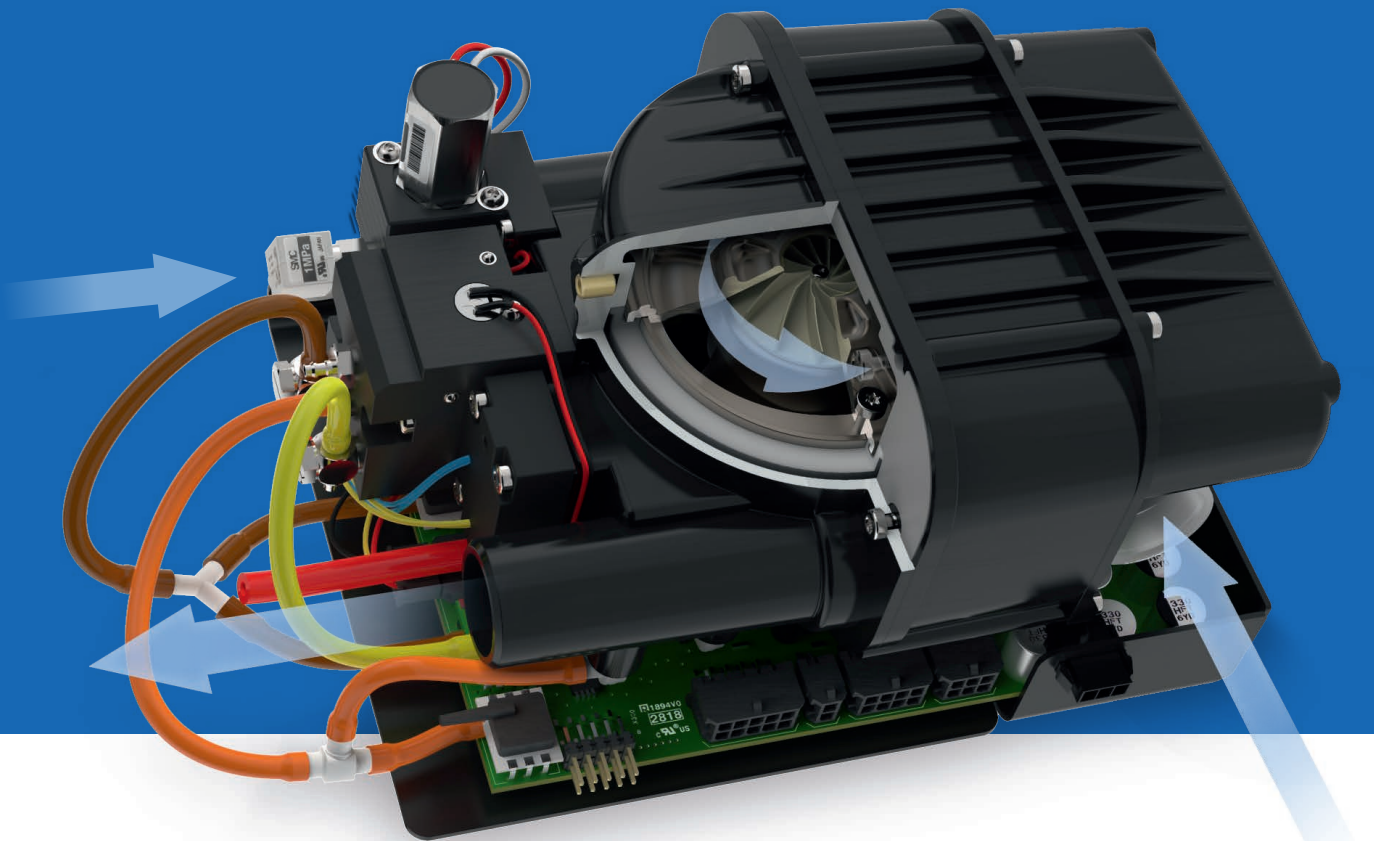


# Macawi Respiratory Module specifications.



## **TURBINE BLOWER BASED FULL FUNCTIONAL RESPIRATORY MODULE FOR VENTILATION**

The Macawi Respiratory Module (MRM) is an easy to integrate and highly flexible solution for ventilation. All invasive and non-invasive ventilation modes, for neonatal, pediatric and adult patients, including oxygen mixing are included in the module.

## VENTILATION MODES

Ventilation mode	Commercial name - description
PC-CMV	PC (Pressure Control)
VC-CMV	VC (Volume Control)
PC-SIMV	SIMV (PC)
VC-SIMV	SIMV (VC)
PC-SIMV+	Bi-Level Ventilation, PC-BIPAP
PC-ACV	ACV (PC)
VC-ACV	ACV (VC)
Spn-CPAP	CPAP
CFLOW	Continuous Flow at pre-set O2 concentration
PC-AMV	Assisted Manual Ventilation, Neonatal T-piece resuscitation
PC-APRV	Pressure controlled – Airway Pressure Release Ventilation
PC-MMV	Pressure controlled – Mandatory Minute Ventilation

## VENTILATION MODE OPTIONS

Ventilation mode option	Commercial name - description
NIV	Non Invasive Ventilation
Inspiratory flow pattern VC	Constant, accelerating, decelerating
PS Low	PSV (Pressure Support Ventilation on expiratory level)
PS High	PSV (Pressure Support Ventilation on inspiratory level)
PPS	Proportional Pressure Support
PCVR (Pressure Controlled Volume Regulation)	PRVC, AutoFlow, Volume Guarantee
HPO & LPO	High Pressure Oxygen & Low Pressure Oxygen
Tube Compensation	On inspiratory and/or expiratory level
Leakage compensation	Up to 80 L/min adult, 50L/min pediatric and 20L/min neo

## VENTILATION MANEUVERS

Name	Commercial name - description
Inspiratory Pause	Manual generation of prolonged inspiration time
Expiratory Pause	Manual generation of prolonged expiration time
Inspiratory Hold	
Expiratory Hold	Intrinsic PEEP, AutoPEEP
Recruitment	Generate a fixed number of elevated pressure strokes
P0.1	Measurement figure for weaning purposes
Sigh	Generate sigh maneuver at set time interval

## VENTILATION RELATED FUNCTIONALITIES

Functionality	Remark
Patient pressure, flow and volume monitoring	Proximal and distal patient flow and pressure measurement (including purge system)
Inspiratory and expiratory triggering	All modes, pressure and flow
Nebulizer control output	Driver for pneumatic valve
Hose compliance correction	For volume controlled modes
Oxygen sensor interface	Galvanic analog sensor or paramagnetic digital sensor
System tests	Sensor zeroing, self-test and test modes
System and patient circuit calibrations	Hose compliance, incl. leakage test, hose resistance, patient flow sensor and oxygen sensor calibrations
Expiration valve control	For external pneumatic valve
Safety valve control	For external pneumatic valve

## VENTILATION SETTINGS RANGE

Setting	Range
$V_T$	50 – 3000 mL in VC, 2 – 3000 mL in PCVR
Inspiratory flow (results in VC pressure plateau phase)	5 – 100 L/min
RR	3 – 200 breaths/min
$T_i$ , $T_e$ and $T_{ramp}$	150 – 30000 ms ( $T_i$ & $T_e$ ) 60 – 30000 ms ( $T_{ramp}$ )
BAP (PEEP setting)	0 – 50 mbar
$P_{insp}$	1 – 90 mbar
Pressure Support	1 – 90 mbar
$FiO_2$	21 – 100 Vol%

## MEASUREMENTS (REAL TIME)

Name	Remark
Airway Pressure	$T_s$ : 2ms
Patient Flow	$T_s$ : 2ms
Patient Volume	$T_s$ : 2ms

## MEASUREMENTS (BREATH BY BREATH)

Measurement	Explanation
VT	Tidal Volume (insp & exp) [mand & spon]
MV	Mandatory Volume (insp & exp & tot) [mand & spon]
RR	Respiratory Rate [mand & spon]
$P_{peak}$	Peak Pressure (PIP)
$P_{plat}$	Plateau Pressure
PEEP	Positive End-Expiratory Pressure
MAP	Mean Airway Pressure
$FiO_2$	Fraction of Inspired Oxygen
$V_{leak}$	Leakage volume per breath
$Flow_{peak\_insp}$	Inspiratory Peak Flow
$Flow_{peak\_exp}$	Expiratory Peak Flow
$P_{min}$	Minimum Pressure
PO.1	Negative pressure after 100 ms no inspiratory support
RSBI	Rapid Shallow Breathing Index
PTP	Pressure Time Product
$C_{stat}$	Static Compliance
$R_{insp}$	Inspiratory Resistance
AutoPEEP	Intrinsic PEEP
Tracheal Pressure	Derived Tracheal Pressure

## VENTILATION PERFORMANCE

Name	Range - Accuracy
Maximum Pressure	100 mbar at sea level (> 80 mbar at 3000m altitude)
Maximum Flow	> 220 L/min
Volume delivery	Adult & Ped: $\pm(10\text{ml} + 10\%)$ in VC Neo: $\pm(3\text{ml} + 15\%)$ in PCVR
Volume monitoring	Adult: $\pm(4\text{ml} + 12\%)$ Ped: $\pm(4\text{ml} + 15\%)$ Neo: $\pm(2\text{ml} + 15\%)$
Pressure delivery	All types: $\pm(2\text{mbar} + 5\%)$
Pressure monitoring	All types: $\pm(2\text{mbar} + 4\%)$
Oxygen delivery	$\pm(2.5\text{vol}\% + 2.5\%)$

## OPERATING CONDITIONS

Quantity	Range	Remark
Operating temperature	-20 – +60 degrees C	Environmental temperature
Relative air humidity	0 – 95% RH	Environmental RH
Air Pressure	500 – 1100 hPa	
Blower lifetime expectancy	> 45.000 hours	L10 @ moderate Ventilation level <sup>1</sup>
Noise generation	< 45 dB	@ a pressure of 40 mbar, ISO 3744

<sup>1</sup> P<sub>insp</sub> = 35 mbar, PEEP = 12 mbar, T<sub>slope</sub> = 200ms, RR = 12 /min @ Rp5C20

## ELECTRICAL OPERATING CONDITIONS

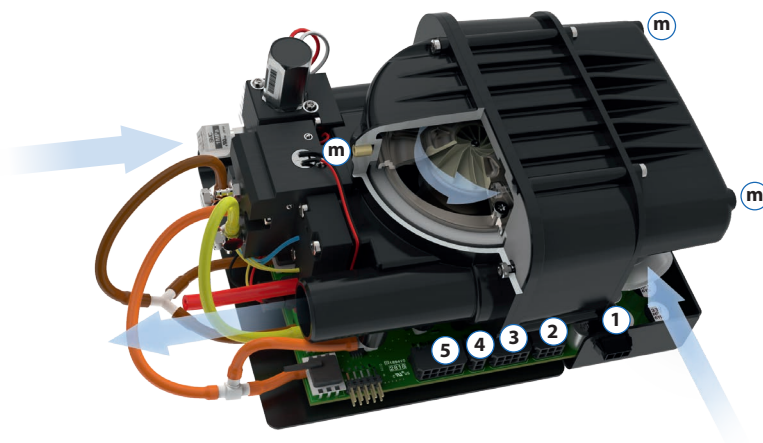
Quantity	Range	Remark
Power Supply Voltage	24V DC	
Peak current	≤ 6A	Max. 250ms during maximum pressure ramp-up
Continuous current	≤ 3A	@ 100 mbar
Nominal Power consumption	5 – 30 W	Depending on ventilation conditions

## DIMENSIONS AND WEIGHT

Property	Value
Dimensions	≈ 130 x 90 x 185 mm
Volume	≈ 2L
Module Weight	≈ 850g

## PRECOMPLIANCE TO STANDARDS

Software class C	(IEC 62304)	Oxygen monitoring	(IEC 80601-2-55)
Biocompatibility	(ISO 18562)	ICU ventilators	(IEC 80601-2-12)
Gas mixers	(ISO 11195)	EMC	(IEC 60601-1-2)
Oxygen compatibility	(ISO 15001)	Electrical Safety	(ISO 60601-1)
Transport Ventilators	(ISO 10651-3)	Emergency Care Ventilators	(EN 1789, IEC 60601-1-12)
QMS	(ISO 13485)	Shock & Vibration	(up to RTCA)



- 1: RS232 communication
- 2: Power supply
- 3: USB communication
- 4: Nebulizer
- 5: O<sub>2</sub> monitoring
- m: Mounting points

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