High Frequency Oscillatory Ventilation
The 3100a

Purpose of HFOV

Support ventilation using lung protective strategy

- Oxygenation
- CO2 removal

Approach full recruitment of the lung

- Tidal volumes equal to or below dead space volume

Purpose of HFOV (cont.)

- Conventional mechanical ventilation (CMV) vs. HFOV:
  - With CMV, alveoli may receive full pressure from ventilator
  - With HFOV, minimal stretching of alveoli and less risk of trauma

HFOV Theory of Operation

- Active exhalation
- Oxygenation and ventilation controls generally decoupled and independent of each other
  - Oxygenation: primarily controlled by mean airway pressure (mPAW) and FiO2
  - Ventilation: primarily determined by stroke volume (amplitude) and frequency of the ventilator
- Gently inflates the lung, normalizing lung architecture while ventilating the patient with near dead space tidal volumes for low stretch lung protection

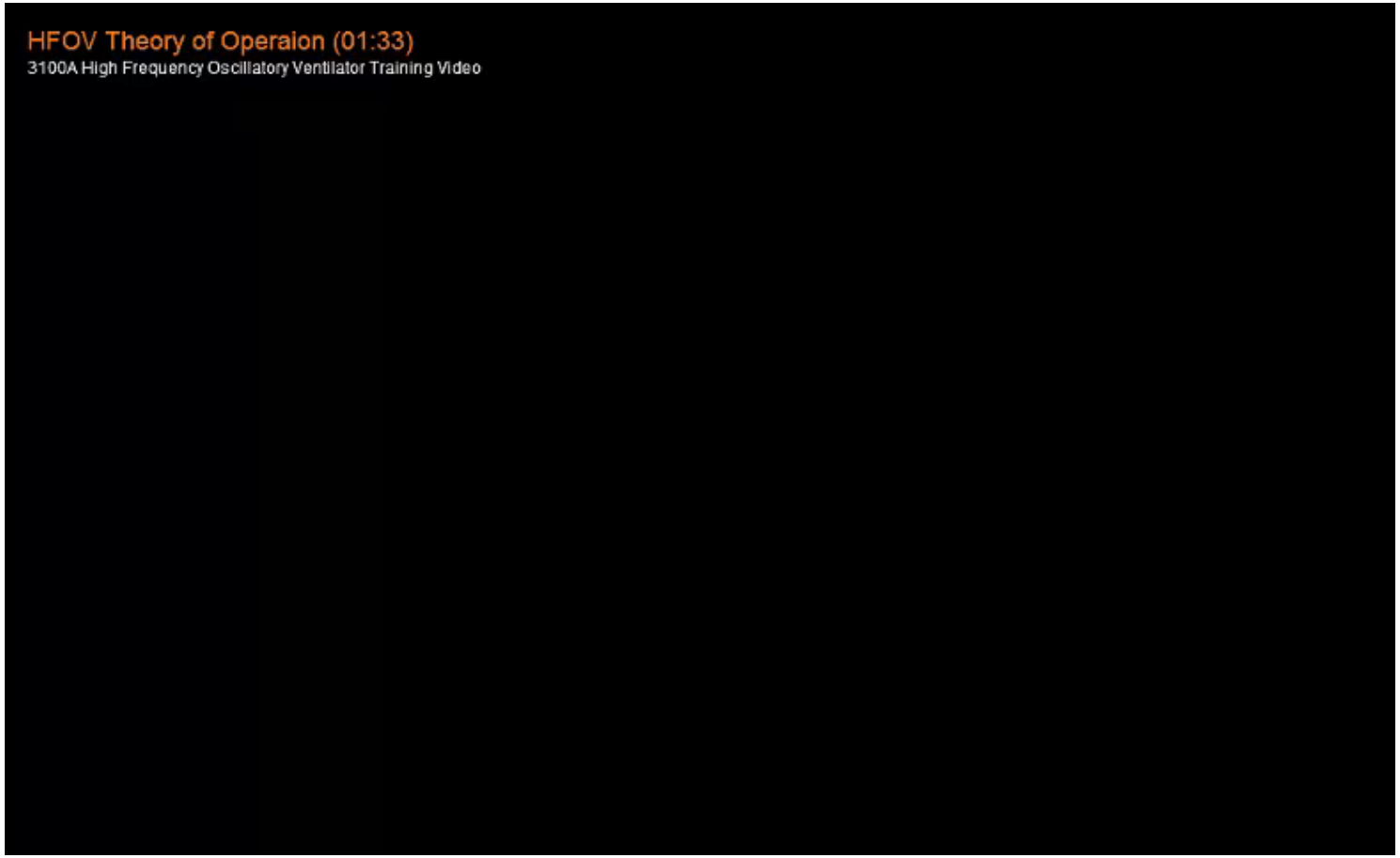
HFOV Theory of Operation - Oxygenation

- Oxygenation is controlled by:
  - Mean Airway Pressure (mPAW)
  - FiO2
- mPAW is used to inflate the lung and optimize the alveolar surface area for gas exchange
- mPAW approx Lung Volume

HFOV Theory of Operation - Ventilation

- Ventilation is controlled by:
  - Amplitude
  - Inspiratory Time Percent
  - Frequency
- Ventilation is primarily controlled by the pump/piston mechanism
- Changes in volume delivery (as a function of amplitude, frequency, or % Inspiratory Time) have the most significant effect on CO2 elimination

Video: Theory of Operation



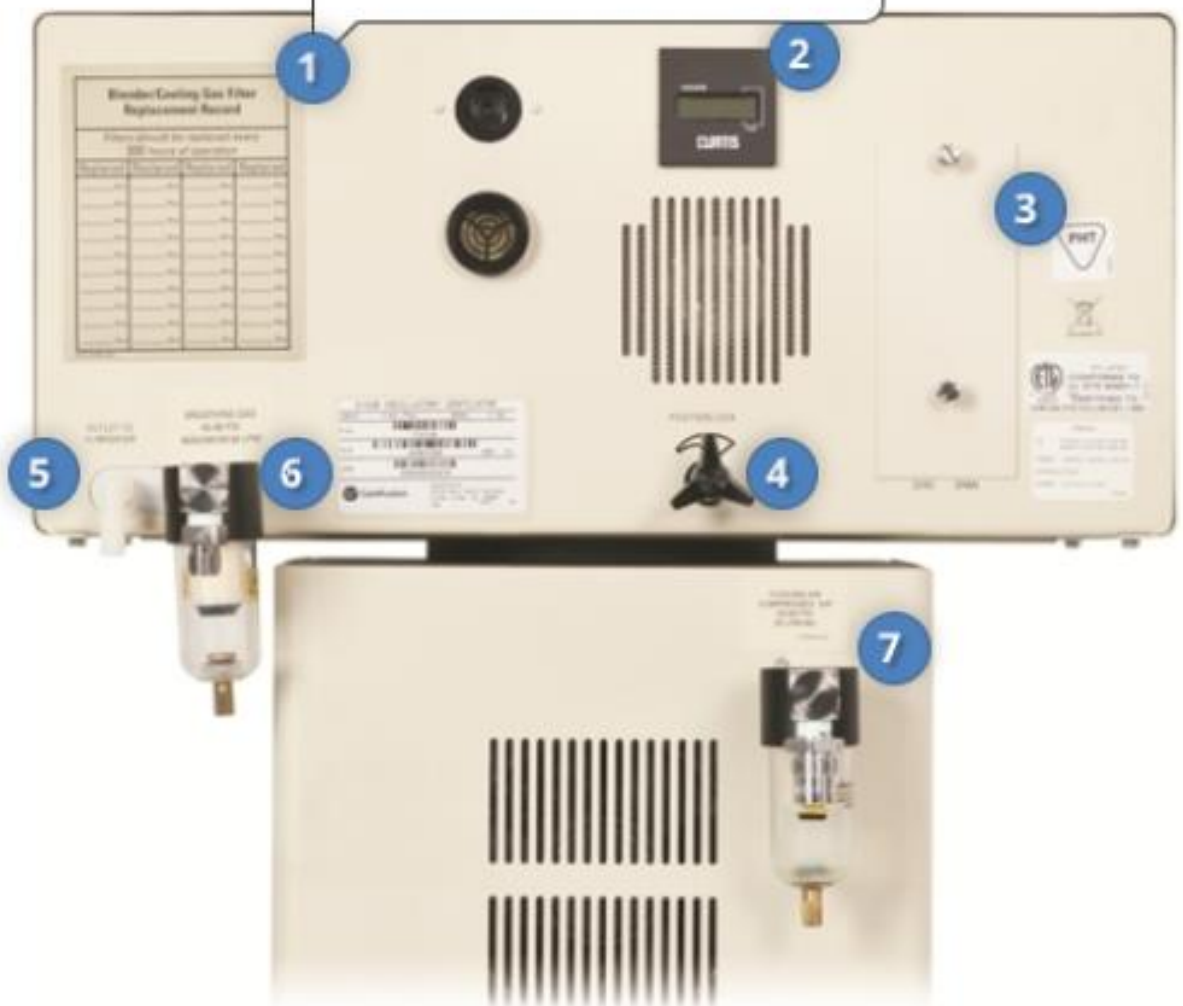
High Frequency Oscillatory Ventilator

Rear Panel

Click each of the numbered bu h the rear panel components of the 3100A.

Filter Replacement Record

The blender/cooling gas filter replacement record provides a place to document the 500 hour filter changes.



Rear Panel

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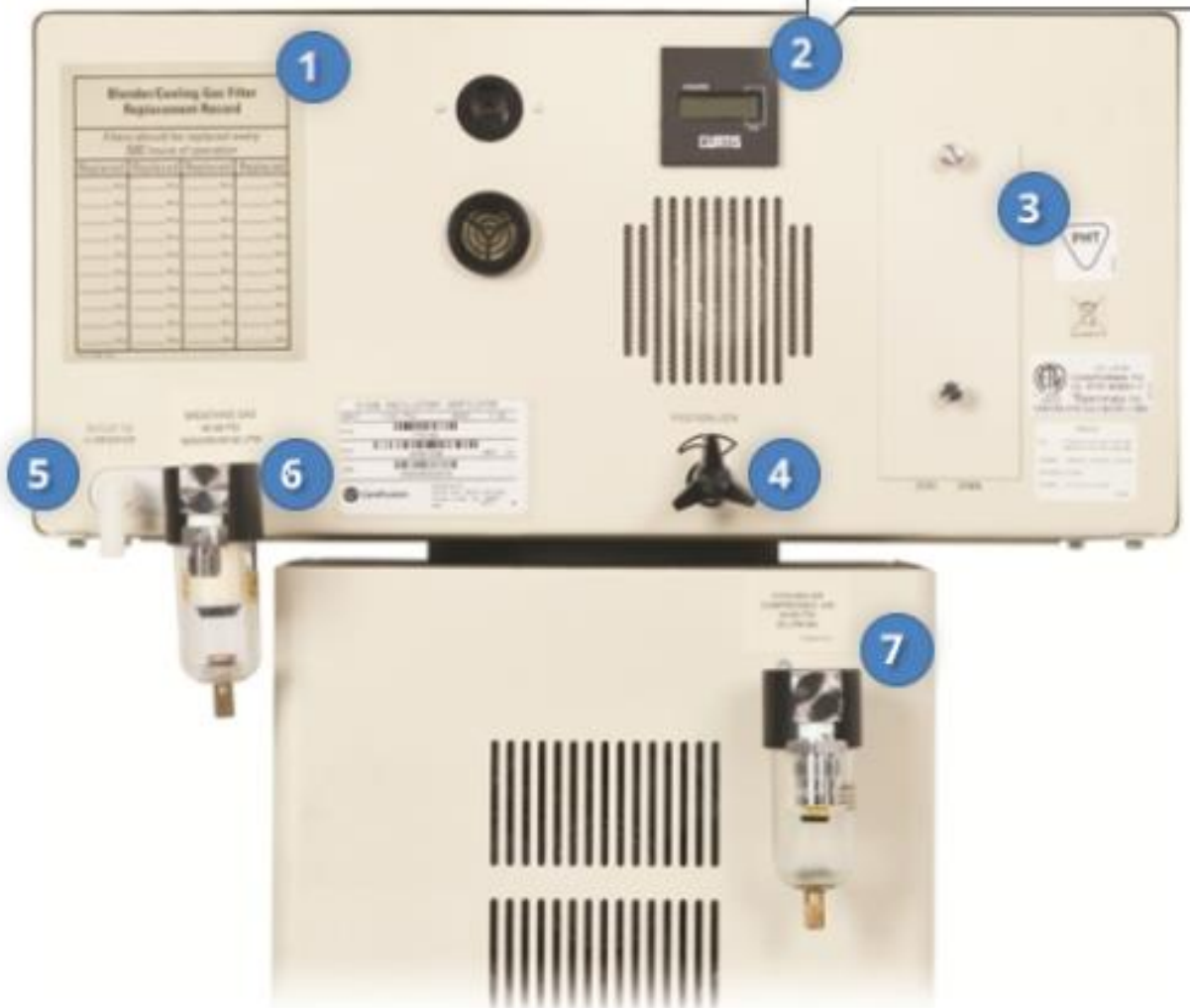
Elapsed Time Meter

Indicates the total amount of time that power had been applied.



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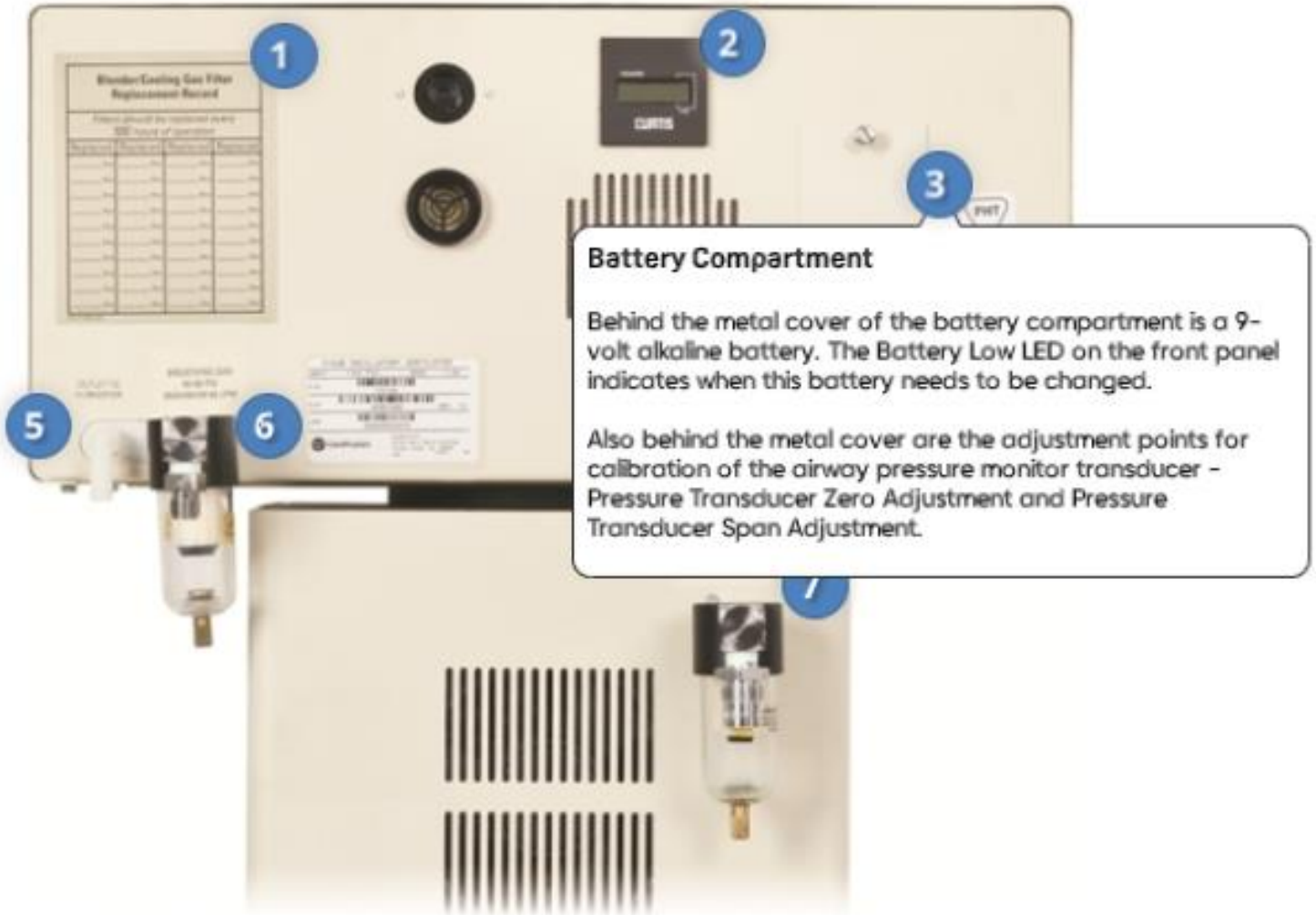

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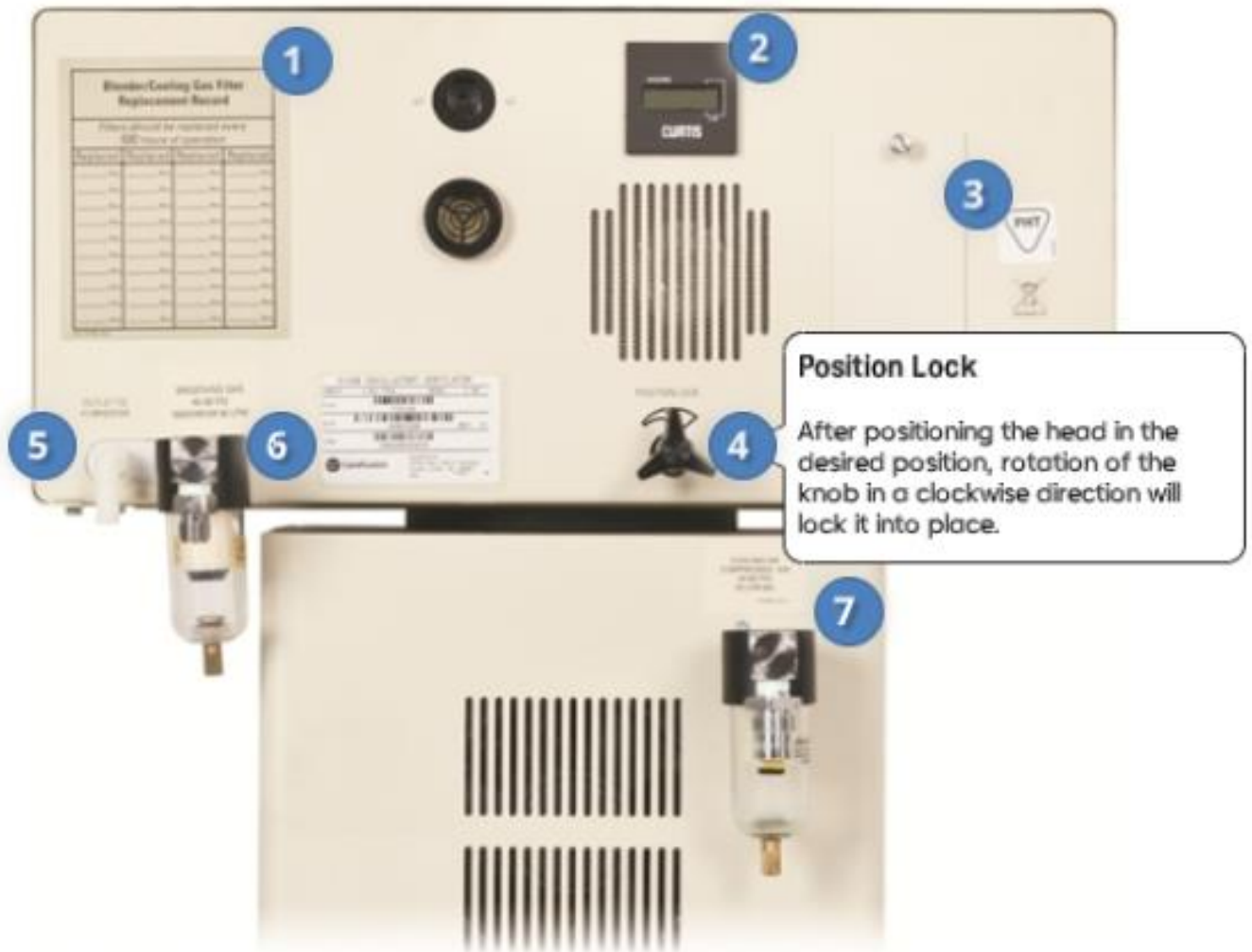

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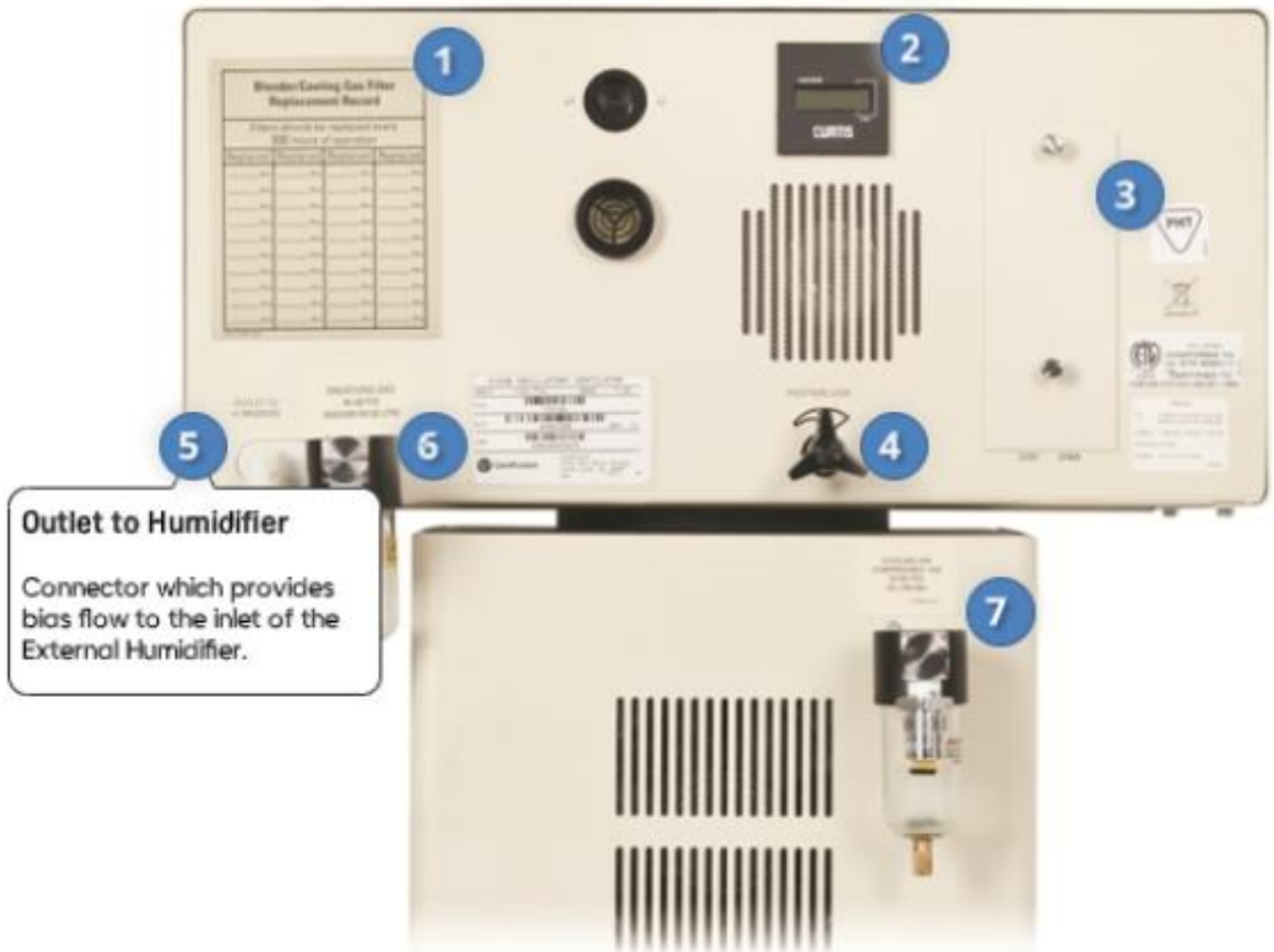

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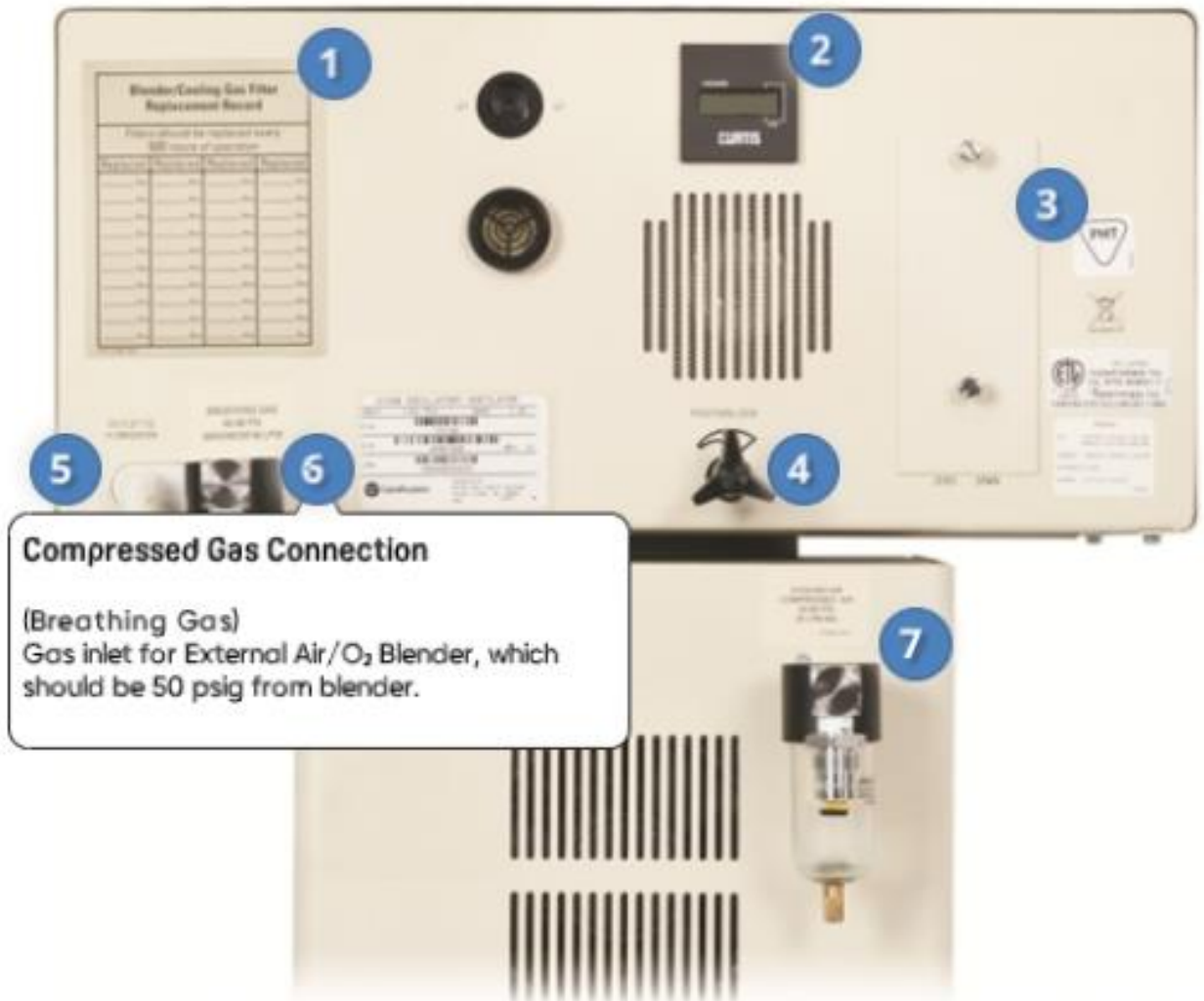

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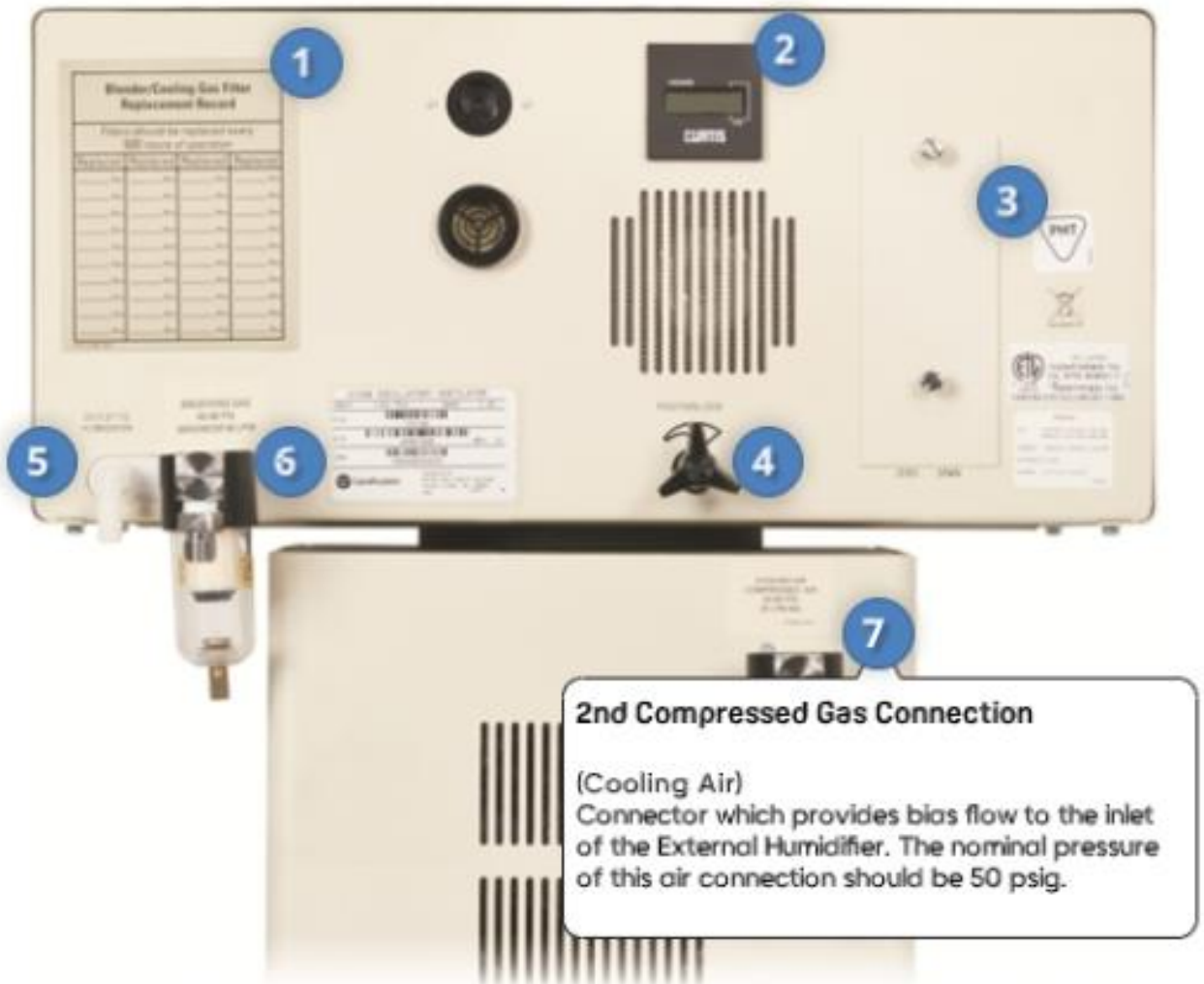
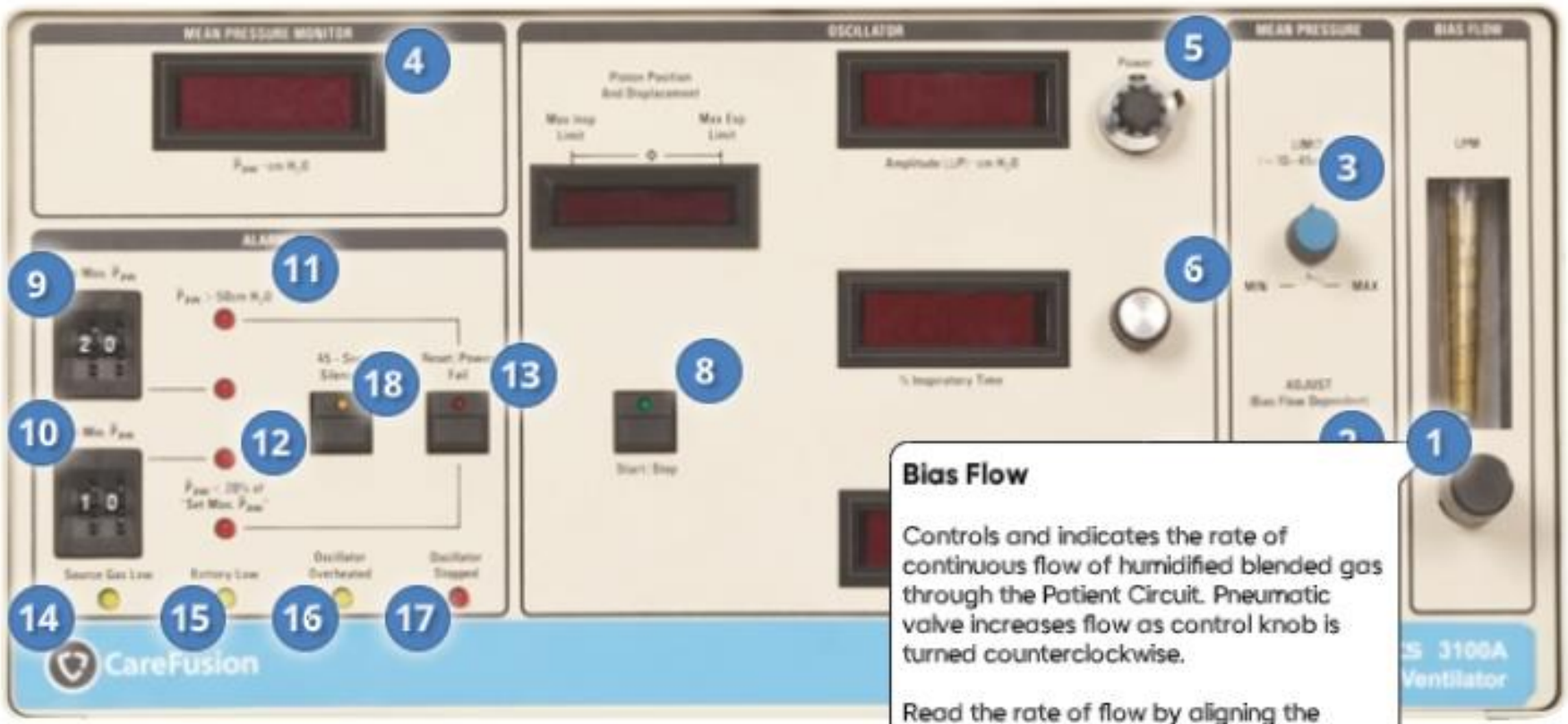


Front Panel Controls and Indicators

Click each circle button below to familiarize yourself with the controls and indicators on the front panel of the 3100A.



Bias Flow

Controls and indicates the rate of continuous flow of humidified blended gas through the Patient Circuit. Pneumatic valve increases flow as control knob is turned counterclockwise.

Read the rate of flow by aligning the center of the ball float with the flow meter scale mark in the glass tube.

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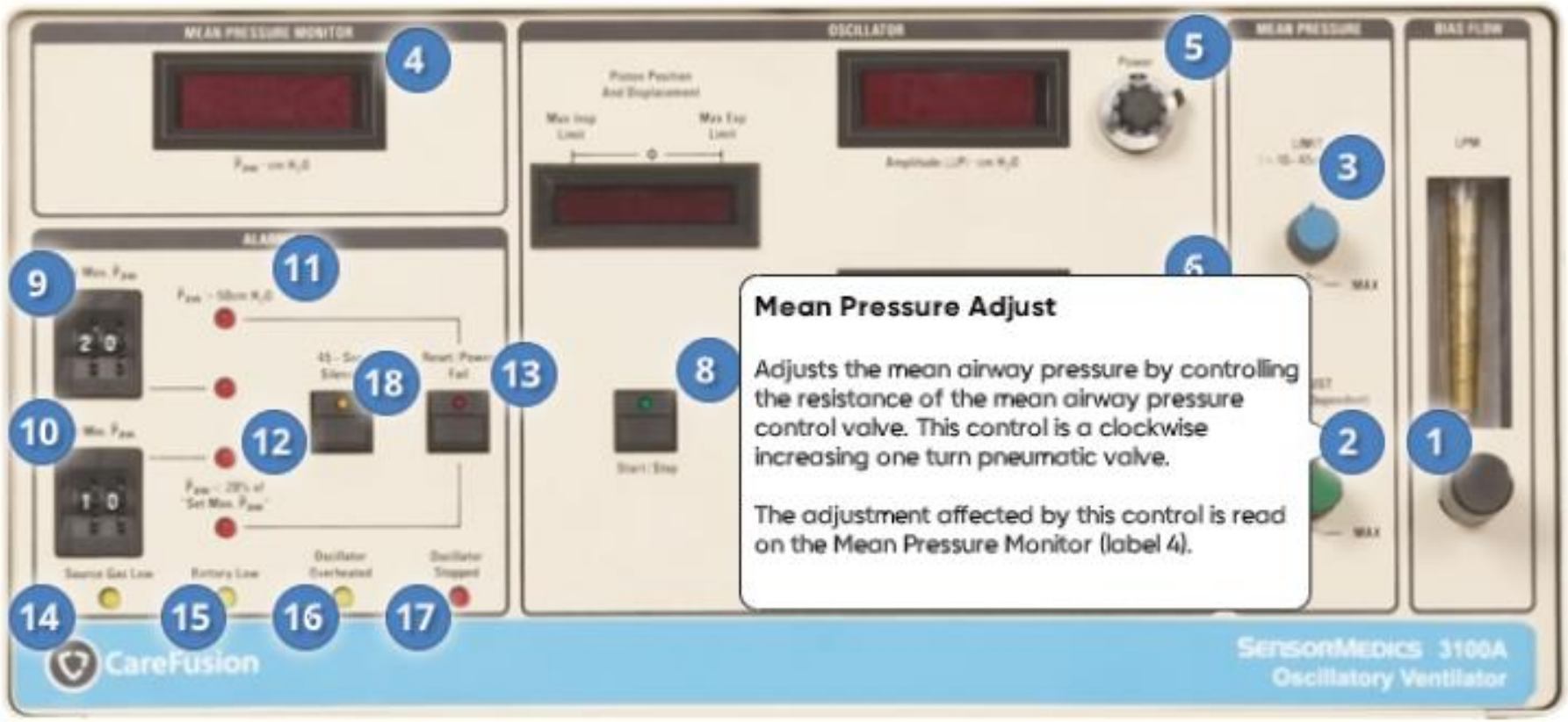

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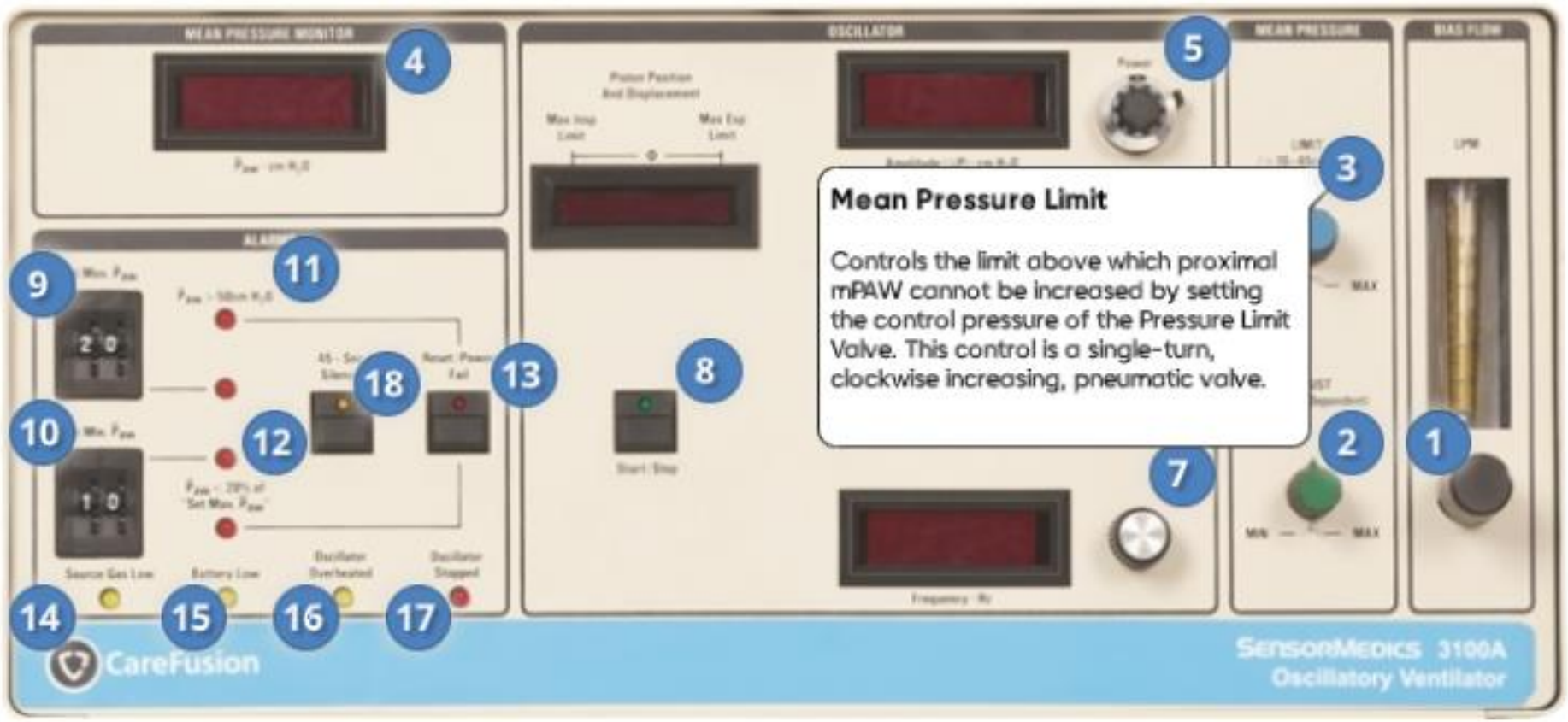

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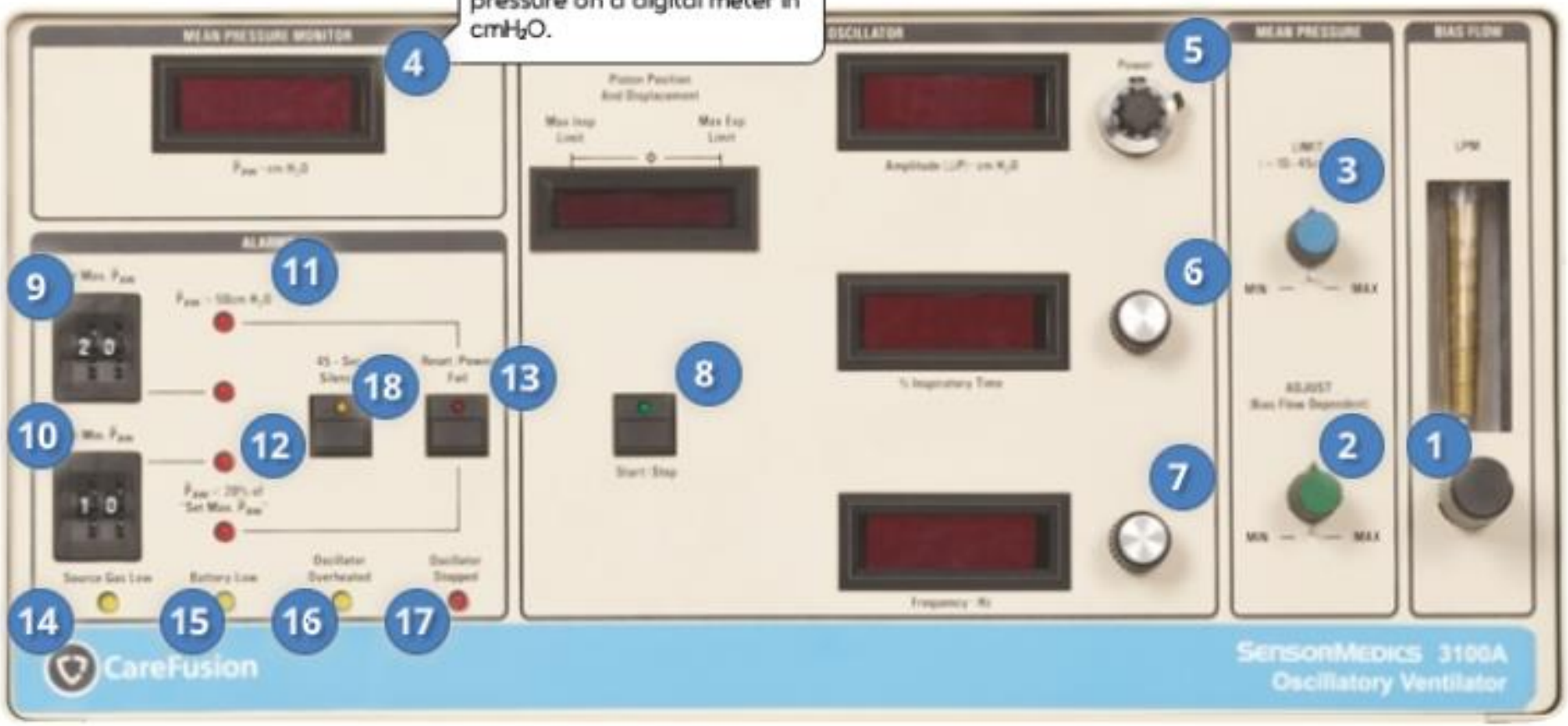
Mean Pressure Monitor

Displays the mean airway pressure on a digital meter in cmH_2O.



Front Panel

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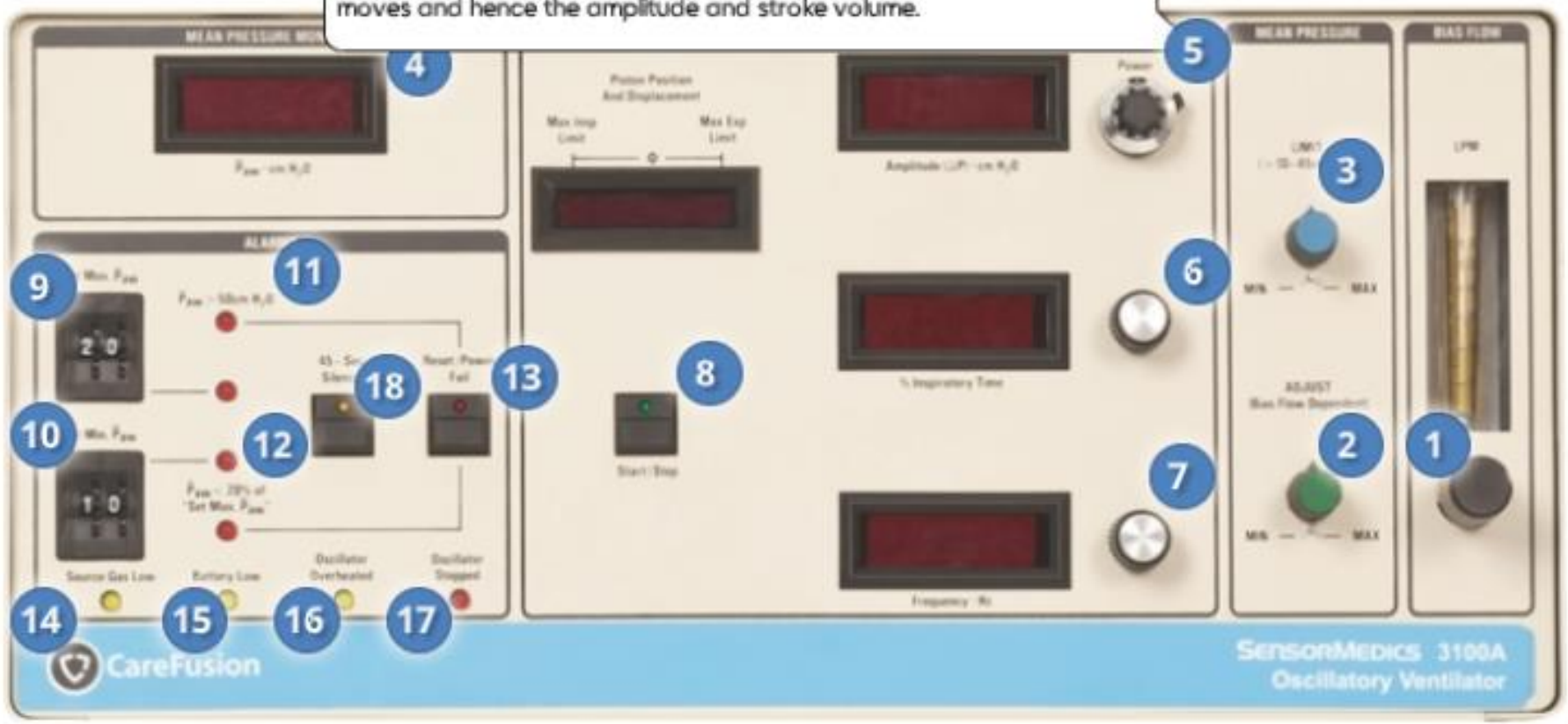
Power

Determines the amount of power that is driving the oscillator piston. The power control is an electrical potentiometer covering the power range of 0 to 10.

The knob scale is a locking dial that is marked for purposes of establishing reference points.

The effect of this control is to change the force with which the piston moves and hence the amplitude and stroke volume.



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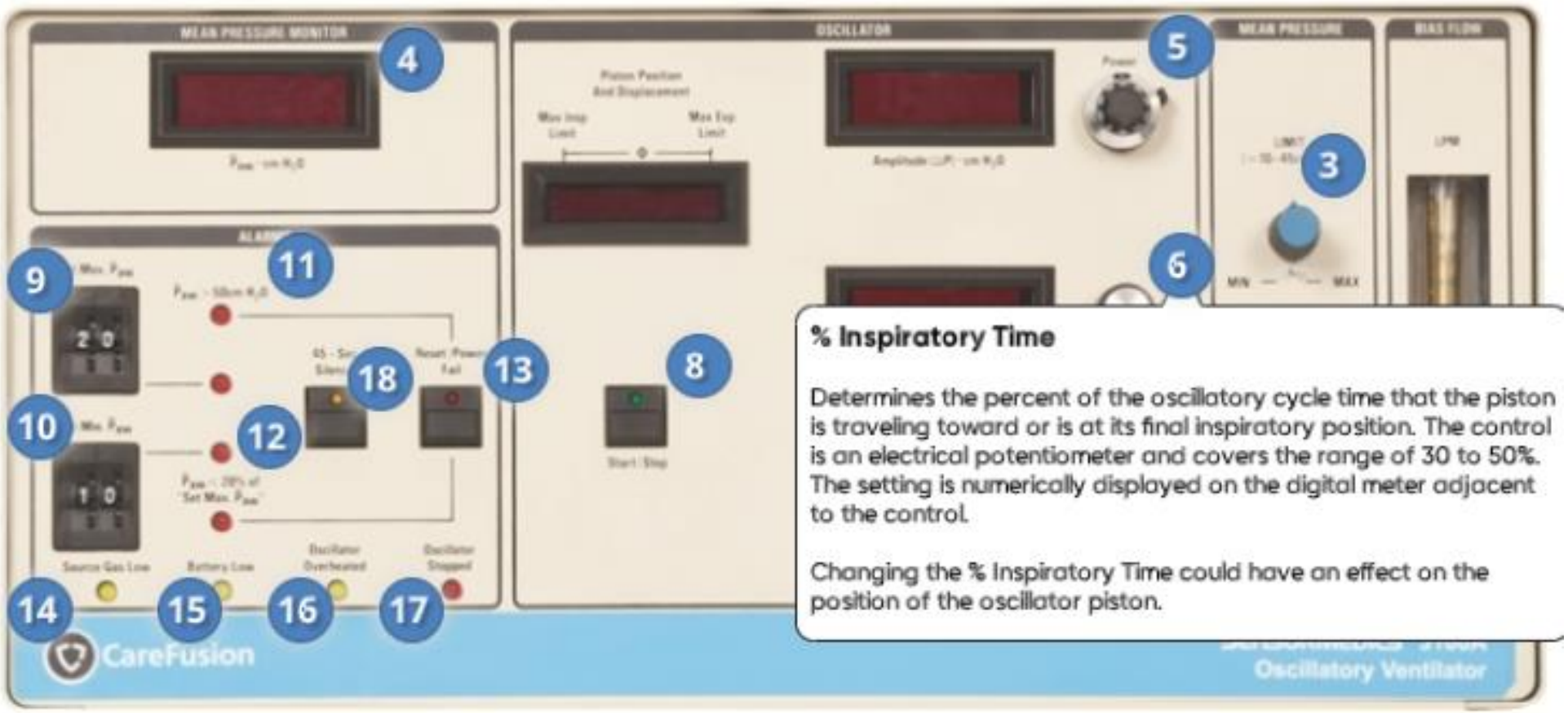

% Inspiratory Time

Determines the percent of the oscillatory cycle time that the piston is traveling toward or is at its final inspiratory position. The control is an electrical potentiometer and covers the range of 30 to 50%. The setting is numerically displayed on the digital meter adjacent to the control.

Changing the % Inspiratory Time could have an effect on the position of the oscillator piston.

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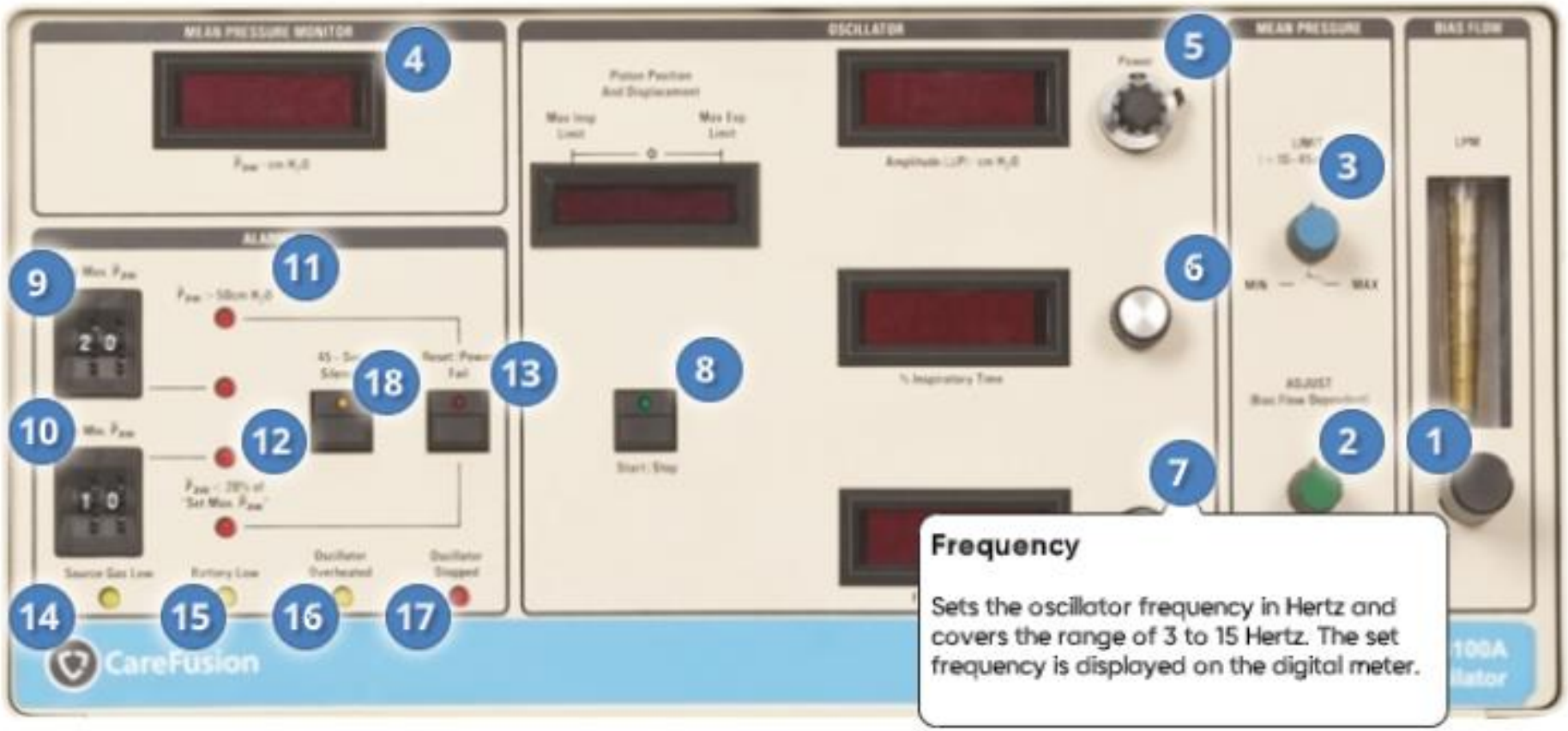

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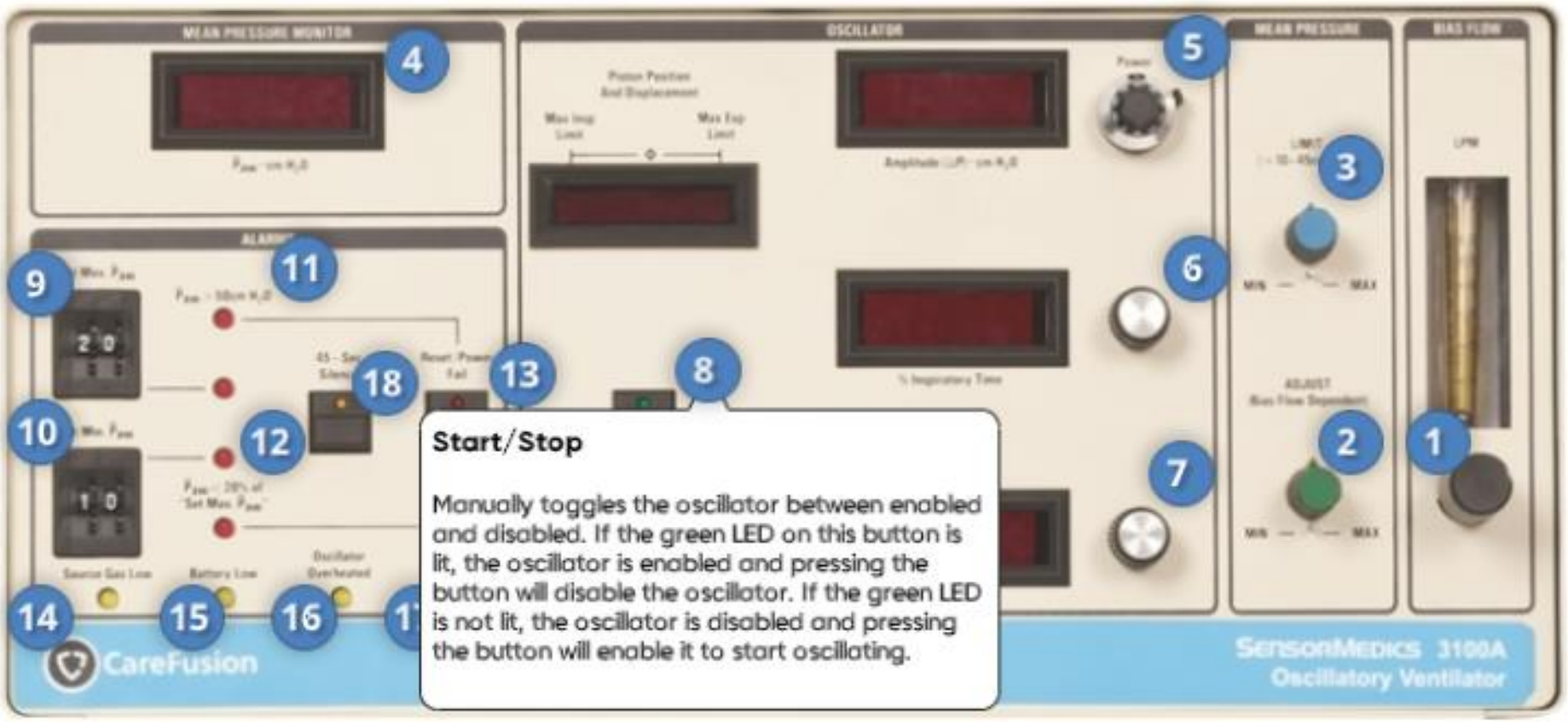

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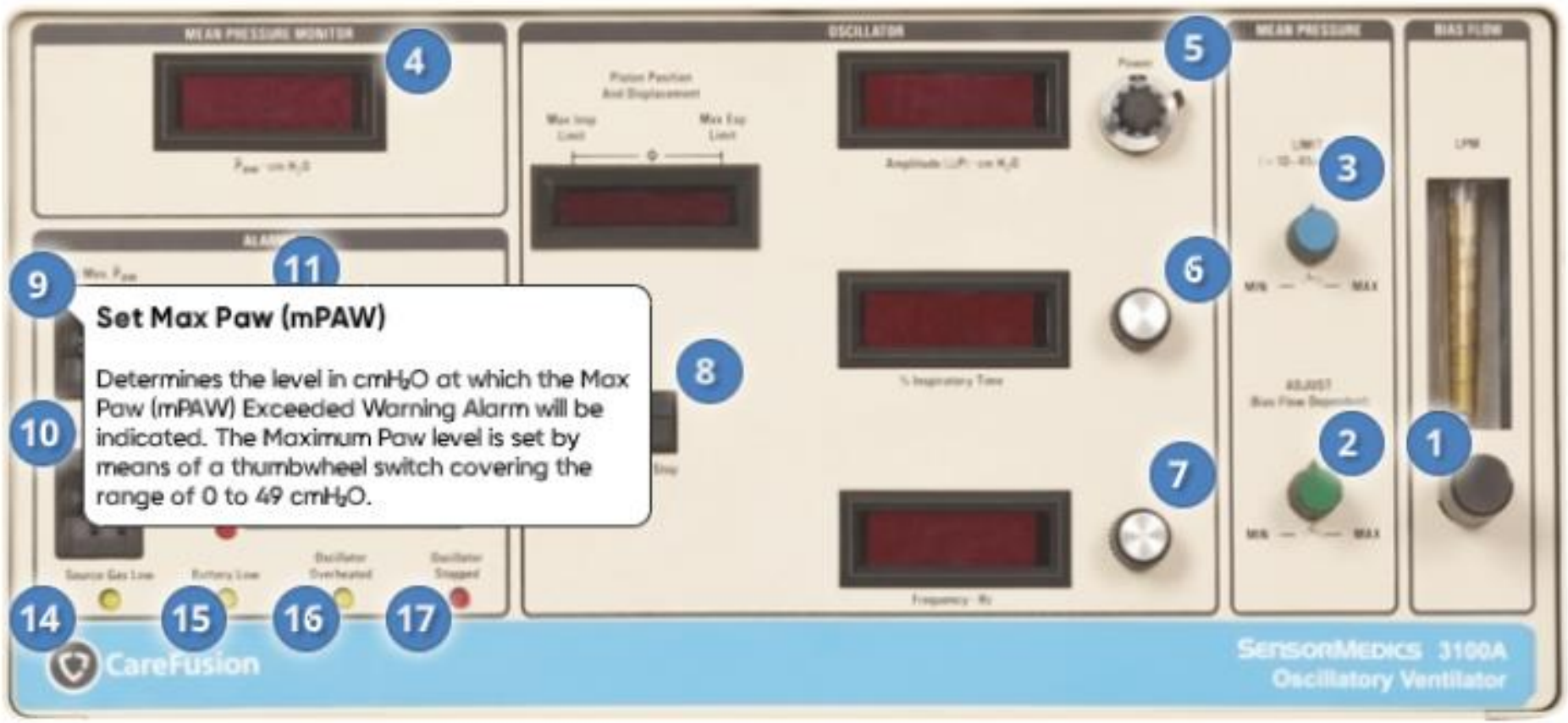

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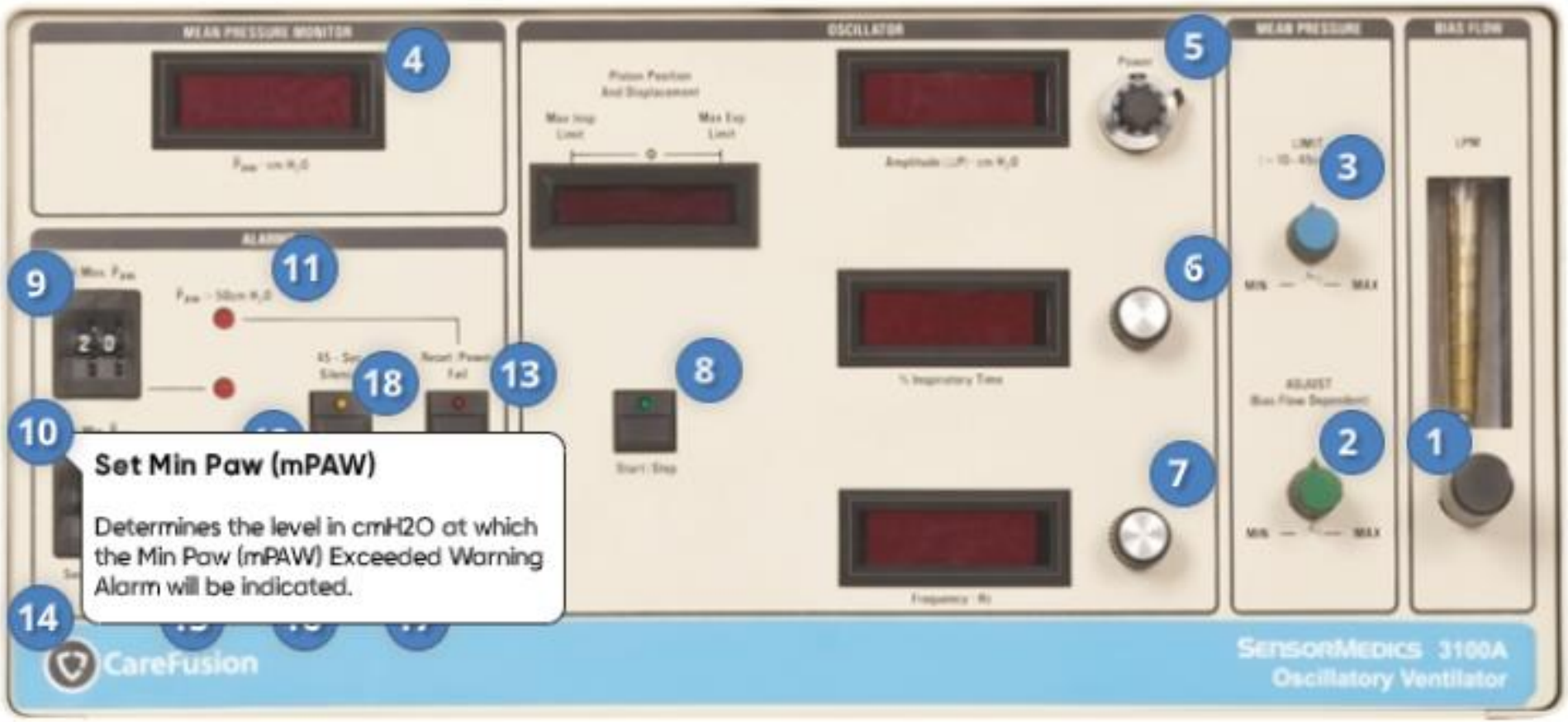

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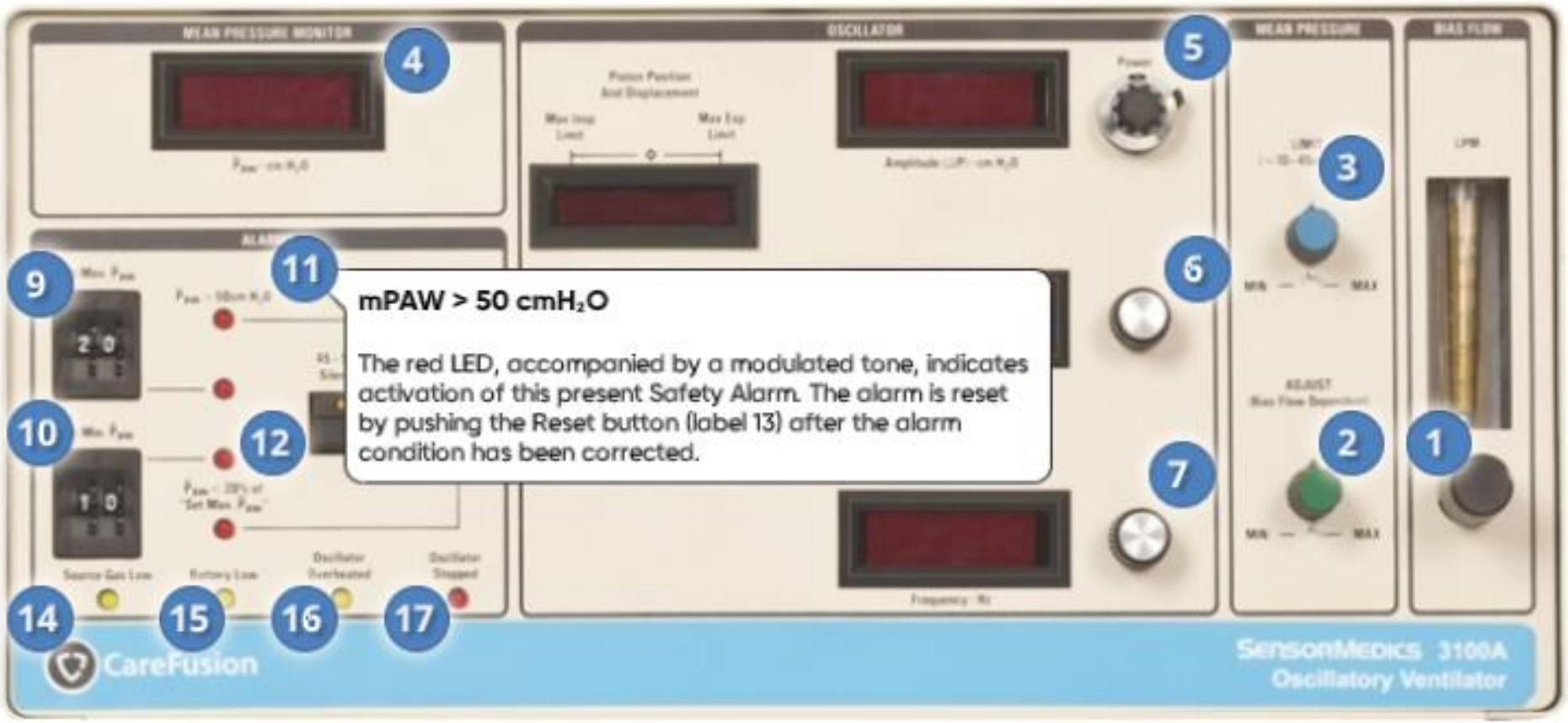

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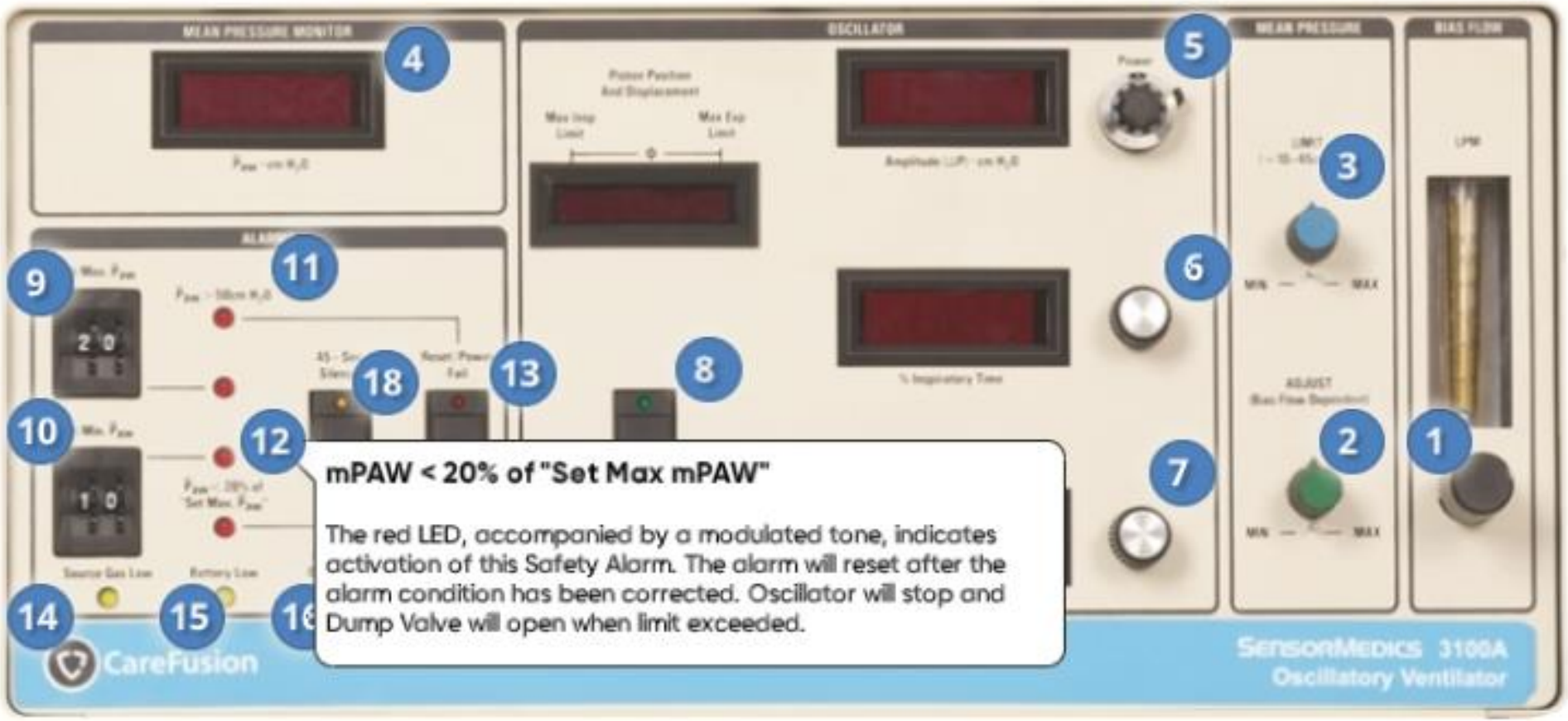

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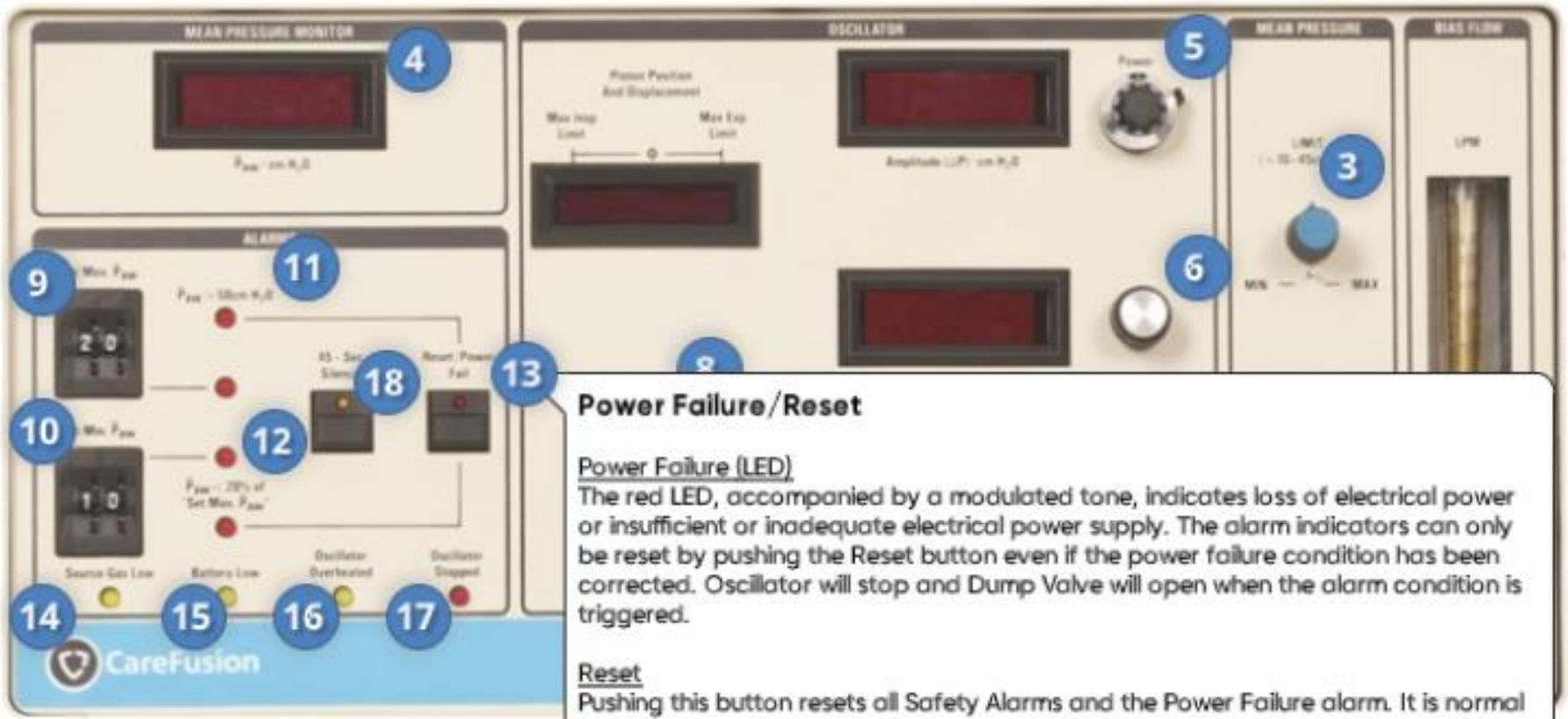

Power Failure/Reset

Power Failure (LED)
The red LED, accompanied by a modulated tone, indicates loss of electrical power or insufficient or inadequate electrical power supply. The alarm indicators can only be reset by pushing the Reset button even if the power failure condition has been corrected. Oscillator will stop and Dump Valve will open when the alarm condition is triggered.

Reset
Pushing this button resets all Safety Alarms and the Power Failure alarm. It is normal for the Battery Low LED to illuminate when the reset button is pressed.

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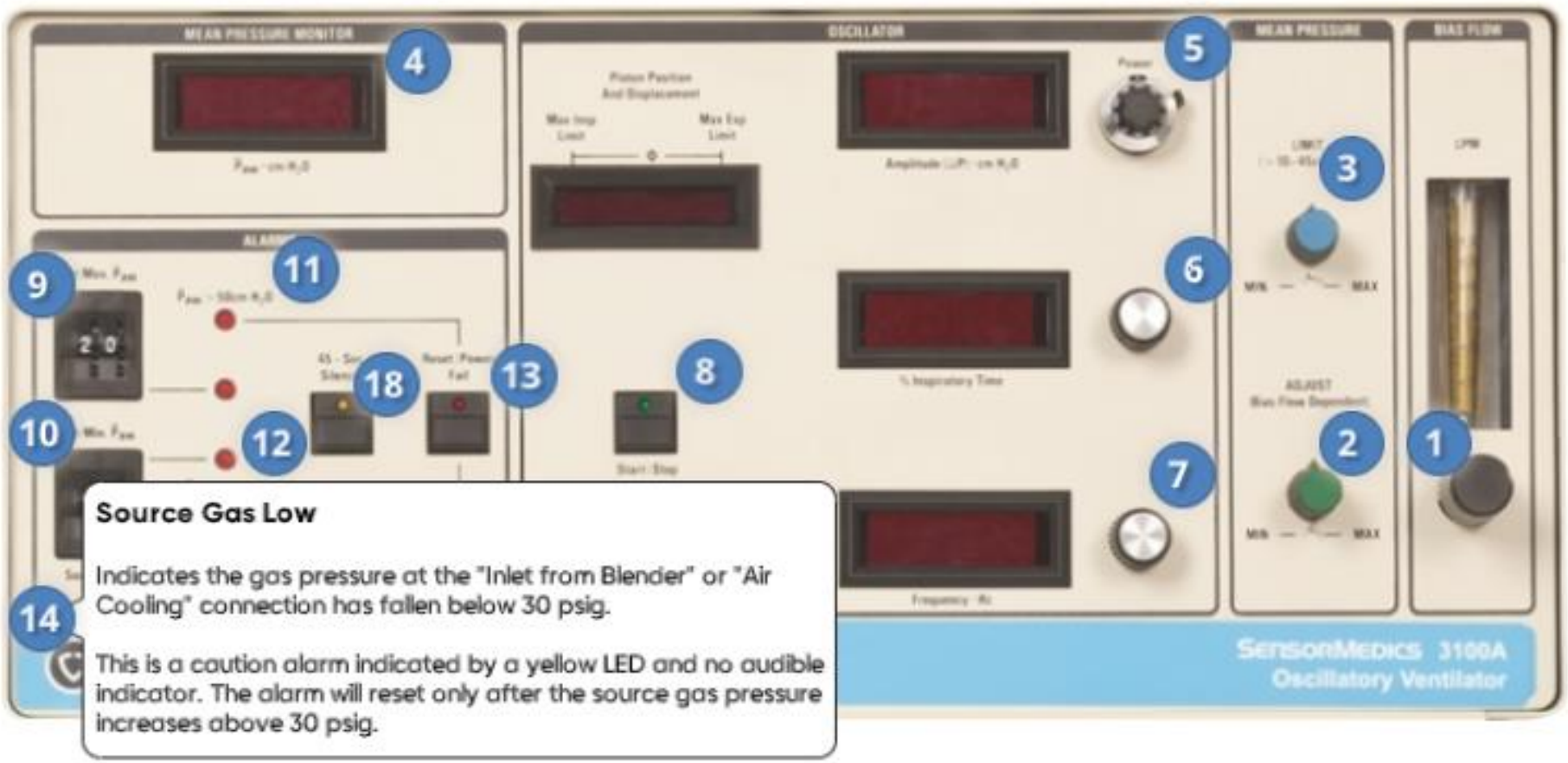

Source Gas Low

Indicates the gas pressure at the "Inlet from Blender" or "Air Cooling" connection has fallen below 30 psig.

This is a caution alarm indicated by a yellow LED and no audible indicator. The alarm will reset only after the source gas pressure increases above 30 psig.

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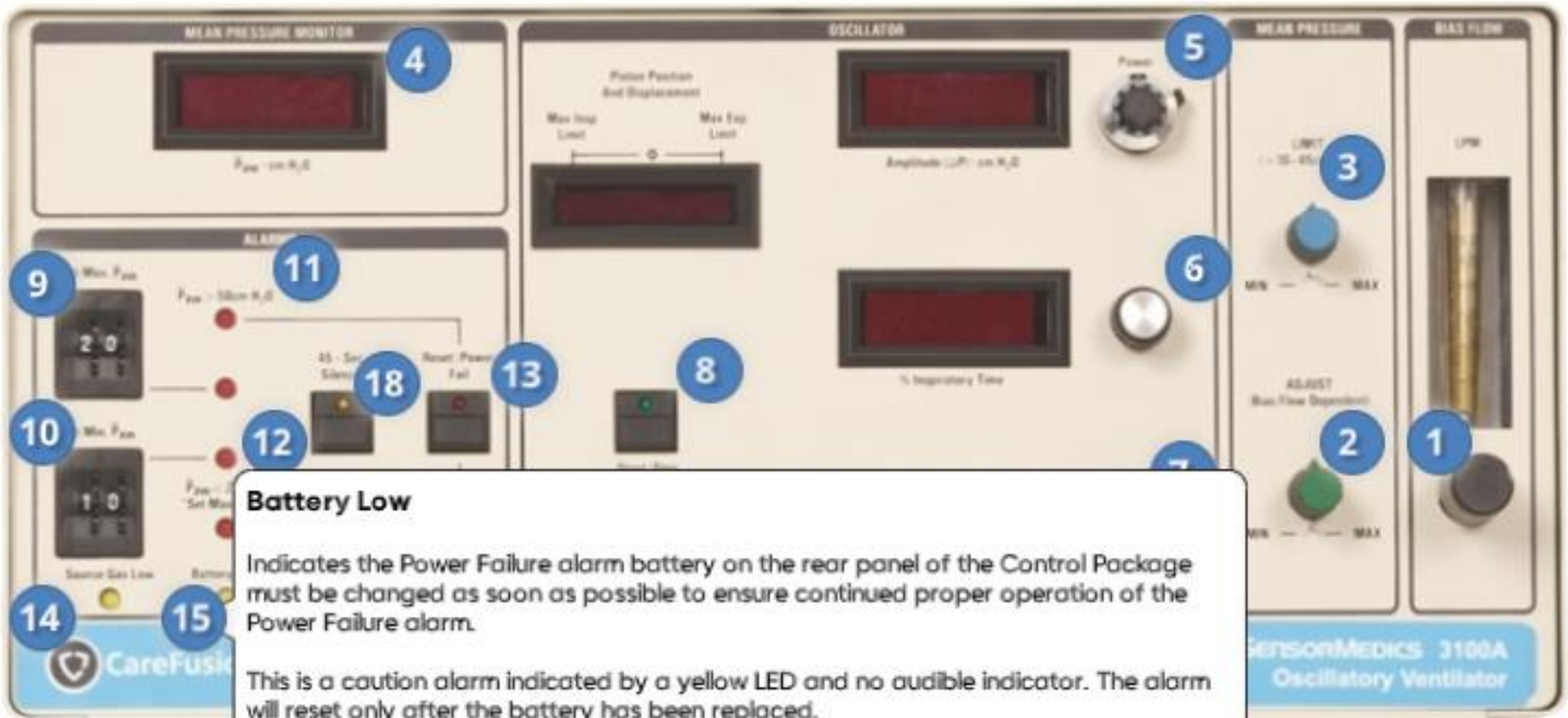

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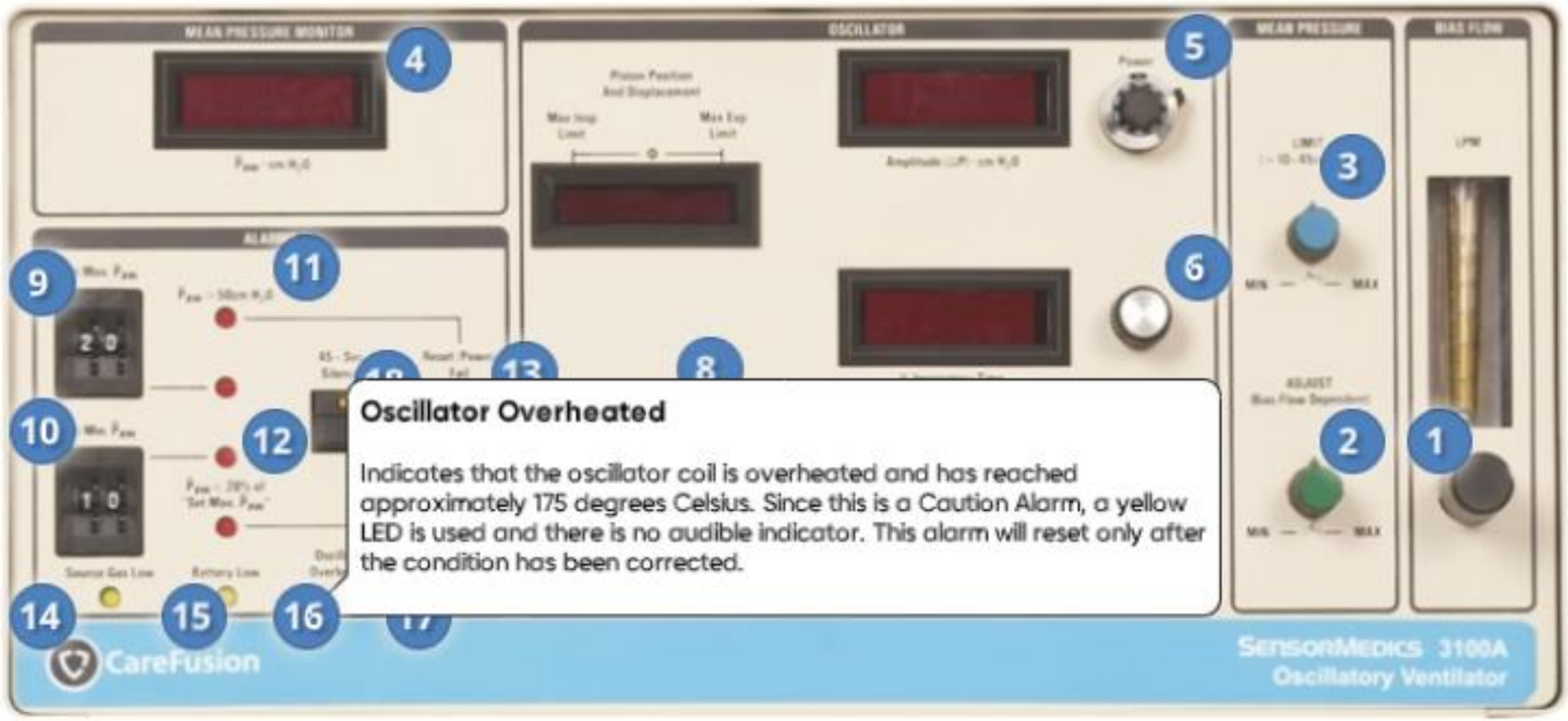

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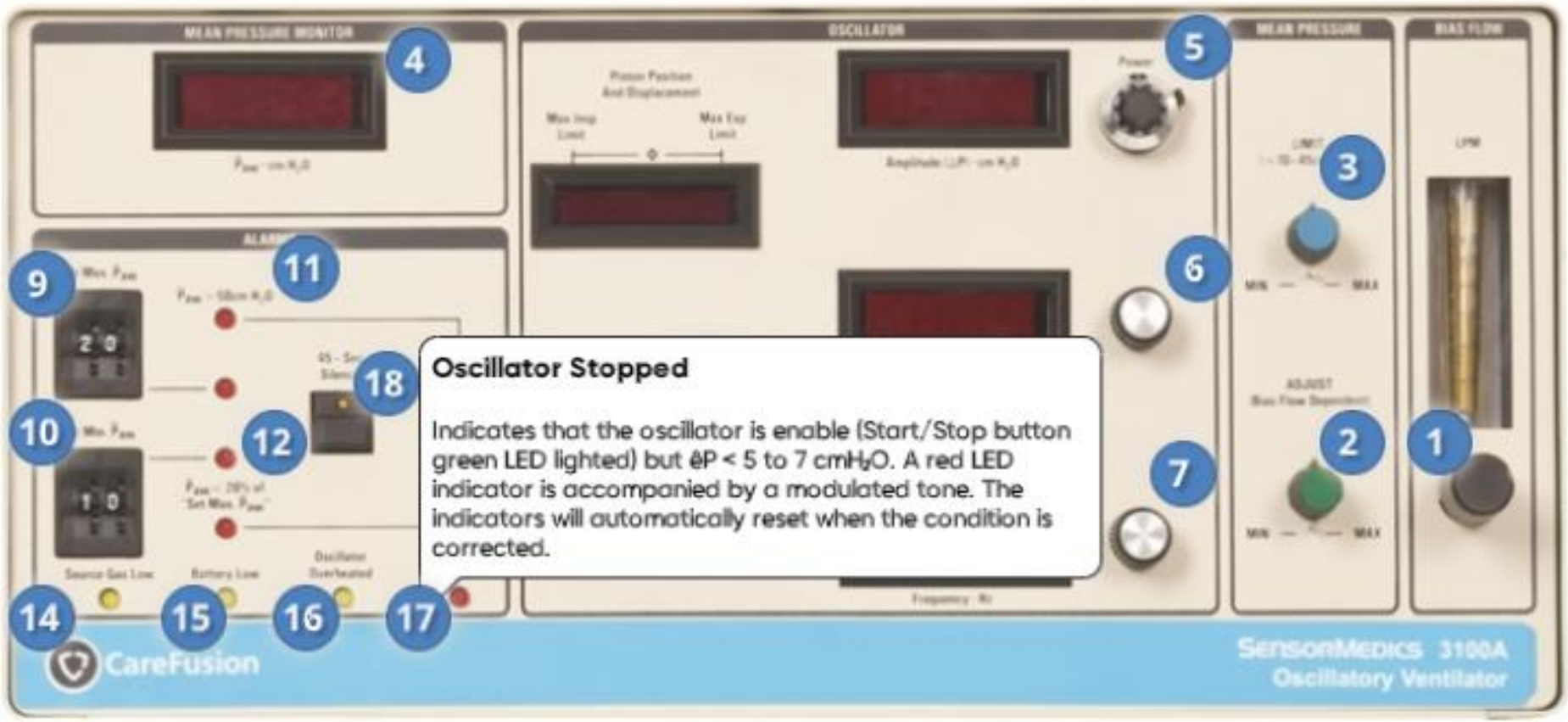

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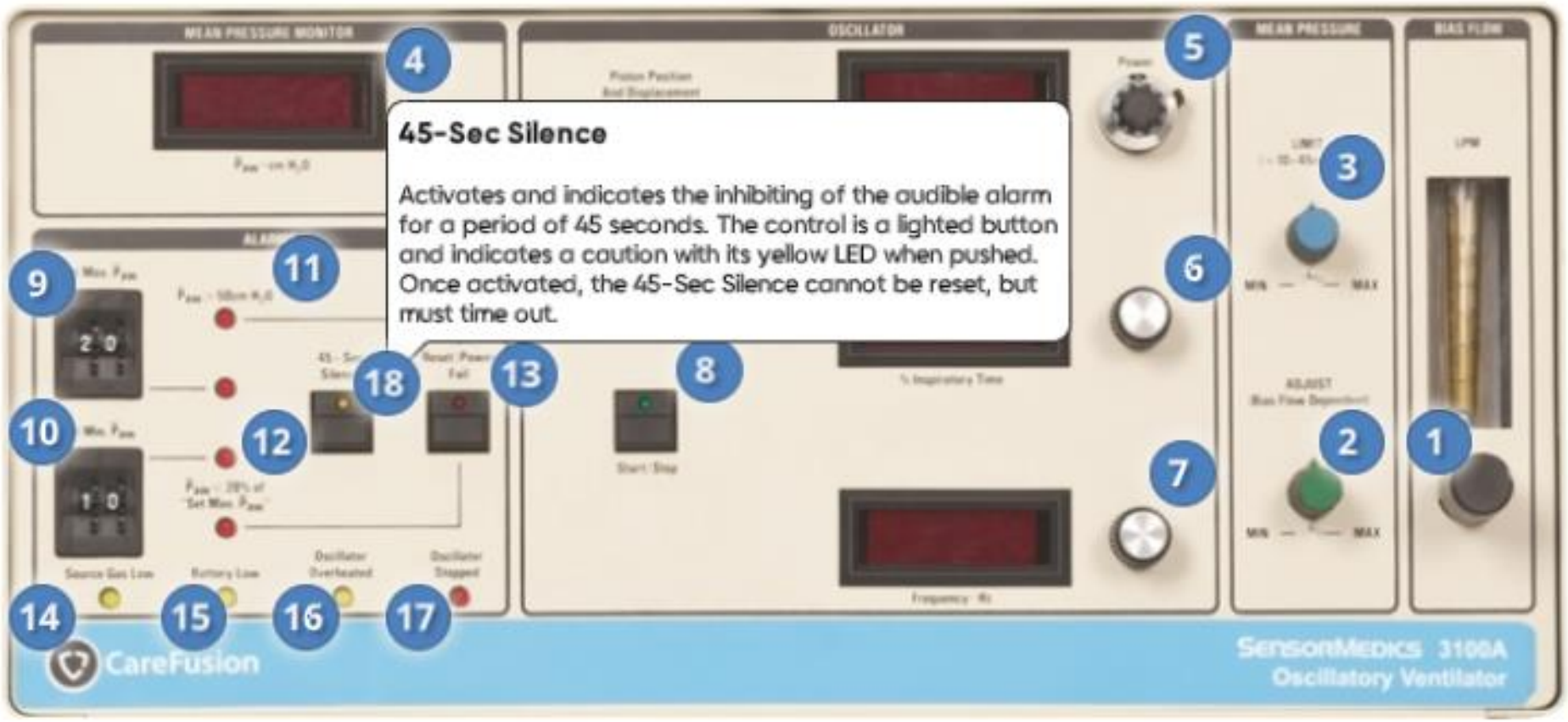
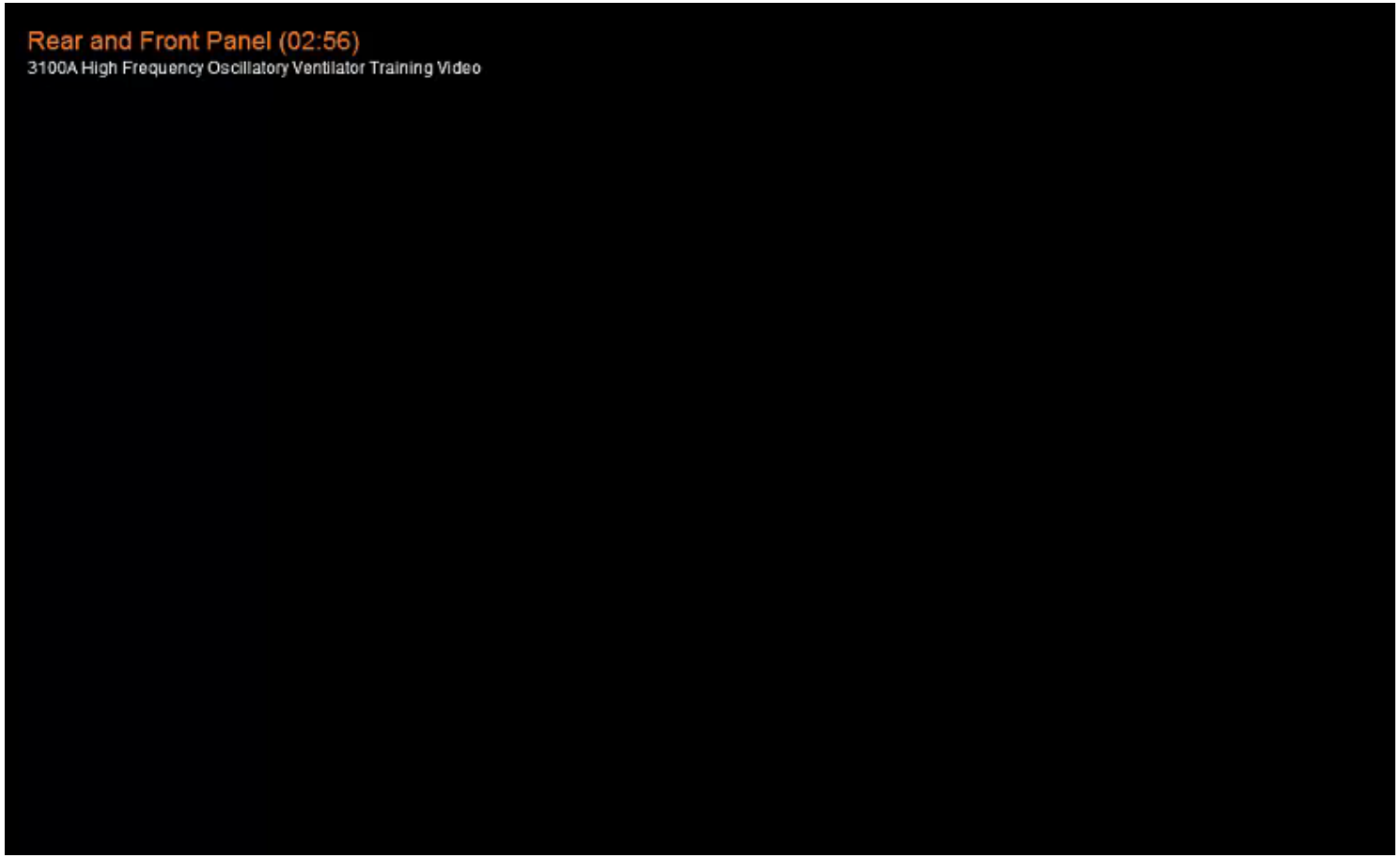
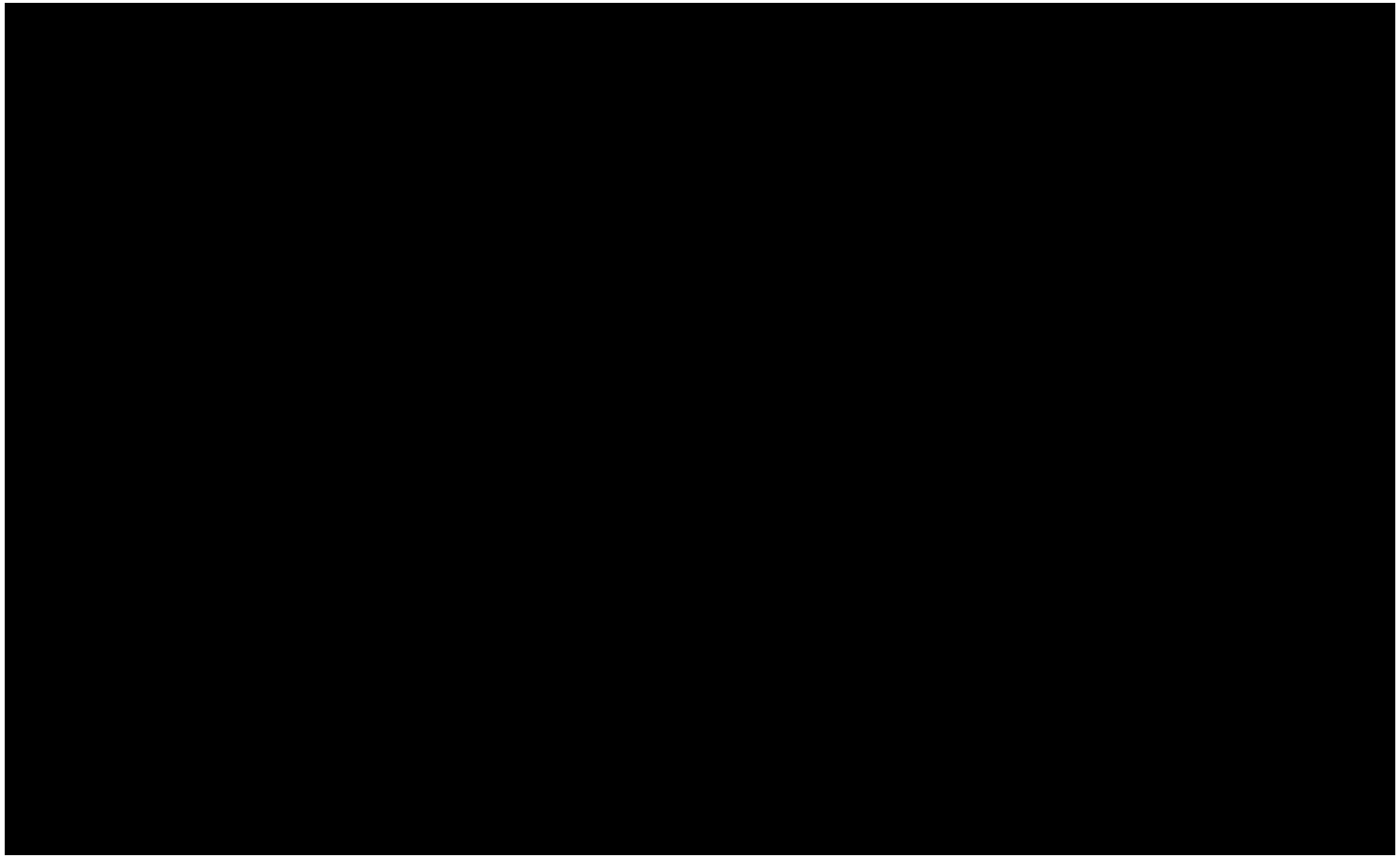


Video: Rear and Front Panel

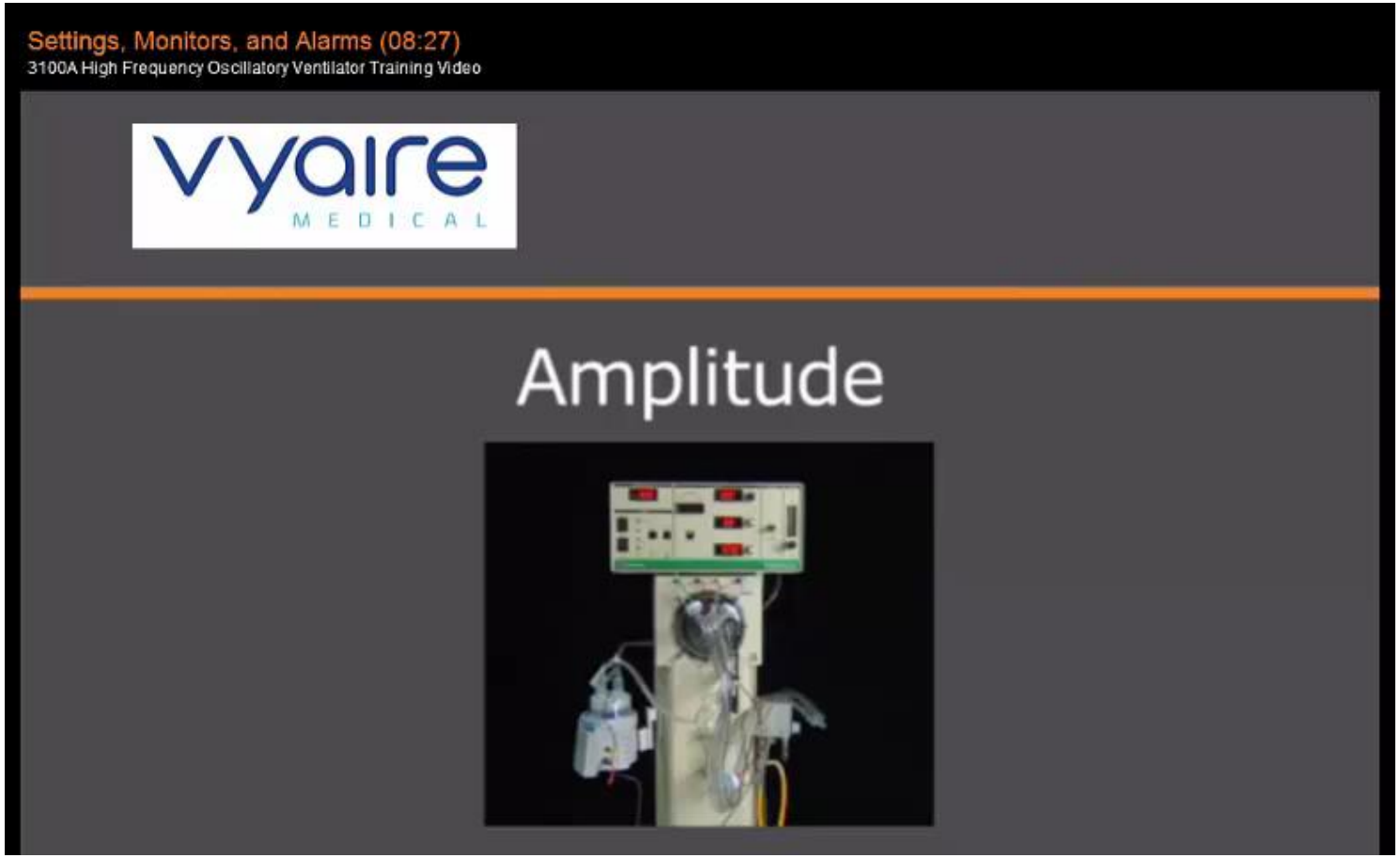


Video: Circuit Set Up Procedure

Video: Operational Verification and Start Up Procedure



Video: Settings Monitors and Alarms



Patient Management Guidelines

- Suctioning
  - Suctioning should be done prior to placing patient on HFOV
  - Subsequent suctioning should be done with an in-line suction catheter to prevent de-recruitment associated with disconnecting from HFOV
  - Observing an increase in amplitude with no adjustment of power may indicate increased airway resistance, which may indicate the need for suctioning
- Only suction PRN
  - Need indicated by a decreased or absent chest wiggle, decrease in saturation, or an increase in PCO2

Basic Patient Management Guidelines (cont.)

- Repositioning
  - Turning and flipping a prone patient is possible while on HFOV
    - Protect the endotracheal tube when turning the patient's head
    - After any position change, observe chest wiggle and endotracheal tube position
- Auscultation
  - In order to assess heart sounds or bowel sounds, you must stop the piston
    - Remember: stopping the piston stops ventilation, so your patient may not tolerate this well
  - Lung sounds may be heard if the patient is breathing spontaneously

Basic Patient Management Guidelines (cont.)

- Sedation
  - Depends on underlying disease process
  - Consider sedation or paralytics if infant is agitated and interfering with ventilation

Potential Complications

- Over-distention
  - Recognizable by increased PCO2 and/ or decreased saturation and possible decrease in blood pressure
  - If left untreated, may lead to a pneumothorax
- Partial endotracheal tube obstruction
  - Recognizable by a decreased chest wiggle and/or decreased saturation

High Paw (mPAW) alarm >50cmH2O

Check the following:

- Obstruction of the circuit expiratory limb
- Obstruction of the pressure sense line
- A patient breathing spontaneously at a high mPAW
- Check bias flow: adjust as needed

Displayed Paw > Set Max Paw Thumbwheel Alarm

Check the following:

- Spontaneously breathing patients may activate this alarm: check and assure bias flow is adequate
- Improper setting of thumbwheel: follow institutional guidelines
- Expiratory limb obstruction: check circuit
- Pressure sensing line obstruction: check circuit
- Patient circuit temperature rise: check humidifier

Displayed Paw (mPAW) < Set Min High Paw Thumbwheel Alarm

Check the following:

- Increased spontaneous breathing: check bias flow and mPAW
- Improper setting of thumbwheel: adjust as needed
- Improper setting of mean airway pressure or flowmeter
- Patient circuit temperature drop
- Leak in circuit or humidifier
- Diaphragm cap leak: replace as needed

Displayed Paw (mPAW) < 20% of Set Max Thumbwheel Alarm

Check the following:

- Improper thumbwheel setting: readjust
- Improper setting of mPAW and/or bias flow: adjust settings accordingly
- Improper setting of mean pressure limit: adjust as needed
- Leak in patient circuit or humidifier: be sure circuit is connected to the patient
- Cap diaphragm leak: replace cap

Low Gas Source Alarm

- Input pressure is less than 30 psi, either from blended gas or cooling air: check both gas supplies
- Check input flter
- Be sure there are no restrictions in the gas systems (high pressure hoses, valves, gas inlets)

Oscillator Stopped (with no other alarm)

Power setting too low

- DeltaP too low
- Gradually increase power setting for desired DeltaP

Oscillator not centered

- Readjust piston centering
- Oscillator failure
  - Remove from use
  - Call technical support

Battery Low Alarm

Battery voltage less than optimal

- Replace battery

Battery disconnected

- Reconnect battery

Oscillator Overheated Alarm

No cooling gas flow

- Check all gas connections
- Check inlet filter for obstructions of cooling gas flow (off patient)

Mis-centered piston at extremely high DeltaP settings

- Center piston

Mechanical failure

- Remove from use
- Call Vyaire Medical technical support

Failure to Pass Circuit Calibration Check

- Leak in circuit or humidifier
- Common leak sites are water trap stopcocks, temperature probe insertion sites, and humidifier chambers and connections
- Improper flow setting
  - Be sure that during circuit calibration, the flow meter ball is set at 20 L/min in the middle of the ball
  - Internal leak
    - Call technical support

Failure to Pass Ventilator Performance Check

- Incorrect circuit calibration
  - Repeat circuit calibration test
- Incorrect flow meter setting
  - Check flow meter and be sure flow meter ball is set at 20 L/min in the middle of the ball
- Incorrect altitude range being used
  - Verify altitude and retest
- Oscillator not centered properly
  - Re-center oscillator

Ventilator does not pass patient circuit calibration

Ensure bias flow is set to 20 L/min with the middle of the ball at 20 L/min at eye level (may have to bend down)

Visually check circuit for leaks, cracks, or open ports

- Check for open or missing water trap stopcock
- Check caps and diaphragms to make sure they are in place correctly and without leaks
- Check airway pressure luer fittings and connecting tubing to ensure good fit without leaks
- Check calibration screw- clicking indicates a defective valve
- Check heater ends – FP and Concha both leak the mPAW down to ~25 cmH,0

Ventilator does not pass performance check

Recheck all gas connections and settings

Repeat test procedure

- If 3100A continues to not pass, check troubleshooting guide in 3100A Operator’s Manual

Fluctuating mean airway pressure

Check the high pressure setting

Check for spontaneous breathing

Low source gas is illuminated

- Indicates an input pressure of less than 30 psi from either blender or cooling air, check input gas lines; ensure hoses are plugged into a gas source; check blender set up configuration

- Some wye or T fittings used to split the high pressure line have an internal restriction; remove the wye or T fitting to check it

Input water trap filter needs to be replaced

Internal leak

- Call Vyaire Medical technical support

Pressure dump is activated

Pressure > 50 cmHO: activates dump valve and stops oscillating

Attempt to re-pressurize system by depressing reset button

Common causes:

- Circuit gets crimped
- Unintentional adjustment of flow or adjust control to maximum
- Patient is abruptly turned to side
- Patient coughs forcefully

Pressure dump is activated (cont.)

Pressure < 20% of Set Max Thumbwheel Alarm: activates dump and stops oscillating

Common cause

- Patient disconnected from ventilator
- Temperature probe pulled out of circuit
- Cap and diaphragm has fallen apart, typically the one on the dump valve
- Inappropriate setting

Low Pressure Alarms

Check for appropriate setting of alarm: adjust as necessary

Assess clinical condition of patient

- If spontaneous breaths are observed, assess sedation and/or adequate bias flow rate
- If insufficient bias flow, increase and reset mPAW using adjust knob

Patient circuit temperature low

Leak in patient circuit or humidifier: fix leak or replace the circuit/humidifier chamber (consider MR290HFV chamber)

Cap diaphragm leak

Water trap stopcock is open

Interference from a radio transmitter

Amplitude changed without a change in power setting

Amplitude increased: airway resistance increased and/or total lung compliance decreased

Amplitude decreased: airway resistance decreased and/or total lung compliance increased

Note: Changes in amplitude are normal as the patient's pulmonary status changes. Assess the patient for chest wiggle, piston sounds, patient position, etc, and take appropriate action.

Questions?

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