

HAMILTON-C1

Technical specification for SW version 3.1.x

Ventilation modes

Standard: ✓ Option: O Not applicable: --

Mode form	Mode name	Mode	Adult/Ped	Neonatal
Volume-targeted modes, adaptive pressure controlled	APVcmv / (S)CMV+	Breaths are volume targeted and mandatory.	✓	✓
	APVsimv / SIMV+	Volume-targeted mandatory breaths can be alternated with pressure-supported spontaneous (patient-triggered) breaths.	✓	✓
	VS	Breaths are flow cycled and deliver a set tidal volume to support patient-initiated breaths.	✓	✓
Pressure-controlled modes	PCV+	All breaths, whether triggered by the patient or the ventilator, are pressure controlled and mandatory.	✓	✓
	PSIMV+	Mandatory breaths are pressure controlled. Mandatory breaths can be alternated with pressure-supported spontaneous (patient-triggered) breaths.	✓	✓
	DuoPAP	Mandatory breaths are pressure controlled. Spontaneous breaths can be triggered at both pressure levels.	O	O
	APRV	Spontaneous breaths can be continuously triggered. The pressure release between the levels contributes to ventilation.	O	O
	SPONT	Every breath is spontaneous, with or without pressure support.	✓	✓
Intelligent ventilation	ASV	Operator sets %MinVol, PEEP, and oxygen. Rate, tidal volume, inspiratory pressure, and I:E ratio are based on physiological input from the patient.	✓	--
	INTELLiVENT-ASV	Ventilator management of CO ₂ elimination and oxygenation is based on clinician-defined target ranges and parameter limits, and physiological input from the patient. The underlying mode is ASV.	O	--
Noninvasive modes ¹	NIV	Every breath is spontaneous.	O	O
	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.	O	O
	nCPAP	Demand flow nasal continuous positive airway pressure.	--	O
	nCPAP-PC	Breaths are pressure controlled and mandatory.	--	O
	HiFlowO ₂	High flow oxygen therapy. No supported breaths.	O	O

¹ When the NIV-only option is installed and enabled, only noninvasive modes and features are supported. All invasive modes are disabled.

Standard configuration and options (in alphabetical order)

Standard: ✓ Option: O Not applicable: --

Functions	Adult/Ped	Neonatal
Capnography, mainstream (volumetric) and sidestream	O	O
Communication board:	O	O
CO2/Nurse Call/COM1, CO2/SpO2/COM1 ² , CO2/SpO2/Humidifier & COM1 ^{2,3}		
Communication protocols. For details, see the <i>HAMILTON Communication Interface User Guide</i> (PN 627052)	O	O
CPR ventilation	✓	✓
Dynamic Lung	✓	--
Event log (up to 10,000 events with date and time stamp)	✓	✓
Hamilton Connect Module (connectivity) ⁴	O	O
HAMILTON-H900 humidifier integration	O	O
IntelliSync®+ (inspiratory and expiratory trigger synchronization) ⁵	O	--
IntelliTrig (leak compensation)	✓	✓
Languages (English, US English, Chinese, Croatian, Czech, Danish, Dutch, Finnish, French, German, Greek, Hungarian, Indonesian, Italian, Japanese, Korean, Norwegian, Polish, Portuguese, Romanian, Russian, Serbian, Slovak, Spanish, Swedish, Turkish, Ukrainian)	✓	✓
Manual breath/prolonged inspiration	✓	✓
Nebulization, pneumatic	✓	--
NIV-only	O	--
O2 assist ⁶	O	O
O2 enrichment	✓	✓
On-screen help	✓	✓
Patient group HAMILTON-C1 neo	--	✓
Patient group HAMILTON-C1	✓	O
Print screen	✓	✓
RJ-45 Ethernet port ⁷	✓	✓
Screen lock	✓	✓
Speak valve compatibility	O	--
SpO2 monitoring	O	O
Standby with timer	✓	✓

² Applies only to devices with serial number > 6000

³ Only available with the HAMILTON-H900 Y-cable

⁴ Available for HAMILTON-C1 PN 1610010.

Available for the HAMILTON-C1 PN 161001 with SN > 6000 with the Hamilton Connect Module (HCM) Upgrade kit.

⁵ Available for HAMILTON-C1 PN 1610010.

⁶ O2 assist is NOT intended to be used with pre-term infants (gestational age < 37 weeks).

⁷ Only available for use if the Hamilton Connect module is activated.

Functions	Adult/Ped	Neonatal
Suctioning tool	✓	--
Trends/Loops	O	O
USB port	✓	✓
Vent Status (visual representation of patient's ventilator dependence)	✓	✓

Technical performance

Description	Specification
Automatic expiratory base flow	<i>Adult/Ped:</i> Fixed at 3 l/min <i>Neo:</i> Fixed at 4 l/min
Inspiratory pressure	0 to 60 cmH ₂ O
Maximum limited pressure	60 cmH ₂ O
Maximum working pressure	<i>Adult/Ped:</i> 60 cmH ₂ O (total inspiratory pressure); ensured through pressure limiting <i>Neo:</i> 45 cmH ₂ O (limitation depending on frequency)
Maximum inspiratory flow	260 l/min (120 l/min with 100% O ₂)
Means of inspiratory triggering	Flow trigger control
Minimum expiratory time	20% of cycle time; 0.2 to 0.8 seconds
Minute volume capability	Up to 60 l/min
Oxygen mixer accuracy	± (volume fraction of 2.5% + 2.5% of actual reading)
Tidal volume	<i>Adult/Ped:</i> 20 to 2000 ml <i>Neo:</i> 2 to 300 ml
Preoperational checks	Leak test, flow sensor/circuit/O ₂ sensor calibration, CO ₂ sensor zero calibration ⁸
Display device	Display of settings, alarms, and monitored data <i>Type:</i> Color TFT <i>Size:</i> 640 x 480 pixels, 8.4 in (214 mm) diagonal
Brightness setting for display	The range is 10% to 100% brightness. By default, Day = 80%; Night = 40%.
Alarm volume (loudness) ⁹	The range is 1 to 10. The default setting is 5.
Sound power level ¹⁰	51 dB(A) ± 3dB(A)
Sound pressure level ¹⁰	43 dB(A) ± 3dB(A)

⁸ CO₂ option required.

⁹ Volume at 1 meter distance from ventilator. A setting of 1 = 62 dB(A), 5 = 76 dB(A), and 10 = 85 dB(A), with accuracy of ±3 dB(A).

¹⁰ Per ISO 80601-2-12.

Approvals

Description	Specification
Classification	Class IIb, continuously operating according to Regulation (EU) 2017/745
Declaration	The HAMILTON-C1 was developed in accordance with pertinent international standards and FDA guidelines. The ventilator is manufactured under a QMS system as required by EN ISO 13485, ISO 9001, and article 10(9) of Regulation (EU) 2017/745. The ventilator meets the general safety and performance requirements according to Regulation (EU) 2017/745, Annex I.
Electromagnetic compatibility	According to IEC 60601-1-2:2014
Safety class	Class II, Type B applied part (ventilator breathing system, VBS), type BF applied part CO2 sensor including CO2 module connector; SpO2 sensor including adapter, continuous operation according to IEC 60601-1

Pneumatic performance

Component	Specifications	
High-pressure oxygen inlet	Pressure:	2.8 to 6 bar / 41 to 87 psi
	Flow:	Maximum of 200 l/min
	Connector:	DISS (CGA 1240) or NIST
Low-pressure oxygen inlet	Pressure:	Maximum 6 bar / 87 psi
	Flow:	≤ 15 l/min
	Connector:	Quick-coupling system, compatible with Colder Products Company (CPC) PMC series
Air supply	Integrated blower	
Gas mixing system	Delivered flow (HAMILTON-C1):	> 260 l/min ±10% against ambient pressure (at sea level) > 200 l/min with 100% oxygen
	Delivered flow (HAMILTON-C1 neo):	> 40 l/min ±10% against ambient pressure (at sea level)
	Delivered pressure:	<i>Adult/Ped:</i> 0 to 60 cmH2O <i>Neo:</i> 0 to 45 cmH2O
	Flow accuracy:	±10% or ±300 ml/min (whichever is greater)
Inspiratory outlet (<i>To patient</i> port)	Connector:	ISO ID15/OD22 conical
Expiratory outlet (<i>From patient</i> port)	Connector (on expiratory valve):	ISO ID15/OD22 conical

Electrical specifications

Element	Specifications
Input power	100 to 240 VAC, 50/60 Hz
Power consumption	50 VA typical, 150 VA maximum
Battery	Hamilton Medical provides a high-capacity battery¹¹. Electrical specifications: 10.8 VDC, 6.7 Ah, 72 Wh Type: Lithium-ion, supplied by Hamilton Medical only Recharge time: While the ventilator is connected to primary power, approximately 3.25 h to fully recharge one battery. Storage: -20°C to 60°C, ≤ 85% relative humidity. The storage location should be free from vibration, dust, direct sunlight, moisture, and corrosive gases, and with a recommended temperature range < 21°C. Extended exposure to temperatures above 45°C can degrade battery performance and life. Normal operating time: Operating times are measured with one fully charged battery, the blower in use, without communication board, and with the following settings: Mode = PCV+, Rate = 10 b/min, ΔPcontrol = 10 cmH2O, I:E = 1:4, PEEP = 5 cmH2O, Flow trigger = 5 l/min, FiO2 = 40%. Approximate operating times under these conditions are as follows: • One battery, display brightness = 80%: 4 h • One battery, display brightness = 20%: 4.5 h This operating time applies to new, fully charged Li-ion batteries that have not been exposed to extreme temperatures. The actual operating time depends on battery age and on how the battery is used and recharged.

Graphical patient data

Graphic type/tab name	Options
Waveforms	Pressure, Volume, Flow, PCO2 ¹² , FCO2 ¹² , Plethysmogram ¹³ , Capnogram ¹²
Intelligent panels	Dynamic Lung ¹⁴ , Vent Status, ASV Graph ¹⁵ , INTELLiVENT-ASV Oxygenation and CO2 elimination maps and horizons ¹⁶ , O2 assist ^{17, 18}
Trends	1-, 6-, 12-, 24-, or 72-h trend data for a selected parameter or combination of parameters
Loops	Pressure/Volume, Pressure/Flow, Volume/Flow, Volume/PCO2 ¹² , Volume/FCO2 ¹²

¹¹ PN 369108, revision 4 and later.

¹² CO2 option required.

¹³ SpO2 option required.

¹⁴ Only for adult/pediatric patients.

¹⁵ Only in ASV mode.

¹⁶ INTELLiVENT-ASV required

¹⁷ If option is installed.

¹⁸ The O2 assist panel can only be displayed if O2 assist is turned on.

Alarms

Priority	Alarm
High priority	Apnea, Blower fault, Buzzer defective, Check flow sensor, Check flow sensor tubing, Check patient interface, Device temperature high, Disconnection on patient/ventilator side, Exhalation obstructed, ExpMinVol high/low, External flow sensor failed, Flow sensor calibration needed (during ventilation), High Pressure during Sigh, Loudspeaker defective, Minute volume high/low, Obstruction, Options not found, Oxygen high/low, Oxygen supply failed, Pressure high/low, Pressure not released, Replace O2 sensor, Self test failed, Vent outlet temperature high Battery 1: Defective, Battery 1: Temperature high, Battery communication error, Battery low, Battery power loss, Battery totally discharged <i>INTELLiVENT-ASV:</i>¹⁹ Oscillation %MinVol, Oscillation PEEP/CPAP <i>O2 assist:</i>²⁰ Low SpO2 <i>SpO2:</i>²¹ SpO2 low
Medium priority	Battery low, Check for blockage, Check flow sensor for water (Neo), Circuit calibration needed, External connections disabled, Fan failure, Flip the flow sensor, Frequency high/low, fTotal high/low, Function key not operational, High Flow, High PEEP, Inspiratory volume limitation, Loss of PEEP, Performance limited by high altitude, Pressure limitation, Real-time clock failure, Vt high/low, Wrong expiratory valve <i>CO2:</i>²² PetCO2 high/low <i>INTELLiVENT-ASV:</i>¹⁹ FiO2 set to 100% due to low SpO2, Oxygen control limit exceeded, Oxygenation adjustment off, Ventilation adjustment off <i>O2 assist:</i>²⁰ Low SpO2, Oxygen adjustment OFF, Oxygen alert limit exceeded <i>SpO2:</i>²¹ SpO2: Adapter missing, SpO2: Light interference, SpO2: Low perfusion index, SpO2: Patient disconnected, SpO2: Poor signal, SpO2: Probe missing, SpO2: Sensor error, PI low/high, PVI low/high, Pulse low/high, SpO2 low
Low priority	Apnea ventilation/Apnea ventilation ended, ASV: Cannot meet the target, Blower service required, Check Plimit, Check settings, CPR ON, External connections disabled²³, Flow sensor calibration needed (in Standby), Invalid communication board, IRV (inverse ratio ventilation), JTAG not working, Loss of external power, Maximum leak compensation, Preventive maintenance required, Pressure limit has changed, Release valve defective, Replace HEPA filter, SpeakValve ON/OFF, Suctioning maneuver, Touch not functional, Battery 1: Calibration required, Battery 1: Replacement required, Battery 1: Wrong battery, Battery low O2 sensor calibration needed, O2 sensor defective, O2 sensor missing, O2 sensor not system compatible <i>CO2:</i>²² CO2 calibration needed, CO2 sensor disconnected, CO2 sensor faulty, CO2 sensor over temperature, CO2 sensor warmup, Check CO2 airway adapter, Check CO2 sampling line, CO2: Poor signal <i>INTELLiVENT-ASV:</i>¹⁹ Oxygen controller at limit, PetCO2 target range changed, Ventilation controller at limit <i>O2 assist:</i>²⁰ High SpO2, Oxygen controller at limit <i>SpO2:</i>²¹ SpO2 high

¹⁹ If INTELLiVENT-ASV is installed.

²⁰ If option is installed.

²¹ If the SpO2 option is installed and enabled.

²² If the CO2 option is installed and enabled.

²³ If the Hamilton Connect module is installed and enabled.

Control settings and ranges

Parameter (units)	Range Adult/Ped ²⁴	Range Neonatal ²⁴
%MinVol (%) ²⁵	25 to 350	--
Apnea backup	On, Off	On, Off
ETS (%) ^{26,27}	5 to 80 <i>NIV-only: OFF²⁸ / 5–80</i>	5 to 80
Flow (l/min) ²⁹	2 to 100 ³⁰	2 to 30
I:E ³¹	1:9 to 4:1	1:9 to 4:1
IBW (kg) (<i>calculated</i>)	3 to 139	--
O2 assist: Emerg-Hi (%)	80 to 100	80 to 100
O2 assist: Emerg-Lo (%)	60 to 92	60 to 92
O2 assist: SpO2 Target (%)	65 to 97	65 to 97
O2 assist: Target-Hi (%)	67 to 99	67 to 99
O2 assist: Target-Lo (%)	63 to 95	63 to 95
Oxygen (%)	21 to 100	21 to 100
Oxygen alert (%)	40 to 100/Off	40 to 100/Off
P high (cmH2O) (in APRV)	0 to 60	0 to 45
P high (cmH2O) (in DuoPAP)	0 to 60	3 to 45
P low (cmH2O) (in APRV)	0 to 35	0 to 25
Pat. height		
(cm)	30 to 250	--
(in)	12 to 98	
PEEP/CPAP (cmH2O)	0 to 35	3 to 25
Plimit (cmH2O)	5 to 60	5 to 45
P-ramp (ms) ³²	0 to 2000 <i>ASV, NIV, NIV-ST, SPONT, VS: max = 200</i>	0 to 600 <i>NIV, NIV-ST, SPONT, nCPAP-PC, VS: max = 200</i>
Rate (b/min) ³³	1 to 80 <i>APVcmv, PCV+: 4 to 80</i> <i>PSIMV+, NIV-ST: 5 to 80</i>	1 to 80 <i>PSIMV+: 5 to 80</i> <i>APVcmv, PCV+, PSIMV+PSync, nCPAP-PC, NIV-ST, APVsimv + Apnea backup: 10 to 80</i>
Set temp (°C)	INV: 35 to 41 NIV: 30 to 35 HiFlowO2: 33 to 37	INV: 35 to 41 NIV: 30 to 35 HiFlowO2: 33 to 37
Sex	Male, Female	--
Sigh	On, Off	--

²⁴ Parameter settings and ranges can vary depending on the selected mode.

²⁵ Only in ASV mode.

²⁶ Expiratory trigger sensitivity, in % of inspiratory peak flow.

²⁷ When selecting a noninvasive mode, the device uses the ETS value used in the previous mode, if available. If the previous mode did not use ETS, the device sets ETS to default values.

²⁸ ETS can be set to OFF only in the *NIV-only* option. The ability to set ETS to OFF can be disabled. For details, contact your Hamilton Medical technical representative.

²⁹ Only for high flow oxygen therapy.

³⁰ In some markets, the maximum possible Flow setting may be limited.

³¹ In PCV+, (S)CMV+, and APVcmv modes, mandatory breath timing can be controlled by using a combination of inspiratory time (TI) and Rate, or by the I:E ratio; set the method in Configuration. All other modes are controlled by using a combination of inspiratory time (TI) and Rate.

³² P-ramp is limited to one-third (1/3) of TI time. Adjustment of TI time can override the P-ramp setting.

³³ Startup setting derived from IBW (adult/pediatric), body weight setting (neonatal). Does not apply in ASV mode.

Parameter (units)	Range Adult/Ped ²⁴	Range Neonatal ²⁴
SpeakValve	On, Off	--
T gradient (°C)	-2 to 3	-2 to 3
T high ³³ (s) (in APRV and DuoPAP)	0.1 to 40.0	0.1 to 40.0
T low (s) (in APRV)	0.2 to 40.0	0.2 to 40.0
TI (s) ^{31,33}	0.1 to 12.0	0.1 to 12.0
TI max (s)	0.5 to 3.0	0.25 to 3.0
Trigger, expiratory: ETS (Expiratory trigger sensitivity)	ETS, IntelliSync+ ³⁴	ETS
Trigger, flow (l/min) ³⁵	0.5 to 20.0 APVcmv, PCV+: 0.5 to 20.0 / Off	0.1 to 5.0 APVcmv, PCV+: 0.1 to 5.0 / Off
Trigger, inspiratory: flow	Flow trigger, IntelliSync+ ³⁴	Flow trigger
Vt (ml)	20 to 2000	2 to 300
Vt/IBW	5 to 12	5 to 12
Vt/Weight (ml/kg) ³⁶		
Weight (kg)	--	0.2 to 30.0
ΔPcontrol (cmH ₂ O) ³⁷	5 to 60	3 to 45 nCPAP-PC: 0 to 45
ΔPinsp (cmH ₂ O) ³⁷	3 to 60	3 to 45
ΔPsupport (cmH ₂ O) ³⁷	0 to 60	0 to 45

³⁴ Not available in all markets.

³⁵ Flow trigger is leak compensated.

³⁶ IBW is calculated using height and sex, for adult and pediatric patients. Actual body weight is used for neonates.

³⁷ ΔPcontrol: Control pressure, added to PEEP/CPAP. ΔPinsp: Inspiratory pressure, added to PEEP/CPAP. ΔPsupport: Pressure support, added to PEEP/CPAP.

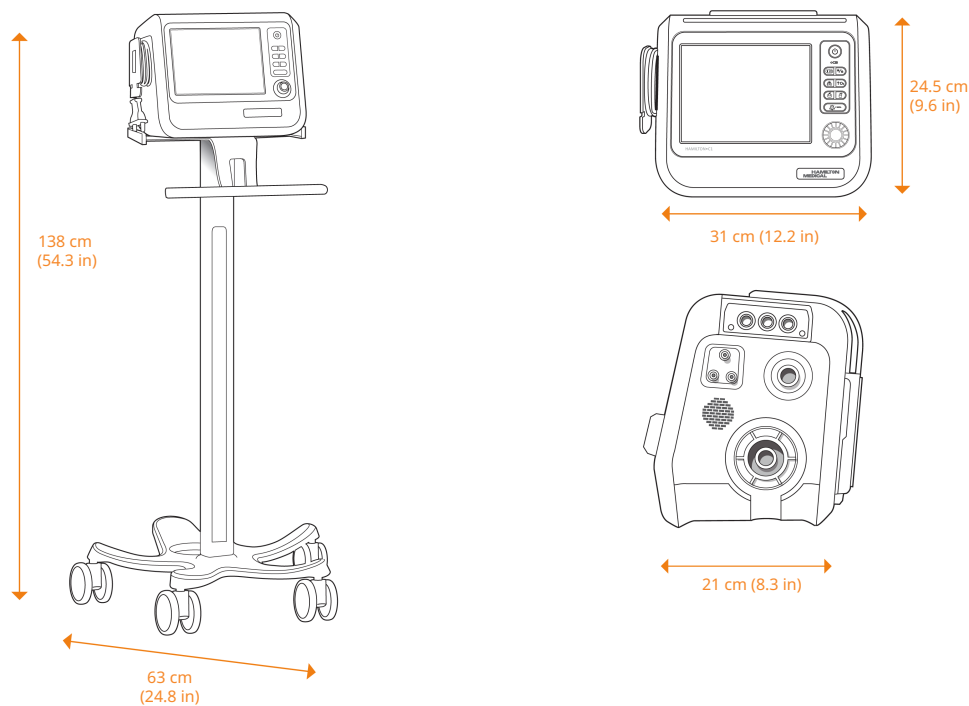
Monitoring parameters

Parameter (units)		Description
Pressure	AutoPEEP (cmH2O)	Unintended positive end-expiratory pressure
	PEEP/CPAP (cmH2O)	PEEP (positive end-expiratory pressure) and CPAP (continuous positive airway pressure)
	Driving pressure, ΔP (cmH2O)	Driving pressure, calculated value reflecting the difference between Pplateau and PEEP
	ΔP_{insp} (cmH2O)	Inspiratory pressure
	Pmean (cmH2O)	Mean airway pressure
	Ppeak (cmH2O)	Peak airway pressure
	Pplateau (cmH2O)	Plateau or end-inspiratory pressure
	Pprox (cmH2O)	Airway pressure at proximal patient interface
Flow	Flow (l/min)	HiFlowO2: The set flow of gas to the patient
		nCPAP: The average flow updated every second
		nCPAP-PC: The average flow during expiration, updated every breath
	Insp Flow (peak) (l/min)	Peak inspiratory flow, spontaneous or mandatory
	Exp Flow (peak) (l/min)	Peak expiratory flow
Volume	ExpMinVol or MinVol NIV (l/min)	Expiratory minute volume
	MVSpont or MVSpont 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
	VLeak (%)	Leakage percent or total minute volume leakage
	MVLeak (l/min)	Leakage percent or total minute volume leakage
	Vt/IBW or Vt/Weight (ml/kg)	Tidal volume is calculated by ideal body weight (adult/pediatric patients) or actual body weight (neonatal patients)
Oxygen	Oxygen (%)	Oxygen concentration of the delivered gas
	O2 consumption (l/min)	The current oxygen consumption rate
Time	CPR timer	MMP during CPR ventilation showing duration of CPR ventilation
	I:E	Ratio of the patient's inspiratory time to expiratory time for every breath cycle
	fControl (b/min)	Mandatory breath frequency
	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
	Rinsp (cmH2O / l/s)	Inspiratory flow resistance
	RSB (1 / l*min))	Rapid shallow breathing index

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
	Valv (l/min)	Alveolar minute ventilation
	Vtalv (ml)	Alveolar tidal ventilation
	VCO2 (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
	Pulse (1/min)	Pulse
	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
	OSI	Oxygen saturation index
	PI (%)	Perfusion index
	PVI (%)	Pleth variability index
Humidifier ³⁸	T Y-piece (°C)	Measured temperature at the Y-piece
	T humidifier (°C)	Measured temperature at water chamber exit

³⁸ If HAMILTON-H900 humidifier integration is enabled, and a humidifier is connected and turned on.

Physical characteristics



Dimension	Specifications
Weight	4.9 kg (10.8 lb)
	16.9 kg (37.3 lb) with trolley
	The trolley can accommodate a maximum safe working load ³⁹ of 44 kg (97 lb).
Dimensions	See figures above
Monitor	Type: Color TFT
	Size: 640 x 480 pixels, 8.4 in (214 mm) diagonal
Trolley accessories	HAMILTON-H900 mounting kit, optional O2 bottle holding system, optional tubing support arm, water bottle holder, basket
Gas cylinder	
Diameter	100 to 140 mm (3.9 to 5.5 inches)
Height	≤ 820 mm (32 inches)
Weight	≤ 8 kg (17.6 lb)

³⁹ The maximum safe working load applies to a stationary, properly load-balanced trolley.



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