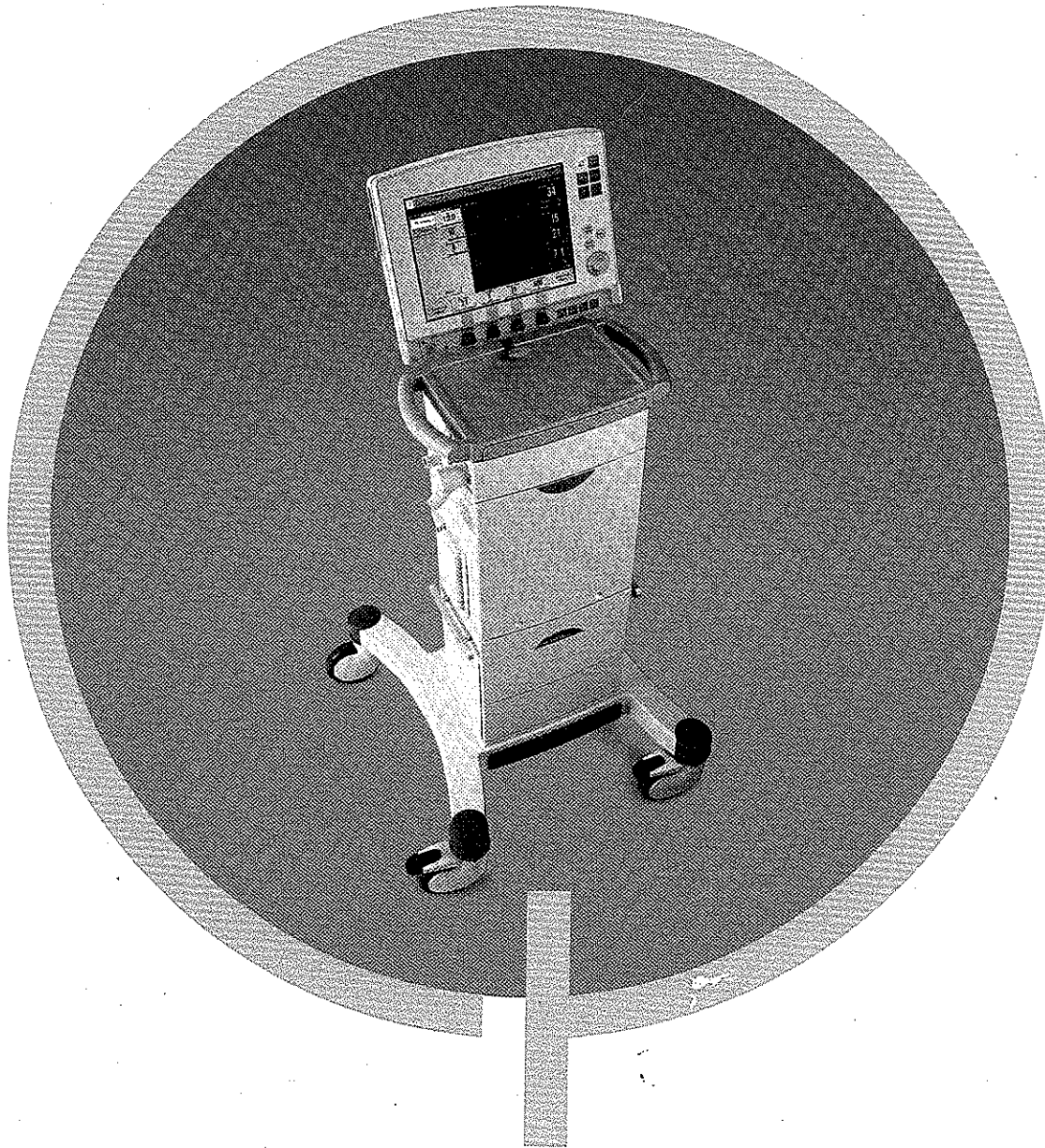


MAQUET

Servo-i Ventilator System Service Manual

CRITICAL CARE



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Notes

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Contents

1. Important	1
2. Introduction	2
3. Description of functions	3
4. Disassembling and assembling	4
5. Service procedures	5
6. Troubleshooting	6
7. Preventive maintenance	7
8. Index.....	8
9. Diagrams	9

Important

1

General

- Service documentation for the Servo-i Ventilator System consists of:
 - User's manual. The User's manual is an indispensable complement to the Service Manual for proper servicing.
 - Service Manual
 - Installation Instructions
 - Spare Parts information.
 - Documentation for all optional equipment included in the Servo-i System is also available.
- The Servo-i Ventilator System is referred to as the **Servo-i** throughout this manual.
- There are two serial number labels on the unit:
 - One label is attached to the Patient Unit close to the supply gas inlets. The serial number stated on this label is the ID number of the Patient Unit. The serial number is also stored in the SW memory as the 'System ID'.
 - One label is attached to the rear side of the User Interface close to the On/Off switch. The serial number stated on this label is the ID number of the User Interface.
- System version number can be found in the Status window on the User Interface. Make sure that the version of the User's manual corresponds to the System version.

Text inside a box is used to highlight important information.

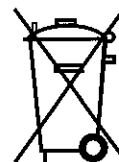
- In addition to the Important information given here and in the related documents (e. g. in the User's manual), always pay attention to applicable local and national regulations.
- Responsibility for the safe functioning of the equipment reverts to the owner or user in all cases in which service or repair has been done by a non-professional or by persons who are not employed by or authorized by Maquet, and when the equipment is used for other than its intended purpose.

Symbols used in this manual

- **ESD sensitive components.** When handling ESD-sensitive devices, established procedures must be observed to prevent damage.



- **Special waste.** Discard disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.



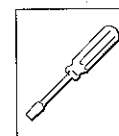
- **Recycling.** Recycle if possible. Recycling facilities may not be available in all areas.



- **Technical training.** Refers to the Technical training supplied by Maquet.



- **Service contract.** Refers to the Service contract supplied by Maquet.



Hazard notices

- Before disassembling or assembling of the Servo-i, make sure that the:
 - On/Off switch is set to Off.
 - Mains power cable is disconnected.
 - Gas supply is disconnected (wall and/or cylinder).
 - Battery modules are disconnected.
 - The Servo-i is cleaned according to instructions in the User's manual, chapter 'Routine cleaning' and chapter 'Regular maintenance', section 'Extended cleaning of inspiratory channel'.
- With power supply connected to the Servo-i, there are energized electrical components inside the unit. All personnel must exercise extreme caution if fault tracing or adjustments are performed with power supply connected and with user interface and patient unit covers removed.

Important

Installation

- Only personnel trained and authorized by Maquet shall be permitted to install the Servo-i. The installation and handing over procedures are described in the 'Servo-i Ventilator System – Installation Instructions'.



Functional check

- After any installation, maintenance or service intervention in the Servo-i, perform a 'Pre-use check' according to instructions in the 'Servo-i Ventilator System – User's manual'.

Service

- The Servo-i must be serviced at regular intervals by personnel trained and authorized by Maquet. Any maintenance or service must be noted in a log book provided.



- It is recommended that maintenance and service is done as a part of a service contract with Maquet.



- Preventive maintenance must be performed at least once every year as long as the unit is not used more than normal. Normal operation is estimated to correspond to approx. 5.000 hours of operation. Details are found in this Service Manual, chapter "Preventive maintenance".

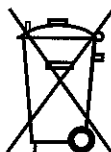
- The Battery modules shall be replaced every three years.

- The internal Lithium batteries (on PC 1771 and PC 1772) shall be replaced every five years.

- Worn-out batteries must be recycled or disposed of properly according to local regulations. Recycle facilities may not be available in all areas.



- Batteries must not be disposed of with ordinary waste. Discard all other disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.



- When working with ESD sensitive components, always use a grounded wrist band and a grounded work surface. Adequate service tools must always be used.



To the responsible service personnel

- The contents of this document are not binding. If any significant difference is found between the product and this document, please contact Maquet for further information.

- We reserve the right to modify products without amending this document or advising the user.

- Only personnel trained and authorized by Maquet shall be permitted to perform installation, service or maintenance of the Servo-i.



Only Maquet genuine spare parts must be used. PC boards (spare parts) must always be kept in a package for sensitive electronic devices. Maquet will not otherwise assume responsibility for the materials used, the work performed or any possible consequences of same.

- The device complies to standards and requirements as stated in the 'Servo-i Ventilator System – User's manual'.

1

Important

Environmental declaration

Purpose

This environmental declaration is for a Servo-i basic unit including the carrier and one battery.

Letters codes within brackets refers to the Functional Block Diagram in chapter Diagrams.

Components with special environmental concern

Components listed below shall be disposed of in an environmentally safe way.

Printed circuit boards

- PC 1770 Main back-plane
- PC 1771 Control, including a Lithium battery (C)
- PC 1772 Monitoring, including Lithium battery (M)
- PC 1775 Plug-and-Play back-plane (P)
- PC 1777 Panel (U)
- PC 1778 DC/DC & Standard connectors (P)
- PC 1780 Pneumatic back-plane (I)
- PC 1781 Pressure transducer, 2 pcs (T)
- PC 1784 Expiratory channel (F)
- PC 1785 Expiratory channel connector (E)
- PC 1786 Expiratory channel cassette (E)
- PC 1789 Remote alarm connector (A)

Other electronics

- TFT assembly including backlight (U)
- Touch screen (U)
- O₂ cell, containing Pb (I)
- Air module, containing multiple PC boards (I)
- O₂ module, containing multiple PC boards (I)
- AC/DC Converter, containing PC boards (P)
- Expiratory cassette (E)
- Expiratory valve coil (E)
- Safety valve pull magnet (I)

Construction materials

The construction materials used in Servo-i in % of the total weight.

Metal – total 77%

- Aluminium 70%
- Steel, zink, brass 8%

Polymeric material – total 9%

- PA (Polyamide)
- POM (Polyoxymethylene)
- SI (Silicone)
- TPE (Thermoplastic elastomer)
- PUR (Polyurethane)
- ABS (Acrylonitrilebutadienstyrene)
- EPDM (Ethylenepropylenedienemonomer)
- PTFE (Polytetrafluoroethylene)
- FPM (Fluororubber)
- NBR (Nitrilerubber)
- PP (Polypropylene)
- PVC (Polyvinyl chloride)
- PS (Polystyrene)

Electronics – total 14%

- Accumulators Nickel Metalhydride
- Printed circuit boards, cables etc.

Others – very small amounts

- Sterile filter paper of glass fibre

Important

Articles of consumption

1. Bacteria filter
2. Filters for the gas modules
3. Filter for the inspiration pressure transducer
4. Filter for the O₂ cell
5. Nozzle units for the gas modules
6. Battery modules
7. Lithium batteries
8. Expiratory cassette
9. Expiratory cassette membrane
10. O₂ cell
11. Backlight lamps.

Item 1: Consumption approximately 250 pcs/year.

Items 2 – 5: Changed approx. every 5.000 hours.

Items 6 – 7: Changed approx. every 15.000 hours.

Items 8 – 11: Changed when needed.

Power consumption

The power consumption depends on the operating mode and whether the internal batteries are being fast or trickle charged.

Mode	Fast charging	Trickle charging
In operation	70 W	38 W
Standby	65 W	33 W
Off	35 W	6 W

Noise level

Less than 50 dBA.

Packing materials

The amounts of packing materials will vary depending on customer adaptation.

Materials for packing:

- Loading pallet. Fulfills the USA requirements 7 CFR 319.40 May 25'th 1995.
- Corrugated cardboard
- Stretch film of Polyethylene, PE.
- Shock-absorbing material of expanded polyethylene, EPE, or expanded polypropylene, EPP.
- Clamps of Polyethylene, PE.

Notes

1

Lined area for notes.

Only personnel trained and authorized by Maquet shall be permitted to perform installation, service or maintenance of the Servo-i.



Make sure to prepare the Servo-i properly before disassembling and assembling. Refer to section 'Hazard notices' in chapter 'Important'.

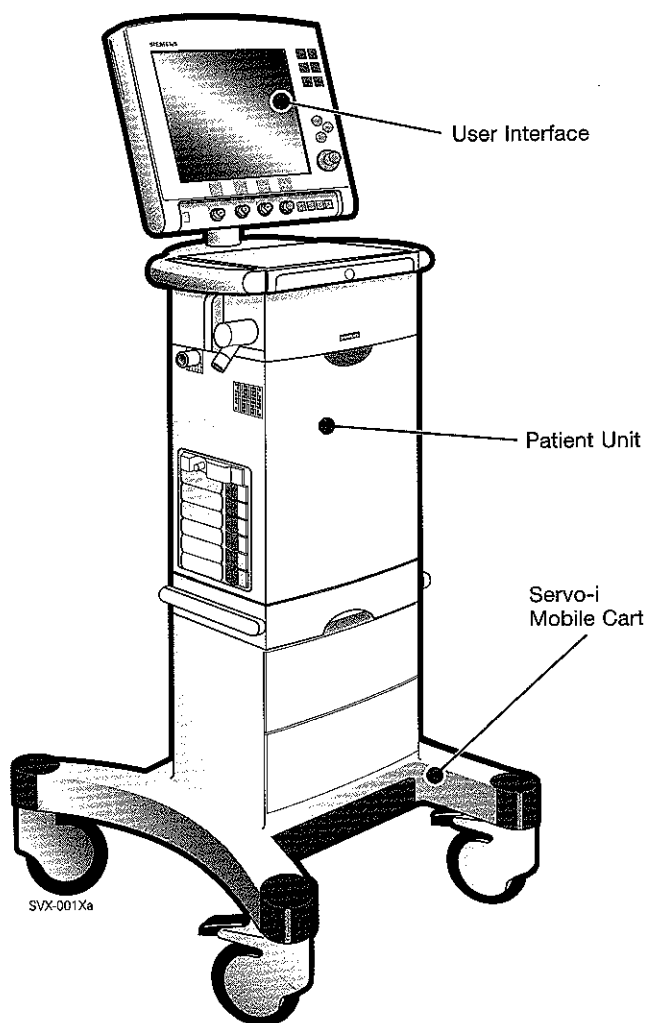
Any service or maintenance must be noted in a log book.

Discard disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.

After any installation, maintenance or service intervention in the Servo-i, perform a 'Pre-use check'. Refer to the 'Servo-i Ventilator System – User's Manual' for details.

2. Introduction

Main units	2 - 2
User Interface	2 - 4
Patient Unit	2 - 6
Servo-i software structure.....	2 - 9
General	2 - 9
Breathing	2 - 9
Monitoring	2 - 9
Panel	2 - 9
System ID	2 - 9



Main units

The Servo-i is available in different main configurations:

- Infant
- Adult
- Universal

These main configurations are as standard equipped with a number of ventilation modes suitable for each patient category. Further ventilation modes can be installed via software Option Upgrades.

The Servo-i can be divided into the following main units:

- **User Interface.** The User Interface contains all controls used to set the ventilation and monitoring parameters. Ventilation parameters as well as other important information are shown on the User Interface display.
- **Patient Unit.** The Patient Unit contains pneumatics and electronics for gas supply to the patient. Power supply and battery back-up is also contained in the Patient Unit.

The Control cable connects the User Interface and the Patient Unit.

The Servo-i shown in the illustration is mounted onto the optional Servo-i Mobile cart.

A number of optional equipment can be added to the Servo-i Ventilator System. For further information, refer to the documents listed below.

Servo-i Mobile cart

- Mobile cart with drawers
- Mobile cart without drawers
- Mobile cart for Compressor Mini.

Refer to:

- Servo-i – User's Manual
- Servo-i Mobile cart – Installation Instructions

Servo Ultra Nebulizer, Servo-i

Refer to:

- Servo-i – User's Manual
- Servo Ultra Nebulizer, Servo-i – Installation Instructions

Compressor Mini

Refer to:

- Servo-i – User's manual
- Compressor Mini – Operating Manual
- Compressor Mini – Service Manual
- Compressor Mini – Installation Instructions

Servo-i Holder

Refer to:

- Servo-i – User's Manual
- Servo-i Holder – Installation Instructions

Servo-i Shelf base

Refer to:

- Servo-i – User's Manual
- Servo-i Shelf base – Installation Instructions

Support Arm 177

- Servo-i – User's manual
- Support Arm 177 – Installation Instructions

Gas trolley

- Servo-i – User's manual
- Gas trolley – Installation Instructions

Gas cylinder restrainer

- Servo-i – User's manual
- Gas cylinder restrainer – Installation Instructions

IV Pole, Servo-i

- Servo-i – User's manual
- IV Pole, Servo-i – Installation Instructions

User Interface panel cover

- Servo-i – User's manual
- User Interface panel cover – Installation Instructions

Battery module

- Servo-i – User's manual
- Battery module – Installation Instructions

CO₂ Analyzer module, Servo-i

- Servo-i – User's manual
- CO₂ Analyzer module, Servo-i – Installation Instructions

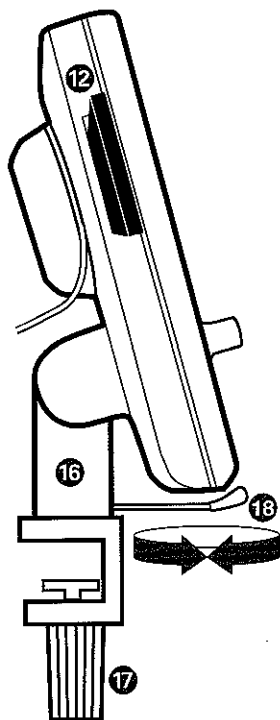
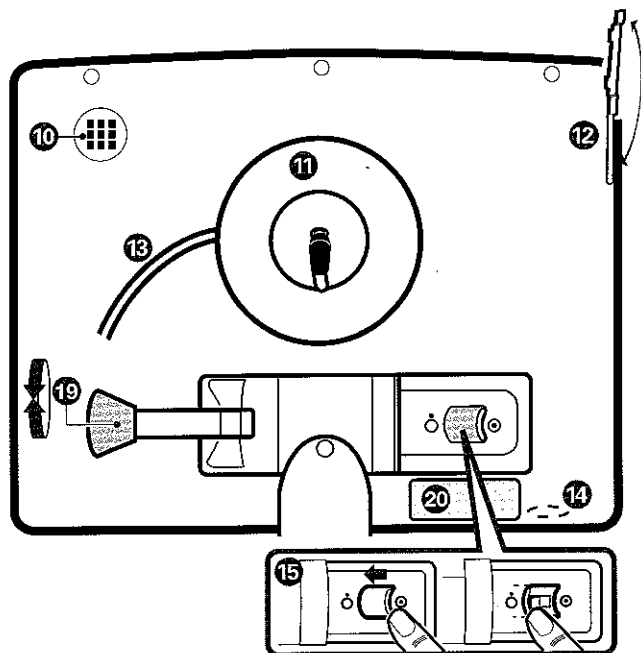
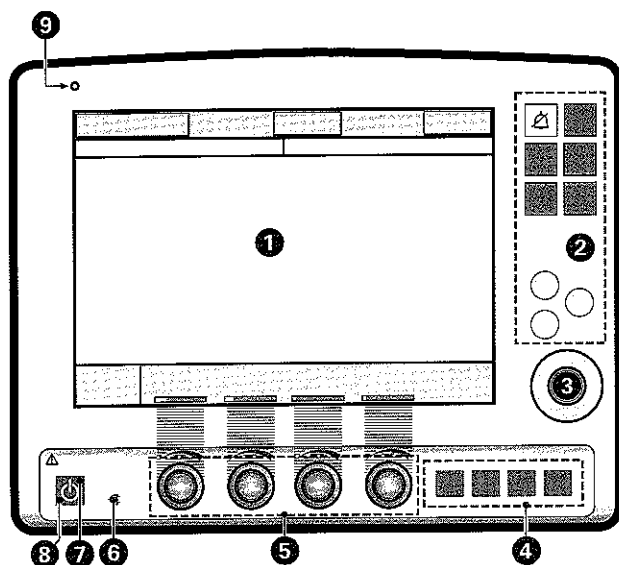
Humidifier holder and Humidifier

- Servo-i – User's manual
- Humidifier – Operating Manual
- Humidifier holder – Installation Instructions

Alarm output connector

- Servo-i – User's manual
- Alarm output connector – Installation Instructions
- Alarm output connector – Reference Manual

2



SVX8011

User Interface

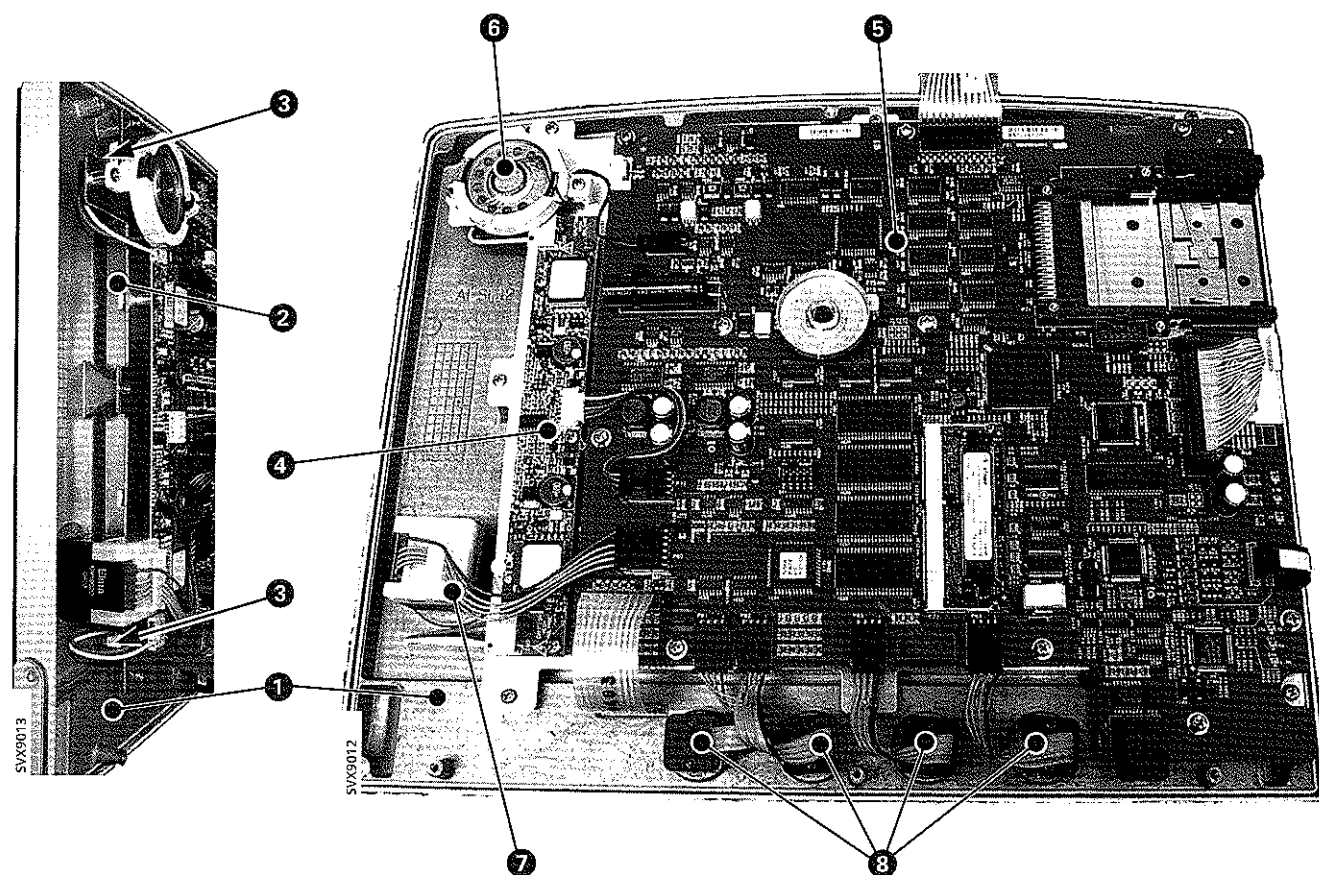
The User Interface can be mounted onto the Mobile cart but can also easily be removed from the cart and mounted on the bed post or table/shelf.

The User Interface can be rotated and tilted into a suitable position. Locking levers, mounting devices and some other items are shown in the illustration above.

1. Display with touch screen.
2. Fixed keys for immediate access to special windows.

3. Main rotary dial.
4. Special function keys.
5. Direct access knobs.
6. Mains indicator (green).
7. Standby indicator (yellow).
8. Start/Stop (Standby) ventilation key.
9. Luminescence detector, adjusts display brightness automatically.
10. Loudspeaker grid.
11. Cable reel.
12. PC card slot with slot cover.
13. Control cable between User Interface and Patient Unit.
14. Service connector, for PC.
15. On/Off switch.
16. Panel holder
17. Locking screw, alternative mounting
18. Locking arm, rotation
19. Locking arm, tilting.
20. Serial number label. The serial number stated on this label is the ID number of the User Interface. This serial number must always be referred to when ordering service, spare parts, etc for the User Interface.

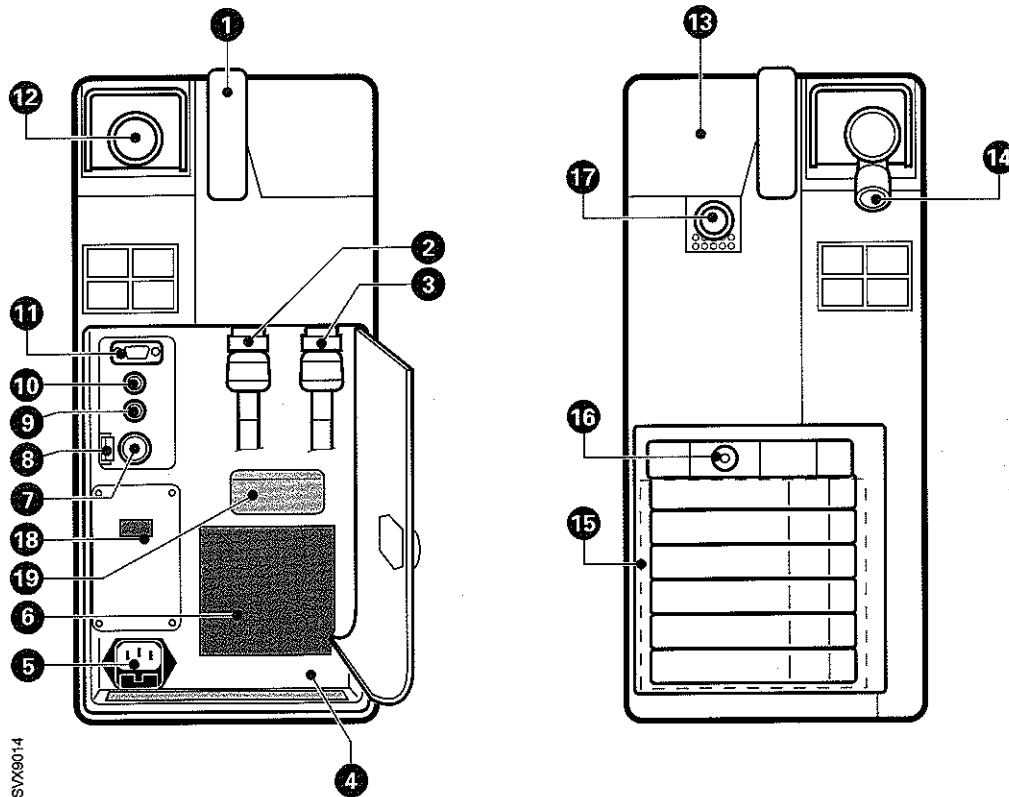
For further information regarding operation of the User Interface, refer to the User's manual.



When the front panel section is removed from the rear cover, the following parts are accessible:

1. Touch screen assembly, front cover frame included.
2. TFT Display.
3. Backlight lamps.
4. PC board Backlight inverter.
5. PC 1777 Panel including PC Card slot.
6. Loudspeaker.
7. Main rotary dial (rotary encoder with switch).
8. Direct access controls (rotary encoder).

2

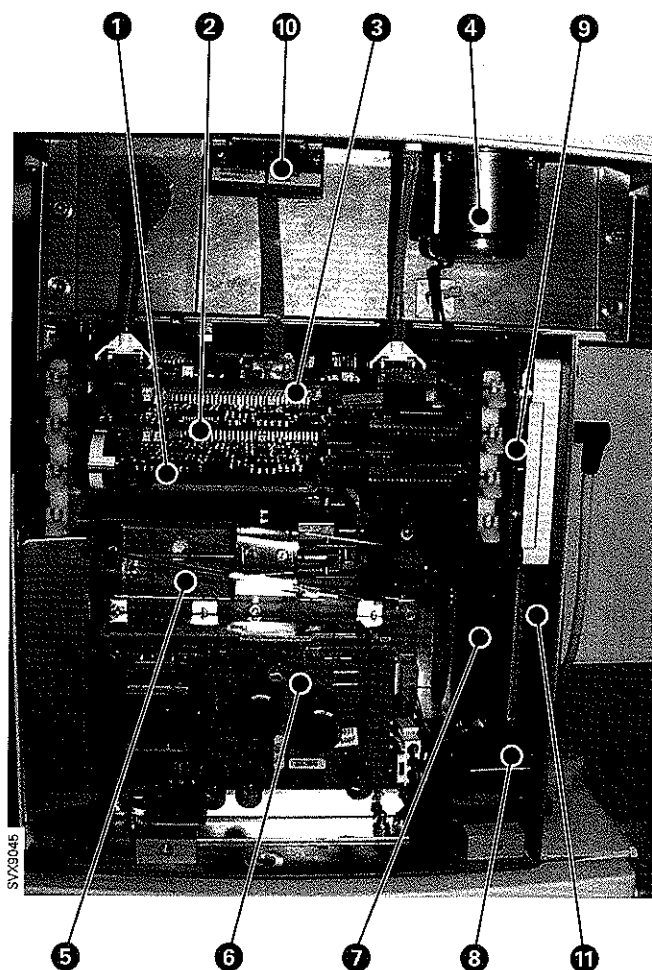


Patient Unit

The Patient Unit can be rotated on and pulled out of the Servo-i Mobile cart. It can also be mounted onto a Servo-i Holder or a Servo-i Shelf base.

Items accessible from the outside of the Patient Unit are shown in the illustration above.

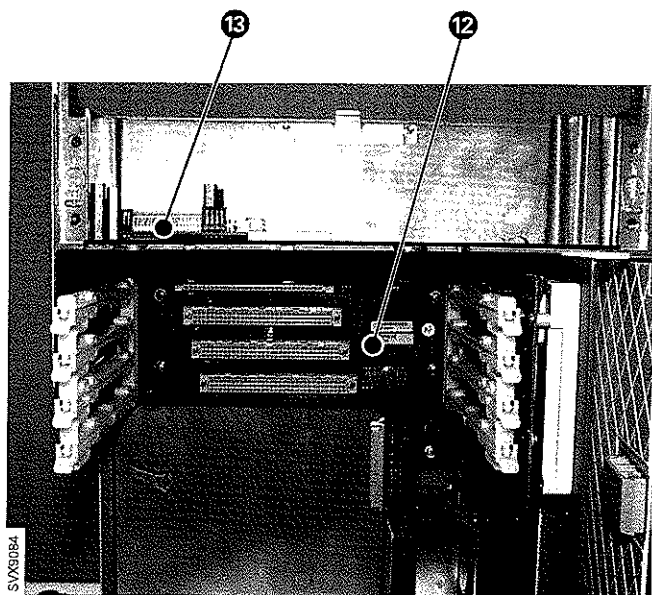
1. Handle.
2. Gas inlet for Air.
3. Gas inlet for O₂.
4. Equipotentiality terminal.
5. Mains supply connector incl. fuses F11 and F12.
6. Internal fan with filter.
7. Connector for external +12V DC power supply.
8. Fuse F1 for external +12V DC power supply.
9. Optional connector.
10. Control cable connector.
11. 9-pole serial port for data communication (RS-232).
12. Expiratory outlet.
13. Inspiratory section cover.
14. Expiratory inlet.
15. Module unit for connecting optional modules, e. g. up to six Battery modules.
16. Connector for Servo Ultra Nebulizer, Servo-i.
17. Inspiratory outlet.
18. Alarm output connector (optional).
19. Serial number label. The serial number stated on this label is the ID number of the unit. This serial number must always be referred to when ordering service, spare parts, software updates/upgrades, etc.



When the Patient Unit front cover is removed, the following parts are accessible:

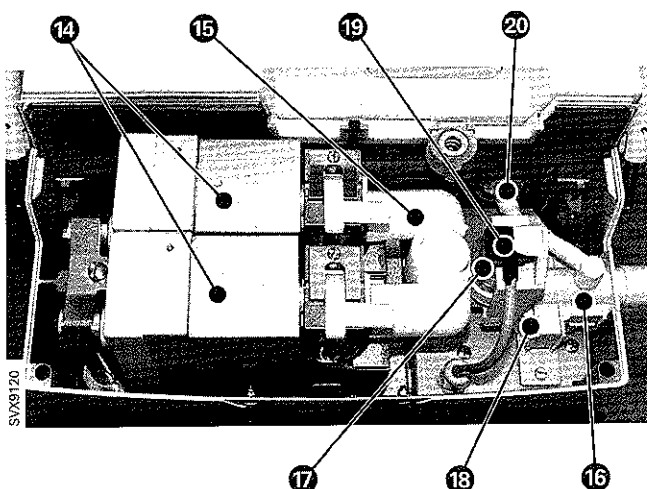
1. PC 1772 Monitoring.
2. PC 1771 Control.
3. PC 1784 Expiratory channel with the two connected PC 1781 Inspiratory and Expiratory Pressure Transducers.
4. Expiratory valve coil.
5. Module unit including PC 1775 Plug-and-play back-plane.
6. AC/DC Converter.
7. Internal fan.
8. Mains supply inlet.
9. PC 1778 DC/DC & Standard connectors.
10. PC 1785 Expiratory channel connector.
11. PC 1789 Remote alarm connector (optional, not shown in the illustration).

2



12. The PC boards, as listed above are directly or indirectly connected to the PC 1770 Main back-plane.
13. The gas modules, the O₂ cell and the safety valve pull magnet are connected to the PC 1780 Pneumatic back-plane.

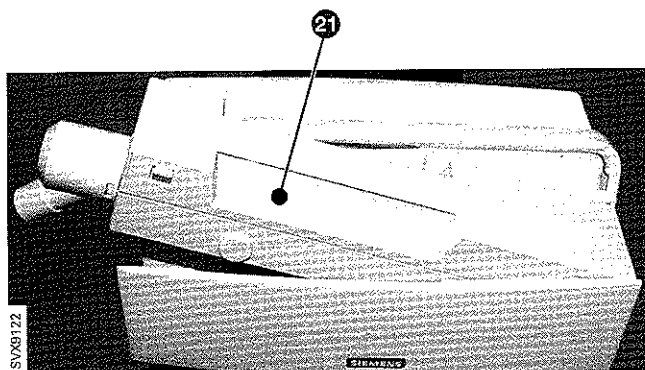
2



The upper part of the Patient Unit contains the inspiratory section and the expiratory section.

The main parts of the inspiratory section are the:

- 14. Two gas modules, Air and O₂, for regulation of the inspiratory gas.
- 15. Connector muff.
- 16. Inspiratory pipe with housings for the O₂ cell and for the safety valve.
- 17. O₂ cell incl. bacteria filter.
- 18. Safety valve.
- 19. Temperature sensor (inside the O₂ cell connector).
- 20. Inspiratory pressure transducer tube incl. bacteria filter, to connect the inspiratory pressure transducer.



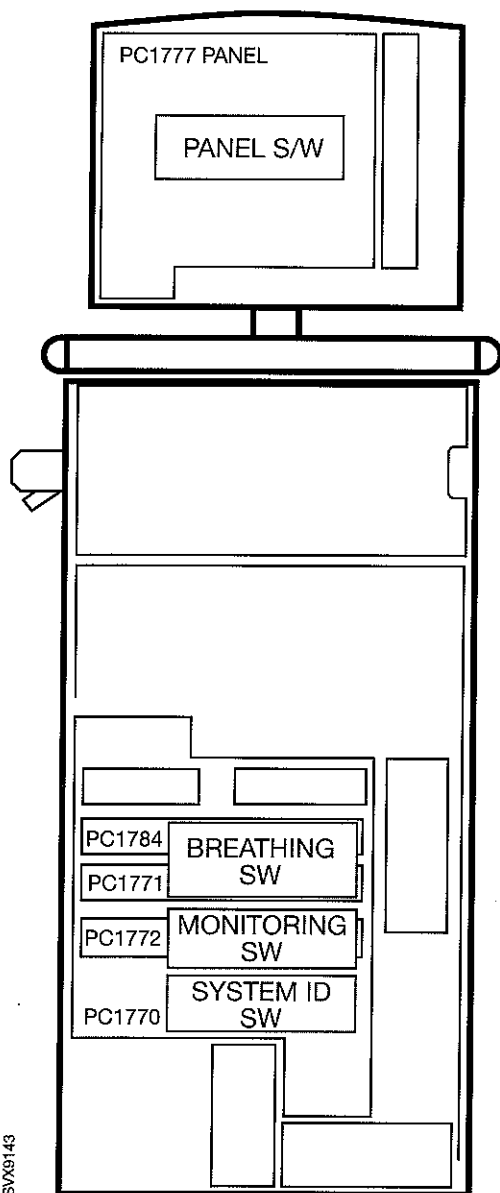
The expiratory cassette (21) is a complete unit and must not be disassembled. It contains the following parts:

- Expiratory inlet with moisture trap.
- PC 1786 Expiratory channel cassette.
- Ultrasonic flowmeter.
- Heating foil to keep a stable temperature in the expiratory gas.
- Pressure transducer connection, incl. bacteria filter, to connect the expiratory pressure transducer.
- Expiratory valve incl. valve membrane.
- Expiratory one-way valve.

The expiratory valve coil, mounted under the expiratory cassette compartment, controls the valve membrane in the cassette.

PC 1786 inside the expiratory cassette is electrically connected to PC 1784 Expiratory channel via PC 1785 Expiratory channel connector.

Servo-i software structure



General

The Servo-i SW installed in the ventilator will contain all available system functionality. The software is separated into different subsystems and stored on some of the PC boards. The separation of the software is handled by the installation program.

The Servo-i software is divided into the following software subsystems:

- Breathing
- Monitoring
- Panel
- System ID

Breathing

The Breathing SW controls the delivery of gases to the patient. This subsystem is responsible for the breathing system, that is:

- Ventilation control and regulation
- Inspiratory channel
- Expiratory channel
- Nebulizer control (software option)

The Breathing SW is stored on PC 1771 Control and PC 1784 Expiratory Channel. New software can be installed via a System SW Update. The System SW must be re-installed if PC 1771 or PC 1784 is replaced.

The Breathing SW is executed by microprocessors on PC 1771 and PC 1784.

Monitoring

The Monitoring SW controls all monitoring and alarm functions in the system, including trends of measured values. Events, such as alarms and change of settings will also be logged.

The Monitoring SW is stored on PC 1772 Monitoring. New software can be installed via a System SW Update. The System SW must be re-installed if PC 1772 is replaced.

The Monitoring SW is executed by the microprocessor on PC 1772.

Panel

The Panel SW controls all user interaction, as well as software updating to all subsystems via the PC Card-interface.

The Panel SW is stored on PC 1777 Panel. New software can be installed via a System SW Update. The System SW must be re-installed if PC 1777 is replaced.

The Panel SW is executed by the microprocessor on PC 1777.

System ID

The System ID SW is a configuration file, stored on PC 1770 Main Back-Plane, that is unique for each ventilator. The System ID SW will enable the functions selected for this ventilator.

To change the functions of the ventilator, a new System ID S/W can be installed via an Option Upgrade.

When replacing PC 1770 Main Back-Plane, a spare part that is factory programmed for the concerned ventilator must be used.

2

Only personnel trained and authorized by Maquet shall be permitted to perform installation, service or maintenance of the Servo-i.



Make sure to prepare the Servo-i properly before disassembling and assembling. Refer to section 'Hazard notices' in chapter 'Important'.

Any service or maintenance must be noted in a log book.

Discard disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.

After any installation, maintenance or service intervention in the Servo-i, perform a 'Pre-use check'. Refer to the 'Servo-i Ventilator System – User's Manual' for details.

3. Description of functions

About this chapter	3 - 2
Memory types used in the Servo-i	3 - 2
User Interface	3 - 2
User Interface controls	3 - 2
PC 1777 Panel	3 - 2
Loudspeaker	3 - 2
Backlight Inverter	3 - 2
Touch screen assembly	3 - 2
TFT Display with Backlight	3 - 2
Patient unit	3 - 3
Inspiratory section	3 - 3
Expiratory section	3 - 6
PC 1770 Main back-plane	3 - 7
Pressure transducers	3 - 7
PC 1784 Expiratory Channel	3 - 8
PC 1771 Control	3 - 8
PC 1772 Monitoring	3 - 8
Power supply	3 - 9
Module unit	3 - 10
Internal fan	3 - 10
Optional PC board slots	3 - 10
Alarm output connector (optional)	3 - 10
Battery modules (optional)	3 - 10
CO ₂ Analyzer module (optional)	3 - 10
Control cable	3 - 10

About this chapter

This text refers to the Functional Main Blocks diagram in chapter 'Diagrams'.

Memory types used in the Servo-i

There are four different types of memories used in the Servo-i:

- Flash memory. For software storage. Can be upgraded / updated via a System SW Update. Present on PC 1771, PC 1772, PC 1777 and PC 1784.
- RAM. For temporary storage of software and data. Present on PC 1771, PC 1772 and PC 1777.
- Non-volatile memory. RAM with battery back-up. For settings, trends and logs. Present on PC 1771 and PC 1772.
- EEPROM. For PC board information, configuration, calibration data, etc. Present on almost all PC boards and in the O₂ cell.

User Interface

Functional Main Blocks diagram marking: 'U'

User Interface controls

Setting of different parameter input values is made with the help of the following different interface devices:

- Main Rotary Dial (rotary encoder with switch).
- Direct Access Control, 4 each (rotary encoders).
- Membrane buttons. Integrated parts of the Touch screen assembly.
- Touch screen.

PC 1777 Panel

Some features included on PC 1777 Panel are:

- SIMM (Single In-line Memory Module) mounted on its connector P77. Memory type: SDRAM
- PC Card Slot intended for connection/insert of a PC Card. PC Cards are used to:
 - Download software into the different flash memories situated on PC-boards marked μP and into the EEPROM on PC 1770 Main Back-plane.
 - Transfer patient and system data for further transfer to a computer.
 - Service purpose.
- Microprocessor on this board includes control of the functions of the User Interface.

- ID-PROM: The ID information can be read by the Servo-i.
- On/Off switch: Switch to Power up or Power down the Servo-i. Refer to section 'Power supply'.
- Connection for PC (P86): Ethernet port intended for test and service purpose. Connected via a service cable. For future options.
- Microphone used to monitor of sounds from the Loudspeaker.

Note: The System SW must be re-installed if PC 1777 is replaced

Loudspeaker

For generation of sound, e.g. alarm. Connected to P72 on PC 1777 Panel.

The loudspeaker generates different tones with individual sound volumes. At start-up and during Pre-use check the function of the loudspeaker is monitored by the microphone on PC 1777. During operation it is continuously monitored through current sensing.

Backlight Inverter

PC board with driving stage for backlight (lamps) mounted behind the TFT Display. The supply voltage delivered by the Backlight Inverter is 660 V.

The Backlight Inverter is connected to P73 on PC 1777 Panel.

Touch screen assembly

The Touch screen implies the touch function of the front panel screen and is interactive with information displayed on the TFT Display. The front panel frame with the touch screen, membrane buttons and DIM sensor forms the Touch screen assembly and must be handled as one complete part. The DIM sensor measures the ambient light and the screen brightness is automatically adjusted.

TFT Display with Backlight

The TFT Display is a Thin Film Transistor Screen for color display of picture- and alphanumeric data.

The Backlight consists of two fluorescent tubes (lamps) mounted behind the TFT Screen. They are driven from the Backlight Inverter. Estimated lifetime (with acceptable brightness level) for the lamps is 30.000 hours. Using the Field Service System (FSS), a time meter for the lamps can be shown. The time meter must be reset after replacement of the lamps.

Patient unit

Inspiratory section

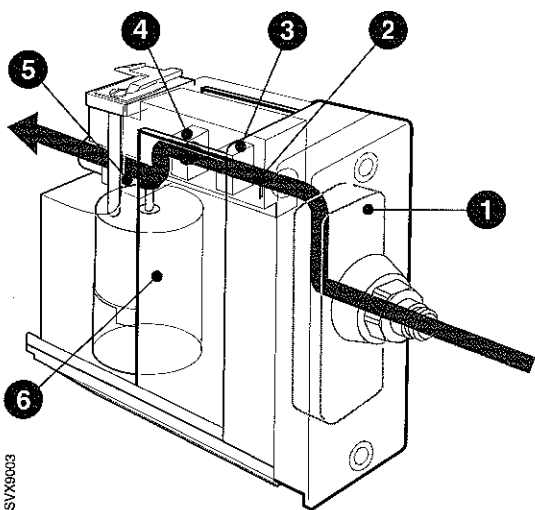
Functional Main Blocks diagram marking: 'I'

The main block Inspiratory Section conveys the breathing gas from its gas inlets for Air and O₂ supply to the patient breathing system. It comprises the following main functions:

- Gas Modules – Air and O₂.
- Connector Muff.
- Inspiratory Pipe.
- O₂ Cell.
- Temperature Sensor.
- Inspiratory Pressure Tube.
- Safety Valve incl. pull magnet.
- Inspiratory Outlet.
- PC 1780 Pneumatic Back-Plane.

Gas modules – Air and O₂

The Air and O₂ Gas Modules regulates the inspiratory gas flow and gas mixture.



1. Filter
2. Inspiratory valve temperature sensor
3. Supply pressure transducer
4. Flow transducer (Delta pressure transducer and net)
5. Nozzle unit with valve diaphragm
6. Inspiratory solenoid

The Gas Modules are factory calibrated. Each Gas Module must not be disassembled further than described in chapter 'Preventive maintenance'.

Gas inlet

Gas supply is connected to the ventilators gas inlet nipples. The design of the gas inlet nipples and their color markings vary according to the standard chosen.

Gas is to be connected from hospital central gas supply or from gas cylinders. The Air supply may be connected from a compressor for medical air.

Filter

The Filter protects the ventilator from particles in the gas delivered to the Gas Modules. The filter must be replaced during the "Preventive maintenance".

The filter housing and the filter cover are provided with matching guide pins. These guide pins prevent mounting of the filter cover (with gas inlet nipple) on the wrong module.

A non-return valve for the gas inlet is located in the filter cover. This valve will suppress short pressure drops in the gas supply.

The non-return valve is also designed to slowly evacuate compressed gas from the module, if the gas supply to the module is disconnected.

Inspiratory valve temperature sensor

The temperature of the supplied gas is measured by the Inspiratory Valve Temperature Sensor. This sensor is situated in the gas flow.

The output signal from this sensor is used to compensate for the gas density variations due to temperature.

Supply pressure transducer

The pressure of the supplied gas is measured by the Supply Pressure Transducer.

The output signal from this transducer is amplified. It is then used to calculate the absolute pressure of the gas to compensate for gas density variations due to pressure.

Flow transducer

The gas flows through a net (resistance) which causes a pressure drop. The pressure is measured on both sides of this net and the differential pressure value is then amplified.

Nozzle unit

The plastic Nozzle Unit contains a valve diaphragm. The valve diaphragm, controlled by the Inspiratory Solenoid, regulates the gas flow through the Gas Module.

The complete plastic nozzle unit must be replaced during the 'Preventive maintenance'. After replacement, allow the diaphragm to settle during approx. 10 minutes before gas pressure is connected to the Gas Module.

Inspiratory solenoid

The gas flow through the Gas Module is regulated by the Inspiratory Solenoid via the Nozzle Unit.

3

The current supplied to the solenoid is regulated so that the gas module will deliver a gas flow according to the settings on the User Interface.

Gas module key

The Gas Modules are provided with a mechanical key to prevent that the module is mounted in the wrong slot.

The key consists of a plastic guide mounted underneath the module and a corresponding guide mounted in the patient unit.

ID PROM

Each Gas Module is provided with an ID-PROM. The ID information can be read by the Servo-i System.

Connector muff

The Connector Muff connects the Gas Module outlets to the Inspiratory Pipe inlet.

Inspiratory pipe

The Inspiratory Pipe leads the gas from the Connector Muff to the Inspiratory Outlet.

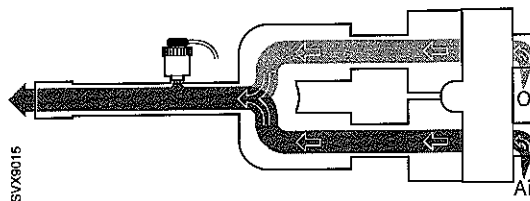
The Inspiratory Pipe comprises:

- Housing and locking lever for the O₂ Cell with its bacteria filter.
- Housing for the Safety Valve.
- Connection for measurement of inspiratory pressure.

The pipe is provided with internal flanges with the purpose to improve mixing of O₂ and Air.

O₂ cell

The O₂ Cell is mounted in a housing on the Inspiratory Pipe and is protected by a bacteria filter.



Maintenance including exchange of bacteria filter according to the User's manual. The bacteria filter must also be replaced during the 'Preventive maintenance'.

The O₂ cell gives an output voltage proportional to the partial pressure of oxygen inside the Inspiratory pipe. At constant ambient pressure this output is proportional to the O₂ concentration in percent.

In each O₂ cell, the output signal will stay at a fairly constant level usually within 10–17 mV in normal air and at standard barometric pressure during the life time of the cell.

The life time of the cell is affected by the O₂ concentration. With a concentration (at the cell) in % and expected cell life time in hours the following applies at 25°C (77°F):

$$O_2 \text{ Conc.} \times \text{Expected cell life} = 500\,000\% \text{ hours.}$$

The O₂ cell is automatically calibrated each time a Pre-use check is performed (if O₂ is connected to the ventilator).

If the ventilator has continually been in use for a long time, the measured O₂ concentration may drop due to normal degradation of the O₂ cell. This will activate a nuisance alarm. For further information, refer to the User's manual, chapter section 'O₂ cell adjustment'.

Note: Pre-use check is recommended to use to calibrate the O₂ cell.

An ID PROM is integrated into each O₂ cell. Its ID information and remaining lifetime can be read by the Servo-i.

Temperature sensor

A Temperature Sensor is integrated into the connector on top of the O₂ Cell. This sensor measures the temperature inside the Inspiratory Section.

The output signal, corresponding to the temperature in the Inspiratory Section, is used for regulation of the Internal Fan. The electronics for this regulation is located on PC 1775 Plug-and-play back-plane.

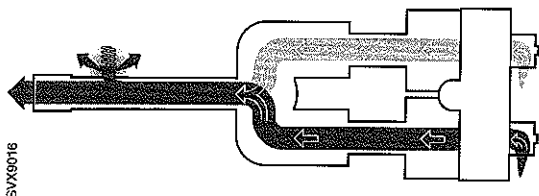
Inspiratory pressure tube

The Inspiratory Pressure Tube connects the Inspiratory Pipe with the Inspiratory Pressure Transducer. A bacteria filter protects the pressure transducer on PC 1781 Pressure Transducer from contamination.

Maintenance including exchange of bacteria filter according to User's manual. The bacteria filter must also be replaced during the 'Preventive maintenance'.

Safety valve

The movable axis of the Safety Valve Pull Magnet controls the opening and closing of the safety valve membrane in the Inspiratory Pipe. The pull magnet is electrically activated (closed) from the main block Expiratory Channel.



When the Safety Valve is not activated, the weight of the pull magnet axis, in combination with the design of the valve membrane, pushes the pull magnet axis downwards. This actuates the Safety Valve to be opened and the inspiratory gas is let out from the Inspiratory Pipe via the Safety Outlet thus enabling a decrease in the inspiratory pressure. The Safety Outlet is covered by a plastic grid.

This is normal safety (pop-off) function.

The opening conditions for the safety valve are:

- The ventilator is switched Off or Standby.
- The pressure inside the inspiratory pipe is 5 cm H₂O above the preset Upper Pressure Alarm limit. This condition is controlled by the Monitoring subsystem.
- The pressure inside the inspiratory pipe is 7 cm H₂O above the preset Upper Pressure Alarm limit. This condition is controlled by the Breathing subsystem.

- The pressure inside the inspiratory pipe is above 117 ±7 cm H₂O. This is an extra safety function and this situation will normally not occur.
- The safety valve will also be opened by some other alarms, e. g. the Out of gas-alarm.

During startup, the pull magnet is electrically activated so that the pull magnet axis is pushed up (with a clicking sound). This is the normal operational position of the pull magnet; the Safety Valve is normally kept closed.

The safety valve opening pressure is calibrated to 117 ±3 cm H₂O during each Pre-use check.

Inspiratory outlet

22 mm / 15 mm tube connector for the inspiratory tube of the patient breathing system.

PC 1780 Pneumatic back-plane

Interconnecting board including connectors for cables to the Gas Modules as well as to the Safety Valve and to the O₂ Cell and the Temperature Sensor.

Expiratory section

Functional Main Blocks diagram marking: 'E'

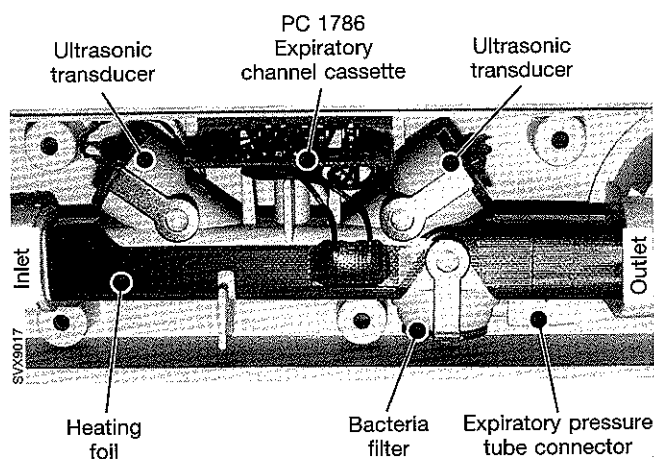
The main block Expiratory Section conveys the breathing gas from the patient breathing system to the Expiratory Outlet. It comprises:

- Measurement of expiratory flow
- Connection for measurement of expiratory pressure.
- Controlling element for the regulation of expiratory pressure.

Expiratory cassette

The expiratory gas conveying parts and PC 1786 Expiratory Channel Cassette are integrated into one part – the Expiratory Cassette – which can be easily removed for cleaning or exchange. See Servo-i Ventilator System – User's manual.

The expiratory cassette can be interchanged between different Servo-i systems. A Pre-use check is always required after exchanging the expiratory cassette.



Expiratory inlet

22 mm / 10 mm tube connector for the expiratory tube of the patient breathing system. The inlet is designed to make condensed water drip out and allow use of a water trap for such water to be collected. Expiratory inlet bacteria filter can be connected to protect the cassette from contamination.

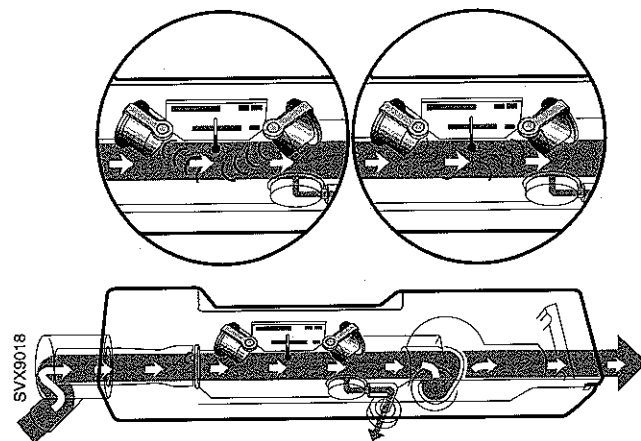
Heating foil

An electrical Heating Foil applied on the outside of the expiratory pipe where the Ultrasonic Flowmeter is situated. The purpose of the Heating Foil to reduce condensation and maintain a stable temperature in the expiratory gas.

Ultrasonic flowmeter

The Ultrasonic Flowmeter is a measuring device for the expiratory gas flow, using ultrasound technique with two ultrasonic transducers/receivers.

The measuring process is controlled from the main block PC 1784 Expiratory Channel.



The left hand side transducer is sending out ultrasonic sound that is reflected against the inner wall of the expiratory channel. The ultrasonic sound is received by the right hand side transducer now acting as a receiver. The time from sending to receiving ultrasonic sound in downstream expiratory gas flow is measured.

Then the right hand side transducer (earlier receiving) is sending out ultrasonic sound upstream the expiratory gas flow. The ultrasonic sound is received by the left hand side transducer now acting as a receiver. The time from sending to receiving ultrasonic sound in upstream expiratory gas flow is measured.

The time difference between the downstream and the upstream time measurements provides flow information.

A temperature sensor inside the cassette measures the expiratory gas temperature. This temperature measurement is also used when calculating the expiratory flow.

Bacteria filter and expiratory pressure tube

Via a Bacteria Filter inside the cassette, the Expiratory Pressure Tube connects the cassette to the Expiratory Pressure Transducer. The filter and the connector are integrated parts of the cassette. The filter protects the transducer on PC 1781 Pressure Transducer from contamination.

Expiratory valve

The Expiratory Valve consists of a membrane in the cassette that is operated by the axis of the Expiratory Valve Coil. The valve is fully open as long as no power is supplied to the coil.

Operating capacity for the membrane is estimated to 10.000.000 breathing cycles. When this limit is passed or if the membrane for some reason has become defective, it must be replaced. Refer to instructions in chapter 'Disassembling and assembling'.

Remaining operating capacity (in %) for the membrane can be shown in the Status window. Select Status / Exp. cassette to check 'Remaining membrane capacity'. The operating capacity meter must be reset after replacement of the membrane.

Expiratory valve coil

The movable axis of the Expiratory Valve Coil controls the opening of the Expiratory Valve by pushing the valve membrane into desired position. The power supply to the coil is regulated so that the remaining pressure in the patient system, towards the end of the expiration time, is kept on the PEEP level according to front panel setting.

Expiratory outlet with expiratory one-way valve

The gas from the patient system leaves the ventilator via this Expiratory Outlet. Backflow via the cassette is prevented by the Expiratory One-Way Valve. Its rubber membrane and valve seat are integrated parts of the Expiratory Outlet.

PC 1786 Expiratory channel cassette

The PC 1786 Expiratory Channel Cassette is a connection board, integrated into the Expiratory Cassette, for the Ultrasonic Flowmeter and for the Heating Foil. It connects to PC 1785 mounted in the expiratory cassette compartment.

Includes an ID PROM. The ID information can be read by the Servo-i System.

PC 1785 Expiratory channel connector

The PC 1785 Expiratory Channel Connector is a connector board including signal filters that is mounted in the expiratory cassette compartment. It connects to PC 1786 mounted in the Expiratory Cassette when the cassette is docked to the expiratory cassette compartment.

PC 1770 Main back-plane

Interconnection board for the PC boards in the lower part of the patient unit.

The ventilators System ID (Serial No.), configuration, time stamp for preventive maintenance, etc, is stored in an EEPROM on PC 1770. Thus, when replacing PC 1770, a spare part that is factory programmed for the concerned ventilator must be used.

As the preventive maintenance time stamp will be reset when replacing PC 1770, a new time stamp must be set via the Biomed menu. In order to make this new time stamp correct, the preventive maintenance must be performed. Refer to chapter 'Preventive maintenance'.

Pressure transducers

Functional Main Blocks diagram marking: 'T'

PC 1781 Inspiratory pressure transducer

The pressure, conveyed via the pressure tube connected to this block, is led to and measured by its differential pressure transducer. With differential reference to the ambient pressure, the output signal is proportional to the measured pressure thus giving a linear measurement in the range -40 cm H₂O to +160 cm H₂O.

Technical limitation: Pressure exceeding ± 400 cm H₂O must be avoided.

Includes an ID PROM. The ID information can be read by the Servo-i System.

PC 1781 Expiratory pressure transducer

Function identical to PC 1781 Inspiratory Pressure Transducer.

PC 1784 Expiratory channel

Functional Main Blocks diagram marking: 'F'

The main block Expiratory channel comprises microprocessor control to achieve measurement of expiratory flow. The output signal Exp. Flow is used in the main block Control.

Electronics including microprocessor (μ P) for handling of:

- All electronic connections to and from the Expiratory Section functions.
- Measurement of airway pressures in both Inspiratory Section and Expiratory Section.
- Control of the Safety Valve functions in the Inspiratory Section.

A thermistor on PC 1784 monitors the temperature inside the Patient Unit. An alarm is activated if the temperature is $77 \pm 5^\circ\text{C}$ ($170 \pm 9^\circ\text{F}$) or higher.

Includes an ID PROM. The ID information can be read by the Servo-i System.

Note: The System SW must be re-installed if PC 1784 is replaced.

PC 1771 Control

Functional Main Blocks diagram marking: 'C'

The main block Control comprises microprocessor control of Breathing pattern for all different ventilation modes.

Electronics including microprocessor (μ P) control to achieve:

1. Regulation of Inspiratory flow which is used during inspiration time in Volume Control (VC) mode.
2. Regulation of Inspiratory pressure which can be used during inspiration time in any mode.
3. Regulation of a constant Inspiratory flow which is used during expiration time in all modes.
4. Respiratory timing pattern including frequency as well as distribution of the duration for Inspiration time, Pause time and Expiration time according to front panel settings.
5. Regulation of Inspiratory flow during inspiration time. The desired total Inspiratory flow value according to front panel settings is used to generate the flow reference signals Insp Flow Ref 1 and Insp Flow Ref 2. The level relation between these two flow reference signals depends on the desired O_2 concentration according to front panel setting. Insp Flow Ref 1 and Insp Flow Ref 2 are used for the control of its respective Gas Module (Air and O_2).

Regulation of a constant Inspiratory flow during expiration time: The desired constant Inspiratory flow value is the default or preset Bias flow value (see User's manual).

This desired constant Inspiratory flow value is used to generate the flow reference signals Insp Flow Ref 1 and Insp Flow Ref 2 with the same relation and same handling as described above under "Regulation of Inspiratory flow..." except this occurs during expiration time.

The electronics controlling the optional Servo Ultra Nebulizer is located on PC 1771 Control.

Includes an ID PROM. The ID information can be read by the Servo-i System.

Note: The System SW must be re-installed if PC 1771 is replaced.

A lithium battery on PC 1771 power supplies the internal memory on the PC board. If the battery on PC 1771 is disconnected or if the battery voltage is too low, user default configurations made via the Field Service System (FSS) and Pre-use check results including transducer calibrations will be erased. The lithium batteries must be replaced after 5 years.

PC 1772 Monitoring

Functional Main Blocks diagram marking: 'M'

The main block Monitoring comprises microprocessor (μ P) calculation of parameters and monitoring of alarm limits with control of alarms (as well as back-up alarm). The main block Monitoring cooperates with the Loudspeaker in the User Interface.

The PC 1772 Monitoring handles all supervision and alarms in the system. It activates pressure reducing mechanisms, including activation of the safety valve, in case of excessive breathing system pressure.

All alarms are conveyed and displayed on the front panel and the alarm sound is also generated. In case of malfunction in the loudspeaker located on PC 1777 Panel, a back-up sound generating device (buzzer) on PC 1772 will be activated automatically. This buzzer is monitored by a microphone at startup and during the Pre-use check.

The following voltages are supervised:

- +24 V
- +12 V
- -12 V
- +5 V
- +3.3 V.

The buzzer on PC 1772 Monitoring generates the alarm signal in case of +5 V or +3.3 V power failure. The buzzer and +5 V / +3.3 V failure logic is powered by back-up capacitors in case of power failure.

The alarm signal used by the optional 'Alarm output connection' is generated on PC 1772.

PC 1772 also contains a barometric transducer and the measured barometric pressure is supplied to the other sub-units in the system.

Trending of measured parameters are performed by Monitoring.

A thermistor on PC 1772 monitors the temperature inside the Patient Unit. An alarm is activated if the temperature is $77 \pm 5^\circ\text{C}$ ($170 \pm 9^\circ\text{F}$) or higher.

Includes an ID PROM. The ID information can be read by the Servo-i System.

Note: The System SW must be re-installed if PC 1772 is replaced.

A lithium battery on PC 1772 power supplies the internal memory on the PC board. If the battery on PC 1772 is disconnected or if the battery voltage is too low, all logs and Pre-use check results including transducer calibrations will be erased. The lithium batteries must be replaced after 5 years.

Power supply

Functional Main Blocks diagram marking: 'P'

The main block Power Supply comprises conversion of mains power to internal power supply as well as the Module unit-connections for optional Battery modules and/or other optional modules.

The power modes in the Servo-i System are:

- At Power up, i. e. when the On/Off switch is turned On, all internal voltages will be enabled.
- At Power down, the Power supply system will deactivate the hardware signal Power_Good.H, and at the same time keep the internal voltages +5 V and +3.3 V for at least 1 ms, in order to let the different subsystems save their current settings in non-volatile memory. Power down can be caused by:
 - Turning the On/Off switch Off.
 - Mains failure and no back-up battery connected.
 - The system is powered from a battery, but the battery voltage is too low for proper operation of the system.

In this Off mode, only charging of Battery modules is enabled (if the system is connected to mains). All other circuitry is un-powered.

- In Standby all circuitry is powered from the Power supply, but no breathing will be active. The operator can set all parameters, including breathing mode, during Standby.

Mains inlet

Inlet for mains power supply including grounding connection.

The Servo-i System will automatically adjust to the connected mains power if the mains power is within specified range. No voltage or frequency setting is required.

The mains inlet is equipped with two mains power fuses, F11 and F12, rated 2.5 A.

AC/DC Converter

Converts the connected AC Power (inlet voltage 85–250 V AC) to the internal DC supply voltage +12 V_Unreg.

PC 1778 DC/DC & Standard connectors

Converts the internal DC supply voltage +12 V_Unreg into the following internal DC supply voltages:

- +24 V
- +12 V
- -12 V
- +5 V
- +3.3 V

All standard connectors are located on this board. The connectors are the following:

- N26 – External +12 V DC supply input. The connectors is equipped with a fuse F1, rated 10 A.
- N27 – Optional equipment.
- N28 – Control cable.
- N29 – RS232.

Pin configuration and signal names can be found in chapter 'Diagrams'.

Includes an ID PROM. The ID information can be read by the Servo-i System.

PC 1775 Plug-and-play back-plane

Connects the Optional Modules that are inserted in the Module Unit.

PC 1775 also controls:

- Charging / discharging of the Battery modules.
- Switching between Mains / Battery / External 12 V power supply.
- Internal fan using input signals from the Temperature sensor in the O₂ cell connector.

Includes an ID PROM. The ID information can be read by the Servo-i System.

Module unit

Connection slots for 6 optional modules, e. g. Battery modules or CO₂ Analyzer module.

Internal fan

The Internal Fan forces cooling air through the Patient Unit. The cooling air flow inside the Patient Unit is indicated in the 'Functional Main Block Diagram'. The cooling air outlets are located in the expiratory section.

The Internal Fan is controlled by the Temperature Sensor in the O₂ cell connector via electronics on PC 1775 Plug-and-play back-plane.

The fan will start with half effect at approx. 33 °C (91 °F) and with full effect at approx. 43 °C (109 °F). When the temperature drops below approx. 37 °C (99 °F), the fan turns to half effect and when the temperature drops below approx. 27 °C (81 °F), the fan stops.

The air inlet is protected by a filter that must be cleaned or replaced during the 'Preventive maintenance'.

Optional PC board slots

Functional Main Blocks diagram marking: 'X'

For optional equipment, the Servo-i is equipped with two extra PC-board slots.

The optional Alarm output connector (see below) is mounted in one of the extra PC-board slots.

Alarm output connector (optional)

Functional Main Blocks diagram marking: 'A'

PC 1789 Remote alarm connector containing the optional function 'Alarm output connector' is mounted in the extra PC-board slot located below PC 1778 DC/DC & Standard connectors.

The Alarm output connector enables connection of an external alarm signal system to the Servo-i System. High and medium priority alarms are transferred, and the alarm output signal is active as long as the audio alarm is active on the ventilator.

The Alarm output connector has two contact functions: NO (Normally Open) and NC (Normally Closed). In an alarm situation the open contact will close and the closed one will open. The contacts are independent of polarity and can be used both with AC and DC systems.

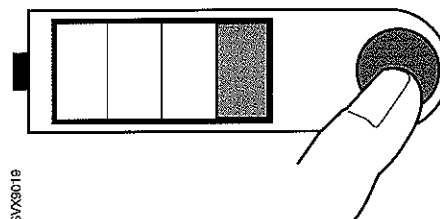
Pin configuration and signal names in P67 – Alarm output connector can be found in chapter 'Diagrams'.

The 'Alarm output'- function must be enabled in the configuration software.

For further information, refer to the 'Alarm output connector – Reference Manual'

Battery modules (optional)

The Battery module is rated 12 V, 3.5 Ah. Battery backup time is approx. 0.5 hour/battery. Up to six backup Battery modules can be connected to the Module unit.



Press the battery power symbol button to check the battery status. The lit sections of the battery power scale show remaining capacity.

- If no section is lit, the battery is fully discharged, e.g. due to long storage time, and requires up to 12 hours/battery charging time.
- If one section is lit or flashing, the battery requires approx. 3 hours/battery charging time.

The battery lifetime is limited and the batteries must thus be replaced after 3 years. Manufacturing date (year-week) is printed on the battery label.

Each battery includes an ID PROM. The ID information can be read by the Servo-i System.

CO₂ Analyzer module (optional)

The CO₂ Analyzer module is an optional accessory that is connected to the Module unit.

The CO₂ Analyzer option allows for continuous monitoring shown in a waveform (capnogram) and as numericals on the screen.

The CO₂ Analyzer module is, via a cable, connected to a Capnostat sensor mounted on an airway adapter at the Y-piece. The sensor uses a solid state and IR based optical system with no moveable parts. It measures the difference between a reference light beam and one filtered for CO₂ wavelength.

The 'CO₂ Analyzer'- function must be enabled in the configuration software.

Control cable

This Control Cable connects the Patient Unit and the User Interface. The cable can be partly wound up under a rubber cover on the rear of the User Interface.

Only personnel trained and authorized by Maquet shall be permitted to perform installation, service or maintenance of the Servo-i.



Make sure to prepare the Servo-i properly before disassembling and assembling. Refer to section 'Hazard notices' in chapter 'Important'.

Any service or maintenance must be noted in a log book.

Discard disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.

After any installation, maintenance or service intervention in the Servo-i, perform a 'Pre-use check'. Refer to the 'Servo-i Ventilator System – User's Manual' for details.

4. Disassembling and assembling

General	4 - 2
Preparations	4 - 2
Handling PC boards	4 - 2
Replacing PC boards	4 - 2
Assembling guidelines	4 - 2
Tightening torque	4 - 2
Threadlocking adhesives	4 - 2
User Interface	4 - 3
PC 1777 Panel	4 - 4
Backlight inverter	4 - 4
TFT Display	4 - 4
Backlight lamps	4 - 5
Touch screen assembly	4 - 6
Patient Unit	4 - 8
Front cover	4 - 8
PC 1771, PC 1772 and PC 1784	4 - 9
AC/DC Converter	4 - 9
Module unit including PC 1775	4 - 10
PC 1778 DC/DC & Standard connectors	4 - 11
Internal fan	4 - 11
PC 1789 Remote alarm connector	4 - 12
PC 1770 Main back-plane	4 - 12
Inspiratory channel	4 - 13
Safety valve membrane	4 - 13
PC 1780 Pneumatic back-plane	4 - 13
Gas modules	4 - 14
PC 1785 Expiratory channel connector	4 - 15
Expiratory valve coil	4 - 15
Expiratory cassette membrane	4 - 16
Fixed battery module	4 - 18
Control cable	4 - 18

General

Disassembling of the main units in the Servo-i System is described in this chapter. If not stated otherwise, the assembling procedure is the reverse of the described disassembling procedure.

The illustrations in the Servo-i Spare Parts List are very useful as a guide when disassembling and assembling the Servo-i System.

4

Preparations

Before disassembling or assembling the Servo-i:

- Set the On / Off switch on the User Interface to **Off**.
- Disconnect the mains power cable.
- Disconnect the gas supplies (wall and/or tank).
- Disconnect Battery modules.
- Make sure that all gas conveying parts are cleaned according to instructions in the 'Servo-i Ventilator System – User's manual'.

After any service intervention in the Servo-i, perform a 'Pre-use check' according to instructions in the 'Servo-i Ventilator System – User's manual'.

Handling PC boards

The PC boards contain components that are highly sensitive to static electricity.

Those who come into contact with circuit boards containing sensitive components must take certain precautions to avoid damaging the components (ESD protection).



When working with ESD sensitive components, always use a grounded wrist band and grounded work surface. Adequate service tools must also be used.

PC boards (spare parts) must always be kept in protective packaging for sensitive electronic device.

PC boards must not be inserted or removed while the mains power or battery power is applied to the PC boards.

Remove and insert the PC boards very carefully to avoid damage to the connectors.

Replacing PC boards

The Servo-i software is distributed on different subsystems, located on the following PC boards:

- PC 1771 Control
- PC 1772 Monitoring
- PC 1784 Expiratory Channel
- PC 1777 Panel.

When delivered as spare parts, these PC boards are equipped with a 'System SW version' that may differ from the version on the unit to be repaired.

To keep the 'System SW version' used prior to the PC board replacement, a 'SW version update card' with the applicable 'System SW version' must be available for re-installation purposes.

For functionality enhancement, the latest released version of the System SW is always recommended.

Before installing a new 'System SW version' on a unit, ensure that the software is fully compatible with all HW-, SW- and mechanical components in the unit. If any compatibility conflicts are apparent this will be noted on the 'MAQUET Critical Care SW download' web site.

Assembling guidelines

The Servo-i system specifications allow unit operation also during patient transportation. All parts of the User Interface and the Patient Unit assembled with screws and nuts are therefore tightened with a specified torque and secured with threadlocking adhesives.

In order to maintain these specifications over time, it must be ensured that after any service intervention removed parts are re-assembled and secured according to instructions. Make sure to follow the guidelines stated below.

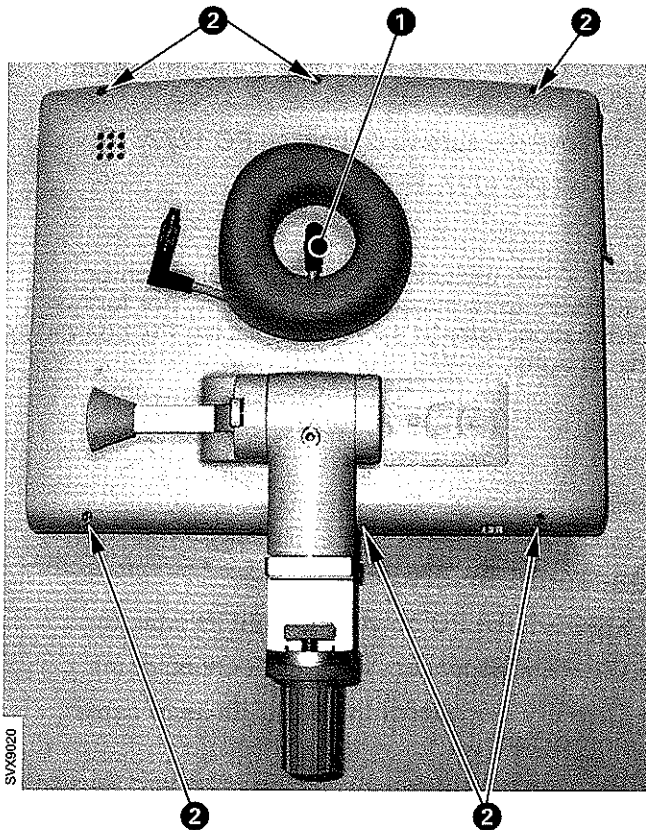
Tightening torque

- Thread size M3: 0.95 ±0.05 Nm
- Thread size M4–M6: 3.1 ±0.1 Nm.

Threadlocking adhesives

- Electrolube Bloc'Lube BLV15ML® on threads in contact with PC boards.
- Loctite 243® on all other threads.

Note: Threadlocking adhesive is not required on Heli-Coil® screw thread inserts as these screw thread-inserts have a self-locking function.



User Interface

To separate the front panel section from the rear cover:

- Disconnect the control cable (1).
- Remove the screws (2).
- Lift off the rear cover from the front panel section.

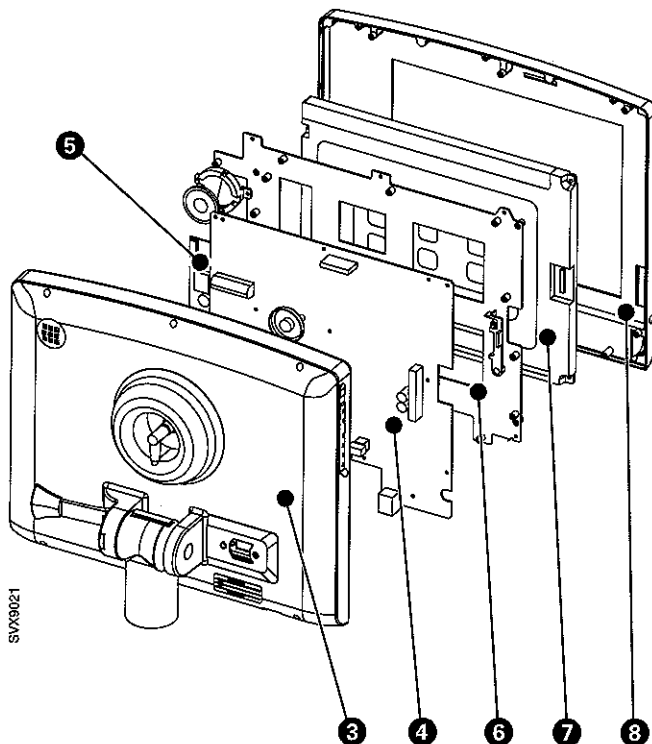
All parts inside the front panel section are now accessible.

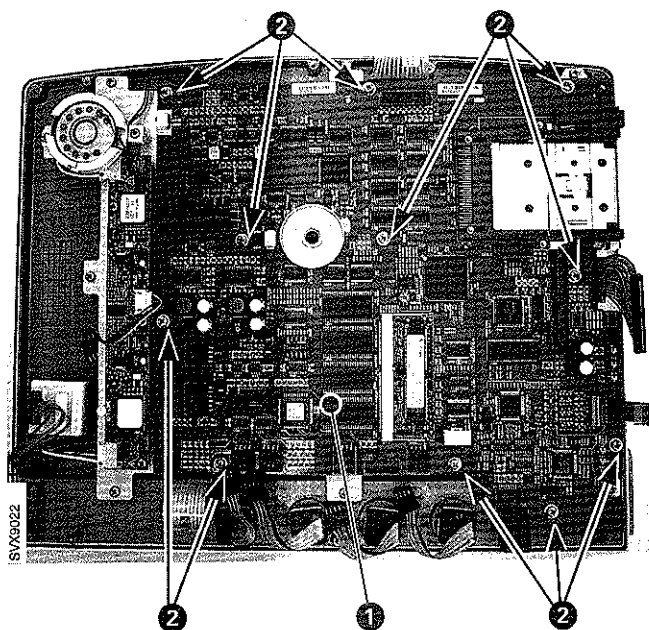
With power supply connected to the Servo-i, there are energized electrical components inside the unit, e. g. the backlight lamps that are supplied with 660 V by the Backlight Inverter. All personnel must exercise extreme caution if fault tracing or adjustments are performed with power supply connected and with the user interface rear cover removed.

4

The main parts of the User Interface are:

- Rear cover (3).
- PC 1777 Panel (4).
- Backlight Inverter (5).
- Support plate (6).
- TFT Display (7) including Backlight lamps.
- Touch screen assembly (8).





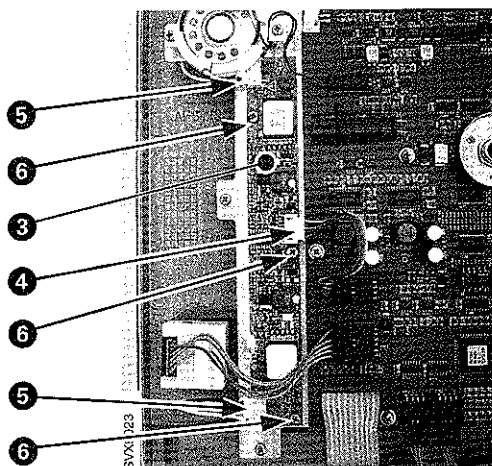
PC 1777 Panel

To remove PC 1777 Panel (1):

- Carefully disconnect all cable connectors from PC 1777.
- Remove the screws (2) holding PC 1777.
- Lift off PC 1777.

Note: When replacing PC 1777 Panel, it can be necessary to re-install the System SW. For further information, refer to section 'Replacing PC boards' in this chapter.

4



Backlight Inverter

To remove the PC board Backlight Inverter (3):

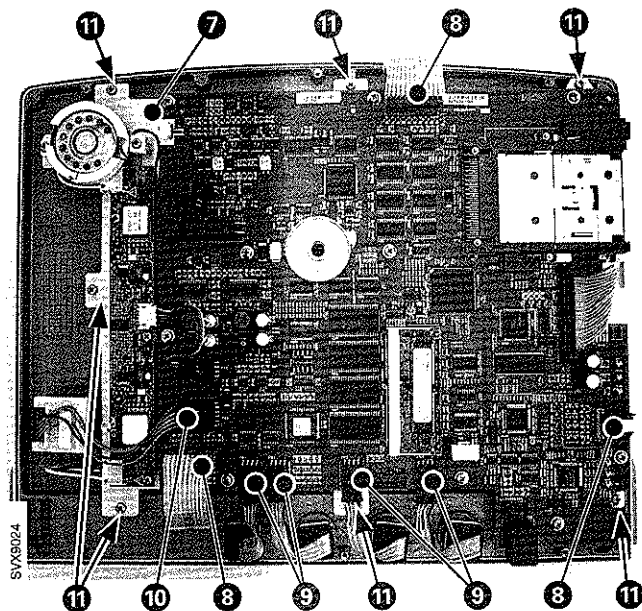
- Carefully disconnect the cable connector (4).
- Carefully disconnect the backlight lamp cable connectors (5).
- Remove the screws (6) holding PC board Backlight Inverter.
- Lift off PC board Backlight Inverter.

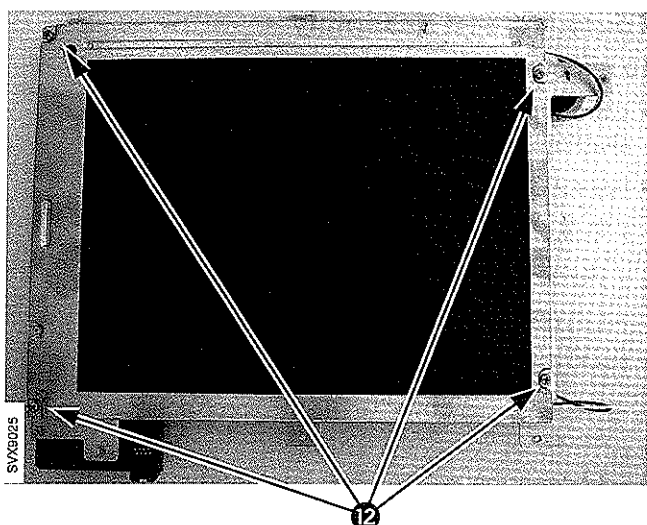
TFT Display

Note: Disassembling of the TFT Display must be performed in a clean and dustfree environment, as the TFT Display is sensitive to contaminants.

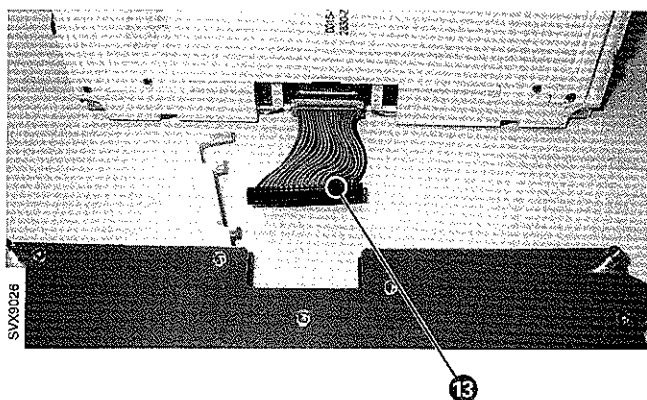
The TFT Display is mounted under the support plate (7). To remove the TFT Display:

- Disconnect the three touch-screen flat-cables (8).
- Disconnect the four Direct access control-cables (9).
- Disconnect the Main rotary dial-cable (10).
- Remove the screws (11) holding the support plate.
- Lift off the support plate-assembly, including TFT Display and PC boards.





- Remove the screws (12) holding the TFT Display to the support plate.



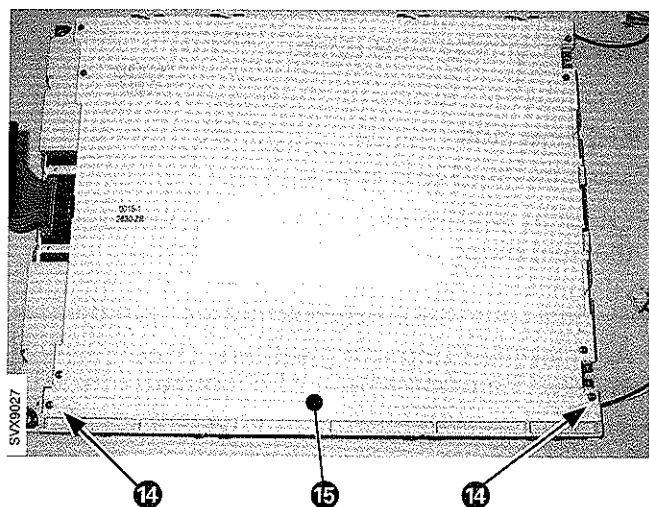
- Carefully disconnect the cable (13) from PC 1777 as shown in the illustration and/or from the TFT Display connector.

4

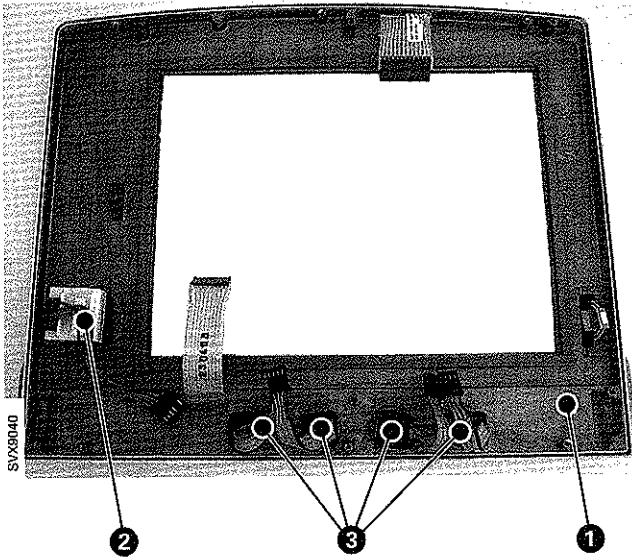
Backlight lamps

To access the Backlight lamps:

- Lift off the TFT Display. Refer to section 'TFT Display'.
- Remove the screws (14) holding the lamp. On older units, the lamps are mounted with a snap-in holder.
- Lift off the lamp (15).



Note: The Backlight lamp kit includes two lamps. Always replace both lamps at the same time. Using the Field Service System (FSS), a time meter for the lamps can be shown. This time meter must be reset after replacement of the lamps.



4

Touch screen assembly

To remove the Touch screen assembly (1):

- Lift off the TFT Display. Refer to section 'TFT Display'.
- Remove the Main rotary dial (2):
 - Pull off the Main rotary dial-knob.
 - Remove the nut holding the Main rotary dial.
 - Lift off the Main rotary dial.
- Remove the Direct access controls (3):
 - Remove the cover on each Direct access control-knob.
 - Loosen the nut on each knob and pull off the knobs.
 - Remove the nut holding each Direct access control and lift off the controls.

Note: When mounting the Main rotary dial and the Direct access controls on a new Touch screen assembly, make sure that the knobs are easy to turn.

Label strips

The touch screen assembly is delivered with label strips in different languages, which have to be mounted before the unit is taken into operation. Protective foils (1) separate the adhesive areas between the front panel film and the front panel.

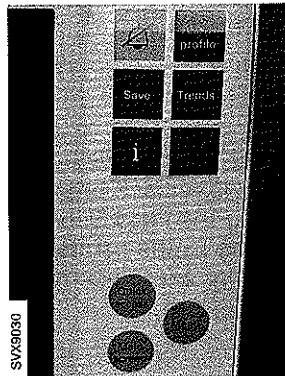
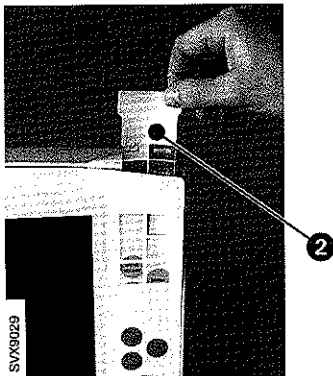
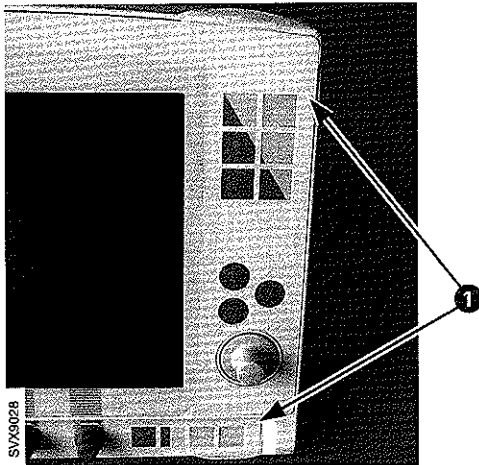
Mount the label strips as follows:

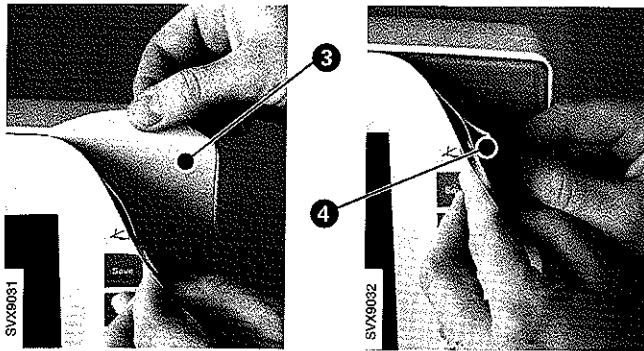
- Select the two appropriate label strips:
 - One label strip for the Fixed keys on the upper right-hand area, and
 - One label strip for the Special functions keys on the lower right-hand area of the User Interface.
- Discard all other label strips.

Fixed keys label

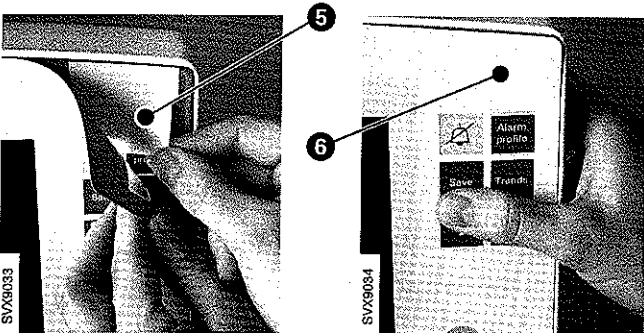
- Insert the fixed keys label strip (2).
- Check its position through the button windows of the front panel film. Adjust if necessary.

Align the label strip with great care. Once installed the process cannot be reversed.





- While holding the label strip in correct position, remove the protective foils (3 and 4).
- Press the label strip against the adhesive area.



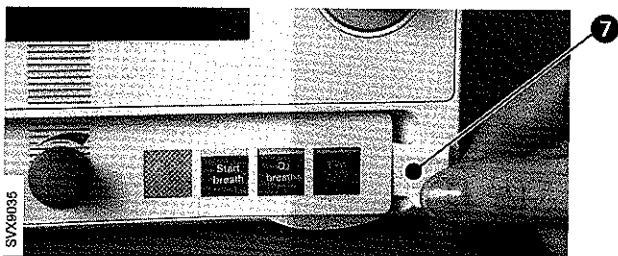
- Remove the protective foil (5).
- Press the front panel film (6) firmly against the front panel to ensure proper adhesion.

4

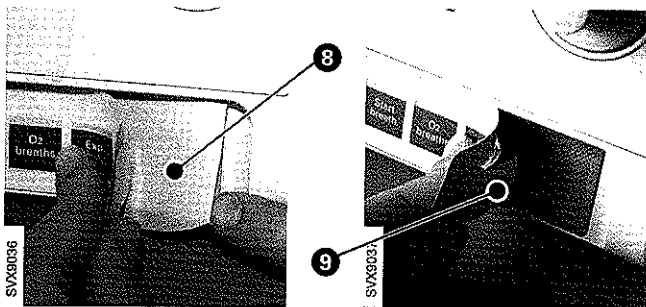
Special functions keys label

- Insert the Special functions keys label strip (7).
- Check its position through the button windows of the front panel film. Adjust if necessary.

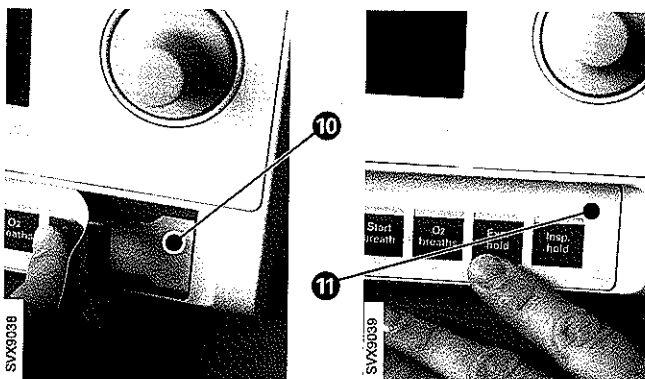
Align the label strip with great care. Once installed the process cannot be reversed.



- While holding the label strip in correct position, remove the protective foils (8 and 9).



- Press the label strip against the adhesive area.
- Remove the protective foil (10).
- Press the front panel film (11) firmly against the front panel to ensure proper adhesion.

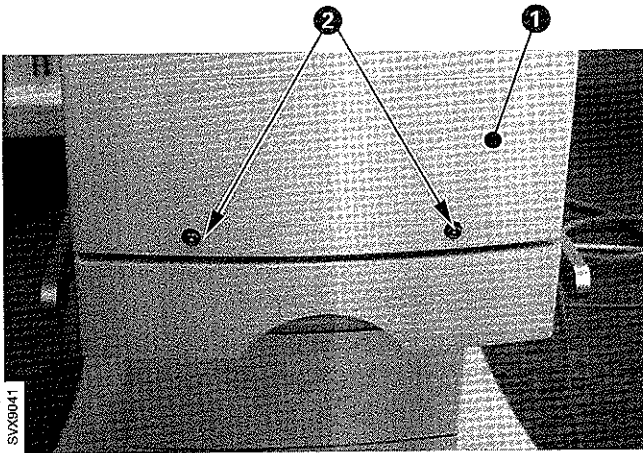


Patient Unit

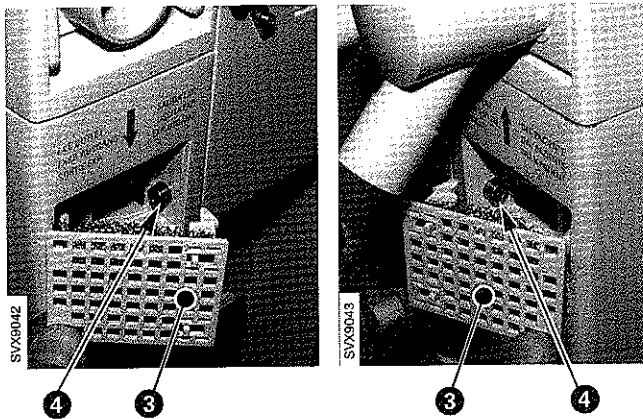
Front cover

To remove the Patient Unit front cover (1):

- Remove the screw covers and the screws (2).



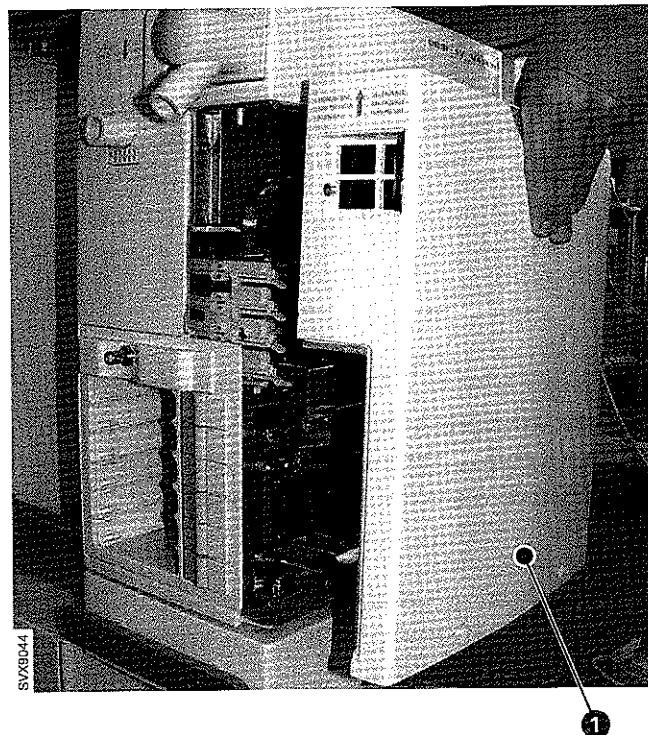
- Remove the two ventilation covers (3).
- Remove the two screws (4).

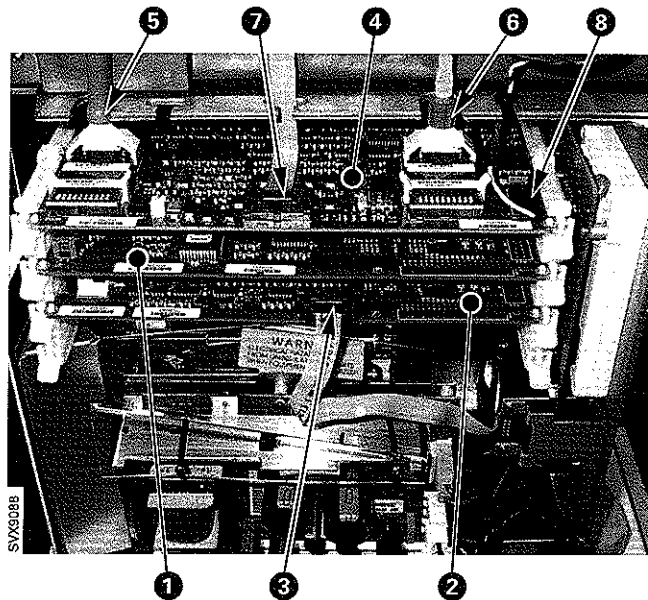


- Carefully lift off the Patient Unit front cover (1).

Note: When assembling the unit, make sure that the inspiratory and expiratory pressure transducer tubes and the PC 1785 and expiratory valve coil cables are not damaged by the Patient Unit front cover (1).

With power supply connected to the Servo-i, there are energized electrical components inside the unit. All personnel must exercise extreme caution if fault tracing or adjustments are performed with power supply connected and with the Patient Unit front cover removed.



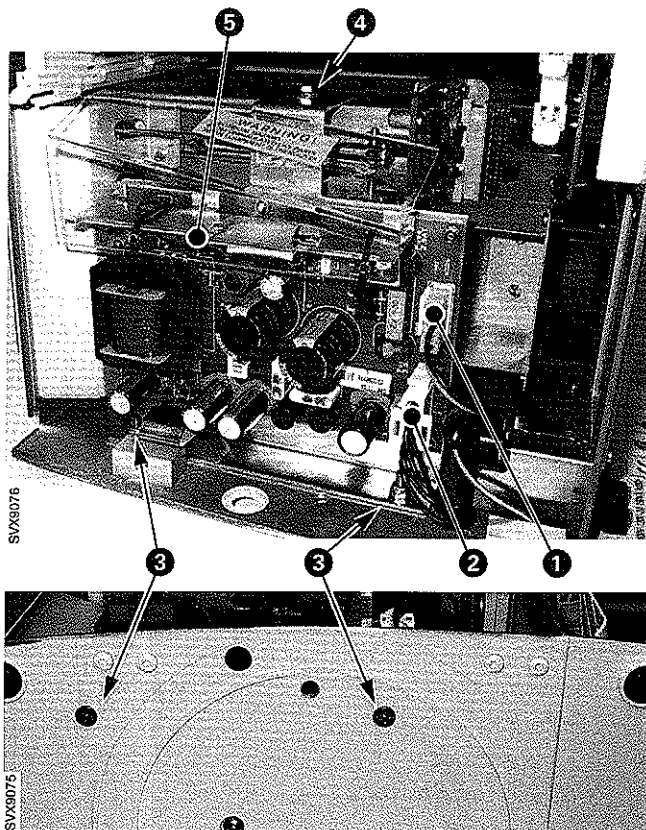


PC 1771, PC 1772 and PC 1784

- Remove the Patient Unit front cover.
- PC 1771 Control (1):
 - Release the locks on the PC board guides.
 - Carefully pull out the PC board.
- PC 1772 Monitoring (2):
 - Disconnect PC 1789 cable connector (3). This is the cable for the optional PC 1789 Remote alarm connector.
 - Release the locks on the PC board guides.
 - Carefully pull out the PC board.
- PC 1784 Expiratory channel (4):
 - Disconnect pressure transducer tubes (5 and 6)
 - Disconnect PC 1785 cable connector (7)
 - Disconnect Exp. valve coil cable connector (8).
 - Release the locks on the PC board guides.
 - Carefully pull out the PC board.

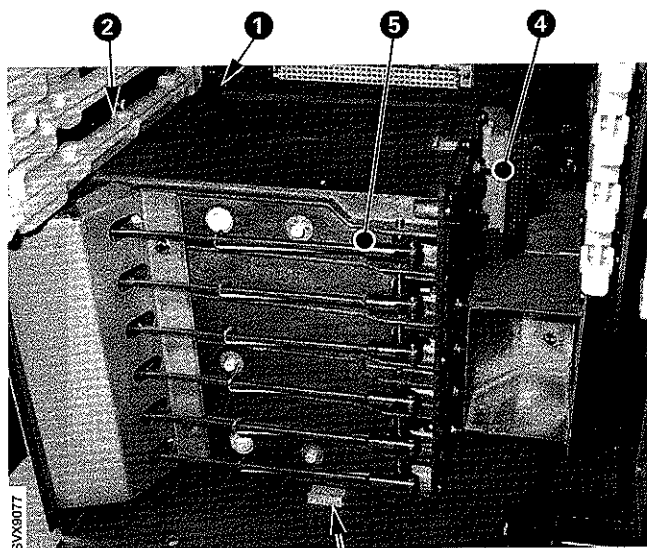
Note: When replacing PC 1771 Control, PC 1772 Monitoring or PC 1784 Expiratory Channel, it can be necessary to re-install the System SW. For further information refer to section 'Replacing PC boards' in this chapter.

4



AC/DC Converter

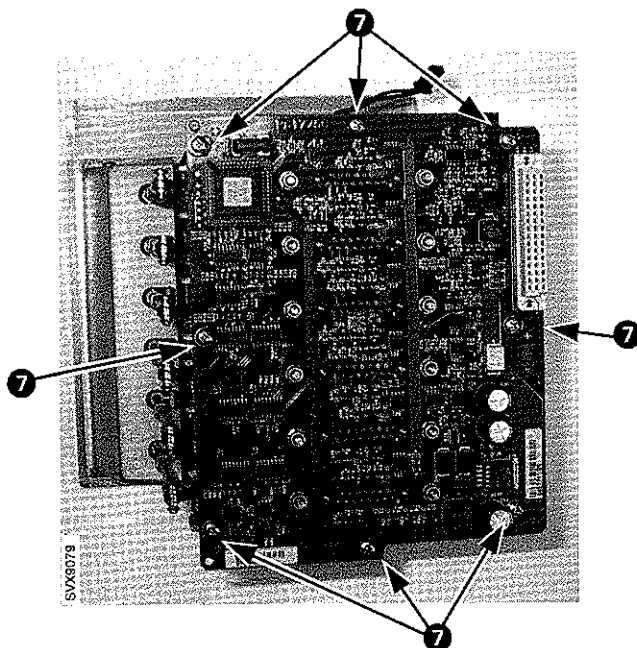
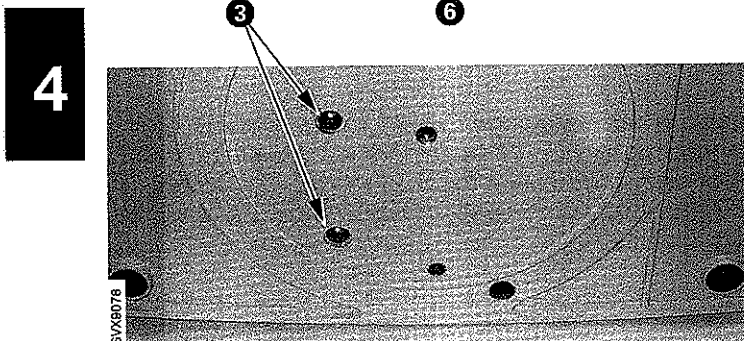
- Remove the Patient Unit front cover.
- Disconnect cable connectors (1 and 2).
- Remove the screws and nuts (3).
- Remove the screw (4).
- Carefully lift out the AC/DC Converter (5).



Module unit including PC 1775 Plug-and-play back-plane

- Remove the Patient Unit front cover.
- Remove the AC/DC Converter.
- Disconnect the nebulizer cable connector (1).
- Remove the screw (2).
- Remove the screws (3).
- Disconnect the Module unit/PC 1775 from PC 1770 Main back-plane at the connector (4).
- Carefully lift out the Module unit (5).

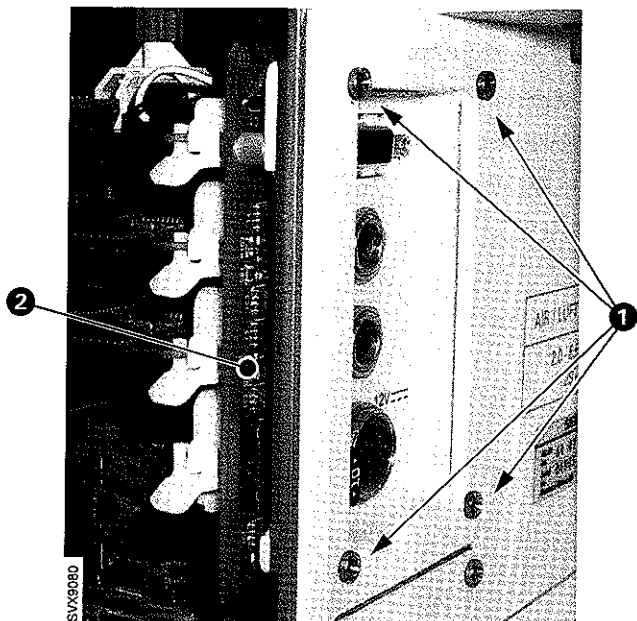
Note: When assembling the unit, make sure that the spacer (6) is in position with its flat side facing down. The spacer, designed as a wedge, should be pushed inwards before the screws (3) are tightened.



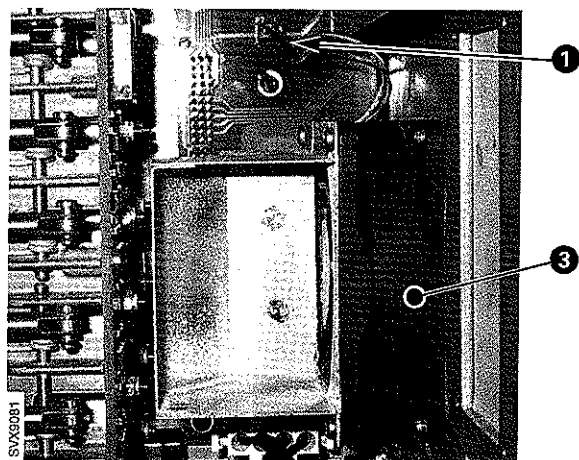
PC 1775 Plug-and-play back-plane is mounted on the Module unit with the screws (7).

PC 1778 DC/DC & Standard connectors

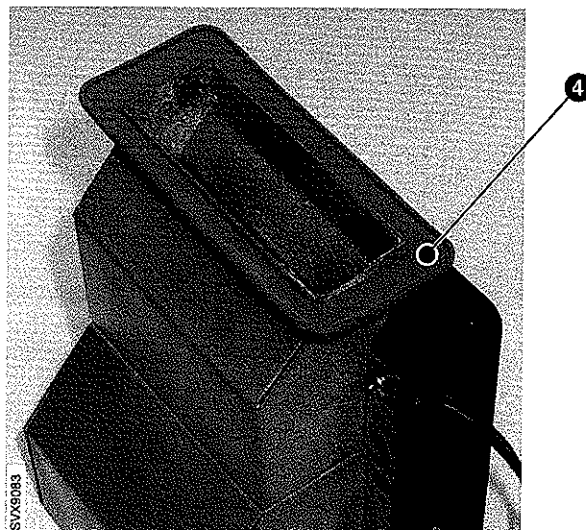
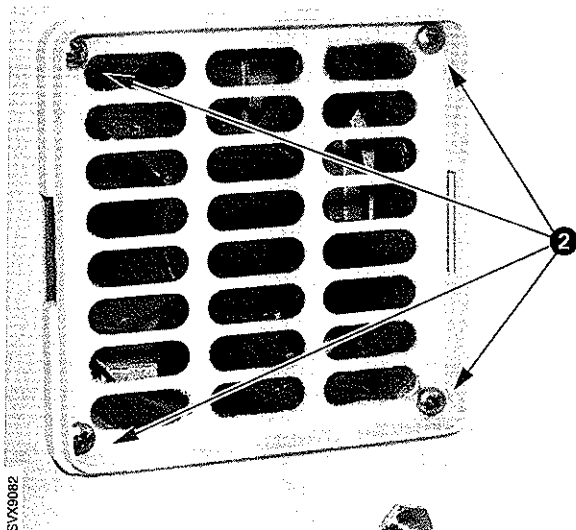
- Remove the Patient Unit front cover.
- Remove the screws (1).
- Carefully pull out PC 1778 (2).

**Internal fan**

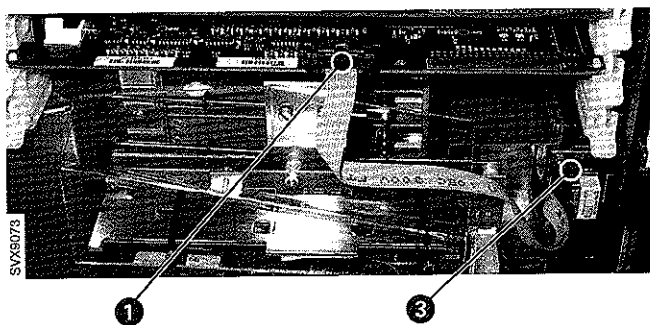
- Remove the AC/DC Converter.
- Remove PC 1789 Remote alarm connector if mounted.
- Disconnect the fan cable connector (1).
- Remove the screws (2).
- Carefully lift out the Internal fan (3).



Note: When assembling, make sure that the rubber seal (4) is mounted as shown in the illustration.



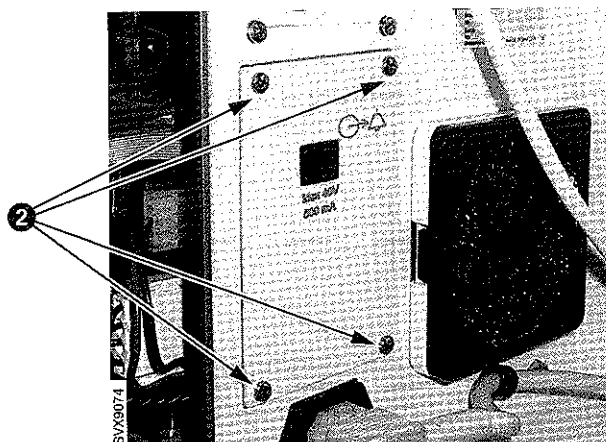
4



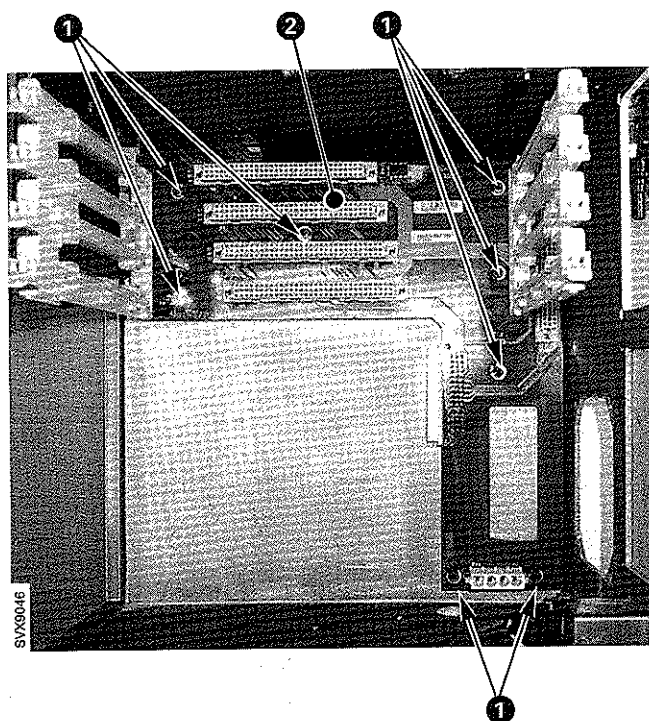
PC 1789 Remote alarm connector

PC 1789 Remote alarm connector is part of the optional Alarm output connector.

- Disconnect the cable (1).
- Remove the screws (2).
- Carefully lift out PC 1789 (3).



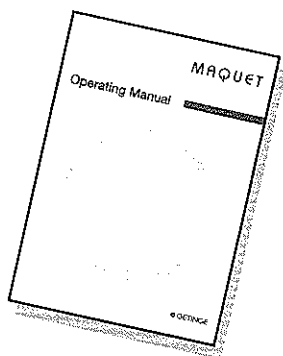
4



PC 1770 Main back-plane

- Remove PC 1780 Pneumatic back-plane (inside the Inspiratory section).
- Remove:
 - PC 1772 Monitoring
 - PC 1771 Control
 - PC 1784 Expiratory channel.
- Remove the AC/DC Converter.
- Remove the Module unit.
- Remove PC 1778 DC/DC & Standard connectors.
- Remove PC 1789 Remote alarm connector if mounted.
- Remove the Internal fan.
- Remove the screws (1).
- Carefully lift out PC 1770 (2).

Note: The ventilators System ID, configuration, time stamp for preventive maintenance, etc, is stored in an EEPROM on PC 1770 Main back-plane (2). Thus, when replacing PC 1770, a spare part that is factory programmed for the concerned ventilator must be used. For further information refer to chapter 'Description of functions'.



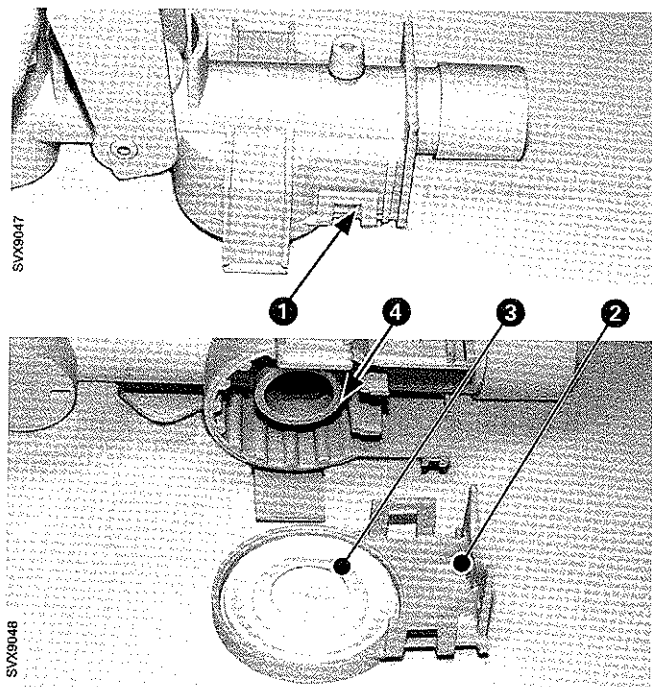
Inspiratory channel

Removal of the inspiratory channel, as well as replacement of O₂ cell/filter, is described in the User's manual, chapter 'Maintenance'.

Safety valve membrane

To remove the safety valve membrane:

- Remove the inspiratory channel.
- Release the latches (1), one on each side of the safety valve housing, and lift off the membrane holder (2).
- The membrane (3) and the valve seat (4) are now accessible, e.g. for inspection and cleaning.



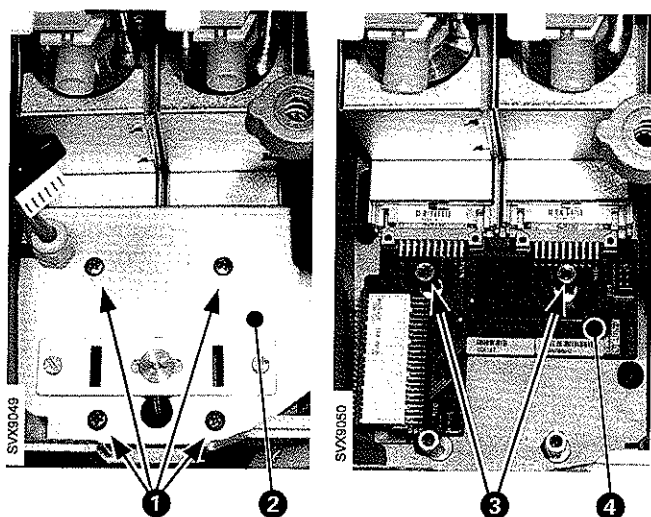
4

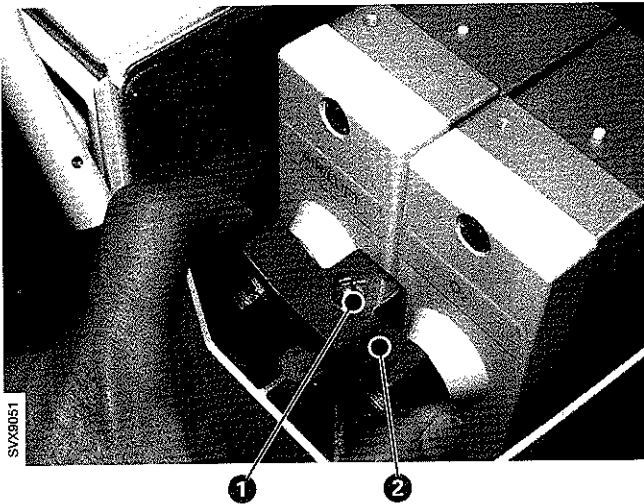
PC 1780 Pneumatic back-plane

To remove PC 1780:

- Remove the inspiratory channel including filter for the inspiratory pressure transducer.
- Remove the screws (1).
- Carefully lift the mounting plate (2) and disconnect the O₂ cell connector and the safety valve pull magnet connector from PC 1780.
- Lift off the mounting plate (2). The safety valve pull magnet is mounted on this plate.
- Pull out the gas modules to disconnect them from PC 1780.
- Remove the threaded studs (3).
- Disconnect and lift off PC 1780 (4).

Note: When assembling, the mounting plate (2) must be adjusted to correspond with the inspiratory channel latches.

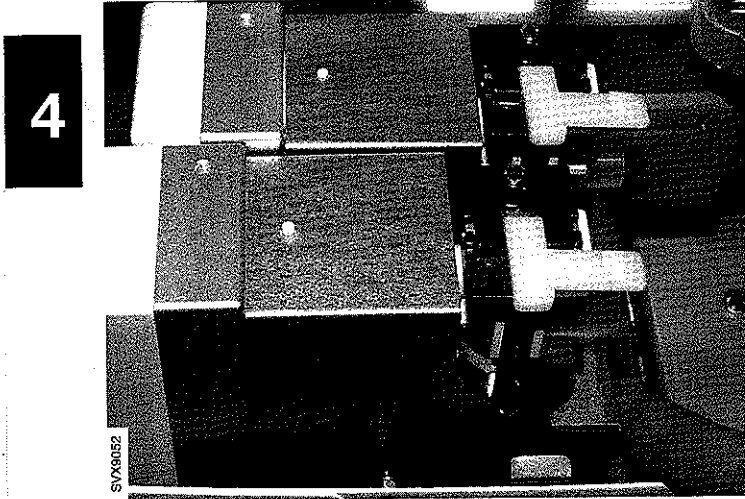




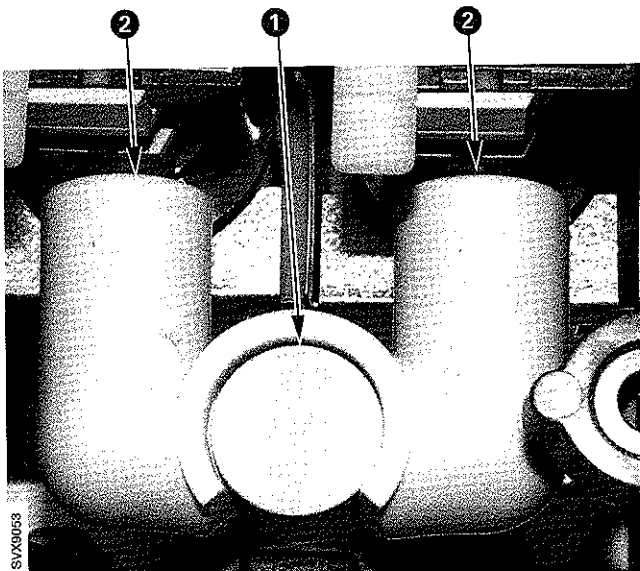
Gas modules

To remove the gas modules:

- Remove the inspiratory section cover.
- Loosen the screw (1).
- Lift off the gas module bracket (2).

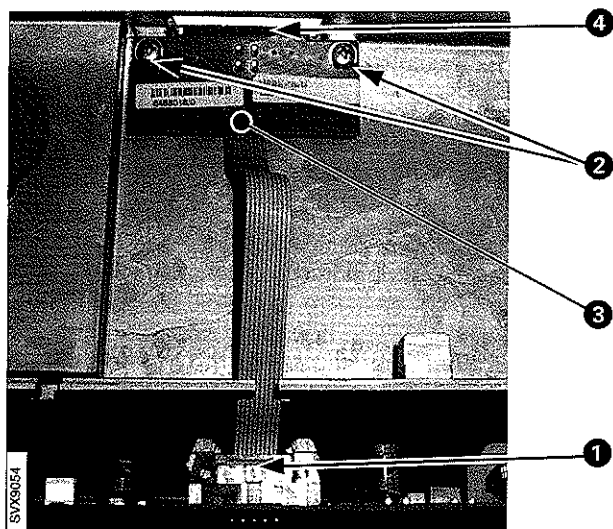


- Pull out and lift off both gas modules.



Note 1: When assembling, make sure that the connector muff properly seals around the inspiratory pipe (1). The connector muff must not be pushed too far onto the nozzle units (2).

Note 2: The gas modules used in Servo-i are factory adjusted for this purpose. When replacing gas modules, make sure to use only Servo-i gas modules. Similar gas modules intended for the SV 300/300A or KION / KION-i Systems must not be used.

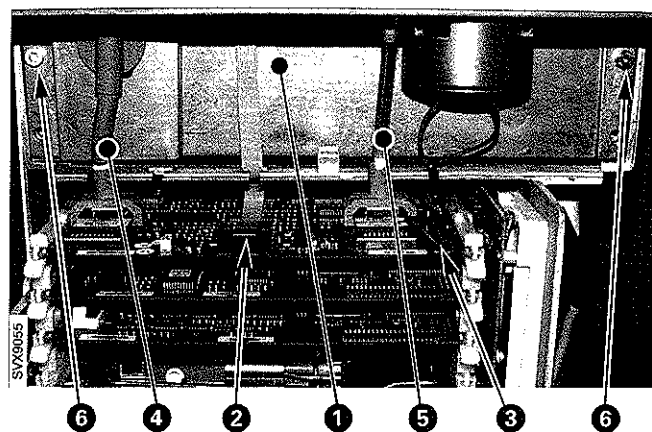


PC 1785 Expiratory channel connector

To remove PC 1785:

- Remove the Patient Unit front cover.
- Disconnect the PC 1785 cable connector (1).
- Remove the screws (2).
- Pull down and lift off PC 1785 (3).

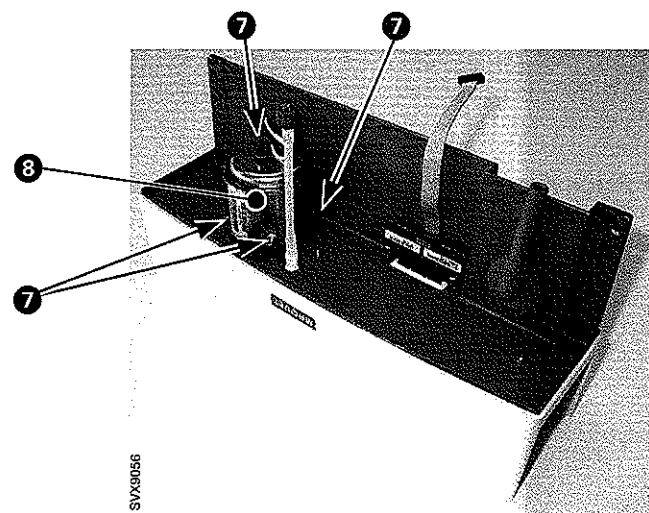
Note: When assembling, make sure that the rubber seal (4) is correctly seated around PC 1785.



Expiratory valve coil

To remove the expiratory valve coil:

- Remove the Patient Unit front cover.
- Disconnect the connectors (2 and 3) from PC 1784.
- Disconnect the tubes (4 and 5) from PC 1784.
- Disconnect the inspiratory pressure tube from the inspiratory pipe inside the inspiratory section (not visible in this illustration).
- Remove the two screws (6).
- Lift off the cassette compartment (1).



- Remove the screws (7).
- Lift off the expiratory valve coil (8).

4

Expiratory cassette membrane

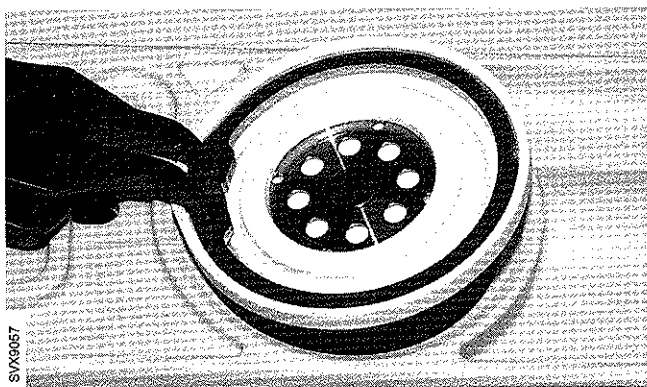
The expiratory cassette is a complete unit and must not be disassembled. The only part that can be replaced is the valve membrane.

Operating capacity for the membrane is estimated to 10.000.000 breathing cycles. When this limit is passed or if the membrane for some reason has become defective, it must be replaced.

Remaining operating capacity (in %) for the membrane can be shown in the Status window. Select Status / Exp. cassette to check 'Remaining membrane capacity'. The operating capacity meter must be reset after replacement of the membrane.

It is very important for the function of the expiratory valve that the valve membrane is removed and mounted correctly as described below.

4

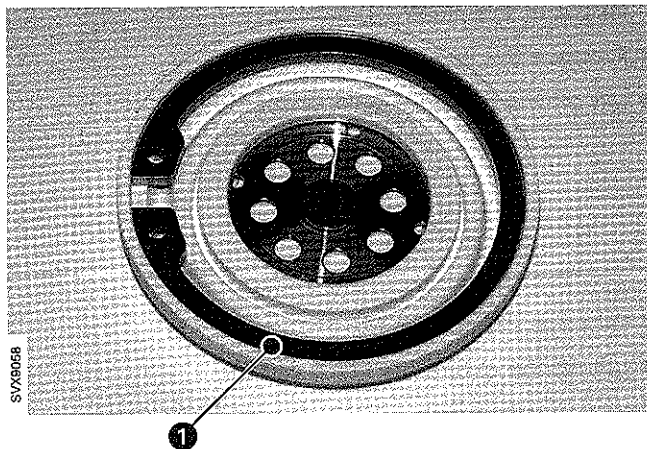


To remove the valve membrane from the cassette:

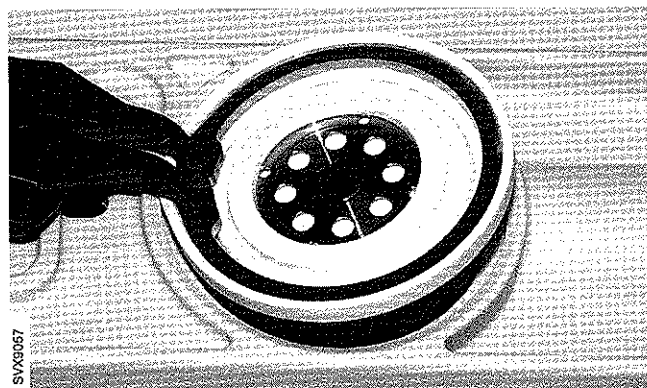
- Carefully remove the membrane including retaining ring using a suitable retaining ring pliers.

To mount the valve membrane into the cassette:

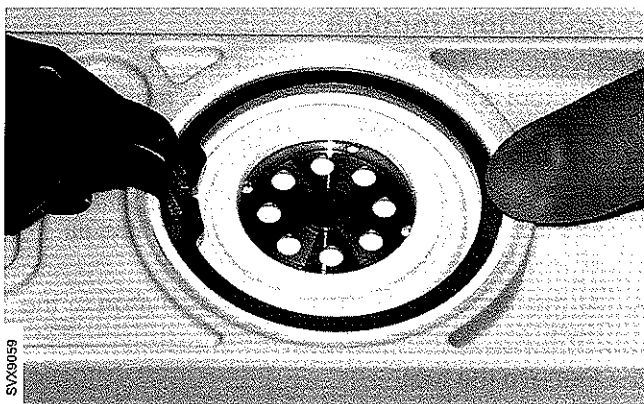
- Place the retaining ring (1) correctly into the membrane.



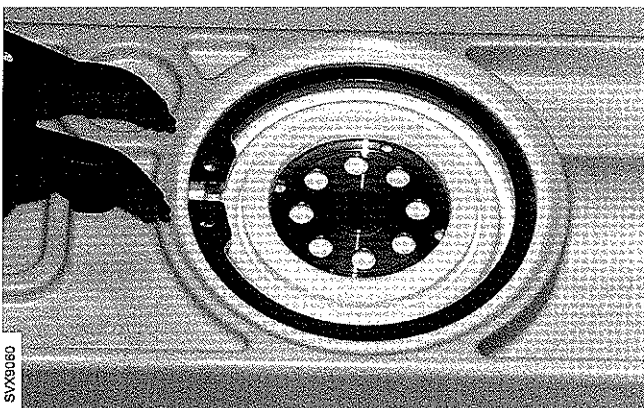
It is very important that the valve membrane and the membrane seat in the cassette is clean. Dirt particles can create leakage in the cassette.



- Place the membrane onto the cassette as shown in the illustration.



- Squeeze the retaining ring pliers and carefully press the membrane in place into the cassette as shown in the illustration.

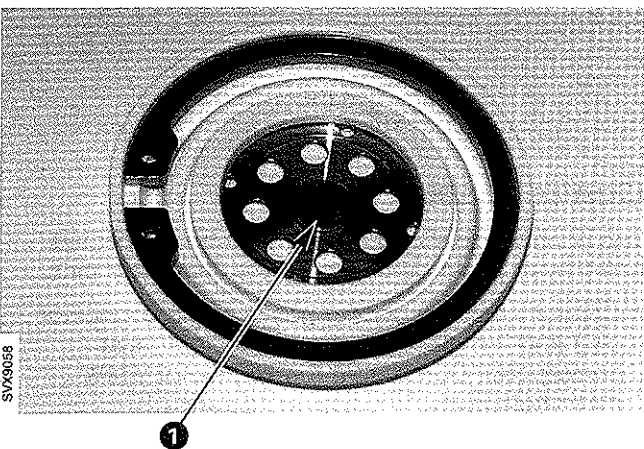


- Carefully release and remove the retaining ring pliers.
- Check that the membrane is not deformed by the retaining ring. If necessary, remove the membrane and redo the complete mounting procedure.

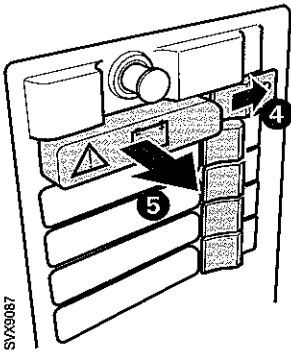
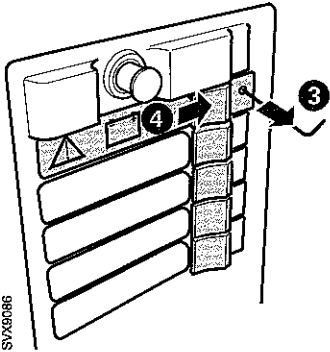
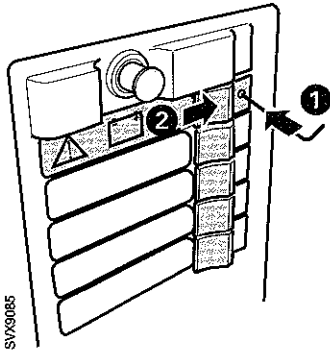
- Mount the expiratory cassette onto the Patient Unit.

- Reset the operating capacity meter after replacement of the membrane. To access the reset button, select Menu / Biomed / Service.

4



Note: If the metal washer has been separated from the membrane, it is important that the washer is correctly mounted. The washers raised hub (1) must be facing outwards as shown in the adjacent illustration.



Fixed battery module

If the upper slot in the Module unit is equipped with a latch, a tool and two-hand operation is required to remove the Battery module. To release the fixed battery module:

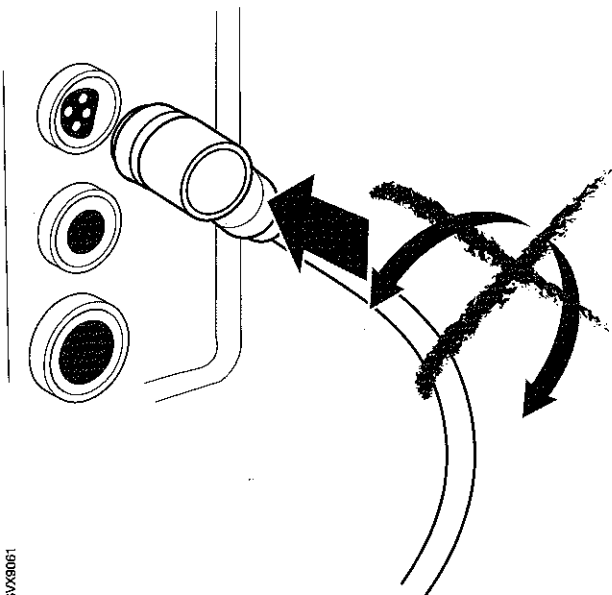
1. Push a suitable tool, e.g. a small hexagonal wrench or a screwdriver, through the hole as shown in the illustration.
2. At the same time, push the release button to the right.
3. Remove the tool.
4. Continue to push the release button until the Battery module snaps out.
5. Pull out the Battery module.

Control cable

The control cable connectors must be connected carefully to avoid damages on the connector pins.

- Carefully find the correct position; the connector pins and the guides in the connectors must correspond. Do not turn the connector while inserting!
- When correct position is found, insert the connector.
- Secure the connector with its locking ring.

The illustration shows the Patient Unit connector, but the procedure for the User Interface connector is the same.



Only personnel trained and authorized by Maquet shall be permitted to perform installation, service or maintenance of the Servo-i.



Make sure to prepare the Servo-i properly before disassembling and assembling. Refer to section 'Hazard notices' in chapter 'Important'.

Any service or maintenance must be noted in a log book.

Discard disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.

After any installation, maintenance or service intervention in the Servo-i, perform a 'Pre-use check'. Refer to the 'Servo-i Ventilator System – User's Manual' for details.

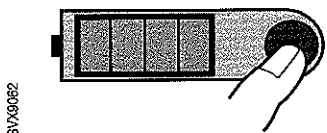
5. Service procedures

Checking the Battery modules	5 - 2
Replacing the lithium batteries on PC 1771 and PC 1772	5 - 3
Using the Menu and Biomed key	5 - 4
Menu	5 - 4
Biomed	5 - 4
Software installation	5 - 6
General	5 - 6
Software information	5 - 6
Software installation procedure	5 - 6
Field Service System	5 - 6
General	5 - 6
Field Service System functions	5 - 6

Checking the Battery modules

Check the manufacturing date of the Battery module. Manufacturing date (year-week) is printed on the battery label.

The batteries must be replaced after 3 years.



- Allow the Battery modules to charge until it is fully charged. To display battery status:

– Press the battery power symbol button on the battery. All four LEDs must be lit.

or

– Select Status / General on the User Interface. Check that Battery backup time is more than 30 minutes on the concerned battery.

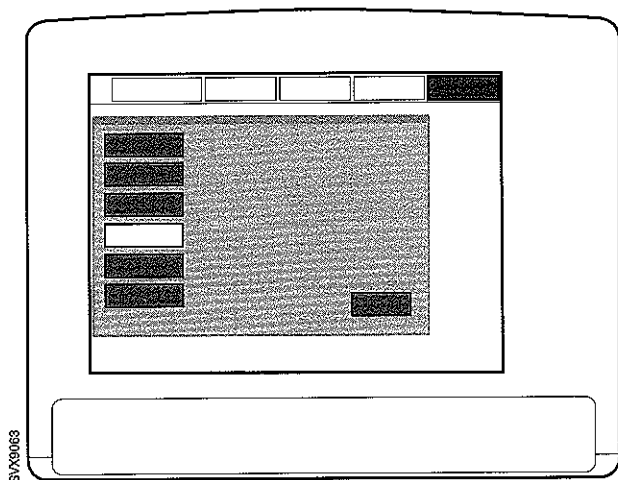
- With gas, patient tubes and test lung connected, let the Servo-i run in a ventilation mode.
- Disconnect mains power to the unit to allow battery operation.
- Let the Servo-i run in battery operation and check that the '**No battery capacity**'-alarm is not activated within the specified time. The operating time is dependent on the number of Battery modules connected, refer to the 'Servo-i Ventilator System – User's manual'.
- Check that the time between the '**Limited battery capacity**'- alarm and the '**No battery capacity**'- alarm is more than 7 minutes.

Note: All alarms are time-stamped and stored. They can be displayed in the Event log.

Allow the backup battery to recharge before clinical use of the Servo-i. For Charging time, refer to the 'Servo-i Ventilator System – User's manual'.

After any maintenance or service of the Servo-i, perform a 'Pre-use check'. Refer to the 'Servo-i Ventilator System – User's manual'.

5



Replacing the lithium batteries on PC 1771 and PC 1772

The lithium batteries must be replaced after 5 years. A Technical error message will appear on the screen if the battery voltage level is too low.

Always replace both batteries at the same time to keep the same replacement date for both batteries.

Preparations

- Set the On/Off switch on the control unit to **Off**.
- Disconnect the mains power cable.
- Disconnect the gas supplies (wall and/or cylinder).
- Remove patient tubing.

Replacing the lithium battery

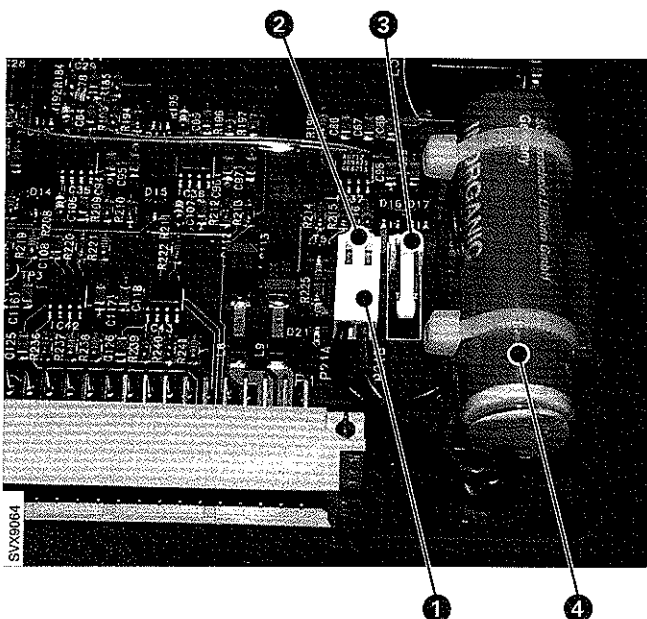
- The lithium batteries are mounted on ESD sensitive PC boards. Refer to chapter 'Disassembling and assembling', section 'Handling PC boards' for further information regarding ESD sensitive components.
- Remove the Patient Unit front cover. Refer to chapter 'Disassembling and assembling'.
- Carefully pull out PC 1771 and PC 1772.

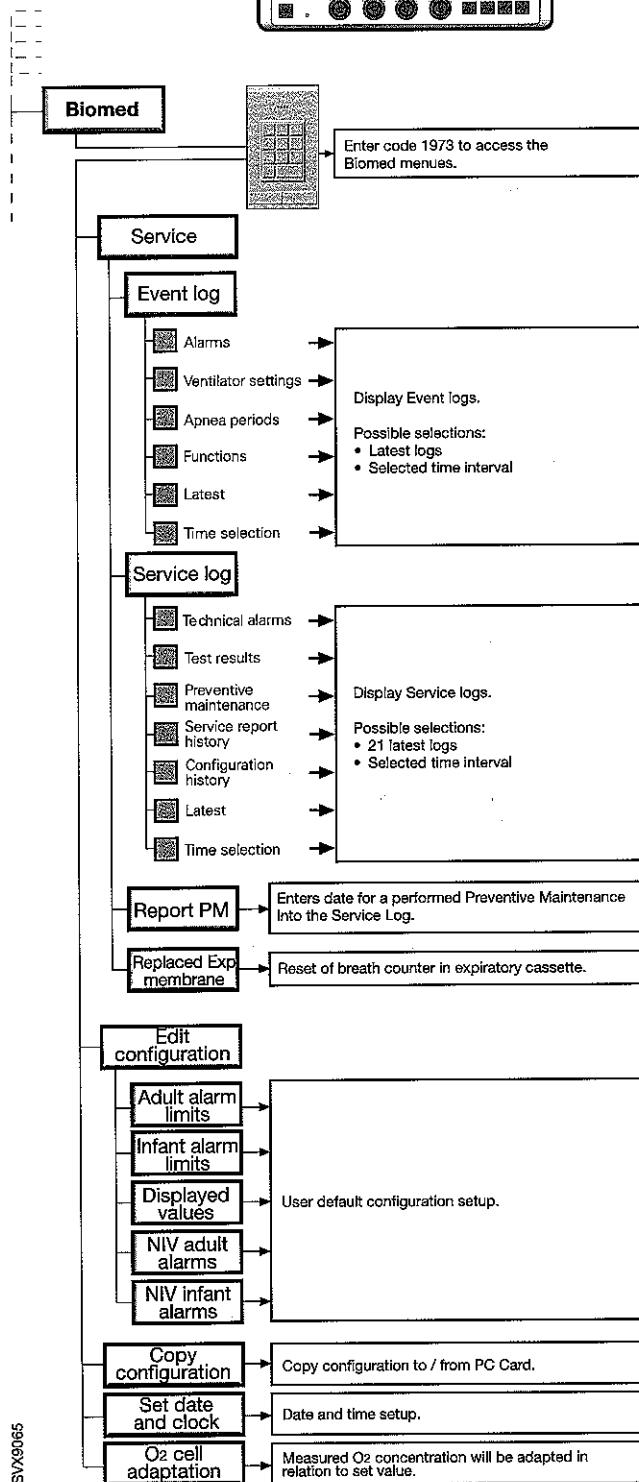
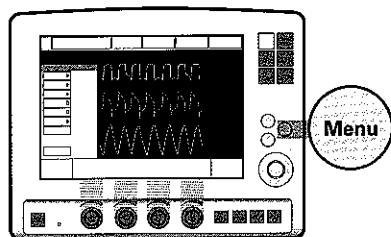
Note: Do not remove the cable connector (1). Information stored in the PC board memory will be erased if the connector is removed:

- If the battery on PC 1771 is disconnected; user default configurations made via the Field Service System (FSS) and Pre-use check results including transducer calibrations will be erased.
- If the battery on PC 1772 is disconnected; all trends, all logs and Pre-use check results including transducer calibrations will be erased.

- There are two equal battery connectors (2 and 3) on the PC boards. Connect the new battery to the un-used connector. The memory functions are now secured by the new battery.
- Cut the cable ties holding the old battery (4) to the PC board.
- Disconnect and remove the old battery.
- Mount the new battery onto the PC board using new cable ties as shown in the illustration.
- Insert the PC board into the correct PC-board slot and reassemble the Patient Unit.

After any maintenance or service of the Servo-i, perform a 'Pre-use check'. Refer to the 'Servo-i Ventilator System – User's manual'.





Using the Menu and Biomed key

The 'Menu' and 'Biomed' functions are useful tools during service.

The adjacent flowchart shows the 'Biomed' functions in System version 2.0. A complete set of flowcharts showing all 'Keys' and 'Screen touch pad' functions can be found in the 'Servo-i Ventilator System – User's Manual', appendix 'User Interface'.

Menu

Pressing the fixed key 'Menu' will open the 'Menu window' on the User Interface.

The 'Menu' is active in Standby and during ventilation mode, but the available submenus differs.

Possible selections in the 'Menu' window are:

- Alarm
- Review
- Options
- Compliance compensation
- Copy
- Biomed
- Panel lock
- Change patient category (only during ventilation).

Biomed

The 'Biomed' submenu is intended only for Service Personnel and the code **1973** is required to access the 'Biomed' submenus.

The 'Biomed' menu is active in Standby and during ventilation mode, but the available submenus differs.

Service

Available only in Standby mode.

Event Log:

Displays Event logs. Useful during troubleshooting.

Service Log:

Displays Service logs. Useful during troubleshooting.

Report PM:

This button must be pressed when a Preventive Maintenance has been performed. This will reset the timer that indicates operating hours until next Preventive Maintenance.

Replaced Exp membrane:

This button must be pressed when the Expiratory cassette membrane has been replaced. This will reset the operating capacity meter (breath counter) in the expiratory cassette.