

HAMILTON-S1

Technical specifications for SW version 2.6x or higher

HAMILTON-S1 - Intelligent Ventilation built in

The HAMILTON-S1 is the most advanced mechanical ventilator available today with a number of unique features: It is the first ventilator featuring the "Ventilation Autopilot" INTELLiVENT-ASV®. INTELLiVENT-ASV automatically controls the patient's ventilation and oxygenation based on targets set by the clinician and on physiologic input from the patient.

The HAMILTON-S1 includes the Protective Ventilation (P/V) Tool to assess recruitability and find the best PEEP based on respiratory mechanics, as well as providing an easy and repeatable method for performing recruitment maneuvers.

For more information, visit our website: www.hamilton-medical.com/HAMILTON-S1

The unique integrated cuff pressure controller, IntelliCuff®, continuously monitors and adjusts cuffed tracheal and tracheostomy tubes, providing real-time optimization of cuff pressure.

Your benefits

- ✓ Advanced ventilation modes including ASV and INTELLiVENT-ASV
- ✓ Automated cuff pressure controller IntelliCuff
- ✓ P/V Tool Pro for lung assessment and recruitment
- ✓ Transpulmonary pressure measurement
- ✓ High flow oxygen therapy
- ✓ Adult, pediatric, and neonatal ventilation



Technical specifications

Ventilation Cockpit

Dynamic Lung	Real-time visualization of the lungs with representations of tidal volume, lung compliance, resistance and patient activity, including hemodynamic status and cuff pressure
Vent Status	Visual representation of ventilator dependency and weaning process, grouped into oxygenation, CO ₂ elimination, patient activity, PetCO ₂ , SpO ₂ , pulse, and heart lung index (HLI)
ASV target graphics	Graphic display of target and actual parameters for tidal volume, frequency, pressure, patient activity and minute ventilation
Monitoring	Display of more than 50 monitoring parameters (see page 3: monitoring parameters)
Real-time waveforms	Up to 8 waveforms at a glance based on: Paw, Pes, Paux, Volume, Flow, FetCO ₂ , PetCO ₂ , SpO ₂
Loops	Up to 4 loops at a glance based on: Volume, Flow, Paw, Pes, Paux, Ptranspulm, SpO ₂ , CO ₂ , reference loops
Trending	Simultaneous display of up to 17 parameter trends, selected from all monitoring parameters, for 1, 3, 12, 24, or 96 h
Event Log	Storage and display of up to 1,000 events with date and time stamp
Others	Graphic curve freeze and cursor function, inspiratory and expiratory hold; user configurable default graphics layout

Additional features and options

IntelliTrig	Automatic leakage compensation
Tube resistance compensation	Adjustable resistance compensation for endotracheal tubes
Transpulmonary monitoring	Transpulmonary pressure monitoring via esophageal catheter
P/V Tool Pro	Automatic maneuver for static compliance assessment and lung recruitment including transpulmonary pressure
Heliox ^(optional)	Heliox application
Capnography	Mainstream (volumetric) or sidestream CO ₂ sensor
SpO ₂ measurement	Pulse oximetry (SpO ₂ sensor)
IntelliCuff	Integrated continuous cuff pressure controller
Nebulizer	Integrated pneumatic nebulizer, Piezo Aerogen [®] nebulizer ^(optional)
Humidifier control ^{1) (optional)}	Control of HAMILTON-H900 humidifier via Ventilation Cockpit
Ventilation modes ^(optional)	Neonatal application, nCPAP-PS ¹⁾
Therapy mode ¹⁾	High flow oxygen therapy

Environment

Temperature	Operating: 10°C to 40°C (50°F to 104°F) / Storage: -10°C to 60°C (14°F to 140°F)
Humidity	Operating: 30% to 75% non condensing / Storage: 5% to 85% non condensing
Altitude	-650 m to 3,000 m (-2'132 to 9'843 ft) above sea level, automatically adjusted
Atmospheric pressure	70 kPa to 110 kPa

Standards and approvals

Declaration	The HAMILTON-S1 was developed in accordance with relevant international standards and FDA guidelines. The ventilator is manufactured within an EN ISO 13485 and EN ISO 9001, Council Directive 93/42/EEC, Annex II, Article 1 certified quality management system. The ventilator meets the Essential Requirements of Council Directive 93/42/EEC.
Classification	Class IIb according to EC directive 93/42/EEC, Class I, continuously operating according to IEC 60601-1
Certification	IEC 60601-1, IEC 60601-1-2, ISO 80601-2-12, C22.2 No. 601.1, UL 60601-1
Safety Class	Type B: ventilator breathing system, cuff controller, pneumatic nebulizer / Type BF: CO ₂ sensor including CO ₂ module connector, humidifier, Aerogen [®] nebulizer, SpO ₂ sensor including SpO ₂ adapter
Electromagnetic compatibility (EMC)	According to IEC 60601-1-2

Technical specifications

Ventilation modes

Type	Mode	Description	Neonatal capability
Closed-loop control	ASV	Adaptive Support Ventilation. Guaranteed minute volume and respiratory rate	
	INTELLiVENT-ASV	Fully closed loop ventilation and oxygenation	
Adaptive	APVcmv	Adaptive pressure ventilation + CMV	✓
	APVsimv	Adaptive pressure ventilation + SIMV	✓
Pressure	P-CMV	Pressure-controlled mandatory ventilation	✓
	P-SIMV	Pressure-controlled synchronized intermittent mandatory ventilation	✓
	SPONT	Pressure support ventilation with bidirectional backup	✓
	DuoPAP	Dual positive airway pressure (biphasic positive airway pressure)	✓
	APRV	Airway pressure release ventilation	✓
Volume	(S)CMV	(Synchronized) controlled mandatory ventilation	
	SIMV	Synchronized intermittent mandatory ventilation	
	VS ¹⁾	Volume support. Tidal volume guaranteed with bidirectional backup	✓
Noninvasive	NIV	Noninvasive ventilation with bidirectional backup	
	NIV-ST	Noninvasive ventilation with mandatory rate	
	nCPAP-PS ¹⁾	Synchronized nasal CPAP for infants/neonates	✓
Oxygen therapy	Hi Flow O ₂ ¹⁾	High flow oxygen therapy	✓

Monitoring parameters

Type	Parameter	Unit	Description	Numeric monitoring	Wave-forms	Vent Status	Dynamic Lung	
Pressure	Paw	cmH ₂ O	Real-time airway pressure		✓			
	Pes (Paux)	cmH ₂ O	Real-time auxiliary pressure		✓			
	Ppeak	cmH ₂ O	Peak airway pressure	✓				
	Pmean	cmH ₂ O	Mean airway pressure	✓				
	Pminimum	cmH ₂ O	Minimum airway pressure	✓				
	Pplateau	cmH ₂ O	Plateau airway pressure	✓				
	PEEP/CPAP	cmH ₂ O	Positive-end expiratory pressure / cont. positive airway pressure	✓		✓		
	Pinsp	cmH ₂ O	Inspiratory pressure			✓		
	Pcuff	cmH ₂ O	Cuff pressure	✓			✓	
	Ptrans I	cmH ₂ O	Transpulmonary pressure at the end of inspiration	✓				
	Ptrans E	cmH ₂ O	Transpulmonary pressure at the end of expiration	✓				
	Ptransplum	cmH ₂ O	Real time transpulmonary pressure			✓		
	Flow	Flow	l/min	Real-time inspiratory/expiratory flow	✓	✓		
		Insp Flow	l/min	Peak inspiratory flow	✓			
Exp Flow		l/min	Peak expiratory flow	✓				
Volume	Volume	ml	Real-time tidal volume		✓		✓	
	VTE/VTEspont/VTI	ml	Expiratory tidal volume / Spont VTE / Inspiratory tidal volume	✓				
	ExpMinVol/MVspont	ml	Expiratory minute volume / Spont minute volume	✓		✓		
	VLeak	ml/%	Leakage volume at the airway	✓				
	VT/IBW	ml/kg	Ratio of tidal volume and ideal body weight to avoid excessive VT	✓				
Humidifier H900	Temperature Y-piece	°C	Temperature Y-piece	✓				
	Temperature humidifier	°C	Chamber outlet temperature	✓				
	Relative humidity	°C	Temperature difference between humidifier chamber and Y-piece	✓				

¹ Not yet available in all markets

Technical specifications

Monitoring parameters

Type	Parameter	Unit	Description	Numeric monitoring	Wave-forms	Vent Status	Dynamic Lung	
Time	I:E	b/min	Inspiratory / expiratory ratio	✓				
	fTotal	b/min	Total breathing frequency	✓			✓	
	fSpont	s	Spontaneous breathing frequency	✓				
	TI	s	Inspiratory time	✓				
	TE	%	Expiratory time	✓				
	VarilIndex	%	Index of spontaneous respiratory rate variability			✓		
	%fSpont	ml/cmH ₂ O	Percentage of spontaneous breathing rate			✓		
Lung mechanics	Cstat	cmH ₂ O	Static compliance	✓			✓	
	PO.1	cmH ₂ O	Airway occlusion pressure	✓		✓		
	AutoPEEP	cmH ₂ O*s	AutoPEEP or intrinsic PEEP	✓				
	PTP	s	Pressure-time product	✓				
	RCexp	s	Expiratory time constant	✓				
	RCinsp	cmH ₂ O / l/s	Inspiratory time constant	✓				
	Rexp	cmH ₂ O / l/s	Expiratory flow resistance	✓				
	Rinsp	l/l*min	Inspiratory flow resistance	✓			✓	
	RSB	J/l	Rapid shallow breathing index	✓		✓		
	WOBimp	%	Imposed work of breathing	✓				
	Oxygen	Oxygen	%	Airway oxygen concentration (FiO ₂)	✓		✓	
	CO ₂	FetCO ₂	%	Fractional end-tidal CO ₂ concentration	✓			
PetCO ₂		mmHg/Torr/kPa	End-tidal CO ₂ partial pressure	✓			✓	
SlopeCO ₂		ml	V/Q status of the lung	✓				
Vtalv		l/min	Alveolar tidal ventilation	✓				
V'alv			Alveolar minute ventilation	✓				
V'CO ₂		ml/min	CO ₂ elimination	✓				
VDaw		ml	Airway dead space	✓				
VDaw/VTE		%	Dead space fraction measured at the airway opening	✓				
VeCO ₂		ml	Exhaled volume of CO ₂	✓				
ViCO ₂		ml	Inspired volume of CO ₂	✓				
SpO ₂	Plethysmogram		Real-time plethysmogram		✓			
	SpO ₂	%	Saturation (pulse oximetry)	✓			✓	
	SpO ₂ /FiO ₂		SpO ₂ /FiO ₂ ratio as approximation to PaO ₂ /FiO ₂ ratio	✓				
	HLI	%	Heart Lung Interaction Index (not available in all markets)	✓			✓	
	Pulse	1/min	Pulse rate	✓			✓	
	SpCO ¹⁾	%	Carbon monoxide concentration	✓				
	SpMet ¹⁾	%	Methaemoglobin concentration	✓				
	SpOC ¹⁾	mL/dL	Total oxygen content	✓				
	SpHb ¹⁾	g/dL \ mmol/L	Total haemoglobin	✓				

Alarms

Operator adjustable alarms	Low/high minute volume, low/high pressure, low/high tidal volume, low/high respiratory rate, apnea time, low/high PetCO ₂ , low/high pulse, low/high SpO ₂ , low/high SpMet, low/high SpOC, %leak,
Special alarms	Oxygen alarm limit exceeded, oxygen concentration, disconnection, loss of PEEP, exhalation obstruction, HLI, high PEEP alarm, flow sensor alarms, ASV/APV, CO ₂ , power supply, gas supplies, cuff leakage, PI (perfusion index), humidifier water level, humidifier temperature, humidifier tilt & disconnection
Loudness (Volume)	adjustable (1-10)

Technical specifications

Controls

Type	Adult	Pediatric	Neonatal
Ventilation modes	see page 3: Ventilation modes	see page 3: Ventilation modes	see page 3: Ventilation modes
Patient groups	Adult	Pediatric	Neonates (optional)
Patient height	130 to 250 cm (50 to 100 in),	30 to 150 cm (12 to 60 in),	--
Patient gender	Male, female	Male, female	--
Patient weight	> 30 kg (> 66.1 lb)	3 to 42 kg (6.61 to 92.6 lb)	0.2 - 15 kg (0.44 to 33 lb)
(S)CMV	5 to 120 b/min	5 to 120 b/min	--
P-CMV	5 to 120 b/min	5 to 120 b/min	5 to 150 b/min
SIMV	1 to 60 b/min	1 to 60 b/min	--
P-SIMV	1 to 60 b/min	1 to 60 b/min	1 to 80 b/min
APVcmv	5 to 120 b/min	5 to 120 b/min	5 to 150 b/min
APVsimv	1 to 60 b/min	1 to 60 b/min	1 to 80 b/min
DuoPAP	1 to 60 b/min	1 to 60 b/min	1 to 80 b/min
APRV	1 to 300 b/min	1 to 300 b/min	1 to 300 b/min
nCPAP-PS ¹⁾	--	--	5 to 150 b/min
Tidal volume/target tidal volume	100 to 2'000 ml	20 to 300 ml	2 to 200 ml (only Vtarget)
PEEP/CPAP (P low)	0 to 50 cmH ₂ O	0 to 50 cmH ₂ O	0 to 25 cmH ₂ O
Oxygen	21% to 100%	21% to 100%	21% to 100%
I:E ratio	1:9 to 4:1 1:599 to 149:1 (APRV/DuoPAP)	1:9 to 4:1 1:599 to 149:1 (APRV/DuoPAP)	1:9 to 4:1 1:599 to 149:1 (APRV/DuoPAP)
Inspiratory time (Ti)	0.1 to 10 s	0.1 to 3 s	0.1 to 3 s
Inspiratory time (Ti) spont	1 to 3 s	0.5 to 3 s	0.25 to 3 s
% Inspiratory time	max. 10 s (10% to 80% of cycle time)	--	--
Inspiratory pause time	0 to 8 s	--	--
Pause time	0 to 8 s (0% to 70% of cycle time)	0 to 8 s (0% to 70% of cycle time)	--
Peak flow	1 to 180 l/min	--	--
T low (APRV)	0.1 to 30 s	0.1 to 30 s	0.1 to 30 s
T high (DuoPAP and APRV)	0.1 to 30 s	0.1 to 30 s	0.1 to 30 s
Pressure trigger below PEEP/CPAP	off, 0.5 to 15 cmH ₂ O	off, 0.5 to 15 cmH ₂ O	off, 0.1 to 5 cmH ₂ O
Flow trigger	0.5 to 15 l/min	0.5 to 15 l/min	0.1 to 5 l/min
Automatic base flow	1 to 30 l/min	1 to 30 l/min	1 to 6 l/min
Pressure control	5 to 100 cmH ₂ O	5 to 100 cmH ₂ O	3 to 50 cmH ₂ O
Pressure support	0 to 100 cmH ₂ O	0 to 100 cmH ₂ O	0 to 50 cmH ₂ O
P high (DuoPAP and APRV)	0 to 50 cmH ₂ O	0 to 50 cmH ₂ O	0 to 50 cmH ₂ O
Pressure ramp	0 to 200 ms	0 to 200 ms	0 to 200 ms
Cuff Pressure	0 to 50 cmH ₂ O	0 to 50 cmH ₂ O	0 to 50 cmH ₂ O
% minute volume (ASV)	25% to 350%	25% to 350%	--
Flow patterns	Sine, square, dec., 50% dec.	Sine, square, dec., 50% dec.	--
Expiratory trigger sensitivity (ETS)	5% to 70% of inspiratory peak flow	5% to 70% of inspiratory peak flow	5% to 70% of inspiratory peak flow
High flow oxygen therapy ¹⁾	1 to 60 l/min	1 to 60 l/min	1 to 12 l/min

Special functions

Pneumatic integrated nebulizer, manual breath, O₂ enrichment, suctioning tool, sigh, apnea backup ventilation, tube resistance compensation (TRC), standby, print screen, screen lock

Sound level

Sound power level: 46.6 dBA ± 3 dBA; Sound pressure level: 38.6 dBA ± 3 dBA

Alarm signal sound level: Maximum 73 dB, Minimum 51 dB

Technical specifications

Physical dimensions and communication

Size	See graphics below
Weight	57 kg (125.6 lb) with standard trolley, 38 kg (83.8 lb) with shelf mount
Display (detachable, incl. rail clamp)	15" XGA, TFT color, LCD touchscreen, 3m (10 ft) cable with optional 7 m (23 ft) extension, 6.4 kg (14.1 lb)
Interface connectors	USB and CompactFlash for screenshots, updates and log data, DVI with VGA output, 2 serial RS-232 ports (data monitoring / HAMILTON-H900 humidifier control), special data interface for nurse call and alarm output, SpO ₂ & CO ₂ sensor, Aerogen, Cuff interface

Electrical and gas supplies

Input voltage	100 to 240 V ~ ±10%, 50/60 Hz, automatic range selection
Power consumption	210 VA maximum
Internal battery	Lead Acid, 12V / 13Ah, Backup time: typical 1 h, Recharge time: 15 h
External hot-swappable battery (optional)	Lithium Ion, 14.4V / 97Wh (6.6 Ah), Backup time: typical 1 h, Recharge time: 7 h, With external charger: 3 h
Degree of protection	IP21
Oxygen, Heliox and air supply inlets	200 to 600 kPa (29 to 86 psi), maximum flow: 120 l/min, DISS male, NIST or NF
Main patient outlet	ISO 22mm OD, 15mm ID
Exhaust port	30mm OD

