INTELLiVENT-ASV

Operator's Manual

HAMILTON-G5/S1

HAMILT⊘N MEDICAL

Intelligent Ventilation since 1983

Operator's Manual

INTELLiVENT-ASV

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624470/05

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About this guide

This guide describes the features and functions of INTELLiVENT-ASV for HAMILTON-G5/S1, and is designed for use with the following documentation:

- Your ventilator *Operator's Manual*

- *Pulse oximetry Instructions for use* for your ventilator

- *INTELLiVENT-ASV Quick Guide*

Conventions used in this guide

In this manual:

- Button and tab names are shown in a **bold** font.

- The notation *XX > XX* shows the sequence of buttons/tabs to touch to open the associated window.

  For example, the text *Open the System > Settings window* means touch the **System** button, then touch the **Settings** tab.

- The graphics shown in this manual may not exactly match what you see in your environment.

- Pressure is indicated in cmH2O, length in cm, and temperature in degrees Celsius (°C). The units of measure for pressure and length are configurable.

- PI and PVI are only available only with a Masimo SET[§] pulse oximeter.

- HLI[1] is available only with a Nihon Kohden[§] pulse oximeter.

- The ability to set a minimum Oxygen limit (between 21% and 30%) is not available in all markets.

Safety messages are displayed as follows:

⚠️ **WARNING**

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

⚠️ **CAUTION**

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

NOTICE

A NOTICE emphasizes information of particular importance.

In tables, safety messages are indicated as follows:

⚠️ **WARNING!**

⚠️ **CAUTION!**

❶ **NOTICE!**

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[1] Not available in all markets.

In our manuals, we refer to *active* and *passive* patients.

- An *active* patient is one who is making inspiratory efforts.

  Active breathing is identified as the occurrence of at least five (5) consecutive spontaneous breaths. Spontaneous breaths are those for which inspiration is both patient triggered and patient cycled.

  In addition to spontaneous breaths as described, an active patient must also meet the requirements described in Section 1.7.3.

- A *passive* patient is one who is not making inspiratory efforts.

  Passive breathing is identified as the occurrence of at least five (5) consecutive mandatory breaths. In general, mandatory breaths are those for which inspiration is either machine triggered or machine cycled. In INTELLiVENT-ASV, mandatory inspirations are both machine triggered and machine cycled.

  In addition to mandatory breaths as described, a passive patient must also meet the requirements described in Section 1.7.3.

1
INTELLiVENT-ASV

1.1 Overview

INTELLiVENT-ASV is an advanced ventilation mode, based on the proven Adaptive Support Ventilation (ASV) mode, to automatically regulate CO2 elimination and oxygenation for both passive and active patients, based on both physiologic data from the patient and clinician-set targets.

With this mode, the clinician sets targets for PetCO2 and SpO2 for the patient. INTELLiVENT-ASV then automates management of the controls for CO2 elimination (%MinVol), and oxygenation (PEEP and Oxygen) based on these targets and on the physiologic input from the patient (PetCO2 and SpO2).

INTELLiVENT-ASV continuously monitors patient conditions and automatically and safely adjusts parameters to keep the patient within target ranges, with minimal clinician interaction, from intubation until extubation.

Figure 1-1. INTELLiVENT-ASV workflow
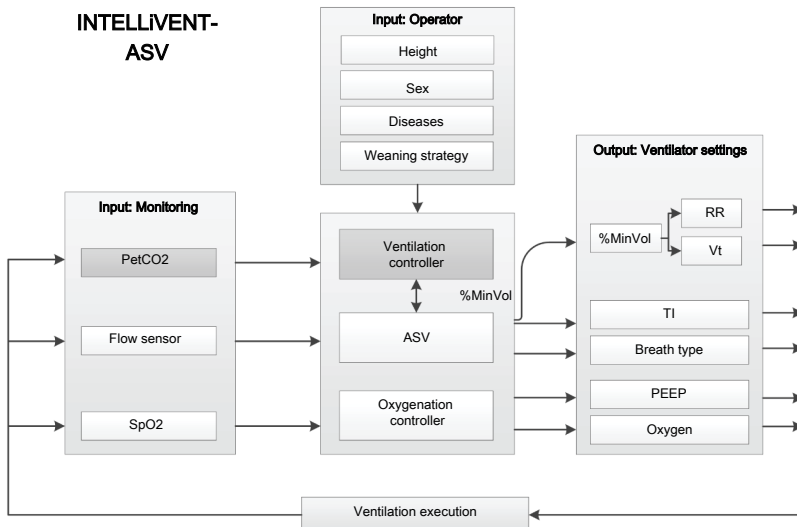
For detailed information about how INTELLiVENT-ASV regulates these parameters, see:

• Section 1.7, Management of minute volume

• Section 1.8, Management of PEEP and Oxygen

• For details on the ASV mode, see your ventilator *Operator's Manual*

When enabled, INTELLiVENT-ASV offers automated recruitment maneuvers and can also help promote early weaning using Quick Wean.

Before using INTELLiVENT-ASV, be sure to review the indications and contraindications for use, as well as all safety-related messages.

1.2 Indications and contraindications for use

Indications for use

> **NOTICE**
>
> - Use the INTELLiVENT-ASV for adult and pediatric patients only.
> - Use INTELLiVENT-ASV for intubated patients only.
> - Be sure you are familiar with the use of the CO2 and SpO2 sensors. See your ventilator *Operator's Manual*, the *Pulse Oximetry Instructions for Use*, and documentation provided with the sensors.

INTELLiVENT-ASV is designed for use with all adult and pediatric patients with an ideal body weight (IBW) of 7 kg or more. It is *not* available for neonatal applications. INTELLiVENT-ASV can be used in the hospital and during primary and secondary transport.

Contraindications for use

> ⚠ **WARNING**
>
> - Do *not* use the INTELLiVENT-ASV automatic **PEEP/Oxygen** adjustment if dyshemoglobin is expected or clearly evidenced, or if the difference between SaO2 and SpO2 is greater than 5%[2].
> - Heliox gas is not compatible with INTELLiVENT-ASV.

> ⚠ **CAUTION**
>
> *Do NOT use SpO2 measurement and automated PEEP/Oxygen adjustments with patients having intravenous dyes.*

Do NOT use INTELLiVENT-ASV if:

- The patient IBW is under 7 kg
- There is airway leakage
- The INTELLiVENT-ASV target ranges for PetCO2 and SpO2 cannot be set according to your hospital protocol or to the patient's condition

1.3 Preparing for ventilation with INTELLiVENT-ASV

> ⚠ **WARNING**
>
> - Additional ventilator-independent patient monitoring (for example, bedside vital monitoring or a blood gas analyzer) must be used during INTELLiVENT-ASV ventilation. Check PaCO2 against displayed PetCO2, and SaO2 against SpO2.
> - The physician is responsible for final decisions.

Preparing for ventilation with INTELLiVENT-ASV comprises the following steps.

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[2] You can compensate for differences between SaO2/SpO2 and PaCO2/PetCO2 up to set limits. For details, see information about Target shift.

Table 1-1. Preparing for ventilation with INTELLiVENT-ASV, overview

To ...	See ...
Set up and enable the CO2 and SpO2 sensors	• Ventilator *Operator's Manual* • Pulse oximetry documentation • CO2 documentation
Prepare the ventilator for operation, including performing the preoperational check	Ventilator *Operator's Manual*
Connect the patient	Ventilator *Operator's Manual*
Specify and confirm INTELLiVENT-ASV settings	Section 1.4
Start ventilation and monitor the patient	Ventilator *Operator's Manual*

1.4 Specifying INTELLiVENT-ASV settings

Once the ventilator is prepared for use and all tests are successfully completed, you are ready to set up INTELLiVENT-ASV for use.

You use the INTELLiVENT-ASV Settings window to specify patient data and the automation strategy, in addition to other options.

Navigating the window differs depending on whether you are setting up INTELLiVENT-ASV for the first time for the current patient or you are adjusting settings during active INTELLiVENT-ASV ventilation.

Further, the setup process differs depending on whether you are switching to INTELLiVENT-ASV from the ASV mode or from another mode.

The INTELLiVENT-ASV Settings window is divided into sections, each one containing a related group of options, which are generally set from the top down: automation, patient conditions, Quick Wean, and limits/auto-recruitment.

To set options when switching to INTELLiVENT-ASV from any mode *other than ASV*

The INTELLiVENT-ASV Settings and Controls windows display **Cancel/Continue** buttons at the bottom. The Alarms window displays **Cancel/Confirm** buttons.

1. In the INTELLiVENT-ASV Settings window, specify options, then touch **Continue** to display the Controls window.

2. After reviewing and adjusting settings (if needed), touch **Continue** to display the Alarms window so you can review limits.

3. Upon touching **Confirm**, INTELLiVENT-ASV is ready to use.

To set options when switching to INTELLiVENT-ASV from the ASV mode or during active ventilation with INTELLiVENT-ASV

1. In the INTELLiVENT-ASV Settings window, specify options.

   Changes are applied as soon as you make them.

2. Touch the **Controls** button to review and adjust control settings.

3. Touch the **Alarms** button to review and adjust alarm limits.

Specifying INTELLiVENT-ASV settings comprises the following steps.

Table 1-2. Specifying INTELLiVENT-ASV settings

To ...	See ...
Verify the patient settings in the Standby window.	Section 1.4.1
Select the INTELLiVENT-ASV mode.	Section 1.4.2
Select ventilation and oxygenation automation options.	Section 1.4.3
Select the patient condition, if needed.	Section 1.4.4
Check target ranges and adjust, if needed.	Section 1.4.5
Select Quick Wean/SBT options.	Section 1.4.6
Specify additional settings (auto-recruitment, upper and lower PEEP limits, minimum Oxygen limit, HLI for PEEP limit).	Section 1.4.7
Review and adjust control settings.	Section 1.4.8
Review and adjust alarm limits.	Section 1.4.9
Adjust settings during active ventilation, if needed.	Section 1.4.10

1.4.1 Specifying patient data

> **NOTICE**
>
> When coming from Standby and Last patient is selected, the last-used settings are active, including patient height and gender, alarm limits, and control settings.

To specify patient data

▸ In the Standby window, choose the correct patient group, gender, and height.

  If needed, you can adjust these settings during ventilation in the Patient window.

Be sure this data is accurate. It is used to calculate the patient's IBW, which is used by the INTELLiVENT-ASV controllers to regulate ventilation parameters.

You can fine-tune the settings at a later time, if needed.

For additional information, see the ventilator *Operator's Manual*.

1.4.1.1 Notes about exiting Standby

When starting ventilation from standby with a new patient selected and activating INTELLiVENT-ASV, the controllers (%MinVol, PEEP, and Oxygen) are set to default settings.

If you select Last patient in the Standby window and start ventilating the patient, the system assumes the same settings that were in place before entering standby.

1.4.2 Selecting the INTELLiVENT-ASV mode

INTELLiVENT-ASV is a mode accessed using the **INTELLiVENT** button in either of two locations: in the Standby window or at the top right of the main display.

To select the INTELLiVENT-ASV mode

▸ Touch the **INTELLiVENT** button.

The INTELLiVENT-ASV Settings window (Figure 1-2) opens.

Note that **Cancel/Continue/Confirm** are displayed only when changing modes from any mode *other than ASV*. When adjusting settings during ventilation or when switching to INTELLiVENT-ASV from the ASV mode, these buttons are not displayed.

Touching **Cancel** (or doing nothing for 1 minute) closes the window and returns you to the previously selected mode.

You can now select INTELLiVENT-ASV options.

1.4.3 Selecting ventilation/oxygenation automation options

> **NOTICE**
>
> - Automated management of *all* controls is disabled if the patient IBW is less than 7 kg.
> - Automated management of %MinVol is disabled when the CO2 sensor is disabled.
> - Automated management of PEEP is disabled when:
>   – Either the Chronic Hypercapnia or Brain Injury patient condition is selected. If Chronic Hypercapnia and ARDS are *both* selected, PEEP management can be automated.
>   – The SpO2 sensor is disabled
> - Automated management of Oxygen is disabled when:
>   – The SpO2 sensor is disabled
>   – The O2 sensor is disabled

Use the INTELLiVENT-ASV Settings automation and patient condition sections to specify:

- Whether adjustments of one or more of the following controls should be performed automatically by the device or manually by the clinician: %MinVol, PEEP, and Oxygen

  Sections 1.7 and 1.8 in this guide provide detailed information about how INTELLiVENT-ASV regulates these controls automatically.

- A patient condition (ARDS, Chronic Hypercapnia, or Brain injury)

- Shift the PetCO2 and/or SpO2 target zones, if needed

Figure 1-2. INTELLiVENT-ASV Settings window, automatic adjustments
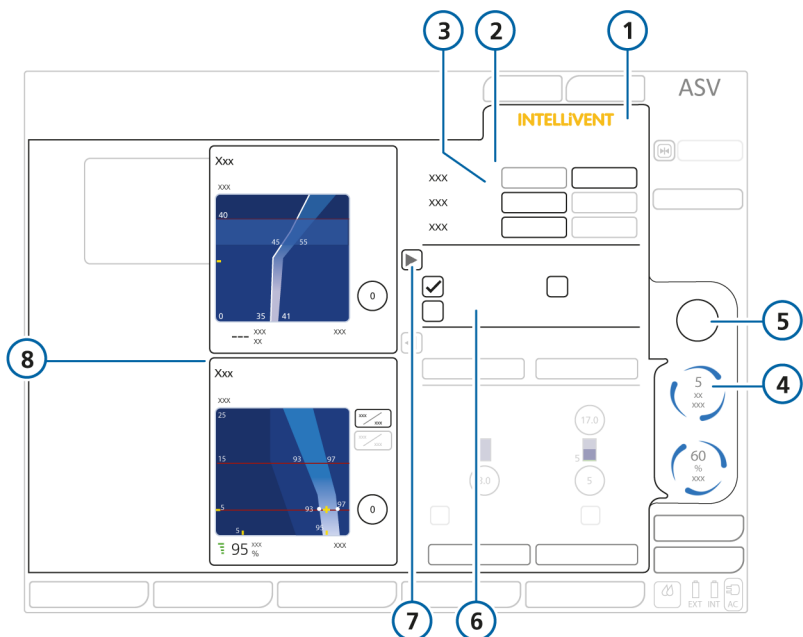
1	INTELLiVENT	5	Manual management indicator and parameter value
2	Automatic adjustments	6	Patient condition options
3	Controller settings: Automatic, Manual buttons for **%MinVol**, **PEEP**, **Oxygen**	7	Open/close button to display maps in side panel
4	Automated management indicator and parameter value	8	Map panel showing the CO_2 elimination map and Oxygenation maps, including the Target Shift controls

To set automation options for INTELLi-VENT-ASV

✓ If you just selected the INTELLiVENT-ASV mode and are going through the initial setup process, start with step 2.

1. To open the INTELLiVENT-ASV Settings window, touch the **INTELLiVENT** button at the top right of the display or in the Standby window, or touch an automated controller.

   The Settings window opens.

2. For each of the controls, %MinVol, PEEP, and Oxygen , choose whether management is performed by the device or by the operator:

   – Touch Automatic to have INTELLi-VENT-ASV regulate the control.

   – When Oxygen is set to Automatic, you can set an absolute lower limit that the controller will not fall below.

   When PEEP is set to Automatic, you can set absolute upper and lower limits for the controller. You can also enable the HLI index to control the PEEP limit.

   You set these limits in the bottom section of the INTELLiVENT-ASV Settings window. For details, see Section 1.4.7.

   – When set to Manual, the device makes no adjustments to the control; it is operator controlled. This is the default setting.

3. Review the control settings on the right and, if desired, make any adjustments.

4. Select a patient condition if your patient has chronic hypercapnia, ARDS, or a brain injury. If the patient has none of these conditions, you do

not need to select a patient condition. See Section 1.4.4.

5. Shift the PetCO2 or SpO2 target zones, if needed, using the **Target Shift** controls. See Section 1.4.11.3.

6. Continue specifying Quick Wean[3] and other options, as needed. See Sections 1.4.6 and 1.4.7.

7. If finished and the **Continue** button[4] is displayed, touch **Continue** to display the Controls window.[5]

   Touching the **Cancel** button or doing nothing for 1 minute closes the window and returns you to the previously selected mode.

1.4.4 Selecting patient conditions

The patient condition options affect some default CO2 elimination and oxygenation startup values and target settings. During initialization, settings are dynamically updated in real-time as you change the patient condition, and are reflected in the control values shown on the right side of the display as well as in the target zone of the associated Ventilation or Oxygenation map.

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[3] Quick wean settings are only available if %MinVol is set to automatic.

[4] Applies only when switching to INTELLiVENT-ASV from any mode *other than ASV*.

[5] Touching the X button at the top left of the window, if displayed, closes the window, using the settings that are specified. This is the same function as in other ventilator windows.

To specify patient conditions

✓ If you just selected the INTELLiVENT-ASV mode and are going through the initial setup process, start with step 2.

1. To open the INTELLiVENT-ASV Settings window, touch the **INTELLiVENT** button at the top right of the display or in the Standby window, or touch an automated controller.

   The Settings window opens.

2. Before proceeding, be sure to read the safety information related to selecting patient conditions, in Section 1.4.11.1.

3. *Only* if the patient has any special conditions, select one or more of the following entries: ARDS, Chronic Hypercapnia, Brain injury. See Figure 1-2.

   Selecting an entry changes the startup settings and targets for ventilation and/or oxygenation, and may affect whether regulation of PEEP can be automated. See Table 1-5.

   The Maps panel (Section 1.5.1) on the left shows the CO2 elimination and oxygenation targets based on the patient condition selections you make. To change the targets, use the **Target Shift** control (Section 1.4.11.3).

   If the Maps panel is not open, touch the arrow next to Patient conditions to display the panel. Touching the arrow again closes the panel.

4. Review the control settings on the right and, if desired, make any adjustments.

5. Set automation options, as needed, if you have not already done so.

6. Review the PetCO2 and SpO2 target ranges, and make changes, if needed, as described in Section 1.4.11.3.

7. Set Quick Wean options, if needed, as described in Section 1.4.6.

8. Specify auto-recruitment, oxygen limit, PEEP limits, and HLI settings, if needed, as described in Section 1.4.7.

9. If finished and the **Continue** button[6] is displayed, touch **Continue** to display the Controls window.

   Touching the **Cancel** button or doing nothing for 1 minute closes the window and returns you to the previously selected mode.[7]

1.4.5 Reviewing PetCO2 and SpO2 target ranges

After setting automation options and patient conditions, review the PetCO2 target range shown in the Ventilation map, and the SpO2 target range shown in the Oxygenation map.

If needed, make adjustments using the **Target Shift** control. For details, see Section 1.4.11.3.

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[6] Applies only when switching to INTELLiVENT-ASV from any mode *other than ASV*.
[7] Touching the X button at the top left of the window, if displayed, closes the window, using the settings that are specified. This is the same function as in other ventilator windows.

1.4.6 Selecting Quick Wean and SBT options

Quick Wean is not available if the patient condition selected in INTELLiVENT-ASV is **Brain injury** or **%MinVol** is set to manual.

Use the INTELLiVENT-ASV Settings > Quick Wean section to specify Quick Wean and spontaneous breathing trial (SBT) settings, if desired.

When Quick Wean is enabled, the device decreases ventilatory support, and, if automated SBTs are also enabled, performs an SBT when criteria are met.

Quick Wean and automated SBTs are both disabled by default, and can be enabled at any time during ventilation. See Section 2.3.

To enable/disable Quick Wean and automated SBTs

✓ If you just selected the INTELLiVENT-ASV mode and are going through the initial setup process, start with step 2.

1. To open the INTELLiVENT-ASV Settings window, touch the **INTELLiVENT** button at the top right of the display or in the Standby window, or touch an automated controller.

   The Settings window opens.

2. In the Quick Wean section (Figure 1-3), select whether to enable Quick Wean.

   By default, Quick Wean is disabled.

   To enable Quick Wean, touch the **Automatic** button. The target range of acceptable **PetCO2** values is permanently shifted up to +5 mmHg to the right, depending on pressure, while

Quick Wean is enabled. For details, see Chapter 2.

3. If desired, enable automated SBTs and specify options, as described in Section 2.3.

4. Specify auto-recruitment, oxygen limit, PEEP limits, and HLI settings, if needed, as described in Section 1.4.7.

5. If finished and the **Continue** button[8] is displayed, touch **Continue** to display the Controls window.

   Touching the **Cancel** button or doing nothing for 1 minute closes the window and returns you to the previously selected mode.[9]

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[8] Applies only when switching to INTELLiVENT-ASV from any mode *other than ASV*.
[9] Touching the X button at the top left of the window, if displayed, closes the window, using the settings that are specified. This is the same function as in other ventilator windows.

Figure 1-3. INTELLiVENT-ASV Settings window, Quick Wean section
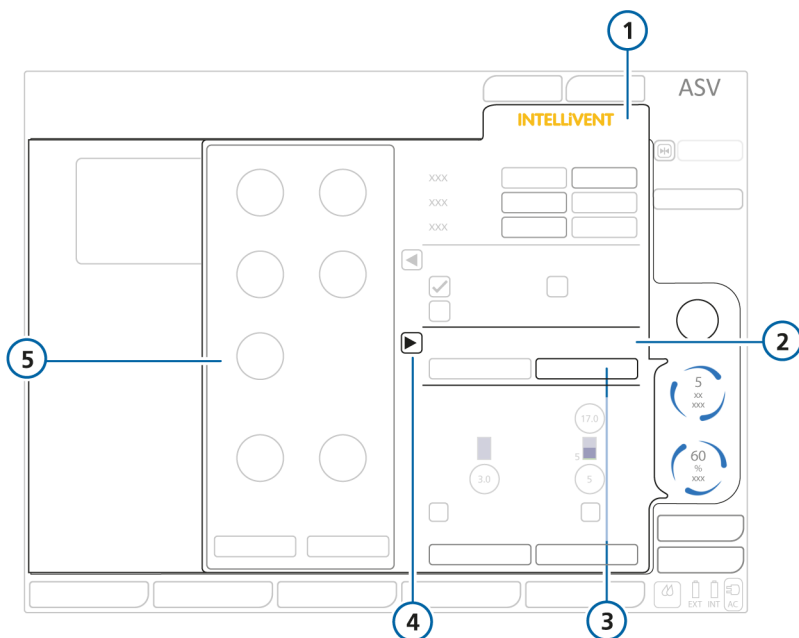
1	INTELLiVENT	4	Open/close button to display SBT settings in side panel
2	Quick Wean section	5	SBT settings panel
3	Disabled (default), Automatic		

1.4.7 Specifying additional settings

The bottom of the INTELLiVENT-ASV Settings window provides access to additional INTELLiVENT-ASV options:

- Set the minimum **Oxygen** level (between 21% and 30%)

- Set an upper and/or lower PEEP limit

- Enable/disable auto-recruitment

- Enable/disable use of the HLI index to limit PEEP (with use of Nihon Kohden pulse oximeter only)

Figure 1-4. INTELLiVENT-ASV Settings window, additional options
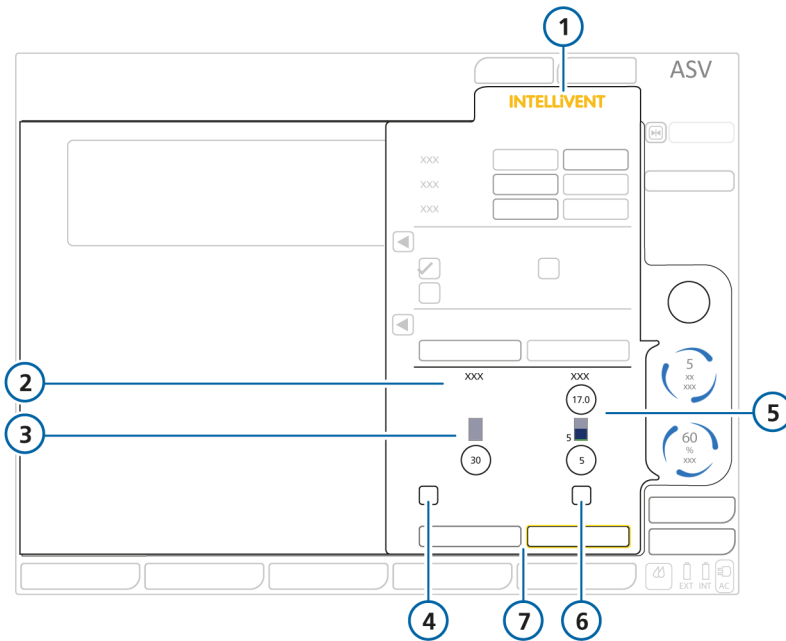
1	INTELLiVENT	5	PEEP limit
2	Additional settings section	6	HLI
3	Minimum Oxygen limit	7	Cancel/Continue (if displayed)
4	Auto-recruitment		

To set auto-recruitment, HLI, PEEP limit, and minimum oxygen limit options

✓ If you just selected the INTELLiVENT-ASV mode and are going through the initial setup process, start with step 2.

1. To open the INTELLiVENT-ASV Settings window, touch the **INTELLiVENT** button at the top right of the display or in the Standby window, or touch an automated controller.

The Settings window opens.

2. Set options as specified in Table 1-3.

3. If the **Continue** button[10] is displayed, touch **Continue** to display the Controls window.

Touching the **Cancel** button or doing nothing for 1 minute closes the window and returns you to the previously selected mode.[11]

Table 1-3. More tab settings

Setting	Description
Oxygen limit	When the Oxygen control is set to Automatic, you can set an absolute lower limit that the Oxygen controller cannot fall below. The limit can be set between 21% and 30%. See Section 1.4.11.4.
PEEP limit	When the PEEP control is set to Automatic, you can set an absolute upper limit that the PEEP controller cannot exceed, as well as an absolute lower limit that it cannot fall below.
	The minimum difference allowed between the low and high limit is 2 cmH2O.
	See Section 1.4.11.5.
Auto-recruitment	When the PEEP control is set to Automatic, you can enable automatic recruitment. For details, see Section 1.4.11.2.
	To enable auto-recruitment, touch the checkbox to select it.
	By default, auto-recruitment is disabled.
	The auto-recruitment status is shown in the SMP list on the left side of the display.
HLI	Available with the Nihon Kohden pulse oximeter only.
	The device analyzes the plethysmogram and assesses the interaction between airway pressure and hemodynamics, and from this data, calculates the heart-lung interaction index (HLI).
	When HLI is enabled, it is used to define the upper PEEP limit.
	To enable use of HLI as the PEEP limit, touch the checkbox to select it.
	For details, see Section 1.4.11.6.

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[10] Applies only when switching to INTELLiVENT-ASV from any mode *other than ASV*.

[11] Touching the X button at the top left of the window, if displayed, closes the window, using the settings that are specified. This is the same function as in other ventilator windows.

1.4.8 Adjusting control settings

As with other modes, you can adjust parameter settings for INTELLiVENT-ASV. The controls are the same as in ASV.

During initial setup of INTELLiVENT-ASV, the Controls window opens automatically after you touch **Continue**, when displayed[12], in the INTELLiVENT-ASV Settings window.

Figure 1-5. INTELLiVENT Controls window
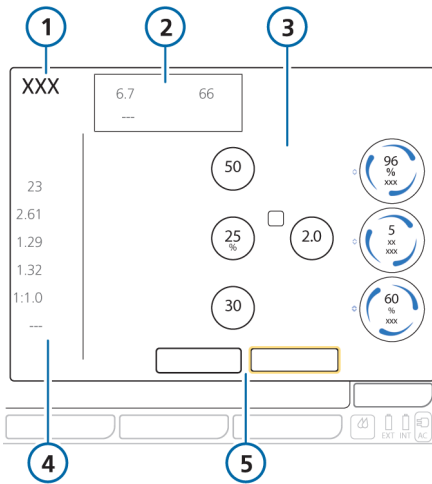
1	Selected mode	4 Display of settings for control breaths: Rate, Ttotal, TI, TE, I:E, Pause
2	Current %MinVol, IBW, Vt	5 Cancel/Continue (if displayed)
3	Control settings: P-ramp, P ASV limit, Trigger, ETS	

To adjust INTELLiVENT-ASV control settings

✓ If you just selected the INTELLiVENT-ASV mode and are going through the initial setup process, start with step 2.

1. To open the Controls window, touch the **Controls** button at the bottom right of the display.

   The Controls window opens.

2. Adjust any settings as needed.

3. If the **Continue** button is displayed, touch **Continue** to display the Alarms window.

   Touching the **Cancel** button or doing nothing for 1 minute closes the window and returns you to the previously selected mode.

1.4.9 Adjusting alarm limits

> ⚠ **WARNING**
>
> • Set all alarms to clinically acceptable values, especially Pressure, ExpMinVol, SpO2, and PetCO2.
>
> • To prevent patient injury, periodically review all alarm settings.

> **NOTICE**
>
> You can suppress the physiological PetCO2 and SpO2 alarms for 2 minutes by pressing the Audio Pause key, in the same manner as other alarms on the ventilator. For details, see the chapter, *Responding to alarms*, in your ventilator *Operator's Manual*.

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[12] Applies only when switching to INTELLiVENT-ASV from any mode *other than ASV*.

As with other modes, you can adjust alarm limits for INTELLiVENT-ASV, including for SpO2 and PetCO2 levels. The adjustable alarms are accessed on multiple tabs in the Alarms window.

For additional information:

- For details about Oxygen level notification, see Section 1.4.11.7.

- For troubleshooting, see Section 1.6.

- For detailed information about alarms, including default settings and ranges, see your ventilator *Operator's Manual*.

To adjust INTELLiVENT-ASV alarm limits

During initial setup of INTELLiVENT-ASV, the Alarms window opens automatically after you touch **Continue**, when displayed, in the Controls window.[13]

1. To open the Alarms window, touch the **Alarms** button at the bottom right of the display.

    The contents of the **Limits 1** tab (Figure 1-7) are displayed by default.

2. Adjust any limits as needed.

3. Touch the **Limits 2** tab and adjust any limits as needed, including setting an oxygen notification level, if desired.

Figure 1-6. Alarms > Limits 2 window
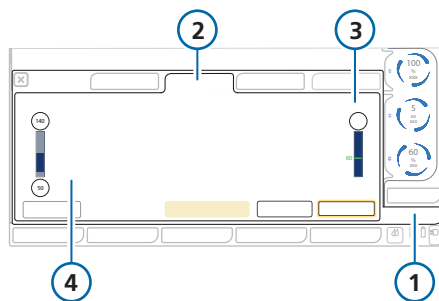
1	Alarms	3	Oxygen %
2	Limits 2	4	Additional SpO2-related alarm settings

4. To set alarm limits automatically, touch the **Auto** button.

    Selecting **Auto** automatically sets alarm limits around the current monitoring parameter values, except for the following alarm limits: Apnea, Vt, SpO2, Pulse, PI (Masimo only). These alarm limits remain unchanged, and must be set manually to the desired level.

5. If displayed, touch **Confirm** to accept the settings.

    Touching the **Cancel** button or doing nothing for 1 minute closes the window and returns you to the previously selected mode.[14]

[13] Applies only when switching to INTELLiVENT-ASV from any mode *other than ASV*.
[14] Touching the X button at the top left of the window, if displayed, closes the window, using the settings that are specified. This is the same function as in other ventilator windows.

Figure 1-7. Alarms > Limits 1 window
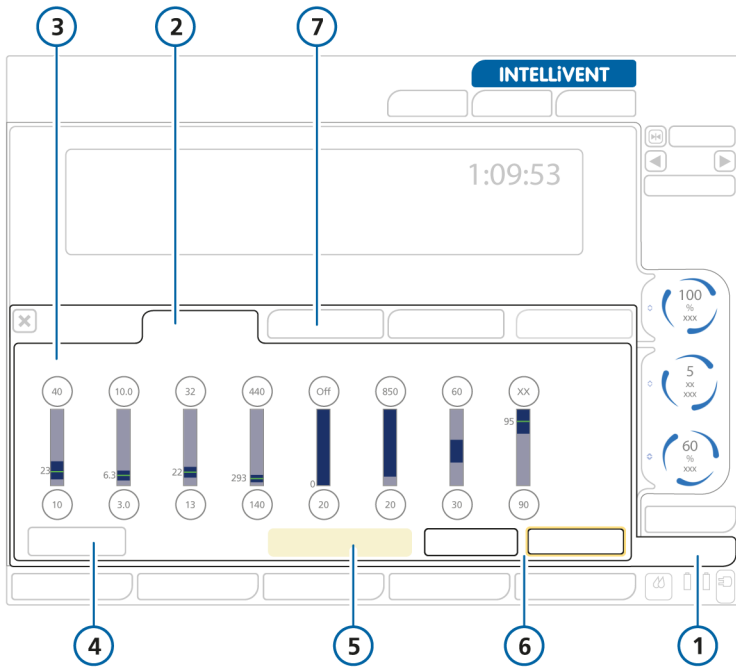
1	Alarms	5	Notice to use ventilator-independent monitoring system when using INTELLiVENT-ASV
2	Limits 1	6	Cancel/Confirm (if displayed)
3	Alarm limit controls	7	Limits 2
4	Auto		

INTELLiVENT-ASV setup is now complete.

1.4.10 Adjusting settings during active ventilation

During active ventilation, you can adjust INTELLiVENT-ASV settings at any time. You can also review the Ventilation/Oxygenation maps and horizons, guides, plethysmogram, capnogram, and Quick Wean-related views (when enabled).

All of the tabs in the INTELLiVENT-ASV Settings window are available and function the same way as during initial setup, except that there are no **Cancel/Continue/ Confirm** buttons. Changes are applied as soon as you make them.

You can also adjust control settings and alarm limits at any time, same as with any other ventilation mode. For details, refer to your ventilator *Operator's Manual*.

Figure 1-8. Active ventilation with INTELLiVENT-ASV
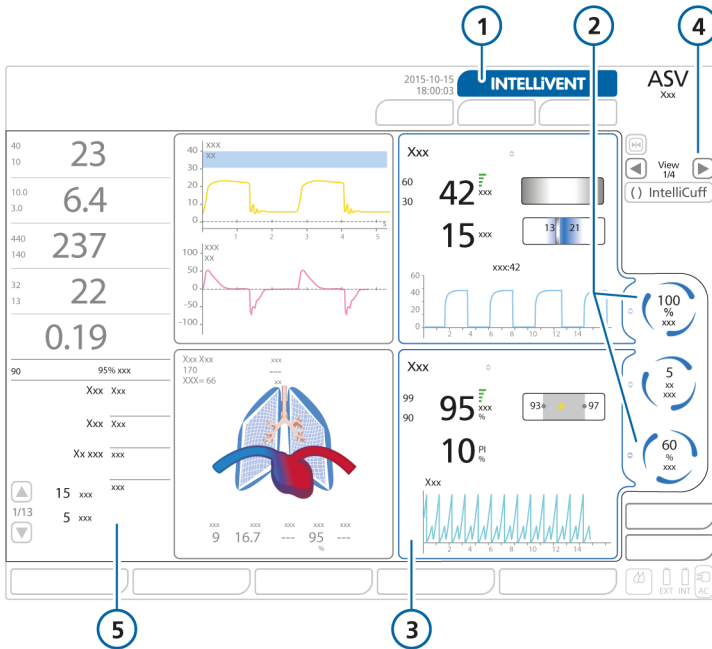
1	INTELLiVENT button to access Settings window	4	View navigation buttons and number
2	Controls managed by INTELLiVENT-ASV	5	INTELLiVENT-ASV settings shown as SMPs (including auto-recruitment status, HLI status, min/max PEEP limits, patient condition, Quick Wean status)
3	Ventilation (top) and Oxygenation (bottom) horizons		

To display the INTELLiVENT-ASV Settings window

1. At any time during ventilation with INTELLiVENT-ASV, touch the **INTELLi-VENT** button at the top right of the display or in the Standby window, or touch one of the automated controllers.

   The INTELLiVENT-ASV Settings window opens.

2. Make changes as desired on any of the tabs.

3. To review or change control settings, touch the **Controls** button and make changes as needed.

4. To review or change alarm settings, touch the **Alarms** button and make changes as needed.

1.4.11 About INTELLiVENT-ASV settings

The following sections provide details about the following features:

Settings	See ...
Patient conditions	Section 1.4.11.1
Auto-recruitment maneuvers	Section 1.4.11.2
Target shift	Section 1.4.11.3
PEEP limit	Section 1.4.11.5
PEEP limit using HLI (Nihon Kohden only)	Section 1.4.11.6
Oxygen limit	Section 1.4.11.4
Oxygen level notification (**Oxygen %**)	Section 1.4.11.7

1.4.11.1 About patient conditions

> ⚠ **CAUTION**
>
> - *Select the Chronic Hypercapnia and/or ARDS patient condition only if the patient has one of these conditions; in case of doubt, do NOT select either of these options.*
>
> - *Always select Brain injury if you are sure that the patient has this condition. If the patient suffers from a brain injury but the Brain injury option is not selected, increased CO2 levels and high cranial pressure might result. Carefully monitor intracranial pressure when available.*
>
> - *If **Brain Injury** is selected but the patient is to be ventilated normally, the patient will be slightly hyperventilated and increased peak pressures might occur.*

> **NOTICE**
>
> - If **Brain injury** is selected, the ventilation controller (**%MinVol**) regulates in accordance with the measured PetCO2 signal even if the patient is breathing spontaneously.
>
> - The **Brain injury** target range has the highest priority of all patient conditions.
>
> - If either the **Chronic Hypercapnia** or **Brain injury** patient condition is selected, management of **PEEP** cannot be automated; you must manually set the desired **PEEP** level. If **Chronic Hypercapnia** and **ARDS** are *both* selected, PEEP management can be automated.

Patient conditions are used in INTELLiVENT-ASV to determine:

- Startup settings to use for %MinVol, PEEP, and Oxygen

- Whether PEEP can be automated or must be manually controlled

- PetCO2 and SpO2 target ranges

- %MinVol for active patients, based on fSpont or PetCO2 (if Brain Injury selected)

For details about selecting patient conditions, see Section 1.4.4.

Table 1-4 lists the patient conditions available in the INTELLiVENT-ASV Settings window. For patients with mixed conditions, you can select more than one option.

Table 1-4. Patient conditions in INTELLiVENT-ASV

Patient condition	Description
Normal patient	No condition selected
ARDS	Acute respiratory distress syndrome, which presents as an acute, severe injury to most segments of the lung
Chronic Hypercapnia	For patients with chronically high arterial CO2 values, usually as a result of obstruction in airways due to chronic bronchitis, emphysema, or both
Mixed (ARDS and Chronic Hypercapnia)	For patients with both listed conditions
Brain Injury	Patients with brain injuries with whom it is critical to maintain CO2 under strict control to keep intracranial pressures at safe levels, and to keep oxygenation within a normal range

---

[15] Control of settings not explicitly marked as *Manual* can be automated.

Table 1-5 provides an overview of the values set for startup and during ventilation. Startup values all depend on the selected patient condition(s).

In all cases, Quick Wean, auto-recruitment, and PEEP limitation by HLI are disabled at startup.

When PEEP must be manually set, PEEP limitation by HLI is inactive.

Table 1-5. Patient conditions and startup values for ventilation

	Ventilation		Oxygenation	
Patient condition	%MinVol startup value (%)	P ASV limit	Oxygen startup value (%)	PEEP startup value (cmH2O)[15]
Normal	100	30	60	5
ARDS	120	35	100	8
Chronic Hypercapnia	100	35	60	Manually controlled
ARDS + Chronic Hypercapnia	120	35	100	8
Brain Injury	100	30	60	Manually controlled

1.4.11.2 Automatic recruitment maneuvers

> ⚠️ **CAUTION**
>
> *Check for pneumothorax and potential susceptibility to pneumothorax before ventilating the patient. Automatic PEEP adjustment during recruitment maneuvers can lead to an increase in ventilation pressure levels.*

Automatic recruitment is a strategy for re-expanding collapsed lung tissue, and then maintaining higher PEEP to prevent subsequent "de-recruitment". To recruit collapsed lung tissue, sufficient pressure must be imposed to exceed the critical opening pressure of the affected lung.

Automatic recruitment in INTELLiVENT-ASV, called *auto-recruitment*, is an optional function designed to reopen collapsed lung units in severely hypoxemic patients, such as those with ARDS.

The ventilator automatically performs a recruitment maneuver when a second consecutive PEEP increase is required *and* the following conditions are met:

- PEEP controller is set to Automatic

- Auto-recruitment is enabled

- The patient is *not* breathing spontaneously; that is, the patient is passive

• Monitored SpO2 is below the target range (that is, the patient is hypoxemic)

• The ventilator has made two consecutive PEEP increases, according to the automated PEEP regulation rules

• The set maximum PEEP has not been reached

When these conditions are met, the ventilator performs a recruitment maneuver. PEEP is increased to 40 cmH2O and held for 20 seconds; PEEP is then decreased to the appropriate setting according to the automated PEEP regulation rules.

Auto-recruitment maneuvers occur after two consecutive automatic increases of PEEP of 1 cmH2O. This means the recruitment maneuver cycle occurs no more often than once every 12 minutes. As soon as a recruitment maneuver is performed, the device generates a Recruitment maneuver in progress message.

Note that use of the P/V Tool also counts as a recruitment maneuver.

By default, auto-recruitment is disabled, and must be manually enabled for use.

To enable or disable auto-recruitment

▶ At the bottom of the INTELLiVENT-ASV Settings window, touch the Auto-recruitment checkbox.

The auto-recruitment status is displayed in the SMP list on the left side of the display.

Important:

• During the recruitment maneuver, all patient alarms are suppressed.

• The maneuver is canceled if a flow sensor failure or any pneumatic disconnection is detected.

• No recruitment maneuver takes place if any of the following occurs:
  – PEEP is manually changed
  – The patient is active
  – HLI > 15% and HLI is used for the PEEP limit

Figure 1-9. Recruitment maneuver cycle
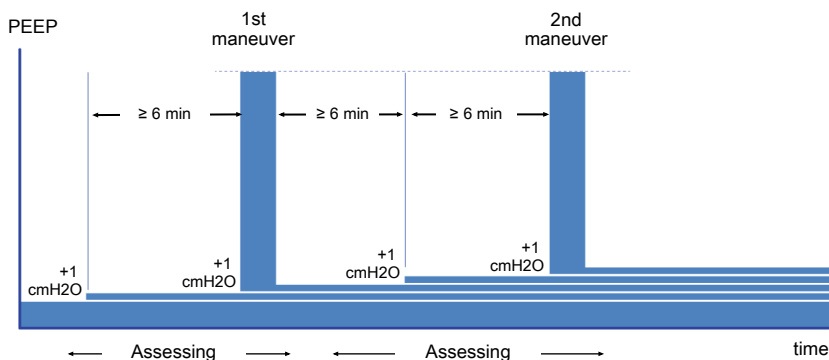
1.4.11.3 Target shift

> ⚠️ **CAUTION**
>
> - *Regularly check the patient after specifying a PetCO2 or SpO2 target shift to verify that the range is still appropriate for the current patient condition.*
> - *Changing the target range and NOT monitoring the patient's progress can increase risk of hyper- or hypoventilation or hyper- or hypoxemia.*

INTELLiVENT-ASV uses PetCO2 and SpO2 as monitoring inputs for regulation of ventilation and oxygenation, and works to keep the patient within the target range for these values.

These target ranges are shown in the Ventilation and Oxygenation maps and horizons. INTELLiVENT-ASV adjusts ventilation and oxygenation controls to bring the patient to the middle of the set range.

In general, PetCO2 and SpO2 values represent a reliable index of CO2 partial pressure in the arterial blood (PaCO2) and partial pressure of dissolved oxygen in the arterial blood (PaO2), respectively (measured using blood gas analysis (BGA)). To get the most accurate approximation of PaCO2, the second highest PetCO2 value out of 8 breaths is used.

Under normal conditions, PaCO2 is approximately 3-5 mmHg higher than PetCO2 — the difference between the values is referred to as the *PaCO2-PetCO2 gradient*. Under special clinical conditions (such as shunt), the PaCO2-PetCO2 gradient can increase, requiring adjustment of the ventilation targets.

The **Target Shift** control allows you to move the PetCO2 and SpO2 target ranges to the left (lower values) or to the right (higher values), within the limits defined in Tables 1-6 and 1-7. INTELLiVENT-ASV always tries to bring patient values to the middle of the specified range.

When determining the appropriate PetCO2 target range for your patient, keep the following considerations in mind (described in more detail with examples):

- Is the displayed PetCO2 target range appropriate for your patient?
- Is the PaCO2-PetCO2 gradient outside of the physiologic normal range?

Is the displayed PetCO2 target range appropriate for your patient?

Check whether one of the patient conditions applies to your patient. If so, select the condition. If the range is still inadequate for your patient, use the **Target Shift** control to adjust the target range as needed to set the appropriate limits.

Example

If INTELLiVENT-ASV sets the PetCO2 target range to 40–50 mmHg and:

- The ideal PetCO2 target for the patient is *50 mmHg*, consider setting the Target Shift to +5 to move the target range 5 mmHg to the right, to 45–55 mmHg.
- The ideal PetCO2 target for the patient is *30 mmHg*, consider setting the Target Shift to -15 to move the target range 15 mmHg to the left, to 25–35 mmHg.

Is the PaCO2-PetCO2 gradient outside of the physiologic normal range?

If the difference between the two is greater than 3-5 mmHg, consider adjusting the PetCO2 target range to achieve the desired PaCO2 value.

Example

Assume the following patient conditions apply:

Measured PetCO2 = 38 mmHg[16]
PaCO2 from the BGA = 60 mmHg
Target PaCO2 = 40-50 mmHg

The PaCO2-PetCO2 gradient is well outside the normal range of 3-5%.

In this case, consider setting the Target Shift to -15[17] to move the PetCO2 target range 15 mmHg to the left, for a target range between 20 and 30 mmHg.

Figure 1-10. Target shift example
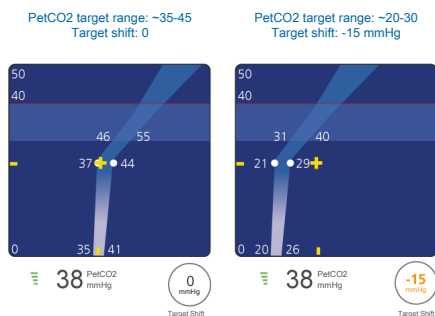
INTELLiVENT-ASV makes adjustments to try to get the patient's PetCO2 values to the middle of the target range, which in this case should result in PaCO2 values within the desired 40 to 50 mmHg target PaCO2.

You can adjust the SpO2 target range in the same manner.

Table 1-6. PetCO2 target shift limits

PetCO2 target shift limits	
All patient conditions	-20 mmHg to 10 mmHg

Table 1-7. SpO2 target shift limits based on patient condition

SpO2 target shift limits[18]	
Normal	-5% to +4%
ARDS	-2% to +4%
Chronic Hypercapnia	-2% to +5%
Mixed (Chronic Hypercapnia + ARDS)	-2% to +5%
Brain Injury	-2% to +2%

The **Target Shift** control is located in the Ventilation and Oxygenation map panel on the left side of the INTELLiVENT-ASV Settings window.

---

[16] PetCO2 is in the middle of the target range.
[17] 60 (current PaCO2 from BGA) – 45 (middle of target PaCO2 range) = 15 shift to the left
[18] If a change in patient condition would cause the existing limit to be exceeded, the target shift is automatically reduced to comply with the new conditions.

Figure 1-11. Target Shift controls (1)
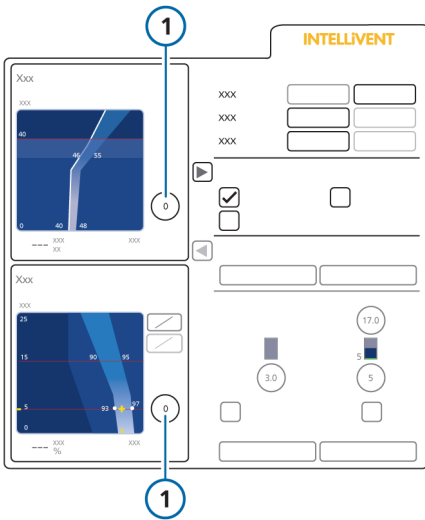
To shift the target zone to the left or to the right

1. To open the INTELLiVENT-ASV Settings window, touch the **INTELLiVENT** button or an automated controller.

2. In the appropriate map (ventilation or oxygenation), touch the **Target Shift** control to activate it, and turn the P&T knob clockwise or counter-clockwise to adjust the target range limits in increments of 1.

   – Setting the value to a positive number shifts the target range to the right, targeting a higher PetCO2 or SpO2.

   – Setting the value to a negative number shifts the target range to the left, targeting a lower PetCO2 or SpO2.

   – To shift the PetCO2 target range to a value beyond ±5 mmHg, set the value now to +5 or -5, as needed.

3. Press the P&T knob to accept the changed value.

4. To shift the PetCO2 target range beyond ±5 mmHg:

   – Touch the **Target Shift** control again, and turn the P&T knob to set the value as desired.

   – Press the P&T knob to accept the changed value.

The change is applied immediately and is visible in the associated Ventilation or Oxygenation map. During ventilation, the applied target shift is displayed on the associated map in view 2.

The PetCO2 **Target Shift** value and text is displayed in different colors depending on the setting.

Table 1-8. Target shift display

Target Shift control	Text color and description
0 xxxx xxx	White text. Target shift is 0; there is no change to the target range values.
2 xxxx xxx	Yellow text. Target shift is between ±1 and ±5.
7 xxxx xxx	Orange text. Target shift is greater than ±5.

1.4.11.4 Minimum Oxygen limit

When the Oxygen controller is set to Automatic, you can set an absolute lower limit for Oxygen; The Oxygen controller cannot fall below this limit.

To set the minimum Oxygen limit

▸ In the lower section of the INTELLi-VENT-ASV Settings window, set the limit to any value between 21% and 30%.

   The default setting is 30%.

1.4.11.5 PEEP limit

When the PEEP controller is set to Automatic, the PEEP limit control allows you to define an absolute high limit that the PEEP controller cannot exceed. If enabled, you can also specify an absolute low limit for PEEP; The PEEP controller cannot fall below this limit, listed in Table 1-9.

When enabled, HLI can be used to automatically limit the maximum PEEP level. See Section 1.4.11.6.

Note that the minimum difference between the low and high limit is 2 cmH2O.

Table 1-9. PEEP limit control settings

PEEP limit control range (cmH2O)	Default (cmH2O)
Low: 5 to 22	Low: 5
High: 7 to 24	High: 15

If the patient condition Chronic Hypercapnia or Brain injury is selected, you set PEEP manually.

To set PEEP limits

▸ In the lower section of the INTELLi-VENT-ASV Settings window, set the desired high and/or low PEEP limits.

1.4.11.6 Heart-Lung interaction (HLI) index

⚠️ **WARNING**

- HLI cannot be used with patients with significant cardiac arrhythmias (examples: atrial fibrillation, frequent premature beats, ventricular fibrillation). Due to the irregular time between heart beats in these patients, HLI does not reflect the effect of mechanical ventilation on the stroke volume of the heart.
- HLI can be incorrect when:
  – Tidal volume is < 6 ml/kg
  – Patient's breath activity is spontaneous
  – Driving pressure is < 10 cmH2O
  – Cardiac dysfunction is present
- HLI sensitivity is decreased when:
  – Transthoracic pressure is low
  – HR/RR < 3 to 4
- HLI can fluctuate when PEEP changes often or frequent recruitment maneuvers take place.
- When HLI is enabled, check the plethysmogram, as well as the SpO2 and the HLI quality index, regularly to monitor patient motion.

Available with the Nihon Kohden pulse oximeter only.

The heart-lung interaction (HLI) index is a noninvasive technique for assessing the hemodynamic effect of mechanical ventilation by determining the pulse pressure variations in the pulse oximeter plethysmogram (POP). The ventilator analyzes the plethysmogram and assesses the interaction between airway pressure and hemodynamics, calculating the HLI index using the following formula:

$$HLI = 100*(POPmax - POPmin) / ((POPmax + POPmin)/2)$$

where POPmax is the maximum amplitude of the plethysmogram within the same breath and POPmin is the minimum. The breath information is extracted from the airway pressure signal delivered by the ventilator.

The HLI index reflects how much airway pressure interacts with hemodynamics.

Patients with a high HLI index show a higher variation in the plethysmogram during the breath cycle, indicating a higher variation of the arterial pressure during the breath cycle. In contrast, patients with a low HLI have less variation in the plethysmogram, indicating more stable hemodynamics during ventilation.

An HLI value above 15% indicates that high plateau pressures might have an influence on the hemodynamics of the patient. As a result, INTELLiVENT-ASV reduces the maximum PEEP limit accordingly. If HLI reaches 25%, the upper PEEP limit is set to 8 cmH2O.

The HLI is:

- Reliable in passive patients, partly reliable in active patients

- Not reliable if cardiac arrhythmia is present

- Signal dependent (artifacts, motion)

Use as PEEP limit

As a safety feature, when PEEP management is automated, you can activate HLI to function as a "watchdog" to automatically limit the maximum PEEP level to prevent hemodynamic instability caused by high PEEP levels.

If the HLI value is not available for an extended time, PEEP is limited to the limits defined in the INTELLiVENT-ASV Settings window, and does not go below the set lower limit.

When PEEP limits are specified and HLI is also active, PEEP is limited to the lower value.

If the patient condition Chronic Hypercapnia or Brain injury is selected, HLI does not control the PEEP limit as it is set manually.

To enable the use of HLI to control the PEEP limit

▸ In the INTELLiVENT-ASV Settings window, at the bottom in the additional settings section, select the HLI checkbox. See Figure 1-4.

1.4.11.7 Oxygen level notification

When the Oxygen controller is set to A utomatic, you can specify an oxygen l evel that, when exceeded, generates a medium-priority alarm message that is d isplayed in the message bar.

The Oxygen message control is only a notification tool; it *does not* affect the percentage of delivered oxygen.

This threshold is set using the Oxygen % control in the Alarms > Limits 2 window. See Section 1.4.9.

1.5 Monitoring INTELLiVENT-ASV

> ⚠️ **CAUTION**
>
> *Check the patient's condition periodically to assess readiness for weaning.*

> **NOTICE**
>
> - If the PetCO2 signal is NOT reliable, the automated %MinVol controller freezes after 30 seconds. See Section 1.7.4.
> - If the SpO2 signal is NOT reliable, the automated PEEP and Oxygen controls freeze after 30 seconds. See Section 1.8.4.

INTELLiVENT-ASV provides easy access to numerical and graphical monitoring data. Data is shown on the main display in the Monitoring window, in the various graphic panels (trends, Dynamic Lung, Vent Status, plethysmogram, capnogram), and in the INTELLiVENT-ASV-specific windows, including the Ventilation/Oxygenation maps and horizon graphs.

Note that trend graphs for PetCO2- and SpO2-related parameters, as well as for the ventilation and oxygenation controller settings are also available. For details, see Section 1.5.8.

The following sections provide details about the Ventilation and Oxygenation maps and horizon graphs. For details about the Quick Wean-related views, see Chapter 2.

For details about other ventilator graphics and displays (for example, the Dynamic Lung, Vent Status panel, waveforms, and the Monitoring window), see your ventilator *Operator's Manual*.

1.5.1 About the INTELLiVENT-ASV windows and views

INTELLiVENT-ASV provides a graphical overview of CO2 elimination (ventilation) and oxygenation, as well as other INTELLiVENT-related data on the main display in specialized windows.

Most of these windows are displayed as a series of views that you can cycle through during ventilation.

To display view windows

▸ Touch the left or right view navigation button to cycle through the views.

The view number is displayed between the buttons.

Figure 1-12. Displaying INTELLiVENT-ASV views
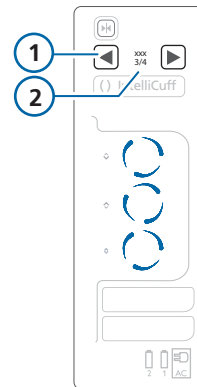
| 1 | View navigation buttons | 2 | View number |

The following table describes the INTELLiVENT-ASV windows, as well as where they are displayed.

Table 1-10. INTELLiVENT-ASV views, overview

View	Description	See …
Ventilation map	Shows the current patient PetCO2 value and target range in relation to Ppeak, together with the set limits. The map is shown: • In the INTELLiVENT-ASV Settings window • During active ventilation in view 2	Section 1.5.2 For details about the rules used to regulate CO2 elimination, see Section 1.7.
Ventilation horizon	For a passive patient, shows a zoom into the map at the current PetCO2 value and target range. For an active patient, the spontaneous breathing rate is displayed (fSpont). The horizon is shown during active ventilation in view 1.	Section 1.5.3
Oxygenation maps	Two maps are available: • The PEEP/SpO2 view shows the current patient SpO2 value and the target range in relation to PEEP, together with the set limits. • The FiO2/PEEP view shows the patient's current combination of Oxygen/PEEP values. The selected map is shown: • In the INTELLiVENT-ASV Settings window • During active ventilation in view 2	Section 1.5.4 For details about the rules used to regulate oxygenation, see Section 1.8.
Oxygenation horizon	Shows a zoom into the map at the current SpO2 value and target range. The horizon is shown during active ventilation in views 1 and 4.	Section 1.5.5
Plethysmogram	Provides a real-time waveform that represents the pulsating blood volume. A plethysmogram is shown: • During active ventilation in views 1 and 4 • As a waveform on the main display, if selected	Section 1.5.6

View	Description	See ...
Capnogram	Provides a real-time end-tidal CO2 waveform. A capnogram is shown: • During active ventilation in view 1 • As a waveform on the main display, if selected	Section 1.5.6
Ventilation and oxygenation guides	Provide description of ventilation/oxygenation management actions. The guides are shown during active ventilation in view 3.	Section 1.5.7
Quick Wean related		
Quick Wean/Quick Wean & SBT status	Shows the status for SBT- and weaning-related parameters.	Section 2.4.4.1
SBT history	The SBT history window is shown during active ventilation in view 4.	Section 2.4.4.2

1.5.2 About the Ventilation (CO2 elimination) map

The INTELLiVENT-ASV ventilation controller monitors end-tidal CO2 (**PetCO2**), and uses this data to adjust **%MinVol** to regulate CO2 elimination, according to the detailed rules and conditions described in Section 1.7.

The INTELLiVENT-ASV ventilation controller uses a predefined end-tidal CO2 target schema with peak pressure (**Ppeak**) on the y-axis and **PetCO2** on the x-axis. Peak pressure is the sum of **PEEP** and the inspiratory pressure set by the controller.

This schema is called the *Ventilation* map. In the map, the yellow cross is the patient symbol denoting the patient's current measured **PetCO2** value at the current peak pressure. The boomerang shaped area of the graph is the target range, which denotes a range of values at a given peak pressure.

1.5.2.1 Reviewing the Ventilation map

> **NOTICE**
>
> The maximum **Ppeak** value that can be shown on the Ventilation map is 50 cmH2O, so in some cases, the map may not show the patient symbol. INTELLiVENT-ASV is running, however.

The Ventilation map is available in two locations:

• INTELLiVENT-ASV Settings window

• During active ventilation with INTELLiVENT-ASV, in view 2

Figure 1-13. Ventilation map, INTELLiVENT-ASV Settings window (left), view 2 during ventilation (right)

1	Target zone	6	Map title: CO2 elimination
2	Yellow patient symbol (cross) and current patient values	7	Target Shift. When set, the map in view 2 shows the setting (*Target Shift: n >* or *Target Shift: < n*)
3	High pressure alarm limit	8	When **%MinVol** is increasing (^) or decreasing (v), the appropriate indicator appears. When the arrows are the same size, **%MinVol** is in target zone.
4	Pressure limitation: P ASV limit	9	For active patient: target range and current **fSpont** value
5	Current measured **PetCO2** value and quality index		

The blue arrows are for clarification purposes only; they do not appear on the display. Up arrow: Increase zone (**PetCO2** too high, increase **%MinVol**); *Down arrow:* Decrease zone (**PetCO2** too low, decrease **%MinVol**).

To display the Ventilation map in the INTELLiVENT-ASV Settings window

1. To open the INTELLiVENT-ASV Settings window, touch the **INTELLiVENT** button at the top right of the display, or touch an automated controller.

   The Settings window opens.

2. If the Maps panel is not open, touch the arrow next to Patient conditions to display the panel. Touching the arrow again closes the panel.

The panel shows the Ventilation and Oxygenation maps, measured values, and the **Target Shift** control for each map.

Figure 1-14. Ventilation map (**1**), INTELLiVENT-ASV Settings window
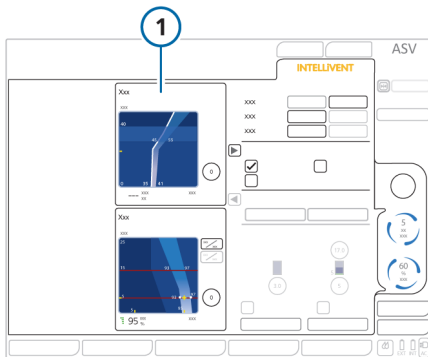
To display the Ventilation map while INTELLiVENT-ASV is running

▸ If it is not already displayed, touch the view navigation arrows at the right of the display until view 2 is displayed.

View 2 shows the Ventilation and Oxygenation maps, and the measured PetCO2 and SpO2 values.

Figure 1-15. Ventilation map (top), view 2 during active ventilation
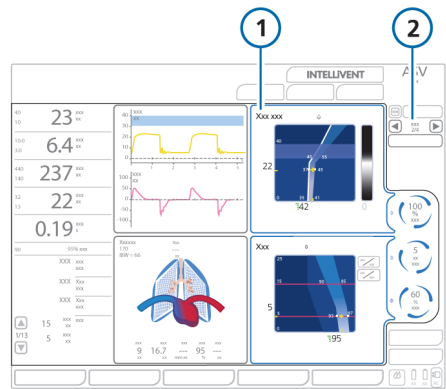
1	Ventilation map	2	View arrows and current view number

1.5.2.2 About the PetCO2 target zone

At a very basic level, the ventilation controller attempts to keep the patient in the target zone as described here.

The Ventilation map provides examples of each situation: PetCO2 is within, above, or below the target zone.
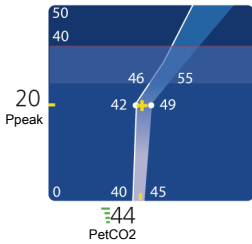
Patient symbol within the PetCO2 target zone

When the patient symbol is within the target zone, the **%MinVol** is fine tuned to get the patient to the middle of the target range.
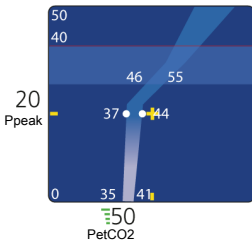
Patient symbol above the PetCO2 target zone

When the patient symbol is to the right of the target zone (in the increase zone, **PetCO2** is too high), the **%MinVol** setting increases.
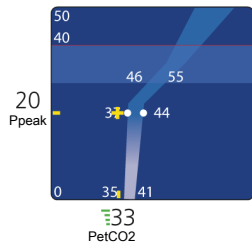
Patient symbol below the PetCO2 target zone

When the patient symbol is to the left of the target zone (in the decrease zone, **PetCO2** is too low), the **%MinVol** setting decreases.

1.5.3 About the Ventilation horizon

For a passive patient, the Ventilation horizon shows a simplified view of the same data as the Ventilation map, together with the upper and lower PetCO2 alarm limits.

When the patient is active, the horizon shows spontaneous breathing activity (fSpont).

Figure 1-16. Ventilation horizon, passive patient

1	Target zone, showing upper and lower boundaries	5	Upper and lower PetCO2 alarm limits
2	Patient symbol (yellow) showing current value	6	Horizon title: CO2 elimination
3	fSpont value (0)	7	When %MinVol is increasing (^) or decreasing (v), the appropriate indicator appears. When the arrows are the same size, %MinVol is in the target zone.
4	Current measured PetCO2 value and quality index		

⬆⬇ *The blue arrows are for clarification purposes only; they do not appear on the display. Up arrow:* Increase zone (PetCO2 too high, increase %MinVol); *Down arrow:* Decrease zone (PetCO2 too low, decrease %MinVol).

Figure 1-17. Ventilation horizon, active patient

1	Spontaneous breathing target zone, showing upper and lower boundaries	5	Upper and lower **PetCO2** alarm limits
2	Patient symbol (floater) showing current value	6	Horizon title: CO2 elimination
3	Current measured **fSpont** value	7	When **%MinVol** is increasing (^) or decreasing (v), the appropriate indicator appears. When the arrows are the same size, **%MinVol** is in the target zone.
4	Current measured **PetCO2** value and quality index		

The appropriate Ventilation horizon (for active or passive patient) is shown on the main display during active ventilation, in view 1.

For details about the rules governing automated **%MinVol** adjustments, see Section 1.7.

Figure 1-18. Ventilation horizon, view 1 during active ventilation
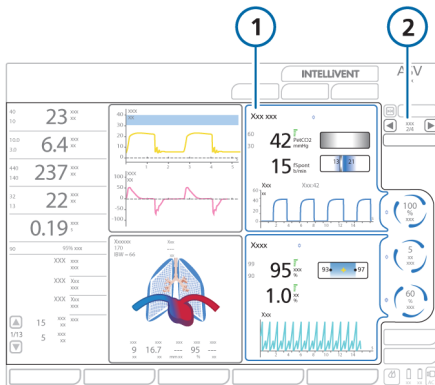
1	Ventilation horizon	2	View arrows and current view number

1.5.4 About the Oxygenation maps

The INTELLiVENT-ASV oxygenation controller monitors SpO2, and uses this data to adjust **PEEP** and **Oxygen** to regulate oxygenation, according to the detailed rules and conditions described in Section 1.8.

We use the term *treatment* to refer to the joint effect of **PEEP** and **Oxygen**:

- *Increasing treatment* refers to changes to **PEEP** and/or **Oxygen** that cause SpO2 to increase. The controller makes these changes based on ARDSnet guidelines.

- *Decreasing treatment* refers to changes in these control values that cause SpO2 to decrease. The controller makes these changes based on the Open Lung concept.

The INTELLiVENT-ASV oxygenation controller uses two predefined schemas, referred to as the *Oxygenation* maps.

The *PEEP/SpO2 target* schema shows **PEEP** on the y-axis and **SpO2** on the x-axis. The yellow cross is the patient symbol denoting the patient's current measured **SpO2** value at the current **PEEP**. The boomerang shaped area of the graph is the target zone, which denotes a range of **SpO2** values at a given **PEEP**.

The *FiO2/PEEP* schema shows **Oxygen** on the y-axis and **PEEP** on the x-axis. The yellow cross is the patient symbol denoting the patient's current measured combination of **Oxygen/PEEP** values. The triangular **PEEP/Oxygen** curve shows the target treatment levels, depending on whether treatment remains unchanged, increases, or decreases.

1.5.4.1 Reviewing the Oxygenation maps

The Oxygenation maps (PEEP/SpO2 and FiO2/PEEP) are available in two locations:

- INTELLiVENT-ASV Settings window

- During active ventilation with INTELLi-VENT-ASV, on the main display in view 2

Figure 1-19. Oxygenation map, PEEP/SpO2, Settings window (left), in view 2 during active ventilation (right)
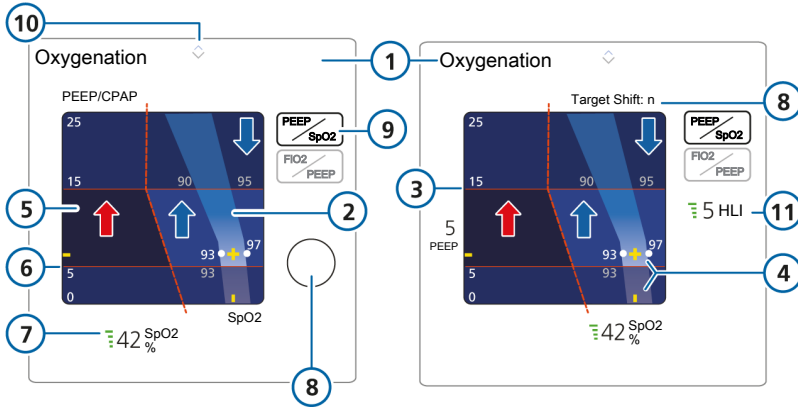
1	Map title: Oxygenation	7	Current measured SpO2 value and quality index
2	Target zone	8	Target Shift. When set, the map in the main display shows the setting (*Target Shift: n >* or *Target Shift: < n*)
3	Upper PEEP limit	9	Oxygenation map selection button: PEEP/SpO2
4	Yellow patient symbol (cross) and current patient values	10	When PEEP or Oxygen is increasing (^) or decreasing (v), the appropriate indicator appears. When the arrows are the same size, SpO2 is in target zone.
5	Dark blue emergency zone	11	HLI index (when enabled)
6	Lower PEEP limit		

The red/blue arrows and dotted line are for clarification purposes only; they do not appear on the display. Blue up arrow: Increase treatment zone. *Blue down arrow:* Decrease treatment zone. *Red arrow:* Emergency increase zone (dark blue area), Oxygen set to 100%.

Figure 1-20. Oxygenation map, FiO2/PEEP, Settings window (left), view 2 during active ventilation (right)

1	Map title: Oxygenation	7	Oxygenation map selection button: FiO2/PEEP
2	Lower PEEP limit	8	Target Shift
3	Upper PEEP limit	9	Lower Oxygen limit
4	Yellow patient symbol (cross) and current patient values	10	When PEEP or Oxygen is increasing (^) or decreasing (v), the appropriate indicator appears. When the arrows are the same size, SpO2 is in target zone.
5	PEEP/Oxygen curve	11	HLI index (when enabled)
6	Current measured SpO2 value and quality index		

To display the Oxygenation map in the INTELLiVENT-ASV Settings window

1. To open the INTELLiVENT-ASV Settings window, touch the **INTELLiVENT** button at the top right of the display or in the Standby window, or touch an automated controller.

   The Settings window opens.

2. If the Maps panel is not open, touch the arrow next to Patient conditions to display the panel. Touching the arrow again closes the panel.

   The panel shows the PEEP/SpO2 Oxygenation map, measured SpO2 value, and the **Target Shift** control.

3. To display the FiO2/PEEP map, touch the **FiO2/PEEP** button.

Figure 1-21. Oxygenation map (**1**), INTELLiVENT-ASV Settings window
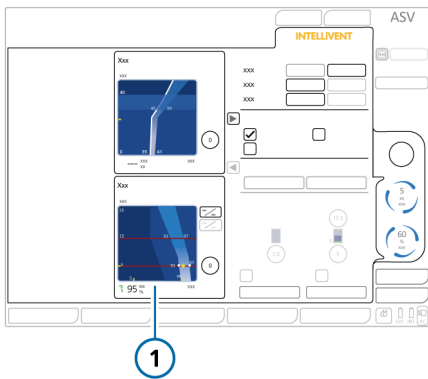
To display the Oxygenation maps while INTELLiVENT-ASV is running

1. If it is not already displayed, touch the view navigation arrows at the right of the display until view 2 is displayed.

   View 2 shows the Oxygenation map and the measured SpO2 value.

2. To display the FiO2/PEEP map, touch the **FiO2/PEEP** button. See Figure 1-15.

   To display the PEEP/SpO2 map, touch the **PEEP/SpO2** button.

Figure 1-22. Oxygenation map (top), view 2 during active ventilation
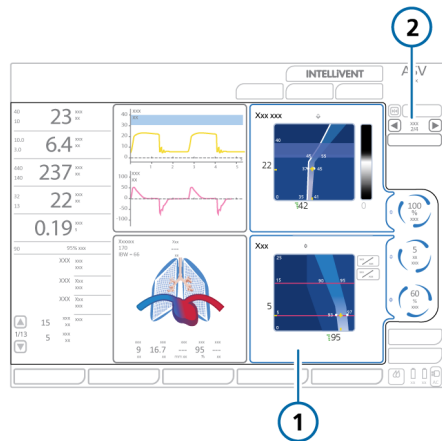
1	Oxygenation map	2	View arrows and current view number

1.5.4.2 About the SpO2 target zone

At a very basic level, the oxygenation controller attempts to keep the patient in the target zone as described here.

The PEEP/SpO2 (left) and FiO2/PEEP (right) maps below provide examples of each situation: SpO2 is within, above, or below the target zone.
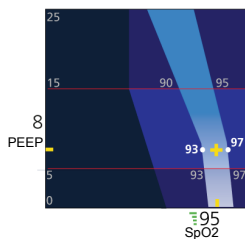
Patient symbol within the SpO2 target zone

When the patient symbol is within the target zone, Oxygen is fine tuned to get the patient to the middle of the target range.
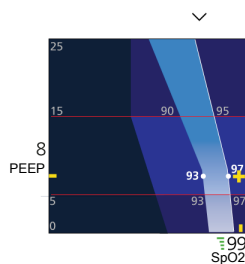
Patient symbol above the target zone

When the patient symbol is to the right of the target zone (in the *decrease zone*, indicating that the treatment is more than sufficient), the treatment is decreased. The down arrow above the map indicates a treatment decrease is occurring.
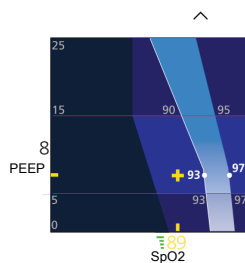
Patient symbol below the SpO2 target zone

When the patient symbol is to the left of the target zone (in the *increase zone*, indicating oxygenation is inadequate), the treatment is increased. The up arrow above the map indicates a treatment increase is occurring. As a result of being below the target zone, a medium-priority alarm is generated; the parameter is shown in the associated color.
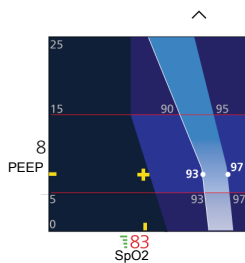
Patient symbol below the SpO2 target zone, in the Emergency zone

If the patient symbol is to the far left of the target zone in the dark blue *emergency zone* indicating hypoxemia, Oxygen is immediately increased to 100%. The up arrow above the map indicates a treatment increase is occurring. As a result of being below the target zone, a high-priority alarm is generated; the parameter is shown in the associated color.

1.5.5 About the Oxygenation horizon

The Oxygenation horizon shows a simplified view of the same data as the SpO2/PEEP Oxygenation map, together with the upper and lower *SpO2* alarm limits. With a Masimo SET SpO2 sensor, the horizon also shows the measured perfusion index (PI).

Figure 1-23. Oxygenation horizon
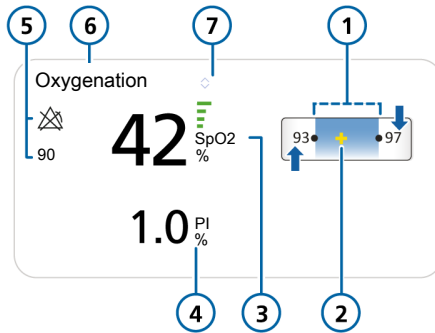
1	Target zone, showing upper and lower boundaries	5	Upper and lower **SpO2** alarm limits
2	Yellow patient symbol (cross) showing current patient value	6	Horizon title: Oxygenation
3	Current **SpO2** value and quality index	7	When **PEEP** or **Oxygen** is increasing (^) or decreasing (v), the appropriate indicator appears. When the arrows are the same size, **SpO2** is in the target zone.
4	Current **PI** value *(Masimo SpO2 sensor only)*		

The blue arrows are for clarification purposes only; they do not appear on the display. Up arrow: Increase treatment zone; Down arrow: Decrease treatment zone.

The Oxygenation horizon is shown on the main display during active ventilation in views 1 and 4.

Figure 1-24. Oxygenation horizon during active ventilation
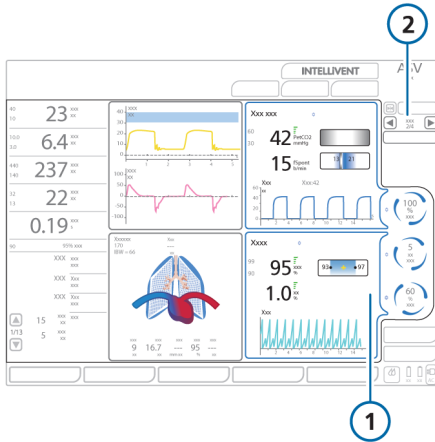
1 Oxygenation horizon	2 View arrows and current view number

1.5.6 About the plethysmogram and capnogram

A CO2 capnogram and SpO2 plethysmogram are available as part of the INTELLiVENT-ASV standard views. You can also display them as individual waveforms, in the same manner as other waveforms on the main display.

The time scale displayed is the same as for other waveforms. See your ventilator *Operator's Manual* for details.

About the capnogram

A capnogram is a waveform that represents CO2 levels throughout a breath cycle.

During active ventilation with INTELLiVENT-ASV, the capnogram is displayed together with the Ventilation horizon, as well as with the SBT history window. For details about selecting the capnogram as a waveform on the ventilator main display, see your ventilator *Operator's Manual*.

About the plethysmogram

A plethysmogram is a waveform that represents the pulsating blood volume; it is generated by the pulse oximeter.

During active ventilation with INTELLiVENT-ASV, the plethysmogram is displayed together with the Oxygenation horizon, as well as with the SBT history window. For details about selecting the plethysmogram as a waveform on the ventilator main display, see the *Pulse Oximetry Instructions for Use*.

1.5.7 About the guides

The Ventilation/Oxygenation guides describe all ventilation and oxygenation management actions in automatic mode. They are available during active ventilation in view 3.

Information is displayed during manual ventilation control, and describes how the automation controller would act if it were active.

1.5.8 About trends

In addition to the trend data available for monitored parameters, you can also trend the actions of the ventilation and oxygenation controllers when using INTELLiVENT-ASV. The same time periods are available as for other parameters, namely, 1-, 3-, 12-, 24-, 96-h trends.

Each parameter is represented by a different color, as indicated in the graph legend.

Trend information is available in two forms:

• Directly under the Ventilation and Oxygenation maps, using the **Trend** button on the main display

• Selecting the Trends graphic panel and selecting the Ventilation Combi or Oxygenation Combi option

Trends in the Ventilation and Oxygenation maps

You can review how the automatic management of %MinVol and PEEP/Oxygen performed over time, directly in the Ventilation and Oxygenation maps in view 2.

Figure 1-25. Reviewing ventilation/oxygenation trends in the maps
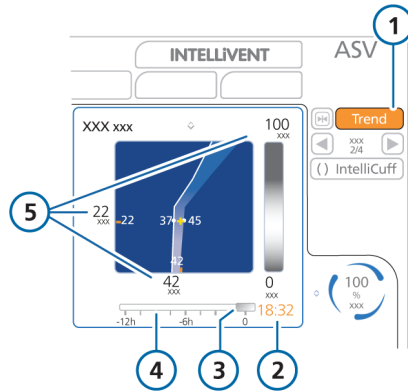
1	Trend button active	4	Timeline
2	Time at selected point in timeline	5	Parameter values at selected point in timeline
3	Cursor		

To review trends in the Map view

1. During active ventilation, display the Ventilation and Oxygenation maps in view 2.

2. Touch the **Trend** button above the automated controllers.

   A trend timeline appears under each of the maps.

3. Use the P&T knob to scroll through the timeline.

   Both trends scroll at the same rate. The values in the map change to reflect the values at the selected time point.

4. To close the trend, touch the **Trend** button again.

To select the Ventilation and/or Oxygenation combination trends

1. Touch the area of the main display where you wish to display trends.

   The graphics selection list appears. For details on displaying a trend graph, refer to your ventilator *Operator's Manual*.

2. Select Trend from the list.

   The Trend selection list appears, prompting you to choose the trend to display on top.

3. Use the P&T knob to scroll through the list and select the desired entry,

then press the knob to accept the selection.

You are prompted to select the trend to show on the bottom.
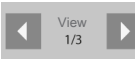
4. Repeat the previous step to select the desired trend.
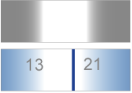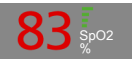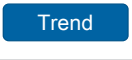
The selected trends are displayed.
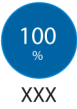
1.5.9 INTELLiVENT-ASV symbols

The following table describes important symbols and controls used with INTELLiVENT-ASV.

Table 1-11. INTELLiVENT-ASV-related symbols and controls

Symbol	Color	Description
View 1/3	White	View selection. During active ventilation, four views are available; the view navigation arrows change the view between those described in Section 1.5.1.
✚	Yellow	Patient symbol. Indicates the current condition of the patient in the graph.
▬▬▬	Gray (4 bars), Red (1 bar), Orange (2 bars)	Quality index showing unreliable signal quality. Sensor values are not usable or sensor not enabled or connected. When this occurs, the related controller freezes and an alarm is generated indicating the automatic management is turned OFF.
▬▬	Green (3 or 4 bars)	Quality index showing stable acceptable signal quality. The data from the sensor is highly stable and reliable.
45 PetCO2 mmHg	White	Measured **PetCO2** sensor value and quality index.

Symbol	Color	Description
13 21	PetCO2 horizon is ghosted; fSpont horizon is active	When the PetCO2 horizon is greyed out, the patient is breathing spontaneously. The fSpont horizon is active. When the fSpont horizon is greyed out, the patient meets the passive criteria. The PetCO2 horizon above it is active.
17 fSpont b/min	White	The fSpont measurement is displayed when spontaneous breathing is detected by the flow sensor and used as physiologic input.
83 SpO2 %	Red	Critical SpO2 value. SpO2 is below the set lower alarm limit.
---	White	Dashes indicate that no sensor value can be detected.
⌃⌄	White	Increase arrow, next to the horizon name and to the left of the automated controllers. Indicates that treatment must be increased.
⌃⌄	White	Decrease arrow, next to the horizon name and to the left of the automated controllers. Indicates that treatment must be decreased.
⌃⌄	Gray	Value is stable, in range. Displayed next to the horizon name and to the left of the automated controllers.
263 ⌃⌄	White	Time to increase. Counts down the time to the next increase of the control.
⌃⌄ 4	White	Time to decrease. Counts down the time to the next decrease of the control.
240	White	Recruitment symbol. Indicates that a recruitment maneuver will be performed after the next PEEP increase. Counts down the time to maneuver.
Trend	Blue	Trend view is inactive.
Trend	Orange	Trend view is active.

Symbol	Color	Description
20	White	Recruitment in progress. Message displayed, and count-down timer indicating duration of maneuver. Located close to the PEEP controller.
100 % XXX	Solid blue circle	Manual management. Indicates that the operator must manage the control.
95 XXX %	Blue circle rotating clockwise	Automatic management. Indicates that INTELLiVENT-ASV is managing the patient and treatment has been increased (comets moving clockwise). A faster rotation provides a visual indication of ongoing or recent changes.
95 XXX %	Blue circle rotating counter-clockwise	Automatic management. Indicates that INTELLiVENT-ASV is managing the patient and treatment has been decreased (comets moving counter-clockwise). A faster rotation gives a visual indication of ongoing or recent changes.
100 XXX %	Red circle	No automatic management – controller is in a frozen state. A sensor value may be absent.
100 % XXX 1:45	Green circle	Oxygen enrichment in progress. For details, see your ventilator *Operator's Manual*.

1.6 Troubleshooting alarms

> ⚠️ **CAUTION**
>
> *You can suppress audible CO2 and SpO2 alarms for 2 minutes by pressing the* **Audio Pause** *key.*

> **NOTICE**
>
> When the device is in Standby, all SpO2-related alarms are suppressed.

The following table provides troubleshooting information for alarms related to INTELLiVENT-ASV.

For information about working with alarms, including resetting them, see your ventilator *Operator's Manual* and SpO2-related documentation.

For the following alarm types, see the listed documentation:

- *Quick Wean/SBT-related alarms*, see Section 2.8.

- *SpO2-related alarms*, see the *Pulse oximetry Instructions for use*.

- *PetCO2-related alarms*, see your ventilator *Operator's Manual*.

Table 1-12. INTELLiVENT-ASV alarms, priority, and corrective actions

Alarm/Priority	Definition/Corrective action
Check INTELLiVENT PEEP limit setting *Low priority.* Nihon Kohden only (HLI related).	All of the following criteria are met: • The PEEP controller is automated • HLI is enabled and ≤10% • Lower PEEP limit is set to >10 cmH2O • Vt is ≤6 ml/kg per IBW *or* • (Ppeak − PEEP) ≤10 cmH2O **To resolve** • Check the hemodynamic condition of the patient • Disable HLI to reset the alarm
FiO2 set to 100% due to low SpO2 *Medium priority.*	Oxygenation controller set Oxygen to 100% due to low SpO2 saturation. SpO2 is in the emergency zone. **To resolve** • Check patient condition • Open and close the alarm buffer to reset the alarm (even if the alarm situation changes)
High HLI *Medium priority.*	Measured HLI is above the set limit. **To resolve** • Check the hemodynamic condition of the patient • Adjust the alarm limits, if needed

Alarm/Priority	Definition/Corrective action
No hemodynamic status available *Medium priority.* Nihon Kohden only (HLI related).	All of the following conditions are met: • HLI has been invalid for an extended period of time • SpO2 is enabled • PEEP management is automated • HLI is used by the controller • The patient is passive **To resolve** Inspect the SpO2 sensor attachment on the patient.
FiO2 Oscillation *Medium priority.*	Large variations in Oxygen in a short time period **To resolve** • Check patient condition • Set Oxygen to Manual
PEEP oscillation *Medium priority.*	Large variations in PEEP in a short time period **To resolve** • Check patient condition • Set PEEP to Manual
%MV oscillation *Medium priority.*	Large variations in %MinVol in a short time period **To resolve** • Check patient condition • Set %MinVol to Manual
Oxygenation adjustment OFF *Low, then Medium priority.*	Oxygenation controller is frozen due to poor or absent SpO2 signal. If the condition is not resolved within 30 seconds, the alarm changes to medium priority. **To resolve** • Check pulse oximeter connections • Set PEEP and/or Oxygen to Manual
Oxygen controller at limit *Low priority.*	PEEP and/or Oxygen are at defined limit and cannot be increased **To resolve** • Check patient condition • Verify limit settings • Set PEEP and/or Oxygen to Manual

Alarm/Priority	Definition/Corrective action
Oxygen alarm limit exceeded *Medium priority.*	Oxygen exceeds the limit defined by the Oxygen message alarm (Alarms window) **To resolve** • Check patient condition • Open and close the alarm buffer to reset the alarm (even if the alarm situation changes)
Oxygen supply failed *High priority.*	Oxygen source flow lower than expected **To resolve** • Check patient condition • Check oxygen supply, change supply if necessary • Check oxygen supply for leaks • Provide alternative ventilation until issue resolved
Recruitment in progress *Low priority.*	Notification about ongoing recruitment maneuver. **To resolve** Check patient condition
Ventilation adjustment OFF *Low, then Medium priority.*	Ventilation controller is frozen when any of the following conditions occurs for longer than 30 seconds: • Poor or absent CO_2 signal • fSpont > 60 b/min (Adult) • fSpont > 100 b/min (Pediatric) **To resolve** • Check patient condition • Check CO_2 connections • Set %MinVol to Manual
Ventilation controller at limit *Low priority.*	%MinVol is at defined limit (200%) and cannot be increased **To resolve** • Check patient condition • Set %MinVol to Manual

1.7 Management of minute volume (%MinVol)

> ⚠️ **WARNING**
>
> Regularly inspect CO2 adapters/sensors. Patient secretions and/or condensation in airway adapters can lead to an incorrect PetCO2 reading.

> ⚠️ **CAUTION**
>
> *Do NOT use the sidestream CO2 sensor with automatic management of %MinVol.*

Ventilation (**%MinVol**) management operates in two modes: Automatic and Manual.

Automatic minute volume management

When automated, the INTELLiVENT-ASV ventilation controller uses the following data to set the minute volume (**%MinVol**):

- The controller uses different inputs to control the target minute volume, depending on whether the patient is passive or active
  - **Passive patient.** The controller uses the measured end-tidal CO2 partial pressure, PetCO2, as described in Section 1.7.1.
  - **Active patient.** The controller uses the difference between the targeted and actual respiratory rate, as described in Section 1.7.2.

For details on how the automated controller manages the transition between spontaneous breathing and passive activity, see Section 1.7.3.

- All ASV safety limits are active for prevention of Apnea, baro- and volu-trauma, auto-PEEP, and dead-space ventilation, including the tidal volume (Vt) limit of **1.5 x (upper Vt alarm limit)**.

- The target PetCO2 that is set depends on:
  - The patient's treatment level (peak inspiratory pressure)
  - Operator-set patient condition (Section 1.4.11.1)
  - Operator-set PetCO2 target shift (Section 1.4.11.3)
  - Whether Quick Wean is enabled (Section 2.2)

- The acceptable spontaneous breathing rate is calculated using the information in Table 1-15.

The **%MinVol** limits that are in force during automatic minute volume management are listed in Table 1-13.

As soon as the upper limit for the automatic management of **%MinVol** is reached, a Ventilation controller at limit message is generated.

Table 1-13. %MinVol limits for automatic minute volume management

Minimum %MinVol	
PetCO2 available	70
PetCO2 not available	100 (automatic control suspended)
Maximum %MinVol	
PetCO2 available	200
PetCO2 not available	200 (automatic control suspended)

Manual minute volume management

In manual mode, you keep the CO2 elimination within the target range by adjusting **%MinVol**, based on the PetCO2 monitoring values and on clinical practice.

1.7.1 Management of %MinVol, passive patient

When the patient is passive, the ventilator adjusts the target minute ventilation based on the PetCO2 value of the patient.

End-tidal CO2 partial pressure (PetCO2), available when the CO2 sensor is connected, is the maximum partial pressure of CO2 exhaled during a breath, just before the start of inspiration. This represents the final portion of air that was involved in the exchange of gases in the alveolar area, and is, generally, a reliable index of CO2 partial pressure in the arterial blood.

Under normal conditions, PaCO2 is approximately 3-5 mmHg higher than PetCO2 — the difference between the values is referred to as the *PaCO2-PetCO2 gradient*. Under special clinical conditions (including ventilation/perfusion mismatch, such as shunt), the PaCO2-PetCO2 gradi-

ent can increase, requiring adjustment of the ventilation targets (using the Target Shift control). For details, see Section 1.4.11.3.

To get the most accurate approximation of PaCO2, the second highest PetCO2 value out of 8 breaths is used.

The PetCO2 target range depends on:

- Operator-set patient condition (Section 1.4.11.1)

- Operator-set PetCO2 target shift (Section 1.4.11.3)

- Current level of ventilator support (Ppeak)

Within these ranges, and based on the PetCO2 response from the patient, %MinVol is adjusted as described in the following table.

Table 1-14. Automated management of %MinVol, passive patient

When these conditions apply ...	%MinVol change
PetCO2 is above the upper limit of acceptable values	%MinVol increase
PetCO2 is below the lower limit of acceptable values	%MinVol decrease
PetCO2 is within the target range	Minor %MinVol changes
PetCO2 measurement is invalid or unreliable for at least 30 seconds	%MinVol control is frozen. The Ventilation adjustment OFF alarm is generated.

1.7.2 Management of %MinVol, active patient

When a patient is active, spontaneously triggering the breaths, the ventilator adjusts the target minute ventilation based on the spontaneous breathing rate of the patient.

The acceptable range for the spontaneous breathing rate is determined as follows:

Table 1-15. Spontaneous breathing rate range calculation[19]

Lower limit of range	ASV target Rate + 2
	When Quick Wean is enabled: ASV target Rate + 3
Upper limit of range	ASV target Rate + d
	d = %MinVol * k where
	k = 0.1 Quick Wean disabled
	k = 0.15 Quick Wean enabled

While the patient is active, the patient's spontaneous rate is detected by the flow sensor. The PetCO2 value is only used in the background for additional safety to avoid excessive values.

The conditions listed in the following table apply to automated control of %MinVol for an active patient, and refer to the transition process specified in Section 1.7.3.

---

[19] For ASV target rate information, see your ventilator *Operator's Manual*.

Table 1-16. Automated management of %MinVol, active patient

When these conditions apply ...	%MinVol change
• The patient complies with the *Active state conditions* in Section 1.7.3 *and* • The patient's Rate is above the upper limit of the acceptable spontaneous rate (danger of patient fatigue)	%MinVol increase
• The patient complies with the *Active state conditions* in Section 1.7.3 *and* • The patient's Rate is below the lower limit of the acceptable spontaneous rate	%MinVol decrease
• The patient complies with Rule 1 in Section 1.7.3 *and* • The patient's Rate value is within the target range	No change in %MinVol. If Quick Wean is enabled, see Section 2.4.1 for details.
The patient's PetCO2 is invalid for more than 30 seconds	%MinVol control is frozen. The Ventilation adjustment OFF alarm is generated.
The patient's spontaneous rate is invalid (Adult > 60 b/min, Pediatric > 100 b/min) for more than 30 seconds	%MinVol control is frozen. The Ventilation adjustment OFF alarm is generated.

1.7.3 How the ventilation controller transitions between active and passive patient states

```
          ┌─────────────────────────────┐
          │ Ventilation management based │
          │          on PetCO2           │
          │      (passive patient)       │
          └─────────────────────────────┘
                         │
                         ▼
                    ╱         ╲
                  ╱             ╲
                ╱   * 5 consecutive ╲
               ╱    spont breaths    ╲       No
              ╱         AND           ╲
              ╲ * PetCO2 ≤ upper PetCO2╱
               ╲   limit              ╱
                ╲      AND           ╱
                  ╲ * No Brain Injury╱
                    ╲             ╱
                       ╲       ╱
                         │ Yes
                         ▼
          ┌─────────────────────────────┐
          │ Ventilation management based │
          │        on spont rate         │
          │       (active patient)       │
          └─────────────────────────────┘
                         │
                         ▼
                    ╱         ╲
                  ╱             ╲
                ╱ * 5 consecutive ╲
         Yes   ╱   mech breaths    ╲      No
              ╱        OR            ╲
              ╲ * PetCO2 above upper ╱
               ╲  limit + 3 mmHg    ╱
                ╲       OR         ╱
                  ╲ * Brain Injury ╱
                    ╲           ╱
                       ╲     ╱
```
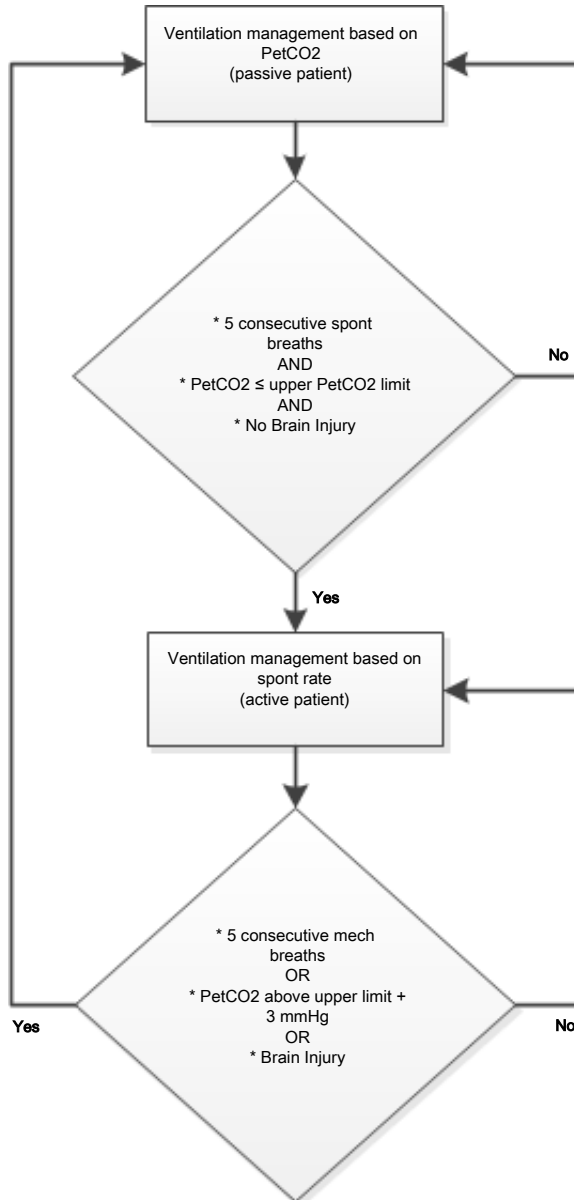
Passive patient

For a passive patient, the controller starts adjusting the %MinVol based on PetCO2 when ANY of the following are true:

- Five consecutive mechanical breaths occur *or*

- The PetCO2 value exceeds the upper limit by at least 3 mmHg *or*

- The Brain Injury patient condition is selected

In this case, the %MinVol is adjusted on the PetCO2 input.

When a reliable PetCO2 measurement is not available (Table 1-18), the ventilation controller suspends automated management, and the %MinVol control is frozen. The Ventilation adjustment OFF alarm is generated.

Active patient

For an active patient, the ventilation controller starts adjusting the %MinVol based on the Rate when ALL of the following are true:

- Five consecutive patient-triggered breaths occur *and*

- The PetCO2 value is below the upper limit *and*

- The Brain Injury patient condition is NOT selected

The controller continuously checks the passive patient conditions (described next) since it uses Rate as input criteria.

If the passive patient conditions do not apply, the controller continues to adjust the %MinVol based on the spontaneous breathing rate of the patient.

If the patient's spontaneous rate is invalid[20] for more than 30 seconds, the ventilation controller suspends automated management and the %MinVol control is frozen. The Ventilation adjustment OFF alarm is generated.

When a reliable PetCO2 measurement is not available (Table 1-18), the ventilation controller suspends automated management, and the %MinVol control is frozen. The Ventilation adjustment OFF alarm is generated.

---

[20] fSpont > 60 b/min (Adult) or fSpont > 100 b/min (Pediatric)

1.7.4 Important notes about ventilation management

When ventilating with INTELLiVENT-ASV, pay particular attention to important notes in the following areas:

Table 1-17. Important notes about ventilation management

For ...	See ...
Signal quality and ventilation	Section 1.7.4.1
Actions that temporarily halt automatic ventilation management	Section 1.7.4.2
PetCO2 is not available	Section 1.7.4.3
Disconnection or flow sensor failure resolved in 5 minutes or less	Section 1.7.4.4
Disconnection or flow sensor failure resolved in more than 5 minutes	Section 1.7.4.5
Returning to active ventilation from standby	Section 1.7.4.6

1.7.4.1 Signal quality and ventilation management

The following table summarizes INTELLi-VENT-ASV operation depending on the quality of the PetCO2 signal.

Table 1-18. PetCO2 signal quality and automated ventilation management

Signal reliability and quality index	These conditions apply ...
PetCO2 signal is unavailable or of poor quality for more than 30 seconds Gray (or blue) or red bars 	• The **%MinVol** control is a solid red circle; it is frozen. • The Ventilation adjustment OFF alarm is generated. • The minute volume adjustment works as it does in ASV, with a constant minute ventilation equal to the last valid automatic **%MinVol** setting. For details, see your ventilator *Operator's Manual*.
PetCO2 signal is available and reliable Green bars 	• The **%MinVol** control is a blue rotating circle. • The alarm is reset. • Automated ventilation management resumes.

1.7.4.2 Actions that temporarily halt automatic ventilation management

Automated ventilation management pauses during the following actions:

- Disconnection
- Flow sensor calibration
- Tightness test
- Suctioning
- P/V Tool maneuver
- Inspiratory/expiratory hold maneuver
- Auto-recruitment

In some cases, the controller remains displayed with a blue rotating circle, and when the action is completed, it resumes automated management with the last-used setting.

Ventilation continues using the last %MinVol setting before the automated management was paused.

1.7.4.3 PetCO2 is not available

Any time the PetCO2 measurement is unavailable or unreliable, the minute volume adjustment is the same as in ASV mode, using the %MinVol setting in effect at the time that the PetCO2 signal became unusable.

Note that if the last %MinVol setting was < 100%, %MinVol is set to 100%.

- The ventilation controller display changes from blue to red.
- The alarm, Ventilation adjustment OFF, is generated. The ventilator provides constant minute ventilation.

When PetCO2 is again available, the alarm is cleared and the minute volume adjustment switches back to fully automatic mode.

- The controller changes from red to a blue rotating circle again.
- %MinVol is adjusted automatically.

1.7.4.4 Disconnection or flow sensor failure resolved in 5 minutes or less

When a disconnection or flow sensor failure situation is resolved in 5 minutes or less, the device:

- The %MinVol management adjustment pauses for 10 breaths.
- The ASV adjustment (Pinsp and ASV target rate) pauses for 4 breaths after reconnection.
- If the adjustment is in its initialization phase, it remains there for at least 3 more breaths.

For details, see your ventilator *Operator's Manual*.

1.7.4.5 Disconnection or flow sensor failure resolved in more than 5 minutes

When a disconnection or flow sensor failure is resolved in more than 5 minutes:

- The ventilation controller adjustment pauses for 2 minutes.
- The ASV adjustment re-initializes. If the adjustment is in its initialization phase, it remains there for at least 3 more breaths.

1.7.4.6 Starting active ventilation from Standby

When starting ventilation with a new patient selected and INTELLiVENT-ASV activated, the **%MinVol** adjustment initializes with the default settings.

If **Last Patient** was selected, the system assumes the patient settings, in addition to the **%MinVol** values from the last patient.

In the event the **PetCO2** quality index is below 50, the **%MinVol** control changes from a blue rotating circle to a red non-pulsing circle. Ventilation management does not start.

When the **PetCO2** quality index is above 50, ventilation management starts in automatic mode. The **%MinVol** control is a blue rotating circle.

1.8 Management of PEEP and Oxygen

As INTELLiVENT-ASV relies on the measurements provided by the SpO2 sensor, be sure to carefully review the safety messages provided in this guide, as well as those provided in the *Pulse oximetry Instructions for use*.

> **NOTICE**
>
> - The emergency increase of oxygen rules remain in place for all cases as long as the **Oxygen** control is set to **Automatic**.
> - The oxygenation controller can only adjust the **Oxygen** between 21% and 100%.
> - When the minimum **Oxygen** limit is set > 21%, a red line indicating the limit appears on the Oxygenation maps.

- Outside of performing an SBT, the PEEP controller can only operate between 5 and 24 cmH2O.
- If the **PEEP** control is automated, the set **PEEP** high and low limit controls are activated. The Oxygenation maps show two red lines, one showing the upper **PEEP** limit and one showing the lower.
- Depending on the selected manufacturer, a second SpO2 sensor may be used on the ventilator to increase the availability and accuracy of SpO2 measurement.

Oxygenation (**PEEP/Oxygen**) management operates in two modes: Automatic and Manual.

Automatic oxygenation (PEEP and Oxygen) management

Automated PEEP/Oxygen management sets the **Oxygen** and **PEEP** values according to the following inputs, which determine the expected **SpO2** range for the patient:

- Measured oxygen saturation (**SpO2**)
- Operator-set patient condition (Section 1.4.11.1)
- Operator-set Target Shift (Section 1.4.11.3)

The lung-protective rules for oxygenation management, used during automated PEEP/Oxygen management, are based on the ARDSnet guidance when increasing the therapy, and the Open Lung concept when decreasing the treatment. See Section 1.8.1.

Manual oxygenation management

In manual mode, you keep the **SpO2** within the target range by adjusting **PEEP** and/or **Oxygen**, based on the **SpO2** monitoring values and on clinical practice.

1.8.1 Management of PEEP/Oxygen for all patients

Using the SpO2 signal retrieved from the pulse oximeter, the system calculates the difference between the current and the target SpO2 value. This calculation, together with the operator's input, is used to determine the treatment action.

Automated PEEP/Oxygen management comprises two steps:

- The operator's input and the actual treatment (PEEP) define the SpO2 target range. The ranges differ based on patient conditions (Section 1.4.11.1). The SpO2 signal and the SpO2 target range are used to define the treatment action (increase, decrease, no change of treatment).

- The system decides, depending on the actual combination of PEEP and Oxygen on the PEEP/Oxygen curve, whether PEEP and/or Oxygen are increased.

  The relationship between PEEP and Oxygen is based on the ARDSnet guidance for increasing therapy (Figure 1-26, the target path is the bold line) and the Open Lung concept for decreasing therapy (Figure 1-27, the target path are the bold lines).

Figure 1-26. Increase of oxygenation support, ARDSnet guidance
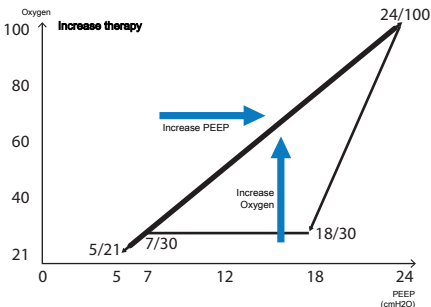
Figure 1-27. Decrease of oxygenation support, Open Lung concept
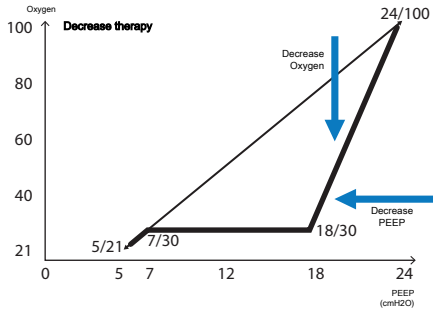
The device adjusts PEEP and Oxygen, which affect the oxygenation of the patient. Section 1.8.3 provides an overview of the controllers' actions depending on the measured SpO2 value.

1.8.2 Emergency increase of Oxygen

When Oxygen is set to Automatic, the device provides a safety feature that continuously monitors the patient's SpO2 to avoid dangerous desaturation. Upon detecting an inadequate SpO2 level, the device reacts immediately to deliver 100% Oxygen to the patient.

The safety feature is activated when the physiologic SpO2 value of the patient falls below the lowest acceptable value, thus triggering the 100% Oxygen response. The FiO2 set to 100% due to low SpO2 alarm is generated.

1.8.3 Oxygenation management rules

The automated oxygenation controller adjusts PEEP and Oxygen as described here.

SpO2 is in range (within the target zone limits) and the Oxygen setting is above the PEEP/Oxygen curve

The controller *decreases Oxygen support* as long as all of the following conditions are met:

- SpO2 remains in range
- Oxygen was last increased over 10 minutes ago
- There is no change in PEEP

SpO2 is too low (below the lower SpO2 target zone limit)

The controller *increases oxygenation support*.

Position of patient symbol in the FiO2/PEEP map, relative to the ARDSnet curve	
Above the curve	The controller changes PEEP stepwise to the PEEP/Oxygen curve.
On the curve	The controller increases PEEP and Oxygen stepwise at the same time to follow the curve.
Below the curve	The controller increases Oxygen stepwise to the curve.

SpO2 is critically low (in the Emergency zone)

The controller *performs an emergency Oxygen increase*.

The Oxygen control displays the value 100%. See Section 1.8.2.

SpO2 measurement is unavailable

The controller *is frozen*.

The PEEP and Oxygen controls are frozen, displayed as solid red circles, and the Oxygenation adjustment OFF alarm is generated. Oxygenation management is no longer automated.

SpO2 is high, above the target zone limit

The controller *decreases oxygenation support*.

Position of patient symbol in the FiO2/PEEP map, relative to the Open Lung curve	
Above the curve	The controller decreases Oxygen stepwise to the PEEP/Oxygen curve.
On the curve	The controller first decreases Oxygen, then PEEP to follow the curve.
Below the curve	The controller automatically decreases PEEP stepwise to the curve.

1.8.3.1 How the controller adjusts Oxygen and PEEP

NOTICE

If an upper PEEP limit is specified, the controller will not exceed the limit.

If a lower PEEP and/or Oxygen limit is specified, the controller will not go below the limit.

The following table describes the rules the controller follows to adjust the oxygenation parameters.

Table 1-19. Increase/decrease increments of Oxygen and PEEP by automated oxygenation controller[21]

Oxygenation management	Action	Takes place when ...
Increase Oxygen stepwise	Increases Oxygen by 10% of current Oxygen value every **30 seconds**	• Oxygen automatically managed • Increasing Oxygen support
Decrease Oxygen stepwise	Decreases Oxygen by 5% of current Oxygen value every **60 seconds**	• Oxygen automatically managed • Decreasing Oxygen support
Increase PEEP stepwise	Increases PEEP by 1 cmH2O every **6 minutes**	• PEEP automatically managed • Increasing PEEP support
Decrease PEEP stepwise	Decreases PEEP by 1 cmH2O every **6 minutes**	• PEEP automatically managed • Decreasing PEEP support
Decrease PEEP stepwise quickly	**Exception:** Decreases PEEP by 1 cmH2O quickly every **30 seconds**	• PEEP automatically managed • PEEP is above the upper PEEP limit (if PEEP was set manually above the limit or PEEP is above the limit allowed by HLI)

---

[21] When the PEEP and/or Oxygen control setting is manually changed and then control is again set to Automatic, these rules still apply. The time interval starts from the time of the last manual change.

1.8.4 Important notes about oxygenation management

When ventilating with INTELLiVENT-ASV, pay particular attention to important notes in the following areas:

Table 1-20. Important notes about oxygenation management

For ...	See ...
Signal quality and oxygenation management	Section 1.8.4.1
Actions that temporarily halt automatic oxygenation management	Section 1.8.4.2
Oxygen level notification	Section 1.8.4.3
Returning to active ventilation from standby	Section 1.8.4.4

1.8.4.1 Signal quality and oxygenation

The following table summarizes INTELLi-VENT-ASV operation depending on the quality of the SpO2 signal.

Note that the controllers may also be frozen as a result of various SpO2- and Oxygen-related alarms.

The automatic emergency increase of Oxygen is inactive when Oxygen is controlled manually.

Table 1-21. SpO2 signal quality and automated oxygenation management

Signal reliability and quality index	These conditions apply ...
SpO2 signal is unavailable or of poor quality for more than 30 seconds Gray (or blue), red, or orange bars	• The PEEP and Oxygen controls are solid red circles; they are frozen. • The Oxygenation adjustment OFF alarm is generated. • The ventilator uses the same oxygenation rules as when in ASV mode. For details, see your ventilator *Operator's Manual*. • Automatic emergency increase of oxygen management is *inactive* (Section 1.8.2).
SpO2 signal is available and reliable Green bars	• The PEEP and Oxygen controls are blue rotating circles. • The alarm is reset. • Automated oxygenation management resumes. • Automatic emergency increase of oxygen management is *active* (Section 1.8.2)

1.8.4.2 Actions that temporarily halt automatic oxygenation

Automated oxygenation management pauses during the following actions:

- Disconnection
- Oxygen enrichment
- Flow sensor calibration
- Tightness test
- Suctioning
- Oxygen cell calibration
- Oxygen supply failure
- P/V Tool maneuver
- Inspiratory/Expiratory hold maneuver
- Auto-recruitment

In some cases, the controller remains displayed with a blue rotating circle, and when the action is completed, it resumes automated management with the last-used setting.

1.8.4.3 Oxygen level notification

When the automatic oxygenation controller is active, you can set the ventilator to display a message if the Oxygen concentration exceeds a specific limit that you specify. If the notification threshold is reached, an alarm is generated and the message Oxygen limit exceeded is displayed. See Section 1.4.11.7.

1.8.4.4 Starting active ventilation from Standby

When starting ventilation with a new patient selected and INTELLiVENT-ASV activated, the PEEP and Oxygen adjustments initialize with the default settings.

If Last Patient was selected, the system assumes the patient settings, in addition to the PEEP and Oxygen values from the last patient.

1.9 Manual control of ventilation and oxygenation

With INTELLiVENT-ASV, you can manage minute volume (%MinVol), Oxygen, and/or PEEP automatically or manually.

When manually controlling these parameters, the ventilator provides protocol guidance through the Ventilation and Oxygenation guides, shown on the main display in view 3. This guidance comprises information based on the current PetCO2 and SpO2 values and the patient's respiratory rate.

The guide describes what strategy the automated controller would use to adjust %MinVol, PEEP, and Oxygen, within the safety limits.

In some cases, automated management is not available, as described in the following sections.

1.9.1 Manual control of ventilation

When **%MinVol** is controlled manually, the device uses the same rules as when in ASV mode. For details, see your ventilator *Operator's Manual*.

Table 1-22. Conditions for manual control of %MinVol

When these conditions are met …	This control must be adjusted MANUALLY by the operator
CO2 monitoring is disabled	**%MinVol** is set to Manual

For control to be automated, you must manually set **%MinVol** to **Automatic** in the INTELLiVENT-ASV Settings window.

1.9.2 Manual control of oxygenation

You must control PEEP and/or Oxygen manually when any of the conditions listed in the following table occur.

Table 1-23. Conditions for manual control of PEEP and/or Oxygen

When these conditions are met …	This control must be adjusted MANUALLY by the operator
PEEP • The Chronic Hypercapnia or Brain injury patient condition is selected • SpO2 monitoring is disabled	PEEP is set to Manual
Oxygen • Oxygen monitoring (O2 sensor) is disabled • SpO2 monitoring is disabled	Oxygen is set to Manual

When **PEEP** or **Oxygen** is controlled manually, the device uses the same rules as when in ASV mode. For details, see your ventilator *Operator's Manual*.

In addition, when PEEP control is manual, HLI cannot be used to control the **PEEP** limit.

For control to be automated, you must manually set the desired controls to **Automatic** in the INTELLiVENT-ASV Settings window.

1.10 Assessing results

After the calculated targets are reached, the ventilation management results need to be assessed. Use the monitored parameters for this purpose. To assess respiratory acid-base status, it is recommended that arterial blood gases be measured to monitor the minute volume adjustment.

2
Quick Wean

2.1 Overview

> ⚠️ **WARNING**
>
> Additional ventilator-independent patient monitoring (for example, bedside vital monitoring or a blood gas analyzer) must be used during INTELLiVENT-ASV ventilation. Check PaCO2 against displayed PetCO2, and SaO2 against SpO2.

> ⚠️ **CAUTION**
>
> *The responsibility for final decisions regarding weaning and extubation rests solely with the physician/operator. Additional criteria not provided by the ventilator have to be taken into account.*

Quick Wean is integrated into INTELLiVENT-ASV, and when activated, provides continuous dynamic monitoring and control of patient conditions to evaluate the patient's potential readiness for extubation. Together with the clinician and the patient, Quick Wean is part of a complex care cycle that has as its goal a respiratorily healthy, spontaneously breathing patient.

Weaning from a ventilator is a difficult process that comprises training, evaluation, and testing. A widely accepted and commonly used method is to decrease ventilatory support and, if possible, perform spontaneous breathing trials (SBTs) to evaluate the patient's muscle activity and endurance.

An SBT is a diagnostic tool that can help determine whether the patient is ready to be removed from ventilator support and can breathe on their own. It is known that the use of a protocolized standard process is beneficial in regard to patient safety and outcomes. Note that in INTELLiVENT-ASV, automated SBTs are disabled until explicitly enabled.

2.1.1 About Quick Wean use and modes

Quick Wean offers two modes of use: with and without automated SBTs. For details on enabling or disabling these options, see Section 2.3.

Table 2-1. Quick Wean modes of use

Quick Wean mode	Description
Quick Wean disabled	Default setting. No continuous monitoring against defined weaning criteria occurs.
Quick Wean enabled (set to Automatic)	The device does the following: • Shifts the PetCO2 range to the right by up to +5 mmHg, depending on pressure, to support spontaneous breathing. • When the patient is active (Section 1.7.2), the device gradually reduces %MinVol. As long as these conditions are met, the %MinVol is decreased to and/or maintained at 70%. • The system continuously monitors the patient against weaning criteria (Section 2.4). Two SBT-related options are then available: automated SBTs enabled or disabled.
Automated SBTs enabled	This option offers all the benefits of providing standardized, protocolized care. • The system continuously monitors the patient against weaning criteria. • When defined criteria are met, automatically initiates an SBT. • All of the related parameters are configurable, and some can be fine tuned during ventilation. • You can manually start an SBT any time the patient is active. See Section 2.3.
Automated SBTs disabled	This is the default setting. • The system continuously monitors the patient against weaning criteria. • As long as the patient is breathing spontaneously and the patient's rate is below the upper limit of the target range, the %MinVol is decreased to and/or maintained at 70%. • All of the related parameters are configurable, and some can be fine-tuned during ventilation. • You can manually start an SBT any time the patient is active.

2.1.2 Key terms

The following table describes some key
terms for Quick Wean.

Table 2-2. Key terms and parameters for Quick Wean

Term/Parameter	Description
SBT	*Spontaneous breathing trial.* Diagnostic test to help determine whether patients are ready to be removed from ventilator support and can breathe on their own.
Automated SBT	When enabled, the device performs an SBT when specified criteria are met. By default, disabled.
To start SBT group of parameters	A list of parameters that must all be within a predefined range for a specific amount of time for the patient to be considered ready for an SBT.
	This set of parameters and values is referred to as the *To start SBT criteria*.
To stop SBT group of parameters	A list of parameters that are monitored during an SBT, to determine whether to stop the SBT. If any of the values is outside the predefined range for a specified period of time, an ongoing SBT is stopped.
	This set of parameters and values is referred to as the *To stop SBT criteria*.
fSpont / %fSpont	**fSpont** is the absolute number of spontaneous breaths taken. **%fSpont** is the percentage of spontaneous breaths to total breaths taken.
	The Quick Wean panel shows **fSpont**; the SBT history panel shows **%fSpont**.
Max. duration (min)	Defines the length of time the SBT can run. If the patient conditions continue to stay within defined thresholds, the SBT ends after the time specified by this parameter.
	Only applies during an SBT.
%MinVol (%)	When Quick Wean is enabled, as long as the patient is active and the patient's rate is below the upper limit of the target range (Section 1.7.2), the device gradually reduces **%MinVol** to 70%.
	When SBTs are enabled and an SBT starts, **%MinVol** is reduced to a default value of 25%.

Term/Parameter	Description
Oxygen (%)	Inspired oxygen.
PEEP (cmH2O)	Positive end-expiratory pressure. Airway pressure at the end of exhalation.
PetCO2 (mmHg)	End-tidal CO2 pressure.
PetCO2 inc (mmHg)	The absolute increase in PetCO2 (relative to an average calculated prior to the start of the SBT) that is permitted during an SBT. Only applies during an SBT.
Psupport max (cmH2O)	The maximum pressure support allowed before starting an SBT, and an absolute upper limit that it cannot exceed during the SBT. If the upper limit is reached during an SBT, the SBT is stopped.
Rate (b/min)	Respiratory rate. Number of breaths per minute. Defines the maximum rate allowed before an SBT can take place, as well as an absolute upper limit that cannot be exceeded during an SBT. If the upper limit is reached during an SBT, the SBT is stopped.
SBT time range	Defines the hours between which an SBT can be started. Even if the *To start SBT* criteria are met, the SBT will not take place until the current time of day is inside the specified range, if criteria are still met. If an SBT is in progress when the time is out of range, the SBT continues until it is completed.
SpO2 (%)	Measurement of oxygen saturation in the blood.
Time before starting SBT (min)	Defines the length of time that patient conditions must stay within the *To start SBT* limits before an SBT can start. Only applies when automated SBTs are enabled.
Time between 2 SBTs (min)	Defines the minimum length of time that must pass between two SBTs. Only applies when automated SBTs are enabled.
Tolerance time (s)	The length of time a parameter value can be out of range without affecting the countdown to an SBT or an ongoing SBT. If any one parameter is out of range for longer than this time period, the countdown timer is reset or an ongoing SBT is stopped.

Term/Parameter	Description
Vt/IBW (ml/kg)	Tidal volume per kilogram of ideal body weight.
RSB (1 / (l*min))	Rapid shallow breathing index. The total breathing frequency (fTotal) divided by the exhaled tidal volume (VTE). The RSB parameter is only used for adult patients. For pediatric patients, the PetCO2 parameter is used.

2.2 Quick Wean in clinical use

This section provides a brief overview of the Quick Wean clinical workflow, key parameters, and indications for use.

2.2.1 Quick Wean workflow

Upon enabling Quick Wean, the device does the following:

- Shifts the PetCO2 range to the right by up to +5 mmHg, depending on pressure, to support spontaneous breathing.

- As long as the patient is active (Section 1.7.2), the device gradually reduces %MinVol to 70%.

  As long as these conditions are met, the %MinVol is decreased to and/or maintained at 70%.

  The device adjusts %MinVol as follows:

  – If %MinVol is already at 70%, the device does nothing.

  – If %MinVol is above 70%, the device decreases %MinVol to 70% in steps of no more than 1% per breath.

- If the patient is passive (Section 1.7.1), INTELLiVENT-ASV continues ventilating the patient. When the conditions are again met, the ventilator repeats the %MinVol reduction process described above.

Note that the up to +5 mmHg PetCO2 target zone shift remains in place as long as Quick Wean is enabled.

2.2.2 About the Quick Wean parameters

Quick Wean monitors a large set of parameters to support weaning. Default settings for these parameters are consensus based, and, if modified, are generally set once and then used as the defaults.

Some of settings can be modified during ventilation; others are defined in Configuration. Further, some parameters are calculated and are not user modifiable.

Parameters are grouped into the following basic categories:

- *To start SBT* parameters that are monitored to determine whether an SBT can be started

- *SBT settings* parameters that determine the settings for an SBT

- *To stop SBT* parameters that are monitored to determine whether to stop an ongoing SBT

For details about the Quick Wean/SBT parameters, see Section 2.10, which lists where each one is set and monitored, and value ranges.

2.2.3 Indications for use

> **NOTICE**
>
> Quick Wean is not available if the patient condition selected in INTELLiVENT-ASV is **Brain injury**.

Quick Wean can be enabled at any time during ventilation. Conducting an SBT, however, is only possible when:

- The patient is active
- Quick Wean is enabled

2.3 Enabling/disabling and setting up automated SBTs

Quick Wean must be enabled to automate SBTs. For details about enabling Quick Wean, see Section 1.4.6.

To enable/disable automated SBTs

1. Ensure Quick Wean is enabled in the INTELLiVENT-ASV Settings window.

2. If not open, touch the arrow in the Quick Wean section (**4**) to open the SBT controls panel.

Figure 2-1. INTELLiVENT-ASV Settings window, Quick Wean enabled, automated SBTs disabled
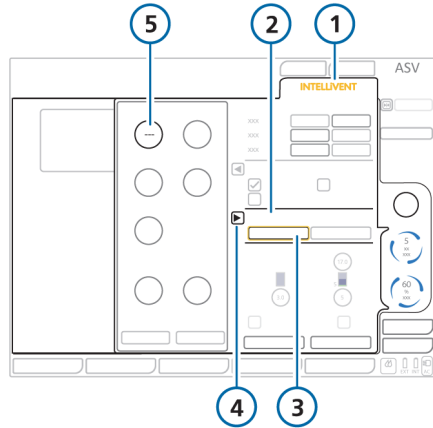
1	INTELLiVENT	4	Open/close SBT Controls panel
2	Quick Wean section	5	**Time before starting SBT** control set to OFF (---) (automated SBTs disabled)
3	Automatic (Quick Wean enabled)		

3. Select whether to enable automated SBTs.

   By default, automated SBTs are disabled – the **Time before starting SBT** control is set to **Off** and displays three dashes (---).

   To enable SBTs, set the **Time before starting SBT** control to the length of time that patient conditions must meet the *To start SBT* criteria before an automated SBT can begin.

   For example, if set to 30 minutes, an automated SBT starts when the *To start SBT* criteria are met for 30 minutes.

Figure 2-2. INTELLiVENT-ASV Settings window, automated SBTs enabled
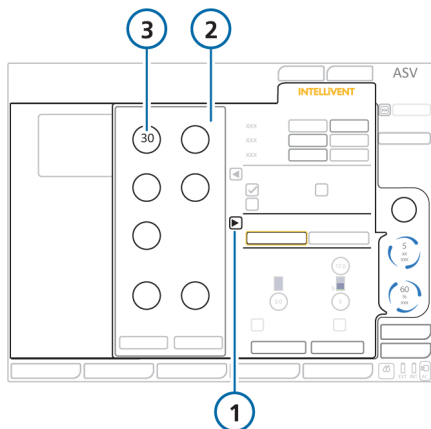
1	Open/close SBT Controls panel	3	Time before starting SBT control (to enable automated SBTs)
2	SBT Controls panel		

4. Using the **SBT time range** controls, set the time period during which automatic SBTs can be performed. By default, they can be performed between 8 am and 8 pm.

   For details about the SBT time range and the rest of the controls available during ventilation, see Table 2-3.

5. Set SBT options as desired.

Table 2-3. SBT settings, available during ventilation

SBT setting	Description
Time before starting SBT (min)	Length of time that *To start SBT* parameters must remain within specified limits before an automated SBT can start.
	This parameter is also used to enable/disable automated SBTs. Automated SBTs are disabled when this is set to Off (---).
	See Section 2.4.2.
Time between 2 SBTs (min)	The minimum length of time after an automated SBT is executed before another automated SBT can be started.
	Setting this control to Off (---) means that only one automated SBT may take place; a second one will not be performed.
Psupport max	The upper limit of applied pressure required during the inspiratory phase. The patient must require less than the limit specified.
	Shown as the upper Pinsp limit in the Quick Wean & SBT Status window.
Rate (b/min)	The maximum rate allowed before starting an SBT, and an absolute upper limit that it cannot exceed during an SBT.
Psupport min (cmH2O)	The bottom limit of the pressure support applied during an SBT; that is, the pressure support will not fall below this value.
	Shown as the lower Pinsp limit in the Quick Wean & SBT Status window.
SBT time range	Hours between which an SBT can be started.
	Even if clinical conditions match the specified SBT starting criteria, if the start time for the SBT is outside of the range specified here, the SBT will not take place.
	To allow automated SBTs to start at any time, set both controls to the same time.
Manually start/stop SBT	Manually start/stop an SBT. Only available when the patient is active.
Start SBT	Touch to immediately start an SBT.
	The system:
	• Reduces %MinVol to the configured settings
	• Adjusts PEEP to the configured setting (if automatically controlled)
	• Displays the SBT history window (view 4)
	• Displays the Quick Wean & SBT Status window

SBT setting	Description
Stop SBT	Select to immediately stop an ongoing SBT.
	The system returns to normal INTELLiVENT-ASV settings and monitors patient conditions for the next possible SBT.

To disable automated SBTs

▸ In the SBT Controls panel, select the **Time before starting SBT** control and change the value to --- (OFF). The setting, ---, indicates that the parameter has no value and no automated SBTs can take place.

2.4 Conditions for starting weaning activities

Quick Wean continuously monitors the patient's condition against a set of criteria that must be met for weaning activities to be possible. They are referred to as the *To start SBT parameters* or *To start SBT criteria*.

1. When Quick Wean is enabled, the device starts monitoring *To start SBT* parameters.

2. When all of the following conditions are met, the steps listed in Table 2-4 occur, depending on whether automated SBTs are enabled:

   - The patient is active
   - The *To start SBT* criteria are met

Table 2-4. Device actions when To start SBT criteria are met

When *To start SBT* criteria are met and ...	Quick Wean/Quick Wean & SBT Status window (see Section 2.4.4)
Automated SBTs are enabled	
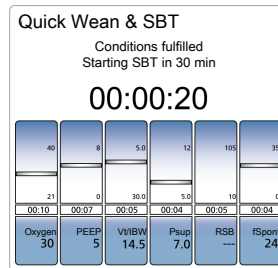
- The device shows the status *Conditions fulfilled, starting SBT in XX min* in the Quick Wean & SBT Status window, and starts a timer.

- The measured values for each of the *To start SBT* parameters must remain within the defined ranges for the length of time specified in the Time before starting SBT parameter.

Note that any of the *To start SBT* parameters can be out of range for up to the time specified by the Tolerance time parameter without affecting the countdown.

For example, with a Tolerance time of 30 seconds, any parameter can be out of range for up to 30 seconds with no effect. If a parameter value remains out of range for 31 or more seconds, the process resets.

When *To start SBT* criteria are met and ...	Quick Wean/Quick Wean & SBT Status window (see Section 2.4.4)
Automated SBTs are disabled	
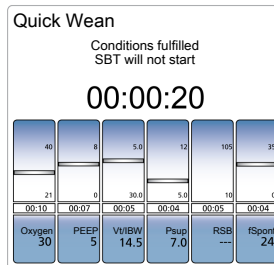
The device shows the status *Conditions fulfilled, SBT will not start* in the Quick Wean Status window.

Note that any of the *To start SBT* parameters can be out of range for up to the time specified by the Tolerance time parameter without affecting this status.

For example, with a Tolerance time of 30 seconds, any parameter can be out of range for up to 30 seconds with no effect. If a parameter value remains out of range for 31 or more seconds, the *Conditions fulfilled* status is removed, and the device continues to monitor the patient's condition.

You can also manually start an SBT. See Section 2.5.1.

2.4.1 About %MinVol calculations

When Quick Wean is enabled, once the patient is active and the patient's Rate is within the target range as described in Section 1.7.2, the device decreases %MinVol stepwise to 70%.

The device adjusts %MinVol as follows:

Table 2-5. %MinVol adjustments

Patient status	Quick Wean status	The device ...
Active, Rate within target range	Quick Wean enabled	Decreases %MinVol to 70%
	Quick Wean disabled	No %MinVol change
Active, Rate out of range	Quick Wean enabled or disabled	INTELLiVENT-ASV %MinVol management

2.4.2 Parameters used to determine weaning readiness (To start SBT group)

The following parameters are monitored to determine the patient's readiness for weaning activities. They are monitored regardless of whether automated SBTs are enabled or disabled.

For the definition of a parameter, see Section 2.1.2. For parameter ranges and other details, see Section 2.10.

Some parameters use different thresholds depending on the patient weight. Where applicable, these differences are marked.

Table 2-6. Quick Wean To start SBT criteria

Parameter (unit)	Description	Default *To start SBT* value
%fSpont	Not configurable.	100% during Time before starting SBT
Oxygen (%)	Configuration > Quick Wean > To start SBT window	≤ 40
PEEP (cmH2O)	Configuration > Quick Wean > To start SBT window	Adult: ≤ 8 Pediatric: ≤ 6
Psupport max (cmH2O)	INTELLiVENT-ASV Settings > SBT Controls panel	≤ 12
Rate (b/min)	INTELLiVENT-ASV Settings > SBT Controls panel	Adult: ≤ 35 Pediatric: ≤ 45
RSB (1/(l*min))	Configuration > Quick Wean > To start SBT window	≤ 105
SpO2 (%)	Not configurable.	In INTELLiVENT-ASV normal/high range (within or above target zone)
VT/IBW (ml/kg)	Configuration > Quick Wean > To start SBT window	≥ 5
Time before starting SBT (min)	INTELLiVENT-ASV Settings > SBT Controls panel	--- (OFF)
Time between 2 SBTs (min)	INTELLiVENT-ASV Settings > SBT Controls panel	30
SBT time range (hh:mm)	INTELLiVENT-ASV Settings > SBT Controls panel To allow automated SBTs to start at any time, set both controls to the same time.	Between 8:00 and 20:00 (8 am to 8 pm)
Tolerance time (s)	Configuration > Quick Wean > To start SBT window If any one parameter (listed in this table) is out of range for longer than this time period, the countdown timer is reset.	Adult: 180 Pediatric: 60

The default values for most of these parameters are set in Configuration (Section 2.9). A few of the parameters can be modified during ventilation in the INTELLi-VENT-ASV Settings window, as described in Section 2.4.3.

2.4.3 User-modifiable SBT parameters, INTELLiVENT-ASV Settings window

The INTELLiVENT-ASV Settings > SBT Controls panel provides access to the SBT-related parameters that you can adjust during ventilation, if needed. You do not have to put the ventilator into Standby to make changes. Changes are implemented immediately, and the system starts making adjustments, if needed.

The time-related parameters (Time between 2 SBTs and SBT time range) are only effective when automated SBTs are enabled; that is, when the Time before starting SBT control is set to a value greater than 0 (---). You can adjust the other parameters in this window at any time.

When Quick Wean is enabled, the system monitors the non-time-related parameters to help determine whether to start an SBT, and once an SBT is taking place, whether to stop an ongoing SBT. These values are used in addition to the *To start SBT* parameters and *To stop SBT* parameters specified during configuration.

To access SBT settings

See Section 2.3.

2.4.4 Monitoring progress

When Quick Wean is enabled, two additional monitoring windows are available:

- Quick Wean or Quick Wean & SBT Status window

- SBT history window (view 4)

2.4.4.1 Quick Wean/Quick Wean & SBT Status window

Like the ventilation Vent Status window, the Quick Wean/Quick Wean & SBT Status window uses floating indicators moving up and down within the columns to show the values for SBT- and weaning-related parameters. The data is updated every breath.

To help you quickly determine the SBT status (automatic or not), the window name changes as follows:

- When automatic SBTs are disabled, the window is labeled *Quick Wean*.

- When automatic SBTs are enabled, the window is labeled *Quick Wean & SBT*.

The content of the window changes depending on which phase the device is in.

Table 2-7. Quick Wean/Quick Wean & SBT
Status window

When ...	Quick Wean/Quick Wean & SBT Status window ...
Quick Wean is enabled	Displays the text *Verifying conditions*.
To start SBT conditions are met	Displays: • The text *Conditions fulfilled/ Starting SBT in XX time period*. • Displays a timer (HH:MM:SS) showing how long the patient values have been within the target ranges.
To start SBT conditions are met	Displays: • The text *Conditions fulfilled/ SBT will not start*. • A timer (HH:MM:SS) showing how long the patient values have been within the target ranges.
SBT is in progress	Displays: • The text *SBT running* • A timer (HH:MM:SS) showing how long the SBT has been running • Pulsing green bars above and below the floats for parameters that are within the defined thresholds Parameters that are out of range do not show the green bar.

2.4.4.2 SBT history window

The SBT history window, available in view 4 of the INTELLiVENT-ASV views, displays an overview of all of the key ventilation parameters.

A green checkmark indicates that the parameter is within acceptable limits. A red up or down arrow indicates a parameter value that is out of the acceptable range.

During an active SBT, the window displays the start time and date, as well as the status message, *SBT running*. When an SBT is ended, the window displays information about how the previous SBT ended (successfully completed (*fulfilled*) or stopped prematurely (*stopped*).

Use the arrow buttons at the bottom of the window to view data for each SBT conducted.

Figure 2-3. SBT history window
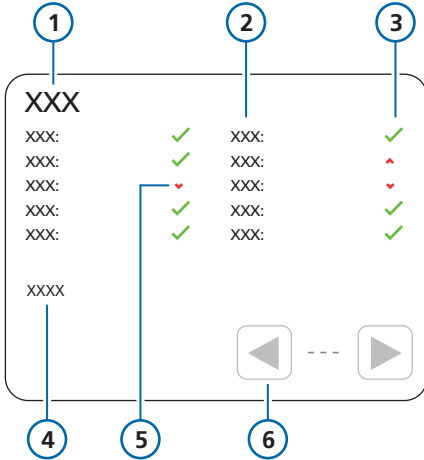
1	Panel title: SBT history	4	SBT status, time started
2	Weaning parameters	5	Value out of range (red up arrow: too high; red down arrow: too low)
3	Value in range (green checkmark)	6	View previous SBT data

To display the SBT history window

▸ Touch the view buttons until the SBT history window is displayed.

2.5 Conducting an SBT

SBTs can be started manually (Section 2.5.1) or automatically.

To start an automated SBT, all of the following conditions must be met:

- The patient must be active

- Automated SBTs are enabled

- Patient conditions must be within target ranges for all of the *To start SBT* criteria, for the time specified in the Time before starting SBT setting

- Enough time has passed since the last SBT (Time between 2 SBTs setting), if applicable

- The current time is within the allowed range (SBT time range setting)

If all conditions are met, the system starts an SBT.

The following changes occur.

Table 2-8. System changes when conducting an SBT

System changes	For details, see ...
The Quick Wean & SBT status window displays pulsing green bars for parameters within the defined thresholds, and starts a timer.	Section 2.4.4.1
The SBT history window shows the time the SBT started.	Section 2.4.4.2

System changes	For details, see ...
Additional parameters are used during the SBT: • Rate inc% • PetCO2 inc (absolute increase in PetCO2) • Pulse inc% (heart rate increase) Rate inc% and PetCO2 inc values are used as *To stop SBT* criteria. The limits are set in Configuration.	Section 2.5.2
The system changes the settings for %MinVol and PEEP, if needed, to those specified in Configuration (Configuration > Modes > SBT settings window). Note that PEEP settings are changed only if PEEP management is automated.	Section 2.9.1

2.5.1 Manually starting/stopping an SBT

You can manually start an SBT any time the patient is active. The **Start SBT** button becomes available in the INTELLiVENT-ASV Settings > SBT Controls panel.

To manually start an SBT

1. Touch the **INTELLiVENT** button to access the INTELLiVENT-ASV Settings window.

2. If the SBT Controls panel is not open, touch the arrow next to Quick Wean to display the panel. See Figure 1-3.

   Touching the arrow again closes the panel.

3. Touch the **Start SBT** button.

   Note that the button is enabled only when the patient is active.

The system immediately starts an SBT by reducing %MinVol and PEEP (when management is automated) to the configured settings.

The SBT continues until it successfully completes or it is stopped. See Section 2.6.

The SBT history window displays the start time of the SBT, with the text, *SBT manually started*. It also provides the end time, with a short description of how the SBT ended. For the list of statuses, see Section 2.8.

To manually stop an SBT

▸ In the INTELLiVENT-ASV Settings > SBT Controls panel, touch the **Stop SBT** button.

The SBT history window records the time the SBT was stopped.

The system returns to normal INTELLi-VENT-ASV settings and starts monitoring patient conditions for the next possible SBT.

2.5.2 PetCO2 increases

> **NOTICE**
>
> PetCO2 inc is used as part of *To stop SBT* criteria; it is not displayed.

During an SBT, the system uses the PetCO2 increase as a *To stop SBT* criterion. You set a maximum allowed value in the *To stop SBT* window in Configuration.

The changes in PetCO2 can give an indication of whether the patient is experiencing increased work of breathing (WOB). The system monitors the PetCO2 increase, as well as the measured PetCO2 value against the defined target range. For details about how the controller uses this data, see Section 1.7.2.

2.5.3 Monitoring pulse and breath rate increases

> **NOTICE**
>
> • Rate inc % and Pulse inc % are only monitored during an SBT.
>
> • Pulse inc% is NOT used as part of *To stop SBT* criteria; it is only provided for informational purposes.

During an SBT, some additional parameters are also monitored: Breathing rate increase (Rate inc %) and pulse rate increase (Pulse inc %), both in percent.

The changes in these values can give an indication of whether the patient is experiencing increased work of breathing (WOB) during an SBT. The rate increases are measured every minute by taking the current value and calculating the percent change from an average rate or pulse established just prior to the start of the SBT.

The parameters are displayed in:

• Monitoring 2 window

• Secondary monitoring parameters (SMP) (configurable)

• Main monitoring parameters (MMP) (configurable)

• Trend graph

• Rate inc is also shown in the SBT history window (view 4)

We recommend displaying these parameters in the SMP list when the patient is undergoing an SBT.

2.6 Conditions for stopping an SBT

The maximum length of time a disconnection is allowed is 1 minute, regardless of the Tolerance time setting.

If an SBT is stopped due to disconnection (whether inadvertent or for suctioning), the ventilator continues with the previous INTELLiVENT-ASV settings.

The SBT window displays the message SBT stopped manually.

During an SBT, the device monitors the *To stop SBT* parameters and other settings to determine whether to stop the SBT.

An SBT (automated or manual) is stopped if any of the following conditions is met:

- If a *To stop SBT* parameter is out of range for longer than the time interval specified in the Tolerance time parameter, the SBT is stopped, and an alarm, SBT aborted, is generated.

- Quick Wean is disabled in the INTELLiVENT-ASV Settings window.

- The device is placed into standby.

- The %MinVol is manually changed.

- The ventilation mode is changed.

- A P/V Tool maneuver is performed.

- The patient becomes passive (no longer meets the active criteria).

- The measured SpO2 value meets the criteria for a rapid therapy escalation.

- A disconnection > 1 minute occurs.

The following table lists the *To stop SBT* parameters and the default threshold values.

For the definition of a parameter, see Section 2.1.2. For parameter ranges and other details, see Section 2.10.

Some of the *To stop SBT* parameters are not explicitly set. Rather, they are either calculated, or you set the *To start/during SBT* value, and a value outside of this setting becomes the *To stop SBT* criterion.

Table 2-9. Quick Wean To stop SBT criteria

Parameter (unit)	Where set/how used	Default *To stop SBT* value
Oxygen (%)	Configuration > Quick Wean > To stop SBT window The value is always set to the *To start SBT* **Oxygen** value + 10.	> 50
PEEP (cmH2O)	Configuration > Quick Wean > To start SBT window Set the upper limit that **PEEP** cannot exceed during an SBT.	Adult: > 8 Pediatric: > 6
PetCO2 (mmHg)	Used indirectly together with **PetCO2 inc** as *To stop SBT* criteria. For additional details, see Section 1.7.2.	If **PetCO2** > (upper limit INTELLiVENT-ASV PetCO2 target range + 3 mmHg), an ongoing SBT is stopped immediately.
PetCO2 inc (mmHg)	Configuration > Quick Wean > To stop SBT window End-tidal CO2 pressure increase compared to the values before the SBT. Only applies during an SBT.	> 8
Psupport max (cmH2O)	INTELLiVENT-ASV Settings > SBT Controls panel Set the upper limit that **Psupport** cannot exceed during the SBT.	> 12
Rate (b/min)	INTELLiVENT-ASV Settings > SBT Controls panel Set the upper limit that **Rate** cannot exceed during SBT.	Adult: > 35 Pediatric: > 45
Rate inc	Configuration > Quick Wean > To stop SBT window Percentage increase in respiratory rate as a result of the SBT. Only applies during an SBT.	> 50% increase over the average rate established just prior to the SBT
RSB (1/(l*min))	Configuration > Quick Wean > To start SBT window Used only for adult patients. The value must exceed the **To start SBT** setting.	> 105

Parameter (unit)	Where set/how used	Default *To stop SBT* value
SpO2 (%)	Not configurable.	< (INTELLiVENT-ASV-set SpO2 target range)
VT/IBW (ml/kg)	Configuration > Quick Wean > To start SBT window Set the lower limit for **VT/IBW** during an SBT.	< 5
Tolerance Time (s)	Configuration > Quick Wean > To stop SBT window	Adult: > 180 Pediatric: > 30
Max Duration (min)	Configuration > Quick Wean > To stop SBT window	30

2.7 Conditions for successfully completing an SBT

During an SBT, the device monitors parameters against the *To stop SBT* threshold values. If parameters remain in range for the duration set for the SBT (specified by the Max. duration parameter), the SBT is ended and marked as SBT successfully fulfilled. An SBT Fulfilled alarm is generated.

When an SBT is fulfilled, the device:

- Returns to the previous INTELLiVENT-ASV settings

- Returns %MinVol and PEEP (when automated) to the value prior to the start of the SBT

- Starts monitoring patient conditions against the *To start SBT* thresholds (Section 2.4), and the Time between 2 SBTs time.

2.8 About Quick Wean alarms and messages

Quick Wean provides a set of alarms and messages related to weaning activities, including SBTs. Messages are written to the Event log. Alarms and messages are displayed in the following locations:

- Alarm message bar

- Event log

- SBT history window

To review and dismiss an alarm

▶ Do any of the following:

– Touch the message. The Alarms > Buffer opens. Review the message, then close the window.

– Touch the red I-icon and view the alarm log.

– Open the Alarms > Buffer window and review the alarm message, then close the window.

The following table provides an overview of the Quick Wean-related alarms and messages. For detailed information about system alarms, see your ventilator *Operator's Manual*.

Table 2-10. Quick Wean alarms and messages

Alarm message	Description
SBT aborted *Medium priority.*	The SBT was stopped. For possible reasons, see Section 2.6. Dismiss the alarm as described in Section 2.8.
SBT successfully fulfilled *Medium priority.*	The SBT was ended because **Max. duration** was reached. Dismiss the alarm as described in Section 2.8.
SBT stopped after HHH hours MM minutes	How long the SBT ran before being stopped. Shown in SBT history window and Event log.
SBT started at YYYY-MM-DD HHH hours MM minutes	When an SBT starts automatically, this message records the time. Shown in SBT history window and Event log.
SBT fulfilled after HHH hours MM minutes	When SBT ends successfully, this message records the time. The time is equal to the **Max. duration** value. Shown in SBT history window.
SBT manually started at YYYY-MM-DD HHH hours MM minutes	When an SBT is manually started by selecting the **Start SBT** button, this message records the time. Shown in SBT history window.
SBT manually stopped after HHH hours MM minutes	When an SBT is manually ended by selecting the **Stop SBT** button, this message records for how long the SBT ran. Shown in SBT history window and Event log.
Too high (red up arrow) and Too low (red down arrow) indicators	When a parameter's value goes above the allowed range, a red up arrow is displayed next to the parameter in the SBT history window. When a parameter's value is below the allowed range, a red down arrow is displayed.
Within range (green checkmark) indicator	When a parameter's value is within the specified range, a green checkmark is displayed.

2.9 Configuring Quick Wean and SBTs

You configure Quick Wean using the Configuration screens, in Standby mode. These settings cannot be modified while ventilating a patient.

While the default parameter values are all based on the currently available literature, you can change the settings if you prefer to use a different protocol.

The system monitors patient conditions against these parameter thresholds to determine whether the patient is ready for weaning activities, what adjustments to make when an SBT begins, and whether to stop the weaning activities.

For details on putting the ventilator into Standby and accessing Configuration mode, refer to the ventilator *Operator's Manual*.

Some settings are based on the patient group: adult or pediatric. For the list of default values, see Table 2-12.

2.9.1 Adjusting default SBT values in Configuration

The default SBT control settings are defined in the following locations:

- In the Configuration > Quick Wean windows: To start SBT, SBT settings, and To stop SBT

- In the INTELLiVENT-ASV Settings > SBT Controls panel (Section 2.9.2)

The SBT configuration windows provide access to the following controls:

Table 2-11. Quick Wean/SBT configuration windows

Configuration > Quick Wean	Controls
To start SBT	Patient conditions are monitored against the limits defined here for the listed parameters to determine when they are ready for an SBT: PEEP, Oxygen, VT/IBW, Tolerance time, RSB
SBT settings	When an SBT begins, the device adjusts PEEP (when automated) and %MinVol to the values specified here.
To stop SBT	During an SBT, patient conditions are monitored against the limits defined here for the listed parameters to determine whether to stop the SBT: Rate inc, Oxygen, PetCO2 inc, Tolerance time, Max. Duration

Each of these windows is divided into two groups: the controls on the top half apply to Adult patients; the controls on the bottom half apply to Pediatric patients.

You can change the default settings to match your institution's protocol, if needed.

To change the default *To start SBT, SBT,* and/or *To stop SBT* settings in Configuration

1. Without a patient connected, put the ventilator into Standby.

2. Access the Configuration screens, and on the left side, touch **Quick Wean**.

    The SBT tabs appear, with the *To start SBT* parameters displayed by default.

3. In the To start SBT window, make changes as desired to the parameter thresholds.

4. Touch the **SBT settings** tab to review and adjust the starting PEEP and %MinVol values for an SBT.

5. Touch the **To stop SBT** tab to review and adjust the threshold values for stopping an SBT.

6. To reset the values to the factory defaults, touch the **Set factory defaults** button, and when prompted to confirm, touch **Yes**.

    Touch **No** to cancel the reset.

    All of the controls on all three SBT windows are reset to the factory default settings.

7. When finished, exit Configuration mode.

2.9.2 Adjusting default SBT values in the INTELLiVENT-ASV Settings window

The SBT controls provided in the INTELLiVENT-ASV Settings window are not available in the Configuration window; however, you can change the default settings if desired. You can also set separate values for adult and pediatric patients.

The default values for these controls, Psupport max, Psupport min, Rate, Time before starting SBT, and Time between 2 SBTs, are stored with individual patient groups.

To change default SBT values in the INTELLiVENT-ASV Settings window

1. Set all ventilator parameters, alarm limits, graphics layout, and SBT values (in the INTELLiVENT-ASV Settings > SBT Controls panel) to the desired settings for the target patient group (adult or pediatric).

2. Put the ventilator into Standby and access the Configuration > Defaults window.

3. Save the settings as described in your ventilator *Operator's Manual*.

The SBT parameter values that you saved in the INTELLiVENT-ASV Settings window are now saved as the default values for the selected patient group.

2.9.3 Restoring factory default settings

To return the SBT parameter values to factory defaults

1. Open the Configuration > Quick Wean window.

2. Touch the **Set factory defaults** button.

    All of the controls on all three SBT windows are reset to the factory default settings.

    Note that this does not affect the SBT parameters that are set in the INTELLiVENT-ASV Settings window. Those parameter defaults are configured for the set patient group.

2.10 Quick Wean parameter specifications

The following table is a comprehensive list of all of the Quick Wean-related parameters.

Note that references to the *Quick Wean Status window* apply to both the *Quick Wean* and *Quick Wean & SBT* Status windows.

Table 2-12. Quick Wean parameters

Parameter	Default values	Where displayed/Where set	Range
%fSpont (%)	To start SBT: 100%	Displayed in: The SBT history window Set in: N/A (calculated value)	---
%MinVol (%)	Quick Wean enabled: 70 During SBT: 25	Displayed in: INTELLiVENT-ASV main display in the **%MinVol** control Set in: Configuration > Quick Wean > SBT settings	%MinVol during SBT: 25 to 70
Max. Duration (min)	By default, set to 30 min. --- (OFF) means that there is no limit to how long the SBT can run.	Displayed and set in: Configuration > Quick Wean > To stop SBT	--- (OFF), 20 to 240

Parameter	Default values	Where displayed/Where set	Range
Oxygen (%)	The *To start SBT* setting is always 10 below the *To stop SBT* setting. **To start SBT:** ≤ 40 **To stop SBT:** > 50	Displayed in: • INTELLiVENT-ASV main display • Monitoring window • Quick Wean Status window • SBT history window Set in: • Configuration > Quick Wean >To start SBT • Configuration > Quick Wean >To stop SBT	**To start:** 30 to 50 **To stop:** 40 to 60
PEEP (cmH2O)	**To start SBT:** Adult: ≤ 8 Pediatric: ≤ 6 **To stop SBT:** Adult: > 8 Pediatric: > 6 **During SBT:** 5	Displayed in: • INTELLiVENT-ASV main display in PEEP control • Monitoring window • Quick Wean Status window • SBT history window Set in: • Configuration > Quick Wean > To start SBT • Configuration > Quick Wean > SBT settings	**To start SBT:** 5 to 10 **PEEP during SBT:** 0 to 5
PetCO2 (mmHg)	**To stop SBT:** PetCO2 > (upper limit INTELLiVENT-ASV PetCO2 target range + 3 mmHg)	Displayed in: • CO2 elimination horizon and map • Monitoring window • Pediatrics: Quick Wean Status window • SBT history window • Dynamic Lung panel Set in: N/A. This value is not configured. You can, however, shift the target range, if needed. See Section 1.4.11.3.	Depends on PetCO2 target range

Parameter	Default values	Where displayed/Where set	Range
PetCO2 inc (mmHg)	To stop SBT: > 8 increase	Not displayed. **Set in:** Configuration > Quick Wean > To stop SBT	4 to 20
Psupport max (cmH2O)	To start SBT: ≤ 12 To stop SBT: > 12	Displayed in: • INTELLiVENT-ASV Settings > SBT Controls panel • SBT history window **Set in:** INTELLiVENT-ASV Settings > SBT Controls panel	6 to 25
Psupport min (cmH2O)	Default: 5	Displayed in: INTELLiVENT-ASV Settings > SBT Controls panel **Set in:** INTELLiVENT-ASV Settings > SBT Controls panel	0 to 10
Pulse inc (%)	This parameter is not used as a stop criterion.	Displayed in: • Monitoring 2 window • SMP list **Set in:** N/A. This value is not configured.	--
Rate (b/min)	To start SBT: Adult: ≤ 35 Pediatric: ≤ 45 To stop SBT: Adult: > 35 Pediatric: > 45	Displayed in: • Quick Wean Status window • SBT history window • INTELLiVENT-ASV Settings > SBT Controls panel **Set in:** INTELLiVENT-ASV Settings > SBT Controls panel	25 to 65

Parameter	Default values	Where displayed/Where set	Range
Rate inc (%)	To stop SBT: > 50	Displayed in: • Monitoring 2 window • SBT history window Set in: Configuration > Quick Wean > To stop SBT	20 to 100
RSB (1 / (l*min))	To start SBT: ≤ 105 To stop SBT: > 105	Displayed in: • Adults: Quick Wean Status window • SBT history window Set in: Configuration > Quick Wean > To start SBT	50 to 300
SBT time range	To allow SBTs at any time, set both controls to the same time. Default: Between 8:00 and 20:00.	Displayed and set in: INTELLiVENT-ASV Settings > SBT Controls panel	HH:MM
SpO2 (%)	To start SBT: in INTELLiVENT-ASV normal or high SpO2 target range To stop SBT: Below INTELLiVENT-ASV normal SpO2 target range minus 2	Displayed in: • Oxygenation horizon and map • Monitoring 2 window • Main window under MMP list • SBT history window • Dynamic Lung panel Set in: N/A. This value is not configured. You can, however, shift the target range, if needed. See Section 1.4.11.3.	Depends on the SpO2 target range

Parameter	Default values	Where displayed/Where set	Range
Time before starting SBT (min)	This parameter is also used to enable or disable automated SBTs. See Section 2.3. **Default:** --- (OFF). Automated SBTs are disabled.	Displayed and set in: INTELLiVENT-ASV Settings > SBT Controls panel	--- (OFF), 10 to 120 When --- (OFF), automatic SBTs are disabled.
Time between 2 SBTs (min)	When set to --- (OFF), only one automated SBT is performed. **To start next SBT:** By default, 30	Displayed and set in: INTELLiVENT-ASV Settings > SBT Controls panel	--- (OFF), 30 to 240
Tolerance time (s)	For the following parameters, the **Tolerance time** setting is predefined (regardless of the Configuration settings): • **%fSpont**: must be 100% for a minimum of 60 seconds • For pediatric patients, the **Tolerance Time** for **Rate** and **Vt/IBW** is 180 seconds		
Tolerance time (s)	**To start SBT:** Adult: 180 Pediatric: 60 **To stop SBT:** Adult: 180 Pediatric: 30	Displayed and configured in: • Configuration > Quick Wean > To start SBT • Configuration > Quick Wean > To stop SBT	10 to 300
VT/IBW (ml/kg)	**To start SBT:** ≥ 5 **To stop SBT:** < 5	Displayed in: • Monitoring window • Quick Wean Status window • SBT history window **Set in:** Configuration > Quick Wean > To start SBT	3 to 6

3
Specifications

3.1 Intended use

The INTELLiVENT-ASV software is an option for the HAMILTON-G5 ventilator and is a standard feature for the HAMILTON-S1 ventilator, and is, for all legal purposes, subject to the Intended Use as stated in the current ventilator *Operator's Manual*.

3.2 Technical data

The following table provides technical data related to INTELLiVENT-ASV.

Table 3-1. INTELLiVENT-ASV technical data

Operator settings	
Patient height (cm)	Adults: 130 to 250 cm (IBW 30 to 139)
	Pediatrics: 58 to 150 cm (IBW 7 to 42)
%MinVol (%)	25 to 350 (manual)
	70 to 200 (automatic)
Oxygen (%)	21 to 100 (manual and automatic)
PEEP (cmH20)	0 to 50 (manual)
	5 to 25 (automatic)

Internal calculations	
Ideal body weight, IBW (kg)	Calculation based on patient height and gender. For details, see your ventilator *Operator's Manual*.
	INTELLiVENT-ASV can only be used for patients weighing more than 7 kg.
MinVol (target) (l/min)	Target MinVol is calculated as:
	IBW x NormMinVent x %MinVol/100
	where *NormMinVent* (l/kg/min) is the normal minute ventilation (not valid for pediatric patients). IBW is in kg.
ASV target respiratory rate (b/min)	Calculated as described in Table 1-15.
Vt (target)	MinVol/f (target)

Monitoring	
Values (numerical)	PetCO2 target range, depending on patient condition and treatment (Ppeak); SpO2 target range, depending on patient condition and treatment (PEEP)
Current ventilation settings	ExpMinVol, fTotal, fControl, Ppeak (Pinsp + PEEP), Oxygen, PEEP
Patient status	fSpont, PetCO2, SpO2
Graphics	F/Vt, PetCO2/target, PEEP/O2, PEEP/SpO2
Trend parameters	Ventilation combi, Oxygenation combi

Performance specifications, Ventilation controller	
Settling time	< 5 minutes
Response time (90% of steady state)	< 5 minutes (typical)
(Rel./command) Overshoot/ undershoot	< 20%
Steady state deviation	5%
Maximum change of %MinVol per breath	1%

Table 3-2. Performance specifications, Oxygenation controller

	Oxygen	PEEP
Settling time	The settling time depends on the patient condition relative to the SpO2 target, as defined by the appropriate approach (Open Lung Concept or ARDSnet) for the current treatment. Note that if SpO2 enters the emergency zone, the system immediately sets Oxygen to 100%.	6 minutes
Response time (90% of steady state)	6 minutes	N/A, only target range for SpO2 specified
Rel/Command overshoot	none	N/A, SpO2 of some patients does not respond at all to PEEP changes. In this case, Oxygen is also changed if it is set to Automatic.
Command overshoot	none	N/A, SpO2 of some patients does not respond at all to PEEP changes. Upper PEEP limit, 24 cmH2O, user can set lower limit.
Steady state deviation	N/A, only target range for SpO2 specified	N/A, only target range for SpO2 specified
Tracking error	N/A	N/A, only target range for SpO2 specified
Maximum change	Decrease: 5% of current Oxygen setting every 60 s Increase: 10% of current Oxygen setting every 30 s	1 cmH2O every 30 seconds

Lung-protective ventilation, Ventilation controller	
Minimum %MinVol	70% (100% if no PetCO2 is available)
Maximum %MinVol	200%

Lung-protective ventilation, Oxygenation controller	
Minimum Oxygen	21% to 30%, depending on what is selected in the Oxygen limit control in the INTELLiVENT-ASV Settings window.[22]
	Default: 30%
Maximum Oxygen	100%
PEEP limits	Low: 5 to 22 (Default: 5)
	High: 7 to 25 (Default: 15, 8 if HLI enabled)

---

[22] Not available in all markets.

3.3 Data logging

Breath-by-breath data representing the actual values of these listed monitoring values and settings are saved by the ventilation unit of the processor.

Table 3-3. Data log inputs

Saved parameters	Unit
Date	N/A
Time	N/A
ARDS	N/A
Chronic hypercapnia	N/A
Brain injury	N/A
Quick Wean	N/A
Controller ventilation	N/A
Controller oxygenation	N/A
Controller PEEP	N/A
Recruitment passive	N/A
Recruitment running	N/A
fSpont	N/A
PEEP limit	cmH2O
%MinVol	%
ExpMinVol	l/min
RRIMV	breaths per min
RRtot	breaths per min
RRtarget	breaths per min
fSpont	breaths per min
Ti	s
Pinsp	cmH2O

Saved parameters	Unit
SpO2	%
PetCO2	mmHg
Oxygen	%
PEEP/CPAP	cmH2O
Pulse	bpm (beats per minute)
QI-SpO2	%
VtTarget	ml
RCexp	s

The memory reserved for breath-by-breath data allows storage of at least 10 days of recording. The data is saved breath-by-breath, but at most one time per second.

Data is exported using the test software. Refer to the ventilator *Service Manual*.

3.4 References

References are available on the Hamilton Medical website, **www.hamilton-medical.com**.

active patient

An active patient is one who is making inspiratory efforts. Active breathing is identified as the occurrence of at least five (5) consecutive spontaneous breaths. Spontaneous breaths are those for which inspiration is both patient triggered and patient cycled. In addition to spontaneous breaths as described, an active patient must also meet the requirements described in the rules for transitioning between active and passive states.

alarm buffer

Contains information on recent alarm occurrences

ARDS

Acute respiratory distress syndrome, which presents as an acute, severe injury to most segments of the lung

brain injury

Patients with brain injuries with whom it is critical to maintain CO_2 under strict control to keep intracranial pressures at safe levels, and to keep oxygenation within a normal range

chronic hypercapnia

For patients with chronically high arterial CO_2 values, usually as a result of obstruction in airways due to chronic bronchitis, emphysema, or both

fSpont

Spontaneous breathing frequency, a monitored parameter

HLI

The heart-lung interaction (HLI) index is a noninvasive technique for assessing the hemodynamic effect of mechanical ventilation by determining the pulse pressure variations in the pulse oximeter plethysmogram (POP)

IBW

Ideal body weight; a calculated value for adult and pediatric patients based on the patient's gender and height; used as the basis for the initial settings of various parameters

Oxygen

Oxygen (FiO2) concentration of the delivered gas, a control setting, monitored parameter

Oxygenation controller

Automated PEEP and Oxygen controller, available in INTELLiVENT-ASV

PaCO2-PetCO2 gradient

The difference between the PaCO2 measured in the blood (using blood gas analysis) and the PetCO2 measured using a noninvasive CO_2 sensor. Under normal conditions, PaCO2 is approximately 3-5 mmHg higher than PetCO2.

passive patient

A passive patient is one who is not making inspiratory efforts. Passive breathing is identified as the occurrence of at least five (5) consecutive mandatory breaths. In general, mandatory breaths are those for which inspiration is either machine triggered or machine cycled. In INTELLiVENT-ASV, mandatory inspirations are both machine triggered and machine cycled. In addition to mandatory breaths as described, a passive patient must also meet the requirements described in the rules for transitioning between active and passive status.

PEEP/CPAP

PEEP (positive end-expiratory pressure) and CPAP (continuous positive airway pressure), a control setting and monitored parameter. PEEP and CPAP are constant pressures applied during both the inspiratory and expiratory phases.

Plethysmogram

The waveform that visualizes the pulsating blood volume; it is delivered by the pulse oximeter

Ventilation controller

Automated %MinVol controller, available in INTELLiVENT-ASV. The controller uses different inputs to control the target minute volume, depending on whether the patient is passive or active.

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More information and free software simulation:

www.intellivent-asv.com

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