



Respironics NM3 Monitor

User's Manual

PHILIPS

NM3

Respiratory Profile Monitor
with *VentAssist*

User's Manual

Model 7900

May 31, 2018
Part No. 1051672-D

Thank you ...

Thank you for purchasing the NM3 Respiratory Profile Monitor from Philips Respironics.

The NM3 monitor provides the clinician with a respiratory profile of the patient using a combination of capnography, volumetric capnography, airway flow and pressure, and pulse oximetry. With the addition of the VentAssist option, the monitor presents easy-to-understand graphical data to support ventilator adjustment advice. With the installation of the cardiac output option, the monitor will also measure cardiac output through respiratory gas analysis based on the well accepted Fick Principle, providing continuous and accurate display of cardiac output.

We expect that you will find the application and use of the NM3 monitor extremely simple, making it easy to adopt this exciting technology into your clinical practice. The NM3 monitor can provide clinical decision support, accurate respiratory monitoring, and cardiac output values without the need for invasive procedures, benefiting the patient, the clinician, and the health care system in general.

We appreciate your patronage and look forward to developing a long-term relationship with you and your institution.

Sincerely,



Customer Service & Product Support:

USA and Canada
Phone 1-800-722-9377

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Introduction

About this manual

This manual is written for clinical personnel using the NM3 Respiratory Profile Monitor, Model 7900, and the sensors and accessories intended for use with the monitor.

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NM3 monitor Technical Description

Per requirements of IEC 60601-1, the NM3 monitor is classified as class I equipment, internally powered, with type BF applied part, and an enclosure protection rating of IPX0.

Transport/Storage: -30 to +60° C (-22 to 140° F), 10-90% R.H. non-condensing
Operating Conditions: +10 to +40° C (50 to 104° F), 10-90% R.H. non-condensing
Barometric Pressure: Storage range 500 - 1060 hPa (375 to 800 mmHg),
Operating range 533 - 1060 hPa (400 - 800 mmHg).

Available software options: VentAssist decision support, Non-Invasive Cardiac Output

The NM3 monitor, Model 7900, contains no user serviceable parts. Refer servicing to qualified service personnel. A technical Service Manual is available for use by technical personnel.

Declaration of Conformity with European Union Directive

The Authorized Representative for this equipment is:



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Manual Revision History

18-Mar-09	Revision 50, Preliminary
18-Aug-09	Version A, Initial release
04-Apr-11	Version B, VentAssist updates
04-Mar-15	Version C, updates
31-May-18	Version D, updates

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Welcome

General Description

The NM3 monitor, a Respiratory Profile Monitor from Philips Respironics, displays various respiratory monitoring parameters including CO₂ elimination (VCO₂), CO₂/SpO₂ and alveolar minute ventilation. With the optional Cardiac Output software installed, the NM3 monitor also non-invasively measures and displays cardiac output (C.O.) and displays cardiac index, stroke volume and pulmonary capillary blood flow. With the addition of the VentAssist option, the monitor presents graphical data to support advice for ventilator adjustment. The monitor can operate in two modes: respiratory mechanics only, or respiratory mechanics with cardiac output. In either mode, the monitor provides the clinician with important information to aid in precise and efficient patient management.

Indications

The NM3 Monitor is intended to provide:

- Cardiac output monitoring via the method of partial rebreathing in adult patients receiving mechanical ventilation during general anesthesia and in the intensive care unit (ICU).
- Spirometric and carbon dioxide monitoring in neonatal, pediatric and adult patients during general anesthesia and in the intensive care unit (ICU) and the emergency department (ED). Separate combination CO₂/flow sensors are provided for adult, pediatric and neonatal use.
- Continuous, non-invasive monitoring of functional arterial oxygen saturation and pulse rate in neonatal, pediatric and adult patients during both no motion and motion conditions and for patients who are well or poorly perfused during general anesthesia and in the intensive care unit (ICU) and the emergency department (ED).

The intended use of the NM3 monitor with VentAssist option is to provide non-invasive monitoring of work of breathing per minute in adult patients receiving pressure support mechanical ventilation. VentAssist also provides on-demand advice in mechanically ventilated adult patients as prescribed by the caregiver regarding (a) modifications to the current pressure support settings in order to assess the work of breathing and breathing pattern and (b) modifications to ventilation in order to maintain end-tidal CO₂ in a range determined by the physician. Patients should be hemodynamically stable and must be breathing spontaneously.

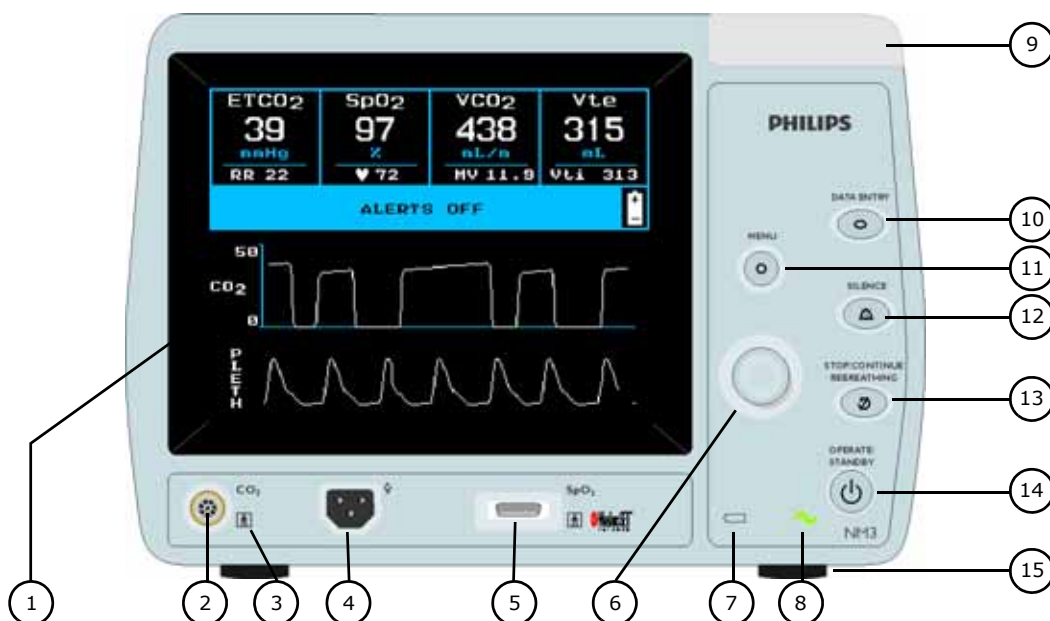
Warnings

In Cardiac Output mode, the NM3 monitor should not be used on patients for whom a small rise (3-5 mmHg, 0.4-0.67 kPa) in PaCO₂ level cannot be tolerated.

On-demand pressure support advice should not be used in cases of severe burn injury or for patients with severe neurological disorders that affect breathing control.

Front Panel

The NM3 monitor's front panel includes a display screen, sensor input connectors, a control knob, and operational push button keys and indicators that are explained below.



- 1 Display Screen.** The screen displays respiratory mechanics, cardiac output data (optional), trends, waveforms and messages, along with setup and configuration data.
- 2 CO₂ (CAPNOSTAT 5 CO₂ Sensor or LoFlo C5 CO₂ Sensor, Input Connector).** Connect only a CAPNOSTAT 5 CO₂ Sensor, PN 1015928, or LoFlo C5 CO₂ sensor, PN 1022045, here.
- 3 Connector Isolation Icon.** Identifies the connector beside this icon as a type BF patient isolation connection.
- 4 $\dot{V}$ (CO₂/Flow or Cardiac Output Sensor Input Connector).** Connect only CO₂/Flow sensors, Catalog Number 9765-00, 9766-00 and 9767-00 or Cardiac Output sensors, Catalog Number 8950-00, 8951-00 and 8952-00.
- 5 Masimo Rainbow SET SpO₂ (Pulse Oximetry Sensor Input Connector).** Connect only Masimo Rainbow SET pulse oximetry sensors and extension cables approved for use with the NM3 monitor.
- 6 KNOB.** The **KNOB** is used to select monitoring screens, scroll through menus and to change or enter values. The **KNOB** is generally turned to access different monitoring screens and to highlight menu options, and pressed to accept or change those selections.
- 7 Battery Charging Icon.** The Battery Charger status icon is illuminated to show the state of the internal battery charger.
 - Not illuminated: Charger is disabled. Connect AC power.
 - Red: Battery Fault Detected. Disconnect and reconnect to AC power. If the icon continues to display red after the disconnect/reconnect, refer to Technical Service.
 - Amber: Battery is being charged.
 - Green: Battery is fully charged.
- 8 AC MAINS Power Indicator.** This icon illuminates green to indicate AC Mains power is applied to the monitor. To illuminate the icon, the monitor must be plugged into the AC outlet.
- 9 Alert Bar.** The Alert Bar is divided into two sections, left and right.
 - The left side of the Alert Bar indicates current Audio Alarm status: Unlit, audio alarms enabled; Yellow, 2-minute silence; Red, audio alarms muted.

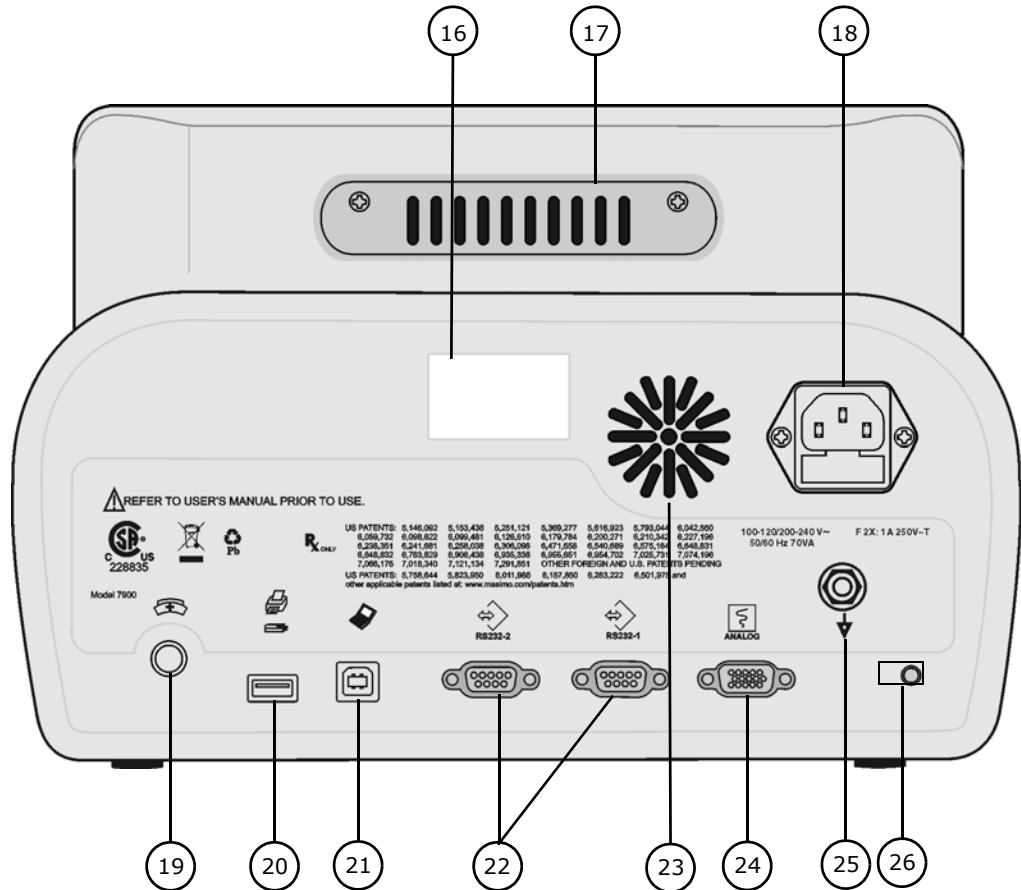
- The right side illuminates in accordance with the current alarm priority: Unlit, no alarms active; Steady blue, low priority alarm active; Blinking yellow, medium priority alarm active; Blinking red, high priority alarm active.
- 10 DATA ENTRY key.** Press to activate the **DATA ENTRY** screen and illuminate the key's green icon. Press the key again to return to the previously displayed screen. From the **DATA ENTRY** screen, you can enter patient information including height, weight and respiratory gas mixture, and access the **ABG DATA ENTRY** screen.
 - 11 MENU key.** Press to activate the **SELECT A SCREEN** menu and illuminate the key's green icon. Press the key again to return to the previously displayed screen. From the **SELECT A SCREEN** menu you can, by turning the knob, highlight the screen you wish to display. Press the **MENU** key or the **KNOB** to display that selected screen.
 - 12 SILENCE key.** The **SILENCE** key is used to mute/pause audible alerts. The Silence feature operates in two modes; a temporary "2 Minute Silence" mode and an "Audio Mute" mode.
 - 2 Minute Silence (Audio Pause) — Press and release to activate or deactivate the two minute silence. The key's icon illuminates amber when active and audible alerts will be muted for two minutes, after which the icon turns off and any audible alert will sound.
 - Audio Mute — Press and hold for one second to prevent or allow any audible alerts. The key's icon illuminates red to indicate that all audible alerts are being suppressed.

Pressing the **SILENCE** key for certain alerts conditions will acknowledge the alert and reset the condition. See "Messages" on page 127 for details on which alerts can be acknowledged.
 - 13 STOP/CONTINUE REBREATHING key.** Applies only when the Cardiac Output option is installed. Press to start cardiac output monitoring and the automatic rebreathing process. Subsequent presses will stop (amber indicator illuminated) or continue (amber indicator off) the rebreathing process. Press and hold for two seconds to clear the values in the C.O. averaging memory. The **STOP/CONTINUE REBREATHING** key will be inactive in Respiratory Mechanics mode.
 - 14 OPERATE/STANDBY key.** Press this key to turn the monitor on; the icon illuminates green. If connected to an AC outlet, the monitor uses AC power, otherwise it powers up using its internal battery (provided the battery is charged). The **OPERATE/STANDBY** key is illuminated green when the monitor is operating.
 - 15 Flip Feet** (front, left and right). The monitor can be positioned for better viewing by extending the kickstands at the front of the monitor.

Rear Panel

The NM3 monitor's rear panel includes a Nurse Call/Remote Alarm connection, an AC Mains power input module, two RS232 serial communications ports, an analog input/output port, equipotential connector, fan and ventilation slots, and the monitor's serial number label. These are explained below.

- 16 Serial Number Label.** The NM3 monitor's serial number is shown here. Refer servicing to qualified personnel.
- 17 Top Cover Handle Vents.** Do not block the air ventilation slots.
- 18 AC Mains Power Cord Connection.** Connect only approved hospital-grade line cords to this connector. If supplied with AC power, the monitor illuminates the front panel AC Mains Power Indicator, energizes the fan and recharges the internal battery.
- 19 Nurse Call/Remote Alarm.** Connecting source for remote alarm devices, such as nurse call.
- 20 USB Host Connection.**
- 21 USB Device Connection.**
- 22 RS232 Communications Ports.** Two 9-pin serial communications ports provide for digital communications with the NM3 monitor (see "RS232 Communications").
- 23 Fan.** The fan draws air in through the monitor. Do not block the fan's air intake slots.
- 24 Analog Output Port.** This 15-pin connector provides analog signal output capability for the NM3 monitor. See "Analog Output" on page 152.



25 Equipotentiality. Connection to the monitor's chassis (earth ground system).

26 Power cord retaining clip. If desired, remove the screw, slip the cord through the clip and insert and tighten the screw. Use only the supplied screw to secure the clip.

Underneath the monitor:

Speaker Cover. Do not block the speaker cover.

Ventilation Slots. Do not block the air ventilation slots.

Mounting Bosses. Use the bosses (raised, threaded screw holes) on the bottom of the cover to securely mount the NM3 to a stand such as Rollstand PN 1043409 or another suitable mount. Use only #8-32, 5/8" Phillips-head screws.

Symbols

These symbols may be found on the NM3 monitor, its sensors, accessories and documentation.



Attention
Consult manual for detailed information.



Single Use
Treat in accordance with protocol for "single use" items.



Mains Fuse Rating
Mains rating for replacement fuses



Patient Isolation
Identifies the patient isolation connection as type BF.



Prescription Only
Indicates use only by or on the order of a licensed medical professional.



Equipotentiality
Connection to monitor's chassis.

**Separate collection**

Compliant with the WEEE/RoHS recycling directives.



Take appropriate steps to ensure that spent batteries are collected separately when disposed of. This symbol is found on the internal battery and the monitor enclosure.

**Recyclable item**

This symbol is found on the internal battery and the monitor enclosure.



Nurse Call / Remote Alarm connection

**Signal Input / Output**

RS232 serial data communication port

**VentAssist Software option**

This symbol is found on right edge of the keypanel, and denotes a monitor that includes the VentAssist software option.

**Information**

Consult operating instructions.

**Manufacturer****Date of manufacture****EC|REP symbol**

European Community Representative

**Printer / USB symbols**

USB connector to a printer or flash drive. Located on the rear of the monitor enclosure.

**Heavy Metal Content**

Indicates heavy metal content, specifically lead. This symbol is found on the internal battery and the monitor enclosure.

**Canadian Standards Association**

approval. Compliance to IEC 60601-1 and applicable standards.

**Analog Output Port****CE mark**

Applies only to accessories and accessory packaging, as applicable.

**Cardiac Output software option**

This symbol is found on right edge of the keypanel, and denotes a monitor that includes the cardiac output software option.

**Reference**

Order number

**Serial number****Lot**

Lot or batch number

**Laptop**

Computer connection. Located on the rear of the monitor enclosure.

**Alarm**

This on-screen symbol accompanies NM3 alarms.

AC/Battery Operation

The NM3 monitor is designed to be operated from AC Mains power. An internal battery provides uninterrupted monitoring and trending capability for short periods (approximately 45 minutes) if the AC power is removed.

AC Mains Operation

To operate the monitor from AC Mains power:

- 1 Plug the line cord into the rear panel connector and the AC Mains power outlet.
(For more information, see "Monitor Specifications" on page 170.)
- 2 Press the front panel **OPERATE/STANDBY** key to turn the monitor on.
 - The **OPERATE/STANDBY** key illuminates.
 - The front panel AC Mains Power indicator and battery charging indicator illuminate.
 - The monitor's fan turns on.
 - The internal battery starts to recharge, as indicated by the battery charger icon.

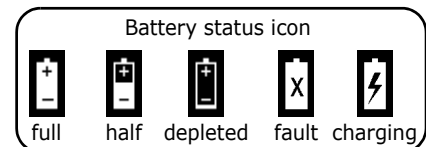


- 3 Press the front panel **OPERATE/STANDBY** key to turn the monitor on and off.
- 4 The battery charger will operate only in an ambient environment between 0° C and 40° C. Spent batteries or batteries that are unable to charge cause the battery charger icon to illuminate red.

NOTE: For best performance, always store the monitor with a fully charged battery. Storage of depleted batteries may adversely impact battery performance, and may cause premature battery aging.

Battery Operation

The NM3 monitor automatically switches to battery power from AC Mains power if the AC source is removed. A fully charged battery will power the monitor for approximately 45 minutes. While on battery power, the NM3 monitor screen displays a battery icon that "drains" as power is consumed.

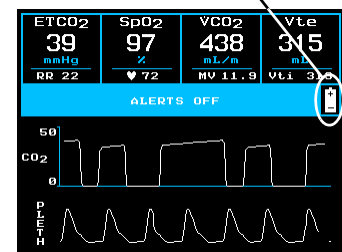


The on-screen battery icon starts to flash when approximately 10 minutes of battery power remain. An audible alert tone also sounds.

Reconnect to AC Mains power or the monitor will automatically shut off. A depleted battery may require 4-8 hours to fully recharge.

To operate the NM3 monitor on battery power:

- 1 Unplug the line cord. The front panel AC Mains Power indicator turns off.
- 2 Press the front panel **OPERATE/STANDBY** key to turn the monitor on and off.
- 3 If the monitor does not power up on battery, the battery may be completely discharged. Connect AC power to recharge the battery.
- 4 After periods of warehousing or long-term storage: The monitor may briefly require AC power. Also, the battery is shipped from the factory electrically disconnected. Connect AC power for a short time.



Parameter List

Respiratory Mechanics mode

The NM3 monitor displays the parameters described in this table.

Label	Parameter	Range / Units	Description	Screen Display
Cdyn	Dynamic Compliance	0-500 ml/cmH ₂ O	Volume the lungs expand for a given pressure Note that if the ventilator is set for an inspiratory pause that is detected by the NM3, Cdyn becomes Cst.	Numerics, Trend & Tabular Data
ETCO ₂	End Tidal Carbon Dioxide	0-150 mmHg 0-20.0 % 0-20.0 kPa	Maximum CO ₂ plateau value at the end of the breath (reflects alveolar CO ₂)	All
IBW	Ideal Body Weight	25.1-120.6 kg (male) 20.6-116.1 kg (female)	Ideal body weight calculated using gender and height input. Based on the Devine formula.	Patient Data Entry & VentAssist
I:E	I:E Ratio	1:9.9 or 4:1	Ratio of inspiratory time (ti) to expiratory time (te)	Flow/Pressure
MAP	Mean Airway Pressure	0-100 cmH ₂ O	Mean (average) pressure in the airway throughout the breath	Numerics, Trend & Tabular Data
MV	Minute Volume	0.4-60 L/min adult 0.06-30 L/min pedi. 0.01-5 L/min neonatal	Volume (in liters) of gas delivered to the patient per minute	All except Flow/Pressure & Loops
MV alv	Alveolar Minute Volume	0-16 L/min adult 0-8 L/min pediatric 0-4 L/min neonatal	MV less deadspace (wasted) ventilation	Numerics, Trend & Tabular Data
NIP	Negative Inspiratory Pressure	0 to -120 cmH ₂ O 0 to -120 hPa	Maximum negative pressure during inspiratory cycle	Loops
PeCO ₂ /FeCO ₂	Mixed expired CO ₂	0-100 mmHg, 0-13.2 kPa or %	Volume weighted average CO ₂ in the breath	Volumetric CO ₂ , Trend & Tabular Data
PEEP	Positive End Expiratory Pressure	0-99 cmH ₂ O 0-99 hPa	Pressure in the lungs at the end of expiration	Numerics, Flow/Pressure, Trend, Tabular Data & VentAssist
PEF	Peak Expiratory Flow	2-180 L/min adult 0.7-100 L/min pedi. 0.25-25 L/min neo.	Highest absolute flow rate during expiration	Loops, Trend & Tabular Data
PIF	Peak Inspiratory Flow	2-180 L/min adult 0.7-100 L/min pedi. 0.25-25 L/min neo.	Highest absolute flow rate during inspiration	Loops, Trend & Tabular Data
PIP	Peak Inspiratory Pressure	0-120 cmH ₂ O	Peak (highest) pressure in the airway during inspiration	Numerics, Flow/Pressure, Trend, Tabular Data & VentAssist
Pplat	Pressure plateau	0-99 cmH ₂ O	Pressure held during an end-inspiratory pause (static measurement). Dynamic Pplat, based on resistance and compliance measurements, is used in the VentAssist option.	Trend, Tabular Data & VentAssist
	Pulse Rate	25-240 bpm	Number of pulse beats per minute	All

Label	Parameter	Range / Units	Description	Screen Display
Raw	Airway Resistance (expired)	0-100 cmH ₂ O/L/sec adult 0-250 cmH ₂ O/L/sec pediatric 0-500 cmH ₂ O/L/sec neonatal	Pressure required to cause gas flow at a given rate	Numerics, Trend & Tabular Data
RR	Respiratory Rate	2-120 br/min adult 2-150 br/min pedi. 10-150 br/min neo.	Number of breaths per minute	All
RSBI	Rapid Shallow Breathing Index	0-1000 br/min/L (adult only)	Respiratory rate divided by average spontaneous tidal volume (only calculated when RR < 57)	Loops, Trend & Tabular Data
SpO ₂	Oxygen Saturation (Functional)	0-100 %	Oxyhemoglobin as a percentage of the sum of oxyhemoglobin and deoxyhemoglobin	All
VCO ₂	Carbon Dioxide Elimination	1-3000 ml/min adult/pediatric 0-300 ml/min neonatal	Volume of CO ₂ eliminated through the breath each minute	All except Flow/ Pressure & Loops
Vd Aw	Airway deadspace	0-500 ml	Total circuit deadspace	Numerics, Volumetric CO ₂ , Trend & Tabular Data
Vd/Vt	Deadspace to tidal volume ratio	0-1.00	(PaCO ₂ -PeCO ₂) / PaCO ₂	Numerics, Volumetric CO ₂ , ABG Data Entry, Trend & Tabular Data
Vd alv	Alveolar deadspace	0-500 ml	Difference between physiologic and airway deadspace	Numerics, Volumetric CO ₂ & ABG Data Entry
Vt alv	Alveolar tidal volume	0-2400 ml adult 0-1200 ml pediatric 0-160 ml neonatal	Tidal volume less airway deadspace	Numerics, Volumetric CO ₂ , Trend & Tabular Data
Vt/IBW	Tidal Volume per Ideal Body Weight	0-25.0 ml/IBW (male) 0-25.0 ml/IBW (female)	Tidal volume divided by ideal body weight	Patient Data Entry, Respiratory Numerics
Vt/kg	Tidal volume per kilogram	0-25.0 ml/kg adult 0-25.0 ml/kg pediatric 0-25.0 ml/kg neonatal	Tidal volume divided by kilogram of body weight	Respiratory Numerics & VentAssist
Vte	Expired Tidal Volume	200-3000 ml adult 30-400 ml pediatric 1-100 ml neonatal	Volume of gas exhaled per breath	All except Flow/ Pressure, Loops, Trend & Tabular Data
Vte-m	Expired Tidal Volume - mechanical	200-3000 ml adult 30-400 ml pediatric 1-100 ml neonatal	Volume of mechanically exhaled gas, per breath	Trend & Tabular Data
Vte-s	Expired Tidal Volume - spontaneous	200-3000 ml adult 30-400 ml pediatric 1-100 ml neonatal	Volume of spontaneously exhaled gas, per breath	Trend & Tabular Data
Vti	Inspired Tidal Volume	200-3000 ml adult 30-400 ml pediatric 1-100 ml neonatal	Volume of gas inhaled per breath	All except Flow/ Pressure, Loops, Trend & Tabular Data
Vti-m	Inspired Tidal Volume - mechanical	200-3000 ml adult 30-400 ml pediatric 1-100 ml neonatal	Volume of mechanically inhaled gas, per breath	Trend & Tabular Data
Vti-s	Inspired Tidal Volume - spontaneous	200-3000 ml adult 30-400 ml pediatric 1-100 ml neonatal	Volume of spontaneously inhaled gas, per breath	Trend & Tabular Data

Label	Parameter	Range / Units	Description	Screen Display
WOB/ min	Work of Breathing per minute	0 - 25 j/m	Amount of energy expended by the patient to move a volume of gas into the lungs, expressed as energy (joules) per minute.	VentAssist

Cardiac Output mode With the Cardiac Output option installed, the NM3 monitor displays the parameters described in this table.

Label	Parameter	Range / Units	Description	Screen Display
C.O.	Cardiac Output	0.5-19.9 L/min	Volume of blood pumped by the heart each minute	All except Trend & Tabular Data
CO-a	Average Cardiac Output	0.5-19.9 L/min	C.O. averaged value	Trend & Tabular Data
CO-f	Fast-mode Cardiac Output	0.5-19.9 L/min	Unaveraged C.O. value from the last completed cycle	Trend & Tabular Data
Cdyn	Dynamic Compliance	0-500 ml/cmH ₂ O	Volume the lungs expand for a given pressure Note that if the ventilator is set for an inspiratory pause that is detected by the NM3, Cdyn becomes Cstat.	Numerics, Trend & Tabular Data
CI	Cardiac Index	0-9.9 L/min/m ²	C.O. divided by body surface area	All
ETCO ₂	End Tidal Carbon Dioxide	0-150 mmHg 0-20.0 % 0-20.0 kPa	Maximum CO ₂ plateau value at the end of the breath (reflects alveolar CO ₂)	Numerics, CO ₂ /SpO ₂ , Volumetric CO ₂ , Trend, Rebreathing curves, Tabular Data & VentAssist
IBW	Ideal Body Weight	25.1-120.6 kg (male) 20.6-116.1 kg (female)	Ideal body weight calculated using gender and height input. Based on the Devine formula.	Patient Data Entry & VentAssist
Insp CO ₂	Inspired Carbon Dioxide	3-50 mmHg 0.4-6.7 % 0.4-6.7 kPa	Maximum CO ₂ value observed during the baseline portion of the Inspiratory phase of the breath (baseline shift above zero point)	General Message Area (if above 3 mmHg for 10 sec (0.4 % or kPa))
MAP	Mean Airway Pressure	0-100 cmH ₂ O	Mean (average) pressure in the airway throughout the breath	Numerics, Trend & Tabular Data
MV	Minute Volume	2-60 L/min Adult	Volume (in liters) of gas delivered to the patient per minute	Numerics, Trend & Tabular Data
MV alv	Alveolar Minute Volume	0.05-16 L/min	MV less deadspace (wasted) ventilation	Numerics, Trend & Tabular Data
NIP	Negative Inspiratory Pressure	0 to -120 cmH ₂ O	Maximum negative pressure during inspiration	Respiratory Numerics
PCBF	Pulmonary Capillary Blood Flow	0.5-19.9 L/min	Portion of the cardiac output that is effective in gas exchange	All except Trend & Tabular Data
PCBFa	Average Pulmonary Capillary Blood Flow	0.5-19.9 L/min	PCBF averaged value	Trend & Tabular Data
PCBFf	Fast-mode Pulmonary Capillary Blood Flow	0.5-19.9 L/min	Unaveraged PCBF from last completed cycle	Trend & Tabular Data
PeCO ₂ / FeCO ₂	Mixed expired CO ₂	0-100 mmHg, 0-13.2 kPa or %	Volume weighted average CO ₂ in the breath	Trend & Tabular Data

Label	Parameter	Range / Units	Description	Screen Display
PEEP	Positive End Expiratory Pressure	0-99 cmH ₂ O	Pressure in the lungs at the end of expiration	Numerics, Flow/Pressure, Trend, Tabular Data & VentAssist
PEF	Peak Expiratory Flow	2-180 L/min	Highest absolute flow rate during expiration	Trend & Tabular Data
PIF	Peak Inspiratory Flow	2-180 L/min	Highest absolute flow rate during inspiration	Trend & Tabular Data
PIP	Peak Inspiratory Pressure	0-120 cmH ₂ O	Peak (highest) pressure in the airway during inspiration	Numerics, Flow/Pressure, Trend, Tabular Data & VentAssist
Pplat	Pressure plateau	0-99 cmH ₂ O	Pressure held during an end-inspiratory pause (static measurement). Dynamic Pplat, based on resistance and compliance measurements, is used in the VentAssist option.	Respiratory Numerics, Trend, Tabular Data & VentAssist
	Pulse Rate	25-240 bpm	Number of pulse beats per minute	Numerics, CO ₂ /SpO ₂ , Trend & Tabular Data
Raw	Airway Resistance	0-100 cmH ₂ O/L/sec	Pressure required to cause gas flow at a given rate	Numerics, Trend & Tabular Data
RR	Respiratory Rate	2-120 br/min	Number of breaths per minute	Numerics, CO ₂ /SpO ₂ , Trend, Tabular Data & VentAssist
RSBI	Rapid Shallow Breathing Index	0-1000 br/min/L	Respiratory rate divided by average spontaneous tidal volume (only calculated when RR < 57)	Respiratory Numerics, Trend & Tabular Data
SpO ₂	Oxygen Saturation	0-100 %	Oxyhemoglobin as a percentage of the sum of oxyhemoglobin and deoxyhemoglobin	Numerics, CO ₂ /SpO ₂ , Rebreathing curves, Trend, Tabular Data & VentAssist
SV	Stroke Volume	0-250 ml	Volume of blood pumped by the heart each beat	All
SVI	Stroke Volume Index	0-125 ml	Stroke volume divided by body surface area	Tabular Data
SVR	Systemic Vascular Resistance	0-9999 dynes sec/cm ⁵	Resistance exerted by the blood vessels on blood flow and is an indicator of left ventricular afterload	SVR Calculation & Tabular Data
SVRI	Systemic Vascular Resistance Index	0-9999 dynes sec/cm ⁵	SVR normalized to body surface area	Tabular Data
VCO ₂	Carbon Dioxide Elimination	0-3000 ml/min	Volume of CO ₂ eliminated through the breath each minute	Numerics, Volumetric CO ₂ , Rebreathing curves, Trend & Tabular Data
Vd Aw	Airway deadspace	0-500 ml	Total airway deadspace, not including Cardiac Output Loop	Respiratory Numerics, Volumetric CO ₂ , Trend & Tabular Data
Vd/Vt	Deadspace to tidal volume ratio	0-1.00	(PaCO ₂ -PeCO ₂)/PaCO ₂	Respiratory Numerics, ABG Data Entry, Trend & Tabular Data

Label	Parameter	Range / Units	Description	Screen Display
Vd alv	Alveolar deadspace	0-500 ml	Difference between physiologic and airway deadspace	Respiratory Numerics & ABG Data Entry
Vt alv	Alveolar tidal volume	0-2400 ml	Tidal volume less airway deadspace	Respiratory Numerics, Volumetric CO ₂ , Trend & Tabular Data
Vt/IBW	Tidal Volume per Ideal Body Weight	0-25.0 ml/IBW (male) 0-25.0 ml/IBW (female)	Tidal volume divided by ideal body weight	Patient Data Entry, Respiratory Numerics
Vt/kg	Tidal volume per kilogram	0-25.0 ml/kg adult 0-25.0 ml/kg pediatric 0-25.0 ml/kg neonatal	Tidal volume divided by kilogram of body weight	Respiratory Numerics & VentAssist
Vte	Expired Tidal Volume	200-3000 ml	Volume of gas exhaled per breath	Respiratory Numerics, Flow/Pressure & Volumetric CO ₂
Vte-m	Expired Tidal Volume - mechanical	200-3000 ml	Volume of gas exhaled per breath during mechanical ventilation	Trend & Tabular Data
Vte-s	Expired Tidal Volume - spontaneous	200-3000 ml	Volume of gas exhaled per breath during spontaneous ventilation	Trend & Tabular Data
Vti	Inspired Tidal Volume	200-3000 ml	Volume of gas inhaled per breath	Respiratory Numerics, Flow/Pressure & Volumetric CO ₂
Vti-m	Inspired Tidal Volume - mechanical	200-3000 ml	Volume of gas delivered by ventilator, per breath	Trend & Tabular Data
Vti-s	Inspired Tidal Volume - spontaneous	200-3000 ml	Volume of gas inhaled by the patient, per breath	Trend & Tabular Data
WOB/min	Work of Breathing per minute	0 - 25 j/m	Amount of energy expended by the patient to move a volume of gas into the lungs, expressed as energy (joules) per minute.	VentAssist

Principles of Operation

Carbon Dioxide (CO₂)

The NM3 monitor uses the CAPNOSTAT 5 CO₂ Sensor or LoFlo C5 CO₂ Sensor to measure CO₂ by using the infrared absorption technique. The principle is based on the fact that CO₂ molecules absorb infrared (IR) light energy of specific wavelengths, with the amount of energy absorbed being directly related to the CO₂ concentration. When an IR beam is passed through a gas sample containing CO₂, the electronic signal from the photodetector (which measures the remaining light energy) can be obtained. This signal is then compared to the energy of the IR source and calibrated to accurately reflect CO₂ concentration in the sample. The CAPNOSTAT 5 CO₂ Sensor or LoFlo C5 CO₂ Sensor's response to a known concentration of CO₂ is stored at the factory in the sensor's memory. A reference channel accounts for optical changes in the sensor, allowing the system to remain in calibration without user intervention.

Flow and Pressure

Flow and pressure measurements in the NM3 monitor are made by a fixed orifice differential pressure pneumotachometer. Respirated gas flowing through the flow sensor causes a small pressure drop across the two tubes connected to the sensor. This pressure drop is transmitted through the tubing to a differential pressure transducer located inside the monitor, and is correlated to flow according to the factory stored calibration. User calibration is not required due to the ability of the plastic injection mold to repeatedly produce precision flow sensors. The pressure transducer is automatically "zeroed" to correct for changes in ambient temperature and electronics. The NM3 monitor system software compensations allow accurate flow and volume measurements in the presence of high oxygen concentrations, anesthetic gases and helium-oxygen mixtures. When compensated, gas density and viscosity effects do not cause significant errors in flow measurement.

Carbon Dioxide Elimination (VCO_2)

Measurement of carbon dioxide elimination (VCO_2) is a fundamental component of the system's calculations. It is calculated based on a mathematical integration of the measured flow and CO_2 signals. These signals are obtained from practically the same point at the patient's airway, thereby insuring optimal accuracy.

Oxygen Saturation (SpO_2) & Pulse Rate

SpO_2 is determined using sensors containing red and infrared light emitting diodes (LEDs). The light from the LEDs are beamed through a pulsating vascular bed such as the patient's finger or toe. The remaining light not absorbed by the tissue reaches a photodiode light receptor in the sensor. Oxygen saturated blood absorbs different amounts of light at each wavelength as compared to unsaturated blood. Therefore, the amount of light absorbed by the blood in each pulse can be used to calculate oxygen saturation.

The NM3 monitor is calibrated to measure and display "functional" saturation. This differs from the "fractional" saturation value displayed by most co-oximeters. Functional saturation represents the amount of oxyhemoglobin as a percentage of the hemoglobin that can be oxygenated. Dysfunctional hemoglobins, (COHb and METHb) are not included in the measurement of functional saturation.

- Functional Saturation = $\text{HbO}_2 / 100 - (\text{COHb} + \text{METHb})$; HbO_2 is oxyhemoglobin (fractional), COHb is carboxyhemoglobin, and METHb is methemoglobin.

Pulse Rate, derived from the pulse oximetry sensor, is calculated by measuring the time interval between the peaks of the infrared light waveform. The inverse of this measurement is displayed as pulse rate.

Oxygen saturation (SpO_2) is used by the NM3 monitor to calculate the shunt correction of the Non-Invasive Cardiac Output calculation, and the pulse rate is used to calculate stroke volume.

Non-Invasive Cardiac Output

With the Cardiac Output option installed, the NM3 monitor calculates pulmonary capillary blood flow (PCBF) and estimates cardiac output (C.O.) non-invasively based on respiratory gas analysis, using a technique known as "differential Fick partial rebreathing." The key to this technique is a Cardiac Output Sensor, consisting of a rebreathing valve and a combined CO_2 /Flow sensor placed in the breathing circuit. The Cardiac Output Sensor is placed into the ventilator circuit between the patient elbow and ventilator wye. The rebreathing valve is automatically controlled by the monitor. When the valve is activated, the flow of the inspired and expired gas is diverted through a rebreathing loop integrated into the Cardiac Output Sensor. When the valve is deactivated, this additional rebreathing volume is bypassed and normal ventilation resumes. Every three minutes, a baseline, rebreathing and stabilization phase occurs. (See "The Cardiac Output Cycle" on page 49.) A non-invasive cardiac output calculation is made following the end of each three minute cycle. The calculation is based on the changes induced in CO_2 elimination and end tidal CO_2 in response to the rebreathing volume. The increase in end tidal CO_2 , which reflects the increase in PaCO_2 , is usually 3-5 mmHg (0.4-0.67 kPa) and returns to baseline in less than 30 seconds.

The Fick equation using CO_2 as an indicator states that cardiac output is equal to CO_2 elimination divided by the venous-arterial difference in the CO_2 content: $\text{VCO}_2 / (\text{CvCO}_2 - \text{CaCO}_2)$. The partial rebreathing method yields a differential form of the Fick equation, eliminating the need to measure mixed venous CO_2 (assumed constant during the rebreathing period and therefore cancels out of the equation). This indirect Fick method is then corrected for shunt, based on the Nunn's iso-shunt curves using SpO_2 (or entered PaO_2) and a user-entered value for FiO_2 (INSP O_2).

VentAssist

A primary goal of mechanical ventilatory support for patients with respiratory failure is reduction of excessive work of breathing per minute (WOB/min). VentAssist assists the caregiver in managing patients with variable degrees of respiratory failure, respiratory system mechanics and/or neuromuscular capabilities that challenge bedside clinical assessments for setting PSV inspiratory pressure levels. For these conditions, VentAssist serves as a computerized ventilatory advisory system to make real-time recommendations for setting PSV for patients with respiratory failure based on a load (work of breathing) and tolerance (flow and tidal volume) strategy. For safety, end-tidal CO_2 monitoring is included to ensure the patient is adequately ventilated.

The VentAssist WOB/min non-invasive algorithm is statistically equivalent to invasive work of breathing calculated for one minute using esophageal manometry. This is done by collating

airway flow, airway pressure and airway volume as measured by the NM3 monitor, and data inputs from the ventilator and/or manual entry by the clinician into an artificial neural network. Resistance and elastance estimates are calculated using various characteristics of the flow and pressure waveforms which, combined with other characteristics, are used as inputs to a fixed-coefficient neural network. This neural network was trained using esophageal manometry data as the reference. VentAssist calculates an intubated adult patient's work of breathing non-invasively on a per-minute basis using two minutes of data and updating the calculation every 20 seconds. When the Cardiac Output rebreathing cycle is active, the WOB/min parameter will be temporarily disabled until the cycle is de-activated.

The Pplat parameter utilized by VentAssist is an averaged indication of the patient's Plateau Pressure as measured by the NM3 proximal flow sensor. VentAssist calculates a dynamic plateau pressure derived from the patient's resistance and compliance measurements. A squarewave and inspiratory hold maneuver is not required for this measurement.

Pressure Support advice parameters RR, V_T /kg, and WOB shown in the VentAssist display are averaged for 2 minutes. Each parameter is classified into probability ranges of Low, Good and High based on the configuration. Probability is drawn from a lookup rule table that selects the most probable rule and advice. If multiple rules apply, the advice is downgraded from a firm recommendation to a "Consider" recommendation. Advice and rule determination are based on expert pulmonologist coding. A measured PSV level is used to ensure the recommendation doesn't contradict fixed PSV limits (5-25 cmH₂O).

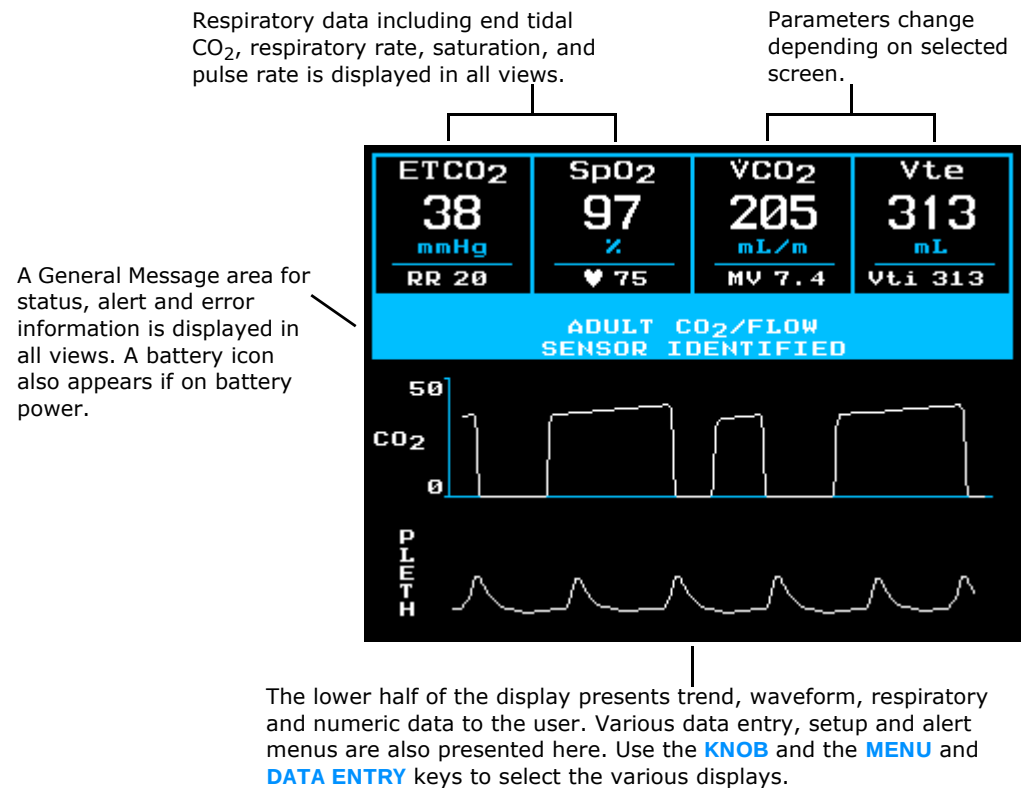
Ventilation advice is based on the current level of ETCO₂ and where the value is within the set range and configuration. High ETCO₂ readings drive an Increase Ventilation recommendation; low ETCO₂ readings drive a Decrease Ventilation recommendation. Between low and high ETCO₂, ventilation advice of Increase MV or Decrease MV will be displayed in lieu of Pressure Support advice.

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Navigating in Respiratory Mechanics mode

Areas of the Display

The major sections of the Respiratory Mechanics mode screen are identified below.



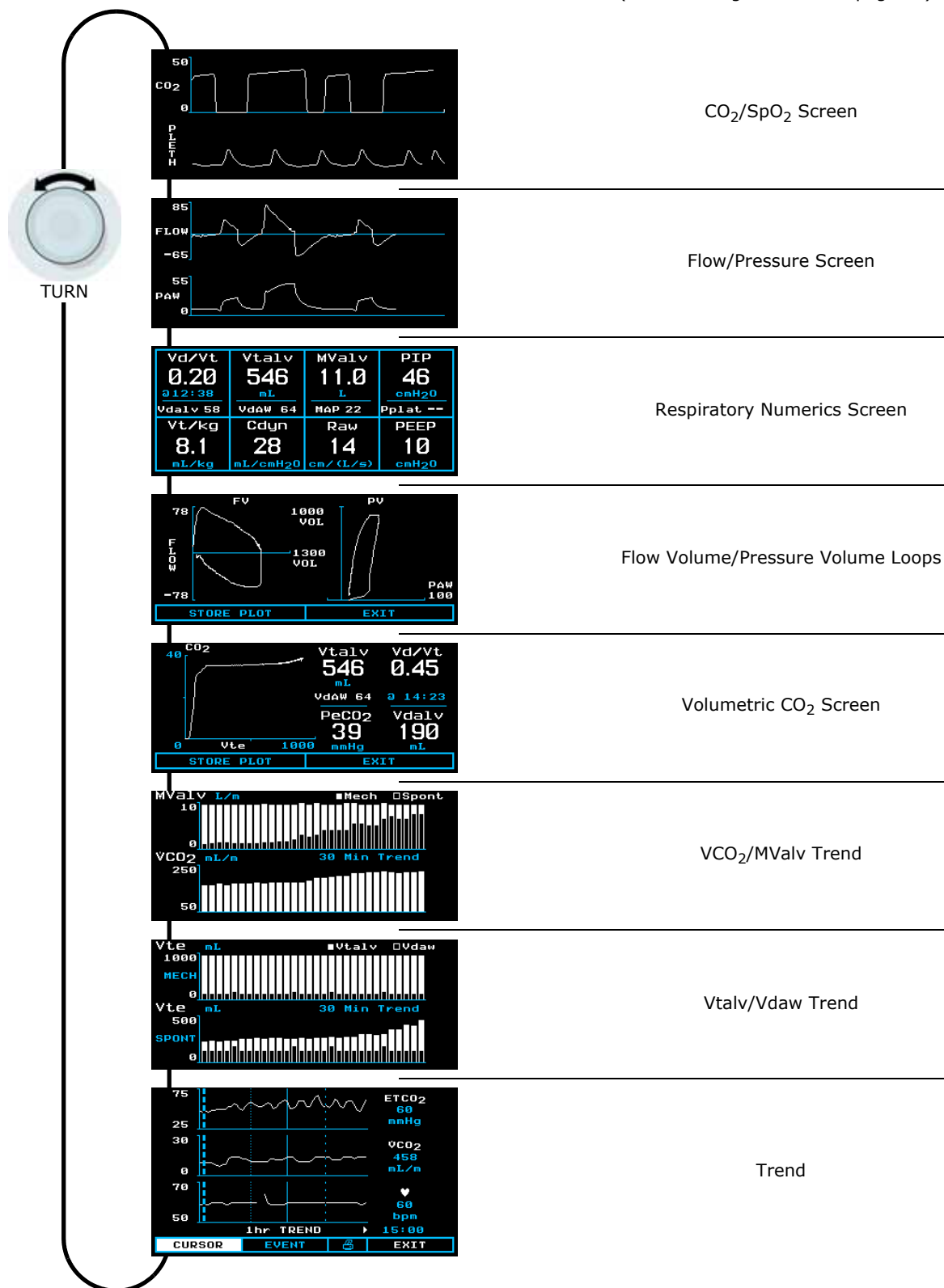
Navigating the Display System

Use the **KNOB**, **MENU**, and **DATA ENTRY** keys to navigate the NM3 monitor's display system (as outlined in the following sections).



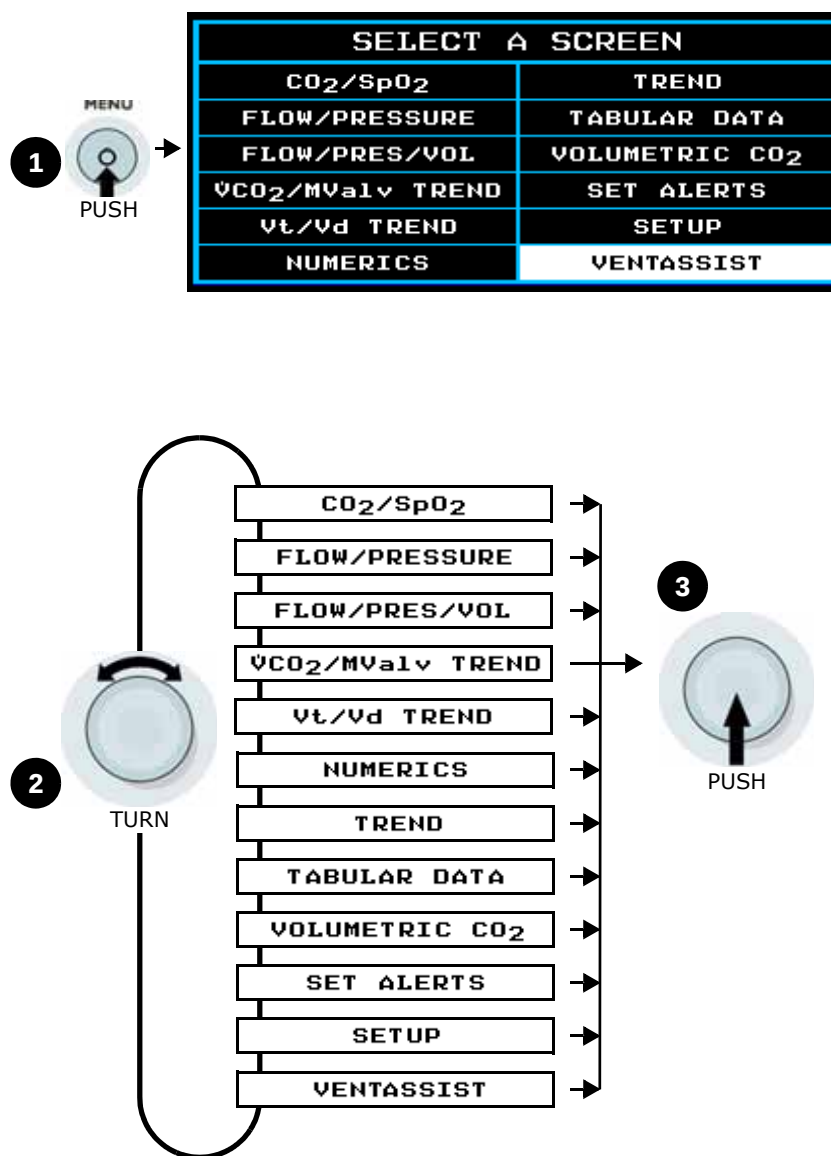
KNOB selectable Monitoring Screens

The **KNOB** is used to page through monitoring screens, scroll through menus and make selections, and to change or enter values. The **KNOB** is generally turned to access different monitoring screens and to highlight menu options, and pressed to accept or change selections. Screens must be enabled from the **CHOOSE SCREENS** menu (see "Enabling Screens" on page 75)



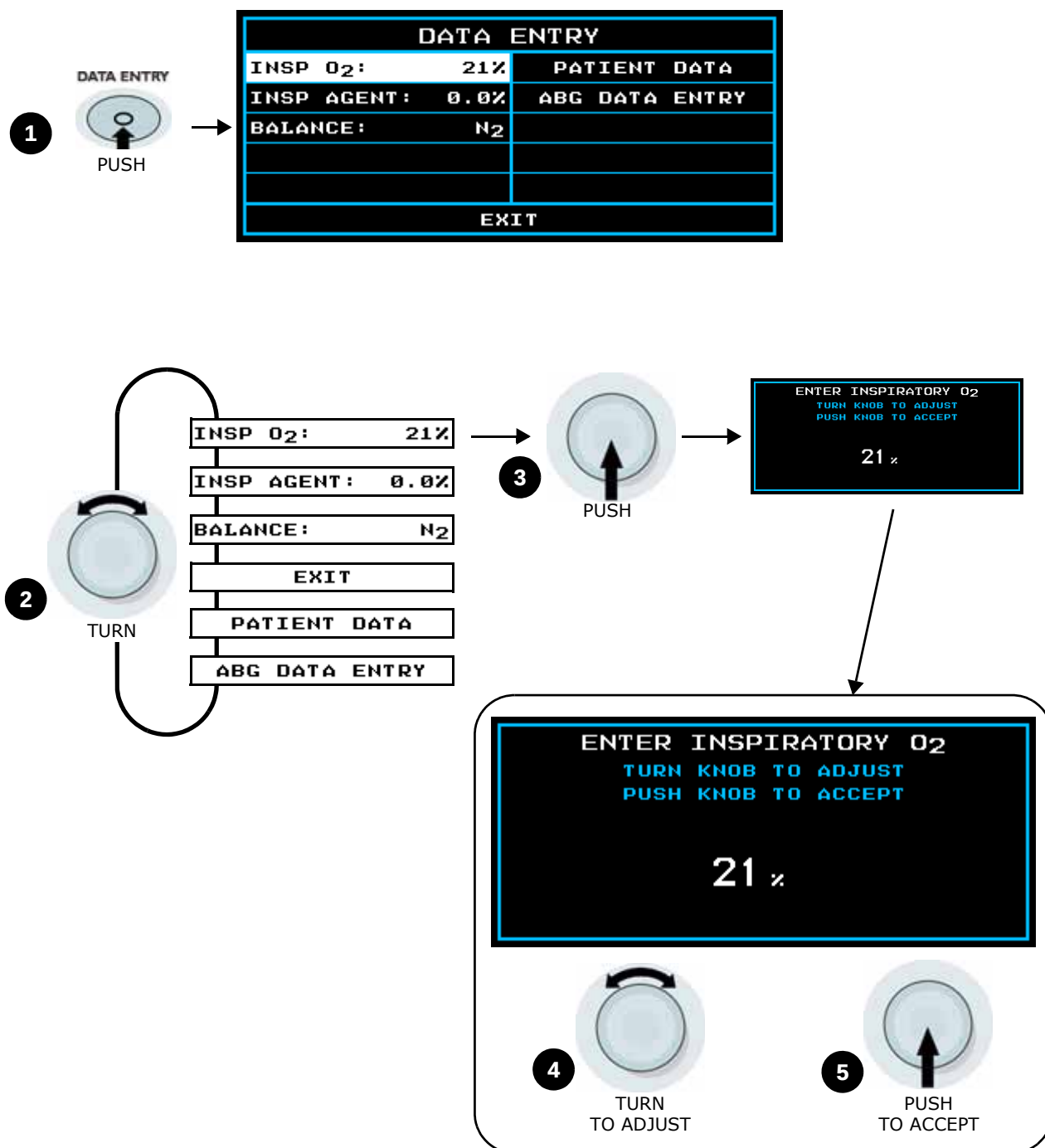
MENU key Screen Displays

Press the **MENU** key to activate the **SELECT A SCREEN** menu and illuminate the key's green icon. Press the key again to return to the previously displayed screen. From the **SELECT A SCREEN** menu turn the **KNOB** to highlight the screen you wish to display. Press the **MENU** key or the **KNOB** to display that selected screen.



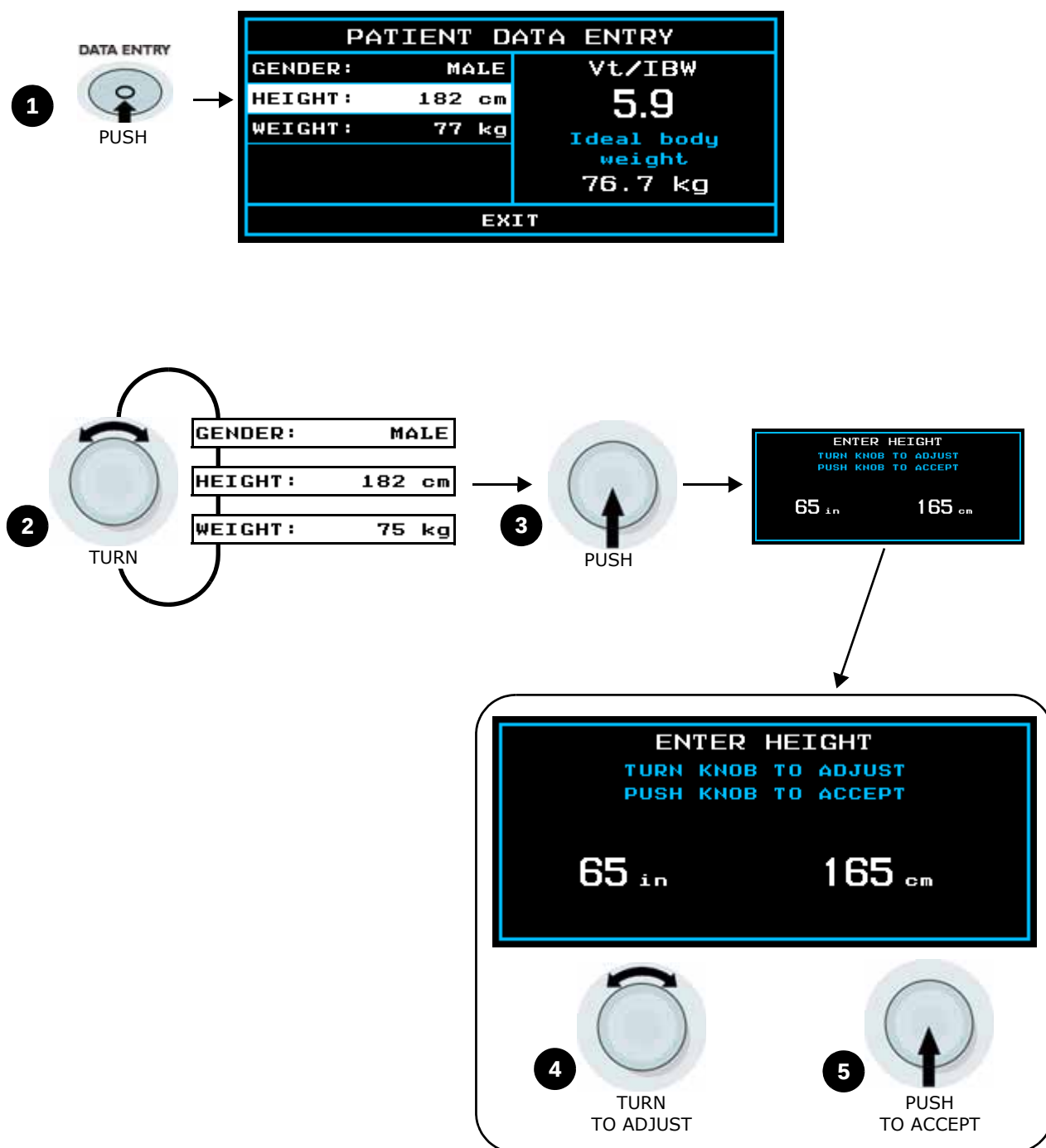
DATA ENTRY key Screen Displays

Press the **DATA ENTRY** key to activate the **DATA ENTRY** screen and illuminate the key's green icon. Press the key again to return to the previously displayed screen. From the **DATA ENTRY** screen, you can enter the respiratory gas composition, and access the **PATIENT DATA** and **ABG DATA ENTRY** screens. (See "Entering Patient Data" on page 38 for details.)



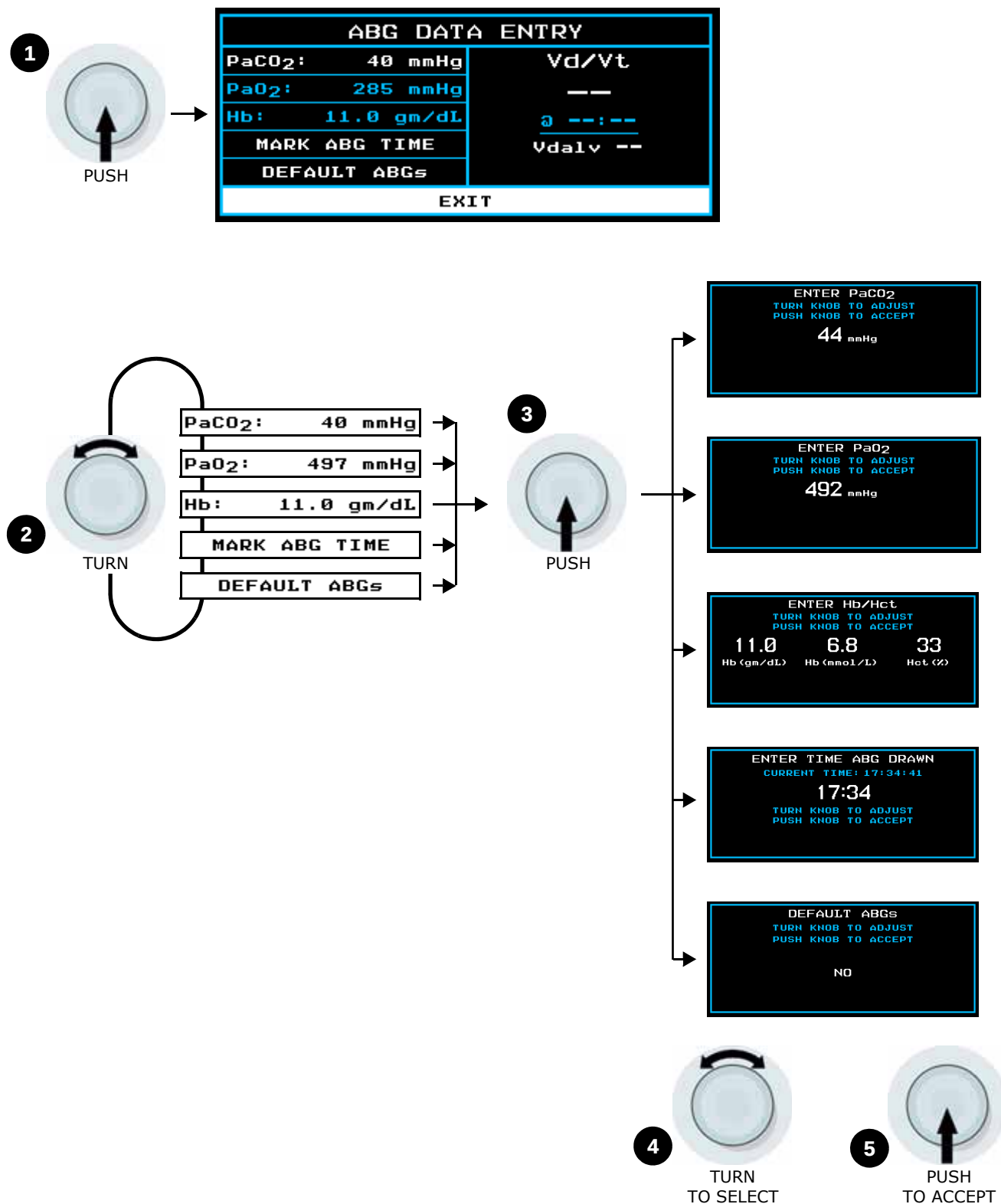
Patient Data Entry Screens

From the **DATA ENTRY** screen, select **PATIENT DATA**. Turn and press the **KNOB** to enter Gender, Height, and Weight entry screens. (See "Patient Data Entry" on page 44 for details.)



ABG Data Entry Screens

From the **DATA ENTRY** screen, select **ABG DATA ENTRY**. Turn and press the **KNOB** to enter PaCO₂, PaO₂, and Hemoglobin entry screens. (See "ABG Data Entry" on page 41 for details.)



Navigating in Cardiac Output mode

Areas of the Display

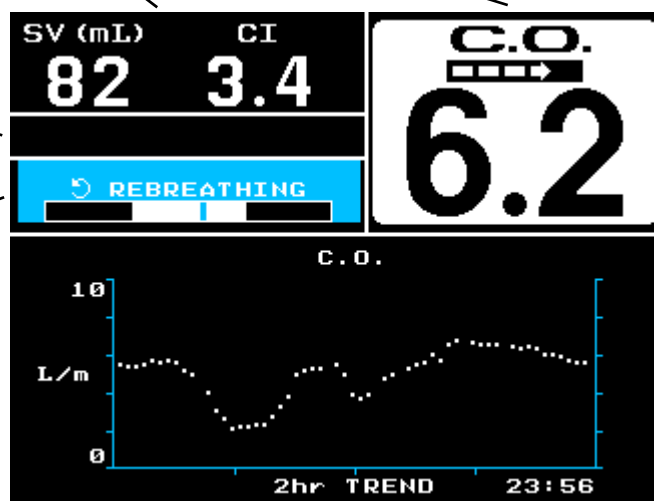
The major sections of the Cardiac Output mode screen are identified below.

Stroke Volume (SV) is displayed in all views. Cardiac Index (CI) or Cardiac Output (C.O.) is displayed. A battery icon also appears if on battery power.

Cardiac Output (C.O.), Cardiac Index (CI), or Pulmonary Capillary Blood Flow (PCBF) value is displayed. The CObar™ confidence indicator, **FAST MODE** or **MANUAL MODE** is displayed above the value.

A General Message area for status, alert and error information. Displayed in all views (here shown blank).

A Cardiac Output Message area for C.O. information is displayed in all views. The Rebreathing Bar is displayed during the rebreathing portion of the cycle.



The lower half of the display presents trend, waveform, respiratory and numeric data to the user. Various data entry, setup and alert menus are also presented here. Use the **KNOB** and the **MENU** and **DATA ENTRY** keys to select the various displays.

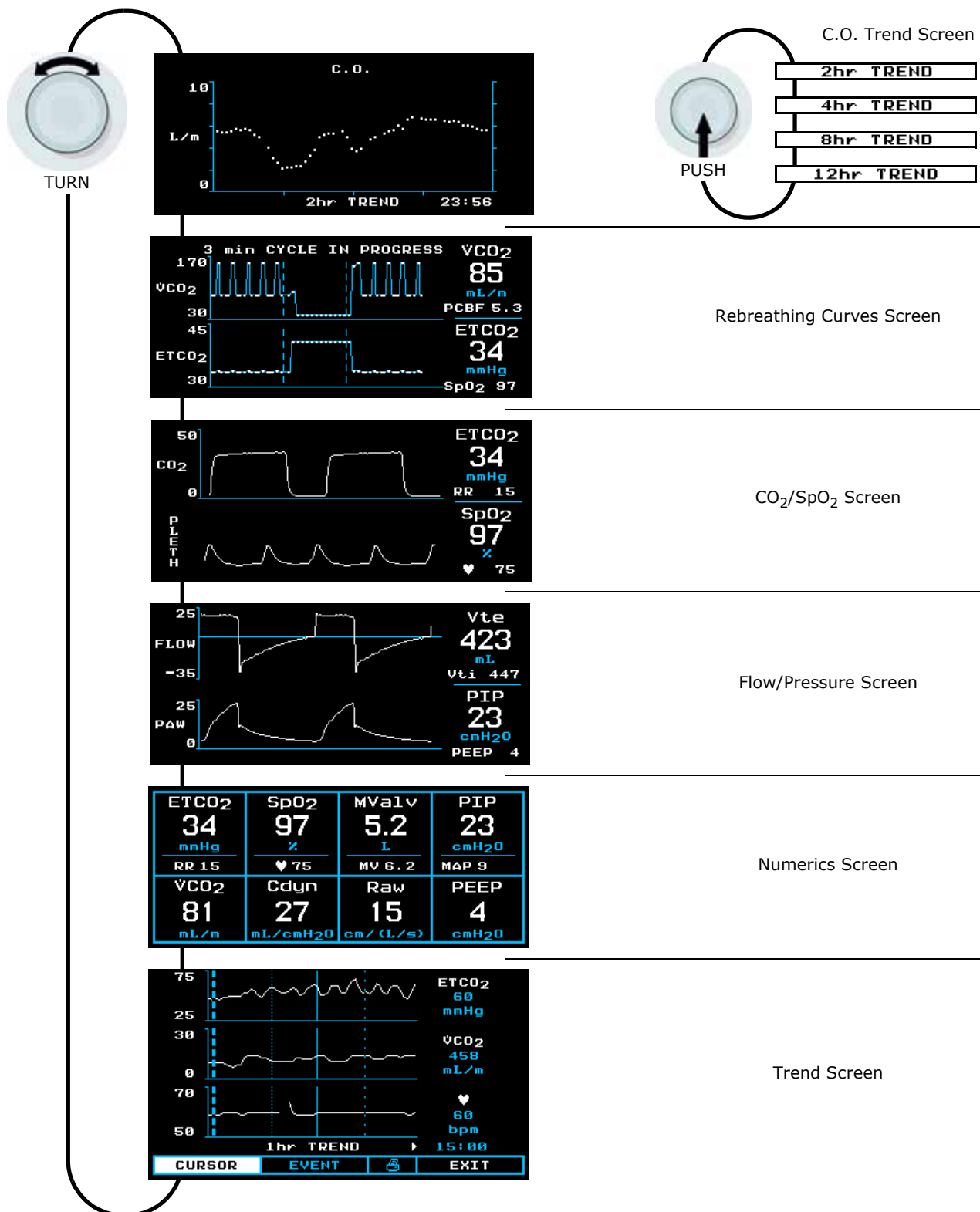
Navigating the Display System

Use the **KNOB**, **MENU**, and **DATA ENTRY** keys to navigate the NM3 monitor's display system (as outlined in the following sections).



KNOB selectable Monitoring Screens

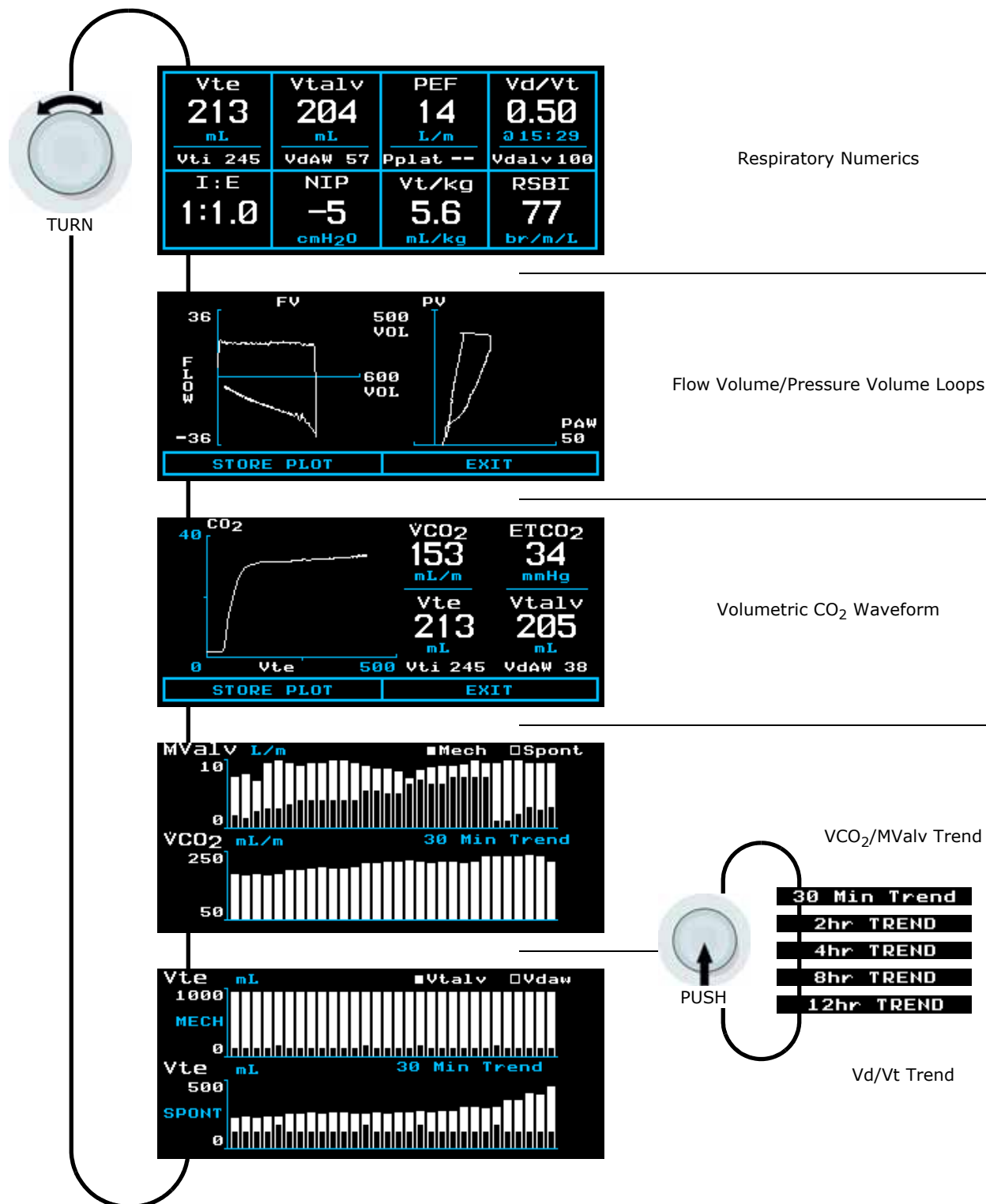
The **KNOB** is used to page through monitoring screens, scroll through menus and make selections, and to change or enter values. The **KNOB** is generally turned to access different monitoring screens and to highlight menu options, and pressed to accept or change selections. Screens must be enabled from the **CHOOSE SCREENS** menu (see "Enabling Screens" on page 75)



Knob Selectable Respiratory Screens

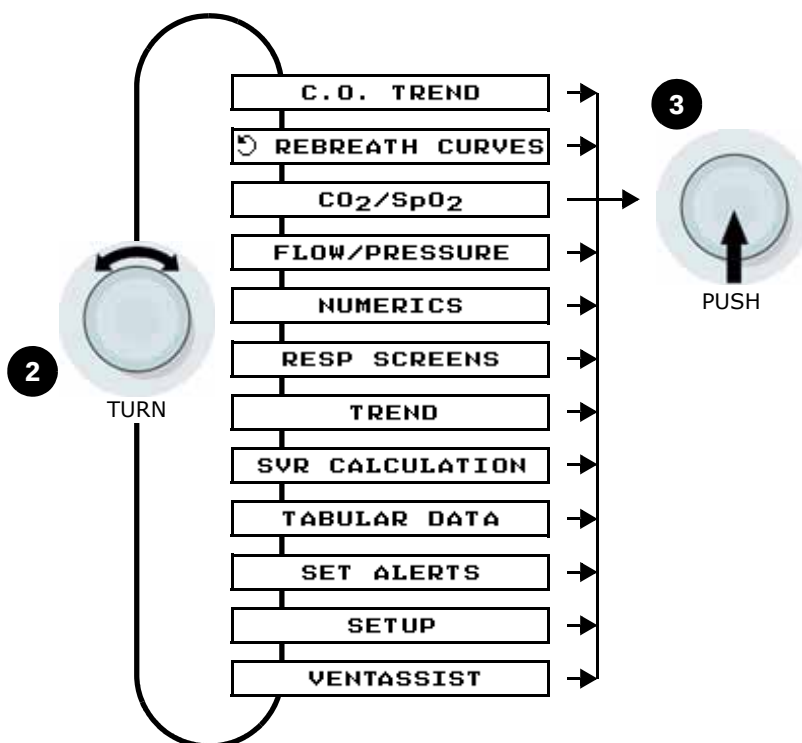
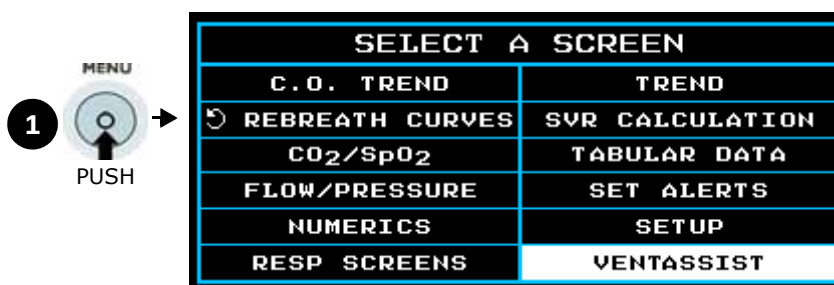
The following Respiratory Screens are available in the monitoring mode. Press the **MENU** key and select **RESP SCREENS** from the **SELECT A SCREEN** menu by turning and then pressing the **Knob**.

From the **SELECT RESPIRATORY SCREENS** menu, highlight and select a screen by turning and then pressing the **Knob**. Screens can also be displayed by turning the **Knob** while viewing any monitoring screen. Screens must be enabled from the **CHOOSE SCREENS** menu (see "Enabling Screens" on page 75)



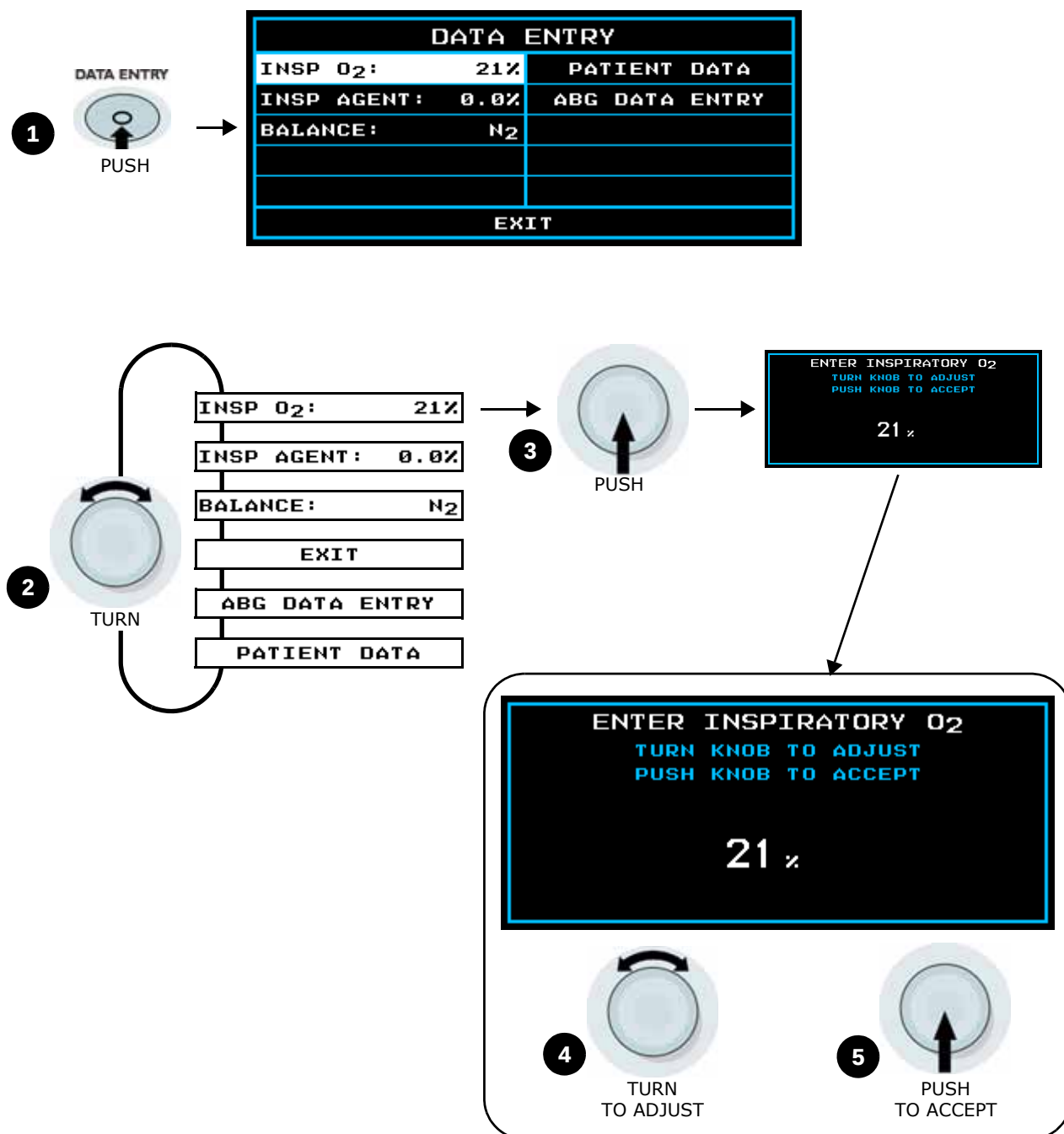
MENU key Screen Displays

Press the **MENU** key to activate the **SELECT A SCREEN** menu and illuminate the key's green icon. Press the key again to return to the previously displayed screen. From the **SELECT A SCREEN** menu turn the **KNOB** to highlight the screen you wish to display. Press the **MENU** key or the **KNOB** to display that selected screen.



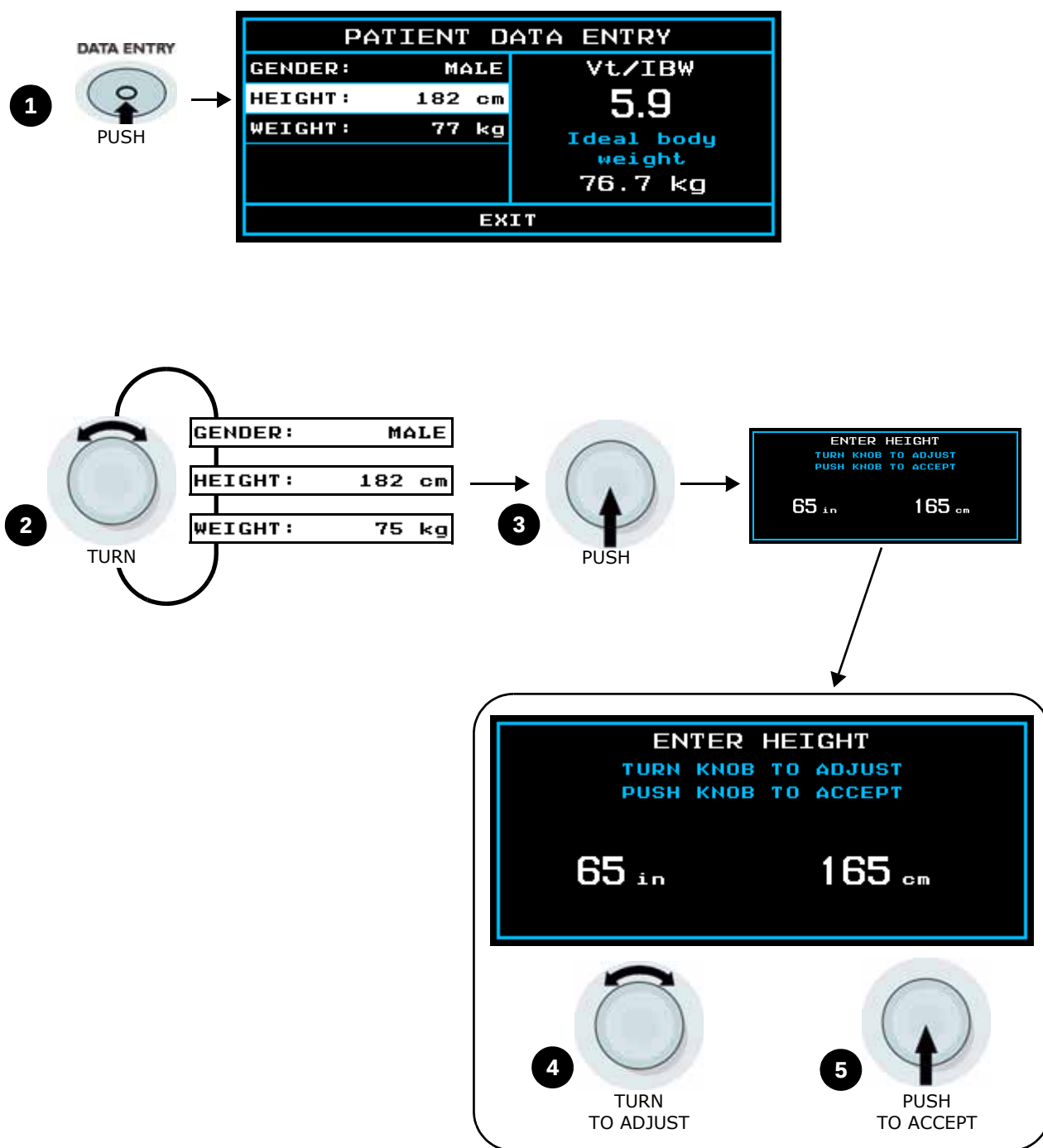
DATA ENTRY key Screen Displays

Press the **DATA ENTRY** key to activate the **DATA ENTRY** screen and illuminate the key's green icon. Press the key again to return to the previously displayed screen. From the **DATA ENTRY** screen, you can enter respiratory gas composition, and access the **PATIENT DATA** and **ABG DATA ENTRY** screen. (See "Entering Patient Data" on page 50 for details.)



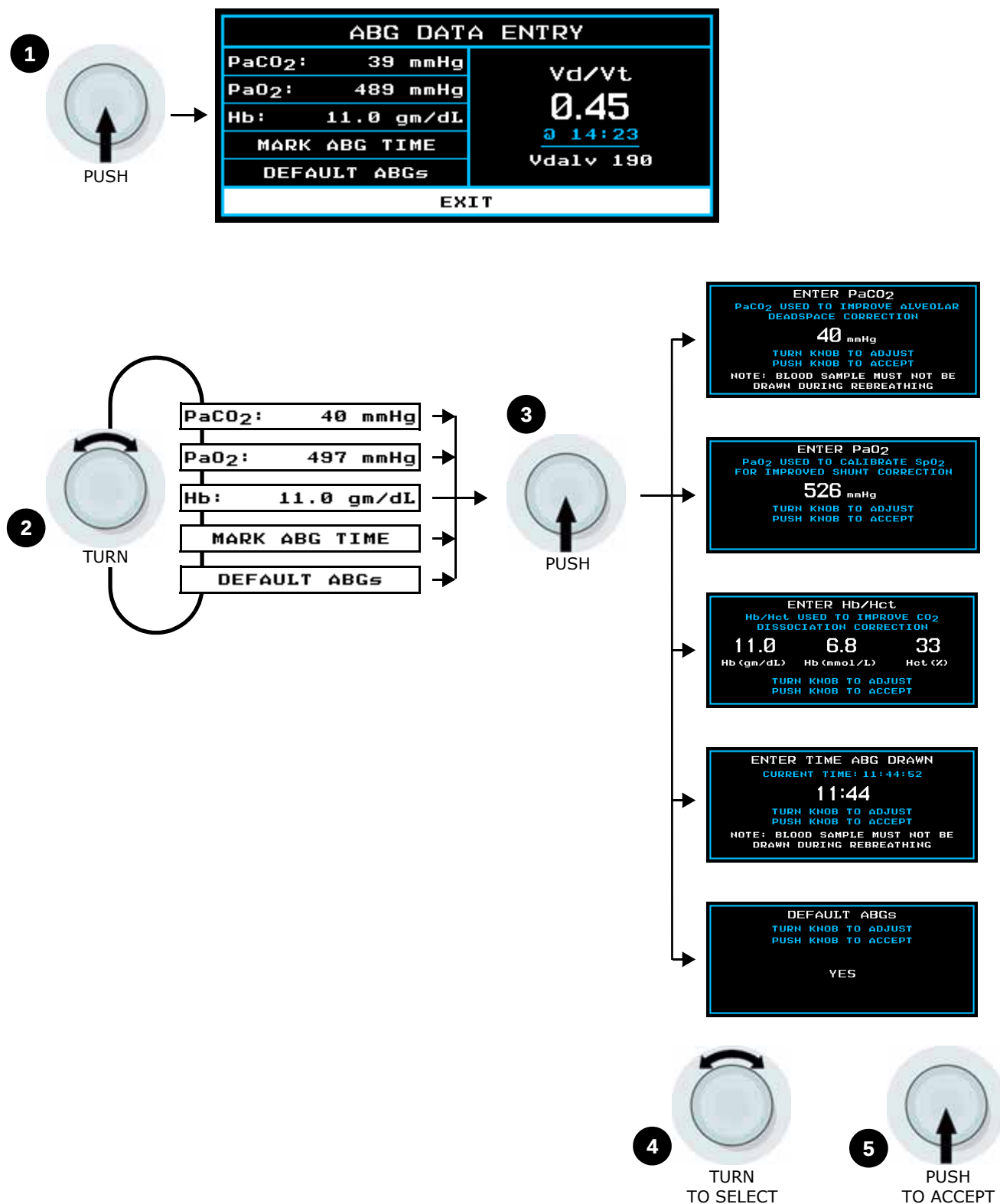
Patient Data Entry Screens

From the **DATA ENTRY** screen, select **PATIENT DATA**. Turn and press the **KNOB** to enter Gender, Height, and Weight entry screens. (See "Patient Data Entry" on page 57 for details.)



ABG Data Entry Screens

From the **DATA ENTRY** screen, select **ABG DATA ENTRY**. Turn and press the **KNOB** to enter PaCO₂, PaO₂, and Hemoglobin entry screens. (See "ABG Data Entry" on page 53 for details.)



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Safety

For maximum patient and operator safety, observe the following warnings, cautions and notes.

Warnings



WARNING:

Indicates a potentially harmful condition that can lead to personal injury.

- In Cardiac Output mode, the NM3 monitor should not be used on patients for whom a small rise (3-5 mmHg, 0.4-0.67 kPa) in PaCO₂ level cannot be tolerated.
- On-demand pressure support advice should not be used in cases of severe burn injury or for patients with severe neurological disorders that affect breathing control.
- Explosion Hazard: Do not use the NM3 monitor in the presence of a flammable anesthetic mixture with air, or with oxygen or nitrous oxide. Use of this instrument in such an environment may present an explosion hazard.
- Do not use the NM3 monitor in an environment in which the concentration of oxygen is greater than 25%.
- Electrical Shock Hazard: Always turn the NM3 monitor off before cleaning it. Do not use with a damaged external power source. Monitor must be grounded at all times to avoid dangerous electrical shock. Refer servicing to qualified service personnel.
- Connect the AC Mains power cord to a properly grounded hospital-grade outlet. The NM3 monitor should be connected to the same electrical circuit as other equipment in use on the patient. Outlets of the same circuit can be identified by members of the hospital's engineering department.
- Failure of Operation: If the monitor fails to respond as described, do not use it until the situation has been corrected by qualified personnel.
- Reuse (disassembly, cleaning, disinfecting, resterilizing, etc.) of the CO₂, CO₂/Flow and Cardiac Output Sensors may compromise device functionality and system performance and cause a potential patient hazard. Performance is not guaranteed if a sensor is reused.
- Inspect all sensors prior to use and periodically during use.
 - Do not use if they appear to be damaged or broken.
 - Do not attempt to rotate the Cardiac Output Sensor in the breathing circuit by grasping the pneumatic tubes exiting the flow sensor.
 - Do not apply excessive tension to any cable or pneumatic tubing.
 - Prevent stress on the ET tube by supporting the airway adapters and sensor.
 - Periodically inspect sensor tubing lines for kinks.
 - Replace the CO₂/Flow sensor, Cardiac Output Sensor or sidestream sampling kit if excessive moisture or secretions are observed in the tubing.
 - Elevated CO₂ baseline or abnormal CO₂ waveforms may be caused by sensor, adapter, or sampling kit issues or patient conditions.
- The NM3 monitor automatically identifies the type of sensor (small, standard or large Cardiac Output Sensor, or neonatal, pediatric or adult CO₂/Flow sensor) when it is connected. If a sensor identification message is not displayed when a sensor is first connected, DO NOT use the sensor. If the condition persists, refer the monitor to qualified service personnel.

- Do not use the NM3 monitor if it is unable to properly identify a CO₂/Flow sensor or a Cardiac Output Sensor. If the condition persists, refer the monitor to qualified service personnel.
- The use of the NM3 monitor is restricted to one patient at a time. Do not connect the sensors to multiple patients simultaneously.
- In the event the message **SENSOR FAILURE REPLACE C.O. SENSOR** is displayed, remove the Cardiac Output Sensor from the patient circuit.
- The CO₂/Flow or Cardiac Output Sensor connector should be properly inserted into the front panel receptacle prior to connecting a sensor to the breathing circuit, in order to avoid a circuit leak, or occlusion of sensor tubing. Remove the sensor from the breathing circuit prior to disconnecting it from the monitor in order to avoid a circuit leak.
- The LoFlo sampling kit connector should be properly inserted into the front panel receptacle prior to connecting a sensor to the breathing circuit, in order to avoid a circuit leak, or occlusion of sensor tubing.
- Cardiac Output Sensors increase airway deadspace by 35 cc (minimum). At low tidal volumes, compensatory changes to ventilation protocol should be considered.
- Cardiac Output Sensors are not for pediatric use.
- Do not use the LoFlo C5 CO₂ Sensor on patients who cannot tolerate the withdrawal of 50 ml/min from the airway, or patients that cannot tolerate the added deadspace to the airway.
- Patient Safety: Care should be exercised with all patients, especially neonates, to assure continued peripheral perfusion distal to the SpO₂ sensor site after application.
 - Periodically inspect the SpO₂ sensor site for adequate circulation.
 - When applying sensors take note of patient's physiological condition. For example, burn patients may exhibit more sensitivity to heat and pressure and therefore additional consideration such as more frequent site checks may be appropriate.
- VentAssist is an open-loop system, meaning that the system provides advice only, and does not perform any actions based on that advice. The clinician is ultimately responsible for all ventilator adjustments.
- The use of pulse oximetry monitoring and limit alerts is recommended while the VentAssist option is in use.
- The advisor functionality of VentAssist is not intended to be used as an alarm system. High or low parameter flags (red and yellow) are displayed as recommendations only, and are not meant to be interpreted as an alarm condition.
- Data Validity: The NM3 monitor should not be used as a substitute for an ECG monitor. The Pulse Rate display reflects the pulsatile flow found at the patient extremity connected to the sensor. This rate can be affected by many factors and may occasionally be "frozen."
- Periodically check sensors and tubing for excessive moisture or secretion build up. Although the NM3 monitor automatically purges the lines, excessive moisture or secretions may still remain.
- While using the sensors, a system leak, such as that caused by uncuffed endotracheal tubes or a damaged sensor may significantly affect flow related readings. These include flow, volume, pressure, deadspace, CO₂ production and other respiratory mechanics parameters.
- Do not position sensor cables or tubing in any manner that may cause entanglement or strangulation.
- The NM3 monitor provides no protection against the effects of a defibrillator. The patient sensors must not be located between defibrillator pads when a defibrillator is used on a patient.
- To reduce the hazard of burns in the high-frequency surgical neutral electrode connection, the patient sensors should not be located between the surgical site and the electro-surgical unit return electrode.
- The NM3 monitor is not intended to be used as an apnea monitor.
- The NM3 monitor is not intended for transport use.
- The NM3 monitor has no protection against the ingress of water.
- Carefully read this User's Manual prior to use of the NM3 monitor.

Cautions



CAUTION:

Indicates a condition that may lead to equipment damage or malfunction.

- Use only approved sensors and accessories with the NM3 monitor.
- Use only a Masimo oximetry sensor for SpO₂ measurements. Other oxygen transducers (sensors) may cause improper SpO₂ performance.
- Do not operate the NM3 monitor when it is wet due to spills or condensation.
- Do not operate the product if it appears to have been dropped or damaged.
- Never sterilize or immerse the monitor in liquids.
- Do not sterilize or immerse sensors except as directed in this manual.
- Do not connect an input/output cable from one port on the monitor to another port on the monitor. For example, RS232-1 to RS232-2, or USB Host to USB Device.
- To avoid the effects of excessive moisture in the measurement circuit, insert the CO₂/Flow sensor or Cardiac Output Sensor in the ventilator circuit with the tubes upright. Improper placement may result in erroneous data. Excessive moisture in the sensor tubing may affect the accuracy of the measurements.
- Insert the sidestream sample cell into the module before inserting the on-airway adapter into the ventilated circuit. Remove the sidestream sampling kit sample cell from the LoFlo C5 CO₂ Sensor when not in use.
- Clean the monitor, sensors, and accessories according to the instructions in the "Maintenance" chapter on page 163. Do not spray cleaning agents directly into the patient sensor connector receptacles. Disconnect sensors from the monitor before cleaning.
- It is recommended that CO₂/Flow or Cardiac Output Sensors be removed from the circuit whenever an aerosolized medication is delivered. These medications may contaminate the sensor windows, causing the sensor to fail prematurely.
- Operate the monitor at temperatures between 10 to +40° C (50 to 104° F), 10-90% R.H. non-condensing.
- Avoid storing the monitor at temperatures less than -30° C or greater than +60° C (<-22° F or >140° F) 10-90% R.H. non-condensing.
- Medical electrical equipment requires special precautions regarding EMC and must be installed and placed into service per the instructions.
- Observe precautions for electrostatic discharge (ESD) and electromagnetic interference (EMI) to and from other equipment.
- Where electromagnetic devices (i.e., electrocautery) are used, patient monitoring may be interrupted due to electromagnetic interference. Electromagnetic fields up to 3 V/m will not adversely affect system performance.
- Sudden erratic changes in the CO₂ and pressure waveforms that do not correlate to the physiological condition of the patient may be signs that the monitor is experiencing electromagnetic interference.
- The NM3 monitor should not be used adjacent to or stacked with other equipment; if adjacent or stacked use is necessary, the equipment should be observed to verify normal operation in the configuration in which it will be used.
- The NM3 monitor complies with IEC 60601-1-2:2004 and IEC60601-1-2:2007, providing reasonable protection against electromagnetic interference in a typical medical installation. The equipment generates, uses and can radiate electromagnetic interference (EMI), and if not installed and used in accordance with the instructions, may cause interference with other devices in the vicinity.

If interference does occur, correct it using one or more of the following measures:

- Move the receiving device or increase separation between the equipment.
- Consult Philips Respironics or members of the hospital's engineering department for more information.

- The use of portable and mobile radio frequency (RF) communications equipment can affect this and other pieces of medical equipment.
- To prevent possible patient injury due to non annunciating alarms, verify the operation of any remote alarm device before use.
- Accessories equipment connected to the analog and digital interfaces must be certified to the respective IEC standards (i.e. IEC 60950 for data processing equipment and IEC 60601-1 for medical equipment).
- Use of non-approved sensors, accessories or cables may increase EMC emissions or decrease the EMC immunity performance of the equipment.
- If required by national or local codes, connect the NM3 monitor to the hospital equalization connector with an equipotential cable.
- Replace fuse only with same type and rating.
- The NM3 monitor is not intended for use in a hyperbaric chamber or an MRI (Magnetic Resonance Imaging) environment.
- Caution: Federal (U.S.A.) law restricts this device to sale, distribution, or use by or on the order of a licensed medical practitioner.
- The NM3 monitor contains no user serviceable parts. Refer servicing to qualified service personnel. A technical Service Manual is available for use by technical personnel.

Notes

NOTE

A point of particular interest or emphasis intended to provide more efficient or convenient operation.

- In order to ensure proper monitoring of oxygenation and ventilation:
 - The use of pulse oximetry is recommended during cardiac output monitoring.
 - Setting of ETCO₂ and SpO₂ alert limits is recommended.
- Before monitoring, confirm settings for delivered oxygen, anesthetic agent, balance gas and hemoglobin by pressing the **DATA ENTRY** key.
- Before monitoring, review the **SET ALERT LIMITS** and verify the limit settings are appropriate for the current monitoring session.
- If the **SELF-TEST** fails, the normal monitoring mode will not appear. Remove the NM3 monitor from use and contact qualified service personnel.
- A **NO RESPIRATION** alert is not generated when the CAPNOSTAT 5 CO₂ sensor, Cardiac Output Sensor, or CO₂/Flow sensor are disconnected from the NM3 monitor.
- When the NICO-Esprit Interface is enabled, the Respiratory Rate alert (RR) is not available as a NM3 monitor function. Respiratory rate parameters and alerts will be provided by the V200/Esprit ventilator.
- Be certain that the monitor is not in Demo mode while monitoring. Demo mode can be identified by the flashing **DEMO MODE** label in the General Message area of the display. To exit Demo mode and return to normal monitoring mode, turn the power off and back on.
- Do not attach an SpO₂ sensor distal to a blood pressure cuff. Valid data cannot be processed when the cuff is inflated. Attach the sensor to the limb opposite to the site used for the blood pressure cuff.
- This product and its accessories which have patient contact are free of latex.
- Data Validity: Inaccurate SpO₂ and Pulse Rate values may be caused by:
 - Incorrect application or use of a sensor
 - Significant levels of dysfunctional hemoglobin
 - Significant levels of intravascular dyes
 - Nail polish or other finger-related issues
 - Exposure to excessive illumination such as surgical lamps—especially ones with a xenon light source, or direct sunlight
 - Excessive patient movement

- Venous pulsations
- Use of an IABP or electrosurgical equipment
- Patient conditions such as hypertension, severe vasoconstriction, etc. may result in loss of vital sign readings.
- The NM3 monitor provides C.O. measurements when the following conditions are met:
 - The Cardiac Output Sensor assembly is properly installed in the patient's breathing circuit.
 - Valid flow and CO₂ signals are detected with no significant signal artifact.
 - VCO₂ is greater than 20 mL/min.
 - ETCO₂ is between 15 and 85 mmHg (2.0 - 11.5 kPa or %) during baseline
 - ETCO₂ is between 15 and 100 mmHg (2.0 - 13.5 kPa or %) during rebreathing
 - The tidal volume is greater than 200 ml (small and standard sizes)
 - The tidal volume is greater than 400 ml (large size).
 - The respiratory rate is between 3 and 60 br/min.
 - The **STOP/CONTINUE REBREATHING** key is not illuminated.
 - The cardiac output cycle is not paused by the monitor for any other reason (displayed in the C.O. message area).
- Before use, carefully read the Masimo® sensor directions for use.
- After the life cycle of the equipment and accessories has been met, disposal should be accomplished following national and local requirements.
- During servicing and calibration, do not touch parts of the monitor and the patient at the same time.
- The Work of Breathing (WOB) parameter is available only for adult patients receiving pressure support ventilation.
- Unavailable parameters or parameters that cannot be calculated are displayed as dashes (---) on the various monitoring screens. Unavailable parameters are not shown as a blank or empty area.
- In the VentAssist Graphics View, when a parameter is unavailable or cannot be calculated, a parameter flag will not be displayed in the column chart.

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Respiratory Monitoring

This section details the steps needed to begin patient respiratory mechanics monitoring with the NM3 monitor.

Preparing for Use

Inspect

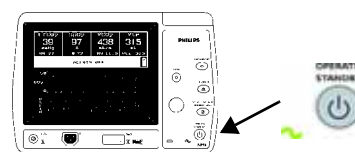
Before monitoring, take a few moments to inspect the NM3 monitor and its sensors. Check that all items are clean, dry, and physically intact with no broken or damaged components.

Turn on the monitor

Turn the NM3 monitor on.

- 1 Press the **OPERATE/STANDBY** key to turn the monitor on and off.

- The NM3 monitor can operate from its internal battery or from the AC Mains. (See "AC/Battery Operation" on page 6 for details.)



- 2 Before every use, inspect the monitor for proper operation.

- At power-up, the monitor performs a quick self-test. An audible tone sounds, indicators illuminate, the Alert Bar illuminates, and a **SELF-TEST IN PROGRESS** message is briefly displayed.

The operator should also:

- Verify that the monitor sounds a tone when powered up.
- Verify the Alert Bar illuminates amber, red, then blue.
- Verify that the **MENU**, **DATA ENTRY**, **SILENCE** and **STOP/CONTINUE REBREATHING** key indicators briefly illuminate. (The **STOP/CONTINUE REBREATHING** key will remain inactive when the Cardiac Output option is not installed. It will remain lit and inactive when the option is installed, but a Cardiac Output sensor is not in use.)
- Verify the **OPERATE/STANDBY** key is illuminated.
- Verify that the AC power symbol (~) illuminates when the monitor is connected to an AC power source.

If the **SELF-TEST** fails, the normal monitoring mode will not appear. If the tone does not sound or any of the indicators fails to illuminate, remove the NM3 monitor from use and contact qualified service personnel.

- 3 The message **PRESS KNOB TO ERASE STORED TRENDS** is displayed for 5 seconds.

- To erase the contents of the monitor's trend memory, press the knob. **TRENDS ERASED** is briefly displayed.
- To retain the contents of the monitor's trend memory, do not press the knob. Wait the 5 seconds and **TRENDS RETAINED** is displayed.
- Note: If the monitor's internal clock is not set, the message **CHECK DATE/TIME** may appear before the **PRESS KNOB TO ERASE STORED TRENDS** message. (See "Configuration Menu" on page 95 for details.)

- 4 The power up sequence is completed and a monitoring screen is displayed.

- The NM3 monitor displays the screen that was displayed when the monitor was last turned off.
- If the monitor is in Cardiac Output mode, connecting a CO₂/Flow sensor will cause the monitor to automatically switch to Respiratory Mechanics mode.

- The monitor is in a READY state and the parameters will be dashed and alerts will not be active until parameters are calculated and displayed.
- Parameters will display and their alerts will become active as they are calculated.

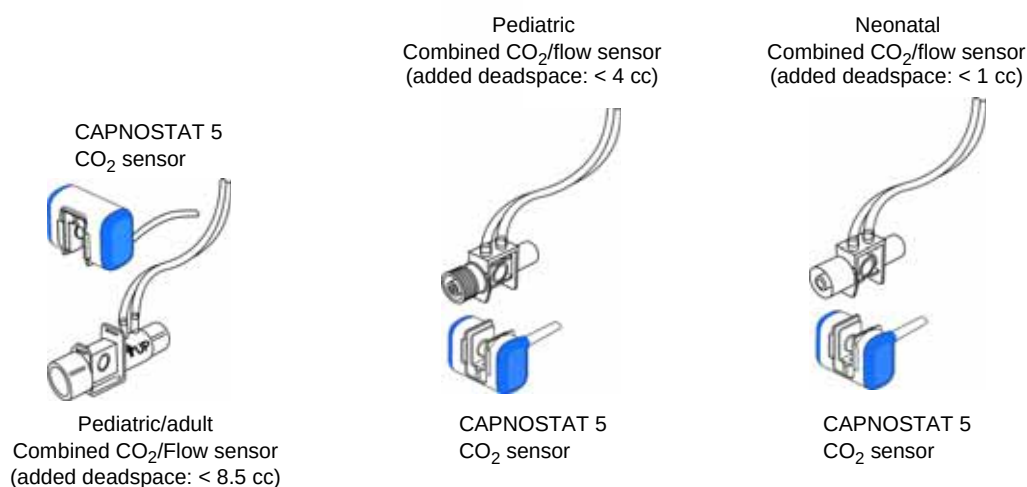
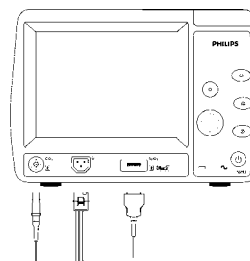
Connect and apply the sensors

Connect the sensors to the monitor, ventilator circuit, and patient.

- 1 Connect the SpO₂ sensor to the monitor and apply it to the patient. (See "Masimo SET® SpO₂" on page 121.)
- 2 Connect the CAPNOSTAT 5 CO₂ Sensor or the LoFlo C5 CO₂ Sensor to the monitor. (See "CAPNOSTAT 5 CO₂ Sensors" on page 109.)

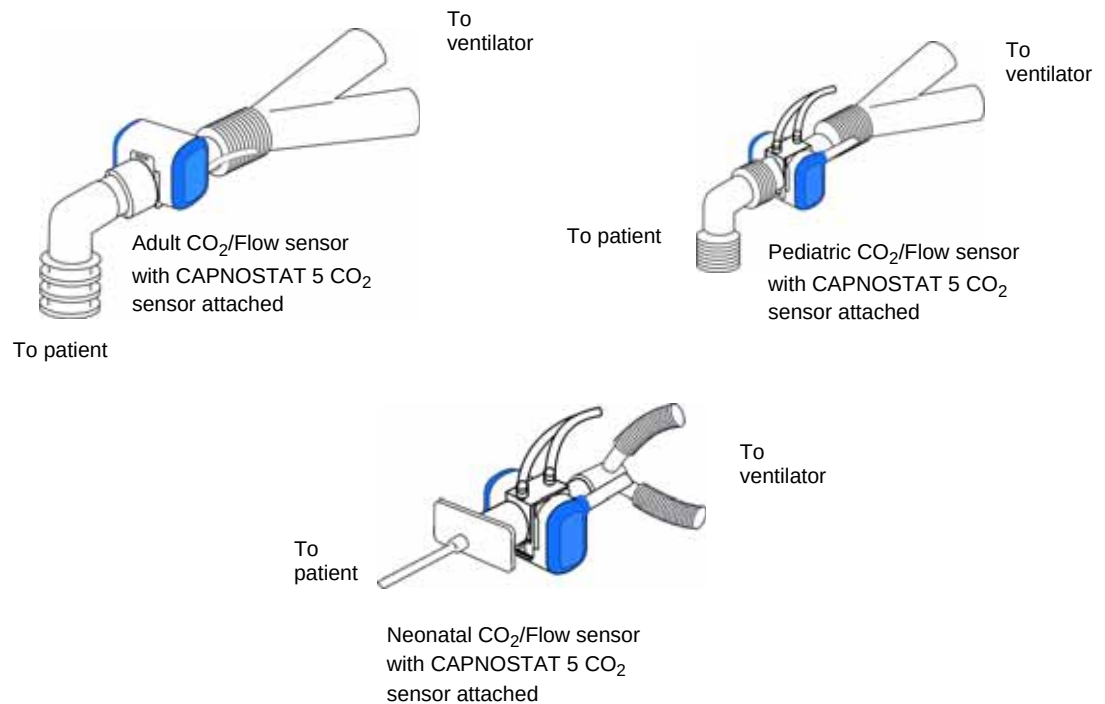
NOTE: If the LoFlo C5 sensor is used, volumetric CO₂ parameters will not be available.

- 3 Select an appropriate size CO₂/Flow sensor.
- 4 Connect a CO₂/Flow Sensor to the monitor and attach a CAPNOSTAT 5 CO₂ Sensor or LoFlo C5 CO₂ Sensor. (See "CO₂/Flow Sensors" on page 105.)
- 5 Connect the CAPNOSTAT 5 CO₂ Sensor or LoFlo C5 CO₂ Sensor to the CO₂/Flow sensor.



- 6 For optimal results, place the CO₂/Flow sensor in the ventilator circuit between the endotracheal tube and the ventilator circuit wye.
 - Place the sensor proximal to the patient if using other devices in the circuit. The white-striped tubing should be proximal to the patient.
 - Place the sensor so that the tubing lines exit from the top of the sensor (to help keep them clear and dry).
 - Keep the sensor clear of accumulations by proper circuit maintenance.

- 7 Connect the combined CO₂/Flow sensor to the patient breathing circuit.

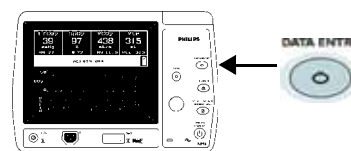


- Do NOT place the CO₂/Flow sensor between the ET tube and the elbow (pediatric/adult circuit), as this may allow patient secretions to block the adapter windows.
- Position the CO₂/Flow sensor with its windows in a vertical and NOT a horizontal position: this helps keep patient secretions from "pooling" on the windows.
- To prevent "rain-out" and moisture from draining into the CO₂/Flow sensor, do NOT place the CO₂/Flow sensor in a gravity dependent position.
- Periodically check the CO₂/Flow sensor and tubing for excessive moisture or secretion build up.
- For routine performance of airway care, separate the system between the ET tube and the airway adapter (neonatal circuit), or between the ET tube and elbow (pediatric/adult circuit). Lavage and suctioning of the airway can then be performed without fluids and mucous accumulating on the CO₂/Flow sensor windows.

Begin Respiratory Monitoring

After the NM3 monitor is turned on and the sensors are properly connected and applied, Respiratory Mechanics monitoring can begin.

- 1 Enter the delivered oxygen and balance gas or anesthetic agent if present, by pressing the **DATA ENTRY** key. (See "Entering Patient Data" on page 38.)
- 2 As you begin monitoring, please note the following:



- Water that accumulates in the CO₂/Flow sensor or the sensor tubing may cause the reported Tidal Volumes to be higher than set volumes. If reported values are higher (or lower) than expected and water is seen in the line or sensor body, purge the lines. If purging does not clear the water, remove the sensor from the circuit and remove the water by shaking the sensor, or by flowing oxygen or compressed air through the tubing or sensor until the water is removed. Do not use high pressure for water removal.
- To minimize the effects of aerosolized medications on the CO₂/Flow sensor, it is recommended that the CO₂/Flow sensor be removed from the ventilator circuit prior to the delivery of the medication. **The decision to remove or not remove the CO₂/Flow sensor is the responsibility of the clinician.**
- During the purge cycle the pump will be heard.
- Water will condense in the pressure sense lines at a faster rate when used in cooler ambient temperatures.
- Always keep the CO₂/Flow sensor tubing pointed in an upward position to minimize pooling of water and secretions at the pressure sense line openings.
- The automatic purge mode may not be disabled.

Entering Patient Data

Respiratory monitoring can be enhanced by the entry of key patient specific data including respired gas composition (anesthetic agent, balance gas, and inspired O₂).

Patient data should be updated in the **DATA ENTRY** screen whenever possible. The screen may be accessed at any time by pressing the **DATA ENTRY** key.

DATA ENTRY settings The following table lists the parameters and ranges accessible in the **DATA ENTRY** screens.

Label	Parameter	Default	Range / Units	Description
INSP O ₂	Inspired Oxygen	21%	21-100 %	Percent of oxygen in the inspired gas. Must be entered in order for the NM3 to accurately calculate parameters. (See "Gas Compensation Effects on CO ₂ " on page 96).
				Not available for NICO-Esprit Interface.
INSP AGENT	Inspired Anesthetic Agent	0%	0.0-20.0 %	Percent of anesthetic agent in the inspired gas. Must enter percent delivered in order to accurately calculate parameters.
BALANCE	Gas Balance	N ₂	N ₂ , He, or N ₂ O	N ₂ , He, or N ₂ O. Must select the correct balance in the inspired gas in order to accurately calculate parameters.

Label	Parameter	Default	Range / Units	Description
PATIENT DATA ENTRY Screen				
GENDER	Patient Gender	--	Male/Female	Enter patient gender. Entered patient gender is used for Ideal Body Weight (IBW) calculations. IBW (male) = 50 + 2.3 (height in inches - 60) IBW (female) = 45.5 + 2.3 (height in inches - 60)
HEIGHT	Patient Height	--	35-91 in 90-230 cm	Enter patient height (unavailable for neonatal and pediatric patients in Respiratory Mechanics mode). Ideal Body Weight calculated for adult patients in the range of 49-91 in (125-230 cm)
WEIGHT	Patient Weight (actual)	--	Neonatal: 1.1 - 44.09 lb 0.5 - 20.00 kg Pediatric: 11 - 220.4 lb 5.0 - 100 kg Adult: 55-551 lb 25-250 kg	Entered WEIGHT and HEIGHT are used for cardiac index calculations. If GENDER and HEIGHT are not entered, then entered WEIGHT will be used for respiratory mechanics calculations.
ABG DATA ENTRY Screen				
PaCO ₂	Arterial Carbon Dioxide	40 mmHg (5.4 kPa or %) ("--" displayed until an initial value is entered)	0-150 mmHg 0.0-20.0 kPa 0.0-20.0 %	Partial pressure of carbon dioxide in arterial blood. Enter this value for calculation of Vd alv (alveolar deadspace), Vd/Vt (deadspace to tidal volume ratio). Must enter correct ABG time in order to accurately calculate parameters.
PaO ₂	Arterial Oxygen	FiO ₂ *(Pb-47 mmHg) ("--" displayed until an initial value is entered)	0-750 mmHg 0.0-99.5 kPa 0.0-99.5 %	Partial pressure of oxygen in arterial blood. Enter a value for this parameter if desired; does not affect CO ₂ /flow calculations.
Hb	Hemoglobin Concentration or Hematocrit	11.0 gm/dL 6.8 mmol/L 33 % ("--" displayed until an initial value is entered)	Hb: 5.0-20.0 gm/dL Hb: 3.1-12.4 mmol/L Hct: 15-60 %	Concentration of hemoglobin or hematocrit in the blood. Enter a value for this parameter if desired; does not affect CO ₂ /flow calculations.
MARK ABG TIME	Time when ABG blood sample is drawn	Current Time	hh:mm (hours:minutes)	Enter time ABG is drawn. Only accepts time since ETCO ₂ was first detected. Note: Menu item is unavailable until PaCO ₂ or PaO ₂ values are entered.

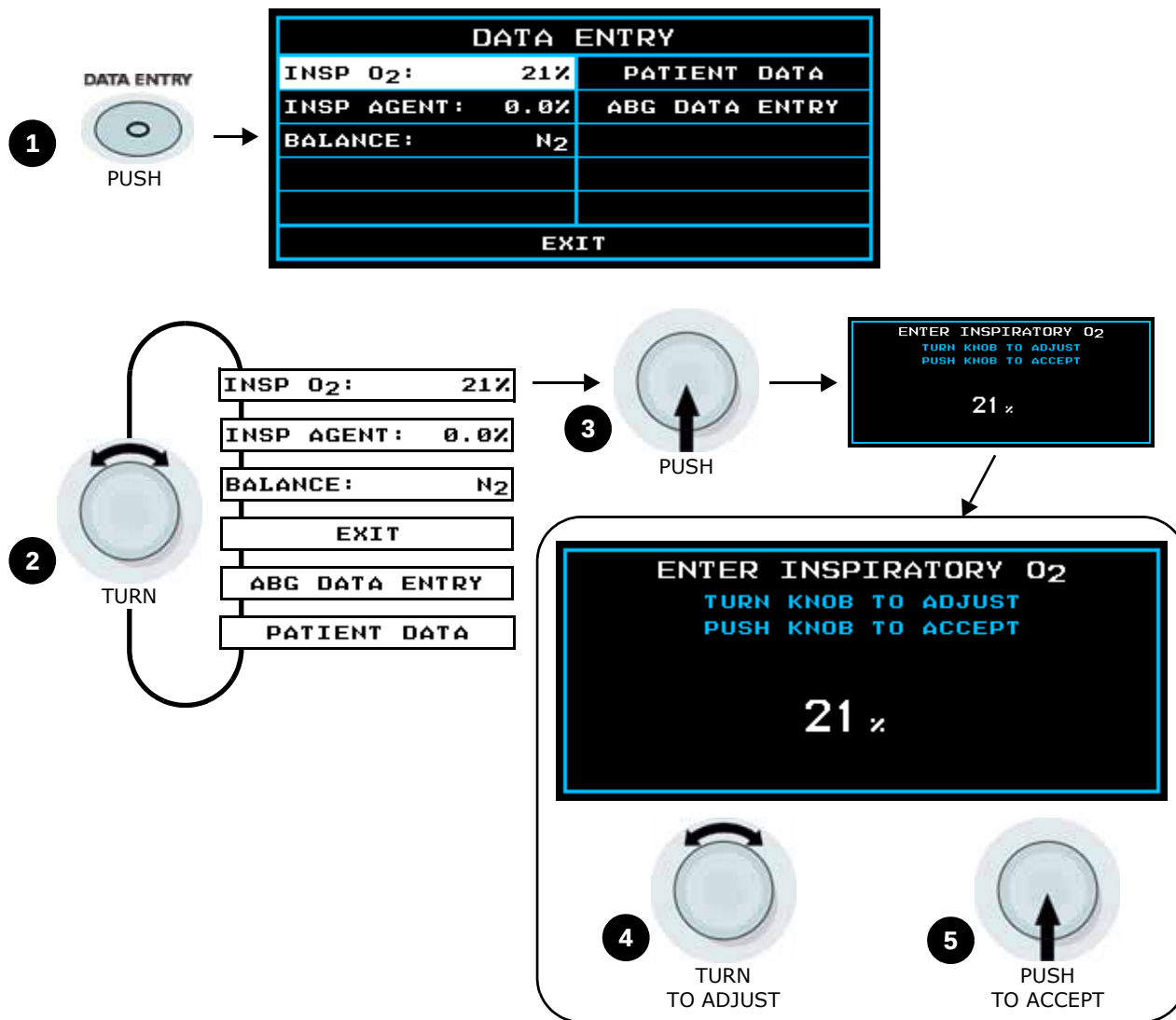
Label	Parameter	Default	Range / Units	Description
DEFAULT ABGs	Blood gas values	PaCO ₂ : 5 mmHg (0.7kPa or %) above the measured ETCO ₂ value ^a PaO ₂ : Based on barometric pressure and INSP O ₂ value. Hb: 11.0 gm/dL	Yes/No	Resets blood gas settings to default values.

a. 40 mmHg (5.4 kPa or %) if ETCO₂ is not available.

Entering Patient Data

To enter (or view) patient data:

- 1 Press the **DATA ENTRY** key to activate **DATA ENTRY**. The key's green icon illuminates.
 - Press the key again to return to the previously displayed screen.
- 2 Highlight the desired data by turning the **KNOB**.
- 3 Select the highlighted data by pressing the **KNOB**.
- 4 Turn the **KNOB** to adjust the value as desired.
- 5 Press the **KNOB** to accept the value.
- 6 Repeat these steps for the other settings.

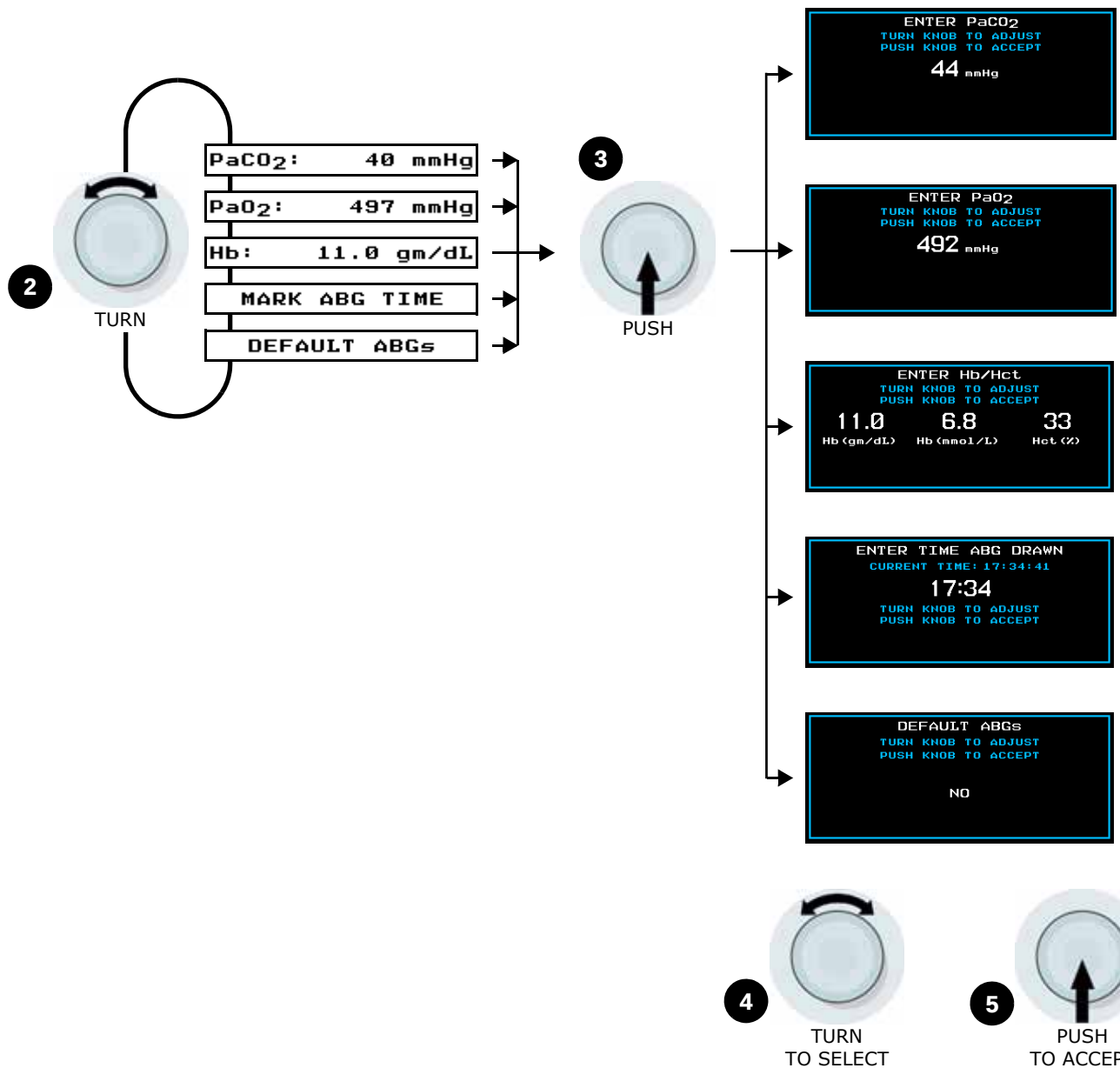
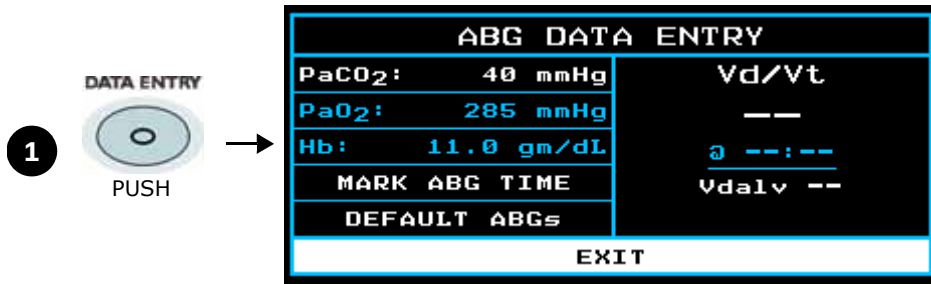


ABG Data Entry

To enter ABG data:

- 1 Press the **DATA ENTRY** key to activate **DATA ENTRY**. The key's green icon illuminates.
 - Press the key again to return to the previously displayed screen.
- 2 Highlight **ABG DATA ENTRY** by turning the **KNOB**.

3 Select **ABG DATA ENTRY** by pressing the **KNOB**.



- 4 Turn and press the **KNOB** to select the PaCO₂, PaO₂, Hb/Hct, Mark ABG Time or Default ABG screen.

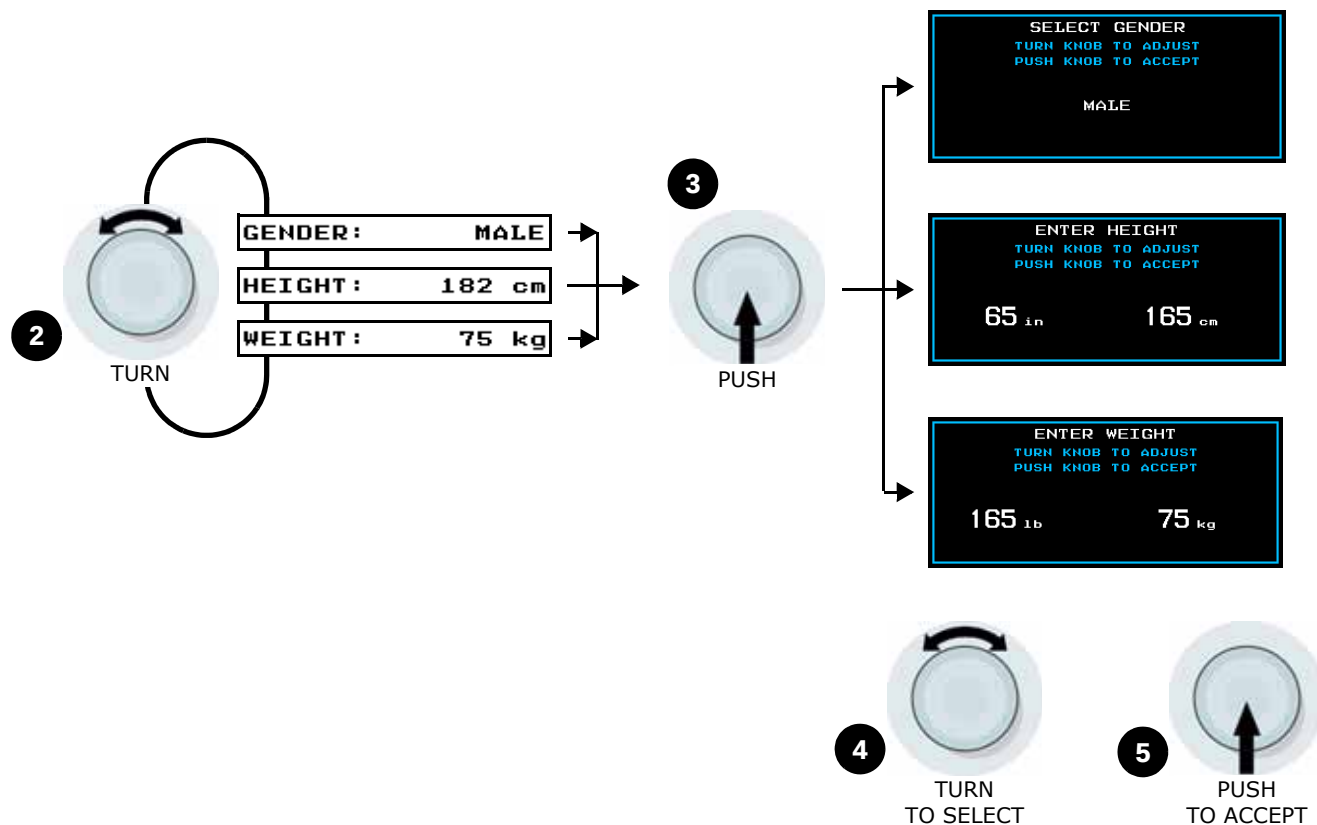
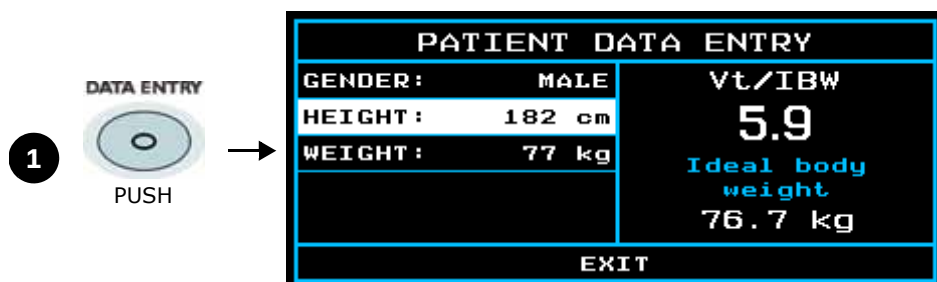
NOTE: PaO₂ and Hb selections are dimmed in Respiratory Mechanics mode to denote that, although they are available for data input, the data will not affect parameter calculations.

- 5 Turn **KNOB** to adjust value.
 - ABG Time is required for PaCO₂.
 - Ensure that the monitor's clock is synchronized to the clock used to determine the draw time.
- 6 Press the **KNOB** to accept the value.
 - Updated Vd/Vt and Vd_{alv} values are displayed.

Patient Data Entry

To enter patient data:

- 1 Press the **DATA ENTRY** key to activate **DATA ENTRY**. The key's green icon illuminates.
 - Press the key again to return to the previously displayed screen.
- 2 Highlight **PATIENT DATA** by turning the **KNOB**.
- 3 Select **PATIENT DATA** by pressing the **KNOB**.



- 4 Turn and press the **KNOB** to select the GENDER, HEIGHT or WEIGHT screen.
- 5 Turn **KNOB** to adjust value.
 - Entered patient data is used for Vt/kg and Vt/IBW calculations.
- 6 Press the **KNOB** to accept the value.
Updated Vt/kg or Vt/IBW values are displayed.

NOTE: Patient data can also be entered in the VentAssist option screen. For more informations, see "Monitoring with VentAssist" on page 68.

Monitoring Cardiac Output

This section details the steps needed to begin patient monitoring with the NM3 monitor. The Cardiac Output option must be installed. When the CO option is installed, the NM3 monitor will show the  icon in the startup screen. A label showing the same icon is also placed on the right side of the monitor case. See "Options and Accessories" for more information.

Preparing for Use

Inspect

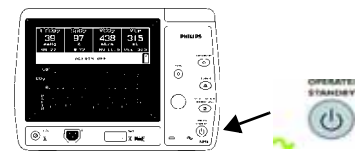
Before monitoring, take a few moments to inspect the NM3 monitor and its sensors. Check that all items are clean, dry, and physically intact with no broken or damaged components.

Turn on the monitor

Turn the NM3 monitor on.

- 1 Press the **OPERATE/STANDBY** key to turn the monitor on and off.

- The NM3 monitor can operate from its internal battery or from the AC Mains. (See "AC/Battery Operation" on page 6 for details.)



- 2 Before every use, inspect the monitor for proper operation.

- At power-up, the monitor performs a quick self-test. An audible tone sounds, indicators illuminate, the Alert Bar illuminates, and a **SELF-TEST IN PROGRESS** message is briefly displayed.

The operator should also:

- Verify that the monitor sounds a tone when powered up.
- Verify the Alert Bar illuminates amber, red, then blue.
- Verify that the **MENU**, **DATA ENTRY**, **SILENCE** and **STOP/CONTINUE REBREATHING** key indicators briefly illuminate. (The **STOP/CONTINUE REBREATHING** key will remain inactive when the Cardiac Output option is not installed. It will remain lit and inactive when the option is installed, but a Cardiac Output sensor is not in use.)
- Verify the **OPERATE/STANDBY** key is illuminated.
- Verify that the AC power symbol (~) illuminates when the monitor is connected to an AC power source.
- If the **SELF-TEST** fails, the normal monitoring mode will not appear. If the tone does not sound or any of the indicators fails to illuminate, remove the NM3 monitor from use and contact qualified service personnel.

- 3 The message **PRESS KNOB TO ERASE STORED TRENDS** is displayed for 5 seconds.

- To erase the contents of the monitor's trend memory, press the knob. **TRENDS ERASED** is briefly displayed.
- To retain the contents of the monitor's trend memory, do not press the knob. Wait the 5 seconds and **TRENDS RETAINED** is displayed.
- Note: If the monitor's internal clock is not set, the message **CHECK DATE/TIME** may appear before the **PRESS KNOB TO ERASE STORED TRENDS** message. (See "Configuration Menu" on page 95 for details.)

- 4 The power up sequence is completed and a monitoring screen is displayed.

- The monitor displays the screen that was displayed when the monitor was last turned off.

- If the monitor is in Respiratory Mechanics mode, connecting a Cardiac Output Sensor will cause the monitor to automatically switch to Cardiac Output mode (Cardiac Output option must be installed).
- The monitor is in a READY state and the parameters will be dashed and alerts will not be active until parameters are calculated and displayed.
- Parameters will display and their alerts will become active as they are calculated.

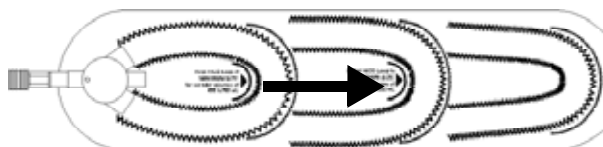
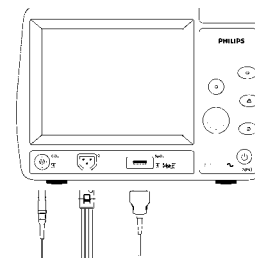
Connect and apply the sensors

Connect the sensors to the monitor, ventilator circuit, and patient.

- 1 Connect the SpO₂ sensor to the monitor and apply it to the patient. (See "Masimo SET SpO₂" on page 121.)
- 2 Connect the CAPNOSTAT 5 CO₂ Sensor to the monitor. (See "CAPNOSTAT 5 CO₂ Sensors" on page 109.)

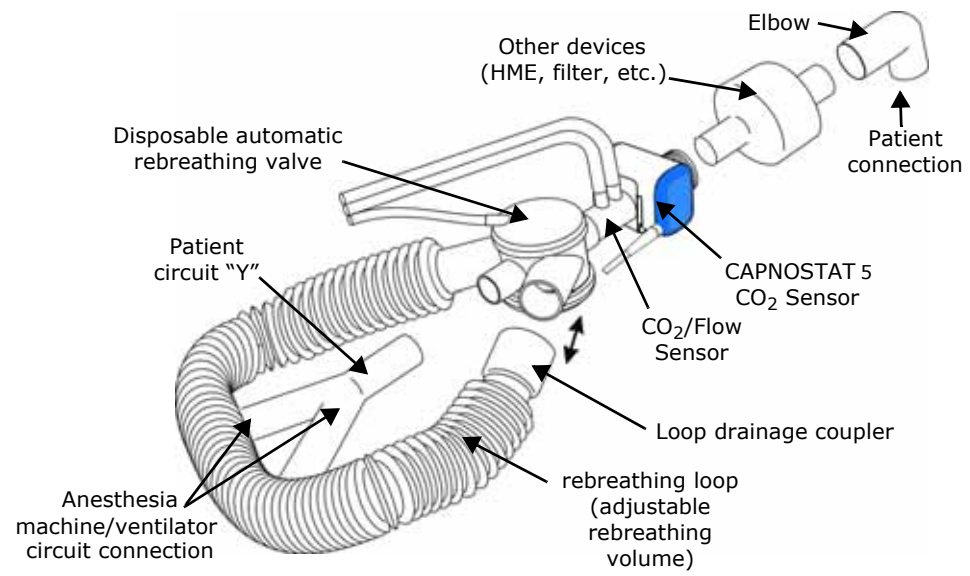
NOTE: Only the CAPNOSTAT 5 CO₂ Sensor should be used when monitoring cardiac output. If the LoFlo C5 CO₂ sensor is used, volumetric CO₂ and cardiac output parameters will not be available.

- 3 Select a Cardiac Output Sensor, see "Choosing a Cardiac Output Sensor size" on page 124.
- 4 Connect the Cardiac Output Sensor to the monitor and attach a CAPNOSTAT 5 CO₂ Sensor. (See "Cardiac Output Sensor" on page 123.)
- 5 Use the Initial Adjustment Template as a guide and adjust the rebreathing loop to match the ventilator's tidal volume setting, then discard the template. (See Instructions on the Cardiac Output Sensor template.)



- 6 For optimal results, place the Cardiac Output Sensor into the ventilator circuit between the endotracheal tube and the ventilator circuit wye.
 - Place other devices (HME, filters, etc.) between Cardiac Output Sensor and the patient connection. The white-striped tubing on the Cardiac Output Sensor should be proximal to the patient.
 - The Cardiac Output Sensor increases airway deadspace by 35 cc (minimum). At low tidal volumes, compensatory changes to ventilation protocol should be considered.
 - Placement of a sidestream gas analyzer sampling port between the Cardiac Output Sensor and the patient connection may reduce measurement accuracy at low tidal volumes.
 - Sidestream or mainstream gas analyzers placed between the Cardiac Output Sensor and the patient circuit "Y" may be inaccurate during the rebreathing phase of the cardiac output cycle.
 - Place the sensor so that the triple lumen tubing lines exit from the top of the sensor (to help keep them clear and dry).
 - Excess moisture may be removed by temporarily opening the circuit at the loop drainage coupler. Securely reconnect the coupler.

Cardiac Output Sensor and CAPNOSTAT 5 CO₂ Sensor



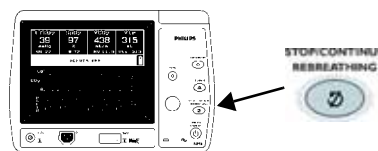
Begin Cardiac Output monitoring

After the NM3 monitor is turned on and the sensors are properly connected and applied, cardiac output monitoring can begin.

- 1 Enter the patient's height and weight (for cardiac index calculations) and the delivered oxygen, anesthetic agent and balance gas by pressing the **DATA ENTRY** key. (See "Entering Patient Data" on page 50.)
- 2 If available, enter the patient's PaCO₂, PaO₂, hemoglobin and hematocrit in the **ABG DATA ENTRY** screens, then mark the ABG time before exiting. (See "Entering Patient Data" on page 50).

NOTE: Vd/Vt Phy, Vd Phy, and Vd alv are calculated based on the PaCO₂ value last entered, and are not updated until the next time the PaCO₂ value is entered or changed.

- 3 Press the **STOP/CONTINUE REBREATHING** key to initiate monitoring. Subsequent presses will Stop/Continue the rebreathing process.
 - An icon "⌘" identifies rebreathing status.
 - ⌘ Illuminated: Rebreathing is DISABLED.
 - ⌘ Not illuminated: Rebreathing is ENABLED.
- 4 As you begin monitoring, please note the following:



- Reliance on Cardiac Output parameters (C.O., PCBF, SV & CI) should be taken in context with other monitoring parameters and the physiologic condition of the patient.
- Entry of patient height and weight is required to calculate and display Cardiac Index.
- Pulse oximetry is required to calculate and display Stroke Volume (SV).
- Accuracy of cardiac output and related parameters will be affected by the following:
 - Significant fluctuations in mixed venous CO₂ content or metabolic CO₂ production during any three minute measurement period.
 - Sudden release of CO₂ into the bloodstream, such as when releasing a cross clamp or injection of sodium bicarbonate.
 - The presence of excessive moisture or secretions in the Cardiac Output sensor.
 - Entry of blood gas information.
- Due to the periodic rebreathing for C.O. measurements, the patient's effective ventilation will be reduced by typically 10-15% (depending on the rebreathing volume required). This can be offset by increasing the minute ventilation before monitoring begins.

Rebreathing Bar

The Rebreathing Bar visually indicates the level of patient rebreathing. Under normal monitoring conditions, the **REBREATHING** icon and Rebreathing Bar appear in the message center each time the automatic rebreathing cycle begins.



- The Rebreathing Bar represents the total possible range of rebreathing from 0-100%.
- The highlighted area within the bar represents the target rebreathing range (35%-70%) for optimal cardiac output performance.
- A vertical pointer within the Rebreathing Bar indicates the current rebreathing percentage.
 - The pointer will appear within the highlighted area of the Rebreathing Bar when the rebreathing loop is properly sized and providing an acceptable percentage of rebreathing.
 - *Note:* The word "OK" will disappear when the pointer falls within that area of the highlighted bar.

Expand/Retract Rebreathing Loop

- If the rebreathing loop is not sufficiently expanded and the Rebreathing Bar pointer falls below 35%, the message **EXPAND LOOP** is displayed during the rebreathing period.
- If the rebreathing loop is over-expanded and the Rebreathing Bar pointer is above 70%, the message **RETRACT LOOP** is displayed during the rebreathing period.



To expand or retract the rebreathing loop:

- 1 Grasp the rebreathing loop with one hand and the automatic rebreathing valve with the other hand so as not to disturb/disconnect the breathing circuit while adjusting the loop.
- 2 Expand or retract the rebreathing loop 3-6 inches.
 - It may take 2-3 additional breaths before the icon changes.
 - Note that if the loop is still not appropriately sized by the end of the rebreathing period, the message will be removed and may be displayed again during the next rebreathing period.

Sensor Size Message

If the **EXPAND** or **RETRACT LOOP** message appears for more than three rebreathing cycles, and resizing the rebreathing loop was not effective, the NM3 monitor will suggest a different sized sensor to correct the condition. See "Status Messages" on page 125.

CONSIDER USING
STD. C.O. SENSOR

The Cardiac Output Cycle

Once rebreathing is enabled, the NM3 monitor automatically repeats a three-minute cardiac output measurement cycle, unless it is set to **MANUAL MODE** in the **C.O. MODE** screen. In that case, a 3-cycle rebreathing sample is user-initiated by pressing the **STOP/CONTINUE REBREATHING** key.

The cardiac output cycle has three phases:

- **Baseline:** During the 60-second baseline period, the rebreathing valve inside the Cardiac Output Sensor is turned off and the rebreathing volume of the rebreathing loop is bypassed. During this time, VCO_2 , $PaCO_2$ and $ETCO_2$ will be at baseline values.
- **Rebreathing:** The 35-second rebreathing period starts when the monitor turns on the rebreathing valve inside the Cardiac Output Sensor causing the rebreathing volume of the rebreathing loop to be added into the circuit. During rebreathing, VCO_2 is reduced, $PaCO_2$ and $ETCO_2$ become elevated (3-5 mmHg, typical) and mixed venous CO_2 remains unchanged.

NOTE: The rebreathing period will typically induce an increase in $PaCO_2$ by 3-5 mmHg. An ABG blood sample drawn during this period (⌚ **REBREATHING** displayed) or during the first twenty seconds of the stabilization period (where **NEXT** ⌚ is displayed), may cause $PaCO_2$ values to reflect higher than normal levels.

- **Stabilization:** After completion of rebreathing, an 85-second stabilization period begins, during which time VCO_2 , $PaCO_2$ and $ETCO_2$ return to their baseline values.

The NM3 monitor updates the displayed C.O. value following the completion of each three minute cardiac output cycle. The CObar (cardiac output confidence bar) provides an indication of the system's confidence in the displayed value. (See "CObar Confidence Indicator" on page 58.)

When the third cycle is completed in **MANUAL MODE**, rebreathing is paused and the **STOP/CONTINUE REBREATHING** key is turned on. To stop rebreathing during the three cycles, press the key again. For details, see "Manual Mode" on page 58.

Rebreathing On/Off or Paused

The user can interrupt or resume the rebreathing cycle at any time by pressing the **STOP/CONTINUE REBREATHING** key. The NM3 monitor will not automatically restart the rebreathing cycle—that must be initiated by the user pressing the **STOP/CONTINUE REBREATHING** key. Note that once rebreathing is initiated by the user, the monitor will, under certain conditions, pause rebreathing until a specified condition (see below) is corrected—at which time the monitor will restart the rebreathing.

Rebreathing can be Off, On, or Paused as indicated below:

Rebreathing OFF (disabled)

- The monitor starts in this state upon power-up.
- The **STOP/CONTINUE REBREATHING** key is illuminated while in this state.
- The rebreathing cycle can be placed into this state at any time by pressing the **STOP/CONTINUE REBREATHING** key (rebreathing is immediately disabled).
- The rebreathing cycle is automatically turned off for certain monitor/sensor conditions. (See "C.O. Message Area" on page 139.)
- Noted in the cardiac output message area as **REBREATHING OFF**.

REBREATHING OFF
PRESS  KEY TO
CONTINUE

Rebreathing ON (enabled)

- When the monitor is initially turned on, this state is entered only after pressing the **STOP/CONTINUE REBREATHING** key.
- The **STOP/CONTINUE REBREATHING** key is not illuminated while in this state.
- The cardiac output is calculated and updated while in this state.
- Noted in the cardiac output message area as **REBREATHING** or **NEXT**.

 **REBREATHING**
OK

NEXT  1:57

Rebreathing Paused

- The NM3 monitor automatically pauses the rebreathing cycle and generates a display message under any of these conditions:
 - ETCO_2 is less than or equal to 15 mmHg (2.0 kPa or %), or greater than or equal to 85 mmHg (11.5 kPa or %)
 - Respiratory rate is less than or equal to 3 or greater than or equal to 60 br/min.
 - VCO_2 is less than or equal to 20 mL/min.
- The rebreathing cycle automatically restarts when the condition is corrected.

REBREATHING PAUSED
WAITING FOR
RR > 3 br/m

Entering Patient Data

Cardiac Output monitoring can be enhanced by the entry of key patient-specific data including respired gas composition (anesthetic agent, balance gas, and inspired O_2), patient height and weight, and arterial blood gas data (PaCO_2 , PaO_2 , Hb or Hct). Inclusion of ABG data is especially important when gas exchange impairment is expected (i.e., high shunt or deadspace). **ABG samples should not be obtained during the rebreathing phase of the 3-minute Cardiac Output cycle.**

Patient data should be updated in the **DATA ENTRY** screen whenever possible. The screen may be accessed at any time by pressing the **DATA ENTRY** key.

DATA ENTRY settings The following table lists the parameters and ranges accessible in the **DATA ENTRY** screens.

Label	Parameter	Default	Range / Units	Description
INSP O_2	Inspired Oxygen	21%	21-100 %	Percent of oxygen in the inspired gas. Must be entered in order for the NM3 to accurately calculate parameters. (See "Gas Compensation Effects on CO_2 " on page 96).
				Not available for NICO-Esprit Interface.

Label	Parameter	Default	Range / Units	Description
INSP AGENT	Inspired Anesthetic Agent	0%	0-20 %	Percent of anesthetic agent in the inspired gas. Must enter percent delivered in order to accurately calculate parameters.
BALANCE	Gas Balance	N ₂	N ₂ , He, or N ₂ O	N ₂ , He or N ₂ O. Must select the correct balance in the inspired gas in order to accurately calculate parameters.
PATIENT DATA ENTRY Screen				
GENDER	Patient Gender	--	Male/Female	Enter patient gender. Entered patient gender is used for Ideal Body Weight (IBW) calculations. IBW (male) = 50 + 2.3 (height in inches - 60) IBW (female) = 45.5 + 2.3 (height in inches - 60)
HEIGHT	Patient Height	--	35-91 in 90-230 cm	Enter patient height for CI calculations. Ideal Body Weight calculated for adult patients in the range of 49-91 in (125-230 cm)
WEIGHT	Patient Weight (actual)	--	55-551 lb 25-250 kg	Entered WEIGHT and HEIGHT are used for cardiac index calculations. If IBW is not calculated, then entered WEIGHT will be used for respiratory mechanics calculations.
ABG DATA ENTRY Screen				
PaCO ₂	Arterial Carbon Dioxide	40 mmHg (5.4 kPa or %) ("--" displayed until an initial value is entered)	0-150 mmHg 0.0-20.0 kPa 0.0-20.0 %	Partial pressure of carbon dioxide in arterial blood. Enter this value for calculation of Vd alv (alveolar deadspace), Vd/Vt (deadspace to tidal volume ratio). Must enter correct ABG time in order to accurately calculate parameters. Entering this value can also enhance the accuracy of cardiac output parameters (C.O., SV, and CI).
PaO ₂	Arterial Oxygen	FiO ₂ *(Pb-47 mmHg) ("--" displayed until an initial value is entered)	0-750 mmHg 0.0-99.5 kPa 0.0-99.5 %	Partial pressure of oxygen in arterial blood. Entering this value can enhance the accuracy of C.O. parameters cardiac output parameters (C.O., SV, and CI).
Hb	Hemoglobin Concentration or Hematocrit	11.0 gm/dL 6.8 mmol/L 33 % ("--" displayed until an initial value is entered)	Hb: 5.0-20.0 gm/dL Hb: 3.1-12.4 mmol/L Hct: 15-60 %	Concentration of hemoglobin or hematocrit in the blood. Entering this value can enhance the accuracy of cardiac output parameters (C.O., SV, and CI).
MARK ABG TIME	Time when ABG blood sample is drawn	Current Time	hh:mm (hours:minutes)	Enter time ABG is drawn. Only accepts time since ETCO ₂ was first detected. Note: Menu item is unavailable until PaCO ₂ or PaO ₂ values are entered.

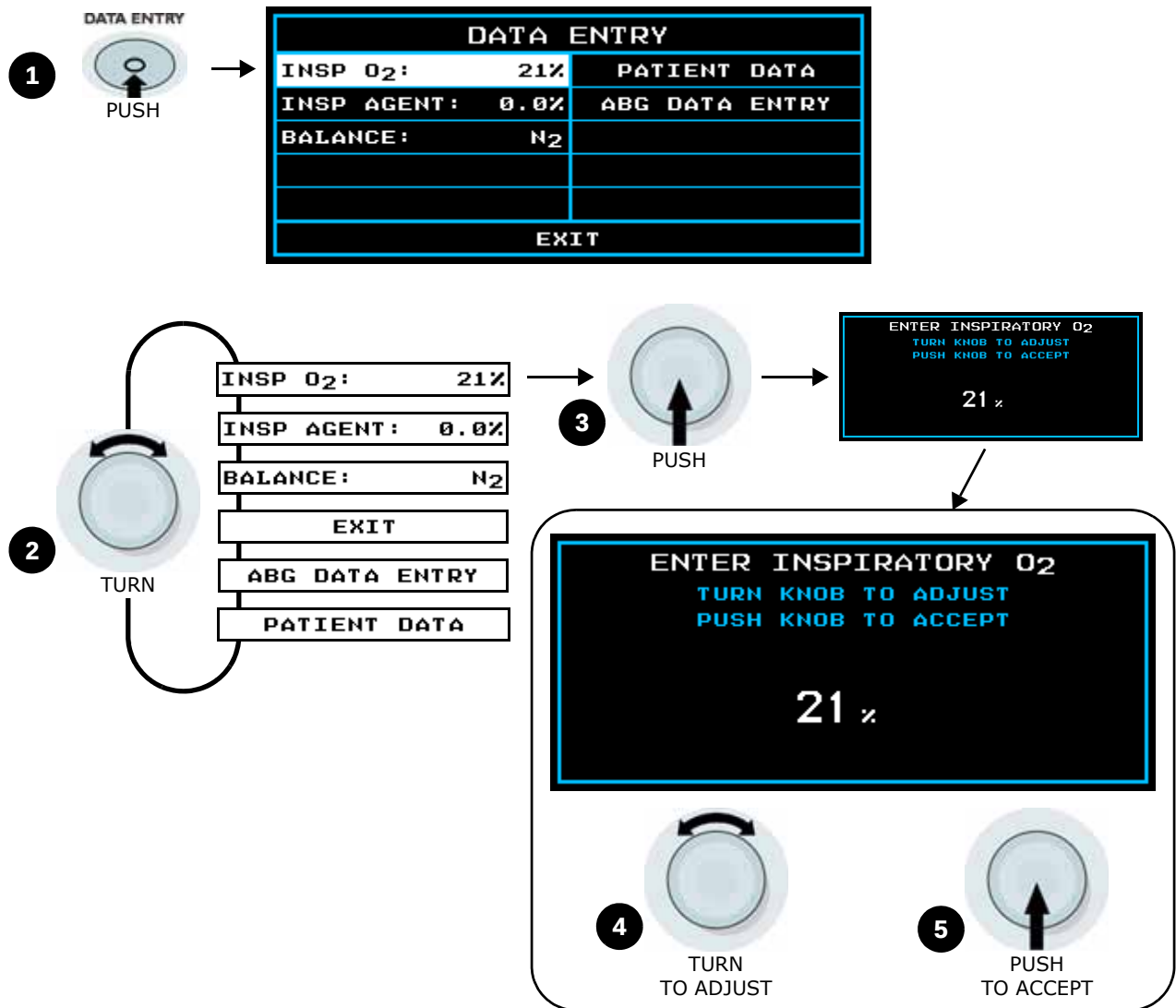
Label	Parameter	Default	Range / Units	Description
DEFAULT ABGs	Blood gas values	PaCO ₂ : 5 mmHg (0.7 kPa or %) above the measured ETCO ₂ value ^a PaO ₂ : Based on barometric pressure and INSP O ₂ value. Hb: 11.0 gm/dL	Yes/ No	Resets blood gas settings to default values.

a. 40mmHg (5.4 kPa or %) if ETCO₂ is not available.

Entering Patient Data

To enter (or view) patient data:

- 1 Press the **DATA ENTRY** key to activate **DATA ENTRY**. The key's green icon illuminates.
 - Press the key again to return to the previously displayed screen.
- 2 Highlight the desired data by turning the **KNOB**.
- 3 Select the highlighted data by pressing the **KNOB**.
- 4 Turn the **KNOB** to adjust the value as desired.
- 5 Press the **KNOB** to accept the value.
- 6 Repeat these steps for the other settings.



ABG Data Entry

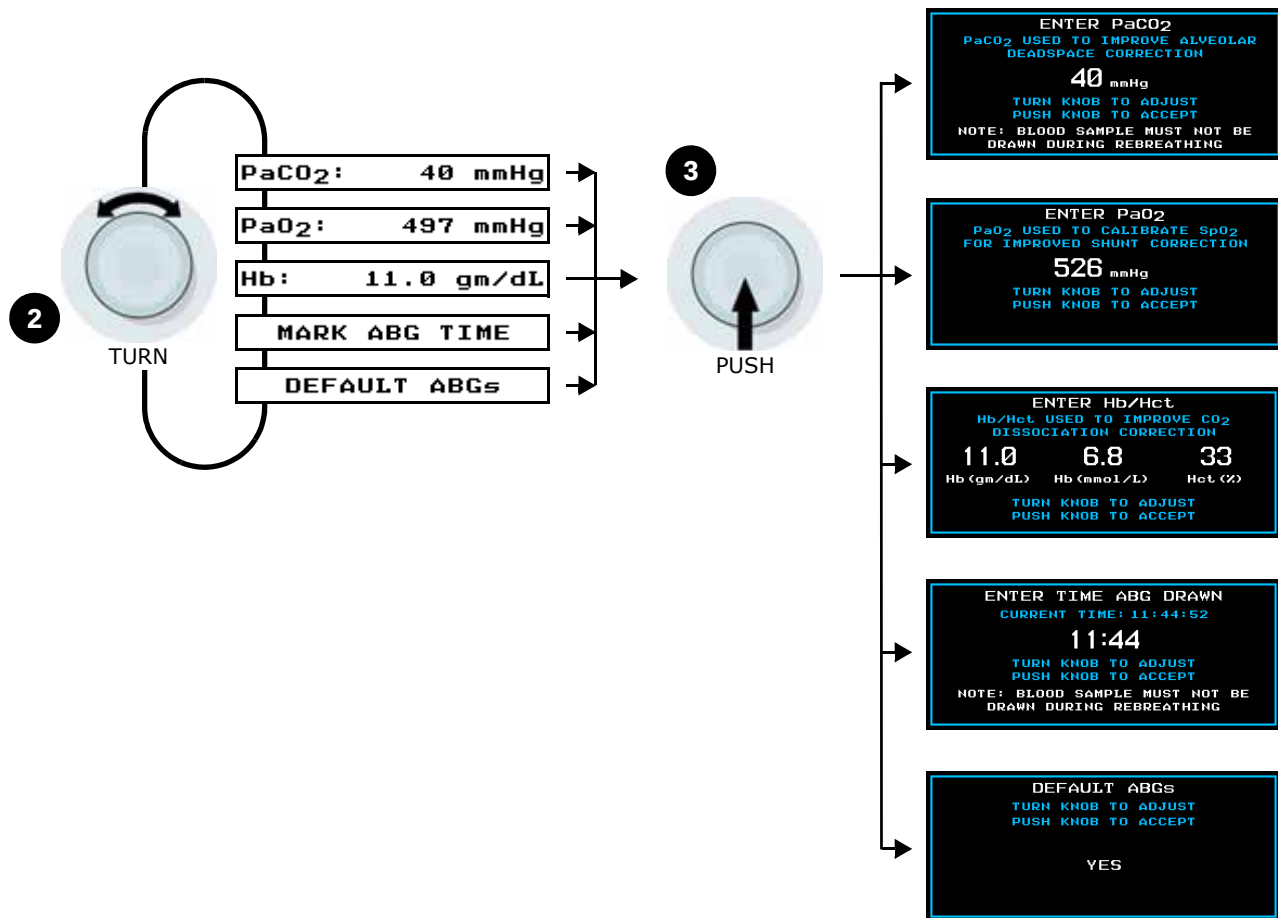
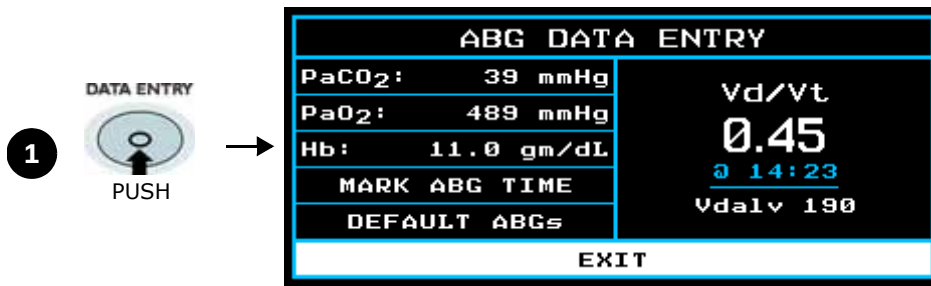
To enter ABG data:

- 1 Draw blood sample during the "normal" phase of the cardiac output cycle, not during the rebreathing phase.

NEXT ⏮ 1:57

- The cardiac output message will display how much time before the next rebreathing phase occurs.
- 2 Press the **DATA ENTRY** key to activate **DATA ENTRY**. The key's green icon illuminates.
 - Press the key again to return to the previously displayed screen.
 - 3 Highlight **ABG DATA ENTRY** by turning the **KNOB**.

- 4 Select **ABG DATA ENTRY** by pressing the **KNOB**.



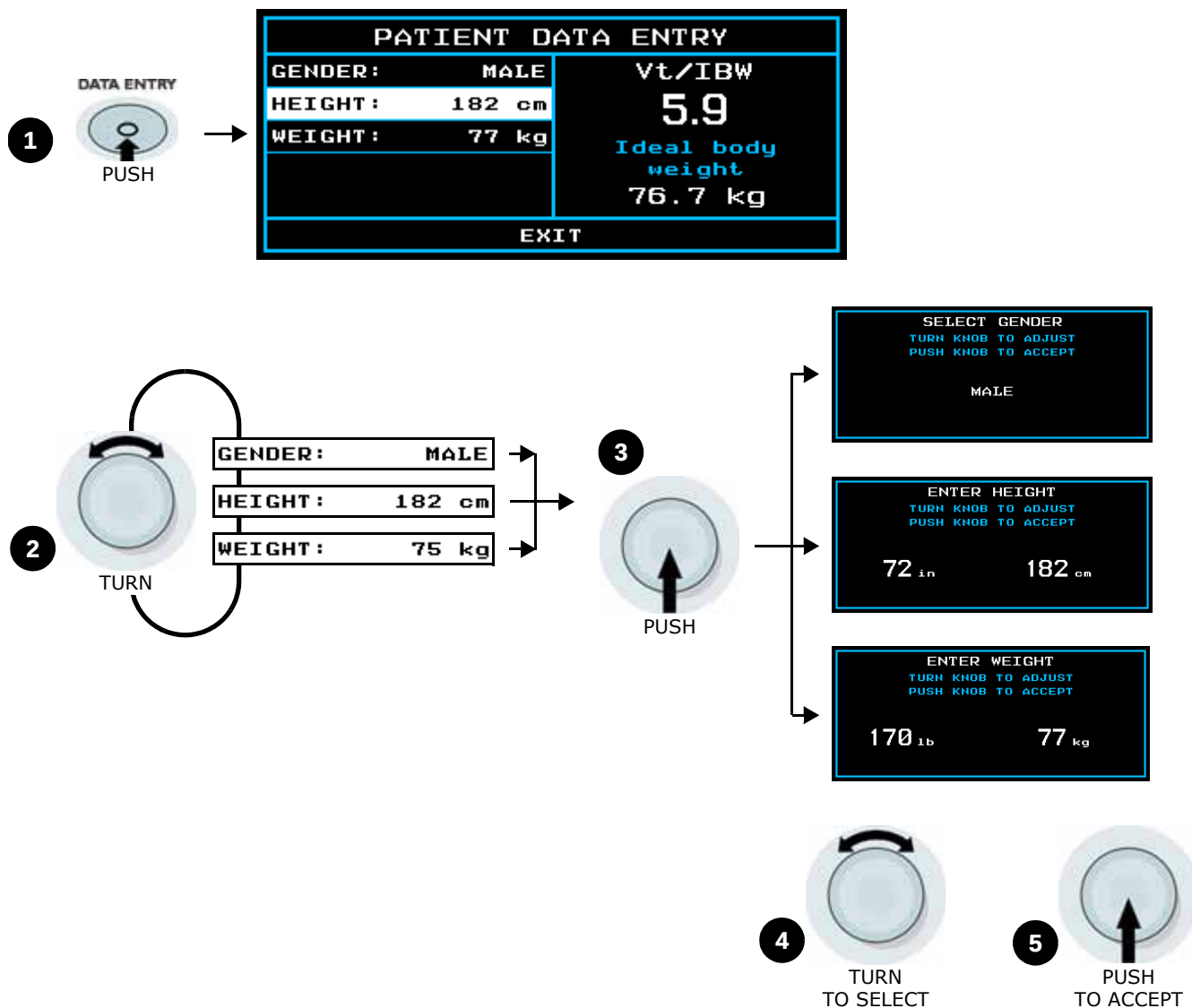
- 5 Turn and press the **KNOB** to select the PaCO₂, PaO₂, Hb/Hct, Mark ABG Time or Default ABG screen.
- 6 Turn **KNOB** to adjust value.

- ABG Time is required for PaCO₂ and PaO₂.
 - Ensure that the monitor's clock is synchronized to the clock used to determine the draw time.
- 7 Press the **KNOB** to accept the value and return to the **ABG DATA ENTRY** screen.
- Updated Vd/Vt and Vd_{alv} values are displayed.

Patient Data Entry

To enter patient data:

- 1 Press the **DATA ENTRY** key to activate **DATA ENTRY**. The key's green icon illuminates.
 - Press the key again to return to the previously displayed screen.
- 2 Highlight **PATIENT DATA** by turning the **KNOB**.
- 3 Select **PATIENT DATA** by pressing the **KNOB**.



- 4 Turn and press the **KNOB** to select the GENDER, HEIGHT or WEIGHT screen.
- 5 Turn **KNOB** to adjust value.
 - Entered patient data is used for Cardiac Index, Vt/kg and Vt/IBW calculations.
- 6 Press the **KNOB** to accept the value and return to the **PATIENT DATA** screen.
 - Updated Vt/IBW value is displayed.

NOTE: Patient data can also be entered in the VentAssist option screen. For more informations, see "Monitoring with VentAssist" on page 68.

Averaging Mode

Averaging options (**C.O. MODE**) for C.O., CI, and PCBF are set in the **SETUP** screen.

CObar Confidence Indicator

The Cardiac Output Confidence Bar, or CObar, is an indicator of the system's confidence in the currently displayed C.O., CI or PCBF value (depending upon which is selected in the Configuration Menu). The CObar indicator is located above the value and can contain up to five segments. The degree of confidence (more segments for higher confidence, fewer segments for lower confidence) is based on multiple factors including ventilatory pattern, sizing of the rebreathing loop, tidal volume, entry of patient data and breathing circuit integrity.



A lower number of segments indicates that the displayed reading is being averaged more with readings from previous rebreathing cycles. If there is no confidence in the signals, the cardiac output value is not displayed and no segments are displayed in the CObar.

Fast Mode

When the **C.O. MODE** is set to **FAST**, the monitor will display the unfiltered cardiac output value (CO-f) or PCBF value (PCBF-f) rather than the averaged value. The text **FAST MODE** will replace the CObar graphic. The stroke volume and cardiac index will be calculated from this value rather than the averaged value.



Averaged and fast values can also be viewed in the **3 MIN CYCLE IN PROGRESS**, **TREND** and **TABULAR DATA** screens. The values shown vary depending on which parameter and mode is selected for the large display.

Manual Mode

When the **C.O. MODE** is set to **MANUAL**, the text **MANUAL MODE** will replace the CObar. Pressing the **STOP/CONTINUE REBREATHING** key will initiate patient rebreathing for three cycles. Displayed C.O., CI or PCBF will correspond to averaged mode values; the stroke volume and cardiac index will be calculated from the averaged value.



Averaged and fast values can also be viewed in the **3 MIN CYCLE IN PROGRESS**, **TREND** and **TABULAR DATA** screens. The values shown vary depending on which parameter and mode is selected for the large display.

Display Hold

In all cardiac output modes, when rebreathing is turned off and eight minutes has elapsed, or the Cardiac Output Sensor has been disconnected, the NM3 monitor will dim and hold the large-digit reading for C.O., PCBF or C.I. The CObar or text for **FAST MODE** or **MANUAL MODE** is replaced with the time the last cycle was completed.



If the user modifies the monitor settings between C.O., PCBF and C.I., the time stamp will not change and the display will remain dimmed. After 12 hours, the large number display will turn to dashes (--) and the time stamp will be removed.

VentAssist

To begin respiratory and ventilation monitoring using VentAssist, the VentAssist option must be installed. When the VentAssist option is installed, the NM3 monitor will show the  icon in the startup screen. A label showing the same icon is also placed on the right side of the monitor case. See "Options and Accessories" for more information.

Introduction

VentAssist is a software option to the NM3 monitor which provides clinical decision support. The VentAssist decision support system is based on a need to more intuitively present data to the clinician, who is increasingly overloaded with parameters and information. Recognizing this specific trend and associated unmet user needs, Philips Respironics has developed a decision support software system that will offer clinicians advice for ventilating patients within ARDSNet Protocol (or equivalent) recommendations. The system provides advice on improving the patient's ventilatory profile by suggesting changes to rate and PSV (Pressure Support Ventilation) to improve the patient's WOB profile while maintaining ETCO_2 within a target range.

The VentAssist decision support system uses non-invasive Work of Breathing per minute (WOB/min), calculated patient parameters, and a decision support algorithm to provide a recommendation on changing the ventilation or pressure support level based on the patient's condition.

An overriding goal of the VentAssist system is to present data and ventilator adjustment advice in a clear and easy-to-use graphical format. Many of the waveforms and patient parameters calculated by the NM3 respiratory profile monitor, including airway flow, airway pressure, airway volume, and airway CO_2 are utilized in the calculation process.

What VentAssist does

- VentAssist is an open-loop advisory system that includes the clinician in the decision and implementation process. The system provides on-demand advice; the clinician is ultimately responsible for all ventilator adjustments.
- VentAssist provides a real-time display of the patient's response to ventilation changes.
- The NM3 with VentAssist is a portable, ventilator-independent monitoring device. The clinician controls ventilator settings, and which ventilator to use.

The VentAssist decision support system is not designed to replace the clinician, who has the choice to implement or reject any recommendation that the system offers. The system is designed to only provide support for clinical decisions that:

- may facilitate accelerated liberation from the ventilator
- may reduce the need for re-intubations
- may reduce the need for frequent blood gas samples
- may reduce ventilator days
- may decrease patient length of ventilation and ultimately improve patient outcomes.

Safety

The VentAssist WOB/min calculation is available only for adult patients receiving pressure support mechanical ventilation. The advice provided by VentAssist is intended for adult patients only.

As an open-loop advisory system, VentAssist requires active clinical participation and judgment for its use.

- VentAssist prompts the user for confirmation when a change in ventilation mode is detected.
- VentAssist will not suggest changes in pressure support that exceed a minimum or maximum pressure support level. These limits are not user configurable.
- The caregiver is prevented from changing the VentAssist configuration settings.
- Ventilation advice (increasing or decreasing MV) will take precedence over pressure support advice recommendations.

Principles of Operation

The Philips Respironics VentAssist decision support system has been designed to provide two categories of clinical decision support for clinicians. These are lung protective monitoring, and pressure support and ventilation recommendations. Each has a specific set of functions and operates in the following manner:

- Lung Protective monitoring - provides the clinician with an indication of how closely within ARDSNet Protocol (or equivalent protocol) that the patient is being ventilated based on desired ml/kg and Pplat. This is done by displaying the calculated V_T /kg based on the patient's measured inspired tidal volume and the ideal body weight that has been entered into the NM3. Similarly, the patient's Pplat is calculated from measured waveform data and is displayed in relation to ARDSNet Protocol recommendations¹.
- Pressure Support and Ventilation recommendations - provide the clinician with on-demand recommendations for adjusting MV and/or PSV to manage the patient's ventilatory and WOB profiles while maintaining a target EtCO₂ range. This is done by collating key inputs measured by the NM3 monitor and data inputs from the ventilator and/or manual entry by the clinician into a decision network that has been designed to assist clinical decisions for changes to the patient's ventilator settings.

Correlation with Clinical Practice

ARDSNet Protocol Values: The lung protective aspects within VentAssist are based on the ARDSNet protocol.

Low, normal and high ranges for Pplat, V_T /kg, RR, WOB/min, EtCO₂ and SpO₂ can be configured according to your institution's practices. Instructions for accessing the VentAssist Setup screen and configuring the VentAssist protocol are available in the *NM3 Service Manual*. Configuration should be governed by approved clinical practice and local standards of care.

For more information on user-configurable VentAssist settings, please see "Monitoring with VentAssist" on page 68.

VentAssist Parameter Overview

With the VentAssist option installed, the NM3 monitor provides ventilation adjustment advice based on parameter calculations derived from measured patient parameters. VentAssist requires the use of an adult CO₂/Flow or cardiac output sensor to provide WOB/min measurements and advice on setting pressure support levels. The use of a CAPNOSTAT CO₂ Sensor, and an appropriate airway adapter to provide advice on adjusting ventilation settings, is also required.

Pressure support advice is provided to the clinician with an on-demand recommendation for adjusting PSV to make desired improvements in the patient's ventilation profile as defined by V_T /kg, RR and WOB/min desired ranges.

1. ARDSNet Report - "Ventilation with Lower Tidal Volumes as Compared with Traditional Tidal Volumes for Acute Lung Injury and the Acute Respiratory Distress Syndrome" - New England Journal of Medicine, May 4, 2001, volume 342, number 18, pp 1301-1308.

The VentAssist screen includes six parameters whose values are shown in a bargraph format:

- **Pplat:**

Pplat data can be viewed in the VentAssist screens, but is not used by the VentAssist algorithm.

Pplat is an averaged indication of the patient's Plateau Pressure as measured by the NM3 proximal flow sensor. VentAssist calculates a dynamic plateau pressure derived from the patient's resistance and compliance measurements. A squarewave and inspiratory hold maneuver is not required for this measurement. A Pplat trend is available in the Lung Protection Trend screen; the parameter is trended as a one-minute average with 24 hours of trended data. Select Pplat in the VentAssist screen to view trends.

- **V_T / kg:**

V_T /kg is the inspired tidal volume per IBW as measured by the NM3 proximal flow sensor. Calculation of V_T /kg requires the user to enter patient height and weight for calculation of ideal body weight (IBW). V_T /kg require the spontaneous threshold to be set by the user (see "Setup Screen" on page 80). The displayed value is calculated using a running two-minute average, updated every 15 seconds.

A V_T /kg trend is available in the Lung Protection Trend screen; the parameter is trended as a one-minute average with 24 hours of trended data. Select V_T /kg in the VentAssist screen to view trends.

- **Respiratory Rate:**

The respiratory rate is calculated using a running two-minute average, updated every 15 seconds.

An RR trend is available in the Patient Effort Trend screen. The parameter is trended as a one-minute average with 24 hours of trended data. Select RR in the VentAssist screen to view trends.

- **WOB (Work Of Breathing) / min:**

The WOB/min non-invasive algorithm is statistically equivalent to invasive work of breathing using esophageal manometry, calculated for one minute. This is done by collating key inputs measured by the NM3 monitor and data inputs from the ventilator and/or manual entry by the clinician into an algorithm which predicts non-invasive work of breathing per minute. The key inputs are airway flow, pressure and volume measurements.

WOB/min parameter is only calculated when in a pressure support mode of ventilation. Pressure support modes include CPAP and SIMV: VCV/SIMV, VCV/CPAP, PCV/SIMV, PCV/CPAP. In SIMV mode, the WOB/min parameter will only be calculated with breath rates less than or equal to four. The WOB/min parameter is calculated every 20 seconds and displayed as a 2-minute running average.

A WOB/min trend is available in the Patient Effort Trend screen. The parameter is trended as a one-minute average with 24 hours of trended data. Select WOB/min in the VentAssist screen to view trends.

- **ETCO₂:**

Appropriate range levels for ETCO₂ are differentiated for normal, hypercapnic (high CO₂), and hypocapnic (low CO₂) patients. Desired ranges for each patient type are:

- Hypocapnic: 30-40 mmHg, 4.0-5.3 kPa, or 3.9-5.3 % (at Pb = 760 mmHg)
- Normal: 35-45 mmHg, 4.7-6.0 kPa, or 4.6-5.9 % (at Pb = 760 mmHg)
- Hypercapnic: 40-50 mmHg, 5.3-6.6 kPa, or 5.3-6.6 % (at Pb = 760 mmHg)

An ETCO₂ trend is available in the Ventilation Trend screen. The parameter is trended as a one-minute average with 24 hours of trended data. Select ETCO₂ in the VentAssist screen to view trends.

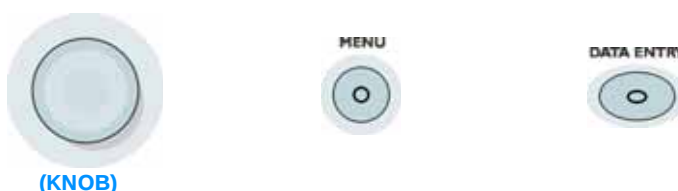
- **SpO₂:**

SpO₂ data (Oxygenation) can be viewed in the VentAssist screens, but is not used by the VentAssist algorithm.

An SpO₂ trend is available in the Oxygenation Trend screen. The parameter is trended as a one-minute average with 24 hours of trended data. Select SpO₂ in the VentAssist screen to view trends.

Navigating in VentAssist

Use the **KNOB**, **MENU**, and **DATA ENTRY** keys to navigate the NM3 VentAssist features, as outlined in the following sections.



A highlighted box on the NM3 screen shows the current selection. This highlight is rotated around the screen for various data entries or data displays.

To open the VentAssist screens, press the **MENU** key to open the **SELECT A SCREEN** menu. Turn and press the **KNOB** to select **VENTASSIST**. NOTE: The VentAssist selection will be dimmed and inactive if a Neonatal or Pediatric flow sensor is connected. If an option is not installed, the menu item will not be displayed.

SELECT A SCREEN	
CO ₂ /SpO ₂	TREND
FLOW/PRESSURE	TABULAR DATA
FLOW/PRES/VOL	VOLUMETRIC CO ₂
VC _{CO2} /MV _{alv} TREND	SET ALERTS
VT/Vd TREND	SETUP
NUMERICS	VENTASSIST

For all of the VentAssist functions, navigate to the desired selection by turning the **KNOB**. When the item is highlighted, press the **KNOB** to select. For Data Entry selections, press the **KNOB** to activate the data field. Turn the **KNOB** to increase or decrease the range, and press the **KNOB** again to accept.

Areas of the Display

The VentAssist screen is divided into three sections. The top, middle and bottom, identified below:

Top: Information and Advice displays

Middle: patient parameter display

Bottom: data entry

12:42:29
New Advice Available Show Advice

Lung Protection		Patient Effort		Ventilation	Oxygenation
Pplat	Vt/kg	RR	WOB/min	ETCO ₂	SpO ₂
30 cmH ₂ O	10 mL/kg	40 br/m	12 J/m	50 mmHg	100 %
28	8 7.9	30	10	45	100 %
13		15	8.5	39	97
5		12	7	35	96
PIP 26				30	92
PSV --					
PEEP 10					

Select View
Vent Mode PSV
CO₂ Mode Normal
Gender Female
Height 165 cm
IBW 57 kg
Exit VentAssist

Top Section

The top section of the VentAssist screen is used for information and advice display. It can appear three ways: as the Confirm Vent Mode Panel, the Standard Panel, or the Advice/Details Panel.

Confirm Vent Mode Panel:

Entering the current ventilation mode is one of the first steps in using the VentAssist system. The system will not calculate the work-of-breathing parameter unless the ventilation mode is specified to be **PRESSURE SUPPORT**, **LOW SIMV** (with PSV), or **CPAP** (with PSV). These are the general pressure support modes.

When the Vent Mode is not set, the user is prompted to set the mode and the **Standard Panel** changes to the **Confirm Vent Mode** panel.



This panel is displayed when the system potentially detects a change in the ventilation mode (assuming the currently set mode is a compatible mode). This prompt does not prevent the display of work-of-breathing but does present the display of advice until the vent mode is confirmed. The advice panel is displayed for up to two minutes; after which the screen reverts to the standard panel.

Standard Panel:

Displays messages and information to the user, and provides the ability for the caregiver to request the display of advice from the system. The system itself is always generating advice based on the current inputs.

When new advice is available from the system, the message **NEW ADVICE AVAILABLE** will be displayed on the left side of the screen. This message is shown whenever the advice or the details text is different than the previous recommendations most recently shown to the user. This panel will also display NM3 messages in the middle section. The current time is displayed to the user for their convenience.



Advice / Details Panel:

The user must actively request the display of advice. To do this, navigate the highlighted menu to the **SHOW ADVICE** button, and press the **KNOB**. The top section changes to the advice panel to display the recommendation:

When **SHOW ADVICE** is selected, VentAssist advice will be displayed:

16:34:04
Updated 16:32

Maintain PSV

×

Show Details

Select **SHOW DETAILS** to view the rationale for the displayed advice.

13:31:29
Updated 13:26

**V_T is outside of the desired range.
Decreasing PSV may decrease V_T.**

×

Hide Details

Also displayed are the current time and the time the recommendation was generated. The user can then view additional information on the recommendation, or close the advice panel using the **×** button) The advice will automatically update if new recommendations are generated while the panel is displayed. The advice panel is displayed for up to two minutes, after which the screen reverts to the standard panel.

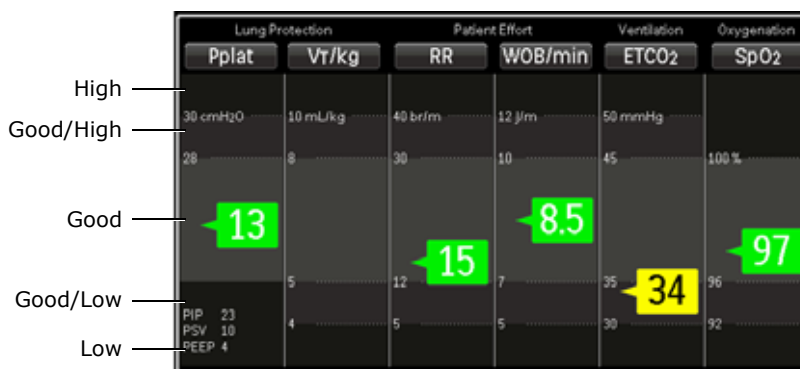
For a full list of VentAssist messages and descriptions, see the Advice, Details, Error and Status Message Tables beginning on page 69.

Middle Section

The middle section can be used in three different ways: as a **Graphics View**, a **Numerics View** and a **Trend View**. To choose graphics or numerics views, use the **SELECT VIEW** button on the bottom left of the screen. To select the Trend view, highlight the parameter title and press the **KNOB**.

Graphics View:

The **Graphics View** is the standard, default view of the system. It presents parameters in a graphical fashion along a column chart. Each column is divided horizontally into five separate sections with the range values labeled. The sections do not represent the same range of values per parameter and are instead organized as a horizon view.



From the top-down, the sections represent the following:

- **High** - when the parameter is in the top section, it is drawn with a Red background with white letters. Parameters within this section represent over-value (undesirable) ranges.
- **Good / High** - when the parameter is between the middle and top sections, it is drawn with a Yellow background with black letters. Parameters within this section typically will generate "Optional" advice, depending how close the value is to the High or Good range.
- **Good** - when the parameter is in the middle section, it is drawn with a Green background with White letters. This section represents the desired range for the parameter.
- **Good / Low** - when the parameter is between the middle and bottom sections, it is drawn with a Yellow background with black letters. Parameters within this section typically will generate "Optional" advice, depending how close the value is to the Good or Low range.
- **Low** - when the parameter is in the bottom section, it is drawn with a Red background with white letters. Parameters within this section represent under-value (undesirable) ranges.
- Also displayed is a numeric value for the peak inspiratory pressure (PIP), the current pressure support value estimate (PSV), and the PEEP value.

10

6.9

15

6.9

10

NOTE: When a parameter is unavailable or cannot be calculated, the parameter flag will not be displayed in the column chart. For example, see the Vt/kg column above.

The parameters displayed are grouped into four general categories: lung protection (plateau pressure and tidal volume per kilogram), Patient Effort (respiratory rate and work-of-breathing), Ventilation (end-tidal CO₂), and Oxygenation (SpO₂).

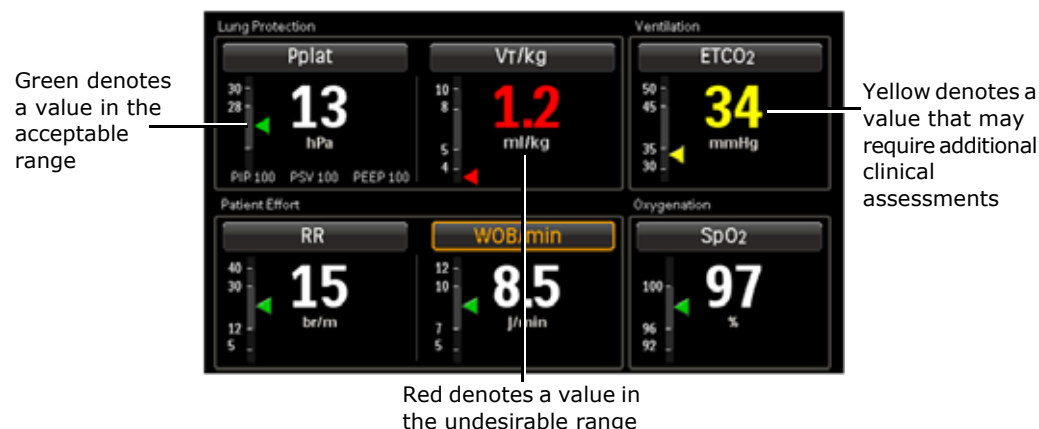


Each parameter's heading serves as a navigation button which can be highlighted and clicked. Clicking displays the **Trend View** for the highlighted parameter; the **Trend View** is discussed below.

Numerics View:

The **Numerics View** displays the parameter values as large numeric values which corresponds to traditional patient monitors. This view displays the same data parameters as the **Graphic View**, but emphasizes the numeric value. To the left of each parameter, there is a small indicator representing the values displayed in the **Graphic View** screen. The colors of the arrows are the same as the flags--high, low and good--shown in that screen.

Each parameter heading serves as a navigation button which can be highlighted and clicked. Clicking displays the **Trend View** for the highlighted parameter. The **Trend View** is discussed below.



Trend View:

The Trend View displays a one hour graphical trend for the desired parameter. The time range of the trend plot is displayed along with controls that allow the user to scroll through the recorded trends. The trends can be scrolled in 15 minute and 1 hour increments.

Highlighting and selecting the Close button (X) in the upper right of the screen returns to either **Graphics** or **Numerics View**.



Bottom Section

The bottom section of the screen presents menu selections for the user to enter various required data or make changes to the view. The bottom right button (**EXIT VENTASSIST**) returns to the standard NM3 menu.

Select View	Vent Mode PSV	CO2 Mode Normal	Gender Female	Height 165 cm	IBW 57 kg	Exit VentAssist
-------------	------------------	--------------------	------------------	------------------	--------------	-----------------

Select View:

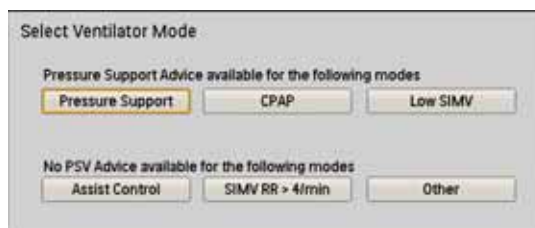
Press the **SELECT VIEW** button to choose either the **Graphics** or **Numerics View**. Turn the **KNOB** to highlight the appropriate button, press the **KNOB** to select.

Vent Mode:

Pressure support advice is provided in the form of Increase/Maintain/Decrease Pressure Support (PSV) recommendations. Hence the system, and the work of breathing parameter, require the use of a pressure support mode of ventilation. This entry prompt provides the user with the ability to tell the system what the current mode of ventilation is.

Within the Vent Mode screen, there are six selections. Three are PSV-compatible modes: **PRESSURE SUPPORT**, **CPAP** (spontaneous), or pressure support with **LOW SIMV** breaths. The Pressure support and CPAP settings are suitable for patients at ≥ 5 cmH₂O. Breath rate for Low SIMV patients must be less than or equal to 4 breaths per minute.

NOTE: For Low SIMV, the SIMV mode can be pressure control or volume control. As long as the set SIMV rate is 4 or less breaths per minute, pressure support advice and WOB/minute are valid.

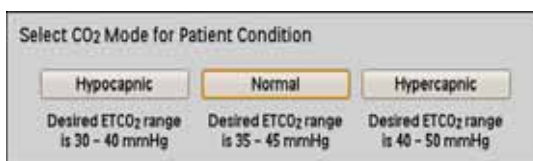


There are also three incompatible modes: Assist Control, SIMV (RR over 4/minute), and an Other. All modes on ventilators can be classified into one of these six categories.

NOTE: If an incompatible ventilator mode is selected—Assist Control, SIMV RR > 4/min, or Other—the system will not provide pressure support advice.

CO₂ Mode:

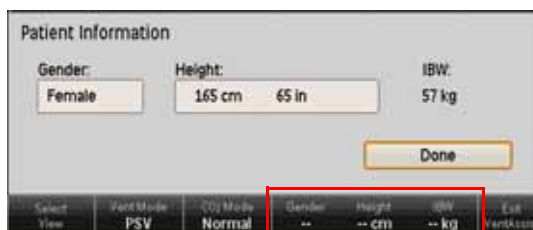
Select the CO₂ patient mode to best fit the desired ETCO₂ values for the ventilation advice. Three modes are available: **HYPOCAPNIC**, **NORMAL** and **HYPERCAPNIC**.



A suggested ETCO₂ range is listed below each selection to guide the user in selecting the appropriate mode. When a mode is chosen, the ranges on the ETCO₂ column and in the ventilation advice columns will be adjusted. This data is only used for ventilation advice and does not affect the pressure support advice.

Patient Information: Gender, Height, IBW

Enter **GENDER** and **HEIGHT** to calculate ideal body weight (**IBW**). Entry of required patient data is critical to the system. The system uses ideal body weight for data calculations. After data entry is complete, the menu bar displays the current settings.



Settings will update

NOTE: Gender and Height data used to calculate IBW can also be entered via **PATIENT DATA** screens in the Respiratory Mechanics and Cardiac Output modes. Information entered in one location is carried through to the other locations.

Monitoring with VentAssist

Preparing for Use

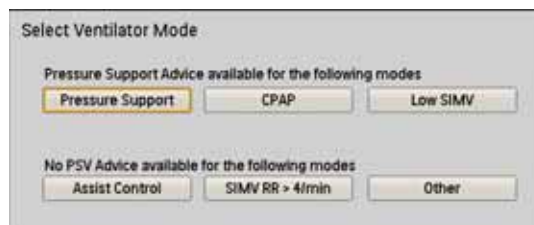
The normal use scenario for the use of the VentAssist system is as follows:

- 1 Power on NM3 monitor.
- 2 Connect sensors to the system and to the patient. For more information on system and patient setup, see "Preparing for Use" on page 35 of the "Respiratory Monitoring" chapter, or "Preparing for Use" on page 45 of the "Monitoring Cardiac Output" chapter.
- 3 Set the spontaneous threshold (see "Setup Screen" on page 80).
- 4 Enter the VentAssist screen using the **MENU** key.



- 5 Highlight and select **VENT MODE**, then set the correct ventilator mode based on the current ventilator settings.

NOTE: Pressure support advice is not available when the ventilator is in an **ASSIST CONTROL** mode, **SIMV** mode with Respiratory Rate below four breaths/min, or **OTHER**.



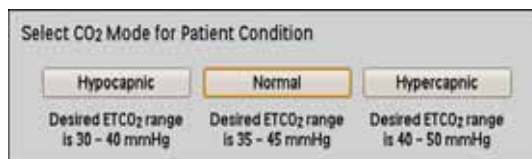
- 6 To enter **GENDER** and **HEIGHT** information use the **DATA ENTRY** key on the front panel, or highlight and select the patient data area in the VentAssist screen. This data is used to calculate Ideal Body Weight (**IBW**).



or

Gender	Height	IBW
Female	164 cm	56 kg

- 7 Use the CO₂ mode prompt to set the appropriate ETCO₂ ranges for the patient: **HYPOCAPNIC**, **NORMAL** or **HYPERCAPNIC**. A suggested patient range (default) is shown below each selection. Hypocapnic: desired range 30-40 mmHg, Normal 35-45 mmHg, Hypercapnic 40-50 mmHg.



- 8 Wait for the system to acquire data.

NOTE: Data acquisition generally takes up to four minutes.

Display of Advice



WARNING

The advisor functionality of VentAssist is not intended to be used as an alarm system. High or low parameter flags (red and yellow) are displayed as recommendations only, and are not meant to be interpreted as an alarm condition.

There are two classes of messages. Minute Ventilation messages take priority if you are using the ETCO₂ sensor. This advice is only generated from ETCO₂ signal. Pressure Support advice is related V_T/kg, RR, WOB/min. They appear if ventilation is within acceptable parameters, or a CO₂ sensor is not in use.

- 1 Select the **SHOW ADVICE** prompt.
The system will display one of the recommendations shown in the "Advice Table" on page 69.
- 2 Request details if desired, using the **SHOW DETAILS** button
The system will display one of the recommendations shown in the "Details Table" on page 70.
- 3 View details. An example is shown below.

Show Advice

Show Details

13:31:29

Updated 13:26

V_T is outside of the desired range.
Decreasing PSV may decrease V_T.



Hide Details

- 4 If an Increase PSV or Decrease PSV is recommended, for example, the ventilator can be adjusted according to hospital protocol.

Note that it is the responsibility of the clinician to act on the provided recommendation. VentAssist is an "open-loop" system where clinician is responsible for ventilator adjustments.

To hide details, highlight and select the **HIDE DETAILS** button. Or choose the **X** button to return to the selected VentAssist view, either **Graphic** or **Numeric**.
- 5 Repeat as necessary over the course of patient care.

Advice Table

Advice is up to two lines of text provided by the system. The **Advice** Panel is displayed for up to two minutes, after which the screen reverts to the **Standard** Panel.

VentAssist Advice	Description
Increase Minute Ventilation	Based on the current ETCO ₂ value, the system recommends increasing MV (RR, VT, or a mode change) to lower ETCO ₂ .
Maintain Minute Ventilation	ETCO ₂ is within the desired range and no pressure support advice can be provided.
Decrease Minute Ventilation	Based on the current ETCO ₂ value, the system recommends decreasing MV (RR, VT or a mode change) to increase ETCO ₂ .
Increase PSV	One or more inputs cause the system to recommend increasing PSV to prevent respiratory muscle fatigue (decrease patient work) and/or increase tidal volume.
Consider Increasing PSV	Inputs are trending towards values that cause the system to recommend increasing PSV but it is a judgment call of the caregiver to either maintain or increase. One or more input values will typically be yellow.

VentAssist Advice	Description
Maintain PSV	Based on the inputs of RR, Vt/kg and WOB, the system recommends maintaining current PSV levels (all values are in the green).
Consider Decreasing PSV	Inputs are trending towards values that cause the system to recommend decreasing PSV but it is a judgment call of the caregiver to either maintain or increase. One or more input values will typically be yellow.
Decrease PSV	One or more inputs cause the system to recommend decreasing PSV to prevent respiratory muscle deconditioning (increase patient work) and/or decrease tidal volume.
Consider Calling Physician	One or more inputs indicate conflicting choices: one recommends increasing and one recommends decreasing, and neither can be prioritized. In this case, the system is unable to provide a pressure support recommendation (these are not common cases).
No Advice Available	Technical conditions, such as no-respiration, sensor disconnects, incompatible ventilation mode, etc., prevent the system from providing any advice.
No Advice, At System Limits	In this case, the system is recommending increasing PSV but the current PSV is at a maximum allowed value, or the system is recommending decreasing PSV but the current PSV is at a minimum allowed value. The system is unable to provide a pressure support recommendation.

Details Table

This is up to three lines of additional background as to why the specific recommendation was generated. The **Details** panel is displayed for up to two minutes, after which the screen reverts to the standard panel.

VentAssist Advice	Details
Increase PSV	Addressing low V_T takes priority over low patient effort. Increasing PSV may increase V_T .
Increase PSV	V_T is lower than the desired range. Increasing PSV may increase V_T .
Increase PSV	V_T is low. High patient effort may lead to respiratory muscle fatigue. Increasing PSV may increase V_T .
Decrease PSV	Low patient effort may lead to respiratory muscle deconditioning. Decreasing PSV may increase patient effort.
Maintain PSV	Patient effort and V_T are within desired ranges. Respiratory rate is low.
Increase PSV	High patient effort may lead to respiratory muscle fatigue. Increasing PSV may decrease patient effort.
Decrease PSV	V_T is high. Low patient effort may lead to respiratory muscle deconditioning. Decreasing PSV may decrease V_T .
Decrease PSV	V_T is high. Decreasing PSV may decrease V_T .
Consider Calling Physician	High V_T indicates a need to decrease PSV, but high effort suggests an increase. Consider additional clinical assessments.(#)
Increase PSV	Addressing low V_T takes priority over low patient effort. Increasing PSV may increase V_T .
Increase PSV	V_T is lower than the desired range. Increasing PSV may increase V_T .
Increase PSV	V_T is low. High patient effort may lead to respiratory muscle fatigue. Increasing PSV may increase V_T .
Decrease PSV	Low patient effort may lead to respiratory muscle deconditioning. Decreasing PSV may increase patient effort.

VentAssist Advice	Details
Maintain PSV	Patient effort and ventilation are in desired ranges.
Increase PSV	High patient effort may lead to respiratory muscle fatigue. Increasing PSV may lower patient effort.
Decrease PSV	V_T is high. Low patient effort may lead to respiratory muscle deconditioning. Decreasing PSV may decrease V_T .
Decrease PSV	V_T is outside of the desired range. Decreasing PSV may decrease V_T .
Consider Calling Physician	High V_T indicates a need to decrease PSV, but high effort suggests an increase. Consider additional clinical assessments.(#)
Increase PSV	V_T is low and RR is high. Addressing this takes priority over low patient effort. Increasing PSV may increase V_T .
Increase PSV	High respiratory rate and low V_T indicate a need for more support. Increasing PSV may increase V_T .
Increase PSV	High RR and low V_T indicate a need for more support. Increasing PSV may increase V_T and decrease patient effort.
Consider Calling Physician	High RR indicates a need to increase PSV, but low effort indicates a need to decrease PSV. Consider additional clinical assessments.(#)
Increase PSV	High spontaneous breathing frequency (RR) may indicate a need to increase PSV.
Increase PSV	Patient effort and spontaneous breathing frequency (RR) are outside desired ranges. Increasing PSV may decrease patient effort.
Consider Calling Physician	High RR indicates a need to increase PSV, but high V_T indicates a need to decrease PSV. Consider additional clinical assessments. (#)
No Advice, At System Limits	Low effort indicates decreasing PSV, but limits on PSV range preclude this change. Consider additional clinical assessments.
No Advice, At System Limits	High V_T indicates decreasing PSV, but limits on desired PSV range preclude this change. Consider additional clinical assessments.
No Advice, At System Limits	Low V_T indicates decreasing PSV, but limits on desired PSV range preclude this change. Consider additional clinical assessments.
No Advice, At System Limits	Low V_T indicates increasing PSV, but limits on desired PSV range preclude this change. Consider additional clinical assessments.
No Advice, At System Limits	High effort indicates increasing PSV, but limits on PSV range preclude this change. Consider additional clinical assessments.
No Advice, At System Limits	High RR indicates increasing PSV, but limits on desired PSV range preclude this change. Consider additional clinical assessments.
No Advice, At System Limits	High RR and effort indicate increasing PSV, but limits on PSV range preclude this change. Consider additional clinical assessments.
Increase Minute Ventilation	$ETCO_2$ is higher than the desired range. Increasing MV (RR, V_T , or a mode change) may lower $ETCO_2$ values.
Increase Minute Ventilation	$ETCO_2$ has been moderately high for over 10 minutes. Increasing MV (RR, V_T , or a mode change) may lower $ETCO_2$ values.
Maintain Minute Ventilation	$ETCO_2$ is in the desired range.
Decrease Minute Ventilation	$ETCO_2$ has been moderately low for over 20 minutes. Decreasing MV (RR, V_T , or a mode change) may raise $ETCO_2$ values.
Decrease Minute Ventilation	$ETCO_2$ is lower than the desired range. Decreasing MV (RR, V_T , or a mode change) may raise $ETCO_2$ values.

Error Messages Table

Error Message	Condition
VentAssist is not running.	An internal system error is present that is preventing VentAssist from providing advice. Contact qualified personnel for monitor repair or exchange if this error persists.
Connect sensors to patient to activate VentAssist.	Flow or CO ₂ sensors are not connected to the monitor, or are not connected to the patient's ventilator circuit.
No respiration detected.	No respiration
Enter ideal body weight (patient gender and height) to receive Pressure Support advice.	Ideal body weight is not entered so the system cannot provide pressure support advice, and a CAPNOSTAT CO ₂ Sensor is not connected.
Set ventilator to a Pressure Support mode to calculate patient effort (WOB/min).	An unsupported ventilator mode is currently selected, and a CAPNOSTAT CO ₂ Sensor is not connected.
Please wait while VentAssist acquires data for advice.	WOB/min requires more data to provide calculation.
Patient effort cannot be calculated. Check ventilator settings.	WOB/min is invalid and cannot be calculated, and a CAPNOSTAT CO ₂ Sensor is not connected.

Status Messages Table

Status Messages	Description
Updated 00:00	Time stamp
New Advice Available	This is shown whenever the advice or the details text is different than the previous recommendations shown to the user.
Ventilation Mode Change Detected Please select the current ventilation mode.	This panel is displayed when the system potentially detects a change in the ventilation mode (assuming the currently set mode is a compatible mode). This prompt will not prevent the display of work-of-breathing, but does prevent the display of advice until the vent mode is confirmed.

Definitions Table

Abbreviation	Definition
CPAP	Continuous Positive Airway Pressure
CO	Cardiac Output
PCV	Pressure Control Ventilation
PS/V	Pressure Support/Ventilation (Advisor)
PSV	Pressure Support
SIMV	Synchronized Intermittent Mandatory Ventilation
V _T /kg	Inspired Tidal Volume per Kg ideal body weight
WOB	Work of breathing, expressed in J/L
WOB/min	Work of breathing per minute (non-invasive measurement), expressed in J/min
VCV	Volume Control Ventilation

Reference – Clinical Bibliography

ARDSNet Report - "Ventilation with Lower Tidal Volumes as Compared with Traditional Tidal Volumes for Acute Lung Injury and the Acute Respiratory Distress Syndrome" - New England Journal of Medicine, May 4, 2009, volume 342, number 18, pp 1301-1308.

Kirton, Orlando, MD, DeHaven, Bryan, RRT, Civetta, Joseph, MD - "Elevated Imposed Work of Breathing Masquerading as Ventilator Weaning Intolerance" - Chest, October 1995, volume 108, number 4, pp 1021 - 1025.

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Monitoring and Setup Screens

Choose Screens Menu

The **CHOOSE SCREENS** menu allows the user to customize the active screen set for monitoring in Respiratory Mechanics mode or the optional Cardiac Output mode. **CO₂/SpO₂** is the base screen, it is always available. The **CHOOSE SCREENS** menu is not available when the NICO-Esprit interface is active.

CHOOSE SCREENS	
TREND	☒ VCO ₂ /MVa1v ☒
FLOW/PRESSURE	☐ Vt/Vd TREND ☒
NUMERICS	☐
FLOW/PRES/VOL	☒
VOLUMETRIC CO ₂	☒
EXIT	

Enabling Screens

To enable or disable specific screens, press the **MENU** key to display **SELECT A SCREEN**. Turn the **KNOB** to highlight **SETUP** and push the **KNOB**. From the **SETUP** screen, select **CHOOSE SCREENS** and push the **KNOB**.

In the **CHOOSE SCREENS** menu, turn and push the **KNOB** to add or remove each monitoring screen from the active screen set. When a screen is enabled, a check is in the checkbox. In monitoring mode, enabled screens will appear with successive turns of the **KNOB**. If a screen is unchecked, it will not appear when the **KNOB** is turned, but can be accessed directly from **SELECT A SCREEN** or **SELECT RESPIRATORY SCREENS**.

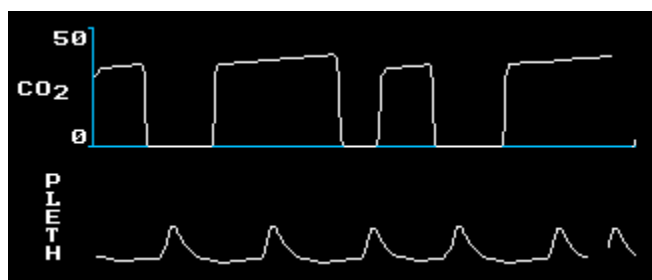
Respiratory Mechanics mode

This section provides an overview of the various monitoring and setup screens in Respiratory Mechanics mode.

When INST CO₂ is selected as the ETCO₂ averaging mode, INST CO₂ is displayed in place of ETCO₂ and RR in the top numerics section of the display. In all other screens, ETCO₂ will be dashed when INST CO₂ is selected.

CO₂ and SpO₂ Waveform Screen

The CO₂ and SpO₂ Waveform Screen plots the capnogram and plethysmogram signals.

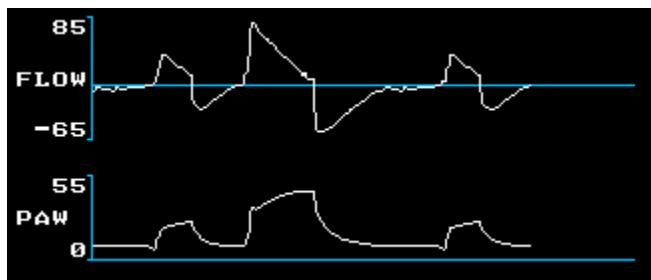


The **CO₂/SpO₂** screen can be displayed by turning the **KNOB** while viewing any monitoring screen, or by pressing the **MENU** key and selecting **CO₂/SpO₂**.

- Information is updated in real time.
- The capnogram and plethysmogram are automatically scaled.
- The capnogram sweep speed is selectable in the **SETUP** menu.

Flow and Pressure Waveform Screen

The Flow and Pressure Waveform screen plots the airway flow and pressure signals over time.



The **FLOW/PRESSURE** screen can be displayed, when enabled, by turning the **KNOB** while viewing any monitoring screen, or by pressing the **MENU** key and selecting **FLOW/PRESSURE**.

- Information is updated in real time.
- The airway flow and pressure waveforms are automatically scaled.
- The waveform sweep speed is selectable in the **SETUP** menu.

Numerics Screen

The **NUMERICS** screen display presents several monitored parameters together in one place.

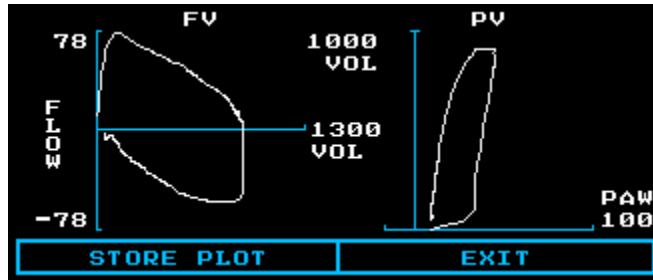
Vd/Vt 0.20 @ 12:38	Vtalv 546 mL	MValv 11.0 L	PIP 46 cmH ₂ O
Vdalv 58	VdAw 64	MAP 22	Pplat --
Vt/kg 8.1 mL/kg	Cdyn 28 mL/cmH ₂ O	Raw 14 cm/(L/s)	PEEP 10 cmH ₂ O

The **NUMERICS** screen can be displayed, when enabled, by turning the **KNOB** while viewing any monitoring screen, or by pressing the **MENU** key and selecting **NUMERICS**.

- Information is updated in real time.
- The PEEP unit label is replaced with AUTO if Auto-PEEP (Intrinsic-PEEP) is detected.
- The Cdyn label is replaced with Cst if static lung compliance is detected.
- The Vt/kg label is replaced with Vt/IBW when ideal body weight is calculated.

Flow Volume and Pressure Volume Loops screen

The Flow Volume and Pressure Volume Loops screen displays a flow versus volume loop and a volume versus peak airway pressure loop.

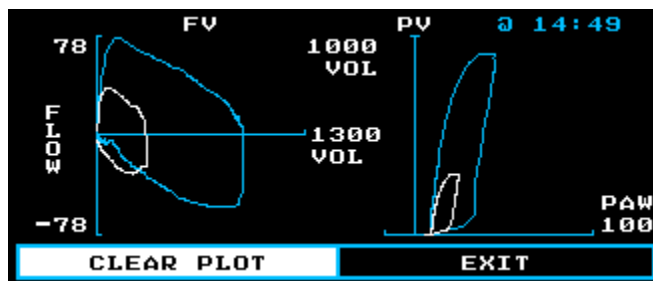


The **FLOW/PRES/VOL** screen can be displayed, when enabled, by turning the **KNOB** while viewing any monitoring screen, or by pressing the **MENU** key and selecting **FLOW/PRES/VOL**.

- The flow-volume loop is plotted in a clockwise direction, comparing flow versus volume for a single patient breath and providing information regarding the condition of the airways.
- The pressure-volume loop is plotted in a counter-clockwise direction; the slope from the beginning of inspiration to the end of inspiration depicts compliance while the width of the loop references resistance.
- The curve is automatically scaled to fit the display area.

Store Plot

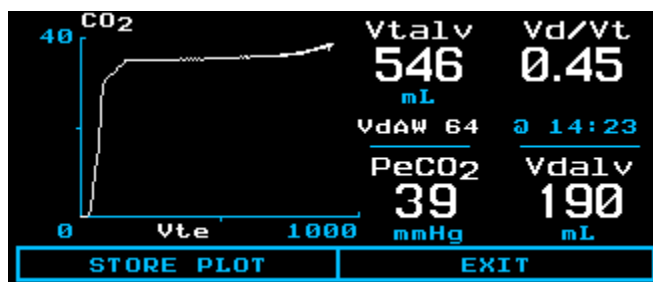
The Store Plot function “freezes” a single breath on the **FLOW/PRES/VOL** screen as a template. Subsequent loops will be drawn over that breath.



- Press the **KNOB** to highlight **STORE PLOT** and again to select the breath.
- Press the **KNOB** to highlight **CLEAR PLOT** and again to erase the selected breath.
- The time stamp above the template waveform corresponds to when the plot was set.

Volumetric CO₂ Screen

The **VOLUMETRIC CO₂** screen displays the CO₂ waveform for a single patient breath, as well as providing numeric displays of Vd/Vt, Vtalv, Vdaw, PeCO₂, and Vdalv.

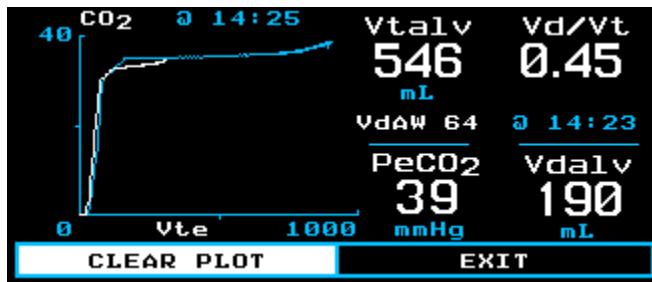


Volumetric CO₂ presents the exhaled concentration of CO₂ versus tidal volume during a single expiration; useful for understanding the ventilation/perfusion relationship. It allows the clinician to detect relative changes in CO₂ production, deadspace, and effective ventilation by observing the shape of the graph.

- The curve is automatically scaled to fit the display area.

Store Plot

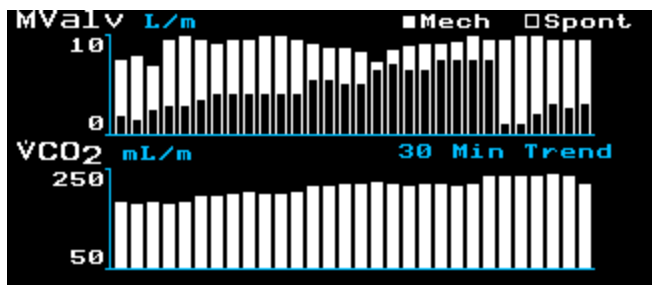
The Store Plot function “freezes” a breath on the **VOLUMETRIC CO₂** screen as a template. Subsequent waveforms will be drawn over that breath.



- Press the **KNOB** to highlight **STORE PLOT** and again to select the breath.
- Press the **KNOB** to highlight **CLEAR PLOT** and again to erase the selected breath.
- The time stamp above the template wave corresponds to when the plot was set.

VCO₂/MValv Trend Screen

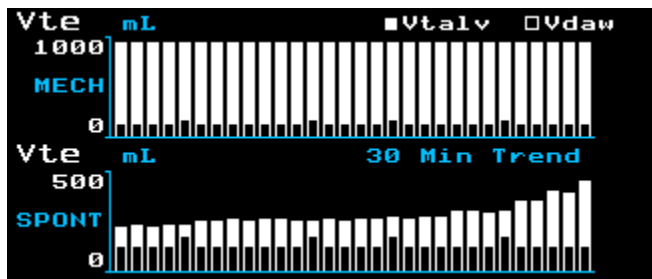
The **VCO₂/MValv** Trend screen displays trends for alveolar minute ventilation and CO₂ elimination. Monitoring spontaneous versus mechanical alveolar ventilation along with CO₂ elimination provides information on continued success or impending failure when weaning a patient off a ventilator.



- While viewing the **VCO₂/MValv** Trend screen, each push of the knob will advance through the available 30 minute, and 2, 4, 8, and 12 hour trend displays.
- Data is plotted from left (oldest data) to right (newest data). Once the display is filled, data shifts left so that the oldest data point on the left is pushed out to make room for the newest point entering from the right.
- Each bar on the trend represents the average MValv or VCO₂ value over a time period. The time periods are: 1 minute average for the 30 minute trend, 4 minute average for the 2 hour trend, 8 minutes for the 4 hour trend, 16 minutes for the 8 hour trend, and 24 minutes for the 12 hour trend.

Vt/Vd Trend Screen

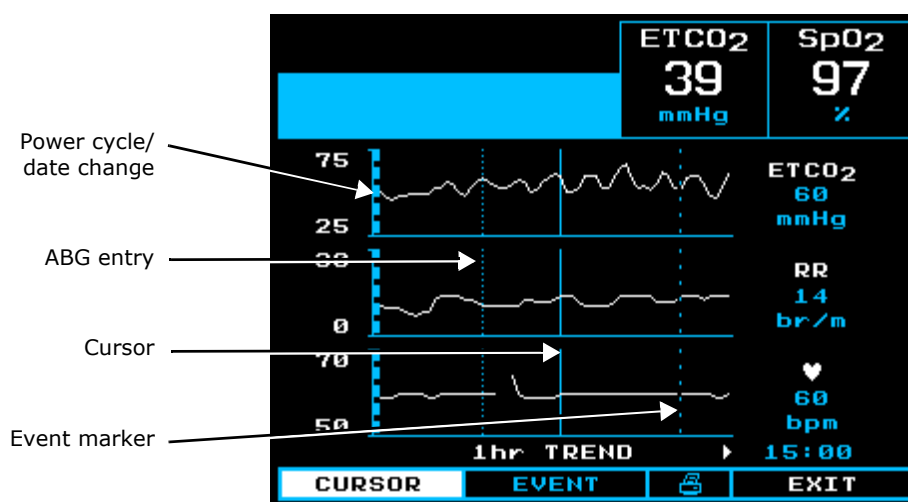
The **Vt/Vd TREND** screen displays trends for mechanical and spontaneous airway deadspace and alveolar tidal volume. Monitoring spontaneous versus mechanical deadspace along with expired tidal volume provides information on continued success or impending failure when weaning a patient off a ventilator.



- While viewing the **Vt/Vd TREND** screen, each push of the knob will advance through the available 30 minute, and 2, 4, 8, and 12 hour trend displays.
- Data is plotted from left (oldest data) to right (newest data). Once the display is filled, data shifts left so that the oldest data point on the left is pushed out to make room for the newest point entering from the right.
- Each bar on the trend represents the average Vtalv or Vdaw value over a time period. The time periods are: 1 minute average for the 30 minute trend, 4 minute average for the 2 hour trend, 8 minutes for the 4 hour trend, 16 minutes for the 8 hour trend, and 24 minutes for the 12 hour trend.

Trend Screen

The **TREND** screen displays two user-selectable numeric parameters and three user-selectable trend graphs. Push then turn the **KNOB** to advance through the displays. Highlight the desired parameter, trend type or trend duration, then select by turning then pressing the **KNOB**.



- Data is plotted from left (oldest data) to right (newest data). Once the display is filled, data shifts left so that the oldest data point on the left is pushed out to make room for the newest point entering from the right.
- To move between newer and less recent trend data on the graph, press and turn the **KNOB** to highlight the **CURSOR**. Press and turn the **KNOB** again to view the desired time period. Arrows will appear below the trend graph, to signify that more data is available by turning the **KNOB**. To view the most recent data, scroll to the right using the **KNOB**, to view less recent data, scroll to the left.
- The time periods are: 1 minute average for the 1 hour trend, 2 minute average for the 2 hour trend, 4 minutes for the 4 hour trend, 8 minutes for the 8 hour trend, 12 minutes for the 12 hour trend and 24 minutes for the 24 hour trend.
- VCO₂, ETCO₂, RR, SpO₂, and pulse rate values will flash if an alert limit is exceeded.
- A wide, dashed, vertical line in the trend is used to denote a power-cycle where the NM3 monitor was turned off and back on or where the time and date setting was changed.
- A narrow, dotted, vertical line in the trend is used to mark the most recent ABG entry.
- A narrow, dashed, vertical line in the **TREND** screen is used as an event marker. To mark an **EVENT** line, press and turn the **KNOB** to highlight **EVENT**, and then press the **KNOB** again. The **EVENT** is marked at the current time.
- The **PRINT** option is dimmed until a compatible printer is connected. See "Analog Output" on page 152 for more information.

Tabular Data Screen

The **TABULAR DATA** screen displays the data collected for all parameters, in one-minute increments, in a table format. Cardiac output-related parameters will not be displayed in Respiratory Mechanics mode when the CO option is not installed.

The parameter displayed in each column will vary, depending on the setting chosen by the user.

- 1 Highlight and select the desired column by turning then pressing the **KNOB**.
- 2 Turn the **KNOB** to advance through all available parameters.
- 3 Press the **KNOB** to accept the displayed parameter; turn to select the next column.

TIME	♥	VdAW	SpO ₂	ETCO ₂	VC0 ₂
14:32	72	75	98	39	458
14:33	72	75	98	39	458
14:34	72	75	98	39	458
14:35	72	74	98	39	456
14:36	72	75	98	39	455
14:37	72	75	98	39	458
14:38	72	75	98	39	460
EXIT					

Time Column

With the **TIME** column selected (flashing), turn the **KNOB** to display parameters collected since the beginning of the monitoring session; the most recent records are at the bottom of the table. Three arrows ↓↓↓ will display at the bottom of the column when more records are available.

Set Alerts Screen

The **SET ALERTS** screen displays the current patient values as well as the LOW and HIGH alert limit settings for various parameters. This screen also allows adjustment of alert limits, audible alert volume, and of the "No Respiration" alert. See "Alerts" on page 99 for details.

SET ALERTS	CURRENT	LOW	HIGH
VC0 ₂ mL/m	454	OFF	OFF
ETCO ₂ (mmHg)	39	1	150
SpO ₂ (%)	97	50	100
RR (br/m)	20	3	150
♥ (bpm)	75	31	249
	AUDIO: 5		NO RESP: 20s
	AUTO LIMITS		EXIT

The **SET ALERTS** screen can only be displayed by pressing the **MENU** key and selecting **SET ALERTS**.

- **CURRENT** - the current patient value for a parameter, shown in real time
- **LOW** and **HIGH** - the values below and above which an alert will be generated. The value will flash when a high or low alert limit is exceeded.
-  (Bell with cross-out) - audible alerts are disabled
-  (Bell) - audible alerts are enabled
- **AUDIO** - set the audible alert volume level
- **AUTO LIMITS** - have the NM3 monitor bracket alerts around current patient values
- **NO RESP** - set the No Respiration alert delay timer

Setup Screen

The **SETUP** screen allows the user to perform certain functions, such as a CO₂ Zero, erase trend data and change items like the waveform trace sweep speed. Once set, the NM3 monitor will use these settings until again changed by the user.

To display the **SETUP** screen:

- 1 Press the **MENU** key to activate **SELECT A SCREEN**. The key's green icon illuminates.
 - Press the key again to return to the previously displayed screen.
- 2 Highlight and then select **SETUP** by turning and then pressing the **KNOB**.
- 3 The **SETUP** screen is displayed.
- 4 Again, turn the **KNOB** to highlight an item and push the **KNOB** to select it.



SETUP	
CO ₂ ZERO NOW	PULSE BEEP: OFF
PURGE NOW	SpO ₂ SENS: NORMAL
SWEEP: MEDIUM	SpO ₂ FASTSAT: OFF
ERASE TRENDS	SET SPON THRESH
INPUT/OUTPUT	
CHOOSE SCREENS	EXIT

Items within the **SETUP** screen are described below:

Label	Settings / Range	Description
CO ₂ ZERO NOW	Start or Cancel (default: Start)	Displays the CO₂ ZERO NOW screen. Place the CAPNOSTAT 5 CO ₂ Sensor onto a clean and dry adapter. Place the adapter in room air and away from all sources of CO ₂ . Select START to begin a CO ₂ Zero or CANCEL to exit the selection and return to the SETUP menu.
PURGE NOW	N/A	The system immediately purges the CO ₂ /Flow Sensor tubing. No messages are displayed. The purge takes approximately 8 seconds. The flow and pressure waveform traces will return to zero during this period.
SWEEP	Slow, Medium, Fast (default: Medium)	Displays the SET SWEEP SPEED screen. Turn the KNOB to select how quickly the CO ₂ , Flow and Pressure waveforms sweep across the display (Plethysmogram is unaffected). Push the KNOB to accept your selection and return to the SETUP menu.
ERASE TRENDS	Yes or No (default: No)	Displays the ERASE STORED TRENDS? screen. Turn the KNOB to select NO (the default setting) or YES . Push the KNOB to accept your selection and return to the SETUP menu.
INPUT/OUTPUT	ANALOG OUT 1-4 ANALOG CAL. RS232-1/RS232-2, SAVE WAVEFORMS, SAVE BREATHS, SAVE TRENDS	Turn the KNOB to select ANALOG OUT 1 through ANALOG OUT 4 , ANALOG CAL. , RS232-1 or RS232-2 . USB data collection to a flash drive is also accessed from this screen. Turn the KNOB to select SAVE WAVEFORMS , SAVE BREATHS , or SAVE TRENDS . Push the KNOB to accept your selection and assign it the desired output parameter. See "External Communications" on page 143 and "USB Data Collection" on page 145 for more information.
CHOOSE SCREENS	N/A	Displays the CHOOSE SCREENS menu. Turn and press the KNOB to select the monitoring screens you want to enable in the active screen set. Turn the KNOB to highlight EXIT and push to return to the SETUP menu. Not available for NICO-Esprit Interface.
PULSE BEEP	OFF and 1-5 (default: OFF)	Displays the SET PULSE BEEP screen. Turn the KNOB to select a volume (1-5 and OFF) for the audible tone to accompany each detected pulse beat. Push the KNOB to accept your selection and return to the SETUP menu.
SPO ₂ SENS	MAX, NORMAL, APOD	Displays the SET SpO₂ SENSITIVITY MODE screen. Turn the KNOB to select MAX , NORMAL , or APOD (Adaptive Probe Off Detection, the default setting). Push the KNOB to accept your selection and return to the SETUP menu.

Label	Settings / Range	Description
SPO ₂ FASTSAT	OFF and ON	Displays the SET SpO₂ FASTSAT MODE screen. FASTSAT enables rapid tracking of arterial oxygen saturation changes by minimizing the averaging. This mode is useful when performing clinical procedures that rely on detecting rapid changes in oxygen saturation. Turn the KNOB to select OFF (the default setting) or ON . Push the KNOB to accept your selection and return to the SETUP menu.
SET SPON THRESH	0-50 cmH ₂ O	Displays the SET SPONTANEOUS THRESHOLD screen. The spontaneous threshold is the airway pressure chosen to help the NM3 monitor differentiate between a spontaneous breath and a mechanical breath. Turn the KNOB to adjust the setting indicated by a dashed line. For optimal setting of the spontaneous threshold, the dashed line should be above the peak of spontaneous breaths and below the peak of mechanical breaths. Push the KNOB to accept your selection and return to the SETUP menu.

Not available for NICO-Esprit Interface.

Cardiac Output mode (Optional)

This section provides an overview of monitoring and setup screens in the optional Cardiac Output mode.

C.O. Trend Screen

The Cardiac Output Trend Screen plots cardiac output over time.

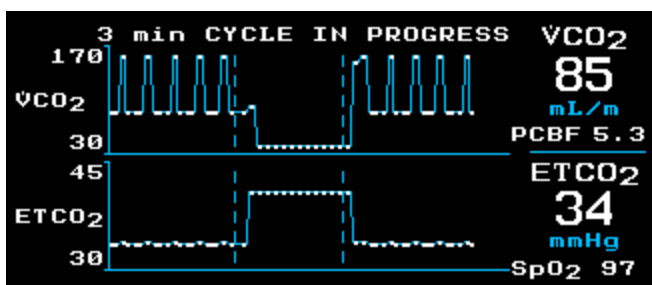


The **C.O. TREND** screen can be displayed, when enabled, by turning the **KNOB** while viewing any monitoring screen, or by pressing the **MENU** key and selecting **C.O. TREND**.

- While viewing the **C.O. TREND** screen, each push of the **KNOB** will advance through the available 2, 4, 8 and 12 hour trend displays.
- Data is plotted from left (oldest data) to right (newest data). Once the display is filled, data shifts left so that the oldest data point on the left is pushed out to make room for the newest point entering from the right.
- The current time is shown in the lower right corner of the display and represents time at the right edge of the screen. See "Setup Screen" on page 90 to set the time.
- Each point on the trend (plotted or blank) represents the average C.O. value over a time period. The time periods are: 1 minute average for the 2 hour trend, 2 minutes for the 4 hour trend, 4 minutes for the 8 hour trend, and 6 minutes for the 12 hour trend.
- C.O. trends are automatically scaled to fit 0-5, 0-10, 0-15 and 0-20 L/min scales.
- A wide, dashed, vertical line in the trend is used to denote a power-cycle where the NM3 monitor was turned off and back on, or where the time and date setting was changed.

Rebreathing Curves Screens

The Rebreathing Curves screen displays the current cardiac output cycle. VCO_2 and ETCO_2 values are plotted over time, and numeric displays for VCO_2 , ETCO_2 , PCBF and SpO_2 .

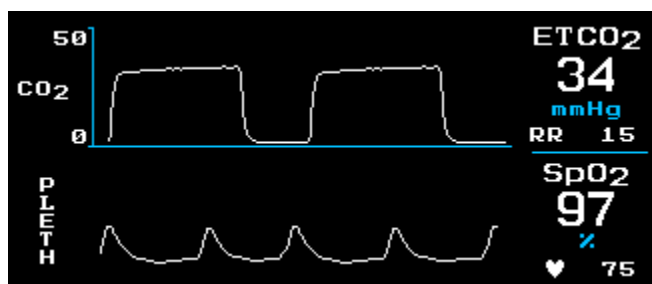


The Rebreathing Curves screen can be displayed, when enabled, by turning the **KNOB** while viewing any monitoring screen, or by pressing the **MENU** key and selecting **REBREATH CURVES**.

- Data is plotted from left (oldest data) to right (newest data).
- Points on the trend (plotted or blank) represent the VCO_2 or ETCO_2 value for each breath.
- The curves are automatically scaled to fit the display area.
- Two one-pixel wide dashed vertical lines are used to divide the curve into its baseline, rebreathing and stabilization phases.
- ETCO_2 and SpO_2 values will flash if an alert limit is exceeded.

CO_2 and SpO_2 Waveform Screen

The CO_2 and SpO_2 Waveform Screen plots the capnogram and plethysmogram signals as well as providing numeric displays of ETCO_2 , Respiratory rate, SpO_2 and pulse rate (♥).

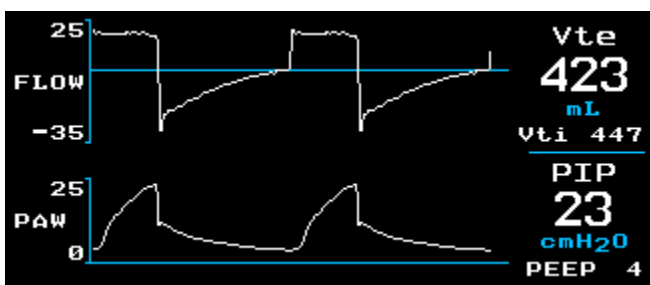


The CO_2/SpO_2 screen can be displayed by turning the **KNOB** while viewing any monitoring screen, or by pressing the **MENU** key and selecting **CO_2/SpO_2** .

- Information is updated in real time and reflects current patient status.
- The capnogram and plethysmogram are automatically scaled.
- The capnogram sweep speed is selectable in the **SETUP** menu.
- ETCO_2 , RR, SpO_2 and pulse rate values will flash if an alert limit is exceeded.
- When INST CO_2 is selected as the ETCO_2 averaging mode, INST CO_2 is displayed in place of ETCO_2 and RR.

Flow and Pressure Waveform Screen

The Flow and Pressure Waveform screen plots the airway flow and pressure signals over time as well as providing numeric displays of Vte, Vti, PIP and PEEP.



The **FLOW/PRESSURE** screen can be displayed, when enabled, by turning the **KNOB** while viewing any monitoring screen, or by pressing the **MENU** key and selecting **FLOW/PRESSURE**.

- Information is updated in real time.
- The airway flow and pressure waveforms are automatically scaled.
- The waveform sweep speed is selectable in the **SETUP** menu.

Numerics Screen

The **NUMERICS** screen display presents several monitored parameters together in one place.

ETCO ₂ 34 mmHg	SpO ₂ 97 %	MValv 5.2 L	PIP 23 cmH ₂ O
RR 15	♥ 75	MV 6.2	MAP 9
VCO ₂ 81 mL/m	Cdyn 27 mL/cmH ₂ O	Raw 15 cm/(L/s)	PEEP 4 cmH ₂ O

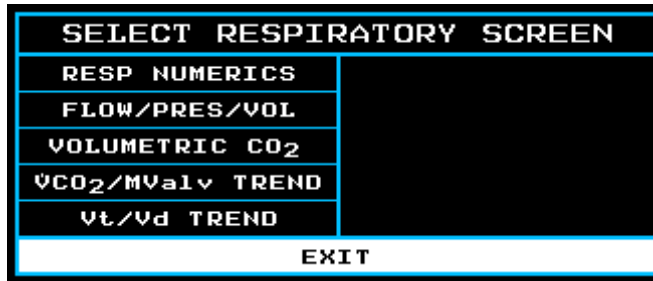
The **NUMERICS** screen can be displayed, when enabled, by turning the **KNOB** while viewing any monitoring screen, or by pressing the **MENU** key and selecting **NUMERICS**.

- Information is updated in real time.
- The PEEP label is replaced with AUTO if Auto-PEEP (Intrinsic-PEEP) is detected.
- ETCO₂, RR, SpO₂ and pulse rate values will flash if an alert limit is exceeded.
- The Cdyn label is replaced with Cst if static lung compliance is detected.
- ETCO₂ will be dashed if INST CO₂ is selected as the ETCO₂ averaging mode.

Respiratory Screens

The NM3 monitor offers five respiratory screens, displaying Respiratory Numerics, Flow Volume and Pressure Volume Loops, a Volumetric CO₂ Waveform, a VCO₂/MValv Trend and the Vt/Vd Trend. Press the **MENU** key and select **RESP SCREENS** from the **SELECT A SCREEN** menu by turning and then pressing the **KNOB**.

From the **SELECT RESPIRATORY SCREEN** menu, highlight and then select the desired screen by turning and then pressing the **KNOB**. Screens can also be displayed, when enabled, by turning the **KNOB** while viewing any monitoring screen (See "KNOB Selectable Respiratory Screens" on page 23). The **SELECT RESPIRATORY SCREEN** menu is not available when the NICO-Esprit interface is active.



Respiratory Numerics The **RESPIRATORY NUMERICS** screen presents several monitored parameters together in one place.

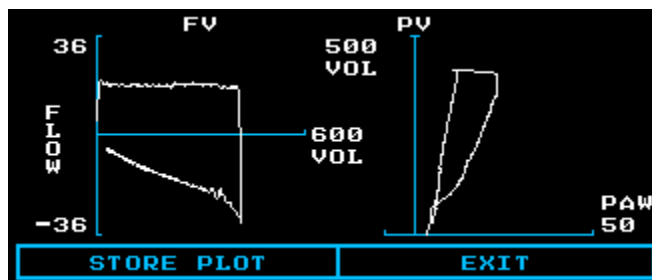
Vte 213 mL	Vtalv 204 mL	PEF 14 L/m	Vd/Vt 0.50 @ 15:29
Vti 245	VdAw 57	Pplat --	VdAlv 100
I:E 1:1.0	NIP -5 cmH ₂ O	Vt/kg 5.6 mL/kg	RSBI 77 br/m/L

The **RESPIRATORY NUMERICS** screen can be displayed, when enabled, by turning the **KNOB** while viewing any monitoring screen.

- Information is updated in real time.
- The Vt/kg label is replaced with Vt/IBW when ideal body weight is calculated.

Flow Volume and Pressure Volume Loops

The Flow Volume and Pressure Volume Loops screen displays a flow versus volume loop and a volume versus peak airway pressure loop.

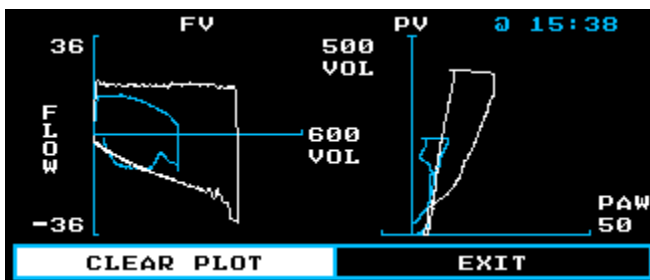


The Flow Volume and Pressure Volume Loops screen can be displayed, when enabled, by turning the **KNOB** while viewing any monitoring screen.

- The flow-volume loop is plotted in a clockwise direction, comparing flow versus volume for a single patient breath and providing information regarding the condition of the airways.
- The pressure-volume loop is plotted in a counter-clockwise direction; the slope from the beginning of inspiration to the end of inspiration depicts compliance while the width of the loop references resistance.
- The curve is automatically scaled to fit the display area.

Store Plot

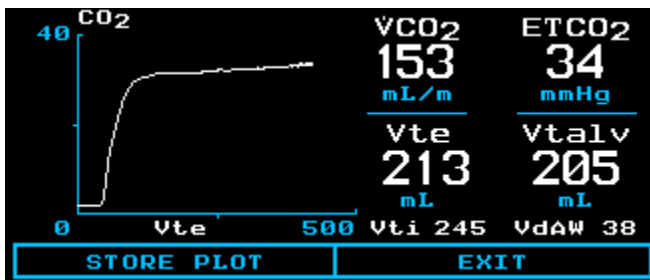
The Store Plot function “freezes” a single breath on the **FLOW/PRES/VOL** screen as a template. Subsequent loops will be drawn over that breath.



- Press the **KNOB** to highlight **STORE PLOT** and again to select the breath.
- Press the **KNOB** to highlight **CLEAR PLOT** and again to erase the selected breath.
- The time stamp above the template wave corresponds to when the plot was set.

Volumetric CO₂ Screen

The **VOLUMETRIC CO₂** screen displays the CO₂ waveform for a single patient breath, as well as providing numeric displays of VCO₂, Vte, ETCO₂, Vtalv, Vti, and VdAw.

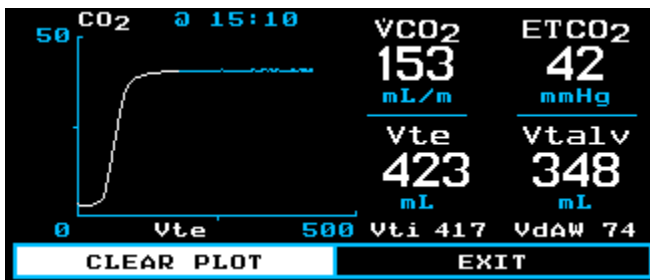


Volumetric CO₂ presents the exhaled concentration of CO₂ versus tidal volume during a single expiration; useful for understanding the ventilation/perfusion relationship. It allows the clinician to detect relative changes in CO₂ production, deadspace, and effective ventilation by observing the shape of the graph.

- The curve is automatically scaled to fit the display area.
- ETCO₂ value will flash if an alert limit is exceeded.
- ETCO₂ will be dashed if INST CO₂ is selected as the ETCO₂ averaging mode.

Store Plot

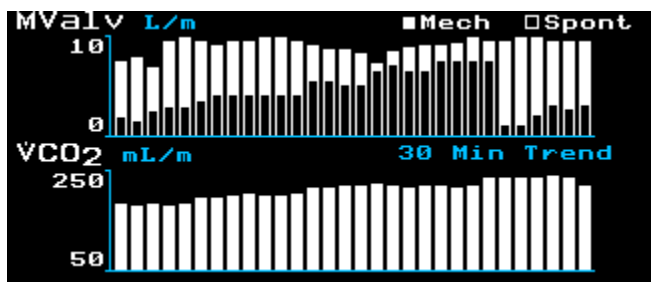
The Store Plot function “freezes” a breath on the **VOLUMETRIC CO₂** screen as a template. Subsequent waveforms will be drawn over that breath for comparison.



- Press the **KNOB** to highlight **STORE PLOT** and again to select the breath.
- Press the **KNOB** to highlight **CLEAR PLOT** and again to erase the selected breath.
- The time stamp above the template wave corresponds to when the plot was set.

VCO₂/MValv Trend

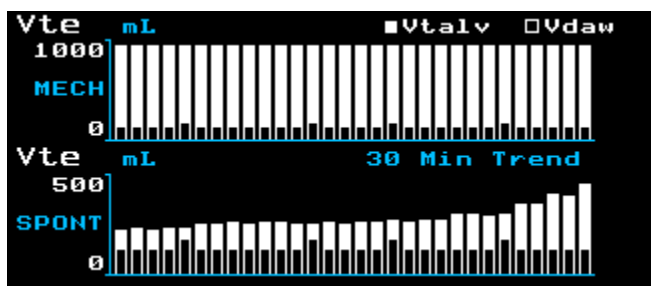
The **VCO₂/MValv Trend** screen displays trends for alveolar minute ventilation and CO₂ elimination. Monitoring spontaneous versus mechanical alveolar ventilation along with CO₂ elimination provides information on continued success or impending failure when weaning a patient off a ventilator.



- While viewing the **VCO₂/MV alv Trend** screen, each push of the knob will advance through the available 30 minute, and 2, 4, 8, and 12 hour trend displays.
- Data is plotted from left (oldest data) to right (newest data). Once the display is filled, data shifts left so that the oldest data point on the left is pushed out to make room for the newest point entering from the right.
- Each bar on the trend represents the average MValv or VCO₂ value over a time period. The time periods are; 1 minute average for the 30 minute trend, 4 minute average for the 2 hour trend, 8 minutes for the 4 hour trend, 16 minutes for the 8 hour trend, and 24 minutes for the 12 hour trend.

Vt/Vd Trend Screen

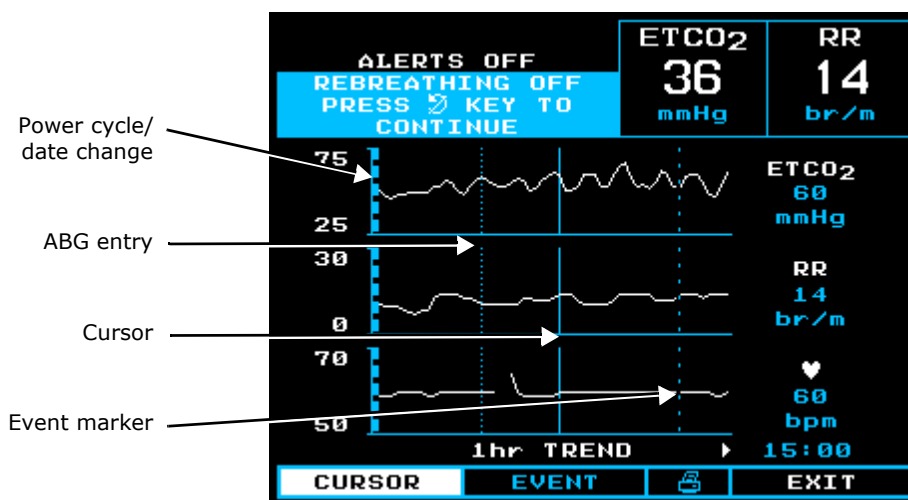
The **Vt/Vd TREND** screen displays trends for mechanical and spontaneous airway deadspace and alveolar tidal volume. Monitoring spontaneous versus mechanical deadspace along with expired tidal volume provides information on continued success or impending failure when weaning a patient off a ventilator.



- While viewing the **Vt/Vd TREND** screen, each push of the knob will advance through the available 30 minute, and 2, 4, 8, and 12 hour trend displays.
- Data is plotted from left (oldest data) to right (newest data). Once the display is filled, data shifts left so that the oldest data point on the left is pushed out to make room for the newest point entering from the right.
- Each bar on the trend represents the average Vt_{alv} or Vd_{aw} value over a time period. The time periods are: 1 minute average for the 30 minute trend, 4 minute average for the 2 hour trend, 8 minutes for the 4 hour trend, 16 minutes for the 8 hour trend, and 24 minutes for the 12 hour trend.

Trend Screen

The **TREND** screen displays two user-selectable numeric parameters and three user-selectable trend graphs. Push then turn the **KNOB** to advance through the displays. Highlight the desired parameter, trend type or trend duration, then select by turning then pressing the **KNOB**.



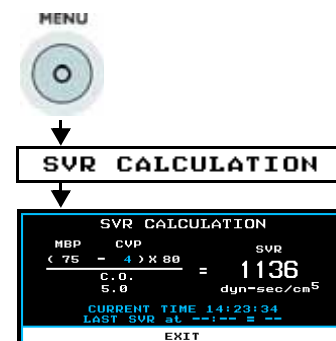
- Data is plotted from left (oldest data) to right (newest data). Once the display is filled, data shifts left so that the oldest data point on the left is pushed out to make room for the newest point entering from the right.
- To move between newer and less recent trend data on the graph, press and turn the **KNOB** to highlight the **CURSOR**. Press and turn the **KNOB** again to view the desired time period. Arrows will appear below the trend graph, to signify that more data is available by turning the **KNOB**. To view the most recent data, scroll to the right using the **KNOB**, to view less recent data, scroll to the left.
- The time periods are: 1 minute average for the 1 hour trend, 2 minute average for the 2 hour trend, 4 minutes for the 4 hour trend, 8 minutes for the 8 hour trend, 12 minutes for the 12 hour trend and 24 minutes for the 24 hour trend.
- CO-a, CO-f, ETCO₂, RR, SpO₂ and pulse rate values will flash if an alert limit is exceeded.
- ETCO₂ will be dashed if INST CO₂ is selected as the ETCO₂ averaging mode.
- A wide, dashed, vertical line in the trend is used to denote a power-cycle where the NM3 monitor was turned off and back on or where the time and date setting was changed.
- A narrow, dotted, vertical line in the trend is used to mark the most recent ABG entry.
- A narrow, dashed, vertical line in the **TREND** screen is used as an event marker. To mark an **EVENT** line, press and turn the **KNOB** to highlight **EVENT**, and then press the **KNOB** again. The **EVENT** is marked at the current time.
- The **PRINT** option is dimmed until a compatible printer is connected. See "Analog Output" on page 152 for more information.

Systemic Vascular Resistance (SVR) Calculation

The **SVR CALCULATION** screen displays the Systemic Vascular Resistance formula and allows for entering the MBP, CVP and C.O. values for calculating the SVR value. The screen also displays the current time and last SVR value. The **SVR CALCULATION** screen serves as a useful tool for understanding systemic vascular resistance.

To calculate the SVR value:

- 1 Press the **MENU** key. The **SELECT A SCREEN** menu appears.
- 2 Highlight and then select **SVR CALCULATION** by turning and then pressing the knob.
- 3 The **SVR CALCULATION** screen is displayed.
- 4 Press then turn the **KNOB** to adjust the setting.
 - **MBP** - Mean Blood Pressure (25 to 300 mmHg).
 - **CVP** - Central Venous Pressure (-9 to 40 mmHg, CVP > MBP).
 - **C.O.** - Cardiac Output (0.5 to 19.9 L/m). This value will correspond to the displayed value (**AVERAGED** or **FAST**) and its value can be manually changed. If manually changed, the value will not be updated to reflect the displayed value.
 - **SVR** - Systemic Vascular Resistance (0 to 9999 dynes sec/cm⁵). Appears as "----" until the **MBP** value is entered.
 - **80** - A constant factor used to convert from Wood to VRU units.
- 5 Press the **KNOB** to accept the displayed value; turn to select the next setting.



$$\frac{(\text{MBP} - \text{CVP}) \times 80}{\text{C.O.}} = \text{SVR} \text{ dyn-sec/cm}^5$$

Tabular Data Screen

The **TABULAR DATA** screen displays the data collected for all parameters, in one-minute increments, in a table format.

The parameter displayed in each column will vary, depending on the setting chosen by the user.

- 1 Highlight and select the desired column by turning then pressing the **KNOB**.
- 2 Turn the **KNOB** to advance through all available parameters.
- 3 Press the **KNOB** to accept the displayed parameter; turn to select the next column.

TIME	CO-a	CI	SpO ₂	ETCO ₂	VC0 ₂
11:41	6.1	2.4	97	35	156
11:42	5.7	2.3	97	35	156
11:43	5.7	2.3	97	35	156
11:44	5.3	2.1	97	39	74
11:45	6.1	2.1	97	34	157
11:46	5.7	2.3	97	35	156
11:47	5.7	2.3	97	35	156
EXIT					

Time Column

With the **TIME** column selected (flashing), turn the **KNOB** to display parameters collected since the beginning of the monitoring session; the most recent records are at the bottom of the table. Three arrows ↓↓↓ will display at the bottom of the column when more records are available.

Set Alerts Screen

The **SET ALERTS** screen displays the current patient values as well as the LOW and HIGH alert limit settings for various parameters. This screen also allows adjustment of alert limits, audible alert volume, and of the "No Respiration" alert. See "Alerts" on page 99 for details.

SET ALERTS	CURRENT	LOW	HIGH
C.O. (L/m)	5.7	4.2	7.1
ETCO ₂ (mmHg)	34	25	42
SpO ₂ (%)	98	93	100
RR (br/m)	15	7	22
♥ (bpm)	72	54	90
	AUDIO: 3	NO RESP: 20s	
	AUTO LIMITS	EXIT	

The **SET ALERTS** screen can only be displayed by pressing the **MENU** key and selecting **SET ALERTS**.

- **CURRENT** - the current patient value for a parameter, shown in real time
- **LOW** and **HIGH** - the values below and above which an alert will be generated. The value will flash when a high or low alert limit is exceeded.
-  (Bell with cross-out) - audible alerts are disabled
-  (Bell) - audible alerts are enabled
- **AUDIO** - set the audible alert volume level
- **AUTO LIMITS** - have the NM3 monitor bracket alerts around current patient values
- **NO RESP** - set the No Respiration alert delay timer

Setup Screen

The **SETUP** screen allows the user to perform certain functions, such as a CO₂ Zero, erase trend data and change items like the waveform trace sweep speed. Once set, the NM3 monitor will use these settings until again changed by the user.

To display the **SETUP** screen:

- 1 Press the **MENU** key to activate **SELECT A SCREEN**. The key's green icon illuminates.
 - Press the key again to return to the previously displayed screen.
- 2 Highlight and then select **SETUP** by turning and then pressing the **KNOB**.
- 3 The **SETUP** screen is displayed.
- 4 Again, turn the **KNOB** to highlight an item and push the **KNOB** to select it.



SETUP		
CO ₂ ZERO NOW	PULSE BEEP:	OFF
PURGE NOW	SpO ₂ SENS:	NORMAL
SWEEP: MEDIUM	SpO ₂ FASTSAT:	OFF
ERASE TRENDS	SET SPON THRESH	
INPUT/OUTPUT	C.O. MODE:	AVERAGE
CHOOSE SCREENS	EXIT	

Items within the **SETUP** screen are described below:

Label	Settings/Range	Description
CO ₂ ZERO NOW	Start or Cancel (default: Start)	Displays the CO₂ ZERO NOW screen. Place the CAPNOSTAT 5 CO ₂ Sensor onto a clean and dry adapter. Place the adapter in room air and away from all sources of CO ₂ . Select START to begin a CO ₂ Zero or CANCEL to exit the selection and return to the SETUP menu.
PURGE NOW	n/a	The system immediately purges the Cardiac Output Sensor tubing. No messages are displayed. The purge takes approximately 8 seconds. The flow and pressure waveform traces will return to zero during this period.

Label	Settings / Range	Description
SWEEP	Slow, Medium, Fast (default: Medium)	Displays the SET SWEEP SPEED screen. Turn the KNOB to select how quickly the CO ₂ , Flow and Pressure waveforms sweep across the display (Plethysmogram is unaffected). Push the KNOB to accept your selection and return to the SETUP menu.
ERASE TRENDS	Yes or No (default: No)	Displays the ERASE STORED TRENDS? screen. Turn the KNOB to select NO (the default setting) or YES . Push the KNOB to accept your selection and return to the SETUP menu.
INPUT/OUTPUT	ANALOG OUT 1-4 ANALOG CAL. RS232-1/RS232-2, SAVE WAVEFORMS, SAVE BREATHS, SAVE TRENDS	Turn the KNOB to select ANALOG OUT 1 through ANALOG OUT 4 , ANALOG CAL. , RS232-1 or RS232-2 . USB data collection to a flash drive is also accessed from this screen. Turn the KNOB to select SAVE WAVEFORMS , SAVE BREATHS , or SAVE TRENDS . Push the KNOB to accept your selection and assign it the desired output parameter. See "External Communications" on page 143 and "USB Data Collection" on page 145 for more information.
CHOOSE SCREENS	N/A	Displays the CHOOSE SCREENS menu. Turn and press the KNOB to select the monitoring screens you want to enable in the active screen set. Turn the KNOB to highlight EXIT and push to return to the SETUP menu. Not available for NICO-Esprit Interface.
PULSE BEEP	OFF and 1-5 (default: OFF)	Displays the SET PULSE BEEP screen. Turn the KNOB to select a volume (1-5 and OFF) for the audible tone to accompany each detected pulse beat. Push the KNOB to accept your selection and return to the SETUP menu.
SPO ₂ SENS	MAX, NORMAL, APOD	Displays the SET SpO₂ SENSITIVITY MODE screen. Turn the KNOB to select MAX , NORMAL , or APOD (Adaptive Probe Off Detection, the default setting). Push the KNOB to accept your selection and return to the SETUP menu.
SPO ₂ FASTSAT	OFF and ON	Displays the SET SpO₂ FASTSAT MODE screen. FASTSAT enables rapid tracking of arterial oxygen saturation changes by minimizing the averaging. This mode is useful when performing clinical procedures that rely on detecting rapid changes in oxygen saturation. Turn the KNOB to select OFF (the default setting) or ON . Push the KNOB to accept your selection and return to the SETUP menu.
SET SPON THRESH	0-50 cmH ₂ O	Displays the SET SPONTANEOUS THRESHOLD screen. The spontaneous threshold is the airway pressure chosen to differentiate between a spontaneous (patient-initiated) breath and a mechanical (ventilator) breath. Turn the KNOB to adjust the pressure setting indicated by a dashed line. For optimal setting of the spontaneous threshold, the dashed line should be above the peak of spontaneous breaths and below the peak of mechanical breaths. Push the KNOB to accept your selection and return to the SETUP menu. Not available for NICO-Esprit Interface.
C.O. MODE	AVERAGE, FAST or MANUAL	Displays the SET C.O. MODE screen. Turn the KNOB to select AVERAGE (CO-a, CObar is displayed), FAST (CO-f, FAST MODE is displayed) or MANUAL (MANUAL MODE is displayed). Push the KNOB to accept your selection and return to the SETUP menu.

VentAssist Screens

See the VentAssist chapter on page 59.

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Notes on Patient Monitoring

Automatic Purging

A double lumen connecting line (tubing) connects the Cardiac Output and CO₂/Flow sensors to the NM3 monitor. The monitor includes an automatic and manual purge feature which provides a flow rate of room air to keep the sensor tubing free from water condensation and patient secretions. This feature is available for the adult, pediatric, and neonatal modes.

Adult mode

The system automatically purges the sensor tubing every 10 minutes or less, depending on system conditions. In adult mode, the system will purge both sides of the line, one at a time, during each purge cycle. The higher the pressure, the more frequent the purging. This action anticipates increased moisture migration into the sensor tubing due to the increase in circuit pressure.



CAUTION

To avoid the effects of excessive moisture in the measurement circuit, insert the CO₂/Flow sensor or Cardiac Output Sensor in the ventilator circuit with the tubes upright. Improper placement may result in erroneous data. Excessive moisture in the sensor tubing may affect the accuracy of the measurements.

Neonatal and Pediatric modes

The automatic purge cycle used in the neonatal or pediatric mode is fixed at every 3 minutes regardless of circuit pressure. Only one side of the sensor tubing will be purged during each purge cycle. The purge will only occur during the exhalation portion of the ventilator cycle, regardless of exhalation time.

Unlike the adult purge mode, the neonatal or pediatric purge mode does not use the full force of the internal pump, but rather pressurizes an internal reservoir which is used for the purge. This minimizes the pressure delivered to the ventilator circuit, but does deliver a sufficient pressure to purge the sensor tubing.

Manual Purging

Occasionally, purging may be required in between the automatic purge cycle. The manual purge may be used as often as needed, and may be used at all times **except** when a rebreathing cycle is in progress or a very low battery condition exists. During these conditions, automatic and manual purging is not allowed.

To manually purge:

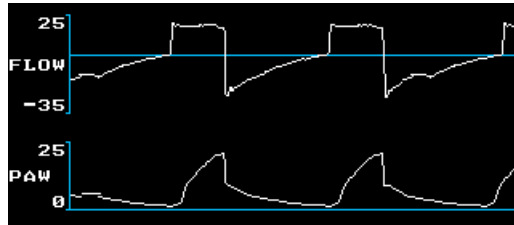
- 1 Press the **MENU** key.
- 2 Turn and press the **KNOB** to select **SETUP**.
- 3 Turn and press the **KNOB** to select **PURGE NOW**.
- 4 The purge cycle will begin:

In adult mode, the system will purge both sides of the line, one at a time, during each purge cycle.

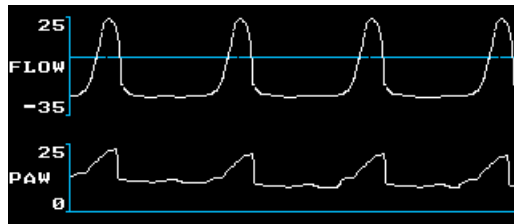
In pediatric and neonatal modes, only one side of the sensor tubing will be purged during each purge cycle. The purge is synchronized to the exhalation phase of the ventilator cycle and will not exceed exhalation time.

A purge can also be initiated upon request if the flow waveform appears as though the lines are partially occluded (see example below) and the purge did not initiate automatically. To initiate a purge, see Manual Purging, above.

Normal



Occluded



NOTE

If the purge does not sufficiently clear the flow tubing lines, the flow sensor should be changed.

Configuration Menu

Simultaneously press and hold the **MENU** and **DATA ENTRY** keys for 3 seconds to access the Configuration Menu. Turn and press the **KNOB** to adjust and accept settings.

Parameter	Range / Units	Description	Factory Default
CO ₂ UNITS	mmHg, %, kPa	Select the desired units for the capnogram, PeCO ₂ , ETCO ₂ and PaCO ₂ values.	mmHg
PRESSURE UNITS	cmH ₂ O, hPa	Select the desired units to display pressure parameters.	cmH ₂ O
ETCO ₂ AVG	10 sec, 20 sec, 1 Breath, INST CO ₂	Select the interval from which the displayed value of end tidal CO ₂ (ETCO ₂) is calculated.	10 sec
VCO ₂ AVG	1 min, 3 min, 5 min, 10 min, 8 Breath, 1 Breath	Select the averaging time for the displayed value of CO ₂ elimination (VCO ₂).	1 min
SpO ₂ AVG	2-4 sec, 4-6 sec, 8 sec, 10 sec, 12 sec, 14 sec, 16 sec	Select the averaging time for the displayed value of SpO ₂ , using the Masimo SET algorithm.	8 sec
DISPLAY MODE	C.O., PCBF, CI	Select the parameter to be displayed as the large number in the upper right of the screen.	C.O.
SET TIME & DATE	hh:mm dd mmm yyyy	Turn the KNOB to highlight the portion of the time/date to change. Push the KNOB to select that item—it begins to flash. Turn the KNOB to adjust the flashing item, and when correctly set, push the KNOB again to accept the value. Repeat for the other time/date entries. Finally, turn the KNOB to highlight EXIT and push the KNOB to return to the CONFIGURATION menu.	

Installation Settings Menu

The Installation Settings Menu should be accessed only by qualified service personnel. Please see the NM3 Service Manual, PN 1051673 for more information.

Gas Compensation Effects on CO₂

Accuracy of the displayed CO₂ value is dependent on correct gas compensation settings. The table below demonstrates the effect on CO₂ of improper gas compensation settings.

Compensation Settings		Inspired (INSP) Gas Used					
O ₂ % Setting	Balance Gas	21 % O ₂ (bal N ₂)	40 % O ₂ (bal N ₂)	40 % O ₂ (bal N ₂ O)	60 % O ₂ (bal N ₂)	80 % O ₂ (bal He)	100 % O ₂
21	N ₂	0.0%	-1.6%	5.8%	-3.3%	-8.5%	-6.7%
40	N ₂	1.6%	0.0%	7.3%	-1.7%	-6.8%	-5.0%
60	N ₂	3.2%	1.6%	8.8%	0.0%	-5.0%	-3.3%
100	N ₂	6.3%	4.8%	11.7%	3.2%	-1.7%	0.0%
100	N ₂ O	7.7%	6.2%	13.1%	4.7%	-0.1%	1.5%
60	N ₂ O	-1.1%	-2.7%	4.8%	-4.5%	-9.7%	-7.9%
40	N ₂ O	-6.2%	-7.9%	0.0%	-9.7%	-15.2%	-13.3%
21	N ₂ O	-11.5%	-13.3%	-5.0%	-15.2%	-20.9%	-19.0%
21	He	10.3%	8.8%	15.5%	7.3%	2.7%	4.3%
80	He	7.8%	6.3%	13.2%	4.8%	0.0%	1.6%

Negative values reflect an underestimation of displayed CO₂ (display reads low).
Positive values reflect an overestimation of displayed CO₂ (display reads high).

Gas Compensation Effects on Flow

Error in the measured flow with incorrect airway gas conditions:

If the airway gas conditions are not properly set in the NM3 monitor, the measured flow will be incorrect. The measurement error is dependent on the airway gas conditions, flow rate and barometric pressure. The table below is an example of the magnitude of error to expect. The first line in the table is the baseline gas conditions at a flow rate of 40 L/min and a barometric pressure of 760 mmHg. Each of the successive lines in the table is the error to expect in the flow measurement with the specified gas condition if the airway gas conditions were improperly set to the baseline conditions in the first line.

Compensation Settings			Gas Compensation Effects on Flow					
Insp O ₂	Balance Gas	Insp Agent	N ₂	N ₂ O	Helium	Temperature	Humidity	Measurement Error
21	N ₂	0	79	0	0	35° C	50%	---
60	N ₂	0	40	0	0	35° C	50%	- 2.5 %
40	N ₂ O	0	0	60	0	35° C	50%	- 14.9 %
60	N ₂	5	35	0	0	35° C	50%	- 19.6 %
30	He	0	0	0	70	35° C	50%	+ 56.7 %
21	N ₂	0	79	0	0	35° C	0%	- 0.5 %

Compensation Settings			Gas Compensation Effects on Flow					
Insp O ₂	Balance Gas	Insp Agent	N ₂	N ₂ O	Helium	Temperature	Humidity	Measurement Error
21	N ₂	0	79	0	0	35° C	100%	+ 0.4 %
21	N ₂	0	79	0	0	35° C	50%	- 2.1 %

NOTE: Set the gas compensation on module startup, and whenever gas comp delivered to the patient is changed.

NOTE: Gas compensations must sum to 100%; if less than 100%, the percent of balance gas is assumed according to selected gas compensations.

Reference Handbooks

For a discussion on waveform interpretations, refer to the Philips Respironics Reference Handbooks on capnography, respiratory mechanics, and cardiac output. Contact Philips Respironics Customer Service or your local sales representative for more information.

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Alerts

This section describes NM3 monitor alerts.

Alert Priorities

The NM3 monitor prioritizes alert notifications. This prioritization allows an alert condition for which an immediate user response is required to take precedence over a lesser alert for which a less urgent response is acceptable. Alert notifications may include on-screen display messages and audible tones, and may result from violations of parameter limit settings, or from monitor or sensor related error conditions.

High Priority Alert

- Action: Immediate user response
- Audible: 3 consecutive tones, a pause, then and 2 more tones. Repeated every 5 seconds (if enabled)
- Visual: the **SILENCE** key indicator flashes red, and a screen message is displayed
- Example: **LOW C.O.**



Medium Priority Alert

- Action: Prompt user response
- Audible: 2 consecutive tones, repeated every 10 seconds (if enabled)
- Visual: Screen message
- Example: **HIGH RESP**

Low priority Alert

- Action: User awareness
- Audible: a single tone, repeated every 15 seconds (if enabled)
- Visual: Screen message
- Example: **WAIT FOR RR<60 br/m**

Status Messages

- Action: Informational, no urgency
- Audible: none
- Visual: Screen message
- Example: **ALERTS OFF**

Alert Bar

The Alert Bar on the upper right corner of the monitor is divided into two sections, left and right:



- The left side of the Alert Bar indicates current Audio Alarm status: Unlit, audio alarms enabled; Yellow, 2-minute silence; Red, audio alarms muted.
- The right side illuminates in accordance with the current alarm priority: Unlit, no alarms active; Steady blue, low priority alarm active; Blinking yellow, medium priority alarm active; Blinking red, high priority alarm active.

Responding to Alert Audio

The **SILENCE** key is used to silence or mute audible alerts. The Silence feature operates in two modes; a temporary "2 Minute Silence" mode and an "Audio Mute" mode.



- 2 Minute Silence — Press and release to activate or deactivate the two minute silence. The key's icon illuminates amber when the generation of audible alerts will be paused for two minutes, after which the icon turns off and any active audible alert will sound.
- Audio Mute — Press and hold for two seconds to disable audible alerts. The **SILENCE** key icon and the left side of the Alert Bar illuminate red to indicate audible alarms are disabled. Audio alerts () will be deactivated () in the **SET ALERTS** screen.

Parameter Limit Alerts

The NM3 monitor allows for the establishment of high and low limit alerts for Cardiac Output (C.O., Cardiac Output mode only), CO₂ elimination (VCO₂, Respiratory Mechanics mode only, adult and pediatric only), End-Tidal Carbon Dioxide (ETCO₂), Oxygen Saturation (SpO₂), Respiratory Rate (RR), and Pulse Rate () (Pulse Rate). These alerts provide a visual (and audible, if desired) indication to the user that a physiological parameter has violated the limit settings.

Respiratory Mechanics mode			Cardiac Output mode		
Parameter	Range	Units	Parameter	Range	Units
ETCO ₂	OFF, 1 - 150	mmHg	C.O.	OFF, 0.1 - 19.9	L/m
	OFF, 0.1 - 19.9	kPa	ETCO ₂	OFF, 1 - 150	mmHg
	OFF, 0.1 - 19.9	%		OFF, 0.1 - 19.9	kPa
SpO ₂	OFF, 50 - 100	%		OFF, 0.1 - 19.9	%
RR	OFF, 3 - 150	br/min	SpO ₂	OFF, 50 - 100	%
 (Pulse Rate)	OFF, 31 - 249	bpm	RR	OFF, 3 - 150	br/min
VCO ₂	OFF, 20 - 999	mL/m	 (Pulse Rate)	OFF, 31 - 249	bpm

- All alert limit values are retained each time the monitor is turned off.
- There is a 10-second delay from the time an alert is detected, until audible and visual alarms are generated.
- The user can select individual limit values or have the monitor automatically assign limit values based on current patient values with the **AUTO LIMITS** feature.
- Audible alarms can be enabled or disabled.
- Limits cannot be adjusted to provide less than a 5 digit separation between the high and low limit values.

NOTE

The message **ALERTS OFF** will appear if the monitor is powered up with all alert limits set to **OFF**.

To cancel the **ALERTS OFF** message, adjust any individual limit value to activate the alert.

Audible alerts are automatically re-enabled at power-up.

Respiratory Rate Alert is not available for NICO-Esprit Interface. For more information, refer to the "Monitor Interface to V200 or Esprit" on page 155.

Default Alert Limits

Note: Limits alerts for safety parameters are activated by default.

Parameter	High	Low
ETCO ₂	55 mmHg	25 mmHg
SpO ₂	100%	85%
RR	120 br/min	5 br/min
☑ (Pulse Rate)	150 bpm	40 bpm

ETCO₂ limits are converted to appropriate units (kPa or %). Note: defaults for VCO₂ and C.O. are OFF. To set alerts to defaults, press and hold the knob during power up. This will reset all settings to factory defaults.

View Alert Settings

To view the existing alert settings:

- 1 Press the **MENU** key. The **SELECT A SCREEN** menu appears.
- 2 Highlight and then select **SET ALERTS** by turning and then pressing the knob.
- 3 The **SET ALERTS** screen is displayed.

Adjust Alert Limits

To adjust **LOW** or **HIGH** alert limit values:

- 1 Display the **SET ALERTS** screen. (Press **MENU**, then select **SET ALERTS**.)
- 2 Highlight and then select the **LOW** or **HIGH** limit you wish to adjust.
- 3 Turn the knob to adjust the limit, then press the knob to accept the displayed value.
- 4 If desired, enable the audio for the alerts. (See below.)

Enable/Disable Audible Alerts

To enable or disable the audible alert tone(s):

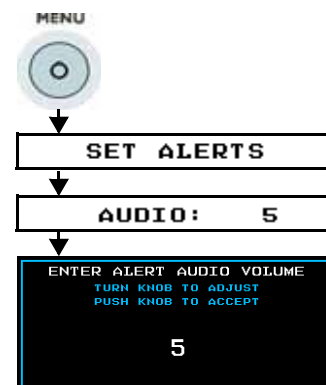
- 1 Display the **SET ALERTS** screen. (Press **MENU**, then select **SET ALERTS** or when the **SILENCE** key is illuminated amber, press and hold for two seconds.)
- 2 Highlight the bell icon.
- 3 Press the knob to switch between audio enabled (🔔) and disabled (🔕) settings.

To disable audible alert tones, press and hold the **SILENCE** key for two seconds.

Adjust Alert Audio Volume

To adjust the Alert Audio Volume:

- 1 Display the **SET ALERTS** screen. (Press **MENU**, then select **SET ALERTS**.)
- 2 Highlight and then select **AUDIO** by turning and then pressing the knob.
- 3 Turn the knob to adjust the volume setting.
 - Volume ranges from 1 to 5 (loudest).
 - A representative tone sounds at each setting.
- 4 Press the knob to accept the displayed value.



NOTE

Make sure that the audible alert volume is not set too low to be heard over ambient noise levels.

Auto Alerts

Alert limits for **LOW** and **HIGH** VCO₂, ETCO₂, SpO₂, RR, Pulse rate and C.O. can be set automatically for alerts which have been enabled. Alert limits are bracketed about the current patient values. For parameter limit ranges, see page 100. Auto Alerts do not affect the status of the audible alert bell icon.

How Auto Alert Limits are Calculated:

Parameter	High limit	Low limit
VCO ₂	Current VCO ₂ reading plus 25%	Current VCO ₂ reading minus 25%
ETCO ₂	If current ETCO ₂ is less than or equal to 40 mmHg, the HIGH limit is ETCO ₂ plus 25%. If current ETCO ₂ is greater than 40 mmHg, the HIGH limit is ETCO ₂ plus 10 mmHg.	If current ETCO ₂ is less than or equal to 40 mmHg, the LOW limit is ETCO ₂ minus 25%. If current ETCO ₂ is greater than 40 mmHg, the LOW limit is ETCO ₂ minus 10 mmHg.
SpO ₂	Current SpO ₂ reading plus 5 %SpO ₂	Current SpO ₂ reading minus 5 %SpO ₂
RR	If current RR is less than or equal to 15 br/min, the HIGH limit is RR plus 7. If current RR is greater than 15 br/min but less than or equal to 40 br/min, the HIGH limit is RR plus 10. If current RR is greater than 40 br/min, the HIGH limit is RR plus 15.	If current RR is less than or equal to 15 br/min, the LOW limit is 50% of the current rate. If current RR is greater than 15 br/min but less than or equal to 40 br/min, the LOW limit is RR minus 7. If current RR is greater than 40 br/min, the LOW limit is RR minus 10.
☑ (Pulse Rate)	Current Pulse Rate plus 25%	Current Pulse Rate minus 25%
C.O. (optional)	Current C.O. reading plus 25%	Current C.O. reading minus 25%

No Respiration Alert

The NM3 monitor incorporates a No Respiration Alert (**NO RESP**). Once the monitor detects respiration, any loss of that signal starts the "No Resp" timer. A visual (and audible, if desired) alert occurs if the monitor does not detect a respiratory rate signal before the timer reaches its user set limit (20 seconds by default). A "No Respiration" alert is a physiological alarm condition.



Note that "No Respiration" is detected by the NM3 monitor from both the CO₂ waveforms (primary) and flow waveforms.

If a No Respiration alert occurs:

- The message **NO RESP: x:xx** is displayed.
- The counter shows the elapsed time (minutes:seconds) since the alert occurred. After 10 minutes, the counter is no longer displayed, but the message NO RESP remains.
- Press the **SILENCE** key to silence the alert.

To clear a No Respiration alert:

- Remove the CAPNOSTAT 5 CO₂ Sensor from the airway adapter/flow sensor.
- Disconnect the CAPNOSTAT 5 CO₂ Sensor from the monitor.
- Disconnect the CO₂/Flow or Cardiac Output Sensor from the monitor.



WARNING

The NM3 monitor is not intended to be used as an apnea monitor.

The use of the NM3 monitor is restricted to one patient at a time. Do not connect the sensors to multiple patients simultaneously.

Adjust the No Resp. Alert Limit

To adjust the No Respiration Alert Limit:

- 1 Display the **SET ALERTS** screen. (Press **MENU**, then select **SET ALERTS**.)
- 2 Highlight and then select **NO RESP** by turning and then pressing the knob.
- 3 Turn the knob to adjust the limit setting.
 - The limit timer is selectable from 10-60 seconds.
- 4 Press the knob to accept the displayed value.

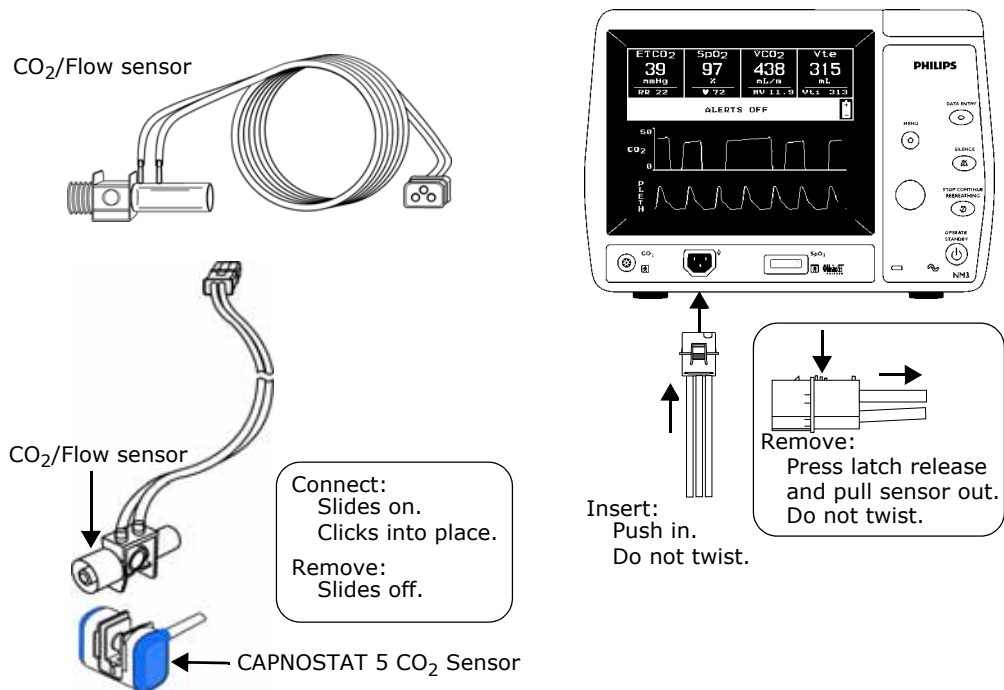


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CO₂/Flow Sensors

This section details the use of combined CO₂/Flow sensors with the NM3 monitor. This section also explains how to connect a sensor to the monitor, and how to apply the sensor to the patient. The NM3 monitor automatically operates in Respiratory Mechanics mode whenever a CO₂/Flow sensor is connected to the monitor. Cardiac output (optional) and associated parameters are not available in Respiratory Mechanics mode.

Use only CO₂/Flow sensors that are compatible with the NM3 monitor. See "Accessories" on page 181. Sensors may be connected and removed with the monitor off or on.



WARNING

The Disposable CO₂/Flow sensor is intended for SINGLE PATIENT USE ONLY ②.

Re-use, including disassembly, cleaning, disinfecting, sterilizing, and other efforts made in an attempt to re-use a CO₂/Flow sensor, may compromise system performance and may cause a potential patient hazard. Performance is not guaranteed if reused.

Before use, verify the sensor is physically intact, with no broken or damaged parts. Do not use a broken or damaged sensor or one with wet, contaminated, or corroded connectors.

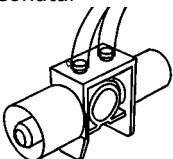
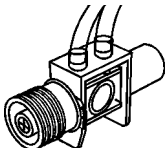
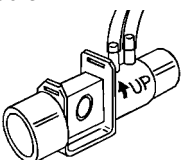
Do not allow the CO₂/Flow sensor to remain in the ventilator circuit when not connected to the NM3 monitor. A ventilator circuit leak will occur.

**CAUTION**

Connect only CO₂/Flow sensors, Catalog Number 9765-00, 9766-00, or 9767-00, to the NM3 monitor. Do not connect any other sensor in its place.

Choosing a CO₂/Flow Sensor

Select the appropriate combined CO₂/Flow sensor based on endotracheal tube size (ETT), volume and flow rate. Ranges for each sensor are listed in the chart below:

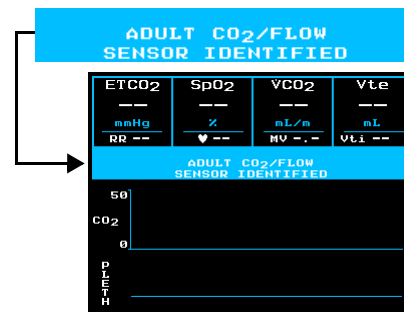
Sensor	Range				
	ETT (mm)	Volume (ml)	Flow	Pressure drop	Deadspace
Neonatal 	2.5-4.0	1-100	0.25-25 LPM 4-417 ml/sec	3.1 cmH ₂ O at 10 LPM	Less than 1 ml
Catalog No. 9765-00					
Pediatric 	3.5-6.0	30-400	0.5-100 LPM 8-1600 ml/sec	2.1 cmH ₂ O at 30 LPM	Less than 4 ml
Catalog No. 9766-00					
Adult 	>5.5	200-3000	2.0-180 LPM 33-3000 ml/sec	2.1 cmH ₂ O at 60 LPM	Less than 8.5 ml
Catalog No. 9767-00					

Connecting a CO₂/Flow Sensor

To connect a CO₂/Flow sensor:

- 1 Remove a new CO₂/Flow sensor from its package. Open and inspect the sensor. Do not use if damaged.
- 2 Insert the connector on the CO₂/Flow sensor into NM3 monitor's front panel. Verify a **CO₂/FLOW SENSOR IDENTIFIED** message is briefly displayed.
- 3 Attach the CAPNOSTAT 5 CO₂ Sensor or LoFlo C5 CO₂ Sensor to the CO₂/Flow sensor. The sensor will "click" when properly seated.

When a CO₂/Flow sensor is replaced, the message **CHECK/CHANGE AIRWAY ADAPTER** may appear, this means a CO₂ zero is required to help the monitor "learn" the specific optical characteristics of the CO₂/Flow sensor in use.



To perform an Adapter Zero:

- 1 Press the **MENU** key.
- 2 Highlight and then select **SETUP** by rotating and then pressing the knob.
- 3 Highlight and then select **CO2 ZERO NOW**.
- 4 Place the CAPNOSTAT 5 CO₂ Sensor onto a clean and dry CO₂/Flow sensor (adapter) that is exposed to room air and away from all sources of CO₂.
- 5 Highlight and then select **START**.
 - **ADAPTER ZERO IN PROGRESS PLEASE WAIT** is displayed during the 10 seconds needed to complete the process. Upon completion, **ADAPTER ZERO SUCCESSFUL** is briefly displayed before the monitor automatically returns to the **SETUP** screen.
- 6 Highlight and then select **EXIT** to return to the previous monitoring screen.



CAUTION

Position the airway adapter with its windows in a vertical and NOT a horizontal position: this helps keep patient secretions from “pooling” on the windows.

To prevent “rain-out” and moisture from draining into the airway adapter, do NOT place the airway adapter in a gravity dependent position.

Periodically check the CO₂/Flow sensor and tubing for excessive moisture or secretion build up.

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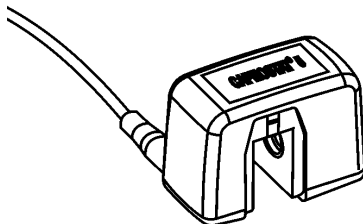
CAPNOSTAT 5 CO₂ Sensors

This section provides information regarding the CAPNOSTAT 5 CO₂ Sensor and its use with CO₂/Flow Sensors, Cardiac Output Sensors and the NM3 monitor. The CAPNOSTAT 5 CO₂ Sensor is a rugged, solid-state, mainstream sensor. It is factory calibrated and does *not* require further calibration during use. See also, "LoFlo C5 CO₂ Sensor" on page 115.

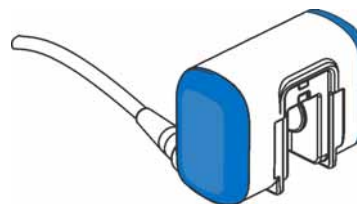
The CAPNOSTAT sensor is currently available in two versions: the CAPNOSTAT 5 and the RoHS-compliant CAPNOSTAT 5. Although both sensors function and measure the same way, there are some notable differences.

How to identify your sensor:

- CAPNOSTAT 5 sensors are solid gray.
- The adapter opening is keyed, permitting one-way insertion of the adapter.

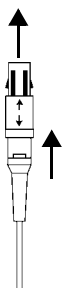
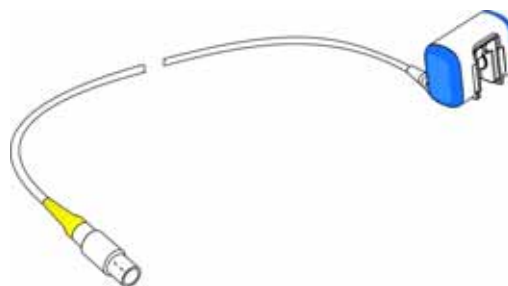
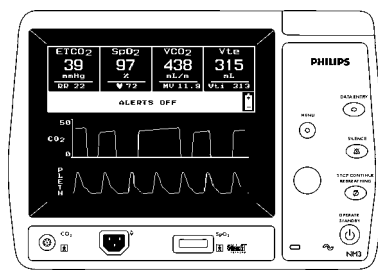


- CAPNOSTAT 5 RoHS sensors are gray and blue.
- The adapter opening is not keyed, permitting two-way insertion of the adapter.

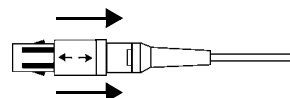


Connecting the CAPNOSTAT 5 CO₂ Sensor

The CAPNOSTAT 5 CO₂ Sensor may be connected to and removed from the NM3 monitor while the monitor is turned off or on.



Insert:
Push in.
Do not twist.



Remove:

Place thumb and index finger on either side of the CO₂ sensor connector sleeve and pull back.

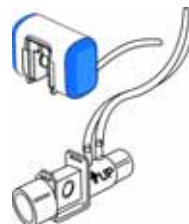
Sensor will disengage from the receptacle.

Do not twist. Do not remove sensor by pulling on the cable.



Cardiac Output Sensor

Pediatric/adult
CO₂/Flow sensor



Pediatric or neonatal
CO₂/Flow sensor



Connect:
Slides on.
Clicks into place.

Remove:
Slides off.



WARNING

Before use, verify the sensor is physically intact, with no broken/frayed wires or damaged parts. Do not use a broken or damaged sensor or one with wet, contaminated, or corroded connectors.



CAUTION

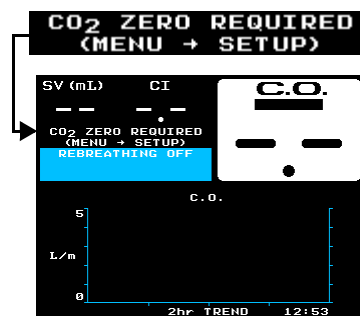
Connect only a CAPNOSTAT 5 CO₂ Sensor, PN 1015928, or the LoFlo C5 CO₂ Sensor, PN 1022054, to the NM3 monitor. Do not use other CAPNOSTAT 5 CO₂ Sensor types or other CO₂ sensors.

CAPNOSTAT 5 CO₂ Sensor Adapter Zero

An “Adapter Zero” is a process that lets the NM3 monitor “learn” the special characteristics of a particular CAPNOSTAT 5 CO₂ Sensor. It is necessary only when the NM3 monitor requests an Adapter Zero.

Such a request may occur the first time a particular CAPNOSTAT 5 CO₂ Sensor is connected to a particular NM3 monitor—as is the case the first time you power up your NM3 monitor and CAPNOSTAT 5 CO₂ Sensor—or if the monitor detects some change in the CAPNOSTAT 5 CO₂ Sensor.

Once an Adapter Zero is performed, the NM3 monitor can be turned on and off and the CAPNOSTAT 5 CO₂ Sensor can be unplugged and reconnected without having to Adapter Zero the sensor. However, if a second CAPNOSTAT 5 CO₂ Sensor is connected in place of the first, the Adapter Zero process may need to be performed on the new sensor—and if at a later time, the first CAPNOSTAT 5 CO₂ Sensor is reconnected, it too may have to be put through the Adapter Zero process.



Adapter Zero

To perform an Adapter Zero:

- 1 Press the **MENU** key.
- 2 Highlight and then select **SETUP** by rotating and then pressing the knob.
- 3 Highlight and then select **CO₂ ZERO NOW**.
- 4 Place the CAPNOSTAT 5 CO₂ Sensor onto a clean and dry airway adapter that is exposed to room air, and away from all sources of CO₂. A Cardiac Output Sensor, CO₂/Flow sensor or Single Patient Use Adult Airway Adapter may be used for the zero procedure.
- 5 Highlight and then select **START**.
 - **ADAPTER ZERO IN PROGRESS PLEASE WAIT** is displayed during the time needed to complete the process. Upon completion, **ADAPTER ZERO SUCCESSFUL** is briefly displayed before the monitor automatically returns to the **SETUP** screen.

NOTE

For best results, the CAPNOSTAT 5 CO₂ Sensor should be connected to the NM3 monitor and placed on the adapter for 2 minutes before performing the Adapter Zero procedure.

- 6 Highlight and then select **EXIT** to return to the previous monitoring screen.

CAPNOSTAT 5 CO₂ Sensor - Cable Management



CAUTION

- DO NOT apply tension to the CAPNOSTAT 5 CO₂ Sensor cable.
- DO NOT pinch, pull, or stretch the CAPNOSTAT 5 CO₂ Sensor cable during cleaning, handling or use.
- DO NOT coil the CAPNOSTAT 5 CO₂ Sensor cable tighter than 3 inches [7.6 cm] in diameter.
- DO NOT bend the CAPNOSTAT 5 CO₂ Sensor cable tighter than 3 inches [7.6 cm] in diameter.
- DO NOT wind the CAPNOSTAT 5 CO₂ Sensor cable on any object smaller than 3 inches [7.6 cm] in diameter.
- DO NOT wind the CAPNOSTAT 5 CO₂ Sensor cable around the sensor head.
- DO NOT fold the CAPNOSTAT 5 CO₂ Sensor cable upon itself.
- DO NOT wind the CAPNOSTAT 5 CO₂ Sensor cable opposite the natural cable coil.
- DO NOT apply tension to any CO₂/Flow sensor, sensor cable, or pneumatic tubing.

The following illustrations demonstrate proper cable management for the CAPNOSTAT 5 CO₂ Sensor cable.

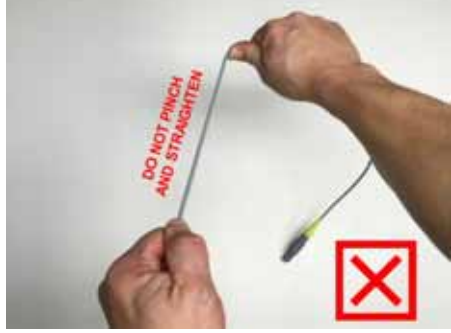


Always coil the cable *in the direction of the natural cable coil*, greater than 3 inches [7.6 cm] in diameter.



Cable ties are acceptable and will help maintain the diameter of the cable during storage. This illustration shows the use of two cable ties to avoid kinking the cable at the connector and sensor strain reliefs.

 A photograph of a grey sensor cable with a blue connector and a yellow-tipped plug. A blue cable tie is wrapped around the cable. A green double-headed arrow indicates the distance between the tie and the connector, labeled "> 3 INCHES [7.6 CM]". There are two green checkmarks: one in the top right corner and one in the bottom right corner.	This illustration shows the user of one cable tie. Position the cable tie to avoid sharp kinks at the connector and sensor strain reliefs.
 A photograph of a coiled grey sensor cable with a blue connector. The cable is wrapped around the blue connector. A red 'X' is in the bottom right corner.	DO NOT wrap the sensor cable around and inside the airway adapter channel on the sensor.
 A photograph of a coiled grey sensor cable with a blue connector. The cable is wrapped around the blue connector. A red 'X' is in the bottom right corner.	DO NOT wrap the sensor cable around the sensor head.
 A photograph of a grey sensor cable with a blue connector labeled "CAPNOSTAT 5". The cable is bent sharply. A red double-headed arrow indicates the bend radius, labeled "< 3 INCHES [7.6 CM]". A red 'X' is in the bottom right corner.	DO NOT kink the sensor cable, or bend the sensor cable less than 3 inches [7.6 cm] in diameter.

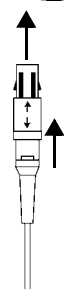
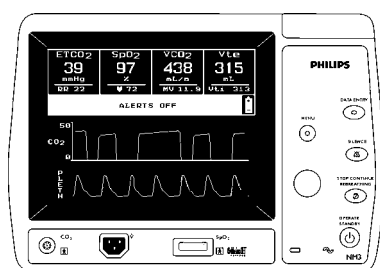
	DO NOT coil the sensor cable less than 3 inches [7.6 cm] in diameter, for example around your hand.
	DO NOT coil and band the cable, as this will kink the cable and bend the cable smaller than 3 inches [7.6 cm] in diameter.
	DO NOT coil the sensor cable around a ventilator circuit support arm, a monitor stand, or any object less than 3 inches [7.6 cm] in diameter.
	DO NOT pinch and straighten the cable during cleaning, handling, or use.

LoFlo C5 CO₂ Sensor

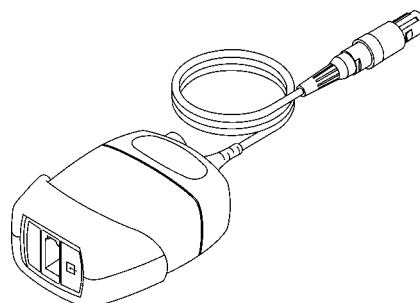
This section provides information regarding the LoFlo C5 CO₂ Sensor and its use with sampling adapters and kits. The LoFlo C5 CO₂ Sensor is a rugged, solid-state, sidestream sensor. It is factory-calibrated and does *not* require further calibration during use.

Connecting the LoFlo C5 CO₂ Sensor

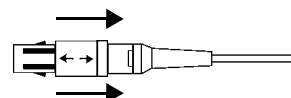
The LoFlo C5 CO₂ Sensor may be connected to and removed from the NM3 monitor while the monitor is turned off or on.



Insert:
Push in.
Do not twist.



C5 LoFlo CO₂ Sensor



Remove:

Place thumb and index finger on either side of the CO₂ sensor connector sleeve and pull back.

Sensor will disengage from the receptacle.

Do not twist. Do not remove sensor by pulling on the cable.



WARNING

Before use, verify the sensor is physically intact, with no broken/frayed wires or damaged parts. Do not use a broken or damaged sensor or one with wet, contaminated, or corroded connectors.



CAUTION

Connect only a CAPNOSTAT 5 CO₂ Sensor, PN 1015928, or the C5 LoFlo CO₂ Sensor, PN 1022054, to the NM3 monitor. Do not use other CAPNOSTAT 5 CO₂ Sensor types or other CO₂ sensors.

LoFlo C5 CO₂ Sampling Kits

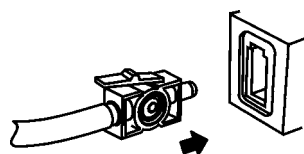
Choosing the Sidestream Cannula Kit

For monitoring CO₂, select a sidestream cannula kit that is appropriate for the patient size and application.

Sidestream Cannula Kit	Application	Part number
Cannula with Nafion tubing, LoFlo CO ₂ , nasal, infant	Intended for use when monitoring non-intubated infant/neonatal patients.	3468INH-00

Sidestream Cannula Kit	Application	Part number
Cannula with Nafion tubing, LoFlo CO ₂ , nasal, pediatric	Intended for use when monitoring non-intubated pediatric patients.	3468PEH-00
Cannula with Nafion tubing, LoFlo CO ₂ , nasal, adult	Intended for use when monitoring non-intubated adult patients.	3468ADH-00
Nasal CO ₂ Sampling Cannula, Adult	Intended for use when monitoring non-intubated adult patients.	3468ADU-00
Nasal CO ₂ Sampling Cannula, Pediatric	Intended for use when monitoring non-intubated pediatric patients.	3468PED-00
Nasal CO ₂ Sampling Cannula, Infant/Neonatal	Intended for use when monitoring non-intubated infant/neonatal patients.	3468INF-00
Cannula with Nafion tubing, LoFlo CO ₂ /O ₂ , nasal, infant	Intended for use when monitoring non-intubated infant/neonatal patients	3469INH-00
Cannula with Nafion tubing, LoFlo CO ₂ /O ₂ , nasal, pediatric	Intended for use when monitoring non-intubated pediatric patients.	3469PEH-00
Cannula with Nafion tubing, LoFlo CO ₂ /O ₂ , nasal, adult	Intended for use when monitoring non-intubated adult patients.	3469ADH-00
Nasal CO ₂ Sampling Cannula w/ O ₂ Delivery, Adult	Intended for use when monitoring non-intubated adult patients.	3469ADU-00
Nasal CO ₂ Sampling Cannula w/ O ₂ Delivery, Pediatric	Intended for use when monitoring non-intubated pediatric patients.	3469PED-00
Nasal CO ₂ Sampling Cannula w/ O ₂ Delivery, Infant/Neonatal	Intended for use when monitoring non-intubated infant/neonatal patients	3469INF-00
Cannula with Nafion tubing, LoFlo CO ₂ ,nasal/oral, pediatric	Intended for use when monitoring non-intubated pediatric patients.	3470PEH-00
Cannula with Nafion tubing, LoFlo CO ₂ ,nasal/oral, adult	Intended for use when monitoring non-intubated adult patients.	3470ADH-00
Oral/Nasal CO ₂ Sampling Cannula, Adult	Intended for use when monitoring non-intubated adult patients.	3470ADU-00
Oral/Nasal CO ₂ Sampling Cannula, Pediatric	Intended for use when monitoring non-intubated pediatric patients.	3470PED-00
Cannula with Nafion tubing, LoFlo CO ₂ /O ₂ , nasal/oral, pediatric	Intended for use when monitoring non-intubated pediatric patients.	3471PEH-00
Cannula with Nafion tubing, LoFlo CO ₂ /O ₂ , nasal/oral, adult	Intended for use when monitoring non-intubated adult patients.	3471ADH-00
Oral/Nasal CO ₂ Sampling Cannula w/ O ₂ Delivery, Adult	Intended for use when monitoring non-intubated adult patients.	3471ADU-00
Oral/Nasal CO ₂ Sampling Cannula w/ O ₂ Delivery, Pediatric	Intended for use when monitoring non-intubated pediatric patients.	3471PED-00
Airway Adapter Sampling Kit, Adult/Pediatric	Intended for use when monitoring non-intubated adult/pediatric patients.	3472ADU-00
Airway Adapter Sampling Kit, Infant/Neonatal	Intended for use when monitoring non-intubated infant/neonatal patients.	3472INF-00
Airway Adapter Sampling Kit w/ dehumidification tubing, Adult/Pediatric	Intended for use when monitoring intubated adult/pediatric patients.	3473ADU-00
Airway Adapter Sampling Kit w/ dehumidification tubing, Infant/Neonatal	Intended for use when monitoring non-intubated infant/neonatal patients.	3473INF-00

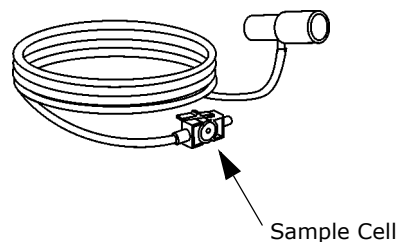
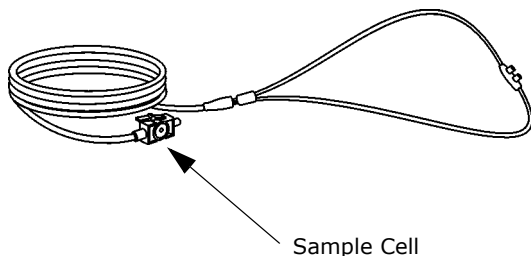
Connecting the LoFlo Sample Kit



The sample cell of the sampling kit must be inserted into the sample cell receptacle of the LoFlo C5 CO₂ Sensor as shown in the figure below. A “click” will be heard when the sample cell is properly inserted.

Inserting the sample cell into the receptacle automatically starts the sampling pump. Removal of the sample cell turns the sample pump off.

To remove the sampling kit sample cell from the sample cell receptacle, press down on the locking tab and pull the sample cell from the sample cell receptacle.



Check CO₂ Sampling Line Message

The sample flow rate of the LoFlo C5 is continually monitored. If the flow rate falls outside the nominal operating range and continues for 15 seconds, the message **CHECK CO₂ SAMPLING LINE** will be sent to the host monitor. The pump will shut off after 2 minutes if the condition that caused this change is not corrected.

Clearing the message:

- When the **CHECK CO₂ SAMPLING LINE** message is displayed, the user should inspect the sample line kit to verify that none of the conditions described above are present. Replace with a new sample kit if needed.
- If the user removes the sample cell for inspection and then reinserts the sample cell without correcting the condition, the **CHECK CO₂ SAMPLING LINE** message will reappear.
- The user should verify that the exhaust port is not obstructed or blocked. If tubing is connected to the exhaust port, the user should also inspect the tubing for any crimping or pinching.
- The **CHECK CO₂ SAMPLING LINE** message will clear and the sample pump will not be turned off if the condition that caused the flow rate change is corrected within 2 minutes.
- The **CHECK CO₂ SAMPLING LINE** message will clear if the sample cell is removed or if the system is reset.
- DO NOT pinch and straighten the cable during cleaning, handling, or use.

LoFlo C5 CO₂ Sensor - Cable Management



CAUTION

- DO NOT apply tension to the LoFlo 5 CO₂ Module cable.
- DO NOT pinch, pull, or stretch the LoFlo 5 CO₂ Module cable during cleaning, handling or use.
- DO NOT coil the LoFlo 5 CO₂ Module cable tighter than 3 inches [7.6 cm] in diameter.
- DO NOT bend the LoFlo 5 CO₂ Module cable tighter than 3 inches [7.6 cm] in diameter.
- DO NOT wind the LoFlo 5 CO₂ Module cable on any object smaller than 3 inches [7.6 cm] in diameter.
- DO NOT wind the LoFlo CO₂ Module cable around the Module in any manner.
- DO NOT wind the LoFlo CO₂ Module cable around the optional Module Mounting Bracket in any manner.
- DO NOT fold the LoFlo CO₂ Module cable upon itself.
- DO NOT wind the LoFlo CO₂ Module cable opposite the natural cable coil.

The following illustrations demonstrate proper cable management for the LoFlo C5 Sensor cable.



Always coil the cable in the direction of the natural cable coil, greater than 3 inches [7.6 cm] in diameter.

Using cable ties is acceptable and will aid in maintaining the diameter of the cable during storage. Position the cable tie to avoid sharp kinks at the connector and sensor strain reliefs.



DO NOT kink the module cable, or bend the sensor cable less than 3 inches [7.6 cm] in diameter.

	DO NOT coil and band the cable, as this will kink the cable and bend the cable smaller than 3 inches [7.6 cm] in diameter.
	DO NOT wrap the cable around the module in any manner.
	DO NOT wrap the cable around the module in any manner.
	DO NOT fold the cable over on itself.

	DO NOT wrap the cable around the optional pole mount in any manner.
	DO NOT wrap the cable around the optional pole mount in any manner.
	DO NOT coil the module cable around a ventilator circuit support arm, monitor stand, or any object less than 3 inches [7.6 cm] in diameter.
	DO NOT pinch and straighten the cable during cleaning, handling, or use.

Masimo SET[®] SpO₂

This section explains how to connect a Masimo SET[®] oximetry sensor to the monitor, and how to apply the sensor to the patient. The NM3 monitor uses the pulse oximeter portion of the monitor to enhance shunt corrections as well as to monitor patient oxygenation levels.



CAUTION

Use only a Masimo oximetry sensor for SpO₂ measurements. Other oxygen transducers (sensors) may cause improper SpO₂ performance.

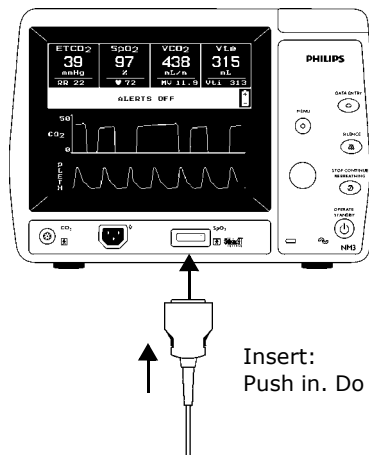


NOTE

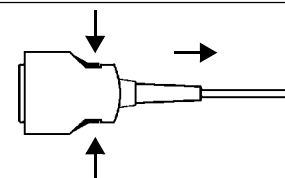
Before use, carefully read the Masimo[®] sensor directions for use.

Oximetry Sensor

The sensor may be connected and removed with the monitor off or on.



Insert:
Push in. Do not twist.



Remove:

Place thumb and index finger on the gray buttons on either side of the patient cable connector.

Press firmly on the gray buttons and pull to remove the sensor.



WARNING

Before applying to the patient, verify the sensor is physically intact, with no broken/frayed wires or damaged parts. Do not use a broken or damaged sensor or one with wet, contaminated, or corroded connectors, exposed electrical contacts, or exposed optical components.

After applying to the patient, inspect the site often for adequate circulation—at least once every four hours. Do not wrap so tightly that circulation is restricted. Note the patient's physiological condition. For example, burn patients may be more sensitive to heat and pressure and require more frequent site checks.



CAUTION

Overstretching the pulse oximeter finger sensor can damage the sensor and potentially affect pulse oximeter readings. Do not stretch the finger sensor open beyond the limit for which it was designed. Overstretching can be prevented: avoid opening the sensor by any means other than squeezing the grips; *DO NOT* force the sensor onto large objects such as a bedrail.

Sensor Procedure

- 1 Select a sensor that is appropriate for the patient and the clinical application.

Use only Masimo sensors, which are available from Masimo Corporation and Philips Respironics. See "Accessories" on page 181.



CAUTION

Use only a Masimo oximetry sensor for SpO₂ measurements. Other oxygen transducers (sensors) may cause improper SpO₂ performance.

- 2 Following the directions for use supplied with the sensor, apply the sensor to the patient. A Masimo sensor is shown below:



- 3 If needed, plug the sensor cable into the patient (extension) cable.



- 4 SpO₂ monitoring is ready for use. The SpO₂ and pulse rate values are displayed on a variety of monitoring screens.

SpO₂ Sensitivity

Normal: Recommended for typical monitoring purposes in care areas where patients are observed frequently.

Adaptive Probe Off Detection (APOD): Default setting. Recommended when there is a high probability of the sensor being detected, and in care areas where patients are not observed frequently. In this mode, the pulse oximeter provides enhanced protection against erroneous pulse rate and SpO₂ values when the sensor becomes inadvertently detached from the monitoring site.

Maximum Sensitivity (MAX): Recommended for patients with low perfusion or when the pulse oximeter frequently displays the **LOW PERFUSION** message. This mode is designed to monitor weak signals due to decreased perfusion. When using this mode, performance of the "sensor off" detection may be compromised, leading to the potential of false readings. It is recommended that other vital sign monitoring be employed to guard against lack of **SENSOR OFF** patient detection.

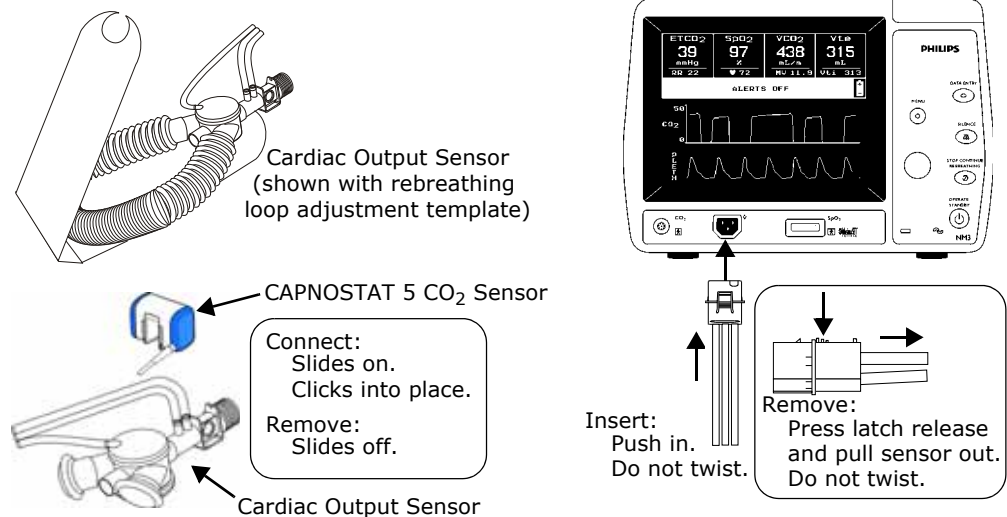
Cardiac Output Sensor

This section provides information regarding Disposable Cardiac Output Sensors and their use with the CAPNOSTAT 5 CO₂ Sensor and the NM3 monitor. Cardiac Output mode is a software option.

Disposable Cardiac Output Sensors

A Cardiac Output Sensor incorporates a rebreathing valve, rebreathing loop (an adjustable rebreathing volume) and an adult CO₂/Flow Sensor. It is disposable and intended for Single Patient Use only. The Cardiac Output Sensor is not for pediatric use.

A Cardiac Output Sensor may be connected to and removed from the NM3 monitor while the monitor is turned off or on.



WARNING

The Disposable Cardiac Output Sensor is intended for SINGLE PATIENT USE ONLY (X).

Re-use, including disassembly, cleaning, disinfecting, sterilizing, and other efforts made in an attempt to re-use a Cardiac Output Sensor, may compromise system performance and may cause a potential patient hazard. Performance is not guaranteed if reused.

Before use, verify the sensor is physically intact, with no broken or damaged parts. Do not use a broken or damaged sensor or one with wet, contaminated, or corroded connectors.

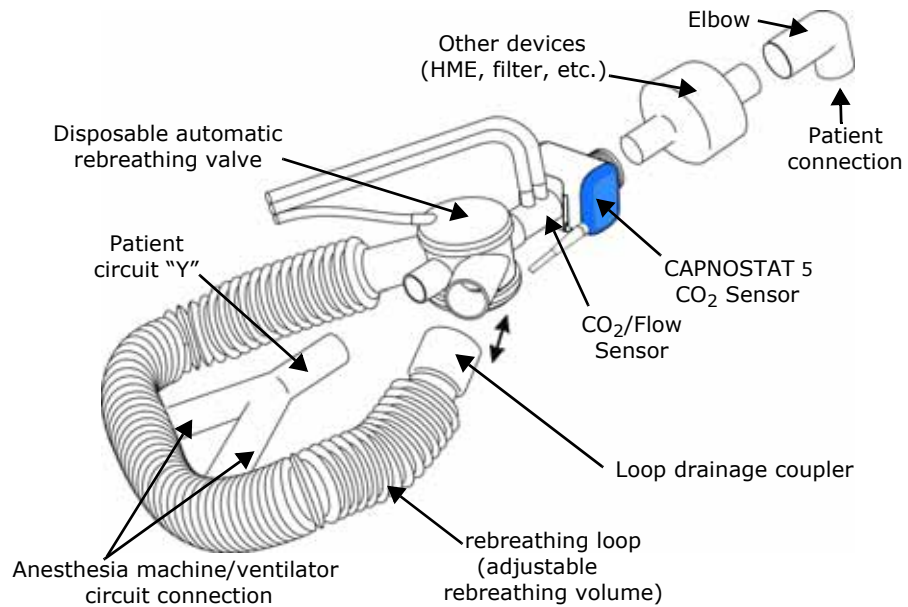
Do not allow the Cardiac Output Sensor to remain in the ventilator circuit when not connected to the NM3 monitor. A ventilator circuit leak will occur.



CAUTION

Connect only a Cardiac Output Sensor, Catalog No. 8950-00, 8951-00 or 8952-00 to the NM3 monitor. Do not connect any other sensor in place of a Cardiac Output Sensor.

Cardiac Output Sensor and CAPNOSTAT 5 CO₂ Sensor



Choosing a Cardiac Output Sensor size

Choose a Cardiac Output Sensor size based on the tidal volume ranges listed below.

Sensor Size	Tidal Volume Range	Part Number
Small	For use with ventilator set tidal volumes of 200-500 ml	8950-00
Standard	For use with ventilator set tidal volumes of 400-1000 ml	8951-00
Large	For use with ventilator set tidal volumes of 750-1500 ml	8952-00



WARNING

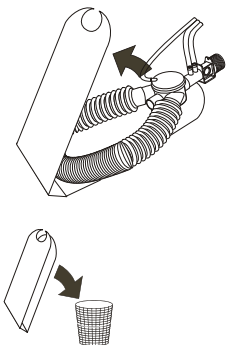
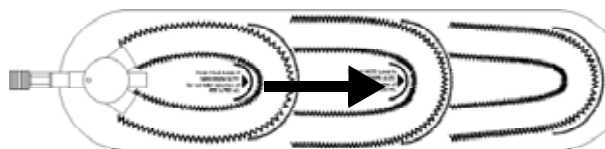
The Cardiac Output Sensor is not for pediatric use.

The Cardiac Output Sensor increases airway deadspace by 35 cc (minimum). At low tidal volumes, compensatory changes to ventilation protocol should be considered.

Connecting a Cardiac Output Sensor

To connect a Cardiac Output Sensor into the ventilator circuit:

- 1 Remove a new Cardiac Output Sensor and loop adjustment template from its package. Open and inspect the sensor. Do not use if damaged.
- 2 Using the Initial Adjustment Template as a guide, adjust the rebreathing loop to match the ventilator's tidal volume setting. Discard the template.

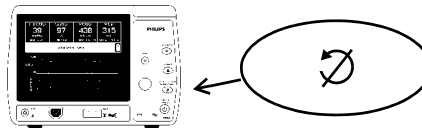


3 Insert the connector on the Cardiac Output Sensor into the monitor's front panel. Verify a **C.O. SENSOR IDENTIFIED** message is briefly displayed.

4 Attach the CAPNOSTAT 5 CO₂ Sensor to the Cardiac Output Sensor and connect the Cardiac Output Sensor to ventilator circuit. For optimal results, place the Cardiac Output Sensor into the ventilator circuit between the endotracheal tube and the ventilator circuit wye.

- Place other devices (HME, filters, etc.) between Cardiac Output Sensor and the patient connection.
- Placement of a sidestream gas analyzer sampling port between the Cardiac Output Sensor and the patient connection may reduce accuracy at low tidal volumes.
- Sidestream or mainstream gas analyzers placed between the Cardiac Output Sensor and the patient circuit "Y" may report diluted readings during the rebreathing phase of the cycle.
- Place the sensor so that the triple lumen tubing lines exit from the top of the sensor (to help keep them clear and dry).
- Excess moisture may be removed by temporarily opening the circuit at the loop drainage coupler. Securely reconnect the coupler.

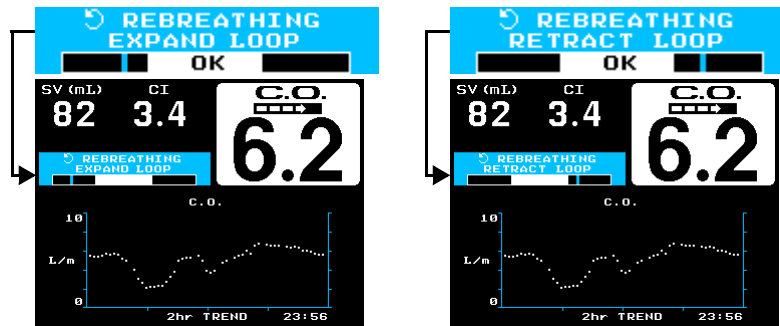
5 To begin monitoring, press the **STOP / CONTINUE REBREATHING** key.



- To enhance accuracy, enter the respiratory gas composition and the arterial blood gas values whenever possible (by pressing the **DATA ENTRY** key).

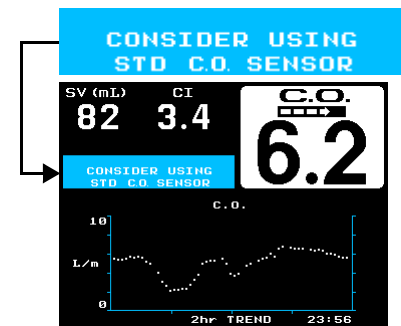
Status Messages

While monitoring, if the **EXPAND** or **RETRACT LOOP** message appears, adjust the loop 3-6 inches (8-15 cm) or until the message is removed.



If the **EXPAND** or **RETRACT LOOP** message appears for more than three consecutive rebreathing cycles, and resizing the rebreathing loop was not effective, the NM3 monitor will suggest a different sized sensor, with a larger or smaller loop, to correct the condition.

- Small Cardiac Output Sensor: the monitor displays **CONSIDER USING STD C.O. SENSOR** when ventilator set tidal volume is greater than 500 ml.
- Standard Cardiac Output Sensor: the monitor displays **CONSIDER USING SMALL C.O. SENSOR** when ventilator set tidal volume is less than 300 ml.
- Standard Cardiac Output Sensor: the monitor displays **CONSIDER USING LARGE C.O. SENSOR** when ventilator set tidal volume is greater than 1000 ml.
- Large Cardiac Output Sensor: the monitor displays **CONSIDER USING STD C.O. SENSOR** when ventilator set tidal volume is less than 1000 ml.



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Messages

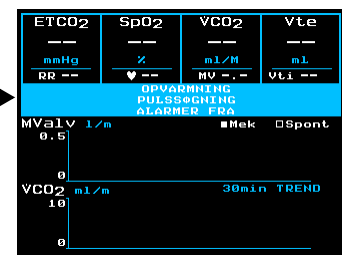
Message Areas - Respiratory Mechanics mode

For Cardiac Output messages, see page 133.

In Respiratory Mechanics mode, the monitor uses one General Message Area to convey information to the user.

General Message Area

CO₂ SENSOR WARM UP
PULSE SEARCH
ALERTS OFF



General Message Area

The General Message Area in Respiratory Mechanics mode displays all messages, including system status, alert, and error conditions. It may be blank or:

- contain 1, 2 or 3 single-line messages
- contain 1 multi-line message
- contain 1 multi-line message and 1 single-line message

ALERTS OFF

CO₂ SENSOR WARM UP
PULSE SEARCH
ALERTS OFF

ADULT CO₂/FLOW
SENSOR IDENTIFIED

ADULT CO₂/FLOW
SENSOR IDENTIFIED
PULSE SEARCH

The General Message Area messages are listed below, in alphabetical order.

(Alert Class: H-High Priority, M-Medium Priority, L-Low Priority, S-Status Message. See "Alert Priorities" on page 99 for details.)

General Message Area	Message Description	Alert Class
ADULT CO ₂ /FLOW SENSOR IDENTIFIED	An adult size CO ₂ /Flow sensor was just connected to the NM3 monitor.	S
ALERTS OFF	Displayed as a reminder that all user selectable alert limits are OFF. To cancel the message, adjust any alert limit value to a value other than OFF.	S
⚠ BATTERY VERY LOW CONNECT A/C POWER	The NM3 monitor is operating on battery, and the battery is very low. Connect A/C MAINS power to prevent the monitor from powering off. NOTE: Begins as a status message (Alert Class S). When approximately 10 minutes of battery life remains, the message will become an alarm (Alert Class H). Audible and visual alarms will occur.	H

General Message Area	Message Description	Alert Class
△ CABLE FAILURE REPLACE SpO ₂ CABLE	The pulse oximeter patient cable is faulty. Replace the cable and contact qualified service personnel.	M
CANNOT SAVE TO USB	Displayed when data files cannot be created on the USB device. This can be caused by a file system error on the USB drive.	S
△ CHECK / CHANGE AIRWAY ADAPTER	A change in the CO₂ adapter portion of the CO₂/Flow sensor is detected. ETCO₂ and other volumetric CO₂ parameters are not displayed. Possible causes: • CAPNOSTAT 5 CO₂ sensor or LoFlo C5 CO₂ Sensor is off adapter. • High level of moisture and/or secretions in the adapter. Replace if needed. NOTE: If this condition is not corrected within X seconds, audible and visual alarms will occur. X = the NO RESP timeout value (select MENU then SET ALERTS). Acknowledge by pressing the SILENCE key. The message remains, but the audio alert is stopped.	M
△ CHECK CO ₂ SAMPLING LINE	A change in the sidestream sampling line or the sample cell has been detected. Possible causes: • Water or patient contaminate has entered the sample tubing • The sample tubing is crimped, cut, split or damaged • The exhaust port of the LoFlo C5 Sensor is obstructed Inspect the sample line kit and replace if necessary. Verify the exhaust port on the LoFlo C5 Sensor is not obstructed. Re-inserting the sample cell may be necessary to clear the error condition if present for more than two minutes. For more information, see "Check CO₂ Sampling Line Message" on page 117. Acknowledge by pressing the SILENCE key. The message remains, but the audio alert is stopped.	M
CHECK COMMUNICATION	The monitor is unable to establish RS-232 communication with the V200 or Esprit ventilator. Displayed in NICO-Esprit Interface mode only.	S
CO ₂ SENSOR WARM UP	The CAPNOSTAT 5 CO ₂ sensor or LoFlo C5 CO ₂ sensor is not at proper operating temperature yet.	S
CO ₂ ZERO REQUIRED (MENU → SETUP)	The CAPNOSTAT 5 CO₂ sensor needs to be zeroed. Press the MENU key, then select SETUP, then CO2 ZERO NOW, and follow the instructions on the screen. For more information, see "Adapter Zero" on page 111.	S
△ C.O. OPTION NOT INSTALLED	The optional Cardiac Output feature is not installed. Call Philips Respironics Customer Service for more information.	M
DATA SAVED TO USB	The system is done saving data to the USB device.	S
DEMO MODE	The monitor is in demonstration mode and is not displaying patient data (all data is simulated). To exit demo mode, turn the monitor off, then back on.	S
GAS COMP ON	The INSP O2 is greater than or equal to 60%, or the INSP AGENT is greater than 0.0%, or N ₂ O or He is selected as the BALANCE gas (press DATA ENTRY key to view the gas compensation settings).	S

General Message Area	Message Description	Alert Class
 HIGH ETCO ₂	The displayed ETCO ₂ value is above the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	H
 HIGH PULSE	The displayed pulse rate value is above the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
 HIGH RESP RATE	The displayed respiratory rate value is above the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
 HIGH SpO ₂	The displayed SpO ₂ value is above the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	H
 HIGH VCO ₂	The displayed VCO ₂ value is above the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
INSP CO ₂ : xx	(where xx is a numeric value with units of mmHg, kPa, or %). At least 3 mmHg, 0.1% or 0.1 kPa of CO ₂ has been detected during inspiration (other than during rebreathing) for at least ten continuous seconds.	S
 INVALID FLOW SENSOR	The wrong flow sensor is connected to the NM3 monitor. Use only a CO ₂ /Flow sensor part number 9765-00, 9766-00, or 9767-00. If message persists, a hardware error may exist. Contact qualified personnel for monitor repair or exchange.	M
 INVALID CO ₂ SENSOR	The wrong part number CAPNOSTAT 5 CO ₂ sensor or LoFlo C5 CO ₂ sensor is connected to the NM3 monitor. Use only a CAPNOSTAT 5 CO ₂ sensor, PN 1015938, or LoFlo C5 CO ₂ sensor, PN 1022054	M
 INVALID SpO ₂ CABLE	The wrong SpO ₂ patient cable is connected to the NM3 monitor. Use only sensors listed in the Accessories list. (See "Accessories" on page 181.)	M
 INVALID SpO ₂ SENSOR	The wrong SpO ₂ sensor is connected to the NM3 monitor. Use only sensors listed in the Accessories list. See "Accessories" on page 181.	M
LNCS SpO ₂ SENSOR CONNECTED	A LNCS-style SpO ₂ sensor was just connected to the NM3 monitor.	S
LNOP SpO ₂ SENSOR CONNECTED	A LNOP-style SpO ₂ sensor was just connected to the NM3 monitor.	S
 LOW ETCO ₂	The displayed ETCO ₂ value is below the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
 LOW PERFUSION	The pulse oximeter has detected very low amplitude arterial pulsations. The oximeter may not be displaying valid SpO ₂ values with respect to the patient's condition. Relocate the sensor to a better perfused monitoring site. Acknowledge by pressing the SILENCE key. The message remains, but the audio alert is stopped.	M
LOW PERFUSION INDEX CONFIDENCE	Ensure proper SpO ₂ sensor application. Check the SpO ₂ sensor to see if it is working properly. If not, replace the sensor and contact qualified service personnel.	S

General Message Area	Message Description	Alert Class
△ LOW PULSE	The displayed pulse rate value is below the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	H
LOW PULSE RATE CONFIDENCE	Ensure proper SpO ₂ sensor application. Check the SpO ₂ sensor to see if it is working properly. If not replace the sensor and contact qualified service personnel.	S
△ LOW RESP RATE	The displayed respiratory rate value is below the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
LOW SpCO CONFIDENCE	Ensure proper SpO ₂ sensor application. Check the SpO ₂ sensor to see if it is working properly. If not replace the sensor and contact qualified service personnel.	S
LOW SpMET PERFUSION	The pulse oximeter has detected very low amplitude arterial pulsations. The oximeter may not be displaying valid SpMET values with respect to the patient's condition. Relocate the sensor to a better perfused monitoring site.	S
LOW SpCO PERFUSION	The pulse oximeter has detected very low amplitude arterial pulsations. The oximeter may not be displaying valid SpCO values with respect to the patient's condition. Relocate the sensor to a better perfused monitoring site.	S
LOW SpMET CONFIDENCE	Ensure proper SpO ₂ sensor application. Check the SpO ₂ sensor to see if it is working properly. If not replace the sensor and contact qualified service personnel.	S
△ LOW SpO ₂ SIG IQ	The signal quality is very low, and the accuracy of the SpO ₂ measurement may be compromised. Check the sensor and ensure proper placement. Check that peripheral blood flow to the sensor site is not compromised or interrupted. Acknowledge by pressing the SILENCE key. The message remains, but the audio alert is stopped.	M
△ LOW SpO ₂	The displayed SpO ₂ value is below the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	H
△ LOW VCO ₂	The displayed VCO ₂ value is below the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
MAIN SPEAKER INOP BACKUP ACTIVATED	One of the audio alarm speakers is not operating, but a secondary backup is functional. Refer the NM3 monitor to qualified personnel for monitor repair or exchange to restore full audio alarm functionality.	S
NEONATAL CO ₂ /FLOW SENSOR IDENTIFIED	A neonatal size CO ₂ /Flow sensor was just connected to the NM3 monitor.	S
△ NO CO ₂ SENSOR	The CAPNOSTAT 5 CO ₂ sensor or LoFlo C5 CO ₂ sensor has been disconnected from the NM3 monitor. Acknowledge by pressing the SILENCE key.	M
△ NO FLOW SENSOR	The CO ₂ /Flow sensor has been disconnected. Acknowledge by pressing the SILENCE key.	M
△ NO RESP: xx:xx	The time selected in the SET ALERTS screen for the NO RESP (no respiration) alert was exceeded since the end of the last detected breath (press MENU key, then 10 minutes the counter xx:xx is no longer displayed).	H

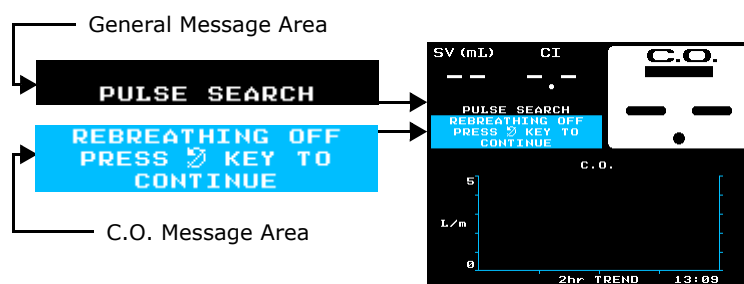
General Message Area	Message Description	Alert Class
△ NO SpO ₂ SENSOR	The pulse oximeter sensor has been disconnected from the NM3 monitor. Acknowledge by pressing the SILENCE key.	M
PEDIATRIC CO ₂ /FLOW SENSOR IDENTIFIED	A pediatric size CO ₂ /Flow sensor was just connected to the NM3 monitor.	S
△ PULSE SEARCH	The pulse oximeter is not detecting a sufficient pulse. This could be due to: • Insufficient perfusion at the site • Tissue at the site is too thick Begins as a status message (Alert Class S). If this condition is not corrected within 30 seconds, audible and visual alarms will occur (Alert class M).	M
RAINBOW SpO ₂ SENSOR CONNECTED	A Rainbow-style SpO ₂ sensor was just connected to the NM3 monitor.	S
REPLACE CLOCK BATT.	The battery for the monitor's internal clock should be replaced. Contact qualified personnel for monitor repair or exchange.	S
SAMPLING LINE DISCONNECTED	Connect a sidestream sample line kit to the LoFlo C5 CO ₂ Sensor.	S
SAVING DATA: 00:00	Displayed occasionally when the system is saving data to the USB device. Shows time until save is completed.	S
△ SENSOR FAILURE REPLACE CO ₂ SENSOR	A problem with the CAPNOSTAT 5 CO ₂ sensor or LoFlo C5 CO ₂ sensor has been identified. Replace the sensor and return it to Philips Respironics for exchange or repair.	M
△ SENSOR FAILURE REPLACE SpO ₂ SENSOR	The pulse oximeter sensor is faulty. Replace the sensor and contact qualified service personnel.	M
SpO ₂ DEMO MODE	The NM3 monitor is showing demonstration SpO ₂ waveforms and patient data. To exit, disconnect the Demo SpO ₂ sensor.	S
△ SpO ₂ LIGHT INTERFERENCE	The monitor detects interference on the SpO ₂ sensor from ambient light. This can be corrected by covering the SpO ₂ sensor, or possibly by changing the sensor site.	M
△ SpO ₂ SENSOR OFF	SpO₂ sensor disconnected from patient, improperly applied, or placed on an area too translucent for proper sensor operation. Reposition sensor. Acknowledge by pressing the SILENCE key. The message remains, but the audio alert is stopped.	M
△ SYSTEM INOP FLOW MODULE ERROR	The NM3 monitor detected a problem with its pneumatic flow and pressure sub-system. Contact qualified personnel for monitor repair or exchange.	H
△ SYSTEM INOP KEY PANEL FAILURE	The NM3 monitor has detected an error with the keypanel. The Alert Bar may not function to indicate an alarm condition. Contact qualified personnel for monitor repair or exchange if this error persists.	H
△ SYSTEM INOP SPEAKER FAILURE	Both the primary and secondary backup audio speakers are not operating. An emergency enunciator is sounding to inform clinical personnel that the monitor cannot provide audio alarms. Contact qualified personnel for monitor repair or exchange if this error persists	H
△ SYSTEM INOP SpO ₂ MODULE FAILURE	The NM3 monitor detected a problem with its pulse oximetry sub-system. Contact qualified personnel for monitor repair or exchange.	H

General Message Area	Message Description	Alert Class
 SYSTEM INOP SYSTEM ERROR	The NM3 monitor detected a problem with an internal component. Contact qualified personnel for monitor repair or exchange.	H
TREND SAVED TO USB	The system is done saving trend data to the USB device.	S
USB MEMORY DEVICE CONNECTED	Displayed when the USB device is connected to the system.	S
USB FULL	There is inadequate free space on the USB device.	S

Message Areas - Cardiac Output mode (Optional)

For Respiratory Mechanics messages, see page 127.

In Cardiac Output mode, the monitor uses two screen locations, the General Message Area and the C.O. Message Area, to convey information to the user.



General Message Area

The General Message Area in Cardiac Output mode displays system status, alert, and error conditions. It may be blank or:

- contain 1 single-line message
- contain 2 single-line messages
- contain 1 multi-line message



The General Message Area messages are listed below, in alphabetical order.

(Alert Class: H-High Priority, M-Medium Priority, L-Low Priority, S-Status Message. See "Alert Priorities" on page 99 for details.)

General Message Area	Message Description	Alert Class
ALERTS OFF	Displayed as a reminder that the default for all user selectable alerts is OFF. To cancel the message, adjust any individual limit value and activate the audible alert. Both the alert limit and audible alert must be activated.	S
⚠ BATTERY VERY LOW CONNECT A/C POWER	The NM3 monitor is operating on battery, and the battery is very low. Connect A/C MAINS power to prevent the monitor from powering off. Begins as a status message (Alert Class S). When approximately 10 minutes of battery life remains, the message will become an alarm (Alert Class H). Audible and visual alarms will occur.	H
⚠ CABLE FAILURE REPLACE SpO ₂ CABLE	The pulse oximeter patient cable is faulty. Replace the cable and contact qualified service personnel.	M
CANNOT SAVE TO USB	Displayed when data files cannot be created on the USB device. This can be caused by a file system error on the USB drive.	S

General Message Area	Message Description	Alert Class
△ CHECK / CHANGE AIRWAY ADAPTER	A change in the CO₂ adapter portion of the Cardiac Output Sensor is detected. ETCO₂ and other volumetric CO₂ parameters are not displayed. Possible causes: • CAPNOSTAT 5 CO₂ sensor or LoFlo C5 CO₂ Sensor is off adapter. • High level of moisture and/or secretions in the adapter. The moisture can be drained from the Cardiac Output Sensor and re-inserted in the circuit. Facing the pneumatic tubing upward as it exits the Cardiac Output Sensor can minimize this. NOTE: If this condition is not corrected within X seconds, audible and visual alarms will occur. X = the NO RESP timeout value (select MENU then SET ALERTS). Acknowledge by pressing the SILENCE key. The message remains, but the audio alert is stopped.	S
△ CHECK CO ₂ SAMPLING LINE	A change in the sidestream sampling line or the sample cell has been detected. Possible causes: • Water or patient contaminate has entered the sample tubing • The sample tubing is crimped, cut, split or damaged • The exhaust port of the LoFlo C5 CO₂ Sensor is obstructed Inspect the sample line kit and replace if necessary. Verify the exhaust port on the LoFlo C5 CO₂ Sensor is not obstructed. Re-inserting the sample cell may be necessary to clear the error condition if present for more than two minutes. For more information, see "Check CO₂ Sampling Line Message" on page 117. Acknowledge by pressing the SILENCE key. The message remains, but the audio alert is stopped.	M
CHECK COMMUNICATION	The monitor is unable to establish RS-232 communication with the V200 or Esprit ventilator. Displayed in NICO-Esprit Interface mode only.	S
CO ₂ SENSOR WARM UP	The CAPNOSTAT 5 CO ₂ sensor or LoFlo C5 CO ₂ sensor is not at proper operating temperature yet.	S
CO ₂ ZERO REQUIRED (MENU → SETUP)	The CAPNOSTAT 5 CO₂ sensor needs to be zeroed. Press the MENU key, then select SETUP, then CO2 ZERO NOW, and follow the instructions on the screen. For more information, see "Adapter Zero" on page 111.	S
DATA SAVED TO USB	The system is done saving data to the USB device.	S
DEMO MODE	The monitor is in demonstration mode and is not displaying patient data (all data is simulated). To exit demo mode, turn the monitor off, then back on.	S
ETCO ₂ : XX mmHg	End tidal CO ₂ is greater than 60 mmHg or exceeds the high alert limit. Appears in the general message area to supplement screens that do not display the ETCO ₂ value.	S
GAS COMP ON	The INSP O2 is greater than or equal to 60%, or the INSP AGENT is greater than 0.0%, or N ₂ O or He is selected as the BALANCE gas (press DATA ENTRY key to view the gas compensation settings).	S

General Message Area	Message Description	Alert Class
△ HIGH C.O.	The displayed cardiac output value is above the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
△ HIGH ETCO ₂	The displayed ETCO ₂ value is above the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	H
△ HIGH PULSE	The displayed pulse rate value is above the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
△ HIGH RESP RATE	The displayed respiratory rate value is above the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
△ HIGH SpO ₂	The displayed SpO ₂ value is above the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	H
INSP CO ₂ : xx	(where xx is a numeric value with units of mmHg, kPa, or %). At least 3 mmHg, 0.1% or 0.1 kPa of CO ₂ has been detected during inspiration (other than during rebreathing) for at least ten continuous seconds.	S
△ INVALID CO ₂ SENSOR	The wrong part number CAPNOSTAT 5 CO ₂ sensor or LoFlo C5 CO ₂ sensor is connected to the NM3 monitor. Use only a CAPNOSTAT 5 CO ₂ sensor, PN 1015938, or LoFlo C5 CO ₂ sensor, PN 1022054	M
△ INVALID FLOW SENSOR	The wrong flow sensor is connected to the NM3 monitor. Use only a Cardiac Output Sensor, part numbers 8950-00, 8951-00 or 8952-00 (the correct flow sensor is an integral part of the Cardiac Output Sensor).	M
△ INVALID SpO ₂ CABLE	The wrong SpO ₂ patient cable is connected to the NM3 monitor. Use only sensors listed in the Accessories list. See "Accessories" on page 181.	M
△ INVALID SpO ₂ SENSOR	The wrong SpO ₂ sensor is connected to the NM3 monitor. Use only sensors listed in the Accessories list. See "Accessories" on page 181.	M
LARGE C.O. SENSOR IDENTIFIED	A large size Cardiac Output Sensor was just connected to the NM3 monitor.	S
LNCS SpO ₂ SENSOR CONNECTED	A LNCS-style SpO ₂ sensor was just connected to the NM3 monitor.	S
LNOP SpO ₂ SENSOR CONNECTED	A LNOP-style SpO ₂ sensor was just connected to the NM3 monitor.	S
△ LOW C.O.	The displayed cardiac output value is below the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	H
△ LOW ETCO ₂	The displayed ETCO ₂ value is below the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
△ LOW PERFUSION	The pulse oximeter has detected very low amplitude arterial pulsations. The oximeter may not be displaying valid SpO ₂ values with respect to the patient's condition. Relocate the sensor to a better perfused monitoring site. Acknowledge by pressing the SILENCE key. The message remains, but the audio alert is stopped.	M

General Message Area	Message Description	Alert Class
LOW PERFUSION INDEX CONFIDENCE	Ensure proper SpO ₂ sensor application. Check the SpO ₂ sensor to see if it is working properly. If not, replace the sensor and contact qualified service personnel.	S
△ LOW PULSE	The displayed pulse rate value is below the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	H
LOW PULSE RATE CONFIDENCE	Ensure proper SpO ₂ sensor application. Check the SpO ₂ sensor to see if it is working properly. If not, replace the sensor and contact qualified service personnel.	S
△ LOW RESP RATE	The displayed respiratory rate value is below the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	M
LOW SpCO CONFIDENCE	Ensure proper SpO ₂ sensor application. Check the SpO ₂ sensor to see if it is working properly. If not replace the sensor and contact qualified service personnel.	S
LOW SpCO PERFUSION	The pulse oximeter has detected very low amplitude arterial pulsations. The oximeter may not be displaying valid SpCO values with respect to the patient's condition. Relocate the sensor to a better perfused monitoring site.	S
LOW SpMET PERFUSION	The pulse oximeter has detected very low amplitude arterial pulsations. The oximeter may not be displaying valid SpMET values with respect to the patient's condition. Relocate the sensor to a better perfused monitoring site.	S
LOW SpMET CONFIDENCE	Ensure proper SpO ₂ sensor application. Check the SpO ₂ sensor to see if it is working properly. If not replace the sensor and contact qualified service personnel.	S
△ LOW SpO ₂ SIG IQ	The signal quality is very low, and the accuracy of the SpO ₂ measurement may be compromised. Check the sensor and ensure proper placement. Check that peripheral blood flow to the sensor site is not compromised or interrupted. Acknowledge by pressing the SILENCE key. The message remains, but the audio alert is stopped.	M
△ LOW SpO ₂	The displayed SpO ₂ value is below the set alert limit in the SET ALERTS screen (press MENU key, then select SET ALERTS to view the alert limit settings).	H
MAIN SPEAKER INOP BACKUP ACTIVATED	One of the audio alarm speakers is not operating, but a secondary backup is functional. Refer the NM3 monitor to qualified personnel for monitor repair or exchange to restore full audio alarm functionality.	S
MVi-MVe MISMATCH	The NM3 monitor detected greater than 15% difference between MVi and MVe measurements. Cardiac Output cycle must be active. Check for leaks in the circuit.	S
△ NO CO ₂ SENSOR	The CAPNOSTAT 5 CO ₂ sensor or LoFlo C5 CO ₂ Sensor has been disconnected from the NM3 monitor. Acknowledge by pressing the SILENCE key.	M
△ NO RESP: xx:xx	The time selected in the SET ALERTS screen for the NO RESP (no respiration) alert was exceeded since the end of the last detected breath (press MENU key, then select SET ALERTS to view the alert limit settings).	H
△ NO SpO ₂ SENSOR	The pulse oximeter sensor has been disconnected from the NM3 monitor. Acknowledge by pressing the SILENCE key.	M

General Message Area	Message Description	Alert Class
 PULSE SEARCH	The pulse oximeter is not detecting a sufficient pulse. This could be due to: • Insufficient perfusion at the site • Tissue at the site is too thick Begins as a status message (Alert Class S). If this condition is not corrected within 30 seconds, audible and visual alarms will occur (Alert class M).	M
RAINBOW SpO ₂ SENSOR CONNECTED	A Rainbow-style SpO ₂ sensor was just connected to the NM3 monitor.	S
REPLACE CLOCK BATT.	The battery for the monitor's internal clock should be replaced. Contact qualified personnel for monitor repair or exchange.	S
SAMPLING LINE DISCONNECTED	Connect a sidestream sample line kit to the LoFlo C5 sensor.	S
SAVING DATA: 00:00	Displayed occasionally when the system is saving data to the USB device. Shows time until save is completed.	S
 SENSOR FAILURE REPLACE CO ₂ SENSOR	A problem with the CAPNOSTAT 5 CO ₂ sensor or LoFlo C5 CO ₂ sensor has been identified. Replace the sensor and return it to Philips Respironics for service.	M
 SENSOR FAILURE REPLACE C.O.SENSOR	A problem with the Cardiac Output sensor has been identified. Replace the Cardiac Output sensor and return it to Philips Respironics for exchange or repair.	M
 SENSOR FAILURE REPLACE SpO ₂ SENSOR	The pulse oximeter sensor is faulty. Replace the sensor and contact qualified service personnel.	M
SMALL C.O. SENSOR IDENTIFIED	A small size Cardiac Output Sensor was just connected to the NM3 monitor.	S
STANDARD C.O. SENSOR IDENTIFIED	A standard size Cardiac Output Sensor was just connected to the NM3 monitor.	S
SpO ₂ DEMO MODE	The NM3 monitor is showing demonstration SpO ₂ waveforms and patient data. To exit, disconnect the Demo SpO ₂ sensor.	S
 SpO ₂ LIGHT INTERFERENCE	The monitor detects interference on the SpO ₂ sensor from ambient light. This can be corrected by covering the SpO ₂ sensor, or possibly by changing the sensor site.	M
 SpO ₂ SENSOR OFF	SpO₂ sensor disconnected from patient, improperly applied, or placed on an area too translucent for proper sensor operation. Reposition sensor. Acknowledge by pressing the SILENCE key. The message remains, but the audio alert is stopped.	M
 SYSTEM INOP C.O. MODULE ERROR	The NM3 monitor detected a problem with its internal rebreathing valve control circuitry or related pneumatic components. Contact qualified personnel for monitor repair or exchange.	H
 SYSTEM INOP FLOW MODULE ERROR	The NM3 monitor detected a problem with its pneumatic flow and pressure sub-system. Contact qualified personnel for monitor repair or exchange.	H
 SYSTEM INOP KEYPANEL FAILURE	The NM3 monitor has detected an error with the keypanel. The Alert Bar may not function to indicate an alarm condition. Contact qualified personnel for monitor repair or exchange if this error persists.	H

General Message Area	Message Description	Alert Class
 SYSTEM INOP SPEAKER FAILURE	Both the primary and secondary backup audio speakers are not operating. An emergency enunciator is sounding to inform clinical personnel that the monitor cannot provide audio alarms. Contact qualified personnel for monitor repair or exchange if this error persists	H
 SYSTEM INOP SpO ₂ MODULE FAILURE	The NM3 monitor detected a problem with its pulse oximetry sub-system. Contact qualified personnel for monitor repair or exchange.	H
 SYSTEM INOP SYSTEM ERROR	The NM3 monitor detected a problem with an internal component. Contact qualified personnel for monitor repair or exchange.	H
TREND SAVED TO USB	The system is done saving trend data to the USB device.	S
USB MEMORY DEVICE CONNECTED	Displayed when the USB device is connected to the system.	S
USB FULL	There is inadequate free space on the USB device.	S

C.O. Message Area

The C.O. Message Area is dedicated to cardiac output related information and may be blank or contain a message.

The C.O. Message Area messages are listed below, in alphabetical order.

(Alert Class: H-High Priority, M-Medium Priority, L-Low Priority, S-Status Message. See "Alert Priorities" on page 99 for details.)

C.O. Message Area	Message Description	Alert Class
CONSIDER USING SMALL C.O. SENSOR	Resizing the rebreathing loop was not effective because the ventilator set tidal volume is less than 300 ml. The NM3 monitor is suggesting a different sized sensor, with smaller loop, to correct the condition.	S
CONSIDER USING STD C.O. SENSOR	If a small Cardiac Output Sensor is currently in use: Resizing the rebreathing loop was not effective because the ventilator set tidal volume is greater than 500 ml. The NM3 monitor is suggesting a different sized sensor, with a larger loop, to correct the condition. If a large Cardiac Output Sensor is currently in use: Resizing the rebreathing loop was not effective because the ventilator set tidal volume is less than 1000 ml. The NM3 monitor is suggesting a different sized sensor, with a smaller loop, to correct the condition.	S
CONSIDER USING LARGE C.O. SENSOR	Resizing the rebreathing loop was not effective because the ventilator set tidal volume is greater than 1000 ml. The NM3 monitor is suggesting a different sized sensor, with a larger loop, to correct the condition.	S
EXPAND LOOP	The rebreathing loop (expandable rebreathing volume on the Cardiac Output Sensor) needs to be expanded. Expand the loop by approximately 3-6 inches or until the message is removed. Note that the message is displayed only during the rebreathing phase of the cardiac output cycle. If the loop is not appropriately sized by the end of the rebreathing phase, the message will be removed and displayed again during the next rebreathing phase. If this message persists with maximal expansion of the rebreathing loop, the tidal volume may be too large for the ventilatory conditions for the NM3 monitor to report accurate results.	S
NEXT  : xx:xx	There are x:xx minutes:seconds until the beginning of the next rebreathing period (provided as an indicator as to the current state of the cardiac output cycle).	S
 NO C.O. SENSOR	The Cardiac Output Sensor has been disconnected from the monitor. The Cardiac Output Sensor should be removed from the breathing circuit in order to avoid leaking breathing circuit gas through the sensor connector. Acknowledge by pressing the SILENCE key.	M
NOISY SIGNALS	The NM3 monitor was not able to calculate an averaged cardiac output value. This can be due to: • Spontaneous breaths or efforts • Surgeon moving the lungs • Ventilator adjustments	S
 REBREATHING	The patient is currently rebreathing a portion of his/her tidal volume in order for the NM3 monitor to calculate cardiac output (provided as an indicator of the current state of the cardiac output cycle). The rebreathing phase of the cardiac output cycle lasts for 35 seconds.	S

C.O. Message Area	Message Description	Alert Class
REBREATHING OFF	Rebreathing and therefore C.O. measurements are currently disabled. The STOP/CONTINUE REBREATHING key is illuminated amber while rebreathing is off, and can be pressed to enable rebreathing and C.O. measurements. Rebreathing is off when: - The monitor is first turned on until the STOP/CONTINUE REBREATHING key is pressed - The STOP/CONTINUE REBREATHING key is pressed while C.O. measurements are enabled - The monitor detected a system fault or condition which warrants automatic disabling of C.O. measurements.	S
⚠ REBREATHING OFF SENSOR FAILURE REPLACE C.O. SENSOR	A problem with the Cardiac Output Sensor was detected by the monitor. Discard the sensor and replace it. If the problem persists, contact qualified service personnel.	M
REBREATHING OFF PRESS  KEY TO CONTINUE	Rebreathing and therefore C.O. measurements are currently disabled and can be enabled by pressing the STOP / CONTINUE REBREATHING key.	S
REBREATHING PAUSED WAITING FOR ETCO ₂ < XX	Rebreathing and therefore C.O. measurements have been temporarily paused automatically by the monitor, and will resume automatically once the indicated parameter is within the stated range (here, XX = 85 mmHg, 11.5 kPa, 11.5 %).	L
REBREATHING PAUSED WAITING FOR ETCO ₂ > XX	Rebreathing and therefore C.O. measurements have been temporarily paused automatically by the monitor, and will resume automatically once the indicated parameter is within the stated range (here, XX = 15 mmHg, 2.0 kPa, 2.0 %).	L
REBREATHING PAUSED WAITING FOR RR < 60 br/m	Rebreathing and therefore C.O. measurements have been temporarily paused automatically by the monitor, and will resume automatically once the indicated parameter is within the stated range.	L
REBREATHING PAUSED WAITING FOR RR > 3 br/m	Rebreathing and therefore C.O. measurements have been temporarily paused automatically by the monitor, and will resume automatically once the indicated parameter is within the stated range.	L
REBREATHING PAUSED WAITING FOR VCO ₂ > 20 mL/min	Rebreathing and therefore C.O. measurements have been temporarily paused automatically by the monitor, and will resume automatically once the indicated parameter is within the stated range.	L
REBREATHING PAUSED WAITING FOR Vt > xx	Rebreathing and therefore C.O. measurements have been temporarily paused automatically by the monitor, and will resume automatically once the indicated parameter is within the stated range. (Here, xx = 200ml or 400ml, depending on the type of C.O. sensor currently connected.)	L

C.O. Message Area	Message Description	Alert Class
RETRACT LOOP	The rebreathing loop (expandable rebreathing volume on the Cardiac Output Sensor) needs to be retracted (made smaller). Retract the loop by approximately 3-6 inches or until the message is removed. Note that the message is displayed only during the rebreathing phase of the cardiac output cycle. If the loop is not appropriately sized by the end of the rebreathing phase, the message will be removed and displayed again during the next rebreathing phase. If this message persists with the rebreathing loop at its minimal size, the tidal volume may be too small for the ventilatory conditions for the NM3 monitor to report accurate results.	S

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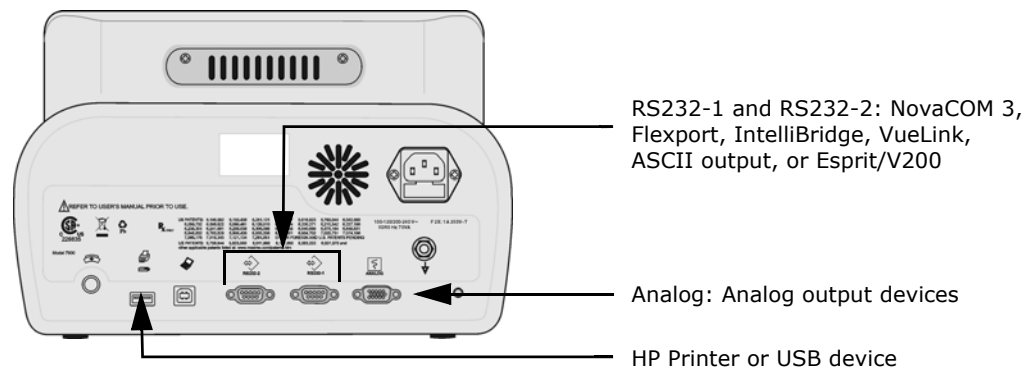
External Communications

The NM3 monitor provides both analog and digital means of communicating with external devices. The monitor must be set to the appropriate interface.

- 1 Press the **MENU** key to activate **SELECT A SCREEN**. The key's green icon illuminates.
 - Press the key again to return to the previously displayed screen.
- 2 Highlight and then select **SETUP** by turning and then pressing the **KNOB**.
- 3 The **SETUP** screen is displayed.
- 4 Turn and press the **KNOB** to select **INPUT/OUTPUT**.



All interfaces, printers and external devices are selected from the **INPUT/OUTPUT SETUP** screen. All devices are connected to a rear panel connector using an appropriate cable.



CAUTION

Accessories equipment connected to the analog and digital interfaces must be certified to the respective IEC standards (i.e. IEC 60950 for data processing equipment and IEC 60601-1 for medical equipment).

Nurse Call/Remote Alarm

The NM3 monitor provides both a normally open and normally closed connection for interfacing to Nurse Call systems. They are accessed through the Nurse Call connector on the back of the monitor. The monitor will provide only medium (M) and high (H) priority alarms via Nurse Call. Low priority status alarms (S) will not be displayed.



CAUTION:

To prevent possible patient injury due to nonannunciating alarms, verify the operation of any remote alarm device before use.

To ensure the functionality of the remote alarm, connect only Philips Respironics-approved cables to the remote alarm port.

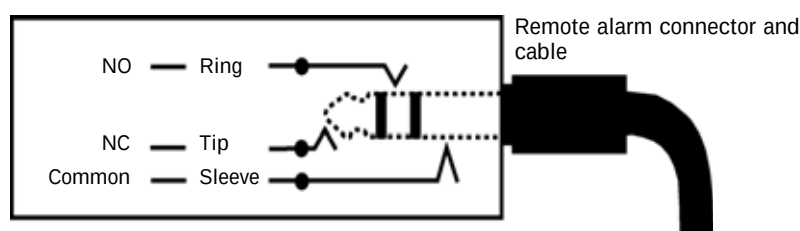
The remote alarm port is intended to connect only to an SELV (safety extra-low voltage and ungrounded system with basic insulation to ground), in accordance with IEC 60601-1. To prevent damage to the remote alarm, make sure the signal input does not exceed the maximum rating of 24 VAC or 36 VDC at 500 mA with a minimum current of 1 mA.

NOTE:

If the **SILENCE** key is pressed on the NM3 monitor, the Nurse Call feature is still active. To disable Nurse Call, disconnect the Nurse Call cable. During use, ensure proper connection of cable between the monitor and Nurse Call connection.

The remote alarm (nurse call) port allows ventilator alarm conditions to be annunciated at locations away from the ventilator, (for example, when the ventilator in an isolation room). The ventilator sends alarm signals to a remote alarm through the connector at the rear of the ventilator. The figure below shows the pin assignments for this connector. The connector is a standard ¼-inch, female, audio (ring, tip, sleeve) connector.

The ventilator signals an alarm using either a normally open (NO) or normally closed (NC) relay contact. The de-energized state of the relay represents an alarm state (any high-priority alarm) and the energized state represents a non-alarm state. This application requires one of the cables listed in the table below.



Remote Alarm Cable Kits	Part Number
Remote alarm cable kit, normally open protocol	1003741
Remote alarm cable kit, normally closed protocol	1003742
Remote alarm cable kit, Philips Respironics (LifeCare)	1003743

USB Data Collection

The NM3 can save waveform, breath, or trend data to a USB device, memory stick, flash drive, etc. NM3 data files are stored on the USB device in a .csv (comma separated value) text format that can be opened with spreadsheet or word processing software.

Waveform and breath data are saved in real-time, while the patient is connected to the monitor and the USB device is connected. A **SAVING DATA** reminder will appear every 2 minutes. Data collection can be discontinued at any time by selecting **STOP**. Data can be saved until the flash drive is full.

SAVE TRENDS can also be selected while saving breath and waveform data. Up to 24 hours of trends (one-minute averages) can be stored in the monitor, then saved to the flash drive. For periods longer than 24 hours, the oldest data is overwritten first.

What data is saved:

- **SAVE WAVEFORMS** saves both waveform and breath data. Breath data is saved in csv format; waveform data is saved in .fcd format.
- **SAVE BREATHS** saves breath data only. Data is saved in .csv format.
- **SAVE TRENDS** saves trend data only. Data is saved in .csv format.

Connect a USB Device

The USB host port is located on the rear of the NM3 monitor.

- 1 Connect the USB device to the USB port located on the rear of the monitor. The message, **USB MEMORY DEVICE CONNECTED** will display.
- 2 When the NM3 monitor connects to the USB device, the file system is mounted and additional processing is performed to determine the free space on the device. Depending on how full the flash drive is, it may take some time before the drive is ready.



Setup NM3 for Data Collection

Press **MENU** and select **SETUP**

ETCO2 -- mmHg RR --	SpO2 97 % ♥ 72	VC02 -- mL/m MV --	Vte -- mL Vti --
SELEZIONARE UNO SCHERMO			
CO2/SpO2		TREND	
FLUSSO/PRESSIONE		TABELLA DATI	
FLUS/PRE/VOL		CO2 RESPIRO SING	
TREND VC02/MVavg		IMPOSTA ALLARMI	
TREND Vt/Vd		IMPOSTAZIONE	
NUMERICI		VENTASSIST	

From the **SETUP** screen, select **INPUT/OUTPUT**

ETCO2 -- mmHg RR --	SpO2 97 % ♥ 72	VC02 -- mL/m MV --	Vte -- mL Vti --
IMPOSTA			
AZZERA CO2		BIP PULSAZ.: OFF	
SPURGA ORA		SENS SpO2: AP00	
SCORR.: MEDIO		FASTSAT SpO2: OFF	
CANCELLA TREND		IMP SOGLIA SPONT	
INGRESSO/USCITA			
SCEGLI SCHERMI		ESCI	

From the **INPUT/OUTPUT**, screen select **SAVE WAVEFORMS**, **SAVE BREATHS**, or **SAVE TRENDS**.

ETCO2 38 mmHg RR 20	SpO2 97 % ♥ 72	VC02 323 mL/m MV 9.2	Vte 605 mL Vti 611
USB MEMORY DEVICE CONNECTED			
INPUT/OUTPUT SETUP			
ANALOG OUT 1		RS232-1	
ANALOG OUT 2		RS232-2	
ANALOG OUT 3		SAVE WAVEFORMS	
ANALOG OUT 4		SAVE BREATHS	
ANALOG CAL.		SAVE TRENDS	
EXIT			

ETCO2 -- mmHg RR --	SpO2 97 % ♥ 72	VC02 -- mL/m MV --	Vte -- mL Vti --
IMPOSTA INGRESSO/USCITA			
USCITA 1 ANALOG.		RS232-1	
USCITA 2 ANALOG.		RS232-2	
USCITA 3 ANALOG.		SALVA FORME ONDA	
USCITA 4 ANALOG.		SALVA RESPIRI	
CALIBR. ANALOGICA		SALVA TREND	
ESCI			

NOTE: If the **SAVE** options are blue text, a flash drive is not connected.

USB Data Analysis

Transferring Data

After data collection is complete, or on a daily basis for longer studies, download data to the flash drive then connect the flash drive to a computer USB port to work with the data.

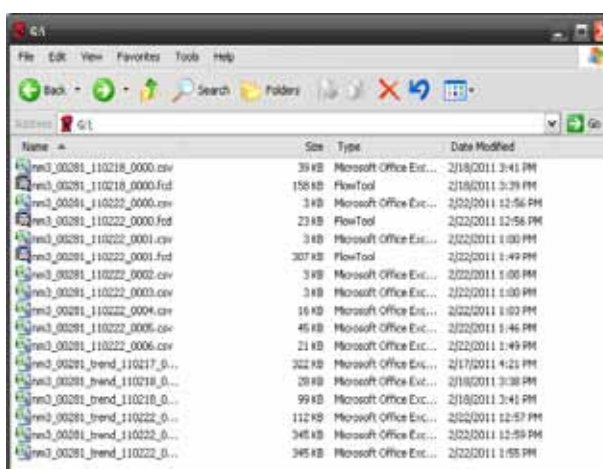
Breath data and trend data are saved.

Data files are named as follows:

- Waveforms: nm3_sn_yymmdd_nnnn.fcd
- Breath data: nm3_sn_yymmdd_nnnn.csv
- Trend data: nm3_sn_trend_yymmdd_nnnn.csv

Where:

- sn = NM3's serial number, 5 digits (not including the 168- prefix)
- yy = year from system clock (last 2 digits)
- mm = month from system clock
- dd = day from system clock
- nnnn = auto-incrementing number



Data Analysis Options

Open a Breath data or Trend data .csv file with a spreadsheet program such as Microsoft Excel. Because .csv is a raw text format, you can then save the file in a format that supports multiple tabs or other more advanced features.

The NM3 monitor provides an HP (Hewlett-Packard) compatible printer interface. When activated, printing is available from the **TREND** screen. Refer to "Trend Screen" on page 79. The **PRINT** selection is dimmed until the NM3 monitor detects a compatible printer.

- 1 Connect an HP (Hewlett-Packard) printer to the monitor USB port.



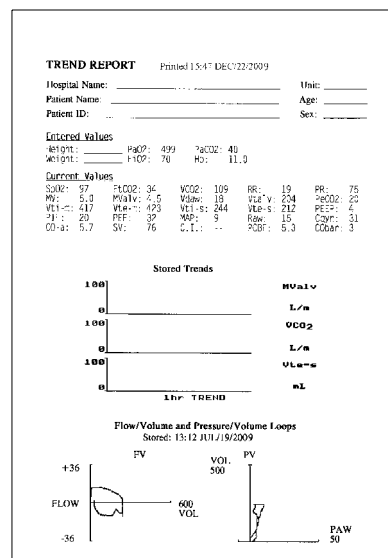


Note: other printer brands may also be compatible. The printer must have a USB port.

- 2 If connected and compatible, the monitor will display the message, **PRINTER CONNECTED**. If an incompatible printer is connected, the message **INCOMPATIBLE USB. DISCONNECT DEVICE** will be displayed.

Output to the printer includes entered values, current values, stored flow/volume and pressure/volume loops and stored trends. To change the trend selection, see "Trend Screen" on page 79. To store FV/PV loops, see "Flow Volume and Pressure Volume Loops screen" on page 77.

Space is provided at the top of the printout for hospital and patient information.



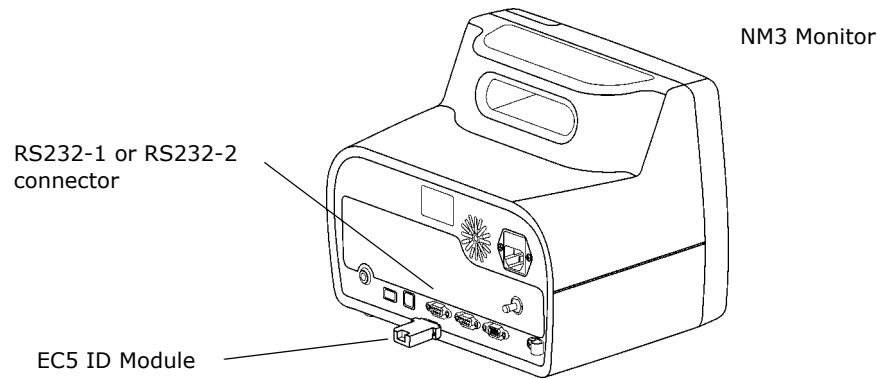
The NM3 monitor can communicate with the Philips IntelliBridge and VueLink modules, allowing data from the monitor to be viewed on the Philips Patient Monitoring System. Data from the NM3 monitor is added to the other parameters displayed on the Philips Medical Systems Patient Monitor.

To setup and connect the NM3 monitor to a Philips IntelliBridge module, you will need the following:

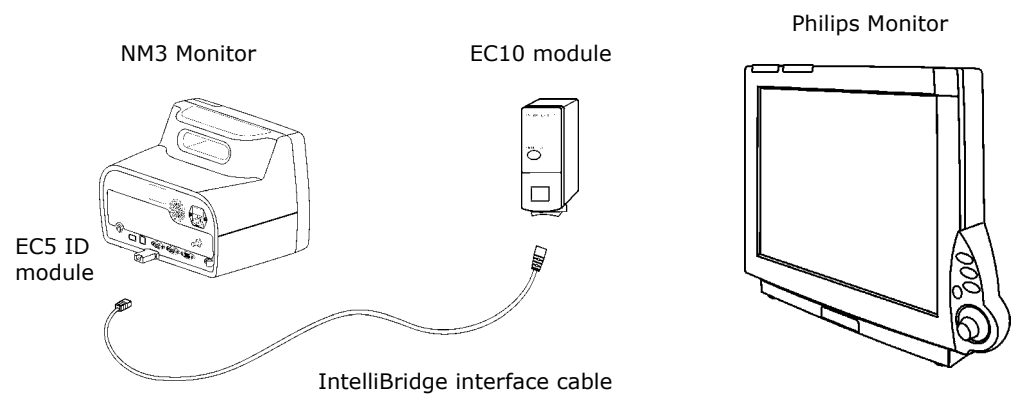
- Philips Patient Monitor with software revision H or higher.
- Philips IntelliBridge EC10 module with Open Interface (PN 865115 A01).
- IntelliBridge EC5 ID module (PN 865114 #102).
- IntelliBridge Interface Cable, 3 meter (PN 865114 #102/L02). Also available in 1.5 meter (L01) and 10 meter (L03) lengths.

- 1** Connect the EC5 Module to an RS232 port on the rear of the NM3 monitor. Tighten

screws.



- 2 Connect the IntelliBridge interface cable to the EC5 module and the EC10 module.



- 3 Refer to Philips Patient Monitor documentation for mounting the EC10 module on the monitor rack.

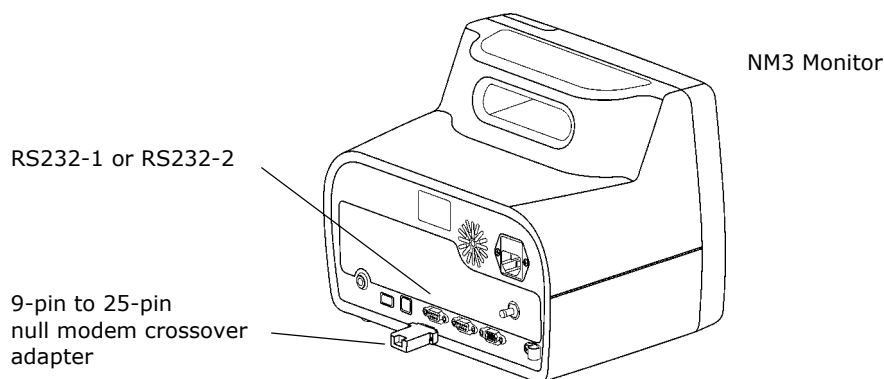
NOTE: It may be necessary to unplug the IntelliBridge interface cable from the IntelliBridge EC10 module when CO₂/Flow Sensor types (e.g., adult to neonate) or CO₂ units are changed.

VueLink Setup*

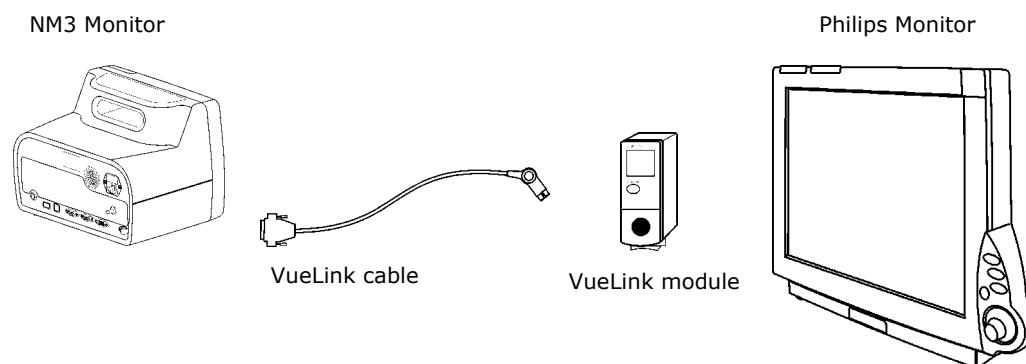
To setup and connect the NM3 monitor to a Philips VueLink module, you will need the following:

- Philips Patient Monitor with software revision C (9.xx) or higher.
- VueLink module: Auxiliary Plus B with Open Interface (PN M1032 A05).
- Philips VueLink interface cable, 4 meter (part number M1032-61654)
- 9-pin male to 25-pin female null modem (crossover) adapter

- 1 Connect the 9-pin to 25-pin null modem adapter to an RS232 port on the rear of the NM3 monitor. Tighten screws.



- 2 Connect the VueLink interface cable to the null modem adapter and tighten screws. Plug the other end into the VueLink module.



- 3 Refer to Philips Patient Monitor documentation for mounting the VueLink module on the monitor rack.

*VueLink is no longer for sale. Information included for backward compatibility.

NM3 Monitor Setup

The NM3 monitor must be set to the appropriate interface for output to the IntelliBridge or VueLink module. From the **INPUT/OUTPUT SETUP** screen:

- 1 Turn and press the **KNOB** to select **RS232-1** or **RS232-2**.
- 2 Turn and press the **KNOB** to select **VUELINK**. Choose VueLink for IntelliBridge also.
- 3 Refer to the operator's manuals for the Philips VueLink or IntelliBridge Module and the Philips Patient Monitor prior to use.

Alerts and Messages

Alarms and messages are not transmitted from the NM3 monitor to the Philips IntelliBridge or VueLink modules. All alarms and messages should be viewed directly from the NM3 monitor.

Transmitted Parameters

The parameter selection varies depending upon whether you are in Respiratory Mechanics mode or the optional Cardiac Output mode. Parameters shown in the right column are displayed on the Philips IntelliVue Information Center and trends are available.

Philips Monitor Label	NM3 Monitor Label	Parameter	Units	Displayed on IntelliVue and Trended?
AWRR	RR	Respiratory Rate	rpm	Yes
Cdyn	Cdyn	Dynamic Compliance	ml/cmH ₂ O	Yes
RAW e	Raw	Expired Airway Resistance (Dynamic)	cmH ₂ O/L/S	--
PIP	PIP	Peak Inspiratory Pressure	cmH ₂ O	Yes
PEEP	PEEP	Positive End Expiratory Pressure	cmH ₂ O	Yes
Pmean	MAP	Mean Airway Pressure	cmH ₂ O	Yes
Pulse	Pulse	Pulse Rate	bpm	Yes
SpO ₂	SpO ₂	SpO ₂	%	Yes
ETCO ₂	ETCO ₂	ETCO ₂	*mmHg, %, kPa	Yes
PECO ₂	PECO ₂	Mixed Expired CO ₂	*mmHg, %, kPa	Yes
PEF	PEF	Peak Expiratory Flow	L/min	--
TVin	Vti	Inspired Tidal Volume	L	Yes
TV	Vte	Expired Tidal Volume	L	Yes
MV t	MV	Total Minute Volume	L	--
MV s	--	Spontaneous Minute Volume	L	--
MV m	--	Mechanical Minute Volume	L	--
VCO ₂	VCO ₂	CO ₂ Elimination	ml/min	Yes
VD aw	Vd Aw	Airway Deadspace	ml	--
Respiratory Mechanics Mode only:				--
RAW i	--	Inspired Airway Resistance (Dynamic)	cmH ₂ O/L/S	--
VT alv t	Vt alv	Total Alveolar Tidal Volume	ml	--
VT alv s	--	Spontaneous Alveolar Tidal Volume	ml	--
VT alv m	--	Mechanical Alveolar Tidal Volume	ml	--
MV alv	MV alv	Alveolar Minute Volume (Total)	L	--
VdVtPh	Vd/Vt	Physiologic deadspace to tidal volume ratio		--
Cardiac Output Mode only (requires C.O. Option):				--
C.O.	C.O.	Average Cardiac Output	L/min	--
CO-f	CO-f	Fast-mode Cardiac Output	L/min	--
CI	CI	Cardiac Index	L/min/m ²	--
PCBF	PCBF	Pulmonary Capillary Blood Flow	L/min	--
SV	SV	Stroke Volume	ml	Yes
SVR	SVR	Systemic Vascular Resistance	dynes sec/cm ⁵	Yes

*CO₂ parameters are reported in either mmHg, kPa, or %, depending upon the CO₂ units currently selected for the NM3 monitor.

Transmitted Waveforms

A total of five waveform are transmitted to the Philips Patient Monitor; a maximum of two may viewed at one time.

Label	Waveform	Units
AWF	Airway Flow	L/min
AWP	Airway Pressure	cmH ₂ O
CO ₂	CO ₂ Capnogram	mmHg, %, kPa
PLETH	Plethysmogram	N/A
AWV	Volume	ml

NovaCOM3 Interface Mode

For use with proprietary data acquisition tools and for engineering use. The NovaCOM3 serial interface is designed to output data in formats easily read by a computer or data logging device. The computer interface provides several communication modes to choose from.



Software option installation, software upgrades and remote troubleshooting can be performed via the NovaCOM3 interface. For more information, see "Software Option Installation" on page 179 and "Troubleshooting" on page 161.



ASCII Output

The NM3 monitor must be set to the appropriate interface for output to a serial printer or data collection using a PC. From the **INPUT/OUTPUT SETUP** screen:

- 1 Turn and press the **Knob** to select **RS232-1** or **RS232-2**.
- 2 Turn and press the **Knob** to select:
 - **ASCII OUTPUT 1** to a serial printer
 - **ASCII OUTPUT 2** for data collection using a PC
- 3 Connect the device to the appropriate rear panel connector.

Output to a Serial Printer

For output to a serial printer such a strip chart recorder, configure your serial printer to 9600 bps, no parity, 8 data bits, 1 stop bit. Parameters related to cardiac output will be dashed if the Cardiac Output option is not installed.

An output sample is shown at right:

JUL 6, 2009	9:47:14			
C.O.	C.I.	S.V.	C.O.-f	PCBF
5.2	2.8	69	5.2	4.9
VCO2	MV	Mvalv	Vti	Vte
0	0.0	0.0	0	0
PIP	MAP	PEEP	Cdyn	Raw
23	9	4	27	15
ETCO2	RR	SpO2	PR	
33.9	15	97	75	

Output files for use on a PC

When configured to **ASCII OUTPUT 2**, the NM3 monitor will output a text string that can be imported into a spreadsheet program. Configure your serial device to 19200 bps, no parity, 8 data bits, 1 stop bit.

Data is output once every breath. An output sample is shown below:

10:40:04, PR=75, SPO2=97, RR=20, C.O.=0.0, C.O.-f=0.0, CI=0.0, SV=0, VCO2=429, ETCO2=39, PECO2=32, MV=12.2, MVALV=11.0, Vti=916, Vte=907, Vtalv=546, VdAW=63, PIP=45, MAP=22, PEEP=9, Cdyn=27, Raw=13

Spacelabs Medical Flexport System

The NM3 monitor transmits data to Spacelabs Medical Ultraview Care Network monitors using the Spacelabs Flexport system.

Setup

To set up and connect the NM3 monitor to the Flexport, you will need the following:

- Spacelabs Medical Flexport system
- Interface cable (supplied by Spacelabs Medical)

The NM3 monitor must be set to the appropriate interface for output to the Flexport. From the **INPUT/OUTPUT SETUP** screen:

- 1 Turn and press the **KNOB** to select **RS232-1** or **RS232-2**.
- 2 Turn and press the **KNOB** to select **FLEXPORT**.
- 3 Connect the Flexport interface cable to the rear panel of the NM3 monitor. Tighten screws.
- 4 Refer to the Flexport System Interface document from Spacelabs Medical.

Alerts and Messages

Alarms and messages are transmitted from the NM3 monitor through the Flexport to the UltraView Care system. Alarms and messages can be viewed from either the NM3 monitor or the Flexport. There is no delay in indicating the alarm on the Flexport other than that inherent in the communications interface (less than a two-second delay can be expected).

For more information, refer to the Flexport System Interface document from Spacelabs Medical.

Analog Output

The NM3 monitor directly supports interface to analog devices such as strip chart recorders, etc. with a minimum impedance of no less than 1.5K Ω . Set the monitor to the appropriate interface from the **INPUT/OUTPUT SETUP** screen:

Setup

- 1 Turn and press the **KNOB** to select **ANALOG OUT 1-4**.
- 2 Turn and press the **KNOB** to select the parameters you want from **ANALOG OUT 1-4** (maximum of 1 per), to be transmitted to an analog device.

ETCO₂, SpO₂, resp rate, and pulse rate value outputs are available, as well as CO₂, plethysmogram, flow, and airway pressure waveform data. CO, CI, SV, and PCBF are also available when the Cardiac Output option is installed.
- 3 Calibrate the recorder to the correct voltage levels using the **ANALOG CAL.** setting. Press **ZERO**, **HALF** and **FULL** to set the analog outputs.
 - **ZERO** — 0 volts
 - **HALF** — 0.50 volts
 - **FULL** — 1.00 volts

NOTE: The NM3 outputs a constant non-zero offset of approximately 30mV. Use the calibration value for your data acquisition equipment.
- 4 Analog Output Specifications: Analog Input/Output Port (selectable, 0 to 1 volt range):
 - ETCO₂ - 0-150 mmHg, 0-20 kPa or %, 6.67mV/mmHg
 - SpO₂ - 0-100%, 10mV/%
 - Resp Rate - 0-150 br/min, 6.67mV/br/min
 - Pulse Rate - 0-250 bpm, 4mV/bpm
 - CO₂ Waveform - 0-150 mmHg, 0-20 kPa or %, 6.67mV/mmHg

- Pleth Waveform - auto scaled
- Flow Waveform - -125 to +125 L/m, 4mV/L/m
- Airway Pressure Waveform - -20 to +105 cmH₂O, 8mV/cmH₂O
- C.O. - Cardiac Output, 0-20 L/m, 50mV/L/m (optional)
- CI - Cardiac Index, 0-20 L/min./m², 50mV/L/min./m² (optional)
- SV - Stroke Volume, 0-200 ml, 5mV/ml (optional)
- PCBF - 0-20 L/m, 50 mV/L/m (optional)

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Monitor Interface to V200 or Esprit

Overview

The NICO-Esprit Interface allows the NM3 monitor to exchange information with the Philips V200 or Respironics Esprit ventilators via a bi-directional RS-232 serial link. Through this link, the V200 or Esprit ventilator supplies the NM3 monitor with breath type and FiO₂ information. In turn, the NM3 monitor provides the ventilator with data for trending parameters related to measuring CO₂ elimination (VCO₂).

NOTE: NICO is an acronym for Non-Invasive Cardiac Output.

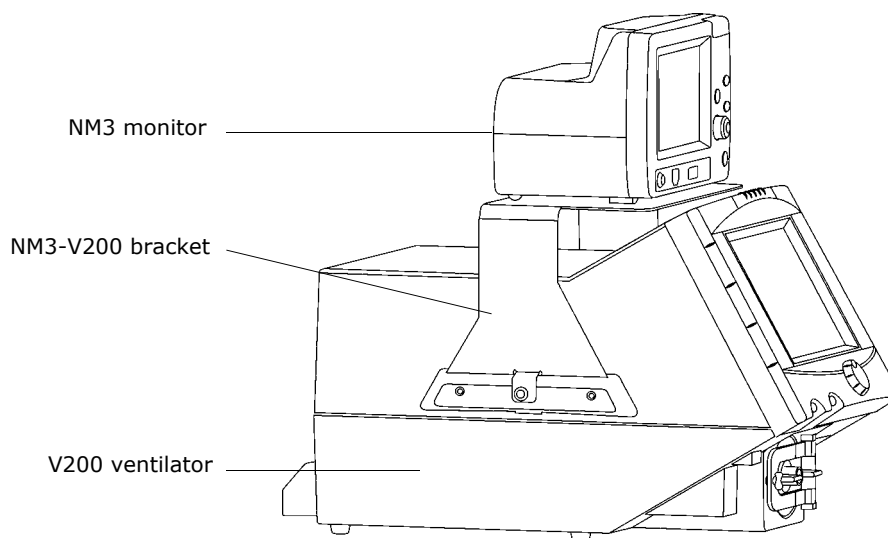
System Requirements

The following hardware and software is required for the proper use of the NICO-Esprit Interface:

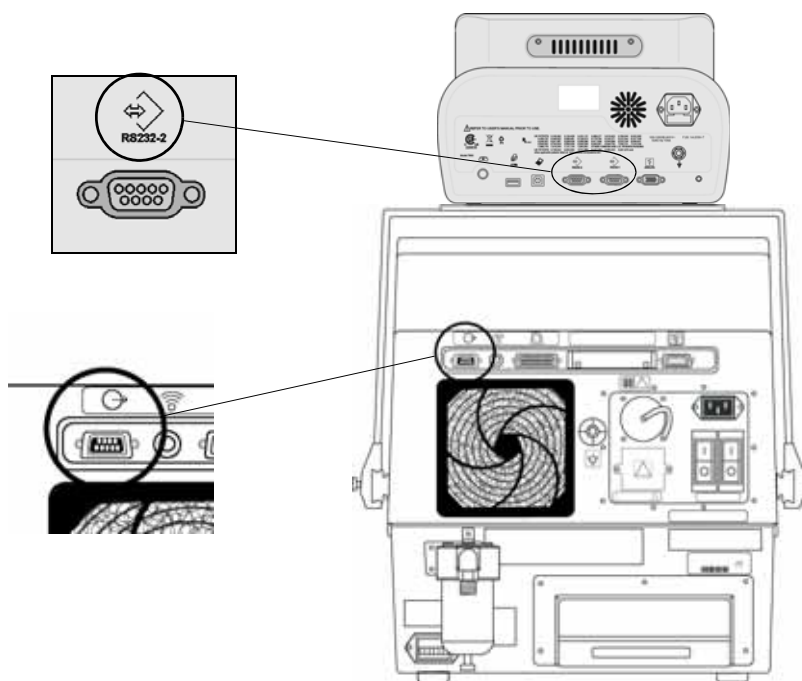
Interface to Esprit or V200: System Requirements	
NM3 monitor	
NM3 Respiratory Profile Monitor with optional Cardiac Output, Model 7900	Part number may vary by country
Esprit or V200 Ventilator	
Trending option loaded and enabled	
V200 ventilator with the NICO-Esprit Interface option loaded and enabled	
or	
Esprit 8.10 or later software with the NICO-Esprit Interface option loaded and enabled	
NOTE: Ventilators with the NICO-Esprit Interface software installed are identified by an option label located near the power switch.	
Accessories	
RS-232 serial communications cable, 3 ft.	PN: 1018292
NOTE: Use only Philips Respironics approved cables when connecting to the Communications port.	
Mounting brackets for monitors:	
Respiratory Profile Monitor Mounting Kit For mounting the NM3 on the V200 ventilator	PN: 1060784
Esprit bracket For mounting the NM3 on the Esprit ventilator	PN: 1013499
NOTE: The NM3 and NICO ₂ monitors can mount on either bracket. The Esprit and V200 brackets each mount only to that ventilator.	

Hardware Setup

- 1 Attach the NM3 monitor to the mounting bracket, then attach the assembly to the ventilator. Assembly instructions are included with the bracket (PN 1060784).



- 2 Attach one end of the RS-232 serial communications cable to the RS232-1 port or the RS232-2 port on the back of the NM3 monitor.
- 3 Attach the other end of the RS-232 serial communications cable to the serial communications port on the back of the V200 or Esprit ventilator. (Please consult the Esprit Operator's Manual for more information on Esprit setup.)



NM3 Monitor Setup

Enabling the NICO-Esprit Interface

- 1 Power up and connect the NM3 monitor following the instructions in "Preparing for Use" on page 45.
- 2 Select the NICO-Esprit interface on the NM3 monitor.
 - Press the **MENU** key to activate the **SELECT A SCREEN** menu.

SELECT A SCREEN	
CO ₂ /SpO ₂	TREND
FLOW/PRESSURE	TABULAR DATA
FLOW/PRES/VOL	VOLUMETRIC CO ₂
VC0 ₂ /MVa1v TREND	SET ALERTS
Vt/Vd TREND	SETUP
NUMERICS	VENTASSIST

- Turn the **KNOB** to highlight **SETUP** and then press the knob. The **SETUP** screen appears.

SETUP	
CO ₂ ZERO NOW	PULSE BEEP: OFF
PURGE NOW	SpO ₂ SENS: NORMAL
SWEEP: MEDIUM	SpO ₂ FASTSAT: OFF
ERASE TRENDS	
INPUT/OUTPUT	
EXIT	

- Turn the **KNOB** to highlight **INPUT/OUTPUT** and then press the **KNOB**. The **INPUT/OUTPUT SETUP** screen appears.

INPUT/OUTPUT SETUP	
ANALOG OUT 1	RS232-1
ANALOG OUT 2	RS232-2
ANALOG OUT 3	
ANALOG OUT 4	
ANALOG CAL.	
EXIT	

- Turn the **KNOB** to highlight **RS232-1** or **RS232-2** and then press the **KNOB**. The selection screen appears.

RS232 -2	
TURN KNOB TO ADJUST	
PUSH KNOB TO ACCEPT	
ESPRIT/V200	

- Turn the **KNOB** to highlight **ESPRIT/V200** and then press the **KNOB**. The **INPUT/OUTPUT SETUP** screen appears.
 - Turn the **KNOB** to highlight **EXIT** and then press the **KNOB**. The monitor returns to the **SELECT A SCREEN** menu.
- 3 The NM3 monitor and the V200 or Esprit ventilator will begin communicating within 60 seconds.

Disabling the NICO-Esprit Interface

To turn off the NICO-Esprit interface, follow the instructions in the previous section, "Enabling the NICO-Esprit Interface". In the RS-232 screen, turn the knob and select any other option. Parameters and alerts that were disabled while the NICO-Esprit interface was active will be restored.

After disabling the NICO-Esprit interface, verify that the alert limits for respiratory rate are still appropriate. Although alert limit settings for the other parameters (SpO₂, EtCO₂, pulse and C.O.), may have been adjusted during the time the NICO-Esprit interface was active, the respiratory rate parameter alerts will still be retained from the last monitoring session that was performed and may no longer be appropriate.

V200 or Esprit Ventilator Setup

For information on ventilator setup, refer to the V200 Operator's Manual (PN 1057983) or the Esprit Operator's Manual (PN 580-1000-01). Or call Philips Respironics Customer Service at 1-800-722-9377.

RS-232 Communications

Information Transfer

The NM3 monitor provides the V200 or Esprit ventilator with the data listed in the following table. The monitor sends the average value for each parameter for the previous 60 seconds.

Information Transferred from the NM3 monitor to the V200/Esprit ventilator	
Data	Description
CO-a	Cardiac Output Average NOTE: Available only when the Cardiac Output option is installed.
SpO ₂	O ₂ Saturation
ETCO ₂	End Tidal CO ₂
VCO ₂	Volume CO ₂
Vtalv	Alveolar Tidal Volume
MValv	Alveolar Minute Volume

The V200 or Esprit ventilator provides the NM3 monitor with the following information.

Information Transferred from the V200/Esprit ventilator to the NM3 monitor	
Breath Type	Mandatory, Assisted, Spontaneous, or Supported
FiO ₂ %	The percentage of oxygen in the gas delivered to the patient. NOTE: If the optional oxygen sensor for the Esprit ventilator is used, this number will be the FiO ₂ % measured by the sensor. If the optional oxygen sensor is not used, this will be the set FiO ₂ %.

Parameter List

When the NICO-Esprit Interface is enabled, the list of parameters displayed on the NM3 monitor is reduced to eliminate redundant parameters. Those parameters will be displayed by the V200 or Esprit ventilator instead of the NM3 monitor.

With the NICO-Esprit Interface active, the monitor will display the following parameters:

Label	Parameter	Range / Units	Description
Displayed NM3 parameters			
ETCO ₂	End Tidal Carbon Dioxide	0-150 mmHg 0-20.0 % 0-20.0 kPa	Maximum CO ₂ plateau value at the end of the breath (reflects alveolar CO ₂)
MV alv	Alveolar Minute Volume	0.05-16 L/min	MV less deadspace ventilation
PeCO ₂	Mixed expired CO ₂	0-100 mmHg, 0-13.2 kPa or %	Volume weighted average CO ₂ in the breath
	Pulse Rate	25-240 bpm	Number of pulse beats per minute
SpO ₂	Oxygen Saturation	0-100 %	Oxyhemoglobin as a percentage of the sum of oxyhemoglobin and deoxyhemoglobin
VCO ₂	Carbon Dioxide Elimination	0-3000 ml/min	Volume of CO ₂ eliminated through the breath each minute
Vd alv	Alveolar deadspace	0-500 ml	Difference between physiologic and airway deadspace
Vd Aw	Airway deadspace	0-500 ml	Total airway deadspace, not including rebreathing loop
Vd/Vt	Deadspace to tidal volume ratio	0-1.00	(PaCO ₂ -PeCO ₂)/PaCO ₂
Vt alv	Alveolar tidal volume	0-2400 ml	Tidal volume less airway deadspace
Additional parameters with Cardiac Output Option installed			
C.O.	Cardiac Output	0.5-19.9 L/min	Volume of blood pumped by the heart each minute
CO-a	Average Cardiac Output	0.5-19.9 L/min	C.O. averaged value.
CO-f	Fast-mode Cardiac Output	0.5-19.9 L/min	Unaveraged C.O. value from the last completed cycle
CI	Cardiac Index	0-9.9 L/min/m ²	C.O. divided by body surface area
PCBF	Pulmonary Capillary Blood Flow	0.5-19.9 L/min	Portion of the cardiac output that is effective in gas exchange
PCBFa	Average Pulmonary Capillary Blood Flow	0.5-19.9 L/min	PCBF averaged value
PCBFf	Fast-mode Pulmonary Capillary Blood Flow	0.5-19.9 L/min	Unaveraged PCBF from last completed cycle
SV	Stroke Volume	0-250 ml	Volume of blood pumped by the heart each beat
SVI	Stroke Volume Index	0-125 ml	Stroke volume divided by body surface area
SVR	Systemic Vascular Resistance	0-9999 dynes sec/cm ⁵	Resistance exerted by the blood vessels on blood flow and is an indicator of left ventricular afterload
SVRI	Systemic Vascular Resistance Index	0-9999 dynes sec/cm ⁵	SVR normalized to body surface area

Parameter Limit Alerts

In NICO-Esprit Interface mode, the NM3 monitor allows for the establishment of high and low limit alerts for Cardiac Output (C.O., Cardiac Output mode only), CO₂ elimination (VCO₂, Respiratory Mechanics mode only, adult and pediatric only), End-Tidal Carbon Dioxide (ETCO₂), Oxygen Saturation (SpO₂), and Pulse Rate (♥). These alerts provide a visual (and audible, if desired) indication to the user that a parameter has violated the limit settings.

Respiratory Mechanics mode			Cardiac Output mode (optional)		
Parameter	Range	Units	Parameter	Range	Units
VCO ₂	OFF, 20 - 999	mL/m	C.O.	OFF, 0.1 - 19.9	L/m
ETCO ₂	OFF, 1 - 150 OFF, 0.1 - 19.9 OFF, 0.1 - 19.9	mmHg kPa %	ETCO ₂	OFF, 1 - 150 OFF, 0.1 - 19.9 OFF, 0.1 - 19.9	mmHg kPa %
SpO ₂	OFF, 50 - 100	%	SpO ₂	OFF, 50 - 100	%
♥ (Pulse Rate)	OFF, 31 - 249	bpm	♥ (Pulse Rate)	OFF, 31 - 249	bpm

NOTE

When the NICO-Esprit Interface is enabled, the Respiratory Rate alert (RR) is not available as a NM3 monitor function. Respiratory rate parameters and alerts will be provided by the V200 or Esprit ventilator.

For information on setting and adjusting alert functions, refer to "Alerts" on page 99.

NICO-Esprit Messages

When the NICO-Esprit Interface is enabled, the monitor will display a CHECK COMMUNICATION status message if the monitor and ventilator are not communicating. See the Troubleshooting section in this chapter for information on how to correct this condition.

(Alert Class: S-Status Alert. See "Alert Priorities" on page 99 for details.)

General Message Area	Message Description	Alert Class
CHECK COMMUNICATION	The monitor is unable to establish RS-232 communication with the V200 or Esprit ventilator. Displayed in NICO-Esprit Interface mode only.	S

Monitoring Screens

When the NICO-Esprit interface is enabled, the screen set normally available from the NM3 monitor is reduced. Redundant parameters are eliminated, since that data will be provided by the V200 or Esprit ventilator.

For more information on how to navigate the monitoring screens, see "Navigating in Respiratory Mechanics mode" on page 15 or "Navigating in Cardiac Output mode" on page 21.

Respiratory Mechanics Mode Screens

When the NICO-Esprit interface is enabled, the available monitoring and setup screens in Respiratory Mechanics mode include CO₂/SpO₂, VOLUMETRIC CO₂, VCO₂/MValv TREND, TREND, TABULAR DATA, VENTASSIST, SET ALERTS and SETUP.

Cardiac Output Mode Screens

When the cardiac output option is installed and the NICO-Esprit interface is enabled, the available monitoring and setup screens in Cardiac Output mode include C.O. TREND, REBREATHING CURVES, CO₂/SpO₂, VOLUMETRIC CO₂, VCO₂/MValv TREND, TREND, TABULAR DATA, SVR CALCULATION, VENTASSIST, SET ALERTS and SETUP.

DATA ENTRY Screen

The inspired O₂ selection (INSP O₂) in the **DATA ENTRY** screen is dimmed and unavailable when the NICO-Esprit interface is enabled. However, the NM3 monitor will continue to display the patient's current inspired oxygen; the displayed value is the same as that displayed by the V200 or Esprit ventilator.

For more information on how to navigate the **DATA ENTRY** screens, see "DATA ENTRY key Screen Displays" on page 25, or page 18.

SETUP Screen

The **SET SPON THRESH** setting is not available when the NICO-Esprit interface is enabled. The breath type information is received from the V200 or Esprit ventilator. If the ventilator is not connected, a default value of 6 cmH₂O is used.

Troubleshooting

Troubleshooting		
Condition:	Probable Cause:	What to Do:
The message CHECK COMMUNICATION is displayed on the NM3 monitor.	The bi-directional communication link is not functioning properly.	Check cable connections to be sure they are connected to the correct locations: the 9-pin D-connectors on the back of the NM3 monitor and the back of the ventilator. Check that the RS-232 serial communications cable (REF 1018292) is being used. Esprit only: Check ventilator for correct software version, 8.10 or later. See the NICO-Esprit Interface Option insert (REF 1018429) for instructions on how to check the software version, or contact Philips Respironics Technical Service: 1-800-722-9377. If the condition persists, contact Philips Respironics Technical Service: 1-800-722-9377.

Troubleshooting		
Condition:	Probable Cause:	What to Do:
	Ventilator is in Diagnostic Mode	Communications are interrupted when the ventilator is in Diagnostic Mode. The message will disappear when the ventilator exits Diagnostic mode.
Ventilator not capturing data sent from NM3 monitor.	The bi-directional communication link is not functioning properly.	Check cable connections to be sure they are connected to the correct locations: the 9-pin D-connector on the back of the monitor and the back of the ventilator. Check that the RS-232 serial communications cable (REF 1018292) is being used. Esprit only: Check ventilator for correct software version, 8.10 or later. See the NICO-Esprit Interface Option insert (REF 1018429) for instructions on how to check the software version, or contact Philips Respironics Technical Service: 1-800-722-9377. If the condition persists, contact Philips Respironics Technical Service: 1-800-722-9377.
	NM3 monitor may not have the RS-232 V200/Esprit interface enabled.	Enable the NICO-Esprit interface. See instructions in "NM3 Monitor Setup" on page 157.
		Contact Philips Respironics Technical Service: 1-800-722-9377.
NICO button does not appear on the ventilator Trended Data screen.	Ventilator may not have NICO-Esprit interface software. (For Esprit, this option requires software version 8.10 or later.)	Check for the NICO-Esprit option label located near the power switch:
		 or  Contact Philips Respironics Technical Service: 1-800-722-9377.
NICO button on the ventilator is dimmed.	NICO-Esprit Interface option is loaded but not enabled.	Contact Philips Respironics Technical Service: 1-800-722-9377.
Any other condition		Contact Philips Respironics Technical Service: 1-800-722-9377.

Maintenance

This section details routine maintenance procedures for the NM3 monitor, its sensors and accessories.

Cleaning

To clean the monitor and its accessories:

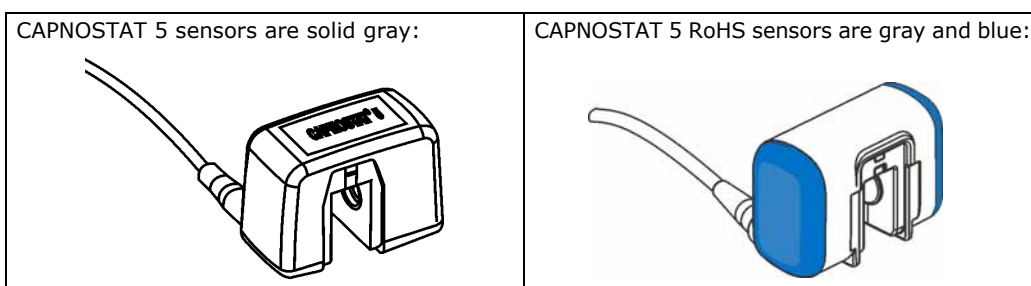
NM3 monitor

- Do not immerse the monitor. Do not sterilize the monitor.
- Turn the monitor off and unplug from the AC power source before cleaning.
- The monitor can be cleaned by wiping with solutions such as a 70% isopropyl alcohol or 10% aqueous bleach solution. Then wipe down with a water dampened clean cloth to rinse. Dry before use.
- Do not spray cleaning agents directly into the patient sensor connector receptacles. Disconnect sensors from the monitor before cleaning.

CAPNOSTAT 5 CO₂ Sensors

The CAPNOSTAT 5 and CAPNOSTAT 5 RoHS sensors have different cleaning requirements. The ROHS-compliant CAPNOSTAT 5 can be cleaned with a wider range of cleaners.

How to identify your sensor:

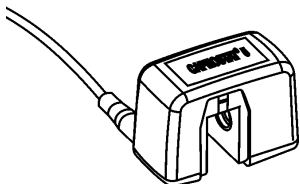
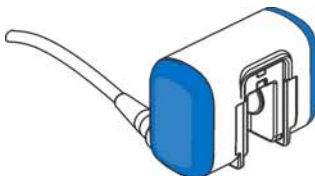


Cleaning the exterior of CAPNOSTAT 5 Sensors and cables:

- Do not immerse the sensor. Do not sterilize the sensor.
- Disconnect sensor from the monitor and allow to cool to room temperature for 30 minutes before cleaning.
- Do not use abrasive cleaners or strong solvents. Small quantities of unapproved cleaners may damage product, shorten lifetime, or cause safety hazards.
- Keep all cleaning agents away from the sensor's electrical connections.
- Use a cloth dampened with any of the approved cleaning agents listed below
- Wipe down with a water dampened clean cloth to rinse. Make certain that the sensor windows are clean and dry before reuse.
- Do not pull or stretch the cable while cleaning.



CAUTION
Use only the approved cleaners listed below. Unapproved cleaners can damage the sensor. Do not use the CAPNOSTAT 5 RoHS cleaners on the standard CAPNOSTAT 5 sensor.

APPROVED CLEANERS	
	
CAPNOSTAT 5 Sensor	RoHS-compliant CAPNOSTAT 5 Sensor
Isopropyl alcohol 70%	Isopropyl alcohol 70%
A 10% aqueous solution of 6% chlorine bleach	A 10% aqueous solution of 6% chlorine bleach
Steris Coverage [®] Spray HB Clinell Wipes [®]	Steris Coverage [®] Spray HB Clinell Wipes [®]
PDI Sani Cloth Bleach [®]	PDI Sani Cloth Bleach [®]
PDI Super Sani Cloth AF [®]	PDI Super Sani Cloth AF [®]
PDI Sani Cloth HB Wipes [™]	PDI Sani Cloth HB Wipes [™]
Speedy Clean [™]	Speedy Clean [™]
Tuffie [™]	Tuffie [™]
Tuffie 5 [™]	Tuffie 5 [™]
WIP Anios [™]	Accel TB RTU*
	Bacillol 30 Foam*
	Bacillol AF*
	Caltech-Dispatch 5200 Wipes*
	Hydrogen Peroxide*
	Meliseptol*
	Metrex CaviWipes 1*
	Oxivir TB Wipes*
	PDI Sani-Cloth Plus Germicidal Wipes*
	PDI Super Sani Cloth*
	Revital-Ox Resert [™] XL HLD*
	Sporox [™] II Sterilizing & Disinfecting Solution*
	Viraguard [®] Isopropanol 70%*
	Virex Tb*
	Wipes Plus [®] Disinfecting Wipes (Item # 74402)*
	Lysoformin*
	Descosept Pur*
	Oxygenon Liquid*
	Big Spray New*
	Dismozon Plus*

*NOTE: These cleaners have been tested and approved for the CAPNOSTAT 5 RoHS Sensor only!

NOTE: The manufacturer's warranty does not cover damage caused by using unapproved cleaners.

LoFlo C5 CO₂ Sensor

General guidelines for cleaning the CAPNOSTAT 5 LoFlo Sensor and cable:



CAUTION

Disconnect sensor from the monitor and allow to cool to room temperature before cleaning.

Use only the approved cleaners listed below.

Do not use abrasive cleaners or strong solvents. Small quantities of unapproved cleaners may damage product, shorten lifetime, or cause safety hazards.

Do not immerse the sensor. Do not sterilize the sensor.

Keep all cleaning agents away from the LoFlo sensor's sample cell receptacle and electrical connections.

Do not pull or stretch the cable while cleaning.

The LoFlo C5 case, cable and connector can be cleaned by the following methods:

- 1 Use a cloth dampened with isopropyl alcohol 70%, a 10% aqueous solution of 6% chlorine bleach, a 2% glutaraldehyde solution, ammonia, mild soap or spray cleaner such as Steris Coverage® Spray HB.
- 2 Wipe down with a water dampened clean cloth to rinse and dry before use.
- 3 Make certain that the sensor windows are clean and dry before reuse.

NOTE: The manufacturer's warranty does not cover damage caused by using unapproved cleaners.

Cardiac Output Sensor

Treat the Cardiac Output Sensor in accordance with hospital protocol for single-patient use items.

CO₂/Flow Sensors

Treat CO₂/Flow sensors in accordance with hospital protocol for single-patient use items.

SpO₂ Sensors

See cleaning instructions in the directions for use for the Masimo sensors and related accessories. Disconnect sensor from the monitor before cleaning.

CAPNO₂mask and CO₂ airway adapters

Treat masks and airway adapters in accordance with hospital protocol for single-patient use items.

Reusable airway adapters

General guidelines for cleaning and sterilizing reusable airway adapters. The following adapters can be cleaned and sterilized for re-use:

Part Number	Airway Adapter Type
7007-01	Adult - Reusable
7053-01	Neonatal - Reusable

Cleaning reusable adapters

NOTE

DO NOT insert any object, such as a brush, into the airway adapter. Irreparable damage may occur to the CO₂ windows.

- 1 Wash the airway adapter with a warm soapy solution, being sure to completely clean the inside and outside surfaces.
- 2 Rinse the airway adapter in clean water, then soak in one of the liquid disinfectants listed below:
 - Isopropyl alcohol 70%
 - 10% aqueous solution of chlorine bleach
 - Glutaraldehyde 2.4% solution such as Cidex®
 - Peracetic Acid such as Steris System 1®
- 3 Rinse thoroughly with sterile water and allow to dry completely.
- 4 Before reuse, ensure the windows are dry and residue free and that the adapter has not been damaged during handling or the cleaning process.
- 5 After cleaning, the reusable airway adapter can be *sterilized* using approved sterilization methods listed below.

Sterilizing reusable adapters

- 1 Before reusable adapters can be sterilized, they must be *cleaned* using the methods listed above.
- 2 Sterilize using one of the following methods:

Adult Airway Adapters	
Method	Approved Temperature / Time
ETO	38°C, 3 hours
Steam Autoclave	121°C, 20 min
Steam Autoclave	134°C, 20 min
3.4% Glutaraldehyde	20°C ±5 ° C, 10 hours

Neonatal Airway Adapters ^a	
Method	Approved Temperature / Time
ETO	38°C, 3 hours
3.4% Glutaraldehyde	20°C ±5 ° C, 10 hours

a Neonatal adapters are not intended for use with steam sterilization

- 3 Allow the reusable airway adapter to cool and dry entirely in a clean and dry environment. Caution: Allow any liquid to evaporate entirely.
- 4 Examine the reusable airway adapter. Ensure the windows are dry and residue free and that the adapter has not been damaged during handling or the sterilization process.

Mounting Instructions

NICO Rollstand

Required equipment and tools:

- NICO Rollstand, PN 989805613301 (Cat. No. 1043409)
- The packaged rollstand includes assembly instructions and all required tools.

To mount the NM3 monitor on the rollstand:

- 1 Position the monitor on the top plate.
- 2 Use the thumb-screws in the plate to engage the bottom bosses (raised, threaded screw holes).
- 3 Tighten to secure.

GCX Instrument Rollstand

Required equipment and tools:

- Instrument Rollstand with basket, PN 989805643911 (Cat. No. 140098)
 - Adapter plate kit for NICO, PN 989805613531 (Cat. No. 140101)
 - Phillips screwdriver
 - 1/2" (13mm) wrench
 - Four #8-32 x 3/8" screws (included with adapter plate)
- 1 Assemble the instrument rollstand according to its assembly instructions.
 - 2 Invert the NM3 monitor so the bottom is exposed and place onto a padded surface.
 - 3 Locate the four screw bosses (raised, threaded screw holes) on the bottom cover. Attach the adapter plate to the bosses with the #8-32 x 3/8" screws.
 - 4 Turn the NM3 monitor right-side up and place onto the rollstand.
 - 5 Connect the assembled NM3 monitor with adapter plate to the rollstand by pressing the spring-loaded plunger. Then slide the adapter plate into the mounting plate on the top of the rollstand. Release the plunger to engage the retaining hole in the adapter plate.

GCX Instrument Mounting Systems

An adapter plate is available to allow the NM3 monitor to mount on a variety of mounting solutions from GCX Corporation.

Required Equipment and tools:

- Adapter Plate Kit, for NICO Style, PN 989805613531 (Cat. No. 140101)
- Phillips screwdriver

Adapter Plate Mounting Instructions:

- 1 Invert the NM3 monitor so the bottom is exposed and place onto a padded surface.
- 2 Locate the four screw bosses (raised, threaded screw holes) on the bottom cover. Attach adapter plate to the bosses with the included #8-32 x 3/8" screws.
- 3 Connect the assembled NM3 monitor with adapter plate to the rollstand by pressing the spring-loaded plunger. Then slide the adapter plate into the mounting plate on the top of the rollstand. Release the plunger to engage the retaining hole in the adapter plate.

Other mounting options

The bottom cover of the NM3 monitor includes four screw-bosses that allow for mounting. These screw-bosses accept a #8-32 machine screw.

WARNING: Verify that the NM3 monitor is securely attached to the mounting surface to prevent damage to the device or injury to the patient or operator.

CAUTION: Do not use any screw that engages more than 5/8" (16 mm) into the screwboss. Using screws that are too long may damage the monitor case.

Monitor Maintenance Schedules

The NM3 monitor performs a diagnostic self-test at power-up that checks the internal electronics. If this self test fails, the normal monitoring display will not appear. Remove the NM3 monitor from use and contact qualified service personnel.

The NM3 monitor should undergo inspection and safety checks on a regular basis or according to institutional protocol. A Service Manual (Catalog No. 1051673) containing information to assist qualified service personnel is available.

Battery Maintenance

The monitor may not power up on battery power if the battery is not sufficiently charged. If the NM3 monitor has not been used or powered by the AC Mains for an extended time—3 months or more—allow the battery to charge for 12 hours before use. (The internal battery may slowly discharge over long periods of non-use.)

To charge the battery, connect the line cord to an AC source. Check that the AC Mains Power Indicator on the front panel is illuminated (green). Allow the battery to charge for 12 hours or until the battery charger icon is illuminated green. (Refer battery replacement to qualified service personnel.)

If the battery charger indicator on the front panel is illuminated red, the battery charger may be disabled. To resolve the issue:

- Try unplugging and reconnecting AC Mains power to reset the battery charger.
- If the ambient environment is too cold or too hot, the battery charger will be disabled. Place the monitor in an ambient environment between 10 C and 40 C.
- If the indicator continues to display red, the battery may be too discharged, or has suffered damage and cannot be recharged. Contact Philips Respironics Customer Service at 1-800-722-9377 for a replacement battery. Refer battery replacement to qualified service personnel.

WEEE/RoHS Recycling Directives

Waste electrical and electronic equipment and restriction of the use of certain hazardous substances in electrical and electronic equipment (WEEE/RoHS) recycling directives.



Compliant with the WEEE/RoHS recycling directives.

If you are subject to the WEEE/RoHS directives, refer to www.healthcare.philips.com/main/about/sustainability for the passport for recycling this product.

Specifications

General

Specifications for the NM3 monitor, Model 7900, are listed for informational purposes only and are subject to change without notice.

CO₂

- Principle of Operation: Non-Dispersive Infrared (NDIR) absorption, dual wavelength ratiometric-single beam optics, mainstream sensor.
- Gas composition effects: O₂, N₂O (operator selectable)
- CAPNOSTAT 5 CO₂ Sensor:
 - Response Time: Less than 60 ms
 - Weight: Less than 18 g without cable
 - Sensor Size: 1.3 x 1.67 x .85 inches (3.3 x 4.2 x 2.2 cm), 8 foot cable (2.44 m)
 - Construction: Durable high performance plastic, ultra-flexible cable. Shock Resistant: Sensor will withstand a 6 foot drop to a tile floor. IPX4 rated.
- LoFlo C5 CO₂ Sensor:
 - Response Time: 3 seconds for on-airway adapter kits. Additional 30 ms for sidestream sampling cannulas.
 - Module weight is less than .5 lbs
 - Module Size: 3.28 x 2.46 x 1.46 inches [83.3 x 62.5 x 37.1 mm], 20 inch (.5 m)
 - Construction: Durable high performance plastic, ultra-flexible cable. IPX4 rated.
- End Tidal CO₂:
 - Range: 0-150 mmHg, 0-20 kPa or 0-20 % at Pb 760 mmHg
 - Accuracy: ± 2 mmHg for 0-40 mmHg, ± 5% of reading for 41-70 mmHg, ± 8% of reading for 71-100 mmHg, ± 12% of reading for 101-150 mmHg
- Respiratory Rate:
 - Range: 2-150 breaths/min
 - Accuracy: ± 1 breath/min

Flow

- Flow Range (L/min) at Pb 760 mmHg, room air, 35°C
 - Adult: 2 to 180
 - Pediatric: .5 to 100
 - Neonatal: .25 to 25
- Flow Accuracy: Greater of ± 3% reading or:
 - Adult: .5 L/min
 - Pediatric: .25 L/min
 - Neonatal: .125 L/min
- Tidal Volume Range (ml)
 - Adult: 200 to 3000
 - Pediatric: 30-400
 - Neonatal: 1-100
- Pressure drop:
 - Adult: 2.1 cmH₂O at 60 LPM
 - Pediatric: 2.1 cmH₂O at 30 LPM
 - Neonatal: 3.1 cmH₂O at 10 LPM
- Airway Pressure Range (cmH₂O): ± 120
 - Accuracy: greater of 0.5 cmH₂O or ± 2% reading
- Gas composition effects: O₂, anesthetic agent, CO₂, N₂O, N₂, He (operator selectable)

SpO₂

- Measurement range:
 - Oxygen Saturation (%SpO₂): 0-100%
 - Pulse Rate: 25-240 beats per minute (bpm)
 - Perfusion Index: 0.02%-20%
 - Response Time: <1 second delay

- Saturation :
 - Saturation accuracy specified from: 70% to 100%
 - No motion (A_{RMS}): adults, pediatrics ± 2 bpm, neonate ± 3 bpm
 - Motion (A_{RMS}): adults, pediatrics, neonate ± 3 bpm
 - Low perfusion (A_{RMS}): adults, pediatrics ± 2 bpm; neonate ± 3 bpm
- Pulse Rate Accuracy:
- Pulse Rate accuracy specified from:
 - 25-240 beats per minute (bpm)
 - No motion (A_{RMS}): adults, pediatrics, neonate ± 3 bpm
 - Motion (A_{RMS}): adults, pediatrics, neonate ± 5 bpm
 - Low perfusion (A_{RMS}): adults, pediatrics, neonate ± 3 bpm
- Resolution:
 - Saturation ($\%SpO_2$): 1%
 - Pulse Rate (bpm): 1 bpm
 - Averaging Mode: 2, 4, 8, 10, 12, 14, 16 seconds.
 - Sensitivity: Normal, Maximum or APOD

Cardiac Output (Optional)

- Measurement Frequency: Rebreathing cardiac output measurement made every three minutes, rebreathing period is 35 seconds.
- Cardiac Output Range: 0.5-19.9 liters/minute
- Cardiac Output Resolution: 0.1 liters/minute
- Pulmonary Capillary Blood Flow (PCBF) Range: 0.5-19.9 L/min, Resolution: 0.1 L/min
- Cardiac Index Range: 0-9.9 L/min/meter², Resolution: 0.1 L/min/meter²
- Stroke Volume Range: 0-250 ml, Resolution: 1 ml
- Rebreathing Valve/sensor:
 - Valve type: dual diaphragm, pneumatically controlled
 - Return spring: automatically returns valve to normal position
 - Resistance: 3 cmH₂O/L/min maximum
 - Rebreathed volume: normal position 35 ml; rebreathing position 150-450 ml (std.)
 - CO₂/flow sensor: integrated into valve assembly
- Parameter limits for cardiac output measurements:
 - VCO₂: >20 ml/min
 - RR: >3, <60
 - Vt: >200 (small and standard), >400 (large)
 - ETCO₂: >15, <85 mmHg (<100 mmHg during rebreathing)
>2.0, <11.5 kPa or % (<13.5 kPa or % during rebreathing)

VentAssist (Optional)

- Parameter limits for VentAssist measurements:
 - Pplat: 0 – 99 cmH₂O, 0 – 99 HPa
 - V_T/kg: 0 – 25 ml/kg (ideal body weight)
 - RR: 2 – 120 breath/min
 - WOB/min: 0 – 25 J/min
 - ETCO₂: 0 – 150 mmHg, 0 – 20.0%, 0 – 20.0 kPa
 - SpO₂: 0 – 100%

Monitor Specifications

- Classification (IEC60601-1): Class I/internal power source, type BF, continuous operating mode, enclosure protection rating IPX0.
- Operating Environment: 50-104° F (10-40° C), 10-90% relative humidity (non-condensing)
- Barometric Pressure: Storage range 500 - 1060 hPa (375 to 800 mmHg), Operating range 533 - 1060 hPa (400 - 800 mmHg)
- Transport/Storage: -30 to +60° C (-22 to 140° F), 10-90% relative humidity non-condensing
- Size: Height 8.25 in., Width 11.5 in., Depth 9.25 in.
- Weight: 9 lbs, 10 oz.
- Audio: Alarm volume is adjustable between approximately 45 - 85 dB.
- Power: 100-230 V~ 50/60 Hz 70VA
- Fuse Rating: F 2X: 1A 250V~T
- Battery: Internal, Sealed lead-acid gel-cell, 45 minute life on full charge (on-screen life indicator), 4 to 8 hour recharge time.
- Display: 6 x 4.5 inch color TFT LCD, 640 x 480 pixels
- Electromagnetic Emissions: Conforms to the EMC requirements of the Medical Device Directive 93/42/EEC, CISPR Class A. Tested to EN55011 and CISPR11 .
- Electromagnetic Immunity: Conforms to the EMC requirements of the Medical Device Directive 93/42/EEC. Tested to IEC60601-1-2, IEC61000-4-2 ESD, IEC61000-4-3 RF, IEC61000-4-4 EFT, IEC61000-4-5 Surge, IEC61000-4-6 Conducted RF, IEC61000-4-8 Magnetic Fields, IEC61000-4-11 Voltage Dips, Interruptions and Variations, IEC61000-3-2 Harmonic Distortion, IEC61000-3-3 Voltage Fluctuations and Flicker.

RS232 Communications

- RS232 Communications Ports:

Pin #	RS232-1	RS232-2
2	Rx	Rx
3	Tx	Tx
5	Ground	Ground
7	RTSA	RTSB
8	CTSA	CTSB
9	n/a	n/a

Analog Specifications

- Analog Output Port (selectable, 0 to 1 volt range):
 - ETCO₂ - 0-150 mmHg, 0-20 kPa or %, 6.67mV/mmHg
 - SpO₂ - 0-100%, 10mV/%
 - Resp Rate - 0-150 br/min, 6.67mV/br/min
 - Pulse Rate - 0-250 bpm, 4mV/bpm
 - CO₂ Waveform - 0-150 mmHg, 0-20 kPa or %, 6.67mV/mmHg
 - Pleth Waveform - auto scaled
 - Flow Waveform - -125 to +125 L/m, 4mV/L/m
 - Airway Pressure Waveform - -20 to +105 cmH₂O, 8mV/cmH₂O
 - C.O. - Cardiac Output, 0-20 L/m, 50mV/L/m (optional)
 - CI - Cardiac Index, 0-20 L/min./m², 50mV/L/min./m² (optional)
 - SV - Stroke Volume, 0-200 ml, 5mV/ml (optional)
 - PCBF - 0-20 L/m, 50 mV/L/m (optional)

Pin#	Description	Pin #	Description
1	Ground	9	Ground
2	Ground	10	Ground
3	Ground	11	Channel 1 - output
4	Ground	12	Channel 2 - output
5	Ground	13	Channel 3 - output
6	Ground	14	Channel 4 - output
7	Ground	15	Output Sense - (must tie to ground)
8	Ground		

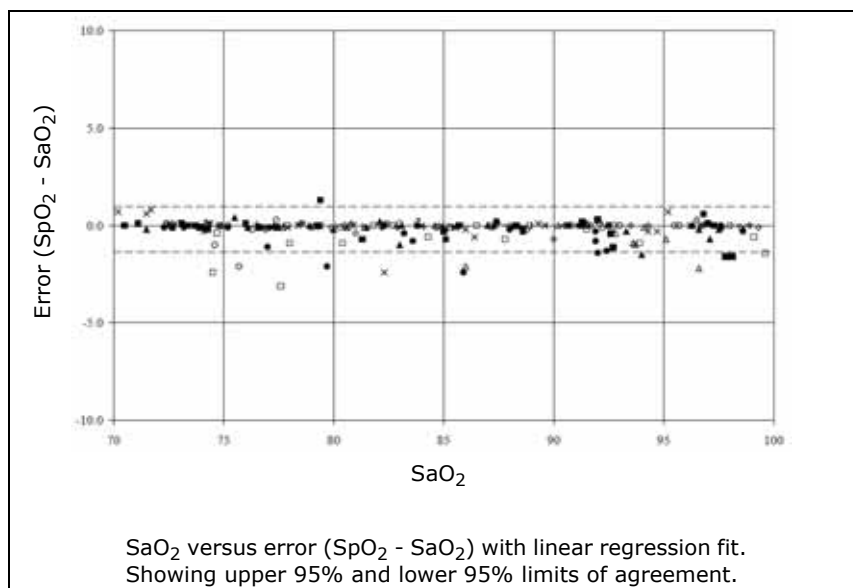
Clinical Validation Studies

Masimo SpO₂

LNCS DCI Adult Reusable Finger Sensor

The table below provides A_{RMS} (Average Root Mean Square) values measured using the Masimo LNCS DCI Adult Reusable Finger Sensor with Masimo SET Oximetry technology in a clinical study.

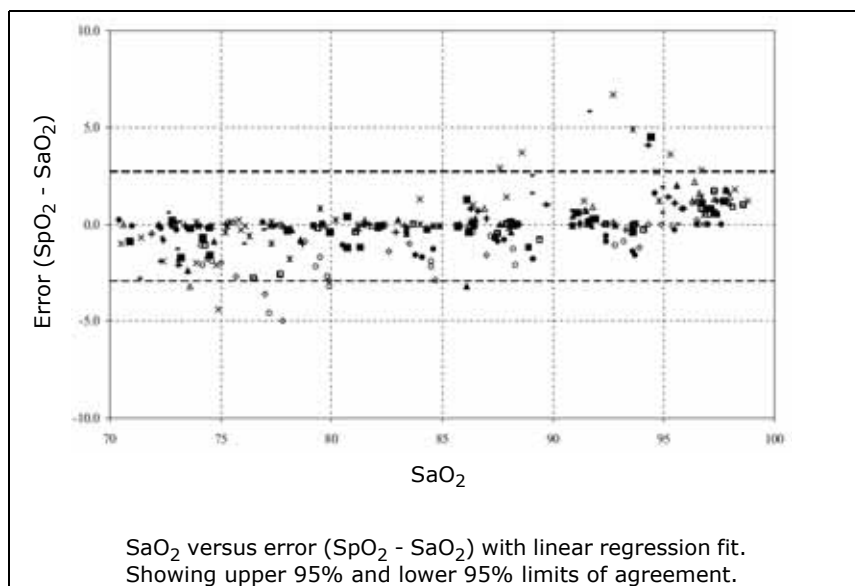
Measured A _{RMS} Values	
Range	A _{RMS}
90% - 100%	0.6%
80% - 90%	0.5%
70% - 80%	0.7%
Overall Claimed Accuracy Value	
70% - 100%	±2%



LNCS A_{dtx}/P_{dtx} Adult/Pediatric Adhesive Sensor, 18 in.

The table below shows A_{RMS} (Average Root Mean Square) values measured using the Masimo LNCS A_{dtx} Adult Adhesive Sensor with Masimo SET Oximetry technology in a clinical study.

Measured A_{RMS} Values	
Range	A_{RMS}
90% - 100%	1.64%
80% - 90%	1.07%
70% - 80%	1.55%
Overall Claimed Accuracy Value	
70% - 100%	$\pm 2\%$

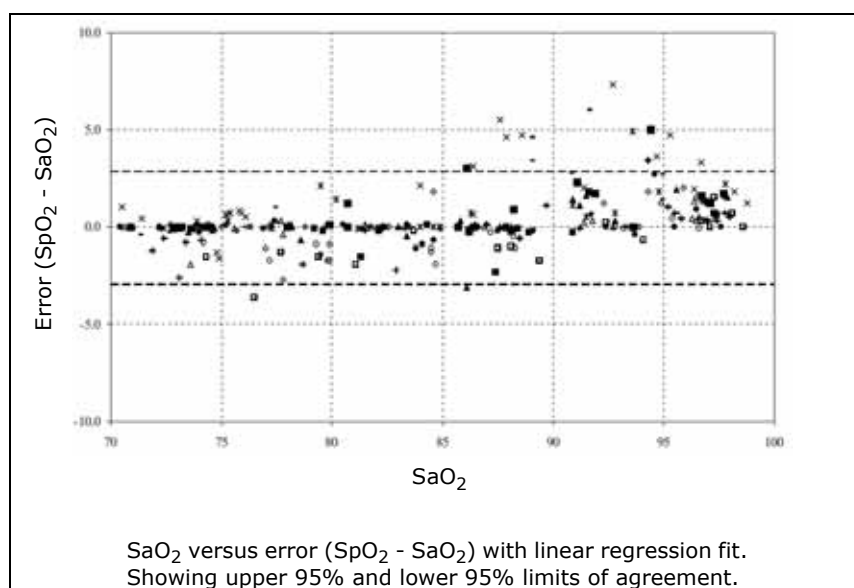


LNCS Neo Neonate Adhesive Sensor, 18 in.

The table below shows A_{RMS} (Average Root Mean Square) values measured using the Masimo LNCS Neo Neonate Adhesive Sensor with Masimo SET Oximetry technology in a clinical study.

Measured A _{RMS} Values			
Range		A _{RMS}	
90% - 100%		1.85%	
80% - 90%		1.44%	
70% - 80%		0.89%	
Overall Claimed Accuracy Value			
	Inf	Neo *	NeoPt*
70% - 100%	±2%	±2% Adult ±3% Neonatal	±3%

* The saturation accuracy of the Neonate and Preterm sensors were validated on adult volunteers and 1% was added to account for properties of fetal hemoglobin.

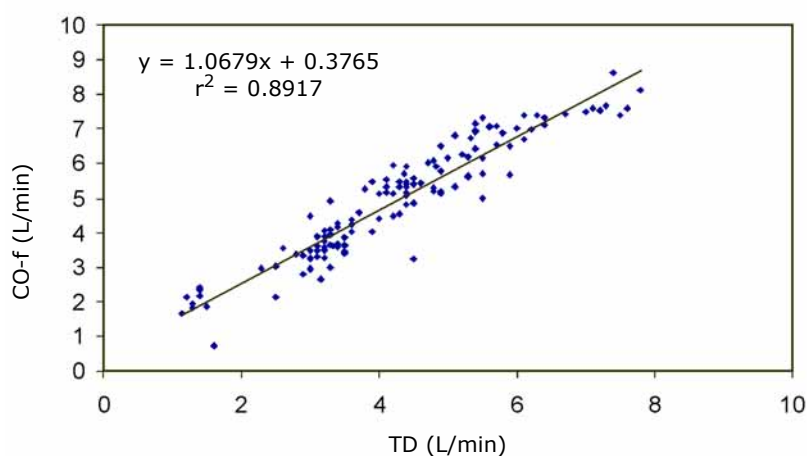


Cardiac Output

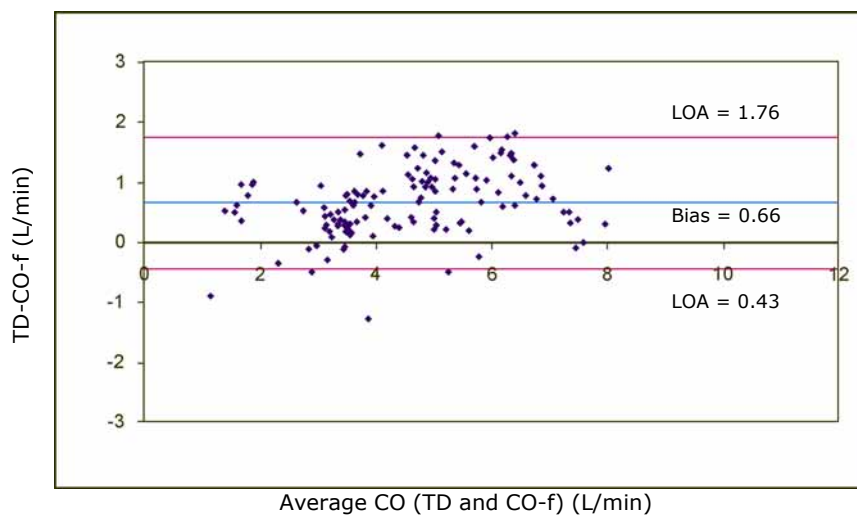
Since the introduction of the non-invasive cardiac output (NICO) system in 1999, over one hundred and fifty supporting clinical literature papers and abstracts have been published. These include the following papers:

- Jaffe¹ summarized the algorithms and performance of the original NICO system.
- Haryadi et al.² reviewed the early animal and patient studies.
- Botero et al.³ demonstrated good agreement in 68 patients undergoing elective CABG between the NICO system and the gold standard aortic transit-time ultrasound measurement pre and post CABG (Pre: $0.04 \text{ L/min} \pm 1.07 \text{ L/min}$, post: $-0.46 \text{ L/min} \pm 1.06 \text{ L/min}$).
- Young and Low⁴ summarized the clinical literature for the device.

An internally sponsored validation study in 2009 compared partial CO₂ rebreathing cardiac output as implemented in the NM3 respiratory profile monitor to average CCO (continuous cardiac output) as calculated by the Edwards Vigilance monitor in five pigs. Linear regression and Bland-Altman plots for the data are shown below.



Linear regression of partial rebreathing cardiac output (CO-f) and CCO thermolulution.

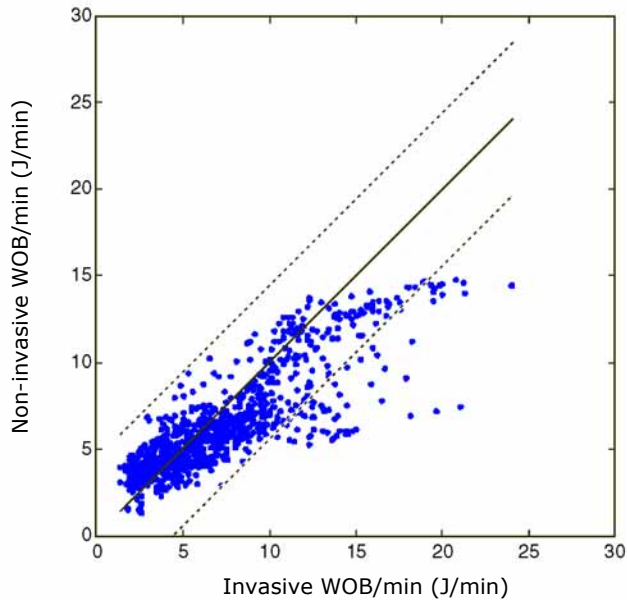


Bland-Altman plot of partial rebreathing cardiac output (CO-f) and CCO thermolulution.

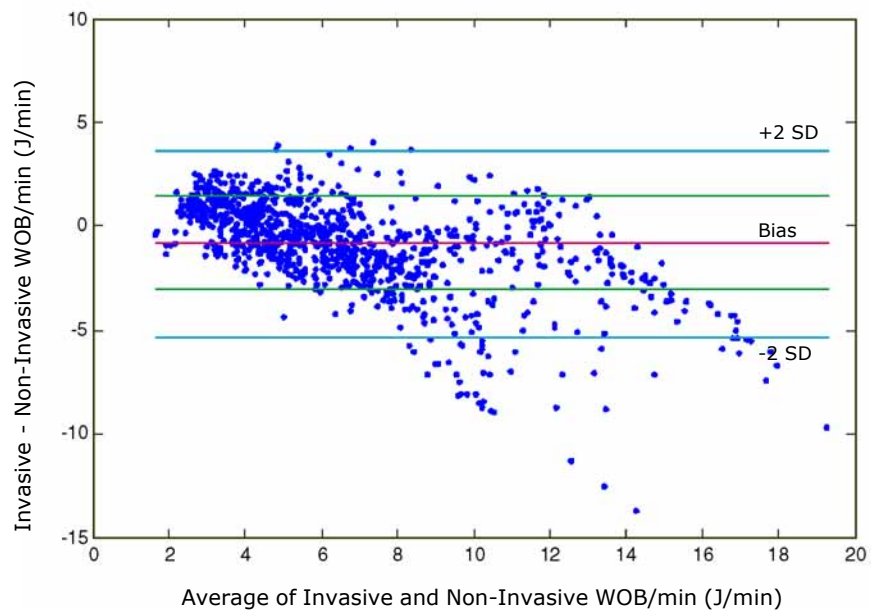
WOB/min

Validation of the work of breathing per minute parameter (i.e. power of breathing) consisted in part of comparing non-invasive measure of WOB/min, based upon derived parameters from the flow and pressure waveform data, to the invasive measurement using esophageal manometry.

An internally sponsored validation study recorded data from mechanically ventilated adult patients in the ICU. Patients were receiving pressure support ventilation with or without IMV (less than 4 breaths per minute). Linear regression and Bland-Altman plots for the data are shown below.



Non-invasive vs Invasive WOB/min ($r^2 = 0.73$) with lines for ± 2 standard deviations



Bland-Altman plot of invasive and non-invasive measurements of WOB/min (bias 0.84 and precision of ± 2.2 J/min).

VentAssist

The VentAssist Option rule set was evaluated in clinical studies⁵ and is classified into ten different recommendations:

- Increase PSV
- Consider Increasing PSV
- Maintain PSV
- Consider Decreasing PSV
- Decrease PSV
- Increase Minute Ventilation
- Maintain Minute Ventilation
- Decrease Minute Ventilation
- No Advice, At System Limits
- Consider Calling Physician

Reference Literature

Clinical Papers and Abstracts

- 1 Jaffe MB. *Partial CO₂ rebreathing cardiac output-operating principles of the NICO system*. J Clin Monit Comput 1999; 15: 387-401.
- 2 Haryadi DG, Orr JA, Kuck K, McJames S, Westenskow DR. *Partial CO₂ rebreathing indirect Fick technique for noninvasive measurement of cardiac output*. J Clin Monit Comput 2000; 16: 361-374.
- 3 Botero M, Kirby D, Lobato EB, Staples ED, Gravenstein N. *Measurement of cardiac output before and after cardiopulmonary bypass: Comparison among aortic transit-time ultrasound, thermodilution, and noninvasive partial CO₂ rebreathing*. J Cardiothorac Vasc Anesth. 2004; 18: 563-72.
- 4 Young BP, Low LL. *Noninvasive monitoring cardiac output using partial CO₂ rebreathing*. Crit Care Clin. 2010; 26: 383-92.
- 5 Banner MJ, Euliano NR, MacIntyre NR, Layon AJ, Bonett S, Gentile MA, Bshouty Z, Peters C, Gabrielli, A. *Ventilator Advisory System Employing Load and Tolerance Strategy Recommends Appropriate Pressure Support Ventilation Settings: Multi-site Validation Study*. Chest 2008; 133: 697-703.

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Options and Accessories

Software Option Installation

Software option installation can be performed two ways:

- At the time of purchase, all options ordered will be installed and shipped with the product.
- Using an Option iButton® kit, PN 1026516 for Cardiac Output, PN 1081900 for VentAssist (qualified service personnel only).

iButton®

When an option upgrade via iButton® is ordered, customers will receive a packet containing connection and upgrade instructions, as well as relevant documents such as monitor stickers and Quick Reference cards.



CAUTION

An Option iButton® can be used one time only. It is not possible to use the same Option iButton® to install into multiple NM3 monitors. Use Option iButton® designed for the NM3 monitor only.



CAUTION

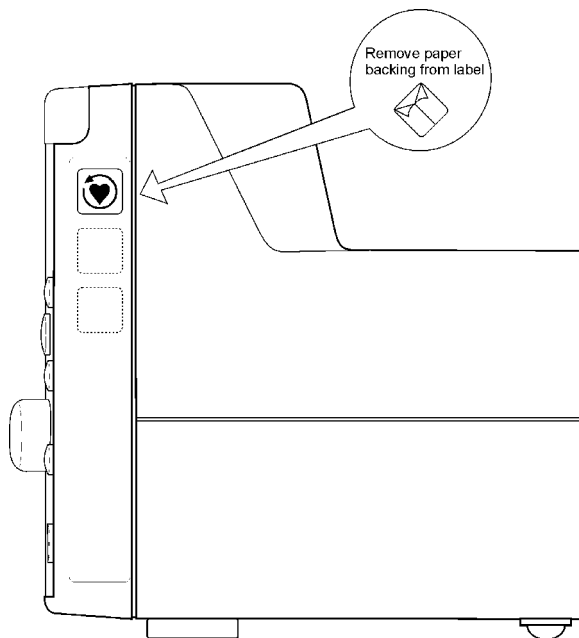
It is recommended that option installation be performed with the NM3 monitor running on AC power (wall cord). If the monitor accidentally powers off during the option installation, for example due to a low battery, the Option iButton® may be rendered inoperable without the option being installed.

To install an NM3 option using an iButton kit, a serial port adapter, an RS232 iButton®¹ Adapter and the Option iButton® are required. All required components are included in the option upgrade kit. Installations should be performed with a fully charged battery and on AC power (wall cord). The upgrade must be performed by qualified service personnel following the instructions in that packet.

1. iButton® is a registered trademark of Dallas Semiconductor / Maxim Integrated Products

Option Labels

Option upgrade kits contain a sticker to help identify which software options are installed on a particular monitor. This sticker should be affixed to the right edge of the front-panel façade. Area should be clean and dry before application of the Option sticker (see "Cleaning" on page 163). Refer to the figure below for correct placement.



Accessories

Part No.	Catalog No.	Description
Monitor and Options		
989805616521	1051674	NM3 Respiratory Profile Monitor , Model 7900, English (part number will vary by language)
989805630741	1081900	VentAssist , software option kit
989805611991	1026516	Cardiac Output , software option kit
989805613301	1043409	Rollstand for NM3/NICO, Fixed plate, adjustable
989805643911	140098	Rollstand for NM3, GCX Rollstand with sliding mount (adapter plate kit required)
989805613531	140101	Adapter Plate Kit for GCX Sliding Mount
989805612681	1060784	Mounting Kit , NM3 Respiratory Profile Monitor to V200 Ventilator
Sensors and accessories: Multi-patient Reuse		
989805618431	1015928	CAPNOSTAT 5 CO₂ Sensor
989805618441	1022054	CAPNOSTAT 5 LoFlo CO₂ Sensor
Sensors and accessories: Single Patient Use		
989805602911	8950-00	Cardiac Output Sensor (10 per box) Small size (for tidal volumes of 200 - 500 mL)
989805602921	8951-00	Cardiac Output Sensor (10 per box) Standard size (for tidal volumes of 400 - 1000 mL)
989805602931	8952-00	Cardiac Output Sensor (10 per box) Large size (for tidal volumes of 750 - 1500 mL)
989805603061	9765-00	CO₂/Flow Sensors (10 per box) Neonatal size
989805603071	9766-00	CO₂/Flow Sensors (10 per box) Pediatric size
989805603081	9767-00	CO₂/Flow Sensors (10 per box) Adult size
989805619071	9960PED-00	CAPNO₂mask - Pediatric O ₂ Delivery/CO ₂ Mainstream Monitoring Mask (10 per bag)
989805619081	9960STD-00	CAPNO₂mask - Adult Standard O ₂ Delivery/CO ₂ Mainstream Monitoring Mask (10 per bag)
989805619061	9960LGE-00	CAPNO₂mask - Adult Large O ₂ Delivery/CO ₂ Mainstream Monitoring Mask (10 per bag)
989805628011	3468ADH-00	Nasal Cannula with Nafion tubing , LoFlo CO ₂ , Adult (package of 10)
989805628021	3468INH-00	Nasal Cannula with Nafion tubing , LoFlo CO ₂ , Infant (package of 10)
989805628031	3468PEH-00	Nasal Cannula with Nafion tubing , LoFlo CO ₂ , Pediatric (package of 10)
989805618591	3468ADU-00	Nasal CO₂ Sampling Cannula , Adult
989805618611	3468PED-00	Nasal CO₂ Sampling Cannula , Pediatric
989805618601	3468INF-00	Nasal CO₂ Sampling Cannula , Infant/Neonatal
989805628041	3469ADH-00	Nasal Cannula with Nafion tubing , LoFlo CO ₂ /O ₂ , Adult (package of 10)
989805628051	3469INH-00	Nasal Cannula with Nafion tubing , LoFlo CO ₂ /O ₂ , Infant (package of 10)
989805628061	3469PEH-00	Nasal Cannula with Nafion tubing , LoFlo CO ₂ /O ₂ , Pediatric (package of 10)
989805618621	3469ADU-00	Nasal CO₂ Sampling Cannula w/ O₂ Delivery , Adult
989805618641	3469PED-00	Nasal CO₂ Sampling Cannula w/ O₂ Delivery , Pediatric
989805618631	3469INF-00	Nasal CO₂ Sampling Cannula w/ O₂ Delivery , Infant/Neonatal
989805628071	3470ADH-00	Oral/Nasal Cannula with Nafion tubing , LoFlo CO ₂ , Adult (package of 10)
989805628081	3470PEH-00	Oral/Nasal Cannula with Nafion tubing , LoFlo CO ₂ , Pediatric (package of 10)
989805618651	3470ADU-00	Oral/Nasal CO₂ Sampling Cannula , Adult
989805618661	3470PED-00	Oral/Nasal CO₂ Sampling Cannula , Pediatric
989805628091	3471ADH-00	Oral/Nasal Cannula with Nafion tubing , LoFlo CO ₂ /O ₂ , Adult (package of 10)
989805628101	3471PEH-00	Oral/Nasal Cannula with Nafion tubing , LoFlo CO ₂ /O ₂ , Pediatric (package of 10)
989805618671	3471ADU-00	Oral/Nasal CO₂ Sampling Cannula w/ O₂ Delivery , Adult
989805618681	3471PED-00	Oral/Nasal CO₂ Sampling Cannula w/ O₂ Delivery , Pediatric
989805618691	3472ADU-00	Airway Adapter Sampling Kit , Adult/Pediatric
989805618701	3472INF-00	Airway Adapter Sampling Kit , Infant/Neonatal
989805618711	3473ADU-00	Airway Adapter Sampling Kit w/ dehumidification tubing , Adult/Pediatric

Part No.	Catalog No.	Description
989805618721	3473INF-00	Airway Adapter Sampling Kit w/ dehumidification tubing , Infant/Neonatal
989805618731	3474-00	Sidestream Sample Line , male luer
989805618741	3475-00	Sidestream Sample Line w/ dehumidification tubing , male luer
989805618801	6063-00	Airway Adapter , Adult (10 per box)
989805618811	6312-00	Airway Adapter , Neonatal (10 per box)
989805618821	6421-00	Airway Adapter with mouthpiece, CO ₂ , single-use (package of 10)
989805618901	7007-01	Airway Adapter , CO ₂ , reusable, Pediatric/Adult
989805618921	7053-01	Airway Adapter , CO ₂ , reusable, Neonatal
989805619001	8935-25	Adapter , 15 mm M/F low deadspace, Neonatal (package of 25)
989805619011	8937-25	Adapter , 15 mm M/F low deadspace, Adult (package of 25)
989805620941	9861-00	Flow Connector Cap , 3 port (25 per bag)
Accessories and Cables: Multi-patient Reuse		
989805629571	601012	Serial Data Cable 9-pin male/female null modem (crossover) cable
453561506711	1018292	Interface Cable , NM3 to V200 or Esprit, 9-pin male/male null modem (crossover) cable
989805612391	1003741	Nurse Call cable , remote alarm cable kit, normally open protocol
989805611881	1003742	Nurse Call cable , remote alarm cable kit, normally closed protocol
989805612511	1003743	Nurse Call cable , remote alarm cable kit, Philips Respironics (LifeCare)
989805618941	8751-00	CAPNOSTAT 5/LoFlo C5 CO₂ Sensor Cable Holding Clips (50 per box)
989805652871	1062269	LoFlo Mounting Bracket – Single Product Packaged
989805600081	600026	Power Cord (included with monitor)
989805613351	600041	Power Cord , AC for UK
989805611891	600042	Power Cord , International
989805619621	1051672	NM3 monitor User Manual (part number will vary by country)
989805619631	1051673	NM3 monitor Service Manual

Compatible Masimo Accessories

Part No.	Catalog No.	Description
Sensors and accessories: Multi-patient Reuse		
989805652251	1118170	Red™ DCI LNCS Reusable Direct Connect Sensors
989805652261	1118171	Red™ LNC-4 - Red LNCS Patient Cables (1 per box)
989805652271	1118172	Red™ LNC-10 - Red LNCS Patient Cables (1 per box)
989805652281	1118173	Red™ PC-08 - Red LNOP Patient Cables

NOTE: Other compatible sensors and accessories are available from Masimo Corporation.

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This end-user agreement applies specifically and only to Masimo products.

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Appendix A: Electromagnetic Compatibility

Medical equipment needs special precautions regarding electromagnetic compatibility (EMC) and needs to be installed and put into service according to the EMC information provided in this document.

The NM3 monitor complies with IEC 60601-1-2:2004 and 2007, providing reasonable protection against electromagnetic interference in a typical medical installation. The equipment generates, uses and can radiate electromagnetic interference (EMI), and if not installed and used in accordance with the instructions, may cause interference with other devices in the vicinity.

If interference does occur, correct it using one or more of the following measures:

- Move the receiving device or increase separation between the equipment.
- Consult Philips Respironics or members of the hospital's engineering department for more information.

Warnings

- The use of portable and mobile radio frequency (RF) communications equipment can affect this and other pieces of medical equipment.
- The use of accessories, sensors and cables other than those specified by Philips Respironics may increase emissions or decrease immunity of the equipment.
- The NM3 monitor should not be used adjacent to or stacked with other equipment; if adjacent or stacked use is necessary, the equipment should be observed to verify normal operation in the configuration in which it will be used.

Cautions

- Observe precautions for electrostatic discharge (ESD) and electromagnetic interference (EMI) to and from other equipment.
- Where electromagnetic devices (e.g., electrocautery) are used, patient monitoring may be interrupted due to electromagnetic interference. Electromagnetic fields up to 3 V/m will not adversely affect system performance.
- Sudden erratic changes in equipment performance that do not correlate to the physiological condition of the patient may be signs that the monitor is experiencing electromagnetic interference.

Electromagnetic Emissions

Guidance and manufacturer's declaration - Electromagnetic emissions		
The NM3 monitor is intended for use in the electromagnetic environment specified below. The customer or user of the device should assure that it is used in such an environment.		
Emissions Test	Compliance	Electromagnetic environment - guidance
RF emissions CISPR 11	Group 1	The NM3 monitor uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby equipment.
RF emissions CISPR 11	Class A	Class A: The NM3 monitor is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Class D	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

Electromagnetic Immunity

Guidance and manufacturer's declaration - Electromagnetic immunity			
The NM3 monitor is intended for use in the electromagnetic environment specified below. The customer or user of the device should assure that it is used in such an environment.			
Immunity Test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Electrostatic Discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transient/burst IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines	±2 kV for power supply lines ±1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1 kV differential mode ±2 kV common mode	±1 kV differential mode ±2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.

Guidance and manufacturer's declaration - Electromagnetic immunity (Continued)			
Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11	$<5\% U_T$ (>95% dip in U_T) for 0.5 cycle $40\% U_T$ (60% dip in U_T) for 5 cycle $70\% U_T$ (30% dip in U_T) for 25 cycles $<5\% U_T$ (>95% dip in U_T) for 5 sec.	$<5\% U_T$ (>95% dip in U_T) for 0.5 cycle $40\% U_T$ (60% dip in U_T) for 5 cycle $70\% U_T$ (30% dip in U_T) for 25 cycles $<5\% U_T$ (>95% dip in U_T) for 5 sec.	Mains power quality should be that of a typical commercial or hospital environment. If the user of the NM3 monitor requires continued operation during power interruptions, it is recommended that the NM3 monitor be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE: U_T is the a.c. mains voltage prior to the application of the test level			

Guidance and manufacturer's declaration - Electromagnetic immunity			
The NM3 monitor is intended for use in the electromagnetic environment specified below. The customer or user of the device should assure that it is used in such an environment.			
Immunity Test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Conducted RF IEC 61000-4-6 Radiated RF IEC 61000-4-3	3 Vrms 150 kHz to 80 MHz 3 V/m 80 MHz to 2.5 GHz	3 Vrms 150 kHz to 80 MHz 3 V/m 80 MHz to 2.5 GHz	Portable and mobile RF communications equipment should be used no closer to any part of the device, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance: $d = \left[\frac{3.5}{V_1} \right] \sqrt{P}$ $d = \left[\frac{3.5}{E_1} \right] \sqrt{P} \quad 80 \text{ MHz to } 800 \text{ MHz}$ $d = \left[\frac{7}{E_1} \right] \sqrt{P} \quad 800 \text{ MHz to } 2.5 \text{ GHz}$ where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m). Field strength from fixed RF transmitters, as determined by an electromagnetic site survey^a, should be less than the compliance level in each frequency range.^b Interference may occur in the vicinity of equipment marked with the following symbol: 
NOTE 1: At 80 MHz and 800MHz, the higher frequency range applies.			
NOTE 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			
a. Field strengths from transmitters, such as base stations for radio (cellular, cordless) telephones and land mobile radios. amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the NM3 monitor is used exceeds the applicable RF compliance level above, the equipment should be observed to verify normal operation. If abnormal operation is observed, additional measures may be necessary, such as reorienting or relocating the NM3 monitor. b. Over the frequency range of 150 kHz to 80MHz, field strengths should be less than 3 V/m.			

Recommended separation distances between portable and mobile RF communications equipment and the NM3 monitor			
The NM3 monitor is intended for use in the electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the device can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the NM3 monitor as recommended below, according to the maximum output power of the communications equipment.			
Rated maximum output power of transmitter (Watts)	Separation distance according to the frequency of transmitter (meters)		
	150 kHz to 80 MHz $d = \left[\frac{3.5}{V_1} \right] \sqrt{P}$	80 MHz to 800 MHz $d = \left[\frac{3.5}{E_1} \right] \sqrt{P}$	800 MHz to 2.5 GHz $d = \left[\frac{7}{E_1} \right] \sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.37	0.37	0.74
1	1.2	1.2	2.3
10	3.7	3.7	7.4
100	12	12	23
For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated by using the equation applicable to the frequency of the transmitter, where P is the maximum power rating of the transmitter in watts (W) according to the transmitter manufacturer. NOTE 1: At 80 MHz and 800MHz, the separation distance for the higher frequency range applies. NOTE 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			

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