User's manual (US Version)

MAQUET

VENTILATOR SYSTEM
SERVO-i V3.1

CRITICAL CARE

Contents

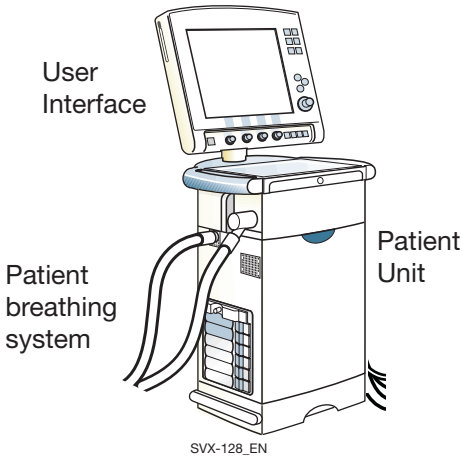
1. Before use

Contents

1 Before use

Welcome as a user of the Servo-i Ventilator system! We hope that you will be very satisfied with your new system. For the latest information about it, call your local MAQUET representative. Before use, please read the general information below.

Brief device description



The Servo-i Ventilator System consists of a Patient Unit where gases are mixed and administered, and a User Interface where the settings are made and ventilation is monitored.

The ventilator delivers controlled or supported breaths to the patient, with either constant flow or constant pressure, using a set oxygen concentration. The entire Servo-i system includes a wide range of optional accessories, e.g. Mobile Cart, breathing systems, compressors, Battery modules, humidifiers and equipment for nebulization, CO_2 measurement and Y-piece measurement.

Intended use

The Servo-i Ventilator System is intended for treatment and monitoring of patients in the range of neonates, infants and adults with respiratory failure or respiratory insufficiency.

Note: The Servo-i Ventilator System is not intended to be used with any anesthetic agents.

Intended user

Servo-i is a ventilator system with advanced functionality. It may be used only by professional health care providers who have sufficient experience in ventilator treatment.

Intended population

The Servo-i Ventilator System can be delivered in three configurations:

- **Servo-i Infant** range 0,5 - 30kg
  NIV (PC+PS) Infant range 3 - 30kg
  NIV Nasal CPAP range 0.5 - 10kg
- **Servo-i Adult** range 10 - 250kg
- **Servo-i Universal** range 0.5 - 250kg
  NIV (PC+PS) Infant range 3 - 30kg
  NIV Nasal CPAP range 0.5 - 10kg

  Note: Servo-i Universal covers both Basic and Extended edition.

Intended Use Environment

The SERVO-i ventilator system should be used:

- in hospitals
- in facilities whose primary purpose is to provide health care
- for in-hospital transport
- for interhospital transport if the conditions stated in the Servo-i Interhospital Transport declaration are fulfilled and an agreement with MAQUET is signed.
- during MR examinations of patients if the conditions in the Servo-i MR Environment declaration are met and an agreement with Maquet signed.

Warnings, Cautions and Important in this manual

WARNING! *Indicates critical information about a potential serious outcome to the patient or the user.*

Caution: Indicates instructions that must be followed in order to ensure the proper operation of the equipment.

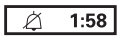
Important: *Indicates* information intended to help you operate the equipment or its connected devices easily and conveniently.

Symbols

User Interface


Audio off Silence alarm or confirm alarm.


Alarm off .



Audio pause Silence alarm or confirm alarm.


Reserved for future use.

Save **Save** To save a recording or to copy screen.


Attention Consult accompanying documents.


Standby/Start ventilation Set standby mode or start ventilation.
Yellow lamp indicating Standby mode.


Mains indicator
Green lamp indicating mains connected.


Battery Symbol indicating battery power supply.The estimated remaining time with current power consumption is indicated in minutes.


ON/OFF switch


Trigger indication The indication appears in the message/alarm field when the patient triggers a breath.


NIV symbol
The NIV symbol appears in the *Mode* pad field during Non Invasive Ventilation.

Patient Unit

CE 0413 **CE label** The device complies with the requirements of the Medical Device Directive 93/42/EEC.


CSA label The device complies with the Canadian standards.


Class I equipment, Type B The device classification according to according to IEC 60601-1/EN 6060-1.


Equipotentiality terminal


Nebulizer
connector for nebulizer.

RS 232 **RS 232 / Serial port**
connector for data communication
Note: The symbol has two different labels depending on panel version.


User Interface connector / Panel
Note: The symbol has two different labels depending on panel version.


Optional connector / Expansion
connector for optional equipment.
Note: The symbol has two different labels depending on panel version.

10A **10A**
fuse for external DC power supply.

1 Before use

12V DC / Ext. bat 12V
external +12V DC inlet.
Note: The symbol has two different labels depending on panel version.

Caution: When external +12 V DC is used, at least one installed Battery module is required to ensure proper operation.

Expiratory label
Gas flow from patient.

Inspiratory label
Gas flow to patient.

Gas exhaust port label
Exhaust gas flow from ventilator.
Note: Should not be connected to a spirometer, as the volume through the exhaust port is not equal to the expired volume from the patient.

Alarm output connection option
External alarm output communication.

In this manual

Adult Information valid for the Adult configuration

Infant Information valid for the Infant configuration

Universal (Basic and Extended editions) Information valid for the Universal configuration.

Options

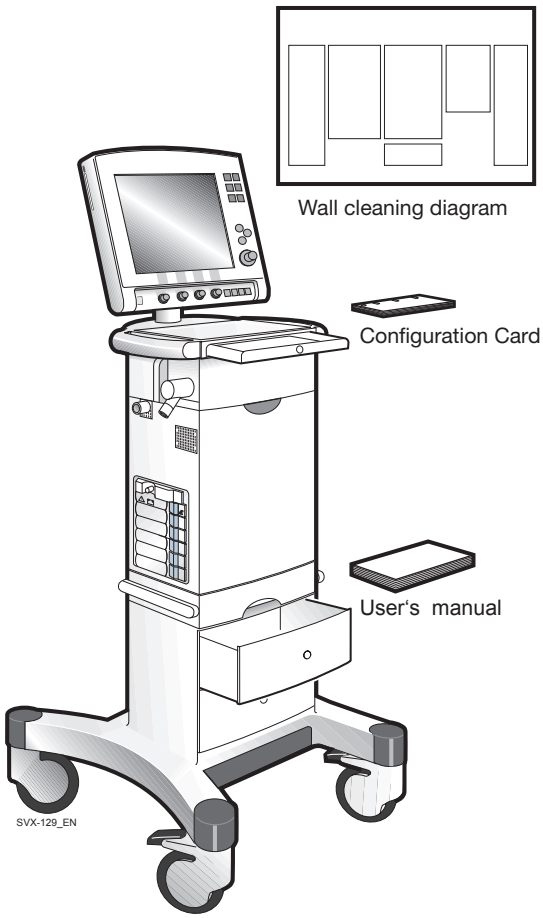
Single use

Special waste
This product contains electronic and electrical components. Discard disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.

Recycling
Worn-out batteries must be recycled or disposed of properly in accordance with appropriate industrial and environmental standards.

Hazardous waste (infectious) The device contains parts which must not be disposed of with ordinary waste.

Support material related to the Servo-i system



This concept comprises components intended to cover the needs of a clinical user. It is divided into different components according to use to facilitate accessibility of information. If you have any comments or suggestions regarding this information material, please let us know.

This User´s manual covers functionality and use but should not be regarded as all inclusive within the very complex field of ventilatory treatment. Clinical judgements or settings are therefore not described in this manual. Authorized, medically competent health care providers with good knowledge of Servo-i Ventilator System have the responsibility to determine the clinical judgement and settings based on the needs of the patient.

Read the User´s manual carefully before use and follow the instructions.

1 Warnings, cautions and important

This User´s manual

The information in this User´s manual is valid for Servo-i Ventilator System 3.1 unless stated otherwise.

Here you will find the information needed to use the Servo-i system safely.

It is divided into five main sections:

- Before use (mandatory information)
- Description
- Operation
- Maintenance
- Miscellaneous

Recommended use

The main document, for every-day use.

Text shown on the User Interface is presented in these instructions in a *special typeface.*

Brief instructions

Overviews and step-by-step instructions for the set-ups. These instructions you will find in the drawer above the ventilator, when positioned on the Mobile Cart.

Recommended use

These documents are intended to be used as a guide for the experienced user.

Wall diagram

Overviews and step-by-step instructions for cleaning, to be posted on a wall.

Recommended use

Checklist for the experienced user.

Ventilator - Information material

Caution: The Servo-i Ventilator System may have different software versions. Before use, make sure the software version shown on the screen under the *Status* / *General* menu corresponds to the version number on the User´s manual. Refer to page 259.

Trademark

Trademark ™ is written only when a product/ method name appears for the first time in this manual.

General warnings

- The Servo-i Ventilator System must be operated only by authorized personnel who are well trained in its use. It must be operated according to the instructions in this User´s manual.
- After unpacking, perform a Routine cleaning and a Pre-use check.
- To provide adequate patient safety, set the alarm limits to relevant values.
- To avoid electrical shock hazard, connect the power cord to a mains outlet equipped with a protective ground.
- Should any unfamiliar events occur, such as irrelevant pop-up windows on the screen, unfamiliar sounds, alarms from the Patient Unit or technical high priority alarms, the ventilator should immediately be checked and, if applicable, replaced.
- Only accessories and auxiliary equipment that meet current IEC standards (e.g. IEC 60601-1-1) may be connected to the Servo-i Ventilator System. If external equipment such as computers, monitors, humidifiers or printers are connected, the total system must comply with IEC 60601-1-1.
- The ventilator must only be used in an upright position.
- When a Servo Ultra Nebulizer is used, always consult the drug manufacturer regarding the appropriateness of ultrasonic nebulization for certain medication.
- All personnel should be aware of the risk of parts being infected when disassembling and cleaning the ventilator.
- Service mode may only be used when no patient is connected to the ventilator.
- Positive pressure ventilation can be associated with the following adverse events: barotrauma, hypoventilation, hyperventilation or circulatory impairment.
- The Servo-i Ventilator System is verified against and complies with IEC 60601-1-2 regarding electromagnetic compatibility. It is the responsibility of the user to take necessary measures to ensure that the clinical environment is compatible with the limits specified in IEC 60601-1-2. Exceeding of these limits may impair the performance and safety of the system. Such measures should include, but are not limited to:
  - Normal precautions with regard to relative humidity and conductive characteristics of clothing in order to minimize the build-up of electrostatic charges.
  - Avoiding the use of radio-emitting devices, such as cellular phones and high-frequency apparatus in close proximity to the system.
- The SERVO-i Ventilator System may only be used during MR examinations if the conditions in the MR Environment Declaration are met and an agreement with Maquet is signed. Disregard of these conditions may cause deactivation of the system functions and may result in permanent damage to the SERVO-i Ventilator System.
- The Servo-i Ventilator System is not intended to be used with any anesthetic agent. To avoid risk of fire, flammable agents such as ether and cyclopropane must not under any circumstances be used with this device.

- To avoid fire hazard, keep all sources of ignition away from the Servo-i Ventilator System and oxygen hoses. Do not use oxygen hoses that are worn, frayed, or contaminated by combustible materials such as grease or oils. Textiles, oils, and other combustibles are easily ignited and burn with great intensity in air enriched with oxygen. Immediately disconnect the ventilator from the oxygen supply, facility power, and backup sources if there is a smell of burning.

General cautions

- As a general rule always avoid contact with external electrical connector pins. It is recommended to have the module compartment filled up with empty modules to protect from spillage and dust.
- Federal law in the USA restricts this device to sale by or on the order of a physician (or a properly licensed practitioner).
- The Servo-i Ventilator System must be serviced at regular intervals by specially trained personnel. The intervals are stated in the chapter Regular maintenance. Any maintenance must be noted in a log book for that purpose in accordance with national regulations.
- MAQUET has no responsibility for the safe operation of the equipment if service or repair is done by a non-professional or by persons who are not employed by or authorized by MAQUET. We recommend that service is done as part of a service contract with MAQUET.
- MAQUET has no responsibility for the safe operation of the equipment if the equipment is used for anything other than its intended use, as specified in this User´s manual.
- A resuscitator should always be readily accessible for extra safety.
- When connected to a patient, the system must never be left unattended.
- The nebulizer module is inoperative when the ventilator is running on batteries, to reduce the power consumption.
- The Expiratory cassette must not be lifted up when the ventilator is in operation. This may, however, be done when in Standby mode.
- Always use heat and moisture exchanger (HME) or equipment to prevent dehydration of lung tissue.
- Refer to the Installation instructions to assemble the system or options to obtain a proper mechanical assembly.
- When lifting or moving the ventilator system or parts of the system, follow established ergonomic guidelines, ask for assistance, and take appropriate safety precautions.
- Antistatic or electrically conductive breathing tubing should not be used with this lung ventilator system.
- Any scavenging system (Gas evac) connected must comply to ISO8835-3 with regard to subatmospheric pressure and induced flow. Otherwise ventilator functions and patient safety may be degraded.
- It is not recommended to use the Servo Evac 180 in the Nasal CPAP mode.
- Values measured at the signal outputs of the Servo-i Ventilator System and which have been processed in auxiliary equipment must not be used as a substitute for therapeutic or diagnostic decisions. Such decisions can be made only by staff with medical expertise, according to established and accepted practice. If auxiliary equipment that has not been delivered by MAQUET with the system is used, MAQUET denies all responsibility for the accuracy of signal processing.

- If there should be any deviation between information shown on the User Interface of the ventilator and that shown by the auxiliary equipment, the ventilator parameters shown on the User Interface shall be considered the primary source for information. When combining the Servo-i Ventilator System with accessories and auxiliary equipment other than those recommended by MAQUET, it is the responsibility of the user to ensure the integrity of system performance and safety. In order to maintain electrical system safety, i.e. such that compliance with IEC 60601-1-1 is fulfilled, only accessories and auxiliary equipment that meet current IEC standards (e.g. IEC 60601-1, IEC 950) may be connected to signal inputs and outputs of the Servo-i Ventilator System.
- Only original parts from MAQUET must be used in the system.
- Only accessories, supplies or auxiliary equipment recommended by MAQUET should be used with the ventilator system ("Products and accessories" catalog and "Spare parts list"). Use of any other accessories, spare parts or auxiliary equipment may cause degraded system performance and safety.
- The displayed information about set and corresponding measured parameters, shall continously be compared by the operator.

Important:

- This symbol on the unit means Attention, consult accompanying documents.

  Note: The are two versions of this symbol depending on System version.
- The gases supplied must be free from water, oil, particles and other contaminants:
  Air ..... $H_2O < 7\ g/m^3$
  ..... Oil < 0.5 mg/m^3
  ..... Chlorine: Must not be detectable[1]
  Oxygen $H_2O < 20\ mg/m^3$
- The environmental declaration is part of the service manual.
- The Servo-i Ventilator system does not contain any latex.
- Data on pressures can be given in cmH_2O, where:
  1 kPa ~ 10 cmH_2O
  100 kPa = 1bar ~1atm ~1kgf/cm^2 (kp/cm^2)
  100 kPa ~15 psi.
- All disposable parts must be discarded according to hospital routine and in an environmentally safe way.
- Do not expose the Expiratory cassette compartment to excessive amounts of fluid, e.g. during cleaning and disinfection, as this may influence ventilator functionality.
- Do not use sharp tools on the screen.
- It is recommended that at least two batteries always is used in the ventilator for backup.
- It is recommended that at least two batteries are used for ventilation during transport.

1. If the compressed air is generated by a liquid ring compressor there is a potential risk of chlorine in the supplied air.

1 Warnings, cautions and important

- Documentation for Servo-i Ventilator System consists of:
  - User´s manual
  - Brief instructions
  - Wall diagram
  - Installation instructions
  - Service manual
  - Products and accessories, catalog
  - Spare parts list

Context-related warnings

Note: General warnings are not listed here even though they are repeated inside the manual.

Note: Context-related Cautions and "Important" are not listed here, but are written in the relevant context inside the manual.

Operation

- Always disconnect the ventilator if any operation which may involve risk for the patient will be done, e.g. replacement of O_2 cell, dismantling etc. (page 211, page 225).
- If the trigger sensitivity is set too high, a self-triggering (auto-triggering) condition may be reached. This condition can also be reached if there is leakage in the breathing system, e.g. if an uncuffed endotracheal tube is used. Triggering will then be initiated by the system and not by the patient.This should always be avoided by decreasing the trigger sensitivity (page 23). This is also important during transport as the movement of the body and the breathing system may lead to false triggering.
- When you turn a Direct Access Knob, ventilation will change accordingly from the next breath without additional confirmation (For further information see page 166).
- If any malfunctions are detected during the start-up procedure, please refer to Chapter, Troubleshooting (page 225).
- If a malfunction persists, the ventilator may not be connected to the patient.
- A Pre-use check must always be done before connecting the ventilator to a patient (page 145).
- To protect the patient against high airway pressures, the upper pressure limit must always be set to the relevant value so as to provide adequate patient safety (page 165).

  Caution: If airway pressure rises 6 cmH_2O above the set upper pressure limit the safety valve opens. The safety valve also opens if system pressure exceeds 117 ± 7 cmH_2O.
- To provide adequate patient safety, always set the alarm limits at relevant values (page 165).

Nebulization

- Servo Humidifier/HME must be disconnected during nebulization otherwise the humidifier may be blocked (page 128).
- The heated humidifier must be switched off during nebulization. Otherwise the particle size may be affected (page 128).
- During nebulization a filter must be connected to the expiratory inlet of the ventilator. Always carefully monitor the airway pressure during nebulization. Increased airway pressure could be caused by a clogged filter. The filter should be replaced if the expiratory resistance increases or every 24 hours when the nebulizer is being used.
- When a Servo Ultra Nebulizer is used, always consult the drug manufacturer regarding the appropriateness of ultrasonic nebulization for certain medications (page 128, 187).
- The nebulizer must not be used without buffer liquid (sterile water). Otherwise the ultrasonic generator crystal may break (page 129, 187).
- To avoid explosion hazards, flammable agents such as ether and cyclopropane must not be used with this device. Only agents which comply with the requirements on non-flammable agents in the IEC standard “Particular requirements for electrical safety of anaesthetic machines” are suitable.
- For adult/pediatric patients, never fill the medication cup with more than 10 ml (page 129).
- For neonatal patients, never fill the medication cup with more than 4 ml (page 129).
- If the patient unit of the nebulizer is tilted, the drug can flow into the patient´s lungs or the ventilator.
- The nebulizer must not be left unattended when connected to a patient.
- Continuously check that the buffer liquid level is between MIN. and MAX. during nebulization (page 187).
- During nebulization: Continuously check that moisture is generated in the medication cup (page 187).
- When the ventilator is running on batteries the nebulizer module is inoperative, to reduce the power consumption (page 187).
- For information about the stand alone Aeroneb Professional Nebulizer System, refer to separate manual.

Cleaning

- All personnel should be aware of the risk of parts being infected when disassembling and cleaning the ventilator (page 191).
- After removing the Expiratory cassette, do not pour any fluid into the Expiratory cassette compartment (page 196).

Replacement of O_2 cell

The sealed unit of the O2 cell, contains a caustic liquid which may cause severe burns to the skin and eyes. In case of contact, immediately flush continuously with water for at least 15 minutes and seek medical attention especially if the eyes are affected (page 214)

1 Notes

2. Ventilation

Contents

2 Modes of ventilation

Ventilatory management

The Servo-i Ventilator System is designed for safe and effective treatment. It can be set for continuous adaptation to the patient´s prevailing condition or for manually controlled operations. The servo systems for pressure, flow and timing operate in all modes of ventilation (set time in control modes and patient-related timing in support modes).

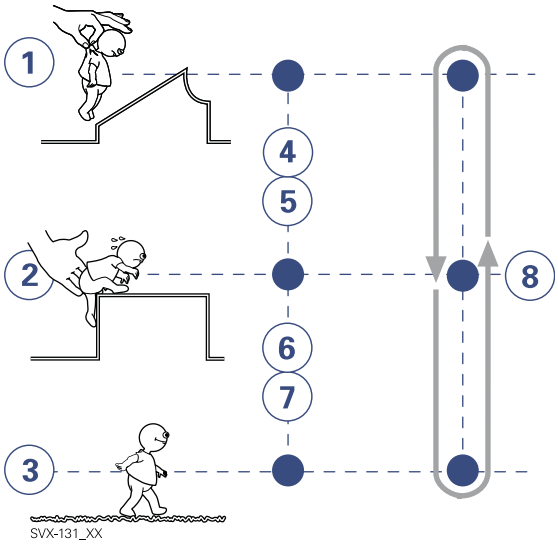
Important:

- To show all available installed ventilation modes, please refer to "Setting ventilation mode" on page 164 in this manual.
- In all pressure controlled modes, it is important to set alarm limits to adequate levels.
- For information about default values and parameter settings refer to page 249.

Application

The Servo-i ventilator system also contains tools to assist the user in application of lung recruitment methodologies.

Scope - ventilatory needs



The ventilator can be used for true:

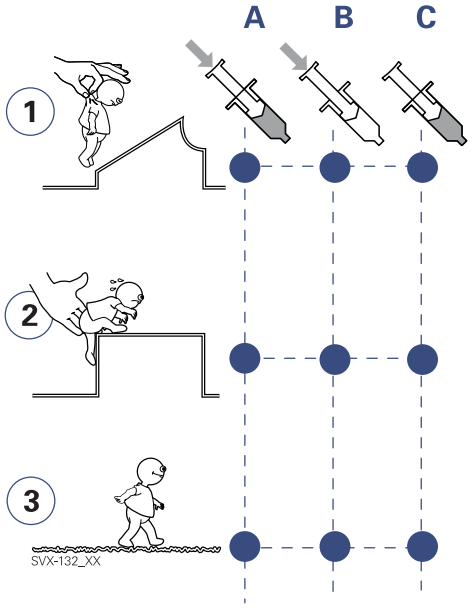
1. controlled ventilation
2. supported ventilation, or
3. spontaneous breathing/CPAP

4-7. It also allows for combined ventilatory control or support. Spontaneous breathing efforts are sensed during controlled ventilation, e.g. Volume Control. Mandatory ventilation can be used during supported/ spontaneous breathing, e.g. the enhanced SIMV functionality.

8. The Automode functionality continuously adapts to the patient´s breathing capability.

When required, all ventilation is provided for mandatorily. When the patient is able to initiate a breath, the ventilator supports and monitors the patient´s breathing capability and controls ventilation only if required.

Implementation



Ventilation can be managed and administered with a focus on:

A. pressure and volume

B. pressure

C. flow/volume.

Pressure and volume in focus

In the pressure- *and* flow- oriented modes, a constant inspiratory Tidal Volume is maintained. The inspiratory pressure level is constant during each breath. (PRVC, Volume Support.)

Pressure in focus

In the pressure-oriented modes, a constant preset pressure level is maintained during inspiration. (Pressure Control, Pressure Support)

Flow/volume in focus

In the flow/volume oriented modes a constant inspiratory volume is maintained. The inspiratory flow is constant during each breath (Volume Control).

Extra flow and extra breaths

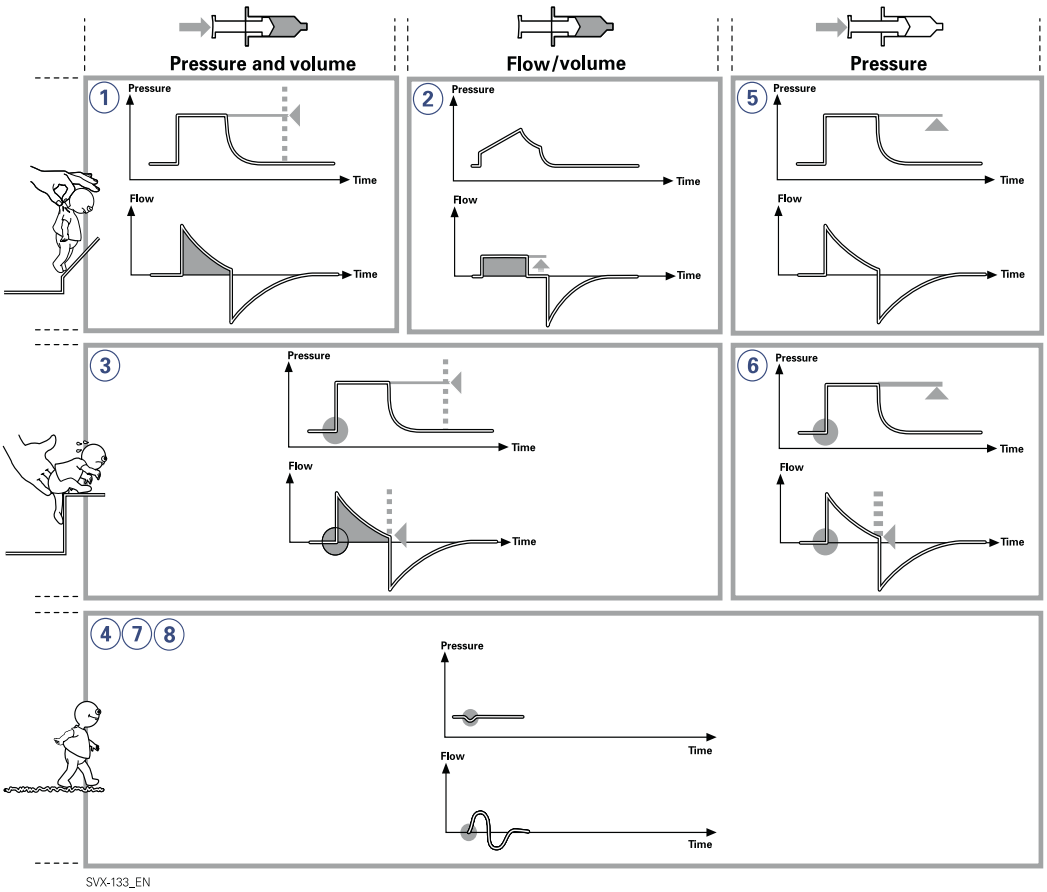
In flow/volume- oriented modes of ventilation, additional on-demand flow can be triggered during inspiration. Additional breaths can always be triggered between the ordinary breaths if the set trigger criteria are met.

Timing

In controlled ventilation modes, timing is related to preset values. In supported ventilation modes, timing is related to patient triggering and Inspiratory cycle-off setting.

2 Modes of ventilation

Basic functionality - An overview



1.(PRVC) Pressure Regulated Volume Control

Breaths are delivered mandatorily to assure preset volumes, with a constant inspiratory pressure continuously adapting to the patient´s condition. The flow pattern is decelerating.

2. Volume Control

Breaths are delivered mandatorily with a constant flow to assure preset volumes.

3. Volume Support

A patient-adapted constant inspiratory support is supplied when activated by patient effort. The resulting volume is continuously monitored and the constant inspiratory pressure automatically adjusts to the required level. The patient determines frequency and duration of the breaths which show a decelerating flow pattern.

4. Spontaneous breathing (CPAP)

When sufficient inspiratory volumes are achieved, spontaneous breathing without ventilator support is allowed for in Volume Support.

5. Pressure Control

Breaths are delivered mandatorily at a preset pressure level, causing a decelerating flow pattern.

6. Pressure Support

Inspiration is supported by a constant preset pressure when activated by patient effort. The patient determines frequency and duration of the breaths, which show a decelerating flow pattern. Inspiratory breath duration can be influenced by adjusting the Inspiratory cycle-off criteria.

7. Spontaneous breathing/CPAP

True spontaneous breathing (CPAP) occurs when the inspiratory pressure level is set to zero in Pressure Support.

8. Nasal CPAP

Spontaneous breathing on a set pressure level.

2 Modes of ventilation

Combined modes - An overview

Automode

The ventilator continuously adapts to the patient's breathing capability and allows the patient to better interact with the ventilator. The ventilator automatically shifts between controlled ventilation, supported ventilation and spontaneous ventilation. Each controlled ventilation mode has a corresponding support mode.

Volume Control	<----> Volume Support
PRVC	<----> Volume Support
Pressure Control	<----> Pressure Support

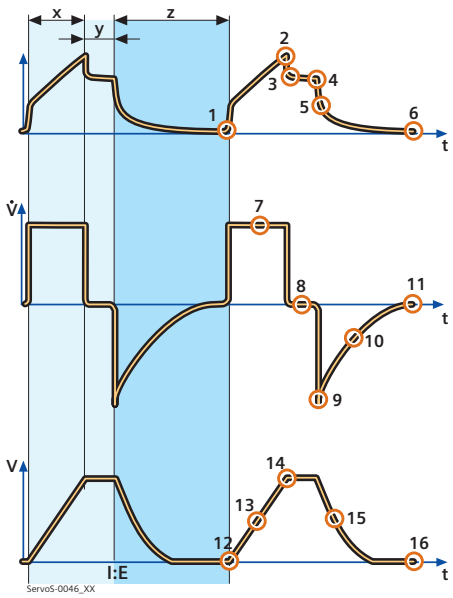
When the patient is making a breathing effort, the ventilator immediately switches to a support mode of ventilation. If the patient is not making any breathing effort, the ventilator will return to the controlled mode and deliver controlled breaths.

Synchronized intermittent Mandatory ventilation (SIMV)

The ventilator provides mandatory breaths which are synchronized with the patient´s spontaneous efforts at a preset rate. The mandatory breaths can be Volume Control, Pressure Control or PRVC breaths.

Bi-Vent

Bi-Vent is pressure controlled breathing, giving the patient the opportunity of unrestricted spontaneous breathing. Two pressure levels are set together with the individually set duration of each level. Spontaneous efforts can be assisted by pressure support.



The graphic display of flow, pressure and volume is visualized in wave forms. Modes of ventilation directly affect flow, pressure and volume patterns.

Volume Control

Pressure-Time waveform. Points and regions of interest

X. Inspiration time
Y. Pause time
Z. Expiration time

1. Start of Inspiration
2. Peak inspiratory pressure
3. Early inspiratory pause pressure
4. End inspiratory pause pressure
5. Early expiratory pressure
6. End expiratory pressure

Flow-Time waveform. Points and regions of interest

X. Inspiration time
Y. Pause time
Z: Expiration time

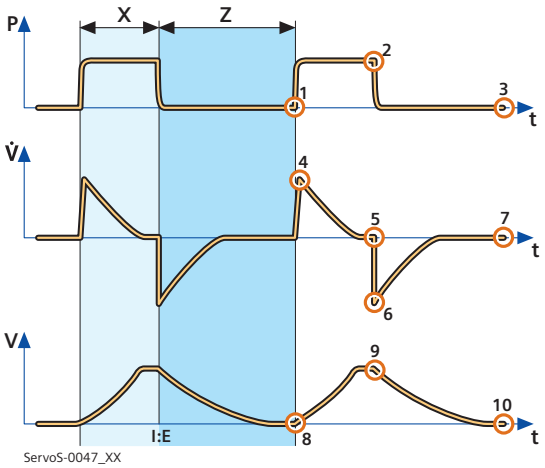
7. Peak inspiratory flow
8. Zero flow phase
9. Peak expiratory flow
10. Slope decelerating expiratory limb
11. End expiratory flow

Volume-Time waveform. Points and regions of interest

X. Inspiration time
Y. Pause time
Z. Expiration time

12. Start of inspiration
13. The slope represents current delivery of inspiratory tidal volume
14. End inspiration
15. The slope represents current patient delivery of expiratory tidal volume
16. End expiration

2 Important definitions



Pressure Control

Pressure-Time waveform. Points and regions of interest

X. Inspiration time

Z. Expiration time

1. Start of Inspiration
2. Peak inspiratory pressure
3. End expiratory pressure

Flow-Time waveform. Points and regions of interest

X. Inspiration time

Z. Expiration time

4. Peak inspiratory flow
5. End inspiratory flow
6. Peak expiratory flow
7. End expiratory flow

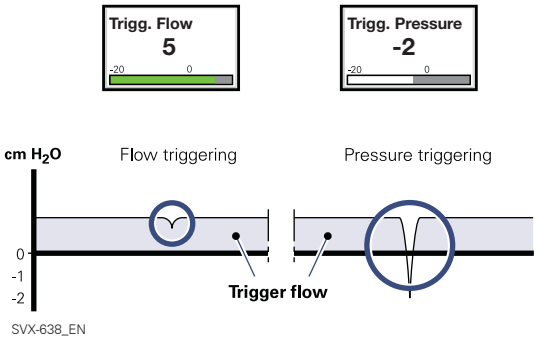
Volume-Time waveform. Points and regions of interest

X. Inspiration time

Z.: Expiration time

8. Start of inspiration
9. End inspiration
10. End expiration

Trigger functionality



SVX-638_EN

This determines the level of patient effort to trigger the ventilator to inspiration.

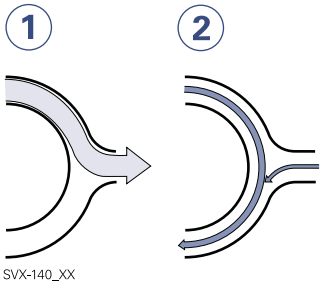
Trigger sensitivity can be set in flow triggering (*Trigg. Flow*) or pressure triggering (*Trigg. Pressure*). Normally flow triggering is preferable as this enables the patient to breath with less effort.

The sensitivity is set as high as possible without self-triggering. This ensures that triggering is patient initiated and avoids auto-cycling by the ventilator.

Pressure triggering can be set in the range -20 to 0 cmH_2O (in reference to set PEEP level, white area on the bar).

When the trigger sensitivity is set above 0 (green and red area on the bar), flow triggering is set, i.e. the amount of the bias flow that the patient has to inhale to trigg a new breath. The sensitivity can be set from 100% of the bias flow (left), to 0% of the bias flow (right). For information about the different colors of the bar refer to page 167.

Important: In NIV it is not possible to set trigger sensitivity.



SVX-140_XX

The ventilator continuously delivers a gas flow during expiration, which is measured in the expiratory channel.

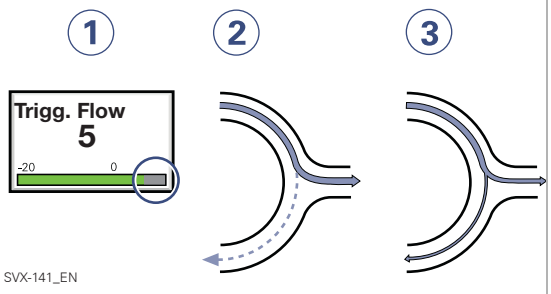
1. Inspiration.

Bias flow during expiration.

2. Bias flow Infant 0.5 l/min.
   Bias flow: Adult 2 l/min.

2 Trigger sensitivity

Weak patient effort



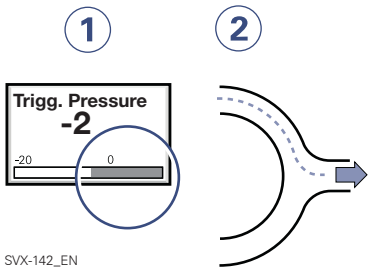
SVX-141_EN

1. At a Trigger sensitivity level above zero (0), the ventilator senses deviations in the bias flow caused by inspiratory efforts of the patient. The more to the right on the scale, the more sensitive is the trigger function.
2. Weak inspiratory effort.
3. Very weak inspiratory effort.

For further information see page 167.

WARNING! If the trigger sensitivity is set too high, a self triggering (auto-triggering) condition may be reached. This condition can also be reached if there is leakage in the breathing system, e.g. if an uncuffed endotracheal tube is used. Triggering will then be initiated by the system and not by the patient.This should always be avoided by decreasing the trigger sensitivity.

Stronger patient effort



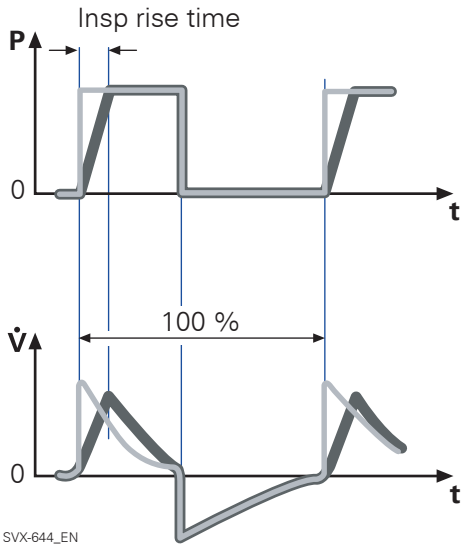
SVX-142_EN

1. At a Trigger sensitivity level below zero (0), the ventilator senses negative pressures created by the patient. Required preset negative pressure to initiate a breath is shown numerically. The more to the left on the scale, the more effort is required to trigger.
2. Stronger patient effort.

For further information see page 167.

WARNING! The trigger sensitivity bar has different colors based on the setting. A green bar indicates a normal setting for the flow triggering. The risk of self-triggering increases when the bar is red. A white bar indicates that pressure triggering is required.

Inspiratory rise time



Time to peak inspiratory flow or pressure at the start of each breath as a percentage of the respiratory cycle time or in seconds. Increased rise time will affect the rate of flow/ pressure increase and can be evaluated by the shape of the flow and pressure waveforms.

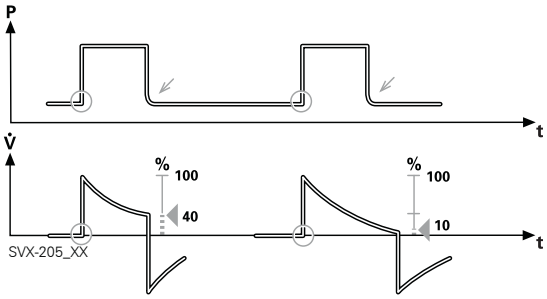
Inspiratory rise time (%) is applicable in Pressure Control, Volume Control, PRVC, SIMV-Volume Control, SIMV-Pressure Control, SIMV-PRVC. Setting can be in the range 0-20% of the respiratory cycle time.

Inspiratory rise time set in seconds is applicable in Pressure Support, Volume Support and Bi-Vent. For adults the range is 0-0.4 seconds and for infants the range is 0-0.2 seconds.

Note: When the ventilator is configured for setting of Inspiration time, the unit for Inspiratory rise time then automatically switches to seconds for all ventilation modes.

Normally in supported modes the Inspiratory rise time should be increased from the default setting and so give more comfort to the patient.

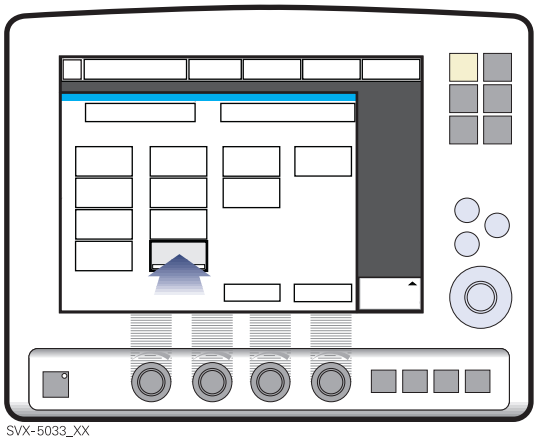
Inspiratory cycle-off



Inspiratory Cycle-off is the point at which inspiration changes to expiration in spontaneous and supported modes of ventilation. A decrease of the inspiratory flow to a preset level causes the ventilator to switch to expiration. This preset level is measured as a percentage of the maximum flow during inspiration. The range of *Inspiratory cycle-off* is 1 - 70%.

Note: In NIV the range is 10-70%.

Breath cycle time


SVX-5033_XX

This is the length of the breath i.e. the total cycle time of the mandatory breath in SIMV (inspiration, pause plus expiration). This is set in seconds within the range:

Infants: 0,5 -15 seconds in half second steps.

Adults: 1-15 seconds in one second steps.

Note: The soft key Breath cycle time is not shown when an SIMV mode is selected and inspiration time is configured. Refer to heading I:E ratio / Inspiration times.

Trigger timeout

Trigger Timeout is the maximum allowed apnea time in Automode before controlled ventilation is activated. It is applicable in:

Automode:

Volume Control <--->Volume Support

PRVC <--->Volume Support

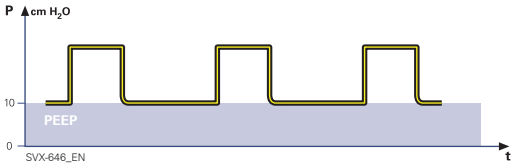
Pressure Control<--->Pressure Support

The settings are within the ranges:

- Infant: 3-15 seconds
- Adult: 7-12 seconds

Initially the ventilator adapts with a dynamic Trigger Timeout limit. This means that for the spontaneously triggering patient the timeout increases successively during the first ten breaths.

PEEP



Positive End Expiratory Pressure (PEEP) can be set in the range of 0 - 50 cmH_2O. A Positive End Expiratory Pressure is maintained in the alveoli and may prevent the collapse of the airways.

Note: In NIV the range is 2-20 cmH_2O.

I:E ratio / Inspiration time

The setting of breathing parameters in Servo-i can be configured in two different ways, based on:

- I:E ratio (independent of changes of e.g. the breathing frequency) or,
- Inspiration time in seconds (independent of changes of e.g. the breathing frequency), to better meet the requirements for infant care.

When the ventilator is configured for setting of Inspiration time, the unit for Pause time and Insp. rise time then automatically switches to seconds. The resulting I:E ratio for each setting is shown in the upper right information area of the ventilation mode window.

As the inspiration time is explicitly set, a change of for example the Respiratory Rate will affect the I:E ratio. As a safety precaution, it will therefore be indicated when the resulting I:E ratio passes 1:1 in either direction.

Note: The soft key Breath cycle time is not shown when an SIMV mode is selected, since there is no need to set Breath cycle time when Inspiration time is directly set.

Note: The configuration is done by a service technician with a service card.

Volume setting

Depending on the ventilator configuration the inspiratory volume can be set as:

– Minute Volume or,

– Tidal Volume

Note: The configuration is done by a service technician with a service card.

Controlled / supported pressure level

PC (Pressure Control level) above PEEP is the set inspiratory pressure level for each mandatory breath in Pressure Control and SIMV (PC) + PS, and also for Apnea back-up in Pressure Support.

PS (Pressure Support level) above PEEP is the set inspiratory pressure support level for triggered breaths in Pressure Support, SIMV modes and Bi-Vent.

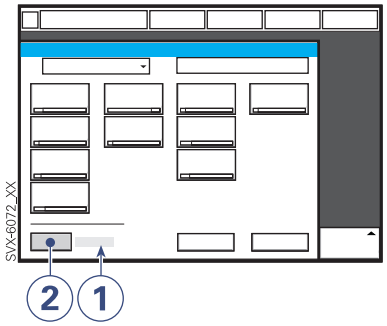
O_2 concentration

The setting range for the gas mixer is 21% O_2 to 100% O_2. The alarm limits are automatically set at approximately 6% O_2 above or below the set concentration value. There is also an absolute minimum alarm limit of 18% O_2 which is independent of operating settings.

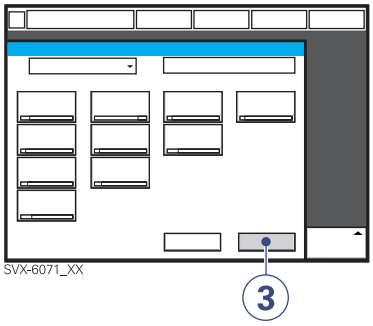
Respiratory rate / SIMV frequency

Respiratory rate is the number of controlled mandatory breaths per minute in controlled modes excluding SIMV. The respiratory rate is also used for calculation of tidal volume if the ventilator is configured for Minute volume setting. SIMV rate is the number of controlled mandatory breaths in SIMV modes.

Previous ventilation mode



1. Time when previous mode was inactivated.
2. Press the pad *Show previous mode* to recall the previous accepted ventilation mode.

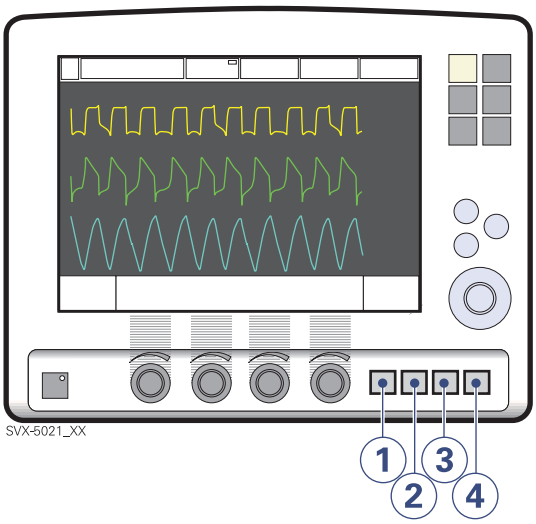


3. Activate the previous used ventilation mode settings by pressing the *Accept* pad.

Note:

- The previous ventilation mode function is not available after a Pre-use check, changing of patient category, admitting a new patient, use of the same ventilation mode for more than 24 hours or after start-up (cold start) of the system.
- In backup ventilation, the ventilator shows the settings for the supported mode when previous mode is activated.
- A recall of previous settings is only possible after a change of ventilation mode.

Fixed keys

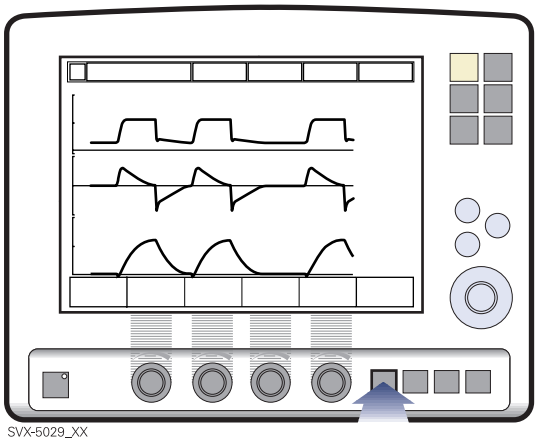


SVX-5021_XX

1. Start breath
2. O_2 breaths
3. Expiratory hold
4. Inspiratory hold

can all be chosen by manually pressing the respective fixed key.

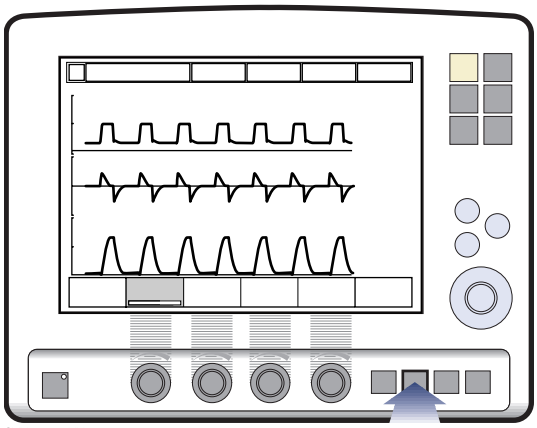
Start breath


SVX-5029_XX

The ventilator will initiate a new breath cycle according to the current ventilator settings.

2 Special functions

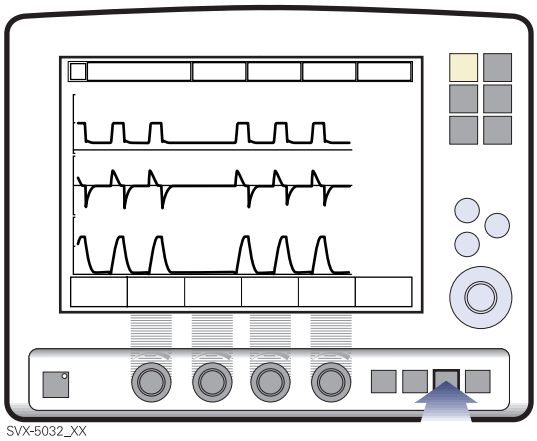
O_2 breaths



SVX-5030_XX

This function allows 100% oxygen to be given for 1 minute. After this time the oxygen concentration will return to the pre-set value. The oxygen breaths can be interrupted by repressing the *O_2 breaths* fixed key during the 1 minute interval.

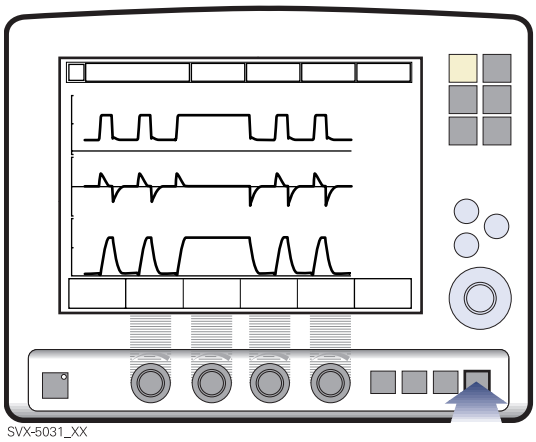
Expiratory hold



SVX-5032_XX

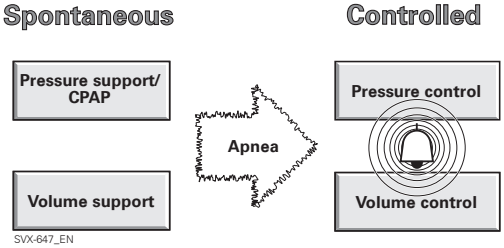
Expiratory and inspiratory valves are closed after the expiration phase is completed, for as long as the fixed key is depressed, up to a maximum of 30 seconds. Expiratory hold provides an exact measurement of the end expiratory pause pressure. It can be used for static compliance measuring and to determine the total PEEP. The dynamic pressure is shown on the PEEP numerical value.

Inspiratory hold


SVX-5031_XX

Inspiratory hold is activated by manually pressing the fixed key. The maximum time is 30 seconds. The inspiratory and expiratory valves close after inspiration. This function can provide an exact measurement of the end inspiratory lung pressure. It can be used during x-ray or to determine Plateau pressure, or static compliance calculation.

Back-up ventilation



SVX-647_EN

Back-up ventilation is available in all support modes (not applicable in Automode and NIV Pressure Support mode).

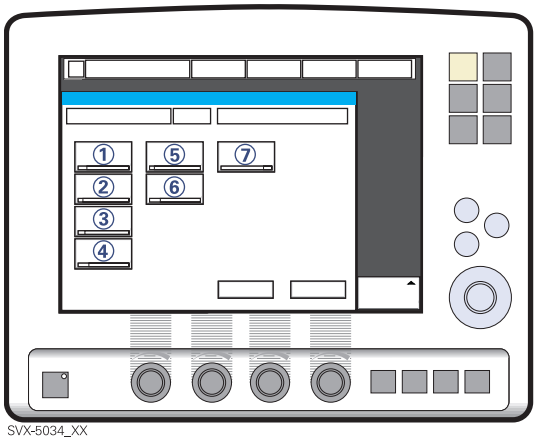
The Back-up function switches Volume Support to Volume Control, Pressure Support and CPAP to Pressure Control. During Back-up ventilation default settings are used for I:E ratio, Respiratory Rate, and Inspiratory rise time. Apnea alarm can be set in infant mode (5-45 seconds) and in adult mode (15-45 seconds). The Back-up pressure level is adjustable, minimum settable value is 5 cmH_2O.

Note: Back-up not applicable in NIV Nasal CPAP.

2 Controlled ventilation - PRVC

Functional description PRVC

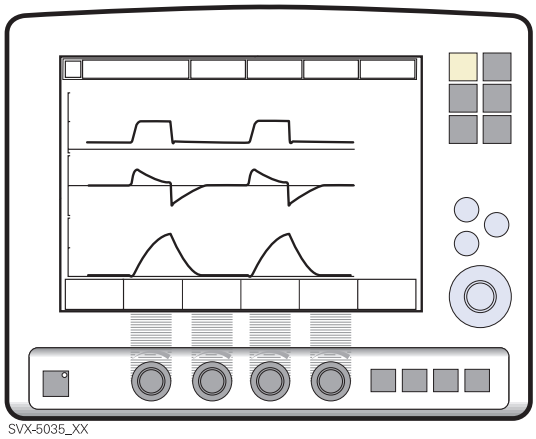
The Pressure Regulated Volume Control (PRVC) mode is a controlled breathing mode.



SVX-5034_XX

Servo-i Ventilator can be configured to set Tidal Volume or Minute Volume. The following parameters are set:

1. Tidal Volume (ml) or Minute Volume (l/min)
2. Respiratory Rate (b/min)
3. PEEP (cmH_2O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Inspiratory rise time (%/s)
7. Trigg. Flow / Trigg. Pressure

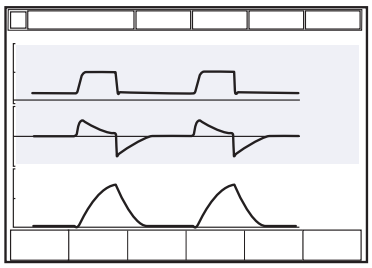


SVX-5035_XX

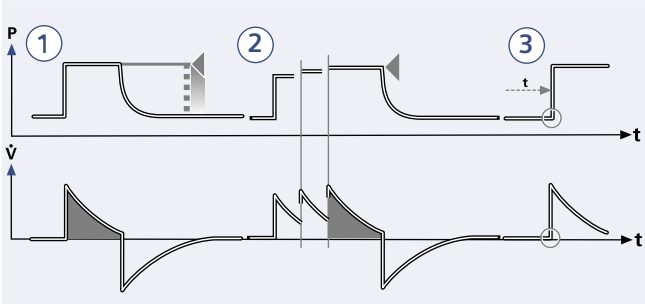
The ventilator delivers a pre-set Tidal Volume. The pressure is automatically regulated to deliver the pre-set volume but limited to 5 cmH_2O below the set upper pressure limit.

The flow during inspiration is decelerating. The patient can trigger extra breaths.

PRVC in detail



SVX-9006_XX



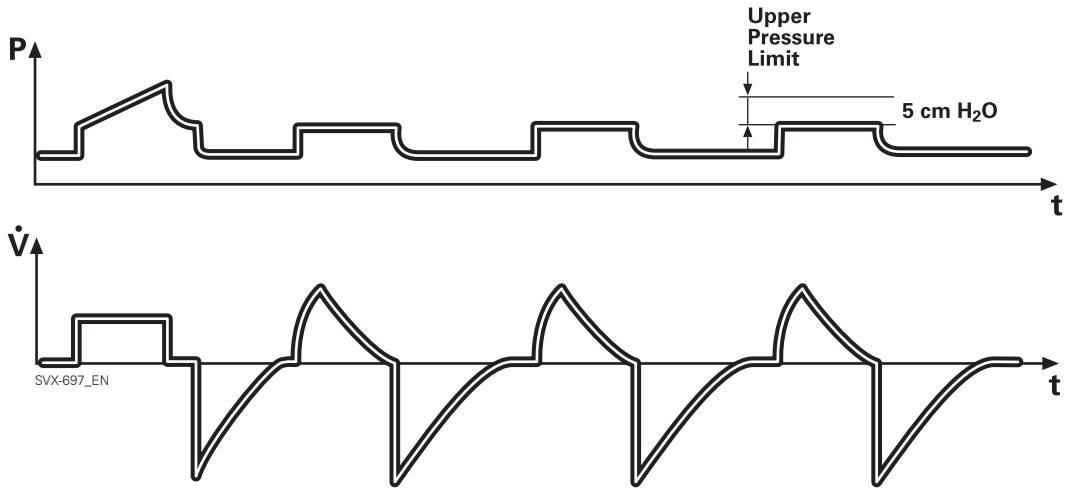
1. PRVC assures a set target minute ventilation to the patient. The target volume is based upon settings for Tidal Volume, frequency and inspiration time.
2. The inspiratory pressure level is constant during each breath, but automatically adapts in small increments breath-by-breath to match the patient´s lung mechanical properties for target volume delivery.
3. Inspiration starts according to a preset frequency or when the patient triggers.

Expiration starts:

a. After the termination of preset inspiration time

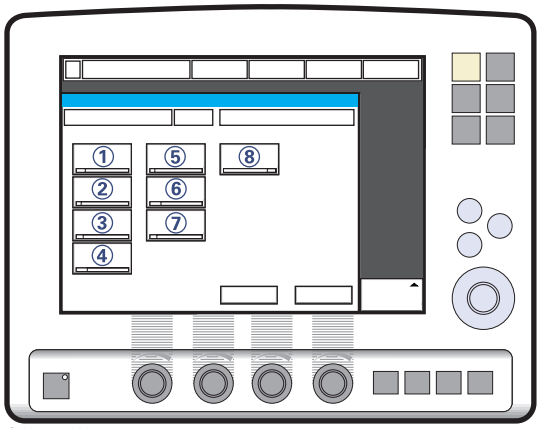
b. If the upper pressure limit is exceeded.

2 Controlled ventilation - PRVC



The first breath of a start sequence is a volume-controlled test breath with Pause time set to 10%. The measured pause pressure of this breath is then used as the pressure level for the following breath. An alarm is activated if the pressure level required to achieve the set target volume cannot be delivered due to a lower setting of the upper pressure limit (- 5 cmH_2O).

Functional description Volume Control

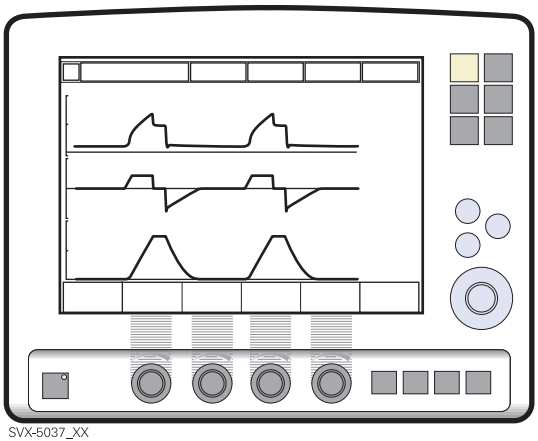


SVX-5036_XX

Volume Controlled ventilation ensures that the patient receives a certain pre-set Minute/ Tidal Volume.

Servo-i Ventilator can be configured to set Tidal Volume or Minute Volume. The following parameters are set:

1. Tidal Volume (ml) or the Minute Volume (l/min)
2. Respiratory Rate (b/min)
3. PEEP (cmH_2O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Pause time (%/s)
7. Inspiratory rise time (%/s)
8. Trigg. Flow / Trigg. Pressure



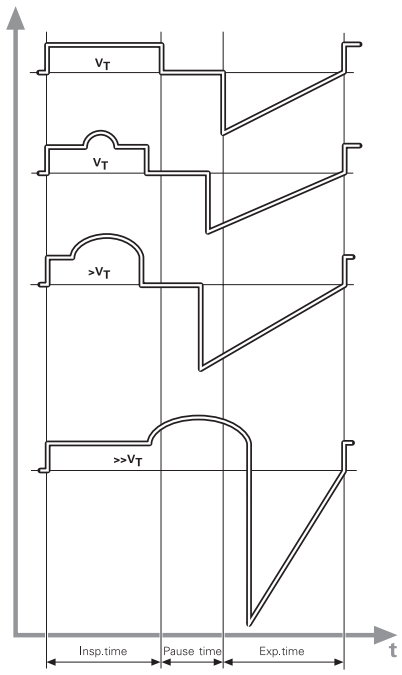
SVX-5037_XX

The airway pressure is dependent on the tidal volume, inspiration time and the resistance and compliance of the respiratory system. The set tidal volume will always be delivered. An increase in the resistance and decrease in compliance will lead to an increased airway pressure. To protect the patient's lungs from excessive pressure, it is very important to set the upper pressure limit to a suitable value.

It is possible for the patient to trigger extra breaths if they can overcome the pre-set trigger sensitivity. It is also possible for the patient, by their own inspiratory efforts, to receive a higher inspiratory flow and Tidal Volume during an inspiration than pre-set. The flow during inspiration is constant. The patient can trigger extra breaths.

2 Controlled ventilation - Volume Control

Volume Controlled ventilation has, by tradition, delivered each breath with a constant flow and constant inspiratory and expiratory times, according to the settings. The Servo-i gives the possibility to the patient to modify both flow rate and timing. So, if a pressure drop of 3 cmH_2O is detected during inspiration, the ventilator cycles to Pressure Support with a resulting increase in inspiratory flow. When the flow decreases to the calculated target level this flow will be maintained until the set Tidal Volume is delivered.

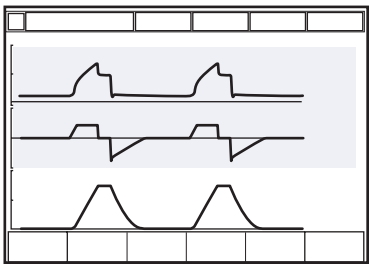


SVX-652_EN

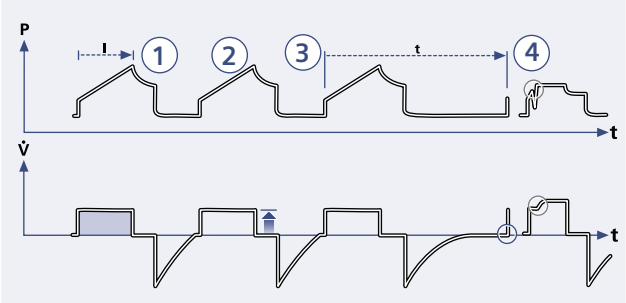
The waveform illustrations above show some practical consequences of this enhanced functionality.

- the top waveform shows the trace for a normal Volume Controlled breath
- the second waveform shows a situation when inspiration is prematurely interrupted as the set tidal volume has been delivered
- the third waveform shows a situation where the patient maintains a flow rate higher than the calculated target value. The set Tidal Volume has been delivered when calculated target flow is reached and the inspiration is prematurely interrupted
- the bottom waveform, shows a situation where the increased flow rate is maintained into the expiratory period. The patient will receive a higher tidal volume than set due to a higher flow/volume demand than calculated.

Volume Control in detail



SVX-9002_XX



1. Volume Control assures a preset tidal volume with constant flow during a preset inspiratory time at a preset frequency.
2. The inspiratory flow is constant and depends on User Interface setting.
3. Inspiration starts according to the preset frequency or when the patient triggers.
4. If the patient makes an inspiratory effort during the inspiratory period, the ventilator will switch to Pressure Support to satisfy the patient´s flow demand.

Expiration starts:

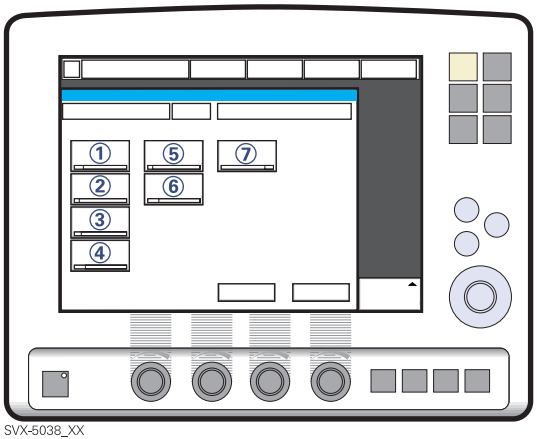
a. When the preset tidal volume is delivered and after the preset pause time.

b. When the flow returns to the set value after the preset tidal volume is delivered and after the preset pause time (on-demand support). The patient is however always guaranteed an expiration time corresponding to at least 20% of the total breath.

c. If the upper pressure limit is exceeded.

Functional description Pressure Control

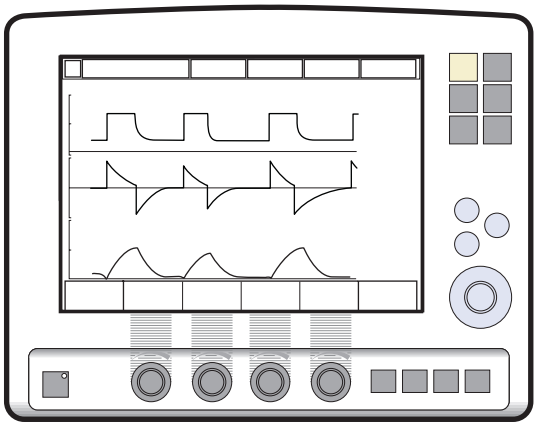
The Pressure Controlled mode is a controlled breathing mode.



SVX-5038_XX

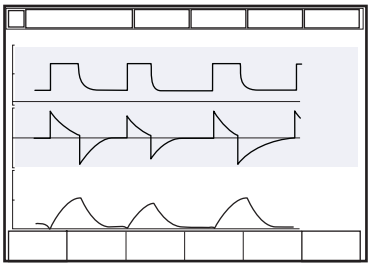
The following parameters are set:

1. PC (Pressure Control level) above PEEP (cmH_2O)
2. Respiratory Rate (b/min)
3. PEEP (cmH_2O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Inspiratory rise time (%/s)
7. Trigg. Flow / Trigg. Pressure

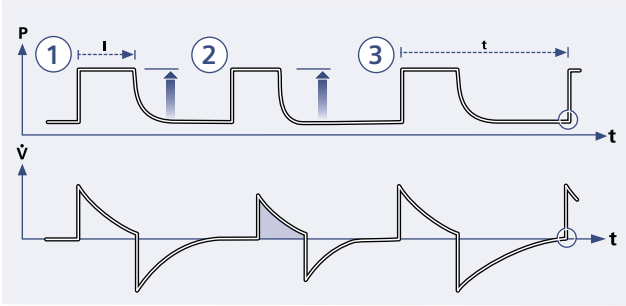

SVX-5039_XX

The delivered volume is dependent upon the pressure above PEEP, lung compliance and resistance in the patient tube system and airways. This means that the Tidal Volume can vary. Pressure Controlled mode is preferred when there is leakage in the breathing system e.g. due to uncuffed endotracheal tube or in situations when the maximum airway pressure must be controlled. The flow during inspiration is decelerating. The patient can trigger extra breaths. If the patient tries to exhale during the inspiration, the expiratory valve will allow exhalation as long as the pressure is more than 3 cmH_2O above the set pressure level. As the delivered tidal volume can vary it is very important to set alarm limits for Minute Volume to adequate levels.

Pressure Control in detail



SVX-9003_XX



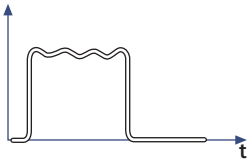
1. Pressure Control assures that the preset inspiratory pressure level is maintained constantly during the entire inspiration. Breaths are delivered according to the preset frequency, inspiration time and inspiratory pressure level resulting in a decelerating flow.
2. The preset pressure level is controlled by the ventilator. The resulting volume depends on the set pressure level, inspiration time and the patient´s lung mechanical properties during each breath with a decelerating flow.
3. Inspiration starts according to the preset frequency or when the patient triggers.

Expiration starts:

a. After the termination of preset inspiration time.

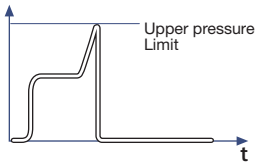
b. If the upper pressure limit is exceeded.

Active expiratory valve



SVX-9008_XX

If a patient tries to exhale during the inspiration, pressure increases. When it increases 3 cmH_2O above the set inspiratory pressure level, the expiratory valve opens and regulates the pressure down to the set inspiratory pressure level.

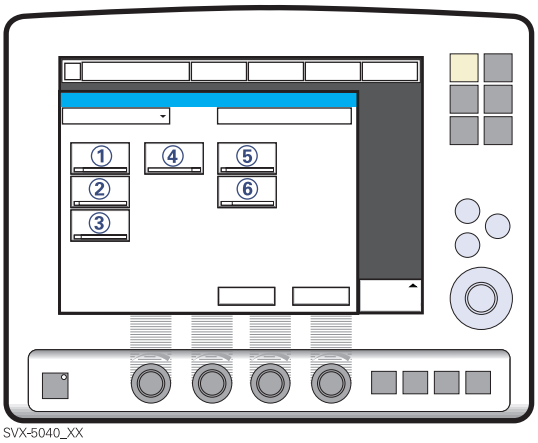


SVX-9009_EN

If the pressure increases to the set upper pressure limit e.g. the patient is coughing, the expiratory valve opens and the ventilator switches to expiration.

Functional description Volume Support

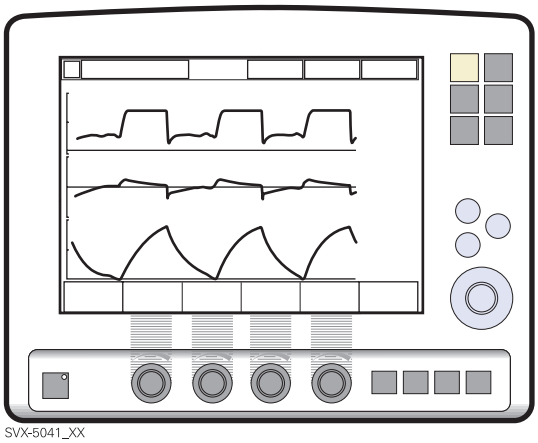
The Volume Support mode is a patient initiated breathing mode, where the patient will be given support in proportion to their inspiratory effort and the target Tidal Volume.



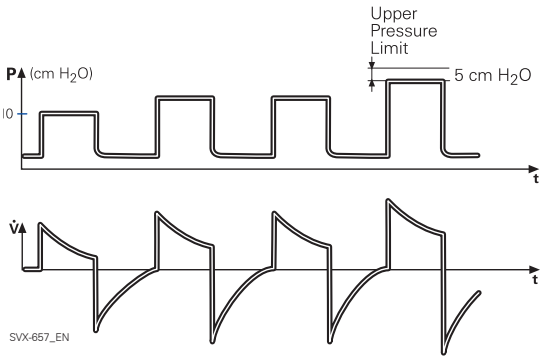
SVX-5040_XX

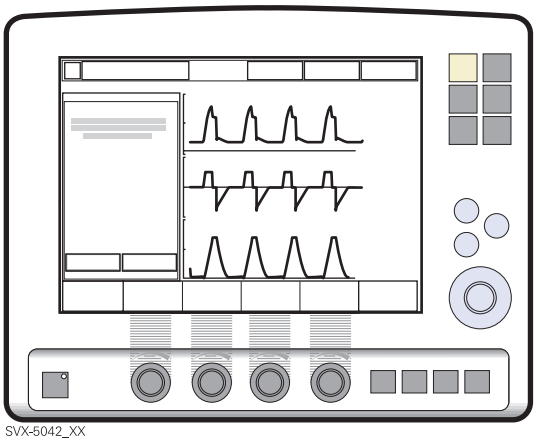
The following parameters are set:

1. Tidal Volume (ml)
2. PEEP (cmH_2O)
3. Oxygen concentration (%)
4. Inspiratory rise time (s)
5. Trigg. Flow / Trigg. Pressure
6. Inspiratory Cycle-off (%)


SVX-5041_XX

If the patient's activity increases the inspiratory pressure support will decrease provided the set Tidal Volume is maintained. If the patient breathes below the set Tidal Volume the inspiratory pressure support will increase.




SVX-5042_XX

The start breath is given with 10 cmH_2O support. From that breath the ventilator calculates and continuously regulates the pressure needed to deliver the pre-set Tidal Volume.

During the remaining 3 breaths of the start up sequence the maximum pressure increase is 20 cmH_2O for each breath. After the start up sequence the pressure increases or decreases in steps of maximum 3 cmH_2O.

If the delivered Tidal Volume decreases below the set Tidal Volume the pressure support level is increased in steps of maximum 3 cmH_2O until preset Tidal Volume is delivered. If the pressure support level causes a larger Tidal Volume than preset, the support pressure is lowered in steps of maximum 3 cmH_2O until the preset Tidal Volume is delivered.

The maximum time for inspiration is:

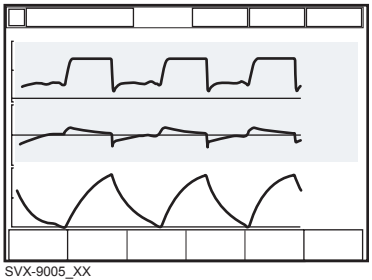
- Infant 1.5 seconds
- Adult 2.5 seconds

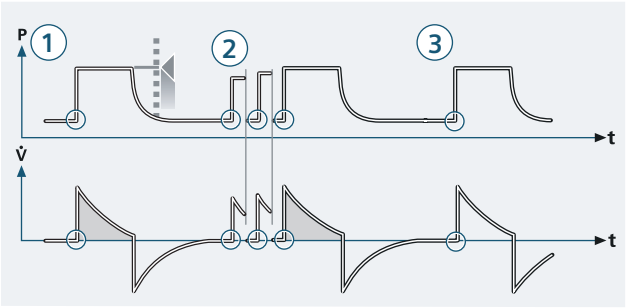
An alarm is activated if the pressure level required to achieve the set target volume cannot be delivered due to a lower setting of the upper pressure limit (- 5 cmH_2O).

In this mode it is also important to set the apnea time appropriate to the individual patient situation. If this time is reached then the ventilator will automatically switch to Back-up mode providing controlled ventilation. In all spontaneous modes it is important to set the Minute Volume alarm.

2 Supported ventilation - Volume Support

Volume Support in detail


SVX-9005_XX



1. Volume Support assures a set target Tidal Volume upon patient effort by an adapted inspiratory pressure support.
2. The inspiratory pressure level is constant during each breath, but alters in small increments, breath-by-breath, to match the patient´s breathing ability and lung mechanical properties.
3. Inspiration with Volume Support starts: When the patient triggers.

Expiration starts:

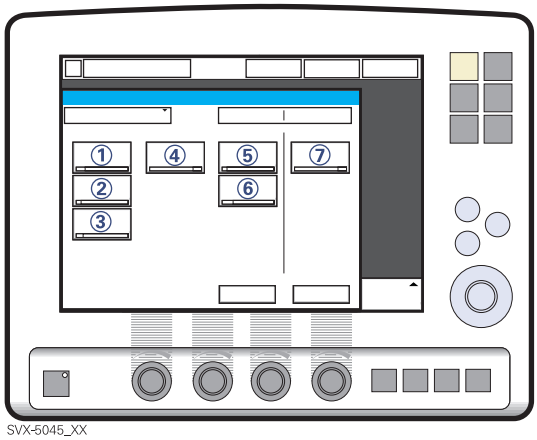
a. When the inspiratory flow decreases below a preset fraction of the inspiratory peak flow (*Inspiratory cycle-off*)

b. If the upper pressure limit is exceeded.

c. Maximum time for inspiration is exceeded.

Functional description Pressure Support

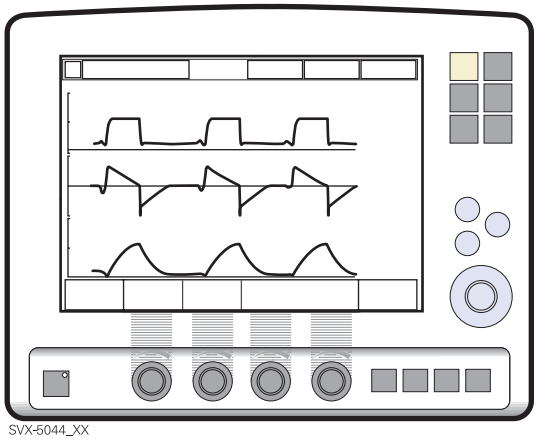
Pressure Support is a patient initiated breathing mode in which the ventilator supports the patient with a set constant pressure.



SVX-5045_XX

The following parameters are set:

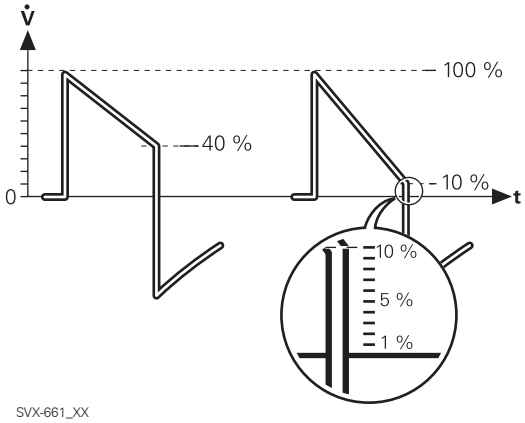
1. PS (Pressure Support level) above PEEP (cmH_2O)
2. PEEP (cmH_2O)
3. Oxygen concentration (%)
4. Inspiratory rise time (s)
5. Trigg. Flow / Trigg. Pressure
6. Inspiratory Cycle-off (%)
7. PC (pressure control level) above PEEP (cmH_2O).


SVX-5044_XX

During Pressure Supported ventilation the patient regulates the respiratory rate and the Tidal Volume with support from the ventilator. The higher the pre-set inspiratory pressure level from the ventilator the more gas flows into the patient. As the patient becomes more active the pressure support level may be gradually reduced. It is important to set the Inspiratory rise time to a comfortable value for the patient. In Pressure Support the Inspiratory rise time should normally be increased.

It is also very important to set lower and upper alarm limit for expired Minute Volume.

2 Supported ventilation - Pressure Support



Inspiratory Cycle-off is important for the patient's comfort and ventilator synchronization with the patient. Inspiratory Cycle-off is the point when inspiration switches to expiration. E.g. for a patient with expiratory resistance the inspiratory Cycle-off should be set to a high value to guarantee enough time for expiration.

Note: It is important to monitor the corresponding Tidal Volume levels.

Inspiration: when the patient triggers a breath, gas flows into the lungs at a constant pressure. Since the pressure provided by the ventilator is constant, the flow will decrease until the Inspiratory Cycle-off is reached.

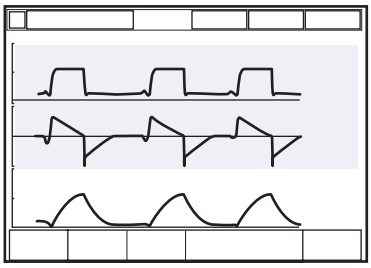
Expiration starts when:

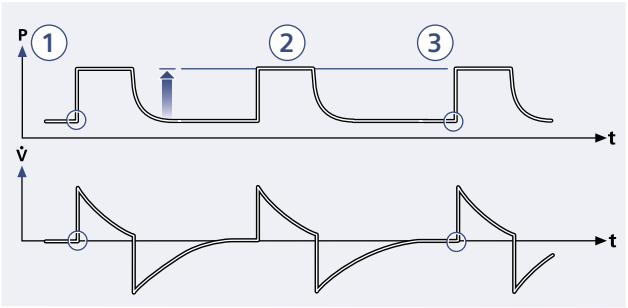
- The inspiratory flow decreases to the pre-set Inspiratory Cycle-off level.
- If the upper pressure limit is exceeded.
- If the flow drops to a flow range between 25% of the peak flow and lower limit for Inspiratory Cycle-off fraction level and the spent time within this range exceeds 50% of the time spent in between the start of the inspiration and entering this range.

The maximum time for inspiration is:

- Infant 1.5 seconds
- Adult 2.5 seconds

Pressure Support in detail


SVX-9004_XX



1. Pressure Support assures that a preset inspiratory pressure level is constantly maintained upon patient effort.
2. The preset pressure level is controlled by the ventilator, while the patient determines frequency and inspiration time.
3. Inspiration starts when the patient triggers.

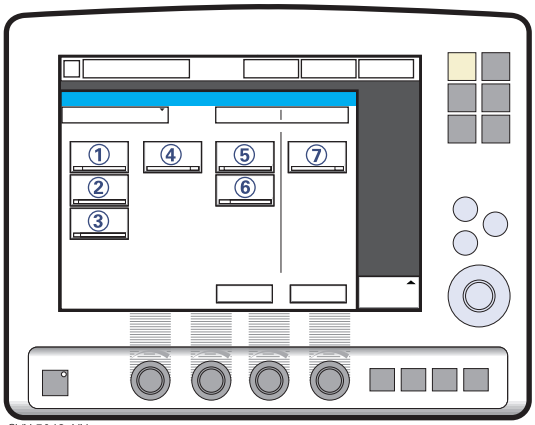
Expiration starts:

a. When the inspiratory flow decreases below a preset fraction of the inspiratory peak flow (*Inspiratory cycle-off*)

b. If the upper pressure limit is exceeded.

Functional description Spontaneous breathing/CPAP

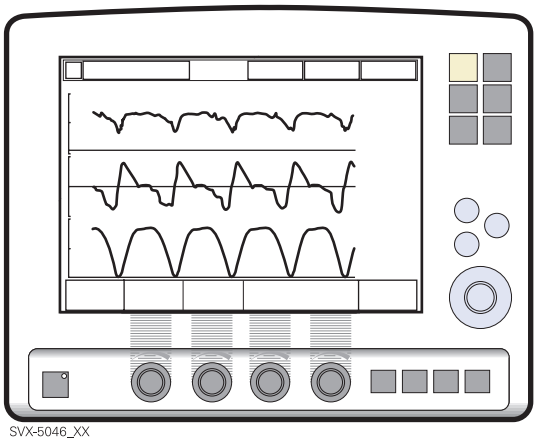
The mode Continuous Positive Airway Pressure is used when the patient is breathing spontaneously.



SVX-5043_XX

The following parameters are set:

1. PS (Pressure Support level) above PEEP (cmH_2O)
2. PEEP (cmH_2O)
3. Oxygen concentration (%)
4. Inspiratory rise time (s)
5. Trigg. Flow / Trigg. Pressure
6. Inspiratory Cycle-off (%)
7. PC (pressure control level) above PEEP (cmH_2O).



SVX-5046_XX

A continuous positive pressure is maintained in the airways. Properly set this may prevent collapse of airways. Inspiration starts upon patient effort. Expiration starts as for Pressure Support above. Always set the Apnea time appropriate to the individual patient situation. If the apnea alarm limit is reached the ventilator will automatically switch back to a Back-up mode.

The alarm should alert staff to take action, either to go back to supported mode or change to a controlled mode of ventilation.

It is also very important to set lower and upper alarm limit for expired Minute Volume

The maximum time for inspiration is:

- Infant 1.5 seconds
- Adult 2.5 seconds.

Spontaneous breathing/CPAP in detail

– True spontaneous breathing will occur:

a. In Volume Support when the target volume is maintained without support (automatically regulated by the ventilator)

b. In Pressure Support when the inspiratory pressure level is set to zero

c. In Automode when either of the above defined conditions is met.

– Inspiration starts upon patient effort.

Expiration starts:

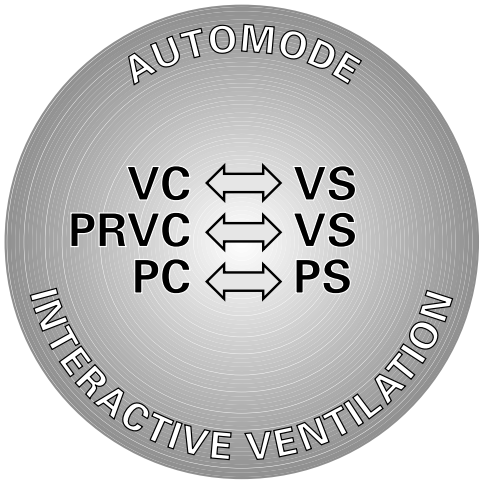
a. When the inspiratory flow decreases below a preset fraction of the inspiratory peak flow (*Inspiratory cycle-off*)

b. If the upper pressure limit is exceeded.

2 Automode

Automode

Functional description



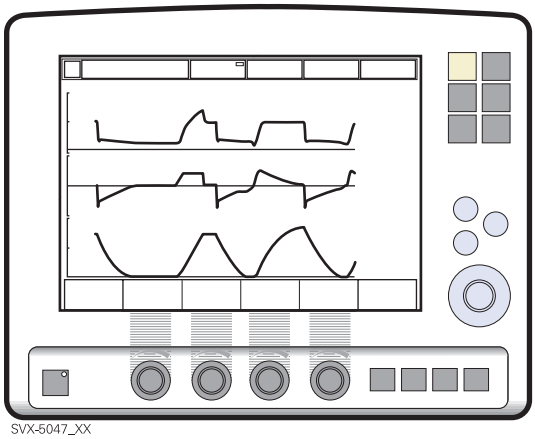
SVX-602_EN

Automode is a ventilator functionality where the ventilator adapts to the patient's varying breathing capacity and automatically shifts between a control mode and a support mode using a fixed combination of ventilation modes. There are three different combinations, depending on the modes installed:

- Volume Control<----> Volume Support
- PRVC <----> Volume Support
- Pressure Control <----> Pressure Support.

Note: Automode is not possible in NIV.

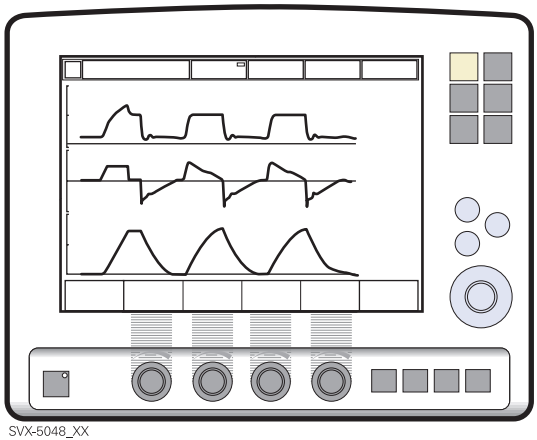
Volume Control<->Volume Support



SVX-5047_XX

The ventilator uses the plateau pressure in the Volume Controlled breath as a reference pressure for the first Volume Supported breath.

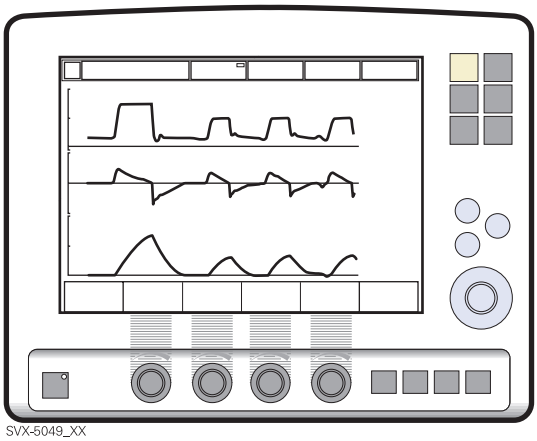
PRVC <-> Volume Support



SVX-5048_XX

The first supported breath delivered to the patient has the same pressure level as the preceding PRVC breath.

Pressure Control<->Pressure Support



SVX-5049_XX

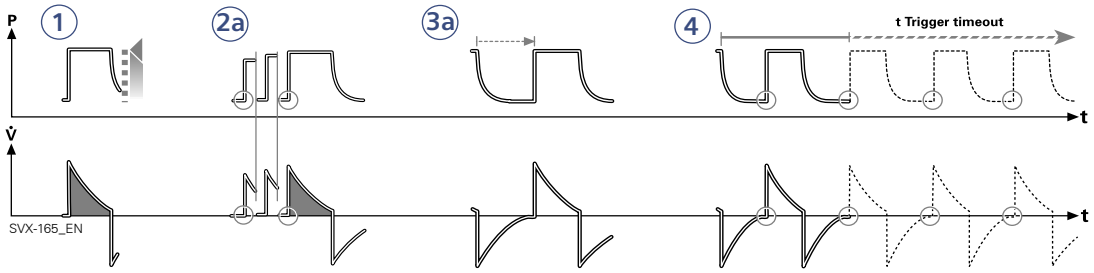
In this combination of Automode - Pressure Control and Pressure Support - the Direct Access Knob will regulate the PC above PEEP (Pressure Control level).

2 Automode

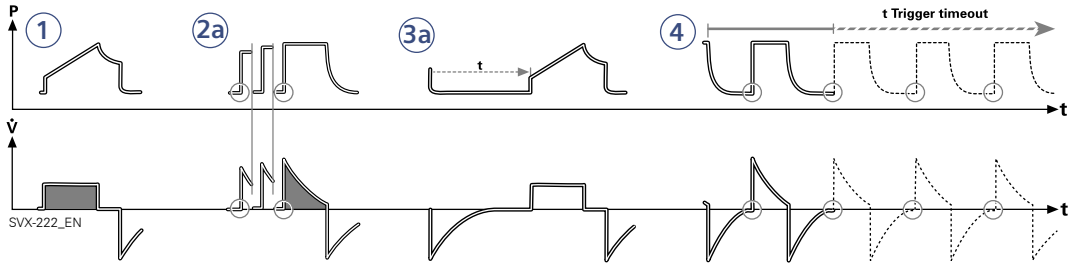
Automode in detail

1. The ventilator starts in control mode and operates according to the Volume Control, PRVC or Pressure Control mode. If the patient triggers a breath, the ventilator will turn to support mode, to encourage the patient's respiratory drive.
2. If the patient is breathing adequately:
   a. In Volume Support the ventilator adjusts the inspiratory pressure level breath-by-breath to assure the preset target volume.
   b. In Pressure Support the ventilator assures that the preset inspiratory pressure level is maintained constantly during the entire inspiration.
3. Exceeding the default or manually set trigger timeout limit without a sufficient patient effort will cause:
   a. In Volume Support; a PRVC or Volume controlled breath will be delivered according to the selected automode functionality.
   b. In Pressure Support; a Pressure controlled breath will be delivered.
4. The ventilator initially adapts with a dynamic trigger timeout limit. This means that for the spontaneously triggering patient, the trigger timeout limit increases successively until the set trigger timeout limit is reached.

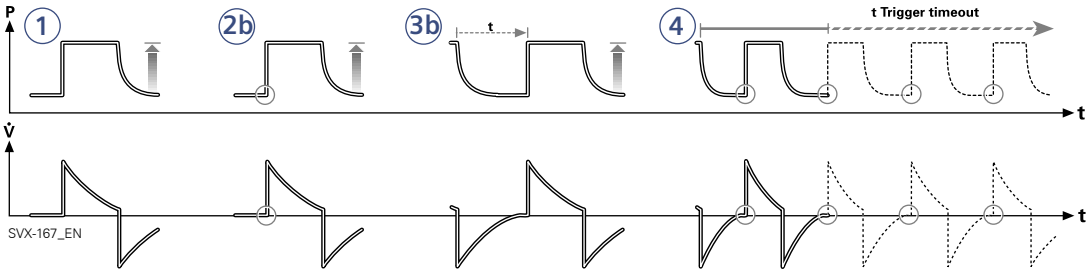
PRVC - Volume Support



Volume Control - Volume Support



Pressure Control - Pressure Support



Functional description SIMV

SIMV is a combination mode where the patient receives mandatory breaths synchronized with his breathing efforts and according to the selected SIMV mode. The patient can breath spontaneously with Pressure Support in between the mandatory breaths.

There are three different SIMV modes, depending on the modes installed:

- SIMV (PRVC) + Pressure Support
- SIMV (Volume Control) + Pressure Support
- SIMV (Pressure Control) + Pressure Support

The mandatory breath

	SIMV (VC)+ PS	SIMV (PRVC)+PS	SIMV (PC) + PS
PC above PEEP			X
Tidal volume / Minute volume	X	X	
SIMV rate	X[1]	X[1]	
Breath cycle time	X[2]	X[2]	X[2]
I:E ratio / Inspiration time	X	X	X
Insp. rise time	X	X	X
Pause time	X[2]		

[1] Only when the ventilator is configured for Minute volume setting.

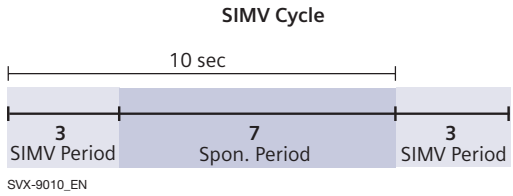
[2] Only when the ventilator is configured for I:E ratio setting.

The Mandatory breath is defined by the basic settings (as shown in the table above): Minute Volume/Tidal Volume (depending on configuration), PC above PEEP, I:E ratio/ Inspiration time (depending on configuration), Pause time, Inspiratory rise time and Breath cycle time.

Note: In the Minute Volume configuration the Tidal Volume is determined by Minute Volume divided by SIMV rate.

The Breath cycle time is the length of the mandatory breath in seconds.

For example: A SIMV rate of 6, a breath cycle time of 3 seconds with an I:E ratio of 1:2 means that the inspiration will take 1 second and the expiration 2 seconds.

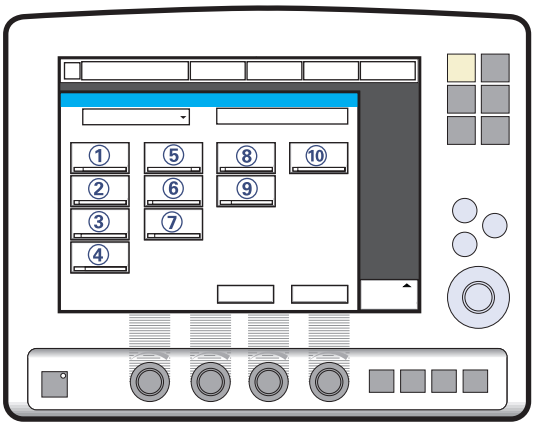


During the SIMV period, the first triggered breath will be a mandatory breath. If the patient has not triggered a breath within the first 90% of the Breath Cycle time a mandatory breath will be delivered.

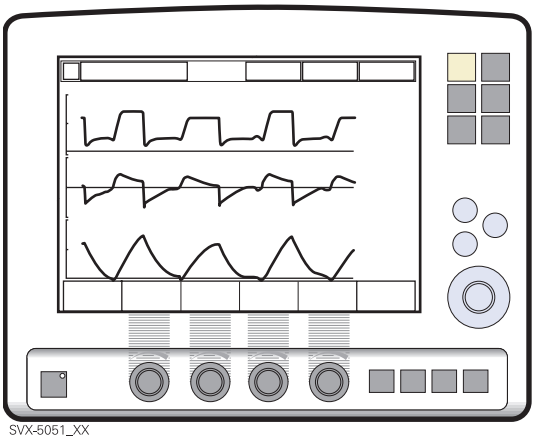
Note: If the ventilator is configured for setting of Inspiration time, an I:E ratio of 1:2 will be used to estimate the Breath cycle time.

The spontaneous/pressure supported breaths are defined by setting the Pressure support level above PEEP.

SIMV (PRVC) + Pressure Support



SVX-5053_XX

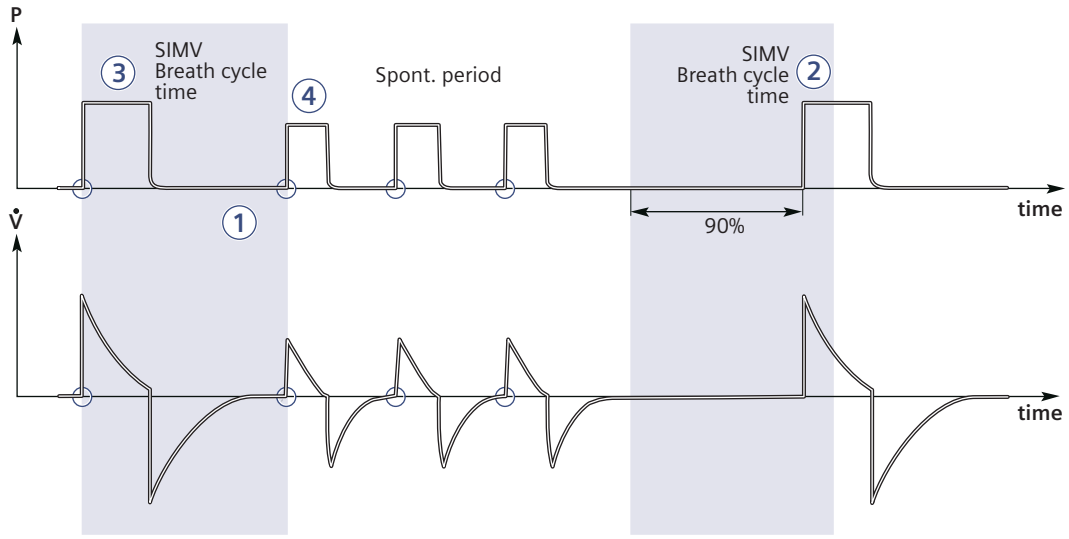

SVX-5051_XX

The following parameters are set:

1. Tidal Volume (ml)/Minute Volume (l/min)
2. SIMV rate (b/min)
3. PEEP (cmH_2O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Inspiratory rise time (%/s)
7. Breath cycle time (s)

   Note: The soft key Breath cycle time is not shown when an SIMV mode is selected and inspiration time is configured. Refer to page 27.
8. Trigg. Flow / Trigg. Pressure
9. Inspiratory Cycle-off (%)
10. PS (Pressure Support level) above PEEP (cmH_2O)

SIMV (PRVC) + Pressure Support

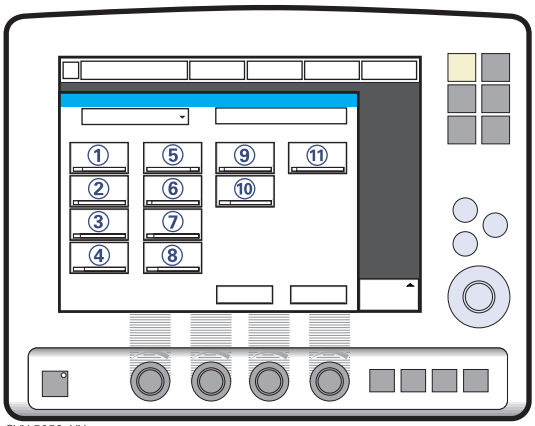


SVX-9027_EN

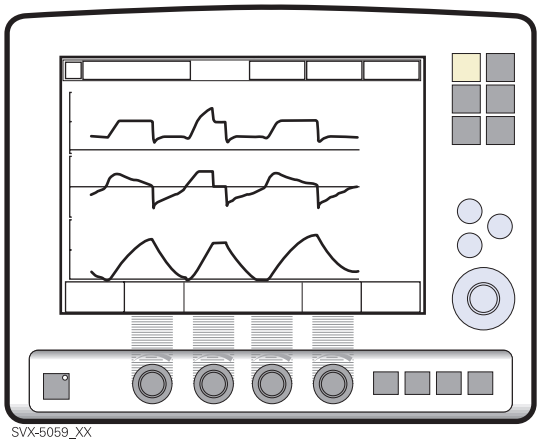
SIMV - in detail

1. This combined control and pressure support/spontaneous function allows for preset mandatory breaths synchronized with the patient's breathing.
2. If there is no trigger attempt within a time window equal to 90% of the set Breath cycle time, a mandatory breath is delivered. (The Breath cycle time is the total time for one mandatory breath.)
3. The mandatory breath is defined by the basic settings (mode of ventilation, breath cycle time, respiratory pattern and volumes/pressures).
4. The spontaneous/pressure supported breaths are defined by the setting for Pressure Support.

SIMV (Volume Control) + Pressure Support



SVX-5052_XX

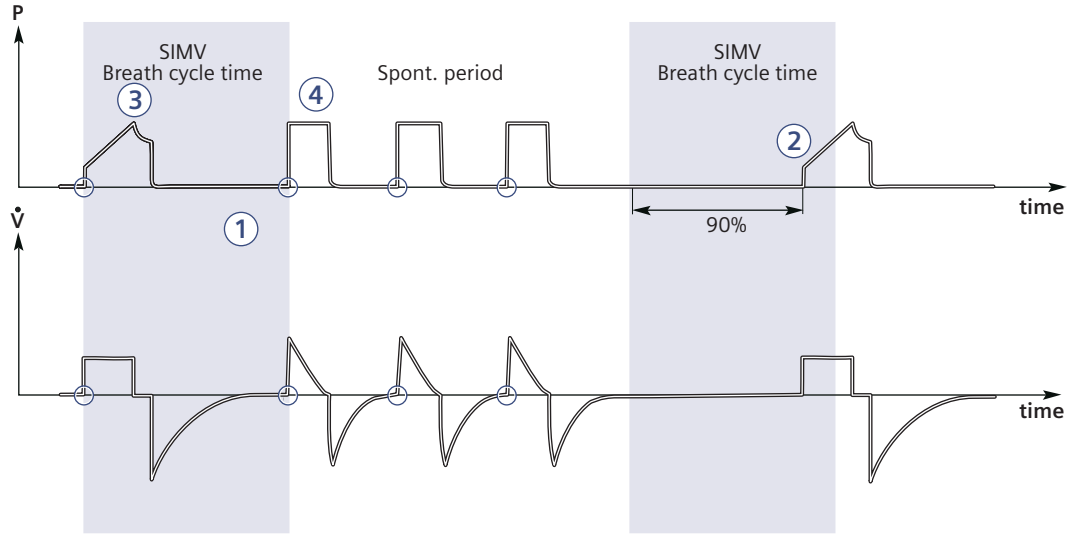

SVX-5059_XX

The following parameters are set:

1. Tidal Volume (ml)/Minute Volume (l/min)
2. SIMV rate (b/min)
3. PEEP (cmH_2O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Pause time (%/s)
7. Inspiratory rise time (%/s)
8. Breath cycle time (s)

   Note: The soft key Breath cycle time is not shown when an SIMV mode is selected and inspiration time is configured. Refer to page 27.
9. Trigg. Flow / Trigg. Pressure
10. Inspiratory Cycle-off (%)
11. PS (Pressure support) above PEEP (cmH_2O)

SIMV (Volume Control) + Pressure Support

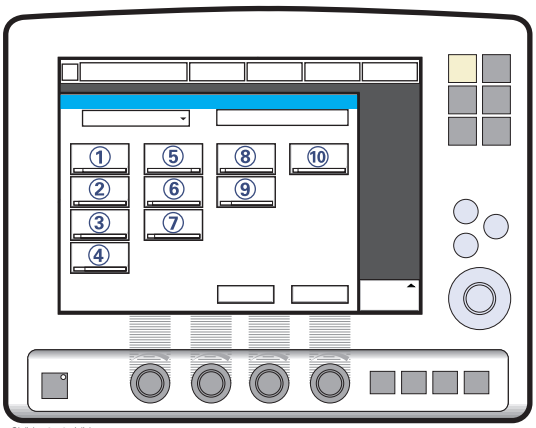


SVX-9011_EN

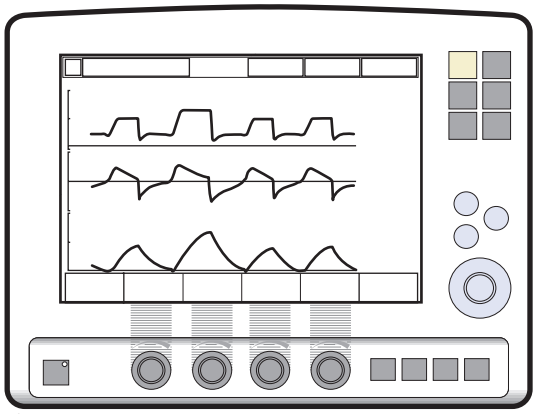
SIMV - in detail

1. This combined control and pressure support/spontaneous function allows for preset mandatory breaths synchronized with the patient's breathing.
2. If there is no trigger attempt within a time window equal to 90% of the set Breath cycle time, a mandatory breath is delivered. (The Breath cycle time is the total time for one mandatory breath.)
3. The mandatory breath is defined by the basic settings (mode of ventilation, breath cycle time, respiratory pattern and volumes/pressures).
4. The spontaneous/pressure supported breaths are defined by the setting for Pressure Support.

SIMV (Pressure Control) + Pressure Support



SVX-5050_XX

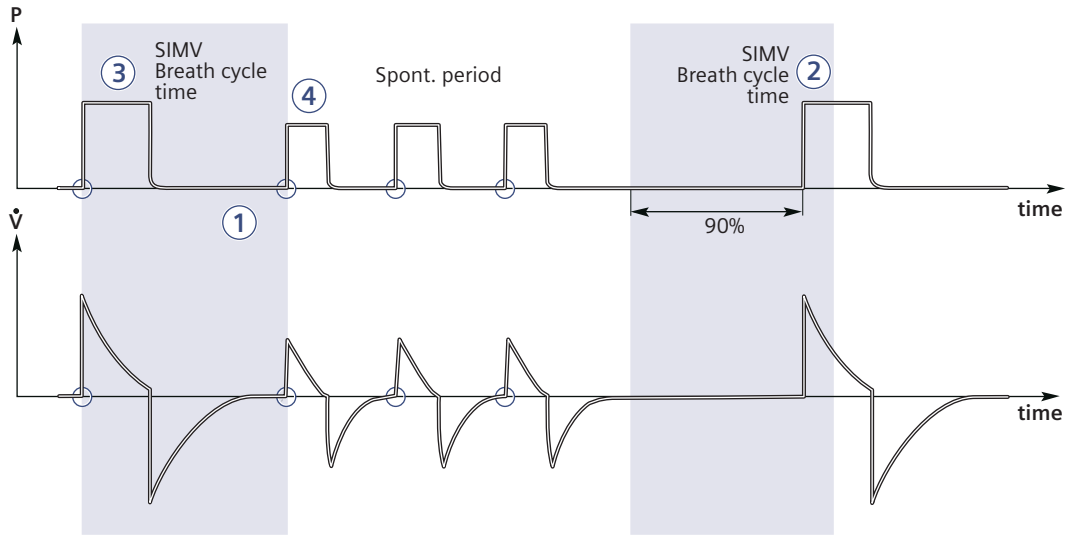

SVX-5054_XX

The following parameters are set:

1. PC (Pressure Control level) above PEEP (cmH_2O)
2. SIMV rate (b/min)
3. PEEP (cmH_2O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Inspiratory rise time (%/s)
7. Breath cycle time (s)

   Note: The soft key Breath cycle time is not shown when an SIMV mode is selected and inspiration time is configured. Refer to page 27.
8. Trigg. Flow / Trigg. Pressure
9. Inspiratory Cycle-off (%)
10. PS (Pressure Support level) above PEEP (cmH_2O)

SIMV (Pressure Control) + Pressure Support

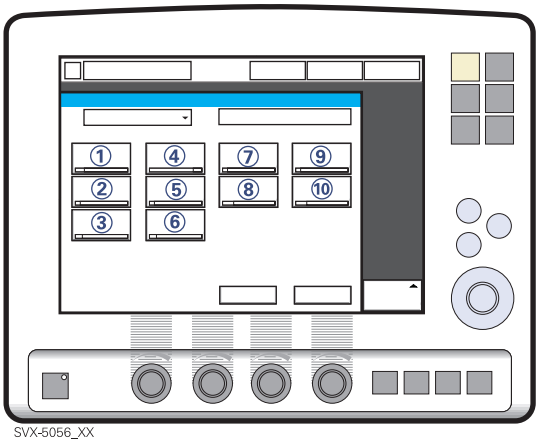


SIMV - in detail

1. This combined control and pressure support/spontaneous function allows for preset mandatory breaths synchronized with the patient's breathing.
2. If there is no trigger attempt within a time window equal to 90% of the set Breath cycle time, a mandatory breath is delivered. (The Breath cycle time is the total time for one mandatory breath.)
3. The mandatory breath is defined by the basic settings (mode of ventilation, breath cycle time, respiratory pattern and volumes/pressures).
4. The spontaneous/pressure supported breaths are defined by the setting for Pressure Support.

Bi-Vent

Functional description

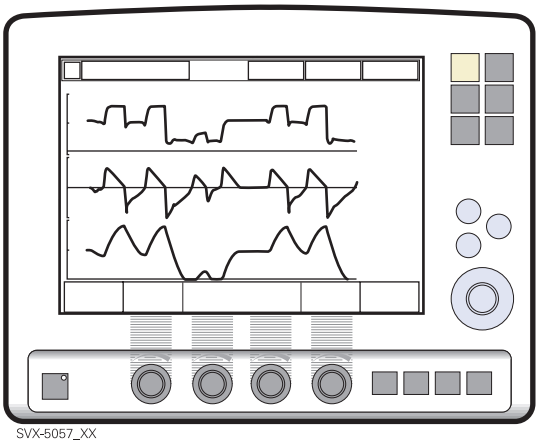


SVX-5056_XX

Bi-Vent is pressure controlled breathing that allows the patient the opportunity of unrestricted spontaneous breathing. Two pressure levels are set together with the individually set duration of each level. Spontaneous breathing efforts can be. assisted by pressure support

The following parameters are set:

1. Pressure high (P_{High}) for the higher pressure level (cmH_2O)
2. PEEP for the lower pressure level (cmH_2O)
3. Oxygen concentration (%)
4. Time at the higher pressure (T_{High}) level (s)
5. Time at the lower pressure (T_{PEEP}) level (s)
6. Inspiratory rise time (s)
7. Trigg. Flow / Trigg. Pressure
8. Inspiratory Cycle-off (%)
9. Pressure Support level above P_{High} (cmH_2O)
10. Pressure Support level above PEEP (cmH_2O)



SVX-5057_XX

In the Bi-Vent mode the ventilator uses two shifting pressure levels, with the patient being able to breath spontaneously on both these levels.

Since Bi-Vent is basically a controlled mode of ventilation, apnea alarm and back-up ventilation are not available. It is also very important to set lower and upper alarm limit for expired Minute Volume.

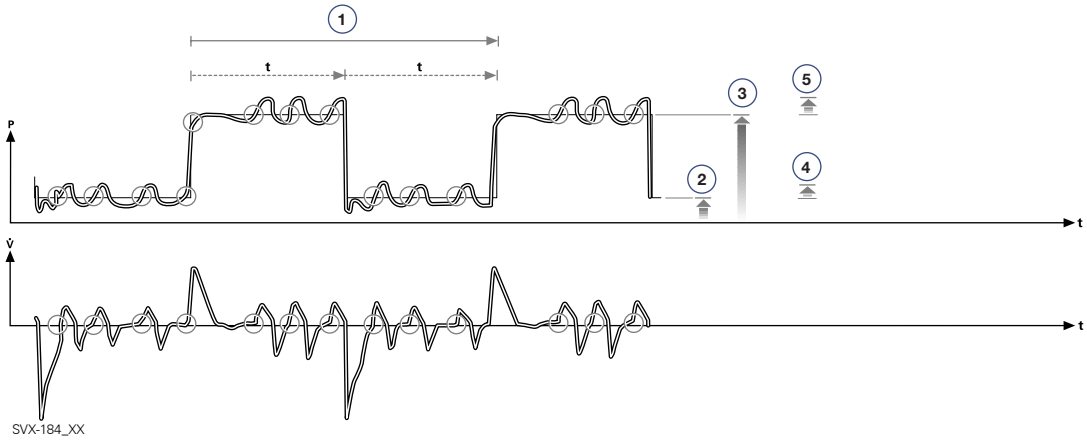
Every Bi-Vent cycle is regarded as autonomous and therefore most of the measured values are updated every Bi-Vent cycle, i.e. minute volumes, respiratory rate, mean pressure and end expiratory pressure. In accordance to this, associated alarms are also handled for every Bi-Vent cycle.

At extreme settings the update of measured values and alarms will show a mandatory frequency dependence even in the face of preserved spontaneous breathing.

As a result of switching between two different pressure levels, the tidal volumes may vary significantly between different breaths. This may also be the case for $etCO_2$ concentration.

It is not recommended to use *Auto scale* in Bi-Vent mode, when patient is breathing spontaneous on both levels.

Bi-Vent in detail



This function allows for spontaneous breathing / pressure supported ventilation at two different pressure levels. These basic levels are individually set, as well as the time in seconds at each level.The ventilator always tries to synchronize with the patient´s breathing.

1. Bi-Vent cycle; T_{High} + T_{PEEP}
2. *PEEP*
3. P_{High}
4. The pressure support level is set individually: *PS above PEEP*
5. *PS above* P_{High}

Non Invasive Ventilation

This chapter refers to when the Servo-i is used during Non Invasive Ventilation (NIV). NIV refers to ventilation, where the patient is not intubated or tracheotomized. It is achieved using a nasal mask / prongs, face mask / prongs or full-face mask / prongs.

Note: In NIV, flow and pressure curves and the measured values: VTi, VTe, MVe, MVi are compensated for leakage.

WARNINGS!

- Avoid high inspiratory pressure as it may lead to gastric overdistension and risk of aspiration. It may also cause excessive leakage.
- The dead space will increase when use of a mask / prongs.
- NIV is not intended to be used on intubated patients.
- CO_2 measurement will be affected by mask / prongs leakage.

Cautions:

- Mask / prongs leakage might affect the nebulizer efficiency.
- It is not recommended to use the nebulizer during NIV as the nebulized drug might come in contact with the patient eyes in case of leakage.

Important:

- The mask / prongs must be applied in order to avoid leakage.
- Selection of the mask / prongs must take into consideration proper size and an accurate adaptation to the patient.
- CO_2 rebreathing will increase during NIV and use of a face mask / prongs.

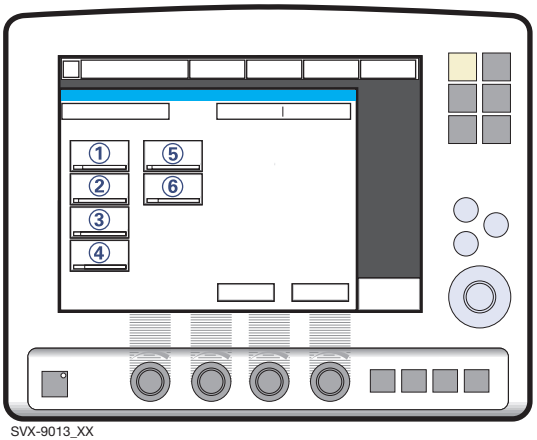
Read more about NIV

Intended population	page 4
Ventilation modes (NIV):	pages 62, 63
Alarm settings:	page 73
Preparation:	page 160

2 NIV - Pressure Control

Functional description Pressure Control

The Pressure Controlled (NIV) mode is a controlled breathing mode.



SVX-9013_XX

The following parameters are set:

1. PC (Pressure Control level) above PEEP (cmH_2O)
2. Respiratory Rate (b/min)
3. PEEP (cmH_2O)
4. Oxygen concentration (%)
5. I:E ratio / Insp. time
6. Inspiratory rise time (%/s)

Differences from invasive Pressure control mode:

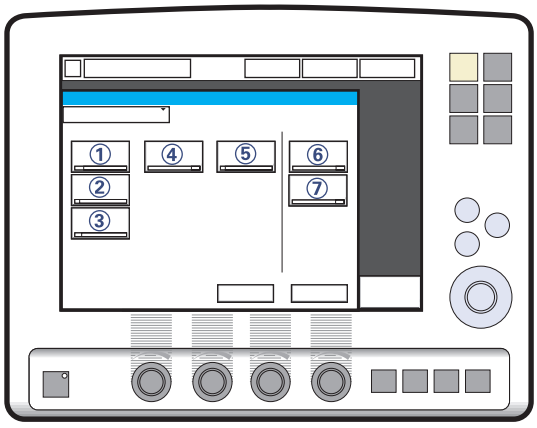
- When the *Standby* key is pressed a waiting position dialog is shown. All patient related alarms are turned off during 120 seconds. Press the *Start ventilation* pad to start the ventilation.
- During NIV the ventilator automatically adapts to the variation of leakage in order to maintain the required pressure and PEEP level. If the leakage is excessive, the ventilator will issue a high priority alarm, deliver a continuous flow and pause breath cycling. Ventilation will resume automatically if the leakage decreases. Ventilation can also be started manually by pressing the *Start ventilation* pad in the excessive leakage dialog.
- Trigger sensitivity cannot be set in NIV.

Read more about NIV

Intended population	page 4
NIV general information:	page 61
Ventilation modes (NIV):	page 63
Alarm settings:	page 73
Preparation:	page 160

Functional description Pressure Support

Pressure Support (NIV) is a patient initiated breathing mode in which the ventilator supports the patient with a set constant pressure.



SVX-9014_XX

The following parameters are set:

1. PS (Pressure Support level) above PEEP (cmH_2O)
2. PEEP (cmH_2O)
3. Oxygen concentration (%)
4. Inspiratory rise time (s)
5. Inspiratory Cycle-off (%)
6. NIV rate (b/min)
7. Backup Ti (s)

Differences from invasive Pressure support mode:

- When the *Standby* key is pressed a waiting position dialog is shown. All patient related alarms are turned off during 120 seconds. Press the *Start ventilation* pad to start the ventilation.
- During NIV the ventilator automatically adapts to the variation of leakage in order to maintain the required pressure and PEEP level. If the leakage is excessive, the ventilator will issue a high priority alarm, deliver a continuous flow and pause breath cycling. Ventilation will resume automatically if the leakage decreases. Ventilation can also be started manually by pressing the *Start ventilation* pad in the excessive leakage dialog.
- During Pressure support the system ensures a minimum Back-up Rate and maintains the set Inspiratory pressure and PEEP level. The Back-up Rate is activated when the spontaneous breathing rate is lower then the Back-up Rate, but the ventilator does not activate a Backup ventilation mode as in Invasive Pressure Support.
- Trigger sensitivity cannot be set in NIV.

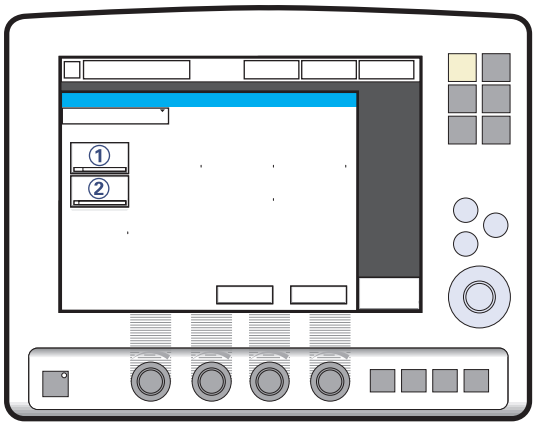
Read more about NIV

Intended population	page 4
NIV general information:	page 61
Ventilation modes (NIV):	page 62
Alarm settings:	page 73
Preparation:	page 160

2 NIV - Nasal CPAP

Functional description Nasal CPAP

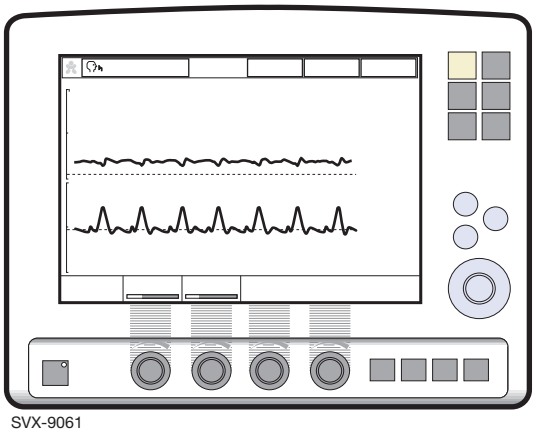
The mode Nasal Continuous Positive Airway Pressure is used when the patient is breathing spontaneously.



SVX-9057

The following parameters are set:

1. CPAP (cmH_2O)
2. Oxygen concentration (%)



SVX-9061

Differences from invasive CPAP

- When the *Standby* key is pressed a waiting position dialog is shown. All patient related alarms are turned off during 120 seconds. Press the *Start ventilation* pad to start the ventilation.
- Trigger and cycle-off is automatically adapted to the leakage and cannot be set in Nasal CPAP.
- There is no backup ventilation available in Nasal CPAP.
- The apnea alarm can be turned off in Nasal CPAP

The following functions are not available during Nasal CPAP ventilation:

- Volume curve
- Loops
- Open Lung Tool
- Additional values
- Additional settings
- Inspiratory hold
- Expiratory hold
- CO_2 Analyzer.

WARNING! Patient effort and artifacts affecting patient flow or pressure such as heart beats, movement of patient tubings, intermittent leakage may not always be correctly detected or discriminated. This may affect the accuracy of alarms and measured parameters, therefore, we advise that a ventilator-independent means of monitoring the patient should be in place.

Read more about NIV

Intended population	page 4
NIV general information:	page 61
Ventilation modes (NIV):	page 62
Alarm settings:	page 73
Preparation:	page 160

Open Lung Tool

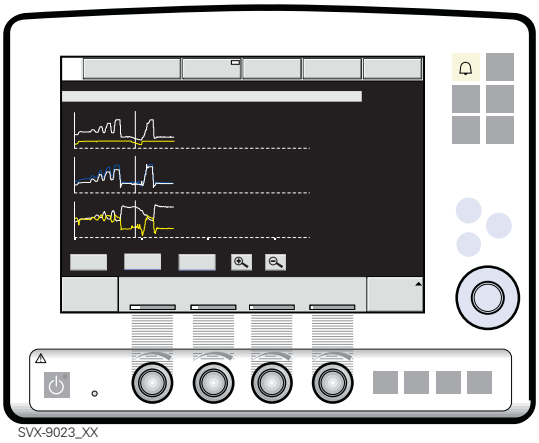
Clinical performance

The Open Lung Tool is a tool for graphically visualizing measured and calculated values for easier interpretation of already available ventilation data. Three simultaneous graphical trends are presented with a fixed set of parameters as a function of a number of collected breaths. The User Interface features an adjustable cursor which helps illustrate the opening and closing airway pressures. This alternative presentation may be used for immediate visualization of the effect of altered settings.

Note: When the ✗ Y Sensor Measuring function is active, then the values recorded in the Open Lung Tool are based on values measured at the Y-piece. Note that when this function is disabled or enabled, then the compliance in the patient circuit may cause the values in the Open Lung Tool to change.

Read more about the Open Lung Tool

Operating: page 175

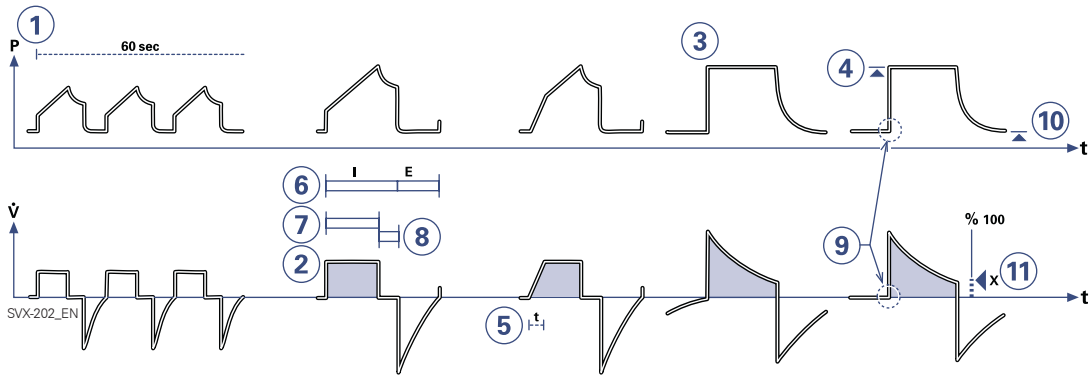


SVX-9023_XX

The following parameters are presented:

- In the top window, measured End Inspiratory Pressure (*EIP*) and Positive End Expiratory Pressure (*PEEP*) are simultaneously presented, breath-by-breath.
- In the middle window, measured Inspiratory tidal volume (*VTi*) and Expiratory tidal volume (*VTe*) are simultaneously presented, breath-by-breath.
- Dynamic compliance (*C dyn i*) is calculated breath-by-breath and filtered before presentation. (*C dyn i = VTi / EIP – PEEP*)
- In the lower window measured Tidal CO_2 elimination ($VTCO_2$) is simultaneously presented as well, breath-by-breath (✗ CO_2 Analyzer).
- The time parameter on the lower right screen indicates how long it will take at the current settings for the waveform to fill the axis. Changing the scaling with the zoom in or out function will change the time and number of breaths needed for filling the axis.
- The breaths parameter on the lower right screen indicates the number of breaths at the current respiratory rate it will take for the waveform to fill the axis.

2 Ventilatory parameters, overview



When a ventilation mode is selected, the only parameters shown are those affecting the actual mode. Below are all the mode-related parameters presented.

1. Respiratory rate (*RR*) Rate of controlled mandatory breaths or used for calculation of target volume (b/min).

2. Tidal volume (*VT*) Volume per breath or target volume (ml).
Minute volume (*Vmin*) Volume per minute or target Minute volume (ml/min or l/min). Presentation can be configured to either tidal or minute volume.

3. PC above PEEP Inspiratory pressure level for each breath (cmH_2O) in Pressure Control.

4. PS above PEEP Inspiratory pressure support level for triggered breaths (cmH_2O) in Pressure Support.

5. Inspiratory rise time (T inspiratory rise) Time to full inspiratory flow or pressure at the start of each breath, as a percentage of the breath cycle time (%), or in seconds (s).

6. I:E ratio (*I:E*) (Inspiration time + Pause time): Expiration time.

7. Inspiration time *(T_i)* Time for active flow or pressure delivery to the patient (s).

8. Pause time (T_{pause}) Time for no flow or pressure delivery (% or s).

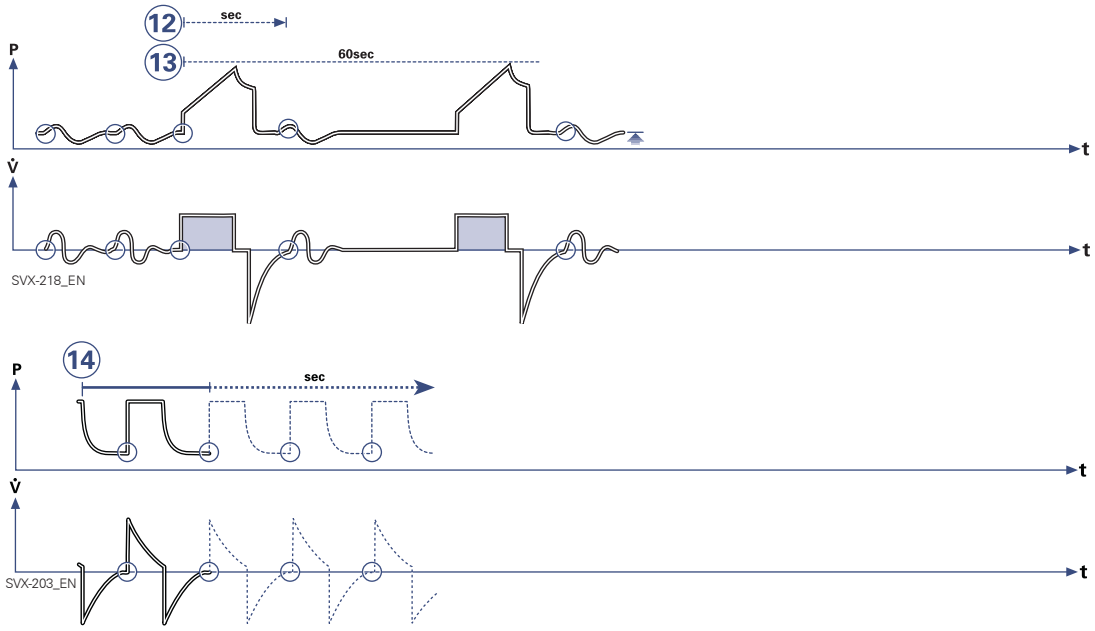
9. Trigger sensitivity

a) Below zero: Trigger sensitivity is pressure dependant. The pressure below PEEP which the patient must create to initiate an inspiration (cmH_2O) is indicated.

b) Above zero: Trigger sensitivity is flow dependent. As the dial is advanced to the right (step wise from the green into the red area) the trigger sensitivity increases i.e the inhaled fraction of the bias flow leading to triggering is reduced.

10. PEEP Positive End Expiratory Pressure (cmH_2O).

11. Inspiratory cycle-off Fraction of maximum flow at which inspiration should switch to expiration (%).



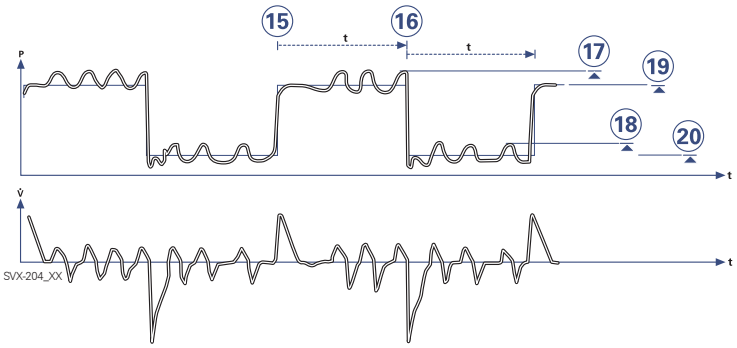
12. Breath cycle time (Breath cycle T) Total cycle time per mandatory breath in SIMV (inspiratory + pause + expiratory). Set in seconds.

13. SIMV rate Rate of controlled mandatory breaths (b/min).

14. Trigger timeout The maximum allowed apnea time in Automode, after which the system switches to controlled ventilation (s).

– **O_2 concentration (*O_2 Conc.*)** O_2 concentration in inspiratory gas (not shown in the figure).

2 Ventilatory parameters, overview



15. Time high (*T_{High}*) Time at *P_{High}* level in Bi-Vent (s).

16. Time PEEP (*T_{PEEP}*) Time at PEEP level in Bi-Vent (s).

17. Pressure Support above Pressure high (*PS above P_{High}*) Inspiratory pressure support level for breaths triggered during the *T_{High}* period in Bi-Vent (cmH_2O).

18. Pressure Support above PEEP (*PS above PEEP*) Inspiratory pressure support level for breaths triggered during the *T_{PEEP}* period in Bi-Vent (cmH_2O).

19. Pressure high (*P_{High}*) Positive End Expiratory Pressure at the upper level in Bi-Vent (cmH_2O).

20. PEEP Positive End Expiratory Pressure at the lower level in Bi-Vent (cmH_2O).

Notes 2

2 Notes

3. Patient safety

Contents

Several measures have been taken to design this system for safe treatment and use.

The alarms are based on three priority levels; High, Medium and Low.

High priority alarms

These alarms are warnings and are indicated by a red background. They are latched, i.e. the visual indication remains even though the alarm condition ceases.The background color switches to yellow if the alarm condition returns to normal. Latched alarms require manual resetting.

Note: NIV alarm *Leakage out of range* is not latched.

For more information about the high priority alarms see page 226.

Medium priority alarms

These alarms are advisory. They may be reset (cleared) even though the alarm condition remains.

For more information about the medium priority alarms see page 231.

Low priority alarms

These alarms are cautionary and are indicated by a yellow background.

For more information about the low priority alarms see page 234.

Technical alarms

Technical problem identified by a code.

For more information about the high priority alarms see page 239.

Alarm signals

All alarms are visual and audible.

WARNINGS!

- To protect the patient against high airway pressures, the Upper pressure limit must always be set to the relevant value so as to provide adequate patient safety.
- To provide adequate patient safety, always set the alarm limits at relevant values.

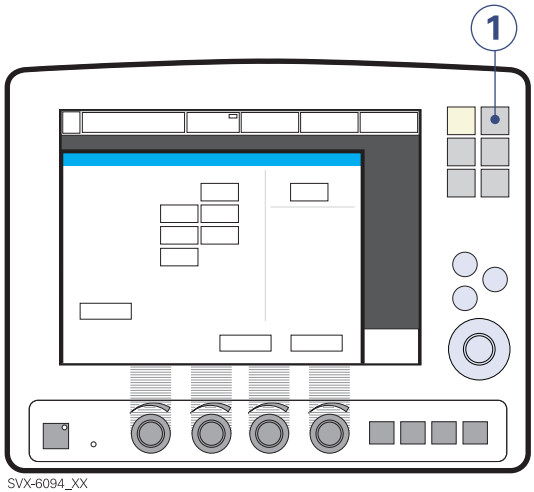
Alarm output connection option

An Alarm output connection option makes it possible to connect the ventilator to an external alarm signal system. High and medium priority alarms are transferred. The alarm output signal is active as long as the audio alarm is active on the ventilator.

Importants:

- It is required that the patient is never left unattended and that external alarm is used only to draw extra attention to a patient.
- The alarm output is a non-guaranteed alarm according to IEC 60601-1-8 and it is recommended that the user establish a pre-use check routine for this application.

Alarm profile window



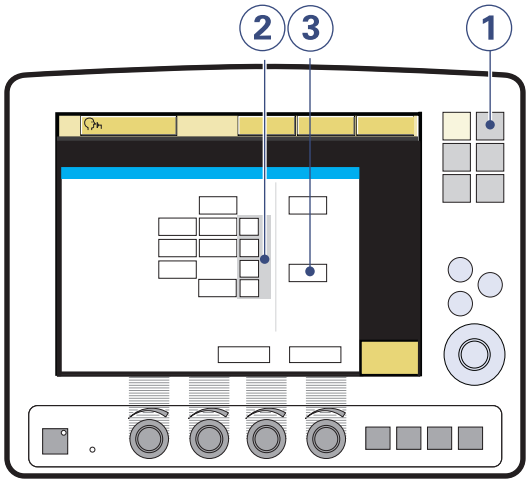
SVX-6094_XX

1. Press the *Alarm profile* key

Shows all applicable alarms and settings for both lower and upper limits. Also used for adjusting current limits and alarm sound level.

Note: Current alarm limits are displayed adjacent to the measured value, in smaller figures to the right of the display. Default values are displayed during power up and when admitting a new patient. Always make sure that values are appropriate for the patient.

✕ Non Invasive Ventilation



SVX-9016_XX

1. Press the *Alarm profile* key to show the applicable alarms for Non Invasive Ventilation (NIV).
2. The bell indicates if the alarm is audible active or Audio off (permanently silenced, a crossed bell).

The apnea alarm can be turned off in Nasal CPAP.

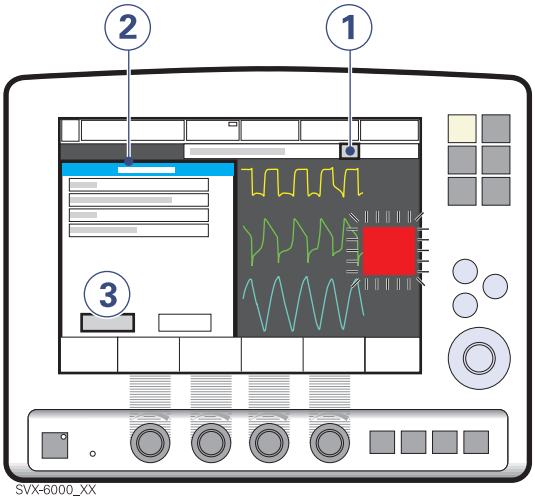
3. To turn off the apnea alarm in Nasal CPAP continue turning control wheel after maximum time limit has been reached.

   When the apnea alarm is turned off, a message is displayed in the message area.

Read more about NIV

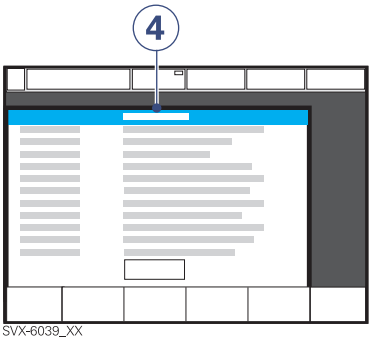
Ventilation modes	page 61
Preparation	page 160

Current alarms window



This window can be displayed if more than one alarm is active.

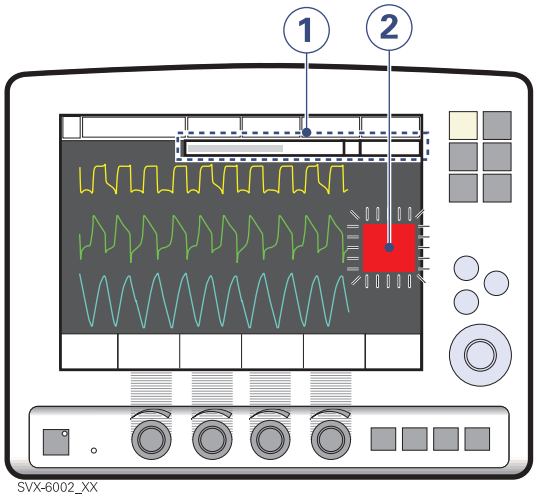
1. Press the bell (s) in the alarm message pad.
2. All alarms are shown in a window. This is dynamic and will be updated if more alarms occur while the window is open. The alarms are listed by priority and 10 alarm messages are displayed at the most.
3. Press the *History* pad.



4. The last 16 alarm-dependent events are listed chronologically. The most recent event is at the bottom.

Note: For viewing more than the latest 10 alarms, use the Event log to view all logged alarms (refer to page 270).

Visual



1. A text message explaining the cause of the alarm flashes in the alarm message area. The alarm with highest priority is displayed first.
2. The corresponding measured value or set value box flashes and an arrow points at the exceeded limit.

A red background color indicates a high priority alarm. A yellow background indicates a medium or low priority alarm.

A high priority alarm which has been active but for which the condition has returned to normal is latched and requires manual resetting. (Latched alarms: The alarm text remains even though the alarm condition ceases.)

Note: NIV alarm *Leakage out of range* is not latched.

Two bells in the alarm message area indicate that more than one alarm is activated.

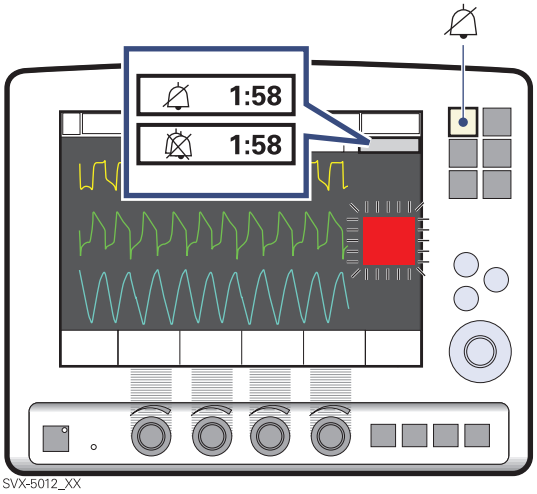
Audible

An active alarm is indicated by a distinct, but soft alarm signal. The sound level can be adjusted, e.g. lowered during the night time. (Set sound level is indicated in the *Alarm profile* window.)

Technical errors may also be indicated by a signal similar to that a medium priority alarm, generated by a sounding device in the Patient Unit.

3 Audio off (Silence / Pre-silence of alarm)

General



SVX-5012_XX

All alarms except for *No battery capacity and* technical error alarms can be silenced *(*Audio pause) for two minutes. New alarms can be activated during this period. In Standby, only the following alarms are applicable:

- *No battery capacity* (when Battery module is connected)
- *Limited battery capacity* (when Battery module is connected)
- *Battery operation* (when Battery module is connected)
- *Technical error*
- *Touch screen or knob press time exceeded*
- *Internal temperature: High*
- *Exp. cassette exchanged*
- *Technical error in Expiratory cassette*

Audio off (Silence of alarms)

At any time while the ventilator is operating (either Invasive or Non Invasive Ventilation modes), alarms can be placed into a state of audio off (silence alarms).

Non Invasive Ventilation

When Non Invasive Ventilation is chosen, the following alarms can be placed into a state of audio off (silenced alarms):

- Minute volume
- Respiratory rate
- PEEP
- End tidal CO_2 (✗ CO_2 Analyzer)
- CPAP (✗ Nasal CPAP)

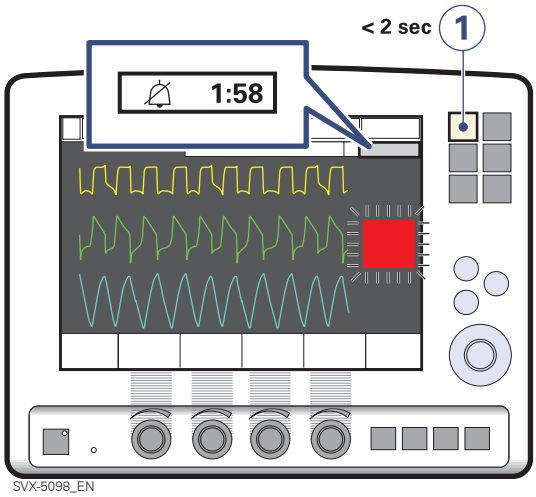
By pressing the corresponding bell symbol in the alarm profile window the button changes to a crossed bell to indicate Audio Off. It is also possible to configure these alarms individually to be set to the Audio Off state by default.

Note: When an alarm is silenced (Audio off) in the NIV mode, a symbol will appear on the screen, next to the corresponding measured value, saying *Audio Off* (a bell with negation cross). The Audio Off symbol will remain on the screen until the user reactivates the alarms or returns to the standby mode. If the user then enters Invasive ventilation and after that returns to NIV, the audible alarms will be reset to their default states.

Audio off of non-latching alarms

For a very limited number of alarms a single alarm condition can be silenced (Audio off) during the remaining time of the continuing alarm condition when the message *Audio off?* is shown. These alarms, such as Battery operation and Low Air/O_2 supply pressure, will be re-activated the next time the alarm condition occurs.

Audio pause/Prolong pre-silence period/Clear latched alarm

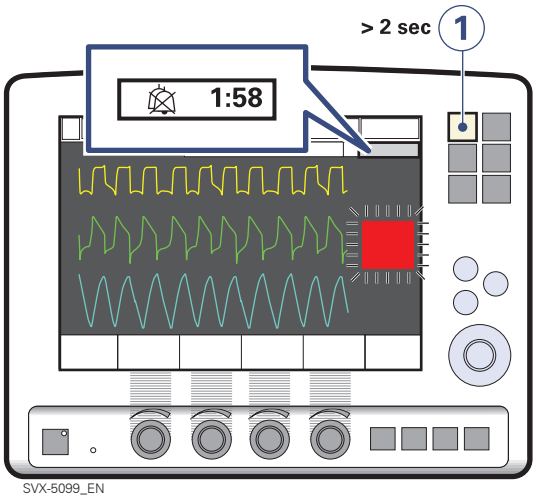


SVX-5098_EN

1. Press the Audio pause (Silence/Pre-silence alarm) key briefly, for less than two seconds:
   - Active alarms are silenced (Audio pause) for 2 minutes.
   - If already silenced, the silent period is prolonged for two minutes.
   - Latched alarms disappear (latched alarms: the alarm text remains even though the alarm condition ceases).

An alarm silence (Audio pause) symbol and the remaining time are then displayed in the message area.

Pre-silence alarm (Audio pause))



SVX-5099_EN

1. If you press the Audio pause (Silence/Pre-silence alarm) key for more than two seconds:
   - The active alarms are silenced (Audio pause), i.e. a two minute period is started.
   - All other alarms are silenced (Audio pause) for 2 minutes, except those which cannot be silenced.
     - Latched alarms disappear from the alarm message area.

3 Built-in safety precautions

For patient safety your Servo-i Ventilator System also has a range of built-in safety precautions.

Apnea alarm

The apnea alarm is applicable in all supported/spontaneous modes.

Note: When using the knob to adjust a value, the defined safety limits may be unintentionally reached or exceeded. In this case, the knob will become inoperable for 2 seconds to make you aware that the safety limit has been passed. (Note that this is only valid for Servo-i Infant and Servo-i Universal System versions).

Backup ventilation

In case of exceeded apnea in Volume Support or Pressure Support, a safety backup mode is activated with default breathing frequency and set / default values.

High pressures

The safety valve opens if the pressure in the inspiratory channel is too high.

Caution: If airway pressure rises 6 cmH_2O above the set upper pressure limit the safety valve opens. The safety valve also opens if system pressure exceeds 117 ± 7 cmH_2O.

Gas supply O_2/Air

If the O_2 or air supply pressure is too low the flow from the missing gas is automatically compensated for. The patient will get preset volumes and pressure with O_2/air and an alarm will be activated.

Mains failure and battery

In case of a mains failure, the ventilator will automatically switch over to battery operation. The switch is indicated by a medium priority alarm. The remaining battery capacity is displayed in the status menu on top of the screen. In case of a mains failure and no Battery module has been inserted or connected, a high priority alarm is activated. The inspiratory and expiratory valves are opened to allow for breathing through the ventilator. All settings are saved until the ventilator is powered again.

NIV rate

During Pressure support (NIV) the system ensures a minimum Back-up Rate and maintains the set Inspiratory pressure and PEEP level. The Back-up Rate is activated when the spontaneous breathing rate is lower then the Back-up Rate.

No gas supply

If the air and O_2 pressure is too low the safety valve and the expiratory valve will open. An alarm will be activated simultaneously.

Parameters and alarm limits

The system has default values for parameters and alarm limits. These are valid until you adjust them before/after connection to a patient. You can also enter new default values or use the values previously applied.

Standby position

All settings will be saved when the ventilator is set in standby position. The ventilator can thus be prepared and the CO_2 transducer warmed up for admission in advance.

Read more about the alarms

Alarm settings:	page 165
Troubleshooting:	page 225
Auto set values calculation:	page 244
Default values:	page 249
Keys and touch pads:	pages 268, 269.

Notes 3

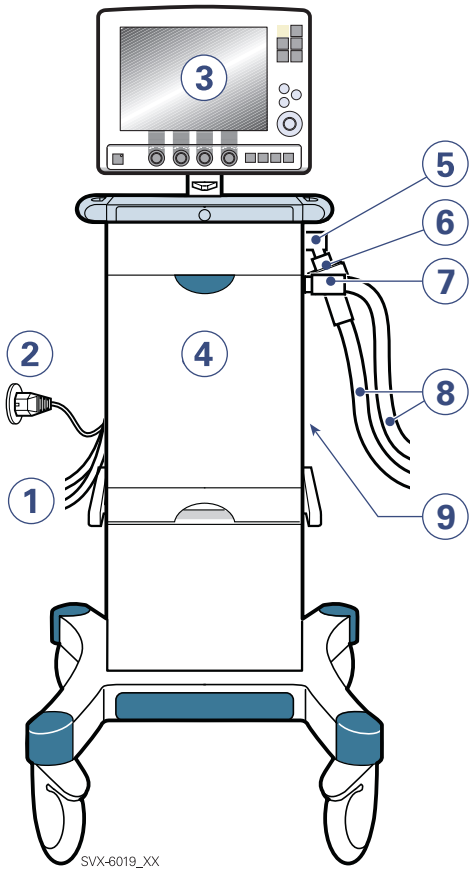
3 Notes

4. Device description

Contents

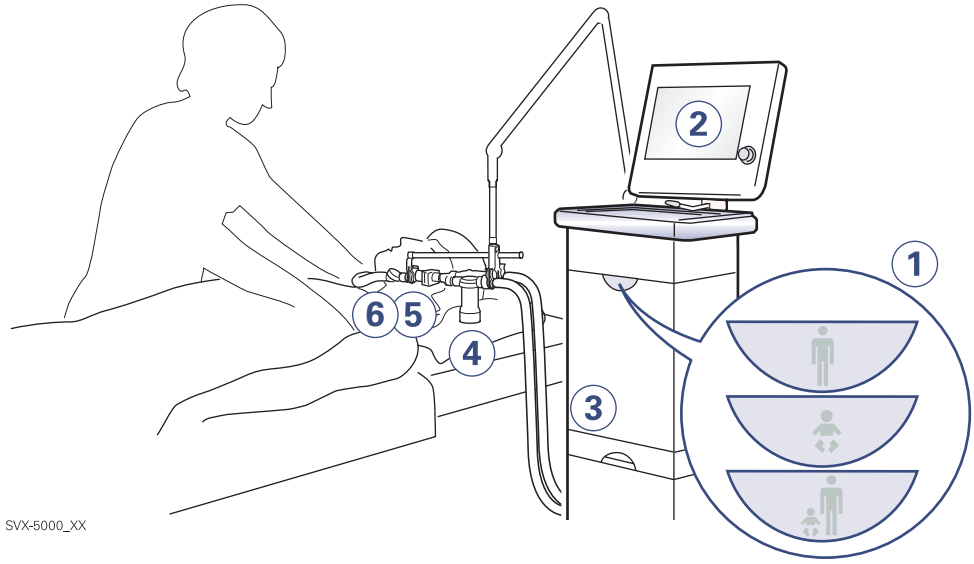
The ventilator

All ventilatory settings are made on the User Interface panel. It can either be operated by the touch screen and the Main Rotary Dial or by using the Main Rotary Dial only. Flow and pressure are continuously measured by transducers and controlled by a feedback system in the Patient Unit. The information is compared with the User Interface settings, and a difference between the actual measured value and the preset/calculated values will cause adjusted gas delivery according to the target flow/volume/ pressure. The Servo-i Ventilator System has two gas modules, one for air and one for O_2. Gas can be connected from a medical pipeline system, a compressor or gas tanks. Air can also be supplied by a compressor.



1. Air and O_2 supply
2. Mains supply
3. User Interface
4. Patient Unit
5. Expiratory inlet
6. Servo guard, viral/bacterial filter
7. Inspiratory outlet
8. Patient system
9. Module compartment

An overview



1. The ventilator can be delivered in three configurations. Your configuration is clearly indicated on the Patient Unit, at start up and in the Brief Instructions.

   The Servo-i Infant with defaults, scales and safety precautions, designed for use with Infant patients. It is standard configurated for pressure controlled modes of ventilation.

   The Servo-i Adult with defaults, scales and safety precautions, designed for use with adolescent and adult patients. It is standard configurated for volume controlled modes of ventilation.

   The Servo-i Universal (Basic or Extended edition) is an advanced ventilator to be used with infants and adults. Enhanced functionality i.e. a comprehensive array of different ventilation modes, extended Tidal Volume range, allows for advanced ventilatory treatment in both categories.

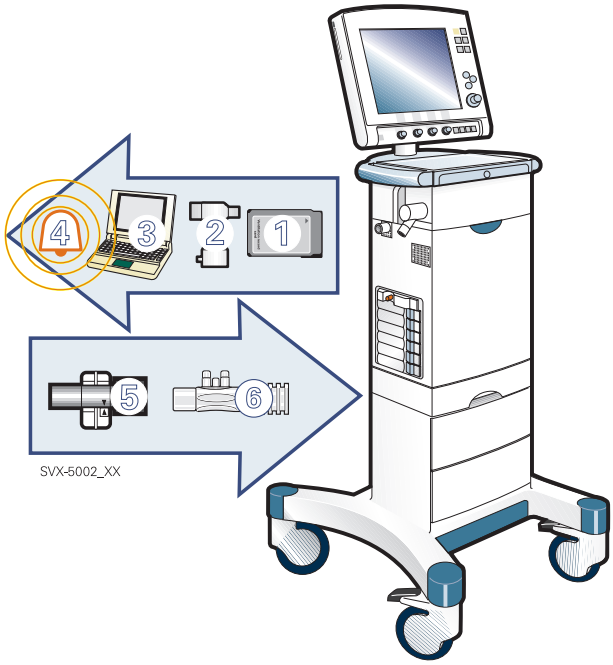
2. The User Interface, where all settings are made and effects are monitored.
3. The Patient Unit, where gases are administrated, also has slots for Battery modules and future function modules. Battery module allow backup during mains failure and transport.
4. ✗ The Servo Ultra Nebulizer is operated from the User Interface.

   Note: The Aeroneb Professional Nebulizer System can be used as a stand alone nebulizer system. Refer to separate manual.

5. ✗ The mainstream CO_2 measurement and calculations are displayed on the User Interface.
6. ✗ Y Sensor measuring. Allows measurement of pressure and flow right up to the Y-piece.

4 The system

In the system



Default values give fast system start-up. User set values tailor the ventilatory management. Signals are fed to the Patient Unit, which executes ventilation managed by the servo control system. The internal design of the Patient Unit allows for true inspiratory and expiratory regulation and measurement. Set, measured and calculated values are presented on-screen breath-by-breath.

1. X Patient data can be transferred to a Personal Computer via the Ventilation record card for further processing and storage.
2. X Signals are conveyed from the User Interface for controlling of drug nebulization.

   Important: Only valid for the built in Servo Ultra Nebulizer.
3. X Data communication to a Personal Computer is possible via the Communication Interface Emulator (CIE) and the serial communication port (RS 232C).
4. X An alarm output connection option makes it possible to connect the ventilator to an external alarm signal system
5. X Signals from the CO_2 Capnostat sensor are conveyed to the User Interface, where they are calculated and displayed on the screen.
6. X Y Sensor measurements are conveyed to the User Interface, where they are calculated and displayed on the screen.

System elements; overview

Functionality/Configuration					Reference in this manual
			Basic	Extended	
Alarm output connection option	✘	✘	✘	✘	pages 72, 150
Automode, pressure	✘	✘	✘	●	page 48
Automode, PRVC	✘	✘	✘	●	page 48
Automode, volume	✘	✘	✘	●	page 48
Bi-Vent	✘	✘	✘	✘	page 59
CO_2 Analyzer	✘	✘	✘	✘	pages 104, 151
NIV (Non Invasive Ventilation)	✘	✘	✘	✘	pages 61, 160
Nasal CPAP	✘	-	✘	✘	page 64
Open Lung Tool	✘	✘	✘	●	pages 65, 175, 176
Pressure Control	●	✘	●	●	page 38
Pressure Support	●	●	●	●	page 43
PRVC (Pressure Reg. Volume Control)	✘	✘	✘	●	page 32
SIMV (Press. Contr.) +Pressure Support	●	✘	●	●	pages 52, 57
SIMV (PRVC) + Pressure Support	✘	✘	●	●	pages 52, 53
SIMV (Vol. Contr.) + Pressure Support	✘	●	●	●	pages 52, 55
Suction Support	●	●	●	●	page 170
Upgrade to universal (all patient categories)	✘	✘			-
Volume Control	✘	●	●	●	page 35
Volume Support	✘	✘	✘	●	page 40
Y Sensor measuring	✘	✘	✘	✘	pages 106,135, 192, 248

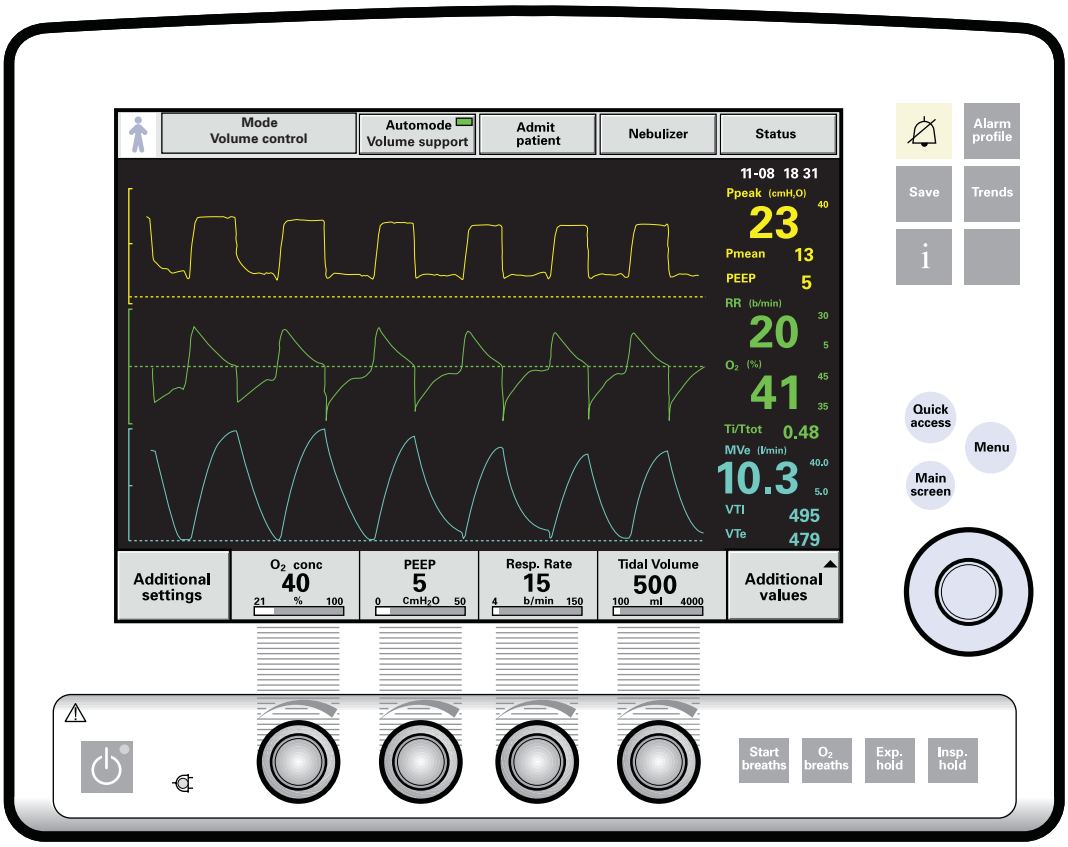
● included (in standard configuration)
✘ optional

Note: Refer to page 83 for Servo-i configuration definition.

4 Options / Accessories

General options / accessories	Reference in this manual
Aeroneb Professional Nebulizer System	Refer to separate manual
Battery module Servo-i	page 108
CO_2 Analyzer Servo-i	pages 104, 151, 207, 238 ,247
Compressor Mini	pages 115, 248
Drawer kit Servo-i	page 99
Extra Expiratory cassette.	page 196
Fisher & Paykel humidfier MR730/MR850	page 127
Gas cylinder restrainer Servo-i	pages 101, 248
Gas trolley Servo-i	pages 101, 126, 248
Holder Servo-i	pages 100, 124, 248
Humidifier Holder	pages 100, 127
IV pole	pages 100, 248
Mobile Cart Servo-i	pages 97, 123, 248
O_2 cell / O_2 Sensor	pages 98, 213
Patient tubing (10, 15, 22 mm diameter)	pages 120, 121, 122
Servo guard (viral/bacterial filter)	page 137
Servo humidifier	page 136
Servo Ultra Nebulizer Servo-i	pages 102, 128, 205, 246
Shelf base Servo-i	page 100
Support Arm 177	pages 100, 125
User Interface panel cover	page 95
Y Sensor measuring	pages 106,135, 192, 248

An overview



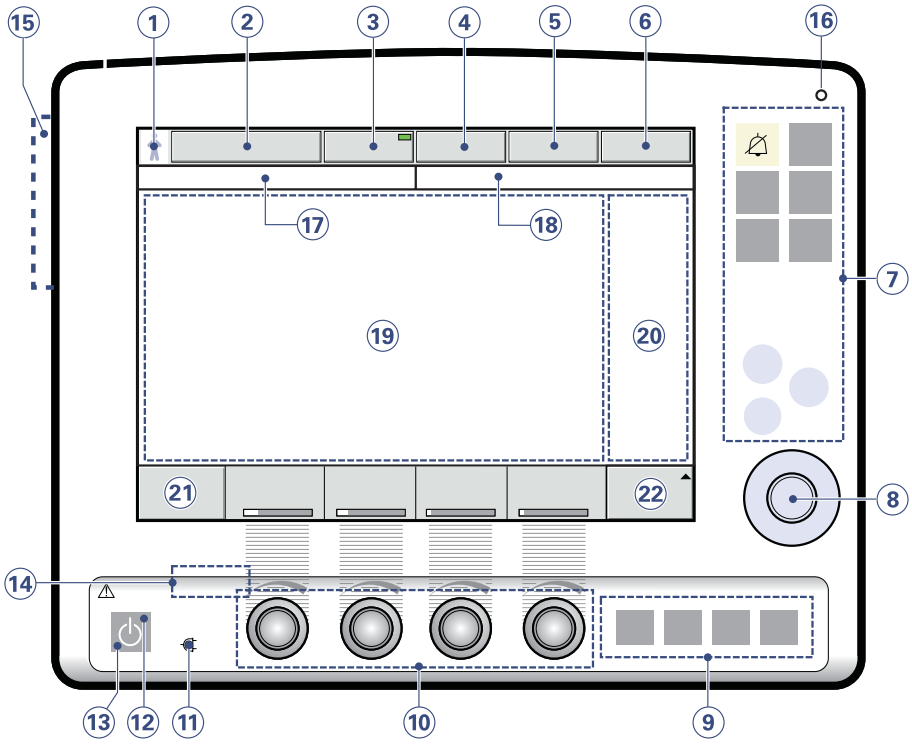
SVX-5001_EN

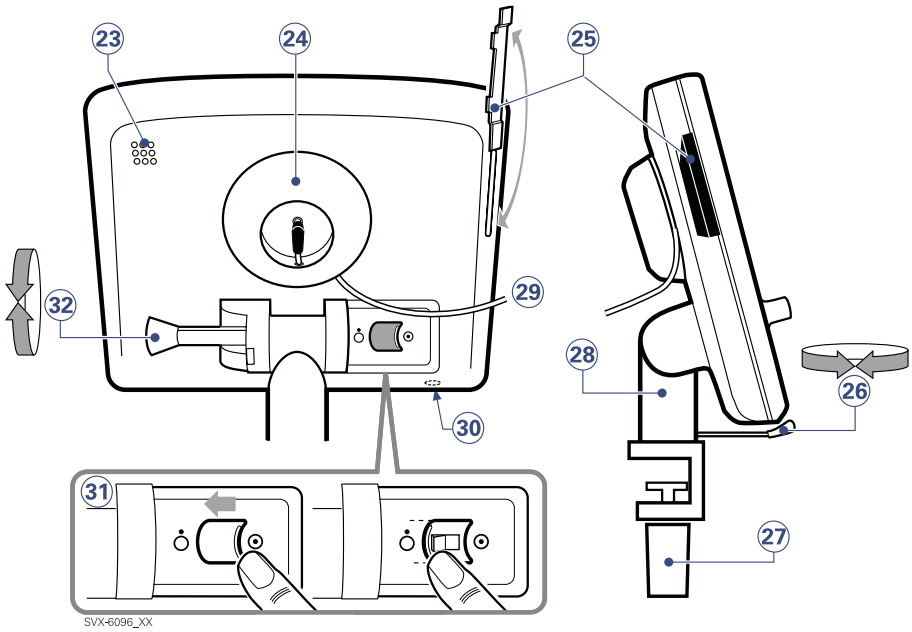
The User Interface is ergonomically designed. You can operate it via the touch screen or by means of the Main Rotary Dial. Fixed keys allow immediate access. Direct Access Knobs allow for immediate adjustments. Data can be shown as waveforms and/or as numerics. The measured value boxes are always visible (also while setting the ventilator). Alarm limits are displayed adjacent to the measured value. All functions and necessary information are gathered in the User Interface. Do not use sharp tools on the screen.

Read more about the User Interface

Positioning:	page 93
Operating:	page 159
Alarm settings	page 165
Cleaning:	page 191
Technical data:	page 241
Keys and touch pads:	page 259

4 User Interface - Connections and labels





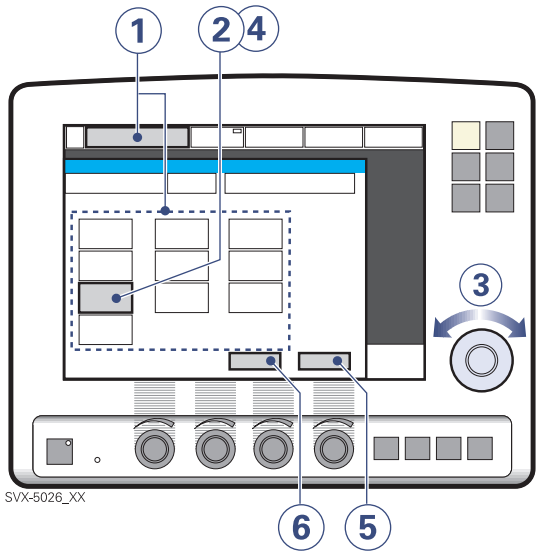
It consists of:

1. Patient category.
2. Active mode of ventilation.
3. ✗ Automode On/Off.
4. Admit patient/Entered patient data and admission date.
5. ✗ Nebulizer On/Off.
6. System status parameters.
7. Fixed keys for immediate access to special windows.
8. The Main Rotary Dial with which you select the desired menu touch pad or parameter box. You can also adjust values. By pressing it, you confirm your settings.
9. Special function keys for immediate ventilatory functions.
10. Direct Access Knobs for immediate adjustments of vital parameters. A built-in 2 seconds safety delay with inactive knobs when a setting reaches predefined safety limits.
11. Mains indicator (green).
12. Standby indicator (yellow).
13. Start/Stop (Standby) ventilation key. In Standby everything is turned on, except for ventilation.
14. On/Off switch (rear side)
15. Slot for Ventilation record card
16. Luminiscens detector: adjusts screen brightness automatically.
17. Informative text messages. A purple symbol indicates patient triggering.
18. Alarm messages.
19. The waveform area which monitors two to four parameters, individually scaled. You can add an pressure/flow loop, with the ordinary waveforms still visible. This waveform area is also used for the trend presentation.
20. A section where measured values and set alarm limits are displayed in boxes. You can choose which parameter values to show.
21. Additional settings.
22. Additional measured values.
23. Loudspeaker.
24. Cable reel for the control cable.
25. Slot for Ventilation record card with a cover.
26. Screen rotation locking lever.
27. Locking screw for alternative cart mounting.
28. Panel holder for positioning on the Mobile Cart.
29. Control cable, 2.9 meters between User Interface and Patient Unit.
30. Service connector
31. On/Off switch. In the off position everything is turned off; however the plug-in battery continues to charge when connected to mains (Set to On in the graph).
32. Locking arm to tilt the screen.

Read more about the User interface

Positioning:	page 93
Operating:	page 159
Alarm settings	page 165
Cleaning:	page 191
Technical data:	page 241
Keys and touch pads:	page 259

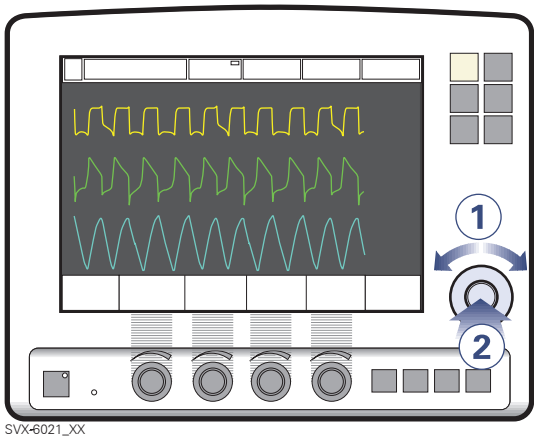
Touch screen



1. Activate the desired menu touch pad by pressing it.
2. Activate the desired parameter by pressing the touch pad (highlighted white with a blue frame). It is now possible to enter a new value.
3. Turn the Main Rotary Dial to the desired value or line.
4. Confirm your setting by pressing the Dial or the parameter touch pad (turns blue again). To set more parameter values repeat steps 2) - 4).
5. To activate your settings, press *Accept*.
6. To cancel your settings, press *Cancel*.

Note: For more information about settings and operating, refer to page 145.

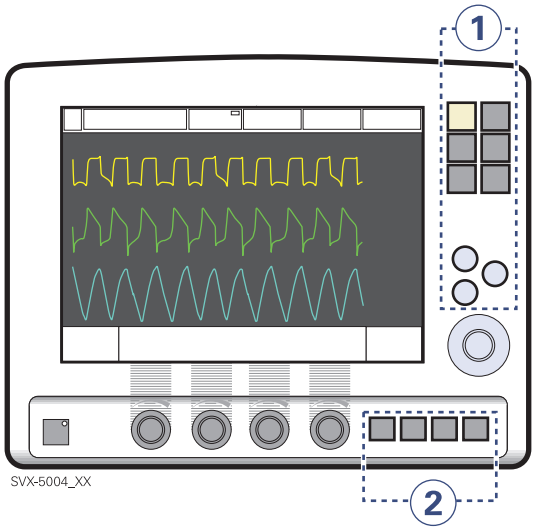
Main Rotary Dial



1. Turn the Main Rotary Dial until the desired menu touch pad is marked with a blue frame.
2. Press the Dial to confirm.
   – The menu touch pad is highlighted in white with a blue frame.
   – Change values by turning the Dial and confirm the settings by pressing the Dial.

Note: For more information about settings and operating, refer to page 145.

Fixed keys



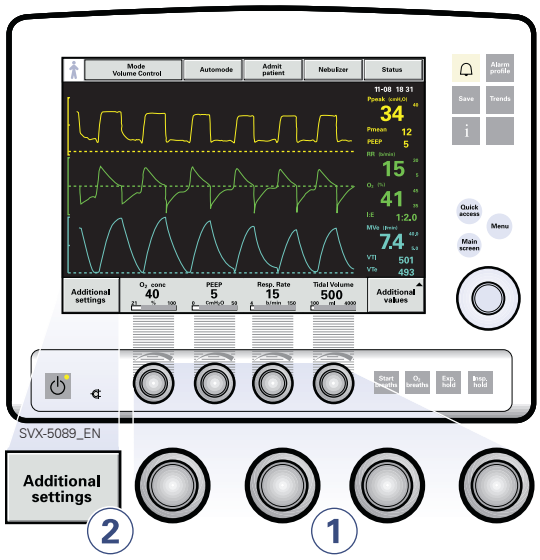
There are two kinds of fixed keys:

1. Short-cut to function or screen.
2. Start special ventilatory function, which demands continuous supervision when used.

Press to activate.

Note: For more information about settings and operating, refer to page 157.

Adjusting parameter values



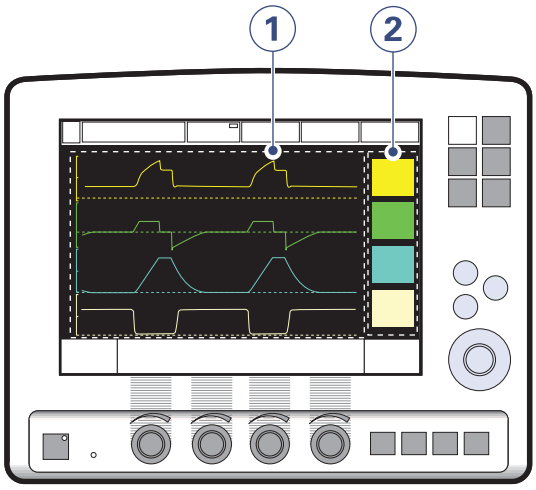
Immediate adjustment

1. Turn the Direct Access Knob to the desired value. When you reach the defined safety limits the knob is inoperative for 2 seconds, to make you aware that you have passed a safety limit.

Combined adjustments

2. Press *Additional settings* and adjust values. Confirm your setting

Waveforms



SVX-5010_XX

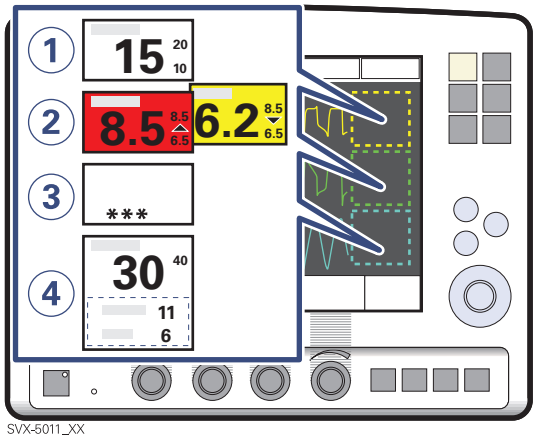
As default four waveforms are shown simultaneously (If x CO_2 Analyzer is connected).

1. Each waveform displays one measured parameter against time (x-axis). The displayed variable and scale are indicated on the y-axis.
2. The waveforms are color-coded (default from factory):
   - Yellow for pressure
   - Green for flow
   - Light blue for volume
   - Light yellow for CO_2 concentration.

The waveform amplitude can be set individually or by the system, using *Auto.* Sweep speed can also be adjusted. For further information see page 157. The settings are effective from the first breath after adjustment.

The displayed waveforms can be configurated using *Waveform configuration*. For further information see page 169.

Measured value boxes



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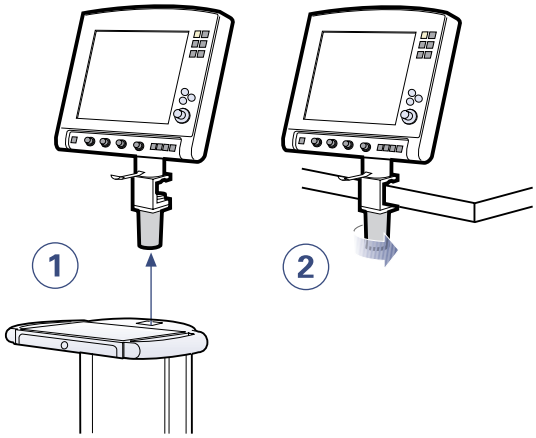
The measured value boxes show measured/ calculated values in numerics and the unit being used.

1. Set Lower and Upper alarm limits are also shown.
2. If an alarm limit is exceeded, the box turns red for a high priority alarm (page 72) and yellow for a medium priority alarm (page 72). The exceeded limit is indicated by an arrow.
3. A value out of range is also labelled "***".
4. Additional measured values can be shown in the box.

User Interface positioning



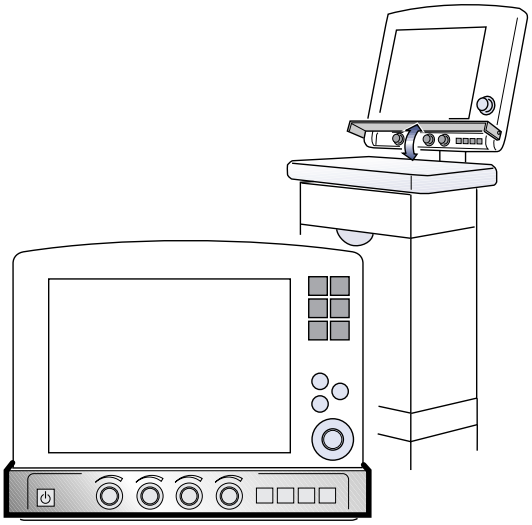
The User Interface can be positioned on the Mobile Cart, a table, a shelf or a pipe.

1. Lift the User Interface straight up.
2. Place the panel on a table, shelf or on a pipe and fasten it securely by turning the handle of the locking screw.

Note: Make sure that the User Interface is fastened firmly. When positioned on a pipe the dimension of the pipe must be between 15 - 30 mm.

4 User Interface - Accessories

Knob cover



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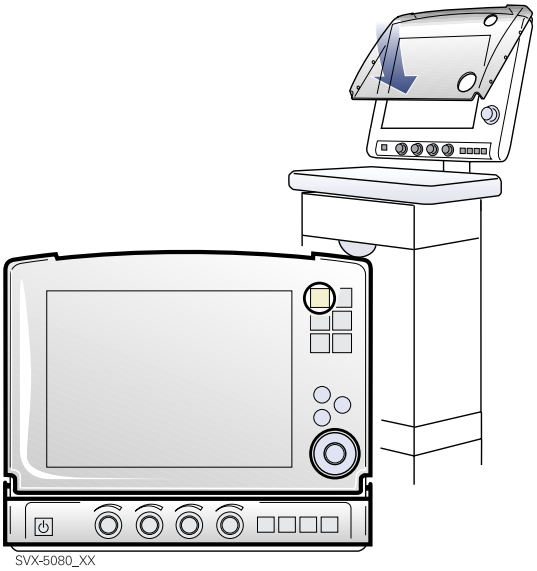
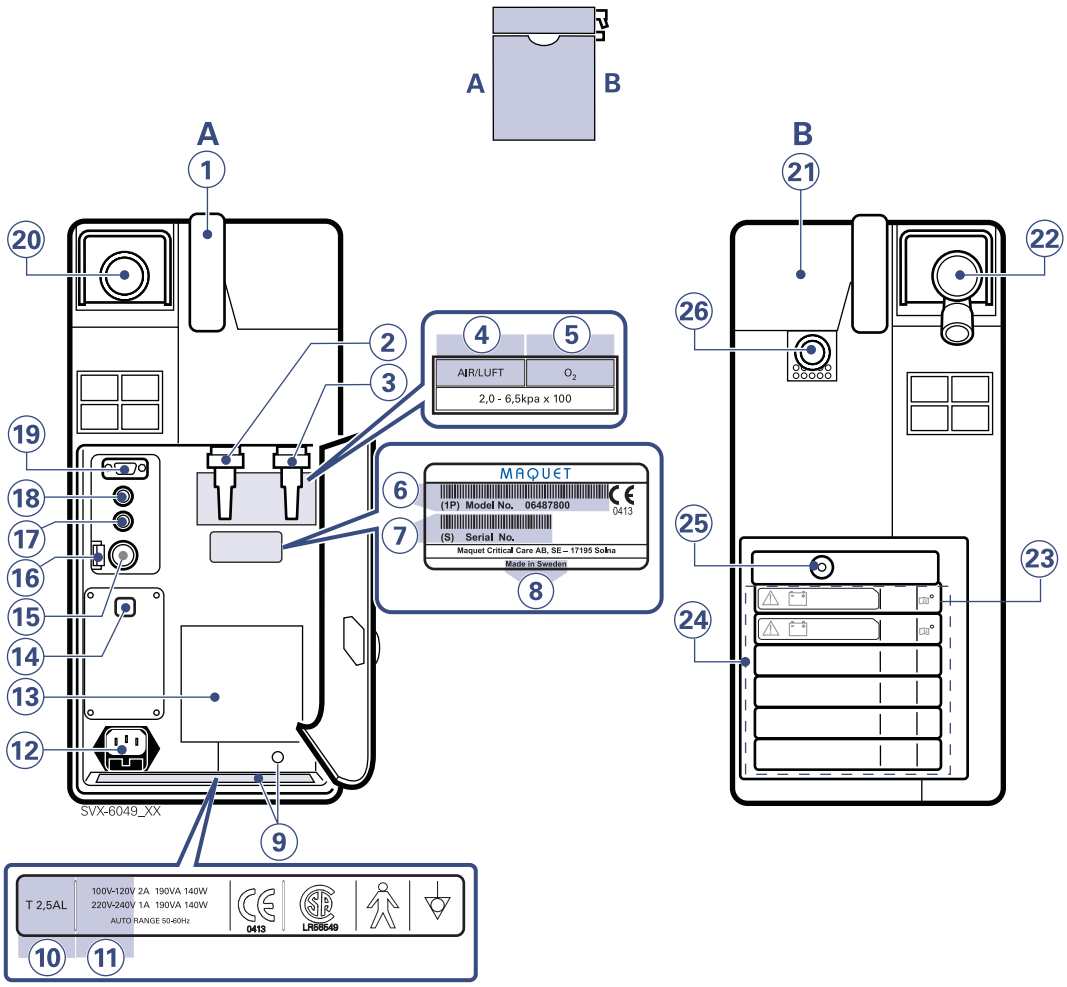
The knob cover protects the Direct Access Knobs against inadvertent activation. Raise the cover to access the Direct Access Knobs.

✗ User Interface panel cover



The User Interface panel cover protects the screen from inadvertent activation of settings and mechanical damage during transport. While attached the user can still access the vital settings. Raise the cover to access the screen.

4 Patient Unit - Connections and labels

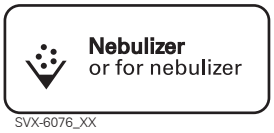


Note: Refer to chapter Before use (page 5) for more information about symbols on the Servo-i Ventilator system.

1. Handle
2. Gas inlet for air
3. Gas inlet for O_2
4. Air / Luft
5. O_2
6. Model number
7. Serial number
8. Manufacturing information
9. Equipotentiality terminal, Label
10. Fuse label *T 2.5AL*
11. Mains power voltage
12. Mains supply connector with fuse
13. Cooling fan with filter
14. Alarm output connection option
15. External +12V DC inlet

    Caution: When external +12 V DC is used, at least one installed Battery module is required to ensure proper operation.
16. Fuse for external DC power supply
17. Optional connector
18. User Interface connector
19. RS232 connector
20. Expiratory outlet
21. Cover, inspiratory channel
22. Expiratory inlet
23. Battery lock
24. Module compartment

    Note: The slots are numbered (1,2,3...) from top to bottom.
25. Nebulizer connector (only for Servo Ultra Nebulizer)



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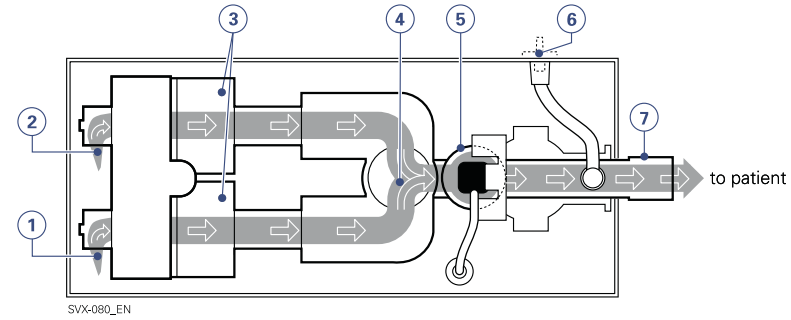
26. Inspiratory outlet

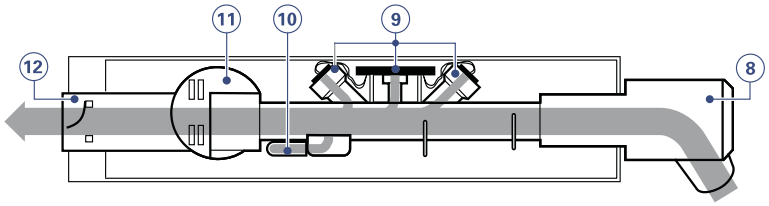
Read more about the patient unit

Positioning: pages 123, 124
Cleaning: page 191
Technical data: page 241

4 Patient Unit - Expiratory cassette

Gas flow through the Patient Unit





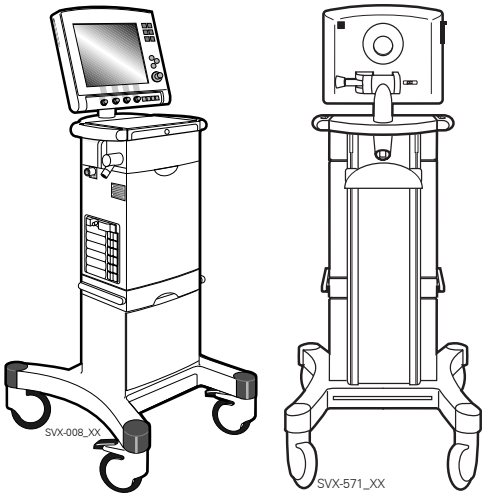
1. Gas inlet for O_2.
2. Gas inlet for air.
3. The gas flow is regulated by the gas modules for Air and O_2.
4. The gases are mixed in the inspiratory mixing section.
5. The Oxygen concentration can be measured either with an O_2 cell or an O_2 Sensor. The O_2 cell is protected by a bacterial filter.

   Note: On the illustration an O_2 cell is connected.
6. The pressure of the mixed gas delivered to the patient is measured by the Inspiratory pressure transducer. The transducer is protected by a bacterial filter.
7. The inspiratory channel delivers the mixed gas to the patient system´s inspiratory tubing. The inspiratory channel also contains a safety valve.
8. The patient system´s expiratory tubing is connected to the expiratory inlet. The inlet also contains a moisture trap.
9. The gas flow through the expiratory channel is measured by ultrasonic transducers.
10. The expiratory pressure is measured by the expiratory pressure transducer (located inside the ventilator). The transducer is protected by a bacterial filter in the cassette.
11. The pressure (PEEP pressure) in the patient system is regulated by the expiratory valve.
12. Gas from the patient system leaves the ventilator via the expiratory outlet. The outlet contains a non-return valve.

Note: The Expiratory cassette can be exchanged between different Servo-i Ventilator System. Always perform a Pre-use check after exchanging an Expiratory cassette.

✗ Mobile Cart

Front and rear side



The Mobile Cart Servo-i is designed for carrying the User Interface, the Patient Unit and all required optional equipment.

A drawer at the top contains brief operating instructions. The Patient Unit is positioned on a console so that it can easily be moved from the Mobile Cart or rotated (to switch sides for the patient breathing system).

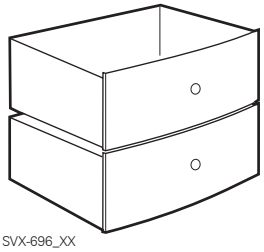
The Mobile Cart has side rails for accessories such as a humidifier and slots in the column for the Support Arm, IV-pole with holder etc.

Two of the wheels can be locked.

Read more about the Mobile Cart

Positioning:	page 123
System transport:	page 116
Cleaning:	page 191
Technical data:	page 241

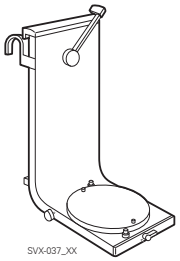
✗ Drawer kit



The drawer kit with two drawers can be mounted on the Mobile Cart.

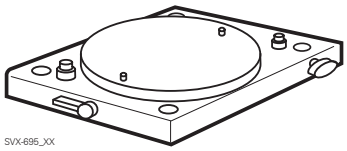
4 Holders

Servo-i Holder



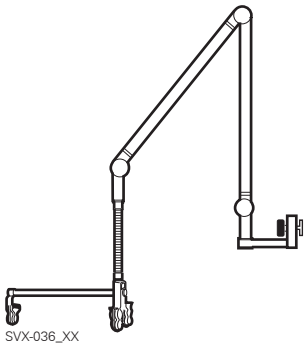
The universal holder allows for positioning of the Patient Unit on a bed, a stretcher or a standard rail.

Servo-i Shelf base



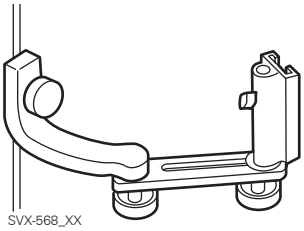
The shelf base allows for positioning of the Patient Unit on a shelf.

Support Arm 177



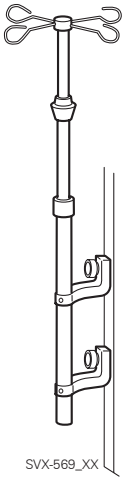
The Support Arm can be attached on the Mobile Cart.

Humidifier Holder



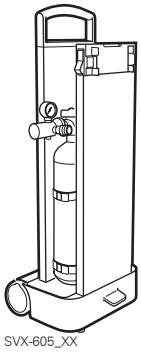
The Humidifier Holder can be attached on the Mobile Cart.

IV Pole



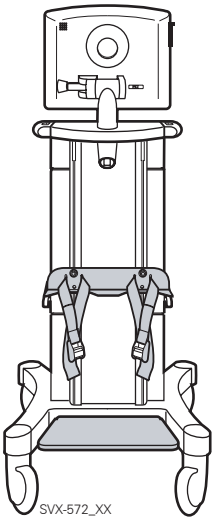
The IV pole with holder can be attached on the Mobile Cart.

✗ Servo-i Gas trolley


SVX-605_XX

The Gas trolley can be attached on the Mobile Cart or to a separate wall clamp.

✗ Servo-i Gas cylinder restrainer


SVX-572_XX

The Gas cylinder restrainer is mounted onto the Mobile Cart. For details, please refer to the Installation instructions.

4 Servo Ultra Nebulizer

✗ Servo Ultra Nebulizer

The Servo Ultra Nebulizer is intended for nebulizing drugs to patients requiring mechanical ventilation or positive pressure breathing assistance via an endotracheal tube or face mask / prongs.

The nebulizer operates continuously regardless of ventilation mode setting. No extra gas volume is added to the inspiratory Minute Volume and thus neither the ventilator settings nor the readings are affected.

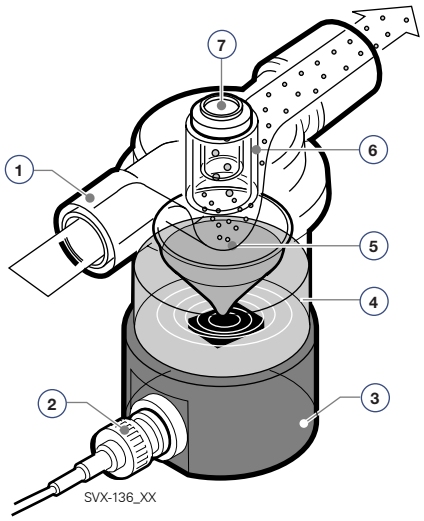
WARNINGS!

- Servo Humidifier/HME must be disconnected during nebulization. Otherwise the humidifier may be blocked.
- The heated humidifier must be switched off during nebulization. Otherwise the particle size may be affected.
- The nebulizer must not be used without buffer liquid (sterile water). Otherwise the ultrasonic generator crystal may break.
- When a Servo Ultra Nebulizer is used, always consult the drug manufacturer regarding the appropriateness of ultrasonic nebulization for certain medications.
- When the ventilator is running on batteries the nebulizer module is inoperative to reduce the power consumption.
- During nebulization a filter must be connected to the expiratory inlet of the ventilator. Always carefully monitor the airway pressure during nebulization. Increased airway pressure could be caused by a clogged filter. The filter should be replaced if the expiratory resistance increases or every 24 hours when the nebulizer is being used.

Note:

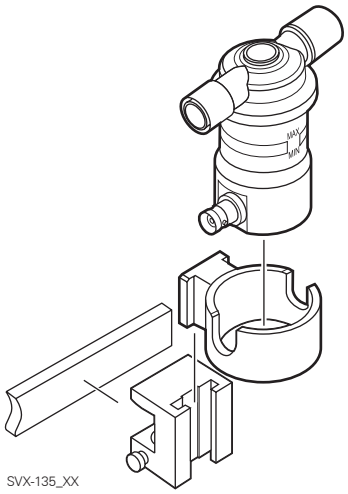
- For information about the stand alone Aeroneb Professional Nebulizer System, refer to separate manual.
- The ✗ Y Sensor measurement (page 135) can be incorrect when the Aeroneb Professional Nebulizer System is in use. Therefore, we recommend that the Y Sensor is removed from the patient circuit during nebulization.

Basic principles



1. Gas from ventilator.
2. Cable from ventilator.
3. The ultrasonic generator produces ultrasonic waves.
4. The waves are transmitted through sterile buffer water.
5. A medication mist is produced in the medication cup. The 10 ml cup is disposable. It can be filled during nebulization through an injection membrane in the T-piece, or before mounting the T-piece. The medication mist is carried to the patient by the inspiratory flow.
6. The T-piece has a mechanical particle separation system (baffles). This ensures a mass median diameter (MMD) of approximately 4.0 μm of droplets in the mist. Larger droplets are re-nebulized.
7. Injection membrane.

Nebulizer Holder



The holder can be used when the Servo Ultra Nebulizer is not in use or when filling with medication.

Read more about the Servo Ultra Nebulizer

Breathing systems:	pages 120 - 122
Preparation:	page 128
Operating:	page 186
Cleaning:	page 205
Technical data:	page 246

4 CO_2 Analyzer Servo-i

✗ CO_2 Analyzer

The CO_2 Analyzer allows for continuous monitoring shown in a waveform indicating the CO_2 concentration. A numerical presentations of End Tidal CO_2 concentration ($etCO_2$), CO_2 minute elimination and CO_2 tidal elimination is also shown on the screen. Alarm limits for high and low $etCO_2$ can be individually set.

The CO_2 Analyzer processes data and derives values for the following parameters:

Instantaneous CO_2 (Capnogram**)** – the instantaneous value of the CO_2 level; displayed on the screen as a waveform depicting the variation in airway CO_2 level during the patient's respiration cycle.

End-tidal CO_2 ($etCO_2$**)** – the level of CO_2 in the airway at the end of expiration; normally the maximum value measured over a specified interval. The current value for $etCO_2$ is displayed on the screen.

CO_2 minute elimination ($\dot{V}CO_2$**)** – expressed in ml per minute indicates the volume of expired CO_2 per minute.

CO_2 tidal elimination ($VTCO_2$**)** – expressed in ml per breath indicates the volume of expired CO_2 per breath.

Note: CO_2 Minute elimination ($\dot{V}CO_2$) and Tidal CO_2 elimination ($VTCO_2$). Elimination of CO_2 from the body takes place via expired gas from the lung. Production of CO_2 takes place in cellular compartments and body tissues.

Cautions:

- Do not insert two CO_2 modules at the same time. The Servo-i Ventilator system can only handle one CO_2 module at a time.
- If the upper alarm limit is set above the maximum measuring range, no alarm will be activated even if the upper limit is exceeded.

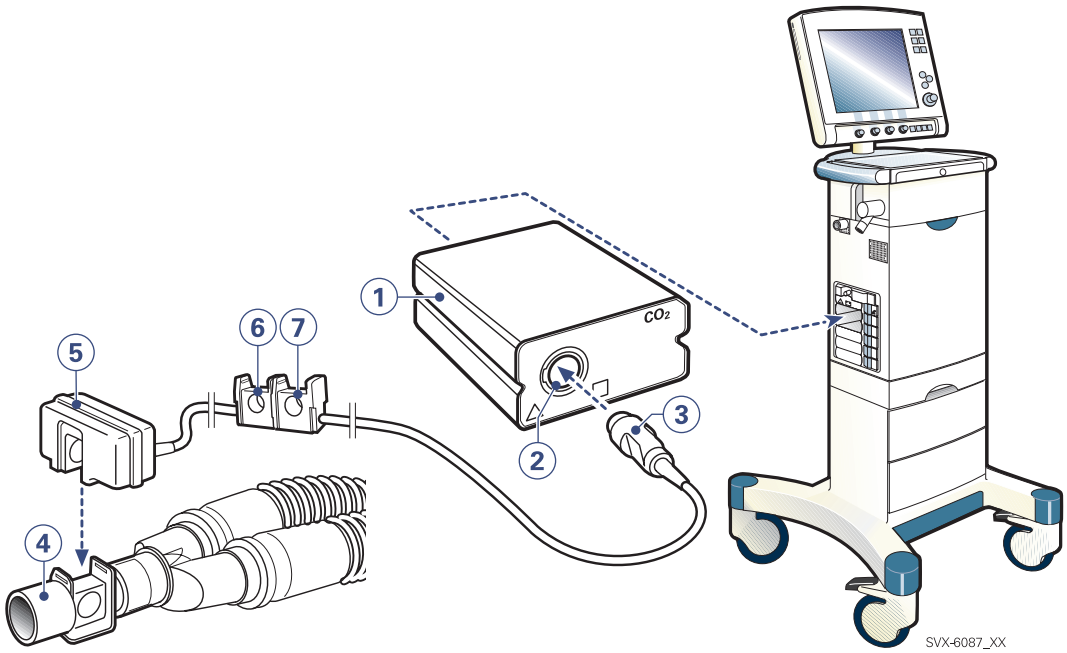
Important:

- The capnostat sensor and airway adapter windows should be placed vertically to reduce the possibility of optical interference due to window contamination.
- If Servo Ultra Nebulizer and CO_2 Analyzer are in use simultaneously. It may affect the CO_2 readings.
- Only MAQUET airway adapter may be used together with the Capnostat sensor.

Read more about the CO_2 Analyzer

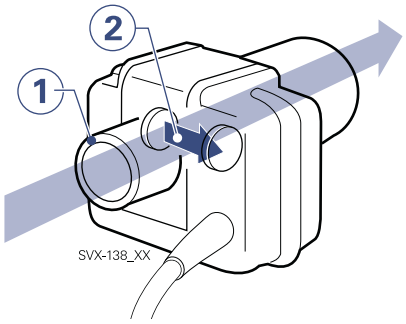
Preparation:	page 134
Calibration:	page 151
Cleaning:	page 208
Technical data:	page 247

CO_2 Analyzer parts



1. CO_2 Analyzer module.
2. Connection for sensor.
3. Connector.
4. Airway adapter.
5. Capnostat sensor.
6. Reference cell.
7. Zero cell.

Basic principles



1. Gas flow through the airway adapter in the Capnostat sensor.
2. The sensor uses a solid state and IR based optical system with no moveable parts. The difference between a reference light beam and one filtered for CO_2 wave length is measured.

Y Sensor measuring

The Y Sensor measuring function is based on fixed orifice, differential pressure sensor technology, and allows the pressure and flow to be measured as close as possible to the patient's airway. The Y Sensor measuring can be used in all modes of ventilation.

The Y Sensor measuring is included in both the Pre-use check and the Patient Circuit Test.

WARNING!

- Do not apply tension to the Y Sensor tubing.
- If the Y Sensor is not connected to the module then do not connect to the patient circuit due to leakage.

Cautions:

- The Y Sensor is intended for single patient use only.
- Avoid kinking the sensor tubing, otherwise the measuring is impaired.
- Condensed water or other fluids in the Y sensor may impair measurement accuracy (immediately or as a long term drift). Therefore it is recommended to always check if the sensor is affected by condensed water or other fluids before adjusting settings.
- Do not insert two Y Sensor modules at the same time. The Servo-i Ventilator system can only handle one Y Sensor module at a time.

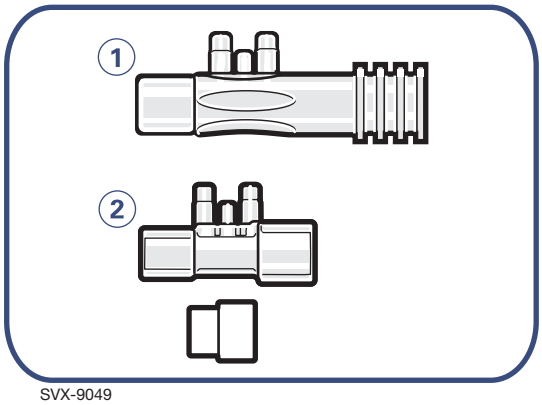
Important: To guarantee that waveforms and metrics are always displayed on the User Interface, the internal pressure and flow sensors are at all times active as back-up. Their readings are compared with the Y Sensor measurement and the Y Sensor is disabled if there is a significant deviation or malfunction. When this occurs a dialog box will inform the User that the Y Sensor measuring has been disabled. If conditions change so that the deviation criteria are no longer fulfilled the ventilator will automatically reactivate the Y Sensor measuring and the dialog will disappear.

Note:

- It is recommended to place an HME or tube between the Y Sensor (Adult version) and the test lung. The high resistance in the test lung may result in inaccurate measurements.
- The Y Sensor measurement can be incorrect when the Aeroneb Professional Nebulizer System is in use. Therefore, we recommend that the Y Sensor is removed from the patient circuit during nebulization.
- A Pre-use check or a Patient Circuit Test is required to use Y Sensor measuring.

Y Sensors

There are two versions of the disposable, single-use Y Sensors - Adult and Neonatal (Infant).



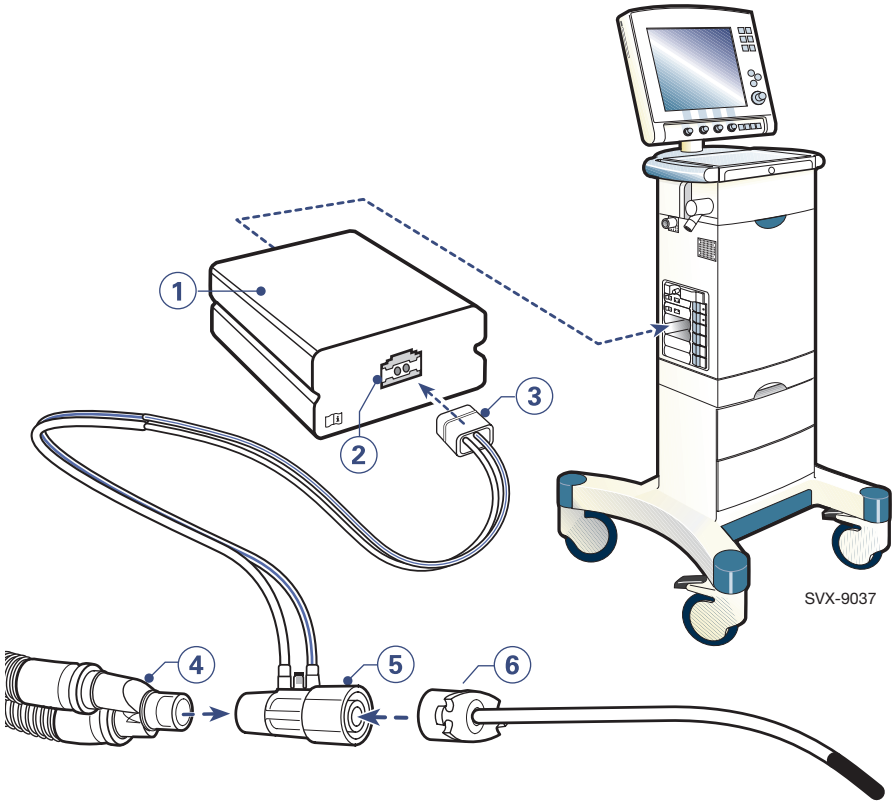
SVX-9049

1. Adult sensor
2. Infant sensor including adapter for use together with the neonate CO_2 adapter.

Read more about the Y Sensor measuring

Breathing systems:	page 120 - 122
Preparation:	page 135
Cleaning:	page 192
Technical data:	page 248

Y Sensor measuring parts



1. Y Sensor module
2. Connector for sensor
3. Connector
4. Y piece
5. Y Sensor
6. Endotracheal tube

4 Battery module Servo-i

General

Battery modules are used as a power backup in the Intensive Care Unit (ICU) and during transportation. The batteries used are “smart” NiMH 12V re-chargeable batteries. On delivery, more recent ventilators have two fixed Battery modules installed, with dummy modules covering the other four slots. Extra Battery modules are ordered and delivered separately.

WARNING! To guarantee safe battery backup, always use at least two batteries. Replace the batteries, due to old age, after two and a half years from their manufacturing date. The ventilator software will notify when batteries need to be replaced.

Basic principles

In case of mains power failure, the ventilator performs an automatic switch to external +12V (if connected) or to the Battery modules. In both cases, the ventilatory settings and stored data remain intact.

The ventilator chooses the Battery module powered with the highest voltage to be the prime module for powering the ventilator, where the other modules adopt an assistance role. This automatic changeover enhances system safety in case of a malfunctioning Battery module.

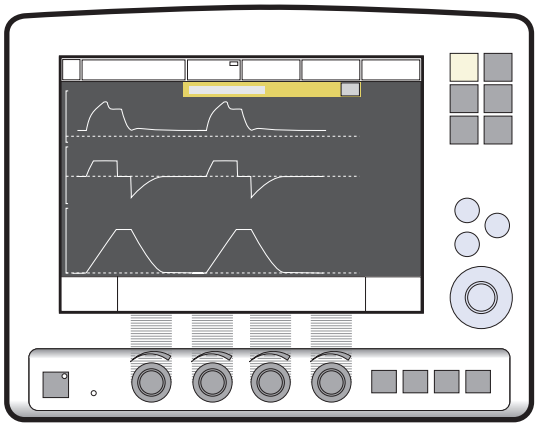
Important:

- When delivered, the Battery modules may not be fully charged. Check the status of the batteries via the User Interface and, if required, charge the battery before clinical use. See “Checking battery status” on page 111.
- Charge new batteries by connecting the ventilator to the mains power supply.
- Always recharge discharged batteries.
- When not in use, the ventilator should always be connected to the mains power supply to ensure fully charged batteries.
- If necessary, batteries can be added during operation (where free slots are available).

Caution: When the ventilator is running on batteries, the Servo Ultra Nebulizer is disabled to reduce power consumption.

Charging/Operating time

The ventilator can be run for at least 30 minutes per Battery module, i.e. two Battery modules for 60 minutes.



SVX-9036

The estimated remaining battery backup time, in minutes, is indicated on the User Interface – see time on Status button (when operating from batteries) at the top-right of screen.

WARNING! If the remaining battery time on the Status button is displayed in red, the battery modules have very little operational time left and at least one battery module must be replaced. If possible, connect the ventilator to the mains power supply.

The Battery status window shows status information for each battery module mounted in the ventilator. See “Battery status window” on page 111 for more information.

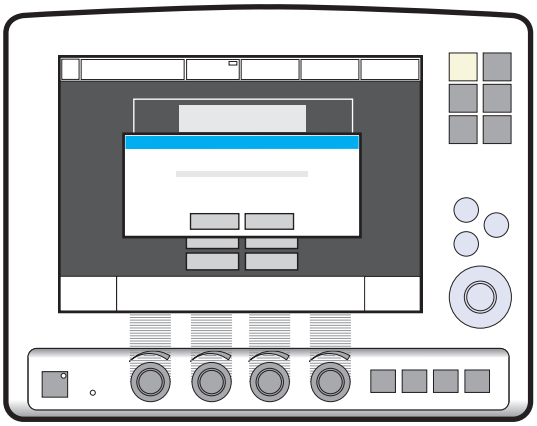
Battery modules are automatically charged when the ventilator is connected to the mains power supply. During Battery module charging, the ventilator charges the batteries in consecutive order using time-sharing to avoid uncharged batteries from blocking charging capacity. Charging starts with the lowest voltage battery.

Each discharged Battery module will need approximately three hours to be fully charged.

Checking battery status

Pre-use check

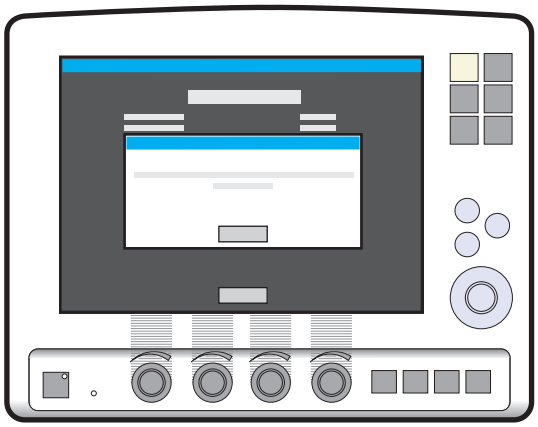
A Pre-use check can be run each time the ventilator is switched on and also from Standby mode. The following dialog box is typically displayed after system start-up:



SVX-9034

- Press *Yes* to start this system status check, or *No* to proceed directly with ventilation.

During the Pre-use check, the Battery module status is checked. If the battery status is unsatisfactory, the following screen will typically be displayed:



SVX-9035

If, as shown in the picture, a battery needs to be replaced due to either old age or poor operational capacity, perform the following:

- Press *OK* to acknowledge the information dialog box. The remaining Pre-use check is then completed.
- Access the Battery status window to identify the Battery module to be replaced. See “Battery status window” on page 111 for a detailed description of both how to access this window and a thorough description of the information found there.
- Replace the ‘poor’ or ‘old’ Battery module with a new Battery module.
- Dispose of the discarded Battery module according to local regulations.

Special waste
This product contains electronic and electrical components. Discard disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.

Recycling
Worn-out batteries must be recycled or disposed of properly in accordance with appropriate industrial and environmental standards.

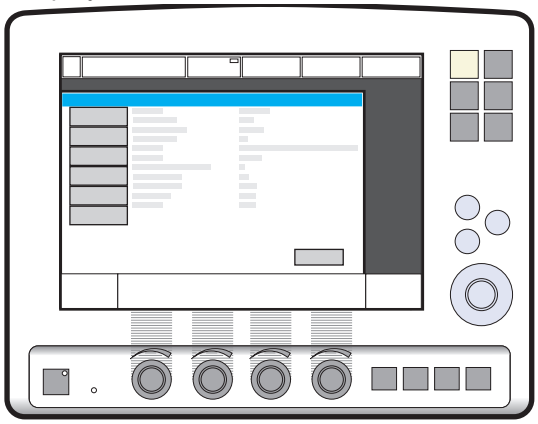
- Re-check the battery status to ensure safe battery operation.

Battery status window

The Battery status window contains status information on each of the Battery modules mounted in the ventilator. It also displays the total usable backup time for the ventilator – this time is also displayed, during battery operation, on the Status button at the top-right of the User Interface, and in the Status window.

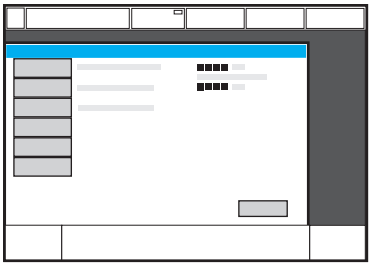
To access the Battery status window, perform the following:

- Press the *Status* pad at the top-right of the User Interface. The Status window is displayed:



SVX-9033

- Press the *Batteries* pad. The Battery status window is displayed.



SVX-9032

Note: The total usable backup time is the sum of the estimated operation time displayed for each Battery module minus 10 minutes. This is a safety feature.

The following information is displayed for each mounted Battery module:

- Slot number
- Serial number
- Charge indicator, where
  0 boxes filled = < 10% relative charge
  1 box filled = 10-25% relative charge
  2 boxes filled = 26-50% relative charge
  3 boxes filled = 51-75% relative charge
  4 boxes filled = 76-100% relative charge
- Remaining operating time in minutes
- Activity instruction. Displayed directly next to the Remaining operating time in minutes.

4 Battery module Servo-i

Informative text message

Text message	Remedy
Check battery status	Mains voltage disappears. Problem with battery module. One or more Battery modules must be replaced. Open the Battery status window for information. Replace and discard battery.

Activity instructions

Activity instruction	Remedy
Expires soon	The Battery module will soon need to be replaced. Order a new battery.
Replace battery	The Battery module has either exceeded its life span or its operational capacity is too poor for continued usage. Replace and discard the battery. **Note:** Even if the battery indicates a significant operational time, e.g. 55 min in the above picture, the battery must be replaced.

Important: Batteries to be discarded must be disposed of according to local regulations. Batteries must not be disposed of with ordinary waste. Recycle facilities may not be available in all areas.

Important: When a battery module has been replaced, re-check the Battery status window to ensure safe battery operation.

Alarms and safety

The status of the Battery modules is continuously monitored by the ventilator. If the status is unsatisfactory, two types of message information can be displayed at the top of the User Interface:

- Informative text message see page 230.
- Alarm message, see page 226.

WARNING! If one of the above message types is displayed, it is important to check the battery status as soon as possible. If no action is taken, while operating the ventilator on batteries, the ventilator may eventually switch itself off!

Battery storage

Battery modules should not be stored over long periods of time. This will negatively affect their capacity. If Battery modules need to be stored for short periods of time (one week), then store them fully charged in a cool (15-20°C) and dry environment.

Caution: Stored batteries need to be recharged before operation.

Special waste
This product contains electronic and electrical components. Discard disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.

Recycling
Worn-out batteries must be recycled or disposed of properly in accordance with appropriate industrial and environmental standards.

Read more about the battery module

Module handling:	page 133
Cleaning:	page 191
Technical data:	page 241

4 Ventilation Record Card

✗ Ventilation record card

The Ventilation record card allows for transfer of patient data or copy of screen from the ventilator system to a personal computer. Patient data can then be further processed and stored.

Accessible patient data in the ventilator are the logged events, trends, recordings and Open Lung Tool data, including patient name, patient identification code, ventilator serial number and pre-use check status. Information (patient data or screen dump) is never overwritten on the card by new information. The card can only be erased in a personal computer.

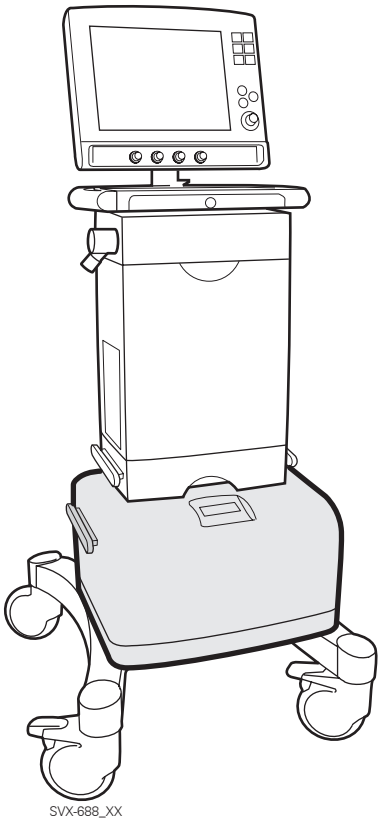
Important: The Ventilation record card and its contents should be handled according to national regulations, hospital routines and established routines for diskettes/pc-cards.

Basic principles

Data can be copied to the card in Standby mode or during ventilatory care. The card is inserted into the User Interface and the user confirms the copying. Insert the card in a personal computer. Patient data is accessed in Excel format (refer to separate manual).

Read more about the Ventilation record card

Set up and preparation	page 140
Copy patient data:	page 174
Copy screen:	page 173
Technical data:	page 241



Compressor Mini and Servo-i Ventilator on the Mobile Cart

✗ Compressor Mini

Basic principles

The Compressor Mini is designed to supply a ventilator with dry, filtered, compressed air. The Compressor Mini is designed to work together with all MAQUET ventilators.

The Compressor Mini is equipped with a Standby function. In Standby mode, the compressor will start to deliver compressed air to the ventilator if the central compressed air supply fails. The compressor automatically stops when the central air supply returns.

The Compressor Mini is fitted with two alarms; a temperature alarm that is activated if the compressor overheats, and a pressure alarm that is activated if the air pressure drops, or increases, outside the acceptable range. Alarms are audible and visible, with error message display.

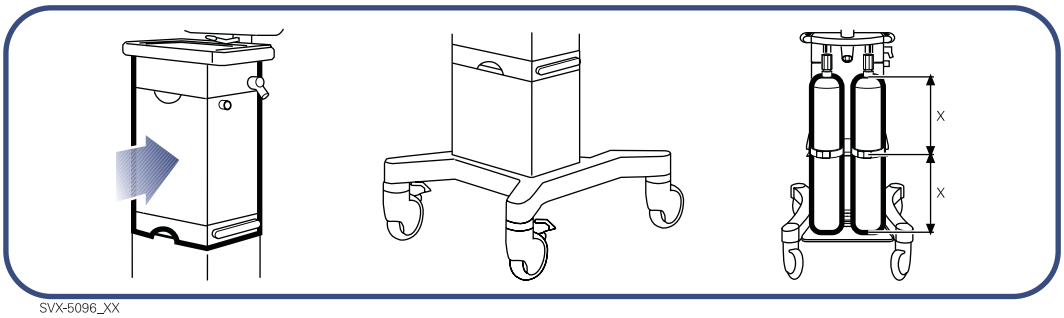
The outlet air pressure and the operating time are also indicated on the display.

For further information please refer to the Compressor Mini User's manual and the Compressor Mini Data Sheet.

Read more about compressor mini

Technical data: page 248

4 System transport and storage



SVX-5096_XX

Before transport

Before transporting the ventilator with or without a patient connected, make sure that the following conditions are fulfilled:

- The Patient Unit and the User Interface panel are securely attached and locked.
- All accessories such as modules, gas cylinders and humidifier are securely attached and locked.
- Connect and check the gas cylinders for amount of gas and the batteries for charged capacity (fully charged when patient connected), and check the resuscitator for function. Follow the hospital guidelines.
- Check that there is no damage to the Mobile Cart.

During transport

During transportation of the ventilator with or without a patient connected, make sure that the following conditions are fulfilled:

- Gas cylinders are connected with a sufficient amount of gas, the Battery module is charged and the resuscitator is functioning. Follow the hospital guidelines.

  Important: It is recommended that at least two batteries are used for ventilation during transport.

- Use the handles on the Mobile Cart.Transport the bed and the ventilator slowly, and watch the patient connection carefully to see that no pulling or other movement occurs.
- Be careful not to tip the Mobile Cart when crossing an obstacle such as a doorstep.

WARNING! *If the trigger sensitivity is set too high, a self-triggering (auto-triggering) condition may be reached. This condition can also be reached if there is leakage in the breathing system, e.g. if an uncuffed endotracheal tube is used. Triggering will then be initiated by the system and not by the patient.This should always be avoided by decreasing the trigger sensitivity (page 23). This is also important during transport as the movement of the body and the breathing system may lead to false triggering.*

Cautions:

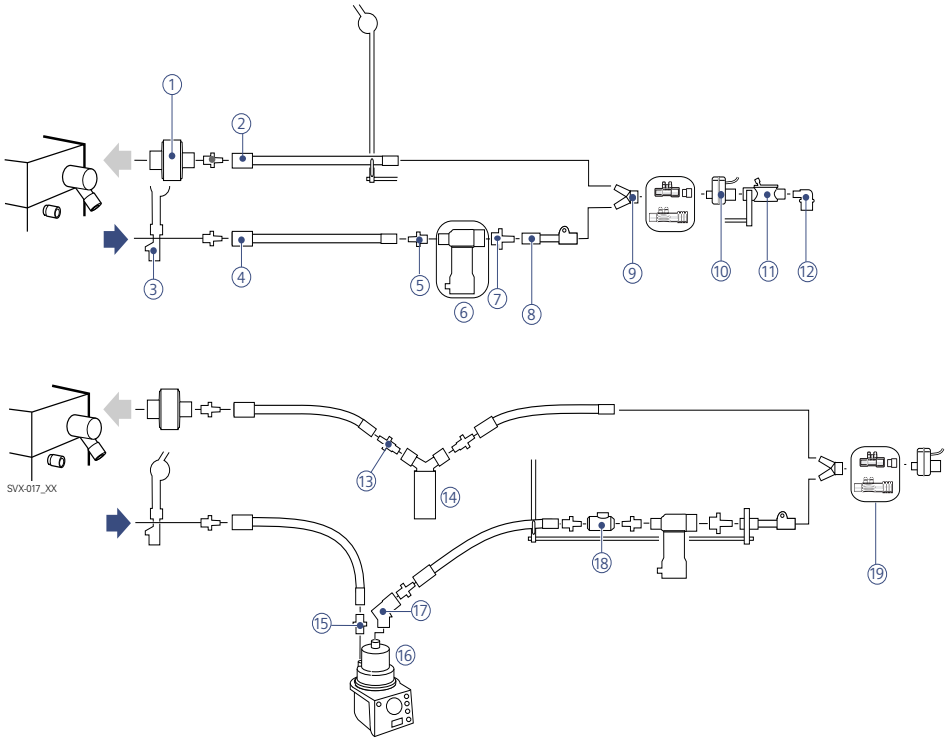
- To prevent the ventilator from tipping over, the Patient Unit must be pushed into its locked position during transportation.
- If Battery modules are inserted, the ventilator should be connected to the mains when not in use. The Battery modules are then charged automatically.
- Batteries and O_2 cell must not be disposed of with ordinary waste.
- Lock the gas cylinders firmly to the Mobile Cart.
- To prevent the gas cylinders from sliding out or tipping over, ensure that the straps are firmly fixed to the center of the cylinders.
- When moving the Support Arm or changing position, watch the patient connection carefully to see that no pulling or other movement occurs.
- Store the system at a temperature between -25 ^{o}C and +60 ^{o}C (-13 ^{o}F to 140 ^{o}F) at <95% RH.

4 Notes

5. Set-ups and preparations

Contents

10 mm diameter

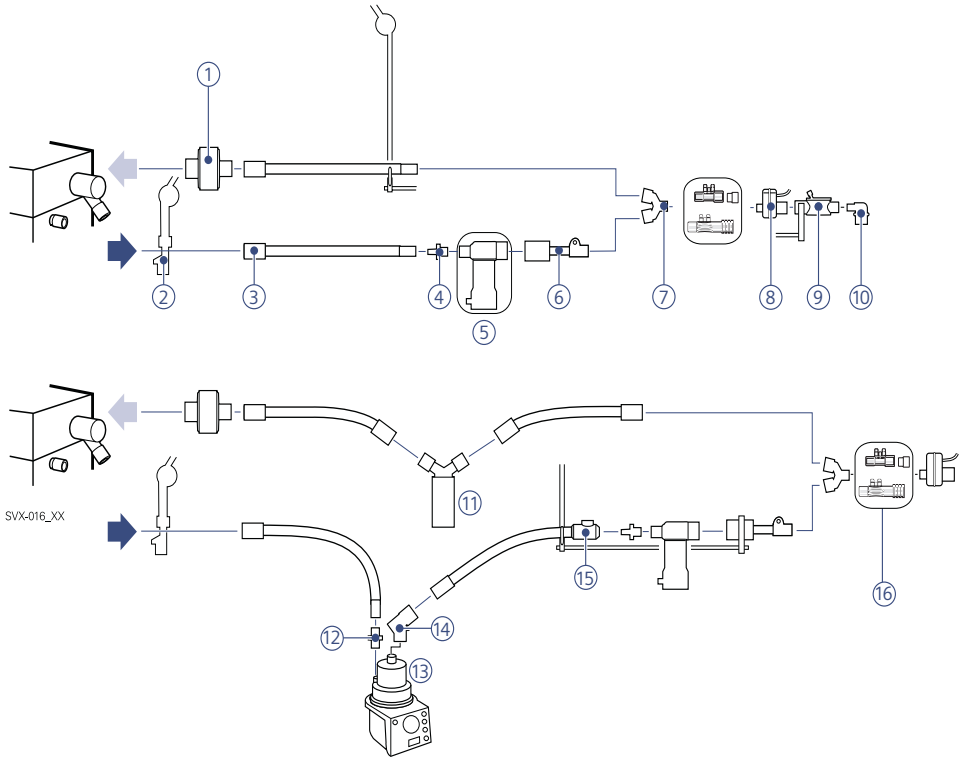


1. Servo guard, viral/bacterial filter - must always be connected during nebulization
2. Nipple connector
3. Support Arm
4. Patient tube
5. Nipple connector for nebulizer
6. Servo Ultra Nebulizer - must be connected only during nebulization, and should be disconnected immediately after medication has been delivered.

   Note: For information about the stand alone Aeroneb Professional Nebulizer System, refer to separate manual.
7. Nipple connector for nebulizer
8. Tube connection
9. Y-piece
10. CO_2 sensor
11. Servo humidifier - must be disconnected during nebulization (page 136).
12. Angled connector for endotracheal tube.
13. Nipple connector
14. Water trap - mandatory if a heated humidifier is used.
15. Nipple connector
16. Humidifier (Fisher &Paykel) - must not be active during nebulization (page 127).
17. Patient tube heater
18. Probe housing
19. Y Sensor (Adult/Infant with adapter)

Important: Some of the equipment shown is available in different versions, e.g. for infant/ pediatric and adults. See the “Products and accessories” catalogue for more information.

15 mm diameter



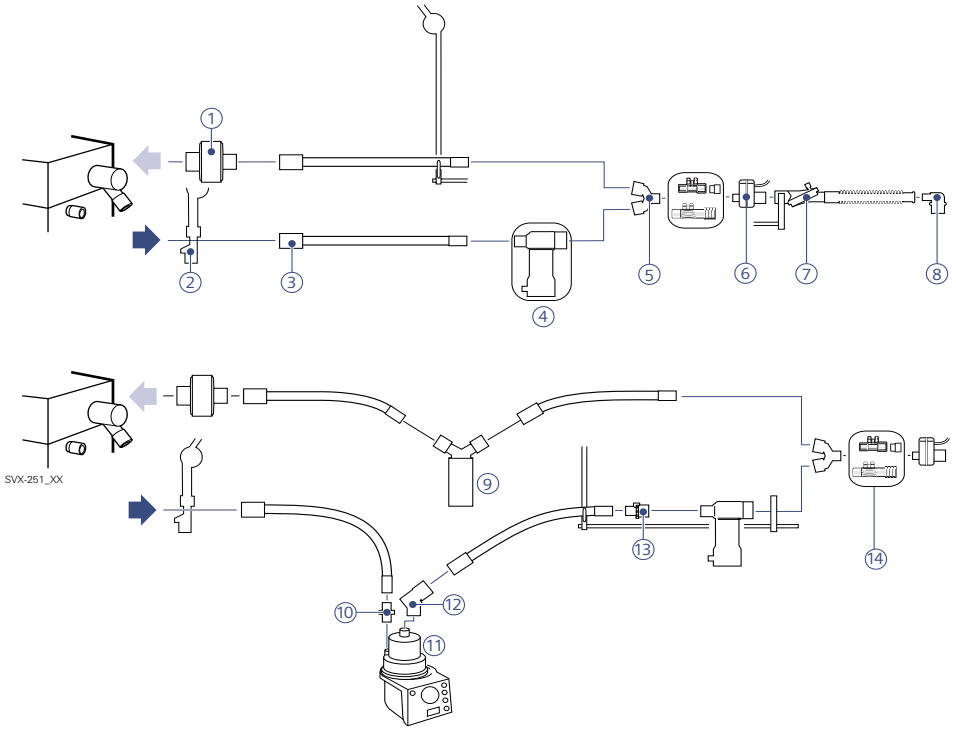
1. Servo guard, viral/bacterial filter - must always be connected during nebulization.
2. Support Arm
3. Patient tube
4. Nipple connector for nebulizer
5. Servo Ultra Nebulizer - must be connected only during nebulization, and should be disconnected immediately after medication has been delivered.

   Note: For information about the stand alone Aeroneb Professional Nebulizer System, refer to separate manual.
6. Tube connection
7. Y-piece
8. CO_2 sensor
9. Servo humidifier - must be disconnected during nebulization (page 136).
10. Angled connector for endotracheal tube.
11. Water trap - mandatory if a heated humidifier is used.
12. Nipple connector
13. Humidifier (Fisher &Paykel) - must not be active during nebulization (page 127).
14. Patient tube heater.
15. Patient tube with probe housing.
16. Y Sensor (Adult/Infant with adapter)

Important: Some of the equipment shown is available in different versions, e.g. for infant/ pediatric and adults. See the “Products and accessories” catalogue for more information.

5 Set-ups - Patient breathing system

22 mm diameter

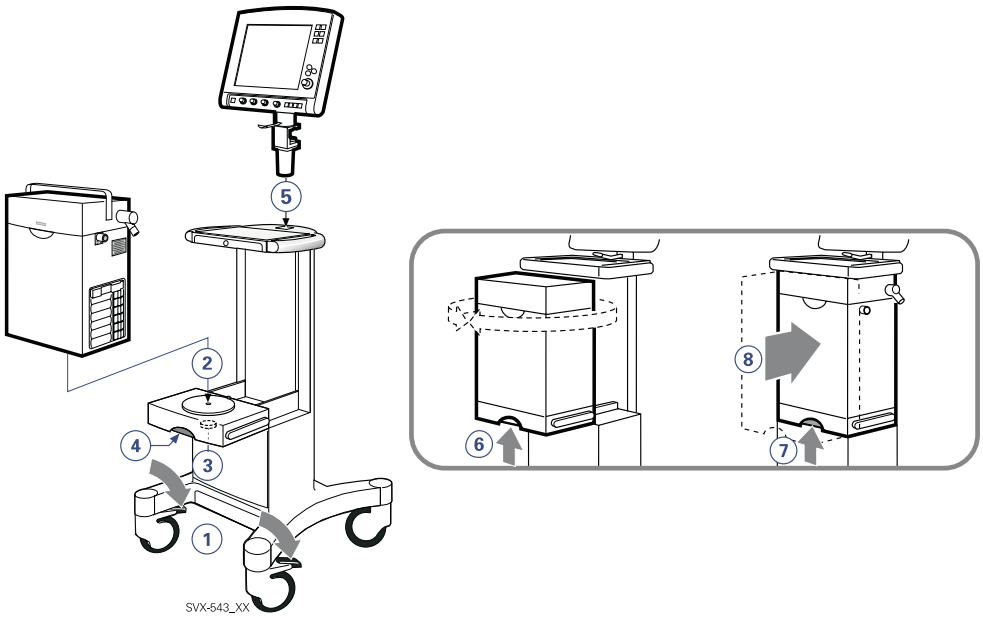


1. Servo guard, viral/bacterial filter - must always be connected during nebulization.
2. Support Arm
3. Patient tube
4. Servo Ultra Nebulizer - must be connected only during nebulization, and should be disconnected immediately after medication has been delivered.

   Note: For information about the stand alone Aeroneb Professional Nebulizer System, refer to separate manual.
5. Y-piece
6. CO_2 sensor
7. Servo humidifier - must be disconnected during nebulization (page 136).
8. Angled connector for endotracheal tube.
9. Water trap - mandatory if a heated humidifier is used.
10. Nipple connector
11. Humidifier (Fisher &Paykel) - must not be active during nebulization (page 127).
12. Patient tube heater
13. Probe housing
14. Y Sensor (Adult/Infant with adapter)

Important: Some of the equipment shown is available in different versions, e.g. for infant/ pediatric and adults. See the “Products and accessories” catalogue for more information.

Mobile Cart/positioning



1. Press the brakes to lock the wheels.
2. Place the Patient Unit on the console plate using the guide pins.
3. Ensure the ventilator is firmly fixed to the console plate by turning the security knob tightly clockwise.
4. Use the locking handle to push or pull the console.
5. Insert the panel.

If you want the Patient Unit oriented towards the left or right.

6. Lift the locking handle and rotate the Patient Unit until you hear a “click”.
7. Lift the locking handle.
8. Push in the Patient Unit to its end position until you hear a “click”.

Cautions:

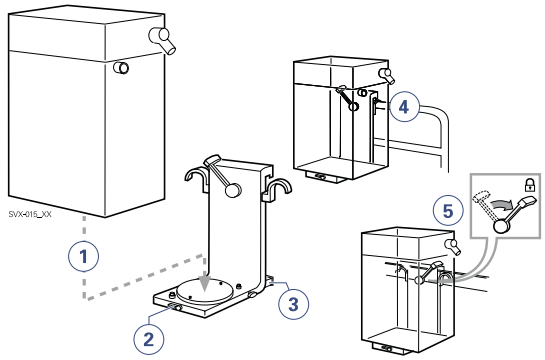
- The ventilator must only be used in an upright position.
- Ensure the ventilator is positioned into its locked position on the Mobile Cart Servo-i, to prevent unintentional movements.
- Lock the wheels if the ventilator is not to be used for transportation.

Read more about the Mobile Cart

Description:	page 99
Cleaning:	page 191
Technical data:	pages 243, 248

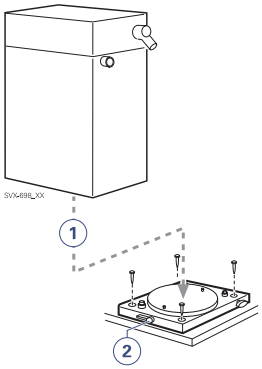
5 Preparations - Holder

Holder/positioning



1. Place the Patient Unit on the holder.
2. Secure the Patient Unit with the handle.
3. Adjust the support and secure with the screws.
4. Place the holder on a Rail (or bed or stretcher).
5. Lock the holder with the arm.

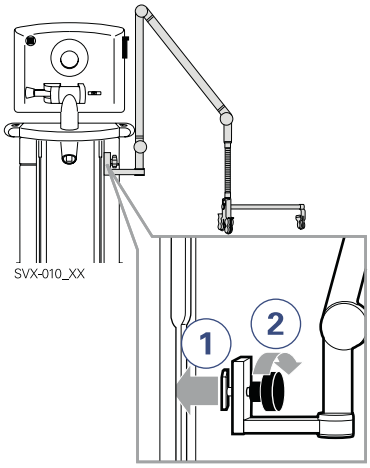
Shelf base / positioning



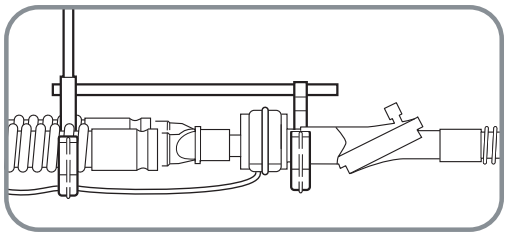
Note: Be sure that the Servo-i Shelf base is securely fixed on the shelf.

1. Place the Patient Unit on the Servo-i Shelf base.
2. Secure the Patient Unit with the handle.

Support Arm 177



1. Insert the Support Arm into the side track.
2. Tighten the screw firmly.



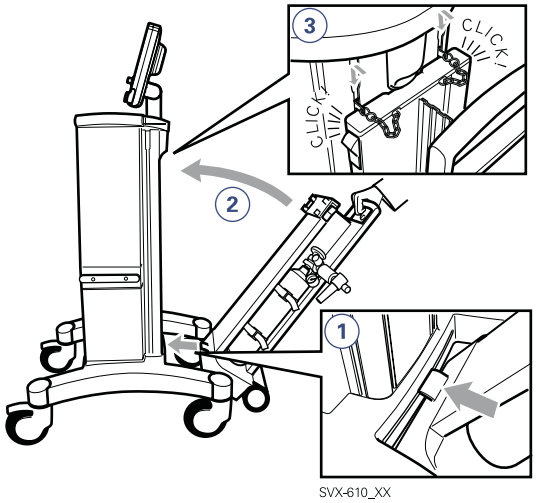
Adjust the Support Arm, CO_2 airway adapter and snap the breathing system into the grip.

Cautions:

- Use the Support Arm to relieve the patient from the weight of the tubing system.
- Ensure the Support Arm is firmly fixed before attaching the tubing.
- When moving the Support Arm or changing position, watch the patient connection carefully to see that no pulling or other movement occurs.

5 Preparations - Gas trolley

Gas trolley/positioning



SVX-610_XX

1. Place the gas trolley in position.
2. Hinge the gas trolley and lift it up into locking position (a "click" is heard).
3. Secure the docking with the security chains.

Note: Press the brakes to lock the wheels on the Mobile Cart before positioning the gas trolley.

Note: The Gas trolley can also be mounted to a separate wall clamp. Refer to installation instructions.

✕ Fisher & Paykel humidifier MR 730 / MR 850

The use of an active humidifier is often beneficial for patients undergoing ventilatory treatment. Please refer to the manufacturer´s Operating manual for instructions on use.

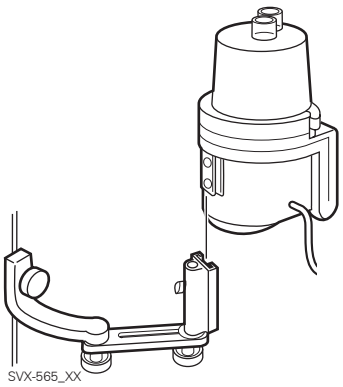
WARNING! The heated humidifier must be switched off during nebulization. Otherwise the particle size may be affected.

Cautions:

- If an active humidifier is used in the system a water trap should be used on the expiratory tubing to avoid condensation in the system.
- During operation the water traps must be checked regularly and if necessary emptied.

Important: It is recommended only to use original tubing from MAQUET. Soft tubing may negatively effect the performance of the ventilator.

✕ Humidifier Holder

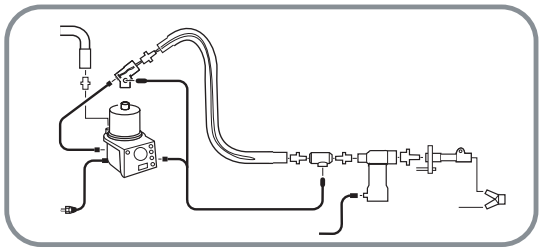


SVX-565_XX

A special holder allows for left or right positioning of the heated humidifier.

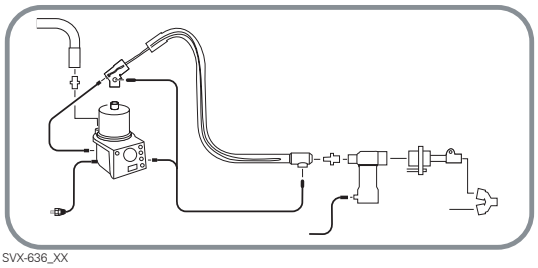
Connection

✕ 10 mm breathing system



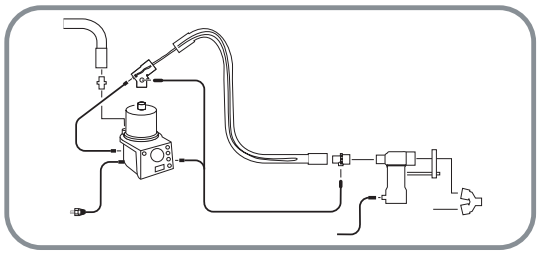
SVX-018_XX

✕ 15 mm breathing system



SVX-636_XX

✕ 22 mm breathing system



SVX-567_XX

Read more about the Fisher & Paykel humidifier

Breathing systems: page 120 - 122
Cleaning: page 191

5 Preparations - Servo Ultra Nebulizer

✗ Servo Ultra Nebulizer

WARNINGS!

- Servo Humidifier/HME must be disconnected during nebulization. Otherwise the humidifier may be blocked.
- The heated humidifier must be switched off during nebulization. Otherwise the particle size may be affected.
- The nebulizer must not be used without buffer liquid (sterile water). Otherwise the ultrasonic generator crystal may break.
- To avoid explosion hazards, flammable agents such as ether and cyclopropane must not be used with this device. Only agents which comply with the requirements on non-flammable agents in the IEC standard “Particular requirements for electrical safety of anaesthetic machines” are suitable.
- For adult/pediatric patients, never fill the medication cup with more than 10 ml.
- For neonatal patients, never fill the medication cup with more than 4 ml.
- If the patient unit of the nebulizer is tilted nebulizer function may be affected, the drug can flow into the patient´s lungs or the ventilator.
- The nebulizer must not be left unattended, when connected to a patient.
- When the ventilator is running on batteries the nebulizer module is inoperative to reduce the power consumption.
- During nebulization a filter must be connected to the expiratory inlet of the ventilator. Always carefully monitor the airway pressure during nebulization. Increased airway pressure could be caused by a clogged filter. The filter should be replaced if the expiratory resistance increases or every 24 hours when the nebulizer is being used.

Important: The patient unit of the Nebulizer must not be located inside an incubator.

Caution: Check that the medication cup is undamaged and that it is firmly in place before the nebulizer is started.

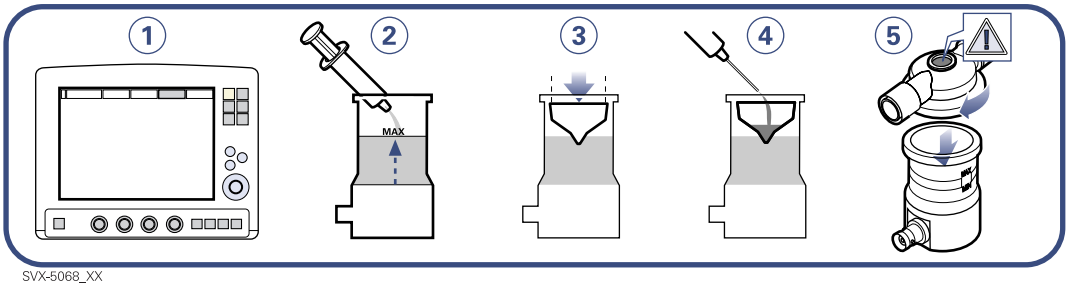
Note: For information about the stand alone Aeroneb Professional Nebulizer System, refer to separate manual.

Note: The Y Sensor measurement can be incorrect when the Aeroneb Professional Nebulizer System is in use. Therefore, we recommend that the Y Sensor is removed from the patient circuit during nebulization.

Read more about the Servo Ultra Nebulizer

Description:	page 102
Breathing systems:	page 120 - 122
Operating:	page 187
Cleaning:	page 205
Technical data:	page 246

Filling

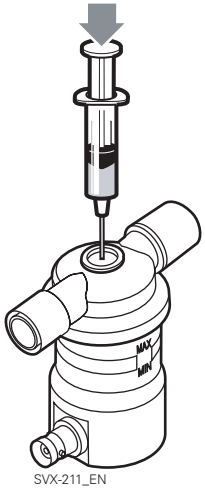


SVX-5068_XX

1. Make sure the nebulizer is turned off.
2. Pour sterile water to the MAX level indication.
3. Attach a new medication cup.
4. Fill the medication cup with medication (max. 10 ml for adults, max. 4 ml for Infants).
5. Fit the T-piece firmly to its end position. Check that the injection membrane is in place and not damaged.

Important: Invisible damage will be detected during the Pre-use check. A faulty injection membrane may cause system leakage. To change the membrane, please refer to page 217.

Refill



SVX-211_EN

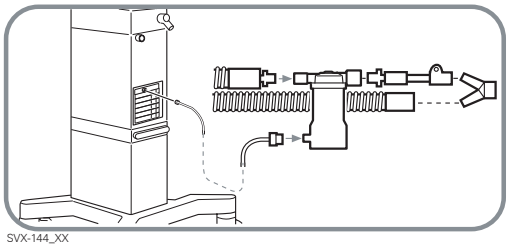
– Fill a sterile syringe with medication. Note that the diameter of the needle must not be more than 1.0 mm.
– Carefully inject the medication into the medication cup through the injection membrane. Make sure the needle does not penetrate the medication cup.

5 Preparations - Servo Ultra Nebulizer

Connection

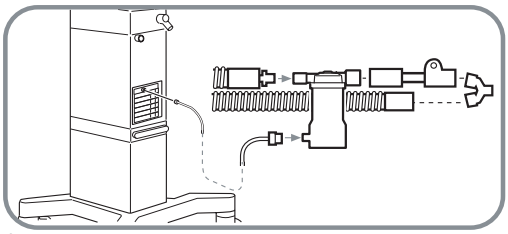
Connect the nebulizer between the inspiratory tube and Y-piece. Connect the cable from the nebulizer to the Patient Unit of the ventilator. Refer to page 120 to 122.

10 mm breathing system



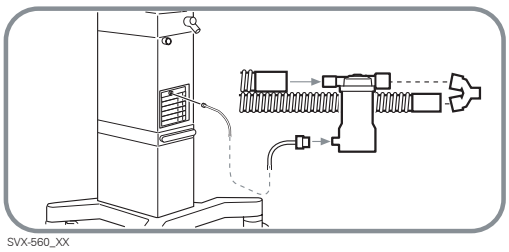
SVX-144_XX

15 mm breathing system



SVX-631_XX

22 mm breathing system

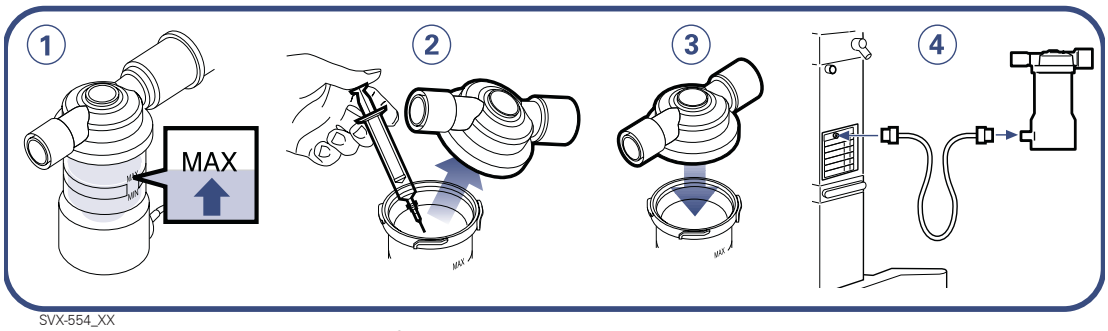


SVX-560_XX

Function test

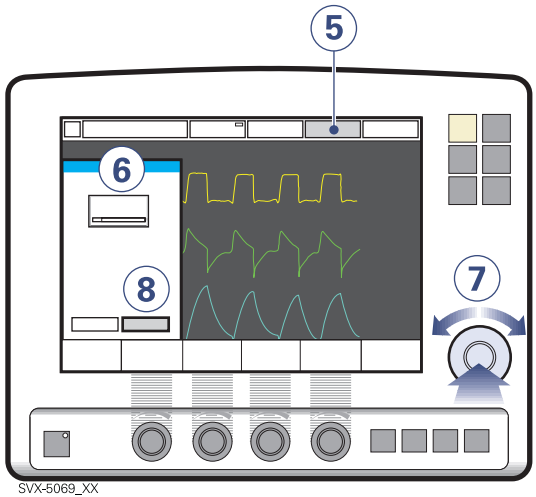
A function test must always be done after cleaning and maintenance.

If any malfunction is detected the Servo Ultra Nebulizer must not be used before the malfunction is remedied.



SVX-554_XX

1. Make sure the patient unit is filled with buffer water to the appropriate level.
2. Remove the T-piece and fill the medication cup with approximately 5 ml water.
3. Put the T-piece back.
4. Connect the connection cable.

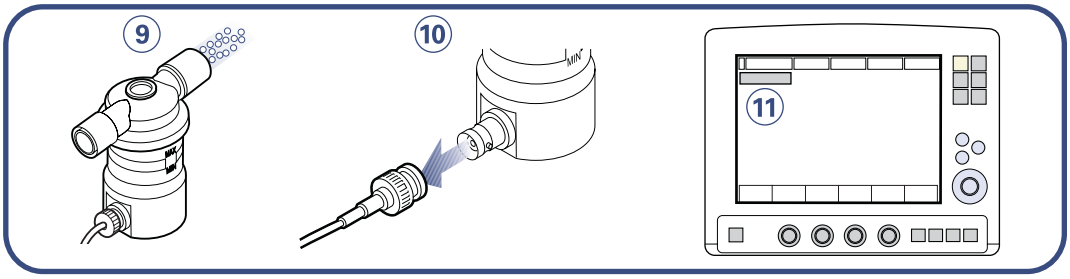


SVX-5069_XX

Start the nebulizer. (See also page 187)

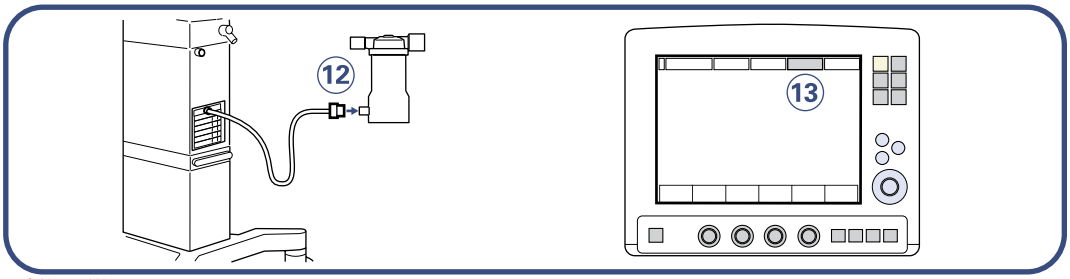
5. Press the *Nebulizer* pad.
6. Press the *Time* pad.
7. Set the time by using the Main Rotary Dial.
8. To accept the time, press *Accept*.

5 Preparations - Servo Ultra Nebulizer



SVX-5070_XX

9. Check that mist is produced.
10. Disconnect the connection cable from the Servo Ultra Nebulizer Patient unit.
11. Make sure an alarm text is given.

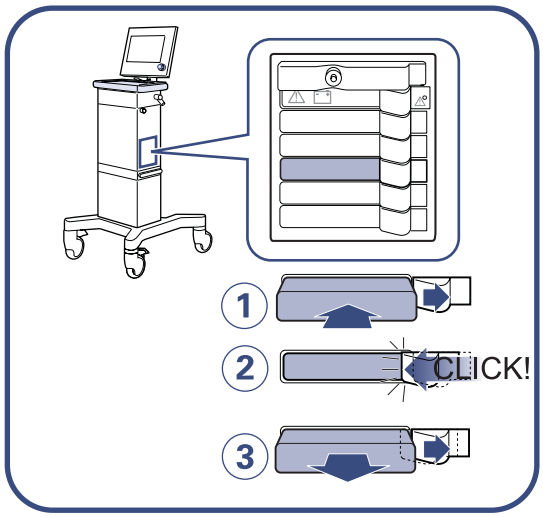


SVX-5071_XX

12. Connect the connection cable.
13. Stop the nebulizer.

WARNING! *Only accessories and auxiliary equipment that meet current IEC standards (e.g. IEC 60601-1, IEC 950) may be connected to the Servo-i Ventilator System. If external equipment such as computers, monitors, humidifiers or printers are connected, the total system must comply with IEC 60601-1-1.*

✗ Inserting / disconnecting



SVX-5094_XX

Insert a module:

1. Insert the module into the slot
2. Make sure it clicks into place.

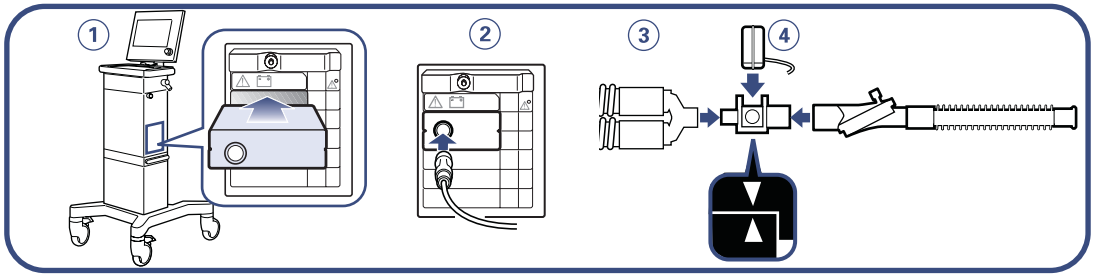
Remove a module:

3. Push the lock handle aside. Remove the module

Note: The slots are numbered (1,2,3...) from top to bottom.

✗ CO_2 Analyzer

The ventilator immediately recognizes when a CO_2 Analyzer is inserted and the Capnostat sensor is connected.



SVX-145_XX

1. Insert the CO_2 Analyzer into the module compartment of the Patient Unit.

   Note: The slots are numbered (1,2,3...) from top to bottom.

2. Connect the Capnostat sensor to the CO_2 Analyzer.
3. Attach the airway adapter between the Y-piece / Servo Humidifier and the endotracheal tube / face mask / prongs. The adapter windows should be placed vertically to minimize condensation on the windows.
4. Snap the Capnostat sensor onto the airway adapter.

Note: The *etCO_2 concentration low* alarm can be permanently silenced (Audio off) when the message *Silence alarm permanently?* is shown.

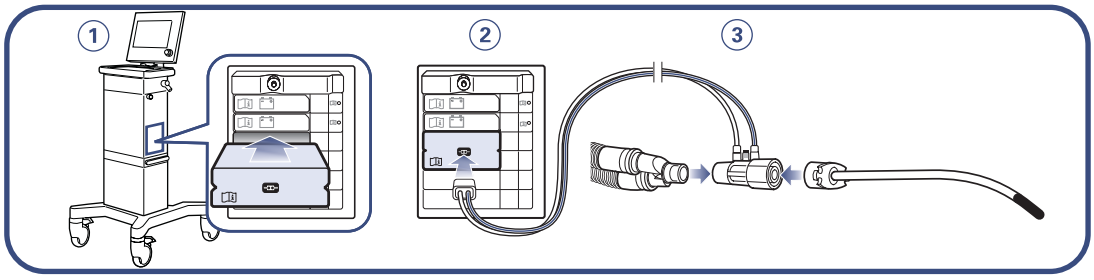
Cautions:

- The Capnostat sensor with airway adapter should be removed during nebulization.
- Do not insert two CO_2 Analyzers at the same time. The Servo-i Ventilator system can only handle one CO_2 Analyzer at a time.
- If the upper alarm limit is set above the maximum measuring range, no alarm will be activated even if the upper limit is exceeded.

Read more about the CO_2 Analyzer

Description: page 104
Calibration: page 151
Cleaning: page 207
Technical data: page 247

✗ Y Sensor measuring



SVX-9031

The ventilator immediately recognizes when an Y Sensor module is inserted and the Y Sensor is connected.

1. Insert the Y Sensor module into the module compartment of the Patient Unit.

   Note: The slots are numbered (1,2,3...) from top to bottom.

2. Connect the Y Sensor to the Y Sensor module, ensuring the tubing is facing upwards on the Y Sensor.

   Note: A special plastic adapter is enclosed for use between the infant Y Sensor and the Y-piece for use together with the neonate CO_2 adapter.

3. Attach the Y Sensor to the endotracheal tube and the Y piece.

   Note: Position the Y Sensor so that the tube with the blue stripe is placed next to the patient.

WARNING!

- Do not apply tension to the Y Sensor tubing.
- If the Y Sensor is not connected to the module then do not connect the sensor to the patient circuit due to leakage.
- If condensed water from the Y Sensor tubing reaches the Y Sensor module, then the module will be damaged**.**

Caution:

- The Y Sensor is intended for single patient use only, do not re-use, clean or sterilize.
- Avoid kinking the sensor tubing, otherwise the measuring is impaired.
- Condensed water or other fluids in the Y sensor may impair measurement accuracy (immediately or as a long term drift). Therefore it is recommended to always check if the sensor is affected by condensed water or other fluids before adjusting settings.
- Do not insert two Y Sensor modules at the same time. The Servo-i Ventilator system can only handle one Y Sensor module at a time.

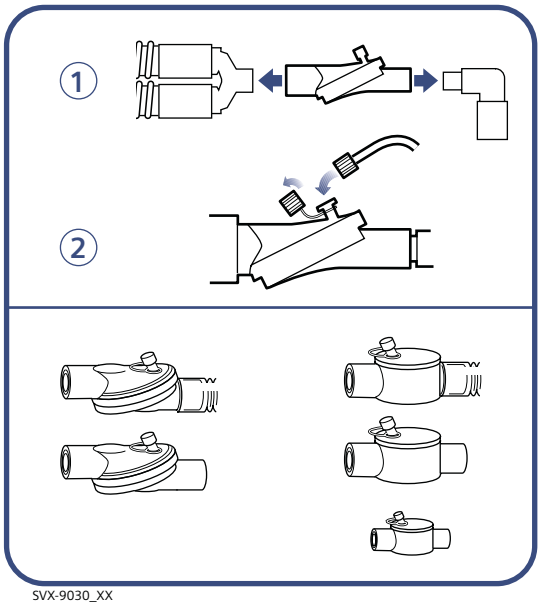
Note:

- A Pre-use check or a Patient Circuit Test is required to use Y Sensor measuring.
- It is recommended to place an HME or tube between the Y Sensor (Adult version) and the test lung. The high resistance in the test lung may result in inaccurate measurements.
- The ✗ Y Sensor measurement can be incorrect when the Aeroneb Professional Nebulizer System is in use. Therefore, we recommend that the Y Sensor is removed from the patient circuit during nebulization.

Read more about Y Sensor measuring

Breathing systems:	page 120 - 122
Description:	page 106
Cleaning:	page 192
Technical data:	page 248

✗ Servo humidifier



SVX-9030_XX

The use of a humidifier is often beneficial for patients undergoing ventilatory treatment.

1. Connect the humidifier between the endotracheal tube or face mask / prongs (15 mm female connection) and the Y-piece.
2. If the sampling port is to be used, connect it to the Luer port (standard Luer connection).

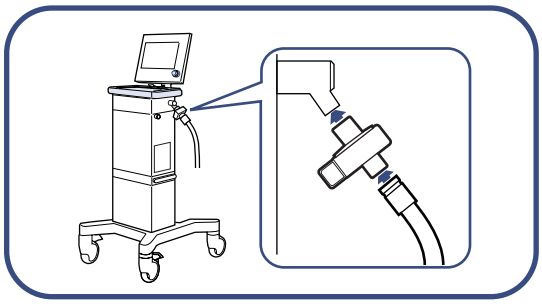
WARNING! Servo Humidifier/HME must be disconnected during nebulization. Otherwise the humidifier may be blocked.

Important: It is recommended only to use original tubing from MAQUET. Soft tubing may negatively effect the performance of the ventilator.

Read more about the Servo humidifier

General options: page 85
Breathing systems: pages 120 - 122

Servo Guard filter



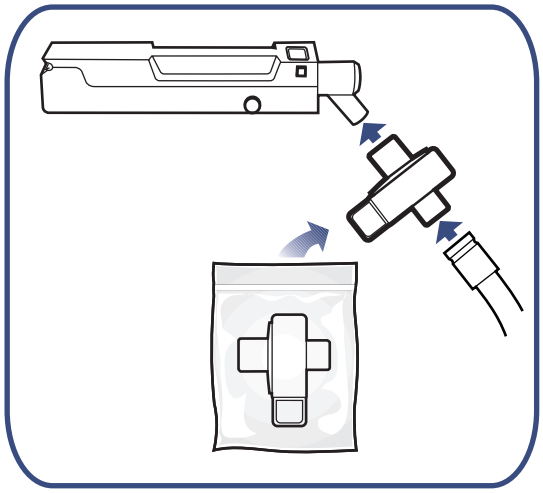
SVX-147_XX

The Servo Guard viral/bacterial filter can be used on both expiratory and/or inspiratory limbs of the breathing circuit

Connect a Servo Guard bacterial filter to the expiratory inlet. A bacterial filter must always be connected during nebulization (see pages 120, 121, 122). The use of filter on the expiratory side will also reduce the need for cleaning and autoclaving of the expiratory cassette.

WARNING! During nebulization a filter must be connected to the expiratory inlet of the ventilator. Always carefully monitor the airway pressure during nebulization. Increased airway pressure could be caused by a clogged filter. The filter should be replaced if the expiratory resistance increases or every 24 hours when the nebulizer is being used.

Change filter



Disconnect and change filter:

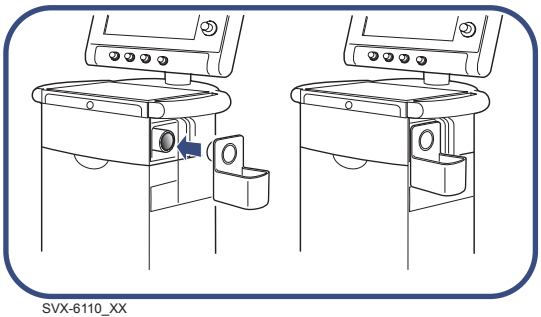
- Every 24 hours
- New patient
- Whenever needed

Read more about Servo Guard viral/ bacterial filter

General options:	page 86
Breathing systems:	page 120 - 122
Cleaning:	page 197

5 Water collector

Water collector



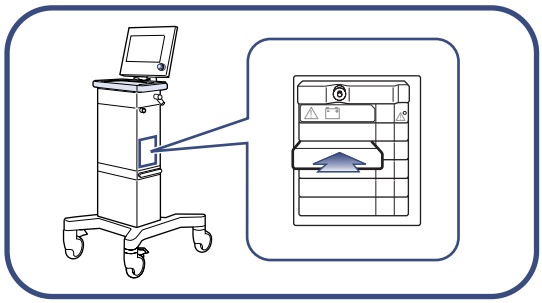
SVX-6110_XX

Condensation at the expiratory outlet may occur when dual heated patient tubing are in use, and there is a draught from an air condition, patient-cooling fan etc. that cools down the expiratory outlet.

To avoid problems with condensation a water collector can be connected to the expiratory outlet. The water collector also works as an insulation of the expiratory outlet and therefore reduces the amount of condensation.

Inserting batteries

Insert a Battery module into the patient unit. Ensure the module is fully inserted so that the battery release button returns to a completely ‘closed’ position..



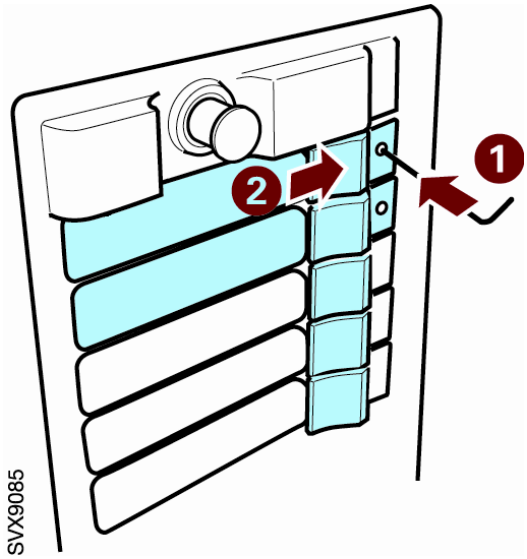
SVX-5081_XX

Note: The slots are numbered (1, 2, 3,...) from top to bottom

Removing batteries

To remove a Battery module:

- Push and press the battery release button to the right (2) until the battery is released from the ventilator.



Note: On more recent ventilators, Slots 1 and 2 are locked to ensure that two Battery modules are always present in the ventilator. These can be opened using an Allen key (1) or similar.

- Remove the battery from the ventilator.

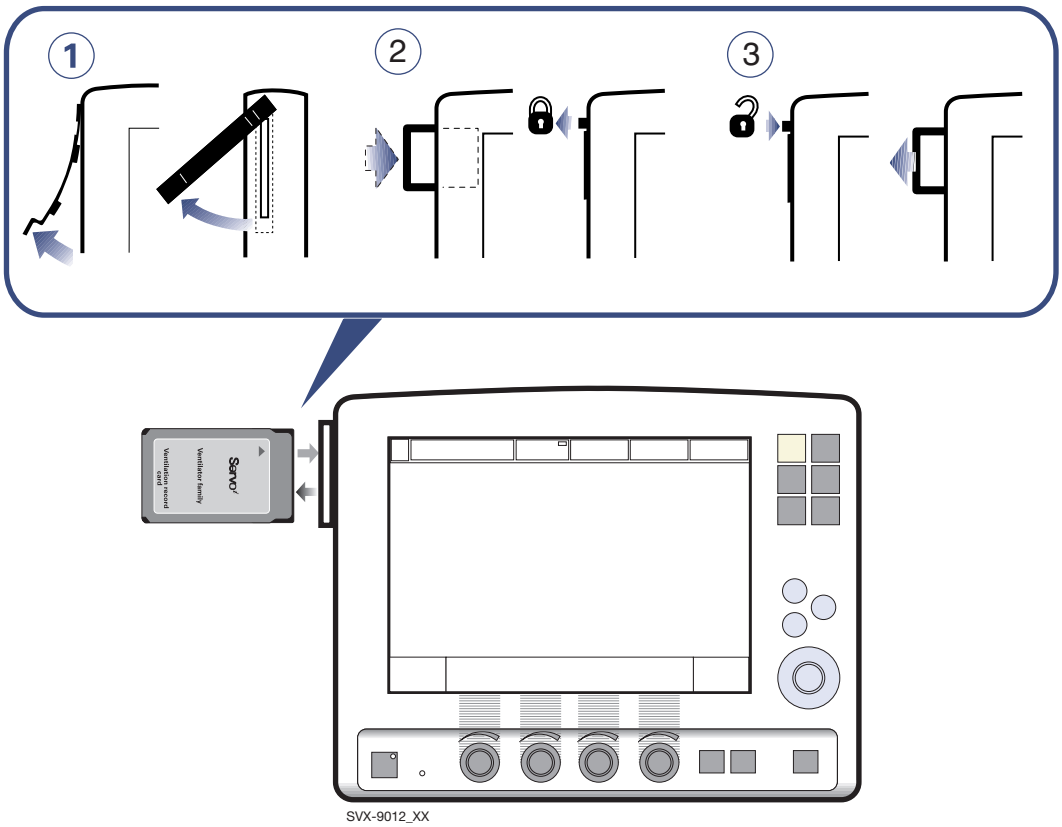
Note: On delivery, one fixed battery module is installed. Dummy modules covers the other slots. Extra battery modules are delivered separately.

Read more about the Battery module

Description:	page 108
Module handling	page 133
Cleaning:	page 191
Technical data:	page 242

5 Preparations - Ventilation Record Card

Ventilation record card (insert and remove)



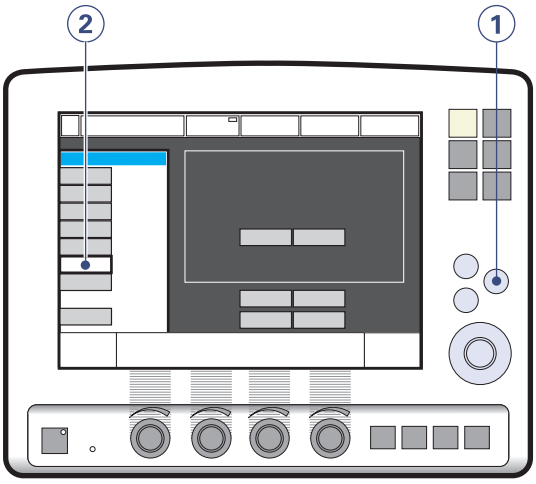
1. Gently pull out the slot cover and turn the slot cover aside.
2. **Insertion**
   - Insert the Ventilation record card into the slot guide.
   - Gently push the card into the slot guide until the eject button comes out.
3. **Remove** the card
   - Press the eject button.
   - Draw the card out of the slot.
   - Put the slot cover back in position.

Start-up configuration

The ventilator always start-up with the set Start-up configuration.

The following Start-up configuration settings can be set by the user:

- Patient category
- Type of ventiation (Invasive or NIV)
- Volume setting
- Breath cycle setting
- Pre/post oxygenation concentration above set O_2 conc (%)
- Mode of ventilation (including parameters settings).



SVX-9046

Note: The ventilator must be in Standby mode. Refer to page 159.

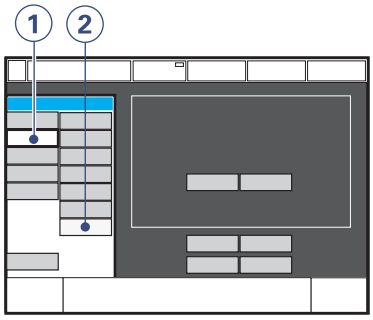
1. Press the fixed key *Menu*
2. Press the *Biomed* pad and enter the access code (1973, factory setting).

   Note: The access code can be changed by the user from a *Biomed* sub menu.

The *Biomed* submenus are:

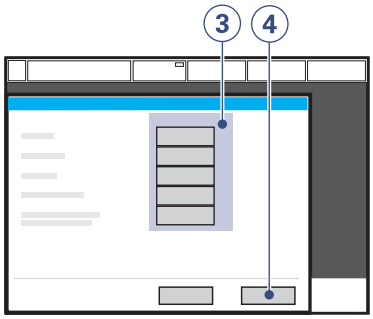
- Service
- Edit configuration
- Copy configuration
- Set date and clock
- Change access code

Edit a Start-up configuration



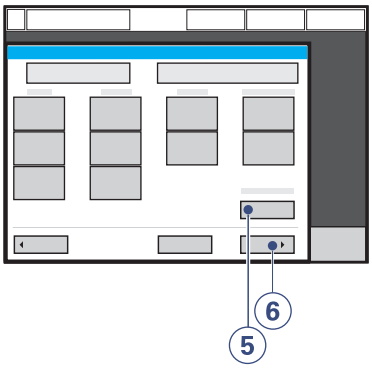
SVX-9045

1. Press the *Edit configuration* pad
2. Press the *Start-up configuration* pad.



SVX-9047

3. Press the touch pad for desired Start-up setting.
4. Press the *Next* pad to continue to ventilation mode settings.



5. Press the touch pad to change the settings

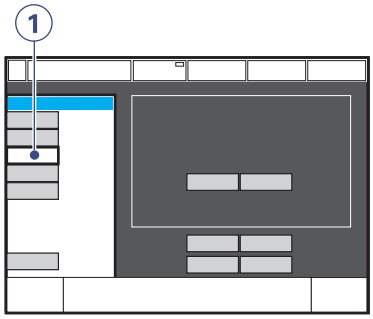
   Note: Press *Restore mode settings* pad to restore factory default settings

6. Press the *Next* pad to view a summary of the Start-up configuration.

7. Press *Accept* pad to save the Start-up settings.

   Note: The ventilator must be restarted to activate the new settings.

Copy configuration

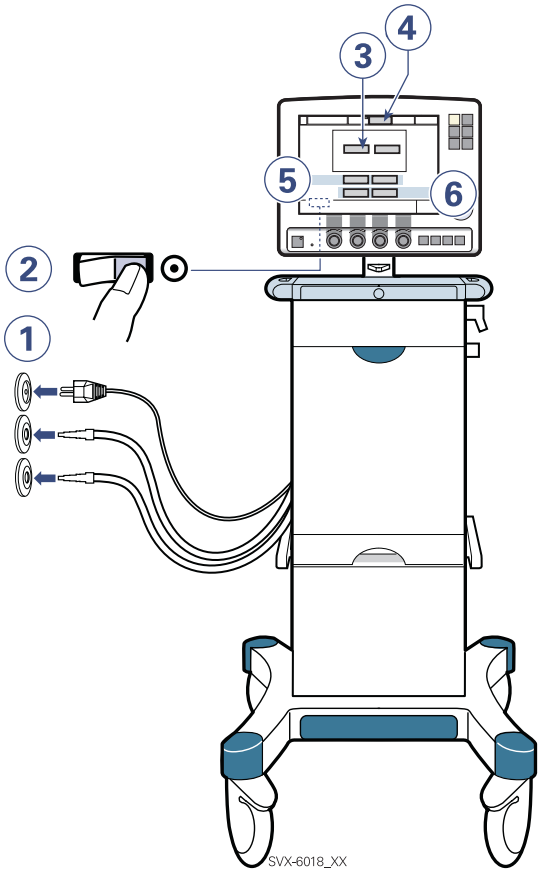


SVX-9048

1. Press *Copy configuration* pad and follow the on-line instructions.

   Note: It is possible to either save or restore a configuration.

Overview - Starting the system



1. Ensure that there is power and gas supply to the ventilator.
2. Set the ventilator On/Off switch to On. The ventilator is then in Standby showing touch pads for Pre-use check, Patient circuit test, ✗ Patient category and ✗ Type of ventilation.
3. Always perform a Pre-use check before connection to patient. The check covers tests of internal technical functionality, internal leakage, pressure transducers, O_2 cell / O_2 sensor, flow transducers, safety valve, battery, leakage in the patient breathing system, modules and calculation of the circuit compliance, which can be automatically compensated for (date for latest check below the touch pad). After the Pre-use check is completed or if a Pre-use check is not performed, a dialog will appear, asking if old patient related data shall be erased or kept.
4. Enter data for the new patient, including body weight and body height. The calculation of tidal and minute volume is based on entered body weight. You can omit this data input. Default values will then be used for ventilation. To get an automatic calculation of Tidal Volume (based on body weight and immediately executed) the Servo-i Ventilator System must be configured to start with "Tidal Volume based on body weight" (refer to Service manual).
5. Select patient category, *Adult* or *Infant*. Your setting will affect pressure and flow regulation, safety limits, defaults and scaling. If you do not select a category, the default range will be used.
6. ✗ Select type of ventilation, *Invasive ventilation* or *NIV (Non Invasive Ventilation)*.

5 Notes

6. Pre-use check

Contents

6 Pre-use check

This check includes tests of internal technical functionality, internal leakage, pressure transducers, O_2 cell / O_2 Sensor, flow transducers, safety valve, battery, patient breathing system leakage, modules and measurement of the circuit compliance. Follow the instructions below in combination with the instructions on-line.

WARNINGS!

- A Pre-use check must always be done before connecting the ventilator to a patient.
- The separate Patient circuit test which can be performed in Standby (refer to page 178) does not replace the Pre-use check.
- To avoid electrical shock hazard, connect the ventilator power cord to a mains outlet equipped with a protective ground.
- If any malfunctions are detected during the start-up procedure, please refer to Chapter 10, Troubleshooting.
- If a malfunction persists, the ventilator may not be connected to the patient.

Caution:

The Expiratory cassette must not be lifted up when the ventilator is in operation. This may, however, be done when in Standby.

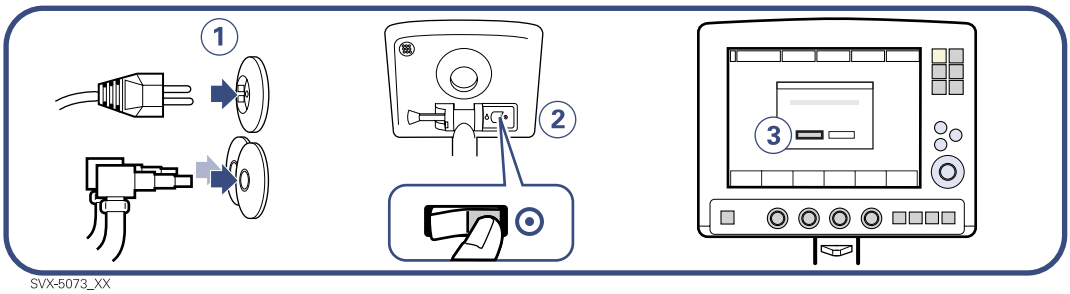
Important:

- If the breathing circuit is changed after the calculation of the circuit compliance compensation factor, perform a new calculation.
- Use only the blue test tube from MAQUET.

Read more about Pre-use check messages

Troubleshooting: page 218

Start-up

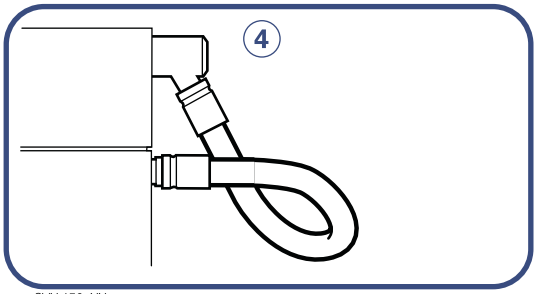


SVX-5073_XX

1. Connect
   - To mains.
   - Gas: Air and O_2.
2. Set the ventilator to On.
3. To start the automatic test: Press *Yes* and follow the on-line instructions.

Note: If the Pre-use check is not performed, a dialog will appear, asking if old patient related data shall be erased or kept.

Internal tests

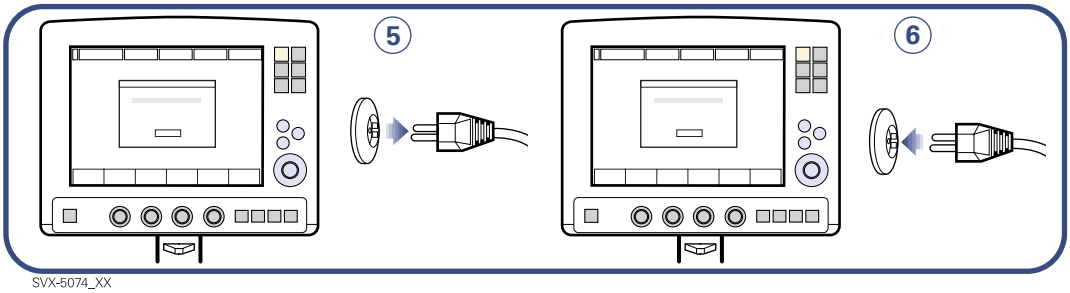


SVX-152_XX

4. Connect the blue test tube between the inspiratory outlet and the expiratory inlet.

6 Pre-use check

Automatic switch between mains/battery



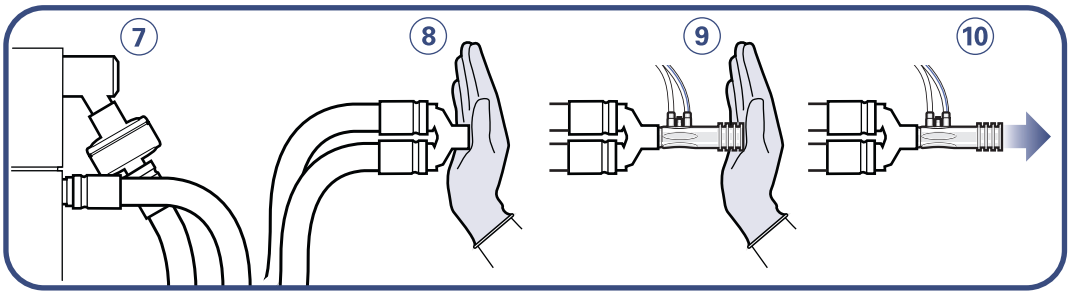
SVX-5074_XX

If at least one Battery module is connected, a test of automatic switch to battery/mains will be performed.

5. When on-line instruction appears:
   – Disconnect the ventilator from mains.
6. When on-line instruction appears:
   – Connect the ventilator to mains.

Note: For further information about Pre-use check messages (battery module), refer to page 220.

Patient breathing system / Y Sensor



SVX-155

7. Connect a complete breathing system including (if available) a humidifier and a Servo Ultra Nebulizer.

   Note: If a X Y Sensor with a X Y Sensor module is connected to the ventilator go direct to step 9.

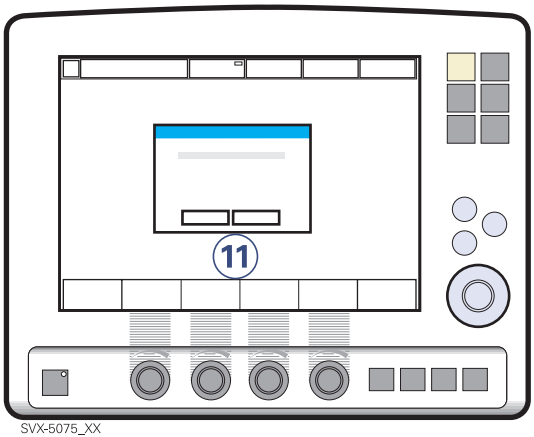
8. Block the Y-piece.

   Important: Make sure there is no leakage when blocking the Y-piece because a leakage will affect the circuit compliance compensation calculation.

9. Block the Y Sensor (if a X Y Sensor is connected) and follow the on-line instructions
10. Unblock the Y Sensor (if a X Y Sensor is connected) and follow the on-line instructions.

Note: Refer to page 178.

Compensate for circuit compliance



The circuit compliance is automatically measured.

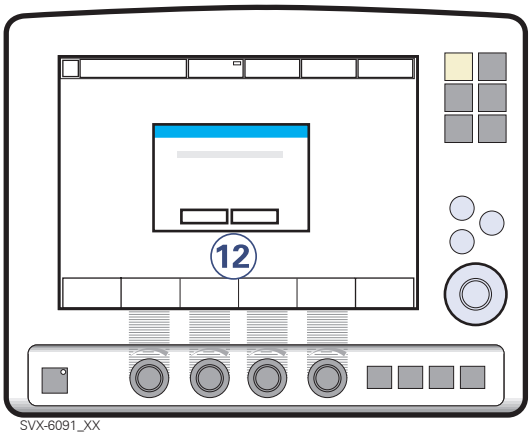
11. When *Compensate for circuit compliance?* appears on screen:
    - To add the compensation, press *Yes*.
    - To ventilate without compensation, press *No*.

If the patient tubing are replaced a new circuit compliance compensation must be performed.

Important: The circuit compliance compensation is not available in X NIV-modes.

Note: Considerable leakage may occur around the endotracheal tube if it is uncuffed. The combination of small tidal volumes, leakage around the tube and activated compliance compensation may trigger the Low Expiratory Minute Volume alarm, due to a very low expiratory flow passing from the patient through the expiratory channel. By observing the difference between the Vti and Vte values presented on the User Interface, a leakage can be detected and its extent easily controlled. The first time an unacceptably large leakage occurs around the tube, correct this problem to avoid triggering the Low Expiratory Minute alarm. If the leakage still persists, adjust the alarm limit right down to its lowest level (i.e. 10 ml) – if this step is clinically judged to be appropriate. Finally, if the leakage still has not been remedied, then deactivate the compliance compensation to avoid triggering the Low Expiratory Minute alarm. If the compliance compensation is deactivated from Pressure Control, Pressure Support or SIMV (Pressure Control) ventilation modes, then no further settings need to be adjusted. However, where volume-related modes are used, then the set volumes must be adjusted.

Alarm output connection option test

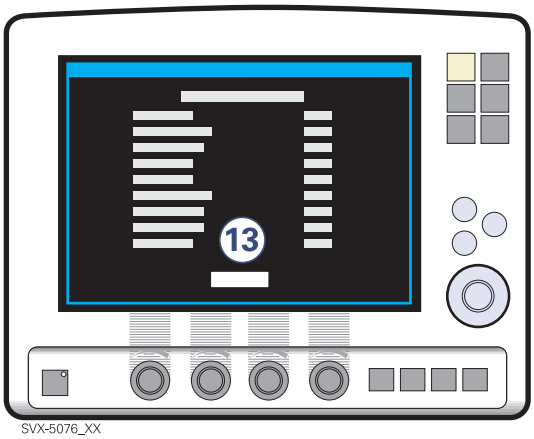


SVX-6091_XX

If the Alarm output connection option is installed a test of the external alarm function can be performed.

12. A dialog for the external alarm system test appears on the screen.
    - –To activate an alarm output signal, press *Yes* and follow the on-line instructions.
    - –To cancel the test, press *No*.

Complete the Pre-use check



SVX-5076_XX

A message is shown after each test case when the test is completed. Refer to page 218 for Pre-use check messages.

13. Press *OK* to confirm and to have the test logged. The ventilator now switches back to Standby mode.

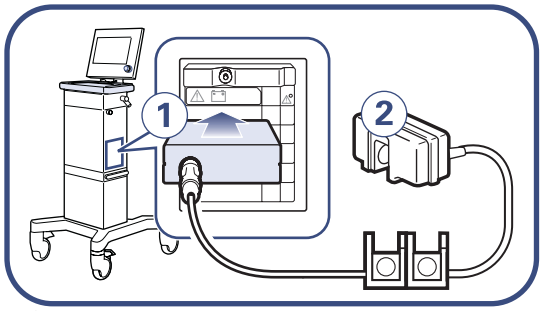
Note: After the Pre-use check is completed, a dialog will appear, asking if old patient related data shall be erased or kept.

Entering patient data

For more information about entering patient data refer to chapter 7, Operating your Servo-i.

CO_2 Analyzer calibration

Preparation



SVX-675_XX

1. Insert the CO_2 Analyzer into the module compartment of the Patient Unit.

   Note: The slots are numbered (1,2,3...) from top to bottom.

2. Connect the Capnostat sensor to the CO_2 Analyzer.

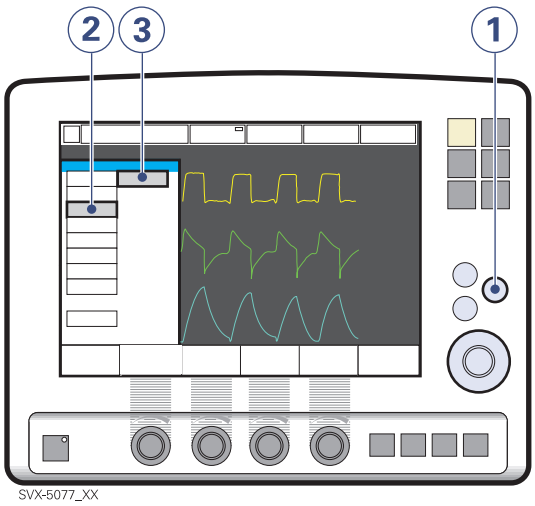
Note: The Capnostat sensor must be warm before calibration can begin. Values displayed during warm-up have reduced accuracy. If calibration is needed, the operator will be notified with a message.

Note: The *etCO_2 concentration low* alarm can be permanently silenced (Audio off) when the message *Silence alarm permanently?* is shown.

Important:

- During calibration no CO_2 waveforms or measured CO_2 values will be displayed.
- During adapter zero calibration the adapter must only contain room air.

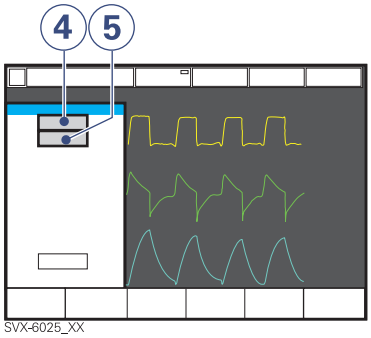
6 Calibration /CO_2 Analyzer Servo-i



There are 2 alternatives for calibration: Cell zero and Verification.

1. Press the fixed pad *Menu*.
2. Press the pad *Options.*
3. Press the pad *CO_2 calibration.*

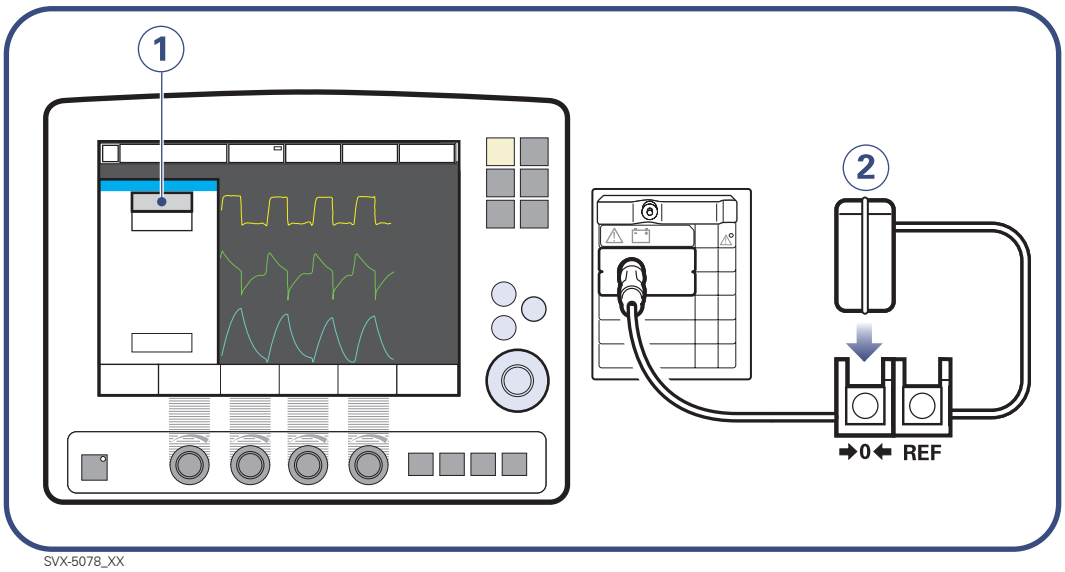
Contents of *CO_2 calibration* window:



4. *Cell zero:* The cell zero calibration is used when the Capnostat sensor has been shifted.
5. *Verification*: The verification calibration includes cell zeroing, verification against reference cell and adapter zeroing.

Note: The verification calibration is recommended. A verification should always be performed when the airway adapter is altered, if a faulty Capnostat sensor is suspected or when prompted. This ensures adequate measurements and calculations.

Cell zero

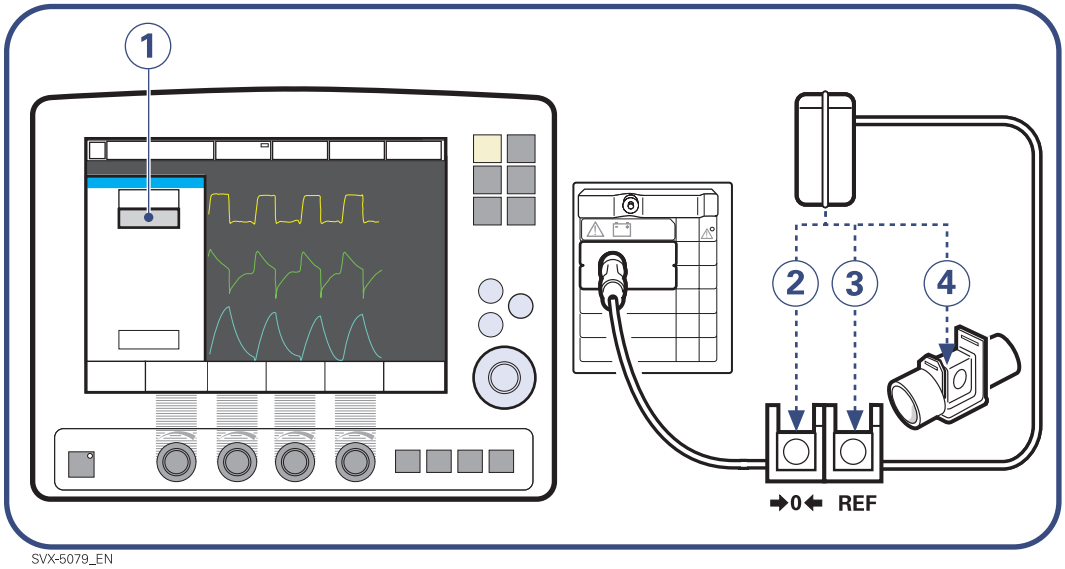


SVX-5078_XX

1. Select *Cell zero* if the Capnostat sensor has been shifted.
2. When instruction appears on screen: place the Capnostat sensor on the zero cell.

Note: For information about CO_2 calibration error messages refer to page 221.

Verification



SVX-5079_EN

1. Select *Verification* when the airway adapter is altered, if a faulty Capnostat sensor is suspected or when prompted.

When instruction appears on screen:

2. Place the Capnostat sensor on the zero cell.
3. When instruction appears on screen: Place the Capnostat sensor on the reference cell.

When instruction appears on screen:

4. Place the Capnostat sensor on a non-connected airway adapter, containing room air.

Note: For information about CO_2 calibration error messages refer to page 221.

Read more about the CO_2 Analyzer

Description:	page 116
Preparation:	page 137
Cleaning:	page 192
Troubleshooting:	page 221
Technical data:	page 232

Notes 6

6 Notes

7. Operating your Servo-i

Contents

7 Important

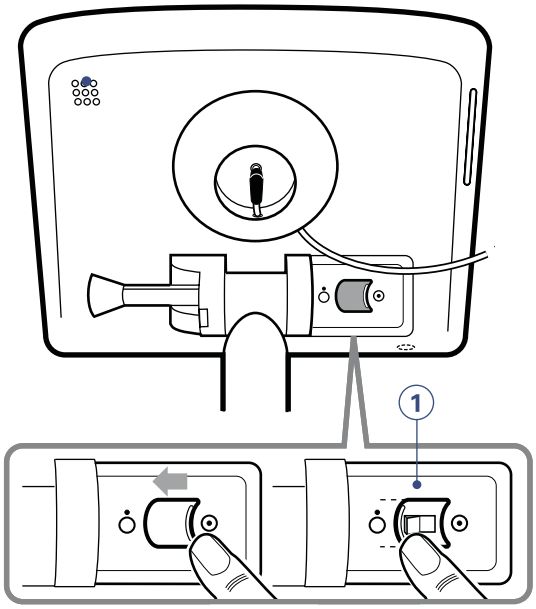
WARNINGS!

- A Pre-use check must always be done before connecting the ventilator to a patient.
- Always disconnect the ventilator if any operation which may involve risk for the patient will be done, e.g. replacement of O_2 cell.
- Should any unfamiliar events occur, such as irrelevant pop-up windows on the screen, unfamiliar sounds, alarms from the Patient Unit or technical high priority alarms, the ventilator should immediately be checked and, if applicable, replaced.
- Check continuously that the patient tubing, connectors and other parts/ equipment are properly connected.
- The Servo-i Ventilator System is not intended to be used with any anesthetic agent. To avoid risk of fire, flammable agents such as ether and cyclopropane must not under any circumstances be used with this device.

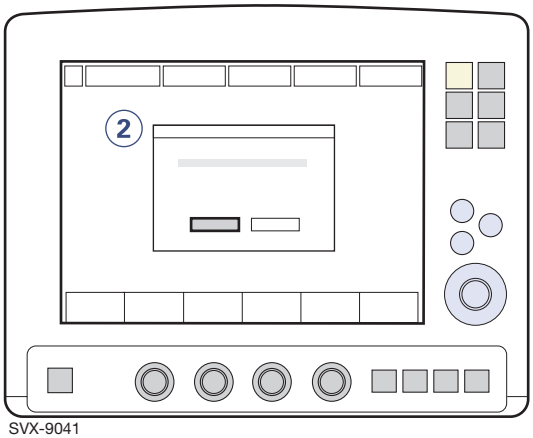
Cautions:

- When connected to a patient, the ventilator must never be left unattended.
- Before use, make sure the software version displayed under *Status* corresponds to the version of the User´s manual.
- Check the water traps regularly during operation and empty if necessary.
- Do not use sharp tools on the screen.
- For extra safety, a resuscitator should always be readily accessible.
- The Expiratory cassette must not be lifted up when the ventilator is in operation. (This may, however, be done when in Standby setting).
- Values measured at the signal outputs of the *Servo-i* Ventilator System and which have been processed in auxiliary equipment must not be used as a substitute for therapeutic or diagnostic decisions. Such decisions can be made only by staff with medical expertise, according to established and accepted practice. If auxiliary equipment that has not been manufactured by MAQUET is used, MAQUET denies all responsibility for the accuracy of signal processing.
- When combining the *Servo-i* Ventilator System with accessories and auxiliary equipment other than those recommended by MAQUET, it is the responsibility of the user to ensure the integrity of system performance and safety. In order to maintain electrical system safety, i.e. such that compliance with IEC 60601-1-1 is fulfilled, only accessories and auxiliary equipment that meet current IEC standards (e.g. IEC 60601-1, IEC 950) may be connected to signal inputs and outputs of the *Servo-i* Ventilator System.
- If there should be any deviation between information shown on the User Interface of the ventilator and that shown by the auxiliary equipment, the ventilator parameters shown on the User Interface shall be considered the primary source for information.
- When using closed system suctioning:
  - If the suctioning flow is higher than that which is delivered by the ventilator, a negative pressure may be generated which will be applied to the lung and the ventilator breathing system.
  - Do not use Inspiratory pause hold, or Expiratory pause hold during the closed suctioning procedure.

Important: When an active humidifier is used the measured expired volume may be larger than the inspired vapour, since gas volume expands when vapour is absorbed.



SVX-9026_XX



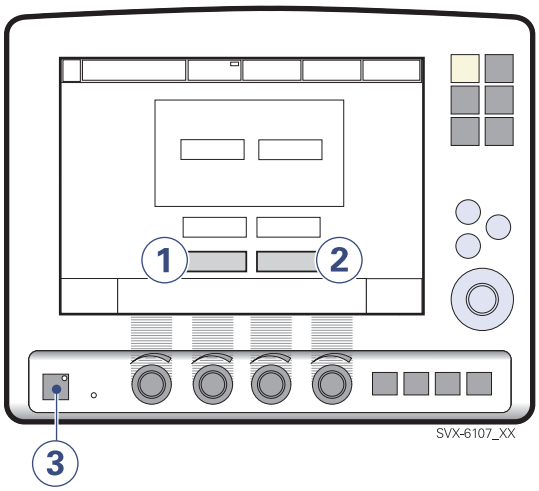
SVX-9041

1. Use the On/Off switch on the rear side of the User Interface to turn the ventilator to the on position. Starting the ventilation, refer to page 163.

   Note: The plug-in battery continues to charge when connected to the mains, refer to page 88.

2. Press *Yes* to perform a Pre-use check and follow the on-line instructions. Refer to page 145.

✗ Select type of ventilation



Select type of ventilation:

1. *Invasive ventilation* or
2. *NIV (Non Invasive Ventilation)*.

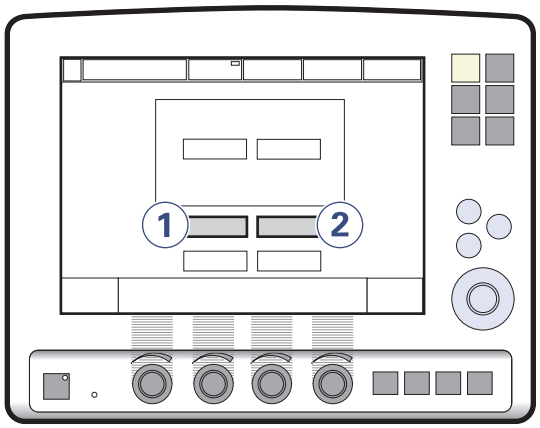
   Note: The background color on the touch pads is changed when NIV is activated.

3. Press the *Standby* key to start the ventilation. Refer to page 163.

This selection determines default values, alarm limits and operating ranges.

Note: The factory default values may have been changed in the Start-up Configuration.

Selecting patient category



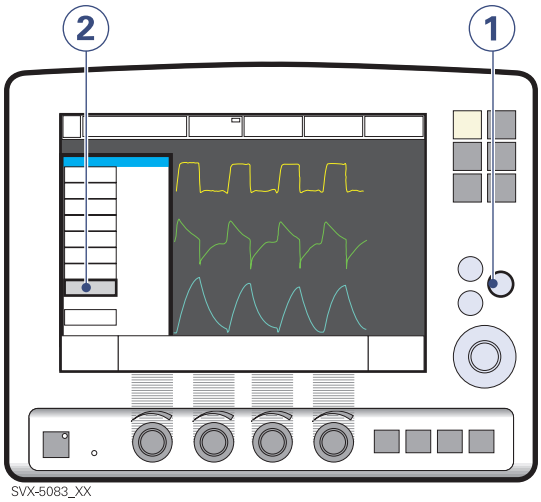
Select patient category:

1. *Adult* or
2. *Infant*.

This selection determines default values, alarm limits and operating ranges.

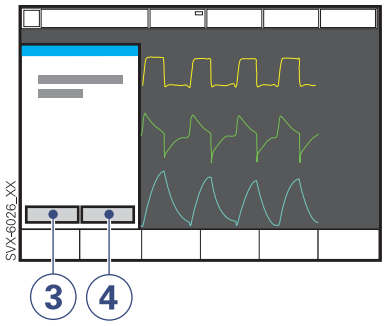
Note: The factory default values may have been changed in the Start-up Configuration.

Changing patient category



In running mode:

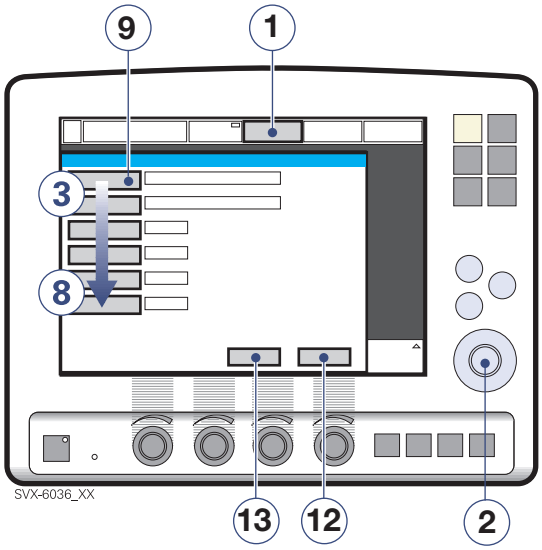
1. Press on the Menu pad
2. Press the *Change patient category* pad



3. Press *Yes* to continue or
4. Press *No* to stop.

Note: Always check the alarm settings after changing the patient category (refer to page 165).

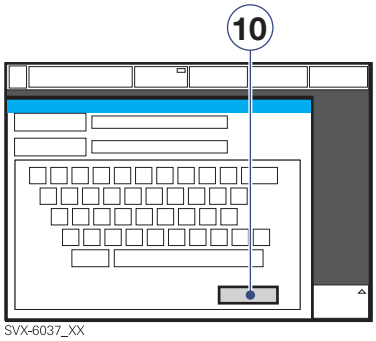
Entering patient data



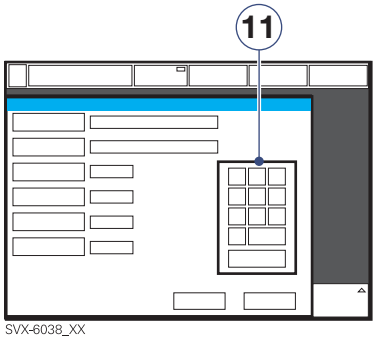
1. Press the *Admit patient* pad.
2. Values are adjusted by turning the Main Rotary Dial.

When activated you can enter/adjust:

3. Patient name
4. Identity number
5. Date of birth
6. Date of admission
7. Body height
8. Body weight
9. To enter the patient´s name press *Name*.



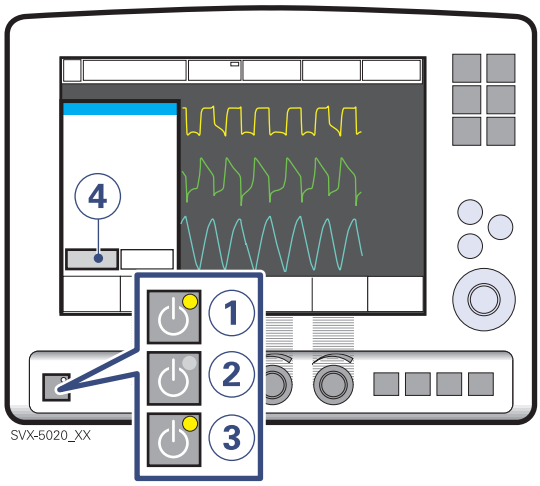
10. Press the pad *Close keyboard.*



11. When *ID* is activated, a keyboard is shown in the window for entering data.
12. To confirm press *Accept*.
13. If you want to cancel the information press *Cancel*.

Important:

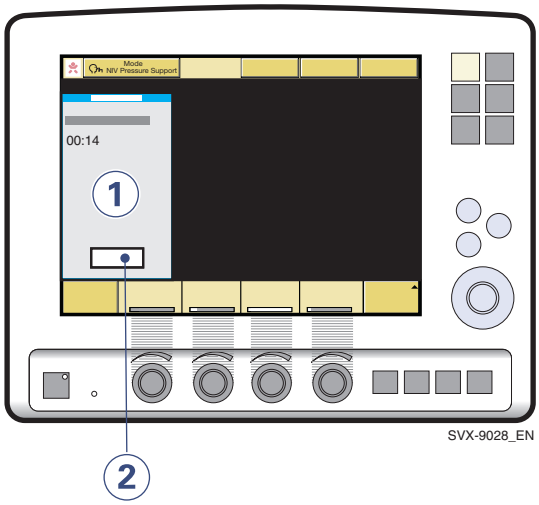
- For *Adult* the weight is in kilograms and for *Infant* the weight is in grams.
- Copy patient data before you enter a new name or ID, otherwise all previous patient data will be erased. (See “System transport and storage” on page 116.)



Start/Stop ventilation (Standby).

1. Standby:
   - Condition for warming up the ventilator electronics.
   - Condition after Pre-use check, ready to use.
2. Standby: push to start ventilation.
3. Stop ventilation, i.e. set to Standby:
   - Push the fixed Start/Stop ventilation (Standby) key.
4. Press on the *Yes* pad to stop ventilation.

NIV (Non Invasive Ventilation)



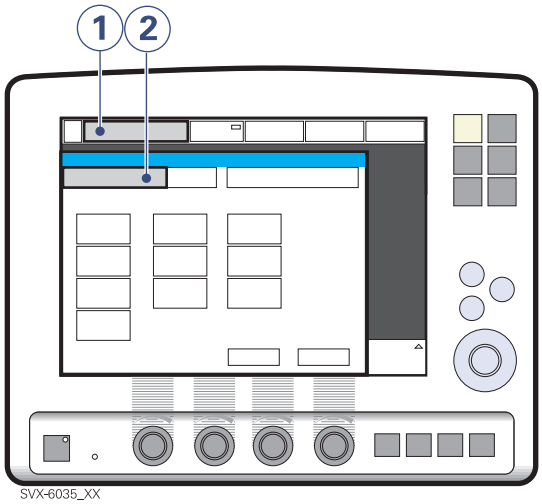
1. When the *Standby* key is pressed a waiting position dialog is shown.

   Note: All patient related alarms are turned off during 120 seconds.
2. Press *Start ventilation* pad to start the ventilation.

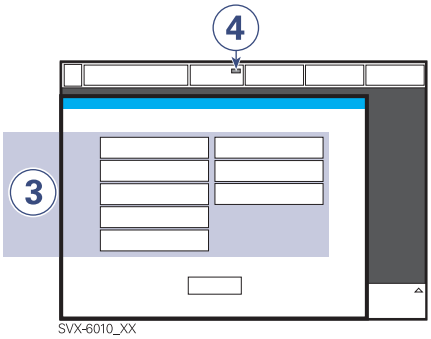
   Note: The ventilation also starts upon patient effort.

Read more about NIV

NIV ventilation	page 61
Alarms	pages 73, 76



1. Activate the pad *Mode*.
2. Press the arrow at the active *Mode* pad and available ventilation modes appear.

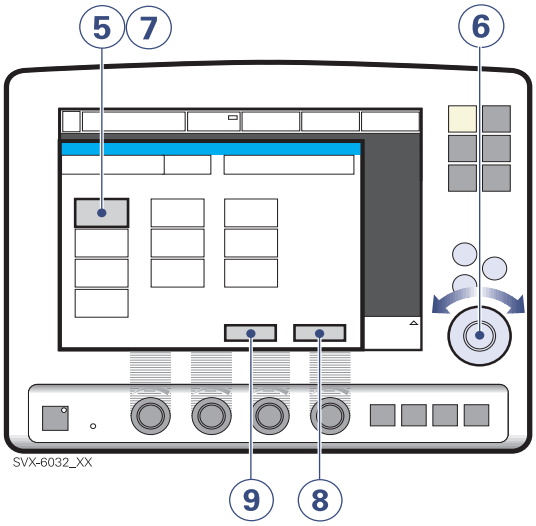


3. Press the touch pad for desired mode of ventilation.

   Note: In *NIV* (refer to page 160) only *NIV Pressure Support*, *NIV Pressure Control* and *Nasal CPAP* are available.

4. *Automode,* green indication in spontaneous breathing.

   Note: Automode is not available in NIV.

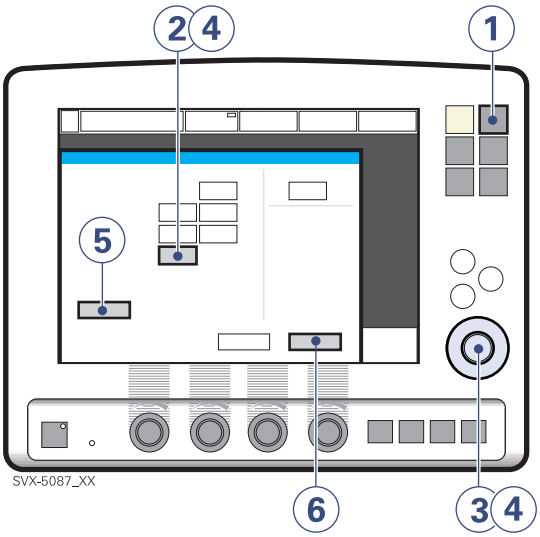


5. When you have selected another mode, all related parameters can be set in this window. You will also find related calculations in the window.
6. Values are adjusted by turning the Main Rotary Dial.
7. Confirm each setting by pressing the parameter touch pad.
8. To activate all settings in the window, press *Accept*.
9. To cancel the settings, press *Cancel*.

Read more about ventilation modes

Type of ventilation: page 160
Ventilation modes: pages 15

Showing Alarm profile



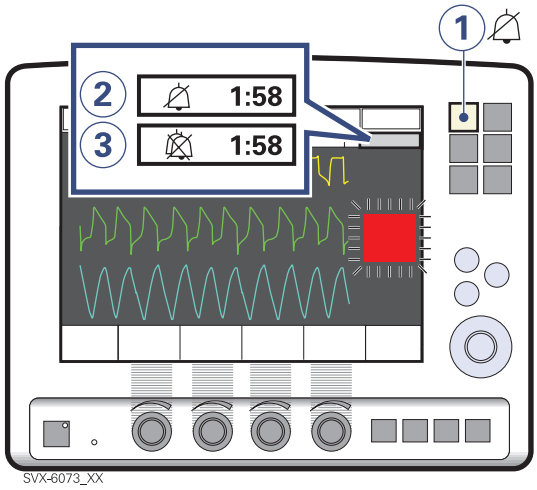
1. Press the fixed key *Alarm profile*.
2. Press the alarm limit you want to adjust or the sound level pad.
3. Turn the Main Rotary Dial to alter the value.
4. Confirm each setting by pressing the parameter touch pad (or pressing Main Rotary Dial).
5. Press *Autoset*, if desired, to get a a proposal for alarm limits in VC, PC and PRVC modes.

   Note: *Autoset* is not possible in Stand by mode as the function needs to get patient values in order to propose values from the calculated patient data. *Autoset* is only available in VC, PC and PRVC modes. When pressing *Autoset* make sure settings are appropriate for the patient. If not the settings must be set manually. Current alarm limits are also displayed during running mode, in smaller figures to the right of the display.

   Note: *Autoset* is not possible in ✗ *NIV* modes.

6. Activate by pressing *Accept*.

Audio pause(Silence/Pre-silence) alarms



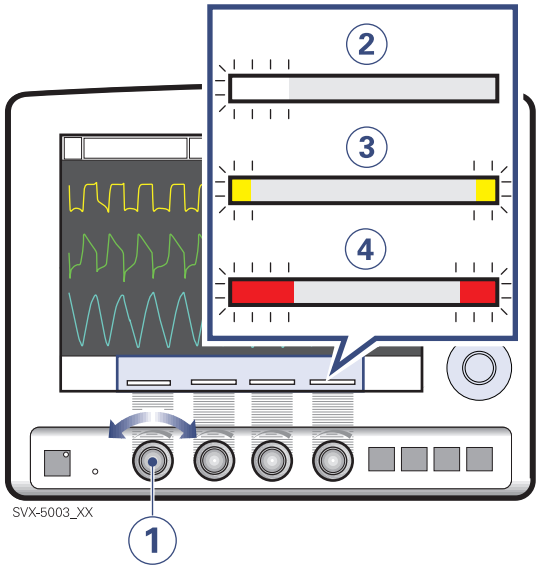
1. Silence or pre-silence (Audio pause) alarms for two minutes.
2. The Alarm Audio pause symbol is then shown, the remaining time. The high priority alarm *No battery capacity* cannot be silenced (Audio off).
3. When alarms are pre-silenced (except those which cannot be silenced) a symbol (Audio off) is shown as well as the mute time.

Note: Some of the alarms can be permanently silenced (Audio off). Refer to page 76.

Read more about the alarms

Patient safety:	page 71
NIV Alarm profile window	page 73
Autoset proposed values calculation:	page 244
Default values:	page 249
Keys and touch pads:	pages 268, 269

7 Initial settings - Direct Access Knobs

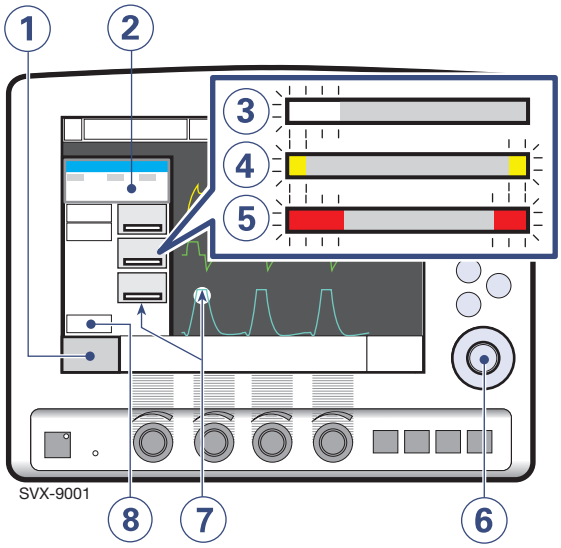


The four Direct Access Knob parameters are automatically selected depending on the active mode of ventilation.

1. Turn the knob to the desired value shown in the corresponding Set parameter box above the knob.
2. If the bar is white, the setting is within what is generally considered safe limits.
3. If the bar turns yellow, the setting is too low or too high compared to what are generally considered safe limits (advisory information).
4. If the bar turns red, the setting is significantly outside what are generally considered safe limits (advisory warning, accompanied by an audible signal and an advisory message).

When you come to a safety limit, the knob is inactive during 2 seconds. This is a safety precaution, intended to make you aware of that you have passed a safety limit.

When you turn a Direct Access Knob, ventilation will change accordingly. from the next breath without additional confirmation.

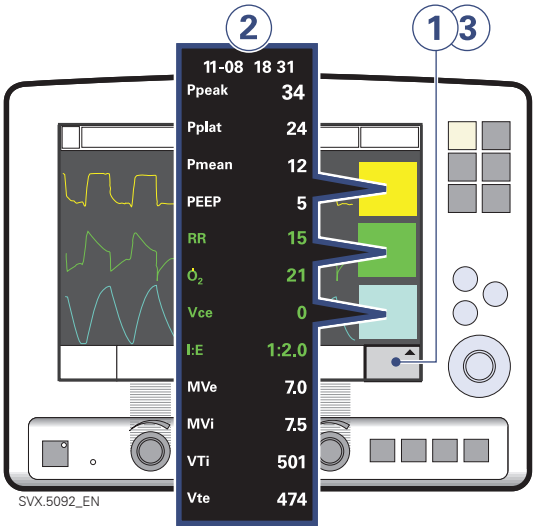


Shortcut for adjusting parameter values

1. Press the pad *Additional settings* to see all settings available. The settings are effective from the first breath after adjustment (when the touch pad is deactivated).
2. This field shows values derived from settings such as inspiration time in seconds and calculated inspiratory flow.
3. A white bar indicates that the setting is within generally considered safe limits.
4. If the bar turns yellow, the setting is beyond what is generally considered safe limits (advisory information).
5. If the bar turns red, the setting is significantly beyond what is generally considered safe limits (advisory warning, accompanied by an audible signal and an advisory message).
6. Values are adjusted by turning the Main Rotary Dial.
7. The waveforms and measured values are visible next to this window. Thus the effects of the adjustments made can be checked immediately.
8. To close window, press *Close*.

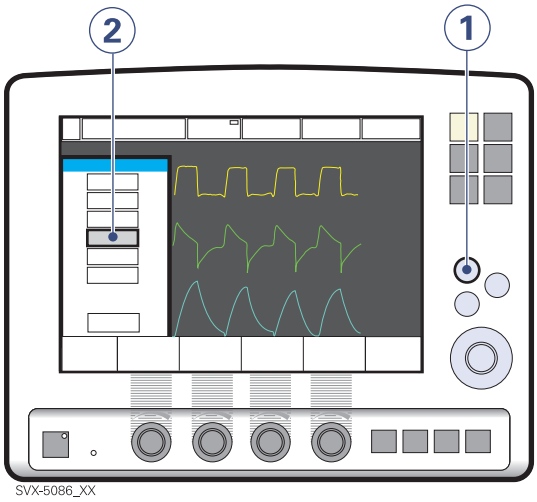
Note: The trigger sensitivity bar has different colors based on the setting. A green bar indicates a normal setting for the flow triggering. The risk of self-triggering increases when the bar is red. A white bar indicates that pressure triggering is required. Refer to page 23.

7 Initial settings - Additional values



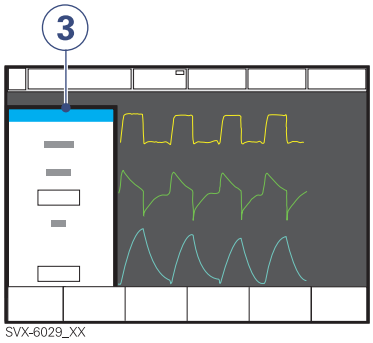
1. Press the *Additional values* pad.
2. Check desired values.
3. If desired, activate *Next page* for more additional values.

   Note: In NIV only one page of additional values is shown. In Nasal CPAP there is no additional value page available.



Waveform configuration: Makes it possible to increase the space for viewing the pressure – flow waveforms.

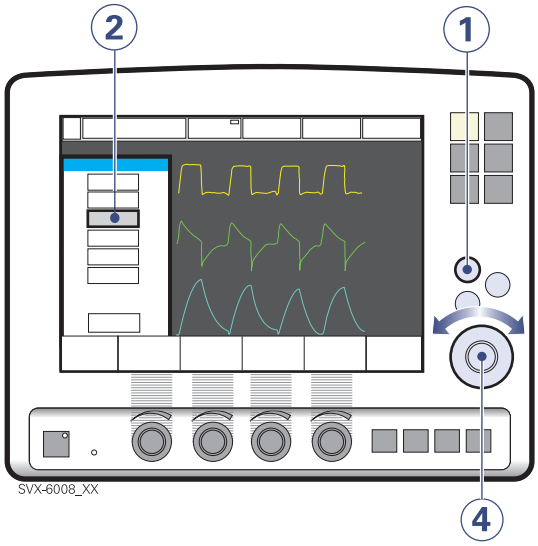
1. Press the fixed key *Quick access.*
2. Press the *Waveform configuration* pad



3. Press the touch pad for desired waveform to display or turn off.

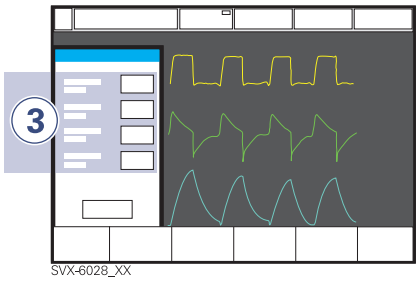
The Pressure waveform and the Flow waveform are mandatory, but the Volume and the CO_2 waveforms (If ɤ CO_2 Analyzer is connected) can be displayed/hidden independent of each other.

Adjusting waveforms scales



Scales: Set sweep speed and amplitude for displayed waveforms (auto scale is possible).

1. Press the fixed key *Quick access.*
2. Activate *Scales*.



3. Press the touch pad for desired waveform or sweep speed (6, 10 or 20 mm/s)
4. Turn the Main Rotary Dial to the desired value or use auto scale (*Auto*)

– To adjust another waveform repeat steps 3) to 4).

– To adjust the time scale, repeat steps 3) to 4) for the sweep speed (mm/s).

Note: It is not recommended to use *auto scale* in Bi-Vent mode, when patient is breathing spontaneous on both levels.

This function makes it possible to automatically inhibit the ventilator from cycling during a tracheal suction procedure without disturbing alarms.

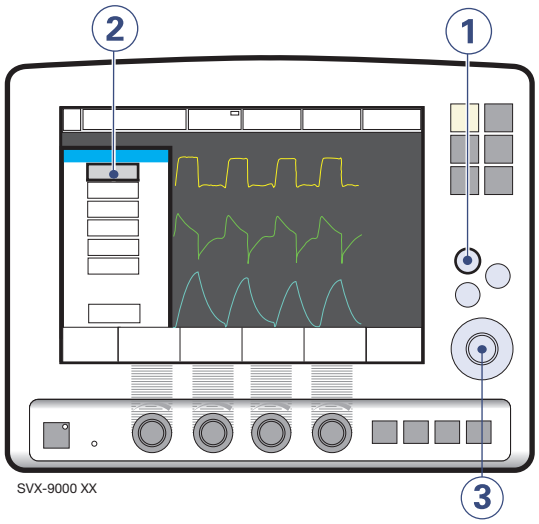
WARNING! Suction Support is not intended to be used together with closed suction systems.

WARNING! Minimum PEEP level during suction support is 3cmH_2O. The Servo-i system will adjust to minimum level if the PEEP level is below 3cmH_2O, in order to detect disconnect of the patient.

Note: Suction Support is not available when NIV or *O_2 Breaths* is activated.

Suction Support phases

Suction Support includes the following phases: Preparation, Disconnect and Post oxygen



1. Press the fixed key *Quick access.*
2. Press the *Suction Support* pad.
3. Set the pre-oxygen value by turning the Main Rotary Knob.

   Note: When only one gas is connected no elevated oxygen level can be set. Post-oxygen phase is excluded in this case.

   Note: The *Cancel* pad will close down the Suction Support program.

Preparation phase

The user has 120 seconds for preparation before the ventilator automatic returns to ventilation with previous oxygen setting. The ventilator will stop cycling and enter the disconnect phase if the patient is disconnected during the preparation phase.

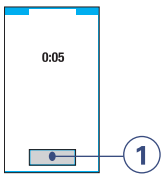
During the preparation phase the *Check tubing* alarm is turned off.

Disconnect phase

During the disconnect phase the following alarms are turned off:

- Apnea
- Minute volume
- Frequency alarm
- $EtCO_2$
- PEEP.

The ventilator will start cycling and enter the post-oxygenation phase at reconnection or manually by the user, see below.



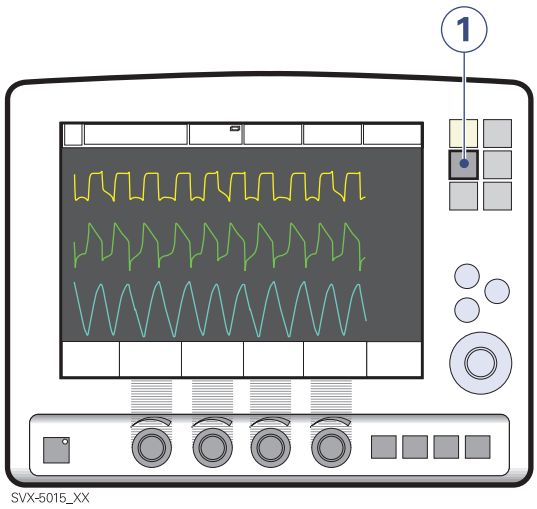
1. Press *Start ventilation* pad to start the ventilation manually.

Note: During the disconnect phase in Suction Support the nebulizer is temporarily paused.

Important: If the patient has not been reconnected within 60 seconds, all alarms are activated.

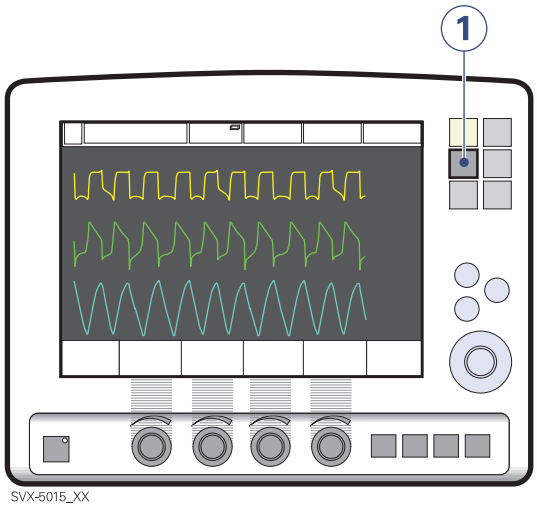
Post-oxygen phase

After reconnection the ventilator will deliver the same oxygen concentration as in the preparation phase. After 60 seconds the oxygen concentration automatically returns to the previous set value.



1. The fixed key *Save* can be used either to
   – save one recording or
   – Copy screen on a Ventilation record card.

   Note: Copy screen only possible if a Ventilation record card is inserted.

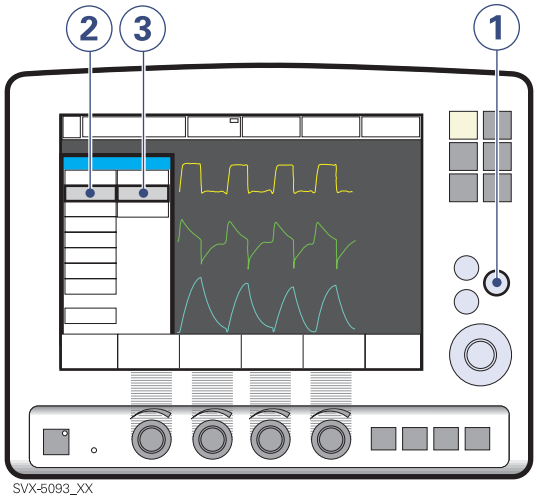


To save one recording of the current waveform and parameter values:

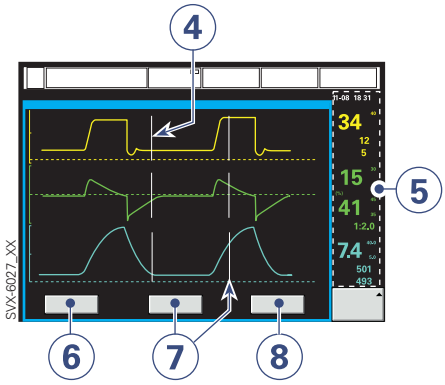
1. Press the fixed key *Save*. 20 seconds of data will be recorded (10 seconds before activated key and 10 seconds after.

   Note: If the key *Save* is pressed again the previous recording will be erased. The previous recording will also be erased if *Admit patient* is used.

Recorded waveforms



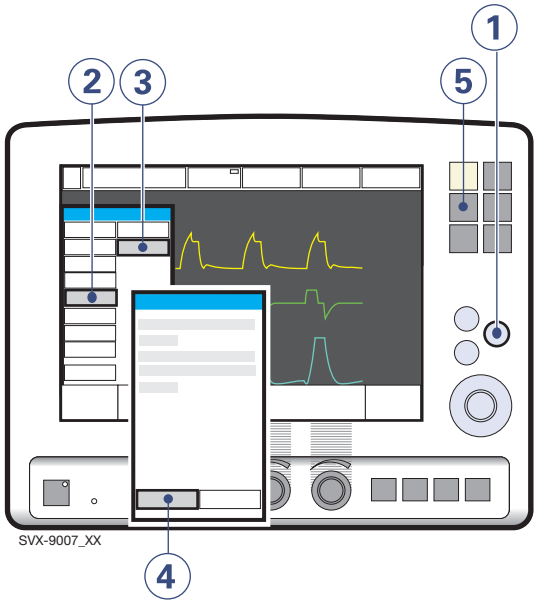
1. Press the fixed key *Menu*
2. Press the *Review* pad
3. Press the *Recorded waveform* pad.



4. Vertical grey lines indicates the time when the *Save* key was pressed.
5. Measured/calculated values are shown next to the line.
6. *Settings*: opens a list of parameter settings (used at the time *Save* pad was activated).
7. *Cursor*: activates an extra, moveable cursor line (adjusted using the Main Rotary Dial.
8. To quit the recorded waveform window press the pad *Close*.

Ventilation record card

Copy screen



To make a copy of the screen a Ventilation record card must be inserted and the *Save* key must be configured. It is possible to copy data (refer to page 174) to the same Ventilation record card.

Insert the Ventilation record card. Refer to page 140.

1. Press the fixed key *Menu*.
2. Press the *Copy* pad.
3. Press the *Copy screen* pad.

Insert the Ventilation record card. Refer to page 140.

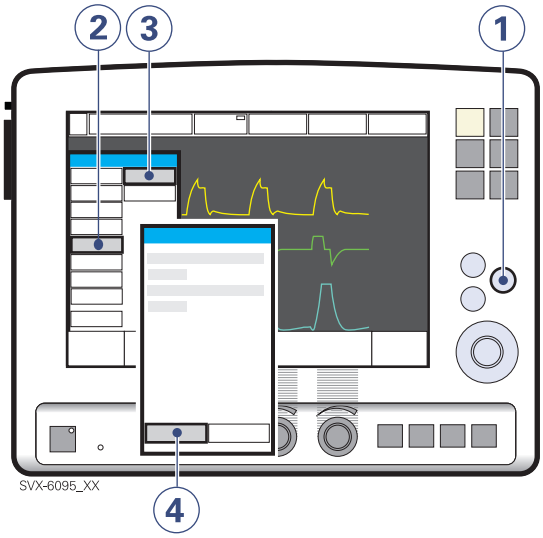
4. Press *OK* to continue
5. Press the fixed key *Save* to make a copy of the screen on the Ventilation record card.

   Note: To make a new screen copy, press the *Save* key again.

When the Ventilation record card is removed or the ventilator is restarted the *Save* key is reconfigured to save a recording. Refer to page 172.

✗ Ventilation record card

Copy patient data



1. Press the fixed key *Menu*.
2. Press the *Copy* pad.
3. Press the *Copy data* pad.

Insert the Ventilation record card. Refer to page 140.

4. Press the *Copy data* pad. The following data is copied:
   - Event log
   - Trends
   - Recordings
   - OLT data

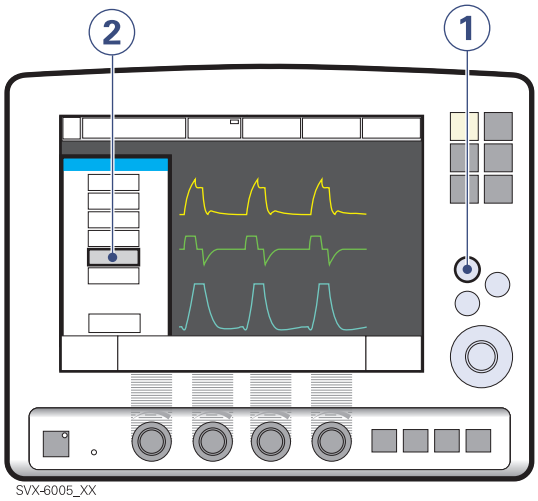
   Included in all data files are patient name and ID, ventilator serial number and pre-use check status.

Remove the Ventilation record card. Refer to page 140.

Read more about the Ventilation record card

Description:	page 114
Insert/remove card:	page 140
Technical data:	page 246

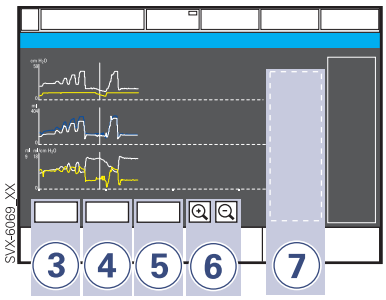
Showing Open Lung Tool



Open Lung Tool for continuous, breath-by-breath graphical presentation of changes in End inspiratory pressure, PEEP, V_T, Dynamic compliance and tidal CO_2 elimination (when ✗ CO_2 Analyzer module is installed).

1. Press the fixed key *Quick access*.
2. Press the *Open Lung Tool pad*.

Note: When the ✗ Y Sensor Measuring function is active, then the values recorded in the Open Lung Tool are based on values measured at the Y-piece. Note that when this function is disabled or enabled, then the compliance in the patient circuit may cause the values in the Open Lung Tool to change.



3. Activate *Cursor* to be able to analyze the stored breath by breath data. This may assist in identifying opening and collapse pressures of the lung.

   – To move the cursor use the Main Rotary Dial or touch screen

   Note: If the *cursor* pad is activated the cursor values will be shown in the value field

4. To clear all waveforms press *Clear* pad.

   Note: The clear pad is not active in *Cursor* mode.

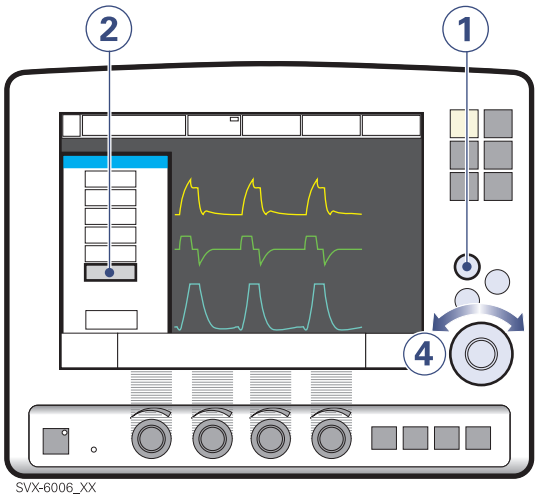
5. To close the window, press *Close*.
6. Use these pads to alter the resolution on the time axis.
7. Real time value field.

Note: If additional windows such as loops are activated, the Open Lung Tool window will be minimized and some function buttons will not be visible.

Note: Open Lung Tool is not available in Bi-Vent and NIV-modes.

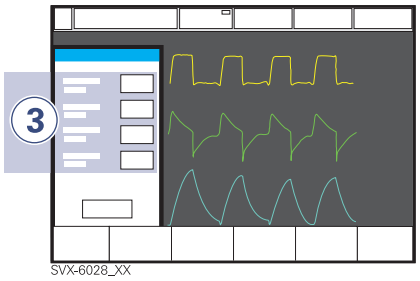
7 Operating - Open Lung Tool scales

Adjusting scales



Open Lung Tool Scales: Set amplitude for displayed waveforms (Auto set possible).

1. Press the fixed key *Quick access*.
2. Press the *Open Lung Tool scales* pad.



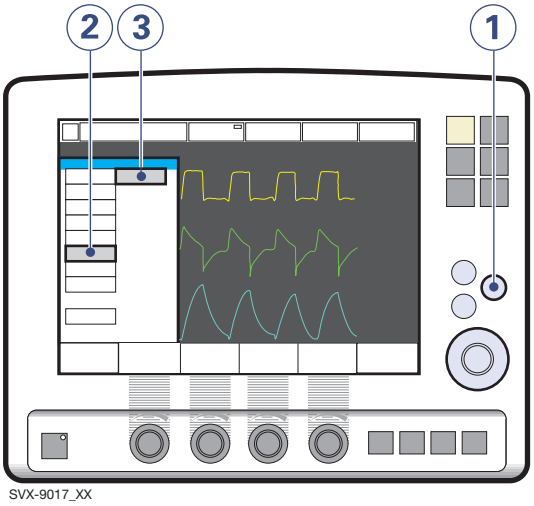
3. Press the touch pad for desired waveform.
4. Turn the Main Rotary Dial to the desired value.
   – To adjust another waveform repeat steps 3) to 4).

   Note: Out of range values will be indicated by a flashing set max value.
5. For more information about Open Lung Tool refer to page 65.

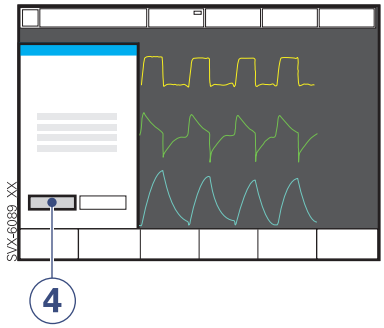
O_2 cell adjustment

If the ventilator has continually been in use for a long time, the measured O_2 concentration may drop due to normal degradation of the O_2 cell. In order to avoid nuisance alarm in this situation, it is possible to temporarily adjust the reading of the O_2 concentration during ventilation. By activating this function, the measured O_2 concentration will be adapted in relation to the set O_2 concentration. This adjustment will only be valid until the ventilator is switched off.

Note: Pre-use check is recommended to use to calibrate the O_2 cell.



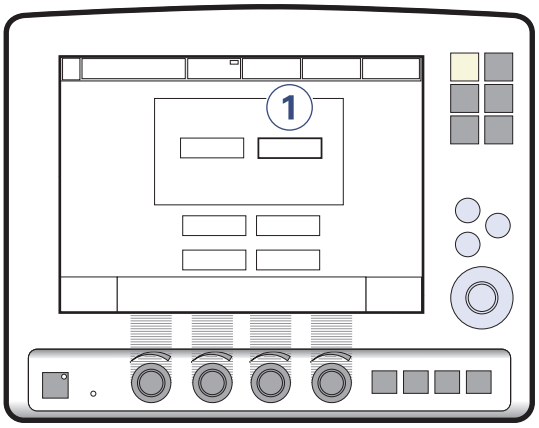
1. Press the fixed key *Menu*
2. Press the *Biomed* pad
3. Press the *O_2 cell adaptation* pad



4. Press the *Yes* pad to perform the O_2 cell adaptation.

Patient circuit test

In Standby mode the patient circuit can be tested separately from the Pre-use check, for example when either changes are made to the circuit, or additional accessories are connected. The test evaluates circuit leakage and measures the circuit compliance.



SVX-9042

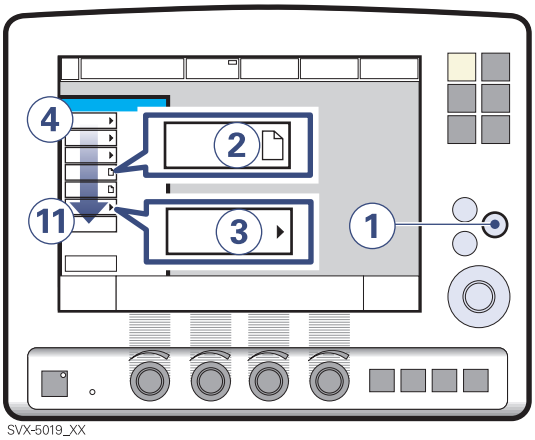
1. Press *Patient circuit test* pad and follow the on-line instructions.

Note: Refer to page 145 for information about the Pre-use check.

WARNING!

- A Pre-use check must always be done before connecting the ventilator to a patient.
- The separate Patient circuit test which can be performed in Standby (refer to page 178) does not replace the Pre-use check.

Menu



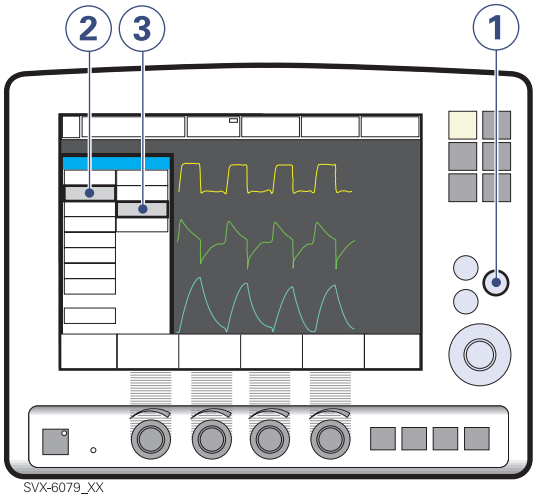
1. Press the fixed key *Menu*.
2. A sheet icon indicates that there are no submenus. You will go directly to a window.
3. An arrow indicates submenus.

Contents of sub menus

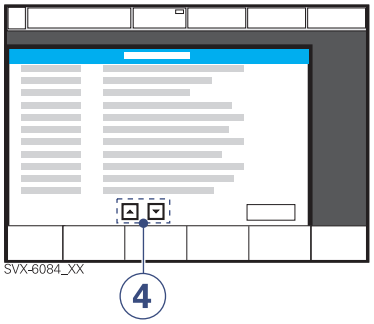
4. *Alarm*: (refer to pages 71, 165)
   - *Profile*
   - *History*
   - *Mute*
5. *Review*
   - *Trends (refer to page 181)*
   - *Recorded waveform (refer to page 171)*
   - *Event log (refer to page 180)*
   - *View configuration (refer to page 184)*
6. *Options (refer to page 151)*
7. *Circuit compliance compensation* (refer to pages 86, 149, 229)
8. *Copy* to Ventilation record card (refer to pages 173, 174)
9. *Biomed* (refer to pages 177, 268, 269)
10. *Panel lock* activates panel lock, e.g. during transportation
11. ✗ *Change patient category* (refer to page 161)

7 Monitoring - Event log

Showing Event log

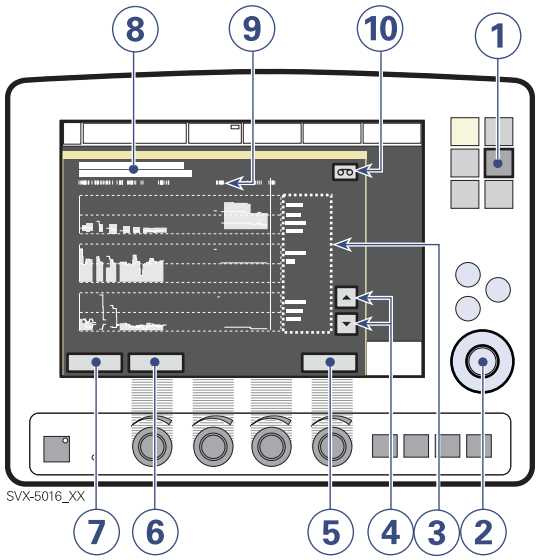


1. Press the fixed key *Menu*
2. Press the *Review* pad
3. Press the *Event log* pad to view all logged events.



4. Use the arrows to scroll list.

Showing trends



Shows previous trend recordings for up to 24 hours. Values are stored every 60 seconds. Stored events and system changes such as a completed Pre-use check, are shown as event stamps on screen.

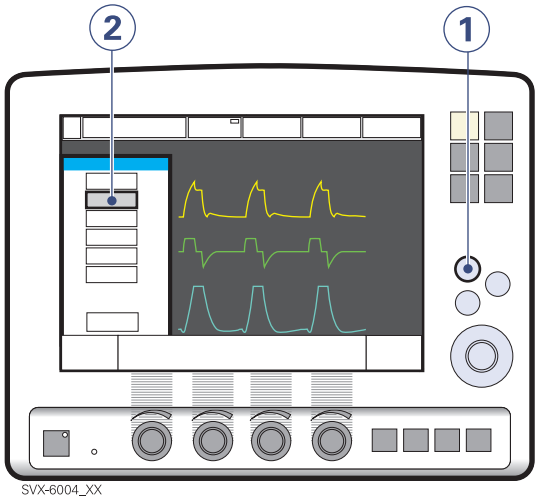
1. Press the fixed key *Trends*.

   Note: The trend window can also be reached via the *Menu* / *Review* window.
2. Values are adjusted by turning the Main Rotary Dial.
3. Area where trended measured values are shown.
4. Use the up and down arrows to scroll between the trend graphs.
5. To quit the trend window press the pad *Close.*
6. Use the *Hours* button to alter the resolution on the time axis (alter with the Main Rotary Dial).
7. When activating the *Cursor*, a vertical cursor line is shown. Move it back and forth on the time axis using the Main Rotary Dial or touch screen.
8. Time, type of event and ventilation mode. Time valid for the cursor position is shown. When the cursor is on an event stamp, the event is explained in the event box.
9. Logged event stamps.
10. If a recording is saved at a time corresponding to the cursor position, a recording button is shown. To see the recording, press the button.

Stored measured values

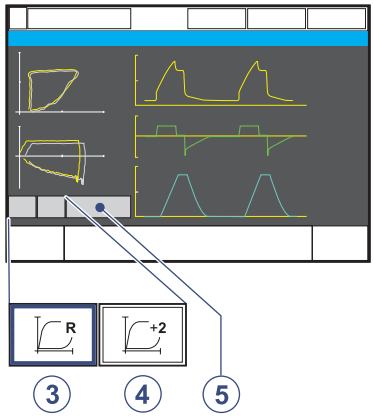
A list of stored measured values can be found in the chapter Technical data / Trend function (refer to page 245).

Showing loops



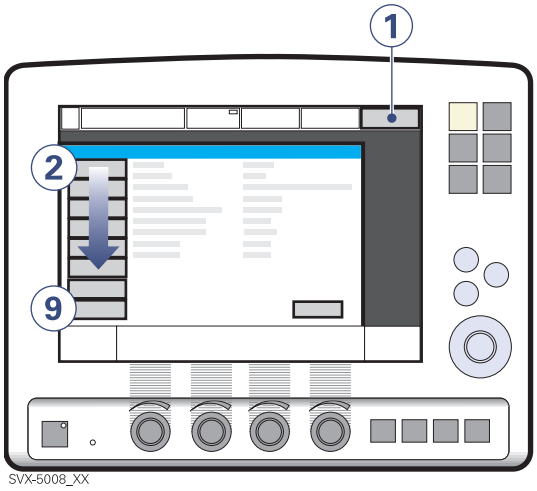
Loops for a graphical presentation of the relationship flow-volume and pressure-volume.

1. Press the fixed key *Quick access*.
2. Press the *Loops* pad.



3. Press [R] *[Reference loop]* to store a reference loop. Time for the reference loop is shown above the pad.
4. Press [+2] [Overlay loops] to see the two previous loops and present loop simultaneously.
5. To close the window, press *Close*.

View status



When the ventilator is running on AC power an indication is shown in the *Status* pad.

Battery indication when the ventilator is running on the battery. Estimated remaining battery capacity time with current power consumption is shown in minutes in figures.

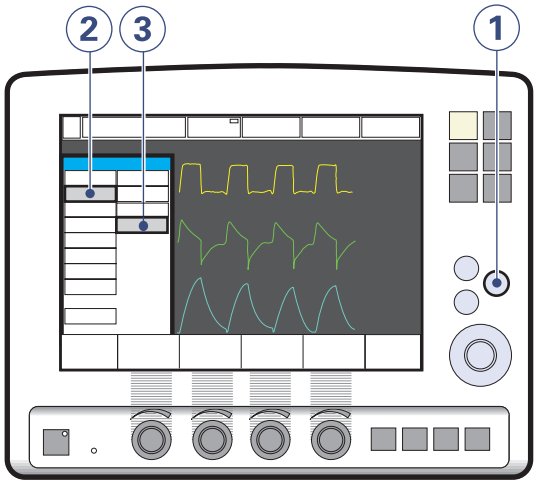
External 12V indication when the ventilator is running on external 12V DC.

Caution: When external +12 V DC is used, at least one installed Battery module is required to ensure proper operation.

1. Press the *Status* pad
2. General system information
3. Status of O_2 cell / O_2 Sensor
4. Status of Expiratory cassette
5. Status of Batteries
6. Status of ✗ CO_2 module (if available)
7. Status of ✗ Y Sensor measuring (if available)
8. Installed options
9. Status of Pre-use check

7 Monitoring - View configuration

View configuration



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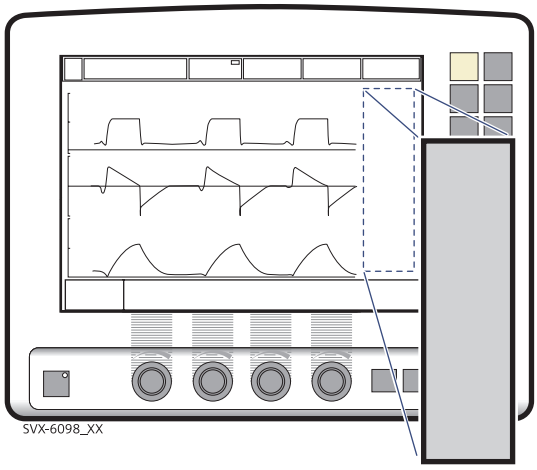
1. Press the fixed key *Menu*
2. Press the *Review* pad
3. Press the *View configuration* to system configuration:
   - –General
   - –Units
   - – Invasive ventilation Adult alarm limits
   - – Invasive ventilation Infant alarm limits
   - – Displayed values
   - – NIV adult alarm limits
   - – NIV infant alarm limits
   - –Start-up Configuration

Shown measured values

Default variables in **boldface**.



In the highlighted area the following measured values are shown.

Ppeak	Maximum inspiratory pressure
Pplat	Pressure during end-inspiratory pause
Pmean	Mean airway pressure
PEEP	Total positive end expiratory pressure
CPAP	Continuous Positive Airway Pressure (NIV Nasal CPAP only)
RR	Respiratory Rate
O_2	Oxygen concentration in vol.%
Ti	Inspiration time
Tc	Time constant
I:E	Inspiration to expiration ratio (only during controlled ventilation)
Ti/Ttot	Duty cycle or ratio of inspiration time to total breathing cycle time (only during spontaneous breathing) and Bi-Vent ventilation.
MVe sp	Spontaneous expiratory minute volume (Bi-Vent)
MVe sp / MVe	The relation between spontaneous expired minute volume and total expired minute volume (only applicable in Bi-Vent).
MVi	Inspiratory Minute Volume
MVe	Expiratory Minute Volume
Leakage	Leakage (%) (NIV)
VTi	Inspiratory Tidal Volume
VTe	Expiratory Tidal Volume
$\dot{V}ee$	End expiratory flow
O_2	Measured Oxygen concentration
$etCO_2$	End tidal carbon dioxide concentration (✗ CO_2 Analyzer)
$\dot{V}$**CO_2**	Volume of expired CO_2 per minute. (✗ CO_2 Analyzer)
$VTCO_2$	CO_2 tidal elimination. (✗ CO_2 Analyzer)
Cdyn	Dynamic characteristics
Cstatic	Static compliance, respiratory system
E	Elastance
Ri	Inspiratory resistance
Re	Expiratory resistance
WOB v	Work of breathing, ventilator
WOB p	Work of breathing, patient
P0.1	Indicator for respiratory drive.
SBI	Shallow Breathing Index

7 Nebulization

✗ Servo Ultra Nebulizer

WARNINGS!

- Servo Humidifier/HME must be disconnected during nebulization. Otherwise the humidifier may be blocked.
- The heated humidifier must be switched off during nebulization. Otherwise the particle size may be affected.
- When a Servo Ultra Nebulizer is used, always consult the drug manufacturer regarding the appropriateness of ultrasonic nebulization for certain medications.
- The nebulizer must not be used without buffer liquid (sterile water). Otherwise the ultrasonic generator crystal may break.
- Continuously check that the buffer liquid level is between MIN. and MAX. during nebulization.
- During nebulization: Continuously check that moisture is generated in the medication cup.
- During nebulization a filter must be connected to the expiratory inlet of the ventilator. Always carefully monitor the airway pressure during nebulization. Increased airway pressure could be caused by a clogged filter. The filter should be replaced if the expiratory resistance increases or every 24 hours when the nebulizer is being used.
- When the ventilator is running on batteries the nebulizer module is inoperative to reduce the power consumption.

Cautions:

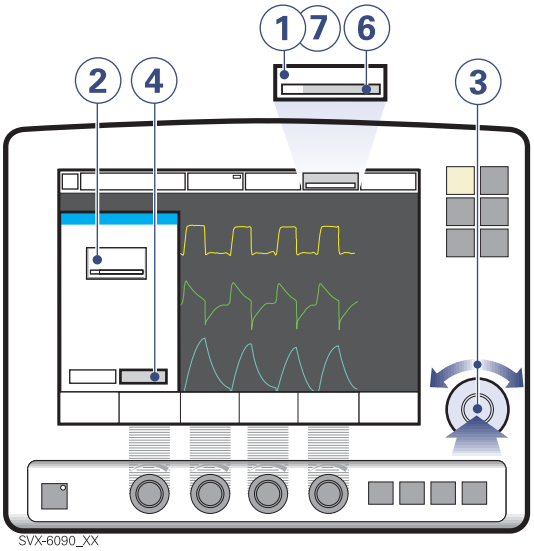
- Check that the medication cup is undamaged and that it is firmly in place before the nebulizer is started.
- If a nebulizer and a CO_2 analyzer are in use simultaneously, the CO_2 reading may be affected.

Important: The Servo Ultra Nebulizer may be interrupted shortly due to overheating. It will automatically start again when the buffer water has cooled. During this short period of time no alarm is activated and the timer is not interrupted.

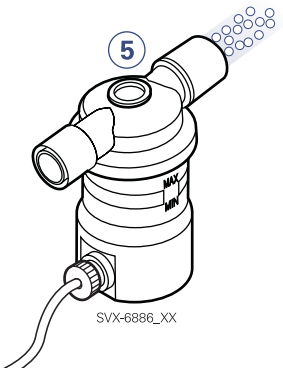
Note: For information about the stand alone Aeroneb Professional Nebulizer System, refer to separate manual.

Note: The ✗ Y Sensor measurement can be incorrect when the Aeroneb Professional Nebulizer System is in use. Therefore, we recommend that the Y Sensor is removed from the patient circuit during nebulization.

Nebulization On/Off



1. Press the *Nebulizer* pad.
2. Press the *Time* pad.
3. Set the time by using the Main Rotary Dial.
4. To accept the time, press *Accept*.



5. Check that medication mist is produced.
6. During nebulization the remaining time is indicated.
7. The *Nebulizer* pad is shown as a bar with the remaining nebulizing time. Press the Nebulizer pad to change the time or cancel the operation.

Read more about the Servo Ultra Nebulizer

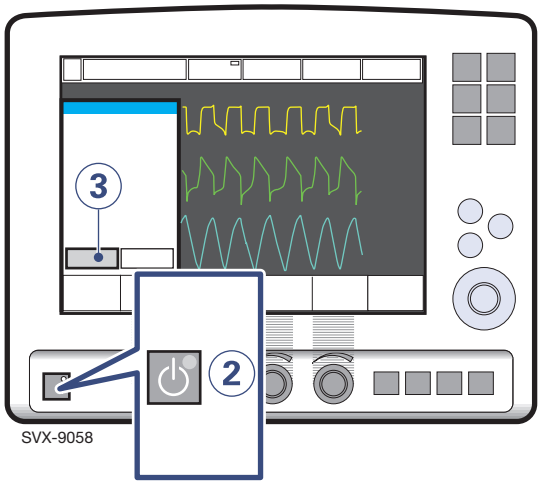
Description:	page 102
Breathing systems:	page 120 - 122
Preparations:	page 128
Cleaning:	page 205
Technical data:	page 246

7 Disconnect the patient

Disconnecting from the patient

When adequate breathing capability without the ventilator is ensured:

1. Disconnect the patient.



2. Press Standby.
3. Press on the *Yes* pad to stop ventilation.
4. Set the ventilator to Off.

   Use the On/Off switch on the rear side to turn the ventilator to the off position (refer to page 159.)The plug-in battery continues to charge when connected to the mains.

Notes 7

7 Notes

8. Routine cleaning

Contents

8 Hygiene

The gas that passes into the ventilator´s inspiration system also passes an inspiratory filter and is usually clean and dry.

Caution:

- All personnel should be aware of the risk of parts being infected when disassembling and cleaning the ventilator.
- All disposable parts must be discarded according to hospital routine and in an environmentally safe way.

Important:

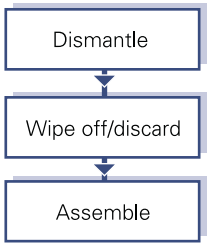
- Bacteria from the patient will appear in the moist environment of the expiration side. MAQUET recommends the use of Servo Guard bacteria filter to reduce the transmission of bacteria from the patient via the expiratory channel to the Expiratory cassette. By using the recommended filter the need for regular cleaning is reduced, which consequently would result in a prolonged lifetime of the expiratory cassette. By regularly replacing the bacteria filter, the risk of infection being spread to the staff and the risk of cross infection between patients are reduced.
- Sterilization is normally not necessary for the expiratory cassette but when applied use validated processes only.
- Autoclaving will reduce the lifetime of the cassette. Lifetime reduction is greater for autoclaving in prolonged cycles (> 4min) at 134 °C (273 °F).
- Cleaning routines for the Fisher & Paykel humidifier are described in a separate operating manual.
- Cleaning routines for the Aeroneb-Pro (Aeroneb professional Nebulizer system) are described in a separate operating manual.
- The single use Y Sensors (Adult/Neonatal) is supplied NON-STERILE in a plastic bag. The Y Sensor can be sterilized before use by EtO or radiation using normal hospital procedures.
- When handling any part of the Servo-i Ventilator System, always follow your hospital‘s guidelines for handling infectious material. Since cleaning, sterilization, sanitation, and disinfection practices vary widely among health care institutions, it is not possible for MAQUET to specify on particular practices that will meet all needs, or to be responsible for the effectiveness of cleaning, sterilization, and other procedures carried out in the patient care setting. MAQUET recommends methods that have been validated using the specified equipment and procedures outlined in this manual. Other methods may work but are not covered by the warranty unless MAQUET has given written permission.
- The result of cleaning/disinfection can be affected by the quality of water. MAQUET recommend drinking water as minimum quality level.
- The most critical step in cleaning/ disinfection is cleaning. It is impossible to disinfect or even thermally sterilize an inadequately cleaned instrument. The reduction of bioburden by cleaning is key to a good result. Whenever possible cleaning shall be performed immediately after use. Foreign particles such as saliva or blood should not be left to dry on the devices. Bacteria filters such as Servo Guard can be used to protect the Expiratory cassette from contamination, a practice recommended by MAQUET. If filters are used and the stated replacement interval for the filter is observed, the only cleaning needed is wiping the exterior. If bacteria filters are not used, MAQUET recommends using medical dish disinfectors for cleaning/disinfection.

The expiratory cassette

- When using an external bacterial filter the only cleaning needed is wiping the exterior.
- Rinsing the cassette in water (<35°C/95°F) immediately after use may be a useful alternative to disinfection. Immediate rinsing increases the probability of removing particles and minimizes the risk of cross contamination between patients.
- After processing, always make sure that the cassette is dry. If not, the cassette may fail the Pre-use check.
- Never dry the cassette by applying high-pressure air. Internal tubing may be damaged.

Recommended cleaning procedure

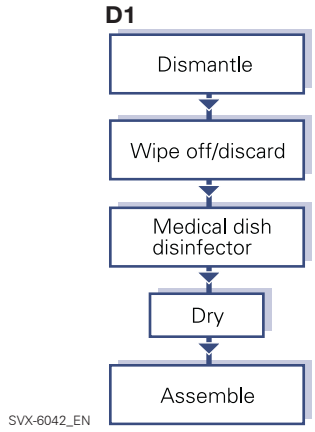
Cleaning procedure when ServoGuard filter (or equivalent) has been used.



Refer to page 198.

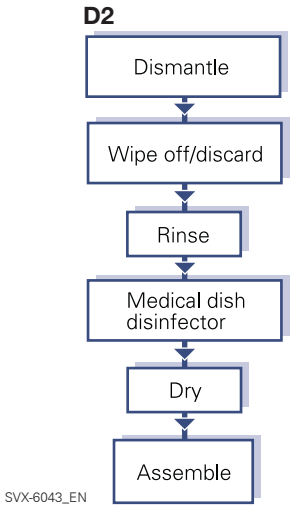
Disinfection procedures

D1) Disinfecting with a medical dish disinfector when an external bacterial filter has been used.



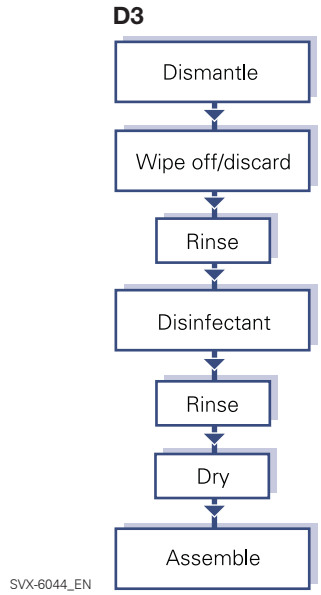
Refer to page 199.

D2) Disinfecting with medical dish disinfector when no external bacterial filter has been used.



Refer to page 199.

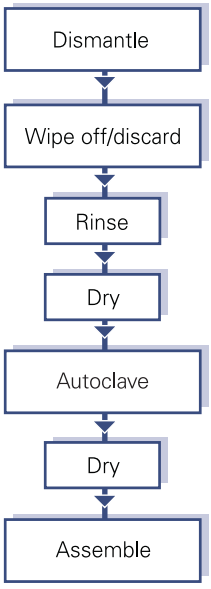
D3) Disinfecting with liquid disinfectant and sterilization methods when no external bacterial filter has been used.



Refer to page 199.

Sterilization procedure

Sterilizing with autoclave when no external bacterial filter has been used.



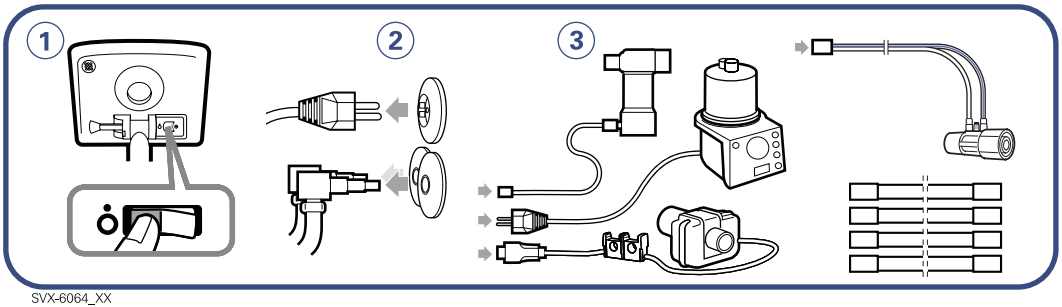
Refer to page 201.

Autoclaving reduces the lifetime of the expiratory cassette

Sterilization of the Expiratory cassette is not necessary as it is not an invasive instrument. MAQUET have clear indications that autoclaving will reduce the lifetime of the Expiratory cassette and therefore do not recommend it as a method for cleaning.

8 Preparation and Dismantling

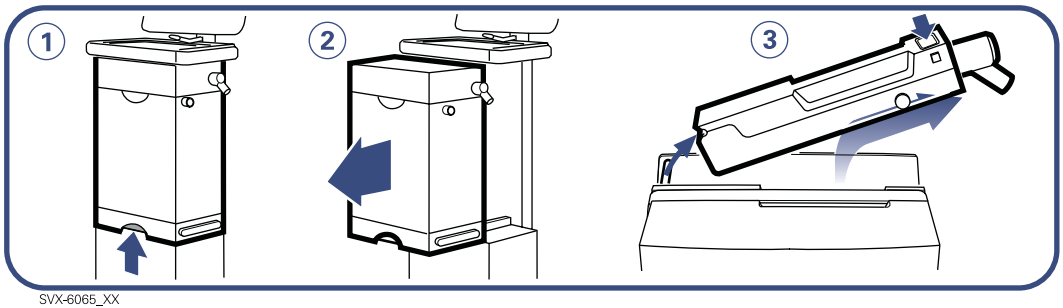
Preparations



SVX-6064_XX

1. Set the ventilator to Off.
2. Disconnect the ventilator from mains and from gas supply.
3. Disconnect optional equipment from mains and from the ventilator.

Expiratory cassette



SVX-6065_XX

1. Lift the locking handle.
2. Pull out the Patient Unit.
3. Press the button on the Expiratory cassette, tilt it upwards and remove.

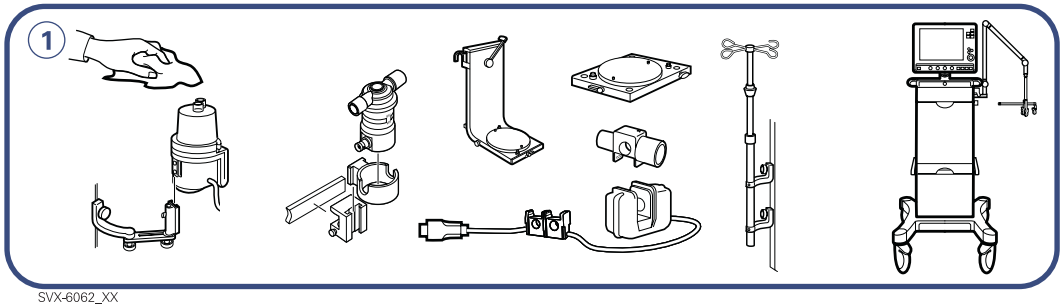
WARNING!

- After removing the Expiratory cassette, do not pour any fluid into the Expiratory cassette compartment. Avoid contact with electrical connectors.

Important:

- The Expiratory cassette is a precision instrument and must be handled carefully.
- The Expiratory cassette can be exchanged between different Servo-i Ventilator Systems. The ventilator may be used immediately by connecting a cleaned Expiratory cassette. After replacing the Expiratory cassette a Pre-use check must be performed.

Wiping and discarding

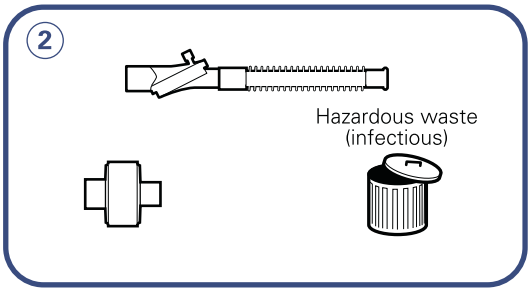


SVX-6062_XX

1. Wipe all parts with a soft lint-free cloth moistened in soap & water or detergent-based disinfectant.

Important: When ServoGuard filter (or equivalent) is used, the only cleaning needed is to wipe the ventilator and accessories with a soft lint-free cloth moistened in soap & water or detergent-based disinfectant.

Note: In case of more contaminated surfaces use ethyl alcohol or isopropyl alcohol.



SVX-6061_EN

2. Discard:
   – the Servo Guard viral/bacterial filter
   – Servo Humidifier/HME
   – Y Sensors
   – disposable patient tubing.

Hazardous waste (infectious) These parts must not be disposed of with ordinary waste.

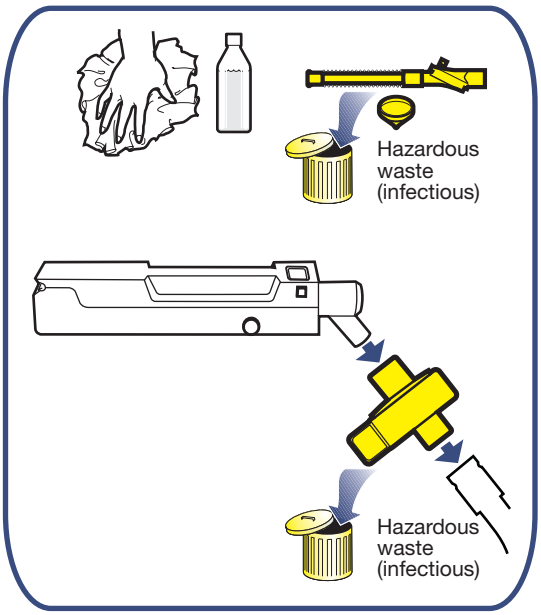
Important: During normal conditions, the filter of the cooling fan (page 96 no. 6) does not need to be cleaned other than during preventive maintenance. In a dusty and warm environment it is recommended to regularly check that the filter looks clean (i.e. black). If dusty it can be removed (snap off/ snap on) and rinsed in water. Shake out and make sure that the filter is free from excess water.

Module cleaning (if available)

- Wipe the Battery, CO_2 Analyzer and Y Sensor modules with a dry soft lint-free cloth. If the surface is contaminated, use ethyl alcohol. Avoid contact with the electrical connector on the modules.
- Do not immerse the CO_2 Analyzer module, the battery module or the Y Sensor module in any fluid.

8 Recommended cleaning procedure

Cleaning procedure when ServoGuard filter (or equivalent) has been used.

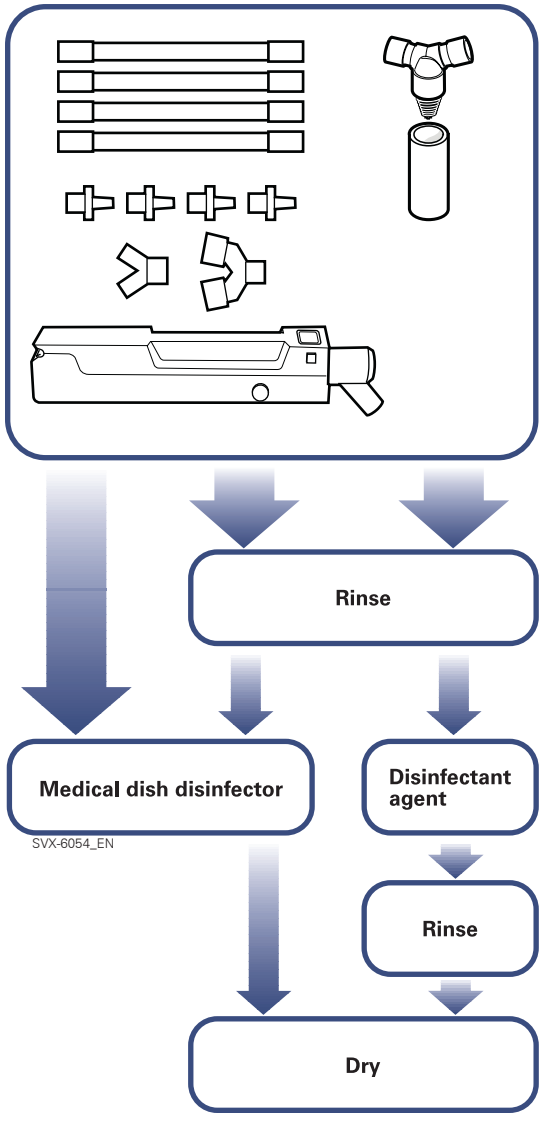


Important: When ServoGuard filter (or equivalent) is used, the only cleaning needed is to wipe the ventilator and accessories with a soft lint-free cloth moistened in soap & water or detergent-based disinfectant.

Note: In case of more contaminated surfaces use ethyl alcohol or isopropyl alcohol.

Disinfection procedures

To disinfect the Expiratory cassette, you may use a medical dish disinfector or a disinfectant.



Important:

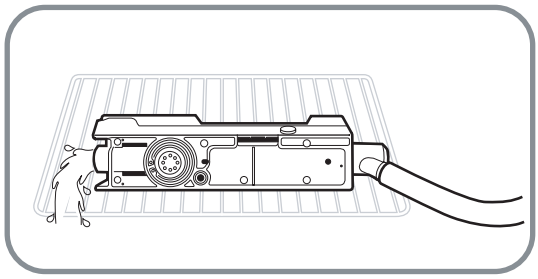
- After disinfection procedure all parts must be dried before use.
- The Expiratory cassette must be dried before use (if not dry - the Expiratory cassette may not pass the Pre-use check).
- To avoid bacteria growth, when no bacterial filter is used, it is recommended to clean the ventilator system as soon as possible.

Rinse before disinfection

Rinse the parts thoroughly in water. Let the water flow through the parts. Rinse the expiratory cassette with water (<35 °C / 95 °F) to remove organic matter e.g. blood and other residue.

Medical dish disinfector

Wash the parts with water in a medical dish disinfector at a temperature of 85 - 95 °C (185 - 203 °F). The water pressure in the dish disinfector should not exceed 1.5 bar. The water must have free passage through the cassette.


SVX-586_XX

Place the Expiratory cassette on its side with the electrical connector uppermost as shown in the picture above. Maximum water flow 10 l/min.

8 Disinfection procedure

Disinfectant

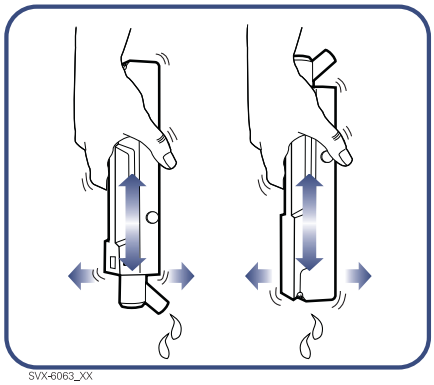
Let the parts soak in a disinfectant agent such as

- Alcohol (ethyl- or isopropyl alcohol)
- CidexOPA
- Hexanios G+R, Aniosyme DD1 and Anioxide 1000.

Important: Follow the disinfectant agent manufacturer's recommendations and instructions. Otherwise the cassette may be damaged.

Rinse after disinfectant

- Rinse the parts thoroughly in water to remove all traces of disinfectant. Let the water flow through the parts.
- Rinse the expiratory cassette by dip it in water and **carefully** shake and tilt the cassette holding it vertically in both directions, repeat this 3-4 times. Mineral deposits on the expiratory cassette affects the function. It is important to rinse the expiratory cassette thoroughly. Residues from chemicals can affect the patient, cause leakage and extra stress on the material.

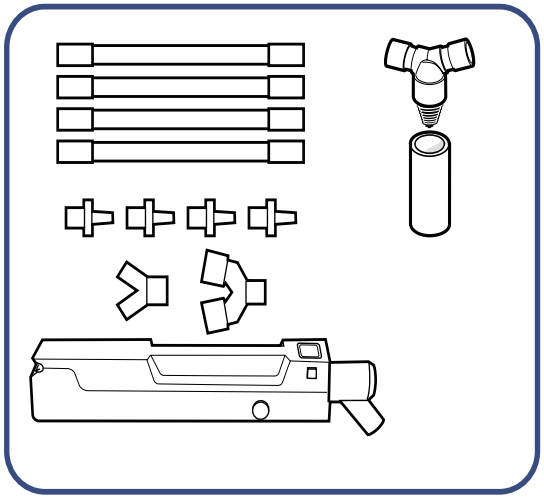


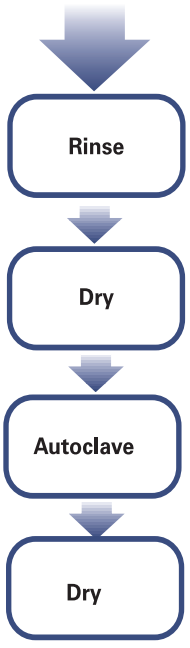
Drying

Refer to page 203.

Sterilization procedures

To sterilize the Expiratory cassette, you may use an autoclave.





Autoclaving reduces the lifetime of the expiratory cassette

Sterilization of the Expiratory cassette is not necessary as it is not an invasive instrument. MAQUET have clear indications that autoclaving will reduce the lifetime of the Expiratory cassette and therefore do not recommend it as a method for cleaning.

Number of cycles in the autoclave

The expiratory cassette will last at least:

- 100 autoclaving cycles with 4 minutes sterilization time at 134° C (273° F)
- 50 autoclaving cycles with 18 minutes sterilization time at 134° C (273° F).

Important:

- If autoclaving is conducted in a prolonged cycle (> 4 min) at 134 °C (273 °F), the estimated remaining time of use of the Expiratory cassette may be negatively affected.
- Before placing the Expiratory cassette in an autoclave make sure that no water remains inside the cassette.
- The Expiratory cassette must be dried before use (if not dry - the Expiratory cassette may not pass the Pre-use check).

  Note: Normally the expiratory cassette does not have to be dried after sterilization as most steam autoclaves have a drying period in the end of the autoclave cycle. If there is no drying phase, the expiratory cassette must be dried before use.
- To avoid bacteria growth when no external bacterial filter is used, it is recommended to clean the ventilator system as soon as possible.

8 Sterilization procedure (not recommended)

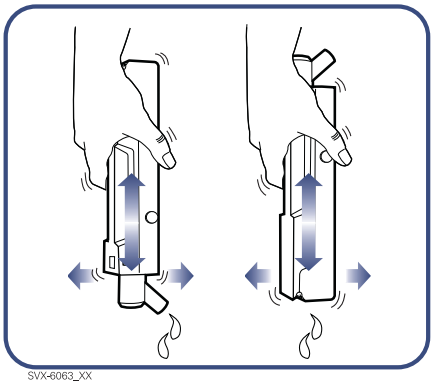
Rinse

Rinse the parts thoroughly in water. Let the water flow through the parts. Rinse the expiratory cassette with water (<35 °C / 95 °F) to remove organic matter e.g. blood and other residue.

Drying before autoclaving

Before placing the Expiratory cassette in an autoclave make sure that no water remains inside the cassette. **Carefully** shake and tilt the cassette holding it vertically in both directions, repeat this 5-7 times or use a test lung for 10 min. Other drying aternatives are; drying cabinet, 1 hour in maximum 70 °C (158 °F) or 12-24 hours in room air depending on surrounding conditions.

Caution: Never dry the cassette by applying high-pressure air as you may damage the internal tubing.



SVX-6063_XX

Autoclave

- Instrument parts should be autoclaved in a validated process at a temperature of 134 °C (273 °F). Typically 4 minutes at 134 °C (273 °F).
- Rubber parts should be autoclaved in a validated process at a temperature of 121 °C (250 °F). Typically 15 minutes at 121 °C (250 °F).

Drying after autoclaving

Refer to page 203.

Drying alternatives

There are several drying alternatives to dry the expiratory cassette:

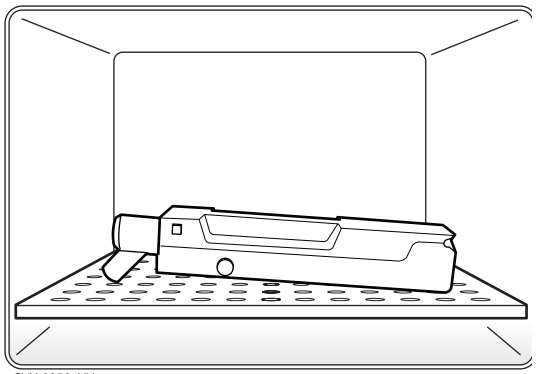
- Carefully shake/tilt the cassette (5-7 times)
- Rune the cassette in a Servo-i ventilator with a test lung for 10 minutes
- Drying cabintett 1 hour in maximum 70°C (158 °F)
- Room air (12-24 hours in room air depending on surrounding conditions.)

Caution: Never dry the cassette by applying high-pressure air as you may damage the internal tubing

Note: The time for drying can be shorter if the medical dish disinfector has a drying phase.

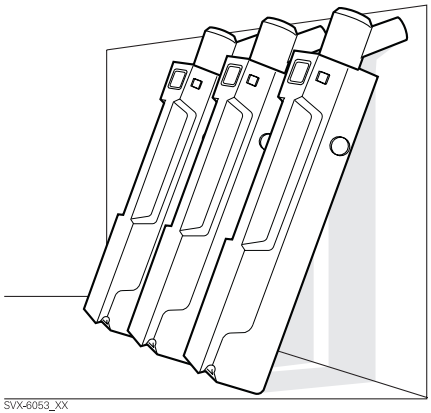
Note: Normally the expiratory cassette does not have to be dried after sterilization as most steam autoclaves have a drying phase in the end of the autoclave cycle. If there is no drying phase, the expiratory cassette must be dried before use.

Recommended postition.



SVX-6052_XX

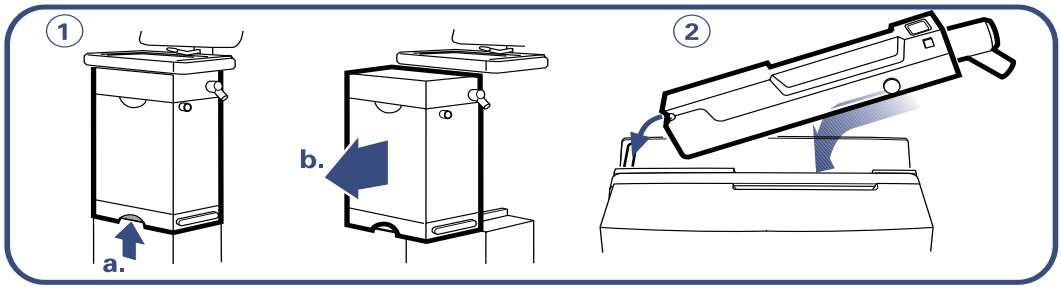
Recommended position in small drying cabinets.



SVX-6053_XX

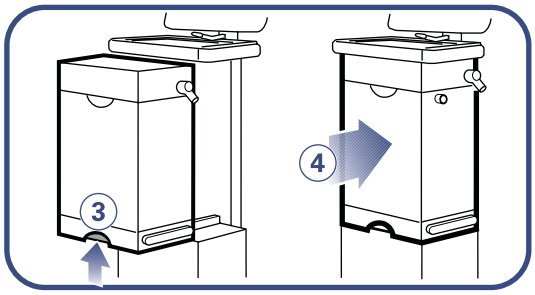
Recommended position in room air or drying cabinet.

Expiratory cassette



SVX-6056_XX

1. Patient Unit: Lift the locking handle (a) and pull out (b).
2. Hinge the Expiratory cassette and press it firmly down into lock position. Check that the cassette cannot be moved upwards.



SVX-6057_XX

3. Patient Unit: Lift the locking handle.
4. Push back the unit until you hear a "click".

Caution: The Expiratory cassette must be pressed all the way down into its bottom position. Make sure that the button on the top of the cassette is completely ejected to ensure that the cassette is firmly locked.

Important:

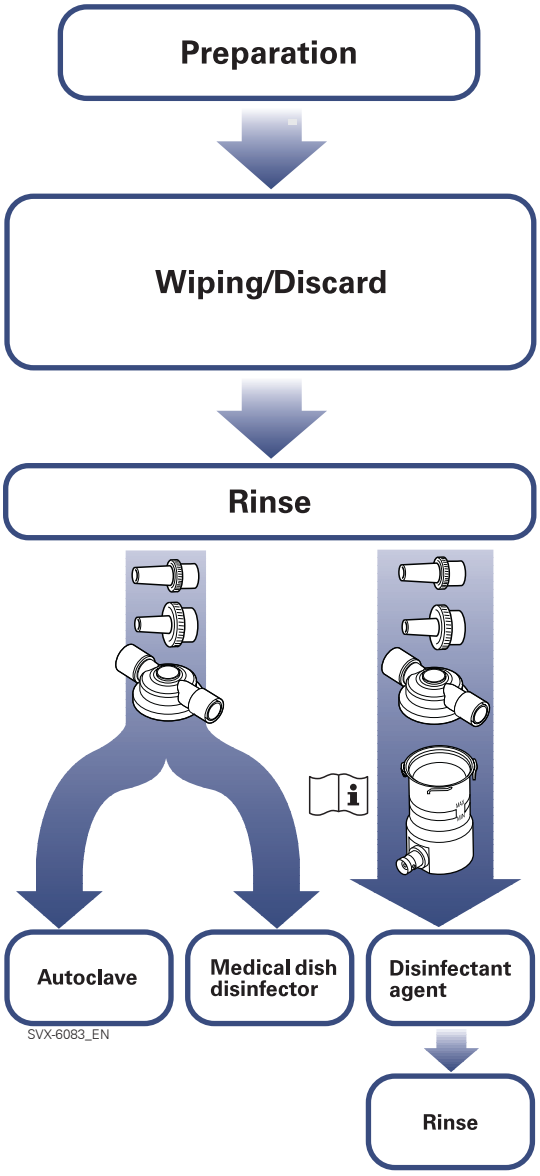
- Note on a log sheet that a routine cleaning has been performed. Refer to hospital guidelines.

Function test

After cleaning, always perform a Pre-use check. For more information please refer to page 146.

✗ Servo Ultra Nebulizer

Cleaning flow



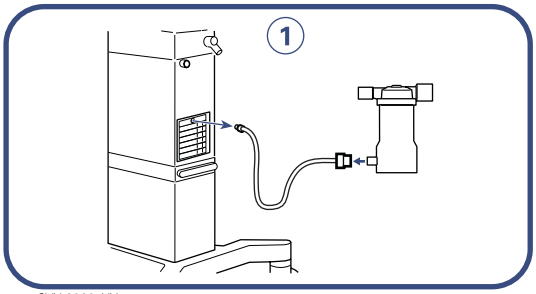
The nebulizing chamber may be cleaned by just wiping with a soft cloth moistened in soap and water or disinfectant.

Important:

- Cleaning shall be done after each patient or according to hospital routine
- Only T-piece and nipples can be autoclaved.
- Do not autoclave or use a medical dish disinfector when cleaning the nebulizing chamber.
- Perform a function test of the Servo Ultra Nebulizer after the cleaning. Refer to page 130.
- The medication cup must not be disposed of with ordinary waste.

Hazardous waste (infectious)

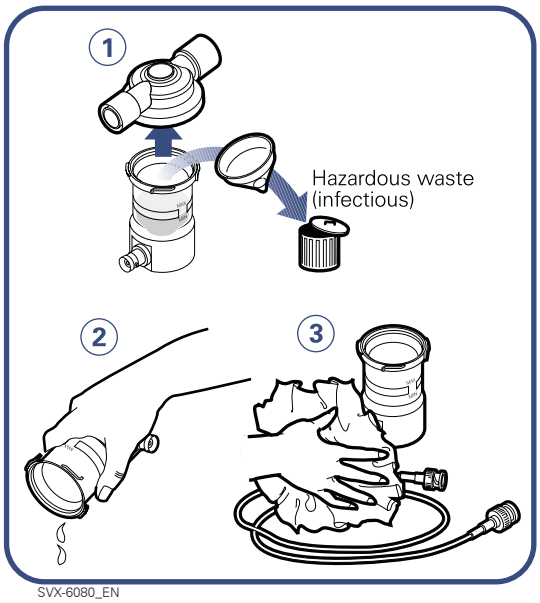
Preparation



1. Disconnect the Servo Ultra Nebulizer from the ventilator.

8 Nebulizer cleaning

Wiping and discarding



SVX-6080_EN

1. Unscrew the T-piece and discard the medication cup.
2. Empty the buffer water from the nebulizing chamber.
3. Wipe the nebulizing chamber and connection cable with a soft cloth moistened in soap & water or detergent-based disinfectant.

   Note: In case of more contaminated surfaces use ethyl alcohol or isopropyl alcohol.

Rinse

Rinse the parts thoroughly in water. Let the water flow through the parts.

Disinfection procedure (medical dish disinfector)

Wash the T-piece and nipples in a medical dish disinfector at a maximum temperature of 85 - 95 °C (185 - 203 °F).

Important: Do not put the nebulizing chamber in a medical dish disinfector.

Disinfection procedure (aldehyde)

Let the nebulizing chamber, the T-piece and the nipples soak in a disinfectant agent such as

- 2% Glutaraldehyde solution
- CidexOPA
- Hexanios G+R, Aniosyme DD1

Important: Follow the disinfectant agent manufacturer's recommendations and instructions.

Rinse

Rinse the parts thoroughly in distilled water.

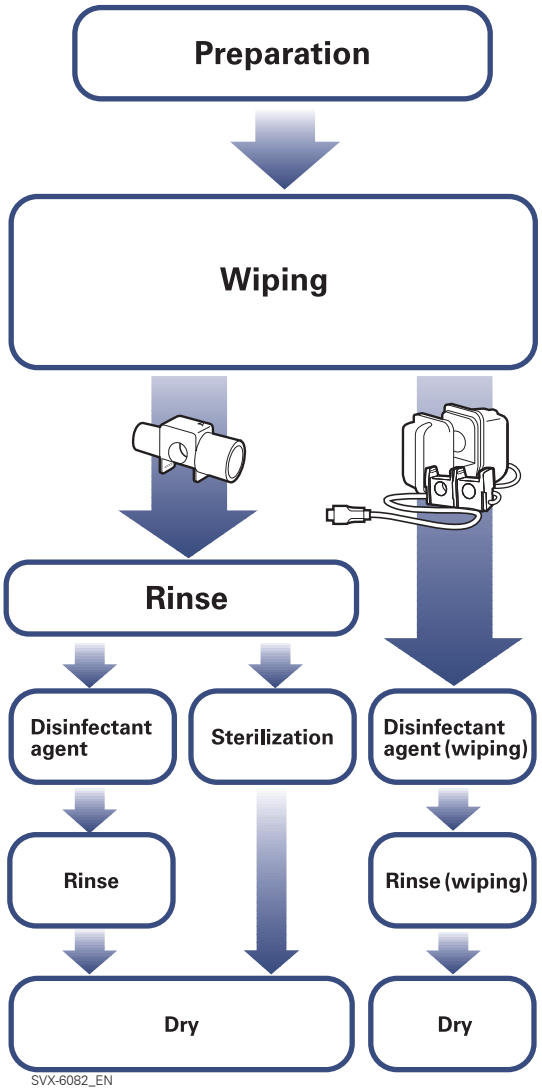
Sterilization procedure (autoclave)

The T-piece and nipples should be autoclaved in a validated process at a temperature of 134 °C (273 °F). Typically 4 minutes at 134 °C (273 °F).

Important: Do not autoclave the nebulizing chamber.

✗ CO_2 Analyzer Servo-i

Cleaning flow

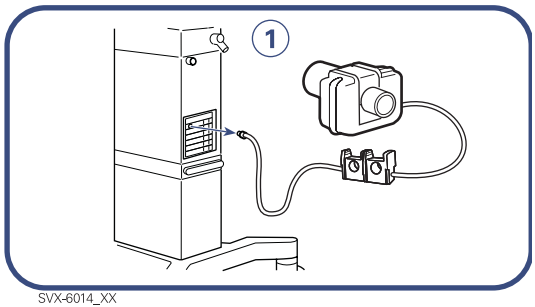


SVX-6082_EN

Important:

- Cleaning shall be done after each patient or according to hospital routine.
- Do not immerse the CO_2 Analyzer module nor the Capnostat sensor in any fluid.

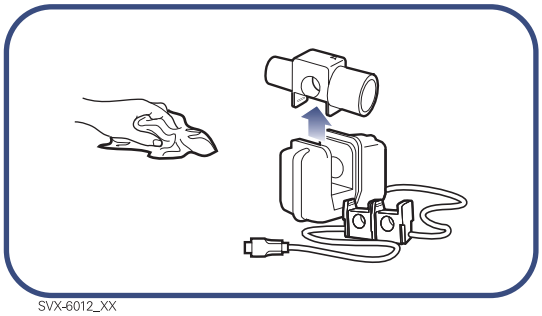
Preparations



SVX-6014_XX

1. Disconnect the Capnostat sensor and airway adapter from the ventilator.

Wiping



SVX-6012_XX

Wipe the adapter and Capnostat sensor with a soft cloth moistened in soap & water or detergent-based disinfectant.

8 CO_2 Analyzer cleaning

Disinfection procedure (airway adapter)

Let the adapter soak in 2% Glutaraldehyde solution for about one hour.

Important: Follow the disinfectant agent manufacturer's recommendations and instructions.

Rinse

Rinse the parts thoroughly in distilled water.

Dry

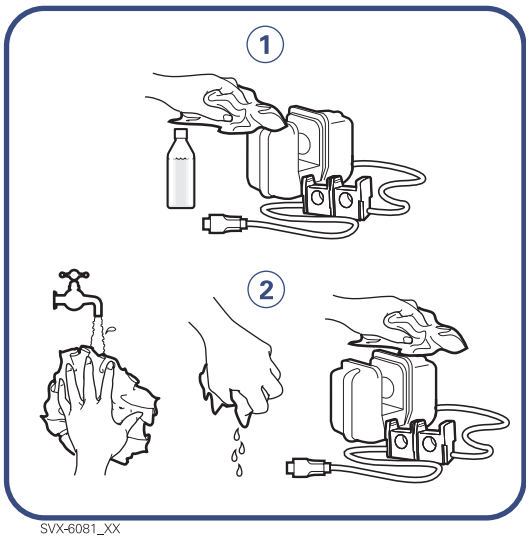
Before reusing the adapter the windows must be dry.

Sterilization procedure (airway adapter)

- The Adult adapter can be sterilized using either Steam or ETO (ethylene oxide) gas methods.
- The Neonate adapter can be sterilized using ETO (ethylene oxide) gas method.
- After sterilization procedure the adapters must be dried before use.

The adult adapter can be autoclaved in a validated process at a temperature of 134 °C (273°F).

Disinfection procedure (Capnostat sensor)



SVX-6081_XX

1. Wipe the Capnostat sensor with a soft cloth moistened in disinfectant (2% Glutaraldehyde or isopropyl alcohol 70%).
2. After cleaning wipe the Capnostat sensor with a water dampened clean cloth.

   Important: The Capnostat sensor windows must be dried after cleaning.

Notes 8

8 Notes

9. Maintenance

Contents

WARNING! Always disconnect the ventilator if any operation which may involve risk for the patient will be done, e.g. replacement of O_2 cell.

9 General

MAQUET recommends that the equipment is inspected regularly. The environmental declaration is part of the service manual.

Important:

Special waste
This product contains electronic and electrical components. Discard disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.

Recycling
Worn-out batteries must be recycled or disposed of properly in accordance with appropriate industrial and environmental standards.

Hazardous waste (infectious) The device contains parts which must not be disposed of with ordinary waste.

Preventive maintenance

A preventive maintenance, according to corresponding chapter in the Service manual, must be performed by authorized personnel at least once every year as long as the unit is not used more than normal. Normal operation during one year is estimated to correspond to approximately 5000 hours of operation. The current operating time and time to next preventive maintenance is presented under the *Status* menu on the User Interface.

Important: Always perform a regular cleaning and an extended cleaning of the Inspiratory channel before performing a preventive maintenance. The extended cleaning must only be performed by personnel who are well trained in its use.

✗ Fisher & Paykel Humidifier MR730 / MR850

Refer to the Operating manual for the Fisher & Paykel Humidifier MR730 / MR850.

✗ CO_2 Analyzer

No regular overhaul required.

✗ Y Sensor measuring

No regular overhaul required.

✗ Aeroneb Professional Nebulizer System

Refer to the Operating manual for the Aeroneb Professional Nebulizer System.

Disposable parts

Use disposable- and spare parts from MAQUET only. All disposable parts must be discarded according to hospital routine and in an environmentally safe way.

Ventilator

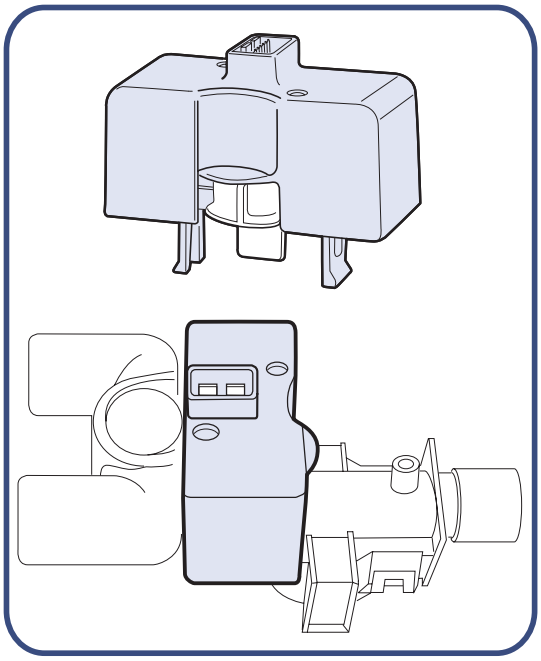
Expiratory cassette

MAQUET recommends that the Expiratory cassette should be exchanged if an instruction appears on screen during Pre-use check: *Exchange Expiratory cassette*.

Bacteria filter for pressure transducer (Inspiratory channel)

The bacteria filter can be exchanged according to hospital routine (page 218).

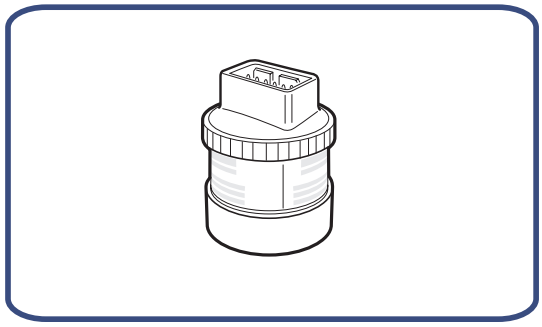
O_2 Sensor (if installed)



SVX-9044

No regular overhaul required.

O_2 cell (if installed)



SVX-9050

Regularly check the cell status in the menu *Status*. The O_2 cell should be exchanged if <10% is indicated for it in the *Status* menu. Refer to page 177 for O_2 cell adaptation.

WARNING! The sealed unit of the O_2 cell contains a caustic liquid which may cause severe burns to the skin and eyes. In case of contact, immediately flush continuously with water for at least 15 minutes and seek medical attention especially if the eyes are affected.

Important:

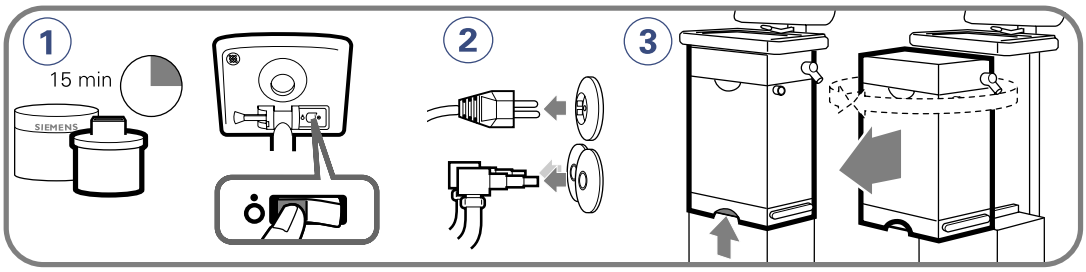
- Make sure the O_2 cell is for the Servo-i model. O_2 cell package must have a blue label.
- Replacement of the O_2 cell and filter and extended cleaning must only be performed by personnel who are well trained in its use.

Bacteria filter for O_2 cell

The bacteria filter for the O_2 cell can be exchanged when the cell is replaced, or at other intervals according to hospital routine.

9 Replacement of O_2 cell/filter

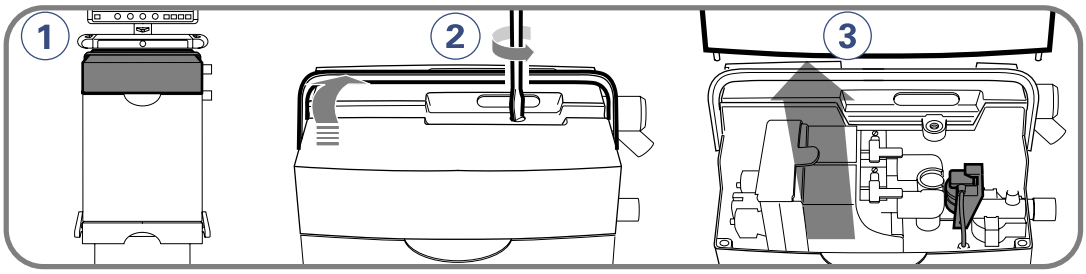
Preparations and dismantling



SVX-076_EN

1. Unpack the O_2 cell at least 15 minutes before replacement. Set the ventilator to off by pressing the button at the back of the screen.
2. Disconnect the ventilator from the mains and gas supply.
3. Lift the locking handle and pull out the Patient Unit.

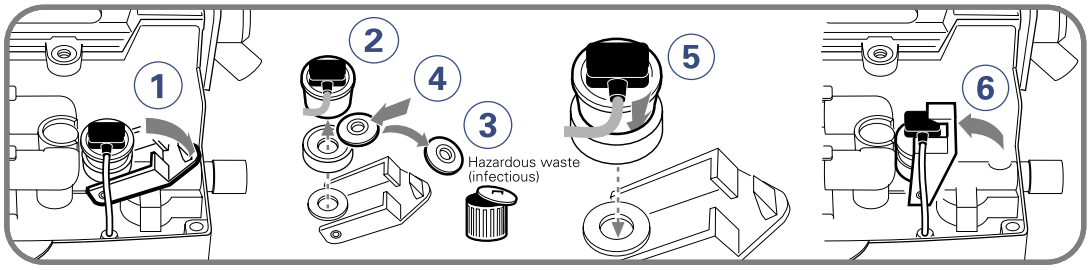
Check that the Inspiratory channel is in the front. If not, Push the locking handle upwards and turn until you hear a “click”.



SVX-075_XX

1. Lift the handle and fold it over the Expiratory cassette.
2. Loosen the screw.
3. Lift off the cover.

Changing bacteria filter only



SVX-072_EN

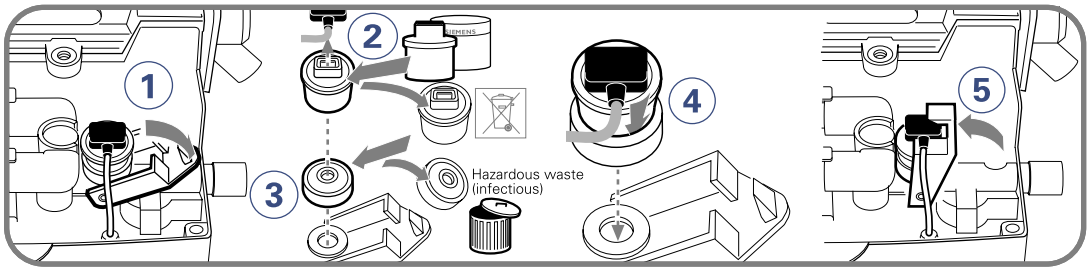
1. Lower the locking catch.
2. Lift the O_2 cell.
3. Remove and discharge the bacteria filter.

Hazardous waste (infectious)
The filter must not be disposed of with ordinary waste!

   – Ensure that the rubber seal is intact, then firmly put a new bacteria filter into it
4. Connect the rubber seal tightly with the filter.
5. Put the O_2 cell in position.
6. Close the locking catch.

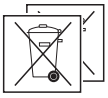
9 Replacement of O_2 cell/filter

Changing O_2 cell including bacterial filter and rubber seal



SVX-073_EN

1. Lower the locking catch.
2. Disconnect the connector.
   - Lift and discharge the O_2 cell with the rubber seal.



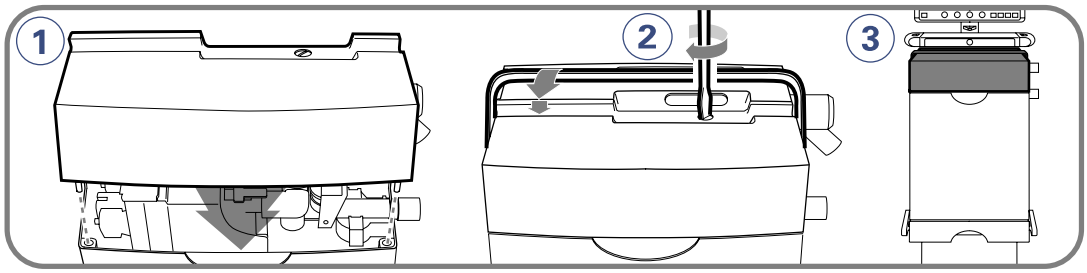
Special waste
This product contains electronic and electrical components. Discard disposable, replaced and left-over parts in accordance with appropriate industrial and environmental standards.

   - Remove and discharge the bacteria filter.

Hazardous waste (infectious)
These parts must not be disposed of with ordinary waste!

3. Ensure that the new rubber seal is not damaged, then firmly put a new bacteria filter into it.
4. Connect the connector
   - Connect the rubber seal tightly with the filter.
   - Put the O_2 cell in position.
5. Close the locking catch.

Assembling



SVX-077_XX

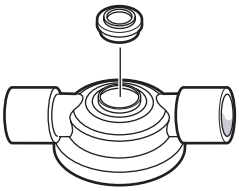
1. Put the cover in position.
2. Tighten the screw.
3. Angle up the handle and push it down in position.

Perform a Pre-use check

For further information see page 145.

✗ Nebulizer membrane

A faulty injection membrane on the Servo Ultra Nebulizer Servo-i may cause system leakage and must be replaced.



SVX-127_XX

- Replacement of membrane:
  - Peel off the old membrane.
  - Put a new membrane in place.
  - Make sure the new membrane is properly attached. This is easiest to see from the inside.

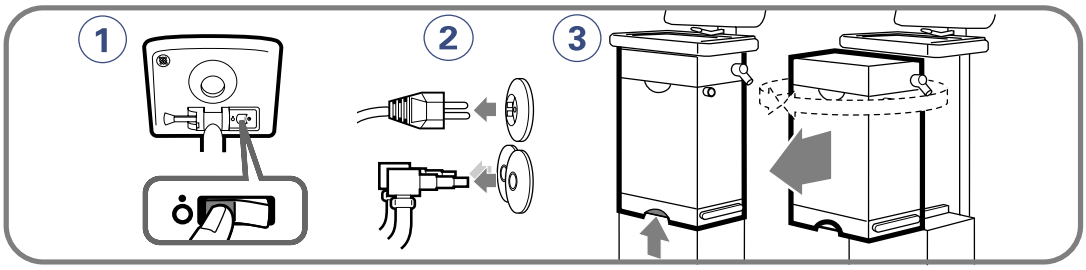
Check the Servo Ultra Nebulizer for leakage (Pre-use check, page 145).

9 Extended cleaning of Inspiratory channel

Important:

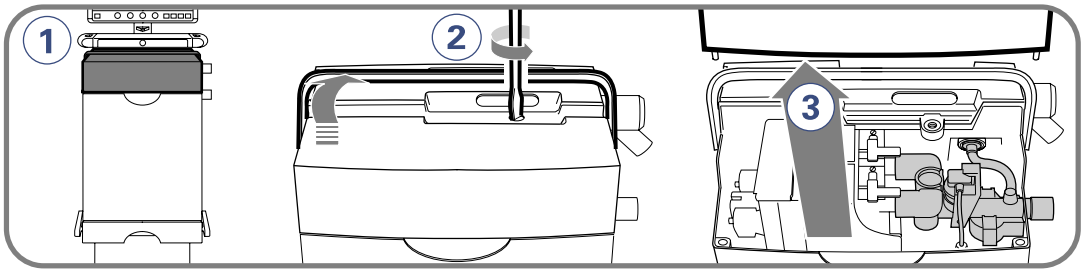
Always perform a regular cleaning and an extended cleaning of the Inspiratory channel before a preventive maintenance. The extended cleaning must only be performed by personnel who are well trained in its use.

Preparations



SVX-589_XX

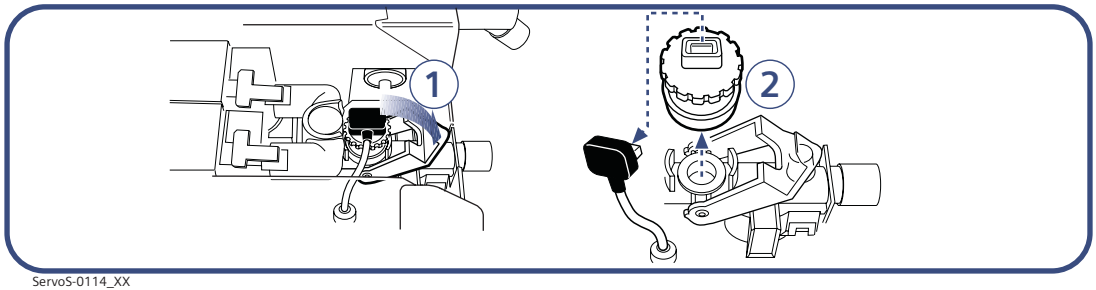
1. Set the ventilator to off by pressing the button at the back of the screen.
2. Disconnect the ventilator from the mains and gas supply.
3. Lift the locking handle and pull out the Patient Unit.



SVX-254_XX

1. Lift the upper handle and fold it over the expiration cassette.
2. Loosen the screw.
3. Lift off the cover.

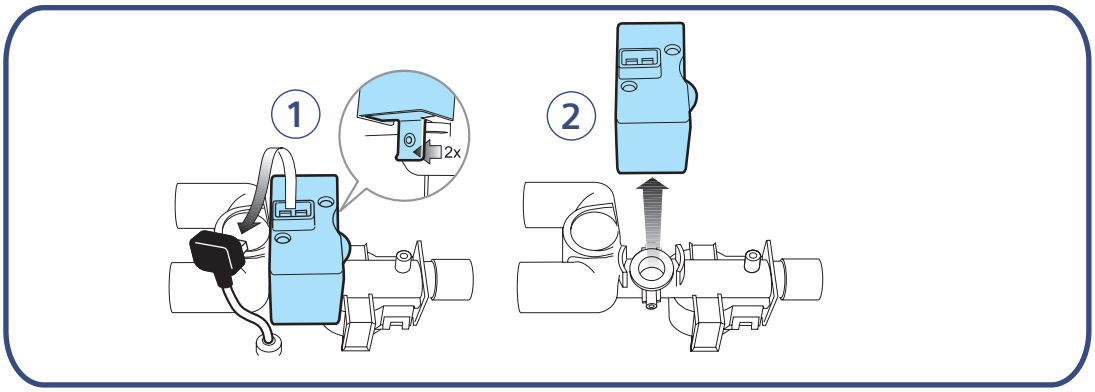
If an O_2 cell is installed



ServoS-0114_XX

1. Lower the locking catch.
2. Disconnect the connector and lift the O_2 cell.

If an O_2 sensor is installed

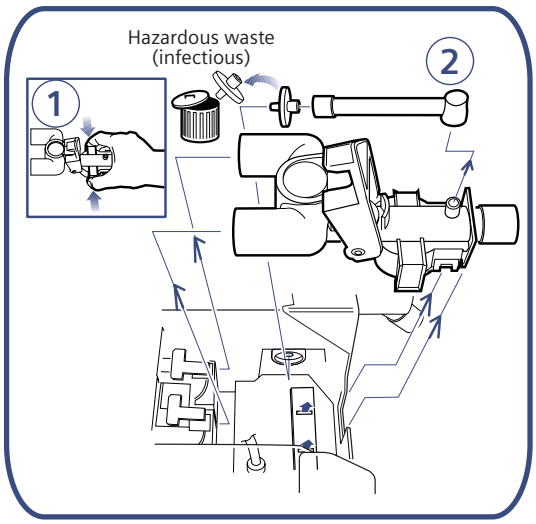


SVX-9060_XX

1. Disconnect the connector and carefully unlock the latches.
2. Lift the O_2 sensor.

9 Remove / insert the Inspiratory channel, tube

Remove the the inspiratory channel and tube

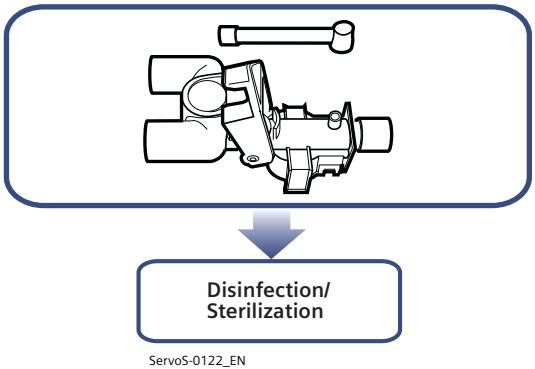


ServoS_0113_EN

1. Press the latches and lift the Inspiratory channel upwards.
2. Disconnect the tube and remove the filter. Discard the bacteria filter.

Hazardous waste (infectious)
The filter must not be disposed of with ordinary waste!

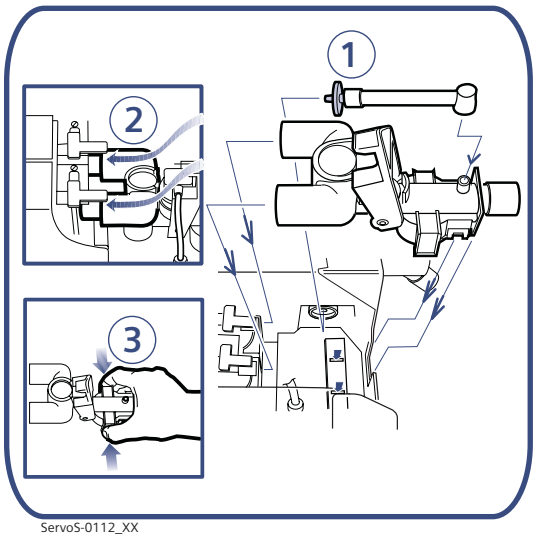
Disinfection / sterilization procedures



ServoS-0122_EN

For cleaning (Disinfection/Sterilization) instructions for the Inspiratory channel and tube please refer to chapter Routine cleaning (page 191).

Insert the Inspiratory channel and tube



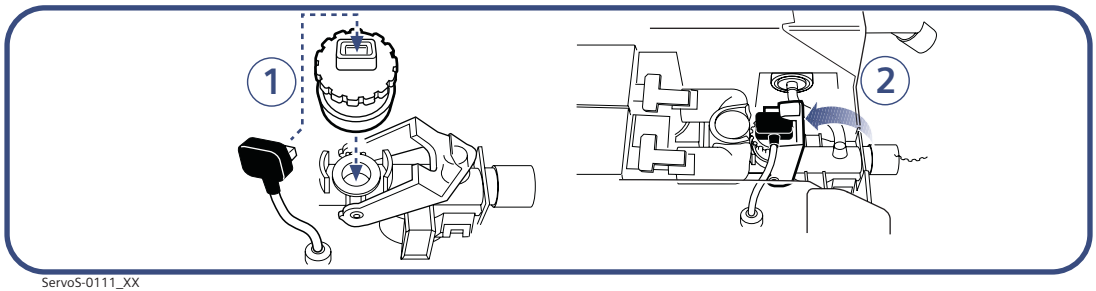
ServoS-0112_XX

1. Put the new bacteria filter in position and connect the filter to the tube.
2. Put the silicon cuffs in position.
3. Press the latches and insert the Inspiratory channel.

Important:

- There shall always be clearance between the cuffs and gas modules.
- Make sure the latches are locked in position.

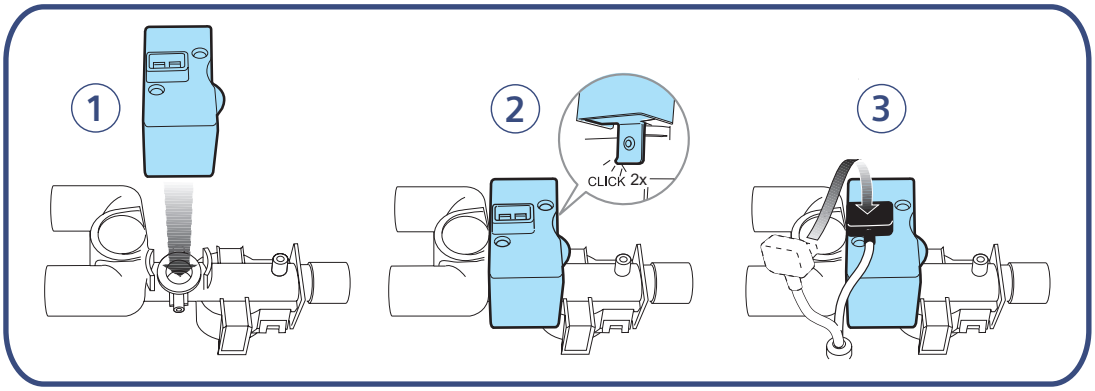
If an O_2 cell is used



ServoS-0111_XX

1. Connect the O_2 cell connector and put the O_2 cell in position.
2. Close the locking catch.

If an O_2 sensor is used

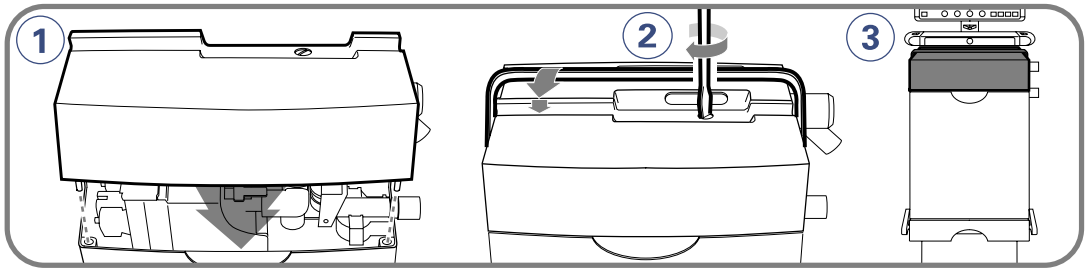


SVX-9059_XX

1. Put the O_2 sensor in position.
2. Connect the O_2 sensor (a "click" is heard)
3. Connect the O_2 sensor connector

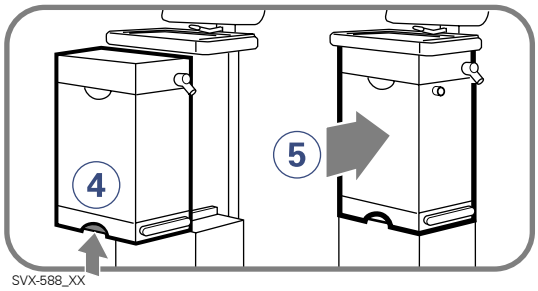
9 Assembling

r



SVX-077_XX

1. Put the cover in position.
2. Tighten the screw.
3. Angle up the handle and push it down in position.



SVX-588_XX

4. Patient Unit: Lift the locking handle and,
5. push back the unit until you hear a "click".

After assembling

- Note on a log sheet that a extended cleaning of the Inspiratory channel has been performed.
- Connect patient tubing and accessories.
- Perform a Pre-use check. (For further information see page 145).

Notes 9

9 Notes

10.Troubleshooting

Contents

WARNING! Always disconnect the ventilator if any operation which may involve risk for the patient will be done, e.g. replacement of O_2 cell.

Caution: The Expiratory cassette must not be lifted up when the ventilator is in operation. This may, however, be done when in Standby setting.

10 High priority alarms

Problem (Display message)	Possible cause	Remedy
Apnea	Preset or default alarm limit exceeded. Time between two consecutive inspiratory efforts exceeds the set alarm limit.	Check patient and breathing system. Check ventilator settings.
Backup ventilation	An apnea has caused the ventilator to switch from support mode to backup ventilation mode.	Check patient. Select ventilator mode. Check ventilator settings. If the problem still remains contact a service technician.
Check tubing	Problems with patient tubing or expiratory pressure transducer. Disconnected pressure transducer (expiratory or inspiratory). Blocked pressure transducer (expiratory or inspiratory). Water in expiratory limb of ventilator. Wet bacteria filter. Clogged bacteria filter. Excessive leakage.	Refer to service. Remove water from tubing and check humidifier settings, i.e. relative humidity. Check heater wires in humidifier (if present). Check connections of tubing and expiratory cassette.
Expiratory cassette disconnected	The Expiratory cassette is disconnected or not connected properly.	Connect the Expiratory cassette. Replace the Expiratory cassette. Perform a Pre-use check if a new Expiratory cassette is inserted.
Expiratory Minute Volume: High	Preset or default alarm limit exceeded. Increased patient activity. Ventilator self-triggering (auto cycling). Improper alarm limit setting.	Check patient and breathing system. Check trigger sensitivity setting. Check alarm limit settings.
Expiratory Minute Volume: Low (See note on page 229.)	Preset or default alarm limit exceeded. **Note:** This alarm also works as a patient disconnect alarm. Low spontaneous patient breathing activity. Leakage around the cuff. Leakage in the patient breathing system. Improper alarm setting.	Check patient and breathing system. Check cuff pressure. Check patient breathing system (perform leakage test if necessary). Check pause time and graphics to verify. Consider increased ventilatory support for the patient.
Gas supply pressures: Low	Air and O_2 supply is below 2.0 kPa x 100. Both air and O_2 gas supply disconnected.	Check the gas connections.
High continuous pressure	Constantly high airway pressure for more than 15 seconds (PEEP + 15 cmH_2O).	Check patient and breathing system. Check ventilator settings. If the problem remains, contact a service technician.

Problem (Display message)	Possible cause	Remedy
Leakage out of range	Leakage to high. The mask / prongs may not be applied correct on the patient. Make sure a proper size of the mask / prongs is used.	Check patient and breathing system. Check mask / prongs size and accurate adaptation to the patient.
Limited battery capacity	Less than 10 minutes left of battery operating time.	Insert a new Battery module or attach to mains.
Low battery voltage	Battery voltage too low. Cannot guarantee continued ventilator operation.	If possible, connect to mains power supply. Replace and discard all batteries. **Note:** If this alarm occurs after one of the battery alarms; Limited battery capacity or No battery capacity, then the batteries do not need to be replaced. However, the ventilator must be connected to the mains power supply.
Nebulizer hardware error	Technical problem with nebulizer hardware. Temperature too high.	Change the nebulizer. If the problem still remains contact a service technician.
No battery capacity	Less than 3 minutes left of battery operation.	Connect to mains. Insert charged Battery modules. (Recharge Battery module by leaving the ventilator plugged into mains.)
No patient effort detected	The time between two consecutive inspiratory efforts has exceeded (Adult 45 seconds, Infant 15 seconds).	Check patient and breathing system. Check ventilator settings.
O_2 cell / sensor failure	*O_2 cell / sensor* missing or disconnected.	Check O_2 cell / sensor and connection. **Note:** If O_2 sensor is used make sure O_2 sensor software is installed.
O_2 concentration: High	Measured O_2 concentration exceeds the set value by more than 6 Vol.%. Refer to page 177 for O_2 cell adaptation. Gas supply or air line disconnected. No supply from wall outlet. The air gas module is disconnected. If no gas is available, then both expiratory and safety valves will open.	Check air supply. Perform a Pre-use check.

10 High priority alarms

Problem (Display message)	Possible cause	Remedy
O_2 concentration: Low	Measured O_2 concentration is below the set value by more than 6 Vol.%, or concentration below 18 Vol.% which is independent of operator settings. Refer to page 177 for O_2 cell adaptation. Gas delivered in O_2 supply line is not O_2. O_2 sensor faulty or exhausted. O_2 cell uncalibrated. O_2/oxygen gas module faulty.	Check O_2 supply line. Perform a Pre-use check. Refer to page 177 for O_2 cell adaptation.
Paw high **Caution:** If airway pressure rises 6 cmH_2O above set upper pressure limit, the safety valve opens.The safety valve also opens if system pressure exceeds 117± 7 cmH_2O.	Airway pressure exceeds preset Upper pressure limit. Kinked or blocked tubing. Mucus or secretion plug in endotracheal tube or in airways. Patient coughing or fighting ventilator. Inspiratory flow rate too high, Improper alarm setting. Blocked expiratory filter.	Check patient and breathing system. Check ventilator settings and alarm limits.
Restart ventilator!	Software related error.	Restart the ventilator and perform a Pre-use check. If the problem still remains, take the unit out of operation and contact a service technician.
Safety valve test failed	During Pre-use check the system found failures during the check of the opening pressure for the safety valve.	Contact a service technician.
Settings lost; Restart ventilator	Software error, memory corrupt.	Restart the ventilator and perform a Pre-use check. Check ventilator settings.
Technical error in Expiratory cassette	Technical problem with the Expiratory cassette.	Perform a Pre-use check. Change the Expiratory cassette and perform a Pre-use check. If the problem still remains contact a service technician.
Technical error: Restart ventilator	Ventilator settings lost.	Restart the ventilator, perform a Pre-use check and check all settings. If the problem still remains contact a service technician.
Time in waiting position exceeds 2 min.	Time in waiting position is exceeded. Patient is not connected to the ventilator or leakage is excessive.	Check patient and breathing system.

Note: Expiratory Minute Volume: Low

Considerable leakage may occur around the endotracheal tube if it is uncuffed. The combination of small tidal volumes, leakage around the tube and activated compliance compensation may trigger the Low Expiratory Minute Volume alarm, due to a very low expiratory flow passing from the patient through the expiratory channel. By observing the difference between the Vti and Vte values presented on the User Interface, a leakage can be detected and its extent easily controlled. The first time an unacceptably large leakage occurs around the tube, correct this problem to avoid triggering the Low Expiratory Minute alarm. If the leakage still persists, adjust the alarm limit right down to its lowest level (i.e. 10 ml) – if this step is clinically judged to be appropriate. Finally, if the leakage still has not been remedied, then deactivate the compliance compensation to avoid triggering the Low Expiratory Minute alarm. If the compliance compensation is deactivated from Pressure Control, Pressure Support or SIMV (Pressure Control) ventilation modes, then no further settings need to be adjusted. However, where volume-related modes are used, then the set volumes must be adjusted.

10 Medium priority alarms

Problem (Display message)	Possible cause	Remedy
Air supply pressure: High	Air supply pressure above 6.5 kPa x 100. Air supply pressure at gas inlet is too high.	Check the gas supply lines. Perform a Pre-use check. If the problem still remains contact a service technician.
Air supply pressure: Low	Air supply pressure below 2.0 kPa x 100. Air supply pressure at gas inlet is too low.Gas supply line disconnected. **Note:** The *Air supply too low* alarm can be permanently silenced (Audio off) when activated.	Check and connect gas supply lines. Perform a Pre-use check.
Alarm output connection error	Technical problems (hardware or software) with the external alarm function.	Contact a service technician.
Battery mode! Nebulizer switched off	Ventilator is running on batteries and the Servo Ultra Nebulizer is inoperative, to reduce the power consumption.	Connect to mains if Servo Ultra Nebulizer is desired. Check the mains connection.
Battery operation	Mains voltage disappears.	Check the mains connection.
Check alarm limits	The persistent memory has corrupt contents.	Check the alarm limits.
Check CO_2 airway adapter	Either the data or reference channel or both channels are out of range. Usually caused when the airway adapter is removed from the Capnostat or when there is an optical blockage on the windows of the airway adapter. May also be caused when changed the adapter type without performing verification to correct for adapter type.	Make sure that the adapter is completely inserted. Clean airway adapter if necessary. If the problem persists open the"CO_2 Calibration" window and perform"Verification" to correct.
Check default alarm limits	Problems in internal memory for default alarm limits.	Check default alarm limits. If the problem still remains contact a service technician.
Check Y Sensor	Y Sensor is not connected to the patient breathing system or Y Sensor not working properly.	Check sensor connection to patient breathing system. If problem persists, change Y Sensor.
CO_2 module error	Hardware error in the CO_2 Analyzer module.	Check that the module is properly plugged in. Re-insert the module if necessary. If the error persists, it is probably hardware related. Change module. Call a service technician.
CO_2 module unplugged	CO_2 Analyzer module is not properly inserted.	Insert the CO_2 Analyzer module.
CO_2 sensor disconnected	CO_2 Capnostat sensor is not attached.	Connect the sensor to the CO_2 Analyzer module.

Problem (Display message)	Possible cause	Remedy
CO_2 sensor error	Hardware error in CO_2 Capnostat sensor. The values in the Capnostat memory failed the internal test.	Check that the Capnostat sensor is properly plugged in. Re insert the Capnostat sensor if necessary. Calibrate the Capnostat sensor (refer to page 151). Change the Capnostat sensor. If the error persists, contact a service technician.
CO_2 sensor temperature too high	Possible hardware error. The Capnostat sensor temperature is higher than 50° C.	Make sure that the Capnostat sensor is not exposed to extreme heat (heat lamp, incubator etc.). If the error persist, the problem is most likely a faulty Capnostat sensor.
CO_2 sensor temperature too low	The Capnostat sensor does not reach operating temperature.	The problem is probably hardware related. Change Capnostat sensor and/or module. Call a service technician.
CPAP High/Low	Preset or default alarm exceeded.	Check patient and breathing system. Check mas k/ prongs size and accurate adaptation to the patient Check alarm settings.
etCO_2 high	Hypoventilation. Leakage with high bias flow. CO_2 sensor, Y-piece, HME	Check patient circuit. Ventilator settings.
etCO_2 low	Hyperventilation. Leakage with high bias flow. CO_2 sensor, Y-piece, HME	Check patient circuit. Ventilator settings.
Exp. cassette exchanged	Expiratory cassette has been exchanged during operation. No Pre-use check performed after exchange.	Perform a Pre-use check.
Inspiratory flow overrange	Combination of settings exceeds the allowable inspiration flow range.	Change the ventilator settings. Increase the gas inlet pressure.
Internal temperature: High	Temperature inside the ventilator is too high.	Check the function of the fan. Check the operating temperature.
Nebulizer disconnected	The nebulizer is disconnected during nebulization. Technical problem with connection cable.	Connect the nebulizer or change connection cable.
Nebulizer hardware error	Technical problem with nebulizer hardware. Temperature too high. Not enough buffer liquid. Technical problem with connection cable.	Restart the nebulizer. Check buffer liquid level. Change the nebulizer. Change connection cable. If the problem still remains contact a service technician.
Nebulizer inhibited due to overheating	Temperature too high.	Turn off the nebulizer and restart when cooled down.

10 Medium priority alarms

Problem (Display message)	Possible cause	Remedy
O_2 supply pressure: High	O_2 supply pressure above 6.5 kPa x 100. O_2 supply pressure at gas inlet is too high.	Check the gas supply lines. Perform a Pre-use check. If the problem still remains contact a service technician.
O_2 supply pressure: Low	O_2 supply pressure below 2.0 kPa x 100 or above 6.5 kPa x 100. O_2 supply pressure at gas inlet is too low.Gas supply line disconnected. **Note:** The *O_2 supply too low* alarm can be permanently silenced (Audio off) when activated.	Check and connect gas supply lines. Perform a Pre-use check.
Panel disconnected	No communication between User interface and Patient unit.	Check control cable. If the problem still remains contact a service technician.
PEEP High	The measured end expiratory pressure is above the preset or default alarm limit for three consecutive breaths.	Check patient breathing system. Check patient connection (cuff pressure/tracheal tube size). Perform a Pre-use check. Check ventilator settings. Check the alarm settings.
PEEP Low	The measured end expiratory pressure is below the preset or default alarm limit for three consecutive breaths. **Note:** Setting the alarm to 0 (zero) is equal to alarm off. Leakage in patient breathing system. Leakage at patient connection (cuff, tracheal tube).	Check patient breathing system. Check patient connection (cuff pressure/tracheal tube size). Perform a Pre-use check. Check the alarm settings.
Regulation pressure limited	It is not possible to reach the Set volume in PRVC and VS, due to restrictions imposed by the set Upper pressure limit. Set high pressure alarm limit, limits the regulatory pressure used in PRVC or VS.	Check ventilator settings.
Remove one CO_2 module	Two CO_2 Analyzer modules are connected at the same time.	Remove one of the CO_2 Analyzer modules.
Respiratory Rate: High	Respiratory frequency too high. Auto triggering.	Attend to the patient. Check the trigger setting.
Respiratory Rate: Low	Respiratory frequency too low. Trigger sensitivity setting incorrect. Large tidal volume.	Attend to the patient. Check trigger setting. Check Inspiratory cycle-off setting.

Problem (Display message)	Possible cause	Remedy
VT inspiratory overrange	Setting causing larger volume than allowed for the selected category. Limited adjustment of too high tidal volume.	Check the adjustment for the inspiratory Tidal Volume.
Y Sensor mismatch	Y Sensor does not match the selected patient category	Check patient category setting. Check Y Sensor.
Y Sensor Module disconnected	Y Sensor module is not properly inserted.	Insert the Y sensor module.
Remove one Y Sensor Module	Two Y Sensor modules are connected at the same time.	Remove one of the Y Sensor modules.
Y Sensor Module error	Hardware error in the Y Sensor measuring module.	Check that the module is properly plugged in. Re-insert the module if necessary. If the error persists, it is probably hardware related. Change module. Contact a service technician.
Y Sensor Module temp high	Possible hardware error. The Y Sensor module temperature is higher than 60^{o} C.	Make sure that the Y Sensor Module is not exposed to extreme heat. If the error persists, it is probably hardware related. Change module. Call a service technician.
Y Sensor disconnected	Y Sensor is not attached.	Connect the sensor to the Y Sensor module.

10 Low priority alarms

Problem (Display message)	Possible cause	Remedy
Touch screen or knob press time exceeded	Screen or knob has been pressed for more than one minute. Screen or knob hardware time out.	Check screen and knobs. If the problem still remains contact a service technician.

Message	Description	Remedy if test fails
Cancelled	The test was cancelled by the user.	It is recommended to perform a Pre-use check before connecting the ventilator to a patient.
Failed	The test did not pass.	Check all connections and the Expiratory cassette. Perform a Pre-use check again. If the problem still exists please contact a service technician.
Not completed	The test was not completed.	*Not completed* means that the test case passed with some reservations. The message will be shown if: • The battery option is installed and the battery capacity is less than 10 minutes or • The test could not be completed due to a missing gas. **Note:** The ventilator may still be used (limited) if the message *Not completed* is shown. If the missing gas is applied a Pre-use check must be performed.
Passed	The test case has passed.	The function is working according to the test specification.
Running	A test is in process.	The message is flashing (white) during the test.

10 Pre-use check messages

Pre Use Check messages in detail

Test (Display message)	Description	Remedy, if test fails
Alarm state test	Checks that no Technical error alarms are active during the Pre-use check.	Refer to Service.
Barometer test	Checks the barometric pressure measured by the internal barometer	Check the Barometric pressure value in the Status window.
Battery switch test	If Battery modules are connected: Checks that the power supply switches to battery when mains power is disconnected. Checks that the power supply switches back to mains power when main is reconnected.	Check that the total remaining time for the connected battery modules are >10 min. If not, replace the discharged battery with a charged battery and repeat the test.
Flow transducer test	Checks the inspiratory flow transducers. Calibrates and checks the expiratory flow transducer.	Check that the connected gas supply pressure (Air and O_2) is within the specified range. Check that the cassette is correctly seated in the cassette compartment.
Gas supply pressure test	Checks that the gas supply pressures (Air and O_2) measured by the internal gas supply pressure transducers are within the specified range.	Check that the connected gas supply pressure (Air and O_2) is within the specified range.
Internal leakage test	Checks the internal leakage, with test tube connected, using the inspiratory and expiratory pressure transducers. Allowed leakage: 10ml/min at 80 cmH_2O.	If message ”Leakage” or ”Excessive leakage” appears: Check that the test tube is correctly connected. Check all connections for the expiratory cassette and inspiratory section. Make sure that the expiratory cassette and the inspiratory channel are well cleaned and dry. Refer to pages 191, 203 and 218. Contact a service technician.
Internal test	Audio test and other internal tests (memories, safety-related hardware, etc.).	Make sure that the Patient Unit front cover and the User Interface rear cover are correctly mounted, otherwise the audio test may fail.
O_2 cell / sensor test	Calibrates and checks the O_2 cell / sensor at 21% O_2 and 100% O_2. Checks if the O_2 cell is worn out. **Note:** As different gas mixtures are used during this test, calibration and check of O_2 cell / sensor will not be performed if one gas is missing.	Check that the connected gas supply pressure (Air and O_2) is within the specified range. Replace the O_2 cell. Replace gas modules (Air and/or O_2).

Test (Display message)	**Description**	**Remedy, if test fails**
Patient circuit leakage test	Checks the patient circuit leakage, with patient tubing connected, using the inspiratory and expiratory pressure transducers. Allowed leakage: 80 ml/min at 50 cmH_2O. Will allow the system to calculate a compensation for circuit compliance (if the leakage requirements are met).	If the internal leakage test has passed, the leakage is to be located to the patient circuit. Check for leakage or replace the patient circuit.
Y Sensor test	Checks the pressure and flow measurement of the Y Sensor.	Check Y module and Y Sensor. If problem persists, change Y sensor. If problem still presists, change Y module
Pressure transducer test	Calibrates and checks the inspiratory and expiratory pressure transducers.	If the Internal leakage test passed (see above): Check/replace Insp. or Exp. pressure transducer. Check that there is no excess water in the expiratory cassette. Refer to pages 202 and 203.
Safety valve test	Checks and if necessary adjusts the opening pressure for the safety valve to 117 ± 3 cm H_2O.	Check the inspiratory section: Check that the safety valve membrane is correctly seated in the inspiratory pipe. Check that the inspiratory pipe is correctly mounted in inspiratory section. Check that the safety valve closes properly when the Pre-use check is started (distinct clicking sound from the valve).

✗ CO_2 Analyzer - Calibration error messages

Error (Display message)	Description	Remedy, if calibration fails
Adapter zero: Failed	An error was detected during the verification calibration (adapter zero). The airway adapter is occluded or CO_2 gas is present in the adapter. The calibration was cancelled and old cell zero parameters were not restored.	Perform a verification calibration. If problem persists it may be a hardware error. Call a service technician.
CO_2 cell zero failed	An error was found during cell zero calibration. The calibration was cancelled and old cell zero parameters were not restored.	Perform a Cell zero calibration. If problem persists it may be a hardware error. Call a service technician.
Verification against Reference cell: Failed	The Capnostat sensor is faulty or there is an optical blockage of the Capnostat sensor windows.	Clean the Capnostat sensor windows. If the problem persists, replace the Capnostat sensor.

Error code no.	Possible cause/ part of sub system	Remedy
Technical error no. xxxx (General)	Technical problem, identified by the error code xxxx.	Restart the ventilator and perform a Pre-use check. If the problem still remains, take the unit out of operation and contact a service technician.
Technical error no. 1 - 6, 29, 10001	Power failure.	Contact a service technician.
Technical error no. 7, 10-11	Expiratory / Inspiratory channel failures.	Contact a service technician.
Technical error no. 12, 16	Connection failures.	Contact a service technician.
Technical error no. 25, 43	Communication failure.	Contact a service technician.
Technical error no. 27	Test of back-up sound device failed.	Restart the ventilator and perform a Pre-use check. If the problem still remains, take the unit out of operation and contact a service technician.
Technical error no. 28, 20004	Alarm sound level too low.	Check that the loudspeaker outlet is not obstructed. Restart the ventilator and perform a Pre-use check. If the problem still remains, take the unit out of operation and contact a service technician.
Technical error no. 38-39	Barometer failures.	Contact a service technician.
Technical error no. 8-9, 33-35, 41	Timeout failures.	Contact a service technician.
Technical error no. 46	Internal failure, Alarm output circuitry.	Contact a service technician.
Technical error no. 48	Timeout failures.	Contact a service technician.
Technical error no. 49	Timeout failures.	Contact a service technician.
Technical error no. 51	Technical problem with Y Sensor module.	Contact a service technician.
Technical error no. 20002	Backlight broken.	Contact a service technician.
Technical error no. 20003	Button stuck.	Check User Interface buttons. Contact a service technician.
Technical error no. 40001	Exp. flow meter failure.	Contact a service technician.
Technical error no. 22, 24,40, 42, 44, 45, 50 10002-10003, 20001	Various failures.	Contact a service technician.

10 Notes

11.Technical data

Contents

11 Technical data

The system

General

The device complies with requirements of Medical Device Directive 93/42/EEC.

Standards EN IEC 60 601-1 (Class 1, Type B).
IEC 60601-2-12
EN 794-1

Electromagnetic compatibility (EMC)
According IEC 60601-1-2, 2nd edition (2001)

Immunity: Extended test to 30V/m
The *EMC declaration, Information to the responsible organization* is available from MAQUET.

Patient range Adult (weight: 10-250kg)
Infant (weight: 0.5-30kg)

NIV (PC+PS) Infant range 3-30kg.

NIV Nasal CPAP Infant range 0.5-10kg

Operating conditions

Operating temperature range +10 to +40 ºC.

Relative humidity 15 to 95% non-condensing.

Atmospheric pressure 660 to 1060hPa.

Lowest pressure in patient circuit - 400 cmH_2O.

Impact
Peak acceleration: 15 g.
Pulse duration: 6 ms.
Number of impacts:1000.

Non-operating conditions

Storage temperature -25 to +60 ºC (-13 to 140 ºF).

Storage relative humidity < 95%.

Storage atmospheric pressure 470 — 1060hPa.

Power supply

Power supply, automatic range selection
100-120V ±10%, 220-240 V ±10%, AC 50-60Hz.

Battery backup
2– 6 battery modules rechargable 12 V, 3.5 Ah each. Recharge time approximately 3 h/battery. Battery backup time approximately 3 h, when using 6 batteries.

External 12V DC 12.0V - 15.0V DC, 10A

Caution: : When external +12 V DC is used, at least one installed Battery module is required to ensure proper operation.

Max power consumption
At 110-120V: 2A, 190VA, 140W.
At 220- 240V: 1A, 190VA, 140W.

The ventilator

General

Dimensions User Interface: W 355 x D 53 x H 295 mm, Patient Unit: W 300 x D 205 x H 415 mm.

Weight Approximately 20 kg
(User interface 5 kg, Patient Unit 15 kg).

Method of triggering Flow and pressure.

Gas supply

The gases supplied must be free from water, oil and particles and other contaminants.

Air: $H_2O < 7\ g/m^3$
Oil < 0.5 mg/m^3
Chlorine: Must not be detectable[1]

Oxygen: $H_2O < 20\ mg/m^3$

Inlet gas pressure 2 – 6.5 kPa x 100 (29 – 94 PSI).

Connection standards available AGA, DISS, NIST or French.

Patient system gas connectors

Conical fittings Male 22 mm and female 15 mm.
In accordance with ISO 5356-1.

Gas exhaust port Male 30 mm cone.

User Interface

Weight approximately 5 kg. Can be attached to the mobile cart, a table, railing or pipe (15 - 30 mm diameter).

1. If the compressed air is generated by a liquid ring compressor there is a potential risk of chlorine in the supplied air.

Standard condition specification

Inaccuracy in this document is given under the following standard conditions and for the worst case, i.e. all errors are summarized positive. Statistically 95% of all values will be within 2/3 of the given inaccuracy.

- Ambient pressure: 101.3 kPa
- Room temperature: 20 ºC
- Dry gases in patient system
- Inlet pressure: 4.3 kPa x 100
- Pre-use check performed on a warmed up ventilator
- Default settings unless otherwise specified

Inspiratory channel

Pressure drop Max. 6 cmH_2O at a flow of 1 l/s
Internal compressible factor Max. 0.1 ml/cmH_2O
Gas delivery system Microprocessor controlled valves
Gas delivery device

Flow range:	
Adult	0-3.3 l/s
Infant	0-0.55 l/s
Inaccuracy:	±5% or ± 0.1 ml/s
Pressure setting:	Max. 80/120 cmH_2O (Infant/Adult)
Inaccuracy:	± 5% or ± 1 cmH_2O[1]

NIV Max leakage compensation level:	
Adult	50 l/min
Infant	15 l/min
Infant Nasal CPAP	10 l/min

O_2 concentration	
Setting range:	21 - 100%
Inaccuracy:	± 3% O_2

Inspiratory Minute Volume

Adult	
Setting range:	0.5 - 60 l/min
Inaccuracy:	± 6%[2]
Infant	
Setting range:	0.3 - 20 l/min
Inaccuracy:	± 6%[3]

Inspiratory Tidal Volume

Adult	
Setting range:	100 - 2000/4000 ml
Inaccuracy:	± 7%[4]
Infant	
Setting range:	2 - 350 ml[5]
Inaccuracy:	± 6%[6]

1. at RR ≤ 100 b/min
2. at 2.5-60 l/min and set I:E<1:1
3. at 1-20 l/min and set I:E<1:1
4. at 400-4000 ml and set I:E<1:1

Expiratory channel

Pressure drop Max. 3 cmH_2O at a flow of 1 l/s
Internal compressible factor Max. 0.1 ml/cmH_2O
PEEP regulation Microprocessor controlled valve

PEEP setting range:	0 - 50 cmH_2O
Inaccuracy:	± 5% or ± 1 cmH_2O[7]
Expiratory flow measurements	
Flow range:	0 - 3.2 l/s
Rise time:	< 12 ms for 10 - 90% response at a flow of 0.05 - 3.2 l/s.
Inaccuracy:	± 5% or ± 2.5 ml/s

Monitoring

Expiratory Minute Volume

Adult	
Range:	0 - 60 l/min
Inaccuracy:	± 8% or ± 0.15 l/min[8]
NIV	± 10%[9]
Infant	
Range:	0 - 20 l/min
Inaccuracy:	± 8% or ± 0.15 l/min[10]
NIV	± 10%[11]
NIV, Nasal CPAP	± 25% or ± 0.15 l/min[12]

Expiratory Tidal Volume

Adult	
Range:	0 - 2000/4000 ml
Inaccuracy:	± 8% or ± 18 ml[13]
Infant	
Range:	0 - 350 ml
Inaccuracy:	± 8% or ± 2 ml[14]
O_2 concentration	
Range:	0 - 100%
Inaccuracy:	± 5% of read value
Airway pressure	
Range:	-40 - 160 cmH_2O
Inaccuracy:	± 5% or ± 1 cmH_2O
Supply pressure	
Range:	0 - 7 bar
Inaccuracy:	± 5% of read value

5. *Infant*: tidal volume range in volume controlled/supported modes is 2-350 ml. When the tidal volume is set below 5 ml, use of Y Sensor measuring is recommended to optimize monitoring of volumes.
6. at 20-350 ml and set I:E<1:1
7. at RR ≤ 60 b/min
8. at RR < 100 b/min
9. at constant leakage fraction <30%
10. at RR < 100 b/min
11. at constant leakage fraction <30%
12. at constant leakage fraction <30%
13. at Expiration time < 4 s and RR <100 b/min
14. at Expiration time < 1 s and RR <100 b/min

11 Technical data

Alarms

Airway pressure (upper) Adult: 16 - 120 cmH_2O. Infant: 16 - 90 cmH_2O.

High continuous pressure Set PEEP level + 15 cmH_2O exceeded for more than 15 seconds.

O_2 concentration Set value ±6vol% or ≤ 18 vol%.

Expired minute volume (Upper alarm limit) Adult: 0.5 – 60 l/min. Infant: 0.01 – 30 l/min.

Expired minute volume (Lower alarm limit) Adult: 0.5 – 40 l/min. Infant: 0.01 – 20 l/min.

Apnea Adult:15 - 45 s. Infant: 5 - 45 s.[1]

Gas supply Below 2.0 kPa x 100 and over 6.5 kPa x 100.

Respiratory frequency 1 – 160 b/min.

High end expiratory pressure 0 - 55 cmH_2O

Low end expiratory pressure 0 - 47 cmH_2O[2]

End-tidal CO_2 (upper and lower limit[3]) 0.5-20%, 4-100 mmHg, 0.5-14 kPa

CPAP (Upper alarm limit) Adult: 0-55 cmH_2O Infant: 0-55 cmH_2O **(Lower alarm limit)** Adult: 0-47 cmH_2O Infant: 0-47 cmH_2O

Battery alarms

Limited battery capacity: 10 min

Low battery voltage

No battery capacity: less than 3 min

Technical See table in chapter Troubleshooting.

Autoset (alarm limits) specification

High airway pressure:
Mean peak pressure +10 cmH_2O or at least 35 cmH_2O.

Upper minute volume:
Expiratory minute volume + 50%.

Lower minute volume:
Expiratory minute volume - 50%.

Upper respiratory frequency:
Breathing frequency + 40%.

Lower respiratory frequency:
Breathing frequency - 40%.

High end expiratory pressure:
Mean end expiratory pressure +5 cmH_2O

Low end expiratory pressure:
Mean end expiratory pressure -3 cmH_2O.

Upper end tidal carbon dioxide concentration ($etCO_2$):
end tidal carbon dioxide concentration + 25%

Lower end tidal carbon dioxide concentration ($etCO_2$):
end tidal carbon dioxide concentration - 25%

1. The apnea alarm can be turned off in Nasal CPAP.
2. **Note:** Setting the alarm to 0 (zero) is equal to alarm off.
3. In NIV low limit can be set to 0 (zero).

Audio pause (Alarm silence/reset) 2 minute silence and reset of latched alarms.

Ventilation modes

Controlled ventilation:
Pressure Control (PC) Pressure controlled ventilation.

Volume Control (VC) Volume controlled ventilation.

Pressure Reg. Volume Control (PRVC) Pressure regulated volume controlled ventilation.

NIV Pressure Control Non-invasive Pressure controlled ventilation.

Supported ventilation:

Volume Support (VS) Volume supported ventilation.

Pressure Support (PS)/CPAP Pressure supported ventilation / Continuous positive airway pressure ventilation.

NIV Pressure Support Non-invasive Pressure supported ventilation.

Nasal CPAP Nasal Continuous positive airway pressure ventilation.

Combined ventilation:
SIMV (VC) + PS Synchronized intermittent mandatory ventilation based on volume controlled ventilation with pressure support.

SIMV (PC) + PS Synchronized intermittent mandatory ventilation based on pressure controlled ventilation with pressure support.

SIMV (PRVC) + PS Synchronized intermittent mandatory ventilation based on pressure regulated volume controlled ventilation with pressure support.

Bi-Vent Pressure controlled ventilation that allows the patient the opportunity of unrestricted spontaneous breathing.

Automode

Control mode		***Support mode***
VC	<---------- ---------->	VS
PC	<---------- ---------->	PS
PRVC	<---------- ---------->	VS

In Servo-i flow measurements and all preset and indicated volumes are referenced to ambient pressure at +21°C (AP21).

Trend function

Peak Airway Pressure	Ppeak
Pause Airway Pressure	Pplat
Mean Airway Pressure	Pmean
End Expiratory Pressure	PEEP
Continuous Positiv Airway Pressure	CPAP
Spontaneous breaths per minute	RRspont
Breathing frequency	RR
Spontaneous Exp. Minute Volume	MVe sp
Inspired Minute Volume	MVi
Expired Minute Volume	MVe
Leakage fraction (%)	Leakage
Inspired Tidal Volume	VTi
Expired Tidal Volume	VTe
End Expiratory Flow	$\dot{V}_{ee}$
Measured Oxygen concentration	O_2
CO_2 End tidal concentration	$etCO_2$
CO_2 Minute elimination	$\dot{V}CO_2$
CO_2 Tidal elimination	$VTCO_2$
Dynamic Characteristics	Cdyn
Static Compliance	Cstatic
Elastance	E
Inspiratory Resistance	Ri
Expiratory Resistance	Re
Work of Breathing ventilator	WOB v
Work of Breathing patient	WOB p
P0.1	P0.1
Shallow Breathing Index (SBI)	SBI

X Open lung tool trend

EIP

PEEP

VT_i

VT_e

C dyn i

$VTCO_2$ (X CO_2 Analyzer)

Log function

Event log

Alarms

Ventilator settings

Apnea periods

Immediate functions

Service log

Technical alarms

Test results

Preventive maintenance

Service report history

Configuration log

Note: For access the logs refer to page 268.

11 Technical data

Immediate functions

Oxygen breaths 100% for 1 minute.

Start breath Initiation of 1 breath in all modes. (In SIMV mode initiation of 1 mandatory breath).
Pause hold inspiratory or expiratory

Communication/Interface

Serial port RS-232C - isolated. For data communication via the *Communication Interface Emulator (CIE).*

Alarm output connection option - isolated 4-pole modular connector for communication of high and medium priority alarms. The Alarm output connection option is a non- guaranteed alarm according to IEC60601-1-8. Max 40 V DC, Max 500 mA, Max 20 W.

Data transfer via Ventilation record card Servo-i File format: Unicode (big endian). Layout format and software requirements: For PC Microsoft Excel 2000 with Visual Basic for applications.

Service

- A preventive maintenance, according to corresponding chapter in the Service manual, must be performed by authorized personnel at least once every year as long as the unit is not used more than normal. Normal operation during one year is estimated to correspond to approximately 5000 hours of operation. The current operating time is presented under the *Status* menu on the user interface.
- Battery modules must be replaced after 3 years.
- Original parts from MAQUET must be used.
- Service repair must be done only by MAQUET authorized personnel.
- Service mode should only be used without a patient connected to the ventilator.

Servo Ultra Nebulizer

Patient Unit

Weight Approximately 125 g.

Dimensions W 60 mm x L 108 mm x H 105 mm.

Nebulizer T-piece connections Inlet/outlet: 22/15 mm outer/inner diameter and 22 mm inner diameter, ISO standard. Infant patient tubing: Nipple connectors 22/10 mm outer diameter and 15/10 mm, outer diameter.

Internal volume 60 ml.

Ultrasonic generator frequency 2.4 MHz.

Particle size (water) Mass Median Diameter (MMD) = approximately 4.0 µm, measured distally in endotracheal tube 8 mm inner diameter.

Output from nebulizer (water)
Minimum water flux:
0.1 ml/min at gas flow 0.1l/s
0.3 ml/min at gas flow 0.5l/s
0.5 ml/min at gas flow 1.0l/s.
Buffer liquid Sterile water.

Max. medication temperature 55° C (131° F).

Volume, medication cup Max. 10 ml.

Noise level Max. 50 dBA, measured at 0.3 m distance.

Connection cable

Length 2.0 m.

Note: For information about the stand alone Aeroneb Professional Nebulizer System, refer to separate manual.

X CO_2 Analyzer Servo-i

General

Standard compliance EN864, ISO9918.

Classification Class I equipment. According to IEC 60 601-1/EN 60 601-1. Type BF.

Size

CO_2 Analyzer module 154 x 90 x 43 mm

Sensor 32.0 x 42.4 x 21.6 mm

Weight

CO_2 Analyzer module 0.45 kg

Sensor 18 g

Airway adapter 10 g

Connectors and cables

CO_2 Analyzer module 15-pole D-sub female connector.

Sensor 20-pole, 2.4 m cable.

Power source

CO_2 Analyzer module Supply voltage: powered from the Servo-i. Power consumption:

- ≤ 8 W at 12V, during warm up.
- ≤ 6.5 W at 12V, during normal operation.

Sensor powered from the CO_2 Analyzer module.

Performance

Measuring method Mainstream, dual-wavelength, non-dispersive infrared.

Stability (within 8-hour period) 0 to 100 mmHg ±2mmHg, 0 to 13.3 kPa ±0.3 kPa, 0 to 13.2% ±0.3% (at a barometric pressure of 1013hPa).

Measuring range

0 to 100 mmHg CO_2 partial pressure
0 to 13.3 kPa CO_2 partial pressure
0 to 13.2% CO_2 volume (at a barometric pressure of 1013hPa).

Accuracy

0 to 40 mmHg ±2mmHg,
41 to 70 mmHg ±5% of reading,
71 to 100 mmHg ±8% of reading,

0 to 5.3 kPa ± 0.3 kPa,
5.4 to 9.3 kPa ± 5% of reading,
9.4 to 13.3 kPa ±8% of reading,

0 to 5.3% ±0.3%,
5.4 to 9.2% ±5% of reading,
9.3 to 13.2% ±8% of reading.

Measurement conditions CO_2 minute elimination and CO_2 tidal elimination measurements are referenced to standard temperature and pressure (STP). Standard gas mixture of CO_2, balance saturated air at 33° C, barometric pressure 1013 hPa, gas flow rate 2 l/mm, halogenated hydrocarbons <5%.

Step response time <25 ms (10 to 90% step response)

Warm-up time 30 s to initial CO_2 indication, max. 5 min to full specification.

Oxygen concentration compensation Automatic. Values supplied from the Servo-i Ventilator System.

Barometric pressure compensation Automatic. Values supplied from the Servo-i Ventilator System.

Digitizing rate 87 Hz

Airway adapter dead space Adult <5 cm^3. Infant <0.5 cm^3

11 Technical data

Y Sensor measuring

Size:
– Y Sensor Module 154 x 90 x 43 mm
– Y sensor adult Length 84 mm
– Y sensor infant Length 51 mm
Weight:
– Y Sensor Module 0.4 kg
– Y sensor adult 10.5 g
– Y sensor infant 7.5 g
Sensor material: Makrolon polycarbonate
Tubing: 2.0 m. Medical grade PVC.
Power source:
– Y Sensor Module supply voltage Powered from Servo-i
< 5 W at 12 V (normal operation)
Y sensor measuring – Performance
Measuring method: Fixed orifice, differential pressure
Parameters: Airway pressure, Airway flow, Inspiratory and expiratory volumes
Measuring range:
– Adult 2 to 180 l/min
– Infant 0.125 to 40 l/min
Airway adapter dead space:
– Adult < 9.0 ml
– Infant < 0.45 ml

Mobile cart Servo-i

Weight 20 kg
Dimensions W 542 mm x L 622 mm x H 1010 mm.

Drawer Kit Servo-i

Weight 4.5 kg
Dimensions W 300 mm x L 210mm x H 240mm.

Holder Servo-i

Weight 3.5 kg
Dimensions W 159 mm x L 247 mm x H 352 mm.

Shelf base Servo-i

Weight 1.2 kg
Dimensions W 159 mm x L 205 mm x H 29 mm.

Gas cylinder restrainer Servo-i

Max load Two 5-litre bottles.

IV Pole

Max load (total) 6 kg.

Gas trolley Servo-i

Max load Two10 kg bottles.

Compressor Mini

Dimensions W 430,D 330,H 250 mm
Weight Approximately 26 kg (70 lbs)
Power supply 115 V AC,60 Hz, 220 –240 V AC,50 Hz

Compressor capacity
Continuous flow at normal atmospheric pressure (approx.1013 hPa) 30 l/min (expanded to ambient air pressure) at 3.5 kPa x 100 (bar)/50 psi.
For more information refer to Compressor Mini Data Sheet.

Default values and parameter settings
(standard configuration)

Parameter	Factory set default				Setting range			
	Infant	*Adult*	*Universal*		*Infant*	*Adult*	*Universal*	
			Infant	*Adult*			*Infant*	*Adult*
Automode ON/OFF	OFF	OFF	OFF	OFF	ON/OFF	ON/OFF	ON/OFF	ON/OFF
Automode trigger timeout (s)	3	7	3	7	3 - 7	7 - 12	3 - 7	7 - 12
Backup pressure above PEEP	10	20	10	20	5-(80-PEEP)	5-(120-PEEP)	5-(80-PEEP)	5-(120-PEEP)
Backup Ti (s)	0.5	1.0	0.5	1.0	0.3-1	0.5-2	0.3-1	0.5-2
Bias flow (l/min)	0.5	2	0.5	2	-	-	-	-
Breath cycle time, SIMV (s)	1	4	1	4	0.5 - 15	1 - 15	0.5 - 15	1 - 15
CMV frequency (b/min)	30	15	30	15	4 - 150	4 - 100	4 - 150	4 - 150
Compensate for compliance	OFF	OFF	OFF	OFF	ON/OFF	ON/OFF	ON/OFF	ON/OFF
CPAP (cmH_2O) in NIV Nasal CPAP	5	-	5	-	2-20	-	2-20	-
Flow trig sensitivity level (fraction of bias flow)	50%	50%	50%	50%	0-100%	0-100%	0-100%	0-100%
I:E ratio	1:2	1:2	1:2	1:2	1:10-4:1	1:10-4:1	1:10-4:1	1:10-4:1
Inspiratory cycle-off (% of peak flow)	30	30	30	30	1 - 70	1 - 70	1 - 70	1 - 70
Inspiratory cycle-off (% of peak flow) in NIV	30	50	30	50	10-70	10-70	10-70	10-70
Inspiratory rise time (%)	5	5	5	5	0 - 20	0 - 20	0 - 20	0 - 20
Inspiratory rise time (s)	0.15	0.15	0.15	0.15	0 - 0.2	0 - 0.4	0 - 0.2	0 - 0.4
Inspiratory rise time (s) in NIV	0.15	0.2	0.15	0.2	0 - 0.2	0 - 0.4	0 - 0.2	0 - 0.4
Maximum inspiratory flow (l/s)	0.56	3.3	0.56	3.3	-	-	-	-

11 Default values and parameter settings

Parameter	Factory set default				Setting range			
	Infant	*Adult*	*Universal*		*Infant*	*Adult*	*Universal*	
			Infant	*Adult*			*Infant*	*Adult*
Maximum permitted absolute pressure (cmH_2O)	80	120	80	120	-	-	-	-
Minute Volume (l/min)	-	7.5	2.4	7.5	-	0.5-60	0.3-20	0.5-60
Mode (in NIV)	PS	PS	PS	PS	-	-	-	-
Mode (Invasive ventilation)	PC	VC	PC	VC	-	-	-	-
Nebulizer	OFF	OFF	OFF	OFF	ON/OFF	ON/OFF	ON/OFF	ON/OFF
Nebulizer time (min)	10	10	10	10	5 - 30	5 - 30	5 - 30	5 - 30
NIV Rate (b/min)	4	4	4	4	4-40	4-20	4-40	4-20
O_2 concentration (%)	40	40	40	40	21 - 100	21 - 100	21 - 100	21 - 100
PEEP (cmH_2O)	5	5	5	5	0 - 50	0 - 50	0 - 50	0 - 50
PEEP in NIV (cmH_2O)	5	5	5	5	2-20	2-20	2-20	2-20
Phigh (cmH_2O)	15	15	15	15	(PEEP+1) - 50	(PEEP +1) - 50	(PEEP +1) - 50	(PEEP +1) - 50
Press trig sensitivity level (cmH_2O)	-	-	-	-	-20 - 0	-20 - 0	-20 - 0	-20 - 0
Pressure level above PEEP (cmH_2O)	20	20	20	20	0 - (80 - PEEP)	0 - (120 - PEEP)	0 - (80 - PEEP)	0 - (120 - PEEP)
Pressure level above PEEP in NIV (cmH_2O)	5	5	5	5	0-(32-PEEP)	0-(32-PEEP)	0-(32-PEEP)	0-(32-PEEP)
PS above PEEP (cmH_2O)	0	0	0	0	0-(80-PEEP)	0-(120-PEEP)	0-(80-PEEP)	0-(120-PEEP)
PS above Phigh (cmH_2O)	0	0	0	0	0-(80-P_{High})	0-(120-P_{High})	0-(80-P_{High})	0-(120-P_{High}
SIMV frequency (b/min)	20	5	20	5	1 - 60	1 - 60	1 - 60	1 - 60
Thigh (s)	1	2	1	2	0.2 - 10	0.2 - 10	0.2 - 10	0.2 - 10
Ti (s)	0.5	0.9	0.5	0.9	0.1-5	0.1-5	0.1-5	0.1-5
Tidal Volume (ml)	-	500	80	500	-	100-2000	5 - 350	100-4000

Parameter	Factory set default				Setting range			
	Infant	*Adult*	*Universal*		*Infant*	*Adult*	*Universal*	
			Infant	*Adult*			*Infant*	*Adult*
Tpause (%)	-	10	10	10	-	0 - 30	0 - 30	0 - 30
Tpause (s)	-	0.4	0.2	0.4	-	0-1.5	0 - 1.5	0-1.5
TPEEP (s)	1	2	1	2	0.2 - 10	0.2 - 10	0.2 - 10	0.2 - 10
Weight (kg)	3	50	3	50	0.5 - 30	10- 250	0.5 - 30	10- 250

11 Default values and parameter settings

Alarm limits	Factory set default				Setting range			
	Infant	*Adult*	*Universal*		*Infant*	*Adult*	*Universal*	
			Infant	*Adult*			*Infant*	*Adult*
Airway pressure, upper limit (cmH_2O)	40	40	40	40	16 - 90	16-120	16 - 90	16 - 120
Airway pressure, upper limit (cmH_2O) in NIV	20	20	20	20	16 - 60	16-60	16 - 60	16 - 60
Apnea, time till alarm (s)	10	20	10	20	5 - 45	15 - 45	5 - 45	15 - 45
CPAP high limit (cmH_2O)	10	10	10	10	0 - 55	0 - 55	0 - 55	0 - 55
CPAP lower limit (cmH_2O) **Note:** Setting the alarm to 0 (zero) is equal to alarm off.	10	10	10	10	0 - 47	0 - 47	0 - 47	0 - 47
End expiratory pressure, high limit (cmH_2O)	10	10	10	10	0 - 55	0 - 55	0 - 55	0 - 55
End expiratory pressure, lower limit (cmH_2O) **Note:** Setting the alarm to 0 (zero) is equal to alarm off.	10	10	10	10	0 - 47	0 - 47	0 - 47	0 - 47
$etCO_2$ lower limit								
%	4.0	4.0	4.0	4.0	0.5-20	0.5-20	0.5-20	0.5-20
mmHg	30	30	30	30	4-100	4-100	4-100	4-100
kPa	4.0	4.0	4.0	4.0	0.5-14	0.5-14	0.5-14	0.5-14

$etCO_2$ lower limit in NIV **Note:** In NIV low limit can be set to 0 (zero).								
%	4.0	4.0	4.0	4.0	0 - 20	0 - 20	0 - 20	0 - 20
mmHg	30	30	30	30	0 - 100	0 - 100	0 - 100	0 - 100
kPa	4.0	4.0	4.0	4.0	0 - 14	0 - 14	0 - 14	0 - 14

Alarm limits	**Factory set default**				**Setting range**			
	Infant	*Adult*	*Universal*		*Infant*	*Adult*	*Universal*	
			Infant	*Adult*			*Infant*	*Adult*
$etCO_2$ upper limit **Note:** In NIV low limit can be set to 0 (zero).								
%	6.5	6.5	6.5	6.5	0.5-20	0.5-20	0.5-20	0.5-20
mmHg	49	49	49	49	4-100	4-100	4-100	4-100
kPa	6.5	6.5	6.5	6.5	0.5-14	0.5-14	0.5-14	0.5-14
Expired minute volume, lower limit (l/min)	2.0	5.0	2.0	5.0	0.01-20.0	0.5 - 40.0	0.01-20.0	0.5 - 40.0
Expired minute volume, upper limit (l/min)	5.0	40.0	5.0	40.0	0.01-30.0	0.5 - 60.0	0.01 - 30.0	0.5 - 60.0
Respiratory frequency, lower limit (b/min)	20	5	20	5	1 - 160	1 - 160	1 - 160	1 - 160
Respiratory frequency, upper limit (b/min)	50	30	50	30	1 - 160	1 - 160	1 - 160	1 - 160

Always make sure that relevant values are set.

Default values are set:

- during power up
- when admitting a new patient
- when changing ✗ type of ventilation or
- when changing ✗ patient category.

11 Notes

b/min Breaths per minute.

Bias flow The continuous flow during the expiratory phase.

Breath cycle time Total cycle time per mandatory breath in SIMV (inspiratory + pause + expiratory). Set in seconds.

Cdyn Dynamic characteristics.

CMV Controlled Mechanical Ventilation.

CPAP Continuous Positive Airway Pressure.

Cstatic Static compliance, respiratory system.

E Elastance.

etCO_2 End tidal carbon dioxide concentration.

Expiratory hold Manual closure of inspiration and expiration valves after expiration (max. 30 seconds). Measures Total PEEP.

Flow sensitivity level The flow which the patient must inhale to open the ventilator for, and start, an inspiration (fraction of the bias flow).The trigger functionality is set for either pressure or flow sensitivity.

HME Heat and moisture exchanger.

I:E Inspiration to Expiration ratio (only during controlled ventilation).

Inspiratory hold Manual closure of inspiration and expiration valves after inspiration (max. 30 seconds). Measures plateau pressure.

Inspiratory cycle-off Fraction of maximum flow at which inspiration should switch to expiration (%).

Inspiratory rise time Time to full inspiratory flow or pressure at the start of each breath, as a percentage or in seconds of the breath cycle time (% or s).

Leakage (%) Leakage during inspiration.

Minute Volume Volume per minute or target volume (l).

MVe expiratory Minute Volume.

MVe **sp** Spontaneous expiratory minute volume.

MVe **sp / MVe** The relation between spontaneous expired minute volume and total expired minute volume (only applicable in Bi-Vent).

MV_i inspiratory Minute Volume.

O_2 Oxygen concentration in vol.%.

O_2 breaths 100% oxygen for one minute. Can be interrupted by pressing the key again within one minute.

Option Optional, add-on functionality or accessory.

NIV Non Invasive Ventilation.

NIV Rate (b/min) Rate of controlled mandatory breaths in NIV in absence of spontaneous breathing.

P Pressure.

P0.1 Indicator for respiratory drive.

Pause time Time for no flow or pressure delivery (%).

PC Pressure Control.

PEEP Positive end expiratory pressure (cmH_2O).

Paw Airway pressure.

Ppeak Max. inspiratory pressure.

Phigh High pressure level.

Pmean Mean airway pressure.

P_{plat} Pressure during end-inspiratory pause.

PRVC Pressure regulated Volume Control.

PS Pressure Support.

PS above Phigh Inspiratory pressure support level for breaths triggered during the T_{High} period in Bi-Vent (cmH_2O).

PS above PEEP Inspiratory pressure support level for breaths triggered during the T_{PEEP} period in Bi-Vent (cmH_2O).

12 Abbreviations and definitions

Re expiratory resistance.

RH Relative Humidity.

Respiratory Rate Rate of controlled mandatory breaths or used for calculation of target volume (b/min).

Ri inspiratory resistance.

RR Respiratory Rate.

Service card Field Service Software card.

SIMV Synchronized Intermittent Mandatory Ventilation.

SIMV rate Rate of controlled mandatory breaths (b/min).

Start breath Manually triggered set breath.

T Time.

Tc Time constant.

Ti Inspiration time.

Ti/Ttot Duty cycle or ratio of inspiration time to total breathing cycle time (only during spontaneous breathing).

Tidal Volume Volume per breath or target volume (ml).

Thigh Time at Phigh level in Bi-Vent (s).

TPEEP Time at *PEEP* level in Bi-Vent (s).

$\dot{V}$ Flow.

$\dot{V}$ **CO_2** CO_2 Minute elimination.

$\dot{V}$**leak** Leakage flow (l/min).

Ventilation record card Documentation card.

$VTCO_2$ CO_2 Tidal elimination.

Va Alveolar ventilation.

VC Volume Control.

VDaw Airway dead space.

$\dot{V}_{ee}$ End expiratory flow.

VS Volume Support.

VTA Alveolar Tidal Volume.

VTe Expiratory Tidal Volume.

VTi Inspiratory Tidal Volume.

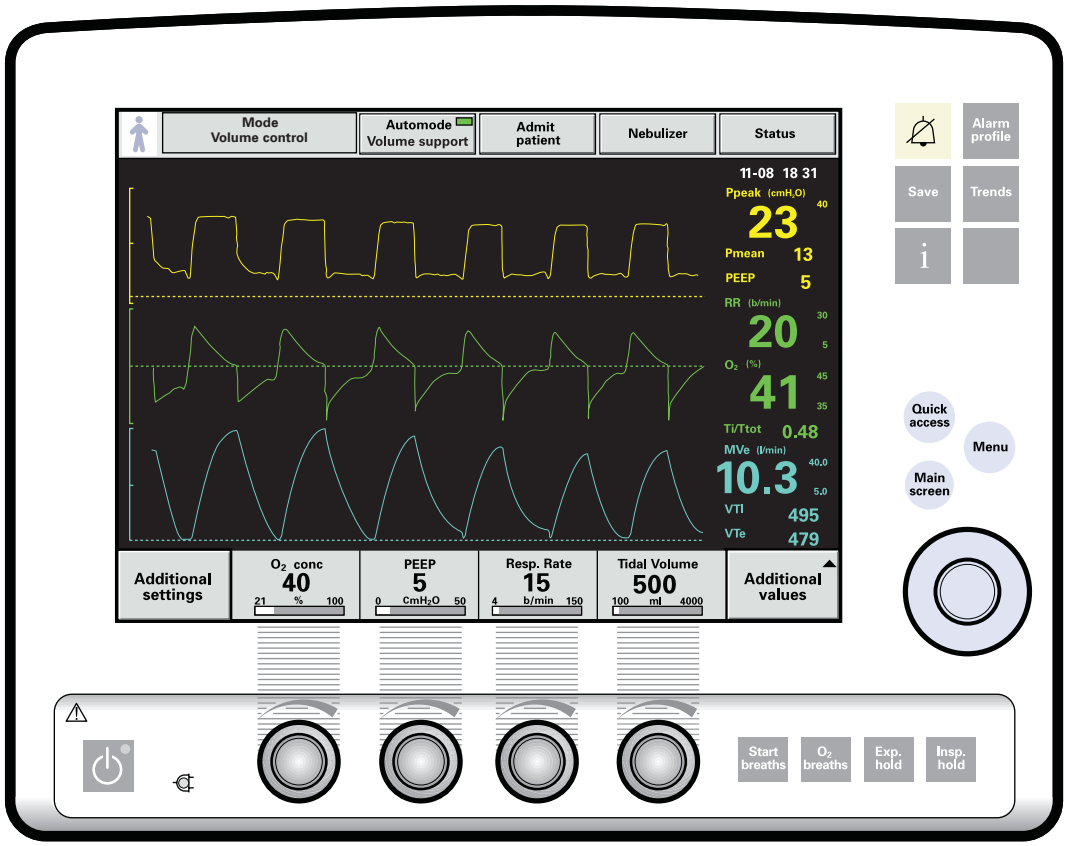
Notes 12

12 Notes

13.Appendix: User Interface

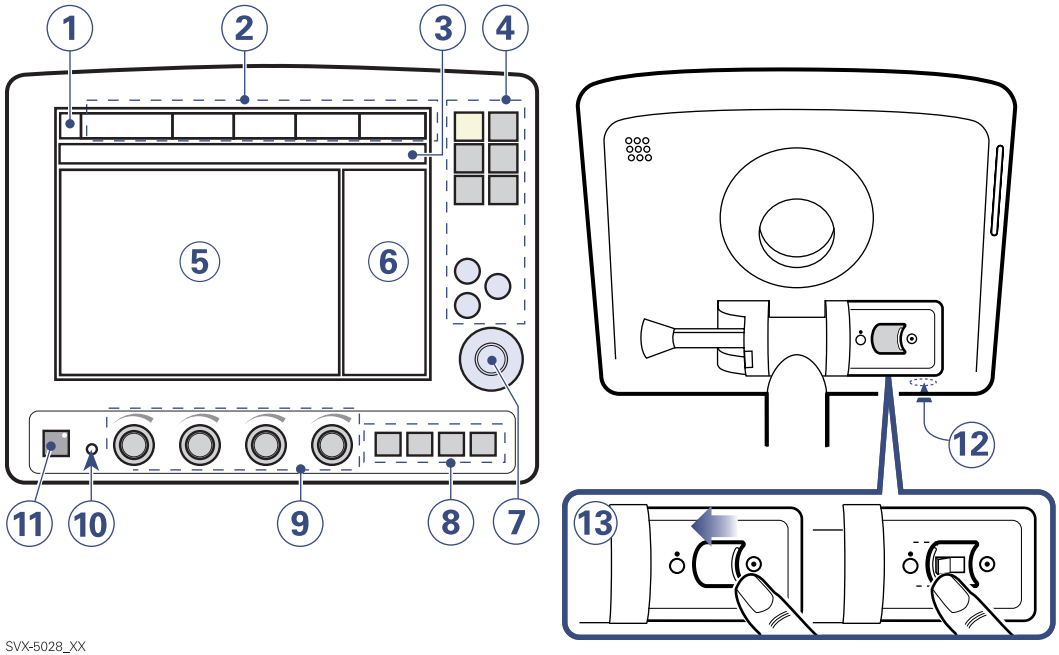
Contents

13 General



SVX-5001_EN

The User Interface is ergonomically designed. You can operate the unit via the soft keys on the touch screen or by means of the knobs or dial and fixed keys. There is a Main Rotary Dial, fixed keys and Direct Access Knobs which allow immediate adjustments. Data can be shown as wave forms, numerical displays and/or loops. The measured value boxes are always available while you are setting the ventilator. Screen brightness is automatically adjusted depending on the ambient light levels.

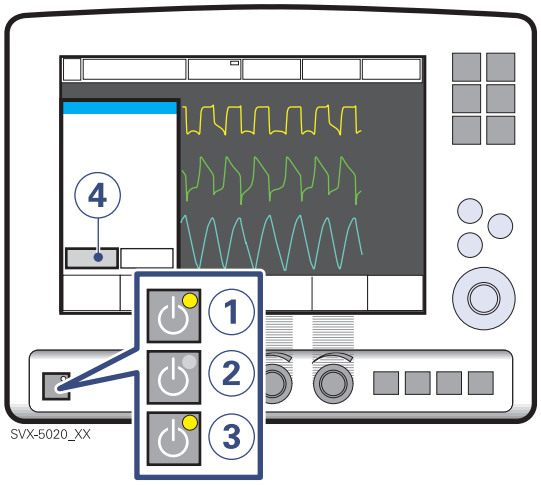


SVX-5028_XX

1. Patient category
2. Menu touch pad
3. Text and alarm messages
4. Fixed keys
5. Waveform area
6. Measured value boxes
7. Main Rotary Dial
8. Special function keys
9. Direct Access Knobs
10. Mains indicator (green)
11. Start ventilation/Stop ventilation (Standby)
12. Service connector
13. On/Off switch (rear side)

13 Start / Stop (Standby) key, Main Rotary Dial

Start/Stop Ventilation (Standby)

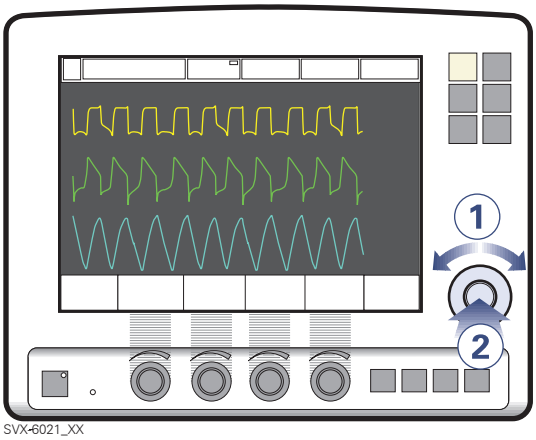


SVX-5020_XX

Start/Stop ventilation (Standby).

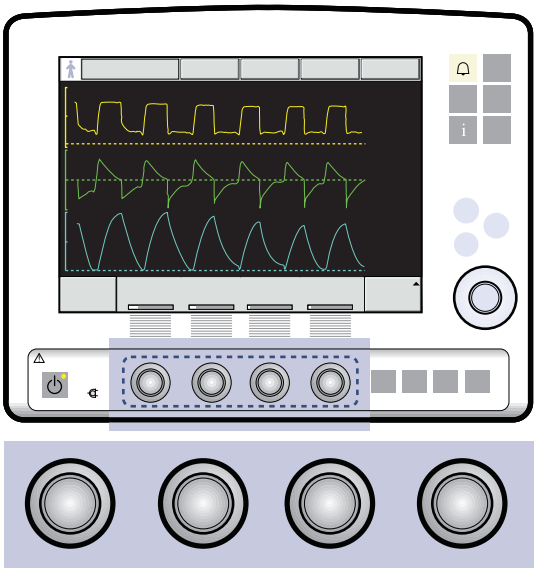
1. Standby:
2. Condition for warming up the ventilator electronics.
3. Condition after Pre-use check, ready to use.
4. Standby: push to start ventilation.
5. Stop ventilation, i.e. set to Standby:
6. Push the fixed Start/Stop ventilation (Standby) key.
7. Press on the Yes pad to stop ventilation.

Main Rotary Dial



SVX-6021_XX

The Main Rotary Dial is a hardware dial that provides a means of selecting on-screen elements and changing values by turning and pressing.The Main Rotary Dial can be turned (1) either clockwise or counter clockwise and then it is pressed (2) to select the value given.

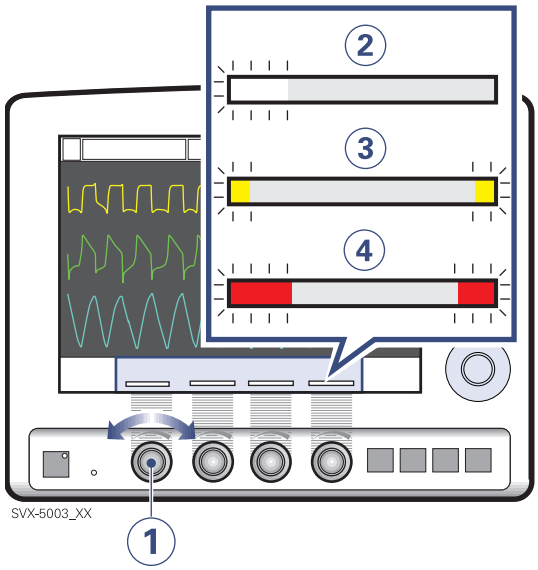


SVX-6020_XX

The Direct Access Knobs allow for immediate adjustment of vital parameters:

- O2 concentration
- PEEP-level
- Respiratory Rate
- Tidal/Minute volume/Pressure above PEEP.

Which vital parameters are available depends upon the ventilation mode you are in and how the ventilator is configured.



SVX-5003_XX

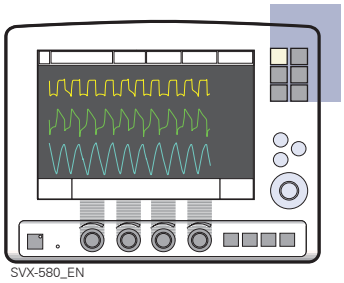
The four Direct Access Knob parameters are automatically selected depending on the active mode of ventilation.

1. Turn the knob to the desired value shown in the corresponding Set parameter box above the knob.
2. If the bar is white, the setting is within what is generally considered safe limits.
3. If the bar turns yellow, the setting is too low or too high compared to what are generally considered safe limits (advisory information).
4. If the bar turns red, the setting is significantly outside what are generally considered safe limits (advisory warning, accompanied by an audible signal and an advisory message).

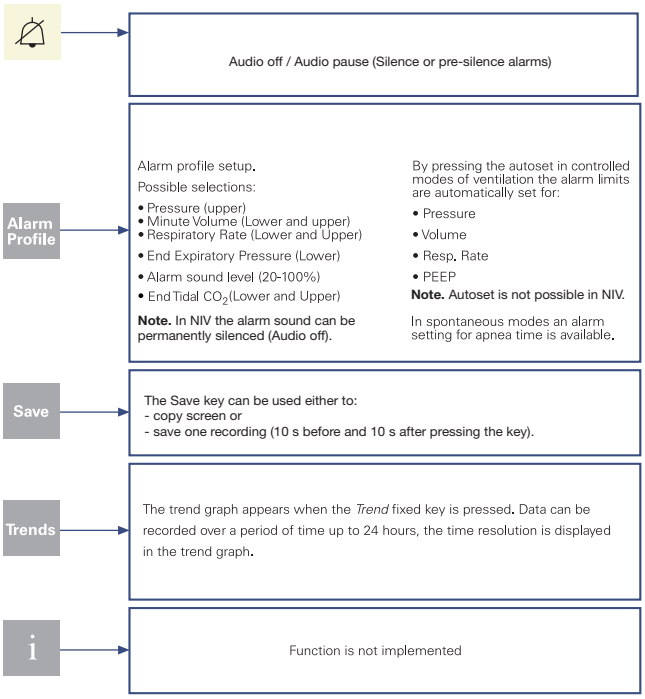
When you come to a safety limit, the knob is inactive during 2 seconds. This is a safety precaution, intended to make you aware of that you have passed a safety limit.

WARNING! When you turn a Direct Access Knob, ventilation will change accordingly. from the next breath without additional confirmation.

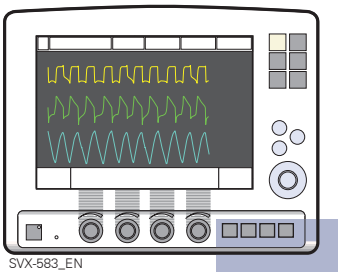
Fixed keys



SVX-580_EN



Special function keys



SVX-583_EN

Start breaths

The ventilator will initiate a new breath cycle according to the current ventilator settings.

O_2-breaths

This function allows 100 % oxygen to be given for 1 minute.
After this time the oxygen concentration will return to the pre-set value.
The oxygen breaths can be interrupted by repressing the *O_2 breaths* fixed key during the 1 minute interval.

Note. If O2 Breaths is activated during the pre- or post-oxygenation phase in Suction Support the procedure will be discontinued.

Exp. hold

Expiratory hold is activated by manually pressing the fixed key. The maximum time is 30 seconds. The inspiratory and expiratory valves close after expiration.
This function can provide an exact measurement of the end expiratory lung pressure. It can be used for static compliance measurement and to determine the total PEEP.

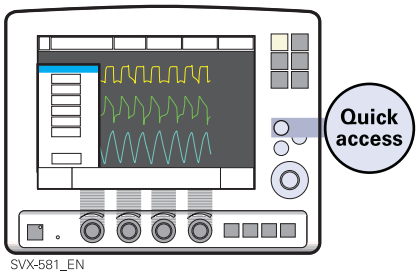
Note. Expiratory hold is not available in Nasal CPAP.

Insp. hold

Inspiratory hold is activated by manually pressing the fixed key. The maximum time is 30 seconds. The inspiratory and expiratory valves close after inspiration.
This function can provide an exact measurement of the end inspiratory lung pressure. It can be used during x-ray or to determine Plateau pressure, or static compliance calculation.

Note. Inspiratory hold is not available in Nasal CPAP.

Quick access key



Suction Support

This function allows the user to disconnect the patient from the ventilator and turning off the alarms (for apnea, minute volume, frequency alarm, check tubing, EtCO2, low PEEP) during suction support.

Note. Suction Support is not available when NIV or O2 Breaths is activated.

Loops

Loops are graphs that show two measured values: one measured value (x-axis) against another measured value (y-axis). Loops are updated breath by breath.

Two loops are available:

- volume-pressure
- flow-volume

Note. A reference loop can be saved by the user.

Scales

Waveform scaling.

- Pressure scale
- Flow scale
- Volume scale
- CO_2 scale

These three scales are by default set to automatic scaling.
The sweep speed, mm/s, can be set to 6, 10 or 20 mm/s (default).

Waveform configuration

Possibility to increase the space viewing the waveform curves. This in turns means that more detailed information can be gained.

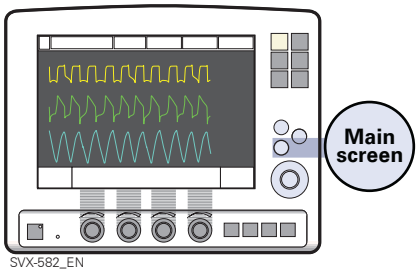
Open Lung Tool

The Open Lung Tool assists in alveolar recruitment procedures. The screen gives information about End inspiratory pressure (EIP) and PEEP inspiratory and expiratory Tidal Volume as well as Dynamic Compliance (Cdyn i).

Note. Open Lung Tool is not available in NIV

Open Lung Tool scales

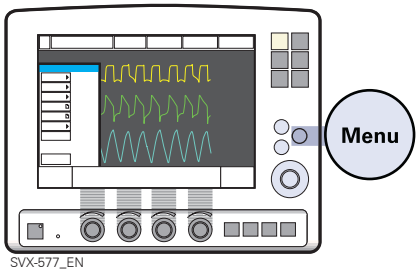
Main Screen key



SVX-582_EN

Main screen → The *Main screen* fixed key will return you to the Main screen, cancelling current work, from wherever you are in the Menu/dialog windows.

Menu key (in Standby mode)



SVX-577_EN

Alarm

Profile

Alarm profile setup

Possible selections:
- Pressure (upper)
- Minute Volume (lower and upper)
- Respiratory Rate (lower and upper)
- End Expiratory Pressure (lower)
- Alarm sound level (20-100%)
- End Tidal CO2 (lower and upper)

By pressing the autoset in controlled modes of ventilation the alarm limits are automatically set for:
- Pressure
- Volume
- Resp.Rate
- PEEP

In spontaneous modes an alarm setting for apnea time is available.

Note. In NIV the alarm sound can be permanently silenced (Audio off).

Note. Autoset is not possible in NIV.

History

This shows alarms that have been activated. The alarms are listed in chronological order.

Audio off / Audio pause (Silence or pre-silence alarms)

Review

Review trends, recorded waveforms, event log or configuration.

Options

CO_2 Calibration

Compliance comp.

The calculation of the circuit Compliance value is performed during Pre-use check.

The calculated value is displayed in the window.To activate or to deactivate select the appropriate soft key.

Copy data

Copy data

Copy data (event log, recordings, trends, OLT data, Start-up configuration) to PC Card.

Copy screen

Copy screen to PC Card.

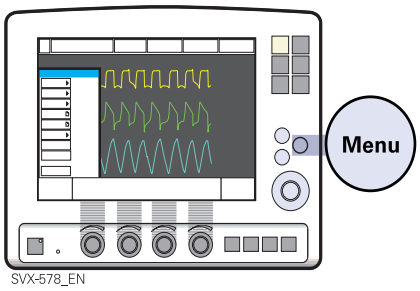
Biomed

For more information, refer to heading "Biomed in standby mode" in this chapter.

Panel lock

Locks all user input functions on the User Interface. Press "Main screen" fixed key to unlock.

Menu key (during ventilation)



SVX-578_EN

Alarm

- Profile
  - **Alarm profile setup**
    Possible selections:
    - Pressure (upper)
    - Minute Volume (lower and upper)
    - Respiratory Rate (lower and upper)
    - End Expiratory Pressure (lower)
    - Alarm sound level (20-100%)
    - End Tidal CO2 (lower and upper)

    By pressing the autoset in controlled modes of ventilation the alarm limits are automatically set for:
    - Pressure
    - Volume
    - Resp.Rate
    - PEEP

    In spontaneous modes an alarm setting for apnea time is available.

    Note. In NIV the alarm sound can be permanently silenced (Audio off).

    Note. Autoset is not possible in NIV.
- History → This shows alarms that have benn activated. The alarms are listed in chronological order.
- 🔕 → Audio off / Audio pause (Silence or pre-silence alarms)

Review

- Trends
- Recorded waveforms
- Event log
- View configuration

→ Review trends, recorded waveforms, event log or configuration.

Options → CO_2 Calibration

Compliance comp. → The calculation of the circuit Compliance value is performed during Pre-use check. The calculated value is displayed in the window.To activate or to deactivate select the appropriate soft key.

Copy

- Copy data → Copy data (event log, recordings, trends, OLT data, Start-up configuration) to PC-card
- Copy screen → Copy screen to PC-card.

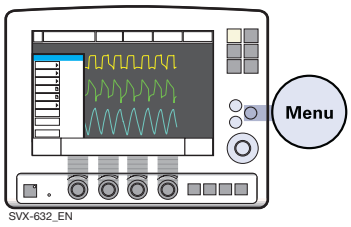
Biomed

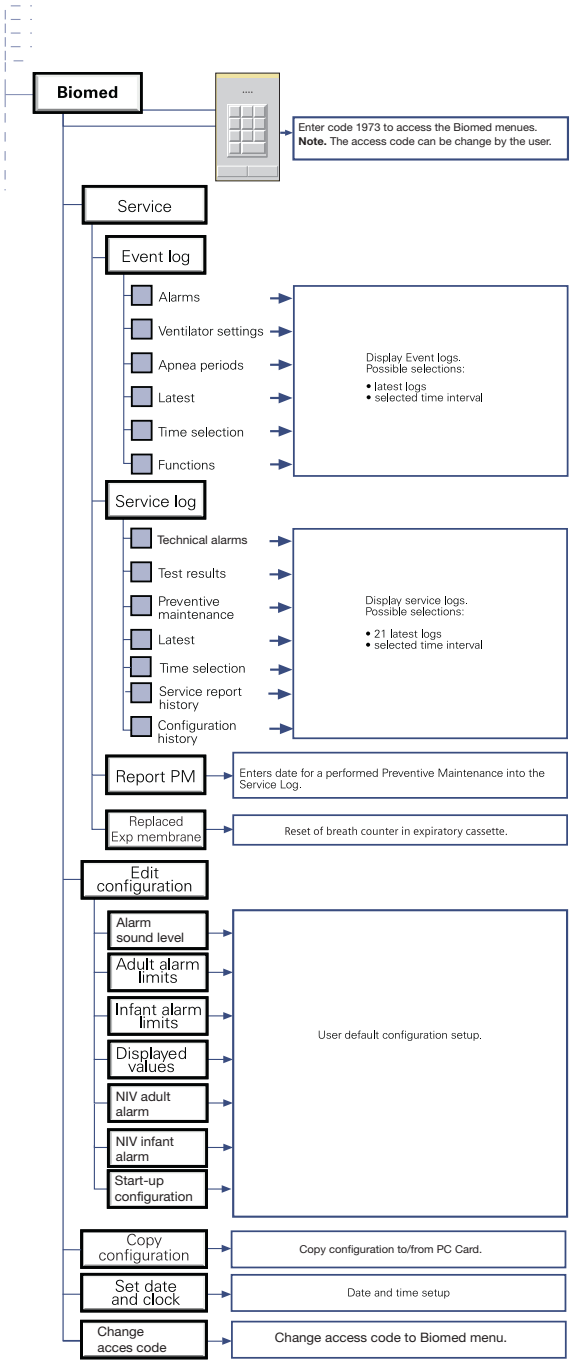
- O_2 cell adaptation → Measured O_2 concentration will be adapted in relation to set value.

Panel lock → Locks all user input functions on the User Interface. Press "Main screen" fixed key to unlock.

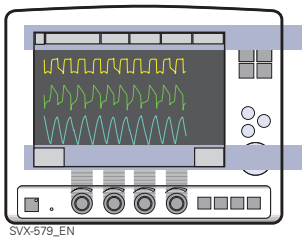
Change category → Available only in Servo-i Universal. Switches between Adult and Infant patient category.

Biomed menu (Standby mode)





Screen touch pads



Mode Xxxxx
When you press the soft key for a selected ventilation mode a window appears with the valid settings for this mode.The window has an accept soft key and a cancel soft key. When the accept soft key is pressed the ventilator starts to ventilate with your new settings. If the cancel soft key is pressed this window will disappear and the ventilator will continue to ventilate with the original settings. To support the clinician in adjusting settings some values, derived from settings, are shown in the upper right field of the set ventilation mode window e.g. inspiration time in seconds, calculated inspiratory flow.

Automode
The soft key Automode selects the Automode function When the patient is breathing spontaneously
- The green indicator is lit
- The ventilation mode text goes from grey to black

Admit patient
When the Admit patient function is activated the clinician can enter or amend patient details:
- patient name
- identity number
- date of birth
- date of admission
- height
- weight

Nebulizer
The Nebulizer function turns the nebulizer on or off. It is possible to set the duration of nebulization to between 5 and 30 minutes. The default time is 10 minutes.
During nebulization the time remaining is displayed in the nebulizer touch pad.
The nebulizer is automatically disabled during battery operation.

Status
General
O_2cell/sensor
Exp. cassette
Batteries
CO_2 Module
Y Sensor Measuring
Installed options
Pre-use check

In the *Status* function you have an icon displaying which power source is currently active i,e. Mains, Ext. 12V, or battery. When one or more batteries are in use, an information is also displayed showing the remaining time in minutes.When the *Status* soft key is activated a window appears displaying the status of:
- General system information
- Status of O_2cell/sensor
- Status of Expiratory cassette
- Status of batteries
- Status of CO_2 module (if available)
- Status ofY Sensor module (if available)
- Installed options
- Status of Pre-use check

Additional settings
Press the soft key Additional settings to see the settings available for the current mode.
Vital parameters are set using the Direct Access Knobs.
The bar below the numeric value is a graphical representation of the chosen value and gives information about the parameter ranges.
- the bar is white if your setting is within what is generally considered safe ranges
- the bar turns yellow if your setting is slightly beyond what is generally considered safe ranges
- the bar turns red if your setting is significantly beyond what is generally considered safe ranges

I:E / Insp. times

Trigger
The trigger sensitivity bar is colored based on the setting:
- the bar is green for a normal setting for flow triggering
- the bar is red when there is a risk of self-triggering
- the bar is white when the pressure triggering is selected.

Pressure support/ Backup ventilation
Depending on set ventilation mode this pad will be visible

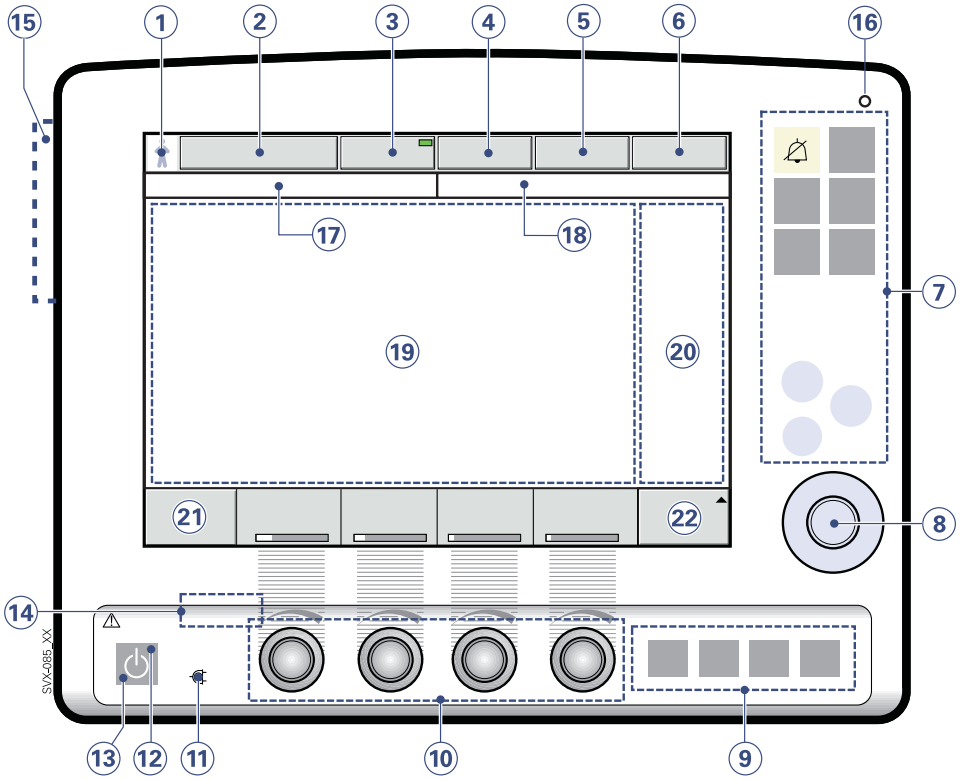
NIV Backup
This pad is only visible during NIV Pressure Support mode.

Additional values
This is an area of the screen which shows measured/calculated values in numerics.
Three pages with values are available. By pressing Additional values it is possible to scroll between pages.
Note. In NIV only one page is available.

13 Notes

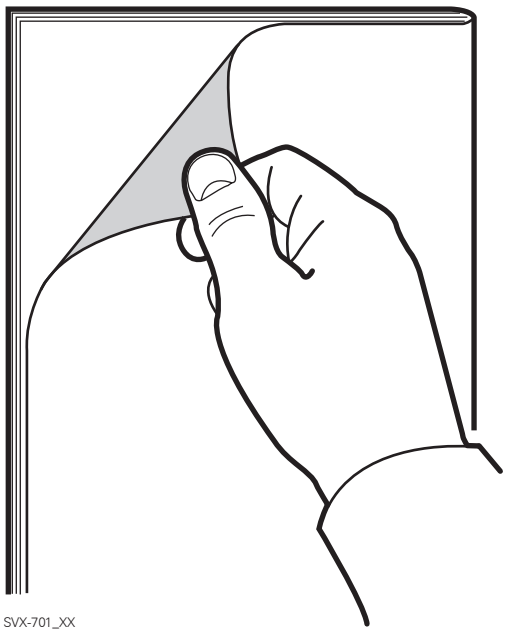
14 Notes

User Interface elements



1. Patient category.
2. Active mode of ventilation.
3. ✗ Automode On/Off.
4. Admit patient/Entered patient data and admission date.
5. ✗ Nebulizer On/Off.
6. System status parameters.
7. Fixed keys for immediate access to special windows.
8. The Main Rotary Dial
9. Special function keys for immediate ventilatory functions.
10. Direct Access Knobs
11. Mains indicator (green).
12. Standby indicator (yellow).
13. Start/Stop (Standby) ventilation key.
14. On/Off switch (rear side)
15. Slot for Ventilation record card
16. Luminiscens detector.
17. Informative text messages.
18. Alarm messages.
19. The waveform area.
20. Field for measured values and set alarm limits.
21. Additional settings.
22. Additional measured values.

Infant Adult Universal ✗ Options



SVX-701_XX

Turn page according to picture above for more information about the User Interface.

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SERVO-i

VENTILATOR SYSTEM V.3.1
USER´S MANUAL (US VERSION)