

HAMILTON-S1

Technical specifications for SW version 2.80

Ventilation modes

Mode form	Mode name	Mode	Adult/Ped	Neonatal
Volume-controlled, flow-controlled	(S)CMV	Breaths are volume controlled and mandatory, including patient triggered breaths.	✓	--
	SIMV	A fixed rate is set for volume-controlled mandatory breaths. These breaths can be alternated with pressure-supported spontaneous breaths.	✓	--
Volume-controlled, flow cycled	VS	Breaths are flow cycled and deliver a set tidal volume to support patient-initiated breaths.	✓	✓
Volume-targeted, adaptive pressure- controlled	APVcmv	Breaths are volume targeted and mandatory.	✓	✓
	APVsimv	Volume-targeted mandatory breaths can be alternated with pressure-supported spontaneous breaths.	✓	✓
Pressure-controlled	P-CMV	All breaths, whether triggered by either the patient or the ventilator, are pressure controlled and mandatory.	✓	✓
	P-SIMV	Mandatory breaths are pressure controlled. Mandatory breaths can be alternated with pressure-supported spontaneous breaths.	✓	✓
	DuoPAP	Mandatory breaths are pressure controlled. Spontaneous breaths can be triggered at both pressure levels.	✓	✓
	APRV	Spontaneous breaths can be continuously triggered. The pressure release between the levels contributes to ventilation.	✓	✓
	SPONT	Every breath is spontaneous, with or without pressure-supported spontaneous breaths.	✓	✓
Intelligent ventilation	ASV®	Operator sets %MinVol, PEEP, and Oxygen. Frequency, tidal volume, pressure, and I:E ratio are based on physiological input from the patient.	✓	--
	INTELLIVENT®-ASV	Fully automated management of ventilation and oxygenation based on physiological input from the patient. The underlying mode is ASV.	✓	--
Noninvasive ventilation	NIV	Every breath is spontaneous.	✓	--
	NIV-ST	Every breath is spontaneous as long as the patient is breathing above the set rate. A backup rate can be set for mandatory breaths.	✓	--
	nCPAP-PS	Every breath is spontaneous as long as the patient is breathing above the set rate. A backup rate can be set for mandatory breaths.	--	0
	Hi Flow O2	High flow oxygen therapy. No supported breaths.	✓	✓

Standard: ✓ Option: 0 Not applicable: --



Standard configuration and options (in alphabetical order)

Functions

Adjustable O2 enrichment

Adjustable Volume limitation

Capnography, mainstream (volumetric) and sidestream

Communication ports: CompactFlash, USB, DVI, COM (RS-232), Special interface

Communication protocols: for details see Connectivity brochure

Distributed alarm system (DAS) compatible

Dynamic Lung (real-time visualization of the lungs)

Event log (up to 1000 events with date and time stamp)

HAMILTON-H900 humidifier control via ventilator

Heliox ventilation

Inspiratory and expiratory hold maneuver

IntelliCuff integrated cuff pressure controller

IntelliSync+ (automatic inspiratory and expiratory trigger synchronization)

IntelliTrig (leak compensation)

Languages

(English, US English, Bulgarian, Chinese, Croatian, Czech, Danish, Dutch, Finnish, French, German, Greek, Hungarian, Indonesian, Italian, Japanese, Korean, Norwegian, Polish, Portuguese, Romanian, Russian, Serbian, Slovakian, Spanish, Swedish, Turkish)

Manual breath / prolonged inspiration

Nebulization (Aerogen[®])

Nebulization (pneumatic)

P/V Tool[®] Pro

Paramagnetic O2 sensor

Patient group

Paux port

Print screen

Screen lock

Second battery (hot-swappable)

SpO2 monitoring

Standby with timer

Suctioning tool

Transpulmonary pressure monitoring

TRC (tube resistance compensation)

Trends/Loops

Trigger, expiratory: ETS

Trigger, inspiratory: flow, pressure

Vent Status (Visual representation of ventilator dependency)

Technical performance data (in alphabetical order)

Description	Specification
Automatic expiratory base flow	<p>Adult/Pediatric.</p> <p>Pressure trigger: 1 l/min</p> <p>Flow trigger setting ≤ 2 l/min: 4 l/min</p> <p>Flow trigger setting > 2 l/min: 2 * Flow trigger</p> <p>Trigger OFF: 1 l/min</p> <p>IntelliSync+: 4 l/min</p> <p>Neonatal.</p> <p>Pressure trigger: 1 l/min</p> <p>Flow trigger setting ≤ 1 l/min: 2 l/min</p> <p>Flow trigger setting > 1 l/min: 2 * Flow trigger max. 6 l/min</p> <p>Trigger OFF: 1 l/min</p>
Inspiratory pressure	0 to 120 cmH ₂ O
Maximum inspiratory flow	180 l/min peak flow, max. 120 l/min continuous flow
Means of inspiratory triggering	Flow, pressure, or optional IntelliSync+ trigger control
Means of expiratory triggering	ETS or optional IntelliSync+ control
Minimum expiratory time	20% of cycle time; 0.1 to 0.8 s
Oxygen mixer accuracy	± (Volume fraction of 2.5% + 2.5% of actual reading)
Preoperational checks	Tightness test, Flow Sensor/O ₂ sensor/CO ₂ sensor calibration
Tidal volume	<p>Adult/Ped: 20 to 2000 ml</p> <p>Neonatal: 2 to 200 ml</p>

Standards and approvals

Classification	Class IIb, continuously operating according to EC directive 93/42/EEC
Certification	EN 60601-1:2006/A1:2013, IEC 60601-1-2:2014, ANSI/AAMI ES60601-1:2005/(R)2012, ISO 80601-2-12:2011, CAN/CSA-C22.2 NO. 60601-1:14, EN ISO 5356-1:2015, ISO 80601-2-55:2011
Declaration	The HAMILTON-S1 was developed in accordance with pertinent 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, Annex I.
Electromagnetic compatibility	According to IEC 60601-1-2:2014
Safety Class	Class I, Type B applied part (ventilator breathing system, VBS), type BF applied parts CO ₂ sensor including CO ₂ module connector, humidifier, Aerogen [®] system, nebulizer, and SpO ₂ sensor including SpO ₂ adapter, continuous operation according to IEC 60601-1
Degree of protection	IP21

Pneumatic specifications

O ₂	Input pressure	2 to 6 bar / 29 to 87 psi
	Connector	DISS (CGA 1240) or NIST (optional), NF (optional)
Air supply	Input pressure	2.8 to 6 bar / 41 to 87 psi
	Connector	CGA 1160-A
Heliox	Input pressure	2.8 to 6 bar / 41 to 87 psi
	Connector	CGA 1180-A (optional)
Inspiratory outlet (To patient port)	Connector	ISO ID15/OD22 conical
Expiratory outlet (From patient port)	Connector (on expiratory valve)	ISO ID15/OD22 conical
	Exhaust port	OD30

Electrical specifications

Input power	100 to 240 VAC \pm 10%, 50/60 Hz	
Power consumption	210 VA maximum	
Battery	Electrical specifications:	12 V DC, 15 Ah
	Type:	Lead-acid
	Normal operating time:	Backup time: typical 1 h, Recharge time: 15 h
External hot-swappable battery (optional):	Electrical specifications:	14.4 V DC, 6.6 Ah
	Type:	Lithium Ion
	Normal operating time:	Backup time typically 1 h, Recharge time: 7 h With external charger: 3 h

Graphical patient data

Graphic type/Tab name	Options
Waveforms	Paw, Flow, Volume, Off, PCO ₂ ¹ , FCO ₂ ¹ , Plethysmogram ² , Pes (Paux) ³ , Ptranspulm ³
Intelligent panels	Dynamic Lung ⁴ , Vent Status, ASV Graph ⁵ , ASV Monitor, SMPs (Secondary monitoring parameter)
Trends	1-, 3-, 12-, 24-, or 96-h trend data for a selected parameter or combination of parameters
Loops	Paw/Volume, Paw/Flow, Volume/Flow, Volume/PCO ₂ ¹

Alarms⁶

Priority	Alarm
High priority	Apnea time (s), ExpMinVol high/low (l/min), Oxygen high/low (%), Pressure high/low (cmH ₂ O), Flow sensor calibration needed, Exhalation obstructed, Disconnection, Oxygen supply failed
Medium priority	fTotal high/low (b/min), PetCO ₂ high/low (mmHg), Pressure limitation (cmH ₂ O), Vt high/low (ml), SpO ₂ high/low, SpOC high/low, %leak, High PEEP, Loss of PEEP, Pulse high/low, Check flow sensor for water
Low priority	High SpO ₂ , Loss of external power, Cuff leak

¹ CO₂ option required | ² SpO₂ option required | ³ Data is available only when an esophageal catheter is connected to the Paux port on the ventilator
⁴ For adult/pediatric patients only | ⁵ Only available in ASV mode | ⁶ For complete list of alarms see the Operator's manual

Control settings and ranges⁷

Parameter (units)	Range Adult/Ped	Range Neonatal
Additional O2 for enrichment (%)	0 to 79	0 to 79
Apnea backup	Enabled, disabled	Enabled, disabled
End PEEP (cmH2O)	0 to 35 ⁸	0 to 35 ⁸
Expiratory trigger sensitivity ETS (%)	5 to 70	5 to 70
Flow for Hi Flow O2 therapy (l/min)	1 to 60	1 to 12
Flow pattern	Square, 50% decelerating, Sine, 100% decelerating	--
Gender (sex)	Male, Female	--
I:E	1:9 to 4:1	--
%MinVol (%)	25 to 350	--
Nebulizer Duration (min)	5 to 40	5 to 40
Nebulizer Synchronization	Inspiration, Exhalation, Insp. and Exh.	Inspiration, Exhalation, Insp. and Exh.
Oxygen (%)	21 to 100	21 to 100
P high (cmH2O)	0 to 50	0 to 50
P low (cmH2O)	0 to 50	0 to 25
P ASV limit (cmH2O)	10 to 110	--
Pat. height (cm)	130 to 250 / 30 to 150	--
Pat. height (in)	50 to 100 / 12 to 60	--
Pause (%)	0 to 70	--
Pcontrol (cmH2O)	5 to 100	3 to 50
Peak flow (l/min)	1 to 180 ⁴	--
PEEP/CPAP (cmH2O)	0 to 50	0 to 25
P-ramp (ms)	0 to 200	0 to 200
Ramp speed (cmH2O/s)	2 to 5	2 to 5
Pstart (cmH2O)	0 to 35 ⁸	0 to 35 ⁸
Psupport (cmH2O)	0 to 100	0 to 50
Ptop (cmH2O)	25 to 60	25 to 60
Rate (b/min)	1 to 120	1 to 150
Sigh	Enabled, disabled	Enabled, disabled
%TI (%)	4 to 80 ⁴	--
TI (s)	0.1 to 9.6	0.1 to 3
T high (s)	0.1 to 30	0.1 to 30
T low (s)	0.1 to 30	0.1 to 30
TI max (s)	0.5 to 3.0	0.25 to 3.0
Tip (s)	0 to 8 ⁴	--
Tpause (s)	0 to 30	0 to 30
TRC compensation (%)	10 to 100	10 to 100
TRC Tube size (I.D.) (mm)	3 to 10	2.5 to 5

⁷ Parameter settings and ranges can change depending on the mode

Control settings and ranges⁷

Parameter (units)	Range Adult/Ped	Range Neonatal
Trigger, Expiratory	ETS, IntelliSync+	ETS
Trigger, Inspiratory	P-trigger, Flowtrigger, IntelliSync+, Trigger OFF	P-trigger, Flowtrigger, Trigger OFF
Trigger, flow (l/min)	0.5 to 15	0.1 to 5.0
Trigger, pressure (P-trigger) (cmH ₂ O)	-0.5 to -15.0 (below PEEP/CPAP)	-0.1 to -5.0 (below PEEP/CPAP)
V limit (ml)	--	4 to 400
Vt (ml)	20 to 2000	--
Vtarget (ml)	20 to 2000	2 to 200
Weight (kg)	--	0.2 to 15.0

⁸ In some markets, the maximum is 20 cmH₂O

Monitoring parameters

Parameter (units)	Description	
Pressure	AutoPEEP (cmH ₂ O)	Unintended positive end-expiratory pressure
	Paux (cmH ₂ O)	Auxiliary pressure
	ΔP (cmH ₂ O)	Driving pressure
	Pcuff (cmH ₂ O)	Cuff pressure
	Ptrans I (cmH ₂ O)	The arithmetic mean value of Ptranspulm over the last 100 ms of the last inspiration.
	Ptrans E (cmH ₂ O)	The arithmetic mean value of Ptranspulm over the last 100 ms of the last expiration.
	PEEP/CPAP (cmH ₂ O)	PEEP (positive end-expiratory pressure) and CPAP (continuous positive airway pressure)
	Pmean (cmH ₂ O)	Mean airway pressure
	Ppeak (cmH ₂ O)	Peak airway pressure
	Pplateau (cmH ₂ O)	Plateau or end-inspiratory pressure
Flow	Pminimum (cmH ₂ O)	Minimum airway pressure of the previous breath cycle
	Insp Flow (l/min)	Peak inspiratory flow, spontaneous or mandatory
	Exp Flow (l/min)	Peak expiratory flow
Volume	Flow (l/min)	Flow of gas to the patient during high flow oxygen therapy
	ExpMinVol or MinVol NIV (l/min)	Expiratory minute volume
	MVSpont or MVSpO NIV (l/min)	Spontaneous expiratory minute volume
	VTE or VTE NIV (ml)	Expiratory tidal volume
	VTESpont (ml)	Spontaneous expiratory tidal volume
	VTI (ml)	Inspiratory tidal volume
	VT/IBW	Tidal volume according to ideal body weight (IBW) for adult/ pediatric patients and
	VT/Wt (ml/kg)	according to the actual body weight for neonatal patients
	VLeak (%) or MVLeak (l/min)	Leakage percent
	VLeak (ml)	Leakage volume

Monitoring parameters (continued)

Parameter (units)	Description	
CO2	FetCO2 (%)	Fractional end-tidal CO2 concentration
	PetCO2 (mmHg)	End-tidal CO2 pressure
	slopeCO2 (%CO2 / l)	Slope of the alveolar plateau in the PetCO2 curve, indicating the volume/flow status of the lungs
	Vtalv (ml)	Alveolar tidal ventilation
	V'alv (l/min)	Alveolar minute ventilation
	V'CO2 (ml/min)	CO2 elimination
	VDaw (ml)	Airway dead space
	VDaw/VTE (%)	Airway dead space fraction at the airway opening
	VeCO2 (ml)	Exhaled CO2 volume
	ViCO2 (ml)	Inspired CO2 volume
SpO2	SpO2 (%)	Oxygen saturation
	HLI (%)	Heart-Lung interaction index
	Pulse (1/min)	Pulse
	Plethysmogram	The waveform that visualizes the pulsating blood volume, which is delivered by the pulse oximeter
	SpO2/FiO2	The SpO2/FiO2 ratio is an approximation of the PaO2/FiO2 ratio, which, in contrast to PaO2/FiO2, can be calculated noninvasively and continuously
	PI (%)	Perfusion index
	PVI (%)	Pleth variability index
	SpCO (%)	Carboxyhaemoglobin saturation
	SpMet (%)	Methaemoglobin saturation
	SpHb (g/dl) (mmol/l)	Total haemoglobin
SpOC (ml/dl)	Oxygen content	
Oxygen	Oxygen (%)	Oxygen concentration of the delivered gas
Time	I:E	Inspiratory:expiratory ratio
	fSpont (b/min)	Spontaneous breathing frequency
	fTotal (b/min)	Total breathing frequency
	TI (s)	Inspiratory time
	TE (s)	Expiratory time
Lung mechanics	Cstat (ml/cmH2O)	Static compliance
	P0.1 (cmH2O)	Airway occlusion pressure
	PTP (cmH2O*s)	Pressure time product
	RCexp (s)	Expiratory time constant
	RCinsp (s)	Inspiratory time constant
	Rexp (cmH2O/l/s)	Expiratory flow resistance
	Rinsp (cmH2O/l/s)	Inspiratory flow resistance
	RSB (1/(l*min))	Rapid shallow breathing index
	VarIndex (%)	Variability index
	WOBimp (J/l)	Imposed work of breathing



Physical characteristics

Weight	Ventilation unit, monitor and shelf mount: 38 kg (83.8 lb) 57 kg (125.6 lb) with standard trolley, monitor, ventilation unit The standard trolley can accommodate a maximum safe working load of 80 kg (176 lb). The universal trolley can accommodate a maximum safe working load of 140 kg (308 lb).
Dimensions	See graphic above
Monitor	15" XGA, TFT color, LCD touchscreen, 3m (10 ft) cable with optional 7 m (23 ft) extension, 6.4 kg (14.1 lb)
Monitor mounting	Pole mount, rail mount, handle mount