HELP THEM BREATHE **MORE NATURALLY.**

User's pocket guide for the Puritan Bennett™ 980 ventilator system

Medtronic
Further, Together

This guide is provided as a convenience companion document to the Operator's Manual. It is not intended to replace the Operator's Manual, which should always be available while using the ventilator It is important to familiarize yourself with all information in the Operator's Manual relevant to your institution's use of the ventilator, including on-screen help, instructions, warnings, and cautions.

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Dear valued Puritan Bennett™ 980 ventilator user,

We hope you are enjoying your Puritan Bennett 980 ventilator. This pocket guide provides an overview of the ventilator, acting as a supplement to the operator's manual, and was designed to help guide you through the typical, everyday process of setting up and using the ventilator. We want you to get the most out of your ventilator, so in this guide you will find descriptions of our advanced modes, safety features, and data capture capabilities, among other useful tips.

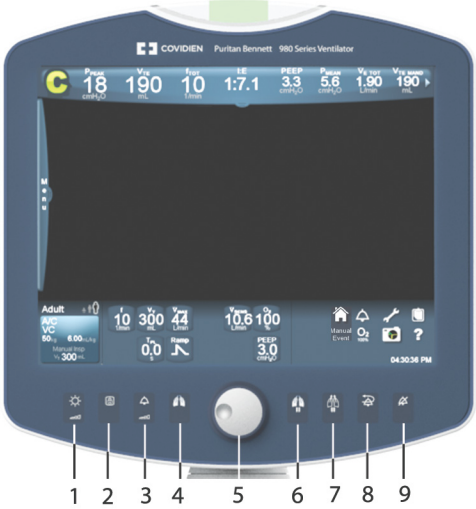
The ventilator should be operated and serviced only by professionals trained specifically on the Puritan Bennett™ 980 ventilator. It is important to familiarize yourself with all information in the operator's manual relevant to your institution's use of the ventilator, including on-screen helps, instructions, warnings, and cautions.

This pocket guide is intended to supplement, not replace, the operator's manual, which should always be available while using the ventilator. Should you encounter any questions or concerns not covered in this guide or the operator's manual, contact Medtronic Technical Services at 800-255-6774 or your local Medtronic representative, per the list at the end of this guide.

1.0 VENTILATOR TOUR

The Puritan Bennett™ 980 ventilator system is designed for use on patient population sizes from pediatric through adult, with a minimum of 0.3 kg. The customizable touchscreen interface provides improved navigation, information visibility, and ventilation management.

1.1 Graphic User Interface (GUI) Touchscreen



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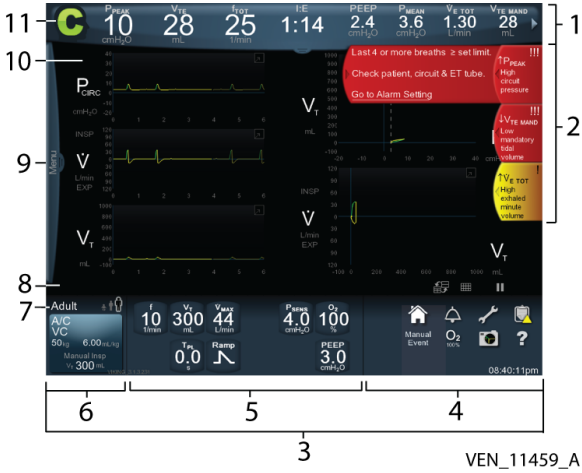
1. Display brightness key
2. Display lock key
3. Alarm volume key
4. Manual inspiration key
5. Rotary encoder (knob)
6. Inspiratory pause key
7. Expiratory pause key
8. Alarm reset key
9. Audio paused key

1.2 Control Keys

Key symbol	Description
	**Display brightness key** — Adjusts screen brightness. Press the key and turn the knob to adjust touchscreen brightness.
	**Display lock key** — Prevents inadvertent setting changes to the ventilator (including the knob function). Useful when cleaning the touchscreen. Press again to unlock. Also use the display lock key to reset the GUI touch screen.
	**Alarm volume key** — Adjusts the alarm volume. The alarm volume cannot be turned OFF.
	**Manual inspiration key** — Use to deliver mandatory breaths to the patient or to run an inspiratory pause maneuver in SPONT mode. In A/C, SIMV, and SPONT modes, delivers one manual breath to the patient based on current mandatory breath parameters. In BiLevel software mode, transitions from low pressure (P_L) to high pressure (P_H), or vice versa.
	**Inspiratory pause key** — Initiates an inspiratory pause that closes the inspiratory and exhalation valves and extends the inspiratory phase of a mandatory breath while measuring end inspiratory pressure ($P_{I\,END}$) for calculation of plateau pressure (P_{PL}), static compliance (C_{STAT}), and static resistance (R_{STAT}).
	**Expiratory pause key** — Initiates an expiratory pause that extends the expiratory phase of the current breath in order to measure total PEEP ($PEEP_{TOT}$).
	**Alarm reset key** — Clears active alarms or resets high-priority alarms and cancels an active audio pause. An alarm reset is recorded in the alarm log if there is an active alarm. DEVICE ALERT alarms cannot be reset.
	**Audio paused key** — Pauses alarms for 2 minutes. Touch **Cancel** to halt the audio paused.

1.3 Areas of the Touchscreen



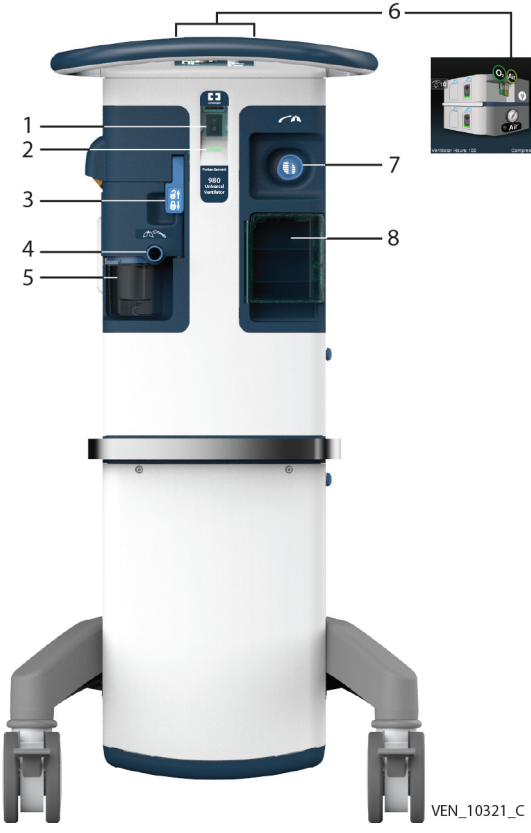
1. Vital patient data banner
2. Alarm banners
3. Constant access area
4. Constant access icons
5. Current settings area
6. Vent Setup button
7. Patient type indicator
8. Prompt area
9. Menu tab
10. Waveform area
11. Breath phase indicator

1.4 Visual Indicators

Symbol	Description
!	**Low-priority alarm icon** — Appears on alarm banner.
!!	**Medium-priority alarm icon** — Appears on alarm banner.
!!!	**High-priority alarm icon** — Appears on alarm banner.
	**Maximize waveform icon** — Enlarge the waveform to its maximum size with a touch.
	**Restore waveform icon** — Restore the waveform to its original size with a touch.
	**Waveform layout icon** — View up to five waveforms simultaneously. Open the waveform layout dialog with a touch.
	**Gridlines icon** — Turn waveform gridlines on or off with a touch.
	**Vent setup button** — Open the ventilator setup screen with a touch.
	**Home icon** — Touch to dismiss all open dialogs. The display resumes showing the ventilator waveforms.

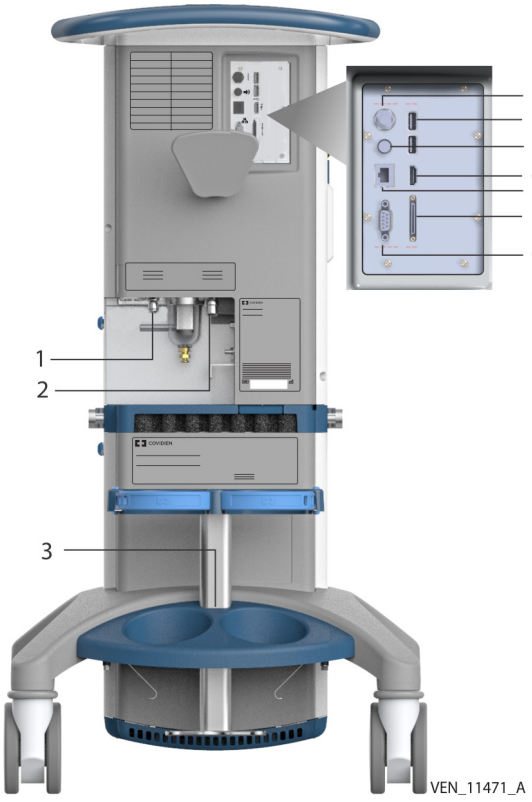
Symbol	Description
	**Alarms icon** — Touch to display alarm settings.
	**Configure icon** — Touch this icon to display the configure screen. Tabs with SST results, options, communication setup, and date/time change are displayed.
	**Logs icon** — Touch to display the logs screen, which contains tabs for Alarms, Settings, Patient Data, Diagnostics, EST/SST status, General Event, and Service logs.
	**Unread items icon** — Overlaid on icons or tabs to indicate unread items at this location.
	**Elevate O_2 control** — Touch to increase the set oxygen concentration to any value between the set value and 100% for 2 minutes.
	**Screen capture icon** — Touch to capture the image displayed on the screen.
	**Help icon** — Drag to the item in question and release. A tooltip will appear describing the item's function.
	**Pause icon** — Touch to pause the waveform graph.

1.5 Breath Delivery Unit (BDU) Front View



1. Power switch
2. AC power indicator
3. Expiratory filter latch
4. Expiratory filter
5. Condensate vial
6. Status display
7. Internal inspiratory filter
8. Option connector panel door

1.6 Breath Delivery Unit (BDU) Rear View



1. Oxygen inlet
2. Air inlet
3. Cylinder mount

a. Service mode switch
b. USB port (2x)
c. Remote alarm port

d. HDMI port
e. Ethernet connector
f. Service port
g. RS-232 serial port

2.0 POWER SOURCES

Batteries charge whenever the ventilator is connected to AC power, whether the ventilator is operating or not. The ventilator's primary battery will fully charge in approximately 6 hours at room temperature. A fully charged battery will provide up to 1 hour of battery power, depending on settings. The ventilator charges its primary battery first, then its extended battery. An optional extended battery is available.

When the ventilator is operating on battery power, the ventilator status display indicates the estimated charge level of the installed batteries. Battery life is approximately 3 years. Actual battery life depends on the history of use and ambient conditions.

3.0 COMMON TASKS

WARNING:*
The ventilator system is not intended to be a comprehensive monitoring device and does not activate alarms for all types of conditions. For a detailed understanding of ventilator operations, be sure to thoroughly read the operators manual before attempting to use the ventilator system.

WARNING:*
Patients on mechanical ventilation should be monitored by clinicians for proper patient ventilation.

WARNING:*
Do not pause, disable, or decrease the volume of the ventilator's audible alarm if patient safety could be compromised.

Warning:*
In case of ventilator failure, the lack of immediate access to appropriate alternative means of ventilation can result in patient death. An alternative source of ventilation, such as a self-inflating, manually powered resuscitator (as specified in ISO 10651-4 with mask) should always be available when using the ventilator.

Warning:*
Before activating any part of the ventilator, be sure to check the equipment for proper operation and, if appropriate, run SST as described in this guide.

The easy-viewing touchscreen rotates in either direction and also allows for a tilt of up to 45º from vertical for easy viewing.

*The warnings included in this guide are a partial list. See Operator manual for full list.

3.1 Initial Setup

Select **New Patient** on the GUI screen, select either **Quick START** (3.1.1) or begin with the standard new patient setup (3.1.2).

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3.1.1 Quick Start Setup

Quick Start allows for rapid setup and initiation of mechanical ventilation. Ensure Quick Start parameters are consistent with institutional practice before using this feature.

1. Touch **New Patient**.
2. Touch the highlighted **PBW** or **Gender/Height**.
3. Turn the knob to adjust.
4. Touch **Quick START** (If the default settings are appropriate).
5. Connect the circuit to the patient's airway to begin ventilation.

3.1.2 Standard New Patient Setup

1. Touch **New Patient**. The New Patient settings screen allows entry of ventilation control parameters.
2. Enter the patient's predicted body weight (PBW) or gender and height. Review and change all settings as needed.
3. Touch the parameter and turn the knob to adjust the setting. Continue for all parameters needing adjustment.
4. Touch **START** to confirm change(s).
5. Connect circuit to patient's airway to begin ventilation.

3.2 Ventilation After Temporary Interrupt in Ventilation

Ventilation of a patient who has been disconnected but whose settings were already configured is easy.

1. Touch **Same Patient**. Previous ventilator settings appear for review prior to applying to the patient.
2. If settings are acceptable, touch **START**. Otherwise, make necessary changes and touch **Accept**.
3. Connect circuit to patient's airway to initiate ventilation.

3.3 Return to Previous Patient Settings

1. Touch **Previous Setup**.
2. If the settings are acceptable, touch **Accept** or **Accept ALL**.

4.0 MODES AND BREATH TYPES

Warning:
The ventilator offers a variety of breath delivery options. Throughout the patient's treatment, the clinician should carefully select the ventilation mode and settings to use for that patient based on clinical judgment, the condition and needs of the patient, and the benefits, limitations, and characteristics of the breath delivery options. As the patient's condition changes over time, the clinician should periodically assess the chosen modes and settings to determine whether those are best for the patient's current needs.

The Puritan Bennett™ 980 ventilator provides mandatory, spontaneous, and two forms of mixed mode ventilation.

A/C, SIMV, SPONT, BiLevel, and CPAP						
Mandatory Breath Types			Spontaneous Breath Types			
PC	VC	VC+	PS	TC	VS	PAV™+

4.1 Ventilation Settings Adjustment

1. Touch **Vent Setup** button. 
2. Touch, then turn the knob to adjust each parameter needing adjustment.
3. Touch **Accept** or **Accept ALL**.

4.2 Mandatory Ventilation: A/C Mode

Assist/control (A/C) mode requires the practitioner to choose patient breath delivery settings. All breaths are mandatory and can be pressure-controlled (PC), volume-controlled (VC), or VC+. Mandatory breath triggering methods can be $P\text{-}_{TRIG}$, $\dot{V}\text{-}_{TRIG}$, time triggered, or operator initiated.

4.2.1 Volume Control (VC)

Volume control breaths are based on a target tidal volume and flow rate. In response to changes in compliance and resistance, the peak pressure can fluctuate to ensure the target tidal volume is delivered.

4.2.2 Pressure Control (PC)

Pressure control breath delivery is based on achieving and sustaining a pressure target at a set rate.

4.2.3 Volume Control Plus (VC+)

Volume control plus breath type provides a mandatory, pressure-controlled breath that does not restrict flow during the inspiratory phase, and automatically adjusts the inspiratory pressure target from breath to breath to achieve the desired tidal volume, despite changing lung conditions.

4.3 Spontaneous Ventilation: SPONT Mode

SPONT mode breath types include pressure support (PS), volume support (VS), tube compensation (TC), and Proportional Assist™* Ventilation Plus software (PAV™*+ software).

4.3.1 Volume Support (VS)

The clinician sets both PEEP and target tidal volume. The set tidal volume is delivered to the patient with varying levels of pressure support to deliver the target tidal volume. If the delivered volume for a breath is above or below the set target volume, VS adjusts the target pressure for the next breath up or down, as necessary, to deliver more or less volume. The breath cycles off when delivered flow declines to a user-set percentage of peak inspiratory flow (E_{SENS}).

4.3.2 Pressure Support (PS)

PS requires that the user set the PEEP and PS levels and allows the patient to control the inhaled tidal volume. The breath cycles off when delivered flow declines to a user-set percentage of peak inspiratory flow (E_{SENS}).

4.3.3 Tube Compensation (TC)

Automatic tube compensation reduces the work of breathing associated with an endotracheal tube and helps in optimizing work of breathing.[1]

The ventilator provides programmable (% Support), inspiratory pressure assistance during otherwise unsupported spontaneous breaths. This assists the patient in overcoming the flow resistance of the artificial airway. The % support setting determines how much assistance is provided.[2]

To enable and setup TC:

1. Touch the **Vent Setup** button.
2. Touch **SPONT** for the mode selection and **TC** for spontaneous type.
3. Finish setting up the ventilator with appropriate patient settings as described above.
4. Select the tube type (either endotracheal or tracheostomy) and set the proper tube inner diameter (ID).
5. After making the changes, touch **Accept ALL** to apply the new settings.

4.3.4 PAV™*+ Software

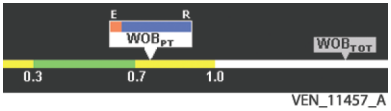
The PAV™*+ software breath type enables the patient to help dictate the breath he or she receives, and helps clinicians more clearly understand the work required by the patient to complete each breath.[2,3]

The PAV™*+ software breath type is indicated for use in spontaneously breathing adult patients whose ventilator PBW setting is at least 25.0 kg (55 lb). Patients must be

intubated with either endotracheal (ET) or tracheostomy (trach) tubes of ID 6.0 mm to 10.0 mm. Patients must have satisfactory neural-ventilatory coupling, and stable, sustainable inspiratory drive.

The clinician sets a desired percent support, and then uses the provided **Work of Breathing (WOB)** bar for real-time feedback on the appropriateness of the support provided, including:

- Estimates of WOB relative to normal, subnormal, and above-normal values
- An indicator showing the proportion of patient inspiratory work relative to the total work of breathing



This enables clinicians to keep the patient at a sustainable level of work — reducing the risk for respiratory muscle atrophy, but potentially off-loading enough work to avoid fatigue.[2,4,5]

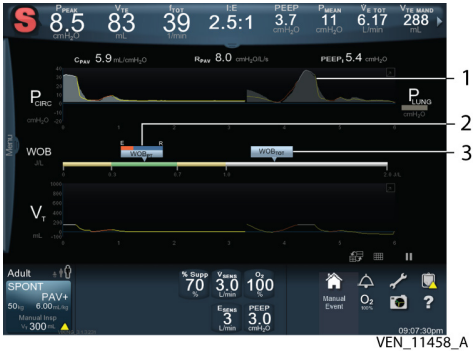
With the PAV™*+ software breath type, the patient and the ventilator share in the work of breathing. The percent WOB_{TOT} performed by the ventilator equals the % Supp setting and the percent WOB_{TOT} performed by the patient (100 minus the % Supp setting). WOB_{TOT} is the sum of the work to move the breathing gas through the artificial airway and the patient's own airways plus the work to inflate the patient's elastic lung-thorax. The WOB_{PT} is the portion of the total work performed by the patient.

With PAV™*+ software selected, Leak Sync software is disabled. The ventilator uses soft- and hard-bound values for estimated tube ID based on PBW.

Warning:
Ensure that the correct artificial airway ID size is entered. Because PAV™+ software amplifies flow, entering a smaller-than-actual airway ID causes the flow-based pressure assistance to oversupport the patient. Conversely, entering a larger-than-actual ID results in undersupport. Do not use noninvasive patient interfaces such as masks, nasal prongs, uncuffed ET tubes, etc., as leaks associated with these interfaces may result in overassist and patient discomfort.

To set up the PAV™+ software breath type:

1. Touch **Vent Setup** button. Enter patient's PBW or gender and height.
2. Touch **Invasive** vent type.
3. Touch **SPONT** mode.
4. Touch **PAV+** to select spontaneous type.
5. Touch the desired trigger type (**P-TRIG** or $\dot{V}$**-TRIG**).
6. Select tube type and ID; initially, a default value is shown based on the PBW entered at ventilator startup. If this ID is not correct for the airway in use, turn the knob to adjust the ID setting.



1. Shadow trace (trace of the estimated lung pressure)
2. Patient's work of breathing (WOB_{PT})
3. Total work of breathing (WOB_{TOT})

4.4 Mixed Mode Ventilation: SIMV and BiLevel Software

Mixed modes allow both mandatory and spontaneous breaths. The breath cycle interval for both mandatory ventilation (SIMV) and BiLevel software modes is 60/f where f is the respiratory rate set by the clinician.

4.4.1 SIMV

SIMV allows a combination of mandatory and spontaneous interactions. Mandatory breath delivery is determined by the ***f*** setting. The mandatory breaths can be PC, VC, or VC+, and the spontaneous breaths are pressure-assisted with either PS or TC. SIMV guarantees one mandatory breath per SIMV breath period.

4.4.2 BiLevel Software

BiLevel software is a mixed mode that overlays the patient's spontaneous breaths onto the breath structure for PC mandatory breaths. Two levels of pressure, P_L and P_H, are employed. Patients may initiate spontaneous breaths at either pressure level. Mandatory breaths are always PC, and spontaneous breaths can be PS or TC. P_H must always be at least 5 cmH_2O greater than P_L.

5.0 NONINVASIVE (NIV) AND LEAK SYNC SOFTWARE

Warning:
With NIV in use, the patient's exhaled tidal volume (V_{TE}) could differ from the ventilator's monitored patient data value for V_{TE} due to leaks around the interface. To avoid this, ensure Leak Sync software is enabled.

NIV is intended for use for all patients possessing adequate neural-ventilatory coupling and stable, sustainable respiratory drive. Noninvasive (NIV) ventilation helps patients avoid the trauma of extended endotracheal tube placement.[6] By effectively managing air leaks, the Puritan Bennett™ Leak Sync software can help clinicians provide the right ventilation even when faced with rapidly changing patient conditions.

To set up a new patient:

1. Turn the ventilator on.
2. Select **New Patient**.
3. Enter patient's PBW or gender and height.
4. Touch NIV ventilation type.
5. Select mode.
6. Select mandatory type.
7. Complete settings, including apnea and alarm settings.

To set up a patient currently being ventilated:

1. Access the **Setup** screen.
2. Refer to the new NIV patient setup to perform steps 4 through 7.
3. Review the settings, including apnea and alarm settings, changing as necessary.

5.1 Approved NIV Breathing Interfaces

Warning:
Use only non-vented patient interfaces with NIV. Leaks associated with vented interfaces could result in the ventilator's inability to compensate for those leaks, even if Leak Sync software is employed.

- **Full face mask** — ResMed Ultra Mirage™* NV non-vented full face mask (medium)
- **Nasal mask** — ResMed Ultra Mirage™* NV non-vented nasal mask (medium)

5.2 Conversions for INVASIVE and NIV Vent Types

Warning:
For proper ventilation when changing the Vent Type on the same patient, review the automatic settings, including D_{SENS}, when transitioning between these INVASIVE and NIV types.

Some ventilator settings available during INVASIVE ventilation are not available when transitioning from INVASIVE to NIV. Refer to the Operator's Manual for automatic settings changes when changing from NIV to INVASIVE.

Current INVASIVE setting	New NIV setting
Breath mode: BiLevel	**Breath mode:** A/C
Breath mode: SIMV or SPONT	High $T_{I\,SPONT}$ ($\uparrow T_{I\,SPONT}$) limit setting available
Mandatory type: VC+	**Mandatory type:** Adult/Pediatric: VC
Spontaneous type: Any type except PS	**Spontaneous type:** PS
Trigger type: Pressure	**Trigger type:** Flow; (flow triggering is the only allowable trigger type during NIV)
Alarm settings: $\downarrow P_{PEAK}$ (if applicable), $\downarrow \dot{V}_{E\,TOT}$, $\downarrow V_{TE\,MAND}$, $\downarrow V_{TE\,SPONT}$, INSPIRATION TOO LONG (not user settable)	**Alarm settings:** $\downarrow P_{PEAK}$, $\downarrow \dot{V}_{E\,TOT}$, $\downarrow V_{TE\,MAND}$, $\downarrow V_{TE\,SPONT}$ and $\uparrow T_{I\,SPONT}$ default to NIV new patient values

5.3 Leak Sync Software

Leaks due to mask or interface movement are common during mechanical ventilation.[7] Breathing circuit leaks can cause the ventilator to mistakenly detect patient inspiratory efforts (auto-triggering) or delay transition to exhalation in pressure support.[1,8] This can lead to patient-ventilator asynchrony, inappropriate flow, and volume delivery, and an increased work of breathing for the patient.[8,9] The Puritan Bennett™ Leak Sync software helps ensure patients receive the flow and volume set by the clinician, regardless of movement or condition changes.

The Leak Sync software option enables the ventilator to compensate for leaks in the breathing circuit while accurately detecting the patient's effort to trigger and cycle a breath. Because the Leak Sync software allows the ventilator to differentiate between flow due to leaks and flow due to patient respiratory effort, it provides dynamic compensation and enhances patient-ventilator synchrony.

The following table lists maximum leak rates at set PEEP pressure for which the Leak Sync software can compensate based on patient type.

Patient type	Maximum leak compensation flow
Pediatric	40 L/min (30 L/min if compressor is the air source)
Adult	65 L/min (30 L/min if compressor is the air source)

To enable Leak Sync Software:

1. At the ventilator setup screen, touch the **More Settings** tab.
2. Touch **Enabled** in the Leak Sync area.
3. Touch **Accept ALL** to enable Leak Sync software.

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Note:
Leak Sync software can be used with both NIV and Invasive ventilation. The default for Leak Sync software is **Disabled** when the circuit type is pediatric or adult and the vent type is Invasive. Otherwise, the default value for Leak Sync software is **Enabled**. When Leak Sync software is disabled, D_{SENS}, which activates the Circuit Disconnect alarm, is set as a percent volume lost. When Leak Sync software is enabled, the D_{SENS} setting is in L/min and the Circuit Disconnect alarm becomes active when the leak rate at set PEEP reaches that level. Leak Sync software is not allowed for tube compensated (TC) and Proportional Assist™* (PAV™*+ software) ventilation breath types.

6.0 APNEA AND ALARM SETTINGS

Warning:
Do not audio pause, disable, or decrease the volume of the ventilator's audible alarm if patient safety could be compromised.

6.1 Apnea Settings

Warning:
Monitor the patient closely if alarms are disabled: there are no audible or visual annunciations for out-of-range conditions when volume, pressure, or apnea alarms are OFF.

Apnea ventilation is intended as an auxiliary mode of ventilation when there is insufficient breath delivery to the patient over a specified period of time. When apnea is detected by the ventilator, the ventilator alarms and delivers apnea ventilation according to the current apnea ventilation settings. Clinicians may set any apnea parameters not rendered unavailable.

To set apnea parameters:

1. Touch the **Apnea** tab on the left side of the Setup area.
1. Enter the desired apnea settings in the same manner as ventilator settings.
2. Set Apnea parameters or verify defaults are appropriate for the patient.
3. Touch **Accept** or **Accept ALL** to confirm apnea settings.

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6.2 Alarm Settings

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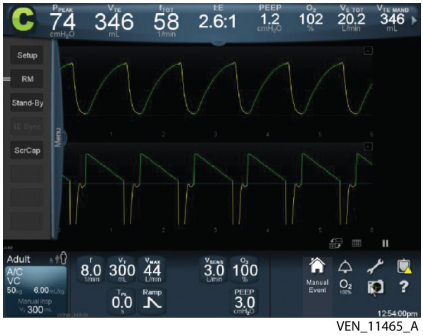
1. Touch each alarm setting slider of the alarm(s) to change. Available alarm settings are P_{PEAK}, f_{TOT}, $\dot{V}_{E\,TOT}$, $V_{TE\,MAND}$, $V_{TE\,SPONT}$, and V_{TI}.
2. Turn the knob to increase or decrease the value.
3. Continue until all desired alarms are set.
4. Touch **Accept ALL** to confirm the alarm settings.

7.0 RESPIRATORY MECHANICS MANEUVERS

The Respiratory Mechanics feature provides respiratory maneuvers, including negative inspiratory force (NIF), occlusion pressure ($P_{0.1}$), and vital capacity (VC). It also provides automatic calculations of lung function and performance, such as dynamic compliance (C_{DYN}) and resistance (R_{DYN}), peak expiratory flow (PEF), end expiratory flow (EEF), and peak spontaneous flow (PSF). This information allows clinicians to assess lung health and performance, and helps determine if the patient is ready to be weaned from the ventilator.



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To access Respiratory Mechanics maneuvers:

1. Touch or swipe the **Menu** tab from the touchscreen left-hand side.
2. Touch **RM**.
3. Touch the particular tab for the desired maneuver.
4. Follow the prompts.
5. Accept or reject the maneuver results. If the result is accepted, its value is saved.

7.1 Inspiratory Pause Maneuvers

An inspiratory pause maneuver closes the inspiration and exhalation valves and extends the inspiratory phase of a single, mandatory breath for the purpose of measuring end inspiratory circuit pressure in order to calculate inspiratory plateau pressure (P_{PL}), lung static compliance (C_{STAT}), and static resistance (R_{STAT}) of the respiratory system. Pressures on either side of the artificial airway are allowed to equilibrate, determining no-flow state pressure.

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7.2 Expiratory Pause Maneuvers

An expiratory pause extends the expiratory phase of the current breath to measure end expiratory lung pressure ($PEEP_{TOT}$) or total PEEP. It has no effect on the inspiratory phase, and only allows one expiratory pause per breath.

7.3 Negative Inspiratory Force (NIF) Maneuver

The NIF maneuver is a coached maneuver where the clinician prompts the patient to draw a maximum inspiration against an occluded airway (both inspiratory and exhalation valves are fully closed). When an NIF maneuver is activated, a single pressure-time waveform is displayed and the calculated NIF result appears. The NIF value displayed represents the maximum negative pressure from PEEP.

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7.4 Occlusion Pressure Maneuver ($P_{0.1}$)

$P_{0.1}$ is the negative airway pressure generated during the first 100 ms of an occluded inspiration. It is an estimate of the neuromuscular drive to breathe. The calculated airway pressure is displayed on the waveforms screen after successful completion of the maneuver. If 7 seconds elapse with no trigger detected, the ventilator cancels the maneuver.

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7.5 Vital Capacity Maneuver (VC)

A VC maneuver is a coached maneuver where the clinician prompts the patient to draw a maximum inspiration (regardless of the current settings) and then slowly and fully exhale. With an active VC maneuver, the ventilator delivers a spontaneous inspiration in response to patient effort and then allows for a full exhalation effort. It displays the calculated expiratory volume when the maneuver ends successfully and a PEEP restoration breath is delivered.

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8.0 MONITORED PATIENT DATA

Warning:

When NIV is in use, the patient's exhaled tidal volume (V_{TE}) could differ from the ventilator's monitored patient data value for V_{TE} due to leaks around the interface. To avoid this, ensure Leak Sync software is enabled.

There are over 30 monitored data values available and more if options are installed. Monitored patient data appear in the Patient Data banner above the waveforms area. Where applicable, this also includes factory defaults.

Note:

Blinking patient data values indicate the displayed value is greater than or less than either of its absolute limits and has been clipped to its limit. Data values in parentheses have questionable accuracy. Dashes (--) indicate the patient data value is not applicable based on mode/breath type combinations. If there is no value, the ventilator is in a state where values cannot be measured.

Note:

All displayed patient volume data represent lung volumes expressed under BTPS conditions.

8.1 Waveforms and Loops

Waveforms and loops are scalable on both the x- and y-axes. Colors denote breath information. Green denotes a mandatory inspiration, yellow denotes exhalation, and orange denotes spontaneous breaths.

Configure the touchscreen to display up to three waveforms and two loops simultaneously. Allowable waveforms include flow vs. time, pressure vs. time, and volume vs. time. Allowable loops include pressure vs. volume or flow vs. volume. Both display 60 seconds of information. View via the redrawing format or trace in a freeze frame by turning the knob.

To pause waveforms and loops:

1. Touch the pause icon, located below the waveforms area. The icon glows yellow and allows the breath to complete. A cursor appears and travels along the waveform while turning the knob, displaying the x- and y-axis values.
2. Press pause again to reactivate the waveform.

Screen capture and download

Note:
A dim screen capture icon indicates the screen capture function is currently processing images and prevents further capture until it completes processing current data.

1. Touch the screen capture (or camera) icon. Repeat this step for up to 10 images. This occurs via first-in, first-out, so any overflow overwrites the oldest images first.
2. Swipe the **Menu** tab on the touchscreen left-hand side.
3. Touch **ScrCap**. A list of screen captures appears, identified by time and date.
4. Insert a USB storage device into either USB port at the rear of the ventilator.
5. Select the destination USB storage device listed on the touchscreen.
6. Select the desired images from the screen capture list, or touch **Select All**.
7. Touch **Copy**.

8.2 Touchscreen Brightness

To adjust touchscreen brightness:

1. Press the display brightness key.
2. Slide the brightness slider to increase or decrease the brightness level. Alternatively, turn the knob.

8.3 Display Lock

Activation of the display lock prevents inadvertent changes

to settings. When active, it disables the touchscreen, knob, and off-screen keys. A transparent image of the display lock icon appears in the background of the touchscreen and remains until unlocked or until an alarm condition disables the display lock and normal use resumes. The display lock resets the touchscreen to restore proper functionality on the rare occasion the touch screen becomes unresponsive.

To activate display lock:

1. Press the display lock key.
2. Press again to release the lock.

To reset the touch screen:

1. Press display lock key. The locked padlock icon appears and the display lock key illuminates.
2. Press the display lock key again. A progress bar below the locked padlock icon appears and the display lock key illuminates.
3. A successful GUI touch screen reset has occurred when the locked icon unlocks.

8.4 Data Storage and Retrieval

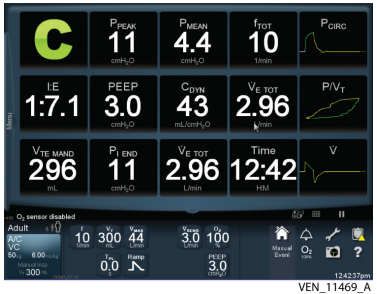
Ventilator data is stored in logs, accessible using the logs (clipboard) icon or in Service mode. Reference the icons section for details.

8.5 Large-Font Patient Data Display

To improve visibility of patient data, use a screen with a larger font. This displays up to 14 data values, including waveforms and loops. These values can be institutionally configured or selected at the time of use.

To display the large-font patient data panel:

1. Touch or swipe the tab on the patient data banner downward; this provides additional patient data.
2. Touch or swipe the tab on the additional patient data banner downward; patient data will appear in a larger font. The parameters can be changed the same way they are changed in the vital patient data banner.
3. Touch or swipe the large-font patient data panel tab upward to return the banner to its normal font size.



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9.0 ALARMS

Warning:

- Do not pause, disable, or decrease the volume of the ventilator's audible alarm if patient safety could be compromised.
- Monitor the patient closely if alarms are disabled. There are no audible or visual annunciations for out-of-range conditions when volume, pressure, or apnea alarms are OFF.
- Setting any alarm limits to OFF or extreme high or low values, can cause the associated alarm not to activate during ventilation, which reduces its efficacy for monitoring the patient and alerting the clinician to situations that may require intervention.

- When vent type is NIV, and D_{SENS} setting is turned OFF, the system may not detect large leaks and some disconnect conditions it would declare as alarms during INVASIVE ventilation.
- The audio alarm volume level is adjustable. Set the volume to a level that distinguishes audio alarms from background noise.
- Disabling the low exhaled minute volume $\downarrow\dot{V}_{E\,TOT}$ alarm increases the patient's risk of hypercarbia or hypoxemia.

9.1 Audible Alarm Types

Audible alarms vary and escalate, depending on urgency.

- **High-priority alarm** — A sequence of five tones sounds, repeats, pauses, then repeats again.
- **Medium-priority alarm** — A repeating sequence of three tones sound.
- **Low-priority alarm** — A single tone sounds.

To change the audible alarm volume, press the alarm volume key, then adjust the alarm volume value.

Press the audio paused key to temporarily pause the alarm. Audio pause lasts for 2 minutes, but can be cancelled.

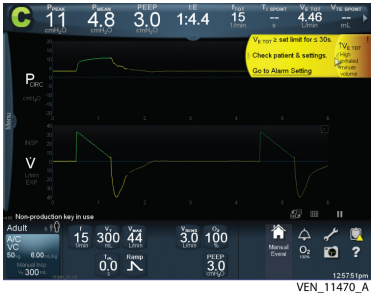
9.2 Visual Alarm Types

Visual alarm indicators vary in type, color, and frequency.

- **High-priority alarm** — A flashing red LED indicator, a red alarm banner, and a red bar next to the alarm setting icon.
- **Medium-priority alarm** — A flashing yellow LED indicator, a yellow alarm banner, and a yellow bar next to the alarm setting icon.
- **Low-priority alarm** — A steady yellow LED indicator, a yellow alarm banner, and a yellow bar next to the alarm setting icon.
- **Normal state** — A steady green LED indicator, no alarm banner, and white values next to the alarm setting icon.

9.3 Active Alarm Banners

Pop-up banners appear on the right side of the touchscreen when an alarm is active. The banners appear in a color corresponding to priority. To open a more detailed banner, touch or swipe the banner, tend to the patient, and make adjustments as needed.



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9.4 Alarm Examples

Location	Visual alarm	Description
Status display		High-priority alarm: Safety Valve Open
Alarm banner		High-priority alarm: Circuit Disconnect. Ventilator displays length of time patient has been without ventilatory support.
Alarm log		High-priority alarm: Patient-related condition.

10.0 FINE TUNE SETTINGS

10.1 Rise Time %

The rise time % setting adjusts the speed at which inspiratory pressure reaches 95% of target pressure. Rise time settings apply to PS (including 0 cmH_2O), BiLevel software, VS, PC, and VC+ breaths. The higher the value of rise time %, the more aggressive and rapid the rise of inspiratory pressure is to the target. The range of rise time is 1% to 100%. A setting of 50% takes approximately half the time to reach 95% of the target pressure as a setting of 1.

10.2 Expiratory Sensitivity (E_{SENS})

The E_{SENS} setting defines the percentage of the measured peak inspiratory flow at which the ventilator cycles from inspiration to exhalation in all spontaneous breath types. When inspiratory flow falls to the level defined by E_{SENS}, exhalation begins. E_{SENS} is a primary setting accessible from the touchscreen.

E_{SENS} complements rise time %. Rise time % should be adjusted first to match the patient's inspiratory drive, then the E_{SENS} setting should cause ventilator exhalation at a point most appropriate for the patient. The higher the E_{SENS} setting, the shorter the inspiratory time. E_{SENS} in a PAV™*+ sofware breath is expressed in L/min instead of percent.

10.3 Disconnect Sensitivity (D_{SENS})

When Leak Sync software is not enabled, disconnect sensitivity (D_{SENS}) is the percentage of returned volume lost due to a leak, above which the ventilator declares a Circuit Disconnect alarm and ceases breath delivery. When D_{SENS} is set to its lowest value (20%), it has the highest sensitivity for detecting leaks or disconnects. Conversely, when set to its highest value (95%), the ventilator is least sensitive, since greater than 95% of the returned volume must be lost before the alarm sounds.

When Leak Sync software is enabled, the D_{SENS} setting is in L/min. The leak compensation flow is limited to that level and the Circuit Disconnect alarm becomes active when the leak rate at set PEEP reaches that level. When D_{SENS} is set to its lowest

value (1 L/min for all patient types), it has the highest sensitivity for detecting leaks or disconnects. Conversely, when set to its highest value (40 L/min and 65 L/min for Pediatric, and Adult patient types respectively), the ventilator is least sensitive, since greater than that level of leak must exist before the alarm sounds and breath delivery ceases.

Note:
When Leak Sync is enabled or disabled, the D_{SENS} setting changes to the default setting in L/min (enabled) or % (disabled).

11.0 SAFETY

11.1 New Ventilator Safety Features

The Puritan Bennett™ 980 ventilator features a host of safety features for your patients.

- **Ventilation assurance** — This safety net feature allows ventilation to continue by bypassing suspect components long enough to replace the ventilator.
- **Stand-by** — This feature allows for the temporary disconnection of a patient. It requires the clinician to confirm the disconnect is intentional. Patient settings are saved while the patient is disconnected or out of the room and can be immediately restored as soon as the patient is reconnected.

Note:
Do not block the patient wye during stand-by, since the ventilator will assume a patient connection and attempt to resume normal ventilation.

- **Redundant display** — An additional, small status display positioned on the BDU provides a redundant check of ventilator operation.

Note:
Should the touchscreen fail, ventilation continues as set. See display lock functionality in section 9.3 to reset screen.

- **Infection control** — The expiratory filter reduces the risk of patient pathogens exiting the ventilator exhalation system into the room.

11.2 Established Ventilator Safety Features

- **Circuit disconnect detection** — Monitors circuit pressure and effective patient volume to instantly detect circuit disconnection and alert the clinician. Detection depends on the selected breath type , whether or not Leak Sync software is enabled, and the D_{SENS} setting.
- **Automatic patient detection** — During normal operation with start-up, the patient receives safety breaths to provide a certain level of ventilation, if connected before setup completes.
- **Ongoing background checks** — Continuously monitors the proper function of the ventilator's electronics and pneumatics hardware during ventilation.
- **Expiratory filter** — Traps greater than 99.999% of pathogens to shield patients, clinicians, and visitors from exposure to viruses and bacteria from exhaled gases.
- **Circuit occlusion detection** — Checks the circuit for occlusions at the delivery of every breath and automatically acts to minimize airway pressure to protect the patient during severe occlusion. In the case of severe occlusion, the ventilator begins Occlusion Status Cycling (OSC), periodically attempting to deliver a pressure-based breath while monitoring the occlusion. The ventilator also displays the length of time the patient has been without ventilatory support.

12.0 TESTING

12.1 Extended Self Test (EST)

Prior to first patient use, have a qualified service technician calibrate the exhalation valve, flow sensors, and atmospheric pressure transducer, and perform an extended self test (EST). Reference the Puritan Bennett™ ventilator service manual for instructions on running EST.

12.2 Short Self Test (SST)

Warning:
Before activating any part of the ventilator, be sure to check the equipment for proper operation and, if appropriate, run SST as described.

Prior to patient connection, with circuit or circuit component changes, and between patients, perform a short self test (SST) to calculate the compliance and resistance of the breathing system and included accessories, checking for possible leaks and considering changes in compliance.

12.2.1 Running SST

To run SST:

1. Ensure a patient is ***not*** connected to the ventilator.
2. Ensure the breathing circuit wye is not attached to a test lung or covered in any way that would cause an increase in pressure at the wye.
3. Turn the ventilator on using the power switch. The ventilator then runs a power on self test (POST). Ensure the ventilator is operating on AC power. Otherwise, SST test failures may result.
4. Wait at least 15 minutes to allow the ventilator to warm up and stabilize to ensure accurate results. The ventilator setup screen appears, displaying **New Patient**, **Same Patient,** and **SST** buttons.
5. Connect the patient circuit, filters, water trap, and all accessories to be used in patient ventilation. Ensure the patient wye is not blocked.
6. At the ventilator startup screen, touch the **SST** button or the configuration icon.
7. Touch **Run all SST** to perform all SST tests or touch **Run Leak Test** to perform the SST leak test of the ventilator breathing circuit.
8. Touch **Accept** or **Cancel** to go back to the previous screen.

9. After accepting, touch the Circuit Type button corresponding to the patient circuit type used to perform SST and to ventilate the patient (adult or pediatric).
10. Touch the Humidification Type button corresponding to the humidification type used for patient ventilation. If no humidifier is used, touch **HME**. If a humidifier is used, touch **Humidification Volume** and turn the knob to enter the volume. See operator's manual, chapter 3, to determine the correct volume to enter for the desired patient type.
11. Touch **Accept** to start SST.
12. Follow the prompts. The SST tests require operator intervention, and will pause indefinitely for a response. Reference "Individual SST Results" in the Puritan Bennett™ 980 ventilator operator's manual for a summary of the SST test sequence and results.
13. If a particular test fails, the test result appears on the touchscreen and provides a choice to repeat the test or perform the next test. When SST completes, the SST status screen displays the individual test results and the overall outcome, along with how to proceed in each case.
14. To proceed to patient setup (if SST did not detect an ALERT or FAILURE), touch **Patient Setup**.
15. Exit SST, then touch **Accept** or cycle the ventilator's power.

12.2.2 SST Results

SST reports results for each individual test. Three status indicators identify the SST results.

- **Pass** — The individual SST passed.
- **Alert** — One or more noncritical faults detected.
- **Failed** — The individual SST test did not meet its requirements SST cannot complete until the failed test passes.

An "alert" notification means the problem is not critical, but not ideal. If SST is in progress, this outcome will halt further testing and prompt a decision. Select one of the following icons:

Should SST fail, SST will not complete and the ventilator remains inoperable until SST successfully passes.

13.0 THE OXYGEN SENSOR

13.1 Oxygen Sensor Function

The ventilator's oxygen sensor is mounted on the BDU mix module and monitors the percentage of oxygen in the gas delivered to the breathing circuit.

New patient default O_2% settings are as follows:

- O_2 sensor enabled
- Pediatric/adult: 100% O_2

13.2 Oxygen Sensor Calibration

The oxygen sensor should be calibrated every 24 hours and before use. The calibration function provides a single-point O_2 sensor calibration.

To calibrate the oxygen sensor:

1. Touch **Vent Setup** in the lower left corner.
2. Touch the **More Settings** tab.
3. Touch **Calibrate** to finish.

13.3 Disable or Enable the Oxygen Sensor

1. Touch **Vent Setup** in the lower left corner.
2. Touch the **More Settings** tab. The More Settings screen appears.
3. Touch the button corresponding to the desired O_2 sensor function: **Enable** or **Disable**.
4. Touch **Accept**.

14.0 PREVENTIVE MAINTENANCE

Frequency	Part	Maintenance
Several times a day or as required by the institution's policy	Patient circuit: inspiratory and expiratory limbs	▪ Check both limbs for water accumulation. ▪ Empty and clean.
	Condensate vial, water traps, and drain bag	Check and empty as needed.
Daily or as necessary	Oxygen sensor calibration	▪ From the ventilator setup screen, touch the More Settings tab. ▪ Touch the Calibrate button in the oxygen sensor area of the screen.
	Inlet air filter bowl	▪ Replace bowl if cracked. ▪ If any sign of moisture is visible, remove ventilator from use and contact a service technician.
When transferring battery to or from another ventilator	Battery	Disinfect by wiping with a damp cloth using one of the solutions listed here. Do not immerse the battery or get the contacts wet. ▪ Mild dish washing detergent solution ▪ Isopropyl alcohol (70% solution) ▪ Bleach (10% solution) ▪ Window cleaning solution (isopropyl alcohol and ammonia) ▪ Ammonia (15% solution) ▪ Hydrogen peroxide (3% solution) ▪ Formula 409® cleaner (Clorox Company) ▪ CaviCide® surface disinfectant (Metrex Research Corporation) ▪ Control III® germicide (Maril Products, Inc.) ▪ Cidex OPA (0.55%) ▪ Mr. Muscle Window & Glass (SC Johnson) ▪ Sani Cloths (PDI, Inc.)
Every 3 years or as necessary		Replace.

Frequency	Part	Maintenance
▪ Before each patient use ▪ After 15 days of continuous use	Disposable expiratory bacteria filter	Discard according to the institution's protocol.
▪ After each patient use ▪ After 15 days of continuous use	Disposable inspiratory bacteria filter	Discard according to the institution's protocol.
Before each patient use‡	Exhalation flow sensor assembly (contains expiratory port, expiratory flow sensor)	▪ Disinfect per the instructions below. ▪ Before disinfection, pre-soak in Empower™* Dual Enzymatic Solution (Metrex Inc.). ▪ Chemically disinfect with Cidex™* (2.5%), Cidex™* OPA (0.55%), or Sporox™* II.
Every 100 disinfection cycles	Exhalation flow sensor assembly	▪ Replace. ▪ Run exhalation flow sensor calibration and SST

‡ The exhalation valve flow sensor assembly is removable and may be disinfected. *Do not sterilize* the exhalation valve flow sensor assembly.

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