This document is intended to provide information to an international audience outside of the US.
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Note

This guide is intended for hospital personnel as start up training using the Servo-n® ventilator. It does not cover all aspects of the Servo-n ventilator. Please see the user’s manual for more information.

Some modes and functions are options and might not be included.
1 System overview

The user interface can swivel/tilt.

The patient unit can be rotated.

All wheels can be locked.
Behind the hatch are gas and electrical connections. The ON/OFF switch is placed to the left of the gas inlets. The switch must be pulled down from lock position before it can be used.

Modules are interchangable between Servo-n® and u ventilator models. The Servo-n can host 2-6 battery modules and several different plug-in modules. An alarm “Missing Battery” will be activated if less than 2 batteries are mounted.

The integrated nebulizer cable outlet

Y sensor module

CO₂ module

Edi module

Batteries

It is important that the expiratory cassette is properly attached (you will hear a ‘click’ sound when it locks into position).
1. Expiratory outlet
2. AC mains power LED, blue
3. Power on LED, green
4. On/Off switch
5. RS-232 connectors
6. Fuse for external DC power
7. External +12V DC inlet
8. User interface control cable connector
9. AC mains power source connector with fuse
10. Potential equalization terminal
11. Alarm output connection
12. Cooling fan with filter
13. Lock for inspiratory channel cover
14. Gas inlet for air
15. Gas inlet for O₂
16. Inspiratory channel cover
17. Inspiratory outlet
18. Emergency air intake
19. Module compartment
20. Expiratory inlet
21. Nebulizer connector
22. Module release levers
1. Alarm indicator, light frame
2. Ambient light sensor for automatic adjustment of screen brightness
3. Cable reel for the user interface control cable
4. Control cable (2.9 m long)
5. User interface stand
6. Loudspeaker
7. Network cable port
8. User interface control cable port
9. VGA port
10. USB port
11. Serial number label
1.2 Workflow to start ventilation

1. Connect the ventilator to the mains power.
2. Connect pressurized O₂ and air tubes.
3. Connect the patient circuit and filter.
   If active humidification add water to the water chamber.
4. Switch on power.
5. Perform a pre-use check.
7. Select invasive or non-invasive ventilation.
8. Select ventilation mode and adjust settings.
9. Check and adjust alarm limits.
10. Start ventilation and connect ventilation system to patient.
11. Adjust alarm limits if necessary.

1.3 Pre-use check

The pre-use check takes approximately four minutes, is started from Standby view and is semi-automatic.

The patient circuit test measures resistance and compliance in the patient circuit. If the patient circuit is changed and no new patient circuit test is performed, the ventilator will compensate incorrectly with the previous patient circuit. If the correct circuit is not tested, the following risks may arise:

- In volume-based modes, the volume delivered to the patient will be incorrect.
- In pressure-based modes, the volume measured will be incorrect.
The patient circuit test is included in the pre-use check but can also be selected separately.

The symbol highlighted below indicates that the circuit compensation is on. If there are no circuit compensation on, or patient circuit test hasn’t been performed, there will not be any symbol present.
1.4 Modes and settings
There are two different patient categories, pediatric and neonatal.

Select non invasive ventilation or invasive ventilation.
Slide the bar to the right or left to increase or decrease the settings. Confirm the setting by tapping ✓. Exit settings without changing by tapping the X.

The bar displays the safety scale, which is the range that represents normal use. To access the full settings range tap the +. To only show the range that represents normal use again tap the -. Note that this can only be done if the current value is within the normal settings range.
1.5 Modes
Tap to select mode. The current mode tile is always highlighted and the previous mode tile is marked PREVIOUS, together with the date and time it was last used.

NIV PS is available in pediatric patient category.
The mode settings are in supported and interactive modes divided into supported and controlled settings.

1.5 Context based guidance
Tap and hold on the mode tile to see more information.
Dynamic images are presented for some of the settings. A dynamic image illustrates the effects of changes made.

Press the (i) symbol and additional information will be presented.
1.7 Trigger settings
When triggering is based on flow, to the left on the scale, the ventilator system senses deviations in the bias flow delivered during expiration. The further to the left on the scale, the less effort the patient has to make. At the far left of the scale, there is a risk of auto-triggering, and the scale and value are therefore marked in red.

When triggering is based on pressure, to the right on the scale, the ventilator system senses deviations in the pressure below PEEP created by the patient. The pressure below PEEP required to initiate a breath is displayed when the setting is made. The further to the right on the scale, the greater the patient effort required to trigger.
1.8 VT/KG
Enter patient weight and the VT/Kg will be presented. It is important that patient circuit compensation is on to receive accurate VT/KG.

The ventilator monitors the ratio of tidal volume to patient weight (VT/BW). In volume controlled modes the VT/BW (ml/kg) is calculated and presented to the right of the volume. VT/BW (ml/kg) is continuously trended and measured.
1.9 User interface

By pressing additional values and settings become available.
1.10 Active/inactive modes and settings
The grey text and settings indicate an inactive mode and settings. If a mode is changed then the other mode becomes white.
2 Alarms

Light frame for 360° visibility. Alarm indication is shown in two ways; blinking value (measured or calculated) and alarm message in the alarm message area.

With some alarms the audio can be turned off by tapping ⚠️. Audio off is displayed in the corresponding parameter in the numerical values area and a message is displayed in the status bar.
The following alarms can be turned off in invasive ventilation when leakage compensation is active:
- Leakage too high.
- Expiratory minute volume low
- Expiratory minute volume high
- Inspiratory tidal volume too high
Settings for alarm limits include upper and lower limits settings and the current measured value.

Autoset alarm limits are available in controlled modes.
2.1 Batteries
If the ventilator system is running on battery power, the battery symbol turns yellow and the mains power symbol disappears. The estimated remaining battery time in minutes is always displayed, regardless of the power supply in use.

2.2 Maneuvers
The **PAUSE OSCILLATION** maneuver pauses the oscillation but maintains the $P_{mean}$ (available in HFOV modes).

When the MANUAL BREATH is tapped, the ventilator system will initiate a new breath cycle according to the current ventilator settings.
2.3 Static measurements

2.4 Inspiratory hold
This function is activated by pressing INSPIRATORY HOLD. This function can provide an exact measurement of the end inspiratory lung pressure.

2.5 Expiratory hold
Expiratory and inspiratory valves are closed after the expiration phase is completed for as long as EXPIRATORY HOLD is pressed.
2.6 Nebulization
Nebulization can be either activated for a certain period of time (5–30 minutes) or continuous (only use Aerogen Solo).

2.7 \(O_2\) boost
When tapped, \(O_2\) boost delivers the oxygen setting displayed here for a period of 1 minute. The \(O_2\) boost function can be interrupted by tapping the red cancel symbol in the \(O_2\) boost timer window anytime during the 1 minute interval.
By tapping O₂ BOOST LEVEL, it is possible to change the desired level for the O₂ boost function. It is possible to lock the O₂ boost level to 100 %. The value entered under O₂ boost (%) level specifies the number of percentage points that will be added to the value set for the O₂ concentration. For example: if the current O₂ concentration is 40 % and the O₂ boost level is 30 %, the O₂ boost function will, when tapped, deliver 70 % O₂. The O₂ boost function figure displayed will change accordingly. Since the minimum O₂ concentration is 21 %, the O₂ boost (%) level scale goes from 0 to 79 %.

It is also possible to set it to 0 %, in which case the O₂ boost function will no longer be active and will be replaced by three asterisks.
2.8 Disconnect/suction support

DISCONNECTION/SUCTION enables automatic inhibition of the ventilator system during a tracheal suction procedure or when briefly pausing ventilation in invasive modes. The ventilator system is prevented from cycling without activating alarms.

When using a closed-suction system, DISCONNECTION/SUCTION should not be used. The $O_2$ boost function should be used instead for oxygenation purposes.

**Important**

Use DISCONNECTION/SUCTION for all disconnections of the patient circuit when ventilating in NAVA or in the neonatal patient category when leakage compensation is active.
3 Trends

Trend values are stored every 60 seconds and retained for a maximum of 72 hours. Stored events and system changes are also displayed here.

The time valid for the cursor position is displayed. If events have been stored, their number is displayed in the ring shown in the figure and an explanation appears to the left of this ring.

If a recording is saved at a time corresponding to the cursor position, a recorder is displayed. To view the recording, tap this recorder.

Tap Organize trends to place the trends in the desired order by dragging and dropping the different trended values presented.
Tap the arrow to open the mini trends. They can be set in the range 15 min to 72 hours.
The backup is trended and are indicators of apneas.
- Backup time %/min
- Backup frequency/min

This indicates the number of times the neonate goes into backup every minute. If the number of switches to backup/min is high and the neonate is stable, the current apnea time may be too short and the neonate could tolerate a longer apnea time. If number of switches to backup/min is high and the neonate is desaturating, the current apnea time (time without any ventilation) may be too long, consider shortening the apnea time. If number of switches to backup/min is low, the neonate is having minimal apnea at the set apnea time, consider lengthening the apnea time.

Percent (%) of time in backup ventilation/min
- This indicates the amount of time (as a %) the neonate is in backup/min. If % of time in backup ventilation/min is high and the number of switches to backup/min are low then the neonate may not be ready to be weaned (the neonate is mostly in backup). If % of time in backup ventilation/min is low the neonate may be ready to be weaned by lengthening the apnea time. If both the % time in backup is high and the number of switches to backup/min is high the neonate may be ready to be weaned by lengthening the apnea time.
4 NAVA and NIV NAVA

The NAVA® and NIV NAVA workflows facilitate the set-up and use of these modes.

In the vertical field both the symbols on the representation of the Edi catheter and the color highlights on the leads show where the Edi signal is strongest. If no Edi signal is detected, there will be no such indications. Note that the color highlights on the leads change more rapidly than the symbols on the Edi catheter.
The pressure waveform (yellow) and the Pest wave (grey) are at the bottom of the positioning window. The waveforms can be used to evaluate synchrony.

Important

The positioning arrows can only be used to fine tune the catheter position when there is a reliable Edi signal. If the Edi signal is low or absent, the arrows should not be used to adjust the catheter position.

4.1 Edi monitoring

It is possible to have Edi monitoring even when the patient is not ventilated. Tap Edi MONITORING on the right of the screen. It is possible to go directly from running mode to Edi monitoring if the catheter is connected. Edi monitoring in Standby. The Edi signal is trended, with up to 72 hours of trends available from the quick menu (to the left) and up to 12 hours available from the Edi monitoring window.
5 HFOV

HFOV is available in pressure control (HFO) and volume target (HFO (V TGT)) modes. The Y sensor module must be connected during HFOV, since it enables measurement of volumes and mean pressure at the Y piece. It is possible to use HFO without the Y sensor. If the Y sensor is not used, the $P_{\text{mean}}$ will be estimated.

In HFO (V TGT) if the Y sensor is disconnected the ventilator system will automatically switch to backup ventilation (HFO).
6 Views

The ventilator system offers different views to suit different needs. They are accessed via the quick menu during ventilation.

5.1 Basic view

The view consists of two or three waveforms – pressure and flow waveforms are always present, together with the volume waveform if desired.

The BASIC view is not available if an Edi or CO₂ module is connected. All non invasive ventilation modes except NIV NAVA start in the BASIC view.
6.2 Advanced view
The view consists of two to five waveforms. Pressure and flow waveforms are always present, together with the volume waveform if desired and the Edi and CO₂ waveforms, if available are presented in two columns of numerical values.

6.3 Loop view
The view consists of:
– up to three loops – pressure-flow, pressure-volume and volume-flow.
6.4 Compass view
SERVO COMPASS® visualizes volume and pressure in relation to set targets in invasive modes. If the driving pressure or total pressure exceeds the pressure limit, the pressure limit the pressure animation will change color.

6.5 Distance view
There are six large tiles displaying:
– Five enlarged numerical values
– The pressure and flow waveforms, as well as the Edi waveform, if available.
6.6 Family view
Displayed information is minimized to:
– One column of numerical values.
– Alarms and messages in the status bar.
– The direct access settings bar.

– A dynamic representation (moving bubbles) shows that ventilation is in progress. To exit the family view you can tap anywhere on the screen.

6.7 Screen layout
The ventilator system can display a minimum of two waveforms and a maximum of five, depending on the view selected.
Pressure and flow waveforms are always mandatory except in the FAMILY view.
(Note: In Nasal CPAP, only pressure and flow waveforms are available).

Choose filled or non-filled waveforms
Filled waveforms

Tap and hold curve to set sweep spread and curve scale.
6.7 Panel lock
Possible to lock the screen for example for cleaning. Tap and hold to unlock.
6.8 High Flow therapy

High Flow therapy can be selected in both invasive and non-invasive ventilation as well as in Standby. Possibility to switch directly from invasive ventilation.

Edi monitoring is available during High Flow therapy.
7 Media

7.1 Recording

Recording highlighted to left and screenshot to right.

A 30 second long recording will be made starting 15 seconds before, and lasting until 15 seconds after the time the recording was initiated.

The recording will be stamped with the date and time that it was initiated and will be saved under the Recordings tab in the MEDIA library. Forty recordings can be saved on the Servo-n.

7.2 Screenshots

The screenshot will be stamped with the date and time it was taken and saved under the Saved screens tab in the MEDIA window. Forty screenshots can be saved.

All screenshots and recordings can be transferred to a USB memory stick. The USB port is under the user interface.
8 Neonatal patient category

8.1 Invasive leakage compensation
Invasive leakage compensation is available in the neonatal patient category to compensate for the leakage around uncuffed endotracheal tubes common when ventilating neonatal patients.

Servo-n has real volume guarantee in PRVC and VS, the leakage loss is added to inspiratory volume.

Compensated values in the user interface will show the symbol for leakage compensation.

Leakage compensation maintains PEEP, compensates for trigger sensitivity, end inspiration and measured values, as well as adding volume in PRVC and VS to reach targeted tidal volume.
8.2 Volume restriction
For the neonatal patient category, the ventilator system has a volume restriction. This means that the alarm limit set for VTi restricts volume delivery, so that a higher volume than set by this limit will not be delivered. This applies in: PC, PS, AUTO-MODE® PC PS and all SIMV modes.

8.3 Y sensor
For tidal volumes below 10 ml, it is recommended to use a Y sensor to increase the accuracy of gas delivery and monitoring.
When the Y sensor is active, the flow through the sensor will replace the bias flow as source for flow based triggering. The patient pressure is measured at the Y piece via a pressure line.

To interrupt the Y sensor measuring, disconnect the Y sensor module.

To guarantee that waveforms and measured values are always displayed on the screen, the internal pressure and flow sensors are at all times active as backup. Their readings are compared with the Y sensor measurement. The Y sensor is disabled if there is a significant deviation or malfunction.
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