HAMILTON-C6

Technical specification for SW version 1.2.x

Ventilation modes

Standard: ✓   Option: O   Not applicable: --

Mode form	Mode name	Mode	Adult/Ped	Neonatal
Volume-controlled modes, flow controlled	(S)CMV	Breaths are volume-controlled and mandatory, including patient-triggered breaths.	✓	--
	SIMV	Volume-controlled mandatory breaths can be alternated with pressure-supported breaths.	✓	--
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 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 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	Ventilator management of CO2 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	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.	--	O
	HiFlowO2	High flow oxygen therapy. No supported breaths.	O	O

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HAMILTON MEDICAL

Standard configuration and options (in alphabetical order)

Standard: ✓   Option: O   Not applicable: --

Functions	Adult/Ped	Neonatal
Capnography, mainstream (volumetric) and sidestream	O	O
Communication ports: Three COM ports, two USB ports, DVI, Nurse call	✓	✓
Communication protocols: for details, see the *Connectivity* brochure	✓	✓
Distributed alarm system (DAS) compatible	✓	✓
Dynamic Lung (real-time visualization of the lungs)	✓	--
Event log (up to 10,000 events with date and time stamp)	✓	✓
HAMILTON-H900 humidifier integration	O	O
Inspiratory and expiratory hold maneuver	✓	✓
IntelliCuff® integrated cuff pressure controller	O	O
IntelliSync+ (inspiratory and expiratory trigger synchronization)	O	--
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)	✓	✓
Leakage compensation	✓	✓
Manual breath/prolonged inspiration	✓	✓
Nebulization (Aerogen§)	O	O
Nebulization (pneumatic)	✓	--
O2 enrichment	✓	✓
On-screen help	✓	✓
P/V Tool® Pro	O	O
Paramagnetic O2 sensor	O	O
Patient group	✓	O
Print screen	✓	✓
Screen lock	✓	✓
Second battery	O	O
SpO2 monitoring	O	O
Standby with timer	✓	✓
Suctioning tool	✓	✓
Transpulmonary pressure monitoring	✓	✓
TRC (tube resistance compensation)	✓	✓
Trends/Loops	✓	✓
Trigger, flow and pressure selectable	✓	✓
Vent Status (visual representation of patient's ventilator dependence)	✓	✓

Technical performance

Description	Specification
Automatic expiratory base flow	Fixed at 6 l/min
Inspiratory pressure	0 to 100 cmH2O
Maximum inspiratory flow	260 l/min
Means of inspiratory triggering	Flow trigger, pressure trigger, or optional IntelliSync+
Means of expiratory triggering	Flow cycling (ETS), or optional IntelliSync+
Minimum expiratory time	20% of cycle time; 0.2 to 0.8 seconds
O2 input flow	80 l/min (at 2.8 bar/ 280 kPa / 41 psi input pressure)
Oxygen mixer accuracy	± (Volume fraction of 2.5% + 2.5% of actual reading)
Preoperational checks	Leak test, Flow sensor/O2 sensor/CO2 sensor calibration
Tidal volume	*Adult/Ped:* 20 to 2000 ml
	Neonatal: 2 to 300 ml

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 80601-2-55:2018
Declaration	The HAMILTON-C6 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 3 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 CO2 sensor including CO2 module connector, humidifier, Aerogen§ system, nebulizer, and SpO2 sensor including SpO2 adapter, continuous operation according to IEC 60601-1

Pneumatic performance

O2	Input pressure:	2.8 to 6 bar / 41 to 87 psi
	Connector:	DISS (CGA 1240) or NIST
Air supply	Integrated turbine with lifetime warranty	
Inspiratory outlet (*To patient* port)	Connector:	ISO 15 mm ID/22 mm OD conical
Expiratory outlet (*From patient* port)	Connector (on expiratory valve):	ISO 15 mm ID/22 mm OD conical

Electrical specifications

Input power	100 to 240 VAC ±10%, 50/60 Hz	
Power consumption	60 VA typical, 210 VA (510 VA with humidifier) maximum	
Battery	Electrical specifications:	14.4 V, 5.0 Ah, 72 Wh, 48 W typical, 288 W maximum
	Type:	Lithium-ion
	Normal operating time:	≥ 90 min with one battery / ≥ 180 min with two batteries

Graphical patient data

Graphic type/tab name	Options
Waveforms	Pressure, Flow, Volume, PCO2[1], FCO2[1], Plethysmogram[1], Ptrach, Pes, Ptranspulm, Off
Intelligent panels	Dynamic Lung[2], Vent Status, ASV Graph[3], SMPs (Secondary monitoring parameters)
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[1], Volume/FCO2[1], Pes/Volume, Ptranspulm/Volume

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[1] CO2 + SpO2 option required
[2] Only for adult/pediatric patients
[3] Only in ASV mode

Alarms

Priority	Alarm
High priority	Apnea, Check for blockage, Minute volume high/low, Oxygen high/low, Pressure high/low, High Pressure during Sigh, Pressure not released
	Flow sensor calibration needed (during ventilation), Check flow sensor tubing, Check flow sensor, External flow sensor failed, Replace O2 sensor, Oxygen supply failed, Buzzer defective, Loudspeaker defective, Disconnection on patient/ventilator side, Exhalation obstructed
	Options not found, Self test failed, Blower fault, Device temperature high, Vent outlet temperature high, Panel connection lost
	Battery low, Battery power loss, Battery totally discharged, Battery temperature high, Battery communication error, Battery defective, No ventilation after power failure
	SpO2:[4] Low SpO2
	HAMILTON-H900: Humidifier tilt, Humidifier chamber temp high, Humidifier Y-piece temp high, Humidifier water high, Humidifier error, Check humidifier
	IntelliCuff: Cuff leak, Check IntelliCuff
Medium priority	Aerogen nebulizer disconnected, Frequency high/low, Vt high/low, Inspiratory volume limitation, High PEEP, Loss of PEEP, Pressure limitation
	Flow sensor calibration needed, Flip the flow sensor, Check flow sensor for water (Neonatal)
	Fan failure, Function key not operational, Performance limited by high altitude, Real-time clock failure, Battery low
	Remote communication error, Remote communication timeout
	CO2:[5] PetCO2 high/low
	SpO2:[4] SpO2: Adapter missing, SpO2: Light interference, SpO2: Low perfusion index, SpO2: Poor signal, SpO2: Probe missing, SpO2: Patient disconnected, SpO2: Sensor error, PI high/low, PVI high/low, Pulse high/low, Low SpO2
	HAMILTON-H900: Check breathing circuit limbs, Check humidifier, Humidifier chamber temp low, Humidifier Y-piece temp low, Humidifier water low, Humidifier check chamber, Humidifier check left/right tube
	IntelliCuff: Check IntelliCuff, Cuff deflated, Cuff pressure high, Cannot turn off IntelliCuff
	INTELLiVENT-ASV: FiO2 set to 100% due to low SpO2, Oscillation Oxygen, Oscillation %MinVol, Oscillation PEEP/CPAP, Oxygenation adjustment off, Oxygen control limit exceeded, Oxygen supply failed, Ventilation adjustment off
Low priority	ASV: Cannot meet target, Maximum leak compensation, Pressure limit has changed, Pressure high, Suctioning maneuver, Apnea ventilation, Apnea ventilation ended
	Flow sensor calibration needed, Replace HEPA filter, IRV (inverse ratio ventilation), Release valve defective, Touch not functional, Check settings, Settings file error, Language not loaded, Panel settings file error
	Continue charging battery, Battery calibration required, Battery replacement required, Wrong battery, Battery low, Loss of external power
	O2 sensor calibration needed, O2 sensor defective, O2 sensor missing, O2 sensor not system compatible
	Invalid communication board
	CO2:[5] CO2 calibration needed, CO2 sensor defect, CO2 sensor disconnected, CO2 sensor over temperature, CO2 sensor warmup, Check CO2 sampling line, Check CO2 airway adapter, CO2: Poor signal
	SpO2:[4] High SpO2
	HAMILTON-H900: Check humidifier, Check humidifier communication
	IntelliCuff: Check IntelliCuff
	INTELLiVENT-ASV:[6] Oxygenation controller at limit, Recruitment in progress, Ventilation controller at limit

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[4] If the SpO2 option is installed and enabled.
[5] If the CO2 option is installed and enabled.
[6] If INTELLiVENT-ASV is installed.

Control settings and ranges

Parameter (units)	Range Adult/Ped[7]	Range Neonatal[7]
%MinVol (%)	25 to 350	--
Apnea backup	On, Off	On, Off
Cuff pressure[8] (cmH2O)	0 to 50	0 to 50
End PEEP[9] (cmH2O)	0 to 35	0 to 35
Expiratory trigger sensitivity ETS (%)	5 to 80	5 to 80
Flow pattern	Square, decel. 50%, Sine, decel. 100%	--
Flow trigger (l/min)	0.5 to 20, Off	0.1 to 5.0, Off
Flow[10] (l/min)	2 to 100	2 to 30
Gender (sex)	Male, Female	--
I:E	1:9 to 4:1	1:9 to 4:1
Max. pressure[8] (cmH2O)	6 to 50	6 to 50
Min. pressure[8] (cmH2O)	5 to 49	5 to 49
Nebulizer Duration (min)	5 to 40, continuous	5 to 40, continuous
Nebulizer Synchronisation	Inspiration, Exhalation, Insp. and Exh.	Inspiration, Exhalation, Insp. and Exh.
Oxygen (%)	21 to 100	21 to 100
P high (cmH2O) (only in DuoPAP and APRV)	0 to 100	0 to 60
P low (cmH2O) (only in APRV)	0 to 50	0 to 25
Pat. height (cm) (in)	30 to 250 / 12 to 98	--
Pause (%)	0 to 70	--
Peak flow (l/min)	1 to 195	--
PEEP/CPAP (cmH2O)	0 to 50	0 to 25
Plimit (cmH2O)	5 to 100	--
P-ramp (ms)	0 to 2000	0 to 600
Pressure trigger (cmH2O)	-0.1 to -15.0, Off	-0.1 to -15.0, Off
Pstart[9] (cmH2O)	0 to 35	0 to 35
Ptop[9] (cmH2O)	25 to 60	25 to 60
Ramp speed[9] (s)	2 to 5	2 to 5
Rate (b/min)	1 to 80	1 to 150
Rel. pressure[8] (cmH2O)	-15 to 5	-15 to 5
Set temp[11] (°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

[7] Parameter settings and ranges can vary depending on the selected mode.
[8] If the IntelliCuff integrated cuff pressure controller option is installed.
[9] If the P/V Tool Pro option is installed.
[10] Only for high flow oxygen therapy.
[11] If the HAMILTON-H900 humidifier integration option is installed.

Parameter (units)	Range Adult/Ped[7]	Range Neonatal[7]
Sigh	On, Off	--
T gradient[11] (°C)	-2 to 3	-2 to 3
T high (s) (in DuoPAP and APRV)	0.1 to 40	0.1 to 40
T low (s) (in APRV)	0.2 to 40	0.2 to 40
TI (s)	0.1 to 12	0.1 to 12
TI max (s)	0.5 to 3	0.25 to 3.0
Tip (s)	0 to 8	--
Tpause[9] (s)	0 to 30	0 to 30
TRC compensation (%)	0 to 100	0 to 100
Vt (ml)	20 to 2000	2 to 300
Weight (kg)	--	0.2 to 30.0
ΔPcontrol (cmH2O)	5 to 100	3 to 60
ΔPinsp (cmH2O)	3 to 100	0 to 60
ΔPsupport (cmH2O)	0 to 100	0 to 60

Monitoring parameters

Parameter (units)		Description
Pressure	AutoPEEP (cmH2O)	Unintended positive end-expiratory pressure
	Paw (cmH2O)	Airway pressure
	ΔP (cmH2O)	Driving pressure
	PTP (cmH2O*s)	Inspiratory pressure time product
	Pcuff (cmH2O)	Cuff pressure
	Ptrans I (cmH2O)	The arithmetic mean value of Ptranspulm over the last 100 ms of the last inspiration.
	Ptrans E (cmH2O)	The arithmetic mean value of Ptranspulm over the last 100 ms of the last expiration.
	PEEP/CPAP (cmH2O)	PEEP (positive end-expiratory pressure) and CPAP (continuous positive airway pressure)
	Pinsp (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
	Pes min (cmH2O)	See PEEP. The pressure is measured through the Pes port instead of using airway pressure.
	Pes max (cmH2O)	See Ppeak. The pressure is measured through the Pes port instead of using airway pressure.
	Pes plateau (cmH2O)	See Pplateau. The pressure is measured through the Pes port instead of using airway pressure.
	Pes PTP (cmH2O*s)	See PTP. The pressure is measured through the Pes port instead of using airway pressure.
	Pes P0.1 (cmH2O)	See P0.1. The pressure is measured through the Pes port instead of using airway pressure.
Flow	Control Flow (l/min)	The set flow of gas to the patient when using HiFlowO2
	Insp Flow (l/min)	Peak inspiratory flow, spontaneous or mandatory
	Exp Flow (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 or VTI NIV (ml)	Inspiratory tidal volume
	Vt/IBW Vt/Weight (ml/kg)	Tidal volume is calculated by ideal body weight (adult/pediatric patients) and according to the actual body weight for neonatal patients.
	VLeak (%) or MVLeak (l/min)	Leakage percent or total minute volume leakage

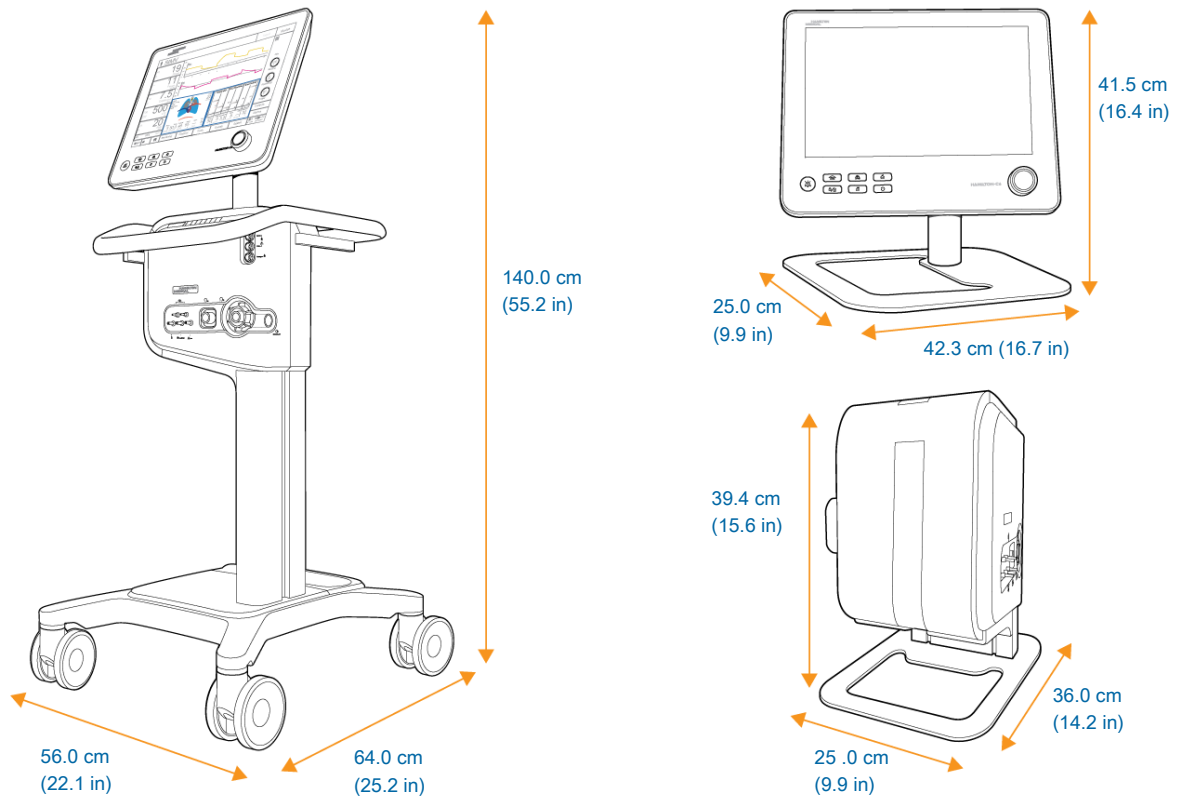| Parameter (units)		Description
CO2	FetCO2 (%)	Fractional end-tidal CO2 concentration
	PetCO2 (mmHg)	End-tidal CO2 pressure
	slopeCO2 (%CO2/l)	Slope of the alveolar plateau in the PetCO2 curve, indicating the volume/flow status of the lungs
	V'alv (l/min)	Alveolar minute ventilation
	Vtalv (ml)	Alveolar tidal 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
	Pulse (1/min)	Pulse
	Plethysmogram	The waveform that visualizes the pulsating blood volume; it 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.
	OSI	Oxygen saturation index
	PI (%)	Perfusion index
	PVI (%)	Pleth variability index
	SpCO (%)	Carboxyhemoglobin saturation
	SpMet (%)	Methemoglobin saturation
	SpHb (g/dl) (mmol/l)	Total hemoglobin
	SpOC (ml/dl)	Oxygen content
Oxygen	Oxygen (%)	Oxygen concentration of the delivered gas
Time	I:E	Inspiratory:expiratory ratio
	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
	Pause (s)	Inspiratory pause or plateau
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
Humidifier related	T humidifier (°C)	Measured temperature at water chamber exit
	T Y-piece (°C)	Measured temperature at the Y-piece

Physical characteristics

Weight	Monitor (interaction panel) without shelf mount: 7.8 kg (17.2 lb)
	Monitor with shelf mount: 10 kg (22 lb)
	Ventilation unit with shelf mount: 10.5 kg (23.2 lb)
	Ventilation unit, monitor, and trolley: 46 kg (101 lb)
	The trolley can accommodate a maximum safe working load[12] of 80 kg (176 lb).
Dimensions, Trolley and shelf mount solutions	See figure below
Dimensions, Combined shelf mount solution, monitor tilt/swivel range	See next page
Monitor	Type: Color TFT, Size: 1920 x 1200 pixels, 17 in (431.8 mm) diagonal
Monitor mounting options	VESA, pole mount, rail mount, handle mount
Trolley accessories	Basket, O2 cylinder holders (two bottles), humidifier mounting system, additional standard rail, bed docking system

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[12] The maximum safe working load applies to a stationary, properly load-balanced trolley.

Figure 1. HAMILTON-C6 dimensions

140.0 cm (55.2 in)

56.0 cm (22.1 in)

64.0 cm (25.2 in)

41.5 cm (16.4 in)

25.0 cm (9.9 in)

42.3 cm (16.7 in)

39.4 cm (15.6 in)

36.0 cm (14.2 in)

25 .0 cm (9.9 in)

Shelf mount dimensions	See the figures below
Monitor mounted to *left* of ventilator body, monitor tilt and swivel ranges (see top figure below)	Monitor tilt range: Forward = 30°; Backward = 37° Monitor swivel range: 34° to the left from neutral
Monitor mounted to *right* of ventilator body, monitor tilt and swivel ranges (see bottom figure below)	Monitor tilt range: Forward = 30°; Backward = 37° Monitor swivel range: 144° to the right from neutral to 22° to the left

Figure 2. Shelf mount dimensions, monitor mounted to the *left* of the ventilator body, monitor swivel and tilt ranges
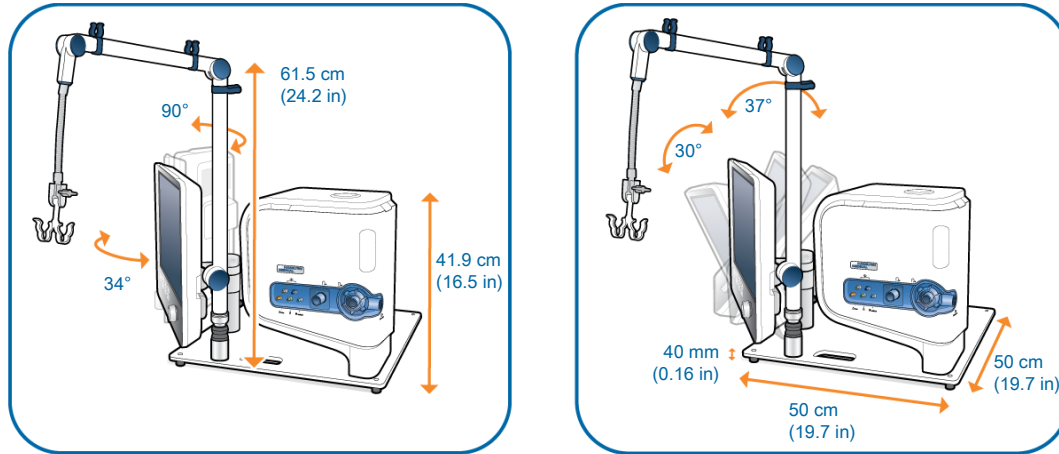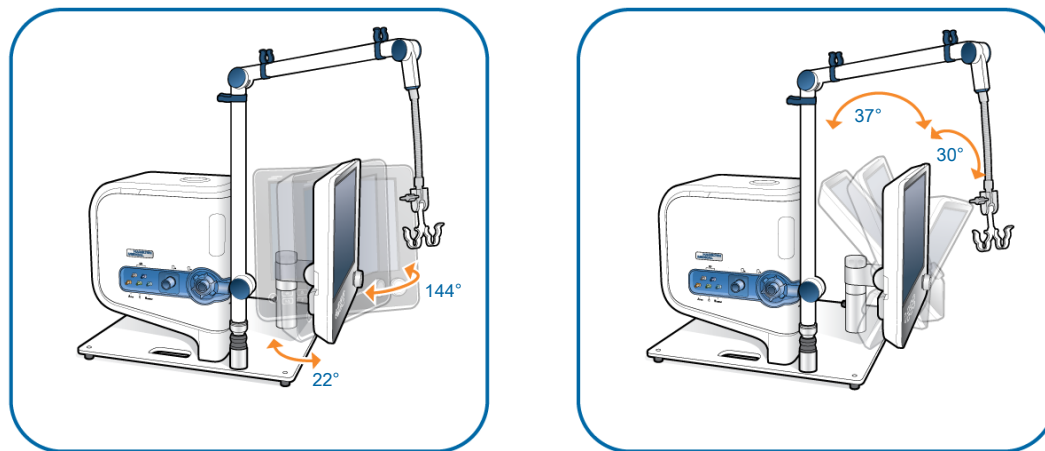

Figure 3. Shelf mount dimensions, monitor mounted to *right* of ventilator body, monitor swivel and tilt ranges

All angles in the figures above are relative to the monitor facing forward, with the bottom of the monitor parallel to the shelf plate, at a 90° angle relative to the floor. References to *left* and *right* refer to the reader's left and right, viewing the monitor from the front.

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HAMILTON-C6