

Carevance™ H1, Carevance™ D12, Carevance™ D15, Carevance™ D19 and Carevance™ D7

User Manual

Software Version 1



6688000-8EN
Revision 2
English

Notice

The information in this manual applies to the software version listed on the first page of the manual. Due to continuing product innovation, specifications in this manual are subject to change without notice.

Revision history

Revision	Date	Reason for change
1	2025-4-3	Initial release.
2	2025-6-13	Minor update of cleaning and disinfection graphics.

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Standards and regulations

Standards compliance

The system complies with the following standards.

- IEC 60601-1: General requirement for basic safety and essential performance
- IEC 60601-1-2: General requirements for basic safety and essential performance – Collateral Standard: Electromagnetic disturbances
- IEC 80601-2-49: Particular safety standard for multifunction patient monitoring equipment
- IEC 60601-1-6: Usability safety standard
- IEC 62366-1: Application of usability engineering to medical device
- EN ISO 14971: Application of risk management analysis to medical device
- IEC 62304: Software life cycle processes
- IEC 60601-1-9: Environmentally conscious design
- The Alarm system of the monitor conforms to IEC 60601-1-8.
- The ECG parameter conforms to IEC 60601-2-27 and ANSI/AAMI EC57.

NOTE

Moderate reduced bandwidths do not comply with all requirements of the IEC 60601-2-27 standard.

- The SpO₂ parameter conforms to ISO 80601-2-61.
- The NIBP parameter conforms to IEC 80601-2-30 and ANSI/AAMI/ISO 81060-2.
- The IBP parameter conforms to IEC 60601-2-34.
- The Temperature parameter conforms to ISO 80601-2-56.
- The Gases parameter conforms to ISO 80601-2-55.
- The Entropy parameter conforms to IEC 80601-2-26.
- The NMT parameter conforms to IEC 60601-2-40.
- The BIS parameter conforms to IEC 80601-2-26.

IEC 60601-1

- Type of protection against electrical shock:
 - Hub: Internally powered ME equipment. Type BF/CF applied part.
 - Dock: Class I. Internally powered ME equipment. Type BF/CF applied part.
 - Mini Dock: Class II. Internally powered ME equipment.
- Degree of protection against electrical shock: applied parts are marked with a symbol indicating degree of protection.

- Degree of safety of application in the presence of flammable anesthetic mixture with air, with oxygen or nitrous oxide: Not suitable.
- Degree of protection against harmful ingress of water: Hub IP44, Dock IP22 and Mini Dock IP22.
- Mode of operation: Continuous.
- Method(s) of sterilization or disinfection recommended by the manufacturer: see the User Manual.
- Portable monitor.

EU Medical Device Regulation

In accordance with the Regulation (EU) 2017/745 concerning Medical Devices: Class IIb

- The CE Mark CE-0197 indicating its conformity with the provisions of the Regulation (EU) 2017/745 concerning Medical Devices. The country of manufacture can be found on the equipment labeling.

CISPR 11

In accordance with the CISPR (International Special Committee on Radio Interference) 11: Group 1, Class A.

FCC

The product contains FCC ID: OU5MULW01.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE

"Harmful interference" is defined in 47 CFR §2.122 by the FCC as follows: Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radio communication service operating in accordance with the [ITU] Radio Regulations.

RF exposure information

NOTE

The device should not be placed within 20 cm from the patient's body or head area for an extended period of time.

The device has been tested and meets the applicable limits (FCC 47CFR §2.1093) for radio frequency exposure (Specific Absorption Rate, SAR). The SAR refers to the rate at which the body absorbs RF energy. The highest reported SAR values for the device are as follows:

- Body SAR 1.08W/kg (limit 1.6W/kg over 1 g of body)

Radio Equipment Directive

The wireless network feature of the monitor bears a CE mark indicating its conformity with the provisions of the Radio Equipment Directive 2014/53/EU.

The CE mark can be found from the monitor’s labeling.

GE Medical Systems (China) Co., Ltd. hereby, declares that the RE type Patient Monitor is in compliance with RED 2014/53/EU.

The full text of the EU DoC is available at the following internet address: <https://www.gehealthcare.com/support/manuals>.

CE manufacturer and EU Representative

Manufacturer name and address	European authorized representative
 GE Medical Systems (China) Co., Ltd. No. 19, Changjiang Road, Wuxi National Hi-Tech Development Zone, 214028 Jiangsu P.R. China	EC REP GE Medical Systems SCS 283 Rue de la Miniere 78530 Buc France

CE marking application year

CE marking application year: 2025.

About this manual

Intended use of this manual

This manual is an integral part of the device and describes its intended use. It should always be kept in a place accessible to users, and information indicating that place should be available close to the equipment. Observance of the manual is mandatory for proper performance and correct operation and ensures patient and user safety. Information which refers only to certain versions of the product(s) is accompanied by the model number(s) of the product(s) concerned. The model number is given on the device plate of the product.

As the device configuration may vary, some menus, displays and functions described may not be available in the device you are using.

See the Supplemental Information Manual for the technical specifications, default settings and compatibility information, including electromagnetic compatibility.

Intended audience of this manual

This manual is intended for clinical professionals. Clinical professionals are expected to have a working knowledge of medical procedures, practices and terminology required to provide patient care. Using the device should never replace nor impede the human intervention and required patient care provided by clinical professionals. The Cleaning and disinfection chapter is also intended for cleaning personnel who clean and disinfect this device.

Manual conventions

This manual uses the following styles to emphasize text or indicate action.

Item	Description
Courier	Indicates hardware terms.
bold	Indicates software terms.
<i>italic</i>	Indicates terms for emphasis.
select	The word select means choosing and confirming.
supplemental information	Indicates information that appears in the Supplemental Information Manual or supplements provided.
NOTE	Note statements provide application tips or other useful information.

Device naming conventions

In this manual, the following naming conventions are used:

Hub or monitor: Carevance H1

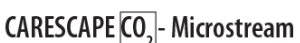
Dock: Any of Carevance D12, Carevance D15 and Carevance D19

Mini Dock: Carevance D7

Acquisition module naming conventions

In this manual, the following naming conventions are used to refer to different modules and module categories:

- E-modules: N-CAiO and all modules with the prefix E-
- E-COP
- E-PiCCO
- E-sCO
- E-sCAiO
- N-CAiO
- E-miniC
- E-NMT
- E-BIS
- E-ENTROPY
- Micro-module: In this manual, Micro-module is used as a generic term when referring to any of the following products. The Micro-module is also referred to as Active Cable Module or Active Cable.

Graphic on the micro-module	Explanation
 or 	Micro-module for measuring invasive pressures. Note that in the manual, the following names are used instead of the graphic: TruSignal Pressure micro-module or TruSignal Pressure. TruSignal Pressure micro-module is the new name of Carescape Pressure micro-module. In this manual, TruSignal Pressure micro-module may be used as a generic term when referring to any of the TruSignal Pressure micro-module or Carescape Pressure micro-module.
	Micro-module for measuring end-tidal carbon dioxide (EtCO ₂), FiCO ₂ , and respiration rate with Microstream technology. Note that in the manual, the following names are used instead of the graphic: Microstream CO ₂ micro-module or Microstream CO ₂ .
	Micro-module for measuring SpO ₂ with Masimo rainbow SET technology. Note that in the manual, the following names are used instead of the graphic: Masimo SpO ₂ micro-module or Masimo SpO ₂ .
	Micro-module for measuring SpO ₂ with Nellcor™ sensors with OxiMax™ technology. Note that in the manual, the following names are used instead of the graphic: Nellcor SpO ₂ micro-module or Nellcor SpO ₂ .

Other naming conventions

In this manual, the device is used to refer to Carevance system, which could be either Hub working alone, or Hub connecting to Dock or Mini Dock.

Where possible, the following icon is also used to identify the device.

Icon	Explanation
	Hub works alone.
	Hub connects to Dock.
	Hub connects to Mini Dock.

Illustrations and names

This manual uses illustrations as examples only. Illustrations in this manual may not necessarily reflect all system settings, features, configurations, or displayed data.

Names of persons, institutions, and places and related information are fictitious; any similarity to actual persons, entities, or places is purely coincidental.

Related documents

- Supplemental Information Manual
- Service Manual
- Supplies and accessories
- Service manuals for acquisition modules
- Carescape Central Station User's Manual
- Carescape Network Configuration Guide
- HL7 Reference Manual
- Privacy and Security Manual
- Carescape™ CO₂ - Microstream™ Parameter instructions for use
- Unity Network Interface Device (ID) User's Manual
- B1X5-REC Recorder Service Manual
- B1X5-REC Recorder Instruction for Use
- B1X5-F2 Frame Instruction for Use
- Nano Dock User Instructions

Ordering manuals

Paper copies of the medical device IFU will be provided within 7 days of receiving the request, at no additional cost. Contact your local GE HealthCare representative and request the part number on the first page of the eIFU.

Accessing manuals online

To obtain the latest version of the manual:

1. Go to <https://www.gehealthcare.com/support/manuals>.
2. Enter the product name or document number into the search field. Check that the selected language is correct. When searching with a document number, wrong language selection causes the search to fail. Click the search icon at the end of the search field to launch the search.
3. Or, select the **Browse by product > Select Modality > Monitoring Solutions (MS) > Select Products**. Select the product and **Apply**.
4. Select the tab according to the type of manual you are looking for:
 - **All**: opens the list of all manuals related to the selected product
 - **Service**: opens the list of service manuals related to the selected product
 - **User/Operation**: opens the list of user manuals related to the selected product
 - **Installation**: opens the list of installation manuals related to the selected product
 - **Others**: opens the list of other types of manuals related to the selected product
5. Identify the manual and select **Download**.

NOTE

It is recommended to download the .zip files for User Documentation Sets or Service Manuals Sets if available because they include all user or service publications for that product. Otherwise, download the individual PDF files.

6. Select **Accept** in the copyright popup window to initiate the download.
Manuals are downloaded to the Downloads folder of your device.
7. If you downloaded a .zip file, unzip the files.

The manuals are in PDF format. Make sure that your viewing device (for instance, computer) has software to open the PDF files (for instance, Adobe® Acrobat® Reader).

Security related documents can be downloaded from <https://securityupdate.gehealthcare.com>.

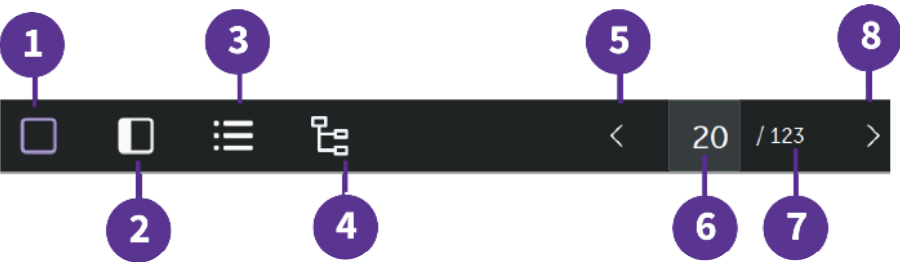
Accessing manuals on device

To access manuals on device:

1. Turn on the device by pressing the **On/Off** button briefly.
2. Select  >  **E-Manual**.
3. Select related manuals.

Using E-manuals on device

The E-manual can be navigated from the top of the menu.



1.		Hide bookmark
2.		Display bookmark
3.		Collapse bookmark
4.		Expand bookmark
5.		Turn to previous page
6.	20	Current page
7.	/ 123	Total page
8.		Turn to next page

- 1. Select to hide the bookmark on the left.
- 2. Select to display the bookmark on the left.
- 3. Select to collapse bookmark.
- 4. Select to expand bookmark.
- 5. Select or to turn pages.
- 6. Entering a page number to current page area can jump to this page.
- 7. Swipe down and up to scroll the page.

Trademarks

Carescape, Carevance, D-fend, DINAMAP, Entropy, TruSignal and Unity Network are trademarks of GE HealthCare.

GE is a trademark of General Electric Company used under trademark license.

Third party trademarks

Masimo, Masimo SET, rainbow, rainbow SET, Adaptive Probe Off Detection and APOD are trademarks of Masimo Corporation.

Covidien, BISx, Bispectral Index, BIS, Microstream, Nellcor and OxiMax are trademarks of Medtronic.

PiCCO and Pulsion are trademarks of Pulsion Medical Systems SE.

PRAM is a trademark of Bio-Si International S.r.l..

Multi-Link is a trademark of CareFusion Corporation or one of its subsidiaries.

HL7 is a registered trademark of Health Level Seven (HL7), Inc.

All other third-party trademarks are the property of their respective owners.

Manufacturer responsibility

GE HealthCare is responsible for the effects on safety, reliability, and performance of the equipment only if:

- Assembly operations, extensions, readjustments, modifications, servicing, or repairs are carried out by authorized service personnel.
- The electrical installation of the relevant room complies with the requirements of the appropriate regulations.
- The equipment is used in accordance with the instructions for use.

WARNING

SAFETY HAZARD.

To avoid risks to personnel and patient, or damage to the equipment, only perform maintenance procedures described in this manual. Unauthorized modifications can lead to safety hazards.

System installation and commissioning, and planned and corrective maintenance must be performed by qualified service personnel according to the service manual.

Product availability

NOTE

Due to continual product innovation and design, specifications for these products are subject to change without notice.

Some of the products mentioned in this manual may not be available in all countries. Please consult your local representative about availability.

Safety and intended use

Safety message signal words

Safety message signal words designate the severity of a potential hazard.

DANGER

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates a hazardous situation not related to personal injury that, if not avoided, could result in property damage.

System safety

System safety messages apply to the entire system. Safety messages specific to parts of the system are found in the relevant section.

Some safety messages only apply to certain products and/or with certain licenses in use. For information on feature availability with the Hub, Hub with Dock and Hub with Mini Dock, see section Feature overview. For a list of available licenses, see section Licensed software options.

System warning safety messages

The following warning safety messages apply to this monitoring system.

Indications for use warnings

WARNING

PATIENT SAFETY.

Read all the safety information before using the device for the first time. This manual contains instructions necessary to operate this device safely and in accordance with its functions and intended use. This manual is intended for clinical professionals. Clinical professionals are expected to have a working knowledge of medical procedures, practices and terminology, as required for the monitoring of all patients.

WARNING

SINGLE PATIENT USE.

This equipment is designed for use on one patient at a time. Using this equipment to monitor different parameters on different patients at the same time compromises the accuracy of data acquired.

WARNING

INSTRUCTIONS FOR USE.

For continued safe use of this equipment, it is necessary that the listed instructions are followed. However, instructions listed in this manual in no way supersede established medical practices concerning patient care.

WARNING

INTRAHOSPITAL TRANSPORT.

Vibrations during intrahospital transport may disturb SpO₂, ECG, impedance respiration, NIBP, and IBP measurements.

Accessories warnings

WARNING

PATIENT SAFETY.

Single-use products are not designed to be reused. Reuse may cause a risk of cross-contamination, affect the measurement accuracy and/or system performance, and cause a malfunction as a result of the product being physically damaged due to cleaning, disinfection, re-sterilization and/or reuse.

WARNING**PATIENT SAFETY.**

Use only approved accessories, including mounts, and defibrillator-proof cables and invasive pressure transducers. For a list of approved accessories, see the Supplies and accessories provided. Other cables, transducers and accessories may cause a safety hazard, damage the equipment or system, result in increased emissions or decreased immunity of the equipment or system or interfere with the measurement.

WARNING**ELECTRIC SHOCK.**

Only use protected leadwires and patient cables with this device. The use of unprotected leadwires and patient cables creates the potential for making an electrical connection to ground or to a high voltage power source which can cause serious injury or death to the patient.

WARNING**PATIENT SAFETY.**

When using any supply or accessory, make sure that you are familiar with their use to avoid any risk to the patient. For detailed instructions and information regarding supplies and accessories, always refer to their own instructions for use.

WARNING**INACCURATE RESULTS.**

When using the device with any supply and accessory, make sure all the equipments are used within their required temperature, humidity, altitude ranges and performance range.

Cables warnings

WARNING**CABLES.**

Route all cables away from patient's throat to avoid possible strangulation.

WARNING**CABLES.**

Route all cables in such a way that they are not under the patient to avoid the risk of possible pressure sores.

WARNING**PERSONAL INJURY.**

To avoid personal injury to users or any other persons moving in the vicinity of the cables or tubing, route all cables and tubing in such a way that they do not present a tripping hazard.

WARNING**SAFETY GROUND.**

Remove power cord from the mains source by grasping the plug. Do not pull on the cable.

Defibrillation warnings

WARNING**ELECTRIC SHOCK.**

To avoid the risk of electric shock, do not touch the patient, table, bed, instruments, or system parts during defibrillation.

WARNING**DEFIBRILLATOR PRECAUTIONS.**

Patient signal inputs labeled with the CF and BF symbols with paddles are protected against damage resulting from defibrillation voltages. To ensure proper defibrillator protection, use only the recommended cables and leadwires.

Electrical warnings

WARNING**POWER SUPPLY.**

Always connect the device power cable to a properly installed power outlet with protective earth contacts before connecting any other interface cables. If the integrity of the protective earth conductor is in doubt, disconnect the device from the power line. If the installation does not provide for a protective earth conductor, disconnect the device from the power line after having disconnected all other interface cables. All devices of a system must be connected to the same power supply circuit. Devices which are not connected to the same circuit must be electrically isolated when operated.

WARNING**EXCESSIVE LEAKAGE CURRENT.**

Do not use a multiple socket outlet or extension cord. A failure in a multiple socket outlet or extension cord may cause increased leakage current when many devices are sharing the same multiple socket outlet or extension cord.

WARNING**EXCESSIVE LEAKAGE CURRENT.**

To avoid summation of leakage currents when interfacing the device with other equipment, the devices may only be interconnected with each other or to parts of the system when it has been determined by qualified biomedical personnel that there is no danger to the patient, the operator, or the environment as a result. In those instances where there is any element of doubt concerning the safety of the connected devices, the user must contact the manufacturers concerned (or other informed experts) for proper use. In all cases, safe and proper operation should be verified with the applicable manufacturer's instructions for use, and system standards IEC 60601-1 clause 16, and the requirements of the local authorities must be complied with.

WARNING**EXCESSIVE TOUCH CURRENT.**

To avoid excessive patient leakage current, do not simultaneously touch the patient and the electrical connectors in the device, or within the module housing or frame.

WARNING**INTERFACING OTHER EQUIPMENT.**

Connect only items that are specified as part of the system and as compatible. For more information, see the supplemental information provided.

WARNING**INTERFACING OTHER EQUIPMENT.**

Devices may only be interconnected with each other or to parts of the system when it has been determined by qualified biomedical personnel that there is no danger to the patient, the operator, or the environment as a result. In those instances where there is any element of doubt concerning the safety of the connected devices, the user must contact the manufacturers concerned (or other informed experts) for proper use. In all cases, safe and proper operation should be verified with the applicable manufacturer's instructions for use, and system standards IEC60601-1 must be complied with.

WARNING**ELECTRIC SHOCK.**

To avoid the risk of electric shock, do not under any circumstances remove the grounding conductor from the power plug. Always check that power cord and plug are intact and undamaged.

WARNING**PATIENT SAFETY.**

During intracardiac application of a device, a defibrillator and pacemaker whose proper functioning has been verified must be kept at hand to ensure timely intervention if necessary.

WARNING**EQUIPMENT DAMAGE.**

If liquid has accidentally entered the system or its parts, disconnect the power cord from the power supply and have the equipment serviced by qualified service personnel. Otherwise, there is a risk of damage to the equipment.

WARNING**DISCONNECTION FROM MAINS.**

When disconnecting the device from the power line, remove the plug from the wall outlet first. Then you may disconnect the power cord from the device. If you do not observe this sequence, there is a risk of coming into contact with line voltage by inserting metal objects, such as the pins of leadwires, into the sockets of the power cord by mistake.

WARNING**INTRACARDIAC APPLICATION.**

When applying devices intracardially, electrically conductive contact with parts connected to the heart (pressure transducers, metal tube connections and stopcocks, guide wires, etc.) must be avoided in all cases. To prevent electrical contact, we recommend the following:

- always wear isolating rubber gloves,
- keep parts that are conductively connected to the heart isolated from ground,
- if possible, do not use tube fittings or stopcocks made of metal.

EMC warnings

WARNING**EMC.**

Other equipment may interfere with the system, even if that other equipment complies with CISPR emission requirements.

WARNING**ESD.**

Pins of connectors identified with the ESD warning symbol should not be touched. Connections should not be made to these connectors unless electrostatic discharge (ESD) precautions are used.

WARNING**EQUIPMENT DAMAGE AND PATIENT SAFETY.**

Do not use the device in high electromagnetic fields (for example, during magnetic resonance imaging).

WARNING**EMC.**

Magnetic and electrical fields are capable of interfering with the proper performance of the device. For this reason make sure that all external devices operated in the vicinity of the device comply with the relevant EMC requirements. X-ray equipment or MRI devices are a possible source of interference as they may emit higher levels of electromagnetic radiation. Changes or modifications to this device/system not expressly approved by GE HealthCare may cause EMC issues with this or other equipment. This device/system is designed and tested to comply with applicable standards and regulations regarding EMC and needs to be installed and put into service according to the EMC information stated as follows: This device/system 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. Mains power should be that of a typical commercial or hospital environment. Device is compliant to Class A.

WARNING**ERRONEOUS READINGS.**

The device/system should not be used adjacent to, or stacked with, other equipment. Consult qualified personnel regarding device/system configuration.

WARNING**DEGRADED PERFORMANCE.**

Do not use portable RF communications equipment (including peripherals such as antenna cables and external antennas) closer than 30 cm (12 inches) to any part of this device/system, including cables specified by the manufacturer. Otherwise, the performance of this device/system may degrade.

System warnings

WARNING**EXPLOSION.**

Do not use this system in the presence of flammable anesthetics, vapors or liquids.

WARNING**PATIENT SAFETY.**

If an error message appears during operation, it is the licensed medical practitioner's responsibility to decide whether the device is still suitable for patient monitoring. As a general rule, monitoring should only continue in extremely urgent cases and under the direct supervision of a licensed healthcare practitioner. The device must be repaired before being used again on a patient. If an error message appears after power-up, the device must be repaired before being used on a patient.

WARNING**EQUIPMENT DAMAGE.**

To avoid the risk of modules falling and getting damaged, always ensure that they are securely latched.

WARNING**EQUIPMENT DAMAGE.**

To avoid the risk of the device falling and getting damaged, DO NOT lift the handle of the Hub directly to move when the Hub is connected to a Dock. In this situation, always lift the handle on the Dock for movements.

WARNING**PATIENT SAFETY.**

If the device, module, or frame is dropped, have them checked by qualified service personnel before taking them back into use.

WARNING**PATIENT SAFETY.**

To avoid risks to patient safety, never modify or alter the connectors on product or accessories in any way. Alterations or modifications may affect patient safety, performance, and accuracy.

Site requirement warnings

WARNING**BEFORE INSTALLATION.**

Compatibility is critical to safe and effective use of this device. Verify the compatibility of all system components and device interfaces, including hardware and software versions, prior to installation and use.

Interfacing warnings

WARNING**INTERFACING OTHER EQUIPMENT.**

Connect only items that are specified as part of the system and as compatible. For more information, see the supplemental information provided.

WARNING**PATIENT SAFETY.**

If a ventilator and a gas acquisition module are connected to the same device, the device issues some respiratory alarms based on the module alarm limits and not those of the ventilator. Make sure that the alarm limits on the module are set to match the patient's ventilation requirements to avoid delayed or suppressed ventilator alarm annunciation at the central station and to ensure timely clinical response to important changes in the patient's condition or the ventilator's status.

WARNING**MISSED ALARMS.**

The peripheral device's alarms must not be turned off or the volume reduced in any way to diminish the importance of the peripheral device as the primary alarm source for parameters monitored by the peripheral device.

WARNING**INCORRECT DATA.**

Rounding or truncation of data from the external device: The value displayed on the device via the Unity Network ID interface device may be rounded or truncated. For detailed information, refer to the User's Manual of the Unity Network ID interface device.

System caution safety messages

The following caution safety messages apply to this monitoring system.

Indications for use cautions

CAUTION**SUPERVISED USE.**

This equipment is intended for use under the direct supervision of a licensed healthcare practitioner.

Loss of data

CAUTION**LOSS OF DATA.**

Should the device at any time temporarily lose patient data, the potential exists that active monitoring is not being done. Close patient observation or alternate monitoring devices should be used until device function is restored. If the device does not automatically resume operation within 60 seconds, power cycle the device using the On/Off button. Once monitoring is restored, you should verify correct monitoring state and alarm function.

Electrical cautions

CAUTION

POWER REQUIREMENTS.

Before connecting the device to the power line, check that the voltage and frequency ratings of the power line are the same as those indicated on the device's label. If this is not the case, do not connect the system to the power line until you adjust the device to match the power source. In U.S.A., if the installation of this equipment will use 240V rather than 120V, the source must be a center-tapped, 240V, single-phase circuit. This equipment is suitable for connection to public mains as defined in CISPR 11.

EMC cautions

CAUTION

DEGRADED PERFORMANCE.

Use of known RF sources, such as cell/portable phones, RFID, electronic article surveillance (EAS) systems, diathermy, or other radio frequency (RF) emitting equipment near the system may cause unexpected or adverse operation of this device/system. Consult qualified personnel regarding device/system configuration.

Site requirement cautions

CAUTION

LOSS OF MONITORING.

Leave space for circulation of air to prevent the device from overheating. The manufacturer is not responsible for damage to device caused by improperly vented cabinets, improper or faulty power, or insufficient wall strength to support device mounted on such walls.

Interfacing cautions

CAUTION

INSTALLATION.

Qualified technical personnel must connect the interface adapter to the peripheral device and make any necessary adjustments to the peripheral device (baud rate, parity, etc.) as described in the specific installation instructions for the interface adapter. Insert cabling from the connectivity device only into specified interface adapters and specified peripheral devices. To avoid inadvertent disconnection, route all cables in a way to prevent a stumbling hazard. Wrap and secure excess cabling to reduce risk of entanglement by patients and personnel. Do not install in a location where the device may drop on a person.

CAUTION**IMPROPER OPERATION.**

The use of the wrong interface adapter may cause improper operation of the supported peripheral device.

CAUTION**TREATMENT.**

Do not treat the patient based solely on the alarm messages and/or numerics presented on device. You must verify the accuracy of the alarm message and/or numerics at the peripheral device itself before initiating treatment, treatment should be based on the information presented at the peripheral device.

CAUTION**DEGRADED PERFORMANCE.**

Use of known RF sources, such as cell/portable phones, or other radio frequency (RF) emitting equipment near the system may cause unexpected or adverse operation of the Unity Network ID interface device. Consult authorized service personnel regarding device configuration.

CAUTION**INCORRECT DATA.**

If a supported external device is set to operate in DEMO mode and connected to the Unity Network ID interface device, the Unity Network ID interface device might send the DEMO data which is received from the external device. Always ensure that the external device is not operating in DEMO mode when a patient is monitored and the patient data is viewed through the Unity Network ID interface device.

Disposal cautions

CAUTION**DISPOSAL.**

At the end of its service life, the product described in this manual, as well as its accessories, must be disposed of in compliance with the guidelines regulating the disposal of each product. If you have any questions concerning disposal of a product, please contact GE HealthCare or its representatives.

CAUTION**PACKAGING DISPOSAL.**

Dispose of the packaging material, observing the applicable waste control regulations.

Notice safety messages

The following notice safety message applies to this monitoring system:

NOTICE

The warranty does not cover damages resulting from the use of accessories and consumables from other manufacturers.

NOTICE**INACCURATE RESULTS.**

After transport or storage of the device outside the specified operating temperature range, always allow the device to stabilize back to operating temperature range before applying power to it. Using the device outside the specified operating environment may result in inaccurate results.

ESD safety precautions

- To avoid electrostatic charges building up, it is recommended to store, maintain and use the equipment at a relative humidity of 30% or greater.
- To prevent applying a possible electrostatic charge to the ESD-sensitive parts of the equipment, touch the metallic frame of the component or a large metal object located close to the equipment. When working with the equipment and specifically when the ESD-sensitive parts of the equipment may be touched, a grounded wrist strap intended for use with ESD-sensitive equipment should be worn. See the documentation provided with the wrist straps for details of proper use. Floors should be covered by ESD-dissipative carpets or similar. Non-synthetic clothing should be used when working with the component.

Indications for use

Indications for use of Carevance H1

The Carevance H1 is a portable multi-parameter patient monitor intended to be used for monitoring, recording, and to generate alarms for multiple physiological parameters of adult, pediatric, and neonatal patients in a hospital environment and during intra-hospital transport.

The Carevance H1 is intended for use under the direct supervision of a licensed health care practitioner.

The Carevance H1 is not intended for use during MRI.

The Carevance H1 can be a stand-alone monitor or interfaced to other devices via network interface.

The Carevance H1 monitors and displays: ECG (including ST segment, arrhythmia detection, ECG diagnostic analysis and measurement), invasive blood pressure, heart/pulse rate, oscillometric non-invasive blood pressure (systolic, diastolic and mean arterial pressure), functional oxygen saturation (SpO₂) and pulse rate via continuous monitoring (including monitoring during conditions of clinical patient motion or low perfusion), temperature with a reusable or disposable electronic thermometer for continual monitoring Esophageal/Nasopharyngeal/Tympanic/Rectal/Bladder/Axillary/Skin/Airway/Room/Myocardial/Core/Surface temperature, impedance respiration, respiration rate, airway gases (CO₂, O₂, N₂O, anesthetic agents, anesthetic agent identification and respiratory rate), Cardiac Output (thermodilution and pulse contour), Entropy, neuromuscular transmission (NMT), Bispectral Index (BIS) and Surgical Pleth Index (SPI).

NOTE

Surgical Pleth Index (SPI) is excluded from Japan.

Indications for use of Carevance D12, Carevance D15 and Carevance D19

The Carevance D12, Carevance D15 and Carevance D19 are docking stations with two-slot module frame, four Active Cable Module connectors and display to be used with Carevance H1.

The Carevance D12, Carevance D15 and Carevance D19 are intended to be used with compatible GE HealthCare multi-parameter patient monitors to provide scalability by interfacing other devices.

The Carevance D12, Carevance D15 and Carevance D19 are intended to interface GE HealthCare E-Module measurement modules, Active Cable Modules, E-Module frame, and thermal recorder.

The Carevance D12, Carevance D15 and Carevance D19 are intended for use on adult, pediatric, and neonatal patients in a hospital environment and during intra-hospital transport.

The Carevance D12, Carevance D15 and Carevance D19 are intended for use under the direct supervision of a licensed health care practitioner.

The Carevance D12, Carevance D15 and Carevance D19 are not intended for use during MRI.

The Carevance D12, Carevance D15 and Carevance D19 can be interfaced to other devices via network interface.

Indications for use of Carevance D7

The Carevance D7 is a vertical stand to be used with Carevance H1.

The Carevance D7 is intended to be used with compatible GE HealthCare multi-parameter patient monitors to provide power source and ethernet connection.

The Carevance D7 is intended for use on adult, pediatric, and neonatal patients in a hospital environment and during intra-hospital transport.

The Carevance D7 is intended for use under the direct supervision of a licensed health care practitioner.

The Carevance D7 is not intended for use during MRI.

TruSignal Pressure micro-module indications for use

The TruSignal Pressure micro-module (TruSignal PRES MM) is intended for monitoring of invasive pressure and pulse rate. TruSignal Pressure micro-module is indicated for all hospital patients. The device is indicated for use by licensed healthcare practitioner.

SPI indications for use

The Surgical Pleth Index (SPI) is indicated for monitoring the patient's response to surgical stimuli and analgesic medications. SPI is a physiologic parameter derived from hemodynamic information in the photoplethysmographic waveform obtained from a patient's finger using GE HealthCare TruSignal SpO₂ modules and sensors.

The SPI is indicated for unconscious and fully anesthetized adults over 18 years of age. The SPI measurement is to be used as an adjunct to other physiological parameters.

The SPI is indicated for use by qualified medical personnel only.

E-COP indications of use

The Cardiac Output module, E-COP and accessories are intended for monitoring cardiac output (CO), right ventricular ejection fraction (REF), and invasive blood pressure of hospitalized patients. The device is indicated for use by qualified medical personnel only.

E-sCO, E-sCAiO, N-CAiO modules' indications for use

The E-sCO, E-sCAiO and N-CAiO modules are indicated for use with a host device for monitoring respiratory parameters (CO₂, O₂, N₂O, anesthetic agents, anesthetic agent identification, and respiratory rate) of adult, pediatric, and neonatal patients.

When monitoring neonatal or other patients that have high respiration rate or low tidal volume, these modules shall be used within the limits of respiration rates and tidal volumes to ensure specified measurement accuracy.

These modules are intended for use by qualified medical personnel only.

E-miniC indications for use

The Single-Width airway module, E-miniC, and accessories are indicated for monitoring CO₂ and respiration rate of all hospital patients. E-miniC is indicated for monitoring patients weighing more than 5 kg (11 lbs). The device is indicated for use by qualified medical personnel only.

E-ENTROPY indications for use

The Entropy module, E-ENTROPY, and accessories are indicated for adult and pediatric patients older than 2 years within a hospital for monitoring the state of the brain by data acquisition of electroencephalograph (EEG) and frontal electromyograph (FEMG) signals. The spectral entropies, Response Entropy (RE) and State Entropy (SE), are processed EEG and FEMG variables. The Entropy measurement is to be used as an adjunct to other physiological parameters.

In adult patients, Response Entropy (RE) and State Entropy (SE) may be used as an aid in monitoring the effects of certain anesthetic agents, which may help the user titrate anesthetic drugs according to the individual needs of adult patients. Furthermore in adults, the use of Entropy parameters may be associated with a reduction of anesthetic use and faster emergence from anesthesia.

The Entropy module is indicated for use by qualified medical personnel only.

E-NMT indications for use

The NeuroMuscular Transmission Module, E-NMT, is a single width plug-in parameter module for monitoring with accessories neuromuscular transmission (NMT) and determining the correct needle tip position from a local nerve in plexus procedures of hospitalized patients. The device is indicated for use by qualified medical personnel only.

E-PiCCO indications for use

The E-PiCCO is intended for determination and monitoring of cardiopulmonary and circulatory variables. Cardiac output is determined both continuously through pulse contour analysis and intermittently through thermodilution technique. In addition, the E-PiCCO measures systolic, and diastolic and derives mean arterial pressure. Analysis of thermodilution curve in terms of mean transit time and downslope time is used for determination of intravascular and extravascular fluid volumes.

If a patient's weight and height are entered, the compatible patient monitor presents the derived parameters indexed to body surface area.

The E-PiCCO is intended for hospitalized patients.

The E-PiCCO and accessories are for use by qualified medical personnel only.

The E-PiCCO patient module is intended for use on one patient at a time.

E-PiCCO measurement parameters are contraindicated if the placement of an indwelling central venous catheter or an arterial catheter is contraindicated or restricted.

E-PiCCO measurement parameters are contraindicated if the patient is receiving intra-aortic balloon counter pulsation (IABP).

The PiCCO-Technology by Pulsion Medical AG may give incorrect thermodilution measurements in patients with intracardiac shunts, aortic aneurysm, aortic stenosis, mitral or tricuspid insufficiency, pneumonectomy, macro lung embolism and extracorporeal circulation (if blood is either extracted from or infused back into the cardiopulmonary circulation).

BIS indications for use

The BIS Module, E-BIS, and accessories are intended to be used with modular multiparameter monitors for monitoring neurophysiological status of hospitalized patients. The BIS Module, E-BIS, and accessories are indicated for monitoring the state of the brain by data acquisition of electroencephalograph (EEG) signals of all hospitalized patients.

The Bispectral index (BIS), a processed EEG variable, may be used as an aid in monitoring the effects of certain anesthetic agents. The device is indicated for use by qualified medical personnel only.

Clinical benefit

- Real-time multi-parameter patient monitoring with the Hub enables continuous evaluation of the patient's ventilation, oxygenation, hemodynamic circulation, and temperature status.
- The Hub can help the clinical professionals to ensure adequate ventilation and circulatory function, and to maintain the appropriate body temperature. In addition, the monitoring system supports clinical decision making by providing alarms, trends, snapshots, and events.
- Using Hub with Dock enables real-time multi-parameter patient monitoring and continuous evaluation of the patient's ventilation, oxygenation, hemodynamic circulation, temperature, and neurophysiological status.
- Using Hub with Mini Dock enables real-time multi-parameter patient monitoring and continuous evaluation of the patient's ventilation, oxygenation, hemodynamic circulation and temperature status.

Clinical benefits of the TruSignal Pressure micro-module

The TruSignal Pressure micro-module (TruSignal PRES MM) enables monitoring of invasive pressure and pulse rate during patient care. Invasive pressure and pulse rate measurement data can help the clinical professional to evaluate the patient's hemodynamic condition and intracranial pressure, and aid in timely patient care decisions when needed.

Clinical benefits of the applicable E-modules

Clinical benefits of the E-COP module

The E-COP module enables cardiac output, right ventricular ejection fraction (REF), and invasive blood pressure monitoring during patient care. Cardiac output, right ventricular ejection fraction (REF), and invasive blood pressure measurement data can help the clinical professional evaluate the patient's hemodynamic condition and aid in timely patient care decisions when needed.

Clinical benefits of gas measurement modules

Respiratory clinical benefit:

- E-sCO₂, E-sCAiO and N-CAiO modules enable CO₂, O₂, N₂O, anesthetic agent, and respiration rate monitoring during patient care. Oxygenation, anesthetic agent, capnography, and respiration rate monitoring can help the clinical professional evaluate the patient's respiratory condition and aid in timely patient care decisions when needed.

E-miniC modules enable capnography and respiration rate monitoring during a patient case. Capnography and respiration rate monitoring can help the clinical professional evaluate the patient's respiratory condition and aid in timely patient care decisions when needed.

Clinical benefits of the E-ENTROPY module

The E-ENTROPY module enables electroencephalography (EEG) and frontal electromyography (FEMG) monitoring during patient care. The Response Entropy (RE) and State Entropy (SE) data can help the clinical professional evaluate the patient's neurophysiological condition, which reflects the consciousness level of the patient, and aid in timely patient care decisions when needed.

Clinical benefits of the E-NMT module

The E-NMT module enables monitoring of neuromuscular transmission (NMT) data, which reflects the level of neuromuscular blockade. NMT data can help the clinical professional evaluate the level of relaxation of the patient and aid in timely patient care decisions when needed.

Clinical benefits of the E-BIS module

The E-BIS module enables processed electroencephalography (EEG) monitoring of the brain during patient care. The processed EEG data can help the clinical professional evaluate the patient's neurophysiological status and aid in timely patient care decisions when needed.

Clinical benefits of the E-PiCCO module

The E-PiCCO module enables cardiopulmonary and circulatory data monitoring during patient care. Cardiac output and invasive arterial blood pressure data can help the clinical professional evaluate the patient's hemodynamic and circulatory condition and aid in timely patient care decisions when needed.

Intended users

The device is intended to be used under the direct supervision of a licensed healthcare practitioner.

The device is intended to be serviced by qualified biomedical engineers or other qualified service engineers.

Contraindications

Contraindications for using the device

Do not use the device in high electromagnetic fields (for example, during MRI).

Contraindications for using micro-modules

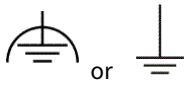
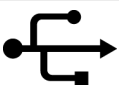
The micro-module is not intended for use within a controlled MR environment.

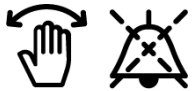
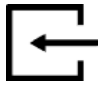
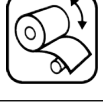
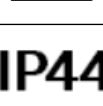
Equipment markings

This table provides explanations for equipment markings. Depending on the device's configuration, registration, and certification status, not all listed markings may be present on your device.

For user interface keys and symbols, please refer to “Monitoring basics” chapter.

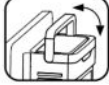
	General warning sign.
	Caution. Highlights the fact that there are specific warnings or precautions associated with the device.
	Warning. Electric shock hazard. This equipment must be serviced by qualified service personnel only. ISO 7010. This symbol is identified by a yellow background, black triangular band, and a black symbol.
	Follow instructions for use.
	Consult operating instructions.
 eIFU indicator	Consult electronic instruction for use.
	Electrostatic sensitive device. Connections should not be made to this device unless ESD precautionary procedures are followed.
	Non-ionizing electromagnetic radiation. Interference may occur in the vicinity of this device.

	Type BF (IEC 60601-1) protection against electric shock. Isolated (floating) applied part suitable for intentional external and internal application to the patient, excluding direct cardiac application.
	Type BF (IEC 60601-1) defibrillator-proof protection against electric shock. Isolated (floating) applied part suitable for intentional external and internal application to the patient, excluding direct cardiac application.
	Type CF (IEC 60601-1) protection against electric shock. Isolated (floating) applied part suitable for intentional external and internal application to the patient, including direct cardiac application.
	Type CF (IEC 60601-1) defibrillator-proof protection against electric shock. Isolated (floating) applied part suitable for intentional external and internal application to the patient including direct cardiac application.
	Functional Earth terminal.
	Class II equipment with Functional Earth terminal.
	Class I equipment with Protective earth ground. Connectors grounded to the AC power source.
	Power On.
	Alternating current power indicator.
	Directing current power indicator.
	Internal battery indicator.
	Equipotentiality. Connect device to a potential equalization conductor.
X1	Defibrillation Synchronized connector.
X2	Nurse call connector.
X3	B1X5-REC recorder and B1X5-F2 connector.
	USB connector.
	Ethernet connector.

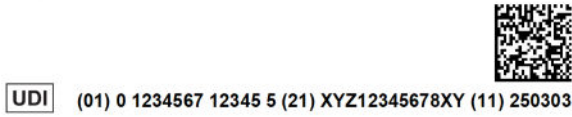
HDMI	HDMI connector.
	Gesture audio pause. Wave hand back and forth to gesture sensor area (on Dock front panel) to pause audio alarms .
	Gas inlet.
	Gas outlet.
	Mini D-fend: Add date.
	Recorder (On B1X5-REC recorder).
	Recorder paper install direction.
	B1X5-F2 communication indicator.
	Fuse. Replace with identical type and rating fuse (On Dock or B1X5-F2 Frame).
IP44	Degree of ingress protection (On Hub).
IP22	Degree of ingress protection (On Dock or Mini Dock).
IP21	Degree of ingress protection (On B1X5-F2 Frame).
	Date of manufacture. This symbol indicates the date of manufacture of this device. YY = year, MM = month, DD = day.
	Manufacturer name and address.
REF	Catalogue or orderable part number.
SN	Device serial number.
UDI	Every device has a unique marking for identification. The UDI marking appears on the device label.

TruSignal  MM and CARESCAPE 	Micro-module for measuring invasive pressures
CARESCAPE  - Microstream	Micro-module for measuring end-tidal carbon dioxide (EtCO ₂), FiCO ₂ , and respiration rate with Microstream technology
CARESCAPE  - Masimo	Micro-module for measuring SpO ₂ with Masimo rainbow SET technology
CARESCAPE  - Nellcor	Micro-module for measuring SpO ₂ with Nellcor Oximax technology
	Atmospheric pressure limitations.
	Temperature limitations.
	Humidity limitations.
	Keep dry. Protect from rain.
	Fragile. Handle with care.
	This way up.
	This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please, contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment. The separate collection symbol is affixed to a battery, or its packaging, to advise you that the battery must be recycled or disposed of in accordance with local or country laws. To minimize potential effects on the environment and human health, it is important that all marked batteries that you remove from the product are properly recycled or disposed. For information on how the battery may be safely removed from the device, please consult the service manual or equipment instructions.
	Recycled materials or may be recycled.

	Recyclable Lithium-Ion.																														
CH REP	Swiss authorized representative.																														
EC REP	European authorized representative.																														
 0197	European Union Declaration of Conformity.																														
ANATEL	Brazil only. Approved under ANATEL (Agência Nacional de Telecomunicações) requirements.																														
CMIIT ID	China only. China Ministry of Industry and Information Technology identification number for Radio Transmission Equipment Type Approval.																														
 <table><tr><td>BE</td><td>BG</td><td>CZ</td><td>DK</td><td>DE</td><td>EE</td><td>IE</td><td>EL</td><td>ES</td><td>FR</td></tr><tr><td>HR</td><td>IT</td><td>CY</td><td>LV</td><td>LT</td><td>LU</td><td>HU</td><td>MT</td><td>NL</td><td>AT</td></tr><tr><td>PL</td><td>PT</td><td>RO</td><td>SI</td><td>SK</td><td>FI</td><td>SE</td><td>UK</td><td></td><td></td></tr></table>	BE	BG	CZ	DK	DE	EE	IE	EL	ES	FR	HR	IT	CY	LV	LT	LU	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	UK			This product is restricted to indoor use, Restricted Member States as below: Belgium (BE), Bulgaria (BG), Czech Republic (CZ), Denmark (DK), Germany (DE), Estonia (EE), Ireland (IE), Greece (EL), Spain (ES), France (FR), Croatia (HR), Italy (IT), Cyprus (CY), Latvia (LV), Lithuania (LT), Luxembourg (LU), Hungary (HU), Malta (MT), Netherlands (NL), Austria (AT), Poland (PL), Portugal (PT), Romania (RO), Slovenia (SI), Slovakia (SK), Finland (FI), Sweden (SE) and United Kingdom (UK).
BE	BG	CZ	DK	DE	EE	IE	EL	ES	FR																						
HR	IT	CY	LV	LT	LU	HU	MT	NL	AT																						
PL	PT	RO	SI	SK	FI	SE	UK																								
PN	Part number.																														
IBP1 IBP2	Indicates IBP connector.																														
T1 T2	Indicates temperature connector.																														
SpO₂	Indicates SpO ₂ connector.																														
ECG	Indicates ECG connector.																														
NIBP	Indicates NIBP connector.																														
	Japan only. Approved under Japan TELEC requirements.																														
	Korea only. Approved under KCC (Korea Communications Commission) requirements. This device has been evaluated to use in a business environment, and there is a risk of radio interference if used in a home environment.																														

	Malaysia only. Malaysian Communication and Multimedia Commission (MCMC) certification mark.
	South Africa only. Approved under ICASA (Independent Communications Authority of South Africa) requirements.
	Brazil only. INMETRO certificate.
	India only. Indian Conformity Assessment Certification granted by the Bureau of Indian Standards.
	Ukraine only. Mark of conformity with the Technical Regulations. This product meets the requirements of the Technical Regulations on medical devices, approved by Resolution No. 753 of the Cabinet of Ministers of Ukraine on October 2nd 2013.
	MR Unsafe. Indicates that the device is not intended for use in an MR environment.
	This product is a medical device.
	Indicates Micro-module connector.
	Indicates Unity Network Interface Device connector.
	Date of manufacture, and Country of manufacture. The first four digits identify the year, the following two digits identify the month, and the last two digits identify the day. The alpha-3 characters in the center identify the country code.
	Philippines only. The product complies with the NTC (National Telecommunications Commission) requirements.
	Dock handle.

Unique Device Identifier (UDI)

	Unique Device Identifier. (UDI) Every medical device has a unique marking for identification. The UDI marking appears on the device labeling. Note that this is only an example of a UDI marking. The device may have a DataMatrix code as in this example, or a linear barcode, or only alphanumeric identifiers with no barcode. Identifiers also vary per product.
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The characters used in the UDI marking represent specific identifiers. In the example above:

Device identifier:

- (01) = GS1 global trade item number (GTIN) of the device.
- 01234567123455 = Global trade item number.

Production identifiers:

- (21) = GS1 application identifier for the serial number of the device.
- XYZ12345678XY = Serial number.
- (11) = GS1 application identifier for the manufacturing date of the device.
- 250303 = Manufacturing date: year-month-day (YYMMDD).

Note that for some product types, the production identifier can have other elements instead of the ones listed above:

- (10) = GS1 application identifier for the batch or lot number, followed by the batch or lot number.
- (17) = GS1 application identifier for the expiration date of the device, followed by the expiration date.

Country of origin

Country of origin: refer to the device label.

Serious incident reporting

Any serious incident related to the use of this GE HealthCare device, should be reported to both the manufacturer and the health authority/competent authority where the device is installed.

To report to GE HealthCare:

- Either contact your local service representative
- Or report to: ln-box.complaints@gehealthcare.com

Please provide the following information:

- The catalogue number or the model designation of the device as stated on its identification plate affixed on the device
- The System ID/serial number/lot number of the device
- Date of incident
- Description of incident, including any patient or user impact/injury

- Your contact information (facility, address, contact name, title, and telephone number)

Training requirements

No product-specific training is required for the use of this device.

Residual risks

There are no specific residual risks for this device. The risk mitigations such as instructions, warnings, and cautions provided within the product manuals have disclosed the risks properly and allow for safe and effective use of the device.

System introduction

System safety precautions

System warnings

WARNING

PATIENT SAFETY.

Never install the equipment above the patient to avoid the risk of any part of the equipment falling on the patient.

WARNING

INACCURATE RESULTS.

Do not use or store the equipment outside the specified temperature, humidity, or altitude ranges, or outside the specified performance range. Using or storing the equipment outside the specified operating environment or outside the specified performance range may cause inaccurate results.

WARNING

PHYSICAL INJURY.

Take care when mounting devices to an IV pole. If a device is mounted too high, the IV pole may become unbalanced and tip over.

WARNING

EXCESSIVE LEAKAGE CURRENT.

A display or printer that is a non-medical grade device and is used within the patient environment, must always be powered from an additional transformer providing at least basic isolation (isolating or separating transformer). Using without an isolating transformer could result in unacceptable enclosure leakage currents.

WARNING**EXCESSIVE LEAKAGE CURRENT.**

Laser printers are UL 60950/IEC 60950/IEC 62368-1 certified equipment, which may not meet the leakage current requirements of patient care equipment. This equipment must not be located in the patient environment unless the medical system standard IEC 60601-1 clause 16 is followed. Do not connect a laser printer to a multiple socket outlet supplying patient care equipment. The use of multiple socket outlet for a system will result in an enclosure leakage current equal to the sum of all the individual earth leakage currents of the system if there is an interruption of the multiple socket outlet protective earth conductor. Consult your local service representative before installing a laser printer.

WARNING**ELECTRIC SHOCK.**

Do not touch the electrical connector located within the module housing or frame to avoid the risk of electric shock.

WARNING**ELECTRIC SHOCK.**

Always unplug the grounded data cables when not in use. Leaving them connected could result in an electric shock from the ground contact in the other end.

WARNING**EXPLOSION OR FIRE.**

Using non-recommended batteries could result in injury/burns to the patients or users. Only use batteries recommended or manufactured by GE HealthCare. The warranty can be voided if non-recommended batteries are used.

WARNING**EXPLOSION HAZARD.**

Do not incinerate a battery or store at high temperatures. Serious injury or death could result.

WARNING**MISSED ALARMS.**

Do not connect a single-color display to the device. Visual alarm indicators may not appear properly.

WARNING**EQUIPMENT DAMAGE.**

To prevent liquids from entering the device, do not tilt the device more than +/-15 degrees (This warning does not apply to Hub).

WARNING**MISSED ALARMS.**

Secondary displays will not sound the audible alarms. Keep the patient under close surveillance.

WARNING**PHYSICAL INJURY.**

Ensure the battery is fully inserted and the battery door is securely closed. Falling batteries could cause serious or fatal injuries to neonatal or other vulnerable patients.

WARNING**EQUIPMENT DAMAGE.**

To avoid the risk of the device falling and getting damaged, DO NOT lift the handle of the Hub directly to move when the Hub is connected to a Dock. In this situation, always lift the handle on the Dock for movements.

System caution

CAUTION**RF EXPOSURE.**

To comply with the FCC RF exposure requirements, the monitor with the wireless network (WLAN) option must be operated with a separation distance of 20 cm or more from a person's body.

Short description of the system

The Hub is the core of the system. Only the Hub has a main CPU inside, neither the Dock nor Mini Dock has a main CPU inside. Neither the Dock nor Mini Dock is the host, even though the Hub can be connected to them as transport module.

The "Host-less" system design is adopted. All patients' data and configuration data are saved in the Hub's internal storage. When connecting the Hub to the Dock or Mini Dock, the Hub drives the Dock or Mini Dock to enable equipment on the Dock or Mini Dock. For example, the display and HDMI.

When the Hub works on its own or is connected to Mini Dock, it works in standalone mode. When the Hub is connected to the Dock, it works in extended mode. Because the Hub's measuring capability is extended by the Dock's E-modules and the micro-modules.

The Hub, either works in standalone mode or extended mode, is a modular multi-parameter patient monitor intended for use in multiple hospital environments and intra-hospital transport within a professional healthcare facility.

The device supports sending measured or manually entered patient data to Electronic Medical Record (EMR) systems by interfacing with Hospital Information Systems (HIS) over a wired or wireless network. It communicates with a variety of other bedside medical devices and monitoring systems.

There are several types of acquisition modules to choose from based on care requirements and patient needs. Measurement values are displayed as graphic or numeric values, like waveforms and numbers, and when applicable, also as alarm messages.

The user interface is touchscreen. The most important and commonly used functions have soft keys on the main menu. The menu structure design allows access to all functions needed by the clinical user with just a few taps.

For all physical and performance specifications, refer to the supplemental information provided.

NOTE

The Dock (also including the connected equipments) cannot function unless the Dock has been connected to the Hub properly.

Feature overview

The following table lists the available features when Hub works alone, Hub connects to Dock and Hub connects to Mini Dock. “√” indicates that the feature is available, “--” indicates the feature is not available and "O" indicates the feature is optional with the device.

Feature	Hub	Hub with Dock	Hub with Mini Dock
3/5-lead ECG	√	√	√
12-lead ECG	√	√	√
Impedance respiration	√	√	√
GE HealthCare TruSignal SpO ₂	O	O	O
NIBP	√	√	√
Integrated IBP	√	√	√
Temperature	√	√	√
Wi-Fi	O	O	O
Wired network	--	√	√
Integrated RACK	--	√	--
B1X5-REC connectivity	--	√	--
B1X5-F2 connectivity	--	√	--
Defibrillator connectivity	--	√	--
Lithium-Ion battery	√	√	O
Charging battery port	--	√	√
Gesture sensor	--	√	--
Alarm light	√	√	√
Barcode reader support	--	√	√
Micro-module connectivity	√	√	√
E-module connectivity	--	√	--
Unity Network ID connectivity	--	√	--
Anesthesia device connectivity	--	√	--
iCollect connectivity	--	√	--

Feature	Hub	Hub with Dock	Hub with Mini Dock
USB disk connectivity	--	√	√
HDMI video support	--	√	√

Licensed software options

The following table lists the software options available for purchase. These options are enabled with licenses during installation/configuration. For more information, refer to the Service Manual.

√: License is required.

Configuration	License
OxyCRG	√
Full Disclosure	√
Full Arrhythmia	√
Early Warning Score	√
TruSignal SpO2	√
AoA with SPI	√
Multi-Parameter Customized Notification	√
Long term PRAM CO access	√
50 patients (or times) PRAM CO access	√

System components

All components listed below can be used within the patient environment as long as an additional transformer providing at least basic isolation is used with non-medical grade secondary displays and printers.

Your system may not include all these components. Consult your local representative for the available components.

NOTE

It is not recommended the system to be connected to other non-isolated monitoring equipment or communication networks. In this event it is the end user's responsibility to ensure compliance with IEC60601-1 or other IEC standards.



1.	Carevance H1	2.	Carevance D12
3.	Carevance D15	4.	Carevance D19

5.	Carevance D7	6.	B1X5-REC Recorder
7.	B1X5-F2 Frame	8.	E-modules
9.	Micro-module		

Front and top view of Hub



1.	On/Off button	2.	Battery LED
3.	Alarm light	4.	Ambient brightness detection area
5.	Transportation handle		

Left side view of Hub



1.	Battery compartment	2.	Interface connector to the Dock or Mini Dock
----	---------------------	----	--

Right side view of Hub



1.	IBP connector	2.	Temperature connector
3.	SpO ₂ connector	4.	ECG and impedance respiration connector
5.	Micro-module connectors	6.	NIBP connector

Back view of Hub



1.	Pull tab of the guide	2.	Guide rail for Dock or Mini Dock
----	-----------------------	----	----------------------------------

Front view of Dock

Carevance D12, Carevance D15 and Carevance D19 have the same hardware. The only difference among them is the screen size. For more information, see the Supplemental Information Manual.



1.	Gesture detection area	2.	Alarm light
3.	Ambient brightness detection area	4.	Power LED
5.	Battery LED	6.	On/Off button

Left side view of Dock



1.	Integrated rack for E-modules	2.	Micro-module connectors
----	-------------------------------	----	-------------------------

Right side view of Dock



1.	Battery compartment		
----	---------------------	--	--

Back view of Dock



1.	Transportation handle	2.	Guide rail for Hub
3.	Defibrillation Synchronized connector	4.	Ethernet connector
5.	ID connector	6.	HDMI connector
7.	USB connectors	8.	B1X5-REC recorder and B1X5-F2 connector
9.	Power inlet connector	10.	Nurse call connector
11.	Equipotential connector		

Front and top view of Mini Dock



1.	Power LED	2.	Battery LED
3.	Guide rail for Hub		

Left side view of Mini Dock



1.	USB connector	2.	HDMI connector
3.	Ethernet connector	4.	Power inlet connector
5.	Power adapter to AC mains power		

Right side view of Mini Dock



1.	Battery compartment		
----	---------------------	--	--

Back view of Mini Dock



1.	Mounting interface		
----	--------------------	--	--

Acquisition modules

In this manual, acquisition modules refer to E-modules or Micro-modules. You can use different types of acquisition modules when Hub is connected to Mini Dock or Dock. They provide connection to the patient, process patient data signals and send patient data signals to the device.

E-modules cannot be directly connected to Hub. To use E-modules, configure it to Dock through the integrated rack or B1X5-F2 frame. For more information about connecting and removing E-module on Dock, refer to [Connecting E-module on page 85](#) and [Removing E-module on page 85](#).

Module compatibility limitations

For detailed information regarding module compatibility, see the supplemental information provided.

Identical E-modules

WARNING

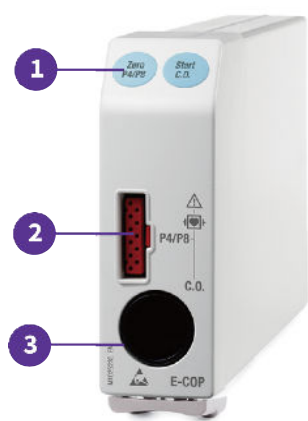
PATIENT SAFETY.

Do not use identical E-modules that map a measurement to the same channel or parameter window. If such modules have been connected, remove both modules and reconnect the new module after five seconds. In some cases, using identical modules may lead to misinterpretations and therefore compromise the patient safety.

The following modules are considered identical and should not be used simultaneously in the same monitoring system.

Module	Simultaneous use
E-sCAiO E-sCO N-CAiO E-miniC NOTE Microstream CO ₂ micro-module is also considered identical.	Only one per system.
E-COP E-PiCCO	Only one per system.
E-ENTROPY	Only one per system.
E-NMT	Only one per system.
E-BIS	Only one per system.

E-COP module



1.	Module's key
2.	IBP connector
3.	CO connector

E-miniC module



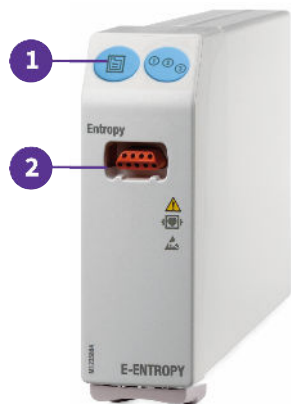
1.	Water trap
2.	Sample gas inlet
3.	Gas outlet

E-sCAiO, E-sCO and N-CAiO module



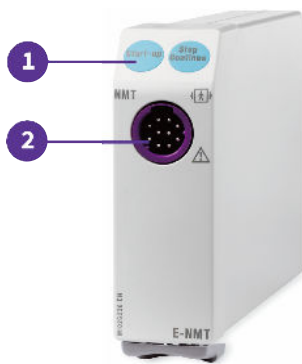
1.	Water trap release/locking latch
2.	Gas sampling line connector (sampling gas in)
3.	Water trap container
4.	Gas exhaust line connector (sampling gas out)

E-ENTROPY module



1.	Module's key
2.	Entropy connector

E-NMT module



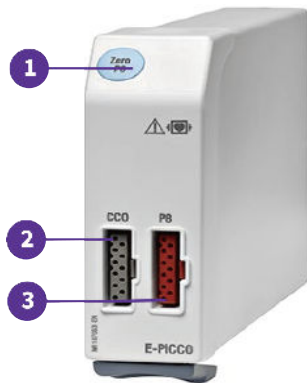
1.	Module's key
2.	NMT connector

E-BIS module



1.	Module's key
2.	BIS connector

E-PiCCO module



1.	Module's key
2.	CCO connector
3.	P8 connector

Micro-modules

Both Hub and Dock provide micro-module interfaces.

Parameter	Micro-module	Graphics
SpO ₂ Masimo	Masimo SpO ₂ micro-module (also known as U-MX).	
SpO ₂ Nellcor	Nellcor SpO ₂ micro-module (also known as U-NSATX).	
IBP	TruSignal Pressure micro-module or Carescape Pressure (also known as U-PP).	
CO ₂	Microstream CO ₂ micro-module (also known as U-MCO2).	

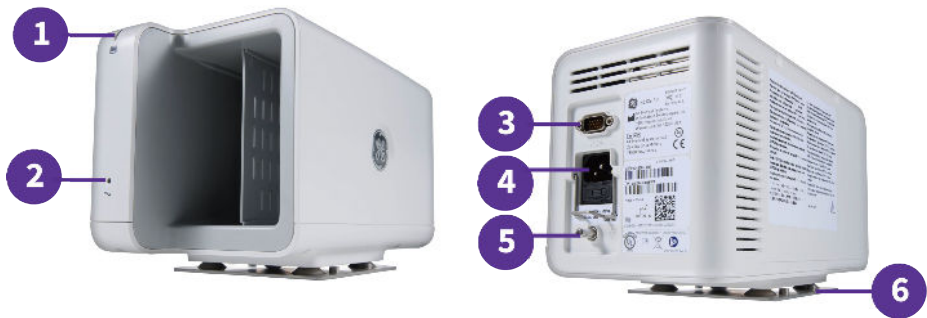
NOTE

The Masimo SpO₂ micro-module and Nellcor SpO₂ micro-module should not be used simultaneously in the same monitoring system.

B1X5-F2 Frame

The B1X5-F2 Frame provides an interface between the Dock and E-modules. The frame allows additional parameters to be monitored.

The B1X5-F2 Frame has 2 module slots that support E-module acquisition modules.



1.	Communication indicator	2.	Power indicator
3.	X3 (15-pin connector): connect to Dock	4.	Power connector
5.	Equipotential connector	6.	Guide rail for GCX mounting

B1X5-REC recorder



1.	Recorder door	2.	Tab for removing recorder
3.	Power on indicator: Illuminates when connecting to power	4.	Symbol indicates the paper install direction
5.	9-pin connector: connect to Dock		

Device battery

The device is designed to operate on battery power when used in transport. The lithium-ion battery is a rechargeable battery containing lithium-ion cells.

For information regarding the operation and charging time of the batteries, see the Supplemental Information Manual.

The LED indicator indicates whether the device is being used on battery, and also whether the battery is charging, full, missing or failed.

Indicator	Meaning
 AC power LED	Device is operating on AC mains power. It only shows on the front panel of Dock.

Indicator	Meaning
 DC power LED	Device is operating on DC mains power. It only shows on the top panel of Mini Dock.
 Battery LED	Green light. Device is powered from internal battery.
	Orange flashing. Battery failure.
	Orange light. Battery is charging. The indicator goes off when the battery is fully charged.

Checking the battery status with device software

You can check the battery status using the device software:

1. Select the  >  **Battery** .
2. Check the battery information that appears. You can check the battery **Remaining Time**, **Battery Status**, **Quality**, current **Capacity Percent** and **Maximum Capacity** in this menu.

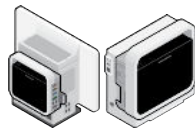
Battery charge symbols on screen



Hub works alone.

When Hub works alone, you can check the battery charge level from the battery symbol on the right upper corner of Hub screen.

Screen symbol	Meaning
 HUB	Hub battery is between 87.5% and 100% capacity.
 HUB	Hub battery is between 62.5% and 87.5% capacity.
 HUB	Hub battery is between 37.5% and 62.5% capacity.
 HUB	Hub battery is between 12.5% and 37.5% capacity.
 HUB	Hub battery is between 0% and 12.5% capacity.
 HUB	Hub is battery failure or missing battery.
 HUB	Hub battery is charging.



Hub connects to Dock or Mini Dock.

When Hub connects to Dock or Mini Dock, you can check the battery charge level from the battery symbol on the right upper corner of the screen.

Screen symbol	Meaning
	Dock or Mini Dock battery is between 87.5% and 100% capacity.
	Dock or Mini Dock battery is between 62.5% and 87.5% capacity.
	Dock or Mini Dock battery is between 37.5% and 62.5% capacity.
	Dock or Mini Dock battery is between 12.5% and 37.5% capacity.
	Dock or Mini Dock battery is between 0% and 12.5% capacity.
	Dock or Mini Dock is battery failure or missing battery.
	Dock or Mini Dock battery is charging.
	Hub battery is between 87.5% and 100% capacity.
	Hub battery is between 62.5% and 87.5% capacity.
	Hub battery is between 37.5% and 62.5% capacity.
	Hub battery is between 12.5% and 37.5% capacity.
	Hub battery is between 0% and 12.5% capacity.
	Hub is battery failure or missing battery.
	Hub battery is charging.

Other devices

other devices	Description
	External display It can be connected to both Dock and Mini Dock. The device has an HDMI connector for external display (resolution should be 1920*1080). NOTE When the cable length is more than 5 meters, GE Health-Care recommends to use high speed HDMI cable (Category 2). When the cable length is more than 20 meters, HDMI connection is not recommended. Incorrect use of HDMI cable may cause increased emissions or decreased immunity of equipment or system, or interference with measurements. NOTE The external display always shows the Dock screen layout, including the case when Hub is connected via Mini Dock.
	USB storage device (file system: FAT32) It can be connected to both Dock and Mini Dock. To export the logs, settings and patient data. To import the settings and license.
	Barcode reader It can be connected to both Dock and Mini Dock. Barcode reader is used to scan patient information by scanning the barcode when you admit a patient for care. Barcode reader is pre-configured. Do not change its configurations, or it cannot function properly for the device.
	Network laser printer You need to connect the device and printer to the same network.
	Unity Network Interface Device (ID) It can only be connected to Dock. A Unity Network Interface Device (ID) is used with the device to communicate with peripheral devices.

Central station

The device can have communication with Carescape MC network and allow the transmission of patient data to the optional Carescape Central Station. For operation instructions, see Carescape Central Station User's Manual.

Peripheral device

The anesthesia device cannot be directly connected to Hub. To establish their connection, connect Hub to Dock first, then connect anesthesia device to Dock directly or via the Unity Network Interface Device. For more information about direct connection, refer to [Connecting the anesthesia device on page 86](#).

Besides the anesthesia device, you can also connect a ventilator to the device via the Unity Network Interface Device. To connect the Unity Network Interface Device to the device, plug the cable into the ID connector on the back side of the Dock. For more information, see [Back view of Dock on page 68](#).

For instructions on connecting the Unity Network Interface Device to an external device and for a list of compatible external devices, refer to the Unity Network Interface Device User's Manual.

The parameter waveform and data of the external device can be intensively displayed on the Dock screen. This device can load these data to Carescape MC Network. And the parameter data can be sent to HL7 network simultaneously.

Monitoring basics

Operation safety precautions

Operation warnings

WARNING

PATIENT SAFETY.

After transferring or reinstalling the device, always check that it is properly connected and all parts are securely attached. Otherwise, there may be a risk of equipment falling on the patient and causing injury.

WARNING

EQUIPMENT DAMAGE.

When detaching modules, be careful not to drop them to avoid equipment damage. Always support with one hand while pulling out with the other.

WARNING

ACCURACY.

If the accuracy of any value displayed on the device, central station, or printed on a graph strip is questionable, determine the patient's vital signs by alternative means. Verify that all equipment is working correctly.

WARNING

PATIENT SAFETY.

If you accidentally drop any of the system parts, have them checked by qualified service personnel prior to clinical use. Using damaged equipment may lead to risks of erroneous readings, missed alarms, or misinterpretation of monitoring data, and therefore result in compromised patient safety.

WARNING

PATIENT SAFETY.

Do not use the device without manufacturer approved mounting attached. Otherwise, there may be a risk of the device falling on the patient and causing injury, or falling on the floor and getting damaged.

WARNING**INACCURATE RESULTS.**

After transport or storage of the device outside the specified operating temperature range, always allow the device to stabilize back to operating temperature range before applying power to it. Using the device outside the specified operating environment may result in inaccurate results.

WARNING**PHYSICAL INJURY.**

Do not install the device above a patient. Ensure the battery is fully inserted and the battery door is securely closed. Falling batteries could cause serious or fatal injuries to neonatal or other vulnerable patients.

WARNING**PHYSICAL INJURY.**

Do not install the device above a patient. Battery cell leaks can occur under extreme conditions. The liquid is caustic to the eyes and skin. If the liquid comes into contact with eyes or skin, flush with clean water and seek medical attention.

WARNING**PATIENT SAFETY.**

The battery is replaceable. To avoid potential loss of monitoring, periodically check the battery and replace when necessary.

Installation points to note

- To avoid electrostatic charges building up, it is recommended to store, maintain and use the equipment at a relative humidity of 30% or greater. Floors should be covered by ESD-dissipative carpets or similar ESD-dissipative products. Non-synthetic clothing should be used when working with the component.
- Choose a location that offers an unobstructed view of the display and easy access to the operating controls, including power cord, connectors at the device or remotely via View on Alarm or remote devices like central stations. Position the equipment so that access to disconnection via appliance coupler or mains plug is easy and unobstructed.
- Set up the device in a location that affords sufficient ventilation. The ventilation openings of the device must not be obstructed (by equipment, walls, or blankets, for example).
- The environmental operating conditions specified in the technical specifications must be ensured at all times.
- The system is designed to comply with the requirements of IEC 60601-1.
- Using the power cord supplied with the device, connect it to the power line. Use only the original cord.
- For measurements in or near the heart, we recommend connecting the system to the potential equalization system (IEC 60601-1) to ensure equal potential levels between the devices in the

system. Use the green and yellow potential equalization cable and connect it to the pin labeled

with the equipotential symbol: .

- For instructions regarding unpacking and how to proceed if the packaging has been damaged, unintentionally opened, or exposed to environmental conditions outside those specified, see the Service Manual.

Connecting and removing parts

Inserting the battery

The following graphics take the Hub battery as an example. For complete information about the location of battery compartment, see the System introduction chapter.

1. Open the battery door by gently peeling down the corner of the battery door pull tab.



2. Position the battery with the connector end facing towards the battery slot and insert the battery all the way into the battery slot.



3. Close the battery door. Ensure that the battery door tightly seals the battery into the battery slot.

Removing the battery

The following graphics take the Hub battery as an example. For complete information about the location of battery compartment, see the System introduction chapter.

1. Open the battery door by gently pulling on the battery door pull tab.

2. Pull on the battery cord to remove the battery from the battery slot.



3. Close the battery door.

Connecting Hub to Dock

1. Connect Hub by aligning it with the guide rail of the Dock.
2. Push Hub into the Dock until it clicks and stops.



Removing Hub from Dock

1. Pull the pull tab out and slide Hub out of the guides.
2. Hold onto Hub to make sure it does not drop when it comes out.



Connecting Hub to Mini Dock

1. Connect Hub by aligning it with the insertion guides of the Mini Dock.

2. Push Hub into the Mini Dock until it clicks and stops.



Removing Hub from Mini Dock

1. Pull the pull tab out and slide Hub out of the guides.
2. Hold onto Hub to make sure it does not drop when it comes out.



Connecting B1X5-F2 frame



Hub connects to Dock only.

B1X5-F2 frame cannot be directly connected to Hub. To use it, connect it to Dock via connector line.

1. Using the F2 connector line, connect the B1X5-F2 frame to **X3**.
2. Using power cord connect B1X5-F2 to the wall outlet.
3. Check whether power LED  on B1X5-F2 is lit.
4. Turn on the device, check whether communication LED  on B1X5-F2 is lit .



Connecting E-module



Hub connects to Dock only.

E-module cannot be directly connected to Hub. To use the E-module, connect it to Dock through the integrated rack or connect to the B1X5-F2 frame.

1. With the module properly oriented (module release latch facing down), align the insertion guide slot in the module with the insertion guide in the Dock rack or B1X5-F2 frame.
2. Push the module into the rack or frame until it clicks.



Removing E-module



Hub connects to Dock only.

1. Press and hold the release latch at the bottom of the module.
2. Grasp the module firmly and pull out.



From Dock



From B1X5-F2 Frame

Connecting Micro-module

1. Connect Micro-module to the corresponding connector on Hub or Dock.

**Connection to Hub****Connection to Dock**

Connecting B1X5-REC recorder



Hub connects to Dock only.

B1X5-REC cannot be directly connected to Hub. To use it, connect it to Dock by using the recorder connector line.

1. Using the recorder connector line, connect the recorder to **X3**.
2. When device is powered on, check that the power indicator on recorder is lit.

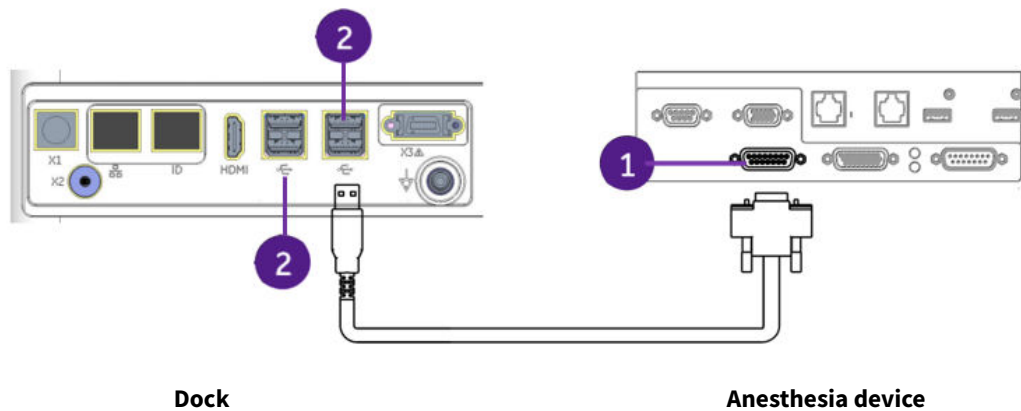


Connecting the anesthesia device



Hub connects to Dock only.

Anesthesia device cannot be directly connected to Hub. To establish the connection, connect it to Dock via connector cable.



1.	15-pin serial port on the Anesthesia device
2.	USB connectors on the Dock

1. Use an anesthesia connection cable, connect to the 15-pin serial port of anesthesia device.
2. Connect the anesthesia connection cable to the pre-configured USB connector on Dock.

The pre-configured USB connector can be configured through the  >  **Service** (password protected) menu.

Please consult qualified and trained technical users to set up. For more information, refer to the Service Manual.

Connecting the Dock to mains power

The Hub cannot be directly connected to mains power, but it is able to be powered when connects to the Dock.

The Dock can be charged when AC mains power is connected.

Connect the Dock to mains power:

1. Connect power cords to a wall outlet and to the mains power supply inlet on the Dock that require AC mains power input.
2. Secure all power cords by routing through the retaining clips, as applicable.

NOTE

Before taking the device into use for the first time, the battery should be fully charged. Keep the device connected to the mains until the battery charge symbol disappears.



Connecting the Mini Dock to mains power

The Hub cannot be directly connected to mains power, but it is able to be powered when connects to the Mini Dock.

The Mini Dock can be charged when external DC power adapter is connected.

Connect the Mini Dock to the mains power:

1. Connect DC power adapter to the power supply inlet on the Mini Dock. Then connect one side of power cord to a wall outlet that require AC mains power input and the other side to the power adapter.

NOTE
Align the white dots when connecting power adapter to the Mini Dock.



2. Secure all power cords by routing through the retaining clips, as applicable.

NOTE
Before taking the device into use for the first time, the battery should be fully charged. Keep the device connected to the mains until the battery charge symbol disappears.



NOTE
To remove the adapter from the Mini Dock, pinch and rotate the interface in the direction indicated by the arrow.



User interface keys

Various functions of the device can be accessed through the following soft keys on screen.

	Home • Close all menus displayed on the device and back to the normal screen.
--	--

	Trends Open Trends menu to: • View, setup and print trends • View gas consumption data • View and print snapshot • View and print alarm history • View and setup full disclosure
	Trends Switch (in Trends menu) • Switch among three views: graphic trends, numeric trends and gas consumption data view.
	Layout Switch • Open menu to switch layout.
	Take Snapshot • Take up snapshot, which is a set of measured data for this moment.
	Print (Soft key field, All ECG Waveforms menu) • Start to print waveforms.
	Stop Print • Stop printing waveforms or trends.
	IBP Zero • Zero all invasive pressure channels. This does not apply to ICP.
	Go in transport • Start a 2 or minute or 5 minute audio pause state. • Deactivate certain alarms.
	Start single manual NIBP • Start a single NIBP measurement. After selection, the icon changes to stop single NIBP measurement key. Measurement does not start unless the cuff size is selected.
	Stop single manual NIBP • Stop a single NIBP measurement. After selection, the icon changes to start single NIBP measurement key.
	Start auto NIBP • Start automatic NIBP measurement at timed intervals. After selection, the icon changes to stop automatic NIBP measurement key. Measurement does not start unless the cuff size is selected.
	Stop auto NIBP • Stop automatic NIBP measurement at timed intervals. After selection, the icon changes to start automatic NIBP measurement key.
	STAT NIBP • Start or stop a continuous five-minute NIBP measurement.
	Standby • Enter standby mode.

	Audio Pause Audio pause active alarms.
	More Display Quick Access Panel with more soft keys.
	More Display the full parameter setup menu.
	Lock Lock the touch screen.
	Alarm Reset Reset active alarms.
	Admit / Discharge Open Admit / Discharge menu, you can: - Enter/load patient information, to admit a patient. - Discharge a patient - Select a mode
	Other Patients Open Other Patients menu to: - View other monitored patients - Setup receive alarms from remote.
	EWS Open National Early Warning Score 2 menu to: - Calculate and view EWS - View EWS history - View EWS clinical risk - View EWS guidance (NEWS2 only)
	Customized Notifications Open Customized Notifications menu to: - View instance and related trends - Create notification groups
	Alarms Setup Open Alarms Setup menu to: - Use default limits or Auto limits - Adjust alarm volume - Audio off alarms or activate alarms - Setup alarm priorities - Setup alarm light
	Parameter Setup Open Parameter Setup menu to: Enter each parameter's menu for settings
	Export Patient Data Open Export Patient Data menu to export patient data to USB disk.

	Night Mode Open Night Mode menu to setup and enter night mode.
	Sound Volumes Open Sound Volumes menu to adjust auditory information signals.
	Screen Brightness Adjust the screen brightness.
	Screen Setup Open Screen Layout Setup menu to: Setup the screen layout
	Printing Setup Open Printing Setup menu to: - Setup and print waveforms - Setup the print devices - Check the printer status
	Service Open Install/Service menu to setup clinical and service settings.
	E-Manual Open the E-Manual menu to review the product's documentations.
	Battery Open Battery Information menu to display battery status.
	Monitor Info Open Monitor Information menu to display the version information and network status.
	OxyCRG Open OxyCRG menu to: - View realtime OxyCRG - View OxyCRG Snapshot - Setup OxyCRG
	Trends Print (in Trends menu, Trends, Snapshot, Alarm History tabs) - Start to print numeric and graphic trends. - Start to print snapshot - Start to print alarm history
	Trends Setup (in Trends menu) Enter numeric trends, graphic trends or full disclosure setup menu.
	Go to a Snapshot for specific alarm (in Alarm History menu) Go to the snapshot for one alarm history.
	Go to a Full Disclosure for specific alarm (in Alarm History menu) Go to the Full Disclosure for one alarm history.

	Go to a Full Disclosure for specific time (in Full Disclosure menu) Go to the Full Disclosure for specific time.
	Refresh the EWS (in EWS menu) Refresh parameter values enter and calculation.
	Next patient view (in bed-to-bed view) Go to next patient view in bed-to-bed field.
	Audio Pause (in bed-to-bed view) Audio pause the remote alarms.
	Hide bookmark (in E-manual view) Hide the bookmark of the current manual
	Show bookmark (in E-manual view) Show the bookmark of the current manual
	Collapse bookmark (in E-manual view) Collapse the bookmark of the current manual
	Expand bookmark (in E-manual view) Expand the bookmark of the current manual
	Delete (in Customized Notification menu) Delete the selected notification group or selected group condition
	Edit (in Customized Notification menu) Edit the selected notification group name
	Add (in Customized Notification menu) Add a notification group or add a group condition
	Group indicator (in Customized Notification menu) Merge the selected conditions into a group.
	Ungroup indicator (in Customized Notification menu) Ungroup the selected conditions.
	Arrow back Tap to turn to the previous page.
	Close indicator Tap to exit page.
	Zoom in (in Notification instance menu) Adjust the trends scale
	Zoom out (in Notification instance menu) Adjust the trends scale

User interface symbols

The following symbols appear in the software user interface.	
	Alarm off indicator - Displays in the upper right corner of the digit field when physiological alarms for this parameter are turned off. The symbol may not display at the central station.
	Audio alarms off indicator - Displays in the upper left corner of the message field when physiological audible alarms are turned off.
	Audio alarms paused indicator - Displays in the upper left corner of the message field and indicates that alarms are audio paused.
	Alarms audio pause indicator. Displays in the upper left corner of each alarm message and indicates that alarm audio pause has been activated.
	Low priority audio off alarm indicator. Indicates that audio indicators have been turned off for low priority alarms (visual indicators are still active).
	Alarm volume adjustment for low priority.
	Alarm volume adjustment for high and medium priority.
	Alarm limit symbol. Low and high parameter alarm limits are displayed on the left and right sides of it.
	Alarm priority indicator: High (red). Indicates a high priority alarm in alarm history.
	Alarm priority indicator: Medium (yellow). Indicates a medium priority alarm in alarm history.
	Alarm priority indicator: Low (cyan). Indicates a low priority alarm in alarm history.
	Alarms setup indicator.
	Alarm volume indicator - Displays beside the alarm volume setup option.
	General warning sign. Displays in the alarm priorities setup menu, indicate the priority setting deviates from the recommendation of international alarm safety standards.
	General information sign. Displays when the priority setting deviates from the recommendation of international alarm safety standards.

The following symbols appear in the software user interface.	
	Alarm limits changed indicator - Displays in the alarms setup menu. Unread notification instances indicator - Displays in the notification bar.
	Unity network is connected.
	Unity network is not connected.
	Network (WLAN) signal strength. The number of green segments corresponds to the signal strength: four segments indicate strong signal, one segment weak signal.
	Network (WLAN) disconnection indicator.
	Dock or Mini Dock battery icon with 87.5% ~ 100% capacity (for example). The battery icon varies with different capacities and on different statuses (charging, failure or missing). Refer to Battery charge symbols on screen on page 76 for the full list of battery icons.
	Hub battery icon with 87.5% ~ 100% capacity (for example). The battery icon varies with different capacities and on different statuses (charging, failure or missing). Refer to Battery charge symbols on screen on page 76 for the full list of battery icons.
	Night mode indicator. Indicates the monitor is on the night mode.
	Beat volume icon. Adjust the volume of the QRS beep tone. Also the beat source indicator. Displays next to the selected beat source.
	Respiration indicator. Indicates a breath is detected by the impedance respiration algorithm.
	Lock indicator. Indicates the screen has been locked.
	Unlock indicator. Swipe down to unlock the screen.
 2 min	Progress bar. Indicates the amount of time remaining until the next automatic measurement.
	Patient discharge indicator.
	Patient information indicator. Displays in the bed-to-bed view.
	Patient admitted indicator.

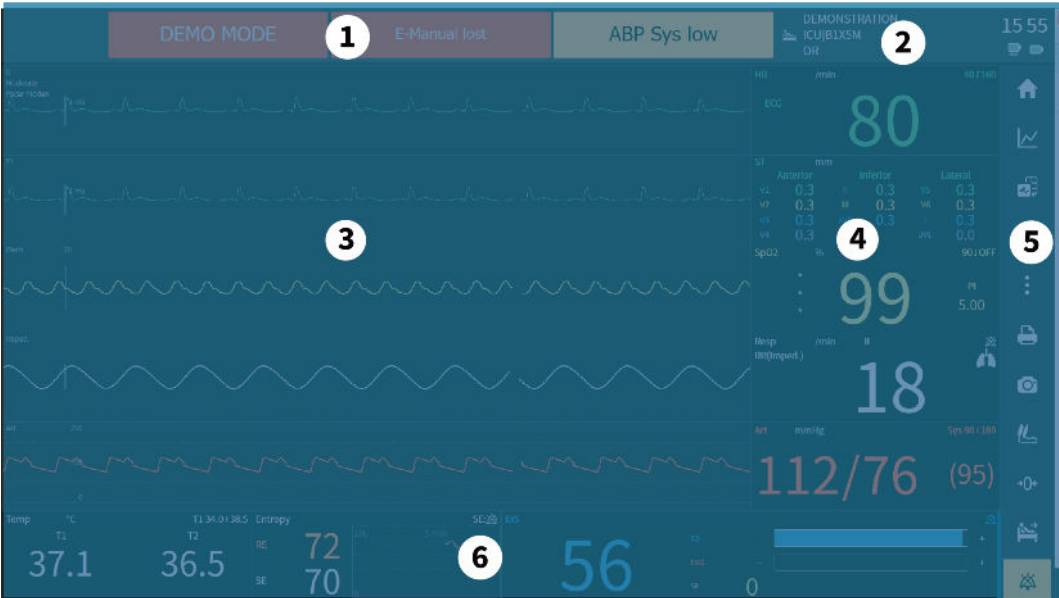
The following symbols appear in the software user interface.	
	Patient discharged indicator.
	Anesthesia device or S/5 channel is disconnected.

Main screen layout

The main screen displays alarms, information, trends, waveforms, digits, and the main menu in pre-defined areas.

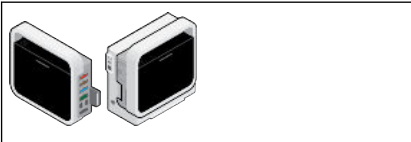
When the information area of the screen is selected, it opens the **Admit / Discharge** menu and provides access to settings related to patient and administrative information, mode selections, unit and bed setup.

Waveform layout



1.	Message field	Select the alarms in message field, can view the Quick Help about possible causes and suggested actions for current alarms.
2.	Information area	Select this area, can enter Admit / Discharge menu.
3.	Waveform field	Display waveforms selected in Screen Layout Setup menu. Select a waveform on Dock screen can open a quick pop-up menu of this parameter.
4.	Upper digit field	Display parameter digits correspond with waveforms. Select a digit field can open the setup menu of this parameter.
5.	Soft key field	Select soft key can trigger related functions.
6.	Lower digit field	Displays up to 4 parameter digits. Select a digit field can open the setup menu of this parameter.

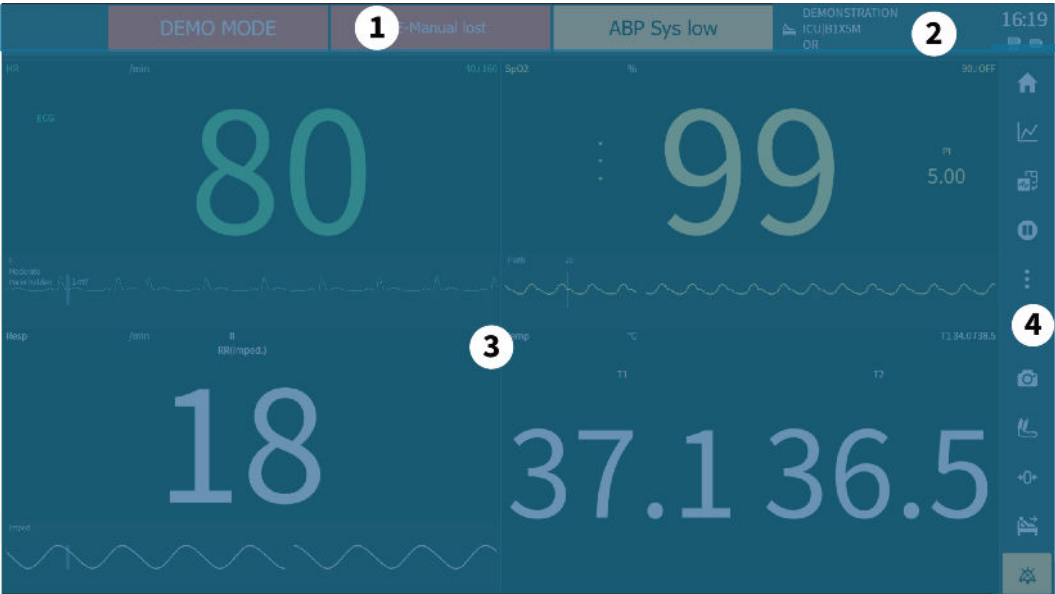
NOTE

	The Hub screen displays up to 5 waveforms and 4 lower digit fields at a time in waveform layout, or displays up to 6 waveforms when the Lower Area is turned off.
	The Dock screen displays up to 11 waveforms and 4 lower digit fields at a time in waveform layout, or displays up to 12 waveforms when the Lower Area is turned off.

The information area of the screen displays the following information, selecting this area can enter the **Admit / Discharge** menu:

- Patient name (if entered).
- Bed name and care unit.
- Mode name.
- Current time.
- Battery status icon.
- WLAN signal symbol (if connected to the wireless network).
- Network symbol (if connected to the MC Network).
- Night mode symbol (if enter night mode).

Large number layout



1.	Message field	Select the alarms in message field, can view the Quick Help about possible causes and suggested actions for current alarms.
2.	Information area	Select this area, can enter Admit / Discharge menu.
3.	Large number field	Select a digit field can open the setup menu of this parameter. Select a waveform on Dock screen can open a quick pop-up menu of this parameter.
4.	Soft key field	Select soft key can trigger related functions.

NOTE

Both Hub and Dock screen have two options for large number layout, you can select to display 4 parameters or 6 parameter.

Split screen and bed-to-bed view layout

The system supports split screen on the Dock screen or external display via HDMI connection. Split screen area is on the left side of main screen.

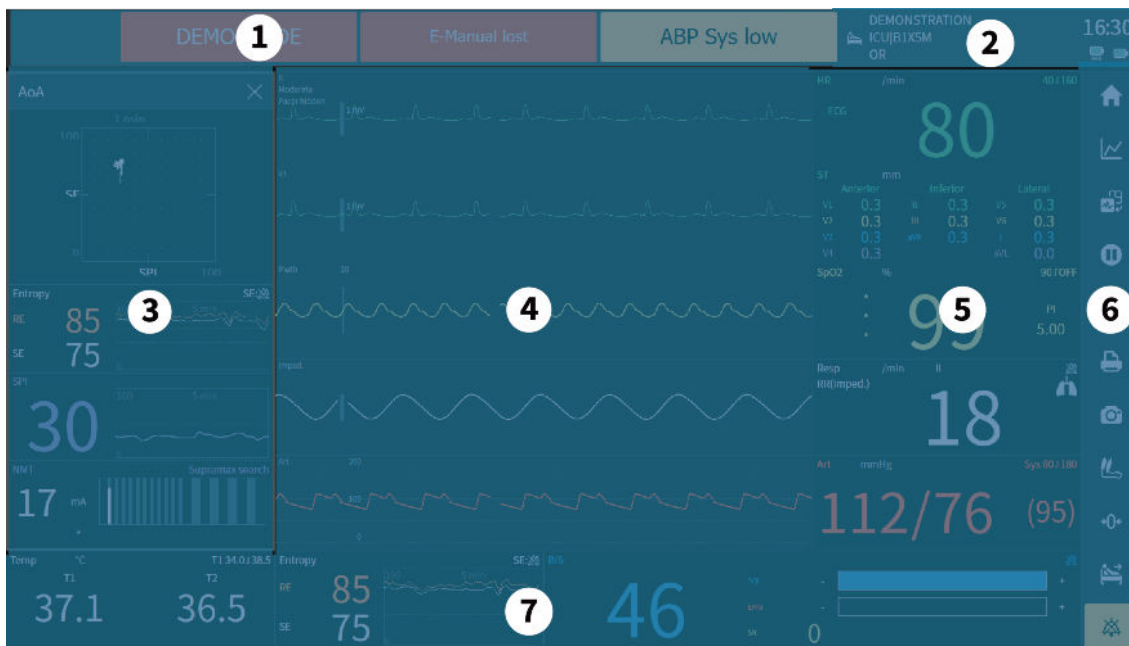
NOTE

When using the external display screen, users can only view it and are not allowed to operate on it.

The system only supports bed-to-bed view only on the Dock screen. Bed-to-bed view area is on the left side of main screen.

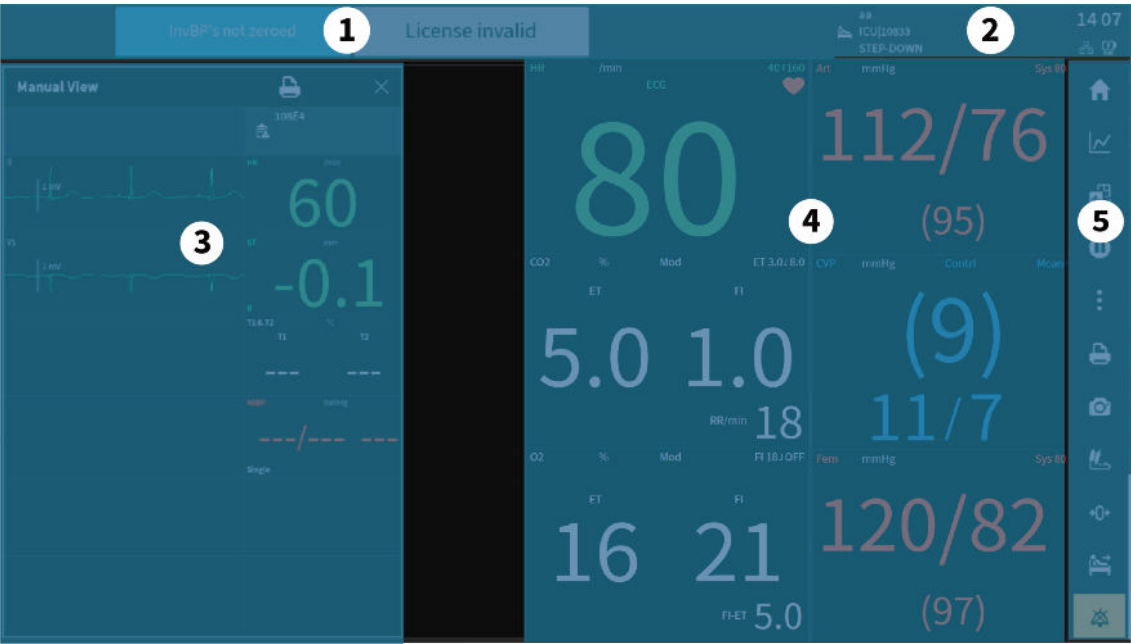
NOTE

- The bed-to-bed view area, split screen, and notification bar cannot appear simultaneously.
- Bed-to-bed view is the first priority, when it opens, split screen and notification bar can't display.



1.	Message field	Select the alarms in message field, can view the Quick Help about possible causes and suggested actions for current alarms.
2.	Information area	Select this area, can enter Admit / Discharge menu.
3.	Split screen and bed-to-bed view area	Displays split screen or bed-to-bed view.
4.	Waveform field	Display waveforms selected in Screen Layout Setup menu. Select a waveform on Dock screen can open a quick pop-up menu of this parameter.
5.	Upper digit field	Displays parameter digits correspond with waveforms. Select a digit field can open the setup menu of this parameter
6.	Soft key field	Select soft key can trigger related functions.
7.	Lower digit field	Displays up to 4 parameter digits. Select a digit field can open the setup menu of this parameter

Or:



1.	Message field	Select the alarms in message field, can view the Quick Help about possible causes and suggested actions for current alarms.
2.	Information area	Select this area, can enter Admit / Discharge menu.
3.	Bed-to-bed view area	Displays bed-to-bed view. NOTE Split screen can't display with large number layout together.
4.	Large number field*	Displays up to 6 large number parameters with 1 waveform of this parameter (except the parameters, which not have waveform, such as NIBP). Select a digit field can open the setup menu of this parameter. Select a waveform on Dock screen can open a quick pop-up menu of this parameter.
5.	Soft key field	Select soft key can trigger related functions.

*The large number layout has two options: display 4 parameters or 6 parameters.

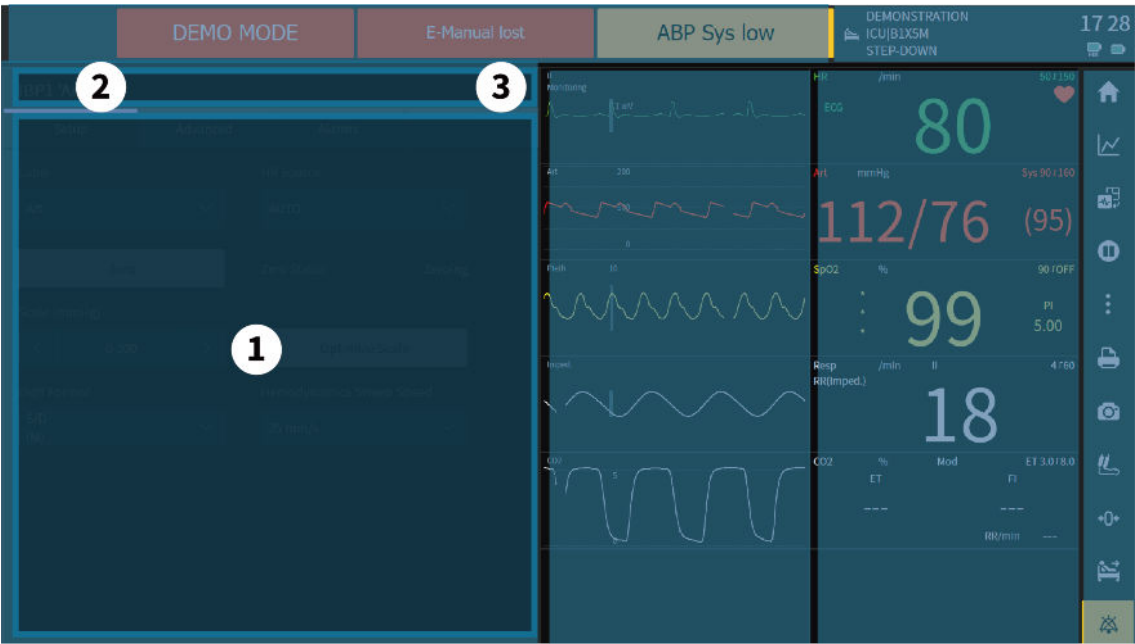
Menu layout

Normal menu layout

When you open the normal menu, parameter waveform and upper digit field still can be shown on the Dock screen. On Hub screen, the parameter waveform disappears and only upper digit field can be shown.

If main screen is large number layout, the parameters configured in large number field will be shown on the upper digit field. If main screen is waveform layout, the parameters configured in upper digit field and the right most lower digit field will be shown on the upper digit field.

The following illustration takes Dock's screen as an example.



1.	Normal menu
2.	Menu title
3.	Exit key: select to close current menu.

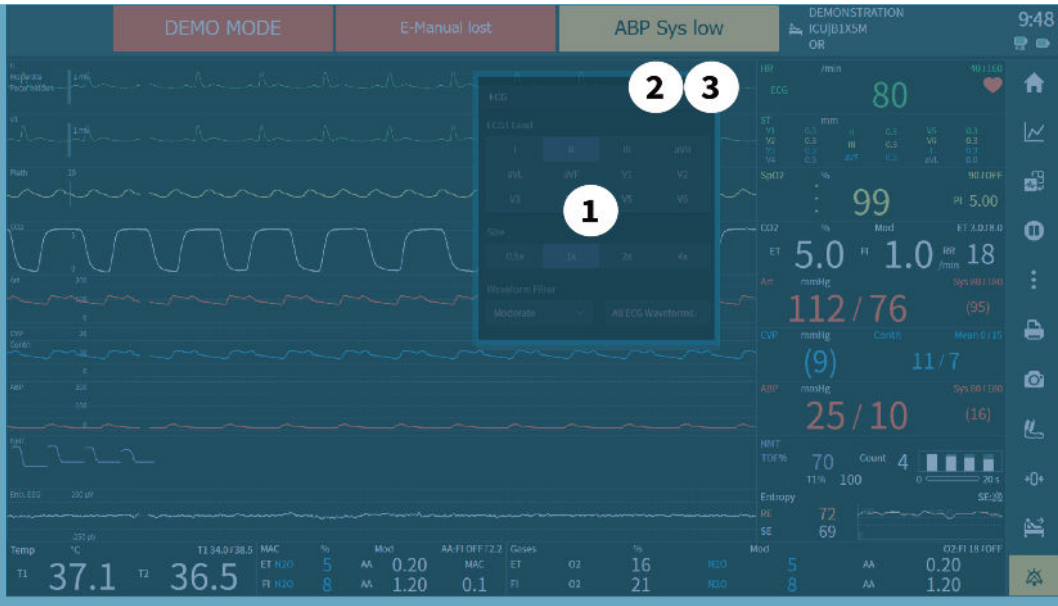
NOTE
Other areas on screen are still active. If you select, still can access to related functions.

Quick pop-up menu layout



Hub connects to Dock only.

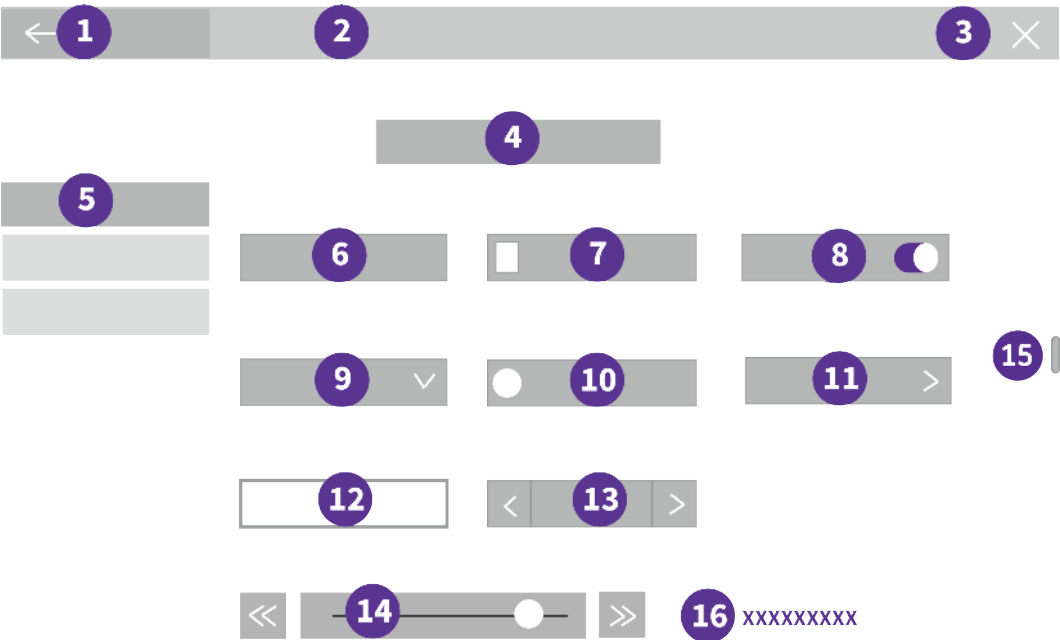
When you select a waveform on Dock screen, a quick pop-up menu of this parameter will show up to help you to adjust parameter settings conveniently.



1.	Quick pop-up menu: Displays frequently used parameter settings.
2.	...: Open the full parameter setup menu.
3.	X: Close the quick pop-up menu.

An example of a menu

The following is an example of a menu illustrating some of the components and how they are referred to in this manual:



1.	Arrow back: Tap to return to the previous page.
2.	Menu title (for example, Install/Service).
3.	Close indicator: Tap to exit the page.
4.	Horizontal tab (for example, Alarm Limits).
5.	Vertical tab (for example, Upper Area, Lower Area, Side Pane).
6.	Button for initiating a actionable function.
7.	Check box for selecting or deselecting a feature.
8.	Toggle: to enable or disable a function.
9.	Selection list: when selecting the arrow, a list of options appear.
10.	Radio button for selecting a feature from the available options.
11.	Further menu selections.
12.	Edit box: to enter or edit the text.
13.	Decrease or increase the value by clicking on the left or right arrow.
14.	Sliding scale: navigate through pages.
15.	Vertical scroll bar: to present contents on more than one page.
16.	Text button. Link to other interfaces by clicking the purple texts.

NOTE
Not all menus have these same components.

Menu options

To reach the system settings, select the soft key to open the related menu.

To reach the parameter settings, three ways as follow:

- Select the digit field to open each parameter’s setup menu.

- Select the waveform field on Dock screen to open the related shortcut menu. The parameter's quick pop-up menu will display.

For more settings, you can select ●●● to open the related parameter's setup menu.

- Select  >  **Parameter Setup** to open the all parameter's setup menu.

Selecting menu options with a touchscreen

NOTE

Do not use pencils, pens, or other sharp objects to activate the touchscreen. The touchscreen will not function properly if tape, paper, or liquid is stuck to the display surface.

1. Touch the menu option with your finger.
2. Lift your finger off the screen, and the selected function is performed (e.g., a list opens).

Entering data

When data entry is required, the device automatically displays an on-screen keyboard for you to use.

1. Select the desired data field.
2. Enter data:
 - Select the characters with the touchscreen.

Locking the screen

You can set the touchscreen feature off when you need to clean the screen.

1. Select  >  **Lock**.
2. To unlock the screen:
 - Swipe down the  scroll bar on the right column of the screen.

Turning the device on/off

The device is preset at the factory for a specific AC voltage. Before applying power, be sure that the power requirements match your power supply. Refer to the label on the device for voltage and current requirements.

Before turning off the device:

- Stop all measurements.
- Stop all activities (e.g. printing waveforms, exporting contents to USB).
- Return main menu to home.



Hub works alone or Hub connects to Mini Dock.

When Hub works alone or connects to Mini Dock, pressing the power button on Hub will turn system on/off.

1. Turn on the power:
Press the power button briefly located on the top panel of Hub.
The welcome screen will appear with a status bar indicating the progress of the startup procedure on the Hub screen.
2. Turn off the power:
Press the power button (more than 3 seconds) located on the top panel of Hub.
The message “**Monitor is shutting down...**” will appear on the Hub screen.



Hub connects to Dock only.

When Hub connects to Dock and the system is powered by Hub battery, the Hub's LCD is on. To turn on/off the device, press the power button on Hub. Follow the same steps as the Hub works alone.

When Hub connects to Dock and the system is powered by Dock (either AC or Dock battery), the Hub's LCD is off. To turn on/off the device, press the power button on either Dock or Hub. Follow the below steps:

1. Turn on the power:
Press the power button briefly located on front panel of Dock or top panel of Hub.
The welcome screen will appear with a status bar indicating the progress of the startup procedure on the Dock screen.
2. Turn off the power:
Press the power button (more than 3 seconds) located on front panel of Dock or top panel of Hub.
The message “**Monitor is shutting down...**” will appear on the Dock screen.

NOTE

When no Hub is connected to Dock, pressing the power button on the Dock shall NOT trigger any system action.

Automatically turn off the device



Hub connects to Dock only.

When Hub connects to Dock and neither of them is powered by mains power supply, the device will run out of the Dock battery first, then the Hub battery. The Dock screen is on when the Dock battery provides power. When the Dock battery remaining time is less than 3 minutes, a message **Monitor is shutting down...** will appear on the Dock screen. The Dock will automatically turn off.

Then the Hub screen is on. The Hub is powered by Hub battery. When the Hub battery remaining time is less than 3 minutes, a message **Monitor is shutting down...** will appear on the Hub screen. Then the Hub will automatically turn off.



Hub connects to Mini Dock only.

When Hub connects to Mini Dock and neither of them is powered by mains power supply, the device will run out of the Mini Dock battery first, then the Hub battery. When the Hub battery remaining time is less than 3 minutes, a message **Monitor is shutting down...** will appear on the Hub screen. Then the Hub will automatically turn off.



Hub works alone.

When Hub works alone, it's powered by Hub battery. When the battery remaining time is less than 3 minutes, a message **Monitor is shutting down...** will appear on the Hub screen. Then the Hub will automatically turn off.

NOTE

There is technical alarm when device battery is low or empty.

NOTE

Always make sure that the device battery power is adequate in your care environment to avoid automatically turning off the device. Otherwise, there is a risk of loss of monitoring.

Password management

Please consult qualified and trained technical users to set up password. For more information about password management, refer to the Service Manual.

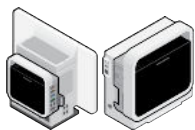
Performance check

After turning on the device, and during operation, the device runs automatic self-tests. If a malfunction is detected, the device displays a message or an alarm, depending on the severity of the malfunction.

Power interruption

If the mains supply to the equipment is interrupted, the device keeps the patient data and the latest user-made settings. If not, contact authorized service personnel.

Downloading logs to USB disk



Hub connects to Dock or Mini Dock.

When Hub connects to Dock or Mini Dock, you can download the system logs, and diagnostic logs to an USB storage device for service use.

For more information about how to download logs to USB disk, refer to Service manual.

Setting up the device before use

About configurations

The device configurations have two levels of access:

- General settings by any user.
- Advanced settings by qualified and trained technical users only (including biomedical engineers, service personnel and IT professionals). These settings are for advanced configuration, calibration and maintenance of the device. To access these settings, select the  >  **Service** (password protected). Instructions for the advanced settings are provided in the Service Manual.

Waveform field safety precautions

WARNING

MISINTERPRETATION.

Always make sure that the waveform size is sufficient for the care environment to ensure that the waveforms can be interpreted correctly and no details are missed.

CAUTION

PATIENT SAFETY.

The waveform autoscaling feature of certain parameters automatically updates the display from the best possible signal amplitude. Always make sure that the waveform display scale is correctly understood and does not lead to delayed patient treatment.

Normal screen

You can return to the normal screen any time during the monitoring.

- Select the  to return to the normal screen.

When monitoring begins, the main page appears automatically. This preconfigured page is called the normal screen. Any changes you make to the screen setup during monitoring will change this normal screen. These changes are not permanent unless they are saved to a mode. They are valid until the patient is discharged.

Adjusting sound volumes

You can adjust various sound volumes according to your care environment needs. While you are adjusting the volume, you will hear a corresponding sound that will guide you in determining a suitable level.

NOTE
Alarm Volume cannot be set to 0.

1. Select the  >  **Sound Volumes**.
2. Adjust following sound volumes with the arrows.
 - **Alarm Volume**

NOTE
High & Medium Priority alarm volume and **Low Priority** alarm volume: display only when **Separate for Low** is selected in the  **Service** menu (password protected).

- **Beat Volume**
- **Completed NIBP Volume**

Adjusting the display brightness

You can set the display brightness level according to your needs.

NOTE
The maximum screen brightness adjustment on Dock is limited to 70% when Dock is not connected to AC mains power.

1. Select the  >  **Screen Brightness**.
2. Select the **Brightness Type** of **Hub** or **Dock**.
3. When the **Brightness Type** is set to **Manual**, adjust the **Screen Brightness** with the arrows.
4. When **Brightness Type** is set to **Auto**, the display adjusts screen brightness automatically according to the ambient light.

Screen setup modifications

The device provides pre-configured layouts: 2 waveform layouts and 2 large number layouts. You can select layouts between waveform and large number during monitoring.

- Use the  to select pre-configured layouts.
- Select  on the right upper corner of the menu to configure the pre-configured layout.

Waveforms layout

	The Hub screen displays up to 5 waveforms and 4 lower digit fields at a time in waveform layout, or displays up to 6 waveforms when the Lower Area is turned off.
---	--



The Dock screen displays up to 11 waveforms and 4 lower digit fields at a time in waveform layout, or displays up to 12 waveforms when the **Lower Area** is turned off.

Waveforms are always evenly distributed to fill the entire waveform area. Whenever there are fewer waveforms configured on the screen, the remaining waveforms are enlarged. Changing a displayed waveform to another waveform will also update the associated digit field that is displayed to the right of the waveform.

Depending on your configuration, if you use the same measurement in the lower digit field that is currently in the waveform field, the waveform field of this measurement will be turned off. This measurement will be displayed in lower digit field.

Large number layout

The device displays up to 6 digit fields at a time in large number layout.

Each field displays large number of digit field and one waveform for each parameter, if applicable.

Setting waveforms layout

1. Select the  >  **Screen Setup**, and the required screen.
2. Select the **Upper Area** vertical tab and then select **Layout 1** or **Layout 2** tab in the upper horizontal area.
3. Select the parameters for related waveforms.
4. Select the **Lower Area** vertical tab.
5. Check that the **Lower Area** is turned on.
6. Select the parameters for related digit fields. You can select up to 4 lower digit fields.

NOTE

If you turn off the **Lower Area**, the parameter selections for digit fields are gray.

Selecting the display mode for IBP waveforms

You can select the invasive pressure waveforms to be shown as individual waveforms, or in a combined view.

1. Select the  >  **Screen Setup**, and the required screen.
2. Select the **Layout 1** or **Layout 2** tab.
3. Enable the **Combine Pressures** toggle to combine up to three adjacent IBP waveforms in one field.

The new waveform field will use the combined height of the original fields.

Setting large number layout

1. Select the  >  **Screen Setup**, and the required screen.

2. Select the **Layout 3** or **Layout 4** tab.
3. Select the parameters for related fields.

Setting the split screen

To view the measured graphic and/or numerical values selected as well as the waveform and digit field, you can set a split screen display bar on the left side of the screen. For more information about split screen, see [Split screen and bed-to-bed view layout on page 97](#).

1. Select the  >  **Screen Setup**, and the required screen.
2. Select the **Side Pane** vertical tab.
3. Select an option from the **Show** list.

On the **Hub Screen Layout Setup** menu, the choices are:

- **CO Monitoring** (not for Neonatal mode)
- **Notification Bar**
- **None**: No split screen is displayed.

On the **Dock Screen Layout Setup** menu, the choices are:

- **Split Screen: Split Screen 1** and **Split Screen 2** (not for Neonatal mode)
- **Split Screen: Spirometry, PiCCO, None** (for Neonatal mode only)
- **Notification Bar**
- **None**

4. If needed, select an option from the **Split Screen 1** list. The choices are:
 - **CO Monitoring**
 - **None**
5. If needed, select an option from the **Split Screen 2** list. The choices are:
 - **AoA**: SPI, Entropy values, mini trend graphic menu and NMT parameter window are displayed. The display contents depend on the module and option you are using. The option is only applicable for OR mode.
 - **Spirometry**: Spirometry measurement data is displayed. The option is activated when either a compatible anesthesia device or the Unity Network Interface Device is connected.
 - **PiCCO**: Show the CCO graphical view contents. The option is activated when E-PiCCO module is connected.
 - **None**

Setting parameters

1. Select the  >  **Parameter Setup**.
2. Select the **Others** tab for more parameters, if necessary.
3. Select each parameter to adjust the settings.

You can also select each parameter's digit field or waveform field to open the setup menu.

For details about the settings, refer to the parameter's chapter.

Setting up printing options

You can check that the printing options for waveforms are set according to your needs when you start monitoring a patient.

1. Select the  >  **Printing Setup**.
2. Check the settings by going through the different options and change if necessary.

For more information, see the “Printing” chapter.

Other setup changes

The following are advanced clinical settings that are password protected.

- Alarm options
- Snapshot
- Parameter settings (Units, Colors, and Others)
- Roving
- Mode settings
- Time and date
- Calculation Units
- Time zone
- USB Import/Export
- EWS (Early Warning Score type)
- Printer
- Gesture Control

Please consult qualified and trained technical users to set up. For more information, refer to the Service Manual.

Starting and ending monitoring

Starting and ending safety precautions

Starting and ending warnings

WARNING

LOSS OF MONITORING AND MISSED ALARMS.

When starting to monitor a patient, always make sure that you are in the normal monitoring mode and not in the DEMO mode. Ensure that there is no **DEMO MODE** text in the message field. If the DEMO mode is active when you start monitoring, there is a risk of loss of monitoring and missed alarms. Consult a qualified service personnel to exit the Demo Mode.

WARNING

MISSED ALARMS.

When starting to monitor a patient, always make sure that you select the correct user mode. The user mode will affect the user default settings for **Alarms Setup**. If you select a wrong user mode, there is a risk of missed alarms.

Starting and ending caution

CAUTION

DISCHARGE TO CLEAR PATIENT DATA.

When admitting a new patient, you must clear all previous patient data from the system. To accomplish this, disconnect the patient sensors, then discharge the previous patient.

About the user default settings

User default settings mean those settings (Default Mode) that the user has saved into the device to replace the factory default settings. If there are no user default settings, factory default settings are used.

About user modes

When start monitoring a patient, you can use the default mode or select another mode. The device has nine user modes for Adult/Pediatric patients and one user mode for Neonatal patient to choose. Mode controls many settings, including parameter defaults, alarm detection limits, and screen display.

You can:

- save the current settings to target mode.
- revert the target mode settings to factory default settings.
- choose the default mode.
- rename the user modes (except **NEONATAL** mode).

Reach these selections through  >  **Service > Mode Settings**, and they are password protected. Please consult qualified and trained technical users to set up. For more information, refer to the Service manual.

For detailed information regarding user modes, see the Supplemental Information Manual.

Selecting a mode

The device starts with the default mode, but you can select another mode according to your needs. You can also change the mode while monitoring a patient without losing any patient data.

1. Select the information area.
2. Select a patient type from the **Patient Type** list.
3. Select the **Select Mode** tab.
4. Select a mode from the **Select Mode** list.
5. You can return to previous mode by selecting **Return**.

If you make changes to mode settings and need to return to its previous settings, first select another mode and then re-select the one you were using.

Pre-monitoring checklist

Before you start monitoring a patient, check the following:

- The battery capacity is enough or the device is connected to the mains power.
- Physiological alarms are in active state.
- Acquisition module is firmly in place.
- Accessories are intact and properly connected.
- Device is displaying the monitoring screen.
- No messages are displayed indicating the device is not functioning.
- Desired parameters are selected to view on the screen.
- Alarm signals are working and can be seen and heard in your care environment.
- Required parameter calibrations are completed.

Starting monitoring

A patient is automatically admitted when the device detects any of the following vital signs: ECG, Art, Fem, ABP, NIBP, SpO₂, CO₂, Entropy or BIS.

A patient is manually admitted when any patient information is entered or loaded. Patient information can be entered locally using the device, loaded from the Carescape Gateway server over the Carescape Network, or entered remotely using a central station.

When a patient is admitted and the device is connected to the network, patient data will display at the central station.

Always observe the device and the patient carefully during start-up periods and when inserting acquisition module.

The following are generic instructions listing the basic steps for starting monitoring. Parameter-specific instructions are more detailed and should always be followed as well.

1. Connect the patient to the device according to the measurement setup requirements. The alarms and parameter settings become active.
2. If the default mode is not suitable, select another mode.
3. Enter patient information, or load the data.
4. Start the measurement.
5. Zero invasive pressure lines.
6. If required, change the parameters on screen.
7. Check alarm limits and adjust if necessary.

Entering patient data

Patient data privacy protection

Patient data and patient information are invisible in the clinical logs or the setting file you downloaded. The patient trend can be download, but it's encrypted.

When the device is connected to an external display, you can choose to show or hide the patient information on the external display. This setting required a password. Please consult qualified and trained technical users to set up. For more information, refer to the Service manual.

Entering patient data with the device

1. Select the information area.
2. Edit or enter the **First Name**, **Last Name**, and **MRN** by selecting the areas you can edit.

NOTE

After entering the **MRN**, the **Second ID** is enabled for input.

3. Select the **Patient Type** from the list. Choices are:
 - **Adult/Pediatric**

- **Neonatal**

NOTE

When you select **Patient Type** to **Neonatal**:

- The mode will automatically become **NEONATAL**.
- The **OxyCRG** will be activated.

4. Enter **Demographics** menu, and select following values with the arrows:

- **Date of Birth: Day, Month, Year**
- **Age, Age unit** options
- **Gender**
- **Height** and **Weight**

NOTE

The **BSA** value is calculated automatically once the height and weight have been selected.

NOTE

Date of Birth is related to **Age**, which **Age** is automatically calculated from **Date of Birth**.

5. Reconfirm the patient data you have entered.

Entering patient data with barcode scanner



Hub connects to Dock or Mini Dock.

You can scan the patient data in the barcode when the function is activated during device configuration.

1. Select the information area.
2. Select **Scan from Barcode**.

You can select **Cancel Scan** to cancel the scanning.

3. Use barcode scanner to scan the code.
4. The patient data will be displayed. Check and select **Confirm** to accept data entering.

NOTE

If you want to admit a new patient, please discharge the current patient first. Or else, the new entered patient data will be regarded as a modification of current patient information, but not admit a new patient.

Loading patient information from the Carescape Network

In the Carescape Network, patient information can be loaded from the Carescape Gateway server. You cannot merge data between the device and the Carescape Gateway server.

1. Select the information area.

2. Select the **Load Patient** tab.
3. Select **Find Patients**.
4. Enter the **MRN** and/or **Last Name** information you have available.
You can also add the **First Name** information but the search does not function with this information only.
5. Select **Find**.
6. When the patient list appears, select the patient.
7. Select **Load** to load the data from the Carescape Gateway server.

About standby

When you intend to disconnect the patient temporarily from the device, but not to discharge the patient, you can use the standby option.

NOTE

When the patient is discharged, the standby mode is not allowed to start.

Starting standby

1. Select .
- If patient cables are still connected and the device is receiving physiological data, a text message will be displayed, indicating that audio alarms have been paused.
2. Disconnect patient cables and stop NIBP automatic measurements to start the standby.
If you do not disconnect the cables and physiological data is still present after the audio pause time expires, the standby is canceled. You can also select  to cancel entering standby immediately.

The screen will go blank and the **Standby** text appears.

End of standby

The device ends the standby state automatically when any of the following conditions occurs:

- Any vital sign is detected.
- The touchscreen is pressed.
- Discharge a patient remotely.
- Dock or Mini Dock connection status is changed.

NOTE

When user presses the **ON/OFF** button for less than 3 seconds, the device will exit standby state. When pressing the **ON/OFF** button for more than 3 seconds, the device will turn off.

After that, a continue menu will open, the options are:

- **Continue Current: Continue monitoring of previous patient.**
- **Discharge Patient: Discharge will erase all the patient data in this device.**

- **Standby: Enter Standby mode.**

NOTE

The continue menu will not appear when the patient is discharged remotely.

About the roving functionality

Roving functionality allows you to move, or rove the device to fit the patient's acuity needs, rather than moving the patient to a monitored room. When you move the device to a new location in the Carescape Network, you can update the unit and/or bed names from lists, or add new names manually. Available selections depend on what has been allowed in configuration.

These settings are configured through  >  **Service** > **Roving** and they are password protected.

Roving between units

If roving between units is allowed, you can update the unit name when moving the device to a new location.

1. Select the information area.
2. Select the **Care Unit & Bed** tab.
3. Select the **Care Unit Name** from the list.

Changing the **Care Unit Name** will also update the contents of the **Bed Name** list.

To change the care unit name, you can also:

- create a new location by selecting **New Care Unit & Bed** if it has been allowed.
- use the **Change Patient Location** window. For more information about this window, see [Transporting the patient to destination on page 140](#).

Roving between beds

If roving between beds is allowed, you can update the bed name when needed.

1. Select the information area.
2. Select the **Care Unit & Bed** tab.
3. Select the **Bed Name** from the list.

The new name appears in the upper right corner of the display. The unit name is given first.

To change the bed name, you can also:

- create a new location by selecting **New Care Unit & Bed** if it has been allowed.
- use the **Change Patient Location** window. For more information about this window, see [Transporting the patient to destination on page 140](#).

Adding new units and beds (manual roving)

If manual roving between beds and/or units is allowed, you can also enter their names manually.

1. Select the information area.
2. Select the **Care Unit & Bed** tab.

3. Select **New Care Unit & Bed**.
4. Select the **Care Unit Name** or the **Bed Name** field and type the new name.
The maximum number of characters for the **Care Unit Name** is seven, and for the **Bed Name** is five.
5. Select **Confirm** to ensure that the names you entered are valid.
6. Or select **Cancel** to return to the previous screen.

You can also add a new location in the **Change Patient Location** window. For more information about this window, see [Transporting the patient to destination on page 140](#).

Selecting mapping mode for care unit

You can configure the mode to automatically map the specified care unit. When the care unit is changed, the mode will be automatically changed according to the configured mapping rule. These settings are in the  >  **Service** > **Roving** menu (password protected). Please consult qualified and trained technical users to set up. For more information, refer to the Service manual.

For more information about mode, refer to [About user modes on page 111](#).

Selecting the printing device

Icon	Local thermal recorder	Remote thermal recorder
	--	√
	--	√
	√	√

You can select the printing device from remote or local during roving.

1. Select the information area.
2. Select the **Care Unit & Bed** tab.
3. Select **Printing Setup**.

You can reach the same menu from  >  **Printing Setup** > **Devices** tab.

About night mode

The night mode feature allows the patient to sleep or rest without being disturbed. In the night mode, the screen brightness, the volume can be set separately. Alarms are logged and trended. If the device is connected to the network, alarms and parameter data will continue to be sent over the network.

When in night mode, a  symbol will appear in the information area.

Setting and entering night mode

1. Select  >  **Night Mode**.
2. Select **Setup** tab and adjust the following settings if needed.

While you are adjusting the volume, you will hear a corresponding sound that will guide you in determining a suitable level.

- **Alarm Volume** : Alarm volume

NOTE

High & Medium Priority alarm volume and **Low Priority** alarm volume: display only when **Separate for Low** is selected in the  **Service** menu (password protected).

- **Silence All Alarms**: Turns off all audible alarms except some high priority alarms defined as breakthrough alarms.

NOTE

This setting is not available if **Alarm Options > Audio of Alarms > Audio Off Allowed** sets to **NO**. This menu is password protected. Please consult qualified and trained technical users to set up.

- **Beat Volume**: HR beat volume
- **Completed NIBP Volume**: NIBP complete beep
- **Screen Brightness**: Device display brightness

NOTE

The maximum screen brightness adjustment is limited to 70% in **Night Mode**.

- **Alarm Light**: Alarm light brightness
3. Select **Enter** tab.
 4. Enable the toggle of **Scheduled** if you want to create a scheduled time span for the device automatically entering the night mode. The schedule time can be set with the **From** and **To** arrows.
 5. Select **Enter Night Mode**.

The night mode symbol  appears on the information area.

Exiting night mode

1. Select  >  **Night Mode**.
2. Select **Exit Night Mode** to exit.

If the toggle of **Scheduled** is enabled, the night mode will automatically exit when out of time.

The night mode symbol  is removed from the information area.

About Demo Mode

The Demo Mode is designed for training and demonstration of primary operations before use. Do NOT start to monitor a patient when **DEMO MODE** message is displayed. Under Demo Mode, the device generates virtual vital signs values and waveforms. No accessories, central station or any other peripheral equipment are needed while in Demo Mode.

The Demo Mode menu is under the service menu of the device and requires a password to enter. Please consult qualified service personnel to enter the Demo Mode.

Shut down the device to end Demo Mode.

If restart is needed during Demo Mode, and you still want to continue demo after restart, perform Restart DEMO mode from the service menu. This feature is password protected. Please consult qualified service personnel.

NOTE

All the values, waveforms and patient information on the device's display are fictional.

NOTE

The Demo Mode is only designed for training and demonstration of primary operations. It is not intended for clinical use or patient monitoring and diagnosis.

About patient discharge

Discharging a patient deletes all patient information in the device. This also happens when the device is in the DEMO Mode.

The patient can be discharged remotely using a central station provided that this option has been enabled.

Discharging a patient

NOTE

Before discharging a patient, please consider to print necessary data for backup.

1. Disconnect patient sensors.
2. Select the information area.
3. Select **Discharge Patient > Confirm**.

Parameter settings, including alarm limits, return to the default settings. All patient data is removed from the device.

About continuing monitoring

The **Continue/Discharge** menu opens when a decision must be made about continuing or discharging a patient case. The menu remains open until you select one of the available options.

Alarms

Alarm safety precautions

Alarm warnings

WARNING

PATIENT SAFETY.

When the alarms are off or while alarm audio is paused either temporarily or indefinitely, observe the patient frequently to avoid the risk of not identifying important changes in the patient status that might lead to compromised patient safety.

WARNING

MISSED ALARMS.

Always make sure that the audio alarm volume level is adequate in your care environment to avoid missing alarms or not recognizing them due to too low a volume. Audio levels that are less than ambient levels may lead to unrecognized or missed alarms.

WARNING

MISSED ALARMS.

Always make sure that the alarm light brightness is adequate in your care environment to avoid missing any alarms.

WARNING

PATIENT SAFETY.

Always make sure that necessary alarm limits are active and set according to the patient's clinical condition when you start monitoring a patient to avoid any risks to the patient safety caused by erroneous or no alarms.

WARNING

PATIENT SAFETY.

Verify that the alarm processing is active and check the patient to ensure no arrhythmia occurred during a power interruption. Otherwise, there is a risk of compromised patient safety.

WARNING**MISSED ALARMS.**

Always check the alarm status after a prolonged power interruption to avoid missing any alarms.

WARNING**PATIENT SAFETY.**

Alarms do not sound, alarm histories are not stored, alarm graphs do not print, and alarms are not sent to the network when the alarms are turned off. Observe the patient frequently to avoid the risk of not identifying important changes in the patient status that might lead to compromised patient safety.

WARNING**MISSED ALARMS.**

Alarms do not sound and alarms are not sent to the Carescape Network during Audio Pause. As this may lead to missed alarms, observe the patient frequently.

WARNING**MISSED ALARMS.**

The audible alarm signal may be paused temporarily from a central station or remote monitor. Always pay attention to the alarm signal status and observe the patient frequently.

WARNING**MISSED ALARMS.**

To avoid missed detection of critical alarms, always inform personnel dependent on the device alarms of remote alarm silencing or pausing interactions.

WARNING**MISSED ALARMS.**

The peripheral device's alarms must not be turned off or the volume reduced in any way to diminish the importance of the peripheral device as the primary alarm source for parameters monitored by the peripheral device.

WARNING**PATIENT SAFETY.**

There are no alarm indications until parameter-specific alarm prerequisites have been met. Keep the patient under close surveillance when starting the monitoring.

WARNING**MISSED ALARMS.**

Do not use automatic view on alarm (AVOA) as a replacement for a primary alarm source or as a central station as this may lead to missed alarms. To avoid missing any alarms and to ensure alarm delivery between AVOA and bed-to-bed monitors, configure the monitors to send and receive alarms to and from each other.

WARNING**PATIENT SAFETY.**

Only the most recent, highest priority alarm is sent to remote devices on the Carescape Network. Therefore, less recent alarms of equal or lower priority may not be displayed or may not be indicated with their associated priority remotely. Observe the patient frequently to avoid the risk of not identifying important changes in the patient status that might lead to compromised patient safety.

WARNING**PATIENT SAFETY.**

Alarm messages may not be visible on the alarm display area when three higher priority alarms are active. Observe the patient frequently to avoid the risk of not identifying important changes in the patient status that might lead to compromised patient safety.

WARNING**MISSED ALARMS.**

Equipment malfunctions, network disconnection, other remote alarm system disconnection, and alarm volume settings may result in missed alarms. Always keep the patient under close surveillance.

WARNING**PATIENT SAFETY.**

Latched alarms are not retained through a monitor reset if the alarm condition has been removed. Observe the patient frequently to avoid the risk of not identifying important changes in the patient status that might lead to compromised patient safety.

WARNING**PATIENT SAFETY.**

The secondary alarm system shall not be relied upon for receipt of alarm signals.

WARNING**MIXED ENVIRONMENT.**

A hazard can exist when the same type of monitors in the same care area are using different monitoring modes and default configuration settings.

WARNING**MISSED ALARM.**

Do not rely on receipt of certain alarm conditions at a central station, remote bedside, or alarm notification device when connected to the Carescape Network. Notification of any of these alarms will only be given when it is the most recent, highest priority active alarm coming from the bedside monitor. This applies to those limit alarms and technical alarms that are defined as broadcast only alarms in this manual.

WARNING**MISSING CRITICAL EVENTS.**

Reducing the physiological alarms' priority levels lower than the default level can lead to missed detection of critical or serious events and therefore to adverse patient outcome. If you adjust the priority levels for the alarms lower than the default value, keep the patient under close surveillance.

WARNING**MISSED ALARMS.**

Do not connect a single-color display to the device. Visual alarm indicators may not appear properly.

WARNING**MISSED ALARMS.**

Reducing the technical alarms' priority levels lower than the default level can lead to missed detection of critical events and therefore to adverse patient outcome. If you adjust the priority levels for ECG lead off, ECG Leads off, Arrhythmia paused, SpO2 probe off alarms lower than the default value, keep the patient under close surveillance.

Alarm overview

Alarm types

There are two types of alarm settings, system and patient-specific. System alarm settings are set globally across an entire care environment. They are configured at the time of installation and are password protected. Examples of system alarm settings are:

- Minimum alarm volume
- Audio off allowed
- Alarm tones

Patient-specific alarm settings are individualized, based on a patient's current condition. Examples of patient-specific alarm settings are:

- Parameter alarm limits
- Alarm priority settings

Alarm conditions

- Physiological alarm conditions are triggered by a patient measurement that is outside the parameter limits, by apnea, or by an arrhythmia condition.
- Technical alarm conditions are triggered by an electrical, mechanical, or other failure of the equipment, or by failure of a sensor or component. Technical alarm conditions may also be caused when an algorithm cannot classify or interpret the available data. The visual manifestation of a technical alarm is active as long as the reason for that alarm exists.

Broadcast only alarms

Alarms are sent to the Carescape Network and displayed on the central station or remote monitor.

For more information, see the supplemental information manual.

Checking alarm function

1. Set a parameter alarm limit outside of the current measured patient values. For example, connect the SpO₂ sensor and adjust the SpO₂ high limit under measured SpO₂ values.
2. Confirm that the following alarm notifications occur:
 - The audible alarm sounds the correct priority tone.
 - The alarm light illuminates.
 - The alarm message displays in the message field.
 - The SpO₂ numeric value flashes in the digit field with the correct priority color.
 - An alarm printout (if enabled) is initiated.
3. Audio pause the alarms and confirm that the audible alarms are paused.
4. Return the parameter alarm limit to the original value.

Visual alarm indications

Alarm icons on the screen

For more information regarding the on screen alarm icons, see [User interface symbols on page 93](#).

Description of alarm and information messages

Alarm and information messages can be displayed in three areas:

- The digit field
- The waveform field
- The message field (upper part of the screen)

In the message field, up to three alarms or information messages may be displayed from left to right, from the newest highest priority alarm to the oldest lowest priority alarm.

Alarm messages are stored in the **Alarm History**. You can access through . The alarm messages stored in the **Alarm History** include:

- Time of occurrence
- Alarm message text
- Label for the parameter, if available
- Current value if a limit alarm
-  (link to Snapshot)
-  (link to Full Disclosure)

Setting alarm light brightness

1. Select  >  **Alarms Setup**.
2. Select **Visual** tab.
3. Select **Alarm Light Type**.
4. When **Alarm Light Type** is set to **Manual**, adjust **Alarm Light** brightness with arrows.
The larger the value, the brighter the alarm light.

When the equipment is on the **Night Mode**:

- the  symbol appears next to the option.
 - the **Alarm Light Type** is fixed to **Manual**.
 - the **Alarm Light** brightness is set to pre-configured value.
5. When **Alarm Light Type** is set to **Auto**, the **Alarm Light** brightness will be adjusted automatically based on ambient brightness.

NOTE

You can set the range of alarm light brightness adjusted through  >  **Service** (password protected) > **Alarm Options**.

- Enable **Allow Turning Alarm Light Off**: Range is 0~100%.
- Disable **Allow Turning Alarm Light Off**: Range is 40~100%.

About alarm message functionality

Alarm messages have alarm icon or message field with touchable functionality.

	Select the icon, to view the list of alarm priority setting deviate from the recommendation of international alarm safety standards.
Alarms in message field	Select the alarms in message field, to view the Quick Help about possible causes and suggested actions for current alarms. There are also shortcut for Alarms Setup and User Manual .
Remote alarms in message field	Select the remote alarms in message field, to open the bed-to-bed view window. (On Dock screen only)

Visual alarm signals and priority levels

Alarm signals indicate that an alarm condition is present. The alarm priority levels are indicated by visual and audible signals. The visual and audible alarm signals assume that the device and the operator are within the patient environment (1.5 meters).

The following table lists alarm signals for different alarm priority levels:

Signal	Priority level			
	High	Medium	Low	Informational
Digit field physiological data values	Black text flashes inside a red box.	Black text flashes inside a yellow box.	Not applicable.	Not applicable.
Message field	White text inside a red box.	Black text inside a yellow box.	White text inside a cyan (blue) box.	Black text inside a gray box.
Waveform field messages	Text	Text	Text	Text
Alarm light indicator	Flashes red Frequency: 1.667 Hz ±10%	Flashes yellow Frequency: 0.625 Hz ±10%	Solid cyan Constantly on	No effect

Audible alarm indications

Audible alarm signals

When more than one alarm occurs at the same time, the device will sound an alarm tone for the highest priority alarm. Any lower priority audible alarm tones are suppressed by the higher priority alarm tone.

The most recent of the alarms that has the highest priority level at this moment is the alarm that is broadcast on the network. For example, if there is one medium-priority alarm and a low-priority alarm appears, the medium-priority alarm is broadcast, not the most recent (low-priority) alarm. If there is one medium-priority alarm and another medium-priority alarm appears, the latest alarm that appeared is broadcast. Physiological alarms always take precedence over technical alarms.

Adjusting the alarm tones

1. Select  >  **Alarms Setup**.
2. Select **Audio** tab.
3. Adjust the alarm tones. The choices are:
 - **General**
 - **IEC**
 - **ISO**
 - **ISO2**

The low priority alarm tone can be configured to **Single** or **Repeat** sound.

The AVOA audible alarm tone pattern can be configured to match the local device's audible tone pattern, or be turned off.

For more information, see the supplemental information manual.

NOTE

To avoid user confusion with alarm tones, configure all related devices to the same type of audible alarm tones used in your clinical environment.

Adjusting the alarm volume

The alarm volume selections vary according to what has been configured in the **Alarm Options** (password protected).

1. Select  >  **Alarms Setup**.
2. Select **Audio** tab.
3. Adjust the volume according to what is available in the menu:
 - **Alarm Volume**: adjust volume for all alarms.
 - **High & Medium Priority** and **Low Priority**: separately to adjust volume for High & Medium priority alarms, and Low priority alarms.

The lower the number, the quieter the alarm volume.

When the equipment is on the **Night Mode**, the  symbol appears next to the option, and the configured volume differs from the setting under normal mode.

NOTE

You can set the alarm volume control and minimum allowed alarm volume levels, through

 >  **Service** (password protected) > **Alarm Options** > **Audio of Alarms**.

For more information, see the supplemental information manual.

Auditory information signals

The device performs a self-diagnostic procedure at startup and generates an auditory test signal. There are also other auditory information signals indicating the status of some parameter measurements.

- Start-up sound
- HR beat beep
- Completed NIBP volume
- Reminder beep

Parameter alarms

About critical alarms

You can configure two different levels of alarms for HR and SpO₂ alarms: basic and critical. This enables an alarm to start with the basic alarm level and priority indication, and then change to high alarm indication once the selected critical alarm level is reached. The critical alarm is always indicated as high, but you can select the priority for the basic alarm. You can set critical alarms only if the corresponding basic alarm is on. Always check that you are configuring the right alarm.

Basic and critical alarm settings are available as follows:

- ECG: basic alarm **HR**, critical alarm **HR Critical**
- SpO₂: basic alarm **SpO2**, critical alarm **SpO2 Critical**

You must always set the critical alarm limits so that they are outside the basic alarm limits. If you try to set them inside the basic alarm limits, the basic alarm limits will also change at the same time. On the other hand, note that once you have set the critical alarm limits, also the basic alarm settings can only be set inside those limits.

Setting parameter alarm limits

Parameter alarm limits are set in **Alarms Setup** menu, or the parameter menus' own **Alarms** tab. Alarm limits should not be set beyond reasonable physiological boundaries in order to maintain patient safety. Parameter settings outside of reasonable boundaries would cause the alarms to be ineffective.

1. Select  >  **Alarms Setup**.
2. Select parameter group in the table header, if needed.
3. Select alarm **ON** or **OFF** for the parameter needed.
4. Adjust the parameter alarm limits with arrows when alarm is set on **ON**.

NOTE

A purple point will be displayed in the first column if anything adjust. You can check your changes before apply.

5. Select **Apply** for the changes.

You can also select the parameter menu's **Alarms** tab where you can select alarms on or off, and set their limits also.

Setting alarm limits automatically

When selected, the auto limits feature automatically sets new high limit and low limit values, based upon the current physiological value. The auto limits feature should only be used for patients whose currently measured values are considered safe.

1. Select  >  **Alarms Setup**.
2. Select **Auto Limits**. You still can do the necessary manual adjustment based on the auto limits.

3. Select **Apply** for the changes.

If you need to undo these changes and return to the previous alarm limit settings, select **Cancel** before closing the menu.

Auto alarm limits

The following table is about how to calculate auto alarm limits by system.

Parameter	High limit	Low limit
HR/PR parameters (ECG, SpO ₂ , UAC, Art, ABP, Fem)	Value*1.25 (rounding)	Value*0.75 (rounding)
Critical HR	Value*1.4375 (rounding)	Value*0.5625 (rounding)
PVC	PVC +10	Not applicable
SVC	SVC +10	Not applicable
RR	RR*1.25+2	RR*0.75-2
SpO ₂	SpO ₂ +5%	SpO ₂ -5%
Critical SpO ₂	SpO ₂ +15%	SpO ₂ -15%
NIBP	Adult and child cuff: S/D/M: Value*1.25+10 mmHg Infant cuff: S/D/M: Value*1.25+2 mmHg	Adult and child cuff: S/D/M: Value*0.75-10 mmHg Infant cuff: S/D/M: Value*0.75-2 mmHg
Art, Fem, ABP	Sys/Dia/Mean: Value*1.25+10 mmHg	Sys/Dia/Mean: Value*0.75-10 mmHg
IBP1, IBP2, IBP8, CVP, FemV, RAP, LAP, ICP, RVP, UAC, UVC, PA (For channels: IBP1, IBP2, IBP8)	Sys/Dia/Mean: Value*1.25+5 mmHg	Sys/Dia/Mean: Value*0.75-5 mmHg
UAC, PA (For channels: IBP3, IBP4)	Sys/Dia/Mean: Value*1.25+5 mmHg	Sys/Dia/Mean: Value*0.75-5 mmHg
IBP3, IBP4, CVP, FemV, RAP, LAP, ICP, RVP, UVC (For channels: IBP3, IBP4)	Mean: Value*1.25+5 mmHg	Mean: Value*0.75-5 mmHg
CCI	CCI+0.5 l/min/m ²	CCI-0.5 l/min/m ²
CCO	CCO+0.5 l/min	CCO-0.5 l/min
Temperature	Tx+1°C (1.8°F)	Tx-1°C (1.8°F)
Tblood	Tx+1°C (1.8°F)	Tx-1°C (1.8°F)
EtCO ₂	EtCO ₂ +1%	EtCO ₂ -1%

Returning the default alarm limits

1. Select  >  **Alarms Setup**.
2. Select **Default Limits**.

3. Select **Apply** for the changes.

If you need to undo these changes and return to the previous alarm limit settings, select **Cancel** before closing the menu.

For more information about the factory default alarm limits, see the supplemental information manual.

Alarm priorities and escalation

Alarm priority levels

Physiological and technical alarms are categorized by priority level:

- High priority alarms require an immediate response.
- Medium priority alarms require a prompt response.
- Low priority alarms require you to be aware of this condition.
- Informational priority messages provide information you should know.

NOTE

Technical alarms with Informational / Low priority, and physiological alarms with Informational priority are not sent to the network.

Alarm priority escalation

An escalating alarm starts at a designated priority level (low or medium) and will escalate to the next higher priority level (after a set number of seconds) if the alarm condition has not been resolved. It is important to note that the alarms escalate up to the next level but will not reset until the condition has been resolved.

NOTE

Alarm priority escalation affects the currently ongoing alarm condition, not any future alarms of the same type. Any new alarms will alarm at their designated priority level, not at the escalated level.

For more information, see the supplemental information manual.

Selecting parameter alarm priority levels

The parameter alarm priorities can be selected. The alarm priority is based on clinical considerations.

The allowed priorities for different alarms are defined in **Alarm Options** and they are password protected.

For more information, see the supplemental information manual.

1. Select  >  **Alarms Setup > Priorities** tab.
2. Select the related vertical tab for parameters.
3. Select the alarm priority from the list.

If the selected alarm priority deviates from the recommended levels of alarm safety standard, the symbol  will display.

Select the **Note** vertical tab, the screen lists the alarm priority settings with risk. And a warning text displays as follow:

"The following alarm priority settings deviate from the recommendation of international alarm safety standards."

Setting arrhythmia alarms

You can set the arrhythmia alarms from **Alarms Setup** menu or from the **ECG** menu.

1. Select the HR digit field > **Alarms** tab.

Or, select  >  **Alarms Setup** > **Priorities** tab.

2. You can select the vertical tabs for the **Lethal**, **Ventricular** and **Atrial** alarms.

- **Lethal:** You can enable or disable the toggle of **Create Snapshot**, the alarm priority for lethal alarms is always high.

You can set up the **V Tach** alarm condition.

- **Ventricular:** You can select the alarm priority and enable or disable the toggle of **Create Snapshot**.
- **Atrial:** You can select the alarm priority and enable or disable the toggle of **Create Snapshot**, and set up **Pause Interval** options.

You can set up the **SVT Length** and **HR for SVT/min**.

Pausing and silencing alarms

Audible alarms off behavior

Depending on the **Audio Off Allowed** settings configured during installation, you can turn audible alarms on or off.

For more information, see the supplemental information manual.

When audible alarms are turned off:

- All audible alarms are turned off except for any high priority alarms configured to breakthrough the audio off setting.
- The audio off bell icon  displays in the upper left corner of the display screen.

Turning audible alarms on/off

You can turn on/off the audible physiological alarm tones for an alarm group or for all alarms.

1. Select  >  **Alarms Setup**.
2. Select the **Audio** tab.

3. Select an alarm group. Choices are:
 - **None:** No audible alarms are turned off.
 - **ECG:** Turns off audible alarms for all HR source limit, arrhythmia, ST, QT/QTc, PVC, and SVC alarms.
 - **Apnea:** Turns off audible alarms for Apnea (Imped., CO₂, Anes CO₂, Ext: Apnea), EtCO₂, FiCO₂, respiration rate limit alarms (Imped. and CO₂), MVexp and TVexp limit alarms, Ppeak low alarm, and PEEP low alarm. Related technical alrms are not silenced.
 - **Apnea & ECG:** Turns off audible alarms for all HR source limit, arrhythmia, ST, QT/QTc, PVC, SVC, Apnea (Imped., CO₂, Anes CO₂, Ext: Apnea), EtCO₂, FiCO₂, respiration rate limit alarms (Imped. and CO₂), MVexp and TVexp limit alarms, Ppeak low alarm, and PEEP low alarm. Related technical alrms are not silenced.
 - **All Alarms:** Turns off all audible alarms except some high priority alarms defined as breakthrough alarms.
4. To turn on all audible alarms again, select **Activate All Audible Alarms**, or select **None** as instructed above.

NOTE

If alarms are turned off for any of the defined alarm groups and an alarm occurs within the alarm group, a beep tone will sound every 2 minutes as a reminder that audible alarms are turned off. The **Reminder Volume** can be adjusted through **Alarm Options** (password protected) > **Audio of Alarms**.

NOTE

France only: The **Reminder Volume** menu is not available. A reminder beep tone sounds every 2 minutes when audible alarms are turned off.

Pause audio and alarm reset behaviors

When device is on the network, alarms can also be audio paused at the central station.

Select  >  **Service** (password protected) > **Alarm Options** > **Audio of Alarms** > **Audio Pause Time**. You can select **2 min** or **5 min**. For more information about audio pause alarm, see the supplemental information manual.

Selection	Result	Indicator
Select  (audio pause) once	- Start a 2 minute or 5 minute audio pause state for all alarms except the specified breakthrough alarms^{*1}. - Remove all latched alarms^{*2} (including message and light).	- Alarm light: Yes - Alarm message: Yes and display the audio pause countdown icon - Alarm audio: No, except the breakthrough alarms
Second selection of  (audio pause) during the 2 minute or 5 minute pause	- Cease the audio pause state. - Deactivate some alarms in list below. - Remove all latched alarms (including message and light).	- Alarm light: Yes - Alarm message: Yes - Alarm audio: Yes

Selection	Result	Indicator
Select  >  Alarm Reset	• Start a 2 minute alarm silence for all current active alarms. • Remove all latched alarms (including message and light). • Does not silence any new alarms. • Cease the audio pause state, if available.	• Alarm light: Yes • Alarm message: Yes, with audio pause symbol in the message block • Alarm audio: No
^{*1} For more information about breakthrough alarms, see the supplemental information manual. ^{*2} For details about latched alarms, refer to “Latched alarms” paragraph below.		

Alarms' deactivation with the pause audio key

Certain alarms can be deactivated by second selection of audio pause key.

- Physiology alarms:
 - **NIBP DIA high/NIBP SYS high/NIBP MAP high**
 - **NIBP DIA low/NIBP SYS low/NIBP MAP low**
- Technical alarms:
 - **Lead off**
 - **Leads off**
 - **Entropy cable off**
 - **Entropy sensor off**
 - **Entropy sensor check failed**
 - **No Entropy sensor**
 - **NMT cable removed**
 - **Block recovery**
 - **No SpO2 cable**
 - **No SpO2 probe**
 - **No adhesive SpO2 probe**
 - **SpO2 probe off**
 - **No SpO2 pulse**
 - **Zero ICP separately**
 - **NIBP cuff loose**
 - **NIBP cuff occlusion**
 - **Check NIBP**
 - **NIBP air leakage**
 - **Long measurement time**
 - **NIBP cycling stopped**
 - **NIBP STAT stopped**
 - **NIBP cuff overpressure**

- **NIBP malfunction**
- **NIBP over range**
- **NIBP under range**
- **NIBP alarm limits changed**
- **Recorder module removed**
- **ECG measurements removed**
- **Entropy measurement removed**
- **STP measurements removed**
- **SpO2 measurement removed**
- **Gas measurements removed**
- **CO measurement removed**
- **Confirm CO**
- **Re-calibrate CCO**
- **No CCO catheter**
- **Confirm CCO Calibration**
- **NMT measurement removed**
- **Alarm volume changed**
- **Recorder: cover open**
- **Recorder: input voltage high**
- **Recorder: input voltage low**
- **Recorder: out of paper**
- **Recorder system error**
- **Recorder thermal array overheat**
- **Printing**
- **Printing Alarm**
- **Saving**
- **Monitor disconnected**
- **All monitors disconnected**
- **No more space Full disclosure disabled**
- **No storage Full disclosure disabled**
- **Storage fail Full disclosure failure**
- **Hub Condition battery**
- **Dock Condition battery**
- **No Hub battery backup**
- **No Dock battery backup**
- **Replace Hub battery**

- **Replace Dock battery**
- **Site Name X sensor disconnected** (where X = 1,2,3,4,8)
- **Art disconnect**
- **Fem disconnect**
- **ABP disconnect**
- **UAC disconnect**
- **Pressure measurement removed**
- **Network down**
- **Network down: HL7**
- **No patients found**
- **CS Gateway communication failure**
- **No BIS sensor**
- **BIS sensor check failed**
- **BIS measurement removed**
- **BIS Apply sensor**
- **High BIS impedance**
- **Place SpO2 probe on finger for SPI measurement**
- **Anesthesia interface removed**
- **Anesthesia incompatible device**
- **Ventilator interface removed**
- **Agent Mixture**
- **Multiple agents present**
- **Invalid barcode configuration**
- **Barcode too long**
- **Incorrect barcode value**
- **Barcode scanned**
- **Printer error**
- **Saving PDF failed**
- **Anes: Apnea**
- **Vent: Apnea**
- **Ext:Hardware error**
- **Vent: No ext device**
- **Vent: Connecting**
- **Vent: Ext not supported**
- **Vent: Check ventilator**
- **Vent: Low battery**

- **Vent: In Alarm**
- **Vent: Disconnect**
- **Barometric sensor fail**

Audible alarms' deactivation with gesture



Hub connects to Dock only.

Alarm audio pause is available with gesture. The gesture sensor locates at the upper left corner of Dock screen. The alarms will audible pause when you wave hands:

- in front of the gesture sensor area
- with a distance of 5-30 cm from the Dock screen
- forth and back wave, twice in 2 s at least



Action	Result	Indicator
Wave hand to gesture sensor area, when there is active alarm and it's not paused or silenced.	• Start 2 minute or 5 minute audio pause state for all alarms except the specified breakthrough alarms^{*1}.	• Alarm light: Yes • Alarm message: Yes and display the audio pause countdown icon • Alarm audio: No, except the breakthrough alarms
^{*1} For more information about breakthrough alarms, see the supplemental information manual.		

NOTE

You can enable or disable the gesture function and set its disabled time periods through

 >  **Service** (password protected) > **Gesture Control**.

Breakthrough alarms

The breakthrough alarms feature allows some alarms to “breakthrough” (interrupt) an alarm audio off or a 2 minute or 5 minute alarm audio pause state.

The **Breakthrough Alarm** settings is configured in **Alarm Options** and it is password protected.

For more information, see the supplemental information manual.

Breakthrough alarms list

The following alarms will breakthrough when escalated to or activated at high priority alarm condition regardless of the alarm audio off or 2 minute or 5 minute audio pause:

User action	Alarm	Condition
Alarm audio off is active	FiO2 low	Escalates to high
		Activates as high
	EtO2 low	Escalates to high
		Activates as high
	FiN2O high	Activates as high
	EtN2O high	Activates as high
Alarm audio pause is active	Ppeak high	Escalate to high
	Asystole	Activates as high
	V Tach	Activates as high
	V Fib / V Tach	Activates as high
	Brady (basic alarm) ^{*1}	Escalates to high
		Activates as high
	Brady (critical alarm)	Activates as high
	Tachy (critical alarm)	Activates as high
	FiO2 low	Activates as high
	EtO2 low	Activates as high
	FiN2O high	Activates as high
	EtN2O high	Activates as high
	Ppeak high	Escalate to high
*1 The Brady alarm will breakthrough only when Breakthrough Alarm option is selected as Peds .		

Latched alarms

Physiological alarms can be configured to latch or not. The **Latching Alarms** setting is configured in the **Alarm Options** and it is password protected. When alarms are latched, the visual message remains after the alarm condition no longer exists. You will also hear a reminder beep every 10 seconds.

For more information, see the supplemental information manual.

To clear the information field and beep of the no longer active alarm messages:

- Select , Or
- Select  >  **Alarm Reset**.

Remote management of alarms

The remote alarm settings are defined in the **Alarm Options > Remote Alarms** tab, and they are password protected. The following settings are available:

- **From Remote Location:** Selecting which remote locations are allowed to pause audio alarms on this device.
- **For Remote Bed:** Enabling or disabling audio pausing remotely for another device.

- **Allow Remote Pausing of:** Selecting alarm priorities that can be paused remotely. Only available when **From Remote Location** is selected to be **Central** or **Central and Remote Beds**.
- **Remote Alarm Light:** Use of the alarm light also for a remote alarm.
- **Remote Alarm Tone:** Selecting the remote alarm tone.
- **Show Remote Patient Name:** Enabling or disabling the display of the remote patient name.
- **Restore Remote Bed after Discharge:** Enabling or disabling the restoring of the remote bed selections after discharge.

For more information, see the supplemental information manual.

Nurse call



Hub connects to Dock only.

The nurse call settings are defined in the **Alarm Options** and they are password protected. You can select whether nurse call can be turned on according to the nurse call system electrical level in the hospital.

- **Normal Open:** high electrical level is exported from the nurse call connector when there is medium or high priority alarm.
- **Normal Close:** low electrical level is exported from the nurse call connector when there is medium or high priority alarm.

For more information, see the supplemental information manual.

Alarm settings after a power loss

If the device loses power, the alarm settings that were in effect before the power loss are restored automatically.

Stored alarm data during a power cycle or power loss

If the device goes through a power cycle or loss power, the stored alarm data in the Alarm log will not be affected. The alarm data remains stored in the Alarm log until the device automatically clears the oldest stored data to allow new data to be stored.

NOTE

The Alarm log is a service level function and it is password protected.

Intra-hospital transport use

Transport precautions

Transport warnings

WARNING

PATIENT SAFETY.

Do not place the Hub on the patient's bed.

WARNING

INTRAHOSPITAL TRANSPORT.

Vibrations during intrahospital transport may disturb SpO₂, ECG, impedance respiration, NIBP and IBP measurements.

Transport monitoring

You can use Hub for continuous monitoring when transferring a patient from one location to another within the hospital. When the Hub is used with Dock or Mini Dock, you can disconnect it from the Dock or Mini Dock, then continue to monitor as you move the patient. The Hub will store and display all the patient data.

During the transport, parameter data and alarms can be sent from the Hub to other devices via network interface. For more information about network setup, see the Service Manual.

After transport, you can return the Hub to a Dock or Mini Dock, and resume monitoring the patient without any interruption.

During normal monitoring when the Hub is connected to Dock, the Hub display is off (except alarm light). All the bedside parameter data and alarm signals are presented on the Dock screen. When the Hub is disconnected from the Dock, the Hub screen is activated.

Preparing to transport a patient

1. Select  ("Go in transport" key). Then the device will start a 2 minute or 5 minute audio pause state. And certain alarms will be deactivated in the same way as second selection of audio pause key. For more information about software behavior, see [Alarms' deactivation with the pause audio key on page 133](#).
2. Add parameters needed for transport to the Hub, or remove those not needed for transport.
3. Ensure that the parameters you need to monitor during transport are selected to display on Hub screen. Refer to the chapter "Setting up the device before use" for more information on selecting parameters to the screen.

4. Ensure that there is a charged battery installed in the Hub.
5. Disconnect Hub from the Dock or Mini Dock, if needed.
6. Confirm network connectivity through the network symbol.
7. Lock the Hub screen, if needed.
8. Place and fix the Hub in a transport location where you can view the Hub screen during patient transport. You can mount the Hub to IV pole using a Nano Dock. For more information, refer to Nano Dock's instructions for use.

NOTE

Make sure the cables do not drag on the floor or interfere with the movement or operation of the transport bed. The cables must be placed so that they do not entangle infusion pump lines or become a hazard to the patient.

9. Transport the patient to destination.

Transporting the patient to destination

Follow these steps after you transport the patient to the destination location.

1. Remove the Hub from the mount, if needed.
2. Connect the Hub to the destination Dock or Mini Dock, if needed.
3. When the Hub is connected to a different docking station, the **Change Patient Location** window will open on the main screen. It displays the patient **Current Location in Monitor** and the information **"Changing care unit may change the mode, which will further impact the alarm and parameter settings, and data visualization on the screen. The mode can be manually changed in Admit / Discharge menu."**

You can change the patient location according to the network status:

- If the Hub is connected to the CareScape network, select the patient location from the **Care Unit Name** and **Bed Name** list.
- If the network is disconnected or no network is available, create a new location by selecting **New Care Unit & Bed**.

Select **Confirm** to proceed.

4. The **Location Changed** window will pop up. It displays patient information, latest patient location and current mode. The following quick links are also provided for you to further change the settings.
 - **Change Mode**
 - **Change Care Unit & Bed**
 - **View Available License**

Exit the window after you change the settings as needed.

5. Review the patient data during transport.
6. Reconnect any parameters that were disconnected during transport, if needed.

Transport troubleshooting

Problem	Solution
A parameter is not visible on the Hub screen during transport.	• Check that the parameter is supported with the Hub. • Check that the module is connected to the Hub. • Check that the parameter is selected to the Hub screen.
The Dock screen does not display the patient case when returning from transport.	• Check that the Hub is securely connected to the Dock.

ECG

ECG safety precautions

ECG warnings

WARNING

ELECTRIC SHOCK.

To avoid the risk of electric shock caused by the leadwire set clips or snaps that may conduct electricity, make sure that they do not touch any other electrically conductive material including ground.

WARNING

BURNS.

When using an electrosurgery unit, note that the measurement cables do not incorporate means to protect against burns in case of a defective ESU return electrode. To avoid burns at the monitor measurement sites, ensure the following:

- Proper contact of the ESU return electrode to the patient.

- ESU return electrode near the operating area.

- Measurement electrodes, leadwires and probes far from the surgical site and the ESU return electrode.

WARNING

MISINTERPRETATION.

This device is intended to record electrocardiograms from surface ECG electrodes. It is not meant for positioning (floating) temporary pacemaker leadwires, performing pericardiocentesis, or other internal applications. Using the device in ways other than its intended use may lead to misinterpretation of measurement data.

WARNING

MISINTERPRETATION.

This device uses a computerized 12 lead ECG analysis program, which can be used as a tool in generating ECG records that provide ECG measurements and interpretative statements from the ECG recordings. The interpretive statements are only significant when used in conjunction with clinical findings. All ECG records should be over read by a qualified physician. To ensure accuracy, use only the ECG records for physician interpretation.

WARNING

MISSED ALARMS.

When transitioning from a 10-lead cable to a 5-, or 3-lead cable, select the **Update Lead Set** option to clear the **Lead off** message from the display.

WARNING

MISSED ALARMS.

Disconnected electrodes or loose electrode connections can lead to missed critical severity ECG alarms. If the device reports **Leads off** after selecting **Update Lead Set** option, always check the electrode connections to the patient.

WARNING

CONDUCTIVE CONNECTIONS.

Extreme care must be exercised when applying medical electrical equipment. Many parts of the human/machine circuit are conductive, such as the patient, connectors, electrodes, transducers. It is very important that these conductive parts do not come into contact with other grounded, conductive parts when connected to the isolated patient input of the device (e.g. electrodes, SpO₂ sensor). Such contact would bridge the patient's isolation and cancel the protection provided by the isolated input.

WARNING

ARTIFACT ALARM.

The **Artifact** alarm indicates that the system is no longer monitoring ECG and there may be no **Tachy** or **Brady** alarms. If you adjust the alarm priority level lower than the default value, keep the patient under close surveillance.

WARNING

PATIENT SAFETY.

The default alarm priority for **V Tach** alarm is high, but you may also select another priority level. If you adjust the alarm priority level lower than the default value, keep the patient under close surveillance. **V Tach** high alarm priority escalation rules only apply when the alarm is active.

WARNING

ARRHYTHMIA PAUSED ALARM.

The **Arrh Paused** alarm indicates that the system is no longer monitoring ECG and there may be no **Tachy** or **Brady** alarms. If you adjust the alarm priority level lower than the default value, keep the patient under close surveillance.

WARNING**ELECTRODES.**

Whenever patient defibrillation is a possibility, use non-polarizing (silver/silver chloride construction) electrodes for ECG monitoring. Polarizing electrodes (stainless steel or silver constructed) may cause the electrodes to retain a residual charge after defibrillation. A residual charge will block acquisition of the ECG signal.

WARNING**DEFIBRILLATOR PRECAUTIONS.**

Patient signal inputs labeled with the CF and BF symbols with paddles are protected against damage resulting from defibrillation voltages. To ensure proper defibrillator protection, use only the recommended cables and leadwires. Using other cables or leadwires may result in damage to the equipment and compromise patient and user safety.

WARNING**HEART RATE ALARM INTERFERENCE.**

Poor cable positioning or improper electrode preparation may cause line isolation monitor transients to resemble actual cardiac waveforms and thus inhibit heart rate alarms. To minimize this problem, follow proper electrode placement and cable positioning guidelines provided with this device.

WARNING**ERRONEOUS READINGS.**

To assure accurate 12 lead analysis when using a 10-leadwire patient cable, you must verify that the correct leadwire block is plugged into the appropriate side of the cable. The V2 through V6 leadwire block is color-coded brown (AHA) or white (IEC). Otherwise, there is a risk of erroneous readings.

ECG cautions

CAUTION**SKIN IRRITATION.**

The patient's skin may become irritated after prolonged contact with electrode gel or adhesive. To avoid skin irritation, periodically check the patient and avoid too long measurement periods if possible.

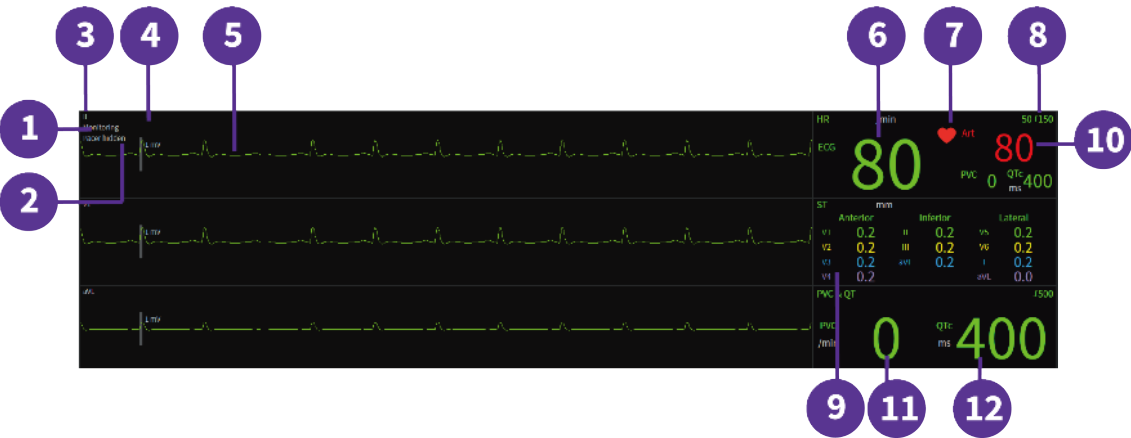
CAUTION**CONDUCTIVE CONNECTIONS.**

The improper grounding may lead to vibrations in ECG and Screen Flickering.

ECG measurement description

The electrocardiogram (ECG) is the primary patient monitoring parameter. It provides heart rate measurement, 3-, 5-, 10-lead ECG monitoring, arrhythmia analysis, pacemaker detection, ST analysis and QT analysis.

ECG measurement displayed on the device screen



1.	Monitoring (Monitoring): Waveform filter	2.	Pacer hidden (Pacer hidden): Pacemaker status
3.	II (II): ECG lead label for waveform	4.	ECG waveform size bar (1 mV reference)
5.	ECG waveform	6.	ECG (ECG): Heart rate from ECG
7.	QRS indicator	8.	HR alarm limits
9.	ST digit field	10.	Art (Art): Heart rate from 2nd source
11.	PVC (PVC): Heart rate from PVC	12.	QT or QTc (QT or QTc): QT/QTc duration

ECG measurement limitations

- The device will display a **Leads off** message in an input overload condition, or upon disconnection of electrode leadwires.

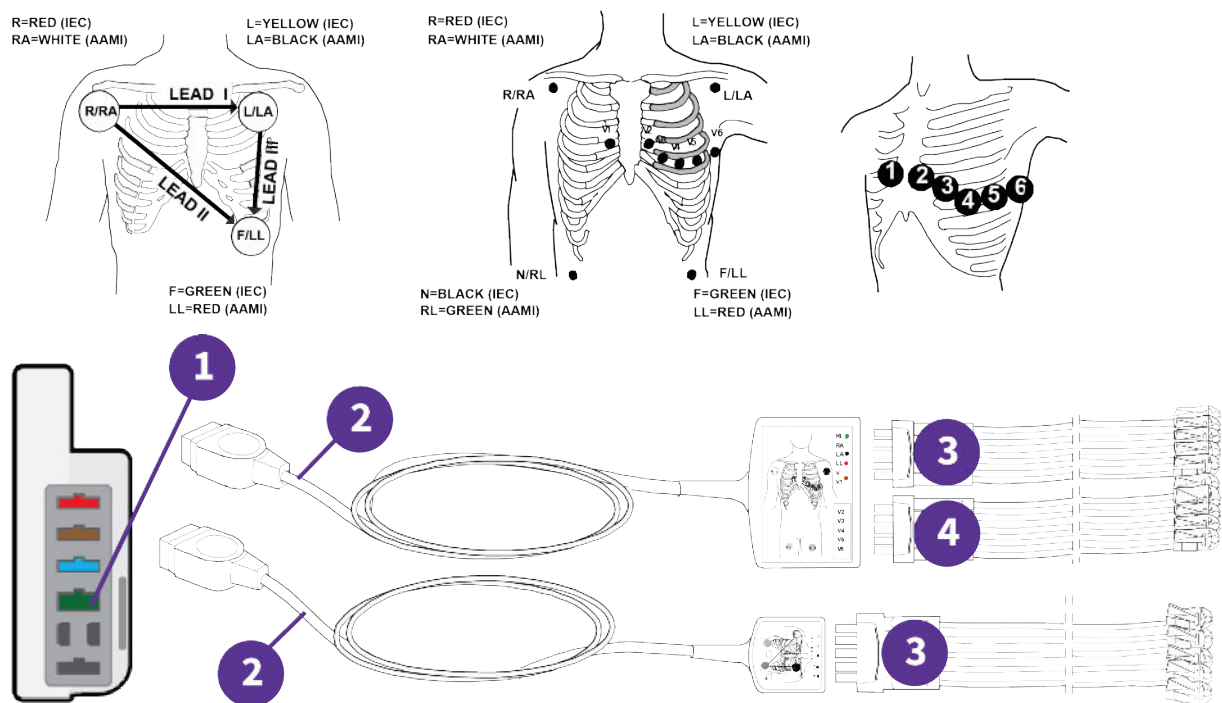
ECG points to note

- This equipment is suitable for use in the presence of electrosurgery, as tested according to IEC 80601-2-49 clause 202.8.102 Disturbances from HF Surgical Equipment.
- For information on materials used in accessories and their biocompatibility, refer to the instructions for use in the accessory package.
- Defibrillator discharge may affect the ECG measurement. Defibrillation recovery time after discharge is < 5 seconds.
- Pre-gelled ECG electrodes are recommended. Check the expiration date.
- Make sure the electrode gel is moist.
- Make sure the electrodes have good skin contact.

- Replace all electrodes at least every 24 to 48 hours.
- Use the Multi-Link electrosurgical unit (ESU) ECG patient cable when using the device in the presence of an electrosurgical unit. This cable, with a built-in ESU filter, helps reduce electrosurgical noise detected on the ECG signal.
- Don't use the electrodes with dissimilar metals.
- Select the HR digit field > **Deactivate ECG Leads off** to remove a **Leads off** message from the display when a cable is off.

ECG measurement setup

ECG equipment to patient connection



1.	The ECG and Impedance respiration connector	2.	Multi-Link 3/5-lead, or 10-lead ECG cable
3.	3-leadwire, 5-leadwire set	4.	Precordial leads leadwire set

Preparing the patient's electrode sites

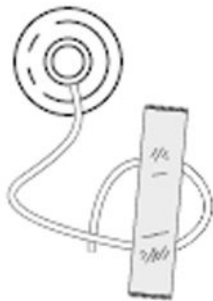
Excessive body hair or skin oil reduces electrode contact with the skin and decreases the quality of electrode signal. When preparing the electrode sites, avoid bones close to skin, obvious layers of fat and major muscles.

1. Shave any hair from the electrode site.
2. Gently rub the surface of the skin to increase capillary blood flow.
3. Clean the skin with alcohol or a mild soap and water solution to remove skin oil and dead or abraded skin cells.

4. Dry the skin completely before applying the electrodes.

Applying the electrodes to the patient

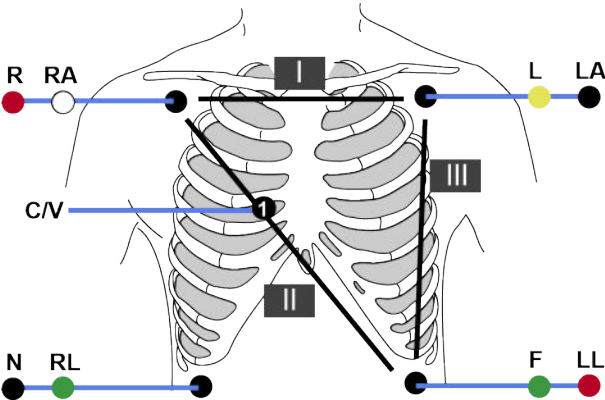
1. Place the electrodes on the prepared sites.
2. Stabilize the electrode and leadwire with a leadwire stress loop near the electrode.
3. Tape the stress loop to the patient (excluding neonates).



A secured stress loop prevents leadwire rotation about the electrode snap, leadwire tugging at the electrode, and ECG artifact.

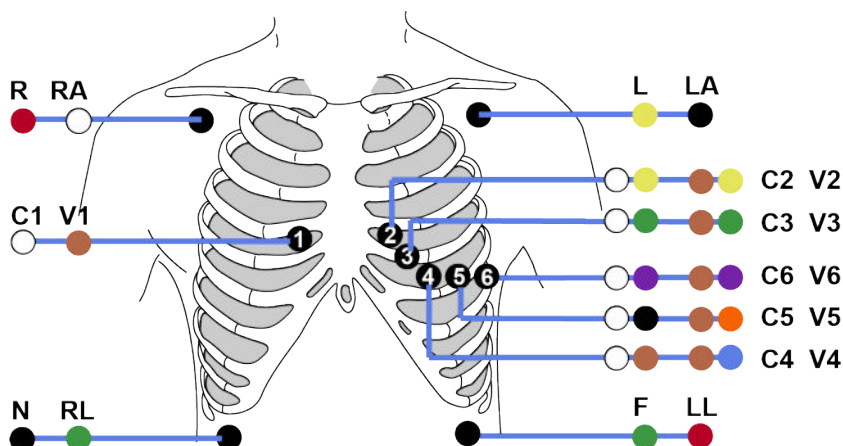
3- lead or 5-lead ECG electrode placement

For a 3-leadwire electrode placement, the R/RA, L/LA, and F/LL electrodes should be used.



IEC	AAMI/AHA	Electrode placement
R (red)	RA (white)	Just below the right clavicle.
L (yellow)	LA (black)	Just below the left clavicle.
C (white)	V (brown)	For the 5-lead placement, place the precordial electrode according to the physician's preference.
N (black)	RL (green)	Lower right edge of the rib cage.
F (green)	LL (red)	Lower left edge of the rib cage.

10-lead ECG electrode placement for cardiac monitoring



IEC	AAMI/AHA	Electrode placement
R (red)	RA (white)	Just below the right clavicle.
L (yellow)	LA (black)	Just below the left clavicle.
N (black)	RL (green)	Lower right edge of the rib cage.
F (green)	LL (red)	Lower left edge of the rib cage.
C1 (white)	V1 (brown)	4 th intercostal space, right sternal border.
C2 (white/yellow)	V2 (brown/yellow)	4 th intercostal space, left sternal border.
C3 (white/green)	V3 (brown/green)	Midway between C2/V2 and C4/V4.
C4 (white/brown)	V4 (brown/blue)	5 th intercostal space, mid-clavicular line.
C5 (white/black)	V5 (brown/orange)	Left anterior axillary line at C4/V4 level.
C6 (white/purple)	V6 (brown/purple)	Mid-axillary line at C4/V4 and C5/V5 levels.

Checking the ECG measurement

1. Check that the waveforms and parameter values are displayed without any error messages when the cable is connected to the patient.

Using the ECG measurement

Setup the parameter to normal screen if needed. Select  >  **Screen Setup**, and select the required screen.

ECG leads settings

You can choose the order of the ECG waveforms displayed in the ECG waveform area.

Lead selection depends on the type of ECG cable used.

The **ECG1 Lead** setting affects arrhythmia detection.

If **ECG1 Lead**, **ECG2 Lead**, or **ECG3 Lead** are changed manually and the lead becomes inactive due to a disconnection, the device looks for lead II, then lead I, and lastly lead III. Later, if the manually selected lead becomes available again, the device will change back to this lead.

Selecting the first displayed ECG lead

The **ECG1 Lead** is the first ECG lead displayed in the ECG waveform area.

1. Select the HR digit field.
2. Select a lead from the **ECG1 Lead** list.

Selecting the second displayed ECG lead

The **ECG2 Lead** is the ECG lead displayed after the **ECG1 Lead** in the ECG waveform field.

NOTE

For 3-lead ECG, the **ECG2 Lead** and **ECG3 Lead** can't select the lead. The menu is gray. They are fixed to **Cascade**.

1. Select the HR digit field.
2. Select a lead from the **ECG2 Lead** list.

If your selection is **Cascade**, the displayed **ECG1 Lead** waveform continues into the **ECG2 Lead** waveform area. The **Cascade** text is shown by the left side of the waveform.

Selecting the third displayed ECG lead

The **ECG3 Lead** is the ECG lead displayed after the **ECG2 Lead** in the ECG waveform field.

NOTE

For 3-lead ECG, the **ECG2 Lead** and **ECG3 Lead** can't select the lead. The menu is gray. They are fixed to **Cascade**.

1. Select the HR digit field.
2. Select a lead from the **ECG3 Lead** list.

If your selection is **Cascade**, the displayed **ECG2 Lead** waveform continues into the **ECG3 Lead** waveform field. The **Cascade** text is shown by the left side of the waveform.

Selecting the V ECG lead position

With 5-leadwire and 10-leadwire ECG, one V lead is measured according to the placement of the V lead electrode.

1. Select the HR digit field.
2. Select a lead from the **V Lead** list.

Changing to an ECG cable with fewer leadwires

This selection will update the measurement mode among 3-, 5-, and 10-lead mode when changing to fewer leadwires.

1. Select the HR digit field.
2. Select **Update Lead Set**.

Deactivating the ECG leads off alarm

The selection is available when there are not enough leads connected for arrhythmia detection. This selection will acknowledge the **Leads off** alarm, but it will not change the measurement mode to fewer leads.

1. Select the HR digit field.
2. Select **Deactivate ECG Leads off**.

Selecting the ECG waveform size

This selection adjusts the size of the displayed ECG waveform.

1. Select the HR digit field.
2. Select a value from the **Size** list.

The selections are **0.5x**, **1x**, **2x**, **4x**. The smaller the value, the smaller the waveform.

NOTE

The **Size** setting affects arrhythmia detection and heart rate calculation sensitivity. Normal waveform size/QRS detection sensitivity is **1x**. Size **2x** and greater increases the QRS detection sensitivity. This may be helpful for low amplitude QRS waveforms. Use with caution since baseline artifact may be detected as a QRS complex.

Selecting the hemodynamic waveform sweep speed

NOTE

This setting adjusts the waveform speed for all of the hemodynamic parameters.

1. Select the HR digit field.
2. Select a numeric value from the **Hemodynamics Sweep Speed** list.

The smaller the value, the slower the sweep speed is.

Setting the beat volume

NOTE

This setting adjusts beat volume for both of ECG and SpO₂ parameters.

You can adjust the volume of heart/pulse beat sound. The beat tone depends on HR source to calculate.

1. Select the HR digit field.
2. Set the beat tone volume with the **Beat Volume** arrows.

The range is 0 (volume off) to 10.

Selecting the ECG waveform filter

You can select how the waveform appears on the display and on the printout.

1. Select the HR digit field.
2. Select the **Advanced** tab.

3. Select a filter from the **Waveform Filter** list. Choices are:
 - **Monitoring:** Use Monitor filter for poor ECG signal.
0.5 to 40 Hz
 - **ST filter:** Use ST filter for optimal ST analysis.
0.05 to 40 Hz
 - **Diagnostic:** Use Diagnostic filter for waveform analysis. This filter is sensitive to artifacts.
0.05 to 145 Hz
 - **Moderate:** Use Moderate filter to reduce high frequency interference.
0.5 to 20 Hz

Setting the QRS width

NOTE

This setting affects the arrhythmia detection sensitivity.

1. Select the HR digit field.
2. Select the **Advanced** tab.
3. Select a setting from the **QRS Width** list. Choices are:
 - **Narrow:** Intended for use with all neonates and the pediatric patient with a QRS complex width of 100 ms or less.
 - **Normal:** Intended for ECG rhythms that have QRS complex widths of approximately 70 ms or wider (for example, almost all adult patients and any patient with electronic ventricular pacing).

Setting the primary HR source

The primary heart rate can be calculated from the ECG leads, SpO₂ measurement, or invasive pressure waveform.

NOTE

This setting adjusts the primary heart rate source for all of the hemodynamic parameters.

1. Select the HR digit field.
2. Select the **Advanced** tab.
3. Select a parameter from the **Primary HR Source** list.

Showing a second HR value

You can display a second heart rate source in the HR digit field.

1. Select the HR digit field.
2. Select the **Advanced** tab.

3. Select a setting from the **Display with Primary HR**. The choices are:
 - **2nd HR Source**
 - If the primary HR source is **ECG**, the secondary HR source displayed in this priority: **Art, Fem, ABP, UAC, Pleth**.
 - If the primary HR source is anything else than mentioned above, the secondary HR source is always **ECG**.
 - **PVC**
 - **QT**

Displaying the ECG grid

You can have a reference grid in the **ECG1 Lead**, **ECG2 Lead**, and **ECG3 Lead** waveform areas. The grid points will be at 200 ms horizontally and 0.5 mV vertically.

1. Select the HR digit field.
2. Select the **Advanced** tab.
3. Enable the toggle of the **ECG Grid** to display the grid.

Viewing and printing all ECG waveforms

1. Select the HR digit field > **Advanced** tab.
2. Select **All ECG Waveforms** to view all ECG waveforms.
3. Check that you have set up the printing options. For more information, see the "Printing" chapter.
Then select  to print all ECG waveforms.
4. You can stop printing by selecting .

Relearning the patient's QRS pattern

During ECG monitoring, you may need to use the **Relearn** feature when a dramatic change in the patient's ECG pattern has occurred. Allowing the device to learn the new ECG pattern may correct false arrhythmia alarms and heart rate values, and restores the ST measurements.

Relearning typically takes 30 seconds or less. This relearn key will turn to gray and display **Learning** while the device relearns the QRS pattern. During this time, arrhythmia detection may not be available. If the device is not able to relearn due to a low amplitude QRS, for example, an **Arrhythmia Paused** alarm is triggered.

1. Select the HR digit field.
2. Select the **Advanced** tab.
3. Select **Relearn**.

Automatic relearning takes place when:

- The measurement mode changes between a 3-lead mode and any other lead mode.
- The **ECG1 Lead** selection is changed in the 3-lead mode.
- The V lead selection is changed in the 5-lead mode, and 10-lead modes.

NOTE

Don't relearn QRS pattern during V Tach conditions, or else the V Tach alarm may not display in future.

ECG alarm limits

From the **Alarms** tab, you can set

- One common HR limit for multiple sources (e.g., ECG, Pleth, Art).
- Arrhythmia alarm settings (For arrhythmia alarm settings, please refer to [Setting arrhythmia alarms on page 158](#)).
- The PVC alarm limits.
- The SVC alarm limits.
- The ST alarm limits (For more information, see [Setting alarm limits for lead groups on page 162](#)).
- The QT alarm limits (For more information, see [Setting QT/QTc alarms on page 163](#)).

Setting the HR alarm limits

1. Select the HR digit field.
2. Select the **Alarms** tab.
3. There are two HR alarm options: **HR** or **HR Critical**. Check that the desired **Alarm** is turned on.
4. Adjust the alarm limits with the arrows. Limits are adjusted in increments of 1 bpm per step.

NOTE

To set the HR alarm off, select **OFF** from the **Alarm** list.

Setting PVC alarm limits

1. Select the HR digit field.
2. Select the **Alarms** tab.
3. Select the **PVC** vertical tab.
4. Check that the **Alarm** is turned on.
5. Adjust the PVC alarm limit with the arrows.

NOTE

If you want the PVC alarm off, select from the **Alarm** list.

Setting SVC alarm limits

The SVC value displays in the menu also.

1. Select the HR digit field.
2. Select the **Alarms** tab.
3. Select the **SVC** vertical tab.
4. Check that the **Alarm** is turned on.
5. Adjust the SVC alarm limit with the arrows.

NOTE

If you want the SVC alarm off, select from the **Alarm** list.

ECG measurement practicalities

Alternate pulse rate source

The alternate pulse rate source allows clinicians to acquire a pulse rate from a source other than ECG (Art, ABP, UAC, Pleth or Fem). The following circumstances may warrant the use of an alternate pulse rate source:

- Excessive artifact due to an electrical interference from equipment (e.g., electrosurgical device).
- Excessive patient movement causing significant artifact (e.g., seizure activity).
- Inability to use standard lead placement (e.g., burns).

Auto algorithm

The device uses the AUTO algorithm. selects the first available heart rate source based on a pre-defined parameter priority:

1. ECG
2. Art
3. ABP
4. UAC
5. Pleth
6. Fem

Pacemaker detection

Pacemaker detection warnings

WARNING

PACEMAKER PATIENTS.

Rate meters may continue to count the pacemaker rate during occurrences of cardiac arrest and some arrhythmias. Do not rely entirely upon the heart rate meter alarms. Keep pacemaker patients under close observation. See the supplemental information provided for disclosure of the pacemaker pulse rejection capability of this device.

WARNING

FALSE CALLS.

False low heart rate indicators or false Asystole calls may result with certain pacemakers because of pacemaker artifact such as electrical overshoot of the pacemaker overlapping the true QRS complexes.

WARNING

MONITORING PACEMAKER PATIENTS.

The monitoring of pacemaker patients can only occur with the pace program activated.

WARNING

PACEMAKER INDICATION.

Pacemaker activity is indicated on the electrocardiogram through the display of a different colored pacemaker marker pulse. All pacemaker marker pulses appear upright and uniform and should not be used for diagnostic interpretation.

WARNING

PATIENT HAZARD.

A pacemaker pulse can be counted as a QRS during Asystole when pacemaker detection is on. Keep pacemaker patients under close observation.

WARNING

PATIENT HAZARD.

Asystole may not be detected if the patient has a pacemaker that produces high-amplitude pacer spikes and pacemaker detection is on. Keep pacemaker patients under close observation.

Pacemaker detection points to note

- Pacemaker detection must be used whenever the monitored patient has a pacemaker.
- The following leads are used for pacemaker detection:
 - 5-lead mode: Leads R/RA, L/LA, F/LL, and C/V
 - 10-lead mode: Leads R/RA, F/LL, C1/V1, and C5/V5
- Pacemaker detection is done on leads I, II, and V simultaneously.
- If the patient has an atrial pacemaker, ST calculations can be performed if the pacer spike does not coincide with the ISO point's adjustment range.
- The V lead plays a critical role in pacemaker detection.

Selecting the pacemaker detection

1. Select the HR digit field.
2. Select the **Advanced** tab.

3. Select a value from the **Pacemaker Detection** list.

Choices are:

- **Show:** Displays pacemaker spikes on the ECG waveform.
- **Hide:** Hides the pacemaker spikes on the ECG waveform.

An indicator will display on the left side of the waveform, when the selection is **Hide**.

- **Sensitive:** Increases pacemaker detection sensitivity and displays the pacemaker spikes on the ECG waveform. By selecting this option you can improve the detection of small amplitude pacemakers. However, this mode is also more sensitive to false pacemaker detections.

Arrhythmia monitoring

Arrhythmia monitoring warnings

WARNING

MISSED ALARMS.

V Fib/V Tach should not be considered a substitute for the V Tach arrhythmia alarm. Efforts to lower the V Tach alarm level can result in missed ventricular tachycardia alarms.

WARNING

LOSS OR DETERIORATION OF ARRHYTHMIA DETECTION.

Automated arrhythmia analysis programs may incorrectly identify the presence or absence of an arrhythmia. A physician must therefore interpret the arrhythmia information in conjunction with other clinical findings. Please take special note of the following ECG waveform conditions:

Noisy waveforms. Noisy portions of ECG waveforms are typically excluded from analysis. The exclusions are necessary to reduce the occurrence of inaccurate beat interpretations and/or rhythm alarms. If the excluded noisy portions of the ECG waveform contain true arrhythmia events, those events may remain undetected by the system.

Beat amplitude and duration. Accurate detection and interpretation of beats becomes increasingly difficult as the amplitude and/or duration of those beats approach the design limits of the analysis program. Thus, as beats become extremely wide or narrow, or especially as beats become small, arrhythmia interpretation performance may degrade.

Other morphology considerations. Automated arrhythmia detection algorithms are designed fundamentally to detect significant changes in QRS morphology. If an arrhythmia event is present and does not exhibit a significant change from the patient's predominant morphology, it is possible for those events to remain undetected by the system.

WARNING**PAUSED ANALYSIS.**

Certain conditions pause arrhythmia analysis. When paused, arrhythmia conditions are not detected and alarms associated with arrhythmias do not occur. Conditions causing paused arrhythmia analysis include arrhythmia paused, leads off, alarm pause, all alarms off, and discharged patient. Always keep the patient under close surveillance.

WARNING**FAILURE TO DETECT LETHAL ARRHYTHMIA.**

Always monitor ECG for arrhythmia detection purposes. HR calculated from pulsatile SpO₂ waveform may differ significantly from ECG HR measured values. Users should be aware that the **SpO2 probe off** and **No SpO2 pulse** alarms escalate no higher than a Medium priority.

WARNING**FAILURE TO DETECT LETHAL ARRHYTHMIA.**

The SpO₂ parameter pulsatile heart rate measurement is based on the optical detection of a peripheral flow pulse and therefore may not detect certain arrhythmias. The pulse oximetry parameter should not be used as a replacement or substitute for ECG based arrhythmia analysis.

WARNING**ARRHYTHMIA PAUSED ALARM.**

The **Arrhythmia paused** alarm indicates that the system is no longer monitoring arrhythmia or heart rate from ECG. If you adjust the alarm priority level lower than the default value, keep the patient under close surveillance.

Arrhythmia detection description

When an ECG signal is detected at the start of monitoring, the arrhythmia detection algorithm begins acquiring and analyzing QRS complexes in the leads used for arrhythmia detection. This phase is known as learning. Once learning is completed, the dominant QRS complex is stored as a reference template. Reference template is used as a normal morphology of that patient and it is compared with incoming beats to identify possible arrhythmias.

The EK-Pro arrhythmia detection algorithm is used. EK-Pro simultaneously analyzes leads I, II, III, and V. Once learning is completed, the dominant QRS complex becomes the template.

The algorithm uses continuous correlation, incremental template updating and contextual analysis. Continuous correlation attempts to find the best match between each incoming complex and the set of stored (learned) templates. If no match is found with the existing template, a new template is stored for the identified new QRS shape. Incremental template updating allows information from each beat, that correlates over time, to be reflected in the associated template. Contextual analysis uses information from neighboring QRS complexes along with existing template measurements to make the best possible decision regarding the beat's origin (e.g., early, wide).

Arrhythmia measurement limitations

- Since the arrhythmia detection algorithm sensitivity and specificity is less than 100%, sometimes there may be some false arrhythmias detected and also some true arrhythmia events may not be detected. This is especially true when the signal is noisy.
- The ECG size and QRS width settings affect arrhythmia detection and heart rate calculation sensitivity.
- If QRS amplitude is low, the device might not be able to calculate HR and false Asystole may occur.
- If learning phase takes place while arrhythmia is already occurring, it may affect the subsequent arrhythmia detection.
- During the learning phase of the algorithm, arrhythmia detection may not be available. As a result, the patient condition should be closely monitored during the learning phase and for several minutes after the learning phase to allow the algorithm to reach optimal detection performance.

Setting arrhythmia alarms

You can set the arrhythmia alarms from **Alarms Setup** menu or from the **ECG** menu.

1. Select the HR digit field > **Alarms** tab.

Or, select  >  **Alarms Setup** > **Priorities** tab.

2. You can select the vertical tabs for the **Lethal**, **Ventricular** and **Atrial** alarms.
 - **Lethal**: You can enable or disable the toggle of **Create Snapshot**, the alarm priority for lethal alarms is always high.
You can set up the **V Tach** alarm condition.
 - **Ventricular**: You can select the alarm priority and enable or disable the toggle of **Create Snapshot**.
 - **Atrial**: You can select the alarm priority and enable or disable the toggle of **Create Snapshot**, and set up **Pause Interval** options.
You can set up the **SVT Length** and **HR for SVT/min**.

Setting the V Tach alarm conditions

This setting determines the conditions to trigger V Tach alarm. The selection is shown only if the **Allow V Tach Event Duration Criteria** has been enabled during configuration through  >  **Service** > **Alarm Options** > **Alarm Delays**. This setting is password protected.

For more information, see the supplemental information manual.

1. Select the HR digit field.
2. Select the **Alarms** tab.
3. Select the **Lethal** vertical tab.
4. Select the following conditions:
 - **Minimum HR/min** : Select the minimum HR value to trigger V Tach alarm.
 - **Event Duration**: Select how long time is needed to trigger V Tach alarm.

- **AND / OR:** Select both of above conditions needed to trigger V Tach alarm, or only one.

About V Tach criteria

If **Allow V Tach Event Duration Criteria** has been enabled during configuration through  >  **Service** > **Alarm Options** > **Alarm Delays**, you can individualize the V Tach alarm to a specific patient condition. The alarm history at the bedside device may not match that of the central station when conditions have been adjusted to other than the default setting (**Minimum HR/min** = 100 and **Event Duration** = Off). You can always check the complete patient history from the central station full disclosure. You can check the current values through HR digit field > **Alarms** tab > **Lethal** vertical tab.

Setting the alarm pause interval

You can set the time interval between the two adjacent beats before the pause alarm condition is annunciated.

1. Select the HR digit field.
2. Select the **Alarms** tab.
3. Select the **Atrial** vertical tab.
4. Select a value from the **Pause Interval** list.

Setting the SVT length

This setting determines how many consecutive SVCs are needed to trigger the **SV Tachy** alarm.

1. Select the HR digit field.
2. Select the **Alarms** tab.
3. Select the **Atrial** vertical tab.
4. Select a value from the **SVT Length** list.

Setting HR for SVT

This setting determines the minimum value for the HR to trigger the **SV Tachy** alarm.

1. Select the HR digit field.
2. Select the **Alarms** tab.
3. Select the **Atrial** vertical tab.
4. Select a value from the **HR for SVT/min** list.

Arrhythmia alarm messages

NOTE

A clinician must analyze the arrhythmia information in conjunction with the other clinical findings.

Table 1 HR alarms

Alarm message	Arrhythmia detection criteria
Brady	HR below the HR basic or critical alarm limit.

Table 1 HR alarms (Table continued)

Alarm message	Arrhythmia detection criteria
Tachy	HR over the HR basic or critical alarm limit.

Table 2 Lethal alarms

Alarm message	Arrhythmia detection criteria
Asystole	HR decreased to zero, or beat detection has not occurred in the last 5 seconds.
V Fib / V Tach	ECG waveform indicates a chaotic ventricular rhythm.
V Tach	A run of PVCs is detected with a run length of six beats or more and the effective HR and V Tach duration meet the user defined criteria.

Table 3 Ventricular alarms

Alarm message	Arrhythmia detection criteria
VT > 2	A run of PVCs is detected with a run length of more than two beats but less than six beats. In addition at least two consecutive RR intervals in the run must have an effective HR that is equal to or exceeds the V Tach Minimum HR/min .
R on T	Isolated PVC is detected within 100 ms of the peak of the T-wave of the patient's predominant normal beat.
V Brady	Run of PVCs are detected with a run length of at least three beats. In addition, at least two consecutive RR intervals in the run must have an effective heart rate less than 50 bpm (60 bpm in Neonatal mode).
Couplet	Two consecutive PVCs are detected between normal beats, N-V-V-N. The coupling interval between the PVCs must be less than 600 ms.
Bigeminy	Every other beat is PVC (N-V-N-V-N-V).
Accel. Ventric.	Accelerated ventricular rhythm - Run of PVCs with a run length of at least six beats and the requirements for user defined V Tach Criteria or V Brady are not met.
Trigeminy	Every third beat is PVC (N, N, V, N, N, V, N, N, V).
Multifocal PVCs	Within 16 previous beats two or more PVCs with different morphologies are detected.

Table 4 Atrial alarms

Alarm message	Arrhythmia detection criteria
A Fib Not available in NEONATAL mode.	Absence of P-waves and irregular RR-interval.
Irregular NEONATAL mode only.	Six consecutive normal RR intervals vary by 100 ms or more.
Missing Beat Not available in NEONATAL mode.	Actual RR interval more than 1.8 times the average RR interval.
Pause	Coupling interval between two beats exceeds: 1 to 5 seconds (configurable)
SV Tachy	A run of SVCs is detected with a run length of at least the set SVT Length and the heart rate is at least the set HR for SVT/min .

Table 5 PVC alarm

Alarm message	Arrhythmia detection criteria
Frequent PVCs	PVC count over the PVC alarm limit.

Table 6 SVC alarm

Alarm message	Arrhythmia detection criteria
Frequent SVCs	SVC count over the SVC alarm limit.

ST detection

About the ST analysis

ST analysis starts automatically after the ECG leads have been connected and QRS detection has started. Once the program has completed the learning phase, ST values and QRS complexes are updated every 10 seconds.

During the learning period, the algorithm uses the isoelectric reference and the J+ reference points to calculate the ST values. The algorithm automatically searches for the J and ISO points. These settings can be adjusted for the current patient.

In order to get the better ST analysis, it is recommended to setup **ST filter** for **Waveform Filter**.

- Select the HR digit field > **Advanced** tab > **Waveform Filter** > **ST filter**.

ST detection measurement limitations

- ST values may be affected by such factors as some drugs or metabolic and conduction disturbances.
- Since ST is often calculated with a fixed delay from the J point, changes in heart rate may affect ST.
- The ST algorithm has been tested for accuracy of the ST segment data. The significance of the ST segment changes needs to be determined by a physician.

Adjusting the ST point manually

- The device automatically set the ST point according to the heart rate. Manual adjustments may be required if the following automatic settings are not adequate for example when QT time is short:
 - If the heart rate is greater than or equal to 120 bpm, then the ST point is set to J + 60 ms.
 - If the heart rate is less than 120 bpm, then the ST point is set to J + 80 ms.

Manually adjusting the ST Point, ISO Point, or J Point overrides the automatic detection of the ST point. As a result, you are responsible for monitoring the patient ST levels with new adjustments and required to make further setting adjustments as necessary according to changes in the patient's rhythm.

1. Select the ST digit field > **ST** tab > **Adjust ST** vertical tab.
2. Select a value from the **ST Point** list.

Adjusting the isoelectric measurement (ISO) point

The device automatically set the isoelectric point. Manual adjustments may be required if, for example, a P-wave is attached to the QRS-wave.

1. Select the ST digit field > **ST** tab > **Adjust ST** vertical tab.
2. Click **Set ISO Point**, adjust the bar with the arrows.

When the ISO point is adjusted, also the ST point changes accordingly and its automatic setting is stopped.

Adjusting the J point

1. Select the ST digit field > **ST** tab > **Adjust ST** vertical tab.
2. Click **Set J Point**, adjust the bar with the arrows.

When the J point is adjusted, also the ST point changes accordingly.

Setting alarm limits for lead groups

1. Select the HR digit field > **Alarms** tab.
2. Select **ST** vertical tab.
3. Check that the **Alarm** is turned on.
4. Set the related alarm limits with arrows.

The limit settings affect all leads in the lead group, which list in the menu.

QT detection

The administration of some drug types can prolong the QT segment. Monitoring QT segment changes can help identify how these drugs are affecting the QT segment.

QT/QTc measurement limitations

- At least one measured V-lead must be available in order for the algorithm to process QT.
- QT/QTc values are calculated in 5-lead or 10-lead measurement modes.

Starting the QT/QTc measurement

1. Select the HR parameter window.
2. Select the **QT** tab.
3. Enable the toggle **QT Analysis**.

Selecting QT or QTc for analysis

1. Select the HR parameter window.
2. Select the **QT** tab.
3. Select **QT** or **QTc** from the **Show in Parameter Window** list.

Setting QT/QTc alarms

1. Select the HR parameter window.
2. Select **Alarms**.
3. Select the **QT** tab.
4. Check that the **Alarm** is turned on.
5. Adjust the QT/QTc high limit with the arrows.

Impedance respiration

Respiration safety precautions

Respiration warnings

WARNING

ELECTRIC SHOCK.

To avoid the risk of electric shock caused by the leadwire set clips or snaps that may conduct electricity, make sure that they do not touch any other electrically conductive material including ground.

WARNING

ERRONEOUS READINGS.

The impedance respiration measurement is inherently very sensitive as it measures very small physiological signals (changes of impedance of the patient's chest area). Electromagnetic interference may cause erroneous measurements at various frequencies, for example interference with the signal/ waveform, leading to respiration rate readings inconsistent with the patient's true respiration rate. If you notice this, use another form of respiration monitoring, for instance end-tidal CO₂.

WARNING

APNEA EVENTS.

The device may not detect all episodes of inadequate breathing, nor does it distinguish between central, obstructive, and mixed apnea events.

WARNING

BURNS.

When using an electrosurgery unit, note that the measurement cables do not incorporate means to protect against burns in case of a defective ESU return electrode. To avoid burns at the monitor measurement sites, ensure the following:

- Proper contact of the ESU return electrode to the patient.

- ESU return electrode near the operating area.

- Measurement electrodes, leadwires and probes far from the surgical site and the ESU return electrode.

**WARNING****DEFIBRILLATOR PRECAUTIONS.**

Patient signal inputs labeled with the CF and BF symbols with paddles are protected against damage resulting from defibrillation voltages. To ensure proper defibrillator protection, use only the recommended cables and leadwires. Using other cables or leadwires may result in damage to the equipment and compromise patient and user safety.

WARNING**ELECTRODE CONFIGURATION.**

Impedance respiration monitoring is not reliable when ECG electrodes are placed anywhere but on the chest.

WARNING**ELECTRODES.**

Whenever patient defibrillation is a possibility, use non-polarizing (silver/silver chloride construction) electrodes for ECG monitoring. Polarizing electrodes (stainless steel or silver constructed) may cause the electrodes to retain a residual charge after defibrillation. A residual charge will block acquisition of the ECG signal.

Respiration cautions

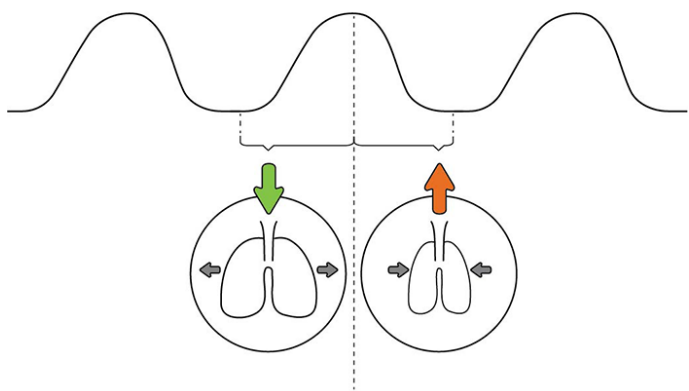
CAUTION**PATIENT SAFETY.**

The impedance respiration measurement may cause rate changes in Minute Ventilation Rate Responsive Pacemakers. Turn off the impedance respiration measurement on the device to avoid risks to the patient.

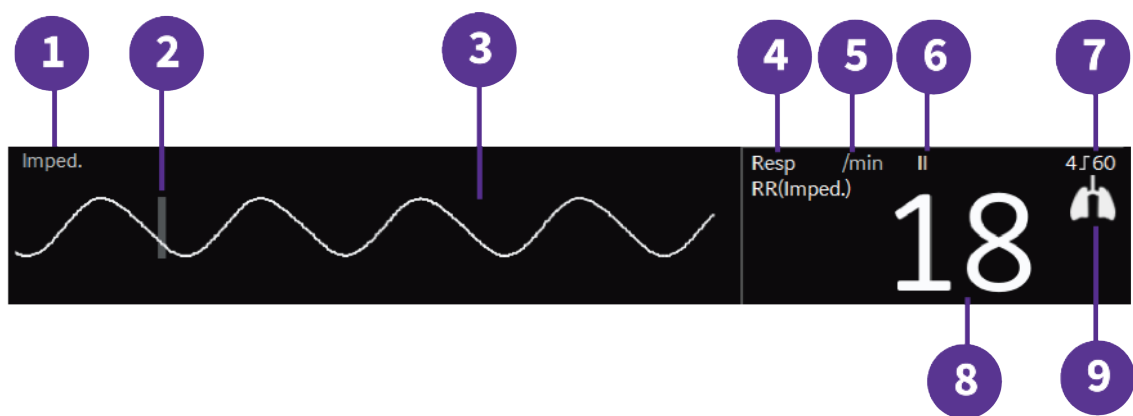
Respiration measurement description

Respiration measurement is based on the variation of the bio-impedance of the patient's thorax and abdomen. To measure impedance, the respiration sensor sends a small electric current to the patient through the electrodes placed on the torso. Air flowing in and out, as well as changes in geometry, change the electrical properties of the body. The impedance respiration waveform reflects those changes.

The following graphic illustrates how inhalation and exhalation are reflected in the respiration waveform:



Respiration measurement displayed on the device screen



1.	Imped. (Imped.): waveform label	2.	Waveform size bar
3.	Impedance respiration waveform	4.	Resp (Resp): parameter label
5.	/min (/min): unit	6.	II (II): Measurement lead
7.	Alarm limits, alarm status, or other messages	8.	RR(Imped.) (RR(Imped.)): Impedance respiration rate
9.	Respiration indicator		

Respiration measurement limitations

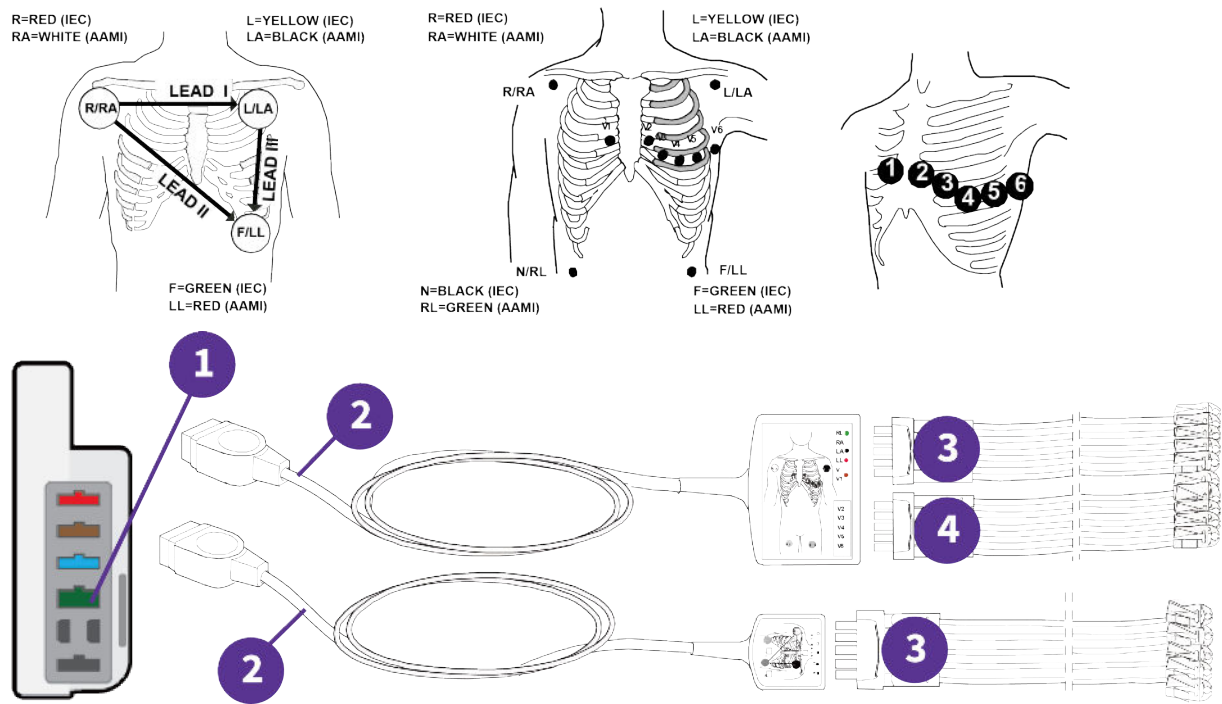
- Electrical devices, such as electrosurgery units and infrared heaters, that emit electromagnetic disturbance, may cause artifacts or disable the respiration measurement completely.
- Motion artifact (such as mobile (walking) patient, shivering, and interference from the beating heart) may interfere with the respiration measurement, reduce the respiration rate accuracy, and/or disable apnea detection. Respiration measurement can only detect central type apnea. Apnea cannot be detected in the presence of any breathing effort or motion of the patient.
- In some rare cases the respiration rate and pulse rate values of the patient may be very close to each other, resulting in too low respiration rate values and false alarms.
- Irregular cardiac rhythm of the patient may cause suboptimal performance of the respiration measurement.
- You can only use one impedance respiration measurement on a patient at a time.

Respiration points to note

- This equipment is suitable for use in the presence of electrosurgery, as tested according to IEC 80601-2-49 clause 202.8.102 Disturbances from HF Surgical Equipment.
- For information on materials used in accessories and their biocompatibility, refer to the instructions for use in the accessory package.
- Defibrillator discharge may affect the respiration measurement. Defibrillation recovery time after discharge is ≤ 15 seconds.
- Always check the patient and the measurement site if the accuracy of the respiration data is questionable.
- Respiration rate may be shown as 0 without an apnea alarm if the patient's respiration frequency and amplitude are very low. Apnea alarm appears if there are no detected breaths during user-configurable apnea alarm time.
- Make sure the electrode gel is moist.
- Make sure electrodes have good skin contact.
- Since respiration monitoring is so closely linked with ECG monitoring, patient preparation and electrode placement are important.
- Intermittent mechanical ventilation: During spontaneous breathing the ventilator may at times support the patient's ventilation with an extra inspiration. If these ventilator inspirations are substantially larger than the spontaneous breaths, the respiration calculation may mistakenly count only the inspirations and expirations produced by the ventilator.

Respiration measurement setup

Respiration equipment to patient connection



1.	The ECG and Impedance respiration connector	2.	Multi-Link 3/5-lead, or 10-lead ECG cable
3.	3-leadwire, 5-leadwire set	4.	Precordial leads leadwire set

Preparing the patient’s respiration electrode sites

Excessive body hair or skin oil reduces electrode contact with the skin and decreases the quality of electrode signal.

NOTE

When preparing the electrode sites, avoid obvious layers of fat and major muscles.

1. Remove any hair from the electrode site.
2. Gently rub the surface of the skin to increase capillary blood flow.
3. Clean the skin with alcohol or a mild soap and water solution to remove skin oil and dead or abraded skin cells.
4. Dry the skin completely before applying the electrodes.

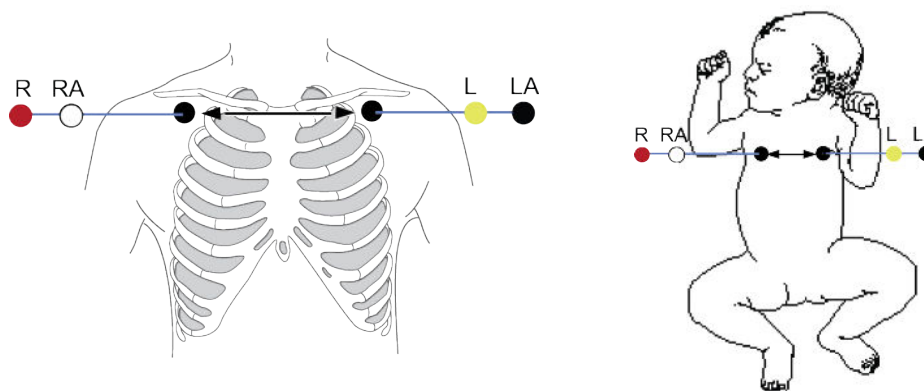
Respiration lead and breath detection

Respiration leads identify the ECG leads used for respiration measurement. Each respiration lead is suited for specific breath detection conditions:

Lead	Description
Lead I	Best for detecting thoracic breathing, but is more susceptible to cardiogenic artifact.
Lead II	Equally good at detecting thoracic or abdominal breathing, but is more susceptible to cardiogenic and motion (head, neck, or arm) artifact.
Lead RL-LL	Best at detecting abdominal breathing and is not as susceptible to cardiogenic or motion artifact. Not available for 3-lead measurement.

Even though the same electrodes are used for ECG and respiration monitoring, it is possible to get a lead fail message for respiration without one for ECG. The impedance may be too high for respiration detection, but the electrode is still good for ECG detection.

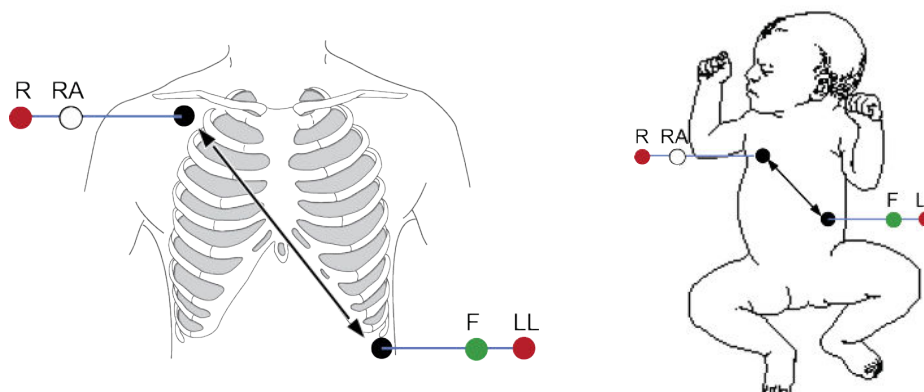
Respiration lead I electrode placement



ECG lead I for upper chest breather

IEC	AAMI/AHA	Electrode placement
R (red)	RA (white)	Just below the right clavicle.
L (yellow)	LA (black)	Just below the left clavicle.

Respiration lead II electrode placement

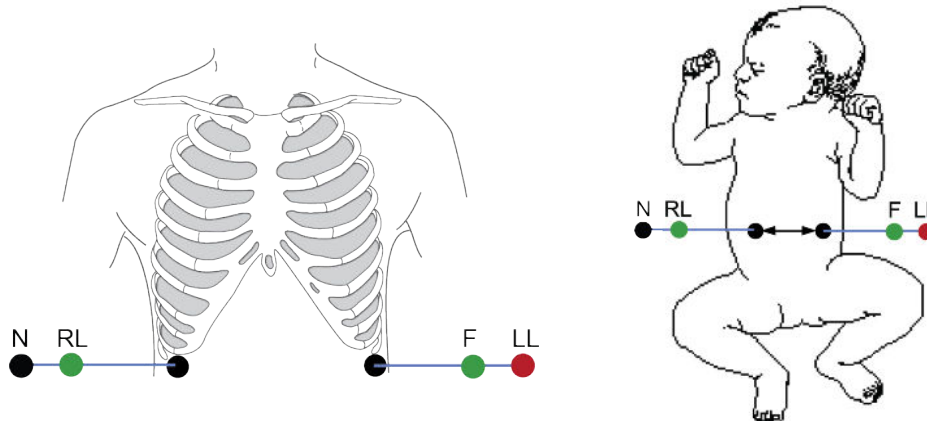


ECG lead II for chest or upper abdominal breather

IEC	AAMI/AHA	Electrode placement
R (red)	RA (white)	Just below the right clavicle.
F (green)	LL (red)	Lower left edge of the rib cage.

Respiration lead RL-LL electrode placement

When monitoring respiration through the RL-LL vector, use a standard 5-, or 10-leadwire electrode placement, except place the RL electrode on the fifth intercostal space on the right side of the chest. Impedance respiration lead between RL and LL provides maximum respiration signal strength, minimum noise/artifact content, and minimum cardiogenic artifact.



RL-LL vector for abdominal breather

IEC	AAMI/AHA	Electrode placement
N (black)	RL (green)	Fifth intercostal space on the right.
F (green)	LL (red)	Lower left edge of the rib cage.

Respiration measurement checks

Check that the waveform and parameter value are displayed when the cable is connected to the patient.

NOTE

There may also be a respiration rate value displayed in the CO₂ digit field. Only the value in the respiration digit field is measured from the impedance respiration source.

Using the respiration measurement

Setup the parameter to normal screen if needed. Select  >  **Screen Setup**, and select the required screen.

Turning on the respiration measurement

If the respiration measurement does not start automatically, you need to select it on.

1. Select the impedance respiration digit field.

2. Select **ON** from the **Measurement** list.

Selecting the respiration lead

1. Select the impedance respiration digit field.
2. Select a lead from the **Measurement Source** list. Lead selections are presented as graphical icons.

Selecting the respiration waveform size

1. Select the impedance respiration digit field.
2. Adjust the **Size** with the arrow.

The greater the value, the larger the waveform size.

Selecting the waveform speed

1. Select the impedance respiration digit field.
2. Select a value from the **Sweep Speed** list.

The smaller the value, the slower the sweep speed is.

Setting the averaging time

1. Select the impedance respiration digit field.
2. Adjust the value of **Resp Averaging Time** with the arrows.

Parameter filtering (Resp averaging)

When configured, the parameter filter calculates a moving average of the calculated parameter values. The averaging time can be configured with the UI **Resp Averaging Time**. Using the parameter filter makes the values more accurate but may delay the visibility of changes. Also increasing the averaging time reduces fast variations in parameter values.

The averaging is weighted using the estimated reliability and time of each value. Short periods of artifact in original values will have limited effect on the displayed value. Also, recent values will have higher weight than older values.

If the original measurement is reliable and the value clearly violates the alarm limit, the value is updated faster to decrease the delay to alarms. Similarly, if the value is reliable and returns within the alarm limits, the value is updated faster to reduce unnecessary alarms. The fixed alarm delays are still applied.

Setting the apnea alarm delay

You can select the apnea alarm delay by defining seconds in the **Apnea Limit Seconds**.

1. Select the impedance respiration digit field.
2. Select the **Alarms** tab.
3. Adjust the value of **Apnea Limit Seconds** with the arrows.

Setting the respiration alarm limits

1. Select the impedance respiration digit field.

2. Select the **Alarms** tab.
3. Check that **Alarm** is turned on.
4. Adjust the alarm limits with arrows.

NOTE

If you want the alarm off, select from the **Alarm** list.

Pulse oximetry

SpO₂ safety precautions

SpO₂ warnings



WARNING

DEFIBRILLATOR PRECAUTIONS.

Patient signal inputs labeled with the CF and BF symbols with paddles are protected against damage resulting from defibrillation voltages. To ensure proper defibrillator protection, use only the recommended cables and leadwires. Using other cables or leadwires may result in damage to the equipment and compromise patient and user safety.

WARNING

PATIENT SAFETY.

The operator is responsible for checking the compatibility of the pulse oximetry device, sensor, and patient cable prior to use. Incompatible components can result in degraded performance and/or device malfunction and compromised patient safety.

WARNING

PATIENT SAFETY.

If the accuracy of any measurement does not seem reasonable, first check the patient's vital signs, then check for conditions that may cause inaccurate SpO₂ readings. If the problem is still not resolved, check the device and the cable, or sensor for proper functioning.

WARNING

PATIENT SAFETY.

A pulse oximeter should not be used as an apnea monitor. A pulse oximeter should be considered an early warning device. As a trend toward patient deoxygenation is indicated, blood samples should be analyzed by a laboratory CO-oximeter to completely understand the patient's condition.

WARNING**PATIENT SAFETY.**

Check that the pulse oximetry waveform is physiological in shape to ensure waveform quality and minimize noise spikes caused by motion conditions. (Not applicable when monitoring SpO₂ with Masimo SET technology.) Otherwise, there is a risk of compromised patient safety.

WARNING**PATIENT SAFETY.**

To prevent erroneous readings, do not use physically damaged sensors, cables or modules. Discard a damaged sensor or cable immediately. Never repair a damaged sensor or cable; never use a sensor or cable repaired by others. A damaged sensor or a sensor soaked in liquid may cause burns during electrosurgery.

WARNING**PATIENT SAFETY.**

Pulse rate measurement is based on the optical detection of a peripheral flow pulse and therefore may not detect certain arrhythmias. The pulse oximeter should not be used as a replacement or substitute for ECG-based arrhythmia analysis. Otherwise, there is a risk of compromised patient safety.

WARNING**PATIENT SAFETY.**

Cable/sensor after care:

- Do not immerse sensors or patient cables in water, solvents or cleaning solutions.

- Do not reuse sensors intended for single patient use.

- Do not sterilize sensors or patient cables by irradiation, steam, or ethylene oxide.

- Clean the surface of the probe before and after each patient use.

- Allow sensor and cable to dry completely after cleaning. Moisture and dirt on the connector can affect the measurement accuracy.

- If a probe is damaged in any way, discontinue use immediately.

- Inaccurate SpO₂ data can result if a sensor is past its useful life. Therefore, re-evaluate the measurement periodically by performing additional assessment of the patient and equipment, including consideration of use of alternate monitoring methods such as direct measurement of arterial oxyhemoglobin saturation (SaO₂).

- A damaged sensor may cause burns during electrosurgery.

WARNING**PATIENT SAFETY.**

Oximetry performance may be impaired when patient perfusion is low or signal attenuation is high. Always keep the patient under close observation.

WARNING**INACCURATE RESULTS.**

The display of inaccurate pulse oximetry (SpO₂) values has been linked to the presence of poor signal strength or artifact due to patient motion during signal analysis. This condition is most likely to be encountered when the device is used on neonates or infants. These same conditions in adults do not impact the SpO₂ values to the same extent.

We recommend the application of the following criteria when using the pulse oximetry function on neonates and infants:

The peripheral pulse rate (PPR) as determined by the SpO₂ function must be within 10% of the heart rate, and

The SpO₂ signal strength should be adequate. This is indicated by the display of two or three asterisks or the absence of the **Low signal quality** message.

Procedures or devices previously applied in your facility for SpO₂ monitoring should be used in the event the SpO₂ value from the device cannot be validated by the above criteria.

WARNING**ERRONEOUS READINGS.**

Interference may occur when the working SpO₂ sensor close to gesture sensor area, leading to low quality of SpO₂ waveform and signal. Do not allow the working SpO₂ sensor close to gesture sensor area.

WARNING**ERRONEOUS READINGS.**

Many factors may cause inaccurate readings and alarms, decreased perfusion, and or low signal strength:

Interfering substances:

Carboxyhemoglobin may erroneously increase SpO₂ reading.

Methemoglobin (MetHb) usually represents less than 1% of the total Hb, but in the case of methemoglobinemia that can be congenital or induced by some IV dyes, antibiotics (such as sulphas), inhaled gases, etc., this level increases sharply and thus can cause inaccuracies in the SpO₂ reading.

Intravascular dyes (such as indocyanine green, methylene blue, etc.)

Physiological characteristics:

Cardiac arrest

Hypotension

Shock

Severe vasoconstriction

Severe anemia

Hypothermia

Venous pulsations

Darkly pigmented skin

Ventricular septal defects (VSDs)

Nail polish or artificial nails at the measurement site

Environmental conditions:

Electromagnetic interference

Excessive ambient light

Electrical interference

Electrosurgery

Defibrillation - may cause inaccurate reading for a short amount of time.

Excessive patient/sensor motion. Artifact can simulate an SpO₂ reading, so that the device fails to sound an alarm. In order to ensure reliable patient monitoring, the proper application of the probe and the signal quality must be checked at regular intervals.

Sensor placement:

Incorrect sensor placement - prolonged monitoring or incorrect sensor application can cause skin irritation or impaired circulation. It is recommended that you check the probe site every four hours (more frequently for poor perfusion or for neonates). Refer to the instructions supplied with the sensor.

Sensor placement on the same extremity as a blood pressure cuff, arterial catheter or intravascular line; or arterial occlusion proximal to the sensor.

Poor sensor fit or sensor applied too tightly.
Do not allow tape to block the sensor light emitter and detector.
Improper connection to the device or interconnect cable.
Contamination of lenses inside the sensor.

WARNING

FAILURE TO DETECT LETHAL ARRHYTHMIA.

Always monitor ECG for arrhythmia detection purposes. HR calculated from pulsatile SpO₂ waveform may differ significantly from ECG HR measured values. Users should be aware that the **SpO2 probe off** and **No SpO2 pulse** alarms escalate no higher than a Medium priority.

WARNING

FAILURE TO DETECT LETHAL ARRHYTHMIA.

The SpO₂ parameter pulsatile heart rate measurement is based on the optical detection of a peripheral flow pulse and therefore may not detect certain arrhythmias. The pulse oximetry parameter should not be used as a replacement or substitute for ECG based arrhythmia analysis.

WARNING

PATIENT SAFETY.

Using the **Maximum** sensitivity setting can reduce the **SpO2 probe off** detection alarm. It is recommended to use the **Maximum** sensitivity setting in care areas where the application site is inspected frequently to ensure patient safety. (Available when monitoring SpO₂ with Masimo SET technology.)

WARNING

PATIENT SAFETY.

With deactivated **SpO2 probe off** alarm, keep the patient under close surveillance.

WARNING

MISSED ALARM.

Check the SpO₂ measurement when switching the SpO₂ measurement sources to avoid missed SpO₂ alarms.

WARNING

SKIN IRRITATION.

Prolonged monitoring or incorrect sensor application can cause skin irritation or impaired circulation. It is recommended that you check the probe site every four hours (more frequently in case of poor perfusion or neonatal patients). Refer to the instructions supplied with the sensor.

SpO₂ cautions

CAUTION

BURNS.

A damaged sensor or a sensor soaked in liquid may cause burns during electrosurgery. To avoid this risk, always ensure that the sensor is undamaged and dry.

Masimo warnings

WARNING

As with all medical equipment, carefully route patient cabling to reduce the possibility of patient entanglement or strangulation.

WARNING

Do not place the pulse co-oximeter or accessories in any position that might cause it to fall on the patient.

WARNING

Do not start or operate the pulse co-oximeter unless the setup was verified to be correct.

WARNING

Do not use the pulse co-oximeter during magnetic resonance imaging (MRI) or in an MRI environment.

WARNING

Do not use the pulse co-oximeter if it appears or is suspected to be damaged.

WARNING

EXPLOSION HAZARD.

Do not use the pulse co-oximeter in the presence of flammable anesthetics or other flammable substance in combination with air, oxygen-enriched environments, or nitrous oxide.

WARNING

To ensure safety, avoid stacking multiple devices or placing anything on the device during operation.

WARNING

To protect against injury, follow the directions below:

- Avoid placing the device on surfaces with visible liquid spills.
- Do not soak or immerse the device in liquids.
- Do not attempt to sterilize the device.
- Use cleaning solutions only as instructed in this operator's manual.
- Do not attempt to clean the device while monitoring a patient.

WARNING

To protect from electric shock, always remove the sensor and completely disconnect the pulse co-oximeter before bathing the patient.

WARNING

If any measurement seems questionable, first check the patient's vital signs by alternate means and then check the pulse co-oximeter for proper functioning.

WARNING

Inaccurate SpO₂ readings may be caused by:

- Improper sensor application and replacement
- Elevated levels of COHb or MetHb: High levels of COHb or MetHb may occur with a seemingly normal SpO₂. When elevated levels of COHb or MetHb are suspected, laboratory analysis (CO-Oximetry) of a blood sample should be performed.
- Elevated levels of bilirubin
- Elevated levels of dyshemoglobin
- Vasospastic disease, such as Raynaud's, and peripheral vascular disease
- Hypocapnic or hypercapnic conditions
- Severe anemia
- Very low arterial perfusion
- Extreme motion artifact
- Abnormal venous pulsation or venous constriction
- Severe vasoconstriction or hypothermia
- Arterial catheters and intra-aortic balloon
- Intravascular dyes, such as indocyanine green or methylene blue
- Externally applied coloring and texture, such as nail polish, acrylic nails, glitter, etc.
- Birthmark(s), tattoos, skin discolorations, moisture on skin, deformed or abnormal fingers, etc.
- Skin color disorders

WARNING**INTERFERING SUBSTANCES.**

Dyes or any substance containing dyes that change usual blood pigmentation may cause erroneous readings.

WARNING

The pulse co-oximeter should not be used as the sole basis for diagnosis or therapy decisions. It must be used in conjunction with clinical signs and symptoms.

WARNING

The pulse co-oximeter is not an apnea monitor.

WARNING

The pulse co-oximeter may be used during defibrillation, but this may affect the accuracy or availability of the parameters and measurements.

WARNING

The pulse co-oximeter may be used during electrocautery, but this may affect the accuracy or availability of the parameters and measurements.

WARNING

The pulse co-oximeter should not be used for arrhythmia analysis.

WARNING

SpO₂ is empirically calibrated in healthy adult volunteers with normal levels of carboxyhemoglobin (COHb) and methemoglobin (MetHb).

WARNING

Do not adjust, repair, open, disassemble, or modify the pulse co-oximeter or accessories. Injury to personnel or equipment damage could occur. Return the pulse co-oximeter for servicing if necessary.

WARNING

Optical, pleth-based measurements (e.g. SpO₂) can be affected by the following:

Improper sensor application or use of incorrect sensor.

Blood pressure cuff applied to the same arm as the sensor site.

Intravascular dyes such as indocyanine green or methylene blue.

Venous congestion.

Abnormal venous pulsations (e.g. tricuspid valve regurgitation, Trendelenburg position).

Abnormal pulse rhythms due to physiological conditions or induced through external factors (e.g. cardiac arrhythmias, intra-aortic balloon, etc.).

Externally applied coloring and texture such as nail polish, acrylic nails, glitter, etc.

Moisture, birthmarks, skin discoloration, nail aberration, deformed fingers, or foreign objects in the light path.

Elevated levels of bilirubin.

Physiological conditions that can significantly shift the oxygen disassociation curve.

A physiological condition that may affect vasomotor tone or changes in vasomotor tone.

Masimo cautions

CAUTION

Do not place the pulse co-oximeter where the controls can be changed by the patient.

CAUTION

Electrical shock and flammability hazard: Before cleaning, always turn off the device and disconnect from any power source.

CAUTION

When patients are undergoing photodynamic therapy they may be sensitive to light sources. Pulse oximetry may be used only under careful clinical supervision for short time periods to minimize interference with photodynamic therapy.

CAUTION

Do not place the pulse co-oximeter on electrical equipment that may affect the device, preventing it from working properly.

CAUTION

If SpO₂ values indicate hypoxemia, a laboratory blood sample should be taken to confirm the patient's condition.

CAUTION

If the Low Perfusion message is frequently displayed, find a better perfused monitoring site. In the interim, assess the patient and, if indicated, verify oxygenation status through other means.

CAUTION

Change the application site or replace the sensor and/or patient cable when a "Replace sensor" and/or "Replace patient cable", or a persistent poor signal quality message (such as "Low SIQ") is displayed on the host monitor. These messages may indicate that patient monitoring time is exhausted on the patient cable or sensor.

CAUTION

If using pulse oximetry during full body irradiation, keep the sensor out of the radiation field. If the sensor is exposed to the radiation, the reading might be inaccurate or the device might read zero for the duration of the active irradiation period.

CAUTION

The device must be configured to match your local power line frequency to allow for the cancellation of noise introduced by fluorescent lights and other sources.

CAUTION

To ensure that alarm limits are appropriate for the patient being monitored, check the limits each time the pulse co-oximeter is used.

CAUTION

Variation in hemoglobin measurements may be profound and may be affected by sampling technique as well as the patient's physiological conditions. Any results exhibiting inconsistency with the patient's clinical status should be repeated and/or supplemented with additional test data. Blood samples should be analyzed by laboratory devices prior to clinical decision making to completely understand the patient's condition.

CAUTION

Do not submerge the pulse co-oximeter in any cleaning solution or attempt to sterilize by autoclave, irradiation, steam, gas, ethylene oxide or any other method. This will seriously damage the pulse co-oximeter.

CAUTION**ELECTRICAL SHOCK HAZARD.**

Carry out periodic tests to verify that leakage currents of patient-applied circuits and the system are within acceptable limits as specified by the applicable safety standards. The summation of leakage currents must be checked and in compliance with IEC 60601-1 and UL60601-1. The system leakage current must be checked when connecting external equipment to the system. When an event such as a component drop of approximately 1 meter or greater or a spillage of blood or other liquids occurs, retest before further use. Injury to personnel could occur.

CAUTION**DISPOSAL OF PRODUCT.**

Comply with local laws in the disposal of the device and/or its accessories.

CAUTION

To minimize radio interference, other electrical equipment that emits radio frequency transmissions should not be in close proximity to the pulse co-oximeter.

CAUTION

Replace the cable or sensor when a replace sensor or when a low SIQ message is consistently displayed while monitoring consecutive patients after completing troubleshooting steps listed in this manual.

SpO₂ measurement description

Pulse oximetry (SpO₂) is a non-invasive method used for monitoring tissue oxygenation. The measurement method is based on the absorption of red and infrared light in pulsating arterial blood. The ratio of oxygen carrying hemoglobin (HbO₂) to the total amount of hemoglobin capable of transporting oxygen (HbO₂ + Hb) is called functional oxygen saturation of arterial blood (SaO₂). GE HealthCare pulse oximetry is calibrated to display functional oxygen saturation.

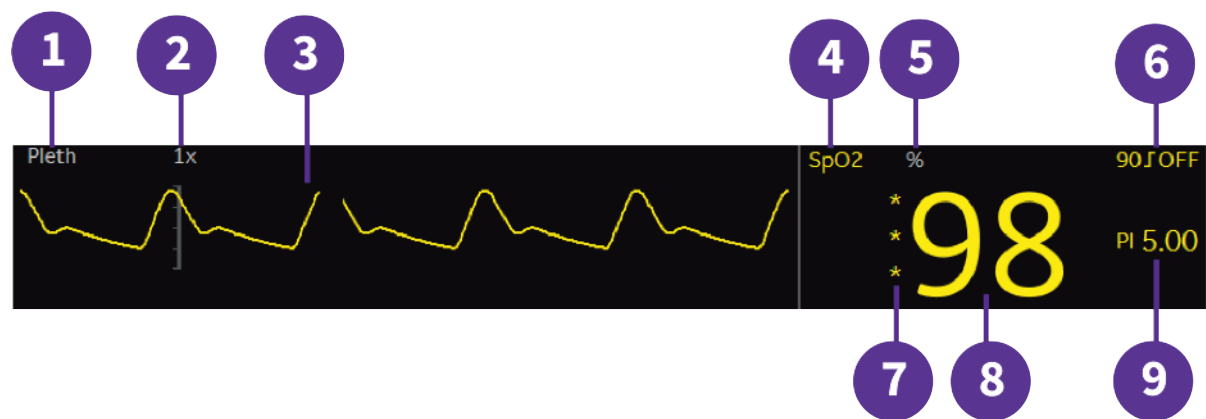
The actual measurement of arterial oxygen saturation is performed by spectrophotometry, a technique that quantifies the amount of transmitted light. A beam of light is passed through a monitored site of pulsating arterial blood. A pulse oximeter emits red and infrared light through its LEDs and measures the relative absorption of red and infrared light. Because HbO₂ and Hb absorb different amounts of light at each of these wavelengths, the oximeter can compare the ratio of each absorbance and convert it into an SpO₂ value.

Plethysmographic pulse waveform is derived from the infrared signal. It reflects the blood pulsation at the measuring site, and the amplitude of the waveform represents perfusion. Peak detection of the plethysmographic pulse wave is used for calculating pulse rate.

There are 3 supported pulse oximetry technologies:

- TruSignal
- Masimo SET
- Nellcor OxiMax

SpO₂ measurement displayed on the device screen



1.	Pleth (Pleth): waveform label	2.	Waveform scale
3.	Pleth waveform	4.	SpO ₂ (SpO2): parameter label
5.	SpO ₂ unit	6.	SpO ₂ alarm limits, alarm status, or other messages
7.	SpO ₂ signal strength indicator.	8.	SpO ₂ value
9.	PI (PI): Perfusion Index value (not for Nellcor Oximax technology).		

SpO₂ measurement limitations

- The pulse oximeter cannot distinguish between oxyhemoglobin and dyshemoglobins.
- Poor perfusion may affect the accuracy of measurement, especially when using an ear sensor.
- To avoid erroneous measurements, do not use a blood pressure cuff on the same limb as the SpO₂ sensor.
- There are several factors that may cause inaccurate readings and alarms. Familiarize yourself with the SpO₂ safety precautions so that you are aware of these factors and can take them into consideration.
- The device supports only one SpO₂ technology at a time for measuring the patient's oxygen saturation.

SpO₂ points to note

- This equipment is suitable for use in the presence of electrosurgery, as tested according to IEC 80601-2-49 clause 202.8.102 Disturbances from HF Surgical Equipment.
- For information on materials used in accessories and their biocompatibility, refer to the instructions for use in the accessory package.
- Defibrillator discharge may affect the SpO₂ measurement. Defibrillation recovery time after discharge is ≤ 15 seconds.
- For more detailed information regarding sensor accuracies, refer to the supplemental analysis graphs provided.

- Use dry and clean sensors only.
- Do not use damaged sensors.
- Check that you are not re-using a disposable sensor or other disposable accessories.
- Refer to the sensor instructions for use for the recommended maximum application times for different sensor types.
- Always check the patient and the sensor site if the accuracy of the SpO₂ values is questionable.
- Depending on the SpO₂ technology used, not all SpO₂ measurements and settings are available to view or change.
- There are three supported pulse oximetry technologies:
 - TruSignal
 - Masimo SET
 - Nellcor OxiMax
- With Nellcor™ sensors with OxiMax™ technology and Masimo SET technology, the pulse oximetry waveform is a normalized waveform. It is not normalized with TruSignal technology. TruSignal technology provides the actual IrMod% values.

Masimo points to note

- A functional tester cannot be used to assess the accuracy of the pulse co-oximeter.
- High-intensity extreme lights (such as pulsating strobe lights) directed on the sensor may not allow the pulse co-oximeter to obtain vital sign readings.
- When using the Maximum Sensitivity setting, performance of the "Sensor Off" detection may be compromised. If the device is in this setting and the sensor becomes dislodged from the patient, the potential for false readings may occur due to environmental "noise" such as light, vibration, and excessive air movement.
- Do not loop the patient cabling into a tight coil or wrap around the device, as this can damage the patient cabling.
- Additional information specific to the Masimo sensors compatible with the pulse oximeter, including information about parameter/measurement performance during motion and low perfusion, may be found in the sensor's directions for use (DFU).
- Cables and sensors are provided with X-Cal™ technology to minimize the risk of inaccurate readings and unanticipated loss of patient monitoring. Refer to the Cable or Sensor DFU for the specified duration of the patient monitoring time.
- Physiological conditions that result in loss of pulsatile signal may result in no SpO₂ readings.

SpO₂ measurement guidelines

TruSignal technology and sensor measurement guidelines

The following measurement guidelines apply to TruSignal SpO₂ technology:

- The time period for acquiring a measurement average is adjustable.

- The SpO₂ waveform corresponds to (but is not proportional to) the arterial pressure waveform.
- Only TruSignal sensors are supported.
- Use the following guidelines when using TruSignal sensors and cables:
 - Read the sensor instructions for use of the SpO₂ sensor before using it.
 - Periodically inspect extension cables and sensors for damage.
 - Do not use damaged sensors.
 - Refer to the cleaning instructions in the instructions for use of reusable TruSignal sensors.
 - Do not use NIBP or constricting instruments on the same appendage as the SpO₂ sensor.

Masimo SET technology and sensor measurement guidelines

With motion, the plethysmographic waveform (or SpO₂ waveform) is often distorted and may be obscured by the artifact. With Masimo SET technology, the plethysmographic waveform is not an indication of signal quality or validity. Even with a waveform obscured by artifact, Masimo SET technology is able to read through the noise and locate the arterial pulsation.

Although Masimo SET technology processes SpO₂ measurements differently than other SpO₂ technologies, the function and appearance is essentially the same as other technologies. The following measurement guidelines apply to Masimo SET technology only:

- The time period for acquiring a measurement average is adjustable.
- Only Masimo RD SET and LNCS sensors are supported. Masimo RD SET or LNCS sensors non-invasively measure pulse rate and the amount of oxygenated hemoglobin. Use the following guidelines when using Masimo RD SET or LNCS sensors:
 - Read the sensor directions before use.
 - Only use sensors with Masimo SET technology.
 - Do not use damaged sensors.
 - Do not use a sensor with exposed optical components.
 - Refer to the cleaning instructions in the directions for use for reusable Masimo RD SET or LNCS sensors.

Additional information for Masimo technology

NO IMPLIED LICENSE: Possession or purchase of this device does not convey any express or implied license to use the device with unauthorized replacement parts which would, alone, or in combination with this device, fall within the scope of one or more of the patents relating to this device. Sensors that are designated for single use are licensed for use on a single patient only, and are not sold. There is no license, implied or otherwise, that would allow use of single-use Masimo sensors beyond their intended single use. After use of single-use Masimo sensors, the license is exhausted, there is no further license granted by Masimo, and they must be discarded.

This device is covered under one or more patents as set forth at <https://www.masimo.com/company/masimo/patents/>.

Masimo SET SpO₂ technology is designed to be used with Masimo Sensors only. Use of sensors other than Masimo Sensors may yield unreliable results. We recommend the use of Masimo SET sensors for use with Masimo technology.

Nellcor OxiMax technology and sensor measurement guidelines

The following measurement guidelines apply to Nellcor OxiMax:

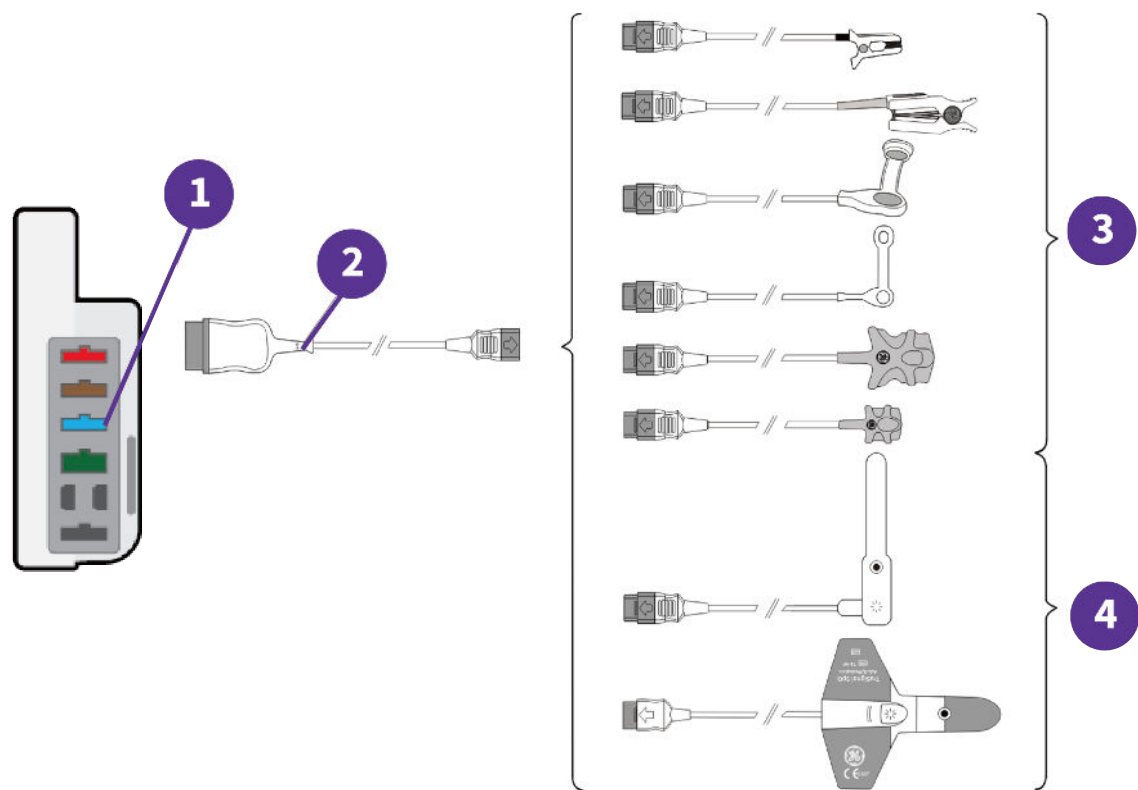
- The SpO₂ waveform corresponds to (but is not proportional to) the arterial pressure waveform.
- Only Nellcor OxiMax sensors are supported. Use the following guidelines when using OxiMax SpO₂ accessories and sensors:
 - Periodically inspect extension cables and sensors for damage and discontinue use if damage is found.
 - Do not immerse sensors.
 - Do not use NIBP or constricting instruments on the same appendage as the SpO₂ sensor.

Additional information for Medtronic technology

NOTICE: Purchase of this instrument confers no express or implied license under any Medtronic patent to use this instrument with any oximetry, level of consciousness, regional oxygen saturation, respiration rate, or other Sensor that is not manufactured or licensed by Medtronic.

SpO₂ measurement setup

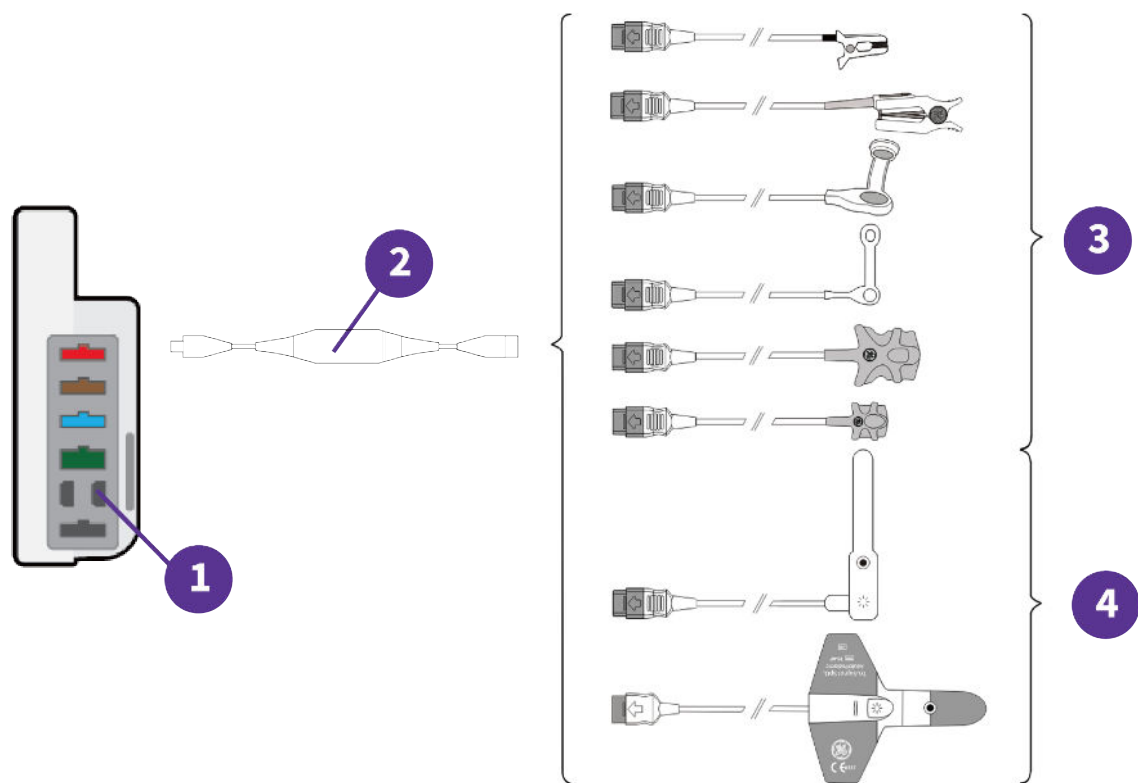
SpO₂ equipment to patient connection with device



1.	The SpO ₂ connector	2.	Interconnect cable
3.	Reusable sensors	4.	Disposable sensors

SpO₂ equipment to patient connection with micro-module

The micro-module can be connected to either Hub or Dock. The following illustration shows the locations of micro-module connectors on Hub. For information about locations of micro-module connectors on Dock, refer to [Left side view of Dock on page 67](#).



1.	The micro-module connectors	2.	Masimo SpO ₂ micro-module or Nellcor SpO ₂ micro-module
3.	Reusable sensors	4.	Disposable sensors

Preparing the SpO₂ connection

1. Connect the adapter cable to device.
2. Clean the surface of reusable sensors.
3. Prepare the application site.
4. Remove nail polish and earrings of patient if needed.
5. Follow the sensor manufacturer's instructions to position the sensor.
6. Attach the sensor to the patient.
7. Stabilize the sensor cable to minimize sensor movement.

Checking the SpO₂ measurement

1. Check that the red light is lit on the sensor.
2. Check that the waveforms and parameter values are displayed when the sensor is connected to the patient.

SpO₂ functional testers

You can verify the functionality of the pulse oximeter sensor and device with a SpO₂ functional tester but you cannot evaluate their accuracy with such a device. For more information, refer to the standard ISO 80601-2-61 Annex FF (Simulators, calibrators and functional testers for pulse oximeter equipment).

Using the SpO₂ measurement

Setup the parameter to normal screen if needed. Select  >  **Screen Setup**, and select the required screen.

Then connect the SpO₂ cable to device, otherwise the SpO₂ measurement does not display on the main screen.

Changing the SpO₂ waveform scale

1. Select the SpO₂ digit field.
2. Select the scale from the **Pleth Scale** list:
 - For TruSignal technology and sensor, the options are:
 - **AUTO**: The scale is automatically selected according to the IrMod % (infrared modulation percentage) received from the measurement source.
 - Other scale options are **2**, **5**, **10**, **20**, or **50**.
 - For Masimo or Nellcor technology and sensor, the options are: **1x**, **2x**, **4x**, or **8x**.

Selecting the SpO₂ response time

NOTE

For TruSignal and Nellcor technology and sensors only.

You can select the response (averaging) time. **Normal** (default) is the recommended setting.

1. Select the SpO₂ digit field.
2. Select the average time from **SpO₂ Response** list. Choices are:
 - **Normal**
 - **Fast**

Selecting the Masimo SpO₂ averaging time

NOTE

Masimo technology and Masimo sensors only.

You can have an average of the SpO₂ measurement on screen instead of the beat to beat values, and you can select how many seconds are used for this averaging: **2s**, **4s**, **8s**, **10s**, **12s**, **14s**, or **16s**.

1. Select the SpO₂ digit field.
2. Select the number of seconds from the **Averaging** list.

Selecting the Masimo SpO₂ sensor sensitivity level

NOTE

Masimo technology and Masimo sensors only.

1. Select the SpO₂ digit field.
2. Select the appropriate option from the **Sensitivity** list:
 - Use the **Normal** sensitivity setting for normal patient monitoring purposes.
 - Use the **Maximum** sensitivity setting for improved poor perfusion performance and for faster tracking of rapid SpO₂ saturation changes.

Using the **Maximum** sensitivity setting delays the **Probe off** detection alarm.

- Use the **APOD** (Adaptive Probe Off Detection) sensitivity settings for better probe off detection.

Additional Masimo parameter

Perfusion index measurement

NOTE

Masimo rainbow SET technology and Masimo sensors only.

The perfusion index (Pi) indicates the strength of the arterial pulse signal. The value is calculated by comparing the arterial pulsatile signal to the non-pulsatile signal and is displayed as a percentage.

Clinicians can use the Pi value:

- to find the optimal measurement site for the SpO₂ sensor. The higher the Pi value, the stronger the pleth signal and more consistent the measurement.
- to troubleshoot problems related to SpO₂ measurement. If SpO₂ measurement values are questionable, the Pi can help determine if this is caused by low perfusion and/or a low signal.

In addition, changes in perfusion may indicate important changes in the patient's physiological status.

Selecting the Pi averaging time

You can select the Pi averaging time according to your care environment needs. For example, a shorter averaging time may be more suitable for trauma patients.

1. Select the SpO₂ digit field.
2. Select the appropriate option in the **PI Averaging** list:
 - **Short**
 - **Long**

Setting the SpO₂ to show PI

NOTE

For TruSignal and Masimo technology and sensors only.

PI (Perfusion Index) is a relative assessment of the pulse strength at the monitoring site.

PI clinical practicalities:

- During sensor placement, use PI to quickly evaluate the appropriateness of an application site, looking for the site with the highest PI number.
- Placing the sensor at the site with the strongest pulse amplitude (highest PI number) improves performance during motion. Monitor the trend of the PI for changes in physiologic conditions.
- Changes in sympathetic nervous tone affect smooth muscle tone, thereby altering levels of perfusion.

1. Select the SpO₂ digit field.
2. Select **ON** or **OFF** from the **Show PI** list.

The larger the PI value, the stronger the strength.

Selecting the SpO₂ as the primary heart rate source

The primary heart rate can be calculated from the ECG leads, SpO₂ measurement, or invasive pressure waveform.

NOTE

This setting adjusts the primary heart rate source for all of the hemodynamic parameters.

1. Select the SpO₂ digit field.
2. Select the heart rate source from the **Primary HR Source** list.

Adjusting the SpO₂ pulse beep tone volume

When the Primary HR Source is SpO₂, a variable beat tone can be set to affect the pitch of the heart rate beep tone. When turned on, the heart rate beep pitch changes according to increasing and decreasing SpO₂ values. Higher SpO₂ saturation values have a higher pitch beep tone, and lower values have a lower pitch.

1. Select the SpO₂ digit field.
2. Adjust the volume with the **Beat Volume** arrows.

Configurable SpO₂ alarm delays

You can check the delays by selecting the SpO₂ digit field > **Alarms** tab.

Alarm delays for **SpO2 High** and **SpO2 Low** are configurable from 0 to 15 seconds in increments of 5 seconds. The delay is set through **Alarm Options** > **Alarm Delays** and it is password protected.

For more information, see the supplemental information provided.

Setting the SpO₂ alarm limits

1. Select the SpO₂ digit field.
2. Select the **Alarms** tab.
3. Check that the **Alarm** of SpO₂ and SpO₂ Critical is turned on.

4. Adjust the alarm limits of SpO₂ and SpO₂ Critical with the arrows.

NOTE

If you want the alarm turn off, select from the **Alarm** list.

Stopping the SpO₂ measurement

1. Remove the SpO₂ sensor from the patient.
2. Disconnect the sensor from the sensor cable.
3. Disconnect the sensor cable from the device.
4. Select  to acknowledge the **SpO2 probe off** alarm.
5. Discard single-use sensors.
 - Always disconnect the sensor from the cable before repositioning the sensor. Reconnect the cable to the sensor after the sensor has been repositioned.
 - Use only sensors and cables listed in the Supplies and accessories.

How to interpret the SpO₂ values

SpO₂ signal strength

For TruSignal technology and Nellcor™ sensors with OxiMax™ technology, signal strength is indicated with asterisks in the parameter window. The signal strength indicator refers to the amplitude of the plethysmographic waveform, not the quality of the waveform. Three asterisks indicate strong pulsation.

For Masimo technology, the signal strength indicator refers to Masimo's proprietary measurement, Signal Identification and Quality (Signal IQ) indicator. The Signal IQ provides an indicator of the assessment of the confidence in the displayed SpO₂ value.

SpO₂ waveform quality

NOTE

Not for Masimo SET technology.

Under normal conditions, the SpO₂ waveform corresponds to (but is not proportional to) the arterial pressure waveform. The typical SpO₂ waveform can help the user find a sensor location with the fewest noise spikes.



Normal waveform

If noise (artifact) is seen on the waveform because of poor sensor placement, the photodetector may not be flush with the tissue. Check that the sensor is secured and the tissue sample is not too thick.

Pulse rate is determined from the SpO₂ waveform, which can be disrupted by hemodynamic pressure disturbances. Motion at the sensor site is indicated by noise spikes in the normal waveform.



Abnormal waveform

SpO₂ waveform stability

The stability of the displayed SpO₂ values can also be used as an indication of signal validity. To aid you in successful SpO₂ monitoring, messages are provided in the SpO₂ digit field.

SpO₂ wavelengths and optical output power

Masimo SET pulse oximetry and Nellcor™ sensors with OxiMax™ technology are calibrated to display functional saturation.

This information may be useful to clinicians such as those performing photodynamic therapy:

- Nellcor sensors with OxiMax technology contain LEDs that emit red light at a wavelength of approximately 660 nm and infrared light at a wavelength of approximately 900 nm. The total optical output power of the sensor LEDs is less than 15 mW.
- Masimo SET pulse oximetry sensors contain LEDs that emit red light at a wavelength of approximately 660 nm and infrared light at a wavelength of approximately 905 nm for RD SET, M-LNCS, or LNCS, and approximately 653 nm and 880 nm for RD SET, M-LNCS, and LNCS tip clips. The total optical output power of the LEDs is less than or equal to 15 mW.

Masimo SET pulse oximetry sensors contain LEDs that emit red light at a wavelength of approximately 660 nm and infrared light at a wavelength of approximately 905 nm for RD SET or LNCS, and approximately 653 nm and 880 nm for RD SET and LNCS tip clips. The total optical output power of the LEDs is less than or equal to 15 mW.

SpO₂ measurement and interference

These types of interference can influence the function of SpO₂:

- Incorrect sensor application, e.g., sensor placement on an extremity with a blood pressure cuff, arterial catheter, or intravascular line, sensor applied too tightly.
- Intravascular dyes, such as indocyanine or methylene blue.
- Externally applied coloring agents with opaque materials in high ambient light conditions, e.g., conditions created from one or more of the following sources:
 - Surgical lights, especially xenon light sources
 - Bilirubin lamps
 - Fluorescent lights
 - Infrared heating lamps
 - Direct sunlight
- Excessive patient activity

- Venous pulsation
- Dysfunctional hemoglobin
- Poor (low) peripheral perfusion
- Arterial occlusion proximal to the sensor
- Loss of pulse (cardiac arrest)
- Electromagnetic interference (EMI)
- Ventilator-induced pressure change

Surgical pleth index

SPI safety precautions

SPI warnings

There are no SPI specific warnings other than those related to the SpO₂ measurement. Refer to the supplemental information provided for the allowed sensor types and modules for the SPI measurement.

SPI cautions

CAUTION

MISINTERPRETATION.

The SPI measurement is to be used as an adjunct to other physiological parameters to avoid possible misinterpretations.

CAUTION

MISINTERPRETATION.

The SPI reflects autonomic nervous system and cardiovascular activity. Any medication, treatment, stimuli, or action that affects either the autonomic nervous system or cardiovascular system or both, might also affect the SPI.

CAUTION

MISINTERPRETATION.

Any direct or indirect action of medication, treatment, stimuli or care that affects PR, amplitude of the plethysmogram (e.g., by vasoconstriction), or both, may also affect the SPI.

CAUTION

MISINTERPRETATION.

A change of SpO₂ sensor from one finger to another may affect the SPI reading.

SPI instruction

The Surgical Pleth Index (SPI) is a parameter to be used in conjunction with other vital signs and monitoring parameters in assessment of adult (≥ 18 years) patients during general anesthesia.

SPI is a non-invasive parameter derived from the pulse photoplethysmogram. By observing the SPI value and trend together with other monitoring parameters and past anesthetic events, SPI may help

the clinician to monitor the responses of an adult patient to surgical stimuli and analgesic medications during general anesthesia.

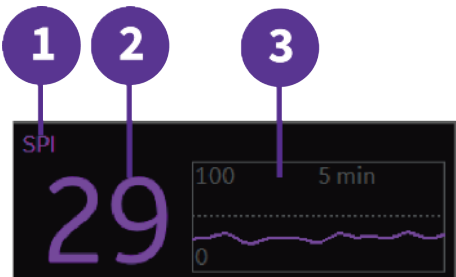
SPI measurement displayed on the device screen

NOTE
SPI is not displayed and AoA is not supported if the **Entropy & SPI** is set to disabled in the current mode. This setting is in the  >  **Service** menu (password protected). For more information, refer to the Service manual.

SPI does not have a menu of its own.

You can configure the SPI data to the Dock screen the same way as any other parameter data. Refer to the screen setup instructions.

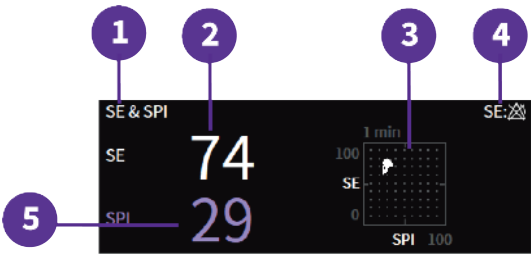
- Select the  >  **Screen Setup** > Dock screen > **Lower Area**, and select **SPI** from the lower field.



1.	SPI (SPI): parameter label
2.	SPI value
3.	SPI microtrend

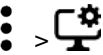
NOTE
The trend length is the same as that of Entropy, and it is set through the **Entropy** menu. If the digit field not have enough space, the microtrend will not display.

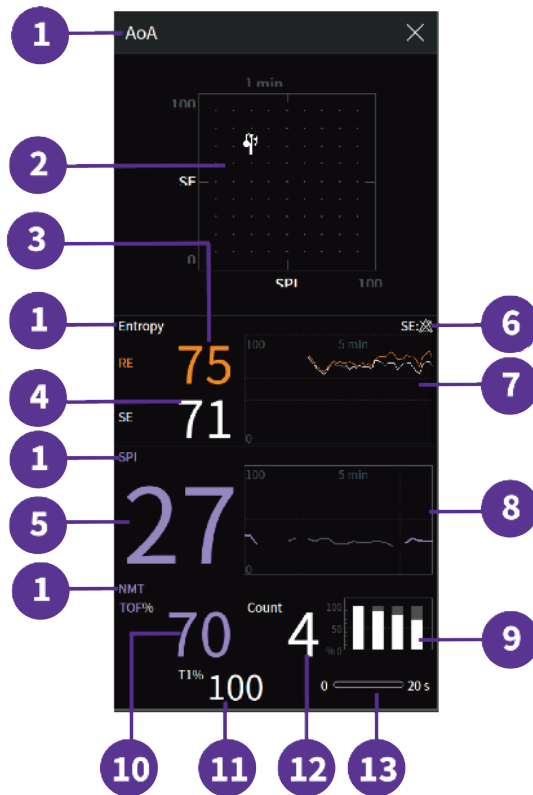
- Select the  >  **Screen Setup** > Dock screen > **Lower Area**, and select **SE & SPI** from the lower field.



1.	SE&SPI (SE & SPI): parameter label
2.	SE (SE): State Entropy value
3.	BalView, which is a view combining the SPI and SE values in an x-y graph
4.	SE alarm limits, alarm status or other messages
5.	SPI (SPI): SPI value

NOTE
If the digit field not have enough space, the BalView will not display.

- Select the  **Screen Setup** > Dock screen > **Side Pane**, and select **Split Screen** from the **Show** list, then you can select **AoA** from the **Split Screen 2**.



1.	AoA (AoA), Entropy (Entropy), SPI (SPI), NMT (NMT): parameter label
2.	BalView
3.	RE (RE): Response Entropy value
4.	SE (SE): State Entropy value
5.	SPI value
6.	SE alarm limits, alarm status or other messages
7.	Entropy microtrend
8.	SPI microtrend
9.	NMT response bar
10.	TOF% (TOF%): TOF value. Display different value according to your stimulus mode selection.
11.	T1% (T1%): T1 value
12.	Count (Count): Count value
13.	cycle time progress bar, or last manual measurement time

When you select the **SE** or **SE & SPI** digit field, the **Entropy** setup window opens. You can select the Entropy/SPI trend length in the **Entropy** setup window.

SPI measurement limitations

- The SPI measurement is only available on TruSignal SpO₂ sensor with SPI function.
- The SPI measurement is applied to unconscious and fully anesthetized adult (≥ 18 years) patients during general anesthesia.
- The SPI measurement is not available in NEONATAL mode.

SPI points to note

- This equipment is suitable for use in the presence of electrosurgery, as tested according to IEC 80601-2-49 clause 202.8.102 Disturbances from HF Surgical Equipment.
- For information on materials used in accessories and their biocompatibility, refer to the instructions for use in the accessory package.
- SPI is based on plethysmographic pulse amplitude and pulse interval. Any medication, treatment, stimuli, or action that may artificially affect a patient's heart rhythm, plethysmographic waveform pulse amplitude, or autonomic nervous system regulation may thus also affect the SPI.
 - Heart rhythm is influenced by factors such as anticholinergic and sympathomimetic drugs, arrhythmias, cardiac arrest, pacemaker rhythm.

- Plethysmographic pulse amplitude is influenced by factors such as vasoactive drugs, hypotension, severe hypovolemia, shock, severe hypothermia, severe cardiac arrhythmias, a change in the SpO₂ measurement site.
- Autonomic nervous regulation of the circulatory system is influenced by factors such as reflexes related to posture change, or autonomic neuropathy.
- Plethysmographic signal quality is influenced by factors such as electrical noise caused by electrosurgery or similar; mechanical movement of the SpO₂ sensor; defibrillation; defective, physically damaged, or poorly attached SpO₂ sensors or cables; NIBP cuff inflation or NMT measurement; excessive ambient light.
- Always relate SPI values to other monitored parameters, such as ECG, Entropy, blood pressure, body temperature, and capnogram.
- Physiological and technical limitations for the SpO₂ measurement may affect the SPI interpretation. For more details, refer to [SPI measurement limitations on page 198](#) and the instructions supplied with SpO₂ sensors.
- Upon placing the SpO₂ sensor on the patient's finger at the beginning of monitoring, or after removing the SpO₂ sensor from the finger for more than 30 seconds, the SPI algorithm performs scaling of the plethysmographic waveform pulse interval and pulse amplitude in order to decrease the interpatient variability in SPI. During the first two-minute initial scaling period, the message **Learning** is displayed and the SPI should not be used for clinical guidance during this time.
- The SPI measurement site must be a finger. Use only SpO₂ finger sensors. SPI has not been validated with ear or foot sensors. Refer to the Supplies and Accessories provided for the allowed sensor types.
- In case the reading seems incorrect, first assess the clinical status of the patient and consult the troubleshooting instruction and the list of messages.

Using the SPI measurement

Patient connections and preparing the patient

Patient connections and preparation are identical to those used in the SpO₂ measurement, but SPI can be measured using TruSignal SpO₂ finger sensors only.

Stopping the SPI and SpO₂ measurement

1. Remove the sensor from the patient.
2. Disconnect the sensor from the patient interface cable.
3. Discard the sensor (if not reusable).

Basics of SPI measurement

SPI clinical implications

SPI is a non-invasive parameter derived from plethysmogram, and it is suitable for use with adult patients. By observing the SPI value and the trend, the clinician can monitor an adult patient's responses to surgical stimuli and analgesic medications during general anesthesia.

SPI measurement description

The SPI incorporates two dimensions of the plethysmogram, the pulse amplitude and pulse interval. Both of these parameters show a patient's hemodynamic responses to surgical stimuli and analgesic medications.

These two parameters are available in the SpO₂ measurement. The SPI algorithm uses these finger pulse wave characteristics to create a single numerical value that correlates with the level of sympathetic activation. This means that the SPI value may be used to monitor the patient's responses to surgical stimuli and analgesic medications during general anesthesia. The degree of responses depends on the levels of surgical stimulation and analgesic medications.

The SPI algorithm uses pulse amplitude and the pulse interval values by normalizing the raw components (thereby considerably reducing the inter-patient variability) and then combining them in an optimal proportion.

Normalization

Clinical indexes are calculated on-line, as the actual patient reactions are taking place. In SPI measurement, the normalization of the individual patient data is based on adaptive histogram transformation. Using this principle, regardless of the original value, a normalized value is produced and distributed between 0 and 100%.

Normalization balances the responsiveness of the SPI, as well as discriminates typical high and low ranges for each patient. Normalization also addresses these factors:

- The normal heart rate range varies between individuals more than within a person.
- The plethysmographic pulse amplitude varies between patients and between sensor sites.
- The plethysmographic amplitude can be too responsive to stimuli.
- Some patients have reactive heart rates, while others have a reactive plethysmogram.

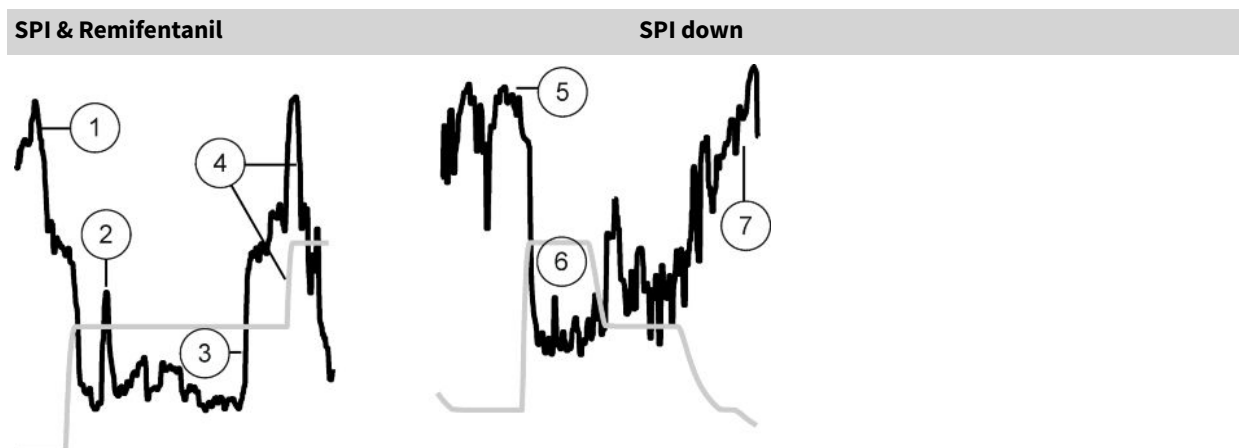
Learning

At the beginning of the measurement, and as needed later on, the algorithm starts to learn the patient's pulse rate and pulse amplitude. During this time of initialization, SPI numbers are shown in gray color and the message **Learning** is displayed. Due to this learning process, the SPI readings may be less accurate during the first two minutes. Learning is marked in the trend as dashed vertical line in SPI color.

How to interpret the SPI values

SPI in typical general anesthesia

In the figure below, black color = SPI, gray = Remifentanyl



1.	Patient awake, SPI not valid	2.	Intubation
3.	Incision	4.	Remifentanyl up, SPI down
5.	Inadequate analgesia	6.	Adequate analgesia
7.	Patient awake, SPI not valid		

When the SPI is high, surgical stimulation may be high or the level of analgesics is low. When the number is low, it may indicate that the level of stimulation has decreased or that the concentration of analgesics is adequate. Individual patients may show different base values and responsiveness to noxious stimuli as the individual sensitivity to both the stimulus and analgesic medication may vary.

Common surgical events

Laryngoscopy and intubation

Sudden reaction to laryngoscopy and intubation is common even in an anesthetized state. It is not necessarily a sign of inadequate anesthesia. The reaction of pulse wave amplitudes and pulse intervals (HR) is reflective in nature, and normally recovers quickly. The SPI, too, will react in relations to the pulse wave amplitude changes. Slow recovery of amplitude may indicate anesthesia that is too light, thus producing higher SPI values.

Skin incision

Skin incision is one of the strongest intraoperative stimuli. Skin incision may cause significant reduction of the pulse wave amplitude/pulse interval.

Maintenance phase

Changes in the intraoperative pulse wave amplitude/pulse interval will affect the SPI. If the intraoperative pulse wave amplitude:

- Remains low or frequently changes, it can be an indication of light anesthesia. This low pulse wave amplitude/pulse interval can produce a higher SPI value.
- Progressively, continuously decreases, it is usually due to discomfort, hypovolemia, hypothermia, or hyperventilation. This lowering pulse wave amplitude/pulse interval can produce a higher SPI value.

Changes in the pulse wave amplitude/pulse interval and their effect on SPI should always be considered together with other parameters in order to diagnose the real cause of any changes.

The end of anesthesia

Vasoconstriction is the expected reaction during this phase. As the patient awakens, the SPI is no longer valid since the parameter is indicated for anesthetized patients.

The waking of the patient can be seen in the SPI values as well as in the Entropy values.

Sensor removal

If the SpO₂ sensor is off of the patient for more than five minutes, the SPI measurement will start the learning process as if the case was just beginning. This is similar to ending a case situation.

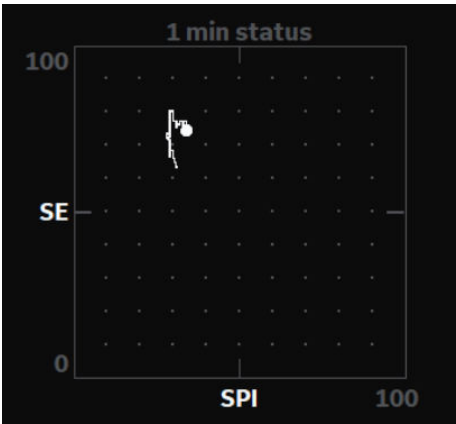
If the sensor's location is changed, the pulse amplitude may abruptly change. This may cause a large and persistent change in the SPI values. To facilitate the learning of new values in this case, the SPI tries to identify these types of changes by seeking periods with unavailable data that are followed by a change in the pulse amplitude.

SPI practicalities

AoA split screen and the BalView

The **AoA** (Adequacy of Anesthesia) split screen includes a view combining the SPI and State Entropy values in an x-y graph. This part of the **AoA** split screen is referred to as BalView. Note that you need an Entropy module for this view. The graph visualizes the combined effects of anesthetic and analgesic medications administered during general anesthesia.

The current SPI and SE values will appear as a dot, and there is a trace to show the trend for the last minute.



The AoA split screen shows:

- The current SPI and SE values as an SPI+SE dot
- The last minute SPI and SE (State Entropy, requires the E-ENTROPY module) values as a trend line
- The Entropy values and minitrend (with Entropy module)
- The SPI numeric value and minitrend
- NMT parameter window (with NMT module)

Observation	May indicate	Consider assessing
SPI ↓ and SE ↓	SPI: a low level of surgical stimulation or adequate analgesia SE: deep anesthesia, adequate anesthesia	• Other parameters
SPI ↓ and SE ↑	SPI: a low level of surgical stimulation SE: waking to awake	• Anesthetics • Other parameters
SPI ↑ and SE ↑	SPI: a high surgical stimulus response SE: waking to awake	• Analgesics • Anesthetics • Other parameters
SPI ↑ and SE ↓	SPI: a high surgical stimulus response SE: deep anesthesia, adequate anesthesia	• Analgesics • Other parameters

SPI and NIBP measurement

NIBP cuff inflation causes temporary blood flow occlusion distal to the measurement site. If an SpO₂ sensor is located distally to the NIBP cuff, this inflation will also cause a temporary interruption to blood flow at the SpO₂ sensor site. SpO₂, SPI, and plethysmogram measurements will be temporarily interrupted. To avoid this situation, it is suggested that you obtain NIBP measurements from another limb.

When the first NIBP measurement is made during a case, the device always performs a safety check. This means that the **NIBP cuff inflated** message will appear on the device screen. After the first NIBP measurement, the SPI algorithm checks for any disturbances in the plethysmogram during subsequent NIBP cuff inflations. If there are no variances detected, the **NIBP cuff inflated** message will appear only once. However, if there are any simultaneous disturbances in the plethysmogram

during NIBP inflation, the message will reappear. Situations that produce external artifact or sensor movement may cause the message to appear. The message will occur until there are no changes in the plethysmogram during NIBP cuff inflation. If, for any reason, the plethysmogram signal is disturbed during NIBP inflation (either coincidentally or because of same-limb measurement), the message will appear.

Physiological and technical issues affecting SPI

There are widely known physiological and technical limitations of pulse oximetry, and some of those that may affect the interpretation of the SPI are mentioned below.

Physiological issues

- Vasoconstriction and low pulse wave amplitude states
- Low perfusion states:
 - Cold extremities (hypothermia)
 - Blood loss (hypovolemia) or
 - Low blood pressure (hypotension)
- Venous congestion or pulsation

Technical issues

- Artifact
 - Any type of patient or clinician induced motion. This includes flexion, clenching, shivering, kicking, sensor/cable movement, or patient repositioning, etc.
- Electrosurgery, magnetic resonance imaging (MRI), or pulsatile interference from external devices
- Sensor selection/application
 - Patient's weight, sensor type (durable or adhesive), site location, sensor placement/displacement, finger circulation (sensor not too tight), correct sensor fit.

SPI calculations

Adaptive histogram transformation (scale of 0 to 100) from the pulse interval and plethysmogram's pulse amplitude (PGA) =

$$100 - 0.3 * \text{Pulse interval (with normalization)} - 0.7 * \text{PGA (with normalization)} = \text{SPI}$$

The SPI algorithm is published: Huiku M, Uutela K, van Gils M, Korhonen I, Kymäläinen M, Meriläinen P, Paloheimo M, Rantanen M, Takala P, Viertiö-Oja H, Yli-Hankala A. Assessment of surgical stress during general anaesthesia. (Br J Anaesth 2007; 98: 447-55).

Non-invasive blood pressure

NIBP safety precautions

NIBP warnings

WARNING

PATIENT SAFETY.

The NIBP parameter will not measure blood pressure effectively on patients who are experiencing seizures or tremors.

WARNING

PATIENT SAFETY.

Arrhythmias will increase the time required by the NIBP parameter to determine a blood pressure and may extend the time beyond the capabilities of the parameter.

WARNING

ERRONEOUS READINGS.

Do not apply external pressure against the cuff while monitoring. Doing so may cause inaccurate blood pressure values. Use care when placing the cuff on an extremity used to monitor other patient parameters.

WARNING

ERRONEOUS READINGS.

NIBP cuff inflation/deflation may lead to inaccurate values from other monitored patient parameters that are measured distally from the NIBP measurement site at the same extremity.

WARNING

PATIENT SAFETY.

Ensure that the connection tubing is not kinked. Kinked tubing may cause continuous cuff pressure, which can interfere with the blood flow and cause injury to the patient.

WARNING

PATIENT SAFETY.

Do not place the cuff on the arm on the side of a mastectomy as this may lead to injury or swelling of the arm due to cuff pressurization. To avoid this risk, use another limb if possible.

WARNING**PATIENT SAFETY.**

Do not place the cuff over a wound as this may cause further injury.

WARNING**ERRONEOUS READINGS.**

GE HealthCare NIBP devices are designed for use with dual-hose cuffs and tubing. The use of single-hose cuffs with dual hose tubing can result in unreliable and inaccurate NIBP data.

WARNING**PATIENT SAFETY.**

To prevent injury to the patient, do not place the cuff on a limb being used for A-V fistulas, intravenous infusion or on any area where circulation is compromised or has the potential to be compromised. To avoid this risk, use another limb if possible.

WARNING**ERRONEOUS READINGS.**

Accuracy of NIBP measurement depends on using a cuff of the proper size. It is essential to measure the circumference of the limb and choose the proper size cuff.

WARNING**NIBP READINGS MAY TIME OUT WHEN USING IABP.**

An IABP creates non-physiological arterial waveforms. These waveforms create an oscillometric signal that may not be interpreted by the NIBP algorithm, causing NIBP to time out. The patient blood pressure can be monitored from the balloon pump device.

WARNING**PATIENT SAFETY.**

The NIBP cuff size must be correctly selected in the NIBP Setup window to obtain reliable NIBP data and to prevent excessive cuff pressure during infant (neonate) or child (pediatric) use.

WARNING**PATIENT SAFETY.**

Always ensure that you are using NIBP neonatal settings when monitoring neonatal patients. Using other settings may lead to risks to the patient due to wrong alarm limits or cuff pressure, for example.

WARNING**ERRONEOUS READINGS.**

If a patient's beat-to-beat pulse amplitude varies significantly (e.g., because of pulsus alternans, atrial fibrillation, or the use of a rapid-cycling artificial ventilator), blood pressure and pulse rate readings can be erratic, and an alternate measuring method should be used for confirmation.

WARNING**INACCURATE READINGS.**

Effectiveness of the NIBP measurement has not been established in pregnant (including pre-eclamptic) patients.

WARNING**BURNS.**

When using an electrosurgery unit, note that the measurement cables do not incorporate means to protect against burns in case of a defective ESU return electrode. To avoid burns at the monitor measurement sites, ensure the following:

- Proper contact of the ESU return electrode to the patient.

- ESU return electrode near the operating area.

- Measurement electrodes, leadwires and probes far from the surgical site and the ESU return electrode.

WARNING**PATIENT SAFETY.**

Devices that exert pressure on tissue have been associated with purpura, skin avulsion, compartmental syndrome, ischemia, and/or neuropathy. To minimize these potential problems, especially when monitoring at frequent intervals or over extended periods of time, make sure the cuff is applied appropriately and examine the cuff site and the limb distal to the cuff regularly for signs of impeded blood flow. Periodically check patient limb circulation distal to the cuff. Check frequently when using auto NIBP in 1 and 2 minute intervals. The 1 and 2 minute intervals are not recommended for extended periods of time.

WARNING**ERRONEOUS READINGS.**

For SuperSTAT NIBP (Adult/Child) only. It takes one to three minutes for the NIBP parameter to identify an irregular rhythm after ECG is connected. For patients with irregular rhythms, wait three minutes after the ECG has been connected and the ECG heart rate is displayed on the screen before performing an NIBP determination.

NIBP cautions

CAUTION

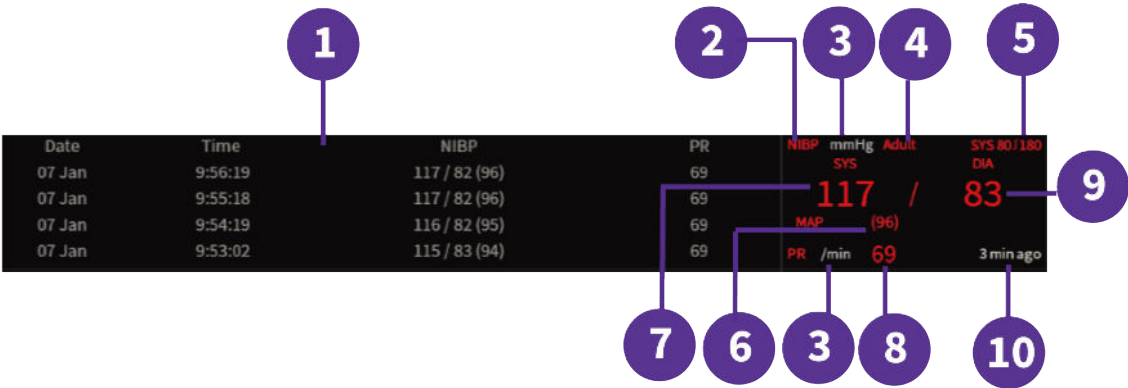
PATIENT SAFETY.

The device sets the inflation pressure automatically according to the previous measurement. Discharge patient to reset the inflation limits before measuring NIBP on a new patient.

NIBP instruction

Non-invasive blood pressure (NIBP) monitoring is an indirect measurement that reflects the force exerted by circulating blood on the walls of blood vessels. NIBP is one of the principal vital signs.

NIBP measurement displayed on the device screen



1.	The history items display in the waveform field, or in large number field. Date , Time (Time), NIBP (NIBP) value and PR (PR) value will be displayed.	2.	NIBP (NIBP): parameter label
3.	mmHg (mmHg), /min (/min): unit	4.	Adult, Child or Infant (Adult , Child or Infant): cuff type according to your selection
5.	Alarm limits, alarm status, or other messages	6.	MAP (MAP): Mean pressure
7.	SYS (SYS): Systolic pressure	8.	PR (PR): Pulse Rate
9.	DIA (DIA): Diastolic pressure	10.	x min ago (x x min ago): indicate how long time for the displayed value are. There is other display in different situation, more details see below instruction.

• **Single NIBP:**

- During measurement, the text **Manual** displays in the NIBP digit field.
- 1 minute after measurement, the text **x x min ago** displays in the NIBP digit field, indicate how long time for the displayed value are.

• **Automatic NIBP:**

During measurement, a time progress bar displays in the NIBP digit field:



- **Continuous for 5 Min:**
During 5 minutes continuous measurement, the text **STAT** displays in the NIBP digit field.
- **Stasis:**
During venous stasis mode, the text **Stasis** displays in the NIBP digit field. In the last 10 seconds, the **Stasis** text starts to flash indicating the device will return to the previously selected cycling interval or manual mode.

During cuff inflation and deflation phases, the cuff inflation pressure will be labeled as **Cuff** to display on digit field. Within a wide or large digit field, the value shows after MAP.

More than 60 minutes after previous measurement, the NIBP value will become gray.

More than 4 hours if no new NIBP data is received, the NIBP value will be replaced by “– – –”.

NIBP measurement limitations

- A patient's vital signs may vary dramatically during the use of cardiovascular agents such as those that raise or lower blood pressure or those that increase or decrease heart rate.
- Although automated NIBP is generally safe and accurate, it has some limitations. It may be difficult to obtain reliable readings under the following circumstances:
 - Shock accompanied by low blood pressure and pulse.
 - Variations in blood pressure and pulse rate.
 - In patients with anatomic abnormalities, such as calcified (hardened) arteries or subclavian compression.
 - Compression of the cuff caused by shivering, seizures, arm movement, or bumping against the cuff.
- Proper sizing and position of the cuff are essential for obtaining reliable readings:
 - Too large a cuff is better than too small a cuff, which may yield falsely high readings.
 - The cuff should also fit properly over the brachial artery (or whatever artery is being used) so that the cuff is sufficiently sensitive to vibrations in the artery.

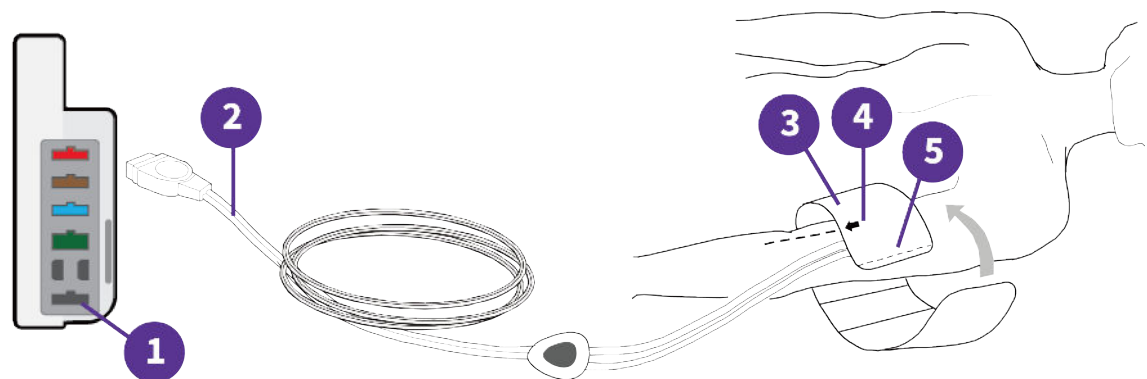
NIBP points to note

- This equipment is suitable for use in the presence of electrosurgery, as tested according to IEC 80601-2-49 clause 202.8.102 Disturbances from HF Surgical Equipment.
- For information on materials used in accessories and their biocompatibility, refer to the instructions for use in the accessory package.
- Blood pressure measurements determined with this device are equivalent to those obtained by an intra-arterial blood pressure measurement device, within the limits prescribed by the standard.
- Use the appropriate size NIBP cuff for the patient (adult, child, or infant).
- Operator position: Make sure you do not lean on the cuff or hoses, and do not disturb the patient in any way during measurement. Position yourself accordingly.
- The measurement site, patient's position (standing, sitting, lying down), exercise, or physiological condition can affect the NIBP readings.
- With mobile patients and when taking routine resting blood pressure, ensure that:
 - The patient is comfortably seated, with their legs uncrossed and feet flat on the floor.

- The patient’s arms and back are supported.
- The middle of the cuff is at the level of the right atrium of the patient’s heart.
- Also consider the following recommendations:
 - Allow 5 minutes to pass before taking the first measurement.
 - Ensure that the patient is relaxed and does not talk during the measurement.

NIBP measurement setup

NIBP equipment to patient connection



1.	The NIBP connector	2.	Cuff hose
3.	Cuff of correct size	4.	Brachial artery arrow (printed on cuff)
5.	Cuff index line (printed on cuff)		

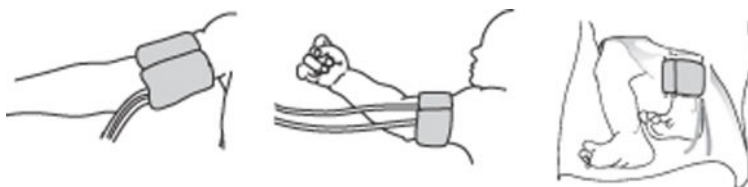
Preparing the NIBP patient connection

1. Select an appropriate NIBP cuff size for the patient.
2. Connect the NIBP cuff hose to the NIBP connector.
3. Position the NIBP cuff on the patient:
 - Place the cuff arrow over the brachial artery (or whatever artery is being used).
 - Make sure that the cuff index line falls within the range markings on the cuff.
 - Wrap the cuff around the limb.
4. Make sure that the NIBP cuff tubes are not kinked, compressed, or stretched.
5. Verify or select the correct **Cuff Size** from the NIBP menu.

NIBP cuffs

NIBP cuff selection and placement

Always choose the appropriate blood pressure measurement site. In adult and pediatric patients, the upper arm is preferred for convenience and because normative values are generally based on this site. When factors prohibit use of the upper arm, the clinician must plan patient care accordingly, taking into account the patient's cardiovascular status and the effect of an alternative site on blood pressure values, proper cuff size, and comfort.



Always measure the patient's limb and select appropriately sized cuff according to size marked on cuff or cuff packaging. When cuff sizes overlap for a specified circumference, choose the larger size cuff.

If patient is standing, sitting, or inclined, ensure that cuffed limb is supported to maintain the cuff at level of patient's heart. If the cuff is not at heart level, the difference in the measured pressure values due to hydrostatic effect must be considered.

Selecting NIBP cuff size

You must first select the NIBP cuff size before starting a NIBP measurement.

1. Select the NIBP digit field.
2. Select **Adult**, **Child** or **Infant** from the **Cuff Size** list.

NOTE

If the **Cuff Size** is set to **Not Selected**, when starting a NIBP measurement, this menu will pop up and require you to setup manually.

Initial NIBP cuff inflation pressure

The default value for initial NIBP cuff inflation pressure corresponds to **Cuff Size** selected. You can adjust the inflation pressure, if you do not wish to use the default value.

Table 7 Default inflation pressure

Cuff Size	Infl. Press.
Adult	135 mmHg (18 kPa)
Child	125 mmHg (16.6 kPa)
Infant	100mmHg (13.3 kPa)

Selecting the initial NIBP cuff inflation pressure

You can determine the cuff inflation pressure automatically based on the **Cuff Size**.

1. Select the NIBP digit field.
2. Enable the toggle **Auto Initial Inflate**.

Setting the target NIBP inflation pressure

You can manually change the target inflation pressure for the first NIBP measurement.

1. Select the NIBP digit field.
2. Check that the toggle **Auto Initial Inflate** is not enabled.
3. Set the value for **Infl. Press.** with arrows depending on the settings for the blood pressure unit.

Single NIBP measurements

Starting or stopping a single NIBP measurement from the NIBP menu

1. Select the NIBP digit field.
2. Start the measurement by selecting  **Start Single**.
3. Stop the measurement by selecting  **Stop**.

Starting or stopping a single NIBP measurement from the key

1. Start the measurement by pressing  from soft key on screen.
2. Stop the measurement by pressing  from soft key on screen.

Automatic NIBP measurements

Automatic NIBP mode

The Automatic NIBP mode initiates repeated measurements for the selected **Cycle Time**. There will be at least a 30 seconds' delay between two consecutive NIBP measurements during auto cycling.

Setting the cycle time between NIBP measurements

To automatically measure NIBP at set time intervals, you must first set the cycle time.

1. Select the NIBP digit field.
2. Select the cycle time from the **Cycle Time** list.

Setting the custom series for NIBP measurement

You can set a custom series for NIBP automatic measurement. NIBP has user-defined 1 to 4 series measurement modes. The measurement interval of each series is adjustable from 1 to 240 minutes. The repeat number of measurements is adjustable from continuous, and 1 to 25 times.

1. Select the NIBP digit field.
2. Select the **Custom Series** tab.
3. Select time interval from the list of **1st BP Series**, **2nd BP Series**, **3rd BP Series** or **4th BP Series**. Set up repeat times with the **Repeat** arrows.

To use the custom mode for NIBP automatic measurement, you should set **Cycle Time** to **Custom** in NIBP setup menu.

Starting or stopping an Auto NIBP measurement from the NIBP menu

1. Select the NIBP digit field.
2. Select  **Start Cycling** for **Automatic NIBP**.
3. Stop the measurement by selecting  **Stop Cycling**.

Continuous five-minute NIBP STAT mode

The Continuous NIBP for 5-minute measurement (also called **STAT** mode) initiates a continuous cycle of measurements for five minutes. A new NIBP measurement starts after the previous measurement completes. After five minutes, the device automatically returns to the previously selected cycling interval or single measurement mode.

STAT NIBP measurement is deactivated when **Cuff Size** is set to **Infant**.

Starting or stopping continuous five-minute NIBP measurements

You can set the NIBP measurement to continue for five consecutive minutes.

1. Select the NIBP digit field.
2. Select  **Start STAT**.
3. Stop the measurement by selecting  **Stop STAT**.

Venous Stasis

The Venous Stasis menu is grayed out and inactive when **Neonatal** patient is admitted, or **Infant** cuff size is selected.

The venous stasis mode can initiate inflation and keep constant pressure in the cuff for venous catheterization. The stasis measurement pressure can be selected by user.

The venous stasis is used to produce continuous NIBP cuff pressure in a short time. The duration of cuff inflation pressure is 2 minutes.

Starting or stopping a Venous Stasis measurement

1. Select the NIBP digit field.
2. Select the **Venous Stasis** tab.
3. Select and confirm the cuff size from the **Cuff Size** list. The options are:
 - **Not Selected**: default option of cuff size. When selected, the Venous Stasis menu is grayed out and inactive.
 - **Infant**: When selected, the Venous Stasis menu is grayed out and inactive.
 - **Child**: When selected, the Venous Stasis is enabled.
 - **Adult**: When selected, the Venous Stasis is enabled.
4. Select a value from the **Stasis Press.** list.
5. Select **Start Stasis**.
6. Cancel the venous stasis by selecting **Stop Stasis**, if needed.

NIBP volume and display settings

Adjusting the NIBP measurement completion tone volume

1. Select the NIBP digit field.
2. Set the **Completed NIBP Volume**.

Selecting the blood pressure unit of measurement

The units of measurement settings required a password. Please consult qualified and trained technical users to set up. For more information, refer to the Service manual.

1. Select the  >  **Service** (password protected) > **Parameter Settings** > .
2. Select the units for **Blood Pressure**.

NOTE

This setting adjusts the blood pressure unit for NIBP and IBP parameters.

Selecting the NIBP color

The color settings required a password. Please consult qualified and trained technical users to set up. For more information, refer to the Service manual.

1. Select  >  **Service** (password protected) > **Parameter Settings** > **Colors** > **Common** horizontal tab.
2. Select the color for **NIBP**.

NIBP alarms

Setting the NIBP alarm limits

- 1. Select the NIBP digit field.
- 2. Select the **Alarms** tab.
- 3. Check that **Alarm** is turned on.
- 4. Adjust the alarm limits with arrows.

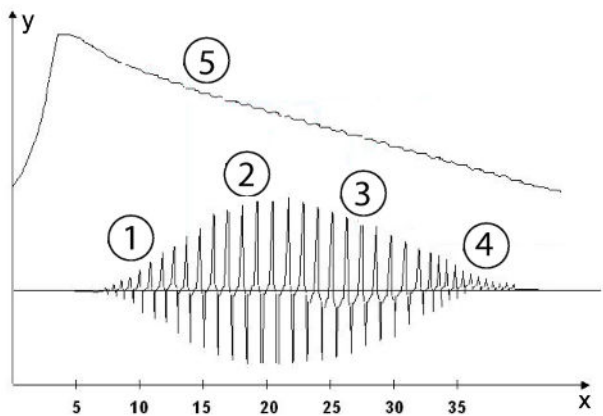
NIBP alarms’ deactivation with pause audio key

Unlike the continuously monitored parameters, NIBP is measured periodically, and its physiological alarms can be deactivated with the pause audio key. Deactivating a physiological NIBP alarm will clear that active alarm until the next NIBP measurement is taken. If the new measurement is outside the alarm limits, the alarm is activated again.

NIBP measurement description

NIBP is acquired using oscillometric technology. Oscillometry is the most commonly used means of indirect blood pressure measurement in automated devices. It is based on the principle that pulsatile blood flow through an artery creates oscillations of the arterial wall.

Oscillometric devices use a blood pressure cuff to sense these oscillations, which appear as tiny pulsations in cuff pressure. By measuring and analyzing at various cuff pressures, the amplitude (which changes based on the pressure within the cuff) and the frequency of these pulsations (which is dependent on the patient’s heart rate), oscillometric devices can non-invasively determine blood pressure.



x = Time(s)

y = Pressures

1.	Systolic	2.	Mean
3.	Diastolic	4.	Extracted pulse wave
5.	Cuff pressure		

DINAMAP SuperSTAT NIBP technology

DINAMAP SuperSTAT technology estimates the systolic, mean arterial, and diastolic values by evaluating all cuff pressure data gathered during an NIBP determination.

The first determination initially pumps up to a default target cuff pressure of about 135 mmHg for adults, 125mmHg for children, or 100 mmHg for infants. To allow for rapid setting of cuff pressure, the device will momentarily inflate to a higher pressure, then immediately deflate to the target pressure.

As a determination is taken, the pattern of the patient's oscillation size is stored as a function of pressure. In any subsequent determination, as few as four pressure steps may be necessary to complete the process. When employing fewer pressure steps, the system uses the stored information from the previous blood pressure determination to decide the best pressure steps to take. The consistency of pulse sizes is measured to ascertain if the oscillations taken at a step are correct and if more steps are needed.

If the current blood pressure reading is similar to the previous reading, some information from the previous blood pressure may be used in the current determination. The data is constantly evaluated during a measurement to try to perform a blood pressure determination in the shortest possible time, providing greater comfort to the patient.

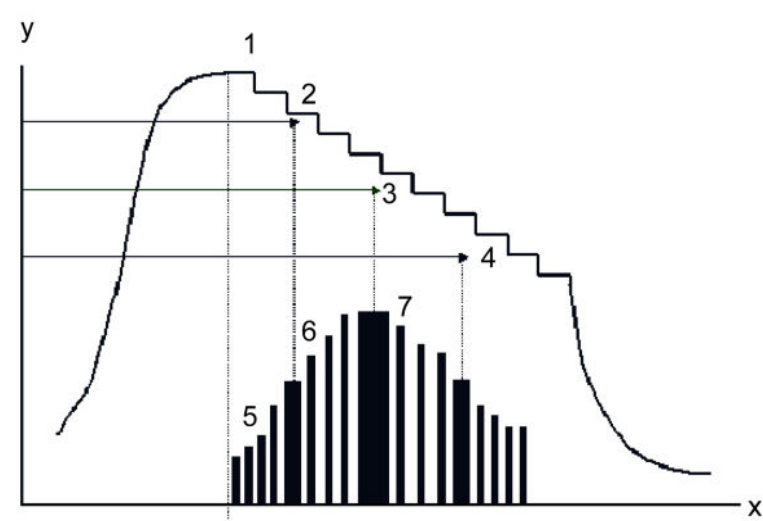
If it has been 16 minutes or less since the last determination and the current blood pressure is similar to the previous reading, the device will try to make an accelerated determination of blood pressure.

During irregular rhythms, only pulses from the current determination are used in calculating the blood pressure values. In order to ensure adequate artifact rejection capability and optimal SuperSTAT NIBP performance, several criteria used to match and qualify the oscillometric pulses at each pressure step are relaxed while supplementing the criteria with additional information from ECG.

DINAMAP Step Deflation technology

DINAMAP SuperSTAT technology includes DINAMAP Step Deflation technology. During the deflation process, the device measures two consecutive pulsations in cuff pressure. If their amplitude differs by an acceptably small amount and the time interval between the pulsations matches the previous time intervals, the pulsations are averaged and stored along with the corresponding cuff pressure. The cuff is then deflated to the next step (in steps of 5-10 mmHg). As the deflation occurs, oscillation waves are assessed for strength and amplitude until the maximum oscillation amplitude or MAP is obtained.

If either of the above criteria is not met, the cuff pressure is maintained until two consecutive pulsations are detected that meet the criteria. Eventually, if the cuff is maintained at one pressure step for longer than one minute or the determination time exceeds 85 seconds (infant cuffs) or two minutes (adult and child cuffs), the device will time out and display an error.



x = Cuff pulsation waveform

y = Cuff pressure

1.	Cuff deflation	2.	Systolic pressure (ratio of maximum amplitude)
3.	Mean arterial pressure (maximum pulsation amplitude)	4.	Diastolic pressure (ratio of maximum amplitude)
5.	Cuff pulsations (each pulsation represents one heart beat)	6.	Amplitude (changes based on cuff pressure)
7.	Resulting waveform		

Systolic and diastolic determinations are based on a mathematical calculation within the algorithm. The deflation mode is heart-rate dependent: it is typically longer with heart rates that are slow and/or irregular.

This patented process of finding two matched pulsations of relatively equal amplitude and frequency at each step rejects artifact due to patient movement or other deviations from ideal conditions (e.g., cuff disturbances) and greatly enhances the overall accuracy of the measurement.

NOTE

NIBP values are based on the oscillometric method of non-invasive blood pressure measurement taken with a cuff on the arm of adult and child patients, and a cuff on the calf of infants. The values correspond to comparisons with intra-arterial values within IEC-specific standards for accuracy (a mean difference of ± 5 mmHg, and a standard deviation of < 8 mmHg).

Invasive blood pressure

Invasive blood pressure safety precautions

Invasive pressure warnings



WARNING

DEFIBRILLATOR PRECAUTIONS.

Patient signal inputs labeled with the CF and BF symbols with paddles are protected against damage resulting from defibrillation voltages. To ensure proper defibrillator protection, use only the recommended cables and leadwires. Using other cables or leadwires may result in damage to the equipment and compromise patient and user safety.

WARNING

PATIENT SAFETY.

All invasive procedures involve risks to the patient. Use aseptic technique. Incorrect use of the catheter can lead to vessel perforation. Follow catheter manufacturer's instructions.

WARNING

ELECTRIC SHOCK.

Make sure that no part of the patient connections touches any electrically conductive material including earth to avoid the risk of electric shock.

WARNING

ERRONEOUS READINGS.

Mechanical shock to an invasive blood pressure transducer may cause severe shifts in the zero balance and calibration, and cause erroneous readings.

WARNING

ERRONEOUS READINGS.

Repositioning the patient after a completed zeroing procedure may cause incorrect measurement values.

WARNING**BURNS.**

When using an electrosurgery unit, note that the measurement cables do not incorporate means to protect against burns in case of a defective ESU return electrode. To avoid burns at the monitor measurement sites, ensure the following:

Proper contact of the ESU return electrode to the patient.

ESU return electrode near the operating area.

Measurement electrodes, leadwires and probes far from the surgical site and the ESU return electrode.

Invasive pressure parameters

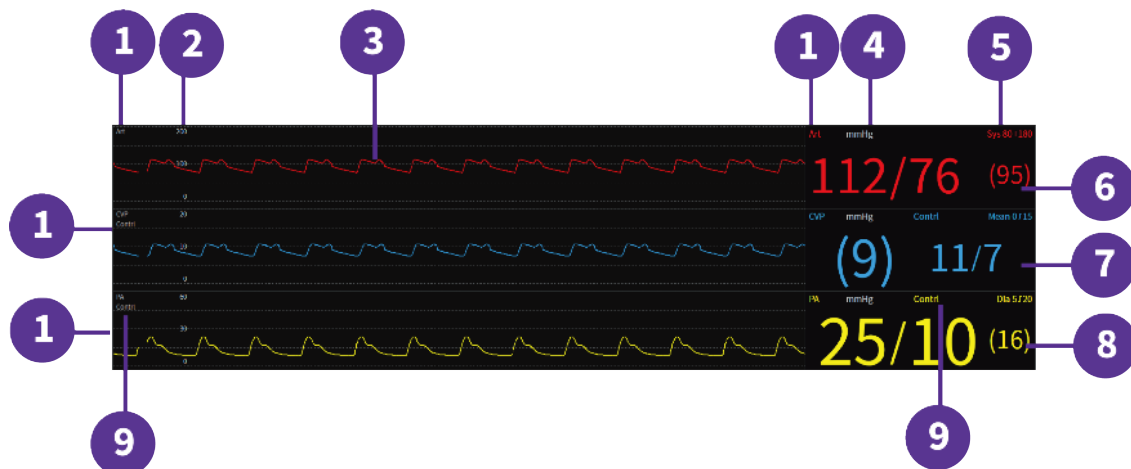
The measured invasive pressure parameters are systolic, diastolic, and mean. Pulse rate can be monitored with any arterial site. CPP is a calculated value that requires a valid ICP value and a valid arterial site value.

PCWP can also be measured for a PA site.

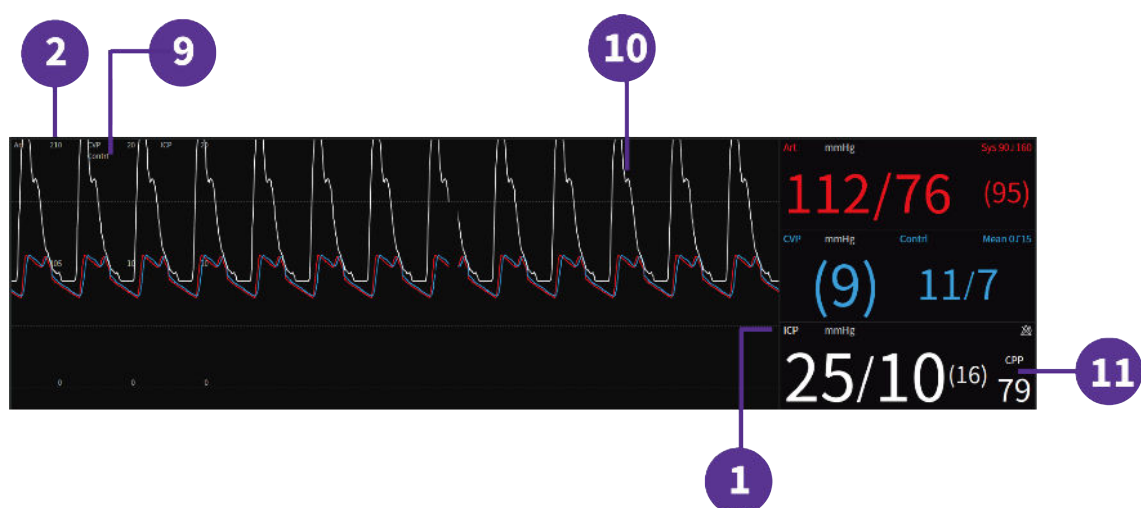
SPV and PPV can also be measured.

You can monitor up to five channel pressures, two channels from Hub, two channels from micro-modules and one channel from E-COP or E-PiCCO module.

Invasive pressure measurement displayed on the device screen



Normal view



Combined pressures view

1.	Art (Art), CVP (CVP), PA (PA), ICP (ICP): parameter label	2.	waveform scale
3.	IBP waveforms	4.	mmHg (mmHg): IBP unit
5.	alarm limits, alarm status, or other messages	6.	IBP value when Digit Format set to S/D (M)
7.	IBP value when Digit Format set to (M) S/D	8.	IBP value when Digit Format set to S/D (M)
9.	Contrl (Contrl): ventilation mode	10.	IBP combined waveforms
11.	CPP displays when channel label is ICP		

The invasive pressure channel labels are as follows:

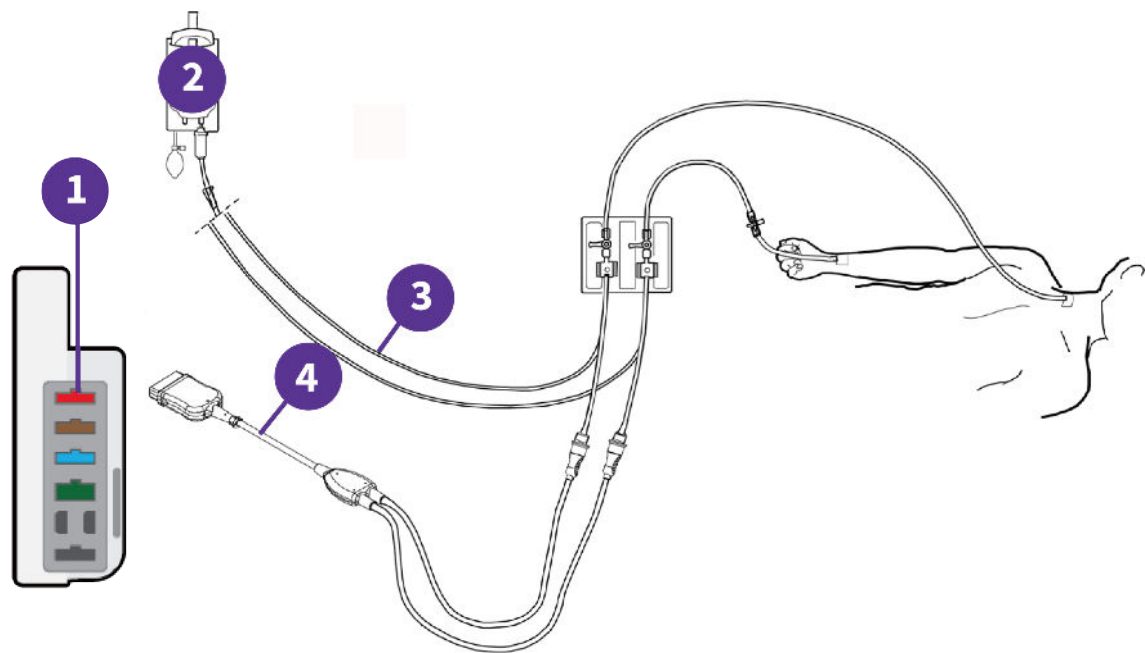
Label	Description
Art	Arterial pressure
ABP	Arterial blood pressure
PA	Pulmonary arterial pressure
CVP	Central venous pressure
LAP	Left atrial pressure
RAP	Right atrial pressure
ICP	Intracranial pressure
RVP	Right ventricular pressure
UAC	Umbilical arterial pressure
UVC	Umbilical venous pressure
Fem	Femoral arterial pressure
FemV	Femoral venous pressure
IBP1, IBP2, IBP3, IBP4, IBP8	Non-specific pressure channel labels
NOTE IBP8 invasive pressure channel is not available in the NEONATAL mode.	

Invasive pressure points to note

- This equipment is suitable for use in the presence of electrosurgery, as tested according to IEC 80601-2-49 clause 202.8.102 Disturbances from HF Surgical Equipment.
- For information on materials used in accessories and their biocompatibility, refer to the instructions for use in the accessory package.
- Defibrillator discharge may affect the invasive pressure measurement. Defibrillation recovery time after discharge is < 10 seconds.
- A pressure channel is activated when a pressure transducer interface cable is connected to the device, or when a pressure transducer is connected to the E-COP module or E-PiCCO module.
- A pressure channel is deactivated when the pressure transducer interface cable is disconnected from the device, or when a pressure transducer is disconnected to the E-COP module or E-PiCCO module.
- PCWP: Follow your care unit’s policy and procedures for obtaining PCWP measurements, including balloon inflation duration.
- SPV and PPV: Measurement is reliable only when the patient is mechanically ventilated.

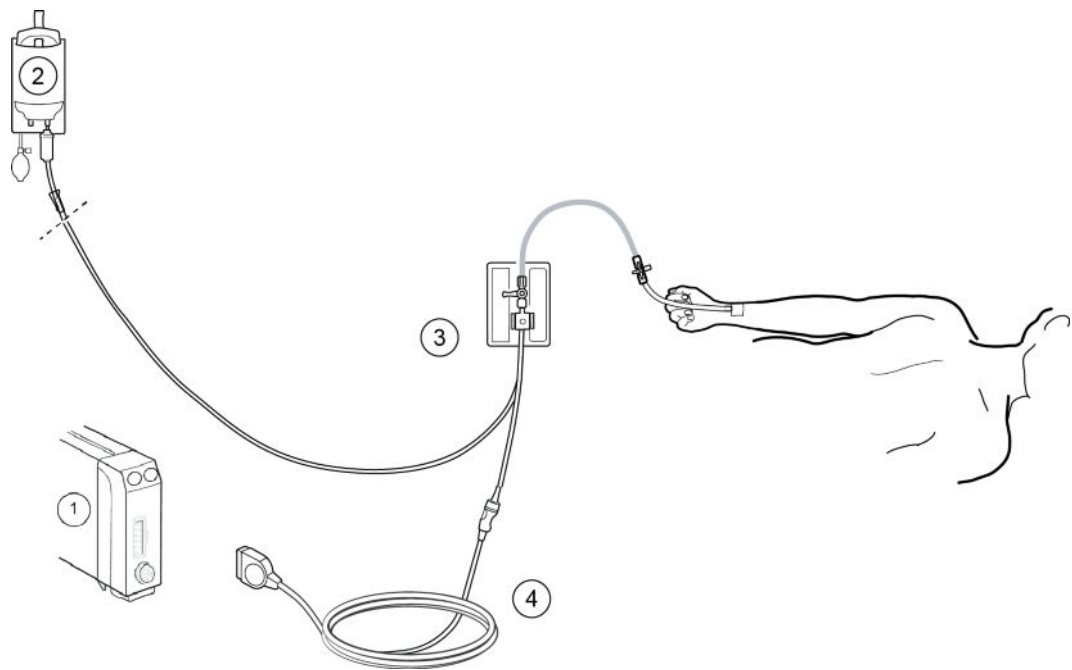
Invasive pressure measurement setup

Invasive pressure equipment to patient connection with device



1.	The IBP connector	2.	Fluid bag with pressure infusor
3.	Transducer setup	4.	Invasive blood pressure adapter cable; single or dual cable (optional).

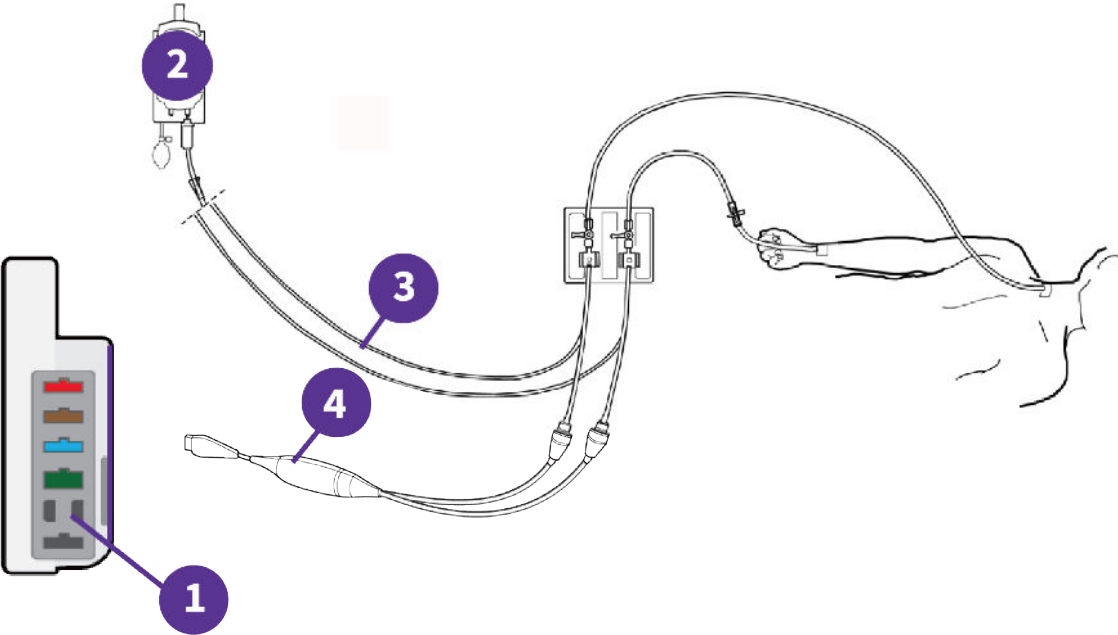
Invasive pressure equipment to patient connection with E-COP or E-PiCCO module



1.	The E-COP or E-PiCCO module	2.	Fluid bag with pressure infusor
3.	Transducer setup	4.	Invasive blood pressure adapter cable; single or dual cable (optional)

Invasive pressure equipment to patient connection with TruSignal Pressure micro-module

The micro-module can be connected to either Hub or Dock. The following illustration shows the location of micro-module connectors on Hub. For information about location of micro-module connectors on Dock, refer to [Left side view of Dock on page 67](#).



1.	The micro-module connectors	2.	Fluid bag with pressure infusor
3.	Transducer setup	4.	Invasive blood pressure micro-module

Connecting the invasive pressure transducer and cable

1. Prepare the transducer kit according to the manufacturer’s instructions.
2. Connect the pressure transducer to the transducer cable.
3. Remove entrapped air from within the transducer setup by tapping the setup and by turning it into different positions.
4. Connect the transducer cable to the device.
5. Connect the transducer to the patient line.

Checking the invasive pressure measurement

1. Check that the device recognizes cable connections (activates the display) for all the pressure channels used and the pressure values and appropriate waveforms are displayed.
2. Make sure that all the transducers are zeroed correctly.

Selecting the display mode for IBP waveforms

You can select the invasive pressure waveforms to be shown as individual waveforms, or in a combined view.

1. Select the  >  **Screen Setup**, and the required screen.
2. Select the **Layout 1** or **Layout 2** tab.
3. Enable the toggle of **Combine Pressures** to combine up to three adjacent IBP waveforms in one field.

The new waveform field will use the combined height of the original fields.

Using the invasive pressure measurement

Setup the parameter to normal screen if needed. Select  >  **Screen Setup**, and select the required screen.

Invasive pressure measurement mapping

Invasive pressure measurements are mapped to one of the invasive pressure channels as follows:

Pressure channel	Pressure measurement source
IBP1	Hub
IBP2	Hub
IBP3	Micro-module
IBP4	Micro-module
IBP8	E-COP module or E-PiCCO module

About zeroing the invasive pressure transducers

- Prior to monitoring, zero transducers at the patient's phlebostatic axis. Zeroing the pressure transducers is very important for accurate pressure measurements. To avoid inaccurate measurements, you must zero the pressure transducers:
 - Before measuring invasive pressures.
 - Before initiating treatment changes reliant upon pressures data.
 - When using a new transducer or tubing.
 - After reconnecting the transducer cable to the acquisition device.
 - Whenever the patient's position is changed.
 - Whenever the pressure reading is questionable.
- Pressures can be zeroed individually by selecting **Zero** on the invasive pressure menu.
- You can zero all active transducers except ICP by selecting .

NOTE

The device records a time stamp of the last successful zeroing for each invasive blood pressure channel.

Zeroing the invasive pressure transducers

1. Level the transducer following your care unit's policy (usually level of the phlebostatic axis).
2. Close the transducer stopcock to the patient and open the venting stopcock to air.
3. You can zero all connected pressure transducers simultaneously by selecting . Or, you can zero a single active pressure transducer by selecting the invasive pressure digit field > **Zero**.
4. Check that a zero reference has been established. Watch the pressure digit field for messages.
5. Close the venting stopcock to air and open the transducer stopcock to the patient.

6. Check that pressure numerics display on screen.

NOTE

The  does not zero a connected ICP channel. The ICP channel must be zeroed separately. When the **Zero ICP separately** message displays, you can zero the ICP channel separately.

Selecting an invasive pressure channel label

One channel label can only be mapped to one channel at a time. If you select a channel label that is already mapped to another channel, the other channel's label will change to the default value.

1. Select the invasive pressure digit field.
2. Select a channel label from the **Label** list.

Selecting the size of the invasive pressure waveform

1. Select the invasive pressure digit field.
2. Set the waveform scale with the **Scale** arrows.

The larger the scale value, the smaller the waveform size.

Optimizing the invasive pressure waveform scale

You can select an automatic calculation for an optimized waveform size. This size will then be used for the local waveform, snapshot waveform, full disclosure waveform, and waveform printouts. Other instances (e.g., information sent to the network) will use the scale selection that is as close as possible to the upper limit of the optimized scale.

The algorithm uses the last four seconds of the waveform data to calculate the scale. If you notice a considerable change in the waveform during that time, wait for the waveform to stabilize and perform the operation again.

1. Select the invasive pressure digit field.
2. Select **Optimize Scale**.

The **Scale** selection will now show the automatic limit range.

NOTE

The **Optimize Scale** selection will not automatically change to match the waveform, you will always have to select it manually every time.

Selecting the hemodynamic waveform sweep speed

NOTE

This setting adjusts the waveform speed for all of the hemodynamic parameters.

1. Select the invasive pressure digit field.
2. Select a numeric value from the **Hemodynamics Sweep Speed** list.

The smaller the value, the slower the sweep speed is.

Selecting the displayed invasive pressure format

You can choose to display systolic, diastolic or mean pressure values in different formats.

1. Select the invasive pressure digit field.
2. Select the format from the **Digit Format** list:
 - **Mean Only**: Only the mean value is shown.
 - **S/D (M)** (S/D is above M): All values are shown, but the sys/dia values are shown in a bigger font.
 - **(M) S/D**: All values are shown, but the mean value is shown in a bigger font.
 - **S/D (M)** (S/D and M are in the same row): All values are shown in the same size font.
 - **CPP**: All values are shown, with additional CPP value. This option displays only when the **Label** is **ICP**.

Selecting invasive pressure as the primary heart rate source

The primary heart rate can be calculated from the ECG leads, SpO₂ measurement, or invasive pressure waveform.

NOTE

This setting adjusts the primary heart rate source for all of the hemodynamic parameters.

NOTE

This setting is available for **Art**, **ABP**, **Fem** or **UAC** invasive pressure channels only.

1. Select the invasive pressure digit field.
2. Select the heart rate source from the **HR Source** list.

Selecting the ventilation mode

Not for TruSignal Pressure micro-module. This setting affects the respiration filter.

1. Select the invasive pressure digit field.
2. Select the **Advanced** tab.
3. Select the mode from **Ventilation Mode** list. Choices are:
 - **Spont**: Spontaneous respiration.
 - **Contrl**: Controlled ventilation.

NOTE

The ventilation mode is shown on the digit field for labels **IBP1**, **IBP2**, **IBP8**, **CVP**, **PA**, **RAP**, **Fem**, **FemV** and **UVC**.

Selecting the invasive pressure response time

Not for TruSignal Pressure micro-module.

1. Select the invasive pressure digit field.
2. Select the **Advanced** tab.

3. Select the invasive blood pressure response time from the **Response** list. Choices are:
 - **Normal**: Normal averaging time is used.
 - **B-TO-B** (beat-to-beat): The last detected pulse is displayed, values can change up to three times per second. This feature is useful when it is necessary to detect fast pressure changes.

Selecting Smart BP

NOTE

TruSignal Pressure micro-module only. **Art** and **Fem** invasive pressure channels only.

Smart BP is an algorithm that temporarily deactivates the arterial and femoral alarms when it detects the zeroing of a transducer, fast flushing of the system, or blood draws. The message **Artifact** displays during the alarm deactivation. When pulsatile pressure returns and 15-20 beats are detected, numerics are displayed and alarms are reactivated.

1. Select the invasive pressure digit field.
2. Select the **Advanced** tab.
3. Toggle on **Smart BP**.

Selecting the invasive pressure noise reduction filter

Measured signal is filtered to remove noise and artifacts.

1. Select the invasive pressure digit field.
2. Select the **Advanced** tab.
3. Set a numeric value with the **Filter Frequency** arrows.

The smaller the filter value, the greater the degree of filtering that occurs.

Setting invasive pressure alarm limits

1. Select the invasive pressure digit field.
2. Select the **Alarms** tab.
3. Check that **Alarm** is turned on.
4. Adjust the alarm limits with arrows.

Systolic pressure variation and pulse pressure variation

Systolic pressure variation (SPV) and pulse pressure variation (PPV) can provide useful information, for example when assessing the effects of fluid therapy on the cardiac output of a patient.

The SPV and PPV measurements are automatic.

NOTE

The SPV and PPV measurements are reliable for mechanically ventilated patients with no arrhythmias, and when the arterial site selected as the SPV source is providing reliable readings.

NOTE

The SPV and PPV measurements are not available in NEONATAL mode.

Changing the SPV source

1. Select the invasive pressure digit field.
2. Select the **Advanced** tab.
3. Select an option from the **SPV Source** list. The options available depend on the arterial pressure channels are configured to be **Art**, **Fem** or **ABP**, and the patient type is **Adult/Pediatric**. You can also turn off the measurement by selecting **Off**.

Pulmonary capillary wedge pressure (PCWP) measurement

You can obtain a PA wedge measurement (PCWP) with the automated wedge program. The automated wedge program displays on-screen messages to inflate or deflate the catheter balloon. The wedge algorithm then determines the PCWP value. You can confirm this value or adjust the measurement with the provided cursor.

Showing the PCWP digit field

1. Select the  >  **Screen Setup**, and the required screen.
2. Select **Lower Area** vertical tab.
3. Select **PCWP** to one of the Lower Field.
4. Make sure one of the IBP channels set to **PA**.

Taking a manual PA wedge measurement

The feature is only available for IBP3 or IBP4.

1. Zero the PA channel, if necessary.
2. Select **PCWP** digit field.
3. Select **Manual** to **Mode**.
4. Inflate the catheter balloon when the **Manually "Freeze / Adjust" when ready** message displays.
5. Select **Freeze/Adjust** once the PCWP waveform is displayed. The **Wedge Complete** message displays.
6. Deflate the balloon.
7. To adjust the PA wedge value, move the cursor up or down with the **PCWP / Cursor** arrows.
8. To save the PCWP value, select **Confirm Wedge**.

The saved PA wedge value displays in the parameter window and is stored in trends and hemodynamic calculations.

Taking an automated PA wedge measurement

1. Zero the PA channel, if necessary.
2. Select **PCWP** digit field.

3. Select **Auto** to **Mode**. (For IBP3 or IBP4)
4. Inflate the catheter balloon when the **Inflate the Balloon** message displays.
After 10 seconds, the automated wedge program displays the **Deflate the balloon**, after another 10 seconds, displays the **Wedge Complete** message.
5. To adjust the PA wedge value, move the cursor up or down with the **PCWP / Cursor** arrows.
6. To save the PCWP value, select **Confirm Wedge**.
The saved PA wedge value displays in the digit field and is stored in trends.

Starting a new PA wedge measurement

You can clear the current wedge measurement and start a new one:

1. Select **PCWP** digit field.
2. Select **Restart Wedge**.

Other selection in the Wedge menu

There is also other selection in the **Wedge** menu:

- **CO**: This selection will open the CO **Setup** menu.

Temperature

Temperature safety precautions

Temperature warnings



WARNING

DEFIBRILLATOR PRECAUTIONS.

Patient signal inputs labeled with the CF and BF symbols with paddles are protected against damage resulting from defibrillation voltages. To ensure proper defibrillator protection, use only the recommended cables and leadwires. Using other cables or leadwires may result in damage to the equipment and compromise patient and user safety.

WARNING

BURNS.

When using an electrosurgery unit, note that the measurement cables do not incorporate means to protect against burns in case of a defective ESU return electrode. To avoid burns at the monitor measurement sites, ensure the following:

- Proper contact of the ESU return electrode to the patient.

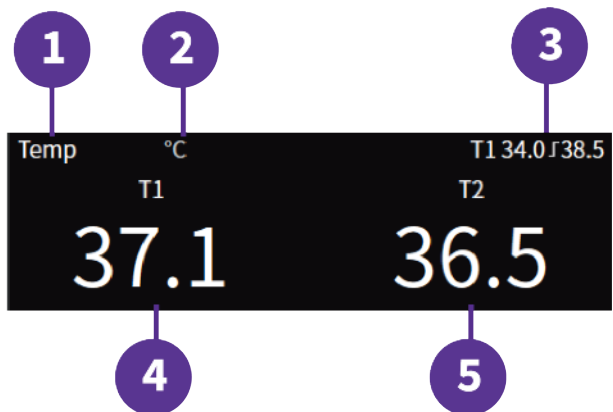
- ESU return electrode near the operating area.

- Measurement electrodes, leadwires and probes far from the surgical site and the ESU return electrode.

Temperature measurement description

Up to 2 temperature sites can be simultaneously measured and monitored (3 sites when monitoring TBlood). Temperature monitoring provides numerics only. No waveform is generated or displayed.

Temperature measurement displayed on the monitor screen



1.	Temp (Temp): parameter label
2.	Temperature unit
3.	Temperature alarm limits, alarm status or other messages
4.	T1 (T1): Channel 1 temperature value
5.	T2 (T2): Channel 2 temperature value

The temperature measuring site labels are as follows:

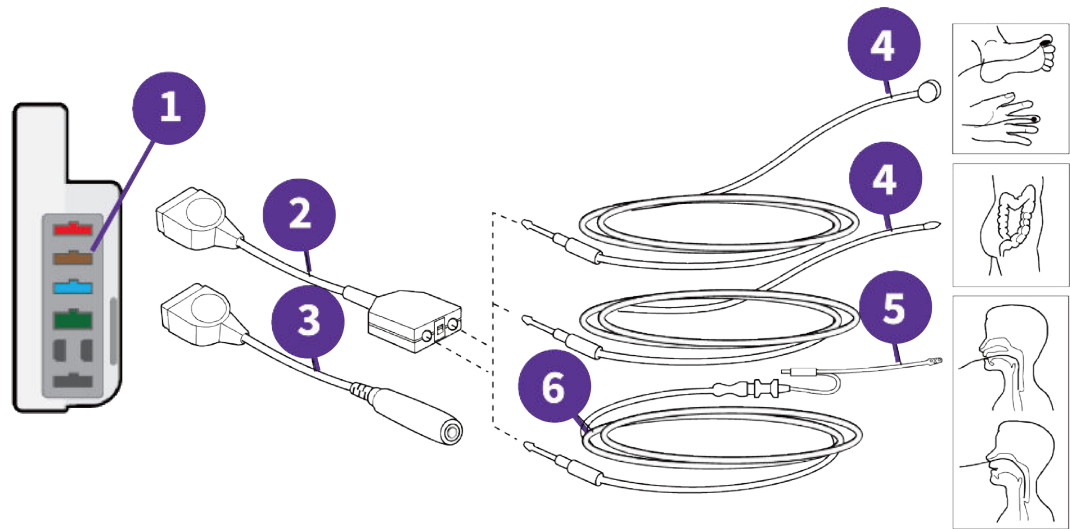
T1, T2 = general label	AirW = airway
Eso = esophageal	Room = room
Naso = nasal	Myo = myocardial
Tymp = tympanic	Core = core
Rect = rectal	Surf = surface
Axil = axillary	Blad = bladder
Skin = skin	

Temperature points to note

- This equipment is suitable for use in the presence of electrosurgery, as tested according to IEC 80601-2-49 clause 202.8.102 Disturbances from HF Surgical Equipment.
- For information on materials used in accessories and their biocompatibility, refer to the instructions for use in the accessory package.
- Use only GE HealthCare approved temperature accessories.
- For more detailed information regarding the temperature probes, refer to their own instructions for use.
- Temperature measurement uses direct mode. Displayed temperature values represent the probe temperature of the measurement site on the patient.
- A temperature channel is activated when the device detects a temperature probe.
- A temperature channel is deactivated when a temperature probe is detached.

Temperature measurement setup

Temperature equipment to patient connection



NOTE
The temperature measurement site in above graphic is only for reference, please refer to the accessories' instruction for details.

1.	The Temperature connector	2.	Dual temperature cable
3.	Single temperature cable	4.	Reusable temperature probe
5.	Disposable temperature probe	6.	Temperature interconnect cable for disposable temperature probes

Preparing the patient for temperature measurement

1. Follow the manufacturer's instructions for probe application.
2. Connect the temperature cable to the parameter connector.

Checking the temperature measurement

1. Check that the temperature value is displayed when the probe is connected to a temperature cable.

Using the temperature measurement

Setup the parameter to normal screen if needed. Select  >  **Screen Setup**, and select the required screen.

Temperature mappings

Temperature measurements are mapped to one of the temperature channels as follows:

Temperature channel	Measurement source
T1	Hub
T2	Hub
Tblood	E-COP module or E-PiCCO module

Changing the temperature site label

1. Select the temperature digit field.
2. Choose a site label from the **T1 Label** and **T2 Label** list.

Selecting the temperature unit

1. Select the temperature digit field.
2. Select the °C or °F from the **Unit** list.

Setting temperature alarms

1. Select the temperature digit field.
2. Select the **Alarms** tab.
3. Check that **Alarm** is turned on.
4. Adjust the alarm limits with arrows.

Temperature practicalities

- Each temperature label can be changed to reflect the temperature measurement site.
- The dual temperature cable allows a two-channel measurement.
- The signal input is a high-insulation port to ensure patient safety and to protect the device during defibrillation and electrosurgery.
- The device automatically calibrates the temperature measurements at startup: every 10 minutes.
- Tblood is obtained from a pulmonary artery catheter.

Cardiac output

Cardiac output measurement compatibility limitations



The cardiac output (CO) measurement is available only when Hub connects to Dock.



The continuous cardiac output (CCO) measurement is available only when Hub connects to Dock.



The PRAM CO measurement is available when Hub works alone, Hub connects to Dock or Hub connects to Mini Dock.

Cardiac output measurement

Cardiac output safety precautions

Cardiac output warnings

WARNING



DEFIBRILLATOR PRECAUTIONS.

Patient signal inputs labeled with the CF and BF symbols with paddles are protected against damage resulting from defibrillation voltages. To ensure proper defibrillator protection, use only the recommended cables and leadwires. Using other cables or leadwires may result in damage to the equipment and compromise patient and user safety.

WARNING**BURNS.**

When using an electrosurgery unit, note that the measurement cables do not incorporate means to protect against burns in case of a defective ESU return electrode. To avoid burns at the monitor measurement sites, ensure the following:

Proper contact of the ESU return electrode to the patient.

ESU return electrode near the operating area.

Measurement electrodes, leadwires and probes far from the surgical site and the ESU return electrode.

WARNING**PATIENT SAFETY.**

All invasive procedures involve risks to the patient. Use aseptic technique. Incorrect use of the catheter can lead to vessel perforation. Follow catheter manufacturer's instructions.

WARNING**ERRONEOUS READINGS.**

The cardiac output measurement results may be erroneous during electrosurgery.

WARNING**ERRONEOUS READINGS.**

During atrial fibrillation the CO readings may be erroneous.

CO instruction

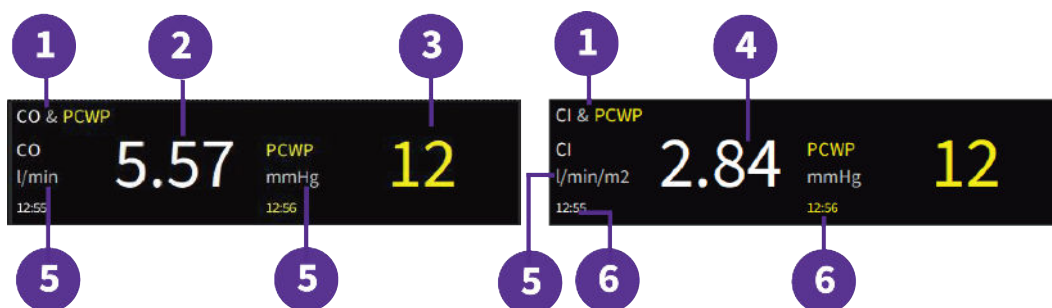
The cardiac output (CO) measurement invasively measures cardiac output and other hemodynamic parameters by use of a thermodilution catheter. Numeric values display in digit field and a real-time cardiac output washout curve display in measurement menu. Performing a cardiac trial allows the user to measure up to 6 times. And the user can select the effective measurements to achieve a reliable CO average value. The confirmed average CO value will be displayed in the digit field.

CO parameters, E-COP

Parameter	E-COP
Cardiac output (CO)	Support
Cardiac Index (CI)	Support
Continuous cardiac output (CCO)	n/a
Right ventricular ejection fraction (REF)	Support
SvO ₂	n/a
ScvO ₂	n/a
Invasive pressure	Support IBP8

Parameter	E-COP
blood temperature (T _{blood})	Support
Injectate temperature (T _{inj})	Support
Pulmonary capillary wedge pressure (PCWP)	Support

CO measurement displayed on the device screen



1.	CO & PCWP (CO & PCWP), CI & PCWP (CI & PCWP): parameter label	2.	CO value
3.	PCWP value. This parameter can be setup by Show With CO/CI .	4.	CI value
5.	l/min (l/min), mmHg (mmHg), l/min/m2 (l/min/m2): unit	6.	Parameter measurement time

CO module key

There are two CO module keys on the E-COP module:

Start C.O.	Starts and stops the cardiac output measurement.
Zero P4/P8	Zero channel IBP8

CO measurement limitations

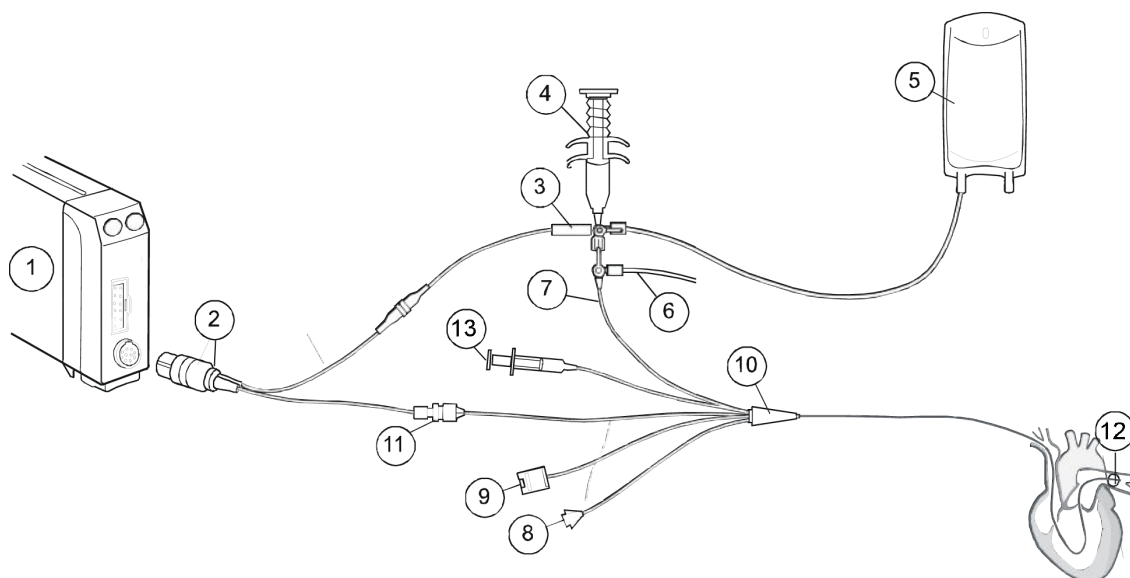
- E-COP module used for this measurement is not suitable for use with neonatal patients.
- The system shall not be able to use CO monitoring with E-COP module when PRAM CO is in use.

CO points to note

- This equipment is suitable for use in the presence of electrosurgery, as tested according to IEC 80601-2-49 clause 202.8.102 Disturbances from HF Surgical Equipment.
- For information on materials used in accessories and their biocompatibility, refer to the instructions for use in the accessory package.
- The CO connector cables are module-specific and can only be used with the appropriate CO module. For detailed information, see the Supplies and accessories.
- The patient's height and weight values are required for determining Cardiac Index (CI).
- The right ventricular ejection fraction (REF) measurement is only available with Baxter REF catheters, the **Catheter Type** should setup to .

CO measurement setup

CO equipment to patient connection with an in-line probe



1.	E-COP module	2.	Cardiac output cable
3.	In-line injectate probe	4.	Injectate syringe
5.	Injectate solution	6.	CVP line to IP transducer or fluid infuser
7.	Proximal injectate port	8.	PA distal port
9.	Optical module connector (used for SvO2 measurement, not available)	10.	Swan-Ganz thermodilution catheter
11.	Thermistor connector	12.	Balloon
13.	Balloon inflation valve		

Preparing the CO measurement

1. Connect the CO cable to the module, thermistor, and injectate temperature port.
2. Follow your care unit's policy and procedures for positioning the patient for the CO measurement.
3. Follow the catheter manufacturer's instructions to set up the in-line or bath probe patient cables.
4. For an in-line setup, make sure the in-line sensor is securely connected to the tubing.
5. For the bath probe setup, make sure the bath probe is correctly sensing the injectate temperature.

Checking the CO measurement

1. Check that the device recognizes cable connections (activates the display) and all CO menu selections are available.
2. Remember that in order to get Cardiac Index (CI) you must first enter the patient height and weight.
3. Check that the message **Press Start CO** appears on the screen.

Using the CO measurement

Entering patient data for the CI value

The patient's height and weight values are required for determining cardiac index (CI).

1. Select the CO digit field.
2. Select **Measurement** tab > **Demographics**.
3. Set the patient's **Height** and **Weight**.

The BSA value is calculated automatically once the height and weight have been selected.

CO catheter selections

You can select a cardiac output catheter type.

777F8	Swan-Ganz CCombo V CCO/SvO2/CEDV/VIP Thermodilution Catheter
782F75M	Swan-Ganz VIP/Oximetry Catheter
131F7	Swan-Ganz Thermodilution Catheter
931F75	Swan-Ganz Paceport Catheter
132F5	Swan-Ganz Thermodilution Catheter
131F7P	Swan-Ganz Thermodilution Catheter
User defined	User defined catheter for temporary use.

Selecting a CO catheter type

1. Select the cardiac output digit field.
2. Select the **Setup** tab.
3. Select a catheter from the **Catheter Type** list.

Entering a user-defined CO catheter

All user-defined catheter settings are erased when the patient is discharged.

1. Select the cardiac output digit field.
2. Select the **Setup** tab.
3. Select **User defined** from the **Catheter Type** list.
4. Set the **Injectate Volume** to match the value listed on the catheter packaging.
5. Set the **Computation Constant** to match the value listed on the catheter packaging.

CO measurement modes

CO measurements can be taken using the automatic or manual measurement modes. Both measurement modes allow you to use up to six CO measurements for calculating a CO average.

You can confirm the CO measurements within 30 minutes from the start of the first thermodilution measurement, so even if you leave the menu the measurements will not disappear during this time.

Taking an automatic CO measurement

When measuring CO using the automatic mode, new measurements can be taken when the **Press Start CO** message displays.

Holding the injectate syringe by the plunger, not the barrel, improves measurement accuracy.

1. Select the cardiac output digit field.
2. Select the **Setup** tab.
3. Select **Auto** for **Measurement Type**.
4. Verify that the catheter settings are correct.
5. Select the **Measurement** tab.
6. When the message **Press Start CO** appears, select **Start CO Serial**.
7. Inject the injectate solution smoothly within 4 to 5 seconds.
8. The message **Measuring** displays, followed by the message **Please wait** until the calculation is completed.
9. Observe the washout curve displayed on the screen.
The curve disappears from the screen when the next measurement cycle can start.
10. To take another CO measurement, wait for the message **Inject now!** displays before injecting the injectate.

Taking a manual CO measurement

Measuring CO using the manual mode allows you to determine when to begin the injection procedure. This mode may be preferred for patients with extreme blood temperature fluctuations, or when the automatic mode is unable to establish a stable baseline.

Holding the injectate syringe by the plunger, not the barrel, improves measurement accuracy.

1. Select the cardiac output digit field.
2. Select the **Setup** tab.
3. Select **Manual** for **Measurement Type**.
4. Verify that the catheter settings are correct.
5. Select the **Measurement** tab.
6. Select **Start CO**, Or, you can also use the **Start C.O.** module key.
7. When the **Inject now!** message appears, inject the injectate solution smoothly within 4 to 5 seconds.
8. The message **Measuring** displays, followed by the message **Please wait** until the calculation is completed.
9. Observe the washout curve displayed on the screen.
10. Allow 1 to 1.5 minutes between injections to stabilize the catheter baseline temperature. The colder the injectate, the longer the time needed.
11. To perform another CO measurement, wait for the **Press Start CO** message to display, then select **Start CO**.

CO trial measurements

A real-time thermodilution curve and numeric value are displayed with each cardiac output trial. Up to six measurements can be retained. After each measured CO the program automatically averages the CO value. It is recommended to use three to five measurements with less than 10% variation between them for average CO. The saved average CO value is displayed in the parameter window with a timestamp.

Editing the CO average

After CO trial measurements, you need to edit and confirm the CO average to save and display the CO average value.

1. Select the cardiac output digit field.
2. Select the **Measurement** tab.
3. Select **Edit Average**.
4. Check the selection boxes for those trials you wish to include in the CO average. If you do not wish to include a trial, ensure its selection box is not checked.
5. Select **Confirm CO** to store the calculated CO average and display it in the cardiac output digit field and measurement menu.

Canceling a CO measurement

When a CO measurement has just completed, you can remove this CO measurement trial without entering the **Edit Average** window.

1. Select the cardiac output digit field.
2. Select the **Measurement** tab.
3. Select the **Cancel/Reject Injection**.

In addition to removing the previous measurement, you can also cancel an in-process measurement.

Setting a CO right ventricular ejection fraction (REF) measurement

A valid heart rate is required to take a REF measurement.

1. Select the cardiac output digit field.
2. Select the **Setup** tab.
3. Enable the toggle of **REF Measurement**.

Selecting the CO scale

This selection sets the upper limit of the waveform scale for the thermodilution waveform fields.

1. Select the cardiac output digit field.
2. Select the **Setup** tab.
3. Select a value from the **Scale** list.

Selecting what to show with CO/CI.

This setting affects the contents of the cardiac output digit field.

1. Select the cardiac output digit field.
2. Select the **Setup** tab.
3. Select a value from the **Show With CO/CI** list: **NONE**, **PCWP**, **Tblood** and **REF**.

Setting the Tblood alarm

1. Select the cardiac output digit field.
2. Select the **Alarms** tab.
3. Check that **Alarm** is turned on.
4. Adjust the alarm limits with arrows.

Adjusting the wedge from the cardiac output menu

The **Wedge** selection is available only when there is a confirmed CO measurement and an invasive pressure channel has been labeled as **PA**.

1. Select the cardiac output digit field.
2. Select the **Measurement** tab.
3. Select **Wedge**.
4. Adjust the wedge settings as required.

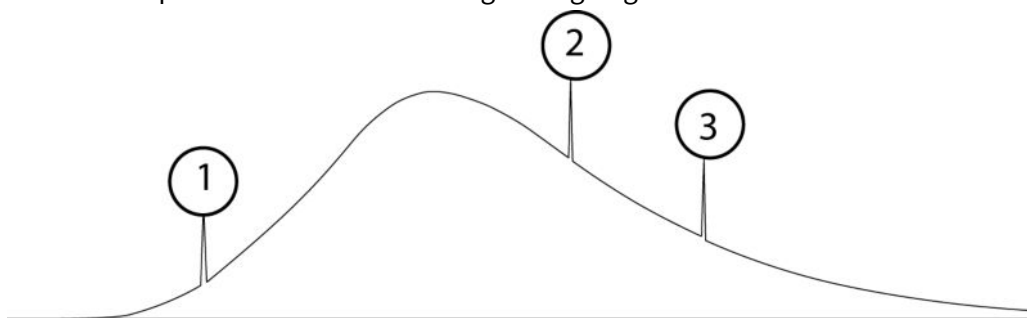
Stopping the cardiac output measurement

1. Remove the catheter from the patient.
2. Disconnect the probe patient cables.

CO practicalities

Cardiac output thermodilution curve

The thermodilution curve, which displays after a CO injection, shows the drop in blood temperature as the injectate mixes with the blood. The peak of the curve indicates the maximum difference in the patient's baseline blood temperature and the temperature of the injectate solution. As the mixture passes through the catheter and then out the pulmonary artery, the temperature difference decreases as indicated by the curve returning to the baseline. A spike is displayed at the onset of the curve, again at 70% of the maximum temperature difference, and again at 35% of the maximum temperature difference. Spikes are also visible during an ongoing CO measurement.



1. Onset spike

2. 70% spike
3. 35% spike

Cardiac output is inversely proportional to the area under the thermodilution curve. Cardiac output varies with body size. To more accurately assess cardiac performance for individual patients, the cardiac index is often used.

How to improve the CO accuracy

The following influencing factors can influence the cardiac output accuracy:

- The technique used in performing a cardiac output.
- Temperature of the injectate solution.
- Volume of the injectate solution.
- Patient's baseline blood temperature.
- Patient's inspiratory/expiratory cycle.
- Placement of catheter with relation to proximity of lung field.
- The pulmonary artery catheter itself.
- The patient's rhythm and hemodynamic status.
- Any other rapid IV solutions which are infused while the cardiac output is being performed.

The following are suggestions about technique that can help obtain accurate cardiac output:

- Always hold the syringe by the plunger, not the barrel.
- Inject solution rapidly and smoothly.
- Inject within four to five seconds.
- Inject at end expiration.
- When not using an automatic program, wait one minute between injections to allow baseline to stabilize.
- The temperature of the injectate should always be colder than blood temperature. Keep the handling and waiting time with a filled syringe before injection as short as possible. Warm injectate may lead to erroneous CO values.
- The probe can be a bath probe continuously measuring the cooling bath temperature or the infusion bag temperature. Alternatively, a flow-through probe is used for a closed injectate delivery. With an in-line system, the displayed injectate temperature is the lowest temperature measured during injection.

Continuous cardiac output (CCO) measurement

Continuous cardiac output (CCO) safety precautions

Continuous cardiac output (CCO) warnings



WARNING

DEFIBRILLATOR PRECAUTIONS.

Patient signal inputs labeled with the Type CF and Type BF symbols with paddles are protected against damage resulting from defibrillation voltages. To ensure proper defibrillator protection, use only the recommended cables and leadwires. Using other cables or leadwires may result in damage to the equipment and compromise patient and user safety.

WARNING

PATIENT SAFETY.

All invasive procedures involve risks to the patient. Use aseptic technique. Incorrect use of the catheter can lead to vessel perforation. Follow catheter manufacturer's instructions.

WARNING

BURNS

When using an electrosurgery unit, note that the measurement cables do not incorporate means to protect against burns in case of a defective ESU return electrode. To avoid burns at the monitor measurement sites, ensure the following:

- Proper contact of the ESU return electrode to the patient.

- ESU return electrode near the operating area.

- Measurement electrodes, leadwires and probes far from the surgical site and the ESU return electrode.

WARNING

ERRONEOUS READINGS.

The cardiac output measurement results may be erroneous during electrosurgery.

WARNING

MISINTERPRETATION.

The assessment of patient status must not be based solely on PPV and SVV measurement data.

WARNING**ERRONEOUS READINGS.**

During atrial fibrillation the CCO readings may be erroneous.

WARNING**PATIENT SAFETY.**

As the pulse contour cardiac output of children has not been sufficiently validated so far the CO should be checked by thermodilution before therapeutic interventions.

WARNING**ERRONEOUS READINGS.**

Aortic aneurysms may cause the displayed blood volume (GEDV/ITBV) derived by thermodilution measurement to be erroneously high.

WARNING**PATIENT SAFETY.**

When placing the arterial catheter into a large artery, do not advance the tip of the catheter into the aorta.

WARNING**PATIENT SAFETY.**

Intracardiac blood pressure measurement is not allowed. This means that the measuring position should not be in the heart.

WARNING**ERRONEOUS READINGS.**

Check that the CVP value is valid for the CCO measurement with E-PiCCO to avoid the risk of erroneous readings.

WARNING**ERRONEOUS READINGS.**

Check that the Art value is valid for the CCO calibration with E-PiCCO to avoid the risk of erroneous readings.

WARNING**PATIENT SAFETY.**

To avoid risks to the patient caused by misinterpretation, do not use the Tblood value measured with E-PiCCO for monitoring the patient's body temperature as it is not an indication of that.

WARNING**MISINTERPRETATION DUE TO INSUFFICIENT BACKGROUND KNOWLEDGE.**

This monitor uses a component modular device in deriving the pulse contour continuous cardiac output and associated parameters purchased from Pulsion Medical Systems AG. It is important to recognize the parameters are derived using Pulsion's proprietary technology. It is recommended that clinicians have reviewed applicable information on its utility and/or risks in published articles and literature/web site information from Pulsion (www.pulsion.com) or contact that company itself if they have clinical-based questions relating to this module portion of GE HealthCare monitor. Failure to do so could potentially result in incorrect values. Clinicians are also recommended to maintain current knowledge of government regulatory, practice or research information on these parameter related topics.

Continuous cardiac output (CCO) cautions

CAUTION**ERRONEOUS READINGS.**

Faulty measurements can be caused by incorrectly placed catheters, interfering signal transmission e.g. of arterial pressure, defective connections or sensors or by electromagnetic interference (e.g. electric blankets, electric coagulation).

The following applies to the E-PiCCO module only:

CAUTION**ERRONEOUS READINGS.**

Recalibration of CCO measurement is recommended when significant changes occur in patient hemodynamic conditions, such as volume shifts or changes to medication.

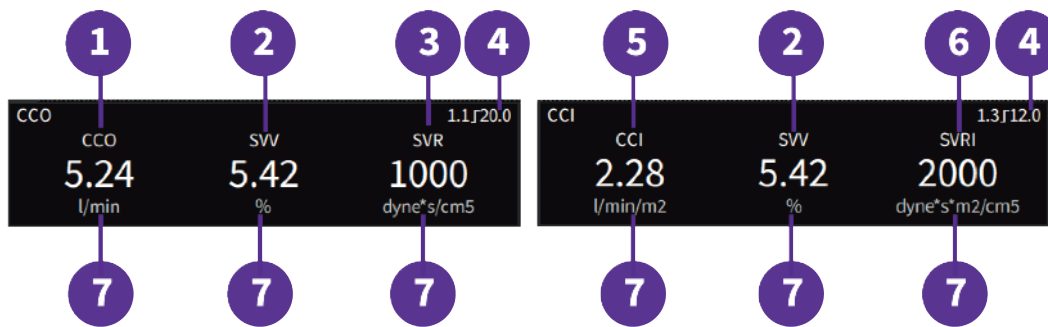
Feature availability

All features mentioned in this manual are not available until the PiCCO function has been activated. Please consult your local representative for availability.

CCO parameters, E-PiCCO

Parameter	E-PiCCO
Continuous cardiac output (CCO)	Support
Continuous cardiac index (CCI)	Support
Right ventricular ejection fraction (REF)	n/a
SvO ₂	n/a
ScvO ₂	n/a
Invasive pressure	Support IBP8
blood temperature (T _{blood})	Support
Injectate temperature (T _{inj})	Support

CCO measurement displayed on the device screen



1.	CCO (CCO): parameter label	2.	SVV (SVV): parameter label
3.	SVR (SVR): parameter label	4.	CCO or CCI alarm limits
5.	CCI (CCI): parameter label	6.	SVRI (SVRI): parameter label
7.	l/min (l/min), % (%), dyne*s/cm5 (dyne*s/cm5), l/min/m2 (l/min/m2), dyne*s*m2/cm5 (dyne*s*m2/cm5): unit		

CCO measurement limitations

- E-PiCCO measurement parameters are contraindicated if the placement of an indwelling central venous catheter or an arterial catheter is contraindicated or restricted.
- E-PiCCO measurement parameters are contraindicated if the patient is receiving intra-aortic balloon counter pulsation (IABP).
- The PiCCO-Technology by Pulsion Medical Systems SE may give incorrect thermodilution measurements in patients with intracardiac shunts, aortic aneurysm, aortic stenosis, mitral or tricuspid insufficiency, pneumonectomy, macro lung embolism and extracorporeal circulation (if blood is either extracted from or infused back into the cardiopulmonary circulation).
- Cardiac output measurement with E-PiCCO is intended for patients weighing over 2 kg (4.4 lb) and therefore it is not available for smaller patients.
- E-PiCCO indexed values are available for patients weighing over 15 kg (33 lb) only.
- The system shall not be able to use CCO monitoring with E-PiCCO module when PRAM CO is in use.

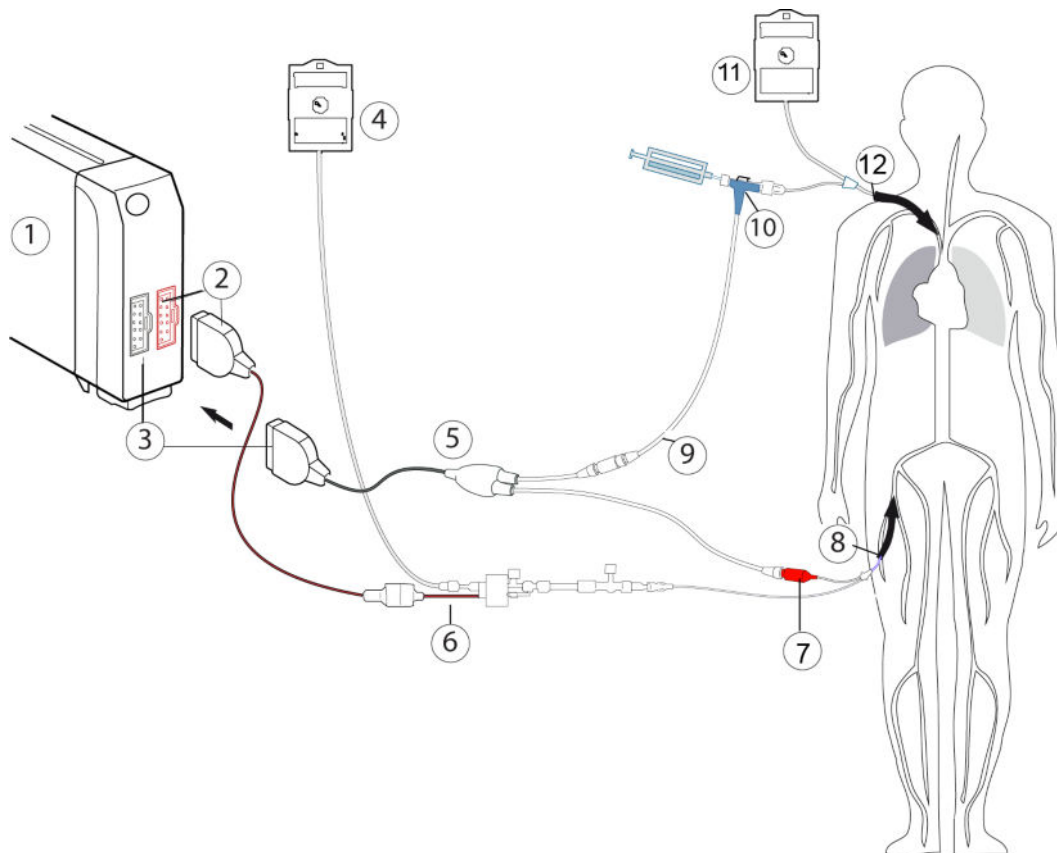
CCO points to note

- For information on materials used in accessories and their biocompatibility, refer to the instructions for use in the accessory package.
- Arterial pressure measured by E-PiCCO and needed for CCO measurement must be assigned to **P8**.
- The patient's height, weight, and gender values are required.
- Always ensure that the catheter is correctly placed and there is no electromagnetic interference or interfering signal transmission.
- Infusion pumps and similar devices may disturb the measurement. To avoid this, consider shutting down these devices if possible especially when monitoring patients with very low CO, high vascular resistance, or a lot of variation in their blood pressure.

- When connecting cables, do not use too much force to avoid the risk of breaking the thread, which might result in loose connection and more instable measurement.
- Do not move the patient until there is a measurement reading on the screen.
- When injecting saline, do not place any extra stop-cocks between the PiCCO catheter and the port.
- It is recommended that the measurement is calibrated at least every 8 hours, or when the message **Re-calibrate CCO** appears and the numerics are grayed out. You can check the calibration date and time through the **View** tab in the CO menu. After 24 hours, the values disappear and can only be checked from the trends.
- Do not add any liquids in the CV line during calibration.
- You can only have one E-PiCCO in the system measuring the CO/CCO. If there are more than one E-PiCCO or some other CO modules with cables connected, the message **Identical CO modules** appears.

CCO measurement setup

CCO equipment to patient connection



1.	E-PiCCO module	2.	P8 pressure connector (red) and cable
3.	CCO connector (gray) and cable	4.	Flush (bag of fluids)
5.	PiCCO continuous cardiac output cable	6.	Disposable pressure transducer
7.	Catheter cable connector	8.	Thermodilution catheter (PULSIOcath)

9.	PiCCO injectate sensor cable	10.	Injectate temperature sensor housing
11.	Flush (bag of fluids)	12.	Central venous catheter (CVC)

Preparing the CCO measurement

1. Select measurement accessories according to the patient type and measurement site.
2. Follow your care unit's policy and procedures for inserting the catheter and positioning the patient for the CCO measurement.
3. Follow the catheter's instructions for use to set up the patient cables.
4. Insert the PULSIOcath catheter into the patient according to the catheter's instructions for use.
5. Connect the PULSIOcath catheter to the continuous cardiac output cable and the invasive pressure transducer.
6. Connect the PiCCO injectate sensor cable to the CV line.
7. Connect the injectate sensor cable to the PiCCO injectate sensor cable.

Checking the CCO measurement

1. Check that the device recognizes cable connections (activates the display) and all **Cardiac Output / CCO** menu selections are available.
2. Select **Art** as the label for **IBP8**.
3. Check that the **IBP8** has been zeroed.

Entering patient data for the CI/CCI value

The patient's height, weight, and gender values are required for determining cardiac index (CI) and continuous cardiac index (CCI), as well as other indexed values.

1. Select the cardiac output parameter window.
2. Select the **Calibrate** tab.
3. Select **Demographics**.
4. Select the patient's gender from the **Gender** list.
5. Set the patient's height and weight with the arrows.

The BSA value is calculated automatically once the height and weight have been selected.

Using the CCO measurement

CO measurement modes

CO measurements for calibration can be taken using the automatic or manual measurement modes. Both measurement modes allow you to use up to six CO measurements for calculating a CO average.

As long as you confirm the CO measurements within 30 minutes from the start of the first thermodilution measurement, the measurements will not disappear during this time even if you leave the menu. To ensure most reliable measurement results with close enough values, it is recommended to perform all injections within 15 minutes. If you are using a very cold injection, wait 1 to 1.5 minutes between each injection. Three to five determinations one after the other within 30 minutes

is the recommended procedure. Also note that there should be less than 10% variation between the measurement results, and their average should be used.

Using automatic CO measurement for calibration

When measuring CO using the automatic mode, new measurements can be taken when the **Press Start CO Serial** message displays.

Holding the injectate syringe by the plunger, not the barrel, improves measurement accuracy.

1. Select the cardiac output parameter window.
2. Select the **Setup** tab.
3. Select **Auto** for **Measurement Type**.
4. Verify that the catheter settings are correct.
5. Select the **Calibrate** tab.
6. When the message **Press Start CO Serial** appears, select **Start CO Serial**.
7. Wait for the message **Inject now!** to display before injecting the injectate.

The **Inject now!** message will remain on screen until the injection starts or **Start CO Serial** is selected.

8. Inject the injectate smoothly. It is recommended to inject as quickly as possible and to take all measurements within 15 minutes.
9. The message **Measuring** displays, followed by the message **Please wait** until the calculation is completed.
10. Observe the thermodilution curve displayed on the screen. The message **CO Complete** displays after the CO determination has been made, followed shortly by the message **Please wait**.
The curve disappears from the screen when the next measurement cycle can start.
11. To take another CO measurement, wait for the **Inject now!** message to display before injecting the injectate.

Using manual CO measurement for calibration

Measuring CO using the manual mode allows you to determine when to begin the injection procedure. This mode may be preferred for patients with extreme blood temperature fluctuations, or when the automatic mode is unable to establish a stable baseline.

Holding the injectate syringe by the plunger, not the barrel, improves measurement accuracy.

1. Select the cardiac output parameter window.
2. Select the **Setup** tab.
3. Select **Manual** for **Measurement Type**.
4. Verify that the catheter settings are correct.
5. Select the **Calibrate** tab.
6. Select **Start CO**.
7. When the **Inject now!** message appears, inject the injectate solution smoothly. It is recommended to inject as quickly as possible and to take all measurements within 15 minutes.

8. The message **Measuring** displays, followed by the message **Please wait** until the calculation is completed.
9. Observe the thermodilution curve displayed on the screen. The message **CO Complete** displays after the CO determination has been made.
The curve remains on the screen.
10. Allow 1 to 1.5 minutes between injections to stabilize the catheter baseline temperature.
11. To perform another CO measurement, wait for the **Press Start CO** message to display, then select **Start CO**.

CO trial measurements

A real-time thermodilution curve and numeric value are displayed with each cardiac output trial. Up to six measurements can be retained. After each measured CO the program automatically averages the CO value. It is recommended to use three to five measurements with less than 10% variation between them for average CO. When saved, the averaged value is entered into the hemodynamic calculations. The saved average CO value is displayed in the parameter window with a timestamp.

Canceling a CO measurement

When a CO measurement has just completed, you can remove this CO measurement trial without entering the **Edit Average** window.

1. In the **Calibrate** tab, select **Cancel/Reject Injection**.
E-modules: In addition to removing the previous measurement, you can also cancel an in-process measurement.

Editing the CO average with E-PiCCO

1. Select the cardiac output parameter window.
2. Select the **Calibrate** tab.
3. Select **Edit Average**.
4. Check the selection boxes for those trials you wish to include in the CO average. If you do not wish to include a trial, ensure its selection box is not checked.
5. Select **Confirm CO & Calibrate** to store the calculated CO average and display it in the cardiac output parameter window.

This will start the continuous measurements of **CCO**, **CCI**, **SVR**, **SVRI**, **SVV**, **SV**, **SVI**, **dPmax**, **PPV**, **CPO**, and **CPI**. It will also open the **Numerical** view.

However, note that other values (**CO**, **CI**, **GEDV**, **GEDI**, **ITBV**, **ITBI**, **EVLW**, **ELWI**, **GEF**, **PVPI**, and **CFI**) are not measured continuously.

Automatic catheter identification

With E-PiCCO, catheters are automatically identified. This is indicated on the **Setup** tab with the text **Catheter** followed by the catheter name.

If the catheter is not identified, the text **Faulty Catheter** is displayed. If no catheter is connected, the text **No CCO catheter** is displayed.

Selecting the measurement site for E-PiCCO

1. Select the cardiac output parameter window.
2. Select the **Setup** tab.
3. Select the measurement site from the **Measurement Site** list: **Femoral**, **Brachial**, or **Axillary**.
With the catheter PV2014L50 only **Radial** is available.

Selecting the patient type

This setting is not related to other patient **Demographics** settings.

1. Select the cardiac output parameter window.
2. Select the **Setup** tab.
3. Select a value from the **Patient Type** list: **Adult** or **Pediatric**.

Selecting the injectate volume

1. Select the cardiac output parameter window.
2. Select the **Setup** tab.
3. Select a value from the **Injectate Volume** list.

Injectate volumes, temperatures, and body weight

Measured thermodilution injectate temperature (Tinj) is shown in the CO menu. The following table lists the recommended injectate volumes based on patient body weight and injectate temperature.

Body weight/kg	ELWI <10	ELWI ≥10	ELWI <10
	iced injectate	iced injectate	room temperature injectate
< 3	2 ml	2 ml	3 ml
< 10	2 ml	3 ml	3 ml
< 25	3 ml	5 ml	5 ml
< 50	5 ml	10 ml	10 ml
< 100	10 ml	15 ml	15 ml
≥ 100	15 ml	20 ml	20 ml

Selecting the CVP source

1. Select the cardiac output parameter window.
2. Select the **Setup** tab.
3. Select a value from the **CVP Source** list: **Manual** or **Auto**.

Selecting the CVP value

You can select the **CVP Value** only after you have selected the **CVP Source > Manual**.

The initial value will be 5 mmHg or 0.7 kPa according to what has been selected as the blood pressure unit.

1. Select the cardiac output parameter window.

2. Select the **Setup** tab.
3. Set the **CVP Value** with the arrows. The **CVP Value** should reflect the actual patient CVP pressure, otherwise the CCO value may not be accurate.

Selecting the CO scale

This selection sets the upper limit of the waveform scale for the thermodilution waveform fields.

1. Select the cardiac output parameter window.
2. Select the **Setup** tab.
3. Select a value from the **Scale** list.

Selecting what to show with CO

This setting affects the contents of the cardiac output parameter window.

1. Select the cardiac output parameter window.
2. Select the **Setup** tab.
3. Select a value from the **Show With CO/CI** list: **None** or **Tblood**.

Selecting indexed values

The parameters in the **Graphical** and **Numerical** views and split screen can be either indexed or non-indexed. The following parameters are indexed: **CI**, **CCI**, **SVRI**, **SVI**, **ELWI**, **CPI**, **ITBI**, and **GEDI**.

E-PiCCO indexed values are only available for patients weighing 15 kg (33 lb) or more.

1. Select the cardiac output parameter window.
2. Select the **Setup** tab.
3. Enable the toggle of **Indexed**.

Setting the Tblood alarm

1. Select the cardiac output digit field.
2. Select the **Alarms** tab.
3. Check that the **Alarm** of **Tblood** is turned on.
4. Set the related alarm limits with arrows.

Selecting the viewing mode

Parameters measured by E-PiCCO can be displayed in **Graphical** or **Numerical** view.

1. Select the cardiac output window.
2. Select the **View** tab.
3. Select **Graphical** or **Numerical** from the **View** list.

About the numerical view

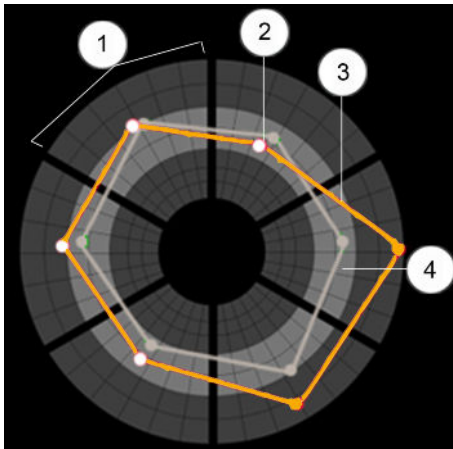
The set of available parameters depends on the license in use. They are grouped in three groups on the screen: **Flow**, **Volume**, and **Organ Function**. The values can be selected to be indexed or not. The displayed values are the confirmed averaged values of the last calibration measurement. There is also

a timestamp beside each confirmed, not continuously measured value, indicating the time when the value was confirmed. The values that are measured continuously do not get a timestamp.

These values remain also after 8 hours have passed since the last calibration. After 24 hours, the values disappear and can only be checked from the trends.

About the graphical view

The **Graphical** view displays a user-selectable number (3 to 7) of parameters as a graph. It will display the label, value, and unit of the selected parameters, and each parameter corresponds to a sector in the circle.



1. Parameter sector
2. Parameter value displayed as a white dot. If values are on the limit of or outside the target zone, the dots are orange.
3. Lines connecting the parameter value dots. If values are inside the target zone, the lines are green. If values are outside the target zone, lines are orange.
4. Target zone. Describes the normal range of the parameter values. If a parameter has alarm limits, its normal range corresponds to these. Other parameters' normal ranges are user-selectable.

Configuring parameters

You can configure 3 to 7 numeric parameters to appear in the **Graphical** view. Each parameter will correspond to one sector.

1. Select the cardiac output parameter window.
2. Select the **View** tab.
3. Select **Configure > Parameters**.
4. Select a value from the **Number of Parameters** list.
5. Select parameters from the lists **Numeric 1** to **Numeric 7** according to your needs.

The parameters will appear in the **Graphical** view in the same places as you can see them when configuring: **Numeric 1** will be top center, and others in a clockwise sequence in the circle.

Configuring target zones

You can configure the upper and lower target zone limits. If a parameter has alarm limits, the limit settings are used, and you cannot configure the target zones separately.

1. Select the cardiac output parameter window.
2. Select the **View** tab.
3. Select **Configure > Target Zones**.
4. Set the **Lower Target Zone** and **Upper Target Zone** with the arrows.
If you set either zone to **OFF**, that target zone will correspond to the parameter's maximum or minimum displayed value.

Saving a graph

You can save the current values of all numerical parameters in the **Graphical** view. You can save six reference graphs at the most. If you try to save more, the message **Saving will erase 2nd saved graph** appears. You can continue with the saving, but the second oldest reference graph will then be deleted.

1. Select the cardiac output window.
2. Select the **View** tab.
3. Select **Graphical** from the **View** list.
4. Select **Save Graph**.

Selecting a reference graph

You can view a previously saved graph as a reference in the **Graphical** view.

1. Select the cardiac output window.
2. Select the **View** tab.
3. Select **Graphical** from the **View** list.
4. Select a graph from the **Reference Graph** list.

Erasing a graph

You can erase unnecessary graphs.

1. Select the cardiac output window.
2. Select the **View** tab.
3. Select **Graphical** from the **View** list.
4. Select a graph from the **Erase Graph** list.

Selecting split screen

You can select the **Cardiac Output / CCO** split screen. It will show the same content as the **Graphical** view. Reference graphs are not shown and parameter units and values are shown below the graph.

1. Select the  >  **Screen Setup**.
2. Select the screen **Dock**.
3. Select the **Split Screen** vertical tab.
4. Select **Show > PiCCO**.

Setting alarms

You can set the high and low limit alarms for **CCO** and **CCI**. The limits cannot be outside the absolute alarm limits, which are set in **Alarms Setup**.

1. Select the cardiac output window.
2. Select the **Alarms** tab.
3. Check that the **Alarm** is turned on.
4. Set the related **CCO** and **CCI** high and low alarm limits with the arrows according to your needs.

How to improve the CCO accuracy

The following factors can influence the continuous cardiac output accuracy:

- The injection technique used.
- Time between injections.
- Temperature of the injectate solution.
- Volume of the injectate solution.
- Prolonged injections or excess handling of the syringe.
- Rapid changes in heart rate, blood pressure, or pulmonary artery blood temperature.

The following are suggestions about technique that can help obtain accurate continuous cardiac output:

- Always hold the syringe by the plunger, not the barrel.
- Inject solution rapidly and smoothly.
- Wait between measurements:
 - 5 minutes with iced injectate
 - 1 minute with room temperature injectate
- In most cases, 10 ml of injectate is enough for patients weighing from 50 to 100 kg.
- Make three to five determinations with less than 10% variation between the measurements and take the average result.

PRAM CO measurement

PRAM CO safety precautions

PRAM CO warnings

WARNING

ERRONEOUS READINGS.

The cardiac output readings may be erroneous in case of sustained Arrhythmia and/or Severe tachycardia.

WARNING

ERRONEOUS READINGS.

The cardiac output reading may be unreliable under specific pathological conditions when the dicrotic notch is not correctly detected for all consecutive heartbeats.

WARNING

ERRONEOUS READINGS.

PRAM CO might provide incorrect values in the event that the pressure signal is affected by detection errors such as, but not limited to, the following:

- Contact between the catheter tip and the artery wall;

- Wrong positioning, folding or excessive angle of the catheter or the line;

- Blood clots in the catheter or line;

- Poor quality of the pressure signal obtained through the transducer line (underdamping; overdamping).

PRAM CO instruction

The Pressure Recording Analytical Method (PRAM) is the method that allows for the calculation of hemodynamic variables by analyzing the shape and area of the arterial pressure wave. The PRAM represents the application within the physiological sector of the Perturbation Theory, which is well known and largely applied in physics. The device integrates the full PRAM algorithm.

The device works in real time, beat by beat. Each individual arterial pulse is detected and analyzed by the PRAM.

The PRAM's uniqueness consists in its ability to calculate the specific, typical cardiovascular system impedance of the subject under observation in real time. By impedance (usually indicated in formula as $Z(t)$), the resultant of different forces that mutually interact and simultaneously operate in the cardiovascular system is meant. Elements, such as cardiac contractility, vascular and arterial resistances and arterial compliance exert characteristic forces that determine different, constantly changing physio pathological profiles; the shape and area of the arterial pressure curve are affected by these elements and, therefore, they describe the instantaneous interaction of all of these elements.

Since impedance is constantly changing, the device does not use constant or pre-assessed values for its calculation so as to reliably follow the physio pathological variations of the impedance. Therefore, the PRAM CO monitoring does not need any direct or indirect calibration.

CO Monitoring displayed on the device screen

The **CO Monitoring** window (with the Decision support view) is displayed as below:



No.	Items	Description
1.	CO Monitoring (CO Monitoring)	Window title.
2.		Switch among the display views: Decision support view, Numeric view, Trends view. Decision support view and Trends view can only be displayed on Dock screen or external display.
3.		Select the key to access more settings about CO Monitoring .
4.		Hide the CO Monitoring window as a bar at the left side of main screen. Right swipe the bar to show the CO Monitoring window again.
5.	Graphic trend	In the Decision support view, the graphic trend is displayed in single width. Clicking on this area, you can open the parameter's extended trend in double width. And you can: • select the trends resolution. There are six options: 5 min, 10 min, 15 min, 30 min, 1 h and 2 h. • slide two cursors to select data of two time points. Once selected, the data difference between two time points and the percentage change are displayed on the screen. The extended trend can only be viewed on Dock screen.
6.	Dashboards	The parameters are displayed as the dashboards in the Decision support view.

About the Decision support view

Decision support view can only be displayed on Dock screen or external display.

The Decision support view displays two graphic trends and six parameter values as dashboards. Physiological changes reflected by the lower-level parameters may have effect on the upper-level parameters in dashboards.

You can configure the display sequence of graphic trends in **Field 1** and **Field 2** of the **Mini Trends Layout Configuration**. For more information, see [Selecting layout configuration for Mini Trends on page 262](#).

When you click on the graphic trend, you can open the parameter's extended trend. For more information about extended trend, see [CO Monitoring displayed on the device screen on page 257](#).

The parameter values are displayed as the dashboards. The green zone of the dashboard indicates the expected range of parameter, which is called target zone. The gray zone indicates the adjustable range of parameter. In this device, you can adjust the **Lower Target Zone** and **Upper Target Zone**. For more information, see [Configuring target zones on page 262](#).

The dot in the dashboard indicates real-time value of parameter. When the parameter value is within the target zone, the dot turns white. When the parameter value exceeds the target zone, the dot turns orange. When no parameter value is available, "---" is displayed without dot.

NOTE

When the real-time value exceeds the adjustable range, the dot will appear on the far left or far right of the dashboard.

Next to the **MAP** dashboard, there is a pie chart. The pie chart represents the recent monitoring time (up to 24 hours) of **MAP**, including time below target zone, time within target zone and time above target zone. The time within target zone is highlighted with a green background in the pie chart.

Clicking the pie chart opens the **MAP Time Within Target** menu. The menu can only be displayed on Dock screen.

About the Time within target

The **MAP Time Within Target** menu can only be displayed on Dock screen.

The **MAP Time Within Target** menu displays a curve chart composed of measured MAP data and monitoring time. From the curve chart, you can check the association between the MAP value and target zone: below target zone, within target zone and above target zone.

In the curve chart, the time scale varies with different monitoring time. The maximum displayed monitoring duration is 24 hours.

Also the menu displays the **Time within target:**, **Time below target:**, **Time above target:**, **Measurement time:** and a pie chart that graphically indicates the proportion of time within target.

About the Numeric view

On Hub screen, Numeric view displays five parameter values.

On Dock screen, Numeric view displays two graphic trends and five parameter values. You can configure the display sequence of graphic trends in **Field 1** and **Field 2** of the **Mini Trends Layout Configuration**. For more information, see [Selecting layout configuration for Mini Trends on page 262](#).

The five parameters are **CO / CI**, **SVR / SVRI**, **MAP**, **SV / SVI**, **HR**.

When you click on the graphic trend, you can open the parameter's extended trend. For more information about extended trend, see [CO Monitoring displayed on the device screen on page 257](#).

About the Trends view

Trends view can only be displayed on Dock screen or external display.

According to the **Mini Trends Layout Configuration** setup, the parameters will be displayed as trends in the Trends view. For more information, see [Selecting layout configuration for Mini Trends on page 262](#).

When you click on the graphic trend, you can open the parameter's extended trend. For more information about extended trend, see [CO Monitoring displayed on the device screen on page 257](#).

PRAM CO measurement limitations

- PRAM CO is suitable for use with adult patients only. The cardiac output indications provided by PRAM CO must be checked by the operator.
- IBP pressure channel is limited to be IBP1 or IBP2, with the **Art** label only. The better the detection of the pressure wave morphology, the more accurate the values provided by PRAM CO will be.
- PRAM CO, cardiac output, continuous cardiac output measurement cannot be used simultaneously. Stop all but one measurement in use.
- PRAM CO has no specific contraindications. However, a careful use of the system is recommended in the following cases:
 - Severe peripheral vasodilation;
 - Serious malformations or cardiovascular system pathologies;
 - Significant pressure wave alterations (underdamping, overdamping).

In such cases, the information provided by the system must be carefully evaluated because it may be affected by errors.

PRAM CO cannot be used to assess haemodynamic variables when the catheter tip is placed into a vein, pulmonary artery or one of the cardiac chambers.

PRAM CO points to note

- The patient's height and weight values are required before starting CO monitoring.

PRAM CO measurement setup

Patient connections and preparing the patient

Patient connections and preparation are identical to those used in the IBP measurement. For more information about patient connection, see [Invasive pressure equipment to patient connection with device on page 221](#).

Changing IBP label

To start PRAM CO monitoring, you need change the IBP label of corresponding channel to **Art** first.

1. Select the digit field of IBP1 or IBP2, which is used as input for CO monitoring.
2. Select **Art** from **Label** list.
3. Check that the selected invasive pressure has been zeroed.

Entering patient data for CO monitoring

The patient's height and weight values are required for starting CO monitoring.

1. Select the information area > **Demographics**.
2. Set the patient's height and weight.

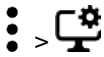
The BSA value is calculated automatically once the height and weight have been selected.

NOTE

The weight shall be between 28 and 200 kg (200 and 440 lb). BSA shall be ≥ 1 .

Using the PRAM CO measurement

Accessing the CO Monitoring window

1. Select  > **Screen Setup**, and the required screen.
2. Select the **Side Pane** vertical tab.
3. Set up the screen layout according to the current menu.
 - On the **Hub Screen Layout Setup** menu: select **Show > CO Monitoring**.
 - On the **Dock Screen Layout Setup** menu: select **Show > Split Screen > CO Monitoring**.
4. Then the **CO Monitoring** window shows up on the left side of main screen.

Starting the CO monitoring

1. Open the **CO Monitoring** window.
2. If you have not set IBP1 or IBP2 label to **Art** ahead, select **Change IBP1 Label** or **Change IBP2 Label** to set up.
3. Select **Start**.
4. Input or check the patient height and weight values.
5. Select **Confirm** to open the view last used.

Selecting indexed values

The parameters in the Decision support view can be either indexed or non-indexed. The following parameters are indexed: **CO**, **CI**, **SVR**, **SVRI**, **SV**, and **SVI**.

1. Select  on **CO Monitoring** window.
2. Select the **Setup** tab.
3. Enable the toggle of **Indexed Values**.

Checking the CVP source

When the device is configured with a CVP label and there is a valid CVP value, the **CVP Source** will be automatically changed to **Auto**. Otherwise, the **CVP Source** is **Manual**.

1. Select  on **CO Monitoring** window.
2. Select the **Setup** tab.
3. Check the current **CVP Source**.

Selecting the CVP value

CVP Value is editable only when **CVP Source** is **Manual**.

1. Select  on **CO Monitoring** window.
2. Select the **Setup** tab.
3. Check that the **CVP Source** is **Manual**.
4. Set the **CVP Value** with the arrows. The **CVP Value** should reflect the actual patient CVP pressure, otherwise the measurement value may not be accurate.

Detecting dicrotic notch

During one arterial pulsation, dicrotic pressure is at the end of the systolic phase, when the aortic valve closes. It's a marker for the end of the ventricular ejection period. The device can detect beat by beat and mark the position of dicrotic notch by a vertical green line.

1. Select  on **CO Monitoring** window.
2. Select the **Setup** tab.
3. Select **Dicrotic Notch Detection**. Then check the position of dicrotic notch through the vertical green line.

NOTE

The dicrotic notch should be positioned on the actual dicrotic incisure, and that there are no artefacts due to poor signal quality.

Selecting layout configuration for Mini Trends

1. Select  on **CO Monitoring** window.
2. Select the **Setup** tab.
3. Set up the **Mini Trends Layout Configuration**. You can select the parameters to be displayed in the graphic trends. The options are **CO / CI, SV / SVI, SVR / SVRI, PPV, MAP, HR, BIS, SE**.

Stopping the CO monitoring

1. Select  on **CO Monitoring** window.
2. Select the **Setup** tab.
3. Select **Stop**.

Configuring target zones

The target zone is displayed as a green range of the dashboard on the **CO Monitoring** decision support view. For more information, see [About the Decision support view on page 258](#).

You can configure the lower and upper target zone limits. Each parameter has a target zone for setup.

1. Select  on **CO Monitoring** window.
2. Select the **Target Zones** tab.
3. If needed, adjust each parameter's **Lower Target Zone** and **Upper Target Zone** with arrows.

Managing the hypotension risk notification

When **Auto Prompt** is enabled, you can configure a threshold MAP value to prompt the **CO Monitoring** window when measured MAP value falls below the threshold. Note that the **CO Monitoring** window will pop up only when you have set up the screen layout. For more information, see [Accessing the CO Monitoring window on page 261](#).

This feature provides clinical decision support related to hypotension. It is not intended to replace the competent judgment of a clinician and must be used in conjunction with observation of clinical signs and symptoms.

1. Select  on **CO Monitoring** window.
2. Select the **Target Zone** tab.
3. Enable the toggle of **Auto Prompt**.
4. Adjust the **Hypotension Risk when MAP below** with arrows, if needed.

NOTE

You can set the **Hypotension Risk when MAP below** to be non-editable through the

 >  **Service** (password protected) menu. Please consult qualified and trained technical users to set up. For more information, refer to the Service Manual.

Setting the PRAM CO alarms

1. Select  on **CO Monitoring** window.
2. Select the **Alarms** tab.
3. Check that the **Alarm of CO and CI** is turned on.
4. Set the related alarm limits with arrows.

Submitting license code

Two types of licenses are available. You can choose to buy Long term PRAM CO access for 10 years, or 50 patients (or times) PRAM CO access for 1 year.

To submit the license code for Long term PRAM CO access, please consult qualified and trained technical users. To submit the license code for 50 patients (or times) PRAM CO access, you can either consult the technical users or follow the steps below:

1. Select  on **CO Monitoring** window.
2. Select the **License** tab.
3. Enter the **License Code** and **Expiration Date (YYYYMMDD)**, then select **Submit**. The device will indicate success by displaying the message **Input successfully**.

If the remaining license is less than 10 times, or the license expiration date is within 1 month, a prompt message will show up on the **CO Monitoring** window.

If no remaining license is available, you should select **Input License** first before starting the CO monitoring.

Airway gases

Airway gases safety precautions

Airway gases warnings

WARNING

PATIENT SAFETY.

Always inspect the airway adapter for a tight connection and proper operation before attaching it to the patient.

WARNING

ERRONEOUS READINGS.

Leaks in the gas sampling circuit (water trap and sampling line) may cause inaccurate readings.

WARNING

WATER TRAP BLOCKAGE.

Remove the airway sampling line from the patient's airway while nebulized medications are being delivered.

WARNING

INFECTION HAZARD.

Handle the water trap and its contents as you would any body fluid. Infectious hazard may be present.

WARNING

EXPOSURE TO ANESTHETIC AGENTS.

Since sample gas may contain anesthetic agents, make sure that it is not released in the room. Connect exhaust to a scavenging system to prevent exposure to anesthetic agents.

WARNING

ERRONEOUS READINGS.

Strong scavenging suction may cause excessive sample gas flow and inaccurate gas readings.

WARNING**STRANGULATION.**

Route all tubing away from the patient's throat to avoid strangulation.

WARNING**INFECTION HAZARD.**

To avoid the spread of infectious disease, do not allow the exhaust to discharge in the direction of the patient or user.

WARNING**MISINTERPRETATION.**

EtCO₂ values may differ from blood gas readings.

WARNING**ERRONEOUS READINGS.**

A failure in zeroing or calibrating airway gases may cause inaccurate readings.

WARNING**INACCURATE READINGS.**

To ensure the accuracy of gas measurement, perform regular calibration according to the instructions provided. Failing to do so may result in inaccurate readings and compromised patient safety. To avoid this risk, always adhere to the specified calibration intervals.

WARNING**EXPOSURE TO ANESTHETIC AGENTS.**

Since calibration gas contains anesthetic agents, always ensure sufficient ventilation of the room during calibration.

WARNING**EQUIPMENT DAMAGE.**

Do not wash, disinfect or open the water trap cartridge. Do not touch the water trap membrane. The hydrophobic membrane is damaged if any cleaning is attempted, and this may result in the contamination of the gas sensors.

WARNING**CROSS-INFECTION.**

E-miniC: To avoid the risk of patient cross-infection, do not return the sampled gas to the breathing system.

WARNING**PATIENT SAFETY.**

Always ensure the correct size and fit of accessories according to patient type and application, especially when monitoring pediatric and neonatal patients. The size and fit of accessories may impact the measured gas concentration values at low tidal volumes. It is recommended to have the gas sampling port close to the proximal end of the endotracheal tube. Excessive dead space in the circuit, including the accessories, may cause re-breathing of gases. Very low accessory dead space between the breathing circuit Y-piece and the gas sampling site may impact the measured gas concentration due to dilution of the sampled exhaled gas with fresh gas from the ventilator. To confirm accurate correlation with measured gases and blood, check arterial blood gas values to confirm a suitable setup is used.

WARNING**PATIENT SAFETY.**

E-miniC module: Do not use this module on patients that cannot tolerate the removal of 150 ml/min from their total minute ventilation.

WARNING**ERRONEOUS READINGS.**

E-miniC module: O₂, N₂O and anesthetic agent gases may interfere with EtCO₂ readings.

WARNING**PATIENT SAFETY.**

Connect only one CO₂ module (E-sCAiO, E-sCO, N-CAiO, or E-miniC module) to the device at a time.

The following apply to the E-sCAiO, E-sCO, or N-CAiO module only:

WARNING**PATIENT SAFETY.**

When using the E-sCAiO, E-sCO, or N-CAiO module with volume controlled ventilation at low tidal volumes, the specified gas withdrawal rate may significantly reduce the amount of gas delivered to the patient.

WARNING**PATIENT SAFETY.**

Make sure to compensate for the possible reduction of tidal volume caused by the 120 ml/min gas sample flow.

WARNING**ERRONEOUS READINGS.**

Ensure that the E-sCAiO, E-sCO, or N-CAiO modules are in vertical position when used. Tilting them may result in erroneous readings.

WARNING**PATIENT CROSS-INFECTION.**

Returning the sampled gas to the patient circuit causes a risk of patient cross-infection.

WARNING**PATIENT CROSS-INFECTION.**

Sampled gas may be returned to the patient circuit only when using a bacterial filter system proximal to the patient. In addition, the anesthesia device must have a bacterial filter between the module gas output and patient circuit. Otherwise, there is a risk of patient cross-infection.

The following apply to the Microstream CO₂ micro-module only:

WARNING**INACCURATE READINGS.**

To avoid the risk of inaccurate CO₂ readings, you must select the appropriate patient age range before starting a CO₂ measurement with the Microstream CO₂ micro-module.

For other Microstream CO₂ micro-module warnings and cautions, refer to the Microstream CO₂ micro-module instructions for use.

Airway gases cautions

CAUTION**EQUIPMENT DAMAGE.**

Do not apply pressurized air or gas to any outlet or tubing connected to the device. Pressure may destroy sensitive elements.

CAUTION**MISINTERPRETATION.**

Patient-specific MAC is affected by several factors such as patient age and body temperature.

For information about Microstream CO₂ micro-module warnings and cautions, refer to Instructions for use for Microstream CO₂ micro-module.

Airway gases instruction

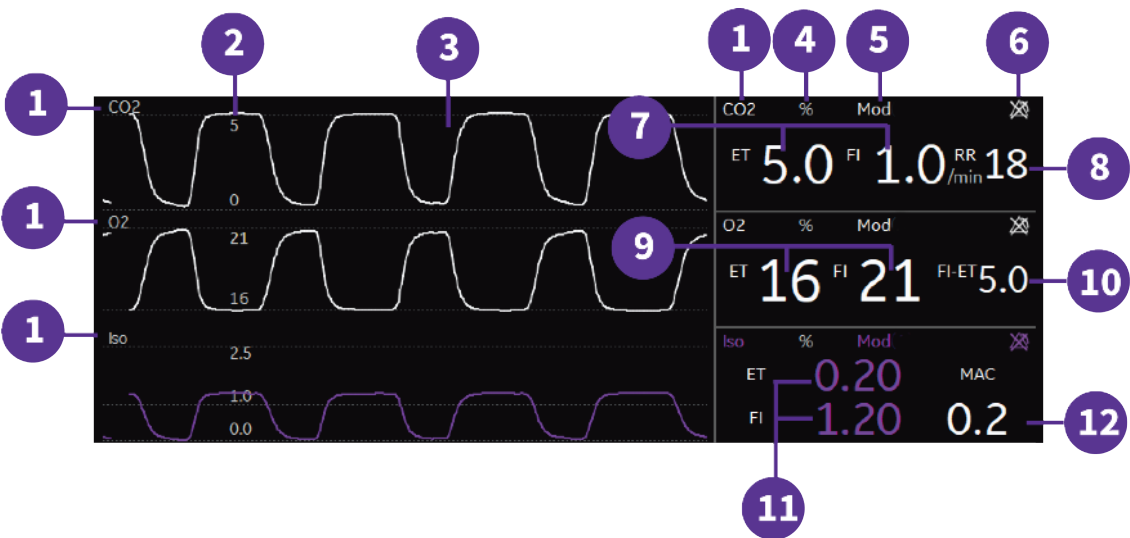
Airway gas measurement is a continuous, non-invasive technology, which provides inspired (Fi) and expired (Et) values of CO₂, O₂, N₂O and anesthetic agents (AA).

According to the module in use, monitoring airway gases, and CO₂ in particular, may help clinician to reduce the risk of hypercapnia and hypocapnia and their consequences. With CO₂ monitoring it is possible to detect unsuccessful (esophageal) intubation and supervise normoventilation.

In intensive care it is to be noted that in critically ill patients there may be arterialalveolar CO₂ difference due to ventilation/perfusion mismatch. However, continuous and non-invasive CO₂ measurement provides useful trend information.

Monitoring of inspiratory and expiratory gas concentrations of oxygen, nitrous oxide, and anesthetic agents guides fresh gas delivery during anesthesia. The lower the amount of fresh gases used, the more important the gas monitoring is, since the rebreathed gases dilute the fresh gas concentrations from the anesthesia device.

Airway gases measurement displayed on the device screen

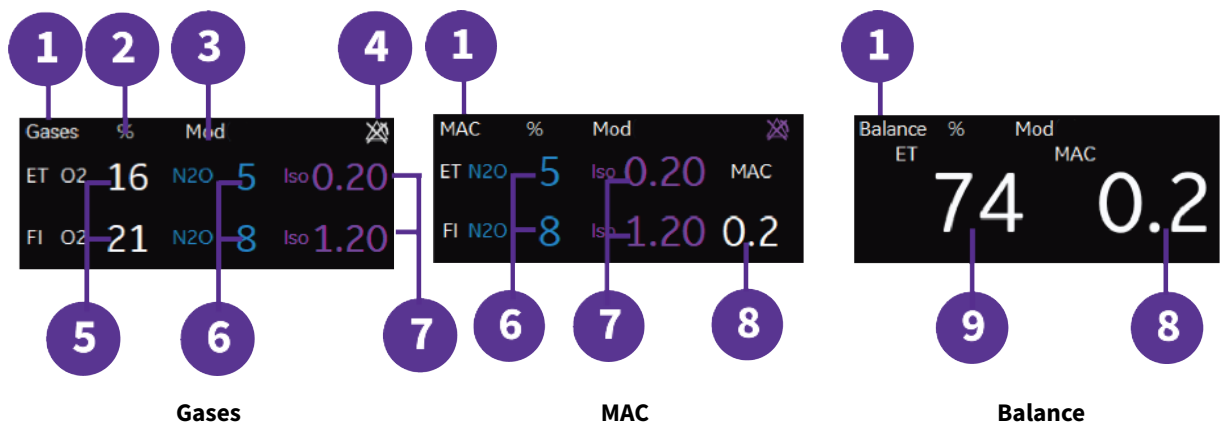


1.	CO2, O2, Iso (CO2 , O2 , Iso): parameter or waveform label	2.	waveform scale
3.	waveforms	4.	unit
5.	Mod (Mod): measurement source, which depends on your selection in CO2 Setup menu.	6.	alarm status, alarm limits, or other messages
7.	ET, FI (ET , FI): value of EtCO ₂ , FiCO ₂	8.	RR (RR): value of respiration rate
9.	value of EtO ₂ , FiO ₂	10.	FI-ET (FI-ET): value of O ₂ diff
11.	value of EtAA, FiAA ^{*1}	12.	MAC (MAC): value of MAC ^{*2}

^{*1} If mixture agent is identified, the 2 agents value will be displayed.

^{*2} If MACage is configured, **MAC xxyrs** will be displayed.

The lower digit field also can configure to display Gases, MAC, and Balance field.



1.	Gases, MAC, Balance (Gases , MAC , Balance): parameter label	2.	unit
3.	Mod (Mod): measurement source, which depends on your selection in CO2 Setup menu.	4.	alarm status, alarm limits, or other messages
5.	O2 (O2): value of EtO ₂ , FiO ₂	6.	N2O (N2O): value of EtN ₂ O, FiN ₂ O
7.	Iso (Iso): value of EtAA, FiAA ^{*1}	8.	MAC (MAC): value of MAC ^{*2}
9.	ET (ET): value of EtBalance		

^{*1} If mixture agent is identified, the 2 agents value will be displayed.

^{*2} If MACage is configured, **MAC xxyrs** will be displayed.

Airway gases parameters

Airway gases parameters, gas modules

The E-sCAiO, E-sCO and N-CAiO modules measure the following airway gas parameters:

Parameter	E-sCAiO	E-sCO	N-CAiO
CO ₂	Support	Support	Support
O ₂	Support	Support	Support
N ₂ O	Support	Support	Support
AA	Support	n/a	Support*
Agent ID	Support	n/a	Support*
Additional measurements			
MAC	Support	n/a	Support
MACage	Support	n/a	n/a
Balance gas	Support	n/a	n/a
Gas exchange	n/a	n/a	n/a
Patient Spirometry	n/a	n/a	n/a
Respiration rate	Support	Support	Support
Sampling method			

Parameter	E-sCAiO	E-sCO	N-CAiO
Sidestream	Support	Support	Support
Mainstream	n/a	n/a	n/a

* The N-CAiO module only supports single agent display and identify.

Airway gases parameters, E-miniC

Parameter	E-miniC
CO ₂	support
O ₂	n/a ^{*1}
N ₂ O	n/a ^{*1}
AA	n/a
Agent ID	n/a
Additional measurements	
MAC	n/a
MACage	n/a
Balance gas	n/a
Gas exchange	n/a
Patient Spirometry	n/a
Respiration rate	support
Sampling method	
Sidestream	support
Mainstream	n/a
*1 The measured N ₂ O and O ₂ value are not displayed. E-miniC requires manual selection from the device menu to compensate for N ₂ O and O ₂ .	

Airway gases parameters, Microstream CO₂ Micro-module

The Microstream CO₂ Micro-module measures the following airway gas parameters:

- end-tidal carbon dioxide (EtCO₂)
- FiCO₂
- respiration rate

Airway gases parameters, external device

You can connect the device to any compatible external device, such as a directly connected anesthesia device or any compatible peripheral device (ventilator or anesthesia device) connected via the Unity Network Interface Device.

After the external device is connected, patient data can be intensively displayed on one device. If the parameter source is the external device, the device can only display the messages delivered from the external device, but not send control commands to the external device, e.g. silencing alarms on the external device.

For more information about the compatible directly connected anesthesia device, see the supplemental information manual provided.

For more information about compatible external devices connected via the Unity Network Interface Device, see the Unity Network Interface Device User's Manual.

The external device can transmit the following data:

- Waveform
- Parameter digits
- Alarm

The message **Ext** appears in the certain area of screen when the data is from the external source.

The device displays the data and based on the measured values generates:

- MAC, MACage, O₂Diff, Et Balance
- Trend
- Print output
- Real-time data transmission to the central station and network compatible with the device

The external device can transmit the following parameters:

- CO₂
- O₂
- N₂O
- AA
- AA ID
- RR

Airway gases measurement limitations

- E-miniC is not suitable for use with patients weighing less than 5 kg (11 lbs). In the NEONATAL mode, the CO₂ parameter and Respiration rate are not displayed.

Airway gases points to note

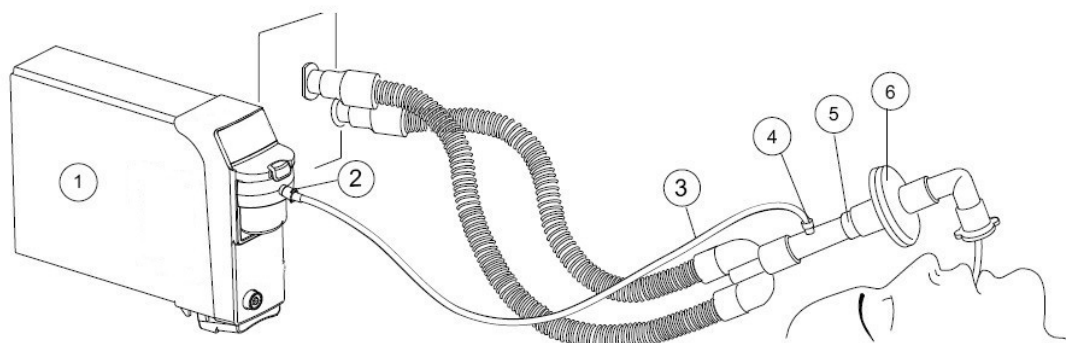
- This equipment is suitable for use in the presence of electrosurgery, as tested according to IEC 80601-2-49 clause 202.8.102 Disturbances from HF Surgical Equipment.
- For information on materials used in accessories and their biocompatibility, refer to the instructions for use in the accessory package.
- Disconnect the sampling line from the patient circuit while administering nebulized medication.
- Make sure that you are using gas exhaust lines that are compatible with the module:
 - GE HealthCare exhaust lines for modules with GE HealthCare custom exhaust connector
 - Luer exhaust lines for modules with a Luer exhaust connector
- If anesthetic agents are present, use GE HealthCare anesthesia sampling lines (PE/PVC). Otherwise, you can use GE HealthCare CO₂ sampling line (PVC).

- Make sure that you are using a water trap that is compatible with the module:
 - E-sCAiO, E-sCO and N-CAiO modules: D-fend Pro or D-fend Pro+
 - E-miniC: Mini D-fend
- Empty the water trap container as soon as it is more than half full.

D-fend Pro or D-fend Pro+: With a sample gas temperature of 37°C, a room temperature of 23°C, and sample gas relative humidity of 100 %RH, the water trap should be emptied every 24 hours (applies when the sample gas flow is within 120 ± 20 ml/min for E-sCAiO, E-sCO and N-CAiO modules, 150 ± 25 ml/min for E-miniC module).
- Place the airway adapter between the HME and Y-piece.
- Place the airway adapter with all sampling ports upwards.
- Always check the tightness of all connections.
- After the E-module is connected to the device, it takes some time for the E-module to warm up before the reading is displayed. For detailed warm-up time of different E-modules, please refer to the Supplemental Information Manual.
- Make sure that the gas sampling line is properly connected to the water trap and the water trap is properly connected to the airway gas module. Gas leaks in these connections may dilute the gas sample from the patient circuit, thus resulting in erroneous gas readings. During normal operation, all sampled gas flows out of the sample gas outlet. Room air is used as reference gas for the oxygen measurement and it is mixed with the sampled gas. The sampled gas is diluted by room air so that the fraction of room air in the exhaust gas is about 20%.
- E-miniC: The system automatically compensates for changes in barometric pressure over the atmospheric pressure range of 500 to 800 mmHg (66.7 to 106.7 kPa) over the specified atmospheric pressure ranges.
- Data from external source: The device's data display may have delay compare with the external device, please observe the patient frequently.

Airway gases measurement setup

Airway gases equipment to patient connections with gas module



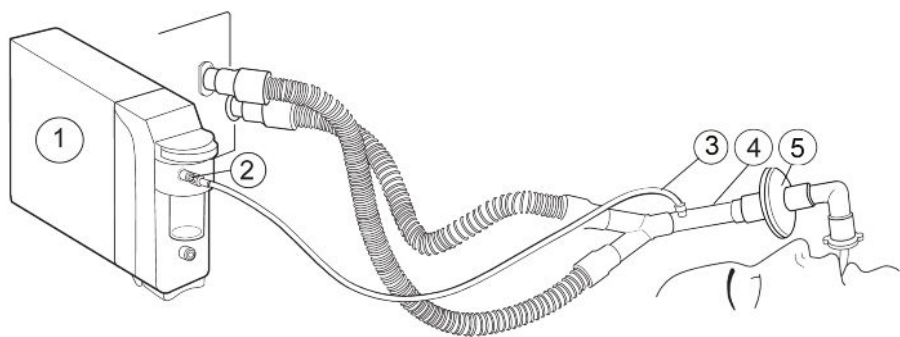
1.	E-sCO ₂ , E-sCAiO, or N-CAiO module	2.	Gas sample, gas sampling line connector on the water trap
3.	Gas sampling line	4.	Gas sampling line connector on the airway adapter; place the connector upwards
5.	Airway adapter with sampling line connector	6.	Heat and moisture exchanger with filter (HMEF) (optional when sampled gas is directed to the scavenging system)

NOTE

Place all D-lite ports upwards with a 20° to 45° tilt to prevent condensed water from entering the sensor interior and the tubings.

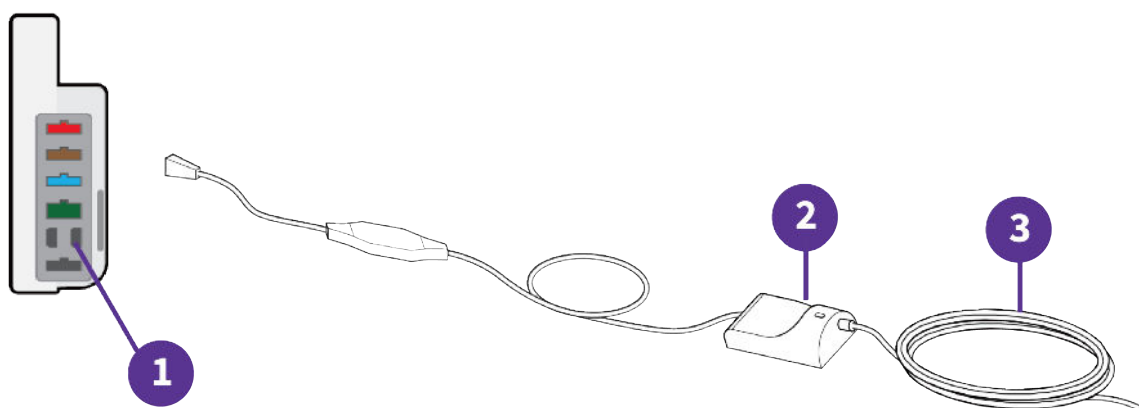
Always ensure the correct size and fit of accessories according to patient type and application, especially when monitoring pediatric and neonatal patients. The size and fit of accessories may impact the measured gas concentration values at low tidal volumes. It is recommended to have the gas sampling port close to the proximal end of the endotracheal tube. Excessive dead space in the circuit, including the accessories, may cause re-breathing of gases. Very low accessory dead space between the breathing circuit Y-piece and the gas sampling site may impact the measured gas concentration due to dilution of the sampled exhaled gas with fresh gas from the ventilator. To confirm accurate correlation with measured gases and blood, check arterial blood gas values to confirm a suitable setup is used.

Airway gases equipment to patient connections with E-miniC, critical care setup



1.	E-miniC module	2.	Sampling line connector on the water trap
3.	Gas sampling line	4.	Adapter with sampling line connector
5.	Heat and moisture exchanger with filter (HMEF)		

Airway gases equipment to patient connections with Microstream CO₂ micro-module



1.	The micro-module connectors	2.	Microstream CO ₂ micro-module
3.	Sampling line		

For more information regarding connection with the Microstream CO₂ micro-module, refer to the manufacturer’s instructions for use.

Connecting to external device

You can connect the device to any compatible external device, such as a directly connected anesthesia device or any compatible peripheral device (ventilator or anesthesia device) connected via the Unity Network Interface Device.

For the direct connection of the anesthesia device, refer to [Connecting the anesthesia device on page 86](#).

To connect the Unity Network Interface Device to the device, plug the cable into the ID connector on the back side of the Dock. For more information, see [Back view of Dock on page 68](#).

For how to connect the Unity Network Interface Device to the external device, refer to the Unity Network Interface Device User's Manual.

For the external device to patient connection, refer to the instructions for use supplied with external device.

Setting up the airway gases measurement

1. Make sure that the water trap container is empty and properly attached.
2. Connect the gas sampling line to the sampling line connector on the water trap.
3. Connect the sample gas outlet to gas scavenging if N₂O or volatile agents are used.
4. Turn on the device or connect the module to the device. The device performs a self-check for the module when the module is connected.

Automatic agent identification is activated in those modules that have this feature.

5. Wait until the message **Calibrating** disappears.
6. Connect the sampling line to the airway adapter or connect the airway adapter to the ventilator circuit. Position the adapter with the sampling port upwards to minimize the amount of condensed water possibly entering the sampling line.
7. Check that the airway adapter connections are tight and that the adapter is operating properly.

NOTE

Check that the sample line is connected to the water trap before connecting the module to the device or turning on the device.

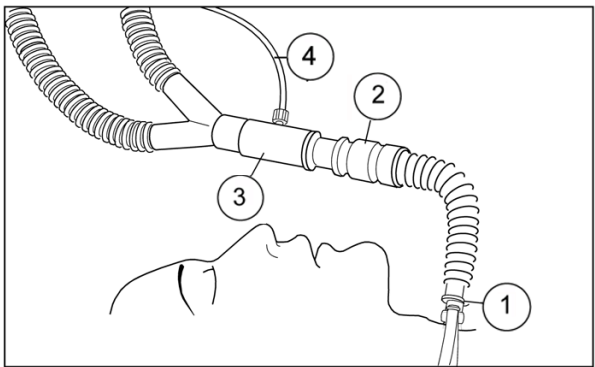
NOTE

To minimize the amount of dust drawn into the gas sampling system, always keep the water trap connected to the module. When gas measurement is not in use, you can disconnect the module from the device to eliminate the operating sound of the gas pump.

Airway gases alternative patient connections

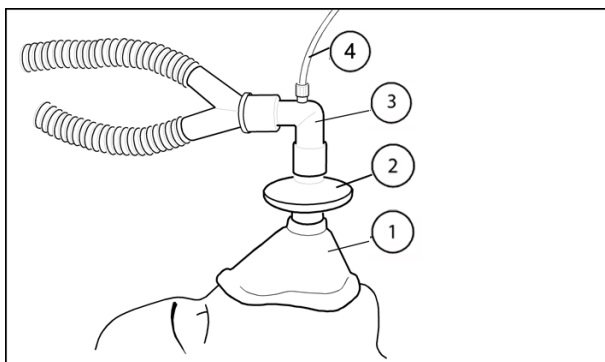
- Use an airway adapter and a sampling line.

Tracheostomy



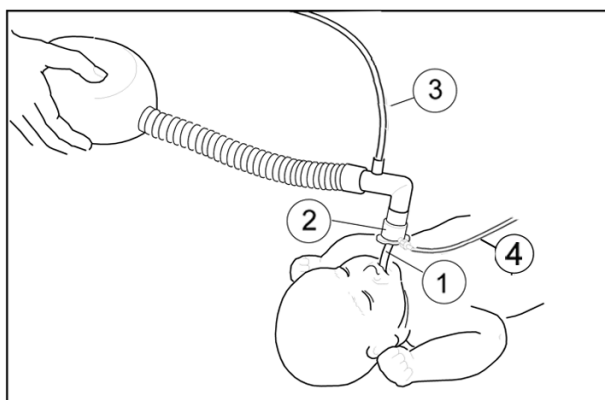
1.	Tracheostomy tube with 15 mm connector
2.	Heat and Moisture Exchanger (HME)
3.	Airway adapter
4.	Sample line

Mask ventilation



1.	Mask
2.	Bacterial filter
3.	Airway adapter
4.	Sample line

Infant ventilation



1.	Endotracheal tube
2.	Pediatric airway adapter
3.	Fresh gas inlet
4.	Sample line

Checking the airway gases measurement

1. Check that the water trap container is empty.
2. Occlude the sampling line and check that the **Sample line blocked** message appears within 30 seconds and gas waveforms are showing zero at the same time.

Using CO₂ measurement

Setup the parameter to normal screen if needed. Select  >  **Screen Setup**, and select the required screen.

Turning on the CO₂ measurement

If **Measurement off** is shown on CO₂ waveform field or **OFF** is shown on CO₂ digit field, you need to select CO₂ measurement on.

1. Select the CO₂ digit field.
2. Select **ON** from the **Measurement** list.

Selecting airway gases measurement source

Before you start monitoring, always check that the measurement source is selected according to your needs.

If the only connected measurement source is a gas module, a Microstream CO₂ micro-module, or an external device, the **Automatic (A)** option selects the measurement source accordingly and locks immediately.

The automatic measurement source detection is triggered when you connect or disconnect a measurement source or if you reselect **Measurement Source > Automatic (A)**. If breaths from another measurement source are detected within 2.5 minutes from the start of the triggering event, the measurement source is locked to the new source. If no breaths are detected within 2.5 minutes, the selected measurement source does not change.

1. Select the CO₂ digit field.
2. Select an option for **Measurement Source**:
 - **Automatic (A)** selects the measurement source automatically based on breath detection. This option is especially useful during transport use.
 - **Gas Module (Mod)** selects the gas module as the measurement source.
 - **CO₂ Device (Dev)** selects the Microstream CO₂ micro-module as the measurement source.
 - **External** selects the external device as the measurement source. The external device can be a directly connected anesthesia device, or any compatible peripheral device connected via the Unity Network Interface Device. If multiple external devices are connected, the **External** option prioritizes the directly connected anesthesia device as the measurement source.

Selecting the age range

NOTE

Microstream CO₂ micro-module only.

You must select the age range before starting a CO₂ measurement with Microstream CO₂ micro-module.

If the age of the patient has been set in **Admit / Discharge**, select information area > **Demographics > Age**, it will be automatically used for CO₂ measurement. You can also select the age range separately as follows:

1. Select the CO₂ digit field.
2. Select **CO₂ Device (Dev)** from the **Measurement Source** list.
3. Select an option from the **Age** list. The options are **Not Selected**, **0-12 months**, and **Over 12 months**.

Starting and stopping pump

NOTE

E-sCO₂, E-sCAiO, N-CAiO module only.

1. Select the CO₂ digit field.

2. Start the pump by selecting **Start Gas Module pump**.
The pump starts and the selection changes to **Stop Gas Module pump**.
3. You can stop the pump by selecting **Stop Gas Module pump**.
Once the module has stopped the pump, the selection changes back to **Start Gas Module pump**.

Selecting the CO₂ scale

If EtCO₂ is above 6% (45 mmHg), change the scale for capnogram.

1. Select the CO₂ digit field.
2. Select an option from the **Scale** list.

Selecting the CO₂ unit

1. Select the CO₂ digit field.
2. Select the %, **kPa**, or **mmHg** from the **Unit** list.

Selecting the FiO₂ level

NOTE

FiO₂ and N₂O compensations must be selected manually when E-miniC is used.

The presence of a large concentration of oxygen causes the CO₂ level appear lower than the actual value. Use this option to compensate for the presence of O₂.

1. Select the CO₂ digit field.
2. Select an option from the **FiO2 Level** list.

Selecting the N₂O level

NOTE

FiO₂ and N₂O compensations must be selected manually when E-miniC is used.

The presence of N₂O causes the CO₂ value to appear higher than the actual value. Use this option to compensate for the presence of N₂O.

1. Select the CO₂ digit field.
2. Select an option from the **N2O Level** list.

Selecting the CO₂ sweep speed

This selection affects the waveform.

1. Select the CO₂ digit field.
2. Select an option from the **CO2 Sweep Speed** list.

The smaller the value, the slower the sweep speed is.

Setting CO₂ limit alarms

When the measurement source is **Automatic (A)**, **Gas Module (Mod)** or **CO₂ Device (Dev)**, you can adjust CO₂ alarm limits.

1. Select the CO₂ digit field.
2. Select the **Alarms** tab.
3. Check that **Alarm** is turned on.
4. Set the alarm limits for **EtCO₂**, **FiCO₂**, and **RR (CO₂)** with arrows.

Setting CO₂ alarms on/off (external source)

When the measurement source is external device, the alarms of related parameters depend on the external data. You can not adjust the alarm limits on the device, but only turn the related alarms on or off.

1. Select the CO₂ digit field.
2. Select the **Alarms** tab.
3. Select the **EtCO₂**, **FiCO₂**, **RR (CO₂)**, **Anes Apnea & Tech Alarms** alarm **ON** or **OFF**.

Using O₂ measurement

Setup the parameter to normal screen if needed. Select  >  **Screen Setup**, and select the required screen.

Turning on the O₂ measurement

If **Measurement off** is shown on O₂ waveform field or **OFF** is shown on O₂ digit field, you need to select O₂ measurement on.

1. Select the O₂ digit field.
2. Select **ON** from the **Measurement** list.

Selecting the O₂ scale

If the difference between FiO₂ and EtO₂ is more than 6%, change the O₂ scale.

1. Select the O₂ digit field.
2. Select an option from the **Scale** list.

Selecting the O₂ sweep speed

This selection affects the waveform.

1. Select the O₂ digit field.
2. Select an option from the **O₂ Sweep Speed** list.

The smaller the value, the slower the sweep speed is.

Setting O₂ limit alarms

1. Select the O₂ digit field.
2. Select the **Alarms** tab.
3. Check that **Alarm** is turned on.
4. Set the related alarm limits with arrows.

Using AA and N₂O measurement

Setup the parameter to normal screen if needed. Select  >  **Screen Setup**, and select the required screen.

Turning on the agent and N₂O measurement

If **Measurement off** is shown on Agent/N₂O waveform field or **OFF** is shown on Agent/N₂O digit field, you need to select Agent/N₂O measurement on.

1. Select the Agent digit field.
2. Select **ON** from the **Agent Measurement** list for Agent.
Or/and,
3. Select **ON** from the **N2O Measurement** list for N₂O.

Selecting the agent scale

1. Select the Agent digit field.
2. Select an option from the **Agent Scale** list.

Selecting the agent sweep speed

This selection affects the waveform.

1. Select the Agent digit field.
2. Select an option from the **Agent Sweep Speed** list.

The smaller the value, the slower the sweep speed is.

Setting agent limit alarms

The following settings are only available when the E-module is the data source.

1. Select the Agent digit field.
2. Select the **Alarms** tab.
3. Check that **Alarm** is turned on.
4. Set the related alarm limits with arrows.

Setting the N₂O alarms on/off

Displays only when an external device is connected via the Unity Network ID interface device.

1. Select the Agent digit field.
2. Select the **Alarms** tab.
3. Set the **EtN2O** or **FiN2O** alarms on or off.

Using MAC, MACage and ET Balance measurement

Setup the parameter to normal screen if needed. Select  >  **Screen Setup**, and select the required screen.

The MAC or ET Balance value can be shown on the digit field.

If MACage calculation is set, the MACage value will be shown instead of MAC value.

Setting MACage calculation

1. Select the  >  **Service** > enter **Username** and **Password**.
2. Select **Parameter Settings** > **Others** tab > **MAC Type**.
For more information, see the Service manual.
3. Select information area > **Demographics**, check or set up **Age**, **Year**.
4. Connect the temperature sensor to user.

Preventing operating room pollution

When N₂O and volatile anesthetics are used, prevent operating room pollution by connecting the sample gas outlet (gas exhaust) of the module to the scavenging system.

Scavenging through the ventilator reservoir

1. Connect an exhaust line to the sample gas outlet (gas exhaust) on the module's front panel.
2. Attach the other end of the line to the ventilator reservoir. Make sure that the reservoir tube diameter is at least 2 to 3 times larger than the exhaust line.

Scavenging through the anesthesia gas scavenging system

Anesthesia devices are equipped with an anesthesia gas scavenging system (AGSS), and in some machines you can connect the sample gas outlet directly to it. See the anesthesia device's user documentation to find out where and how the sample gas can be connected.

Connecting directly to the scavenging system

1. Connect the exhaust line to the module's sample gas outlet.
2. Connect the exhaust line only to an open scavenging system where gas is removed at room pressure.

NOTE

Do not connect the module directly to a strong vacuum scavenging system.

NOTE

If the E-miniC is used, do not return sample gas to the patient circuit.

Stopping the airway gases measurement

1. Remove the added adapters from the patient's breathing circuit and gas scavenging.
2. Check the patient's breathing circuit.
3. Select the gas digit field > **Measurement** > **OFF**.
4. Remove the gas module from the device when it is not used.

Basics of airway gases measurement

Airway gases measurement description, E-sCAiO, E-sCO₂, and N-CAiO modules

With E-sCAiO, E-sCO₂, and N-CAiO modules you can measure and monitor gases being delivered to the patient and exhaled by the patient through the breathing circuit. The modules consist of an infrared sensor for measuring CO₂ and N₂O, and paramagnetic O₂ sensor. The E-sCAiO and N-CAiO modules also include anesthetic agents measurement.

The gas sampling system samples the measured air to the module, and removes water and impurities from it. The pump of the gas sampling system draws gas at a fixed rate through the sampling line into the gas measuring units. The gas enters the module through the water trap, where it is divided into two flows, a main flow and a side flow. The main flow goes into the analyzers. This flow is separated from the patient side by a hydrophobic filter. The side flow creates a slight sub-atmospheric pressure within the water trap, which causes fluid removed by the hydrophobic filter to collect in the bottle. After the measurement, gas is exhausted through the sample gas out connector.

The module finds the time instant of the highest CO₂ concentration in each breath. Concentration at that instant is the ET CO₂ reading. Because nitrous oxide and anesthetic agents are measured by the same sensor as CO₂, the ET readings of those gases are obtained directly at the time instant of ET CO₂. For calculating ET readings of oxygen, the module synchronizes the O₂ waveform with the CO₂ waveform. The ET reading of O₂ is then determined as O₂ concentration at the time instant of ET CO₂. If no breaths are detected for a given time (20 s, for example), an apnea situation is triggered. During apnea, the ET values are updated every two seconds to the current concentration of each gas.

Total sample size volume during one respiratory cycle depends on the respiration rate. The following table shows different sample size volumes with a 120 ml/min sample flow and I:E ratio of 1:2.

Respiration rate	10	30	50	70
Duration of inspiration	2.0 seconds	0.7 seconds	0.4 seconds	0.3 seconds
Duration of expiration	4.0 seconds	1.3 seconds	0.8 seconds	0.6 seconds
Volume sampled during inspiration	4 ml	1.3 ml	0.8 ml	0.6 ml

Volume sampled during expiration	8 ml	2.7 ml	1.6 ml	1.1 ml
Total volume sampled	12 ml	4 ml	2.4 ml	1.7 ml

Airway gases measurement description, E-miniC

The E-miniC is designed for critical care environment to measure and monitor the expired and inspired CO₂ concentration (EtCO₂, FiCO₂) as well as the respiration rate (RR) up to 80 breaths per minute.

E-miniC has a sample flow of 150 ml/min.

Respiration rate from the CO₂ parameter is counted from the frequency of end-tidal (peak) CO₂ measurements per minute. A sufficient respiration is defined as a difference of at least 1% (at least 7 mmHg) between the measured inspired fraction and end-tidal CO₂.

Total sample size volume during one respiratory cycle depends on the respiration rate. The following table shows different sample size volumes with a 150 ml/min sample flow and I:E ratio of 1:2.

Respiration rate	10	20	40	60
Duration of inspiration	2.0 seconds	1.0 seconds	0.5 seconds	0.3 seconds
Duration of expiration	4.0 seconds	2.0 seconds	1.0 seconds	0.7 seconds
Volume sampled during inspiration	5 ml	2.5 ml	1.3 ml	0.8 ml
Volume sampled during expiration	10 ml	5 ml	2.5 ml	1.7 ml
Total volume sampled	15 ml	7.5 ml	3.8 ml	2.5 ml

Sidestream gas sampling

The E-modules use a sidestream gas sampling method. It means that a sample of patient's respired gases from the sampling site is transported through a sampling line to the module for analysis.

A sidestream gas analyzer takes a constant sample from the patient airway adapter at the following sample rates:

- E-sCAiO, E-sCO, N-CAiO: 120 ml/min
- E-miniC: 150 ml/min

Total sample size volume during one respiratory cycle depends on the respiration rate.

Minimum Alveolar Concentration (MAC)

NOTE

E-sCAiO module is for MAC and MACage. N-CAiO module is for MAC only.

The use of either traditional MAC or MACage is selected during device configuration. The MACage provides age and temperature compensated measurement. To enable MACage calculations, enter patient's age to the device and attach a temperature sensor. If the patient's age is not given, the device shows normal MAC even if MACage has been selected.

NOTE

The MAC value displayed by the device is that of exhaled air, and it does not always correspond to the amount of anesthetic in the patient's organs.

MAC and MACage

The minimum alveolar concentration (MAC) concept is based on the assumption that in a steady state, the alveolar partial pressure of a gas is equal to the partial pressure in the effector organ of the central nervous system. MAC values are used to estimate the level of anesthesia caused by volatile anesthetics.

The MAC value can be displayed in digit field: 1 MAC is the alveolar concentration (end-tidal) of the agent at which 50% of patients do not respond to a noxious or surgical stimulus. The value is calculated from the actual measured anesthetic agent and N₂O values with empirical formulas based on statistical studies with anesthetized patients.

The device can display two different MAC values, MAC or MACage, based on different formulas. The use of MAC or MACage is selected during installation and configuration.

The MAC values correspond to those of healthy adults of about 40 years old, and cannot be applied to children or elderly patients. Age and some other individual factors influencing the effect of volatile agents are not taken into account.

The other calculation method, MACage, takes the patient's age into account. The age range is 0 to 150 years. The calculation uses 0 if age is less than 0, and 100 if age is more than 100. In addition, MACage calculations include the atmospheric pressure and the patient's (highest measured) temperature values. If no patient temperature is measured, 37°C is used instead. For volatile agents this calculation method means about 6.7% decrease of MAC value with each increasing decade of life. MACage is calculated if it is enabled in the care unit settings and the patient's age is given on the device. If no age is given, MAC is calculated despite the care unit setting.

References used for MAC and MACage values

The alveolar concentrations of traditional (MAC) and age dependent (MACage) values are based on the following references:

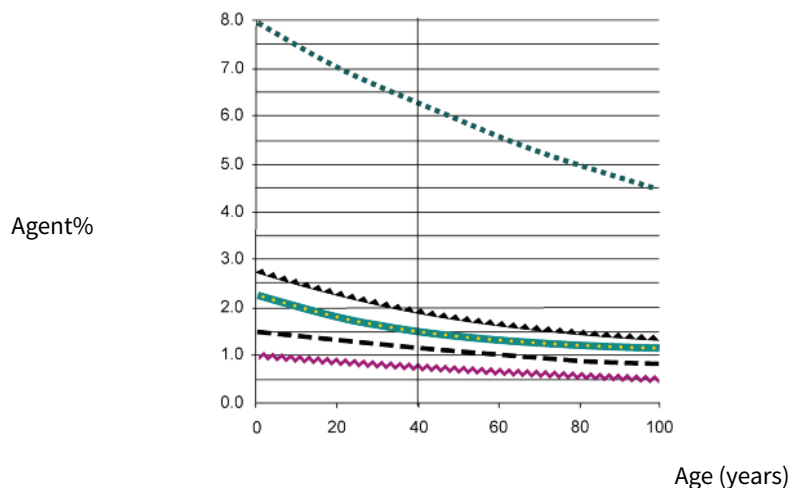
- References for anesthetic agent MAC values:
 - Mapleson W.W.: Effect of age on MAC in humans: a meta-analysis. Br. J. of Anaesthesia 1996; 76: 179-185
 - Rampil I.J.; Zwass M.; Lockhart S.; Eger E.I. II; Johnson B.H.; Yasuda N.; Weiskopf R.B.: MAC of I653 in surgical patients, Anesthesiology. 71 (3A):A269, September 1989
 - Scheller M.S., Partridge B.L., Saidman L.J.: MAC of sevoflurane in humans and the New Zealand white rabbit. Anesthesiology 1987; 67: A373
 - ISO21647:2004 + C1:2005, Medical electrical equipment - Particular requirements for the basic safety and essential performance of respiratory gas monitors.
- References for MACage calculations:
 - Eger, E.I. II.: Age, minimum alveolar anesthetic concentration, and minimum alveolar anesthetic concentration-awake. Anesth. Analg. 2001; 93:947-953
 - Rampil I.J.; Zwass M.; Lockhart S.; Eger E.I. II; Johnson B.H.; Yasuda N.; Weiskopf R.B.: MAC of I653 in surgical patients, Anesthesiology. 71 (3A):A269, September 1989

MAC values of different anesthetics in oxygen

Normal values (40-year-old patient) and compensated values (65-year-old and 3-year-old patients):

	1 MAC	1 MAC (65 yrs)	1 MAC (3 yrs)
Halothane	0.75%	0.63%	0.97%
Enflurane	1.70%	1.43%	2.2%
Isoflurane	1.15%	0.97%	1.5%
Sevoflurane	2.05%	1.73%	2.65%
Desflurane	6.00%	5.05%	7.80%
N ₂ O	100%	82%	N/A

The following illustration shows the Agent% corresponding to 1 MAC as function of age:



Symbol	Anesthetic
■ ■ ■ ■ ■	Desflurane
▲ ▲ ▲ ▲ ▲	Sevoflurane
● ● ● ● ●	Enflurane
— — — — —	Isoflurane
~~~~~	Halothane

## MAC values of different anesthetics in 65% N₂O

Normal values (40-year-old patient) and compensated values (65-year-old and 3-year-old patients).

	1 MAC	1 MAC (65 yrs)	1 MAC (3 yrs)
Halothane	0.27%	0.14%	0.51%
Enflurane	0.61%	0.31%	1.15%
Isoflurane	0.41%	0.21%	0.78%
Sevoflurane	0.73%	0.37%	1.40%
Desflurane	2.09%	1.1%	4.1%

## ET balance gas

### NOTE

E-sCAiO module only.

You can obtain a calculated value for balance gas, EtBal. End-tidal balance gas is the percentage of gas concentration not measured by the gas sensors. It is displayed in digit field with the MAC value.

An increased balance gas value may indicate the amount of nitrogen flushed out from the patient into the circuit. The increase may be due to an accumulation of nitrogen during low flow anesthesia.

The device calculates end-tidal balance gas when oxygen and CO₂ measurements are active. If oxygen or CO₂ status is invalid or agent identification fails, the device displays the balance gas value as invalid.

## Automatic agent identification

### NOTE

E-sCAiO, N-CAiO module only.

The modules with agent identification option will automatically identify and select Isoflurane, Desflurane, Sevoflurane, Enflurane and Halothane. The E-sCAiO module is able to identify two agents simultaneously and displaying them as primary and secondary agents. The N-CAiO module is able to identify and display one agent. The inspiratory and expiratory concentrations of the agent are displayed in digit field. Minimum concentration for the identification is 0.15 vol%. The agent selection remains active even if the concentration decreases below 0.15 vol%. Automatic agent identification is operational after the normal warm up of the module (approximately five minutes).

- If rapid agent concentration changes are required, fresh gas flow must be increased.
- Anesthetic agent concentration in the circuit is affected by patient uptake, breathing system volume and the fresh gas flow. It quantifies the speed of wash-in and wash-out anesthetic agents.

## Basics of CO₂ measurement

### Normal CO₂ waveform

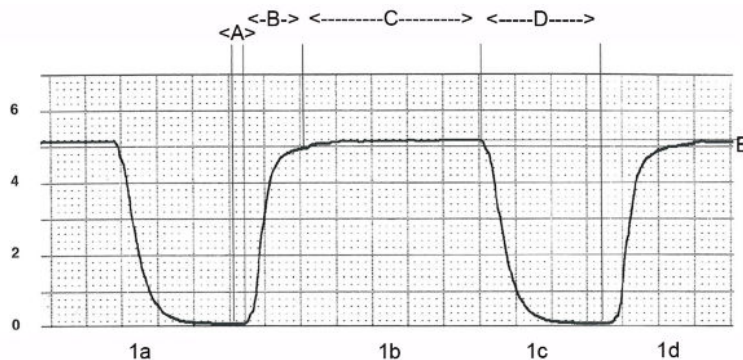
The CO₂ waveform is referred to as capnogram and it reflects the different stages in breathing. The capnogram of a healthy patient under controlled ventilation has a normal shape. Changes in the CO₂ waveform may indicate compromised patient respiratory and/or circulatory function or improper mechanical ventilator functionality.

### The origin of the CO₂ waveform

The following illustration shows a normal capnogram. In this illustration, the letters indicate the following:

- **A:** The gas first exhaled is from the anatomical and apparatus dead-space. It contains no CO₂ because it has not been in the alveoli and no gas exchange has taken place.

- **B:** Briefly, the exhaled gas is a mixture of gas from the anatomical dead-space and gas from the alveoli.
- **C:** A plateau is reached when the gas exhaled is entirely from the alveoli. The end-tidal CO₂ (EtCO₂) concentration is measured at the end of this plateau.
- **D:** When the next inspiration starts the capnogram rapidly falls towards the baseline. The minimum level of CO₂ measured during the inspiratory phase is called the inspired CO₂ concentration (normally 0.0%).
- **E:** With a scale, the height of the capnogram tells you the end-tidal CO₂ concentration. The device automatically calculates and display the EtCO₂ in numbers. EtCO₂ approximates the alveolar CO₂ concentration because it is measured when the patient exhales virtually pure alveolar gas.



- 1a and 1c = inhalation
- 1b and 1d = exhalation

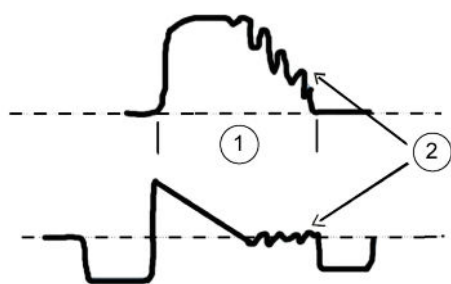
EtCO ₂ value %	EtCO ₂ value mmHg	Indicates
4.5% to 5.5%	34 mmHg to 41 mmHg	normocapnia
< 4%	< 30 mmHg	hypocapnia
> 6%	> 45 mmHg	hypercapnia

## Dips in capnogram

The dips seen in the capnogram during expiration are related to the sidestream gas sampling, the continuous gas flow to the Y-piece, and patient's cardiac contractions, which cause intra-thoracic pressure changes and therefore flow variations.

The alterations in expired CO₂ waveform are cardiogenic movements of exhaled and circuit gas at the sidestream gas sampling site. When the respiratory gas flow drops below the gas sampling rate, a variable mixture of CO₂ free fresh gas and exhaled CO₂ rich gas is sampled. This causes variations in sampled CO₂ concentrations.

In the illustration below, CO₂ waveform is the one on top, and flow is the lower waveform.



1. Expiration
2. Cardiogenic oscillations

Cardiogenic oscillations appear when:

- A continuous fresh gas flow is fed into the patient Y-piece.
- Sidestream gas sampling is done at the Y-piece.
- The patient is ventilated with a long expiration time or low respiration times, and when there is a long zero flow at end-expiration for some other reason.

Oscillations can be eliminated by adding a spacer with a 5 ml dead space between the Y-piece and the airway adapter. Increased dead space creates a buffer volume between the Y-piece and the sampling point, preventing the inspiratory and expiratory air from mixing during gas sampling. Misinterpretation of EtCO₂ information can be avoided through identifying cardiogenic oscillation and understanding the reasons for it.

## Airway gases CO₂ unit conversions

Respiratory gases are in contact with lungs and become saturated with water vapor. The module reports the patient gas concentrations relative to ambient pressure and temperature as if the patient gas was without water vapor in dry conditions (ATPD). The monitor can convert the ATPD CO₂ partial pressures to be displayed in saturated water vapor conditions (BTPS). The module provides the measured atmospheric pressure for the monitor to convert ATPD to BTPS. Selecting **Wet** (BTPS) humidity compensation type activates calculations where the EtCO₂ value is normalized to assume 100 %RH and 37 °C. **Wet** compensation is not done if EtCO₂ is shown in %.

To select the humidity compensation type, select  >  **Service** (password protected) > **Clinical** > **Parameter Settings** > **Others** > **CO2 Numbers**.

### NOTE

47 mmHg is the partial pressure of the saturated water vapor at 37 °C.

The following table lists the relationship between gas concentration and its partial pressure.

Partial pressure	Gas concentration (%)
Reading in mmHg (dry gas)	$(\text{ambient pressure in mmHg} * \text{gas concentration in \%}) / 100$
Reading in mmHg (water vapor saturated gas)	$((\text{ambient pressure in mmHg} - 47 \text{ mmHg}) * \text{gas concentration in \%}) / 100$
Reading in kPa (dry gas)	$(\text{ambient pressure in mmHg} * \text{gas concentration in \%}) / 750$
Reading in kPa (water vapor saturated gas)	$((\text{ambient pressure in mmHg} - 47 \text{ mmHg}) * \text{gas concentration in \%}) / 750$

## Oxygen measurement interpretation

The E-sCAiO, E-sCO₂, and N-CAiO modules' oxygen measurement provides:

- Inspired oxygen level, the actual inspired oxygen concentration
- End-tidal oxygen level, the expired oxygen concentration
- Inspiratory-expiratory oxygen difference reflects patient's consumed oxygen volume-percentage from the administered gas mix
- Oxygram, a diagnostic tool both in real time and as a trend

The patient oxygen provides breath-by-breath information about the breathing circuit, alveolar ventilation and some vital indicators of adequate oxygenation.

Oxygram is a mirror image of a capnogram in a steady state in normal patient. It is a graphic presentation of changes in O₂ concentrations in the airway gas. The oxygram reflects the oxygen uptake from the alveoli. To avoid patient administered hypoxic gas mixes the inspired fraction of oxygen (FiO₂) should never be lower than 21%.

## Airway gases practicalities

### Ventilation management

Normoventilation (adequate alveolar ventilation of a patient) can be maintained by monitoring the end-tidal carbon dioxide and oxygen concentrations, and adequacy of ventilation can be maintained by monitoring airway pressures, volumes and spirometry loops. Alveolar minute ventilation is usually adjusted to achieve normocapnia, where EtCO₂ is in the range of 4.5% to 5.5% (34 mmHg to 41 mmHg). This is called normoventilation as it is the normal situation in healthy people.

A low EtCO₂ concentration (EtCO₂ < 4% / 30 mmHg) indicates hyperventilation.

#### NOTE

A low EtCO₂ value in itself is dependent from the ventilation volume vs. circulation status (lung perfusion). This means that in case of low blood pressure (e.g. shock) or shunting low EtCO₂ values may be observed while using a "normal" TV/MV.

Increased EtCO₂ concentration (EtCO₂ > 6.0% / 45 mmHg) indicates hypoventilation or ineffective alveolar ventilation, which will lead to hypercapnia and respiratory acidosis. Increased inspiratory CO₂ (FiCO₂) concentrations may also be caused by:

- Exhausted CO₂ absorber.
- Malfunction of the breathing system valves.
- Rebreathing when a rebreathing system without a CO₂ absorber is used with inadequate fresh gas flows.

**NOTE**

During some surgical procedures, e.g. laparoscopy, CO₂ may be used to inflate the abdomen which may result in rise of PaCO₂ due to the absorption of CO₂ into the blood via the vascular wound bed. This may lead to an increase in the EtCO₂.

## Prevention of the breathing system contamination

You can use a microbial filter between the endotracheal tube and the airway adapter. Change the filter for every patient. Change the patient circuit at intervals given in the circuit manufacturer's documentation, and according to your hospital protocols.

## How to prevent effects of humidity

In anesthesia, the lower the fresh gas flow, the more rebreathed gas recirculates through the CO₂ absorber and the more humidity and heat is produced through the chemical CO₂ absorption process.

- If a moisture exchanger is used, place it between the endotracheal or intubation tube and the airway adapter. In intensive care, the moisture exchanger must be replaced at least every 24 hours.
- Place all airway adapter ports upwards with a 20° to 45° tilt to prevent condensed water from entering the sensor interior and the tubings.
- The airway adapter should be emptied of clearly visible water droplets, or replaced with a dry and clean adapter.
- If active humidification is used, extra water collectors may be placed between the ventilator's inspiratory and expiratory breathing tubings. They are also useful for condensed water collection during long-lasting anesthesia.

## Oxygen delivery, E-sCAiO, E-sCO, N-CAiO modules

### Oxygen uptake and consumption

Oxygen consumption is the difference between the amount of oxygen delivered to the tissues by the arterial circulation and the amount of oxygen returned to the heart by the venous system. The formula for oxygen consumption is a simple restatement of the Fick equation, which identifies all of the pertinent variables of oxygen supply and demand.  $VO_2 = CO \times Hb \times 13.8 \times (SaO_2 - SvO_2)$ . Dependent from the patient's circulation status the mechanical ventilator settings for, amongst others, FiO₂ in the delivered gas mix (min. > 25%) should guarantee a sufficient PAO₂ and PaO₂. Patients with fever may consume oxygen at considerably higher rates.

Oxygen supply to the breathing system must meet the metabolic need of the patient.

To prevent hypoxemia and to ensure safe and sufficient oxygen supply, the alveolar oxygen concentration (EtO₂) should be at the level of 25% minimum.

### Nitrogen elimination

During the maintenance of minimal low flow anesthesia, a small amount of nitrogen may accumulate in the circuit. It may be detected as decreased concentration of other gases, and eliminated by temporarily increasing the fresh gas flow.

## Flow reduction

Reduction of fresh gas flow may increase rebreathing in case of a CO₂ absorber malfunction or during the use of open anesthesia gas delivery systems.

The lower the fresh gas flow, the higher the oxygen concentration required in the fresh gas.

## Level of anesthesia: E-sCAiO, N-CAiO modules

### Anesthetic agent uptake

Fresh gas flow reduction decreases the total amount of anesthetic agent fed into the breathing system if agent concentration is maintained constant.

The lower the fresh gas flow rate, the longer the time required to reach the effect of a change in the fresh gas settings.

# Spirometry

## Spirometry compatibility



Hub connects to Dock only.

This measurement is available only when Hub connects to Dock.

## Spirometry instruction

You can connect the device to any compatible external device, such as a directly connected anesthesia device or any compatible peripheral device (ventilator or anesthesia device) connected via the Unity Network Interface Device.

After the external device is connected, patient data can be intensively displayed on one device. If the parameter source is the external device, the device can only display the messages delivered from the external device, but not send control commands to the external device, e.g. silencing alarms on the external device.

For direct anesthesia connection, the source of spirometry should be compatible anesthesia device runs Datex-Ohmeda Com 1.2 Protocol. For more information about compatibility, see the supplemental information provided.

For more information about compatible external devices connected via the Unity Network Interface Device, see the Unity Network Interface Device User's Manual.

## Spirometry measurement displayed on the device screen

The message **Ext** appears in the certain area of screen when the data is from the external source.

You can setup following screen views from  >  **Screen Setup > Dock.**

- Split screen: displays the spirometry parameter digits
- Normal screen: displays the waveform field and digit field of **Paw** and **Flow**: