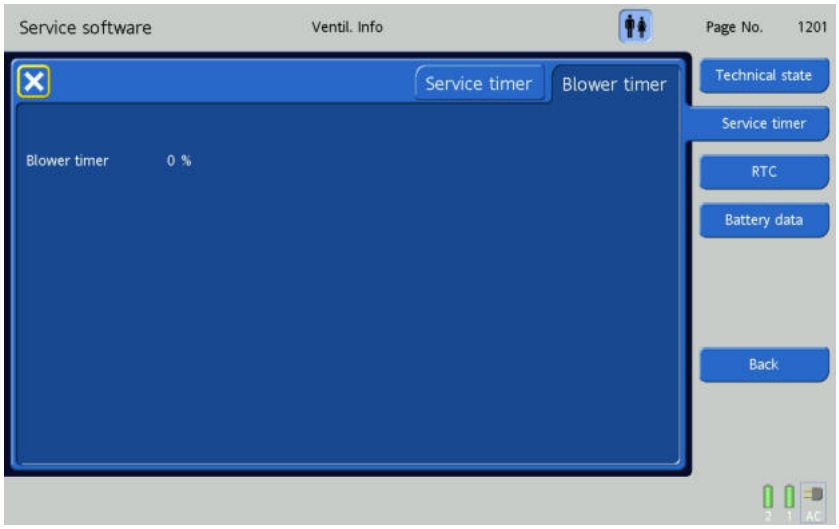
ebt = expected blower timer in 6 months [%]

bt = current blower timer [%]

y = number of years since the installation of the blower [Year(s)]

1. Touch the **Blower timer** tab.
2. On the **Blower timer** tab, the total blower time hours are displayed in percentage.

Figure 9-18. The Blower Timer Tab

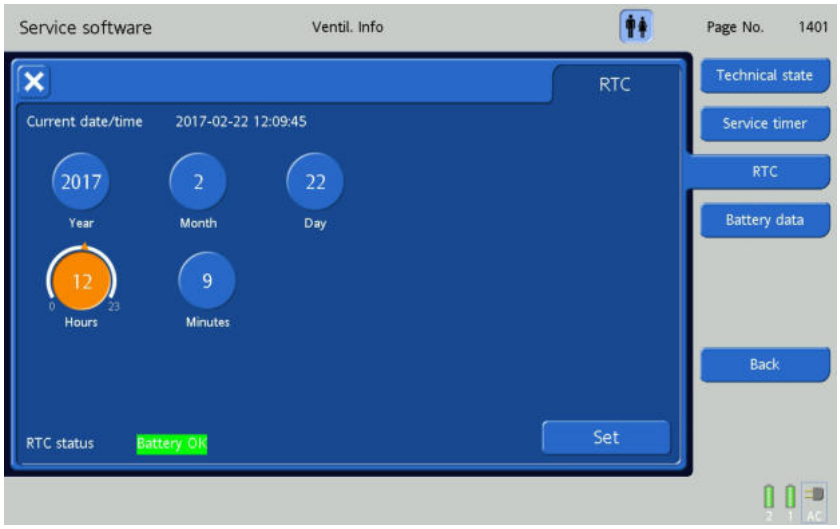


3. Record the blower timer % on the HAMILTON-C3 Test Report. See Section 17.2.

9.10 Real Time Clock (RTC)

1. Check the current Date and Time:

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



2. Touch 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.

3. Change the number displayed by rotating the P&T Control Knob.

4. Touch the Screen Button again or press the P&T Control Knob to keep the new value.

5. When all selections are complete, touch the **Set** Button.

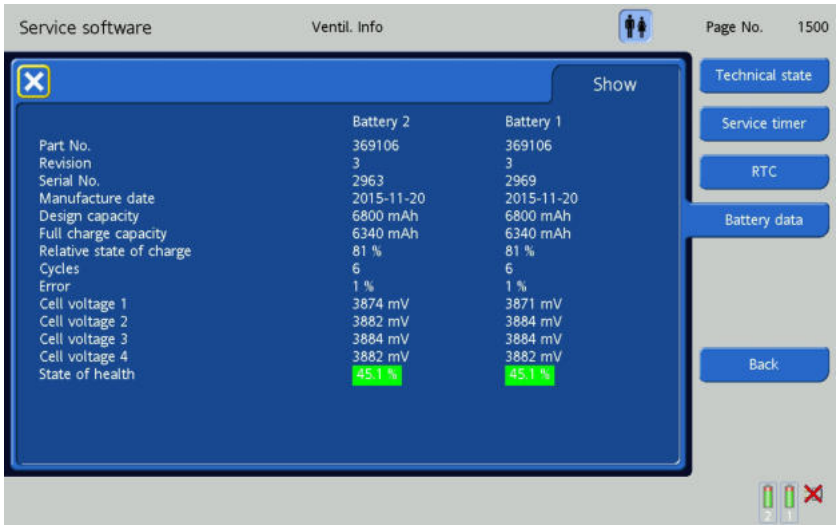
Figure 9-20. Current Date and Time Reset Step 2

6. To change to the Main Menu, touch the **Back** Button.

9.11 Battery data

The **Battery Data** button displays all of the data provided for the batteries (see Section 5.5).

Figure 9-21. Battery data tab



9.12 Tests Overview

NOTICE

Record all results on the *HAMILTON-C3 Test Report*. See Section 17.2.

Table 9-2. Adjustments / Calibration

Tests	Screenshots	Page No.
Touch Screen	Page No 2321	Touch Screen, see Section 9.14.1.1
Inspiratory Valve	Page No 2342	Inspiratory Valve, see Section9.14.1.2
Pressure	Page No 2341	Pressure, see Section9.14.1.3
Expiratory Valve	Page No 2343	Expiratory Valve, see Section9.14.1.4
Oxygen Sensor	Page No 2346	Oxygen Sensor, see Section9.14.1.5
Flow Sensor	Page No 2347	Flow Sensor, see Section9.14.1.6

Table 9-3. Components Tests

Tests	Screenshots	Page No.
Alarm System	Page No 2102	Alarm System, see Section9.15.1.1
Alarm Monitor 1	Page No 2113	Alarm Monitor 1, see Section9.15.1.2
Alarm Monitor 2	Page No 2114	Alarm Monitor 2, see Section9.15.1.3
User Interface Tab	Page No 2115	User Interface Tab, see Section9.15.2
Binary Valve	Page No 2106	Binary Valve, see Section9.15.3.1
Autozero	Page No 2109	Autozero, see Section 9.15.3.2
Blower Flow	Page No 2104	Blower Flow, see Section9.15.3.3
Blower Pressure	Page No 2105	Blower Pressure, see Section9.15.3.4
Expiratory Valve	Page No 2111	Expiratory Valve, see Section9.15.3.5
Inspiratory Valve	Page No 2107	Inspiratory Valve, see Section9.15.3.6
O2 Input	Page No 2112	O2 Input, see Section9.15.4.1
Nebulizer Valve	Page No 2116	Nebulizer Valve, see Section9.15.4.2
Ambient Valve	Page No 2108	Ambient Valve, see Section9.15.4.3
Proximal Test	Page No 2110	Proximal Test, see Section9.15.4.4
Air Entry Test	Page No 2117	Air Entry Test, see Section9.15.4.5

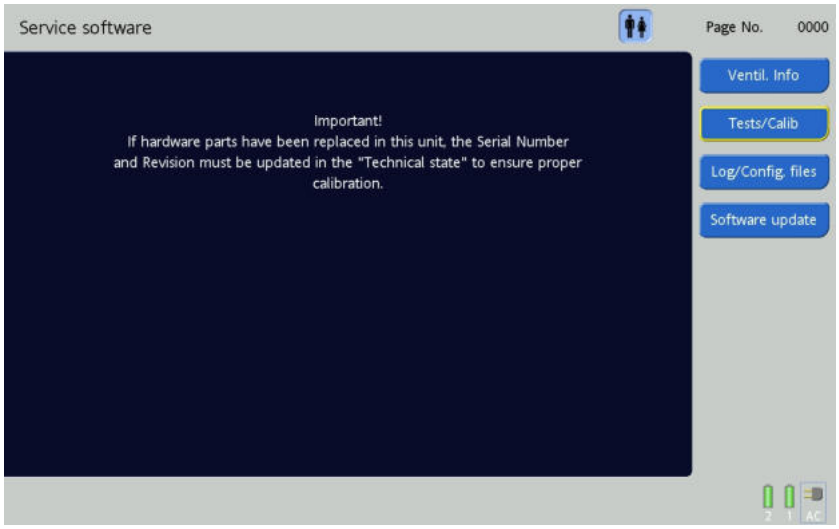
Table 9-4. System Tests

Tests	Screenshots	Page No.
Pressure	Page No 2201	Pressure, see Section9.16.1
Flow Test	Page No 2202	Flow, see Section9.16.2
O2 Mixer	Page No 2203	O2 Mixer, see Section9.16.3
Tightness Test	Page No 2204	Tightness, see Section9.16.4
Alarming	Page No 2205	Alarming, see Section9.16.5

9.13 Tests / Calibration Screen

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

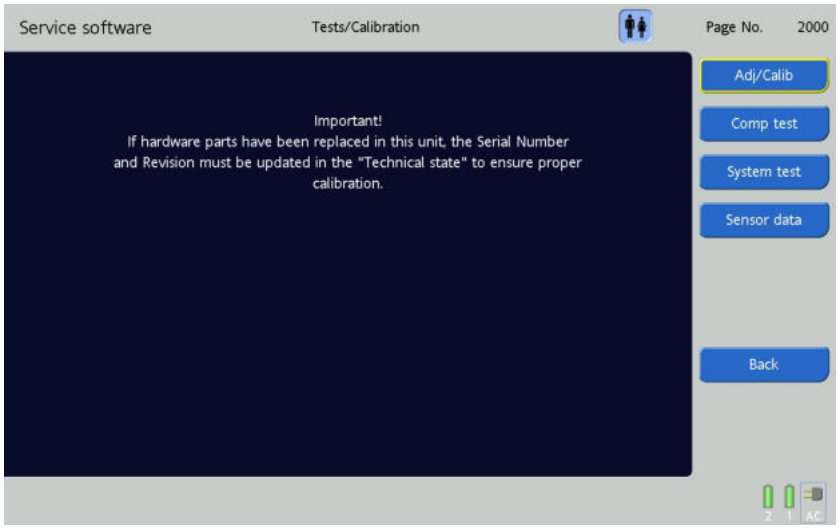
Figure 9-22. Main Service Software Screen



2. On the **Test / Calibration** Screen are the:

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

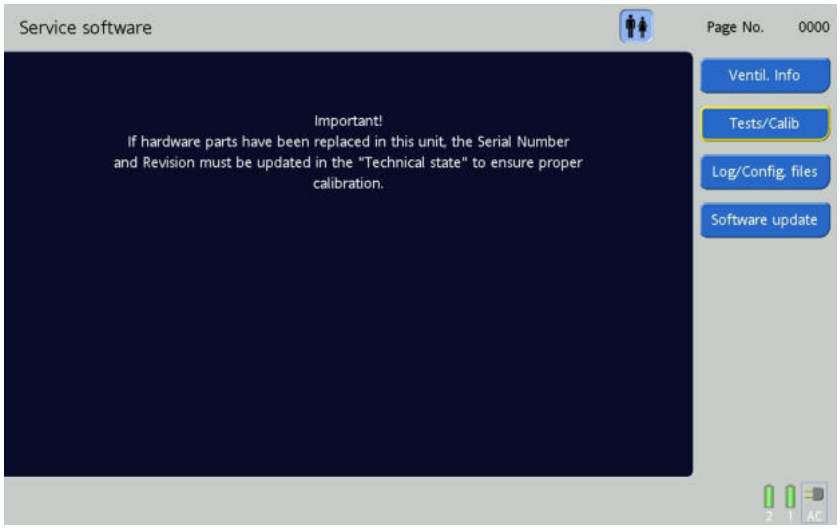
Figure 9-23. The Tests / Calibration Screen



9.14 Adjustments / Calibration

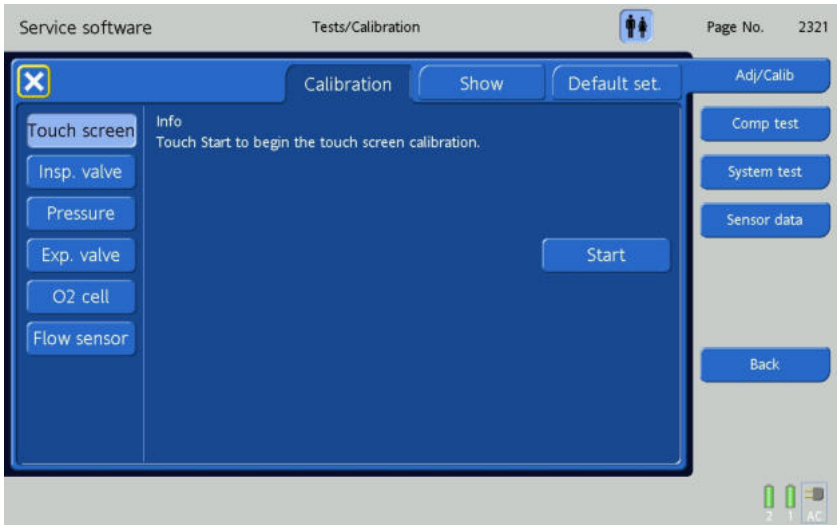
1. From the Main Service Software Screen, touch the **Tests / Calibration** Button.

Figure 9-24. Main Service Software Screen



2. Touch the **Adjustment / Calibration** Button.

Figure 9-25. Adjustments / Calibration Screen



9.14.1 Calibration Tab

Touch the **Calibration** Tab.

Figure 9-26. Calibration Tab

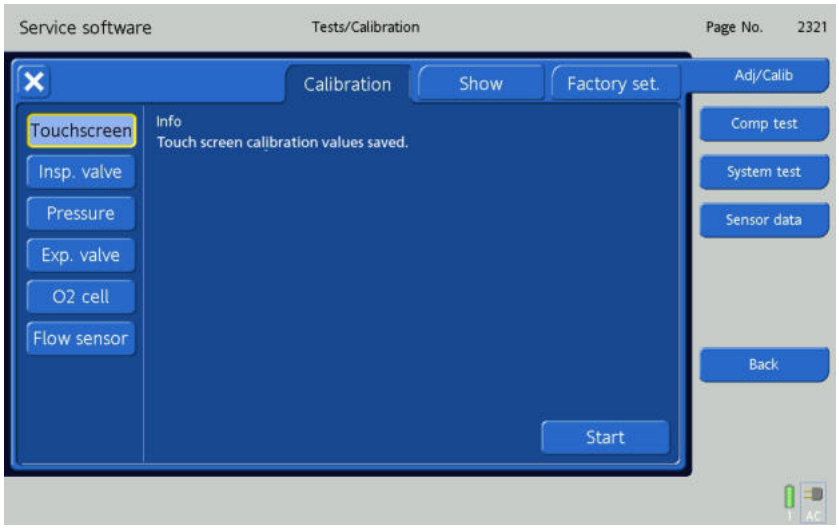


Table 9-5. Adjustments / Calibration

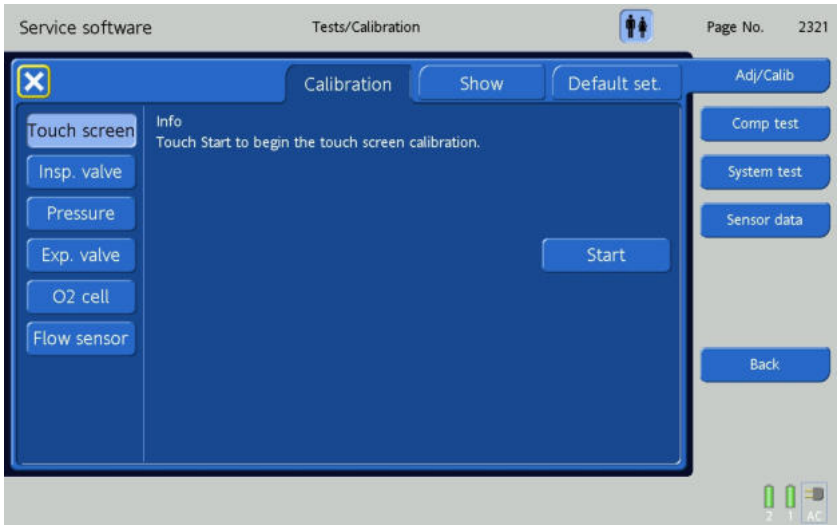
Adjustment/Calibration	Description	Component adjusted/calibrated
Adj/Calib > Calibration > **Touchscreen (Page No 2321)** Touch Screen Section 9.14.1.1	Allows calibrating the coordinates of the touch controller (4–point calibration).	• Touch Screen
Adj/Calib > Calibration > **Inspiratory Valve (Page No 2321)** Inspiratory Valve Section 9.14.1.2	Allows aligning the gain and offset for voltage-offset of the inspiratory valve. Sets Offset 1 (low pressure) at 20 mbar blower pressure and Offset 2 (high pressure) at 60 mbar blower pressure when required Qvent flow is reached.	• Inspiratory Valve
Adj/Calib > Calibration > **Pressure (Page No 2341)** Pressure Section 9.14.1.3	Allows adjusting the pressure sensor gain using an external pressure measurement as reference.	Pressure Sensor: • Pvent_control • Pvent_monitor and Paw
Adj/Calib > Calibration > **Exp. valve (Page No 2343)** Expiratory Valve Section 9.14.1.4	Before calibration starts, an autozero of Pvent_control, Pvent_monitor, Paw, Pflow-sensor and IexpValve is performed. If the autozero procedure fails, a failure will be displayed and calibration cannot be started. During calibration, gain and offset for the valve characteristics of the expiratory valve will be aligned.	• Expiratory Valve
Adj/Calib > Calibration > **O2 cell (Page No 2346)** Oxygen Sensor Adjustment / Calibration Section 9.14.1.5	The Oxygen Sensor calibration is separated into two parts: • - **Offset** calibration. Calibrates the offset voltage of the amplifier circuit. • - **Gain** calibration. During this 2-min calibration of the Oxygen Sensor, the ventilator delivers an increased oxygen concentration (if oxygen is connected in the high pressure mode) or 21% oxygen (if oxygen is connected in the low pressure mode or disconnected). It tests the Oxygen Sensor and resets the calibration points specific to the Oxygen Sensor in use.	• Oxygen Sensor
Adj/Calib > Calibration > **Flow sensor (Page No 2347)** Patient Flow Sensor Calibration Section 9.14.1.6	This calibration checks and resets the calibration point specific to the Patient Flow Sensor in use. The Patient Flow Sensor is calibrated in both directions.	• Patient Flow Sensor

9.14.1.1 Touch Screen

Allows calibrating the coordinates of the touch controller (4–point calibration).

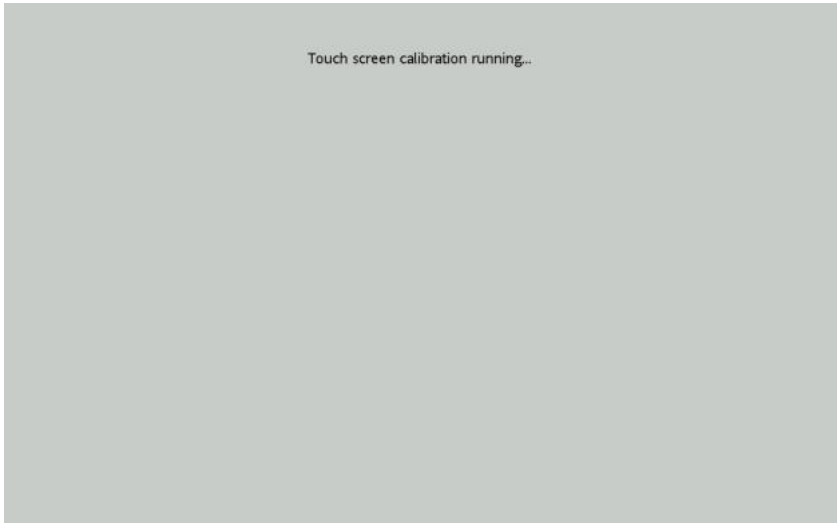
1. Touch the **Touch Screen** Button.

Figure 9-27. Touch screen calibration - step 1



2. Touch the **Start** Button begin the touch screen calibration.
3. The test begins automatically indicated by **Touch screen calibration is running...** displayed on the screen.

Figure 9-28. Touch screen calibration - step 2

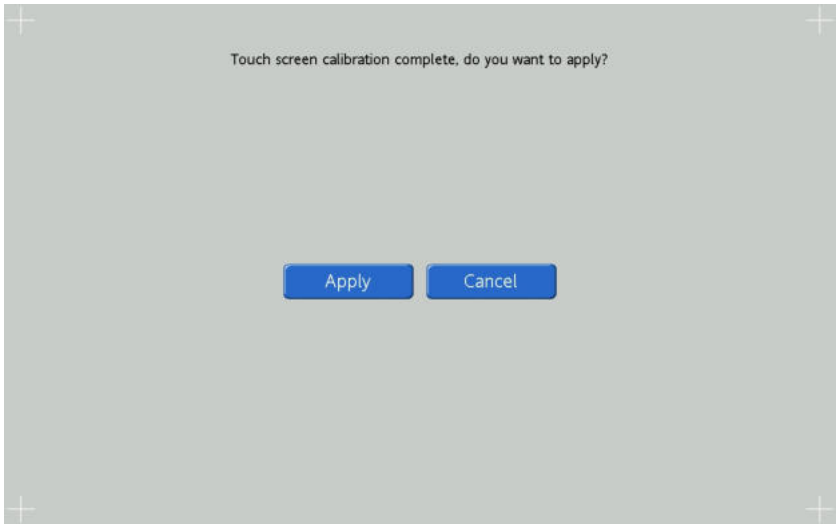


4. You are instructed to touch the cross located on the top left of the screen with your finger.

Figure 9-29. Touch screen calibration - step 3

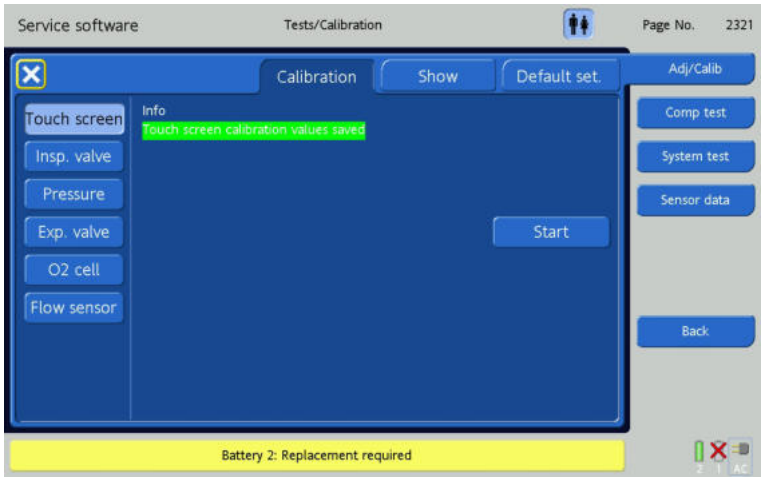
5. Next, you are instructed to touch the cross located on the top right, then the bottom right and then the bottom left of the screen with your finger.
6. Next, you are instructed to touch the **Test** button in the middle of the screen with your finger.
7. The touch screen calibration is complete. Touch **Apply** to accept the new touch screen calibration or **Cancel**.

Figure 9-30. Touch screen calibration - step 4



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

Figure 9-31. Touch screen calibration - step 5



9.14.1.2 Inspiratory valve

Allows aligning the gain and offset for voltage-offset of the Inspiratory valve.

Sets Offset 1 (low pressure) at 20 mbar blower pressure and Offset 2 (high pressure) at 60 mbar blower pressure when required Qvent flow is reached.

NOTICE

– To adjust in small steps use the P&T control knob to set the step width on 5 mV.

– Confirm that the Technical State is updated with the fitted Inspiratory Valve Serial Number AND Revision Number (see the Modify Tab Section 9.8.3). The calibration values depend on software version, but the calibration process is the same.

– Make sure the HAMILTON-C3 cools down before the calibration.

The Inspiratory Valve has a flow-voltage-hysteresis. In other words the valve opening characteristic is different from the valve closing characteristic. The valve needs to be calibrated with either the opening process or the closing process. Based on the design and pressure control mechanism, the Inspiratory Valve is calibrated with the closing characteristic.

The required flow adjustment depends on the Inspiratory Valve revision:

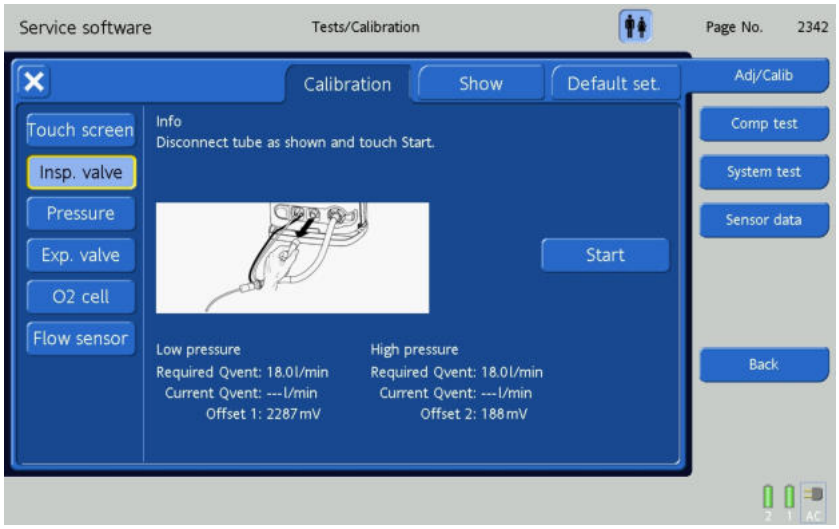
- MSP160230/02 or higher –> 18 l/min (Qvent)

The Technical State needs to contain the correct Inspiratory Valve revision (≥ 02) to ensure proper control function.

Inspiratory Valve Calibration:

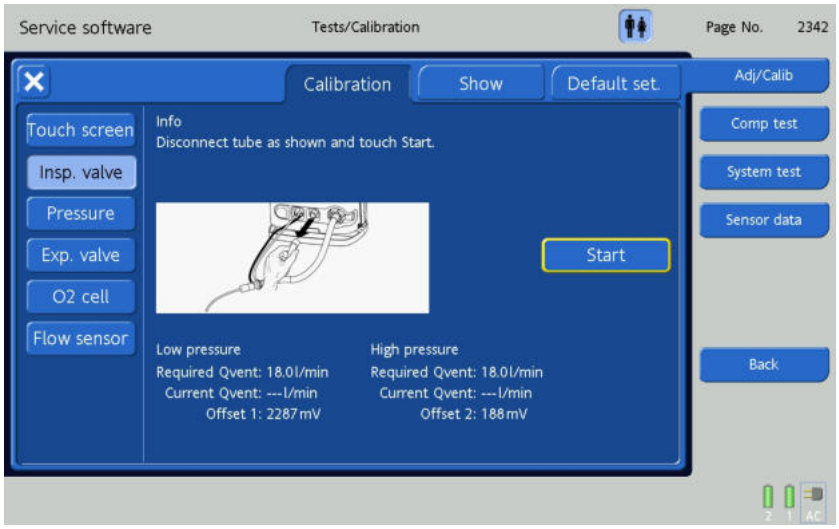
1. Touch the **Insp. Valve** button.
2. Wait approximately ten seconds until the flow has stabilized.

Figure 9-32. Inspiratory Valve Adjustment / Calibration Step 1



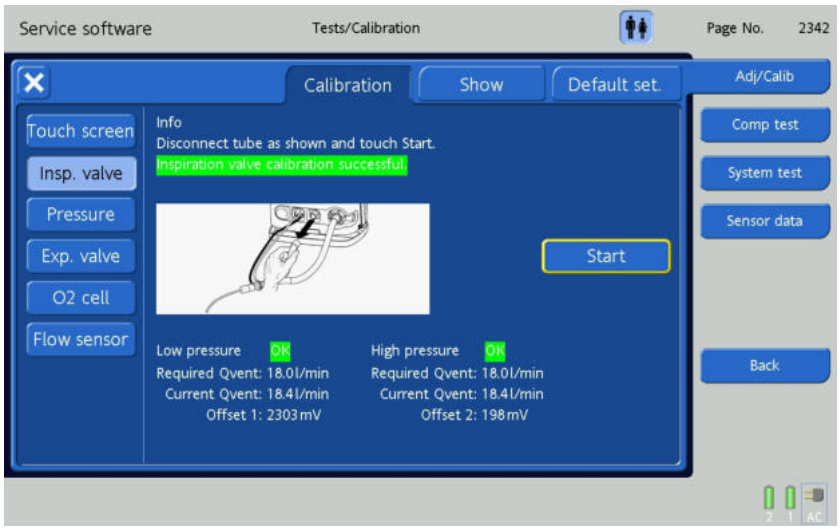
3. Disconnect the inspiration tube as shown.
4. Touch the **Start** button.

Figure 9-33. Inspiratory Valve Adjustment / Calibration Step 2



5. The inspiratory valve calibration is complete indicated by **Inspiration valve calibration successful** displayed on the screen.

Figure 9-34. Inspiratory Valve Adjustment / Calibration Step 3



9.14.1.3 Pressure

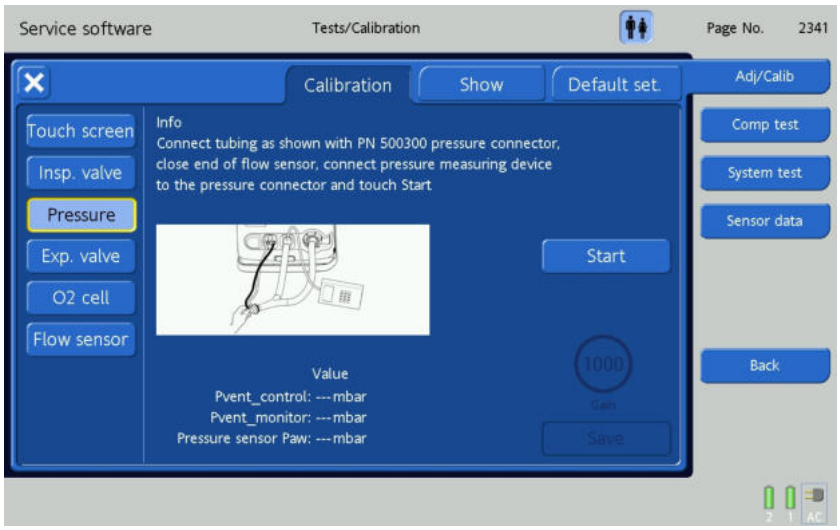
NOTICE

If the test cannot be performed, check the whole setup for leaks. Furthermore, there should be almost no flow from the expiration outlet. If you perform this test more than once, please close, then re-open the pressure calibration window.

Allows adjusting the Pressure Sensor Gain using an external pressure measurement as a reference.

1. Touch the **Pressure** button.

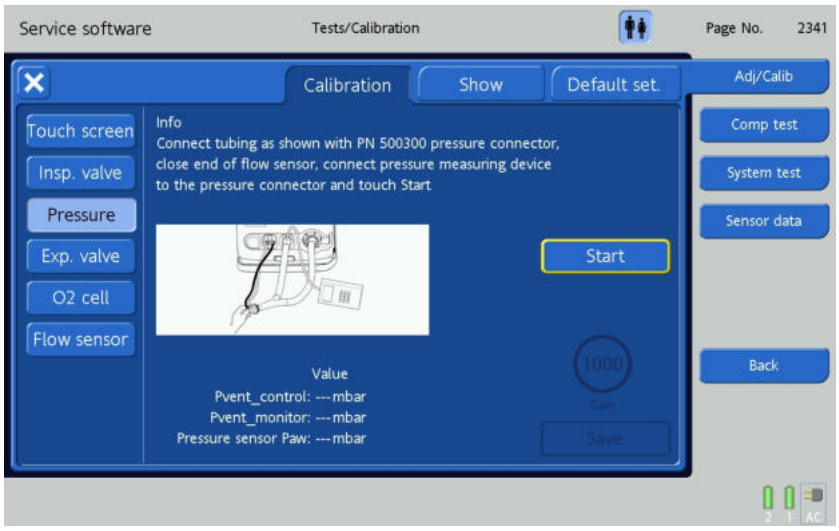
Figure 9-35. Pressure Adjustment / Calibration Step 1



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.

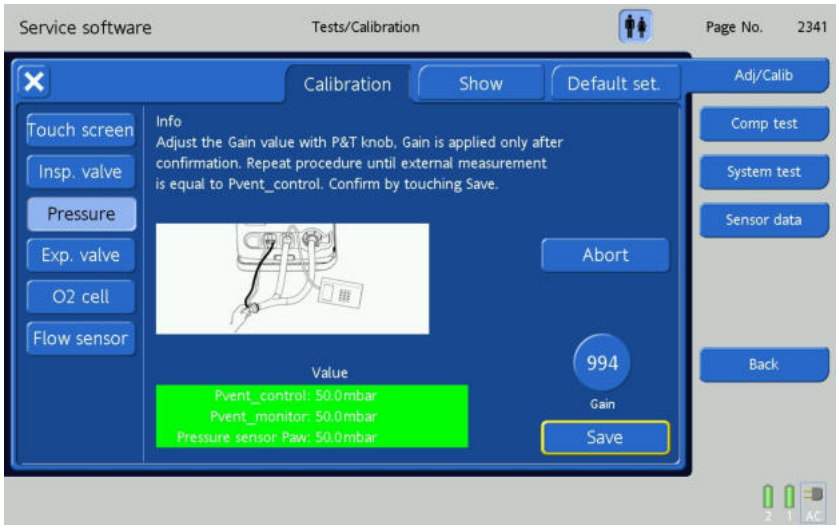
6. Touch the **Start** button.

Figure 9-36. Pressure Adjustment / Calibration Step 2



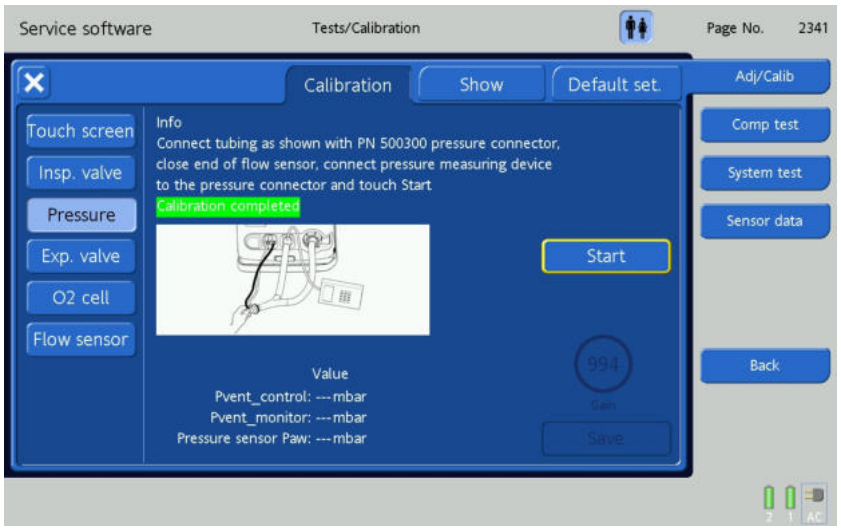
7. As soon as you touch the start button, the ventilator performs an autozero procedure to prevent wrong calibration due to remaining pressure inside the patient breathing circuit.
8. The values on the screen should equal the value on the pressure gauge.
9. If adjustment is necessary, adjust the **Gain** by using the P&T knob. Make the adjustment with the P&T knob, then, press the P&T knob for the change in **Gain** to be applied.

Figure 9-37. Pressure Adjustment / Calibration Step 3



10. After completion, touch the **Save** Button to save the changes.

Figure 9-38. Pressure Adjustment / Calibration Step 4



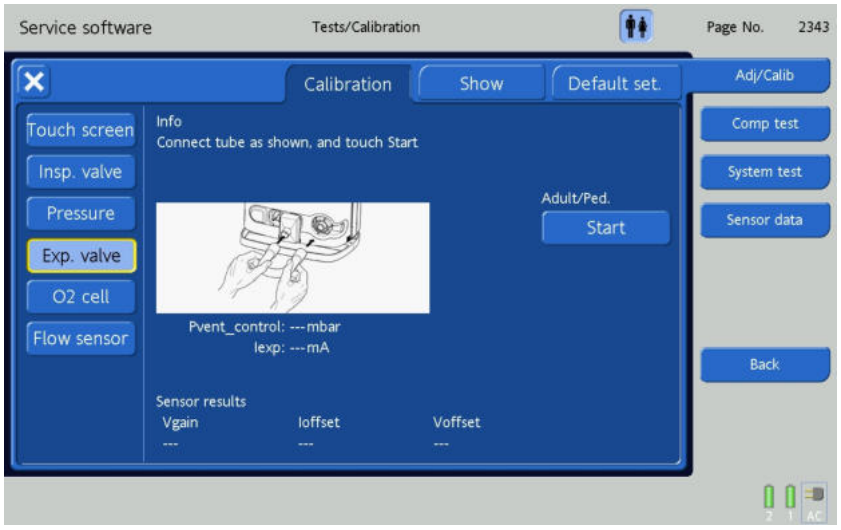
9.14.1.4 Expiratory valve

Before calibration starts, an autozero of Pvent_control, Pvent_monitor, Paw, Pflow-sensor and IexpValve is performed. If the autozero procedure fails, a failure will be displayed and calibration cannot be started.

During calibration, gain and offset for the valve characteristics of the Expiratory Valve will be aligned.

1. Touch the **Exp. valve** Button.

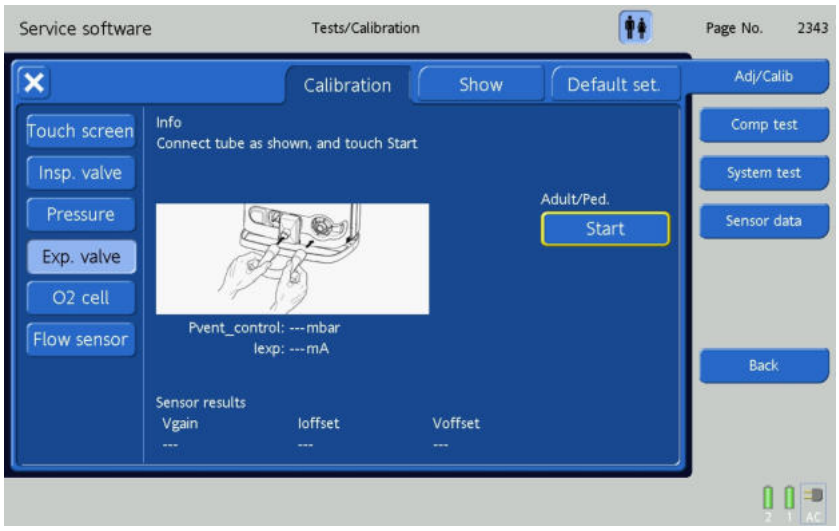
Figure 9-39. Expiratory Valve Adjustment / Calibration Step 1



2. Connect a **30cm** tube with a filter (PN 279204) as shown on the screen.

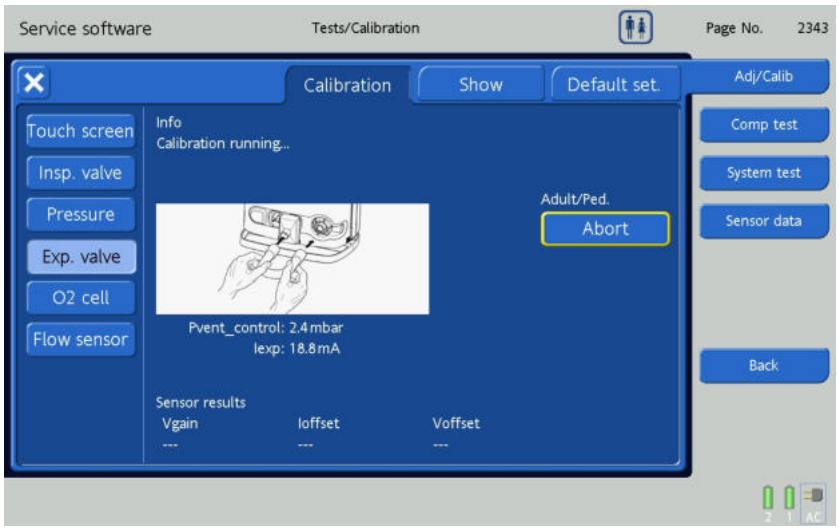
3. Touch the **Start** Button.

Figure 9-40. Expiratory Valve Adjustment / Calibration Step 2



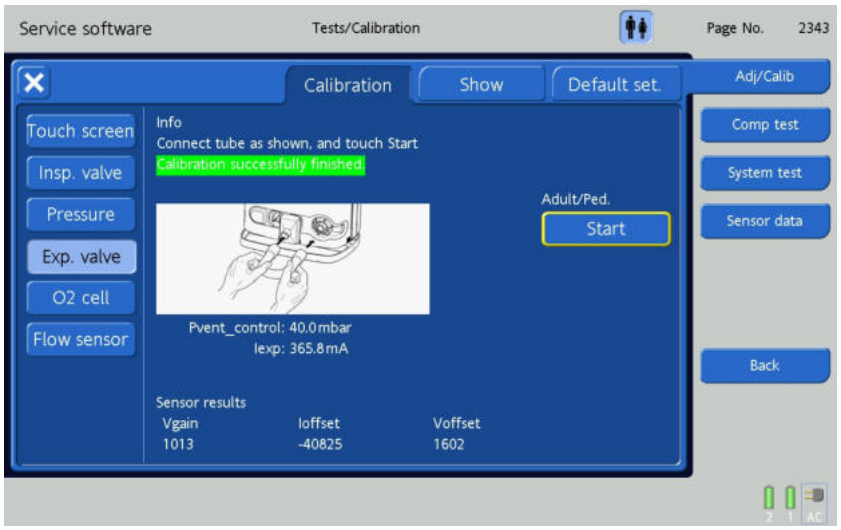
4. The ventilator performs an autozero procedure to prevent wrong calibrations due to remaining pressure inside the limb.
5. The calibration runs automatically indicated by the Pvent_monitor and Iexp. values changing during the calibration process.

Figure 9-41. Expiratory Valve Adjustment / Calibration Step 3



6. The successful finish of the Expiratory Valve is indicated with following message: **Calibration successfully finished**.

Figure 9-42. Expiratory Valve Adjustment / Calibration Step 4



NOTICE

If the test takes more than 3 minutes or if the calibration is not OK, replace the membrane and perform the test again.

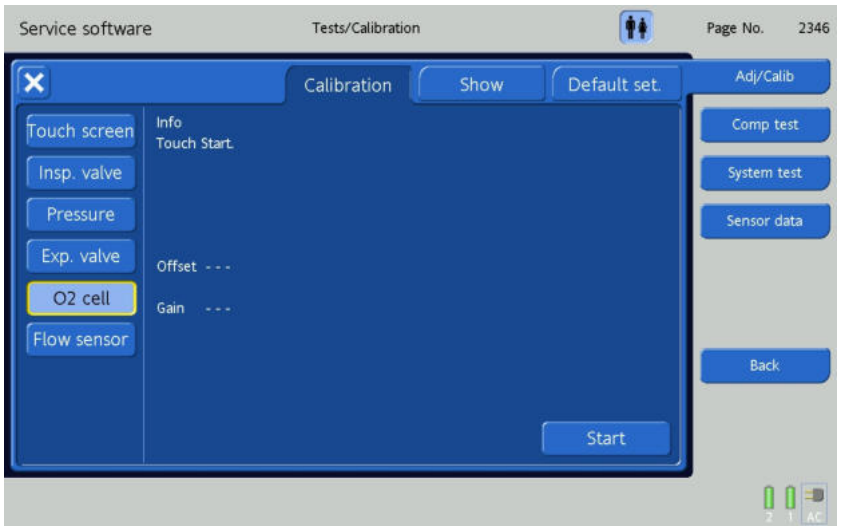
9.14.1.5 O2 sensor

The O2 sensor calibration is separated into two parts:

- **Offset** Calibration. Calibrates the offset voltage of the amplifier circuit.
- **Gain** Calibration. During this 2-min calibration of the O2 sensor, the ventilator delivers an increased oxygen concentration (if oxygen is connected in the high pressure mode) or 21% oxygen (if oxygen is connected in the low pressure mode or disconnected). It tests the Oxygen Sensor and resets the calibration points specific to the O2 sensor in use.

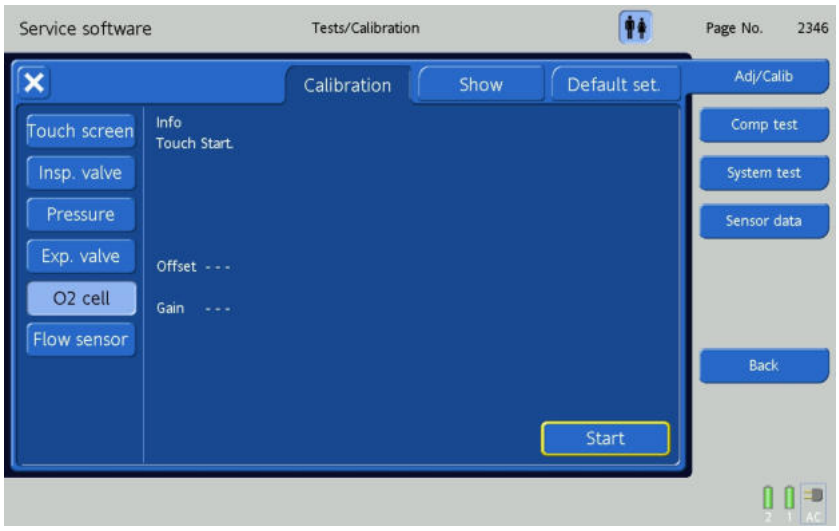
1. Connect the HAMILTON-C3 to high pressure O2 (if available).
2. Touch the **O2 cell** Button.

Figure 9-43. O2 sensor Adjustment / Calibration Step 1



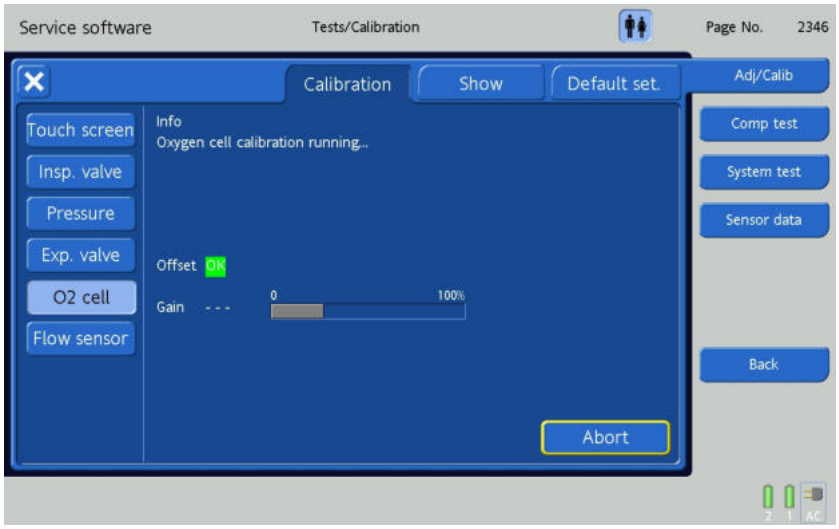
3. Touch the **Start** Button.

Figure 9-44. O2 sensor Adjustment / Calibration Step 2



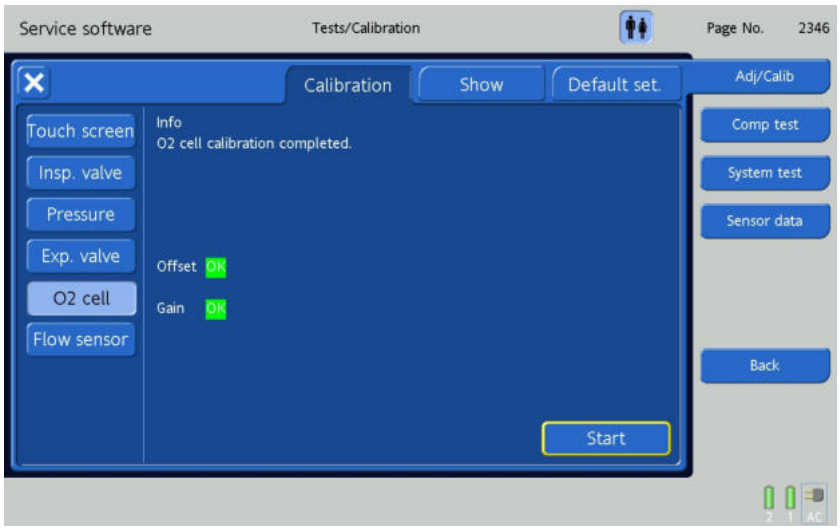
4. The Gain Calibration runs automatically indicated by **Oxygen cell calibration running...** indicated on the screen.

Figure 9-45. O2 sensor Adjustment / Calibration Step 3



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

Figure 9-46. O2 sensor Adjustment / Calibration Step 4



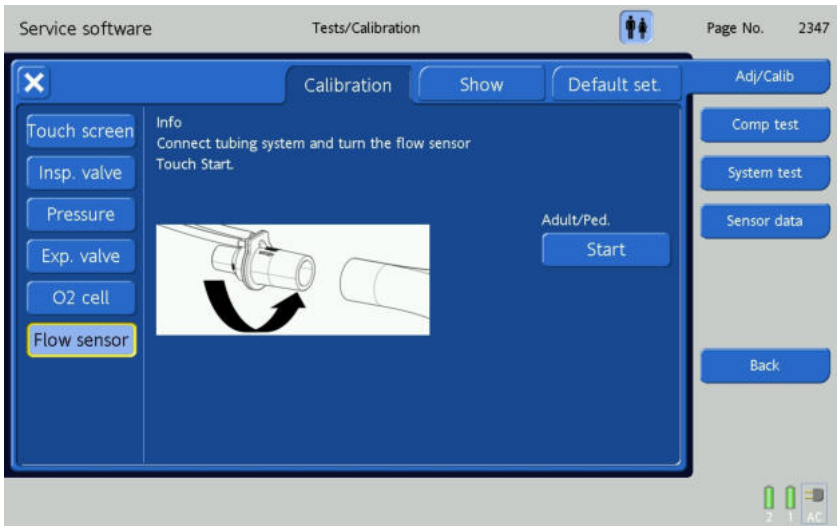
9.14.1.6 Flow sensor

This calibration checks and resets the calibration point specific to the patient flow sensor in use.

The patient flow sensor is calibrated in both directions.

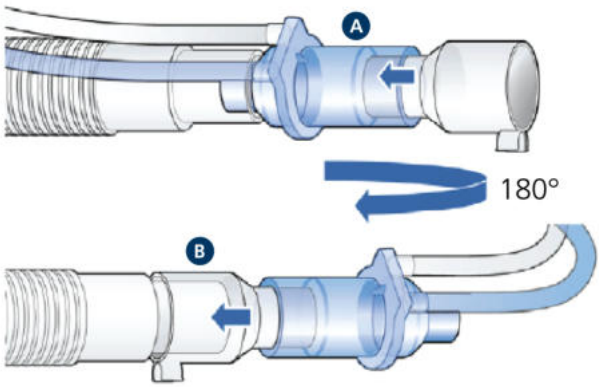
1. Touch the **Flow sensor** button.

Figure 9-47. Patient flow sensor calibration



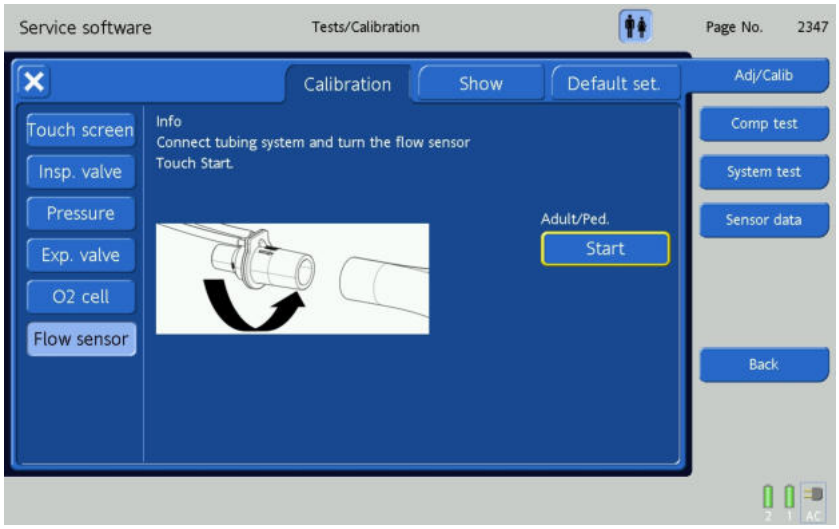
2. Connect the tubing system and turn the Patient Flow Sensor. The Patient Flow Sensor has to be inverted for the Flow Sensor Calibration and an adapter is required.

Figure 9-48. Patient flow sensor calibration setup



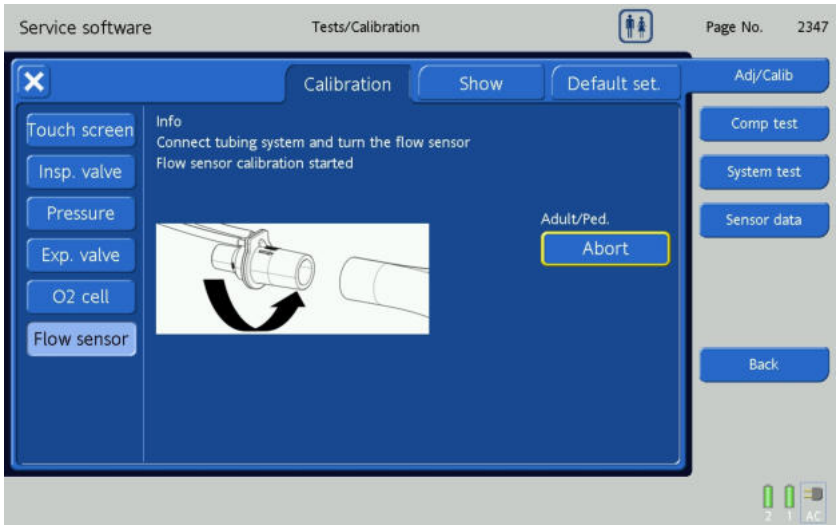
3. Touch the **Start** button.

Figure 9-49. Patient flow sensor adjustment/calibration - step 1



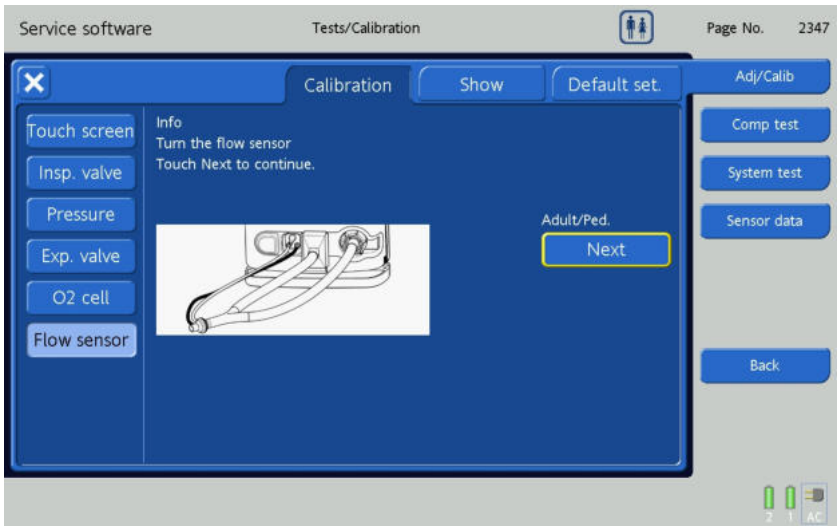
4. The Patient Flow Sensor Calibration is in process.

Figure 9-50. Patient flow sensor adjustment/calibration - step 2



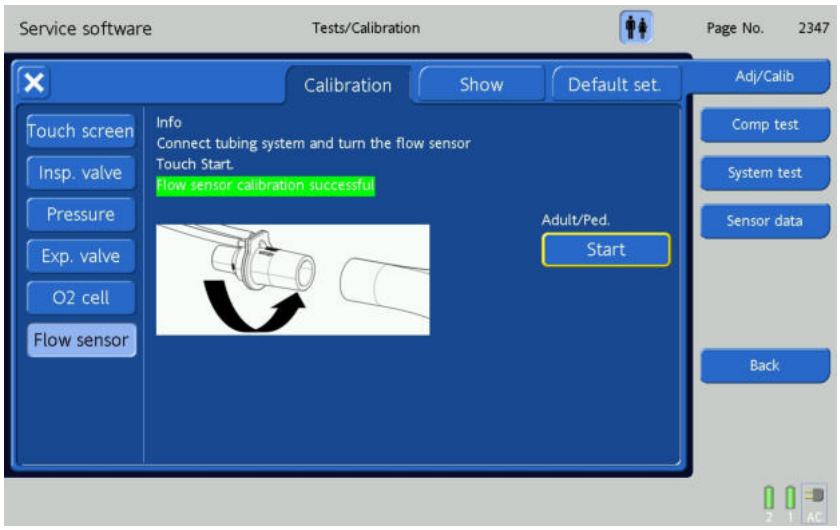
5. Turn the Patient Flow Sensor.
6. Touch the **Next** Button to continue.

Figure 9-51. Patient flow sensor adjustment/calibration - step 3



7. The successful finish of the Patient Flow Sensor Calibration will be indicated with following message: **Flow sensor calibration successful**.

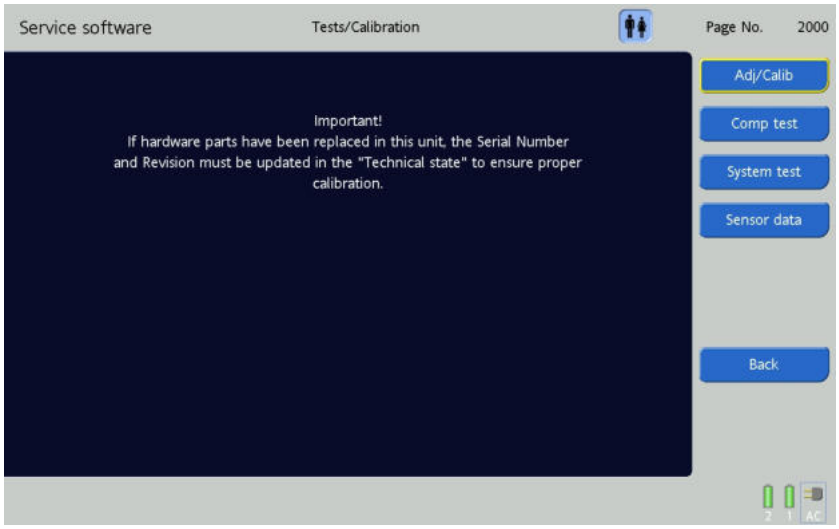
Figure 9-52. Patient flow sensor adjustment/calibration - step 4



9.14.2 Show Tab

1. Touch the **Adjustment/Calibration** Button.

Figure 9-53. Adjustment / Calibration Screen



2. Touch the **Show** Tab.

Figure 9-54. Show Tab

9.14.2.1 Pressure

1. Touch the **Pressure** Button.

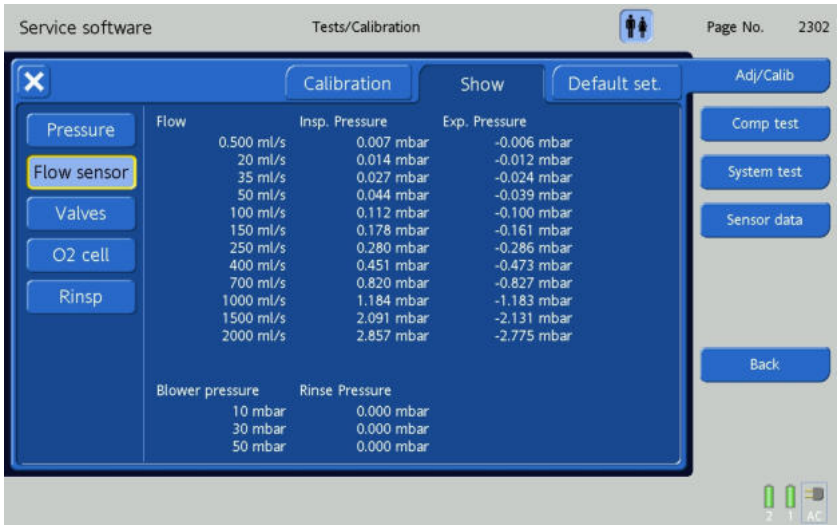
Figure 9-55. Pressure Screen

2. The screen displays the Pvent_control, Pvent_monitor and Paw Pressure Sensors **Offset** and **Gain** values.

9.14.2.2 Flow Sensor

1. Touch the **Flow Sensor** Button.

Figure 9-56. Flow Sensor Screen



2. The screen displays the **Inspiratory Pressure** and **Expiratory Pressure** values at different flows.

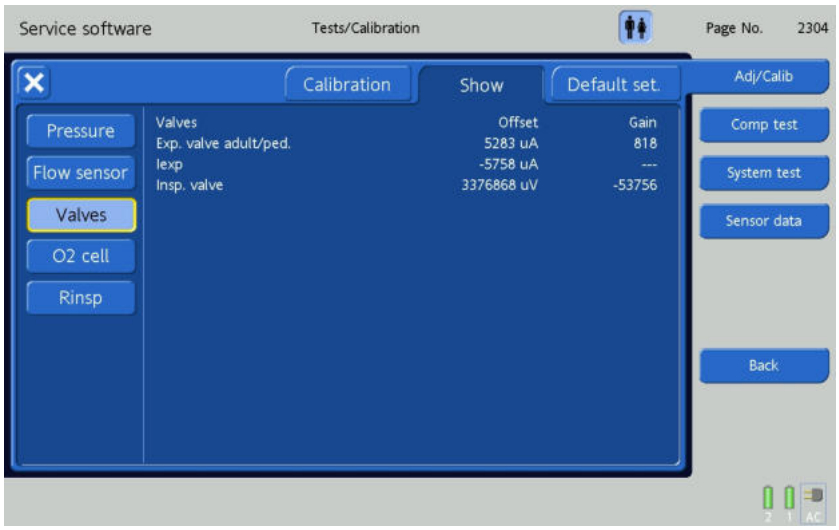
NOTICE

Not required on the HAMILTON-C3 Summary of Test Report.

9.14.2.3 Valves

1. Touch the **Valves** button.

Figure 9-57. Valves Screen

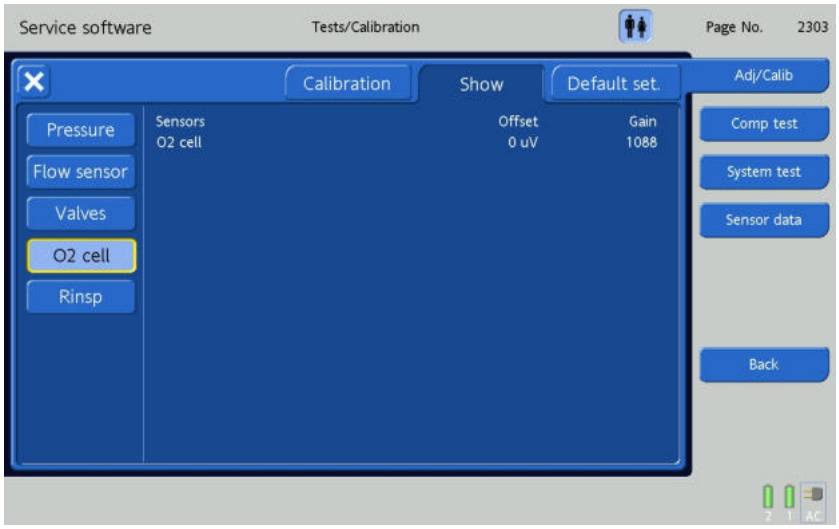


2. The screen displays the expiratory valve **Offset** and **Gain** values

9.14.2.4 Oxygen Sensor

1. Touch the **O2 Cell** Button.

Figure 9-58. Oxygen Sensor Screen

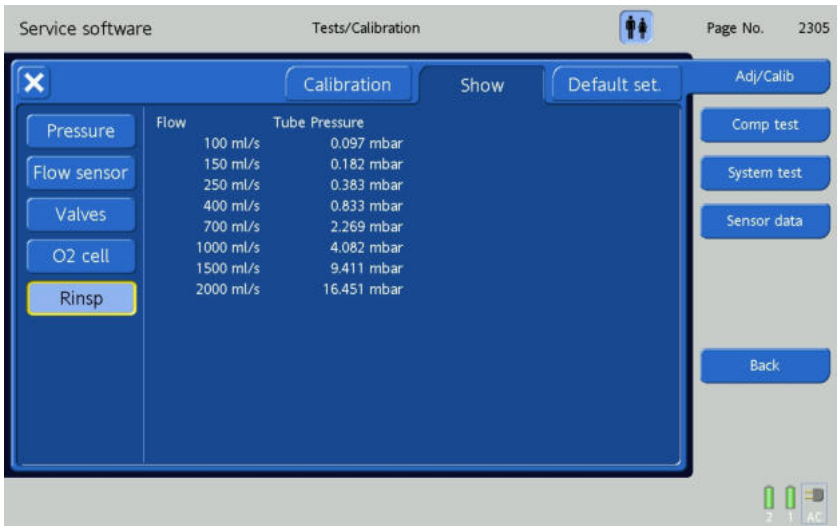


2. The screen displays the Oxygen Sensor **Offset** and **Gain** values.

9.14.2.5 Rinsp

1. Touch the **Rinsp** button.

Figure 9-59. Rinsp screen



2. The screen displays the **Inspiratory Resistance** values.

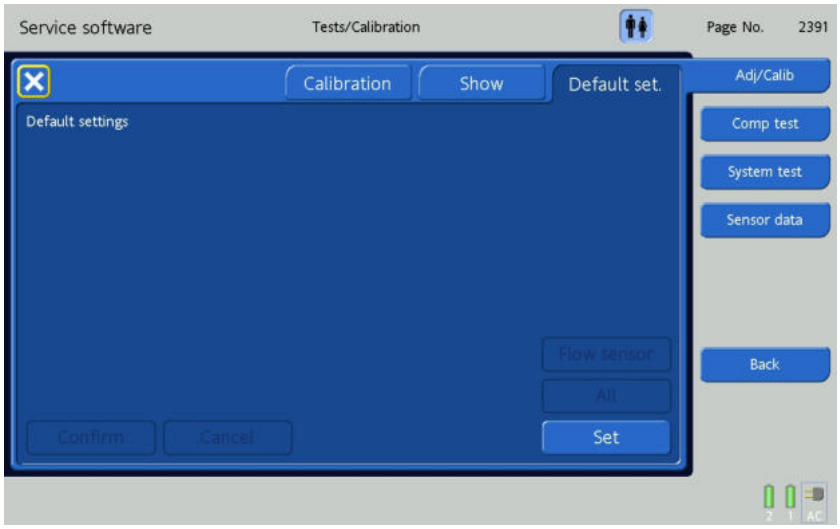
9.14.3 Default settings tab

⚠ CAUTION

*If calibration is not possible due to a corrupt calibration file, touch the **Default set.** Tab. Therefore, all steps of the service software have to be run again.*

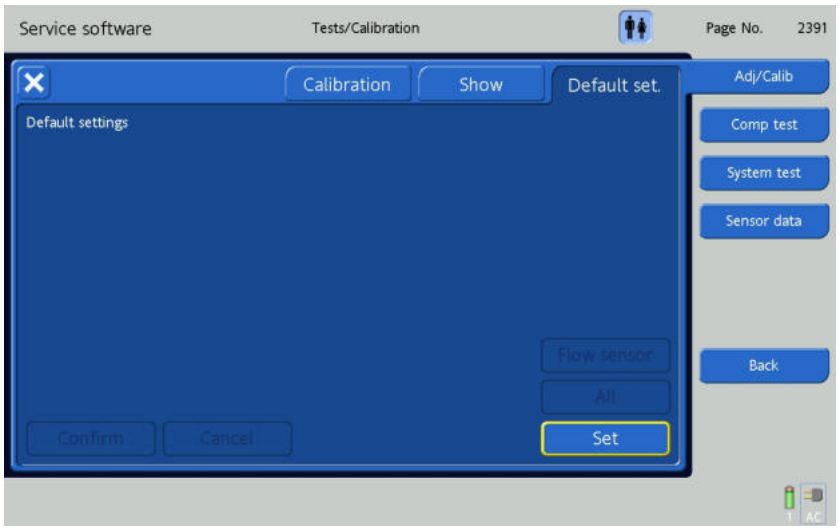
1. Touch the **Default Settings** tab.
2. The **Default set.** tab provides a method to reset or set the values to a pre-determined default setting. You can choose between setting the default values of only the **Flow Sensor** or of **All** settings.

Figure 9-60. Default settings tab



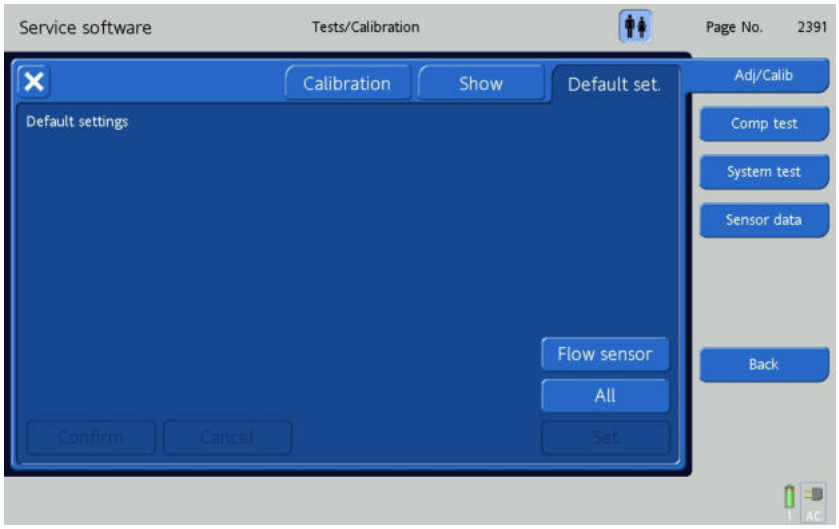
3. To reset the values, touch the **Set** button.

Figure 9-61. Default settings reset - step 1



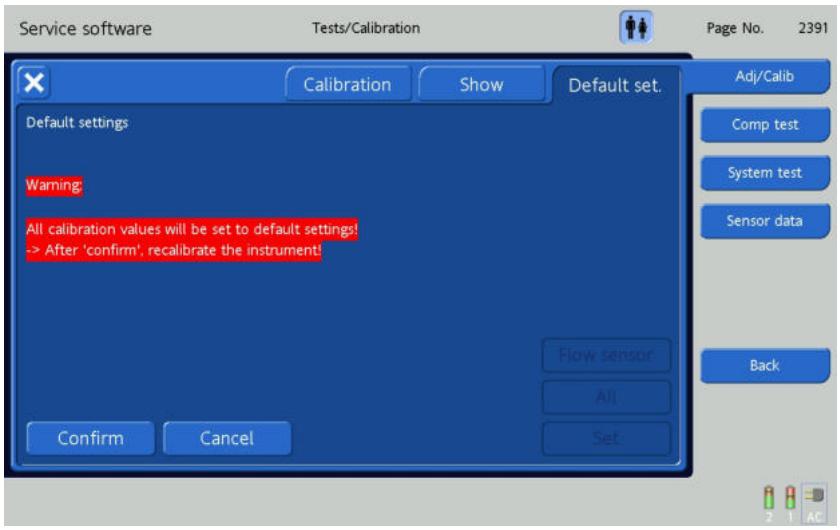
4. When the **Set** button is touched, choose between **Flow Sensor** or **All** settings.

Figure 9-62. Default settings reset - step 2



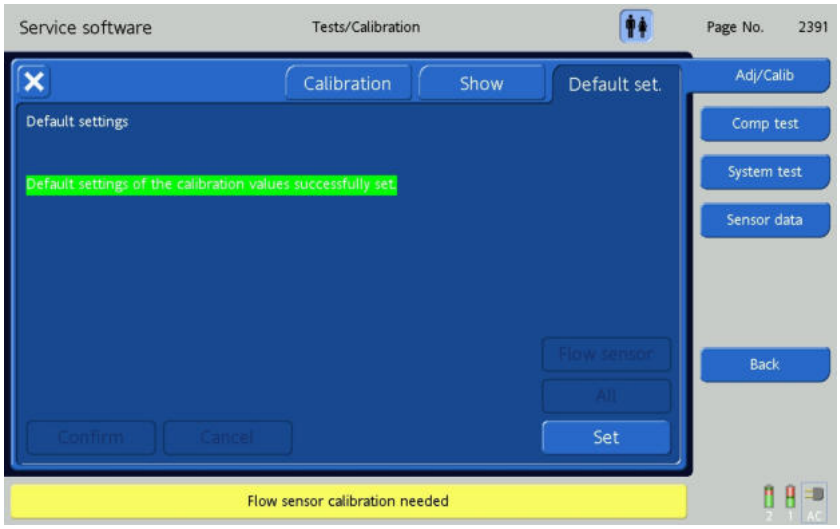
5. If you choose **All** settings, a warning is displayed.

Figure 9-63. Default settings reset - step 3



6. You must touch the **Confirm** button to reset to the **Default Settings**.

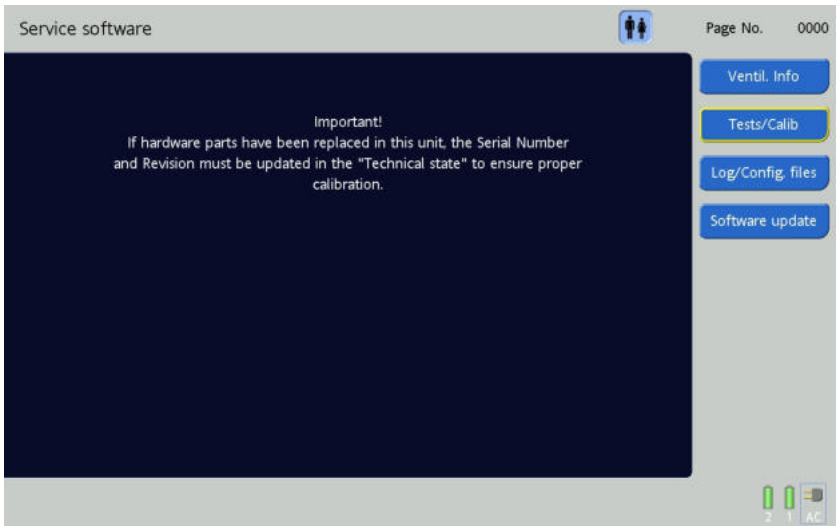
Figure 9-64. Default settings reset - step 4



9.15 Component tests

1. From the main service software screen, touch the **Tests / Calibration** button.

Figure 9-65. Main service software screen



2. Touch the **Comp test** button.

Figure 9-66. Component tests screen

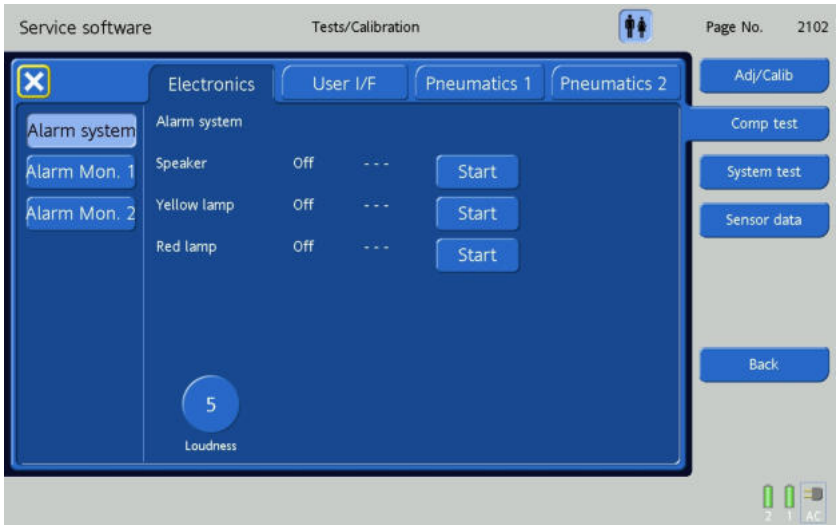


Table 9-6. Electronics tab

Component tests	Description	Component tested
Adj/Calib > Calibration > Comp test > **Alarm System (Page No 2102)** See Section 9.15.1.1	This test allows activating the components related to the alarm system, it also tests the loudness levels. The test result needs to be confirmed manually.	• Touch screen • Alarm lamp lights red or yellow, depending
Adj/Calib > Calibration > Comp test >**Alarm Monitor 1 (Page No 2113)** See Section 9.15.1.2	**(Steps 1 — 10)** These tests diagnose the alarm monitoring system components. **(Steps 11 — 13)** Testing the ambient state. The HAMILTON-C3 ventilator will be switched to ambient state causing all valves to switch to their unpowered position. The ambient state has activated the alarm silence LED and the buzzer. The test result needs to be confirmed manually. **(Step 14 — 17)** This test checks the alarm in case of fan failure. It requires stopping the fan.	• Alarm silence button and LED • Ambient state • Buzzer • Fan • Inspiratory valve • Ambient valve
Adj/Calib > Calibration > **Alarm Monitor 2 (Page No 2114)** See Section 9.15.1.3	This test activates the software watchdog. The test result has to be confirmed manually. Afterwards the ventilator needs to be restarted.	• Watchdog (software tasks)

Table 9-7. User interface tab

Component tests	Description	Component tested
Adj/Calib > Calibration > **User Interface Tab (Page No 2115)** See Section 9.15.2	With this test, the User Interface related components can be activated in order to check the interaction of the hard keys with the GUI. Hard key combination can also be tested. Dimming the screen and alarm lamp is tested using the day/night button. The P&T knob has 16 steps. The test is to see that all 16 steps register with the ventilator.	• P&T knob • Hard keys + LED's • Backlight (day/night brightness)

Table 9-8. Pneumatics 1 tab

Component Tests	Description	Component Tested
Adj/Calib > Calibration > **Binary Valve (Page No 2106)** See Section 9.15.3.1	This test checks the Autozero Valves during operation and autozeroing sequence. A constant pressure is applied. Both status, "running" and"autozero",are tested for the following valves: Pvent_monitor, PFlowsensor.	• Autozero Valves • Pvent_monitor Pflowsensor
Adj/Calib > Calibration > **Autozero (Page No 2109)** See Section 9.15.3.2	The test repeats the Autozero sequence five times under a defined pressure.	Autozero of: • Paw Pressure Sensor • Qaw Proximal Flow Sensor • Pvent_monitor • Pvent_control
Adj/Calib > Calibration > **Blower Flow (Page No 2104)** See Section 9.15.3.3	Several flows (ml/s) will be set as target to the blower module. The achieved blower flow (ml/second) must be within the defined tolerance.	• Blower module
Adj/Calib > Calibration > **Blower Pressure (Page No 2105)** See Section 9.15.3.4	Several pressures are set as target to the blower module. The achieved pressure measured by the Pvent_monitor Pressure Sensor should be within the given tolerance.	• Blower module

Component Tests	Description	Component Tested
Adj/Calib > Calibration > **Expiratory Valve (Page No 2111)** See Section 9.15.3.5	This test checks the expiratory valve. Several pressures are set as target for a constant flow Qinsp to the blower module. The pressures are measured by Paw and have to be within the defined tolerance	• Expiratory Valve
Adj/Calib > Calibration > **Inspiratory Valve (Page No 2107)** See Section 9.15.3.6	This test checks the Inspiratory Valve tightness and flow control with Qinsp 0, 3, 18 and 150 l/min as well as pressure measurement Pvent_monitor with Pinsp of 2, 10, 25 and 40 mbar.	• Inspiratory Valve

Table 9-9. Pneumatics 2 tab

Component Tests	Description	Component Tested
Adj/Calib > Calibration > **O2 Input (Page No 2112)** Section 9.15.4.1	For this test the ventilator needs to be connected to high pressure oxygen. Several flows will be set as a target for the O2 Mixer Valve. The oxygen flow is measured by the internal QO2 Flow Sensor and has to be within a certain tolerance. In a second test the leakage is tested.	• O2 Mixer Assembly
Adj/Calib > Calibration > **Nebulizer Valve (Page No 2116)** See Section 9.15.4.2	For this test the ventilator needs to be connected to high pressure oxygen. The Patient Flow Sensor is used to measure the generated flow when the Nebulizer Valve is in a closed or opened state. The test results successfully if the measured Qaw matches to the defined tolerances.	• Nebulizer Valve
Adj/Calib > Calibration > **Ambient Valve (Page No 2108)** See Section 9.15.4.3	This test checks the Ambient Valve with a blower pressure of 20 and 60 mbar in off, closed and active opened state. The result is measured with Pvent_monitor Pressure Sensor.	• Ambient Valve
Adj/Calib > Calibration > **Proximal Flow (Page No 2110)** See Section 9.15.4.4	This test consists of three parts: **- Rinse Flow Test:** This test requires checking the rinse flow manually by immersing the 2 flow tubes in a glass of water as depicted. The number of bubbles has to be approximately equal on each outlet. **- Proximal Pressure:** This test allows checking the proximal pressure of the patient flow sensor. Two different pressures are applied consecutively by the blower module. The achieved pressure is measured by the Paw pressure sensor and has to be within the tolerance. **- Proximal Flow:** A certain flow is set as target to the blower module, controlled by the internal Qvent flow sensor. The flow through the proximal side of the patient flow sensor is measured by the internal differential Qaw proximal flow sensor and has to be within a certain tolerance.	• Rinse Flow • Paw Pressure Sensor • Qaw Proximal Flow Sensor
Adj/Calib > Calibration > **Air Entry (Page No 2117)** See Section 9.15.4.5	This test allows checking the Pfilter Pressure Sensor with and without an obstructed filter.	• HEPA Filter • Pfilter Pressure Sensor

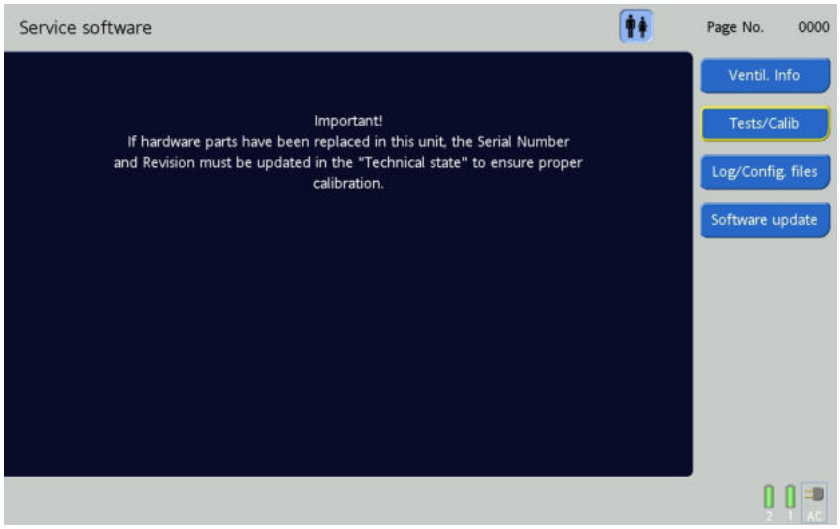
9.15.1 Electronics Tab

NOTICE

This loudness setting also sets the loudness for the System Test, Alarming. To check the alarm sound on High-, Medium-, Low-Priority Alarms with the loudness range 1–10, set the loudness here, then perform the System Test, Alarming (see Alarming Section 9.16.5).

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

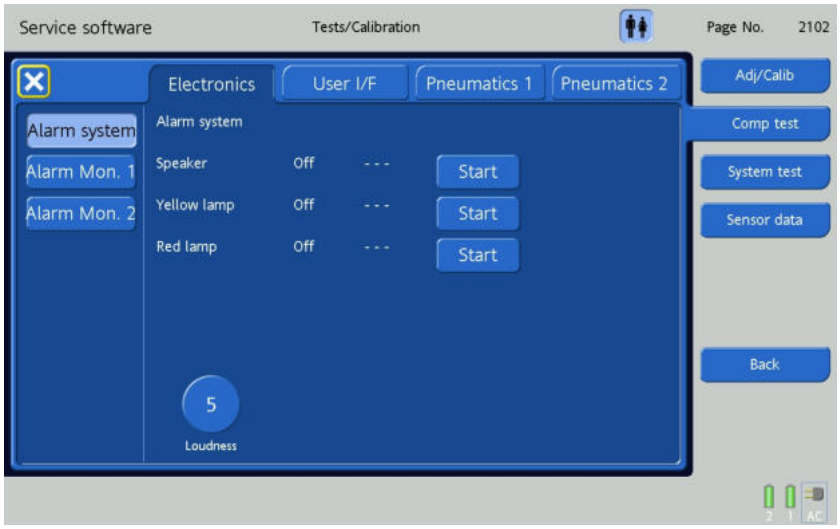
Figure 9-67. Main Service Software Screen



2. Touch the **Comp test** Button.

3. Touch the **Electronics** Tab.

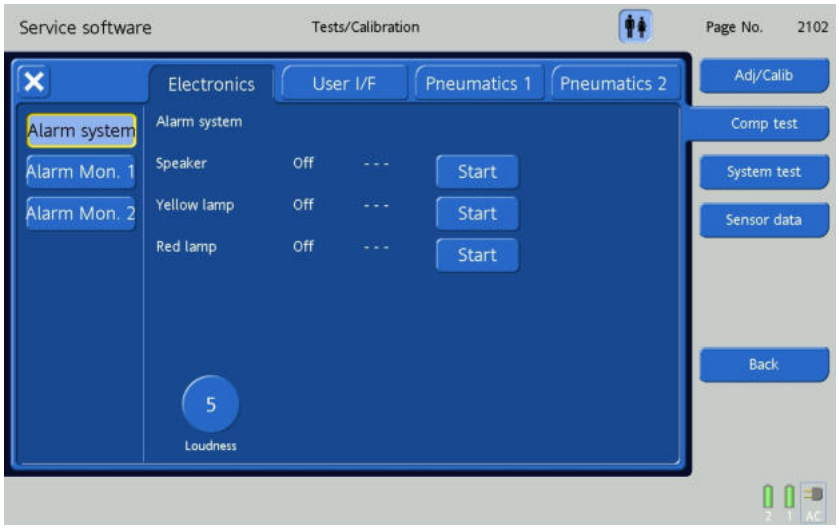
Figure 9-68. Electronics Tab Screen



9.15.1.1 Alarm system

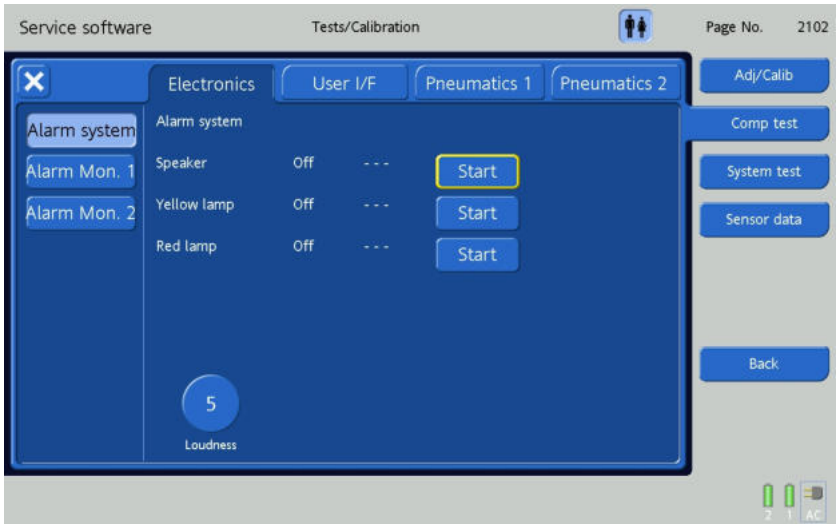
1. This test allows activating the components related to the alarm system, it also tests the loudness levels. The test result needs to be confirmed manually.
2. Touch the **Alarm System** button.

Figure 9-69. Alarm system tests - step 1



3. Touch the **Speaker Start** button.

Figure 9-70. Alarm system tests - step 2



4. Observe that the speaker makes an audible sound.
5. The speaker volume can be adjusted with the screen adjustment knob. Check that the volume changes to minimum and maximum.

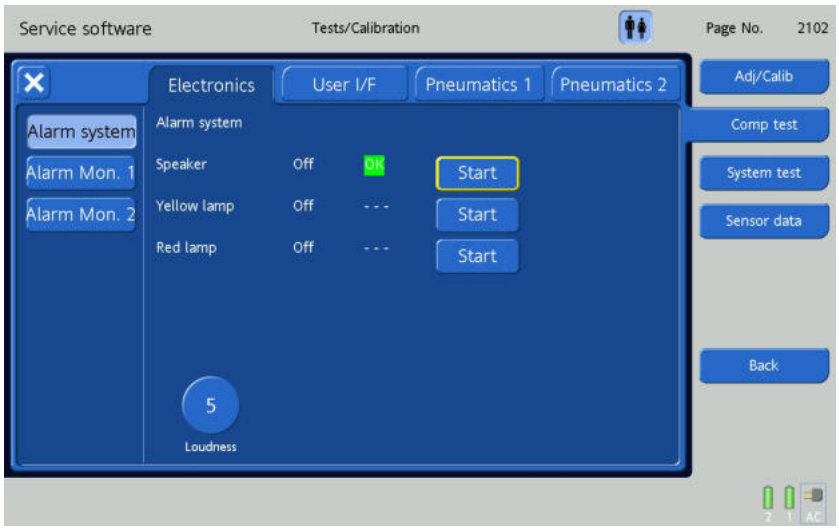
Figure 9-71. Alarm system tests - step 3

6. Indicate on the screen if the speaker is operating properly by pressing **OK** or **NOT OK**.

Figure 9-72. Alarm system tests - step 4

7. When the **OK** Button is touched, the speaker will switch OFF, the **Speaker Start** Button switches to **Start** and **OK** is indicated on the screen.

Figure 9-73. Alarm system tests - step 5

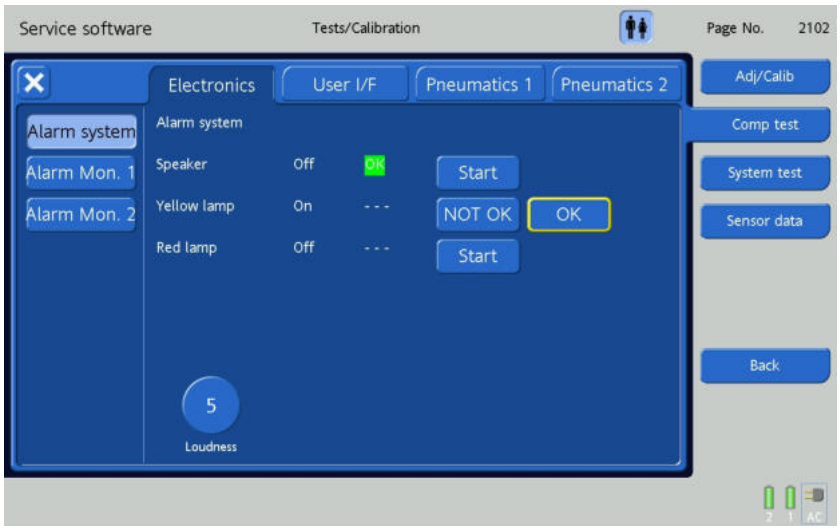


8. Touch the **Yellow Lamp Start** button.

Figure 9-74. Alarm system tests - step 6

9. Observe that the yellow lamp is switched **ON**.
10. Indicate on the screen if the yellow lamp is operating properly by pressing **OK** or **NOT OK**.

Figure 9-75. Alarm system tests - step 7

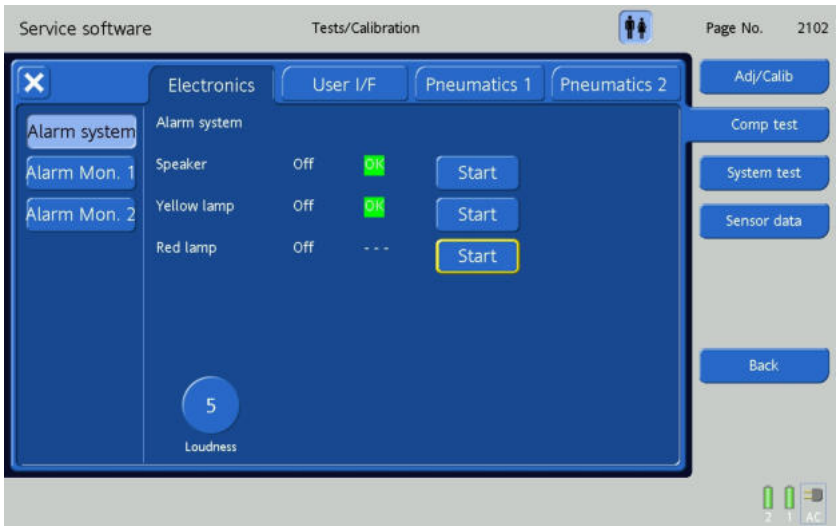


11. When the **OK** Button is touched, the Yellow Lamp with switch **OFF**, the **Yellow Lamp Start** Button will switch to **Start** and **OK** will be indicated on the screen.

Figure 9-76. Alarm system tests - step 8

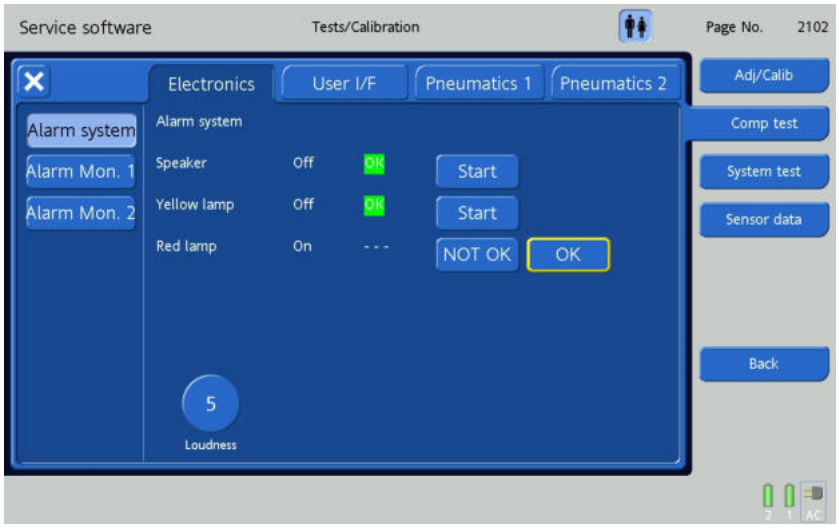
12. Touch the **Red Lamp Start** button.

Figure 9-77. Alarm system tests - step 9



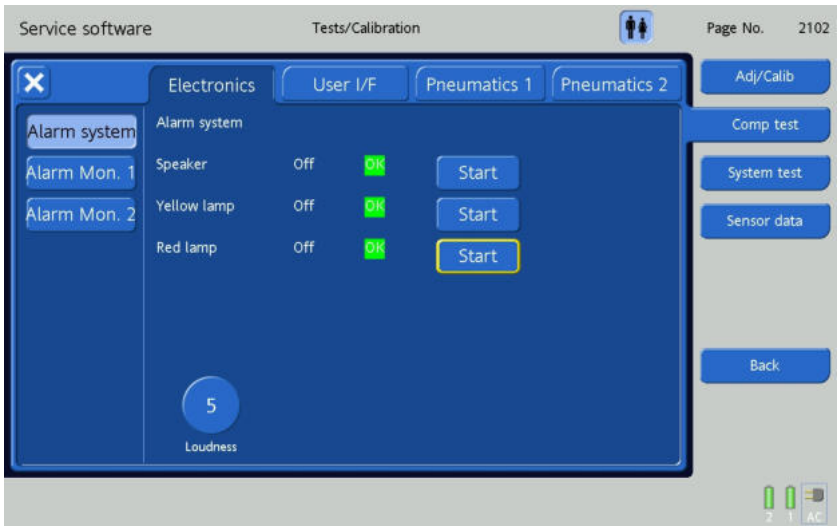
13. Observe that the red lamp is switched **ON**.
14. Indicate on the screen if the red lamp is operating properly by pressing **OK** or **Not OK**.

Figure 9-78. Alarm system tests - step 10



15. When the **OK** Button is touched, the Red Lamp will switch **OFF**, the **Red Lamp Start** Button will switch to **Start** and **OK** is indicated on the screen.

Figure 9-79. Alarm system tests - step 11



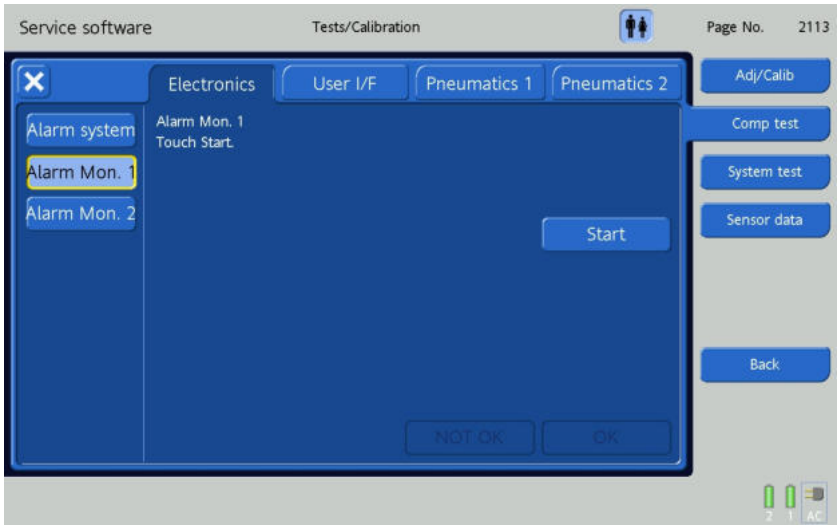
16. After completion of the Alarm System Tests, the results are indicated on the screen.

9.15.1.2 Alarm monitor 1

- **Procedure Steps 1 — 10**
  - These tests diagnose the alarm monitoring system components.
- **Procedure Steps 11 — 13**
  - Testing the Ambient State. The HAMILTON-C3 will be switched to ambient state causing all valves to switch to their unpowered position.
  - The Ambient State will activate the Alarm Silence LED and the buzzer. The test result needs to be confirmed manually.
- **Procedure Steps 14 — 17**
  - This test checks the alarm in case of fan failure. It requires stopping the fan.

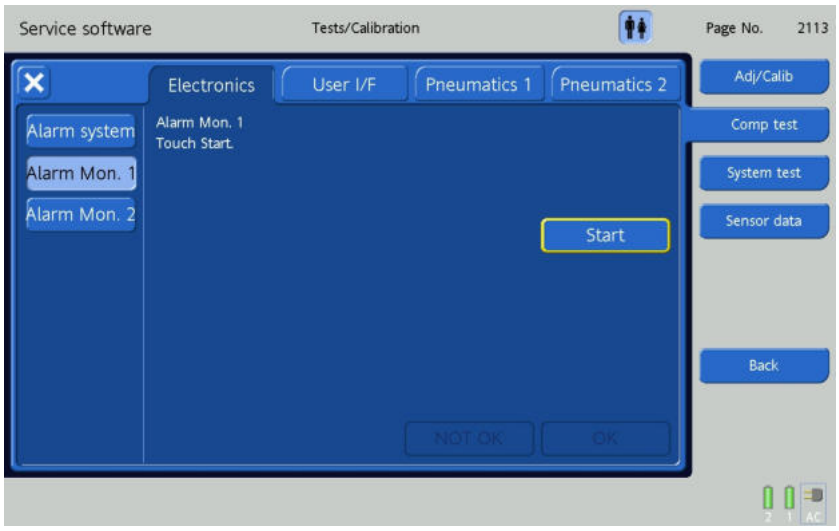
1. Touch the **Alarm Mon. 1** button.

Figure 9-80. Alarm monitor 1 screen



2. Touch the **Start** button.

Figure 9-81. Alarm Monitor 1 tests start



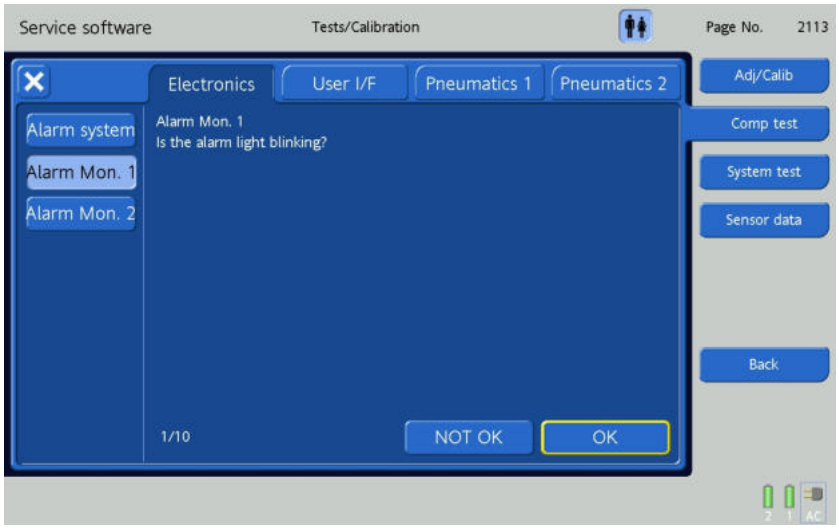
3. Indicate on the screen if the alarm light and the alarm silence LED are **blinking** by pressing **OK** or **NOT OK**.

NOTICE

Depending on the revision of the installed Front Panel Board this part of the test runs different:

- If the installed Front Panel Board is rev. 00, the Alarm Light and the Alarm Silence LED will **blink** during this test.
- If the installed Front Panel Board is rev. 01, only the Alarm Silence LED will **blink** during this test.

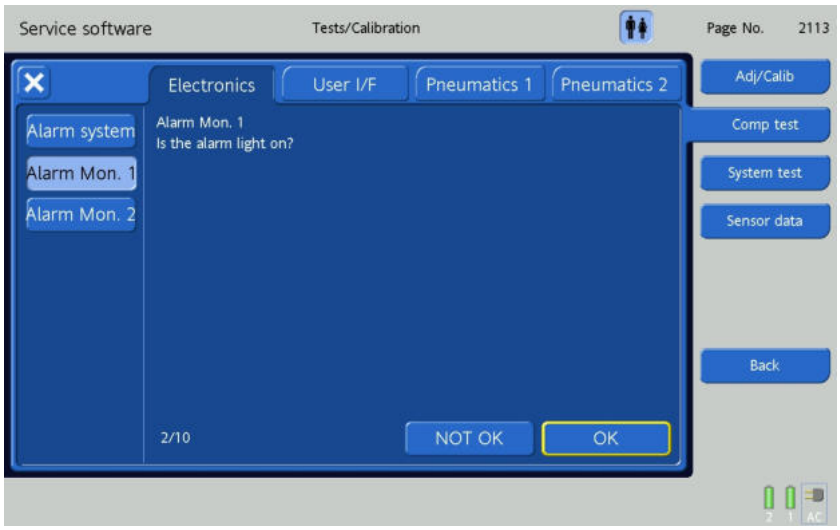
Figure 9-82. Alarm monitor 1 tests - step 1



4. Record the results in HAMILTON-C3 Test Report. See Section 17.2.

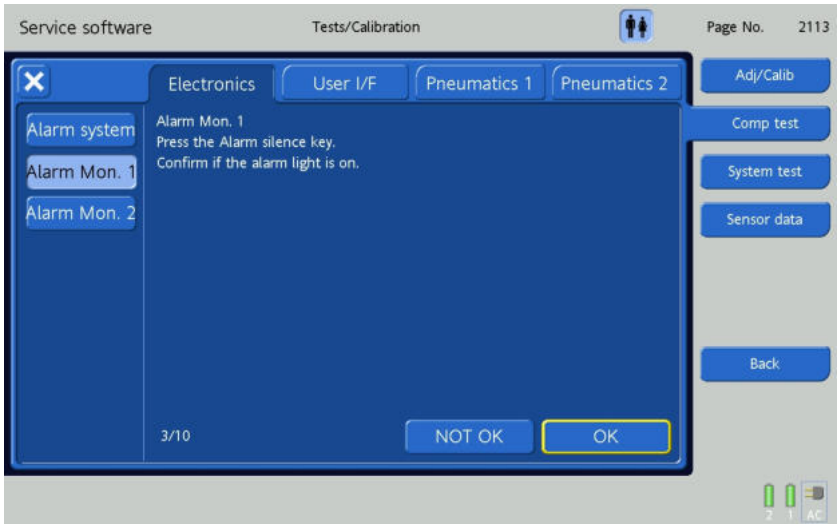
5. Indicate on the screen if the alarm light and the alarm silence LED are **ON** by pressing **OK** or **NOT OK**.

Figure 9-83. Alarm monitor 1 tests - step 2



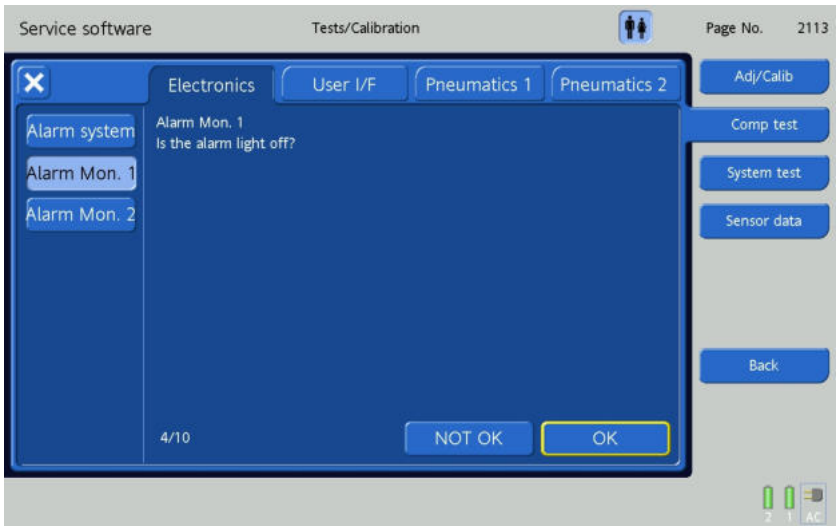
6. Next, touch the **Alarm Silence** Button.
7. Indicate on the screen if the alarm light is **ON** by pressing **OK** or **NOT OK**.

Figure 9-84. Alarm monitor 1 tests - step 3



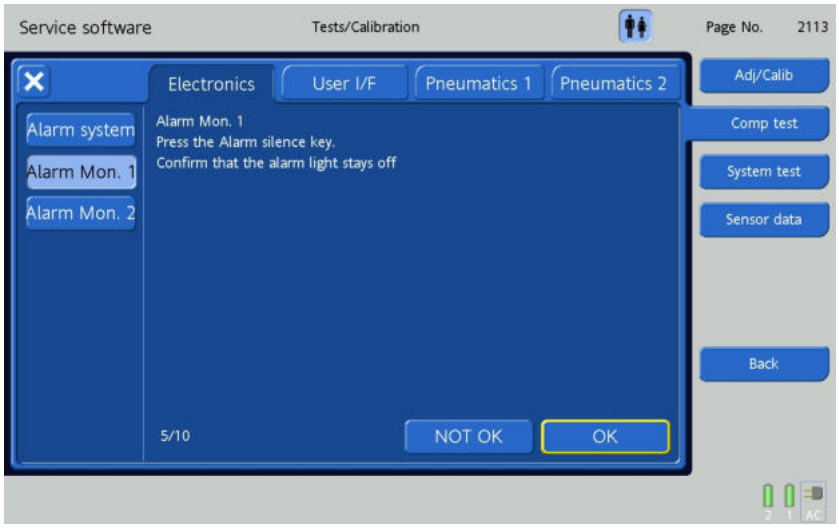
8. Next, indicate on the screen if the Alarm Light is **OFF** by pressing **OK** or **NOT OK**.

Figure 9-85. Alarm monitor 1 tests - step 4



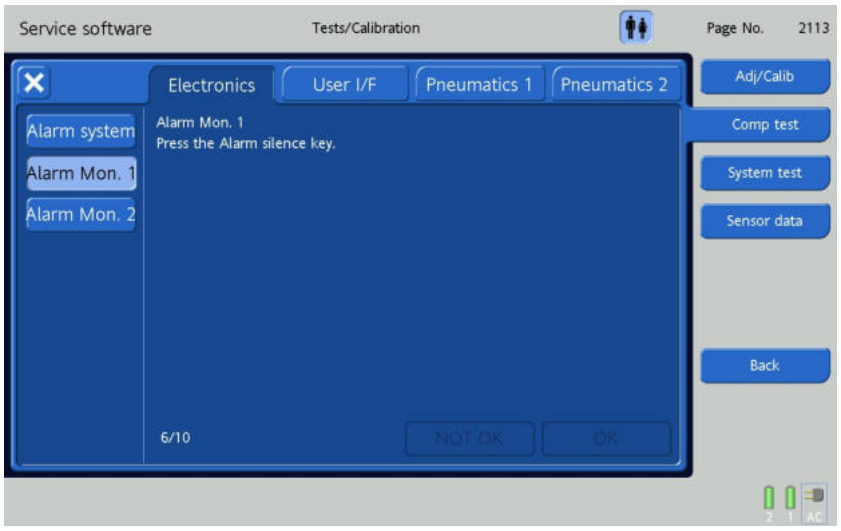
9. Next, touch the **Alarm Silence** Button.
10. Indicate on the screen if the alarm light is **OFF** by pressing **OK** or **NOT OK**.

Figure 9-86. Alarm monitor 1 tests - step 5



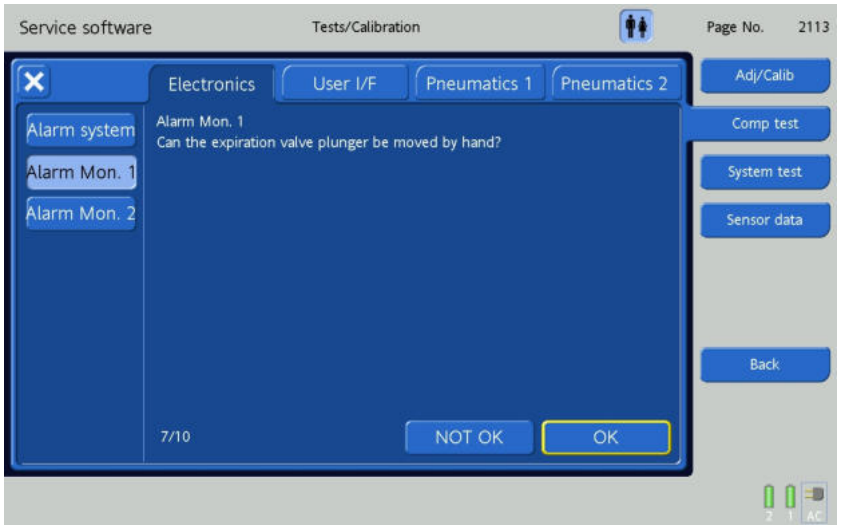
11. Touch the **Alarm Silence** Button and wait 5 seconds.

Figure 9-87. Alarm monitor 1 tests - step 6



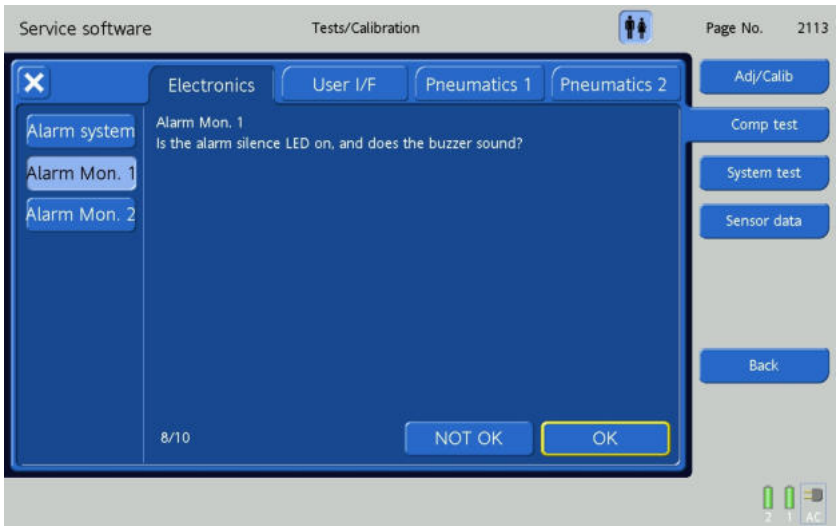
12. Indicate on the screen if the Expiratory Valve Plunger can be moved by hand by pressing **OK** or **NOT OK**.

Figure 9-88. Alarm monitor 1 tests - step 7



13. Indicate on the screen if the Alarm Silence LED is **ON** and the Buzzer sounds by pressing **OK** or **NOT OK**.

Figure 9-89. Alarm monitor 1 tests - step 8

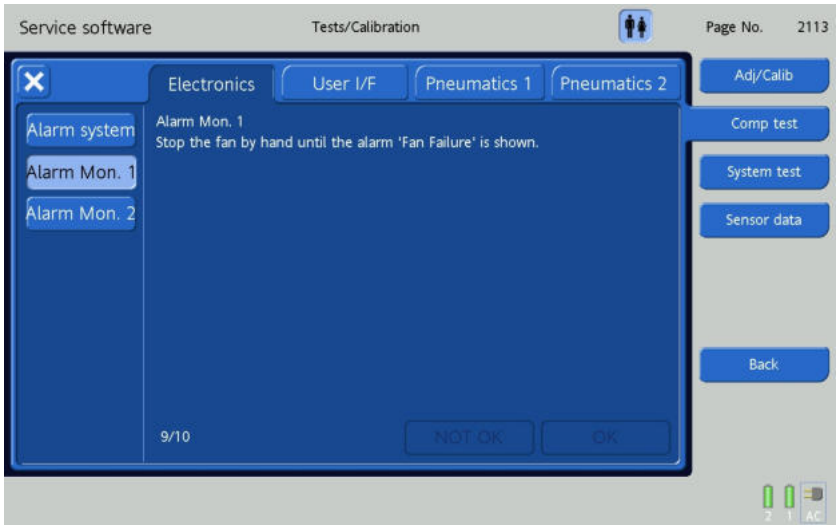


⚠ WARNING

Be careful when stopping the cooling fan by hand.

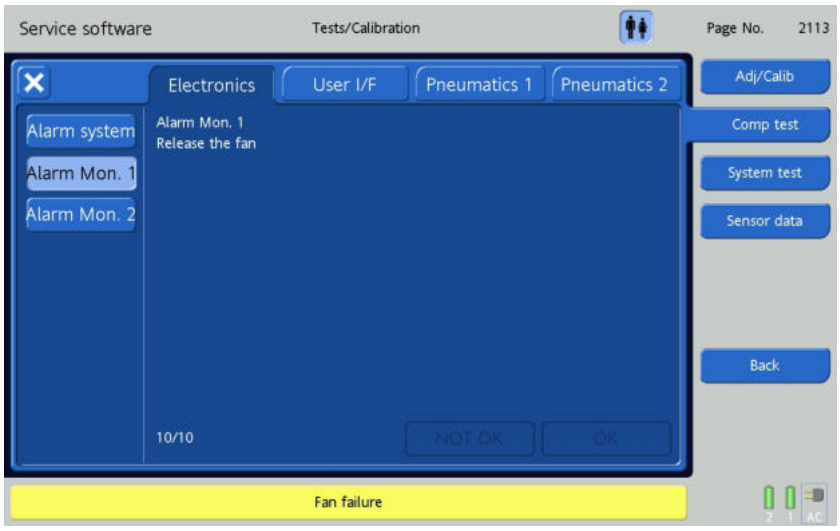
14. Remove the Rear Cover and Fan Filter, then physically STOP the cooling fan by hand until the alarm is shown on the screen.

Figure 9-90. Alarm monitor 1 tests - step 9



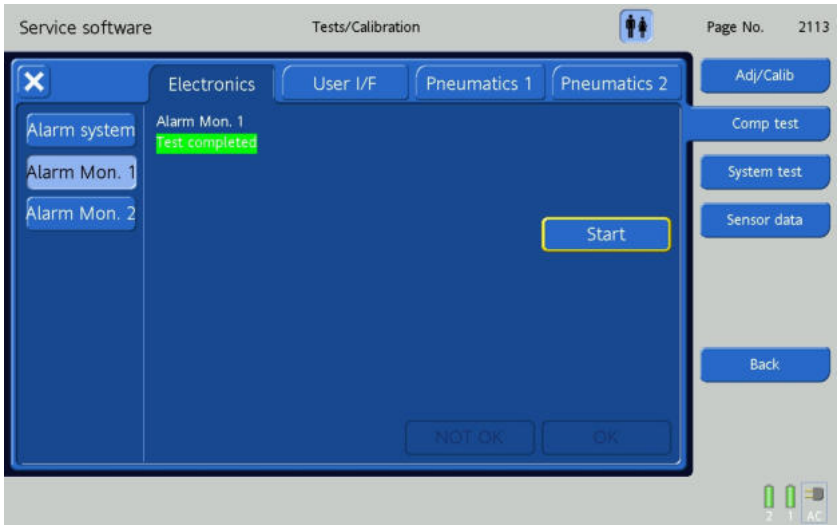
15. After the **Fan Failure** Alarm is displayed, release the fan.

Figure 9-91. Alarm monitor 1 tests - step 10



16. Verify that the message **Test completed** is displayed on the screen.

Figure 9-92. Alarm monitor 1 tests - step 11



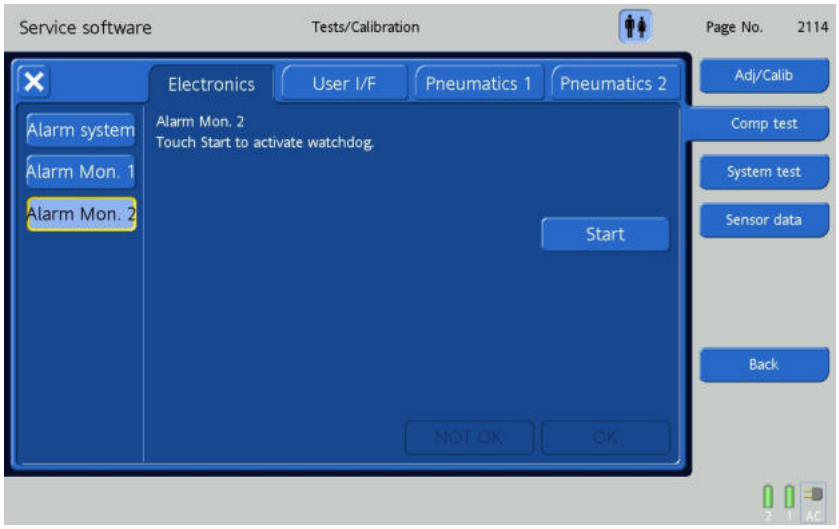
17. Re-install the Fan Filter and Rear Cover.

9.15.1.3 Alarm monitor 2

This test activates the software watchdog. The test result has to be confirmed manually. Afterwards, the ventilator needs to be restarted.

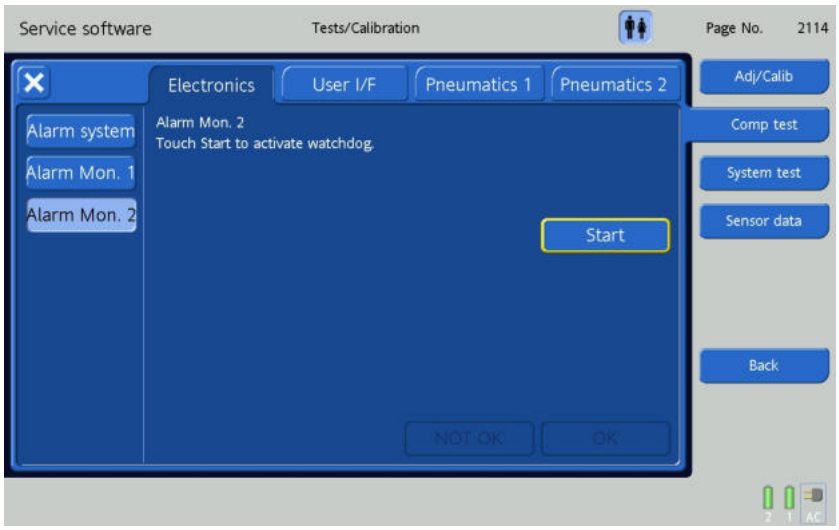
1. Touch the **Alarm Mon. 2** button.

Figure 9-93. Alarm monitor 2 screen



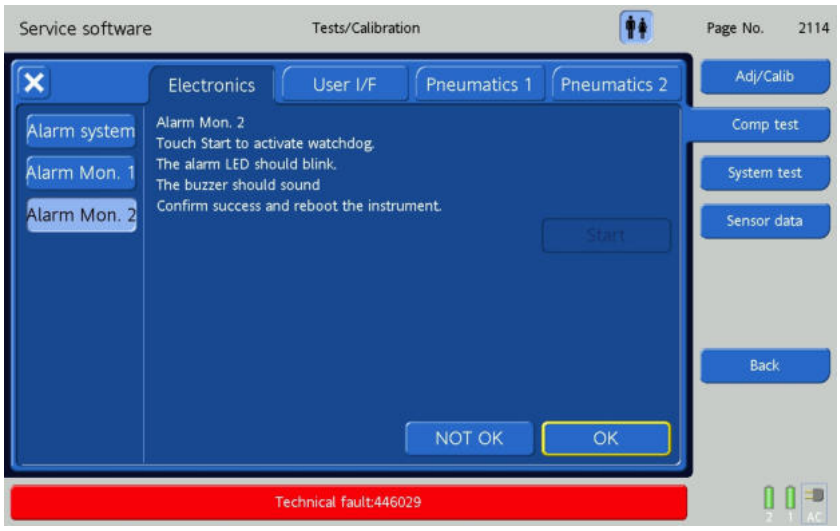
2. Touch the **Start** button to activate the watchdog.
   – The alarm LED should blink.
   – The buzzer should sound.

Figure 9-94. Alarm monitor 2 tests - step 1



3. Touch the **OK** or **NOT OK** button and reboot the ventilator into the service software.

Figure 9-95. Alarm monitor 2 tests - step 2



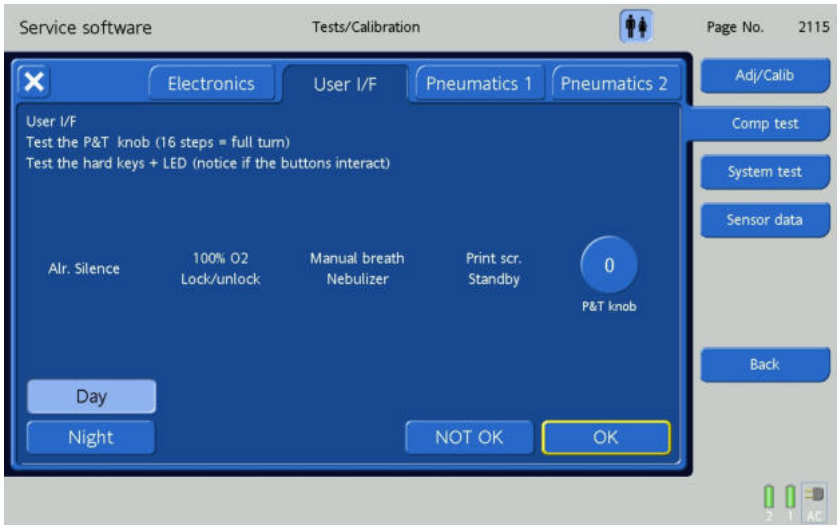
4. After completion, the HAMILTON-C3 must be switched OFF, then ON again.

9.15.2 User interface tab

With this test, the User Interface related components can be activated in order to check the interaction of the Hard Keys with the GUI. Hard Key combinations can also be tested. Dimming the screen and alarm lamp is tested using the Day/Night Button. The P&T Control Knob Encoder has 16 steps. The test is to see that all 16 steps register with the ventilator.

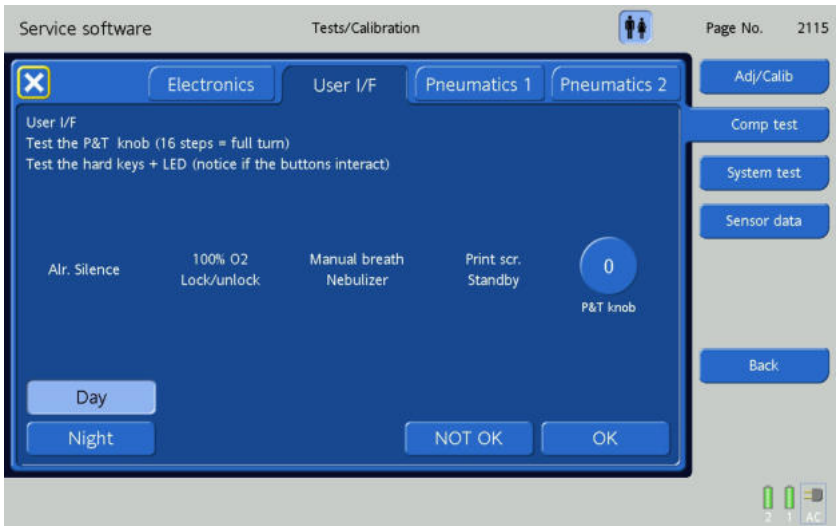
1. From the main service software screen, touch the **Tests / Calibration** button.
2. Touch the **Comp test** button.
3. Touch the **User I/F** tab.

Figure 9-96. User interface tab screen



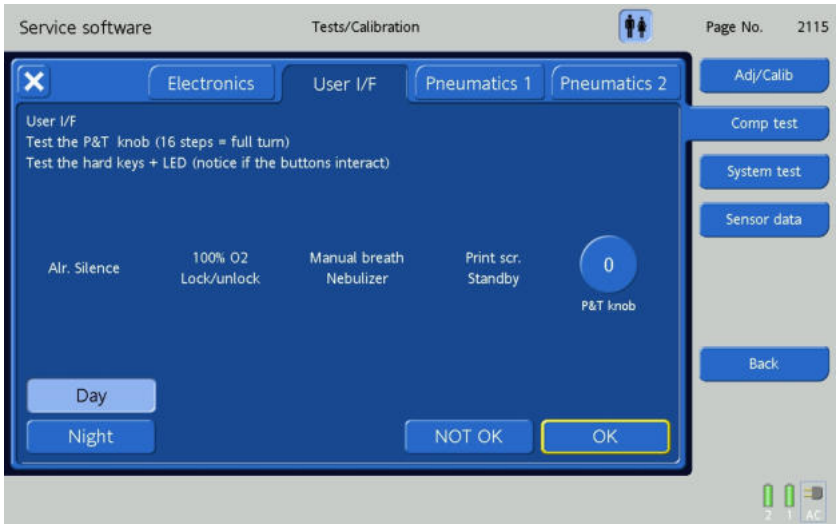
4. Test the P&T knob encoder by selecting the **P&T Control Knob** on the screen and rotating the knob. Observe there are 16 steps in 1 full turn of the P&T knob.

Figure 9-97. User interface tests - step 1



5. Touch each button on the interaction panel and observe the reaction to the button pressed on the screen.
6. Touch the **Night/Day** button to switch between the two display brightness levels.
7. Confirm with **OK/NOT OK**.

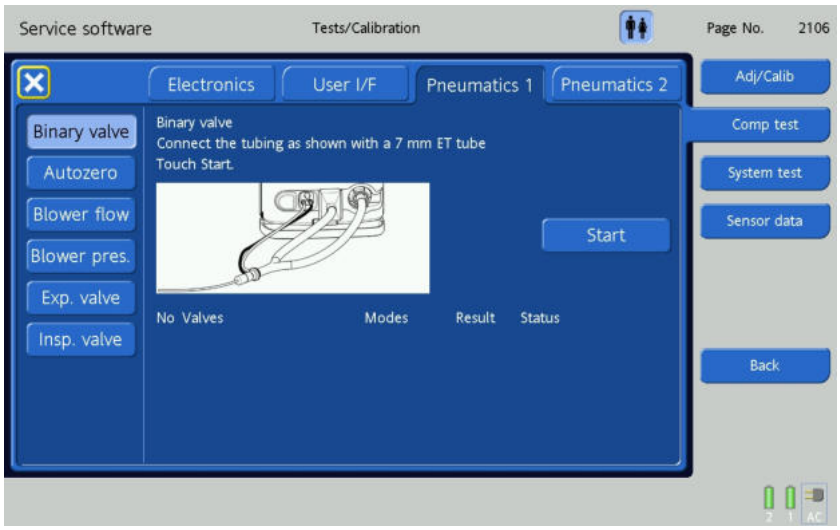
Figure 9-98. User interface tests - step 2



9.15.3 Pnematics 1 tab

1. Connect a complete patient breathing circuit.
2. From the main service software screen, touch the **Tests/Calibration** button.
3. Touch the **Comp test** tab.
4. Touch the **Pneumatics 1** tab.

Figure 9-99. Pneumatics 1 tab screen

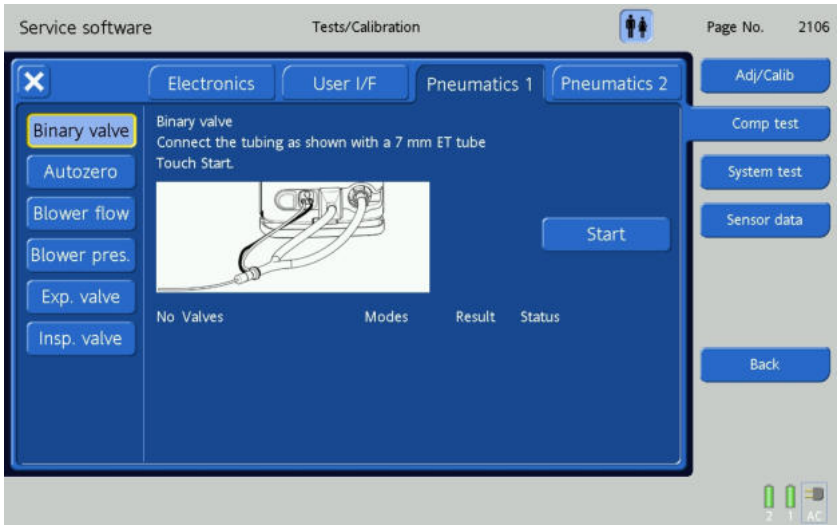


9.15.3.1 Binary valve

This test checks the autozero valves during operation and autozeroing sequence. A constant pressure is applied. Both status, "running" and"autozero",are tested for the following valves: Pvent_monitor, PFlowsensor.

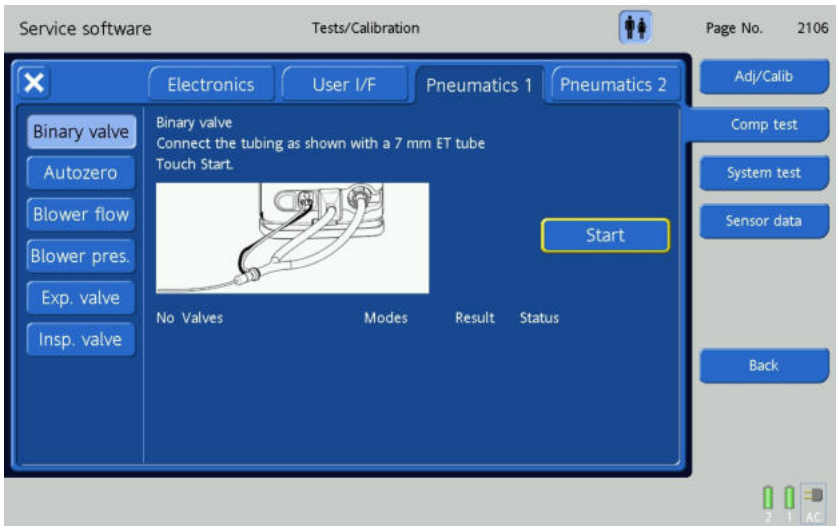
1. Touch the **Binary valve** button.
2. Connect the tubing as shown with a 7 mm ET tube to the flow sensor.

Figure 9-100. Binary valve tests screen



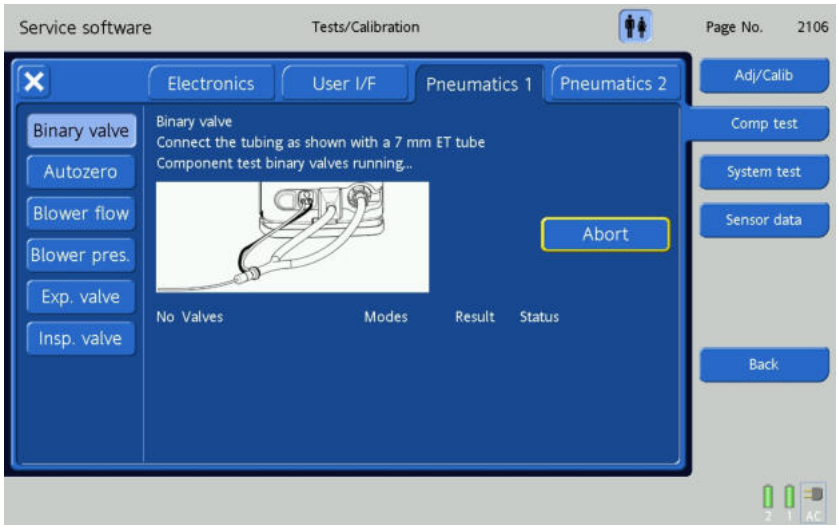
3. Touch the **Start** Button to begin the binary valve test.

Figure 9-101. Binary valve tests - step 1



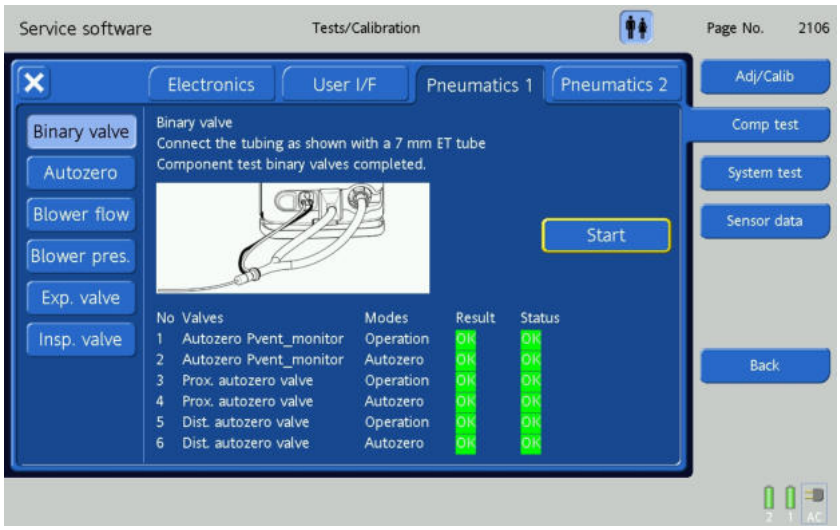
4. The test runs automatically indicated by **Component test binary valves running...** displayed on the screen.

Figure 9-102. Binary valve tests - step 2



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 9-103. Binary valve tests - step 3

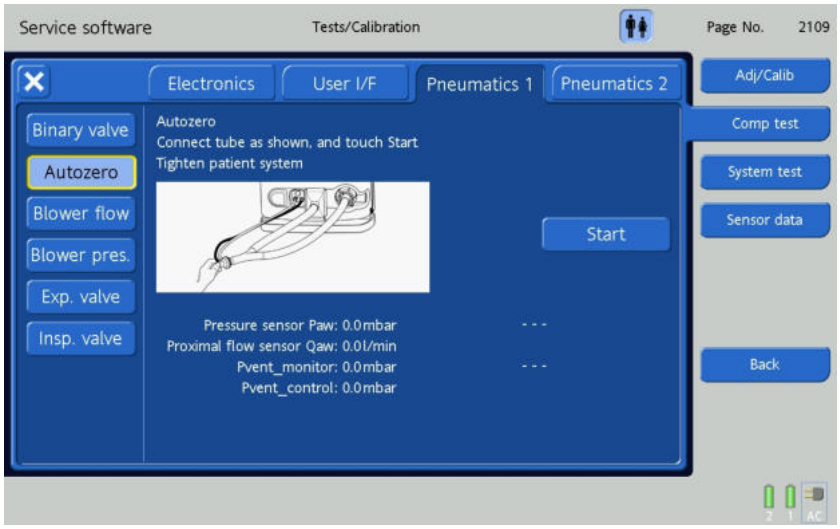


9.15.3.2 Autozero

The test repeats the Autozero sequence 5 times under a defined pressure.

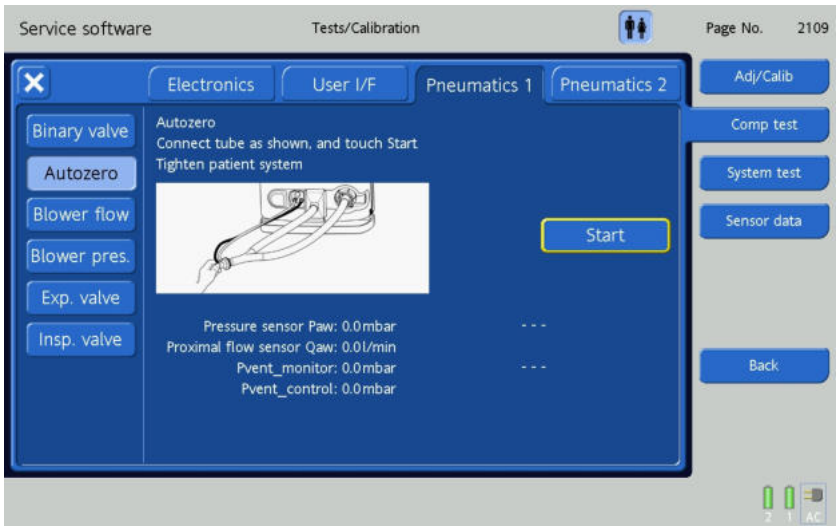
1. Touch the **Autozero** Button.

Figure 9-104. Autozero Valves Tests Screen



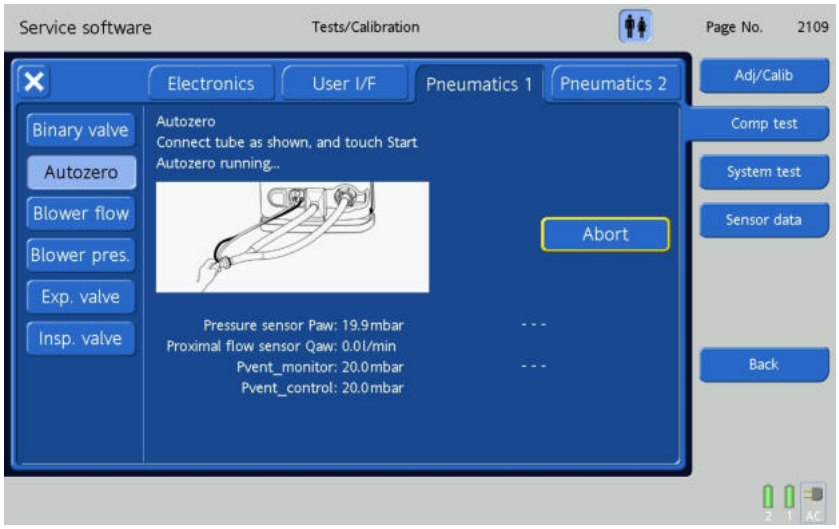
2. Touch the **Start** Button.

Figure 9-105. Autozero Valves Tests Step 1



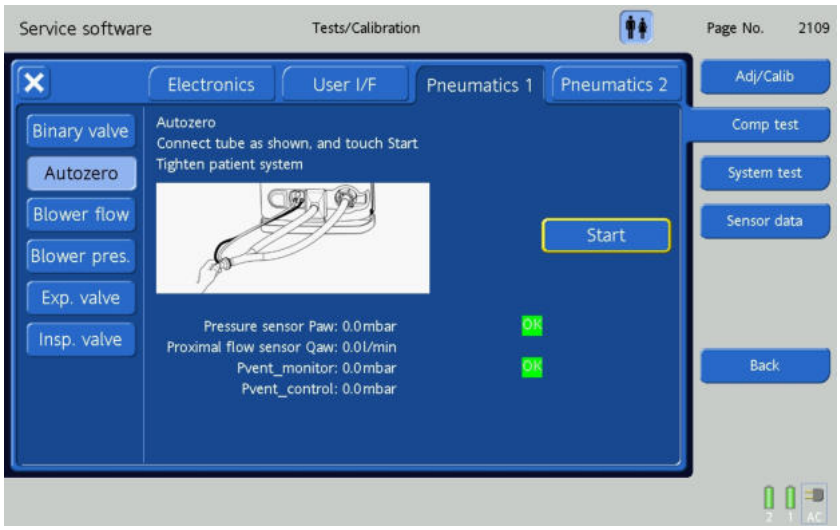
3. The Paw Pressure Sensor and Qaw Proximal Flow Sensor will Autozero.

Figure 9-106. Autozero Valves Tests Step 2



4. The Paw Pressure Sensor and Qaw Proximal Flow Sensor Autozero adjustment is complete when **OK** is indicated on the screen.

Figure 9-107. Autozero Valves Tests Step 3



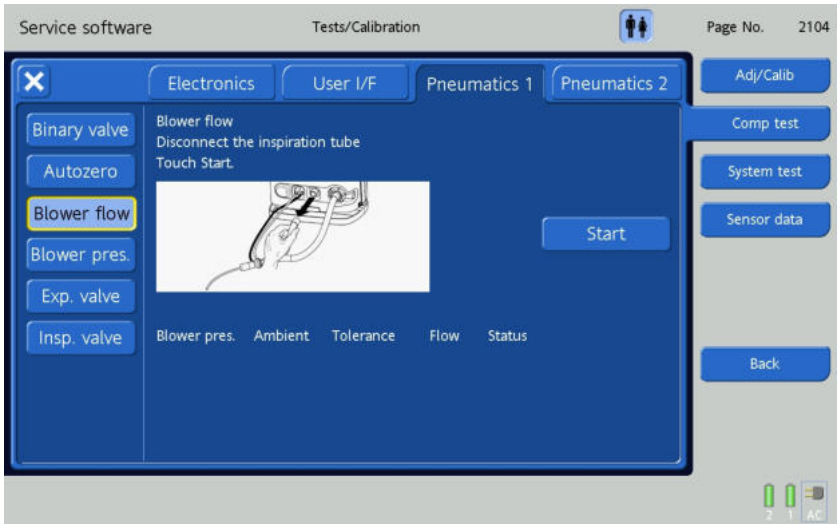
5. The Autozero results will be recorded in the Service Log.

9.15.3.3 Blower flow

Several flows (ml/second) will be set as target to the blower module. The achieved blower flow (ml/second) must be within the defined tolerance.

1. Touch the **Blower flow** button.

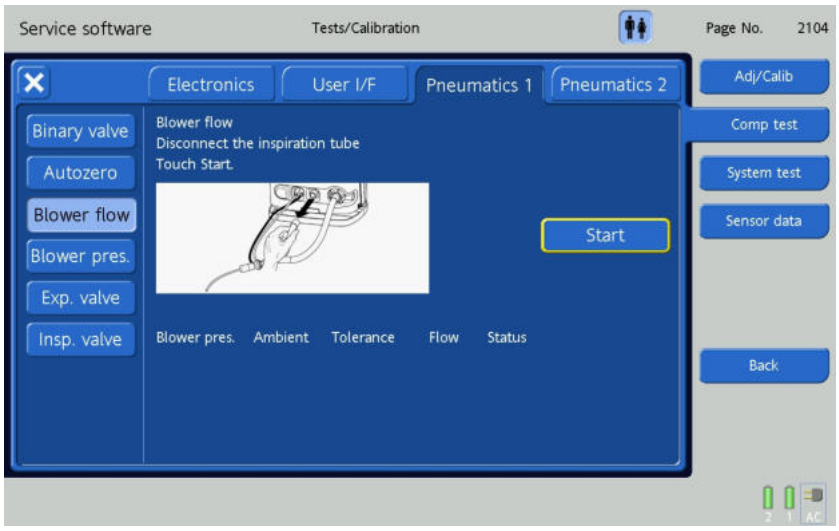
Figure 9-108. Blower flow tests screen



2. Disconnect the inspiration tube.

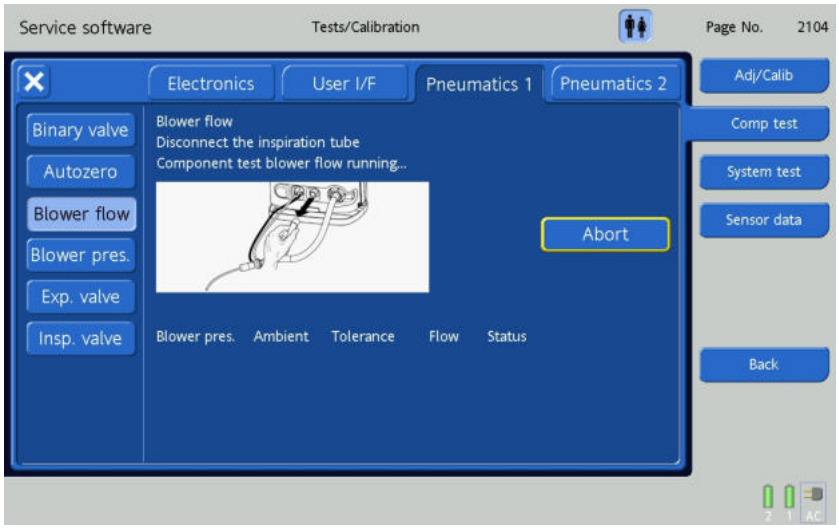
3. Touch the **Start** button.

Figure 9-109. Blower flow tests - step 1



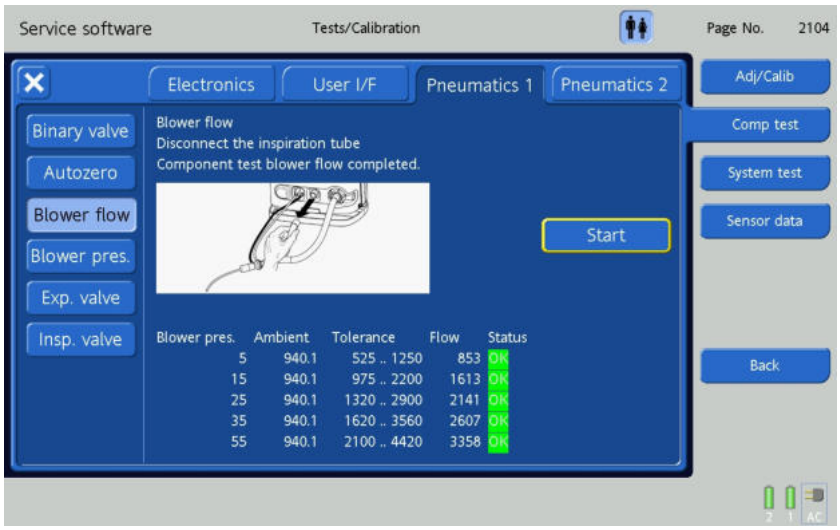
4. The test runs automatically indicated by **Component test blower flow running...** displayed on the screen.

Figure 9-110. Blower flow tests - step 2



5. The test is complete when **Component test blower flow completed** is displayed on the screen and the results are displayed with **OK** or **Not OK**.

Figure 9-111. Blower flow tests - step 3



NOTICE

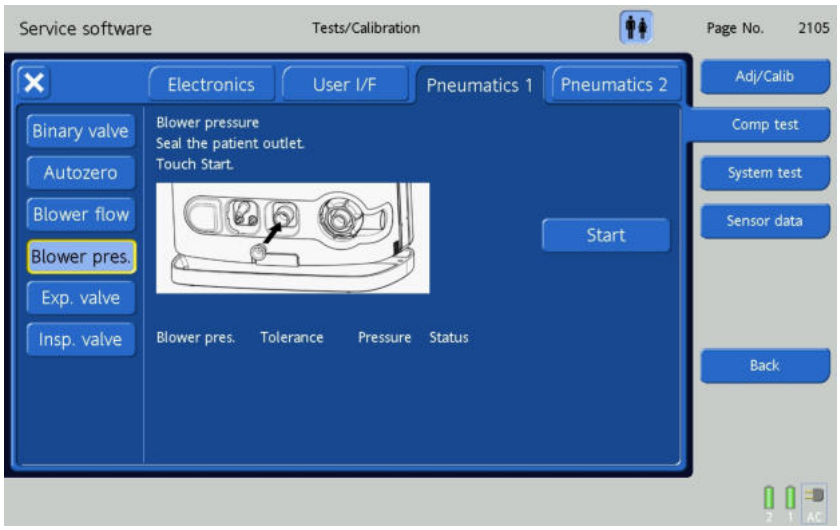
The blower pressure values are in **mbar** and the flow values are in **ml/second**.

9.15.3.4 Blower pressure

Several pressures are set as a target for the blower module. The achieved pressure measured by the Pvent_monitor Pressure Sensor should be within the given tolerance.

1. Touch the **Blower pres.** button.

Figure 9-112. Blower pressure tests screen



2. Disconnect the inspiration tube and seal the patient outlet with a stopper.