1.2.

Instructions for Use

IntelliVue Patient Monitor

MX100/X3

Release P with Software Revision P.0x.xx

Patient Monitoring

PHILIPS

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Introduction

These Instructions for Use are for clinical professionals using the IntelliVue MX100 patient monitor (867033), and using the X3 Multi-Measurement Module (867030) as a standalone monitor.

For information regarding the use of the X3 as a Multi-Measurement Module with a host monitor, refer to the Instructions for Use for the host monitor.

This introductory section gives you an overview of the monitor and its functions. It tells you how to perform tasks that are common to all measurements (such as entering data, switching a measurement on and off, setting up and adjusting wave speeds, working with profiles). The alarms section gives an overview of alarms. The remaining sections tell you how to perform individual measurements, use individual functionality, and how to care for and maintain the equipment.

Familiarize yourself with all instructions including warnings and cautions, before starting to monitor patients. Read and keep the Instructions for Use that come with any accessories, as these contain important information about care and cleaning that is not repeated here.

This guide describes all features and options. Your monitor may not have all of them; they are not all available in all geographies. Your monitor is highly configurable. What you see on the screen, how the menus appear and so forth, depends on the way it has been tailored for your hospital and may not be exactly as shown here.

This guide may contain descriptions of functionality and features that are not implemented in the equipment currently shipped to Japan and/or of products that are not currently sold in Japan due to limitations and restrictions under the applicable local laws and regulations in Japan. Contact your local sales representative and/or Philips Customer Support for details.

In this guide:

- A **warning** alerts you to a potential serious outcome, adverse event or safety hazard. Failure to observe a warning may result in death or serious injury to the user or patient.

- A **caution** alerts you to where special care is necessary for the safe and effective use of the product. Failure to observe a caution may result in minor or moderate personal injury or damage to the product or other property, and possibly in a remote risk of more serious injury.

- A **contraindication** describes a situation, such as patient population, medical reason, or clinical condition, in which a device may not be used because the risk of use clearly outweighs any possible benefit. Always use clinical judgment to decide whether the benefit of using the device / the measurement in a specific situation outweighs the risk.

- **Monitor** refers to the entire patient monitor. **Display** refers to the physical display unit. **Screen** refers to everything you see on the monitor's display, such as measurements, alarms, patient data and so forth.

Use the monitors and accessories according to their intended use, as stated and described in these Instructions for Use. Disregarding the contents of the Instructions for Use is considered abnormal use.

For installation, repair, testing and troubleshooting instructions, refer to the Service Guide for your monitor model.

Rx only: U.S. Federal Law restricts this device to sale by or on the order of a physician.

Safety Information

The following warnings apply to the monitors in general. Warnings that apply to specific measurements or procedures can be found in the corresponding chapters.

Electrical Hazards and Interference

WARNING

Electrical shock hazard: Do not open the monitor or measurement device. Contact with exposed electrical components may cause electrical shock. Refer servicing to qualified service personnel.

Leakage currents: If multiple instruments are connected to a patient, the sum of the leakage currents may exceed the limits given in:

- IEC/EN 60601-1
- ANSI/AAMI ES60601-1
- CAN/CSA C22.2 No. 60601-1:14

Consult your service personnel.

Radio frequency interference: The monitor generates, uses and radiates radio-frequency energy, and if it is not installed and used in accordance with its accompanying documentation, may cause interference to radio communications.

Use Environment

WARNING

Explosion Hazard: Do not use in the presence of flammable anesthetics or gases, such as a flammable anesthetic mixture with air, oxygen or nitrous oxide or in the presence of other flammable substances in combination with air, oxygen-enriched environments, or nitrous oxide. Use of the devices in such environments may present an explosion hazard.

Positioning Equipment: The monitor should not be used next to or stacked with other equipment. If you must stack the monitor, check that normal operation is possible in the necessary configuration before you start monitoring patients. Do not position any electronic equipment directly in front of the monitor.

Environmental Specifications: The performance specifications for the monitors, measurements and accessories apply only for use within the temperature, humidity and altitude ranges specified in the environmental specifications in the *Instructions for Use.*

Liquid Ingress: If you spill liquid on the equipment, battery, or accessories, or they are accidentally immersed in liquid, contact your service personnel or Philips service engineer. Do not operate the equipment before it has been tested and approved for further use.

Prohibited Environments: The monitors are not intended for use in an MRI environment or in an oxygen-enriched environment (for example, hyperbaric chambers).

The monitors are also not intended for use within an incubator. For use with a neonate in an incubator, always position the monitor outside of the incubator.

High Ambient Temperatures: Avoid prolonged contact with the monitor housing or display when the ambient temperature is high. When the monitor cannot cool down, the housing and display can become hot to the touch. Ensure that there is no contact between the monitor and the patient, especially during transport and with sedated or unconscious patients. In extreme cases, with very high ambient temperatures, prolonged contact could result in superficial burns.

Out-of-Hospital Use:

Devices used for out-of-hospital transport require an ingress protection of at least IPX3, e.g. IP33. See the Environmental Specifications section for details on ingress protection.

WARNING

- **Liquid Ingress:** If you spill liquid on the equipment, battery, or accessories, or they are accidentally immersed in liquid, contact your service personnel or Philips service engineer. Do not operate the equipment before it has been tested and approved for further use.
  If the connectors of the monitor or the Microstream Extension are exposed to rain, make sure to dry the connector area before plugging in a parameter cable. If the monitor is exposed to rain, dry and wipe the monitor before using it to monitor patients. Note that rain may activate the screen lock.

- **Environmental Specifications:** The performance specifications for the monitors, measurements and accessories apply only for use within the temperature, humidity and altitude ranges specified in the environmental specifications in the Instructions for Use. Individual environmental specifications apply for storage, transport and operating conditions. See the Environmental Specifications section for details.

Alarms

WARNING

- Do not rely exclusively on the audible alarm system for patient monitoring. Adjustment of alarm volume to a low level or off during patient monitoring may result in patient danger. Remember that the most reliable method of patient monitoring combines close personal surveillance with correct operation of monitoring equipment.

- Be aware that the monitors in your care area may each have different alarm settings, to suit different patients. Always check that the alarm settings are appropriate for your patient before you start monitoring.

Accessories

WARNING

Philips' approval: Use only Philips-approved accessories. Using other accessories may compromise device functionality and system performance and cause a potential hazard.

Reuse: Never reuse disposable transducers, sensors, accessories and so forth that are intended for single use, or single patient use only. Reuse may compromise device functionality and system performance and cause a potential cross-infection hazard.

Electromagnetic compatibility: Using accessories other than those specified may result in increased electromagnetic emission or decreased electromagnetic immunity of the monitoring equipment.

Damage: Do not use a damaged sensor or one with exposed electrical contacts. Do not use damaged accessories. Do not use accessories where the packaging has been damaged or opened.

Cables and tubing: Always position cables and tubing carefully to avoid entanglement or potential strangulation.

MR Imaging: During MR imaging, remove all transducers, sensors and cables from the patient. Induced currents could cause burns.

Use-by date: Do not use accessories where the use-by date has been exceeded.

Electrosurgery: Do not use antistatic or conductive endotracheal tubes as they may cause burns in case of electrosurgery.

Security Information

Protecting Personal Information

Protecting personal health information is a primary component of a security strategy. Each facility using the monitors must provide the protective means necessary to safeguard personal information consistent with country laws and regulations, and consistent with the facility's policies for managing this information. Protection can only be realized if you implement a comprehensive, multi-layered strategy (including policies, processes, and technologies) to protect information and systems from external and internal threats.

As per its intended use, the patient monitor operates in the patient vicinity and contains personal and sensitive patient data. It also includes controls to allow you to adapt the monitor to the patient's care model.

To ensure the patient's safety and protect their personal health information you need a security concept that includes:

- **Physical security access measures** - access to the monitor **must** be limited to authorized users. It is essential that you consider physical security measures to ensure that unauthorized users cannot gain access.

- **Operational security measures** - for example, ensuring that patients are discharged after monitoring in order to remove their data from the monitor.

- **Procedural security measures** - for example, assigning only staff with a specific role the right to use the monitors.

In addition, any security concept must consider the requirements of local country laws and regulations.

Always consider data security aspects of the network topology and configuration when connecting patient monitors to shared networks. Your medical facility is responsible for the security of the network, where sensitive patient data from the monitor may be transferred.

When a monitor is returned for repair, disposed of, or removed from your medical facility for other reasons, always ensure that all patient data is removed from the monitor by ending monitoring for the last patient (see "Ending Monitoring for a Patient" on page 104).

NOTE

Log files generated by the monitors and measurement modules are used for system troubleshooting and do not contain protected health data.

When a monitor is returned for repair, disposed of, or removed from your medical facility for other reasons, always ensure that all patient data is removed from the monitor:

- End monitoring for the last patient (see "Ending Monitoring for a Patient" on page 104).

- Perform a cold start of the monitor. In Service Mode, select **Main Setup** > **Hardware** > **Coldstart**.

- Overwrite/clear all passwords, certificates, and network credentials.

OR

Reset the monitor to factory defaults using the Support Tool Mark2.

For details, see the Service Guide and the Support Tool Mark2 Instructions for Use.

- Erase any patient data stored by your applications on the iPC as applicable.

About HIPAA Rules

If applicable, your facility's security strategy should include the standards set forth in the Health Insurance Portability and Accountability Act of 1996 (HIPAA), introduced by the United States Department of Health and Human Services. You should consider both the security and the privacy rules and the HITECH Act when designing policies and procedures. For more information, please visit: http://www.hhs.gov/ocr/privacy/

NOTE

The patient monitor does not use the concept of user accounts and does not provide audit trail capabilities.

About the EU Directives

If applicable, your facility's security strategy should include the practices set forth in the Directive on the protection of individuals with regard to the processing of personal data and on the free movement of such data (Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016). In addition, your facility should also take into account any additional, more stringent standards put forward by any individual EU countries; that is, Germany, France, and so on.

Philips Product Security Policy Statement

Additional security and privacy information can be found on the Philips product security web site at: http://www.usa.philips.com/healthcare/about/customer-support/product-security

Manufacturer Disclosure Statement for Medical Device Security – MDS2

You can view the Manufacturer Disclosure Statements for Medical Device Security (MDS^2) for specific devices at:
http://www.usa.philips.com/healthcare/about/customer-support/product-security

Cyber Security Requirements and Controls

The IntelliVue Patient Monitor cannot be connected to portable media such as USB drives or CDs. Cyber security threats therefore result mainly from network connectivity and may impact safe and secure operation of your network or any devices attached to this network.

As part of your security concept, you are responsible for establishing controls to protect your network and any networked devices, including the IntelliVue Patient Monitor, against such cyber security threats.

Network Cyber Security Measures

Only connect the IntelliVue Patient Monitor to networks that are explicitly intended for that purpose. The monitor is intended to be used for monitoring of, and to generate alarms for, multiple physiological signals of patients. If you connect the monitor to a network, it is therefore highly recommended that you deploy measures for protecting the network against cyber security threats. This includes the deployment of firewalls to limit remote access and antivirus protection of standard computer systems.

Network Security Requirements for Connectivity to Philips Systems

You must follow the network configuration instructions of the specific Philips system product. For the Philips Information Center, the IntelliVue Network Specification provides detailed network configuration requirements associated with the safe and secure operation of Philips IntelliVue devices within your hospital network for the purpose of patient monitoring. The IntelliVue Network Specification ensures the configuration and operation of a logical isolated network (LAN or VLAN) for IntelliVue devices by the configuration of network infrastructure devices (switches, routers, etc.). The document also defines the interconnection of the isolated network with other hospital networks using firewalls as well as the use of antivirus software for computer platforms based on standard operating systems.

Compliance to the IntelliVue Network Specifications is verified by Philips in cooperation with the customer prior to go-live.

If network authentication is configured, the patient monitor uses a Certificate Authority (CA) to establish its identity. The CA plays an important role in the overall network security. You must protect the CA from tampering and physical damage. You must ensure that valid certificates are issued only to trusted devices. Please refer to the Certificate Authority documentation (e.g. PIC iX) for details.

Network Security Requirements for Connectivity to other Systems

To ensure safe and secure operation of networked data collection applications involving IntelliVue Patient Monitors, you must implement network traffic isolation by using dedicated physical or logical networks (isolated VLANs). Network traffic separation can be achieved by configuration of network infrastructure devices (switches, routers and firewalls) as outlined in the IntelliVue Network Specification. Only devices required by the specific system application should share this dedicated network. To prevent malware from affecting network performance or device operation, always ensure that all networked devices with standard operating systems have virus protection installed and kept up to date.

For managing risks in clinical network deployments, Philips recommends that you apply a formal process such as the IEC 80001 series of standards to address safety, effectiveness, and data and system security.

Security Software Updates

All software for the IntelliVue Patient Monitor is completely built and integrated by Philips. There are no separate user-updatable software components from other manufacturers.

Philips authorized software updates for the IntelliVue Patient Monitor, including any potential cyber security updates, are communicated via the Field Change Order Process which is a component of the Philips Quality System. Field Change Orders are published and available on InCenter at: http://incenter.medical.philips.com/.
The procedure on how to install software updates is described within this Field Change Order.

If you have questions about InCenter access, please contact your Philips Patient Monitoring Account Manager or Field Service Engineer.

Incident Reporting

NOTE

Any serious incident that has occurred in relation to this device should be reported to Philips and the competent authority of the member state in which the user and/or patient is established.

In this context, "member state" refers to European Economic Area (EEA) countries including Switzerland and Turkey.

Introducing the IntelliVue MX100

The IntelliVue MX100 monitor provides a comprehensive set of basic physiological measurements, with a color touchscreen display. It can simultaneously monitor ECG (using 3-, 5-, 6- or 10-lead sets, including arrhythmia and ST monitoring), respiration, SpO_2, NBP, two invasive pressures, temperature, and CO_2.
The multi-touch screen allows easy interaction by swiping and tapping with one or two fingers.

Through networking, the monitor provides information integration, documentation and information access.

The monitor can be used with adult, pediatric and neonatal patients in a hospital environment and during patient transport inside hospitals.

The monitor stores data in trend databases. You can see tabular trends (vital signs) and document them on a central printer. You can view measurement trend graphs, including horizon trends, to help you identify changes in the patient's physiological condition.

The monitor can be powered from:

- a rechargeable battery

13.6. • AC mains using the optional docking solution IntelliVue Dock (867043) or the external power supply (M8023A)

For battery charging, care and status information, refer to the chapter "Using Batteries" on page 273.

Introducing the IntelliVue X3

The IntelliVue X3 is a versatile patient monitoring device with a color touchscreen display. It can simultaneously monitor ECG (using 3-, 5-, 6- or 10-lead sets, including arrhythmia and ST monitoring), respiration, SpO_2, NBP, two invasive pressures, temperature, and CO_2. The multi-touch screen allows easy interaction by swiping and tapping with one or two fingers.

The X3 can be used in two ways:

- As a stand-alone patient monitor.
- As a Multi-Measurement Module for the IntelliVue family of patient monitors.

In these Instructions for Use, the X3 is generally referred to as "the monitor", except in situations describing its use with a host monitor, where it is referred to as "the X3" to distinguish it from the host monitor.

The monitor can be used with adult, pediatric and neonatal patients in a hospital environment and during patient transport inside hospitals.

The monitor stores data in trend databases. You can see tabular trends (vital signs) and document them on a central printer. You can view measurement trend graphs, including horizon trends, to help you identify changes in the patient's physiological condition.

The X3 can run on one of three power sources:

- a rechargeable battery
- a host monitor connected to the X3
- AC mains using the optional docking solution IntelliVue Dock (867043) or the external power supply (M8023A)

For battery charging, care and status information, refer to the chapter "Using Batteries" on page 273.

X3 as Multi-Measurement Module

You can connect the X3 to an IntelliVue patient monitor, where it acts as a Multi-Measurement Module, providing measurements, trends and patient information to the host monitor. Its measurement capabilities can be extended using measurement extensions. You can connect the X3 to a host monitor via the MSL cable, or attach it directly to the host.

When connected to a host monitor, the X3 takes power from the host, including that required for battery charging. The host controls the connected X3, including all alarm functionality. No alarms are available on the X3, and the alarm lamps are controlled by the host. You can recognize when an X3 is connected to a host monitor by a blue bar on the screen containing the text **Companion Mode** and **No Alarm Display**.

X3 as Stand-alone Monitor

You can use the X3 as a stand-alone, highly portable monitor. In stand-alone mode, you can run the monitor from the rechargeable battery, or from mains power using the optional docking solution IntelliVue Dock or the external power supply (M8023A). Its measurement capabilities can be extended using measurement extensions, some of which can be powered by the X3 during transport.

Through networking, the X3 in stand-alone mode provides information integration, documentation and information access.

Continuous Monitoring Including Transport

Combining its role as Multi-Measurement Module with that of stand-alone monitor, the X3 is particularly suited to transport situations. When the X3 is disconnected from the original host monitor, it continues to monitor the patient as a stand-alone monitor, eliminating the need for a separate transport monitor. During transport the X3 runs on battery power and can power a connected current-generation measurement extension. When the X3 is connected to a new host monitor, it resumes its role as Multi-Measurement Module. It can upload trend data, patient demographic information and measurement settings, depending on the configuration, allowing fully continuous monitoring.

Controls, Indicators and Connectors

The MX100 and the X3 have the same controls, indicators, and connectors. In the following sections only one of the monitors is shown.

Controls and Indicators
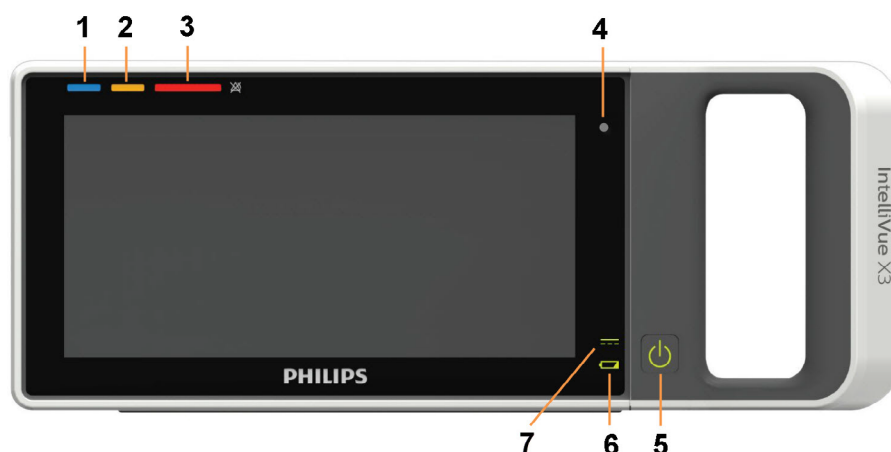
1   Active INOP lamp - lights continuously for light blue INOPs, flashes in the appropriate color for red and yellow INOPs.
    If no patient alarms are present, red and yellow INOPs will use both lamps (1 and 2).

2   Active alarm lamp - red or yellow, depending on the alarm level. The lamp flashes until the active alarm is acknowledged. For short yellow alarms, the lamp lights constantly for approximately six seconds and does not flash.
    If no INOPs are present, red and yellow patient alarms will use both lamps (1 and 2).

3   Alarms off lamp. When all alarms are off or paused, the lamp is red. When only yellow alarms are off or paused, the lamp is yellow.

4   Light sensor used for ambient light adaptation - if the sensor is covered (for example by a sticker), the display cannot adapt to the ambient light conditions.

5   Power on/off switch with integrated LED:

    –   green - on

    –   red - error

6   Battery status indicator - green when full, yellow when charging, flashing red when the battery is empty.

7   External power indicator - green when the monitor is powered from an external power source.

Patient Connectors, Right Side
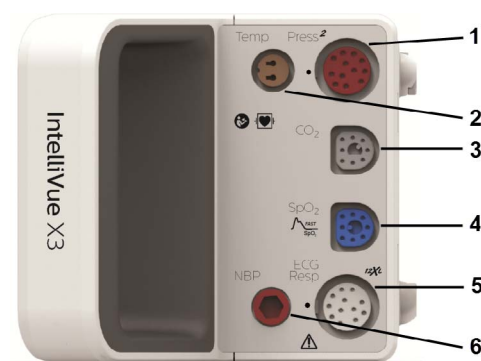
1   Pressure (option) - one or two pressure lines can be connected.

2   Temperature (option, together with pressure)

3   CO_2 (option) or alternatively a second SpO_2

4   SpO_2 (various options, see below)

5   ECG/Respiration

6   Noninvasive blood pressure

The connectors may have text labels, as shown above, or symbols, as shown below, depending on local regulatory requirements (e.g. FDA):

The SpO_2 option shown above is the Philips FAST SpO_2. It is the only SpO_2 option that can be combined with the built-in CO_2 or a second Philips FAST SpO_2. Also available are:

- SpO_2 measurement and additional derived measurements using Masimo rainbow SET technology

- SpO_2 measurement using Nellcor OxiMax technology

Connectors, Left Side
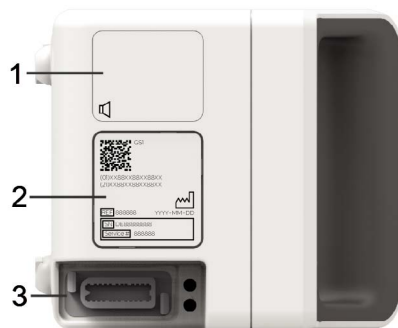
1 Loudspeaker (do not cover with labels or stickers as this will reduce the loudspeaker volume)

2 Device labeling area (do not cover with additional labels or stickers as the air input/output for the NBP pump is located here)

3 MSL Connector - a proprietary interface allowing interconnection of specified Philips devices. Connects to:

  – a host monitor (X3 only)

  – IntelliVue Dock for power, battery charging, communication with a network and flexible sync output

  – external power supply (M8023A) for power, battery charging, and communication with a network

Extending Measurements

Your monitor is compatible with Philips Measurement Extensions. These allow you to add specific measurements to those already integrated into your monitor.

The Measurement Extensions connect to the monitor and use the monitor's settings. Trend data and measurement settings from the measurements in the extensions are stored in the monitor.

Measurement Extension 867039 attached to the X3.

There are two categories of measurement extensions:

Measurement Extensions	Differences	Referred to as:
867039, 867040, 867041	**Can** be powered from the X3/ MX100 battery during transport	**current generation** Measurement Extensions
M3012A, M3014A, M3015A, M3015B	**Cannot** be powered from the X3/ MX100 battery during transport	**previous generation** Measurement Extensions

For previous generation measurement extensions: the monitor with the connected measurement extension can be powered by the Battery Extension during patient transport (see "Using the Battery Extension" on page 32).

WARNING

- Measurements from a previous generation Measurement Extension connected to an MX100 or X3 are not available when the MX100 or X3 is running on its own battery power. They are only available when the MX100 or X3 is running on external power. This is the case

    – when the X3 is connected to a host monitor

    – when the X3 or MX100 is connected to IntelliVue Dock (867043)

    – when the X3 or MX100 is connected to the external power supply (M8023A)

    – when the X3 or MX100 is connected to the Battery Extension (865297).

- Any measurements on a Measurement Extension that conflict with those in the monitor cannot be used. For example, only one CO_2 measurement is supported.

- The Cardiac Output and Continuous Cardiac Output options of the Measurement Extensions cannot be used with the MX100 monitor.

X3 with a corresponding measurement extension can only measure cardiac output when connected to a host monitor, or to a PC running the XDS Software and providing a remote display. Cardiac Output (C.O.) measurements can be performed and can be used to calibrate Continuous Cardiac Output (CCO). These stored C.O. results and the calibrated CCO measurement are still available in the X3 when it is disconnected from the host monitor or PC.

No Cardiac Output (C.O.) measurements can be performed when the X3 is not connected to a host monitor or to a PC running the XDS Software and providing a remote display.

Current Generation Measurement Extensions

867039 Hemodynamic Extension

1   Cardiac Output (orange; optional)

2   Temperature connector (brown)

3   Pressure connector, for one or two pressures (red)

4   Connection to Multi-Measurement Module or monitor

The 867039 Hemodynamic Extension adds temperature, two pressures, and optionally cardiac output/ PiCCO to the monitor.

867040 Capnography Extension
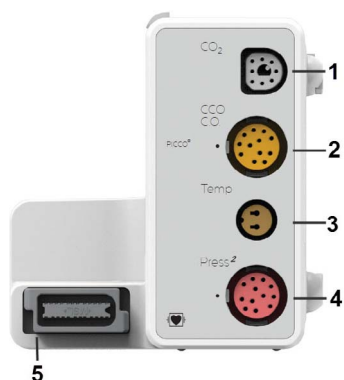
1   Mainstream/sidestream connector CO_2 (gray)

2   Cardiac Output (orange, optional)

3   Temperature connector (brown, optional)

4   Pressure connector, for one or two pressures (red, optional)

5   Connection to Multi-Measurement Module or monitor

The 867040 Capnography Extension adds mainstream/sidestream capnography, and optionally temperature, two pressures, and cardiac output/PiCCO to the monitor.

When a capnography extension is connected to an MX100 or X3 with CO_2, the CO_2 from the extension will be automatically deactivated in favor of the one in the MX100 or X3. If you prefer to use the CO_2 measurement on the extension, you can activate it via the measurement selection key (see "Resolving Label Conflicts" on page 49).

PiCCO in the 867040 Capnography Extension is not available in the USA and other territories relying on FDA market clearance.

867041 Microstream CO2 Extension

1	Microstream connector CO_2
2	Cardiac Output (orange, optional)
3	Temperature connector (brown, optional)
4	Pressure connector, for one or two pressures (red, optional)
5	Connection to Multi-Measurement Module or monitor

The 867041 Microstream CO_2 Extension adds Microstream capnography, and optionally temperature, two pressures, and cardiac output/PiCCO to the monitor.

PiCCO in the 867041 Microstream CO_2 Extension is not available in the USA and other territories relying on FDA market clearance.

Previous Generation Measurement Extensions

M3014A, M3015A, and M3015B Measurement Extensions

The **M3014A** Capnography extension adds mainstream/sidestream capnography, and optionally one pressure plus either a pressure or a temperature, and cardiac output/PiCCO to the monitor.

M3014A

1	Pressure connectors (red)
2	Temperature connector (brown)
3	Mainstream/sidestream connector CO_2
4	Cardiac Output connector

The **M3015A** Microstream CO_2 extension adds Microstream capnography and optionally either pressure or temperature to the monitor. The **M3015B** Microstream CO_2 extension adds Microstream capnography, two pressures and a temperature to the monitor.

Only one CO_2 measurement at a time is supported.
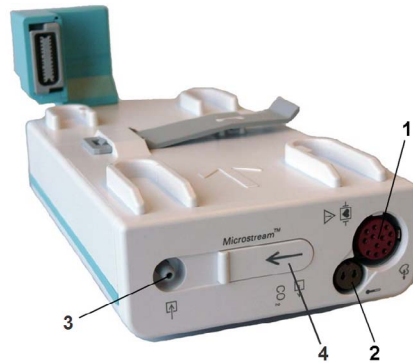
M3015A   **M3015B**

1   Pressure connectors (red) - M3015A optional

2   Temperature connector (brown) - M3015A optional

3   Gas sample outlet

4   Microstream connector CO_2 and Inlet

NOTE

The M3015A Microstream CO2 Measurement Extension with Hardware B (indicated by serial number prefix DE435; year of last manufacture: 2011) cannot be used with the IntelliVue X3 and MMX Multi-Measurement Modules. Using this Measurement Extension with an X3 or an MMX may cause the Multi-Measurement Module to lose its connection to the host monitor.

M3012A Hemodynamic Measurement Extension
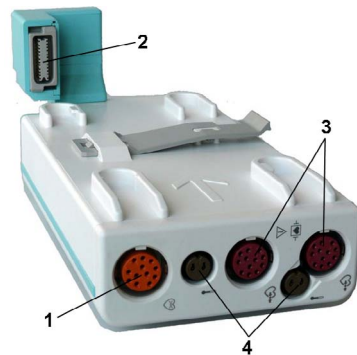
1   Cardiac Output (orange, optional)

2   Connection to Multi-Measurement Module

3   Pressure connectors (red)

4   Temperature connectors (brown)

The M3012A Hemodynamic extension adds temperature, pressure, an additional pressure or a temperature, and cardiac output/PiCCO to the monitor.

Removing a Measurement Extension

To separate a current generation extension from the monitor, press the release button and slide the extension away from the monitor.

CAUTION

If the measurement extension cannot be removed, check whether the monitor and extension have been fixed together with special plugs. You can recognize this when small gray plugs with a recess are inserted as shown below:

If this is the case, the plugs must be removed with a screwdriver before the measurement extension can be separated from the monitor.

To separate a previous generation extension from the monitor, press the release lever and slide the extension away from the monitor.

Using IntelliVue Dock (867043)

IntelliVue Dock combines an external power supply for the monitor with convenient mounting. When the monitor is mounted on an IntelliVue Dock that is connected to mains power, IntelliVue Dock provides power to run the monitor and any attached extensions, and to charge the monitor's battery.

Additionally there are connections available:

- to output a sync signal, for example ECG, to interface to other medical devices
- to connect to a wired network for access to an Information Center or PC running IntelliVue XDS.

IntelliVue Dock has been designed for stationary (non-transport) use in a horizontal position, as shown on the picture above.

CAUTION

Do not mount the IntelliVue Dock upside down, to avoid the following consequences:

- Liquid could enter the housing and cause damage to the IntelliVue Dock.
- Docked monitors could fall down if not properly secured.

Connectors

1. MSL connector for monitor connection

2. Flexible sync output connector, to provide signals to other medical devices
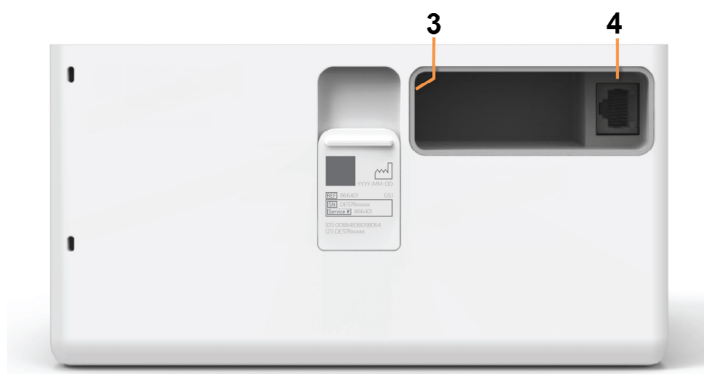
3. AC power connector

4. LAN connector for connection to a network or PC

WARNING

- Connect only medical devices that have been tested to IEC 60601-1 to the signal output connector socket.

- Connecting an output signal to external equipment should only be done by a qualified user. Do not touch the patient when you have contact to the signal output connector socket.

- Always connect the sync cable first to the external device and then to the monitor. Wherever possible, pre-install the cable before the patient is brought into the vicinity of the equipment.

Docking the Monitor

1 Set the monitor onto the base of IntelliVue Dock, flush to the vertical surface

2 Push the monitor sideways so that the connectors engage and continue until you hear the monitor click into place.

Power Indicator

1   Power LED

The power LED lights green when IntelliVue Dock is connected to external power.

Undocking the Monitor

To disconnect the monitor from the IntelliVue Dock, push the release button and pull the monitor to the right so that the connectors disengage.

CAUTION

If the monitor cannot be removed, check if the monitor and the IntelliVue Dock have been secured with a release lock. You can recognize this by checking the appearance of the release lock/button. Release locks are white instead of gray, and they have two symbols on the top: an electronic IFU symbol and a lock symbol.

Dock with Release Button   **Dock with Release Lock**

If the monitor is fixed to the IntelliVue Dock with a release lock, the monitor must be removed with a plastic card. For more information, see the *IntelliVue MX100/X3 Service Guide*.

Docking and Undocking the Monitor using the IntelliVue X3 Ambulance Mount

For installation outside of the hospital environment, you can use, for example, the IntelliVue X3 Ambulance Mount, provided by GCX. (Part number: PH-0062-87).

1   Install the IntelliVue Dock in the Ambulance Mount. See the installation guide provided by GCX for instructions on how to do this.

2   Push the slide-lock release knob of the Ambulance Mount to the left and lift the latch.
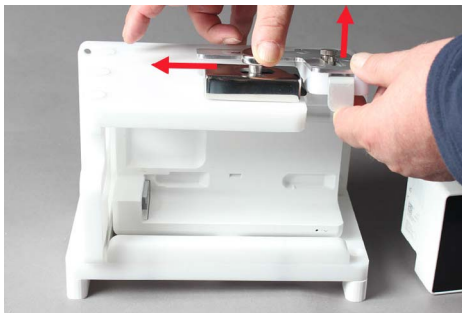
3   Set the monitor onto the base of the IntelliVue Dock, flush to the vertical surface. Push the monitor sideways so that the connectors engage and continue until you hear the monitor click into place.

4   To secure the monitor, push the latch all the way down until the slide lock is positioned on top of the latch. The latch can be closed without pushing the slide-lock release knob.

5   To undock the monitor, open the latch as described in step 2, then press the monitor release lever and pull out the monitor by its handle.

Adjusting the Ambulance Mount for use with a Microstream CO2 Extension

1   To insert a monitor with a Microstream CO2 Extension push the slide-lock release knob of the Ambulance Mount to the left and lift the latch.
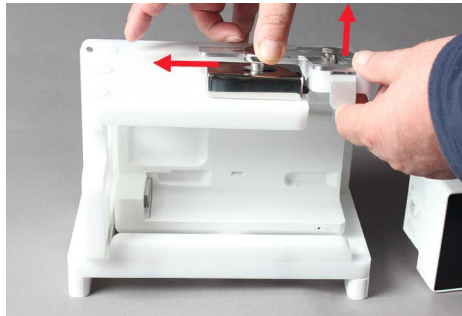
2   Push the monitor and extension sideways so that the connectors engage and continue until you hear the monitor click into place.

3   Pull the adjustment knob on the latch and move the slider from position A to position B to extend the arm of the latch.
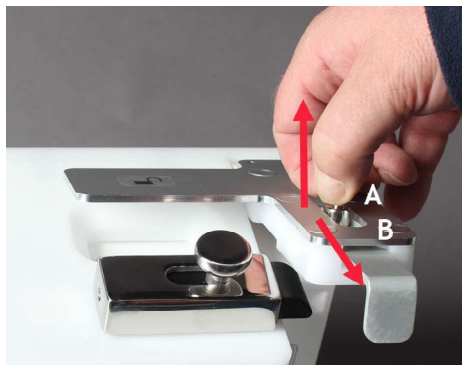
4   To secure the monitor and the Microstream CO2 Extension, push the latch all the way down until the slide lock is positioned on top of the latch. The latch can be closed without pushing the slide-lock release knob.

Fixing the Monitor on Rails and Poles

You can mount the monitor using either the bedhanger mount or the rotatable quick claw mount.

Bedhanger Mount:

Rotatable Quick Claw Mount:

1.2.

To mount the monitor,

1   Slide it onto the mounting plate, aligning the monitor feet with the four recesses in the plate. The arrows on the mounting plate show you the correct direction.

2   Push the monitor across the plate until you hear it click into place.

CAUTION

If the monitor does not click into place, it is not fixed securely on the mounting plate and can fall off the mount.

Bedhanger Mount

The bedhanger mount can then be simply hung on a rail or the foot of a bed. If it is used on a bed rail, it is essential that there is a board or other support below the rail to stop the mount tilting (see example below).

Rotatable Quick Claw Mount

The clamp is fixed onto a rail or pole in two steps.

1   Press the black lever and push the handle to bring the clamp into position.

2   Turn the handle to screw the mount securely into place.

To rotate the quick claw mount, press the silver-colored lever and rotate the mount into the desired position.

WARNING

Ensure that the monitor is mounted in the horizontal position, to avoid liquid entering the connectors and causing damage to the monitor.

Using the Battery Extension

To provide power for the use of a previous generation measurement extension during transport, you can use the Battery Extension (865297). The Battery Extension provides additional battery power for situations when no mains power is available and can typically power the monitor with a measurement extension for at least 6 hours.

Connecting the Battery Extension
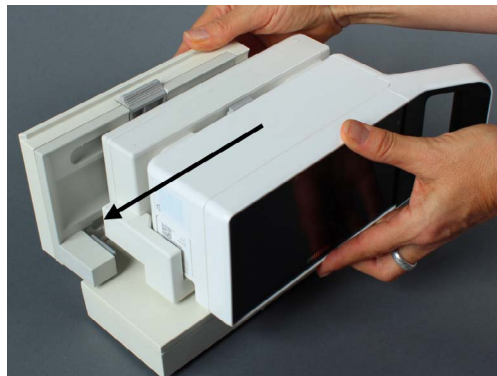
To connect to the Battery Extension, place the monitor with Measurement Extension onto the Battery Extension, and then slide it across so that the connection is made and it is firmly seated.
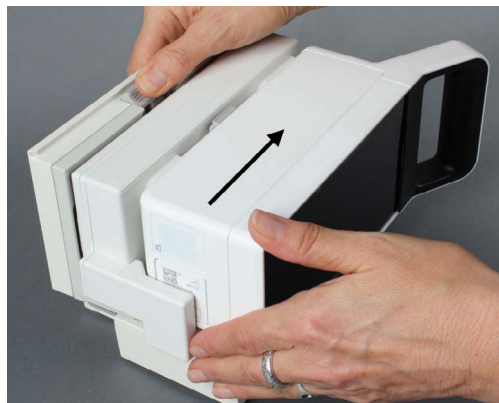
To remove the monitor with Measurement Extension, press the release lever and push the monitor across to release the connection.

1.1.

LED Indicators

The Battery Extension has two LED indicators. The power LED lights green when the Battery Extension is connected to external power.

The battery charge LED gives battery status information.

External power available	
LED indication	**Status**
green	Battery fully charged.
yellow	Battery charging.
red flashing (short on-phase)	Battery maintenance required.
red flashing (long on-phase)	Battery Extension malfunction.
off	No battery inserted in the Battery Extension.

External power not available	
LED indication	**Status**
yellow flashing (short on-phase)	Battery Extension is charging the monitor battery (monitor is switched off).
red flashing (short on-phase)	If the monitor is running, this indicates very low battery charge (<10 minutes running time left). If the monitor is not running, this indicates that battery maintenance is required.
red flashing (long on-phase)	Battery Extension cannot provide power to the monitor. Either the Battery Extension needs charging, or it has a malfunction.

Operating and Navigating

The main method of operating your monitor is using the touchscreen. Almost every element on the Screen is interactive. Screen elements include measurement numerics, information fields, alarms fields, waveforms and menus. The typical operator's position is in front of the monitor.

A typical monitoring Screen looks like this:
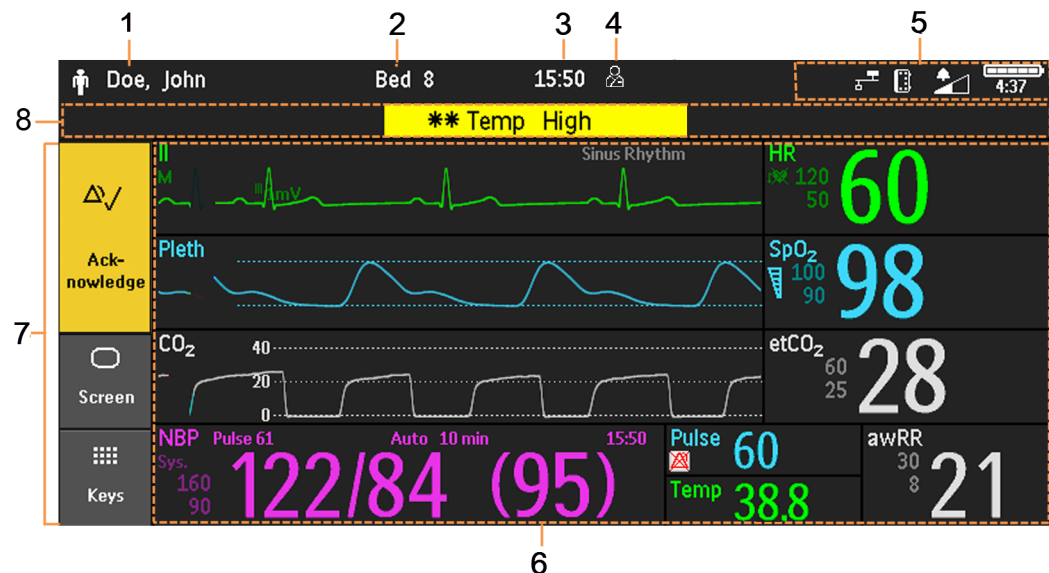
Item	Description
1	Patient name and patient category
2	Bed label
3	Time
4	User Management Icon. If a user is logged on, the name is displayed next to the icon.
5	Status area with various indicators, for example, • notification flag (not visible on the Screen above) • network connection indicator • measurement selection symbol • alarms off/alarm volume indicator • battery indicator
6	Area for measurement waves and numerics. The layout and numeric sizing are flexible.
7	Permanent keys: **Acknowledge**, **Screen** (return to monitoring screen), **Keys** (show SmartKeys)
8	Area for alarm messages, INOP messages and Alarms Off/Alarms Paused messages.

Using the Touchscreen

Touch a screen element to get to the actions linked to that element. For example, touch a measurement numeric to open the setup menu for that measurement. Touch a wave to enter the setup menu for that wave.

This type of touch screen cannot be operated with a pen or another object; you must use a finger. Touch operation while wearing medical gloves is no problem.

Using the monitor on battery power during electrosurgery can lead to reduced performance of the touchscreen. Provide external power using IntelliVue Dock or the external power supply, or a host monitor for X3, during electrosurgery.

Swiping and Tapping on the Touchscreen

To scroll through lists, menus, and keys, **swipe** your finger over the Screen, similar to using a smartphone.

You see that there are more list items or keys available, by the presence of the scroll bar.
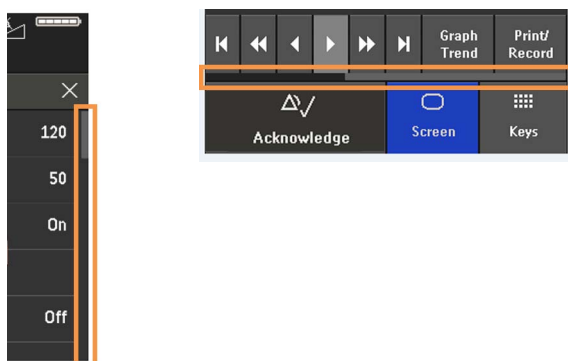
To select an item from a list, or to select a key, **tap** on it with your finger.

If you have opened multiple sub-menus, you can close them one at a time by tapping the area outside the open menus.

To switch to another Screen, swipe with **two** fingers across the Screen to pull it to the right or left, and display the next Screen.
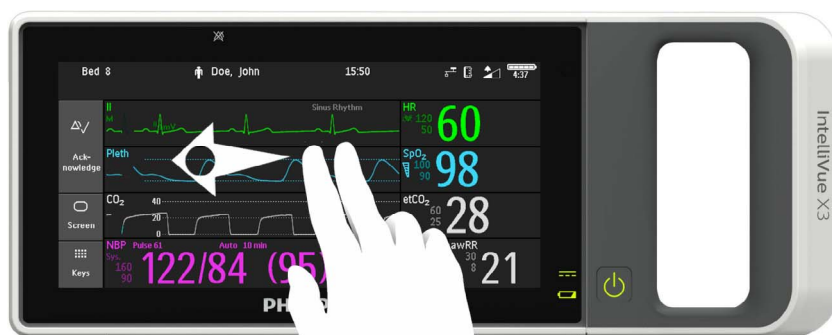
Rotating the Monitor

When the monitor is rotated from a horizontal to a vertical position, or back again, it will adapt to the new position and show a corresponding Screen:

CAUTION

Only the position with the handle pointing down is not allowed. In this position, if the mounting release lever is inadvertently pressed, the monitor could be released from the mounting and fall.

In this position, the Screen does not adapt and an error message is displayed.

The rotation of the Screen works best when the monitor is upright. It may be delayed, if the monitor is tilted.

If a menu is open when the monitor is rotated, you must close it to allow the Screen to adapt.

You can also rotate the monitor completely, so that it is upside down. In this case, an open menu will not prevent the Screen adapting.

NOTE

The automatic rotation of the Screen to match the position of the monitor can be configured off.

Temporarily Stopping Automatic Screen Rotation

To temporarily stop the automatic Screen rotation:

1   Select the **Screen** permanent key.
2   Select the **Auto Rotation** key.
    A padlock symbol appears on the key to show that rotation is locked.

Locking the Touchscreen

You can lock the touchscreen, temporarily disabling touch operation of the monitor.

Touch and hold the **Screen** key - a padlock symbol appears on the key. Touch and hold the key again to unlock the touchscreen.

Alternatively, select the **Screen** key, then select the **Lock Touch** pop-up key.

If the touchscreen detects an operating problem, such as fluid on the screen or an unexpected type of contact, it will be automatically locked to prevent accidental operation. When you have checked that nothing is causing unwanted operation, or when you have dried the screen in the case of fluid, you can unlock it again as described above.

Using Keys

The monitor has three different types of keys.

Permanent Keys

The permanent keys are located at the left of the screen, or at the bottom when the monitor is rotated.

Acknowledge/Pause Alarms/Alarms Off

In the default configuration, there is a large key that has three functions:

- If there is one or more active alarms or INOPs, the key is yellow and reads **Acknowledge**. To acknowledge all active alarms and INOPs, touch the key.

- When all alarms have been acknowledged, the key changes its labeling and reads **Pause Alarms** or **Alarms Off**, depending on your configuration. Select this key to pause alarms or to turn alarms off.

  The alarms off lamp then lights and the corresponding message appears in the alarm status area. For more details, see "Pausing or Switching Off Alarms" on page 61.

- When alarms are switched off and there is no alarm to acknowledge, the key labeling switches to **Alarms On.** Select this key to switch the alarms back on. For more details, see "Restarting Paused Alarms" on page 63.

In the alternative configuration, there are two smaller keys each with a single function:

- The **Acknowledge** key, to acknowledge all active alarms and INOPs - it is yellow when one or more alarms or INOPs are active.

- The **Pause Alarms** key, to pause alarms or the **Alarms Off** key to switch alarms off, depending on your configuration.

  The alarms off lamp then lights and the corresponding message appears in the alarm status area. See "Pausing or Switching Off Alarms" on page 61 for more details.

  When alarms are switched off, the key labeling switches to **Alarms On.** Select this key to switch the alarms back on. For more details, see "Restarting Paused Alarms" on page 63.

Screen

The **Screen** key has three functions:

- To return you to the monitoring screen, closing any open windows or menus. The key is blue when any window or menu is open.

- To open a window to change to another Screen (when used in the monitoring screen).

- To *temporarily* disable touchscreen operation of the monitor. Touch and hold the key - a padlock symbol appears on the key. Touch and hold the key again to re-enable touchscreen operation.

Keys
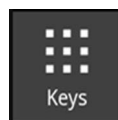
The **Keys** key displays all the SmartKeys and the **Main Setup** key - when you are in the monitoring screen.

SmartKeys

A SmartKey is a configurable graphical key, located at the bottom of the monitoring screen. It gives you fast access to functions. The selection of SmartKeys available on your monitor depends on your monitor configuration and on the options purchased.

	enter profile menu, or revert to default profile		change Screen, or revert to default screen
	pause alarms or switch alarms off (depending on configuration)		previous Screen
	freeze waves		quick admit a patient
	set alarm limits		enter patient identification menu to admit/discharge/transfer
	change alarm volume		end case to discharge a patient
	change QRS volume		view information for patients in other beds
	enter standby mode - suspends patient monitoring. All waves and numerics disappear from the display. All settings and patient data information are retained.		change screen brightness (not for independent displays)
	review beat labels (annotate arrhythmia wave)		re-learn arrhythmia
	change amplitude (size) of ECG wave		suppress zero for all gas measurements

Icon	Function	Icon	Function
	• start/stop manual NBP measurement • start auto series • stop current automatic measurement within series		start/stop NBP STAT measurement
			stop automatic or STAT NBP measurement and measurement series
	start NBP measurement and measurement series		stop current NBP measurement
	start veni puncture (inflate cuff to subdiastolic pressure)		start NBP STAT measurement
	set the NBP repeat time	→0←	zero invasive pressure transducer
	start a delayed recording		access pop-up recording keys
	access Vital Signs recording function		access Select Waves recording function
	set wide automatic alarm limits		set narrow automatic alarm limits
	review vital signs trend		review graph trend
	unpair equipment and continue central monitoring with the monitor		unpair equipment and continue central monitoring with the telemetry device
	start 12-Lead Capture (only available if Information Center is connected)		access ST Map application
	set standard or EASI lead placement		access patient reports
	new lead setup		open the Equipment window
	open the histogram window		access timers
	select a bed		remove a monitor from a patient

Pop-up Keys

Pop-up keys are task-related graphical keys that normally appear automatically on the monitor screen when required. If more pop-up keys are available than can be shown, you see a scroll bar and can scroll though the keys with your finger.

Some application windows may open without pop-up keys. If this is the case, you see three dots on the right side of the window title bar:
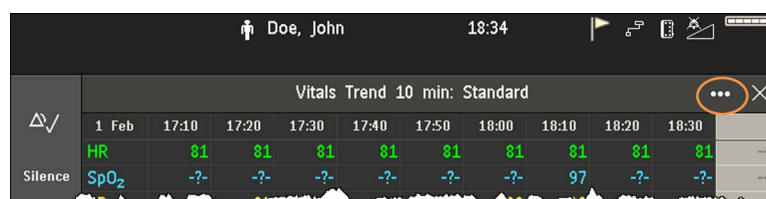
To display the pop-up keys, just select the title bar. To hide them, select the title bar again.

Main Setup Menu

There is usually more than one way to enter a setup menu for a measurement, to change a setting or to execute a task. Some routes are more direct than others. You can use whichever method you find most convenient. Which routes are available to you, however, can vary depending on your monitor's configuration.

For this reason, this book generally describes entry to a measurement's setup menu via the **Main Setup** menu, as this route is always available and is not subject to configuration dependencies. You can get to all setup windows from the **Main Setup** menu. You enter the **Main Setup** menu by pressing the **Keys** key, then selecting the **Main Setup** SmartKey.

Identifying and Authenticating Users

When the monitor is used with PIC iX, user authentication functionality is available that allows you to log in at the monitor and to obtain user permissions.

User permissions allow an authentication for specific actions and procedures at the monitor. For example, you can have permission to change alarm limits or switch alarms for individual measurements on or off.

NOTE

Always log off when leaving a monitor to ensure that no other user can use your permissions to change alarm settings or acknowledge notifications.

User Credentials

The following data can be part of the user credentials needed to log on to the system or carry out specific actions and procedures:

• User name

• Password and/or PIN (depending on the monitor configuration)

Logging On

User identification requirements are configurable to fit your unit's ways of working. When you log on, the title of the window and the entry fields available will indicate what you need to enter.

When attempting to perform an action or procedure at the monitor that requires user identification, a login window will open.
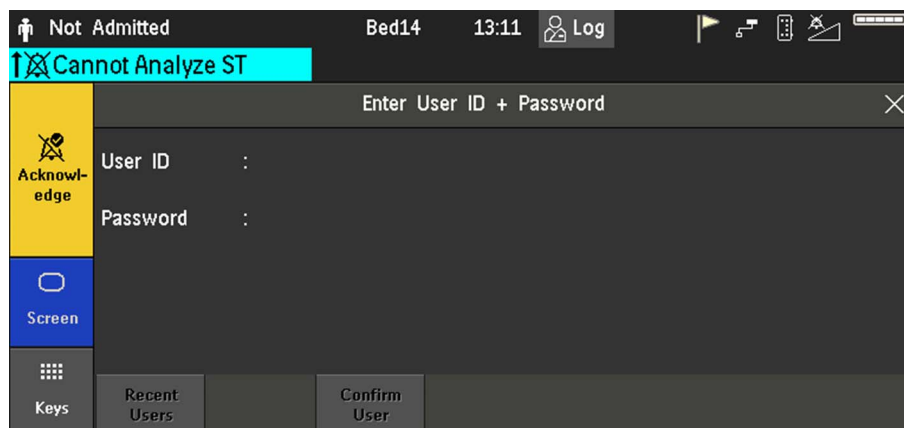
Your user ID can be entered manually with the keyboard. When you select the **Confirm User** pop-up key, your credentials will be checked and confirmed by PIC iX.

If your monitor is configured to do so, it can keep a local list of recent users and their credentials so that you can also log on when no connection to PIC iX is available. To do this, use the **Recent Users** pop-up key.

When single sign-on is configured for your monitor, you log on to the monitor with your user name and password/PIN once, and for a configured time you can now log on to any other monitor with your user ID only.

If you enter an incorrect password four times, the login procedure will be locked, and you will be unable to log on for 30 seconds. Each time you enter an incorrect password after this, the lock time is doubled. The maximum lock time for the login procedure is four minutes.

Logging Off

Depending on the configuration,

- You are automatically logged off when:
    - A configured time has passed with no interaction with the monitor
    - Another user is logged on
- Or you need to manually log off using either the **Log On/Off** SmartKey or the user icon in the monitor's information line.

Emergency Login

If you do not have permission to perform a certain action at the monitor for which user authentication is required, you have the possibility to perform an emergency login without user credentials.

1   When prompted to enter your user credentials, select the **Emerg. Login** pop-up key.
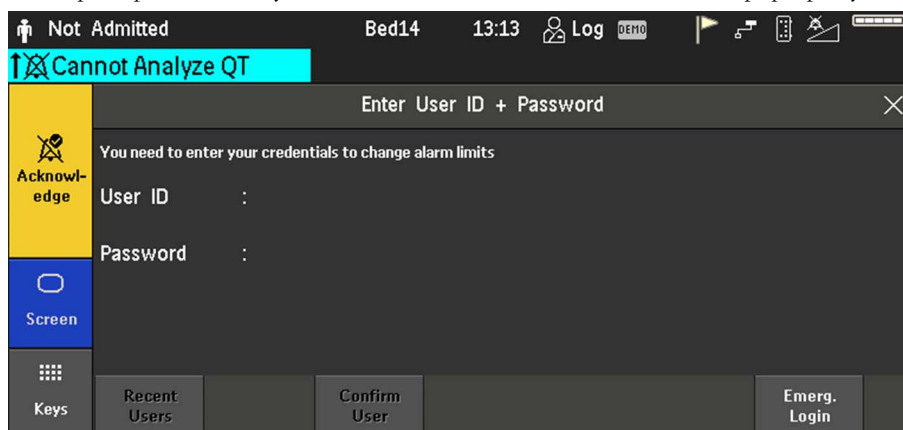
2   Select **Confirm**. Enter a user ID. This can be any ID that you define yourself. You will then be logged on and can perform the desired action at the monitor.
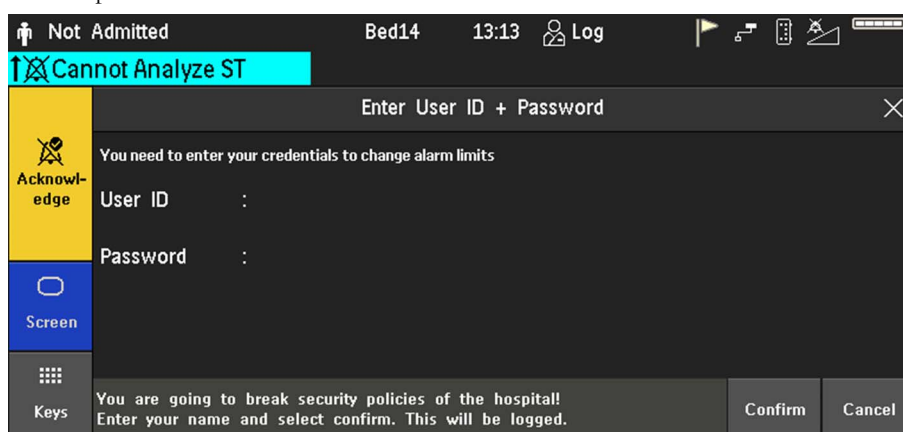
A notification will be displayed at the monitor and the PIC iX that indicates your emergency login. An authenticated user must clear this notification manually.
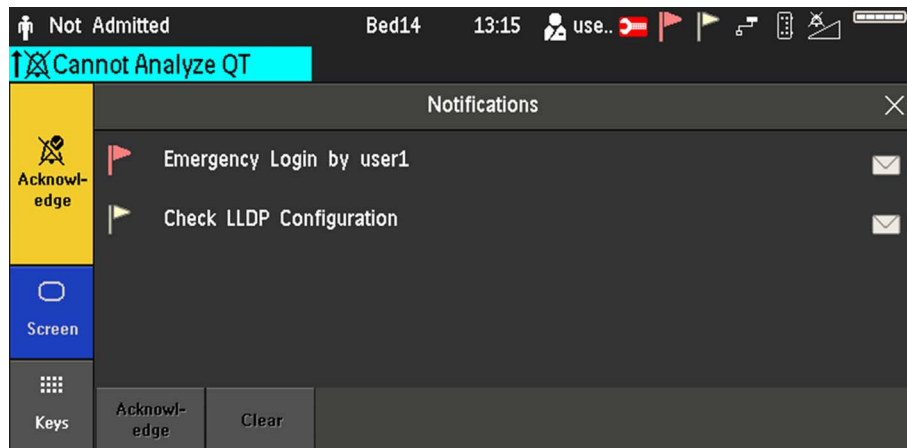
User Identification and Companion Mode

When using an IntelliVue X3 in companion mode, the host monitor defines the user management settings.

When a companion is connected to a host, any user logged on at the companion is automatically logged off, and the user management settings from the host monitor are synchronized to the companion. If an action is performed on the companion that requires user authentication, the user is prompted to log on via the host monitor.

When disconnected from the host, the companion retains the currently logged in user. User Management host settings are removed and the local companion settings are restored.

When using an X3 that does not support user management, all operations on the companion, including the touch display, are disabled by the host. If you try to operate the companion, a message is displayed that indicates the temporarily disabled operation and refers you to the host monitor.

If the host monitor does not support user management, user management on the companion device is disabled while connected to this host.

Operating Modes

When you switch the monitor on, it starts up in monitoring mode. To change to a different mode:

1   Select the **Main Setup** menu.

2   Select **Operating Modes** and choose the mode you require.

Your monitor has four operating modes. Some are passcode protected.

- **Monitoring Mode**: This is the normal, every day working mode that you use for monitoring patients. You can change elements such as alarm limits, patient category and so forth. When you discharge the patient, these elements return to their default values. Changes can be stored permanently only in Configuration Mode. You may see items, such as some menu options or the altitude setting, that are visible but 'grayed out' so that you can neither select nor change them. These are for your information and can be changed only in Configuration Mode.

- **Demonstration Mode**: Passcode protected, this is for demonstration purposes only. You must not change into Demonstration Mode during monitoring. In Demonstration Mode, all stored trend information is deleted from the monitor's memory.

- **Configuration Mode**: Passcode protected, this mode is for personnel trained in configuration tasks. These tasks are described in the Configuration Guide. During installation the monitor is configured for use in your environment. This configuration defines the default settings you work with when you switch on, the number of waves you see and so forth.

- **Service Mode**: Passcode protected, this is for trained service personnel.

When the monitor is in Demonstration Mode, Configuration Mode, or Service Mode, this is indicated by a box with the mode name in the center of the Screen and a symbol in the bottom right-hand corner. Select the mode box in the center of the screen to change to a different mode.

Standby Mode

Standby mode can be used when you want to temporarily interrupt monitoring.

To enter Standby mode,

1   Select the **Keys** key.

2   *Either* select the **Monitor Standby** SmartKey
    Or select the **Main Setup** SmartKey, then select **Monitor Standby**.

The Standby screen is a neutral screen with information about the monitor and instructions on how to leave Standby mode.

The monitor enters Standby mode automatically after the End Case function is used to discharge a patient. Standby suspends patient monitoring. All waves and numerics disappear from the display but all settings and patient data information are retained. The Standby screen is displayed.

If a temporary patient location has been entered at the monitor or at the Information Center, this location will also be displayed on the Standby screen.

To resume monitoring, touch the screen.

When monitoring is resumed, alarms are paused for 1 minute to allow time to finish plugging in the measurement cables.

Understanding Screens

Your monitor comes with a set of pre-configured Screens, optimized for common monitoring scenarios such as "OR adult", or "ICU neonatal". A Screen defines the overall selection, size and position of waves, numerics and other elements on the monitor screen. You can easily switch between different Screens during monitoring. Screens do **not** affect alarm settings, patient category and so forth. When the monitor is rotated from a horizontal to a vertical position, or back again, it will adapt to the new position and show a corresponding Screen, see "Rotating the Monitor" on page 36. The pre-configured Screens delivered with the monitor include horizontal and vertical versions.

Switching to a Different Screen

There are two ways to switch to a different Screen.

Using the Screen Key

1   After closing any open menus or windows, select the **Screen** key to access the **Change Screen** menu.

2   Choose the new Screen from the **Change Screen** menu.

Swiping Across the Screen

Swipe with **two** fingers across the Screen to pull it to the right or left, and display the next Screen.

The screens will be displayed in the order they appear in the **Change Screen** menu, including any modified Screens, which replace the original Screens in the sequence.

Changing a Screen's Content

If you do not want to change the entire Screen content, but only some parts of it, you can substitute individual waves, numerics, or trends. Be aware that these changes cannot be stored permanently in Monitoring Mode.

To change the selection of elements on a Screen,

1   Select the element you want to change. For example, touch the wave to enter the wave setup menu, or touch the numeric to enter the numeric setup menu.

2   From the menu that appears, select **Change Wave** or **Change Numeric**, and then select the wave or numeric you want.

In the **Change Screen** menu, the changed Screen is shown linked to the original Screen and marked with an asterisk.

Up to three modified Screens can be accessed via the **Change Screen** menu.

To recall Screens, select the name of the Screen in the **Change Screen** menu.

After a patient discharge, the monitor's default Screen is shown. Modified Screens are still available in the **Change Screen** menu.

If the monitor is switched off and then on again, modified Screens are erased from the monitor's memory and cannot be recalled. If a modified Screen was the last active Screen when the monitor was switched off, it is retained unless the monitor is configured to revert to the default.

Viewing Notifications

There are various types of notifications that can be generated by the monitor.

- **Status messages** inform about a current state or condition, for example, **Local Recorder door open**.
- **Prompt messages** inform about an action that is required from the user, for example, **Ready for new measurement**.
- **Clinical notifications** inform about clinically relevant events that are not alarms, for example, an early warning score or an alarm advisor.

When a notification is triggered, a message pops up on the screen for a short time. In addition, a notification symbol appears in the status area of the screen (also called the system tray).

Example of an early warning score notification symbol

Alarm advisor notification symbol

Status and prompt notification symbol

By selecting the symbol you can open the **Notifications** window.

Notifications Window

In the **Notifications** window, you see a list of all notifications currently active on the monitor. Each notification includes the corresponding notification symbol (see), a text message, and a symbol indicating the acknowledgment status.

New

Seen

Acknowledged or resolved

When you select a notification,

- the status changes to "seen".
- you may see more details, depending on the source.
- a pop-up key may appear for you to acknowledge receipt of the notification. Some prompt and status notifications cannot be acknowledged and some notifications come from clinical applications that manage acknowledgment and resolution in their own windows.

Using the XDS Remote Display

Using the IntelliVue XDS Software it is possible to view an independent monitor Screen on an external display. Depending on the configuration you can also operate the monitor from the external display.

For more details, including limitations and restrictions, refer to the IntelliVue XDS Software Instructions for Use.

Using the Visitors Screen

If a visitors Screen is configured for your monitor, you can use it to clear the screen of all waves and numerics but continue to monitor the patient with active alarms and trend storage at the bedside and Information Center. When the visitors Screen is selected, no automatic pop-up windows will be displayed. You can change the name of the visitors Screen in Configuration Mode.

To activate this Screen,

1   Select the **Screen** key to open the **Change Screen** menu.

2   Select the name of the visitors Screen configured for your monitor from the list of available Screens.

To select a Screen with waves and numerics again,

- Touch the gray box in the center of the screen showing the name of the visitors Screen, or select the **Screen** key, to open the **Change Screen** menu and then select a Screen from the list.

Understanding Profiles

Profiles are predefined monitor configurations. They let you change the configuration of the whole monitor so you can adapt it to different monitoring situations. The changes that occur when you change a complete profile are more far reaching than those made when you change a Screen. Screens affect only what is shown on the display. Profiles affect all monitor and measurement settings.

The settings that are defined by Profiles are grouped into three categories. Each category offers a choice of 'settings blocks' customized for specific monitoring situations. These categories are:

- **Display** (screens)

  Each profile can have a choice of many different predefined screens.

  When you change the profile, the screen selection configured for the new profile becomes active.

- **Measurement Settings**

  Each profile can have a choice of different predefined measurement settings. These relate directly to individual measurements, for example, measurement color, alarms limits, NBP alarm source, NBP repeat time, temperature unit (°F or °C), pressure unit (mmHg or kPa).

- **Monitor Settings**

  Each profile can have a choice of different predefined monitor settings. These relate to the monitor as a whole; for example, display brightness, alarms off/paused, alarm volume, QRS tone volume, tone modulation, prompt tone volume, wave speed, resp wave speed, pulse source.

You can change from one complete profile to another or swap individual settings blocks (display/monitor settings/measurement settings) to change a subset of a profile. Changes you make to any element within the settings blocks are not saved when you discharge the patient, unless you save them in Configuration Mode.

Depending on your monitor configuration, when you switch on or discharge a patient the monitor either continues with the previous profile, or resets to the default profile configured for that monitor.

WARNING

- If you switch to a different profile, the patient category and paced status normally change to the setting specified in the new profile. However some profiles may be set up to leave the patient category and paced status unchanged. Always check the patient category, paced status, and all alarms and settings, when you change profiles.

When you leave Demonstration Mode, the monitor uses the default profile.

Swapping a Complete Profile

1 Select the **Keys** key and

- *Either* select **Main Setup** and then **Profiles** in the **Main Setup** menu.

- *Or* select the **Profiles** SmartKey

2 In the **Profiles** menu, select **Profile**.

3 Chose a profile from the pop-up list.

4 Confirm your selection.

Swapping a Settings Block

1 Select the **Main Setup** SmartKey and then **Profiles** in the **Main Setup** menu.

2 Select the **Profile Details** key.

3 In the **Profile Details** menu, select **Display** or **Measmnt.Settings** or **Monitor Settings** to call up a list of the settings blocks in each category.

4 Choose a settings block from the list.

5 Confirm your selection, if required.

Default Profile

Your monitor has a default profile that it uses when you leave Demonstration mode, or when you discharge a patient. This profile is indicated by a diamond shaped symbol.

Understanding Settings

Each aspect of how the monitor works and looks is defined by a setting. There are a number of different categories of settings, including,

Screen settings, to define the selection and appearance of elements on each individual Screen

Measurement settings, to define settings unique to each measurement, for example, high and low alarm limits

Monitor settings, including settings that affect more than one measurement or Screen and define general aspects of how the monitor works, for example, alarm volume, reports and recordings, and display brightness.

You must be aware that, although many settings can be changed in Monitoring Mode, permanent changes to settings can only be done in the monitor's Configuration Mode.

All settings are reset to the stored defaults:

- when you discharge a patient
- when you load a Profile
- when the monitor is switched off for more than one minute (if **Automat. Default** is set to **Yes**).

Changing Measurement Settings

Each measurement has a setup menu in which you can adjust all of its settings. You can enter a setup menu:

- via the measurement numeric - select the measurement numeric to enter its setup menu. For example, to enter the **Setup ECG** menu, select the HR (heart rate) numeric.

- via the **Main Setup** SmartKey - if you want to setup a measurement when the measurement is switched off, use the **Main Setup** SmartKey and select **Measurements**. Then select the measurement name from the pop-up list.

Switching a Measurement On and Off

When a measurement is off, its waves and numerics are removed from the monitor's screen. The monitor stops data acquisition and alarming for this measurement.

1   Enter the measurement's setup menu and select the measurement.

2   Select the measurement name to toggle between on and off. The screen display indicates the active setting.

If you disconnect a transducer, the monitor replaces the measurement numeric with question marks. If you acknowledge the resulting INOP, the measurement is switched off. Also if you pause or switch off alarms, the measurement may be switched off completely, depending on monitor configuration.

Adjusting a Measurement Wave

To quickly adjust wave-related measurement settings (such as speed or size), select the measurement wave itself. This displays the measurement wave menu, which has only wave-related measurement settings.

Changing Wave Speeds

Lowering the wave speed compresses the wave and lets you view a longer time period. Increasing the speed expands the waveform, giving you a more detailed view.

The monitor distinguishes two groups of wave speed settings:

- **RespiratorySpeed**, for CO_2 waves.

- **Global Speed**, for all waves not included in the other group.

Changing the Wave Group Speed

The wave speed group setting defines the speed of all the waves in the group.

To change the wave speed of a wave speed group,

1   Select **Main Setup** and then select **User Interface**

2   Select **Global Speed** or **RespiratorySpeed**, as required

3   Select a value from the list of available speeds.

Changing Wave Speed for a Channel

To change the wave speed of an individual wave channel,

1   Enter the wave menu for a measurement by selecting its wave.

2   Select **Change Speed**.

3   To set the speed to the wave group speed, select **RespiratorySpeed** or **Global Speed**.
    To set an individual channel speed, select a numeric value from the list of available speeds. This overrides the wave group speed setting and sets the speed for the individual wave channel on the monitor Screen. The wave channel speed is independent of the wave (label) depicted in the channel, if you change the wave, the new wave will retain the set channel speed.

Freezing Waves

You can freeze waves on the screen and measure parts of the wave using cursors. The waves are frozen with a history of 20 seconds so that you can go back and measure what you have seen.

Freezing An Individual Wave

To freeze a wave,

1 Enter the Wave menu for the measurement by selecting the wave on the screen.

2 Select **Freeze Wave**.

The realtime wave is replaced with the frozen wave.

Freezing All Waves

To freeze all waves on the screen,

1 Select the **Freeze Waves** SmartKey.

All realtime waves are replaced with frozen waves.

Measuring Frozen Waves

To measure a frozen wave,

1 Select the frozen wave.
This automatically positions the vertical cursor. The cursor can be repositioned by touching the required point on the wave.

2 Use the up/down arrow keys to activate and move the horizontal cursor.
The horizontal cursor measures the wave value, which is displayed above the cursor line. If the wave is a pressure wave, the cursor value can be stored as a systolic, diastolic or mean pressure value; if the pressure wave is a PAP wave it can also be stored as a PAWP value; for pressure waves P, P1 to P8 it can also be stored as an IAP value. The stored value appears in the trend database as a manually entered value.
To return to the vertical cursor use the <> pop-up key.

Changing The Wave Speed

Lowering the wave speed compresses the wave and lets you view a longer time period. Increasing the speed expands the waveform, giving you a more detailed view.

To change the wave speed,

1 Select the frozen wave.

2 Select **Change Speed**.

3 Select a speed from the list.

Updating The Frozen Wave

To update the wave, that is freeze the current wave,

1 Select the frozen wave.

2 Select **Freeze Again**.

Releasing Frozen Waves

To release frozen waves,

1 Select a frozen wave.

2 Select **Unfreeze Waves**.

All frozen waves are released.

Using Labels

You can measure more than one invasive pressure or temperature simultaneously. The monitor uses the labels to distinguish between them. The default settings defined in the profile (such as measurement color, wave scale, and alarm settings) are stored within each label. When you assign a label to a measurement, the monitor automatically applies these default settings to the measurement. The labels assigned are used throughout the monitor, in reports, recordings, and in trends.

Changing Measurement Labels (e.g. Pressure)

To change a measurement label of a measurement with multiple labels (e.g. invasive pressure or temperature),

1   Enter the wave menu of the measurement.

2   Select **Label**.

3   Choose a label from the list.

The monitor automatically applies the scale, color, etc. settings stored in the Profile for the label you select. You can change scale settings in Monitoring Mode, but color can only be changed in the monitor's Configuration Mode.

Any labels already being used in the monitor are shown "grayed-out" in the list and cannot be selected.

Resolving Label Conflicts

Each label must be unique, that is, it can only be assigned once. If you have a Measurement Extension equipped with a pressure measurement connected to the monitor, there is a potential conflict with, for example, the ABP label. If you manually enter measurement values, these may also conflict with existing labels on the monitor.

Depending on your configuration, the monitor will either

•   display the **Measurement Selection** window automatically for you to resolve the conflict

•   take no action. You must enter the **Measurement Selection** window manually and resolve the conflict

All the currently available measurements are depicted in the **Measurement Selection** window. Any measurement labels causing a label conflict are shown in red. If a measurement is connected but currently unavailable, for example, because it was deactivated due to a label conflict, that measurement is shown "grayed-out".
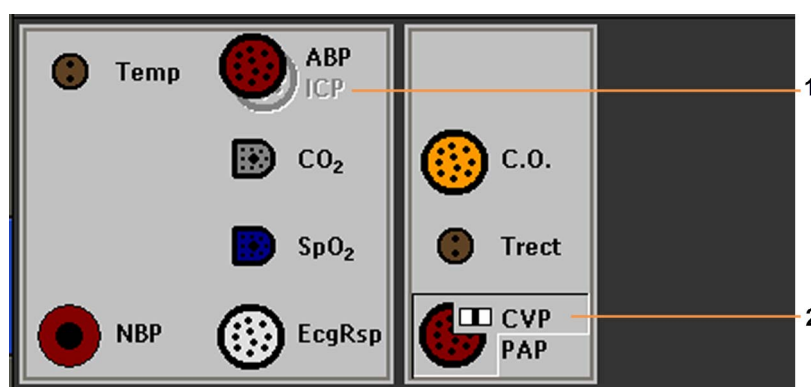
1   Unavailable measurement shown grayed-out.

2   When two pressures are connected to one connector, select the connector in the window to show one pressure with the channel symbol. The channel symbol is also shown on the dual pressure adapter cable. Select the connector again to show the second pressure.

A previous generation Measurement Extension is only shown in the **Measurement Selection** window when the monitor is connected to AC mains via IntelliVue Dock, the external power supply (M8023A) or is attached to the Battery Extension (865297).

To resolve a label conflict:

1 To open the **Measurement Selection** window, select the Measurement Selection symbol in the status area at the top right of the Screen.
Or, alternatively:
Select the **Keys** key and

– *Either* select **Main Setup** and then **Meas. Selection**

– *Or* select the **Meas. Select.** SmartKey
to display the **Measurement Selection** window.

2 Select the label to be corrected.

3 Use the measurement selection keys to resolve the conflict. Select either:

– **Change Label**: to assign a different label to the conflicting measurement.
The disabled measurement can then be activated.

– **De- Activate**: to disable the conflicting measurement. It retains its label for future use but becomes invisible to the monitor, as though it had been unplugged.
The other measurement with that label can then be activated.

– **Activate**: to activate a measurement that has been added. A confirmation window appears, allowing you to confirm that the currently active measurement with this label should be deactivated.

Label Compatibility

When a new measurement is introduced, or new labels for an existing measurement, these labels will not be shown on older Information Centers, and consequently not on the Overview screen sourced from the Information Center.

When a patient is transferred from a monitor with these new labels to one with an older software revision, the labels will be replaced with a generic label for that measurement. The settings for that generic label will then be used.

If it is critical that the measurement labels are available at the Information Center and after transfers, the older monitors and the Information Center must be upgraded to the appropriate software revision.

Setting Up the Flexible Sync Output

When the monitor is connected to IntelliVue Dock, it can use the flexible sync output from IntelliVue Dock. The output provides measured physiological signals, in the form of an electrical signal in real time, to external medical devices. To use these signals, the external device must be connected by cable to the output on IntelliVue Dock.

There are two output channels. To select a channel:

1 Select **Main Setup**, then **Measurements**.

2 Select **SyncOut**.

The **Setup SyncOut** window opens with the two channels for selection.

For each channel, you can select the **Source** for the signal, and then, if applicable, further settings that depend on the **Source**.

1 Select **Dock-1 (xxx)** or **Dock-2 (xxx)** to set up the corresponding channel (**xxx** indicates the source currently set up).

2 Select the **Source** you require.

If you select a pressure, the **Signal Type** is always **Analog Wave**, and there are no further settings that can be made.

If you select ECG, with the setting **Primary Lead**, you can select a **Signal Type**:

1 Select **Signal Type**.

2 Select **Analog Wave** or **Sync Pulse**.

Further settings depend on the **Signal Type** selected. If you select **Analog Wave**, you can set the signal gain for the ECG wave output, using **ECG Out Gain**. If you select **Sync Pulse**, you can set the sensitivity level, and whether a pulse marker is shown:

1 Select **Sensitivity** and select a sensitivity level from the list.

2 Select **Pulse Marker** and set to **On** or **Off**, as required.

Changing Monitor Settings

To change monitor settings such as brightness, or QRS tone volume:

1 Press the **Keys** key.

2 *Either* select the appropriate SmartKey for the setting you want to change
*Or e*nter the **Main Setup** menu by selecting the **Main Setup** SmartKey; then select **User Interface** to enter a submenu where you can change the settings.

Adjusting the Screen Brightness

1 Select the **Brightness** SmartKey.

2 Select the appropriate setting for the screen brightness. 10 is the brightest, 1 is the least bright. **Optimum** is suitable for most monitoring locations and optimizes power usage for battery powered monitors.

The monitors can be configured to automatically adapt the screen brightness to the ambient light conditions. The range within which this adaptation is made is determined by the setting made with the **Brightness** SmartKey.

Your monitor may be configured with a lower brightness for Standby mode and also for transport to conserve battery power. These settings can only be changed in the monitor's Configuration Mode.

If you are using a monitor with an external display, the **Brightness** SmartKey does not adjust the brightness of this display. Refer to the documentation supplied with the external display for instructions

Setting the Date and Time

Enter the **Main Setup** menu by selecting the **Main Setup** SmartKey, then select **Date, Time** to enter the **Date, Time** menu.

1 Select, in turn, the **Year**, **Month**, **Day**, **Hour** (in 24 hour format, only) and **Minute** as necessary. Select the correct values from the pop-up list.

2 Select **Store Date, Time** to change the date and time.

If your monitor is connected to an Information Center, the date and time are automatically taken from this. Once it is set, the internal clock retains the setting even when you switch off the monitor.

Checking Your Monitor Revision

1 Select **Main Setup** then select **Revisions** to open the **Monitor Revision** menu.

2 Select the correct device from the device pop-up keys.

3 From the **Monitor Revision** menu, select the monitor component for which you need revision information.

Getting Started

Once you understand the basic operation principles and have completed the Training Program, you can get ready for monitoring.

Inspecting the Monitor

WARNING

If the monitor is mechanically damaged, or if it is not working properly, do not use it for any monitoring procedure on a patient. Contact your service personnel.

1   Before you start to make measurements, carry out the following checks on the monitor.
   – Check for any mechanical damage.
   – Check all the external cables, plug-ins and accessories.

2   Always ensure that the battery is loaded in the battery compartment when monitoring a patient, even when the monitor is running on external power.

3   If you are using battery power, ensure that the battery has sufficient power for monitoring. When you use a battery for the first time, you must charge it, following the instructions given in the section on charging batteries in the Using Batteries chapter.

4   Check all the functions that you need to monitor the patient, and ensure that the monitor is in good working order.

NOTE

Measurements from a previous generation Measurement Extension are only available when the extension is connected to the monitor, **and** the monitor is running on external power. This is the case when the monitor is running on AC mains via the external power supply (M8023A) or is attached to the Battery Extension (865297).

Switching On

Press the power on/standby switch on the monitor for one second. The monitor performs a self test during which all lamps will light up and a tone will be sounded, and is then ready to use. If you see a message such as **CO₂ Sens Warmup** wait until it disappears before starting to monitor that measurement.

Power On/Power Off Behavior

The general rules determining the behavior of the monitor when connected to, or disconnected from power are as follows:

• A monitor that was switched on prior to a temporary power loss switches on again when power is restored.

• A monitor that was switched off prior to a temporary power loss remains off when power is restored.

• When AC mains power is lost, a battery powered monitor continues to run without interruption on battery power.

X3 Behavior When a Host Monitor is Powered Off

If a host monitor is switched off and then immediately on again, the X3 may not power on because it had not completed powering off before the host was switched on again. To avoid this, wait until the X3 has completely powered off before switching the host monitor on again.

Setting up the Measurements

1   Decide which measurements you want to make.

2   Connect the required patient cables and sensors. The connectors are color-coded to the patient cables and sensors for easy identification.

WARNING

When connecting devices for acquiring measurements, always position cables and tubing carefully to avoid entanglement or potential strangulation.

Starting Monitoring

After you switch on the monitor,

1 Admit your patient to the monitor.

2 Check that the profile, alarm limits, alarm and QRS volumes, patient category and paced status and so forth are appropriate for your patient. Change them if necessary.

3 Refer to the appropriate measurement chapter for further details of how to perform the measurements you require.

Disconnecting from AC Mains Power

To disconnect the monitor from AC mains power, depending on your setup:

- Unplug the power cord for the external power supply (M8023A) from the mains socket or disconnect the MSL cable.

- Unplug the power cord for IntelliVue Dock (867043) from the mains socket or remove the monitor from IntelliVue Dock.

- Detach the X3 from the host monitor (if directly connected) or disconnect the MSL cable.

Monitoring After a Power Failure

If external power is disconnected or there is a power failure, the monitor continues to run on its rechargeable battery.

If the monitor is without any power (no external power or the battery is empty) for **less** than one minute, monitoring will resume with all active settings unchanged. If the monitor is without power for **more** than one minute, the behavior depends on your configuration. If **Automat. Default** is set to **Yes**, the default profile will be loaded when power is restored. If **Automat. Default** is set to **No**, all active settings are retained, if power is restored within 48 hours. The **Automat. Default** setting is made in Configuration Mode.

Networked Monitoring

You can connect your monitor to an Information Center on a network, using one of the optional interfaces:

- Standard wired LAN

- Wireless LAN

- IntelliVue Instrument Telemetry System (IIT)

WARNING

Do not connect patient monitors to the standard hospital network.

If your monitor is connected to a network, a network symbol is displayed in the upper left corner next to the bed label. To see details about the monitoring equipment and technical information about the network, select the **Main Setup** SmartKey to enter the **Main Setup** menu, then select **Bed Information**.

In wireless networks, interference from other radio sources or the mis-configuration or malfunction of wireless network infrastructure components can lead to data loss. Take this into account when determining monitoring needs for a patient.

Be aware that some network-based functions may be limited for monitors on wireless networks in comparison to those on wired networks.

Using X3 with the Philips Interventional Hemodynamic System

For detailed instructions on using the X3 with the Philips Interventional Hemodynamic System (Hemo System), see the Instructions for Use for the Philips Hemodynamic Application (Hemo App). The following sections describe how to connect the X3 to the Hemo App and list the differences in behavior of the X3 when connected to the Hemo App.

Connecting the X3 to the Hemo App

The X3 is connected to the Hemo App via a LAN connection when connected to the IntelliVue Dock. A specific Hemo System configuration profile is required on the X3. For detailed requirements for the connection to the Hemo App, see the IntelliVue MX100/X3 Service Guide and Configuration Guide.

Behavior of the X3 with the Hemo App

While establishing the connection to the Hemo App, the X3 automatically loads the specific Hemo System profile. When connected, the X3 sends the relevant numerics and waves to the Hemo App. The X3 can be remotely controlled from the Hemo App. See the Hemo App Instructions for Use for details.

When connected to the Hemo App,

- any measurements not supported by the Hemo App are ignored. However, alarms generated by these measurements will still be shown on the Hemo App.

- only standard ECG lead placement is supported (no EASI lead placement, no Hexad lead placement).

- new patient detection on the X3 is switched off.

- patient management must be performed in the Hemo App.

WARNING

When the X3 is connected to the Hemo App, the Hemo App determines the audible alarms volume and minimum alarm volume. Alarms can be paused from the Hemo App. The touchscreen of the X3 is locked.

Disconnecting from the Hemo App

When the X3 is disconnected from the Hemo App, the monitor automatically loads the default profile, the main alarm state is switched to "on", and the X3 touchscreen is unlocked.

NOTE

If one of the pressure labels listed in the table below is used while the X3 is connected to the Hemo App, the X3 can only be used with MX400-550 or MX750/MX850 host monitors with SW Rel. N.0 or higher after disconnection from the Hemo App. In this case, if you want to use the X3 with other host monitors, the pressure label must be manually reconfigured. See your host monitor IfU for details on pressure labels and pressure label fallback behavior.

Label	Description
IAP	Intra-abdominal pressure
RFP	Right femoral arterial pressure
LFP	Left femoral arterial pressure
SCP	Spinal cord pressure
UBP	Urinary bladder pressure
Ppr	Pressure pre
Ppo	Pressure post
Pa1, Pa2, Pa3, Pa4	Alternative non-specific arterial pressure labels
Pv1, Pv2, Pv3, Pv4	Alternative non-specific venous pressure labels

What's New?

This section lists the most important new features and improvements to the monitor and its user interface introduced with each release. Further information is provided in other sections of this book.

You may not have all of these features, depending on the monitor options purchased by your hospital.

What's New in Release P.0

QRS /Pulse Tone for Selectable Label

The QRS Tone source can now be set manually to a fixed label from a selected label set.

Available labels are: HR, SpO₂, SpO₂pr, SpO₂po, SpO₂r, SpO₂l, P, ABP, ART, Ao, PAP, UAP, FAP, RFP, LFP, BAP, Ppr, Ppo, Pa1, Pa2, Pa3, Pa4.

ECG Lead Diagram

The new ECG lead diagram view provides assistance for the correct positioning of electrodes and information about the electrodes' skin contact based on the electrode to skin impedance measurement of the ECG measurement device.

User Authentication

When the monitor is used with PIC iX, user authentication functionality is available that allows you to log in at the monitor and obtain user permissions for specific tasks.

User Interface Enhancements

Alarming

• With the new user management feature, permissions can be set for changing alarm limits and switching alarms on and off.

• The **Acknowledge** key automatically changes to the **Pause Alarms/Alarms Off** key when all alarms have been acknowledged.

• New Philips 2021 alarm sounds are introduced with Release P.0.

NBP

• If no NBP values are available, three dashes are displayed instead of the NBP numerics.

• The NBP reference method is displayed in the monitor information line for several seconds and a prompt tone is issued every time a new measurement is started or the reference method is changed.

What's New in Release N.0

User Interface Enhancements

With Release N.0, the Silence key has been renamed **Acknowledge**.

Visual Alarm Indicators

In the new default configuration, the background of the alarming measurement numeric flashes in the alarm severity color. Once the alarm is acknowledged, the background stops flashing, and the numeric flashes.

Alarms

The alarm information here applies to all measurements. Measurement-specific alarm information is discussed in the sections on individual measurements.

The monitor has two different types of alarm: patient alarms and INOPs.

Patient Alarms

Patient Alarms are red and yellow alarms. A red alarm indicates a high priority patient alarm such as a potentially life threatening situation (for example, asystole). A yellow alarm indicates a lower priority patient alarm (for example, a respiration alarm limit violation). Additionally there are short yellow alarms, most of which are specific to arrhythmia-related patient conditions (for example, ventricular bigeminy).

INOPs

INOPs are technical alarms, they indicate that the monitor cannot measure or detect alarm conditions reliably. If an INOP interrupts monitoring and alarm detection (for example, **Leads Off**), the monitor places a question mark in place of the measurement numeric and an audible indicator tone will be sounded. INOPs without this audible indicator indicate that there may be a problem with the reliability of the data, but that monitoring is not interrupted.

Most INOPs are light blue, however there are a small number of INOPs which are always yellow or red to indicate a severity corresponding to red and yellow alarms. The following INOPs can also be configured as red or yellow INOPs to provide a severity indication:

- **ECG Leads Off**
- **NBP Cuff Overpress**
- **Cuff Not Deflated**
- **Occlusion**
- **<SpO₂ Label> No Pulse**
- **<Press Label> No Pulse**
- **Tele Disconnected**
- **Battery Empty / Replace Battery**

All monitors in a unit should have the same severity configured for these INOPs.

Alarm Delays

There is a delay between a physiological event at the measurement site and the corresponding alarm indication at the monitor. This delay has two components:

- **The general measurement delay time is the time between the occurrence of the physiological event and when this event is represented by the displayed numerical values**. This delay depends on the algorithmic processing and, for certain measurements (e.g. SpO_2), on the configured averaging time. The longer the averaging time configured, the longer the time needed until the numerical values reflect the physiological event.

- **The time between the displayed numerical values crossing an alarm limit and the alarm indication on the monitor**. This delay is the sum of the alarm delay configured for the specific measurement plus the system alarm delay. The system alarm delay is the processing time the system needs for any alarm on the monitor to be indicated after the measurement has triggered the alarm. See the performance specifications in the Specifications chapter for the system alarm delay specification.

The alarm delay configured for a specific measurement is normally a fixed time. For SpO$_2$ it is also possible to configure a Smart Alarm Delay that is calculated using an intelligent algorithm. See "Smart Alarm Delay" on page 178 in the SpO$_2$ chapter for more details.

Multiple Alarms

If more than one alarm is active, the alarm messages are shown in the alarm status area in succession. An arrow symbol next to the alarm message informs you that more than one message is active.

The monitor sounds an audible indicator for the highest priority alarm. If more than one alarm condition is active in the same measurement, the monitor announces the most severe. Your monitor may be configured to increase alarm indicator volume automatically during the time when the alarm is not acknowledged.

Visual Alarm Indicators

WARNING

- No alarms are available on the X3 when connected to a host monitor. Alarms become active again as soon as the X3 is disconnected from the host monitor.
- Alarm fields and other visual alarm indicators are disabled on the X3 when connected to a host monitor. The only visual alarm indication is provided by the alarm lamps, which are controlled by the host monitor. **No Alarm Display** is shown in the field for red/yellow alarms, and **Companion Mode** is shown in the INOP field.

Alarm Message

An alarm message text appears in the alarm status area at the top of the screen indicating the source of the alarm. There is a field for INOPs (light blue, red or yellow) and a field for patient alarms, which is shared for red and yellow alarms. If more than one measurement is in an alarm condition, the message changes every two seconds, and has an arrow at the side. If both red and yellow alarm conditions are active simultaneously, they alternate every two seconds in the patient alarms field. The background color of the alarm message matches the alarm priority: red for red alarms, yellow for yellow alarms, light blue for standard INOPs, red for red INOPs and yellow for yellow INOPs. The asterisk symbols (*) beside the alarm message match the alarm priority: *** for red alarms, ** for yellow alarms, * for short yellow alarms. Standard INOPs do not have a symbol, red and yellow INOPs have exclamation marks beside the alarm message: !!! for red INOPs and !! for yellow INOPs.

Depending on how your monitor is configured, it may display alarm limit violation messages:

- in text form, for example **** SpO₂ Low** or
- in numeric form, for example **** Pulse xxx>yyy** where the first number shows the maximum deviation from the alarm limit, and the second number shows the currently set limit.

Flashing Numeric

In the default configuration, the background of the alarming measurement numeric flashes in the alarm severity color. Once the alarm is acknowledged, the background stops flashing, and the numeric flashes.

In the alternative configuration, the numeric of the measurement in alarm flashes and continues to flash in the same way after the alarm is acknowledged.

Bright Alarm Limits

If the alarm was triggered by an alarm limit violation, the corresponding alarm limit on the monitor screen is shown more brightly if **Show AlarmLimits** is enabled and there is sufficient room on the screen.

Alarm Lamp

A lamp on the monitor's front panel flashes. The alarm lamp is divided into two sections. The right one flashes for a patient alarm, except for short yellow alarms where the lamp will light for approximately six

seconds. The color is yellow or red corresponding to the highest priority patient alarm currently present. The left one lights continuously for a light blue INOP and flashes for yellow or red INOPs as follows:

Lamp Color	On	Off
Yellow	1.0 seconds	1.0 seconds
Red	0.25 seconds	0.25 seconds
Cyan	continuously	-

If only patient alarms are present, and no INOPs, the patient alarms will use both left and right sections to flash (for red and yellow alarms) or light for approximately six seconds (for short yellow alarms). If only INOPs are present, and no patient alarms, red and yellow INOPs will use both left and right sections to flash but light blue INOPs will always light continuously in the left section only.

If the screen brightness is configured to automatically adapt to ambient light conditions, the alarm lamps will also adapt their brightness accordingly.

Audible Alarm Indicators

The audible alarm indicators configured for your monitor depend on which alarm standard applies in your hospital. Audible alarm indicator patterns are repeated until you acknowledge the alarm by switching it off or pausing it, or until the alarm condition ceases (if audible alarm indication is set to non-latching).

WARNING

- Do not rely exclusively on the audible alarm system for patient monitoring. Adjustment of alarm volume to a low level or off during patient monitoring may result in patient danger. Remember that the most reliable method of patient monitoring combines close personal surveillance with correct operation of monitoring equipment.

- No alarms are available on the X3 when connected to a host monitor. (**Companion Mode** is indicated). Alarms become active again as soon as the X3 is disconnected from the host monitor.

- When connected to a host monitor (**Companion Mode** is indicated), no alarm tones are available on the X3.

Alarm Tone Configuration

The audible alarm indicators of your monitor are configurable. In the monitor's Configuration Mode, you can:

- increase the alarm volume of unacknowledged alarms at regular intervals

- change the interval between alarm sounds (ISO/IEC Standard alarms only)

- change the base volume of the red and yellow alarm tones and the INOP tones

- change the alarm sound to suit the different alarm standards valid in different countries.

Traditional Audible Alarms (HP/Agilent/Philips/Carenet)

- Red alarms and red INOPs: A high pitched sound is repeated once a second.

- Two-star yellow alarms and yellow INOPs: A lower pitched sound is repeated every two seconds.

- One-star yellow alarms (short yellow alarms): The audible indicator is the same as for yellow alarms, but of shorter duration.

- Standard INOPs: an INOP tone is repeated every two seconds.

IEC/ISO 2003 Standard Audible Alarms

- Red alarms and red INOPs: A high-pitched tone is repeated five times, followed by a configurable pause.

- Two-star yellow alarms and yellow INOPs: A lower pitched tone is repeated three times, followed by a configurable pause.

- One-star yellow alarms (short yellow alarms): The audible indicator is the same as for yellow alarms, but of shorter duration.

- Standard INOPs: a lower pitched tone is repeated twice, followed by a pause.

IEC/ISO 2020 Standard Audible Alarms

- Red alarms and red INOPs: A high-pitched tone is repeated five times, followed by a configurable pause.

- Two-star yellow alarms and yellow INOPs: A lower pitched tone is repeated three times, followed by a configurable pause.

- One-star yellow alarms (short yellow alarms): The audible indicator is the same as for yellow alarms, but of shorter duration.

- Standard INOPs: a lower pitched tone, followed by a pause.

Philips 2021 Audible Alarms

- Red alarms and red INOPs: A high-pitched sound is repeated every second.

- Yellow alarms and yellow INOPs: A lower pitched sound is repeated every four seconds.

- Standard INOPs: an INOP tone is repeated every six seconds.

Changing the Alarm Tone Volume

If you want to change the alarm volume setting, or see where the current setting is on a scale from zero to 10, select the **Alarm Volume** SmartKey. The volume scale pops up. The current setting is indented. To change the setting, select the required number on the scale. Any settings that are inactive ("grayed out") have been disabled in the monitor's Configuration Mode.

When the alarm volume is set to zero (off), the alarm volume symbol reflects this. If you switch the alarm volume off, you will not get any audible indication of alarm conditions.

Minimum Volume for No Central Monitoring INOP

If your monitor is connected to an Information Center, and the connection is interrupted, the INOP message **No Central Monit.** will appear within 30 seconds, accompanied by an INOP tone. To help ensure that this INOP, and any other active alarm, is not overlooked, the INOP and alarm tones may be configured to have a minimum volume. In this case, INOP and alarm tones will sound even if the monitor alarm volume is set to zero.

Minimum Volume for Severe Yellow or Red INOPs

Severe yellow or red INOPs require action to ensure the well-being of the patient. Therefore the minimum volume for the INOP tone is set to at least alarm volume 8, irrespective of the current alarm volume setting. The INOP tone will sound even if the monitor alarm volume is set to zero.

The severe INOPs for which this applies are:

Cuff Not Deflated (configurable to yellow or red)

NBP Cuff Overpress (configurable to yellow or red)

!! Insert Battery (yellow)

Battery Empty / **Replace Battery** (configurable to light blue, yellow or red)

Acknowledging Alarms

To acknowledge all active alarms and INOPs, select the **Acknowledge** key. This switches off the audible alarm indicators and alarm lamps.

A crossed out bell and a check mark beside the alarm message indicate that the alarm has been acknowledged . If the monitor is configured to realarm, the bell will be crossed out with dashed lines

If the condition that triggered the alarm is still present after the alarm has been acknowledged, the alarm message stays on the screen with a crossed out bell and a check mark symbol beside it, except for NBP alarms and alarms from other intermittent measurements. When such an alarm is acknowledged, the alarm message disappears.

If the alarm condition is no longer present, all alarm indicators stop and the alarm is reset.

Switching off the alarms for a specific measurement, or switching off the measurement itself, also stops alarm indication.

Acknowledging Disconnect INOPs

Acknowledging an INOP that results from a disconnected transducer switches off the associated measurement. The only exception is ECG/Resp: acknowledging a disconnect INOP for ECG leads does not switch off the ECG and Resp measurements. Acknowledging a disconnect INOP at the Information Center switches off the audible INOP indicator but does not switch off the measurement.

Alarm Reminder

If **Alarm Reminder** is configured on for your monitor, you will get an audible reminder of alarm conditions that remain active after you have acknowledged the alarm. This reminder may take the form of a repetition of the alarm tone for a limited time (1, 2, or 3 minutes), or an unlimited repetition of the alarm tone (this is the same as a new alarm). **Alarm Reminder** is not available for standard, light blue INOPs but for yellow and red INOPs.

In Configuration Mode, you can set the interval between acknowledging the alarm and sounding the reminder tone to one, two, or three minutes.

The alarm reminder behavior at the Information Center is different to that at the monitor. Refer to the Information Center Instructions for Use for further information.

Pausing or Switching Off Alarms

If you want to temporarily prevent alarms from sounding, for example while you are moving a patient, you can pause alarms. Depending on your monitor configuration, alarms are paused for one, two, three, five, or ten minutes, or infinitely. Pausing alarms infinitely is equivalent to switching the alarms off.

To view the alarm pause setting chosen for your unit,

1   Select **Main Setup**, **Alarms**, then **Alarm Settings**

2   Check the **Alarms Off** setting.

This setting can only be changed in Configuration Mode.

There are some settings made in Configuration Mode that can affect the availability of the pause alarms functionality.

To Pause or Switch Off all Alarms

There are three ways to pause alarms:

- Select the **Pause Alarms** key.

  or

- Select the **Keys** key, then the **Pause Alarms** SmartKey.

  or

- Select **Main Setup**, **Alarms**, then **Pause Alarms**.

A confirmation window appears. In the window, select the pause time to confirm that alarms be paused. If you select 5 or 10 minutes pause time, you will need to confirm your choice for a second time. If your monitor is configured to allow infinite alarms pause, select **Yes** in the window to confirm that the alarms be switched off.

To Switch Individual Measurement Alarms On or Off

NOTE

Depending on your monitor configuration, you may be required to enter your user credentials in order to obtain permission to switch individual measurement alarms on or off. For details, see "Identifying and Authenticating Users" on page 40.

1 Select the measurement numeric to enter its setup menu.

2 Select **Alarms** to switch between on and off.

The alarms off symbol is shown beside the measurement numeric.

While Alarms are Paused or Off

When red alarms are paused or off:

- The red Alarms Paused lamp on the monitor front panel is lit.

  In the alarm field, the monitor displays the message **Al. Paused x:yy** or **Alarms Off**, together with the alarms paused symbol **or** the alarms off symbol.

When yellow alarms are paused or off:

- The yellow Alarms Paused lamp on the monitor front panel is lit.

  In the alarm field, the monitor displays the message **YellowPaused x:yy** or **Yellow Alarms Off**, together with the alarms paused symbol **or** the alarms off symbol.

For red and yellow alarms:

 Alarms Paused   Alarms Off

- No alarms are sounded and no alarm messages are shown.

- INOP messages are shown but no INOP tones are sounded.

  The only exceptions are the INOPs **Cuff Not Deflated**, **NBP Cuff Overpress** and INOPs relating to empty, missing and malfunctioning batteries.

These INOPs switch the alarms on, and the INOP tones are sounded, even if alarms are paused or off. You need to remove the INOP condition first before you can switch the alarm tones off again.

If a disconnect INOP is present and alarms are paused or switched off, the measurement in question may be switched off, depending on monitor configuration.

The alarms off symbol is not displayed when the X3 is connected to a host monitor.

Restarting Paused Alarms

Alarm indication starts again automatically after the pause period expires. If the monitor is configured for alarms to stay paused infinitely, you must manually switch on alarm indication again.

To manually switch on alarm indication again during a pause, select the **Alarms On** key.

Resetting Arrhythmia Alarm Timeouts

To reset the timeout period, either

- select the **Alarms Off** or **Pause Alarms** permanent key and then reselect it, or

- select **Reset Alarming** in the **Review Alarms** window or the **Alarm Messages** window.

Alarm Settings for Unattended Monitoring

When monitoring patients that are not continuously attended, use appropriate alarm settings to optimize monitoring:

- Always leave alarms switched on when the patient is unattended.

- Recommended configuration: Use one of the temporary settings for the **Alarms Off** setting, not **Infinite**, and make sure that the **AlarmOffReminder** and the **Alarm Reminder** are switched on (these settings are made in Configuration mode).

- Set alarm limits so that alarms will be triggered for those changes in the patient condition that you want to be advised of. Setting limits to very high or low values can render the alarm system useless.

- Use available notification routes, such as a nurse call system or the connection to an Information Center, or at least select an appropriate alarm volume to ensure that alarms are recognized.

Alarm Limits

The alarm limits you set determine the conditions that trigger yellow and red limit alarms. For some measurements (for example, SpO_2), where the value ranges from 100 to 0, setting the high alarm limit to 100 switches the high alarm off. In these cases, the alarms off symbol is not displayed.

WARNING

Be aware that the monitors in your care area may each have different alarm settings, to suit different patients. Always check that the alarm settings are appropriate for your patient before you start monitoring.

When changing alarm limits, use clinical judgment to assess appropriate limits for your patient and observe hospital policy.

Viewing Individual Alarm Limits

You can usually see the alarm limits set for each measurement next to the measurement numeric on the main screen.

If your monitor is not configured to show the alarm limits next to the numeric, or if the numeric is so small that the limits cannot be displayed, you can see them in the appropriate measurement setup menu. Select the measurement numeric to enter the menu and check the limits.

Viewing All Alarm Limits

The **Alarm Limits** overview window lists the currently set alarm limits for all measurements. If an Apnea alarm delay time is set, this is also shown. The alarms off symbol is shown beside the measurement label of any measurement whose alarm switched off.

To open the **Alarm Limits** window, either select one of the alarm fields then select the **Alarm Limits** pop-up key, or select the **Alarm Limits** SmartKey, if configured.
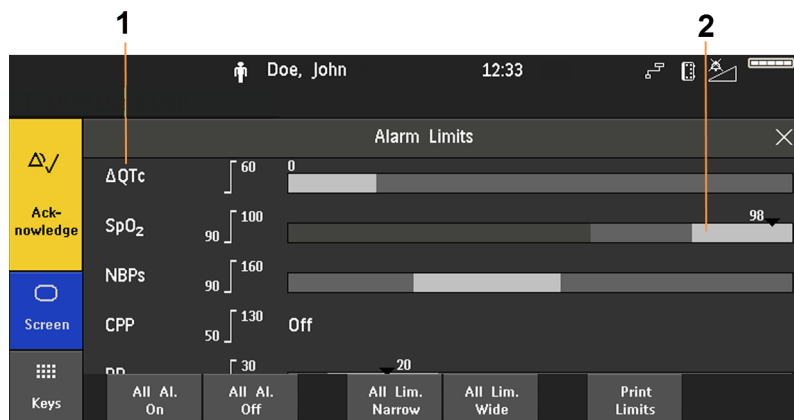
1 Measurement labels, with alarms off symbol where appropriate

2 Graphic view of current yellow and red alarm limits and currently monitored measurement value. **Off** indicates the measurement is switched off.

Select **Show ST Limits** to expand the list of ST leads and view the currently set alarm limits. Selecting **Hide ST Limits** hides the list again.

You can use the pop-up keys that open with the **Alarm Limits** window to perform common tasks:

– **All Lim. Narrow**/**All Lim. Wide** to set narrow or wide alarm AutoLimits for all measurements.

– **All Al. On**/**All Al. Off** to switch all measurement alarms on or off

These pop-up keys are not available in the window for changing individual alarm limits which you access by selecting the measurement label in the **Alarm Limits** window.

Changing Alarm Limits

NOTE

Depending on your monitor configuration, you may be required to enter your user credentials in order to obtain permission to change alarm limits. For details, see "Identifying and Authenticating Users" on page 40.

To change individual measurement alarm limits using the measurement's Setup Menu,

1 In the measurement's setup menu, select the alarm limit you want to change. This calls up a list of available values for the alarm limit.

2 Select a value from the list to adjust the alarm limit.

For example, to change the alarm limits for SpO_2:

* Touch the high limit on the alarm limits menu button.
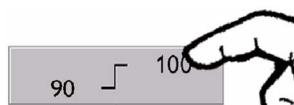
* Choose the high alarm limit from the pop-up list that opens.

* Touch the low limit on the alarm limits menu button.

* Choose the low alarm limit from the pop-up list that opens.

Alternatively, you can use the keys in the measurement alarm limits window, which you access by selecting the measurement label in the **Alarm Limits** window.
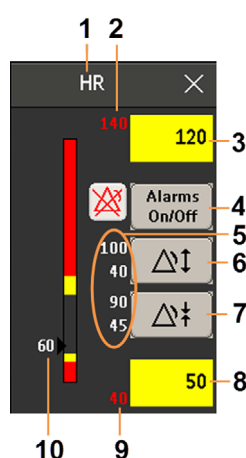
1	Parameter label
2	High red alarm (view only)
3	High yellow alarm field. Select to open a pop-up list of high alarm limits
4	**Alarms On/Off** key - select to toggle between alarms on or off
5	Preview Alarm AutoLimits for a measurement before applying
6	Select to apply wide AutoLimits
7	Select to apply narrow AutoLimits
8	Low yellow alarm field. Select to open a pop-up list of low alarm limits
9	Low red alarm (view only)
10	Graphic view of alarm limits with currently measured value

To change alarm limits,

1 Enter the **Alarm Limits** window.

2 To set the high alarm limit, select the high yellow alarm field to open a pop-up list of high alarm limits. Select a limit from the list. Repeat to set the low yellow alarm field.

If you set the yellow alarm limit outside the red alarm limit, the monitor will automatically set the red alarm to the yellow alarm limit.

When an ST measurement is in the alarm limits window, there are also two pop-up keys available labeled **All ST Narrow**/**All ST Wide**. With these keys, you can set Auto Limits for all ST Leads.

About Automatic Alarm Limits

NOTE

Depending on your monitor configuration, you may be required to enter your user credentials in order to obtain permission to use the Automatic Alarm Limits function. For details, see "Identifying and Authenticating Users" on page 40.

The monitor automatically calculates alarm limits suited to your individual patient, using the Automatic Alarm Limits function (AutoLimits). The monitor calculates safe AutoLimits for the patient based on the last minute of measured values.

The wide and narrow limits have a fixed relationship to the measured value within the non-pathological range. Outside of this range, no auto limits are calculated. To set values outside of the non-pathological range, limits must be changed manually, based on the clinician's judgment about the specific patient.

1   Wide alarm limits

2   Narrow alarm limits

3   Alarm Limits

4   Measurement value
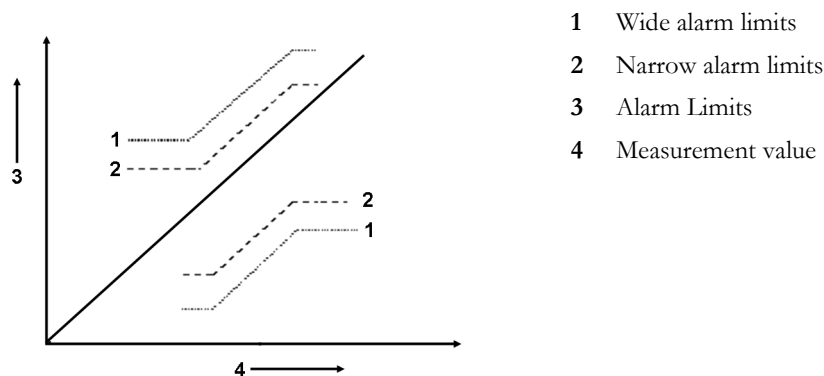
Using narrow alarm limits sets limits close to the currently measured values, for situations where it is critical for you to be informed about small changes in your patient's vital signs.

Using wide alarm limits sets limits further away from the currently measured values, for situations where small changes are not so critical.

Use the keys in the measurement alarm limits window to apply AutoLimits for individual measurements.

    Narrow limits   Wide limits

These keys are not available if AutoLimits have been disabled for the measurement in the monitor's Configuration Mode.

AutoLimits are not available for all measurements. The list of measurements for which AutoLimits can be used is defined in the monitor's Configuration mode.

Use the measurement alarm limits window to check AutoLimits before you apply them to ensure that they are appropriate for your individual patient and their clinical condition. Once applied, AutoLimits are shown on the monitor screen just like manually-set alarm limits. If the AutoLimits are not appropriate for your patient, you must set alarm limits manually. The limits remain unchanged until you set them again or change them manually.

Documenting Alarm Limits

To print a list of all current alarm limit settings on an available printer:

1   Select the **Main Setup** SmartKey.

2   Select **Reports** from the **Main Setup** menu.

3   Select **Alarm Limits**.

Reviewing Alarms

You can see which alarms and INOPs are currently active in the respective alarms and INOPs fields at the top of the screen.

To review the history of alarms and INOPs, select the alarms or INOPs field to open the **Review Alarms** window.

All alarms and INOPs are erased from the **Review Alarms** window when you discharge a patient, or if you change to Demonstration Mode.

Review Alarms Window

The **Review Alarms** window contains a list of the most recent alarms and INOPs with date and time information.

If configured to do so, each alarm is shown with the alarm limit active when the alarm was triggered and the maximum value measured beyond this limit. The **Review Alarms** window also shows when the monitor was switched on (after being switched off for longer than 1 minute) and any actions related to switching alarms on and off, entering or leaving Standby mode, acknowledging alarms or changing the ECG source.

No entries are made in the **Review Alarms** window of the X3 while it is connected to a host monitor, except the time when the X3 was connected to the host (**Companion Entered**), and when it was disconnected (**Companion Left**). Alarms can be reviewed on the host monitor.

When you select an item from the list, you can get additional information about that item. If you select a high or low limit alarm in the list, the **Graphical Trends** window will open to provide further data. If you select an alert other than a high or low alarm, a help text window opens with more information. Some items in the list are simply log items not related to a patient alert as such (for example, Alarms On or Alarms Off). You cannot see any further information if you select one of these items. When you close these windows you will return to the **Review Alarms** window.

The information in the **Review Alarms** window is deleted when a patient is discharged, and when you leave Demonstration Mode.

The **Review Alarms** window pop-up keys appear when the window is opened. If alarm pause extension is disabled, the pause pop-up keys are inactive.

Alarm Advisor

Alarm advisor provides feedback on recurring and continuous alarm limit violations, for a specific measurement over a period of time. The information provided supports you in adapting alarm limits more specifically for individual patients.

Which Measurements Can Use Alarm Advisor?

The following alarms can have alarm advisor set up:

- HR (low and high limit alarm, yellow and short yellow)
- PVCs/minute (high limit alarm)
- SpO_2 (low and high limit alarm)
- Pressure - ART, ABP, Ao, P (low and high limit alarm)
- RR (low and high limit alarm)
- awRR (low and high limit alarm)

You can switch alarm advisor on and off for each individual alarm (for example, for an SpO_2 low alarm, a HR low alarm, and so on).

How Does Alarm Advisor Work?

A period of time is selected for the alarm behavior to be observed. This can vary from 30 minutes to 12 hours.

Then two criteria are selected for triggering alarm advisor:

1 The number of times an alarm was acknowledged in the set time period.
   This can highlight situations where a measurement value is close to the limit, some of the time above and some of the time below. Changing the limit just a little would avoid these repeated alarms.

2 The percentage of the time period that an alarm limit was violated.
   This can highlight alarm limit violations that are present over a long time. If the limit is not appropriate, changing it will avoid these alarms and the repeated alarm reminders.

An example of a resulting setup would be: Observing a **60 minute** period, alarm advisor will be triggered for alarms that are **acknowledged at least 5 times** or are **present for more than 50% of the time**.

The settings described above are made in Configuration Mode.

Getting Notified About an Alarm Advisor

When the alarm advisor criteria are met for a particular alarm limit, an alarm advisor is triggered. The alarm advisor window appears automatically the next time you acknowledge the alarm (depending on your configuration).

In addition, a notification symbol appears in the status area at the bottom right of the screen (also called the system tray):

If the alarm advisor window is not displayed:

1   Select the notification symbol.
     The **Notifications** window opens.

2   Select the alarm advisor notification from the list.
     The alarm advisor window opens.

If you have closed the alarm advisor window without changing an alarm limit, you can open it again using the notification symbol, as described above. If, in the meantime, the criteria are no longer met, the notification will be canceled and you can no longer view the window.

Alarm Advisor Window

Here is an example of an alarm advisor window:
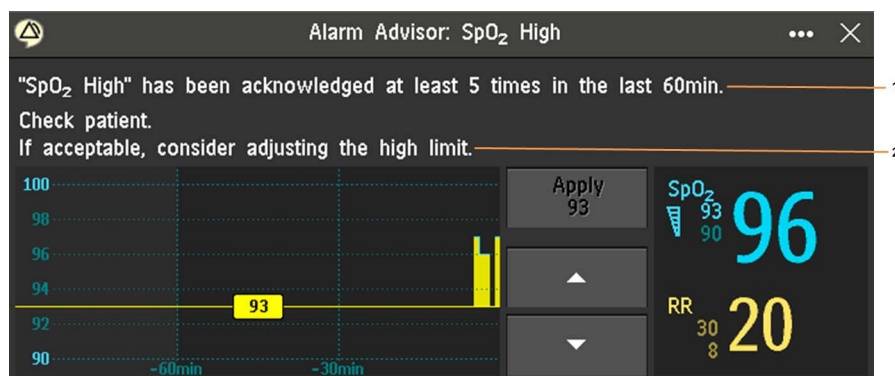
1   **"SpO₂ High" has been acknowledged at least 5 times in the last 60 min.**This first text line gives you information about the criterion that has been met. In this case, a high SpO_2 alarm was acknowledged at least 5 times in the set time period.

2   **Check patient. If acceptable, consider adjusting the high limit.**This second text line is a recommendation for a change that may avoid such situations in future. Here, this is an adjustment of the high alarm limit. Your monitor may be configured not to show a recommendation, or to show a different text than the standard one.

Under the text there are three elements shown:

•   On the left is a graphical trend showing the alarm limit violations over one and a half times the set time period.

     The current alarm limit, here 93, is shown as a horizontal line. The area above the line, filled in yellow, represents violations of the limit. You can see at a glance what proportion of the time the limit was violated.

•   Next to the graphical trend, there are up and down arrow keys that let you try out a new limit.

     In the case above, you would use the down arrow key to move the limit to, for example, 90. The line on the graphical trend then also moves to show what effect this new limit has on the alarm violations. If you want to keep the new limit, use the **Apply** key to set that limit. When you apply a new limit, the window closes.

CAUTION

Be aware that setting a new limit in the alarm advisor window is the same as changing an alarm limit in a setup menu. The limit you set will stay active indefinitely, until the setting is changed again.

Changing alarm limits always requires your clinical judgment of the patient's condition, and observation of hospital policy.

- On the right, the currently measured value and the current alarm limits are shown. Additionally, a second numeric provides additional clinical context. For SpO_2 alarms, the second numeric is the respiration rate numeric. Note that these values are not shown when using the monitor in a vertical position.

Tap on the screen to access pop-up keys that provide the following functions:

- **Viewing the graphical trend** - use the right and left arrow keys to move along the time axis and view alarm behavior at other times. Use the key between the arrow keys, here **Trend 60 min**, to select a longer or shorter graphical trend for viewing.
- **Clearing collected data and starting a new collection time period** - use the **Reset Counter** key to delete the collected alarm behavior data and start again. For example, after a procedure or moving a patient has caused atypical values to be measured, that are not a suitable basis for evaluating alarm behavior.

Latching Alarms

The alarm latching setting for your monitor defines how the alarm indicators behave when you do not acknowledge them. When alarms are set to non-latching, their indicators end when the alarm condition ends. Switching alarm latching on means that visual and/or audible alarm indications are still displayed or announced by the monitor after the alarm condition ends. The indication lasts until you acknowledge the alarm.

NOTE

If a latching alarm is not acknowledged and the same alarm condition occurs again,

- this alarm is not listed in the alarm review or the audit log of PIC iX as a new alarm.
- this alarm cannot be paged.
- no alarm recording is available for this alarm.

Note that when your monitor is configured to visual latching and audible non-latching, the reoccurrence of the alarm condition generates a new audible alarm and the corresponding alarm lamp flashes, but the alarm banner displays the latched alarm. If your alarm text is configured to **Enhanced**, the alarm text shows the maximum deviation from the alarm limit and is updated with the reoccurred alarm.

Viewing the Alarm Latching Settings

To see the alarm latching setting for your monitor:

1 In the monitor's **Main Setup** menu, select **Alarms**.

2 Select **Alarm Settings**, and see the **Visual Latching** and **Audible Latching** settings.

This setting can only be changed in Configuration Mode. You should be aware of the settings chosen for your unit. There are three possible choices each for visual and audible latching, red only, red and yellow, and off. These choices can be combined to give the following settings:

Visual Latching	Audible Latching
Red&Yellow	Red&Yellow
Red&Yellow	Red Only
Red&Yellow	Off
Red Only	Red Only
Red Only	Off
Off	Off

Alarm Latching Behavior

Red & Yellow Measurement Alarms		Non-latching alarms	Visual and audible latching	Visual latching, audible non-latching
Alarm has not been acknowledged.	Alarm condition still present.	Alarm tone on. Alarm lamp on. Alarm message. Flashing numerics.	Alarm tone on. Alarm lamp on. Alarm message. Flashing numerics.	Alarm tone on. Alarm lamp on. Alarm message. Flashing numerics.
	Alarm condition no longer present.	All audible and visual alarm indicators automatically stop.	Alarm tone on. Alarm lamp on. Alarm message. Flashing numerics.	Alarm message. Flashing numerics. Audible alarm indicators automatically stop.
Alarm has been acknowledged.	Alarm condition still present.	Alarm tone off. Alarm lamp off. Alarm message. Flashing numerics. Audible alarm reminder (if configured).	Alarm tone off. Alarm lamp off. Alarm message. Flashing numerics. Audible alarm reminder (if configured).	Alarm tone off. Alarm lamp off. Alarm message. Flashing numerics. Audible alarm reminder (if configured).
	Alarm condition no longer present.	Audible and visual alarm indicators automatically stop.	Audible and visual alarm indicators automatically stop.	Audible and visual alarm indicators automatically stop.

All INOPs are non-latching. See "Yellow Arrhythmia Alarms" on page 145 for information on one-star yellow alarms latching behavior.

Testing Alarms

When you switch the monitor on, a selftest is started. You must check that the alarms lamps light, one after the other, and that you hear a single tone. This indicates that the visible and audible alarm indicators are functioning correctly. For further testing of individual measurement alarms, perform the measurement on yourself (for example SpO_2 or CO_2) or use a simulator. Adjust alarm limits and check that appropriate alarm behavior is observed.

Alarm Behavior at Power On

If the monitor is switched off for longer than one minute and then switched on again (or after a loss of power lasting longer than one minute, or when a patient is discharged), the monitor can be configured to:

- restore the alarm settings from the monitor's configured default Profile,

- restore the most recently used alarm settings, or

- switch the alarms off.

After any of these situations, you should check that the alarm settings are appropriate for your patient and monitoring situation, and if necessary, select the correct Profile and patient category.

If power is lost for less than one minute, the alarm on/off condition prior to the power loss is restored.

Alarm Recordings

You can set up your monitor so that it automatically triggers alarm recordings locally or at the Information Center, or if configured, to a printer as a realtime report.

1 Press the **Main Setup** SmartKey.

2 Select **Alarms** from the **Main Setup** menu.

3 Select **Alarm Recording** from the **Alarms** menu to open the **Alarm Recordings** menu.

4 Select a measurement from those listed for which you want to change the alarm condition that triggers an alarm recording. This opens a pop-up list.

5 For the desired measurement(s), choose the alarm condition to trigger an alarm recording:

Red Only: an alarm recording will automatically be triggered when the measurement enters a red alarm condition.

Red&Yellow: both yellow and red alarms will trigger an alarm recording.

Off: disables automatic alarm recording.

Refer to the "Recording" chapter for details of how to set up a recording.

3 Alarms

Patient Alarms and INOPs

This chapter lists patient alarms alphabetically, and technical alarms (INOPs) arranged by the source of the INOP and then alphabetically, irrespective of their priority. All alarms and INOPs are listed here; the ones which can appear on your monitor will depend on the model and the individual options.

Patient Alarm Messages

The measurement labels and abbreviations for pressure, temperature, and SpO_2 alarms are explained in the individual chapters.

Some alarms may be shown at the Information Center in shortened form, when transferred through IntelliVue Instrument Telemetry. These shortened alarm texts are included in the list and identified with the note "at Information Center".

Alarm Message	From	Condition	Indication
** 3D Desat Index	Oxygen Saturation	The number of detected desaturations has exceeded the specified 3D Desat Index Count	SpO_2 numeric flashes, yellow alarm lamp, alarm tone
** 3D Perf Delta	Perfusion Index	The perfusion index change from the Perf baseline has exceeded the selected Delta % Decrease value.	SpO_2 numeric flashes, yellow alarm lamp, alarm tone
* AFIB	ECG/Arrhythmia	An irregular rhythm of beats labeled as **N AND** variability in PR intervals **AND** P-wave variability (For adult patient category only)	yellow alarm lamp, short yellow alarm tone
** AGT Mix MAC > 3	GM	An agent mixture has been detected and the sum of the 2 agent MAC components + MAC (N_2O) is ≥ 3 MAC (uncorrected)	yellow alarm lamp, alarm tone
*** Apnea	CO_2, Respiration, GM, Spirometry	Respiration has stopped for longer than the preset apnea time.	numeric flashes, red alarm lamp, alarm tone
*** Apnea x:yy	CO_2, Respiration, GM	This is the alternative alarm message for *** **Apnea**, when the alarm text setting is **Enhanced**. Respiration has stopped for longer than the preset apnea time. "x:yy" denotes the Apnea duration in minutes and seconds.	numeric flashes, red alarm lamp, alarm tone
*** Asystole	ECG	No beat detected for a period > the asystole threshold (2.5 - 4.0 seconds)	numeric flashes, red alarm lamp, alarm tone
** awRR High	CO_2, Respiration, AGM, GM	The airway respiration rate has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** awRR Low	CO_2, Respiration, AGM, GM	The airway respiration rate has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** <BIS Label> High	BIS	The Bispectral Index value has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone

Alarm Message	From	Condition	Indication
** <BIS Label> Low	BIS	The Bispectral Index value has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
*** Brady (Pulse)	SpO2, Pressure, cmResp	Pulse rate < the extreme brady alarm limit.	numeric flashes and alarm limit is highlighted, red alarm lamp, alarm tone
*** Brady/P xxx<yyy	SpO2, Pressure, cmResp	This is the alternative alarm message for *** Brady (Pulse), when the alarm text setting is Enhanced. Pulse rate < the extreme bradycardia alarm limit. xxx denotes the lowest measured value; yyy is the extreme bradycardia limit.	numeric flashes and alarm limit is highlighted, red alarm lamp, alarm tone
*** Bradypnea	cmResp	The respiration rate has dropped below the bradypnea limit.	numeric flashes and alarm limit is highlighted, red alarm lamp, alarm tone
** CCI High	CCI	CC Index is above the high alarm limit.	numeric flashes and high alarm limit is highlighted, yellow alarm lamp, alarm tone
** CCI Low	CCI	CC Index is below the low alarm limit.	numeric flashes and low alarm limit is highlighted, yellow alarm lamp, alarm tone
** CCO High	CCO	Continuous Cardiac Output is above the high alarm limit.	numeric flashes and high alarm limit is highlighted, yellow alarm lamp, alarm tone
** CCO Low	CCO	Continuous Cardiac Output is below the low alarm limit.	numeric flashes and low alarm limit is highlighted, yellow alarm lamp, alarm tone
** cmRR High	cmResp	The respiration rate has exceeded the high alarm limit.	numeric flashes and high alarm limit is highlighted, yellow alarm lamp, alarm tone
** cmRR Low	cmResp	The respiration rate has dropped below the low alarm limit.	numeric flashes and low alarm limit is highlighted, yellow alarm lamp, alarm tone
** CPP High	CPP	The CPP value has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** CPP Low	CPP	The CPP value has fallen below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
*** Desat	SpO$_2$	The SpO$_2$ value has fallen below the desaturation alarm limit.	numeric flashes, red alarm lamp, alarm tone
*** Desat xx < yy	SpO$_2$	This is the alternative alarm message for *** Desat, when the alarm text setting is Enhanced. The SpO$_2$ value has fallen below the desaturation alarm limit. xx denotes the lowest measured value, and yy is the desaturation limit.	numeric flashes, red alarm lamp, alarm tone
** EC10 Alarm *** EC10 Alarm at Information Center	EC10 IntelliBridge	A yellow (**) or red (***) patient alarm is present on the IntelliBridge module. Check the monitor display for more detailed alarm information.	(on monitor) yellow or red alarm lamp; the alarm text is defined by the IntelliBridge device driver
* End AFIB	ECG/Arrhythmia	Atrial fibrillation no longer detected for the Afib end delay time (For adult patient category only)	yellow alarm lamp, short yellow alarm tone

Alarm Message	From	Condition	Indication
* End Irregular HR	ECG/Arrhythmia	Irregular HR rhythm no longer detected for the Irregular HR end delay time.	yellow alarm lamp, short yellow alarm tone
** et<Agent Label> High	GM	The end tidal agent high alarm limit has been exceeded.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** et<Agent Label> Low	GM	The end tidal agent value has fallen below the low alarm limit	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** etCO₂ High	CO_2, AGM, GM	The end tidal CO_2 high alarm limit has been exceeded.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** etCO₂ Low	CO_2, AGM, GM	The end tidal CO_2 value has fallen below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** etO₂ High	O_2, AGM	The end tidal O_2 high alarm limit has been exceeded.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** etO₂ Low	O_2, AGM	The end tidal O_2 value has fallen below the low alarm limit.	numeric flashes, and low limit is highlighted, yellow alarm lamp, alarm tone
* Event ** Event *** Event at Information Center	Event surveillance	An event has occurred and the event notification is configured to alarm. Check on the monitor for more details on event group.	(on monitor) event group name flashes, yellow or red alarm lamp and alarm tone
* Event:<Event Group> ** Event:<Event Group> *** Event:<Event Group>	Event surveillance	An event has occurred and the event notification is configured to alarm.	event group name flashes, yellow or red alarm lamp and alarm tone
*** Extreme Brady	ECG	Heart rate < the extreme brady alarm limit.	numeric flashes and alarm limit is highlighted, red alarm lamp, alarm tone
*** Extreme Tachy	ECG	Heart rate > the extreme tachy alarm limit.	numeric flashes and alarm limit is highlighted, red alarm lamp, alarm tone
* HR High ** HR High	ECG	Heart rate > the high HR alarm limit	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone. If configured to short yellow, the sound switches off after 5 seconds if Arrhythmia is switched on.
* HR Low ** HR Low	ECG	Heart rate < the low HR alarm limit	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone. If configured to short yellow, the sound switches off after 5 seconds if Arrhythmia is switched on.
** imCO₂ High	GM	The inspired minimum CO_2 high alarm limit has been exceeded	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone.
** in<Agent Label> High	GM	The inspired agent high alarm limit has been exceeded	numeric flashes, high limit is highlighted, yellow alarm lamp, alarm tone
** in<Agent Label> Low	GM	The inspired agent value has fallen below the AGT low alarm limit	numeric flashes, low limit is highlighted, yellow alarm lamp, alarm tone

Alarm Message	From	Condition	Indication
** inN₂O High	GM	The inspired N_2O high alarm limit has been exceeded.	numeric flashes, high limit is highlighted, yellow alarm lamp, alarm tone
** inO₂ High	GM	The inspired O_2 high alarm limit has been exceeded.	numeric flashes, high limit is highlighted, yellow alarm lamp, alarm tone
** inO₂ Low	GM	The inspired O_2 value has fallen below the low alarm limit	numeric flashes, low limit is highlighted, yellow alarm lamp, alarm tone
*** inO₂ Low Oxygen	GM	The inspired O_2 value has fallen below 18 vol%.	numeric flashes, low limit is highlighted, red alarm lamp, alarm tone
** IPI Low	CO₂	The IPI value has fallen below the low alarm limit.	numeric flashes, and low limit is highlighted, yellow alarm lamp, alarm tone
* Irregular HR	ECG/Arrhythmia	An irregular rhythm of beats labeled as **N** (R-R interval changes > 12.5%)	numeric flashes, yellow alarm lamp, short yellow audible alarm
** <iTemp Label> High	iTemp	The temperature value has exceeded the high alarm limit.	numeric flashes and high limit is high-lighted, yellow alarm lamp, alarm tone
** <iTemp Label> Low	iTemp	The temperature value has dropped below the low alarm limit.	numeric flashes and low limit is high-lighted, yellow alarm lamp, alarm tone
* Missed Beat	ECG/Arrhythmia	No beat detected for a period > 1.75 times the averaged R-R interval for HR < 120, **OR** no beat detected for > 1 second with HR > 120 (Paced mode off).	numeric flashes, yellow alarm lamp, short yellow audible alarm
* More Alarms ** More Alarms *** More Alarms	other assigned devices	There is more than one physiological alarm of the corresponding severity active on the devices that monitor this patient. For details, check the information displayed at the Information Center.	yellow or red alarm lamp and alarm tone
* Multiform PVCs	ECG/Arrhythmia	The occurrence of two differently shaped beats labeled as **V** within the last 60 beats **AND** each occurring at least twice within the last 300 beats	numeric flashes, yellow alarm lamp, short yellow audible alarm
** NBP High	NBP	The measured NBP value is above the high alarm limit. **s**, **d**, or **m** after the label indicates whether the systolic, diastolic or mean pressure has crossed the limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** NBP Low	NBP	The measured NBP value is below the low alarm limit. **s**, **d**, or **m** after the label indicates whether the systolic, diastolic or mean pressure has crossed the limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
* Non–Sustain VT	ECG/Arrhythmia	A run of consecutive beats labeled as **V** with run length < the V-Tach Run Limit **AND** ventricular HR > V-Tach HR limit	numeric flashes, yellow alarm lamp, short yellow audible alarm
* OtherMon Alarm ** OtherMon Alarm *** OtherMon Alarm	another assigned monitor	Another monitor used for the patient is in an alarm condition. Check the detailed alarm information at the Information Center.	yellow or red alarm lamp and alarm tone
* Pacer Not Capt	ECG/Arrhythmia (paced patients only)	No beat detected for a period > 1.75 times the average R-R interval **AND** pace pulse(s) detected (Paced mode On)	numeric flashes, yellow alarm lamp, short yellow audible alarm

Alarm Message	From	Condition	Indication
* Pacer Not Pacing	ECG/Arrhythmia (paced patients only)	No beat detected for a period > 1.75 times the average R-R interval **AND** no pace pulse(s) detected (Paced mode On)	numeric flashes, yellow alarm lamp, short yellow audible alarm
* Pair PVCs	ECG/Arrhythmia	Two consecutive beats labeled as **V** between 2 beats not labeled as **V**	numeric flashes, yellow alarm lamp, short yellow audible alarm
* Pause	ECG/Arrhythmia	No beat detected for a period > the pause alarm threshold (1.5-2.5 seconds)	numeric flashes, yellow alarm lamp, short yellow audible alarm
** <Perf Label> High	Perfusion Index	The perfusion index has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** <Perf Label> Low	Perfusion Index	The perfusion index has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
*** <Press Label> Disconnect	Pressure	The pressure is non-pulsatile and the mean pressure is continuously less than 10 mmHg (1.3 kPa). This alarm occurs only with arterial pressures (P, ABP, ART, Ao, BAP, FAP, LFP, RFP, PAP, UAP, P1, P2, P3, P4, Pa1, Pa2, Pa3, Pa4).	numeric flashes, red alarm lamp, alarm tone
*** <Press Label> High	Pressure	The measured pressure value is above the **extreme** high alarm limit. **s**, **d**, or **m** after the label indicates whether the systolic, diastolic or mean pressure has crossed the limit.	numeric flashes, high limit is highlighted, red alarm lamp, alarm tone
** <Press Label> High	Pressure	The measured pressure value is above the high alarm limit. **s**, **d**, or **m** after the label indicates whether the systolic, diastolic or mean pressure has crossed the limit.	numeric flashes, high limit is highlighted, yellow alarm lamp, alarm tone
*** <Press Label> Low	Pressure	The measured pressure value is below the **extreme** low alarm limit. **s**, **d**, or **m** after the label indicates whether the systolic, diastolic or mean pressure has crossed the limit.	numeric flashes and low limit is highlighted, red alarm lamp, alarm tone
** <Press Label> Low	Pressure	The measured pressure value is below the low alarm limit. **s**, **d**, or **m** after the label indicates whether the systolic, diastolic or mean pressure has crossed the limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** <pTemp Label> High	pTemp	The temperature value has exceeded the high alarm limit.	numeric flashes and high limit is high-lighted, yellow alarm lamp, alarm tone
** <pTemp Label> Low	pTemp	The temperature value has dropped below the low alarm limit.	numeric flashes and low limit is high-lighted, yellow alarm lamp, alarm tone
** Pulse High	Pressure, SpO$_2$, cmResp	The pulse rate has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** Pulse Low	Pressure, SpO$_2$, cmResp	The pulse rate has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
* PVCs/min High	ECG/Arrhythmia	Within 1 minute, the number of beats labeled as **V** > the PVCs/min limit	numeric flashes, yellow alarm lamp, short yellow audible alarm
** PVI High	Pleth Variability Index	The pleth variability index has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone

Alarm Message	From	Condition	Indication
** PVI Low	Pleth Variability Index	The pleth variability index has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** QTc High	ECG/QT	QTc value has exceeded the QTc high limit for more than 5 minutes	numeric flashes, yellow alarm lamp, alarm tone
** ΔQTc High	ECG/QT	ΔQTc value has exceeded the ΔQTc high limit for more than 5 minutes	numeric flashes, yellow alarm lamp, alarm tone
* R–on–T PVCs	ECG/Arrhythmia	For HR < 100, a beat labeled as **V** with R-R interval < 333 ms and < 1/3 of the average R-R interval followed by a compensatory pause > 1.25 times the average R-R interval **OR** 2 such beats labeled as **V** without a compensatory pause occurring within 5 minutes of each other (Note: When HR > 100, 1/3 of the R-R interval is too short for detection)	numeric flashes, yellow alarm lamp, short yellow audible alarm
** RR High	Respiration	The respiration rate has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** RR Low	Respiration	The respiration rate has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** RRac High	Acoustic Respiration Rate	The acoustic respiration rate has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** RRac Low	Acoustic Respiration Rate	The acoustic respiration rate has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
*** RRac Pause	Acoustic Respiration Rate	No breath detected for a configured time period.	numeric flashes, red alarm lamp, alarm tone
* Run PVCs High	ECG/Arrhythmia	A run of > 2 consecutive beats labeled as **V** with run length < Vent rhythm run limit **AND** ventricular HR < V-Tach HR limit.	numeric flashes, yellow alarm lamp, short yellow audible alarm
** <SO₂ Label> High	SvO_2/SO_2	The measured intravascular oxygen saturation has exceeded the high limit.	numeric flashes and high alarm limit is highlighted, yellow alarm lamp, alarm tone
** <SO₂ Label> Low	SvO_2/SO_2	The measured intravascular oxygen saturation has fallen below the low limit.	numeric flashes and low alarm limit is highlighted, yellow alarm lamp, alarm tone
** SpCO High	Carboxyhemoglobin Saturation	The carboxyhemoglobin saturation has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** SpCO Low	Carboxyhemoglobin Saturation	The carboxyhemoglobin saturation has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** <SpHb Label> High	Total Hemoglobin Concentration	The total hemoglobin concentration has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** <SpHb Label> Low	Total Hemoglobin Concentration	The total hemoglobin concentration has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** SpMet High	Methemoglobin Saturation	The methemoglobin saturation has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone

Alarm Message	From	Condition	Indication
** SpMet Low	Methemoglobin Saturation	The methemoglobin saturation has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** \<SpO₂ Label\> High	SpO$_2$	The arterial oxygen saturation has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** \<SpO₂ Label\> Low	SpO$_2$	The arterial oxygen saturation has fallen below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** SpOC High	Total Oxygen Content	The total oxygen content has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** SpOC Low	Total Oxygen Content	The total oxygen content has dropped below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
** ST Multi \<n\>,\<n\>	ECG/ST	Two contiguous ST leads \<n\> and \<n\> have exceeded elevation or depression limits for more than 60 seconds. The limit violations for both leads must be with respect to same limit; either both above the high limit or both below the low limit.	numeric flashes, yellow alarm lamp, alarm tone
** ST Multi at Information Center	ECG/ST	The ST depression or elevation is outside of the limit in two or more leads. Check on the monitor	(on monitor) numeric flashes, yellow alarm lamp, alarm tone
** STE \<n\>,\<n\>	ECG/ST	Two contiguous leads \<n\> and \<n\> are above their respective STE limits	numeric flashes, yellow alarm lamp, alarm tone
** ST–\<n\> High	ECG/ST	The ST elevation in lead \<n\> is higher than the limit. Lead is not contiguous with any other lead.	numeric flashes and high alarm limit is highlighted, yellow alarm lamp, alarm tone
** ST–\<n\> Low	ECG/ST	The ST depression in lead \<n\> is lower than the limit. Lead is not contiguous with any other lead.	numeric flashes and low alarm limit is highlighted, yellow alarm lamp, alarm tone
* SVT	ECG/Arrhythmia	A run of consecutive beats labeled as S with run length > SVT run limit **AND** SVT HR > SVT HR limit	numeric flashes, yellow alarm lamp, alarm tone
*** Tachy (Pulse)	SpO$_2$, Pressure, cmResp	Pulse rate > the extreme tachy alarm limit.	numeric flashes, alarm limit is highlighted, red alarm lamp, alarm tone
*** Tachy/P xxx>yyy	SpO$_2$, Pressure, cmResp	This is the alternative alarm message for *** **Tachy (Pulse)** when the alarm text setting is **Enhanced**. Pulse rate >the extreme tachycardia alarm limit. xxx denotes the highest measured value; yyy is the tachycardia limit.	numeric flashes, alarm limit is highlighted, red alarm lamp, alarm tone
** Tblood High	C.O.	The blood temperature value has exceeded the high alarm limit.	numeric flashes, high alarm limit is highlighted, yellow alarm lamp, alarm tone
** Tblood Low	C.O.	The blood temperature value has fallen below the low alarm limit.	numeric flashes, low alarm limit is highlighted, yellow alarm lamp, alarm tone
** tcpCO₂ High	tcGas	The tcpCO$_2$ value has exceeded the high alarm limit.	numeric flashes, high alarm limit is highlighted, yellow alarm lamp, alarm tone

Alarm Message	From	Condition	Indication
** tcpCO₂ Low	tcGas	The $tcpCO_2$ value has fallen below the low alarm limit.	numeric flashes, low alarm limit is highlighted, yellow alarm lamp, alarm tone
** tcpO₂ High	tcGas	The $tcpO_2$ value has exceeded the high alarm limit.	numeric flashes, high alarm limit is highlighted, yellow alarm lamp, alarm tone
** tcpO₂ Low	tcGas	The $tcpO_2$ value has fallen below the low alarm limit.	numeric flashes, low alarm limit is highlighted, yellow alarm lamp, alarm tone
* Tele Alarm ** Tele Alarm *** Tele Alarm	an assigned telemetry device	A telemetry device used for the patient is in an alarm condition. Check the detailed alarm information at the Information Center.	yellow or red alarm lamp and alarm tone
** <Temp Label> High	Temperature	The temperature has exceeded the high alarm limit.	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
** <Temp Label> Low	Temperature	The temperature has fallen below the low alarm limit.	numeric flashes and low limit is highlighted, yellow alarm lamp, alarm tone
* T–Mon Alarm ** T–Mon Alarm *** T–Mon Alarm	an assigned transport monitor	A transport monitor used for the patient is in an alarm condition. Check the detailed alarm information at the Information Center.	yellow or red alarm lamp and alarm tone
** TOFcnt High	NMT	TOFcnt value has exceeded the high alarm limit	numeric flashes and high limit is highlighted, yellow alarm lamp, alarm tone
* Vent Bigeminy	ECG/Arrhythmia	A dominant rhythm of beats labeled as **N**, **V**, **N**, **V**, **N**	numeric flashes, yellow alarm lamp, short yellow audible alarm
*** Vent Fib/Tach	ECG	Fibrillatory waveform (sinusoidal wave between 2 - 10 Hz) for 4 consecutive seconds.	numeric flashes, red alarm lamp, alarm tone
* Vent Rhythm	ECG/Arrhythmia	A run of consecutive beats labeled as **V** with run length > Vent rhythm run limit **AND** ventricular HR < V-Tach HR limit	numeric flashes, yellow alarm lamp, short yellow audible alarm
* Vent Trigeminy	ECG/Arrhythmia	A dominant rhythm of beats labeled as **N, N, V, N, N, V, N, N**	numeric flashes, yellow alarm lamp, short yellow audible alarm
*** VTach	ECG/Arrhythmia	A run of consecutive beats labeled as **V** with run length > V-Tach Run limit **AND** ventricular HR > V-Tach HR limit	numeric flashes, red alarm lamp, alarm tone
** VueLink Alarm *** VueLink Alarm at Information Center	VueLink	A yellow (**) or red (***) patient alarm is present on the VueLink module. Check the monitor display for more detailed alarm information.	(on monitor) yellow or red alarm lamp; the alarm text is defined by the VueLink device driver
*** xBrady xxx<yyy	Pressure, SpO₂, ECG	This is the alternative alarm message for *** **Extreme Brady**, when the alarm text setting is **Enhanced**. Heart rate < the extreme bradycardia alarm limit. xxx denotes the lowest measured value; yyy is the extreme bradycardia limit.	numeric flashes and alarm limit is highlighted, red alarm lamp, alarm tone
*** xTachy xxx>yyy	Pressure, SpO₂, ECG	This is the alternative alarm message for *** **Extreme Tachy** when the alarm text setting is **Enhanced**. Heart rate >the extreme tachycardia alarm limit. xxx denotes the highest measured value; yyy is the tachycardia limit.	numeric flashes, alarm limit is highlighted, red alarm lamp, alarm tone

Technical Alarm Messages (INOPs)

If an INOP interrupts monitoring and alarm detection, the measurement numeric will be replaced by **–?–**. If an INOP may lead to unreliable measurement values, a **?** appears next to the numeric.

The measurement labels and abbreviations for pressure, temperature and SpO$_2$ INOP messages are explained in the individual measurement chapters.

Monitor INOPs

INOP Message, Indication	What to do
Act.Display Disc. INOP tone	Connection to the Active Display has been lost. Check all network connections and verify that the Active Display is powered and functioning correctly.
Act.Display Unsupp INOP tone	Connection to the Active Display is not possible. Check if the software revisions of the monitor and the Active Display are compatible and check the configuration and the password.
AD: Data Delayed INOP tone	Data and alarms on the Active Display are delayed due to high network traffic. If the INOP persists, contact your service personnel.
Bad MSL INOP tone	1) A Multi-Measurement Module with an incompatible software revision is connected to the monitor. This combination does not allow monitoring, OR 2) You cannot use this combination of monitor, Multi-Measurement Module and cable. Switch off the monitor and contact your service personnel.
Central: Tele Only INOP tone	System connectivity via telemetry device is limited (No alarms, only local numerics) when in companion mode and host monitor does not have system connectivity. Only telemetry device parameters can be displayed at central station.
Check Alarm Lamps INOP tone	Perform a visual check of the alarm lamp to establish whether there is a problem. Contact your service personnel to check the internal connections to the alarm lamps.
Check DrugSettings INOP tone	There was a problem loading the drug settings. Check that the settings are complete and correct.
!! Check ECG Source Yellow tone	The telemetry device and the monitor both have valid ECG signals. Unpair the telemetry device and the monitor if they are no longer used for the same patient.
Check Equipment **!! Check Equipment** Corresponding INOP tone may sound	There is an equipment status dispute relating to one or more of the devices assigned to this patient. See the **Equipment** window for details.
Check Flex Texts INOP tone	Check the names of the monitor menus, for example the labels for screens, profiles, event or trend group names, before you resume monitoring. If they are unexpected, there may be a problem with the monitor software. Contact your service personnel.
Check Keyboard INOP tone	Perform a visual and functional check of the keyboard. Contact your service personnel.
Check Monitor Func INOP tone	Potential problem with alarm lamps, display or interfaces detected. Contact your service personnel.
Check Monitor Temp INOP tone	The temperature inside the monitor is too high. Check that the monitor ventilation is not obstructed. If the situation continues, contact your service personnel.
Check Mouse INOP tone	Perform a visual and functional check of the mouse input device. Contact your service personnel.
Check MSL Voltage INOP tone	There is a problem with the voltage of the Measurement Link (MSL). Contact your service personnel.
Check Network Conf INOP tone may sound	The monitor is receiving network topology information from more than one source, e.g. the Database Server and an Application Server. Contact your service personnel.
Check NFC INOP tone	The NFC subsystem is not working correctly. Switch the monitor off and on again after a few seconds. If the INOP persists, contact your service personnel.
!! Check Pairing INOP tone	There is a problem with device pairing. Check that the monitor and telemetry device are correctly paired.

INOP Message, Indication	What to do
Check Passwords INOP tone	There is a problem with the password settings. Contact your service personnel.
!! Check Patient ID Yellow tone	There is a mismatch between patient data in two connected devices. Resolve the mismatch to allow settings and data synchronization.
Check Settings INOP tone	If this INOP appears, check the monitor and patient settings before you resume monitoring. If the settings are unexpected, there may be a problem with the monitor software. Contact your service personnel.
Check Touchscreen	Perform a visual and functional check of the touch input device. Contact your service personnel.
Check Waves INOP tone	The options purchased with this monitor may not support the number of waves required to show the selected Screen, so some waves or high resolution trends are missing from the Screen. Select a different Screen with fewer waves. Contact your service personnel if you want the Screen deleted from the Profile(s) to avoid this in future.
Chk Audio Settings INOP tone	The current audio configuration is invalid. Check audio settings and the connection to the remote alarm device. If the INOP persists, contact your service personnel.
Chk Global Sett. INOP tone	Check the monitor's global and network settings before you resume monitoring.
Chk <Measurement Label> Settings INOP tone	Synchronization of the settings for the measurement cited, has failed. Check that settings are appropriate for your patient.
Chk MSL Connection INOP tone	Check that the MSL cable is properly connected. If this is the case, try using another MSL cable, to check if your cable is defective. If this does not help, the device connected via the MSL cable may be defective, contact your service personnel.
Chk SyncOut Cable INOP tone	The ECG Sync is detecting an invalid signal, or the ECG Sync cable is disconnected.
Internal.Comm.Malf INOP tone	There is a problem with I2C Bus communication in the monitor. Contact your service personnel.
Meas. Deactivated INOP tone	A measurement device has been connected to a host monitor (companion mode) and all derived measurements have been deactivated and/or measurements with a label conflict. The measurements can only be reactivated by disconnecting the measurement device from the host monitor.
!! More Bed Alarms **!!! More Bed Alarms** at Information Center	The monitor is associated with a telemetry device and is sending data to the Information Center via the telemetry device. There are currently more alarms at the bedside than can be transmitted to the Information Center.
More INOPs **!! More INOPs** **!!! More INOPs** Corresponding INOP tone	There is more than one technical alarm of the corresponding severity active on the devices that monitor this patient. For details check the information displayed at the Information Center.
MSL Power High INOP tone	The power consumption of the devices connected to the Measurement Link (MSL) cable is too high. If this situation continues, the MSL will be switched off. Contact your service personnel.
MSL Power Off INOP tone	The power consumption of the devices connected to the Measurement Link (MSL) cable was too high for too long and the MSL has been switched off. Contact your service personnel.
MSL Power Overload INOP tone	The power consumption of the devices connected to the Measurement Link (MSL) cable is much too high or there has been a short circuit. The MSL has been switched off. Contact your service personnel.
NetworkDeactivated INOP tone	The network interface has been deactivated for security reasons. All network connections have been closed. Contact your service personnel.
NetworkMalfunction INOP tone	Network malfunction or adverse or malicious traffic detected. Network connections are not possible. Contact your service personnel.
No Central Monit. INOP tone	There is a problem with the communication to the network. Central monitoring is currently not possible (no patient alarms or information). Check the connection. In case the connection is via a telemetry device, the current telemetry use model does not support central monitoring. Contact your service personnel.
No ECG at Central INOP tone	The ECG measured with the monitor ECG is not being sent to the Information Center via the telemetry device.

INOP Message, Indication	What to do
No System INOP tone may sound	There is a communication problem. System monitoring is currently not possible. Check if you are out of range and check the equipment label.
OtherMon INOP **!! OtherMon INOP** **!!! OtherMon INOP** Corresponding INOP tone	Another monitor assigned to the patient (e.g. a transport monitor) is in an INOP condition. Check the detailed INOP information at the Information Center and resolve the INOP condition(s) at the other monitor.
Rem. Display Malf. INOP tone	One of the Remote Display's input devices is not working correctly. Perform a visual and functional check.
Rem.AlarmDev.Malf. INOP tone	There is a problem with the connection to the remote alarm device. Contact your service personnel to check the remote alarm device and its connections.
Settings Malfunct INOP tone	The monitor cannot use the predefined settings for monitoring. Contact your service personnel.
Speaker Malfunct INOP tone	Contact your service personnel to check the speaker and the connection to the speaker.
SRR Incompatible INOP tone	The short range radio component has compatibility problems. Contact your service personnel.
SRR Malfunction INOP tone	Malfunction in the short range radio device. If the INOP persists contact your service personnel.
TAAP Disabled INOP tone	The currently selected telemetry configuration on the monitor does not allow connection of telemetry devices to the monitor.
Tele Config Unsupp INOP tone	Telemetry Workflow configuration not supported. Check revision and configuration of monitor and central.
Tele Equip Malf INOP tone	The telemetry device has a malfunction. Disconnect and reconnect the telemetry device. If the INOP reappears, replace the telemetry device.
Tele Incompatible INOP tone	SRR-enabled telemetry device is not supported by this central software revision. Please check configuration.
Tele INOP **!! Tele INOP** **!!! Tele INOP** Corresponding INOP tone	A telemetry device assigned to the patient is in an INOP condition. Check the detailed INOP information at the Information Center and resolve the INOP condition(s) at the telemetry device.
Tele Unsupported INOP tone	This telemetry device is not supported for direct connection to the monitor.
<TimerLabel>:TimeElapsed INOP tone	The time has expired for the timer indicated in the INOP text. Clearing the timer clears the INOP.
T–Mon INOP **!! T–Mon INOP** **!!! T–Mon INOP** Corresponding INOP tone	A transport monitor assigned to the patient is in an INOP condition. Check the detailed INOP information at the Information Center and resolve the INOP condition(s) at the transport monitor.
Unknown INOP **!! Unknown INOP** **!!! Unknown INOP** Corresponding INOP tone may sound In some cases, during this INOP alarms cannot be paused or switched off.	A technical alarm has been received but is not known. Check all devices that are assigned to this patient to avoid missing the unknown technical alarm and contact your service personnel.
Unsupported LAN INOP tone	There is a problem with the communication to the network and central monitoring is currently not possible. Check the connection. If the INOP persists, switch off the monitor and contact your service personnel.
User I/F Malfunct INOP tone	Perform a visual and functional check of all the monitor input devices. Contact your service personnel.
X3 Timer Elapsed INOP tone	A timer in the X3 companion monitor has elapsed.

Battery INOPs

INOP Message, Indication	What to do
Batt Empty **!! Batt Empty** **!!! Batt Empty** Corresponding INOP tone, battery LED flashes During this INOP, alarms cannot be paused or switched off.	The estimated remaining battery-powered operating time is less than 10 minutes. Replace the battery immediately. If the condition persists and the monitor is not connected to mains power, this INOP is re-issued two minutes after you acknowledge it.
Batt Extensn Malf INOP tone	There is a hardware error in the Battery Extension. Contact your service personnel.
Batt Incompat INOP tone	The battery cannot be used with this monitor. Replace with the correct battery as specified in this book.
Batt Low INOP tone	The estimated battery-powered operating time remaining is less than 20 minutes.
Batt Malfunction INOP tone, battery LED flashes During this INOP, alarms cannot be paused or switched off unless the monitor is connected to mains power.	The monitor cannot determine the battery status. If this INOP persists, replace the faulty battery. If the condition persists and the monitor is not connected to mains power, this INOP is re-issued two minutes after you acknowledge it. Place the battery in a different monitor or in a battery charger. If the same INOP is shown, contact your service personnel.
Charger Malfunct INOP tone, battery LED may flash	There is a problem with the battery charger in the monitor. Connect the monitor to mains power and contact your service personnel.
Check Batt Temp INOP tone	The temperature of one or both batteries is too high. Check that ventilation openings (if applicable) are not blocked and monitor is not exposed to heat.
ExtBat Empty **!! ExtBat Empty** **!!! ExtBat Empty** Corresponding INOP tone, battery LED flashes During this INOP, alarms cannot be paused or switched off.	The estimated battery-powered operating remaining time is less than 10 minutes. Replace the battery in the battery extension immediately. If the condition persists and the monitor is not connected to mains power, this INOP is re-issued two minutes after you acknowledge it.
ExtBat Incompat INOP tone	The battery in the battery extension cannot be used. Replace with the correct battery as specified in this book.
ExtBat Low INOP tone	The estimated battery-powered operating time remaining is less than 20 minutes.
ExtBat Malfunction INOP tone, battery LED flashes During this INOP, alarms cannot be paused or switched off unless the monitor is connected to mains power.	The monitor cannot determine the status of the battery in the battery extension. If this INOP persists, replace the faulty battery in the battery extension. If the condition persists and the monitor is not connected to mains power or a host monitor, this INOP is re-issued two minutes after you acknowledge it.
ExtBat Missing INOP tone	There is no battery in the Battery Extension
!! Insert Battery Yellow INOP tone During this INOP, alarms cannot be paused or switched off.	MX100/X3/X2/MP2 only: There is no battery in the battery compartment. You cannot operate the monitor on AC mains or battery extension when no battery is in the compartment. Load a battery immediately.

Multi-Measurement Module, Measurement Extensions and Module Rack INOPs

INOP Message, Indication	What to do
FMS Msmt Malf INOP tone	A measurement module in the connected FMS Module Rack is defective and cannot be used for monitoring. Unplug the module and plug it again after a few seconds. If the INOP persists, contact your service personnel.
FMS Unplugged INOP tone	Make sure that the Module Rack is connected to the monitor. All Module Rack measurements are off while the Module Rack is unplugged.
FMS Unsupported INOP tone	An FMS connected to the Measurement Link (MSL) is incompatible or not supported in this configuration. Contact your service personnel.
FMX Msmt Malf INOP tone	A measurement module in the connected FMX Module Rack is defective and cannot be used for monitoring. Unplug the module and plug it again after a few seconds. If the INOP persists, contact your service personnel.
FMX Unplugged INOP tone	Make sure that the Module Rack is connected to the monitor. All Module Rack measurements are off while the Module Rack is unplugged.
FMX Unsupported INOP tone	An FMX connected to the Measurement Link (MSL) is incompatible or not supported in this configuration. Contact your service personnel.
\<Measurement Label\> Unsupported INOP tone	A plug-in module is incompatible or not supported in this configuration. Contact your service personnel.
MMS Msmt Malf INOP tone	Measurement hardware in Multi-Measurement Module or Measurement Extension is defective. Unplug the Multi-Measurement Module and Measurement Extension and plug them in again after a few seconds. If the INOP persists, contact your service personnel.
MMS Unplugged INOP tone	Make sure that the Multi-Measurement Module is connected to the monitor. All Multi-Measurement Module measurements are off while the Multi-Measurement Module is unplugged.
MMS Unsupported INOP tone	An MMS connected to the Measurement Link (MSL) is incompatible or not supported in this configuration. Contact your service personnel.
MMX Msmt Malf INOP tone	Measurement hardware in Multi-Measurement Module or Measurement Extension is defective. Unplug the Multi-Measurement Module and Measurement Extension and plug them in again after a few seconds. If the INOP persists, contact your service personnel.
MMX Unplugged INOP tone	Make sure that the Multi-Measurement Module is connected to the monitor. All Multi-Measurement Module measurements are off while the Multi-Measurement Module is unplugged.
MMX Unsupported INOP tone	An MMX connected to the Measurement Link (MSL) is incompatible or not supported in this configuration. Contact your service personnel.
MON Msmt Malf INOP tone	A measurement module or measurement hardware in the monitor or a connected X2/X3 companion monitor is defective. Restart the monitor. If the INOP persists, contact your service personnel.
MSL Device Unsupp. INOP tone	A device connected to the Measurement Link (MSL) is unknown or a Multi-Measurement Module or Module Rack are incompatible or not supported in this configuration. Contact your service personnel.
Msmt Ext. Detached INOP tone	The Measurement Extension has been disconnected from the Multi-Measurement Module.
Msmt Ext. Malf INOP tone	Loss of communication between the Multi-Measurement Module and the Measurement Extension. Contact your service personnel.
Msmt Ext. Unsupp INOP tone	The Measurement Extension is not supported by your monitor. Contact your service personnel.
Msmt Ext.Unpowered INOP tone	The Measurement Extension cannot operate while the Multi-Measurement Module is running on battery power.
X2 Unplugged INOP tone	Make sure that the Multi-Measurement Module is connected to the monitor. All Multi-Measurement Module measurements are off while the Multi-Measurement Module is unplugged.
X2 Unsupported INOP tone	An X2 connected to the Measurement Link (MSL) is incompatible or not supported in this configuration. Contact your service personnel.
X3 Msmt Malf INOP tone	Measurement hardware in the X3 is defective. If connected to a host monitor, disconnect it. Switch the X3 off and on again after a few seconds and connect it again. If the INOP persists, contact your service personnel.

INOP Message, Indication	What to do
X3 Unplugged INOP tone	Make sure that the Multi-Measurement Module is connected to the monitor. All Multi-Measurement Module measurements are off while the Multi-Measurement Module is unplugged.
X3 Unsupported INOP tone	An X3 connected to the Measurement Link (MSL) is incompatible or not supported in this configuration. Contact your service personnel.

ECG, Arrhythmia, QT and ST INOPs

INOP Message, Indication	What to do
Cannot Analyze ECG INOP tone	The arrhythmia algorithm cannot reliably analyze the ECG data. Check the ECG signal quality of the selected primary and secondary leads. If necessary, improve lead position or reduce patient motion.
Cannot Analyze QT	The QT algorithm cannot generate a valid QT value for more than 1 minute.
Cannot Analyze ST	The ST algorithm cannot generate a valid ST value. Possible causes are large variations in the measured ST values for consecutive beats, or ventricular paced beats. Review the ECG signal quality and the ST measurement points. If the patient has a ventricular pacemaker, ST analysis is not possible.
Cannot Analyze STE	The STE algorithm cannot generate valid ST elevation values. Possible causes are large variations in the measured ST values for consecutive beats, or ventricular paced beats. Review the ECG signal quality and the ST measurement points.
ECG Check Cable INOP tone	Defective ECG cable was detected, which can result in inaccurate ECG signals and measurements, e.g. ST numeric, displayed on the monitor. Check trunk cable and lead set for damage and replace if INOP persists.
ECG Equip Malf Numeric is replaced by -?- INOP tone	Contact your service personnel. The ECG hardware is faulty.
<ECG Lead> Lead Off **!! <ECG Lead> Lead Off** **!!! <ECG Lead> Lead Off** If no ECG lead is measurable, numeric is replaced by -?- Corresponding INOP tone	Not all the required leads for ECG monitoring are connected. Check the ECG connections and make sure that the electrode indicated by <ECG lead> is attached [e.g. RA, LA, LL, RL, V or C electrodes]. With EASI lead placement all 5 electrodes must be connected, and with Hexad lead placement all 6 electrodes must be connected.
ECG Leads Off **!! ECG Leads Off** **!!! ECG Leads Off** Numeric is replaced by -?- Corresponding INOP tone	Check that all of the required ECG leads are attached, and that none of the electrodes have been displaced. The INOP may also be caused by a saturated or overloaded ECG amplifier.
ECG Noisy Elec <ECG Lead>	The ECG signal from the named ECG electrodes [RA, LA, LL, RL, V (or C)] is noisy. Check the ECG connections and make sure that the electrode indicated is attached. Depending on the software version in the measurement device, this INOP can also indicate a defective ECG cable (see INOP **ECG Check Cable**).
ECG Noisy Signal INOP tone	The ECG signal is too noisy. Check that the electrodes are properly placed and have not dried out. Remove any possible sources of signal noise (such as power cords) from the area around the cable and the patient. The ECG signal may be saturated or overloaded.
ECG Upgrade	The ECG measurement is currently in Upgrade Mode. Monitoring is not possible in this mode.
ECG/Arrh AlarmsOff **!! ECG/Ar AlarmsOff** Corresponding INOP tone may sound	All ECG alarms have been switched off, or the HR alarm source is not ECG. To resume ECG alarm generation, switch ECG alarms on or select ECG as the alarm source.
ExtSyncOutUnsupptd INOP tone	The external SyncOut this monitor is currently connected to is not supported. Contact your service personnel.

INOP Message, Indication	What to do
Some ECG AlarmsOff	This message appears (if configured to do so) when the on/off settings of the yellow arrhythmia alarms differ from the current Profile.
SyncOut Equip Malf INOP tone	There is a problem with the device connected to the ECG Out connector. Contact your service personnel.

Pulse INOPs

INOP Message, Indication	What to do
Pulse Not Alarming Numeric is replaced by -?-	Pulse has no alarming because the system pulse is measured by an external device. Select another pulse source to enable pulse alarming.

Resp INOPs

INOP Message, Indication	What to do
Resp Equip Malf Numeric is replaced by -?- INOP tone	Contact your service personnel. The RESP hardware is faulty.
Resp Erratic Numeric is displayed with a ?	The monitor has detected too many artifacts in the measured Resp signal. Check that the RA and LL electrodes are correctly attached and have not dried out.
Resp Leads Off Numeric is replaced by -?- INOP tone	Not all the required leads for Resp monitoring are attached. Make sure that the RA, LA, and LL leads are attached.

NBP INOPs

INOP Message, Indication	What to do
Cuff Not Deflated **!! Cuff Not Deflat** **!!! Cuff Not Deflat** Numeric is replaced by a -?- Corresponding INOP tone During this INOP, alarms cannot be paused or switched off.	Remove the cuff from the patient. Make sure that the tubing is not kinked or twisted and that the correct patient category is selected. Try repeating the measurement. You can acknowledge the INOP, but the INOP message remains visible until the next NBP measurement is started or the **Stop All NBP** SmartKey is selected. [Adult or pediatric patients: The NBP cuff pressure has exceeded 15 mmHg (2 kPa) for more than 3 minutes. Neonatal patients: The NBP cuff pressure has exceeded 5 mmHg (0.7 kPa) for more than 90 seconds.]
NBP Check Cuff Numeric is replaced by -?- INOP tone	Check that a cuff is connected, that it is applied properly to the patient, and that no leakage can be observed. The maximum inflation time has been exceeded. You can acknowledge this INOP, but the INOP message remains visible until the next measurement is started or the **Stop All NBP** SmartKey is selected.
NBP Cuff Overpress **!! Cuff Overpress** **!!! Cuff Overpress** Numeric is replaced by a -?- Corresponding INOP tone During this INOP, alarms cannot be paused or switched off.	The NBP cuff pressure exceeds the overpressure safety limits. Remove the cuff from the patient. Make sure that the tubing is not kinked or twisted and that the correct patient category is selected. Try restarting the measurement. You can acknowledge this INOP, but the INOP message remains visible until the next measurement is started or the **Stop All NBP** SmartKey is selected.
NBP Deactivated INOP tone	The NBP measurement label in the measurement device has been deactivated by deactivating the label in the **Measurement Selection** window. The measurement automatically disappears from the display. To switch the measurement on again, reactivate the measurement label in the **Measurement Selection** window.
NBP Equip Malf Numeric is replaced by -?- INOP tone	Remove the cuff from the patient. The NBP hardware is faulty. Contact your service personnel. You can acknowledge this INOP, but the INOP message remains visible until the next measurement is started or the **Stop All NBP** SmartKey is selected.

INOP Message, Indication	What to do
NBP Interrupted Numeric is replaced by -?- INOP tone	Check the tubing and cuff for leakages or kinks. Check that you are using the correct cuff size and placement, and that the correct patient category is selected. Try restarting the measurement. If the INOP occurs repeatedly, contact your service personnel. You can acknowledge this INOP, but the INOP message remains visible until the next measurement is started or the **Stop All NBP** SmartKey is selected. This INOP arises when the measurement needed longer than the maximum time for inflation, deflation or the total measurement.
NBP Measure Failed Numeric may be replaced by -?- INOP tone	Check that you are using the correct cuff size and placement, and that the correct patient category is selected. Try restarting the measurement. You can acknowledge this INOP, but the INOP message remains visible until the next measurement is started or the **Stop All NBP** SmartKey is selected. Check the condition and suitability of the patient for NBP monitoring. Use another cuff to continue measuring.

Temperature INOPs

INOP Message, Indication	What to do
T1, **T2**, **T3**, **T4** INOPs	See **<Temp Label>** INOPs
Tamb INOPs	See **<Temp Label>** INOPs
Tart INOPs	See **<Temp Label>** INOPs
Tbladd INOPs	See **<Temp Label>** INOPs
Tcereb INOPs	See **<Temp Label>** INOPs
Tcore INOPs	See **<Temp Label>** INOPs
ΔTemp Chk Sources	One of the measurements required to perform the calculation is not available. Check that both temperature measurements are available.
ΔTemp Chk Units	The monitor has detected a conflict in the units of the measurements. Check the unit settings.
<Temp Label> Deactivated INOP tone	A Temp measurement label in the measurement device has been deactivated by connecting a Pressure transducer in the shared Press/Temp socket. The measurement automatically disappears from the display. To switch the measurement on again, either reconnect a Temp transducer or reactivate the measurement label in the **Measurement Selection** window.
<Temp Label> Equip Malf Numeric is replaced by -?- INOP tone	Contact your service personnel. The temperature hardware is faulty.
<Temp Label> NoTransducer Numeric is replaced by -?- INOP tone	Make sure the Temp probe is connected to the Multi-Measurement Module or module. If you acknowledge this INOP, the measurement will be switched off.
<Temp Label> Overrange Numeric is replaced by -?- INOP tone	Try changing the application site of the transducer. [The temperature is less than -1°C, or greater than 45°C.]
<Temp Label> Unplugged INOP tone	A Temp measurement label has been deactivated, either by unplugging a module, or by deactivating the label in the **Measurement Selection** window. The measurement automatically disappears from the display. To switch the measurement on again, either replug the module or reactivate the measurement label in the **Measurement Selection** window.
Tesoph INOPs	See **<Temp Label>** INOPs
Tfoley INOPs	See **<Temp Label>** INOPs
Tnaso INOPs	See **<Temp Label>** INOPs
Trect INOPs	See **<Temp Label>** INOPs
Tskin INOPs	See **<Temp Label>** INOPs
Ttymp INOPs	See **<Temp Label>** INOPs

INOP Message, Indication	What to do
Tven INOPs	See **<Temp Label>** INOPs
Tvesic INOPs	See **<Temp Label>** INOPs

SpO2 INOPs

INOP Message, Indication	What to do
<SpO₂ Label> Chk Sensor Numeric is replaced by -?- or Numeric is displayed with a ? INOP tone may sound	Unexpected signal condition of the SpO2 sensor, accuracy may be compromised. Ensure proper application of the sensor and proper connection of sensor / adapter cable. If the INOP persists, exchange the sensor / adapter cable.
<SpO₂ Label> Deactivated INOP tone	The SpO_2 measurement label in the measurement device has been deactivated by deactivating the label in the **Measurement Selection** window. The measurement automatically disappears from the display. To switch the measurement on again, reactivate the measurement label in the **Measurement Selection** window.
<SpO₂ Label> Equip Malf Numeric is replaced by -?- or Numeric is unavailable INOP tone	The Multi-Measurement Module or module is faulty. Unplug and replug the Multi-Measurement Module or module. If the INOP persists, contact your service personnel.
<SpO₂ Label> Erratic Numeric is replaced by -?- INOP tone	Check the sensor placement. Try another adapter cable and sensor. If the INOP persists, contact your service personnel.
<SpO₂ Label> Extd.Update Numeric is displayed with a ?	The update period of displayed values is extended due to an NBP measurement on the same limb or an excessively noisy signal.
<SpO₂ Label> Interference Numeric is replaced by -?- or Numeric is displayed with a ? INOP tone may sound	There is too much interference, caused by a high level of ambient light and/or electrical interference. Cover the sensor to minimize ambient light. If the INOP persists, make sure that the sensor cable is not damaged or positioned too close to power cables.
<SpO₂ Label> Low Perf Numeric is replaced by -?- or Numeric is displayed with a ? INOP tone may sound	Accuracy may be compromised due to very low perfusion. Stimulate circulation at sensor site. If INOP persists, change the measurement site.
<SpO₂ Label> No Pulse **!! <SpO₂ Label> No Pulse** **!!! <SpO₂ Label> No Pulse** Numeric is replaced by -?- Corresponding INOP tone	Check the perfusion at measurement site. If necessary, stimulate circulation or change measurement site. Check if the sensor is applied correctly. If the INOP is due to NBP measurement on the same limb, wait until the NBP measurement is finished.
<SpO₂ Label> No Sensor Numeric is replaced by -?- INOP tone	Make sure the SpO_2 sensor is connected. If the INOP persists, try another adapter cable and sensor. If you acknowledge this INOP, the measurement will be switched off.
<SpO₂ Label> NoisySignal Numeric is replaced by -?- INOP tone	Excessive patient movement or electrical interference is causing irregular pulse patterns. Try to reduce patient movement or to relieve the cable strain on the sensor.
<SpO₂ Label> Poor Signal Numeric is displayed with a ?	The signal condition of the SpO_2 measurement is poor and measurement accuracy may be compromised. If the INOP persists, consider changing the application site or using another sensor.
<SpO₂ Label> Pulse? Numeric is replaced by -?- INOP tone	The detectable pulsations of the SpO_2 signal are outside the specified pulse rate range.
<SpO₂ Label> Searching Numeric is unavailable	SpO_2 is analyzing the patient signal to derive Pulse, SpO_2 and Perf values. Please wait until the search analysis is complete.
<SpO₂ Label> Sensor Malf Numeric is replaced by -?- INOP tone	The SpO_2 sensor or adapter cable is faulty. Try another adapter cable and sensor. If the INOP persists, contact your service personnel.

INOP Message, Indication	What to do
<SpO₂ Label> Sensor Off Numeric is replaced by -?- INOP tone	The SpO$_2$ sensor is not properly applied to the patient. Apply the sensor following the instructions supplied by the manufacturer.
<SpO₂ Label> Unkn.Sensor Numeric is replaced by -?- INOP tone	The connected sensor or adapter cable is not supported by the SpO$_2$ measurement. Use only specified sensors and cables.
<SpO₂ Label> Unplugged INOP tone	An SpO$_2$ measurement label has been deactivated, either by unplugging a module, or by deactivating the label in the **Measurement Selection** window. The measurement automatically disappears from the display. To switch the measurement on again, either replug the module or reactivate the measurement label in the **Measurement Selection** window.
<SpO₂ Label> Upgrade Numeric is replaced by -?- or Numeric is unavailable INOP tone may sound	The SpO$_2$ measurement is currently in upgrade mode. Monitoring is not possible in this mode.

Pressure INOPs

INOP Message, Indication	What to do
ABP INOPs	See **<Press Label>** INOPs
Ao INOPs	See **<Press Label>** INOPs
ART INOPs	See **<Press Label>** INOPs
BAP INOPs	See **<Press Label>** INOPs
CPP Chk Sources Numeric is replaced by -?- INOP tone	Not all measurements or values required to perform the calculation are available. Check the measurement sources. Acknowledging this INOP switches CPP off.
CPP Chk Units Numeric is replaced by -?- INOP tone	The monitor has detected a conflict in the units used for this calculation. Check the unit settings.
CPP Disabled INOP tone	CPP has been disabled, either in the setup in Configuration mode, or by loading settings with CPP disabled. Enable CPP in the current profile to clear the INOP.
CVP INOPs	See **<Press Label>** INOPs
FAP INOPs	See **<Press Label>** INOPs
IAP INOPs	See **<Press Label>** INOPs
IC1 / **IC2** INOPs	See **<Press Label>** INOPs
ICP INOPs	See **<Press Label>** INOPs
LAP INOPs	See **<Press Label>** INOPs
LFP INOPs	See **<Press Label>** INOPs
P / **P1** / **P2** / **P3** / **P4** INOPs	See **<Press Label>** INOPs
Pa1 / **Pa2** / **Pa3** / **Pa4** INOPs	See **<Press Label>** INOPs
PAP INOPs	See **<Press Label>** INOPs
Ppo INOPs	See **<Press Label>** INOPs
Ppr INOPs	See **<Press Label>** INOPs
PPV bad <Press Label> Signal Numeric is replaced by -?-	The arterial pressure source selected for PPV is not providing a pulsatile signal.
PPV bad Signal at Information Center Numeric is replaced by -?-	The arterial pressure source selected for PPV is not providing a pulsatile signal.
PPV Chk Sources Numeric is replaced by -?-	The arterial pressure source selected for PPV is unplugged or switched off. When this INOP has displayed for 1 minute PPV will be switched off.

INOP Message, Indication	What to do
<Press Label> Artifact Numeric questionable	A non-physiological event (flush or blood sample) is detected. A resulting limit alarm or non-pulsatile INOP will be suppressed.
<Press Label> Change Scale	Increase the scale for the pressure wave.
<Press Label> Deactivated INOP tone	A Pressure measurement label in the measurement device or extension has been deactivated by connecting a Temp transducer in the shared Press/Temp socket. The measurement automatically disappears from the display. To switch the measurement on again, either reconnect a Pressure transducer or reactivate the measurement label in the **Measurement Selection** window.
<Press Label> Equip Malf Numeric is replaced by -?- INOP tone	Contact your service personnel. The pressure hardware is faulty.
<Press Label> No Pulse **!! <Press Label> No Pulse** **!!! <Press Label> No Pulse** Pulse numeric is replaced by -?- Corresponding INOP tone	This INOP can only arise when a pressure is selected as the pulse source. It occurs when the pulse rate being measured is less than 25 beats per minute or the amplitude is less than three mmHg. Check the catheter and connections to the patient.
<Press Label> No Transducer Numeric is replaced by -?- INOP tone	Make sure that the pressure transducer is connected to the measurement device or module. If you acknowledge this INOP, the measurement will be switched off.
<Press Label> Noisy Signal Pulse numeric is replaced by -?- INOP tone	This INOP can only arise when a pressure is selected as the pulse source. It occurs when the pulse detector finds a pulse rate above 350 bpm. This is usually caused by movement artifact or electrical interference.
<Press Label> Overrange Numeric is replaced by -?- INOP tone	Possible causes are a measured pressure above the allowed pressure range, or a broken wire to the transducer. Make sure that the measurement has been properly prepared and zeroed, and that the transducer is level with the heart. If this INOP persists, try another transducer.
!!! <Press Label> Overrange Numeric is replaced by -?- Red INOP tone	Possible causes are a measured pressure below the allowed pressure range, or a broken wire to the transducer. Make sure that the measurement has been properly prepared and zeroed, and that the transducer is level with the heart. If this INOP persists, try another transducer.
<Press Label> Unplugged INOP tone	A Pressure measurement label has been deactivated by unplugging a module The measurement automatically disappears from the display. To switch the measurement on again, either replug the module or reactivate the measurement label in the **Measurement Selection** window.
<Press Label> Zero+Check Cal Numeric is replaced by -?-	Perform a zero and check the calibration of the transducer.
Pv1 / **Pv2** / **Pv3** / **Pv4** INOPs	See **<Press Label>** INOPs
RAP INOPs	See **<Press Label>** INOPs
RFP INOPs	See **<Press Label>** INOPs
SCP INOPs	See **<Press Label>** INOPs
UAP INOPs	See **<Press Label>** INOPs
UBP INOPs	See **<Press Label>** INOPs
UVP INOPs	See **<Press Label>** INOPs

CO2 INOPs

INOP Message, Indication	What to do
CO₂ Alarm Suppress	CO_2 alarms will be paused until first breath is detected.
CO₂ Auto Zero Initially, numerics are displayed with a ?. If the Autozero lasts > 15 sec, the numeric is displayed with a -?- and an INOP tone may sound.	The automatic zero calibration is in progress. During this time the CO_2 values may not be updated, or they may be replaced by -?-. Wait until the zero calibration is complete to resume monitoring.
CO₂ Cal Running Numeric is replaced by -?-	Wait until calibration is finished.
CO₂ Cannot Meas Numeric is replaced by -?- INOP tone	CO_2 value is invalid/unavailable for an unexpected long period of time. Check the sensor placement. Try another sensor. If the INOP persists, contact your service personnel.
CO₂ Change Scale	The CO_2 wave is clipped. Select a more appropriate wave scale to display the whole wave.
CO₂ Check Tubing Numeric is replaced by a -?- INOP tone	There is a problem with the CO_2 tubing. Check for leakages and replace the tubing if necessary. Disconnect the sensor and connect it again after a few seconds. If the INOP persists, contact your service personnel.
CO₂ Chk Adapter Numeric is replaced by -?- INOP tone	Check that the sensor is connected to the airway adapter, clean or replace the airway adapter, if necessary. Perform a zero calibration. If the INOP persists, contact your service personnel.
CO₂ Deactivated INOP tone	The CO_2 measurement label in the measurement device has been deactivated by deactivating the label in the **Measurement Selection** window. The measurement automatically disappears from the display. To switch the measurement on again, reactivate the measurement label in the **Measurement Selection** window.
CO₂ Equip Malf Numeric is replaced by -?- INOP tone	The measurement hardware is faulty. Unplug and replug the Multi-Measurement Module with Extension or the plug-in module. If the INOP persists, contact your service personnel.
CO₂ No Sensor from M3014A or 867185 Numeric is replaced by -?- INOP tone	There is no CO_2 sensor connected. If you acknowledge this INOP the CO_2 measurement will be switched off.
CO₂ No Tubing Numeric is replaced by -?- INOP tone	Either the sample line is disconnected, or an incorrect line is attached. Check the connection. If necessary, connect another sample line (Use only the approved accessories). If you acknowledge this INOP, the measurement will be switched off.
CO₂ Occlusion **!! CO₂ Occlusion** **!!! CO₂ Occlusion** Numeric is replaced by -?- Corresponding INOP tone	The sample line or exhaust tube is blocked. Check the tubing, then disconnect and reconnect the sample line. If the INOP persists, connect a new sample line.
CO₂ Overrange Numeric is displayed with a ?	The CO_2 value is higher than the measurement range. If you suspect a false high value, contact your service personnel.
CO₂ Pump Off Numeric is replaced by -?-.	The pump has been switched off for fifteen minutes. To switch it on again, select **Pump On** in the **Setup CO₂** menu.
CO₂ Purging Numeric is replaced by -?- INOP tone	The Filterline is being purged to remove an occlusion in the line or airway adapter. If the occlusion is removed, the INOP will disappear. If not, the INOP **CO₂ Occlusion** is displayed.
CO₂ Sens Warmup Numeric is replaced by -?- or Numeric is displayed with a ? INOP tone may sound	Wait until the sensor reaches operating temperature and the INOP disappears.
CO₂ Sensor Incomp Numeric is replaced by -?- INOP tone	The sensor or sensor type is unsupported, unknown or not supported by your software revision. Replace the sensor.

INOP Message, Indication	What to do
CO₂ Sensor Malf Numeric is replaced by -?- INOP tone	The CO_2 sensor is faulty. Disconnect the sensor and reconnect it after a few seconds. If the INOP persists, replace the sensor.
CO₂ Upgrade FW Numeric is replaced by -?- INOP tone may sound	The firmware of the CO_2 measurement is not supported. A firmware upgrade is required. Contact your service personnel.
CO₂ Zero Failed Numeric is replaced by -?- INOP tone	An error occurred during the last zero calibration. Check the airway adapter and clean or replace, if necessary. Perform another zero calibration. If the INOP persists, contact your service personnel.
CO₂ Zero Running Numeric is replaced by -?-	Wait until zero calibration is finished.
CO₂ ZeroRequired Numeric is replaced by -?- INOP tone	Perform zero calibration for the CO_2 sensor. If the INOP persists, contact your service personnel.
IPI Check Pat. Age Numeric is replaced by -?- INOP tone	For Adult patients: a date of birth has been entered that results in a calculated patient age of less than 12 years. Enter correct date of birth or, if patient is pediatric, correct patient category. For pediatric patients: either no date of birth has been entered (it is required for calculation of IPI for pediatric patients) or the calculated age is below 1 year or above 12 years. Check that correct date of birth is entered.
IPI Check Sources Numeric is replaced by -?- INOP tone	The IPI numeric cannot be provided as one or more of the measurement sources required for IPI is not available. Check availability of $etCO_2$, awRR, SpO_2, and pulse rate.
IPI Neo Patient ? Numeric is replaced by -?- INOP tone	Check patient category. The IPI numeric is not available for neonatal patients.

C.O. INOPs

INOP Message, Indication	What to do
C.O. Deactivated INOP tone	The Cardiac Output measurement label in the measurement device has been deactivated by deactivating the label in the **Measurement Selection** window. The measurement automatically disappears from the display. To switch the measurement on again, reactivate the measurement label in the **Measurement Selection** window.
C.O. Equip Malf Numeric is replaced by -?- INOP tone	There is a problem with the C.O. hardware. Contact your service personnel.
C.O. Unplugged Numeric is unavailable INOP tone	Plug in the C.O. module. Acknowledging this INOP switches off the measurement.
CCI No BSA CCI numeric unavailable INOP tone	CCI cannot be calculated because the patient's body surface area is unknown. Enter the patient weight and height to provide the BSA for CCI calculation.
CCO BadPressSignal Numeric is replaced by -?- INOP tone	The arterial pressure wave can currently not be used for pulse contour calculation for CCO or CCI measurement. Possible causes are air bubbles in the tubing or a physiological condition, for example severe arrhythmia.
CCO No Calibration Numeric is replaced by -?-	The CCO measurement is currently not calibrated.
CCO No <Press Label> Numeric is replaced by -?- INOP tone may sound	CCO/CCI cannot be calculated. Make sure that the pressure chosen in the **Setup CCO** menu under **CCO from** matches the pressure measured with the arterial catheter for CCO measurement. A pressure from an external device cannot be used. Select another pressure label, either ABP, Ao, ART, BAP, FAP, or UAP.

INOP Message, Indication	What to do
CCO No Press at Information Center	CCO/CCI cannot be calculated. Make sure that the pressure chosen in the **Setup CCO** menu under **CCO from** matches the pressure measured with the arterial catheter for CCO measurement. A pressure from an external device cannot be used. Select another pressure label, either ABP, Ao, ART, BAP, FAP, or UAP.
CCO Overrange **CCI Overrange** Numeric is replaced by -?- INOP tone	The measured CCO or CCI value is not within the specified range for CCO/CCI measurement.
CCO Press Invalid at Information Center	The arterial pressure selected for pulse contour calculation for CCO is available but currently invalid. Make sure the pressure transducer is connected and the zero calibration is valid.
CCO <Press Label> Invalid Numeric is replaced by -?- INOP tone may sound	The arterial pressure selected for pulse contour calculation for CCO is available but currently invalid. Make sure the pressure transducer is connected and the zero calibration is valid.
CCO PressOverrange Numeric is replaced by -?- INOP tone	The mean value of the arterial pressure values used for pulse contour calculation for CCO is below 0 mmHg or above 300 mmHg.
CCO PulseOverrange Numeric is replaced by -?- INOP tone	The pulse rate of the pressure used for pulse contour calculation for CCO is below 30 bpm or above 240 bpm.
CCO Recalibrate Numeric is displayed with a ?	The most recent CCO or CCI calibration was made over 8 hours ago or the arterial pressure measurement used for CCO calculation has been zeroed after the CCO calibration was performed. You should recalibrate CCO or CCI with transpulmonary C.O. measurements at least every 8 hours or when the hemodynamic condition of the patient has changed. The pressure measurement must be zeroed before a CCO calibration.
CCO/Tbl NoTransduc Numeric is replaced by -?- INOP tone	No transducer attached to the module or catheter disconnected.
Tblood NoTransducer Numeric is replaced by -?- INOP tone	No transducer attached to the module or catheter disconnected.
Tblood Overrange Numeric is replaced by -?- INOP tone	Tblood out of range 17°C - 43°C.

Masimo rainbow SET INOPs

PVI INOPs

INOP Message, Indication	What to do
PVI Cannot Meas Numeric is replaced by -?- INOP tone	The PVI value is invalid/unavailable for an unexpected long period of time. Check the sensor placement. Try another adapter cable and sensor. If the INOP persists, contact your service personnel.
PVI Poor Signal Numeric is displayed with a ?	The signal of the PVI measurement is poor and measurement accuracy may be compromised. If the INOP persists, consider changing the application site, or using another sensor.

SpCO INOPs

INOP Message, Indication	What to do
SpCO Cannot Meas Numeric is replaced by -?- INOP tone	The SpCO value is invalid/unavailable for an unexpected long period of time. Check the sensor placement. Try another adapter cable and sensor. If the INOP persists, contact your service personnel.
SpCO Low Perf Numeric is displayed with a ?	The Perfusion Index is low and SpCO accuracy may be compromised. Stimulate the circulation at the sensor site. If the INOP persists, change the measurement site.
SpCO Poor Signal Numeric is displayed with a ?	The signal of the SpCO measurement is poor and measurement accuracy may be compromised. If the INOP persists, consider changing the application site or using another sensor.

SpHb INOPs

INOP Message, Indication	What to do
<SpHb Label> Cannot Meas Numeric is replaced by -?- INOP tone	The SpHb value is invalid/unavailable for an unexpected long period of time. Check the sensor placement. Try another adapter cable and sensor. If the INOP persists, contact your service personnel.
<SpHb Label> Low Perf Numeric is displayed with a ?	The Perfusion Index is low and SpHb accuracy may be compromised. Stimulate the circulation at the sensor site. If the INOP persists, change the measurement site.
<SpHb Label> Poor Signal Numeric is displayed with a ?	The signal of the SpHb measurement is poor and measurement accuracy may be compromised. If the INOP persists, consider changing the application site or using another sensor.

SpMet INOPs

INOP Message, Indication	What to do
SpMet Cannot Meas Numeric is replaced by -?- INOP tone	The SpMet value is invalid/unavailable for an unexpected long period of time. Check the sensor placement. Try another adapter cable and sensor. If the INOP persists, contact your service personnel.
SpMet Low Perf Numeric is displayed with a ?	The Perfusion Index is low and SpMet accuracy may be compromised. Stimulate the circulation at the sensor site. If INOP persists, change the measurement site.
SpMet Poor Signal Numeric is displayed with a ?	The signal of the SpMet measurement is poor and measurement accuracy may be compromised. If the INOP persists, consider changing the application site, or using another sensor.

SpO2 INOPs

INOP Message, Indication	What to do
No 3D Desat Index INOP tone	The 3D Desat Index is "On", but currently no 3D Desat Index alarming is possible, wait until the values are recalculated.
No 3D Perf Delta INOP tone	The 3D Perf Delta is "On", but currently no 3D Perf Delta alarming is possible. Check the Perf settings and set the Perf Baseline.
<SpO2 Label> : Only SpO2 SpO2, Pulse and Perf numerics are available, Other numerics are unavailable INOP tone	If issued, additional Masimo rainbow measurements are not available. Use a Masimo light shield to cover the sensor. Refer to the sensor's DFU for further details. To reinitialize rainbow parameters, remove and reapply the sensor.
<SpO2 Label> ReplaceSensr Numeric is replaced by -?- INOP tone	The lifetime of the connected cable, sensor, or adhesive has expired. No more monitoring is possible. Replace the cable, sensor, or adhesive sensor part.

INOP Message, Indication	What to do
<SpO₂ Label> ReplaceSensr Numeric may be displayed with a ?	If issued without a tone, the lifetime of the cable, sensor, or adhesive has expired, but you still have a grace period for monitoring. Replace the cable, sensor, or adhesive part before monitoring is no longer possible.
<SpO₂ Label> Sensor Malf Numeric is replaced by -?- INOP tone	Make sure the adhesive part of the sensor is connected. If the INOP persists, try another adhesive sensor, or exchange the adhesive part. The cable, sensor, or adhesive sensor part type are unknown, or not supported by your software revision. Replace the cable, sensor, or adhesive sensor part using only Philips supported sensors listed in the "Accessories" section. The connected adhesive sensor part is defective.

SpOC INOPs

INOP Message, Indication	What to do
SpOC Cannot Meas Numeric is replaced by -?- INOP tone	The SpOC value is invalid/unavailable for an unexpected long period of time. Check the sensor placement. Try another adapter cable and sensor. If the INOP persists, contact your service personnel.
SpOC Low Perf Numeric is displayed with a ?	The Perfusion Index is low and SpOC accuracy may be compromised. Stimulate the circulation at the sensor site. If the INOP persists, change the measurement site.
SpOC Poor Signal Numeric is displayed with a ?	The signal of the SpOC measurement is poor and measurement accuracy may be compromised. If the INOP persists, consider changing the application site or using another sensor.

RRac INOPs

INOP Message, Indication	What to do
RRac Cannot Meas Numeric is replaced by -?- INOP tone	The RRac numerics are not displayed after the start-up phase. Check if the connected accessories are compatible for the RRac measurement. Check if the sensor is placed correctly.
RRac Chk Sensor Numeric is displayed with a ?	RRac Monitoring is still possible but accuracy may be compromised. Check sensor, cable, and connections. If the INOP persists replace the sensor or the cable
RRac Chk Sensor Numeric is replaced by -?- INOP tone	No RRac monitoring is possible. Check sensor, cable, and connections. If the INOP persists replace the sensor or the cable.
RRac Extd.Update Numeric is displayed with a ?	The RRac update period is extended due to bad signal conditions. Check the proper fit of the sensor, and reduce environmental noise level.
RRac Interference Numeric is displayed with a ?	The signal of the RRac measurement is affected by interference or noise, and accuracy may be compromised. If the INOP persists, check if the sensor is placed correctly or use another sensor.
RRac Interference Numeric is replaced by -?- INOP tone	RRac cannot be derived, because of interference or noise. Check that the sensor is applied according to instructions. Try to reduce background noise, and check that nothing comes into contact with the sensor.
RRac No Sensor Numeric is replaced by -?- INOP tone	Make sure the cable and the sensor are connected. If the INOP persists, try another adapter cable and sensor. If you acknowledge this INOP, the RRac measurement will be switched off.
RRac No SpO₂ Numeric is replaced by -?- INOP tone	An SpO₂ measurement has to be enabled for the RRac measurement to work. Connect an SpO₂ sensor and enable an SpO₂ measurement.
RRac Poor Signal Numeric is displayed with a ?	The signal of the RRac measurement is poor and measurement accuracy may be compromised. If the INOP persists, check if the sensor is placed correctly. If INOP still persists, use another sensor.
RRac ReplaceSensr	The lifetime of the connected sensor or cable has almost expired. Replace the sensor or cable before monitoring is no longer possible.

INOP Message, Indication	What to do
RRac ReplaceSensr Numeric is replaced by -?- INOP tone	The lifetime of the connected cable, sensor, or adhesive has expired. No more monitoring is possible. Replace the cable, sensor, or adhesive sensor part.
RRac Sensor Malf Numeric is replaced by -?- INOP tone	Defective sensor or cable. Replace the sensor or cable.
RRac Sensor Off Numeric is replaced by -?- INOP tone	The sensor is not properly applied to the patient. Apply the sensor following the instructions supplied by the manufacturer.
RRac Unkn.Sensor Numeric is replaced by -?- INOP tone	Incompatible or unrecognized sensor or cable. Replace the sensor or cable using only supported sensors listed in the "Accessories" section.

Managing Patients and Equipment

When the monitor is used together with an Information Center, a variety of services are provided to manage the interconnections between patients, equipment, hospital beds, caregivers, and so on.

Many services can be used both at the monitor and at the Information Center, resulting in a more efficient workflow.

Which services are available will depend on which Information Center you have. The **Philips Patient Information Center iX (PIC iX)** provides more services and functionality than the **Philips IntelliVue Information Center (PIIC)**. In these Instructions for Use, information that is only valid for one of the Information Centers will be marked with a corresponding side heading, for example:

PIC iX For a list of the differences between the two Information Centers, see "Information Center Compatibility" on page 114.

Patient Concepts

For a patient to be part of the system their identification data must be entered into the system. A patient can then be assigned to a bed, have equipment assigned directly to him, and have a location set when he is not currently in the bed.

Equipment Concepts

Depending on how equipment is used in your facility, there are various ways to associate devices with patients, beds or monitors. Equipment usage must be configured appropriately at the Information Center and the monitoring equipment.

PIC iX By configuration, equipment can be assigned:

- permanently to a bed,
- on demand to a bed or host monitor, or
- directly to a patient.

The foundation for a particular equipment use model is laid in the configuration settings in the monitor and the Information Center. Refer to the corresponding configuration guides for further details.

Additionally there are mechanisms to automatically free up equipment that is no longer used. This prevents unnecessary patient mismatches when the equipment is used for the next patient and avoids data of different patients getting mixed.

PIC iX When connected to PIC iX, equipment states are tracked by the system. When the equipment is not assigned to a patient or no patient is admitted at a monitor, the equipment is considered as free equipment in the system. Equipment that is assigned or has a patient admitted is tracked as used (i.e. not free) equipment.

The Information Center uses the equipment state (free/not free) to maintain and support workflow and equipment lists.

Bed Management with a Hospital Information System

(Not available with PIIC iX Release B and earlier)

Depending on your setup, the PIC iX may receive patient identification and bed assignment information from a hospital information system (HIS). This information triggers an action at the monitor (admission, discharge, or transfer), that requires your confirmation.

This situation is indicated at the monitor with a symbol next to the patient name.

 Admission pending

 Discharge pending

 Transfer pending

Additionally, a window pops up on the monitor asking you to confirm the action proposed by the HIS.

In the confirmation window, the proposed action is stated, for example, **Admit <Patient ID> to <Bed>.**. You have two options:

• You can confirm that the action be completed.

   In the example above, the patient is then admitted to the bed. The HIS symbol is no longer displayed and all equipment conflicts are resolved. The data on the monitor, the Information Center and the HIS are in agreement.

• You can delay the confirmation.

   In the example above, the patient is then not admitted at the monitor. The HIS symbol continues to be displayed next to the patient name.
   If the bed is not available for the patient proposed by the HIS, the data at the HIS must be corrected. After this correction, the HIS symbol is no longer displayed.

If the confirmation window is not open, you can open it by selecting the HIS symbol.

Managing Patients

In order to attribute collected measurement data to a specific patient, or assign equipment or a bed to a specific patient, each patient in the system must be identified. By admitting a patient, you identify them for the system.

When equipment is freed up (for example by discharging the patient, removing a monitor from a patient or using End Case) the collection of data is officially ended for this patient and important settings on the monitor are reset to the defaults.

WARNING

Always perform a discharge or free up the monitor before starting monitoring for a new patient, even if your previous patient was not admitted. Failure to do so can lead to data being attributed to the wrong patient.

Admitting a Patient

The monitor displays physiological data and stores it in the trends as soon as a patient is connected. This lets you monitor a patient who is not yet admitted. It is however important to admit patients properly so that you can identify your patient on recordings, reports, and networked devices.

During admission you enter data that the monitor needs for safe and accurate operation. For example, the patient category setting determines the algorithm the monitor uses to process and calculate some measurements and the safety limits that apply for some measurements.

If admission data has been provided from a hospital information system, you will not be able to manually enter admission data at the monitor, or to edit the data provided.

NOTE

Philips strongly recommends that the same patient data fields be configured to be mandatory at the monitor and the Information Center.

When No Patient is Admitted

To admit a patient:

1 Select the patient name field or select the **Patient Demogr.** SmartKey to open the **Patient Demographics** window.

2 Select **Admit Patient**.
The **Enter Demographics** window appears. You can enter data as normal, using the keyboard or a barcode scanner, or, with **PIC iX**, use the **Find Patient** key to search for patient data in connected systems as described in "Using "Find Patient" to Search for Patient Data" on page 102.

3 Enter the patient information: select each field and use the keyboard or barcode scanner or choose from the pop-up list of alternatives to input information.
When you enter data, the Information Center will automatically check for corresponding data and will suggest an appropriate action based on what it finds. You can select **Confirm** to accept the suggestion or **Cancel** to reject it.

   – **Last Name**: Enter the patient's last name (family name).

   – **First Name**: Enter the patient's first name.

   – **Middle Name** (if configured to appear): Enter the patient's middle name.

   – **Lifetime ID**, **Encounter ID**: Whether these fields appear and how they are labeled can be configured for your hospital. One or both fields may be displayed and the labels may read: **MRN**, **Case ID**, **Visit Number**, or other alternatives. Enter the appropriate data for the fields displayed.

   – **Patient Cat.**: Choose the patient category, either **Adult**, **Pedi**, or **Neo**.

   – **Paced Mode**: Choose **On** or **Off** (You must use **On** if your patient has a pacemaker). With **PIC iX** there is a third choice: **Unconfirmed**. When the paced mode is **Unconfirmed**, the algorithm for paced patients will be used.

   – **Height**: Enter the patient's height.

   – **Weight**: Enter the patient's weight.

   – **BSA**: The monitor calculates the body surface area automatically.

   – **Date of Birth**: Enter the patient's date of birth, in the form dd/mmm/yyyy.

   – **Age**: The monitor calculates the patient age automatically.

   – **Gender**: Choose **Male** or **Female**.

   – **Notes (1)** / **Notes (2)**: Enter any extra information about the patient or treatment.
When admission is complete, the patient's name appears on the monitor info line at the top of the screen together with the symbol indicating the patient category. By clicking on this section of the information line, also when no patient is admitted, you can open the **Patient Demographics** window at any time. There you can change patient data or set patient category and paced mode as described above.

When a Patient is Already Admitted

If the patient monitor already has a patient admitted, the **Admit Patient** key is replaced by the **New Patient** key.

When you select **New Patient**, the monitor is freed. All settings are reset to the defaults, all patient data and trend data are deleted, and monitoring at the Information Center may stop for monitors designated as transport monitors. Depending on your equipment configuration, selecting **New Patient** may transfer the currently admitted patient out of the bed. A message will appear requiring your confirmation of these actions.

After selecting **New Patient**, you can admit your patient as described in "When No Patient is Admitted" above.

Using "Find Patient" to Search for Patient Data

PIC iX   You can use the **Find Patient** key to search for patient data in the Information Center and any connected hospital information systems. The search will look for currently admitted or previously admitted patients matching the search data you enter.

To search for patient data:

1   Select the **Find Patient** key.
A window opens with an on-screen keyboard.

2   Type in the last name or an ID, or a part of it, and select **Enter** on the keyboard.
The search results will be displayed in a **Select Patient** window. The system provides a list of all matching patients.

3   Highlight the patient you want to admit to this bed.

4   Depending on their current status, you will be asked whether you want to readmit them, or transfer them to this bed.

5   Select **Confirm** to complete the admission or transfer.

Patient Category and Paced Mode

The patient category setting determines the algorithm the monitor uses to process and calculate some measurements, the safety limits that apply for some measurements, and the alarm limit ranges.

The paced mode setting determines whether the monitor shows pacemaker pulses or not. When **Paced Mode** is set to **Off**, pace pulses are filtered and therefore do not show in the ECG wave.

WARNING

Patient Cat. and **Paced Mode** will always contain a value, regardless of whether the patient is fully admitted or not. If you do not specify settings for these fields, the monitor uses the default settings from the current profile, which might not be correct for your patient.

Patient category

Changing the patient category may change the arrhythmia and NBP alarm limits. If possible, always load a suitable profile after changing patient category, and always check alarm limits to make sure that they are appropriate for your patient.

Paced mode

For paced patients, you must set **Paced Mode** to **On**. If it is incorrectly set to **Off**, the monitor could mistake a pace pulse for a QRS and fail to alarm during asystole. With PIC iX, the paced mode may be **Unconfirmed** which will assume a pacemaker is present. You should still set the **Paced Mode** to **On** for paced patients to make the status clear.

Admitting a Centrally-Monitored Patient

You can admit a patient at either the bedside or the Information Center. When you admit a patient, the patient's name appears on the bedside monitor and the Information Center.

If you do not fill in all patient information required by the Information Center, the Information Center may reject the admission. Complete all the required fields and try again to admit the patient.

Starting Central Monitoring from the Bedside

(Not available with PIIC iX Release B and earlier)

Admitting a Patient and Starting Central Monitoring

Before starting, check that the monitor is not assigned to a patient or bed. If it is, first remove the monitor from the patient or bed. See "Removing Equipment" on page 109.

1   Select the **Select Bed** SmartKey, if configured. If not, open the **Equipment** window, select the Information Center area, then **Select Bed**.

2   If a unit list appears, select the correct unit.

3   Select the correct bed from the list shown.

4   Select the **Confirm** pop-up key.

5   Wait until the bed label is displayed at the top of the screen.

6   Confirm by selecting **Yes**. This ensures that any data from a previous patient is cleared.

7   Select the **Quick Admit** SmartKey.

8   Enter the required data (ID fields or last name depending on configuration) with the keyboard or a barcode scanner.

9   Select **Enter**.

10 Select the **Confirm** pop-up key, if it appears (configuration-dependent).

Adding the Monitor to a Centrally Monitored Bed

1   Admit the patient to the monitor (see "When No Patient is Admitted" on page 101).
    If the patient is admitted at the Information Center and the bed is assigned to a sector, a window will appear asking you to confirm that the monitor be assigned to the bed.

2   Select the **Confirm** pop-up key.

Quick Admitting a Patient

Use Quick Admit to quickly admit a patient using only a limited set of demographic data.

1   Select the **Quick Admit** SmartKey.

2   Enter the required data (ID fields or last name depending on configuration) with the keyboard or a barcode scanner.

3   Select **Enter**.

4   In the confirmation window, select **Confirm** to stop monitoring for the previous patient or free up the monitor (if confirmation is configured).

5   Check that patient category and paced status are correct for the new patient.

6   Check the current profile and, if necessary, load an appropriate profile.

If the monitor is connected to an Information Center and only the ID field is entered, the patient name may be set to - - - at the Information Center, depending on the configuration. Complete the rest of the demographic details as soon as possible to fully identify the patient on the network, on the monitor and on printed reports. To complete the details, open the **Patient Demographics** window and complete all required fields.

Using Stat Admit

Stat Admit allows you to admit a patient with a temporary patient identification. It can be used in cases when the patient ID is unknown or when the data is not yet available.

The Stat Admit function generates content for a name or ID field using the current date and time. A random lower case letter is added at the end to reduce the chance of creating the same name or ID simultaneously at two monitors. So a name field would be filled with, for example:

19:32:45-30MAR15a

Depending on your configuration, a name field, an ID field, or all fields defined as mandatory will be filled. The exact format of the date and time data depends on the size of the field being filled and the language of the monitor user interface.

Additionally, if configured, Stat Admit can enter the current bed label or equipment label as a record of the location at admission time.

Admitting with Stat Admit

If Stat Admit is available for use, one of the following two methods will be set up:

- Using the SmartKey - select the **Stat Admit** SmartKey.

- Using a barcode or RFID label - read the special Stat Admit code.

Depending on your configuration, either the temporary ID will appear directly on the monitoring screen or the **Enter Patient Demographics** window will open for you to confirm the temporary ID.

Editing Patient Information

To edit the patient information after a patient has been admitted, select the patient name field on the Main Screen to open the **Patient Demographics** window, and make the required changes.

PIC iX If data has been provided by a hospital information system, you will not be able to edit it on the monitor.

Ending Monitoring for a Patient

There are several ways to end monitoring for a patient, depending on whether there is an Information Center connection, and on the configuration of the Information Center and the monitor. Discharging a patient and removing the monitor from a patient are described here. You can also end monitoring by admitting a new patient, as described in "When a Patient is Already Admitted" on page 101.

Depending on your configuration, monitoring for a patient may end automatically when the monitor has been powered off or in standby mode for a set time, or when no basic measurements have been made for a set time.

WARNING

Always end monitoring for the previous patient (with **Dischrge Patient**, **Remove Monitor**, **End Case** or **New Patient**) before starting monitoring for a new patient, even if your previous patient was not admitted. Failure to do so can lead to data being attributed to the wrong patient.

Discharging a Patient

The discharge function is only available when the patient is monitored centrally at an Information Center. A discharge transfers the patient out of the bed and frees all devices used for the patient. The discharge function may be disabled at a monitor designated as a transport monitor, to ensure that a patient cannot be accidentally discharged from the system when the transport monitor is used for another patient.

A discharge:

– clears the patient demographics

– erases all patient measurement data (such as trend, event, and calculation data) from the monitor, measurement modules and Information Center. This ensures that data from a previous patient are not mixed with data from a new patient.

– resets patient category and paced settings to the settings defined in the default Profile

– resets all monitor and measurement settings as well as the active Screen to the settings defined in the default Profile

– discharges the patient from the Information Center.

Make sure that you have printed out any required reports before discharging. Check that a functioning local or central printer is available before you use **End Case**.

To Discharge a Patient

1 Select the patient name field or select the **Patient Demogr.** SmartKey to open the **Patient Demographics** window and associated pop-up keys.

2 Select the pop-up key for either:

– **End Case** - to print any configured end case reports or vital signs recording, discharge the patient and clear the patient database, then enter standby mode. If an **End Case** SmartKey is configured for your monitor, you can also select this instead and then confirm.

To see which end case reports are set up for your monitor, select **Main Setup**, **Reports**, then **Auto Reports**. For each auto report, if **End Case Report** is set to **On**, this report will be printed when you select **End Case**. See "Setting Up Auto Reports" on page 261 for information on setting up end case reports.

– **Dischrge Patient** - to discharge the patient without printing any reports.

Removing the Monitor

Removing a monitor stops using the monitor for the current patient and frees up the monitor and all devices assigned to that monitor.

Removing the monitor:

– clears the patient demographics in the monitor.

– erases all patient measurement data (such as trend, event, and calculation data) from the monitor and devices assigned to the monitor. This ensures that data from a previous patient are not mixed with data from a new patient.

– resets patient category and paced settings to the settings defined in the default Profile.

– resets all monitor and measurement settings as well as the active Screen to the settings defined in the default Profile.

If the monitor is locked to the bed and is connected to an Information Center, the remove function is not available and you will have to discharge the patient.

To Remove a Monitor

1 Open the **Equipment** window - either directly in **Main Setup** or by selecting the bed label in the information line.

2 Select the monitor.

3 Select the **Remove Monitor** pop-up key.

New Patient Check

The monitor can be configured to ask you whether a new patient is now being monitored in certain situations:

• after a specified power-off period

• after a specified standby period

• when no basic vitals (HR, RR, Pulse, SpO$_2$, NBP) have been measured for a specified period

The pop-up window is entitled **Is this a New Patient?**. The monitor offers a **Yes** key to stop monitoring for the previous patient and begin monitoring a new patient and a **No** key to continue monitoring with the current patient data and settings.

The time periods for the three conditions can be configured independently.

Transferring Patients

To save you from having to enter the same patient data multiple times and enable patient transfer without loss of data, patient demographic information is shared between patient monitors and Information Centers.

Data Exchange Between Information Centers

You can transfer demographic data and trend data from one Information Center to another by selecting **Transfer** on the patient monitor. Trend data is not shared between Information Centers and monitors.

Transferring Patients with PIC iX

PIC iX   There are several ways to transfer a patient from or to another bed. When a patient is transferred to the destination bed, Information Center monitoring continues in the destination bed and equipment that is not transferred with the patient is freed up.

Using the Transfer Function

PIC iX   To transfer a patient using the transfer function provided on the patient monitor by the Information Center:

1   Select the patient name or the **Not Admitted** text at the top of the monitor screen to open the **Patient Demographics** window.

2   Select the **Transfer** pop-up key.
      The **Transfer** window opens. If a patient is currently admitted, the window offers the possibility to transfer that patient to another bed (**To Other Bed**). If no patient is currently admitted, the window offers the possibility to transfer a patient **from** another bed using the patient search as described in "Using "Find Patient" to Search for Patient Data" on page 102.

3   With **To Other Bed**, if more than one unit is configured, a list of units will appear. When you have selected a unit, or if only one unit is configured, a list of free beds will appear.

4   Select a bed from the list.
      You will be asked to confirm the transfer of the patient to this bed.

5   Select **Confirm** to complete the transfer.

WARNING

Before doing a transfer ensure that no other patient is using the destination bed and/or equipment from the destination bed.

When a patient is transferred you need to check that the patient has all the required monitoring equipment at the destination bed.

Using the New Patient Key

PIC iX   If the monitor at the destination bed is not free:

1   Select the patient name field at the top of the monitor to open the **Patient Demographics** window.

2   Select **New Patient** to free up the monitor.

3   Select **Find Patient** and enter your patient's name to get the patient data from the system.
      When you select your patient from the list, you will be asked to confirm that the patient should be transferred into this bed. After confirmation the transfer is complete.

Transferring Patients with IntelliVue Information Center

Transferring a Centrally-Monitored Patient with the Monitor

Scenario: A centrally-monitored patient is moved with the monitor to another monitoring location on the same Information Center database server without interrupting the collection of patient trend information.

1   Select the patient name field or select the **Patient Demogr.** SmartKey to open the **Patient Demographics** window, then select the **Transfer** pop-up key. If the patient is not admitted or not monitored by an Information Center, the **Transfer** key is inactive ("grayed-out").
This step preserves the patient's demographic data during the transfer.

2   At the new location, connect the monitor to the network (only needed for wired networks). If the monitor detects a patient mismatch, a window will open showing your patient's data and asking **Complete transfer of this patient?**.

3   Select **Yes** to complete the transfer.

4   Verify that the settings for patient category and paced mode are correct.

If you accidentally transfer a patient, use **Re–Admit** to restore this patient's data to the Information Center. If you are not connected to the network, select **Clear Transfer** to leave transfer mode. The patient data remains in the monitor.

Resolving Patient Information Mismatch

When you connect together devices which store patient demographic data, for example, a monitor and an Information Center, the system compares patient category, paced status, and unique patient identification in order to synchronize this information. If configured to do so, the monitor indicates a mismatch if the information is not identical.

WARNING

• It is important to resolve the mismatches as soon as they are identified. Failure to do so could result in using incorrect/confusing data to make clinical decisions. Certain settings, for example **Paced Mode** and **Patient Cat.**, may not match between the Information Center and the monitor. If the **Paced Mode** is set incorrectly, the system could mistake a pace pulse for a QRS and fail to alarm in the case of asystole. It is important that the patient category is set correctly so the ECG can be analyzed correctly and initial arrhythmia alarm limits set. A **Check Patient ID** INOP will appear when a mismatch has not been resolved.

• As long as patient mismatch has not been resolved, data integration in the Information Center and the own patient overview functionality might not work as equipment is not assigned correctly to the patient.

PIIC • When a monitor is connected to an Information Center by the wireless IntelliVue Instrument Telemetry interface, the patient data will automatically be merged in the case of a transfer. This means there is no patient discharge at the monitor and settings and trend data will be retained. You will see a message on the monitor and the **Patient Demographics** window will automatically appear so that you can check the data and change it if necessary.

Manually Resolving Patient Mismatch

The source of the patient mismatch is indicated by question marks (???) and displayed in a pop-up message on the screen (**Patient ???**, **Patient Category ???** or **Paced Mode ???**).

The **Select Patient** window automatically opens so you can decide which patient data to use. You do not have to resolve the mismatch immediately, but the indicators remain until you do. After 5 minutes a **Check Patient ID** INOP will appear to remind you to resolve the mismatch.

For some common mismatch situations, the monitor will simplify the resolution by suggesting a solution for the mismatch. For example, when a patient arrives after transport and the **Transfer** key has been selected, the monitor will show this patient's data and ask **Complete transfer of this patient?**. You can then select **Yes** to complete the transfer. If you select **No** you will go to the **Select Patient** window.

After you resolve the mismatch, the monitor displays a confirmation window that shows the patient that has been selected and where data will be erased, if applicable. Confirm your choice. The monitor automatically displays the **Patient Demographics** window after confirmation. Verify that the settings shown are correct for the patient.

Gender, date of birth, height, weight, and nursing notes do not generate a mismatch. If these fields are different on different devices, monitor resolves them itself. For example, it may take date of birth from the Information Center, whilst taking gender from the monitor. Always check the patient demographics after combining patients, to ensure that you are satisfied with the results. Change them if necessary.

WARNING

After resolving a patient mismatch, check that the monitor settings (especially patient category, paced status and alarm limits) are correct for the patient.

Patient Mismatch - If One Set of Patient Data is Correct

If there is a mismatch between an Information Center and a monitor, choose the data set you want to continue using for this patient by selecting one of the sectors in the **Select Patient** window.

After you resolve the mismatch, the monitor displays a confirmation window that shows the patient that has been selected and where data will be erased, if applicable. Confirm your choice. The monitor automatically displays the **Patient Demographics** window after confirmation. Verify that the settings shown are correct for the patient.
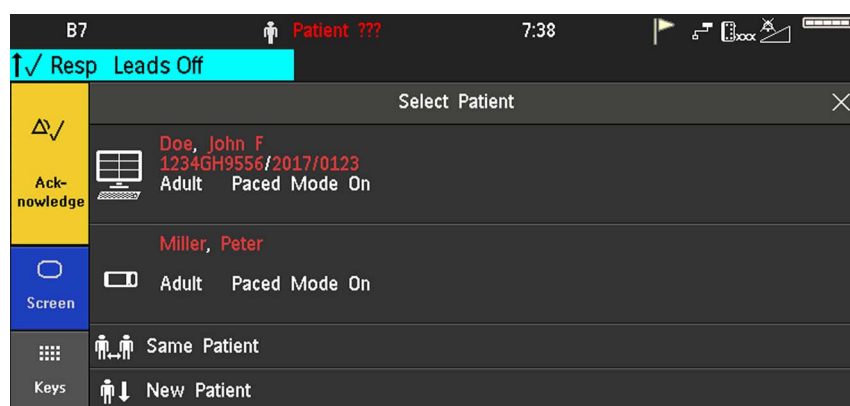
Managing Equipment

Multiple pieces of monitoring equipment can be used for a patient. The association between a patient and a device can be made by:

- identifying the patient at the device (by entering patient data or using **Find Patient** to get patient data)
- "adding" equipment for an existing patient

The association between a patient and a device can be ended by:

- discharging the patient, or selecting **End Case**.
- "removing" the device from the patient.
- transferring the patient without the device.
- admitting a new patient to the device.
- automatic freeing of the device.

WARNING

In all cases listed above, when equipment is freed, all patient identification and measurement data are deleted, all settings are reset to the defaults, and monitoring at the Information Center (if active) is stopped. Any associated devices, e.g. multi measurement modules connected to a monitor, or cableless measurement devices assigned to a monitor, may also be freed, depending on the configuration.

Adding Equipment (PIC iX)

By selecting the **Add Equipm.** key you can display a list of all free equipment (not currently assigned to a patient) and select a device for use with this patient. If you add another monitor, you need to confirm this at the selected monitor.

For information on combining equipment when connected to a PIIC, see "Using a Telemetry Device and a Monitor (PIIC only)" on page 239.

Removing Equipment

The association between a monitor and the patient can be ended by selecting **Remove Monitor**. With PIC iX, the **Remove Monitor** key is not available when the monitor is locked to a bed.

Other equipment such as telemetry devices or IntelliVue Cableless Measurements can be removed by selecting the device then selecting **Remove** in the menu displayed.

Equipment Status Disputes

Equipment can come into situations where its status does not match its location. There are three typical situations where this may occur:

- PIC iX only - equipment is locked to a bed, but has been removed and used at another bed.
- PIC iX only - equipment has been configured for use in a specific unit, but is now being used in a different unit.
- Equipment has an equipment label but has not been configured at the Information Center and therefore cannot be managed.

If a monitor or a companion device is in one of these situations, a **Check Equipment** INOP will appear and the equipment status will be shown in the **Equipment** window.

The following symbols (in red) are used to show the status in the **Equipment** window:

🛏	equipment is locked to another bed
▦	equipment is not configured for use in this unit
!	equipment label is not in system configuration, or duplicate equipment labels

Using the Equipment Window

In the **Equipment** window you have access to patient management, workflow functions (set location, transfer), equipment management functions (add/remove equipment) and caregiver-related functions.

You can open the **Equipment** window directly in **Main Setup** or by selecting the bed label in the information line.

1 This bed is Bed 104803, the connection to the Information Center is active.

2 Caregiver area - depending on your network connection, the name of assigned caregiver may be shown.

3 Patient name, category and paced mode.

4 This monitor is assigned to the patient and is the one on which you are viewing the window.

The top part of the window contains the patient data, with the assigned caregiver and the status of the connection to the Information Center, and the bed label. In the lower part of the window, all equipment for this patient is shown, with the corresponding assignments and connections.

The device you are currently viewing the window on is shown highlighted (in the above example, the monitor with the label E104U808).

Changing Caregiver Assignment

When a caregiver is assigned, the caregiver name may appear next to the caregiver symbol in the **Equipment** window (depending on your network connection). Whether the name is shown or not, when you select this area of the window, a menu opens offering the following functions:

PIC iX • **Select Caregiver** - you can select a different caregiver from a list. When a new caregiver is assigned, the patient will be automatically added to that caregiver's Care Group. The availability of the function and the caregiver list depends on the Information Center configuration.

• **My Patients** - opens the **My Patients** window showing all patients in your Care Group.

Using the Patient Area

The patient name, patient category and paced status are normally shown in the **Equipment** window. When a patient has been prepared for transfer, the transfer symbol will be shown:

When you select this area in the **Equipment** window, a menu opens giving access to the **Enter Demographics** window, the **Transfer** function (see) and the **End Case** function.

Changing the Location

If the monitor is currently assigned to a bed, but the patient is in another department for treatment or a diagnostic procedure, you can show a temporary location for the patient.

1 Select the Information Center area on the **Equipment** window.

2 Select the current location from the list.

Or alternatively use the **Select Location** pop-up key.

The temporary location is then shown in the **Equipment** window, on the Standby screen on the monitor, and in the sector at the Information Center. When the patient returns, you can set the location back to the bed number in the same way as described above.

When Multiple Equipment is Used for One Patient

It is possible to assign additional monitoring equipment and a telemetry device to the same patient, resulting in the information from multiple devices being combined in one sector at the Information Center. The measurement data from the other devices will be displayed on the monitor screen in the own patient overview window.
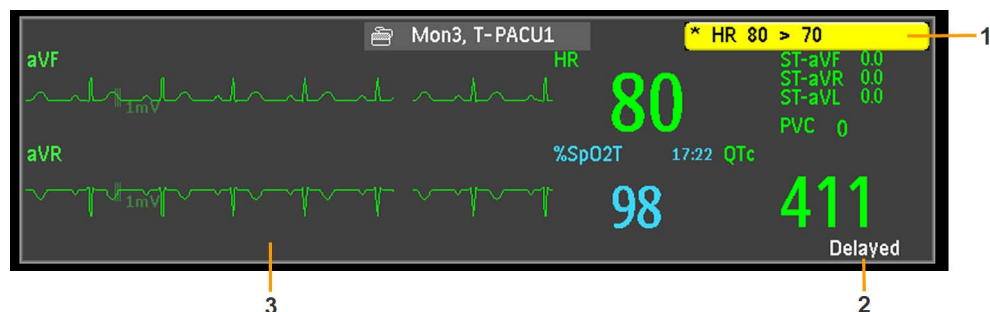

WARNING

When new equipment has been added for a patient, you will be asked to confirm that the device be used for the patient. Always do this as soon as possible to avoid patient data mismatch.

If multiple equipment is assigned to the patient, resolving a patient mismatch at the monitor may resolve other pending patient mismatches or remove other associated equipment.

Own Patient Overview Window

The measurements from other monitoring devices and telemetry devices are shown combined in the own patient overview window on the monitor, together with related information integrated by the Information Center, such as alarms.

1 Current alarm generated by another device

2 **Delayed** - indication that data in the window is delayed.

3 Own patient overview window

WARNING

All data presented in the own patient overview window are delayed for several seconds.

If you need real-time data, always use the host monitor ECG instead of telemetry or ECG from another monitoring device. As long as the ECG is being measured with another device there will be no ECG signal available at the ECG analog output.

Visual Alarm Status Information in the Own Patient Overview Window

- If individual measurement alarms are switched off at any of the devices in use for the patient, an alarms off symbol on a white background is shown beside the measurement numeric

- If all alarms are switched off or paused for one of the devices in use for the patient, an alarms off or alarms paused symbol on a dark gray background is shown beside all affected measurement numerics (if so configured). If all red and yellow alarms are switched off/paused, the symbol is red. If only yellow alarms are switched off/paused, the symbol is yellow.

Controlling Other Devices from the Bedside

You can change ECG settings for the current ECG source from the patient monitor.

1 Select the own patient overview window.

2 Select the **Setup Equipm.** pop-up key.

A setup menu will appear with the settings available for the current ECG source. If it is a telemetry transmitter or patient monitor connected to the Information Center via LAN or WLAN, the following settings are available: adjust HR alarms, relearn arrhythmia, select primary/secondary ECG lead, select arrhythmia analysis mode, change primary/secondary ECG lead size. PIC iX only: if the current ECG source is a patient monitor connected to the Information Center via IntelliVue Instrument Telemetry (IIT), only the adjust HR alarms setting is available.

Viewing and Acknowledging Other Device Alarms at the Bedside

When other devices are assigned to the patient, alarms from those devices will also be indicated on the monitor, in addition to the main indication at the Information Center.

If configured, a generic alarm message will appear in the alarm status area with standard alarm tones. The alarm message will have the color and * or ! coding corresponding to the severity of the alarm. The specific alarm message (for example **** HR Low**) will appear in the own patient overview window.

If configured, alarms generated from another device can be acknowledged at the bedside. Either the monitor **Acknowledge** key is configured to acknowledge both monitor and other device alarms (must be configured at the Information Center) or the **Acknowl. Bed Alms** pop-up key will be available:

1 Select the own patient overview window.

2 Select the **Acknowl. Bed Alms** pop-up key. Note that this key may be labeled "Silence" on older devices.

Depending on your Information Center configuration, the **Acknowl. Bed Alms** key may acknowledge both other device alarms **and** bedside alarms.

WARNING

Even when the other device data is not visible on the screen, you may be acknowledging monitor alarms **and** other device alarms, if the Information Center and monitor are so configured.

Switching Off or Pausing Alarms From Other Devices

When you select **Pause Alarms** or **Alarms Off** at the monitor, the alarms are off or paused for the bedside measurements. When you switch alarms off or pause alarms at the Information Center, both monitor alarms and alarms from other assigned devices are affected.

Refer to the Information Center Instructions for Use for more details on the Suspend/Pause alarms behavior of the Information Center.

Using Standby

When you select Standby mode at the monitor, the bedside goes into Standby mode but other assigned devices may continue monitoring.

Refer to the Information Center Instructions for Use for details on how selecting Standby at the Information Center affects the monitor and other devices.

ECG Source Tracking at the Information Center

The Information Center continuously checks whether a valid ECG signal is coming from the monitor or from another assigned device. If you unplug the ECG patient cable from the monitor and plug it into another device, the Information Center will automatically switch to monitoring the ECG from the other device. At the monitor, its own ECG measurement will be deactivated and the **Setup ECG** menu will no longer be accessible.

When you unplug the patient cable from the other device and plug it back into the monitor again, the Information Center will switch back to monitoring the ECG from the monitor. The ECG measurement will be activated again at the monitor. [Note that in this case, as the screen switches back to the monitor's own measurements, the SpO_2T measurement (if present) will no longer be displayed].

In the same way the source is tracked when a telemetry device is directly connected to a monitor, then disconnected and vice versa.

In case of ambiguity, a yellow INOP message **!! Check ECG Source** indicates that more than one valid ECG source is active.

Synchronized Settings

For some measurements, settings can be synchronized between the monitor and another measurement device. For example, if ECG is measured at the monitor, and then the patient is connected to a telemetry device for monitoring, the Information Center will use the monitor settings for the telemetry device. In general, the following settings will be synchronized:

Heart Rate	HR/Pulse Alarm On/Off, Heart Rate High/Low Limit
ECG	ECG On/Off[1], Primary Lead, Secondary Lead, Va Lead, Vb Lead, Lead Placement, QRS detection threshold
Arrhythmia	Analysis Mode, Arrhythmia On/Off, Asystole Threshold, Pause Threshold, VTach HR, VTach Run, PVCs/min, Vent. Rhythm, SVT HR, SVT Run, PVCs/min On/Off, Pacer not capture On/Off, Pacer not pace On/Off, Non-Sustain On/Off, Vent. Rhythm On/Off, Run PVCs On/Off, Pair PVCs On/Off, Missed Beat On/Off, Pause On/Off, R-on-T PVCs On/Off, Vent. Bigeminy On/Off, Vent. Trigeminy On/Off, Multiform PVCs On/Off, Irregular HR On/Off, SVT On/Off, Afib On/Off, Afib/IrrHR End Threshold, All ECG Alarm INOP mode.
ST	ST Analysis On/Off, ST Alarm On/Off, ISO Point, J point, ST point, ST Alarm Limits, ST-Index On/Off, ISO/J-Point Detection, ST Lead On/Off, ST Baseline
QT	QT analysis On/Off, QT Lead, QTc High Alarm On/Off, ΔQTc Alarm On/Off, QTc High Limit, ΔQTc High Limit, QT Baseline[2]
SpO_2T	SpO_2 Alarms on/off, SpO_2 Alarm limits, SpO_2 Low Alarm Delay, SpO_2 High Alarm Limit, Desat Alarm Limit
	NBP Alarm Suppression On/Off, Pulse(SpO_2) On/Off

[1]ECG On/Off setting is forced to ON by the monitor, if the local setting is ON.

[2]With PIIC, QT baseline is synchronized, but not QT snippets.

PIC iX   With the Patient Information Center iX, the following additional measurement settings can be synchronized:

ECG/Arrhythmia	Some ECG Alarms INOP On/Off, Hexad Reconstruction Mode
ST	STE On/Off, STE Alarm On/Off
NBP	Sys/Dia/Mean Alarm Limits, Alarms On/ Off, Alarm Source
Resp	Apnea Time, Alarm Limits, Alarm On/Off, Resp On/Off
SpO$_2$	SpO$_2$ Alarms on/off, SpO$_2$ Alarm limits, Desat Alarm Limit, NBP Alarm Suppression On/Off, Pulse(SpO$_2$) On/Off, Measurement Mode[1], Repetition Time[1]
[1]Measurement Mode and Repetition Time can only be synchronized if SpO$_2$ comes from a Cableless SpO$_2$ Pod or a telemetry device.	

WARNING

- Not all settings are synchronized; after changing the measurement source, always check that the settings are appropriate.

If later the patient is disconnected from the other device, and reconnected to the monitor again, any changes in the settings made in the meantime will be passed on to the monitor. In this way, settings continuity is preserved when the measurement source changes.

NOTE

Settings synchronization can be switched off at the monitor in Configuration mode.

In certain situations, you will be asked to confirm that synchronization of settings is appropriate.

Settings synchronization can only take place when there is no patient information mismatch between the monitor and the Information Center.

PIIC   If a **Check ECG Settings** or **!! Check Pairing** INOP appears always check that the ECG settings, especially the paced setting, are appropriate for your patient.

PIC iX   If a **Check ECG Settings**, **Chk SpO₂T Settings**, or another check settings INOP appears, always check that the settings, especially the paced setting for ECG, are appropriate for your patient.

Information Center Compatibility

The functionality available for managing patients and equipment depends on the Information Center being used. In the following table the main differences between the PIIC and PIC iX are shown.

PIIC	PIC iX
Not available	**Find Patient** - searching for a patient in the Information Center or other connected hospital systems. (With LAN and WLAN connection only)
Transfer Patient - patient is moved to transfer list.	**Transfer Patient** - can transfer patient directly to another bed/unit and from another bed/unit. (With LAN and WLAN connection only)
Not available	A unique patient list provides information about the current status of a patient allowing intelligent prompts and preventing the same patient being admitted twice.
Add Equipment - allows only assignment of telemetry devices via manual pairing.	**Add Equipment** - allows assignment of other monitors and telemetry devices. (With LAN and WLAN connection only)

PIIC	PIC iX
Remove equipment - allows only removal of telemetry devices via **Unpair To Mon.** and **Unpair To Tele**.	**Remove** equipment - allows removal of other monitors and telemetry devices.
Not available	**Select Location** - allows a temporary location to be shown when a patient is not in the unit. (With LAN and WLAN connection only)
Not available	**Select Caregiver** - allows a Caregiver to be assigned to a patient
Not available	Paced status **Unconfirmed** is the initial setting before a paced status has been entered. **Unconfirmed** will switch pace pulse rejection on but makes the user aware that no paced status has been selected.

6

ECG, Arrhythmia, ST and QT Monitoring

The electrocardiogram (ECG) measures the electrical activity of the heart and displays it on the monitor as a waveform and a numeric. This section also tells you about arrhythmia monitoring (see "About Arrhythmia Monitoring" on page 140), ST monitoring (see "About ST Monitoring" on page 149) and QT monitoring (see "About QT/QTc Interval Monitoring" on page 160).

Skin Preparation for Electrode Placement

Good electrode-to-skin contact is important for a good, noise-free ECG signal, as the skin is a poor conductor of electricity.

1   Select sites with intact skin, without impairment of any kind.

2   Clip or shave hair from sites as necessary.

3   Wash sites thoroughly with soap and water, leaving no soap residue.
    We do not recommend using ether or pure alcohol, because this dries the skin and increases the resistance.

4   Dry skin thoroughly.

Clinical considerations for possible causes of noisy ECG signal include poor skin prep, dried electrodes, broken lead wires, muscle artifact, baseline wander, respiration artifact, or interference from equipment.

Connecting ECG Cables

1   Attach the clips or snaps to the electrodes before placing them. If you are not using pre-gelled electrodes, apply electrode gel to the electrodes before placement.

2   Place the electrodes on the patient according to the lead placement you have chosen.

3   Attach the electrode cable to the patient cable.

4   Plug the patient cable into the white ECG connector. An ECG waveform and numeric appears on the monitor display.

CAUTION

To protect the monitor from damage during defibrillation, for accurate ECG information and to protect against noise and other interference, use only ECG electrodes and cables specified by Philips. Some non-authorized electrodes may be subject to large offset potentials due to polarization.

Selecting the Primary and Secondary ECG Leads

The monitor uses the primary and secondary lead to compute HR and to analyze and detect cardiac arrhythmias. They are also available for recordings and for display on the Information Center.

The secondary lead is only used if your monitor is configured for multi-lead (instead of single-lead) arrhythmia analysis.

You should choose a lead as primary and (if multi-lead analysis) secondary lead that has the following characteristics:

- the QRS complex should be either completely above or below the baseline and it should not be bi-phasic
- the QRS complex should be tall and narrow
- the T-wave is less than 1/3 the R-wave height
- the P-wave is less than 1/5 the R-wave height, preferably less than 0.15 mV.

To select a lead as primary or secondary lead:

- In the **Setup ECG** menu, select **Primary** or **Secondary**, then select the appropriate lead. You can assign any available lead whether it is currently displayed or not.

Checking Paced Mode

It is important to set the paced mode correctly when you start monitoring ECG.

- To change the paced mode in the **Setup ECG** menu, select **Paced Mode** to switch between **On**, **Off** or **Unconfirm**.


WARNING

Pace pulse rejection must be switched on for paced patients by setting **Paced Mode** to **On**. Switching pace pulse rejection off for paced patients may result in pace pulses being counted as regular QRS complexes, which could prevent an asystole event from being detected. When changing profiles, and at admission/discharge, always check that paced mode is correct for the patient.

If the paced mode is On for a patient without a pacemaker, the algorithm's effectiveness in detecting ventricular beats may be reduced and may result in not receiving some PVC alarms

Some pace pulses can be difficult to reject. When this happens, the pulses are counted as a QRS complex, and could result in an incorrect HR and failure to detect cardiac arrest or some arrhythmias. Make sure that pace pulses are detected correctly by checking the pace pulse markers on the display. Keep pacemaker patients under close observation.

Understanding the ECG Display

Your display may be configured to look slightly different.
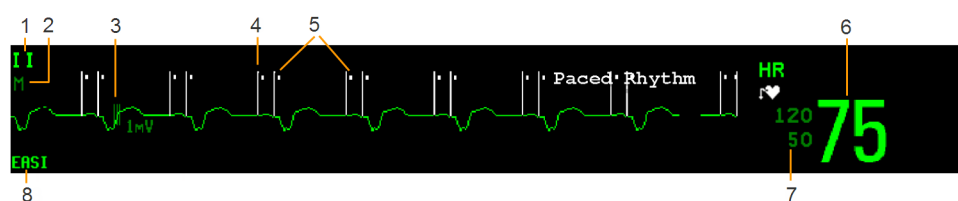
1. Lead label of the displayed wave
2. ECG Filter label
3. 1 mV calibration bar
4. Pacer spikes
5. Pace pulse markers
6. Current heart rate
7. Current heart rate alarm limits and paced mode symbol
8. EASI or Hexad lead placement label

ECG HR numeric: This is the heart rate derived from the monitored ECG.

Pace pulse markers: These are shown if the **Paced Mode** status has been set to **On**, the pacer spikes are not configured to have a fixed size, and the patient has a paced signal.

Pacer Spikes: The pacer spikes are shown in white, unless the ECG wave is white, then they will be green. If the pacer spikes have been configured to have a fixed size, they will be displayed in the background as a dotted line.
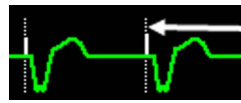
1	Pacer spikes configured to have a fixed size

Synchronization pulse marks: When a cable is connected to the ECG sync pulse output connector, and the synchronization pulse is configured to be shown, the synchronization marks appear as vertical lines on the ECG wave. The synchronization marks will be shown in yellow, unless the ECG wave is yellow, then they will be green.
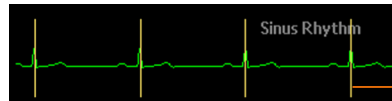

1	Synchronization marks in yellow

ST numerics in ECG wave: ST numerics can be configured to show underneath the ECG wave on the left side.

Hexad lead placement label: When 6-lead placement for a Hexad derived 12-lead ECG is used, the **Hexad** lead placement label is displayed and all derived leads are marked with a "d" in front of the lead label, for example dV1.

Monitoring Paced Patients

An ECG optimized for monitoring a paced patient should look like this:
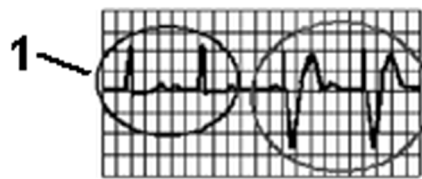
1	Normal Beats
2	Pace Pulses/Pace Beats

You should choose a lead as primary and (if multi-lead analysis) secondary lead that has these characteristics:

• the normal QRS complex should be either completely above or below the baseline and it should not be bi-phasic. For paced patients, the QRS complexes should be at least twice the height of pace pulses.

• the QRS complex should be tall and narrow

• the T-wave is less than 1/3 the R-wave height

• the P-wave is less than 1/5 the R-wave height, preferably less than 0.15 mV.

For ease of identification on the screen, the pacer spikes can be configured to have a fixed size. They are then shown in the background as dotted lines. The length of the dotted line is fixed to the wave channel height and is independent of the actual pacer amplitude.

Setting the Paced Status

In the **Setup ECG** menu, select **Paced Mode** to switch between **On**, **Off** or **Unconfirm**.

You can also change the paced mode in the **Patient Demographics** window.

When **Paced Mode** is set to **On**:

– Pace Pulse Rejection is switched on. This means that pacemaker pulses are not counted as extra QRS complexes.

– pace pulse marks are shown on the ECG wave as a small dash (only when the pacer spikes are not configured to have a fixed size).

– the paced symbol is displayed under the HR label.

When **Paced Mode** is set to **Off**, pacer spikes are not shown in the ECG wave. Be aware that switching pace pulse rejection off for paced patients may result in pace pulses being counted as regular QRS complexes, which could prevent an asystole event from being detected.

When the paced mode has not yet been set for a patient, the paced symbol will have a question mark indicating the **Unconfirm** mode. When the paced mode is **Unconfirm**, pace pulse rejection is switched on.

Paced Mode On

Paced Mode Off

Paced Mode
Unconfirmed

Avoiding Pace Pulse Repolarization Tails

Some unipolar pacemakers display pace pulses with repolarization tails. These tails may be counted as QRSs in the event of cardiac arrest or other arrhythmias.

If you note a visible repolarization tail, choose a lead that decreases the size of the repolarization tail.

1 Repolarization tail (note width)

Changing the Size of the ECG Wave

If any of the displayed ECG waves is too small or clipped, you can change the size of one or all of the ECG waves on the screen.

Changing the adjustment factor only changes the visual appearance of the ECG wave on the screen. It does not affect the ECG signal analyzed by the monitor.

Comparing the wave size to the 1 mV calibration bar on the ECG wave channel can help you to get an idea of the true ECG signal strength. If you choose a fixed adjustment factor, the 1 mV calibration bar will be the same size for all the displayed ECG waves. If you choose **Auto Size**, or an individual size using the **Size Up**/**Size Down** keys, the calibration bar may be a different size for each wave.

Using any of the options to change the wave size will automatically reposition the wave in the middle of the channel, standardizing the offset. You can use this effect to reposition your waves, if they are shown at the top or bottom of the channel, or even clipped. Correct positioning, and a standardized offset, is also important for recordings and reports, to allow reliable interpretation of the data.

To Change the Size of an Individual ECG Wave

1 Select the wave channel you want to change. This calls up the lead menu for this channel.

2 In the lead menu, select **Size Up** to increase wave size or **Size Down** to decrease the size.
Selecting **Auto Size** lets the monitor choose the optimal adjustment factor for all available ECG waves.

To Change the Size of all the ECG Waves

To change the size of all the ECG waves on the screen by a fixed adjustment factor,

1 In the **Setup ECG** menu, select **Adjust Size**.

2 Select the required adjustment factor from the line of pop-up keys.

– **Size x0.5** to halve the wave size

– **Size x1** to display the wave without zoom

– **Size x2** to double the wave size

– **Size x4** to multiply the wave size by four

Changing the Minimum QRS Detection Threshold

A major goal of the QRS detection algorithm is to avoid P-waves, T-waves, atrial fibrillatory waves, atrial flutter waves, or noise from being detected as QRS complexes during complete heart block or asystole. The QRS detection threshold is the level above which peaks will be counted as QRS complexes. The actual threshold at any time depends on the noise present and the shape of the original ECG signal.

The QRS detection threshold never goes below the larger of 1/5 the average R-wave height, 150 μV, or the minimum detection threshold set by the user. Any peak smaller than this value is not detected. The size of the P-wave can affect accurate detection of the QRS. When the P-wave is larger than 1/5 the height of the QRS, adjust the threshold level above the P-wave.

To adjust the threshold:

1 Enter the **Setup ECG** menu.

2 Select **QRS Detection**.

3 Select a value from the pop-up menu.
The values are shown in microvolts. For comparison, you can refer to the 1 millivolt calibration bar on the wave. 1 millivolt equals 1000 microvolts.

You may want to manually adjust the minimum QRS detection threshold if the monitor miscounts the heart rate. If the ECG morphology changes, you may need to readjust the QRS detection threshold.

CAUTION

False or missed alarms can occur if the QRS detection threshold is inappropriately set for the patient.

Changing the Volume of the QRS Tone

The QRS tone is derived from either the HR or Pulse, depending on which is set up as QRS tone source. Alternatively, the QRS tone source can be selected manually from a fixed list of labels (see "QRS Tone" on page 167 for details).

The QRS volume can be set from 0 to 10 (0 means off).

To change the QRS volume, in the **Setup ECG** menu select **QRS Volume** and then select the appropriate volume from the pop-up list.

There will be no QRS tone when the X3 is connected to a host monitor.

Changing the ECG Filter Settings

The ECG filter setting defines how ECG waves are smoothed. An abbreviation indicating the filter type is shown underneath the lead label on the monitor display. Filter settings do not affect ST measurement.

To change the filter setting, in the **Setup ECG** menu, select **Filter** and then select the appropriate setting.

– **Monitor**: Use under normal measurement conditions.

– **Ext. Monitor**: Use when diagnostic quality is required but low frequency interference or a wandering baseline may be expected. The upper edge frequency is the same as the **Diag** setting and the lower edge frequency is the same as the **Monitor** setting.

– **Filter**: The filter reduces interference to the signal. It should be used if the signal is distorted by high frequency or low frequency interference. High frequency interference usually results in large amplitude spikes making the ECG signal look irregular. Low frequency interference usually leads to a wandering or rough baseline. In the operating room, the Filter reduces artifacts and interference from electrosurgical units. Under normal measurement conditions, selecting **Filter** may suppress the QRS complexes too much and thus interfere with the clinical evaluation of the ECG displayed on the monitor. This does not affect the ECG analysis performed by the monitor.

If **AutoFilter** is set to **On** in Configuration Mode, the filter setting will automatically be set to **Filter** if electromagnetic interference is detected.

– **Diag**: Use when diagnostic quality is required. The unfiltered ECG wave is displayed so that changes such as R-wave notching or discrete elevation or depression of the ST segments are visible.

The setting **Diag** selects the highest available ECG bandwidth which is 0.05 to 150 Hz for the Adult, Pedi and Neo patient category. The term "diagnostic" relates only to the ECG bandwidth requirements for diagnostic electrocardiographic devices as outlined in the ANSI/AAMI standard EC11-1991.

When you are using a telemetry transmitter connected via short range radio to the monitor, the upper bandwidth for all filter settings is limited to 40 Hz.

Choosing EASI or Standard Lead Placement

You must enable either standard lead placement or EASI lead placement.

• In the **Setup ECG** menu, select **Placement** and then **Standard** or **EASI**.

EASI is shown beside the 1mV calibration bar on the ECG wave on the display, and **EASI** is marked on any printouts.

See the section on for electrode placement diagrams.

Selecting Positions of Va and Vb Chest Leads (for 6-electrode placement)

6-Electrode Lead Placement

The two chest electrodes for the 6-electrode lead placement can be positioned at any two of the V1 to V9 and V3R to V6R positions. Select the positions you have used in the **Setup ECG** menu, so that the chest leads will be correctly labeled.

1 In the **Setup ECG** menu, select **Va Lead**.

2 Select the position used from the list.

3 Select **Vb Lead** and select the position used from the list.

6-Electrode Placement for Hexad Derived 12-lead ECG

The Hexad ECG lead system uses a 6-electrode cable set, connected to four limb electrodes (using Mason-Likar placement) and two chest electrodes. The algorithm derives the four remaining V-leads to provide a non-diagnostic 12-lead view, including ECG waves and ST/QT measurements.

The two chest electrodes for Hexad must be positioned at two of the V1 to V6 positions. The following combinations of positions can be used:

- V1 and V3
- V2 and V5
- V1 and V4
- V3 and V5
- V1 and V5
- V3 and V6
- V2 and V4

Select the two positions you have used in the **Setup ECG** menu:

1   In the **Setup ECG** menu, select **Hexad (Va,Vb)**.

2   Select the correct combination of chest electrode positions from the list.

Making the selection switches the Hexad derived 12-lead ECG on.

The Hexad derived 12-lead ECG is intended for use with adult patients only. For this reason, the **Hexad (Va,Vb)** selection will not be available in neonatal and pediatric modes.

About ECG Leads

To make it possible to compare measured ECG signals, the electrodes are placed in standardized positions, forming so-called "leads". To obtain ECG signals optimized for use in diagnosis and patient management in different care environments, different electrode cable sets in varying lead placements can be used. You can use either standard lead placements or EASI lead placements with this monitor.

When placing electrodes, choose a flat, non-muscular site where the signal will not be interfered with by either movement or bones. Correct electrode placement is always important for accurate diagnosis. Especially in the precordial leads, which are close to the heart, QRS morphology can be greatly altered if an electrode is moved away from its correct location.

ECG Leads Monitored

If you are using	these leads are available:	Leads that can be viewed simultaneously
a 3-electrode set	I, II, III	One lead
a 5-electrode set	I, II, III, aVR, aVL, aVF, V, MCL, Va	All listed leads
a 6-electrode set	I, II, III, aVR, aVL, aVF, Va, Vb	All listed leads
a 6-electrode set with the Hexad algorithm	I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6 Two V leads are directly measured and four are derived.	All listed leads
a 10-electrode set	I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6	All listed leads
an EASI 5-electrode set	I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6	All listed leads

Changing the Number of Electrodes

To change the number of electrodes,

- **When adding electrodes**: place the additional electrodes as required - the monitor automatically recognizes the new lead placement.

- **When removing electrodes:** there are two possibilities - removing the complete chest leads block or removing individual electrodes.
  If you unplug the chest lead block from the trunk cable connector, the monitor will automatically recognize the new lead placement.
  Remove individual leads by removing the electrodes. The monitor will issue a **Lead Off** INOP message; select **New Lead Setup** in the **Setup ECG** menu and the INOP message will disappear.

ECG Lead Fallback

If fallback is configured on and there is a leads off INOP in the primary lead (and in the secondary lead, if you are using multi-lead monitoring) for longer than 10 seconds, and if another lead is available, this available lead automatically becomes the primary lead. This is known as lead fallback. When the Leads Off condition is corrected, the leads are automatically switched back.

This setting can only be changed in Configuration Mode.

ECG Lead Placements

The labels and colors of the ECG electrodes differ according to the standards that apply for your hospital. The electrode placement illustrations in this chapter use the AAMI labels and colors.

| Electrode labels			Electrode colors	
AAMI	EASI	IEC	AAMI	IEC
RA	I	R	White	Red
LA	S	L	Black	Yellow
LL	A	F	Red	Green
RL	N	N	Green	Black
V	E	C	Brown	White
V1/Va		C1/Ca	Brown/Red	White/Red
V2/Vb		C2/Cb	Brown/Yellow	White/Yellow
V3		C3	Brown/Green	White/Green
V4		C4	Brown/Blue	White/Brown
V5		C5	Brown/Orange	White/Black
V6		C6	Brown/Violet	White/Violet

Lead Placement for a 3-Electrode Cable Set
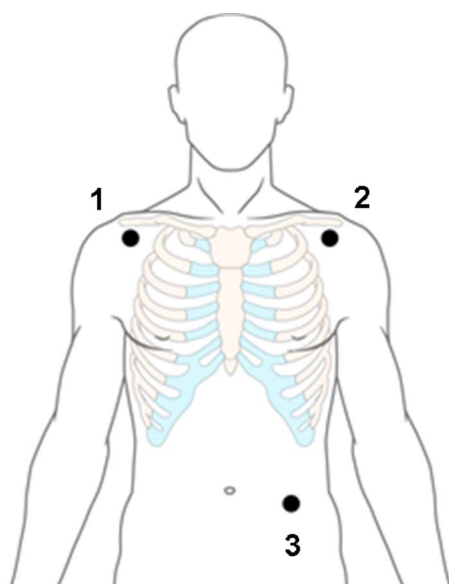
1   RA placement: directly below the clavicle and near the right shoulder

2   LA placement: directly below the clavicle and near the left shoulder

3   LL placement: on the left lower abdomen

Lead Placement for a 5-Electrode Cable Set
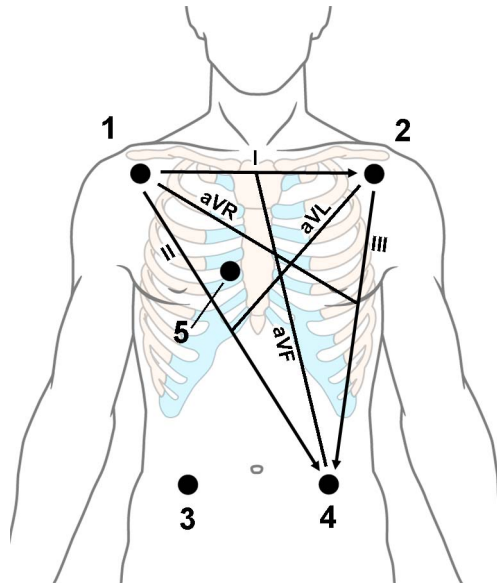
1. RA placement: directly below the clavicle and near the right shoulder

2. LA placement: directly below the clavicle and near the left shoulder

3. RL placement: on the right lower abdomen

4. LL placement: on the left lower abdomen

5. V placement: on the chest, the position depends on your required lead selection. If configured, the label of the chest lead will be displayed with its exact position (V1 to V6R)

Lead Placement for a 6-Electrode Cable Set

Use the positions from the 5-electrode diagram above but with two chest leads. The two chest leads, Va and Vb, can be positioned at any two of the V1 to V9 or V3R to V6R positions shown in the chest electrode diagram below (see "Chest Electrode Placement" on page 126).

The Va and Vb lead positions chosen must be selected in the **Setup ECG** Menu.

Hexad Lead Placement for a 6-Electrode Cable Set

Use the positions from the 5-electrode diagram above but with two chest leads. For Hexad derived 12-lead, the two chest leads, Va and Vb, must be positioned at two of the V1 to V6 positions shown in the chest electrode diagram below (see "Chest Electrode Placement" on page 126). The following combinations of positions can be used:

- V1 and V3
- V1 and V4
- V1 and V5
- V2 and V4

- V2 and V5
- V3 and V5
- V3 and V6

The Va and Vb lead positions chosen must be selected in the **Setup ECG** Menu.

When Hexad lead placement is selected, **Hexad** is shown beside the 1 mV calibration bar on the ECG wave and all derived leads are marked with a "d" in front of the lead label, for example dV1.

WARNING

Hexad derived 12-lead ECGs and their measurements are approximations to conventional 12-lead ECGs. They should not be used for diagnostic interpretations.

Chest Electrode Placement
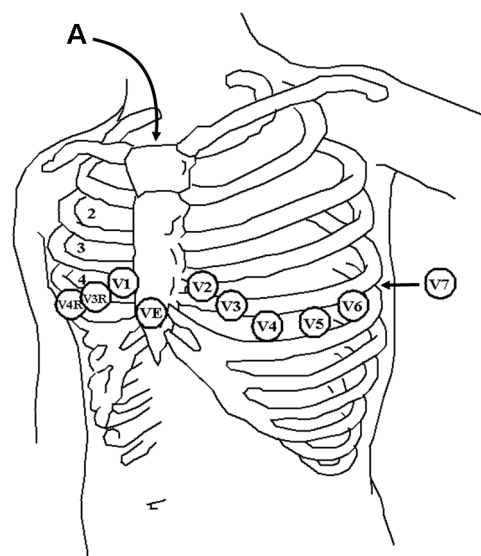
A - Angle of Louis

V1 on the fourth intercostal space at the right sternal border

V2 on the fourth intercostal space at the left sternal border

V3 midway between the V2 and V4 electrode positions

V4 on the fifth intercostal space at the left midclavicular line

V5 on the left anterior axillary line, horizontal with the V4 electrode position

V6 on the left midaxillary line, horizontal with the V4 electrode position

V3R -V6R on the right side of the chest in positions corresponding to those on the left

VE over the xiphoid process

V7 on posterior chest at the left posterior axillary line in the fifth intercostal space

V7R on posterior chest at the right posterior axillary line in the fifth intercostal space

V8 posterior lead, level with V7 at the left midscapular line

V9 posterior lead, level with V7 at the left spinal border.

For accurate chest electrode placement and measurement, it is important to locate the fourth intercostal space.

1   Locate the second intercostal space by first palpating the Angle of Louis (the little bony protuberance where the body of the sternum joins the manubrium). This rise in the sternum is where the second rib is attached, and the space just below this is the second intercostal space.

2   Palpate and count down the chest until you locate the fourth intercostal space.

Lead Placement for a 10-Electrode Cable Set

When monitoring 12 leads of ECG, using a 10-electrode lead placement, it is important to correctly place electrodes and to label all 12-lead ECG reports with the correct lead placement.

Conventional 12-Lead ECG

1	V1 - V6
2	LA
3	RA
4	RL
5	LL
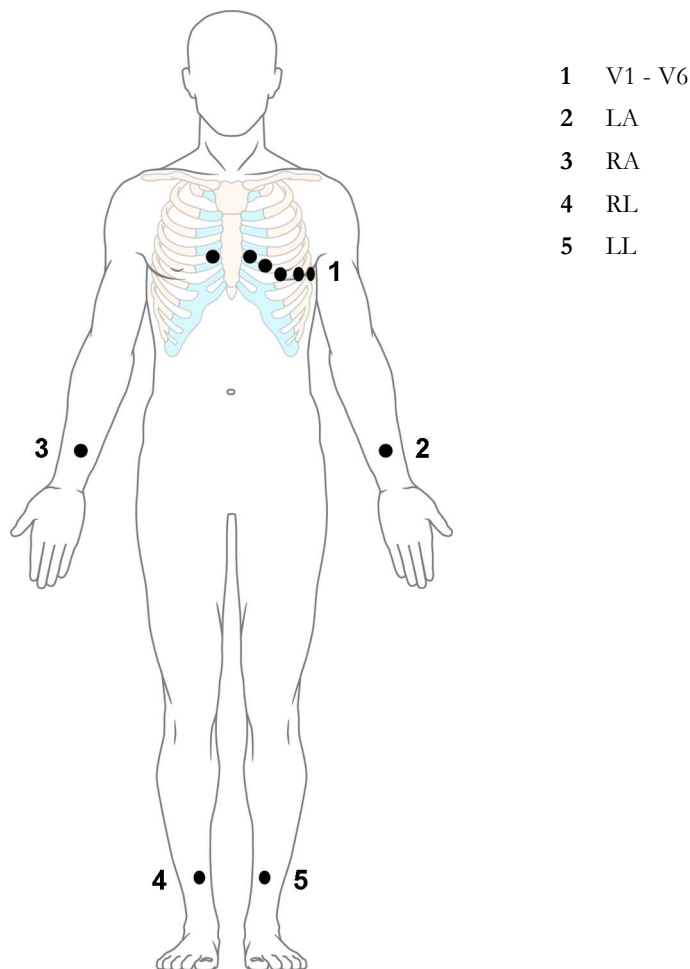
In conventional 12-Lead ECG using 10 electrodes, an electrode is placed on the right arm, left arm, right leg, and left leg. Six V- electrodes are placed on the chest. The right leg electrode is the reference electrode.

Limb electrodes:

– Place arm electrodes on the inside of each arm, between the wrist and the elbow.

– Place leg electrodes inside of each calf, between the knee and the ankle.

Chest electrodes:

V1 - on the 4th intercostal space at the right sternal border

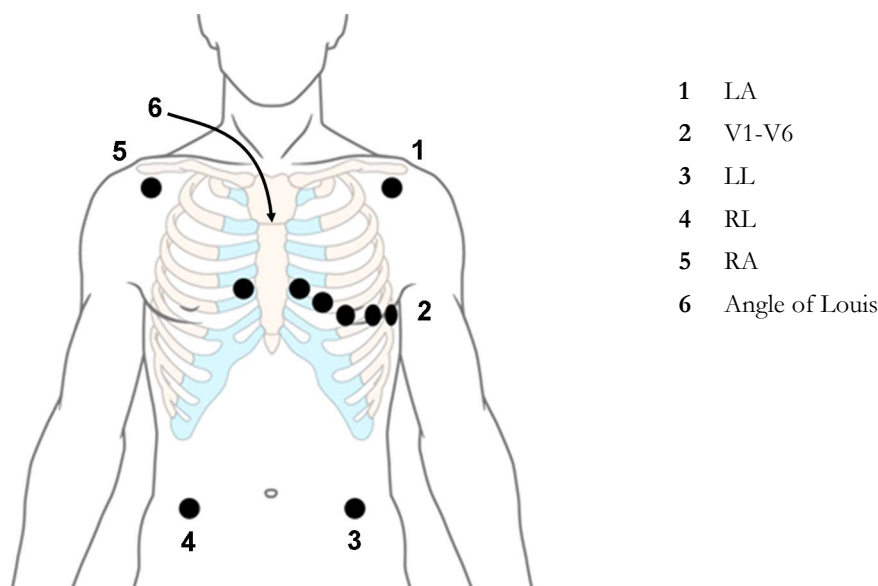V2 - on the 4th intercostal space at the left sternal border

V3 - midway between the V2 and V4 electrode positions

V4 - on the 5th intercostal space at the left midclavicular line

V5 - on the left anterior axillary line, horizontal with the V4 electrode position

V6 - on the left midaxillary line, horizontal with the V4 electrode position

Modified 12-Lead ECG

1	LA
2	V1-V6
3	LL
4	RL
5	RA
6	Angle of Louis

If your institution uses modified 10-lead ECG electrode placement (the Mason-Likar Lead System), place the four limb electrodes close to the shoulders and lower abdomen.

The six V electrodes are placed on the chest in the same position as the conventional 12-lead placement.

Choosing Standard or Modified Electrode Placement

If your institution uses modified 10 Lead ECG electrode placement (the Mason-Likar Lead System), you must set **Limb Leads** to **on Trunk** in the monitor. To do this,

- in the **Setup ECG** menu, select **Limb Leads** and select **on Trunk**.
  - When **Limb Leads** is set to **on Trunk**, ECG Reports A/B will be labeled **12 Lead ECG Report (Mason–Likar)**.
  - When **Limb Leads** is set to **on Limbs**, ECG Reports A/B will be labeled **12 Lead ECG Report (Standard)**.

The limb leads setting for 12-lead captures is made separately, see .

WARNING

Interpretations and analysis results provided by the Philips DXL 12-lead Analysis Algorithm for 12-lead ECG captures are intended for use with Standard (conventional) 12-lead placement and are not validated for use with other lead placements.

Using ECG analysis interpretation statements and measurements for 12-lead ECGs obtained using modified limb electrode placement (for example, Mason-Likar) may lead to misdiagnosis. The modified limb electrode placement does not look the same as the conventional 12-lead ECG and may mask inferior infarction due to calculated axis, R, P and T wave magnitudes shifts and ST slope.

When exporting 12-lead ECGs obtained using the Mason-Likar limb electrode placement, be aware that on non-Philips systems the Mason-Likar label will not be visible.

Capture 12-Lead

You can view a 12-Lead ECG on the screen, capture a 12-Lead ECG episode, preview the captured ECG data and then store it and send it to a connected Information Center for analysis. You can download the resulting analysis from the Information Center and also other 12-Lead captures for review at the monitor. A

12-Lead report can be printed that also includes the downloaded analysis results and an ST Map. You can operate the 12-Lead Export function and the 12-Lead Lock/Unlock function at the Information Center remotely from the monitor.

The monitor can store one 12-Lead ECG episode at any time.

Viewing the Realtime 12-Lead ECG

To open the 12-Lead ECG window and view the realtime ECG waves,

- Select the **Capture 12 Lead** SmartKey, or
- Select the **Main Setup** SmartKey then select **Capture 12 Lead**.

If **Initial View** is set to **Lead Diagram** in configuration mode, the lead diagram view will open. See "Lead Diagram" on page 133 for details. To return to the realtime 12-Lead ECG view from the lead diagram view, select the **Show Waves** pop-up key.

If a previously viewed 12-Lead ECG was not stored, a window will pop up asking whether you want to keep it or not. The title bar of the window shows the date and time when this 12-Lead ECG was captured. If you do not need the ECG, select **No** to discard it, otherwise, select **Yes** and then select **Store & Send** to store that 12-Lead ECG and send it to an Information Center (if one is connected).

If your patient is not admitted, you will be prompted to enter at least the age and gender of the patient. This information is needed for analysis of the 12-Lead ECG at the Information Center but is not essential if you only want to capture the 12-Lead ECG without sending it for analysis. To enter this information:

1   Select the **Admit Patient** pop-up key, then
2   Enter the information in the **Patient Demographics** window.
3   Open the 12-Lead ECG window again as described above.

The age and gender will now be displayed in the title bar of the pop-up keys.

To change the way the realtime waves are displayed, select the **Change View** pop-up key or select the wave area. You can switch between a one or two column display. The two column display lets you see a larger representation of the waves.

If you are using the Hexad lead placement, you can select the **Setup Leads** pop-up key to select the positions of the chest leads (Va and Vb or Ca and Cb).

While the realtime 12-Lead waves are being viewed in the window, the ECG filter mode (see "Changing the ECG Filter Settings" on page 121) is changed to the 12-Lead filter setting (see "Changing Settings for a Captured 12-Lead ECG" on page 129).

Capturing the 12-Lead ECG

To capture the last 10 seconds of ECG data, select the **Capture Waves** pop-up key. The pop-up key is active as soon as enough wave data is available; until then a progress bar is displayed in the title bar of the pop-up keys. A preview of the captured data appears on the screen (unless your monitor is connected to an Information Center with software release earlier than Revision M — then the captured data is automatically stored and sent to the Information Center).

The title bar of the pop-up keys will now show the current filter setting and, if you are using EASI or Hexad lead placement, an **EASI** or **Hexad** indicator will appear at the bottom of the captured data.

You can at any time return to the realtime 12-Lead ECG view by selecting the **Show Waves** pop-up key. From there, you return to the preview window by selecting the **Review 12 Lead** pop-up key and then selecting the 12-Lead marked with * from the list.

Changing Settings for a Captured 12-Lead ECG

Select the **Setup 12 Lead** pop-up key to choose settings for filter, gain, etc., if changes are needed. All changes apply to both the display and the printed 12-Lead report. The changes are only applied temporarily and will not be stored. If you want to change the default settings, see "Setting Up the 12-Lead ECG" on page 132.

High Pass Filter	Sets the high pass filter for the waveforms. Choices are **0.05 Hz**, **0.15 Hz** and **0.5 Hz**.
Low Pass Filter	Sets the low pass filter for the waveforms. Choices are **40 Hz**, **100 Hz** and **150 Hz**.
AC Filter	Switches the AC (line frequency) filter **On** or **Off**.
Gain	Defines the gain used for the waveforms. Choices are **2.5 mm/mV**, **5 mm/mV**, **10 mm/mV** and **20 mm/mV**.
Chest Gain	Defines the gain for the chest leads relative to the standard gain setting. Choices are **Full** and **Half**.
Paper Speed	Defines the waveform speed. Choices are **25 mm/sec** and **50 mm/sec**.
Limb Leads	Sets the position of the limb leads. Choices are **on Limbs** and **on Trunk**.
Format	Defines the page layout. Choices are **12x1**, **6x2**, **3x4**, **3x4 1R**, **3x4 3R**,**3x4 ST** and **3x4 1R ST**. 1R and 3R refer to 1 or 3 rhythm leads, ST formats contain an ST map.
Time	Defines whether all leads show simultaneous or sequential intervals of time, when displaying or printing 2 or more columns. Choices are **Sequential** and **Simultaneous**.
Rhythm Lead 1 **Rhythm Lead 2** **Rhythm Lead 3**	Defines which lead will be used as rhythm lead 1, 2 or 3. Choices are **Primary**, **Secondary**, **I**, **II**, **III**, **aVR**, **aVL**, **aVF**, **V1**, **V2**, **V3**, **V4**, **V5**, **V6**, **V7**, **V8**, **V9**, **V3R**, **V4R**, **V5R**, **V6R**, and **MCL**. This setting is only relevant when **3x4 1R**, **3x4 1R ST** or **3x4 3R** is selected as **Format**.
Lead Sequence	Defines the sequence in which the leads are presented. Choices are **Cabrera** and **Internat**.

Storing and Sending the 12-Lead ECG

You can assign an order number that will then be associated and stored with the 12-Lead ECG.

If you have an Information Center connected, it may provide order management, in which case an **Order (xx)** pop-up key is displayed. This opens the order window from the Information Center, showing a list of any pending 12-lead orders for the patient. In this window you can assign and remove orders, in the same way as you would do directly at the Information Center.

If no Information Center is connected, you can enter an order number manually. Select the **Enter Order #** pop-up key and type in the number. The order number will be stored with the capture and displayed in the title bar of the pop-up keys.

To store the previewed data on the monitor and send it to a connected Information Center for storage and analysis, select the **Store & Send** pop-up key.

If the monitor is connected to an Information Center, use the **Store & Send** function before patient transport to store the 12-Lead ECG centrally, as the 12-Lead ECG data will not be uploaded from the Multi-Measurement Module to another monitor after transport.

If the connection to the Information Center is not active while storing, the 12-Lead ECG will be automatically sent as soon as the connection is established or restored. If a previously stored 12-Lead ECG is waiting to be sent to the Information Center, it will be overwritten when a new 12-Lead ECG is stored and can then not be sent to the Information Center.

Printing the 12-Lead ECG

Print a dedicated 12-Lead ECG report by selecting the **Print Report** pop-up key.

When you are working with a PIC iX that provides 12-Lead analysis data to the monitor, the report contains the 12-Lead analysis results as well as measurement values (e.g. ST values, QT values, HR) that are also downloaded from the PIC iX.

If you work with a PIIC, or a PIC iX without the necessary license, no 12-Lead analysis data is provided to the monitor. In this case, the report only contains the real-time measurement values from the bedside.

Consequently, the measurement values in the report might differ in the two cases, due to the slightly different algorithm approaches of the patient monitor (real-time measurement) and the PIC iX (diagnostic interpretation of 12-Lead capture).

Downloading Analysis Results (PIC iX only)

Download analysis results from the Information Center by selecting **Show Analysis**. Return to the previous screen by selecting **Hide Analysis**.

Reviewing Previewed or Stored 12-Lead Captures

To view 12-Lead captures previewed or stored on the monitor or 12-Lead captures stored at the Information Center (PIC iX only), select **Review 12 Lead**. You can then select from a list of 12-Lead captures available for the current patient.

The 12-Lead captures in the list may be marked with a symbol, for example an open or closed padlock to indicate unlocked or locked status or a * to indicate preview status.

Information Center Remote Export (PIC iX only)

Use the **Export** key to remotely start the 12-Lead export functionality of the Information Center. A list of export fields appears where you can enter corresponding information, as required.

Information Center Remote Lock/Unlock (PIC iX only)

Use the **Lock** key to remotely lock the 12-Lead capture at the Information Center. If it is already locked, the **Unlock** key will be displayed.

Capture 12-Lead Pop-up Keys

Here is a summary of all the pop-up keys available during the 12-Lead ECG procedure:

Pop-up Keys	Selecting this pop-up key lets you
Admit Patient	enter the age and gender for the patient, to allow analysis of the 12-Lead ECG.
Change View	switch between the single column and two-column display of the realtime wave data.
Capture Waves	capture the current ECG waves and open the preview window.
Show Waves	return to the realtime 12-Lead ECG view.
Setup 12 Lead	choose settings for filter, gain, display layout, etc.
Order (xx)	open the order window from the Information Center (if available) and assign order numbers to 12-Lead captures.
Enter Order #	enter an order number that is stored with the capture and displayed in the title bar of the pop-up keys.
Print Report	print a 12-Lead report.
Store & Send	store the captured 12-Lead ECG in the monitor and send it to the Information Center.
Review 12 Lead	view a list of 12-Lead captures available at the monitor or at the Information Center, and select one for review.
Show Analysis	download analysis results from the Information Center.

Pop-up Keys	Selecting this pop-up key lets you
Export	remotely export 12-Lead ECG data from the Information Center to an ECG management system (see the Information Center Instructions for Use for details).
Lock / **Unlock**	remotely lock/unlock the 12-Lead capture at the Information Center.
Setup Leads	switch between Standard and EASI lead placement and select the positions of the chest leads (Va and Vb or Ca and Cb), when using Hexad lead placement.
Lead Diagram	open the lead diagram view.

Setting Up the 12-Lead ECG

You can make settings that will be stored and used in future as default settings for each 12-Lead ECG capture made.

1   Select the HR numerics on the screen to enter **Setup ECG**.

2   Select **12Lead**.

3   The **Setup 12 Lead** window opens for you to make the default settings.

For a description of the available settings, see "Changing Settings for a Captured 12-Lead ECG" on page 129.

EASI Lead Placement for a 5-Electrode Cable Set

Using a 5-electrode set in EASI lead placement you can monitor up to 12 ECG leads simultaneously and continuously at the bedside. EASI provides a monitoring method for trending ST segment changes that can provide an early indication of ischemia.

WARNING

EASI-derived 12-lead ECGs and their measurements are approximations to conventional 12-lead ECGs. As the 12-lead ECG derived with EASI is not exactly identical to the 12-lead conventional ECG obtained from an electrocardiograph, it should not be used for diagnostic interpretations.

Respiratory monitoring is also possible with the EASI placement; respiration is measured between the I and A electrodes.

Place the electrodes as accurately as possible to obtain the best quality EASI measurements.

When EASI lead placement is selected, **EASI** is shown beside the 1 mV calibration bar on the ECG wave on the display, and **EASI** is marked on any recorder strips and printouts.

EASI Monitoring During INOP Conditions

If one of the derived EASI leads has an INOP condition (for example, **Lead Off**), a flat line is displayed. After 10 seconds, the directly acquired EASI AI, AS, or ES lead (depending on which is available) is displayed with the corresponding lead label. This causes an arrhythmia relearn.

EASI Electrode Placement
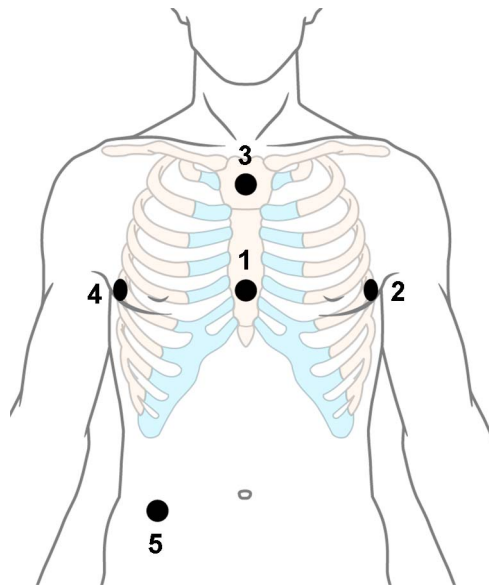
1 E (V) - on the lower sternum at the level of the fifth intercostal space

2 A (LL) - on the left midaxillary line at the same level as the E electrode

3 S (LA) - on the upper sternum

4 I (RA) - on the right midaxillary line at the same level as the E electrode

5 N - reference electrode - can be anywhere, usually below the sixth rib on the right hip

Lead Diagram

The lead diagram view provides assistance for the correct positioning of electrodes and information about the electrodes' skin contact. This information is based on the electrode to skin impedance measurement of the ECG measurement device.

To open the lead diagram view,

- Select the **Lead Diagram** SmartKey, or

- In the either the **Setup ECG** menu or in the ECG wave menu, select **Lead Diagram**, or

- Select the alarm message during, for example, an active **ECG Leads Off** alarm and select **Lead Diagram**.

- If the **Initial View** setting is set to **Lead Diagram** in configuration mode, you can also access the lead diagram view in the **Capture 12 Lead** view.
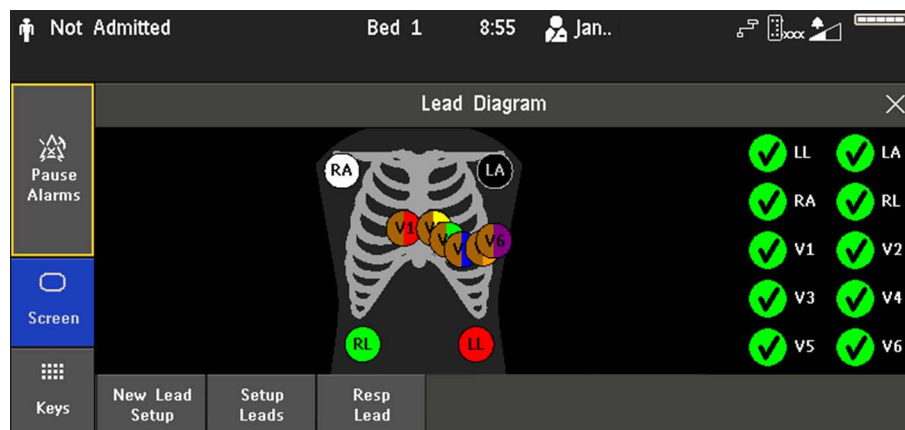
The state of each electrode is displayed in the lead diagram with the following symbols:

Symbol	Meaning	Electrode Flashing
✔	Electrode has good skin contact.	No
↑	Electrode has poor skin contact.	Yes
✘	Electrode has no skin contact.	Yes

Depending on your monitor configuration, the connected lead set, the configured lead placement and the selected **ECG Leadset Type** in **Setup Leads**, the following number of electrodes are displayed:

- EASI lead placement: 5 electrodes
- Hexad lead placement: 6 electrodes
- Standard lead placement without option #C12 (conventional 12-Lead ECG): 3, 5 ,6 electrodes
- Standard lead placement with option #C12 (conventional 12-Lead ECG): 3, 5, 6, 10 electrodes

Limb electrodes are displayed either on the limbs or on the trunk, depending on your **Limb Leads** setting.

Select an electrode either in the torso view or in the electrode list on the right side of the lead diagram to view detailed information about the selected electrode.
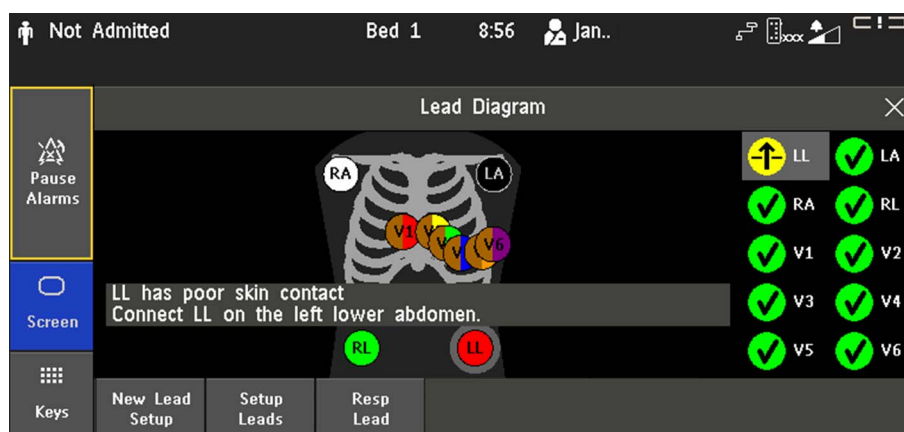
If electrodes are not attached, a help text is displayed.
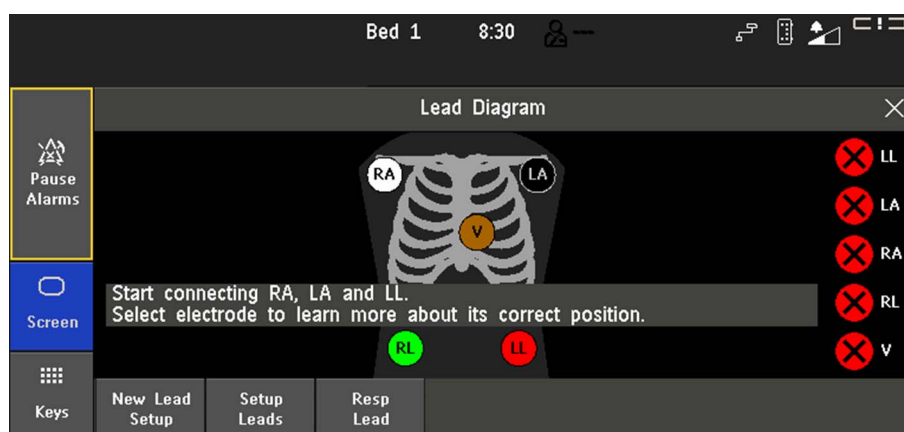
Lead Diagram Pop-Up Keys

Here is a summary of all the pop-up keys available in the lead diagram window:

Pop-up Keys	Selecting this pop-up key lets you
New Lead Setup	remove **Lead Off** INOP if leads are removed from the patient in order to use a new lead setup. The system learns the new lead setup.
Setup Leads	choose an ECG lead set type, select the positions of the chest leads and limb leads, and change lead placement mode.
Resp Lead	show/hide the selected respiration lead vector.
The following pop-up keys are only available during the 12-Lead ECG procedure:	
Admit Patient	enter the age and gender for the patient, to allow analysis of the 12-Lead ECG.
Show Waves	return to the realtime 12-Lead ECG view.
Review 12 Lead	view a list of 12-Lead captures available at the monitor or at the Information Center, and select one for review.

ECG and Arrhythmia Alarm Overview

The ECG and arrhythmia alarms available depend on which measurements are switched on, and the arrhythmia option enabled for your monitor.

- Cardiotach alarms are available when HR is on and the active alarm source is ECG, but Arrhythmia is switched off
- Basic arrhythmia alarms are available when Arrhythmia is switched on
- Enhanced arrhythmia alarms are available when Arrhythmia is switched on and the Enhanced Arrhythmia option has been enabled for your monitor

Alarm	Description	Arrhythmia Configuration		
		Arrhythmia Off	Basic Arrhythmia	Enhanced Arrhythmia
*** Asystole	No beat detected for a period > the asystole threshold (2.5 to 4.0 seconds)	x	x	x
*** Vent Fib/Tach	Fibrillatory wave (sinusoidal wave between 2 - 10 Hz) for 4 consecutive seconds	x	x	x
*** VTach	A run of consecutive beats labeled as V with run length ≥ the V-Tach Run limit **and** ventricular HR > V-Tach HR limit		x	x
*** Extreme Tachy	Heart Rate > the Extreme Tachy limit	x	x	x
*** Extreme Brady	Heart Rate < the Extreme Brady limit	x	x	x
** HR High	Heart rate > the high HR limit	x	x (see note)	x (see note)
** HR Low	Heart rate < the low HR limit	x	x (see note)	x (see note)
* Non–Sustain VT	A run of consecutive beats labeled as V with run length < the V-Tach Run Limit **and** ventricular HR > the V-Tach HR limit			x

Alarm	Description	Arrhythmia Configuration		
		Arrhythmia Off	Basic Arrhythmia	Enhanced Arrhythmia
* Vent Rhythm	A run of consecutive beats labeled as V with run length > the Vent rhythm limit **and** ventricular HR ≤ the V-Tach HR limit			x
* Run PVCs High	A run of > 2 consecutive beats labeled as V with run length < Vent rhythm run limit **and** ventricular HR ≤ V-Tach HR limit			x
* Pair PVCs	Two ventricular beats labeled as V between two beats not labeled as V			x
* R–on–T PVCs	For HR < 100, a beat labeled as V with R-R interval < 1/3 of the average R-R interval followed by a compensatory pause > 1.25 times the average R-R interval **or** 2 such beats labeled as V without a compensatory pause occurring within 5 minutes of each other (Note: When HR > 100, 1/3 of the R-R interval is too short for detection)			x
* Vent Bigeminy	A dominant rhythm of beats labeled as N, V, N, V, N			x
* Vent Trigeminy	A dominant rhythm of beats labeled as N, N, V, N, N, V, N, N			x
* PVCs/min High	Within 1 minute, the number of beats labeled as V > the PVCs/min limit		x	x
* Multiform PVCs	The occurrence of two differently shaped beats labeled as V within the last 60 beats **and** each occurring at least twice within the last 300 beats			x
* Pause	No beat detected for a period > the pause alarm threshold (1.5 to 2.5 seconds)			x
* Missed Beat	No beat detected for a period > 1.75 times the average R-R interval for HR < 120, **or** no beat detected for > 1 second with HR > 120 (Paced mode off)			x
* Pacer Not Capt	No beat detected for a period > 1.75 times the average R-R interval **and** pace pulse(s) detected. (Paced mode on)		x	x
* Pacer Not Pacing	No beat detected for a period > 1.75 times the average R-R interval **and** no pace pulse(s) detected (Paced mode on)		x	x
* SVT	A run of consecutive beats labeled as S with run length ≥ SVT run limit **and** ventricular HR > SVT HR limit			x
* HR High	Heart rate > the high HR limit		x (see note)	x (see note)
* HR Low	Heart rate < the low HR limit		x (see note)	x (see note)

Alarm	Description	Arrhythmia Configuration		
		Arrhythmia Off	Basic Arrhythmia	Enhanced Arrhythmia
* AFIB	An irregular rhythm of beats labeled as N **and** variability in P-R intervals **and** P-wave variability (For adult patient category only)			x
* End AFIB	Atrial Fibrillation no longer detected for the Afib end delay time (For adult patient category only)			x
* Irregular HR	An irregular rhythm of beats labeled as N (irregular R-R intervals changes greater than 12.5%)			x
* End Irregular HR	Irregular HR rhythm no longer detected for the irregular HR end delay time			x

Note: **** HR Low** and **** HR High** are available only if HR alarms are configured as yellow alarms, and *** HR Low** and *** HR High** are available only if HR alarms are configured as short yellow alarms.

Using ECG Alarms

ECG alarms can be switched on and off and the high and low alarm limits changed just like other measurement alarms, as described in "Alarms". Special alarm features which apply only to ECG are described here.

Extreme Alarm Limits for Heart Rate

The extreme rate alarms, extreme tachycardia and extreme bradycardia, are generated by the active alarm source, either HR or Pulse.

The difference between the low HR alarm limit and the extreme bradycardia limit is unit configured. For example, if the low alarm limit is 60 bpm and the extreme bradycardia limit difference is configured to be 20 bpm, then the extreme bradycardia limit is 40 bpm. If the difference is configured to be 0, there will always be an extreme bradycardia alarm when the HR falls below the HR low limit.

The same is true for the difference between the high HR alarm limit and the extreme tachycardia limit. In the same way, the extreme tachycardia limit is determined by adding a difference to the high HR limit.

1 Extreme Brady Limit

2 Low Limit

3 High Limit

4 Extreme Tachy Limit

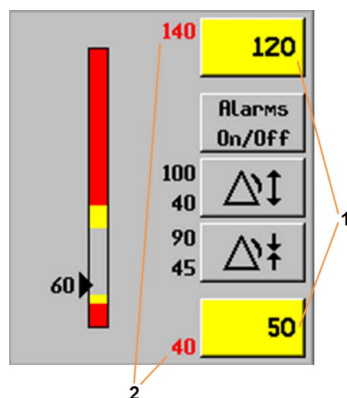5 Δ Extreme Brady

6 Δ Extreme Tachy
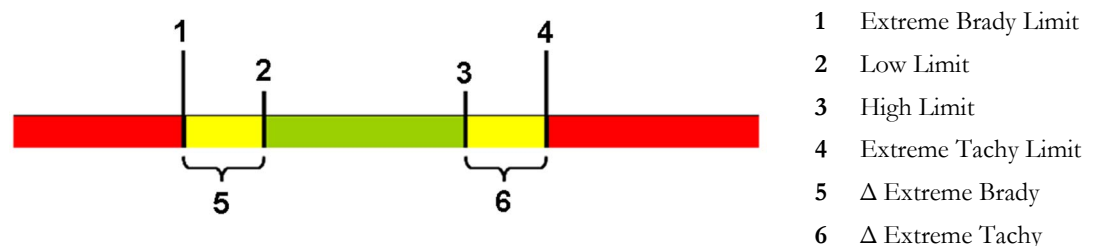
The difference is set in Configuration Mode. You need to know which value has been configured for your monitor. To see the difference value for the extreme rate alarms on your monitor, in the **Setup ECG** menu, see the menu items **Δ ExtrTachy** and **Δ ExtrBrady**.

For safety, the extreme bradycardia and extreme tachycardia limits clamp at a configured value. For example, the extreme bradycardia limit for neonates has a default limit clamp at 70 bpm. Thus if the HR low alarm limit is moved to 80 bpm and the extreme bradycardia limit difference is 20 bpm, the extreme bradycardia limit will be 70 bpm. However, if you move the HR low alarm limit below the clamp to 65 bpm, the extreme bradycardia limit will also be 65 bpm and only the extreme bradycardia alarm will occur if the HR falls below this limit.

You can view the current limits for the extreme rate alarms, Extreme Tachy and Extreme Brady, in the measurement's alarm limits window:

1   Select one of the alarm fields.

2   Select the **Alarm Limits** pop-up key.

3   Select **HR**.

The alarm limit window for HR is shown, with the high and low limits and the Extreme Tachy and Extreme Brady limits.

1   High and low alarm limits

2   Extreme Tachy and Extreme Brady limits

ECG Alarms Off Disabled

Be aware that your hospital department may have decided to disable the **Alarms Off** setting for ECG in the monitor's Configuration Mode. In this case, HR alarms cannot be switched off in Monitoring Mode. If you try to switch off the HR alarms, you will see the message **To activate enter Config and enable Alarms Off**.

HR Alarms When Arrhythmia Analysis is Switched Off

When arrhythmia analysis is switched off, only these HR-related alarms will be detected:

• the asystole alarm

• the ventricular fibrillation/tachycardia alarm

• the extreme tachycardia and extreme bradycardia alarms

• the high heart rate and low heart rate alarms.

Enhanced Asystole Detection

In order to improve alarming on asystole under certain conditions, you can set **Asystole Detect.** in Configuration Mode to **Enhanced**. In enhanced mode an asystole alarm will be suppressed for up to five seconds if a valid beat-to-beat Pulse is detected from an arterial Pressure.

ECG Safety Information

CAUTION

Interference from instruments near the patient and ESU interference can cause problems with the ECG wave. See the monitor specifications for more information.

WARNING

Defibrillation and Electrosurgery:

Do not touch the patient, or table, or instruments, during defibrillation.

6.4.   After defibrillation, the screen display recovers within 10 seconds if the correct electrodes are used and applied in accordance with the manufacturer's instructions.

ECG cables can be damaged when connected to a patient during defibrillation. Check cables for functionality before using them again.

According to AAMI specifications the peak of the synchronized defibrillator discharge should be delivered within 60 ms of the peak of the R-wave. The signal at the ECG output on the IntelliVue patient monitors is delayed by a maximum of 30 ms. Your biomedical engineer should verify that your ECG/Defibrillator combination does not exceed the recommended maximum delay of 60 ms.

When using electrosurgical (ES) equipment, never place ECG electrodes near the grounding plate of the ES device, as this can cause a lot of interference on the ECG signal.

General:

When you are connecting the electrodes or the patient cable, make sure that the connectors never come into contact with other conductive parts, or with earth. In particular, make sure that all of the ECG electrodes are attached to the patient, to prevent them from contacting conductive parts or earth.

Noisy Signal:

A noisy ECG signal makes it difficult to accurately detect and/or classify beats thus affecting event detection and alarm generation.

During surgery:

Use the appropriate orange ECG OR trunk cable, **or** ECG OR electrode cable set with an orange connector, for measuring ECG in the operating room. These cables have extra circuitry to protect the patient from burns during cautery, and they decrease electrical interference. This also reduces the hazard of burns in case of a defective neutral electrode at the HF device. **Do not use** the OR trunk cable and the OR electrode cable set together. Only one orange-coded part must be used for the additional protection.

These cables cannot be used for measuring respiration.

Pacemaker failure:

During complete heart block or pacemaker failure to pace/capture, tall P-waves (greater than 1/5 of the average R-wave height) may be erroneously counted by the monitor, resulting in missed detection of cardiac arrest.

Patients exhibiting intrinsic rhythm:

When monitoring paced patients who exhibit only intrinsic rhythm, the monitor may erroneously count pace pulses as QRS complexes when the algorithm first encounters them, resulting in missed detection of cardiac arrest.
The risk of missing cardiac arrest may be reduced by monitoring these patients with low heart rate limit at or slightly above the basic/demand pacemaker rate. A low heart rate alarm alerts you when the patient's heart rate drops to a level where pacing is needed. Proper detection and classification of the paced rhythm can then be determined.

Filtered ECG signal from external instruments:

Instruments such as defibrillators or telemetry units produce a filtered ECG signal. When this signal is used as an input to the bedside monitor, it is filtered again. If this twice-filtered signal is passed to the arrhythmia algorithm, it may cause the algorithm to fail to detect pace pulses, thus compromising paced patient monitoring performance.

External pacing electrodes:

When an external transcutaneous pacemaker is being used on a patient, arrhythmia monitoring is severely compromised due to the high energy level in the pacer pulse. This may result in the arrhythmia algorithm's failure to detect pacemaker noncapture or asystole.

Fusion beat pacemakers:

Pacemakers can create fusion beats, which occur when an intrinsically conducted beat and a paced beat occur simultaneously, that may not be detected by the monitor's QRS detector.

Rate adaptive pacemakers:

Implanted pacemakers which can adapt to the Minute Ventilation rate may occasionally react on the Impedance measurement used by patient monitors for the determination of the Resp value and execute pacing with the maximum programmed rate. Switching off the Resp measurement can prevent this.

Line isolation monitor transients:

When electrodes or lead wires are loose or detached, the monitor becomes susceptible to switching transients from some types of line isolation monitors. Line isolation monitor transients may resemble actual cardiac waveforms and thus inhibit heart rate alarms. To minimize the chance of this occurring, always adhere to the instructions for skin preparation and electrode placement given in this chapter.

About Arrhythmia Monitoring

Arrhythmia analysis provides information on your patient's condition, including heart rate, PVC rate, rhythm, and ectopics. The monitor uses the user-selected primary ECG lead for single-lead arrhythmia analysis and the selected primary and secondary ECG lead for multi-lead arrhythmia analysis. During arrhythmia analysis, the monitor continuously:

- optimizes ECG signal quality. This is important for arrhythmia analysis. The monitor continuously filters the ECG signal to remove baseline wander, muscle artifact, and signal irregularities. Also, if the Patient Paced status is set to **Yes**, pace pulses are filtered out to avoid processing them as QRS beats.

- detects beats, for example, QRS complexes, identifying them for further analysis.

- measures signal features such as R-wave height, width, and timing.

- creates beat templates, and classifies and labels beats to aid in rhythm analysis and alarm detection.

- examines the ECG signal for ventricular fibrillation, asystole, and noise.

Arrhythmia Options

Your monitor has either the basic or the enhanced arrhythmia option. Both options provide rhythm and ectopic status messages and beat labeling. The number of rhythms being classified, events being detected, and alarms generated differs according to the option. The alarms available with the different options are listed in the section "ECG and Arrhythmia Alarm Overview" on page 135, the rhythm and ectopic messages detected are listed in "Arrhythmia Status Messages" on page 143.

Where Can I Find More Information?

See the Application Notes on ST and Arrhythmia supplied on your documentation DVD for detailed information on the arrhythmia algorithm and its clinical application.

Switching Arrhythmia Analysis On and Off

1 In the **Setup Arrhy** menu, select **Arrhythmia** to switch between **On** and **Cardiotach**.

2 Select the **Confirm** pop-up key which appears at the bottom of the screen.

Be aware that when arrhythmia analysis is switched to **Cardiotach** mode,

- the message **Cardiotach Mode** appears beside the ECG wave, if configured to do so

- only the HR-related alarms are detected (the asystole alarm, the ventricular fibrillation/tachycardia alarm, the extreme tachycardia and extreme bradycardia alarms, the high heart rate and low heart rate alarms)

- HR High and HR Low alarms behave like normal yellow alarms, no timeout periods are active.

Choosing an ECG Lead for Arrhythmia Monitoring

It is important to select a suitable lead for arrhythmia monitoring.

Guidelines for non-paced patients are:

- QRS complex should be tall and narrow (recommended amplitude > 0.5 mV)

- R-Wave should be above or below the baseline (but not bi-phasic)

- T-wave should be smaller than 1/3 R-wave height

- the P-wave should be smaller than 1/5 R-wave height.

For paced patients, in addition to the above, the pace pulse should be:

– not wider than the normal QRS

– the QRS complexes should be at least twice the height of pace pulses

– large enough to be detected, with no repolarization.

To prevent detection of P-waves or baseline noises as QRS complexes, the minimum detection level for QRS complexes is set at 0.15 mV, according to IEC 60601-2-27 and AAMI-EC 13 specifications. Adjusting the ECG wave size on the monitor display (gain adjustment) does not affect the ECG signal which is used for arrhythmia analysis. If the ECG signal is too small, you may get false alarms for pause or asystole.

Clinical considerations for possible causes of noisy ECG signal include poor skin preparation, dried electrodes, broken lead wires, muscle artifact, baseline wander, respiration artifact, or interference from equipment.

WARNING

Always ensure that the arrhythmia algorithm is labeling beats correctly.

CAUTION

If beats are not classified correctly, check that the ECG is optimized for arrhythmia monitoring. You may need to select a different lead(s) or change the electrodes or electrode position if there is excessive noise, unstable voltage, low amplitude, or large P-wave or T-waves.

Aberrantly-Conducted Beats

As P-waves are not analyzed, it is difficult and sometimes impossible for the monitor to distinguish between an aberrantly-conducted supraventricular beat and a ventricular beat. If the aberrant beat resembles a ventricular beat, it is classified as ventricular. You should always select a lead where the aberrantly-conducted beats have an R-wave that is as narrow as possible to minimize incorrect calls. Ventricular beats should look different from these 'normal beats'. Instead of trying to select two leads with a narrow R-wave, it may be easier to just select one lead and use single lead arrhythmia monitoring. Extra vigilance is required by the clinician for this type of patient.

Atrial Fibrillation Alarm

The monitor performs atrial fibrillation analysis using information about the R-R irregularity, P-R interval variability and P wave variability.

In order to generate an Afib alarm the following criteria must be detected for 1 minute:

• normal beat R-R intervals must be irregular

• P-R interval deviation must be large

• P-wave region must not match well

Atrial fibrillation analysis is only available for adult patients and atrial fibrillation detection cannot be performed on PVCs or Paced beats.

An *** End AFIB** alarm will occur when no atrial fibrillation waveform was detected for a configured delay time.

Since most atrial flutters have regular R-R intervals, they cannot be detected by the atrial fibrillation algorithm.

An *** AFIB** can be falsely detected in the presence of:

• sinus arrhythmia,

• muscle noise, or

• electrode motion artifact.

If you also have monitors with earlier software revisions, the *** AFIB** and *** End AFIB** alarms will not be generated after a transfer to one of these monitors. Always leave the Irregular HR alarm switched on, so that this alarm can be generated in such situations.

See the Application Note on Arrhythmia/ST supplied on your documentation DVD for detailed information on the arrhythmia algorithm and ECG analysis.

Intermittent Bundle Branch Block

Bundle branch and the other fascicular blocks create a challenge for the arrhythmia algorithm. If the QRS during the block changes considerably from the learned normal, the blocked beat may be incorrectly classified as ventricular, causing false PVC alarms. You should always select a lead where the bundle branch block beats have an R-wave that is as narrow as possible to minimize incorrect calls. Ventricular beats should look different from these 'normal beats'. Instead of trying to select two leads with a narrow R-wave, it may be easier to just select one lead and use single lead arrhythmia monitoring. Extra vigilance is required by the clinician for this type of patient.

Understanding the Arrhythmia Display

Your monitor screen may look slightly different from the illustration.

1 Pace pulse marks

2 Beat label

3 HR Numeric

4 PVC Numeric

5 Ectopic status message

6 Rhythm status message

7 Delayed arrhythmia wave

Viewing Arrhythmia Waves

To review arrhythmia beat labels, in the **Setup Arrhy** menu, select **Annotate Arrhy**.

The wave showing the primary ECG lead will be delayed by six seconds and shown on a gray background. Beat labels will be annotated above the ECG wave and **Delayed** will be written beside it.

To return to the normal ECG primary lead display, select **Annotate Arrhy** again.

Arrhythmia Beat Labels

Arrhythmia beat labels tell you how the monitor is classifying beats.

Beat Label	Beat Classification
N [1]	Normal
V [1]	Ventricular Ectopic
S [1]	Supra-ventricular Premature
P [1]	Paced
'	Pacer Spike
"	Biventricular Pacer Spike
L	Learning patient's ECG
A	Artifact (noisy episode)

Beat Label	Beat Classification
?	Insufficient information to classify beats
I	Inoperative condition (e.g., Leads Off)
M	Pause or missed beat

1 In Cardiotach Mode these beats are labeled **B**.

Arrhythmia Status Messages

The monitor displays two types of status messages:

- Rhythm Status Messages -- to indicate the patient's rhythm.
- Ectopic Status Messages -- to indicate the presence of ectopic beats.

These status messages are shown on the right hand side of the primary ECG wave. They are updated every second, with the exception of the Sinus and Supraventricular (SV) rhythm messages.

The Sinus and SV rhythm messages are updated based on the current heart rate, taking into account the patient category (adult, pediatric, or neonatal). For the message to change from one rhythm status to another, the HR must be in the new range for five beats.

If you have basic arrhythmia capability, you will get only messages for the alarms provided with this level.

Rhythm Status Messages

The label B or E indicates basic (B) or enhanced (E) arrhythmia capability.

Rhythm Status Message	Description	B or E
Asystole	No beat detected for a period > the asystole threshold (2.5 - 4.0 seconds)	B, E
Afib Rhythm	An irregular rhythm of beats labeled as N AND variability in PR intervals AND P-wave variability (For adult patient category only)	
Vent Fib/Tach	Fibrillatory wave (sinusoidal wave between 2 - 10 Hz) for 4 consecutive seconds	B, E
VTach	A run of consecutive beats labeled as V with run length ≥ the V-Tach Run limit **and** ventricular HR > V-Tach HR limit	B, E
Sustained VT	Ventricular tachycardia rhythm for more than 15 seconds	E
Vent Rhythm	A run of consecutive beats labeled as V with run length > the Vent rhythm limit **and** ventricular HR ≤ the V-Tach HR limit	E
Vent Bigeminy	A dominant rhythm of beats labeled as N, V, N, V, N	E
Vent Trigeminy	A dominant rhythm of beats labeled as N, N, V, N, N, V, N, N	E
Paced Rhythm	A dominant rhythm of beats labeled as P	B, E
Irregular HR	Consistently irregular rhythm	E
Sinus Brady Sinus Rhythm Sinus Tach	A dominant rhythm of beats labeled as N or S preceded by P-waves	B, E
SV Brady SV Rhythm SV Tach	A dominant rhythm of beats labeled as N or S not preceded by P-waves	B, E
Unknown ECG Rhythm	Rhythm cannot be determined	B, E
Learning ECG	Algorithm is learning the ECG beat morphology	B, E

6.2.

Rhythm Status Message	Description	B or E
Learning Rhythm	Algorithm is learning the rhythm of the classified beats	B, E
Cannot Analyze ECG	ECG signal is predominantly invalid or too noisy and therefore cannot be analyzed	B, E

Ectopic Status Messages

The label B or E indicates basic (B) or enhanced (E) arrhythmia capability.

Ectopic Status Message	Explanation	B or E
(No message displayed)	No ectopic activity within the last minute	
Run PVCs	More than 2 consecutive beats labeled as V within the last minute	E
Pair PVCs	Two beats labeled as V between two beats not labeled as V	E
Pacer Not Capt	No beat detected for a period > 1.75 times the average R-R interval **and** pace pulse(s) detected. (Paced mode on)	B, E
PacerNotPacing	No beat detected for a period > 1.75 times the average R-R interval **and** no pace pulse(s) detected (Paced mode on)	B, E
Pause	No beat detected for a period > 1.75 times the average R-R interval for HR <120, **or** No beat for 1 second with HR >120 (non-paced patient only), **or** No beat detected for more than the set pause threshold.	E
R–on–T PVCs	R-ON-T detected within the last minute	E
Multiform PVCs	Within the last minute, the occurrence of two differently shaped beats labeled as V within the last 60 beats **and** each occurring at least twice within the last 300 beats	E
Frequent SVPBs	Count of beats labeled as S within last minute is greater than 5	E
SVPBs	1-5 beats labeled as S in the last minute	E
SV Beats	Count of beats labeled as N or S within last minute and rhythm status is paced	B, E
Paced Beats	Count of beats labeled as P within last minute and rhythm status is not paced	B, E

Arrhythmia Relearning

During a learning phase:

- Alarm timeout periods are cleared

- Stored arrhythmia templates are cleared

- Asystole, Vfib, and HR alarms (when there are enough beats to compute the HR) are active. No other alarms are active.

Initiating Arrhythmia Relearning Manually

To initiate relearning manually, in the **Setup Arrhy** menu, select **Relearn Arrhy**.

– While the monitor is learning, the delayed arrhythmia wave displays the beat label **L** and the rhythm status message **Learning ECG**.

– Next, the monitor determines the dominant rhythm. The beats are labeled **N**, and the rhythm status message changes to **Learning Rhythm**.

After relearning is complete, you should check the delayed arrhythmia wave to ensure that the algorithm is labeling the beats correctly.

If beats are not classified correctly, check that the ECG is optimized for arrhythmia monitoring. You may need to select a different lead or change the electrodes or electrode positions if there is excessive noise, unstable voltage, low amplitude, or large P- or T-waves.

Automatic Arrhythmia Relearn

Arrhythmia relearning is initiated automatically whenever:

- ECG monitoring is switched on

- The ECG Lead or Lead Label of the primary/secondary lead is changed manually, or when fallback occurs

- A Leads Off INOP condition (that has been active for > 60 seconds) ends.

If you are monitoring multi-lead arrhythmia and there is a change in one lead only, relearning happens only in the affected lead. During this learning phase, the system will continue monitoring using the other lead. Therefore, the delayed arrhythmia wave is not labeled **L** and there is no **Learning ECG** rhythm status message. In addition, alarm timeout periods are maintained, stored arrhythmia templates are maintained for the operative lead, and all alarms switched on are active.

Arrhythmia Relearn and Lead Fallback

Lead fallback triggers an automatic arrhythmia relearn.

WARNING

If arrhythmia learning takes place during ventricular rhythm, the ectopics may be incorrectly learned as the normal QRS complex. This may result in missed detection of subsequent events of V-Tach and V-Fib.

For this reason you should:

- take care to initiate arrhythmia relearning only during periods of predominantly normal rhythm and when the ECG signal is relatively noise-free

- be aware that arrhythmia relearning can happen automatically

- respond to any INOP messages (for example, if you are prompted to reconnect electrodes) as the effectiveness of the arrhythmia monitoring for the patient is compromised.

- be aware that a disconnected EASI electrode triggers an arrhythmia relearn on all leads

- always ensure that the arrhythmia algorithm is labeling beats correctly.

Arrhythmia Alarms

Arrhythmia alarms can be switched on and off and the alarm settings changed just like other measurement alarms, as described in the Alarms section. Special alarm features which apply only to arrhythmia are described here.

The different alarms detected and generated by the monitor depend on the level of arrhythmia analysis that is enabled. For a complete list of arrhythmia alarms and INOPs, see the "Alarms" chapter.

The monitor detects arrhythmia alarm conditions by comparing ECG data to a set of pre-defined criteria. An alarm can be triggered by a rate exceeding a threshold (for example, HR >xx), an abnormal rhythm (for example, Ventricular Bigeminy), or an ectopic event (for example, Pair PVCs).

Yellow Arrhythmia Alarms

Yellow arrhythmia alarms are short yellow alarms specific to arrhythmia-related patient conditions. The heart rate alarms (High HR and Low HR) can be configured as short yellow or standard yellow alarms. When they are standard yellow alarms they exist independently of the other arrhythmia alarms and no timeout periods apply.

WARNING

When arrhythmia analysis is on, all yellow ECG and arrhythmia alarms are short yellow alarms (one-star). This means that the yellow alarm lamp and the tones are active for six seconds only, after which the blinking numeric and the alarm message remain for up to three minutes. The only exception to this are the HR High and Low alarms which can be configured as standard yellow alarms. Red alarms behave as usual.

Arrhythmia Alarms and Latching

When using arrhythmia analysis, **Visual Latching** and **Audible Latching** should be on for red alarms. Because of the transient nature of arrhythmia alarms, many arrhythmia conditions may go unnoticed if alarm latching is off. This setting can only be changed in Configuration Mode.

Switching Individual Arrhythmia Alarms On and Off

Some arrhythmia alarms can be individually switched on or off:

Non-Sustain, **Vent Rhythm**, **Run PVCs**, **Pair PVCs**, **R-on-T PVCs**, **V.Bigeminy**, **V.Trigeminy**, **Multif.PVCs**, **Pacer n.Cap**, **Pacer n.Pac**, **Pause**, **SVT**, **IrregularHR**, **Missed Beat**, **PVCs/min** and **Afib**.

To switch individual alarms on or off, in the **Setup Arrhy** menu, select the alarm from the list to switch between **On** and **Off**. Depending on your configuration, some alarms may not be available in the list and cannot be switched on or off here.

The monitor displays the INOP message **Some ECG AlarmsOff**, if configured, when more alarms are switched off than configured in your active profile.

Switching All Yellow Arrhythmia Alarms On or Off

All yellow arrhythmia alarms can be switched on and off together. To do this,

• In the **Setup Arrhy** menu, select **All Yellow Off** or **All Yellow On**.

Adjusting the Arrhythmia Alarm Limits

Some arrhythmia alarms have limits which can be individually adjusted:

VTach HR, **VTach Run**, **PVCs/min**, **Vent Rhythm**, **SVT HR**, **SVT Run**, **Asystole Thresh.**, **Pause Threshold**, **Afib/ IHR End Dly**.

1 To adjust alarm limits, in the **Setup Arrhy** menu, select the alarm to be adjusted.

2 Select the appropriate setting from the pop-up list.

Arrhythmia Alarm Timeout Periods

Normally, an arrhythmia alarm is announced when an alarm condition is detected. However, there are certain situations that can inhibit the audible and visible indications of the alarm even though the alarm condition was detected. These include:

• if a more serious alarm condition is active in the same chain

• if a timeout period is in effect for a particular alarm

• if a timeout period is in effect for a higher alarm in that chain.

See for more details on alarm chains.

What is a Timeout Period?

Timeout periods are automatically started when a yellow arrhythmia alarm is detected. During this period, the same alarm condition will not generate another alarm. Alarm conditions further down the same arrhythmia alarm chain will also not generate an alarm, but alarms further up the chain will: see .

To view the timeout period configured for your monitor, in the **Setup Arrhy** menu, see the menu items **TimeOut 1st** and **TimeOut 2nd**.

This setting can only be changed in Configuration Mode.

** AFIB and **** Irregular HR** alarms do not have a timeout period. These alarms can be generated immediately after the corresponding end alarm was generated.

When **** HR High** and **** HR Low** alarms are configured as standard yellow alarms, they do not have a timeout period.

Resetting the Timeout Period

To reset the timeout period, either

- select the **Alarms Off** or **Pause Alarms** permanent key and then reselect it, or
- select **Reset Alarming** in the **Review Alarms** window or the **Alarm Messages** window.

How are Yellow Arrhythmia Alarms Indicated?

When a yellow arrhythmia alarm is generated, it triggers visual and audible indicators. Yellow arrhythmia alarms are always set to latch visually for three minutes except HR High/Low alarms, if configured to standard yellow. Depending on the alarm condition, audible and visual alarm indicators will appear as follows:

Alarm Condition	Example	Short yellow alarm tone sounds	Alarm message displayed
Single alarm instance	Non-Sustained V-tach	when alarm condition is initially detected	for 3 minutes (latching time)
Continuous alarm condition	PVCs/min HIGH	when alarm condition is initially detected and - as an alarm reminder - every time the configured timeout period has expired	until the alarm condition stops, plus a maximum of three minutes latching time
Same intermittent alarm condition	Pair of PVCs	each time the alarm condition is detected, provided that the configured timeout period has expired	

If you acknowledge a yellow arrhythmia alarm and the alarm condition still exists, the visual indicators continue until the condition stops. You will get an alarm reminder every time the configured timeout period has expired.

If you acknowledge a yellow arrhythmia alarm and the alarm condition has stopped, the visual indicators are immediately cleared. Acknowledging an alarm does not reset its timeout period, so you will not get a realarm for the same condition or lower on the chain until the timeout expires.

Arrhythmia Alarm Chaining

When arrhythmia analysis is switched on, multiple alarm conditions may be present. Announcing all of the detected alarm conditions would be confusing, and might hide a more serious condition. For this reason, the arrhythmia system sets alarm priorities through an alarm chaining system.

Only the highest priority alarm condition in each chain is announced. Lower priority alarms in the same chain will not be announced while an alarm is active or during the configured timeout period. If alarm conditions of equal severity from different chains are detected, the alarm condition that occurred most recently is announced.

See "ECG and Arrhythmia Alarm Overview" on page 135 for information on which alarms are included in the different arrhythmia options. See "Arrhythmia Alarm Timeout Periods" on page 146 for an explanation of how alarm timeouts work.

Red Arrhythmia Alarms

Asystole

↓

Vent Fib/Tach

↓

V-Tach

↓

Extreme Tachy/Extreme Brady

↓

Yellow Arrhythmia Alarms

higher priority →

lower priority →

PVC Chain	Missed Beat Chain	Arrhy HR Chain	AFib/HR Chain

First level timeout period **(TimeOut 1st)**

PVC Chain	Missed Beat Chain	Arrhy HR Chain	AFib/HR Chain AFib/End AFib
Non-sustain VT/ Vent Rhythm ↓ Run PVCs ↓ Pair PVCs ↓ R-on-T PVCs	Pause ↓ Pacer Not Captured/ Pacer Not Pacing/ Missed Beat	SVT ↓ HR High/ HR Low*	↓ IHR/EndIHR

Second level timeout period **(TimeOut 2nd)**

Vent Bigeminy ↓ Vent Trigeminy ↓ PVCs > xx/min ↓ Multiform PVCs

*If HR High/Low alarms are configured as standard yellow alarms, they are independent of the arrhythmia alarms and are not in the Arrhy/HR alarms chain.

Examples of Alarm Chaining Logic

– If there is an active Vent Bigeminy alarm, a PVCs > xx/min will not be triggered because it is lower on the same chain. However, a high HR alarm will become active because it is on a different chain.

– Higher priority alarms supersede previous alarms. For example, if a Vent Trigeminy alarm is active and a Pair PVCs occurs, the Pair alarm will be activated.

Understanding PVC-Related Alarms

PVC-related alarms are detected on the basis of the current ventricular heart rate and the number of consecutive PVCs counted (referred to as PVC Runs).

As an example, this diagram illustrates the conditions under which PVC alarms would be generated if the Vent Rhythm Run limit is set to 11, the V-Tach Run Limit is set to 8, and the V-Tach HR Limit is set to 100.
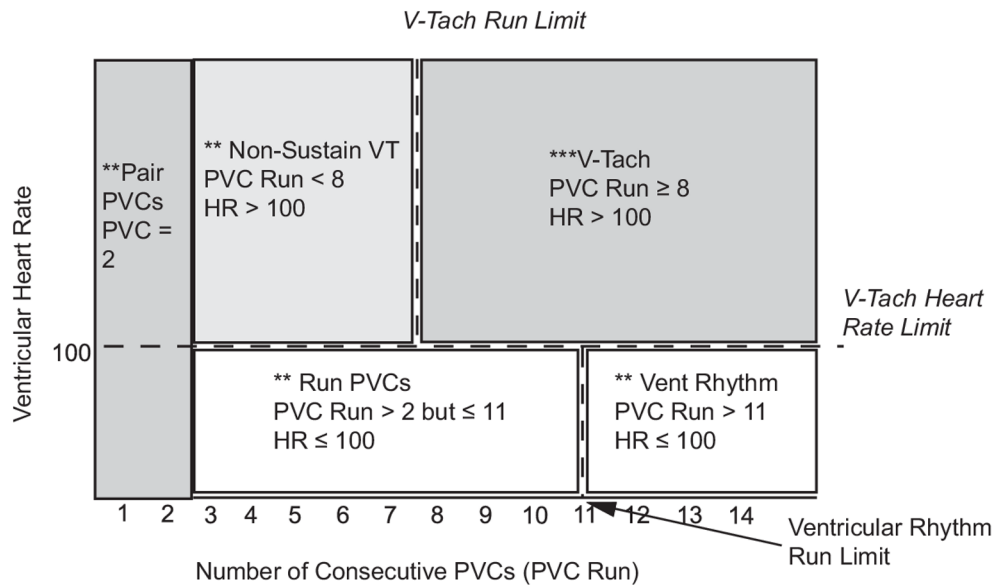
V-Tach Run Limit

You will see that

- if both the V-Tach Heart Rate Limit and the V-Tach Run Limit are exceeded, a red V-Tach alarm is generated

- if the ventricular heart rate exceeds the V-Tach Heart Rate Limit but not the V-Tach Run Limit, a yellow Non-Sustain VT alarm is generated.

About ST Monitoring

The monitor performs ST segment analysis on normal and atrially paced beats and calculates ST segment elevations and depressions. This information can be displayed in the form of ST numerics and snippets on the monitor.

The monitor also performs ST Elevation (STE) analysis using automated ISO and J point determination and measuring the ST segment directly at the J point (J +0). This is based on the recommendations for measuring ST Elevation published by the American Heart Association, the American College of Cardiology and the European Society of Cardiology.

All available leads can be monitored continuously. The ECG waveform does not need to be displayed on the monitor for ST Segment analysis.

ST analysis is always performed using a dedicated filter which ensures diagnostic quality. If you are monitoring ECG using an ECG filter mode other than Diagnostic, the ST segment of the ECG wave may look different from the ST segment of the ST snippet for the same wave. For diagnostic evaluation of the ST segment, always switch to Diagnostic filter mode or use the ST snippet.

Due to the different algorithm approaches, ST measurements from a diagnostic 12-lead program may differ from the real-time measurement.

WARNING

Some clinical conditions may make it difficult to achieve reliable ST monitoring, for example:

- if you are unable to get a lead that is not noisy
- if arrhythmias such as atrial fib/flutter are present, which may cause an irregular baseline
- if the patient is continuously ventricularly paced
- if the patient has left bundle branch block
- if the patient's primary lead has a biphasic QRS complex and you adjusted the ISO/J point setting to manual.

You should consider switching ST monitoring off if these conditions are present.

The ST algorithm has been tested for accuracy of the ST level change information for adult patients. The clinical significance of the ST level change information should be determined by a physician.

ST segment monitoring is intended for use with adult patients only and is not clinically validated for use with neonatal and pediatric patients. For this reason, the recommended - and default - setting for ST monitoring in neonatal and pediatric modes is **ST Analysis**: **Off**.

Switching ST or STE On and Off

ST and STE analysis can be switched on and off independently.

To switch all ST monitoring on or off, in the **Setup ST Analysis** menu, select **ST Analysis** to switch between **On** and **Off**.

To switch all STE monitoring on or off, in the **Setup ST Elevation** menu, select **STE** to switch between **On** and **Off**.

Selecting Leads for ST Analysis

You select which leads to use for ST analysis in the **Setup ST Analysis** menu.

To see the current list of leads selected for ST analysis:

1   Enter the **Setup ST Analysis** menu.

2   Select **Setup ST Leads**. This opens the **Setup ST Leads** pop-up window. Leads chosen for ST monitoring are listed here. There are two pop-up keys at the bottom of the screen, **Add** and **Delete**. If all leads are already selected, the **Add** pop-up key is disabled.

To choose a lead for ST monitoring:

1   Select the **Add** key at the bottom of the **Setup ST Leads** window. This opens the **Choices** pop-up window.

2   Choose a lead from the list for ST monitoring. This closes the **Choices** window and adds the selected lead to the list of chosen leads.

To disable ST monitoring for a lead:

1   Choose a lead from the list in the **Setup ST Leads** window.

2   Select the **Delete** key. This removes this lead from the list.

NOTE

The order in which ST leads are listed in the **Setup ST Leads** menu determines the order in which ST leads are displayed on the monitor screen.

To change the order in which ST leads are displayed,

1   In the **Setup ST Leads** menu, choose a lead from the list.

2   Select the **Sort Up** or **Sort Down** key to move the lead up or down in the list.

Understanding the ST Display and Windows

Your monitor screen may be configured to look slightly different from the illustrations.

1   Current HR alarm limits
2   Current heart rate
3   ST numerics
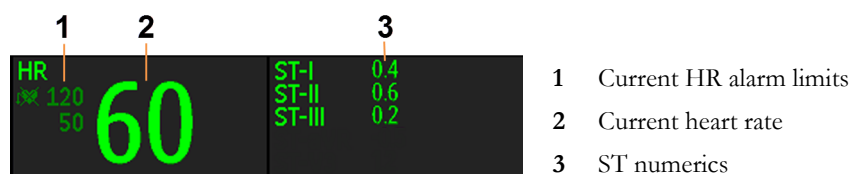
ST Numerics

Up to 12 ST numerics plus the ST index can be displayed on the monitor screen. They can be configured to show beside the measurement numerics, beside the ECG wave, or beside the ST snippet.

A positive ST value indicates ST segment elevation; a negative value indicates depression.

ST numerics are displayed in the order in which you select ST leads for analysis. If there is additional space in the field assigned to ST numerics, the monitor will display extra numerics in the order in which they appear in the list in **Setup ST Leads**, in the **Setup ST Analysis** menu. Any ST leads switched on for analysis that do not fit in the assigned numerics field are shown in succession in place of the last ST numeric.

ST Index

The ST index numeric (**STindx**) is the sum of the absolute values for the ST leads V2, V5, aVF. Because it is based on absolute values, it is always a positive number. If you haven't selected one of the leads V2, V5, and aVF for ST analysis, the ST index numeric will display a question mark "?".

To switch the ST index numeric on or off for display, in the **Setup ST Analysis** menu, select **ST-Index** to toggle between **On** and **Off**.

ST Snippets

ST snippets show a one second wave segment for each measured ST lead. The most recent snippet is drawn in the same color as the ECG wave, usually green, superimposed over the stored baseline snippet, drawn in a different color. The comparison shows any deviation in the measurement since the baseline snippet was stored, for example as a result of a procedure carried out on the patient. The information is updated once per minute.

You can see ST snippets in the **Adjust ST Points** window or the **ST View** window.

ST View Window

The **ST View** Window shows a current ST snippet and numeric with a baseline snippet and numeric. The two snippets are in different colors, so that you can differentiate between them easily and see at a glance which numerics belong to which snippet. In the upper left corner the current lead and the ISO/J-Point mode for current and baseline snippets is shown. On the right side all available ST numerics are shown. The date and time of the baseline snippet is shown at the bottom of the window.

The **ST View** Window opens with the ST pop-up keys **Current** / **Baseline** / **Overlap** (to select viewing mode), **Show Points** / **Hide Points**, **Update Baseline**, **Record ST**, **STE View**, **Adjust ST Points**, **ST Map**, **Setup ST** and arrow keys for scrolling through the available leads.

- To view the **ST View** window, select the ST numerics, then **ST View**.
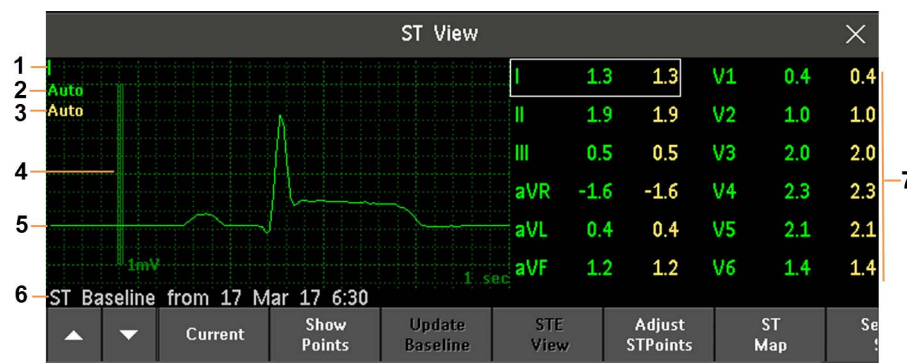
1   Current Lead

2   ISO/J-point mode for current snippet

3   ISO/J-point mode for baseline snippet

4   1 mV calibration bar

5   Current ST snippet and ST baseline snippet overlapped

6   Timestamp of most recently stored baseline snippet

7   All available ST numerics for current snippet and baseline snippet

The ST point, J-point and ISO point can be hidden using the **Hide Points** pop-up key.

STE View Window

The **STE View** window shows a current ST snippet and STE numeric with an ST baseline snippet. The two snippets are in different colors, so that you can differentiate between them easily. In the upper left corner the current lead is shown. On the right side all available STE numerics are shown. The date and time of the ST baseline snippet is shown at the bottom of the window.
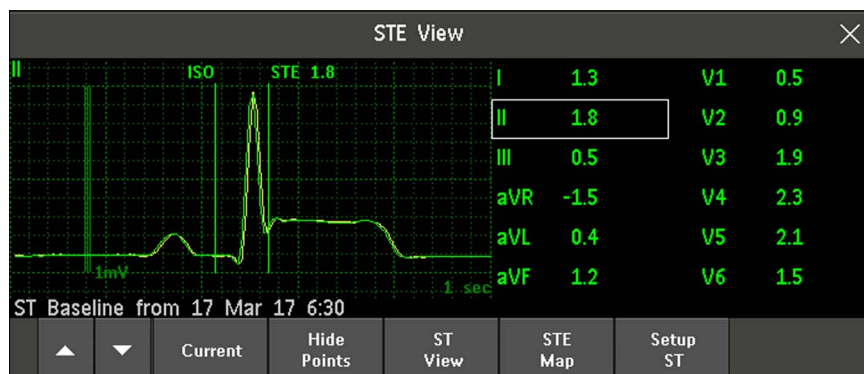
The **STE View** window opens with the pop-up keys **Current** / **Baseline** / **Overlap** (to select viewing mode), **Show Points**/**Hide Points**, **Record STE**, **ST View**, **ST Map**, **Setup ST** and arrow keys for scrolling through the available leads.

The ST point, J-point and ISO point can be hidden using the **Hide Points** pop-up key.

Updating ST Baseline Snippets

ST analysis requires valid samples to measure and store a snippet. ST Snippets and ST values are updated every minute. If there is artifact in the signal, it may take longer for an ST snippet and an ST value to appear.

The first baseline is stored automatically after ST monitoring is started, or when a new patient is admitted.

To update ST baselines,

1 Select the ST numerics then **ST View** to open the **ST View** window.

2 In the **ST View** window, select **Update Baseline** to store all current snippets as baselines. This deletes all previously-stored baselines.

About the ST Measurement Points

The ST value for each beat complex is the vertical difference between the ISO point and the ST point, as shown in the diagram below. The isoelectric (ISO) point provides the baseline, the ST point is at the midpoint of the ST segment. The J point is where the QRS complex changes its slope; as it is a fixed distance away from the ST point, it can be useful to help you position the ST point correctly.

1 R-wave peak at 0 msec

2 J point, for example, 48 msec

3 Difference = ST value

4 ST measurement point, for example, J + 60 msec

5 Isoelectric point set to -80 msec

6 P

7 Q

8 S

9 T
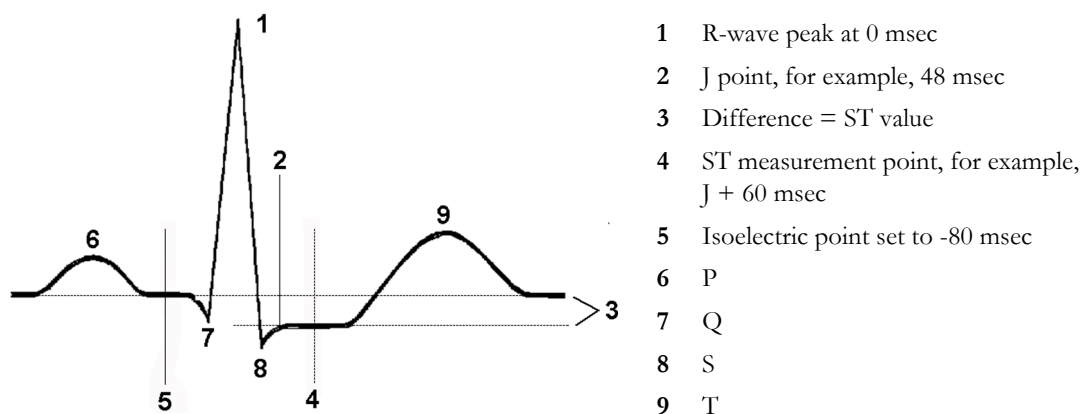
CAUTION

If using ST analysis, the ST measurement points need to be adjusted when you start monitoring, if the patient's heart rate or ECG morphology changes significantly, or when changing ECG lead modes (Standard/EASI lead placement) as this may affect the size of the QT interval and thus the placement of the ST point. Artifactual ST segment depression or elevation may occur if the isoelectric point or the ST point is incorrectly set.

Always ensure that ST measurement points are appropriate for your patient.

Setting ISO and J-Point Detection Mode

There are two modes for ISO and J-point detection: **Auto** and **Manual**. In **Manual** mode you can set the measurement points yourself. In **Auto** mode the measurement points will be determined automatically.

To set the detection mode, in the **Setup ST Analysis** window,

1   Select **ISO/J Pt**.

2   Select **Auto** or **Manual** mode.

Adjusting ST Measurement Points

If the ISO and J-point detection mode is set to **Manual**, all three measurement points can be set. In **Auto** mode, only the ST point can be changed.

To adjust the ST measurement points, in the **Setup ST Analysis** menu,

1   Select **Adjust ST Points** to open the **Adjust ST Points** window.
     Alternatively, you can use the **Adjust ST points** pop-up key in the **ST View** window.

2   Select a suitable ECG lead for ST measurement, with a visible J-point and a visible P wave. Use the up and down arrow keys to scroll through the ST snippets for the other ECG leads.

3   Select the ST point you need to adjust by touching the appropriate point on the screen. The current choice is highlighted (ISO point -80 in the screen example).
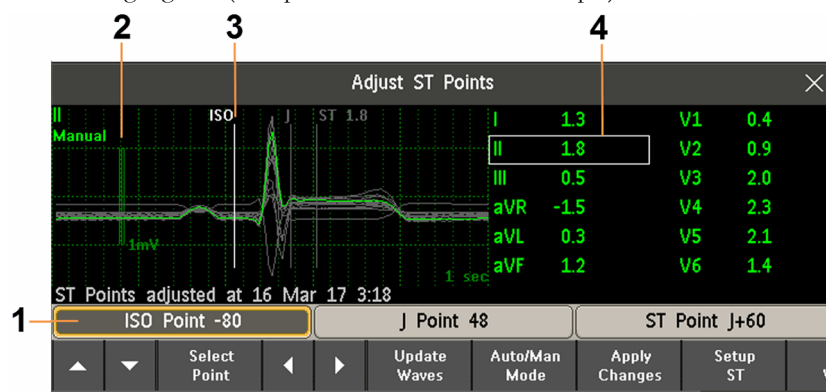
1   Highlighted ST point

2   1mV calibration bar

3   Cursors for adjusting ST points

4   ST label and the ST numeric that would apply using the current points
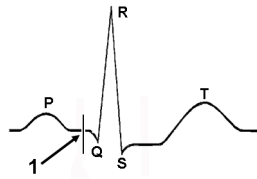
The ISO-point cursor (1) positions the isoelectric point relative to the R-wave peak. The relation is shown beside the ISO-point in milliseconds. Position the ISO-point in the middle of the flattest part of the baseline (between the P and Q waves or in front of the P wave).
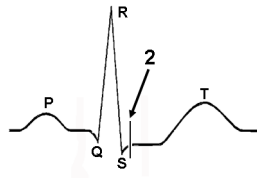
The J-point cursor (2) positions the J-point relative to the R-wave peak. It helps you to correctly position the ST-point. Position the J-point at the end of the QRS complex and the beginning of the ST segment.

The J-point cursor is not available if your monitor is configured to let you set the ST point directly.
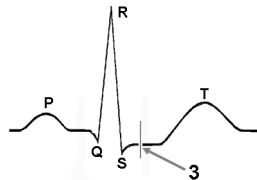
To position the ST-point (3) relative to the J-point:

select either **J+60** or **J+80**. Select **J Point** and use the arrow keys to move the J-Point and position the ST-point at the midpoint of the ST segment.

To position the ST-point directly:

select **ST Point** and use the left and right arrow keys to position the ST point at the midpoint of the ST segment.

4   Select the **Apply Changes** pop-up key to activate the new ST measurement points and recalculate all ST values.

The most recent ST Points adjustment time is displayed in the **Adjust ST Points** window. This information is cleared when a patient is discharged or when a new Profile is loaded into the monitor.

5   To update the ST snippet shown in the **Adjust ST Points** window, select the **Update** pop-up key.

ST Alarms

ST alarms are yellow alarms. Each ST lead has its own alarm limit. ST alarms are triggered when an ST value exceeds its alarm limit for more than one minute. Switching ST alarms off switches off alarms for all ST leads.

If more than one ST measurement is in alarm, the monitor only displays the alarm message of the ST lead which is currently furthest from its set alarm limits.

Changing ST Alarm Limits

The monitor can detect alarms on each ST lead separately, so you can set high and low ST alarm limits individually for each ST lead. When two contiguous leads are available, ST alarms will be generated when ST values of the two contiguous leads are outside the limit. When no contiguous lead is available an ST alarm is generated when the ST value of the single lead is outside the limit.

Set the high and low alarm limits based on your assessment of the patient's clinical condition, unit protocols, physician orders or medication-specified limits. A good guideline is + 1.0 mm or - 1.0 mm from the patients's ST, or follow your hospital protocol.

1   In the **Setup ST Analysis** menu, select the alarm to be adjusted.

2   Select the appropriate setting.

STE Alarms

The STE alarm is a yellow alarm. It can be switched on and off in the **Setup ST Elevation** menu but the limits can only be changed in Configuration mode. The STE alarm limits are gender specific and can be set individually for limb leads, V2/V3 leads, V1/V4/V5/V6 leads, V7/V8/V9 leads and V3R, V4R, V5R, V6R leads. The default values, for example on V2 and V3 1.5 mm for females and 2.0 mm for males, are based on the recommendations from the American Heart Association and American College of Cardiology.

The ST Elevation measurements with automated J-point determination generate ST Elevation alarms, in addition to the ST measurements at the user-defined ST point (J+offset), which may be useful for ST depression alarms. When ST and STE analysis are both in use, this may result in redundant alarms for ST elevations. Because of the different measurement points, there may be different values obtained. Thus there could be an ST alarm and an STE alarm but the STE alarm may announce sooner based upon the values obtained.

Viewing ST Maps

The monitor can derive a multi-axis portrait (map) from the ST analysis to help you detect changes in ST values. Two planes obtained from a multi-lead ECG are displayed in a multi-axis diagram, where each axis represents a lead. The value at the ST point is given. The position of the axes within the diagram correspond to the placement of the ECG leads. Each ST value is assigned to either a limb lead, or to a chest lead. Every axis shows the polarity of the lead it represents. By joining adjacent ST values, the monitor obtains an ST map. The contour line and the map shading are shown in the same color as the ECG parameter.

Viewing an ST Map

To display an ST map,

•   In the **Main Setup** menu, select **ST Map**.

Current View

In current view, the monitor displays an ST map that corresponds to the current ST values.

The left of the following diagrams shows leads I, II, III, aVR, aVL, and aVF on the limb leads plane. On the right, the V-leads V1, V2, V3, V4, V5, V6 (and V7, V8, V9, V3R, V4R, V5R, V6R, if configured) are on the chest leads plane.
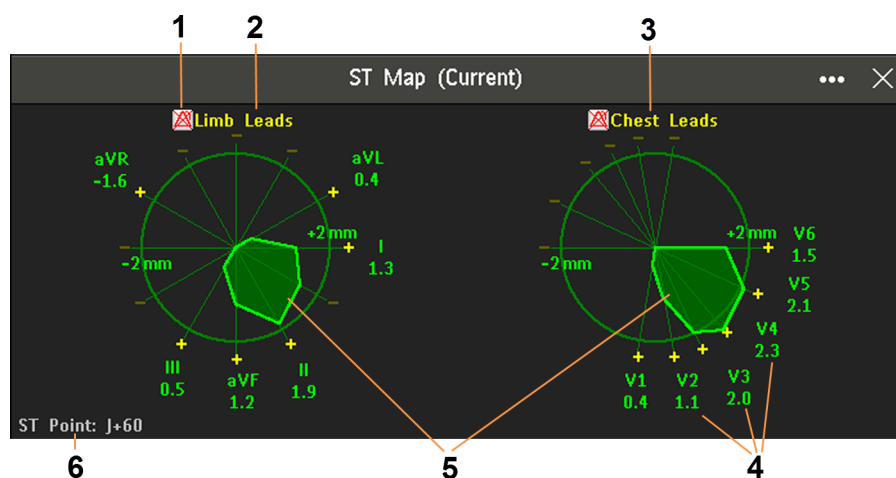
1 ST Alarm status indicator

2 **Limb Leads**

3 **Chest Leads**

4 Label, value and polarity of corresponding lead

5 ST map

6 The position of the current ST measurement point

If an ST lead is switched off, its axis is not shown in the map.

If a lead is in INOP (the value is being measured but is invalid or unavailable because, for example, the corresponding ECG electrode is off), the area formed by the remaining ST leads is left open.
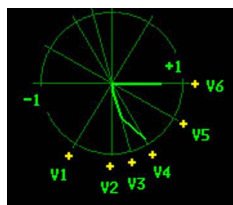
If there is insufficient information for a second ST map to be displayed (for example if no chest leads are measured), the currently available ST values are displayed in place of the second ST map. This applies only when the pop-up keys are shown and not currently hidden.

Additionally, when both ST maps are displayed, you can view the currently available ST values in the **ST Map (Current)** or **ST Map (Trend)** window at any time. To do this, select the **Show Values** pop-up key. The ST values are shown in place of the second ST map, and the pop-up key text changes to **Hide Values**. Select the **Hide Values** pop-up key and the display shows both ST maps again. This applies only when the pop-up keys are shown and not currently hidden.

Trend View

In trend view, you can see up to four trended ST maps, and the current ST map, simultaneously. You can configure the time interval between trended samples. The most recent map is shown in the same color as the parameter itself. Past values change from white through dark gray. In the diagram below, the time interval between trends is one minute. The first trended sample is white and is one minute old. The second trended sample corresponds to the ST values two minutes ago and so forth. The ST values on the diagrams show the current ST values.

If a lead is turned off, its axis is no longer shown. This has no impact on the presentation of trended values that were recorded while the lead was still on.
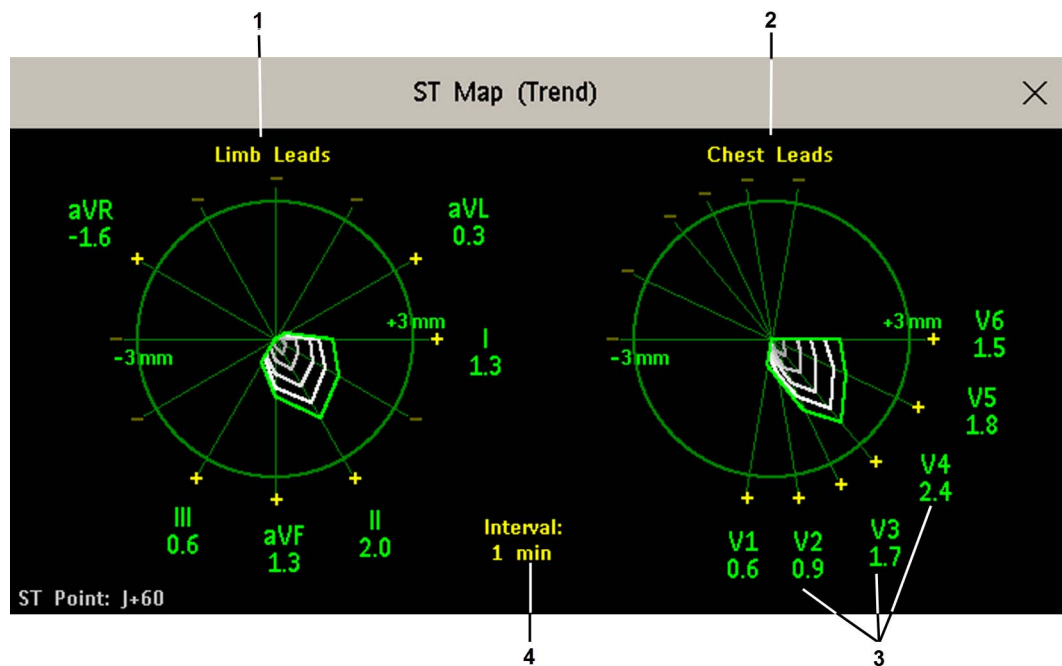
1   **Limb Leads**

2   **Chest Leads**

3   current ST values

4   trending interval
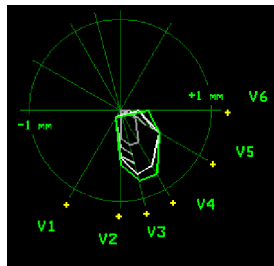
In this diagram, V4 was either temporarily switched off or in INOP for around 30 seconds. No data was recorded. Consequently, the affected maps are not closed.

Working in the ST Map Task Window

You may need to activate the ST map task window to see all the data, and to access the pop-up keys. Select the map view on screen to activate its task window. Once you activate it, you can perform the tasks detailed here.

Switching Between ST Map Views

To switch between views,

•   Select **Current View** or **Trend View** to toggle between views.

If your trend view is empty, you need to adjust the priority of this measurement in the trending priority list. See "Trend Priority" on page 245.

Displaying an ST Reference Baseline

You can display an ST reference baseline for the current view, or for the trended view. The baseline is shown in yellow. However, if the ECG color is yellow, the baseline is shown in green. Use this baseline to detect ST changes. The baseline is derived automatically whenever the monitor relearns arrhythmia and also on user request.

Select **Show Baseline**/**Hide Baseline** to toggle between baseline display on and off.

Updating an ST Map Reference Baseline

To update the baseline,

- In the **Setup ST Analysis** menu, select **ST View** then select **Update Baseline**.

Changing the Scale of the ST Map

To change scale,

- Select **Size Up** or **Size Down** to alter the size at which monitor displays the map.

Changing the Trending Interval

To determine how frequently the monitor displays a trended sample,

1   In Trend view, select **Select Interval**.

2   Select the required interval from the menu. The interval ranges between 12 seconds to 30 minutes.

Printing an ST Map Report

To print the most recently viewed (current or trend) window,

1   Select **Main Setup** then select **Reports**.

2   Select **ST Map Report**.

3   Press **Print**.

Viewing STE Maps

The STE Map displays STE values, ST values measured at the J point, together with the STE Limits as configured in the **Setup ST Elevation** menu for the gender of the current patient. Just like ST Map, it displays two planes obtained from a multi-lead ECG in a multi-axis diagram, where each axis represents a lead. The position of the axes within the diagram correspond to the placement of the ECG leads. Each STE value is assigned to either a limb lead, or to a chest lead. Every axis shows the polarity of the lead it represents. The STE limits are indicated by a gray colored area which contains all values that lie above those limits. If the ECG parameter color is white, shades of green are used instead.

If two contiguous leads exceed the corresponding STE limits, the violation area between the two STE values and two corresponding limit values is colored in red. If the ECG parameter color is red, green is used instead.

NOTE

If the gender of the patient is not specified, the STE Map does not show any limits and does not indicate any limit violations.

The STE Map does not provide Trend View or the ST baseline.
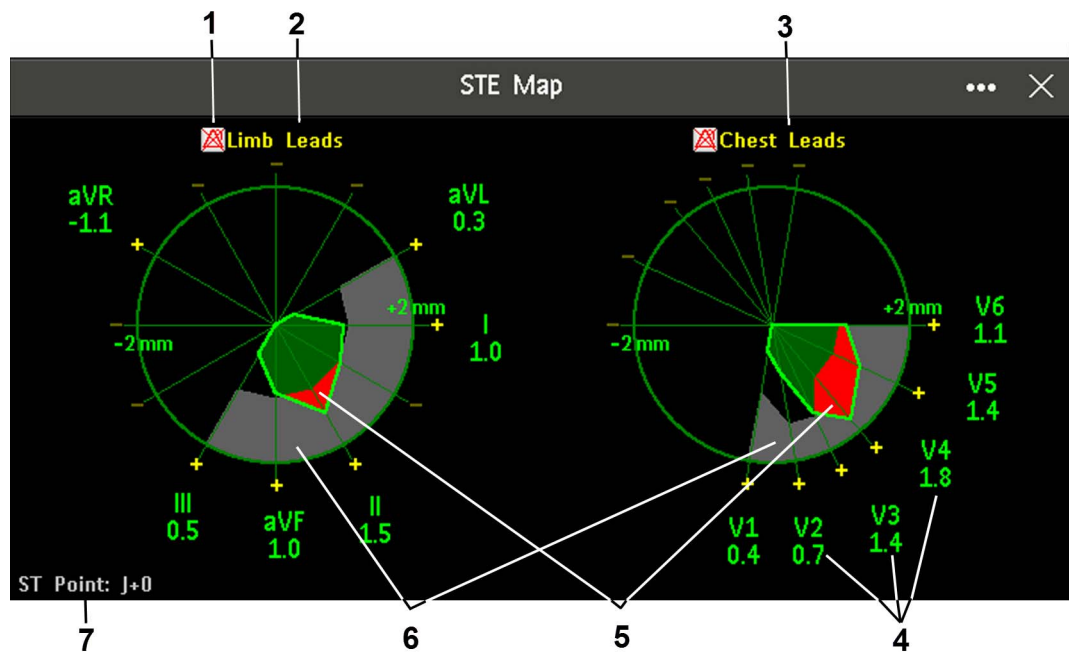
1   STE Alarm status indicator

2   **Limb Leads**

3   **Chest Leads**

4   Label, value and polarity of corresponding lead

5   STE Limit Violations

6   STE Limit Area

7   The position of the current ST measurement point (always J + 0)

Viewing an STE Map

To display an STE map,

• In the **Main Setup** menu, select **STE Map**.

Working in the STE Map Task Window

You may need to activate the STE map task window to see all the data, and to access the pop-up keys. Select the map view on screen to activate its task window. Once you activate it, you can perform the tasks detailed here.

Changing the Scale of the STE Map

To change scale,

• Select **Size Up** or **Size Down** to alter the size at which monitor displays the map.

Printing an STE Map Report

To print the most recently viewed window,

1   Select **Main Setup** then select **Reports**.

2   Select **STE Map Report**.

3   Press **Print**.

Switching between STE Map and ST Map

If you are running ST Map or STE Map as an embedded screen application, you can switch back and forth between STE Map and ST Map by selecting the **Change Map** pop-up key.

Note that changes made here will be saved in the current screen.

About QT/QTc Interval Monitoring

The QT interval is defined as the time between the beginning of the Q-wave and the end of the T-wave. It measures the total duration of the depolarization (QRS duration) and repolarization (ST-T) phases of the ventricular action potential. QT interval monitoring can assist in the detection of prolonged QT interval syndrome.
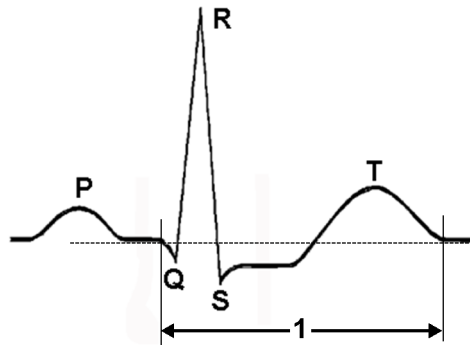
The QT interval (1) has an inverse relationship to heart rate. Faster heart rates shorten the QT interval and slower heart rates prolong the QT interval. Therefore there are several formulas used to correct the QT interval for heart rate. The heart rate corrected QT interval is abbreviated as QTc. The monitor uses as a default the Bazett correction formula and the alternative Fridericia formula can be selected in Configuration Mode. Using a consistent formula for measuring the QTc is recommended within the hospital.

For QT interval monitoring to be effective, basic or enhanced arrhythmia monitoring should be turned on.

QT Measurement Algorithm

The QT values are updated once per minute. QT interval monitoring cannot be performed if the beats are predominately labeled as V or P. Normal or atrial paced beats and beats with a similar morphology are averaged to form a representative waveform for further processing. Normal beats followed by a premature QRS will be excluded from the measurements to prevent the premature beat from obscuring the end of the T-wave. If the algorithm cannot form a representative waveform, for example because the morphology of the beats is too varied, a **Cannot Analyze QT** INOP will be generated after one minute. This is also the case if normal beats have been falsely labeled so that the algorithm does not have enough valid beats to make QT measurements. No QT value is calculated if the QT-HR is >150 bpm (Adult) or >180 bpm (Pedi/Neo).

Because of the different algorithm approaches, a QT/QTc measurement from a diagnostic 12-lead program may differ from the realtime measurement on the monitor.

Where Can I Find More Information?

See the Application Note on QT/QTc Interval Monitoring and the QT Interval Monitoring Quick Guide supplied on your documentation DVD for detailed information on the QT algorithm and performance.

Indications For Use Of QT Interval Monitoring

Of special concern for QT monitoring is the administration of QT prolonging drugs to patients identified with risk factors for Torsade de Pointe. Females, older patients and patients with bradycardia, impaired left ventricular function (ischemia, left ventricular hypertrophy), hypokalemia and hypomagnesemia are in this increased risk category.

Limitations For Use Of QT Interval Monitoring

Conditions that can cause difficulty for continuous QT interval monitoring are:

Flat T-wave

T-wave amplitude in some ECGs may be too low for identification of the end of the T-wave. For reliable QT interval monitoring, select a lead with sufficient T-wave amplitude.

U-wave

A discrete and separate U-wave is not considered as part of the QT interval. U-waves often overlap the T-wave and the midpoint of the overlap is taken as the end of the T-wave. The ST/AR QT interval algorithm will usually measure the end of the T-wave correctly in the presence of a U-wave. However, if the presence of a U-wave causes the algorithm to produce erroneous measurements, select a lead without a predominant U-wave.

High heart rate

When the heart rate is high, the P-wave of the subsequent P-QRS-T complex may approach the end of the T-wave and produce an effect similar to that of a U-wave. The midpoint will be taken as the end of the T-wave. If the heart rate is above 150 bpm for adults or 180 bpm for pediatric and neonatal patients, no measurement will be made. If a P-wave causes the algorithm to produce erroneous measurements, select a lead without a predominant P-wave.

Wide QRS complex

Increases in QRS duration contribute to a long QTc interval. Patients with left or right bundle branch block, Wolff-Parkinson-White or hypertrophy may have widened QRS durations. If the QRS changes considerably from the learned normal, the beats may be incorrectly labeled as ventricular beats causing them to be excluded from the QT analysis. If a long QTc is observed, it should be verified to ensure that it is not caused by QRS widening.

Atrial fibrillation and atrial flutter

Patients with atrial fibrillation or atrial flutter often do not have clear T-waves because of the interference due to atrial activity. In addition, the marked variation of rate usually makes correction more problematic. QTc interval measurements are difficult to interpret. Some of these problems may be reduced by choosing leads with no visible flutter activity.

Leads used for QT interval measurement

The apparent end of T-wave varies from lead to lead. The biggest problem comes from small T-waves and from respiratory variation in the morphology. If a single lead is being used for patient monitoring, it is advisable to choose a lead with a large T-wave and no terminal inversion.

Prolonged PR intervals

With rapid heart rates typical in neonatal and young pediatric patients, the P-wave and T-wave may overlap. Some extreme cases of prolonged PR intervals may result in the P-wave occurring before the end of the T-wave. In such cases, the end of the T-wave should still be measurable. If a P-wave is causing the algorithm to produce erroneous measurements, select a lead without a predominant P-wave.

Arrhythmia algorithm accuracy

To reject beats that should not be measured, beat labeling from the arrhythmia algorithm is used in the QT interval algorithm. Incorrect beat labeling by the arrhythmia algorithm can influence the accuracy of the QT interval measurement algorithm.

To obtain accurate QT interval measurement, factors that affect the arrhythmia monitoring performance should be corrected. QT interval monitoring cannot be performed if the beats are predominantly labeled as V or P.

Normal or atrial paced beats and beats with similar morphology are averaged to form a representative waveform for further processing.

Because normal beats followed by ventricular beats are not included in the analysis, no QT interval measurement will be generated in the presence of a bigeminy rhythm if the premature beat's R-R interval is 20% less than the average R-R interval.

When the heart rate changes, it can take several minutes for the QT interval to stabilize. For reliable QTc calculation it is important to avoid a region where the heart rate is changing.

WARNING

QT/QTc measurements should always be verified by a qualified clinician.

Selecting the QT Leads

For QT Monitoring you can select one of the following three modes:

- All Leads mode - all available leads (I, II, III, V, MCL, V1 - V9, V3R to V6R) are used to produce a global QT measurement. For EASI lead placement, directly acquired AI, AS and ES leads are used. For Hexad lead placement, all leads are available except for the four derived chest leads and augmented leads.

- Primary-Lead mode - the primary lead will be used for QT measurement. If the original primary lead becomes unavailable or is changed, QT measurement will continue with the new primary lead.

- Single-Lead mode - a single lead selected from all available leads (except the augmented leads) will be used for QT measurement. QT measurement will stop if the selected lead becomes unavailable.

To select the mode,

1 Select the QT numeric to enter the **Setup QT Analysis** window.

2 Select QT Lead and select **All**, **Primary Lead** or one of the available single leads.

When using the All Leads mode, make sure when you compare QT values that they are based on the same set of leads.

QT and QTc interval values can vary between different leads or QT interval monitoring modes due to the algorithm identification of the end of the T- wave. The QT and QTc interval values should be checked and validated when choosing a different lead for monitoring or if the monitoring mode is changed.

Changing the lead(s) used for QT measurements will not cause the baseline to be reset.

QT View

In the **QT View** window you can verify that the QT algorithm detects correct Q and T points.
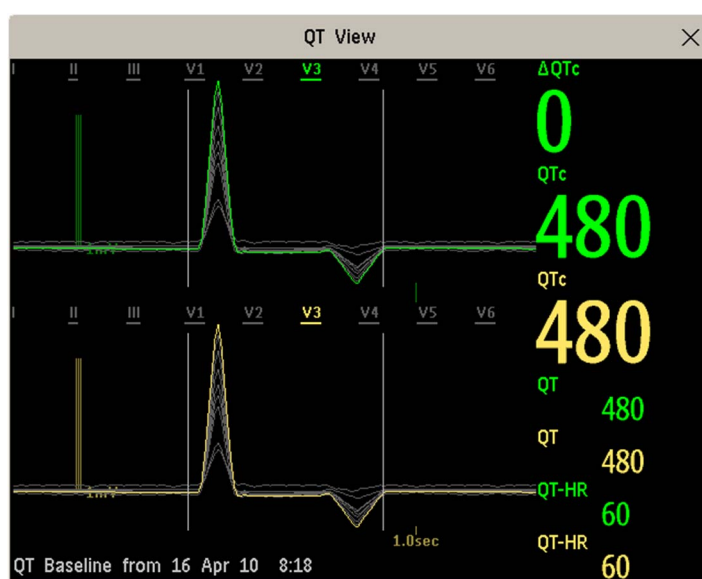
The current waves are shown in the upper half of the window and the baseline waves in a different color below. The Q and T points are marked with a vertical line. By selecting one of the lead labels at the top of the window you can highlight the corresponding wave; the other waves are shown in gray. The underlined lead labels are the leads used for the QT calculation. By selecting the numeric area you can highlight all underlined leads.

If EASI or Hexad lead placement is in use, the corresponding lead placement label will be shown.

Changing The View To A Single Wave Set

To view one set of waves in a larger scale, you can cycle through the different views,

1 Select **Current** view to see the set of current waves.

2 Select **Baseline** view to see the set of baseline waves.

3 Select **Split** view to return to the combined view with current and baseline waves.

Setting The QT Baseline

In order to quantify changes in the QTc value, you can set a QTc baseline. For example to assess the effect of medication on the QT interval you can set the current value as the baseline before you begin medication. This baseline will then be used to calculate the ΔQTc value.

To set the baseline,

• Select **Set Baseline** and set the value.

When QT interval monitoring is initiated, the baseline will be automatically set after the active leads have been stable for five minutes and there is a valid QT measurement. You can select a new baseline anytime during QT interval monitoring. If you set a new baseline the previous baseline is discarded. As the ΔQTc alarm is based on the difference between the baseline and the current value, setting an inappropriate new baseline may prevent a ΔQTc alarm from being generated. The baseline should be checked and validated. Discharging a patient clears the baseline.

Printing The QT Waves

To start a printout,

• Select **Print QT**.

Recording The QT Waves

To start a recording,

• Select **Record QT**.

QT Alarms

There are two QT alarms, QTc high limit alarm and ΔQTc high alarm. The QTc high limit alarm is generated when the QTc value exceeds the set limit for more than 5 minutes. The ΔQTc alarm is generated when the difference between the current value and the baseline value exceeds the set limit for more than 5 minutes.

The **Cannot Analyze QT** INOP and the -?- will be displayed when no QT measurement could be calculated for one minute. Up to this time the previous valid value will be displayed. The following additional messages on the cause of the invalid measurements may also be displayed.

Additional Message	Cause of Invalid QT Measurement
QT Startup	QT monitoring was just turned on or has been reset
Asystole or Leads Off	1 Not all specified leads needed to perform QT analysis are available, or 2 Asystole condition is detected
Too few N labeled beats	Not enough valid QRS complexes to generate a QT measurement
Invalid Rhythm for QTc	Not enough valid R-R intervals to generate QT-HR, the averaged HR used for QTc calculation
High QT-HR	QT-HR exceeds the specified upper limit of 150 bpm (for adults) or 180 bpm (for neonates and pediatrics)
Small R Wave	R-wave of the signal is too small
Small T Wave	T-wave of the signal is too small
End of T not Detected	End of the T-Wave cannot be accurately detected
QT out of Range	QT measurement is outside the specified range of valid QT values (200-800 msec)
QTc out of Range	QTc measurement is outside the specified range of valid QTc values (200-800 msec)
QTc Erratic	QTc measurements are not stable

Switching Individual QTc Alarms On and Off

Each QTc alarm can be switched off individually. To switch an alarm on or off, in the **Setup QT Analysis** menu, select **QTc Alarm** or **ΔQTc Alarm** to toggle between **On** and **Off**.

Changing QTc Alarm Limits

Set the high alarm limits based on your assessment of the patient's clinical condition, unit protocols, physician orders or medication specified limits.

1   In the **Setup QT Analysis** menu, select **High Limit**.

2   Select the appropriate setting.

3   Select **ΔHighLimit**.

4   Select the appropriate setting.

Switching QT Monitoring On and Off

To switch all QT monitoring on or off, in the **Setup QT Analysis** menu, select **QT Analys.** to switch between **On** and **Off**.

7

Monitoring Pulse Rate

The pulse numeric counts the arterial pulsations that result from the mechanical activity of the heart in beats per minute (bpm). You can display a pulse from any measured SpO_2 signal (pleth wave), from the CL Respiration Pod, or any arterial pressure (P, ABP, ART, Ao, PAP, UAP, FAP, BAP: see the "Monitoring Invasive Pressure" chapter for an explanation of the pressure labels). The displayed pulse numeric is labeled and color-coded to match its source wave. If the pulse numeric is not displayed, see the **Setup Pulse** menu to check whether it is switched on.

Entering the Setup Pulse Menu

If a pulse numeric is displayed on the screen, select it to enter the setup menu for that pulse source. If no pulse numeric is visible, in the setup menu from the measurement, select pulse with the correct source, e.g. **Pulse (HR)**.

System Pulse Source

The currently selected system pulse source is shown in the setup menus of the pulse source measurements. The pulse rate chosen as system pulse:

- is monitored as system pulse and generates alarms when you select pulse as the active alarm source
- is sent via the network to the Information Center, if available
- is trended in the HighRes Trends and stored in the monitor's databases.

To define which pulse rate is used as system pulse,

1 In the **Setup Pulse** menu, select **System Pulse**.

2 Select one of the SpO_2, cmResp or arterial pressure labels from the pop-up list, or select **Auto**.
If you select **Auto**, the monitor automatically chooses a pulse rate to be used as system pulse. It looks through the list from top to bottom and activates the first pulse rate that is switched on and available.

If your selected pulse source measurement becomes unavailable or is switched off, the monitor will use the next measurement from the list as system pulse until the selected pulse source measurement becomes available again.

Switching Pulse On and Off

To switch a particular pulse numeric on or off, enter the **Setup Pulse** menu via the measurement setup menu or wave menu of the pulse source. For example, to switch an SpO_2 pulse numeric on or off,

1 Enter the **Setup Pulse** menu by selecting the Pulse numeric or by selecting **Pulse** in the **Setup SpO₂** menu.

2 In the **Setup Pulse** menu, select the correct pulse label, e.g. **Pulse (SpO₂)**, to toggle between **On** and **Off**.

Using Pulse Alarms

You can change pulse rate alarm limits in the **ECG/Pulse Alarms** menu which can be accessed from the **Setup Pulse** menu or the **Setup ECG** menu by selecting **AlarmSrc(xxx)** where xxx is the current alarm source. Changing the alarm limits for a specific Pulse numeric changes the alarm limits for all pulse rate alarms and heart rate alarms.

Pulse alarms are only generated when the active alarm source is set to Pulse, a pulse source is set as system pulse and pulse alarms are switched on.

Selecting the Active Alarm Source: ECG or Pulse?

In most cases the HR and Pulse numerics are identical. In order to avoid simultaneous alarms on HR and Pulse, the monitor uses either ECG **or** Pulse as its active alarm source. To change the alarm source, select **Al. Source** in the **ECG/Pulse Alarms** menu, then select

- **ECG/Arrhythm**: if you want the HR to be the alarm source for HR/Pulse.

- **Pulse**: If you select Pulse as the active alarm source, the monitor will prompt you to confirm your choice. Be aware that if you select Pulse as the alarm source, all arrhythmia and ECG HR alarms are switched off.

- **Auto**: If the alarm source is set to **Auto**, the monitor will use the heart rate from the ECG measurement as the alarm source whenever the ECG measurement is switched on and at least one ECG lead can be measured without an INOP condition.

  The monitor will automatically switch to Pulse as the alarm source if:

  – a valid ECG lead can no longer be measured

    and

  – a Pulse source is switched on and available,

  The monitor then uses the pulse rate from the measurement currently active as system pulse. While Pulse is the alarm source, all arrhythmia and ECG HR alarms are switched off. If an ECG lead becomes available again, the monitor automatically uses HR as alarm source.

NOTE

If ECG is switched off, the monitor will always change to Pulse as alarm source, if a Pulse is available. One exception to this rule can arise when you have a telemetry device paired with your monitor. The monitor ECG is then deactivated but the monitor may be configured to allow only ECG as the active alarm source. In this case the monitor will not switch to Pulse as alarm source and Pulse will not be available as a selection in the **ECG/Pulse Alarms** menu.

WARNING

Selecting Pulse as the active alarm source for HR/Pulse switches off the arrhythmia alarms listed in the section "ECG and Arrhythmia Alarm Overview" on page 135, including **Asystole**, **Vfib** and **Vtach** alarms, and the heart rate alarms. This is indicated by the message **ECG/Arrh AlarmsOff** (unless this has been configured off for your monitor), and the crossed-out alarm symbol beside the ECG heart rate numeric. The message **ECG/Arrh AlarmsOff** can be configured off, or to switch to a yellow (medium severity) INOP after a fixed number of hours.

High and low pulse rate and extreme bradycardia and extreme tachycardia alarms from pulse are active.

Alarm Source Selection Disabled

If you cannot change the alarm source, selection of the alarm source may be disabled. If you try to change the source, the monitor displays the message **To activate enter Config and enable Alarm Source Selection**. This setting can only be changed in Configuration Mode.

Changing HR/Pulse Alarm Limits

As Pulse and HR share the same high and low alarm limits, if you change the alarm limit in the **Setup Pulse** menu, the high or low alarm limits for HR in the **Setup ECG** menu change automatically, and vice versa. The only exceptions are caused by a low limit clamp for each measurement: the lowest value for Pulse when derived from SpO_2 is 30 bpm; from HR 15 bpm, and from Pressure 25 bpm.

Extreme Alarm Limits for Heart Rate

The extreme rate alarms, ***** Extreme Tachy** and ***** Extreme Brady**, are generated by the active alarm source, either HR or Pulse. The limits are set automatically by adding a set value (the Δ value) to the high and low alarm limits. So, changing the high and low alarm limits automatically changes the extreme alarm limits (within an allowed range, see for details).

You need to know which value has been configured for your monitor.

• To see the values added to the high and low limit alarms to create the extreme rate alarms for your monitor, in the **Setup ECG** menu, see the menu items **ΔExtrTachy** and **ΔExtrBrady**.

QRS Tone

If the QRS tone selection mode is set to **Auto**, the source for the QRS tone can be set to automatically follow the alarm source, or set specifically to HR or Pulse. To set up the source:

1 In the **Setup Pulse** menu, select **QRS Tone**. The **Setup QRS Tone** menu opens.

2 Select **Selection Mode** and then select **Auto**.

3 Select **QRS Source** and then select the required source from the pop-up list.

If the QRS tone selection mode is set to **Manual**, the source for the QRS tone can be chosen from a fixed list of labels with no fallback. Available labels are: **HR, SpO₂, SpO₂pr, SpO₂po, SpO₂r, SpO₂l, P, ABP, ART, Ao, PAP, UAP, FAP, RFP, LFP, BAP, Ppr, Ppo, Pa1, Pa2, Pa3, Pa4**. To set up the source:

1 In the **Setup Pulse** menu, select **QRS Tone**. The **Setup QRS Tone** menu opens.

2 Select **Selection Mode** and then select **Manual**.

3 Select **QRS Source** and then select the required source from the pop-up list.

You can also set up QRS tone modulation in the **Setup QRS Tone** menu. You can change the QRS tone volume in the **Setup SpO₂** and **Setup ECG** menus.

WARNING

The audible QRS tone might be influenced by external interference and is not intended to be used as a substitute for ECG based arrhythmia analysis.

If arrhythmia detection is needed, do not rely on the audible QRS tone.

Monitoring Respiration Rate (Resp)

For the respiratory measurement (Resp), the monitor measures the thoracic impedance between two ECG electrodes on the patient's chest. Changes in the impedance due to thoracic movement produce the Resp waveform on the monitor screen. The monitor counts the waveform cycles to calculate the respiration rate (RR).

Lead Placement for Monitoring Resp

Correct patient skin preparation techniques for electrode placement are important for Resp measurement: you will find this information in the chapter on ECG.

The Resp measurement uses the standard ECG cable sets and lead placements. You can use any of the different types of ECG cable sets - 3-lead, 5-lead, 6-lead or 10-lead, using either standard or EASI placement - to measure Resp, as long as you use ICU ECG cables.

The Resp signal is always measured between two of the ECG electrodes. Note that at least a standard 3-lead placement is required to measure Resp. The Resp measurement cannot be performed with only two electrodes.

Selecting the Resp Lead for Measurement

To choose the leads for the Resp measurement:

In the **Setup Resp** menu, select **Resp Lead** and choose one of the following vectors:

- **I (RA-LA)** or
- **II (RA-LL)**.

Note that if EASI is configured, Respiration will be measured between the I and A electrodes.

Optimizing Lead Placement for Resp

If you want to measure Resp and you are already measuring ECG, you may need to optimize placement of the two electrodes between which Resp will be measured for some patients. Repositioning ECG electrodes from standard positions, especially when you are using EASI ECG electrode placement, results in changes in the ECG waveform and may influence ST and arrhythmia interpretation.

Cardiac Overlay

Cardiac activity that affects the Resp waveform is called cardiac overlay. It happens when the Resp electrodes pick up impedance changes caused by the rhythmic blood flow. Correct electrode placement can help to reduce cardiac overlay: avoid the liver area and the ventricles of the heart in the line between the respiratory electrodes. This is particularly important for neonates.

Lateral Chest Expansion

Some patients, especially neonates, expand their chests laterally. In these cases it is best to place the two respiratory electrodes in the right midaxillary and left lateral chest areas at the patient's maximum point of breathing movement to optimize the respiratory wave.

Abdominal Breathing

Some patients with restricted chest movement breathe mainly abdominally. In these cases, you may need to place the left leg electrode on the left abdomen at the point of maximum abdominal expansion to optimize the respiratory wave.

Understanding the Resp Display

The Resp measurement is displayed on the monitor as a continuous wave and a numeric respiration rate. If the detected respiration rate is close to the heart rate, this is indicated by the text **HR = RR** next to the respiration wave if you are in manual monitoring mode. Your monitor screen may look slightly different from the illustration.
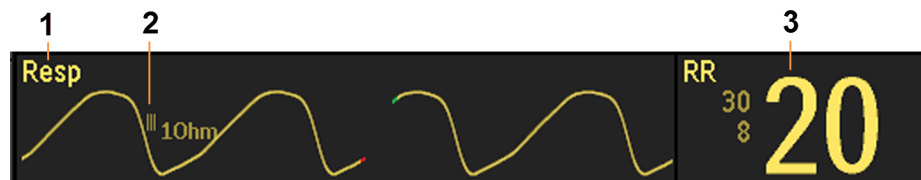
1   Resp wave label

2   One Ohm calibration bar

3   Resp numeric and label

Changing Resp Detection Modes

The Resp detection level can be set either automatically or manually.

- To change the resp detection mode, in the **Setup Resp** menu, select **Detection** to toggle between the settings.

Auto Detection Mode

In Auto Detection Mode, the monitor adjusts the detection level automatically, depending on the wave height and the presence of cardiac artifact.

Note that in Auto Detection Mode,

- the detection level (a dotted line) is not displayed on the waveform,

- the algorithm expects a heart rate and therefore needs at least 3 electrodes attached to the patient.

Use Auto Detection Mode for situations where:

- the respiration rate is not close to the heart rate

- breathing is spontaneous, with or without continuous positive airway pressure (CPAP)

- patients are ventilated, except patients with Intermittent Mandatory Ventilation (IMV).

Manual Detection Mode

In Manual Detection Mode you must set the Resp detection level.

- In the **Setup Resp** menu, select **Manual Up** or **Manual Down**. Use the dotted detection level line in the Resp waveform to determine when the desired level is reached.

Once set, the detection level will not adapt automatically to different respiration depths. It is important to remember that if the depth of breathing changes, you may need to change the detection level.

Use Manual Detection Mode for situations where:

- the respiration rate and the heart rate are close.

- patients have Intermittent Mandatory Ventilation.

- respiration is weak. Try repositioning the electrodes to improve the signal.

Resp Detection Modes and Cardiac Overlay

In Auto Detection Mode:

If you are monitoring Resp and the ECG is switched off, the monitor cannot compare the ECG and Resp rates to detect cardiac overlay. The respiration detection level is automatically set higher to prevent the detection of cardiac overlay as respiration.

In Manual Detection Mode:

Cardiac overlay can in certain situations trigger the respiration counter. This may lead to a false indication of a high respiration rate or an undetected apnea condition. If you suspect that cardiac overlay is being registered as breathing activity, raise the detection level above the zone of cardiac overlay. If the Resp wave is so small that raising the detection level is not possible, you may need to optimize the electrode placement as described in the section "Lateral Chest Expansion" on page 169.

Changing the Size of the Respiration Wave

WARNING

When monitoring in Manual Detection Mode, make sure to check the respiration detection level after you have increased or decreased the size of the respiration wave.

• In the **Setup Resp** menu, select **Size Up** to increase the size of the wave or **Size Down** to decrease it.

Changing the Speed of the Respiration Wave

Resp waveforms are usually viewed at a slower speed than other waveforms. For this reason, the Resp measurement has its own speed control and is not affected by the wave speed settings of the other measurements.

• Select the Resp wave to enter the **Resp Wave** menu, then select **Change Speed**. Choose the required speed from the pop-up list. This defines the speed at which the wave is drawn across the screen in millimeters per second (mm/s).

Using Resp Alarms

Resp alarms can be switched on and off and the high and low alarm limits can be changed just like other measurement alarms, as described in the Alarms chapter.

Changing the Apnea Alarm Delay

The apnea alarm is a high priority red alarm used to detect apneas. The apnea alarm delay time defines the time period between the point where the monitor cannot detect any respiration activity and the indication of the apnea alarm.

1 In the **Setup Resp** menu, select **Apnea Time**.

2 Select the appropriate setting.

Resp Safety Information

WARNING

Respiration detection level

If you do not set the detection level for the respiration correctly in manual detection mode, it may not be possible for the monitor to detect apnea. If you set the detection level too low, the monitor is more likely to detect cardiac activity, and to falsely interpret cardiac activity as respiratory activity in the case of apnea.

Apnea

The respiration measurement does not recognize obstructive and mixed apneas - it only indicates an alarm when a pre-adjusted time has elapsed since the last detected breath.

The safety and effectiveness of the respiration measurement method in the detection of apnea, particularly the apnea of prematurity and apnea of infancy, has not been established.

Interference

If operating under conditions according to the EMC Standard EN 60601-1-2 (Radiated Immunity 3V/m), field strengths above 1V/m may cause erroneous measurements at various frequencies. Therefore it is recommended to avoid the use of electrically radiating equipment in close proximity to the respiration measurement unit.

Resp Accessories

To monitor respiration, use only the non-OR ECG accessories listed in the Resp section of the accessories chapter. You cannot measure respiration if you are using an orange OR ECG cable set. This is because of the higher internal impedance of the OR cable set, required for use if electrosurgery is being performed.

Rate adaptive pacemakers

Implanted pacemakers which can adapt to the Minute Ventilation rate may occasionally react on the Impedance measurement used by patient monitors for the determination of the Resp value and execute pacing with the maximum programmed rate. Switching off the Resp measurement can prevent this.

9

Monitoring SpO2

Philips pulse oximetry uses a motion-tolerant signal processing algorithm, based on Fourier artifact suppression technology (FAST). It provides the following measurements:

- Oxygen saturation of arterial blood (SpO_2) - percentage of oxygenated hemoglobin in relation to the sum of oxyhemoglobin and deoxyhemoglobin (functional arterial oxygen saturation).

- Pleth waveform - visual indication of patient's pulse.

- Pulse rate (derived from pleth wave) - detected pulsations per minute.

- Perfusion indicator - numerical value for the pulsatile portion of the measured signal caused by arterial pulsation.

The monitor is also compatible with the Nellcor™ OxiMax™ SpO_2 technology from Medtronic. Where use of this technology results in different behavior or has different requirements, the differences are described in these Instructions for Use.

WARNING

A pulse oximeter should be considered an early warning device. As a trend towards patient deoxygenation is indicated, blood samples should be analyzed by a laboratory CO-oximeter to completely understand the patient's condition.

SpO2 Sensors

Depending on the purchased SpO_2 option, different sensors and adapter cables can be used. The sensors for the different options are color-coded to match the connectors. See the "Accessories" chapter for a compatibility table.

Familiarize yourself with the instructions for use supplied with your sensor before using it. In particular, check that the sensor being used is appropriate for your patient category and application site.

CAUTION

Do not use OxiCliq disposable sensors in a high humidity environment, such as in neonatal incubators or in the presence of fluids, which may contaminate sensor and electrical connections causing unreliable or intermittent measurements. **Do not use** disposable sensors when there is a known allergic reaction to the adhesive.

Applying the Sensor

1   Follow the SpO_2 sensor's instructions for use, adhering to all warnings and cautions.

2   Remove colored nail polish from the application site.

3   Apply the sensor to the patient. The application site should match the sensor size so that the sensor can neither fall off, nor apply excessive pressure.

4   When using the M1195A Infant Finger Sensor, select a finger or toe with a diameter of between 7 and 8 mm (0.27" and 0.31"). When applying a M1193A neonatal sensor do not overtighten the strap.

5   Check that the light emitter and the photodetector are directly opposite each other. All light from the emitter must pass through the patient's tissue.

WARNING

Proper Sensor Fit: If a sensor is too loose, it might compromise the optical alignment or fall off. If it is too tight, for example because the application site is too large or becomes too large due to edema, excessive pressure may be applied. This can result in venous congestion distal from the application site, leading to interstitial edema, hypoxemia and tissue malnutrition. Skin irritations or lacerations may occur as a result of the sensor being attached to one location for too long. To avoid skin irritations and lacerations, periodically inspect the sensor application site and change the application site regularly.

Venous Pulsation: Do not apply sensor too tightly as this results in venous pulsation which may severely obstruct circulation and lead to inaccurate measurements.

MRI Scanning: Do not use the pulse oximeter or oximetry sensors during magnetic resonance imaging (MRI) scanning. Induced current could potentially cause burns. The device may affect the MRI image, and the MRI unit may affect the accuracy of the oximetry measurements.

Damaged Sensors: Do not use damaged sensors / cables or sensors with exposed optical components.

Low Perfusion: With very low perfusion at the monitored site, the performance might be impaired and the SpO_2 readings may read lower than arterial oxygen saturation.

Conditions Affecting Performance: During hypotension, severe vasoconstriction, severe anemia, or hypothermia of the patient the performance may be impaired. Also in these conditions or when the patient is in cardiac arrest or in shock, it may not be possible to make measurements at all.

Ambient Temperature: At elevated ambient temperatures be careful with measurement sites that are not well perfused, because this can cause severe burns after prolonged application. All listed sensors operate without risk of exceeding 41°C on the skin if the initial skin temperature does not exceed 35°C.

Extremities to Avoid: Avoid placing the sensor on extremities with an arterial catheter, an NBP cuff or an intravascular venous infusion line.

Do not immerse the sensors.

Nellcor OxiMax technology: This product contains chemicals known to the state of California to cause cancer and birth defects or other reproductive harm.

NOTE

NBP Alarm Suppression: The **NBP Alarm Suppr.** setting which can be made in Configuration Mode has no effect when using the SpO2 measurement with Nellcor OxiMax technology.

The use of NBP cuffs or other constricting devices on the same extremity as the SpO2 sensor is not recommended.

Connecting SpO2 Cables

Connect the sensor cable to the color-coded socket on the monitor. You can connect some Philips sensors directly to the measurement device. For other sensors, use the corresponding adapter cable.

CAUTION

Extension cables: Do not use more than one extension cable (M1941A). Do not use an extension cable with Philips reusable sensors or adapter cables with part numbers ending in -L (indicates "long" cable version).

Electrical Interference: Position the sensor cable and connector away from power cables, to avoid electrical interference.

Humidity: For neonatal patients, make sure that all sensor connectors and adapter cable connectors are outside the incubator. The humid atmosphere inside can cause inaccurate measurements.

Measuring SpO2

1   Select the correct patient category setting (adult/pediatric and neonatal), as this is used to optimize the calculation of the SpO_2 and pulse numerics.

2   During measurement, ensure that the application site:

   – has a pulsatile flow, ideally with a perfusion indicator value above 1.0.

   – has not changed in its thickness (for example, due to edema), causing an improper fit of the sensor.

WARNING

• If not specified otherwise in the SpO_2 sensor's instructions for use, the following applies:

   – For fully conscious pediatric or adult patients, who have a normal function of perfusion and sensory perception at the measurement site:

   To ensure skin quality and correct optical alignment of the sensor, inspect the application site when the measurement results are suspicious or when the patient complains about pressure at the application site, but at least every 24 hours. Correct the sensor alignment if necessary. Move the sensor to another site, if the skin quality changes.

   – For all other patients:

   Inspect the application site every two to three hours to ensure skin quality and correct optical alignment. Correct the sensor alignment if necessary. If the skin quality changes, move the sensor to another site.
   Change the application site at least every four hours.

• Injected dyes such as methylene blue, or intravascular dyshemoglobins such as methemoglobin and carboxyhemoglobin may lead to inaccurate measurements.

• Inaccurate measurements may result when the application site for the sensor is deeply pigmented or deeply colored, for example, with nail polish, artificial nails, dye or pigmented cream.

• Interference can be caused by:

   – High levels of ambient light (including IR warmers) or strobe lights or flashing lights (such as fire alarm lamps). (Hint: cover application site with opaque material.)

   – Another SpO_2 sensor in close proximity (e.g. when more than one SpO_2 measurement is performed on the same patient). Always cover both sensors with opaque material to reduce cross-interference.

   – Electromagnetic interference, especially at perfusion indicator values below 1.0 or signal quality indicator below medium.

   – Excessive patient movement and vibration.

Understanding the SpO2 Numerics
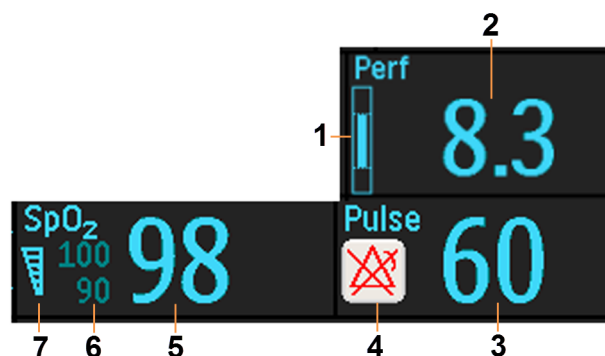
1   Perfusion change indicator

2   Perfusion numeric

3   Pulse numeric

4   Alarms off indicator (here for Pulse alarms)

5   SpO$_2$ numeric

6   SpO$_2$ alarm limits

7   Signal Quality indicator

SpO2 Signal Quality Indicator (FAST SpO2 only)

The SpO$_2$ numeric is displayed together with a signal quality indicator (if configured and enough space is available) which gives an indication of the reliability of the displayed values.

The level to which the triangle is filled shows the quality of the signal; the indicator below shows a medium signal quality, the signal quality is at a maximum when the triangle is completely filled.

Assessing a Suspicious SpO2 Reading

Traditionally, pulse rate from SpO$_2$ was compared with heart rate from ECG to confirm the validity of the SpO$_2$ reading. With newer algorithms, such as FAST-SpO$_2$, this is no longer a valid criteria because the correct calculation of SpO$_2$ is not directly linked to the correct detection of each pulse.

When pulse rate is very low, or strong arrhythmia is present, the SpO$_2$ pulse rate may differ from the heart rate calculated from ECG but this does not indicate an inaccurate SpO$_2$ value.

If you doubt the measured SpO$_2$, use the signal quality indicator (if available) or the pleth wave and perfusion indicator instead to assess the signal quality.

WARNING

With pulse oximetry, sensor movement, ambient light (especially strobe lights or flashing lights) or electromagnetic interference can give unexpected intermittent readings when the sensor is not attached. Especially bandage-type sensor designs are sensitive to minimal sensor movement that might occur when the sensor is dangling.

Comparing Values and Waves

Be aware when using two different SpO_2 technologies that under certain conditions the displayed values and especially the perfusion values may differ due to the different algorithms used.

Masimo SET technology applies advanced filtering techniques which result in a slight delay of the displayed Pleth waveform relative to other waveforms.

Changing the Averaging Time

Depending on the monitor configuration, you may be able to change the averaging time for the SpO_2-related values.

The averaging time represents the approximate time period used for the calculation. The exact averaging algorithm and how it impacts the different SpO_2-related values depends on the SpO_2 technology (option) used and on the signal conditions. The longer the averaging time, the longer the time needed until the SpO_2-related values reflect the physiological event. Shorter averaging time is useful for situations where extremely fast responses of the measurements to changes are required or few artifacts are expected. Use longer averaging time where you expect the number of artifacts to be relatively high.

1   In the **Setup SpO₂** menu, select **Average**.

2   Select the required averaging time from the list.

Understanding SpO2 Alarms

This refers to SpO_2 specific alarms. See the "Alarms" chapter for general alarm information. SpO_2 offers high and low limit alarms, and a high priority desat alarm. You cannot set the low alarm limit below the desat alarm limit.

CAUTION

If you measure SpO_2 on a limb that has an inflated noninvasive blood pressure cuff, a non-pulsatile SpO_2 INOP can occur. To avoid this, the monitor can be configured to suppress corresponding SpO_2 INOPs when it detects an inflated cuff (for FAST SpO_2 technology only).

If INOPs are suppressed, there may be a delay of up to 60 seconds in indicating a critical status, such as sudden pulse loss or hypoxia.

Alarm Delays

There is a delay between a change in the oxygen saturation at the measurement site and the corresponding alarm indication at the monitor. This delay has two components:

- **The general measurement delay time is the time between the occurrence of the saturation change and when the new value is represented by the displayed numerical values.** This delay depends on the algorithmic processing and the averaging time configured for SpO_2. The longer the averaging time configured, the longer the time needed until the numerical values reflect the change in saturation.

- **The time between the displayed numerical values crossing an alarm limit and the alarm indication on the monitor**. This delay is the sum of the alarm delay time configured for SpO_2, plus the system alarm delay. The system alarm delay is the processing time the system needs for any alarm to be indicated on the monitor, after the measurement has triggered the alarm. See "Monitor Performance Specifications" on page 323 for the system alarm delay specification.

For SpO_2 high and low limit alarms, there are two different types of alarm delay time. The **standard alarm delay** is set to a fixed value. The **Smart Alarm Delay** varies, based on an intelligent algorithm, and can be used instead of the standard alarm delay.

The **Desat** alarm always uses the standard alarm delay.

Standard Alarm Delay

The standard alarm delay time can be configured to a fixed value between 0 and 30 seconds, in 1 second steps.

Smart Alarm Delay

The Smart Alarm Delay feature tries to reduce "nuisance" alarms.

WARNING

Before using Smart Alarm Delays, make sure that you fully understand how the delay is applied and what the consequences are.

How Does it Work?

The monitor assesses the severity of a limit violation by looking at its magnitude and duration, and can delay the alarm, depending on the assessed severity. Examples for the delay are given in the table in the example below.

Clinical Example

You are monitoring a patient with a low SpO_2 limit of 90%. Then, while sleeping, your patient drops to 89% for 20 seconds, and then recovers.

The Smart Alarm Delay would tolerate this limit violation up to 50 seconds (upper shaded cell in the table) before issuing an SpO_2 low alarm. So in this case there would be no alarm notification.

If the SpO_2 drops further (e.g. to 85%), the tolerance time is much lower (10 seconds, see lower shaded cell).

Actual deviation from violated alarm limit	Resulting alarm notification delay according to selected mode		
	Short	Medium	Long
1%	25 sec (maximum delay)	50 sec (maximum delay)	100 sec (maximum delay)
2%	12 sec	25 sec	50 sec
3%	10 sec (minimum delay)	16 sec	33 sec
4%	10 sec	12 sec	25 sec
5%	10 sec	10 sec (minimum delay)	20 sec
6%	10 sec	10 sec	16 sec
7%	10 sec	10 sec	14 sec
8%	10 sec	10 sec	12 sec
9%	10 sec	10 sec	11 sec
>9%	10 sec	10 sec	10 sec (minimum delay)

Table with Detailed Delays for Specific Limit Violations

In the clinical example above, the **Medium** delay mode has been selected. For less stable or more robust patients, the tolerance time can be adjusted using **Short** or **Long** mode.

Smart Alarm Delay Dynamics
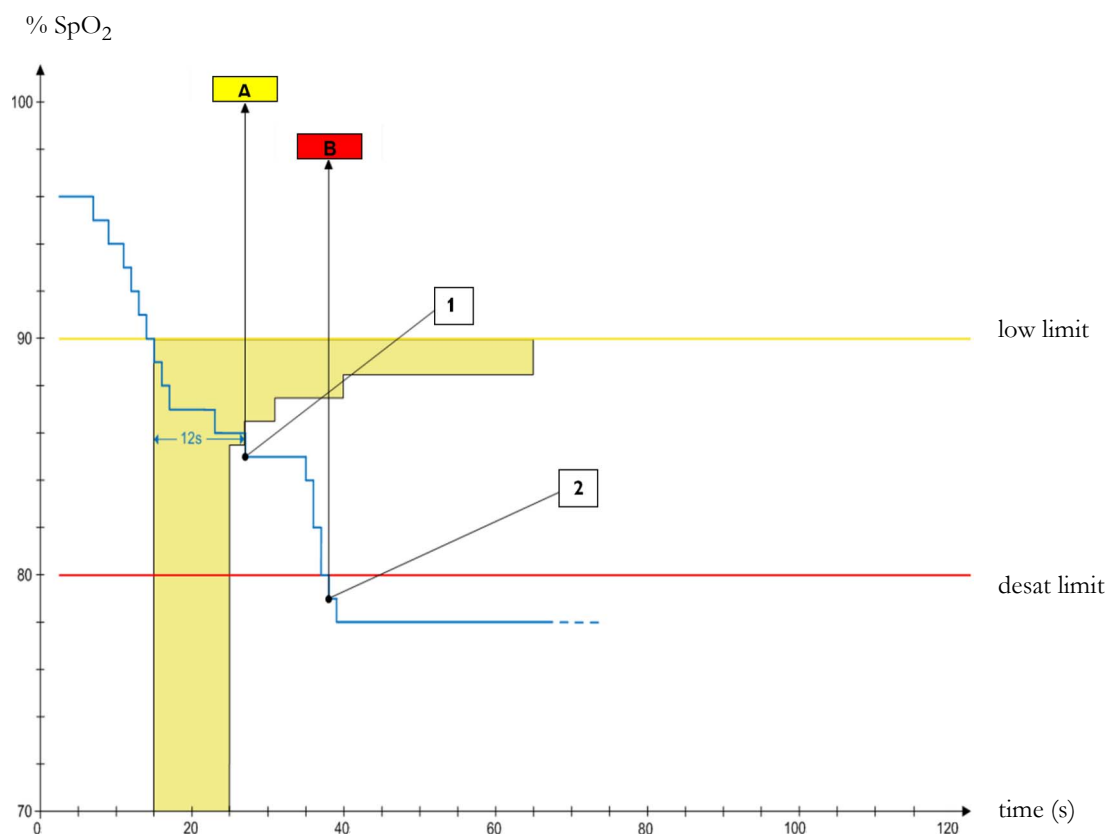
1   First trigger point - with the smart alarm delay setting "medium", the low alarm is triggered 12 seconds after the SpO_2 value has fallen below the low limit.

   A - **** SpO₂ Low** alarm

2   Second trigger point - with zero desat delay, the alarm is triggered as soon as the SpO_2 value falls below the desat limit.

   B - ***** Desat** alarm

As long as the SpO_2 value stays in the shaded zone, the low alarm is delayed.

Setting Smart Alarm Delay Mode

To set the mode for Smart Alarm Delays, in the **Setup SpO₂** menu:

1 Check that **SmartAlarmDelay** is set to **On**.
   This setting is made in Configuration Mode and will be shown in the menu in gray. If it is set to **Off**, a standard alarm delay is in use.

2 Select **High Alarm Delay** and choose **Short**, **Medium**, or **Long** mode.

3 Select **Low Alarm Delay** and choose **Short**, **Medium**, or **Long** mode.

If you also use monitors with earlier software revisions, be aware that smart alarm delays will not be used after a transfer to one of these monitors. Monitors with earlier software revisions will always use the standard alarm delay. If you are not sure whether a monitor has the Smart Alarm Delay function, check whether there is a **SmartAlarmDelay** entry in the **Setup SpO₂** menu.

Smart Alarm Delay Indicator

If the Smart Alarm Delay is switched on, a special indicator will be displayed next to the SpO_2 alarm limits. This indicator consists of a general alarm symbol with three blocks above and below it.

Indicator   Indicator with Numerics

The blocks above and below the alarm symbol indicate which Smart Alarm Delay modes have been set:

Short   Medium   Long

The blocks **above** the alarm symbol show the delay mode for the high limit, and the blocks **below** for the low limit.

When the SpO_2 value crosses an alarm limit, the delay period starts. During the delay period, the symbol is highlighted to indicate that an alarm limit has been violated:

If the SpO_2 value returns inside the limits during the delay period, the highlighting will be removed and no alarm is indicated. If the SpO_2 value is still outside the alarm limit at the end of the delay period, the alarm is indicated and the highlighting will be removed from the symbol.

Adjusting the Alarm Limits

In the **Setup SpO₂** menu:

• Touch the high limit on the alarm limits menu button. Choose the high alarm limit from the pop-up list that opens.

• Touch the low limit on the alarm limits menu button. Choose the low alarm limit from the pop-up list that opens.

WARNING

High oxygen levels may predispose a premature infant to retrolental fibroplasia. If this is a consideration do NOT set the high alarm limit to 100%, which is equivalent to switching the high alarm off.

Adjusting the Desat Limit Alarm

The Desat alarm is a high priority (red) alarm notifying you of potentially life threatening drops in oxygen saturation.

1 In the **Setup SpO₂** menu, select **Desat Limit**.

2 Adjust the limit.

Pleth Wave

The Pleth wave is autoscaled to maximum display size. It decreases only when the signal quality becomes marginal. It is NOT directly proportional to the pulse volume. If you need an indication of change in pulse volume, use the perfusion indicator.
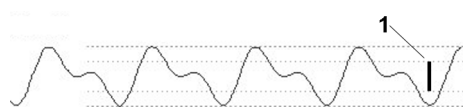
1 Minimum size for reliable SpO_2 value

Perfusion Numeric

The perfusion numeric (**Perf**) gives a value for the pulsatile portion of the measured signal caused by the pulsating arterial blood flow.

As pulse oximetry is based on the pulsatile nature of the signal, you can also use the perfusion numeric as a quality indicator for the SpO_2 measurement. Above 1 is optimal, between 0.3-1 is acceptable. Below 0.3 is marginal; reposition the sensor or find a better site.

Perfusion Change Indicator (Philips FAST SpO2 and X3 Nellcor OxiMax only)

The perfusion change indicator is a graphic symbol which shows the change in the perfusion value, relative to a reference value which you can set.

To set the current perfusion value as the reference value:

• In the **Setup SpO₂** menu, select **Set Perf Ref.**.

When a reference value has been set, the perfusion change indicator is displayed next to the perfusion numeric.

Setting SpO2/Pleth as Pulse Source

1 In the **Setup SpO₂** menu, select **Pulse (SpO₂)** to enter the **Setup Pulse** menu.

2 In the **Setup Pulse** menu, select **Syst.Pulse** and select **SpO₂** from the pop-up list.

Setting Up Tone Modulation

If tone modulation is on, the QRS tone pitch lowers when the SpO_2 level drops. Remember, the QRS tone is derived from either heart rate or pulse depending on which is currently set up as the QRS tone source. Alternatively, the QRS tone source can be selected manually from a fixed list of labels (see "QRS Tone" on page 167).

1 In the **Setup SpO₂** menu, select **QRS Tone**. The **Setup QRS Tone** menu opens.

2 Select **Tone Modulation** to switch between **Yes** (for on) and **No** (for off).

Setting the QRS Volume

In the **Setup SpO₂** menu, select **QRS Volume** and set the appropriate QRS tone volume.

When the X3 is connected to a host monitor there will be no QRS tone.

Calculating SpO2 Difference

When a second SpO_2 measurement is present, the monitor displays both SpO_2 values, and calculates the difference between them. The second value is subtracted from the first.

1 From the **Main Setup** menu, select **Measurements**.

2 From the **Setup ΔSpO₂** menu, select **First SpO₂**.

3 Choose the first measurement source.

4 Select **Second SpO₂**.

5 Choose the second measurement source.

10

Monitoring with Masimo rainbow SET

Masimo rainbow SET technology provides the following optional measurements, in addition to the standard SpO_2 measurement:

- SpCO
- SpMet
- SpHb/SpOC
- PVI
- Acoustic Respiration Rate (RRac)

Specific information for these measurements is included in this chapter.

Refer to the "Monitoring SpO2" chapter for all general information on the SpO_2 measurement and all operating instructions. The information here is limited to the parts which differ from the standard SpO_2 information in that chapter.

Refer to the sensor's Direction for Use (DFU) for all information, warnings, and cautions, and all specifications that apply when using a Masimo sensor.

Masimo Patents

The Masimo technology in this product is covered under one or more patents as set forth at www.masimo.com/patents.htm.

No Implied License

Possession of the Masimo technology in this product does not convey any express or implied license to use the product with unauthorized sensors or cables that would, alone, or in combination with this product, fall within the scope of one or more of the patents relating to that product with Masimo technology.

Safety Information

General

WARNING

- EMI radiation interference from computer displays and/or LCD/plasma TVs can cause errors or incorrect Masimo rainbow SET measurements.
- The Masimo rainbow SET technology only provides pulse rate values up to 240 bpm. To get pulse rate alarms, set the high alarm limit below 240 bpm.

WARNING

The Masimo rainbow SET measurement is not an apnea monitor.

WARNING

The Masimo rainbow SET measurement may be used during defibrillation, but this may affect the accuracy or availability of the parameters and measurements.

WARNING

The Masimo rainbow SET measurement should not be used for arrhythmia analysis.

WARNING

To protect from electric shock, always remove the sensor and completely disconnect the Masimo rainbow SET measurement accessories before bathing the patient.

WARNING

The Masimo rainbow SET measurement is intended only as an adjunct device in patient assessment. It should not be used as the sole basis for diagnosis or therapy decisions. It must be used in conjunction with clinical signs and symptoms.

WARNING

The Masimo rainbow SET technology only provides respiration rate values from 4 rpm to 70 rpm. For respiration rate limit alarms, set the high alarm limit below 70 rpm and the low alarm limit above 4 rpm.

CAUTION

- SpO_2, SpCO, SpMet, and SpHb are empirically calibrated monitoring healthy adult volunteers with normal levels of carboxyhemoglobin (COHb) and methemoglobin (MetHb).
- Masimo rainbow SET technology cannot measure elevated levels of COHb or MetHb.

CAUTION

Loss of pulse signal can occur when:

- The sensor is too tight.
- The patient has hypotension, severe vasoconstriction, severe anemia, or hypothermia.
- There is arterial occlusion proximal to the sensor.
- The patient is in cardiac arrest or is in shock.

CAUTION

Interference, resulting in inaccurate or no measurements, can be additionally be caused by:

- Elevated levels of total bilirubin.

CAUTION

If using pulse oximetry during full body irradiation, keep the sensor out of the radiation field. If the sensor is exposed to the radiation, the reading might be inaccurate or the device might read zero for the duration of the active irradiation period.

CAUTION

Do not place the device on electrical equipment that may affect the device, preventing it from working properly.

CAUTION

If the Low Perf INOPs are frequently displayed, find a better perfused monitoring site. In the interim, assess the patient and, if indicated, verify oxygenation status through other means.

CAUTION

The patient monitor must be configured to match your local power line frequency to allow for the cancelation of noise introduced by fluorescent lights and other sources.

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

Once the lifetime of a used sensor, adhesive, or patient cable has expired, monitoring of the corresponding parameters are no longer possible with this sensor, adhesive, or patient cable. Once the end of lifetime is reached, the sensor, adhesive, or patient cable continues to operate until power is removed from the measurement device (e.g. Multi-Measurement Module is moved to a different monitor), the sensor or patient cable is disconnected, or a sustained sensor off condition occurs.

CAUTION

The 3D Perf Delta alarm is also cleared/disabled, when the sensor or the patient cable is disconnected or in the event of a sensor off condition.

CAUTION

The 3D Desat Index alarm restarts counting when power is removed from the measurement device (e.g. Multi-Measurement Module is moved to different monitor), the sensor or patient cable is disconnected, or in the event of a sensor off condition.

SpHb

CAUTION

Variation in hemoglobin measurements may be profound and may be affected by sample type, body positioning, as well as other physiological conditions. As with most hemoglobin tests, Masimo rainbow SET technology test results should be scrutinized in light of a specific patient's condition. If any results show an inconsistency with the patient's clinical status, the measurement should be repeated with another measurement method and/or supplemented with additional test data.

Possible Causes of Inaccurate Readings

SpCO and SpMet

- Improper sensor application
- Intravascular dyes such as indocyanine green or methylene blue
- Abnormal hemoglobin levels
- Low arterial perfusion
- Low arterial oxygen saturation levels including altitude induced hypoxemia
- Elevated total bilirubin levels
- Motion artifact

SpHb and SpOC

- Improper sensor application
- Elevated PaO_2 levels
- Elevated levels of bilirubin
- EMI radiation interference
- Elevated carboxyhemoglobin levels
- Elevated methemoglobin levels
- Intravascular dyes such as indocyanine green or methylene blue
- Externally applied coloring and texture such as nail polish, acrylic nails, glitter, etc.
- Low arterial perfusion
- Low arterial oxygen saturation levels
- Motion artifact
- Hemoglobinopathies and synthesis disorders such as thalassemias, Hb S, Hb C, sickle cell, etc.
- Vasospastic disease such as Raynaud's
- Elevated altitude
- Peripheral vascular disease
- Liver disease

RRac

- Improper sensor application
- Low arterial perfusion
- Motion artifact
- Low arterial oxygen saturation
- Excessive ambient or environmental noise

Alarm Capabilities

The standard physiological limit alarm capabilities for SpO_2 and pulse rate also apply to the Masimo rainbow SET measurement. For details, refer to the "Monitoring SpO2" chapter.

3D Alarms

The Masimo rainbow SET measurement provides additional alarms that are named 3D Alarms. 3D Alarms include:

- Desat Index 3D Alarm™ referred to within IntelliVue as 3D Desat Index
- 3D PI Delta Alarm™ referred to within IntelliVue as 3D Perf Delta

3D Desat Index

The 3D Desat Index alarm alerts you to an increasing number of smaller desaturations that may not exceed the low SpO_2 alarm threshold. The smaller desaturations provide an early indication that the patient's respiratory status is declining.

The SpO_2 alarm has to be on to set the 3D Desat Index. The 3D Desat Index alarm is issued when:

- a specified threshold (**Delta Threshold**) is exceeded
- for a specified number of desaturations (**Count**)
- over a specified period (**Period**).

The baseline to determine the desaturations is calculated automatically. The extended alarm text contains the maximum exceeded count.

3D Perf Delta

Changes in the peripheral perfusion are a valuable indicator of a patient's condition worsening, but they are difficult to identify and often missed. The 3D Perf Delta alarm helps you to notice early changes in peripheral perfusion.

A 3D Perf Delta alarm indicates that a patient's perfusion is deteriorating. The Perf alarms have to be on, to set the 3D Perf Delta. Set a Perf baseline as a reference for the current Perf value. Set the **Delta % Decrease** to a configurable value. The **Delta % Decrease** determines the delta from the set Perf baseline to the point where a 3D Perf Delta alarm is issued. Set the **Duration** to configure the time span in which you want to monitor the **Delta % Decrease** from the set Perf baseline. The 3D Perf Delta alarm is only enabled during the configured **Duration**.

The extended alarm text contains the maximum exceeded Perf Delta value.

SpO2 Measurement with Masimo rainbow SET

Basic Measurements

Masimo rainbow SET technology has the same basic measurement functionality as Masimo SET SpO_2 measurements: SpO_2 (functional oxygen saturation), Pulse from Pleth, Perfusion Index, and an auto-scaled plethysmogram wave. The basic SpO_2 measurement functionality is described in the "Monitoring SpO2" chapter.

NOTE

The **NBP Alarm Suppr.** setting has no effect when using the SpO_2 measurement with Masimo rainbow SET technology.

Optional Measurements

Masimo rainbow SET technology provides optional noninvasive measurements, if the corresponding option is activated in your device:

- **SpHb** measures the levels of total hemoglobin (SpHb) concentration in arterial blood.
- **SpOC** calculates the levels of total oxygen content in the arterial blood.
- **SpCO** measures the levels of carboxyhemoglobin saturation (reflecting the blood levels of carbon monoxide bound to hemoglobin) in arterial blood.
- **SpMet** measures the levels of methemoglobin saturation (SpMet) in arterial blood.
- **PVI** (pleth variability index) may show changes that reflect physiological factors such as vascular tone, circulating blood volume, and intrathoracic pressure excursions.
- **RRac** (respiration rate) provides a respiration rate value and an auto-scaled acoustic (acResp) waveform.

SpO2 Average

If you switch from a Masimo rainbow SET measurement to a non-rainbow SET SpO_2 measurement, the **Average** setting is mapped as listed in the table:

Masimo rainbow SET Average	SpO$_2$ Average
2 sec, 4 sec	5 sec
8 sec, 10 sec, 12 sec, 14 sec	10 sec
16 sec	20 sec

If you switch from a non-rainbow SET SpO_2 measurement to a Masimo rainbow SET measurement, the **Average** setting is mapped as listed in the table:

SpO$_2$ Average	Masimo rainbow SET Average
5 sec	4 sec
10 sec	10 sec
20 sec	16 sec

Making Measurements

Selecting the Sensor

Use only the accessories that are specified for use with this device, otherwise patient injury can result.

Not all sensors support all optional measurements. Some Masimo sensors require that certain options are activated in the measurement device. Otherwise those sensors are not compatible, and no measurements including SpO_2 measurements are possible. In this case, an INOP **Unkn.Sensor** is issued. For details and accuracy specifications for the specific sensor, refer to the sensor's DFU.

Applying the Sensor

Regarding the application of the sensor, follow the instructions given in the sensor's DFU while adhering to all warnings and cautions. Consider using the Masimo light shield to cover the sensor. Ensure to regularly inspect and reapply the sensor as indicated in the sensor's DFU.

NOTE

High-intensity extreme lights (such as pulsating strobe lights) directed on the sensor, may not allow the Masimo rainbow SET measurement to obtain vital sign readings. Use the Masimo light shield to cover the sensor.

Connecting Cables

For the Masimo rainbow SET measurements you require:

- Masimo rainbow SET compatible sensors
- Adapter cables
- A Masimo rainbow SET compatible sensor socket at the monitor.

Connection Example
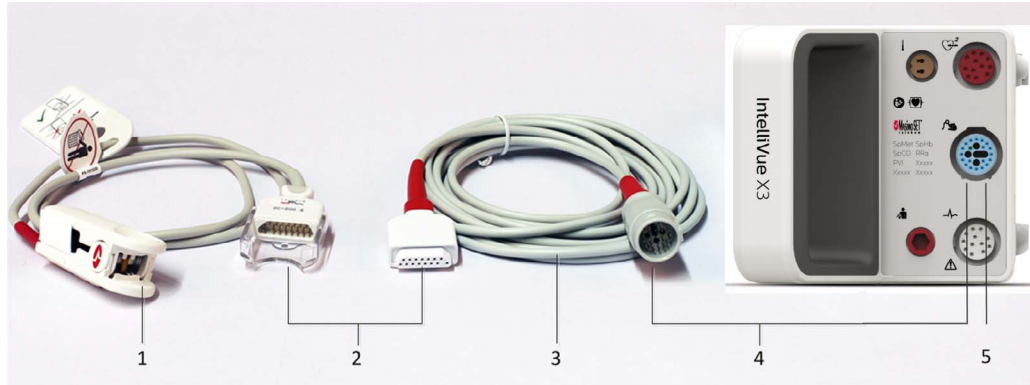
1 rainbow compatible sensor

2 Connection of the sensor and the adapter cable

3 Adapter cable

4 Connection of the adapter cable and the rainbow sensor socket

5 rainbow sensor socket at the monitor

Masimo rainbow SET Measurements

To use the optional rainbow SET measurements with your device, activate the corresponding option. Set the label for SpO_2 to the standard SpO_2, and not to an alternative label for example to SpO_2po. Also enable the corresponding measurement in the SpO_2 menu.

To use the measurements SpCO, SpHb/SpOC, and SpMet, the sensor must support those measurements.

Understanding Numerics

Screen Layout Example
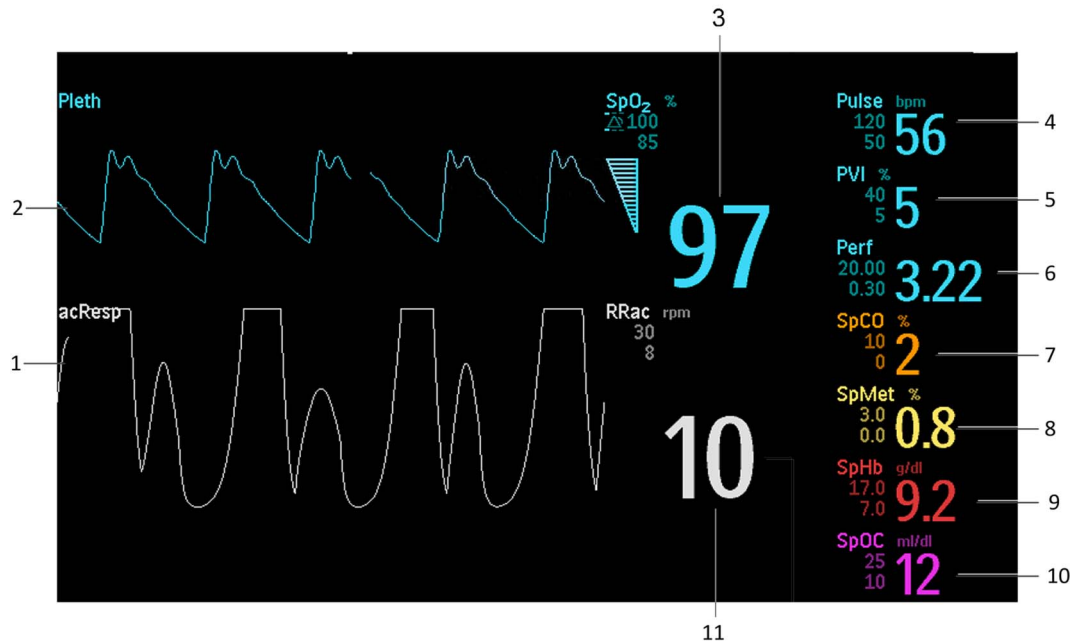
1 acResp wave

2 Pleth wave

3 SpO$_2$ label with unit, alarm limits, and numeric

4 Pulse label with unit, alarm limits, and numeric

5 PVI label with unit, alarm limits, and numeric

6 Perf label with alarm limits, and numeric

7 SpCO label with unit, alarm limits, and numeric

8 SpMet label with unit, alarm limits, and numeric

9 SpHb label with unit, alarm limits, and numeric

10 SpOC label with unit, alarm limits, and numeric

11 RRac label with unit, alarm limits, and numeric

The Masimo rainbow SET measurements can be set up and customized in Configuration and Monitoring Mode.

Measurement Modes

SpO$_2$ Sensitivity

The different sensitivity settings allow you to adapt the SpO$_2$ measurement sensitivity to the strength and quality of the SpO$_2$ signal at the measurement site.

Normal Sensitivity: This setting is recommended for patients who are experiencing some compromise in blood flow or perfusion. It is advisable for care areas where patients are observed frequently, such as an intensive care unit (ICU).

Adaptive Probe Off Detection (APOD) Sensitivity: This setting is recommended for care situations in which there is a high probability of the sensor becoming detached. It is also the suggested mode for care areas where patients are not visually monitored continuously. This mode delivers enhanced protection

against erroneous pulse rate and arterial oxygen saturation readings when a sensor becomes inadvertently detached from a patient due to excessive movement.

1   Select the **Setup SpO₂** menu.

2   Select **Sensitivity** from the menu.

3   Switch between **APOD** and **Normal**.

Maximum Sensitivity

Maximum sensitivity is recommended for use on patients with weak signals, for example, patients with very low perfusion, or in clinical environments with high ambient light.

1   Select the **Setup SpO₂** menu.

2   Select **Max. Sensitivity** from the menu.

3   Switch between **On** and **Off**

4   When you select **On** the prompt **Select Confirm to enable maximum sensitivity. Sensor off detection is compromised, attended monitoring recommended.** is issued.

5   Select **Confirm**.

Sensitivity will fall back to the configured sensitivity (**APOD** or **Normal**) after a patient is discharged. Also if the sensitivity mode is manually set to **APOD** or **Normal**, the maximum sensitivity falls back to **Off**. The Maximum sensitivity setting survives a short power interruption.

NOTE

When using the **Max. Sensitivity** setting, performance of the "Sensor Off" detection may be compromised. If the sensor is detached or falls off the patient, you may receive false readings due to environmental "noise" such as light, vibration, and excessive air movement (e.g. vents or ventilators).

FastSat

FastSat enables rapid tracking of arterial oxygen saturation changes. Arterial oxygen saturation data is averaged using averaging algorithms to smooth the trend. When **FastSat** is set to **On**, the averaging algorithm evaluates all the saturation values providing an averaged saturation value that is a better representation of the patient's current oxygenation status. With FastSat, the averaging time is dependent on the input signal.

1   Select the **Setup SpO₂** menu.

2   Select **FastSat Algor.** from the menu.

3   Switch between **On** and **Off**.

Setting Up 3D Desat Index Alarm

The configurable 3D Desat Index alarm is issued when a patient experiences a specified number of desaturations that exceed a specified threshold over a specific period of time.

1   Select the **Setup SpO₂** menu.

2   Select **3D Desat Index** from the menu.

3   Select if the **3D Desat Index** should be **On** or **Off**.

4   Set the **Delta Threshold** for the alarm between minimum 2% and maximum 10%, in steps of 1%.

5   Set the **Count** for the alarm between minimum 1 and maximum 25, in steps of 1.

6   Set the **Period** to the time duration for which the desaturations are counted. Select a minimum of 1 hour to a maximum of 4 hours, and in a step size of 1 hour.

NOTE

The 3D Desat Index restarts counting:

• when power is removed from the measurement device (for example, Multi-Measurement Module is moved to different monitor),

• the sensor, or patient cable is disconnected,

• or in the event of a **Sensor Off** condition.

Setting Up SpCO

The SpCO numeric reflects the carboxyhemoglobin saturation at the measurement location.

1 Select the **Setup SpO₂** menu.

2 Select **SpCO** from the menu.

3 Select if the **SpCO** measurement should be **Enabled** or **Disabled**.

4 Select if **Alarms** should be **On** or **Off** for the measurement.

5 Enter values for the **High Limit** and **Low Limit**.

Setting Up SpMet

The SpMet numeric reflects the methemoglobin saturation at the measurement location.

1 Select the **Setup SpO₂** menu.

2 Select **SpMet** from the menu.

3 Select if the **SpMet** measurement should be **Enabled** or **Disabled**.

4 Select if **Alarms** should be **On** or **Off** for the measurement.

5 Enter values for the **High Limit** and **Low Limit**.

Setting Up SpHb

The SpHb numeric reflects the total hemoglobin concentration at the measurement location.

1 Select the **Setup SpO₂** menu.

2 Select **SpHb / SpOC** from the menu.

3 Select if the **SpHb** measurement should be **Enabled** or **Disabled**.

4 Select if **SpHb Alarms** should be **On** or **Off** for the measurement.

5 Enter values for the **SpHb High Limit** and **SpHb Low Limit**.

NOTE

When the device is configured to show the level of total hemoglobin in arterial blood, the label is SpHb. Whereas the label is SpHbv, when the device is configured to show the level of total hemoglobin in venous blood.

Setting Up SpOC

The SpOC numeric reflects the total oxygen content at the measurement location. The SpOC numeric has to be enabled during configuration, and requires the SpHb measurement to be available. SpOC is calculated from SpO$_2$ and SpHb values.

1   Select the **Setup SpO₂** menu.

2   Select **SpHb / SpOC** from the menu.

3   Select if the **SpHb** measurement should be **Enabled** or **Disabled**. **SpOC** is only enabled when the **SpHb** measurement is **Enabled**.

4   Select if **SpOC Alarms** should be **On** or **Off** for the measurement.

5   Enter values for the **SpOC High Limit** and **SpOC Low Limit**.

SpHb Average

Depending on your configuration, you may be able to select the averaging period for SpHb in Monitoring Mode. The choices are **Short**, **Medium**, or **Long**. This setting adjusts the responsiveness of the SpHb measurement to make rapid variations of SpHb values more visible.

Setting Up PVI

The Pleth Variability Index (PVI) numeric may reflect physiological factors such as vascular tone, circulating blood volume, and intrathoracic pressure excursions.

1   Select the **Setup SpO₂** menu.

2   Select **PVI** from the menu.

3   Select if the **PVI** measurement should be **On** or **Off**.

4   Select if **Alarms** should be **On** or **Off** for the measurement.

5   Enter values for the **High Limit** and **Low Limit**.

NOTE

If the PVI measurement is on, the Pleth wave is shown with potential respiratory modulation and without gridlines. If the PVI measurement is off, the Pleth wave is displayed with gridlines.

Setting Up Perf

The Perf measurement is only available, if it is set to **On** during configuration.

1   Select the **Setup SpO₂** menu.

2   Select **Perf** from the menu.

3   Select if **Alarms** should be **On** or **Off**.

4   Enter values for the **High Limit** and **Low Limit**.

Setting up Perf Baseline

Select **Set Baseline** to update the Perf baseline. Setting the Perf baseline also turns on the **3D Perf Delta**. Whenever the perfusion baseline is set, the alarm active time is set automatically to the configured 3D Perf Delta **Duration**.

Setting up 3D Perf Delta

1 Select **3D Perf Delta** from the menu.

2 Select if the **3D Perf Delta** should be **On** or **Off**.

3 Enter a value for the **% Decrease** parameter.

4 Enter a value for the **Duration** the alarm should be active.

NOTE

The **3D Perf Delta** is switched off when the sensor is unplugged, or when a **Sensor Off** condition occurs, or when a patient is discharged. It will not be re-enabled automatically. The extended alarm text contains the maximum exceeded Perf Delta value.

Setting Up RRac

The RRac numeric reflects the respiration rate at the measurement location. SpO_2 monitoring is required when monitoring RRac.

1 Select the **Setup SpO₂** menu.

2 Select **RRac** from the menu.

3 Select if the **RRac** measurement should be **On** or **Off**.

4 Select if **Alarms** should be **On** or **Off** for the measurement.

5 Enter values for the **High Limit** and **Low Limit**.

6 Set the **Pause Time** from minimum 15 sec to maximum 40 sec, in steps of 5 sec. The **Pause Time** is the maximum time the measurement will wait between breaths of the patient before alarming.

7 Set the **Max.Extd. Update** choosing from 0, 1, 5, 10, or 15 minutes.
The **Max.Extd. Update** value determines the maximum amount of time the measurement displays the last known RRac value before the value becomes invalid. If it is set to a value other than 0, and the measurement cannot detect a respiration signal, there is no immediate indication (INOP issued) that the displayed status is an older one, and that currently no measurement is possible. If you do change the value, you are prompted to confirm your choice.
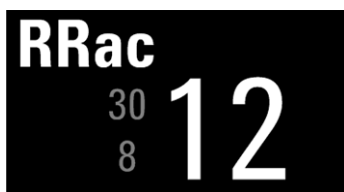
Monitoring NBP

This monitor uses the oscillometric method for measuring NBP.

The NBP measurement is suitable for use in the presence of electrosurgery and during the discharge of a cardiac defibrillator according to IEC 80601-2-30.

A physician must determine the clinical significance of the NBP information.

9.1. Introducing the Oscillometric NBP Measurement

Oscillometric devices measure the amplitude of pressure changes (oscillations) in the occluding cuff as the cuff deflates from above systolic pressure. The amplitude suddenly increases as the pulse breaks through the occlusion in the artery. As the cuff pressure decreases further, the pulsations increase in amplitude, reach a maximum (which approximates to the mean pressure), and then diminish.

WARNING

9.2. **Patient Category**: Select the correct patient category setting for your patient. The higher adult/pediatric initial inflation pressures, overpressure limit and measurement duration may cause injury (hematoma) to neonatal patients. Further, blood pressure readings may be incorrect, if the selected patient category does not match the patient.

Intravenous infusion: Do not use the NBP cuff on a limb with an intravenous infusion or arterial catheter in place. This could cause tissue damage around the catheter when the infusion is slowed or blocked during cuff inflation.

Skin Damage/Existing Wounds: Measuring NBP in any condition where skin damage has occurred or is expected (i.e. sickle cell disease), or applying the cuff over a wound can cause further injury. Exercise clinical judgment in these cases to assess whether the benefit outweighs the risk.

Mastectomy or Lymph Node Clearance: Avoid applying the cuff on the side of the mastectomy or lymph node clearance, as the pressure increases the risk of lymphedema. For patients with a bilateral mastectomy or lymph node clearance, use clinical judgement to decide whether the benefit of the measurement outweighs the risk.

Unattended Measurement: Use clinical judgement to decide whether to perform frequent unattended blood pressure measurements. Too frequent measurements can cause blood flow interference potentially resulting in injury to the patient. In cases of severe blood clotting disorders frequent measurements increase the risk of hematoma in the limb fitted with the cuff.

Temporary Loss of Function: The pressurization of the cuff can temporarily cause loss of function of monitoring equipment used simultaneously on the same limb.

CAUTION

If you spill liquid onto the equipment or accessories, particularly if there is a chance that it can get inside the tubing or the measurement device, contact your service personnel.

Measurement Limitations

NBP readings can be affected by the position of the patient, their physiological condition, the measurement site, and physical exercise. Thus a physician must determine the clinical significance of the NBP information.

Measurements are impossible with heart rate extremes of less than 40 bpm or greater than 300 bpm, or if the patient is on a heart-lung machine.

The measurement may be inaccurate or impossible:

- with excessive and continuous patient movement such as shivering or convulsions

- if a regular arterial pressure pulse is hard to detect with cardiac arrhythmias

- with rapid blood pressure changes

- with severe shock or hypothermia that reduces blood flow to the peripheries

- with obesity, where a thick layer of fat surrounding a limb dampens the oscillations coming from the artery

- on an edematous extremity.

The effectiveness of this sphygmomanometer has not been established in pregnant, including pre-eclamptic patients.

When the accelerated measurement is used the minimum number of oscillations per deflation step is 1, instead of the 2 in the standard measurement. This allows a faster measurement result but requires that the patient keeps the limb in question still. The accelerated measurement is recommended for use when very few or no artifacts are expected, for example with sedated patients.

You can see whether the accelerated measurement is in use by looking in the **Setup NBP** menu. The **Accelerated Msmt** setting shows whether the accelerated measurement is **Off**, on for **Manual** measurements or on for **All** measurements. You can see this setting in Monitoring Mode but it can only be changed in Configuration Mode.

When the accelerated measurement is in use, no pulse rate is derived from NBP.

Measurement Modes

There are three modes for measuring NBP:

- **Manual** - measurement on demand.

9.4.
- **Auto** - continually repeated measurements (between one minute and 24 hours adjustable interval).

- **Sequence** - up to four measurement cycles which will run consecutively, with number of measurements and interval between them configurable for each cycle.

Auto and **Sequence** modes must be set up, before a measurement series can be started. See "Enabling Automatic Mode and Setting Repetition Time" on page 200 and "Enabling Sequence Mode and Setting Up The Sequence" on page 201.

Additionally, you have the possibility to start an immediate, one-time measurement series at any time:

9.4.
- **STAT** - rapid series of measurements over a five minute period. Use only on supervised patients.

After a STAT measurement series, the monitor returns to the previous mode. If an **Auto** or **Sequence** measurement series was running before the STAT measurement, it will continue to run afterwards.

Reference Method

The measurement reference method can be Auscultatory (manual cuff) or Invasive (intra-arterial). For further information, see the Application Note supplied on the monitor documentation DVD.

In Neonatal mode, to comply with safety standards, invasive is always used as the reference method. This setting cannot be changed and is not visible in any operating mode.

In Adult and Pediatric mode, to check the current setting, select **Main Setup**, **Measurements**, then **NBP**, and check whether the **Reference** setting is set to **Auscult.** or **Invasive**. This setting can only be changed in Configuration Mode.

Every time a new measurement is started or the reference method is changed, the reference method is also displayed in the monitor information line for several seconds and a prompt tone is issued.

Preparing to Measure NBP

1 Connect the cuff to the air tubing.

2 Plug the air tubing into the red NBP connector. Avoid compression or restriction of pressure tubes. Air must pass unrestricted through the tubing.

WARNING

• Kinked or otherwise restricted tubing can lead to a continuous cuff pressure, causing blood flow interference and potentially resulting in injury to the patient.

• IntelliVue patient monitors use an alternative small-bore connector design different from those specified in the ISO 80369 series for the NBP measurement. Thus, there is a possibility that misconnection can occur between the NBP measurement of IntelliVue patient monitors and other medical devices using small-bore connectors, which can result in a hazardous situation causing harm to the patient. Take appropriate measures to mitigate these potential risk (e.g. user training, marking of affected connectors/devices, etc.).

---

1 Make sure that you are using a Philips-approved correct sized cuff and that the bladder inside the cover is not folded or twisted.
A wrong cuff size, and a folded or twisted bladder, can cause inaccurate measurements. The width of the cuff should be in the range from 37% to 47% of the limb circumference. The inflatable part of the cuff should be long enough to encircle at least 80% of the limb.

2 Apply the cuff to a limb at the same level as the heart. If it is not, you must use the measurement correction formula to correct the measurement.
The marking on the cuff must match the artery location. Do not wrap the cuff too tightly around the limb. It may cause discoloration, and ischemia of the extremities.

WARNING

Inspect the application site regularly to ensure skin quality and inspect the extremity of the cuffed limb for normal color, warmth and sensitivity. If the skin quality changes, or if the extremity circulation is being affected, move the cuff to another site or stop the blood pressure measurements immediately. Check more frequently when making automatic or stat measurements.

Correcting the Measurement if Limb is not at Heart Level

To correct the measurement if the limb is not at heart level, to the displayed value

Add 0.75 mmHg (0.10 kPa) for each **centimeter** higher or	Deduct 0.75 mmHg (0.10 kPa) for each **centimeter** lower or
Add 1.9 mmHg (0.25 kPa) for each **inch** higher.	Deduct 1.9 mmHg (0.25 kPa) for each **inch** lower.

Recommendations For Measurements Used in Diagnosis of Hypertension

To make a measurement for use in the diagnosis of hypertension, follow the steps below:

1 Ensure the patient is comfortably seated, with their legs uncrossed, feet flat on the floor and back and arm supported.

2 Ask the patient to relax and not talk before and during the measurement.

3 If possible, wait 5 minutes before making the first measurement.

Understanding the NBP Numerics
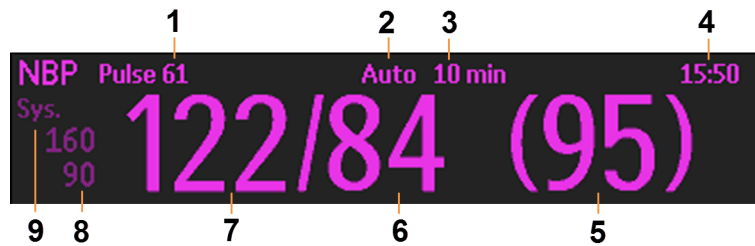
1   Pulse numeric

2   Measurement Mode

3   Repetition Time

4   Timestamp/Timer

5   Mean pressure

9.5.   6   Diastolic

7   Systolic

8   Alarm limits

9   Alarm source

Depending on the NBP numeric size, not all elements may be visible. Your monitor may be configured to display only the systolic and diastolic values. If configured to do so, the pulse from NBP will display with the NBP numeric.

The measured NBP value, together with the corresponding pulse rate if this is switched on, will be displayed for one hour. After that the values are regarded as invalid and are no longer displayed.

During this hour, measurement values may be grayed out or disappear from the screen and be replaced by dashes after a set time, if configured to do so. This avoids older numerics being misinterpreted as current data. The time can be set in Configuration mode.

In **Auto** mode the measurement values may disappear more quickly (to be replaced by new measurement values), if the repeat time is set to less than one hour.

If no NBP values are available at the moment, three dashes are displayed instead of the NBP numerics.

One or two dashes instead of one or multiple numerics indicate that a measurement is in progress and values will follow.
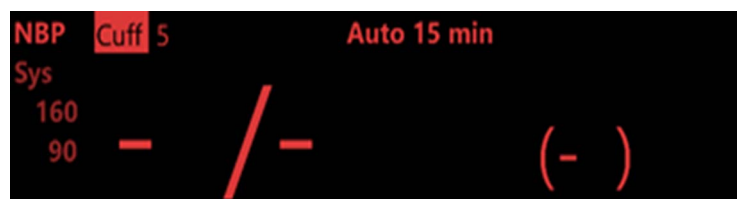
Alarm Sources

If you have parallel alarm sources, the sources are displayed instead of the alarm limits.

NBP Timestamp

Depending on your configuration, the time shown beside the NBP numeric can be:

– the time of the most recent NBP measurement, also known as the "timestamp", or

– the time until the next measurement in an automatic series, displayed with a graphic representation of the remaining time, as shown here.

The NBP timestamp will normally show the **completion** time of the NBP measurement. Only under the following conditions the timestamp shows the **beginning** of the measurement:

• when in **Auto** or **Sequence** mode, **and**

• the monitor is configured to synchronize the measurements in a measurement series to an "easy-to-document" time. For example, if you start the first measurement at 08:23, and the **Repeat Time** is set to 10 minutes, the monitor automatically performs the next measurement at 8:30, then 8:40 and so on.

During Measurements

The cuff pressure is displayed instead of the units and the repeat time. An early systolic value gives you a preliminary indication of the systolic blood pressure during measurement.

When Unexpected Values are Measured

When values measured are higher or lower than expected, check the following potential causes:

Possible Cause	Solution
The patient was talking or moving before or during the measurement.	Allow the patient to rest quietly, then try again after three to five minutes.
The incorrect cuff size was used or the cuff was not at heart level	Check the cuff size, level, and position then repeat the measurement.
The noninvasive blood pressure reference method is set incorrectly.	Check the reference method (auscultation or intra-arterial) in the **Setup NBP** menu. If it is incorrect, have it changed in Configuration Mode.
Measurement limitations have not been taken into account.	Check the list in "Measurement Limitations" on page 196.
NBP algorithm searching in wrong cuff pressure range. Artifacts during a previous measurement have falsified internal parameters of the algorithm (e.g. inflation pressure)	Press **Stop All NBP** and start a NBP measurement or restart NBP measurement series. This resets the internal parameters of the NBP algorithm.
The standards for measuring NBP have not been adhered to.	Make sure you use the current standards to measure NBP.

Starting and Stopping Measurements

Use the **Setup NBP** menu or SmartKeys to start and stop measurements.

Action to be performed	NBP Setup menu	SmartKeys
Start manual measurement **Start Auto series**	Start/Stop NBP	 **Start/ Stop NBP**
		  Start NBP

Action to be performed	NBP Setup menu	SmartKeys
Start STAT measurement	NBP STAT	NBP STAT
		Start NBP STAT
Stop Manual measurements	Start/Stop NBP	Start/ Stop NBP
		Stop NBP
Stop current Auto measurement	Start/Stop NBP	Start/ Stop NBP
		Stop NBP
Stop ongoing measurement and end STAT series	Start/Stop NBP	Start/ Stop NBP
	NBP STAT	NBP STAT
		Stop NBP
Stop Auto, Manual or STAT measurement AND series	Stop All NBP	Stop All NBP

CAUTION

Use clinical judgment to decide whether to perform repeated series of STAT measurements because of the risk of purpura, ischemia and neuropathy in the limb with the cuff.

Enabling Automatic Mode and Setting Repetition Time

1 In the **Setup NBP** menu, select **Mode** and select **Auto** from the pop-up menu.

2 For an automatic measurement, select **Repeat** and set the time interval between two measurements.

Enabling Sequence Mode and Setting Up The Sequence

1 In the **Setup NBP** menu, select **Mode** and select **Sequence** from the pop-up menu.

2 Select **Setup Sequence** to open the **Setup Sequence** window.
Up to four measurement cycles can be set up which will run consecutively. For each cycle you can set the number of measurements and the interval between them. If you want to run less than four cycles in a sequence, you can set the number of measurements for one or more cycles to **Off**.

3 Select each sequence in turn and select the number of measurements and the time interval between the measurements.

4 To have measurements continue after the sequence, set the number of measurements for your last cycle to **Continuous** and this cycle will run indefinitely.

CAUTION

Be aware that, if none of the cycles are set to **Continuous**, NBP monitoring will end after the last measurement of the cycle.

When the NBP measurement mode is set to **Sequence**, the repetition time for **Auto** mode cannot be changed.

Choosing the NBP Alarm Source

You can monitor for alarm conditions in systolic, diastolic and mean pressure, either singly or in parallel. Only one alarm is given, with the priority of mean, systolic, diastolic.

In the **Setup NBP** menu, select **Al. from** and choose from:

Menu option	Pressure value monitored
Sys.	systolic
Dia.	diastolic
Mean	mean
Sys & Dia	systolic and diastolic in parallel
Dia & Mean	diastolic and mean in parallel
Sys & Mean	systolic and mean in parallel
Sys&Dia&Mean	all three pressures in parallel

If **Mean** is not selected as alarm source (**Sys.**, **Dia.**, or **Sys & Dia** selected), but the monitor can only derive a mean value, mean alarms will nevertheless be announced using the most recent mean alarm limits. Check that the mean alarm limits are appropriate for the patient, even when not using mean as the alarm source. When no value can be derived an **NBP Measure Failed** INOP will be displayed.

Switching Pulse from NBP On/Off

In the process of making the NBP measurement, a pulse value can be derived and displayed. The pulse value is displayed together with the time the measurement was made. After one hour the value becomes invalid. There are no alarms associated with pulse from NBP.

When the accelerated measurement is in use, no pulse value can be derived.

To switch the display of the pulse value on or off:

• In the **Setup NBP** menu select **Pulse (NBP)**.

Assisting Venous Puncture

You can use the NBP cuff to cause subdiastolic pressure. The cuff deflates automatically after a set time (adult/pediatric 170 seconds, neonatal 85 seconds) if you do not deflate it.

1   In the **Setup NBP** menu select **VeniPuncture**.

2   Puncture vein and draw blood sample.

3   Reselect **VeniPuncture** to deflate the cuff.

During measurement, the NBP display shows the inflation pressure of the cuff and the remaining time in venous puncture mode.

NOTE

Performing a venous puncture while automatic or sequence NBP measurements are being made suspends the measurement series for the duration of the venous puncture inflation and for three minutes afterwards.

Calibrating NBP

NBP is not user-calibrated. NBP pressure transducers must be verified at least once every two years by a qualified service professional, and calibrated, if necessary. Refer to the Service Guide for more information.

Monitoring Temperature

WARNING

Measurements from a **previous generation** Measurement Extension connected to an MX100/X3 are not available when the MX100/X3 is running on its own battery power. They are only available when the MX100/X3 is powered by external power: when connected to a host monitor (X3 only), to the external power supply (M8023A), to the Battery Extension (865297) or to IntelliVue Dock (867043).

You can measure temperature using the built-in temperature measurement (optional), or one of the Measurement Extensions.

The Temp measurement automatically switches on when you connect a probe. You can switch the measurement off manually.

The displayed temperature is the temperature measured directly at the measurement site. No predictions or adjustments are made (direct mode thermometer).

Making a Temp Measurement

1   Select the correct type and size of probe for your patient.

2   If you are using a disposable probe, connect the probe to the temperature cable.

3   Plug the probe or temperature cable into the temperature connector socket.

4   Apply the probe to the patient. You are advised to use a protective rubber cover on rectal probes.

5   Select an appropriate temperature label.

6   Check that the alarm settings (on or off, high and low limits) are appropriate for this patient and this type of temperature measurement.

WARNING

Make sure you set alarm limits for the correct label. The alarm limits you set are stored for that particular label only. Changing the label may change the alarm limits.

Selecting a Temperature for Monitoring

Tell the monitor which temperature you want to monitor by selecting its temperature label. The label is a unique identifier for each type of temperature. When you choose a label, the monitor uses that label's stored color and alarm settings.

1   In the **Setup <Temp Label>** menu, select **Label**.

2   Select the appropriate label from the list.

Temp	non-specific temperature label	**Trect**	rectal temperature
Tart	arterial temperature	**Tskin**	skin temperature
Tcore	core temperature	**Tven**	venous temperature
Tesoph	esophageal temperature	**Tnaso**	nasopharyngeal temperature

Extended Temperature Label Set

The following additional labels are available if **Label Set** is set to **Full**. This setting can only be changed in Configuration Mode.

Note that if your monitor is connected to an Information Center, the additional labels in the extended label set may not be correctly displayed. See the Configuration Guide for your monitor for more information.

T1, **T2**, **T3**, **T4**	Non-specific temperature labels
Tamb	ambient temperature
Tbladd*	bladder temperature
Tcereb	cerebral temperature
Tfoley*	foley temperature
Ttymp	tympanic temperature
Tvesic	vesical temperature

*If Tbladd or Tfoley is active in an X3, and the X3 is connected to a host monitor that does not support these labels, the X3 will not enter companion mode and a prompt "*Deactivate <label> or change label to enter Companion mode*" will be issued.

Calculating Temp Difference

The monitor can calculate and display the difference between two temperature values by subtracting the second value from the first. The difference is labeled **ΔTemp**.

1   In the **Main Setup** menu, select **Measurements**.

2   Select **ΔTemp**.

3   In the **Setup ΔTemp** menu, select **First Temp**.

4   Select the appropriate label for the measurement source.

5   Select **Second Temp**.

Select the appropriate label for the second measurement source.

The **ΔTemp** value is not available when the X3 is connected to a host monitor.

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Monitoring Invasive Pressure

WARNING

Measurements from a **previous generation** Measurement Extension connected to an MX100/X3 are not available when the MX100/X3 is running on its own battery power. They are only available when the MX100/X3 is powered by external power: when connected to a host monitor (X3 only), to the external power supply (M8023A), to the Battery Extension (865297) or to IntelliVue Dock (867043).

You can measure pressure using the monitor's built-in pressure measurement (optional), or one of the Measurement Extensions.

The built-in pressure measurement, and the pressure measurement in the current generation measurement extensions, are dual pressure measurements. With one pressure connector, two pressures can be measured. To measure two pressures, you need a dual pressure cable or adapter. See "Invasive Pressure Accessories" on page 295 for details.

The two arms of the dual pressure cable are marked for identification with one ring and two rings. In the **Measurement Selection** window, the two pressure connectors are shown overlapping. When you select one of the labels, a symbol is displayed showing one bar or two bars, corresponding to the arm of the dual pressure cable that the pressure transducer is connected to.

If you connect a transducer without using a dual pressure cable or adapter, only one pressure can be measured.

The X3 and the current generation Measurement Extensions can be used in companion mode with IntelliVue Patient Monitors with software revision ≥J.0. However, the dual pressure measurement is only available with host monitors with software revision M.0 or higher.

CAUTION

Do not use dual pressure cables with the X3 or a current generation Measurement Extension if you are planning on using them in companion mode with a host monitor with software revision <M.0. If you use an X3 or a current generation Measurement Extension in companion mode with a host monitor with software revision <M.0, the second pressure channel will be deactivated.

Setting up the Pressure Measurement

1 Plug in the pressure cable. If you are connecting two pressure lines, use the appropriate adapter cable (see "Invasive Pressure Accessories" on page 295) to connect the lines to the pressure connector.

2 Prepare the flush solution.

3 Flush the system to exhaust all air from the tubing. Ensure that the transducer and stopcocks are free of air bubbles.

WARNING

If air bubbles appear in the tubing system, flush the system with the infusion solution again. Air bubbles may lead to a wrong pressure reading.

4   Connect the pressure line to the patient catheter.

5   If you are using an infusion pressure cuff with the pressure line, attach the pressure cuff to the fluid to be infused. Inflate it according to your standard hospital procedure, then start the infusion.

6   Position the transducer so that it is level with the heart, approximately at the level of the midaxillary line.

WARNING

If measuring intracranial pressure (ICP, IC1 or IC2) with a sitting patient, level the transducer with the top of the patient's ear. Incorrect leveling may give incorrect values.

No special measures regarding the use of HF surgical equipment must be taken when setting up the pressure measurement. The use of HF surgical equipment does not lead to a hazard of burns with this type of measurement, also not in the event of a defective neutral electrode at the HF device.

Selecting a Pressure for Monitoring

Tell the monitor the source of the pressure you want to monitor by selecting an appropriate pressure label. The label is a unique identifier for each type of pressure. When you choose a label, the monitor uses that label's stored settings, for example color, wave scale and alarm settings. The label also determines which algorithm is used to process the pressure signal, so an incorrect label can lead to incorrect pressure values.

1   In the **Setup <Press Label>** menu, select **Label**.

2   Select the appropriate label from the list.

Label	Description
ABP	Arterial blood pressure
ART	Arterial blood pressure (alternative)
Ao	Aortic pressure
CVP	Central venous pressure
ICP	Intracranial pressure
LAP	Left atrial pressure
P	Non-specific pressure label
PAP	Pulmonary artery pressure
RAP	Right atrial pressure
UAP	Umbilical arterial pressure
UVP	Umbilical venous pressure

Extended Pressure Label Set

The following additional labels are available if **Label Set** is set to **Full**. This setting can only be changed in Configuration Mode.

Note that if your monitor is connected to an Information Center, the additional labels in the extended label set may not be correctly displayed. See the Configuration Guide for your monitor for more information.

Label	Description
BAP	Brachial arterial pressure
FAP	Femoral arterial pressure
IC1, IC2	Alternative intracranial pressures
P1, P2, P3, P4	Alternative non-specific pressure labels
IAP*	Intra-abdominal pressure
RFP*	Right femoral arterial pressure
LFP*	Left femoral arterial pressure
SCP*	Spinal cord pressure
UBP*	Urinary bladder pressure
Ppr*	Pressure pre
Ppo*	Pressure post
Pa1*, Pa2*, Pa3*, Pa4*	Alternative non-specific arterial pressure labels
Pv1*, Pv2*, Pv3*, Pv4*	Alternative non-specific venous pressure labels

*If IAP, RFP, LFP, SCP, UBP, Ppr, Ppo, Pa1, Pa2, Pa3, Pa4, Pv1, Pv2, Pv3, or Pv4 is active in an X3, and the X3 is connected to a host monitor that does not support these labels, the X3 will not enter companion mode and a prompt *"Deactivate <label> or change label to enter Companion mode"* will be issued.

Pressure Label Fallback Behavior

With Release N, the following new labels have been added to the extended pressure label set:

IAP, RFP, LFP, SCP, UBP, Ppr, Ppo, Pa1, Pa2, Pa3, Pa4, Pv1, Pv2, Pv3, Pv4

These labels are only available in MX100, MX400-550, and MX750/MX850 patient monitors, FMX-4 Module Racks, and MMX and X3 Multi-Measurement Modules with SW Release N.0 or higher. An FMX , MMX or an X3 in companion mode can only be used with the new labels, if the host monitor also supports the new labels.

If you are using an X3 or MMX with the new labels to transfer patients to different units, the following conditions define whether the new labels are kept or whether the X3 or MMX falls back to an alternative label:

•   whether the host monitor supports the new labels,

•   the software version of the host monitor,

•   the label set configuration in the X3 and the host monitor, and

•   whether the measurement is activated or deactivated on an X3.

X3/MMX Fallback Behavior

The following table lists the different scenarios and the corresponding fallback behavior.

Multi-Measurement Module	Host Monitor	Fallback Behavior
X3 with new labels activated	Host monitor supports new labels	Labels in X3 are kept, even if the label set in the host monitor is set to **Restricted**.
X3 with new labels activated	Host monitor does not support new labels	• X3 does not enter companion mode. • **X3 Unsupported** INOP is issued on the host monitor. • Notification message **Device on MSL with incompatible SW** is displayed on the host monitor. • **Deactivate or change label to enter Companion Mode** is displayed on X3. • Once you have deactivated or changed all unsupported labels, it may take up to one minute until companion mode is established and all notification messages have been cleared.
X3 with new labels deactivated	Host monitor does not support new labels	X3 falls back to alternative label. See Configuration Guide for details.
MMX	Host monitor supports new labels	• Labels in the MMX are kept if the label set in the host monitor is set to **Full** • Labels in the MMX are not kept, if the label set in the host monitor is set to **Restricted**. The MMX falls back to an alternative label. See Configuration Guide for details.
MMX	Host monitor does not support new labels	MMX falls back to an alternative label. See Configuration Guide for details.

Overview of Calibration Procedures

Calibration requirements depend on the situation and the type of transducer used. Recommendations for the different calibration procedures are given in the table below.

Procedure	When to perform	For which transducers?	
		Disposable	Reusable
Zero	• Every time you use a new or a different transducer or tubing • Every time you reconnect the transducer to the monitor • If you think the monitor's pressure readings are not correct	X	X

Procedure	When to perform	For which transducers?	
		Disposable	Reusable
Calibration	**Calibration Procedure** • Every time you use a new or a different transducer • According to your hospital policy	N/A	X
	Adjust Calibration Factor • When switching from a reusable to a disposable transducer or vice versa	X (Always set calibration factor to 200)	X (Can be done instead of the calibration procedure when a calibration factor is marked on your reusable transducer)

CAUTION

The calibration factor is not stored in the monitor's configuration file. This setting is stored in the built-in pressure hardware or the pressure plug-in module and is used by the monitor until it is changed (initial factory default of 200). The calibration factor setting does not return to a default when the profile is reloaded or a patient is discharged. Make sure you are using the correct calibration factor. An incorrect calibration factor will affect readings.

Zeroing the Pressure Transducer

To avoid inaccurate pressure readings, the monitor requires a valid zero. Zero the transducer in accordance with your hospital policy. You must perform a zero:

• when you use a new transducer or tubing

• every time you reconnect the transducer cable to the monitor

• if you think the monitor's pressure readings are not correct.

Zeroing ICP (or IC1/IC2) and SCP

Your hospital guidelines may require you to zero the ICP and SCP transducer less frequently than other transducers, due to the need for aseptic conditions. When you zero an ICP or SCP transducer, the zero values are automatically stored and you will not be prompted to repeat the zero procedure.

If you want to simultaneously zero all pressures except ICP and SCP, disconnect the ICP and SCP transducer from the monitor while zeroing. Reconnecting the transducer recalls the stored values.

WARNING

If you select the label ICP (or IC1/IC2) or SCP, the measurement device uses the most recently stored zero. Therefore, make sure you zeroed the transducer correctly in accordance with the transducer manufacturer's instructions and your hospital policy. When you use a transducer that you cannot rezero after placement, ensure that you keep the measuring device with the patient so that you are certain you have the correct zero data for this patient.

Determining a Pressure's Most Recent Zero

The monitor displays a message with the most recent zero. If this has "timed-out" after you have performed a zero, redisplay the information by entering the pressure's setup menu.

Zeroing a Pressure Measurement

WARNING

Invasive pressure alarms (and pulse alarms, if derived from invasive pressure) are temporarily suppressed until 30 seconds after the transducer finishes zeroing.

1 Turn off the stopcock to the patient.

2 Vent the transducer to atmospheric pressure, to compensate for the static and atmospheric pressure exerted on the transducer.

3 In the setup menu for the pressure, select **Zero <Press Label>**.

4 When you see the message **<Press Label> zero done at <Date and Time>** on the screen, close the stopcock to atmospheric pressure, and open the stopcock to the patient.

CAUTION

When using high frequency ventilation, ensure that the tubing from the ventilator does not touch the arterial line, or connect with it indirectly, while zeroing the pressure. This could cause small pressure variations which can interfere with the zero procedure.

Troubleshooting the Zero

A message appears with the probable cause of an unsuccessful zero:

Message	Corrective Action
<Press Label> can't zero; equipment malf.	The hardware is faulty. Contact your service personnel.
<Press Label> can't zero; excessive offset	Make sure the transducer is vented to air and try again. If this fails, the hardware may be faulty. Replace the adapter cable and try again. If it fails, replace the transducer and try again. If it still fails, contact your service personnel.
<Press Label> can't zero – unstable signal	
<Press Label> can't zero – no transducer	Make sure that the transducer is connected and try again. If this fails, exchange the adapter cable and try again. If this fails, exchange the transducer.
<Press Label> can't zero; pulsat. pressure	Make sure that the transducer is vented to air, not to the patient, and try again.
<Press Label> unable to zero – timed out	Try pressing the Zero key again. If this fails, replace the transducer and adapter cable and contact your service personnel.
Switch <Press Label> on first	Pressure measurement is switched off. To switch it on, in the Setup Pressure menu, select the pressure's label.

Calibrating Reusable Transducers

Depending on your monitor's configuration, you may be able to perform a calibration in monitoring mode. Perform a mercury calibration when you use a new transducer, and at regular intervals according to your hospital policy. You require:

• reference manometer, accuracy +/-0.8 mmHg.

• sterile 10cc syringe with heparinised solution.

• 3-way stopcock.

• approximately 25 cm of tubing.

NOTE

Only reusable transducers must be calibrated.

Making the Pressure Calibration

WARNING

Never perform the invasive pressure calibration while a patient is being monitored.

1 Zero the transducer.

2 Connect the syringe and manometer.

    a. Attach the tubing to the manometer.

    b. Connect the 3-way stopcock to the stopcock that is not connected to the patient catheter when you measure a patient.

    c. Attach the syringe to one port and the manometer tubing to the other port.

    d. Open the port to the manometer.
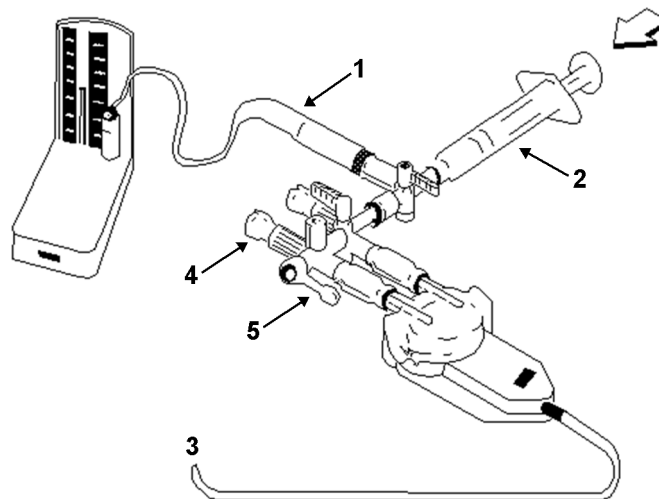
1 Tubing to manometer
2 Syringe with heparinised solution
3 To pressure connector on monitor
4 Patient connection stoppered
5 Off

3 Move the syringe plunger in and raise the mercury to 200 mmHg (30 kPa). 200 mmHg is the recommended calibration pressure.

4 In the **Setup <Press Label>** menu, select **Cal. Press**.

5 Select the calibration pressure from the list, for example 200 mmHg.

6 Select **Confirm** to recalculate the calibration factor using the applied pressure.

7 When the monitor displays **<Press Label> calibration done at <Date and Time>**, remove the manometer tubing, syringe and extra stopcock. We recommend you replace the transducer dome and tubing with sterile ones.

8 Label the transducer with the calibration factor shown in the **Cal. Factor** field in the pressure's setup menu.

9 Reconnect the patient and start measuring again.

Troubleshooting the Pressure Calibration

A message appears with the probable cause of an unsuccessful calibration.

Message	Corrective Action
<Press Label> can't calibr.; equipmt malf.	Contact your service department. The pressure hardware is faulty.
<Press Label> can't calibrate;out of range	Make sure that you have selected the value for **Cal. Press** that you are applying to the transducer, and repeat the calibration.
<Press Label> can't calibrate; no transd.	Make sure that the transducer is connected and try again.
<Press Label> can't cal.; unstable signal	Make sure there are no disturbances to the transducer, and repeat the calibration.
<Press Label> can't calibr.;do zero first	No valid zero. Zero the transducer.

Adjusting the Calibration Factor

Each time you use a reusable transducer, compare the calibration factor written on your transducer with the calibration factor shown on the monitor. To ensure accurate measurement, they **must** be the same.

1   In the **Setup <Press Label>** menu, select **Cal. Factor**.
    If the value here does **not** match that on the transducer, select the corresponding value from the list, in accordance with your hospital's procedure.

2   To confirm you want to use the new calibration factor, select the **Confirm** pop-up key.

Displaying a Mean Pressure Value Only

Use this when you want to see only the mean pressure.

In the pressure's setup menu, select **Mean only**. Toggle between **On** to display mean pressure value only, and **Off** to display all pressure values (systolic, diastolic and mean).

Changing the Pressure Wave Scale

1   Select the label of the pressure wave whose scale you want to set to enter the **Setup <Press Label>** menu.

2   In the **Setup <Press Label>** menu, (for example **ABP**) select **Scale**.

3   Select a value from the pop-up list:

    –   a positive value sets the top gridline. The bottom gridline is set at zero.

    –   a negative value sets the bottom gridline. The middle gridline is set at zero.

Optimizing the Waveform

In the **Setup <Press Label>** menu, select **Optimum Scale** to let the monitor select the best minimum and maximum scales for the current wave.

Non-Physiological Artifact Suppression

Some clinical procedures may affect blood pressure, for example, a flush procedure or a blood sample. Your monitor may be configured to suppress these non-physiological artifacts for a specified duration (**Artifact Suppr.** is configured to **30 sec**, **60 sec**, or **90 sec**). During artifact suppression, the monitor shows the INOP message **<Press Label> Artifact**, and a question mark is shown beside the pressure numerics. Pressure alarms and the **<Press Label> No Pulse** INOP are suppressed during the configured period. The CPP alarms are not suppressed.

Choosing the Pressure Alarm Source

WARNING

Make sure you set alarm limits for the correct label. The alarm limits you set are stored for that particular label only. Changing the label may change the alarm limits.

You can monitor for alarm conditions in systolic, diastolic and mean pressure, either singly or in parallel. Only one alarm is given at a time, in this order of priority: mean, systolic, diastolic.

- In the **Setup <Press Label>** menu, select **Al. from** and choose the source.

Menu option	Pressure value monitored
Sys.	systolic
Dia.	diastolic
Mean	mean
Sys & Dia	systolic and diastolic in parallel
Dia & Mean	diastolic and mean in parallel
Sys & Mean	systolic and mean in parallel
Sys&Dia&Mean	all three pressures in parallel

Select and set the **High Limit** and **Low Limit** for the pressure(s) you have selected.

Extreme Alarm Limits for Pressure

The extreme pressure alarms, Extreme High and Extreme Low, can be made available for your monitor in Configuration Mode and are additional to the standard High and Low limit alarms. They are generated by the active pressure alarm source, and are setup in Configuration Mode by adding a set value (the Δ value) to the high and low alarm limits. This value can be set for each pressure label individually.
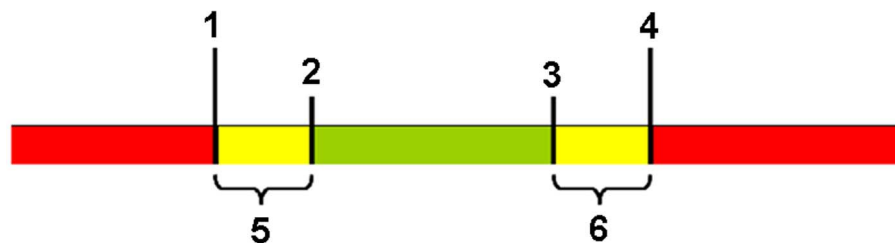
1   Extreme Low Limit

2   Low Limit

3   High Limit

4   Extreme High Limit

5   Δ Extreme Low

6   Δ Extreme High

You need to know which values have been configured for your monitor. Changing the high and low alarm limits automatically changes the extreme alarm limits within the allowed range.

To see the extreme pressure alarms set for your monitor, in the setup menu for that pressure, see the menu items **ΔExtr.High** and **ΔExtr. Low**.

The extreme pressure alarms are high priority, red alarms, marked ******* in the alarm message.

Calculating Cerebral Perfusion

The monitor can calculate the difference between mean arterial pressure and the intracranial pressure. The difference is labeled CPP.

1   In the **Main Setup** menu, select **Measurements**.

2   Select **CPP**.

In the **Setup CPP** menu, select which arterial pressure source should be used in the calculation.

The CPP value will not be available when the X3 is connected to a host monitor.

Calculating Pulse Pressure Variation

Pulse Pressure Variation (PPV) is calculated from beat-to-beat arterial pressure values. Pulse pressure is the difference between the systolic and the diastolic pressure values for a single beat. Pulse pressure variation is defined as the maximal pulse pressure less the minimum pulse pressure, divided by the average of the two. The average variation in pulse pressure is calculated over periods of 32 seconds.

WARNING

•   This monitor can calculate PPV from beat-to-beat values of any arterial pulsatile pressure. The circumstances under which the calculation of a PPV value is clinically meaningful, appropriate and reliable must be determined by a physician.

•   The clinical value of the derived PPV information must be determined by a physician. According to recent scientific literature, the clinical relevance of PPV information is restricted to sedated patients receiving controlled mechanical ventilation and mainly free from cardiac arrhythmia.

•   PPV calculation may lead to inaccurate values in the following situations:

    –   at respiration rates below 8 rpm

    –   during ventilation with tidal volumes lower than 8 ml/kg

    –   for patients with acute right ventricular dysfunction ("cor pulmonale").

•   The PPV measurement has been validated only for adult patients

---

To select an arterial pressure as PPV source:

1   In the **Main Setup** menu, select **Measurements**.

2   In the **Setup PPV** menu, select **ABP**, **ART**, **Ao**, **BAP**, **P**, **FAP**, **RFP**, **LFP**, **Ppr**, **Pa1**, **Pa2**, **Pa3** or **Pa4** as the arterial pressure source.

Availability of PPV

As with other measurements, PPV can be switched on and off by selecting **PPV** in its setup menu. When switched off, PPV will no longer be calculated and displayed.

For PPV you have additionally the possibility to disable the PPV measurement by selecting **Measurement** in the PPV setup menu. The two settings are **Enabled** and **Disabled**. When the PPV measurement is disabled, it no longer appears in the **Measurement Selection** window and will not cause conflicts when PPV from CCO is used.

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Monitoring Carbon Dioxide

WARNING

Measurements from a **previous generation** Measurement Extension connected to an MX100/X3 are not available when the MX100/X3 is running on its own battery power. They are only available when the MX100/X3 is powered by external power: when connected to a host monitor (X3 only), to the external power supply (M8023A), to the Battery Extension (865297) or to IntelliVue Dock (867043).

CAUTION

Only one CO_2 measurement at a time is supported.

Use the CO_2 measurement to monitor the patient's respiratory status and to control patient ventilation.

There are two methods for measuring carbon dioxide in the patient's airway:

- Mainstream measurement uses a CO_2 sensor attached to an airway adapter directly inserted into the patient's breathing system. This method is available using the monitor's built-in CO_2 measurement (optional) or using a Capnography Extension: 867040 or M3014A (Respironics CAPNOSTAT technology).

- Sidestream measurement takes a sample of the respiratory gas with a constant sample flow from the patient's airway and analyzes it with a remote CO_2 sensor. You can measure sidestream CO_2 using the monitor's built-in CO_2 measurement (optional) or using a Capnography Extension: 867040 or M3014A (Respironics LoFlo technology), or a Microstream Extension: 867041 or M3015A/B (Medtronic Microstream technology).

WARNING

Correlation: The etCO$_2$ readings do not always correlate closely with paCO$_2$, especially in neonatal patients and patients with pulmonary disease, pulmonary embolism or inappropriate ventilation.

Pharmaceuticals in aerosols: Do not measure CO_2 in the presence of pharmaceuticals in aerosols.

Explosion Hazard: Do not use in the presence of flammable anesthetics or gases, such as a flammable anesthetic mixture with air, oxygen or nitrous oxide. Use of the devices in such an environment may present an explosion hazard.

Failure of operation: if the measurement or a sensor fails to respond as described, do not use it until the situation has been corrected by qualified personnel.

Low etCO2 values: Leakages in the breathing system or sampling system may cause the displayed etCO$_2$ values to be significantly too low. Always connect all components securely and check for leaks according to standard clinical procedures. Displacement of the nasal or combined nasal oral cannulas can cause lower than actual etCO$_2$ readings. Even with combined nasal oral cannulas, the etCO$_2$ readings may be slightly lower than actual in patients breathing through the mouth only.

Oxygen 93: The use of Oxygen 93 e.g. supplied from oxygen concentrators and the impact on the measurement accuracy has not been validated and therefore Oxygen 93 shall not be used.

Measurement Principles

For both mainstream and sidestream measurements, the measurement principle is infrared transmission, where the intensity of infrared light passing the respiratory gas is measured with a photo detector. As some of the infrared light is absorbed by the CO_2 molecules, the amount of light passing the gas probe depends on the concentration of the measured CO_2.

When using a wet ventilator circuit, monitor mainstream CO_2 if available, in preference to sidestream CO_2.

The partial pressure is calculated from the gas concentration by multiplying the concentration value with the ambient pressure.

The measurement provides:

- a CO_2 waveform.

- an end tidal CO_2 (etCO_2) value: the CO_2 value measured at the end of the expiration phase.

- an inspired minimum CO_2 (imCO_2): the smallest value measured during inspiration.

- an airway respiration rate (awRR): the number of breaths per minute, calculated from the CO_2 waveform.

Medtronic Microstream Technology only
Depending on the **Max Hold** setting configured for your monitor, the etCO_2 numeric shows either the highest CO_2 value measured within the configured time period (**Max Hold** set to **10 sec** or **20 sec**) or the etCO_2 numeric shows breath-to-breath value (**Max Hold** set to **Off**).

The Microstream method also provides an **Integrated Pulmonary Index** (IPI) numeric, which is an indication of the patient's overall ventilatory status based on four measurement parameters: etCO_2, awRR, pulse rate and SpO_2. IPI can thus provide an early indication of a change in ventilatory status which may not be shown by the current value of any of these four parameters individually. The IPI is designed to provide additional information regarding patient status, possibly before etCO_2, awRR, SpO_2, or pulse rate values reach levels of clinical concern.

The IPI is available for all three groups of pediatric patients (1-3 years, 3-6 years, and 6-12 years), and for adult patients. It is displayed as a single value between 1 and 10.

Availability of the SpO_2 and pulse values for the IPI calculation is not affected by the labels used or the SpO_2 technology in the monitor.

Measuring CO2 using the CO2 Option, 867040 or M3014A

The monitor (with the CO_2 option) or the Capnography Extension measures partial pressure of carbon dioxide in a patient's expired gas using the mainstream method or the sidestream method.

The mainstream CO_2 measurement can be used, with appropriate accessories, with intubated adult, pediatric and neonatal patients. The sidestream CO_2 measurement can be used, with appropriate accessories, with intubated and non-intubated adult, pediatric, infant and neonatal patients. With intubated patients, a sample of the respiratory gas is drawn from the patient's breathing circuit through an airway adapter and a gas sampling tube. With non-intubated patients, the gas sample is drawn through a nasal or oral-nasal cannula.

WARNING

Altitude Setting: The monitor is not equipped with automatic barometric pressure compensation. Before the CO_2 measurement is used for the first time, the altitude must be set to the correct value. An incorrect altitude setting will result in incorrect CO_2 readings. The CO_2 readings will typically deviate 5% for every 1000 m difference.

CAUTION

Use the CO_2 measurement with Philips approved accessories only. Refer to the instructions for use provided with the accessory.

Preparing to Measure Mainstream CO2

You must perform a zero as described in this procedure each time you use a new airway adapter.

1   Attach the sensor connector to the CO_2 connector on the monitor (when the optional CO_2 measurement is integrated) or on the extension.

2   Wait 2 minutes, allowing the sensor to reach its operating temperature and a stable thermal condition.

3   Choose the appropriate airway adapter and connect it to the sensor head. The airway adapter clicks into place when seated correctly.
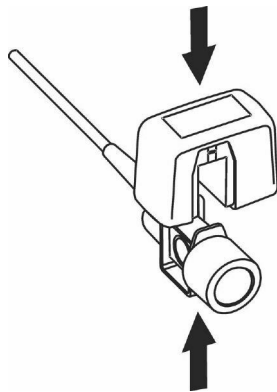
4   Zero the sensor:

   –   Expose the sensor to room air and keep it away from all sources of CO_2 including the ventilator, the patient's breath and your own.

   –   In the setup menu for the CO_2, select **Start Zero Cal**.

   –   When you see the message **CO₂ calibration done at <Date and Time>** on the screen, the zero calibration is finished and you can begin monitoring.

5   Install the airway adapter at the proximal end of the circuit between the elbow and the ventilator Y-section.
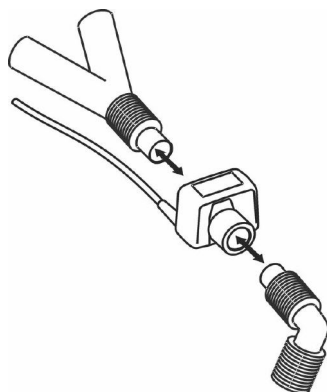
WARNING

To prevent stress on the endotracheal tube, support the sensor and airway adapter.

Position sensor cables and tubing carefully to avoid entanglement or potential strangulation. Do not apply excessive tension to any cable.

Replace the airway adapter, if excessive moisture or secretions are observed in the tubing or if the CO_2 waveform changes unexpectedly without a change in patient status.

To avoid infection, use only sterilized, disinfected or disposable airway adapters.

Inspect the airway adapters prior to use. Do not use if airway adapter appears to have been damaged or broken. Observe airway adapter color coding for patient population.

Preparing to Measure Sidestream CO2

1   Plug the sensor cable into the monitor's CO_2 input connector. Allow the sensor two minutes warm up time
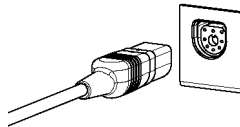
2   Connect the cannula, airway adapter, or sample line as appropriate, to the sensor. It will click into place when seated correctly.
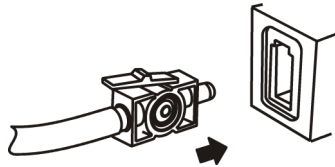
3   To zero the sensor:

– expose the sensor to room air and keep it away from all sources of CO_2 including the ventilator, the patient's breath and your own.

– in the setup menu for the CO_2, select **Start Zero Cal**.

– when you see the message **CO₂ calibration done at <Date and Time>** on the screen, the zero calibration is finished and you can begin monitoring.

4   *For intubated patients requiring an airway adapter:* Install the airway adapter at the proximal end of the circuit between the elbow and the ventilator Y-section.
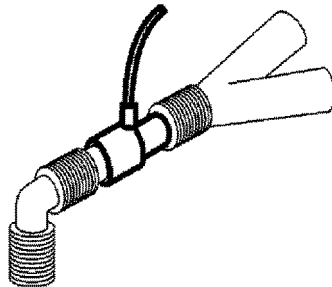
For intubated patients with an integrated airway adapter in the breathing circuit: Connect the male luer connector on the straight sample line to the female port on the airway adapter.
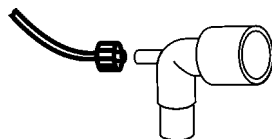
For non-intubated patients: Place the nasal cannula onto the patient.
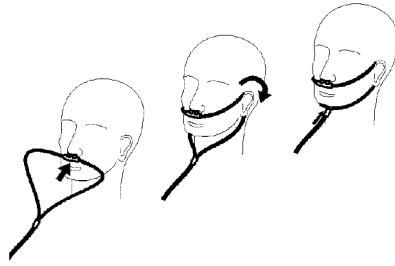
For patients prone to mouth breathing use an oral-nasal cannula.

For nasal or oral-nasal cannulas with oxygen delivery, place the cannula on the patient as shown then attach the oxygen supply tubing to the oxygen delivery system and set the prescribed oxygen flow.

WARNING

Always connect the airway adapter to the sensor before inserting the airway adapter into the breathing circuit. In reverse, always remove the airway adapter from the breathing circuit before removing the sensor.

Make sure that you do not accidentally connect the luer connector of the gas sample line to an infusion link or any other links in the patient vicinity.

CAUTION

Always disconnect the cannula, airway adapter or sample line from the sensor when not in use.

Using the Sidestream Sensor Holder

The holder delivered with the sensor can be used to clamp the sensor onto an IV pole or a shelf.
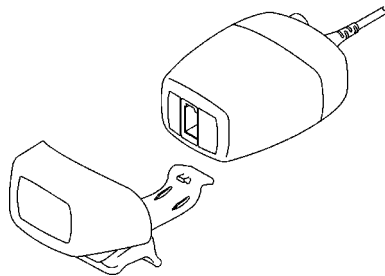
1   Push the sensor into the holder until it clicks into position.

2   Clamp the holder onto an IV pole, a shelf or another appropriate location.

To remove the sensor from the holder, release the clip and pull the sensor out of the holder.

Removing Exhaust Gases from the System

WARNING

- **Anesthetics**: When using the sidestream CO_2 measurement on patients who are receiving or have recently received anesthetics, connect the outlet to a scavenging system, to avoid exposing medical staff to anesthetics.

- **Patient cross-infection:** Do not return the sampled gas to the breathing system of the patient.

- Make sure that you do not accidentally connect the exhaust tube to an infusion link or any other links in the patient vicinity.

- Ensure that the tubing is positioned to avoid kinking or compression that could cause an occlusion.

Use an exhaust tube to remove the sample gas to a scavenging system. Attach it to the sidestream sensor at the outlet connector.

Measuring Microstream CO2 using 867041 or M3015A/B

The Microstream CO_2 Extension measures the partial pressure of carbon dioxide in a patient's expired gas using Microstream technology.

The measurement is equipped with an automatic barometric pressure compensation.

WARNING

When using the IPI numeric (available for adult and pediatric patients), always ensure that the patient's date of birth is entered correctly and that the monitor is displaying the current date. These two pieces of information are used to calculate the age of the patient, which affects the algorithm used to provide the IPI numeric.

Preparing to Measure Microstream CO2

Use appropriate accessories for:

- the patient type (adult, pediatric or neonatal),

- the ventilation situation (including humidification)

- the duration - short term use, (typically OR), or long term use (typically ICU).

All accessories are for single patient use only.

Using Microstream Accessories

The Microstream measurement can be operated with the special Microstream accessories only. Refer to the instructions for use provided with the accessory.

For intubated patients with non-humidified ventilation, you can use a Microstream FilterLine set. For humidified ventilation, use a FilterLine H Set.

For non-intubated patients, the gas sample is taken through a Nasal FilterLine, or a Smart CapnoLine (which is a combined oral-nasal FilterLine). In parallel to the measurement of the CO_2, oxygen (O_2) may be delivered to the patient to support gas exchange. This is done by using an O_2/CO_2 FilterLine, or a Smart CapnoLine O_2 (a combined oral-nasal O_2/CO_2 FilterLine).

Using the FilterLine and Airway Adapter

WARNING

Make sure that you do not accidentally connect the luer connector of the gas sample line to an infusion link or any other links in the patient vicinity.

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1 Attach the female Luer connector to the CO_2 inlet connector by pushing the socket cover aside and screwing the connector clockwise into the CO_2 inlet until it can no longer be turned.

This will assure that there is no leak of gases at the connection point during measurement and that measurement accuracy is not compromised. Following connection of the CO_2 sampling line, check that CO_2 values appear on the monitor display.

2 Check that the FilterLine is not kinked.

3 Change the FilterLine if a **CO₂ Occlusion** INOP appears on the monitor or if the readings become extremely erratic.

Disconnect the FilterLine during suctioning and nebulizing therapies or suppress sampling by turning off the pump as described in .

Check the table in the Microstream CO_2 Accessories section of the Accessories chapter for typical usage times for the different Microstream accessories.

CO_2 values for non-intubated patients using Microstream accessories will always tend to be lower than for intubated patients. If values appear extremely low, check whether the patient is breathing through the mouth or whether one nostril is blocked.

Removing Exhaust Gases from the System

WARNING

- **Anesthetics**: When using the Microstream CO_2 measurement on patients who are receiving or have recently received anesthetics, connect the outlet to a scavenging system, or to the anesthesia machine/ventilator, to avoid exposing medical staff to anesthetics.

- **Patient cross-infection**: Do not return the sampled gas to the breathing system of the patient.

- Make sure that you do not accidentally connect the exhaust tube to an infusion link or any other links in the patient vicinity.

- Ensure that the tubing is positioned to avoid kinking or compression that could cause an occlusion.

Use an exhaust tube to remove the sample gas to a scavenging system. Attach it to the Measurement Extension at the outlet connector.

Suppressing Zero Calibration

To prevent an automatic zero calibration from being started in the next five minutes,

- in the **Setup CO₂** menu, select **No Zero for 5min**, or select the **Suppress CO₂ Zero** SmartKey, if configured.

Selecting **No Zero for 5min** or selecting the **Suppress CO₂ Zero** SmartKey again before the timer has timed out resets the timer to five minutes, unless an AutoZero became due during the previous suppression.

Setting up all CO2 Measurements

These tasks are common to all CO_2 measurements except where otherwise noted.

Adjusting the CO2 Wave Scale

1 In the **CO₂ Wave** menu or the **Setup CO₂** menu, select **Scale**.

2 Choose a suitable scale range from the pop-up list.

Setting up CO2 Corrections

Temperature, water vapor in the patient's breath, barometric pressure, and the proportions of O_2, N_2O and Helium in the mixture all influence CO_2 absorption. If values seem inaccurately high or low, check that the monitor is using the appropriate corrections.

Correction	
Altitude (X3, 867040 or M3014A only)	Altitude is set during installation. The monitor automatically applies an appropriate correction.
O_2 (X3, 867040, or M3014A only)	In the **Setup CO₂** menu, select **Oxy. Corr** and select a value between 20% and 100%, the default value is 20%.
Humidity	At installation, the monitor is configured to automatically apply either Body Temperature Pressure Saturated (BTPS) or Ambient Temperature Pressure Dry (ATPD). To see which, go to the **Setup CO₂** menu, and scroll down to look at **Hum. Corr** or **Humidity Corr.**.
N_2O (867041 or M3015A/B Microstream only)	In the **Setup CO₂** menu, select **N₂O Corr.** and turn on or off. If N_2O is present in the ventilation gas mixture, you must turn this on.
	If the N_2O correction is not available in the **Setup CO₂** menu, the CO_2 measurement in your Measurement Extension does not require N_2O correction or it is setup with **Gas Corr.** (see below).
Gas (X3, 867040 or M3014A only)	In the **Setup CO₂** menu, select **Gas Corr.** and select **Helium**, **N₂O** or turn off. If Helium or N_2O is present in the ventilation gas mixture, you must make the appropriate selection.
	If the Gas correction is not available in the **Setup CO₂** menu, the CO_2 measurement in your Measurement Extension does not require N_2O or Helium correction or the N_2O correction is setup with **N₂O Corr.** (see above).
Agent (X3, 867040 or M3014A only)	In the **Setup CO₂** menu, select **Agt. Corr** and select the concentration of the anesthetic agent (between 0.0% and 20.0%). If an anesthetic agent is present in the ventilation gas mixture, you must select the appropriate concentration.

Suppressing Sampling (not Mainstream CO2)

To temporarily stop sampling, in the **Setup CO₂** menu, select **Pump 15min Off** or use the **CO₂ Pump Off** SmartKey if available.

Selecting **Pump 15min Off** again before fifteen minutes have passed resets the timer to fifteen minutes.

To re-start the pump, in the **Setup CO₂** menu, select **Pump On**.

Changing CO2 Alarms

This refers to CO_2 specific alarms. See the Alarms section for general alarm information.

To change the etCO$_2$ alarm limits, in the **Setup CO₂** menu:

1   Touch the high limit on the alarm limits menu key.

2   Choose the high alarm limit from the pop-up list that opens.

3   Touch the low limit on the alarm limits menu key.

4   Choose the low alarm limit from the pop-up list that opens.

To change the imCO$_2$ high limit:

• Select **imCO₂ High** and choose the high alarm limit from the pop-up list that opens.

Changing the Apnea Alarm Delay

This determines the time limit after which the monitor alarms if the patient stops breathing.

1   In the **Setup CO₂** menu, select **awRR**.

2   In **Setup awRR** menu, select **Apnea Time**.

3   Choose the apnea alarm delay time.

WARNING

Safety and effectiveness of the respiration measurement method in the detection of apnea, particularly the apnea of prematurity and apnea of infancy, has not been established.

Prolonged delay: The selected apnea alarm delay may be prolonged by up to 17 seconds, if an apnea occurs during the automatic zero process. This applies to the Microstream (M3015A) measurement only.

Deriving Alarms From awRR

1 In the **Setup CO₂** menu, select **awRR**.

2 In the **Setup awRR** menu, select **Alarms**.

3 Choose **On** to derive alarms from the airway respiration signal or **Off** to disable them.

Changing awRR Alarm Limits

1 In the **Setup CO₂** menu, select **awRR**.

2 Select **High Limit** to set the upper alarm limit.
Select **Low Limit** to set the lower alarm limit.

3 Select the appropriate setting.

Changing IPI Alarm Limits

Medtronic Microstream Technology only

1 In the **Setup CO₂** menu, select **IPI**.

2 Select **Low Limit** to set the low alarm limit.

3 Select a value between 2 and 9.

If you also have monitors with earlier software revisions than J.0, the IPI low alarm will not be generated after a transfer to one of these monitors, or when a monitor/Multi-Measurement Module with the IPI functionality is connected to one of these monitors in companion mode. In this case, do not rely only on the IPI low alarm but leave the individual alarms switched on (etCO$_2$, awRR, pulse rate and SpO$_2$) so that these alarms can be generated in such situations.

Understanding the IPI Numeric

Medtronic Microstream Technology only

The index is modeled on normal healthy patients (ASA Physical Status value of 1 according to the ASA Physical Status Classification System). Patients with ASA Physical Status values of 3 or higher are expected to have low IPI values by definition. Therefore, for patients with an ASA Physical Status value of 3 or higher, the index may have no added value.

The value of the Integrated Pulmonary Index given in the IPI numeric is associated with the patient status as follows:

IPI	Patient Status
10	Normal
8-9	Within normal range
7	Close to normal range; requires attention
5-6	Requires attention and may require intervention
3-4	Requires intervention
1-2	Requires immediate intervention.

NOTE

The interpretation of the patient's IPI score may change in different clinical environments. For example, patients with specific respiratory difficulties (in contrast to normally healthy patients who are being monitored during sedation or pain management) may require a lower IPI Low Alarm threshold to reflect their impaired respiratory capacity.

The IPI is available for all three groups of pediatric patients (1-3 years, 3-6 years, and 6-12 years), and for adult patients.

WARNING

Ensure that the patient category and date of birth are set correctly before monitoring a patient's IPI. An incorrect patient category or date of birth could produce incorrect IPI data.

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Monitoring Cardiac Output

CAUTION

X3 with a corresponding measurement extension can only measure Cardiac Output when connected to a host monitor, or to a PC running the XDS Software and providing a remote display. The operating instructions in this chapter must be understood in this context.

The Cardiac Output and Continuous Cardiac Output options of the measurement extensions cannot be used with the MX100 monitor.

The Cardiac Output (C.O.) measurement invasively measures cardiac output and other hemodynamic parameters using a technique called thermodilution. This can be used to determine the flow rate of a system by introducing a cold solution into the system and measuring the resulting drop in temperature at a downstream site. The temperature change is displayed as a curve in the C.O. procedure window, and the monitor calculates the C.O. value from this curve. The C.O. value is inversely proportional to the area under the curve. As cardiac output varies continuously, a series of measurements must be carried out to achieve a reliable C.O. average value. Always use the average of multiple thermodilution measurements for therapy decisions.

The measurements can be carried out using the right heart thermodilution method or the PiCCO method (transpulmonary thermodilution).

- The right heart method is available with

    – C.O. module M1012A standard- labeled as C.O. in all languages, and option #C10 - labeled as CCO/C.O. in all languages.

    – M3012A Hemodynamic Measurement Extension Module, options #C05 and #C10

    – 867039 Hemodynamic Measurement Extension Module, options #B05 and #B10

    – M3014A Capnography Measurement Extension Module, option #C05 and #C10

    – 867040 Capnography Measurement Extension Module, option #B05 and #B10

    – 867041 Microstream Capnography Measurement Extension Module, option #B05 and #B10

- The PiCCO method is available with

    – C.O. module M1012A option #C10 - labeled as CCO/C.O. in all languages

    – M3012A Hemodynamic Measurement Extension Module, option #C10

    – 867039 Hemodynamic Measurement Extension Module, option #B10

    – M3014A Capnography Measurement Extension Module, option #C10

    – 867040 Capnography Measurement Extension Module, option #B10

    – 867041 Microstream Capnography Measurement Extension Module, option #B10

The PiCCO method additionally lets you measure Continuous Cardiac Output (CCO) by performing pulse contour analysis on the blood pressure waveform.

The Cardiac Output Options 867040 #B10 and 867041 #B10 are not available in the USA and other territories relying on FDA market clearance.

Hemodynamic Parameters

This table illustrates the hemodynamic parameters available with each method, whether they are measured continuously, and whether they can be shown on the monitor's main screen or in the **Hemodynamic Calculations** window.

Measured and Calculated Hemodynamic Parameters and Indexes	PiCCO Method (Transpulmonary Thermodilution)			Right Heart Thermodilution		
	Continuous?	Main Screen	HemoCalc Window	Continuous?	Main Screen	HemoCalc Window
Blood Temperature (Tblood)	Yes	Yes	No	Yes	Yes	No
C.O./C.I.: Cardiac Output	No	Yes	Yes	No	Yes	Yes
CCO/CCI: Continuous Cardiac Output	Yes	Yes	Yes (in the **C.O.** field)	Not available		
CPO/CPI: Cardiac Power Output	Yes	Yes	Yes	Not available		
SVR/SVRI: Systemic Vascular Resistance	Both	Yes	Yes	No	No	Yes
SV/SI: Stroke Volume/SV Index	Both	Yes	Yes	No	No	Yes
SVV: Stroke Volume Variation	Yes	Yes	Yes	Not available		
*dPmax: Left Ventricular Contractility Index	Yes	Yes	Yes	Not available		
CFI: Cardiac Function Index	No	Yes	Yes	Not available		
PPV: Pulse Pressure Variation	Yes	Yes	Yes	Not available		
ITBV/ITBVI: Intrathoracic Blood Volume	No	Yes	Yes	Not available		
EVLW/EVLWI: Extravascular Lung Water	No	Yes	Yes	Not available		
GEDV/GEDVI: Global End-Diastolic Volume	No	Yes	Yes	Not available		
*PVPI: Pulmonary Vascular Permeability Index	No	Yes	Yes	Not available		
*GEF: Global Ejection Fraction	No	Yes	Yes	Not available		
*RLShnt: Right-Left-Shunt Fraction	No	No	No	Not available		
PVR/PVRI: Pulmonary Vascular Resistance	Not available			No	No	Yes
LCW/LCWI: Left Cardiac Work	No	No	Yes	No	No	Yes
RCW/RCWI: Right Cardiac Work	Not available			No	No	Yes
RVSW/RVSWI: Right Ventricular Stroke Work	Not available			No	No	Yes

* currently not available in the U.S.A. and territories relying on FDA market clearance.

NOTE

EVLWI is calculated using Ideal Body Weight (IBW). ITBVI and GEDVI are calculated using Ideal Body Surface Area (IBSA). IBW and IBSA are based on the patient category, gender and height that you have entered for the patient.

Using the C.O. Procedure Window

The procedure window displays up to six trials (measurement curves) with the trial number and the C.O. value under the thermodilution curve. When you open the window, a line of pop-up keys automatically appears to let you carry out C.O.-related tasks. This example shows the procedure window for the transpulmonary (PiCCO) Method. The window may be configured to look slightly different on your monitor.

To open the procedure window,

- Select **Cardiac Output** in the **Setup C.O.** or **Setup CCO** menu, or

- Select the **Cardiac Output** SmartKey on the Screen, if configured, or

- Press a remote start switch, if you are using one.
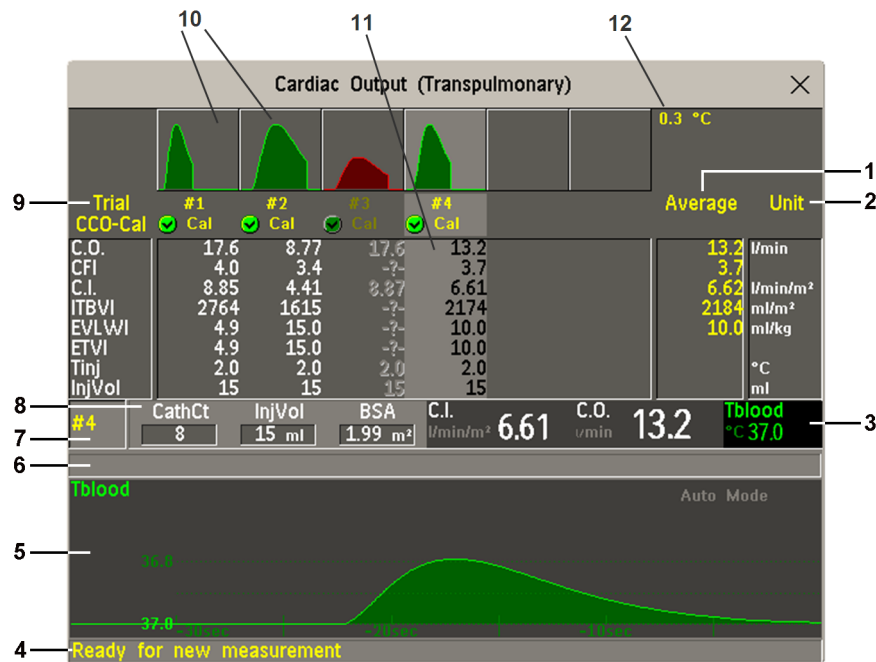
1 **Average** - column of averaged values

2 **Unit** column

3 Continuously measured numeric

4 Prompt message field

5 Thermodilution curve of current trial

6 Curve alert message field

7 Current trial number

8 Setup information

9 **Trial** numbers for the trial curves

10 Trial curves

11 Results table of current trial

12 Trial curve scale

• To change the measurement parameters shown in the results table of the procedure window, select the **Table Contents** pop-up key and choose from the list of available parameters.

• To view the currently-used temperature unit, see the "grayed-out" setting **Temperature Unit** in the **Setup C.O.** menu. This setting can only be changed in Configuration Mode.

• The Cardiac Output screen element may be configured to display permanently on a specially designed Screen. Selecting the screen element opens the cardiac output pop-up keys.

Accessing the Setup C.O. and Setup CCO Menus

C.O. settings can be changed in the **Setup C.O.** menu. To access this menu, select any of the discontinuous C.O. numerics (for example, C.O., C.I.) on the screen.

CCO/CCI settings can be changed in the **Setup CCO** menu. To access this menu, select any of the continuously measured hemodynamic numerics (CCO, CCI.) on the screen.

Entering the HemoCalc Window

From the procedure window, select the pop-up key **Hemo Calc** to open the **Hemo Calculations** window.

Measuring C. O. Using the PiCCO Method

The PiCCO method combines transpulmonary thermodilution and pulse contour analysis on the blood pressure waveform. A fluid with a known volume and temperature is injected into the right atrium through a CVP catheter. The injectate bolus mixes with the blood in the heart and the change in blood temperature is measured with a thermistor at the distal end of an arterial catheter placed in one of the bigger systemic arteries, for example, the femoral or the axillary artery.

The PiCCO Method requires a pressure measurement made using either the X3 or one of the following measurement extensions 867041, 867040, 867039, M3015A/B, M3014A, or M3012A. You will also need a conventional central venous (CVP) line and an arterial catheter from PULSION Medical Systems. You must use the approved catheters and puncture locations.

Measuring Continuous Cardiac Output

Every time C.O. is measured with the PiCCO method, the monitor uses this C.O. value and the result of the pulse contour analysis to calculate a patient-specific calibration factor. The monitor uses this value to compute CCO and the other continuous hemodynamic parameters. CCO values are calculated on a beat-to-beat basis and then averaged over a 12-second time frame. The calculated values are displayed as numerics on the monitor screen.

Measuring Systemic Vascular Resistance

The monitor uses CCO, an arterial pressure, and CVP to calculate a continuous SVR value. If a continuously measured CVP value is not available, the monitor uses a preset, static CVP value to calculate the SVR (you will see the INOP message **SVR Set CVP Used**). If the BSA is available, the monitor uses the CCI to calculate the SVRI. A CCO or CCI from an external device can also be used for the SVR/SVRI calculation.

SVR/SVRI settings can be changed in the corresponding setup menu. To enter the menu, select **Main Setup** then **Measurements** followed by **SVR** or **SVRI**.

To display a **SVR/SVRI** numeric on the Screen, select any numeric, then select **Change Numeric** and select **SVR** or **SVRI** from the list of available numerics.

Measuring Pulse Pressure Variation

Pulse Pressure Variation can be calculated in two different ways on this monitor - in conjunction with CCO or directly from the pressure measurement. Refer to the Invasive Pressure chapter for information on PPV from pressure. Only one PPV can be active at a time.

Pulse Pressure Variation (PPV) is calculated from beat-to-beat arterial pressure values. Pulse pressure is the difference between the systolic and the diastolic pressure values for a single beat. Pulse pressure variation is defined as the maximal pressure less the minimum pressure divided by the average of these two pressures.

WARNING

- The monitor calculates PPV from beat-to-beat values of the arterial pressure selected for CCO. The circumstances under which the calculation of a PPV value is clinically meaningful, appropriate and reliable must be determined by a physician.

- The clinical value of the derived PPV information must be determined by a physician. According to recent scientific literature, the clinical relevance of PPV information is restricted to sedated patients receiving controlled mechanical ventilation and mainly free from cardiac arrhythmia.

- PPV calculation may lead to inaccurate values in the following situations:
  - at respiration rates below 8 rpm
  - during ventilation with tidal volumes lower than 8 ml/kg
  - for patients with acute right ventricular dysfunction ("cor pulmonale").

- The PPV measurement has been validated only for adult patients

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Setting Up the PiCCO C.O. Measurement
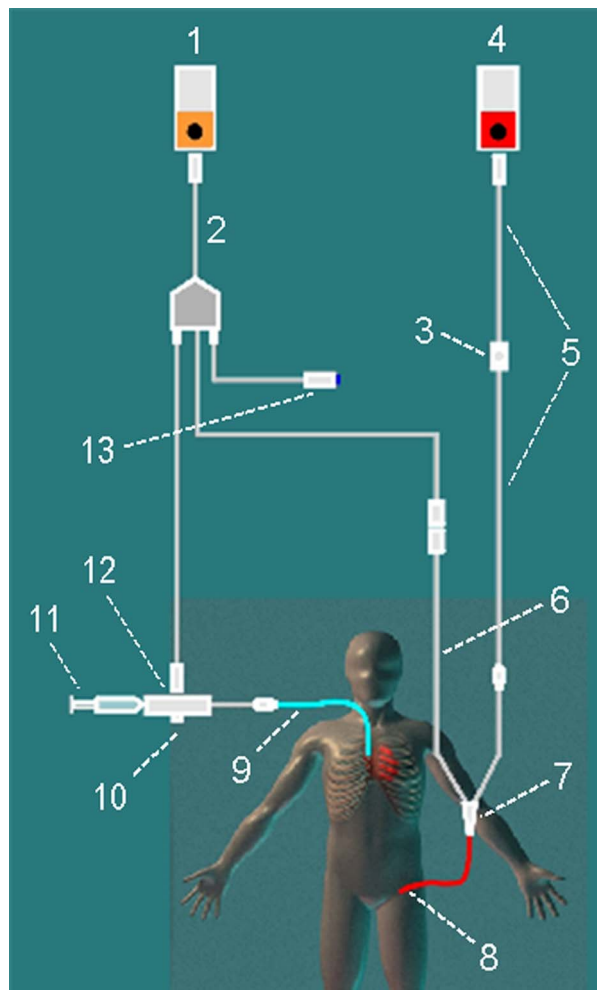
1 C.O. Measurement
2 C.O. Interface Cable
3 Getinge Pressure Transducer
4 Pressure Measurement
5 Pressure Adapter Cable
6 Thermistor Connection Cable
7 Thermistor Connection
8 Getinge Arterial Catheter
9 CVP Line
10 Injectate Temperature Probe Housing
11 Injectate Syringe
12 Injectate Temperature Probe
13 Remote Switch

1   Set up the arterial line using the arterial catheter (transpulmonary catheter) and the transducer kit from Getinge. It must be placed in one of the bigger systemic arteries, for example, the femoral or the axillary artery. You must use the approved catheters and puncture locations.

2   Set up the central venous line.

3   Connect the injectate temperature probe housing to the venous line.

4   Plug the C.O. interface cable into the C.O. measurement extension or module and connect the following devices to the C.O. interface cable:

–   Injectate temperature probe

–   Thermistor connector

–   Remote start switch (if used).

Follow your hospital standards to avoid unintentional extraction of the C.O. catheter. Secure the cable using the mounting clip shipped with each C.O. interface cable. You may also find it helpful to loop the C.O. interface cable, tape the loop, and attach it to the undersheet of the patient's bed using a safety pin.

5   If you are measuring CCO, set up the pressure measurement now. The CCO measurement requires a minimally dampened invasive pressure setup. You must ensure that there are no air bubbles in the pressure line or dome and use only specified accessories.

6   Check that the correct measurement method is selected.

If a catheter is already connected to the Cardiac Output Interface Cable, the monitor automatically recognizes the method used. If not, in the **Setup C.O.** menu, select **Method** and then select **Transpulmnry**.

7   Check that you are using the correct probe - Part No. 453564960661, previously M1646A. This is the only probe supported for use; it can be used with room temperature injectate or with cold injectate.

8   Check that the correct arterial catheter constant is selected.

If the catheter is recognized by the monitor, the catheter constant is automatically displayed and cannot be changed manually. If it is not recognized, in the procedure window, select **CathCt** and use the pop-up keypad to enter the correct value. The catheter constant is usually written either on the catheter or on the catheter packaging.

9   Make sure that the injectate volume setting matches the injectate volume you will use. To change the volume, in the procedure window, select **InjVol** and select the correct injectate volume from the pop-up list.

If there is a problem with the volume or temperature you have chosen, the monitor will issue a curve alert message to inform you of this.

10 If you are measuring CCO or CCI, check that the correct pressure source is selected in the **Setup CCO** menu. The pressure label under **CCO from** must match the pressure measured with the arterial catheter. To change the pressure source, select **CCO from** to call up a list of available pressure labels and select the correct label.

11 If you are measuring CCO or CCI, verify that the correct alarm source is selected in the menu item **Alarms from**. To change the alarm source, select **Alarms from** and choose either **CCO** or **CCI**.

12 Check whether values have been entered for patient category, gender, weight and height by selecting **BSA** in the procedure window. If not, enter the values before making a measurement, as they are used to calculate Ideal Body Weight (IBW) and Ideal Body Surface Area (IBSA). IBW and IBSA are required to calculate Extravascular Lung Water Index and Preload Indexes.

Performing PiCCO C.O. Measurements

Always wait for the monitor to indicate readiness for the next step before proceeding.

If you are measuring CCO, all measurements should be conducted within 15 minutes. Older measurements "expire" for CCO calibration.

1   Enter the procedure window.

2   When you see the message **Ready for new measurement**, start the measurement by selecting the pop-up key **Start C.O.** or pressing the remote start switch. If the measuring mode is set to **Auto** the **Start C.O.** key will also enable the automatic start of consecutive measurements.

3   When you hear the ready tone and see the message **Stable baseline, inject now!**, inject the solution into the CVP catheter.
    At the end of the measurement the thermodilution curve, cardiac output, index values, ITBV and EVLW values and any curve alerts are displayed and a message will appear **Wait before starting new measurement** or in **Auto** mode **Prepare for next injection or press Stop**.

4   When you see the **Stable baseline, inject now!** message, repeat the procedure until you have completed the measurements you want to perform. You can perform a maximum of 6 measurements before editing. If you perform more than 6 measurements without rejecting any, the oldest will automatically be deleted when a 7th curve is stored.

Editing PiCCO C.O. Measurements

It is important to identify and reject erroneous trials, as the monitor uses all the measurement trial values you do not reject to calculate the averaged cardiac output.

1   Review the trials. Irregular trials or trials marked with a **"?"** should be reviewed carefully. Consider the similarity of the values and the shape of the C.O. curve. A normal C.O. curve has one smooth peak and returns to the temperature baseline level after the peak.

2   Reject unsatisfactory trials: use the **Select Trial** pop-up key to move between trials, then select the **Accept Reject** pop-up key to accept or reject trials. If you are using a touch screen you can accept or reject trials directly by tipping on the trial curve. Discard conspicuously different values. The background of rejected trials is red and the background of accepted trials is green. The monitor recalculates the average values after you reject or accept trials.
    If all values are different from each other, there may be true hemodynamic instability caused, for example, by severe cardiac arrhythmia.

Saving and Calibrating PiCCO C.O. Measurements

When you have finished editing the trials, you must save the results. This closes the measurement series, sends the average C.O. numeric to be displayed on the main screen, and stores the averaged values in the trends and calculations databases.

Before the monitor can calculate CCO, you must calibrate the measurement. You should also calibrate CCO every eight hours, or if the hemodynamic condition of the patient changes consistently in the same direction over 15 minutes, or if there are large or sudden changes in the patient's condition.

The monitor only uses C.O. measurements from within the last 15 minutes for calibrating CCO.

To save and calibrate,

•   In the procedure window, select the pop-up key **SaveC.O. &Cal CCO** to use the averaged C.O. value to calibrate Continuous Cardiac Output (CCO).

Your monitor may be configured to have two separate pop-up keys, **Save C.O.** and **Cal CCO**, instead of the combined **SaveC.O. &Cal CCO**.

WARNING

CCO calibration is patient-specific. When the C.O. measurement extension or module is plugged in after the patient has changed, make sure that the correct CCO calibration is used. When in doubt perform a new CCO calibration first.

CCO Calibration Status Indicators

Each measurement trial is tagged with a calibration status indicator next to its trial number. Reflecting the quality of the pressure signal during the thermodilution measurement, this tag indicates each trial's validity to be used in a CCO calibration.

For a trial to be eligible for calibration, the pressure signal must be continuously available and undisturbed starting 30 seconds before the first C.O. measurement of the series. Do not zero the pressure measurement, change the pressure label, or disturb the pressure signal in any other way during this time.

Cal	A pressure signal for CCO was available during the measurement (valid for calibration)
?Cal	A disturbed pressure signal for CCO was available during the measurement (valid for calibration)
N/A	No adequate pressure signal for CCO was available during the measurement (no valid calibration data)
Exp	This trial is more than 15 minutes older than the most recent trial and has expired for CCO calibration (no valid calibration data)

Measuring C.O. Using the Right Heart Thermodilution Method

In the right heart thermodilution method, a fluid of known volume and temperature is injected into the right atrium through the proximal port of a pulmonary artery (PA) (Swan-Ganz) catheter. The injectate bolus mixes with the blood in the right ventricle and the change in blood temperature is measured with a thermistor at the distal end of the catheter in the pulmonary artery.

Setting up RH C.O. Measurements
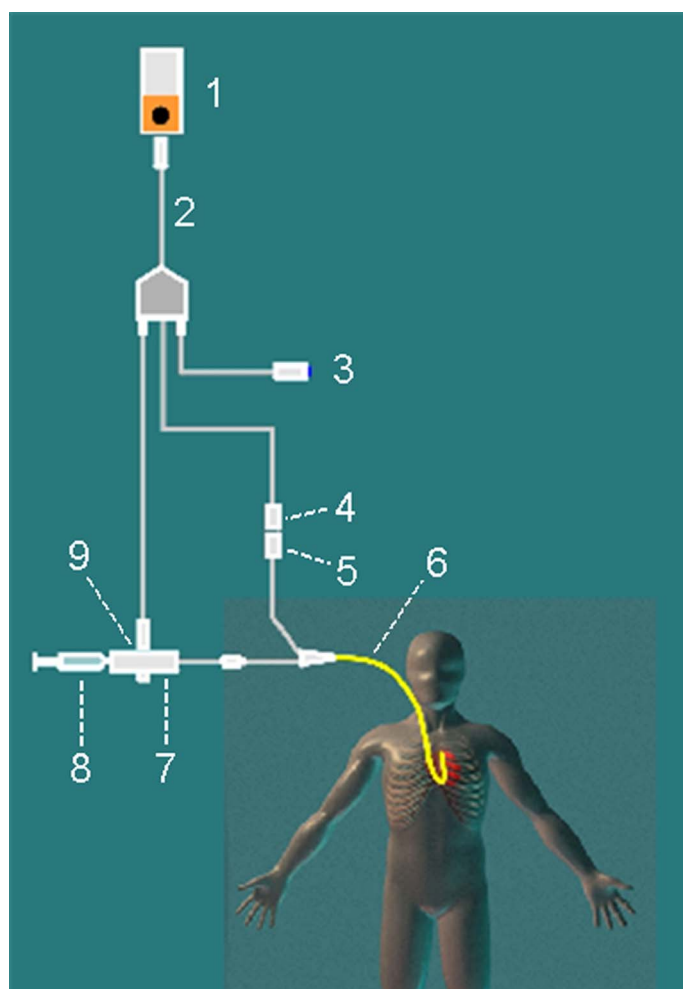
1 C.O. Measurement

2 C.O. Interface Cable

3 Remote Start Switch

4 Thermistor Connector

5 Thermistor Connection Cable

6 PA Catheter

7 Injectate Temperature Probe Housing

8 Injectate Syringe

9 Injectate Temperature Probe

1 Set up the PA line using a PA catheter.

2 Attach the injectate temperature probe housing to the PA line.

3 Plug the C.O. interface cable into the C.O. measurement extension or module and connect the following devices into the C.O. interface cable:

– injectate temperature probe

– remote start switch (if used).

Follow your hospital standards to avoid unintentional extraction of the C.O. catheter. Secure the cable using the mounting clip shipped with each C.O. interface cable. You may also find it helpful to loop the C.O. interface cable, tape the loop, and attach it to the undersheet of the patient's bed using a safety pin.

4 Plug the thermistor connection cable of the PA catheter into the thermistor connector.

5 Connect the injectate temperature probe to the injectate temperature probe housing.

6 Check that the correct measurement method is selected.

If a catheter is already connected to the Cardiac Output Interface Cable, the monitor automatically recognizes the method used. If not, in the **Setup C.O.** menu, select **Method** and then select **Right Heart**.

Ice-Bath Setup for RH Thermodilution C.O. Measurements

If you are using the flow-through method illustrated above, the injectate temperature is measured at the time of injection by the temperature probe in the injectate temperature probe housing.

If you are using the ice-bath setup, the injectate temperature probe and the injectate are both placed in an ice-bath and the probe measures the temperature of the contents of the ice bucket.

Setting the Computation Constant

Check that the correct **Computation Constant** is entered in the procedure window. This can be found in the documentation supplied with the catheter and is based on the injectate volume, injectate temperature and catheter type. To change the value, in the procedure window, select **Computation Constant** and use the pop-up keypad to enter the correct value.

Performing RH C.O. Measurements

1 Enter the procedure window.

2 When you see the message **Ready for new measurement**, select the pop-up key **Start C.O.**. If the measuring mode is set to **Auto** the **Start C.O.** key will also enable the automatic start of consecutive measurements.

3 When you hear a ready tone and see the message **Inject now!**, inject the solution into the right atrial port of the Swan-Ganz catheter. The optimal injection rate is 2.5 ml/second.

At the end of the measurement the thermodilution curve, cardiac output, index values and curve alerts (if necessary) are displayed and a message will appear **Wait before starting new measurement** or in **Auto** mode **Prepare for next injection or press Stop**.

4 When you see the **Inject now!** message, repeat the procedure until you have completed the measurements you want to perform. You can perform a maximum of six measurements before editing. If you perform more than six measurements without rejecting any, the oldest will automatically be deleted when a seventh curve is stored.

Editing and Saving RH C.O. Measurements

It is important to identify and reject erroneous measurements (called "trials"), as the monitor uses all the measurement trial values you do not reject to calculate the averaged cardiac output.

1 Review the trials. Irregular trials or trials marked with a **"?"** should be reviewed carefully. Consider the similarity of the values and the shape of the C.O. curve. A normal C.O. curve has one smooth peak and returns to the temperature baseline level after the peak.

2 Reject unsatisfactory trials: use the **Select Trial** pop-up key to move between trials, then select the **Accept Reject** pop-up key to accept or reject trials. If you are using a touch screen you can accept or reject trials directly by tipping on the trial curve. Discard conspicuously different values. The background of rejected trials is red and the background of accepted trials is green. The monitor recalculates the average values after you reject or accept trials.

If all values are different from each other, there may be true hemodynamic instability caused, for example, by severe cardiac arrhythmia.

3 Save average C.O. values. To close a measurement series, you must save the average values by selecting the pop-up key **Save C.O.**. This sends the average C.O. numeric to be displayed on the main screen, and stores the averaged values in the trends and calculations databases.

Documenting C.O. Measurements

You can document C.O. measurements on the default printer or recorder.

1 In the procedure window, select the pop-up key **Print/ Record**.

2 From the pop-up list, choose:

– **Print Results** to print the contents of the procedure window

– **Record Results** to record the contents of the procedure window

– **Record Trial** to send an individual trial curve to the recorder.

C.O. Injectate Guidelines

The greater the injectate volume and the colder the temperature, the more accurate the measurement. Reduced injectate volume or higher injectate temperature may reduce the specified accuracy.

For adult patients, to ensure the greatest measurement accuracy, use a cold injectate (< 8°C) of 10 ml volume, if not contra-indicated by the patient's condition. Your choice of injectate volume should be based on the injectate temperature and the patient's cardiac output.

Guidelines for Right Heart Thermodilution C.O. Injectate

If you are using the right heart thermodilution method, the use of injectate with a temperature less than 8°C lower than the blood temperature may cause incorrect values for the thermodilution.

Guidelines for PiCCO C.O Injectate

If you are using the PiCCO method, the use of injectate with a temperature that is not at least 12°C lower than the blood temperature may cause incorrect values for the thermodilution and CCO calibration.

Injectate Volume, Patient Weight and ETVI Values (PiCCO Only)

When deciding on an injectate volume and temperature, you must consider your patient's Ideal Body Weight (IBW) and extra-vascular thermal volume index (ETVI). IBW is based on the patient category, gender and height that you have entered for the patient. The calculated IBW is displayed in the window that opens when you select the **InjVol** field.

High ETVI

The dilution of injectate is influenced by extravascular tissue and fluid. The accuracy of the PiCCO method may be reduced in patients with high extra-vascular thermal volume index (ETVI) values. Use the table below as a guide in selecting the correct injectate temperature. As shown in the table, if your patient has an ETVI > 10, you must use cold injectate.

Weight

Use the table below as a guide in choosing an injectate volume appropriate for the patient weight.

IBW	Cold Injectate		Room Temperature Injectate	
	ETVI < 10	**ETVI ≥ 10**	**ETVI < 10**	**ETVI ≥ 10**
< 3 kg	2 ml	2 ml	3 ml	Use cold injectate
< 10 kg	2 ml	3 ml	3 ml	
< 25 kg	3 ml	5 ml	5 ml	
< 50 kg	5 ml	10 ml	10 ml	
< 100 kg	10 ml	15 ml	15 ml	
≥ 100 kg	15 ml	20 ml	20 ml	

C.O./CCO Curve Alert Messages

After each measurement trial, the monitor analyzes the thermodilution curve. If the curve appears abnormal, a curve alert message appears in the procedure window. A question mark symbol ("**?**") may appear next to the cardiac output numeric if any of these messages appear. The curve alert messages are not error messages and do not necessarily mean that the measured values are invalid.

C.O./CCO Curve Alert Messages	Possible Causes
Tinj off scale	The Tinjectate is out of the range -1°C and 30°C. Cool down or heat up the injectate or change the injectate solution and repeat the measurement.
Noisy baseline	A blood temperature baseline drift that could not be compensated was detected during the C.O. measurement. Possible causes are: - Interference may be caused by a ventilator. - Interference may be caused by an infusion pump: infusions of significant volume through the central line should be paused at least 30 seconds before the first thermodilution measurement in a series and should not recommence until the measurement series is completed. - Do not administer injections through the central line during a measurement series. - Electrical devices in the vicinity can cause interference: check for infusion pumps connected to the central catheter, cables parallel to the thermodilution cable, electrocautery. Make sure all devices are properly grounded. - Wait until measurement results are displayed before moving the patient or catheter. - Close the stopcock to the injectate syringe after the injection. - Do not rinse the catheter during measurement, to avoid temperature fluctuations.
Temperature baseline drift	May occur if patient is recovering from open heart surgery, or if patient was cooled down for surgery and is in the process of regaining normal body temperature when the measurement is made.
Small signal, more indicator required	The peak of the transpulmonary thermodilution curve was below 0.1°C. Increase injectate volume and/or lower injectate temperature.
Injectate temperature too high	The difference between the blood and injectate temperatures is too small. The calculated value for C.O. may not be accurate.
High ETVI, use cold injectate or greater inj. volume	The ETVI value is too high. The accuracy of the transpulmonary thermodilution measurement may be reduced. Increase injectate volume and/or lower injectate temperature following the guidelines given in the section "Guidelines for PiCCO C.O Injectate" on page 235.
Disturbed injection	The injection should be performed quickly and with a steady pressure. Shaking, unsteady pressure, or injections that take longer than six seconds may cause this message to appear; you should bear this in mind if you are using a large injectate volume (> 10 ml).
Check Injectate Temperature Probe Type	The recorded Tinj signal is uncharacteristic for the 453564960661/ M1646 injectate temperature probe. An incorrect probe type may have been used.
Unsteady baseline	There is a noisy baseline, and thermal baseline drift.
Multiple peaks	Caused by faulty injection technique.
Abnormal decay time	May be caused by low cardiac output. Calculated value for C.O. may not be accurate.
Very long curve	The decay time of the curve is longer than 15 seconds.
Very short curve	Decay time of the curve is less than 0.5 seconds. If there is a noisy baseline, part of the baseline may have been mistaken for a thermodilution curve. Calculated value for C.O. may not be accurate.

C.O./CCO Curve Alert Messages	Possible Causes
Irregular curve	Any combination of curve alert messages.
Delayed injection	Injection is given more than 15 seconds after **Start C.O.** is selected. Calculated value for C.O. may not be accurate.

If you have followed all of these guidelines, your measurement values should be valid, even if you still see a curve alert message. Ensure that at least three subsequent measurements within the current series do not differ by more than 15%. If the difference exceeds 15%, use your clinical judgment to determine the appropriate intervention.

C.O./CCO Prompt Messages

Prompt messages appear in the procedure window if a C.O. measurement trial must be terminated.

C.O./CCO Prompt Messages	Possible Causes
Curve below baseline, measurement terminated	May be caused by thermal baseline drift. No C.O. value calculated.
Excessive curve height, measurement terminated	The curve exceeds the upper limit. This may be caused by an injectate that was too cold. No C.O. value calculated.
Unstable baseline, injection not recommended!	The baseline is unstable. Wait until the baseline is stable before injecting. If this does not occur within a reasonable time, injection is possible but the accuracy of the measured values may be reduced.
Excessive baseline drift, don't inject now!	No measurement is possible. Measured values are incorrect.

C.O./CCO Warning Messages

Warning messages contain important information about the C.O. measurement.

C.O./CCO Warning Messages	Possible Causes
Next measurement erases older curve	Six curves are stored, this is the maximum possible. If another measurement is stored, the oldest thermodilution curve will be erased.
Previous C.O. setup data replaced	A C.O. measurement extension or module has been plugged in with different C.O. setup data from the previous data. The new C.O. setup data is read from the new C.O. device, and replaces the current data. The message disappears when the **Start C.O.** pop-up key is pressed.
Verify C.O. setup data	A new transpulmonary thermodilution catheter has been connected to the C.O. Interface Cable.
Check arterial pressure, CCO cal currently not possible	Poor or invalid pressure signal, for example if pressure was not zeroed.
Verify the Computation Constant	A new catheter has been plugged in, or the computation constant has been changed and **Start C.O.** has not been selected.
Previous Comp. Constant replaced	A new C.O. measurement extension or module with a different computation constant from the current one has been connected. The new computation constant is read from the new C.O. device, and replaces the current one. The message disappears when **Start C.O.** is selected.

C.O./CCO Safety Information

WARNING

Catheter constant - Make sure that the arterial catheter constant for the measurement is appropriate to the catheter used.

Computation Constant - Make sure that the computation constant for the measurement is appropriate to the injectate volume, injectate temperature and catheter type used.

IABP - Do not perform transpulmonary thermodilution measurements on patients undergoing IABP treatment.

CCO accuracy - Accuracy of the CCO measurement and all the derived values may be influenced by patients with valve diseases or artificial valves.

C.O. and MRI - Do not use the Cardiac Output Interface Cable or the injectate temperature probe in Magnetic Resonance Imaging (MRI) Applications.

Aortic graft patients - Do not use an arterial catheter in the arteria femoralis, as it may be contraindicated, for example, with patients who have an aortic graft.

CAUTION

During the cardiac output measurement procedure, the blood temperature alarms are inactive. This is indicated by a crossed-out alarm symbol next to the temperature numeric. Making alarms inactive during this procedure prevents false alarms. The alarms are automatically reactivated when you have completed the measurement procedure.

Using a Telemetry Device and a Monitor (PIIC only)

The information here is for the "monitor plus telemetry" workflow with a PIIC. Refer to "Managing Equipment" on page 108 for information on corresponding workflows with the PIC iX.

It is possible to assign a monitor and a telemetry device to the same patient, resulting in the information from both devices being combined in one sector at the Information Center. This is called "pairing" and when a telemetry device and a monitor are paired, the measurement data from the telemetry device will be displayed on the monitor screen.

A telemetry device can be:

- any Philips telemetry device (only for indirect connections, see below).
- a TRx/TRx+ IntelliVue Telemetry system transceiver.
- an X3, declared as a telemetry device at the Information Center.

For complete user information, including accessory listings and specifications, for the M4841A/M4851A TRx/TRx+ IntelliVue Telemetry Transceiver, refer to the Instructions for Use provided with the device.

How Can You Combine Devices?

- With an **indirect** connection, using standard telemetry transmission: The data are sent to the monitor via the Information Center and arrive with a delay of several seconds at the monitor.
- With a **direct** connection to the monitor, when an X3 declared as a telemetry device is connected by MSL cable to the monitor.

Indirect Connection - Manual Pairing

The telemetry device can be paired with the monitor at the Information Center or at the monitor. For detailed information regarding pairing and configuration at the Information Center, see the Information Center Instructions for Use.

To pair the monitor with a telemetry device at the monitor:

1   Select **Main Setup** then **Measurements**

2   Select **Telemetry**
    The **Setup Telemetry** menu will appear with only one entry **Paired Equipment**.

3   Enter here the equipment label of the telemetry device to be paired.

Pairing at the monitor is only possible when the monitor already has a connection to the Information Center and the Information Center software version allows pairing at the monitor.

Own Patient Overview Window

The measurements from the telemetry device are shown in the own patient overview window on the monitor.

See "Own Patient Overview Window" on page 111.

Direct Connection - Automatic Pairing

A direct connection is possible with an X3, declared as a telemetry device, and connected with an MSL cable to a host monitor.

Pairing an X3 With a Telemetry Interface to a Host Monitor

An X3 using an IntelliVue Instrument Telemetry interface will be automatically paired when it is connected to a host monitor and it has been declared as a "telemetry device" at the Information Center.

When the X3 is disconnected from the host monitor it will remain paired and the measurement data will appear at the host monitor in the Telemetry Data window. After the X3 is disconnected from the monitor it may take over 15 seconds until its data is displayed at the Information Center.

NOTE

Pairing of a host monitor and a telemetry device, with all the related functionality, is only possible when the **host monitor** is using a wired LAN connection or a wireless LAN interface (but not using the IntelliVue Instrument Telemetry interface).

Unpairing the Monitor and Telemetry Device

If the patient will no longer be monitored with the telemetry device, or only with the telemetry device and no longer with the monitor, you need to end the device pairing. After unpairing, the Information Center will receive data exclusively from the monitor or from the telemetry device:

• select the **Unpair To Mon.** SmartKey to end pairing and have the Information Center receive the measurement data from the monitor

• select the **Unpair To Tele** SmartKey to end pairing and have the Information Center receive the measurement data from the telemetry device

or use the Unpair function at the Information Center.

NOTE

The SmartKeys and pop-up keys for unpairing appear only on the monitor which is directly involved in pairing.

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Trends

Trends are patient data collected over time and displayed in graphic or tabular form to give you a picture of how your patient's condition is developing. Trend information is stored in the trends database for continuously-monitored measurements, such as ECG, as well as for aperiodically-measured parameters, such as Cardiac Output.

Viewing Trends

Trend information can be viewed embedded as a screen element on specially-designed Screens, or you can open a trend window over the current Screen.

- To view trends embedded as a screen element, enter the **Change Screen** window, then select a Screen designed to show an embedded trend window.

- To open the tabular trends window over the current Screen, select **Main Setup**, **Trends**, then **Vitals Trend**, or select the **Vitals Trend** SmartKey .

- To open the graphic trends window over the current Screen, select the **Graph Trend** SmartKey

   .

The trend windows open displaying the most recent data and are updated as new data is stored. A timescale along the bottom or the top of the screen shows you where you are in the trends database. The preview column on the right-hand side shows the latest available measurement value. The preview column is updated every five minutes or whenever an NBP or other aperiodic measurement is completed.

A question mark (?) beside a value means that the data may not be reliable, due perhaps to an INOP condition in the measurement.

Your monitor screen may look slightly different to the examples shown in this chapter.

Trends Pop-Up Keys

When you open the graphic, tabular or histogram trends window, a selection of pop-up keys appears to let you navigate through the stored trend data and carry out trends-related tasks.

Pop-Up Keys	Selecting this pop-up key lets you....
Select Group	see a pop-up list of trend groups and select a group for viewing.
Select Interval	see a pop-up list of available data resolution settings and select the level of detail shown in the trend view.
Print/ Record	print a tabular trends report or make a tabular trend recording of the data in the current window. The report will use the current trend interval settings.
Print	print a graphic trends report or histogram report of the data in the current window. The report will use the current trend interval settings.
◀ ▶	move the cursor one step to the left or right to navigate through the trends database timeline.

Pop-Up Keys	Selecting this pop-up key lets you....
◄◄ ►►	move the cursor one page to the left or right to navigate through the trends database timeline.
◄ ►	jump to the beginning or the end of the trends database to see the most recent or oldest trend information stored.
▲ ▼	scroll up and down the screen to see measurement trends that do not fit in the current view.
Vital Signs	open the current trend view in tabular form. The displayed time period and resolution stay the same.
Graph Trend	open the current trend view in graphic form. The displayed time period and resolution stay the same.
Data Source	select a realtime SpO_2 or realtime system pulse or trended data for display in the histogram.
Period	select a time period for the histogram.
Select Range	define the range of values to be displayed in the histogram by selecting an upper and a lower limit.
Column	select a column width for the histogram. For each width selection the resulting number of columns is shown.
Curve On/Off	switch the display of the cumulative value columns in the histogram on or off.
Adjust Cursor	open a new set of pop-up keys for switching on cursors and setting their positions.

Viewing Graphic Trends
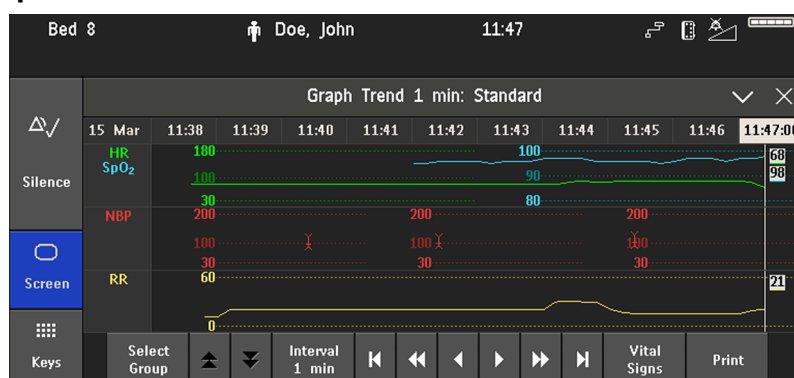
A cursor spanning all measurements in the trend group helps you to navigate through the trends database and shows you your current position in the database. When the cursor is moved across the time line, the values measured at the cursor time are shown in the right hand column.

In graphical trends, aperiodic measurement trends are shown as an asterisk, NBP has a special symbol.

To use the trend cursor to navigate in time through the trends database,

1   Select the graphical trend or the arrow pop-up keys to activate the cursor.

2   Use the arrow pop-up keys to move the trend cursor backwards and forwards in time, or

3   Place the cursor at a specific time by touching the graph.

Viewing Vital Signs Trends

1 Aperiodic values are shown with a timestamp

The currently-selected column is highlighted. The values can be configured to display in the same colors as the waves and numerics on the realtime display.

Any values available for display before the next scheduled update are shown in the right hand column, with a timestamp in brackets.

If more than one value is available for an aperiodic trend for a certain trend period, all measured values are stored in the database and the value closest to the timestamp is shown in the Vital Signs display marked with an arrow.

To view the Vital Signs trend with one column for each NBP measurement (see "Defining the Column Interval Using the NBP Measurement" on page 246):

1 With the Vital Signs trend open, select **Interval**.

2 Select **NBP** from the pop-up list.

Viewing Histogram Trends
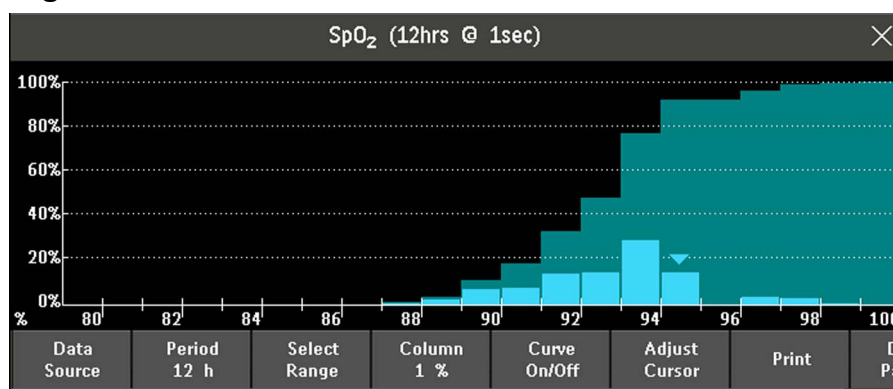
The title line of the window shows the label of the trended measurement and the resolution of the data; in the SpO_2 histogram above, 1 second realtime samples.

The horizontal axis shows the range and unit of the displayed measurement. The vertical axis shows the percentage of time.

The columns in the foreground show how much of the time the measured values fell into this range on the scale. For example, in the histogram above, the SpO_2 value was between 93 and 94% during 20% of the last 12 hours. The display of the percentage value above each column, can be switched on or off by selecting the histogram. The arrow mark over a column shows that the currently measured value is also in this range. The columns are displayed in the same color as the measurement data.

The columns in the background show the cumulative percentage value: each of the foreground columns is added to the sum of those columns to the left of it. The cumulative columns can be switched off using the **Curve On/Off** pop-up key.

A question mark is displayed if less than two-thirds of the data are valid samples.

The pop-up keys in the window can be used to change the measurement, the time period and the range. You can also print out a histogram report.

The SpO$_2$ and System Pulse histograms can use trended data or realtime data with 1 second samples.

Using Cursors

You can set two cursors that span a "corridor", for example to divide a histogram into in-range and out-of-range areas. Or you can set both cursors to the same value and use them as one cursor to divide the histogram into an upper and a lower segment. The cursors are represented by a vertical line from the x-axis and a dotted horizontal line from the y-axis. When two cursors are used, they can be locked using **Lock/ Unlock**, so that the distance between them is fixed. Moving a cursor will then move both together. Select **Lock/ Unlock** again to separate the cursors and move them independently again.

A summary column on the y-axis shows the lower, middle and upper ranges as determined by the cursor positions. When only one cursor is used there will be a lower and an upper range. Color shading is used to differentiate the ranges in the cumulative column and to highlight the columns between the cursors.

Setting Up Trends

Trends are set up in Configuration Mode. You can make temporary changes to trends settings such as trend groups, priorities, or scales in Monitoring Mode. The general settings for all Trends are under **Main Setup**, **Trends**.

Settings for a single segment in graphical trends or for the corresponding trend group can be made more easily in that segment menu.

Making Segment Settings

The **Graphical Trends** window is divided into measurement segments, each of which has its own settings.

To enter the segment menu,

- select the left hand column of the segment, where the measurement label is displayed.

Expanded View

To expand the segment to fill the **Graphical Trends** window,

- in the **Segment** menu, select **Expand** to have that segment enlarged to fill the window.

In the expanded view, you can also highlight a measurement to make it more easily visible (for example when multiple ST trends are in one segment). To highlight a measurement,

- in the **Segment** menu, select **Highlight** repeatedly until the highlight is on the required measurement.

To return the segment to its original size,

- in the **Segment** menu, select **Expand** again.

Trend Scales for Segment Measurements

To change the trend scales for a measurement in the current segment:

1 In the **Segment** menu, select the measurement label.

2 Select **Upper** to change the upper limit of the scale or **Lower** to change the lower limit of the scale.

Optimum Scale

To have the monitor automatically select an optimum scale for viewing, based on current values,

- in the **Segment** menu, select **Optimum Scale**.

This scale change is temporary. When the graphical trend window is closed the scale reverts back to the setting in **Parameter Scales**.

To switch off automatic optimum scaling,

- in the **Segment** menu, select **Optimum Scale** again.

Trend Group

To add or remove measurements for this trend group or change the order of the existing measurements:

1   In the **Segment** menu, select **Change Group**.

2   Use the **Add**, **Change**, **Sort Up** and **Sort Down** pop-up keys to change or re-order the group as required.

Number of Segments

In an embedded graphical trend window, you can select the number of segments to be displayed in the **Segment** menu:

•   In the **Segment** menu, select **No. of Segments**.

Trend Groups

The measurements grouped in trend groups define the trends displayed together in the **Vital Signs** or **Graphical Trends** windows and printed in trends reports and recordings. The sequence of the measurements in the group defines the order in which they are displayed. Measurements listed between dotted line separators are displayed overlapping. The trend group **All** contains all available measurements, you cannot change the order or selection of this group.

To change the selection of measurements in a trend group, either use the **Change Group** setting in the **Segment** menu or:

1   Select **Main Setup**, **Trends**, then **Trend Groups**.

2   Select the Trend Group you want to change and use the pop-up keys to **Add**, **Change**, or **Delete** the selection of measurements trended.

To temporarily change the order in which the measurements are displayed in a group,

1   Select **Main Setup**, **Trends**, then **Trend Groups**.

2   Select the Trend Group and then the measurement you want to move and use the **Sort Up**/**Sort Down** pop-up keys.

Trend Interval

The trend interval defines the resolution of trend data shown on the Screen.

To set the trend resolution, in the **Vital Signs** or **Graphical Trends** window,

•   Select the **Select Interval** pop-up key and then select the required interval from the list.

Trend Priority

The monitor stores trend information for all monitored measurements, if configured to do so. If your configuration restricts the number of measurements trended, you must choose which measurements will be included. A priority list is used to select the trended measurements.

To see the measurement priority list for trending,

1   In the **Main Setup** menu, select **Trends**.

2   Select **Trend Priority**.

To add measurements to the priority list,

1   Select the pop-up key **Add** and choose from the pop-up list of available measurements.

2   Use the **Sort Up** and **Sort Down** pop-up keys to change the priority order.

Trend Parameter Scales

Parameter scales define how the trend waveform will appear on the screen and in trend reports. Separate scales can be set for adult, pediatric, and neonatal patient trends.

To change the trend parameter scales settings, either use the **Scale** setting in the **Segment** menu or:

1   In the **Main Setup** menu, select **Trends**.

2   Select **Parameter Scales**.

3   Select the measurement or parameter you want to change from the list.

4   Select the pop-up key **Change** to call up the **Scale** menu.

5   In the **Scale** menu, select the parameter label you want to define settings for. Select **Adult**, **Pedi**, and **Neo** and use the pop-up keypad to enter new upper and lower scale definitions.

Graphical Trend Presentation

Graphical trends and screen trends for measurements with compound values (for example ABP or CO_2) can be viewed in line or band form.

To change the presentation style,

1   Select **Main Setup** then select **Trends**.

2   Select **Global Style** and choose

•   **Line** to display the trends as a continuous line

•   **Band** to fill the area between the trend lines, for example, between the systolic and diastolic pressures, with color.
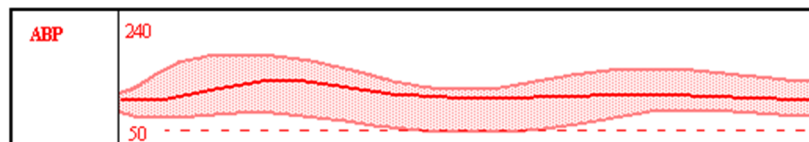
This sample ABP trend shows the continuously-measured values for the systolic, diastolic and mean pressures displayed in band form.

Defining the Column Interval Using the NBP Measurement

You can have the NBP measurement determine the interval between the columns on the Vital Signs trend. Each NBP measurement will generate a column in the trend table. The values for the other measurements are added to the column to provide a complete vital signs set for the NBP measurement time.

To use the NBP measurement to determine the column interval:

1   Select **Main Setup** then **Trends**.

2   In the **Trends** menu, select **Setup VitalSigns**.

3   In the **Vital Signs** menu, select **Column** and then **NBP** from the pop-up menu.

Documenting Trends

To print a Vital Signs or Graphical Trends report,

•   in the **Vital Signs** or **Graphical Trends** window, select the pop-up key **Print** to print a report for the trend group currently on the monitor screen.

Reports include the most recent information in the trends database and extend backwards in time according to the selected trend interval and your monitor's configuration. Trends reports can be printed on central or local printers.

Trends Databases

The trend databases store information for up to 16 measurements for up to 48 hours.

The values in the trends database are stored as measured by the monitor, they are not averaged values. The trend resolution defines how often a value is stored. In general, if more than one value is available for storage in the trends database, the most recent value is used. Some values in the trends are marked with arrows. This indicates that for this time period, more values were available and the most recent one is shown.

Example database configuration

In this example, we see that the monitor stores the most recent data at the highest resolution, older data are stored at a lower resolution.

"4 hours @ 12 second resolution" means that the monitor stores trend data every 12 seconds, for the most recent four hours.
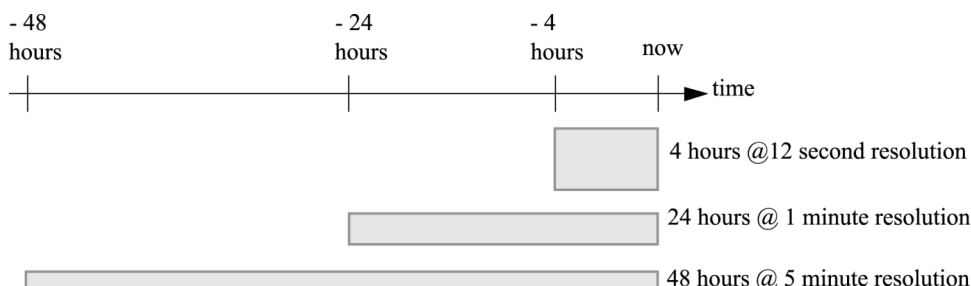
Aperiodic Trends Database

Aperiodic trends do not count toward the maximum number of trends allowed by the trend configuration. Trend data for aperiodic measurements is stored in a separate database and timestamped with the measurement time.

Trending Multiple-Value Measurements

Some measurements generate multiple values, for example invasive pressure measurements can provide systolic, diastolic, and mean values. These values are trended as separate measurements.

Screen Trends

Trends configured to display permanently on special monitor Screens are called Screen Trends. The selection and number of measurement waves in the Screen Trend segment depends on your monitor configuration. Screen Trends are color-coded to match the measurement wave and numerics, and they can be viewed in graphical, tabular, histogram or horizon format.

If you do not see Screen Trends on the monitor Screen, select a different Screen, one that is configured to show Screen Trends. Screen Trends are only available on specially designed Screens.

Screen Trend information is taken from the Trends database. If you do not see a Screen Trend for a particular measurement on the Screen, check the trend priority list to ensure that this measurement is being trended.

Setting the Screen Trend Time

To set the **ScreenTrend Time** for all graphical, histogram and horizon screen trends ("global" trend time),

1   Select a screen trend then select **Setup Trend**, or select **Main Setup** then select **Trends**.

2   Select **ScreenTrend Time** and select the required time: 30 minutes, one, two, four, eight, or twelve hours. This is now the Global screen trend time and defines the period of trend information shown for all screen trends.

To set a different **ScreenTrend Time** for a screen trend or a group of aligned screen trends,

1   Select a screen trend.

2   Select **Change TrendTime**.

3   Select the required trend time.
Selecting **Global** leaves the trend time set to the global screen trend time.

Changing the Selection of Screen Trends Displayed

1 Select the screen trend.

2 Select **Change Trend** and select the required trend from the list of available trends.

Select **Blank** to remove the selected trend from the Screen.

If you do not see **Change Trend** in the screen trend menu, the trend is aligned to display with the measurement wave. Changing the wave automatically changes the trend.

To display two or more screen trends overlapping,

1 Select the screen trend to open the screen trend menu,

2 Select **Change Trend** followed by **Add Trend** and select a screen trend from the pop-up list.

Activating the Cursor for Screen Trends

To activate the cursor for Screen Trends:

1 Select the screen trend.

2 Select **Activate Cursor**.

You can now use the arrow keys to move the cursor across the time line. The values measured at the cursor time are shown next to the cursor.

To de-activate the cursor,

• Select the **Screen** key.

Changing the Screen Trend View

To switch between tabular, graphic, histogram and horizon views, select the screen trend then select **Change View** and select the required view.

Tabular View

Aperiodic measurements such as NBP, can be viewed as a screen trend in tabular form. The measured values and their timestamps are shown, with the measurement label.

Horizon View
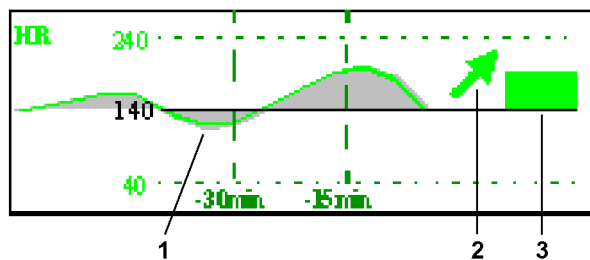
The horizon view presents trend information superimposed over a defined baseline or base range. This helps you visualize changes in your patient's condition since the baseline was set.

The horizon view is made up of:

• a horizon, drawn in white, as a reference point or baseline to help you visualize changes in your patient's condition. The horizon can be set to represent your patient's current condition, or a target condition and can be a single value or a range.

• a graphical trend, displaying patient data for the set trend time (1).

• a trend indicator arrow, indicating how the patient trend has developed in the set time period (10 minutes, 5 minutes or 2 minutes) (2).

• a deviation bar, showing how the currently measured value deviates from the set horizon (3). The height of the deviation bar is an indication of the extent of the change in your patient's condition relative to the (horizon) baseline.

Your monitor may not be configured to show all elements of the screen trend horizon view.

Setting the Horizon

The horizon is the reference value to which deviations in the measurements are compared.

To set the horizon:

1   Select the horizon trend.

2   Select

– **Set High Horizon** to select the upper horizon value. If the high and low horizon values are the same, the horizon is a baseline - if the values are different the horizon is a range.

– **Set Low Horizon** to select the lower horizon value.

– **Auto Horizon** to set the horizon for the selected horizon trend to the currently-measured value.

– **Auto All** to reset the horizon for all horizon screen trends to the currently-measured values.

– **Set Horizon** to set the horizon to a specific value from a pop-up list.

Setting the Horizon Trend Scale

The horizon trend scale is defined with respect to the horizon. If your horizon is set to 100 and you select 20 as the horizon scale delta, the upper limit of the horizon scale will be 120 and lower limit 80.

To set the horizon trend scale delta,

1   Select the horizon trend.

2   Select **Set Scale Delta** and select a value to define the distance between the horizon and the upper and lower scale limits.

Be aware that changing the horizon trend scale can change the angle of the trend indicator, without the patient's condition having changed.

If a measurement exceeds the outer limits of the scale, the wave will be clipped and you must either reset the horizon or the horizon trend scale to display the values outside the scale limits.

Setting the Time Period for the Trend Indicator Arrow

The time period for which the trend indicator arrow is displayed can be set in the **Trends** window.

1   Select **Main Setup** then select **Trends**.

2   Select **HorizonArrowTime**.

3   Select 10, 5 or 2 minutes.

Recording

There are two ways to record data using your monitor, depending on availability. If a central paper-strip recorder is available, you can make paper recordings, selecting from a variety of recording types.

If no paper-strip recorder is available, or if you want to record data in electronic form, you can use electronic strip recording.

Paper-Strip Recording

Central Recording

For central recording from the bedside, your monitor must be connected via a network to an Information Center. You can use either the M1116B or 862120 2-Channel Recorder or the standalone M3160A 4-Channel Recorder. See the documentation supplied with the Information Center for information on the 4-Channel Recorder.

When an X3 is connected to a host monitor (**Companion Mode** is indicated):

- No central recording is available on the X3. Central recordings are made via the host monitor.

Starting and Stopping Recordings

The recordings pop-up keys let you start and stop recordings. Select the **Main Setup** SmartKey then select **Recordings** to call up the line of pop-up keys. Scroll right or left to see any pop-up keys not displayed.

Delayed Recordng
RT A Recordng
RT B Recordng
Select Waves
Setup Recordng
Stop All Recordng

Recording Without a Template

To record without a preconfigured template, selecting the waves you require,

1   Select the **Main Setup** SmartKey, then select **Recordings**.

2   Select the pop-up key **Select Waves**.

3   Use the pop-up keys to choose up to three measurement waves to be printed on the recording. If you want fewer than three waves on the recording, select the waves you want then select the **Continue** pop-up key.

4   Select one of the recording speed pop-up keys to set the required recording speed.

5   Select the **Start** pop-up key to start the recording.

Select Waves recordings use default values for any recorder settings not defined: runtime is continuous, overlapping is set to non-overlapping.

Overview of Recording Types

	Delayed	Alarm		Realtime (RT)
Type of recording	manual	automatic, triggered by defined alarm conditions		manual
Recording Destination	central	central	printer	central
Information recorded	from the start trigger minus the delay time	from the start trigger minus the delay time	n/a	from the start trigger
Number of waves	up to 2	up to 2	n/a	up to 2
Speed	50, 25, 6.25 mm/sec	25 mm/sec	n/a	50, 25, 6.25 mm/sec
Runtime	n/a	n/a	n/a	continuously
Stops	automatically	automatically	n/a	manually
Delay Time	10, 15 seconds	10, 15 seconds	n/a	none
Overlap	Off On (up to 2 waves)	Off On (up to 2 waves)	n/a	Off On (up to 2 waves)
n/a = not applicable				

Creating and Changing Recordings Templates

To save you defining recording settings each time you start a recording, you can create templates for commonly-used types of recordings in the **Setup Recordings** menu. You can create templates for one delayed recording, one alarm recording and two realtime recordings (**Realtime A** and **Realtime B**).

Changing recordings templates changes the settings that will be used each time a recording of this name is triggered.

1 Select the **Main Setup** SmartKey to call up the **Main Setup** menu.

2 Select **Recordings**.

3 Select the **Setup Recordng** pop-up key to enter the **Setup Recordings** menu.

4 Select the name of the template you want to create or change. Each recording name is linked to a recording type: delayed, alarm, and realtime. Recording names can be changed in Configuration Mode.

5 Design the template by selecting each menu item and entering the information for the template.

- **Recorder**: choose which recorder the recording will print to (**Central 2–Ch** or **Central 4–Ch** recorder, or a printer (for realtime reports in alarm recording only).

- **Channel 1**, **Channel 2**, etc: choose which waveform to record in each channel.

  In addition to the currently available waves, you can choose from several other settings which make an automatic allocation when the recording starts:

  – **Alarm Par** will always record the measurement in alarm in the chosen recorder channel

  – **Primary Lead** will always record the current primary lead in the chosen recorder channel

  – **SecondryLead** will always record the current secondary lead in the chosen recorder channel

- **Overlap**: define whether the recorded waveforms will be printed overlapping or beside each other.

- **Speed**: choose the recording print speed.

- **Delay Time**: Delayed recordings start documenting on the recorder strip from a pre-set time before the recording is started. This interval is called the "Delay Time" and can be set as specified in "Overview of Recording Types" on page 252. This setting can only be changed in Configuration Mode.

- **Run Time**: see how long this type of recording is configured to run. This setting can only be changed in Configuration Mode. Continuous recordings run indefinitely.

- **Central Config** - if available in the **General** menu, select this setting to use the recording settings made for the centrally-connected recorder.

Maintaining Recording Strips

Recording ink sometimes fades when covered with transparent tape. Avoid covering any part of a recording that is clinically relevant (annotation or waveforms) when taping a recording strip to a patient record or other patient documentation.

Recorder Status Messages

CAUTION

If no central recorder is available, alarm recordings may be lost. The message **No alarm recording available** will be displayed. This message is not shown if **Printer** is configured as the alarm recording destination.

Recorder Status Messages	Explanation
<Recording Name> running	The named recording is currently running.
No alarm recording available	No recorder available. Alarm recordings will be lost. Try configuring **Printer** as the alarm recording destination.
Central Recorder out of paper	The named recorder is out of paper.
Central Recorder door open	The door of the specified recorder is open.

Electronic Strip Recording

Electronic strip recording allows alarm-triggered and manually-started electronic strips to be captured in the monitor print database. They can then be printed in the form of reports when a printer is available.

The strips can be sent to an Information Center[*] or to the XDS Printing Service that is part of the IntelliVue XDS Software. The reports can then be printed to a standard off-the-shelf printer and can also be stored as files on the Information Center[*] or the PC hosting the XDS Printing Service.

If an X3 is connected to a host monitor, electronic strip reports can only be printed if the host monitor is an MX400/450/500/550 with software revision M.0 or above.

* Not available with PIIC iX Release B and earlier

Setting up Electronic Strip Recordings

You can create a template for alarm-triggered electronic strip recordings and delayed electronic strip recordings as described in "Creating and Changing Recordings Templates" on page 252. For **Recorder**, you must select **Strip Report**. For all other menu items you can select the settings most appropriate for your requirements.

Starting an Electronic Strip Recording

When the templates have been set up (see "Setting up Electronic Strip Recordings" on page 254), recordings can be started. An alarm-triggered electronic strip recording starts automatically, when the corresponding alarm condition occurs.

To start a delayed electronic strip recording:

1 Select the **Recor- dings** SmartKey.

2 Select the **Delayed Recordng** pop-up key.

Setting up Printing and Storage for Electronic Strips

The electronic strips captured in the database remain there until they are printed in the form of a report, even after patient discharge. You can make settings to define how electronic strips are printed and whether they are stored.

1 In the **Reports** menu select **Print Strip Rep.**

2 Select one of the following settings:

– **Auto+Delete** - Strips will be automatically printed and then deleted from the monitor's print database.

– **Auto + Keep** - Strips will be automatically printed and will remain in the monitor's print database for viewing.

– **Manual** - No strips will be automatically printed. You can print individual strips manually by selecting the strip report in the **Report List** and selecting the **Print** pop-up key. After printing, the strips are deleted from the monitor print database.

The **Auto + Keep** setting is only available when the report capability is set to **Enhanced** in Configuration mode.

CAUTION

Be aware that the **Auto + Keep** setting can lead to the print database quickly becoming full, depending on your report frequency. The maximum number of reports that can be stored in the database varies depending on the database configuration and the size of the reports. When the print database is full, no more reports can be generated that are set up to print to the database. This includes alarm-triggered electronic strip recordings. In this case, print or delete reports to make space available in the database.

Depending on the settings made at the Information Center[*] or the XDS Print Server, strips may also be stored there, as well as printed.

* Not available with PIIC iX Release B and earlier

Generating Patient Reports

A variety of different reports can be generated, for specific measurements, trends, events and procedures.

Depending on availability, reports can be sent:

- to a locally connected printer
- to an Information Center, for printing, storage and transmission to hospital systems
- to an IntelliVue XDS Printing Service, for printing and storage
- to the monitor print database

Reports sent to an Information Center, or to a PC hosting the IntelliVue XDS Printing Service, are encrypted to protect patient privacy. If no **Lifetime ID** or **Encounter ID** is entered for the patient, it may not be possible to assign the reports to the patient in an EMR system.

Print jobs in the print database are **not deleted** after a patient discharge. A new patient can be admitted and their reports are saved in addition to the previous reports. Always admit your patient so that reports can be clearly assigned to a patient.

Starting Reports

Patient reports can be started in one of three ways:

- by selecting **Main Setup** then **Reports** (or the **Print Reports** SmartKey) and then selecting the report name in the top half of the **Reports** menu. Report names are shown for all reports that have been correctly set up.
- in the context of the window or menu for the measurement or function addressed in the report, for example, in the **Graphical Trends** window. See "Starting the Different Types of Report" on page 257 for details.
- with a SmartKey, for those reports that have their own SmartKey, such as **Realtime Report**, **Graph Trends**, **Vital Signs**, **ECG Report A**, **ECG Report B**.

For most reports different ways are possible and you can choose the most convenient.

Data from the time of the print request is included in the report, even if the print job is delayed in the printer queue.

Starting the Different Types of Report

Report types	Report contents	How to start printing reports
Vital Signs Report	Depends on selected trend group, data resolution, and period.	In the **Vital Signs** window, select **Print/ Record**, then select **Print**.
Graphic Trends Report		In the **Graphical Trends** window, select **Print**.
ECG Reports	Depends on format selected.	Select the **ECG Report A**, or **ECG Report B** SmartKeys, if configured, or the **Print Reports** SmartKey followed by **ECG Report A** or **ECG Report B**.
12-Lead Report	Captured ECG waves, measurement values, ST Map (optional) and analysis results from the Information Center (PIC iX only)	In an active 12-Lead application window, select the **Print Report** pop-up key.

Report types	Report contents	How to start printing reports
ST Map Report	ST data in a transversal and/or horizontal multi-axis diagram	In the **ST Map (Current)** or **ST Map (Trend)** window, select **Print**.
STE Map Report	ST elevation data in the form of the STE map and STE snippet	In the **STE Map** window, select **Print**.
ECG QT Report	QT waveforms with Q and T points, QT numerics and supplemental information for the current and baseline QT measurement	In the **QT View** window, select **Print QT**.
Histogram Report	Depending on where the report is triggered, it will show the currently displayed histogram or the histogram set up as default.	In the window displaying the histogram, select **Print**.
Alarm Limits Report	Graphic and numeric report of all current alarm limits	In the **Alarm Limits** window, select **Print Limits**.
Realtime Reports	Patient data and numerics, and either: all displayed waves OR all measured waves OR all measured RT waves	Select the **Realtime Report** SmartKey, if configured.
Strip Report*	The content of an electronic strip recording	In the **Report List**, select the required Strip report and then select **Print**.
Central Report A/B/C	These are reports configured at the Information Center. Monitors connected via the IntelliVue Instrument Telemetry wireless network can have these reports available.	In the **Main Setup** select **Reports** then **Central Report A**, **Central Report B** or **Central Report C**.

*If an X3 is connected to a host monitor, electronic strip reports can only be printed if the host monitor is an MX400/450/500/550 with software revision M.0 or above.

Canceling Reports

To cancel the report that is currently printing, in the **Reports** menu, select **Delete Report** to stop the current print job.

To cancel all queued reports, in the **Reports** menu, select **Delete All Repts**.

You can also cancel individual reports in the **Report List**, see

Checking Report Status and Printing Manually

A list of all print requests which are waiting, printing or stored can be viewed in the **Report List**. To view the list, in the **Reports** menu, select **Report List**, or use the **Report List** SmartKey, if configured.

The following information is displayed for each print request:

• Report title

• Patient name, or Lifetime ID/Encounter ID when no patient name is available (except for system reports)

• Request date and time

• Job status: **Preparing**, **Printing**, **Waiting**, **In Database**, **Retry**, **Cancelling**, **Unsupported**, **Error**.

Additionally, if the report capability is set to **Enhanced** in Configuration mode, a symbol indicates which reports have been printed:

Reports shown in black will be printed automatically when a matching printer is available. Reports shown in gray must be printed manually, see

Individual reports can be deleted from the list with the **Delete** key, and all reports with the **Delete All Repts** key.

With the **Filter** key, you can reduce the number of reports visible by selecting a certain category to be shown, for example, **Unprinted Rep.** to show all reports not yet printed.

CAUTION

The **Report List** includes privacy information, in the form of the patient name with the related report title and date. It is advisable to provide controlled access to this data to ensure confidentiality.

If an X3 is connected to a host monitor, all print requests which are stored in the print database of the X3 are shown "grayed out" in the **Report List** on the X3. These reports can only be accessed at the host and cannot be printed or deleted at the X3.

Printing Manually

Any reports shown in gray must be printed manually, if a printout is required:

1   In the **Report List**, select the required report.

2   Select **Print**, to print to the default printer, or **Print To** to select a printer when more than one is available.

Selecting **Print All** will send all reports to the default printer.

The **Print** and **Print All** keys will not be available, if the database setting for all reports is **Auto+Delete** (see "Setting Up Printing and Storage for the Print Database" on page 262).

Setting Up Reports

In most cases, the standard reports used in your facility have been configured to match your requirements. If you need to make changes to the report setup for your patient, you can do that in the reports setup menus described in the following sections.

The content you define in the individual setup menus will be used in all reports of this type: for example, if you set a print speed of 50 mm/sec in the **ECG Reports** menu, every ECG report will be printed at this speed, irrespective of format.

The lead sequence for ECG reports, and the Auto reports settings, must be defined in Configuration Mode.

As the content of context-linked reports, such as the ST Map report, is defined by the content of the procedure window, these reports do not need to be set up. However, a target printer can be set up in the **Setup Reports** menu.

General Report Setup

Select **Main Setup**, **Reports**, then **Setup Reports** to enter the **Setup Reports** menu.

1 Select **Report** and then select the report you want to set up.

2 For the following reports, select **Report Type**, and then select the reports template you want to use.

Realtime Reports:

– **VisibleWaves**: all waves currently visible, in the order they appear on the screen.

– **All Waves**: all measured waves.

– **RT Waves**: all currently measured realtime waves, according to the monitor's priority list.

– **HiRes Waves**: all measured HiRes waves.

– **OxyCRG Waves**: the OxyCRG/Neonatal Event Review waves.

ECG reports:

– **ECG3x4**, **ECG6x2**, **ECG12x1**, **ECG4x2**, **ECG8x1**, **ECG12x1 (2P)**

Event Review Reports:

– **Review**: event review report for the event group with the most current episode

– **EventRev All**: summary event review report of all patient events

– **CAR Report**: the last CAR Seat report

All other reports have a fixed template.

3 Select **Report Size** to set the paper size to be used for the report: **Unspecified** to use the default size for the template chosen, **Universal**, **A4**, **Letter**, **LrgUniversal**, **A3**, or **Ledger**. The list of available sizes depends on the report type selected.

4 Select **Orientation** to set the orientation of the report printout: **Unspecified** to use the default size for the template chosen, **Landscape** or **Portrait**.

5 Select **Target Device** and choose which printer the print job will be sent to: **Unspecified** to use the default printer, or choose from the list of printer names defined at the Information Center or in the monitor's Configuration Mode (for example, **Remote 1** or **Database**).

Some settings may not be available in this menu for reports that can only be started in a special window.

Setting Up ECG Reports

The settings you choose in the **ECG Reports** menu apply for all ECG-A and ECG-B reports printed. To set up ECG Reports,

1 Select **Main Setup**, **Reports**, then **ECG Reports**. Note the report layout configured for your monitor, either **Internat** or **Cabrera**. This setting is inactive ("grayed-out") in Monitoring Mode and can only be changed in Configuration Mode.

2 Select **ECG Gain** and set the required ECG gain to define how ECG waves will appear on the ECG report printouts.

3 Select **Speed** and select the report print speed.

4 Select **Annotation** and switch to **On** if the printed ECG wave should be annotated with beat labels. See the "ECG, Arrhythmia, ST and QT Monitoring" chapter for a list of beat labels. Pace pulse marks are automatically printed beside the wave for paced patients.

Setting Up Vital Signs and Graphic Trend Reports

The settings you choose in the **Vital Signs Report** and **Graphical Trend Report** menus apply for all Vital Signs and Graphic Trend reports printed.

To set up Vital Signs and Graphic Trend reports,

Select **Main Setup**, **Reports**, then **Vital Signs Rep.** or **Graph Trend Rep.**.

1 Select **Trend Group** and select the group you want to print on the report. The groups available depend on your monitor's trend configuration.

2 Select **Period** and select the period of time for which trend data should be printed on the report. If **Automatic Period** is configured to **On**, all trend data for the current patient will be printed, irrespective which trend period is selected.

3 Select **Interval** (Vital Signs Reports only) and select the resolution of the trend data printed on the report.

Setting Up Auto Reports

Auto Reports print automatically when a specified trigger occurs. There are two types of Auto Reports: Scheduled Reports, which print at predefined intervals, and End Case Reports, which print when a patient is discharged using the End Case function. An Auto Report can be both a Scheduled Report and an End Case report.

To set up Auto Reports,

1 Select **Main Setup**, **Reports**, then **Auto Reports** and select the Auto Report you want to set up (A, B, C, or D).

2 Select **Report** and assign a report type to the Auto Report.

3 Select **End Case Report** and switch to **On** if you want the selected report to print automatically when you select **End Case** to discharge a patient.
Switch **End Case Report** to **Off** if the report is a Scheduled Report only.

4 Select **Scheduled Rep.** and toggle to **On** if you want the selected report to print at predefined intervals, starting at a predefined time of day. The start time you set applies for every following day. For example, if you set a start time of 07:00 and a repeat time of six hours, the first report will print at 07:00 every day, the next at 13:00 and so on.

   – To set the time of day at which you want the report to print every day: select **Start Hour** and **Start Minute** and select the required time from the pop-up list

   – To set the time interval in minutes between two scheduled reports: select **Rep. Freq. (h)** and **Rep. Freq. (min)** and select the time interval from the pop-up list.

   If you are setting up an end case report, these settings will be inactive ("grayed-out").
   Switch **Scheduled Rep.** to **Off** if the report is an End Case Report only.

5 Repeat the procedure for all Auto Reports you want to set up.
   All Auto Reports or Scheduled Reports set to **On** print automatically at the predefined trigger.

Be aware that the monitor's memory for reports is limited. The number of reports that can be stored depends on the size of the reports and the size of the printing database; the maximum is 30 reports. If the memory is full, reports cannot be saved on the printing database and therefore cannot be printed.

If you set up regular scheduled reports, and you have long case durations, make sure that the print database is configured to **Medium** and plan to print reports at appropriate intervals in order to avoid losing information due to a full memory.

Setting Up Printing and Storage for the Print Database

Your monitor can be set up to automatically print reports from the print database when a printer is available. To set this up:

1 In the **Reports** menu select **Print Dbs Rep.**. The settings shown are for all reports except electronic strip reports; see *"Setting up Printing and Storage for Electronic Strips" on page 254* for the electronic strip report settings.

2 Select one of the following settings:

– **Auto+Delete** - Reports will be automatically printed and then deleted from the monitor's print database.

– **Auto + Keep** - Reports will be automatically printed and will remain in the monitor's print database for viewing.

– **Manual** - No reports will be automatically printed. You can print individual reports manually by selecting the report in the **Report List** and selecting the **Print** pop-up key. After printing, the reports are deleted from the monitor print database.

The **Auto + Keep** setting is only available when the report capability is set to **Enhanced** in Configuration mode.

CAUTION

Be aware that the **Auto + Keep** setting can lead to the print database quickly becoming full, depending on your report frequency. The maximum number of reports that can be stored in the database varies depending on the database configuration and the size of the reports. When the print database is full, no more reports can be generated that are set up to print to the database. This includes automatic alarm-triggered reports. In this case, print or delete reports to make space available in the database.

Checking Printer Settings

The printer settings for your monitor are defined in Configuration Mode. The printer settings **Paper Size**, **Resolution**, **Color Support**, and **Duplex Option** for the active printer are visible but inactive ("grayed-out") in the **Setup Printers** menu. When **Print Database** is selected as active printer only the **Paper Size** setting will be shown.

• To enter the **Setup Printers** menu, in the **Reports** menu, select **Setup Printers**.

If you are using an IntelliVue XDS Printing Service, you may see XDS printers in the **Setup Printers** menu that have "Local" or "Remote" in their name. Their names and settings can only be configured in the XDS Software. Refer to the IntelliVue XDS Software Installation and Configuration Guide for full details about the configuration possibilities.

Printing a Test Report

A test report can be printed in Configuration mode, refer to the Service Guide for more information.

Switching Printers On or Off for Reports

You can enable or disable printer status to switch individual printers on or off for report printouts.

1 In the **Setup Printers** menu, select **Printer** and then select the name of the device you want to switch on or off for Reports printing from the pop-up list.

2 Select **Printer Status** to switch between the settings **Enabled** and **Disabled**. If you set this to **Disabled**, no reports will be printed to the named printer.
If the monitor detects that no printer of a particular type is available, the **Printer Status** setting will automatically be set to **Disabled** and "grayed out".
Local printers from the IntelliVue XDS Printing Service are always enabled and cannot be disabled here.

Dashed Lines on Reports
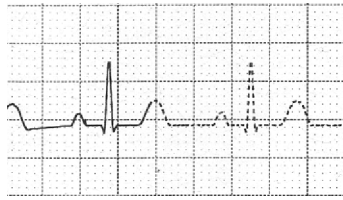
If a section of a wave on a report is drawn with dashed lines, this tells you that a setting that affects the appearance of the wave on the screen was changed while the report was printing. For Realtime Reports and ECG reports, an additional annotation **Wave Settings Changed** is printed on the report.

For example, if you change the wave scale while a report is printing, the wave scale and wave size are changed immediately on the monitor screen and on the report. To indicate that the scale information printed at the beginning of the report no longer matches the currently used scale, the wave will be printed using dashed lines, starting from the moment the change took place.

Some examples of settings that cause dashed lines in reports if changed during printing are: Filter mode, ECG lead placement, wave scale, measurement unit, paced/non-paced setting, and measurement mode. Note that as ECG waves are drawn with a fixed gain on reports (either 10 mm/mV or 20 mm/mV), changing the ECG wave scale will not cause dashed-line reports.

To avoid dashed lines on reports, wait 15 seconds after changing a setting before you trigger a report.

Unavailable Printer: Re-routing Reports

If you send a report to be printed on a printer that is not available, for example, because it has run out of paper, this print job is suspended and stored in the monitor's memory.

If the target device of this print job was set to **Unspecified**, the monitor will periodically try to resend the print job to the first printer listed in the **Setup Printers** menu under **Printer** that is set to **Enabled** and that has paper of the correct size.

To allow the report to print, you must either solve the problem with the target printer, or re-route the print job to another printer with paper of the correct size. To re-route a print job,

• Enable the new target printer by selecting it in the **Setup Printers** menu and toggling to **Enabled**. As the monitor tries to send the report to the printers in the order they are listed, you must make sure that all the printers above the new target printer are disabled.

If the target device of the print job was set to a specific printer, re-routing is not possible.

Printer Status Messages

Printer Status Message	Possible causes and suggested action
Print job queued for <Printer Name>	The report has been placed in the queue for the named printer.
Print job can't queue;resources? Print job can't queue;queue full Print job can't queue;no printer	The printer queue is full and the monitor cannot accept another report request. Wait until some more reports have been printed, then try again, OR A report has been triggered that uses a paper size unavailable with the target printer. Try another printer, if available, or change the paper size of the print request.
Cancelling all print jobs	**Delete All** has been selected in the **Reports** menu, OR The Operating Mode has been changed from Monitoring Mode to Demonstration or Service Mode.
Cancelling the active print job	The current report is being canceled as the result of a user request.
Cancelling print jobs from queue	Print requests are being canceled as the result of a user request or because the Operating Mode has been changed from Monitoring Mode to Demonstration or Service Mode.

Printer Status Message	Possible causes and suggested action
Basic report capabilities only	The PIC iX is release B or below and does not support enhanced reporting capability.
Deleted # print jobs;discharge	When a patient is discharged, all queued reports are canceled except those stored in the print database. "#" is the number of reports canceled.
Deleted # print jobs; restart	The monitor has restarted and all report requests have been canceled except those stored in the print database. "#" is the number of reports canceled.
Print failed;No report configurd	A report has been triggered which has not been correctly set up. Enter the setup menu for the report type to set up the report.
Printing on <Printer Name>...	A report is in progress, or the monitor is waiting for the central printer to accept the print job.
NoPrinter <Printer Name>;job susp.	The chosen device is unavailable. Check that the printer is properly connected and that paper is available. The requested report will start printing when the printer becomes available.
Print database full->job suspnd.	The requested report does not fit into the print database. You can select another printer to print the report (see "Unavailable Printer: Re-routing Reports" on page 263). Alternatively you can delete another report from the **Report List** (using the **Delete** key) to create space for your report.
Job <Printer Name> fail;no printer **Job <Printer Name> fail;data error**	A report cannot be started on the requested printer. The reason is shown in the status message: • printer unavailable - make sure the printer is plugged in, switched on, and has paper loaded. • data requisition error - an internal error has caused data required for the report to be unavailable, try starting the report again.
Print job on <Printer Name> done	The report has been printed.
Print database nearly full	The print database is nearly full. Print or delete reports to increase the available space.
Print database full	The print database is full. Print or delete reports to increase the available space.
Found no printer for A4 format **Found no printer for A3 format** **No printer for Letter format** **No printer for Ledger format** **No printer for Strip reports**	A report cannot not be printed, because the available printers do not support the report paper size.
No printer for Unicode encoding	A report cannot not be printed because the report is Unicode encoded and the available printers do not support Unicode.

Sample Report Printouts

Each report header contains the patient's bed label, last name and first name, middle name (if there is enough space) the patient ID, the date and time, and the name of the report. The report footer contains the hospital label and page number, and the last page contains a note to mark the report end.

The monitor may be configured to leave a space on the top left or right of the report printout to enable you to stick a patient address label on it. This setting is called the **Addressograph** and it can only be changed in the monitor's Configuration Mode.

Alarm Limits Report

1   Measurement labels, with alarms off symbol where alarms are switched off

2   Graphic view of current alarm limits in relation to currently monitored measurement value
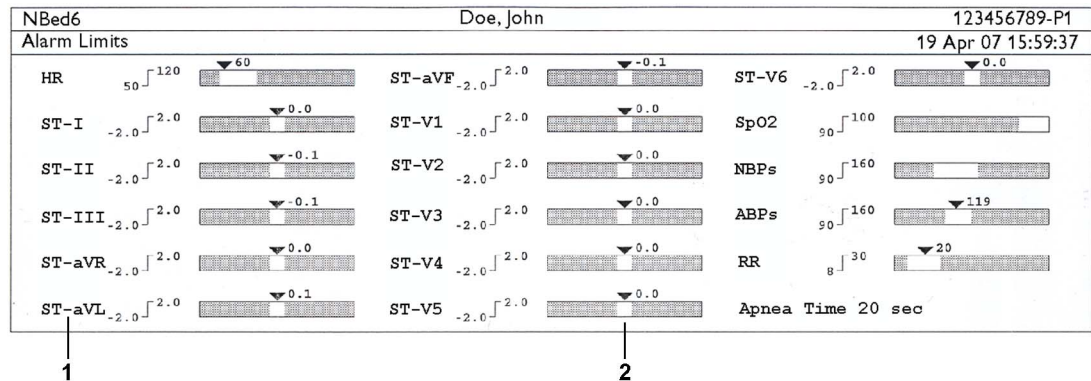
Realtime Report
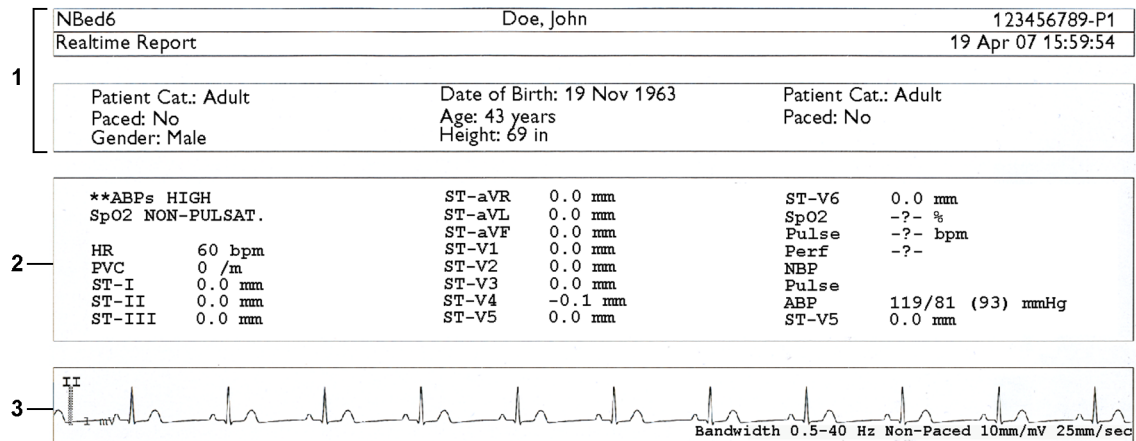
1   Patient demographic information, time stamp

2   Active Alarms and INOPs, followed by vital signs

3   Measurement waves section (printed with a millimeter grid not shown here)

ECG Reports
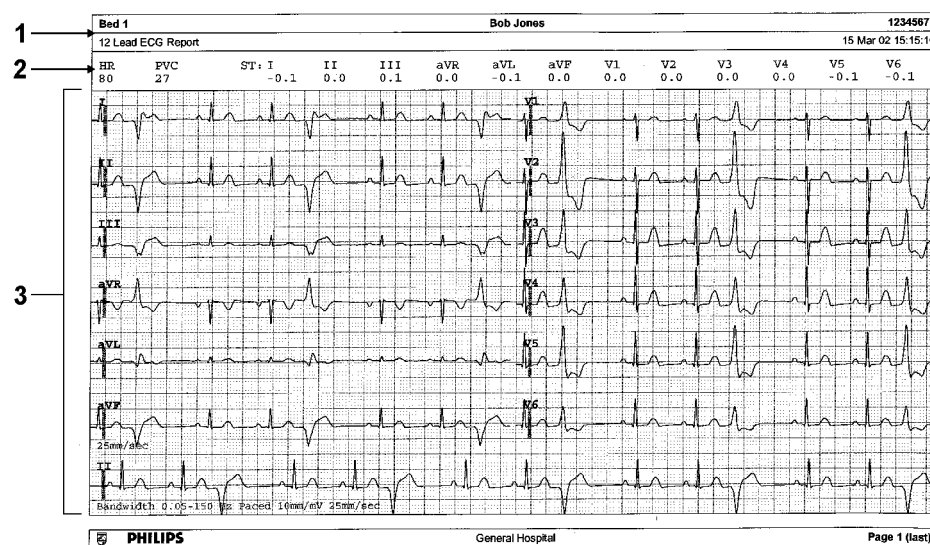
1 Patient information
2 Numeric block
3 Wave area

Below the header on ECG Reports, the numeric block shows the current HR, PVC, and ST values. The wave area shows the printed waves for all available ECG leads. A 1 mV calibration bar is printed at the beginning of each wave. With the 3X4, 6X2, and 2X4 formats, a rhythm stripe prints a longer section of the ECG wave from the primary ECG lead for ECG rhythm evaluation. The ECG signal bandwidth, the patient's paced status, the ECG gain, and the print speed are printed at the bottom of the wave area. Pace pulse marks are automatically printed beside the wave for paced patients. Beat labels can be set to print on the rhythm stripe. If no rhythm stripe is present, the beat labels will be printed on the primary lead. The 12X1 (2P) format prints the report over two pages.

ECG Report type	Available Formats	Available Paper Sizes
12-Lead ECG	3X4 landscape	A4, letter, A3, ledger
	6X2 landscape	A4, letter, A3, ledger
	12X1 portrait	A4 and letter only
	12X1 landscape	A4, letter, A3, ledger
	12X1 (2P) landscape	A4, letter (2 pages)
Multi-lead ECG	2X4 landscape	A4, letter, A3, ledger
	8X1 portrait	A4 and letter only
	8X1 landscape	A4, letter, A3, ledger

12-Lead ECG Report
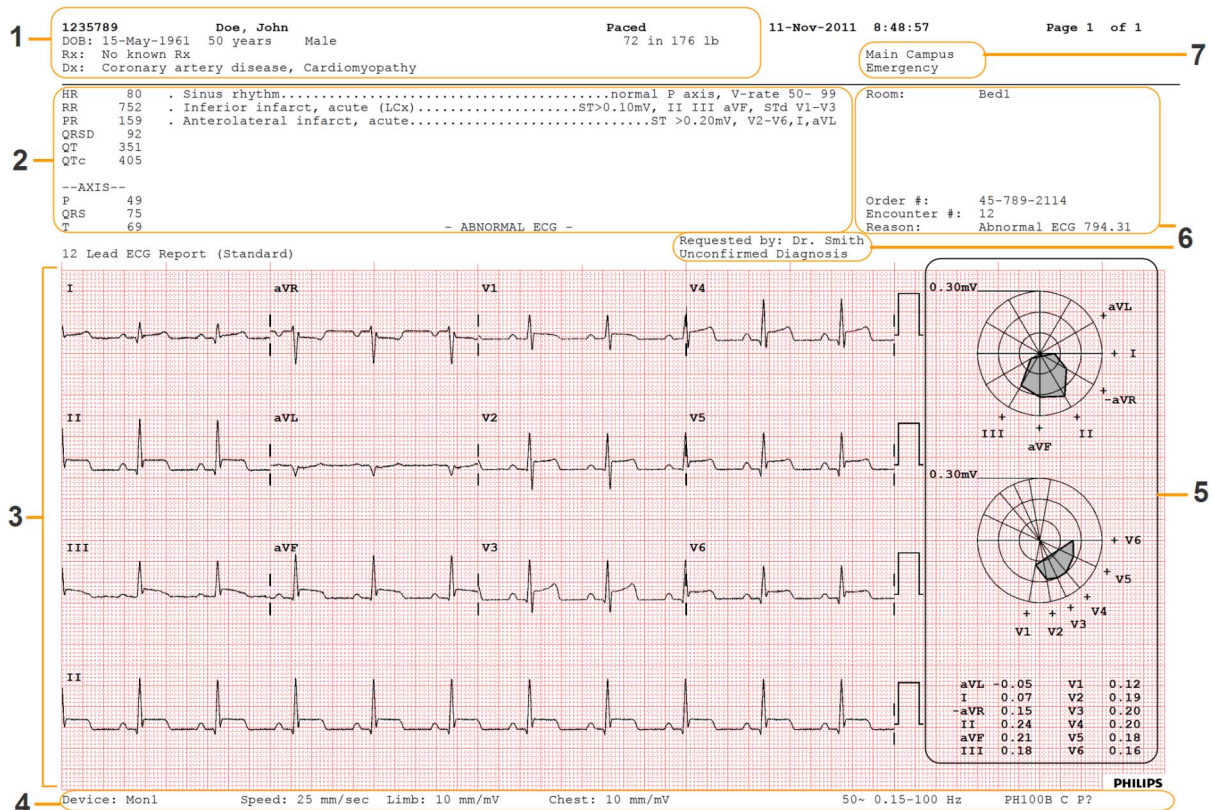
1 Patient data

2 Analysis data from the Information Center (PIC iX only)

3 12-Lead wave area

4 Data related to the wave presentation

5 ST Map with related ST numerics (optional)

6 Administrative data - including optional custom text fields

7 Hospital ID data - Institution, facility and department, if configured

Other Reports

See the sections on Trends for other example reports.

Using Timers

With the timers function you can set timers to notify you when a specific time period has expired.

CAUTION

Do not use the timers to schedule critical patient-related tasks.

Viewing Timers

You can view currently active timers in the **Timers** window or directly on the Main Screen (if a timer has been substituted for a numeric).

To open the **Timers** window:

- Select the **Timer** SmartKey

or

- Select **Main Setup** then select **Timer**

The maximum number of timers which can be active depends on your monitor model.

For a timer with a defined run time a progress bar is shown with the run time for that timer. Next to the progress bar the elapsed time or the remaining time is shown, depending on whether the timer is counting up or down. On the left, the label of the timer and a symbol indicating the type of expiry notification is shown.

Timer Types

There are four types of timer: **Basic**, **Enhanced**, **Cyclic** and **No Limit**. A **Basic** timer has a single, defined run time and progress is shown in the progress bar. An **Enhanced** timer is like a **Basic** timer but the progress bar shows progress beyond the end of the run time. A **Cyclic** timer is like a **Basic** timer but restarts automatically when the run time is expired. A **No Limit** timer has no run time or progress bar and shows the time elapsed since the timer was started.

The type of timer is set in the monitor's Configuration Mode and is associated with the timer label.

Timer Setup Pop-up Keys

When you open the **Timers** window and select a timer, then select the setup key, the setup window opens and a selection of pop-up keys appear to let you activate and control the timers.

Pop-Up Keys	Selecting this pop-up key lets you....
Start	start the timer.
Stop	stop the timer, allowing either restarting after a pause (**Start** key) or clearing (**Clear** key).
Clear	clear the timer, ending this timer episode.
Timers	return to the timer window showing all active timers

Setting Up Timers

The timer type, display color of the timer and whether a window automatically pops up on expiry are settings made in Configuration Mode for each timer label.

The remaining timer settings can be made in Monitoring Mode. If you change settings when a timer is running it will not be stopped. The timer will continue to count but the new settings will be applied.

To display the setup window for a timer,

- in the **Timers** window, select the required timer, then select the setup key or

- select a timer on the Screen then select **Setup Timers**.

Timer Label

You can select from a variety of specific labels, for example **Tourniquet**, **Infus**, **Docu** or from four non-specific labels **TimerA**, **TimerB**, **TimerC**, and **TimerD**. When you assign a label to a timer, the monitor automatically applies the associated configuration settings to this timer, but the timer continues counting and is not reset.

To select a label, in the **Timers** window:

1   Select the required timer and display the **Setup** window.

2   Select **Label**.

3   Select a specific or non-specific label from the list.

Run Time

The run time can be set between 1 minute and 96 hours. **No Limit** timers have no run time.

To set the run time, in the **Timers** window:

1   Select the required timer and display the **Setup** window.

2   Select **Run Time**.

3   Select a run time from the list.

Timer Counting Direction

Timers can count up or down, showing elapsed time or remaining time. **No Limit** timers automatically count up.

To change the direction, in the **Timers** window:

1   Select the required timer and display the **Setup** window.

2   Select **Direction** to switch between **Up** and **Down**.

Notification

When a timer expires (except a **No Limit** timer), the color changes to red and a message pops up briefly. Be aware that if a timer has been configured to display in light red, the color will not visibly change when the timer expires.

Additional notification is also available and can be set to:

Alarm: An INOP alarm indicates the expiry of the timer

Sound: A single tone indicates the expiry of the timer

No Sound: No additional notification

To set the additional notification, in the **Timers** window:

1   Select the required timer and display the **Setup** window.

2   Select **Notification** and select the notification level required from the list.

Timer Volume

For all timers with the notification setting **Sound**, you can set the volume of the tone.

To set the volume, in the **Timers** window:

1   Select the required timer and display the **Setup** window.

2   Select **Timer Volume** and select a volume setting from the list.

Displaying a Timer On The Main Screen

If you want to have a timer displayed on the Main Screen, you can substitute it for a numeric which is not directly associated with a wave. If limited space is available, some of the timer display elements may not be displayed. The minimum information displayed is the label and the elapsed or remaining time.

To display a timer on the Main Screen:

1   Select the numeric you want to substitute.

2   Select **Change Numeric**.

3   Select **Any Timer**.

Main Screen Timer Pop-up Keys

When you select a timer displayed on the Main Screen, additional pop-up keys become available:

Pop-Up Keys	Selecting this pop-up key lets you....
Setup <Timer Label>	enter the setup screen for the currently selected timer.
Change Timer	select a different timer for display.
Timers	enter the **Timers** window.

Displaying A Clock On The Main Screen

In the same way that you can substitute a timer for a numeric, you can also substitute a larger analog or digital clock display for a numeric.

To display a clock on the Main Screen:

1   Select the numeric you want to substitute.

2   Select **Change Numeric**.

3   Select **Clock**.

When you select the clock on the Main Screen you can select **Date, Time** in the menu to set the date and time.

20 Using Timers

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Using Batteries

The Lithium Ion batteries used in your monitor store a large amount of energy in a small package. This allows reliable battery-operated monitoring but also requires care in use and handling of the batteries. Follow the instructions in this chapter and refer to the Service Guide for more information.

When monitoring a patient, **one** Philips rechargeable Lithium Ion battery (453564526811) must **always** be inserted into the battery compartment on the underside of the MX100/X3. This applies even when you are running the MX100/X3 on external power.

A severe yellow INOP (**!! Insert Battery**) will be issued if the monitor is connected to external power without a battery fully inserted in the battery compartment. This INOP will persist until a battery is inserted.

1 Battery compartment

To use the MX100/X3 with battery power, disconnect it from its current power source:

- IntelliVue Dock (867043)
- External power supply (M8023A)
- Battery Extension (865297)
- host monitor (X3 only)

You can switch between battery-powered and externally-powered operation without interrupting monitoring.

When an X3 is connected to a host monitor, no battery data from the X3 is visible on the host. Battery INOPs, however, are displayed.

The battery recharges automatically when MX100/X3 is connected to IntelliVue Dock or the optional external power supply (M8023A), or when X3 is connected to a host monitor (running either on AC mains or battery power).

CAUTION

Ensure that the battery in an MX100/X3 is charged regularly to avoid an exhaustive discharge. Batteries that have been exhaustively discharged (voltage below 6 V) can no longer be charged and must be taken out of use. Remember also to charge batteries that are stored for longer periods in an MX100/X3 that is switched off.

Battery Power Indicators

The battery indicator and battery status information on the Main Screen, in combination with INOP messages and prompts, help you keep track of the battery power status. The indicators always show the remaining capacity in relation to the battery's actual maximum capacity, which may lessen as the battery ages. You can see the actual capacity in the **Battery Status** window.

Battery LED

The battery indicator on the front panel of the monitor is in the form of a battery symbol.

1   Battery indicator

1
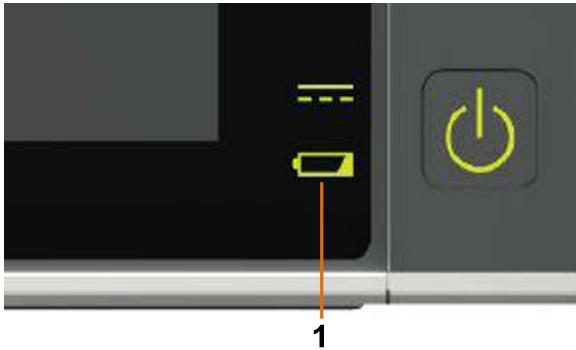
Battery indicator colors	If the MX100/X3 is connected to external power, this means	If the MX100/X3 is running on battery power, this means
Green	battery power is > 90%	-
Yellow	battery charging (battery power < 90%)	-
Red, flashing	-	less than 10 minutes power remaining
Red, flashes intermittently	battery or charger malfunction	battery malfunction

When the monitor is running on battery power the battery indicator is off. The only exceptions are when power is very low or there is a battery malfunction, as described in the table above.

Battery Status on the Monitoring Screen

The battery status information includes the battery power remaining and, when the battery is not charging, an estimate of the monitoring time this represents.

Battery power gauge:

This shows the remaining battery power. It is divided into sections, each representing 20% of the total power. If three sections are filled, as in this example, this indicates that 60% battery power remains. If no battery is detected, a blank battery gauge marked with a flashing red X is displayed. If no data is available from the battery, a question mark is shown in the gauge. If the monitor is powered from the Battery Extension, the battery gauge shows the remaining power for the battery in the Battery Extension.

If there are problems or changes in the status of the battery this is indicated by a blank battery gauge containing a symbol. If the symbol is red, this indicates a critical situation. You can check the specific cause of the problem by looking at the symbol(s) displayed in the **Battery Status** window (see).

Battery status indicator		Battery malfunction indicator	
[!]	Alternates with the battery gauge on the Main Screen. Check in the **Battery Status** window to see which status symbol is displayed for which battery to identify the cause.	[!]	The red **!** flashes. Critical battery situation or malfunction. Check in the **Battery Status** window to see which malfunction indicator is displayed, or refer to the INOP, to identify the cause.
		[X]	Indicator for missing battery (flashing red X). An **!! Insert Battery** INOP is issued when the battery compartment is empty, and the monitor is connected to external power. This INOP is suppressed for 15 seconds while the monitor is connected to external power, allowing you sufficient time to insert new battery. After silencing, the INOP reappears every 10 seconds until a battery is inserted.

Monitoring Time Available: While the monitor is running on battery power, a time is displayed below the battery power gauge. No time is displayed when the monitor is running on external power. This is the estimated monitoring time available with the current battery power. Note that this time fluctuates depending on the system load (the display brightness and how many measurements you carry out). If the remaining operating time is 00:00, the monitor shuts down automatically.

Battery Status Window

To access the **Battery** window and its associated pop-up keys, select the battery status information on the Screen, or select **Main Setup** then select **Battery**.

If you are using a Battery Extension, status information for both batteries will be shown in the **Battery** window. If the battery in the Battery Extension is completely discharged, there may be no status information available for it.

Capacity, **remaining** tells you how much power is left in the battery.

Capacity, **fullCharge** tells you how much power the battery can hold when fully charged.

TimeToEmpty tells you approximately how long you can continue to use the monitor with this battery. Note that this time fluctuates depending on the system load (the display brightness and how many measurements you carry out).

TimeToFull is shown in place of **TimeToEmpty** if the monitor is connected to mains power via a host monitor, IntelliVue Dock (867043), or the M8023A external power supply, and tells you how much time is left until the battery is charged to 90%. You can use the 865432 Smart Battery Conditioner (previously M8043A) to charge the batteries externally.

Checking Battery Charge

To check the charge status of a battery, refer to the battery power gauge on the screen, or open the **Battery Status** window.

When Battery Lifetime is Expired

When the battery is aged, either after 3 years from manufacturing date or after 500 full charge/discharge cycles, it is recommended to replace the battery. To remind you of this, a message will appear in the **Battery Status** window. This message will only be displayed at the appropriate time when the date and time on the monitor is correct.

WARNING

The risk of battery failure increases with age, when a battery remains in use longer than 3 years or 500 full charge-discharge cycles. Such failures can result in overheating that in rare cases can cause the battery to ignite or explode.

Replacing a Battery

1   Push the tab towards the cover of the battery compartment, then pull upwards to open it.

2   Remove the battery by pulling on the battery tab.

3   Slide in the new battery, with the contacts first. The battery tab is visible when the battery is correctly inserted.

4   Push the cover closed, with the outer tab latched into position.

WARNING

Do not insert your fingers or any objects into the open battery compartment.

Replacing the Battery in the Battery Extension

To replace the battery,

1   Push the battery cover downwards, so that it opens.

2   Remove the battery from the compartment.

3   Slide the new battery firmly into position with the label facing downwards.

4   Close the battery cover and push it upwards, so that it remains closed.

Optimizing Battery Performance

The performance of rechargeable batteries may deteriorate over time. Battery maintenance as recommended here can help to slow down this process.

Display Brightness Setting

1   In the **Main Setup** menu, select **User Interface**, **Brightness**, then **Optimum**. This selects a level of brightness suitable for most monitoring locations that uses less battery power than brighter settings.

2   Ensure that the current level of brightness is suitable for your monitoring location.

Charging a Battery

A battery can be charged in a monitor during monitoring. You can also use the 865432 Smart Battery Conditioner (previously M8043A) to charge batteries. When using the Smart Battery Conditioner, you require an adapter (453564658631) to fit the battery into the charging slot.

1   Insert the battery into an X3 connected to a host monitor, or into an MX100/X3 connected to the external power supply (M8023A) or IntelliVue Dock, that is connected to mains power.

2   Charge the battery until it is full, the battery indicator is green, and the battery power gauge is filled.

In certain situations, internal temperature conditions may mean that the battery will not charge. This is sometimes necessary to protect the battery from damage, and does not indicate a malfunction. In this case you must use the 865432 Smart Battery Conditioner (previously M8043A Smart Battery Conditioner) to charge the battery or, for X3, mount the monitor on an M8040A mount instead of on the back of the host monitor.

Conditioning a Battery

You must condition a battery when its "battery requires maintenance" symbol shows on the Screen. Do not interrupt the charge or discharge cycle during conditioning. You can condition a battery in a monitor.

CAUTION

Do not use a monitor that is being used to condition batteries to monitor patients. The monitor switches off automatically when there is no battery power left.

It is, however, preferable to use the 865432 Smart Battery Conditioner (previously M8043A) for external battery conditioning. The Smart Battery Conditioner automatically performs the correct charge or conditioning process and evaluates the capacity when fully charged. For details please see the Instructions for Use for the Smart Battery Conditioner. Do not use any other battery chargers or conditioners.

To condition a battery using a monitor,

1   Insert the battery into an X3 connected to a host monitor, or into an MX100/X3 connected to IntelliVue Dock (867043), or to the external power supply (M8023A), that is connected to mains power.

2   If the monitor is connected to the external power supply, switch the monitor power switch off.

3   Charge the battery until it is completely full. Open the **Battery** window and check that the **Batt fully charged** message is displayed.

4   Disconnect the monitor from the external power supply (M8023A), IntelliVue Dock or host monitor, and let it run until there is no battery power left and the monitor switches itself off.

5   Reconnect the monitor to the external power supply (M8023A), IntelliVue Dock or host monitor and charge the battery until it is full for use, or charge to 20% to 40% for storage.

To condition the battery from a Battery Extension, use the 865432 Smart Battery Conditioner.

Storing a Battery

A battery should not remain inside the monitor or Battery Extension if it is not used for a longer period of time. If batteries are stored for an extended period of time, they should be stored in a cool place, ideally at 15°C (60°F), with a state of charge of 20% to 40%. Storing batteries in a cool place slows the aging process. The batteries should not be stored at a temperature outside the range of -20°C (-4°F) to 60°C (140°F).

Stored batteries should be partially charged to 20% to 40% of their capacity every 6 months. They should be charged to full capacity prior to use.

Storing batteries at temperatures above 38°C (100°F) for extended periods of time could significantly reduce the batteries' life expectancy.

CAUTION

Ensure that the battery in an MX100/X3 is charged regularly to avoid an exhaustive discharge. Batteries that have been exhaustively discharged (voltage below 6 V) can no longer be charged and must be taken out of use. Remember also to charge batteries that are stored for longer periods in an MX100/X3 that is switched off.

NOTE

The battery will discharge over time if it is stored inside the monitor or Battery Extension when not connected to a powered (either running or in Standby) host monitor, the external power supply (M8023A), or IntelliVue Dock. The reported values for "remaining capacity" and "runtime" will become less accurate when the battery is stored in this way for a longer period of time (that is, several weeks).

Disposing of Used Batteries

Dispose of used batteries promptly and in an environmentally-responsible manner. Discharge the batteries and insulate the terminals with tape before disposal. Do not dispose of the battery in normal waste containers. Consult your hospital administrator to find out about local arrangements.

Battery Safety Information

WARNING

- Use only Philips batteries specified in the chapter on "Accessories". Use of a different battery may present a risk of fire or explosion.
- Do not open batteries, heat above 60°C (140°F), incinerate batteries, or cause them to short circuit. They may ignite, explode, leak or heat up, causing personal injury.
- If battery leakage should occur, use caution in removing the battery. Avoid contact with skin. Refer to qualified service personnel.
- Do not expose batteries to liquids.
- Do not apply reverse polarity.
- Do not crush, drop or puncture batteries - mechanical abuse can lead to internal damage and internal short circuits which may not be visible externally.
- If a battery has been dropped or banged against a hard surface, whether damage is visible externally or not:
  – discontinue use
  – dispose of the battery in accordance with the disposal instructions above.
- Keep batteries out of the reach of children
- Keep batteries in their original package until you are ready to use them.

Care and Cleaning

Philips recommends that you use only the substances and methods listed in this chapter to clean or disinfect your equipment. Warranty does not cover damage caused by using substances or methods which are not described in this chapter.

General Points

Keep your monitor, cables and accessories free of dust and dirt.

After cleaning and disinfection, check the equipment carefully. Do not use if you see signs of deterioration or damage. If you need to return any equipment to Philips, decontaminate it first.

Observe the following general precautions:

• Always dilute cleaning agents according to the manufacturer's instructions or use lowest possible concentration.

• Do not allow liquid to enter the case.

• Do not immerse any part of the equipment or any accessories in liquid.

• Do not pour liquid onto the system.

• Never use abrasive material (such as steel wool or silver polish).

• Never use bleach except in an approved product listed in this chapter.

• When cleaning cables, do not allow liquid to enter the connector or to collect around connector pins.

• Avoid cleaning or disinfecting while the equipment is in operation or in direct sunlight.

• Ensure that all parts of the equipment dry completely after cleaning and disinfection.

WARNING

If you spill liquid on the equipment, battery, or accessories, or they are accidentally immersed in liquid, contact your service personnel or Philips service engineer. Do not operate the equipment before it has been tested and approved for further use.

Cleaning the Monitor

The cleaning procedure described below has been validated using an enzymatic solution. Before cleaning, visually inspect the monitor for moderate to severe soiling. If the monitor is severely soiled, use swabs to clear soil before cleaning.

To clean the monitor:

1 Prepare an enzymatic detergent solution (for example, Prolystica® Manual 2X Enzymatic Presoak and Cleaner, Cidezyme® or Enzol®) per the manufacturer's instructions.
Using non-linting wipe(s) wetted (but not dripping) with the prepared detergent solution, thoroughly wipe the exterior surfaces of the device for a minimum of one (1) minute and until visibly clean. Pay attention to surfaces such as seams and ridges.

NOTE

– Take extra care when cleaning the screen of the monitor because it is more sensitive to rough cleaning methods than the housing.

– Do not permit any liquid to enter the monitor case and do not pour liquid onto the monitor while cleaning. Do not allow water or cleaning solution to enter the measurement connectors. Wipe around, not over, connector sockets.

CAUTION

To clean the touch-enabled display, disable the touch operation by switching off the monitor during the cleaning procedure, or by touching and holding the Screen key. Touch and hold the Screen key again to re-enable touch operation.

2 Remove the cleaner residue by wiping the device surfaces a minimum of one (1) time with non-linting wipe(s) wetted (but not dripping) with tap water.

3 Thoroughly dry the device using non-linting wipe(s).

4 Inspect the device in a well-lit area to ensure that all surfaces are clean.

Disinfecting the Monitor

NOTE

The disinfection procedure described below has been tested and its efficacy validated using 70% Isopropyl Alcohol (IPA).

Clean equipment before disinfecting.

1 Thoroughly wipe all exterior surfaces of the device using non-linting wipe(s) wetted (but not dripping) with 70% Isopropyl Alcohol (IPA).

NOTE

Do not permit any liquid to enter the monitor case and do not pour liquid onto the monitor while cleaning. Do not allow water or disinfectant to enter the measurement connectors. Wipe around, not over, connector sockets.

CAUTION

To disinfect the touch-enabled display, disable the touch operation by switching off the monitor during the disinfection procedure, or by touching and holding the Screen key. Touch and hold the Screen key again to re-enable touch operation.

2 Allow all surfaces to remain visibly wet for a minimum of ten (10) minutes. If needed, use additional wipes to ensure that the surfaces remain wet for the full duration.

3 Thoroughly dry the device using non-linting wipe(s).

Material Compatibility with Disinfectants

Philips IntelliVue patient monitors are made of damage resistant materials and designed for easy cleaning and disinfection. Philips recommends using one of the agents/disinfectants listed in the tables below. These contain the most common ingredients and have been tested by Philips for compatibility. They have not, however, been validated for efficacy.

NOTE

The materials used in the monitor have shown the best resistance to the disinfectants listed below. These disinfectants have **not** been tested for their efficacy as a means for controlling infection. Please contact the disinfectant manufacturer for information on efficacy and any further information. With the method described in "Disinfecting the Monitor" on page 280, using 70% Isopropyl Alcohol (IPA), it has been proven that the monitor is suitable for intermediate level disinfection.

List of Disinfectants

CAUTION

Solutions: Do not mix disinfecting solutions (such as bleach and ammonia) as hazardous gases may result.

NOTE

The disinfectants listed below were tested for material compatibility during product development. Philips is not responsible for the ingredients used or for any changes made to the ingredients afterwards. In case of doubt, contact the disinfectant manufacturer.

Product Name, Dilution (v/v)[1]	Manufacturer
Isopropanol, 70%[2]	-
Sodium Hypochlorite, bleach, 2%[3]	-
Hydrogen Peroxide, 3%	-
Bacillol® 30	BODE Chemie GmbH
Dismozon® plus, 0.4%	BODE Chemie GmbH
Meliseptol®	B. Braun Melsungen AG
Incidin® Foam	Ecolab Inc.
Incidin® Plus[3], 0.5%	Ecolab Inc.
Oxivir® Tb Disinfectant Cleaner	Diversey Inc.
Super Sani-Cloth® Germicidal Disposable Wipes	PDI Inc.
Sani-Cloth® Plus Germicidal Disposable Wipes	PDI Inc.
Sani-Cloth® Bleach[3] Germicidal Disposable Wipes	PDI Inc.
Sani-Cloth® AF3[3] Germicidal Disposable Wipes	PDI Inc.
Mikrozid® Sensitive Wipes	Schülke & Mayr GmbH
Mikrozid® PAA Wipes	Schülke & Mayr GmbH
Descogen® Liquid r.f.u.	Antiseptica Dr. Hans-Joachim Molitor GmbH
Lysoformin®, 6%	Lysoform Dr. Hans Rosemann GmbH
DESCOSEPT pur	Dr. Schumacher GmbH
Virex® Tb Disinfectant Cleaner[3, 4]	Diversey Inc.

1 Where no specific information is given on the dilution, refer to the manufacturer's instructions.

2. Isopropanol has been tested for compatibility with a concentration of up to 80%.

3 Do not use these disinfectants on the Bedhanger Mount or the Rotatable Quick Claw Mount.

4 Regular use of this disinfectant increases material stress and may lead to a slightly reduced lifetime of the monitor housing.

Use of Other Disinfectants

If you use disinfectants other than the ones listed above, contact your disinfectant manufacturer for information on efficacy and compatibility.

CAUTION

• Be aware that individual ingredients of disinfectants may cause discoloration or damage to the monitor housing and may lead to reduced product lifetime. For example, specific ingredients could cause cracks in surfaces. If you notice significant changes on your monitor housing after disinfection, see your Service Guide for troubleshooting information or contact your service personnel.

• Damage is more likely to occur the more often a disinfection is performed.

• Note that in case of an epidemic the disinfectants requested by the local authorities should be used for the duration of the epidemic. Be aware that long-term use of high-level disinfectants can cause damage to the device.

Cleaning and Disinfecting the Cardiac Output Inline Injectate Temperature Probe

Validated Cleaner and Disinfectant:

Philips has validated the following cleaner and disinfectant which were tested for efficacy and use on the probe. These agents were tested by Philips for both efficacy and prevention of damage to the Philips products being cleaned and disinfected:

Cleaner:

• Enzymatic detergent - composition:

Name	Percent %
Alcohols, C9-11, ethoxylated surfactant	1 - 5
Glycerin	1 - 5
Citric Acid	1 - 5
N,N-Dimethyloctadecylamine oxide	1 - 2
Subtilisins (proteolytic enzymes)	0.1 - 1

• Please refer to the detergent manufacturer's label for proper dilution and water temperature instructions.

Disinfectant:

• 70% Isopropyl Alcohol (Chemical Abstract Service #67-63-0)

Getting Started:

Before cleaning and disinfecting the product:

1 Visually inspect the probe for damage or deterioration. Check for any type of damage, such as tears or cracks. Discard the product if damaged since there is a potential for incorrect readings.

2 Always replace the product when there is extensive visible damage to the product.

3 Visually inspect the product for moderate to severe soiling. Products with moderate to severe soiling are not intended to be cleaned or disinfected. If this situation occurs, dispose of the product.

4 Secure the following supplies:

   – non-linting wipes

   – cotton swabs with tapered mini tips

   – the validated cleaner and disinfectant using the concentration recommended by the manufacturer.

Cleaning the Probe:

Lay the probe on a clean, flat surface. If at any time during the procedure the non-linting wipes become visibly soiled, discard soiled wipes and use more clean wipes. Use cotton swabs during the procedure, as needed, to clean and rinse seams, grooves, and narrow spaces.

1 Saturate a non-linting wipe with the validated cleaner.

2 Saturate all surfaces of the product with the cleaner.

3 Allow surfaces to remain visibly wet for 3-5 minutes.

4 Dampen another non-linting wipe with cleaner.

5 Wipe all surfaces of the product until they are visibly clean. Be sure to clean all sides of the product.

6 Saturate a non-linting wipe with tap water.

7 Wipe all surfaces of the product at least one time.

8 Visually inspect the product and repeat steps 6 and 7, if needed. If any part is not visibly clean, use a cotton swab to clean between the grooves and narrow spaces.

9 Using clean wipes, dry all surfaces of the product.

Disinfecting the Probe:

Lay the probe on a clean, flat surface. If at any time during the procedure the non-linting wipes become visibly soiled, discard soiled wipes and use more clean wipes. Use cotton swabs during the procedure, as needed, to disinfect and rinse seams, grooves, and narrow spaces.

1 Saturate a non-linting wipe with the validated disinfectant.

2 Thoroughly saturate all surfaces of the product.

3 Allow surfaces to stay visibly wet for 10 minutes. Ensure that all seams, grooves and narrow spaces are saturated.

4 Saturate a non-linting wipe with tap water.

5 Wipe all surfaces of the product.

6 Repeat step 5 two more times, using more wipes as needed.

7 Using clean wipes, dry the entire product.

8 Visually inspect the product to ensure all surfaces are clean and dry.

Sterilizing the Equipment

Sterilization is not allowed for this monitor, related products, accessories, or supplies unless otherwise indicated in the Instructions for Use that accompany the accessories and supplies.

Cleaning, Sterilizing and Disinfecting Monitoring Accessories

To clean, disinfect, and sterilize reusable transducers, sensors, cables, leads, and so forth, refer to the instructions delivered with the accessory. If no instructions are delivered with the accessory, the instructions given in this chapter for cleaning, disinfecting, and sterilizing the monitor are applicable.

Wiping Batteries and the Monitor Battery Compartment

Wipe with a lint-free cloth, moistened with warm water (40°C/104°F maximum) and soap. Do not use strong solvents. Do not soak the battery.

Maintenance and Troubleshooting

WARNING

Schedule: Failure on the part of the responsible individual hospital or institution employing the use of this equipment to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazards.

Contact: If you discover a problem with any of the equipment, contact your service personnel, Philips, or your authorized supplier.

Inspecting the Equipment and Accessories

Perform a visual inspection before every use, and in accordance with your hospital's policy. With the monitor switched off:

1   Examine unit exteriors for cleanliness and general physical condition. Make sure that the housings are not cracked or broken, that everything is present, that there are no spilled liquids and that there are no signs of abuse.

2   Inspect all accessories (cables, transducers, sensors and so forth). If any show signs of damage, or the use-by date has been exceeded, do not use.

3   Switch the monitor on and make sure the backlight is bright enough. Check that screen is at its full brightness. If the brightness is not adequate, contact your service personnel or your supplier.

WARNING

Electrical Shock Hazard: Do not open the monitor or measurement device. Contact with exposed electrical components may cause electrical shock. Always turn off and remove power before cleaning the sensor, monitor or measurement device. Do not use a damaged sensor or one with exposed electrical contacts. Refer servicing to qualified service personnel.

Inspecting the Cables and Cords

1   Examine all system cables, the power plug and cord for damage. Make sure that the prongs of the plug do not move in the casing. If damaged, replace it with an appropriate Philips power cord.

2   Inspect the patient cables, leads and their strain reliefs for general condition. Make sure there are no breaks in the insulation. Make sure that the connectors are properly engaged at each end to prevent rotation or other strain.

3   Apply the transducer or electrodes to the patient, and with the monitor switched on, flex the patient cables near each end to make sure that there are no intermittent faults.

Maintenance Task and Test Schedule

The following tasks are for Philips-qualified service professionals only. All maintenance tasks and performance tests are documented in detail in the service documentation supplied on the monitor documentation DVD.

Ensure that these tasks are carried out as indicated by the monitor's maintenance schedule, or as specified by local laws. Contact a Philips-qualified service provider if your monitor needs a safety or performance test. Clean and disinfect equipment to decontaminate it before testing or maintaining it. Never do service or maintenance on any parts of the monitor or accessories while in use with a patient.

Type	Maintenance and Test Activities	Frequency
Monitor Tests	Safety checks as described in the service documentation.	At least once every two years, or as needed, after any repairs where the power supply is removed or replaced, or if the monitor has been dropped.
	Change of the parameter covers. (only for devices with option #E60)	At least once every two years, or if the connector sealing is damaged.
Monitor Maintenance	Check ECG synchronization of the monitor and defibrillator (only if hospital protocol requires use of monitor during defibrillation).	At least once every two years, or as needed.
Measurement Tests	Performance assurance for all measurements not listed below.	At least once every two years, or if you suspect the measurement values are incorrect.
Measurement Maintenance	NBP calibration according to Service Guide	At least once every two years, or as specified by local laws.
	Microstream CO_2 calibration and performance test	At least once a year or after 4000 operating hours.
	Mainstream and sidestream CO_2 calibration and sidestream flow check	At least once a year, or if you suspect the measurement values are incorrect.
Battery Maintenance	See "Optimizing Battery Performance" on page 276 for battery maintenance activities.	

CAUTION

Devices used for out-of-hospital transport require an ingress protection of at least IPX3. Be aware that damaged connector sealing or a failure to perform regular maintenance can lead to a loss of this ingress protection. See the Environmental Specifications section for details on ingress protection.

Troubleshooting

If you suspect a problem with an individual measurement, read the Instructions for Use and double-check that you have set up the measurement correctly.

If you suspect an intermittent, system-wide problem call your service personnel. You may be asked for information from the status log. To view the status log,

In the **Main Setup** menu, select **Revisions**.

1 Select **Status Log**.

Disposing of the Monitor

WARNING

To avoid contaminating or infecting personnel, the environment or other equipment, make sure you disinfect and decontaminate the monitor appropriately before disposing of it in accordance with your country's laws for equipment containing electrical and electronic parts. For disposal of parts and accessories such as thermometers, where not otherwise specified, follow local regulations regarding disposal of hospital waste.

You can disassemble the monitor as described in the Service Guide.

You will find detailed disposal information on the following web page:
http://www.healthcare.philips.com/main/about/Sustainability/Recycling/pm.wpd

The Recycling Passports located there contain information on the material content of the equipment, including potentially dangerous materials which must be removed before recycling (for example, batteries and parts containing mercury or magnesium).

Do not dispose of electrical and electronic equipment as unsorted municipal waste. Collect it separately, so that it can be safely and properly reused, treated, recycled, or recovered.

Disposing of Empty Calibration Gas Cylinders

1   Empty the cylinder completely by pushing in the pin of the regulator valve or by pulling out the pin of the fill valve using a tire valve stem wrench or a pair of needle nose pliers.

2   When the cylinder is empty, either remove the valve stem from the fill (or regulator) hole, or drill a hole in the cylinder.

3   Write "Empty" on the cylinder and dispose of it appropriately for scrap metal.

WARNING

Ensure that the cylinder is completely empty before trying to remove the valve stem or drill a hole in the cylinder.

Accessories

This chapter lists Philips-approved accessories for use with patient monitors as described in this document. You can order parts and accessories from Philips supplies at www.medical.philips.com or consult your local Philips representative for details. Some accessories may not be available in all countries.

The accessories listed in this chapter include applied parts that have direct physical contact with the patient such as electrodes, sensors and cuffs. All accessories listed that can come into contact with the patient, are protected against the effects of defibrillation.

All accessories listed in this chapter comply, in combination with the patient monitor, with the requirements of IEC 60601-1-2.

WARNING

Reuse: Never reuse disposable transducers, sensors, accessories and so forth that are intended for single use, or single patient use only. Reuse may compromise device functionality and system performance and cause a potential hazard.

Philips' approval: Use only Philips-approved accessories. Using non-Philips-approved accessories may compromise device functionality and system performance and cause a potential hazard.

Packaging: Do not use a sterilized accessory if its packaging is damaged.

Correct Use: Always follow the instructions for use supplied with the accessories.

Defibrillation Protection: The defibrillation protection requires the use of the accessories specified in this section. Using other accessories may cause risk to patients, users or bystanders or may cause damage to the monitor.

ECG/Resp Accessories

The cables and accessories are designed to have special protection against electric shocks (particularly regarding allowable leakage currents), and are defibrillator proof.

The following cables may not all be available in all countries. Please check availability with your local Philips supplier.

Trunk Cables

For use with:	Part No.	Length
3-Electrode Cable Set	M1669A[1]	2.7 m
3-Electrode Cable Set, OR	989803170171	2.7 m
5-Electrode Cable Set	M1668A[1]	2.7 m
5-Electrode Cable Set, OR	989803170181	2.7 m
6-Electrode Cable Set	M1667A[1]	2.7 m
10-Electrode Cable set (5+5)	M1663A[1]	2.0 m
10-Electrode Cable set (6+4)	M1665A	2.7 m

13.1.

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

3-Electrode Cable Sets

13.1.

Description	Length	AAMI Part No.	IEC Part No.
OR Grabber shielded	1.0 m	M1675A[1]	M1678A
ICU Grabber shielded	1.0 m	M1671A[1]	M1672A
ICU snap shielded	1.0 m	M1673A[1]	M1674A
ICU Clip non-shielded	0.7 m	M1624A[1]	M1626A

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Single Patient 3-Electrode Cable Sets

Description	Length	AAMI Part No.	IEC Part No.
ICU Grabber shielded[1]	1.0 m	989803173121	989803174201
ICU Grabber shielded	0.84 m	989803173141	--

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

5-Electrode Cable Sets

Description	Length	AAMI Part No.	IEC Part No.
OR Grabber shielded	1.0 m/1.6 m	M1973A[1]	M1974A
ICU Grabber shielded	1.0 m/1.6 m	M1968A[1]	M1971A
ICU Snap shielded	1.0 m/1.6 m	M1644A[1]	M1645A
ICU Miniclip non-shielded	0.7 m/1.3 m	M1647A[1]	M1648A

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Single Patient 5-Electrode Cable Sets

Description	Length	AAMI Part No.	IEC Part No.
ICU Grabber shielded[1]	1.0 m	989803173131	989803174211
ICU Grabber shielded	0.85 m	989803173151	--

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

6-Electrode Cable Sets

Description	Length	AAMI Part No.	IEC Part No.
ICU Grabber	1.0 m/1.6 m	M1680A[1]	M1681A
ICU Snap	1.0 m/1.6 m	M1682A[1]	M1683A

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Single Patient 6-Electrode Cable Sets

Description	Length	AAMI Part No.	IEC Part No.
ICU Grabber, shielded[1]	1.0 m	989803197511	989803197521

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

10-Electrode (5+5) Cable Sets

Description	Length	AAMI Part No.	IEC Part No.
ICU Grabber, chest, shielded	1.0 m	M1976A[1]	M1978A
ICU Snap, chest, shielded	1.0 m	M1602A[1]	M1604A
OR Grabber, chest, shielded	1.0 m	M1979A	M1984A
For Limb Leads see 5-electrode cable sets			

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Single Patient 10-Electrode (5+5) Cable Sets

Description	Length	AAMI Part No.	IEC Part No.
ICU Grabber, chest, shielded[1]	1.0 m	989803192141	989803192151

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

10-Electrode (6+4) Cable Sets

Description	Length	AAMI Part No.	IEC Part No.
ICU Grabber, chest, shielded	1.0 m	M1532A	M1533A
For Limb Leads see 6-electrode cable sets			

One-piece Cables

Description	Length	AAMI Part No.	IEC Part No.
3-lead Grabber, ICU	1.0 m	989803143181	989803143171
5-lead Grabber, ICU	1.0 m	989803143201	989803143191

Miscellaneous Accessories

Description	Part No.
Tab/Snap adapters, 10 pieces	989803193821

Compatible MX40 ECG Accessories

Description	Part No.
Trunk Cable	
5-lead Trunk Cable, IEC/AAMI 0.3m	989803172221
Reusable Lead Set	
3-lead set, grabber, AAMI, Telemetry	989803171801
3-lead set, grabber, AAMI, SpO2, Telemetry	989803171811
5-lead set, snap, AAMI, Telemetry	989803171821
5-lead set, grabber, AAMI, Telemetry	989803171831
5-lead set, snap, AAMI, SpO2, Telemetry	989803171841
5-lead set, grabber, AAMI, SpO2, Telemetry	989803171851
6-lead set, grabber, AAMI, Telemetry	989803171861
6-lead set, grabber, AAMI, SpO2, Telemetry	989803171871
3-lead set, grabber, IEC, Telemetry	989803171901
3-lead set, grabber, IEC, SpO2, Telemetry	989803171911
5-lead set, grabber, IEC, Telemetry	989803171931
5-lead set, grabber, IEC, SpO2, Telemetry	989803171951
6-lead set, grabber, IEC, Telemetry	989803171961
6-lead set, grabber, IEC, SpO2, Telemetry	989803171971
Disposable Lead Set	
5-lead set, grabber, AAMI, Telemetry	989803172031
5-lead set, grabber, AAMI, SPO2, Telemetry	989803172051
5-lead set, grabber, IEC, Telemetry	989803172131
5-lead set, grabber, IEC, SPO2, Telemetry	989803172151
ECG Lead Wire Electrode Set	
5-lead wire, AAMI, radiolucent, lead set incl. electrode	989803156261
5-lead wire, IEC, radiolucent, lead set incl. electrode	989803156271

NBP Accessories

These cuffs and tubings are designed to have special protection against electric shocks (particularly regarding allowable leakage currents), and are defibrillator proof. You can use them during electrosurgery.

All NBP accessories listed in this section have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Adult/Pediatric Reusable Comfort Care Cuffs

Patient Category	Limb Circumference	Part No.	Tubing
Adult (Thigh)	42 - 54 cm	M1576A	M1598B (1.5 m) or M1599B (3 m) or 989803209761 (1.5 m) or 989803209771 (3.0 m)
Large Adult	34 - 43 cm	M1575A	
Adult	27 - 35 cm	M1574A	
Adult XL	27 - 35 cm	M1574XL	
Small Adult	20.5 - 28 cm	M1573A	
Pediatric	14 - 21.5 cm	M1572A	
Infant	10 - 15 cm	M1571A	

Adult/Pediatric Reusable Easy Care Cuffs

Patient Category	Limb Circumference	Part No. (Pack of five)	Tubing
Adult Thigh	44 - 56 cm	M4559B	M1598B (1.5 m) or M1599B (3 m) 13.5. or 989803209761 (1.5 m) or 989803209771 (3.0 m)
Large Adult X-Long	35 - 45 cm	M4558B	
Large Adult	35 - 45 cm	M4557B	
Adult X-Long	27.5 - 36 cm	M4556B	
Adult	27.5 - 36 cm	M4555B	
Small Adult	20.5 - 28.5 cm	M4554B	
Pediatric	14 - 21.5 cm	M4553B	
Infant	10 - 15 cm	M4552B	

13.4.

Adult/Pediatric Reusable Easy Care Cuff Kits

Cuff Kits	Part No.
Assortment pack of one small adult, one adult, one large adult and one thigh cuff	864288
Assortment pack of one infant, one pediatric, one small adult and one adult cuff	864289
Assortment pack of one infant, one pediatric, one small adult, one adult, one large adult and one thigh cuff	864290
Assortment pack of one small adult, one adult, one adult X-long, one large adult, one large adult X-long and one thigh cuff	864291

Adult/Pediatric Multi Care Cuffs

Patient Category	Limb Circumference	Part No.	Tubing
Adult Thigh	42.0 - 54.0 cm	989803183371	M1598B (1.5 m) or M1599B (3 m) or 989803209761 (1.5 m) or 989803209771 (3.0 m)
Large Adult	34.0 - 43.0 cm	989803183361	
Adult X-Long	27.0 - 35.0 cm	989803183351	
Adult	27.0 - 35.0 cm	989803183341	
Small Adult	20.5 - 28.0 cm	989803183331	
Pediatric	14.0 - 21.5 cm	989803183321	
Infant	10.0 - 15.0 cm	989803183311	

Adult/Pediatric Single Patient, Gentle Care Cuffs

Patient Category	Limb Circumference	Part No.	Tubing
Large Adult X-Long	35 - 45 cm	M4578B	M1598B (1.5 m) or M1599B (3 m) or 989803209761 (1.5 m) or 989803209771 (3.0 m)
Large Adult	35 - 45 cm	M4577B	
Adult X-Long	27.5 - 36 cm	M4576B	
Adult	27.5 - 36 cm	M4575B	
Small Adult	20.5 - 28.5 cm	M4574B	
Pediatric	14.0 - 21.5 cm	M4573B	
Infant	10 - 15 cm	M4572B	

Adult/Pediatric Single Care Cuffs

Patient Category	Limb Circumference	Part No.	Tubing
Large Adult	35.0 - 45.0 cm	989803182321	M1598B (1.5 m) or M1599B (3 m) or 989803209761 (1.5 m) or 989803209771 (3.0 m)
Adult X-Long	27.5 - 36.0 cm	989803182311	
Adult	27.5 - 36.0 cm	989803182301	
Small Adult	20.5 - 28.5 cm	989803182291	
Pediatric	14.0 - 21.5 cm	989803182281	

Neonatal/Infant Single Patient Cuffs

Cuffs	Limb Circumference	Part No.	Tubing
Size 1	3.1 - 5.7 cm	M1866B	M1596C (1.5 m) or M1597C (3 m) or 989803209741 (1.5 m) or 989803209751 (3.0 m)
Size 2	4.3 - 8.0 cm	M1868B	
Size 3	5.8 - 10.9 cm	M1870B	
Size 4	7.1 - 13.1 cm	M1872B	
Size 5 (Infant)	10 - 15 cm	M1873B	

Neonatal/Infant Single Patient, Soft Cuffs
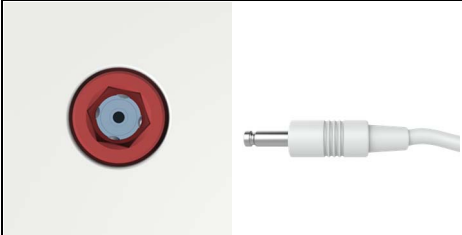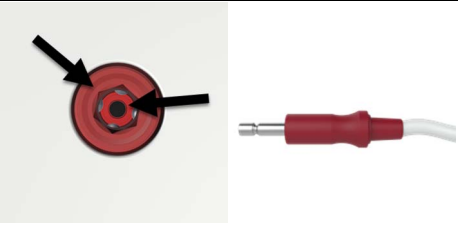
Cuffs	Limb Circumference	Part No.	Tubing
Size 1	3.1 - 5.7 cm	M1866S	M1596C (1.5 m) or M1597C (3 m) or 989803209741 (1.5 m) or 989803209751 (3.0 m)
Size 2	4.3 - 8.0 cm	M1868S	
Size 3	5.8 - 10.9 cm	M1870S	
Size 4	7.1 - 13.1 cm	M1872S	
Size 5 (Infant)	10 - 15 cm	M1873S	

Neonatal/Infant Cuff Kits

Cuff Kits	Part No.
Standard, Single Patient: 5 x M1866B, 10 x M1868B, 20 x M1870B, 10 x M1872B, and 5 x M1873B	989803167541
Soft, Single Patient: 5 x M1866S, 10 x M1868S, 20 x M1870S, 10 x M1872S, 5 x M1873S	989803167551

NBP Tubing

Accessories with a new ISO 80369-1 compliant device connector, require the respective ISO 80369-1 compliant socket at the monitor. The ISO 80369-1 compliant sockets can be identified by an additional ring which is visible in the middle of the NBP socket, and by the red color of the connector sealing:

Traditional socket and device connector	ISO 80369-1 compliant socket and device connector

NBP Tubing (traditional device connector)	Part No.	Comments
Tubing for neonatal cuffs (1.5 m); ISO 80369-1 compliant cuff connector	M1596C	Tubing with traditional device connector not compatible to the ISO 80369-1 compliant socket at the monitor.
Tubing for neonatal cuffs (3.0 m); ISO 80369-1 compliant cuff connector	M1597C	
Tubing for adult / pediatric cuffs (1.5 m)	M1598B	
Tubing for adult / pediatric cuffs (3.0 m)	M1599B	

NBP Tubing (ISO 80369-1 compliant device connector)	Part No.	Comments
Neonatal NIBP Air Hose 1.5m	989803209741	Tubing has ISO 80369-1 compliant cuff and device connector.
Neonatal NIBP Air Hose 3.0m	989803209751	
Adult NIBP Air Hose 1.5m	989803209761	
Adult NIBP Air Hose 3.0m	989803209771	Device connector is not backwards compatible and requires the ISO 80369-1 compliant socket at the monitor

Invasive Pressure Accessories

 These transducers and accessories are designed to have special protection against electric shocks (particularly regarding allowable leakage currents), and are defibrillator proof.

If you are using the M3012A Hemodynamic Measurement Extension, and you want to measure temperature and invasive pressure at the same time, we recommend that you use the pressure transducer CPJ840J6, with a round module connector piece, and not a transducer with a square connector. Pressure transducers with square connectors may make it difficult to connect the adjacent Temperature connector at the same time.

Contact ICU Medical or Edwards Lifesciences for compatible disposable pressure transducers and accessories.

Transducer and accessories	Part No.
Reusable pressure transducer 5 μV/V/mmHg sensitivity	CPJ840J6
Sterile disposable pressure domes for CPJ840J6 (pack of 50)	CPJ84022
Transducer holder for CPJ840J6 (pack of 4)	CPJ84046
IV pole mount for CPJ840J6	CPJ84447
Monitoring Line Set	CPJ84026
Transpac IV dual IBP cable[1,2]	#K16[1]
Dual IBP adapter	989803199741

1 This cable is available from Philips only under option K16 of compatible monitors. Additional or replacement cables can be ordered from ICU Medical.

2 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Transducer kits	Part No.
PiCCO monitoring kit, 30 cm pressure line, includes PV4046 injectate temperature sensor housing	PV8103
PiCCO monitoring kit, 150 cm pressure line, includes PV4046 injectate temperature sensor housing	PV8115
PiCCO monitoring kit, 150 cm pressure line, includes PV4046 injectate temperature sensor housing and central venous pressure line	PV8115CVP
PULSION Pressure Interface Cable for disposable pressure transducer	PMK 206

SpO2 Accessories

Some Nellcor sensors contain natural rubber latex which may cause allergic reactions. See the Instructions for Use supplied with the sensors for more information.

Do not use more than one extension cable with any sensors or adapter cables. Do not use an extension cable with:

- Masimo adapter cables,
- Philips reusable sensors or adapter cables with part numbers ending in -L (indicates "**L**ong" version) or with a cable longer than 2 m.

All listed sensors operate without risk of exceeding 41°C on the skin, if the initial skin temperature does not exceed 35°C.

Make sure that you use only the accessories that are specified for use with your monitor and measurement technology, otherwise patient injury can result.

Familiarize yourself with the instructions for use supplied with your sensor before using it. In particular, check that the sensor being used is appropriate for your patient category and application site. Incorrect sensor application or use may result in inaccurate measurements.

In the accessory tables, a column indicates which SpO_2 technologies the sensors can be used with, Philips FAST SpO_2 (P), Nellcor OxiMax (N) or Masimo SET (M).

Philips SpO2 Technology

This section lists accessories for use with Philips SpO$_2$ technology. For accessory lists for other SpO$_2$ technologies, refer to the following sections and the instructions for use provided with these devices.

Option #SP1 is the standard Philips FAST-SpO2 version.

Philips Reusable Sensors

All Philips reusable sensors listed in this section have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Product Number	Description	Comments
M1191B	Adult sensor (2 m cable), for patients over 50 kg. Any finger, except thumb.	No adapter cable required.
M1191BL	M1191A/B with longer cable (3 m)	
M1192A	Small adult, pediatric sensor (1.5 m cable) for patients between 15 kg and 50 kg. Any finger except thumb.	
M1193A	Neonatal sensor (1.5 m cable) for patients between 1 kg and 4 kg. Hand or foot.	
M1194A	Ear sensor (1.5 m cable) for patients over 40 kg.	
M1195A	Infant sensor (1.5 m cable) for patients between 4 kg and 15 kg. Any finger except thumb.	
M1196A	Adult clip sensor (3 m cable) for patients over 40 kg. Any finger except thumb.	
M1191T	Adult sensor (0.45 m cable), for patients over 50 kg. Any finger, except thumb.	Requires M1943A (1 m) or M1943AL (3 m) adapter cable
M1196T	Adult clip sensor (0.9 m cable) for patients over 40 kg. Any finger except thumb.	

13.3.

Philips Disposable Sensors

Product Number	Description	Comments
M1131A[1]	Adult/Pediatric finger sensor, 0.45 m cable (patient size > 20 kg)	Use M1943A or M1943AL adapter cable.
M1132A[1]	Infant finger or toe sensor, 0.9 m cable (patient size 3 - 10 kg)	Use M1943A or M1943AL adapter cable.
M1133A[1]	Adult/Infant/Neonatal, 0.9 m cable Foot or hand for neonates < 3 kg Big toe or thumb for patients between 10 kg and 20 kg Any finger except thumb for patients > 40 kg	Use M1943A or M1943AL adapter cable.
M1134A[1]	Adhesive-free, Adult/Infant/Neonatal, 0.9 m cable Foot or hand for neonates < 3 kg Big toe or thumb for patients between 10 kg and 20 kg Any finger except thumb for patients > 40 kg	Use M1943A or M1943AL adapter cable.
989803205381	Nasal Alar SpO2 Sensor FAST Only for adult and pediatric patients at least 4 years and older and weighing >= 15 kg.	Use M1943A or M1943AL adapter cable

Product Number	Description	Comments
989803205391	Nasal Alar SpO2 Sensor MLT CPTL for adult and pediatric patients at least 4 years and older and weighing >= 15 kg.	Use M1943A or M1943AL adapter cable
989803205401	Nasal Alar SpO2 Sensor, Tri-anim for adult and pediatric patients at least 4 years and older and weighing >= 15 kg..	Use M1943A or M1943AL adapter cable

[1]These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Nellcor Sensors

Nellcor sensors must be ordered from Nellcor/Covidien.

Product Number	Description	Comments
OxiMax MAX-A	Adult finger sensor (patient size > 30 kg)	**For Philips FAST SpO2:** use M1943A or M1943AL adapter cable. **For Nellcor OxiMax SpO2:** use M1943NL adapter cable.
OxiMax MAX-AL	OxiMax MAX-A with long cable	
OxiMax MAX-P	Pediatric foot/hand sensor (patient size 10 - 50 kg)	
OxiMax MAX-I	Infant foot/hand sensor (patient size 3 - 20 kg)	
OxiMax MAX-N	Adult finger or neonatal foot/hand sensor (patient size > 40 kg or < 3 kg)	
Oxisensor II D-25	Adult sensor (patient size > 30 kg)	Use M1943A or M1943AL adapter cable.
Oxisensor II D-20	Pediatric sensor (patient size 10 - 50 kg)	
Oxisensor II I-20	Infant sensor (patient size 3 - 20 kg)	
Oxisensor II N-25	Neonatal sensor (patient size < 3 kg or > 40 kg)	
Oxicliq A	See OxiMax MAXA	**For Philips FAST SpO2:** use M1943A or M1943AL adapter cable together with OC-3. **For Nellcor OxiMax SpO2:** use M1943NL adapter cable together with OC-3.
Oxicliq P	See OxiMax MAXP	
Oxicliq I	See OxiMax MAXI	
Oxicliq N	See OxiMax MAXN	

Extension Cables and Adapter Cables for Philips and Nellcor Sensors

All extension cables and adapter cables listed in this section have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Product Number	Description	Comments
M1941A	Extension cable (2 m)	For use with Philips reusable sensors (with cable length ≤ 2 m) and M1943A adapter cable.
M1943A	Adapter cable (1.1 m cable)	Adapter cable for Philips/Nellcor disposable sensors.
M1943AL	Adapter cable (3 m cable)	
OC-3	Adapter Cable for Oxicliq sensors	Available from Nellcor/Covidien only.

Masimo Sensors

The monitor with Philips FAST SpO$_2$ and Masimo Sensors uses Masimo certified pulse oximetry for reduced noise and low perfusion performance under the Masimo NR&LP protocol. Masimo sensors must be ordered from Masimo or from Masimo's distributors.

All Masimo reusable and disposable sensors listed in this section have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

LNCS Reusable Sensors

Product Number	Description	Comments
LNCS DCI	Adult Finger Sensor (> 30 kg)	Use LNC MP10 or LNC MP4 Adapter Cable
LNCS DCIP	Pediatric Finger Sensor (10 - 50 kg)	
LNCS YI	Multi-Site Sensor (> 1kg)	
LNCS TC-I	Ear Sensor (> 30 kg)	

M-LNCS Reusable Sensors

Product Number	Description	Comments
M-LNCS DCI	Adult Finger or Toe Sensor (> 30 kg)	Use M-LNC MP10 or M-LNC MP4 Adapter Cable
M-LNCS DCIP	Pediatric Finger or Toe Sensor (10-50 kg))	
M-LNCS TC-I	Ear Sensor (> 30 kg)	
M-LNCS YI	Multi-Site Sensor (>1 kg)	

RD SET Reusable Sensors

Product Number	Description	Comments
RD SET DCI	Adult Finger or Toe Sensor (> 30 kg)	Use RD SET MP12 or RD SET MP05 Adapter Cable
RD SET DCIP	Pediatric Finger or Toe Sensor (10 - 50 kg)	
RD SET TC-I	Ear Sensor (> 30 kg)	

RD SET Disposable Adhesive Sensors

Product Number	Description	Comments
RD SET Adt	Adult Finger or Toe Sensor (> 30 kg)	Use RD SET MP12 or RD SET MP05 Adapter Cable
RD SET Adt CS-2	Adult Finger or Toe Sensor (> 30 kg)	
RD SET Adt CS-3	Adult Finger or Toe Sensor (> 30 kg)	
RD-SET Pdt	Pediatric Finger or Toe Sensor (10 - 50 kg)	
RD SET Pdt CS-2	Pediatric Finger or Toe Sensor (10 - 50 kg)	
RD SET Pdt CS-3	Pediatric Finger or Toe Sensor (10 - 50 kg)	
RD SET Inf	Infant Thumb or Great Toe Sensor (3-10 kg) or Finger or Toe Sensor (10-20 kg)	
RD SET Inf CS-2	Infant Thumb or Great Toe Sensor (3-10 kg) or Finger or Toe Sensor (10-20 kg)	
RD SET Inf CS-3	Infant Thumb or Great Toe Sensor (3-10 kg) or Finger or Toe Sensor (10-20 kg)	
RD SET Neo (Adult)	Adult Finger or Toe Sensor (>40 kg)	
RD SET Neo CS-2 (Adult)	Adult Finger or Toe Sensor (>40 kg)	
RD SET Neo CS-3 (Adult)	Adult Finger or Toe Sensor (>40 kg)	
RD SET Neo (Neo)	Neonatal Hand or Foot Sensor (<3 kg)	
RD SET Neo CS-2 (Neo)	Neonatal Hand or Foot Sensor (<3 kg)	
RD SET Neo CS-3 (Neo)	Neonatal Hand or Foot Sensor (<3 kg)	
RD SET NeoPt	Neonatal Hand or Foot Sensor (<1 kg)	
RD SET NeoPt CS-2	Neonatal Hand or Foot Sensor (<1 kg)	
RD SET NeoPt CS-3	Neonatal Hand or Foot Sensor (<1 kg)	
RD SET Newborn Neonatal	Neonatal Hand or Foot Sensor (<3 kg)	
RD SET Newborn Infant/ Pediatric	Infant/Pediatric Thumb or Great Toe Sensor (3-10 kg) or Finger or Toe Sensor (10-30 kg)	
RD SET Trauma	Adult Finger or Toe Sensor (>30 kg)	

LNCS Disposable Adhesive Sensors

Product Number	Description	Comments
LNCS Adtx	Adult Finger Sensor, 18 inch/45 cm (> 30 kg)	Use LNC MP10 or LNC MP4 Adapter Cable
LNCS Adtx-3	Adult Finger Sensor, 3 feet/90 cm (> 30 kg)	
LNCS Pdtx	Pediatric Finger Sensor, 18 inch/45 cm (10 - 50 kg)	
LNCS Pdtx-3	Pediatric Finger Sensor, 3 feet/90 cm (10 - 50 kg)	
LNCS Inf	Infant Toe Sensor, 18 inch/45 cm (3 - 20 kg)	
LNCS Inf-3	Infant Toe Sensor, 3 feet/90 cm (3 - 20 kg)	
LNCS Inf-L	Infant Thumb or Great Toe Sensor (3-20 kg)	
LNCS Neo	Neonatal Foot Sensor, 18 inch/45 cm (< 3 kg) or Adult Finger Sensor 18 inch/45 cm (> 40 kg)	
LNCS Neo-3	Neonatal Foot Sensor, 3 feet/90 cm (< 3 kg) or Adult Finger Sensor, 3 feet/90 cm (> 40 kg)	
LNCS Neo-L (Adult)	Adult Finger or Toe Sensor (> 40 kg)	
LNCS Neo-L (Neo)	Neonatal Hand or Foot Sensor (< 3 kg)	
LNCS NeoPt	Neonatal pre-term sensitive skin Sensor 18 inch/ 45 cm (< 1 kg)	
LNCS NeoPt-3	Neonatal pre-term sensitive skin Sensor 3 feet/90 cm (< 1 kg)	
LNCS NeoPt-L	Neonatal Hand or Foot Sensor (< 1 kg)	
LNCS Newborn Neonatal	Neonatal Hand or Foot Sensor (<3 kg)	
LNCS Newborn Infant/ Pediatric	Infant/Pediatric Thumb or Great Toe Sensor (3-10 kg) or Finger or Toe Sensor(10-30 kg)	
LNCS Trauma	Adult Finger or Toe Sensor (>30 kg)	

M-LNCS Disposable Sensors

Product Number	Description	Comments
M-LNCS Adtx	Adult Finger or Toe Sensor, 18 inch/45 cm (> 30 kg)	Use M-LNC MP10 or M-LNC MP4 Adapter Cable
M-LNCS Pdtx	Pediatric Finger or Toe Sensor, 18 inch/45 cm (10-50 kg)	
M-LNCS Adtx-3	Adult Finger or Toe Sensor, 3 feet/90 cm (> 30 kg)	
M-LNCS Pdtx-3	Pediatric Finger or Toe Sensor, 3 feet/90 cm (10-50 kg)	
M-LNCS Inf	Infant Thumb or Great Toe Sensor, 18 inch/45 cm (3-20 kg)	
M-LNCS Neo (Adult)	Adult Finger or Toe Sensor 18 inch/45 cm (> 40 kg)	
M-LNCS Neo (Neo)	Neonatal Hand or Foot Sensor, 18 inch/45 cm (< 3 kg)	
M-LNCS Inf-3	Infant Thumb or Great Toe Sensor, 3 feet/90 cm (3-20 kg)	
M-LNCS Neo-3 (Adult)	Adult Finger or Toe Sensor, 3 feet/90 cm (> 40 kg)	
M-LNCS Neo-3 (Neo)	Neonatal Hand or Foot Sensor, 3 feet/90 cm (< 3 kg)	
M-LNCS Inf-L	Infant Thumb or Great Toe Sensor (3-20 kg)	
M-LNCS Neo-L (Adult)	Adult Finger or Toe Sensor (> 40 kg)	
M-LNCS Neo-L (Neo)	Neonatal Hand or Foot Sensor (< 3 kg)	
M-LNCS NeoPt	Neonatal Hand or Foot Sensor 18 inch/45 cm (< 1 kg)	
M-LNCS NeoPt-3	Neonatal Hand or Foot Sensor 3 feet/90 cm (< 1 kg)	
M-LNCS NeoPt-L	Neonatal Hand or Foot Sensors (< 1 kg)	
M-LNCS Newborn Neonatal	Neonatal Hand or Foot Sensor (<3 kg)	
M-LNCS Newborn Infant/ Pediatric	Infant/Pediatric Thumb or Great Toe Sensor (3-10 kg) or Finger or Toe Sensor(10-30 kg)	
M-LNCS Trauma	Adult Finger or Toe Sensor (>30 kg)	

Adapter Cables for Masimo Sensors

Product Number	Description	Philips Part Number
LNOP MP10	LNCS MP Series Patient Cable (3.0 m) Adapter Cable for Masimo LNCS Sensors	989803148221
RD SET MP12	RD SET Series Patient Cable (3.6m) Adapter Cable for RD SET sensors	989803206911
RD SET MP05	RD SET Series Patient Cable (1.5m) Adapter Cable for RD SET sensors	989803206901
LNC MP4	LNCS MP Series Patient Cable (1.2m) Adapter Cable for Masimo LNCS Sensors	Available from Masimo only

Product Number	Description	Philips Part Number
M-LNC MP4	M-LNCS Series Patient Cable (1.2m) Adapter Cable for Masimo M-LNCS Sensors	Available from Masimo only
M-LNC MP10	M-LNCS Series Patient Cable (3m) Adapter Cable for Masimo M-LNCS Sensors	Available from Masimo only

Nellcor SpO2 Technology

This section lists accessories for use with Nellcor SpO$_2$ technology. Nellcor SpO$_2$ technology is included in option #SP6.

Nellcor Sensors

Nellcor sensors must be ordered from Nellcor/Covidien.

Product Number	Description	Comments
OxiMax MAX-A	Adult finger sensor (patient size > 30 kg)	**For Philips FAST SpO2:** use M1943A or M1943AL adapter cable. **For Nellcor OxiMax SpO2:** use M1943NL adapter cable.
OxiMax MAX-AL	OxiMax MAX-A with long cable	
OxiMax MAX-P	Pediatric foot/hand sensor (patient size 10 - 50 kg)	
OxiMax MAX-I	Infant foot/hand sensor (patient size 3 - 20 kg)	
OxiMax MAX-N	Adult finger or neonatal foot/hand sensor (patient size > 40 kg or < 3 kg)	
Oxicliq A	See OxiMax MAXA	**For Philips FAST SpO2:** use M1943A or M1943AL adapter cable together with OC-3. **For Nellcor OxiMax SpO2:** use M1943NL adapter cable together with OC-3.
Oxicliq P	See OxiMax MAXP	
Oxicliq I	See OxiMax MAXI	
Oxicliq N	See OxiMax MAXN	
MAX-R	Adult SpO$_2$ Nasal Sensor	Use M1943NL adapter cable.
MAXFAST	Forehead SpO$_2$ Sensor	
Oxiband OXI-A/N	Adult/Neonatal SpO$_2$ Sensor with Wraps	
Oxiband OXI-P/I	Pediatric-Infant SpO$_2$ Sensor with Wraps	
SC-A	Adult SpO$_2$ Sensor	
SCNEO-I	Neonatal SpO$_2$ Sensor	
SC-PR-I	Preemie SpO$_2$ Sensor	
DS100A-I	Adult SpO$_2$ Sensor	
Dura-Y D-YS	SpO$_2$ Sensor	
FLEXMAX[1]	Nellcor Flexible SpO$_2$ Sensor - Large	
FlexMAX-P[1]	Nellcor Flexible SpO$_2$ Sensor - Small	

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Extension Cables and Adapter Cables

All extension cables and adapter cables listed in this section have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Product Number	Description	Comments
M1943NL	OxiMax adapter cable (3 m cable)	Adapter cable for Philips disposable/Nellcor disposable and reusable sensors.
OC-3	Adapter Cable for Oxicliq sensors	Available from Nellcor/ Covidien only.

Masimo SpO2 Technology

This section lists accessories for use with Masimo SpO_2 technology. Masimo rainbow SET technology is included in options #SP5.

Masimo RD SET Reusable Sensors

Product Name	Description
RD SET DCI	Adult Finger or Toe Sensor (>30 kg)
RD SET DCIP	Pediatric Finger or Toe Sensor (10-50 kg)
RD SET TC-I	Ear (Tip Clip) Lobe or Pinna Sensor (>30 kg)
RD SET YI	Multi-Site Sensor, Foot/Hand (1-3 kg), Foot/Toe/Hand/Finger (>3 kg)
RD SET-TF-I	Forehead (Transflectance) Sensor (>30 kg)

Masimo LNC Reusable Sensors

Product Name	Description
LNCS DCI	Adult Finger or Toe Sensor (>30 kg)
LNCS DCIP	Pediatric Finger or Toe Sensor (10-50 kg)
LNCS TC-I	Ear (Tip Clip) Lobe or Pinna Sensor (>30 kg)
LNCS YI	Multi-Site Sensor, Foot/Hand (1-3 kg), Foot/Toe/Hand/Finger (>3 kg)
LNCS-TF-I	Forehead (Transflectance) Sensor (>30 kg)
LNCS DBI	Adult (Boot) Finger Sensor (>30 kg)

Masimo rainbow Reusable Sensors

Product Name	Description
rainbow DCI SC-200*	Adult Finger or Toe Sensor for $SpHb/SpO_2/SpMet$, 3 feet/90 cm (>30 kg)
rainbow DCIP SC-200*	Pediatric Thumb or Great Toe Sensor for $SpHb/SpO_2/SpMet$, 3 feet/90 cm (10-50 kg)
rainbow DCI SC400*	Adult Finger or Toe Sensor for $SpHb/SpO_2/SpMet$, 3 feet/90 cm (>30 kg)
rainbow DCIP SC400*	Pediatric Thumb or Great Toe Sensor for $SpHb/SpO_2/SpMet$, 3 feet/90 cm (10-50 kg)
rainbow DCI SC-1000*	Adult Finger or Toe Sensor for $SpHb/SpO_2/SpMet$, 3 feet/90 cm (>30 kg)
rainbow DCIP SC-1000*	Pediatric Thumb or Great Toe Sensor for $SpHb/SpO_2/SpMet$, 3 feet/90 cm (10-50 kg)

Product Name	Description
rainbow DCI	Adult Sensor, SpO_2/SpCO/SpMet, 3 feet/90 cm (>30 kg)
rainbow DCIP	Pediatric Slender Digit Sensor, SpO_2/SpCO/SpMet, 3 feet/90 cm (10-50 kg)
rainbow DCI-6	Adult Sensor, SpO_2/SpCO/SpMet, 6 feet/180 cm (>30 kg)
rainbow DCIP-6	Pediatric Slender Digit Sensor, SpO_2/SpCO/SpMet, 6 feet/180 cm (10-50 kg)

*These sensors are only supported, if the SpHb option (#R01) is activated in the measurement device.

Masimo ReSposable Sensors

Product Name	Description
LNCS S-ROS 3U	Universal Reusable Optical Sensor
S-DOS 25	Adult Disposable Finger or Toe Sensor (SpO_2) (>30 kg)
S-DOS 20	Pediatric Disposable Finger or Toe Sensor (SpO_2) (10–50 kg)
S-DOS 25L	Adult/Neonatal Disposable Sensor (SpO_2), Finger/Toe (>30 kg), Foot/Hand (<3 kg)
S-DOS 20L	Infant Disposable Sensor (SpO_2), Finger/Toe (10–30 kg), Foot/Hand/Great Toe/Thumb (3-30 kg)
S-DOS 30L	Large Adult Disposable Sensor (SpO_2), Foot/Hand (3-10 kg), Finger/Toe (>40 kg)
S-DOS 25Pt-L	Neonatal Disposable Foot or Hand Sensor (SpO_2) (<1 kg)
S-DOS 20L-500	Neonatal Disposable Finger Sensor (SpO_2) (3-30 kg), non-adhesive
rainbow R2-25 (R2-25a and R2-25r)	Adult Two-Piece Finger Sensor, R2-25a adhesive sensor, and R2-25r reusable sensor (SpO_2/SpHb/SpMet) (>30 kg)
rainbow R2-20 (R2-20a and R2-20r)	Pediatric Two-Piece Finger Sensor, R2-20a adhesive sensor, and R2-20r reusable sensor (SpO_2/SpHb/SpMet) (10-50 kg)

Masimo RD SET Disposable Sensors

Product Name	Description
RD SET Adt	Adult Finger or Toe Sensor (>30 kg)
RD SET Pdtx	Pediatric Finger or Toe Sensor (10-50 kg)
RD SET Inf	Infant Sensor, Thumb/Great Toe (3-10 kg), Finger/Toe (10-20 kg)
RD SET Neo	Neonatal/Adult Sensor, Hand/Foot (<3 kg), Finger/Toe (>40 kg)
RD SET NeoPt	Neonatal Hand or Foot Sensor (<1 kg)
RD SET NeoPt-500	Neonatal Hand or Foot Sensor (<1 kg), non-adhesive
RD SET Trauma	Adult Specialty Finger or Toe Sensor (>30 kg)
RD SET Newborn Neonatal	Newborn/Neonatal Specialty Hand or Foot Sensor (<3 kg)
RD SET Newborn Infant/Pediatric	Newborn/Infant/Pediatric Specialty Sensor, Thumb/Great Toe (3-10 kg), Finger/Toe (10-30 kg)
RD SET E-1	Adult/Pediatric Ear Sensor (>30 kg)
RD SET TFA-1	Adult/Pediatric Transflectance Forehead Sensor, 3 feet/90 cm (>10 kg)

Masimo LNC Disposable Sensors

Product Name	Description
LNCS Adtx	Adult Finger or Toe Sensor, 1.5 feet/45 cm (>30 kg)
LNCS Adtx-3	Adult Finger or Toe Sensor, 3 feet/90 cm (>30 kg)
LNCS Pdtx	Pediatric Finger or Toe Sensor, 1.5 feet/45 cm (10-50 kg)
LNCS Pdtx-3	Pediatric Finger or Toe Sensor, 3 feet/90 cm (10-50 kg)
LNCS Inf	Infant Thumb or Great Toe Sensor, 1.5 feet/45 cm (3-20 kg)
LNCS Inf-3	Infant Thumb or Great Toe Sensor, 3 feet/90 cm (3-20 kg)
LNCS Inf-L	Infant Thumb or Great Toe Sensor (3-20 kg)
LNCS Neo	Neonate Sensor, 1.5 feet/45 cm, Hand/Foot (<3 kg), Finger/Toe (>40 kg)
LNCS Neo-3	Neonate Sensor, 3 feet/90 cm, Hand/Foot (<3 kg), Finger/Toe (>40 kg)
LNCS Neo-L	Neonate Sensor, Hand/Foot (<3 kg), Finger/Toe (>40 kg)
LNCS NeoPt	Neonate Hand or Foot Sensor, 1.5 feet/45 cm (<1 kg), sensitive skin
LNCS NeoPt-3	Neonate Hand or Foot Sensor, 3 feet/90 cm (<1 kg), sensitive skin
LNCS NeoPt-L	Neonate Hand or Foot Sensor (<1 kg), sensitive skin
LNCS NeoPt-500	Neonate Hand or Foot Sensor, 1.5 feet/45 cm (<1 kg), non-adhesive
LNCS Trauma	Adult Finger or Toe Sensor (>30 kg)
LNCS Newborn Neonate	Newborn/Neonatal Specialty Hand or Foot Sensor (<3 kg)
LNCS Newborn Infant/Pediatric	Newborn/Infant/Pediatric Specialty Sensor, Thumb/Great Toe (3-10 kg), Finger/Toe (10-30 kg)
LNCS E-1	Adult/Pediatric Ear Sensor (>30 kg)
LNCS TFA-1	Adult/Pediatric Transflectance Forehead Sensor, 3 feet/90 cm (>10 kg)

Masimo rainbow Disposable Sensors

Product Name	Description
RD rainbow SET-2 Adt	Adult Finger Sensor for SpHb/SpO2/SpMet (>30 kg)
RD rainbow SET-2 Ped	Pediatric Finger Sensor for SpHb/SpO2/SpMet (10-50 kg)
RD rainbow SET-2 Inf	Infant Sensor for SpHb/SpO2/SpMet, Thumb/Great Toe (3-10 kg), Finger/Toe (10-30 kg)
RD rainbow SET-2 Neo	Adult/Neonatal Sensor for SpHb/SpO2/SpMet, Hand/Foot (<3 kg), Finger (>30 kg)
rainbow R1 25	Adult Finger Sensor for SpO_2/SpHb/SpMet (>30 kg)
rainbow R25	Adult Finger or Toe Sensor for SpO_2/SpCO/SpMet (>30 kg)
rainbow R1 25L	Adult Sensor for SpHb/SpO_2/SpMet, Hand/Foot (<3 kg), Finger/Toe (>30 kg)
rainbow R25-L	Adult/Neonatal Sensor for SpO_2/SpCO/SpMet, Hand/Foot (<3 kg), Finger/Toe (>30 kg)
rainbow R1 20	Pediatric Finger Sensor for SpO_2/SpHb/SpMet (10-50 kg)
rainbow R20	Pediatric Finger or Toe Sensor for SpO_2/SpCO/SpMet (10-50 kg)
rainbow R1 20L	Infant Finger/Thumb/Great Toe Sensor for SpHb/SpO_2/SpMet (3-10 kg/10-30 kg)
rainbow R20-L	Infant Sensor for SpO_2/SpCO/SpMet, Thumb/Great Toe (3-10 kg), Finger/Toe (10-30 kg)

Masimo Acoustic Respiration Sensors

Product Name	Description
RAS-45	Adult/Pediatric Neck Sensor (>10 kg)
RAS-125	Adult Disposable Neck Sensor (>30 kg)
RAS-125c	Adult/Pediatric Disposable Cloth Neck Sensor (>10 kg)
RAS-125c	Adult/Pediatric Disposable Cloth Neck Sensor (>10 kg), short term monitoring

Masimo Compatible Sensor Adapter Cables

Product Name	Description	Philips Part Number
RED 25 LNC-10	rainbow 25-pin to LNCS, Patient Cable, Straight, 10 feet/3.04 m	989803186501
RED 25 LNC-4	rainbow 25-pin to LNCS, Patient Cable, Straight, 4 feet/1.21 m	989803186531
RED 25 LNC-4RA	rainbow 25-pin to LNCS, Patient Cable, Right Angle, 4 feet/1.21 m	
RED 25 LNC-1	rainbow 25-pin to LNCS, Patient Cable, Straight, 1 foot/0.35 m	
RED 25 LNC-1RA	rainbow 25-pin to LNCS, Patient Cable, Right Angle, 1 foot/0.35 m	
rainbow RC25-12	rainbow 25-pin to M-LNCS, Patient Cable, Straight, 12 feet/3.65 m	989803186471
RD rainbow SET 25R - 1.5	rainbow 25-pin to RD, Patient Cable, Straight, 1.5 feet/0.45 m	
RD rainbow SET 25RA - 1.5	rainbow 25-pin to RD, Patient Cable, Right Angle, 1.5 feet/0.45 m	
RD rainbow SET 25R - 05	rainbow 25-pin to RD, Patient Cable, Straight, 5 feet/1.52 m	
RD rainbow SET 25RA - 05	rainbow 25-pin to RD, Patient Cable, Right Angle, 5 feet/1.52 m	
RD rainbow SET 25R - 12	rainbow 25-pin to RD, Patient Cable, Straight, 12 feet/3.65 m	989803206931
RD rainbow SET 25RA - 12	rainbow 25-pin to RD, Patient Cable, Right Angle, 12 feet/3.65 m	
RD rainbow SET 25R - 08	rainbow 25-pin to RD, Patient Cable, Straight, 8 feet/2.43 m	
RD rainbow SET 25RA - 08	rainbow 25-pin to RD, Patient Cable, Right Angle, 8 feet/2.43 m	
RAM Dual RED 25 LNC-10	rainbow 25-pin to LNCS and RAS, Patient Cable, Straight, 10 feet/3.04 m	
RAM Dual RD rainbow SET R25-12	rainbow 25-pin to RD and RAS, Patient Cable, Straight, 12 feet/3.65 m	

Temperature Accessories

Reusable Temperature Probes	Part No.	Minimum measurement time for accurate readings
General purpose probe	21075A	90 sec
Small flexible vinyl probe (Infant/Pediatric)	21076A	60 sec
Attachable surface probe	21078A	60 sec
Esophageal/Rectal Temp Probe, 12 FR	989803203561[1]	3 minutes
Esophageal/Rectal Temp Probe, 10 FR	989803203571[1]	3 minutes
Skin Surface Temperature Probe	989803203581[1]	3 minutes

13.7.

1 These accessories have an ingress protection of at least IPX3 and can therefore be used for out-of-hospital transport. The level of ingress protection may be printed on the accessory itself, the packaging, or the accompanying documents.

Disposable Temperature Probes	Part No.	Minimum measurement time for accurate readings
General purpose probe	M1837A	90 sec
Skin probe	21091A	60 sec
Esophageal/Stethoscope Probe, 12 Fr	21093A	180 sec
Esophageal/Stethoscope Probe, 18 Fr	21094A	210 sec
Esophageal/Stethoscope Probe, 24 Fr	21095A	310 sec
Esophageal/Rectal Probe, 12 Fr	21090A	90 sec
Foley Catheter Probe, 12 Fr	M2255A	180 sec
Foley Catheter Probe, 16 Fr	21096A	180 sec
Foley Catheter Probe, 18 Fr	21097A	180 sec
Adapter cable, 1.5 m	21082B	--
Adapter cable, 3.0 m	21082A	--

Cardiac Output (C.O.) Accessories

See "Invasive Pressure Accessories" on page 295 for Getinge continuous cardiac output accessories.

Right Heart Thermodilution		Part No.
C.O. Interface Cables	2.7 meter cable	M1642A
	2.4 m + 2.4 m cable	M1643A
Right heart catheter for thermodilution	(from Edwards Lifesciences)	831HF75
Edwards CO-Set+ (only with 23001A/B)	contact Edwards Lifesciences for information	
Injectate Probes	2.4 m injectate temp. probe (reusable)	23001A
	0.5 m injectate temp. probe (reusable)	23001B
	Ice bath temp. probe	23002A

Transpulmonary Thermodilution		Part No.
C.O. Interface Cables	2.4 m + 2.4 m cable	M1643A
Getinge Pressure Transducer Kits (pressure line available in various lengths)	Contact Getinge for information	
Pressure Interface Cable for disposable pressure transducer	Getinge PMK 206	

Mainstream CO2 Accessories

Description	Part No. (Philips branded)	Part No. (Respironics branded)
CO_2 Sensor	M2501A	
Adult/Pediatric Airway Adapter (reusable)	M2513A	989803206591
Infant Airway Adapter (reusable)	M2516A	989803206601
Adult Airway Adapter (single-patient use)	M2533A	
Infant Airway Adapter (single-patient use)	M2536A	

Sidestream CO2 Accessories

Description	Part No.
CO_2 Sensor	M2741A
Gas Exhaust Tubing	M1015-40001

Nasal and Oral-Nasal Cannulas	Part No. (Philips branded)	Part No. (Respironics branded)
CO_2 Nasal Cannula, Adult	M2744A	989803206611
CO_2 Nasal Cannula, Pediatric	M2745A	989803206621
CO_2 Nasal Cannula, Infant	M2746A	989803206631
CO_2/O_2 Nasal Cannula, Adult	M2750A	989803206641
CO_2/O_2 Nasal Cannula, Pediatric	M2751A	989803206651
CO_2/O_2 Nasal Cannula, Infant	989803144471	989803206661
CO_2 Oral-Nasal Cannula, Adult	M2756A	989803206671
CO_2 Oral-Nasal Cannula, Pediatric	M2757A	989803206681
CO_2/O_2 Oral-Nasal Cannula, Adult	M2760A	989803206691
CO_2/O_2 Oral-Nasal Cannula, Pediatric	M2761A	989803206701

Airway Adapters	Part No. (Philips branded)	Part No. (Respironics branded)
Airway Adapter Set, ET > 4.0 mm	M2768A	989803206711
Airway Adapter Set, ET ≤ 4.0 mm	989803144531	989803206721
Airway Adapter Set H, ET > 4.0 mm	M2772A	989803206731
Airway Adapter Set H, ET ≤ 4.0 mm	M2773A	989803206741

Straight Sample Lines	Part No. (Philips branded)	Part No. (Respironics branded)
Straight Sample Line	M2776A	989803206751
Straight Sample Line H	M2777A	989803206761

Microstream CO2 Accessories

- "FilterLine Set" is a combination of a FilterLine with an Airway Adapter.
- "H" in the accessory name indicates suitability for humidified ventilation and longer usage due to the active removal of humidity from the sample line.
- "Smart CapnoLine" is a combined oral-nasal FilterLine.
- "Smart CapnoLine O_2" is a combined oral-nasal-O_2-CO_2 FilterLine.
- "NIV Line" is a nasal FilterLine suitable for mask ventilation (for example, C-PAP).

The accessories are supplied in packs of 25.

NOTE

Not all accessories are available in all countries.

Accessories for Intubated Patients	Part Number	Part Number for Long Version
FilterLine® SET Adult/Pediatric	M1920A	989803160241
FilterLine® H SET Adult/Pediatric	M1921A	989803160251
FilterLine® H SET Infant/Neonatal	M1923A	989803160261
VitaLine™ H SET Adult/Pediatric	989803159571	
VitaLine™ H SET Infant/Neonate	989803159581	

Accessories for Non-Intubated Patients	Part Number	Part Number for Long Version
CapnoLine® H Adult	M4689A	
CapnoLine® H Infant/Neonatal	M4691A	989803178011
CapnoLine® H O_2 Adult	M4680A	
CapnoLine® H O_2 Pediatric	M4681A	
CapnoLine® H O_2 Infant/Neonatal	989803178001	
NIV Line™ Adult	M4686A	
NIV Line™ Pediatric	M4687A	
Nasal FilterLine® Infant/Neonatal	989803178021	
Nasal Filterline® O_2 Adult	989803179101	989803179111
Nasal Filterline® O_2 Pediatric	989803179121	
Smart CapnoLine® O_2 Adult	M2522A	989803160281
Smart CapnoLine® H O_2 Adult	989803177951	989803177961
Smart CapnoLine® O_2 Pediatric	M2520A	989803160271
Smart CapnoLine® H O_2 Pediatric	989803177971	989803177981
Smart CapnoLine® Adult	M2526A	989803160301
Smart CapnoLine® Pediatric	M2524A	

Accessories for Non-Intubated Patients	Part Number	Part Number for Long Version
Accessories for Endoscopic Procedures		
Smart CapnoLine® Guard	989803178031	
Smart CapnoLine® Guard O$_2$	989803178041	989803178051

Microstream Advance Accessories	Part Number	Part Number for Long Version
FilterLine® SET Adult/Pediatric	989803204511	989803204321
FilterLine® H SET Adult/Pediatric	989803204521	989803204331
FilterLine® H SET Infant/Neonatal	989803204531	989803204341
VitaLine™ H SET Adult/Pediatric	989803204301	
VitaLine™ H SET Infant/Neonatal	989803204311	
CapnoLine® H Adult	989803204621	
CapnoLine® H Infant/Neonatal	989803204631	989803204431
CapnoLine® H O$_2$ Adult	989803204581	
CapnoLine® H O$_2$ Pediatric	989803204591	
CapnoLine® H O$_2$ Infant/Neonatal	989803204421	
NIV Line™ Adult	989803204611	
NIV Line™ Pediatric	989803204601	
Nasal Filterline® O$_2$ Adult	989803204481	989803204491
Nasal Filterline® O$_2$ Pediatric	989803204501	
Nasal FilterLine® Infant/Neonatal	989803204441	
Smart CapnoLine® O$_2$ Pediatric	989803204541	989803204351
Smart CapnoLine® H O$_2$ Pediatric	989803204401	989803204411
Smart CapnoLine® O$_2$ Adult	989803204551	989803204361
Smart CapnoLine® H O$_2$ Adult	989803204381	989803204391
Smart CapnoLine® Pediatric	989803204561	
Smart CapnoLine® Adult	989803204571	989803204371
Accessories for Endoscopic Procedures		
Smart CapnoLine® Guard	989803204451	
Smart CapnoLine® Guard O$_2$	989803204461	989803204471

Miscellaneous Accessories	Part Number
Gas Exhaust Tubing	M1015-40001

Battery Accessories

Description	Part No.
Lithium Ion Smart Battery 2 Ah (internal battery for monitor)	989803196521
Lithium Ion Smart Battery 6 Ah (for 865297 Battery Extension)	M4605A

24 Accessories

Description	Part No.
Battery Charger and Conditioner (requires size adapter to charge 453564526811 battery, see below)	865432
Size adapter for 453564526811 battery	453564658631

Specifications

The specifications in this chapter apply to the MX100 and to the X3 used as a standalone patient monitor.

Intended Purpose

In accordance with the European Medical Device Regulation 2017/745: The IntelliVue MX100 and IntelliVue X3 Patient Monitors are part of the device group "Vital Signs Monitoring Instruments." The intended purpose of this device group is to be used for monitoring and recording of, and generating alarms for, multiple physiological parameters of adults, pediatrics, and neonates.

Intended Use

The monitor is intended to be used for monitoring and recording of, and to generate alarms for, multiple physiological parameters of adults, pediatrics, and neonates.

Indications for Use

The monitor is indicated for use by healthcare professionals whenever there is a need for monitoring the physiological parameters of patients.

The monitor is only for use on one patient at a time.

The monitor is not a therapeutic device.

CAUTION

The monitor is for prescription use only.

The ECG measurement is intended to be used for diagnostic recording of rhythm and detailed morphology of complex cardiac complexes (according to AAMI EC11).

ST segment monitoring is intended for use with adult patients only and is not clinically validated for use with neonatal and pediatric patients.

The Integrated Pulmonary Index (IPI) is intended for use with adult and pediatric (1 to 12 years) patients only.

WARNING

The IPI is an adjunct to and not intended to replace vital sign monitoring.

The derived measurement Pulse Pressure Variation (PPV) is intended for use with sedated patients receiving controlled mechanical ventilation and mainly free from cardiac arrhythmia. The PPV measurement has been validated only for adult patients.

The Masimo rainbow SET measurement is indicated for the noninvasive monitoring of functional oxygen saturation of arterial hemoglobin (SpO2), pulse rate, carboxyhemoglobin saturation (SpCO), methemoglobin saturation (SpMet), total hemoglobin concentration (SpHb), and/or respiratory rate (RRac). The Masimo rainbow SET measurement is indicated for use during both no motion and motion conditions, and for patients who are well or poorly perfused.

Use Environment

The monitor is intended for use by trained healthcare professionals in a hospital environment.

The monitor is also intended for use during patient transport inside the hospital environment.

It is not intended for home use.

A modified version of the monitor with a subset of parameters is also intended for use during patient transport outside the hospital environment.

Hospital Environment:

The monitor is suitable for use in all medically used rooms which fulfill the requirements regarding electrical installation according to IEC 60364-7-710 "Requirements for special installations or locations - Medical locations", or corresponding local regulations.

WARNING

The monitor is not intended for use in an MRI environment or in an oxygen-enriched environment (for example, hyperbaric chambers).

Contraindications

There are no known contraindications for the IntelliVue MX100/X3 Patient Monitor/Multi-Measurement Module.

Manufacturer's Information

You can write to **Philips** at this address:

Philips Medizin Systeme Böblingen GmbH
Hewlett-Packard-Strasse 2
71034 Böblingen
GERMANY

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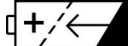
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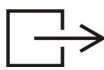
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Symbols

These symbols can appear on the monitor and its associated equipment and packaging (depending on options).

Symbols			
⚠	Caution is necessary when operating the device	⏻	On/Off/Standby
📖	Follow instructions for use	Rx only	Prescription use only
🔒	Indicates that a function is locked.	📖ℹ	Consult the instructions for use.
🏭 DE	Indicates the country and date of manufacture	📖ℹ	Indicates that IfU is available in electronic form
∼	Alternating current	+/▱	Rechargeable battery symbol
---	DC power source	● ●	Connection direction indicator
→0←	Zero the invasive pressure transducer	●	Connection direction indicator
♡→•←	Pressure connector	🌡	Temperature connector
♡²→•←	Dual pressure connector	⊣♥⊢	Applied part has special protection against electric shocks and is defibrillator proof (Type CF according to IEC 60601-1)
🧍	NBP connector	☝	SpO₂ connector
FAST	Uses FAST SpO₂ algorithm	⟋ᐯ⟍	ECG connector
LATEX	Not made with natural rubber latex	OXIMAX WORKS HERE	Nellcor OxiMax compatible
Masimo SET rainbow	Masimo rainbow SET Technology	⊠	Alarms Switched Off
🏭	Identifies date of manufacture	LAN	LAN connection indicator for connection to a wired network
🔊	Indicates location of loudspeaker	⟋⟋	IntelliVue Instrument Telemetry wireless network
🗑	Always use separate collection for waste electrical and electronic equipment (WEEE)	12XL	Monitor supports 12-lead ECG

Symbols			
	Indicates location of the date of manufacture and/or name and address of manufacturer		Built-in short range radio interface
	Built-in wireless network		Non-ionizing radiation symbol
REF	Indicates location of catalog number	IP	Followed by two alphanumeric characters, indicates ingress protection grade
SN	Indicates location of serial number	SERVICE#	Indicates location of service number
PN	Indicates location of technical part number	GTIN	Indicates location of GTIN (Global Trade Item Number)
	Gas input indicator		Gas output indicator
	Electrical output indicator (In some cases gas output indicator)		Electrical input indicator (In some cases gas input indicator)
LOT	Indicates location of batch number		Mass in kilogram (kg)
	Atmospheric pressure limitations for storage		Indicates the location of the "use by" date
	Humidity limitations for storage	NON STERILE	Contents of the packaging are not sterile
	Temperature limitations for storage	CLICK	For successful mounting, the monitor must audibly click into place.
CE 0123	CE mark accompanied by the Notified Body number 0123 (EU compulsory product compliance mark used for medical devices)		Indicates that the product was tested and has met the CSA certification requirements for Canada and the US
EAC	Customs Union EAC Qualification Certification (Customs Union established by Russia, Belarus and Kazakhstan)	50	China RoHS mark
	RCM certification mark (Australian Communications Product Certification)		An information sign or warning sign that is part of the CE mark and is used to inform the user of the restrictions on the use of the device.
CE	CE Mark (EU compulsory product compliance mark)		Japan TELEC wireless certification mark
	Class II equipment	MD	Medical Device
	Ready to use in an out-of-hospital environment	MR	It is unsafe to use the device in MR environments (may be printed black on device)
UDI	Indicates the location of the UDI (Unique Device Identification). Identifier symbol with the GTIN (Global Trade Item Number).		

Installation Safety Information

WARNING

If multiple instruments are connected to a patient, the sum of the leakage currents may exceed the limits given in:

• IEC/EN 60601-1

• ANSI/AAMI ES60601-1

• CAN/CSA C22.2 No. 60601-1:14

Consult your service personnel.

Earthing	If MX100/X3 is connected to IntelliVue Dock or the optional external power supply (M8023A), or X3 is connected to a host monitor, the monitor/IV Dock/M8023A must be earthed.
	The earthing is for functional purposes and does not provide protection against electric shock. The protection against electric shock in this device is provided by double and/or reinforced insulation. If a three-wire receptacle is not available, consult the hospital electrician. Never use a three-wire to two-wire adapter.
Combining equipment	Combinations of medical equipment with non-medical equipment must comply with Clause 16 of:
	IEC/EN 60601-1
	ANSI/AAMI ES60601-1
	CAN/CSA C22.2 No. 60601-1:14
	Never use a multiple portable socket-outlet or extension cord when combining equipment unless the socket outlet is supplied specifically for use with that equipment.
Network Cables	All network cables must be unshielded.

Connectors

The actual placement of boards and configuration of connections for your monitor depends on how your hardware has been configured. See the symbols table in this chapter to see which symbols are used to mark the connections.

Monitor Mounting Precautions

WARNING

• Select the mounting equipment and the mounting position so that no patient, operator or other person can be harmed by a monitor removed intentionally or released accidentally from the mount. Refer to the monitor Service Guide, Installation Instructions chapter, for more information.

• Do not transport a monitor with a measurement extension and/or battery extension by carrying it by the handle or when it is mounted in a suspended position. If the release button or lever is accidentally pressed in these situations, the extension(s) will fall, possibly causing injury or damage.

• Ensure that the monitor is mounted in the horizontal position, to avoid liquid entering the connectors and causing damage to the monitor.

Altitude Setting

Altitude affects CO_2 measurements. The monitor must be configured at installation to the correct altitude.

EMC and Radio Regulatory Compliance

MX100/X3 Including the 802.11 IntelliVue Wireless Adapter

FCC and ISED Canada Radio Compliance: This device complies with Part 15 of the FCC Rules and RSS-247 of ISED Canada. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Any changes or modifications to this equipment not expressly approved by Philips Medical Systems may cause harmful radiofrequency interference and void your authority to operate this equipment.

The maximum antenna gain permitted (for devices in the 5250-5350 MHz and 5470-5725 MHz bands) complies with the e.i.r.p. limits as stated in RSS-247.

The maximum antenna gain permitted (for devices in the 5725-5850 MHz band) complies with the e.i.r.p. limits specified for point-to-point operation, as stated in RSS-247.

The device for the band 5150-5350 MHz is only for indoor usage to reduce potential for harmful interference to co-channel mobile satellite systems.

CAUTION

High power radars are allocated as primary users (meaning they have priority) of 5250-5350 MHz and 5650-5850 MHz and these radars could cause interference and /or damage to license-exempt local area network (LE-LAN) devices.

IntelliVue 802.11 Wireless Adapter CE compliances:

This radio equipment is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU (Radio Equipment Directive).

In addition, the product complies with: ETSI EN 300 328; ETSI EN 301 893; AS/NZS 4268; Japan Ordinance concerning Technical Regulations Conformity Certification etc. of Specified Radio Equipment Article 2 clause 1 Item 19.

MX100/X3 Including IntelliVue Instrument Telemetry WMTS (US only)

The MX100/X3 including IntelliVue Instrument Telemetry WMTS complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Any changes or modifications to this equipment not expressly approved by Philips Medical Systems may cause harmful radiofrequency interference and void your authority to operate this equipment. Operation of this equipment requires the prior coordination with a frequency coordinator designated by the FCC for the Wireless Medical Telemetry Service.

MX100/X3 including IntelliVue Instrument Telemetry ISM (2.4 GHz)

ISED Canada Radio Compliance: This device complies with RSS-247 of ISED Canada. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Any changes or modifications to this equipment not expressly approved by Philips Medical Systems may cause harmful radiofrequency interference and void your authority to operate this equipment.

This radio equipment is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU (Radio Equipment Directive).

Out-Of-Hospital Transport

The out-of-hospital option (#E60) is available for the following devices:

- X3 (867030) / MX100 (867033)
- Microstream Extension (867041)

Devices with the out-of-hospital transport feature have white parameter covers and are marked with either the out-of-hospital symbol or the text "out-of-hospital transport":

| out–of–hospital transport |

CAUTION

Only IntelliVue X3/MX100 patient monitors and 867041 Microstream Extensions that are marked with an out-of-hospital transport label can be used for out-of- hospital transport.

NOTE

- The IntelliVue X3/MX100 either alone or in combination with an 867041 Microstream Extension requires additional mounting during transport within a road ambulance. Any mounting solution must comply with EN 1789 (crash safety) and/or IEC 60601-1-12.

  The IntelliVue Dock (867043) is restricted to use as a permanently installed device according to IEC 60601-1 Ed. 3.1: 2012. Therefore, it must be mounted permanently when used outside of the hospital environment. This means that it must be fixed or otherwise secured at a specific location either permanently or such that it can only be detached with a tool.

  For permanent installation outside of the hospital environment, you can, for example, use the IntelliVue X3 Ambulance Mount, provided by GCX (part number: PH-0062-87), or any other mounting solution provided by a third party supplier which allows safe and reliable mounting for the X3/Microstream Extension and IntelliVue Dock according to EN 1789 and/or IEC 60601-1-12.

  Note that the Philips IntelliVue X3 Ambulance Mount must be mounted in a horizontal position.

- The IntelliVue Dock is not marked with the out-of-hospital transport symbol. However, it can be used for out-of-hospital transport (limited to ground transport) in combination with for example, the IntelliVue X3 Ambulance Mount, provided by GCX (part number: PH-0062-87), or any other mounting solution provided by a third party supplier which allows safe and reliable mounting for the X3/Microstream Extension and IntelliVue Dock according to EN 1789 and/or IEC 60601-1-12.

- For out-of-hospital transport, the Microstream Extension must be fixed to the monitor with locking pins. See *"Fixing the Current Generation Extensions to the Monitor"* in the MX100/X3 Service Guide for details.

Standards Compliance

The following measurements and interfaces can be used for out-of-hospital transport:

- ECG / Respiration, NBP, SpO2, Pressure, Temperature, CO2
- Battery, LAN

CAUTION

- Wireless functionality is restricted to use inside the hospital. For out-of-hospital transport only a LAN connection is permitted.

- For compliance with the out-of-hospital standards listed below, applied parts and accessories must have ingress protection of at least IPX3.

The devices designed for out-of-hospital transport can be used in a transport environment such as a road ambulance. For this purpose, the monitor fulfills the following additional mechanical, EMC and environmental requirements:

IEC 60601-1-12 Ed. 1.0: 2014 - General requirements for basic safety and essential performance - Collateral Standard: Requirements for medical electrical equipment and medical electrical systems intended for use in the emergency medical services (limited to ground transport)

EN 1789: 2007 + AMD 2: 2014 - Medical vehicles and their equipment (Road ambulances)

General Compliance

Shock Tests in accordance with IEC 60068-2-27:2008, represents Class 7M3 as described in IEC TR 60721-4-7:2001, Type 1

Bump Test according to IEC 60068-2-29: 2008 – 15g / 6 ms, 1000 bumps vertical

Random Vibration in accordance with IEC 60068-2-64:2008, represents Class 7M3 as described in IEC TR 60721-4-7: 2003

Sinusoidal Vibration according to IEC 60068-2-6:2007, as described in EN1789

Free Fall Test in accordance with IEC 60068-2-31 Ed. 2: 2008, represents Class 7M3 as described in IEC TR 60721-4-7:2001. X3 (867030) / MX100 (867033) drop height 1 m

Free Fall Test in accordance with EN 60068-2-32:1993, procedure 1 for X3 / MX100 in combination with Microstream Extension 867041. X3 (867030) / MX100 (867033) in combination with Microstream Extension 867041 drop height 0.75 m when connected with locking pins.
Note: The 867043 IntelliVue Dock is excluded from this requirement, as it is a permanently installed device according to IEC 60601-1 Ed. 3.1:2012

Degrees of protection provided by enclosures (IP Testing) – IP33

Radiated susceptibility - 20 V/m according to IEC 80601-2-30:2013 (NBP)

EMC Tests according to IEC 60601-1-2: 2014 Ed. 4 for EMS Environment CISPR11

Additional EMC Tests in accordance with MIL STD 461G:2015, sections RE101 and CS114 (curve #3)

NOTE

There may be additional requirements for transport situations in difficult terrain in certain countries, for example, in the EU.

Monitor Safety Specifications

CE_{0123}

The monitor and current generation measurement extensions comply with the EU Regulation 2017/745 of the European Parliament and of the Council of 5 April 2017 on medical devices.

In addition, the product complies with:

IEC 60601-1, Ed. 3.1:2012-08 (cons.) / EN 60601-1:2006 + AC:2010 + A1:2013, Ed. 3
ANSI/AAMI ES60601-1:2005/(R)2012, Ed. 3 (cons.)
CAN/CSA-C22.2 No. 60601-1:14, Ed. 3 (cons.)
IEC 60601-1-6:2010 + A1:2013 / EN 60601-1-6:2010
IEC 60601-1-8:2006 + A1:2012 / EN 60601-1-8:2007 + A1:2013
IEC 80601-2-49:2018 (MX100/X3 require an internal battery in order to be compliant with clause 202.8.1 of this standard)
IEC 60601-1-2:2007, Ed. 3 / EN 60601-1-2:2007 + AC:2010, Ed. 3
IEC 60601-1-2:2014, Ed. 4 / EN 60601-1-2:2015, Ed. 4

The possibility of hazards arising from software errors was minimized in compliance with:

ISO 14971:2007 / EN ISO 14971:2012 / ANSI/AAMI ISO 14971:2010
IEC 62304:2006 / EN 62304:2006 +AC:2008

Classification (according to IEC 60601-1): Class II, Type CF, Continuous Operation. All applied parts are defibrillation-proof.

Safe Use Instructions

Do not repair or service the product yourself. Always refer to qualified service personnel for service or repair of the product.

To avoid unintended exposure to chemicals, wash your hands after use and avoid food intake while handling the product.

Declarable Substances

WARNING

The EU REACH Regulation 1907/2006 requires Philips to provide chemical content information for Substances of Very High Concern (SVHC), if they are present in the relevant article above a concentration of 0.1% weight by weight.

Information on substances contained in the Philips products can be found on the Philips REACH website: www.philips.com/REACH.

Physical Specifications

Product	Maximum Weight	Size (W x H x D)	Comments
MX100/X3 Monitor	1.4 kg (3.1 lb)	249 x 97 x 111 mm (9.8 x 3.8 x 4.4 in)	including battery and options, with handle
		194 x 97 x 85 mm (7.6 x 3.8 x 3.3 in)	including battery and options, without handle
867043 IntelliVue Dock	0.79 kg (1.7 lb)	190 x 112 x 100 mm (7.5 x 4.4 x 3.9 in)	without cable management
		190 x 172 x 100 mm (7.5 x 6.8 x 3.9 in)	with cable management
M8023A External Power Supply	0.6 kg (1.4 lb)	208 x 105 x 135 mm (8.2 x 4.1 x 5.3 in)	
865297 Battery Extension	1.3 kg (2.9 lb)	193 x 140 x 132 mm (7.6 x 5.5 x 5.2 in)	
867039 Hemodynamic Extension	0.5 kg (1.1 lb)	200 x 97 x 90 mm (7.9 x 3.8 x 3.5 in)	
867040 Capnography Extension	0.5 kg (1.1 lb)	200 x 97 x 90 mm (7.9 x 3.8 x 3.5 in)	
867041 Microstream Extension	0.6 kg (1.4 lb)	200 x 97 x 90 mm (7.9 x 3.8 x 3.5 in)	
M3012A Hemodynamic Extension	0.6 kg (1.4 lb)	200 x 98 x 89 mm (7.9 x 3.9 x 3.5 in)	
M3014A Capnography Extension	0.6 kg (1.4 lb)	200 x 98 x 89 mm (7.9 x 3.9 x 3.5 in)	
M3015A/B Microstream Extension	0.6 kg (1.4 lb)	202 x 98 x 89 mm (8 x 3.9 x 3.5 in)	

Environmental Specifications

The monitor may not meet the performance specifications given here if stored or used outside the specified temperature and humidity ranges.

The monitor is protected against ingress of objects and fluids according to IEC 60529 IP32 (see specifications below). Do not expose the monitor or other system components listed below directly to heavy rain.

When the monitor and related products have differing environmental specifications, the effective range for the combined products is that range which is common to the specifications for all products.

MX100, X3, and all Measurement Extensions		
Item	**Condition**	**Range**
Temperature Range	Operating	0 to 40°C (32 to 104°F)
	Operating when charging the battery, when equipped with wireless LAN or IntelliVue Instrument Telemetry Wireless network, or when X3 is mounted directly on a host monitor	0 to 35°C (32 to 95°F)
	Storage including transportation	-20 to 60°C (-4 to 140°F)
Humidity Range	Operating	15% to 95% Relative Humidity (RH)
	Storage including transportation	5% to 90% Relative Humidity (RH)
Altitude Range	Operating	-500 m to 3000 m (-1640 ft to 9842 ft)
	Storage including transportation	-500 m to 4600 m (-1640 ft to 15091 ft)[1]
Ingress Protection	Monitor	IP32 when mounted horizontally
	Monitor with option #E60 (standalone)	IP44 when mounted horizontally
	Monitor with option #E60 (system)	IP33 when mounted horizontally
	Monitor with 867041 Microstream Extension	IP44 when mounted horizontally
	867041 Microstream Extension	IP32 when mounted horizontally
	867041 Microstream Extension with option #E60	IP33 when mounted horizontally
	867040 Capnography Extension	IP32 when mounted horizontally
	867039 Hemodynamic Extension	IP32 when mounted horizontally
	867043 IntelliVue Dock	IP32 when mounted horizontally
	External Power Supply (M8023A)	IP31 when rested on its rubber feet on a flat, level surface.
		IP32 when mounted as described in the Service Guide.
	Battery Extension (865297)	IP32
Definition of IP codes used:		
IP31	Protected against ingress of water when the water is dripping vertically, and ingress of solid foreign objects 2.5 mm in diameter or larger.	
IP32	Protected against ingress of water when the water is dripping vertically and the monitor is tilted up to 15°, and ingress of solid foreign objects 2.5 mm in diameter or larger.	
IP33	Protected against ingress of water when the water is falling as a spray at any angle up to 60° from the vertical on the monitor, and ingress of solid foreign objects 2,5mm in diameter or larger.	
IP44	Protected against ingress of water when the water is splashing from any angle on the monitor, and ingress of solid foreign objects 1 mm in diameter or larger.	

[1] Sufficient for flight altitudes up to 12,000 m with pressurized cabins

M3012A #C10, M3014A #C10		
Item	**Condition**	**Range**
Temperature Range	Operating	0 to 40°C (32 to 104°F)
	Storage including transportation	-20 to 60°C (-4 to 140°F)
Humidity Range	Operating	up to 95% Relative Humidity (RH) max. @40°C (104°F).
	Storage including transportation	up to 90% Relative Humidity (RH) max. @60°C (140°F)
Altitude Range	Operating	-500 m to 4600 m (-1600 to 15000 ft)
	Storage including transportation	-500 m to 4600 m (-1600 to 15000 ft)

Transient operating conditions:

The devices will operate normally for up to 20 minutes when moved from room temperature (20°C +/- 2°C) to an environment with a temperature range from -20°C to 50°C, and relative humidity range from 15% to 90% (non-condensing).

The devices will operate normally for up to 20 minutes when moved from storage temperature (range from-20°C to 60°C) to room temperature (20°C +/- 2°C), and started up within 10 minutes after the movement.

Masimo rainbow SET Measurement (additional specifications)	
Incandescent Light Intensity	≤ 100 kilolux
Fluorescent Light Intensity	≤ 10 kilolux
Fluorescent Light Frequency	50, 60 Hz ± 1.0 Hz (LNOP, LNCS Sensors)
	50, 60 Hz ± 0.5 Hz (rainbow Sensors)
Ambient Noise Level (Sound Pressure Level) (applies to acoustic respiration measurement only)	≤ 65 dB Alarm tolerant

Monitor Performance Specifications

Performance Specifications		
Power Specifications	Power consumption	<12 W average <20 W when on IntelliVue Dock
	Operating Voltage	36 to 60 V DC floating
Battery Specifications	Operating Time (with new, fully charged battery at 25°C)	Basic monitoring configuration: minimum 5 hours (**Brightness** set to **Optimum** (4) - **Auto Brightness** off, ECG/Resp, SpO$_2$, measurements in use, NBP measurement every 15 minutes) Extended monitoring configuration: minimum 3 hours (**Brightness** set to **Optimum** (4) - **Auto Brightness** off, ECG/Resp, SpO$_2$, CO$_2$, dual pressure, and temperature measurements in use, NBP measurement every 15 minutes, wireless network interface in use)
	Charge Time [There are some combinations, with a monitor and measurement extension in use, where not enough power is available to charge the battery. To increase the probability of the battery charging you can: • dim the display brightness • remove the extension • use IntelliVue Dock • switch the X3 off At high environmental temperatures, the battery may not be charged in an X3 directly connected to a host monitor, as the battery must be protected from overheating.]	When the monitor is switched off and connected to IntelliVue Dock, the external power supply (M8023A), or a host monitor (X3 only): **3 hours approx.** When the monitor is in use (basic monitoring configuration), and connected to IntelliVue Dock, without measurement extensions: **2.5 hours approx.** When an X3 is in use (basic monitoring configuration), and connected to an MX400-550 monitor, without measurement extensions: **3 hours approx.** When the monitor is in use (basic monitoring configuration), with a measurement extension with Microstream CO$_2$, dual pressure and temperature measurements in use, and connected to IntelliVue Dock: **4 hours approx.**
Sounds	Audible feedback for user input Prompt tone QRS tone, or SpO$_2$ modulation tone 4 different alarm sounds	

Performance Specifications		
Indicators	Alarms Off	red or yellow LED with crossed out alarms symbol
	Alarms	red/yellow/light blue (cyan) LED
	On/Standby / Error	green / red LED
	Battery	green (full)/yellow (charging)/red blinking (empty) LED
	External Power	green LED
Display Wave Speeds		6.25 mm/s, 12.5 mm/s, 25 mm/s, 50 mm/s
		with ±5% accuracy (guaranteed only for integrated displays)
Trends	Resolution	50 numerics @ 12 sec, 1 minute, 5 minute resolution.
	Information	Multiple choices of number of numerics, resolution and duration depending on trend option and application area.
Alarm signal	System alarm delay The system alarm delay is the processing time the system needs for any alarm to be indicated on the monitor, after the measurement has triggered the alarm.	less than 4 seconds
	Delay for alarm availability on the network This is the time needed after alarm indication on the monitor until the alarm signal is available on the network, to the Information Center or for transmission to other systems.	less than 5 seconds
	Pause duration	1,2,3 minutes or infinite, depending on configuration
	Extended alarm pause	5 or 10 minutes
	Sound pressure range	min. 0 dB(A) max. 45-85 dB(A)
Review Alarms	Information	all alarms / inops, main alarms on/off, alarm acknowledgement and time of occurrence
	Capacity	300 items
Real Time Clock	Range	from: January 1, 1997, 00:00 to: December 31, 2080, 23:59
	Accuracy	<4 seconds per day
	Hold Time	• if powered by external power supply: infinite • with battery: time is stored but a hold time is not specified, as storing a battery in an unused device for a longer period of time is not recommended • without power or battery: at least 48 hours
Buffered Memory	Hold Time	• if powered by external power supply: infinite • with battery: memory is buffered but a hold time is not specified, as storing a battery in an unused device for a longer period of time is not recommended • without power or battery: at least 4 hours
	Contents	Active settings, trends, patient data, realtime reports, review alarms

867043 IntelliVue Dock		
Power Specifications	Line voltage	100 to 240 V ~
	Current	1.0 to 0.5 A
	Frequency	50/60 Hz ~
Indicators	AC power	green LED

3.1.

M8023A External Power Supply (for M3002A) Performance Specifications		
Power Specifications	Line Voltage	100 to 240 V ~
	Current	1.3 to 0.7 A
	Frequency	50/60 Hz
Indicators	AC Power	green LED

Display Specifications		
Integrated display (Active matrix color LCD display with multi-touch screen)	Sweep Speeds	6.25, 12.5, 25 and 50 mm/s
	Resolution	1024 x 480
	Refresh frequency	60 Hz
	Useful screen	140 x 65 mm (5.5 x 2.6 in)
	Pixel size	0.14 x 0.14 mm

Monitor Interface Specifications

Monitor Interface Specifications		
Measurement Link (MSL)	Connectors	Female ODU (Proprietary)
	Power	36 V to 60 V input
	LAN signals	IEEE 802.3 10-Base-T compliant
	Serial signals	RS-422 compliant
	Local signals	Provided for connecting measurement extensions
	Local voltage	9 V to 12.3 V - provided to power current generation measurement extensions when the monitor is using battery power
IntelliVue 802.11 Bedside Adapter (Wireless Network Adapter)	Type	Internal wireless adapter
	Technology	IEEE 802.11a/b/g/n/ac[2]
	Frequency Band	USA: 2.400 - 2.483 GHz, 5.15 - 5.35 GHz, 5.725 - 5.825 GHz
		Europe: 2.400 - 2.483 GHz, 5.15 - 5.35 GHz, 5.47 - 5.725 GHz
		Japan: 2.400 - 2.483 GHz, 5.15 - 5.25 GHz, 5.25 - 5.35 GHz, 5.470 - 5.725 GHz
		China: 2.400 - 2.483 GHz, 5.725 -5.85 GHz
	Modulation Technique	802.11b/g/n DSSS (DBPSK, DQPSK, CCK) OFDM (BPSK, QPSK, 16-QAM, 64-QAM) 802.11a/n/ac OFDM (BPSK, QPSK, 16-QAM, 64-QAM, 256-QAM[2])
	Effective isotropically radiated power (EIRP)	below 20 dBm
IntelliVue Instrument Telemetry Wireless Network		
Internal WMTS Adapter	Technology	compatible with Philips IntelliVue Telemetry System (ITS), cellular infrastructure
	Frequency Band	WMTS: 1395-1400 MHz and 1427-1432 MHz
	Effective isotropically radiated power (EIRP)	below 22 dBm

Monitor Interface Specifications		
Internal ISM Adapter	Technology	compatible with Philips IntelliVue Telemetry System (ITS), cellular infrastructure
	Frequency Band	2.400 - 2.483 GHz
	Modulation technique	GFSK
	Effective isotropically radiated power (EIRP)	Below 20 dBm

[1] See "Connectors" on page 317 for safety-related information)

[2] IEEE 802.11 ac Technology and OFDM (256-QAM) Modulation Technique only available in monitors with WLAN card ID 6645 (see Revision Window)

867043 IntelliVue Dock Interface Specifications		
Measurement Link (MSL)	Connectors	Male ODU (Proprietary)
	Power	48 V output
	Power Sync.	5 V CMOS Level; 78.125 kHz
	LAN signals	IEEE 802.3 10-Base-T and 100Base-TX compliant
	Serial signals	RS422 compliant
	Local signals	One wire EEPROM for detection of the device
Flexible Sync Output		
General	Connector	1/4" stereo phone jack with channel 1 at tip, channel 2 at ring, sleeve
	Isolation	Functional isolation
	Short circuit current	<13 mA
Analog ECG Output (Performance specification for load impedance >10 kOhm)	Gain	2 V/mV default; user selectable choices: 4.0 V/mV, 2.0 V/mV, 1.0 V/mV, 0.5 V/mV, 0.25 V/mV
	Gain error	<11%
	Baseline offset	<40 mV
	Bandwidth	1 to 100 Hz
	Output voltage swing	+/- 4 V (minimum)
	Signal delay	<20 ms
	Pacemaker Pulse	filtered and included in ECG output signal
Analog Pressure Output (Performance specification for load impedance >10 kOhm)	Gain	1 V/100 mmHg
	Gain error	<2%
	Baseline offset	<50 mV
	Output voltage swing	+/- 4 V (minimum)
	Signal delay	<30 ms
Digital Pulse Output	Pulse shape	rectangular
	Pulse width	100 ms±10 ms (active high)
	Output low voltage level	<0.4 V at I=-1 mA
	Output high voltage level	>2.4 V at I=1 mA (3.3 V at no load)
	Pulse rise time	<1 ms (from 0.4 V to 2.4 V)
	Signal delay	<25 ms per AAMI EC13
	Output impedance	<10 Ohm for load currents from -1 mA to 1 mA

M8023A External Power Supply Interface Specifications		
Measurement Link (MSL)	Connectors	Male ODU (Proprietary)
	Power	48 V output
	Power Sync.	RS-422 compliant output 78.125 kHz (typical)
	LAN signals	IEEE 802.3 10-Base-T compliant
	Serial signals	RS-422 compliant output 78.125 kHz (typical)
	Local signals	Not connected

865297 Battery Extension Interface Specifications		
Measurement Link (MSL)	Connectors	Male ODU (Proprietary)
	Power	36 -38 V output
	Power Sync.	RS-422 compliant output 78.125 kHz (typical)
	LAN signals	IEEE 802.3 10-Base-T compliant
	Serial signals	RS-422 compliant
	Local signals	Not connected
Measurement Link (MSL)	Connectors	Female ODU (Proprietary)
	Power	30-60 V input
	Power Sync.	RS-422 compliant input 78.125 kHz (typical)
	LAN signals	IEEE 802.3 10-Base-T compliant
	Serial signals	RS-422 compliant
	Local signals	Not connected

865297 Battery Extension Specifications

865297 Battery Extension Battery Specifications	
Battery Type	M4605A
Indicators	green power LED and green-yellow-red battery status LED

453564526811 Battery Specifications

One battery is required for battery operation of the monitor.

The battery lifetime is 3 years from manufacturing date or 500 charge/discharge cycles.

453564526811 Battery Specifications	
Physical Specifications	
W x D x H	69.6 x 72.3 x 21.6 mm (2.74 x 2.85 x 0.85 in)
Weight	<200 g (0.44 lb) per battery
Performance Specifications	
Nominal Voltage	10.8 Volt
Rated Capacity at discharge C/5	2000 mAh
Continuous Discharge Capability	4 A
Environmental Specifications	
Temperature Range	Discharge 0 to 65°C (32 to 149°F) Charge 0 to 60°C (32 to 140°F) Storage and Transportation: -20 to 60°C (-4 to 140°F)

453564526811 Battery Specifications	
Humidity Range	Operating: 15% to 95% Relative Humidity (RH) Storage and Transportation: 5 % to 95 % Relative Humidity (RH)
Battery Type	Smart Battery 10.8 V, 2000 mAh, Lithium Ion
Safety	Complies with UL62133/IEC62133
Electromagnetic Compatibility (EMC)	Complies with the requirements for FCC Type B computing Device, and EN 61000-4-2 and EN 61000-4-3
Communication Standard	Complies with the SMBus specification v 1.1

M4605A Battery Specifications

One M4605A battery is required to power the 865297 Battery Extension.

The battery lifetime is 3 years from manufacturing date or 500 charge/discharge cycles.

M4605A Battery Specifications	
Physical Specifications	
W x D x H	149 x 89 x 20 mm (5.9 x 3.5 x 0.8 in)
Weight	500 g (1.1 lb) per battery
Performance Specifications	
Nominal Voltage	10.8 Volt
Rated Capacity at discharge C/5	6000 mAh
Continuous Discharge Capability	6.5 A
Environmental Specifications	
Temperature Range	Discharge 0 to 50°C (32 to 122°F) Charge 0 to 50°C (32 to 122°F) Storage and Transportation: -20 to 65°C (-4 to 149°F)
Humidity Range	Operating: 15% to 95% Relative Humidity (RH) Storage and Transportation: 5 % to 95 % Relative Humidity (RH)
Battery Type	Smart Battery 10.8 V, 6000 mAh, Lithium Ion
Safety	complies with UL 2054
Electromagnetic Compatibility (EMC)	complies with the requirements for FCC Type B computing Device, and EN 61000-4-2 and EN 61000-3-2
Communication Standard	complies with the SMBus specification v 1.1

Measurement Specifications

See the "Default Settings Appendix" for a list of the settings the monitor is initially shipped with.

ECG/Arrhythmia/ST/QT

Complies with:

IEC 60601-2-25:2011
ANSI/AAMI/IEC 60601-2-25:2012
IEC 60601-2-27:2011
ANSI/AAMI/IEC 60601-2-27:2011 + Err:2012

ECG/Arrhythmia/ST Performance Specifications		
Cardiotach	Range 6.1.	Adult/pedi: 15 to 300 bpm Neo range: 15 to 350 bpm Note: for rates less than 15 bpm, the displayed heart rate is 0.
	Accuracy	±1% of range
	Resolution	1 bpm
	Sensitivity	≥200 μV_{peak}
PVC Rate	Range	0 to 300 bpm
	Resolution	1 bpm
ST Numeric	Range	-25 to +25 mm
	Accuracy	±0.5 mm or 15%, whichever is greater
	Resolution	0.1 mm
QT Numeric	Range	200 to 800 ms
	Accuracy	±30 ms
	Resolution	8 ms
QTc Numeric	Range	200 to 800 ms
	Resolution	1 ms
Δ QTc Numeric	Range	-600 to +600 ms
	Resolution	1 ms
QT-HR Numeric	Range - adult	15 to 150 bpm
	Range - pediatric and neonatal	15 to 180 bpm
Sinus and SV Rhythm Ranges	Brady	Adult: 15 to 59 bpm Pedi: 15 to 79 bpm Neo: 15 to 89 bpm
	Normal	Adult: 60 to 100 bpm Pedi: 80 to 160 bpm Neo: 90 to 180 bpm
	Tachy	Adult: >100 bpm Pedi: >160 bpm Neo: >180 bpm
Bandwidth	Diagnostic Mode	Adult/neo/pedi: 0.05 to 150 Hz
	Extended Monitoring Mode	Adult/neo/pedi: 0.5 to 150 Hz
	Monitoring Mode	Adult: 0.5 to 40 Hz Neo/pedi: 0.5 to 55 Hz
	Filter Mode	Adult/neo/pedi: 0.5 to 20 Hz
Bandwidth when the ECG is transmitted from a telemetry device via short range radio	Diagnostic Mode	Adult/neo/pedi: 0.05 to 40 Hz
	Extended Monitoring Mode	Adult/neo/pedi: 0.5 to 40 Hz
	Monitoring Mode	Adult: 0.5 to 40 Hz Neo/pedi: 0.5 to 40 Hz
	Filter Mode	Adult/neo/pedi: 0.5 to 20 Hz
Differential Input Impedance		>2 MΩ RA-LL leads (Resp) >5 MΩ at all other leads (at 10 Hz including patient cable)
Common Mode Rejection Ratio		Diagnostic mode: >86 dB (with a 51 kΩ/47 nF imbalance). Filter mode: >106 dB (with a 51 kΩ/47 nF imbalance).
Electrode Offset Potential Tolerance		±500 mV
Auxiliary Current **(Leads off Detection)**		Active electrode: <100 nA Reference electrode: <900 nA
Input Signal Range		±5 mV
Noise		<30 μV p-p at 0.05 to 150 Hz

ECG/Arrhythmia/ST/QT Alarm Specifications	Range	Adjustment
HR	15 to 300 bpm maximum delay: 10 seconds according to AAMI EC 13-1992 standard	Adult:1 bpm steps (15 to 40 bpm) 5 bpm steps (40 to 300 bpm) Pedi/Neo:1 bpm steps (15 to 50 bpm) 5 bpm steps (50 to 300 bpm)
Extreme Tachy	Difference to high limit 0 to 50 bpm	5 bpm steps
	Clamping at 150 to 300 bpm	5 bpm steps
Extreme Brady	Difference to low limit 0 to 50 bpm	5 bpm steps
	Clamping at 15 to 100 bpm	5 bpm steps
Run PVCs	None, fixed setting 2 PVCs	Not adjustable by user
PVCs Rate	1 to 99 PVCs/minute	1 PVC
Vent Tach HR	20 to 300 bpm	5 bpm
Vent Tach Run	3 to 99 PVCs/minute	1 PVC
Vent Rhythm Run	3 to 99 PVCs/minute	1 PVC
SVT HR	120 to 300 bpm	5 bpm
SVT Run	3 to 99 SV beats	1 SV beat
ST High	-19.8 to +20.0 mm	0.2 mm
ST Low	-20.0 to +19.8 mm	0.2 mm
STE Limit	-20.0 to +20.0 mm	0.2 mm
QTc High	200 ms to 800 ms	10 ms steps
Δ QTc High	30 ms to 200 ms	10 ms steps

ECG/Arrhythmia/ST Supplemental Information as required by AAMI EC11/13, IEC 60601-2-27		
Respiration Excitation Waveform		Sinusoidal signal, 260 μA, 48 kHz
Noise Suppression		RL drive gain 44 dB max., max. voltage 1.8 Vrms
Time to Alarm for Tachycardia	Vent Tachycardia 1 mV$_{pp}$,206 bpm	Gain 0.5: 5.4 seconds + 4 seconds
		Gain 1.0: 3.9 seconds + 4 seconds
		Gain 2.0: 3.7 seconds + 4 seconds
	Vent Tachycardia 2 mV$_{pp}$,195 bpm	Gain 0.5: 3.2 seconds + 4 seconds
		Gain 1.0: 3.5 seconds + 4 seconds
		Gain 2.0: 3.1 seconds + 4 seconds
Tall T-Wave Rejection Capability		Maximum rejected T-wave amplitude is 1.8 mV (According to IEC 60601-2-27, 201.12.1.101.17)
Heart Rate Averaging Method		Three different methods are used: Normally, heart rate is computed by averaging the 12 most recent R-R intervals. For runs of PVCs, up to 8 R-R intervals are averaged to compute the HR. If each of 3 consecutive R-R intervals is greater than 1200 ms (that is, rate less than 50 bpm), then the 4 most recent R-R intervals are averaged to compute the HR.
Response Time of Heart Rate Meter to Change in Heart Rate		HR change from 80 to 120 bpm: Range: [6.4 to 7.2 seconds] Average: 6.8 seconds
		HR change from 80 to 40 bpm: Range: [5.6 to 6.4 sec] Average: 6.0 seconds

ECG/Arrhythmia/ST Supplemental Information as required by AAMI EC11/13, IEC 60601-2-27	
Heart Rate Meter Accuracy and Response to Irregular Rhythm	Ventricular bigeminy: 80 bpm Slow alternating ventricular bigeminy: 60 bpm Rapid alternating ventricular bigeminy: 120 bpm Bidirectional systoles: 90 bpm
Accuracy of Input Signal Reproduction	Methods A and D were used to establish overall system error and frequency response.
Pacemaker Pulse Rejection Performance	Rejection of pacemaker pulses with amplitudes from ±2 mV to ±700 mV and widths from 0.1 ms to 2.0 ms (Method B)
Pacemaker Pulse Rejection of fast ECG signals	2.2 V/s RTI (Paced Mode)
Minimum input slew rate	2.2 V/s RTI

Respiration

Respiration Performance Specifications		
Respiration Rate	Range _7.1._	Adult/pedi: 0 to 120 rpm Neo: 0 to 170 rpm
	Accuracy _7.2._	at 0 to 120 rpm ±1 rpm at 120 to 170 rpm ±2 rpm
	Resolution	1 rpm
Bandwidth		0.3 to 2.5 Hz (-6 dB)
Noise		Less than 25 mΩ (rms) referred to the input

Respiration Alarm Specifications	Range	Adjustment	Delay
High	Adult/pedi: 10 to 100 rpm Neo: 30 to 150 rpm	< 20 rpm: 1 rpm steps ≥ 20 rpm: 5 rpm steps	max. 14 seconds
Low	Adult/pedi: 0 to 95 rpm Neo: 0 to 145 rpm	< 20 rpm: 1 rpm steps ≥ 20 rpm: 5 rpm steps	for limits from 0 to 20 rpm: max. 4 seconds for limits above 20 rpm: max. 14 seconds
Apnea Alarm	10 to 40 seconds	5 second steps	

SpO2

Complies with:

ISO 80601-2-61:2017 + Corr1:2018

Measurement Validation

The SpO_2 accuracy has been validated in human studies against arterial blood sample reference measured with a CO-oximeter. Pulse oximeter measurements are statistically distributed, only about two-thirds of the measurements can be expected to fall within the specified accuracy compared to CO-oximeter measurements.

Philips FAST SpO2 Performance Specifications

Philips FAST SpO$_2$ Performance Specifications		
SpO2	Range	0 to 100%
The specified accuracy is the root-mean-square (RMS) difference between the measured values and the reference values	Accuracy	**Philips Reusable Sensors:** M1191A, M1191AL, M1191B, M1191BL, M1192A, = 2% (70% to 100%) 8.2. M1193A, M1194A, M1195A, M1196A, M1196S = 3% (70% to 100%) M1191T, M1192T, M1193T (Adult), M1196T = 3% (70% to 100%) M1193T (Neonate) = 4% (70% to 100%) **Philips Disposable Sensors with M1943A(L):** M1132A, M1133A (adult/infant), M1134A (adult/infant) = 2% M1901B, M1902B, M1903B, M1904B, M1131A, M1133A (neonate), M1134A (neonate) = 3% (70% to 100%) **Nellcor** [®] Sensors with M1943A(L): MAX-A, MAX-AL, MAX-P, MAX-I, MAX-N, D-25, D-20, I-20, N-25, OxiCliq A, P, I, N = 3% (70% to 100%) **Masimo Reusable Sensors** [®] **with LNOP MP12 or LNC MP10:** LNOP DC-I, LNOP DC-IP, LNOP YI (adult/pedi/infant), LNCS DC-1, LNCS DC-IP, LNCS YI (adult/pedi/infant) = 2% (70% to 100%) LNOP YI (neonate), LNCS YI (neonate) = 3% (70% to 100%) LNOP TC-I, LNCS TC-I: 3.5% (70% to 100%) **Masimo Disposable Sensors** [®] **with LNOP MP12 or LNC MP10:** LNOP Adt, LNOP Adtx, LNOP Pdt, LNOP Pdtx, LNOP Inf-L, LNOP Neo-L (adult), LNCS Adtx, LNCS Adtx-3, LNCS Pdtx, LNCS Pdtx-3, LNCS Inf, LNCS Inf-3, LNCS Neo (adult), LNCS Neo-3 (adult) = 2% (70% to 100%) LNOP Neo-L (neonate), LNOP NeoPt-L, LNCS Neo (neonate), LNCS Neo-3 (neonate), LNCS NeoPt, LNCS NeoPt-3 = 3% (70% to 100%)
	Resolution	1%
Pulse	Range	30 to 300 bpm 8.3.
	Accuracy	±2% or 1 bpm, whichever is greater
	Resolution	1 bpm
Numeric Update Rate		Typical: 2 seconds, Maximum: 30 seconds. Maximum with NBP Alarm Suppr. on: 60 seconds.
Sensors		Wavelength range: 500 to 1000 nm Emitted Light Energy: ≤15 mW Information about the wavelength range can be especially useful to clinicians (for instance, when photodynamic therapy is performed)
Pulse Oximeter Calibration Range		70% to 100%

8.1.

Nellcor OxiMax Performance Specifications

Pulse Oximetry Performance Specifications		
SpO2 The specified accuracy is the root-mean-square (RMS) difference between the measured values and the reference values	Range	1 to 100%
	Accuracy	M1901B[1], M1902B, M1903B, M1904B, MAXA, MAXAL, MAXP, MAXI, MAXN[1], MAXFAST: adult/infant = 2% (70% to 100%)
		M1902B, M1903B, M1904B, MAXA, MAXAL, MAXP, MAXI, MAXN[1], MAXFAST: adult =3% (60% to 80%)
		MAXN[1]: neonate = 2% (70% to 100%)
		Oxicliq A, Oxicliq P, Oxicliq L, Oxicliq N[4]: adult/infant =2.5% (70% to 100%)
		Oxicliq N[4]: neonate = 3.5% (70% to 100%)
		MAXR[2], D-YSE, D-YSPD: adult/infant = 3.5% (70% to 100%)
		SoftCare SC-A (adult/infant), SoftCare SC-PR-I[3] (neonate), SoftCare SCNEO-I[3]: (neonate) = 2% (70% to 100%)
		DS-100A-I, D-YS, Oxiband OXI-A/N, Oxiband OXI-P/I: adult/infant = 3% (70% to 100%)
		D-YS[4], Oxiband OXI-A/N[4]: neonate = 4% (70% to 100%)
	Low perfusion accuracy[5]	2% (70 - 100%)
	Resolution	1%
Pulse	Range	20 to 300 bpm
	Accuracy	+/- 3 bpm (20 to 250 bpm)
	Low perfusion accuracy[5]	+/- 3 bpm (20 to 250 bpm)
	Resolution	1 bpm
Numeric update rate		typical 1 second, max ≤60 seconds
Sensors		Wavelength range: 500 to 1000 nm Emitted Light Energy: ≤15 mW Information about the wavelength range can be especially useful to clinicians (for instance, when photodynamic therapy is performed)

1. M1901B/MAXN:

Clinical functionality has been demonstrated on a population of hospitalized neonate patients. The observed SpO_2 accuracy was 2.5% in a study of 42 patients with ages of 1 to 23 days, weight from 750 to 4100 grams, and 63 observations made spanning a range of 85 to 99% SaO_2 while monitored with Nellcor OxiMax N-595 pulse oximeters.

2. The accuracy specification has been determined between saturations of 80%–100%.

3. SoftCare SC-PR-I, SCNEO-I:

Clinical functionality has been demonstrated on a population of hospitalized neonate and infant patients. The observed SpO_2 accuracy was 3.0% in a study of 57 patients with ages of 24 to 40 weeks, weight from 710 to 5,000 grams, and 185 observations made spanning a range of 63 to 100% SaO_2 while monitored with Nellcor OxiMax N-595 pulse oximeters.

4. Neonatal accuracy: When sensors are used on neonatal subjects as recommended, the specified accuracy range is increased by ± 1 digit, as compared to adult usage, to account for the theoretical effect on oximeter measurements of fetal hemoglobin in neonatal blood. For example, Oxicliq N accuracy on neonates is ± 3.5 digits, rather than ± 2.5.

5. Specification applies to the performance of the device. Reading accuracy in the presence of low perfusion (detected IR pulse modulation amplitude 0.03% - 1.5%) was validated using signals supplied by a patient simulator. SpO_2 and pulse rate values were varied across the monitoring range over a range of weak signal conditions and compared to the known true saturation and pulse rate of the input signals.

SpO2 Alarm Specifications

SpO$_2$ Alarm Specifications	Range	Adjustment
SpO2	Adult: 50 to 100% Pedi/Neo: 30 to 100%	1% steps
Desat	Adult: 50 to Low alarm limit Pedi/Neo: 30 to Low alarm limit	1% steps
Pulse	30 to 300 bpm[1]	Adult: 1 bpm steps (30 to 40 bpm) 5 bpm steps (40 to 300 bpm) Pedi/Neo: 1 bpm steps (30 to 50 bpm) 5 bpm steps (50 to 300 bpm)
Tachycardia	Difference to high limit 0 to 50 bpm	5 bpm steps
	Clamping at 150 to 300 bpm	5 bpm steps
Bradycardia	Difference to low limit 0 to 50 bpm	5 bpm steps
	Clamping at 30 to 100 bpm	5 bpm steps

1. The Masimo SET technology only provides pulse rate values up to 240 bpm, therefore do not set the corresponding high pulse rate alarm limits to 240 bpm or above when using this technology.

SpO$_2$ Alarm Specifications (cont.)	Standard Delay	Smart Alarm Delay (alternative to standard alarm delay)		
		Short Mode	Medium mode	Long Mode
SpO2 high and low limit alarms	0 to 30 seconds (adjustable in 1 second steps) + system alarm delay[1]	10 to 25 seconds + system alarm delay	10 to 50 seconds +system alarm delay	10 to 100 seconds + system alarm delay
Desat	0 to 30 seconds (adjustable in 1 second steps) + system alarm delay	not supported		
Pulse	10 seconds + system alarm delay			
Tachycardia	10 seconds + system alarm delay			
Bradycardia	10 seconds + system alarm delay			

1. Refer to "Monitor Performance Specifications" on page 323 for system alarm delay specification.

SpO$_2$ Smart Alarm Delay - Detailed Specifications			
Deviation from violated alarm limit	Resulting alarm delay according to selected mode		
	Short	Medium	Long
1%	25 seconds (maximum delay)	50 seconds (maximum delay)	100 seconds (maximum delay)
2%	12 seconds	25 seconds	50 seconds
3%	10 seconds	16 seconds	33 seconds
4%	10 seconds	12 seconds	25 seconds
5%	10 seconds	10 seconds	20 seconds
6%	10 seconds	10 seconds	16 seconds
7%	10 seconds	10 seconds	14 seconds
8%	10 seconds	10 seconds	12 seconds
9%	10 seconds	10 seconds	11 seconds
>9%	10 seconds	10 seconds	10 seconds

Masimo rainbow SET

Performance Specifications

The SpO$_2$ performance specifications in this section apply to monitors with the Masimo rainbow SET technology. Unless otherwise noted the SpO$_2$ accuracy specifications are valid for the measurement range 70-100%.

Complies with ISO 80601-2-61:2011 / EN ISO 80601-2-61:2011.

General Performance Specification SpO$_2$	
Numeric update rate for SpO$_2$, Pulse Rate, and Perf	Typical: 1 second Maximum: 30 seconds
Sensors	Emitted Light Energy ≤ 25mW Wavelength Range 500-1400nm Information about wavelength range can be especially useful to clinicians (for instance when photodynamic therapy is performed).

Measurement Accuracy

The following accuracy specifications represent only the monitor's portion of the integrated Masimo rainbow SET technology performance. The actual measurement performance and accuracy depends on the accessory used, and can be limited by the accessory as specified in the sensor's DFU.

Ensure you only use accessories that are specified and provide accuracy specifications applicable for your monitor.

Measurement	For range	Accuracy
SpO$_2$, no motion	60 to 80%	± 3%, adults/pediatrics/infants
	70 to 100%	± 2%, adults/pediatrics/infants ±3%, neonates
SpO$_2$, motion	70 to 100%	± 3%, adults/pediatrics/infants/neonates
SpO$_2$, Low Perfusion	70 to 100%	± 2%, adults/pediatrics/infants/neonates
Pulse Rate, no motion	25 to 240 bpm	±3 bpm, adults/pediatrics/infants/neonates
Pulse Rate, motion	25 to 240 bpm	±5 bpm, adults/pediatrics/infants/neonates
Pulse Rate, Low Perfusion	25 to 240 bpm	±3 bpm, adults/pediatrics/infants/neonates
SpCO	1 to 40%	± 3%, adults/pediatrics/infants
SpMet	1 to 15%	±1% adults/pediatrics/infants/neonates
SpHb	8 to 17 g/dl	± 1 g/dl (arterial or venous), adults/pediatrics
RRac	4 to 70 rpm	± 1 rpm, adults/pediatrics (>10 kg)

Measurement Validation

The Masimo rainbow SET technology with the designated sensors has been validated by Masimo during motion and no motion conditions in human studies against an arterial blood sample reference measured with a CO-oximeter and an ECG monitor. Pulse oximeter measurements are statistically distributed, only about two-thirds of the measurements can be expected to fall within the specified accuracy compared to CO-oximeter measurements. For more details refer to the sensor's DFU.

NOTE

A functional tester cannot be used to assess the accuracy of the Masimo rainbow SET measurement or accessories.

Measurement Range and Resolution

Measurement	Measurement Range	Resolution
Arterial Oxygen Saturation (SpO$_2$)	0-100%	1%
Signal Quality Indicator (SQI)	The signal quality indicator represents the functional SpO$_2$ Confidence as it is reported by the Masimo rainbow SET measurement board. >90% is represented as filled: >30% and ≤90% is represented as half-filled: ≤30% is represented as empty:	1%
Perfusion Index (Perf)	0.02-20.00 for disposable sensors 0.05-20.00 for reusable sensors	0.01
Pleth Variability Index (PVI)	0-100%	1%
Pulse Rate from Plethysmogram (Pulse)	25-240 bpm	1 bpm
Carboxyhemoglobin Saturation (SpCO)	0-100%	1%
Methemoglobin Saturation (SpMet)	0-100%	0.1%
Total Hemoglobin Saturation (SpHb)	0.0-25.0 g/dl (0.0-15.5 mmol/l)	0.1 g/dl (0.1 mmol/l)
Total Oxygen Concentration (SpOC)	0.0-35 ml/dl	1 ml/dl
Acoustic Respiration Rate (RRac)	4-70 rpm	1 rpm

Alarm Specifications

Alarm Limits

SpO2

Patient Category	High Range	Low Range	Desat Range	Adjustment Steps
Adult	51-100%	50-99%	50-99%	1%
Neonate/Pediatric	31-100%	30-99%	30-99%	1%

SpMet

Patient Category	High Range	Low Range	Adjustment Steps
Adult/Pediatric/Neonate	0.1-100%	0.0-99%	0.1% (0.0-9.9%) 1% (10-100%)

SpCO

Patient Category	High Range	Low Range	Adjustment Steps
Adult/Pediatric/Neonate	1-100%	0-99%	1%

SpHb

Patient Category	High Range	Low Range	Adjustment Steps
Adult/Pediatric/Neonate	0.1-25.0 g/dl 0.1-15.5 mmol/l	0.0-24.5 g/dl 0.0-15.0 mmol/l	0.1g/dl (0.0-9.9 g/dl) 0.1mmol/l (0.0-9.9 mmol/l) 0.5 g/dl (10.0-25.0 g/dl) 0.5 mmol/l (10.0-15.5 mmol/l)

SpOC

Patient Category	High Range	Low Range	Adjustment Steps
Adult/Pediatric/Neonate	1-35 ml/dl	0-34 ml/dl	1 ml/dl

Pulse

NOTE

The Masimo rainbow SET technology only provides pulse rate values up to 240 bpm. To get pulse rate alarms, set the high alarm limit below 240 bpm.

Patient Category	High Range	Low Range	Adjustment Steps
Adult	31-300 bpm	30-295 bpm	1 bpm (30-40 bpm) 5 bpm (40-300 bpm)
Neonate/Pediatric	31-300 bpm	30-295 bpm	1 bpm (30-50 bpm) 5 bpm (50-300 bpm)

	Range	Clamping at	Adjustment Steps
Tachycardia	Delta to the high limit 0-50 bpm	150-300 bpm	5 bpm
Bradycardia	Delta to the low limit 0-50 bpm	30-100 bpm	5 bpm

PVI

Patient Category	High Range	Low Range	Adjustment Steps
Adult/Pediatric/Neonate	1-100%	0-99%	1%

RRac

The Masimo rainbow SET technology only provides respiration rate values from 4 rpm to 70 rpm. For respiration rate alarms, set the high alarm limit below 70 rpm and the low alarm limit above 4 rpm.

Patient Category	High Range	Low Range	Adjustment Steps
Adult/Pediatric	10-100 rpm	0-95 rpm	1 rpm steps below 20 rpm 5 rpm steps above 20 rpm
Neonate	30-150 rpm	0-145 rpm	1 rpm steps below 20 rpm 5 rpm steps above 20 rpm

RRac Pause Time

Range	Adjustment Steps
15-40 seconds	5 seconds

Perf

Patient Category	High Range	Low Range	Adjustment Steps
Adult/Pediatric/Neonate	0.10-20.00	0.02-19.00	0.01 (0.02-0.10) 0.10 (0.10-1.00) 1.00 (1.00-20.00)

3D Perf Delta

% Decrease	Adjustment Steps	Duration	Adjustment Steps
10-100%	2%	1 min - 48 hr, Infinite	1 min, 5 min, 30 min, 1 hr, 4 hr, 8 hr, 12 hr, 24 hr, 36 hr, 48 hr, Infinite

3D Desat Index

3D Desat Index Settings	Range	Adjustment Steps
Delta Threshold	2-10%	1 %
Count	1-25	1
Period	1-4 hrs	1 hrs

Alarm Delays

Alarm	Standard Delay	Smart Alarm Delay		
		Short Mode	Medium Mode	Long Mode
SpO$_2$ high and low limit alarms	0-30 seconds (adjustable in 1 second steps) + system alarm delay	10-25 seconds + system alarm delay	10-50 seconds + system alarm delay	10-100 seconds + system alarm delay

Alarm	Standard Delay
Desat	0-30 seconds (adjustable in 1 second steps) + system alarm delay
Pulse	10 seconds + system alarm delay
Tachycardia	10 seconds + system alarm delay
Bradycardia	10 seconds + system alarm delay
RRac	0, 10, 15, 30, 60 seconds + system alarm delay
PVI	system alarm delay
Perf	system alarm delay
SpCO	system alarm delay
SpHb	system alarm delay
SpMet	system alarm delay
SpOC	system alarm delay

NBP

Complies with:

IEC 80601-2-30:2010 + A1:2013/
EN 80601-2-30:2010 + A1:2015

NBP Performance Specifications		
Measurement Ranges	**Systolic** 9.3.	Adult: 30 to 270 mmHg (4 to 36 kPa) Pedi: 30 to 180 mmHg (4 to 24 kPa) Neo: 30 to 130 mmHg (4 to 17 kPa)
	Diastolic	Adult: 10 to 245 mmHg (1.5 to 32 kPa) Pedi: 10 to 150 mmHg (1.5 to 20 kPa) Neo: 10 to 100 mmHg (1.5 to 13 kPa)
	Mean	Adult: 20 to 255 mmHg (2.5 to 34 kPa) Pedi: 20 to 160 mmHg (2.5 to 21 kPa) Neo: 20 to 120 mmHg (2.5 to 16 kPa)
	Pulse Rate	Adult: 40 to 300 bpm Pedi: 40 to 300 bpm Neo: 40 to 300 bpm
Accuracy		Max. Std. Deviation: 8 mmHg (1.1 kPa) Max. Mean Error: ±5 mmHg (±0.7 kPa)
Pulse Rate Measurement Accuracy		40 to 100 bpm: ±5 bpm 101 to 200 bpm: ±5% of reading 201 to 300 bpm: ±10% of reading (average over NBP measurement cycle)
Pulse Rate Range		40 to 300 bpm
Measurement Time		Typical at HR >60 bpm Auto/manual/sequence: Adult: 30 seconds Neonatal: 25 seconds Stat: 20 seconds Maximum time: Adult/pedi: 180 seconds Neo: 90 seconds
Cuff Inflation Time		Typical for normal adult cuff: Less than 10 seconds Typical for neonatal cuff: Less than 2 seconds
Initial Cuff Inflation Pressure		Adult: 165 ±15 mmHg Pedi: 130 ±15 mmHg Neo: 100 ±15 mmHg
Maximum Cuff Pressure		Adult/Pedi: 300 mmHg Neo: 150 mmHg
Auto Mode Repetition Times		1 min, 2 min, 2.5 min, 3 min, 5 min, 10 min, 15 min, 20 min, 30 min, 45 min, 1 h, 2 h, 4 h, 8 h, 12 h, 24 h
STAT Mode Cycle Time		5 minutes plus time to complete the last measurement
Venipuncture Mode Inflation		
Inflation Pressure	**Adult**	20 to 120 mmHg (3 to 16 kPa)
	Pediatric	20 to 80 mmHg (3 to 11 kPa)
	Neonatal	20 to 50 mmHg (3 to 7 kPa)
Automatic deflation after	**Adult/pediatric**	170 seconds
	Neonatal	85 seconds

Measurement Validation: Clinical investigation according to ISO 81060-2:2013 with the auscultatory reference method:

- the 5th Korotkoff sound (K5) was used in adult / adolescent subjects and the 4th Korotkoff sound (K4) was used in pediatric subjects to determine the diastolic reference pressures.
- the approximation MAP = (2*DIA + SYS) / 3 was used to calculate reference MAP (mean arterial pressure) values from the systolic and diastolic reference pressures.

Clinical investigation according to ISO 81060-2:2013 with the intra-arterial reference method:

- the radial artery was used for the intra-arterial reference measurement.
- the MAP values displayed by the reference invasive blood pressure monitor were used as MAP reference values.
- blood pressure recordings with any arrhythmias were excluded.

NBP Alarm Specifications	Range	Adjustment
Systolic	Adult: 30 to 270 mmHg (4 to 36 kPa)	10 to 30 mmHg: 2 mmHg (0.5 kPa) >30 mmHg: 5 mmHg (1 kPa)
	Pedi: 30 to 180 mmHg (4 to 24 kPa)	
	Neo: 30 to 130 mmHg (4 to 17 kPa)	
Diastolic	Adult: 10 to 245 mmHg (1.5 to 32 kPa)	
	Pedi: 10 to 150 mmHg (1.5 to 20 kPa)	
	Neo: 10 to 100 mmHg (1.5 to 13 kPa)	
Mean	Adult: 20 to 255 mmHg (2.5 to 34 kPa)	
	Pedi: 20 to 160 mmHg (2.5 to 21 kPa)	
	Neo: 20 to 120 mmHg (2.5 to 16 kPa)	

NBP Overpressure Settings		
Adult	>300 mmHg (40 kPa) >2 sec	not user adjustable
Pediatric	>300 mmHg (40 kPa) >2 sec	
Neonate	>150 mmHg (20 kPa) >2 sec	

Invasive Pressure and Pulse

Complies with:

IEC 60601-2-34:2011
EN 60601-2-34:2014

10.1.

Invasive Pressure Performance Specifications		
Measurement Range		-40 to 360 mmHg (-5 to 48 kPa)
Pulse Rate	Range	25 to 350 bpm
	Accuracy	±1% Full Range
	Resolution	1 bpm
Input Sensitivity		Sensitivity: 5 µV/V/mmHg (37.5 µV/V/kPa) Adjustment range: ±10%
Transducer		Load Impedance: 200 to 2000 Ω (resistive) Output Impedance: ≤3000 Ω (resistive)
Frequency Response		dc to 12 Hz or 40 Hz
Zero Adjustment	Range	±200 mmHg (±26 kPa)
	Accuracy	±1 mmHg (±0.1 kPa)
	Drift	Less than 0.1 mmHg/°C (0.013 kPa/°C)

Invasive Pressure Performance Specifications		
Gain Accuracy	Accuracy	±1%
	Drift	Less than 0.05%/°C
	Non linearity and Hysteresis	Error of ≤0.4 % FS (@CAL 200 mmHg)
Overall Accuracy	(including transducer)	±4% of reading or ±4 mmHg (±0.5 kPa), whichever is greater
Volume displacement of CPJ840J6		0.1 mm^3 /100 mmHg

10.2.

Invasive Pressure Alarm Specifications

Invasive Pressure Alarm Specifications	Range	Adjustment	Delay
Pressure	-40 to 360 mmHg (-5.0 to 48.0 kPa)	-40 to 50 mmHg (-5.0 to 7.0 kPa) 2 mmHg (0.5 kPa) \u000a>50 mmHg (>7.0 kPa) 5 mmHg (1.0 kPa)	max. 12 seconds
Extreme High	Difference to high limit 0 to 25 mmHg (0 to 3.5 kPa)	5 mmHg steps (0.5 kPa)	
	Clamping at -35 to 360 mmHg (-4.0 to 48.0 kPa)	5 mmHg steps (1.0 kPa)	
Extreme Low	Difference to low limit 0 to 25 mmHg (0 to 3.5 kPa)	5 mmHg steps (0.5 kPa)	
	Clamping at -40 to 355 mmHg (-5.0 to 47.0 kPa)	5 mmHg steps (1.0 kPa)	
Pulse	25 to 300 bpm	Adult: 1 bpm steps (25 to 40 bpm) 5 bpm steps (40 to 300 bpm) \u000aPedi/Neo: 1 bpm steps (25 to 50 bpm) 5 bpm steps (50 to 300 bpm)	max. 14 seconds
Tachycardia	Difference to high limit 0 to 50 bpm	5 bpm steps	max. 14 seconds
	Clamping at 150 to 300 bpm	5 bpm steps	
Bradycardia	Difference to low limit 0 to 50 bpm	5 bpm steps	max. 14 seconds
	Clamping at 25 to 100 bpm	5 bpm steps	

Cerebral Perfusion Specifications

CPP Specifications		
CPP	Range	-40 to 360 mmHg (-5 to 48 kPa)

CPP Alarm Specifications	Range	Adjustment
CPP	-30 to 270 mmHg (-4 to 36 kPa)	2 mmHg steps (30 to 50 mmHg) 5 mmHg steps (50 to 270 mmHg) \u000a[0.5 kPa steps (-4.0 to 7.0 kPa) \u000a1.0 kPa steps (7.0 to 36.0 kPa)]

Pulse Pressure Variation Specifications

PPV Specifications		
PPV	Measurement range	0 to 200%
	Physiological range	0 to 25%

Temp

Complies with:

ISO 80601-2-56:2017 + A1:2018

Specified without transducer.

Temp Performance Specifications			
Temp	Range	11.1.	-1 to 45°C (30 to 113°F)
	Resolution		0.1°C (0.1°F)
	Accuracy	11.2.	±0.1°C (±0.2°F)
Average Time Constant			Less than 10 seconds

Temp Alarm Specifications	Range	Adjustment
Temp High/Low Alarms	-1 to 45°C (30 to 113°F)	-1 to 30°C (30 to 86°F), 0.5°C (1.0°F) steps 30 to 45°C (86 to 113°F), 0.1°C (0.2°F) steps

Temperature Difference Specifications

Temp Difference Specifications		
ΔTemp	Range	-46 to 46°C (-83 to 83°F)
	Resolution	0.1°C (0.1°F)

CO2

The CO_2 measurement in the monitor and extensions complies with:

ISO 80601-2-55:2018

Specifications apply to the following devices:

Mainstream CO_2	MX100, X3, M3014A, 867040
Sidestream CO_2	MX100, X3, M3014A, 867040
Microstream CO_2	M3015A/B, 867041

Microstream CO_2 Performance Specifications		
CO2	Range	0 to 150 mmHg (0 to 20 kPa), or 20% CO_2, whichever is lower
	Accuracy	Up to 5 minutes during warmup: ±4 mmHg or 12%, whichever is greater After 5 minutes warmup: 0 to 40 mmHg (0 to 5.3 kPa):±2.2 mmHg (±0.3 kPa) Above 40 mmHg (5.3 kPa):±(5.5% + (0.08%/mmHg above 40 mmHg)) of reading These specifications are valid for 21% O_2 and N_2 balance, up to 35°C ambient temperature, up to 60 rpm in adult mode and 100 rpm in neonatal mode. Outside of these conditions the accuracy reaches at a minimum ±4 mmHg or ±12% of the reading, whichever is greater.
	Resolution	Numeric: 1.0 mmHg (0.1 kPa) Wave: 0.1 mmHg (0.02 kPa)
	Stability	Included in Accuracy specifications
awRR	Range	0 to 150 rpm
	Accuracy	0 to 40 rpm: ±1 rpm 41 to 70 rpm: ±2 rpm 71 to 100 rpm: ±3 rpm >100 rpm: ±5% of reading
IPI	Range	1 to 10
	Resolution	1
Warm-up Time		5 minutes for full accuracy specification
Rise Time		190 ms for neonatal mode (measured with FilterLine H for neonatal) 240 ms for adult mode (measured with FilterLine H for adult)
Sample Flow Rate		50 + 15/-7.5 ml/minute
Gas Sampling Delay Time		Maximum: 3 seconds (2m sample lines) 6 seconds (4m sample lines)
Sound Pressure		Acoustic noise: <45 dBA
Total System Response Time		Less than the sum of the gas sampling delay time and rise time plus 1 second.

Microstream CO_2 Humidity Correction Factor

Either BTPS or ATPD can be selected as the humidity correction factor for the Microstream CO_2 readings. The formula for the correction calculation is:

$$P_{BTPS} = (P_{ATPD} \cdot 0.94)$$

where:

P_{BTPS} = partial pressure at body temperature and pressure, saturated

P_{ATPD} = partial pressure at ambient temperature and pressure, dry

Mainstream CO$_2$ Performance Specifications		
CO2	Range	0 to 150 mmHg (0 to 20.0 kPa)
	Accuracy	after 2 minutes warmup: For values between 0 and 40 mmHg (0 and 5.3 kPa): ±2.0 mmHg (±0.29 kPa) For values from 41 to 70 mmHg (5.4 to 9.3 kPa): ±5% of reading For values from 71 to 100 mmHg (9.4 to 13.3 kPa): ±8% of reading For values from 101 to 150 mmHg (13.4 to 20.0 kPa): ±10% of reading The specifications are valid for standard gas mixtures, balance air, fully hydrated at 35°C, P_{abs} = 760 mmHg, flow rate = 2 l/min.
	Resolution	Numeric: 1.0 mmHg (0.1 kPa) Wave: 0.1 mmHg (0.02 kPa)
	Stability: Short term drift	±0.8 mmHg over four hours
	Stability: Long term drift	Accuracy specification will be maintained over a 120 hour period
awRR	Range	2 to 150 rpm
	Accuracy	±1 rpm
awRR	Range	2 to 150 rpm
	Accuracy	±1 rpm
Warm-up Time		2 minutes with CO$_2$ transducer attached for full accuracy specification
Rise Time		Less than 60 ms (with adult or infant reusable or disposable adapter)
Total System Response Time		Less than the rise time plus 1 second

Sidestream CO$_2$ Performance Specifications		
CO2	Range	0 to 150 mmHg (0 to 20.0 kPa)
	Accuracy	after 2 minutes warmup: For values between 0 and 40 mmHg (0 and 5.3 kPa): ±2.0 mmHg (±0.29 kPa) For values from 41 to 70 mmHg (5.4 to 9.3 kPa): ±5% of reading For values from 71 to 100 mmHg (9.4 to 13.3 kPa): ±8% of reading For values from 101 to 150 mmHg (13.4 to 20.0 kPa): ±10% of reading At respiration rates above 80 rpm, all ranges are ±12% of actual. The specifications are valid for gas mixtures of CO$_2$, balance N$_2$, dry gas at 760 mmHg within specified operating temperature range.
	Resolution	Numeric: 1.0 mmHg (0.1 kPa) Wave: 0.1 mmHg (0.02 kPa)
	Stability: Short term drift	±0.8 mmHg over four hours
	Stability: Long term drift	Accuracy specification will be maintained over a 120 hour period
awRR	Range	2 to 150 rpm
	Accuracy	±1 rpm
Warm-up Time		2 minutes with CO$_2$ sensor attached for full accuracy specification
Sample Flow Rate		50 ±10 ml/minute
Gas Sampling Delay Time		Less than 3 seconds
Rise Time		Less than 240 ms
Total System Response Time		Less than the sum of the gas sampling delay time and rise time plus 1 second

Mainstream and Sidestream CO$_2$ Humidity Correction Factor

Either BTPS or ATPD can be selected as the humidity correction factor for the CO$_2$ readings. The formula for the correction calculation is:

$$P_{ATPD} = P_{BTPS} \cdot \frac{P_{abs}}{P_{abs} - P_{H2O}}$$

Where p = partial pressure, Pabs = absolute pressure, and P$_{H2O}$ = 42 mmHg @35°C and 100% RH.

CO$_2$ Alarm Specifications	Range	Adjustment	Delay (excluding Total System Response Time)
etCO2 High	20 to 95 mmHg (2 to 13 kPa)	1 mmHg (0.1 kPa)	less than 14 seconds
etCO2 Low	10 to 90 mmHg (1 to 12 kPa)		
imCO2 High	2 to 20 mmHg (0.3 to 3.0 kPa)	steps of 1 mmHg (0.1 kPa)	less than 14 seconds
awRR High	Adult/pedi: 10 to 100 rpm Neo: 30 to 150 rpm	under 20 rpm: 1 rpm steps	less than 14 seconds
awRR Low	Adult/pedi: 0 to 95 rpm Neo: 0 to 145 rpm	over 20 rpm:5 rpm steps	settings <20 rpm: less than 4 seconds settings >20 rpm: less than 14 seconds
IPI Low (Microstream CO2 only)	Adult/pedi: 2 to 9	steps of 1	Maximum 14 seconds after displayed value goes below the low alarm limit setting.
Apnea delay	10 to 40 seconds	5 second steps	set apnea delay time + 4 seconds

Interfering Gas and Vapor Effects on CO2 Measurement Values

The specified deviations for mainstream and sidestream CO$_2$ are valid when the appropriate corrections are switched on and set correctly.

Gas or Vapor	Gas Level (% volume fraction)	Mainstream/sidestream CO$_2$	Microstream CO$_2$
Additional deviation due to gas interference, measured at 0 - 40 mmHg CO$_2$			
Nitrous Oxide	60%	±1 mmHg	±5%
Halothane	4%	±1 mmHg	±5%
Enflurane	5%	±1 mmHg	±5%
Isoflurane	5%	±1 mmHg	±5%
Sevoflurane	5%	±1 mmHg	±5%
Xenon	80%	-5 mmHg	±5%
Helium	50%	±1 mmHg	±5%
Metered dose inhaler propellants	-	not specified for use	
Desflurane	15%	+3 mmHg	±5%
Ethanol	0.1	±1 mmHg	±5%
Isopropanol	0.1	±1 mmHg	±5%
Acetone	0.1	±1 mmHg	±5%
Methane	1%	±1 mmHg	±5%

Cardiac Output / Continuous Cardiac Output

Complies with ISO 80601-2-56:2017+A1:2018

C.O./CCO Performance Specifications		
C.O. (right heart)	Range	0.1 to 20.0 l/min
	Accuracy	Instrument Specification (electrical): ±3% or 0.1 l/min System Specification: ±5% or 0.2 l/min
	Repeatability	Instrument Specification (electrical): ±2% or 0.1 l/min System Specification: ±3% or 0.1 l/min
C.O. (transpulmonary)	Range	0.1 to 25.0 l/min
	Accuracy	Instrument Specification (electrical): ±4% or 0.15 l/min System Specification: ±5% or 0.2 l/min
	Repeatability	Instrument Specification (electrical): ±2% or 0.1 l/min System Specification: ±3% or 0.1 l/min
EVLW	Range	10 to 5000 ml
	Standard Deviation	10% or 1 ml/kg
ITBV	Range	50 to 6000 ml
	Accuracy	±10% or 30 ml
	Repeatability	±5% or 20 ml
GEDV: Global End Diastolic Volume	Range	40 to 4800 ml
CFI: Cardiac Function Index	Range	1 to 15
PVPI: Pulmonary Vascular Permeability Index [1]	Range	0 to 9.9
GEF: Global Ejection Fraction [1]	Range	0 to 100%
RLShnt: Right-Left-Shunt Fraction [1]	Range	0 to 100%
CCO	Range	0.1 to 25.0 l/min
	Standard Deviation	10% or 0.3 l/min
	Display Update	2 seconds nominal
CCI: Continuous Cardiac Index	Range	0.1 to 15 l/min/m^2
SV: Stroke Volume	Range	1 to 250 ml
SI: Stroke Volume Index	Range	1 to 125 ml/m^2
SVV: Stroke Volume Variation	Range	0 to 50%
PPV: Pulse Pressure Variation	Range	0 to 50%
dPmax: Left Ventricular Contractility Index [1]	Range	200 to 5000
Blood Temperature	Range	17.0 to 43°C (62.6 to 109,5°F)
Injectate Temperature	Range	-1 to 30°C (30.1 to 86.0°F)

1 Not available in the USA and territories relying on FDA market clearance.

C.O./CCO Alarm Specifications	Range	Adjustment	Delay
TBlood	17 to 43°C (63 to 109°F)	Steps of 0.5°C (17 to 35°C) Steps of 0.1°C (35 to 43°C) Steps of 1°F (63 to 95°F) Steps of 0.2°F (95 to 109°F)	10 seconds after the value exceeds the set limit
CCO	0.1 to 25.0 l/min	Steps of 0.1 l/min (0.1 to 10.0 l/min) Steps of 0.5 l/min (10.0 to 25.0 l/min)	10 seconds after the value exceeds the set limit
CCI	0.1–15 l/min/m^2	Steps of 0.1 l/min/m^2 (0.1 to 7.0 l/min/m^2) Steps of 0.5 l/min/m^2 (7.0 to 15.0 l/min/m^2)	10 seconds after the value exceeds the set limit

Safety and Performance Tests

You must observe any national regulations on the qualification of the testing personnel and suitable measuring and testing facilities. See the maintenance section for a list of required tests. Safety and performance tests, and what to do if the instrument does not meet these specifications, are described in the Service Guide.

Essential Performance Characteristics

This section defines the Essential Performance for MX100 and X3 patient monitors in combination with current generation measurement extensions.

Under normal and single fault conditions and when operating under non-transient electromagnetic phenomena according to IEC 60601-1-2, either at least the performance listed in the following table is provided or failure to provide this performance is readily identifiable by the user. For example, identifiers are technical alarms, no waveforms and/or numeric values, complete failure of the monitor, readily identifiable distorted signals, and so on.

The following are non-transient electromagnetic phenomena according to IEC 60601-1-2:

• Radiated radio frequency (RF) electromagnetic fields

• Conducted disturbances induced by RF fields

• Power frequency magnetic fields

• Voltage dips

• Proximity electromagnetic fields from RF wireless communication equipment

Parameter	Performance
General	No interruption or cessation of current operating mode (for example, no reboot, display OK). No spontaneous operation of controls (for example, no activation of touchscreen without user interaction).
	Visual and audible alarm indications (monitor internal or remote alarm device).
CO_2	Measurement of CO_2 within the following measurement accuracy ranges: ± (0,43% absolute + 8% of reading)
	Measurement of airway respiration rate within specified accuracy/error limits.
	Alarming on apnea, airway respiration rate and CO_2 limit violations.

Parameter	Performance
C.O./C.C.O	Measurement of blood temperature within ±0.3°C.
	Alarming on blood temperature limit violations.
ECG	Measurement of heart rate within ±10% or ±5 bpm, whichever is greater.
	Alarming on Asystole, or heart rate limit violation within specified delay time.
	Detection of VFIB and alarming on it.
	ECG-Out Signal delay ≤35 ms.
Invasive Pressure	Measurement of systolic, diastolic and mean blood pressure within ±4% or ±4 mmHg, whichever is greater, and pulse rate within ±10% or ±5 bpm, whichever is greater.
	Alarming on systolic, diastolic and mean blood pressure limit violations.
Masimo SET	SpO_2 (Functional Oxygen Saturation) Accuracy shall be root-mean-square difference of less than or equal to 2.0% SpO_2 over the range of 70% to 100% SaO_2 without Motion.
	SpO_2 Accuracy shall be root-mean-square difference of less than or equal to 3.0% SpO_2 over the range of 70% to 100% SaO_2 with Motion.
	BPM (pulse rate) Accuracy shall be root-mean-square difference of less than or equal to 3 bpm over the range of 25-240 bpm without Motion.
	Alarming on oxygen saturation and pulse rate limit violation.
Masimo rainbow SET	SpO_2 (Functional Oxygen Saturation) Accuracy shall be root-mean-square difference of less than or equal to 2.0% SpO_2 over the range of 70% to 100% SaO_2 without Motion.
	SpO_2 Accuracy shall be root-mean-square difference of less than or equal to 3.0% SpO_2 over the range of 70% to 100% SaO_2 with Motion.
	SpO_2 Accuracy shall be root-mean-square difference of less than or equal to 3.0% SpO_2 over the range of 60% to 80% SaO_2 with Motion.
	SpCO (carboxyhemoglobin saturation) Accuracy shall be root-mean-square difference of less than or equal to 3.0% SpCO over the range of 0% to 100% without Motion.
	SpMet (methemoglobin saturation) Accuracy shall be root-mean-square difference of less than or equal to 1.0% SpMet over the range of 0% to 100% without Motion.
	SpHb (total hemoglobin) Accuracy shall be root-mean-square difference of less than or equal to 1.0% SpHb over the range of 0-25 g/dl without Motion.
	RPM (respiratory rate) Accuracy shall be root-mean-square difference of less than or equal to 1 rpm over the range of 0-70 rpm without Motion.
	BPM (pulse rate) Accuracy shall be root-mean-square difference of less than or equal to 3 bpm over the range of 25-240 bpm without Motion.
	Alarming on limit violation of the respective parameters.

Parameter	Performance
NBP	Measurement of systolic, diastolic and mean blood pressure and pulse rate within specified accuracy/error limits.
	Automatic cycling.
	Alarming on systolic, diastolic and mean blood pressure limit violations.
Respiration	Measurement of respiration rate within specified accuracy/error limits.
	Alarming on apnea and on respiration rate limit violation.
SpO_2	Measurement of oxygen saturation within $4\%_{RMS}$ over the range from 70 to 100% and pulse rate within $\pm 10\%$ or ± 5 bpm, whichever is greater.
	Alarming on oxygen saturation and pulse rate limit violation.
Temperature	Measurement of temperature within $\pm 0.3°C$.
	Alarming on temperature limit violation.

When operating under transient electromagnetic phenomena according to IEC 60601-1-2, either at least the performance listed in the following table is provided or failure to provide this performance is readily identifiable by the user. For example, identifiers are technical alarms, no waveforms and/or numeric values, complete failure of the monitor, readily identifiable distorted signals, and so on.

The following are transient electromagnetic phenomena according to IEC 60601-1-2:

- Electrostatic Discharge (ESD)
- Electrical Fast Transients/Bursts
- Surges
- Voltage interruptions
- Electrosurgery
- Defibrillation

Parameter	Performance
All	After electrostatic discharge, fast transients/bursts, surges, electro surgery interference and defibrillation the equipment returns to previous operation mode within 30 seconds without operator intervention and without loss of any stored data.
	After voltage interruptions, the equipment returns to previous operating mode without operator intervention and without loss of any stored data.

NOTE

Some standards of the IEC 60601 family (for example IEC 60601-2-49, IEC 60601-2-27, and so on) may specify additional essential performance or shorter recovery times for defibrillation.

Electromagnetic Compatibility (EMC) Specifications

Take special precautions regarding electromagnetic compatibility (EMC) when using medical electrical equipment. You must operate your monitoring equipment according to the EMC information provided in this book.

WARNING

Do not expose the equipment to X-ray or strong magnetic fields (MRI).

The monitor should not be used next to or stacked with other equipment. If you must stack the monitor, check that normal operation is possible in the necessary configuration before you start monitoring patients.

Radio frequency interference: Portable and mobile radio frequency (RF) communications equipment (for example cell phones and wireless LAN) including their antennas can affect the monitor, potentially leading to safety risks. Do not use portable radio frequency (RF) communications equipment closer than 30 cm (12 in) to the monitor and the specified accessories.

This monitor generates, uses and radiates radio frequency energy, and if it is not installed and used in accordance with its accompanying documentation, may cause interference to radio communications.

The monitor, equipped with a wireless network interface, intentionally receives RF electromagnetic energy for the purpose of its operation. Therefore, other equipment may cause interference, even if that other equipment complies with CISPR emission requirements.

Electromagnetic compatibility: Using accessories other than those specified may result in increased electromagnetic emission or decreased electromagnetic immunity of the monitoring equipment.

Based on their emission characteristics, MX100 and X3 patient monitors, when used in combination with the M2741A LoFlo CO_2 Sensor or the M8023A Power Supply, are suitable for use in hospitals only (CISPR 11 class A). If one of these combinations is used in a residential environment (for which CISPR 11 class B is usually required), they might not offer adequate protection to radio frequency communication services. You might need to take mitigation measures, such as relocating or reorienting the equipment.

Restart time

After a power interruption, an ECG wave will be shown on the display after 30 seconds maximum. If an X3 is connected to a host monitor, it can take up to a maximum of 45 seconds until the ECG wave is shown.

Default Settings Appendix

This appendix documents the most important default settings of your monitor as it is delivered from the factory. For a comprehensive list and explanation of default settings, see the Configuration Guide supplied with your monitor. The monitor's default settings can be permanently changed in Configuration Mode.

NOTE

If your monitor has been ordered pre-configured to your requirements, the settings at delivery will be different from those listed here.

Alarm and Measurement Default Settings

The default wave speed for all measurements except Respiration is 25 mm/sec. For Respiration the default wave speed is 6.25 mm/sec.

In the following tables, settings may be entered only once per table row if they are the same for all patient categories.

There are two standard Adult profiles, A and B. Some measurements have different default settings for the two profiles. This mainly affects alarm limits and some alarm settings. Profile A then uses the established defaults from the IntelliVue monitor family and profile B uses wider default settings more tolerant of differences in patient status.

Alarm Default Settings

Alarm Settings	Factory Defaults
Alarm Volume	5
Alarms Off	2 min
Auto Alarms Off	Disabled
AlarmOffReminder	Off
Visual Latching	Red&Yellow
Audible Latching	Red&Yellow
Alarm Reminder	On
Reminder Time	3 min
Alarm Sounds	Traditional
Alarm Low	4
Red Alarm Volume	AlarmVol. +2
Yell.AlarmVolume	AlarmVol. +0
INOP Volume	AlarmVol. +0
AutoIncrease Vol	2 Steps
IncreaseVolDelay	20 sec
Keep Blinking	Yes
Relay1 Sensitiv.	R&Y&C
Relay2 Sensitiv.	Red&Yellow

Alarm Settings	Factory Defaults
Relay3 Sensitiv.	**Red**
CyanRelayLatency	5 sec
Yel.RelayLatency	2 sec
Alarm Text	**Standard**
NoCentrMonMinVol	4
Numeric Blinking	**Enhanced**

ECG, Arrhythmia, ST and QT Default Settings

ECG Settings	Factory Defaults		
	Adult A/B	Pedi	Neo
High Limit	120 bpm/140 bpm	160 bpm	200 bpm
Low Limit	50 bpm	75 bpm	100 bpm
ECG/Arrhy Alarms	On	On	On
Alarm Source	Auto	Auto	Auto
ECG	On	On	On
QRS Volume	1	1	1
Primary Lead	II	II	II
Secondary Lead	V	V	V
Analysis Mode	Multi Lead	Multi Lead	Multi Lead
Lead Placement	Standard	Standard	Standard
Filter	Monitor	Monitor	Monitor
AutoFilter	Off	Off	Off
Adjust Size	Size x1	Size x1	Size x1
Color	Green	Green	Green
Asystole Thresh.	4.0 sec	4.0 sec	3.0 sec
Δ ExtrTachy	20 bpm	20 bpm	20 bpm
Tachy Clamp	200 bpm	220 bpm	240 bpm
Δ ExtrBrady	20 bpm	20 bpm	20 bpm
Brady Clamp	40 bpm	40 bpm	50 bpm
ECG Alm Off INOP	Cyan	Cyan	Cyan
Fallback	On	On	On
Alarms Off	Enabled	Enabled	Enabled
AlarmSource Sel.	Enabled	Enabled	Enabled
Va Lead	V2	V2	V2
Vb Lead	V5	V5	V5
SyncPulse Sensit	Medium	Medium	Medium
SyncPulse Marker	On	On	On
PulseAlarms Tele	Enabled	Enabled	Enabled

Arrhythmia Default Settings

Arrhythmia Settings	Factory Defaults		
	Adult A/B	Pedi	Neo
Arrhythmia	On	On	Off
Pause Threshold	2.0 sec	2.0 sec	1.5 sec
VTach HR	100	120	150
VTach Run	5	5	5
Vent Rhythm	14	14	14
SVT HR	180	200	210
SVT Run	5	5	5
PVCs/min	10	5	5
Non–Sustain	On	On	On
Vent Rhythm	On	On	On
Run PVCs	On	On	On
Pair PVCs	On/Off	On	On
R–on–T PVCs	On/Off	On	On
V.Bigeminy	On/Off	On	On
V.Trigeminy	On/Off	On	On
PVCs/min	On/Off	On	On
Multif.PVCs	On/Off	On	On
Pacer n.Cap	On	On	On
Pacer n.Pac	On	On	On
Pause	On	On	On
Missed Beat	On	On	On
SVT	On	On	On
Afib	On	On	On
Irregular HR	On/Off	On	On
HR Alarms	Short Yellow	Short Yellow	Short Yellow
TimeOut 1st	3 min	3 min	3 min
TimeOut 2nd	10 min	10 min	10 min
Cardiotach Msg	Yes	Yes	Yes
Some ECG Al INOP	On	On	On

ST and QT Default Settings

Lead-independent ST Settings	Factory Defaults		
	Adult	Pedi	Neo
ST Alarm Mode	Single ST	Single ST	Single ST
Alarms	On	On	On
ST Analysis	On	Off	Off
ST–Index	Off	Off	Off
ISO Point	-80 ms	-68 ms	-56 ms
J Point	48 ms	20 ms	0 ms
ST Offset	J+60	J+60	J+60

Lead I, II, III, V, aVR, aVL, V1-6, MCL Settings	Factory Defaults		
	Adult	**Pedi**	**Neo**
ST Analysis	**On**	**Off**	**Off**
For Alarm Mode = Single ST			
ST (Label) High	+2.0 mm	+2.0 mm	+2.0 mm
ST (Label) Low	-2.0 mm	-2.0 mm	-2.0 mm
For Alarm Mode = Multi ST			
ST (Label) High	+1.0 mm	+1.0 mm	+1.0 mm
ST (Label) Low	+1.0 mm	+1.0 mm	+1.0 mm

QT Settings	Factory Defaults		
	Adult	**Pedi**	**Neo**
QT Lead	**All**	**All**	**All**
QTc High Limit	500 ms	480 ms	460 ms
ΔQTc High Limit	60 ms	60 ms	60 ms
QTc High Alarm	**On**	**On**	**On**
ΔQTc High Alarm	**On**	**On**	**On**
QT Analysis	**Off**	**Off**	**Off**
QTc Formula	**Bazett**	**Bazett**	**Bazett**

Pulse Default Settings

Pulse Settings	Factory Defaults		
	Adult	**Pedi**	**Neo**
Alarm Source	**Auto**	**Auto**	**Auto**
Pulse (source label)	**On**	**On**	**On**
System Pulse	SpO_2	SpO_2	SpO_2
Alarms Off	**Enabled**	**Enabled**	**Enabled**
AlarmSource Sel.	**Enabled**	**Enabled**	**Enabled**

Pulse Alarm Settings	Factory Defaults		
	Adult A/B	**Pedi**	**Neo**
Pulse (SpO_2)	**On**	**On**	**On**
Pulse Alarms	**Off**	**Off**	**Off**
High Limit	120/140 bpm	160 bpm	200 bpm
Low Limit	50 bpm	75 bpm	100 bpm
Δ ExtrBrady	20 bpm	20 bpm	20 bpm
Brady Clamp	40 bpm	40 bpm	50 bpm
Δ ExtrTachy	20 bpm	20 bpm	20 bpm
Tachy Clamp	200 bpm	220 bpm	240 bpm

Pulse alarms use the settings of the currently selected Pulse alarm source.

Respiration Default Settings

Respiration Settings	Factory Defaults		
	Adult A/B	Pedi	Neo
High Limit	30 rpm	30 rpm	100 rpm
Low Limit	8 rpm/5 rpm	8 rpm	30 rpm
Apnea Time	20 sec	20 sec	20 sec
Alarms	On	On	On
Resp	On	On	On
Detection	Auto (Trigger Mode)	Auto (Trigger Mode)	Auto (Trigger Mode)
Color	Yellow	Yellow	Yellow

SpO2 Default Settings

SpO$_2$ Settings	Factory Defaults		
	Adult A/B	Pedi	Neo
Mode	Continuous	Continuous	Continuous
Repeat Time	15 min	15 min	15 min
Alarms	On	On	On
QRS Volume	1	1	1
Tone Modulation	Yes	Yes	Yes
Tone Mod. Type	Enhanced	Enhanced	Enhanced
Perfusion	On	On	On
Average	10 sec	10 sec	10 sec
NBP Alarm Suppr.	On	On	On
Extd. Auto OnOff	Disabled	Disabled	Disabled
Color	Cyan (light blue)	Cyan (light blue)	Cyan (light blue)
Average in Mon.	No	No	No
Signal Quality	On	On	On

SpO$_2$ Alarm Default Settings			
Setting	Adult A/B	Pedi	Neo
Desat Limit	80	80	80
Low Limit	90	90	85
High Limit	100	100	95
Desat Delay	20 sec	20 sec	20 sec
High Alarm Delay	10 sec	10 sec	10 sec
Low Alarm Delay	10 sec	10 sec	10 sec
SmartAlarmDelay (SAD)	Off/On	Off	Off
High Alarm Delay (SAD)	Short/Long	Short	Short
Low Alarm Delay (SAD)	Short/Long	Short	Short
Label	SpO₂	SpO₂	SpO₂
Pulse settings			

SpO$_2$ Alarm Default Settings			
Setting	Adult A/B	Pedi	Neo
Pulse (SpO₂)	On	On	On
For all other Pulse default settings, refer to the Pulse Default Settings table.			

Masimo rainbow SET Default Settings

SpO2

Setting	Adult A/B	Pedi	Neo
Desat Limit	80	80	80
Low Limit	90	90	85
High Limit	100	100	95
Desat Delay	20 sec	20 sec	20 sec
High Alarm Delay	10 sec	10 sec	10 sec
Low Alarm Delay	10 sec	10 sec	10 sec
Average*	8 sec	8 sec	8 sec
NBP Alarm Suppr.*	On	On	On
SpO₂ Alarms	On	On	On
Perfusion	On	On	On
Color	Cyan	Cyan	Cyan
Extd. Auto OnOff	Disabled	Disabled	Disabled
Average in Mon.	No	No	No
Signal Quality (Also available with Masimo rainbow SET)	On	On	On
Mode*	Continuous	Continuous	Continuous
Repeat Time*	15 min	15 min	15 min
SmartAlarmDelay (SAD) (If set to On, the High/Low Alarm Limit Delay (SAD) settings are valid; if set to Off, the Standard SpO$_2$ High/Low Alarm limit delay setting (0-30 sec) is valid)	Off/On	Off	Off
High Alarm Delay (SAD)	Short/Long	Short	Short
Low Alarm Delay (SAD)	Short/Long	Short	Short
Aging Time*	10 min	10 min	10 min

*Not supported with Masimo rainbow SET technology

SpO2 rainbow

Setting	Adult	Pedi	Neo
Average Average Time (rainbow)	8 sec	8 sec	8 sec
Sensitivity Algorithm Sensitivity	APOD	APOD	APOD

Setting	Adult	Pedi	Neo
FastSat Algor. FastSat Algorithm	Off	Off	Off
Smart Tone	Off	Off	Off
3D Desat Index	Off	Off	Off
Delta Threshold 3D Desat Index Threshold	4%	4%	4%
Count 3D Desat Index Count	5	5	5
Period 3D Desat Index Period	1 hr	1 hr	1 hr

Pulse

Setting*	Adult A/B	Pedi	Neo
Pulse (SpO₂)	On	On	On
Pulse Alarms	Off	Off	Off
High Limit	120/140 bpm	160 bpm	200 bpm
Low Limit	50 bpm	75 bpm	100 bpm
Δ ExtrBrady	20 bpm	20 bpm	20 bpm
Brady Clamp	40 bpm	40 bpm	50 bpm
Δ ExtrTachy	20 bpm	20 bpm	20 bpm
Tachy Clamp	200 bpm	220 bpm	240 bpm

*(The presentation may depend on whether SpO_2 is selected as the HR/PULSE source or not)

Perf rainbow

Setting	Adult	Pedi	Neo
High Limit	20.00	20.00	10.00
Low Limit	0.30	0.30	0.30
Alarms Perf alarms	Off	Off	Off
Delta % Decrease 3D Perf Delta threshold	50%	50%	50%
Duration 3D Perf Delta alarm active time	Infinite	Infinite	Infinite

PVI

Setting	Adult	Pedi	Neo
High Limit	40	40	40
Low Limit	5	5	5
Alarms PVI alarms	Off	Off	Off
PVI	On	On	On

NOTE

The PVI numeric has the same color that is configured for the SpO_2 numeric.

SpMet

Setting	Adult	Pedi	Neo
High Limit	3.0%	3.0%	3.0%
Low Limit	0.0%	0.0%	0.0%
Alarms SpMet alarms	**On**	**On**	**On**
SpMet	**Enabled**	**Enabled**	**Enabled**
Color	**Yellow**	**Yellow**	**Yellow**

SpCO

Setting	Adult	Pedi	Neo
High Limit	10%	10%	10%
Low Limit	0%	0%	0%
Alarms SpCO alarms	**On**	**On**	**On**
SpCO	**Enabled**	**Enabled**	**Enabled**
Color	**Orange**	**Orange**	**Orange**

SpHb/SpOC

Setting	Adult	Pedi	Neo
SpHb	**Enabled**	**Enabled**	**Enabled**
SpHb High Limit	17.0 g/dl	17.0 g/dl	17.0 g/dl
SpHb Low Limit	7.0 g/dl	7.0 g/dl	7.0 g/dl
SpHb Alarms	**On**	**On**	**On**
SpHb Unit	**g/dl**	**g/dl**	**g/dl**
Average	**Medium**	**Medium**	**Medium**
SpHb Precision	0.1	0.1	0.1
SpHb Cal	**Arterial**	**Arterial**	**Arterial**
SpHb Color	**Red**	**Red**	**Red**
SpOC	**On**	**On**	**On**
SpOC High Limit	25 ml/dl	25 ml/dl	25 ml/dl
SpOC Low Limit	10 ml/dl	10 ml/dl	10 ml/dl
SpOC Alarms	**Off**	**Off**	**Off**
SpOC Color	**Magenta**	**Magenta**	**Magenta**

RRac

Setting	Adult A/B	Pedi	Neo
High Limit	30 rpm	30 rpm	60 rpm
Low Limit	8 rpm/5 rpm	8 rpm	30 rpm
Alarms	**On**	**On**	**On**
Alarm Delay	30 sec	15 sec	15 sec
Average	**Slow**	**Slow**	**Slow**
Pause Time	30 sec	30 sec	30 sec

Setting	Adult A/B	Pedi	Neo
Max.Extd. Update	0 min	0 min	0 min
Color	White	White	White

NBP Default Settings

NBP Settings	Factory Defaults		
	Adult A/B	Pedi	Neo
Mode	Auto	Auto	Manual
Alarms from	Sys.	Sys.	Sys.
High Limit	160/90 (110) / 180/100 (130)	120/70 (90)	90/60 (70)
Low Limit	90/50 (60) / 100/40 (60)	70/40 (50)	40/20 (24)
Alarms	On	On	On
NBP	On	On	On
Repeat Time	10 min	10 min	10 min
Pulse (NBP)	On	On	On
Unit	mmHg	mmHg	mmHg
Done Tone	Off	Off	Off
Start Time	Synchronized	Synchronized	Synchronized
VP Pressure	60 mmHg	40 mmHg	30 mmHg
Reference	Auscultatory	Auscultatory	Invasive
Color	Red	Red	Red

Temperature Default Settings

Temp Settings	Factory Defaults		
	Adult	Pedi	Neo
Low Limit	36	36	36
High Limit	39	39	39
Alarms	On	On	On
Unit	°C	°C	°C
Range	35...43	35...43	35...43
Color	Green	Green	Green

ΔTemp Settings	Factory Defaults		
	Adult	Pedi	Neo
First Temp	Trect	Trect	Trect
Second Temp	Tblood	Tblood	Tblood
ΔTemp	Off	Off	Off
Measurement	Enabled	Enabled	Enabled
Color	Green	Green	Green

Invasive Pressure Default Settings

P, ABP, ART, Ao, UAP, FAP, RFP, LFP, BAP, Ppr, Ppo, Pa1, Pa2, Pa3, Pa4, P1, P2, P3, P4

P, ABP, ART, Ao, UAP, FAP, RFP, LFP, BAP, Ppr, Ppo, Pa1, Pa2, Pa3, Pa4, P1, P2, P3, P4 Settings	Factory Defaults		
	Adult A/B	Pedi	Neo
Alarms from	Sys.	Sys.	Sys.
High Limit	160/90 (110) / 180/100 (130)	120/70 (90)	90/60 (70)
Low Limit	90/50 (70) / 80/40 (60)	70/40 (50)	55/20 (36)
Alarms	On	On	On
Extreme Alarms	Disabled	Disabled	Disabled
Δ Extreme High	15	10	5
Δ Extreme Low	15	10	5
Sys. High Clamp	190/100 (125)	140/80 (100)	105/75 (75)
Sys. Low Clamp	80/45 (65)	60/35 (45)	45/15 (30)
Scale	150	100	100
Mean only	No	No	No
Filter	12 Hz	12 Hz	12 Hz
Calibration	No	No	No
Artifact Suppr.	60 sec	60 sec	60 sec
Unit	mmHg	mmHg	mmHg
Color	Red	Red	Red

CVP, RAP, LAP, UVP, Pv1, Pv2, Pv3, Pv4

CVP, RAP, LAP, UVP, Pv1, Pv2, Pv3, Pv4 Settings	Factory Defaults		
	Adult	Pedi	Neo
Alarms from	Mean	Mean	Mean
High Limit	14/6 (10)	10/2 (4)	10/2 (4)
Low Limit	6/-4 (0)	2/-4 (0)	2/-4 (0)
Alarms	On	On	On
Extreme Alarms	Disabled	Disabled	Disabled
Δ Extreme High	5	5	5
Δ Extreme Low	5	5	5
Mean High Clamp	20/10 (15)	15/5 (10)	15/5 (10)
Mean Low Clamp	0/-5 (-5)	0/-5 (-5)	0/-5 (-5)
Scale	30	30	30
Mean only	Yes	Yes	Yes
Filter	12 Hz	12 Hz	12 Hz
Calibration	No	No	No
Artifact Suppr.	60 sec	60 sec	60 sec

CVP, RAP, LAP, UVP, Pv1, Pv2, Pv3, Pv4 Settings	Factory Defaults		
	Adult	Pedi	Neo
Unit	mmHg	mmHg	mmHg
Color	**Cyan** (light blue)	**Cyan** (light blue)	**Cyan** (light blue)

PAP

PAP Settings	Factory Defaults		
	Adult	Pedi	Neo
Alarms from	Dia.	Dia.	Dia.
High Limit	34/16 (20)	60/4 (26)	60/4 (26)
Low Limit	10/0 (0)	24/-4 (12)	24/-4 (12)
Alarms	On	On	On
Extreme Alarms	Enabled	Enabled	Enabled
Δ Extreme High	5	5	5
Δ Extreme Low	5	5	5
Dia. High Clamp	45/20 (25)	65/5 (35)	65/5 (35)
Dia. Low Clamp	5/-5 (-5)	15/-5 (5)	15/-5 (5)
Scale	30	30	30
Mean only	No	No	No
Filter	12 Hz	12 Hz	12 Hz
Calibration	No	No	No
Artifact Suppr.	60 sec	60 sec	60 sec
Unit	mmHg	mmHg	mmHg
Color	Yellow	Yellow	Yellow

ICP, IC1, IC2, SCP

ICP, IC1, IC2, SCP Settings	Factory Defaults		
	Adult	Pedi	Neo
Alarms from	Mean	Mean	Mean
High Limit	14/6 (10)	10/2 (4)	10/2 (4)
Low Limit	6/-4 (0)	2/-4 (0)	2/-4 (0)
Alarms	On	On	On
Extreme Alarms	Disabled	Disabled	Disabled
Δ Extreme High	10	10	10
Δ Extreme Low	10	10	10
Mean Low Clamp	20/10 (-5)	15/5 (-5)	15/5 (-5)
Mean High Clamp	0/-5 (0)	0/-5 (0)	0/-5 (0)
Scale	30	30	30
Mean only	Yes	Yes	Yes
Filter	12 Hz	12 Hz	12 Hz
Calibration	No	No	No
Artifact Suppr.	60 sec	60 sec	60 sec

ICP, IC1, IC2, SCP Settings	Factory Defaults		
	Adult	Pedi	Neo
Unit	mmHg	mmHg	mmHg
Color	Magenta	Magenta	Magenta

IAP/UAP

IAP, UBP Settings	Factory Defaults		
	Adult	Pedi	Neo
Alarms from	Mean	Mean	Mean
Mean High	12	10	10
Mean Low	0	0	0
Alarms	On	On	On
Extreme Alarms	Disabled	Disabled	Disabled
Δ Extreme High	10	5	5
Δ Extreme Low	5	5	5
Mean High Clamp	25	20	20
Mean Low Clamp	0	0	0
Scale	30	30	30
Mean only	Yes	Yes	Yes
Filter	12 Hz	12 Hz	12 Hz
Calibration	No	No	No
Artifact Suppr.	60 sec	60 sec	60 sec
Unit	mmHg	mmHg	mmHg
Color	Magenta	Magenta	Magenta

CPP

CPP Settings	Factory Defaults		
	Adult	Pedi	Neo
High Limit	130	100	90
Low Limit	50	40	30
Alarms	On	On	On
CPP	Off	Off	Off
Measurement	Enabled	Enabled	Enabled
Arterial Source	ABPm	ABPm	ABPm
Scale	105 mmHg	105 mmHg	105 mmHg
Color	Magenta	Magenta	Magenta

PPV

PPV Settings	Factory Defaults		
	Adult	Pedi	Neo
Arterial Source	ABP	ABP	ABP
PPV	Off	Off	Off
Measurement	Disabled	Disabled	Disabled

Pulse

Pulse settings for all arterial pressures except P1 to P4	Factory Defaults		
	Adult	Pedi	Neo
Pulse (<Press Label>)	On	On	On
For all other Pulse default settings, refer to the Pulse Default Settings table.			

Cardiac Output Default Settings

C.O. Settings	Factory Defaults		
	Adult	Pedi	Neo
Auto-Calibration	On	On	On
Tblood HighLimit	39.0°C	39.0°C	39.0°C
Tblood Low Limit	36.0°C	36.0°C	36.0°C
Tblood Alarms	On	On	On
Temperature Unit	°C	°C	°C
Color	Green	Green	Green

CCO/CCI Settings	Factory Defaults		
	Adult	Pedi	Neo
Settings common to CCO and CCI			
Alarms from	CCO	CCO	CCO
CCO from	ABP	ABP	ABP
Color	Green	Green	Green
CCO			
Alarms	On	On	On
CCO High Limit	8.5 l/min	3.7 l/min	1.3 l/min
CCO Low Limit	4.0 l/min	2.6 l/min	0.3 l/min
CCI			
Alarms	On	On	On
CCI High Limit	4.3 l/min/m2	4.3 l/min/m2	5.2 l/min/m2
CCI Low Limit	2.0 l/min/m2	2.6 l/min/m2	1.2 l/min/m2

CO2 Default Settings

CO$_2$ Settings	Factory Defaults		
	Adult A/B	Pedi	Neo
etCO$_2$ Low	25	25	25
etCO$_2$ High	60/70	60	60
imCO$_2$ High	4	4	4
CO$_2$ Alarms	On	On	On
Unit	mmHg	mmHg	mmHg
Scale	50 mmHg	50 mmHg	50 mmHg
imCO$_2$	On	On	On
N$_2$O Corr. (only Microstream CO$_2$)	Off	Off	Off
Oxygen Corr. (only mainstream/sidestream CO$_2$)	20%	20%	20%
Gas Corr. (only mainstream/sidestream CO$_2$)	Off	Off	Off
Humidity Corr.	BTPS	BTPS	BTPS
Max Hold	20 s	20 s	20 s
awRR	On	On	On
awRR Alarms	On	On	On
High Limit (awRR)	30 rpm	30	100
Low Limit (awRR)	8 rpm/5 rpm	8	30
Apnea Time	20 sec	20 sec	20 sec
Color	Yellow	Yellow	Yellow

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