



Figure 2-35 • Free breathing valve

2.13.12 Breathing circuit flow sensors

Two flow sensors (18) are used to monitor inspiratory and expiratory gas flow:

- The inspiratory flow sensor is located at the input of the breathing system inspiratory check valve.
- The expiratory flow sensor is located at the input to the breathing system expiratory check valve.

Feedback from both the inspiratory and expiratory transducers is used to:

- supply tidal volumes that make allowances for the effects of fresh gas flow and circuit compressibility.
- supply signals for expiratory tidal volume monitoring and the breath rate.

The breathing circuit flow sensors include two flex boards (one for each sensor). Each flex board contains a heating circuit and an EEPROM.

Each flex board has an I2C interface for communication with SIB. The SIB provides +12.5 VDC power with a minimum of 200 mA supply current to each flex board for flow sensor heating circuit, and provides +5 VDC with a minimum of 200 mA supply current to each flex board for EEPROM.

7 Alarms and troubleshooting

Message	Priority	Cause	Action
Inspiration stopped	Medium	High airway pressure.	Check system for blockages.
Internal failure. System may shut down.	High	Power controller software failure.	Contact an authorized service representative.
Internal failure. System may shut down.	Medium	Power controller software failure.	Contact an authorized service representative.
Low gas sample flow	Low	Sample flow is less than 80% of nominal flow for 20 seconds.	Check for blockage in the airway module sample gas line.
Memory (EEPROM) failure	Low	Software error.	Contact an authorized service representative.
Module fail. No CO ₂ , AA, O ₂ data.	Medium	Airway module hardware failure.	Replace module.
Module not compatible	Low	The monitoring module detected is not compatible with system software.	Remove the incompatible module. Use a compatible module.
Move Bag/Vent switch to Bag	Medium	Bag/Vent switch was in the Vent position when the case was changed from Aux O ₂ +Air to circle mode.	Move switch to the Bag position.
MVexp high	Medium	MVexp is greater than MVexp high alarm limit (for nine breaths and one minute has elapsed).	Set the alarm limits appropriately. Check the ventilation settings.
MVexp low	Medium	MVexp is less than MVexp low alarm limit (for nine breaths and one minute has elapsed).	Set the alarm limits appropriately. Check the ventilation settings.
N ₂ O Inaccurate	Low	Airway module has fault.	Calibrate the airway module. If problem persists, contact an authorized service representative.
N ₂ O supply pressure low	Medium	N ₂ O pipeline pressure is less than 252 kPa (36 psi) and the N ₂ O cylinder pressure is less than 2633 kPa (381 psi).	Ensure the N ₂ O pipeline and cylinder are properly connected. Ensure facility gas supply pressure is within specification and the backup cylinder is full and open.
Negative airway pressure	High	Paw is less than -10 cmH ₂ O.	Check for blockages in the patient circuit.
No battery backup	Medium	Battery or charging failure.	Between cases turn the system off, then back on after 15 seconds to reset the system.
No exp flow sensor	Medium	Electrical signals show the flow sensor is not connected.	Connect the flow sensor. Replace the flow sensor if necessary.
No insp flow sensor	Medium	Electrical signals show the flow sensor is not connected.	Connect the flow sensor. Replace the flow sensor if necessary.
O ₂ flow low	Low	The O ₂ flow is less than 150 ml/min.	Adjust the O ₂ flow.
O ₂ flush stuck on?	Low	Switch detected "on" continuously for more than 30 seconds.	Check flush valve. Ensure flush valve is not sticking.

11 Specifications and theory of operation

Breath rate	4 to 100 bpm (non-spontaneous) 2 to 60 bpm (spontaneous) 1 bpm resolution
Volume sensor type	Variable flow orifice

Oxygen

Display range	5 to 110% O ₂
Display resolution	1% increments
Sensor type	Galvanic fuel cell
Measurement range	0 to 100% O ₂
Measurement accuracy	+/- (2.5% full scale plus 2.5% of reading)
Cell response time	Less than 35 seconds Note: Response time of cell and adapters is measured using the text method described in ISO 7767 (1997).
Low O ₂ alarm range	18% to 99%
High O ₂ alarm setting	19 % to 100% or Off Note: Low O ₂ limit may not be set above high O ₂ limit. High O ₂ limit may not be set below the low O ₂ limit.
Expected cell life	One year of shelf life (23°C room air) and additional two years of normal operation.
Output drift in 21% O ₂	Less than 1% over one month
Influence of humidity	- 0.03% of reading per %RH
Gas cross effect	Less than 0.3% vol% anesthetic agents and N ₂ O

Case defaults

Use the **Case Defaults** menu to set the default case types that show on the **Start Case** menu and access the **Apnea Alarm Setup** menu.

Configuring case defaults

Set the case defaults for the case types that are selectable from the **Start Case** menu. In each case type, the name, patient defaults, gas defaults, screen layout defaults, alarm defaults, and ventilator settings for each available ventilation mode can be preset.

1. From Super User mode, select **Case Defaults**.
2. Select the case name to enter the adjustment window.
3. Select an item to change. Make the change.
4. Continue to select items and make changes.
5. Select **Confirm**.
6. Repeat to set the defaults for another default case.

Setting case name

1. From Super User mode, select **Case Defaults**.
2. Select the name of the case to enter the adjustment window.
3. Select **Name**.
 - Select **Clear** to remove the existing name.
 - Select up to 10 characters from the drop-down list.
 - Select **Delete** to delete a character.
 - Select **Save** to save the name and close the drop-down list.
 - Select **Reset** to return the name to the factory default name.
 - When the 10 character maximum is reached, the name is automatically saved. The drop-down list closes.
4. Select **Confirm** when done.

Setting apnea alarm

Use the **Apnea Alarm Setup** menu to enable or disable the user's ability to turn the volume apnea alarms off during manual ventilation.

1. From **Super User** mode, select **Case Defaults**.
2. Select **Apnea Alarm Setup**.

3. Set **Volume Apnea Selection** to **Enable** or **Disable**.
 Set to **Enable** to allow the user to turn the volume apnea alarm on or off from the **Start Case** menu.
 Set to **Disable** to set the volume apnea alarms as always on during manual ventilation.
4. Set the **Volume Apnea** for each case default.
5. Set the **Apnea Delay** for each case default.
 - The apnea time delay range is 10 to 30 seconds.
 - CO2 apnea minimum delay is 20 seconds.
6. Select **Back** to return to the **Case Defaults** menu.

Note When the **Volume Apnea Selection** is set to **Disable**, the **Volume Apnea Alarm** menu selection does not show on the user's **Start Case** menu and the **Vol Apnea Alarm** selection does not show on the **Alarm Setup** menu.

Default case type setting

Each case has multiple settings. The default settings for the default case types are shown in the following table. An * indicates that the setting is not used for the default ventilation mode in the case type. Use the empty columns to write in facility changes.

Note **VCV ADULT** settings are used as the default if the system does not have an optional ventilation mode shown.

Page 1 Default settings for default case types							
Settings	ADULT		PEDIATRIC		LOCAL		CUSTOM 1
Name	ADULT		PEDIATRIC		LOCAL		CUSTOM 1
Patient and Sensor	Adult		Pedi		Adult		Adult
Ideal Weight	70		18		70		70
Age	40		5		40		40
Other Gas	Air		Air		Air		Air
Data Source	Vent		Vent		Vent		Vent
O2%	100		100		100		100
Total Flow	6.00		6.00		0.20		6.00
Auto MV Limits	Off		Off		Off		Off
Alarm Volume	3		3		1		3

Airway module specifications

Use only airway modules that have anesthetic agent monitoring and O₂ monitoring on this system. The following modules can be used on this system:

CARESCAPE™ series: E-sCAiO and E-sCAiOV

Gas specifications for airway modules

Airway humidity (patient spirometry)	10% RH to 100% RH
Sampling delay	3.0 seconds typical with a 3 m sampling line
Total system response time	Less than 3.8 seconds with a 3 m sampling line
Warm-up time	1 minute for operation with CO ₂ , O ₂ , and N ₂ O 5 minutes for operation of anesthetic agents 20 minutes for full specifications
Respiration rate	4 to 100 breaths/min
Diversion flow	120 +/- 20 ml/min
Airway pressure	-20 cmH ₂ O to 100 cmH ₂ O

Accuracy during stable conditions	
Ambient temperature: 10 to 40°C	
Ambient pressure: 495 to 795 mmHg	
Ambient humidity: 10 to 98% RH, non-condensing	
Automatic compensation for ambient pressure	
Full module accuracy for Respiration rate of 4 to 70 breaths/min	
CO ₂	+/- (0.2 vol% + 2% of reading)
O ₂	+/- (1 vol% + 2% of reading)
N ₂ O	+/- (2 vol% + 2% of reading) between 0 and 85 vol% +/- (2 vol% + 8% of reading) for N ₂ O between 85 and 100 vol%
Iso, Sev, Des	+/- (0.15 vol% + 5% of reading)

Typical performance	
CO ₂	Measurement range 0 to 15 vol% (0 to 15 kPa, 0 to 113 mmHg). Measurement rise time less than 260 ms typical. Accuracy +/- (0.2 vol% + 2% of reading). 6 hour drift less than 0.1 vol% Gas cross effects less than 0.2 vol% (O ₂ , N ₂ O, anesthetic agents).

Carestation™ 750/750c (A1)

Typical performance	
O2	Measurement range 0 to 100 vol%. Measurement rise time less than 260 ms typical. Accuracy +/- (1 vol% + 2% of reading). 6 hour drift less than 0.3 vol% Gas cross effects less than 1 vol% anesthetic agents, less than 2 vol% N2O.
N2O	Measurement range 0 to 100 vol%. Measurement rise time less than 320 ms typical. Accuracy +/- (2 vol% + 2% of reading). 6 hour drift less than 0.3 vol% Gas cross effects less than 2 vol% anesthetic agents.
Anesthetic agents	Measurement range Iso 0 to 6% vol%. Measurement range Sev 0 to 8 vol%. Measurement range Des 0 to 20 vol%. Measurement rise time Des, Iso, Sev less than 420 ms typical. Accuracy +/- (0.15 vol% + 5% of reading). 6 hour drift for Iso, Sev less than 0.1 vol% 6 hour drift for Des less than 0.3 vol% Gas cross effects less than 0.15 vol% N2O.

Note The effects caused by N2O to the measurement of CO2, O2, and anesthetic agents are automatically compensated for when using the airway module. The effects caused by anesthetic agents to the measurement of CO2 and N2O are automatically compensated for when using the airway module.

Alarms

Alarms may be high priority, medium priority, or low priority. When an alarm occurs during a case, an alarm tone sounds and the alarm message is displayed in the alarm message field. The system checks for alarm conditions at 1 second intervals. The alarm tone is from 47 to 70 dB (A) depending on the alarm volume setting.

CAUTION No repair should ever be attempted by anyone not having experience in the repair of devices of this nature. See the "Repair policy" in the "User maintenance" section.

WARNING If an alarm occurs, safeguard the patient first before performing troubleshooting or doing repair procedures.

Alarm priorities

Alarm priority is indicated by the color of the alarm message and the audio sequence.

- High-priority alarm messages appear in white text on a red background.
- Medium-priority alarm messages appear in black text on a yellow background.
- Low-priority alarms appear in black text on a blue background.

Pausing alarms

Selecting **Audio Pause** for an active alarm stops the audible tone for 120 seconds. The alarm message shows in the alarm message field. Selecting **Audio Pause** when no medium or high priority alarms are active prevents the audible alarm tones (audio off) for 90 seconds.

Alarms in the apnea alarm family have special silence behavior to reduce apnea nuisance alarms. Apnea family alarms include 'Apnea', 'EtCO2 low', 'MVexp low', 'RR low', and 'TVexp low'.

When pausing an apnea family alarm, the audio tone for the active alarm is paused for 120 seconds. The audible tone for any additional apnea family alarm that occurs during the audio paused period is silenced for the remaining time shown on the audio pause countdown. Only the audible alarm tone is silenced. The alarm messages still show in the alarm message fields. 'APN' shows above the audio pause countdown when the audible tone silence is in effect for the apnea family alarms.