# RESMED

# AutoSet CS™2 and Adaptive Servo-Ventilation

Airflow

**APNEA**
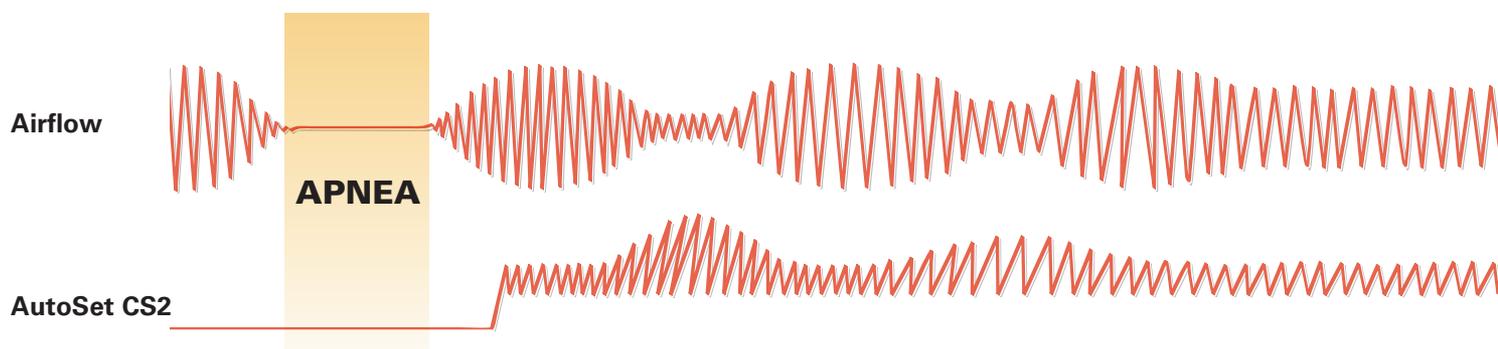
AutoSet CS2

AUTOSET CS2 RESPONDS TO APNEA BY INCREASING SUPPORT

Cheyne-Stokes respiration (CSR) is a common disorder in heart failure patients. With its unique Adaptive Servo-Ventilation (ASV-CS) algorithms, the AutoSet CS2 device has been designed specifically to rapidly respond to CSR providing ventilatory support.

## ASV-CS algorithms deliver customized therapy

### Ventilation to a moving target

To determine the degree of pressure support needed, the ASV-CS algorithm continuously calculates a target ventilation. Based on respiratory rate and tidal volume, the target is 90% of the patient's recent average ventilation—this means that ventilation can vary gradually and naturally over the course of the night.

### Patient–device synchronization

The algorithm uses three factors to achieve synchronization between pressure support and the patient's breathing.

1. The patient's own recent average respiratory rate, including the ratio of inspiration to expiration and the length of any expiratory pause.

2. The instantaneous direction, magnitude, and rate of change of the patient's airflow, which are measured at a series of set points during each breath.

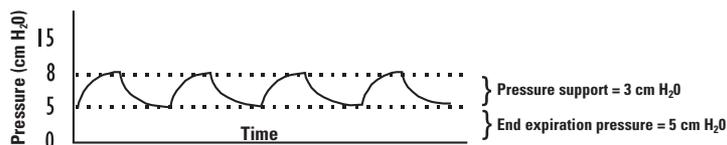3. A backup respiratory rate of 15 breaths per minute.

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Airflow

Late mid-inspiration

Early end-inspiration

−

Time
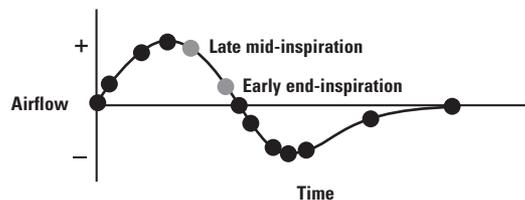
**Delivered ventilation is matched to patient respiration via a series of set points identified in each breath.**

To ensure ventilatory support is synchronized to the patient's breathing effort, AutoSet CS2 relies on the first two factors. When a central apnea/hypopnea occurs, support initially continues to reflect the patient's recent breathing pattern. However, as the apnea/hypopnea persists, the device increasingly uses the backup respiratory rate.

## Minimal support during stable breathing

ASV-CS algorithms start working even before the CSR cycle begins, from the moment the patient lies down, puts on the mask, and switches on the AutoSet CS2 device.

Pressure (cm $H_2O$)

15

8

5

0

Time

} Pressure support = 3 cm $H_2O$

} End expiration pressure = 5 cm $H_2O$

**Comfortable, minimal pressure support when breathing is stable**

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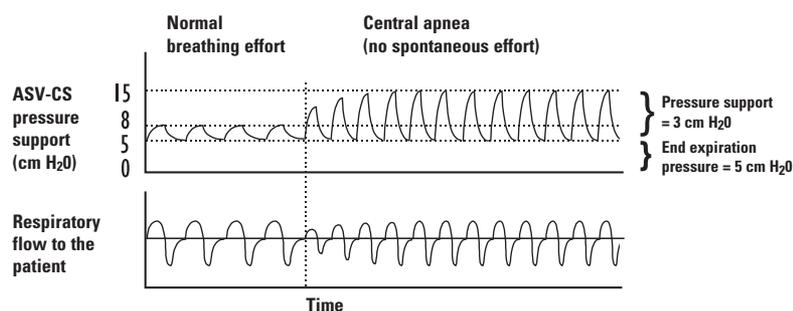So long as ventilation is at or above the target:

- the magnitude of the pressure support remains minimal—the default minimum value of 3 cm $H_2O$ provides enough support to do about half the work of breathing. The total pressure (5 + 3 = 8 cm $H_2O$) peaks at end inspiration

- the underlying end expiration pressure (EEP) is adjustable from 5–10 cm $H_2O$ and helps reduce dyspnea, excessive preload, and pulmonary congestion, while preventing obstructive apneas.

## Support when it is needed

When a central hypopnea/apnea occurs and ventilation suddenly drops below the target:

- pressure support rapidly increases, over a few breaths, to keep ventilation at the target

- the default maximum pressure support value of 10 cm $H_2O$ should fully ventilate a centrally apneic patient with an open airway and normal lungs.

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**RESPONSIVE SUPPORT WHEN BREATHING RESUMES**

Normal breathing effort — Central apnea (no spontaneous effort)

ASV-CS pressure support (cm $H_2O$): 15 8 5 0

} Pressure support = 3 cm $H_2O$
} End expiration pressure = 5 cm $H_2O$
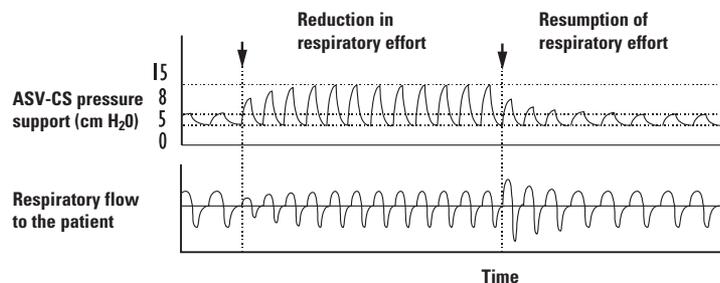
Respiratory flow to the patient

Time

ASV-CS algorithms respond to central hypopnea/apnea

As breathing resumes and total ventilation exceeds the target:

- pressure support is rapidly reduced back towards the minimum 3 cm $H_2O$

- this reduces the likelihood of over-ventilation and hypocapnia, which can lead to vocal cord closure and further apneas.

**ASV-CS ALGORITHMS STABILIZE PATIENT BREATHING**

Reduction in respiratory effort — Resumption of respiratory effort

ASV-CS pressure support (cm $H_2O$): 15 8 5 0

Respiratory flow to the patient

Time

ASV-CS responds when breathing effort resumes

By ventilating the patient appropriately during periods of hypopnea and apnea, and reducing support during periods of hyperventilation and normal breathing, ASV-CS algorithms rapidly stabilize breathing patterns and arterial blood gases. AutoSet CS2 therapy reduces sympathetic nervous system activity and the stress on the failing heart.