



# INTELLiVENT-ASV

## Operator's Manual

### HAMILTON-C1/T1

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**HAMILTON**  
**MEDICAL**



# Operator's Manual

## INTELLiVENT-ASV

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## About this guide

This guide describes the features and functions of INTELLiVENT®-ASV® for HAMILTON-C1/T1, and is designed for use with the following documentation:

- Your ventilator *Operator's Manual*
- *INTELLiVENT-ASV Quick Guide*
- *Pulse oximetry Instructions for use* for your ventilator

## 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 "Touch **System** > **Settings**" means touch the **System** button, then touch the **Settings** tab.
- Window names are shown using the sequence of buttons/tabs used to open them.  
For example, "**Alarms** > **Limits 1** window" means the window is accessed by touching the **Alarms** button, then the **Limits 1** tab.
- *Units of measure*: Pressure is indicated in cmH<sub>2</sub>O, length in cm, and temperature in degrees Celsius (°C). The units of measure for pressure and length are configurable.
- A green check mark  or button  indicates a selected item or feature.
- The graphics shown in this manual may *not* exactly match what you see in your environment.
- Some figures use callouts in a white circle with a blue border.
  - ① These figures may have an associated legend table, or may provide the legend in the figure title, if a single item. Callouts may be numeric or alphabetic. Callouts are *unrelated* to any nearby procedures and refer only to the figures themselves and their associated legend.
- Some figures use small dark blue callouts.
  - ① These callouts show the sequence of steps. Note that any numbering is *not* directly related to the numbering of any associated procedure.
- PI and PVI<sup>1</sup> are only available with a Masimo SET<sup>5</sup> pulse oximeter.
- The ability to set a minimum Oxygen limit (between 21% and 30%) is not available in all markets.
- Not all features or products are available in all markets.
- Product description and order number may differ depending on region.

<sup>1</sup> Available as an option.

Safety messages are displayed as follows:

### **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**

*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**

Emphasizes information of particular importance.

In tables, safety messages are indicated as follows:

 **WARNING!**

 **CAUTION!**

 **NOTICE!**

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

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## 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, using both physiologic data from the patient and clinician-set targets and limits.

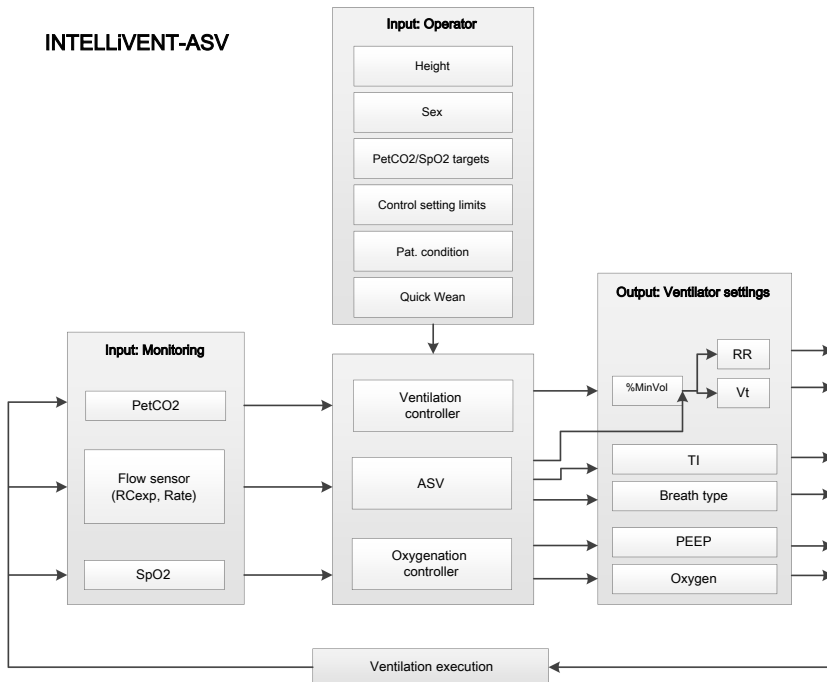
With this mode, the clinician sets targets for PetCO2 and SpO2, as well as limits for various controls, including PEEP and Oxygen, for the patient. INTELLiVENT-ASV

then manages the controls for CO2 elimination (%MinVol), and oxygenation (PEEP and Oxygen) based on these targets, clinician-defined limits, 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.

When enabled, INTELLiVENT®-ASV® can also help promote early weaning with the Quick Wean feature. See Section 2.1.

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*

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 INTELLiVENT-ASV for adult and pediatric patients only.
- Use INTELLiVENT-ASV for intubated patients only.
- Automated oxygenation control is only available when using HPO as the oxygen source.
- Be sure you are familiar with the use of the CO<sub>2</sub> and SpO<sub>2</sub> 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 intra- and interhospital 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 SaO<sub>2</sub> and SpO<sub>2</sub> is greater than 5%<sup>2</sup>.

#### CAUTION

Do **NOT** use SpO<sub>2</sub> measurement and automated PEEP/Oxygen adjustments with patients being treated with intravenous dyes.

Do NOT use INTELLiVENT-ASV if:

- The patient IBW is under 7 kg
- There is high airway leakage (NIV or broncho-pleural fistula)
- Irregular drive, for example, Cheyne-Stokes respiration
- The INTELLiVENT-ASV target ranges for PetCO<sub>2</sub> and SpO<sub>2</sub> cannot be set according to your hospital protocol or to the patient's condition

<sup>2</sup> You can compensate for differences between SaO<sub>2</sub>/SpO<sub>2</sub> and PaCO<sub>2</sub>/PetCO<sub>2</sub> up to set limits. For details, see information about Target shift.

## 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 PaCO<sub>2</sub> against displayed PetCO<sub>2</sub>, and SaO<sub>2</sub> against SpO<sub>2</sub>.
- The physician is responsible for deciding which settings are managed by INTELLiVENT-ASV, the acceptable ranges, and alarm limits.
- Use *only* parts and accessories specified in the ventilator *Operator's Manual* and in the product e-catalog, or that are specified as being compatible with this ventilator. Doing so ensures proper ventilation operation, avoids degraded performance, and keeps your warranty in force.

### NOTICE

Any incident with the device leading to serious patient injury, death, or a potential threat to public health must be reported to the manufacturer and the relevant authorities.

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

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

To ...	See ...
Set up and enable the CO <sub>2</sub> and SpO <sub>2</sub> sensors	<ul style="list-style-type: none"> <li>• Ventilator <i>Operator's Manual</i></li> <li>• Pulse oximetry documentation</li> <li>• CO<sub>2</sub> documentation</li> </ul>
Prepare the ventilator for operation, including performing the preoperational check	<ul style="list-style-type: none"> <li>• Ventilator <i>Operator's Manual</i></li> <li>• <i>Preoperational Check Quick Reference</i></li> </ul>
Set up and connect the patient	Ventilator <i>Operator's Manual</i>
Specify and confirm INTELLiVENT-ASV settings	Section 1.4
Start ventilation and monitor the patient	Ventilator <i>Operator's Manual</i>

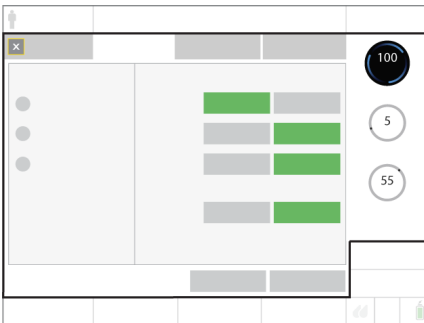
## 1.4 Specifying INTELLiVENT-ASV settings

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

The INTELLiVENT-ASV Settings window allows you to:

- Set the control management strategy (**Automatic** or **Manual**)
- If applicable, select one or more conditions that apply to the patient (for example, ARDS)
- Review SpO<sub>2</sub> and PetCO<sub>2</sub> target ranges, and adjust if needed
- Enable or disable **Quick Wean**
- Set **Oxygen** and **PEEP** limits for the Oxygenation controller (if set to **Automatic**)
- Fine-tune %MinVol, PEEP, and **Oxygen** settings

Figure 1-2. INTELLiVENT-ASV Settings window




### Navigating the INTELLiVENT-ASV Settings window

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.

- When you first select the INTELLiVENT-ASV mode, you are guided through the setup process to enter patient information and adjust the INTELLiVENT-ASV settings as required for the patient.

The setup process then prompts you to fine-tune any control settings, and review and adjust alarm limits. You are prompted to confirm the settings on each window.

- When displayed:
  - Touching **Back** returns you to the previously displayed window.
  - Touching  or **Cancel**, or doing nothing for 1 minute, closes the INTELLiVENT-ASV Settings window and returns you to the previously selected mode.
- During active ventilation, you can access the INTELLiVENT-ASV Settings window at any time to make further adjustments. All of the tabs in the window are available and function the same way as during initial setup, except that there are no navigation buttons. Changes are applied as soon as you make them. For details, see Section 1.4.10.

You can also adjust control settings and alarm limits at any time, as with any other ventilation mode.

## Specifying INTELLiVENT-ASV settings

Specifying settings comprises the following steps.

Table 1-2. Specifying INTELLiVENT-ASV settings

To ...	See ...
Specify the patient settings in the <b>Standby</b> window.	Section 1.4.1
Select the INTELLiVENT-ASV mode.	Section 1.4.2
Select control management options (Auto or manual).	Section 1.4.3
Select one or more specific conditions ( <b>ARDS</b> , <b>Brain Injury</b> , <b>Chronic Hypercapnia</b> ), if applicable.	Section 1.4.4
Enable or disable <b>Quick Wean</b> .	Section 1.4.5
Review and adjust target ranges, if needed.	Section 1.4.6
Specify additional settings (minimum <b>Oxygen</b> limit, upper and lower <b>PEEP</b> limits).	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

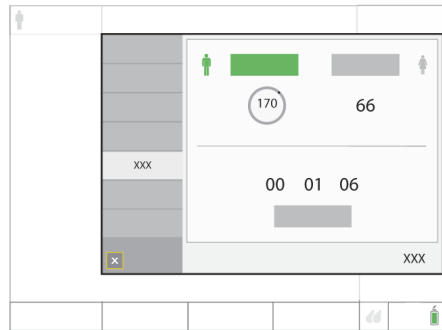
### NOTICE

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

### To specify patient data

- ▶ In the **Standby** window, choose the correct patient group, sex, and height. You can adjust these settings during ventilation in the **Controls > Patient** window.

Figure 1-3. Controls > Patient window



Be sure the patient 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 your 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 an option in the ventilator **Modes** window.

#### To select the INTELLiVENT-ASV mode

- Open the **Modes** window by doing any of the following:
  - Touch the mode name at the top left of the display.
  - Touch the **Modes** button at the top right of the display.
- In the **Modes** window, touch **INTELLiVENT-ASV**.
- Touch **Confirm**.

The **INTELLiVENT-ASV Settings** window opens, displaying the **Auto** tab (Figure 1-4).

You can now configure **INTELLiVENT-ASV** options. Continue to the next step, selecting control management options.

### 1.4.3 Selecting control management options (Auto/Manual)

#### NOTICE

- Only **Manual** mode is available for all controls when the patient **IBW** is below 7 kg. (**INTELLiVENT-ASV** is designed for use *only* with adult and pediatric patients with an **IBW** of 7 kg or more.)
- Only **Manual** mode is available for %MinVol when the CO2 sensor hardware option is *deactivated* in **Configuration**.<sup>3</sup>
- Only **Manual** mode is available for PEEP when:
  - Either the **Chronic Hypercapnia** or **Brain Injury** condition is selected.
  - The SpO2 sensor hardware option is *deactivated* in **Configuration**.<sup>3</sup>
  - However, if **Chronic Hypercapnia** and **ARDS** are *both* selected, PEEP management can be set to **Automatic**.
- Only **Manual** mode is available for **Oxygen** when the SpO2 sensor hardware option is *deactivated* in **Configuration**.<sup>3</sup>

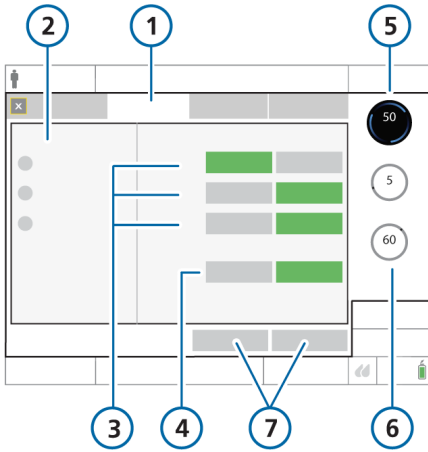
Use the **INTELLiVENT-ASV Settings > Auto** window to:

- 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** automatically regulates these controls.

<sup>3</sup> When sensor hardware is activated in **Configuration**, selecting *automatic* management of the %MinVol, PEEP, and/or Oxygen control in **INTELLiVENT-ASV** *automatically* enables the associated CO2 and/or SpO2 sensor in the **System > Sensors** window. If a sensor is not connected, a medium-priority sensor-related alarm is generated.

- Select one or more conditions (ARDS, Brain injury, or Chronic Hypercapnia), if appropriate
- Enable or disable Quick Wean

Figure 1-4. INTELLiVENT-ASV Settings window, Auto tab



- |   |  |
|---|--|
| 1 Auto  | 5 Automated management indicator and parameter value |
| 2 Specific conditions   | 6 Manual management indicators and parameter value   |
| 3 Controller settings: Automatic or Manual for %MinVol, PEEP/CPAP, Oxygen | 7 Cancel/Continue (if displayed)                     |
| 4 Quick Wean settings: Automatic, Disabled                                |  |

**NOTICE**

- When setting PEEP and/or Oxygen to Automatic, you can specify limits that the controllers cannot exceed. These limits are set in the INTELLiVENT-ASV Settings > More window. For details, see Section 1.4.11.
- By default, all controllers are set to Manual control when first setting up INTELLiVENT-ASV.

**To select management options (Auto/Manual) for %MinVol, PEEP, and Oxygen**

- ✓ If you just selected the INTELLiVENT-ASV mode and are going through the initial setup process, start with step 2.
1. Open the INTELLiVENT-ASV Settings window (Section 1.4.10).
  2. For each of the controls, %MinVol, PEEP, and Oxygen, choose whether they are managed automatically by the device or manually by the operator as follows:
    - Touch **Automatic**<sup>4</sup> to have INTELLiVENT-ASV automatically regulate the control setting to keep the patient within the target range.
    - If needed, touch **Manual** to manually adjust the control setting as appropriate. The ventilator does **not** make any adjustments to control settings in response to changes in the patient condition; settings are changed by the ventilator operator.
- In all cases, the selected button turns green.

<sup>4</sup> When sensor hardware is activated in Configuration, selecting *automatic* management of the %MinVol, PEEP, and/or Oxygen control in INTELLiVENT-ASV *automatically* enables the associated CO2 and/or SpO2 sensor in the System > Sensors window. If a sensor is *not* connected, a medium-priority sensor-related alarm is generated.

3. Select a specific condition (such as ARDS), if needed. See Section 1.4.4. Otherwise, continue to step 4.
4. Enable (or disable) **Quick Wean**, if needed. See Section 1.4.5. Otherwise, continue to step 5.
5. Review the control settings on the right (%MinVol, PEEP/CPAP, Oxygen), and make adjustments, if needed.
6. If displayed, touch **Continue** to accept the settings and proceed to the next step, reviewing SpO2 and PetCO2 target ranges.

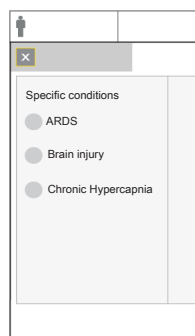
### 1.4.4 Adjusting for specific conditions

If appropriate for the patient, you can select one or more of the following conditions, ARDS, Chronic Hypercapnia, and Brain Injury in the Auto window, under **Specific conditions**.

Selecting a condition may affect ventilation and oxygenation control setting startup values and PetCO2 and SpO2 target ranges, as well as the upper and lower target shift limits. For details on the use of specific conditions, see Section 1.4.11.1.

When selecting a condition, control settings are automatically updated in real-time. The changes are reflected in the control values shown on the right side of the display (%MinVol, PEEP/CPAP, Oxygen), as well as in the target ranges of the associated CO2 elimination and Oxygenation maps shown in the **Target** window (Figure 1-7).

Figure 1-5. Specific conditions



#### To select a specific condition

- ✓ If you just selected the INTELlIVENT-ASV mode and are going through the initial setup process, start with step 2.
1. Open the INTELlIVENT-ASV Settings window (Section 1.4.10).
  2. Before proceeding, be sure to read the safety information related to specific conditions, in Section 1.4.11.1.
  3. *Only* if the patient has any specific conditions, select the appropriate entry(ies): ARDS, Brain Injury, or Chronic Hypercapnia. See Figure 1-5.

If the patient does *not* have a specific condition, proceed to step 4.

Selecting a condition may change the startup settings and targets for CO2 elimination and/or oxygenation, and can affect whether regulation of PEEP can be set to Automatic. It may also affect whether **Quick Wean** can be enabled. See Table 1-5.

4. Set control management options (**Automatic**, **Manual**), as needed, if you have not already done so.
5. Review the control settings on the right (%MinVol, PEEP/CPAP, Oxygen) and, if needed, make any adjustments.
6. If displayed, touch **Continue** to accept the settings and proceed to the next step.

### 1.4.5 Enabling or disabling Quick Wean

#### NOTICE

Quick Wean remains disabled when either of the following occurs:

- The **Brain injury** condition is selected
- %MinVol is set to **Manual**

When **Quick Wean** is enabled, the target range of acceptable PetCO<sub>2</sub> values is permanently shifted up to +5 mmHg to the right to support spontaneous breathing. The ventilator also continuously screens the readiness-to-wean criteria. These parameters are displayed in the **Quick Wean** panel in view 5 (see Table 1-11).

When the patient becomes active, so long as they meet the required criteria as described in Section 2.2, the ventilator gradually reduces %MinVol to 70%. In addition, the target respiratory **Rate** range is also increased. For details, see Section 1.7.2.

By default, **Quick Wean** is disabled when first setting up INTELLiVENT-ASV.

Figure 1-6. Quick Wean options in the INTELLiVENT-ASV Settings > Auto window



#### To enable or disable Quick Wean

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

1. Open the INTELLiVENT-ASV Settings window (Section 1.4.10).
2. To enable or disable **Quick Wean**, select one of the following options:

To enable **Quick Wean**, touch **Automatic**.

A low-priority alarm, **PetCO<sub>2</sub> target range changed**, is generated, indicating that **Quick Wean** is enabled and the target range is moved +5 mmHg (+0.67 kPa) to the right.

If needed, disable **Quick Wean** by touching **Disabled**.

The selected button turns green.

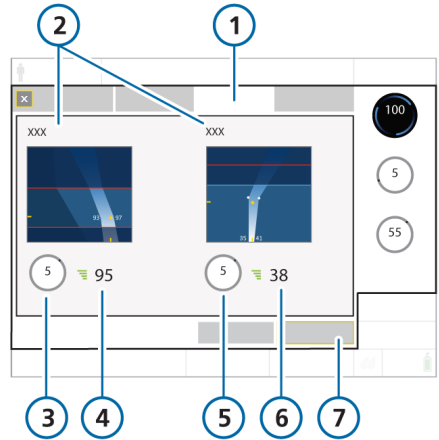
3. Continue to Section 1.4.3 to select control management options, if needed.  
Otherwise, continue to step 4.
4. Continue to Section 1.4.4 to select a condition (ARDS, Brain Injury, and/or Chronic Hypercapnia), if appropriate.  
Otherwise, continue to step 5.
5. Review the control settings on the right (%MinVol, PEEP/CPAP, Oxygen), and make adjustments, if needed.
6. If displayed, touch **Continue** to accept the settings and proceed to Section 1.4.6, *Reviewing SpO2 and PetCO2 target ranges*.

### 1.4.6 Reviewing SpO2 and PetCO2 target ranges

INTELLiVENT-ASV uses SpO2 and PetCO2 target ranges as inputs (upper and lower limits), among others, for dynamic management of controls.

Use the **Target** window to review the configured SpO2 and PetCO2 target ranges, and adjust them, if needed.

Figure 1-7. INTELLiVENT-ASV Settings window, Target tab



- |  |  |
|--|--|
| 1 Target                               | 5 Target Shift control (PetCO2)          |
| 2 Oxygenation and CO2 elimination maps | 6 Current PetCO2 value and quality index |
| 3 Target Shift control (SpO2)          | 7 Back/Continue (if displayed)           |
| 4 Current SpO2 value and quality index |  |

### To review the SpO2 and PetCO2 target ranges

- ✓ If you just selected the INTELLiVENT-ASV mode and are going through the initial setup process, start with step 3.
1. Open the INTELLiVENT-ASV Settings window (Section 1.4.10).
  2. To display the SpO2 and PetCO2 target ranges, touch the **Target** tab (Figure 1-7).
  3. Carefully review the target ranges.  
Note that selecting a condition in the **Auto** window affects the default SpO2 and PetCO2 target ranges, as well as the upper and lower target shift limits.

*If you have changed the condition selection, carefully review the target ranges.*

The **Oxygenation** map shows the SpO2 target range; the CO2 elimination map shows the PetCO2 target range.

4. If needed, make adjustments using the appropriate **Target Shift** control, as described next.
5. When finished, if displayed, touch **Continue** to accept the settings, and proceed to the next step.

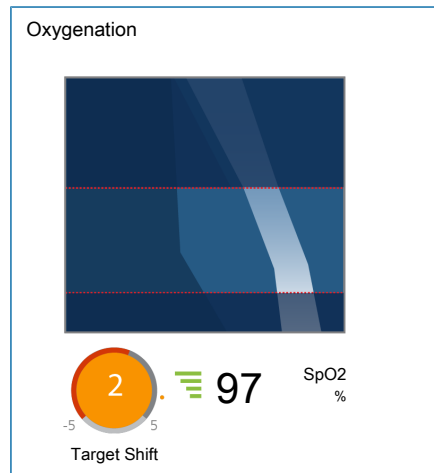
### To adjust the SpO2 target range

For details on target shift limits associated with specific conditions, see Tables 1-7 and 1-6.

1. Under the **Oxygenation** map, touch **Target Shift** next to the SpO2 value.  
The button turns orange, and the limits appear on either side of the control. See Figure 1-8.

2. Turn the P&T knob clockwise or counterclockwise to move the target range as described next, then press the P&T knob to accept the setting. The control turns gray again.
  - Setting the value to a positive number moves the target range to the right, targeting a higher SpO2.
  - Setting the value to a negative number moves the target range to the left, targeting a lower SpO2.

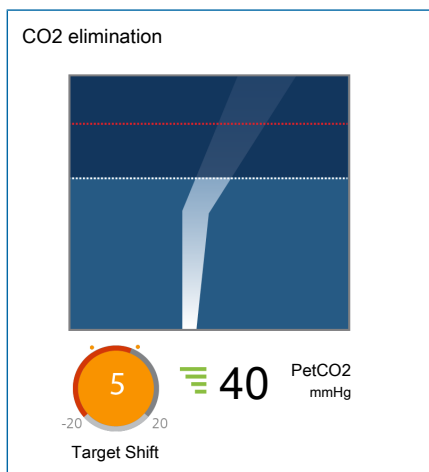
Figure 1-8. Target shift active: SpO2



### To adjust the PetCO2 target range

1. Under the CO2 elimination map, touch **Target Shift** next to the PetCO2 value.  
The button turns orange, and the limits appear on either side of the control. See Figure 1-9.
2. Turn the P&T knob clockwise or counterclockwise to move the target range as described below, then press the P&T knob to accept the setting. The control turns gray again.
  - Setting the value to a positive number moves the target range to the right, targeting a higher PetCO2.

- Setting the value to a negative number moves the target range to the left, targeting a lower PetCO<sub>2</sub>.
3. To shift the PetCO<sub>2</sub> target range to a value beyond  $\pm 5$  mmHg:
    - a. Set the value now to +5 or -5, as needed, and press the P&T knob to accept the value.
    - b. Touch the **Target Shift** control again and set the value beyond  $\pm 5$ , as needed, and press the P&T knob to accept the value.

Figure 1-9. Target shift active: PetCO<sub>2</sub>

### 1.4.7 Specifying additional settings

If you set the PEEP and/or Oxygen controls to **Automatic** in the Auto window, the **More** tab becomes available, providing access to additional options:

- When PEEP is set to **Automatic**, you can set an upper and/or lower PEEP limit for the PEEP controller
- When Oxygen is set to **Automatic**, you can set the minimum Oxygen level for the Oxygen controller

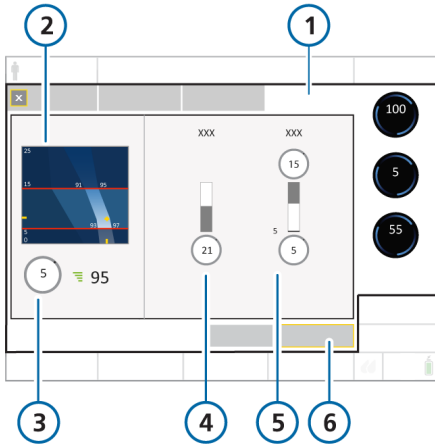
The **Oxygen** map is also displayed in the window.

If both controls are set to **Manual**, the **More** tab is disabled. In this case, clicking **Continue** in the Target window opens the Controls window.

Table 1-3. More window settings

Setting	Description
Oxygen limit (%)	<p>When the <b>Oxygen</b> control is set to <b>Automatic</b>, you can set an absolute lower limit that the <b>Oxygen</b> controller cannot fall below.</p> <p>The limit can be set between 21% (the default) and 30%. For details, see Section 1.4.11.3.</p>
PEEP limit (cmH <sub>2</sub> O)	<p>When the <b>PEEP</b> control is set to <b>Automatic</b>, you can set an absolute upper limit that the <b>PEEP</b> 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 cmH<sub>2</sub>O.</p> <p>You can set a range of values between 5 and 24 cmH<sub>2</sub>O. By default, the lower limit is set to 5, and the upper limit is set to 15. For details, see Section 1.4.11.4.</p>

Figure 1-10. INTELLiVENT-ASV Settings window, More tab



- |                             |                                |
|-----------------------------|--------------------------------|
| 1 More                      | 4 Oxygen limit*                |
| 2 Oxygenation map           | 5 PEEP limit*                  |
| 3 SpO2 Target Shift control | 6 Back/Continue (if displayed) |

\* The PEEP and/or Oxygen limit control is displayed only when the associated controller (PEEP, Oxygen) is set to Automatic.

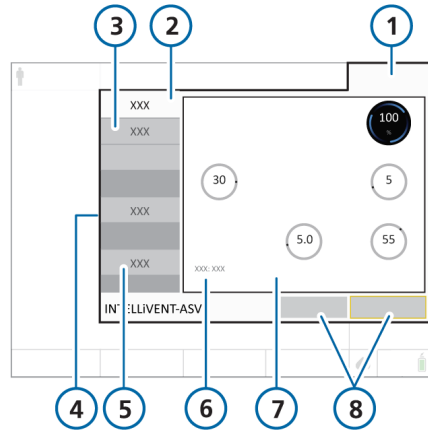
**To set a minimum/maximum PEEP and/or minimum Oxygen limit**

- ✓ If you just selected the INTELLiVENT-ASV mode and are going through the initial setup process, start with step 3.
- 1. Open the INTELLiVENT-ASV Settings window (Section 1.4.10).
- 2. Touch the **More** tab (Figure 1-10).
- 3. Set options, described in Table 1-3, if needed.  
If not needed, continue to step 4.
- 4. If displayed, touch **Continue** to accept the settings and proceed to the next step, reviewing and adjusting control settings.

**1.4.8 Adjusting control settings**

Reviewing and possibly adjusting the control settings is part of the INTELLiVENT-ASV setup process. You can also adjust settings at any time during ventilation. The controls are the same as in the ASV mode.

Figure 1-11. INTELLiVENT-ASV Controls window, Basic tab



- |           |   |
|-----------|---|
| 1 Modes   | 5 Target  |
| 2 Basic   | 6 Current minute volume   |
| 3 More    | 7 Controls: Plimit, Flow trigger, %MinVol, PEEP/CPAP, Oxygen<br>In More window: P-ramp, ETS, Sigh |
| 4 Patient | 8 Cancel/Confirm (if displayed)   |

Reviewing and possibly adjusting the control settings is part of the INTELLiVENT-ASV setup process. You can also adjust settings at any time during ventilation.



## To review and adjust INTELLiVENT-ASV control settings

- ✓ If you just selected the INTELLiVENT-ASV mode and are going through the initial setup process<sup>5</sup>, start with step 2.
1. To open the **Controls** window, touch the **Controls** button at the bottom right of the display.  
The **Basic** tab (Figure 1-11) is displayed.
  2. Adjust any settings as needed.
  3. Touch the **More** tab to review or adjust additional settings.
  4. Touch the **Patient** tab (Figure 1-3) to review patient data (height, sex), and ensure the correct **IBW** is calculated.  
You can also access the **Patient** window by touching the **Patient** icon at the top left of the display, next to the mode name.
  5. The **Target** button is displayed during active INTELLiVENT-ASV ventilation; touching the button displays the INTELLiVENT-ASV Settings > Target window.
  6. If displayed, touch **Confirm** to accept the settings and proceed to the next step, reviewing and adjusting alarm limits.

## 1.4.9 Adjusting alarm limits

### WARNING

- Set all alarms to clinically acceptable values, especially **Pressure**, **ExpMinVol**, **Vt**, **Oxygen msg**, **SpO2**, and **PetCO2**.
- To prevent patient injury, periodically review all alarm settings.

### NOTICE

You can suppress the **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*.

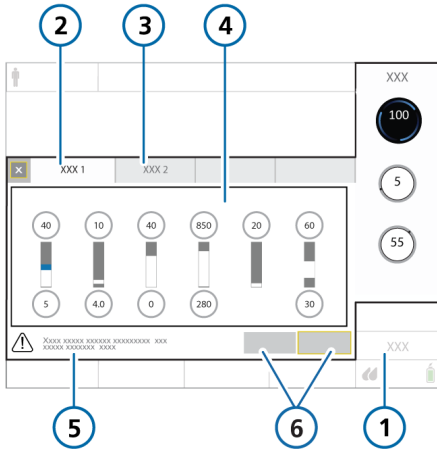
As with other modes, you can adjust alarm limits for INTELLiVENT-ASV, including for **SpO2** and **PetCO2** levels. The adjustable alarms are accessed on multiple tabs in the **Alarms** window.

For additional information:

- For troubleshooting, see Section 1.6.
- For detailed information about alarms, including default settings and ranges, see your ventilator *Operator's Manual* and the *Pulse Oximetry Instructions for Use*.

<sup>5</sup> The **Controls** window is displayed when you touch **Continue** in the INTELLiVENT-ASV Settings > **More** window, when available. If both the **PEEP** and **Oxygen** controllers are set to **Manual**, the **More** window is disabled; in this case, touching **Continue** in the INTELLiVENT-ASV Settings > **Target** window displays the **Controls** window.

Figure 1-12. Setting alarm limits



- |            |                                 |
|------------|---------------------------------|
| 1 Alarms   | 4 Alarm limit controls          |
| 2 Limits 1 | 5 Safety information            |
| 3 Limits 2 | 6 Cancel/Confirm (if displayed) |

### 1.4.10 Adjusting settings during active ventilation

During active ventilation, you can adjust INTELLiVENT-ASV settings at any time.

You can also review patient information in multiple scrollable views. For details, see Section 1.5.1.

During active ventilation, 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/Back**, **Continue/Confirm** buttons. Changes are applied at the end of the current breath cycle.

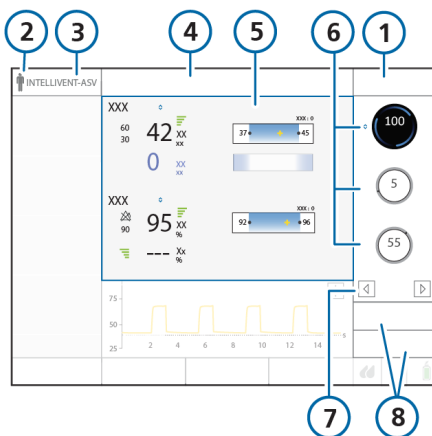
You can also adjust control settings and alarm limits at any time, as with any other ventilation mode. For details, refer to your ventilator *Operator's Manual*.

#### To adjust INTELLiVENT-ASV alarm limits

- ✓ If you just selected the INTELLiVENT-ASV mode and are going through the initial setup process, start with step 2.
- 1. To open the **Alarms** window, touch the **Alarms** button at the bottom right of the display.  
The **Limits 1** tab (Figure 1-12) is displayed.
- 2. Adjust any alarm limits as needed.
- 3. Touch the **Limits 2** tab to review and adjust additional alarm limits.
- 4. If displayed, touch **Confirm** to accept the settings.

INTELLiVENT-ASV setup is now complete.

Figure 1-13. Active ventilation with INTELLiVENT-ASV



- |  |   |
|--|---|
| 1 Modes  | 5 Selected INTELLiVENT-ASV view                                       |
| 2 Touch patient icon to open the Patient window                  | 6 Controls managed by INTELLiVENT-ASV shown with rotating blue comets |
| 3 Touch mode name to display the INTELLiVENT-ASV Settings window | 7 View number and navigation arrows                                   |
| 4 Alarm message bar  | 8 Alarms, Controls bar  |

### To adjust INTELLiVENT-ASV settings during ventilation

- At any time during ventilation with INTELLiVENT-ASV, do any of the following:
  - Touch the INTELLiVENT-ASV mode name at the top left of the display.
  - Touch an automated controller on the right of the display, if available.
  - In the Controls window, touch **Target** in the left pane.

The INTELLiVENT-ASV Settings window opens.
- Make changes as needed in each window, touching the tabs to display each one; close the window when finished.
 

Changes are applied at the end of the current breath cycle.
- To review or change control settings, touch **Controls** and make changes, as needed.
- To review or change alarm settings, touch **Alarms** and make changes, as needed.

### 1.4.11 About INTELLiVENT-ASV settings

This section provides details about the following additional INTELLiVENT-ASV features:

Settings	See ...
Specific conditions	Section 1.4.11.1
Target shift	Section 1.4.11.2
Oxygen limit	Section 1.4.11.3
PEEP limit	Section 1.4.11.4
Oxygen level notification (Oxygen msg %)	Section 1.4.11.5

#### 1.4.11.1 How the Specific conditions selections are used

##### WARNING

- To prevent possible hyper- or hypoventilation, or hyper- or hypoxemia, ensure the patient data is accurate.
- 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.

##### CAUTION

- *Select the **Chronic Hypercapnia** and/or **ARDS** 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 CO<sub>2</sub> levels and high cranial pressure might result. Carefully monitor intracranial pressure when available.*

##### NOTICE

- If **Brain Injury** is selected, the Ventilation controller (%MinVol) regulates settings in accordance with the measured PetCO<sub>2</sub> signal even if the patient is breathing spontaneously.
- The **Brain Injury** target range has the highest priority of all conditions.
- If either the **Chronic Hypercapnia** or **Brain Injury** condition is selected, management of PEEP cannot be set to **Automatic**; you must manually set the desired PEEP level.
- If **Chronic Hypercapnia** and **ARDS** are *both* selected, PEEP management can be set to **Automatic**.

The selection of a specific condition is used in INTELLiVENT-ASV to determine:

- Startup settings to use for %MinVol, PEEP, and Oxygen, as well as upper and lower alarm limits
- Whether PEEP can be set to **Automatic** or must be manually controlled
- SpO<sub>2</sub> and PetCO<sub>2</sub> target ranges, and upper and lower target shift limits
- %MinVol for *active* patients based on fSpont, or, based on PetCO<sub>2</sub> for *passive* patients when the **Brain injury** condition is selected
- Whether or not **Quick Wean** can be activated

Table 1-4 lists the conditions available in the INTELLiVENT-ASV Settings > Auto window.

For details about selecting a condition, see Section 1.4.4. For patients with mixed conditions, you can select more than one.

Table 1-4. Specific conditions, description

Condition	Description
Normal	No condition selected.
ARDS	Acute respiratory distress syndrome, which presents as an acute, severe injury to most segments of the lung.
Brain Injury	For patients with brain injuries for whom it is critical to maintain CO <sub>2</sub> under strict control to keep intracranial pressures at safe levels, and to keep oxygenation within a normal range. When selected, <b>Quick Wean</b> remains disabled.
Chronic Hypercapnia	For patients with chronically high arterial CO <sub>2</sub> 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. In this case, select both entries.

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

You can change these values at any time.

For details about changing the SpO2 or PetCO2 target ranges, see Section 1.4.11.2.

In all cases, Quick Wean is disabled at startup.

Table 1-5. Specific condition selections and associated startup values for ventilation

Condition	Ventilation		Oxygenation	
	%MinVol startup (%)	Plimit (cmH2O) <sup>6</sup>	Oxygen startup (%)	PEEP startup (cmH2O) <sup>7</sup>
Normal	100	30	60	5
ARDS	120	35	100	8
Chronic Hypercapnia	100	35	60	Manual
ARDS + Chronic Hypercapnia	120	35	100	8
Brain Injury	100	30	60	Manual

<sup>6</sup> Changing Plimit or the high Pressure alarm limit automatically changes the other: the high Pressure alarm limit is always 10 cmH2O greater than Plimit.

<sup>7</sup> The control of settings not explicitly marked as Manual can be set to Automatic.

### 1.4.11.2 Adjusting the SpO<sub>2</sub>/PetCO<sub>2</sub> target range (Target Shift)

#### CAUTION

- Regularly check the patient after changing the SpO<sub>2</sub> or PetCO<sub>2</sub> target range to verify that the range is still appropriate for the patient's current 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 SpO<sub>2</sub> and PetCO<sub>2</sub> as monitoring inputs for regulation of oxygenation and CO<sub>2</sub> elimination, and works to keep the patient within the target range for these values.

These target ranges are shown in the Oxygenation and CO<sub>2</sub> elimination maps and horizons. INTELLiVENT-ASV adjusts oxygenation and CO<sub>2</sub> elimination controls to bring the patient to the middle of the set range.

In general, SpO<sub>2</sub> and PetCO<sub>2</sub> values represent a reliable index of partial pressure of dissolved oxygen in the arterial blood (PaO<sub>2</sub>) and CO<sub>2</sub> partial pressure in the arterial blood (PaCO<sub>2</sub>), respectively (measured using blood gas analysis (BGA)). To get the most accurate approximation of PaCO<sub>2</sub>, the second highest PetCO<sub>2</sub> value (with a reliable quality index) out of 8 breaths is used.

Under normal conditions, PaCO<sub>2</sub> is approximately 2–5 mmHg higher than PetCO<sub>2</sub>; the difference between the values is referred to as the PaCO<sub>2</sub>-PetCO<sub>2</sub> gradient. With diseased or injured lungs, the PaCO<sub>2</sub>-PetCO<sub>2</sub> gradient can increase due to ventilation-perfusion mismatch, requiring adjustment of the PetCO<sub>2</sub> targets.

The **Target Shift** control allows you to move the SpO<sub>2</sub> and PetCO<sub>2</sub> 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.

#### Considerations for evaluating the PetCO<sub>2</sub> target range

When determining the appropriate PetCO<sub>2</sub> target range for your patient, keep the following considerations in mind (with examples):

- Is the displayed PetCO<sub>2</sub> target range appropriate for your patient?
- Is the PaCO<sub>2</sub>-PetCO<sub>2</sub> gradient outside of the physiologic normal range?

To get the most appropriate PetCO<sub>2</sub> target range, a BGA is required. Collect the BGA sample when the patient's current PetCO<sub>2</sub> is in the middle of the target range.

Check whether one of the **Specific conditions** entries 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.

**To evaluate and adjust the PetCO<sub>2</sub> target range**

1. Measure the difference between current PaCO<sub>2</sub> and the desired PaCO<sub>2</sub>.
2. Adjust the PetCO<sub>2</sub> target range by the same value as the difference between the current and the desired PaCO<sub>2</sub>.
3. If the desired PaCO<sub>2</sub> is less than the current value, move the PetCO<sub>2</sub> target range to the left.
4. If the desired PaCO<sub>2</sub> is higher than the current value, move the PetCO<sub>2</sub> target range to the right.

**Example 1<sup>8</sup>**

Say the patient’s BGA with PetCO<sub>2</sub> in the middle of the target range is 45 mmHg, shows a PaCO<sub>2</sub> of 55 mmHg, and the physician-desired PaCO<sub>2</sub> is 45 mmHg.

What is a good PetCO<sub>2</sub> target range for this patient?

The difference between the current and desired PaCO<sub>2</sub> is  $55 - 45 = 10$ .

The desired PaCO<sub>2</sub> is lower than the current value, so the PetCO<sub>2</sub> target range should be shifted to the *left* by 10.

The desired PetCO<sub>2</sub> ( $45 - 10 = 35$ ) will be the middle of the new target range.

**Example 2<sup>8</sup>**

Say the patient’s BGA with PetCO<sub>2</sub> in the middle of the target range is 35 mmHg, shows a PaCO<sub>2</sub> of 42 mmHg, and the physician-desired PaCO<sub>2</sub> is 50 mmHg.

What is a good PetCO<sub>2</sub> target range for this patient?

The difference between the current and desired PaCO<sub>2</sub> is  $50 - 42 = 8$ .

The desired PaCO<sub>2</sub> is higher than the current value, so the PetCO<sub>2</sub> target range should be shifted to the *right* by 8.

The desired PetCO<sub>2</sub> ( $35 + 8 = 43$ ) will be the middle of the new target range.

INTELLIVENT-ASV makes adjustments to get the patient’s PetCO<sub>2</sub> values to the middle of the target range, which in this case should result in PaCO<sub>2</sub> values within the desired 40 to 50 mmHg target PaCO<sub>2</sub>.

You adjust the SpO<sub>2</sub> target range in the same manner.

Table 1-6. PetCO<sub>2</sub> target shift limits

PetCO <sub>2</sub> target shift limits	
All conditions	-20 mmHg to 20 mmHg <sup>9</sup>

<sup>8</sup> The example situations and values provided here are for illustration purposes only; they are *not* intended to be used as clinical recommendations or guidelines.

<sup>9</sup> In some markets, the upper target shift limit is 10 mmHg.






Table 1-7. SpO2 target shift limits

SpO2 target shift limits <sup>10</sup>	
Normal (no condition selected)	-5% to +4%
ARDS	-5% to +4% <sup>11</sup>
Chronic Hypercapnia	-2% to +5%
Mixed (Chronic Hypercapnia + ARDS)	-2% to +5%
Brain Injury	-5% to +2% <sup>12</sup>

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
	Black text. Target shift is 0; there is no change to the target range values.
	Yellow text. Target shift is between ±1 and ±5.
	Orange text. Target shift is greater than ±5.

### To access the SpO2 and PetCO2 Target Shift controls




The Target Shift controls are under the associated **Oxygenation** and **CO2 elimination** maps in the **INTELLiVENT-ASV Settings > Target** window.

For details, see Section 1.4.6.

#### 1.4.11.2.1 About the Target Shift display on the horizons

The **Oxygenation** and **CO2 elimination** horizons display the associated **Target Shift** setting as follows.

Table 1-9. Target Shift setting in Oxygenation and CO2 elimination horizon display

Target Shift setting	Display in Horizon
<b>Target Shift: 0</b> indicates the target range is unchanged.	In this example, no target shift is set. 
<b>Target Shift: n &gt;</b> indicates the range is shifted to the right.	In this example, the setting is +2. 
<b>Target Shift: &lt; n</b> indicates the range is shifted to the left.	In this example, the setting is -2. 

<sup>10</sup> If changing a condition selection causes the existing limits to be exceeded, the target shift is automatically adjusted to comply with the limits for the newly selected condition.

<sup>11</sup> In some markets, the lower target shift limit is -2% when the ARDS condition is selected.

<sup>12</sup> In some markets, the lower target shift limit is -2% when the Brain Injury condition is selected.

### 1.4.11.3 Minimum Oxygen limit

When the Oxygen controller is set to **Auto-matic**, you can set an absolute lower limit for Oxygen; the Oxygen controller does not allow Oxygen to go below this limit.

#### To set the minimum Oxygen limit

- ▶ In the INTELLiVENT-ASV Settings > More window, set the limit to any value between 21% and 30%. See Section 1.4.7.  
The default setting is 21%.

### 1.4.11.4 PEEP limit

When the PEEP controller is set to **Auto-matic**, 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 1-10.

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

Table 1-10. PEEP limit settings

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

If the **Chronic Hypercapnia** or **Brain Injury** condition is selected, you must set PEEP manually.

#### To set PEEP limits

- ▶ In the INTELLiVENT-ASV Settings > More window, set the desired high and/or low PEEP limits. See Section 1.4.7.

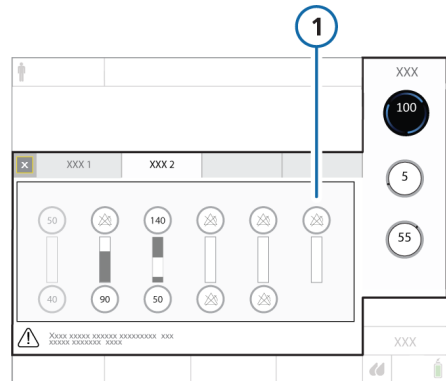
### 1.4.11.5 Oxygen level notification

When the Oxygen controller is set to **Auto-matic**, you can specify an oxygen level that, when exceeded, generates a medium-priority alarm message that is displayed in the message bar.

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

This threshold is set using the **Oxygen msg** control in the Alarms > Limits 2 window.

Figure 1-14. Alarms > Limits 2 window, Oxygen msg control (1)



For alarm details, 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 SpO<sub>2</sub> signal is *not* reliable, the automated PEEP and Oxygen controls freeze after 30 seconds. See Sections 1.8.4 and 1.8.4.1.
- If the PetCO<sub>2</sub> signal is *not* reliable, the automated %MinVol controller freezes after 30 seconds. See Sections 1.7.4 and 1.7.4.1.

INTELLiVENT-ASV provides access to numerical and graphical monitoring data.

Data is shown on the main display in the Monitoring window, in the various graphic panels, as MMPs, and in the INTELLiVENT-ASV windows, called views.

These views present the following information:

- CO<sub>2</sub> elimination and Oxygenation horizons
- Capnogram and plethysmogram
- Intelligent panels (Dynamic Lung, Vent Status, Quick Wean (when enabled), and ASV Graph)
- Up to three waveforms
- Trends

Trend graphs for SpO<sub>2</sub>- and PetCO<sub>2</sub>- related parameters, as well as for the Ventilation and Oxygenation controller settings, are also available. For details, see Section 1.5.11.1.

The following sections provide details about the views.

### 1.5.1 About the INTELLiVENT-ASV windows and views

INTELLiVENT-ASV provides a graphical overview of CO<sub>2</sub> elimination (ventilation) and oxygenation, as well as other INTELLiVENT-ASV-related data, on the main display in specialized windows.

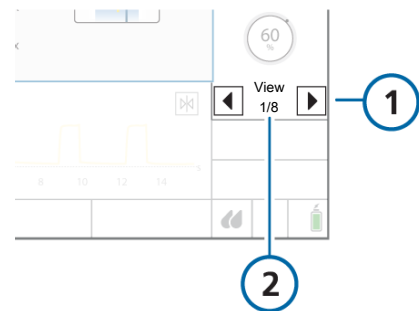
Most of these windows are displayed as a series of views that you can cycle through during ventilation.

#### To display view windows

- ▶ Touch the left or right view navigation arrow to cycle through the views.

The view number is displayed between the arrows.

Figure 1-15. Displaying INTELLiVENT-ASV views



- |                          |               |
|--------------------------|---------------|
| 1 View navigation arrows | 2 View number |
|--------------------------|---------------|

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

Table 1-11. INTELLiVENT-ASV views and maps, overview

View or map	Description	For details, see ...
CO2 elimination horizon, view 1	<p>For a <i>passive</i> patient, the CO2 elimination horizon shows a focused view of the map at the current PetCO2 value and target range.</p> <p>For an <i>active</i> patient, shows the spontaneous breathing rate (fSpont).</p> <p>The CO2 elimination horizon is shown during active ventilation in views 1 and 2.</p>	Section 1.5.3
CO2 elimination map	<p>The CO2 elimination map shows the current patient PetCO2 value and target range in relation to Ppeak, together with the set limits.</p> <p>The map is shown in the INTELLiVENT-ASV Settings &gt; Target window.</p>	<p>Section 1.5.2</p> <p>For details about the rules used to regulate CO2 elimination, see Section 1.7.</p>
Oxygenation horizon, view 1	<p>The Oxygenation horizon shows a focused view of the map at the current SpO2 value and target range.</p> <p>The Oxygenation horizon is shown during active ventilation in views 1 and 3.</p>	Section 1.5.5
Oxygenation map	<p>The Oxygenation map shows the current patient SpO2 value and the target range in relation to PEEP, together with the set limits.</p> <p>The map is shown in the INTELLiVENT-ASV Settings &gt; Target and More windows.</p>	<p>Section 1.5.4</p> <p>For details about the rules used to regulate oxygenation, see Section 1.8.</p>
Capnogram, view 2	<p>The capnogram provides a real-time CO2 waveform.</p> <p>It is shown:</p> <ul style="list-style-type: none"> <li>• During active ventilation in view 2 together with the CO2 elimination horizon.</li> <li>• As a waveform on the main display, if selected.</li> </ul>	Section 1.5.6

View or map	Description	For details, see ...
Plethysmogram, view 3	<p>The plethysmogram provides a real-time waveform that represents the pulsating blood volume.</p> <p>It is shown:</p> <ul style="list-style-type: none"> <li>• During active ventilation in view 3 together with the <b>Oxygenation</b> horizon.</li> <li>• As a waveform on the main display, if selected.</li> </ul>	Section 1.5.6
Dynamic Lung, view 4	<p>The <b>Dynamic Lung</b> provides a visual representation, as well as numeric data, for key ventilation data, including tidal volume, lung compliance, patient triggering, and resistance.</p> <p>The panel is shown during active ventilation in view 4.</p>	Your ventilator <i>Operator's Manual</i>
Vent Status panel or Quick Wean panel, view 5	<p>Which panel is displayed depends on whether Quick Wean is enabled or disabled, as follows:</p> <ul style="list-style-type: none"> <li>• When Quick Wean is <i>disabled</i>, the <b>Vent Status</b> panel is displayed.</li> <li>• When Quick Wean is <i>enabled</i>, the panel is labeled <b>Quick Wean</b>, and shows the status of the monitored weaning criteria.</li> </ul> <p>The panel is shown during active ventilation in view 5.</p>	<ul style="list-style-type: none"> <li>• <i>Vent Status panel.</i> See your ventilator <i>Operator's Manual</i>.</li> <li>• <i>Quick Wean panel.</i> See Section 2.2.4.</li> </ul>
ASV Graph panel, view 6	<p>The <b>ASV Graph</b> shows how the adaptive lung controller moves toward its targets. The graph shows both the target and real-time patient data for tidal volume, frequency, pressure, and minute ventilation.</p> <p>The panel is shown during active ventilation in view 6.</p>	Your ventilator <i>Operator's Manual</i>

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View or map	Description	For details, see ...
Waveforms, view 7	<p>The <b>Waveform</b> panel shows the waveforms you have selected in the <b>Graphics &gt; Waveforms</b> window.</p> <p>When a CO2 sensor is connected, the following waveforms are shown in view 7: <b>Paw</b>, <b>Flow</b>, <b>PCO2</b></p> <p>When no CO2 sensor is connected, the <b>Volume</b> waveform is shown in place of <b>PCO2</b>.</p> <p>The panel is shown during active ventilation in view 7.</p>	Section 1.5.10
Trend panel, view 8	<p>The <b>Trend</b> panel shows the trends you have selected in the <b>Graphics &gt; Trends</b> window.</p> <p>By default, the <b>Oxygenation controller</b> combination trends are displayed.</p> <p>The panel is shown during active ventilation in view 8.</p>	Section 1.5.11

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## 1.5.2 About the CO2 elimination map

The INTELLiVENT-ASV Ventilation controller (CO2 elimination) 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 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 CO2 elimination 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 CO2 elimination map

#### NOTICE

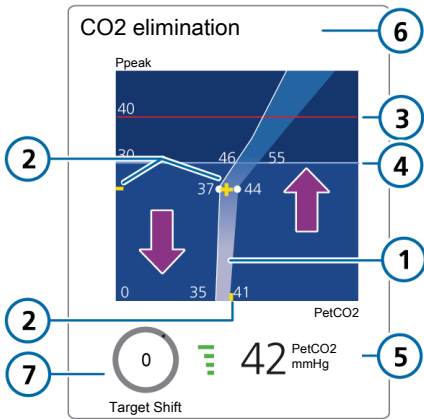
The maximum Ppeak value that can be shown on the CO2 elimination map is 50 cmH2O, so in some cases, the map may not show the patient symbol. INTELLiVENT-ASV is running, however.

The CO2 elimination map is available in the INTELLiVENT-ASV Settings > Target window.

Notes for the following figure: The purple 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 1-16. CO2 elimination map, INTELLiVENT-ASV Settings > Target window

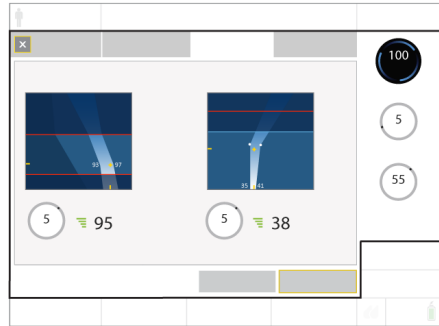


- |                                  |                                       |
|----------------------------------|---------------------------------------|
| 1 Target zone                    | 5 Current PetCO2 value, quality index |
| 2 Patient symbol, patient values | 6 Map title                           |
| 3 High Pressure alarm limit      | 7 Target Shift control                |
| 4 Plimit                         |                                       |

**To view the CO2 elimination map**

1. Open the INTELLiVENT-ASV Settings window (Section 1.4.10).
2. Touch the **Target** tab, if needed.  
The window shows the both the Oxygenation (left) and the CO2 elimination (right) maps.

Figure 1-17. INTELLiVENT-ASV Settings > Target window

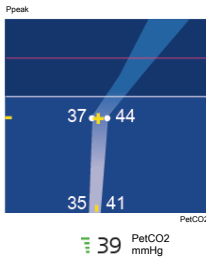


To change the target range, see Section 1.4.11.2.



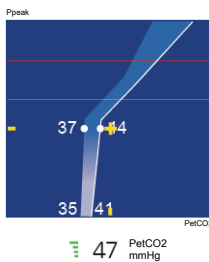
### 1.5.2.2 About the PetCO<sub>2</sub> target zone

At a very basic level, the Ventilation controller (CO<sub>2</sub> elimination) attempts to keep the patient in the target zone as described here.



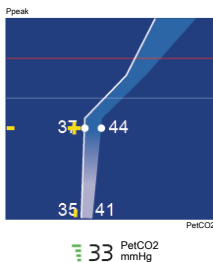
#### Patient symbol within the PetCO<sub>2</sub> target zone

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 PetCO<sub>2</sub> target zone

When the patient symbol is to the right of the target zone (in the increase zone, PetCO<sub>2</sub> is too high), the %MinVol setting increases.



#### Patient symbol below the PetCO<sub>2</sub> target zone

When the patient symbol is to the left of the target zone (in the decrease zone, PetCO<sub>2</sub> is too low), the %MinVol setting decreases.

### 1.5.3 About the CO2 elimination horizon

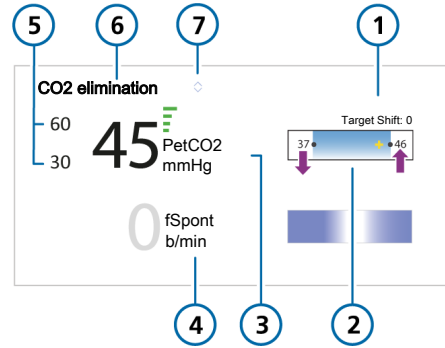
For a *passive* patient, the CO2 elimination horizon shows a simplified view of the same data as the CO2 elimination map, together with the upper and lower PetCO2 alarm limits.

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

Notes for the following two figures:

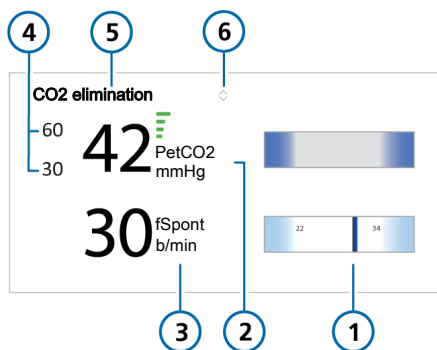
- When %MinVol is increasing (^) or decreasing (v), the appropriate indicator is highlighted (7 in the following figure). When the arrows are the same size, %MinVol is in the target zone.
- The purple arrows are for clarification purposes only; they do not appear on the display.
  - *Up arrow*: Increase zone (PetCO2 too high, increase %MinVol)
  - *Down arrow*: Decrease zone (PetCO2 too low, decrease %MinVol)
- When the PetCO2 target range is changed (using the **Target Shift** control), the setting is shown above the horizon. For details, see Section 1.4.11.2.1.

Figure 1-18. CO2 elimination horizon, passive patient



- |   |   |
|---|---|
| 1 Target shift setting                          | 5 PetCO2 alarm limits                   |
| 2 Target zone (blue) and patient symbol (cross) | 6 Horizon title                         |
| 3 Current PetCO2 value, quality index           | 7 %MinVol increase, decrease indicators |
| 4 fSpont value (0)                              |   |

Figure 1-19. CO2 elimination horizon, active patient



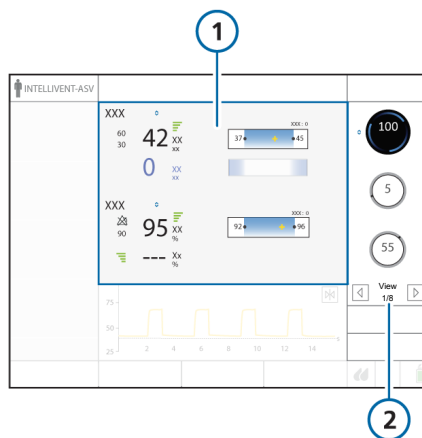
- |  |   |
|--|---|
| 1 Spont. breaths target zone, patient symbol | 4 PetCO2 alarm limits                   |
| 2 Current PetCO2 value, quality index        | 5 Horizon title                         |
| 3 Current fSpont value                       | 6 %MinVol increase, decrease indicators |

The appropriate CO2 elimination horizon (for *active* or *passive* patient) is shown on the main display during active ventilation, in views 1 and 2.

### To display the CO2 elimination horizon

- ▶ During active ventilation with INTELLiVENT-ASV, touch the left or right view arrow until view 1 or 2 is displayed.

Figure 1-20. CO2 elimination horizon during active ventilation, view 1



- |                           |                          |
|---------------------------|--------------------------|
| 1 CO2 elimination horizon | 2 View number and arrows |
|---------------------------|--------------------------|

### 1.5.4 About the Oxygenation map

The INTELLiVENT-ASV Oxygenation controller monitors SpO<sub>2</sub>, 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 SpO<sub>2</sub> to increase. The controller makes these changes based on ARDSnet guidelines.
- *Decreasing treatment* refers to changes in these control values that cause SpO<sub>2</sub> to decrease. The controller makes these changes based on the Open Lung concept.

With the HAMILTON-C1/T1 ventilators, the controller uses the PEEP/SpO<sub>2</sub> target predefined schema. The visual presentation of the schema is referred to as an Oxygenation map.

The Oxygenation map shows PEEP on the y-axis and SpO<sub>2</sub> on the x-axis. The yellow cross is the patient symbol denoting the patient's current measured SpO<sub>2</sub> value at the current PEEP. The boomerang shaped area of the graph is the target zone, which denotes a range of SpO<sub>2</sub> values at a given PEEP.

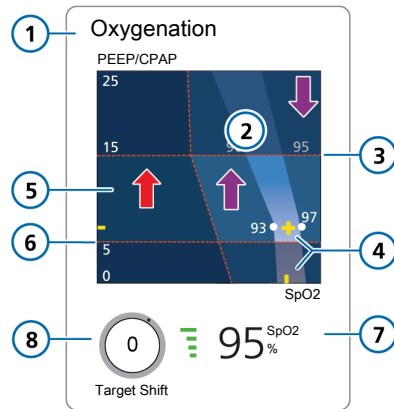
#### 1.5.4.1 Reviewing the Oxygenation maps

The Oxygenation map is displayed in the INTELLiVENT-ASV Settings > Target and More windows (Figures 1-7 and 1-10).

Notes for the following figure: The red/ purple arrows and red dotted lines are for clarification purposes only; they do not appear on the display.

- *Purple up arrow*: Increase treatment zone
- *Purple down arrow*: Decrease treatment zone
- *Red up arrow*: Emergency increase zone (dark blue area), Oxygen set to 100%

Figure 1-21. Oxygenation map in INTELLiVENT-ASV Settings > Target and More windows



- |                                  |   |
|----------------------------------|---|
| 1 Map title                      | 5 Emergency zone                                |
| 2 SpO <sub>2</sub> target zone   | 6 Lower PEEP limit                              |
| 3 Upper PEEP limit               | 7 Current SpO <sub>2</sub> value, quality index |
| 4 Patient symbol, patient values | 8 Target Shift control                          |

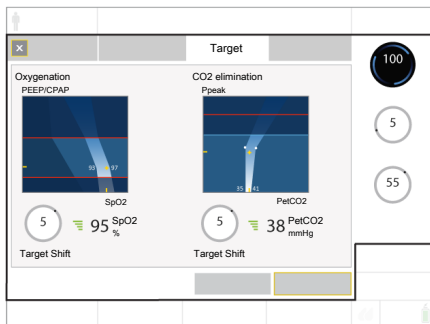
## To view the Oxygenation map

1. Open the INTELLiVENT-ASV Settings window (Section 1.4.10).
2. Touch either the **Target** or the **More** tab.

The **Target** window (shown next) shows the both the **Oxygenation** (left) and the **CO2 elimination** (right) maps.

The **More** window shows only the **Oxygenation** map.

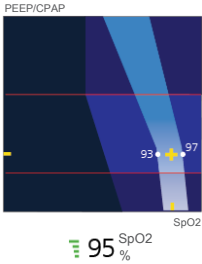
Figure 1-22. INTELLiVENT-ASV Settings > Target window



To change the target range, see Section 1.4.11.2.

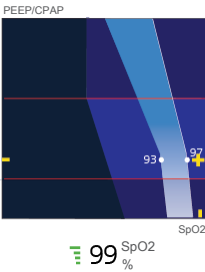
### 1.5.4.2 About the SpO2 target zone

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



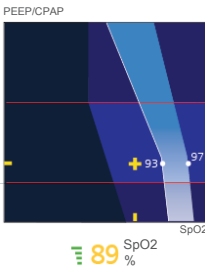
#### Patient symbol within the SpO2 target zone

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



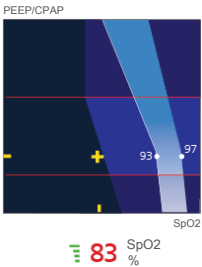
#### Patient symbol above the SpO2 target zone

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.



#### 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. As a result of being below the target zone, a medium-priority alarm is generated; the SpO2 parameter is shown in the associated alarm 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%. As a result of being below the target zone, a high-priority alarm is generated; the SpO2 parameter is shown in the associated alarm color.

### 1.5.5 About the Oxygenation horizon

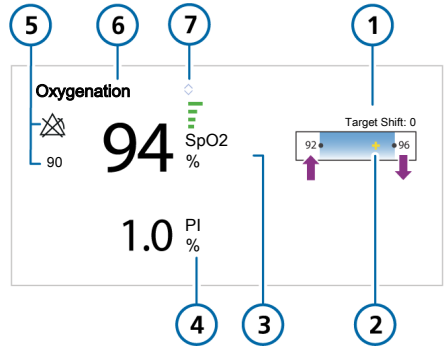
The **Oxygenation horizon** shows a simplified view of the same data as the **SpO<sub>2</sub>/PEEP Oxygenation map**, together with the upper and lower **SpO<sub>2</sub>** alarm limits.

With a **Masimo SET SpO<sub>2</sub>** sensor, the horizon also shows the measured perfusion index (**PI**).

Notes for the following figure:

- When **PEEP** or **Oxygen** is increasing (^) or decreasing (v), the appropriate indicator is highlighted (**7** in the following figure). When the arrows are the same size, **SpO<sub>2</sub>** is in the target zone.
- The purple arrows in the following figure are for clarification purposes only; they do not appear on the display.
  - *Up arrow*: Increase treatment zone
  - *Down arrow*: Decrease treatment zone
- When the **SpO<sub>2</sub>** target range is changed (using the **Target Shift** control), the setting is shown above the horizon. For details, see Section 1.4.11.2.1.

Figure 1-23. Oxygenation horizon



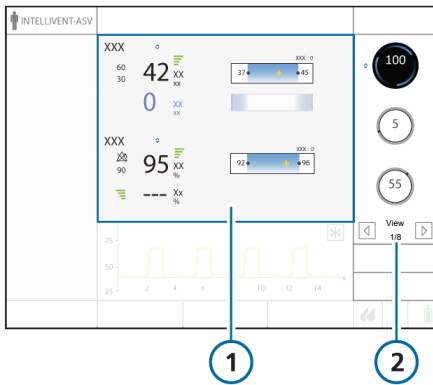
- |  |  |
|--|--|
| 1 Target shift setting   | 5 SpO <sub>2</sub> alarm limits            |
| 2 Target zone (blue)   | 6 Horizon title and patient symbol (cross) |
| 3 Current SpO <sub>2</sub> value, quality index                  | 7 PEEP, Oxygen increase/decrease indicator |
| 4 Current PI value ( <i>Masimo SpO<sub>2</sub> sensor only</i> ) |  |

The Oxygenation horizon is shown on the main display during active ventilation in views 1 and 3.

**To display the Oxygenation horizon**

- ▶ During active ventilation with INTELLIVENT-ASV, touch the left or right view arrow until view 1 or 3 is displayed.

Figure 1-24. Oxygenation horizon during active ventilation, view 1



- 1 Oxygenation horizon
- 2 View number and arrows

**1.5.6 About the capnogram and plethysmogram**

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.

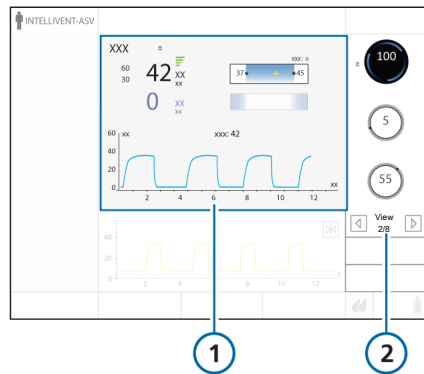
**To display the capnogram**

- ▶ During active ventilation with INTELLIVENT-ASV, touch the left or right view arrow until view 2 is displayed.

The capnogram is displayed together with the CO2 elimination horizon.

For details about selecting the capnogram as a waveform on the ventilator main display, see your ventilator *Operator's Manual*.

Figure 1-25. Capnogram during active ventilation, view 2



- 1 Capnogram and CO2 elimination horizon
- 2 View number and arrows



## About the plethysmogram

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

### To display the plethysmogram

- ▶ During active ventilation with INTELLiVENT-ASV, touch the left or right view arrow until view 3 is displayed.

The plethysmogram is displayed together with the Oxygenation horizon.

For details about selecting the plethysmogram as a waveform on the ventilator main display, see your ventilator *Operator's Manual*.

Figure 1-26. Plethysmogram during active ventilation, view 3



- |   |                          |
|---|--------------------------|
| 1 Plethysmogram and Oxygenation horizon | 2 View number and arrows |
|---|--------------------------|

## 1.5.7 About the Dynamic Lung

The Dynamic Lung shows an up-to-date visual representation of key ventilation data (Figure 1-27). It visualizes tidal volume, lung compliance, patient triggering, and resistance in real-time.

In addition to the graphic representation, the panel shows numeric data for key parameters.

The Dynamic Lung comprises the following components:

- Mechanical breath action
- Respiratory compliance
- Airway resistance
- Patient triggering
- SpO2 data

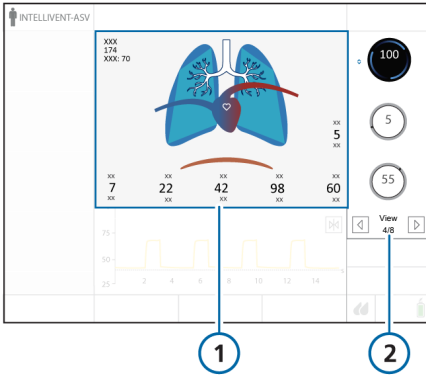
For details about the Dynamic Lung, see your ventilator *Operator's Manual*.

In INTELLiVENT-ASV, the Dynamic Lung is provided in view 4.

### To display the Dynamic Lung

- ▶ During active ventilation with INTELLIVENT-ASV, touch the left or right view arrow until view 4 is displayed.

Figure 1-27. Dynamic Lung during active ventilation, view 4



- 1 Dynamic Lung
- 2 View number and arrows

### 1.5.8 About the Vent Status and Quick Wean panels

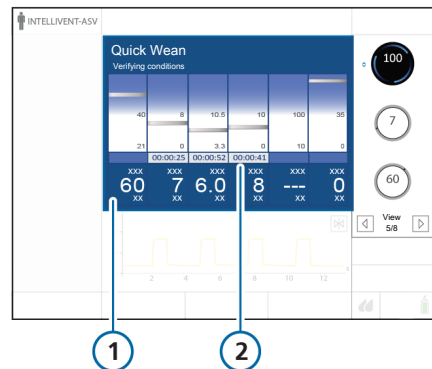
The panel shown in view 5 is either the Vent Status panel or the Quick Wean panel, depending on whether Quick Wean is enabled in the INTELLIVENT-ASV Settings window, as follows:

- When Quick Wean is *disabled* (the default), the Vent Status panel is displayed, showing the standard ventilation parameters. For details about this panel, see your ventilator *Operator's Manual*.
- When Quick Wean is *enabled*, the panel is labeled **Quick Wean**, and shows the status of the monitored weaning criteria. For details, see Sections 2.2.2 and 2.2.4.

### To display the Vent Status or Quick Wean panel

- ▶ During active ventilation with INTELLIVENT-ASV, touch the left or right view arrow until view 5 is displayed.

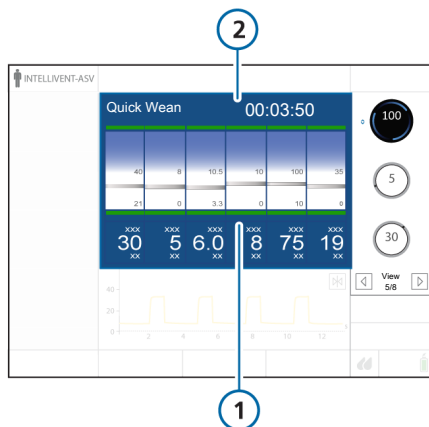
Figure 1-28. Quick Wean panel during active ventilation, view 5



- 1 Monitored parameter, outside the weaning zone
- 2 Monitored parameter, in the weaning zone

When **Quick Wean** is *enabled* and the parameters within their target weaning ranges, that is, in the weaning zone, the **Quick Wean** panel shows green bars for each of the parameters. A timer is also displayed, showing the length of time the parameters values have been in the weaning zone.

Figure 1-29. Quick Wean panel, all parameters in the weaning zone, timer activated



- 1 Parameter in the weaning zone (with green bar)
- 2 Weaning timer

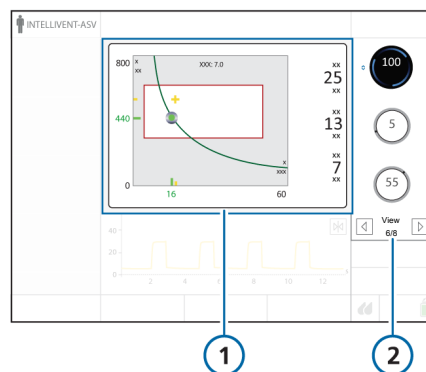
## 1.5.9 About the ASV Graph

View 6 shows the **ASV Graph**, the same as in **ASV mode**. The graph shows both the target and real-time patient data for tidal volume, frequency, pressure, and minute ventilation. For additional details, see your ventilator *Operator's Manual*.

### To display the ASV Graph

- ▶ During active ventilation with **INTELLiVENT-ASV**, touch the left or right view arrow until view 6 is displayed.

Figure 1-30. ASV Graph during active ventilation, view 6



- 1 ASV Graph
- 2 View number and arrows

### 1.5.10 About the Waveform display

View 7 provides a full display of up to three waveforms during active ventilation. By default, the Paw, flow, and volume waveforms are displayed.

You can change the selection at any time in the same manner as in any other mode. For details, see your ventilator *Operator's Manual*.

#### To display the Waveform view

- ▶ During active ventilation with INTELLiVENT-ASV, touch the left or right view arrow until view 7 is displayed.

Figure 1-31. Waveform display during active ventilation, view 7



- 1 Waveform display    2 View number and arrows

### 1.5.11 About the Trend panel

The Trend panel in view 8 displays the selected trend. You can change the selection at any time in the same manner as in any other mode. For details, see your ventilator *Operator's Manual*.

In INTELLiVENT-ASV, two additional trend combinations are available, **Oxygenation control** and **Ventilation control**. For details, see Section 1.5.11.1.

#### To display the Trend view

- ▶ During active ventilation with INTELLiVENT-ASV, touch the left or right view arrow until view 8 is displayed.

Figure 1-32. Trends during active ventilation, view 8



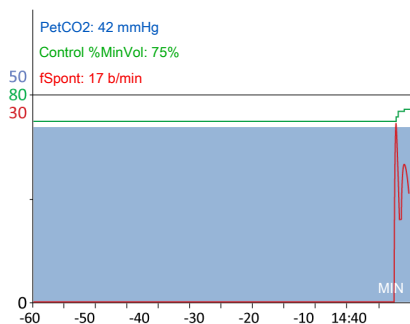
- 1 Trend graph    2 View number and arrows

### 1.5.11.1 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-, 6-, 12-, 24-, or 72-h trends. Each parameter is represented by a different color, as indicated in the graph legend.<sup>13</sup>

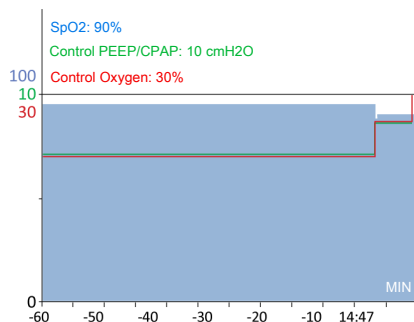
#### Ventilation control trend graph

The Ventilation control trend graph provides data for the following parameters: PetCO<sub>2</sub>, Control %MinVol, and fSpont.



#### Oxygenation control trend graph







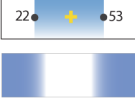

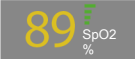
The Oxygenation control trend graph provides data for the following parameters: SpO<sub>2</sub>, Control PEEP/CPAP, and Control Oxygen.















<sup>13</sup> Note that the graphs provided here do not represent actual data, they just illustrate how the different parameters are represented.

### 1.5.12 INTELLiVENT-ASV symbols

Table 1-12. INTELLiVENT-ASV-related symbols and controls

Symbol/Control	Color	Description
	White	<i>View selection.</i> During active ventilation, several views are available. The view navigation arrows change the views. See Section 1.5.1.
	Yellow	<i>Patient symbol.</i> Indicates the current condition of the patient in the graph.
	Gray (4 bars), Orange (2 bars), Red (1 bar)	<i>Quality index showing unreliable signal quality.</i> Sensor values are not usable, or the sensor is not enabled or connected. When this occurs, the related controller freezes and an alarm is generated indicating automatic management is turned OFF.
	Green (3 or 4 bars)	<i>Quality index showing stable acceptable signal quality.</i> The data from the sensor is highly stable and reliable.
	White	Measured PetCO2 sensor value and quality index.
<p><i>Active patient</i></p>  <p><i>Passive patient</i></p> 	The inactive component is greyed out.	When the PetCO2 horizon (top) is greyed out, and the fSpont horizon is active, the patient is breathing spontaneously ( <i>active</i> ). When the PetCO2 horizon is active, and the fSpont horizon is greyed out, the patient meets the <i>passive</i> criteria.
	White	The fSpont measurement is displayed when spontaneous breathing is detected by the flow sensor, and is used as physiologic input.
	Yellow	Low SpO2 value. SpO2 is below the set lower alarm limit. A medium-priority Low SpO2 alarm is active. For details, see the <i>Pulse Oximetry Instructions for Use</i> .

Symbol/Control	Color	Description
	Red	Critical SpO2 value. SpO2 is well below the set lower alarm limit. A high-priority Low SpO2 alarm is active.  For details, see the <i>Pulse Oximetry Instructions for Use</i> .
	White	Dashes indicate that no sensor value can be detected.
	White	<i>Increase arrow</i> , next to the horizon name and to the left of the automated controllers. Indicates that treatment must be increased.
	White	<i>Decrease arrow</i> , next to the horizon name and to the left of the automated controllers. Indicates that treatment must be decreased.
	Black	<i>Value is stable, in range</i> . Displayed next to the horizon name and to the left of the automated controllers.
	White	<i>Time to increase</i> . Counts down the time to the next increase of the control.
	White	<i>Time to decrease</i> . Counts down the time to the next decrease of the control.
	Gray circle	<i>Manual management</i> . Indicates that the operator must manage the control.
	Blue comets rotating clockwise	<i>Management is set to Automatic</i> . Indicates that INTELLiVENT-ASV is dynamically updating the settings, and treatment has been increased (comets moving clockwise). A faster rotation provides a visual indication of ongoing or recent changes.
	Blue comets rotating counter-clockwise	<i>Management is set to Automatic</i> . Indicates that INTELLiVENT-ASV is dynamically updating the settings, and treatment has been decreased (comets moving counter-clockwise). A faster rotation gives a visual indication of ongoing or recent changes.

Symbol/Control	Color	Description
	Red circle	No settings management – controller is in a frozen state. A sensor value may be absent.
	Green circle	Oxygen enrichment in progress. For details, see your ventilator <i>Operator's Manual</i> .

## 1.6 Troubleshooting alarms

### CAUTION

You can suppress audible CO<sub>2</sub> and SpO<sub>2</sub> alarms for 2 minutes by pressing the Audio pause key.

### NOTICE

When the device is in Standby, all SpO<sub>2</sub>-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 SpO<sub>2</sub>-related documentation.

For the following alarm types, see the listed documentation:

- SpO<sub>2</sub>-related alarms, see the *Pulse oximetry Instructions for use*.
- PetCO<sub>2</sub>-related alarms, see your ventilator *Operator's Manual*.



Table 1-13. INTELLiVENT-ASV alarms, priority, and corrective actions

Alarm/Priority	Definition/Corrective action
FiO2 set to 100% due to low SpO2 <i>Medium priority.</i>	The Oxygenation controller set <b>Oxygen</b> to 100% due to low SpO2 saturation. SpO2 is, or was, in the emergency zone.  <b>To resolve</b> <ul style="list-style-type: none"> <li>• Check patient condition.</li> <li>• Open and close the alarm buffer to reset the alarm (even if the alarm situation changes).</li> </ul>
Oscillation PEEP/CPAP <i>Medium priority.</i>	Large variations in PEEP in a short time period.  <b>To resolve</b> <ul style="list-style-type: none"> <li>• Check patient condition.</li> <li>• Set PEEP to <b>Manual</b>.</li> </ul>
Oscillation %MinVol <i>Medium priority.</i>	Large variations in %MinVol in a short time period.  <b>To resolve</b> <ul style="list-style-type: none"> <li>• Check patient condition.</li> <li>• Set %MinVol to <b>Manual</b>.</li> </ul>
Oxygenation adjustment off <i>Medium priority.</i>	The Oxygenation controller is frozen due to poor or absent SpO2 signal.  <b>To resolve</b> <ul style="list-style-type: none"> <li>• Check pulse oximeter connections.</li> <li>• Set PEEP and/or <b>Oxygen</b> to <b>Manual</b>.</li> </ul>
Oxygen controller at limit <i>Low priority.</i>	PEEP and/or <b>Oxygen</b> are at the defined limit and cannot be increased.  <b>To resolve</b> <ul style="list-style-type: none"> <li>• Check patient condition.</li> <li>• Verify limit settings.</li> <li>• Set PEEP and/or <b>Oxygen</b> to <b>Manual</b>.</li> </ul>
Oxygen control limit exceeded <i>Medium priority.</i>	<b>Oxygen</b> exceeds the limit defined by the <b>Oxygen</b> msg alarm ( <b>Alarms</b> window).  <b>To resolve</b> <ul style="list-style-type: none"> <li>• Check patient condition.</li> <li>• Open and close the alarm buffer to reset the alarm (even if the alarm situation changes).</li> </ul>

Alarm/Priority	Definition/Corrective action
<p>PetCO2 target range changed <i>Low priority.</i></p>	<p>Quick Wean has been set to Automatic; it is now active. As a result, the PetCO2 target range is moved +5 mmHg to the right. See Section 2.2.3 for details about the workflow.</p>
<p>Ventilation adjustment OFF <i>Medium priority.</i></p>	<p>The Ventilation controller (CO2 elimination) is frozen when any of the following conditions persists for longer than 30 seconds:</p> <ul style="list-style-type: none"> <li>• Poor or absent CO2 signal</li> <li>• fSpont &gt; 60 b/min (&gt; 40 kg IBW)</li> <li>• fSpont &gt; 100 b/min (≤ 40 kg IBW)</li> </ul> <p><b>To resolve</b></p> <ul style="list-style-type: none"> <li>• Check patient condition.</li> <li>• Check CO2 connections.</li> <li>• Set %MinVol to Manual.</li> </ul>
<p>Ventilation controller at limit <i>Low priority.</i></p>	<p>%MinVol is at the defined limit (200%) and cannot be increased.</p> <p><b>To resolve</b></p> <ul style="list-style-type: none"> <li>• Check patient condition.</li> <li>• Set %MinVol to Manual.</li> </ul>

## 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.

During automated management of ventilation, the lung-protective strategy principles inherent in ASV are always applied. For details, see the section *Working with ASV* in your ventilator *Operator's Manual*.

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

### Minute volume (%MinVol) management in Automatic mode

When set to Automatic, the INTELLiVENT-ASV Ventilation controller (CO2 elimination) 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 rates, as described in Section 1.7.2.

For details on how the 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 volutrauma, AutoPEEP, 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)
  - Any specific condition(s) set by the operator (Section 1.4.11.1)
  - Operator-set PetCO2 target shift (Section 1.4.11.2)
  - Whether Quick Wean is enabled (Section 2.2)
- The acceptable spontaneous breathing rate is calculated using the information in Table 1-16.

The %MinVol limits that are in force when minute volume management is set to Automatic are listed in Table 1-14. As soon as the upper limit for the management of %MinVol is reached, a **Ventilation controller at limit message** is generated.

Table 1-14. %MinVol limits when minute volume management set to Automatic

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

PetCO2 status	%MinVol
Maximum %MinVol	
PetCO2 available	200
PetCO2 not available	200 (automatic control suspended)

**Minute volume (%MinVol) management in Manual mode**

In **Manual mode**, you keep the CO2 elimination within the target range by manually adjusting %MinVol, based on the PetCO2 monitoring values and 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 2–5 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 gradient can increase, requiring adjustment of the ventilation targets (using the **Target Shift control**). For details, see Section 1.4.11.2.

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:

- Any specific condition(s) set by the operator (Section 1.4.11.1)
- Operator-set PetCO2 target shift (Section 1.4.11.2)
- 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 1-15. 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 <b>Ventilation adjustment OFF</b> 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 1-16. Spontaneous breathing rate range calculation<sup>14</sup>

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 PetCO<sub>2</sub> value is only used in the background for additional safety to avoid excessive values.

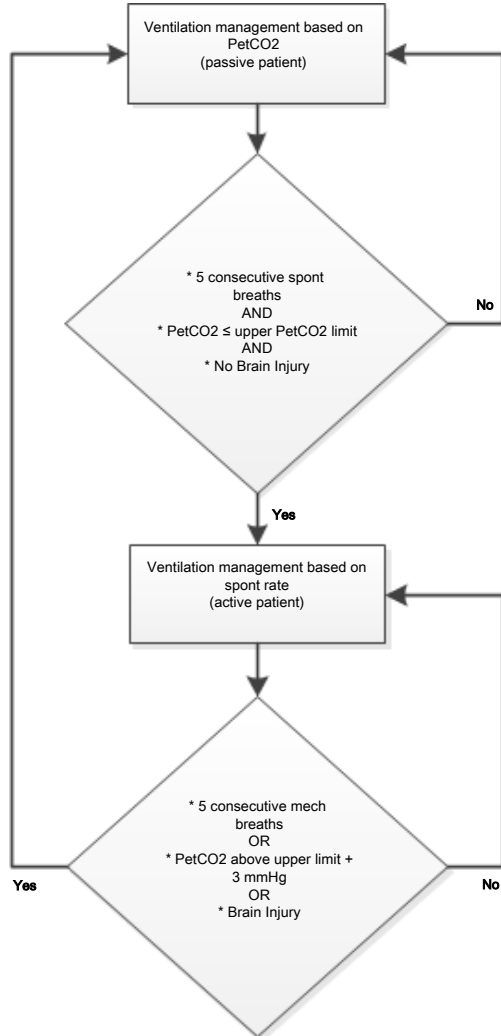
The conditions listed in the following table apply to automated control of %MinVol for an *active* patient, and refer to the transition process specified in Section 1.7.3.

<sup>14</sup> For ASV target rate information, see your ventilator *Operator's Manual*.

Table 1-17. Automated management of %MinVol, active patient

When these conditions apply ...	%MinVol change
<ul style="list-style-type: none"> <li>• The patient complies with the <i>Active state conditions</i> in Section 1.7.3 <i>and</i></li> <li>• The patient's <b>Rate</b> is above the upper limit of the acceptable spontaneous <b>Rate</b> (danger of patient fatigue)</li> </ul>	%MinVol increase
<ul style="list-style-type: none"> <li>• The patient complies with the <i>Active state conditions</i> in Section 1.7.3 <i>and</i></li> <li>• The patient's <b>Rate</b> is below the lower limit of the acceptable spontaneous <b>Rate</b></li> </ul>	%MinVol decrease
<ul style="list-style-type: none"> <li>• The patient complies with the <i>Active state conditions</i> in Section 1.7.3 <i>and</i></li> <li>• The patient's <b>Rate</b> value is within the target range</li> </ul>	No change in %MinVol. If <b>Quick Wean</b> is enabled, see Section 2.2.3 for details.
The patient's <b>PetCO<sub>2</sub></b> is invalid for more than 30 seconds	%MinVol control is frozen. The <b>Ventilation adjustment OFF</b> alarm is generated.
The patient's spontaneous <b>Rate</b> is invalid (> 60 b/min for patients over 40 kg <b>IBW</b> or > 100 b/min for patients ≤ 40 kg <b>IBW</b> ) for more than 30 seconds	%MinVol control is frozen. The <b>Ventilation adjustment OFF</b> alarm is generated.

### 1.7.3 How the Ventilation controller transitions between active and passive patient states



**Passive patient**

For a *passive* patient, the controller starts adjusting the %MinVol based on PetCO<sub>2</sub> when ANY of the following are true:

- Five consecutive mechanical breaths occur *or*
- The PetCO<sub>2</sub> value exceeds the upper limit by at least 3 mmHg *or*
- The Brain Injury condition is selected

When a reliable PetCO<sub>2</sub> measurement is not available (Table 1-19), the Ventilation controller suspends dynamic management of the control, 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 PetCO<sub>2</sub> value is below the upper limit *and*
- The Brain Injury condition is NOT selected

The controller continuously checks the *passive* patient conditions 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<sup>15</sup> 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 PetCO<sub>2</sub> measurement is not available (Table 1-19), the Ventilation controller suspends automated management, and the %MinVol control is frozen. The Ventilation adjustment OFF alarm is generated.

<sup>15</sup> fSpont > 60 b/min (> 40 kg IBW) or fSpont > 100 b/min (≤ 40 kg IBW)



### 1.7.4 Important notes about ventilation management

When ventilating with INTELLiVENT-ASV, pay particular attention to the following important notes.



Table 1-18. Important notes about ventilation management

For ...	See ...
Quality index 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 Quality index and ventilation management

If the signal quality is unreliable, the PetCO2 quality index can show gray, red, or orange bars. The following table summarizes INTELLiVENT-ASV operation depending on the PetCO2 quality index.

Table 1-19. PetCO2 quality index and automated ventilation management

Quality indicator	These conditions apply ...
<p>The data from the sensor is unavailable or not reliable for more than 30 seconds</p> <p>Gray, red, or orange bars</p> 	<ul style="list-style-type: none"> <li>The %MinVol control is a solid red circle; it is frozen.</li> <li>The Ventilation adjustment OFF alarm is generated.</li> <li>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 <i>Operator's Manual</i>.</li> </ul>
<p>The data from the sensor is reliable</p> <p>Green bars</p> 	<ul style="list-style-type: none"> <li>The %MinVol control is a blue rotating circle.</li> <li>The Ventilation adjustment OFF alarm is reset.</li> <li>Automated ventilation management resumes.</li> </ul>

### 1.7.4.2 Actions that temporarily halt automatic ventilation management

Automated ventilation management pauses during the following actions:

- Disconnection
- Flow sensor calibration
- Leak test
- Suctioning

In some cases, the %MinVol control 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 PetCO<sub>2</sub> is not available

Any time the PetCO<sub>2</sub> measurement is unavailable or unreliable<sup>16</sup>, the minute volume adjustment is the same as in ASV mode, using the %MinVol setting in effect at the time that the PetCO<sub>2</sub> signal became unusable.

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

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

When PetCO<sub>2</sub> is again available, the alarm is resolved and the minute volume adjustment switches back to Automatic mode.

- The %MinVol control 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 %MinVol management adjustment pauses for 10 breaths.
- The ASV adjustment ( $\Delta P_{insp}$  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.

<sup>16</sup> If the PetCO<sub>2</sub> value falls below 10 mmHg, the quality indicator bar is red; the value is considered unreliable.

### 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.

If the PetCO<sub>2</sub> 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 PetCO<sub>2</sub> 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 SpO<sub>2</sub> 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 above 21%, a red line indicating the limit appears on the **Oxygenation** map.

- The PEEP controller can only operate between 5 and 24 cmH<sub>2</sub>O.
- If the PEEP control is set to **Automatic**, the set PEEP high and low limit controls are activated. The **Oxygenation** map shows two red lines, one showing the upper PEEP limit and one showing the lower.

During automated management of oxygenation, the lung-protective strategy principles inherent in ASV are always applied. For details, see the section *Working with ASV* in your ventilator *Operator's Manual*.

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 SpO<sub>2</sub> range for the patient:

- Measured oxygen saturation (SpO<sub>2</sub>)
- Any specific condition(s) set by the operator (Section 1.4.11.1)
- Operator-set **Target Shift** (Section 1.4.11.2)

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 **SpO<sub>2</sub>** within the target range by manually adjusting **PEEP** and/or **Oxygen**, based on the **SpO<sub>2</sub>** monitoring values and clinical practice.

### 1.8.1 Management of PEEP/Oxygen for all patients

Using the **SpO<sub>2</sub>** signal retrieved from the pulse oximeter, the system calculates the difference between the current and the target **SpO<sub>2</sub>** values. 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 current treatment (**PEEP**) define the **SpO<sub>2</sub>** target range. The ranges differ based on the selected specific condition(s), if any (Section 1.4.11.1). The **SpO<sub>2</sub>** signal and the **SpO<sub>2</sub>** target range are used to define the treatment action (increase, decrease, no change of treatment).
- The system decides, depending on the current combination of **PEEP** and **Oxygen** on the **PEEP/Oxygen** curve, whether **PEEP** and/or **Oxygen** are increased.

*For increasing therapy*, the relationship between **PEEP** and **Oxygen** is based on the **ARDSnet guidance** (Figure 1-33, the target path is the bold line).

*For decreasing therapy*, the relationship is based on the **Open Lung concept** (Figure 1-34, the target path is the bold lines).

Figure 1-33. Increase of oxygenation support, ARDSnet guidance

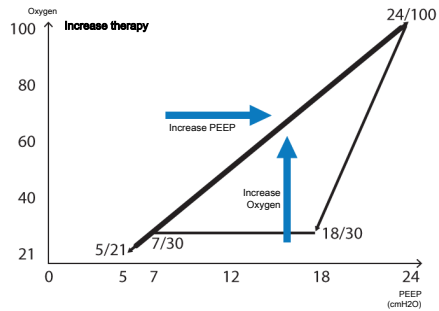
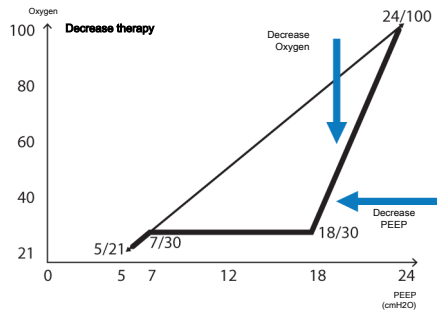


Figure 1-34. Decrease of oxygenation support, Open Lung concept



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 **SpO<sub>2</sub>** 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 SpO<sub>2</sub> to avoid dangerous desaturation. Upon detecting an inadequate SpO<sub>2</sub> level, the device reacts immediately to deliver 100% Oxygen to the patient.

This feature is activated when the physiologic SpO<sub>2</sub> value of the patient falls below the lowest acceptable value, thus triggering the 100% Oxygen response. The FiO<sub>2</sub> set to 100% due to low SpO<sub>2</sub> alarm is generated.

## 1.8.3 Oxygenation management rules

When set to Automatic, the Oxygenation controller adjusts PEEP and Oxygen as described here.

### SpO<sub>2</sub> 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:

- SpO<sub>2</sub> remains in range AND
- Oxygen was last increased over 10 minutes ago AND
- There is no change in PEEP

### SpO<sub>2</sub> is too low (below the lower SpO<sub>2</sub> target zone limit)

The controller *increases oxygenation support*.

#### Position of patient symbol in the FiO<sub>2</sub>/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.

### SpO<sub>2</sub> 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.

### SpO<sub>2</sub> 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 1-20. Increase/decrease increments of Oxygen and PEEP by automated Oxygenation controller<sup>17</sup>

Oxygenation management/Action	Takes place when ...
Increase Oxygen stepwise: Increases Oxygen by 10% of current Oxygen value every <b>30 seconds</b>	<ul style="list-style-type: none"> <li>• Oxygen automatically managed</li> <li>• Increasing Oxygen support</li> </ul>
Decrease Oxygen stepwise: Decreases Oxygen by 5% of current Oxygen value every <b>60 seconds</b>	<ul style="list-style-type: none"> <li>• Oxygen automatically managed</li> <li>• Decreasing Oxygen support</li> </ul>
Increase PEEP stepwise: Increases PEEP by 1 cmH2O every <b>6 minutes</b>	<ul style="list-style-type: none"> <li>• PEEP automatically managed</li> <li>• Increasing PEEP support</li> </ul>
Decrease PEEP stepwise: Decreases PEEP by 1 cmH2O every <b>6 minutes</b>	<ul style="list-style-type: none"> <li>• PEEP automatically managed</li> <li>• Decreasing PEEP support</li> </ul>
Decrease PEEP stepwise quickly: <b>Exception:</b> Decreases PEEP by 1 cmH2O quickly every <b>30 seconds</b>	<ul style="list-style-type: none"> <li>• PEEP automatically managed</li> </ul>

<sup>17</sup> These rules still apply when the PEEP and/or Oxygen control setting is manually changed and then control is again set to Automatic. 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 the following important notes.

Table 1-21. Important notes about oxygenation management

For ...	See ...
Quality index 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 Quality index and oxygenation

The following table summarizes INTELLiVENT-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 1-22. SpO2 quality index and automated oxygenation management

Quality indicator	These conditions apply ...
<p>The data from the sensor is unavailable or unreliable for more than 30 seconds</p> <p>Gray, red, or orange bars</p> 	<ul style="list-style-type: none"> <li>The PEEP and Oxygen controls are solid red circles; they are frozen.</li> <li>The Oxygenation adjustment OFF alarm is generated.</li> <li>The ventilator uses the same oxygenation rules as when in ASV mode. For details, see your ventilator <i>Operator's Manual</i>.</li> <li>Automatic emergency increase of oxygen management is <i>inactive</i> (Section 1.8.2).</li> </ul>
<p>The data from the sensor is reliable</p> <p>Green bars</p> 	<ul style="list-style-type: none"> <li>The PEEP and Oxygen controls are blue rotating circles.</li> <li>The Oxygenation adjustment OFF alarm is reset.</li> <li>Automated oxygenation management resumes.</li> <li>Automatic emergency increase of oxygen management is <i>active</i> (Section 1.8.2)</li> </ul>

### 1.8.4.2 Actions that temporarily halt automated oxygenation management

Automated oxygenation management pauses during the following actions:

- Disconnection
- Oxygen enrichment
- Flow sensor calibration
- Leak test
- Suctioning
- Oxygen sensor calibration
- Oxygen supply failure

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 Oxygenation controller is set to **Automatic** and is active, you can set the ventilator to display a message if the **Oxygen** concentration exceeds a specified limit. For details, see Section 1.4.11.5.

If the notification threshold is reached, an alarm is generated and the message **Oxygen control limit exceeded** is displayed.

### 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** is selected, the system uses the patient settings, as well as 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.

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 1-23. Conditions for manual control of %MinVol

When these conditions are met ...	This control must be adjusted MANUALLY by the operator
CO2 monitoring is disabled or CO2 sensor is disconnected	%MinVol is set to <b>Manual</b>

For control to be automated, you must set **%MinVol** to **Automatic** in the INTELLiVENT-ASV Settings > Auto 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 1-24. Conditions for manual control of PEEP and/or Oxygen

When these conditions are met ...	This control must be adjusted MANUALLY by the operator
<p><b>PEEP</b></p> <ul style="list-style-type: none"> <li>• The <b>Chronic Hypercapnia</b> or <b>Brain injury</b> condition is selected</li> <li>• The ventilator is using a low pressure oxygen (LPO) supply</li> <li>• SpO2 monitoring is disabled</li> <li>• SpO2 sensor is disconnected</li> </ul>	<p>PEEP is set to <b>Manual</b></p>
<p><b>Oxygen</b></p> <ul style="list-style-type: none"> <li>• The ventilator is using a low pressure oxygen (LPO) supply</li> <li>• Oxygen monitoring (O2 sensor) is disabled</li> <li>• SpO2 monitoring is disabled</li> <li>• SpO2 sensor is disconnected</li> </ul>	<p>Oxygen is set to <b>Manual</b></p>

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*.

For control to be automated, you must set the **PEEP** and/or **Oxygen** controls to **Automatic** in the **INTELLiVENT-ASV Settings > Auto** 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

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## 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 PaCO<sub>2</sub> against displayed PetCO<sub>2</sub>, and SaO<sub>2</sub> against SpO<sub>2</sub>.

### CAUTION

*Responsibility for final decisions regarding weaning and extubation rests solely with the physician/operator. Additional criteria not provided by the ventilator must be taken into account.*

Quick Wean is integrated into INTELLiVENT-ASV, and when activated, provides continuous dynamic monitoring and control of patient conditions to assess the patient's potential readiness for discontinuing mechanical ventilation.

Together with the clinician and the patient, Quick Wean is part of a complex care cycle that has as its goal a spontaneously breathing patient with good respiratory function.

Discontinuation of mechanical ventilation involves three general steps:

- Measurement and assessment of weaning predictors during a screening phase
- A spontaneous breathing trial (SBT)
- An extubation trial

Quick Wean helps with this first phase.

## 2.2 Quick Wean in clinical use

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

### 2.2.1 Indications for use

#### NOTICE

When the Brain Injury condition is selected in INTELLiVENT-ASV, Quick Wean is unavailable.

A clinical assessment of the patient's readiness for weaning prior to enabling Quick Wean is mandatory!

Once the patient is deemed ready, Quick Wean can be enabled at any time.

### 2.2.2 About the Quick Wean parameters and key terms

Quick Wean monitors a key set of parameters to help you identify patients who may be ready for your facility's weaning protocol and eventual extubation.

The default settings for these parameters are consensus based. However, you can change them to suit your facility's protocols. Once modified, they are generally set once and then used as the defaults. Settings are defined in **Configuration**. Some parameters are calculated and are not user modifiable.

The monitored weaning parameters are:

- Oxygen
- PEEP
- Rate
- $\Delta$ Pinsp
- Vt/IBW
- RSB or PetCO<sub>2</sub> (depending on patient IBW), not configurable

Table 2-1. Quick Wean key terms

Term/Parameter	Description
<i>For parameter details, see Table 2-3.</i>	
fSpont (b/min)	fSpont is the absolute number of spontaneous breaths taken. See <b>Rate</b> .
RSB (1 / (l*min))	Rapid shallow breathing index. The total breathing frequency (fTotal) divided by the exhaled tidal volume (VTE).
%MinVol (%)	When <b>Quick Wean</b> is enabled, as long as the patient is <i>active</i> and the patient's <b>Rate</b> is below the upper limit of the target range (Section 1.7.2), the device gradually reduces %MinVol to 70%, if it is above this level.
Oxygen (%)	Inspired oxygen. The target <b>Oxygen</b> is configurable.
PEEP (cmH <sub>2</sub> O)	Positive end-expiratory pressure. Airway pressure at the end of exhalation. The target <b>PEEP</b> is configurable.
PetCO <sub>2</sub> (mmHg)	End-tidal CO <sub>2</sub> pressure.
$\Delta$ Psupport max (cmH <sub>2</sub> O)	The maximum pressure support allowed. The target <b><math>\Delta</math>Psupport max</b> is configurable.
Quick Wean panel	When <b>Quick Wean</b> is active, view 5 displays the <b>Quick Wean</b> panel showing the monitored weaning parameters and their status. When all parameters are in the weaning zone, the timer is also displayed in this panel.
Rate (b/min)	Respiratory rate, as number of breaths per minute. Shown on the <b>Quick Wean</b> panel as fSpont.  Defines the maximum <b>Rate</b> allowed. The target <b>Rate</b> is configurable.

Term/Parameter	Description
SpO <sub>2</sub> (%)	Measurement of oxygen saturation in the blood.
Timer	When all of the monitored weaning parameters are in the weaning zone, a timer becomes active in the <b>Quick Wean</b> panel. For details, see Section 2.2.4.
Tolerance time (s)	<p>The length of time a parameter value can be out of range without affecting the timer.</p> <p>If any one parameter is out of range for longer than the specified time period (180 s for patients over 40 kg, 60 s for patients <math>\leq</math> 40 kg), the timer is reset to zero and starts over again once all parameters are in the weaning zone.</p>
Vt/IBW (ml/kg)	Tidal volume per kilogram of ideal body weight.

---

### 2.2.3 Quick Wean workflow

Upon enabling Quick Wean, the device does the following:

- Shifts the PetCO<sub>2</sub> range to the right by up to +5 mmHg to support spontaneous breathing.

This shift remains in place as long as Quick Wean is enabled.

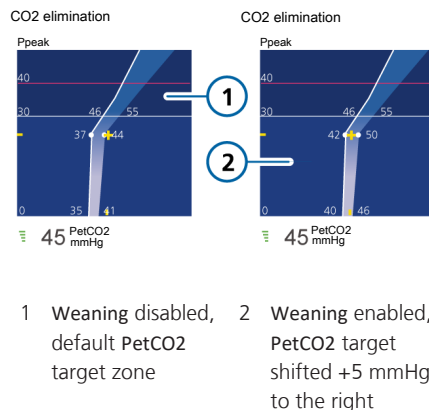
- Increases the spontaneous respiratory rate target range limits.
- As long as the patient is *active* and their *Rate* is below the upper limit of the target range, the device gradually reduces %MinVol to 70% as follows:
  - If %MinVol is already at 70%, the device does nothing.
  - If %MinVol is above 70%, the device decreases %MinVol to 70% in steps of no more than 1% per breath.
- If the patient is *passive*, INTELLiVENT-ASV continues ventilating the patient. When the patient becomes *active*, the ventilator proceeds with the %MinVol reduction process described above.

- Starts screening the readiness-to-wean criteria, and shows the **Quick Wean** panel in view 5 on the main display.

For details about:

- How the Quick Wean panel indicates progress, see Section 2.2.4
- How the device controls minute volume, see Sections 1.7.2 and 1.7.1

Figure 2-1. CO<sub>2</sub> target shift with Weaning



### 2.2.4 Monitoring progress with the Quick Wean panel

When enabled, Quick Wean continuously screens the readiness-to-wean criteria that can help the physician assess whether the patient might be ready for the hospital's SBT and extubation protocols.

The ventilator monitors a set of weaning parameters and their values, and once all parameters are within the weaning ranges, starts a Weaning timer. Once the timer has started, the nonconfigurable **Tolerance time** determines the length of time a weaning parameter can be out of range before causing the timer to reset. For details, see Table 2-2.

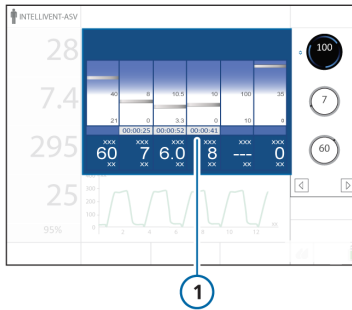
These parameters are displayed in the Quick Wean panel in view 5.

The following table describes how this panel displays the status of the weaning parameters.

Any of the weaning parameters can be out of range for up to the time specified by the **Tolerance time** parameter without affecting the timer progress.

Table 2-2. Vent Status or Quick Wean panel

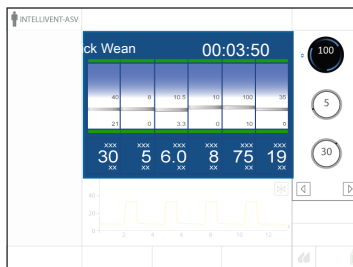
When ...	Vent Status or Quick Wean panel ...
Quick Wean is disabled	INTELLiVENT-ASV displays the Vent Status panel, showing the ventilation parameters. For details, see your ventilator <i>Operator's Manual</i> .
Quick Wean is enabled	INTELLiVENT-ASV displays the Quick Wean panel, showing the monitored weaning parameters (Table 2-3).
One or more parameter values are in the weaning zone	Parameters that are within their target weaning ranges are in their weaning zone. When individual parameters are within their weaning zone, an individual timer is shown indicating the amount of time the parameter has been in the weaning zone (1 below).



All of the parameter values are in the weaning zone

The Quick Wean panel displays:

- A green bar above and below the target zone for each of the parameters.
- A timer (HH:MM:SS) showing how long the patient values have been in the weaning zone.





## 2.3 Configuring Quick Wean parameters

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

You can configure the following control settings: PEEP, Oxygen,  $\Delta P$ support max, and Rate.

The following parameters are set by the ventilator and are nonconfigurable: Tolerance time, Vt/IBW, and RSB.

For parameter ranges and default settings, see Section 2.4. 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.

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

### 2.3.1 Adjusting values in Configuration

The Quick Wean criteria are set in Configuration. You can change the default settings to match your institution's protocol, if needed.

#### To change the Quick Wean criteria

1. Without a patient connected, put the ventilator in Standby.
2. Access the Configuration windows, and on the left side, touch **Setups** > **Adult/Ped x** > **Status** > **Quick Wean**.  
Note that *Adult/Ped x* is any of the three Quick Setups for which you wish to define Quick Wean settings.  
The Quick Wean window displays the user-configurable weaning-related parameters.
3. Make changes as desired to the parameter thresholds.
4. Touch the **Back** button to return to the main Configuration window.
5. When finished, exit Configuration.

### 2.3.2 Restoring factory default settings

#### To reset the Quick Wean criteria to the factory default settings

1. Without a patient connected, put the ventilator in Standby.
2. Access the Configuration windows, and on the left side, touch **Setups** > **Adult/Ped x** > **Status** > **Quick Wean**.  
Note that *Adult/Ped x* is any of the three Quick Setups for which you wish to define Quick Wean settings.
3. Touch the **Use factory settings** button, and when prompted to confirm, touch **Yes**.  
Touch **No** to cancel the reset.
4. Touch the **Back** button to return to the main Configuration window.
5. When finished, exit Configuration.

## 2.4 Quick Wean parameter specifications

Table 2-3. Quick Wean parameters, default settings, and ranges

Parameter	Default values	Where displayed/Where set	Range
%MinVol (%)	Quick Wean enabled: 70	<b>Displayed in:</b> INTELLiVENT-ASV main display in the %MinVol control	--
For the definition of a parameter, see Section 2.2.2.			
fSpont	--	<b>Displayed in:</b> <ul style="list-style-type: none"> <li>Quick Wean panel</li> <li>Monitoring window</li> </ul>	--
Oxygen (%)	≤ 40	<b>Displayed in:</b> <ul style="list-style-type: none"> <li>INTELLiVENT-ASV main display in the Oxygen control</li> <li>Quick Wean panel</li> <li>Monitoring window</li> </ul> <b>Set in:</b> Configuration > Setups > Adult/Ped x > Status > Quick Wean	30 to 50
PEEP (cmH <sub>2</sub> O)	Patient IBW > 40 kg: ≤ 8 Patient IBW ≤ 40 kg: ≤ 6	<b>Displayed in:</b> <ul style="list-style-type: none"> <li>INTELLiVENT-ASV main display in the PEEP control</li> <li>Quick Wean panel</li> <li>Monitoring window</li> </ul> <b>Set in:</b> Configuration > Setups > Adult/Ped x > Status > Quick Wean	5 to 10

Parameter	Default values	Where displayed/Where set	Range
PetCO2 (mmHg)	PetCO2 < (upper limit INTELLiVENT-ASV PetCO2 target range + 3 mmHg)	<p><b>Displayed in:</b></p> <ul style="list-style-type: none"> <li>• Patient IBW <math>\leq</math> 40 kg: Quick Wean panel.</li> <li>• For patients with IBW over 40 kg, RSB is used instead.</li> <li>• CO2 elimination horizon and map</li> <li>• Monitoring &gt; CO2 window</li> <li>• Dynamic Lung panel</li> </ul> <p>PetCO2 is only used for patients with IBW <math>\leq</math> 40 kg. This value is not configured. You can, however, shift the target range, if needed. See Section 1.4.11.2.</p>	Depends on PetCO2 target range
Rate (b/min)	<p>Patient IBW &gt; 30 kg: <math>\leq</math> 35</p> <p>Patient IBW <math>\leq</math> 30 kg: <math>\leq</math> 45</p>	<p><b>Displayed in:</b> Quick Wean panel (as fSpont)</p> <p><b>Set in:</b> Configuration &gt; Setups &gt; Adult/Ped x &gt; Status &gt; Quick Wean</p>	25 to 65
RSB (1 / (l*min))	$\leq$ 105	<p><b>Displayed in:</b> Patient IBW over 40 kg: Quick Wean panel</p> <p>For patients with IBW <math>\leq</math> 40 kg, PetCO2 is used instead.</p> <p>RSB is only used for patients with IBW over 40 kg. This value is not configured.</p>	105

Parameter	Default values	Where displayed/Where set	Range
SpO2 (%)	Within or above the INTELLiVENT-ASV SpO2 target range	<p><b>Displayed in:</b></p> <ul style="list-style-type: none"> <li>• Oxygenation horizon and map</li> <li>• Monitoring &gt; SpO2 window</li> <li>• Dynamic Lung panel</li> <li>• Main display under MMP list</li> </ul> <p>This value is not configured. You can, however, shift the target range, if needed. See Section 1.4.11.2.</p>	Depends on the SpO2 target range
Tolerance time (s)	<p>Patient IBW &gt; 40 kg: 180 s Except for %fSpont, which is 60 s</p> <p>Patient IBW ≤ 40 kg: 60 s Except for Rate and Vt/IBW, which is 180 s</p>	This value is not configured.	--
Vt/IBW (ml/kg)	≥ 5 ml/kg	<p><b>Displayed in:</b></p> <ul style="list-style-type: none"> <li>• Quick Wean panel</li> <li>• Monitoring window</li> </ul> <p><b>Set in:</b> Configuration &gt; Setups &gt; Adult/Ped x &gt; Status &gt; Quick Wean</p>	3 to 6
ΔPsupport max (cmH2O)	≤ 12	<p><b>Displayed in:</b> Quick Wean panel</p> <p><b>Set in:</b> Configuration &gt; Setups &gt; Adult/Ped x &gt; Status &gt; Quick Wean</p>	6 to 25

# 3

## Specifications

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### 3.1 Intended use

#### Intended medical purpose

The INTELLiVENT-ASV software is an option for the ventilator, and is, for all legal purposes, subject to the Intended Use as stated in the current ventilator *Operator's Manuals*.

### 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)	30 to 250 (adult, pediatric)
%MinVol (%)	25 to 350 (manual) 70 to 200 (automatic)
Oxygen (%)	21 to 100 (manual and automatic)
PEEP (cmH2O)	0 to 50 (manual) 5 to 24 (automatic)
Internal calculations	
Ideal body weight, IBW (kg)	Calculation based on patient height and sex. For details, see your ventilator <i>Operator's Manual</i> . INTELLiVENT-ASV can only be used for patients weighing more than 7 kg.
MinVol (target) (l/min)	Target MinVol is calculated as: $IBW \times \text{NormMinVent} \times \% \text{MinVol} / 100$ where NormMinVent (l/kg/min) is the normal minute ventilation (not valid for pediatric patients < 30 kg). For details, see your ventilator <i>Operator's Manual</i> .
ASV target respiratory rate (b/min)	Calculated as described in Section 1.7.2.
VDaw (ml/kg)	Calculation of the dead space: $IBW \times 2.2$
Vt (target)	MinVol/f (target)

Monitoring	
Values (numerical)	PetCO <sub>2</sub> target range, depending on patient condition and treatment (P <sub>peak</sub> ); SpO <sub>2</sub> target range, depending on patient condition and treatment (PEEP)
Current ventilation settings	ExpMinVol, f <sub>Total</sub> , f <sub>Control</sub> , P <sub>peak</sub> ( $\Delta P_{insp} + PEEP$ ), Oxygen, PEEP
Patient status	f <sub>Spont</sub> , PetCO <sub>2</sub> , SpO <sub>2</sub>
Graphics	f (target)/Vt, PetCO <sub>2</sub> /target, PEEP/SpO <sub>2</sub>
Trend parameters	Ventilation control, Oxygenation control

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%

Performance specifications, Oxygenation controller	Oxygen	PEEP
Settling time	The settling time depends on the patient condition relative to the SpO <sub>2</sub> target, as defined by the appropriate approach ( <i>ARDSnet</i> or <i>Open Lung</i> concept) for the current treatment. Note that if SpO <sub>2</sub> enters the emergency zone, the system immediately sets Oxygen to 100%.	6 minutes
Response time (90% of steady state)	N/A, only target range for SpO <sub>2</sub> specified	6 minutes

Performance specifications, Oxygenation controller	Oxygen	PEEP
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	<i>Decrease:</i> 5% of current Oxygen setting every 60 s <i>Increase:</i> 10% of current Oxygen setting every 30 s	1 cmH2O every 6 min

**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 > More window. <i>Default:</i> 21%
Maximum Oxygen	100%
PEEP limits	<i>Low:</i> 5 to 22 (Default: 5) <i>High:</i> 7 to 24 (Default: 15)



### 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's processor.

Table 3-2. Data log inputs

Saved parameters	Unit
ARDS	N/A
Brain injury	N/A
Chronic hypercapnia	N/A
Controller ventilation	N/A
Controller oxygenation	N/A
Controller PEEP	N/A
Date	N/A
Time	N/A
Weaning	N/A
RRIMV	breaths per min
RRtot	breaths per min
RRtarget	breaths per min
fSpont	breaths per min
PEEP limit	cmH2O
%MinVol	%
ExpMinVol	l/min
Ti	s
$\Delta$ P <sub>insp</sub>	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 once 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](http://www.hamilton-medical.com).



**%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, the device gradually reduces MinVol to 70%

**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<sub>2</sub> 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<sub>2</sub> values, usually as a result of obstruction in airways due to chronic bronchitis, emphysema, or both

**CO<sub>2</sub> elimination horizon**

For a passive patient, shows a zoom into the CO<sub>2</sub> elimination map at the current PetCO<sub>2</sub> value and target range. For an active patient, shows the spontaneous breathing rate (fSpont). Displayed during active ventilation in INTELLiVENT-ASV. Also called the Ventilation horizon.

**Dynamic Lung**

Intelligent panel that graphically represents tidal volume, lung compliance, patient triggering, and resistance in real time

**fSpont**

The absolute number of spontaneous breaths taken. %fSpont is the percentage of spontaneous breaths to total breaths taken

**IBW**

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

**Oxygen**

Inspired oxygen

**Oxygenation controller**

Automated PEEP and Oxygen controller, available in INTELLiVENT-ASV

**Oxygenation horizon**

Shows a zoom into the Oxygenation map at the current SpO<sub>2</sub> value and target range. Displayed during active ventilation in INTELLiVENT-ASV

**Oxygenation map**

The PEEP/SpO<sub>2</sub> view shows the current patient SpO<sub>2</sub> value and target range in relation to PEEP, together with the set limits. The FiO<sub>2</sub>/PEEP map shows the patient's current combination of Oxygen/PEEP values.

**PaCO<sub>2</sub>-PetCO<sub>2</sub> gradient**

The difference between the PaCO<sub>2</sub> measured in the blood (using blood gas analysis) and the PetCO<sub>2</sub> measured using a noninvasive CO<sub>2</sub> sensor. Under normal conditions, PaCO<sub>2</sub> is approximately 2-5 mmHg higher than PetCO<sub>2</sub>.

**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.

**PetCO<sub>2</sub>**

Measured end-tidal CO<sub>2</sub> partial pressure.

**Plethysmogram**

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

**Rate**

Respiratory rate, as number of breaths per minute. Defines the maximum rate allowed.

**RSB**

Rapid shallow breathing index. The total breathing frequency (f<sub>Total</sub>) divided by the exhaled tidal volume (VTE). The RSB parameter is only used for patients weighing >40 kg. For patients weighing less, the PetCO<sub>2</sub> parameter is used.

**SpO<sub>2</sub>**

Measurement of oxygen saturation in the blood.

**Tolerance time**

The length of time a parameter value can be out of range without affecting the timer.

**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.

**Vt/IBW**

Tidal volume per kilogram of ideal body weight.

**ΔPsupport max**

The maximum pressure support allowed for an SBT. If this value is exceeded, the SBT is aborted.

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