GE HealthCare

Patient Monitor B155M-OR/B125M-OR/B105M-OR

User's Manual

Software Version 4.0

CE 0197

5829100-EN
Revision 1
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	2024-05-08	Initial release.

Contents

Standards and Regulations

Standards compliance

The system complies with the following standards.

- IEC 60601-1/GB9706.1: General requirement for basic safety and essential performance
- IEC 60601-1-2/YY0505: EMC safety standard
- IEC 80601-2-49/YY0668: 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
- The alarm systems of the Monitor conforms to IEC 60601-1-8 and YY0709.
- The ECG parameter conforms to IEC 60601-2-27, AAMI EC57 and YY1079

  NOTE
  Moderate reduced bandwidths do not comply with all requirements of the IEC 60601-2-27 standard.
- The SpO_2 parameter conforms to ISO 80601-2-61 and YY0784.
- The NIBP parameter conforms to IEC 80601-2-30, YY0667, YY0670, and ANSI/AAMI/ISO 81060-2.
- The IBP parameter conforms to IEC 60601-2-34 and YY0783.
- The Temperature parameter conforms to ISO 80601-2-56 and YY0785.
- The Gases parameter conforms to ISO 80601-2-55 and YY0601.
- The Entropy parameter conforms to IEC 80601-2-26 and GB9706.26.
- The NMT parameter conforms to IEC 60601-2-40.
- The BIS parameter conforms to IEC 80601-2-26 and GB9706.26.

IEC 60601-1

Monitor

- Type of protection against electrical shock: Class I. 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 or with oxygen or nitrous oxide: Not suitable.
- Degree of protection against harmful ingress of water: IP22.
- Mode of operation: Continuous.

- Method(s) of sterilization or disinfection recommended by the manufacturer: see the User's 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.

- Group 1 contains all ISM (Industrial, scientific and medical) equipment in which there is intentionally generated and/or used conductively coupled radio-frequency energy which is necessary for the internal functioning of the equipment itself.
- Class A equipment is equipment suitable for use in all establishments other than domestic and those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes.

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	 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 monitor configuration may vary, some menus, displays and functions described may not be available in the monitor 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.

Manual conventions

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

Item	Description
`Courier`	Indicates hardware terms.
bold	Indicates software terms.
italic	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.

Acquisition module naming conventions

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

- E-miniC: Single-width airway module
- E-sCO, E-sCAiO: CARESCAPE respiratory modules
- N-CAiO: Airway Gas Option

- E-modules: All modules with the prefix E-

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

- B155M-OR/B125M-OR/B105M-OR Patient Monitor Supplemental Information Manual
- B155M-OR/B125M-OR/B105M-OR Patient Monitor Technical Manual
- Supplies and accessories
- Service manuals for acquisition modules
- Patient Monitoring Network Configuration Guide
- CARESCAPE Central Station User’s Manual
- HL7 Reference Manual
- Privacy and Security Manual

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 representative and request the part number on the first page of the eIFU.

Accessing manuals online

To access manuals online,

1. Go to https://www.gehealthcare.com/documentationlibrary.
2. Enter **Customer Documentation Portal** site.
3. Select **Modaility** to **Monitoring Solutions (MS)** and **Products** to related products you want to search. Launch the search.
4. Identify and download the IFUs.

The IFUs are in PDF format, make sure the device has software to open the PDF files (e.g. Adobe® Acrobat® Reader).

Accessing manuals on monitor

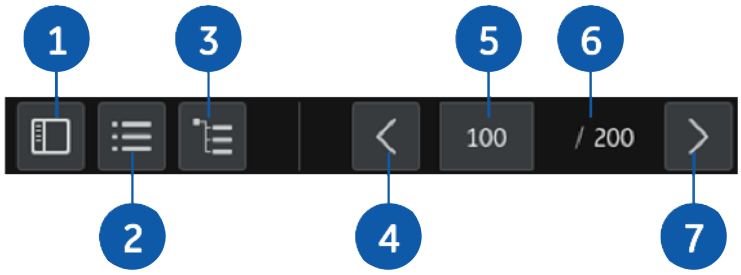
To access manuals on monitor:

1. Press the **On/Off** button (more than 3 seconds) to turn on the monitor.
2. Select > **E-Manual**.

3. Select related manuals.

Using E-manuals on monitor

The E-manual's navigation are on the top of the menu.



1.	Show/Hide bookmark view softkey	5.	Current page area
2.	Collapse bookmark view softkey	6.	Total page
3.	Expand bookmark view softkey	7.	Next page softkey
4.	Previous page softkey		

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

Trademarks

GE, GE Monogram, and CARESCAPE are trademarks of General Electric Company.

DINAMAP, UNITY NETWORK, D-fend, and Entropy are trademarks of General Electric Company or one of its subsidiaries.

Third party trademarks

Masimo and SET are trademarks of Masimo Corporation.

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

Multi-Link is the 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.

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.

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 SpO_2, 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.

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 monitor from the power line. If the installation does not provide for a protective earth conductor, disconnect the monitor 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 monitor, 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 monitor 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 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

PATIENT SAFETY.

If the monitor, 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 monitor, the monitor 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.

System caution safety messages

The following caution safety messages apply to this monitoring system.

Indications for use cautions

CAUTION

PRESCRIPTION DEVICE.

U.S. Federal law restricts this device to sale by or on the order of a physician.

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 monitor 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 monitor function is restored. If the monitor does not automatically resume operation within 60 seconds, power cycle the monitor using the On/Off button. Once monitoring is restored, you should verify correct monitoring state and alarm function.

Electrical caution

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 monitor. 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.

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 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.

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

The patient monitor products are portable multi-parameter patient monitors 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 patient monitor products are intended for use under the direct supervision of a licensed health care practitioner.

The patient monitor products are not intended for use during MRI.

The patient monitor products can be stand-alone monitors or interfaced to other devices via network.

The patient monitor products monitor and display: 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 (CO_2, O_2, N_2O, anesthetic agents, anesthetic agent identification and

respiratory rate), Cardiac output (C.O.), Entropy and neuromuscular transmission (NMT), Bispectral Index (BIS) and Surgical Pleth Index (SPI).

NOTE
Surgical Pleth Index (SPI) is excluded from 510(k) countries and Japan.

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 SpO_2 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 (C.O.), 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 CARESCAPE Respiratory Modules (E-sCO, E-sCAiO) and Airway Gas Option (N-CAiO) are indicated for use with a host device for monitoring respiratory parameters (CO_2, O_2, N_2O, 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 CO_2 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 GE 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.

BIS indications for use

The BIS module is intended for use by personnel trained in its proper use. It is intended for use on adult and pediatric patients within a hospital or medical facility providing patient care to monitor the state of the brain by data acquisition of EEG signals. The Bispectral index (BIS), a processed EEG variable, and one component of the BIS module, may be used in adults as an aid in monitoring the effects of certain anesthetic agents. The Bispectral index is a complex technology, intended for use only as an adjunct to clinical judgement and training. In addition, the clinical utility, risk/benefit, and application of BIS have not undergone full evaluation in the pediatric population.

B1X5-F2 frame intended use

B1X5-F2 frame is a two-slot single width frame which is intended for use with patient monitor to support more E-modules to improve parameter acquisition capability.

B1X5-REC recorder intended use

The B1X5-REC recorder is intended for use with patient monitor for data printing.

Clinical benefit

Clinical benefit

- Use of patient monitoring device systems for the acquisition of, transfer, and analysis of patient data benefits the patient in that this method is efficient for medical staff to use.
- Provides real time information on physiological parameters that can be used in assessing the patient’s condition and to be used to aid in diagnostic purposes, monitoring the effects if the treatment &/or disease progression.
- Secure and accurate transmission of patient data between patient monitor and clinical information systems.
- Access to assist the physician with clinical decision support for the treatment of patients.
- The physician or nurse has access to monitoring data at bedside that can be displayed in customized layout or logically grouped manner on one screen.

Clinical benefits of the applicable E-modules

E-COP module clinical benefit

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.

Gas measurement modules clinical benefit

Respiratory Clinical Benefits:

- E-sCO, E-sCAiO, and N-CAiO modules enable CO2, O2, N2O, anesthetic agent, and respiration rate monitoring during patient care. Oxygenation, anestethic 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.

E-Entropy module clinical benefit

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.

E-NMT module clinical benefit

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.

E-BIS module clinical benefit

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.

B1X5-F2 frame clinical benefit

Support more E-module to improve GE HealthCare monitoring equipment parameter acquisition capability.

B1X5-REC recorder clinical benefit

Enables local printing capability with GE HealthCare monitoring equipment for patient monitoring data review or medical record keeping.

Intended users

The device is intended for use 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.

Contraindication

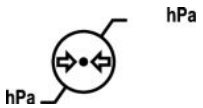
Do not use the device in high electromagnetic fields (for example, during MRI).

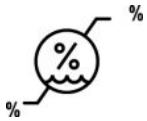
Equipment symbols

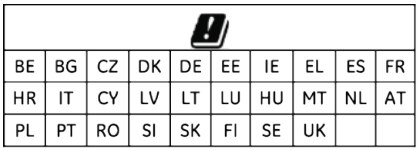
For user interface keys and symbols, please refer to “Monitoring basics” chapter.

	General warning sign.
	Caution. Highlights the fact that there are specific warnings or precautions associated with the device.
	Follow instructions for use.
	Consult operating instructions.
 eIFU indicator	Consult electronic instruction for use.
	Instructions For Use are supplied in electronic format.
	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.
	Power On/Off key.
	On the front cover: power indicator. On the back cover: alternating current.
	On the front cover: battery indicator.
	Equipotentiality. Connect device to a potential equalization conductor.
X1	Recorder connector.
X3	B1X5-F2 connector (On B1X5-F2 Frame).
X4	Nurse call connector.
X5	Serial port.
X6	Defibrillator connector.
X7	B1X5-F2 connector (On monitor).
	USB connector.
	Ethernet connector.
HDMI	HDMI connector.
	Audio pause from gesture (On monitor front panel).
	Gesture sensor area: wave hand to gesture sensor area.

	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 indentical type and rating fuse (On B1X5-F2 Frame).
IP22	Degree of ingress protection (On monitor).
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.
CH REP	Swiss authorized representative.
	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.
	European authorized representative.
	European Union Declaration of Conformity.
Rx Only U.S.	Prescriptive Device. USA only. For sale by or on the order of a Physician.
	Eurasian Economic Union countries only. Eurasian Conformity mark. Conformity to applicable technical regulations of Customs Union.
	Underwriters Laboratories product certification mark.

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.
	Australia and New Zealand only. Regulatory Compliance Mark (RCM). Indicates compliance with electrical safety, EMC, electromagnetic energy, and telecommunications requirements applicable to each product.
	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).
	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.
	Philippines only. The product comply the NTC (National Telecommunications Commission) requirements.
	South Africa only. Approved under ICASA (Independent Communications Authority of South Africa) requirements.
	Brazil only. INMETRO certificate.
	MR Unsafe. Indicates that the device is not intended for use in an MR environment.
	This product is a medical device.

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 bar-code, or only alphanumeric identifiers with no barcode. Identifi-ers also vary per product.

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.
- 01234567123456 = 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.
- 180718 = 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 device, should be reported to both the manufacturer and the health authority/competent authority where the device is installed.

To report to GE:

- Either contact your local service representative
- Or report to: In-box.complaints@ge.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. 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 monitor. Visual alarm indicators may not appear properly.

WARNING

EQUIPMENT DAMAGE.

To prevent liquids from entering the monitor, do not tilt the monitor.

WARNING

MISSED ALARMS.

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

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 equipment

The device is modular multi-parameter patient monitor intended for use in multiple hospital environment and intra-hospital transport within a professional healthcare facility.

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 used with a 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.

The monitor can transfer the measurement data to central stations and to the hospital EMR. It communicates with a variety of other bedside medical devices and monitoring systems.

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

Product models

The following table shows features for different product models:

√: support

O: optional

Feature	B105M-OR	B125M-OR	B155M-OR
Host			
3/5-lead ECG	√	√	√
12-lead ECG	O	O	O
Impedance respiration	√	√	√
GE SpO_2	√	√	√
Masimo SpO_2	O	O	O
Nellcor SpO_2	O	O	O
NIBP	√	√	√

Feature	B105M-OR	B125M-OR	B155M-OR
Integrated IBP	√	√	√
Temperature	√	√	√
Wi-Fi[*1]	O	O	O
Integrated RACK	√	√	√
B1X5-REC Connector	√	√	√
B1X5-F2 Connector	√	√	√
Defibrillator Connector	√	√	√
Nurse Call Connector	√	√	√
RS232 Connector	√	√	√
Mounting Plate	√	√	√
Basic Battery	O	O	O
High Capacity Battery	O	O	O
Gesture Sensor		√	√
Back Cover Alarm Light		√	√
E-Module			
E-miniC	O	O	O
E-sC(Ai)O	O	O	O
N-CAiO	O	O	O
E-Entropy	O	O	O
E-BIS	O	O	O
E-COP	O	O	O
E-NMT	O	O	O
Software Function			
SPI	O	O	O
AM Connection	O	O	O
Full Disclosure	O	O	O
Bed-to-Bed View and AVOA	O	O	O
Full Arrhythmia	O	O	O
SPV and PPV	O	O	O
EWS	O	O	O
OxyCRG	O	O	O
Unity	O	O	O
HL7	O	O	O
Remote Service	O	O	O
Customized Notification	O	O	O
N-CAiO Support	√	√	√
E-Entropy Support	√	√	√

Feature	B105M-OR	B125M-OR	B155M-OR
E-BIS Support	√	√	√
E-COP Support	√	√	√
E-NMT Support	√	√	√
*1 Wi-Fi is not available in Europe.			

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.

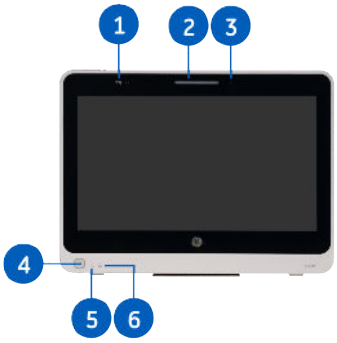
Your system may not include all these components. Consult your local representative for the available components.

NOTE

It is not recommended the system 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.	B105M-OR	4.	Acquisition modules
2.	B125M-OR	5.	B1X5-F2 Frame
3.	B155M-OR	6.	B1X5-REC Recorder

Front view



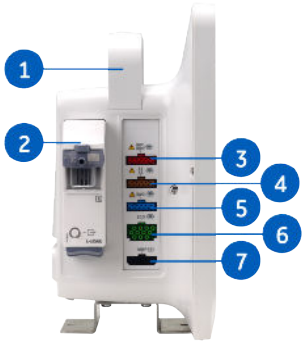
B155M-OR

B125M-OR

B105M-OR

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

Left side view



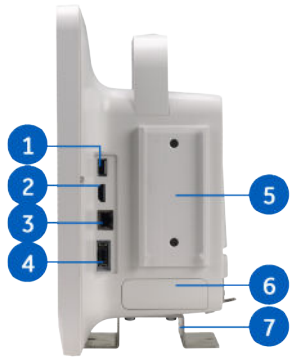
B155M-OR

B125M-OR

B105M-OR

1.	Transportation handle	5.	SpO_2 connector
2.	Parameter acquisition module	6.	ECG and impedance respiration connector
3.	IBP connector	7.	NIBP connector
4.	Temperature connector		

Right side view



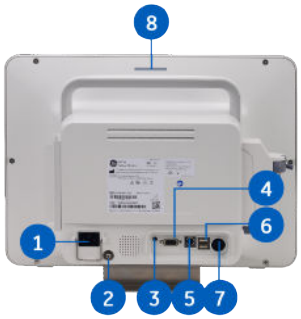
B155M-OR

B125M-OR

B105M-OR

1.	USB connector	5.	Guide rail for recorder
2.	HDMI connector	6.	Battery compartment
3.	Ethernet connector	7.	Mounting plate
4.	**X1** recorder connector		

Back view



B155M-OR

B125M-OR

B105M-OR

1.	Receptacle for power cord	5.	**X6** Defibrillator connector
2.	Equipotential connector	6.	2 USB connectors
3.	**X4** Nurse call connector	7.	**X7** B1X5-F2 Frame connector
4.	**X5** Serial port	8.	Back cover alarm light

Acquisition modules

You can use different types of acquisition modules with the monitor. They provide connection to the patient, process patient data signals, and send patient data signals to the monitor.

Module compatibility limitations

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

Identical acquisition modules

WARNING

PATIENT SAFETY.

Do not use identical acquisition modules or 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	Only one per system.
E-COP	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.	C.O. connector

E-miniC module

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

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

E-sCAiO **E-sCO** **N–CAiO**

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

B1X5-F2 Frame

The B1X5-F2 Frame provide an interface between the monitor and E-modules. The frame allow additional parameters to be monitored.

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

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

B1X5-REC recorder

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

Monitor battery

The device is designed to operate on battery power when used in transport or whenever AC power is interrupted. 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 indicators on the monitor's front panel indicate whether the monitor is being used on battery or mains power, and also whether the battery is charging, full or missing:

Front panel indicator	Meaning
Power LED	Monitor is operating on mains power.
Battery LED	Green lit. Monitor is operating on battery power.
	Orange flashing. Battery failure.
	Orange lit. Battery is charging. The indicator goes off when the battery is fully charged.

Checking the battery charge with monitor software

You can check the monitor battery status using the monitor software:

1. Select the > **Battery** .
2. Check the battery status that appears.

NOTE
You can check the **Maximum Capacity** and current **Capacity Percent** in this menu. When the battery charge completes, the **Capacity Percent** may not reach to 100%.

Monitor battery charge symbols on screen

You can check the battery charge level from the monitor battery symbol on the right upper corner of the display.

Screen symbol	Meaning
	Monitor battery is full.
	Monitor battery is less than 87.5% capacity.
	Monitor battery is less than 62.5% capacity.
	Monitor battery is less than 37.5% capacity.
	Monitor battery is empty when there is less than 12.5% capacity.
	Monitory battery failure or missing battery.
	Monitor battery is charging. There is a white bar inside the symbol.

Other devices

Other devices	Description
	External display The monitor has the HDMI port for the commercial display, which resolution should be 1280*800 or 1366*768.

Other devices	Description
	USB storage device (file system: FAT32) To save and load the logs, settings, trends, patient data in PDF format. **NOTE** Don't insert multiple USB storage devices, the system only support one USB storage device.
	Barcode reader 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 monitor.
	Network laser printer You need to connect the device and printer to the same network.

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 device can be connected to the anesthesia machine. The parameter waveform and data of the anesthesia machine can be intensively displayed on the monitor. And this device can load these data to CARESCAPE MC Network or HL7 Network.

InSite RSvP

InSite RSvP provides a set of software applications to manage, diagnose, and track system at customer sites by using the Internet for secure communications between the customers' and GE's firewalls. InSite RSvP consists of Enterprise Server, which resides at GE's support center, and Remote Service Agent that resides on a system at the customer site (or on a PC controlling the system(s) at the customer site).

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 something 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 monitor, 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 monitor without manufacturer approved mounting attached. Otherwise, there may be a risk of the monitor 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.

Monitor 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 ESC-dissipative products. Non-synthetic clothing should be used when working with the component.
- Choose a location that affords an unobstructed view of the display and easy access to the operating controls, including power cord, connectors at the monitor 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 monitor 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 manuals.

Connecting and removing parts

Connecting B1X5-F2 module

1. Using the F2 connector line, connect **X3** and **X7**.
2. Using power cord connect B1X5-F2 to the wall outlet.
3. Check whether power LED lit  .
4. Turn on the monitor, check whether communication LED lit  .

Connecting E-module

To use the E-module, your device need to be pre-configured with the integrated rack or connect 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 rack or frame.
2. Push the module into the rack or frame until it clicks.

Removing E-module

1. Press the release latch at the bottom of the module.
2. While pressing the release latch, grasp the module firmly and pull out.

NOTE
It is recommended to insert the E-Blank module after removing E-module, to avoid dust and liquid into rack or B1X5-F2 frame.

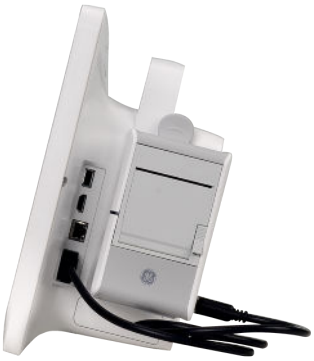
From rack

From B1X5-F2 Frame

Connecting the B1X5-REC recorder

Please make sure the monitor is pre-configured with recorder fixing plate.

1. Using the recorder connector line, connect the recorder connector to **X1**.
2. When the monitor is power on, make sure the power indicator on recorder is lit.



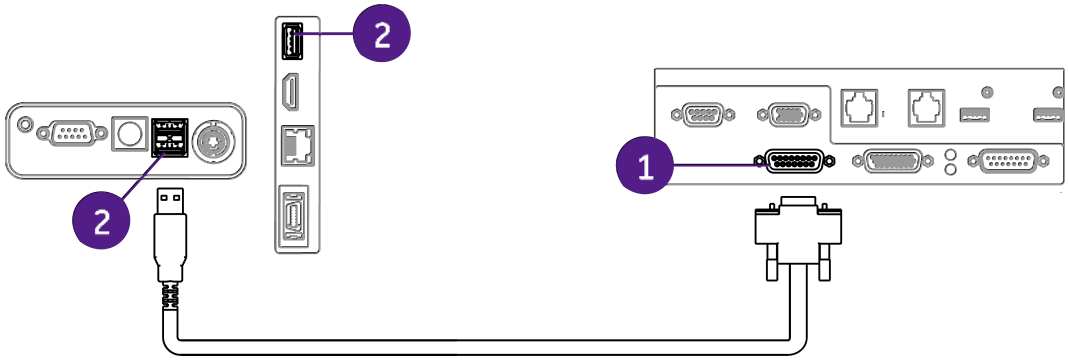
Inserting the B1X5-REC recorder

1. Align the recorder to the insertion guides.
2. Push down the recorder until it clicks.

Removing the recorder

1. Pull the recorder outwards by the tab. Make sure not to drop it when it comes out.

Connecting the anesthesia machine



Monitor **Anesthesia machine**

1.	15-pin serial port on the Anesthesia machine.
2.	USB connector on the monitor.

1. Use a anesthesia connection cable (PN: 5890224), connect to the 15-pin serial port of anesthesia machine.
2. Connect the converter cable to one of the USB connectors on the monitor.

   The default connector is USB3 connector (at the bottom).

   If you not connect to this port, please configure the connector selection through > **Service**(password protected) > **Service** tab > **Page 3** vertical tab > **S5/Anesthesia**.

   For more information, see the technical manual.

Connecting to the mains power

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

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

User interface keys

Various functions of the monitor can be accessed through the monitor's soft keys on screen.

	Home • Close all menus displayed on the monitor and back to the normal screen.
	Trends Open **Trends** menu to: • View, setup and print trends • View and print snapshot • View and print alarm history • View and setup full disclosure
	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.
	Manual NIBP • Start or stop a manual NIBP measurement.
	Standby • Enter standby mode.
	Audio Pause • Audio pause active alarms.
	More • Display more quick access soft keys.
	**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 risk • View EWS guidance, (NEWS2 only)
	**Customized Notifications** Open **Customized Notifications** menu to: • View instance and related trends • Setup customized groups
	**OxyCRG** Open **OxyCRG** menu to: • View realtime OxyCRG • View OxyCRG Snapshot • Setup OxyCRG

	**Alarm 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 in PDF format.
	**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 monitor 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
	**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.
	Trends Switch (in Trends menu) • Shift between graphic trends and numeric trends.

	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.
	Goto a Snapshot for specific alarm (in Alarm History menu) • Goto the snapshot for one alarm history.
	Goto a Full Disclosure for specific alarm (in Alarm History menu) • Goto the Full Disclosure for one alarm history.
	Goto a Full Disclosure for specific time (in Full Disclosure menu) • Goto 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) • Goto next patient view in bed to bed field.
	Audio Pause (in bed to bed view) • Audio pause the remote alarms.
	Show/hide bookmark (in E-manual view) • Show or hide 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
	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.
	Alarm pause 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-level alarms audio off indicator - Displays in the upper left corner of the message field and beside the low-level alarm volume option. It indicates that the low-level alarm volume has been set to 0.
	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 in the upper left corner of the message field, when the priority setting deviates from the recommendation of international alarm safety standards.
	Default alarm limits indicator - Displays in the alarm setup menu.
	Auto alarm limits indicator - Displays in the alarm setup menu.
	Alarm limits changed indicator - Displays in the alarm setup menu. Unread notification instances indicator - Displays in the notification bar.
	Alarm volume indicator - Displays beside the alarm volume setup option.
	Displays in the remote alarm message. Indicate that more remote alarms existing in other remote beds. To check more remote alarms:  >  **Other Patients**, and select the unit and **Show** to **Notification Patients Only**.

The following symbols appear in the software user interface.	
	Unity network is 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) is failed.
	Remote service is enabled, but Field Force Automation (FFA) is not connected.
	Remote service is enabled, and FFA is connected.
	Monitor battery is full.
	Monitor battery is less than 87.5% capacity.
	Monitor battery is less than 62.5% capacity.
	Monitor battery is less than 37.5% capacity.
	Monitor battery is empty when there is less than 12.5% capacity.
	Monitor battery failure or missing battery.
	Monitor battery is charging.
	Night mode indicator. Indicates the monitor is on the night mode.
	Snapshot indicator. Indicates the event has an associated snapshot.
	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.

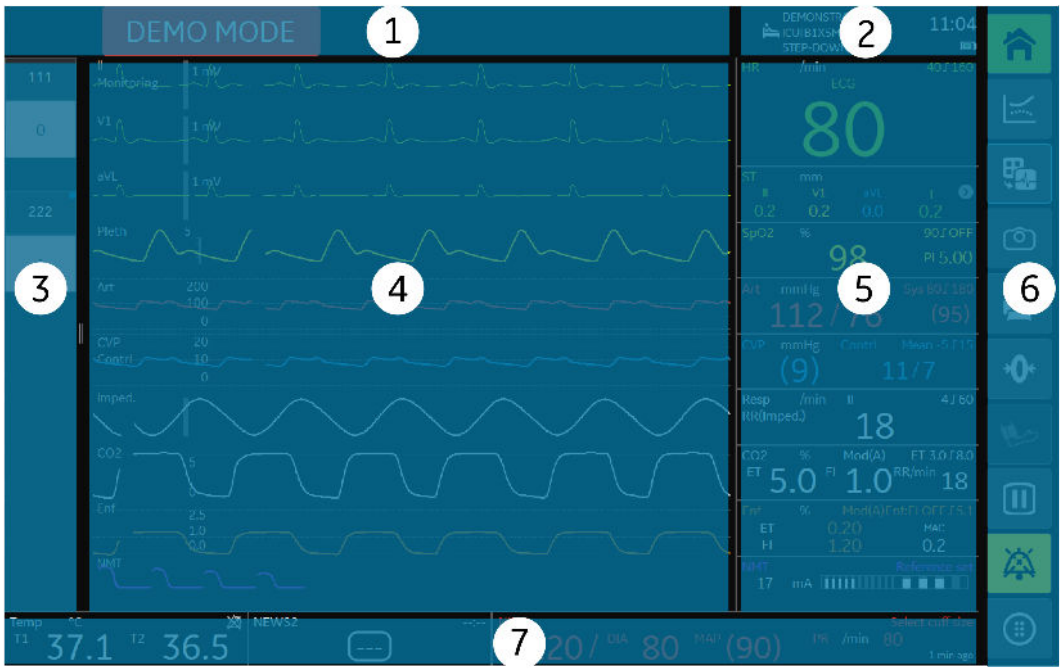
The following symbols appear in the software user interface.	
	Masimo SpO_2 only. SpO_2 signal strength indicator. Indicates the signal strength, with three asterisks indicating the strongest signal.
	NIBP progress bar. Indicates the amount of time remaining until the next automatic measurement.
	NMT progress bar. Indicates the amount of time remaining until the next automatic measurement.
	Patient discharge indicator.
	Indicates patient has been admitted.
	Indicates no patient admitted.

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.	Notifications bar	Select instance, can review the trends around the instance happened. The notification bar also can be hidden or unhidden by left and right swiping the bar on screen.
4.	Waveform field	Displays up to 12 waveforms. Select a waveform 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

NOTE
The monitor displays up to 11 waveforms and 4 lower digit fields at a time, or displays up to 12 waveforms.

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 to 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.	Notifications bar	Select instance, can review the trends around the instance happened. The notification bar also can be hidden or unhidden by left and right swiping the bar on screen.
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 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 have 2 options, display 4 parameters, or 6 parameters.

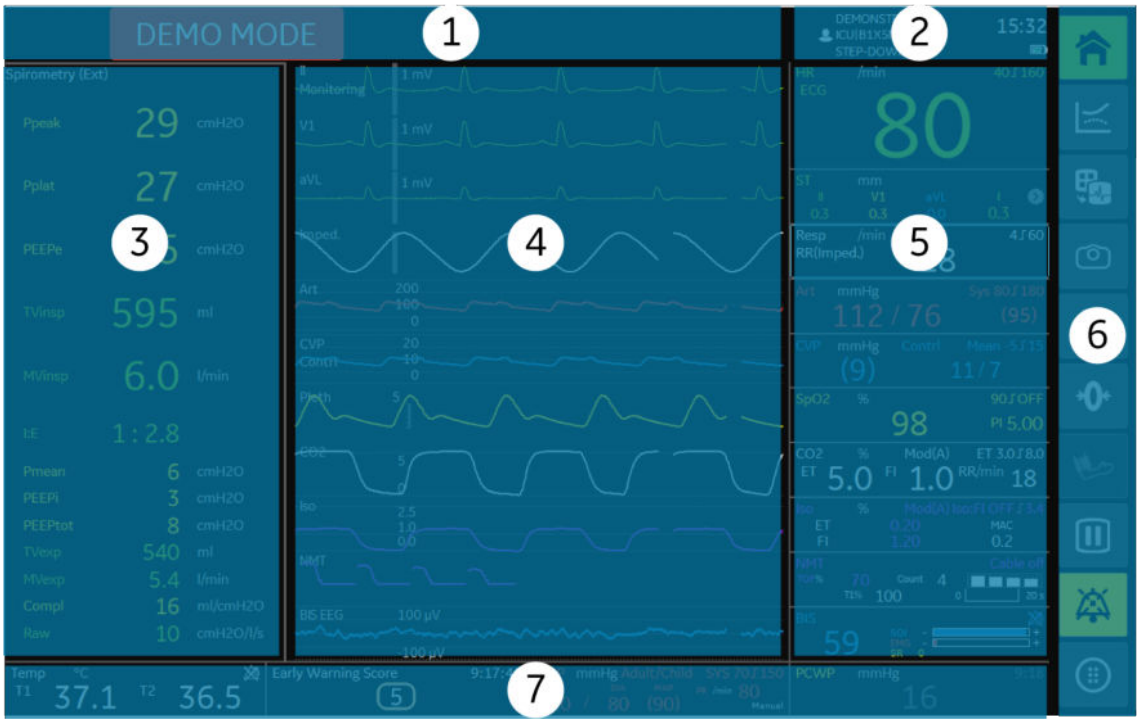
Split screen and bed to bed view layout

Split screen and bed to bed view area is on the left side of the screen.

NOTE

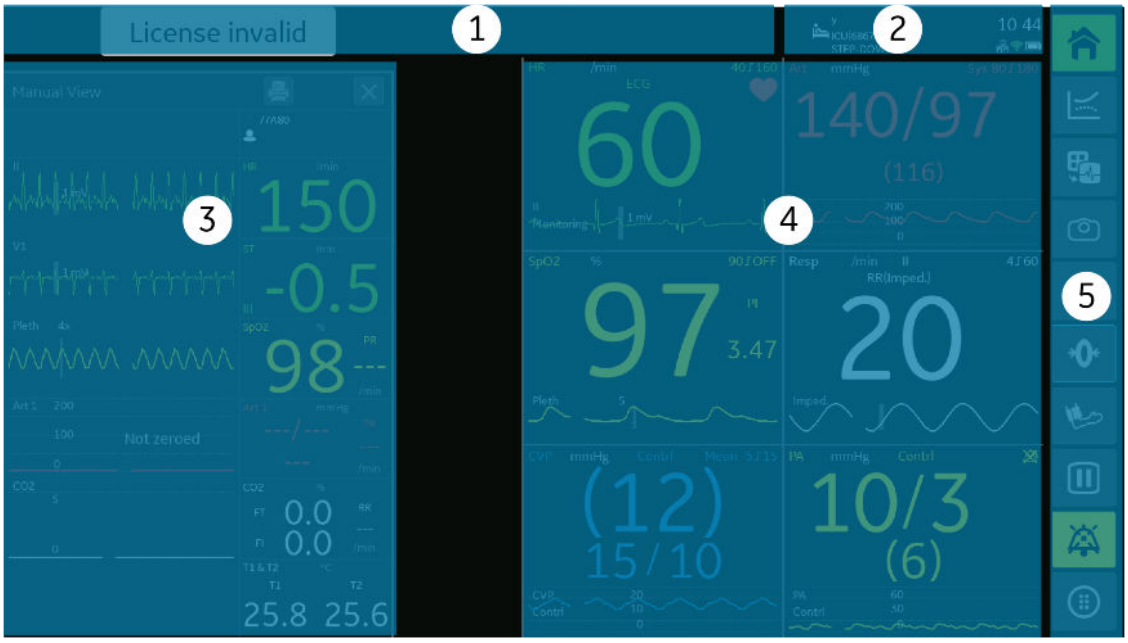
The bed to bed view area, split screen, and notification bar cannot appear simultaneously.

- Bed to bed view is the first priority, when it open, split screen and notification bar can't display.
- For split screen and notification bar, when open one of them, another will be replaced.



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	Displays up to 12 waveforms. Select a waveform 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:



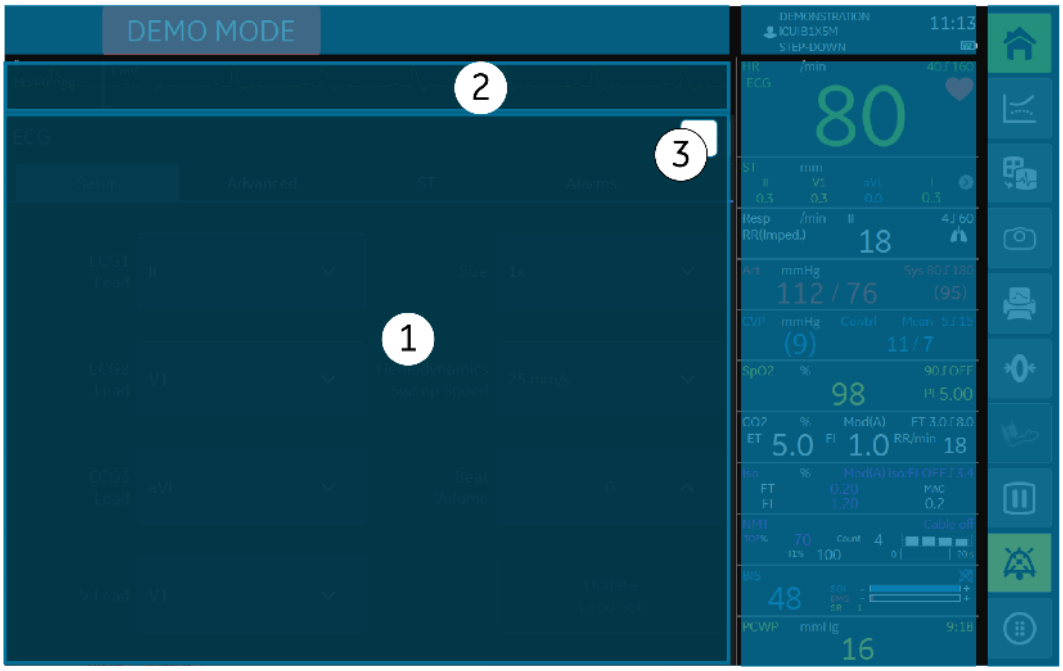
1.	Message field	Select the alarms in message field, can view the Quick Help about possible causes and suggested actions for current alarms.
2.	Information area	Select this area, can enter **Admit/Discharge** menu.
3.	Bed to bed view area	Displays bed to bed view. **NOTE** Split screen can't display 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 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 have 2 options, display 4 parameters, or 6 parameters.

Menu layout

Normal menu layout

When you open the normal menu, ECG 1 waveform and upper digit filed still can be shown on the screen. 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.

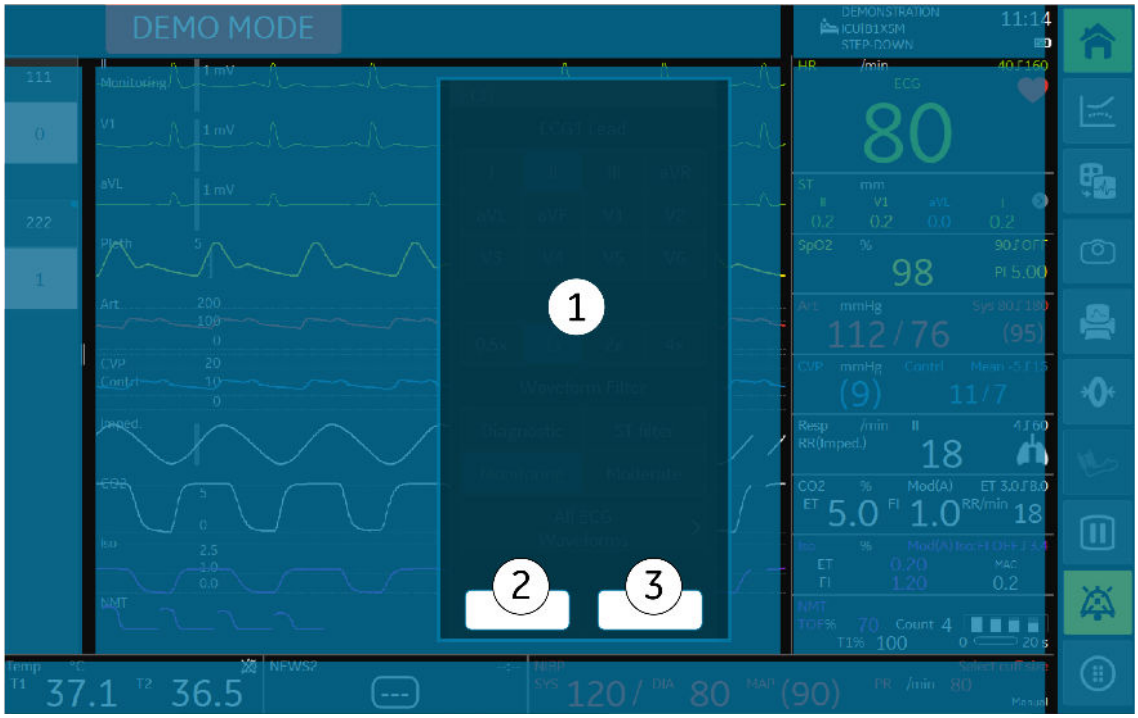


1.	Normal menu
2.	ECG 1 Waveform
3.	Exit key: select to close current menu.

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

Quick pop-up menu layout

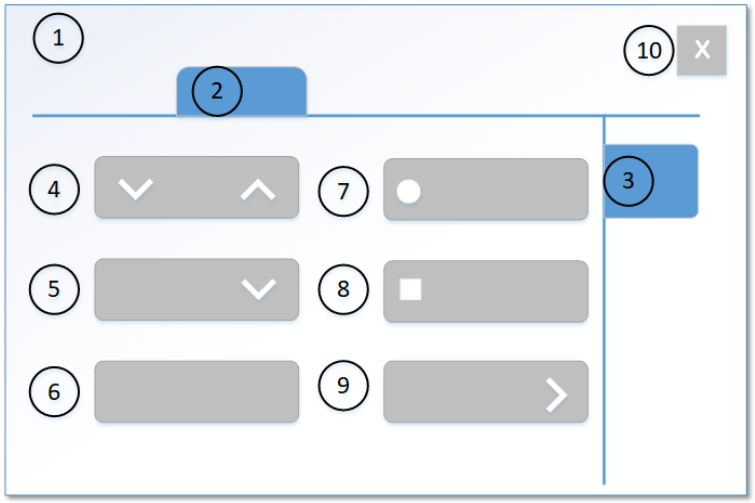
When you select a waveform, will open a quick pop-up menu of this parameter, help you to adjust parameter settings conveniently.



1.	Quick pop-up menu: displays frequently used parameter settings.
2.	**More...**: open the full parameter setup menu.
3.	**Close**: 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.	Menu title (for example, **ECG**)
2.	Horizontal tab (for example, **Alarms**)
3.	Vertical tab (for example, **HR**, **Lethal**, **Ventri cular**)
4.	Arrow selector spinner for increasing/decreasing a value
5.	Selection lists: when selecting the arrow, a list of options appears
6.	Button for initiating a actionable function
7.	Radio button for selecting or deselecting a feature from the available options
8.	Check box for selecting or deselecting a feature
9.	Further menu selections
10.	Exit key (for example, Close, Previous Menu)

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 to open the related shortcut menu. The parameter's quick popup menu will display.

  For more settings, you can select **More...** 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. The highlight on screen moves to this option.
3. 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 monitor 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 monitor on/off

The monitor 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.

1. Ensure all cables are properly connected.
2. Turn on the power:

   Press the `On/Off` button (more than 3 seconds) located on the keypad.

   The welcome screen will appear with a status bar indicating the progress of the startup procedure.
3. Turn off the power:

   Press the `On/Off` button (more than 3 seconds).

   The message "**Monitor is shutting down...**" will appear on the screen.

Automatically turn off the monitor

When the monitor is not connected to the mains AC power, and the battery remaining time is less than 3 minutes, the monitor will automatically turn off.

Before turning off the monitor:

- Stop NIBP, C.O., PCWP, NMT measurement.
- Stop the printing activity.
- Return main menu to home.

Password management

Setup password at first time to use

When first time turn on the monitor, the password setup wizard will be displayed on the screen. You need to setup all the monitor's passwords.

There are 2 ways to setup password: from USB disk to import setting file, or setup manually.

Import settings from USB at first time to use

The setting file can be exported from other monitor, refer to Exporting settings on page 90.

1. Select **Settings Activation from USB Disk** tab.
2. Select the related setting file from **Setting Files** list.
3. Enter the decryption **Key for the File**.
4. Select **Activate & Restart**.

The monitor's settings and password have been setup, and the monitor will restart.

Setup password manually

1. Select **Set Password Manually** tab.
2. Enter and retype the passwords for **Clinical** and **Service**.

   The passwords are case sensitive. 8 digits at least.
3. If necessary, select the checkbox, and select the value for **Password expired duration(month)**.

   You have to change passwords after the month you selected.
4. If necessary, export password recovery key:

   The recovery key is used to reset password when you forget.

   NOTE
   Make sure the file system format for USB storage device should be FAT32.

   4.1. Insert USB disk to monitor.

   4.2. Select the checkbox **Export Password Recovery Key to USB Disk**

5. Select **Activate & Restart**.

The password have been setup, and the monitor will restart.

Changing passwords

Each account can change the password for itself and the lower level access.

NOTE
Username and password are case sensitive. You can view and change **Password Policy**.

1. Select the > **Service** > enter **Username** and **Password**.
2. Select **Change Password**.
3. Select **Clinical** or **Service** radio button as required.
4. Enter and retype the new passwords, then select **Confirm**.

Setup the password policy

You can setup the password policy to enhance the security of the device.

1. Select the > **Service** > enter **Username** and **Password**.
2. Select **Change Password** > **Password Policy**
3. Setup the following items for **Basic Policy**, if necessary.
   - **Password Minimum Length**: Configure minimum allowed password length.
   - **Uppercase characters Minimum number**: Configure minimum number of uppercase letters (A ~ Z) in password.
   - **Lowercase characters Minimum number**: Configure minimum number of lowercase letters (a ~ z) in password.
   - **Digit Minimum number**: Configure minimum number of numeric characters (0 ~ 9) in password.
   - **Special characters Minimum number**: Configure minimum number of special characters in password.
4. Select **Advanced Policy** tab, select the check box and setup the following items, if necessary.
   - **Maximum repeating character length**: Configure number of forbidden repeated characters in password.
   - **Maximum monotonic sequence length**: Configure number of forbidden sequential characters in password.
   - **Password history**: Configure number of historical passwords be checked when set new password.
   - **Maximum error attempts**: Configure password lockout attempts. The username will be locked after error attempts reach the setup time. You should reset the password.
   - **Password expired duration(month)**: Configure password lifetime duration.

Bad password

When you set password, please avoid to use bad password as follow:

- **BAD PASSWORD: It is too simple**, for example "12345678"
- **BAD PASSWORD: It is based on a word in the forbidden list**, for example "Change Me", "Password"
- **BAD PASSWORD: It contains less than 5 different characters**, for example "aaaaaaaa"

Password expired

After password expired, if user try to use old password **Login**, the monitor will go to **Change Password** menu automatically.

To change password is the necessary process. It is recommended you to change password immediately.

NOTE
If give up to change password, user still can return to the normal screen. But can't enter **Clinical** or **Service** menu.

Generate and export recovery key

You can generate and export the recovery key to USB disk. The recovery key is used to reset password when you forget.

NOTE
Make sure the file system format for USB storage device should be FAT32.

1. Insert the USB disk to monitor.
2. Select the > **Service** > enter **Username** and **Password**.
3. Select **Change Password** > **Generate Recovery Key**.
4. Select **Generate**.

The recovery key have been generated and exported to USB disk.

Reset passwords

You can reset the password when forget. There are two ways for resetting passwords:

- Via activation code, which contact GE service to get
- Via recovery key, which saved in USB disk

Resetting password via activation code

1. Connect GE service to get the Expiration Date and Activation Code.
2. Select the > **Service** > enter **Username** and **Password**.
3. Select **Reset Password**.
4. Enter the **Expiration Date (YYYYMMDD)** and **Activation Code**.
5. Select **Confirm**.

Enter the **Change Password** menu to setup new password.

Resetting password via recovery key in USB

If you have generated recovery key in USB before, you can use the recovery key to reset password.

1. Insert USB disk with recovery key files to the monitor.
2. Select the > **Service** > enter **Username** and **Password**.
3. Select **Reset Password**.
4. Select **Confirm** in **Option 2** section.

Enter the **Change Password** menu to setup new password.

Performance check

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

Mains supply interruption

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

Downloading logs to USB disk

You can download the system logs, and diagnostic logs to an USB storage device for service use.

NOTE
Make sure the file system format for USB storage device should be FAT32.

1. Discharge the patient first.
2. Select the > **Service** > enter **Username** and **Password**.
3. Select **USB Import/Export** > **Export logs to USB Disk**.
4. Enter an encryption **Key** for the logs file, the length of key shall be at least 6.

   This key will be used when open the logs.
5. Select **Export logs to USB Disk**.

   When finish to download logs, a message “**Export logs successfully.**” displays on the menu.
6. To remove the USB disk, select **Safe to remove USB Disk**.

Setting up the monitor before use

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. All volumes other than **Alarm Volume** can be set to 0 if required.

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

     NOTE

     After selecting > **Service** (password protected) > **Alarm Options** > **Audio of Alarms** > **Alarm Volume Control** > **Separate for Low**, there are two options: **High & Medium Alarm Volume** and **Low Alarm Volume**.
   - **Beat Volume**
   - **Completed NIBP Volume**

Adjusting the display brightness

You can set the display brightness level according to your needs. When **Brightness Type** is set to **Auto**, the display adjusts screen brightness automatically according to the ambient light.

1. Select the .
2. Select the **Screen Brightness**.
3. Select the **Brightness Type**.
4. When the **Brightness Type** is set to **Manual**, adjust the **Screen Brightness** with the arrows.

Screen setup modifications

The monitor provides pre-configured layouts: 2 waveform layouts and 2 large number layouts.

You can select layouts between waveform and large number during monitoring.

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

Waveforms layout

NOTE
The monitor displays up to 11 waveforms and 4 lower digit fields at a time, or displays up to 12 waveforms.

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 also will update the associated digit field that is displayed to the right of the waveform.

If the **Lower Area** is turned off, up to 12 waveforms can be displayed.

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 disappears.

Large number layout

The large number layout displays up to 6 fields at a time. Each field displays large number of digit field and one waveform for each parameter, if applicable.

Setting waveforms layout

1. Select the > **Screen Setup**.
2. Select the **Layout 1** or **Layout 2** tab > **Upper Area** vertical tab.
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.

NOTE
If you turn off the **Lower Area**, the parameter selections for digit fields are gray. And on the **Upper Area** vertical tab, you can set 12 waveforms.

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**.
2. Select the **Layout 1** or **Layout 2** tab.
3. Select the **Combine Pressures** checkbox 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**.
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 dight field, you can set a split screen display bar on the left side of the screen.

1. Select the > **Screen Setup**.
2. Select the **Split Screen** vertical tab.
3. Select a split screen display type from the **Show** list. Choices are:
   - **None**: No split screen is displayed.
   - **Spirometry**: Spirometry measurement data is displayed. The option is activated when a compatible anesthesia machine is connected.
   - **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.

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

All other setup changes require a password.

- Alarm options
- Snapshot
- Parameter settings (Units, Colors, and Others)
- Roving
- Gesture Control
- Save Modes
- Time and date
- Time zone
- USB import/export
- EWS (Early Warning Score type)
- Printer

For more information, see the supplemental information manual.

Transferring settings from a monitor to another

Exporting settings

You can save the user settings to the USB storage device.

NOTE
Make sure the file system format for USB storage device should be FAT32.

1. Discharge the patient. Insert the USB storage device to the USB port of the monitor.
2. Select the > **Service** > enter **Username** and **Password**.
3. Select **USB Import/Export** > **Export settings to USB Disk**.

4. Enter an encryption **Key** for the settings' file, the length of key shall be at least 6. (This key will be used when import settings).
5. Select **Export settings to USB Disk**.

   When finish to export settings, the screen returns and a message "**Export settings successfully.**" displays on the screen.
6. To remove the USB disk, select **Safe to remove USB Disk**.

Importing settings

You can import the saved user settings from the USB storage device when:

- first time to use the monitor, refer to Import settings from USB at first time to use on page 83 for more details.
- other time, see following instruction.

1. Discharge the patient. Insert the USB storage device to the monitor’s USB port.
2. Select the > **Service** > enter **Username** and **Password**.
3. Select **USB Import/Export** > **Import settings from USB Disk**.
4. Select the settings' file from **Import Setting file list**.
5. Enter the decryption **Key** for the settings' file.
6. Select **Import settings from USB Disk**.

   When finish to import settings, the screen returns and a message “**Import settings successfully. Please restart the monitor.**” displays on the menu.
7. To remove the USB disk, select **Safe to remove USB Disk**.
8. Restart the monitor.

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.

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 monitor 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 seven user modes 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 to factory default settings.
- choose the default mode.

Reach these selections through > **Service** > **Save Modes**, and they are password protected.

For more information, see the supplemental information manual.

Selecting a mode

The monitor 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 the **Select Mode** tab.
3. Select a mode from the **Select Mode** list.
4. You can return to the previous mode by selecting **Return to previous mode:**.

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:

- Acquisition module is firmly in place.
- Accessories are intact and properly connected.
- Monitor is displaying the monitoring screen.
- No messages are displayed indicating the monitor 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 monitor detects any of the following vital signs: ECG, Art, ABP, NIBP, SpO_2, CO_2, Entropy, or BIS.

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

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

Always observe the monitor 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 monitor 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 demographics, 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 needs encryption.

Entering patient data with the monitor

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

   NOTE
   Date of Birth is related with **Age** that **Age** is automatically calculated from **Date of Birth**. **Age** can be set manually, but the settings of **Date of Birth** will be cleared when no match is found with **Date of Birth**.
5. Reconfirm the patient data you have entered.

Entering patient data with barcode scanner

You can scan the patient data in the barcode if the function is activated during monitor configuration.

1. Select the information area.

2. Select **Scan from Barcode**.

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

3. Use barcode 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 monitor 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 Patient Information** to load the data from the CARESCAPE Gateway server.

About standby

When you remove the patient temporarily from the monitor, 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 monitor 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 monitor ends the standby state automatically when any of the following conditions occurs:

- Any physiological data is detected.
- The touchscreen is pressed.
- Discharge a patient remotely.

NOTE
When user presses the `ON/OFF` less than 3 seconds, the monitor will still be in standby state. When pressing the `ON/OFF` more than 3 seconds, the monitor 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 menu will not appear when the patient is discharged remotely.

About the roving functionality

Roving functionality allows you to move, or rove the monitor to fit the patient's acuity needs, rather than moving the patient to a monitored room. When you move the monitor 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 monitor to a new location.

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

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

You can also change the name manually through **New Unit & Bed** if it has been allowed.

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 **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.

You can also change the name manually through **New Unit & Bed** if it has been allowed.

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 **Unit & Bed** tab.
3. Select **New Unit & Bed**.
4. Select the **Unit Name** or the **Bed Name** field and type the new name.

   The maximum number of characters for the **Unit Name** is seven, and for the **Bed Name** is five.
5. Select **Confirm** to ensure that the names you entered are valid.

Selecting the printing device

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

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

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 monitor 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 on 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

     After selecting > **Service** (password protected) > **Alarm Options** > **Audio of Alarms** > **Alarm Volume Control** > **Separate for Low**, there are two options: **High & Medium Alarm Volume** and **Low Alarm Volume**.
   - **Beat Volume** : HR beat volume

- **Completed NIBP Volume**: NIBP complete beep
- **Screen Brightness**: Monitor display brightness
- **Silence ALL**: Turns off all audible alarms except some high priority alarms defined as breakthrough alarms.

  NOTE
  This setting not available if **Alarm Options** > **Audio of Alarms** > **Audio Off Allowed** set to **NO**, it is password protected.
- **Alarm Light** (not for VSP 3.0 upgrade device): Alarm light brightness

3. Select **Enter** tab.
4. Select the check box 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 field.

Exiting night mode

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

   If **Scheduled** check box is selected. the night mode will automatically exit when out of time.

The night mode symbol is removed from the information field.

About Demo Mode

The Demo Mode is designed for training and demonstration of primary operations before use. Under Demo Mode, the monitor displays the main 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 monitor and requires a password to enter. Please consult qualified service personnel to enter the Demo Mode.

Shut down the monitor 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 and waveforms on the monitor’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 monitor. This also happens when the monitor 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 monitor.

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 arrhythmias 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 monitor 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 monitor. 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.

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 SpO_2 sensor and adjust the SpO_2 high limit under measured SpO_2 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 SpO_2 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 for the on screen alarm icons, see User interface symbols.

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 or information message text
- Label for the parameter, if available
- Current value if a limit alarm
- Snapshot, if available
- Full Disclosure, if available

Setting alarm light brightness

1. Select > **Alarm 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** fixes to **Manual**
   - the **Alarm Light** brightness settings range is differ from the settings under normal mode

NOTE

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

- Select **0%(OFF) Allowed**: Range is 0~100%.
- Unselect **0%(OFF) Allowed**: 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 **Alarm Reset**, **Alarm Setup**, and **View User's Manual**.
Remote alarms in message field	Select the remote alarms in message field, to open the bed to bed view window.

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 patient monitor 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 grey 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 monitor 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.

Alarm tones

The alarm tones can be configured to sound in one of four different tone patterns: **General**, **IEC**, **ISO**, or **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 monitor’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 monitors to the same type of audible alarm tones used in your clinical environment.

Adjusting the alarm volume

1. Select > **Alarm Setup**.
2. Select **Audio** tab.
3. Adjust the value. (The menu has difference according to setup):
   - **Alarm Volume**: adjust volume for all alarms.
   - **High & Medium Alarm Volume** and **Low Alarm Volume**: 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.

   When **Low Alarm Volume** is set to 0, the appears beside the option.

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 monitor 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

Setting parameter alarm limits

Parameter alarm limits are set in **Alarm 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 the > **Alarm Setup**.
2. Select parameter group in the header of table if need.

3. Adjust the parameter alarm limits with arrows.
4. Select alarms **ON** or **OFF**.

> **NOTE**
> A blue point will be display 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 the > **Alarm Setup**.
2. Select **Auto Limits**. You still can do the necessary manual adjustment base 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)	Value*1.25 (rounding)	Value*0.75 (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%
NIBP	Sys/Dia/Mean: Value*1.25+10 mmHg (1.3 kPa)	Sys/Dia/Mean: Value*0.75-10 mmHg (1.3 kPa)
Art, ABP, IBP1, RVP, UAC, UVC, PA	Sys/Dia/Mean: Value*1.25+10 mmHg (1.3 kPa)	Sys/Dia/Mean: Value*0.75-10 mmHg (1.3 kPa)
CVP, RAP, LAP, ICP, IBP2, IBP8	Sys/Dia/Mean: Value*1.25+5 mmHg (0.67 kPa)	Sys/Dia/Mean: Value*0.75-5 mmHg (0.67 kPa)
Temperature, 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 the > **Alarm 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
Informational messages 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 > **Alarm 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 list 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 > **Alarm Setup** > **Priorities** tab.
2. You can select the vertical tabs for the **Lethal**, **Ventri cular** and **Atrial** alarms.
   - **Lethal**: You can select the **Create Snapshot** options, the alarm priority for lethal alarms is always high.

     You can setup the **V Tach** alarm condition.
   - **Ventri cular**: You can select the alarm priority or turn off **Create Snapshot** options.
   - **Atrial**: You can select the alarm priority or turn off **Create Snapshot**, and setup **Pause Interval** options.

     You can setup the SVT settings.

Pausing and silencing alarms

Audible alarms off behavior

Depending on the **Audio Off Allowed** default 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 > **Alarm Setup**.
2. Select the **Audio** tab.
3. Select an alarm group. Choices are:
   - **None**: No audible alarms are turned off.
   - **Silence Apnea**: Turns off audible alarms for Apnea (Imped. and CO_2), $EtCO_2$, $FiCO_2$, respiration rate limit alarms (Imped. and CO_2).
   - **Silence ECG**: Turns off audible alarms for all HR source limit, arrhythmia, ST, PVC, and SVC alarms.
   - **Silence Apn&ECG**: Turns off audible alarms for all HR source limit, arrhythmia, ST, PVC, SVC, Apnea (Imped. and CO_2), $EtCO_2$, $FiCO_2$, respiration rate limit alarms (Imped. and CO_2).
   - **Silence ALL**: 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 monitor is on the network, alarms can also be audio paused at the central station.

Selection	Result	Indicator
Select (audio pause) once	• Start a 2 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 pause	• Cease the audio pause state. • Deactivate some alarms in list below.	• Alarm light: Yes • Alarm message: Yes • Alarm audio: Yes
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

Selection	Result	Indicator
*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 probe**
  - **SpO2 probe off**
  - **Check SpO2 probe**
  - **No SpO2 pulse**
  - **Zero ICP separately**
  - **NIBP cuff loose**
  - **NIBP cuff occlusion**
  - **Check NIBP**
  - **Weak pulsation**
  - **Long measurement time**
  - **NIBP manual**
  - **NIBP cuff overpressure**
  - **NIBP call service error**
  - **NIBP measurement removed**
  - **Recorder module removed**
  - **Gas measurements 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**
- **ECG measurements removed**
- **STP measurements removed**
- **SpO2 measurement removed**
- **Entropy measurement removed**
- **C.O. measurement removed**
- **NMT measurement removed**
- **Monitor disconnected**
- **All monitors disconnected**
- **No more space Full disclosure disabled**
- **No storage Full disclosure disabled**
- **Storage fail Full disclosure failure**
- **Condition battery**
- **No battery backup**
- **Replace battery**
- **No Px transducer**
- **Art disconnect**
- **ABP disconnect**
- **UAC disconnect**
- **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**
- **Agent Mixture**
- **Multiple agents present**
- **Invalid barcode configuration**
- **Barcode too long**
- **Incorrect barcode value**
- **Barcode scanned**
- **Printer error**
- **Saving PDF failed**

Audible alarms' deactivation with gesture

Alarm audio pause is available with gesture. The gesture sensor locates at the upper left corner of monitor. 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 monitor
- forth and back wave, twice in 2 s at least.

Action	Result	Indicator
Wave hand to gesture sensor area, when there has active alarm and it's not paused or silenced.	• Start 2 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 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 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
	Ppeak high	Escalate to high
2 minutes alarm audio pause is active	**Asystole**	Activates as high
	V Tach	Activates as high
	V Fib / V Tach	Activates as high
	Brady[*1]	Escalates to high
		Activates as high
	FiO2 low	Activates as high
	EtO2 low	Activates as high
	FiN2O 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

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 monitor
- **For Remote Bed**: Enabling or disabling audio pausing remotely for another monitor.
- **Allow Remote Pausing of**: Selecting alarm priorities that can be paused remotely.

- **Remote Alarm Light**: Use of the alarm light also for a remote alarm.
- **Show Remote Patient Name** (check box): Enabling or disabling the display of the remote patient name.
- **Remote Alarm Tone**: Selecting the remote alarm tone.
- **Remote Bed Selections** (check box) : Enabling or disabling the restoring of the remote bed selections after discharge.

For more information, see the supplemental information manual.

Nurse call

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 monitor 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 monitor 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 monitor 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.

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, SpO_2 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

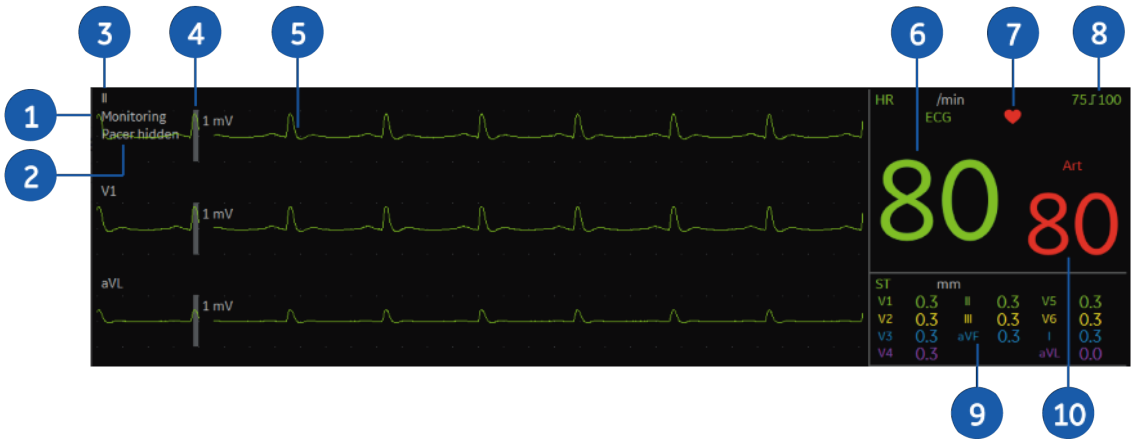
CONDUCTIVE CONNECTIONS.

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, and ST analysis.

ECG measurement displayed on the monitor screen



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

ECG measurement limitations

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

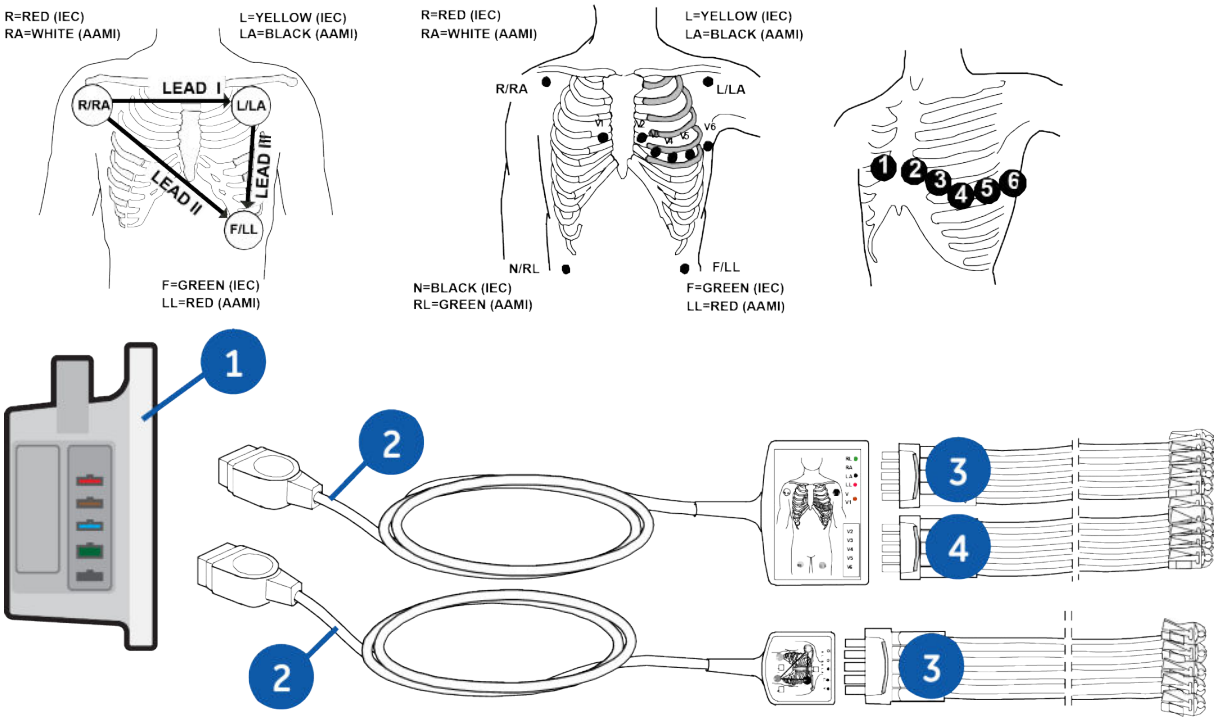
ECG points to note

- 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 monitor 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 monitor	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

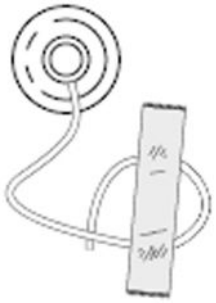
Excessive body hair or skin oil reduces electrode contact with the skin and decreases the quality of electrode signal. When preparing the electrode sites, avoid bones close to skin, obvious layers of fat and major muscles.

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

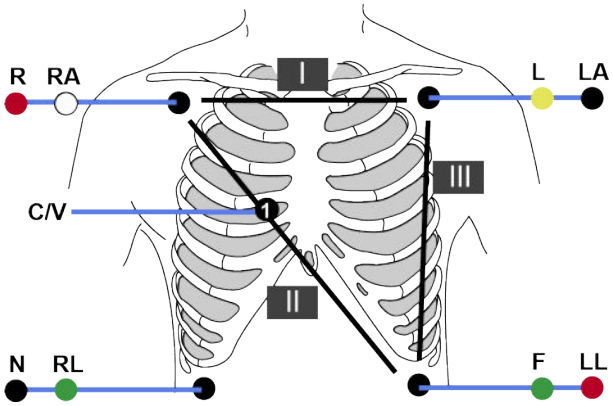
1. Place the electrodes on the prepared sites.
2. Stabilize the electrode and leadwire with a leadwire stress loop near the electrode.
3. Tape the stress loop to the patient (excluding neonates).



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

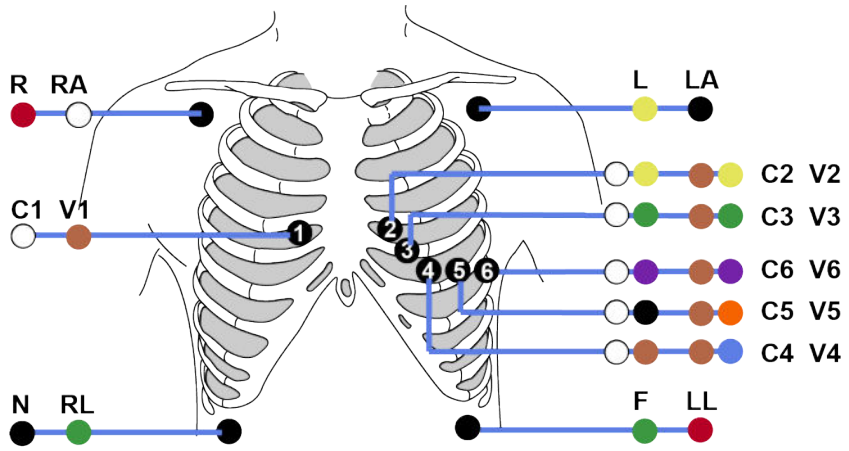
3– lead or 5–lead ECG electrode placement

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)	4th intercostal space, right sternal border.
C2 (white/yellow)	V2 (brown/yellow)	4th intercostal space, left sternal border.
C3 (white/green)	V3 (brown/green)	Midway between C2/V2 and C4/V4.
C4 (white/brown)	V4 (brown/blue)	5th 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 when the cable is connected to the patient.

Using the ECG measurement

Setup the parameter to normal screen, if need: > **Screen Setup**.

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 monitor looks for lead II, then lead I, and lastly lead III. Later, if the manually selected lead becomes available again, the monitor 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.

Setting the beat volume

NOTE
This setting adjusts beat volume for both of ECG and SpO_2 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, SpO_2 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:
   - **None**
   - **2nd HR Source**

- If the primary HR source is **ECG**, the secondary HR source displayed in this priority: **Art**, **ABP**, **UAC**, **Pleth**.
- If the primary HR source is anything else than mentioned above, the secondary HR source is always **ECG**.

- **PVC**

Displaying the ECG grid

You can have a reference grid in the **ECG1**, **ECG2**, and **ECG3** 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. Select the check box 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. 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 monitor 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 monitor relearns the QRS pattern. During this time, arrhythmia detection may not be available. If the monitor 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.
- The PVC alarm limits.
- The SVC alarm limits.

Setting the HR alarm limits

1. Select the HR digit field.
2. Select the **Alarms** tab.
3. Check that the **Alarm** is turned on.
4. Adjust the alarm limits with the arrows. Limits are adjust in increments of 5 bpm per step.

NOTE
If you want the HR alarm off, select 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 or Pleth). 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 monitor use the AUTO algorithm. **AUTO** selects the first available heart rate source based on a pre-defined parameter priority:

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

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 is on by default. If you turn pacemaker detection off, you should turn it back on for patients with pacemakers. 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 SpO_2 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 SpO_2 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 complete, 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 complete, 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 monitor 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 > **Alarm Setup** > **Priorities** tab.

2. You can select the vertical tabs for the **Lethal**, **Ventri cular** and **Atrial** alarms.
   - **Lethal**: You can select the **Create Snapshot** options, the alarm priority for lethal alarms is always high.

     You can setup the **V Tach** alarm condition.
   - **Ventri cular**: You can select the alarm priority or turn off **Create Snapshot** options.
   - **Atrial**: You can select the alarm priority or turn off **Create Snapshot**, and setup **Pause Interval** options.

     You can setup the SVT settings.

Setting the V Tach alarm conditions

This setting determines the conditions to trigger V Tach alarm. The selection is shown only if the **V Tach Event Duration Criteria** has been allowed 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 **V Tach Event Duration Criteria** has been allowed 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 monitor 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 alarm limit.

Table 1 HR alarms (Table continued)

Alarm message	Arrhythmia detection criteria
Tachy	HR over the HR 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 ECG 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 > **ST** tab.
2. Select **ST Alarm** 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.

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 CO_2.

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

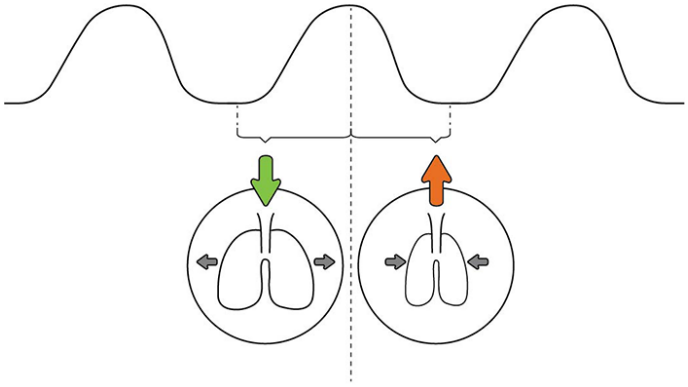
PATIENT SAFETY.

The impedance respiration measurement may cause rate changes in Minute Ventilation Rate Responsive Pacemakers. Turn off the impedance respiration measurement on the monitor 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 monitor screen

1.	Imped. (**Imped.**): waveform label	6.	II (**II**): Measurement lead
2.	Waveform size bar	7.	Alarm limits, alarm status, or other messages
3.	Impedance respiration waveform	8.	RR(Imped.) (**RR(Imped.)**): Impedance respiration rate
4.	Resp (**Resp**): parameter label	9.	Respiration indicator
5.	/min (**/min**): unit		

Respiration measurement limitations

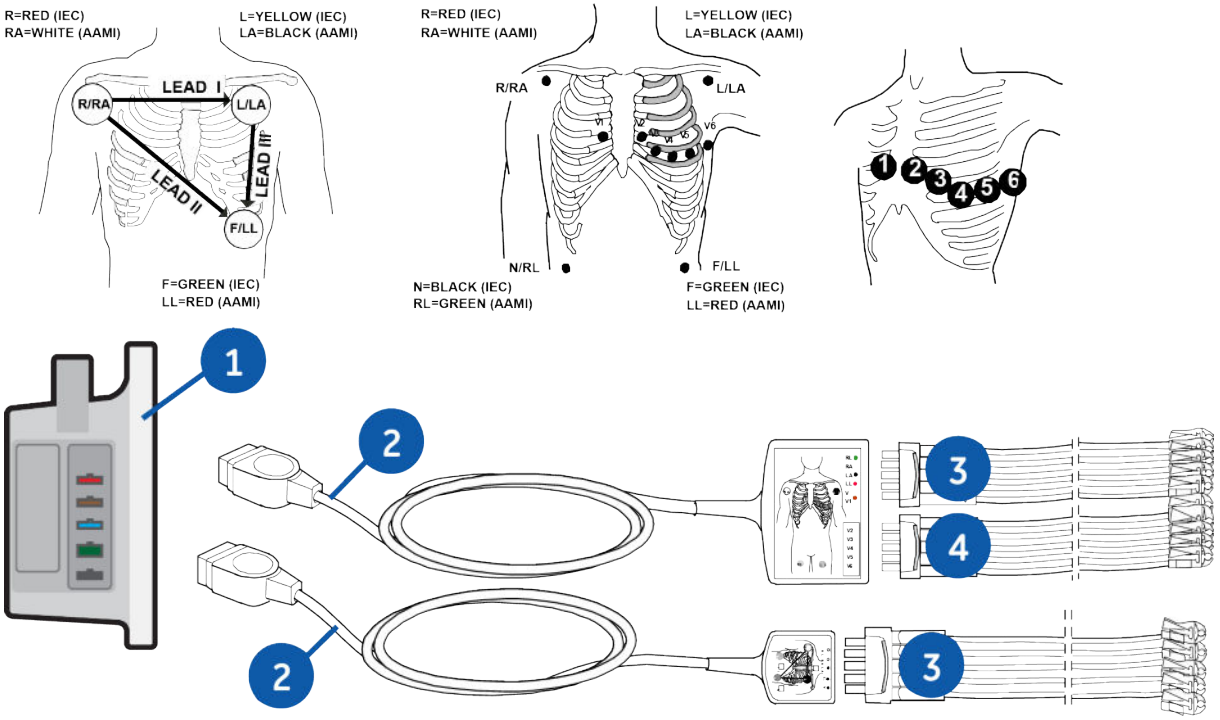
- Electrical devices, such as electrosurgery units and infrared heaters, that emit electromagnetic disturbance, may cause artifacts or disable the respiration measurement completely.
- Motion artifact (such as mobile (walking) patient, shivering, and interference from the beating heart) may interfere 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 vaules 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 monitor	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.

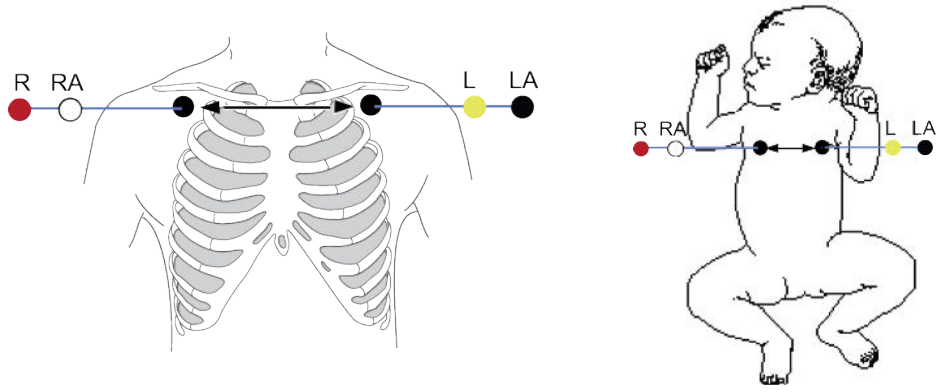
Respiration lead and breath detection

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.

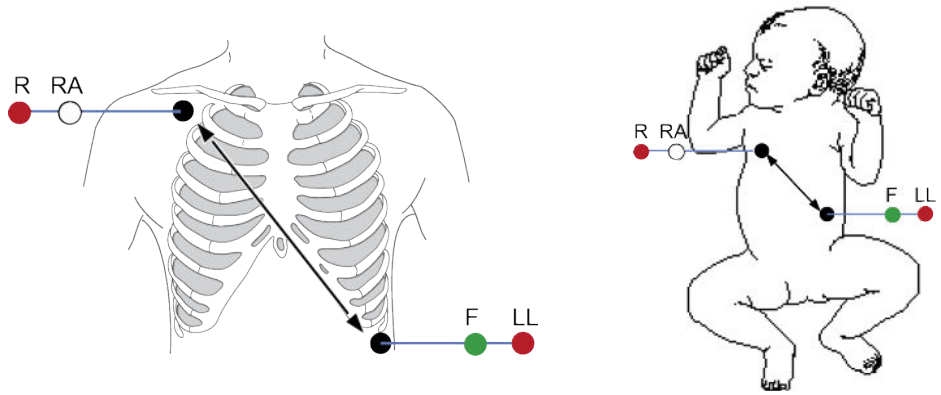
Respiration lead I electrode placement



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

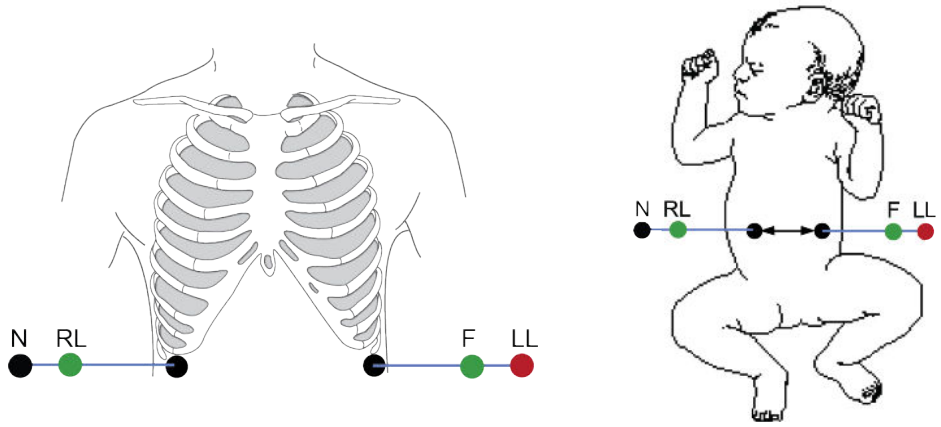


ECG lead II for chest or upper abdominal breather

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 CO_2 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 need: > **Screen Setup**.

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. Select a value from the **Size** list.

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.

Setting the averaging time

1. Select the impedance respiration digit field.
2. Select a value from the **Resp Averaging Time** list.

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. Select a value from the **Apnea Limit Seconds** list.

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.

Turning off the respiration measurement

1. Select the impedance respiration digit field.
2. Select **OFF** from the **Measurement** list.

Pulse oximetry

SpO_2 safety precautions

SpO_2 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 SpO_2 readings. If the problem is still not resolved, check the monitor 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 SpO_2 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 SpO_2 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 (SaO_2).

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 (SpO_2) 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 monitor is used on neonates or infants. These same conditions in adults do not impact the SpO_2 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 SpO_2 function must be within 10% of the heart rate, and

The SpO_2 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 SpO_2 monitoring should be used in the event the SpO_2 value from the monitor cannot be validated by the above criteria.

WARNING

ERRONEOUS READINGS.

Interference may occur when the working SpO_2 sensor close to gesture sensor area, leading to low quality of SpO_2 waveform and signal. Do not allow the working SpO_2 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 SpO_2 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 SpO_2 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 SpO_2 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 monitor 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 SpO_2 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 SpO_2 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 SpO_2 with Masimo SET technology.)

WARNING

PATIENT SAFETY.

With deactivated **SpO2 probe off** alarm, keep the patient under close surveillance.

WARNING

MISSED ALARM.

Check the SpO_2 measurement when switching the SpO_2 measurement sources to avoid missed SpO_2 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.

SpO_2 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 oximetry device or accessories in any position that might cause it to fall on the patient.

WARNING

Do not start or operate the pulse oximetry device unless the setup was verified to be correct.

WARNING

Do not use the pulse oximetry device during magnetic resonance imaging (MRI) or in an MRI environment.

WARNING

Do not use the pulse oximetry device if it appears or is suspected to be damaged.

WARNING

EXPLOSION HAZARD.

Do not use the pulse oximetry device 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 instrument 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 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 oximetry device 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 oximetry device for proper functioning.

WARNING

Inaccurate SpO_2 readings may be caused by:

Improper sensor application.

Elevated levels of COHb or MetHb: High levels of COHb or MetHb may occur with a seemingly normal SpO_2. When elevated levels of COHb or MetHb are suspected, laboratory analysis (CO-oximetry) of a blood sample should be performed.

Externally applied coloring and texture, such as nail polish, acrylic nails, glitter, etc.

Elevated levels of bilirubin.

Severe anemia.

Low arterial perfusion.

Motion artifact.

WARNING

INTERFERING SUBSTANCES.

Dyes or any substance containing dyes that change usual blood pigmentation may cause erroneous readings.

WARNING

The pulse oximetry device should not be used as the sole basis for medical decisions. It must be used in conjunction with clinical signs and symptoms.

WARNING

The pulse oximetry device is not an apnea monitor.

WARNING

The pulse oximetry device may be used during defibrillation, but this may affect the accuracy or availability of the parameters and measurements.

WARNING

The pulse oximetry device may be used during electrocautery, but this may affect the accuracy or availability of the parameters and measurements.

WARNING

The pulse oximetry device should not be used for arrhythmia analysis.

WARNING

SpO_2 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 oximetry device or accessories. Injury to personnel or equipment damage could occur. Return the pulse oximetry device for servicing if necessary.

Masimo cautions

CAUTION

Do not place the pulse oximetry device where the controls can be changed by the patient.

CAUTION

Electrical shock and flammability hazard: Before cleaning, always turn off the instrument 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 oximetry device on electrical equipment that may affect the instrument, preventing it from working properly.

CAUTION

If the SpO_2 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 persistent poor signal quality message 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 instrument might read zero for the duration of the active irradiation period.

CAUTION

To ensure that alarm limits are appropriate for the patient being monitored, check the limits each time the pulse oximetry device 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 instruments prior to clinical decision making to completely understand the patient's condition.

CAUTION

Do not submerge the pulse oximetry device 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 oximetry device.

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 instrument 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 oximetry device.

CAUTION

Replace the cable or sensor when a replace sensor or when Low signal quality is consistently displayed while monitoring consecutive patients after completing troubleshooting steps listed in this manual.

SpO_2 measurement description

Pulse oximetry (SpO_2) 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 (HbO_2) to the total amount of hemoglobin capable of transporting oxygen (HbO_2 + Hb) is called functional oxygen saturation of arterial blood (SaO_2). GE pulse oximetry is calibrated to display functional oxygen saturation.

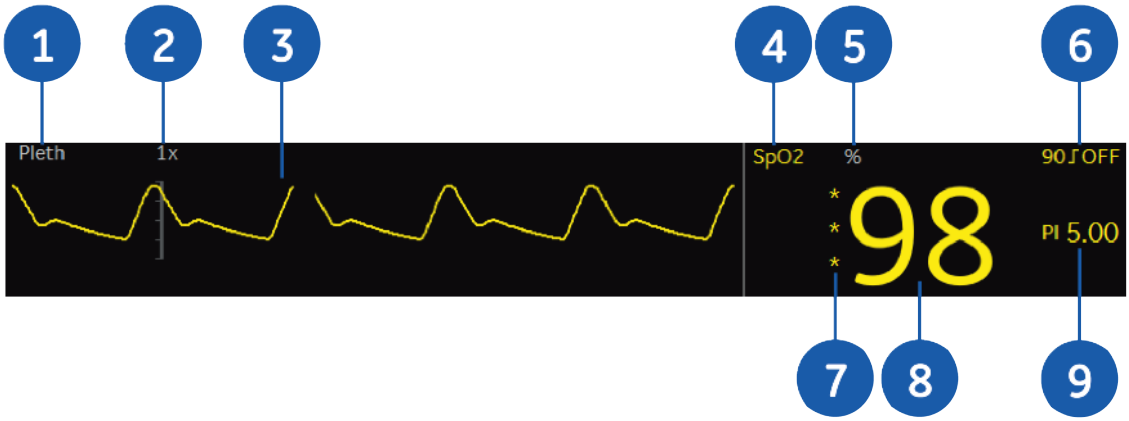
The actual measurement of arterial oxygen saturation is performed by spectrophotometry, a technique that quantifies the amount of transmitted light. A beam of light is passed through a monitored site of pulsating arterial blood. A pulse oximeter emits red and infrared light through its LEDs and measures the relative absorbtion of red and infrared light. Because HbO_2 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 SpO_2 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:

- GE TruSignal
- Masimo SET
- Nellcor OxiMax

SpO_2 measurement displayed on the monitor screen



1.	Pleth (**Pleth**): waveform label	6.	SpO_2 alarm limits, alarm status, or other messages
2.	Waveform scale	7.	Masimo SpO_2 only. SpO_2 signal strength indicator.
3.	Pleth waveform	8.	SpO_2 value
4.	SpO_2 (**SpO2**): parameter label	9.	PI (**PI**): Perfusion Index value (not for Nellcor OxiMax technology).
5.	SpO_2 unit		

SpO_2 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 SpO_2 sensor.
- There are several factors that may cause inaccurate readings and alarms. Familiarize yourself with the SpO_2 safety precautions so that you are aware of these factors and can take them into consideration.

SpO_2 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.
- 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 SpO_2 values is questionable.
- Depending on the SpO_2 technology used, not all SpO_2 measurements and settings are available to view or change.
- There are three supported pulse oximetry technologies:
  - Masimo SET
  - Nellcor OxiMax
  - GE TruSignal
- With Nellcor™ sensors with OxiMax™ technology and Masimo SET technology, the pulse oximetry waveform is a normalized waveform. It is not normalized with GE TruSignal technology. GE TruSignal technology provides the actual IrMod% values.

Masimo points to note

- A functional tester cannot be used to assess the accuracy of the pulse oximetry device.
- High-intensity extreme lights (such as pulsating strobe lights) directed on the sensor may not allow the pulse oximetry device to obtain vital sign readings.
- When using the Maximum Sensitivity setting, performance of Sensor Off detection may be compromised. If the instrument is on 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.

SpO_2 measurement guidelines

GE TruSignal technology and sensor measurement guidelines

The following measurement guidelines apply to GE TruSignal SpO_2 technology:

- The time period for acquiring a measurement average is adjustable.
- The SpO_2 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 SpO_2 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 SpO_2 sensor.

Masimo SET technology and sensor measurement guidelines

With motion, the plethysmographic waveform (or SpO_2 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 SpO_2 measurements differently than other SpO_2 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/.

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 SpO_2 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 SpO_2 accessories and sensors:

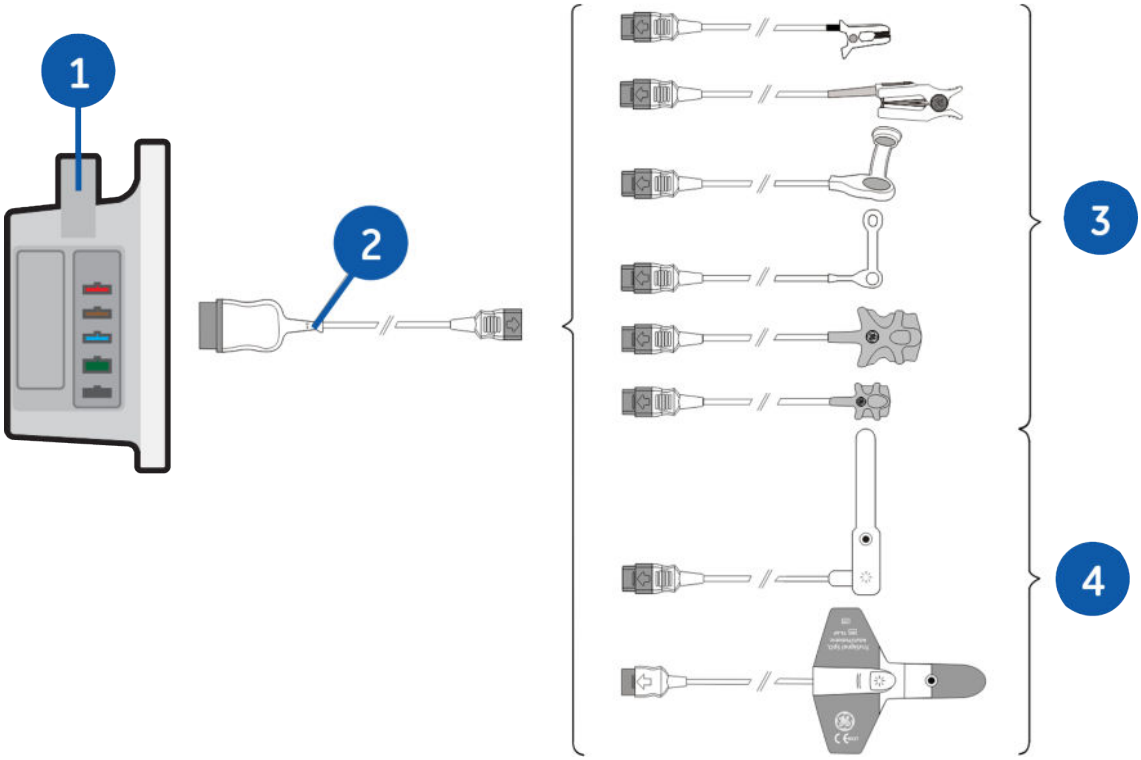
- Periodically inspect extension cables and sensors for damage and discontinue use if damage is found.
- Do not immerse sensors.
- Do not use NIBP or constricting instruments on the same appendage as the SpO_2 sensor.

Additional information for Covidien technology

NOTICE: Purchase of this instrument confers no express or implied license under any Covidien patent to use this instrument with any oximetry, level of consciousness, regional oxygen saturation and respiration rate, as an applicable Sensor that is not manufactured or licensed by Covidien.

SpO_2 measurement setup

SpO_2 equipment to patient connection



1.	The monitor	3.	Reusable sensors
2.	Interconnect cable	4.	Disposable sensors

Preparing the SpO_2 connection

1. Connect the adapter cable to the SpO_2 connector.
2. Clean the surface of reusable sensors.
3. Prepare the application site.

4. Remove nail polish and earrings.
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 SpO_2 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.

SpO_2 functional testers

You can verify the functionality of the pulse oximeter sensor and monitor with a SpO_2 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 SpO_2 measurement

Setup the parameter to normal screen, if need: > **Screen Setup**.

Changing the SpO_2 waveform scale

1. Select the SpO_2 digit field.
2. Select the scale from the **Pleth Scale** list:
   - For GE 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 GE TruSignal SpO_2 response averaging time

NOTE
GE TruSignal technology and sensors only.

You can have an average of the SpO_2 measurement on screen instead of the beat to beat values. You can select the average time for response.

1. Select the SpO_2 digit field.
2. Select the average time from **SpO2 Response** list. Choices are:
   - **Normal**: 12 seconds
   - **Fast**: 3 seconds

Selecting the Masimo SpO_2 averaging time

NOTE
Masimo technology and Masimo sensors only.

You can have an average of the SpO_2 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 SpO_2 digit field.
2. Select the number of seconds from the **Averaging** list.

Selecting the Masimo SpO_2 sensor sensitivity level

NOTE
Masimo technology and Masimo sensors only.

1. Select the SpO_2 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 SpO_2 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.

Setting the SpO_2 to show PI

NOTE
For GE 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 SpO_2 digit field.
2. Select **ON** or **OFF** from the **Show PI** list.

The larger the PI value, the stronger the strength.

Selecting the SpO_2 as the primary heart rate source

The primary heart rate can be calculated from the ECG leads, SpO_2 measurement, or invasive pressure waveform.

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

1. Select the SpO_2 digit field.
2. Select the heart rate source from the **Primary HR Source** list.

Adjusting the SpO_2 pulse beep tone volume

The beat tone is depends on HR source to calculate. When the source is SpO_2, a variable pitch beep tone rises in pitch with increasing oxygen saturation or falls in pitch with decreasing oxygen saturation.

1. Select the SpO_2 digit field.
2. Adjust the volume with the **Beat Volume** arrows.

Setting the SpO_2 alarm limits

1. Select the SpO_2 digit field.
2. Select the **Alarms** tab.
3. Check that the **Alarm** is turned on.
4. Adjust the alarm limits with the arrows.

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

Setting the Masimo SpO_2 alarm delay

NOTE
Masimo technology and Masimo sensors only.

The alarm delay time for **SpO2 low** alarm can be selected. But if the SpO_2 value drops below the alarm limit by more than 5%, the **SpO2 low** alarm will be triggered immediately, regardless of the alarm delay setting.

1. Select the SpO_2 digit field.
2. Select the **Alarms** tab.
3. Select the seconds from the **Alarm Delay** list. The choices are: **0s**, **5s**, **10s**, or **15s**.

Stopping the SpO_2 measurement

1. Remove the SpO_2 sensor from the patient.
2. Disconnect the sensor from the sensor cable.
3. Disconnect the sensor cable from the host.

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 SpO_2 values

SpO_2 signal strength

- For Masimo technology.

  The Signal strength is indicated with asterisks in the digit field. 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 SpO_2 value.
- For GE TruSignal technology.

  The signal strength indicator is displayed as the PI value in digit field.

SpO_2 waveform quality

NOTE
Not for Masimo SET technology.

Under normal conditions, the SpO_2 waveform corresponds to (but is not proportional to) the arterial pressure waveform. The typical SpO_2 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 SpO_2 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

SpO_2 waveform stability

The stability of the displayed SpO_2 values can also be used as an indication of signal validity. To aid you in successful SpO_2 monitoring, messages are provided in the SpO_2 digit field.

Surgical pleth index

SPI safety precautions

SPI warnings

There are no SPI specific warnings other than those related to the SpO_2 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 SpO_2 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

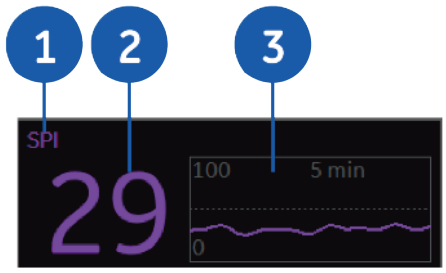
the clinician to monitor the responses of an adult patient to surgical stimuli and analgesic medications during general anesthesia.

SPI measurement displayed on the monitor screen

SPI does not have a menu of its own.

You can configure the SPI data to the screen the same way as any other parameter data. Refer to the screen setup instructions.

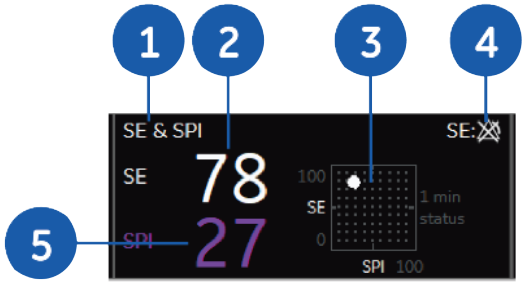
- Select **SPI** from the list of parameters.



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.

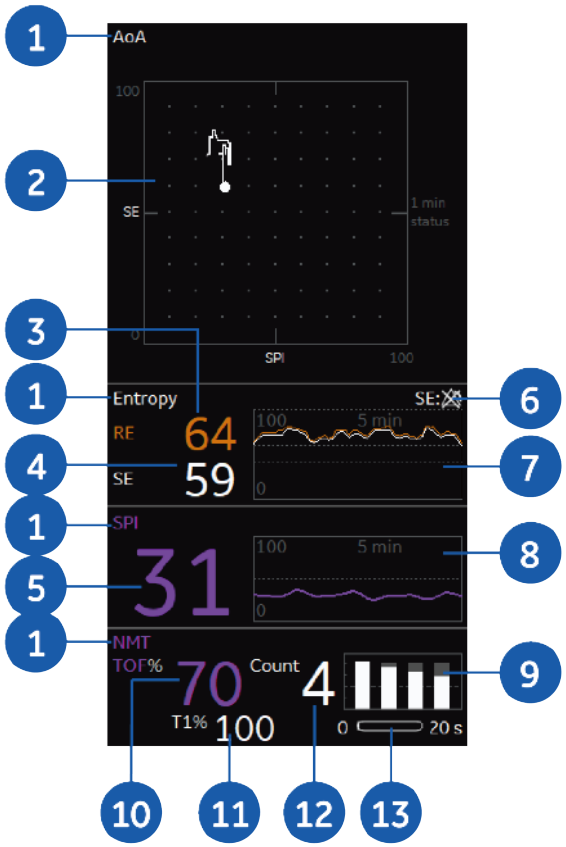
- Select **SE & SPI** from the list of parameters.



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 **AoA** from split screen menu:



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 **SPI** or **SE & SPI** digit field, the **Entropy** setup window open. You can select the Entropy/SPI trend length in the **Entropy** setup window.

SPI measurement limitations

- The SPI measurement is only available on GE TruSignal SpO_2 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 only available in the OR 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 SpO_2 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 SpO_2 sensor; defibrillation; defective, physically damaged, or poorly attached SpO_2 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 SpO_2 measurement may affect the SPI interpretation. For more details, refer to SpO_2 measurement limitations on page 157 and the instructions supplied with SpO_2 sensors.
- Upon placing the SpO_2 sensor on the patient's finger at the beginning of monitoring, or after removing the SpO_2 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 SpO_2 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 SpO_2 measurement, but SPI can be measured using GE SpO_2 finger sensors only.

Stopping the SPI and SpO_2 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 SpO_2 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.

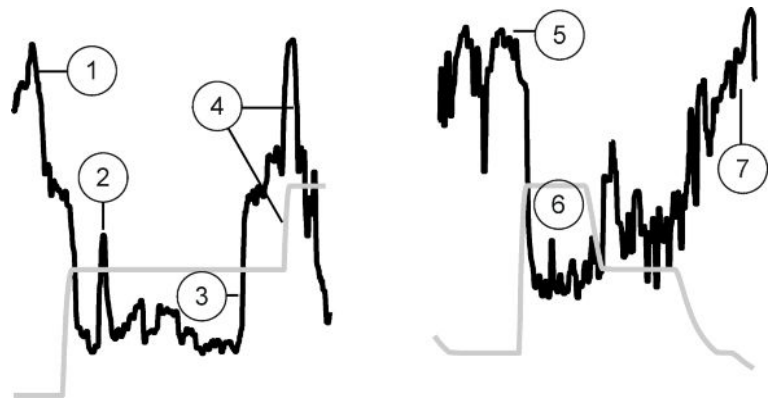
Learning

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 = Remifentanil



1.	Patient awake, SPI not valid	5.	Inadequate analgesia
2.	Intubation	6.	Adequate analgesia
3.	Incision	7.	Patient awake, SPI not valid
4.	Remifentanil up, SPI down		

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 SpO_2 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.

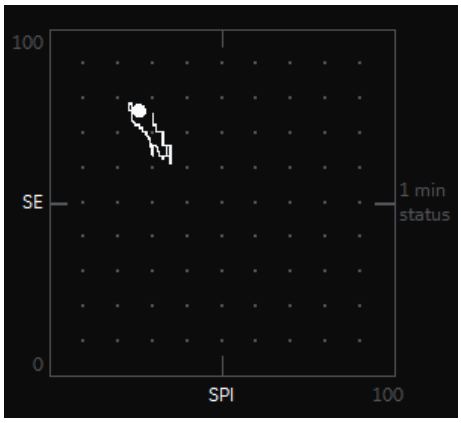
If the sensor's location is changed, the pulse amplitude may abruptly change. This may cause a large and persistent change in the SPI values. To facilitate the learning of new values in this case, the SPI tries to identify these types of changes by seeking periods with unavailable data that are followed 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 SpO_2 sensor is located distally to the NIBP cuff, this inflation will also cause a temporary interruption to blood flow at the SpO_2 sensor site. SpO_2, 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 monitor always performs a safety check. This means that the **NIBP cuff inflated** message will appear on the monitor 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

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 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.

NIBP cautions

CAUTION

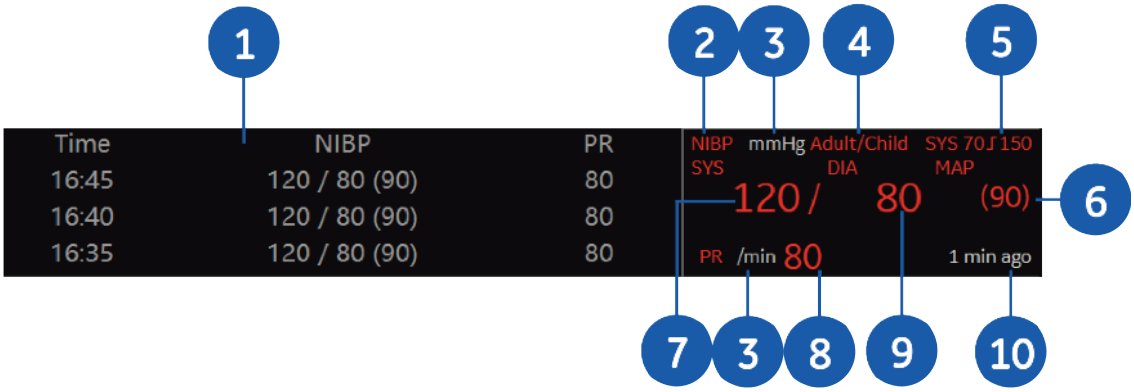
PATIENT SAFETY.

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.

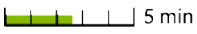
NIBP measurement displayed on the monitor screen



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.	6.	MAP (**MAP**): mean pressure
2.	NIBP (**NIBP**): parameter label	7.	SYS (**SYS**): Systolic pressure
3.	mmHg (**mmHg**), /min (**/min**): unit	8.	PR (**PR**): Pulse Rate
4.	Adult/Child (**Adult/Child**): cuff type according to your selection	9.	DIA (**DIA**): Diastolic pressure
5.	SYS alarm limits, alarm status, or other messages	10.	x min ago (**x min ago**): indicate how long time for the displayed value are. There have other display in different situation, more details see below instruction.

- **NIBP Manual**:
  - During measurement, the text **Manual** displays in the NIBP digit field.
  - 1 minute after measurement, the text **x min ago** displays in the NIBP digit field, indicate how long time for the displayed value are.
- **NIBP Auto**:

  During measurement, a time progress bar displays in the NIBP digit field:

- **STAT**:

  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 monitor 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.

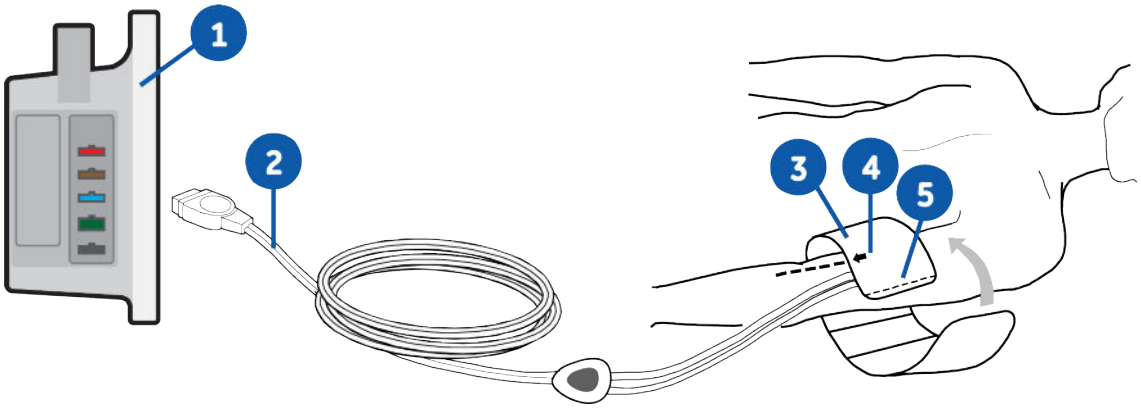
NIBP points to note

- 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 monitor	4.	Brachial artery arrow (printed on cuff)
2.	Cuff hose	5.	Cuff index line (printed on cuff)
3.	Cuff of correct size		

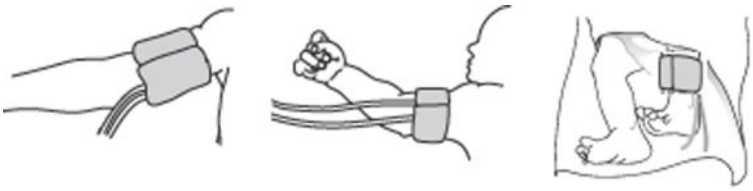
Preparing the NIBP patient connection

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 **Neonatal** 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 not wish to use the default value.

Table 7 Default inflation pressure

Cuff Size	Infl. Press.
Adult/Child	135 mmHg (18 kPa)
Neonatal	100 mmHg (13.3 kPa)

Selecting the auto 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. Select **Use Default Inflation Pressure**.

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 **Use Default Inflation Pressure** is not selected.
3. Select a value from the **Infl. Press.** list.

Manual 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 Manual** for **NIBP Manual**.
3. Stop the measurement by selecting **Stop** for **NIBP Manual**.

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

NIBP Auto mode

The NIBP Auto 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 120 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. Set up time interval from **X BP Series** list. Set up repeat times from 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 **NIBP Auto**.

3. Stop the measurement by selecting **Stop Cycling**.

NIBP STAT mode

The **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 monitor automatically returns to the previously selected cycling interval or manual mode.

STAT NIBP measurement is deactivated when **Cuff Size** is set to **Neonatal**.

Starting or stopping a Stat NIBP measurement

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 mode can initiate inflation and keep constant pressure in the cuff for venous catherization. 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.

NOTE
The venous stasis is disabled when selecting **Neonatal** as **Cuff Size**.

Selecting the venous stasis pressure

1. Select the NIBP digit field.
2. Select **Venous Stasis** tab.
3. Select a value from the **Stasis Press.** list.

Selecting the cuff size for venous stasis

1. Select the NIBP digit field.
2. Select **Venous Stasis** tab.
3. Select a type from the **Cuff Size** list.

NOTE
This setting adjusts the cuff size for all of the NIBP measurement. It's the same setting as in NIBP **Setup** tab.

Starting or stopping a Venous Stasis measurement

1. Select the NIBP digit field.
2. Select **Start Stasis**.
3. Stop the measurement by selecting **Stop Stasis**.

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. For more information, see the supplemental information manual.

1. Select the **Service** > **Parameter Settings** > **Units**.
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. For more information, see the supplemental information manual.

1. Select the > **Service** > enter **Username** and **Password**.
2. Select the **Parameter Settings** > **Colors** > **Common** horizontal tab.
3. 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 the **Alarm** is turned on.
4. Set the related alarm limits with arrows.

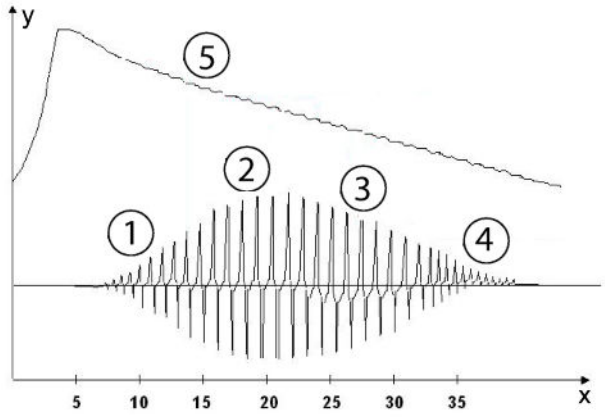
NIBP alarms' deactivation with pause audio key

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	4.	Extracted pulse wave
2.	Mean	5.	Cuff pressure
3.	Diastolic		

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/children, or 100 mmHg for neonatal patients. To allow for rapid setting of cuff pressure, the monitor 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.

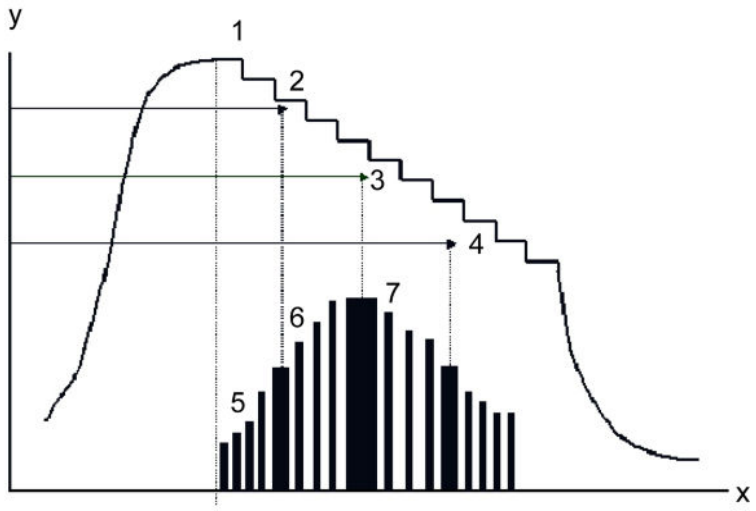
If the current blood pressure reading is similar to the previous reading, some information from the previous blood pressure may be used in the current determination. The data is constantly evaluated during a measurement to try to perform a blood pressure determination in the shortest possible time, providing 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 monitor will try to make an accelerated determination of blood pressure.

DINAMAP Step Deflation technology

DINAMAP SuperSTAT technology includes DINAMAP Step Deflation technology. During the deflation process, the monitor 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 (neonatal cuffs) or two minutes (adult and child cuffs), the monitor will time out and display an error.



x = Cuff pulsation waveform

y = Cuff pressure

1.	Cuff deflation	5.	Cuff pulsations (each pulsation represents one heart beat)
2.	Systolic pressure (ratio of maximum amplitude)	6.	Amplitude (changes based on cuff pressure)
3.	Mean arterial pressure (maximum pulsation amplitude)	7.	Resulting waveform
4.	Diastolic pressure (ratio of maximum amplitude)		

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

PATIENT SAFETY.

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

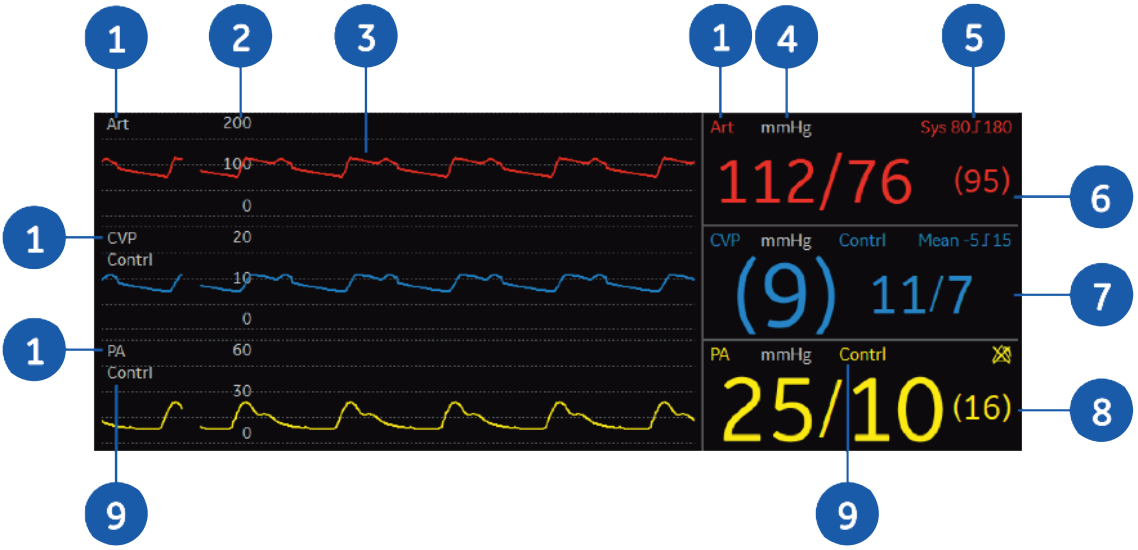
The measured invasive pressure parameters are systolic, diastolic, and mean. Pulse rate can be monitored with any arterial site. CPP is a calculated value that requires a valid ICP value and a valid arterial site value.

PCWP can also be measured for a PA site.

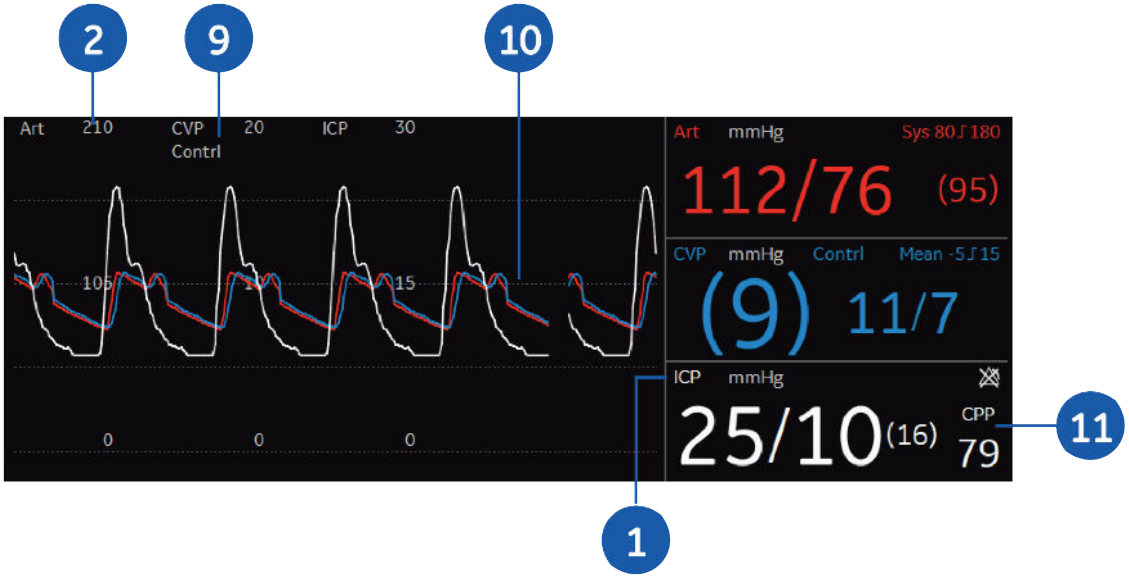
SPV and PPV can also be measured.

You can monitor up to three channel pressures, two channels from monitor frame, one channel from E-COP module.

Invasive pressure measurement on the monitor screen



Normal view



Combined pressures view

1.	Art (**Art**), CVP (**CVP**), PA (**PA**), ICP (**ICP**): parameter label	7.	IBP value when **Digit Format** set to **Mean**
2.	waveform scale	8.	IBP value when **Digit Format** set to **S/D/M**
3.	IBP waveforms	9.	Contrl (**Contrl**): ventilation mode
4.	mmHg (**mmHg**): IBP unit	10.	IBP combined waveforms
5.	alarm limits, alarm status, or other messages	11.	**CPP** display when channel label is **ICP**
6.	IBP value when **Digit Format** set to **S/D**		

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
IBP1, **IBP2**, **IBP8**	Non-specific pressure channel labels

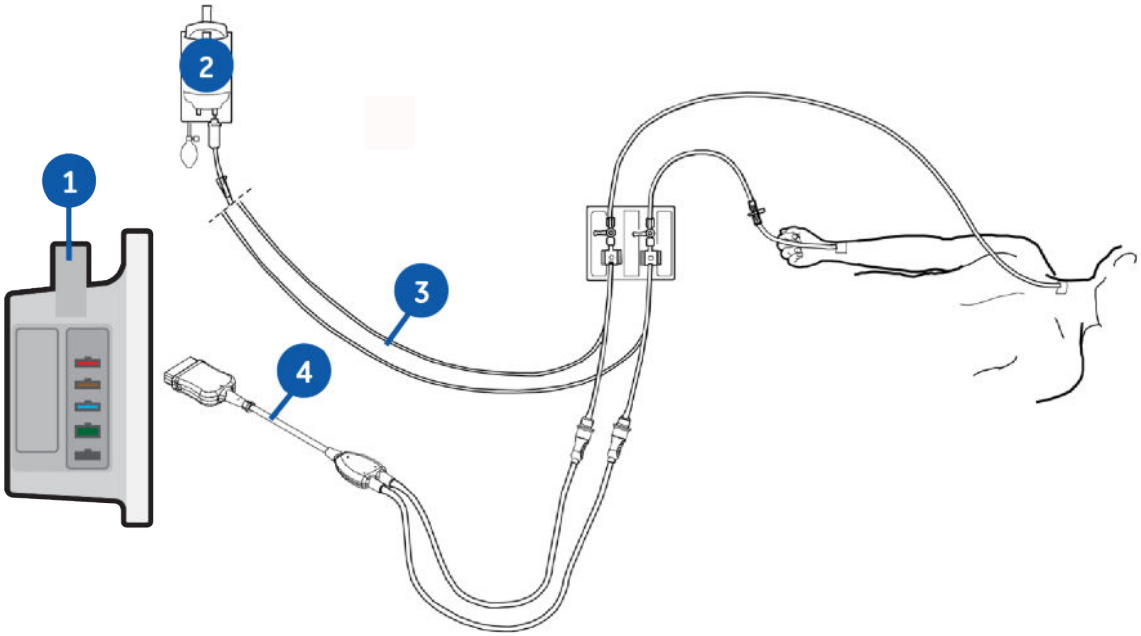
Label	Description
	NOTE **UAC** and **UVC** are only available in the **NEONATAL** mode. **NOTE** **IBP8** invasive pressure channel is not available in the **NEONATAL** mode.

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 monitor, or when a pressure transducer is connected to the E-COP module.
- A pressure channel is deactivated when the pressure transducer interface cable is disconnected from the monitor, or when a pressure transducer is disconnected to the E-COP 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.

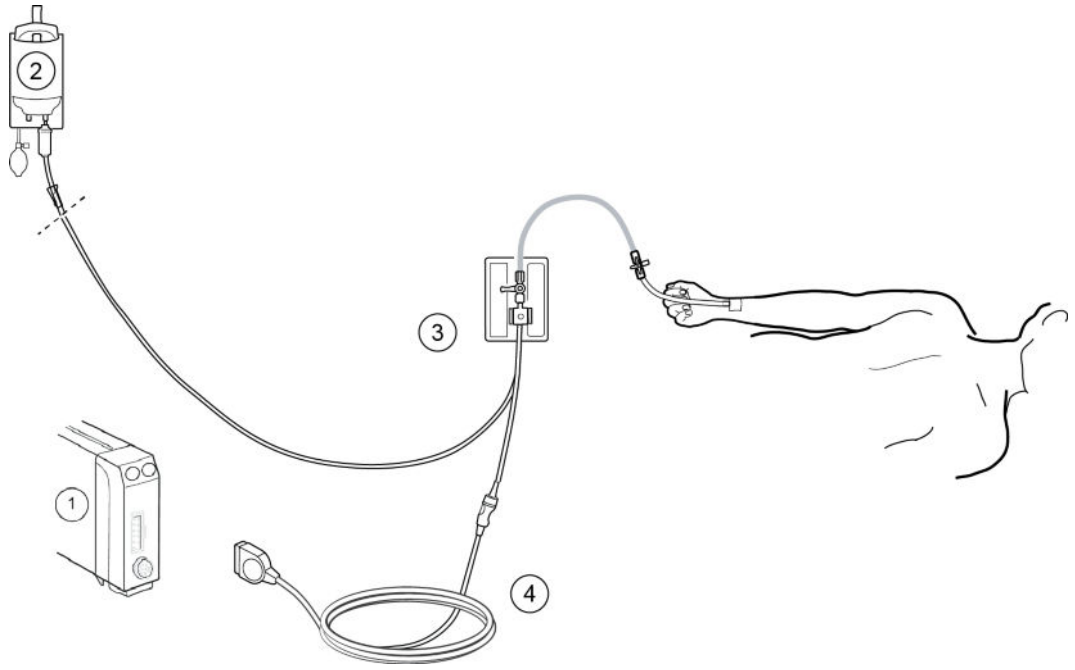
Invasive blood pressure measurement setup

Invasive pressure equipment to patient connection with monitor



1.	The monitor	3.	Transducer setup
2.	Fluid bag with pressure infusor	4.	Invasive blood pressure adapter cable; single or dual cable (optional)

Invasive pressure equipment to patient connection with E-COP module



1.	The E-COP module	3.	Transducer setup
2.	Fluid bag with pressure infusor	4.	Invasive blood pressure adapter cable; single or dual cable (optional)

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 invasive pressure connector.
5. Connect the transducer to the patient line.

Checking the invasive pressure measurement

1. Check that the monitor 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**.
2. Select the **Layout 1** or **Layout 2** tab.
3. Select the **Combine Pressures** checkbox 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 blood pressure measurement

Setup the parameter to normal screen, if need: > **Screen Setup**.

Invasive pressure measurement mapping

Invasive pressure measurements are mapped to one of the invasive pressure channels as follows:

Pressure channel	Pressure measurement source
IBP1	Monitor frame
IBP2	Monitor frame
IBP8	E-COP 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 0.

NOTE
The monitor record 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.

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**: All values are shown, but the mean value is shown in a bigger font.
   - **S/D**: All values are shown, but the sys/dia values are shown in a bigger font.
   - **S/D/M**: All values are shown in an equally big font.
   - **CPP**: All values are shown, with additional CPP value.

     NOTE
     This option is available 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, SpO_2 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**, or **UAC** invasive pressure channels only.

1. Select the invasive pressure digit filed.
2. Select the heart rate source from the **HR Source** list.

Selecting the ventilation mode

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 **IBP2**, **IBP8**, **CVP**, **PA**, **RAP**, **RVP**, and **LAP**.

Selecting the invasive pressure response time

1. Select the invasive pressure digit field.
2. Select **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 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. Select a numeric value from the **Filter Frequency** list.

   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 the **Alarm** is turned on.
4. Set the related 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 that are configured. You can also turn off the measurement by selecting **Off** (default).

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 > **Screen Setup** > **Lower Area** vertical tab.
2. Select **PCWP** to one of the Lower Field.
3. Make sure one of the IBP channels set to **PA**.

Taking an automated PA wedge measurement

1. Zero the PA channel, if necessary.
2. Select **PCWP** digit field.
3. 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.
4. To adjust the PA wedge value, move the cursor up or down with the **PCWP / Cursor** arrows.
5. 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:

- **C.O.**: This selection will open the C.O. **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.

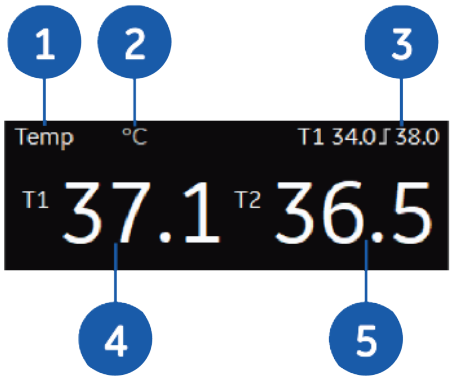
Measurement electrodes, leadwires and probes far from the surgical site and the ESU return electrode.

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.

Tblood is obtained from a pulmonary artery catheter.

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:

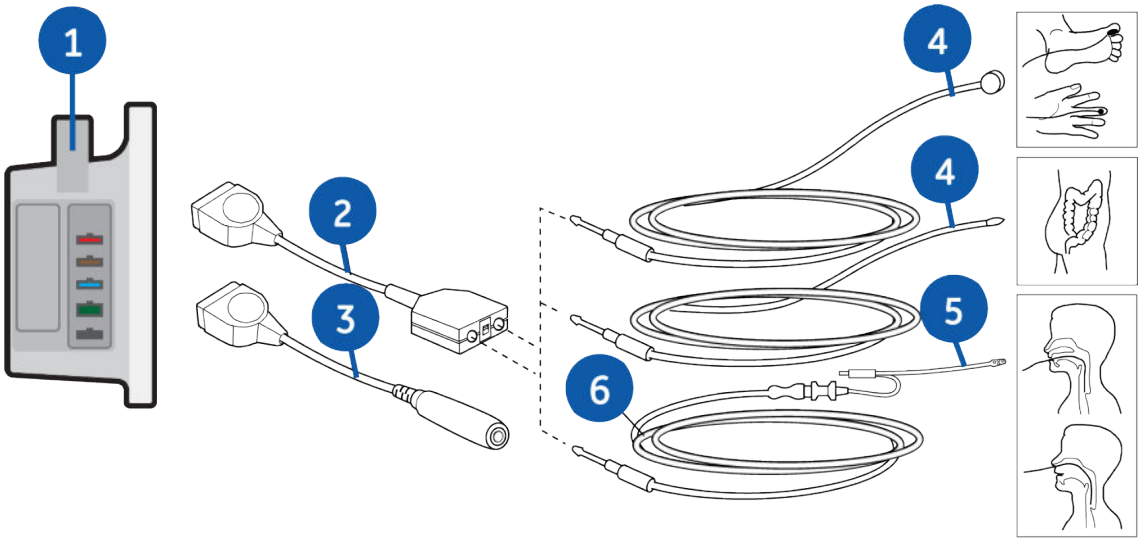
T1, **T2** = general label	**AirW** = airway
Eso = esophageal	**Room** = room
Naso = nasal	**Myo** = myocardial
Tymp = tympanic	**Core** = core
Rect = rectal	**Surf** = surface
Axil = axillary	**Blad** = bladder
Skin = skin	

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-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 monitor 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 monitor	4.	Reusable temperature probe
2.	Dual temperature cable	5.	Disposable temperature probe
3.	Single temperature cable	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 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 need: > **Screen Setup**.

Temperature mappings

Temperature measurements are mapped to one of the temperature channels as follows:

Temperature channel	Measurement source
T1	Monitor frame
T2	Monitor frame
Tblood	E-COP 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 the **Alarm** is turned on.
4. Set the related 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 monitor automatically calibrates the temperature measurements at startup: every 10 minutes.
- Tblood is obtained from a pulmonary artery catheter.

Cardiac output

C.O. safety precautions

C.O. 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 C.O. readings may be erroneous.

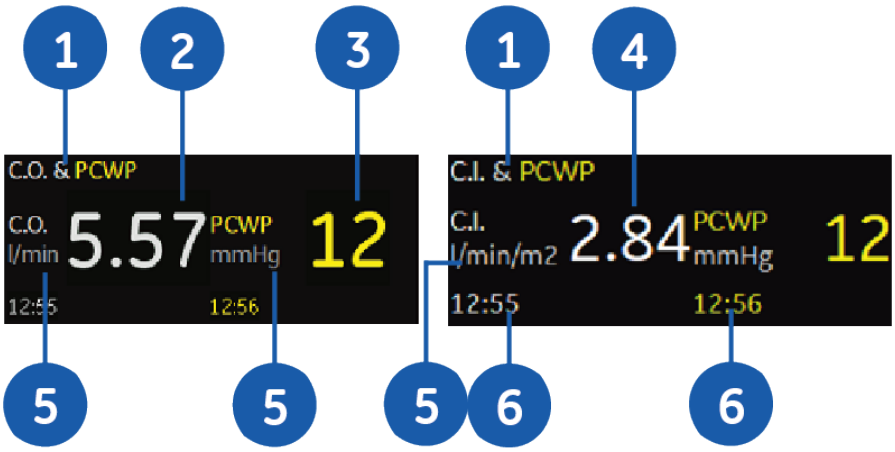
C.O. instruction

The cardiac output (C.O.) 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 trail allows to perform up to six time measurements and you can select the effective measurements to achieve a reliable C.O. average value. The confirmed average C.O. value will be displayed in the digit field.

C.O. parameters, E-COP

Parameter	E-COP
Cardiac output (C.O.)	Support
Cardiac Index (C.I.)	Support
Continuous cardiac output (CCO)	n/a
Right ventricular ejection fraction (REF)	Support
SvO_2	n/a
$ScvO_2$	n/a
Invasive pressure	Support 1 channel
blood temperature (Tblood)	Support
Injectate temperature (TInj)	Support
Pulmonary capillary wedge pressure (PCWP)	Support

C.O. measurement displayed on the monitor screen



1.	C.O. & PCWP (**C.O. & PCWP**), C.I. & PCWP (**C.I. & PCWP**): parameter label	4.	C.I. value
2.	C.O. value	5.	l/min (**l/min**), mmHg (**mmHg**), l/min/m2 (**l/min/m2**): unit
3.	PCWP value. This parameter can be setup by **Show With C.O./C.I.**.	6.	parameter measurement time

C.O. module key

There is two C.O. module key on the E-COP module:

Start C.O.	Starts and stops the cardiac output measurement.
Zero P4/P8	Zero channel IBP8

C.O. measurement limitations

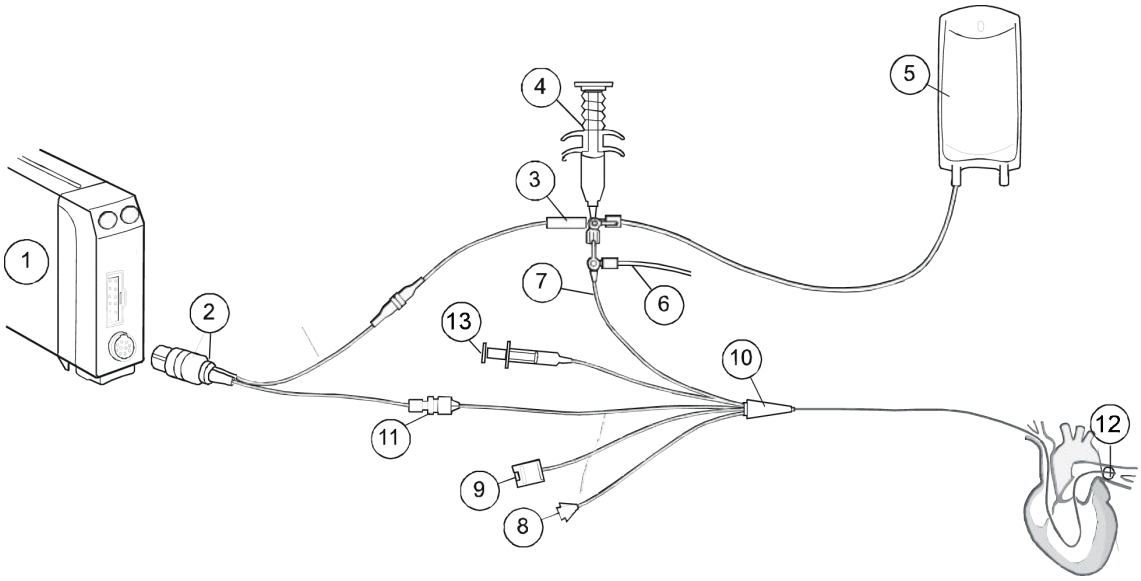
- E-module used for this measurement is not suitable for use with neonatal patients.

C.O. 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 C.O. connector cables are module-specific and can only be used with the appropriate C.O. module. For detailed information, see the Supplies and accessories.
- The patient's height and weight values are required for determining Cardiac Index (C.I.).
- The right ventricular ejection fraction (REF) measurement is only available with Baxter REF catheters, the **Catheter Type** should setup to **User Defined**.

C.O. measurement setup

C.O. equipment to patient connection with an in-line probe



1.	E-COP module	8.	PA distal port
2.	Cardiac output cable	9.	Optical module connector (used for SvO2 measurement, not available)
3.	In-line injectate probe	10.	Swan-Ganz thermodilution catheter
4.	Injectate syringe	11.	Thermistor connector
5.	Injectate solution	12.	Balloon
6.	CVP line to IP transducer or fluid infuser	13.	Balloon inflation valve
7.	Proximal injectate port		

Preparing the C.O. measurement

1. Connect the C.O. cable to the module, thermistor, and injectate temperature port.
2. Follow your care unit’s policy and procedures for positioning the patient for the C.O. 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 C.O. measurement

1. Check that the monitor recognizes cable connections (activates the display) and all C.O. menu selections are available.

2. Remember that in order to get Cardiac Index (C.I.) you must first enter the patient height and weight.
3. Check that the message **Press Start C.O.** appears on the screen.

Using the C.O. measurement

Entering patient data for the C.I. value

The patient's height and weight values are required for determining cardiac index (C.I.).

1. Select the C.O. 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.

C.O. catheter selections

You can select a cardiac output catheter types.

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 C.O. 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 C.O. catheter

All user-defined catheter settings are erased when the monitor 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.

C.O. measurement modes

C.O. measurements can be taken using the automatic or manual measurement modes. Both measurement modes allow you to use up to six C.O. measurements for calculating a C.O. average.

You can confirm the C.O. 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 C.O. measurement

When measuring C.O. using the automatic mode, new measurements can be taken when the **Press Start C.O.** 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 C.O.** appears, select **Start C.O. 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 C.O. measurement, wait for the message **Inject now!** displays before injecting the injectate.

Taking a manual C.O. measurement

Measuring C.O. 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 C.O.**, 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 C.O. measurement, wait for the **Press Start C.O.** message to display, then select **Start C.O.**.

C.O. 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 C.O. the program automatically averages the C.O. value. It is recommended to use three to five measurements with less than 10% variation between them for average C.O. The saved average C.O. value is displayed in the parameter window with a timestamp.

Editing the C.O. average

After C.O. trial measurements, you need to edit and confirm the C.O. average to save and display the C.O. 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 C.O. average. If you do not wish to include a trial, ensure its selection box is not checked.
5. Select **Confirm C.O.** to store the calculated C.O. average and display it in the cardiac output digit field and measurement menu.

Canceling a C.O. measurement

When a C.O. measurement has just completed, you can remove this C.O. 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 C.O. 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. Select the check box for **REF Measurement**.

Selecting the C.O. 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 C.O./C.I.

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 C.O./C.I.** 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 the **Alarm** is turned on.
4. Set the related alarm limits with arrows.

Adjusting the wedge from the cardiac output menu

The **Wedge** selection is available only when there is a confirmed C.O. 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

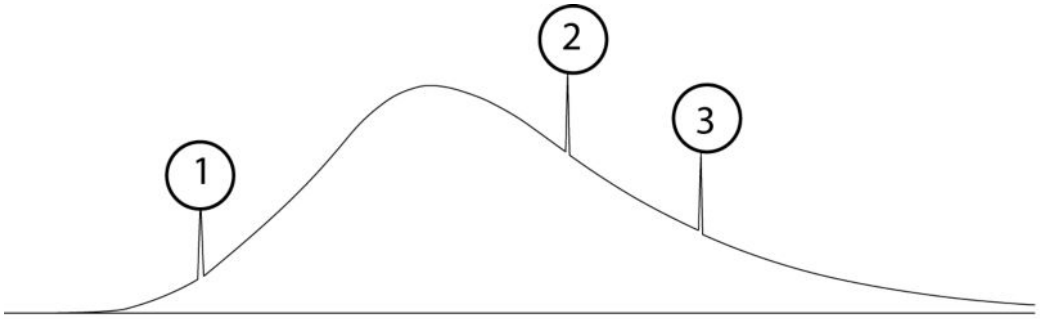
1. Remove the catheter from the patient.
2. Disconnect the probe patient cables.

C.O. practicalities

Cardiac output thermodilution curve

The thermodilution curve, which displays after a C.O. 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 C.O. 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 C.O. 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 C.O. 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.

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.

$EtCO_2$ 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: O_2, N_2O and anesthetic agent gases may interfere with $EtCO_2$ readings.

WARNING

PATIENT SAFETY.

Connect only one CO_2 module (E-sCAiO, E-sCO, N-CAiO, or E-miniC module) to the monitor 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 machine must have a bacterial filter between the module gas output and patient circuit. Otherwise, there is a risk of patient cross-infection.

Airway gases cautions

CAUTION

EQUIPMENT DAMAGE.

Do not apply pressurized air or gas to any outlet or tubing connected to the monitor. Pressure may destroy sensitive elements.

CAUTION

MISINTERPRETATION.

Patient-specific MAC is affected by several factors such as patient age and body temperature.

Airway gases instruction

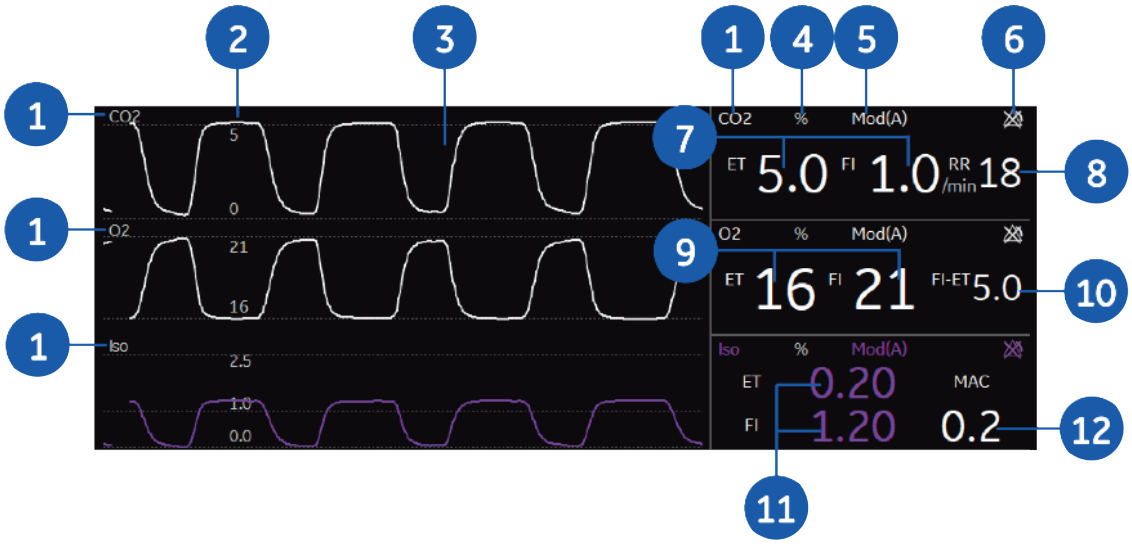
Airway gas measurement is a continuous, non-invasive technology, which provides inspired (Fi) and expired (Et) values of CO_2, O_2, N_2O and anesthetic agents (AA).

According to the module in use, monitoring airway gases, and CO_2 in particular, may help clinician to reduce the risk of hypercapnia and hypocapnia and their consequences. With CO_2 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 CO_2 difference due to ventilation/perfusion mismatch. However, continuous and non-invasive CO_2 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 machine.

Airway gases measurement displayed on the monitor screen

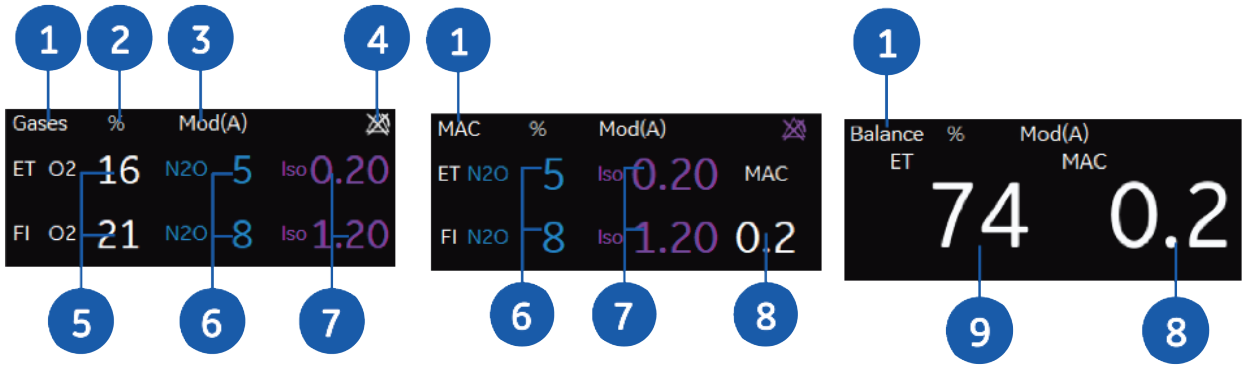


1.	CO2, O2, Iso (**CO2**, **O2**, **Iso**): parameter or waveform label	7.	ET, FI (**ET**, **FI**): value of $EtCO_2$, $FiCO_2$
2.	waveform scale	8.	RR (**RR**): value of respiration rate
3.	waveforms	9.	value of EtO_2, FiO_2
4.	unit	10.	FI-ET (**FI-ET**): value of O_2 diff
5.	Mod(A) (**Mod(A)**): measurement source, which depends on your selection in **CO2 Setup** menu.	11.	value of EtAA, FiAA[*1]
6.	alarm status, alarm limits, or other messages	12.	MAC (**MAC**): value of MAC[*2]

[*1] If mixture agent identified, will be display 2 agents value.

[*2] If MACage is configured, it is displayed **MAC xxyrs**.

The in lower digit field also can configure to display Gases, MAC, and Balance field.



Gases **MAC** **Balance**

1.	Gases, MAC, Balance (**Gases**, **MAC**, **Balance**): parameter label	6.	N2O (**N2O**): value of EtN_2O, FiN_2O
2.	unit	7.	Iso (**Iso**): value of EtAA, FiAA[*1]

3.	Mod(A) (**Mod(A)**): measurement source, which depends on your selection in **CO2 Setup** menu.	8.	MAC (**MAC**): value of MAC[*2]
4.	alarm status, alarm limits, or other messages	9.	ET (**ET**): value of EtBalance
5.	O2 (**O2**): value of EtO_2, FiO_2		

[*1] If mixture agent identified, will be display 2 agents value.

[*2] If MACage is configured, it is displayed **MAC xxyrs**.

Airway gases parameters

Airway gases parameters, gas modules

The CARESCAPE respiratory module (E-sCAiO, E-sCO modules) and Airway Gas Option (N-CAiO module) measure the following airway gas parameters:

Parameter	E-sCAiO	E-sCO	N-CAiO
CO_2	Support	Support	Support
O_2	Support	Support	Support
N_2O	Support	Support	Support
AA	Support	n/a	Support[*1]
Agent ID	Support	n/a	Support[*2]
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			
Sidestream	Support	Support	Support
Mainstream	n/a	n/a	n/a

[*1] The N-CAiO module only supports single agent display and identify.

[*2] 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_2O	n/a[*1]
AA	n/a
Agent ID	n/a

Parameter	E-miniC
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_2O and O_2 value are not displayed. E-miniC requires manual selection from the monitor menu to compensate for N_2O and O_2.	

Airway gases parameters, anesthesia machine

Connect the device to any compatible anesthesia machine, so that patient data can be intensively displayed on one device. If the parameter source is the anesthesia machine, the device can only display the messages delivered from the anesthesia machine, but not send control commands to the anesthesia machine, e.g. silencing alarms on the anesthesia machine.

The compatible anesthesia machine is DOCom device as required. For more information, see the supplemental information provided.

The anesthesia machine 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 monitor displays the data and based on the measured values generates:

- MAC, MACage, O_2Diff， Et Balance
- Trend
- Print output
- Real-time data transmission to the central station and network compatible with the device

The anesthesia machine 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 CO_2 parameter is not displayed.

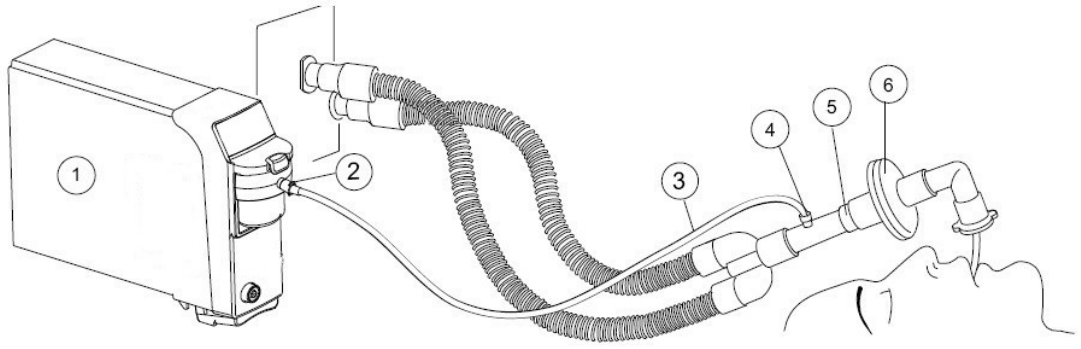
Airway gases points to note

- 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.
- If anesthetic agents are present, use GE anesthesia sampling lines (PE/PVC). Otherwise, you can use GE CO_2 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.
- 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 monitor's data display may have delay compare with the anesthesia machine, please observe the patient frequently.

Airway gases measurement setup

Airway gases equipment to patient connections with gas module

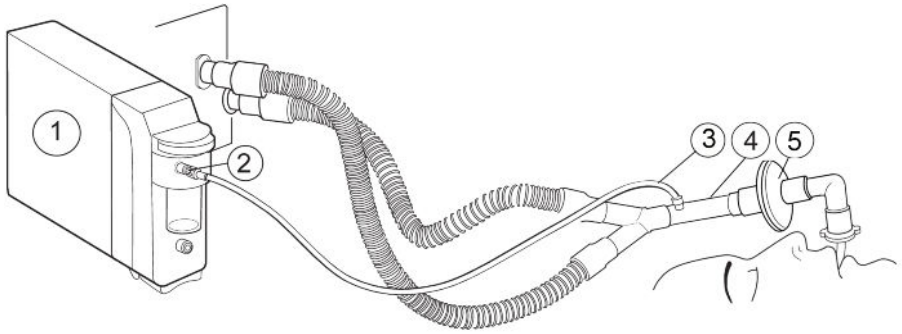


1.	E-sCO, E-sCAiO, or N-CAiO module	4.	Gas sampling line connector on the airway adapter; place the connector upwards
2.	Gas sample, gas sampling line connector on the water trap	5.	Airway adapter with sampling line connector
3.	Gas sampling line	6.	Heat and moisture exchanger with filter (HMEF) (optional 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	4.	Adapter with sampling line connector
2.	Sampling line connector on the water trap	5.	Heat and moisture exchanger with filter (HMEF)
3.	Gas sampling line		

Connecting to anesthesia machine

For the anesthesia machine to monitor connection, refer to Connecting the anesthesia machine on page 67.

For the anesthesia machine to patient connection, refer to the instructions for use supplied with related 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 N_2O or volatile agents are used.
4. Turn on the monitor or connect the module to the monitor. The monitor 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 monitor or turning on the monitor.

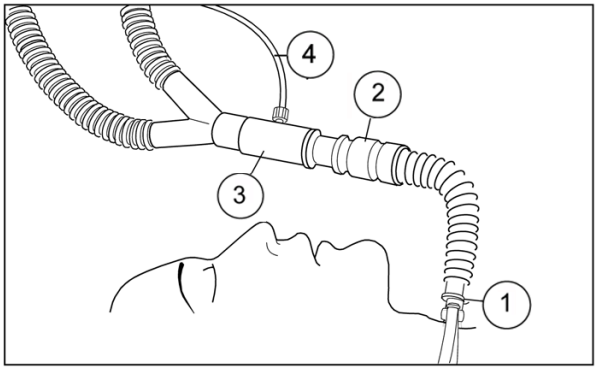
NOTE

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 monitor to eliminate the operating sound of the gas pump.

Airway gases alternative patient connections

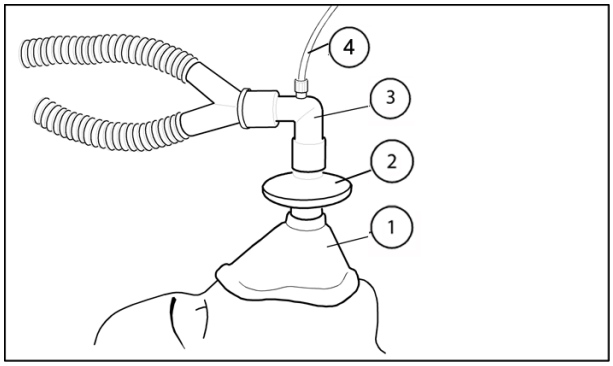
- Use an airway adapter and a sampling line.

Tracheostomy



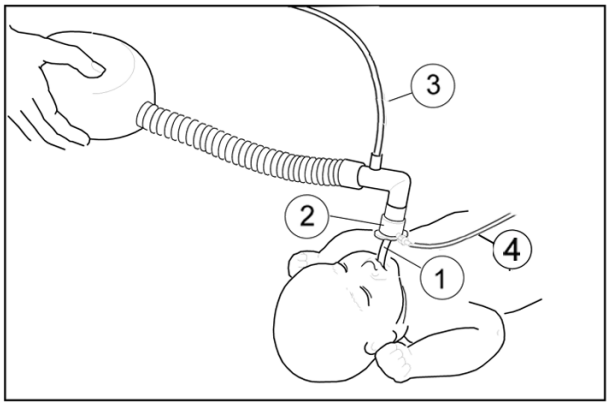
1.	Tracheostomy tube with 15 mm connector
2.	Heat and Moisture Exchanger (HME)
3.	Airway adapter
4.	Sample line

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 CO_2 measurement

Setup the parameter to normal screen, if need: > **Screen Setup**.

Turning on the CO_2 measurement

If **Measurement off** is shown on CO_2 waveform field or **OFF** is shown on CO_2 digit field, you need to select CO_2 measurement on.

1. Select the CO_2 digit field.
2. Select **ON** from the **Measurement** list.

Starting and stopping pump

NOTE
E-sCO, E-sCAiO, N-CAiO module only.

1. Select the CO_2 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 CO_2 scale

If $EtCO_2$ is above 6% (45 mmHg), change the scale for capnogram.

1. Select the CO_2 digit field.
2. Select an option from the **Scale** list.

Selecting the CO_2 unit

1. Select the CO_2 digit field.
2. Select the **%**, **kPa**, or **mmHg** from the **Unit** list.

Selecting the FiO_2 level

NOTE
FiO_2 and N_2O compensations must be selected manually when E-miniC is used.

The presence of a large concentration of oxygen causes the CO_2 level appear lower than the actual value. Use this option to compensate for the presence of O_2.

1. Select the CO_2 digit field.
2. Select an option from the **FiO2 Level** list.

Selecting the N_2O level

NOTE

FiO_2 and N_2O compensations must be selected manually when E-miniC is used.

The presence of N_2O causes the CO_2 value to appear higher than the actual value. Use this option to compensate for the presence of N_2O.

1. Select the CO_2 digit field.
2. Select an option from the **N2O Level** list.

Selecting the CO_2 sweep speed

This selection affects the waveform.

1. Select the CO_2 digit field.
2. Select an option from the **CO2 Sweep Speed** list.

The smaller the value, the slower the sweep speed.

Selecting airway gases measurement source

1. Select the CO_2 digit field.
2. Select the **Measurement Source**. The available options are **Automatic (A)**, **Gas Module (Mod)**, **Anesthesia (Ext)**.

   When you select the **Automatic (A)**, the source of gas module is prioritized.

Setting CO_2 limit alarms

1. Select the CO_2 digit field.
2. Select the **Alarms** tab.
3. Check that the **Alarm** is turned on.
4. Set the alarm limits for **EtCO2**, **FiCO2**, and **RR(CO2)** with arrows.

Setting CO_2 alarms on/off (anesthesia source)

When the measurement source is anesthesia machine, the alarms of related parameters depend on the external data. You can not adjust the alarm limits on the monitor, but only turn the related alarms on or off.

1. Select the CO_2 digit field.
2. Select the **Alarms** tab.

3. Select the **EtCO2**, **FiCO2**, **RR(CO2)**, **Anes Apnea & Tech Alarms** alarm **ON** or **OFF**.

Using O_2 measurement

Setup the parameter to normal screen, if need: > **Screen Setup**.

Turning on the O_2 measurement

If **Measurement off** is shown on O_2 waveform field or **OFF** is shown on O_2 digit field, you need to select O_2 measurement on.

1. Select the O_2 digit field.
2. Select **ON** from the **Measurement** list.

Selecting the O_2 scale

If the difference between FiO_2 and EtO_2 is more than 6%, change the O_2 scale.

1. Select the O_2 digit field.
2. Select an option from the **Scale** list.

Selecting the O_2 sweep speed

This selection affects the waveform.

1. Select the O_2 digit field.
2. Select an option from the **O2 Sweep Speed** list.

   The smaller the value, the slower the sweep speed.

Setting O_2 limit alarms

1. Select the O_2 digit field.
2. Select the **Alarms** tab.
3. Check that the **Alarm** is turned on.
4. Set the related alarm limits with arrows.

Using AA and N_2O measurement

Setup the parameter to normal screen, if need: > **Screen Setup**.

Turning on the agent and N_2O measurement

If **Measurement off** is shown on Agent/N_2O waveform field or **OFF** is shown on Agent/N_2O digit field, you need to select Agent/N_2O 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 N_2O.

Selecting the agent scale

1. Select the Agent digit filed.
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.

Setting agent limit alarms

1. Select the Agent digit field.
2. Select the **Alarms** tab.
3. Check that the **Alarm** is turned on.
4. Set the related alarm limits with arrows.

Using MAC, MACage and ET Balance measurement

Setup the parameters to main screen if need: > **Screen Setup**.

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 supplemental information manual.

3. Select information area > **Demographics**, check or setup **Age**, **Years**.
4. Connect the temperature sensor to user.

Preventing operating room pollution

When N_2O 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 machines 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 machine'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 monitor when it is not used.

Basics of airway gases measurement

Airway gases measurement description, E-sCAiO, E-sCO, and N-CAiO modules

With E-sCAiO, E-sCO, 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 CO_2 and N_2O, and paramagnetic O_2 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 CO_2 concentration in each breath. Concentration at that instant is the ET CO_2 reading. Because nitrous oxide and anesthetic agents are measured by the same sensor as CO_2, the ET readings of those gases are obtained directly at the time instant of ET CO_2. For calculating ET readings of oxygen, the module synchronizes the O_2 waveform with the CO_2 waveform. The ET reading of O_2 is then determined as O_2 concentration at the time instant of ET CO_2. 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 CO_2 concentration ($EtCO_2$, $FiCO_2$) 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 CO_2 parameter is counted from the frequency of end-tidal (peak) CO_2 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 CO_2.

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)

The use of either traditional MAC or MACage is selected during monitor configuration. The MACage provides age and temperature compensated measurement. To enable MACage calculations, enter patient's age to the monitor and attach a temperature sensor. If the patient's age is not given, the monitor shows normal MAC even if MACage has been selected.

NOTE
The MAC value displayed by the monitor 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 N_2O values with empirical formulas based on statistical studies with anesthetized patients.

The monitor 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 monitor. 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.

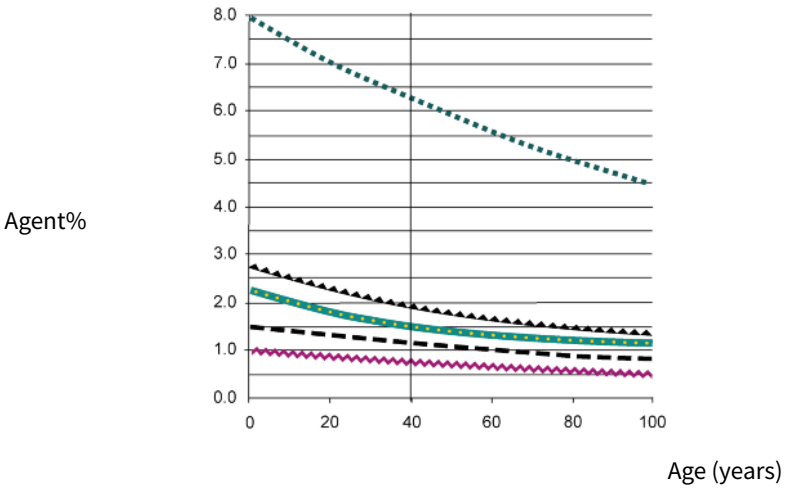
- References for MACage calculations:
  - Eger, E.I. II.: Age, minimum alveolar anesthetic concentration, and minimum alveolar anesthetic concentration-awake. Anesth. Analg. 2001; 93:947-953
  - Rampil I.J.; Zwass M.; Lockhart S.; Eger E.I. II; Johnson B.H.; Yasuda N.; Weiskopf R.B.: MAC of I653 in surgical 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_2O	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% N_2O

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

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 monitor calculates end-tidal balance gas when oxygen and CO_2 measurements are active. If oxygen or CO_2 status is invalid or agent identification fails, the monitor 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 CO_2 measurement

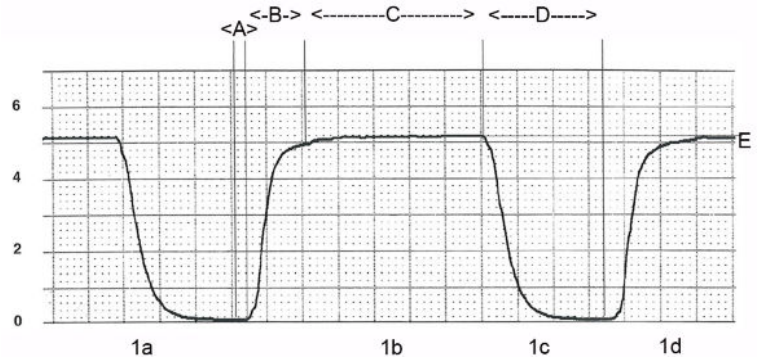
Normal CO_2 waveform

The CO_2 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 CO_2 waveform may indicate compromised patient respiratory and/or circulatory function or improper mechanical ventilator functionality.

The origin of the CO_2 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 CO_2 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 CO_2 ($EtCO_2$) 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 CO_2 measured during the inspiratory phase is called the inspired CO_2 concentration (normally 0.0%).
- **E**: With a scale, the height of the capnogram tells you the end-tidal CO_2 concentration. The monitor automatically calculates and display the $EtCO_2$ in numbers. $EtCO_2$ approximates the alveolar CO_2 concentration because it is measured when the patient exhales virtually pure alveolar gas.



- 1a and 1c = inhalation
- 1b and 1d = exhalation

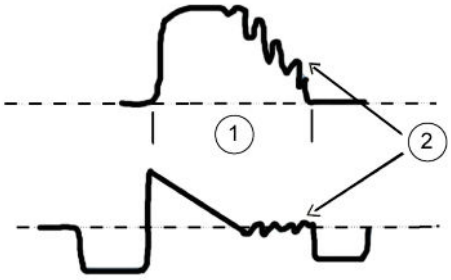
$EtCO_2$ value %	$EtCO_2$ value mmHg	Indicates
4.5% to 5.5%	34 mmHg to 41 mmHg	normocapnia
< 4%	< 30 mmHg	hypocapnia
> 6%	> 45 mmHg	hypercapnia

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 CO_2 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 CO_2 free fresh gas and exhaled CO_2 rich gas is sampled. This causes variations in sampled CO_2 concentrations.

In the illustration below, CO_2 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 $EtCO_2$ information can be avoided through identifying cardiogenic oscillation and understanding the reasons for it.

Oxygen measurement interpretation

The E-sCAiO, E-sCO, 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 O_2 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 (FiO_2) should never be lower that 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 $EtCO_2$ 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 $EtCO_2$ concentration ($EtCO_2$ < 4% / 30 mmHg) indicates hyperventilation.

NOTE
A low $EtCO_2$ 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 $EtCO_2$ values may be observed while using a “normal” TV/MV.

Increased $EtCO_2$ concentration ($EtCO_2$ > 6.0% / 45 mmHg) indicates hypoventilation or ineffective alveolar ventilation, which will lead to hypercapnia and respiratory acidosis. Increased inspiratory CO_2 ($FiCO_2$) concentrations may also be caused by:

- Exhausted CO_2 absorber.
- Malfunction of the breathing system valves.
- Rebreathing when a rebreathing system without a CO_2 absorber is used with inadequate fresh gas flows.

NOTE
During some surgical procedures, e.g. laparoscopy, CO_2 may be used to inflate the abdomen which may result in rise of $PaCO_2$ due to the absorption of CO_2 into the blood via the vascular wound bed. This may lead to an increase in the $EtCO_2$.

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 CO_2 absorber and the more humidity and heat is produced through the chemical CO_2 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 x Hb x 13.8 x (SaO_2 - SvO_2). Dependent from the patient's circulation status the mechanical ventilator settings for, amongst others, FiO_2 in the delivered gas mix (min. > 25%) should guarantee a sufficient PAO_2 and PaO_2. 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 (EtO_2) 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 CO_2 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 (from interfaced Anesthesia machine)

Spirometry instruction

Connect the device to any compatible anesthesia machine, so that patient data can be intensively displayed on one device. If the parameter source is the anesthesia machine, the device can only display the messages from the anesthesia machine, but not send control commands to the anesthesia machine, e.g. silencing alarms on the anesthesia machine.

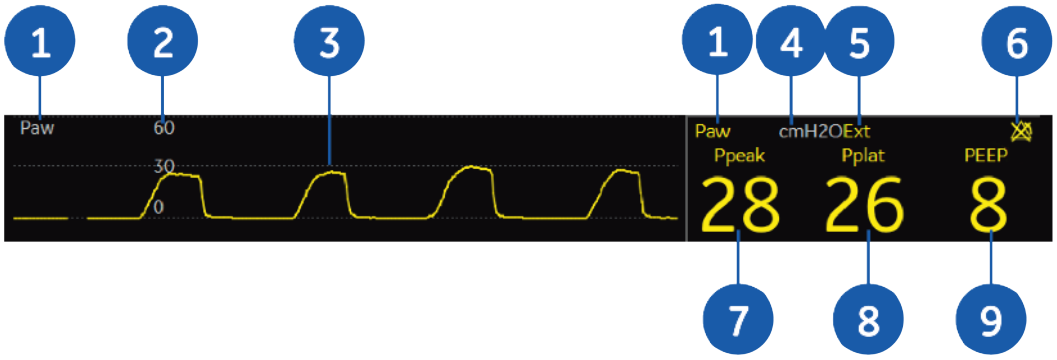
The source of spirometry should be compatible anesthesia machine runs Datex-Ohmeda Com 1.2 Protocol. For more information, see the supplemental information provided.

Spirometry measurement displayed on the monitor screen

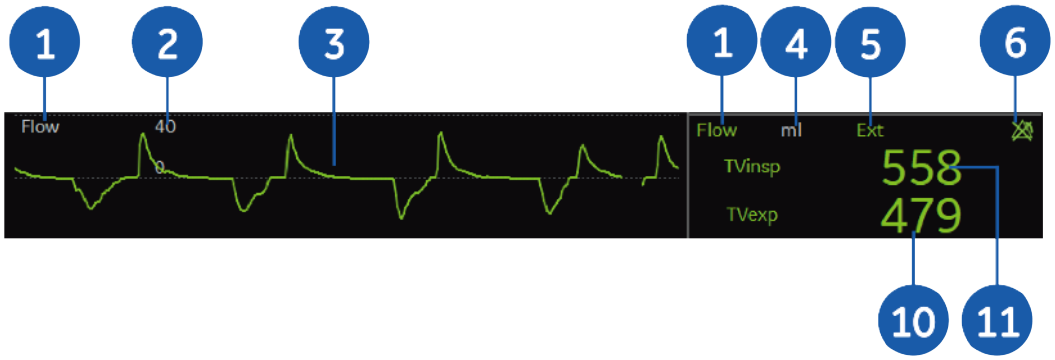
The message **Ext** appears in the certain area of screen when the data is from the external source.

You can setup following screen views from > **Screen Setup**.

- Split screen: displays the spirometry parameter digits
- Normal screen: displays the waveform field and digit field of **Paw** and **Flow**:



Paw parameter



Flow parameter

1.	Paw (**Paw**) or Flow (**Flow**): parameter or waveform label	7.	Ppeak (**Ppeak**): peak pressure
2.	waveform scale	8.	Pplat (**Pplat**): plateau (pause) pressure
3.	waveforms	9.	PEEP (**PEEP**): total positive end expiratory pressure
4.	cmH2O (**cmH2O**) or ml (**ml**): unit	10.	TVinsp (**TVinsp**): inspired tidal volume
5.	Ext (**Ext**): indicate external source	11.	TVexp (**TVexp**): expired tidal volume
6.	alarm status, alarm limits, or other messages		

NOTE
Flow digit field displays **TVinsp**, **TVexp** when **Show Volume** is **TV**; displays **MVinsp**, **MVexp** when **Show Volume** is **MV**.

Spirometry supported data

The device supports the data of the following parameters:

- Waveforms
- Parameter digits
- Numeric trends (including vent settings)
- Alarm broadcast
- Printing output

- Transferring data to CARESCAPE network and HL7 network

Spirometry parameters

- Peak pressure (Ppeak): maximum pressure during one breath
- Plateau pressure (Pplat): pressure at the reversal point of the flow
- Mean pressure (Pmean): average pressure during one breath
- Positive end expiratory pressure (PEEP)
- Inspiratory and expiratory tidal volumes (TVinsp/TVexp)
- Inspiratory and expiratory minute volumes (MVinsp/MVexp)
- Compliance (Compl): calculated for each breath, indicates the pressure difference required to deliver a certain volume of gas into the patient
- Airway resistance (Raw): calculated from an equation describing the kinetics of gas flow between the lungs and a flow sensor
- (Paw): Real-time pressure waveform
- (Flow): Real time waveform

Vent settings in numeric trends:

Vent mode	Display parameters
Volume Control Ventilation (VCV)	TV, RR, I:E, PEEP
Synchronized Intermittent Mechanical Ventilation with Volume Control (SIMV VCV)	TV, RR, PEEP, Psupport, Tinsp
Synchronized Intermittent Mechanical Ventilation Pressure Control Volume Guaranteed (SIMV PCV-VG)	TV, RR, PEEP, Psupport, Tinsp
Synchronized Intermittent Mechanical Ventilation Pressure Control (SIMV PCV)	RR, PEEP, Pinsp, Psupport, Tinsp
Pressure Supported Ventilation with apnea protection (PSVPro)	RR, PEEP, Pinsp, Psupport, Tinsp
Pressure Control Ventilation - Volume Guaranteed (PCV-VG)	TV, RR, I:E, PEEP
Pressure Control Ventilation (PCV)	RR, I:E, PEEP, Pinsp
Continuous Positive Airway Pressure plus Pressure Supported Ventilation (CPAP + PSV)	RR, PEEP, Pinsp, Psupport, Tinsp

Spirometry points to note

Refer to the instructions supplied with the anesthesia machine for spirometry related information, such as safety precautions, limitations and points to note, measurement setup and check, clinical guidance.

NOTE
The monitor's data display may have delay compare with the anesthesia machine, please observe the patient frequently.

Spirometry measurement setup

Connecting to anesthesia machine

For the anesthesia machine to monitor connection, refer to Connecting the anesthesia machine on page 67.

For the anesthesia machine to patient connection, refer to the instructions for use supplied with related device.

Using the patient spirometry measurement

Selecting the spirometry scales

You can change **Paw** and **Flow** waveform scales.

1. Select the spirometry digit field.
2. Select a value from the **Paw Scale** or **Flow Scale** list.

Selecting the spirometry sweep speed

1. Select the spirometry digit field.
2. Select a value from the **Paw Sweep Speed** or **Flow Sweep Speed** list.

   The smaller the value, the slower the sweep speed.

Selecting the displayed spirometry show volume type

This setting determines which numeric data - tidal volumes (**TVinsp** and **TVexp**), or minute volumes (**MVinsp** and **MVexp**) will appear in the **Flow** digit field.

1. Select the spirometry digit field.
2. Select an option from the **Show Volume** list.

Setting the spirometry alarm on/off

1. Select the spirometry digit field.
2. Select the **Alarms** tab.
3. Set the **Ppeak**, **MVexp**, **TVexp**, **Apnea (Ane. Machine)** alarm **ON** or **OFF**.

Entropy

Entropy safety precautions

Entropy warnings

WARNING

PATIENT SAFETY.

E-ENTROPY module is defibrillation proof up to 3 kV. Ensure that the sensor is placed on the patient's forehead according to the instructions. Placing the sensor in a way other than instructed might result in risks during patient defibrillation.

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

ELECTRIC SHOCK.

Make sure that the electrodes, sensor and connectors do not touch any electrically conductive material, including ground.

WARNING

DEFIBRILLATOR PRECAUTIONS.

Proper placement of defibrillator pads in relation to the electrodes is required to ensure successful defibrillation.

Entropy cautions

CAUTION

ERRONEOUS READINGS.

Strong 30-40 Hz magnetic fields may cause erroneous Entropy measurement. Do not use devices with such a field close to the module or sensor.

CAUTION

ERRONEOUS READINGS.

Diathermy and external interference may degrade the performance.

CAUTION

MISINTERPRETATION.

The Entropy measurement is always to be used only as an adjunct to other physiological parameters. Clinicians are advised to use their knowledge and experience when making clinical judgements. Entropy values are not to be used as sole indicators of the patient status.

CAUTION

ERRONEOUS READINGS.

Check the sensor expiration date on the sensor package. Do not use expired sensors to avoid the risk of erroneous readings.

CAUTION

SKIN IRRITATION.

Do not use a sensor for more than 24 hours to avoid the risk of patient skin irritation.

CAUTION

SKIN IRRITATION.

Long-term use of the electrodes may degrade condition of the skin especially on patients with liver diseases.

CAUTION

ERRONEOUS READINGS.

Automatic sensor check may need to be disabled if the 70 Hz impedance check signal interferes with other equipment, such as EEG module with evoked potentials measurement.

CAUTION

ERRONEOUS READINGS.

Allow the cable to dry completely after cleaning. Moisture and dirt on the connector can affect the measurement accuracy.

Entropy instruction

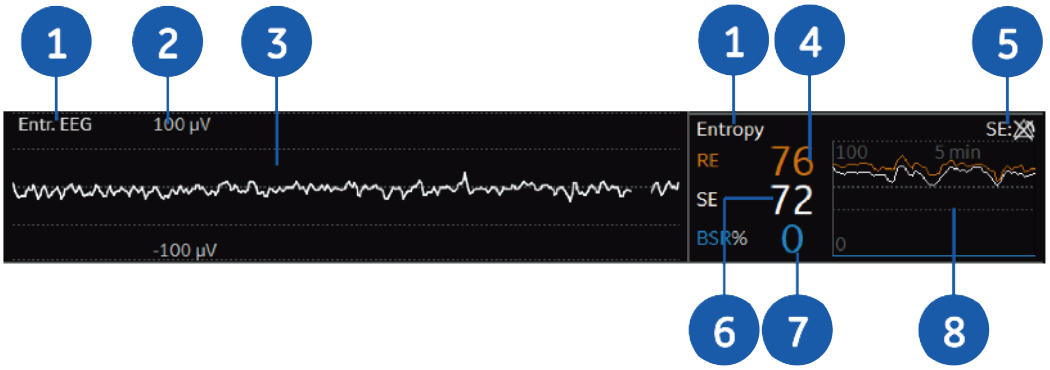
Entropy is a non-invasive parameter suitable for adults and pediatric patient population older than two years of age.

Entropy may be used as an aid in monitoring the effects of certain anesthetic agents on the patient's central nervous system (CNS) during general anesthesia. Displaying and using clinical information from Response Entropy (RE) and State Entropy (SE) may allow the clinician to tailor the anesthetic according to the individual needs of a patient.

The use of Entropy parameters may help the clinician to improve drug management. It may also enable a faster recovery from anesthesia and a more predictable wake-up and extubation.

Prior to using Entropy as an adjunct to guide anesthesia care, it is recommended to review important situations and limitations that can influence the Entropy number. GE recommends that clinicians review the following practice advisory that includes a section on brain function monitoring: The American Society of Anesthesiologists, Practice Advisory for Intraoperative Awareness and Brain Function Monitoring (Anesthesiology 2006; 104: 847-64). Clinicians are also recommended to maintain current knowledge of government regulatory, practice or research information on brain function monitoring and related topics.

Entropy measurement displayed on the monitor screen



1.	Entr. EEG (**Entr. EEG**): parameter/waveform label	5.	alarm limits, alarm status or other messages
2.	waveform scale	6.	SE (**SE**): State Entropy value
3.	Entropy EEG waveform	7.	BSR% (**BSR%**): Burst suppression ratio
4.	RE (**RE**): Response Entropy value	8.	Entropy microtrend

NOTE
For which digits display in digit field is depended on the **Display Format** settings configured in the Entropy menu.

NOTE
For the microtrend length display in digit field is depended on the **Entropy/SPI Trend Length** settings configured in the Entropy menu.

Entropy module keys

There are two keys on the module. Depending on the module version either the text only or symbol only appear on the keys, and the table below covers both versions.

or `Entropy`	Opens the Entropy menu on the screen.
or `Check Sensor`	Starts the manual sensor check.

Entropy measurement limitations

- This measurement is available in OR mode only.
- Entropy measurement is not indicated for pediatric patients younger than two years old.
- Entropy is not validated with patients undergoing sedation.
- Potential artifact may be caused by unusual or excessive electrical interference; high FEMG activity caused by shivering, coughing, muscle activity or rigidity, sustained eye movements, head and

body motion; or ECG in case of low EEG signal amplitude. Also, improper sensor placement and poor skin contact (high impedance) may cause artifact and interfere with the measurement.

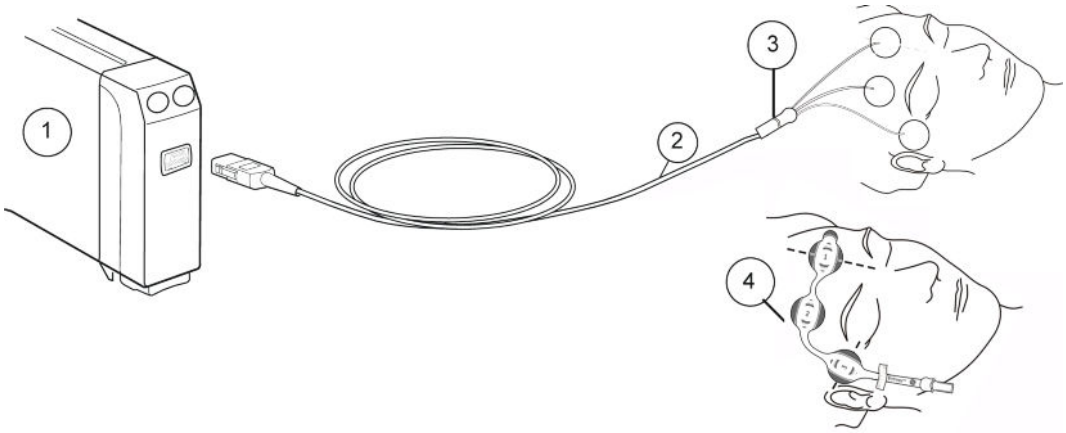
- During extended periods of electrocautery there may not be any good EEG epochs, and Entropy values will not be displayed.
- Entropy readings may be inconsistent when monitoring patients with neurological disorders, traumas or their sequelae.
- Entropy readings may be inconsistent when using benzodiazepines, nitrous oxide or ketamine as anesthetics.
- Psychoactive medication or very high opiate doses may suppress EEG and cause inconsistent Entropy readings.
- Cooling the patient may suppress their EEG and cause inconsistent Entropy readings.

Entropy 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.
- A portion of the Entropy software is derived from the RSA Data Security, Inc. MD5 Message-Digest Algorithm.
- Entropy sensors are disposable, for single-patient use only, and not made with natural rubber latex.
- Make sure that the sensor connectors of the sensor cable are not in contact with fluids.
- Always ensure that the sensor is properly attached to the patient and connected to the cable.
- Prior to using Entropy as an adjunct to guide anesthesia care, it is recommended to review important situations and limitations that can influence the Entropy number. GE recommends that clinicians review the following practice advisory that includes a section on brain function monitoring: The American Society of Anesthesiologists, Practice Advisory for Intraoperative Awareness and Brain Function Monitoring (Anesthesiology 2006; 104: 847-64). Clinicians are also recommended to maintain current knowledge of all required regulatory, practice or research information on brain function monitoring and related topics.

Entropy measurement setup

Entropy equipment to patient connection



1.	E-ENTROPY module	3.	GE Entropy sensor
2.	GE Entropy cable	4.	Entropy EasyFit sensor

Preparing the patient for Entropy measurement

1. Connect the Entropy sensor cable to the module.
2. Clean the application site according to the sensor’s instructions for use and let it dry before attaching the sensor.
3. Place the Entropy sensor on the patient's forehead; see sensor package for instructions.
4. Connect the sensor to the Entropy sensor cable.
5. Observe the results of the automatic sensor check in the digit field.
6. The measurement starts automatically after the sensor has passed the check.

Checking the Entropy measurement

1. Check that the sensor/electrode passes the sensor/electrode check when you are starting to monitor a new patient.

Using the Entropy measurement

Selecting the Entropy scale

1. Press the module key, or select the Entropy digit field.
2. Select a value from the **Entr. EEG Scale** list.

Selecting the EEG sweep speed

This setting determines the drawing speed for the EEG waveform.

1. Press the module key or select the Entropy/BIS digit field.
2. Select a value from the **EEG Sweep Speed** list.

The smaller the value, the slower the sweep speed.

NOTE
This setting can change the EEG sweep speed of BIS and Entropy parameters.

Selecting the display format for Entropy

You can select which Entropy parameters are shown in the digit field.

1. Press the module key, or select the Entropy digit field.
2. Select an option from the **Display Format** list:
   - **RE** = Response Entropy
   - **SE** = State Entropy
   - **RE+SE** = both of the above
   - **RE+SE+BSR** = RE, SE and Burst Suppression Ratio (BSR)

Selecting the Entropy/SPI trend length

This setting affects the width of the Entropy and SPI microtrend in the digit field.

1. Press the module key, or select the Entropy digit field.
2. Select a trend length from the **Entropy/SPI Trend Length** list.

Using the manual Entropy sensor check

Whenever required, you can perform the sensor check manually. Press the module key, or:

1. Press the module key, or select the Entropy digit field.
2. Select **Check Sensor**.
3. Observe the results on the screen. Do not press the sensor during the check to avoid signal noise.

The measurement continues automatically after the sensor has passed the check.

Using the automatic Entropy sensor check

Sensor impedance check is performed at the start up whenever a sensor or an electrode is attached. If the automatic sensor check has been selected on, the check is also performed periodically every 10 minutes.

1. Press the  module key, or select the Entropy digit field.
2. Select the **Automatic** check box for **Check Sensor**.

Bypassing the Entropy sensor check

If the sensor does not pass the impedance check, this option becomes selectable. It allows you to start the measurement without completing the sensor check. In this case, the measurement may be unreliable.

1. Press the  module key, or select the Entropy digit field.
2. Select **Bypass Check**.

Setting Entropy alarm limits

1. Press the  module key, or select the Entropy digit field.
2. Select the **Alarms** tab.
3. Check that the **Alarm** is turned on.
4. Set the related alarm limits with arrows.

Stopping the Entropy measurement

1. Remove the Entropy sensor from the patient.
2. Disconnect the sensor from the sensor cable.
3. Discard the sensor.

Entropy measurement basics

Entropy measurement description

EEG signals reflect the underlying state of brain activity. As a person falls asleep or is anesthetized, the brain function (activity) starts to decrease and becomes more orderly and regular. EEG changes from irregular to more regular patterns when anesthesia deepens. Similarly, frontal EMG quiets down as the deeper parts of the brain are increasingly saturated with anesthetics.

Entropy measurement is based on processing of raw EEG and FEMG signals by using the Entropy algorithm, a GE application of Spectral Entropy. The algorithm is published: Viertiö-Oja H et al. Description of the Entropy algorithm as applied in the Datex-Ohmeda S/5 Entropy Module. (Acta Anaesthesiologica Scandinavica 2004; Volume 48: Issue 2:154-161, 2004).

Entropy measures irregularity of EEG and FEMG. The GE Entropy measurement devices are responsible for EEG and FEMG signal acquisition, amplification, filtering and digitization and electrode impedance measurement.

Entropy parameters

RE is a fast reacting parameter, which measures EEG and FEMG in the frequency range 0.8 Hz to 47 Hz. Its reaction time is two seconds. It may give an indication of the patient's reaction to external stimuli, such as intubation and skin incision, if neuromuscular blocking agents are not used.

SE is a more stable and robust parameter, which measures EEG in the frequency range of 0.8 Hz to 32 Hz. Its reaction time is 15 seconds. SE may be used to assess the effect of certain anesthetic drugs on the brain.

Entropy frequency and display ranges

Parameter	Display range	Cortical EEG, frequency range	Facial EMG, frequency range
RE	0 to 100	0 Hz to 32 Hz	32 Hz to 47 Hz
SE	0 to 91	0 Hz to 32 Hz	no measurement

How to interpret the Entropy values

High values of Entropy indicate high irregularity of the signal, signifying that the patient is awake. A more regular signal produces low Entropy values, which can be associated with low probability of consciousness. A decrease in Entropy may enable the physician to observe the moment when the patient loses responsiveness. During continued anesthesia, both Entropies stabilize.

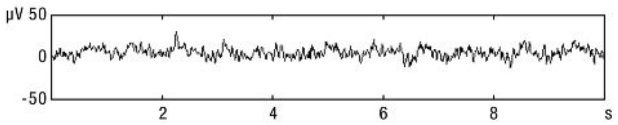
During general anesthesia with adequate anesthesia and hypnosis the RE and SE values will be within a narrow range or equal. The numbers will also merge during profound neuromuscular paralysis with neuromuscular blocking agents since the patient's facial muscles are unable to react.

RE is typically higher during periods prior to induction and before wake-up. If the numbers diverge (RE exceeds SE) during general anesthesia, it indicates that the facial muscles are activated. This may happen due to noxious stimuli. SE value may remain within a constant range if the level of hypnosis is adequate. A quick rise in RE may give an early warning of impending wake-up.

Patients emerging from general anesthesia will demonstrate a rise in both the RE and SE values.

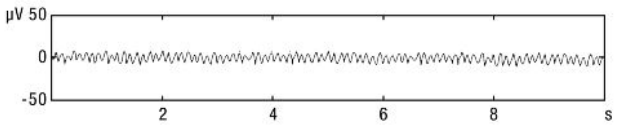
Relation of Entropy values to EEG and patient status

- Entropy values: High Entropy values
- EEG: Irregular EEG
- Patient Status: Awake
- Graphical display:

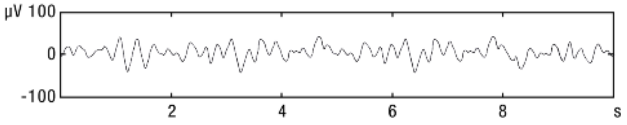


- Entropy values: High Entropy values
- EEG: Irregular EEG
- Patient Status: Deepening sedation

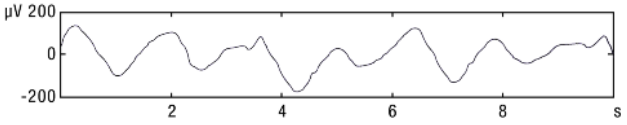
- Graphical display:



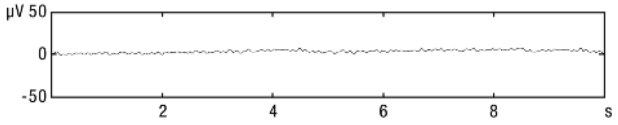
- Entropy values: Low Entropy values
- EEG: Regular EEG
- Patient Status: Moderate anesthesia
- Graphical display:



- Entropy values: Low Entropy values
- EEG: Regular EEG
- Patient Status: Very deep anesthesia
- Graphical display:



- Entropy values: Low Entropy values
- EEG: Regular EEG
- Patient Status: Suppressed EEG
- Graphical display:



Entropy range guidelines

NOTE

Individual patients may show different values. These are only guidelines.

RE	SE	Description
100	90	Awake
60–40	60–40	Low probability of recall, clinically adequate level for most surgical operations
<40	<40	Deep anesthesia
0	0	Suppressed EEG

Burst suppression ratio (BSR)

BSR is defined as the percentage of time of suppressed (isoelectric, flatline) EEG periods during the last minute of observation. Emergence of burst suppression pattern may indicate very deep anesthesia, hypothermia or ischemia.

Typically, during general anesthesia, in the absence of requirements for profound levels of anesthesia, BSR is 0%. Higher levels of burst suppression indicate very deep hypnosis/unconsciousness level.

Burst suppression generally emerges with Entropy values below 40, but may not appear even with very low Entropy values.

Entropy practicalities

- It is very important to ensure good contact between the sensor electrodes and skin. With careful skin preparation, correct sensor placement and use of correct cable, the skull and sinuses between the electrodes and the brain interfere minimally with the signal acquisition. See the sensor instructions for use for more detailed information.
- A high quality EEG signal is the prerequisite for successful Entropy calculation. Displaying the raw EEG within the Entropy EEG waveform adjacent to the Entropy values may help the user to confirm the signal quality. Raw EEG on the screen may also enable the clinician to view the EEG for recognizable and clinically relevant patterns of EEG activity.
- Do not use other sensors than Entropy sensors by GE.
- Entropy is not a parameter for monitoring neuromuscular blockade. Though RE may give an indication of the patient's reaction to external stimuli, such as intubation and skin incision, the level of neuromuscular blockade should be assessed with NMT, which is an active assessment of the effects of neuromuscular blockade agents on the neuromuscular junction.
- Neuromuscular blocking agents (NMBA) administered in surgically appropriate doses are not known to affect the EEG, but are known to have an effect on the EMG. RE values may drop in response to NMBA administration, due to paralysis of facial muscles.
- The Entropy sensors and cable are designed to be defibrillation-proof.

Entropy reference studies

Entropy reference studies supporting reduction of drugs

The following studies support the indication for reducing the amount of certain hypnotic drugs and enabling faster emergence from anesthesia:

- Vakkuri A, Yli-Hankala A, Sandin R, Mustola S, Hoymork S, Nyblom S, Talja P, Sampson T, Van Gils M, Viertiö-Oja H: Spectral Entropy monitoring is associated with reduced propofol use and faster emergence in propofol-nitrous oxide-alfentanil anesthesia Anesthesiology 2005, Volume 103, Issue 2:274-279, 2005

  In the study reported by Vakkuri et al using propofol, Entropy monitoring helped in determining the titration rates of propofol especially during the last part of the procedures. This is indicated by higher entropy values, decreased consumption of propofol ($P<0.001$), and shorter recovery times in the Entropy monitored group
- Aimé I, Verroust N, Masson-Lefoll C, Taylor G, Laloe PA, Liu N, Fischler M (2006): Does monitoring bispectral index or spectral entropy reduce sevoflurane use? Anesth Analg 103: 1469-77

  In the study by Aimé et al, the authors reported that they were able to cut down the sevoflurane usage by 29% in the Entropy monitored group, when compared to the standard clinical practice.

Entropy reference studies supporting titration of drugs

The following studies support the indication that use of Entropy may help the user to titrate certain anesthetic drugs according to the individual needs of adult patients:

- Vanluchene A.L.G., Vereecke H, Thas O, Mortier E.P, Shafer S.L, Struys M. M. R. F Spectral Entropy as an Electroencephalographic Measure of Anesthetic Drug Effect: A Comparison with Bispectral Index and Processed Midlatency Auditory Evoked Response Anesthesiology 2004; Volume 101: Issue 1:34–42.

  In this study by Vanluchene et al using propofol, the authors conclude that both SE and RE seem to be useful measures for anesthetic drug effect, with low baseline variability and accurate burst suppression detection.
- Vanluchene A.L.G, Struys M. M. R. F, Heyse B. E. K, Mortier E.P: Spectral entropy measurement of patient responsiveness during propofol and remifentanil. A comparison with the bispectral index. British Journal of Anaesthesia 2004; Volume 93: Issue 5: 645–54.

  In this study by Vanluchene et al using propofol, the authors conclude that loss of response to verbal command and loss of response to noxious stimulation were accurately detected by Entropy and BIS.
- Vakkuri A, Yli-Hankala A, Talja P, Mustola S, Tolvanen-Laakso H, Sampson T, Viertiö-Oja H: Time-frequency balanced spectral entropy as a measure of anesthetic drug effect in central nervous system during sevoflurane, propofol, and thiopental anesthesia Acta Anaesthesiologica Scandinavica 2004; Volume 48: Issue 2: 145-153, 2004.

  In this study using sevoflurane, propofol and thiopental, the authors found that SE and RE distinguished excellently between conscious and unconscious states. The authors conclude that RE indicates emergence from anesthesia earlier than SE or BIS.

Reference studies regarding pediatric use of Entropy

Entropy has been used with pediatric patients in the following studies:

- Klockars JGM, Hiller A, Ranta S, Talja P, van Gils MJ, Taivainen T: Spectral entropy as a measure of hypnosis in children. Anesthesiology 2006, 104: 708-17.

  In the study by Klockars et al using sevoflurane, the authors used Entropy monitoring on anesthetized children.
- Davidson A.J, Kim M.J, Sangolt G.K: Entropy and Bispectral Index During Anaesthesia in Children. Anesthesia and Intensive Care 2004; Volume 32: Issue 4: 485-493.

  In this study by Davidson et al used Entropy Module on toddlers and children during isoflurane and nitrous oxide anesthesia.
- Davidson A, Huang G, Rebmann C, Ellery C: Performance of Entropy and Bispectral Index as measures of anaesthesia effect in children of different ages. British Journal of Anaesthesia 2005, 95: 674-9.

  In this study by Davidson et al using sevoflurane, the authors concluded that there was no difference in performance of Entropy Module and BIS in children.
- Choi SR, Lim YH, Lee JH & Chung CJ: Spectral entropy monitoring allowed lower sevoflurane concentration and faster recovery in children. Acta Anaesthesiologica Scandinavica 54 (7): 850—862; Aug 10 2010.

Neuromuscular transmission

NMT safety precautions

NMT warnings

WARNING

PATIENT SAFETY.

Make sure that the measurement electrodes, sensor and connectors do not touch the patient during defibrillation.

WARNING

ELECTRIC SHOCK.

Make sure that the electrodes, sensor and connectors do not touch any 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

PATIENT SAFETY.

Do not place the NMT stimulating electrodes on the patient's chest. Application of the electrodes near the thorax may increase the risk of cardiac fibrillation.

WARNING

ERRONEOUS READINGS.

If used in close proximity to shortwave or microwave therapy equipment, stimulator output may become unstable.

WARNING

PATIENT SAFETY.

Never subject a patient with an implanted electronic device to electrical stimulation without consulting a medical specialist first.

NMT cautions

CAUTION

ELECTRIC SHOCK.

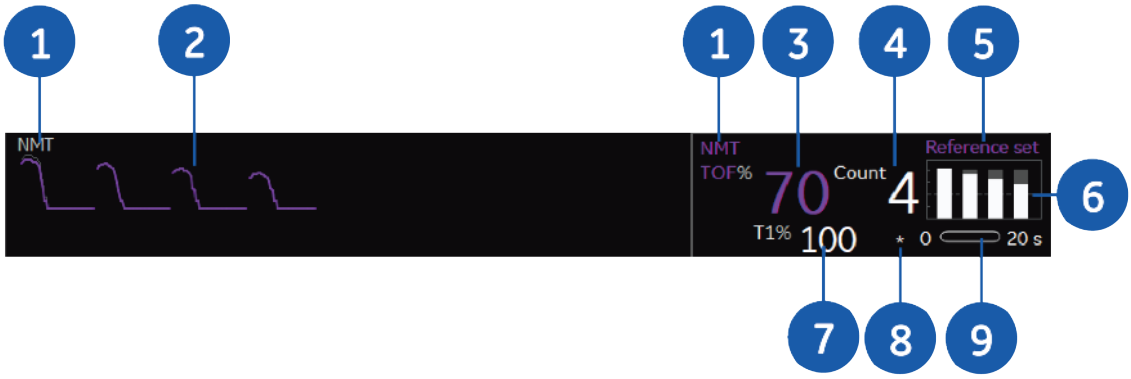
Always stop the NMT measurement before handling the stimulating electrodes or connectors.

NMT instruction

Neuromuscular transmission (NMT) is a non-invasive measurement suitable for adults and pediatric patient populations weighing more than 5 kg (11 lbs).

Quantitative neuromuscular transmission monitoring helps to optimize the administration of neuromuscular blocking agents (NMBA) according to the patient’s individual needs. Monitoring the level of neuromuscular block enables follow-up and prediction of recovery, helps in correct timing of antagonism, and may also decrease the incidence of residual paralysis. In the recovery room, low current stimulation can be used for revealing possible residual block by observing the fade in the train of four (TOF). NMT monitoring also helps to determine when the patient can be extubated safely, and respiratory complications after extubation due to the effects of NMBAs can be prevented.

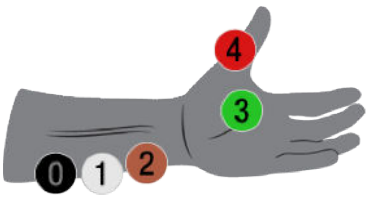
NMT measurement displayed on the monitor screen



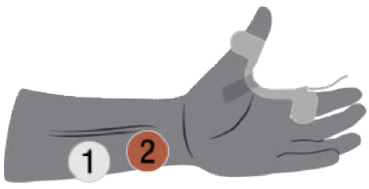
1.	NMT (**NMT**): waveform/parameter label	6.	NMT response bar
2.	NMT waveform	7.	T1% (**T1%**): T1 value
3.	TOF% (**TOF%**): TOF value. Different display according to stimulus mode selection. • TOF mode: **TOF%** ratio • DBS mode: **DBS%** ratio • ST mode: There only label **Single TW.**	8.	stimulus pulse asterisk, flash when a stimulus pulse is generated
4.	Count (**Count**): Count value	9.	cycle time progress bar, or last manual measurement time
5.	Reference set (**Reference set**): digit field messages		

The digit field have different view:

- Normal measurement view: see above
- Sensor check view: graphics indicates different type sensor is connected. If sensor failure identified, the related sensor will be in red to indicate, and the passed sensor will be display as ✓.



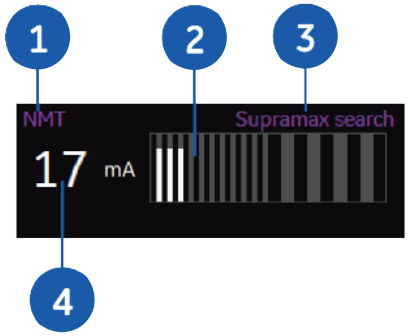
EletroSensor



MechanoSensor

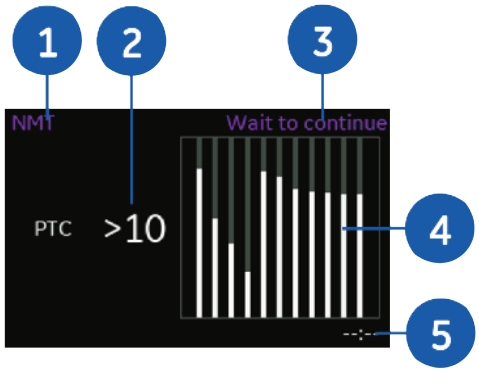
Sensor failure identified example

- Calibration view: when supramaximal current or reference (When not using supramax) search is started, current value and response bar will be displayed.



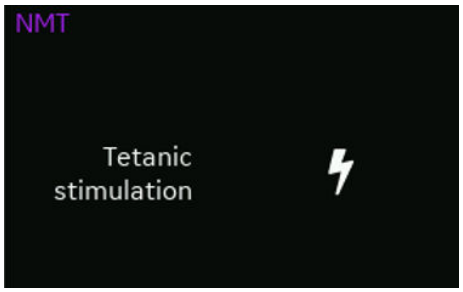
1.	NMT (**NMT**): parameter label
2.	response bar
3.	Supramax search (**Supramax search**): digit field messages
4.	current value with unit.

- PTC view: during and after PTC measurement, the count of detected responses, the measurement time, response bar will be displayed.

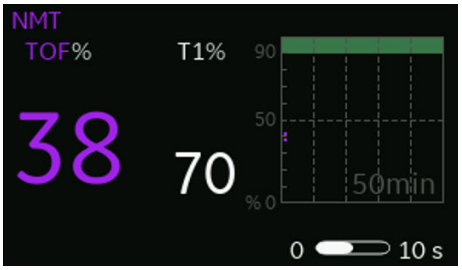


1.	NMT (**NMT**): parameter label
2.	PTC (**PTC**): the count of detected responses
3.	Wait to continue (**Wait to continue**): digit field messages
4.	response bar
5.	the measurement time

- Tetanic stimulation view: during the Tetanic stimulation (**Tetanic stimulation**), the corresponding will be displayed.



- Recovery microtrend view: the NMT microtrend (for TOF or DBS) shows the patient recovery trend for the past 50 minutes. It is also display the ratio and T1% value.



For microtrend:

- Vertical axis indicates the scale of 0 to 100 %.
- Horizontal axis indicates the time from 0 to 50 minutes.
- The target zone of 90 to 100 % is colored green.

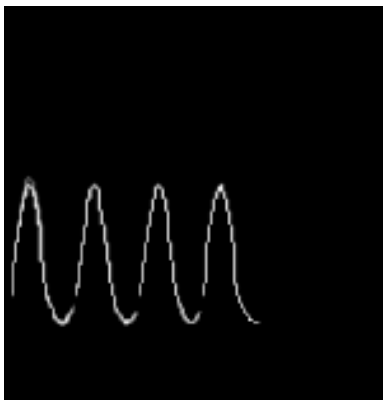
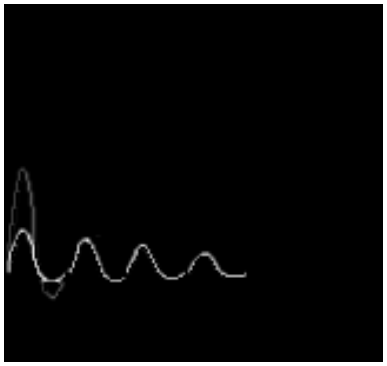
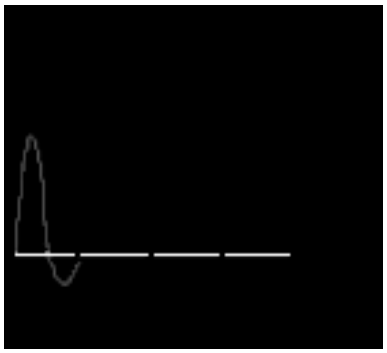
NMT waveforms on the monitor screen

Both ElectroSensor and MechanoSensor have a characteristic stimulus-response waveform that is available on the monitor waveform field.

Typical ElectroSensor TOF responses

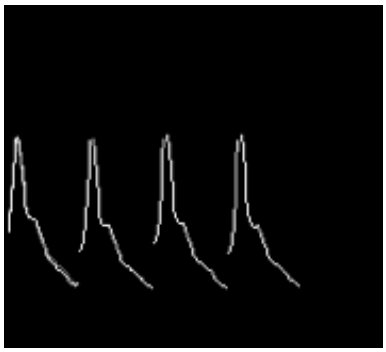
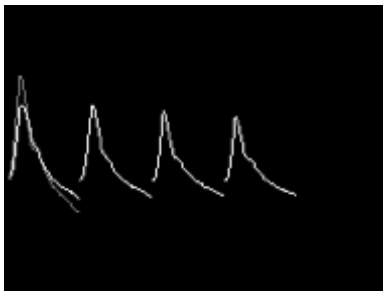
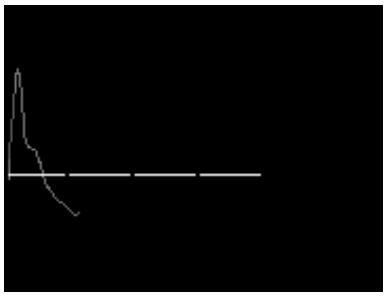
ElectroSensor measures the evoked electromyogram (EMG) response. A typical response is a compound muscle action potential (CMAP).

The following graphes present typical ElectroSensor TOF responses:

• Unrelaxed state (no fade)	
• Moderate block (four responses with fade)	
• Deep block (no responses)	

Typical MechanoSensor TOF responses

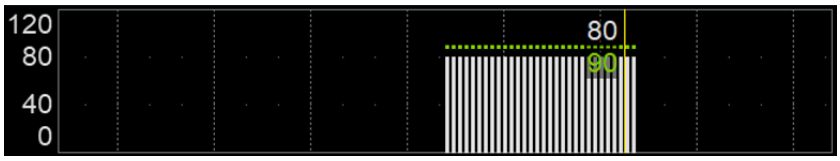
MechanoSensor measures the bending of the thumb. A typical response is a monophasic curve representing thumb bending (positive slope) and relaxation (negative slope). The following graphes present typical MechanoSensor TOF responses:

• Unrelaxed state (no fade)	
• Moderate block (four responses with fade)	
• Deep block (no responses)	

NMT graphic trends on the monitor screen

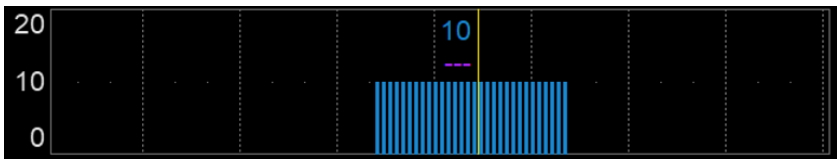
The NMT related parameters display in 2 fields of graphic trends, different NMT values have their own specific colors in the graphic trends. The values are shown as follows:

- **NMT T1 & Ratio** field:



  - White bars = Ratio% (TOF or DBS)
  - Green dots = T1%

- **NMT PTC & Count** field:



  - Cyan dashed bars = PTC

- Magenta dashed bars = Count

NMT module keys

There are two keys on the module:

Start-up	• Starts the search for supramaximal current and reference level. • Proceeds with the selected measurement cycle.
Stop Continue	• Interrupts monitoring. • Restarts monitoring of the same patient. If the module has been disconnected, but you wish to continue the previous NMT monitoring, select **Recall reference**.

NMT measurement limitations

- This measurement is not available in neonatal mode.
- NMT measurement is not indicated for pediatric patients weighing less than 5 kg (11 lbs).
- Pediatric MechanoSensor is validated for children weighing 5 to 20 kg (11 to 44 lbs).
- Electrosurgery may cause incorrect measurement results.
- Refer to the accessory instructions for use for any limitations when defibrillating the patient.
- NMT measurement is not indicated for patients with known abnormal function of neuromuscular junction.

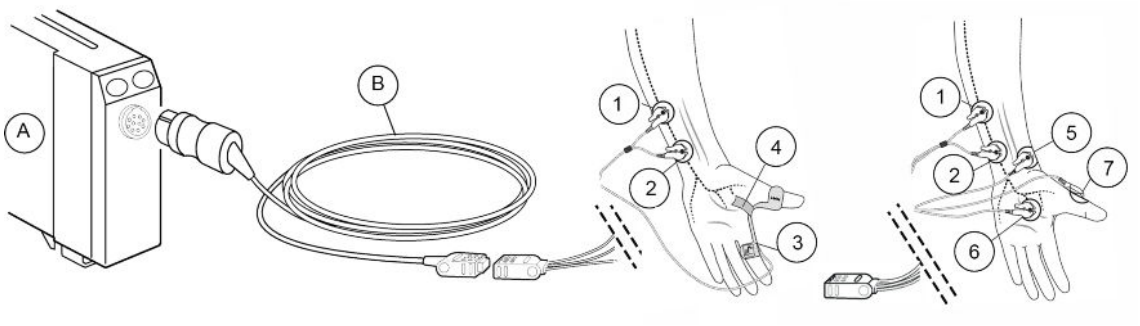
NMT points to note

- 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.
- For safe extubation after nondepolarizing neuromuscular block, the TOF% should be higher than 90. Also assess other clinical signs.
- Start monitoring before the administration of a muscle relaxant drug (but after the induction of sleep in general anesthesia) to prevent voluntary muscle contraction and tension from interfering with the reference search.
- When placing the electrodes, make sure that they do not touch each other.
- Do not place electrodes on areas with excessive body hair or lesions.
- If the electrodes are placed incorrectly, wrong nerves are stimulated and this causes wrong muscle response.
- When multiple nerves are stimulated, the measured response may be affected by electrical activity of other muscles.
- If the stimulation electrodes are placed very close to the palm of the hand, the muscles are stimulated directly by the stimulation pulses.
- Avoid trans-thoracic stimulation.

- Do not apply stimulation across or through the head, directly on the eyes, covering the mouth, on the front of neck (especially over the carotid sinus), or from electrodes placed on the chest and the upper back or crossing over the heart.
- Moving or touching the patient during measurement may cause incorrect results.
- For nondepolarizing neuromuscular block, use either TOF or DBS mode. For depolarizing neuromuscular block, use ST mode.

NMT measurement setup

NMT equipment to patient connection



A = Module with NMT measurement capability

B = NMT sensor cable

1.	Electrode, white (stimulating)	5.	Electrode, black (ground)
2.	Electrode, brown (stimulating)	6.	Electrode, green (measuring)
3.	Sensor (measuring)	7.	Electrode, red (measuring)
4.	Tape		

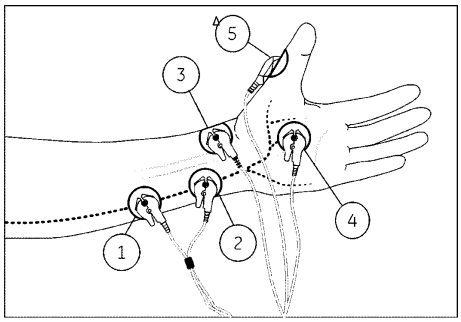
Preparing the patient for NMT measurement

1. Connect the NMT sensor cable to the module.
2. Clean the skin at the NMT application area.
3. Apply the electrodes.

   Ensure that:

   - the electrodes are not expired.
   - the entire surface of each electrode makes an optimal contact to the skin.
   - the electrodes do not touch each other.
4. Always check the correct electrode positioning.
5. Connect the leads in the correct order to ensure reliable measurement results.
6. Connect the sensor cable to the MechanoSensor or ElectroSensor leadwire set.

Preparing the ElectroSensor setup

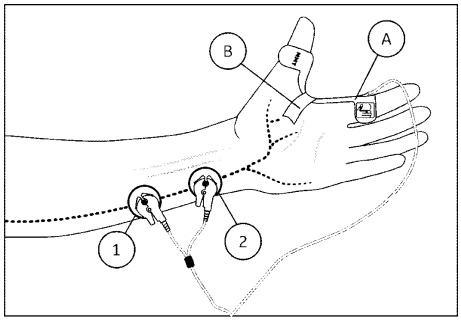


1.	White (stimulating)	4.	Green (measuring)
2.	Brown (stimulating)	5.	Red (measuring)
3.	Black (ground)		

- - - = Ulnar nerve

1. Place two electrodes for white and brown lead connection along the ulnar nerve. Ensure that the entire electrode surface has optimal contact with the skin. Ensure that the electrodes do not touch each other.
2. Place the electrodes for red and green lead connection as indicated in the illustration above.
3. Place the electrode for black lead connection where convenient, preferably between the stimulating and measuring lead connection electrodes.

Preparing the MechanoSensor setup

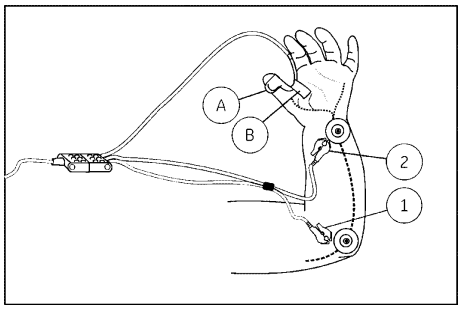


1.	White (stimulating)	A.	Sensor (measuring)
2.	Brown (stimulating)	B.	Tape

- - - = Ulnar nerve

1. Place the two electrodes along the ulnar nerve. Ensure that the entire electrode surface has optimal contact with the skin. Ensure that the electrodes do not touch each other. Palpating the ulnar artery near the wrist area may be helpful in identifying the ulnar nerve.
2. Attach the sensor in the groove between thumb and index finger. Secure with narrow tape only, allowing free finger movement.
3. Make sure that the sensor sets tightly in the groove and that the thumb can move freely. Do not immobilize the hand.

Preparing the Pediatric MechanoSensor setup



1.	White (stimulating)	A.	Pediatric MechanoSensor
2.	Brown (stimulating)	B.	Tape

- - - = Ulnar nerve

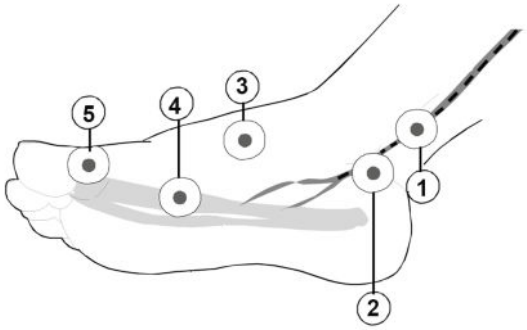
1. Place the two electrodes along the ulnar nerve. Ensure that the entire electrode surface has optimal contact with the skin. Ensure that the electrodes do not touch each other.
2. Attach the sensor in the groove between thumb and index finger. Secure with narrow tape only, allowing free finger movement. Bend the sensor along its middle groove.
3. Ensure that the NMT measurement is stopped before connecting the sensor clips to the electrodes.

Checking the NMT measurement

1. Always check the electrode quality.
2. Check that the electrodes are correctly positioned on the ulnar nerve and the message **Supramax search** is displayed. Ensure that you get a stimulus response. If the supramaximal stimulus current is not found, the message **Supramax not found** is displayed.

NMT alternative connections

If the patient's arm and/or hand cannot be used for NMT measurement, the foot may be an alternative measurement site. Place the electrodes for white and brown lead connection along the posterior tibial nerve (causing plantar reflexion of the great toe and foot) or peroneal nerve (stimulated behind the head of fibula). Place the electrodes for red and green lead connection site on the m. flexor hallucis brevis, and the electrode for black lead connection (ground) as indicated in the figure.



1.	White stimulating electrode	4.	Green measuring electrode
2.	Brown stimulating electrode	5.	Red measuring electrode
3.	Black ground electrode		

- - -= Tibial nerve

Using the NMT measurement

Starting the NMT measurement

You can setup following settings at first time, and later press the `Start-Up` module key when each time need to start NMT measurement.

1. Select the NMT digit field > **Advanced** tab.
2. Select **Stimulus Mode** to **TOF**, **DBS** or **ST**.
3. Select **Setup** tab.
4. Select **Start-up Settings** > **AUTO**.
5. Select **Start-up NMT**.

Starting the NMT measurement with an already relaxed patient

If the patient is already in a relaxed state, you can start the measurement with the stimulus current set in **Current mA** and no reference level.

1. Select the NMT digit field.
2. Select **Stimulus Mode** to **TOF**, **DBS** or **ST**.
3. Select **Setup** tab.
4. Select **Start-up Settings** > **Relaxed Patient**.
5. Press the `Start-up` module key, or select **Start-up NMT**.

Changing the NMT stimulus current

You can either search for the supramaximal stimulus current or set the stimulus current manually. You cannot change the stimulus current after the NMT measurement has been started.

To search for the stimulus current, select the **Use Supramax** check box.

To select the stimulus current manually:

1. Select the NMT digit field.
2. Deselect the **Use Supramax** check box.
3. Select a value from the **Current mA**.

Changing the NMT cycle time

This selection also affects the recovery note.

1. Select the NMT digit field.
2. Select a value from the **Cycle Time** list.

Changing the stimulation type

1. Select the NMT digit field > **Advanced** tab.
2. Select a value from the **Stimulation Type** list.

NOTE
It is recommended to choose **Large Adult** when the wrist circumference is more than 25 cm.

Adjusting the NMT beep volume

You can set the beep value to best suit your care environment.

1. Select the NMT digit field > **Advanced** tab.
2. Set a value for the **Stimulus Beep Volume**.

Using the NMT recovery note

The recovery note option is designed to be used with the TOF stimulus mode. The recovery note alarms you with the **Block recovery** message when the count reaches the value you have selected. It indicates that the patient is responding more clearly to the stimuli and the neuromuscular block is decreasing.

The recovery note is activated when the count is equal to or greater than the selected limit within the last minute.

NOTE
The recovery note will not be shown if the count has already been equal to or greater than the selected limit within the last minute.

To take this feature into use:

1. Select the NMT digit field > **Advanced** tab.
2. Select the count limit that will activate the note from **Recovery Note** list.

Measuring deep relaxation

When no responses are detected for TOF stimulation, the post tetanic count (PTC) is the only way to measure the neuromuscular block. A tetanic stimulation (50 Hz) is generated for five seconds and post-tetanic responses to single-twitch stimulation are counted. The larger the PTC (the number of detected responses), the sooner the normal TOF responses return. To monitor the deep relaxation level, start the PTC measurement.

NOTE
The PTC measurement is enabled when the count is 1 or less.

1. Select the NMT digit field.
2. Select **Start PTC**.

Showing the NMT microtrend

You can display the patient recovery trend for the past 50 minutes as a microtrend.

If this feature has been activated, the NMT microtrend is shown after the following sequence has taken place:

1. The patient is in a deep relaxation state (the count is zero).
2. DBS% or TOF% reaches a value between 20% and 90%.
3. The patient starts to recover, and one of the following takes place:
   3.1. NMT measurement is started with the **Relaxed Patient** option or the reference was not found:
      - The DBS% or TOF% has been increasing for three consecutive measurements

   3.2. NMT measurement is started with an unrelaxed patient and T1% is available
      - The DBS% or TOF% has been increasing for two consecutive measurements and T1% is over 30%, or
      - The DBS% or TOF% is over 30 and T1% is over 50%

NOTE
If the measurement is started with an unrelaxed patient and MechanoSensor is used, the monitor measures T1% even though the values are not displayed on the monitor.

To activate the feature:

1. Select the NMT digit field > **Advanced** tab.
2. Select the **Show Ratio Microtrend** check box.

   The microtrend is not shown if the patient is discharged/case is ended.

Continuing the NMT measurement

To continue interrupted NMT measurement with the same patient and monitor, press the `Stop Continue` module key, or:

1. Select the NMT digit field.
2. Select **Continue**.

Continuing the NMT measurement in OR after induction

When you move the patient with the module to the OR and want to continue the measurement with the already found and determined current and reference values, use the **Recall Patient** function. Connect the module to the monitor and:

1. Select the NMT digit field.
2. Select **Start-up Settings** to **Recall Patient**.
3. Select **Start-up NMT** or, press the `Start-up` module key.

Stopping the NMT measurement

Press the `Stop Continue` module key, or:

1. Select the NMT digit field.
2. Select **Stop**.

Once the measurement is stopped, unfasten the sensor clips. Remove the electrodes carefully pulling from their edge to avoid damaging the patient skin.

Restarting the NMT measurement

To restart the measurement with different settings:

1. Stop the NMT measurement
2. Select the NMT digit field.
3. Select **Enable Start-up**.
4. Change the settings as required.
5. Select **Start-up NMT** or, press the `Start-up` module key.

NMT measurement basics

NMT measurement description

The GE NMT measurement devices are used for monitoring the relaxation of the patient.

Neuromuscular transmission is the transfer of a motor nerve impulse over the neuromuscular junction. The GE NMT devices deliver stimulating electrical pulses to a motor nerve and the muscle response to these stimulations is measured.

Two electrodes are needed for electrical stimulation of a peripheral nerve. The resulting response can be measured either with a MechanoSensor, which measures the bending of the thumb, or an ElectroSensor, which measures the electrical activity of the muscle with three electrodes.

The monitor searches for the stimulus current needed to activate all the fibers of the stimulated (recorded) muscles. The search begins with a 10 mA stimulus and the response is measured. The current is increased in steps of 5 mA until the increase in the current no longer increases the response. This maximal current is then automatically increased by 15%, resulting in the supramaximal current.

If the supramaximal current is not found or the response is too weak for searching a supramaximal current, the current is set to 70 mA.

MechanoSensor and kinemyography (KMG)

Measurement with MechanoSensor is based on kinemyography principle. Two electrodes are placed on the ulnar nerve, and the innervating nerve is stimulated. The core of the MechanoSensor is a strip of piezoelectric polymer, housed inside the sensor. When this piezoelectric material changes shape due to muscle contraction as a result of nerve stimulation, the electrical charge in the material is redistributed, causing an electron flow to balance the charges. This flow can be measured as a potential change, which is proportional to the amount of material bending.

ElectroSensor and electromyography (EMG)

Measurement with ElectroSensor is based on evoked electromyography, which is the process of recording the electrical muscular fiber activity in response to the nerve stimulation. In addition to the two stimulus electrodes, two measuring electrodes and a grounding electrode are also placed on the patient, wherein one of the measurement electrodes must be above the muscle that is innervated by the stimulated nerve.

EMG captures the electric signal caused by the depolarization of the muscular membrane — the location just next to the neuromuscular junction, which is the site of action for the neuromuscular blocking agents. All other technologies, such as acceleromyography (AMG) and kinemyography (KMG) amongst others, measure the response caused by the muscle activity, being therefore indirect measurements for the actual drug effect and prone to inaccuracy, interference, and noise. Adequate recovery from nondepolarizing neuromuscular block, indicated by TOF% > 90%, can be reliably determined only with quantitative monitoring.

EMG train of four ratio (TOF%) is the gold standard for detecting nondepolarizing neuromuscular block in a clinical setting and is not interchangeable with, for example, AMG TOF[1] [2] that may overestimate the recovery by at least 15.1%. Therefore, residual neuromuscular block, defined as an EMG TOF% ratio of < 90%, cannot be excluded immediately on reaching an AMG TOF% of 90% or even 100%. Studies have shown that the implementation of quantitative EMG neuromuscular transmission monitoring resulted in a significant reduction of PACU patients that were incompletely recovered from NMBAs[3].

EMG measurement is recommended for surgeries in which the arm is fixed tightly to the patient's body (for example, robotic surgery). Compared to other measurements, EMG allows measurement even with impaired movement of the hand.

References for the information in this section:

1. Liang et al. "An ipsilateral comparison of acceleromyography and electromyography during recovery from nondepolarizing neuromuscular block under general anaesthesia in humans." Anesthesia & Analgesia (2013): 117(2); 373-9
2. Naguib M et al. "Consensus Statement on Perioperative Use of Neuromuscular Monitoring." Anesthesia & Analgesia (2018): 127(1); 71-80
3. Todd et al. "The implementation of quantitative electromyographic neuromuscular monitoring in an academic anaesthesia department." Anesthesia & Analgesia (2014): 119(2); 323-31

Stimulation modes

- Train of four, TOF: Recommended for most cases. It is also the default setting.

- Double burst stimulation, DBS: Useful when using the MechanoSensor. It enables better visual observation of the fading in responses.
- Post tetanic count, PTC: Used for estimating the relaxation level with tetanic stimulation.
- Single twitch, ST: Single twitch mode is practical when using depolarizing relaxants: in these cases, TOF% does not give any additional information about the patient status.

How to interpret the NMT values

When neuromuscular block deepens, different stimulation modes may be needed to assess the relaxation status. The following table describes the depth of relaxation.

TOF%	100%	10%	- - -		
TOF Count	4	3 or 2	1	0	
PTC			10	< 10	0
Relaxation	None → Deep				

Train of four (TOF) mode

In TOF stimulus mode, four stimulation pulses are generated at 0.5 second intervals. The response is measured after each stimulus and the ratio of the fourth to the first response of the TOF sequence is calculated, resulting in TOF%.

With the ElectroSensor, T1% is displayed. If the reference is successfully found, a scale is also included. Scale markers represent 0%, 30%, 60%, 90% and 120% reference values. When no reference is available, no T1% value is displayed and the bars are not scaled.

When relaxation deepens, the TOF% declines until the fourth response disappears and no TOF% is available. The degree of neuromuscular block is then estimated from the number of responses, the count, which represents the number of responses detected to the four stimuli. The fewer the responses, the deeper the relaxation.

Double burst stimulation (DBS) mode

DBS consists of two separate bursts. Each burst consists of three consecutive pulses at a 50 Hz frequency. The response ratio of the second to the first burst is calculated, resulting in DBS% (equivalent to TOF%).

Post tetanic count (PTC) mode

When the response to the fourth TOF stimulation pulse disappears or the first twitch is very weak, the TOF% is not available and only the counts can be observed.

When the stimulation pulses no longer give any stimulation response, the count also disappears. To monitor the relaxation level, you can then start tetanic stimulation and estimate the relaxation level from the post tetanic count, PTC. The PTC measurement is enabled when the count is 1 or less. Tetanic stimulation is a continuous stimulation of five seconds. After tetanic stimulation, single twitch stimulations are generated. The number of detected responses is counted and expressed as PTC. The fewer the responses, the deeper the relaxation.

If the responses do not fade away, a maximum of 11 responses are counted and the PTC value >10 is given.

After tetanic stimulation, NMT measurement is stopped and **Wait to continue** is shown for one minute. After that, the monitor automatically continues with the previously selected cycle.

Single twitch (ST) mode

In single twitch stimulation one pulse is generated and its response is measured.

NMT practicalities

- Normally, defasciculating doses of non-depolarizing neuromuscular blocking agents (precurarisation) do not affect the supramaximal current nor the reference value.
- Average lifetime of a MechanoSensor is two years, depending on the use. The sensor has been validated to last 700,000 twitches.

Inappropriate function of the measurement is often caused by incorrect accessory connection or misuse of the products. Therefore, note the following:

- Handle the sensor and cables carefully to maximize their lifetime.
  - Piezosensor inside the MechanoSensor is very sensitive to shocks.
- Attach the MechanoSensor correctly.
  - It is recommended to secure the MechanoSensor with a narrow tape. Wide tape might prevent adequate movement of the sensor with the thumb during the measurement.
- Check the quality of the stimulation electrodes.
  - Use GE approved NMT electrodes for stimulation. They are tested with the module and provide low impedance, which is crucial for accurate measurement. In addition, they provide a wider conducting surface than standard ECG electrodes, which ensures better measurement and improved signal output. Make sure that the wide conductive areas of the NMT electrodes do not overlap, as this can cause short circuits and loss of measurement.
  - Do not use the electrodes after their expiration date.
  - NMT electrodes are for single use only, do not reuse them as it could pose a risk for infection and/or result in measurement errors.
- Make sure the NMT lead wires are not of tension and do not pull on the electrodes.
- Perform a visual check of the MechanoSensor or ElectroSensor and cable.
  - Regular visual checking of the cable and sensor is recommended. If you see any signs of broken cables or joints of the MechanoSensor, replace those parts.

Bispectral index

BIS safety precautions

BIS 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

ELECTRIC SHOCK.

Make sure that the electrodes, sensor and connectors do not touch any 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

EQUIPMENT DAMAGE.

Do not autoclave the signal processing unit (BISx) or the digital signal converter (DSC). Do not open it for any reason.

WARNING

PATIENT SAFETY.

The sensor must not be located between defibrillator pads when a defibrillator is used on a patient connected to BIS devices.

WARNING

PATIENT SAFETY.

This monitor uses a component modular device in deriving the Bispectral index (BIS) purchased from Medtronic. It is important to recognize this index is derived using solely that company'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 Medtronic (www.medtronic.com) or contact that company itself if they have clinical-based BIS questions relating to this module portion of the GE monitor. Failure to do so could potentially result in incorrect administration of anesthetic agents and/or other potential complications of anesthesia or sedation. We recommend that clinicians also review the following practice advisory (that includes a section on BIS monitoring): The American Society of Anesthesiologists, Practice Advisory for Intraoperative Awareness and Brain Function Monitoring (Anesthesiology 2006; 104:847-64). Clinicians are also recommended to maintain current knowledge of government regulatory, practice or research information on BIS and related topics.

WARNING

PATIENT SAFETY.

Misinterpretation of BIS can result in incorrect administration of anesthetic agents and/or other potential complications of anesthesia or sedation.

WARNING

PATIENT SAFETY.

E-BIS module is defibrillation proof up to 250 V. Ensure that the sensor is placed on the patient's forehead according to the instructions. Placing the sensor in a way other than instructed might result in risks during patient defibrillation.

BIS cautions

CAUTION

PATIENT DISCOMFORT.

Due to elevated surface temperature, do not place the BIS device in prolonged direct contact with the patient's skin, as it may cause discomfort.

CAUTION

ERRONEOUS READINGS.

The BIS measurement based on measuring the EEG signal is inherently very sensitive. Radiated electromagnetic fields may cause erroneous measurements at various frequencies. Do not use electrical radiating equipment close to the BISx or DSC. Details regarding radiated field strengths are given in the technical specifications.

CAUTION

ERRONEOUS READINGS.

Automatic sensor check may need to be disabled if the 1 nA 128 Hz impedance check signal interferes with other equipment, such as EEG module with evoked potentials measurement.

CAUTION

PATIENT SAFETY.

The BIS module has been designed to operate with a disposable BIS sensor. Only use recommended sensors to ensure patient safety.

CAUTION

ERRONEOUS READINGS.

Do not use the BIS sensor if the sensor gel is dry. To avoid dryout, do not open the pack until you are ready to use the sensor. Dry sensors may lead to erroneous readings.

CAUTION

ERRONEOUS READINGS.

Check the sensor expiration date on the sensor package. Do not use expired sensors to avoid the risk of erroneous readings.

CAUTION

SKIN IRRITATION.

If skin rash or any unusual symptom develops, discontinue the BIS measurement and remove the sensor.

CAUTION

EQUIPMENT DAMAGE.

When connecting or disconnecting BIS, take care not to touch the exposed contacts of either connector. Damage due to electrostatic discharge may result to the equipment.

BIS measurement description

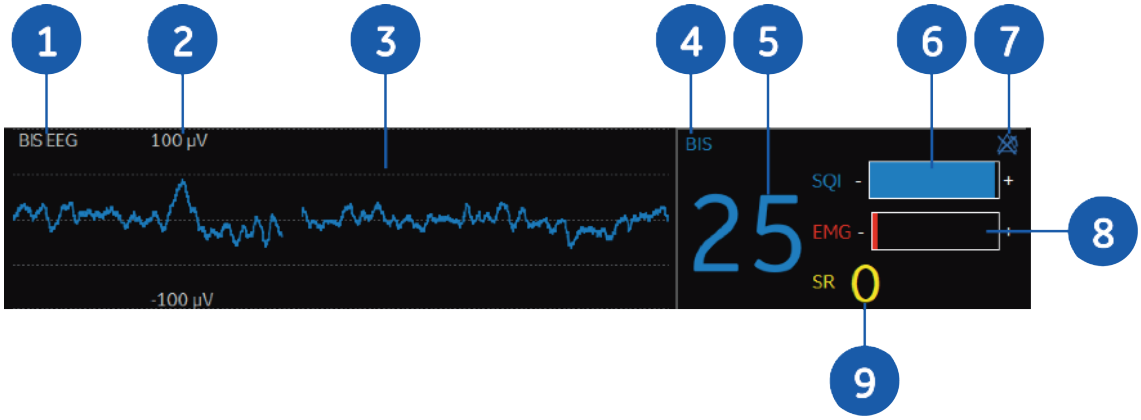
A sensor placed on the patient’s forehead transmits EEG signals to the BIS module. The BIS module filters the data, analyzes it for artifact and processes it using digital signal processing techniques, then

sends the data to the monitor for display. The purpose of processing the EEG waveform data is to extract characteristic features from the complex signal in order to provide easier pattern recognition of changes over time during the recording.

The BIS is computed in real-time using three steps:

1. The raw EEG signal is broken down second by second, and the segments that have artifact are identified and removed.
2. The BIS is calculated by combining EEG features associated with anesthetic effect.
3. The index is modified to reflect the amount of suppressed EEG signal in the raw waveform.

BIS measurement displayed on the monitor screen



1.	BIS EEG (**BIS EEG**): waveform label	6.	SQI (**SQI**): Signal Quality Index, the quality of the EEG signal. *1
2.	Waveform scale	7.	Alarm status, alarm limits, or other messages
3.	BIS EEG waveform	8.	EMG (**EMG**): Electromyograph, the absolute power in the 70 Hz to 110 Hz frequency band, the range from 30 to 55 dB.*2
4.	BIS (**BIS**): parameter label	9.	SR (**SR**): Suppression ratio, the percentage of suppressed (flatline) EEG detected over the last 63 seconds.
5.	Bispectral Index (BIS index) value		

*1 When the SQI is in the range 15% to 50%, the BIS index value is displayed in gray.

*2 When the EMG value less than 30 dB, not display this EMG bar.

BIS module keys

There are two keys on the module:

	Opens or closes the BIS menu on the screen.
	Starts the manual sensor check.

BIS measurement limitations

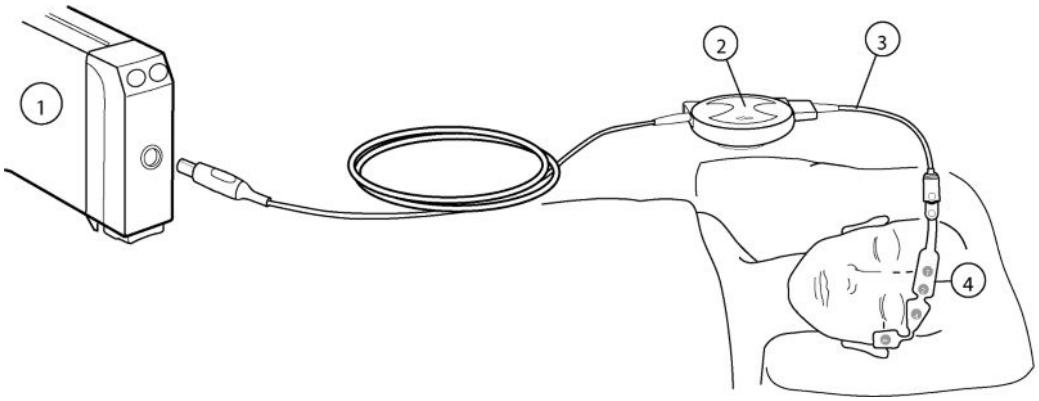
- This measurement is not available in neonatal mode.
- E-modules used for this measurement are not suitable for use with neonatal patients.
- BIS is a complex monitoring technology intended for use only as an adjunct to clinical judgment and training. Clinical judgment should always be used when interpreting BIS in conjunction with other available clinical signs. Reliance on BIS alone for intraoperative anesthetic management is not recommended.
- BIS values should be interpreted cautiously with certain anesthetic combinations, such as those relying primarily on either ketamine or nitrous oxide/narcotics to produce unconsciousness.
- External radiating devices may disturb the measurement.
- Poor signal quality may lead to inappropriate BIS values.
- Artifact may lead to inappropriate BIS values. Potential artifact may be caused by unusual or excessive electrical interference or high EMG activity like shivering, muscle activity or rigidity, sustained eye movements, head and body motion. Also, improper sensor placement and poor skin contact (high impedance) may cause artifact and interfere with the measurement.
- Due to limited clinical experience in the following applications, the BIS value should be interpreted cautiously in patients with known neurological disorders and those taking psychoactive medications.

BIS 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 BIS measurement. Defibrillation recovery time after discharge is ≤ 25 seconds.
- Make sure that the sensor connectors of the patient interface cable are not in contact with fluids.
- BIS sensors are disposable, for single patient use only, and not made with natural rubber latex.
- Check the sensor expiration date on the sensor package.
- Do not use a sensor for more than 24 hours.
- Use only Medtronic BIS sensors.

BIS measurement setup

BIS equipment to patient connection



1.	E-BIS module	3.	Patient Interface Cable, PIC Plus
2.	BISx	4.	BIS sensor

Preparing the patient for BIS measurement

1. Connect the digital signal processing unit (BISx) cable to the module.
2. Connect the patient interface cable to the BISx.
3. Secure the BISx to a convenient location, preferably close to the patient's head.
4. Clean the application site with alcohol and let dry.
5. Place the BIS sensor on the patient; see sensor package for instructions.
6. Connect the sensor to the patient interface cable.
7. Observe the results of the automatic sensor check in the digit field.
8. The measurement starts automatically after the sensor has passed the check.

Checking the BIS measurement

1. Check that the sensor/electrode passes the sensor/electrode check when you are starting to monitor a new patient.

Using the BIS measurement

Selecting the BIS waveform size

This setting determines the maximum drawing scale for BIS waveforms.

1. Press the module key or select the BIS digit field.

2. Select a value from the **BIS EEG Scale µV** list.

Selecting the EEG sweep speed

This setting determines the drawing speed for the EEG waveform.

1. Press the module key or select the Entropy/BIS digit field.
2. Select a value from the **EEG Sweep Speed** list.

The smaller the value, the slower the sweep speed.

NOTE
This setting can change the EEG sweep speed of BIS and Entropy parameters.

Selecting the BIS smoothing rate

Smoothing rate affects the appearance of the BIS trend and the BIS value. It determines the amount of artifact-free data that is required for calculating the BIS value.

1. Press the module key or select the BIS digit field.
2. Select a value from the **Smoothing Rate** list. The bigger the value, the “smoother” the trend.

Setting BIS filters

With BIS filters you can filter out disturbances from the EEG signal and improve the signal quality.

1. Press the module key or select the BIS digit field.
2. Select the check-box of **Filters** to open the filters.

Using the manual BIS sensor check

Whenever required, you can perform the sensor check manually.

1. Press the module key.

   Or,

2. Press the module key or select the BIS digit field.
3. Select **Check Sensor**.
4. Observe the results on the screen.

The measurement continues automatically after the sensor has passed the check.

Using the automatic BIS sensor check

1. Press the module key or select the BIS digit field.
2. Select the **Automatic** check-box for **Sensor Check**.

The sensor check will start every 10 minutes.

Testing the BISx

In case the measurement does not work and checking the cables and sensors does not help, make sure that the BISx functions properly.

1. Press the module key or select the BIS digit field.
2. Select **Test DSC**.
3. Observe the results on the screen.

After the test is completed, the result shown is **PASS** or **FAIL**.

Setting BIS alarm limits

You can set the alarm limits according to your needs.

1. Press the module key or select the BIS digit field.
2. Select the **Alarms** tab.
3. Check that the **Alarm** is turned on.
4. Set the related alarm limits with arrows.

Stopping the BIS measurement

1. Remove the BIS sensor from the patient.
2. Disconnect the sensor from the patient interface cable.
3. Discard the sensor.

How to interpret the BIS values

The Bispectral Index is an absolute value, so baseline information about the patient is not required for BIS monitoring. The following table lists the BIS values and their significance.

BIS value	Clinical endpoint	Comments
100	Awake	Patient responds to normal voice.
80	Light/moderate sedation	Patient responds to loud commands or mild prodding/shaking.
40 to 60	General anesthesia	Patient has low probability of explicit recall and is unresponsive to verbal stimulus.
20	Deep hypnotic state	EEG suppression, or burst suppression as it is sometimes referred to, is an easily recognizable EEG pattern characterized by bursts of activity of varying shape alternating with episodes of flat-line activity.
0	Isoelectric EEG	No brain activity detected

This chart reflects a general association between clinical state and BIS values. Ranges are based on results from a multi-center study of the BIS involving the administration of specific anesthetic agents. BIS values and ranges assume that the EEG is free of artifact that can affect its performance.

Titration of anesthetics to BIS ranges should be dependent upon the individual goals for hypnotic state that have been established for each patient. These goals and associated BIS ranges may vary over time and in the context of patient status and treatment plans.

Low BIS values (below 40) may indicate overdosing of hypnotic medication, and high BIS (over 60 to 65) may indicate too low concentrations of the drug.

Data review tools

Patient data safety precautions

Patient data cautions

CAUTION

MISINTERPRETATION.

Changing the system time will result in time differences between stored and realtime data. Always check the time carefully to avoid the risk of misinterpretation.

CAUTION

MISINTERPRETATION OF HISTORICAL DATA.

Changing the date and time on one network device on the CARESCAPE Network will also update the date and time for all other devices on the same network. To avoid possible misinterpretation of historical data when viewing it, special attention should always be paid to the time and date information.

Patient data views

The device provides different tools to review patient data:

- graphic trends
- numeric trends
- snapshot
- alarm history
- OxyCRG
- full disclosure

The snapshot can be configured through > **Service** > **Snapshot**. These selections are password protected.

For more information, see the supplemental information manual.

The graphic trends include a predefined set of parameters. The numeric trend selections include all parameters that can be used. If you are viewing trends for parameters for which you do not have a license, trend labels are shown, but no new data is collected. Therefore, no data is shown in the trend view or printouts.

Graphic trends

Viewing graphic trends

Graphic trends contain 168 hours (7 days) of trend data. They contain four trend pages, each having up to four fields with different parameters.

If IBP or TEMP changes label, a dot line will display, only after dot line's data is for the latest label.

1. Select the  .
2. Select  to shift to graphic trends view, if necessary.
   - To see more parameters, select vertical tabs **Page 1** to **Page 4**.
   - To see numeric values at a certain time, use **< >** at the bottom bar to that point of time. The numeric values are displayed next to the cursor.
   - To see more values for a previous time, use **<< >>** at the bottom bar.

Changing the graphic trend scales

1. Select the  .
2. Select  to shift to graphic trends view, if necessary.
3. Select the  on the right corner of the bottom.
4. Select the **Scales** tab.
5. Select the **Time Scale** and parameter scales for graphic trends.

Graphic trend resolution

The graphic trend resolution depends on the time scale of the trend.

Time scale	Resolution
20 min	10s
1 h and 2 h	1 min
4 h	2 min
6 h	3 min
8 h	4 min
10 h	5 min
12 h	6 min
24 h	12 min
36 h	18 min
48 h	24 min
72 h	36 min

Time scale	Resolution
96 h	48 min
120 h	60 min
144 h	72 min
168 h	84 min

Setting the graphic trend pages

1. Select the .
2. Select to shift to graphic trends view, if necessary.
3. Select the on the right corner of the bottom.
4. Select the **Pages** tab.
5. Select the **Page 1**, **Page 2**, **Page 3** and **Page 4** vertical tab for trend pages.
6. Setup the parameters for related field.

Printing currently viewed graphic trends

1. Select the > **Trends** tab.
2. Select the to shift to graphic trends, if necessary.
3. Select the , check the scales for graphic trends.
4. Back to the trends menu, select vertical tab for desired parameters.
5. Select (in the top right of trends menu) to start printing.
6. Select to stop printing, if necessary.

Numeric trends

Viewing numeric trends

Numeric trends contain up to 7 pages with 168 hours (7 days) of trend data.

You cannot configure the layout of the **Numeric Trends** view.

1. Select .
2. Select to shift to numeric trends view, if necessary.

- To see more parameters, select their vertical tabs in the trend view.

- To see more numeric trend data, use **<< >>** at the bottom bar.

Changing the time interval of numeric trends

Numeric trends display values according to the selected time interval. Numeric trends are updated with averaged measurement data once a minute independent of the selected time scale.

1. Select the .
2. Select to shift to numeric trends view, if necessary.
3. Select the on the bottom right corner.
4. Select a value from the **Trends Interval** list.

For example, a 5-minute interval will show data every 5 minutes, and a 30-minute interval will show data every 30 minutes. The data is displayed in columns on the screen. NIBP measurement will always add one column independent of the **Trends Interval** setting.

Printing numeric trends

Manual printing is possible only when the printing device is not processing another job at the same time.

1. Select the > **Trends** tab.
2. Select the to shift to numeric trends, if necessary.
3. Select the .
4. Check the value of **Trends Interval** for numeric trends.
5. Select a setting from the **Trends Printing** list. Choices are:
   - **Screen Data**: Print only current viewed data on screen for current tab's parameters.
   - **All Data**: Print all data for current tab's parameters.
6. Back to the trends menu, select vertical tab for desired parameters.
7. Select (in the top right of trends menu) to start printing.
8. Select to stop printing, if necessary.

Exporting numeric trends to USB disk

You can export the numeric trends to the USB storage device.

NOTE
Make sure the file system format for USB storage device should be FAT32.

1. Insert the USB storage device to the USB port of the monitor.
2. Select the > **Service** > enter **Username** and **Password**.

3. Select **USB Import/Export** > **Export trends to USB Disk**.
4. Enter an encryption **Key** for the trends' file, the length of key shall not be less than 6. (This key will be used when open the file in PC).
5. Select **Export trends to USB Disk**.

   When finish to export trends, the screen returns and a message "**Export trends data to USB Disk successfully.**" displays on the menu.

   The trends' file is named as "*_trends.7z", saved to the \B1x5\v2 folder of the USB disk.
6. To remove the USB disk, select **Safe to remove USB Disk**.

Snapshots

Description of snapshots

A snapshot is a set of measured data saved from a certain moment of time. Snapshots can contain waveform clips and trigger events. You can take up to 200 snapshots. The duration of the stored snapshot may not contain the entire duration of the physiological event that triggered it. The duration of each snapshot that gets displayed in the waveform box will be about 11.5 seconds for B105M-OR, 13.5 seconds for B125M-OR, and 18.5 seconds for B155M-OR.

Snapshot configuration

Snapshots can be configured for waveforms and whether create on alarms. Configure snapshot through > **Service** > **Snapshot** and these settings are password protected.

For more information, see the supplemental information manual.

Manually created snapshots

You can create a snapshot manually by selecting on the main menu. The monitor saves the image of waveforms at that moment in time.

When a snapshot is taken manually, it is automatically numbered. A **Mark X** message is shown in the message field (xxx = the sequence number of the snapshot).

Automatically created snapshots

- You can create snapshots automatically on alarms if automatic snapshot creation is enabled. The alarm conditions for creation are: **Brady**, **Tachy**, **Art Sys high**, **Art Sys low**, **Art Mean high** , **Art Mean low**, **Art Dia high** , **Art Dia low**.

  To enable this feature:

  > **Service** > **Snapshot** > **Create on Alarms**, this setting is password protected.

  For more information, see the supplemental information manual.
- You can define automatic snapshot creation for each arrhythmia alarm separately. To select arrhythmia alarms that will automatically create a snapshot:

ECG digit field > **Alarms** tab > related arrhythmia alarms vertical tab.

For more information, see “Setting arrhythmia alarms” in the ECG chapter.

Viewing snapshots

1. Select the  .
2. Select the **Snapshot** horizontal tab.

Three waveforms can be displayed on the snapshot page.

The lowest field in the **Snapshot** view shows the snapshot scale time, generate time, and alarm text.

You can see more snapshots by using **<< >>** at the bottom bar.

Printing snapshots

1. Select the  > **Snapshot** tab.
2. Select  (in the top right of this menu) to start printing.
3. Select  to stop printing, if necessary.

The printed waveform speed is 12.5 mm/s, and duration is 20 s.

Alarm history

Viewing alarm history

Alarm history is a list that stores high, medium, and low priority alarms.

1. Select the  .
2. Select the **Alarm History** horizontal tab.

- The alarm history list displays the latest 100 alarms.
- The color of each alarms indicate the alarm priority.
- The  symbol means there is a snapshot created by the alarm, you can click the symbol to view the related snapshot.
- The  symbol means there is a Full Disclosure data at the time of the alarm, you can click the symbol to view the related full disclosure.

Printing alarm history

Depends on the number of saved alarm history, one or more pages are printed.

1. Select the  > **Alarm History** tab.

2. Select  (in the top right of trends menu) to start printing.
3. Select  to stop printing, if necessary.

OxyCRG

OxyCRG description

The OxyCRG (oxycardiorespirogram) provides services to view and review specific high resolution trends, high resolution beat-to-beat HR trend, high resolution beat-to-beat SpO_2 trend and compressed respiration waveform - simultaneously in the same view.

The device displays 8-minute OxyCRG function in the NEONATAL mode. Two types of views are provided: OxyCRG Snapshot view and OxyCRG Realtime view.

Viewing the realtime OxyCRG

1. Select the information area.
2. Check **Patient Type** is **Neonatal**.
3. Select **OxyCRG**.

   Or:

4. In NEONATAL mode, select the  >  **OxyCRG**.

Viewing OxyCRG snapshot

The OxyCRG snapshot is created when an OxyCRG event is triggered. The device can store up to 70 OxyCRG snapshots. OxyCRG snapshot includes the trend data 6 minutes before and 2 minutes after the OxyCRG event. If multiple OxyCRG events are triggered within 2 minutes, they will be detected as one OxyCRG event. During this time, only the first OxyCRG event will trigger OxyCRG snapshot creation.

1. In the NEONATAL mode, select the  >  **OxyCRG**.
2. Select the **OxyCRG Snapshot** tab.

The lowest field shows the snapshot triggered time and condition.

You can see more OCRG snapshots by using **<< >>** at the bottom bar.

Setup OxyCRG snapshot

The OxyCRG snapshot will be triggered by any of HR, SpO2 value and Apnea time is out of OxyCRG limits range. You can setup these limits.

1. In the NEONATAL mode, select the  >  **OxyCRG**.
2. Select the **OxyCRG Setup** tab.
3. Adjust each parameter’s limits with the arrows.

Full Disclosure

Full Disclosure description

Full disclosure can display up to 72 hours ECG, SpO2, IBP and RESP waveform data.

Viewing Full Disclosure

1. Select the  .
2. Select the **Full Disclosure** horizontal tab.
3. Select the vertical tab for more parameters.

- To see the waveform data 1 second before current time, use < > at the bottom bar to that point of time.
- To see the waveform date 1 page before/after current page, use << >> at the bottom bar.

Go to Full Disclosure view for specific time

1. Select the  .
2. Select the **Full Disclosure** horizontal tab.
3. Select the  on the bottom right corner.
4. Select the values from **Date**, **Hour**, and **Minute** list.
5. Select **Go**.

Setting the sweep speed of Full Disclosure

1. Select the  .
2. Select the **Full Disclosure** horizontal tab.
3. Select the  on the bottom right corner.
4. Select an option from the **Hemodynamics Sweep Speed** list.

Time change during a patient admit

Time adjustment is allowed during a patient admit if the monitor is configured to the CARESCAPE Network, independent on its connection status to the network. When the time is adjusted, the monitor shifts the timestamps of continuous data, but not discrete data (e.g. NIBP measurement).

After time adjustment, continuous and discrete data cannot be compared to each other, because their timestamps no longer match.

2 minutes before device is disconnected from network, the monitor may not be able to transmit the NIBP trends data to the CARESCAPE Gateway Server.

Erasing patient data

The patient’s data is erased when:

- discharge a patient
- the monitor has been abrupt crash
- the data out of time or quantity

Erased snapshots cannot be recovered.

To erase patient data, you must discharge the patient.

NOTE
This will also return monitor settings to their defaults.

1. Select the information area.
2. Select **Discharge Patient**.

Clinical applications

Clinical applications safety precautions

Early Warning Score warning

WARNING

PATIENT SAFETY.

Consider EWS as a secondary source for deterioration of vitals. Early Warning Score and Clinical Response Message serve as guide to protocols at your facility. Do not replace patient physiological alarms with EWS. Appropriate alarm settings must be set and maintained to ensure patient safety.

Clinical applications description

The monitor provides some useful clinical guidelines and tools, which gathering parameter measurements together and provides comprehensive analysis results.

Clinical applications is not intended to replace the competent judgment of a clinician. It must be used in conjunction with observation of clinical signs and symptoms.

The monitor provides following clinical applications:

- Early Warning Score
- Customized Notification

Early Warning Score

Early Warning score (EWS) is an optional, license-based feature that helps to recognize the early signs of deterioration in medical patients.

EWS is a simple scoring system in which a score is allocated to physiological parameters measured in clinical practice. Some parameters for EWS may be entered manually.

EWS feature can help clinician to recognize the early signs of deterioration in medical patients, follow prompt and effective action, and minimize the occurrence of adverse events.

The device supports the following scores' protocol type:

- NEWS2 (National Early Warning Score 2)

  GE provides the National Early Warning Score reference from the Royal College of Physicians to enable caregivers to track patient conditions. National Early Warning Score (NEWS)2: Standardizing the assessment of acute-illness severity in the NHS. Updated report of a working party. London: RCP, 2017.

- MEWS (Modified Early Warning Score)

Selecting the EWS type

The device is configured with a default EWS protocol. To change the EWS protocol type, through > **Service** (password protected) > **EWS** > **Protocol Type**.

Viewing EWS

The EWS can be set to digit field to display last score.

1. Select > **Screen Setup**.
2. Setup EWS to digit field.
   - For waveform layout: Select **Layout 1** or **Layout 2** horizontal tab > **Lower Area** vertical tab.
   - For large number layout: Select **Layout 3** or **Layout 4** horizontal tab.

Calculating EWS

1. Select > **EWS**.
2. Confirm if the patient meets the intended use.
3. Select the following items.
   - For NEWS2: **Hypercapnic Respiratory Failure** (check box), **Air or oxygen?**, **Consciousness**
   - For MEWS: **Consciousness**, **Hourly Urine for 2 hours**
4. Check other parameter values, if the parameter is not available on monitor; adjust values if necessary.
5. Select **Score** to do a single calculation.

If need to refresh parameter values entering and calculation, please select .

The EWS will display in menu and digit field.

Viewing EWS history

The EWS can be set to digit field to display last score.

1. Select > **EWS**.
2. Select **History** tab.
3. Select one historical score, you can review the detail parameters value for this EWS.

Viewing EWS clinical risk/patient risk

NOTE
Different EWS protocol type has different risk rating system. Please review the clinical risk/patient risk lists to make sure fully understand the score's meaning.

1. Select > **EWS**.
2. Confirm if the patient meets the intended use.
3. Select the **Clinical Risk** or **Patient risk** tab.
4. Select **Page 1** vertical tab to review thresholds and triggers.
5. Select **Page 2** vertical tab to review scoring system.

Viewing EWS guidance

NOTE
NEWS2 type only.

1. Select > **EWS**.
2. Select the **Guidance** tab to review EWS guidance.

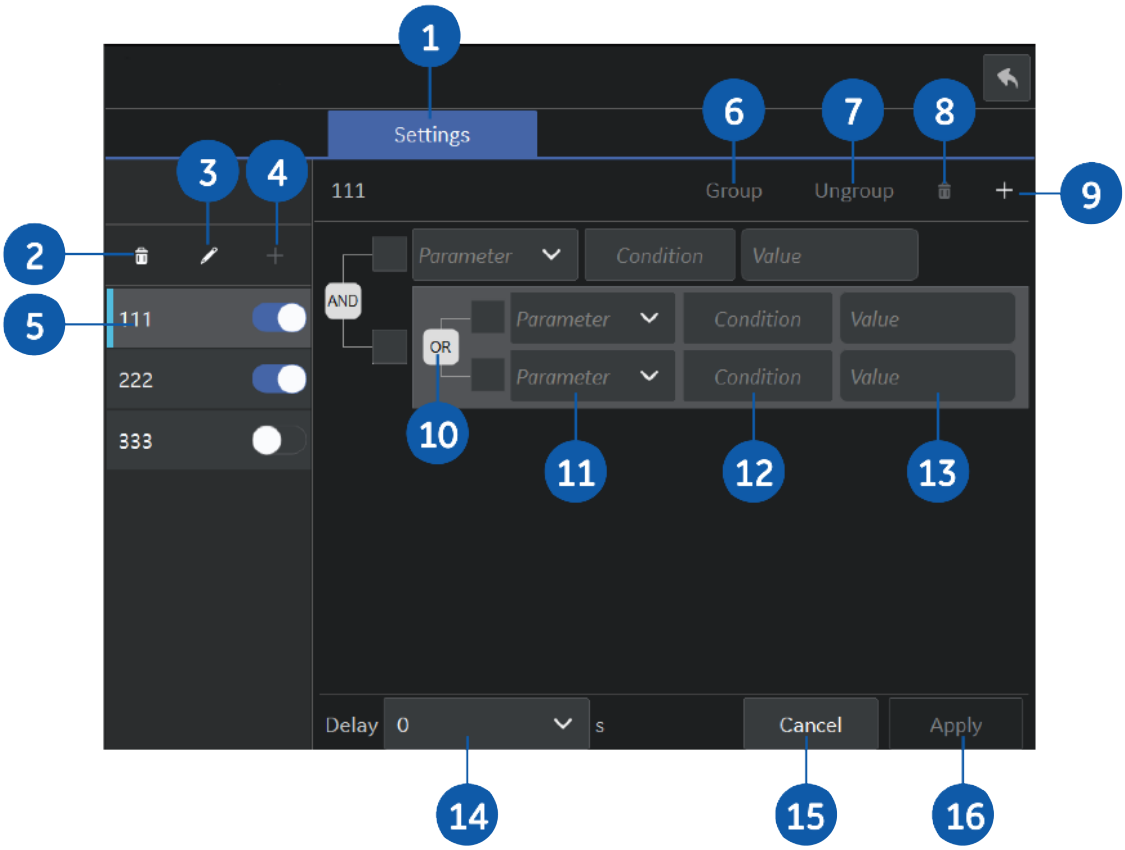
Customized Notification

The device can provide visual notification when multiple parameters meet the customized conditions simultaneously.

The function is effective to detect advese events which helps clinicians to make treatment decisions with multiple paramerers.

Setting customized notifications

To use customized notifications, you should setup the notification group to customize conditions first. The following is the **Settings** menu.



No.	Items	Description
1.	Settings (**Settings**)	Menu tab.
2.		Delete the selected notification group.
3.		Edit the selected notification group's name.
4.		Create a new notification group.
5.	Notification group	Select a notification group. Swipe  or  to enable or disable this notification group.
6.	Group (**Group**)	Create a subgroup for multiple selected conditions.
7.	Ungroup (**Ungroup**)	Cancel the selected subgroup.
8.		Delete the selected group condition.
9.		Add a new condition for the notification group.
10.	**AND** (**AND**) and **OR** (**OR**)	Criteria softkey, select to switch AND and OR.
11.	Parameter (**Parameter**)	Select the specific parameter
12.	Condition (**Condition**)	Condition softkey, select to switch "<" and ">".
13.	Value (**Value**)	Set parameter's value with arrows.
14.	Delay (**Delay**)	Set delay time for notifications
15.	Cancel (**Cancel**)	Cancel the settings setup.

No.	Items	Description
16.	Apply (**Apply**)	Apply the settings and active current notification group.

1. Select > **Customized Notifications** > **Create Notification Group**.
   - First time to use: select **Create Notification Group**, The **Settings** menu appears.
   - Update settings or create new groups: select **Settings** tab.
2. Select , , or , to delete, edit, or create a notification group.
3. Setup conditions for the notification group:
   3.1. Select to add a new parameter condition (item).
   3.2. Select to delete the selected items, if needed.
   3.3. Setup the **Parameter**, **Condition**, and **Value**.
   3.4. Select the check box of items, then select **Group**.
   A subgroup are generated for the selected items
   3.5. Select AND or OR to setup criteria of the subgroups.
   The notification group conditions will be textual displayed on screen.
   3.6. Select the check box of items, then select **Ungroup** to release the subgroup.
   3.7. Enter the time of **Delay** for this notification group that all the conditions have been met.
   3.8. Select **Apply** to save changes.
   The current notification group will be active.
   You can also select **Cancel** to cancel the settings setup.
4. Swipe the or to enable or disable the selected notification group.

NOTE

If you want to update one group settings, should select for this group first, then to do setup.

Customized notification displays on monitor's screen

The customized notification is displayed in the notification menu, or in the notification bar, which locate on the left side of the main screen. The notification bar also can be hidden or shown by left or right swiping the bar on screen.

There is a number represents how many instances have not been read. And the background color becomes pink indicating that there are instances happening.

You can select the group to review history instances, with their related parameter's graphic trends.

Viewing customized notification from menu

1. Select > **Customized Notifications**.

The all notification groups appears. The group name, unread instances count, last instance duration, and start and end time display for each group.

2. Select one of the notification groups, you can open the corresponding instance menu and find the list of all related instances on left side.

   Start and end time, and duration display for each instance to help you to check.

   A blue circle will appear on the upper left corner to indicate unread instances.

Viewing history instances

You can review history instances, with each related parameters' graphic trends.

1. Select a instance on the left side to open the related graphic trends.
2. Select or on the top left of the trends screen, to adjust the trends scale.

   The trends scale is 1, 2, 4, 6, 8, 10, 12, and 24 h.
3. Select < or > at the bottom bar to move cursor to a specific time, the numeric values are displayed next to the cursor.
4. Select << or >> at the bottom bar to view more trends.

Viewing customized notification from notification bar

Setup the notification bar to the normal screen first:

1. Select > **Customized Notifications** > Swipe **Show Notification Bar** to turn on.

   NOTE
   The split screen will be turned off with showing the notification bar instead.
2. Go to the normal screen.

   On notification bar, display the group name and unread instances count.

   A a blue circle will appear on the upper left corner to indicate unread instance.
3. Select one of the notification groups, you can open the corresponding instance menu and find the list of all related instances on left side.

   Start and end time, and duration display for each instance to help you to check.

   A a blue circle will appear on the upper left corner to indicate unread instance.

You can review history instances, with each related parameters' graphic trends.

Refer to Viewing history instances on page 292.

Printing

Printing description

Depending on the system configuration, the following printing capabilities are available:

- Printing to a recorder connected directly to the monitor.
- Printing to a network laser printer.
- Printing to a remote recorder connected to a central station in the CARESCAPE Network.
- Printing to a remote laser printer connected to a central station in the CARESCAPE Network
- Printing to PDF and export to USB.

NOTE
Before you start printing, check that the printer is operational, make sure the recorder door is closed.

NOTE
Recordings on thermal paper may be destroyed when exposed to light, heat, alcohol, etc. Take a photocopy for your archives.

Printing device selections

Selecting printer

1. Select the > **Printing Setup**.
2. Select the **Devices** tab.
3. Select the printout type from the **Printout** list.

   You may assign only one print location for each printout type.

   - **Waveforms**: current waveforms
   - **Alarm Waveforms**: waveforms triggered by alarms
   - **All ECG Waveforms**: all ECG waveforms
   - **Numeric Trends**: numeric trends according to **Trends Printing** settings in Trends menu
   - **Graphic Trends**: graphic trends, the same as on screen
   - **Snapshot**: Snapshot
   - **Alarm History**: Alarm history

4. Select the location for the printout:

Devices	Option	Printout types for this location
Local recorder	**Local**	• **Waveforms** • **Alarm Waveforms** • **All ECG Waveforms** • **Numeric Trends**
Remote recorder or printer which connected to a central station in the network.	**Remote**	• **Waveforms** • **Alarm Waveforms** • **All ECG Waveforms** • **Numeric Trends**
Network printer	**Network**	• **All ECG Waveforms** • **Numeric Trends** • **Graphic Trends** • **Snapshot** • **Alarm History**

   Changing the print location does not affect printing currently in progress.

5. According to your location selection above:
   - If you selected **Remote**: Choose the central station from the **Care Unit** list, then select the print device from the **Remote Device** list.
   - If you selected **Network**: Select the print device from the **Network Device** list.

Checking the print status

You can view the assigned print locations for each type of printout and check the printer status for each print device.

1. Select the > **Printing Setup**.
2. Select the **Status** tab.

The location for each assigned printout and printer status are listed in the table.

Setting the printer

1. Select the > **Service** > enter **Username** and **Password**.
2. Select **Page 2** vertical tab.
3. Select **Printer**
4. Setup following settings if needed:
   - **Paper Size**: Network printer paper size
   - **ECG Printout Format**: all ECG waveform format
   - **Print Patient Name**: whether display patient name in printout

For more information, see the supplemental information manual.

Printing waveforms

Printing waveforms on alarms

The following are the default settings for alarm waveform printouts:

- The print delay is 10 seconds.
- The print duration is 30 seconds.
- The waveform speed is 25 mm/s.

An automatic printing of waveforms will be triggered by following alarms:

Asystole, **Tachy**, **Brady**, **V Fib / V Tach**, **V Tach**, **Art Sys high**, **Art Sys low**, **Art Mean high**, **Art Mean low**, **Art Dia high**, **Art Dia low**, **ABP Sys high**, **ABP Sys low**, **ABP Mean high**, **ABP Mean low**, **ABP Dia high**, **ABP Dia low**, **UAC Sys high**, **UAC Sys low**, **UAC Mean high**, **UAC Mean low**, **UAC Dia high**, **UAC Dia low**.

1. Select the > **Printing Setup** > **Waveforms** tab.
2. Choose a value from the **Start On Alarms** list:
   - **No**: Not waveform print during an alarm condition.
   - **High**: Waveforms print during high priority alarm conditions only.
   - **All**: Waveforms print during any alarm condition.

Starting a waveform printout

1. Select one of the following options to start a waveform printout:
   - Select the . Or,
   - Select the > **Printing Setup** > **Waveforms** tab > **Print Waveforms**.

If print length has been configured for **Continuous**, you will be required to stop the print request.

Stopping a waveform printout

1. Select one of the following options to stop printing a waveform:
   - Select the . Or,
   - Select the > **Printing Setup** > **Waveforms** tab > **Stop Printing**.

Setting the print delay

1. Select the > **Printing Setup** > **Waveforms** tab.

2. Select a value from the **Delay** list:
   - **10 s**: Manual waveform printing starts with 10 seconds of the most recently saved data first. After that, the real time data begins to print.
   - **0 s**: Manual waveform printing starts with real time data.

Setting the print speed

To select the sweep speed for the actual paper speed of a recorder:

1. Select the > **Printing Setup** > **Waveforms** tab.
2. Select a value from the **Paper Speed** list.

Setting the print duration

The length of the event shall determine the length of the printout.

1. Select the > **Printing Setup** > **Waveforms** tab.
2. Choose a time value from the **Length** list: **10 s**, **30 s** or **Continuous**.

   If you select **Continuous**, waveforms continue to print until you stop the printing.

Selecting waveforms to print

1. Select the > **Printing Setup** > **Waveforms** tab.
2. Choose the desired ECG lead/parameter for waveforms 1-3.

NOTE
If choose 3 waveforms to print, the waveforms may not display entirely.

You can also print all ECG waveforms from ECG menu. See Viewing and printing all ECG waveforms on page 127.

Printing trends, snapshots, and alarm history

For how to print trends, snapshots and alarm history, please refer to follow sections in "Data review tools" chapter for more details:

- Printing currently viewed graphic trends on page 280
- Printing numeric trends on page 281
- Printing snapshots on page 283
- Printing alarm history on page 283

Exporting patient data to USB disk in PDF format

The device can generate the network printer's printout as PDF report, and export to the USB storage device.

NOTE
Make sure the file system format for USB storage device should be FAT32.

1. Insert the USB storage device to the USB port of the monitor.
2. Select the > **Export Patient Data**.
3. Select the multiple options for which patient data to export.
4. Select the **Export Latest Data** for trend and snapshot.
5. Select **Export**.

   When finish to export, a message "**Export success.**" displays on the menu.

   The report files are saved to the `\B1x5\v2\[Day]\` folder of the USB disk.
6. To remove the USB disk, select **Safe to remove USB Disk**.

If the file's encryption key (This key will be used when open the file in PC) haven't setup. There will be a **Set Key for Patient Data Export** menu. To enter this menu, need to enter password to **Login** first. Enter an encryption **Key** for the file, the length of key shall not be less than 6.

This menu also can reach from > **Service** (password needed) > **USB Import/Export**. You can modify key if necessary.

Printing format

Network laser printer print header

Laser printer print header can include:

- Patient name (displayed if configured through > **Service** > **Page 2** tab > **Printer**)
- Medical record number
- Second ID
- Unit and Bed number
- Date and time of the printout
- Title (e.g., Alarm History)
- Current page/total number of pages (e.g., 1/12)
- Identification field for a patient identification sticker
- Notes field for manually written notes

Recorder print header

Recorder print header for waveforms, alarm waveforms, and all ECG waveforms can include:

- Title
- Unit and Bed number
- Date and time of the printout

- Speed
- Parameter's value
- Alarm audio
- Alarm volume
- Alarm audio pause
- Patient name (displayed if configured through > **Service** > **Page 2** tab > **Printer**)
- Medical record number
- Second ID
- Alarm message

Recorder print header for numeric trends can include:

- Title
- Unit and Bed number
- Patient name (displayed if configured through > **Service** > **Page 2** tab > **Printer**)
- Date and time of the printout

Inserting recorder paper

1. Press the door latch to open the recorder door.
2. Remove the paper core.
3. Place a new paper roll between the tabs of the paper holder. Make sure the paper unrolls from underneath the paper roll.

4. Pull out 3 to 4 cm of paper, then close the door.
5. Select the to print out a strip.

Viewing other monitored patients

About viewing other monitored patients

When the monitor is on the network, you can open a bed-to-bed view of other remote patient beds that are on the same network. You can choose to view a remote patient bed under an alarm condition, or simply view any available bed on your network.

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.

Up to six remote parameters' waveforms and numeric values, one remote alarm, and location information are displayed inside a separate bed-to-bed window. The bed-to-bed window is located on the left side of the display screen.

Function	Network features
View on alarm notification	Monitor alarms for up to 40 beds.
View remote beds	View one bed from up to 1023 beds.

Some settings related to remote alarm configuration are given through > **Service** > **Alarm Options** > **Remote Alarms** tab, and they are password protected:

- **From Remote Location**: Selecting which remote locations are allowed to pause audio alarms on this monitor
- **For Remote Bed**: Enabling or disabling audio pausing remotely for another monitor.
- **Allow Remote Pausing of**: Selecting alarm priorities that can be paused remotely.
- **Remote Alarm Light**: Use of the alarm light also for a remote alarm.
- **Show Remote Patient Name** (check box): Enabling or disabling the display of the remote patient name.
- **Remote Alarm Tone**: Selecting the remote alarm tone.
- **Remote Bed Selections** (check box) : Enabling or disabling the restoring of the remote bed selections after discharge.

For more information, see the supplemental information manual.

Automatic view of remote beds in alarm

You can set the monitor to automatically notify you with an alarm message or with a bed-to-bed window when selected remote patient beds go into an alarm condition. All automatically viewable

alarming beds are displayed or placed in a display queue in order from the highest to lowest alarm priority and from the newest to oldest alarms.

You can configure how the monitor notifies you of a remote patient bed alarm condition, and which remote patient alarm priority levels you want notification of. You can do this for individual beds, or for all remote beds of a selected care unit at once.

The remote alarm message field contains unit and bed name, alarm message, and  if more than one remote bed are alarming.

Selecting the alarm notification type

1. Select > **Other Patients**.
2. Select the **Receive Alarms** tab.
3. Select a care unit from the **Unit** list.
4. Select a patient bed from the display list.
5. Select the type of alarm notification desired from the **Alarm Notification** list:
   - **Off**: Remote alarm notification is turned off.

     NOTE
     All new monitors appear on the list automatically with the notification setting **Off** (default).
   - **Message**: Remote alarm messages display in the alarm area. At any time, you can select a remote alarm message to open a bed-to-bed window and view the remote patient's data.
   - **Auto View**: Bed-to-bed window opens immediately if no other procedure or setup window is currently open. Otherwise, a remote alarm message displays in the alarm message area. To open the bed-to-bed window and view the remote patient's data, close the currently open menu, or select the remote alarm message.
   - **Auto View Always**: Immediately closes any open procedure or setup windows and opens a bed-to-bed window with the remote patient's data.

Selecting the notifying alarm priority level

1. Select > **Other Patients**.
2. Select the **Receive Alarms** tab.
3. Select a care unit from the **Unit** list.
4. Select a patient bed from the display list.
5. Select the type of alarm priority desired from the **Alarm Priorities** list:
   - **High**: Opens a bed-to-bed window or displays the alarm messages for remote patients in a high alarm priority condition.
   - **High, Medium**: Opens a bed-to-bed window or displays the alarm messages for remote patients in a high or medium alarm priority condition.
   - **High, Medium, Low**: Opens a bed-to-bed window or displays the alarm messages for remote patients in a high, medium, or low alarm priority condition.

Changing the settings for multiple beds

You can select a care unit and change all of the listed remote patient beds to a single notification setting and/or a single alarm priority setting. If there are more than 40 beds in the unit, the settings will be changed for the first 40 beds only.

1. Select > **Other Patients**.
2. Select the **Receive Alarms** tab.
3. Select a care unit from the **Unit** list.
4. Select a setting from the **Change All Notifications** list:
   - **Off**: Remote alarm notification is turned off.
   - **Message**: Remote alarm messages display in the alarm area.
   - **Auto View**: Bed-to-bed window opens immediately if no other procedure or setup window is currently open. Otherwise, a remote alarm message displays in the alarm message area.
   - **Auto View Always**: Immediately closes any open procedure or setup windows and opens a bed-to-bed window.
5. Select a setting from the **Change All Priorities** list: **High**; **High, Medium**; **High, Medium, Low**.

Next alarming remote bed to screen

If you have a bed-to-bed window open and another **Auto View** or **Auto View Always** bed goes into alarm, the softkey in bed to bed window becomes selectable. It allows you to view the next highest and newest alarming patient bed.

Viewing remote patient beds

You can select and view a networked alarming or non-alarming remote patient bed.

1. Select > **Other Patients**.
2. Select a care unit from the **Unit** list.
3. You can select to see a list of all patient beds in the care unit or a list of remote patient beds configured for alarm notification. Select an option from the **Show** list:
   - To show a list of all the remote beds in the care unit, select **All Patients**.
   - To show the list of remote patients configured for alarm notification, select **Notification Patients Only**.
4. Select a patient bed from the display list.
5. Select **View**.

   The text **Manual View** is displayed when the remote patient bed viewing has been selected manually. If the automatic viewing is in use, the text is **Automatic View**.

6. You can stop viewing the selected patient bed and close the bed-to-bed window by selecting Exit key.

NOTE
Selecting the home key will not close any opened bed-to-bed view of an alarming or non-alarming patient bed.

Audio pause for a remote patient bed alarms

When remote alarms are received, you can pause active alarms remotely by selecting from the bed-to-bed window. If the softkey is not displayed, this option has not been enabled during configuration. It is enabled through > **Service** > **Alarm Options** > **Remote Alarms** tab > **From Remote Location**, and they are password protected.

Manual printing of remote bed waveforms

Waveform data of a remote monitor can be manually printed by selecting from the bed-to-bed window. The waveforms that appear on the printout are determined by the remote monitor's print configuration.

Periodic Maintenance

Maintenance safety precautions

Care warnings

WARNING

EQUIPMENT FAILURE.

Regular preventive maintenance should be carried out every 24 months. Failure to implement the recommended maintenance schedule may cause equipment failure and possible health hazards.

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.

WARNING

ENVIRONMENTAL HAZARD.

Cleanup and disposal of broken displays must be in compliance with the safety and waste control guidelines regulating this product.

WARNING

ELECTRIC SHOCK.

Non-medical equipment does not provide the same level of protection against electrical shock. Do not touch the patient and any part of non-medical equipment at the same time. An example of non-medical equipment is external display.

Before any planned maintenance or regular checks

Make sure that the patient is not being monitored during maintenance or regular check procedures.

Planned maintenance for the monitor

Service personnel should perform the following checkout procedures every 24 months after installation. Refer to the technical manuals for planned maintenance procedures.

- Visual inspection

- Electrical safety tests
- Functional check

Planned maintenance for the module

For E-sCAiO, E-sCO, N-CAiO, and E-miniC module, service personnel shall perform the checkout procedures every 12 months after installation, unless otherwise indicated in the device service manual.

For E-COP, E-Entropy, E-BIS, and E-NMT module, service personnel shall perform the checkout procedures every 24 months after installation, unless otherwise indicated in the device service manual.

Refer to the service manuals for planned maintenance procedures.

- Replacement of planned maintenance parts, if needed
- Visual inspection
- Electrical safety tests, if needed
- Functional check

Recommended check schedules

Daily checks

- Check that the accessories, cables, cable connectors, monitor, module and display parts are clean and intact.
- Check the charge of the monitor battery.

Check every two months

- Change the water trap.
- Check the airway gases calibration if the measurement is in continuous use.

Check every six months

- Check the airway gases calibration if the measurement is in normal (not continuous) use.

Check every 24 months

- Check the calibration of temperature, NIBP and invasive blood pressure.
- Planned maintenance check

NOTE
The invasive blood pressure transducers should be calibrated whenever a transducer error occurs.

NOTE
Discharge patient before doing calibration and maintenance.

Regular calibration checks

Calibrating airway gases

To ensure that the measurement accuracy remains within specifications, follow the recommended calibration check intervals: every six months when used several hours a day on most days each week, and every two months in more continuous use, and whenever there are indications of errors in the gas readings.

NOTE
Ensure that the calibration gas and regulator are functioning properly before calibration. Perform annual maintenance of the regulator as required.

NOTE
Make sure that you are using a correct GE calibration gas, see the supplies and accessories provided. Do not use any other calibration gases.

NOTE
Calibration gas bottles with anesthetic agents must be disposed in compliance with the guidelines regulating the disposal of products containing anesthetic agents.

1. Turn on the patient monitor. For maximum accuracy, let the monitor warm up for 30 minutes.
2. Attach a regulator to the calibration gas cylinder.
3. Attach a new sampling line to the water trap. Connect the other end of the sampling line to the regulator on the gas container.
4. Select the > **Parameter Setup** > **Others** tab > **Gases** > **Gas Calibration**.
5. Wait until the messages **Zero OK** and **Feed gas** appear on the screen.
6. Open the regulator and feed gas until the adjust menu appears, then close the valve.
7. Check that the displayed values match the values on the calibration gas container. Adjust if necessary:
   7.1. Adjust the value with arrows until all gas values match with the desired values on the gas container.
8. Confirm by selecting **Accept**.
9. If the calibration is successful, the message **OK** is displayed and the last calibration time and date is updated for a few seconds. If the calibration fails, the message **Calibr. Error** appears instead. In this case, start a new calibration by selecting **Recalibrate**.

If the message **Zero error** appears, repeat the calibration procedure. If the problem persists, contact authorized service personnel.

NIBP, IBP, and Temperature calibration checks

The calibration check interval for NIBP, IBP, and Temperature is at least once every two years.

For calibration instructions, please see the Technical manual of the monitor.

Water trap care instructions

- Empty the water trap container when it is more than half full. 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 150 ± 25 ml/min for E-miniC).
- In anesthesia: Replace the D-fend or Mini D-fend water trap when the message **Replace water trap** appears. The maximum lifetime of the water trap is two months.
- E-sCAiO, E-sCO and N-CAiO module: If the sampled gas is returned to the patient circuit, ensure the protective function of the D-Fend Pro water trap by replacing it at least once a week, or immediately in case of a defective or missing HMEF bacterial breathing system filter.
- In critical care: Replace the D-fend Pro+ or Mini D-fend water trap for each new patient, when the message **Replace water trap** appears, or every 24 hours.
- Attach the water trap by pushing it firmly to its place, so that the locking latch makes a clicking sound.
- Remove the water trap by pressing the release latch and pulling the water trap out.
- Empty the container whenever it is more than half full by disconnecting it from the water trap cartridge. Do not use a syringe.
- The water trap cartridge is disposable. Do not dry, wash, or reuse an exhausted or occluded water trap.
- When taking a new water trap into use, mark the date on the appropriate label on the water trap cartridge: 
- Read the water trap instructions for use in the accessory package.

About battery care

Monitor battery

The monitor has one rechargeable lithium-ion battery to supply device operation without AC power.

- Condition battery: Connect device to the AC mains to charge battery. If the message **Condition battery** still persists, contact authorized service personnel to replace battery.
- Check battery status and performance: see Checking the battery charge with monitor software on page 62.
- Recycle battery: When the battery fails, or its runtime is significantly less than the specification, it should be replaced. A **Replace battery** message may appear. Please contact authorized service personnel to replace the old battery, and properly dispose of the battery according to your local recycling guidelines.

Internal RTC battery

The monitor has one button cell to retain the correct time and date for the device.

If the message **Check RTC** appears, please contact qualified service personnel to replace this battery.

How to store devices

- Store the device in a clean and dry, well-ventilated area.
- Hang the device using a holder, if available.
- If cables are attached, they should hang straight. Do not coil cables tightly around the device.

NOTE
If the device will enter long-term storage after usage, fully charge the monitor battery beforehand.

Disposal instructions

The product described in this manual, as well as its accessories and packaging, must be disposed of according to local environmental and waste disposal regulations. Always consider your hospital guidelines as well.

For detailed information regarding the substances contained in the product and their treatment, please request WEEE Selective Treatment Passports from GE or its representatives.

This product contains lithium-ion batteries. At the end of their service life, batteries in this product must be recycled or disposed of in accordance with local or national regulations. Do not dispose of batteries as trash or unsorted municipal waste. Requirements and services for recycling of batteries vary between countries.

Cleaning and disinfection

About these instructions

The following cleaning and disinfection information applies to the devices and device components listed in this instruction and manufactured by GE. Follow these instructions to clean and disinfect the devices and parts that are not in direct contact with the patient, referred to as non-applied parts, unless there are separate part-specific instructions.

For details about cleaning, disinfecting and sterilizing accessories, see the instructions for use in the accessory package.

Always consider your professional healthcare facility guidelines as well.

For cleaning, disinfection, and care information for devices, device components, supplies, and accessories made by manufacturers other than GE, see the applicable instructions for use provided by the manufacturer. The information provided in this supplement does not supersede any instructions for use provided by the manufacturer or provided with a device, device component, supply, or accessory.

- Cleaning is physical removal of soil and contaminants.
- Disinfection reduces the number of viable microorganisms on a product to a level previously specified as appropriate for its use.

About cleaning and disinfection

Cleaning warnings

WARNING

EQUIPMENT DAMAGE.

Avoid using other chemicals than the ones described in this manual as they may damage device surfaces, labels, or cause equipment failures.

WARNING

EQUIPMENT DAMAGE.

To prevent liquids from entering the monitor, do not tilt the monitor. Any liquids entering the device may damage it.

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.

WARNING

EQUIPMENT DAMAGE.

Never immerse any part of the device, cables, or leadwires in liquids or allow liquid to enter the interior of the device.

WARNING

EQUIPMENT DAMAGE.

Do not autoclave any part of the system with steam (including cables or leadwires) or sterilize with ethylene oxide.

WARNING

EQUIPMENT DAMAGE.

To avoid the risk of damaging the devices, do not use any automated cleaning procedures. Always clean manually according to the instructions provided.

WARNING

EQUIPMENT DAMAGE.

Do not pour or spray any liquid directly on the device, cables, or leadwires or permit fluid to seep into connections or openings.

WARNING

EQUIPMENT DAMAGE.

Never use conductive solutions, oxidizing compounds, wax, or wax compounds to clean the device.

Cleaning cautions

CAUTION

EQUIPMENT DAMAGE.

Do not apply pressurized air or gas to any outlet or tubing connected to the monitor. Pressure may destroy sensitive elements.

Cleaning points to note

Observe these guidelines while cleaning the device.

- Your professional healthcare facility guidelines permitting, all cleaning activities can be carried out at the bedside.
- Be especially careful when cleaning the displays. They are more sensitive to rough cleaning methods than for example the monitor housing.
- Avoid contact with open vents, plugs, or connectors during the cleaning procedures.
- Always dilute cleaning agents according to their manufacturer’s instructions. Always consider your professional healthcare facility guidelines as well.

- Prolonged contact of cleaning solutions with metal parts may cause corrosion.
- Do not clean any part of the system in automated cleaning.
- Do not use excessive drying techniques, such as oven, forced heat, or sun drying.
- Soiled devices must be separated from non-contaminated devices to avoid contamination of personnel or surroundings.
- Warranty does not cover any damages caused by using other than GE approved substances and methods.

Disinfection points to note

- Your professional healthcare facility guidelines permitting, all disinfection activities can be carried out at the bedside.
- Always clean before disinfecting.
- Always dilute disinfectant agents according to their manufacturer's instructions. Always consider your professional healthcare facility guidelines as well.
- Use only the permitted substances.
- Prolonged contact of disinfecting solutions with metal parts may cause corrosion.

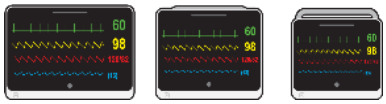
Visual inspection before cleaning and disinfection

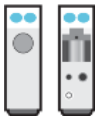
Carefully inspect devices visually to verify proper function. Do not use improperly functioning, damaged, or excessively worn devices, or devices with unrecognizable markings or missing or worn device labeling or marking. Evidence of damage and wear on a device may include but is not limited to discoloration, excessive scratches, melting, dulling, distortion, wear, and cracks. If a device is extremely soiled and cannot be cleaned using the normal procedure, replace it. Contact qualified service personnel and follow your professional healthcare facility procedures.

If you discover any signs of deterioration or damage in the device, discontinue its use.

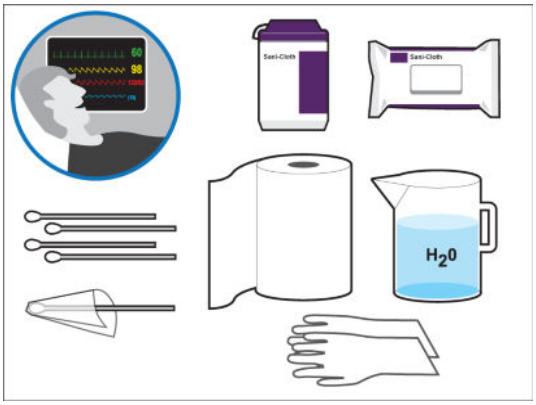
Cleaning and disinfection frequency

The following table indicates the frequency of visual inspection, cleaning, and disinfection procedures.

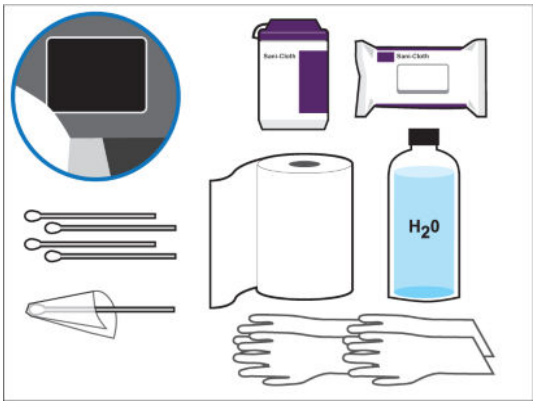
Device	Visual inspection	Cleaning	Disinfection
Monitor 	• Before and after each patient use • Before and after cleaning or disinfection	• After each patient use • When in use and visible soil is present	• After each patient use • Perform disinfection after cleaning, not before
B1X5-F2 Frame 	• Before and after each patient use • Before and after cleaning or disinfection	• After each patient use • When in use and visible soil is present	• After each patient use • Perform disinfection after cleaning, not before

Device	Visual inspection	Cleaning	Disinfection
B1X5-REC Recorder 	• Before and after each patient use • Before and after cleaning or disinfection	• After each patient use • When in use and visible soil is present	• After each patient use • Perform disinfection after cleaning, not before
E-modules 	• Before and after each patient use • Before and after cleaning or disinfection	• After each patient use • When in use and visible soil is present For instructions refer to: • Cleaning and disinfecting the B1X5-F2 frame between patients on page 321	• After each patient use • Perform disinfection after cleaning, not before For instructions refer to: • Cleaning and disinfecting the monitor between patients on page 317

Supplies needed for cleaning and disinfection



Cleaning supplies



Disinfection supplies

1. Cleaning/disinfection wipes (commercial) or detergent/disinfectant
2. Water, if required for rinsing off the detergent/disinfectant.
   - Cleaning: Tap (utility) water is water that has not been processed. You can use tap water if it is not contaminated.
   - Disinfection: Critical water (sterile water, water that is extensively treated to ensure microorganisms, inorganic, and organic materials are removed).
3. Non-linting cloths
4. Cotton swabs
5. Disposable gloves

Replace soiled or dry wipes or non-linting cloths as needed.

- Do not use sharp tools to clean the device.
- Do not damage or bend connector pins when cleaning or disinfecting.
- Do not use a dripping cloth on surfaces.

Permitted cleaning and disinfection agents

GE used Super Sani-Cloth wipes during cleaning and disinfection efficacy validation. This cleaning agent is not listed in preference to other available cleaning agents which may also perform satisfactorily.

The following products are compatible with the devices and may be used for cleaning and disinfection. It should be noted that the generic agents have not been validated.

All third party trademarks are property of their respective owners.

Trademark names and product availability may vary in different countries. Consult the column that lists ingredients to determine if an equivalent disinfectant is available in your country.

When using other than validated cleaning or disinfection agents, note the following:

- Use only soft, non-linting cloths.
- Prepare and use the agent according to the manufacturer instructions.
- Let the disinfectant remain on the device surface according to the manufacturer instructions.

Product	Manufacturer	Type of Disinfectant	Active Ingredients*
70-96%Ethanol	Generic	Alcohol	Ethanol (CAS 64-17-5)
Clinell wipes Universal - Green	GAMA Healthcare	Quaternary ammonium	• 2-Phenoxyethanol (CAS 122-99-6) ≤0.6% • Benzalkonium chloride (CAS 68424-85-1) ≤0.6% • Didecyldimethyl ammonium chloride (CAS 7173-51-5) ≤0.6% • Biphenyl-2-ol (CAS 90-43-7) ≤0.1%
Terralin liquid	Shülke & Mayr GmbH	Alcohol	• Propan-1-ol (CAS 71-23-8) 35% • Ethanol (CAS 64-17-5) 25%
Oxivir TB wipes	Diversey	Hydrogen peroxide	• Benzyl alcohol (CAS 100-51-6) 1-5% • Hydrogen peroxide (CAS 7722-84-1) >0.1 - <1%
Incidine oxy wipes	Ecolab	Hydrogen peroxide	Hydrogen peroxide (CAS 7722-84-1) >= 1 - < 2.5
Mikrozid universal wipes	Shülke & Mayr GmbH	Alcohol	• Ethanol (CAS 64-17-5) 12.6% • Propan-2-ol (CAS 67-63-0) 17.4%

Product	Manufacturer	Type of Disinfectant	Active Ingredients*
Super Sani-Cloth® Germicidal Disposable Wipe (Purple)	PDI	Quaternary ammonium and alcohol	• Isopropyl alcohol (CAS 67-63-0) 55.5% • Quaternary ammonium compounds, C12-18-alkyl [(ethylphenyl) methyl] dimethyl, chlorides (CAS 68956-79-6) 0.25% • n-Alkyl Dimethyl Benzyl Ammonium Chloride (CAS 68391-01-5) 0.25%
Clorox hydrogen peroxide wipes	Clorox	Hydrogen peroxide	• Hydrogen peroxide (CAS 7722-84-1) 0.5-2% • Benzyl alcohol (CAS 100-51-6) 1-5%
Reynard premier detergent and disinfectant wipes	Reynard	Quaternary ammonium	• Didecyldimethyl ammonium chloride (CAS 7173-51-5) <5% • C12/16 Alkyl dimethyl benzyl ammonium chloride (CAS 68424-85-1) <5% • C12/14 Alkyl dimethylethyl benzyl ammonium chloride (CAS 854090-23-0) <5%
Rely+on Virkon	LANXESS	Organic salts and organic acids	Concentrate is dissolved to a 1% solution. Concentrate contains: • Pentapotassium bis(peroxymonosulphate bis(sulphate) (CAS 70693-62-8) >30 - <50% • Malic acid (CAS 6915-15-7) >20 - <30% • Sulphamidic acid (CAS 5329-14-6) >5 - <10% • Sodium dodecylbenzenesulfonate (CAS 25155-30-0) >1 - <5% • Potassium hydrogensulphate (CAS 7646-93-7) >1 - <5% • Dipotassium peroxodisulphate (CAS 7727-21-1) 1 - <5% • Dipotassium disulphate (CAS 7790-62-7) 1 - <5%
Bleach max. 5.25% by volume mixed with water in the ratio of 1:10	Generic	Chlorine	Sodium hypochlorite (CAS 7681-52-9) 0.525 %
70% IPA	Generic	Alcohol	Isopropyl alcohol (CAS 67-63-0)
Sani-Cloth Bleach Germicidal Disposable Wipes	PDI	Chlorine	Sodium hypochlorite (CAS 7681-52-9) 0.63%
PDI Easy Screen Cleaning Wipes	PDI	Alcohol	Isopropyl alcohol (CAS 67-63-0) 70%
Getinge Clean*1	Getinge	Enzymatic or neutral pH detergents	Enzymatic or neutral pH detergents
* Ingredients, if applicable. Listed as indicated in the disinfectant package or Material Safety Data sheet at the time of publishing this manual. All generic agents: check the minimum disinfection times as per your healthcare facility guidelines.			
*1 The agent can only be used for cleaning.			

Do NOT use any of the following to clean the device because they may damage its surfaces:

- Organic solvents
- Abrasive cleaners or solvents of any kind
- Acetone
- Ketone
- Betadine
- Sodium salts

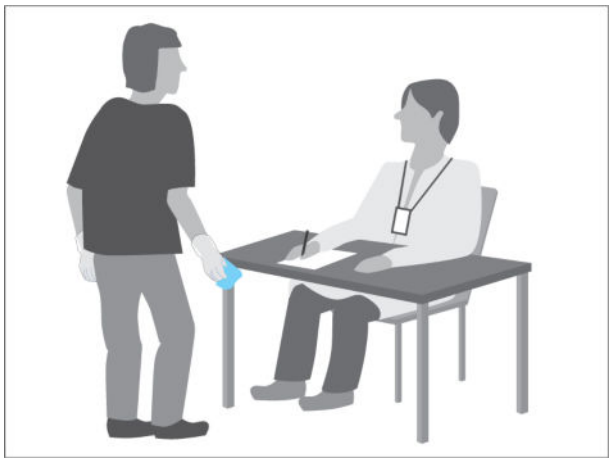
How to clean and disinfect

Before started

Your professional healthcare facility guidelines permitting, all cleaning activities can be carried out at the bedside.

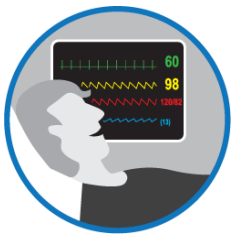
Please consult clinical personnel to determine and operate the following options:

- Lock the touchscreen, if patient during monitoring. Or,
- Discharge patient, and disconnect cables or devices if between patients.



NOTE
It is recommended the cleaning/disinfection operation person ask the clinician whether can start your cleaning and disinfection process.

Cleaning during patient monitoring

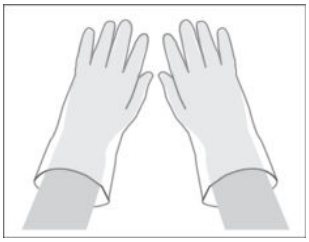


If cleaning is permitted during patient monitoring, do NOT clean any part of the system that is directly in contact with the patient. Otherwise, there may be a risk of contamination, loss of monitoring, or contact of detergents with the patient's skin.

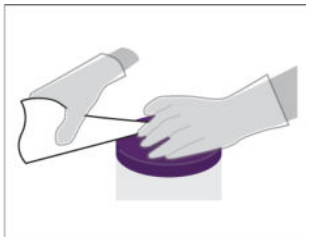
NOTE
Follow this procedure only when there is a patient connected to the monitor.

Cleaning the monitor during monitoring

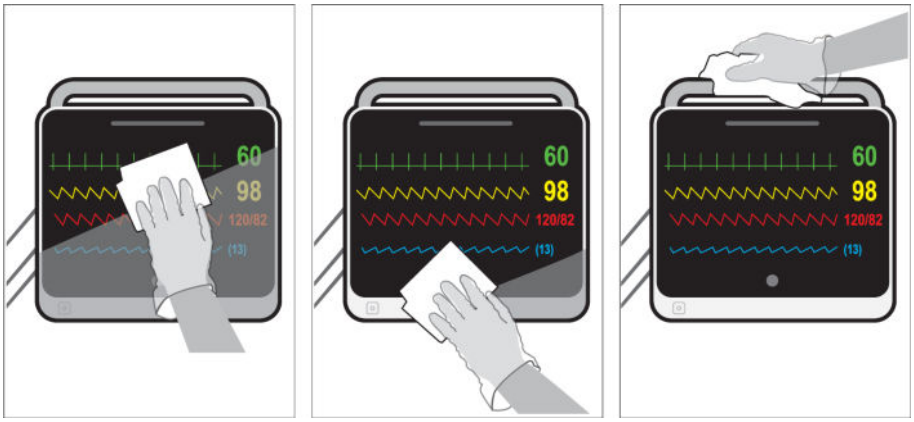
1. Put on new gloves.



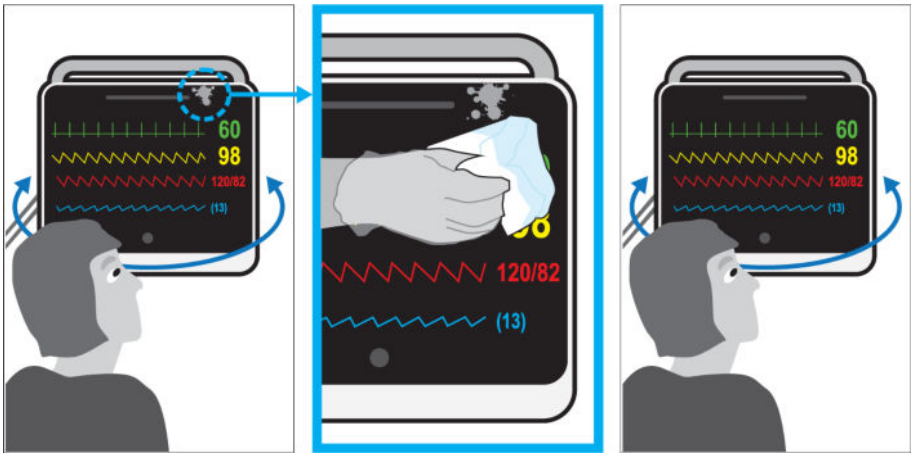
2. Get a new wipe or dampen a soft non linting cloth with one of the permitted detergents.



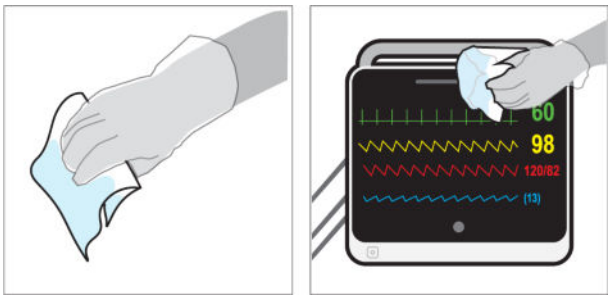
3. Wipe the device's exterior surface. Remove any soil by wiping the device until soil and organic matter have been visibly removed.



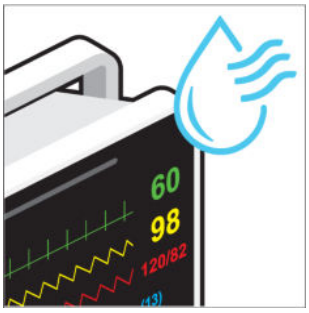
4. Inspect the device to ensure the complete removal of soil from surfaces, cavities, and movable parts. If visible soil remains, repeat cleaning procedure until the device is thoroughly clean.



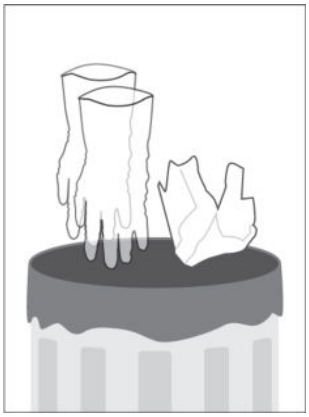
5. If required, rinse the device thoroughly using a soft non-linting cloth saturated with lukewarm water (temperature range 27 to 44 °C, 81 to 111 °F).



6. Allow the device to air dry until it is visibly dry. Drying times may vary based on the environmental conditions.



7. Discard disposable wipes and gloves according to your professional healthcare facility guidelines. Do not reuse wipes or gloves.



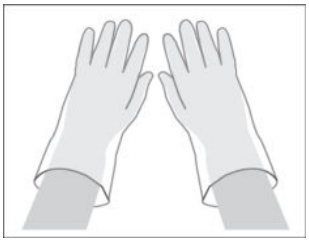
Cleaning and disinfection between patients

NOTE
Follow this procedure only when there is no patient connected to the monitor and no ongoing monitoring.

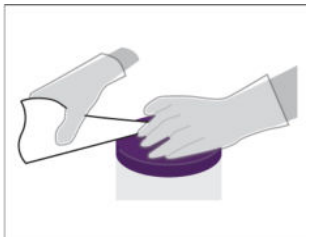
Cleaning and disinfecting the monitor between patients

NOTE
Clean the devices thoroughly prior to disinfection. Follow these instructions.

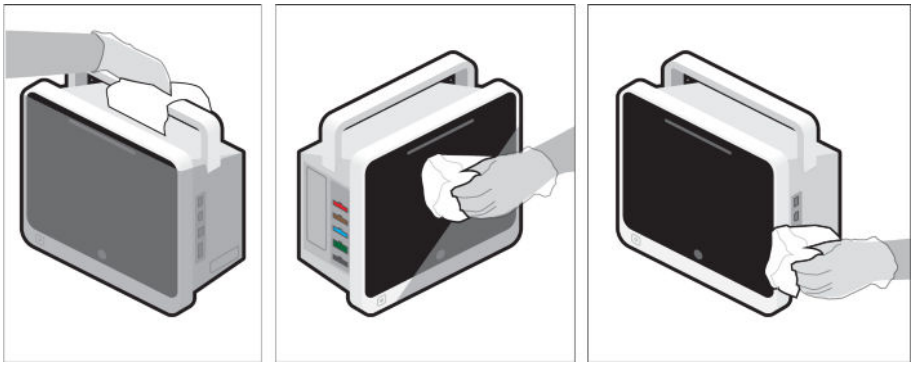
1. Put on new gloves.



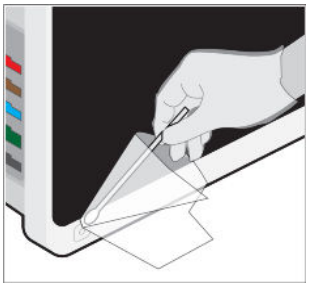
2. Get a new wipe or dampen a soft non linting cloth with one of the permitted detergents.



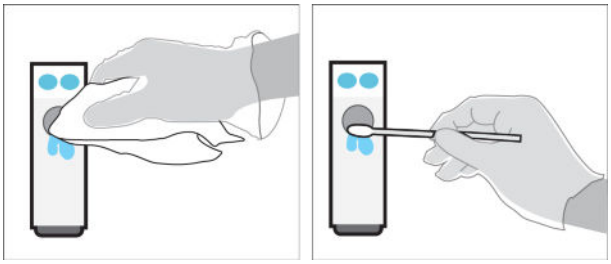
3. Wipe the device's exterior surface. Remove any soil by wiping the device until soil and organic matter have been visibly removed.



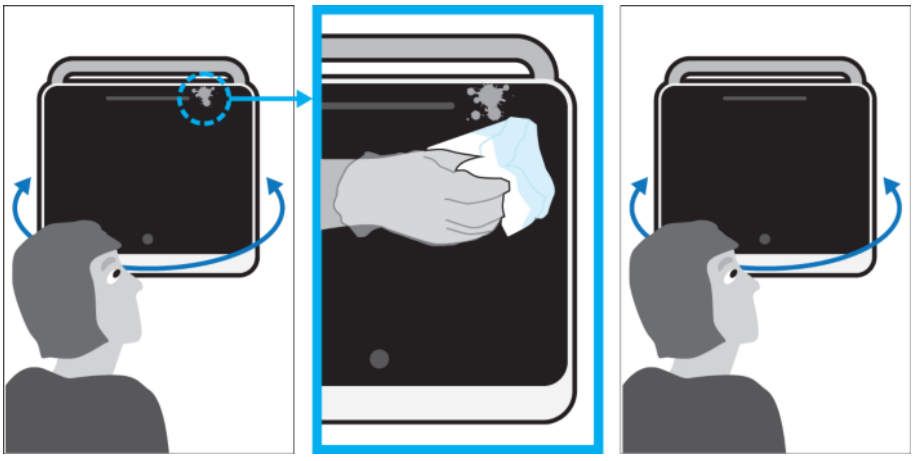
Pay special attention to hard-to-clean areas like grooves and crevices. Scrub these areas with a cotton swab inside a wipe.



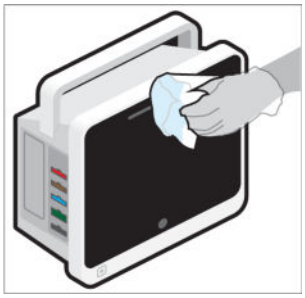
4. Ensure there is no liquid pooling around connection pins. If this happens, blot dry with a cotton swab or soft non-linting cloth.



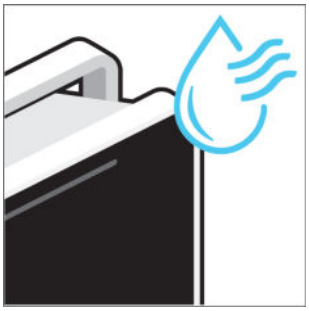
5. Inspect the device to ensure the complete removal of soil from surfaces, cavities, and movable parts. If visible soil remains, repeat cleaning procedure until the device is thoroughly clean.



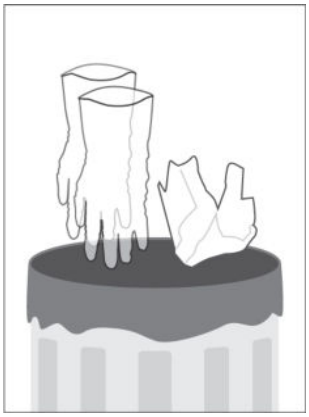
6. If required, manually rinse the device by wiping it for 30 seconds using a sterile, soft, non-linting cloth saturated with lukewarm water (temperature range 27 to 44°C, 81 to 111°F).

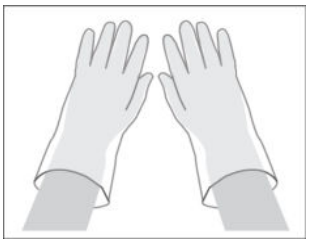
7. Allow the device to air dry until it is visibly dry. Drying times may vary based on the environmental conditions.



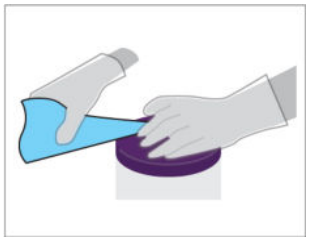
8. Discard disposable wipes and gloves according to your professional healthcare facility guidelines. Do not reuse wipes or gloves.



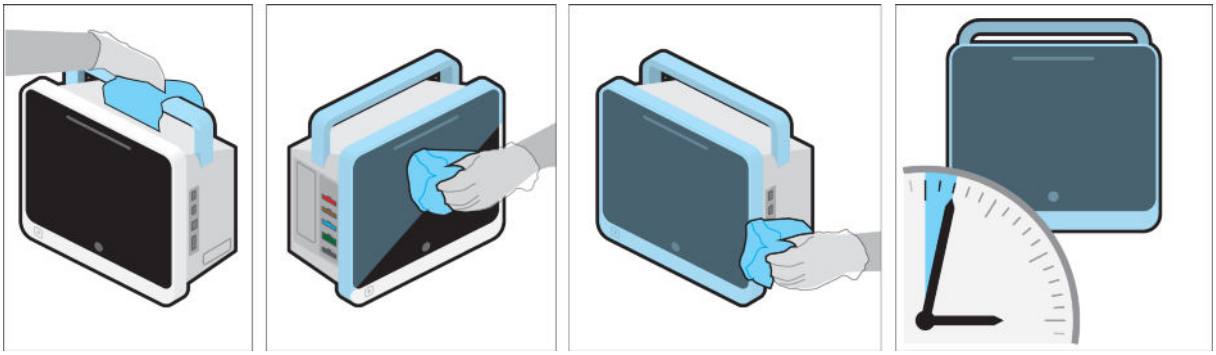
9. Start disinfection by putting on new gloves.



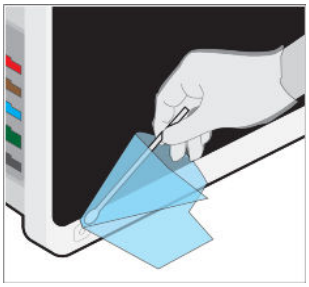
10. Get a new wipe.



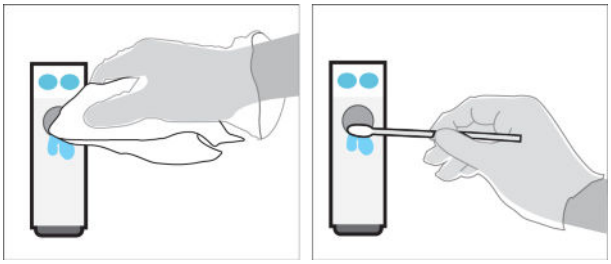
11. Wipe the device surface. Make sure all surfaces are uniformly wiped. Treated surfaces must remain visibly wet for a minimum of two minutes (Super Sani-Cloth) or according to the disinfectant manufacturer's instructions. To ensure this, use additional disinfectant wipes as necessary.



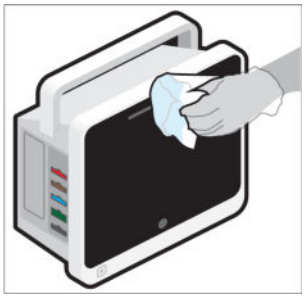
Pay special attention to hard-to-clean areas, like grooves and crevices. Scrub these areas using a cotton swab inside the wipe.



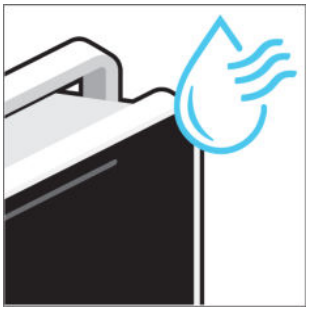
12. Ensure there is no liquid pooling around the pins. If this happens, blot dry with a cotton swab or soft non-linting cloth.



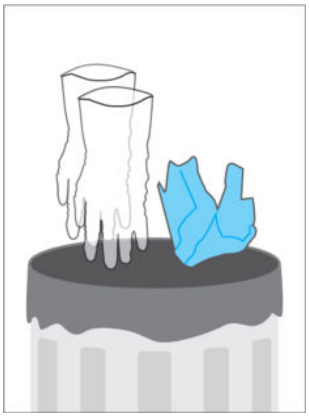
13. If required, manually rinse the device by wiping it for 30 seconds using a sterile, soft, non-linting cloth saturated with critical water (temperature range 27 to 44°C, 81 to 111°F).

14. Allow the device to air dry until it is visibly dry. Drying times may vary based on the environmental conditions.



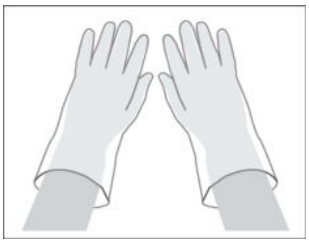
15. Discard disposable wipes and gloves according to your professional healthcare facility guidelines. Do not reuse wipes or gloves.



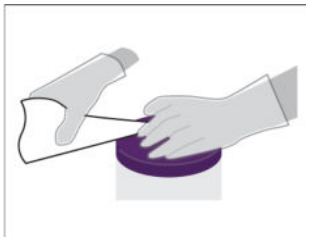
Cleaning and disinfecting the B1X5-F2 frame between patients

Following is the cleaning procedure between patients for B1X5-F2 frame.

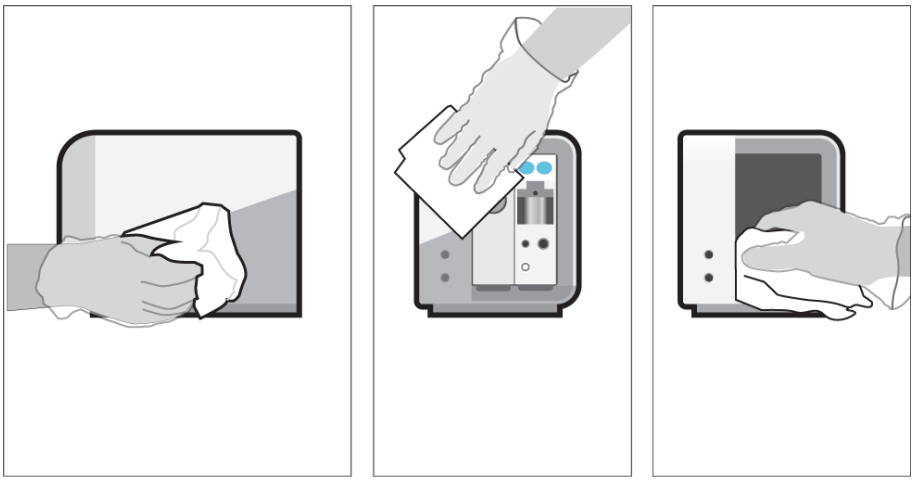
1. Put on new gloves.



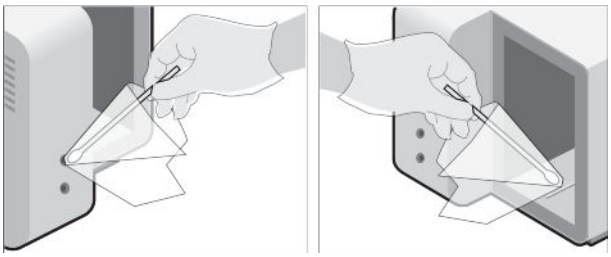
2. Get a new wipe or dampen a soft non linting cloth with one of the permitted detergents.



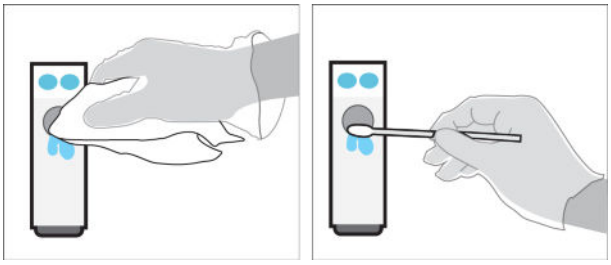
3. Wipe the device's exterior surface. Remove any soil by wiping the device until soil and organic matter have been visibly removed.



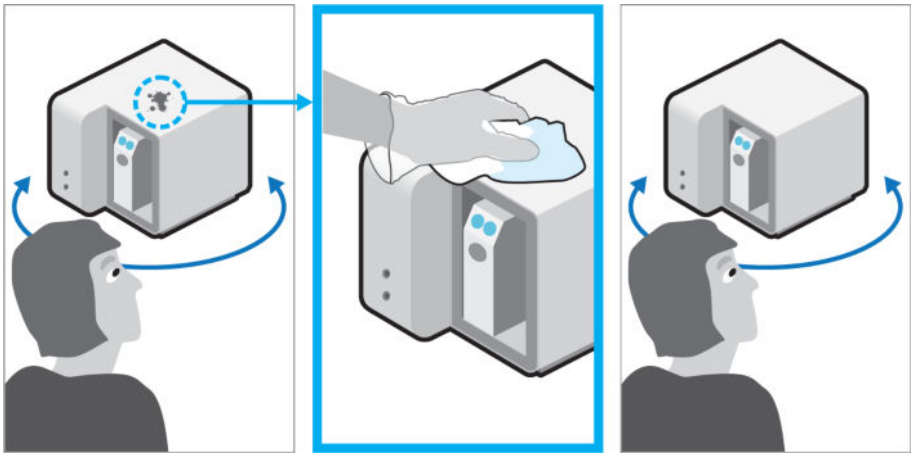
Pay special attention to hard-to-clean areas like grooves and crevices. Scrub these areas with a cotton swab inside a wipe.



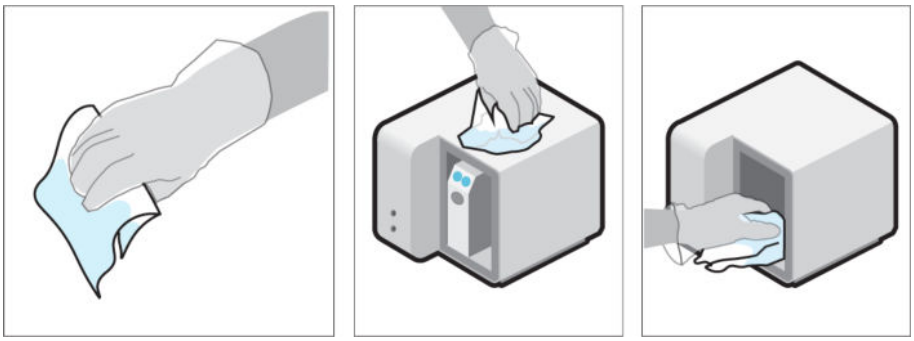
4. Ensure there is no liquid pooling around connection pins. If this happens, blot dry with a cotton swab or soft non-linting cloth.



5. Inspect the device to ensure the complete removal of soil from surfaces, cavities, and movable parts. If visible soil remains, repeat cleaning procedure until the device is thoroughly clean.

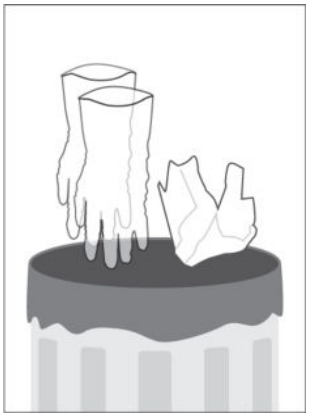


6. If required, manually rinse the device by wiping it for 30 seconds using a sterile, soft, non-linting cloth saturated with lukewarm water (temperature range 27 to 44 °C, 81 to 111 °F).

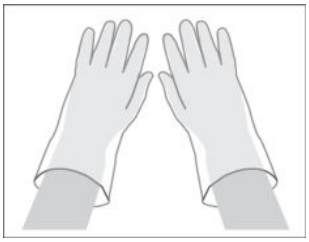


7. Allow the device to air dry until it is visibly dry. Drying times may vary based on the environmental conditions.

8. Discard disposable wipes and gloves according to your professional healthcare facility guidelines. Do not reuse wipes or gloves.

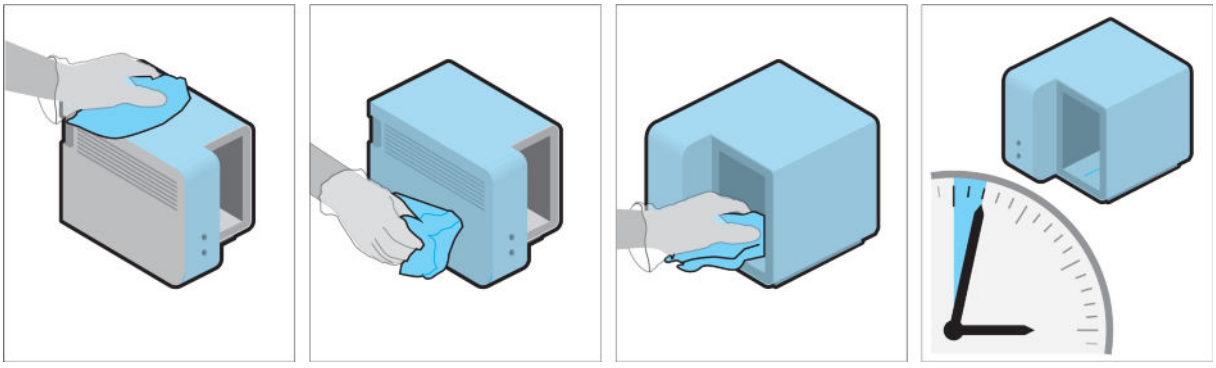


9. Start disinfection by putting on new gloves.

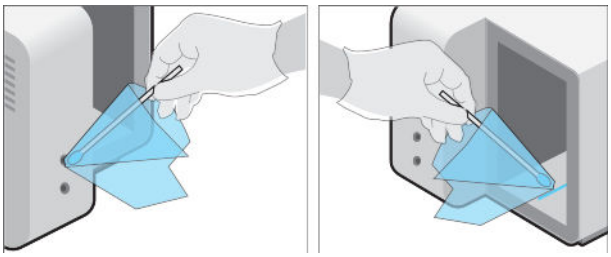


10. Get a new wipe.

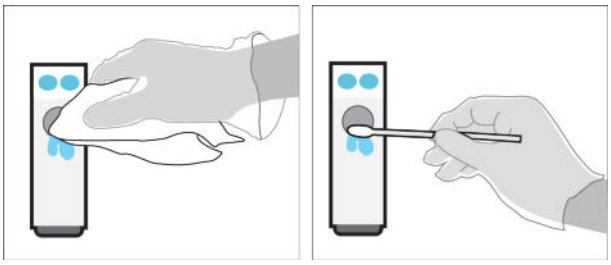
11. Wipe the device surface. Make sure all surfaces are uniformly wiped. Treated surfaces must remain visibly wet for a minimum of two minutes (Super Sani-Cloth) or according to the disinfectant manufacturer's instructions. To ensure this, use additional disinfectant wipes as necessary.



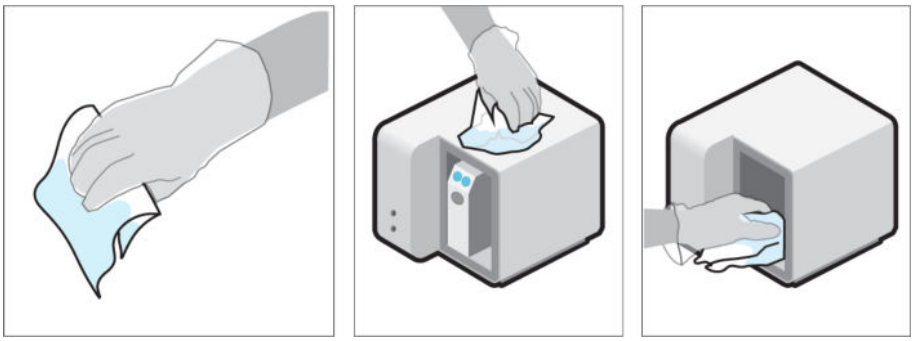
Pay special attention to hard-to-clean areas, like grooves and crevices. Scrub these areas using a cotton swab inside the wipe.



12. Ensure there is no liquid pooling around the pins. If this happens, blot dry with a cotton swab or soft non-linting cloth.

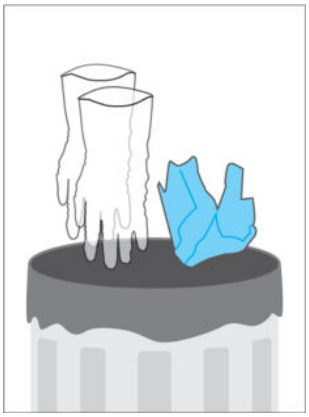


13. If required, manually rinse the device by wiping it for 30 seconds using a sterile, soft, non-linting cloth saturated with critical water (temperature range 27 to 44°C, 81 to 111°F).



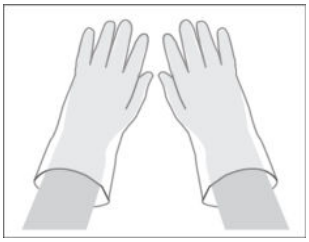
14. Allow the device to air dry until it is visibly dry. Drying times may vary based on the environmental conditions.

15. Discard disposable wipes and gloves according to your professional healthcare facility guidelines. Do not reuse wipes or gloves.

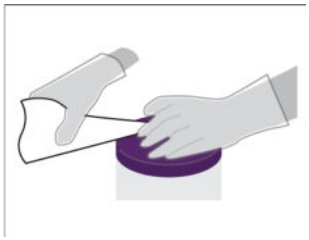


Cleaning and disinfecting the B1X5-REC recorder between patients

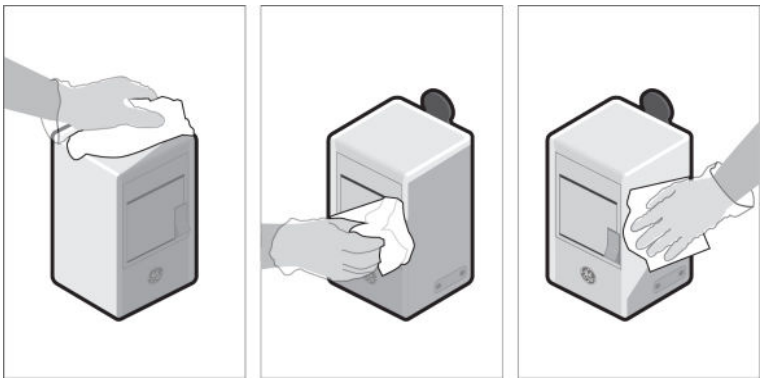
1. Put on new gloves.



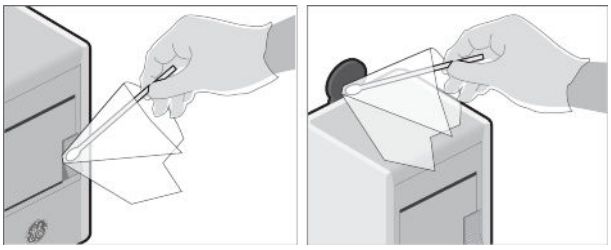
2. Get a new wipe or dampen a soft non linting cloth with one of the permitted detergents.



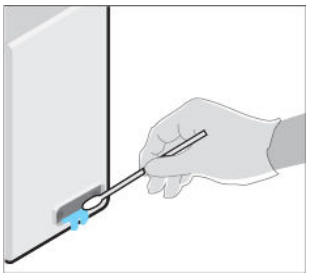
3. Wipe the device's exterior surface. Remove any soil by wiping the device until soil and organic matter have been visibly removed.



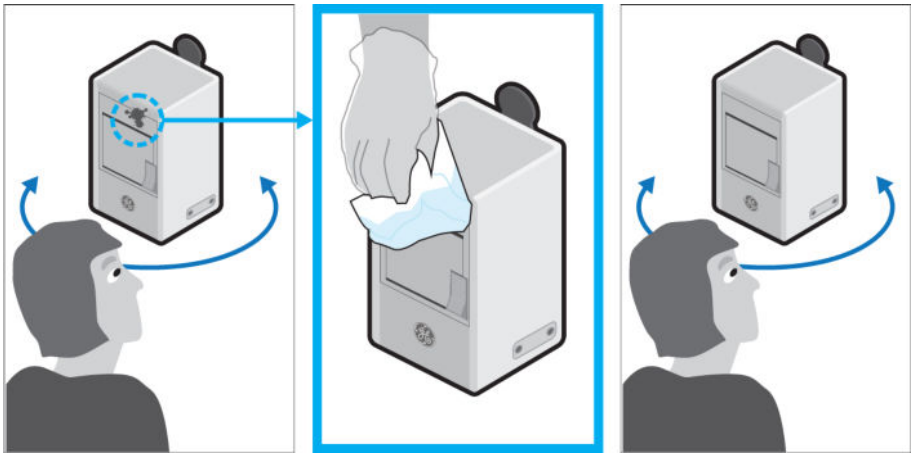
Pay special attention to hard-to-clean areas like grooves and crevices. Scrub these areas with a cotton swab inside a wipe.



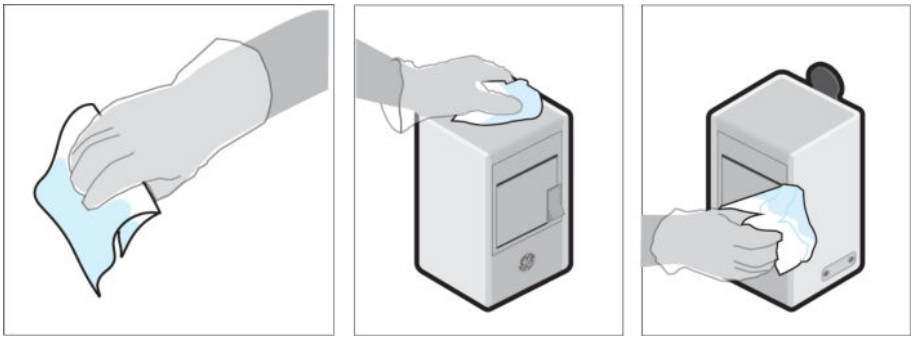
4. Ensure there is no liquid pooling around connection pins. If this happens, blot dry with a cotton swab or soft non-linting cloth.



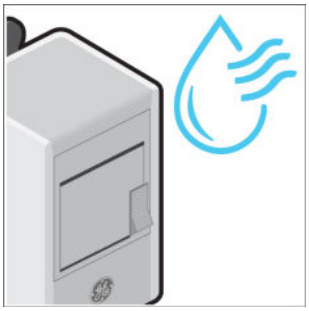
5. Inspect the device to ensure the complete removal of soil from surfaces, cavities, and movable parts. If visible soil remains, repeat cleaning procedure until the device is thoroughly clean.



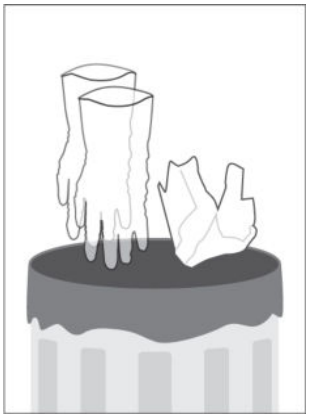
6. If required, manually rinse the device by wiping it for 30 seconds using a sterile, soft, non-linting cloth saturated with lukewarm water (temperature range 27 to 44 °C, 81 to 111 °F).



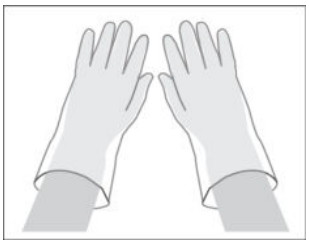
7. Allow the device to air dry until it is visibly dry. Drying times may vary based on the environmental conditions.



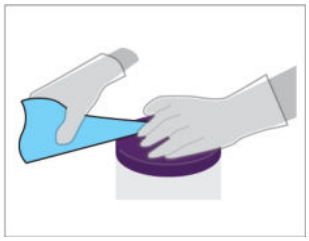
8. Discard disposable wipes and gloves according to your professional healthcare facility guidelines. Do not reuse wipes or gloves.



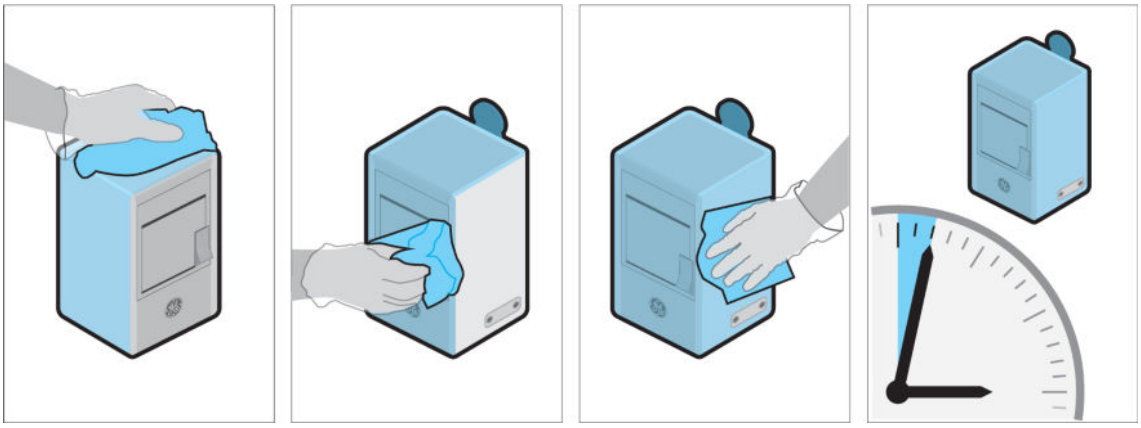
9. Start disinfection by putting on new gloves.



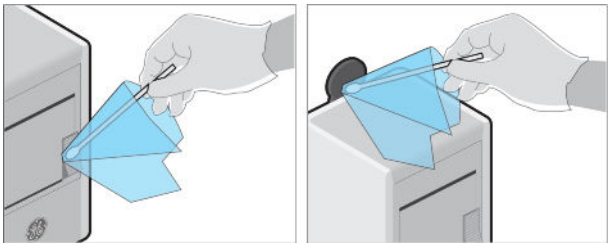
10. Get a new wipe.



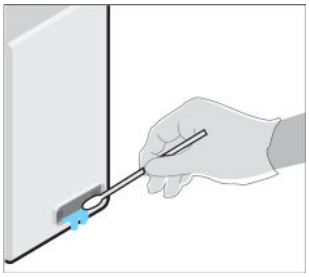
11. Wipe the device surface. Make sure all surfaces are uniformly wiped. Treated surfaces must remain visibly wet for a minimum of two minutes (Super Sani-Cloth) or according to the disinfectant manufacturer's instructions. To ensure this, use additional disinfectant wipes as necessary.



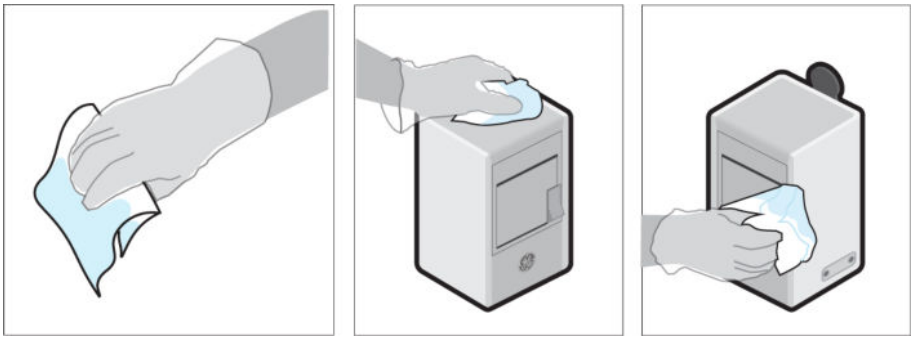
Pay special attention to hard-to-clean areas, like grooves and crevices. Scrub these areas using a cotton swab inside the wipe.



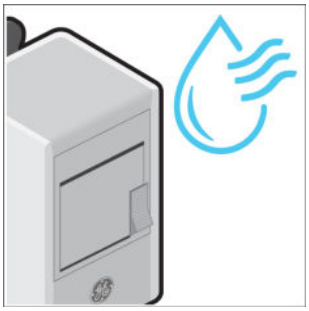
12. Ensure there is no liquid pooling around the pins. If this happens, blot dry with a cotton swab or soft non-linting cloth.



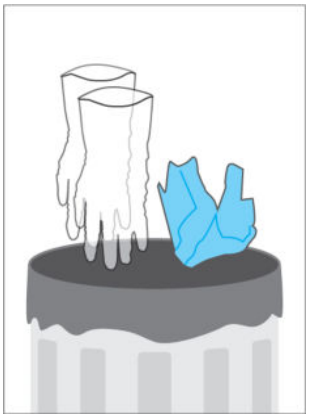
13. If required, manually rinse the device by wiping it for 30 seconds using a sterile, soft, non-linting cloth saturated with critical water (temperature range 27 to 44°C, 81 to 111°F).



14. Allow the device to air dry until it is visibly dry. Drying times may vary based on the environmental conditions.



15. Discard disposable wipes and gloves according to your professional healthcare facility guidelines. Do not reuse wipes or gloves.



Additional information

- The cleaning and disinfection information is provided in accordance with ANSI/AAMIST81, ISO 17664. The instructions have been validated as capable of preparing non-sterile medical devices. It remains the responsibility of the professional healthcare facility to ensure that the cleaning and disinfection are performed according to these instructions, using appropriate equipment, materials, and personnel, so that the desired result is achieved. This requires validation and routine monitoring of the process.
- Personnel should wear appropriate Personal Protective Equipment (PPE) when cleaning and disinfecting devices in accordance with their local blood-borne pathogen guidelines.

Troubleshooting

ECG troubleshooting

Problem	Solution
ECG signal is noisy or no QRS is detected	• Ensure that the patient is not shivering. • Select the correct filter by selecting the HR digit field > **Advanced** tab > **Waveform Filter**. • Check the electrode quality and positioning. Do not place electrodes on body hair, bones close to skin, layers of fat and major muscles. Pre-gelled electrodes are recommended. • Change the lead in ECG1 to the best available signal. • Consider using **Size** > **2x**. • Try on alternative location for the V lead to improve signal quality. • Check all cable connectors.

Pacemaker detection troubleshooting

Problem	Solution
How does activating pacemaker detection impact monitoring?	• Beats that would otherwise be classified as ventricular are instead classified as V-paced if a ventricular pacemaker event is detected. • Residual pacemaker energy that might otherwise appear in the ECG is removed, and a pacemaker enhanced spike is placed in the ECG. • On the ECG waveform, pacemaker detection is indicated by uniform, upright pacemaker enhancement spikes in the ECG data, both displayed and graphed.
How can pacemaker detection be improved?	• Possible problems include: ◦ Heart rate double counting. ◦ Inaccurate alarms for low heart rate or asystole. ◦ Pacemaker spikes not recognized by the software. ◦ False PVC detections and arrhythmia alarms. • Possible solutions include: ◦ Relearn arrhythmia. ◦ Re-prepare the patient skin, replace the electrodes, and adjust the electrode placement. ◦ Try an alternate electrode placement. ◦ Switch to another pacemaker detection mode.

Problem	Solution
Why is the monitor double-counting the heart rate, alarming for a low heart rate, or not detecting pacemaker spikes?	The monitor is not detecting pacemaker activity. Causes may include: • The pacemaker signal is too weak for the monitor to detect. • The ECG signal is too weak for the monitor to detect. • The monitor is detecting atrial pacemaker artifact or non-QRS features as beats. If the monitor is alarming for low heart rate or asystole, assess the QRS amplitude: • View all ECG leads to assess the amplitude of the QRS complexes. To ensure correct HR readings, a 0.5 mV QRS amplitude is recommended for a normal ECG signal. If the QRS amplitude drops below 0.5 mV or an abnormal QRS width occurs (more than 120 ms), QRS detection may be reduced, leading to false asystole alarms. • If necessary, reprep the skin and reposition the electrodes. • Relearn ECG.

Arrhythmia troubleshooting

Problem	Solution
Why is the monitor alarming for asystole, bradycardia, or inaccurate heart rate when a visible QRS waveform is present?	The monitor may not be detecting sufficient QRS amplitude in all analyzed leads. Multiple leads are used for arrhythmia processing. 1. Assess the patient. 2. Check the ECG signal acquired from the patient. 3. View all ECG leads to assess the amplitude of the QRS complexes. To ensure correct HR readings, a 0.5 mV QRS amplitude is recommended for a normal ECG signal. If the QRS amplitude drops below 0.5 mV or an abnormal QRS width occurs (more than 120 ms), QRS detection may be reduced, leading to false **Asystole** alarms. 4. Relearn arrhythmia. It is important to relearn the patient's ECG pattern any time the electrode configuration is adjusted. 5. The ECG size settings affect the arrhythmia detection and heart rate calculation. Increase the ECG size by selecting a value from the **Size** list.
Why is the monitor calling V Tach when the patient is not in V Tach?	The monitoring system may be detecting a wider QRS complex or artifact in some of the analyzed ECG waveforms. In addition, the V leads may be exhibiting polarity changes, which may occasionally cause an inaccurate call. 1. Assess the patient. 2. Check the ECG signal acquired from the patient. • View all ECG leads to assess the width of the QRS complexes in the analyzed leads. • If artifact exists in any of the analyzed leads, reprep the patient's skin, replace electrodes, and adjust the electrode placement. • It may be beneficial to move V lead electrodes (chest lead) to alternate precordial electrode placements to improve detection. 3. Relearn arrhythmia. It is important to relearn the patient's ECG pattern any time the electrode configuration is adjusted.

Respiration troubleshooting

Problem	Solution
What can I do if the respiration measurement fails?	• Check electrode quality (e.g. that the gel is not dry) and positioning. • Other electrical devices may interfere with the measurement. Reposition as needed.

Problem	Solution
Respiration rate value variations are too fast.	Contact an authorized clinical user and ask them to increase the **Resp Averaging Time** in the UI.
Respiration rate value responds too slowly.	Contact an authorized clinical user and ask them to decrease the **Resp Averaging Time** in the UI.
Respiration rate values are too low and trigger false alarms	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.
Respiration rate value is 0, but there is no apnea alarm.	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.
What if the respiration signal is poor?	The signal may be disturbed by motion, the electrode placement may be poor, or the electrode gel may be dry. Reposition the electrodes or replace the respiration patch as needed.
What does motion artifact look like, what problems can it cause, and how can it be corrected?	Motion artifact occurs with excessive motion of the patient. In other words, for example the patient moving his upper body can cause motion artifact. Motion artifact can be reduced, if not eliminated, by good skin to electrode contact and optimal placement of the respiration electrodes.

SpO_2 troubleshooting

Problem	Solution
SpO_2 signal is poor	• Check the sensor and sensor position. • Make sure the patient is not shivering, moving, or does not have tremors. • The patient’s pulse may be too low to measure.
Why does the pulse oximeter sometimes read differently to a blood gas analyzer?	Blood gas analyzers calculate the O_2 saturation based on normal values for pH, $PaCO_2$, Hb, temperature, etc. (i.e., a normal oxyhemoglobin dissociation curve). Depending on the patient’s physiological and metabolic status, this curve and all values may be shifted away from normal. Thus the oximeter, which measures O_2 saturation, may not agree with the blood gas.
What effect can ambient light have on pulse oximetry monitoring?	Light sources such as surgical lamps, bilirubin lamps, fluorescent lights, infrared heating lamps, and sunlight can cause poor waveform quality and inaccurate readings. Error messages are possible. Shielding the sensor with opaque tape, a Posey wrap, or other dark or opaque material can increase oximetry accuracy, verified by good waveform and signal strength.
What does electrosurgical interference look like and how can it be minimized?	Electrosurgical interference is most obvious on the displayed waveform. It is a very spiky, erratic looking waveform caused by the electrosurgical unit’s overwhelming interference. It can result in grossly inaccurate pulse oximeter results. Electrosurgical interference can be minimized by: • Making sure the pulse oximeter sensor is as far away from the return pad and operating site as possible. • Making sure the sensor is not between the return pad and operating site. • Keeping the power cord and sensor cable away from the power cord of the electrosurgical unit. • Plugging the electrosurgery unit into a separate set of outlets from the monitor.

Problem	Solution
What does motion artifact look like, what problems can it cause, and how can it be corrected?	For the device using Nellcor OxiMax technology, the main problem motion artifact can cause is erroneous SpO_2 readings. Motion artifact occurs with excessive motion of the sensor, the cable leading to the sensor, or the cable/sensor junction. In other words, anything that causes any of these things to move, like the patient moving his hands, or the cable lying across the ventilator tubing and being moved with every cycle, can cause motion artifact. A non-arterial, often erratic looking waveform and a pulse rate that does not coincide with the heart rate on the ECG will result. Motion artifact can be reduced, if not eliminated, by selecting a “quieter” site on the patient. An ear sensor if the hands do not remain still, an adhesive sensor on the toe, or an adhesive sensor on the little finger for an adult or on the sole of the foot in a newborn can help greatly. Cable movement can be reduced by applying the sensor with the cable leading toward the patient, then taping the cable to the side of the hand or foot. The cable and sensor can also be stabilized with a stress loop near the sensor. Tape the stress loop to the patient (excluding children). In the case of the butterfly sensor, the tape was designed to secure the cable to the finger. It has been noted that letting the patient view the SpO_2 waveform enables the patient to assist in reducing motion artifact.
Why is the digit field not displayed on the monitor after connecting the SpO_2 interface cable and sensor?	No SpO_2 data is displayed due to hardware failure or an unrecognized or defective sensor. • Make sure the accessories are compatible with the monitor. • Make sure the sensor is attached to the interface cable and the cable is connected to the monitor. • Change the sensor. • Change the cable. If the problem persists, contact authorized service personnel.

SPI troubleshooting

Basic SPI troubleshooting

Problem	What to do
AoA Split Screen is not shown	• Configure the **AoA** Split Screen to the screen. • Make sure that both Entropy and SPI are being measured.
BalView dot is missing in the **AoA** Split Screen	• Make sure that both Entropy and SPI are being measured.
SPI color is gray	• Wait until the message **Learning** disappears. • Wait for the NIBP measurement to finish. • Try to ensure that the plethysmogram is as artifact-free as possible.
SPI measurement is not available	• Check that SPI is licensed in your configuration. • Configure SPI into a digit field. • Check the connections and compatibility.

Problem	What to do
SPI values seem incorrect	• Check the sensor contact and position on the finger. • Check the compatibility of the sensor and measurement device. • Assess the patient. Check that the plethysmogram is as artifact-free as possible. • SPI only works with fully anesthetized patients. • Anticholinergic agents may increase SPI values. Refer to SPI points to note on page 167 for other possible reasons why SPI values may seem incorrect.
SPI values shown as ---	• Check the connections and compatibility. • Wait for the measurement to start. • If possible, do not place the NIBP cuff on the same arm.
SpO_2 signal is poor	• Assess the patient and the measurement site.

Advanced SPI troubleshooting

If you feel that a reading is not correct, first confirm the clinical status of the patient and consult the troubleshooting and messages tables, as well as the measurement limitations section.

- Check your sensor and the sensor site.
- Assess the trends and values of other monitored parameters, especially blood pressure, body temperature, capnogram.
- Confirm the use of anesthetics and other drugs.
- Assess for the possibility of clinical stimulation arising from a non-nociceptive origin (for example: severe hypovolemia or hypothermia may cause SPI responses similar to, but not originating from, nociception. They are not related to inadequate analgesia.)

After your assessment is complete, consider the appropriate interventions. These may include pharmacological or non-pharmacological interventions such as intravenous fluid administration, patient/sensor temperature factors, etc.

Factors that affect the hemodynamic stability of the anesthetized patient may affect the SPI, as well. In some special situations, the SPI may not correctly indicate the nociception-antinociception balance. These situations can be:

- Severe arrhythmia affecting pulse interval or pulse amplitude
- Medications directly affecting both the autonomic nervous system and the hemodynamic system
- A paradoxical response to treatment, for example in elderly hypotensive patients

NIBP troubleshooting

Problem	Solution
NIBP measurement does not work or the values seem unstable.	• Check that the cuff tubing is not bent, stretched, compressed, or loose. • Check the cuff position and cuff tube connection. • Prevent motion artifact. • Use NIBP cuffs of correct size.

Problem	Solution
Why does the mean value display while the associated systolic and diastolic values display as - - -?	Assess the patient and perform a visual inspection of the equipment to ensure system integrity. The following conditions may cause the mean value to display in the NIBP digit field while the associated systolic and diastolic values display as - - -: • Very low systolic and diastolic amplitude fluctuations (e.g., patient in shock). • Very small difference between the mean and systolic pressure or the mean and diastolic pressure. • Loss of system integrity (e.g., loose connections or worn parts)
Why is the monitor re-inflating the cuff automatically?	The cuff target pressure must be higher than the patient's systolic pressure to obtain an accurate systolic and diastolic measurement. If a systolic blood pressure cannot be found, a systolic reading is searched for by re-inflating the cuff to a higher pressure. During a systolic search, the maximum cuff inflation pressure will not exceed the normal pressure range of the cuff. For more information, refer to the technical specifications.

Invasive pressure troubleshooting

Problem	Solution
Invasive pressure readings seem unstable.	• Make sure there are no air bubbles in the transducer systems. • Flush and zero. • Place the transducer on the patient's phlebostatic axis.
Invasive pressure waveform is displayed but no numeric values are displayed.	• Zero the channel. Invasive pressure numeric values are displayed only for successfully zeroed channels.
Zeroing of invasive pressure channel(s) fails.	• Ensure that the channels are open to air.
The measurement values in the SPV and PPV parameter window are not displayed.	• Ensure that there are no arrhythmia present. • Check that the correct arterial site has been selected as the SPV source. • SPV and PPV is not available in NEONATAL mode. • The algorithm requires at least three pulse beats per each respiration cycle and when this is not true, the values are not shown.
Why are displayed pressure values different than expected?	• Check the patient. Values could be valid, the patient could be lying on the tubing, or the tubing could be kinked. • Check tubing for bubbles. • Remove excess tubing. • Check phlebostatic axis placement of transducer. • Rezero pressure.

Problem	Solution
Why are the arterial, non-invasive (oscillometric), and auscultated blood pressure readings indicating different values?	The three measurement methods use different technologies. Auscultation and oscillometric are both indirect methods of measuring blood pressure. In auscultation, changes in arterial sounds during cuff deflation are related to systolic and diastolic pressure. With oscillometric measurement, changes in measured pressure oscillations during cuff deflation are related to systolic, mean and diastolic pressures. Changes in the vascular tone of the arterial system can cause these two indirect methods to differ from one another and from direct arterial pressure measurements. Invasive arterial blood pressure is a direct method of measuring blood pressure. Differences between direct and indirect blood pressure measurements are expected. These differences occur because direct methods measure pressure and indirect methods measure flow. In addition, differences occur because the measurement location is not the same (e.g., brachial artery for NIBP vs. radial artery for invasive arterial pressure monitoring).
Why is the monitor alarming arterial line disconnect?	• Check the patient immediately in the event the catheter has been dislodged. • If the mean pressure falls below 10 mmHg, the monitor alarms. When zeroing a pressure line, start the zeroing process within 8 seconds. After that time the disconnect alarm is activated. • If zeroing, close the stopcock. Once the monitor detects the return of waveform and numeric data, the alarm will reset.
Why can't the monitor detect PA wedge?	The monitor must detect a 30% decrease in waveform amplitude to initiate a wedge. • Use the manual method for PA wedge measurement.
Why is the monitor displaying a message indicating that it is processing the wedge when the balloon has not been inflated?	• Begin wedge processing again. If a wedge is again detected due to respiratory artifact on the PA waveform, use the manual method for wedge measurement.
Why is monitor displaying the **Deflate the balloon** message after the balloon was inflated?	The monitor must detect a 30% decrease in waveform amplitude to initiate a wedge. If the waveform does not change accordingly, the message will continue to be displayed.
Why is the displayed wedge measurement different than expected?	• Repeat the wedge measurement, allowing a minimum of three respiratory cycles of data. • Verify end-expiration using the respiratory waveform on the display and observing the patient’s breathing pattern. Vertical cursors help to identify the end-expiration and align it with the PA pressure waveform. • Adjust the PA wedge cursor to the end-expiratory wedge value if necessary.

Temperature troubleshooting

Problem	Solution
Temperature measurement fails	• Check that the temperature cable is properly connected to the monitor. • Check that the probe is properly connected to the temperature cable or interconnect cable. • Check that you are using the correct probe for the anatomical location being monitored. • Use a probe that is compatible with your system. • Try using a known good probe in case the sensor is damaged. • Check the patient connection. • Check that there are not two identical acquisition modules in the system. • If the problem persists, contact authorized service personnel.

C.O. troubleshooting

Problem	Solution
C.O. measurement fails?	The amount of injectate is too small or the injectate is too warm. • Inject smoothly and within 4 to 5 seconds.
What if the C.O. value is lower than expected?	Cardiac output must be computed within 20 seconds. Decreasing the volume and increasing the temperature will give you a smaller differential change and should increase the chance of computing a cardiac output within the 20-second period. • Decrease the volume injected. • Increase the temperature of the injectate.
What if the C.O. value is higher than expected?	Cardiac output must be computed within 20 seconds. Increasing the volume and decreasing the temperature will give you a greater differential change. • Increase the volume injected. • Decrease the temperature of the injectate.
What if a stable baseline temperature cannot be detected?	A message indicating a failure is displayed. • Check the patient and the C.O. setup (both the settings and the cables). • Check for a significant amount of respiratory variation and for rapid IV solution infusion, either of which may influence the baseline temperature. It may be necessary to stop or slow the solution infusion during C.O. measurement, however, use caution if the solution includes drugs/medication. • Check the injectate temperature (IT). There should be a minimum temperature difference of 10° C (18° F) between the patient blood temperature and the injectate solution temperature. Cool the injectate solution if needed to increase the difference. • Replace the injectate temperature cable. • The pulmonary artery catheter may be damaged. Replace it.

Problem	Solution
What if the cardiac output values are inaccurate?	When in-line is being used along with iced injectate, the initial temperature displayed will be the room temperature. However, when the solution is injected, the temperature displayed will decrease. • Technique. It is important to understand the technique used in performing a cardiac output since it is a major influencing factor in obtaining accurate cardiac output values. ◦ If room temperature solution is used, be sure the bag is not exposed to a supplemental heat source or touching other solutions or equipment. This is important so the solution temperature will be the same as the room air temperature sensed through the bath or in-line probe. Any difference in temperature could give an inaccurate reading. ◦ When injecting, always hold the syringe by the plunger and not by the barrel. The temperature of the solution increases at a slower rate if the barrel is not held, and therefore reduces the potential for error in a cardiac output value. ◦ It is recommended that you inject rapidly and smoothly into the proximal port of the pulmonary artery catheter, within 4 to 5 seconds. ◦ Allow the baseline to stabilize between injections. If automatic program is not being used, allow one minute between injections. If automatic program is being used, follow the monitor prompts to inject. ◦ It is also recommended that you inject at the patient's end expiration. This helps reduce any respiratory noise and therefore lessens error. ◦ A minimum difference of 10° C (18° F) between the patient blood temperature and solution/injectate temperature is recommended. • Respiration. The patient's inspiratory/expiratory cycle and placement of the catheter affects the cardiac output value. Whenever the patient inhales and exhales, the temperature in the lung changes. During inspiration, the patient's blood temperature decreases and during expiration it increases. Therefore, placement of the catheter in relation to proximity of the lung fields affects the baseline. If there is a significant amount of respiratory noise on the patient's baseline, cardiac output may be calculated even if no injection was performed. There is no differentiation between temperature change caused by breaths versus injections. It simply looks for a change in baseline temperature. • Baseline blood temperature. As little as a half a degree Celsius change in blood temperature due to respiratory noise may cause a C.O. value to be displayed when an injection has not been performed. Using auto mode looks for a stable baseline before allowing an injection. • Pulmonary artery catheter. The catheter itself may be damaged (e.g., defective thermistor or defective tubing). • Hemodynamics. The patient's rhythm can affect the cardiac output value. If cardiac output trials are being done at a time when the patient has arrhythmias, you may notice a discrepancy in the cardiac output values. • Rapid IV solutions. Any rapid IV solution that is infusing at the time when the solution is injected can alter the cardiac output value. Maintain a constant rate, or if possible, stop the solution 30 seconds before the C.O. injection and then restart the infusion after the cardiac output is calculated. • Injectate temperature fluctuation. If the injectate temperature is fluctuating, check the injectate temperature cable connection.
What if cardiac output is being calculated even though solution has not been injected?	There may be a change in the patient's blood temperature consistent with an injection. • Check the patient and the C.O. setup (both the settings and the cables). • Check for a significant amount of respiratory variation and for rapid IV solution infusion, either of which may influence the baseline temperature. It may be necessary to use the manual cardiac mode rather than the automatic mode.

Airway gases troubleshooting

Problem	Solution
Airway gas values seem too low	• Check the sampling line and connectors for leakage. • Check the patient status. • Check the arterial blood gas values.
Airway gas values seem too high	• Check the sampling line for blockage. • Check the patient status. • Check the arterial blood gas values.
Module does not work	• Check and clean the filter if necessary. • Check the water trap and water trap connectors. Liquid may have entered the module. Replace the module and have it checked by authorized service personnel.
No airway gas values	• Check that the gas sampling line is connected to the water trap. • Check that the gas sampling line is connected to the patient.
Gas measurement values show off and there is a message on screen indicating standby.	• Turn on the gas module pump by selecting CO_2 digit field > **Start Gas Module pump**.
Why can we see dips in the capnogram during expiration?	• 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.
Why can we see variations in the oxygram during inspiration?	• Changes in the fresh gas flow reate and oxygen concentrations affect the shape of the oxygram during inspiration. Rule out any potential clinical complications such as hypoventilation, hyperventilation, circuit hypoxia, disconnection.
Why is the $EtCO_2$ value considerably lower than the CO_2 partial pressure determined by blood gas analysis?	• The major clinical reasons are dead-space ventilation, ventilation/perfusion mismatch, a drop in cardiac output, alveolar shunts, and incomplete emptying of the alveoli. • Also check the following technical issues: integrity of the breathing circuit; blood-gas analysis corrected to a lower temperature in case of hypothermia.
Why is the $EtCO_2$ value unexpectedly higher than the CO_2 partial pressure determined by blood gas analysis?	• Gas sensor is measuring gases in Dry (ATPD) conditions. Selecting Wet (BTPS) humidity compensation type activates calculations where the $EtCO_2$ value is normalized to assume 100 %RH and 37 °C. Wet compensation is not done if $EtCO_2$ is shown in %. • Check the humidity compensation type through > **Service** > **Parameter Settings** > **Others** > **CO2 Numbers**. This setting is password protected.

Spirometry troubleshooting

Problem	Solution
No measurement values	• Check that the device has license for this function. • Check connection to the anesthesia machine. • Check anesthesia machine's status.
Values seem unstable or erroneous.	• The device only displays the reference data obtained from the anesthesia machine. For more clinical troubleshooting, see the instructions for use of the anesthesia machine.

Entropy troubleshooting

Problem	Solution
Entropy values seem unstable	• Check that the sensor is not dried out. • Check the sensor attachment and placement. • Check the patient status.
Entropy EEG signal is noisy	• Remove disturbing equipment from the proximity of the Entropy module or sensor. • Check the sensor's contact with skin. • Check electrodes.
Entropy EEG signal is poor	• Check the sensor's contact with skin. • Check electrodes.
Entropy EEG waveform and numbers do not correspond	• Check raw EEG as impedance check may cause a temporary increase in the numeric values. • Check the patient's overall status.
Entropy readings seem inconsistent with the patient status	• Check raw EEG for QRS or other artifact. • Check electrode placement.
There is a sudden drop in values.	A sudden drop in values can be caused by the following: • Bolus administration of intravenous anesthetics. • Increase in inhalation anesthesia level. • Administration of other medication affecting EEG/FEMG.
There is an unexpected increase in values.	An unexpected increase in values can be caused by the following: • Change in infusion pump settings for intravenous anesthetics. • Change in vaporizer settings, or fresh-gas flow rate. • Volume loading with infused fluids. • Fault in the operation of anesthetic delivery systems. • Impedance check.

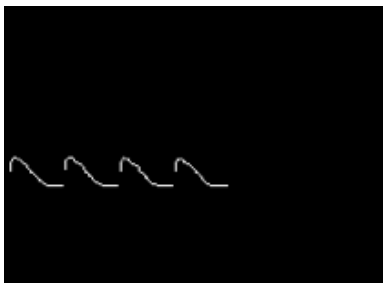
NMT troubleshooting

Verifying measurement reliability

Measurement reliability can be easily verified from the waveform display. Both the ElectroSensor and MechanoSensor have characteristic response waveforms as presented in other sections of this manual. If the waveforms do not follow the characteristic curves, the NMT measurement has failed and corrective action should be done.

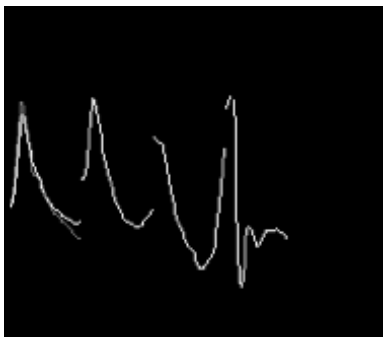
Faulty measurements with ElectroSensor

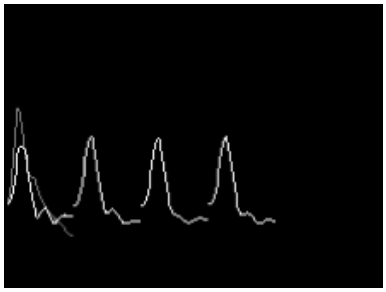
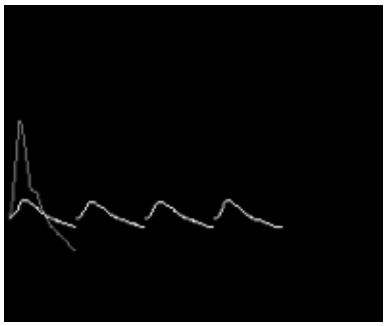
Examples of NMT waveforms produced by possibly faulty ElectroSensor measurements are displayed below:

Example waveform	Problem	What to do
	Ground electrode (black lead) is off.	Attach electrode.
	Ground electrode (black lead) contact is poor.	Fix electrode contact.
	Either of the measurement electrode contacts is poor.	Fix both electrodes.

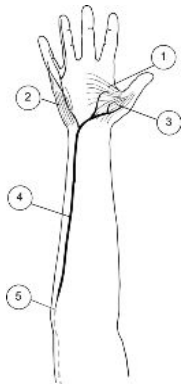
Faulty measurements with MechanoSensor

Examples of NMT waveforms produced by possibly faulty MechanoSensor measurements are displayed below:

Example waveform	Problem	What to do
	Faulty TOF measurement.	Repeat the measurement ensuring there is no external interference.

Example waveform	Problem	What to do
	MechanoSensor is not attached properly.	Fix attachment.
	Thumb bending is blocked.	Check hand and give room for bending.

Troubleshooting other problems

Problem	Solution
NMT reference search and measurement fail.	• Check the electrode quality and positioning. • Replace stimulating electrodes.
What can I do if the monitor does not find the supramaximal stimulation current?	• If the monitor is unable to find the supramaximal stimulation current, check the electrode placement. The nerve may be outside the dense current flow or both the ulnar and median nerves may be stimulated; progressively more muscle activity is detected as the increasing stimulation current activates new motor units. Consult the figure below when placing the electrodes:  1. adductor pollicis 2. abductor digiti minimi (hypothenar) 3. flexor pollicis brevis (thenar) 4. ulnar medial 5. epicondyle • Also, supramaximal current may not be found if the patient has anatomical and/or physiological anomalies.

Problem	Solution
Difficulty in getting the response when locating the nerve for plexus stimulation	• You may try using the local muscle response as an indication of current in the needle. If there is no response, the needle may be broken. • Change the needle if necessary.

BIS troubleshooting

Problem	Solution
Measurement does not start	• Check sensor attachment to the patient and the sensor placement. • Check the sensor's contact with skin. • Check the sensor type. • Check all cable connections. • Check the digital signal processing unit.
BIS signal is poor	• Check the sensor's contact with skin. • Check the sensor. • Ensure that the digital signal processing unit is not close to any electrical radiating equipment.
What happens during the BISx self test?	The BISx self test tests the digital signal acquisition and conversion functions. The test reports pass/fail status, noise, high-pass blocked, high-pass normal and gain values. • If any of the self tests fail, contact authorized service personnel.
What if the sensor does not pass the sensor check?	• The sensor check may fail for the following reasons: ◦ Impedance too high. ◦ Incorrect sensor application. ◦ Poor sensor connection. ◦ Defective patient interface cable or sensor. To correct the situation: • Recheck the sensor. • Reapply the sensor according to instructions. • Check sensor connection. • Replace patient interface cable or sensor.

Messages

Messages related to ECG measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **Alarm setup changed from Central**	• MF	Any of the ECG alarms (HR, ST alarms) are turned ON/OFF or its limits are adjusted from the Central.	• Check the alarm settings at the Central.
• **Arrhythmia Paused**	• WF	ECG channels have not been available for analysis for the last 20 seconds or the internal HR calculation has not been updated for the last 30 seconds due to excessive artifact.	• Check patient status. • Check electrode placement. • Prepare the patient's skin at electrode sites. • Change or move electrodes.
• **Arrh Paused**	• MF		
• **Asystole**	• MF, WF	Physiological alarm.	• Check patient status.
• **ASY**	• DF		
• **Artifact**	• WF	Muscle artifact or high/low frequency noise.	• Check electrode contact. • Check lead placement. • Perform skin preparation. • Reposition/replace electrodes. • Request the patient to remain still.
• **Brady**	• MF, WF	Physiological alarm.	• Check patient status.
• **ECG measurements removed**	• MF	Lost ECG measurement.	• If the problem persists, contact authorized service personnel.
• **ECG module error**	• MF	The ECG module communication problem.	• If the problem persists, contact authorized service personnel.
• **Frequent PVCs** • **Frequent SVCs**	• MF, WF	Physiological alarm.	• Check patient status.
• **Incompatible ECG firmware**	• MF	The ECG firmware is not compatible, or the version is too old.	• If the problem persists, contact authorized service personnel.
• **Lead off**	• MF	One or more leadwires or electrodes disconnected. Other ECG leads are available for arrhythmia detection.	• Check the leadwire and electrode connections.

Message	Location	Possible causes	Suggested actions
• **LA/L lead off** • **LL/F lead off** • **RA/R lead off** • **RL/N lead off** • **V/C lead off** • **V2/C2 lead off** • **V3/C3 lead off** • **V4/C4 lead off** • **V5/C5 lead off** • **V6/C6 lead off**	• WF		
• **Lead changed**	• WF	The monitor automatically switches the ECG1 waveform selection to a measurable ECG Lead (I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5 or V6) if the current ECG1 waveform is not measurable.	• Check the lead. (Note that the ECG waveform changes according to the lead it is measured from.)
• **Leads off**	• MF, WF	One or more of the connected electrodes is disconnected and arrhythmia detection is not possible.	• Check the connections.
• **ST Ant high** • **ST Ant low** • **ST Inf high** • **ST Inf low** • **ST Lat high** • **ST Lat low**	• MF	Physiological alarm.	• Check patient status. • Adjust alarm limits if necessary.
• **Tachy**	• MF, WF	Physiological alarm.	• Check patient status.
• **V Fib / V Tach**	• MF, WF	Physiological alarm.	• Check patient status.
• **V Tach**	• MF, WF	Physiological alarm.	• Check patient status.
• **VT > 2**	• MF, WF	Physiological alarm.	• Check patient status.
• **R on T**	• MF, WF	Physiological alarm.	• Check patient status.
• **V Brady**	• MF, WF	Physiological alarm.	• Check patient status.
• **Couplet**	• MF, WF	Physiological alarm.	• Check patient status.
• **Bigeminy**	• MF, WF	Physiological alarm.	• Check patient status.
• **Accel. Ventric.**	• MF, WF	Physiological alarm.	• Check patient status.
• **Trigeminy**	• MF, WF	Physiological alarm.	• Check patient status.
• **Multifocal PVCs**	• MF, WF	Physiological alarm.	• Check patient status.
• **A Fib**	• MF, WF	Physiological alarm.	• Check patient status.
• **Irregular**	• MF, WF	Physiological alarm.	• Check patient status.
• **Missing Beat**	• MF, WF	Physiological alarm.	• Check patient status.
• **Pause**	• MF, WF	Physiological alarm.	• Check patient status.
• **SV Tachy**	• MF, WF	Physiological alarm.	• Check patient status.

Messages related to impedance respiration measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **Apnea (Imped.)** • **Apnea** • **APN**	• MF • WF • DF, WF	No breathing detected.	• Check patient status. • Check the ventilator and the patient's breathing status.
• **Apnea deactivated**	• DF	The case has recently been patient admitted on the monitor, or the measurement has just been started.	• No action required. The message disappears after the monitor detects breaths.
• **Check electrodes**	• WF, DF	The electrodes touch together.	• Check the electrodes and their connections.
• **Lead I failed** • **Lead II failed** • **Lead RL-LL failed**	• WF, DF	One of the electrodes is off.	• Check the electrodes and their connections.
• **Learning**	• WF, DF	The patient's breathing pattern is being learned because the measurement has just been started or because of very large artifacts in the signal.	• Wait until the message disappears.
• **Measurement off** • **OFF**	• WF, DF • DF	ECG leads are not connected to the patient. Measurement has been turned off from the setup menu.	• Connect the ECG leads to the patient to start the impedance respiration measurement. • Turn on the measurement from the setup menu.
• **Resp artifact**	• WF, DF	Artifact has been detected.	• Check patient status. • Check electrode placement and skin to electrode contact. • Select alternate leads to monitor. • Adjust average time.
• **RR (Imped.) high** • **RR (Imped.) low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **Small resp curve**	• DF	Signal amplitude < 0.4 Ohm	• Check patient status. • Check the electrodes placement.

Messages related to SpO_2 measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **Check Device**	• DF	Only for Masimo type. Module malfunction.	• If the problem persists, contact authorized service personnel.
• **Check SpO2 probe**	• MF	There is no detectable SpO_2 signal, the sensor is faulty or is detached from the patient.	• Check the sensor and connections.
• **Check Probe**	• DF		
• **Faulty Probe**	• DF	The sensor has failed, or not compatible.	• Replace the sensor.
• **Identical SpO2 modules**	• MF	There are two or more identical SpO_2 modules are connected to the same monitor.	• Remove identical SpO_2 modules.
• **Incompatible Probe**	• DF	Only for GE TruSignal or Masimo type. The sensor is not compatible.	• Replace the sensor.
• **Incompatible SpO2 Probe**	• MF	The sensor is not compatible.	• Replace the sensor.
• **Interference**	• DF	Only for Nellcor or Masimo type. The measurement is disturbed.	• Check the sensor.
• **Low Perfusion**	• DF	Only for Masimo type. Low perfusion at the measurement point.	• Check the sensor and sensor positioning. • Relocate the sensor to a better measurement site, if possible. • Make sure the patient is not shivering.
• **Low signal quality**	• DF	Only for Masimo type. The quality of the signal is questionable.	• Check the sensor and sensor positioning. • Relocate the sensor to a better measurement site, if possible. • Make sure the patient is not shivering.
• **No SpO2 probe** • **No Probe**	• MF • DF	Sensor is not connected to the monitor. Sensor is not compatible.	• Check connection between the sensor and the monitor. • Replace the sensor.
• **No SpO2 pulse** • **No Pulse**	• MF • DF	No pulses detected.	• Try another measuring site.

Message	Location	Possible causes	Suggested actions
• **Poor Signal**	• DF	Only for GE TruSignal type. When the low perfusion is detected.	• Check the sensor and sensor positioning. • Relocate the sensor to a better measurement site, if possible. • Make sure the patient is not shivering.
• **Pulse Search**	• DF	Defective or damaged sensor or cable. Sensor is off of the patient. Detection of a repeatable pulse has stopped.	• Check the sensor and cable. • Reposition or replace sensor.
• **SpO2 faulty probe**	• MF	The sensor has failed, or not compatible.	• Replace the sensor.
• **SpO2 high** • **SpO2 low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **SpO2 measurement removed**	• MF	Only for Nellcor or Masimo type. Lost SpO_2 measurement.	• If the problem persists, contact authorized service personnel.
• **SpO2 module error**	• MF	Only for Nellcor or Masimo type. SpO_2 module has encountered a communication problem.	• If the problem persists, contact authorized service personnel.
• **STP module error**	• MF	Only for GE SpO_2 type. SpO_2 module has encountered a communication problem.	• If the problem persists, contact authorized service personnel.
• **Incompatible Masimo**	• MF	The Masimo version is not compatible.	• Replace the sensor.
• **Identical STP modules**	• MF	Two or more GE STP modules are connected to the same monitor.	• Remove the identical STP modules.
• **SpO2 probe off**	• MF	The finger or earlobe may be too thin or the sensor is off the patient.	• Check patient status. • Reposition the SpO_2 sensor. • Replace the SpO_2 sensor.
• **Probe Off**	• DF		

Messages related to SPI measurement by GE TruSignal

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

NOTE
The SPI messages are shown in the **SE & SPI** digit field only if no Entropy messages are active at the same time.

Message	Location	Possible causes	Suggested actions
• **Incompatible probe**	• DF	The SpO_2 and sensor combination are not compatible.	• Check the compatibility and change the sensor.
• **Irregular pulse**	• DF	Patient is having a cardiac arrhythmia. Since arrhythmia may affect pulse rate and amplitude, the SPI calculation is disabled.	• Check patient status.
• **Learning**	• DF	SPI is being initialized.	• When the measurement is started for the first time, the initialization will take 2 minutes.
• **Noise**	• DF	SpO_2 signal or amplitude is poor. Artifacts are disturbing the measurement.	• Check the patient's hemodynamic stability. • Check the sensor contact and make sure nothing is pulling and/or rubbing against the sensor and that there is no constriction at the sensor site.
• **NIBP cuff inflated**	• DF	There may be some disturbances in the plethysmogram.	• See description of the measurement.
• **No SpO2 signal**	• DF	There is no SpO_2 sensor. The sensor or cable is faulty. The cable or sensor is not properly connected.	• Place the sensor on the patient's finger. • Replace the sensor or cable. • Check all connections.
• **Place SpO2 probe on finger for SPI measurement**	• MF	The SPI measurement is not available for the new case.	• Attach the sensor on patient's finger.

Messages related to NIBP measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **Call service: Error x** where x = 0 - 18	• DF	Technical fault.	• Restart the monitor. • Contact authorized service personnel.
• **NIBP call service error**	• MF		
• **Check NIBP**	• MF	Systolic and/or diastolic results missing.	• Check patient status. • Check NIBP cuff and hoses. • Repeat the measurement.
• **Cuff loose**	• DF	Loose cuff or cuff hose.	• Check the cuff and cuff hose.
• **Cuff occlusion**	• DF	Occlusion during measurement or overpressured cuff.	• Check the cuff.

Message	Location	Possible causes	Suggested actions
• **Cuff overpressure** • **NIBP cuff overpressure**	• DF • MF	NIBP cuff has exceeded the maximum cuff pressure during an NIBP measurement.	• Check NIBP cuff and hoses.
• **Long measurement time**	• MF, DF	The measurement time is long. The triggering values vary according to the module and inflation limits in use: • >2 min for adult/ child, 75 s to 80 s for infant	• Check patient status. • Check the cuff and hose connections. • Restart the measurement.
• **NIBP manual**	• MF	During auto cycling • Loose cuff or cuff hose. • Long measurement time	• Check whether the cuff or the cuff hose are loose.
• **NIBP cuff loose**	• MF	Loose cuff or cuff hose.	• Check whether the cuff or the cuff hose are loose.
• **NIBP cuff occlusion**	• MF	Occlusion during measurement or overpressured cuff.	• Check the cuff.
• **NIBP DIA high** • **NIBP DIA low** • **NIBP MAP high** • **NIBP MAP low** • **NIBP SYS high** • **NIBP SYS low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **NIBP measurement removed**	• MF	Lost NIBP measurement.	• If the problem persists, contact authorized service personnel.
• **Select cuff size**	• MF	Cuff size has not been selected.	• Select a valid cuff size from NIBP menu.
• **Unstable zero pressure**	• DF	Pressure is unstable at start of the NIBP measurement.	• Check patient status. • Check hose and cuff position. • Repeat the measurement. • If the problem persists, contact authorized service personnel.
• **Weak pulsation**	• MF, DF	Weak or unstable oscillation signal.	• Check patient status. • Reposition the cuff. • Repeat the measurement.

Messages related to invasive pressures measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **P1 over range** • **P2 over range** • **P8 over range**	• MF	Measurement is over range, or the sensor is faulty. Transducer has not been zeroed correctly.	• Check the patient's pressure by alternative means. • Check the cable and connections. • Rezero the transducer. • Replace the sensor. • Replace the transducer. • If the problem persists, contact authorized service personnel.
• **Over range > 320 mmHg** • **Over range > 43 kPa**	• DF		
• **P1 under range** • **P2 under range** • **P8 under range**	• MF	Measurement is under range, or the sensor is faulty. Transducer has not been zeroed correctly.	• Check the patient's pressure by alternative means. • Check the cable and connections. • Rezero the transducer. • Replace the sensor. • Replace the transducer. • If the problem persists, contact authorized service personnel.
• P1, P2: **Under range < -40 mmHg** • P8: **Under range < -30 mmHg** • P1, P2: **Under range < -5 kPa** • P8: **Under range < -4 kPa**	• DF		
• **ABP disconnect** • **Art disconnect** • **UAC disconnect**	• MF	Invasive pressure line is disconnected.	• Check patient status. • Check connections. • If pressure drops because of zeroing, perform the zeroing process.
• **ABP Sys high** • **ABP Sys low** • **ABP Mean high** • **ABP Mean low** • **ABP Dia high** • **ABP Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **Art Sys high** • **Art Sys low** • **Art Mean high** • **Art Mean low** • **Art Dia high** • **Art Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **Calibrated**	• Menu	Channel calibrated successfully.	• Wait until the message disappears before starting a measurement.
• **Calibrating**	• Menu	Calibration of a channel is in progress.	• No action required.
• **Failed**	• Menu	Unsuccessful calibration.	• If the problem persists, contact authorized service personnel.
• **Failed: P<100**	• Menu	Unsuccessful calibration.	• If the problem persists, contact authorized service personnel.

Message	Location	Possible causes	Suggested actions
• **CVP Sys high** • **CVP Sys low** • **CVP Mean high** • **CVP Mean low** • **CVP Dia high** • **CVP Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **IBP1 Sys high** • **IBP1 Sys low** • **IBP2 Sys high** • **IBP2 Sys low** • **IBP8 Sys high** • **IBP8 Sys low** • **IBP1 Mean high** • **IBP1 Mean low** • **IBP2 Mean high** • **IBP2 Mean low** • **IBP8 Mean high** • **IBP8 Mean low** • **IBP1 Dia high** • **IBP1 Dia low** • **IBP2 Dia high** • **IBP2 Dia low** • **IBP8 Dia high** • **IBP8 Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **ICP Sys high** • **ICP Sys low** • **ICP Mean high** • **ICP Mean low** • **ICP Dia high** • **ICP Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **InvBP's not zeroed** • **Not Zeroed**	• MF • DF	There is at least one invasive pressure channel that has not been zeroed.	• Perform zeroing for all channels.
• **LAP Sys high** • **LAP Sys low** • **LAP Mean high** • **LAP Mean low** • **LAP Dia high** • **LAP Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **No Px transducer**	• MF	No transducer connected to the channel indicated in the message, or the sensor is faulty.	• Connect a transducer. • Check the cable and connections. • Replace the sensor. • Replace the transducer.

Message	Location	Possible causes	Suggested actions
• **PA Sys high** • **PA Sys low** • **PA Mean high** • **PA Mean low** • **PA Dia high** • **PA Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **STP measurements removed**	• MF	Lost GE SpO_2, Temperature, IBP measurement.	• Restart monitor. • If the problem persists, contact authorized service personnel.
• **RAP Sys high** • **RAP Sys low** • **RAP Mean high** • **RAP Mean low** • **RAP Dia high** • **RAP Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **RVP Sys high** • **RVP Sys low** • **RVP Mean high** • **RVP Mean low** • **RVP Dia high** • **RVP Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **UAC Sys high** • **UAC Sys low** • **UAC Mean high** • **UAC Mean low** • **UAC Dia high** • **UAC Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **UVC Sys high** • **UVC Sys low** • **UVC Mean high** • **UVC Mean low** • **UVC Dia high** • **UVC Dia low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **Zero adj > 100 mmHg**	• DF	IBP channel zeroed to over 100 mmHg pressure.	• Repeat the transducer zeroing. • Replace the sensor. • Replace the transducer. • Re-zero the pressure channel.
• **Zeroed**	• DF	Zeroing was successful.	• No action required. Message is automatically removed after 10 seconds.
• **Zeroing**	• DF	IBP channel is currently being zeroed.	• No action required. Message is automatically removed and replaced with the zeroing results after completion.

Message	Location	Possible causes	Suggested actions
• **Zeroing failed**	• DF	Pulsating waveform detected. Defective transducer Offset is >150 mmHg.	• Open the transducer to room air and zero the channel. • Replace the transducer, open it to room air, and zero the channel.
• **Zero ICP separately**	• MF	The ICP channel must be zeroed separately from all other invasive pressures.	• Zero the channel using the **Zero** option found under the ICP channel setup menu.
• **Out of range**	• DF	Measurement is over range, or the sensor is faulty. Transducer has not been zeroed correctly.	• Check the patient's pressure by alternative means. • Check the cable and connections. • Rezero the transducer. • Replace the sensor. • Replace the transducer. • If the problem persists, contact authorized service personnel.

Messages related to temperature measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **Performing temp test**	• DF	Temperature is calibrating.	• No action required.
• **STP measurements removed**	• MF	Lost GE SpO_2, Temperature, IBP measurement.	• Restart monitor. • If the problem persists, contact authorized service personnel.
• **T1 high** • **T1 low** • **T2 high** • **T2 low** • **Tblood high** • **Tblood low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **Temperature error** • **T1 temperature error** • **T2 temperature error**	• DF • MF	Hardware or calibration test failure in the measurement device.	• Change the cable. • If the problem persists, contact authorized service personnel.

Messages related to C.O. measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

For IBP8 and Tblood messages please refer to IBP and Temperature message section.

Message	Location	Possible causes	Suggested actions
• **C.O. Complete**	• C.O. menu	The C.O. measurement is completed but not ready for the next C.O. determination.	• Wait until the message disappears.
• **C.O. measurement removed**	• MF	E-COP module has been removed.	• Reconnect the module if necessary.
• **C.O. module error**	• MF	Communication between monitor and module contain errors.	• Reconnect the module. • If the problem persists, contact authorized service personnel.
• **C.O. out of range**	• C.O. menu	The measurement results are invalid.	• Perform a new measurement.
• **Calibration Timeout**	• C.O. menu	30 minutes have passed since the first intermediate measurement.	• Perform a new calibration.
• **Confirm C.O.**	• DF, MF	The C.O. measurement is stopped within 30 minutes since it started, or when the measurement data has not been confirmed.	• Perform a new measurement.
• **Curve over range**	• C.O. menu	Thermodilution waveform values are over the valid range.	• Wait for the blood temperature to stabilize and retry the measurement.
• **Curve under range**	• C.O. menu	Thermodilution waveform values are under the valid range.	• Wait for the blood temperature to stabilize and retry the measurement.
• **Identical C.O. modules**	• MF	There are two or more C.O. modules in the system.	• Remove all but one C.O. module.
• **Inject now!**	• C.O. menu	A prompt text during the C.O. measurement.	• Inject the injectate solution smoothly within 4 to 5 seconds.
• **Irregular curve**	• C.O. menu	Thermodilution waveform is irregular.	• Perform a new measurement.
• **Irregular HR**	• C.O. menu	HR measurement values are irregular.	• Check patient status.
• **Measuring**	• C.O. menu	Determining the C.O. value.	• Wait until the message disappears.
• **No C.C. Check C.O. setup**	• C.O. menu	The computation constant is not selected by user if catheter type is **User Defined**.	• Check the C.O. setup selections.
• **No catheter**	• C.O. menu	No catheter connected.	• Connect a catheter.

Message	Location	Possible causes	Suggested actions
• **No HR for REF**	• C.O. menu	REF measurement cannot be done. ECG source is telemetry.	• Check that the patient's heart rate is being monitored. • Add HR measurement if needed.
• **No injectate temp probe**	• C.O. menu	No injectate temperature probe connected.	• Connect an injectate temperature probe.
• **Noisy baseline**	• C.O. menu	Changes in patient's blood temperature affect C.O. measuring.	• Check patient status. • Check the blood temperature connector.
• **No module**	• C.O. menu	No C.O. module connected.	• Connect a C.O. module to measure cardiac output.
• **Please wait**	• C.O. menu	A failed, canceled, or stopped C.O. determination and the module not yet ready for the next measurement.	• Wait until the message disappears.
• **Press Start C.O.**	• C.O. menu	A prompt text during the C.O. measurement.	• Proceed with the measurement by selecting **Start C.O.** You can also use the `Start C.O.` module key.
• **Press Start C.O. Serial**	• C.O. menu	A prompt text during the serial C.O. measurement.	• Proceed with the measurement by selecting **Start C.O.** You can also use the `Start C.O.` module key.
• **REF out of range**	• C.O. menu	The result of REF measurement is invalid.	• Perform a new measurement.
• **Service C.O. module**	• MF	Blood temperature is inaccurate.	• Check the catheter position. • Check that there is no heat or cold source near the catheter. • The temperature sensor may be damaged; replace the catheter.
• **Tblood over range**	• C.O. menu	Blood temperature is over the limit: 43°C (109.4°F)	• Check the catheter position. • Check that there is no heat or cold source near the catheter. • The temperature sensor may be damaged; replace the catheter.
• **Tblood under range**	• C.O. menu	Blood temperature is under the limit: 17.5°C (63.5°F)	• Check the catheter position. • Check that there is no heat or cold source near the catheter. • The temperature sensor may be damaged; replace the catheter.
• **Tinj high**	• C.O. menu	Injectate temperature is too close to blood temperature or too warm.	• Use colder injectate.
• **Tinj low**	• C.O. menu	Injectate temperature is too low for current catheter.	• Use warmer injectate.
• **Unstable Tblood**	• DF, C.O. menu	Measurement in auto mode detects the unstable baseline patient temperature.	• Check patient status. • Change C.O. measurement to manual mode and repeat the measurement.

Messages related to gases measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **Agent Mixture**	• MF	Mixture of halogenated agents is detected.	• Check the ventilator and agent vaporizer settings.
• **Agent inaccurate**	• MF	For E-sC(Ai)O and N-CAiO module: Agent inaccurate and $FiO_2 \leq 100\%$	• Check gas levels. • Check patient status.
• **Apnea** • **Apnea (CO2)** • **APN**	• WF • MF • DF	No breathing detected.	• Check patient status. • Check the ventilator and breathing status.
• **Apnea deactivated**	• DF	A new patient has been admitted, or the measurement has been started and the apnea alarm is not active yet.	• Wait. The message disappears after the monitor detects 3 breaths during the last minute.
• **Calibrating gas sensor**	• WF	Due to the module warm-up, CO_2 measurement is not available during the first minute after the module has been connected.	• Wait until the warm-up has been completed.
• **Check sample gas out**	• MF, WF, DF	The water trap is not connected, the sample gas outflow is blocked, or there is a leak inside the module.	• Check water trap connection. • Remove the blockage from the sample gas outlet. • Change module, if needed.
• **Check water trap and sample gas out. Wait 30 sec and press Home to continue.**	• WF	The water trap is not connected, the sample gas outflow is blocked, or there is a leak inside the module.	• Check patient status. • Check water trap connection. • Remove the blockage from the sample gas outlet. • Change module, if needed.
• **Check water trap**	• MF, WF, DF		
• **Continuous blockage. Check sample line and water trap.**	• WF	The gas sampling line is blocked or the water trap is occluded.	• Change sampling line and water trap.
• **Sample line blocked**	• MF, WF, DF		
• **CO2 over scale**	• WF	Gas signal exceeds the maximum waveform field.	• Check patient status. • Select a larger scale for waveform.
• **CO2 inaccurate**	• MF	For E-sC(Ai)O and N-CAiO module: CO_2 inaccurate and $FiO_2 \leq 100\%$ For E-miniC module: EtCO2 value > 20%.	• Check gas levels. • Check patient status.

Message	Location	Possible causes	Suggested actions
• **Failure in Agent ID**	• MF • DF	An unknown agent or three or more agents detected. Vaporizer may contain a mixture of agents.	• Flush the breathing circuit with O_2 flush (O_2 +, 100% O_2). • Empty the vaporizer and refill from an unopened container.
• **EtCO2 high** • **EtCO2 low** • **EtO2 high** • **EtO2 low** • **EtHal high** • **EtEnf high** • **EtIso high** • **EtSev high** • **EtDes high** • **EtHal low** • **EtEnf low** • **EtIso low** • **EtSev low** • **EtDes low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **FiCO2 high** • **FiCO2 low** • **FiO2 high** • **FiO2 low** • **FiHal high** • **FiEnf high** • **FiIso high** • **FiSev high** • **FiDes high** • **FiHal low** • **FiEnf low** • **FiIso low** • **FiSev low** • **FiDes low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **FiN2O high**	• MF	FiN2O ≥ 82%	• Check patient status.
• **Gas measurements removed**	• MF	Acquisition module has been removed.	• Connect the module if you want to restart the measurement.
• **Gas module standby**	• MF	Acquisition module has shut down the gas pump.	• No action required. • To exit the standby mode, touch any field of screen. • If needed, you can also turn on the pump from CO_2 menu.
• **Standby**	• DF		
• **Gas module standby. Touch to activate.** • **Gas module standby. Start from CO2 menu.**	• WF		
• **Identical gas modules**	• MF	There are two or more identical gas modules in the system.	• Remove all but one gas modules.

Message	Location	Possible causes	Suggested actions
• **Low gas sample flow**	• MF	Sample flow is less than 80% of the module's nominal flow value. This can happen if nebulized medications are given without disconnecting the sample line.	• Check the sample line. • If the problem persists, contact authorized service personnel.
• **Multiple agents present**	• MF, WF, DF	Mixture of 2 agents are detected.	• Check if the anesthetic agents are more than one. • Check patient status.
• **N2O inaccurate**	• MF	For E-sC(Ai)O and N-CAiO module: N_2O inaccurate and $FiO_2 \leq 100\%$ and EtN_2O or $FiN_2O > 2\%$.	• Check gas levels. • Check patient status.
• **O2 inaccurate**	• MF	O_2 inaccurate and $FiO_2 \leq 100\%$.	• Check gas levels. • Check patient status.
• **Replace water trap**	• MF	Water trap is partially blocked.	• Replace the water trap.
• **RR (CO2) high** • **RR (CO2) low**	• MF	Measurement values are equal to or outside the set alarm limits.	• Check patient status. • Adjust alarm limits if necessary.
• **Service gas module**	• WF, MF	Ambient pressure is too high or too low. No response from the gas module, high temperature inside the module, or EEPROM checksum failure.	• If the problem persists, contact authorized service personnel.

Messages related to spirometry measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **Ppeak low** / **Ppeak high** • **MVexp low** / **MVexp high** • **TVexp low** / **TVexp high**	• MF	Measurement values are equal to or outside the set alarm limit.	• Check the patient status. • Adjust alarm limits if necessary.
• **Anes: Apnea**	• MF	No breathing detected.	• Check the patient status. • Check the equipment connections.
• **Anesthesia interface removed**	• MF	The anesthesia machine has been disconnected from the monitor.	• Reconnect the cables if you want to restart the measurement.
• **Anesthesia incompatible device**	• MF	The connecting device is not compatible.	• Replace with a compatible device. For information regarding the compatible devices, see the supplemental information.

Messages related to Entropy measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible explanations	Suggested actions
• **Artifacts**	• DF	Signals contain noise or artifact.	• Check sensor contact. • Remove sources of excessive noise.
• **Automatic check off**	• DF	Automatic sensor check has been turned off.	• If required, activate the automatic check from the Entropy menu.
• **Cable off**	• DF	The Entropy sensor cable is not connected to the Entropy module.	• Connect the Entropy cable to the Entropy module.
• **Entropy cable off**	• MF		
• **Checking sensor**	• DF, WF	Sensor check is in progress.	• Wait until the check is over. Check results are displayed.
• **Confirm sensor electrode 1** • **Confirm sensor electrode 2** • **Confirm sensor electrode 3**	• DF	One of the sensor electrodes has poor contact.	• Confirm proper sensor electrode 1, 2 or 3 contact as indicated in the message.
• **Confirm sensor electrodes**	• DF	More than one of the sensor electrodes have poor contact.	• Confirm proper electrode contact.
• **Entropy measurement removed**	• MF	Acquisition module has been removed.	• Connect the module if you want to restart the measurement.
• **Entropy RE high** • **Entropy RE low**	• MF	Measurement values are equal to or outside the alarm limits.	• Check patient status. • Adjust alarm limits if necessary. • Adjust drug titration.
• **Entropy SE high** • **Entropy SE low**	• MF	Measurement values are equal to or outside the alarm limits.	• Check patient status. • Adjust alarm limits if necessary. • Adjust drug titration.
• **Entropy sensor check failed**	• MF	The sensor has not passed the impedance check.	• Check sensor placement and attachment. • Confirm proper contact of each electrode in the sensor. • Replace the sensor.
• **Sensor check failed**	• DF		
• **Entropy sensor off**	• MF	The sensor is connected to the cable but not attached to the patient, or the sensor type is not correct.	• Check that the sensor is properly attached to the patient. • Check that the sensor is an Entropy sensor.
• **Sensor off**	• DF		

Message	Location	Possible explanations	Suggested actions
• **Identical Entropy modules**	• MF	There are two or more Entropy modules in the system.	• Remove all but one Entropy module.
• **Isoelectric EEG**	• DF, WF	Isoelectric (flatline) EEG detected in Entropy measurement.	• Check the patient status. The patient's anesthetic status may be unnecessarily deep.
• **Low signal**	• DF	Measured EEG signal is too low for reliable Entropy calculation.	• Check sensor placement. • The patient may be in total suppression; check the patient status.
• **No sensor**	• DF	The Entropy sensor is not connected to the cable, or the sensor and cable are not compatible.	• Check connection between Entropy sensor and cable. • Check that the cable and sensor are compatible.
• **No Entropy sensor**	• MF		
• **Noise**	• WF	Unreliable Entropy calculation or distorted EEG waveform may appear during electrosurgery or other high frequency noise.	• Interpret Entropy values with caution.
• **Starting up**	• DF	The sensor check has been passed and the Entropy measurement is starting.	• Wait for about 30 seconds. Entropy values appear automatically.

Messages related to NMT measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **Block recovery**	• MF	Count number has reached the value you have selected for the recovery note function.	• Check patient status.
• **Check electrodes**	• DF	Adjusted stimulus current could not be delivered properly due to a broken connection of the stimulating electrode or cable.	• Check the white and brown stimulating electrodes and their connections. • Check the cable. • Change the cable if necessary.
• **Identical NMT modules**	• MF	There are two or more NMT modules in the system.	• Remove all but one NMT module.
• **Measurement off**	• DF	The measurement has been stopped.	• Restart the measurement if required.
• **NMT cable removed** • **Sensor off**	• MF • DF	The NMT cable and sensor have been disconnected from the module.	• Reconnect the cable and sensor if you want to restart the measurement.

Message	Location	Possible causes	Suggested actions
• **NMT measurement removed**	• MF	Acquisition module has been removed.	• Connect the module if you want to restart the measurement.
• **Reference not stable**	• DF	Reference setting fails because responses differ more than 10%: • The patient has been given relaxants. • There are movement artifacts.	• Stop measurement, reposition electrodes and restart the measurement.
• **Reference set**	• DF	The reference setting has been set.	• Wait until the message disappears.
• **Response too weak**	• DF	The measurement cannot be performed because the response is too weak. The maximum gain is insufficient to increase the response signal amplitude to a measurable level: • Stimulus electrodes are loose. • Response electrodes are attached to a wrong place.	• Check electrode placement and connections. • Replace dry electrodes. • Check that the stimulus current is not too weak.
• **Setting reference**	• DF	Automatic reference search is in progress.	• Wait until the reference search is completed.
• **Start measurement**	• DF	Sensor check has been passed.	• Wait until the message disappears.
• **Supramax not found**	• DF	Supramaximal stimulus current was not found. 70 mA is used as stimulus current.	• Stop measurement, reposition the stimulating or recording electrodes and restart the measurement.
• **Supramax search**	• DF	Supramaximal stimulus current search is in progress.	• Wait until the search is completed.
• **Wait to continue**	• DF	Waiting period after tetanic stimulation and/or PTC is started.	• Wait until the message disappears.

Messages related to BIS measurement

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible explanations	Suggested actions
• **Artifact**	• WF, DF	Signals contain noise or artifact.	• Check sensor contact. • Remove sources of excessive noise.
• **Automatic check off**	• DF	Automatic sensor check has been turned off.	• If required, activate the automatic check.

Message	Location	Possible explanations	Suggested actions
• **BIS Apply sensor** • **Apply sensor**	• MF • DF	The sensor connection to the patient may be loose.	• Press the BIS sensor electrodes to improve connection.
• **BIS high** /**BIS low**	• MF	Measurement values are equal to or outside the alarm limits.	• Check patient status. • Check the dosage of anesthetics. • Adjust alarm limits if necessary.
• **BIS DSC error** • **DSC error**	• MF • DF	The BISx is not communicating or operating properly.	• Test the BISx. • Replace the BISx unit.
• **BIS measurement removed**	• MF	The module or BISx is disconnected.	• Connect the module or BISx to start the measurement.
• **BIS module error** • **Module error**	• MF • WF, DF	The module is not working properly.	• Check cable and connections. • Replace the BISx unit. • Replace the module.
• **BIS sensor check failed** • **Sensor check failed**	• MF • WF, DF	The sensor has not passed the impedance check.	• Check sensor placement and connection.
• **BIS sensor expired** • **Replace sensor**	• MF • DF	The sensor date has expired, the sensor has been used too many times, or the validity time for the sensor cannot be determined.	• Replace the sensor.
• **Checking sensor**	• WF, DF	The sensor checking is ongoing.	• The checking results are displayed after the checking ends. • If the test fails, check electrode connections.
• **Demo data**	• WF, DF	BIS simulator is connected.	• Disconnect the BIS simulator.
• **High BIS impedance**	• MF	The BIS impedance is too high.	• Check electrode connections.
• **Identical BIS modules**	• MF	There are two or more BIS modules in the system.	• Remove all but one BIS module.
• **Incompatible sensor**	• WF, DF	An non-BIS sensor is connected.	• Make sure that you are using a Medtronic BIS sensor.
• **No BIS sensor** • **No sensor**	• MF • WF, DF	The sensor is not connected to the digital signal processing unit BISx.	• Check the sensor connection to BISx and PIC (patient interface cable).
• **Poor signal**	• WF, DF	The BIS cannot be calculated because the SQI is below 50.	• Check electrode connections.
• **Testing DSC**	• WF, DF	The BISx test has been activated.	• Wait until the check is completed. • If the test result is FAIL, repeat the test. • If the problem persists, replace the BISx.

Messages related to trends, snapshots, OxyCRG, and full disclosure

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **Check OxyCRG**	• MF	A new OxyCRG snapshot has been created. (After a warm start and continuing to monitor the previous patient, this message is still present.)	• Check OxyCRG snapshot, if needed.
• **Creating OxyCRG snapshot**	• MF	HR is out of limit SpO_2 is out of limit Apnea time is out of limit	• No action required.
• **End of 20 min trend data**	• MF	There is more trend data available but not with current resolution.	• Change the time resolution in graphic trends to be more than 20 minutes (e.g., 1 hour, 2 hours). • Scroll the trends to see past data.
• **No storage Full disclosure disabled**	• MF	The storage disk not recognized by monitor.	• If the problem persists, contact authorized service personnel.
• **No more space Full disclosure disabled**	• MF	Insufficient disk storage for full disclosure data.	• Contact authorized service personnel.
• **Mark X** (where xxx = snapshot sequence number)	• MF	A snapshot has been taken manually.	• No action required.
• **Snapshot created**	• MF	A snapshot has been created.	• No action required.
• **Snapshot memory full. Oldest snapshot erased.**	• MF	You are trying to save a snapshot but the memory capacity is full.	• No action required.
• **Storage fail Full disclosure failure**	• MF	Writing to storage failed.	• If the problem persists, contact authorized service personnel.

Messages related to various situations

For information regarding alarm priorities and escalation times, see the supplemental information manual.

Make sure you are familiar with the generic layout of the screen. This will help you identify where on screen the following messages appear. The message location is indicated with the following abbreviations:

- MF = message field
- WF = waveform field
- DF = digit field

Message	Location	Possible causes	Suggested actions
• **Alarm setup changed from Central**	• MF	The alarm setup is retrieved from the central station.	• Check the alarm settings and adjust if necessary.
• **Alarms reset remotely**	• MF	The alarms were remotely paused from the remote device.	• No action required.
• **Alarm volume changed**	• MF	The network connection is lost, and the local alarm volume is increased.	• Readjust volume if needed.
• **All monitors disconnected** (Bed to Bed)	• MF	The monitor is disconnected from the network.	• Re-establish connection. • If the problem persists, contact authorized service personnel.
• **Audio fail**	• MF	The system can't communicate with audio chip hardware.	• Check patient status. • If the problem persists, contact authorized service personnel.
• **Barcode scanned**	• MF	All data has been successfully stored to the monitor.	• No action required.
• **Barcode too long**	• MF	The maximum length of the barcode has been exceeded.	• Verify the information read by the barcode reader and edit if necessary.
• **Battery empty**	• MF	The monitor is battery powered and less than 5 min of monitoring time is available with battery.	• Charge the battery by using the monitor on main power.
• **Battery low**	• MF	The monitor is battery powered and less than 20 min of monitoring time is available with battery.	• Charge the battery by using the monitor on main power.
• **Battery temperature high**	• MF	The battery’s temperature is too high.	• If the problem persists, contact authorized service personnel.
• **Call service UMBC error**	• MF	UMBC communication error, and UMBC communication is disabled.	• Contact authorized service personnel.
• **Certificate close to expiration**	• MF	The CA and client certificate in system time is 0-14 days before expire time.	• Contact authorized service personnel to install another CA certificate.
• **Certificate expired**	• MF	CA and client certificate is expired.	• Contact authorized service personnel to install another CA certificate.
• **Condition battery**	• MF	Battery is not working properly.	• Connect AC main to condition battery. • If the problem persists, contact authorized service personnel.

Message	Location	Possible causes	Suggested actions
• **CS Gateway communication failure**	• MF	An error occurred when trying to search for patient on the CARESCAPE Gateway.	• Check the network connectivity. • Check whether the CARESCAPE Gateway is offline. • Retry loading from the network. • If the problem persists, contact authorized service personnel.
• **DEMO MODE**	• MF	DEMO mode has been enabled.	• To exit the DEMO mode: Contact authorized service personnel.
• **E-Manual lost**	• MF	E-manual is not available.	• Contact authorized service personnel.
• **Entering standby**	• MF	Activate standby has been selected.	• No action required.
• **Frame temperature high**	• MF	The temperature inside the frame is over 70°C/158 °F.	• Turn off the monitor, wait for it cool down. • Make sure there is sufficient ventilation. • Check and clean monitor ventilation holes.
• **Identical IP address noticed**	• MF	Two or more monitors on the network have the same IP address.	• Contact authorized service personnel.
• **Identical unit&bed name noticed**	• MF	Two or more monitors in the network have the same unit and bed name.	• Disconnect the patient monitor that has the identical unit and bed name. • Change the unit and bed name of the duplicate patient monitor unit and bed name.
• **Incorrect barcode value**	• MF	The barcode string differs from the defined values.	• Contact authorized service personnel.
• **Invalid barcode configuration**	• MF	The barcode configuration is not correct.	• Contact authorized service personnel.
• **License invalid**	• MF	License is invalid during start up.	• Contact authorized service personnel.
• **Monitor disconnected** (Bed to Bed)	• MF	The monitor with alarm notification enabled is disconnected from the network.	• Re-establish the connection.
• **Motion Sensor Start Failed** (not for device with VSP 4.0 Upgrade Software)	• MF	The motion sensor for alarm gesture start failed for 10 times continuously.	• Restart the monitor. • If the problem persists, contact authorized service personnel.
• **Network: HL7**	• MF	When network connection between HL7 TCP Client application and monitor is made.	• No action required.
• **Network down: HL7**	• MF	No HL7 TCP Client is configured to connect to monitor on the network.	• Try to re-establish the connection. • If the problem persists, contact authorized service personnel.

Message	Location	Possible causes	Suggested actions
• **Network down**	• MF	CARESCAPE Network connection has failed.	• Try to re-establish the connection. • If the problem persists, contact authorized service personnel.
• **Network made**	• MF	When CARESCAPE network is connected.	• No action required.
• **No battery backup**	• MF	Battery missing from the battery compartments.	• Contact authorized service personnel.
• **No patients found**	• MF	No patients were found when searching on CARESCAPE gateway.	• Verify or change search criteria. • Manually enter patient information.
• **No printer selected**	• MF	There is no printer selected on the monitor.	• Select a printer.
• **Patient admitted**	• MF	The current patient has been admitted.	• No action required.
• **Patient discharged**	• MF	The patient has been discharged.	• No action required.
• **Printing**	• MF	Printing is occurring.	• Wait for the printing to finish.
• **Printing Alarm**	• MF	An alarm has triggered printing.	• Wait for the printing to finish.
• **Printer error**	• MF	A printer is not present or the printer needs paper.	• Choose a different printer. • Add paper to the printer.
• **Printing ready**	• MF	Your printing request has been forwarded to the printer.	• No action required.
• **Recorder: cover open**	• MF	The recorder cover is open.	• Close the recorder cover.
• **Recorder: input voltage high** • **Recorder: input voltage low**	• MF	There are problems with the recorder input voltage.	• Contact authorized service personnel.
• **Recorder: out of paper**	• MF	The recorder is out of paper.	• Replace recorder paper.
• **Recorder module removed**	• MF	Recorder module has been removed.	• Reconnect the recorder module if you need.
• **Recorder system error**	• MF	The local recorder is not working.	• Disconnect and reconnect the recorder cable. • If the problem persists, contact authorized service personnel.
• **Recorder thermal array overheat**	• MF	There are problems with the recorder temperature. Long time printing.	• Try stopping the recording. • If the problem persists, contact authorized service personnel.
• **Replace battery**	• MF	Battery is not working properly.	• Replace the battery.
• **Restart needed**	• MF	The monitor should be restarted.	• Restart the monitor.
• **Saving**	• MF	The printing device is not available, and the records are saved for later printing.	• Check the printing device. • Select a printing location.
• **Saving PDF**	• MF	The patient data are exporting to USB in PDF format	• No action required.

Message	Location	Possible causes	Suggested actions
• **Saving PDF failed**	• MF	The patient data failed to export to USB in PDF format.	• Check whether the USB disk is in FAT32 format, or whether the USB disk's space is full. • Check whether the USB disk is inserted into the correct USB connector.
• **Speaker failure**	• MF	Speaker failure	• Check the patient status. • If the problem persists, contact authorized service personnel.

Abbreviations

List of abbreviations

The abbreviations that appear in the monitor software and manuals. Some abbreviations listed have multiple meanings but are differentiated by the context in which they appear.

/min	beats per minute, breaths per minute
°C	Celsius degree
°F	Fahrenheit degree
µ	micro
12RL	twelve reduced leads
12SL	twelve simultaneous leads
a	arterial
A	auricular alveolar
A Fib	atrial fibrillation
AA	anesthetic agent
AaDO2	alveoli-arterial oxygen difference
AAMI	Association for the Advancement of Medical Instrumentation
AC	alternating current
Accel. Ventric.	accelerated ventricular rhythm
AGSS	anesthetic gas scavenging system
AHA	American Heart Association
AirW	airway temperature
Alpha	alpha frequency band
Alpha%	alpha frequency band percentage
Amp	amplitude
ANATEL	Agência Nacional de Telecomunicações
ANSI	American National Standards Institute
Ant.	anterior
AoA	adequacy of anesthesia
APN	apnea
Arrh	arrhythmia
Art; ABP	arterial pressure
ASA	American Society of Anesthesiologists
ASB	assisted spontaneous breathing

ASY	asystole
ATMP	atmospheric pressure
ATPD	atmospheric/ambient temperature and pressure, dry gas
Auto	continuous NIBP measurement mode
aVF	left foot augmented lead
aVL	left arm augmented lead
AVOA	automatic view on alarm
aVR	right arm augmented lead
Axil	axillary temperature
BAEP	brainstem auditory evoked potential
BE	base excess
Beta	beta frequency band
Beta%	beta frequency band percentage
BIPAP	biphasic positive airway pressure
BIS	bispectral index
BISx	digital signal processing unit
Blad	bladder temperature
BNP	B-type natriuretic peptide
bpm	beats per minute
Brady	bradycardia
BSA	body surface area
BSR	burst suppression ratio
B-to-B	beat-to-beat
BTPS	body temperature and pressure, saturated gas
BUN	blood urea nitrogen
C	central
C (C1 - C6)	chest
C(a-v)O_2	arteriovenous oxygen content difference
C.I.	cardiac index
C.O.	cardiac output
C1 to C6	ECG lead C1 to ECG lead C6
CaO2	arterial oxygen content
cc	cubic centimeter
CCI	continuous cardiac index
CCO	continuous cardiac output
CcO2	capillary oxygen content
CCU	cardiac (coronary) care unit
CFI	Cardiac function index

CIC	Clinical Information Center
CIcalc	cardiac index calculated by Fick equation
CISPR	International Special Committee on Radio Interference
CK-MB	cardiac muscle type creatine kinase
Cl	chlorine
cmH2O	centimeter of water
CMRR	common mode rejection ratio
CNS	central nervous system
CO2	carbon dioxide
COcalc	cardiac output calculated by Fick equation
Compl	compliance
Core	core temperature
Count	count of responses
CPP	cerebral perfusion pressure
CPU	central processing unit
CSA	Canadian Standards Association compressed spectral array
CT	computed tomography
CvO2	venous oxygen content
CVP	central venous pressure
d	day
dB	decibel
DBS	double burst stimulation
DC	direct current
Delta	delta frequency band
Delta%	delta frequency band percentage
DEMO	demonstration (mode)
Des	desflurane
Dia; DIA	diastolic pressure
DO2	oxygen delivery
DO2I	oxygen delivery index
dPmax	Index of left ventricular contractility
DS	dead space ventilation
DSC	digital signal converter
e	estimated
ECG	electrocardiogram
ECT	electroconvulsive therapy
ED	emergency department
EDV	end-diastolic volume

EEG	electroencephalogram
EMC	electromagnetic compatibility
EMG	electromyogram
EMI	electromagnetic interference
EMMV	extended mandatory minute ventilation
Enf	enflurane
EP	evoked potential
ESD	electrostatic discharge electrostatic sensitive devices
Eso	esophageal temperature
ESU	electrosurgical unit
ESV	end-systolic volume
ESVI	end-systolic volume index
ET	endotracheal
ET; Et	end-tidal concentration
EtAA	end-tidal anesthetic agent
EtBal	end-tidal balance gas
EtCO2	end-tidal carbon dioxide
EtN_2O	end-tidal nitrous oxide
EtO_2	end-tidal oxygen
EVLW	Extravascular lung water
Exp; exp	expiratory
F	foot (describing location) frontal
$feCO_2$	mixed expired carbon dioxide concentration
Fem	femoral
FEMG	frontal electromyogram
FemV	femoral venous
feO_2	mixed expired oxygen concentration
FFT	fast Fourier transform
FI; Fi	fraction of inspired gas
FiAA	fraction of inspired anesthetic agent
Fib	fibrillation
FiCO2	fraction of inspired carbon dioxide
FiN_2	fraction of inspired nitrogen
FiN2O	fraction of inspired nitrous oxide
FiO2	fraction of inspired oxygen
Flow; F	flow

Flow-Vol Loop	flow volume loop
Fp	fronto-polar
Fr	French (unit of measure for a Catheter diameter scale)
ft	feet foot
g	gram
g/dl	grams per deciliter
g/l	grams per liter
GND	ground
h	hour
Hal	halothane
Hb	hemoglobin
HbO_2	oxyhemoglobin
HCO3-	bicarbonate
Hct	hematocrit
Hemo	hemodynamic
HFV	high frequency ventilation
HME	heat and moisture exchanger
HMEF	heat and moisture exchanger with filter
hPa	hectopascal
HR	heart rate
HRdif	heart rate difference
Hz	hertz
I	lead I
I.U.	international unit
I:E	inspiratory-expiratory ratio
IABP	intra-aortic balloon pump
iCa	ionized Calcium
ICASA	Independent Communications Authority of South Africa
ICP	intracranial pressure
ICU	intensive care unit
ID	identification
IEC	International Electrotechnical Commission
II	lead II
III	lead III
IM	intramuscular
Imped	impedance
in	inch
Insp; insp	inspiratory

Intellirate	automatic heart rate source selection of PDM
IP	internet protocol invasive blood pressure
IPPV	intermittent positive pressure ventilation
IPPV/ASSIST	intermittent positive pressure ventilation & assisted
IrMod%	infrared modulation percentage
Iso	isoflurane
ISO	International Standards Organization
ITBI	Intrathoracic blood volume index
ITBV	Intrathoracic blood volume
ITTV	Intrathoracic thermal volume
IV	intravenous
J	joule
K	potassium
kcal	kilocalorie
KCC	Korea Communications Commission
kg	kilogram
kJ	kilojoule
kPa	kilopascal
l	liter
l/min	liters/minute
LA	left arm (describing location)
Lab	laboratory
LAN	local area network
LAP	left atrial pressure
lb	pound
LCD	liquid crystal display
LCW	left cardiac work
LCWI	left cardiac work index
LED	light emitting diode
LL	left leg (describing location)
MAC	minimum alveolar concentration
MACage	MAC compensated with patient age, patient temperature, and atmospheric pressure
Man	manual
Man/Spont	manual/spontaneous
MAP	mean arterial pressure
Max.	maximum
mbar	millibar

mcg/l	microgram per liter
mcmol/l	micromole per liter
Mean; M	mean blood pressure
mEq	milliequivalent
mEq/l	milliequivalent per liter
MetHb	methemoglobin
mg	milligram
mg/dl	milligram per deciliter
mI.U.	milli International Unit
min	minute
ml	milliliter
MLAEP	middle-latency auditory evoked potential
mm	millimeter
mmHg	millimeters of mercury
mmol	millimol
mmol/l	millimole per liter
MMV	mandatory minute ventilation
MMV/ASB	mandatory minute ventilation & assisted spontaneous breathing
mol	mole
MRI	magnetic resonance imaging
MRN	medical record number
ms	millisecond
MV	minute volume
MVexp	expired minute volume (l/min)
MVinsp	inspired minute volume (l/min)
MVspont	spontaneous minute volume
Myo	myocardiac temperature
N	neutral
N/A	not applicable
N_2	nitrogen
N2O	nitrous oxide
Na	sodium
Naso	nasopharyngeal temperature
Neo	neonate
Neuro	neurological
ng/l	nanogram per liter
ng/ml	nanogram per milliliter
NIBP	non-invasive blood pressure

NICU	neonatal intensive care unit
NMBA	neuromuscular blocking agent
NMT	neuromuscular transmission
NTPD	normal temperature and pressure, dry gas
O	occipital
O2	oxygen
O2ER	oxygen extraction ratio
OR	operating room
Oxy	oxygenation
P	pressure
Pa	Pascal
PA	pulmonary arterial pressure
Paced	paced beats
PaCO2	partial pressure of carbon dioxide in the arteries
PACU	post anesthesia care unit
PaO_2	partial pressure of oxygen in the arteries
PAO2	partial pressure of oxygen in the alveoli
Paw	airway pressure
Paw-Vol Loop	pressure volume loop
PBSA	Predicted body surface area
PBW	Predicted body weight
pCO2; PCO2	carbon dioxide partial pressure
pcs	pieces
PCV	pressure controlled ventilation
PCV-A/C	pressure controlled ventilation & assisted control
PCV-CMV	pressure controlled ventilation – controlled mandatory ventilation
PCV-CPAP	pressure controlled ventilation & continuous positive airway pressure
PCWP	pulmonary capillary wedge pressure
PCV-SIMV	pressure controlled ventilation & synchronized intermittent mandatory ventilation
PDF	portable document format
PE	polyethylene
Peds	pediatrics
PEEP	positive end-expiratory pressure
PEEPe	extrinsic positive end expiratory pressure (ICU, NICU, ED software packages)
PEEPe+PEEPi	total positive end expiratory pressure (ICU, NICU, ED software packages)
PEEPi	intrinsic positive end expiratory pressure (ICU, NICU, ED software packages)
PEEPtot	total positive end expiratory pressure (OR, PACU software packages)
pg/ml	picogram per milliliter

pH	potential of hydrogen
pHa	arterial pH
pHv	mixed venous pH venous pH
PIC	patient interface cable
Pinsp	inspiratory (target) pressure
Pleth	plethysmographic pulse waveform
Pmean	mean pressure
PN	part number
pO2; PO2	oxygen partial pressure
Ppeak	peak pressure
Pplat	plateau (pause) pressure
PPV	pulse pressure variation
PR	pulse rate
PT	prothrombin time
PTC	post tetanic count
PVC	polyvinyl chloride premature ventricular contraction
PvCO2	carbon dioxide partial pressure in mixed venous blood
PvO2	partial pressure of oxygen in (mixed) venous blood
PVPI	Pulmonary vascular permeability index
PVR	pulmonary vascular resistance
PVRI	pulmonary vascular resistance index
QRS	QRS complex
Qs/Qt	venous admixture
QT	Q-T interval
QTc	corrected value of the QT interval
R	right (describing location)
R on T	early PVC, close to the T wave of the preceding normal beat
RA	right arm (describing location)
RAP	right atrial pressure
Raw	airway resistance
RCW	right cardiac work
RCWI	right cardiac work index
RE	response Entropy
Rect	rectal temperature
REF	right ventricular ejection fraction
Resp Rate	respiration rate (total) (measured)
RF	radio frequency

RL	reduced leadset
RMS	average (root mean square) power
Room	room temperature
RQ	respiratory quotient
RR	respiration rate
RVP	right ventricular pressure
RVSW	right ventricular stroke work
RVSWI	right ventricular stroke work index
s	second
SaO2	arterial oxygen saturation
SB	spontaneous breathing
ScvO2	central venous oxygen saturation
SE	state Entropy
SEF	spectral edge frequency
Sev	sevoflurane
Skin	skin temperature
SL	simultaneous leads
SN	serial number
SO2	saturated oxygen
SPI	surgical pleth index
Spiro	Patient Spirometry
SpO2	oxygen saturation
Spont	spontaneous
SPV	systolic pressure variation
SQ	subcutaneous
SQI	signal quality index
SR	suppression ratio
ST	single twitch ST segment
Stat	five minute continuous NIBP measurement mode
STPD	standard temperature and pressure, dry gas
Supra	supramaximal
Surf	surface temperature
SV	stroke volume supraventricular
SW; sw	software
SVC	supra ventricular contraction
SVI	stroke volume index
SvO2	mixed venous oxygen saturation

SVR	systemic vascular resistance
SVRI	systemic vascular resistance index
SV Tachy	supra ventricular tachycardia
SVV	stroke volume variation
Sync MAS	Synchrom Master
Sync SLV	Synchrom Slave
Sys; SYS	systolic pressure
T	temperature temporal
T(BTPS)	temperature in BTPS conditions
T1	first twitch
T1%	first stimulus as percent of the reference value NMT
Tab	tabular
Tachy	tachycardia
Tblood	blood temperature
TC	transcutaneous
TcCO2	transcutaneous carbon dioxide
TcO2	transcutaneous oxygen
TCO2	total carbon dioxide
Tcorr	patient temperature used to correct pH, PCO_2, PO_2
Temp	temperature
Texp	expiratory time
Theta	theta frequency band
Theta%	theta frequency band percentage
Tinj	injectate temperature
Tinsp	inspiratory time
TOF	train of four
TOF%	train of four percentage
Tpause	pause time
TTX	telemetry transmitter
TV	tidal volume
TVexp	expired tidal volume (ml)
TVinsp	inspired tidal volume (ml)
Tx-Ty	temperature difference
Tymp	tympanic temperature
UAC	umbilical arterial catheter
UI	user interface
UVC	umbilical venous catheter
V	ventricular

V; Vent	ventilation
V (V1-V6)	chest
V Brady	ventricular bradycardia
V Fib	ventricular fibrillation
V Tach	ventricular tachycardia
v	venous
VA	alveolar ventilation
VCO2	carbon dioxide production
Vd	dead space
Vd/Vt	dead space ventilation
Vent	ventilator
WLAN	wireless local area network
VO2	oxygen consumption
VO2calc	calculated oxygen consumption
VO2Icalc	calculated oxygen consumption index
VO2	oxygen consumption index
Vol; V	volume
Vol Assist	volume assisted
VT > 2	ventricular tachycardia with more than two beats
yrs	years

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
BUC 78530 France

GE HealthCare

www.gehealthcare.com