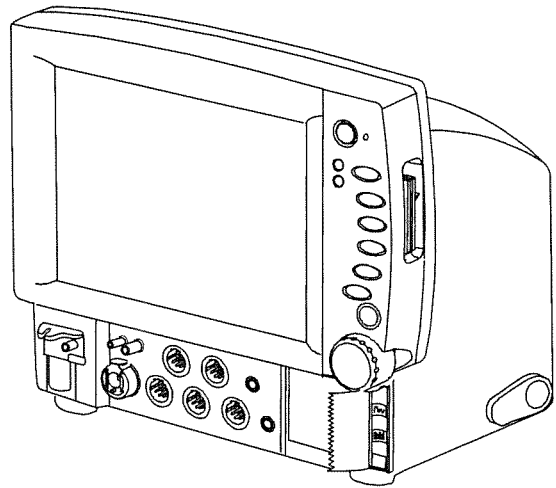# Datex-Ohmeda Cardiocap™/5
for Anesthesia
Software S-XANE01

User's Reference Manual

$C\epsilon$

Conformity according to the Council Directive 93/42/EEC concerning Medical devices

CAUTION: U.S. Federal law restricts this device to sale by or on the order of a licensed medical practitioner.
Outside the USA, check local laws for any restriction that may apply.
All specifications subject to change without notice.
Document Number M1031868-02
November 2004

NOTICE

Intended use

The Datex-Ohmeda Cardiocap^{TM}/5 and accessories are indicated for indoor monitoring of hemodynamic (ECG, impedance respiration, NIBP, temperature, SpO$_2$, and invasive pressure), respiratory (CO$_2$, O$_2$, N$_2$O, respiration rate, anesthetic agent, and agent identification), ventilatory (airway pressure, volume, and flow), and relaxation status (NMT) of all hospital patients.

With the N-XOSAT option, monitoring of arterial oxygen saturation includes monitoring hospital patients during conditions of clinical patient motion.

The Cardiocap/5 is indicated for patients weighing 5 kg (11 lb.) or more.

Impedance respiration measurement is indicated for patients ages 3 years and older.

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

CAUTION: US Federal law restricts this device to sale by or on the order of a licensed medical practitioner. Outside the USA, check local laws for any restrictions that may apply.

Classifications

IEC 60601-1:

- Type of protection against electric shock: Class I equipment.
- Degree of protection against electric shock (indicated by a symbol on the monitor beside each connector): Type BF applied part or Type CF applied part.
- The equipment is not suitable for use in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide.
- Mode of operation: Continuous.

IEC 60529 (degree of protection against harmful ingress of water): IPX1

EU Medical Device Directive: IIb

CISPR 11: Group 1, class A

Responsibility of the manufacturer

Datex-Ohmeda Division, Instrumentarium Corp. is responsible for the safety, reliability and performance of the equipment only if:

- Assembly, operation, extensions, readjustments, modifications, service, and repairs are carried out by personnel authorized by Datex-Ohmeda.
- Electrical installation complies with appropriate requirements.
- The equipment is used in accordance with the Cardiocap/5 User's Guide and serviced and maintained in accordance with the Cardiocap/5 Technical Reference Manual.

Trademarks

Datex®, Ohmeda®, and other trademarks (Cardiocap/5, AS/3, CS/3, S/5, S/5 Light, D-lite, Pedi-lite, D-fend, D-fend+, MemCard, ComWheel, EarSat, FlexSat, OxyTip, PatientO$_2$, and Patient Spirometry) are the property of Instrumentarium Corp. or its subsidiaries.

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Cardiocap/5 User's Reference Manual—Anesthesia

Part I – Setup and General Use

Part II – Measurement Parameters

Chapter 1. Monitor Description

Table of Figures

1. MONITOR DESCRIPTION

Introduction

This *User's Reference Manual* contains detailed information about the features of the Datex-Ohmeda Cardiocap/5 monitor with Anesthesia software (S-XANE) installed.

Additional information

The Datex-Ohmeda Cardiocap/5 *User's Guide for Anesthesia* ships with the monitor. It contains basic information for using the Cardiocap/5.

The Datex-Ohmeda Cardiocap/5 *Technical Reference Manual* describes installation, maintenance, service, and repair procedures to be performed by authorized service personnel only.

For information about other devices closely related to the Cardiocap/5, see the Datex-Ohmeda S/5 *Network and Central, User's Reference Manual*

Licensed accessories are listed in the Datex-Ohmeda *Supplies and Accessories Catalog.*

Clinical application

This manual contains specific information about clinical and technical aspects of the Cardiocap/5. In addition, Datex-Ohmeda produces application guides that contain detailed information about clinical applications, such as patient spirometry, CO_2 monitoring, ST segment analysis, impedance respiration, etc.

Configuration

This manual describes most configurable features of the Datex-Ohmeda Cardiocap/5. Due to the possibility of different factory configurations, some menus, displays, and functions described in this manual may not be available in the monitor you are using.

When your monitor was delivered, it was configured with the default settings and ready to use. Instructions for changing settings to make your own permanent configuration are located within the appropriate chapters in this manual.

Configuration passwords

Some features can be configured only from the Install/Service menu. A password is required to access the Install/Service options. The default password is 16–4–34.

To enter the Install/Service menu:

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.

2. Select **Install/Service**.

3. Turn the ComWheel until the first number (16) appears in the adjustment window, then press the ComWheel to select the number. Select the other password numbers (4, then 34) in the same way. When you finish, the Install/Service menu opens.

Most modifications are temporary unless you save them in the Save Modes menu, a password-protected submenu of the Install/Service menu. The default password for entering the Save Modes menu is 13–20–31.

Cardiocap/5 model and options for Anesthesia software

The Cardiocap/5 F-MXG model is used for Anesthesia software. The F-MXG is a hemodynamic model with airway gas measurement that can be equipped with built-in options.

- All measurement parameter options (and the Recorder option, N-XREC) are factory-configured and cannot be added after purchase.
- Data collection and management options (N-XNET and N-XDNET) can be added later.

Hemodynamic model with airway gas measurement (F-MXG)

The F-MXG model with Anesthesia software installed measures NIBP, ECG (3-lead and 5-lead), pulse oximetry (SpO$_2$), temperature (T1), impedance respiration, and airway gases. Gas measurement depends on which airway gas option is installed (N-XC, N-XCO, or N-XCAiO):

N-XC	Carbon Dioxide (CO$_2$)
N-XCO	CO$_2$, N$_2$O, and Patient Oxygen (O$_2$)
N-XCAiO	CO$_2$, anesthetic agents, agent identification, N$_2$O, and O$_2$

The F-MXG can also be equipped with each of these built-in options:

N-XP	Two invasive pressure channels and second temperature (T2)
N-XV	Patient Spirometry (N-XCO or N-XCAiO option required)
N-XREC	Recorder

In addition, the F-MXG can be equipped with **one** of the following built-in options:

N-XOSAT	Datex-Ohmeda enhanced pulse oximetry (SpO$_2$)
N-XNSAT	Nellcor® compatible pulse oximetry (SpO$_2$)
N-XNMT	NeuroMuscular Transmission (NMT) for relaxation measurement and plexus stimulation (N-XCAiO option required)

Data collection and management options

These options can be factory-built or added later as upgrades:

N-XNET	Network
N-XDNET	Data card and Network

Order codes

Items and corresponding order codes are given in the table below:

Abbreviation	Description	Order code
F-MX	Cardiocap/5 Hemodynamic Frame	6050-0005-614
F-MXG	Cardiocap/5 Hemodynamic Frame with gas measurement	6050-0005-617
S-XANE01	Cardiocap/5 Anesthesia Software	6050-0005-615
N-XC	Airway Gas Option (CO_2)	6050-0005-611
N-XCO	Airway Gas Option (CO_2, O_2 and N_2O)	6050-0005-612
N-XCAIO	Airway Gas Option (CO_2, O_2, N_2O and anesthesia agents with automatic identification)	6050-0005-613
N-XV	Patient Spirometry Option	6050-0005-620
N-XP	Invasive Pressure Option with second temperature channel	6050-0005-940 or 6050-0005-939
N-XREC	Recorder Option	6050-0005-941
N-XNET	Network Option	6050-0005-622
N-XDNET	DataCard and Network Option	6050-0005-700, 6050-0005-735 or 6050-0005-736
N-XNMT	NeuroMuscular Transmission (NMT) Option	6050-0005-914
N-NSAT	Nellcor Compatible SpO_2 Option	6050-0005-916
N-XOSAT	Enhanced Datex-Ohmeda SpO_2	6050-0005-917

Parts of the monitor
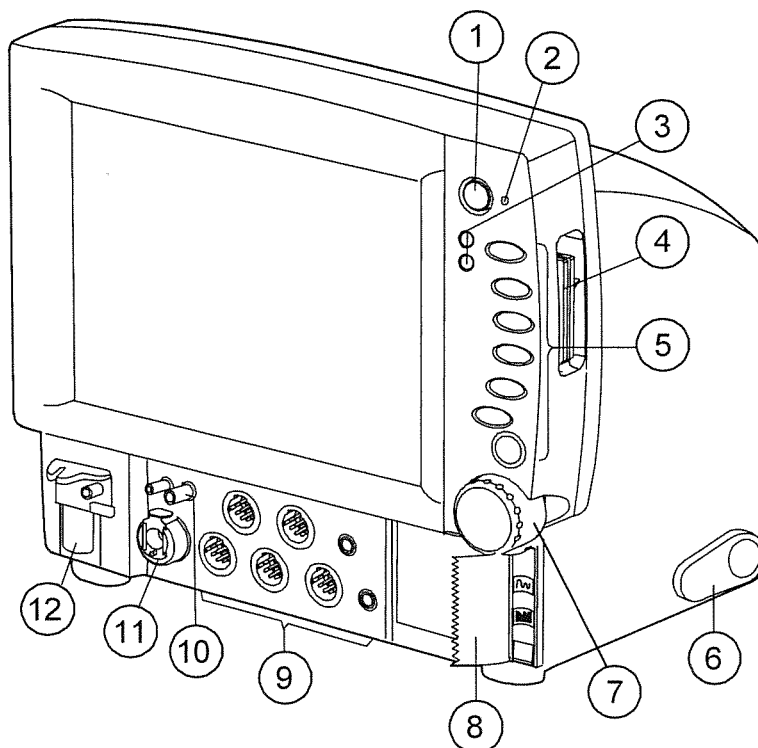
Figure 1-1. Cardiocap/5 monitor (F-MXG)

(1) Power On/Standby key

(2) External power indicator / Battery charge status LED

(3) Alarm indicators

(4) Insertion slots for two memory cards
NOTE: A cover for the slots is available.

(5) Direct access keys

(6) Adjustable rear support

(7) ComWheel

(8) Recorder (N-XREC option)
NOTE: The two-button recorder (shown) is for Cardiocap/5 monitors using software version 3.0 or higher. A one-button recorder was available previously.

(9) Patient connectors

(10) Spirometry connectors

(11) NIBP connector

(12) D-fend housing

Patient connectors panel
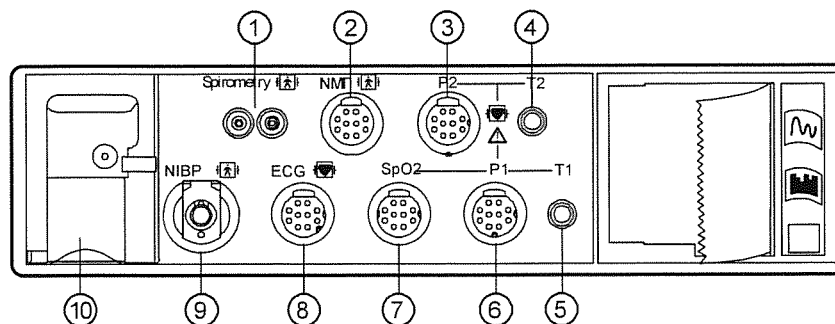
Figure 1-2. Patient connectors (F-MXG)

(1) Spirometry (N-XV option)

(2) NMT (N-XNMT option)

(3) Invasive pressure, P2 (N-XP option)

(4) Temperature, T2 (N-XP option)

(5) Temperature, T1

(6) Invasive pressure, P1 (N-XP option)

(7) SpO$_2$ (connector differs depending on pulse oximetry configuration)

	Connector for Datex-Ohmeda standard pulse oximetry
	Connector for Datex-Ohmeda enhanced pulse oximetry
	Connector for Nellcor® compatible pulse oximetry

(8) ECG

(9) NIBP

(10) D-fend housing

Rear panel
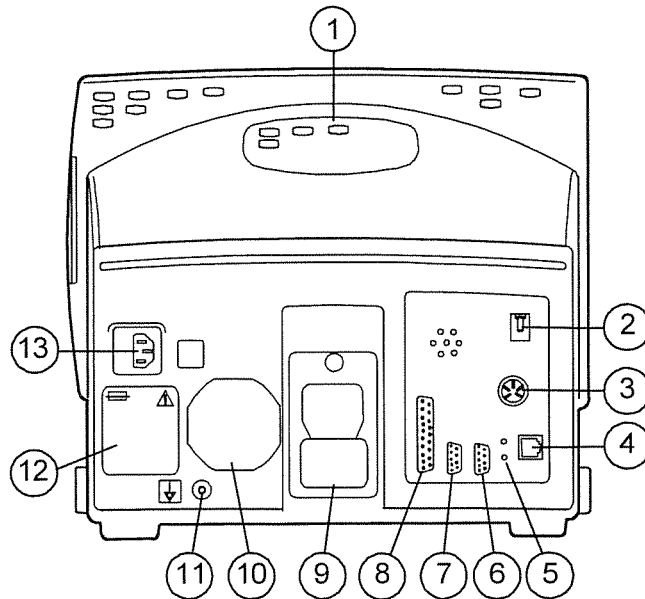
Figure 1-3. Cardiocap/5 rear panel (F-MXG)

(1)   Built-in handle

(2)   Gas outlet, X6

(3)   Remote Control connector, X5

(4)   Ethernet connector, X4

(5)   Network connection LEDs

(6)   Network identification plug connector, X3

(7)   Serial communication interface/local printer connector, X2

(8)   Analog/digital output connector, X1
(includes nurse call and defibrillator synchronization signals)

(9)   Mounting attachment

(10)   Dust filter

(11)   Potential equalization

(12)   Fuse and voltage information

(13)   Receptacle for mains power cord

Rear panel connections

WARNING: Electrical shock hazard. Use only hospital-grade, grounded electrical outlets.

CAUTION: Turn off the power before making any rear panel connections.

- Place the monitor on a flat surface that can hold at least 10 kg (22 lb.).

- Use only the power cord provided to connect the monitor to the wall outlet.

Symbols

Attention! Read accompanying instructions, including all warnings and cautions, before using this device.

This symbol has the following meanings when it appears on the screen:

- On the front panel indicates that protection against cardiac defibrillator discharge is due in part to the accessories for pulse oximetry (SpO_2), temperature (T) and invasive pressure (P) measurement.

- When displayed beside the O_2 value, indicates that the FiO_2 low-alarm limit is set below 21%.

- When displayed next to the HR value, indicates that there is a risk that the monitor counts pacemaker spikes (pacer is set ON R) or the monitor counts T-waves (a wide QRS is selected).

Alarm silence indicator. When displayed at the upper left corner of the screen, indicates that all alarms are silenced. When in a menu or digit field, indicates that the alarm source has been turned off.

Main Menu. Located beside the ComWheel to indicate you can open the Main Menu by pressing the ComWheel when no other menu is displayed.

Submenu. Appears in a menu to indicate the selection will open a new menu. A submenu contains functions that are used less frequently.

The monitor is connected to the Datex-Ohmeda Network.

Data card (green) and/or the Menu card (white) is inserted.

Flashes next to the heart rate value or pulse rate value to indicate the beats detected.

Appears next to the respiration rate value to indicate that the respiration rate is calculated from the impedance respiration measurement.

Battery operation and remaining capacity.

Battery charging.

Type BF applied part (IEC 60601-1). Defibrillator-proof protection against electric shock.

Type CF applied part (IEC 60601-1). Defibrillator-proof protection against electric shock.

Gas outlet (in airway gas models only).

Ethernet connectors.

Equipotentiality. Monitor can be connected to potential equalization conductor.

Alternating current.

Fuse.

Power On/Standby.

ESD warning symbol for electrostatic sensitive devices. Pins of connectors identified with the ESD warning symbol should not be touched. Connections should not be made to these connectors unless ESD precautionary procedures are used. See "Safety precautions: ESD precautionary procedures" for details.

Symbol for non-ionizing electromagnetic radiation. Interference may occur in the vicinity of equipment marked with the symbol.

Delayed standby function

A delayed switch-off mechanism makes it possible to return to monitoring if the monitor is accidentally switched to standby.

When the **Power On/Standby** key is pressed, a message box is displayed in the center of the waveform display and the waveform fields are frozen. After eight seconds, the monitor display is switched off and the monitor enters standby mode.

Pressing the **Power On/Standby** key during this 8-second delay will allow you to continue monitoring. The message box will be removed and all data and configurations will be retained.

Back-up battery

If mains power is lost during monitoring, the Cardiocap/5 can run on power from the internal battery. The capacity of a fully charged internal battery is 15 minutes minimum.

NOTE: The monitor can be started only when connected to mains power.

Battery time

A symbol on the display indicates the remaining operating time of the battery. It is displayed only when the monitor is not connected to mains power.
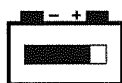
The operating time that remains is updated every minute.

- When about five minutes of battery operating time is left, a "Batt low" alarm is activated and the monitor makes one beep.

- When about one minute of operating time is left, a "Batt empty" alarm is activated.

The battery is charged automatically when the monitor is connected to mains power. Battery charging time is normally five hours.

A charging symbol is displayed during charging:
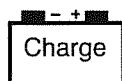
The symbol is removed from the display when the battery is fully charged.

During battery charging, the standby LED is flashing in standby mode.

Installation and service

A separate "Technical Reference Manual" describes installation, interfacing, connectors, service, maintenance and reparation procedures of the monitor. Medical electrical equipment needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided in the "Technical Reference Manual" by qualified personnel. Service and reparations are allowed for authorized service personnel only.

WARNING: Before starting to use the system, ensure that the whole combination complies with the international standard IEC 60601-1-1 and with the requirements of the local authorities.
Do not connect any external devices to the system other than those specified.

Safety precautions

This section lists the warnings and cautions you should know before using the monitor.

Warnings

A WARNING indicates a situation in which the user or the patient may be in danger of injury or death.

Failure of operation

It is possible for any device to malfunction; therefore, always verify unusual data by performing a formal patient assessment.

The monitor or its components should not be used adjacent to or stacked with other equipment. If adjacent or stacked use is necessary, the monitor and its components should be observed to verify normal operation in the configuration in which it will be used.

Explosion hazard

To avoid an explosion hazard, do not use the monitor in the presence of flammable anesthetics. The monitor measures only non-flammable anesthetics.

Electrical shock hazard

When you connect equipment to the Cardiocap/5 input and output connectors, you are configuring a medical system and are responsible for ensuring that the system complies with IEC/EN 60601-1-1 and with local requirements.

Do not connect external equipment to the system, except equipment specified by Datex-Ohmeda.

Make sure external equipment is hospital-grade and grounded before connecting.

Use only hospital-grade, grounded electrical outlets and power cords.

Pins of connectors identified with the ESD warning symbol should not be touched. Connections should not be made to these connectors unless ESD precautionary procedures are used. See "ESD precautionary procedures" later in this section (Users Guide: See "Safety precautions: ESD precautionary procedures" in the "User's Reference Manual) for details.

NMT

Always stop NMT measurement before handling stimulation electrodes.

Do not place the NMT stimulation electrodes on the patient's chest.

Cleaning

Before cleaning, disconnect the monitor from the electrical outlet.

After cleaning, make sure that every part of the monitor is dry before reconnecting it to the power supply.

If liquid has accidentally entered the equipment, disconnect the power cord from the power supply and have the equipment serviced by authorized service personnel.

Patient safety

All invasive procedures involve risks to the patient. Use aseptic technique. Follow the instructions provided by the catheter manufacturer.

The output signals are not floating and they must not be connected directly to a patient.

Connect only one patient to one monitor at a time.

Constant attention by a qualified professional is needed whenever a patient is under anesthesia or connected to a ventilator. Some equipment malfunctions may pass unnoticed in spite of the monitor alarm.

Do not use antistatic or electrically-conductive breathing tubes. They may increase the risk of burns when an electrosurgery unit is used.

Do not use the Cardiocap/5 during magnetic resonance imaging (MRI).

Use only approved accessories, mounts and defibrillator-proof cables and invasive pressure transducers. For a list of approved supplies and accessories, see the "Supplies and Accessories" catalog. Other cables, transducers and accessories may cause a safety hazard, damage the equipment or system, result in increased emissions or decreased immunity of the equipment or system or interfere with the measurement. Protection against cardiac defibrillator discharge is due in part to the accessories for pulse oximetry (SpO$_2$), temperature (T) and invasive pressure (P) measurement. Single-use accessories are not designed to be re-used. Re-use may cause a risk of contamination and affect the measurement accuracy.

To prevent erroneous readings, do not use physically damaged sensors or sensor cables. Discard a damaged sensor or sensor cable immediately. Never repair a damaged sensor or cable; never use a sensor or cable repaired by others. A damaged sensor or a sensor soaked in liquid may cause burns during electrosurgery.

ECG, Impedance respiration, Invasive blood pressure

Ensure proper contact of the return electrode of the electrosurgery unit to your patient to avoid possible burns at sensor sites.

ECG, Impedance respiration, NMT

Make sure that the lead set clips or snaps do not touch any electrically conductive material, including earth.

Impedance respiration

In obstructive apnea, respiration movements and impedance variations may continue.

NIBP

The monitor sets the inflation pressure automatically according to the first measurement. Reset the case to reset the inflation limit before measuring a new patient.

Invasive blood pressure

Make sure that no part of the patient connections touches any electrically conductive material, including earth.

Patients with pacemakers or arrhythmia

The monitor may count pacemaker pulses as heart beats during cardiac arrest, some arrhythmias, and with certain types of pacemakers particularly in *ON R* mode. Do not rely entirely upon rate meter alarms. Keep patients with pacemakers and arrhythmias under close surveillance.

The impedance respiration measurement may cause rate changes in Minute Ventilation Rate Responsive Pacemakers. Set the pacemaker rate responsive mode to off or turn off the impedance respiration measurement on the monitor.

Gases

MAC values are empirical, not absolute. Cardiocap/5 MAC values correspond to those of healthy adults and cannot be applied to children. Age and other individual factors influencing the effect of volatile agents are not taken into account.

Pulse oximetry

Use clean and dry sensors and cables only. Moisture and debris on connectors may affect measurement accuracy.

Patient conditions (such as reddening, blistering, skin discoloration, ischemic skin necrosis, and skin erosion) may warrant changing the sensor site frequently or using a different style of sensor. For details, refer to the instructions supplied with the sensor.

Conditions that may cause inaccurate readings and impact alarms include interfering substances, excessive ambient light, electrical interference, ventricular septal defects (VSD), excessive motion, low perfusion, low signal strength, incorrect sensor placement, poor sensor fit, and/or movement of the sensor on the patient.

To prevent erroneous readings, do not use an inflated blood pressure cuff or arterial blood pressure measurement device on the same limb as the oximeter sensor.

Temperature

To prevent patient injury, use Datex-Ohmeda temperature probes only.

Alarms

Make sure that necessary alarm limits are set and alarms are on when you start monitoring a patient.

When alarms are suppressed, observe the patient frequently.

Cautions

A **CAUTION** indicates a situation that may cause damage to the unit or devices connected to it..

US Federal law restricts this device to sale by or on the order of a licensed medical practitioner.

The system is intended for use by qualified medical personnel only.

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

Do not store the monitor outside the specified temperature range (-10 to + 50 °C / 14 to 122 °F).

Do not subject memory cards to excessive heat, bending, or magnetic fields.

Leave space for circulation of air to prevent the monitor from overheating.

Turn off the power before making any rear panel connections.

Use only cables and accessories approved by Datex-Ohmeda. Other cables and accessories may damage the system or interfere with measurement. Single-use accessories are not designed to be reused.

Vibrations during transport may disturb SpO_2, ECG, impedance respiration, and NIBP measurements.

Airway gas measurement

Strong scavenging suction may change the operating pressure of the monitor and cause inaccurate readings or internal damage.

Invasive blood pressure

Mechanical shock to the invasive blood pressure transducer may cause severe shifts in zero balance and calibration and may produce erroneous readings.

Cleaning

Do not disinfect or open the water trap cartridge. To avoid damage, do not touch or try to clean the water trap hydrophobic membrane (other than to rinse it with water).

Do not sterilize any part of the monitor with steam autoclave or ethylene oxide.

Do not immerse any part of the device in liquids or allow liquid to enter the interior.

Do not use hypochlorite, acetone-based, phenol-based, or ammonia-based cleaners.

Disposal

Dispose of the whole device and its parts in accordance with local environmental and waste disposal regulations.

Points to note

Medical electrical equipment needs special precautions regarding electromagnetic compatibility and needs to be installed and put into service according to the electromagnetic compatibility information provided in the "Technical Reference Manual" by qualified personnel.

Portable and mobile RF communications equipment can affect the medical electrical equipment.

The allowed cables, transducers and accessories for the system are listed in the "Supplies and Accessories" catalog delivered with the monitor.

The equipment is suitable for use in the presence of electrosurgery. Please notice the possible limitations in the parameter sections and in the "Safety precautions" section.

Service and reparations are allowed for authorized service personnel only.

CISPR 11 classifications:

- Group 1 contains all ISM (Industrial, scientific and medical) equipment in which there is intentionally generated and/or used conductively coupled radio-frequency energy which is necessary for the internal functioning of the equipment itself.

- Class A equipment is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.

ESD precautionary procedures

To avoid electrostatic charges to build up, it is recommended to store, maintain and use the components at a relative humidity of 30% or greater. Floors should be covered by ESD dissipative carpets or similar. Non-synthetic clothing should be used when working with the component.

To prevent applying a possible electrostatic discharge to the ESD sensitive parts of the component, one should touch the metallic frame of the component or to a large metal object located close to the component. When working with the component and specifically when the ESD sensitive parts of the component may be touched, a grounded wrist strap intended for use with ESD sensitive equipment should be worn. Refer documentation provided with the wrist straps for details of proper use

ESD precautionary procedure training

It is recommended that all potential users receive an explanation of the ESD warning symbol and training in ESD precautionary procedures.

The minimum content of an ESD precautionary procedure training should include an introduction to the physics of electrostatic charge, the voltage levels that can occur in normal practice and the damage that can be done to electronic components if they are touched by and operator who is electrostatically charged. Further, an explanation should be given of methods to prevent build-up of electrostatic charge and how and why to discharge one's body to earth or to the frame of the equipment or bond oneself by means of a wrist strap to the equipment or the earth prior to making a connection.

Specifications

All specifications are subject to change without notice.

WARNING: Operation of the monitor outside the specified values may cause inaccurate results.

General

Power supply

Rated voltages and frequencies: 100-240 V 60/50 Hz
Allowed voltage fluctuations: ± 10%
Maximum power consumption: 80 VA
Fuses (2): T2AH/250V

Back-up battery

Type: 12V 2.6AH lead acid
Back-up battery time: at least 15 minutes when fully charged
Charging time (typical): 5 hours
Charging indicator: Green LED On: full charge, battery on the holding voltage
                    Green LED flashing: charging

Environmental conditions

Operating temperature: +10 to +40°C (50 to 104°F)
Storage and transport temperature: −10 to +50°C (14 to 122°F)
Relative humidity: 0 to 85% noncondensing; in airway 0 to 100% condensing
Atmospheric pressure: 660 to 1060 hPa (500 to 800 mmHg)

ECG

Waveform display (with 50 Hz power supply frequency):
    Monitoring filter 0.5 to 30 Hz
    ST filter 0.05 to 30 Hz
    Diagnostic filter 0.05 to 100 Hz
Waveform display (with 60 Hz power supply frequency):
    Monitoring filter 0.5 to 40 Hz
    ST filter 0.05 to 40 Hz
    Diagnostic filter 0.05 to 100 Hz
Minimizing the effects of the line isolation monitor transients: Crystal controlled oscillator is used as the operating frequency source of the patient isolation power supply.
Offset voltage range: ±0.4 V

WARNING. The ±0.4 V offset voltage range of the ECG measurement may be insufficient to handle the offset potentials when using ECG electrodes of dissimilar metals

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The isolation barrier capacitance has been minimized to reduce the hazard of burns in the event of a defect in the ESU return electrode connection.
Direct current for leads-off detection through any patient electrode : ≤50 nA
The normalized respiration sensing current : ≤3.0 µA
Frequency of respiration sensing current: 31.25 kHz
Maximum Tall T wave amplitude that does not disturb the heart rate calculation time (according to ANSI/AAMI EC13 4.1.2.1): 10 mV

Pacemaker pulse detection:
detection level: 2 to 700 mV
pulse duration: 0.5 to 2 ms

The monitor is specified for both of the methods A and B required in ANSI/AAMI EC13 4.1.4.2.

Pacer pulse rejection of fast ECG signals:
0.2 V/s with Sensit pacemaker selection and 1.6 V/s with other selections according to the test defined in ANSI/AAMI EC13 section 4.1.4.3.

ST segment analysis

Measured and displayed simultaneously for up to three ECG leads

ST level range: –6 to +6 mm (–0.6 to +0.6 mV)

Display resolution: 0.1 mm (0.01 mV)

Averaging: Calculated from 16 QRS complexes

Display update interval: 5 seconds

Test result of ST segment measurement algorithm testing.
The algorithm testing has been performed by using The European Society of Cardiology ST-T Database
Average results from ischemic ST detection
Episode sensitivity: 77
Episode positive predictive accuracy: 67
Duration sensitivity: 74
Duration positive predictive accuracy: 61

Heart rate

Measurement range: 30 to 250 bpm
Measurement accuracy: ± 5% or ± 5 bpm
Pacemaker pulse detection level: 2 to 500 mV
Pacemaker pulse duration: 0.5 to 2 ms

Display averaging time: 10 seconds

Display update time: 5 seconds

The heart rate calculation operates with irregular rhythms of ANSI/AAMI EC13 4.1.2.1 (e) as follows: a): 40 bpm b): 87 bpm c): 60 bpm d): 117 bpm

Average heart rate response time and time range of response time (according to ANSI/AAMI EC13 4.1.2.1 (f)):

Response time 80 to 120 bpm: 5.0s (3.7 to 6.2 s)

Response time 80 to 40 bpm: 6.5s (4.1 to 9.2 s)

The average time and time range ( ) to alarm for tachycardia are as follows ANSI/AAMI EC13 4.1.2.1 (g)):

Figure 4a halved amplitude: 5.5 s (4.8 to 5.9 s)

Figure 4a normal amplitude: 6.6 s (4.8 to 7.2 s)

Figure 4a doubled amplitude: 7.2 s (5.3 to 9.4 s)

Figure 4b halved amplitude: 7.4 s (7.0 to 7.7 s)

Figure 4b normal amplitude: 6.2 s (4.7 to 8.1 s)

Figure 4b doubled amplitude: 6.4 s (4.4 to 8.2 s)

Auxiliary ECG output:

Bandwidth of auxiliary output: 0.5 to 40Hz
Gain: 1 mV ECG signal is 1 V at the auxiliary output.

Propagation delay: < 15 ms

The pacemaker pulses are absent but may cause interference at the auxiliary ECG output.

An auxiliary device that fulfils the requirements of the IEC 60601-1 standard can be connected to the auxiliary output. There are no other limitations, because the auxiliary output of the monitor is galvanically isolated from patient applied part of the ECG measurement.

Impedance respiration

Respiration range: 4 to 120 resp/minute
Accuracy: ± 5% or ± 5 resp/minute

NIBP

Measurement range:
    Adult 25 to 260 mmHg; Child 25 to 195 mmHg; Infant 15 to 145 mmHg
Pulse rate range accepted: 30 to 250 bpm
Typical measuring time: Adult 23 seconds; Infant 20 seconds

Invasive blood pressure

Measurement range: −40 to 320 mmHg
Measurement accuracy: ± 5% or ± 2 mmHg
Transducer sensitivity: 5 µV/V/mmHg, 5 VDC, max 20 mA

Pulse rate

Measurement range: 30 to 250 bpm
Accuracy: ± 5% or ± 5 bpm

Temperature

Measurement range: 10 to 45°C (50 to 113°F)
Measurement accuracy:
    25 to 45.0 °C ± 0.1 °C (77 to 113 °F ± 0.2 °F)
    10 to 24.9 °C ± 0.2 °C (50 to 76.8 °F ± 0.4 °F)
Probe type: Datex-Ohmeda only

Pulse oximetry, standard

Display update time: 5 seconds
Averaging time: adjustable
Plethysmographic waveform scaling: adjustable

SpO_2

Calibration range: 50 to 100%
Calibrated against functional saturation
Measurement range: 40 to 100%
Measurement accuracy (% SpO_2 ± 1SD):
    80 to 100% ± 2 digits;
    50 to 80% ± 3 digits;
    Below 50% unspecified

NOTE: SpO_2 measurement accuracy is based on deep hypoxia studies using Datex-Ohmeda FingerSat sensors on volunteers. Arterial blood samples were analyzed by a Radiometer OSM CO-oximeter. Refer to the sensor instructions for specific accuracy data.

Pulse rate

Measurement range: 30 to 250 bpm
Measurement accuracy: ± 5% or ± 5 bpm

Default alarm limits

SpO_2: high Off, low 90%
Pulse rate: high 160, low 40
NOTE: Limits are adjustable.

Sensor emitter wavelength ranges

Red LED: 660 nm
Infrared LED: 900 nm

Pulse oximetry, Datex-Ohmeda enhanced (N-XOSAT option)

Display update time: 5 seconds
Averaging time: 12 seconds
Plethysmographic waveform scaling: automatic

SpO_2

Calibration range: 70 to 100%
Calibrated against functional saturation
Measurement range: 1 to 100%
Measurement accuracy (± 1SD):
    70 to 100% ± 2 digits
    70 to 100% ± 3 digits during conditions of clinical patient motion
    Below 70% unspecified
NOTE: SpO_2 measurement accuracy is statistically derived and correlated to simultaneous arterial blood gases measured on a Radiometer OSM3 CO-oximeter. Refer to the sensor instructions for specific accuracy data.

Pulse rate

Measurement range: 30 to 250 bpm
Measurement accuracy: ± 2% or ± 2 bpm (whichever is greater)

Default alarm limits

SpO_2: high Off, low 90%
Pulse rate: high 160, low 40
NOTE: Limits are adjustable.

Sensor emitter wavelength ranges

Red LED: 650 to 665 nm
Infrared LED: 930 to 950 nm
Average power: ≤ 1 mW

Pulse oximetry, Nellcor compatible (N-XNSAT option)

Display update time: 5 seconds

Averaging time: 5 to 7 seconds
Plethysmographic waveform scaling: automatic

SpO$_2$

Calibrated against functional saturation
Measurement range: 1 to 100%
Measurement accuracy (% SpO$_2$ ±1SD):
    70 to 100% (± 2 digits to ± 3.5 digits, depending on the sensor)
    Below 70% unspecified
    See the *Pulse Oximetry* chapter for a list of approved sensors and accuracy details.
NOTE: SpO$_2$ measurement accuracy is based on testing healthy adult volunteers in induced hypoxia studies.

Pulse rate

Measurement range: 30 to 250 bpm
Measurement accuracy: ± 3 digits

Default alarm limits

SpO$_2$: high Off, low 90%
Pulse rate: high 160, low 40
NOTE: Limits are adjustable.

Sensor emitter wavelength ranges

Red LED: 660 nm
Infrared LED: 920 nm

Airway gases

Sampling rate (typical value): 200 ml/minute
Sampling delay: 2.5 seconds typical with a 3 meter sampling line
Total system response time: 2.9 seconds typical with a 3 meter sampling line, including sampling delay and rise time
Warm-up time: 2 to 5 minutes, 30 minutes for full spec.
Default alarm limits:
    NOTE: Limits are adjustable within the measurement range. Alarm limits and their adjustment range may vary depending on the mode used.

EtCO$_2$ high 8%, low 3%	FiEnf high 5.1%, low Off
FiCO$_2$ high 3%, low Off	EtEnf high 3.4%, low Off
EtO$_2$ high Off, low 10%	FiIso high 3.4%, low Off
FiO$_2$ high Off, low 18%	EtIso high 2.3%, low Off
FiN$_2$O high 82%	FiDes high 18%, low Off
FiHal high 2.2%, low Off	EtDes high 12%,low Off
EtHal high 1.5%, low Off	FiSev high 5.1%, low Off
	EtSev high 3.4%, low Off

Non-disturbing gases:

Ethanol C$_2$H$_5$OH (< 0.3%)	Acetone (< 0.1%)
Methane CH$_4$ (< 0.2%)	Nitrogen N$_2$
Carbon monoxide CO	Nitric oxide NO (< 200 ppm)
Water vapor	

Maximum effect on readings
    CO$_2$: < 0.2 vol%

O$_2$, N$_2$O: < 2 vol%
Anesthetic agents: < 0.15 vol%
Effect of helium: Decreases CO$_2$ readings < 0.6 vol% typically

Respiration rate (RR)

Measurement range: 4 to 60 breaths/minute
Detection criteria: 1% variation in CO$_2$

Agent identification

Identification threshold (typical value): 0.15 vol%

Carbon Dioxide (CO$_2$), Oxygen (O$_2$), and Nitrous Oxide (N$_2$O)

Measurement	Carbon Dioxide (CO$_2$)	Oxygen (O$_2$)	Nitrous Oxide (N$_2$O)
Range	0 to 15%, (0 to 15 kPa) (0 to 113 mmHg)	0 to 100%	0 to 100%
Accuracy (typical)	≤ 0.3 vol%	≤ 2 vol%	≤ 3 vol%
Rise time	< 400 ms typical	< 400 ms typical	< 450 ms typical
Gas cross effects	< 0.2 vol% (O$_2$, N$_2$O, and anesthetic agents)	< 1 vol% (anesthetic agents); < 2 vol% (N$_2$O)	< 2 vol% (anesthetic agents)

Anesthetic Agent (AA)

Measurement	Halothane, Isoflurane, Enflurane	Sevoflurane	Desflurane
Range	0 to 6%	0 to 8%	0 to 20%
Accuracy (typical)	≤ 0.2 vol%	≤ 0.2 vol%	0 to 5% ≤ 0.2 vol% 5 to 10% ≤ 0.5 vol% 10 to 20% ≤ 1.0 vol%
Rise time	< 400 ms typical		
Gas cross effects	< 0.15 vol% N$_2$O		

Patient Spirometry

Detection through D-lite™ or Pedi-lite™ flow sensor and gas sampler:

Measurement	D-lite flow sensor	Pedi-lite flow sensor
Tidal volume Measurement range Accuracy (typical value)	150 to 2000 ml ± 6% or 30 ml	15 to 300 ml ± 6% or 4 ml
Minute volume Measurement range Accuracy (typical value)	2 to 20 l/minute ± 6%	0.5 to 5 l/minute ± 6%
Airway pressure Measurement range Accuracy (typical value)	−20 to +100 cmH$_2$O ± 1 cmH$_2$O	−20 to +100 cmH$_2$O *not applicable*
Flow Measurement range	1.5 to 100 l/minute	0.25 to 25 l/minute
Compliance		

Measurement range	4 to 100 ml/cmH$_2$O	4 to 100 ml/cmH$_2$O
Airway Resistance Measurement range	0 to 40 cm H$_2$O/l/second	0 to 40 cm H$_2$O/l/second
Sensor specifications Dead space Resistance at 30 l/minute Resistance at 10 l/minute	9.5 ml 0.5 cmH$_2$O *not applicable*	2.5 ml *not applicable* 1.0 cmH$_2$O

NMT

Stimulation modes:
  Train of four (TOF)
  Double burst (3.3) (DBS)
  Single twitch (ST)
  50 Hz tetanic + post-tetanic count (PTC)
Measurement intervals:
  TOF and DBS: Manual; 10 seconds, 12 seconds, 15 seconds, 20 seconds, 1 minute,
    5 minutes, 15 minutes
  ST: Manual; 1 second, 10 seconds, 20 seconds

Stimulator

Stimulus pulse: Square wave, constant current
Pulse width: 100, 200 or 300 µs
Stimulus current range (supramax and manual): 10 to 70 mA with 5 mA steps
Stimulus current accuracy: 10% or ± 3mA (whichever is greater)
Max load: 3 kΩ
Max voltage: 300 V

Regional block mode

Stimulation mode: Single twitch (ST)
Intervals: 1 second, 2 seconds, 3 seconds
Stimulus pulse: Square wave, constant current
Pulse width: 40 µs
Stimulus current range: 0 to 5.0 mA with 0.1 mA steps
Stimulus current accuracy: 20% or 0.3 mA (whichever is greater)

Recorder

Principle: thermal array
Print resolution:
  Vertical: 8 dots/mm (200 dots/inch)
  Horizontal: 32 dots/mm (800 dots/inch) at speed of 25 mm/second and slower
Paper width: 50 mm; printing width 48 mm
Traces: selectable; 1, 2, or 3 traces
Print speed: 1, 6.25, 12.5, 25 mm/second

For your notes

Chapter 2. Monitoring Basics

Table of Figures

2. MONITORING BASICS

Introduction

You can control Cardiocap/5 monitoring with the ComWheel, the direct access keys, or the optional Remote Control.

- The ComWheel provides access to all monitor functions.
- The direct access keys provide direct access to frequently-used functions that are also available through the Main Menu.
- The Remote Control Menu key lets you enter all monitoring functions. Each Remote Control direct access key lets you enter a common function.

See *Main Menu map* and *Direct access key maps* later in this chapter for the menus you can access from the Main Menu and by pressing the direct access keys.

Keys and controls
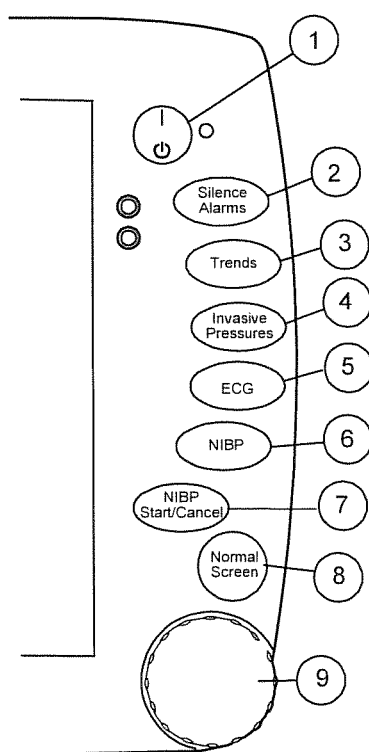
Figure 2-1. Cardiocap/5 keys and controls

(1) Power On/Standby key

(2) Silence Alarms key

(3) Trends direct access key

(4) Pulse Oximetry, Invasive Pressures, or NMT direct access key (depending on configuration)

(5) ECG direct access key

(6) NIBP direct access key

(7) NIBP Start/Cancel key

(8) Normal Screen key

(9) ComWheel

Key functions

Power On/Standby key.

NOTE: The monitor will start only when connected to mains power.

Silence Alarms — Silences an active alarm or pre-silences all alarms for two minutes (press the key once) or five minutes (press the key for three seconds). Pressing the key once again clears the alarm message field of all alarm messages and enables new alarms. A lighted yellow LED indicates a yellow alarm; a lighted red LED indicates a red alarm.

Trends — Displays trends (numerical and graphical) and snapshots. Press the **Normal Screen** key to return to monitoring mode.

The next oval-shaped key can be **Pulse Oximetry, Invasive Pressures,** or **NMT**, depending on which built-in options your monitor contains.

Pulse Oximetry — Displays the menu for adjusting Oxygen saturation measurement settings (all models with no Invasive Pressure or NMT option)

Invasive Pressures — Displays the menu for adjusting Invasive Pressure measurement settings (all models with the Invasive Pressure option and no NMT option)

NMT — Displays the menu for adjusting NMT measurement settings (all models with the NMT option).

ECG — Displays the menu for adjusting ECG measurement settings.

NIBP — Displays the menu for adjusting NIBP measurement settings.

NIBP Start/Cancel — Starts or cancels a single non-invasive blood pressure measurement, STAT, and manual measurements; stops venous stasis.

Normal Screen — Returns to the normal monitoring display.

The **ComWheel** is the main tool for all menu functions. You turn and/or press it to access, navigate, and choose all menu options.

Pushing the ComWheel while no menu is displayed opens the Main Menu from which you have access to all monitor functions.

Recorder keys

See the *Recording and Printing* chapter for descriptions of the keys on the optional recorder.

Remote control

The optional Remote Control (K-CREMCO) contains keys that help you in most common situations and tasks. You can use these direct access keys to start or end a function.
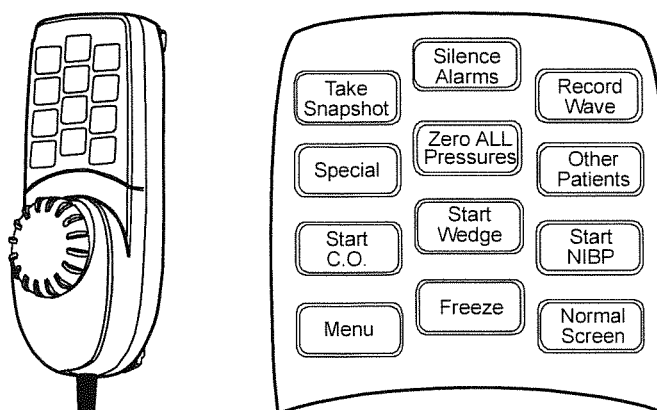

Figure 2-2. Remote Control

Remote control keys

Key	Function
Take Snapshot	Creates a freeze frame, which is saved to the monitor memory. Pressing the key also marks a number beside the numerical trend.
Menu	Opens the Main Menu from which you can access all menus and functions of the monitor.
Silence Alarms	Silences an active alarm or pre-silences all alarms for two or five minutes.
Zero ALL Pressures	Zeroes all invasive pressure channels.
Freeze	Freezes the waveform sweep for 60 seconds. To unfreeze the waveforms, press the **Freeze** key again (or press the **Normal Screen** key).
Record Wave	Records the selected real-time waveforms.
Other Patients	If the monitor is connected to the network, it is possible to view alarms and general views for another site.
Start NIBP	Starts a single NIBP measurement and cancels any measurement.
Normal Screen	Closes open menus and returns to normal monitoring display.
Start Wedge	Displays the customized wedge view and starts wedge measurement.
Special	Not in use with Cardiocap/5.
Start C.O.	Not in use with Cardiocap/5.

Using menus

A menu is a list of functions or commands displayed on the screen.
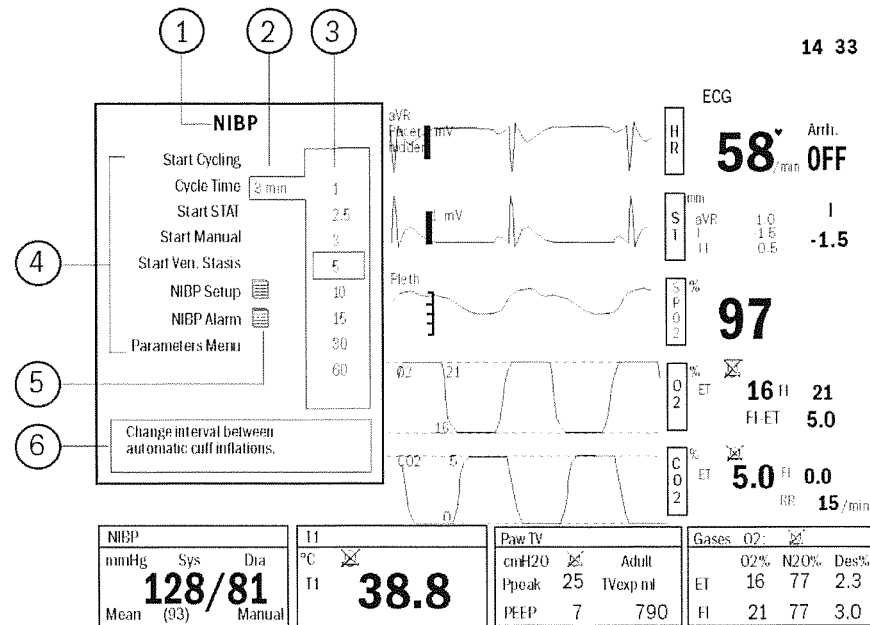
Figure 2-3. Parts of a menu

(1) Header of the menu

(2) Indicates the present selection

(3) Adjustment window with other options

(4) List of menu selections

(5) Entry indicator to submenus

(6) Short instructions

Opening the Main Menu

If you press the ComWheel when no menu is displayed, you will open the Main Menu.
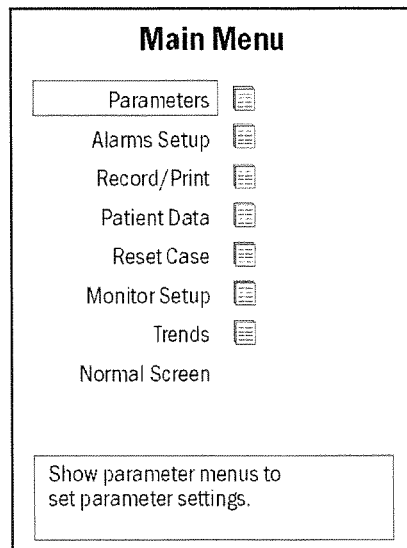
Figure 2-4. Main Menu

The Main Menu provides access to all other menus. To display a different menu, such as the Parameters menu, select it from the Main Menu.

You can enter the Main Menu from other menus by using the ComWheel to select the previous menu until you reach the Main Menu.

To exit the Main Menu, select **Normal Screen** or press the **Normal Screen** key.

Using the direct access keys

The direct access keys allow you to bypass the Main Menu and go directly to the menu activated by the direct access key. For example:

ECG

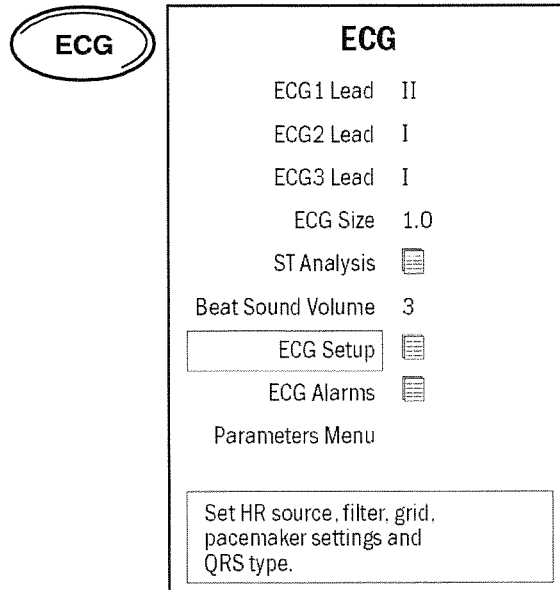| ECG	
ECG 1 Lead	II
ECG 2 Lead	I
ECG 3 Lead	I
ECG Size	1.0
ST Analysis	▤
Beat Sound Volume	3
ECG Setup	▤
ECG Alarms	▤
Parameters Menu	

Set HR source, filter, grid, pacemaker settings and QRS type.

To quickly enter the ECG menu, press the ECG direct access key.

The menu related to the key you pressed is displayed.

Choosing menu options

Once a menu is displayed, you use the ComWheel to make selections and adjustments. For example, to make adjustments in the ECG menu:

ECG	
ECG 1 Lead	II
ECG 2 Lead	I
ECG 3 Lead	I
ECG Size	1.0
ST Analysis	▤
Beat Sound Volume	3
ECG Setup	▤
ECG Alarms	▤
Parameters Menu	

10

0

Adjust volume of pulse/heart beat sound.
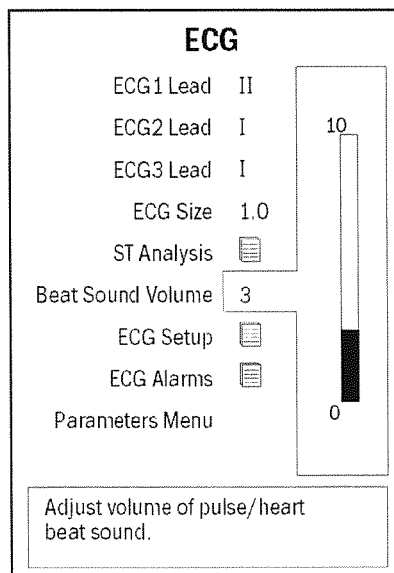
Turn the ComWheel to move to and highlight the menu item.

Then, press the ComWheel to enter the adjustment window or a submenu.

Turn the ComWheel to choose the adjustment.

Press the ComWheel to confirm the change.

Returning to the normal display

Press the **Normal Screen** key to exit a menu and return to the normal monitoring display.

Monitoring a patient

Use only supplies and accessories approved by Datex-Ohmeda for use with the Cardiocap/5. See the Datex-Ohmeda *Supplies and Accessories Catalog*.

Preparations

1. Check that the monitor and patient accessories are clean and intact.

2. Press the **Power On/Standby** key to turn on the monitor.

    NOTE: The monitor will start only when connected to mains power.

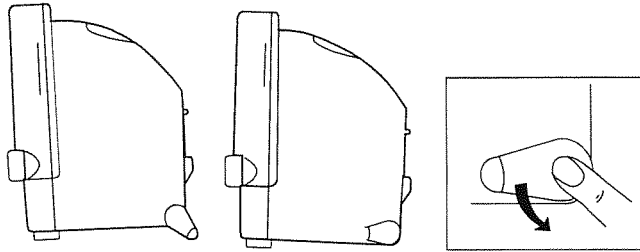3. Tilt the monitor to the optimal viewing angle:

    - Press the center of the foot and adjust.

    - Make sure both feet are at the same angle.

    NOTE: If wall mounting is used, make sure the monitor's front and back attachment bars fit tightly to the edges of the mounting plate and the locking bolt in the back of the monitor locks into place.

4. If necessary, change the operating mode:

    - Press the ComWheel and select **Monitor Setup** from the Main Menu.

    - Select **Select Mode**.

    The operating mode defines what is displayed on the screen and in the trends. Note that changing the mode also changes, for example, the alarm limits.

Starting monitoring

1. Prepare the patient connections. Refer to the applicable measurement parameter chapter(s) later in this manual.

2. Alarms are operative and the parameter default settings are active when the patient is connected to the monitor. To review alarm limits, press the ComWheel and select **Alarms Setup** from the Main Menu.

    You can also select **Alarms Setup** through the corresponding parameter menu.

3. Check that you have the desired waveforms and digits in the fields. To adjust them:

    - Press the ComWheel and select **Monitor Setup** from the Main Menu.

    - Select **Screen Setup**.

    - Select **Waveform Fields** or **Digit Fields.**

4. Carry out measurement-specific start-up. For example, start NIBP measurement to get the reference values.

5. Enter patient data (press the ComWheel and select **Patient Data** from the Main Menu).

During monitoring

If you need to suppress alarms, press the **Silence Alarms** key.
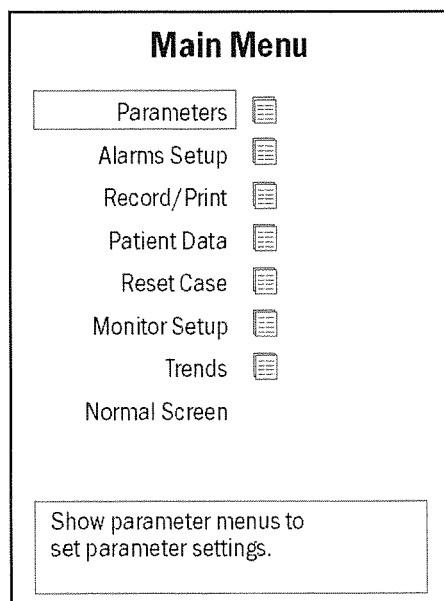
- To silence the alarms for two minutes, press the key once.

- To silence the alarms for five minutes, press the key for more than three seconds.

If you accidentally press the **Power On/Standby** key during monitoring, the "Switching to standby mode in X seconds" message is displayed. If the **Power On/Standby** key is not pressed again within eight seconds, the monitor will switch to standby mode.

To return to monitoring, press the **Power On/Standby** key again within eight seconds.

Ending monitoring

6. Press the ComWheel to open the Main Menu.

```
┌─────────────────────────────────┐
│           Main Menu             │
│  ┌──────────────────┐           │
│  │       Parameters │  ▤        │
│  └──────────────────┘           │
│         Alarms Setup   ▤        │
│         Record/Print   ▤        │
│          Patient Data  ▤        │
│            Reset Case  ▤        │
│         Monitor Setup  ▤        │
│               Trends   ▤        │
│         Normal Screen           │
│                                 │
│  ┌──────────────────────────┐   │
│  │ Show parameter menus to  │   │
│  │ set parameter settings.  │   │
│  └──────────────────────────┘   │
└─────────────────────────────────┘
```
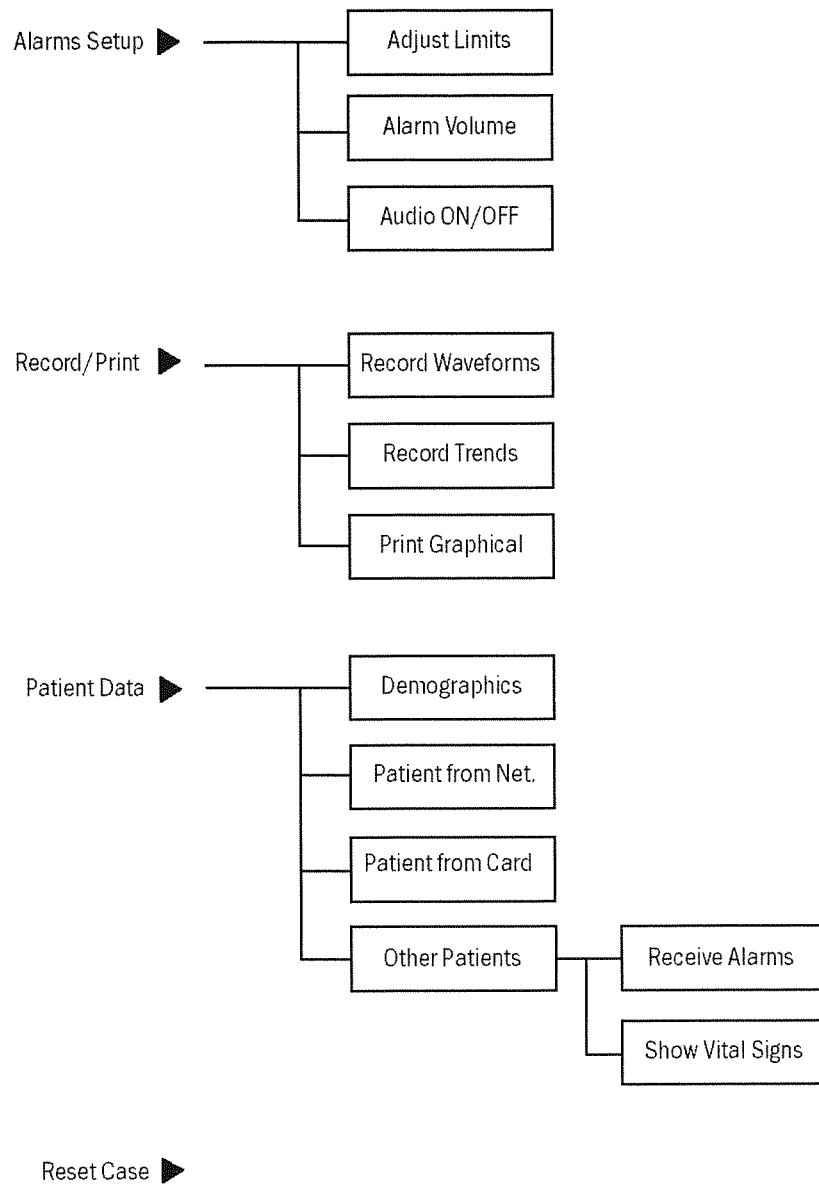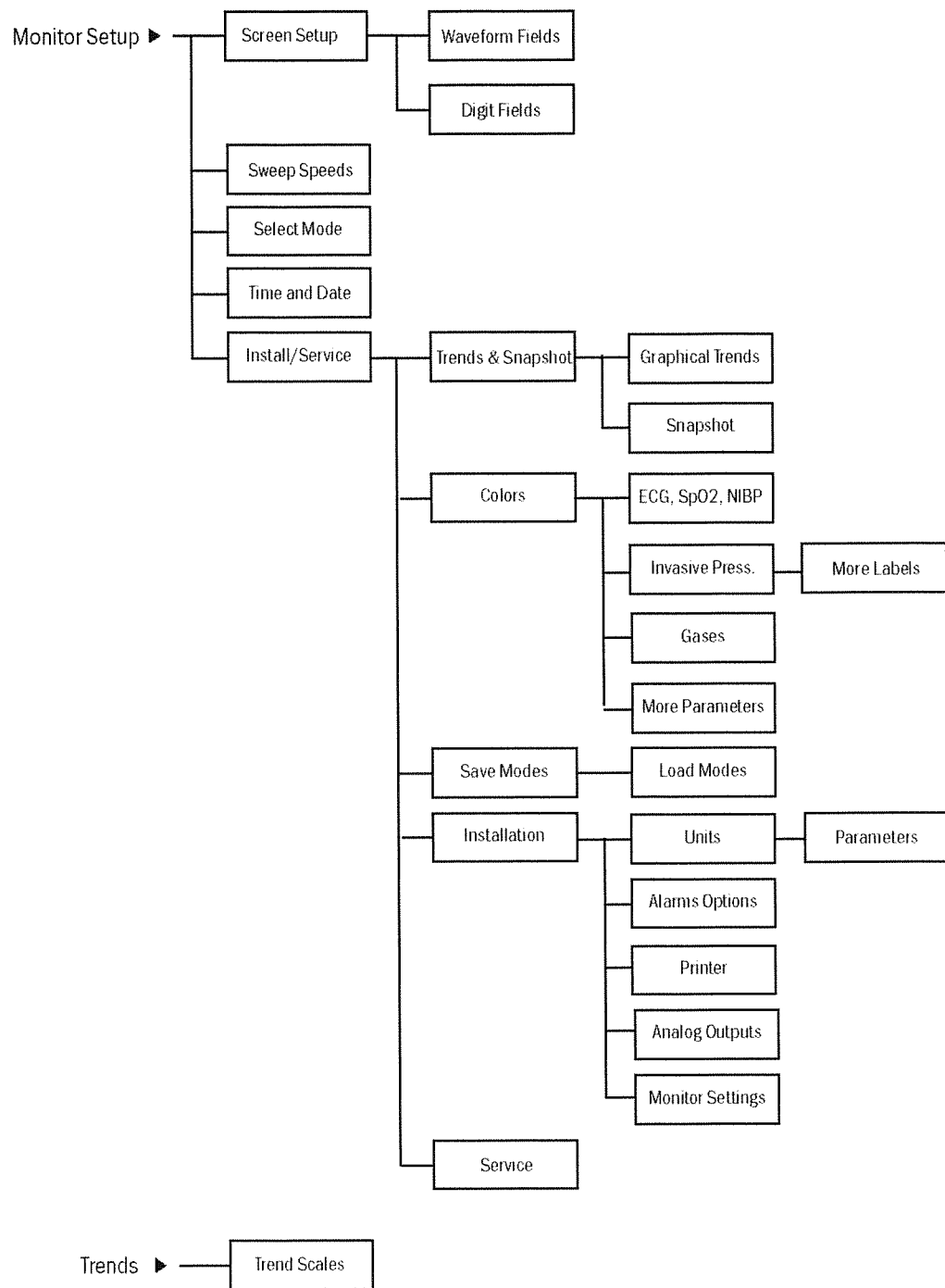
7. To print necessary information, select **Record/Print.** Wait until printing is finished.

8. To clear patient data and return settings to their defaults:

- Select **Reset Case** in the Main Menu.

- Select **Reset ALL** and **YES.**

9. Turn the power switch to standby if the monitor will not be used.

10. Clean the monitor according to the instructions.

Main Menu map

Parameters ▶

Airway Gas ── Spirometry Loops ── Scaling

CO2 Setup ── CO2 Alarm ── Adjust Limits

Resp Rate Alarm ── Adjust Limits

O2 Setup ── O2 Alarm ── Adjust Limits

Agent/N2O Setup ── Agent Alarm ── Adjust Limits

Spirometry Setup ── Scaling

Gas Calibration ── Paw Alarms ── Adjust Limits

ECG ── ST Analysis ── MVexp Alarm ── Adjust Limits

ECG Setup

ECG Alarms ── Adjust Limits

ST Alarms

NIBP ── NIBP Setup

NIBP Alarm ── Adjust Limits

Invasive Press. ── Wedge Pressure

P1 'Art' setup ── P1 'Art' Alarm ── Adjust Limits

P2 'CVP' Setup ── P2 'CVP' Alarm ── Adjust Limits

Pulse Oximetry ── SpO2 Alarm ── Adjust Limits

Resp Setup ── Resp Rate Alarm ── Adjust Limits

Temp Setup ── Temp Alarms ── Adjust Limits

NMT ── Regional Block *

NMT Setup

* Menu is displayed when the NMT Regional Block Adapter is connected to monitor.

Alarms Setup ▶ ──────┬─── Adjust Limits

├─── Alarm Volume

└─── Audio ON/OFF

Record/Print ▶ ──────┬─── Record Waveforms

├─── Record Trends

└─── Print Graphical

Patient Data ▶ ──────┬─── Demographics

├─── Patient from Net.

├─── Patient from Card

└─── Other Patients ──┬── Receive Alarms

└── Show Vital Signs

Reset Case ▶

Monitor Setup ▶

- Screen Setup
  - Waveform Fields
  - Digit Fields
- Sweep Speeds
- Select Mode
- Time and Date
- Install/Service
  - Trends & Snapshot
    - Graphical Trends
    - Snapshot
  - Colors
    - ECG, SpO2, NIBP
    - Invasive Press.
      - More Labels
    - Gases
    - More Parameters
  - Save Modes
    - Load Modes
  - Installation
    - Units
      - Parameters
    - Alarms Options
    - Printer
    - Analog Outputs
    - Monitor Settings
  - Service

Trends ▶

- Trend Scales

Direct access key maps

Trends ▶ —— Trend Scales

Pulse Oximetry ▶ —— SpO2 Alarm —— Adjust Limits

or

Invasive Pressures ▶ —— Wedge Pressure

P1 'Art' Setup —— P1'Art' Alarm —— Adjust Limits

or

P2 "CVP" Setup —— P2 'CVP' Alarm —— Adjust Limits

NMT ▶ —— Regional Block *

NMT Setup

ECG ▶ —— ST Analysis

ECG Setup

ECG Alarms —— Adjust Limits

ST Alarms

NIBP ▶ —— NIBP Setup

NIBP Alarm —— Adjust Limits

* Menu is displayed when the NMT Regional Block Adapter is connected to monitor.

Abbreviations

The abbreviations that appear on the monitor screen and/or in this manual are listed below.

AA	anesthetic agent
ABP	arterial blood pressure
AirW	airway temperature
APN	apnea
Art	arterial
Asy	asystole
ATMP	atmospheric pressure
ATPD	ambient temperature and pressure, dry gas
AVF	augmented voltage foot—usually left (ECG)
AVL	augmented voltage left (ECG)
AVR	augmented voltage right (ECG)
Axil	axillary temperature
B-To-B	beat to beat
Blad	bladder temperature
BP	blood pressure
BSA	body surface area
BTPS	body temperature and pressure, saturated gas
°C	degrees Celsius
Casc.	cascaded (ECG)
CO_2	carbon dioxide
Compl	compliance
Cont.	continuous recording
Contrl	controlled ventilation
Core	central temperature
CVP	central venous pressure
DBS	double burst stimulation (NMT)
Des	desflurane
Dia	diastolic pressure
Diagn	diagnostic (ECG filter)
DIFF	difference
Dyn	dynamic
E	expiratory
ECG	electrocardiography
ECG1	first ECG waveform (top)
ECG1/r	real time ECG
ECG2	second ECG waveform
ECG3	third ECG waveform
EMC	electromagnetic compatibility
EMG	electromyography (NMT)
Enf	enflurane
ESD	electrostatic discharge
Eso	esophageal temperature
ET, Et	end tidal concentration

Exp	expired
°F	degrees Fahrenheit
FI, Fi	fraction of inspired gas
FiO_2	fraction of inspired oxygen
Flow	airway gas flow
FVloop	flow volume loop
Graph.	graphical
Hemo	hemodynamic
Hal	halothane
Hgb	hemoglobin
HR	heart rate
I	inspiratory
ICP	intra cranial pressure
ID	identification
Imped.	impedance
indep.	independent
Inv.	invasive
Iso	isoflurane
LAP	left atrial pressure
LED	light emitting diode
MAC	minimum alveolar concentration
Mean	mean of diastolic and systolic pressures
Monit	monitoring (ECG filter)
MV	minute volume
MYO	myocardial temperature
N_2O	nitrous oxide
Naso	nasopharyngeal temperature
Net	network
NIBP	non-invasive blood pressure
NMT	neuromuscular transmission
NTPD	normal temperature and pressure, dry gas
Num.	numerical trends
O_2	oxygen
Oxy	oxygen
P1, P2	invasive pressure channels
PA	pulmonary arterial pressure
$PaCO_2$	arterial carbon dioxide level
Pedi	pediatric
Paw	airway pressure
PCWP	pulmonary capillary wedge pressure
$PEEP_{tot}$	positive end expiratory pressure
Pleth	plethysmograph waveform
Ppeak	airway peak pressure
Pplat	airway plateau (pause) pressure

PR	pulse rate
Prev.	previous
PTC	post tetanic count (NMT)
PVloop	pressure volume loop
PVC	premature ventricular contraction
RAP	right atrial pressure
Raw	airway resistance
Rect	rectal temperature
Resp	respiration rate
Room	room temperature
RR	respiration rate
RVP	right ventricular pressure
S/D	systolic/diastolic
SaO$_2$	arterial oxygen saturation
Sev	sevoflurane
Skin	skin temperature
Snaps.	snapshot
Spiro	spirometry
SpO$_2$	oxygen saturation measured by pulse oximeter
Spont	spontaneous breathing
ST	single twitch stimulation (NMT)
ST	ST segment of ECG
ST inf.	ST segment on inferior leads (II, III, aVF)
ST lat.	ST segment on lateral leads (I, aVL, V5)
STAT	continuous NIBP cuff inflation for 5 minute
Stfilt	ST filter (ECG)
STPD	standard temperature and pressure, dry gas
Surf	skin temperature
Sw	software
Sys	systolic pressure
T1, T2	temperature
T1%	first stimulus as a percentage of the reference value (NMT)
Tab.	tabular trends
Temp	temperature
TOF	train of four stimulation(NMT)
TOF%	ratio of the fourth response to the first response (NMT)
TV	tidal volume
Tymp	tympanic temperature
V	precordial (chest) lead (ECG)
Vol	volume

Chapter 3. Monitor Setup

Table of Figures

3. MONITOR SETUP

Overview

The Cardiocap/5 has setup options for display, parameters, alarms, etc. You can change the settings to suit your specific needs. General monitor settings can be changed in the Monitor Setup menu. Other settings are changed in setup menus for each parameter.

Modifications remain in effect until the case is ended, a user mode is changed, or for 15 minutes after the monitor is turned off. Replacing the CPU Board also returns settings to their defaults.

NOTE: You can load or reload the settings using the Datex-Ohmeda Network.

Selecting a user mode

User modes are predefined groups of settings that include general monitor settings and some measurement-specific settings. A user mode defines, for example, what is displayed on the screen and in trends. The preconfigured, factory-default user modes are General, Regional, and Pediatric.

GENERAL   Mode for basic general anesthesia and for low- and medium-risk adult patients.

REGIONAL   Mode for all types of regional anesthesia and anesthesia care.

PEDIATRIC   Mode for basic general anesthesia and for low- and medium-risk pediatric patients.

The monitor always starts in startup mode. Startup mode is one of your user modes, chosen during configuration. You can change mode settings during monitoring.

To change the startup mode to another mode:

Monitor Setup
Select Mode

1.	GENERAL ◄	3 Apr 2001
2.	REGIONAL	3 Apr 2001
3.	PEDIATRIC	3 Apr 2001
4.		3 Apr 2001
	Previous Menu	

Activate mode.
All preconfigured stettings are loaded into monitor.

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.

2. Select **Select Mode.**

3. Select **GENERAL, REGIONAL,** or **PEDIATRIC.**

The mode you select is marked with an arrow.

Changes made separately are maintained when returning to the previous mode.

Changing and saving configuration settings

Permanent changes to the configuration are made in the Install/Service menu, a submenu of the Monitor Setup menu. You need a password to enter this menu and change the configuration. Almost all modifications are only temporary unless you save them in the Save Modes menu, which is a submenu of the Install/Service menu. A password is also required to enter this menu and save changes.

See *Configuration* at the beginning of chapter 1 for the default passwords needed to enter the Install/Service menu and the Save Modes menu.

If you wish to make permanent changes, we recommend that you contact the person responsible for the entire configuration. When settings are changed and saved, they should be recorded.

Parts of the display
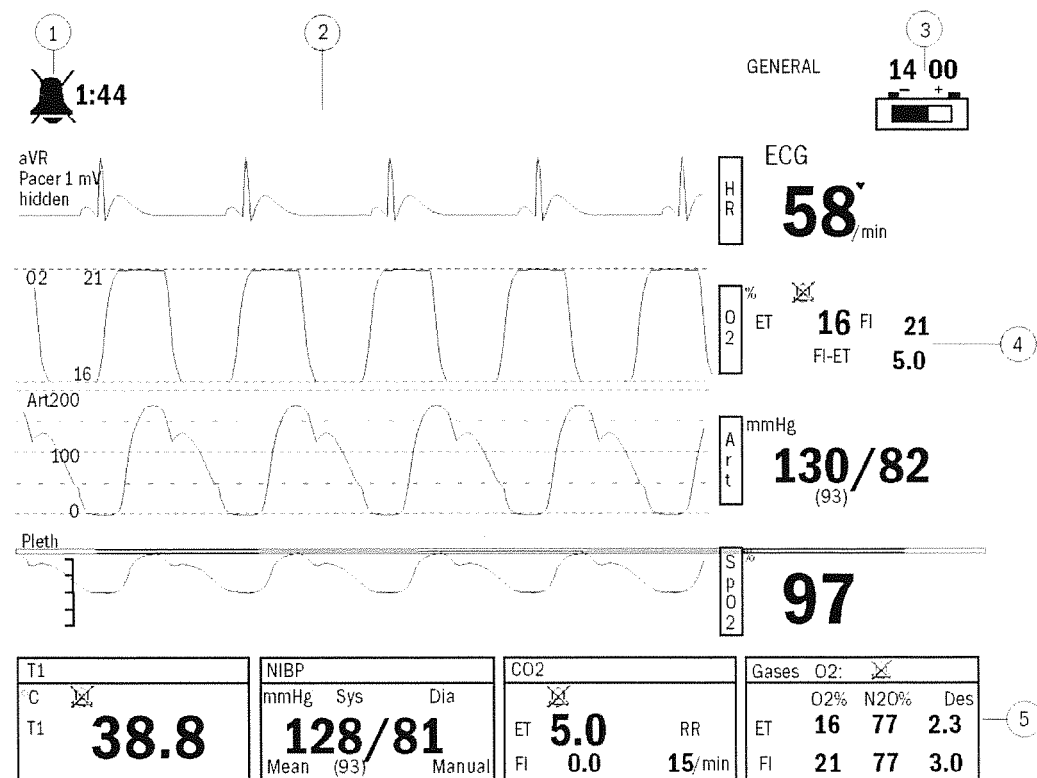
Figure 3-1. Parts of the display

(1) Alarm silence indicator

(2) Alarm message field (for five messages)

(3) Actual time

(4) Waveform fields with corresponding numeric information on the right

(5) Digit fields

Waveform fields and digit fields are configurable.

Display setup

At startup, the display is arranged according to the startup mode definitions. Unused parameters are not displayed and no space is reserved for them.
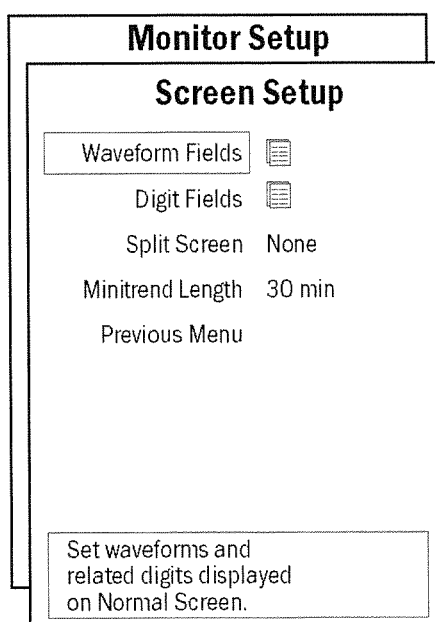

Figure 3-2. Display fields

Changing setup temporarily

You can choose which waveforms and numeric information are displayed, and how they are arranged on the screen.

To change the setup:

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.

2. Select **Screen Setup.**

3. Select **Waveform Fields, Digit Fields, Split Screen,** or **Minitrend Length.**

NOTE: Choosing to display the same parameter in the waveform field and the digit field makes the previously chosen field disappear so that the same information is not displayed in two fields at the same time.

Modifying waveform fields

You can choose which parameters are displayed on the waveform fields, and in which order they are arranged.

Figure 3-3. Waveform field

Up to six waveforms can be displayed at a time. When fewer than six waveforms are displayed, the remaining waveforms are enlarged to fill the entire waveform area.

Changing the waveform also changes the numerical field on the right of the waveform. It may also change the digit fields. If you choose the same measurement in the waveform field that is currently in the digit field, the digit field will disappear so that the same information will not be displayed in two fields at the same time.

To set the parameters for the waveform fields:

4. Press the ComWheel and select **Monitor Setup** from the Main Menu.

5. Select **Screen Setup**.

6. Select **Waveform Fields**.

7. Choose the parameter to be displayed in each field.

The invasive pressure waveforms are displayed only when the transducer is connected to the monitor.

Selecting **Combine Pressures** in the Waveform Fields menu displays invasive pressures in the same waveform field with individual scales.

When you use a 5-lead set in the ECG measurement, up to three different ECG leads can be displayed simultaneously in different fields.

Changing sweep speeds

You can change the waveform sweep speed. Alternatives are **Fast** (6.25 mm/second) and **Slow** (0.62 mm/second). Slow waveforms have a sweep speed one tenth of normal. Slow waveforms show changes better than fast waveforms.

To change the sweep speeds:

8. Press the ComWheel and select **Monitor Setup** from the Main Menu.

9. Select **Sweep Speeds.**

10. Select the parameter and choose the the sweep speed.

Modifying digit fields

Measured patient data may be displayed in up to four digit fields, which are located on the lower part of the screen. You may change the contents or turn each field OFF. If a digit field is turned OFF, the digit field to its left is usually enlarged to fill the space.

T1		NIBP		CO2		Gases O2:			
°C		mmHg Sys Dia		%			O2%	N20%	Des
T1	**38.8**	**128/81**		ET **5.0**	RR	ET	16	77	2.3
		Mean (93) Manual		FI 0.0	15/min	FI	21	77	3.0

Figure 3-4. Digit fields

The digit fields are numbered from left to right in the Digit Fields menu (Lower Field 1 is the left-most field; Lower Field 4 is the right-most field).

Changing the digit field may also change the waveform field setup. If you choose the same measurement in the digit field that is currently in the waveform field, the measurement waveform field will disappear so that the same information will not be displayed in two fields at the same time.

To modify digit fields:

Screen Setup

Digit Fields

Lower Field 1	SpO2	
Lower Field 2	NIBP	OFF
Lower Field 3	HR	HR
Lower Field 4	P2	ST
Previous Menu		P1
		P2
		PCWP
		NIBP
		SpO2
		-More-

Change contents of lower digit field 1. Select OFF to clear field.

11. Press the ComWheel and select **Monitor Setup** from the Main Menu.

12. Select **Screen Setup**.

13. Select **Digit Fields**

14. Choose the parameter to be displayed in each digit field.

▶

Splitting the screen display

You can split a display so that one part always displays spirometry or trend data.
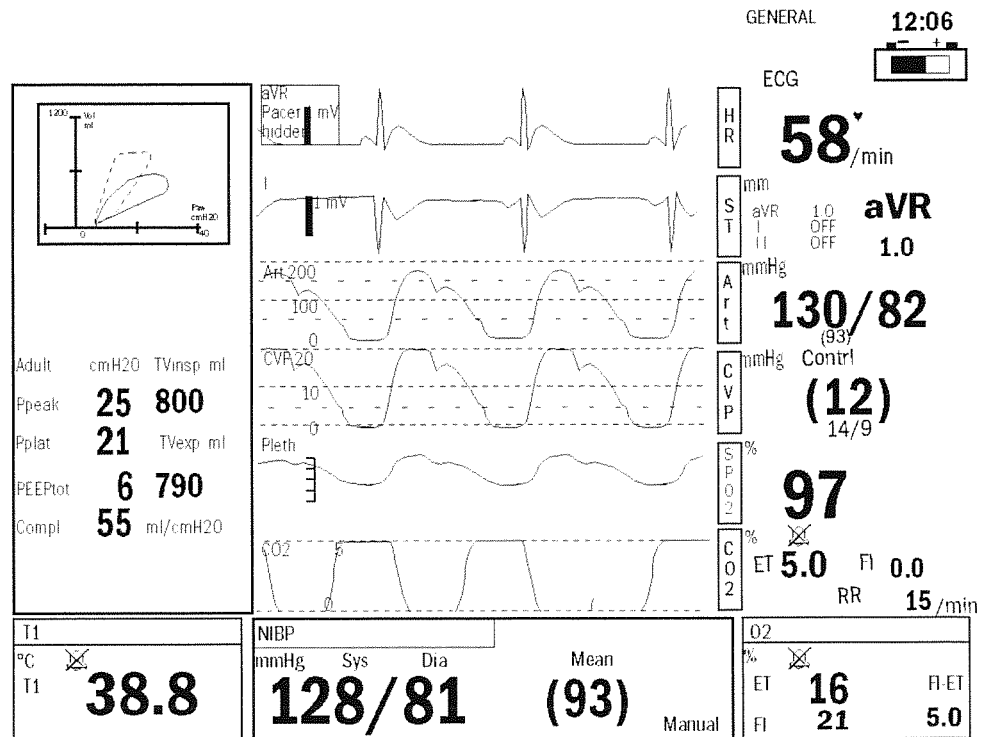
Figure 3-5. Split screen view

To select a split screen view:

15.   Press the ComWheel and select **Monitor Setup** from the Main Menu.

16. Select **Screen Setup**.

17. Select **Split Screen** and choose the option you wish.

- **Spiro 1:** Basic spirometry view information.

- **Spiro2**: Basic spirometry view with additional values.

- **Trend**: Minitrend of the parameters selected to the waveform field.

Minitrend view

You can choose to view the Minitrend data from the last five minutes or the last 30-minute period next to the waveform field for the parameter. 5-minute minitrend is updated every 10 seconds, 30-minute minitrend is updated once every minute.

To modify the trend split screen view:

18. Press the ComWheel and select **Monitor Setup** from the Main Menu.

19. Select **Screen Setup**.

20. Select **Minitrend Length** and choose **5 min** or **30 min**.

Setting time and date

The time is shown in the upper right corner of the screen. The clock format is 24 hours. Turning the monitor off does not affect the clock.

If the monitor is connected to the Datex-Ohmeda S/5 Network and Central, the Time and Date menu is not available. The monitor follows the time and date settings for the center.

NOTE: To prevent the loss of trend data, you cannot change the time settings after starting a new case.

To set the time and date:

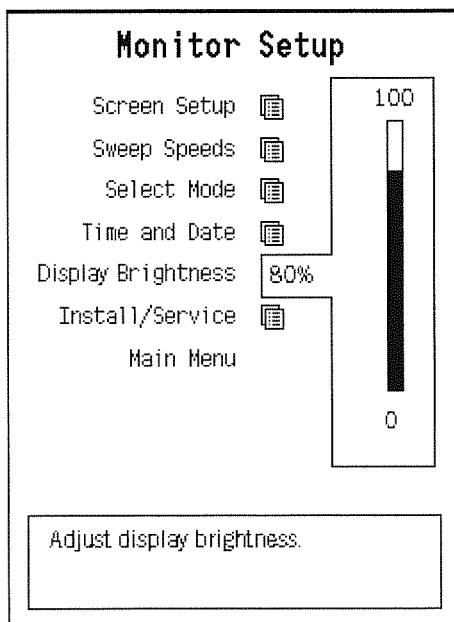| Monitor Setup |
| --- |
| **Time and Date** |
| Hour 14 |
| Minutes 4 |
| Zero Seconds 16 |
| Day 3 |
| Month Apr |
| Year 2001 |
| Previous Menu |
| Set hour. |

21. Press the ComWheel and select **Monitor Setup** from the Main Menu.

22. Select **Time and Date.**

23. Select the option you want to adjust.

- Hour, minutes, and seconds.

- Day, month, and year.

Display brightness

To adjust display brightness according to environmental conditions:

```
Monitor Setup

Screen Setup  ▤         100
Sweep Speeds  ▤
Select Mode   ▤
Time and Date ▤
Display Brightness 80%
Install/Service ▤
Main Menu

                         0

Adjust display brightness.
```

24. Press the ComWheel and select **Monitor Setup** from the Main Menu.

25. Select **Display Brightness.**

26. Choose the desired adjustment (30% to 100%).

Displaying pulse rate

Combined Heart Rate and Pulse Rate can be displayed next to the ECG waveform. The current HR source is displayed with bigger font and the QRS symbol flashes next to it.

```
ECG            Art
HR  58/min  58/min
```
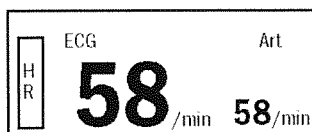
To display a combined Heart Rate and Pulse Rate:

27. Press the **ECG** key.

28. Select **ECG Setup.**

29. Select **Display with HR.**
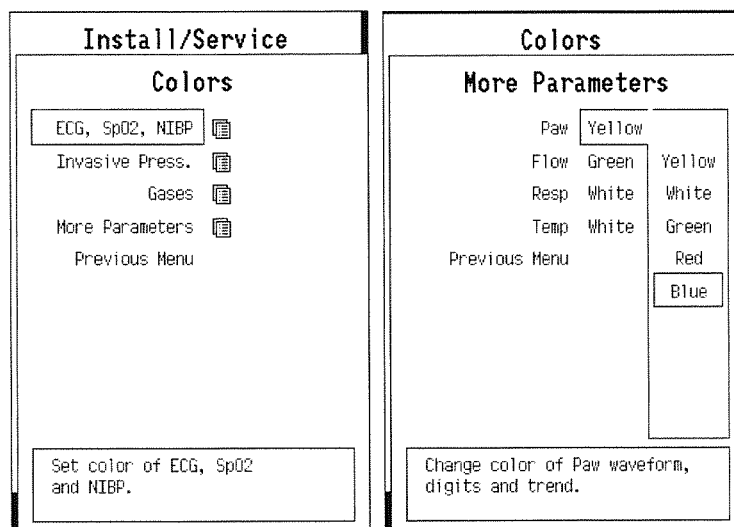
Other adjustable features

This section describes other adjustable features associated with setting up the monitor. A password is required for entering the Install/Service menu where the adjustments are made. If you wish to make changes, we recommend that you contact the person responsible for the entire configuration.

Changing parameter colors

You can select the color of each parameter to be yellow, white, green, red or blue.

To change the color:

30. Press the ComWheel and select **Monitor Setup** from the Main Menu.

31. Select **Install/Service** and enter the password.

32. Select **Colors**.

33. Select the desired parameter and the color you wish for it in the opened adjustment window.

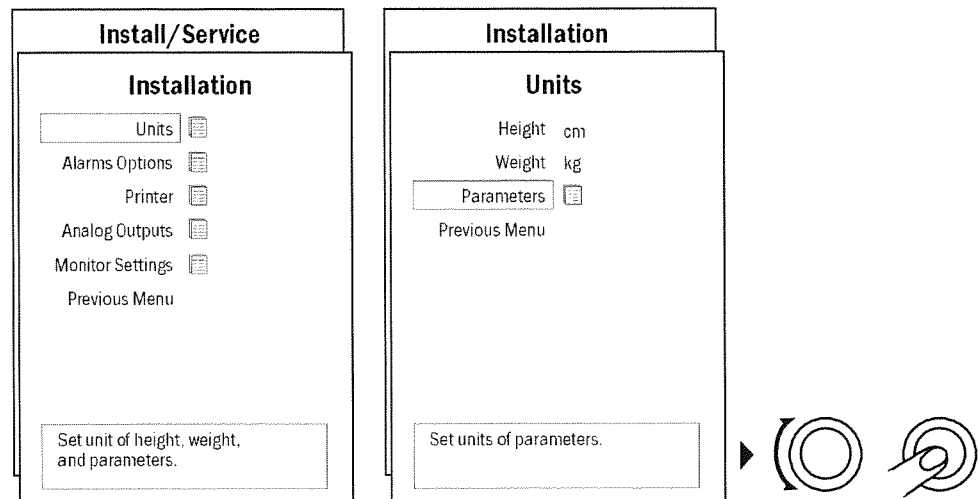| Install/Service		Colors		
Colors		**More Parameters**		
ECG, SpO2, NIBP ▤		Paw	Yellow	
Invasive Press. ▤		Flow	Green	Yellow
Gases ▤		Resp	White	White
More Parameters ▤		Temp	White	Green
Previous Menu		Previous Menu		Red
				Blue
Set color of ECG, SpO2 and NIBP.		Change color of Paw waveform, digits and trend.		

Changing units of measurement

You can choose the units for height, weight, and for individual parameters.

To change the units:

34. Press the ComWheel and select **Monitor Setup** from the Main Menu.

35. Select **Install/Service** and enter the password.

36. Select **Installation**.

37. Select **Units** and choose the units for **Height** and **Weight**.

38. To review and/or change the units for a specific parameter, select **Parameters**.

Install/Service	Installation
Installation	**Units**
Units ▤	Height cm
Alarms Options ▤	Weight kg
Printer ▤	Parameters ▤
Analog Outputs ▤	Previous Menu
Monitor Settings ▤	
Previous Menu	
Set unit of height, weight, and parameters.	Set units of parameters.

For your notes:

Chapter 4. Alarms

Table of Figures

4. ALARMS

Overview

When an alarm for the monitored parameter becomes active, an audible tone sounds and the screen changes as shown and described below:
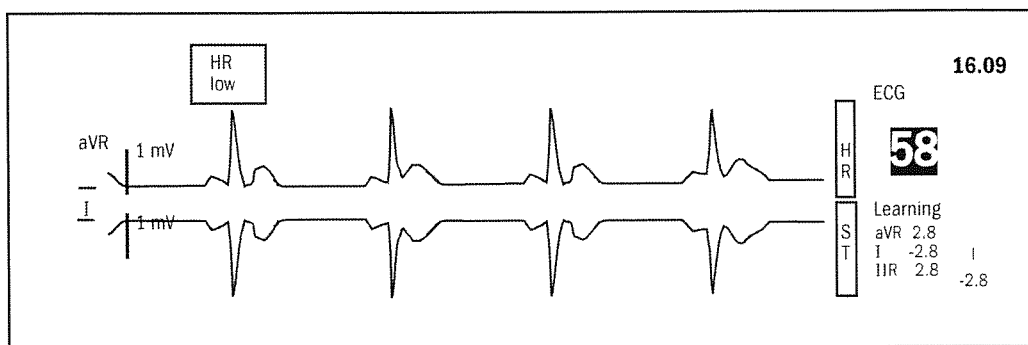

Figure 4-1. View of alarms

(1) Alarm messages appear in order of priority in the message field.

(2) The measurement value flashes. The background color signifies the alarm category.

(3) In some cases, a message in the digit or waveform fields gives more detailed information, using the color of the corresponding parameter.

WARNING: Patient safety. Make sure that necessary alarm limits are set and alarms are on when you start monitoring a patient.

WARNING: Patient safety. When alarms are suppressed, observe the patient frequently.

Alarm categories

Alarms are classified into three categories according to their priority: RED ALARM (highest priority), YELLOW ALARM, and NOTE (white color).

The alarm type depends primarily on the physiological significance and the duration (generally a minimum of 20 seconds) of the alarm. Thus, for example, asystole advances rapidly to a red priority, whereas apnea is allowed a slightly longer duration.

The monitor has three choices of alarm tones and patterns: ISO, ISO2 (the default), and General.

NOTE: There is also a sound for catastrophic situations. A continuous beep sounds if the FiO_2 is less than 18% and EtO_2 less than 10%, FiN_2O is high, or Ppeak is high.

To change the alarm pattern, contact the person responsible for the configuration.

ISO pattern alarms

VISUAL	TONE PATTERN	MEANING
Red LED and measurement value flash	Triple + double beep every 5 seconds. – – – – – 5 – – – – – 5 Exception: The second tone pattern is produced 1 second after the first pattern.	Life-threatening situation.
Yellow LED and measurement value flash	Triple beep every 19 seconds. – – – 19 – – – 19	Serious, but not a life-threatening situation.
White	Single beep –	Advisory note that may be equipment-related, such as "Leads off."

ISO2 pattern alarms

The difference between the ISO pattern and the ISO2 pattern is the rising sound of the tone pattern in the ISO2.

VISUAL	TONE PATTERN	MEANING
Red LED and measurement value flash	Rising triple + double beep every 5 seconds. Exception to this is the second tone pattern which is produced 1 second after the first pattern. – – – – – 5 – – – – – 5	Life-threatening situation.
Yellow LED and measurement value flash	Triple beep every 19.5 seconds. – – – 19.5 – – – 19.5	Serious, but not a life-threatening situation.
White	Single beep. –	Advisory note that may be equipment-related, such as "Leads off."

General pattern alarms

VISUAL	TONE PATTERN	MEANING
Red LED and measurement value flash	Continuous beeping. —	Life-threatening situation.
Yellow LED and measurement value flash	Double beep every 5 seconds. – – 5 – – 5 – – 5	Serious, but not a life-threatening situation.
White	Single beep. –	Advisory note that may be equipment-related, such as "Leads off."

Alarm activation

To make the alarms operative, connect the patient cables. Alarms are operative even when the measurement is not selected on the display (except for the respiration measurement), unless the alarm source is selected Off.

Individual alarms have their own specific requirements before they become active:

- Apnea requires five breaths to be activated.

- Invasive pressures are required to be within alarm limits for 20 seconds after zeroing.

Displaying alarms

Patient alarm limits can be viewed and adjusted in the Alarms Setup menu.

To display the Alarms Setup menu, press the ComWheel and select **Alarms Setup** from the Main Menu.
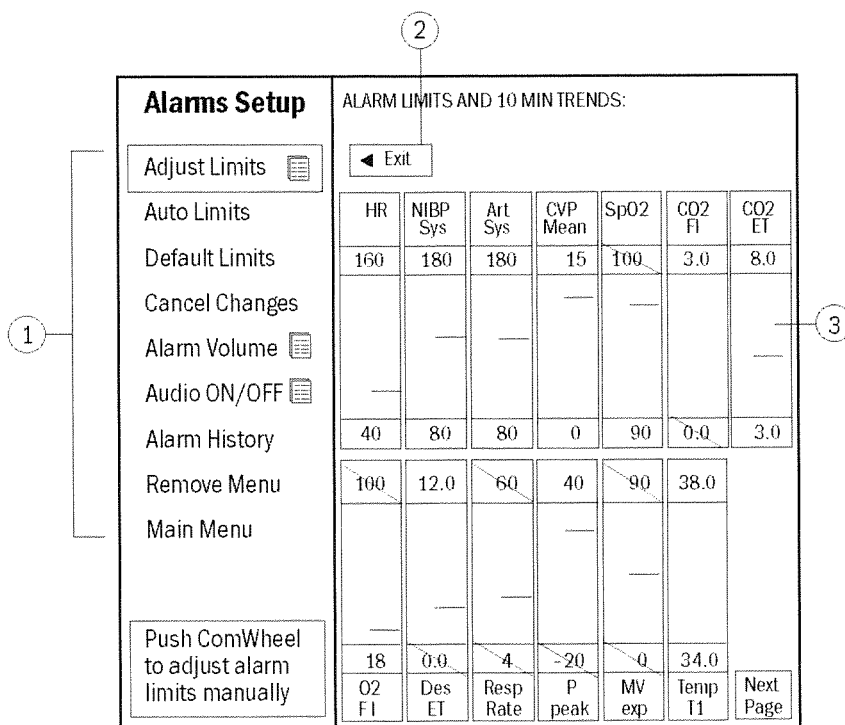

Figure 4-2. Alarms Setup menu and limits screen

(1) List of selections.

(2) **Exit** the alarm limit adjustment area and return to the Alarms Setup menu.

(3) Parameter box with high- and low-limit values with a 10-minute trend displayed to show the current status.

Alarms Setup menu options

Adjust Limits   Adjusts individual measurement alarm limits. The adjustment menu can also be accessed through each parameter menu.

Auto Limits   Auto limits are calculated from the displayed patient reading at the time when auto limits are selected. They are calculated from the last two minutes.

Default Limits   Sets the alarms to the default alarm limits. Default limits can be changed and saved to modes.

                       NOTE: Resetting the case also returns alarm limits to their defaults.

Cancel Changes   Returns all limits to the ones set before entering the Alarms Setup menu, if you have not yet exited the menu.

Alarm Volume   Adjusts the volume of the audio alarms. The range is from 1 (silent) to 10 (loud). **Alarm Volume** does **not** totally silence audible alarms.


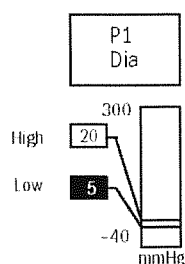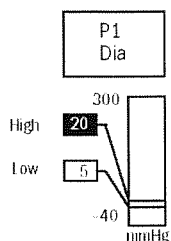**Audio ON/OFF**   Displays the following options:

- **Activate Alarms** activates the silenced alarms.

- **Silence Apnea** silences Apnea and disconnection alarms as well as respiration rate, CO_2, low Ppeak, PEEP, and minute volume limit alarms.

- **Silence ECG** silences asystole alarm and heart rate limit alarms.

- **Silence apnea & asy** is the same as **Silence Apnea** and **Silence ECG** combined (see above).

- **Silence ALL** silences all alarms permanently, except $FiO_2<18\%$ (or $EtCO_2< 10\%$), $FiN_2O>82\%$, and Ppeak > 70 cmH_2O alarms.

Alarm History   Displays a list of the last 20 alarms which have reached the yellow or the red alarm level. The alarm list items have the occurrence time and the type beside them.

Remove Menu   Displays only the alarm limits and 10-minute trends.

Adjusting alarm limits

Changing limits

To change alarm limits for parameters:

Adjust Limits 🔳			
100	8.0	3.0	100
90	3.0	0.0	18
SpO2	CO2 ET	CO2 FI	O2 FI	Next Page

1. Press the ComWheel and select **Alarms Setup** from the Main Menu.

2. Select **Adjust Limits**.

3. Turn the ComWheel to highlight the measurement you wish.

4. Press the ComWheel to display an adjustment window.

P1 Dia

300

High 20

Low 5

-40

mmHg

5. Turn the ComWheel to change the High alarm limit and/or press the ComWheel to accept the limit.

The cursor moves to the Low setting.

P1 Dia

300

High 20

Low 5

-40

mmHg

6. Turn the ComWheel to change the Low alarm limit and/or press the ComWheel to accept the limit.

7. To adjust other measurements, select **Previous Menu.**

or

To return to the Alarms Setup menu, select **Alarms Setup.**

or

To return to the normal monitoring display, press the **Normal Screen** key.

You can also enter the alarm limit adjustment window through the measurement menus. When you are in a parameter menu, select the alarm for that parameter or enter the setup menu for that parameter, then select the alarm.

NOTE: The ST alarm limits, located in the HR alarm limits menu, can be set after the ST learning sequence. For ST, you receive advisory messages only.

Canceling changes

Before you exit the Alarms Setup menu, select **Cancel Changes** to return all limits to those that were in effect before you entered the Alarms Setup menu.

Returning to default limits

Select **Default Limits** in the Alarms Setup menu to set the alarms to the factory default alarm limits.

Choosing automatic limits

To get automatic patient-related alarm limits that enable close patient control, select **Auto Limits** in the Alarms Setup menu. These limits are calculated using the displayed patient readings during the two minutes immediately prior to the time when **Auto Limits** is selected.

Calculation formulas for automatic limits

The basis for calculating automatic limits is shown below.

Parameter	Calculation formula
Pulse Oximetry	
SpO_2 high	(100) = OFF
SpO_2 low	$SpO_2 - 5\%$
Temperature	
T1 high	T1 + 1 °C
T1 low	T1 – 1 °C
T2 high	T2 + 1 °C
T2 low	T2 – 1 °C
Hemodynamic Parameters	
HR high	HR * 1.25
HR low	HR * 0.75
NIBP sys, dia, mea high	NIBP sys/dia/mea * 1.25 + 10
NIBP sys, dia, mea low	NIBP sys/dia/mea * 0.75 – 10
P1, P2 high	P * 1.25 + 5/10 depending on the label
P1, P2 low	P * 0.75 – 5/10 depending on the label
Gases	
$EtCO_2$ high	$EtCO_2 + 1\%$
$EtCO_2$ low	$EtCO_2 - 1\%$
Resp high	RR * 1.25 + 2
Resp low	RR * 0.75 – 2
Spirometry	
Ppeak high	Ppeak + 10
Ppeak low	Ppeak – 10
PEEP high	PEEP + 5
PEEP low	PEEP – 5
Mvexp high	Mvexp + 2
Mvexp low	Mvexp – 2

Changing alarm sources

For NIBP, invasive pressure, O_2, anesthetic agents, and temperature, you can select which measured values trigger the alarm.
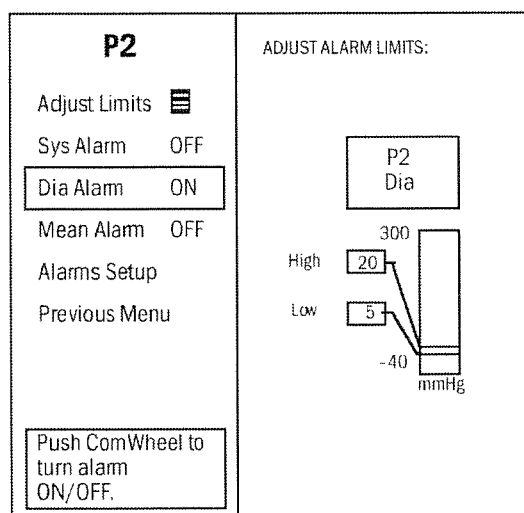
- For the pressures, the choices are **Systolic**, **Diastolic**, **Mean**, or **OFF**. If **OFF** is selected, the parameter box with the 10-minute trend is not displayed.

- For O_2 and anesthetic agents, the alternative alarm sources are ETO_2 or FiO_2.

- Temperature choices are **T1** and **T2**. Only the last-modified source is active.

To change the alarm source:

8. Press the ComWheel and select **Alarms Setup** from the Main Menu.

9. Select **Adjust Limits**.

10. Turn the ComWheel to highlight the measurement you wish, then press the ComWheel.

   An adjustment window is displayed.

11. Wheel as many times as required to get from the limit setting to the menu selections.

12. Select the desired alarm and press the ComWheel to change the selection to **OFF** or **ON**.

P2	ADJUST ALARM LIMITS:
Adjust Limits ▤	
Sys Alarm OFF	
Dia Alarm ON	P2 Dia
Mean Alarm OFF	300
Alarms Setup	High 20
Previous Menu	Low 5
	-40 mmHg
Push ComWheel to turn alarm ON/OFF.	

▶ ◎ ◎

Suppressing alarms

🔔 APN.
ASY.   When alarms are suppressed, this warning symbol is displayed.

NOTE: If alarms are suppressed and a power interruption occurs, or if the monitor is turned off for up to 15 minutes, check the alarm status before you resume monitoring or begin monitoring a new patient.

Warning: Patient Safety. When alarms are suppressed, observe the patient frequently.

Suppressing audible alarms permanently

For special cases, such as lung operations, it may be desirable to suppress certain audible alarms entirely.

13. Press the ComWheel and select **Alarms Setup** from the Main Menu.

14. Select **Audio ON/OFF**.

15. Select **Silence Apnea**, **Silence ECG**, **Silence Apn&ECG** or **Silence ALL**.

Alarms Setup	ALARM LIMITS AND 10 MIN TRENDS:

Audio ON/OFF		P	SpO2	CO2 FI	O2 ET
Activate Alarms		s			
Silence Apnea		22	100	3.0	100
Silence ECG					
Silence Apn&ECG			—		
Silence ALL					
Previous Menu		5	92	0.0	10
		4	39.8		
Silence audible apnea, CO2, RR, spirometry and ECG alarms permanently.		0 V P	37.7 Temp T1		

▶ ⊙ ⊚

If an active alarm is suppressed, a reminder beep sounds every two minutes. You can adjust the volume of the reminder beep in the Audio ON/OFF menu.

Reactivating alarms

Select **Activate Alarms** to turn audible alarms on.

Suppressing audible alarms for two or five minutes

- To suppress audible alarms for two minutes, press the **Silence Alarms** key once.

- To suppress audible alarms for five minutes, press the **Silence Alarms** key for more than three seconds.

If the alarms are not active when you press the **Silence Alarms** key, they are pre-silenced for two minutes or five minutes. Exception: $FiO_2 < 18\%$, $EtO_2 < 10\%$, $FiN_2O > 82\%$, and high Ppeak alarms are silenced for 20 seconds. New alarms are displayed.

Reactivating suppressed alarms

Press the **Silence Alarms** key during the silent period to activate new alarms immediately, activate silenced alarms (after one minute), and the apnea alarm (after five breaths).

Suppressing alarms for individual parameters

You can turn off the alarms without changing the alarm limits for the following parameters:

- $FiCO_2$

- EtO_2 and FiO_2

- NIBP (Sys, Dia, and Mean)

- ST (Lat. and Inf.)

- Temperature (T1 and T2)

To turn off or turn on alarms for a parameter:

16. Press the ComWheel and select **Alarms Setup** from the Main Menu.

17. Select **Adjust Limits**.

18. Turn the ComWheel to highlight the measurement and press the ComWheel.

19. In the adjustment window that is displayed, press the ComWheel as needed to move to the menu selections.

20. Select the parameter alarm to be suppressed from the menu and press the ComWheel to turn the selection **OFF**.

This symbol is displayed in the digit field for each alarm you suppress.

or

Select the parameter alarm to be reactivated from the menu and press the ComWheel to turn the selection **ON**.

Transferring alarms

All alarms can be transferred to the Datex-Ohmeda S/5 Network and Central or to another monitor that is connected to the Datex-Ohmeda monitor network.

21. Press the ComWheel and select **Patient Data** from the Main Menu.

22. Select **Other Patients**.

23. Select **Receive Alarms.**

24. Select one of the sites on the list that is displayed.

Recording alarms automatically

You can choose to generate an automatic strip chart recording when asystole, heart rate, and pressure alarms reach the red alarm level. The recorder will print the ECG + Art waveforms.

To record on alarms automatically:

Record & Print

Record Waveforms

Record Wave		
Waveform 1	ECG1	YES
Waveform 2	OFF	NO
Waveform 3	OFF	
Start on Alarms	YES	
Delay	12 s	
Paper Speed	25 mm/	
Length	30 s	
Previous Menu		

Select YES for automatic start of recording when serious arrhythmias occur.

25. Press the ComWheel and select **Record/Print** from the Main Menu.

26. Select **Record Waveforms**.

27. Select **Start on Alarms** and choose **YES**.

Recording will start from the following alarms:

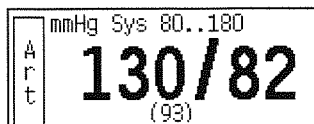| Alarm	Recorded parameters
Asystole	ECG + P1 waveforms, 25 mm/sec
HR High/Low	ECG + P1 waveforms, 25 mm/sec
P1 High/Low	ECG + P1 waveforms, 25 mm/sec

Recording time is 30 seconds: 12 seconds recording from the recorder memory, 18 seconds real-time recording. Alarm recordings are annotated with the alarm source.
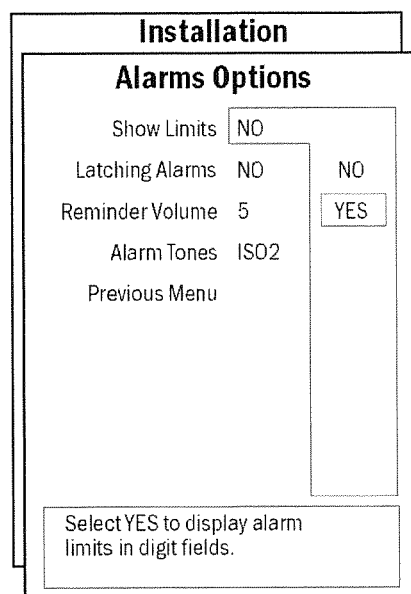
Other adjustable features

This section describes the other adjustable features related to alarms. A password is required for entering the Install/Service menu where the adjustments are made. If you wish to make changes, we recommend that you contact the person responsible for the entire configuration.

Displaying limits

Alarm limits can be displayed next to the numerical parameter value as shown below.

```
┌──┬──────────────────┐
│  │ mmHg Sys 80..180 │
│ A│                  │
│ r│  130/82          │
│ t│     (93)         │
└──┴──────────────────┘
```

To display alarm limits:

```
┌─────────────────────────────┐
│        Installation         │
│ ┌─────────────────────────┐ │
│ │      Alarms Options      │ │
│ │                          │ │
│ │  Show Limits │ NO │      │ │
│ │                          │ │
│ │  Latching Alarms  NO    NO│ │
│ │                          │ │
│ │  Reminder Volume  5   │YES││ │
│ │                          │ │
│ │   Alarm Tones    ISO2    │ │
│ │                          │ │
│ │   Previous Menu          │ │
│ │                          │ │
│ │                          │ │
│ │                          │ │
│ │                          │ │
│ ├──────────────────────────┤ │
│ │ Select YES to display alarm│ │
│ │ limits in digit fields.   │ │
│ └──────────────────────────┘ │
└─────────────────────────────┘
```

28. Press the ComWheel and select **Monitor Setup** from the Main Menu.

29. Select **Install/Service** and enter the password.

30. Select **Installation**.

31. Select **Alarms Options**.

32. Select **Show Limits** and choose **YES** or **NO**.

▶ (◎) (ⓐ)

Make sure the alarm source is selected. The alarm limits become visible when patient monitoring begins and the monitor receives patient data.

Changing the tone pattern

The monitor has three choices of alarming tone patterns: ISO, ISO2, and General.

To change the tone pattern:

33. Press the ComWheel and select **Monitor Setup** from the Main Menu.

34. Select **Install/Service** and enter the password.

35. Select **Installation**.

36. Select **Alarms Options**.

37. Select **Alarm Tones** and choose **ISO**, **ISO2**, or **General**.

Latching alarms

Latching alarms enables unattended monitoring. If **Latching Alarms** is active, alarm messages continue to be displayed even if the initial alarm condition has ceased. A reminder beep sounds every 10 seconds.

- To clear all inactive alarm messages and the beep, press the **Silence Alarms** key once.

- To clear all inactive and active alarm messages, enabling only new upcoming alarm messages, press the **Silence Alarms** key twice.

To select latching alarms:

Installation
Alarms Options
Show Limits YES
Latching Alarms YES   NO
Reminder Volume 5   YES
Alarm Tones ISO2
Previous Menu
Alarm messages remain on screen until Silence Alarms key is pressed.

38. Press the ComWheel and select **Monitor Setup** from the Main Menu.

39. Select **Install/Service** and enter the password.

40. Select **Installation**.

41. Select **Alarms Options**.

42. Select **Latching Alarms** and choose **YES**.

Alarm behavior

If the alarm mode is latched, the technical alarms are latched as well. This does not comply with the NIBP (IEC 60601-2-30) and invasive pressure (IEC 60601-2-34) standard requirements.

Automatic snapshots and printouts of them

When an Asystole, HR high or low, or P1 high or low alarm occur, the monitor can automatically create and print a snapshot that you can view in the Trends menu. A snapshot is created when the Asystole, heart rate, or P1 red alarm is activated. The snapshot contains data from the last 15 seconds.

To create a snapshot on alarms and print it automatically:

Trends & Snapshot

Snapshot

Field 1	ECG1/r	
Field 2	ECG1	NO
Field 3	P1	Alarms
Field 4	ST	ALL
Field 5	P1+HR	
Field 6	Num 1	
Print Loops	NO	
Create on Alarms	YES	
Automatic Print	NO	
Previous Menu		

Automatic printing when
serious arrhythmias occur.

43. Press the ComWheel and select **Monitor Setup** from the Main Menu.

44. Select **Install/Service** and enter the password.

45. Select **Trends&Snapshot.**

46. Select **Snapshot**.

47. Select **Create on Alarms** and choose **YES**.

48. Select **Automatic Print** and choose **Alarms**.

For your notes:

Chapter 5. Trends and Snapshots

Table of Figures

5. TRENDS AND SNAPSHOTS

Overview

A trend is a collection of the measured patient data. The monitor displays two types of trend information: graphical and numerical. You can create snapshots (frozen frames saved to memory) of this information.

The monitor collects graphical and numerical trend data automatically from the trended parameters. You can select between 20 minutes and 24 hours of trend time.

You can view the trends in the Trends menu, or you can continuously display graphical "minitrends" next to the waveform fields. A minitrend is a view of collected trend data from the last 5-minute period or 30-minute period, depending on which period of time you chose.

Trended parameters

The trend parameters are listed below

- Electrocardiograph (HR)
- ST analysis
- Invasive pressure
- Noninvasive blood pressure
- Oxygen saturation (Pleth, SpO_2)
- Gases (CO_2, O_2, N_2O, AA, MAC, Resp)
- Respiration rate (RR)
- Temperature
- Airway pressure
- Airway flow
- Derived values from airway pressure and flow
- NMT

Trend data is stored in memory for 15 minutes after the power is turned to Standby.

Factory default parameters

For factory default parameters, contact the person responsible for the entire configuration.

The configuration and the mode determine which parameters are displayed.

The unit of the parameter matches the real-time waveform settings for that parameter.

To change the snapshot or graphical trend settings, see *Configuring snapshot and graphical trend pages* at the end of this chapter.

NOTE: You cannot change the contents of numerical trend fields. Numerical trend fields cannot be configured.

Most common tasks

To display trends		Press the **Trends** key to open the Trends menu.
		The trend (graphical or numerical) that was displayed last appears beside the Trends menu.
	To scroll time with the trend cursor	1. Select **Cursor**.
		2. Turn the ComWheel to move the cursor.
		For the graphical trend, the numeric measurement values for the displayed time are next to the cursor.
		3. Press the ComWheel to return to the Trends menu.
	To see more parameters on other pages	Select **Next Page**.
	To change time scale	Select **Time Scale** and the trend time (**20 min** or **1 , 2, 4, 6, 8, 10, 12, 24 hours**).
	To change trend type or a snapshot to be viewed	Select **Graphical**, **Numerical** or **Snapshot**.
	To change scaling	Select **Trend Scales**.
To select minitrend split screen		1. Select **Monitor Setup** in the Main Menu.
		2. Select **Screen Setup**.
		3. Select **Split Screen** and **Trend**.
To create snapshots		Select **Take Snapshot** in the Trends menu.
To record trends		Press the **Record Trend/Stop** key.
		or
		1. Select **Record/Print** in the Main Menu.
		2. Select **Record Trends**.
		3. Select **Record Numerical** or **Record Graphical.**
To print trends		To print the currently viewed trend data, press the **Trends** key and select **Print Page**.
		To print graphical trend data, select **Print Graphical** in the **Record/Print** menu.
		To print numerical trend data, select **Numerical** and then **Print Page**.
To erase trend history		1. Select **Reset Case** in the Main Menu.
		2. Select **Reset Trends** and **Yes** in the adjustment window.

Recording trend data

Press the **Record Trend/Stop** key.

or

1. Press the ComWheel and select **Record/Print** from the Main Menu.

2. Select **Record Trends**.

3. Select **Record Numerical** or **Record Graphical.**

    Graphical trends are recorded from the time period that corresponds to the time scale (20min - 24h) chosen for them in the Trends menu.

Changing graphical trend parameters

To change the recorded parameters for graphical trends:

4. Press the ComWheel and select **Record/Print** from the Main Menu.

5. Select **Record Trends**.

6. Select **Graphic Trend 1** and choose the parameter to be recorded.

7. Select **Graphic Trend 2** and choose the parameter to be recorded.

Printing trend data

8. Press the **Trends** key.

9. Select **Graphical** or **Numerical**.

10. Select **Print Page**.

    If you wish to print trend data located on other pages, select **Next Page** and **Print Page**.

Printing selected pages of graphical trend data

11. Press the ComWheel and select **Record/Print** from the Main Menu.

12. Select **Print Graphical**.

13. Select the page (**Page 1**, **Page 2**, etc.).

Erasing trend data

14. Press the ComWheel and select **Reset Case** from the Main Menu.

15. Select **Reset Trends**.

16. In the opened window, select **YES** to erase the trends.

    or

    Select **NO** to cancel the function.

Graphical trend view

Graphical trend pages contain up to four pages with five fields on each page. All five fields are usually visible and can be printed.

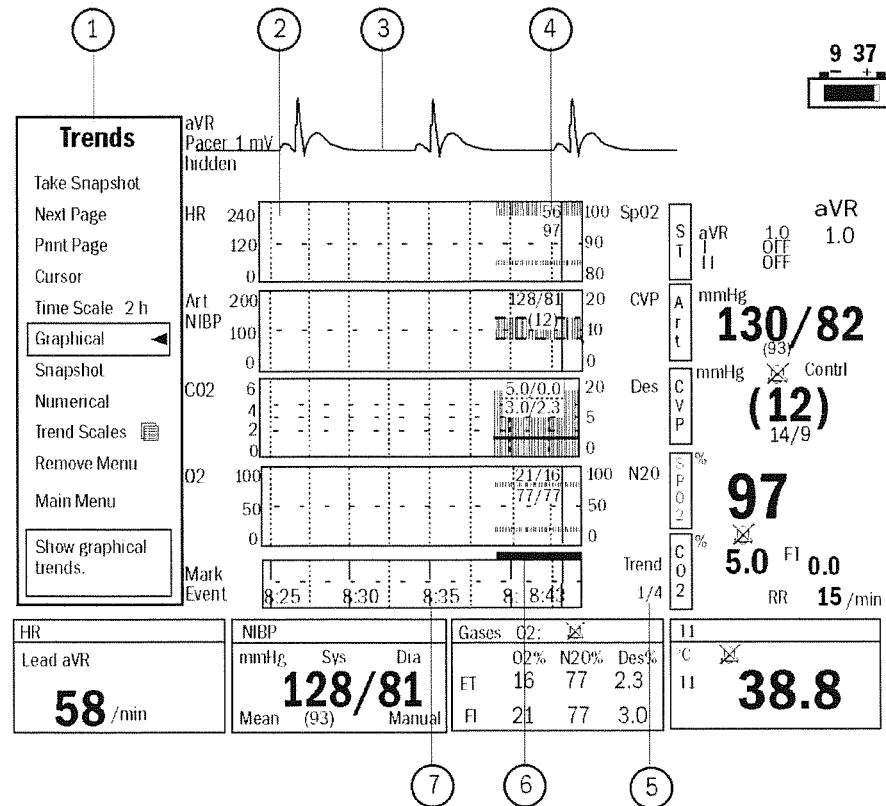Parameter scale, label, unit, and color follow the real-time waveform settings for each parameter. Exceptions: you can select the HR and temperature scales in the Trend Scales menu.

Figure 5-1. Graphical trend view

(1) Trends menu

(2) Trend measurement field

(3) Real-time ECG

(4) Numeric value of a measurement at the trend cursor point

(5) Trend page number

(6) Indication of the amount of data gathered and viewed

(7) Time and marker field

Graphical trend view symbols

] ̲ Trend bar, parameter scale to the left. The gap shows the mean value (except in the Paw field where it indicates Pplat).

[̲ Trend bar, parameter scale to the right. The gap shows the mean value (except in the Paw field where it indicates Pplat).

[̲ NIBP trend bar.

⋮ A dotted vertical line across the trend field indicates a change, such as a change of ECG lead, anesthetic agent, or zeroing the invasive blood pressure channel.

___ A blue, white, or red line above the marker field indicates the following:

- **Blue line**: the left end of the line is the point at which gathering of trend data started. The right end shows the last moment data was gathered.
- **White line**: the proportion of data shown on the screen. If the line is on the left, leaving space on the right, there is more data to see after the current view. If the line is on the right, there is more data before the current view. If the line is in the middle, there is more data at the beginning and end of the case.
- **Red line**: the time period during which a 20-minute trend was gathered.

Changing the time scale (trend length and resolution)

Adjust the time scale (and/or parameter scale) as needed to view the desired level of trend detail.

To change trend length and resolution:

17. Press the **Trends** key and select **Time Scale** in the Trends menu.

18. Select the trend length.

Trend length on the display	Resolution	Trended Time Period
20 min	10 seconds	last 30 minutes
1 h	1 minute	last 24 hours
2 h	1 minute	last 24 hours
4 h	2 minutes	last 24 hours
6 h	3 minutes	last 24 hours
8 h	4 minutes	last 24 hours
10 h	5 minutes	last 24 hours
12 h	6 minutes	last 24 hours
24 h	12 minutes	last 24 hours

Moving on graphical trend pages

Numerical measurement values for trended parameters appear next to the cursor on the graphical trend. The displayed values were measured at the time indicated by the cursor.

To view trend values for specific times:

19. Press the **Trends** key and select **Cursor**.

20. Turn the ComWheel to move the cursor and scroll the values for specific times.

21. To return to the Trends menu, press the ComWheel.

22. To see more parameters on other pages, select **Next Page** in the Trends menu.
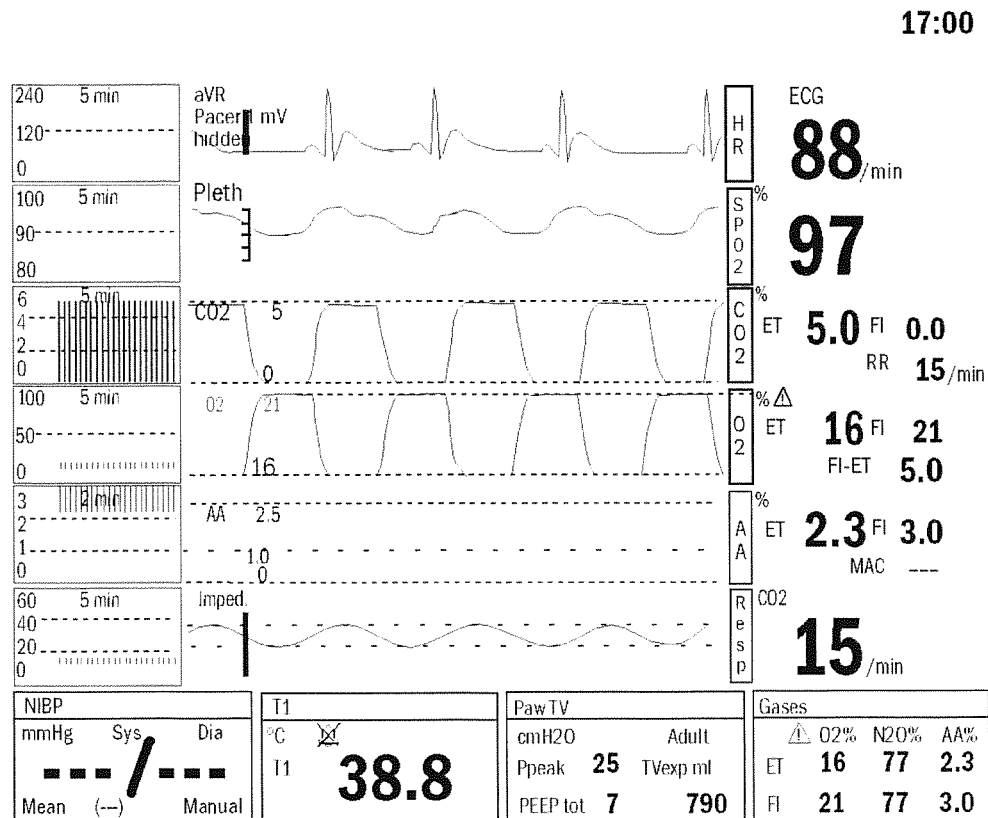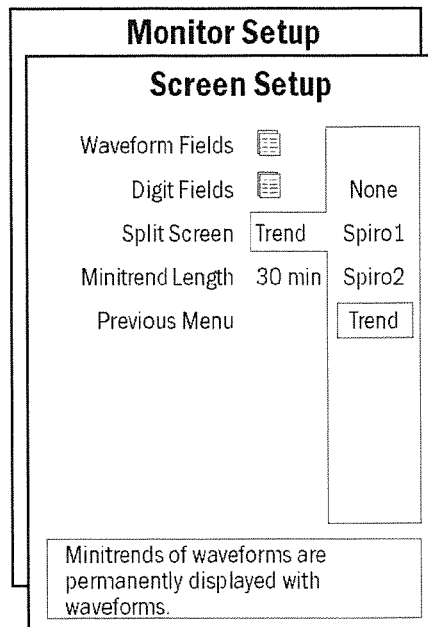
Minitrend view

17:00

Figure 5-2. Minitrend view

You can split the **Normal Screen** display so that one fourth of the display (on the left) shows continuous graphical minitrends. Minitrends show the measurements selected for the waveform fields.

NOTE: The split screen option is possible only with displays that have waveforms on the **Normal Screen**.

Adding a minitrend

To split the screen and show minitrends:

Monitor Setup

Screen Setup		
Waveform Fields	▤	
Digit Fields	▤	None
Split Screen	Trend	Spiro1
Minitrend Length	30 min	Spiro2
Previous Menu		Trend

Minitrends of waveforms are permanently displayed with waveforms.

23. Press the ComWheel and select **Monitor Setup** from the Main Menu.

24. Select **Screen Setup**.

25. Select **Split Screen** and choose **Trend**.

▶ ◎ ⊚

Choosing the length of minitrend data

You can view a minitrend consisting of the last 5 minutes or the last 30 minutes of trend data. A 5-minute minitrend is updated every 10 seconds; a 30-minute minitrend is updated once every minute.

To choose the length of the minitrend data:

26. Press the ComWheel and select **Monitor Setup** from the Main Menu.

27. Select **Screen Setup**.

28. Select **Minitrend Length** and choose **5 min** or **30 min**.

Removing a minitrend

To remove the minitrend from the display:

29. Press the ComWheel and select **Monitor Setup** from the Main Menu.

30. Select **Screen Setup**.

31. Select **Split Screen** and choose **None**.

Numerical trend view

Numerical trends contain:

- One to four pages of trend information (24 hours maximum).
- Real-time ECG at the top of each page.
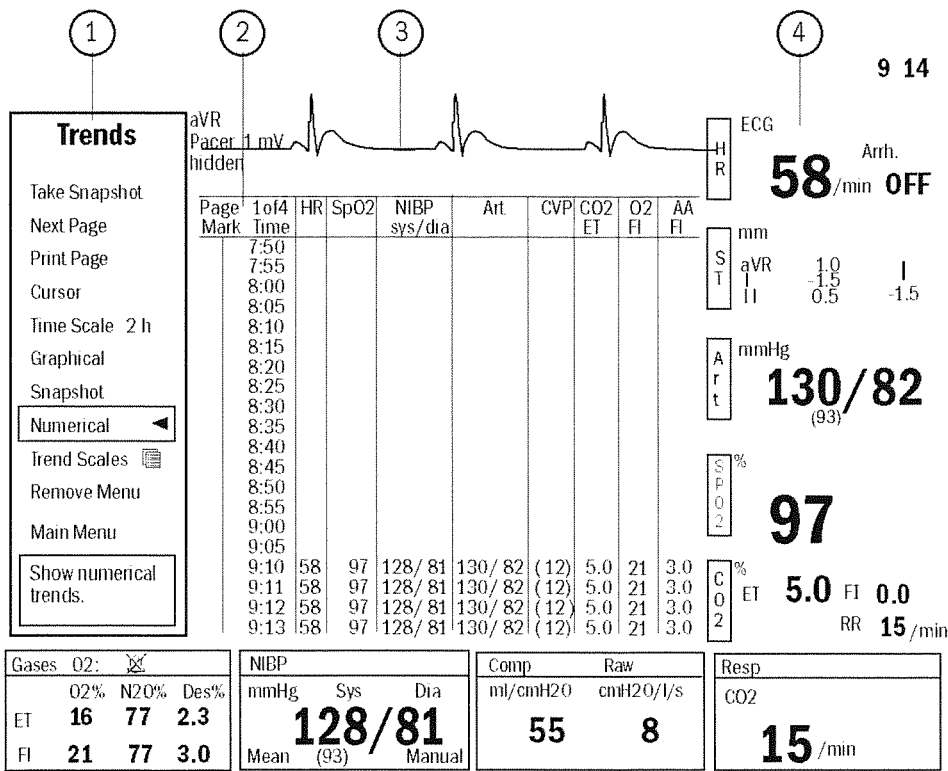
The resolution is five minutes.

Figure 5-3. Numerical trend page

(1) Trend menu

(2) Page number

(3) Real-time ECG

(4) Real-time digit fields, if the waveform display is **Normal Screen**

Scrolling numerical trend pages

Use the ComWheel to scroll the trend vertically.

When the highlight reaches the top or the bottom of the view, the next five minutes of information appears.

Snapshots

A snapshot is a frozen frame that is saved to the monitor memory. A snapshot captures the contents of the frozen frame chosen during configuration, not the image you are currently viewing when you take the snapshot. A snapshot can contain waveforms, numerical trends, and graphical trends.
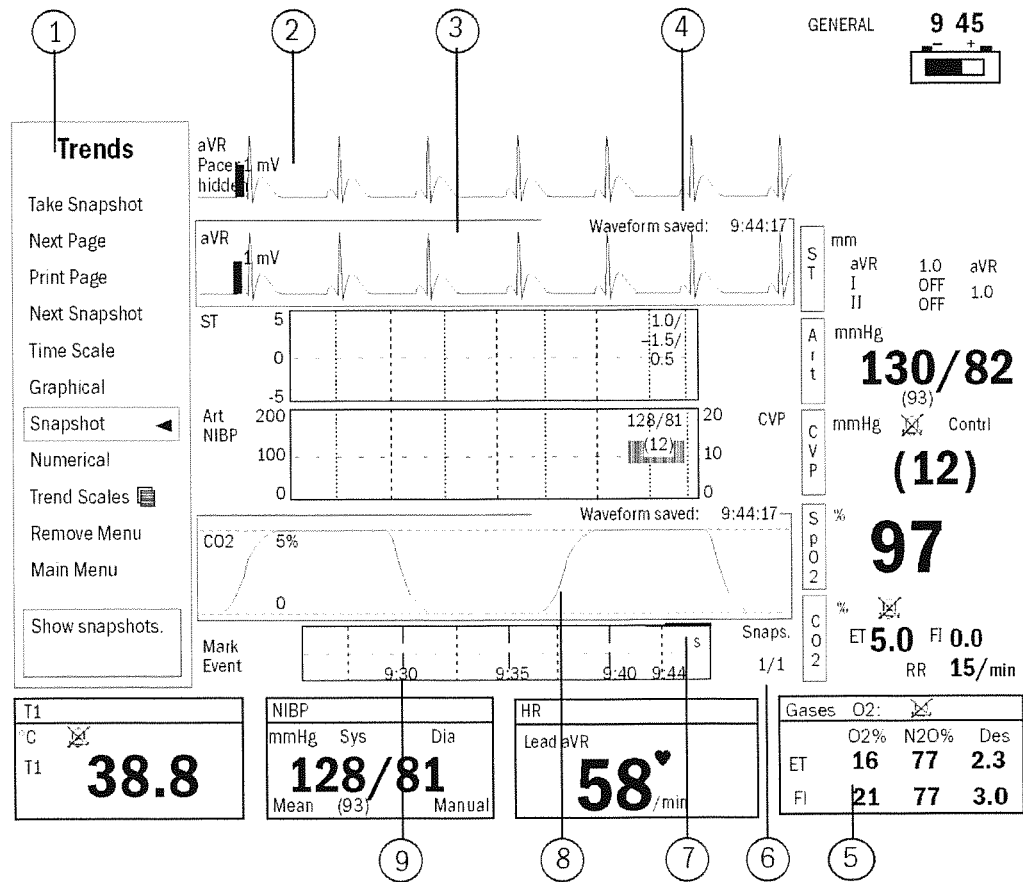
Figure 5-4. Waveform snapshot page

(1) Trends menu

(2) Real-time ECG

(3) Waveform snapshot

(4) Time of the snapshot (If created on an alarm, the cause of the alarm appears.)

(5) Real-time digit fields, if the waveform display is **Normal Screen**

(6) Page number

(7) Waveform cursor

(8) Graphical trend snapshot

(9) Time and marker field

To change the content of the snapshot page, see *Configuring snapshot and graphical trend pages* at the end of this chapter.

Viewing snapshots

A snapshot includes 15 seconds of a waveform and/or graphical trend from the time period that corresponds to the time scale selected for the graphical trend and/or the numerical trend.
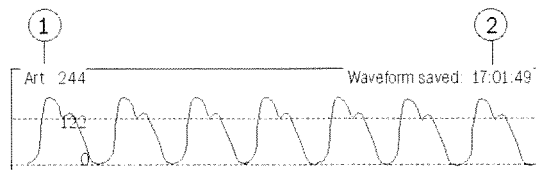

Figure 5-5. Waveform snapshot

(1) Numerical label

(2) Time when saved

The rest of the settings depend on the current settings for each real-time waveform.

There is one configurable waveform snapshot page. The page contains up to six fields that can include snapshots of waveforms and graphical and numerical trends.

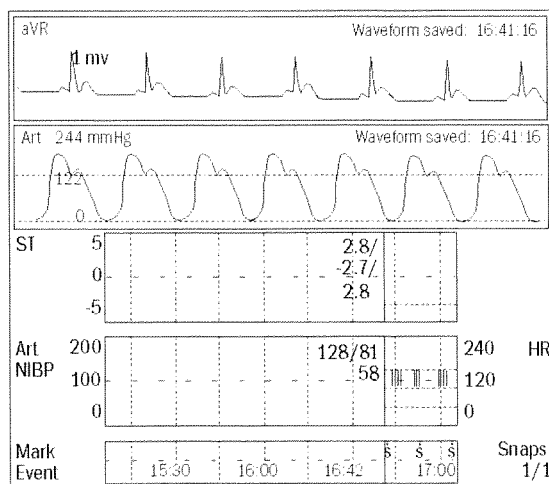You can see five fields on the display but six on the printout.

Figure 5-6. Snapshot fields

To view snapshots:

32. Press the **Trends** key and select **Snapshot** from the Trends menu.

33. Select **Next Snapshot**.

34. Turn the ComWheel to move the cursor in the time and marker field.

35. When the cursor reaches the saving time of a snapshot (marked with an "S" in the time axis), the snapshots that were saved at that time appear.

36. Press the ComWheel to return to the menu.

Creating snapshots

To create a snapshot, press the **Trends** key and select **Take Snapshot**.

The waveforms and trends that are currently selected to the Snapshot page will be saved. You can take up to 16 snapshots, depending on the data load and the amount of fields chosen to contain information on the snapshot page.

Marking an event

At the time **Take Snapshot** is selected, a number is inserted in the numerical trends beside the trend information. This number marks the event at which a snapshot was created.

Also, NIBP measurement marks a trend line. If there are several measurements during one minute, a one-minute average appears instead of individual measurements.

Page 4 Of 4	T1	T2	SpO2
Mark Time	T1	T2	
12:25			
12:30			
12:35			
1 12:39	38.8	20.0	
12:40	38.8	20.0	
2 12:43	38.8	20.0	
12:45	38.8	20.0	

Figure 5-7. Marking numerical trends

The event number also appears on numerical trend printouts.

Erasing snapshots

The snapshots will be erased when you reset the case or reset the trends. They are also erased after 24 hours automatically.

To erase snapshots:

37. Press the ComWheel and select **Reset Case** from the Main Menu.

38. Select **Reset Trends** or **Reset ALL**, and choose **YES**.

As memory fills up, older snapshots are overwritten automatically.

Other adjustable features

This section describes the other adjustable features related to trends and snapshots. A password is required for entering the Install/Service menu where the adjustments are made. If you wish to change the adjustments, contact the person responsible for the entire configuration.

Creating snapshots on alarms

The monitor can automatically create snapshots when the following alarms occur: Asystole, HR high, HR low, P1 high, P1 low.

Trends & Snapshot		
Snapshot		
Field 1	ECG1/r	
Field 2	ECG1	NO
Field 3	ECG2	YES
Field 4	P2	
Field 5	P1+HR	
Field 6	Num 1	
Print Loops	NO	
Create on Alarms	YES	
Automatic Print	NO	
Previous Menu		
Select YES to create a snapshot automatically when Brady, Tachy or ART High/Low alarm occurs.		

39. Press the ComWheel and select **Monitor Setup** from the Main Menu.

40. Select **Install/Service** and enter the password.

41. Select **Trends & Snapshot**.

42. Select **Snapshot**.

43. Select **Create on Alarms** and choose **YES**.

Printing snapshots automatically

Snapshots can be printed on request, on alarms, or when they are created.

Trends & Snapshot		
Snapshot		
Field 1	ECG1/r	
Field 2	ECG1	NO
Field 3	P1	Alarms
Field 4	ST	ALL
Field 5	P1+HR	
Field 6	Num 1	
Print Loops	NO	
Create on Alarms	YES	
Automatic Print	NO	
Previous Menu		
Automatic printing when serious arrhythmias occur.		

44. Press the ComWheel and select **Monitor Setup** from the Main Menu.

45. Select **Install/Service** and enter the password.

46. Select **Trends & Snapshot**.

47. Select **Snapshot**.

48. Select **Automatic Print**.

Choose **NO**, if you want printing to occur only on request.

or

Choose **ALARMS**, if you want to print only snapshots that are created on alarms.

or

Choose **ALL**, if you want to print all snapshots immediately after they are created.

Printing loops on snapshots

You can have Patient Spirometry loops printed whenever snapshots are taken.

49. Press the ComWheel and select **Monitor Setup** from the Main Menu.

50. Select **Install/Service** and enter the password.

51. Select **Trends & Snapshot**.

52. Select **Snapshot**.

53. Select **Print Loops**.

54. Select **YES**.

Configuring snapshot and graphical trend pages

You can change the parameters on the snapshot page and on graphical trend pages.

- For the snapshot page, you can also select graphical trend boxes.

- For graphical trend pages, you can also select events. An event list will appear if there is no menu to hide it.

NOTE: Numerical trend pages cannot be configured.

To configure the snapshot page and/or graphical trend pages:

55. Press the ComWheel and select **Monitor Setup** from the Main Menu.

56. Select **Install/Service** and enter the password.

57. Select **Trends & Snapshot**.

58. Select **Snapshot**.

    or

    Select **Graphical Trends** and select the trend page you want to configure.

59. Select the parameter for each field.

    The field numbers start on the top of the display. Select one parameter for each field on the trend page, or turn the field **OFF**.

    When all fields are **OFF**, the page is displayed with empty fields. The time scale and page number appear at the bottom of the page.

If several equal fields are selected on top of each other, they will form one higher field. Equal fields can not be defined separate from each other.

For your notes:

Chapter 6. Patient Data Management

Table of Figures

6. PATIENT DATA MANAGEMENT

Overview

The Cardiocap/5 monitor continuously collects and saves patient data, such as trends. Saving is activated when the monitor receives vital signs. With a single, stand-alone monitor, you can add patient demographics and place markers on the trends.

The data management capabilities can be expanded if your monitor is connected to the Datex-Ohmeda S/5 Network and iCentral or if you use memory cards to store and transfer data.
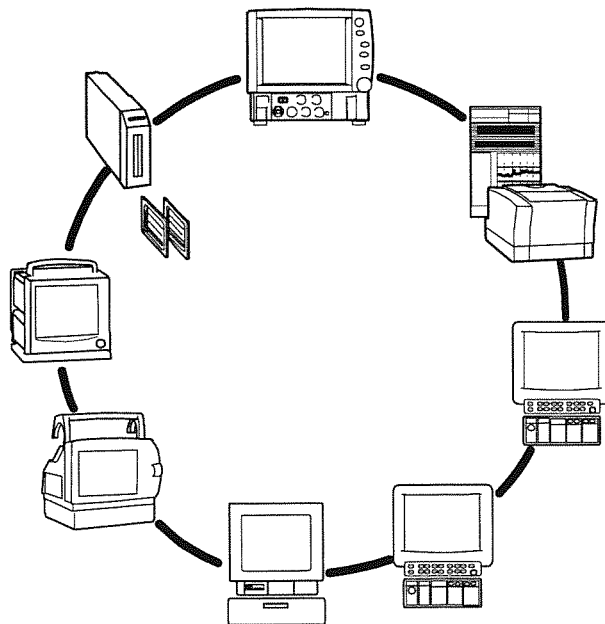
Network options

The monitor can be equipped with the following options to enhance network and data continuity capabilities:

N-XNET   Network

N-XDNET   Data card and Network

- The N-XNET option allows real-time information sharing between your Cardiocap/5 and monitors that are connected to the same monitor network (the Datex-Ohmeda S/5 Network and iCentral). When the monitor is connected to the network, patient information is saved to the network computer. The network offers the possibility of viewing real-time patient information, such as alarms, from another monitoring site.

- The N-XDNET option offers the same capabilities as the N-XNET option and, in addition, it allows you to load trend data from a Data card. With this option, you can assure the continuity of patient data by gathering all previously collected information for a patient, then adding new information to the same patient file.

Using the network

With the N-XNET or N-XDNET option, you can connect the monitor to the Datex-Ohmeda S/5 Network and iCentral for central monitoring and printing services.

This symbol is displayed when the monitor is connected to the network.

- Time and date are set by the network and cannot be adjusted in the monitor.

- The patient's ID entered in the Patient Data menu can be displayed on the Datex-Ohmeda S/5 Network and iCentral screen and printed on the laser printouts.

- Measured and entered patient data can be viewed on the Datex-Ohmeda S/5 Network and iCentral.

- Measured patient data and alarms can be viewed on other Datex-Ohmeda S/5, CS/3, and AS/3 monitoring systems, and vice versa.

Connecting to the network

To connect your monitor to the network:

- Connect the ethernet and location ID plug to the corresponding connectors on the rear panel of the monitor.

- Configure the location IDs in the Datex-Ohmeda S/5 Network and iCentral.

Using memory cards

With the N-XDNET option, you can load collected patient data from a monitor that is connected to the same monitor network or from a Data card.

The Data card and the Menu card are memory cards. Each is housed internally in a built-in memory module.

- The Data card is for storing and transferring trend data.

- The Menu card is for storing menus.

When the Data card is inserted, continuous patient trend data is stored on it automatically. The capacity of the card is approximately 48 hours, depending on the complexity of the saved data. When the card is full, the oldest data is erased.

The trend data stored on a Data card can be transferred to and viewed at all S/5, AS/3, and CS/3 systems as well as other Cardiocap/5 monitors.

See *Loading a previous case* later in this chapter for information about loading trend data.

CAUTION: Do not subject memory cards to excessive heat, bending, or magnetic fields.

Inserting a memory card

You can insert a memory card into either slot. The monitor recognizes whether the inserted card is a Data card or a Menu card.
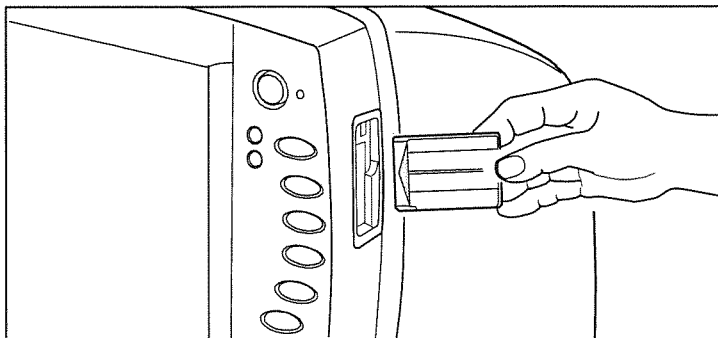

Figure 6-1. Inserting and removing a memory card

Insert the end of the card with the small connectors first. Push the card firmly into place. The release button will come up. To remove the card, press the release button, then pull the card out of its slot.
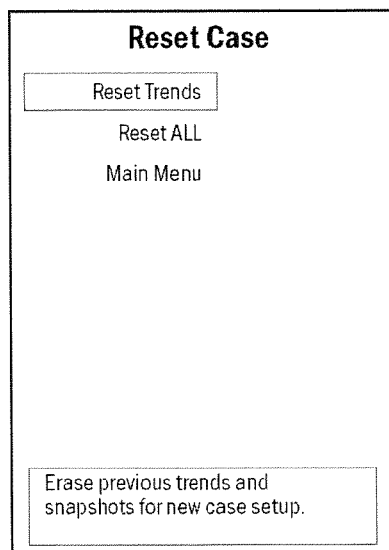
This symbol appears on the display to indicate that a memory card is inserted. The "Data card inserted" or "Menu card inserted" message appears in the message field of the display.

Resetting a case

At the beginning of a new procedure, you should erase the screen layout, trend data, and all alarm and parameter settings of the previous case.

To reset a case:

Reset Case
Reset Trends
Reset ALL
Main Menu
Erase previous trends and snapshots for new case setup.

1. Press the ComWheel and select **Reset Case** from the Main Menu.

2. Select **Reset ALL** and choose **YES**.

▶ (◎ ◎)

Selecting **Reset ALL** returns you to the starting mode and its settings (screen layout, trend parameters, alarm limits, etc.).

Adding demographics

To add demographics:

Patient Data
Demographics
Height
Weight
BSA
Previous Menu
Give patient's height.
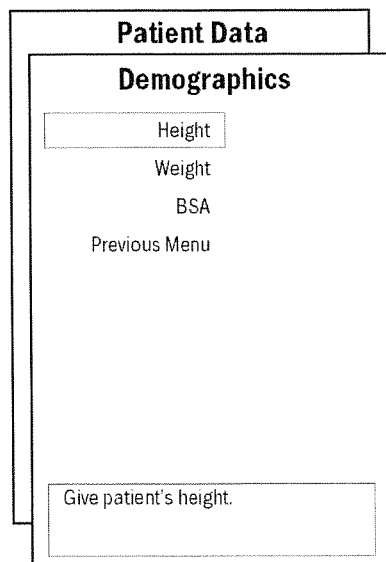
1. Press the ComWheel and select **Patient Data** from the Main Menu.

2. Select **Demographics**.

3. Enter the patient's height and weight.

▶ (◎ ◎)
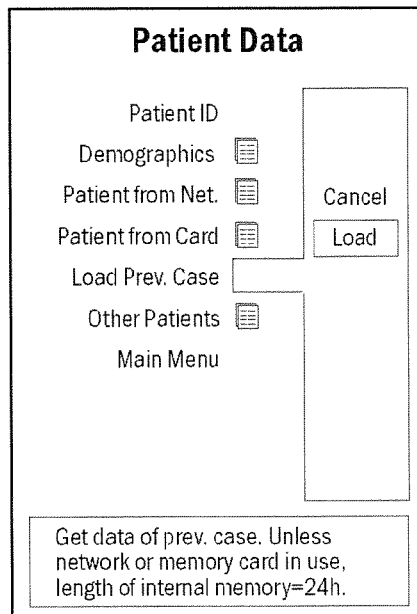
Height   Adjustable from 15 cm to 250 cm.

Weight   Adjustable from 1 kg to 250 kg.

BSA   The body surface area is calculated automatically using the du Bois formula. The body surface area is used when calculating index values of certain parameters.

Loading a previous case

To load data from a previous case:

```
┌─────────────────────────────────────┐
│          Patient Data               │
│                                     │
│       Patient ID      ┌──────────┐  │
│       Demographics ▦  │          │  │
│       Patient from Net. ▦  Cancel │  │
│       Patient from Card ▦ ┌──────┐│  │
│       Load Prev. Case    │ Load ││  │
│       Other Patients ▦   └──────┘│  │
│          Main Menu               │  │
│                       └──────────┘  │
│  ┌────────────────────────────────┐ │
│  │ Get data of prev. case. Unless │ │
│  │ network or memory card in use, │ │
│  │ length of internal memory=24h. │ │
│  └────────────────────────────────┘ │
└─────────────────────────────────────┘
```

4. Press the ComWheel and select **Patient Data** from the Main Menu.

5. Select **Load Prev. Case.**

Load Prev. Case

When the network is not in use, you can retrieve the trend data of the previous case from the monitor memory. You can retrieve trend data that was stored during the previous 24 hours under these circumstances:

- The monitor was turned off for less than 15 minutes.

- The monitor remained on (even if the case was reset).

Reloading trend data after the case has been closed for several hours is not recommended. The period that contains no information results in empty record pages.

Patient from Net. (with N-XNET or N-XDNET)

You can retrieve the last 24 hours of trend data from the network if the monitor is connected to it.

Patient from Card (with N-XDNET only)

When the data memory card is inserted, you can load trend data from a case on that card. The Data card saves previous patient data from the time it is inserted in the monitor. You can retrieve approximately 24 hours of information. The memory capacity depends on the complexity of the saved data.

Marking events

During monitoring, you can place numbers beside the numerical trend to mark the event.

To mark events:

6. Press the **Trends** key.

7. Select **Take Snapshot.**

The events are numbered from 1 to 16, depending on the data load. A number is displayed beside the numerical trend information that was recorded at the time **Take Snapshot** was selected.

Page 4 Of 4 Mark Time	T1 T1	T2 T2	SpO2
12:25			
12:30			
12:35			
1 12:39	38.8	20.0	
12:40	38.8	20.0	
2 12:43	38.8	20.0	
12:45	38.8	20.0	

Figure 6-2. Marked events in trends

A trend printout is also marked with this number.

A snapshot is created at the same time. For more information about Snapshots, refer to the *Trends and Snapshots* chapter.

Viewing other sites (with N-XNET or N-XDNET option)

With your Cardiocap/5 monitor you can see the numerics, waveforms, and alarms of another Cardiocap/5, S/5 Light, S/5, AS/3 or CS/3 monitor if both monitors are connected to the same monitor network.

To view data for a patient at another site:

Patient Data
Other Patients

Receive Alarms

Show Vital Signs

Main Menu

Show waveforms and numerical trends from other monitors in the network.

1. Press the ComWheel and select **Patient Data** from the Main Menu.

2. Select **Other Patients**.

3. Select **Show Vital Signs.**
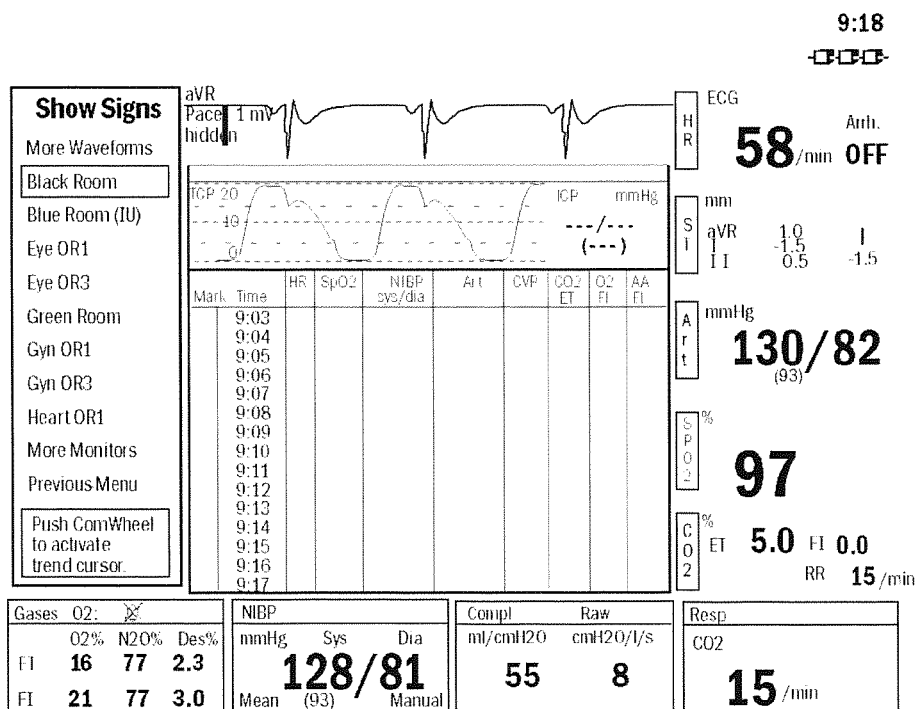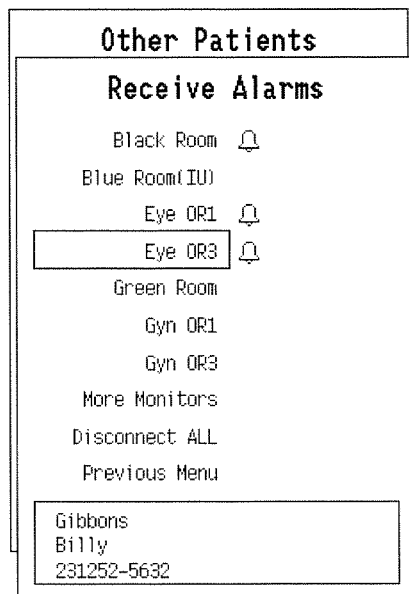
4. Select the site you wish to view.

9:18

Show Signs

More Waveforms

Black Room

Blue Room (IU)

Eye OR1

Eye OR3

Green Room

Gyn OR1

Gyn OR3

Heart OR1

More Monitors

Previous Menu

Push ComWheel to activate trend cursor.

aVR Pace 1 mV hidden

ICP 20
10
0

Mark	Time	HR	SpO2	NIBP sys/dia	Art	CVP	CO2 ET	O2 FI	AA FI
	9:03								
	9:04								
	9:05								
	9:06								
	9:07								
	9:08								
	9:09								
	9:10								
	9:11								
	9:12								
	9:13								
	9:14								
	9:15								
	9:16								
	9:17								

ECG
H R
58 /min   Arh. OFF

mm
S i   aVR   1.0   -1.5 |
I I   0.5   -1.5

mmHg
A r t
130/82
(93)

ICP   mmHg
---/---
(---)

S p O 2
97

C O 2   ET **5.0**   FI **0.0**
RR **15** /min

Gases	O2:			NIBP				Compl	Raw		Resp
	O2%	N2O%	Des%	mmHg	Sys	Dia		ml/cmH2O	cmH2O/l/s		CO2
FI	16	77	2.3	**128/81**				**55**	**8**		**15** /min
FI	21	77	3.0	Mean	(93)	Manual					

Figure 6-3. Data from another site

Viewing other site alarms (with N-XNET or N-XDNET option)

With a networked Cardiocap/5 monitor, you can view the alarms of another monitor on the same network, including the Cardiocap/5, S/5 Light, S/5, AS/3, or CS/3, or the iCentral station.

To view the alarms of a monitor at another site:

```
┌─────────────────────────────────┐
│      Other Patients             │
│  ┌───────────────────────────┐  │
│  │     Receive Alarms        │  │
│  │                           │  │
│  │    Black Room    ♫        │  │
│  │    Blue Room(IU)          │  │
│  │        Eye OR1   ♫        │  │
│  │        Eye OR3  │♫│       │  │
│  │      Green Room           │  │
│  │        Gyn OR1            │  │
│  │        Gyn OR3            │  │
│  │    More Monitors          │  │
│  │    Disconnect ALL         │  │
│  │    Previous Menu          │  │
│  ├───────────────────────────┤  │
│  │ Gibbons                   │  │
│  │ Billy                     │  │
│  │ 231252-5632               │  │
│  └───────────────────────────┘  │
└─────────────────────────────────┘
```

8. Press the ComWheel and select **Patient Data** from the Main Menu.

9. Select **Other Patients**.

10. Select **Receive Alarms**.

11. Select the site you wish to view.

The sites from where the alarms are forwarded to your monitor are marked by a bell next to the site name.

Chapter 7. Recording and Printing

Table of Figures

7. RECORDING AND PRINTING

Overview

You can record waveforms, values, and loops and print them to a laser printer that is either connected to the monitor or accessible over the Datex-Ohmeda monitor network.

Recording and printing options are located in the Record/Print menu and its submenus.

- You can record or print just one loop or one view of trends from within the corresponding measurement menu.

- You can record or print several pages, several parameters, or all gathered information from the Record/Print menu.

Recorder (N-XREC option)

You can use the optional built-in recorder (N-XREC option) to do the following:

- Record the graphical or numerical trend and print up to 24 hours of trend data.

- Record up to three real-time waveforms simultaneously.

- Display recordings of numerical information (in horizontal and vertical plane).

NOTE: Thermal paper printouts may be destroyed when exposed to light, heat, alcohol, etc. Make a photocopy for your archives.
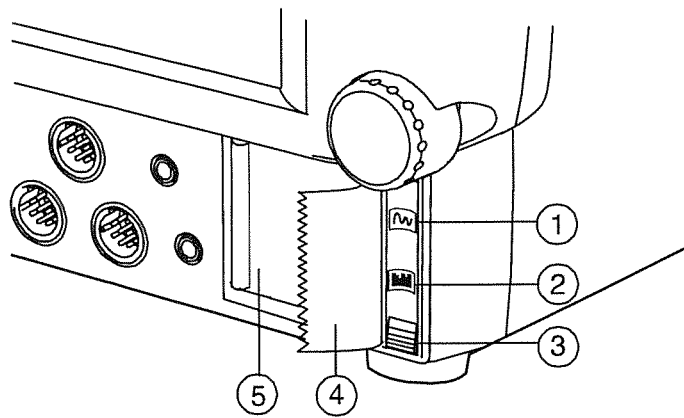
Figure 7-1. Built-in recorder

NOTE: The two-button recorder (shown) is for Cardiocap/5 monitors using software version 3.0 or higher. A one-button recorder was available previously.

(1) **Record Waveform/Stop** key. Press to start or stop recording selected real-time waveforms. This key functions like the **Record Start/Stop** key on a one-button recorder.

(2) **Record Trend/Stop** key. Press to start or stop recording selected numerical or graphical trend data. Since this key is not available on a one-button recorder, use the Record/Print menu options to print trend data.

(3) Key to release and open the recorder paper compartment.

(4) Recorder paper.
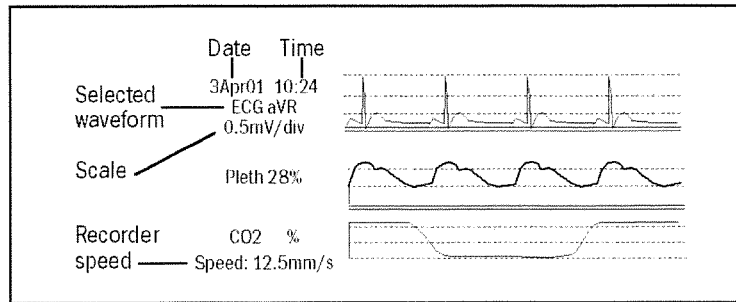
(5) Recorder paper compartment.

Recording waveforms

Date   Time

Selected waveform — 3Apr01 10:24 ECG aVR 0.5mV/div

Scale — Pleth 28%

Recorder speed — CO2 % Speed: 12.5mm/s

Figure 7-2. Sample recording

NOTE: Waveform scaling follows the displayed parameter scaling, when applicable.

Start/Stop recording waveforms

To record waveforms:

1. Make sure paper is installed in the recorder.

2. Press the **Record Waveform/Stop** key.
    or
    Press the ComWheel and select **Record/Print** from the Main Menu.
    Select **Record Waveforms**.
    Select **Record Wave**.

    The waveforms are recorded according to the current waveform selections.

3. To stop recording, press the **Record Waveform/Stop** key again.
    or
    Select **Stop Wave** in the Record Waveforms menu.

Controlling paper speed

To see the waveforms more clearly or more generally, you can adjust the paper speed:

Record & Print		
Record Waveforms		
Record Wave		
Waveform 1	ECG1	1
Waveform 2	OFF	6.25
Waveform 3	OFF	12.5
Start on Alarms	NO	25
Delay	12 s	
Paper Speed	25 mm/s	
Length	30 s	
Previous Menu		

Change paper speed:
1, 6.25, 12.5 or 25 mm/s.

1. Press the ComWheel and select **Record/Print** from the Main Menu.

2. Select **Record Waveforms**.

3. Select **Paper Speed** and choose the speed you prefer (1, 6.25, 12.5, or 25 mm/second).

Selecting waveform parameters

To select the waveforms you want to record:

4. Press the ComWheel and select **Record/Print** from the Main Menu.

```
Record & Print
┌─────────────────────┐
│ Record Waveforms  ▤ │
│     Record Trends  ▤ │
│   Print Graphical  ▤ │
│         Print Loops  │
│ Printer Connection None │
│           Main Menu  │
│                      │
│                      │
│                      │
│ ┌──────────────────┐ │
│ │ Record waveforms. │ │
│ └──────────────────┘ │
│                      │
└─────────────────────┘
```

5. Select **Record Waveforms**.

6. Select **Waveform 1**, **Waveform 2**, or **Waveform 3** and choose the parameter to be recorded.

   You can record up to three waveforms simultaneously. If you want to record only one waveform, select **OFF** for the other waveform fields.

7. Choose the parameter for the waveform.

   Scroll toward **–More–** to see additional options.

```
Record & Print
┌──────────────────────────────┐
│ Record Waveforms             │
│ Record Wave        ┌──────┐  │
│   Waveform 1 │ECG1││ OFF  │  │
│   Waveform 2  OFF  │ ECG1 │  │
│   Waveform 3  OFF  │ ECG2 │  │
│ Start on Alarms  NO │ ECG3 │  │
│          Delay  12 s│ P1   │  │
│   Paper Speed  25 mm/│ P2  │  │
│         Length  30 s│ Pleth│  │
│   Previous Menu     │ CO2  │  │
│                     │-More-│  │
│ ┌───────────────────────────┐ │
│ │ Change waveform recorded  │ │
│ │ in upper field.           │ │
│ │ Select OFF to clear field.│ │
│ └───────────────────────────┘ │
└──────────────────────────────┘
```

Controlling the recording time

You can select 30 seconds (the default) or continuous as the recording time.

To select the length of the recording:

Record & Print

Record Waveforms		
Record Wave		
Waveform 1	ECG1	30 s
Waveform 2	OFF	Cont.
Waveform 3	OFF	
Start on Alarms	NO	
Delay	12 s	
Paper Speed	25 mm/	
Length	30 s	
Previous Menu		

Change length of recording:
30 s or continuous.

8. Press the ComWheel and select **Record/Print** from the Main Menu.

9. Select **Record Waveforms**.

10. Select **Length** and choose **30 s** or **Cont.**

▶

NOTE: When recording is activated by alarms, the recording time is always 30 seconds.

Selecting the recording time initiation

The recorder can record only real-time data (delay of 0 seconds) or the first 12 seconds from memory (delay of 12 seconds, the recording delay default).

You can set the recording delay to 0 seconds and record only real-time data.

To change the delay:

11. Press the ComWheel and select **Record/Print** from the Main Menu.

12. Select **Record Waveforms**.

13. Select **Delay** and choose **0 sec**.

NOTE: When recording is activated by alarms, the delay is always 12 seconds.

Recording waveforms on alarms

You can generate a strip chart recording automatically when asystole, heart rate, and pressure alarms reach the red-alarm level, by setting up the recorder to start recording on alarms.

To start recording on an alarm:

Record & Print
Record Waveforms

Record Wave		
Waveform 1	ECG1	YES
Waveform 2	OFF	NO
Waveform 3	OFF	
Start on Alarms	YES	
Delay	12 s	
Paper Speed	25 mm/	
Length	30 s	
Previous Menu		

Select YES for automatic start of recording when serious arrhythmias occur.

14. Press the ComWheel and select **Record/Print** from the Main Menu.

15. Select **Record Waveforms.**

16. Select **Start on Alarms** and choose **YES.**

The alarms listed below will start the recording:

Alarm	Recorded parameters
Asystole	ECG + P1 waveforms, 25 mm/second
HR High/Low	ECG + P1 waveforms, 25 mm/second
P1 High/Low	ECG + P1 waveforms, 25 mm/second

Alarm recordings are annotated with the alarm source.

Recording trends

Adjust the parameter and time scales to record the desired level of trend detail.

Start/Stop recording trends

To record numerical or graphical trends:

17. Make sure paper is installed in the recorder.

18. Press the **Record Trend/Stop** key.
    or
    Press the ComWheel and select **Record/Print** from the Main Menu.
    Select **Record Trends**.
    Select **Record Numerical** or **Record Graphical**.

    A numerical or graphical trend is recorded according to the current selections.

19. To stop recording, press the **Record Trend/Stop** key again.
    or
    Select **Stop Numerical** or **Stop Graphical** in the Record Trends menu.

Numerical trend printout

You do not need to choose parameters for a numerical trend recording.

Figure 7-3. Numerical trend printout

Numerical trend recordings contain the following parameters:

Parameter	Printed values and units
HR and SpO_2	bpm/SpO_2
NIBP	Sys/dia or mean mmHg
P1 "Art"	Sys/dia or mean mmHg
P2 "CVP"	Sys/dia or mean mmHg
T1	Celsius or Fahrenheit
T2	Celsius or Fahrenheit
CO_2	Et/Fi %, kPa or mmHg
O_2	Et/Fi %
AA	Et/Fi %
Resp. Rate	Breaths per minute

Either Sys/Dia or mean pressures are recorded, depending on the digit format selected in the pressure setups.

Changing the resolution

To select the resolution for a numerical trend record:

20. Press the ComWheel and select **Record/Print** from the Main Menu.

21. Select **Record Trends**.

22. Select **Trend Resolution** and choose from the options.

Selecting graphical trend parameters

You can record graphical trends for two parameters.

To choose the parameters for a graphical trend recording:

23. Press the ComWheel and select **Record/Print** from the Main Menu.

24. Select **Record Trends**.

25. Select **Graphic Trend 1** or **Graphic Trend 2**.

26. Choose the parameter for the graphical trend.

Scroll toward **-More-** to see additional options.

Recorder paper replacement

Figure 7-4. Recorder paper replacement

To change the paper in the recorder:

27. Press the key that releases the paper compartment door.

28. Remove the roll and insert a new roll.

29. Close the paper compartment door.

Printing to a laser printer

You can print the following to a laser printer:

- Graphical and numerical trends.

- Patient Spirometry values and loops.

You can print several pages, all saved loops, or trend data from the Record/Print menu. You can print one page or one loop from the corresponding parameter menu.

Changing the printer

To check or change the printer connection:

```
┌─────────────────────────────┐
│       Record & Print        │
│                             │
│  Record Waveforms  ▤         │
│     Record Trends  ▤         │
│   Print Graphical  ▤         │
│        Print Loops           │
│  ┌──────────────┐            │
│  │Printer Connection│ Serial │
│  └──────────────┘            │
│        Main Menu             │
│                             │
│                             │
│                             │
│  ┌────────────────────────┐ │
│  │ Change default printer.│ │
│  └────────────────────────┘ │
│                             │
└─────────────────────────────┘
```
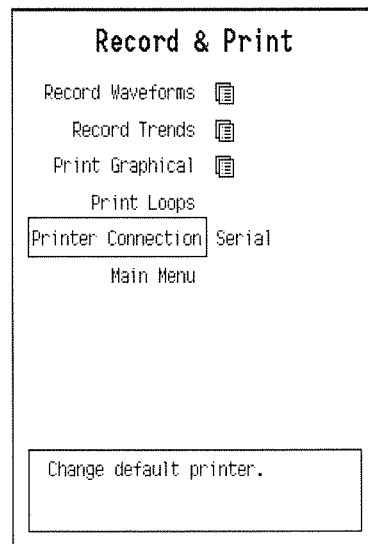
30. Press the ComWheel and select **Record/Print** from the Main Menu.

31. Select **Printer Connection**.

32. Select **Serial, Net,** or **None**.

- Choose **Serial** if the printer is connected to your monitor.

- Choose **Net** if your monitor is connected to the Datex-Ohmeda S/5 Network and Central.

Printing trend data

Adjust the parameter and time scales to print the desired level of trend detail.

To print a specific trend view:

33. Press the ComWheel and select **Trends** from the Main Menu.

34. Select the trend type you wish to print: **Snapshot, Numerical,** or **Graphical**.

35. Select **Next Page** to choose a specific trend page.

36. Select **Print Page**.

To print all numerical trend data:

37. Press the ComWheel and select **Trends** from the Main Menu.

38. Select **Numerical**.

39. Select **Print Page**.

To print several pages of graphical trend data:

40. Press the ComWheel and select **Record/Print** from the Main Menu.

41. Select **Print Graphical**.

Printing spirometry loops

To print a pair of loops:

42. Press the ComWheel and select **Parameters** from the Main Menu.

43. Select **Airway Gas**.

44. Select **Spirometry Loops**.

45. Select **Print Loop**.

To print all saved loops:

46. Press the ComWheel and select **Record/Print** from the Main Menu.

47. Select **Print Loops**.

Other adjustable features

This section describes the other adjustable features related to recording and printing. A password is required for entering the Install/Service menu where the adjustments are made. If you wish to make changes, we recommend that you contact the person responsible for the entire configuration.

Changing the format for recorded numerical trends

You can select the kind of numerical trend that will be recorded when you select **Record Numerical** from the Record/Print menu

48. Press the ComWheel and select **Monitor Setup** from the Main Menu.

49. Select **Install/Service** and enter the password.

50. Select **Installation**.

51. Select **Printer & Recorder.**

52. Select **Num Trend Type**.

53. Select **Num.** or **Tab**.

Chapter 8. Troubleshooting

8. TROUBLESHOOTING

This chapter consists of three parts that should help you solve common monitoring problems: *Checklist*, *Messages*, and *Other situations*.

Checklist

Check the following items to ensure you remember to make all essential preparations before monitoring. They also help if problems occur during monitoring.

General

Check that

- The monitor has no visual defects, such as cracks or loose parts.
- The power cord is connected to an electrical wall outlet and to the monitor.
- The D-fend water trap is empty and properly pushed into its place (with F-MXG).
- The sampling line is connected to the monitor (with F-MXG).
- Patient connection cables are attached to the connectors so that the color coding on the plug matches the color coding on the connector.
- Trends of the previous patient are erased.
- Alarm limits are suitable for the patient.

ECG

Check that

- Electrodes are positioned correctly, electrode gel is moist, and skin contact is good.
- Correct lead-wire set is selected (3-lead or 5-lead) and correct lead-wire type is selected in the ECG Setup menu.
- Lead-wire set is properly connected to the ECG extension cable.
- ECG extension cable is plugged into the blue connector.
- Pacemaker selection in the ECG Setup menu is **Show** when a pacemaker is used.
- ECG is selected for display (Main Menu – Monitor Setup – Screen Setup).

Impedance respiration

Check that

- Electrodes are positioned correctly, electrode gel is moist, and skin contact is good.
- Correct lead-wire set is selected (either 3 or 5 lead) and correct lead-wire type is selected in the ECG Setup menu.
- Lead-wire set is properly connected to the extension cable.
- ECG extension cable is plugged into the blue connector.
- Resp is selected for display (Main Menu – Monitor Setup – Screen Setup).

Pulse oximetry

Check that

- Correct sensor is selected for the size of the patient and sensor is positioned correctly on the patient.

- The sensor is completely dry after cleaning.

- Sensor cable is plugged into the gray connector and is properly connected to an extension cable or sensor, as applicable.

- SpO_2 is selected for display (Main Menu – Monitor Setup – Screen Setup).

Non-invasive blood pressure (NIBP)

Check that

- Correct NIBP hose is used (black hose for adults and children; white hose for infants).

- NIBP cuff is not loose; correct cuff for patient size is used.

- O-rings on hose connectors and cuff connector are intact; cuff connector is firmly pushed inside the cuff tube.

- NIBP hose is properly connected to the monitor connector and will not detach by pulling.

- There are no holes or cracks in the cuff bladder or cuff tube.

- Symbol indicating the center of the bladder is over the artery.

- All residual air is squeezed out of the cuff before wrapping it around the arm.

- Cuff is at heart level.

- Cuff tubes and NIBP tube are not kinked or squeezed together.

- Non-invasive blood pressure is selected for display
(**Main Menu – Monitor Setup – Screen Setup**).

If a leak is suspected, start venous stasis and check that the pressure is stable during stasis.

Invasive blood pressure

Check that

- Invasive blood pressure transducer cable is plugged into a red connector.

- Pressure transducer is connected to the cable.

- Patient catheter is connected to the pressure line.

- There is no air in the transducer dome or catheter line.

- Transducer is at mid-heart level.

- Pressure transducer is zeroed.

- Invasive blood pressure is selected for display
(**Main Menu – Monitor Setup – Screen Setup**).

Temperature

Check that

- You are using a Datex-Ohmeda temperature probe.

- Temperature probe is positioned correctly.

- Temperature probe is inserted properly into the appropriate temperature connector.

- Temperature is selected for display (Main Menu – Monitor Setup – Screen Setup).

Airway gases

Check that

- D-fend water trap is properly placed in the monitor.

- Water trap container is empty.

- A new sampling line is used after each patient.

- Sampling line is connected to the water trap and to the airway adapter.

- Monitor is turned on and self-check is performed with the sampling line attached.

- Humidification and/or bacteria filter is placed correctly.

- Breathing circuit or accessories are free of residuals from alcohol-based disinfectants.

- Desired gas parameter is selected for display (**Main Menu – Monitor Setup – Screen Setup**).

Patient spirometry

Check that

- Correct flow sensor is used (D-lite for adults and Pedi-lite for pediatrics).

- Correct flow sensor type is selected
  (Main Menu – Parameters – Airway Gas – Spirometry Setup).

- Straight luer connectors of the spirometry tube are attached to the connector on the monitor and the angled luer connectors are attached to the sensor.

- Spirometry tube is not kinked or squeezed.

- D-lite and spirometry tube are free of water drops.

- Humidification and/or bacteria filter is placed correctly.

- Desired spirometry parameter is selected for display
  (**Main Menu – Monitor Setup – Screen Setup**).

NeuroMuscular Transmission (NMT)

Check that

- The application site of the electrodes is cleaned of oil and dirt.

- Electrodes are positioned correctly, electrode gel is moist, and skin contact is good. Avoid placement over lesions or excessive body hair.

- NMT is selected for display (Main Menu – Monitor Setup – Screen Setup).

Messages

Message	Explanation and/or Corrective Action
Acknowl. alarms silenced	Acknowledged alarms are silenced. (**Silence Alarms** key pressed during silencing period).
Air leakage	Air leakage in NIBP cuff or hose. Check all connections and test the cuff tightness using venous stasis.
Apnea	No change detected in CO_2 during the last 20 seconds. (Impedance respiration) No change detected in impedance respiration waveform for 20 seconds.
Apnea deactivated	Apnea alarm is silenced until reactivation after five breaths.
Artifact(s)	Unsuccessful NIBP measurement. Patient is moving, shivering, or breathing deeply; also marked arrhythmia or irregular beats. Calm the patient and start a new measurement.
Asystole	Asystole, no QRS detected in ECG. NOTE: This does not depend on the heart rate source.
Back-up batt. failure	Backup battery is discharged or faulty. Use mains power for 4 hours, then switch to battery power. If the message reappears, contact authorized service personnel.
Cable off	NMT or regional block cable is not connected.
Calibrate Agent ID	Agent identification error. Perform gas calibration.
Calibration not protected	(NIBP) Contact authorized service personnel.
Calibration switch ON	(NIBP) Calibration protection switch at the bottom of the monitor is turned to the right. Contact authorized service personnel.
Call service: Error X	NIBP hardware error. Note the error number (X) and contact authorized service personnel.
Check D-fend	Check that the water trap is properly attached.
Check SpO2 probe	Pulse search active for 20 seconds but no acceptable pulse is found. Either there is no detectable SpO_2 signal, the sensor is faulty, or it is detached from the patient.
Check stim. electrodes	NMT stimulus current could not be delivered due to poor stimulus electrode connection or damaged cable.
Control measurement	NIBP alarm limit was exceeded and a new measurement was started automatically.
Cuff loose	NIBP cuff is loose or not attached to the patient. Hose is not connected to the monitor.
Cuff occlusion	Check NIBP cuff hose and tubes; restart measurement. If the problem persists, contact qualified service personnel.
Cuff over-pressure	NIBP cuff is squeezed during measurement and pressure safety limits are exceeded.
EEPROM Error	Faulty EEPROM circuit on the CPU board. Contact authorized service personnel.

Message	Explanation and/or Corrective Action
EMG electrodes off	(NMT) EMG recording electrodes are off. Electrodes or stimulus clip is loose.
EtAA high / EtAA low	Measured EtAA is equal to or above/below the alarm limit.
EtCO2 high / EtCO2 low	Measured $EtCO_2$ is equal to or above/below the alarm limit.
EtO2 high / EtO2 low	Measured EtO_2 is equal to or above/below the alarm limit.
FiAA high / FiAA low	Measured FiAA is equal to or above/below the alarm limit.
FiN2O high	Measured FiN_2O is equal to or above 82%.
FiO2 high / FiO2 low	Measured FiO_2 is equal to or above/below the alarm limit.
HR high / HR low	Heart rate (ECG or invasive pressure) or pulse rate (pulse oximetry) is equal to or exceeds the upper/lower alarm limit.
Infl. limits! Check setup	Adult or child NIBP cuff is being used but the selected infant mode keeps the inflation pressure too low.
Leads off	One or more cables are disconnected or off the patient. Check ECG cable, all leads, and the neutral electrode (RL/N). Offset voltage between two electrodes is too high. NOTE: This message may appear during defibrillation.
Long measurement time	NIBP measurement is prolonged over the maximum measurement time (two minutes with adult or child inflation limits; one minute with infant inflation limits). Reapply the cuff, calm the patient, and start a new measurement.
Measurement off	(NMT) Cable is connected but measurement has not started. (Impedance respiration) Measurement has been turned off.
Monitor is overheating	Temperature inside the monitor is above the maximum limit. Check the dust filter at the back of the monitor.
MVexp high / MVexp low	Measured expiratory minute volume value is above/below the set volume limit.
MVexp<<MVinsp	Exhaled volume is noticeably smaller than inhaled. Check the whole system for leakage.
MVexp<0.5 l/min (MVexp<0.2 l/min with Pedi-lite)	Measured volumes are too small for reliable calculation and, for example, waveforms and loops may be unreliable.
Network connection down	Too many monitors may be active on the network.
NIBP high / NIBP low	NIBP value is equal to or above/below the alarm limit.
NIBP manual	Autocycling is interrupted because of air leakage or loose cuff.
No P1/P2 transducer	Invasive pressure or transducer cable not connected.
No SpO2 probe	SpO_2 sensor is not connected to the monitor. Faulty or wrong type of SpO_2 sensor. Use only sensors approved for use with the type of pulse oximetry installed in the monitor.
No SpO2 pulse	Pulse signal is found but then lost for 10 seconds or longer. Try a different site.

Message	Explanation and/or Corrective Action
Noise	(ECG) Unreliable heart rate (HR) calculation or distorted waveform due to: Too much high frequency or electrical mains noise in ECG. The DC offset voltage between two electrodes is too high. NOTE: This message may appear during defibrillation.
P1/P2 high P1/P2 low	Invasive pressure of marked channel is equal to or above/below the alarm limit.
PEEP high / PEEP low	Measured PEEP value is above/below the set pressure limit.
Performing temp test	Monitor makes a two point calibration test for temperature immediately after the warm-up time and after that once in 10 minutes. Test lasts 10 seconds.
Ppeak high / Ppeak low	Measured peak pressure is above/below the pressure limit setting.
Printer error	Printer is out of paper or paper is jammed. Printer is not online or is not turned on. Printer cable is loose or broken.
Printer failure	Printer is not responding, see **Printer error**. Select another printer.
Printing	Laser printer is printing.
Pulse search	Monitor is searching for pulse oximetry signal.
RAM Error	Faulty RAM circuit on the CPU board. Contact authorized service personnel.
Rebreathing	Measured $FiCO_2$ is equal to or above the alarm limit.
Recorder: cover open	The lid of the recorder is open.
Recorder: input voltage high Recorder: input voltage low	Call service to check the monitor.
Recorder: out of paper	Insert a new roll of paper.
Recorder: system error n	(**n** can be 1, 2 or 3.) Contact authorized service personnel.
Recorder: thermal array overheat	Wait for the recorder to cool down.
Reference not stable	(NMT) Deviation between the four reference stimulation responses is too big, causing reference setting to fail. Can be caused by movement artifact; may occur when patient is relaxed.
Replace D-fend	D-fend water trap is partially blocked. This decreases air flow.
Resp high / Resp low	Respiration rate (RR) is equal to or above/below the alarm limit.
Response too weak	(NMT) The maximum gain is insufficient to increase the response signal amplitude to a measurable level. Can occur if: Stimulation current is too weak. Stimulation electrodes are not connected or they are improperly placed on the nerve. Recording electrodes are disconnected. One or more electrodes are dry and should be replaced. The skin at the electrode site is not properly prepared. Reposition the stimulating or recording electrodes. Change the site of the measuring electrodes.

Sample line blocked	The gas sampling line inside or outside the monitor is blocked or the water trap is occluded.
Message	**Explanation and/or Corrective Action**
Sensor inop.	Gas measuring sensor is inoperative or the temperature in the monitor has increased. Contact authorized service personnel.
Setting reference	NMT reference search in progress.
Small resp. curve	(Impedance Respiration) Signal amplitude is less than 0.4 ohms.
Snapshot memory full	Creating a new snapshot will erase older ones.
SpO2 high / SpO2 low	SpO_2 is equal to or above/below the alarm limit.
SpO2 probe off	SpO_2 sensor is not attached to the patient, site is unsuitable, or sensor is faulty. Check connections; try a new site or sensor.
SRAM Error	Faulty SRAM circuit on the CPU board. Contact authorized service personnel.
Supramax not found	(NMT) Supramaximal stimulus current (70 mA) was not found. Stop measurement, reposition the stimulating or recording electrodes, and restart the measurement.
Supramax search	(NMT) Supramaximal stimulus current search in progress.
Temperature error	A repeated temperature test has failed. Contact authorized service personnel.
Tetanic	(NMT) Tetanic stimulation is on.
Unable to measure Dia	(NIBP) Accurate diastolic pressure not achieved because of artifacts, weak pulsation, etc.
Unable to measure Sys	(NIBP) Initial inflation pressure is not high enough to enable proper measurement. Systolic pressure is higher than maximum inflation pressure; artifacts interfere in systolic area.
Unstable zero pressure	Pressure is unstable when starting the NIBP measurement. Calm the patient and retry.
Voltage error	Erroneous voltage level detected. Contact service personnel.
Wait for the measurement to be done	Venous stasis is attempted while a regular measurement is under way.
Weak pulsation	(NIBP) Weak or unstable oscillation signal due to: Improper cuff position or attachment; small air leakage. Weak or abnormal blood circulation. Slow heart rate associated with artifacts. Patient is moving or disturbed during measurement.
... lead off	A lead wire (...) is disconnected.

Other situations

Other problem situations which may occur during monitoring, with possible explanations and instructions, are listed below.

Situation	Cause and/or Recommended Action
Extra Asystole alarms	Bad electrode quality or positioning. Remove the ECG cable from the monitor and insert again. Enlarge the size from 1.0 mV to 2.0 mV.
ECG baseline is thick	ECG lead cable is looped. Other electrical power cables are near the ECG wires. Incorrect ECG filter. Incorrect power frequency of the monitor.
ECG is noisy	Patient is shivering. Incorrect ECG filter. Bad electrode quality or positioning.
NIBP readings are high	Cuff too small or loose. Cuff is under mid-heart level.
Pacer markers are not visible	Check that: The pacer markers have been selected **ON**. The pacemaker was adjusted correctly and is not above R. The pacemaker functions correctly; check that ECG cables, electrodes, and setup are correct.
Patient spirometry accuracy is poor—TV less than 50 ml reported as 0 (zero) ml	An adult sensor is used for a pediatric patient and the monitor's spirometry sensor selection is **Pediatric**. Use a pediatric sensor.
Patient spirometry values are 1/4 of real values	An adult sensor is used for an adult patient, but the monitor's spirometry sensor selection is **Pediatric**. Change the selection to **Adult**.
Patient spirometry values are 4 times larger than real values	A pediatric sensor is used for a pediatric patient, but the monitor's spirometry sensor selection is **Adult**. Change the selection to **Pediatric**.
Patient spirometry Paw-Vol loop is vertical	A pediatric sensor is used for an adult patient and the monitor's spirometry sensor selection is **Pediatric**. Use an adult sensor and change the selection to **Adult**.

Situation	Cause and/or Recommended Action
Pressure readings are high	Air bubbles or a swinging catheter are causing a resonating waveform.
	Wrong zero because the transducer position in relation to the patient has changed (too low).
	Transducer failure.
	Incorrect calibration.
Pressure readings are low	Dampened waveform because of air bubbles, clotting or kinked tubes.
	Transducer is positioned above patient's mid-heart level.
	Transducer failure.
	Incorrect calibration.
Temperature is not displayed on monitor screen	Datex-Ohmeda temperature probe is not being used.
	The temperature may be outside the measurable range (10 to 45 °C).
	If problem persists, contact authorized service personnel.
Cannot see some trend details	Adjust the parameter and time scales to see the desired trend detail.

For your notes:

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9. MAINTENANCE AND CLEANING

Introduction

For safe, reliable function and operation of the monitor, regular care has to be carried out according to the instructions in this manual and the Planned Maintenance procedures described in the Cardiocap/5 *Technical Reference Manual*.

If the monitor does not function as it should, and information in the *Troubleshooting* chapter does not provide help, contact your sales representative. Do not perform cleaning or maintenance procedures other than those described in the Cardiocap/5 manuals.

Preventive maintenance

Daily tasks

Check that all accessories, cables and monitor parts are clean and intact.

Clean the device as described in *Cleaning* later in this chapter.

Check the parameter items as directed below:

ECG and respiration

The "Leads off" message is displayed when the cable is connected to the monitor and the leads are not connected. Shorting all the leads should make the message disappear (ASY alarm appears).

Pulse oximetry

Sensor functions when properly connected to the patient.

NIBP

Cuff hose detection (Adult/Infant) works properly.

Pump is not restarting in Venous Stasis mode. If it starts, there may be a leak in the cuff.

InvBP

The monitor recognizes the cable connection (activates the display) for all the pressure channels used.

Zeroing of all transducers is working correctly.

Temperature

Measurement starts when a temperature probe is connected.

Airway gases and spirometry

The "Sample line blocked" message appears within 30 seconds after you have occluded the airway adapter; gas waveforms show zero at the same time.

The D-fend water trap is empty. If the green D-fend+ is used (patient with extensive mucus secretion), replace it daily with a new one.

NMT

Check that the electrodes are correctly positioned on the ulnar nerve and the message 'Supramax search' is displayed. Ensure that you get a stimulus response. If the supramaximal stimulus current is not found, the message 'Supramax not found' is displayed. If the current is set manually the message "Setting reference" is displayed directly. Always check the electrode quality.

Every month

Cooling fan dust filter

Check the fan filter on the rear panel of the monitor. Replace the filter if it is damaged.

Clean the fan filter every month or whenever needed:

Pull the filter out.

Wash in detergent solution.

Allow to dry before reinserting. Do not use pressurized air.

Every two months

Black D-fend

Replace the D-fend water trap at least every two months, or when a "Sample line blocked" or "Replace D-fend" alarm message persists.

Every six months

Gas calibration

Perform gas calibration according to the instructions in the *Airway Gases* chapter.

If gas measurement is in extensive use, calibration is recommended **every two months** to ensure that measurement accuracy stays within specifications.

Backup battery check

The power supply includes a backup battery that saves up to 15 minutes of information.

To check the battery:

1. Switch on the monitor.

    When the battery is fully charged, the charging symbol is not displayed on the screen.

    Disconnect the monitor from mains power.

    The monitor should function normally for 15 minutes.

Every 12 months

Planned Maintenance check

The Planned Maintenance check detailed in the *Technical Reference Manual* requires trained service person and appropriate testing tools and equipment.

Calibration check of temperature, NIBP and invasive blood pressures

Calibration check of temperature, NIBP and invasive blood pressures should be performed at least once a year by qualified service personnel as a part of the Planned Maintenance, see "Technical Reference Manual."

Cleaning

The appropriate cleaning procedure depends on where and how the part or accessory is used, and on the condition of the patient.

Method	Why?	Which items?	How?
Cleaning	To remove dirt and most microbes.	All parts daily. Items to be disinfected or sterilized.	2. Wipe away visible organic material. Rinse as recommended by the detergent manufacturer. Allow to dry completely.
Disinfecting	To kill and remove pathogenic microbes.	Accessories and supplies (other than SpO2 sensors) in contact with the patient's skin or airways. NOTE: Some SpO2 sensors cannot be disinfected. Read the sensor instructions before attempting to disinfect a sensor.	**With heat:** Wash in a washing machine at 85 °C (185 °F) for at least one minute. **With chemicals:** Immerse in 2% glutaraldehyde for 10 minutes (pH=6.5). After tuberculosis, HIV, or hepatitis patient, immerse for 20 minutes. Rinse carefully or wipe with alcohol and let dry.
Sterilizing	To kill microbes and bacterial spores.	Accessories and supplies penetrating the patient's tissue.	Steam autoclave for 15 minutes at 121° C (250 °F) maximum. Use ethylene oxide mixture at 50 to 60°C (120 to 140°F). Follow the sterilizer manufacturer's recommendations for required aeration times. Immerse in 2% glutaraldehyde for three hours, rinse carefully, and let dry.

WARNING: Electrical Shock Hazard. Before cleaning, disconnect the monitor from the electrical outlet.

WARNING: Electrical Shock Hazard. After cleaning, or if liquid has accidentally entered the interior of the monitor, make sure that every part of the monitor is dry before reconnecting it to the power supply.

CAUTION: Do not sterilize any part of the monitor with steam autoclave or ethylene oxide.

CAUTION: Do not immerse any part of the monitor in liquids or allow liquid to enter the interior.

CAUTION: Do not use hypochlorite, acetone-based, phenol-based, or ammonia-based cleaners.

Monitor

To clean the monitor:

3. When the display surface becomes dusty, wipe it gently with absorbent cotton, chamois or other soft material. The display may also be cleaned using a small amount of normal hexane. Do not use acetone, toluene or alcohol because they cause chemical damage to the polarizer.

Wipe the monitor with a mild detergent solution such as the Datex-Ohmeda Cleaning Fluid. Do not leave liquid spills on any metal part.

Let dry completely before connecting to power source.

The internal sampling system does not need to be cleaned nor sterilized. The D-fend water trap functions as a bacteria filter and there is no reverse flow to the patient.

ECG cables

Wipe the cables with a mild detergent solution. Disinfect when necessary.

Pulse oximetry sensors

WARNING: Patient Safety. A damaged sensor or a sensor soaked in liquid may cause burns during electrosurgery.

Disposable sensors are for single-patient use only. Do not attempt to clean them.

For cleaning instructions and recommended cleaning agents for a reusable sensor, consult the instructions for using that sensor.

Consider possible patient allergies when selecting the cleaning agent.

In general, to clean any reusable sensor or sensor cable, detach it from the patient and the monitor. Wipe it with a pad moistened with a mild cleaning solution, such as 70% isopropyl alcohol. Allow the sensor and/or cable to dry completely before use.

NIBP cuff hose

Wipe the cables and hose with a mild detergent solution. Disinfect when necessary.

NIBP cuff

Clean only when necessary. Remove the bladder from the cuff. Wash the bladder and the cuff in mild detergent solution. Do NOT use alcohol.

Cables for invasive pressure

Wipe the cables with a sterile alcohol-based detergent. After cleaning, rinse surfaces by wiping them with a cloth damped with sterile water. Dry with a dry cloth.

Temperature probes

Clean with a mild detergent solution and rinse with water. Disinfect or sterilize when necessary.

NMT sensor cable, sensors, and regional block adapter

Wipe the cable, sensor, and adapter with mild detergent solution.

If disinfection is required, use ethanol or isopropyl alcohol. Do not use hypochlorite. Do not immerse in liquid.

Reusable D-lite sensor

Reusable D-lite sensors can be washed in a dishwasher. After cleaning, allow the sensor to dry thoroughly.

Make sure that the sensor is intact. Connections must be tight for exact measurements.

Airway adapter

Replace the single-use adapter after each patient.

A reusable adapter can be disinfected with glutaraldehyde or alcohol. A reusable steel adapter may be autoclaved.

If you want to clean the adapter before use, submerge it in 70% alcohol solution for 30 seconds and rinse carefully with water.

Rinse away all traces of alcohol or detergent. Dry the adapter before connecting to the patient.

Sampling line

Do not reuse the sampling line. Attempting to clean and reuse a sampling line may affect measurement results.

D-fend water trap

The D-fend water trap contains a hydrophobic membrane that prevents water and secretions from entering the measuring chamber. Condensed water and saliva are collected into a washable container.

The green D-fend+ is for patients with extensive mucus secretion and for single-patient use only. Replace it every 24 hours or when a "Sample line blocked" or "Replace D-fend" message persists.

The water trap container can be cleaned with disinfecting solutions or sterilized using cold chemicals or ethylene oxide.

CAUTION: Do not disinfect or open the water trap cartridge. To avoid damage, do not touch or try to clean the water trap hydrophobic membrane (other than to rinse it with water).

To lengthen the lifetime of your monitor and minimize downtime:

- Empty the water trap container whenever it is more than half full.

- Do not open, wash, or sterilize the D-fend water trap cartridge.

- After washing or disinfecting the airway adapter or water trap container, make sure no alcohol or detergent remains. Traces of alcohol or other organic cleaning solutions may affect measurement.

- Do not force air or oxygen through the D-fend; do not allow smoke or dust to enter the D-fend.

- While administering nebulized medication, disconnect the gas sampling line from the patient circuit for 30 minutes.

- If a "Sample line blocked" alarm occurs, replace the sampling line and empty the water trap container.

Removing the water trap
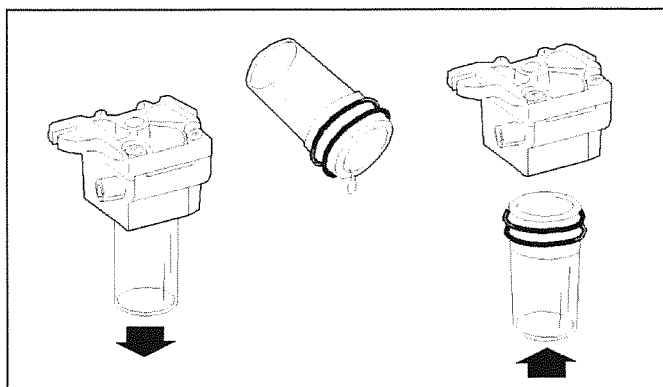
Figure 9-1. Emptying the water trap container

To remove the water trap:

4. Push the water trap latch to the right. The water trap is spring-loaded. The "Check D-fend" message appears.

Detach the container from the water trap cartridge by pulling it carefully downward.

Empty and clean the container.

Attach the container back into the cartridge tightly.

Push the whole unit into its housing on the front panel until the latch is set.

Press the **Normal Screen** key to restart monitoring. Check that the "Check D-fend" message is no longer displayed.

Other accessories

See the accessory packages for checkout and cleaning instructions. Do not reuse disposable accessories.

For your notes:

Chapter 10. ECG

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10. ECG

Overview

The electrocardiograph, ECG, reflects the electrical activity generated by the heart muscle. ECG monitoring is used for heart rate measurement and to detect arrhythmias, pacemaker function, and myocardial ischemia.

When you use a 5-lead set, you may monitor the waveforms of up to three different ECG leads. When you use a 3-lead set, the monitor displays one ECG lead.

When monitoring ECG, the monitor simultaneously analyzes ST segment changes. Changes of up to three different ECG leads are analyzed depending on your lead set.

ECG and heart rate display
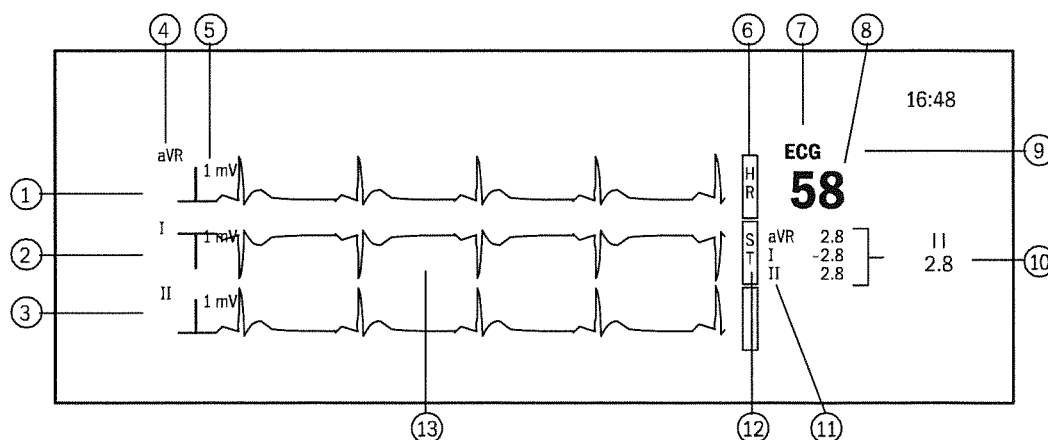
Figure 10-1. ECG and HR display

(1)   ECG1 displayed first
(2)   ECG2 displayed below ECG1
(3)   ECG3 displayed below ECG2
(4)   Selected lead label
(5)   ECG gain bar (1 mV reference)
(6)   Heart rate (HR) label
(7)   Heart rate calculation source and message field for HR messages
(8)   HR value is always displayed with ECG1
(9)   Heart beat detector is flashing with every detected heart beat
(10) ST values appear next to ECG1; the lead with the largest absolute ST value is also displayed
(11) Selected ST leads
(12) ST label
(13) Message field for parameter messages

NOTE: You can choose the number of ECG waveforms on the display in the Monitor Setup menu (select **Screen Setup** and **Waveform Fields**). You choose the ECG leads in the ECG menu.

Patient connections

Patient preparation

Good signal quality requires good skin contact with the electrodes. Excessive body hair or skin oil can affect the contact. Pre-gelled electrodes are recommended. Check that the electrodes are moist and have not dried out during storage.

WARNING: Make sure the lead set clips or snaps do not touch any electrically conductive material including earth.

Placing electrodes

When placing the electrodes, avoid bones close to the skin, obvious layers of fat, and major muscles.
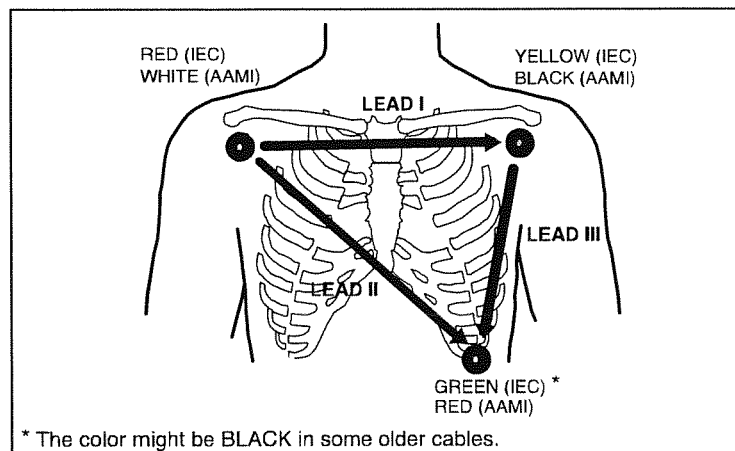
Figure 10-2. Standard electrode positioning with 3-lead set

You can use a CB_5-lead when you want the 3-lead set connection to resemble the 5-lead set V5 connection. The red (IEC standard) or white (AAMI standard) electrode, which is shaded, is on the back.
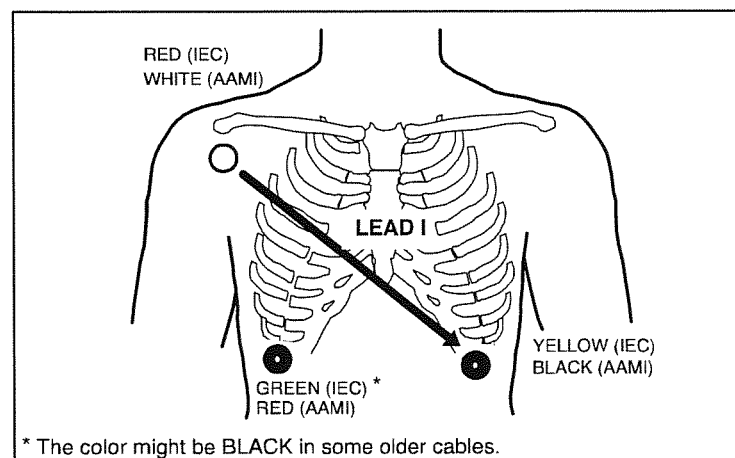
Figure 10-3. Modified electrode positioning, CB_5, with 3-lead set

When you use routine positioning with a 5-lead set, place the chest electrode on one of the six places indicated in the picture. If the lead set follows the IEC standard, the chest electrode is white; if the set follows the AAMI standard, the chest electrode is brown.
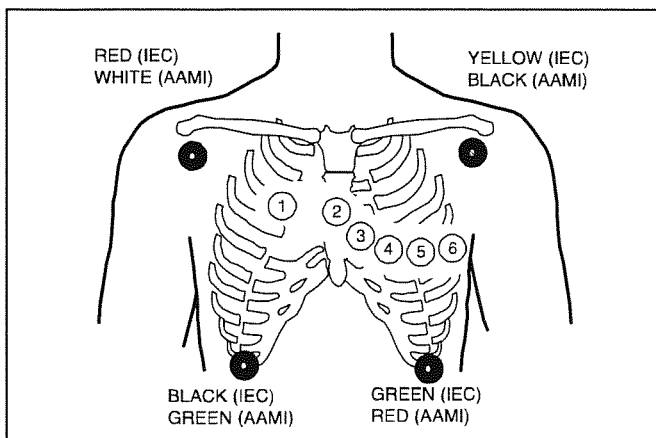
Figure 10-4. Standard electrode positioning with 5-lead set

Cable set
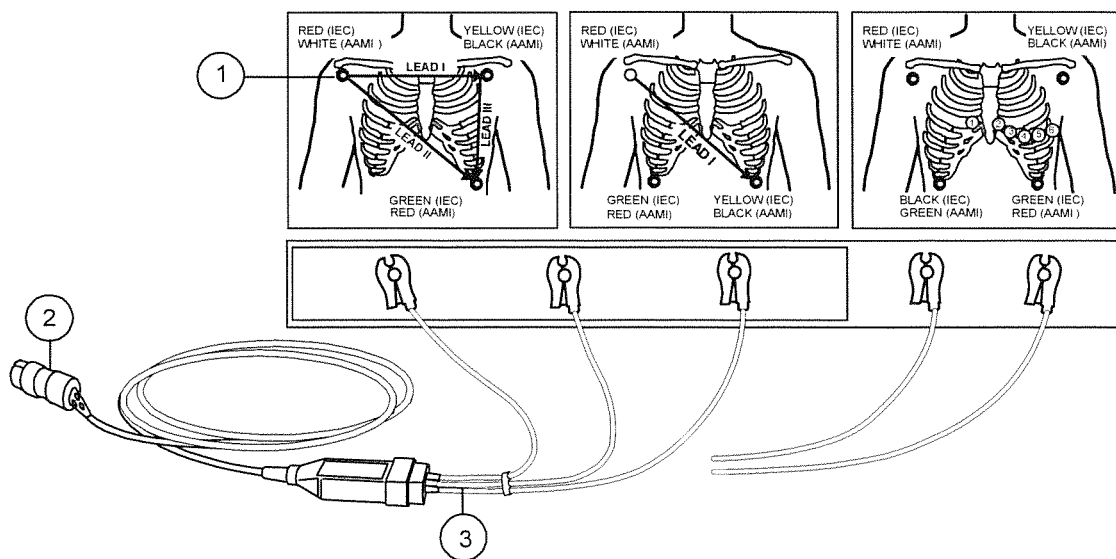
Figure 10-5. ECG setup

(1) ECG electrode(s)

(2) Trunk cable

(3) 3-lead set or 5-lead set

WARNING: Patient Safety. Ensure proper contact of the return electrode of the electrosurgery unit to your patient to avoid possible burns on the patient via ECG electrodes and probes.

NOTE: The module input circuits are protected against the effects of electrosurgery and defibrillation. However, the ECG trace on the monitor screen may be disturbed during electrosurgery.

Color and letter coding

3-LEAD IEC STANDARD	5-LEAD IEC STANDARD
L = yellow (left arm) F = green (foot) R = red (right arm)	R = red (right arm) N = black (neutral) L = yellow (left arm) F = green (foot) C = white (chest)

3-LEAD AAMI STANDARD	5-LEAD AAMI STANDARD
LA = black (left arm) LL = red (left leg) RA = white (right arm)	RA = white (right arm) RL = green (right leg) LA = black (left arm) LL = red (left leg) V = brown (chest)

Connecting the lead wires and the trunk cable

To make lead wires and trunk cable connections:

1. Attach the lead wires to the corresponding electrodes, paying attention to the color codes.

2. Connect the lead wire set to the trunk cable and ensure a proper connection.

3. Plug the trunk cable into the corresponding monitor connector.

It takes about 10 minutes for the electrodes to stabilize. During this time errors may occur in the signal.

ECG setup menu

To open the ECG setup menu:

1. Press the **ECG** key.

2. Select **ECG Setup**.

ECG	
ECG1 Lead	II
ECG2 Lead	I
ECG3 Lead	I
ECG Size	1.0
ST Analysis	▤
Beat Sound Volume	3
ECG Setup	▤
ECG Alarms	▤
Parameters Menu	

Set HR source, filter, grid, pacemaker settings and QRS type.

ECG

ECG Setup	
HR Source	AUTO
Display with HR	None
Filter	STfilt
5-lead Cable	5elect
ECG Grid	OFF
⚠ Pacemaker	Hide
⚠ QRS Type	Normal
Previous Menu	

Change origin of HR calculation. Priority in AUTO selection: ECG, Art, ABP, Pleth.

HR Source   Selects the heart rate source. When **ECG** is selected, the HR source is always calculated from ECG 1. If the ECG signal is affected by too much noise for a reliable heart rate calculation, heart rate can be calculated from pressure (Art and ABP) or the plethysmographic pulse waveform.

The selected heart rate source is shown above the numerical heart rate display. The heart rate color is the same as the source parameter.

The **AUTO** selection priorities for heart rate calculation are: ECG, Pressure (Art or ABP), and Plethysmographic pulse waveform. The first heart rate source available is selected.

Display with HR   Select **PR** to display combined Heart Rate and Pulse Rate next to the ECG waveform. The current HR source is displayed in a larger font size and the QRS symbol flashes next to the reading.

ECG	Art
H R	**58**/min **58**/min
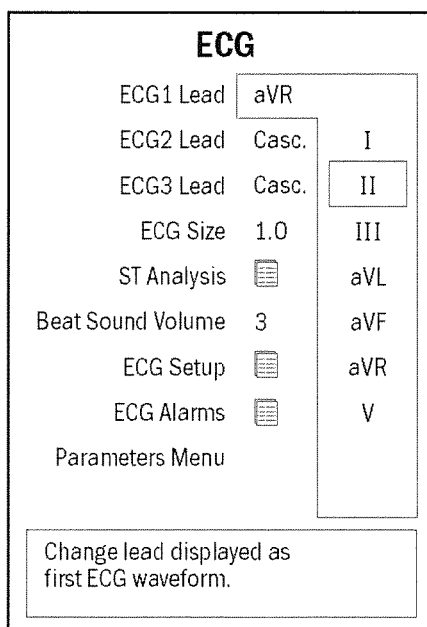
Filter   Filters the ECG signal high frequency noise and slow respiratory
                      artifacts. The selections are **Monit**, **Diagn**, and **STfilt**.

- **Monit** (monitor) filter is used in routine monitoring. It effectively
  filters the high frequency artifacts caused by the electrosurgery
  unit and respiration, for example.

- **Diagn** (diagnostic) filter is used if more accurate information of the
  waveform is needed (e.g., of P-wave or AV block). The diagnostic
  filter is more susceptible to both high frequencies and baseline
  wander than the monitor filter.

- **STfilt** (ST filter) permits more accurate of ST segment information.
  It filters the high frequency artifacts caused by an electrosurgery
  unit but catches the slow changes in ST segment. The ST filter is
  more susceptible to baseline wander than the monitor filter.

5-lead Cable   This selection is visible only when a 5-lead trunk cable is connected to
                      the monitor. Select **5elect** if you are using 5 electrodes or **3elect** if you
                      are using 3 electrodes with the 5-lead trunk cable.

ECG Grid   Selects a background to be shown on the ECG waveforms, making it
                      easier to evaluate the waveform. The grid scale is 0.5 mV.

Pacemaker   Selects how the pacing pulse of a cardiac pacemaker is displayed. The
                      selections are **Show**, **Hide**, **ON R** and **Sensit**.

- **Show**—the pacer pulse is filtered away from ECG data but the pulse
  is displayed as a constant height marker.

- **Hide**—the pacer pulse is filtered away from ECG data.

- **ON R**—pacer pulses are not filtered away from ECG data. This
  improves ECG monitoring with A-V pacemaker patients, as QRS
  complexes are counted even if the pacer pulse hits the QRS
  complex. However, during asystole the monitor may count pacer
  pulses as heart beats.

- **Sensit**—uses a more sensitive pacemaker detection. A pacemaker
  spike is displayed on ECG.

QRS Type   QRS detection and HR calculation may be affected by the shape of the
                      QRS complex. **Normal** QRS type detects a heart beat between 40 and
                      120 ms. **Wide** QRS type detects a beat between 40 and 220 ms.

Selecting a lead

The following lead selections are possible:

- With 3-lead set: I, II, III

- With 5-lead set: I, II, III, aVR, aVL, aVF and V5

To select the ECG1 lead:

ECG		
ECG1 Lead	aVR	
ECG2 Lead	Casc.	I
ECG3 Lead	Casc.	II
ECG Size	1.0	III
ST Analysis	▤	aVL
Beat Sound Volume	3	aVF
ECG Setup	▤	aVR
ECG Alarms	▤	V
Parameters Menu		

Change lead displayed as
first ECG waveform.

3. Press the **ECG** key.

4. Select **ECG1 Lead**.

You can select all the leads (ECG1, ECG2 and ECG3) in the ECG menu.

The label of the lead is displayed in the ECG field and above the numeric HR.

NOTE: It is possible to connect a 3-lead set to a 5-lead trunk cable. The combination functions as a 3-lead set.

Viewing a cascaded ECG

If more than one ECG waveform is configured to be displayed in the waveform fields when using a 3-lead set, the same ECG is displayed in each of these fields. Thus, more QRS complexes are displayed at the same time.

With a 5-lead set, a cascaded ECG or different leads can be displayed. Select the different leads in the ECG menu.

Adjusting ECG size

Increasing or decreasing the ECG gain affects the size of the 1 mV bar at the left end of the ECG waveform, and the size of the ECG waveform accordingly.

To make adjustments in ECG size:

ECG	
ECG 1 Lead	aVR
ECG 2 Lead	Casc.
ECG 3 Lead	Casc.
ECG Size	1.0
ST Analysis	📑
Beat Sound Volume	3
ECG Setup	📑
ECG Alarms	📑
Parameters Menu	1 mV

Change size of ECG waveforms by adjusting scale height.
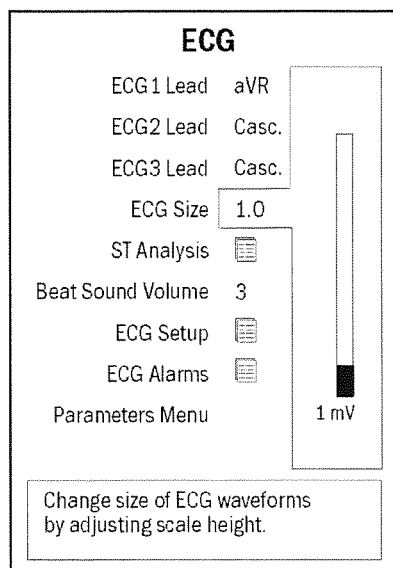
5. Press the **ECG** key.

6. Select **Size**.

Adjusting beat sound volume

When the monitor detects a QRS complex or a pulse (pleth or pressure), a beep tone sounds. You can raise, lower, or turn off the beat sound volume. Adjusting the beat sound volume also affects the SpO_2 beat sound volume.

When SpO_2 is monitored, the monitor provides a variable pulse beep, so that the tone of the pulse beep rises with increasing oxygen saturation and falls as saturation decreases. This also affects the ECG tone.

To adjust the beat volume:

ECG	
ECG 1 Lead	II
ECG 2 Lead	I
ECG 3 Lead	I
ECG Size	1.0
ST Analysis	📑
Beat Sound Volume	3
ECG Setup	📑
ECG Alarms	📑
Parameters Menu	0

Adjust volume of pulse/heart beat sound.
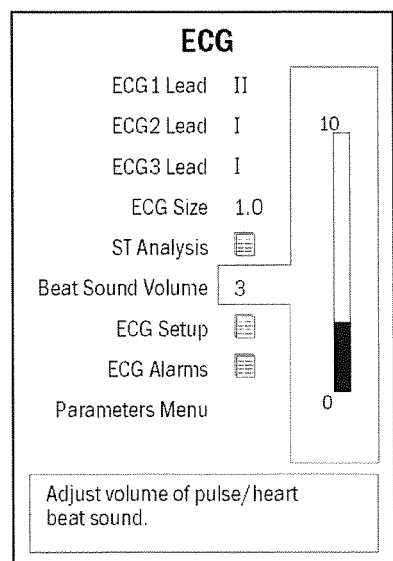
7. Press the **ECG** key.

8. Select **Beat Sound Volume** and turn the ComWheel to choose the volume. The range is from 1 (silent) to 10 (loud) or 0 (OFF).

ST segment analysis

The ST value illustrates the electrical activity difference between ISO points and ST points. The points are based on R-wave detection.

Myocardial ischemia manifests itself in the ECG by causing the ST segment to deviate from the isoelectric line (ISO point). The ST segment generally rises above the PQ isoelectric line in the presence of transmural ischemia and is pressed below the isoelectric line in the subendocardial ischemia. Ischemic heart disease may result in myocardial infraction, fatal arrhythmias, or acute coronary insufficiency.

ST segment changes may also be affected by other factors than myocardial ischemia. These factors can be, for example, drugs, or metabolic or conduction disturbances.

Monitoring the ST segment

The monitor continuously analyzes the ST segment changes in active leads. ST numerical data is shown on the right of the second real-time ECG waveform field.

When monitoring begins or when a lead is changed, the monitor starts to learn the ST segment. During a learning period of 16 accepted beats, the ST values are displayed beat to beat.

Optimal leads for ST analysis are

- With 5-lead set: II, aVF and V5

- With 3-lead set: CB_5.

NOTE: Select the ST filter (in the ECG Setup menu) as well as the monitored leads (in the ECG menu) at the beginning of the case. Changing the filter and/or the lead affects the ST measurement values.

Accessing ST analysis view

To access the ST analysis view:

ECG	
ECG1 Lead	aVR
ECG2 Lead	Casc.
ECG3 Lead	Casc.
ECG Size	1.0
ST Analysis	▤
Beat Sound Volume	3
Relearn	
ECG Setup	▤
ECG Alarms	▤
Parameters Menu	
Review all ECG lead waveforms. View QRS complexes and ST analysis points.	
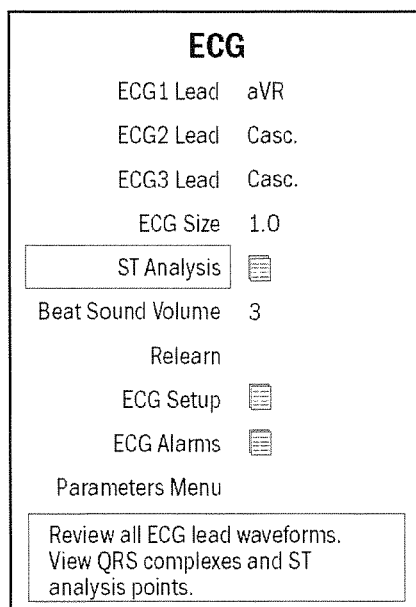
9.   Press the **ECG** key.

10.   Select **ST Analysis**.

When the ST analysis view is accessed, the display shows three measured ECG leads and an averaged QRS complex for each ECG lead. In addition, a graphic trend display for each ECG lead is shown. Changing the lead causes a new learning of the ST segment. The learning period is shown as a line in the trend display.
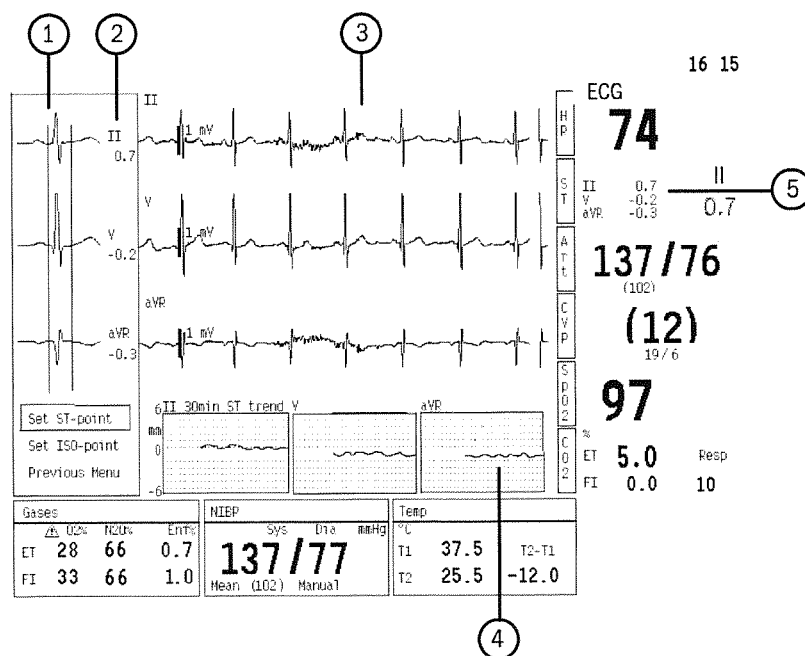
Figure 10-6. ST analysis view

(1) ST view showing QRS complex average for each lead with ST and ISO point cursors

(2) Lead label, ST values

(3) ECG waveform area showing 3 ECG leads

(4) A trend of ST values of each selected lead

(5) Current ST values displayed continuously

ST display in a digit field

You can also select ST numerical data to the lower digit field.
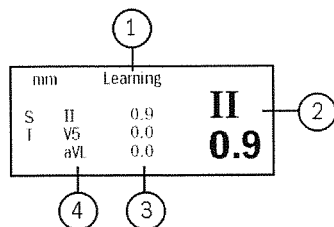
(1) Message field

(2) The lead that has the largest absolute ST value

(3) ST values of ECG 1, ECG 2, and ECG 3

(4) Lead label

Figure 10-7. ST number field

To do this:

11. Press the ComWheel and select **Monitor Setup** from the Main Menu.

12. Select **Screen Setup**.

13. Select **Digit Fields**.

Setting ST point manually

In the monitor, the ST point is initially set 80 ms after the R detection. If this setting is changed, the original point is shown as a dashed line. If the ST point is set manually, the set value remains until the monitor is turned off or reset.

To set the ST point:
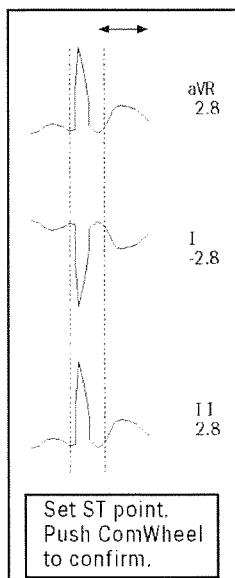
14.	Press the **ECG** key.
15.	Select **ST Analysis.**
16.	Select **Set ST point.**
17.	Set the ST point by turning the ComWheel. To confirm the setting, press the ComWheel.

aVR
2.8

I
-2.8

I I
2.8

Set ST point.
Push ComWheel
to confirm.

Setting ISO point manually

The ISO (isoelectric) point is initially set 74 ms before the R detection. If this setting is changed, the original point is shown as a dashed line. If the ISO point is set manually, the set value remains until the monitor is turned off or reset.

To set the ISO point:
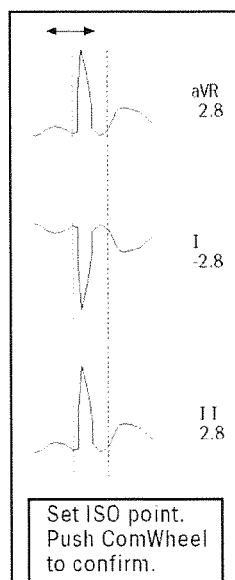
18.	Press the **ECG** key.
19.	Select **ST Analysis**.
20.	Select Set **Set ISO point.**
21.	Set the ISO-point by turning the ComWheel. Confirm the setting by pressing the ComWheel.

aVR
2.8

I
-2.8

I I
2.8

Set ISO point.
Push ComWheel
to confirm.

NOTE: The ST algorithm has been tested for accuracy of the ST segment data. The significance of the ST segment changes needs to be determined by a clinician.

Setting ECG alarms

You can set the ST alarm limit and change the high and low heart rate alarms from the ECG menu (as described below). You can also make the adjustments by selecting **Adjust Limits** in the Alarms Setup menu.

To adjust ST and heart rate alarms:

ECG	
ECG1 Lead	II
ECG2 Lead	I
ECG3 Lead	I
ECG Size	1.0
ST Analysis	📋
Beat Sound Volume	3
ECG Setup	📋
ECG Alarms	📋
Parameters Menu	

Change high and low HR alarm limits. Set ST alarm limts.
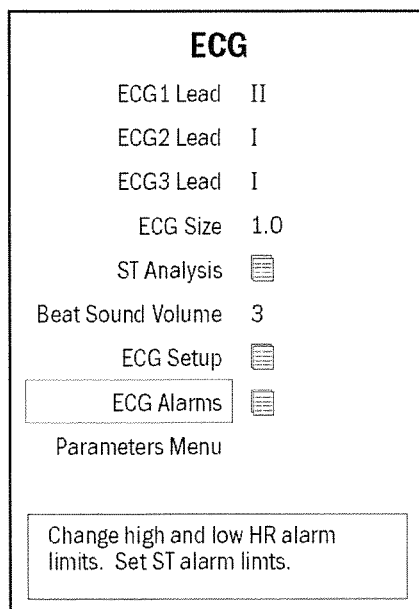
22. Press the **ECG** key.

23. Select **ECG Alarms**.

24. Select **Adjust Limits** and make the desired adjustments.

Monitoring pacemaker patients

1. Press the **ECG** key.

2. Select *ECG Setup - Pacemaker* and select one of the following:

- *Show* = Pacemaker spike is displayed on ECG.

- *Sensit* = Sensitive pacemaker detection; spike displayed on ECG

- *ON R* = Pacemaker suppression weakened; asystole alarm may not be reliable with active pacemakers.

- *Hide* = Pacemaker spike is not displayed on ECG.

NOTE: Pacemaker detector may not operate correctly during the use of high-frequency (HF) surgical equipment. The disturbances of HF surgical equipment typically cause false positive pacer detection.

NOTE: The pacemaker may change the shape of the QRS complex so much that QRS detection may be affected.

WARNING: Do not rely entirely upon rate meter alarms when monitoring patients with pacemakers. The monitor may count the pacemaker pulses as heartbeats. In this case, asystole and ventricular fibrillation may go undetected. Always keep these patients under close surveillance and monitor their vital signs carefully.

Other adjustable features

This section describes other adjustable features related to ECG measurement. A password is required for entering the Install/Service menu where the adjustments are made. If you wish to change a feature, we recommend that you contact the person responsible for the entire configuration.

Analog signal output

WARNING: Output signals are not floating and must not be connected directly to a patient.

25. Press the ComWheel and select **Monitor Setup** from the Main Menu.

26. Select **Install/Service** and enter the password.

27. Select **Installation**.

28. Select **Analog Outputs**.

For more information, refer to the *Technical Reference Manual*.

For your notes:

Chapter 11. Impedance Respiration

Table of Figures

11. IMPEDANCE RESPIRATION

Overview

Impedance respiration is measured across the thorax. When the patient is breathing or is ventilated, the volume of air changes in the lungs, resulting in impedance changes between the electrodes. A respiration rate is calculated from these impedance changes, and a respiration waveform is displayed on the monitor screen.

Respiration detection

The respiration rate is the sum of respirations that exceed the detection limit.
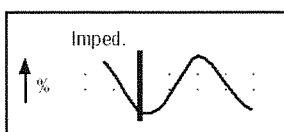
The dotted lines are the zero line and the detection limit. The signal strength produced by a respiration should thus exceed this minimum limit to be included in the respiration rate calculation. Peaks within the grids are not calculated.

If **AUTO** detection mode is chosen, the grid lines are the minimum limits but the limits in use may be larger. The RR value can include fewer respirations than indicated by the gridline.

Respiration rate calculation

Respiration rate is calculated automatically when ECG is measured, unless respiration measurement is turned off or CO_2 is measured.

When CO_2 is measured (only possible with F-MXG model), the respiration rate is automatically calculated from the CO_2.

Respiration rate calculation switches back to impedance respiration if you press the **Silence Alarms** key during an Apnea alarm.

The respiration rate source is displayed above the respiration numeric value.
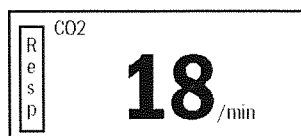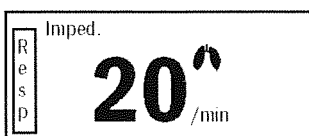
Figure 11-1. Respiration rate source indication for impedance and CO₂

The impedance respiration waveform is also displayed next to the RR value when the RR value is calculated from CO_2.

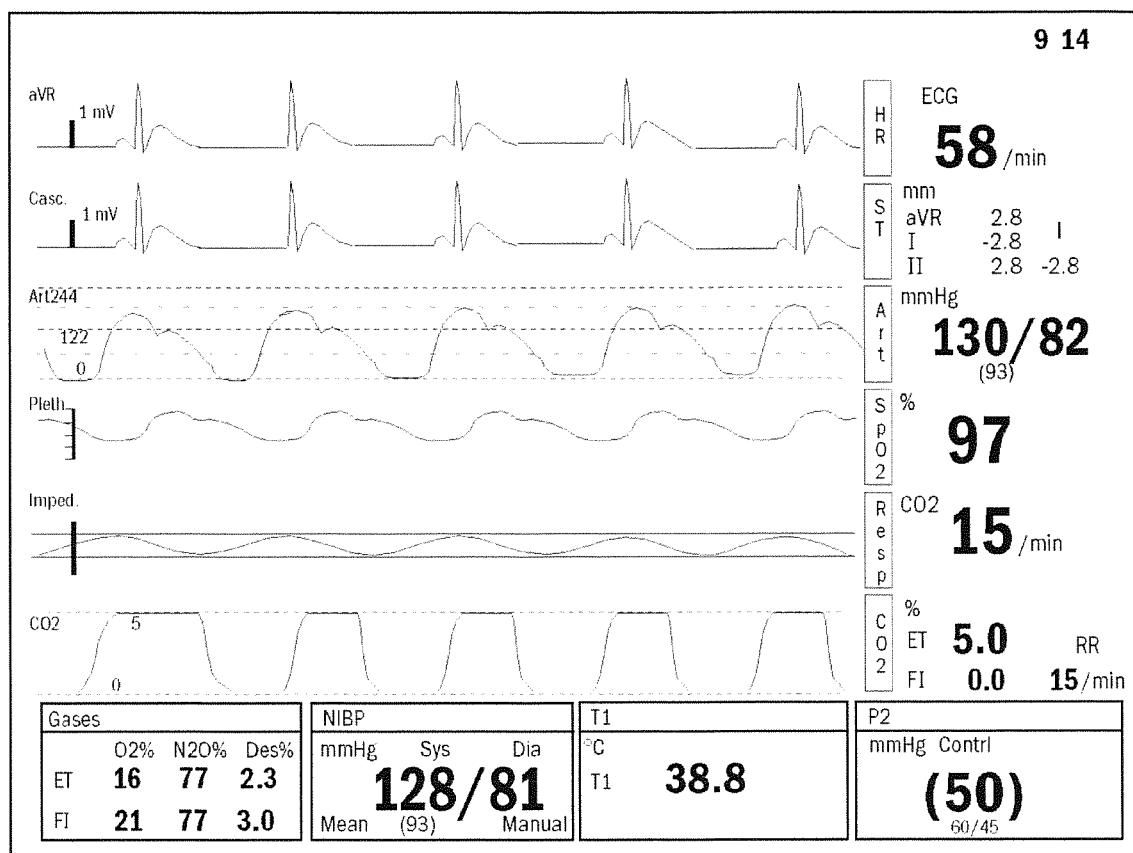# Impedance respiration display

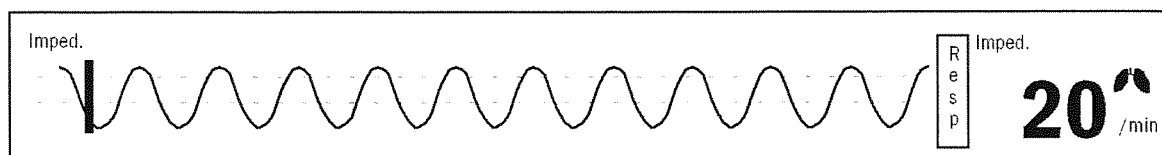**Figure 11-2. Monitor display with impedance respiration measurement**

Figure 11-3. Impedance respiration waveform and respiration rate numeric value

Patient connections

The setup for impedance respiration is the same as for ECG measurement. If you do not have the ECG setup, see *Patient connections* in the *ECG* chapter.
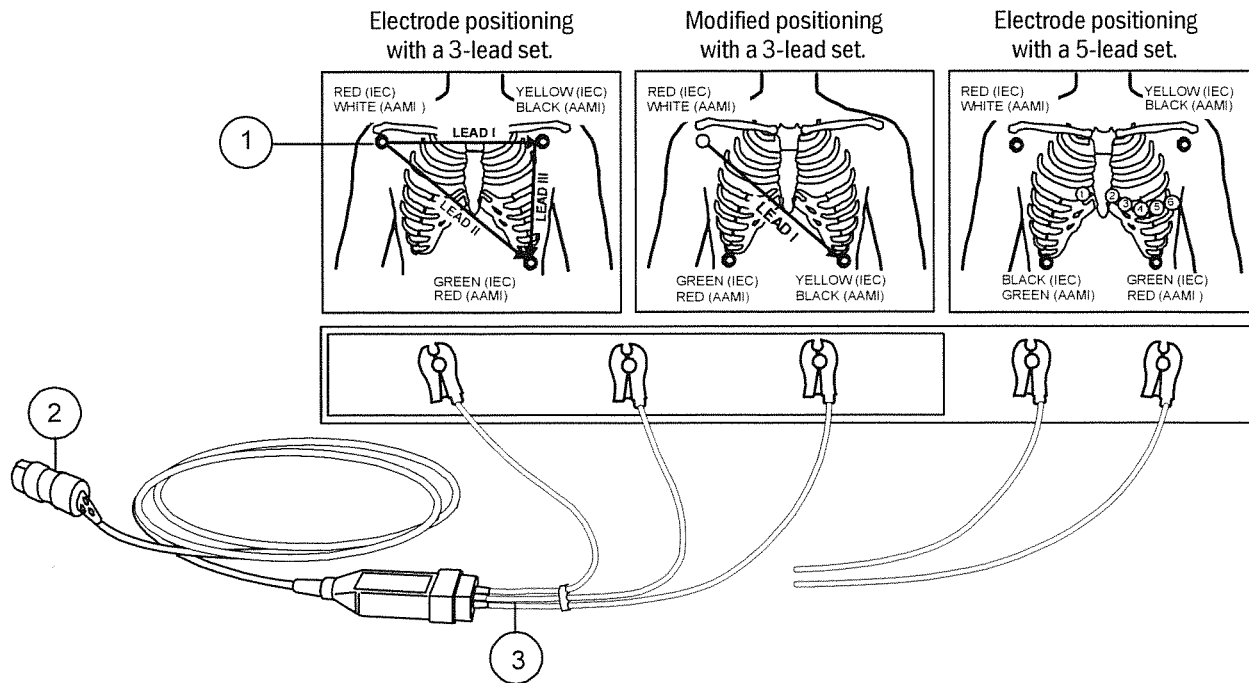
You can use 3-lead or 5-lead ECG sets.

Figure 11-4. Impedance respiration setup

(1) ECG electrode(s)

(2) Trunk cable

(3) Lead set (3-lead or 5-lead set)

NOTE: Use of the impedance respiration measurement is recommended only for patients over three years old.

WARNING: In obstructive apnea, respiration movements and impedance variations may continue.

WARNING: Patient Safety. Ensure proper contact of the return electrode of the electrosurgery unit to avoid possible burns at sensor sites.

WARNING: Make sure that the lead set clips or snaps do not touch any electrically conductive material including earth.

Activating the respiration measurement

The respiration information is not included in the trends and the alarms are not operative unless respiration is selected in a waveform or in a digit field.

To select respiration in a waveform or a digit field:

Screen Setup	
Waveform Fields	
Field 1	ECG1
Field 2	ECG2	OFF
Field 3	P1	ECG1
Field 4	P2	P1
Field 5	Pleth	P2
Field 6	CO2	Pleth
	CO2
Combine Pressures	NO	O2
Previous Menu	AA
	-More-

Change waveform in field 1. Select OFF to clear field.

Screen Setup	
Digit Fields	
Lower Field 1	Compl	-More-
Lower Field 2	NIBP	Resp
Lower Field 3	Flow	Paw
Lower Field 4	Gases	Flow
Previous Menu	Paw TV
	Compl
	T1
	OFF

Change contents of lower digit field 1. Select OFF to clear field.

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.

2. Select **Screen Setup**.

3. Select **Waveform Fields** or **Digit Fields**.

4. Choose **Resp**.

Turning the measurement ON

To turn on the impedance respiration measurement:

Parameters		
Resp Setup		
Size	2.0	
Resp Rate Source	Imped.	ON
Measurement	OFF	OFF
Detection Limit	40%	
Resp Rate Alarm		
Parameters Menu		

Select ON to enable impedance respiration measurement.

5. Press the ComWheel and select **Parameters** from the Main Menu.

6. Select **Resp Setup**.

7. Select **Measurement** and choose **ON**.

Turning the measurement OFF

In case the impedance respiration measurement signal interferes with other measurements, such as ECG, you can turn it off:

8. Press the ComWheel and select **Parameters** from the Main Menu.

9. Select **Resp Setup.**

10. Select **Measurement** and choose **OFF.**

Choosing the respiration rate source

To manually choose the respiration rate source:

```
┌─────────────────────────────────────┐
│           Parameters                │
│  ┌────────────────────────────────┐ │
│  │        Resp Setup              │ │
│  │                                │ │
│  │        Size   2.0              │ │
│  │ Resp Rate Source  Imped.  AUTO │ │
│  │   Measurement   ON        CO2  │ │
│  │  Detection Limit  40%    Imped.│ │
│  │   Resp Rate Alarm  ▤           │ │
│  │   Parameters Menu              │ │
│  │                                │ │
│  │                                │ │
│  │                                │ │
│  ├────────────────────────────────┤ │
│  │ Change source of respiration   │ │
│  │ rate: AUTO, CO2 or Impedance   │ │
│  │ (received from ECG electrodes).│ │
│  └────────────────────────────────┘ │
└─────────────────────────────────────┘
```

11. Press the ComWheel and select **Parameters** from the Main Menu.

12. Select **Resp Setup**.

13. Select **Resp Rate Source** and choose **AUTO, CO2,** or **Imped.**

Improving waveform readability

To improve the readability of the waveform, increase its size:

```
┌─────────────────────────────────────┐
│           Parameters                │
│  ┌────────────────────────────────┐ │
│  │        Resp Setup              │ │
│  │                                │ │
│  │        Size   2.5              │ │
│  │ Resp Rate Source  AUTO     ┌─┐ │ │
│  │   Measurement   OFF        │ │ │ │
│  │  Detection Limit  40%      │ │ │ │
│  │   Resp Rate Alarm  ▤       │ │ │ │
│  │   Parameters Menu          │ │ │ │
│  │                            │ │ │ │
│  │                            │█│ │ │
│  │                        1 mm└─┘ │ │
│  ├────────────────────────────────┤ │
│  │ Change size of waveform by     │ │
│  │ adjusting scale height.        │ │
│  └────────────────────────────────┘ │
└─────────────────────────────────────┘
```

14. Press the ComWheel and select **Parameters** from the Main Menu.

15. Select **Resp Setup**.

16. Select **Size** and turn the ComWheel to change the size of the waveform.

The bar at the left of the waveform always indicates a 1 Ω reference.

Improving respiration rate detection

When respirations are weak, you can adjust the detection limits (measurement sensitivity) closer to each other to ensure that all respirations are included in the RR value. In this case, the dotted line represents the absolute detection limits.

When there are numerous artifacts, you can separate smaller artifacts from larger, true respiration peaks by adjusting the grids farther apart. The small peaks fall within the grids and are not calculated; the larger peaks cross the grids and are calculated as true respirations.

During spontaneous breathing, the ventilator may support the patient's ventilation with an extra inspiration. If these ventilator inspirations are substantially larger than the spontaneous breaths, the respiration calculation may mistakenly count only the ventilator-produced inspirations and expirations. You can correct this by adjusting the detection limit.

To adjust the detection limit:

Parameters		
Resp Setup		
Size	2.5	
Resp Rate Source	AUTO	AUTO
Measurement	OFF	20%
Detection Limit	40%	40%
Resp Rate Alarm	▦	60%
Parameters Menu		80%
		100%
Select detection limit of impedance respiration. AUTO will adjust to signal.		

17. Press the ComWheel and select **Parameters** from the Main Menu.

18. Select **Resp Setup**.

19. Select **Detection Limit**.

The percentage is the ratio to the 1 Ω reference bar, which is 100%.

Measurement limitations

Movement artifacts

Changing the patient position, moving the head or the arms, or shaking will result in movement artifacts. Also, the heart may cause noticeable movement and sometimes this may interfere with the respiration measurement.

Electrical interference

Electrical devices that emit electromagnetic disturbance, such as electrosurgery units and infrared heaters, will result in artifacts or may disable the respiration measurement.

Pacemaker patients

WARNING: Pacemaker Patients. The impedance respiration measurement may cause rate changes in Minute Ventilation Rate Responsive Pacemakers. Set the pacemaker rate responsive mode off or turn the impedance respiration measurement off on the monitor.

Chapter 12. Pulse Oximetry

Table of Figures

12. PULSE OXIMETRY

Overview

Oxygen saturation (SpO_2) is the percentage of saturated hemoglobin compared to total hemoglobin as measured by a two-wavelength pulse oximeter (also called functional or in vivo oxygen saturation).

SpO_2 is measured with light absorption techniques: red and infrared light are emitted from the emitter side of the sensor. The light is partly absorbed when it passes through the monitored tissue. The amount of transmitted light is detected in the detector side of the sensor. When the pulsative part of the light signal is examined, the amount of light absorbed by arterial hemoglobin is discovered and the saturation level is calculated.

The plethysmographic pulse wave is derived from variations of the intensity of the transmitted light. It reflects the blood pulsation at the measuring site. Thus, the amplitude of the waveform reflects the perfusion.

NOTE: See the pulse oximetry product specifications in chapter 1 for more details.

Pulse oximetry options

The Cardiocap/5 monitor offers three oxygen saturation measurement technologies:

- Datex-Ohmeda standard pulse oximetry.
- Datex-Ohmeda enhanced pulse oximetry (N-XOSAT option).
- Nellcor® compatible pulse oximetry (N-XNSAT option).

NOTE: Use only sensors identified for use with a specific option. For example, use only Nellcor® sensors with the N-XNSAT option.

Consult the *User's Guide* for appropriate Datex-Ohmeda sensors. Datex-Ohmeda Sat sensors and OxyTip®+ sensors are latex-free.

Nellcor® sensors

Use the sensors listed below with the N-XNSAT option (* indicates latex-free).

Oxygen Transducer Name	Patient Type	Order Number	SpO_2 Accuracy (± 1 SD)
Oxisensor® II	Adult	D-25 * / D-25L *	70-100% ± 2 digits
	Pediatric	D-20 *	
	Infant	I-20 / I-20LF *	
	Adult Nasal	R-15	80-100% ± 3.5 digits
OxiCliq®	Adult	A *	70-100% ± 2.5 digits
	Pediatric	P *	
	Infant	I	
Durasensor® II	Adult	DS-100A *	70-100% ± 3 digits
Dura-Y® II Multisite	Adult, Pediatric, Infant	D-YS	
Oxiband® II	Pediatric, Infant	OXI-P/I *	

Pulse oximetry display

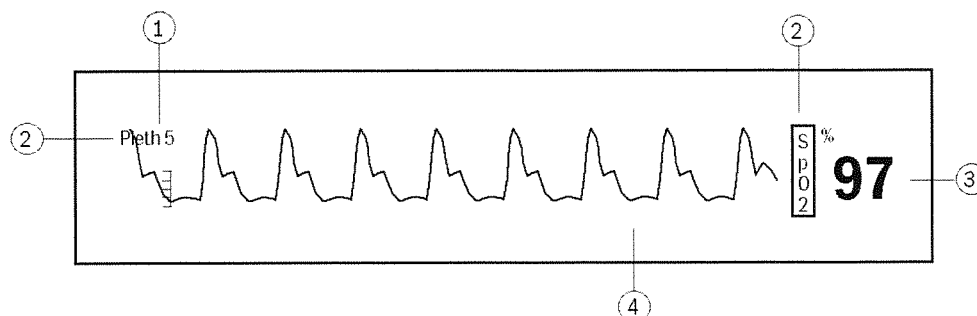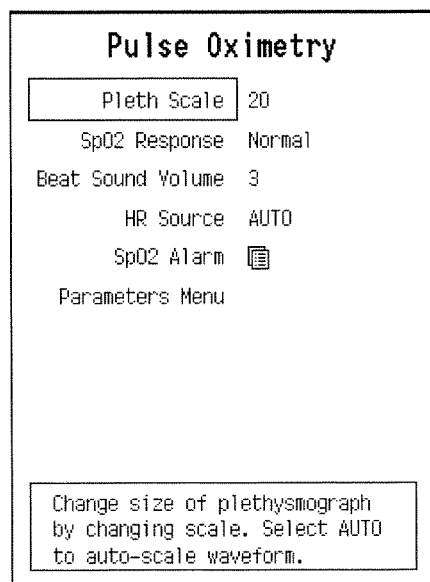**Figure 12-1. Display of SpO₂ value and Pleth waveform**

(1)   Scale of Plethysmogram

(2)   Label(s)

(3)   Oxygen saturation (SpO₂) value

(4)   Pulse oximetry message field

Opening the pulse oximetry menu

NOTE: Models with the Invasive Pressures or NMT option do not have the **Pulse Oximetry** direct access key.

To open the pulse oximetry menu:

1.   Press the **Pulse Oximetry** key.

   or

2.   Press the ComWheel and select **Parameters** from the Main Menu. Then, select **Pulse Oximetry**.

Menu selections

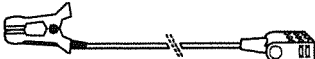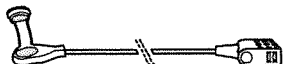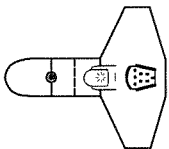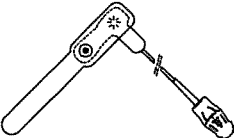|	
Pleth Scale	The scale of the plethysmographic waveform display is set automatically during "Pulse search." To adjust it further, select **2**, **5**, **10**, **20**, **50**, or **AUTO**.
	NOTE: This selection is not available for the N-XNSAT or N-XOSAT options, both of which are preset to **AUTO**.
	When **AUTO** scaling is used, the scale changes automatically if the amplitude of the pleth waveform exceeds the current scale or falls below the maximum value of the next lower scale by 10% for 30 seconds or more. When the scale changes, the "Scale changed" message is displayed.
	The scale indicator number appears at the left of the waveform.
SpO$_2$ Response	Selects the SpO$_2$ averaging time: **b-to-b** (beat to beat), **Normal** (10 seconds), or **Slow**: (20 seconds, the default setting).
	NOTE: This selection is not available for the N-XNSAT option, which is preset to 5–7 seconds, or for the N-XOSAT option, which is preset to 12 seconds.
Beat Sound Volume	Adjusts the SpO$_2$ beat volume. This adjustment also affects the ECG beat volume.
	When SpO$_2$ is monitored, the tone of the pulse beep rises as oxygen saturation increases and falls as it decreases.
HR Source	Selects the heart rate source. If the ECG signal is affected by too much noise for a reliable heart rate calculation, the heart rate can also be calculated from the invasive pressure (**Art**) or from the plethysmographic pulse waveform (**Pleth**).
	The selected heart rate source is shown above the numerical display of the heart rate. The color of the heart rate is the same as the source parameter.
	If **AUTO** is selected, the heart rate calculation priorities are: **ECG** (the lead with the highest R-wave), invasive pressure (**Art**), then Plethysmographic pulse waveform (**Pleth**).
SpO2 Alarm	Select to adjust the SpO$_2$ alarm limits as described in the *Alarms* chapter.

Plethysmographic pulse wave

If the site is poorly perfused, use smaller scale indicators to display an optimal pulse wave. A small pulse wave may be a sign of impaired circulation that may require increased attention.

Higher scale indicators together with a well-defined pulse wave indicate strong circulation and a relaxed patient.

Patient connections

Selecting the sensor

Choose a sensor that is appropriate for the patient and the monitoring requirements. Sensors are categorized as reusable (durable) or disposable (single-patient use). Examples of both types are shown and described below.

Reusable Sensors	Description
	Finger sensor. Widely-used. Quick application is possible; some may be used on toes.
	Ear sensor. Similar in appearance to finger sensor, but smaller. Used on upper or lower part of ear.
	Wrap sensor. Flexible sensor that wraps around the site (usually fingers, toes, or the fleshy part of a hand or foot). Useful for small children.
Disposable Sensors	**Description**
	Adhesive sensor that wraps around a finger or toe. A separate sensor cable snaps into a connector on the sensor.
	Adhesive sensor with integrated cable; wraps around a finger or toe.
	Adhesive sensor with integrated cable. The sensor is positioned inside tape that is wrapped around the site to hold the sensor in place. This sensor is used on fingers, toes, and the fleshy part of a hand or foot, depending on the patient.

A finger sensor is usually appropriate for short-term patient monitoring. For long-term monitoring, a single-patient, disposable sensor or a wrap-type sensor is commonly used.

WARNING: Patient safety. Use clean and dry sensors and cables only. Moisture and debris on connectors may affect measurement accuracy.

Choosing a site

Site selection depends on the type of sensor and the weight of the patient. When choosing a site for a sensor, refer to the instructions for that sensor.
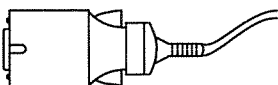
Choose a well-perfused site on a nondominant hand or foot, or the fleshy upper or lower part of the ear when using an ear sensor.

- Clean the application site you choose, if necessary.
- Finger or toe—remove nail polish and artificial fingernails; clip long fingernails.
- Ear—remove earrings.

Connecting the sensor

WARNING: Patient safety. To prevent erroneous readings, do not use an inflated blood pressure cuff or arterial blood pressure measurement device on the same limb as the oximeter sensor.

3. Connect the sensor (or sensor extension cable) to the SpO₂ connector on the monitor.

Monitor Connections
SpO2 Datex-Ohmeda standard pulse oximetry
SpO2 Datex-Ohmeda enhanced pulse oximetry (N-XOSAT)
SpO2 Nellcor pulse oximetry (N-XNSAT)

4. If applicable, connect the sensor cable to the extension cable.

Cable Connections
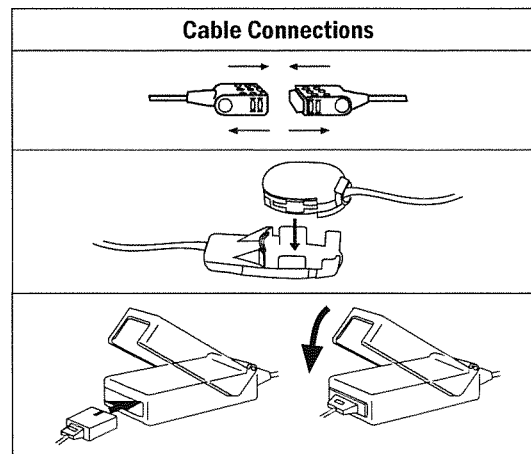
5. Position the sensor and attach it to the patient. For proper sensor positioning and application, consult the instructions that accompany the sensor.

6. To minimize movement, attach the sensor cable to the wrist or bed clothes.

The "Pulse search" message appears. After the pulse search is completed, the plethysmographic pulse waveform and the SpO₂ reading appear on the screen.

Disconnecting the sensor

When disconnecting a sensor, grasp the connector, not the cable. Some connectors contain "buttons" on each side of the connector that you press to release the connector.

During monitoring

WARNING: Patient safety. Do not use a pulse oximeter with magnetic resonance imaging (MRI).

WARNING: Patient safety. A damaged sensor or a sensor soaked in liquid may cause burns during electrosurgery.

WARNING: Patient safety. Patient conditions (such as reddening, blistering, skin discoloration, ischemic skin necrosis, and skin erosion) may warrant changing the sensor site frequently or using a different style of sensor. For details, refer to the instructions supplied with the sensor.

Patient condition or prolonged use may require changing the sensor site periodically. Check skin integrity, circulatory status, and correct alignment.

For patients with poor peripheral blood circulation, change the site at intervals of 30 minutes to one hour. To confirm the circulatory status, observe the size of the plethysmographic waveform with a fixed pleth scale.

Be especially careful when monitoring infants.

Measurement limitations

Use Cardiocap/5 pulse oximetry only for patients weighing 5 kg (11 lb.) or more, even if the SpO_2 sensor can be used for patients weighing less than 5 kg.

Interfering substances

WARNING: Data validity. Conditions that may cause inaccurate readings and impact alarms include interfering substances, excessive ambient light, electrical interference, ventricular septal defects (VSD), excessive motion, low perfusion, low signal strength, incorrect sensor placement, poor sensor fit, and/or movement of the sensor on the patient.

The pulse oximeter cannot distinguish between oxyhemoglobin and dyshemoglobins (methemoglobin or carboxyhemoglobin, for example). Dyes that change usual arterial pigmentation, or substances containing dyes, may also cause erroneous readings.

Carboxyhemoglobin may erroneously increase readings in all pulse oximeters. The level of increase is approximately equal to the amount of carboxyhemoglobin present. Cigarette smokers and victims of smoke inhalation often have increased levels of carboxyhemoglobin. Therefore, the saturation values may be somewhat higher for smokers and for patients with carbon monoxide (CO) intoxication.

NIBP measurement and cold infusions

Do not attach the pulse oximetry sensor to a limb that is used for noninvasive blood pressure measurement or for administrating cold infusions. These circumstances reduce the pulsation and perfusion and may affect the pulse oximetry measurement.

Chapter 13. Non-Invasive Blood Pressure (NIBP)

Table of Figures

13. NON-INVASIVE BLOOD PRESSURE (NIBP)

Overview

The non-invasive blood pressure (NIBP) measurement uses the oscillometric measuring principle. The cuff is inflated with a pressure slightly higher than the presumed systolic pressure, then slowly deflated at a speed based on the patient's heart rate, collecting data from the oscillations produced by the pulsating artery. Based on this data, the unit calculates values for systolic, mean and diastolic pressures.

The measurement can be used for adults, children and infants. The monitor automatically recognizes the type of cuff hose (black hose for adults and children, white hose for infants) used for each patient type at the beginning of each measurement.

It is possible to set an automatic cycling mode to make measurements at desired time intervals. It is also possible to measure NIBP continuously for five minutes in STAT mode or take separate single measurements.

NIBP display

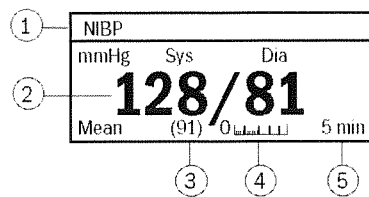NIBP can be displayed in the digit field:

Figure 13-1. NIBP digit field display

(1) Label

(2) Systolic and diastolic pressure value of non-invasive blood pressure

(3) Mean pressure value of NIBP

(4) Time since the last autocycle measurement

(5) NIBP autocycle time indicator

Patient connections

Cuff hose

Over brachial artery

Cuff

INDEX LINE

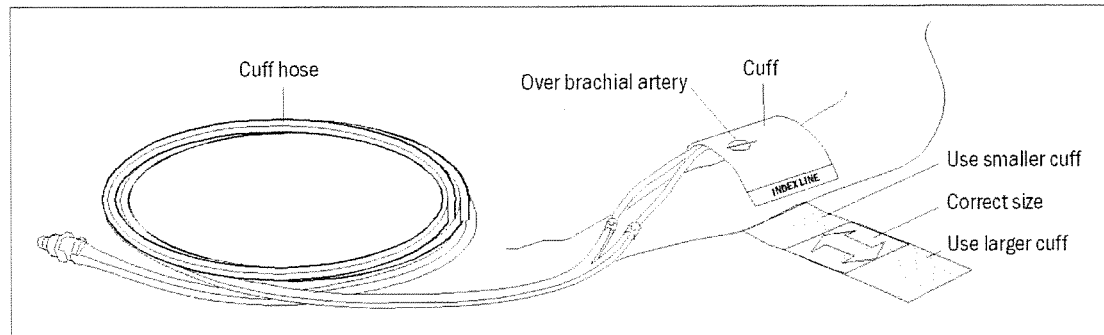Use smaller cuff

Correct size

Use larger cuff

Figure 13-2. Cuff positioning

Selecting the cuff hose

Two different cuff hoses with different cuff connections are available:

- BLACK hose for adults and children
- WHITE hose for infants

The monitor automatically recognizes the hose and selects the appropriate inflation pressure. Another inflation limit can be selected in the NIBP Setup menu. Adult inflation limits cannot be selected for an infant cuff.

NOTE: The NIBP system incorporates a safety circuit to prevent over-pressurization or prolonged inflation of the cuff.

Selecting the cuff

To determine whether the cuff size is correct, check that the white index line on the outer edge of the cuff falls between the range lines. If not, use a larger or smaller cuff.

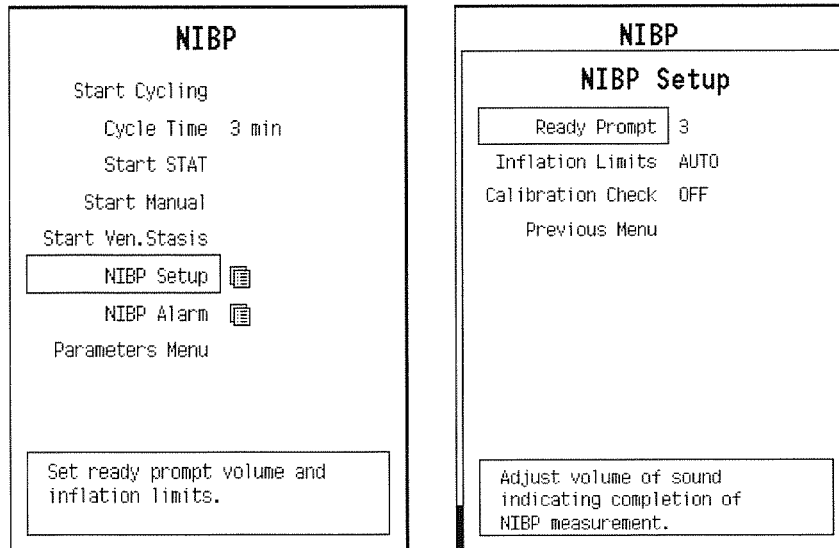| Cuff size	Color	Limb circumference	Hose
Child	Green	12-19 cm	Adult – Black
Small adult	Royal Blue	17-25 cm	Adult – Black
Adult	Navy Blue	23-33 cm	Adult – Black
Adult Long	Navy White	23-33 cm	Adult – Black
Long Adult	Wine	31-40 cm	Adult – Black
Large Adult Long	Wine	31-40 cm	Adult – Black
Thigh	Brown	38-50 cm	Adult – Black
Infant	Orange	8-13 cm	Infant – White
Neonatal #3	White	6-11 cm	Infant – White
Neonatal #4	White	7-13 cm	Infant – White
Neonatal #5	White	8-15 cm	Infant - White

The material of the reusable cuffs is soft, durable Nylon.
The material of the disposable cuffs is soft, durable, latex-free vinyl.

NOTE: When using infant cuffs, the white infant cuff hose must be used. Also make sure the **Inflation Limits** selection is set to **Infant** or **Auto**.

NIBP setup menu

To open the NIBP Setup menu, press the **NIBP** key and select **NIBP Setup**.

```
┌─────────────────────────────────┐
│            NIBP                 │
│                                 │
│     Start Cycling               │
│        Cycle Time   3 min       │
│        Start STAT               │
│        Start Manual             │
│     Start Ven.Stasis            │
│        ┌─────────────┐          │
│        │ NIBP Setup  │ ▦        │
│        └─────────────┘          │
│          NIBP Alarm   ▦         │
│     Parameters Menu             │
│                                 │
│                                 │
│   ┌─────────────────────────┐   │
│   │ Set ready prompt volume and│ │
│   │ inflation limits.       │   │
│   └─────────────────────────┘   │
└─────────────────────────────────┘
```

```
┌─────────────────────────────────┐
│            NIBP                 │
│  ┌───────────────────────────┐  │
│  │        NIBP Setup         │  │
│  │   ┌───────────────┐       │  │
│  │   │ Ready Prompt  │ 3     │  │
│  │   └───────────────┘       │  │
│  │   Inflation Limits  AUTO  │  │
│  │   Calibration Check  OFF  │  │
│  │      Previous Menu        │  │
│  │                           │  │
│  │  ┌─────────────────────┐  │  │
│  │  │ Adjust volume of sound│ │  │
│  │  │ indicating completion of│ │
│  │  │ NIBP measurement.   │  │  │
│  │  └─────────────────────┘  │  │
│  └───────────────────────────┘  │
└─────────────────────────────────┘
```

Ready Prompt   Gives an audible tone when the NIBP measurement is ready. Adjust the volume of the beep tone from 1 (silent) to 10 (loud), or to 0 (OFF).

Inflation Limits   The selections are: **Infant**, **Child**, **Adult**, and **AUTO**.

When the selection is **AUTO** (default), the monitor automatically identifies the cuff hose and selects the right inflation pressure and alarm limits. The **Child** selection decreases the maximum inflation pressure to 200 mmHg when using adult hoses/cuffs.

NOTE:

- When using infant cuffs, the white infant cuff hose must be used. The **Child** selection increases the maximum inflation pressure to 200 mmHg when using infant hoses/cuffs.

- When using very large adult cuffs, use **Adult** limits to prevent a "Cuff loose" message from appearing.

Calibration Check   Enables a calibration check using an external manometer (see below).
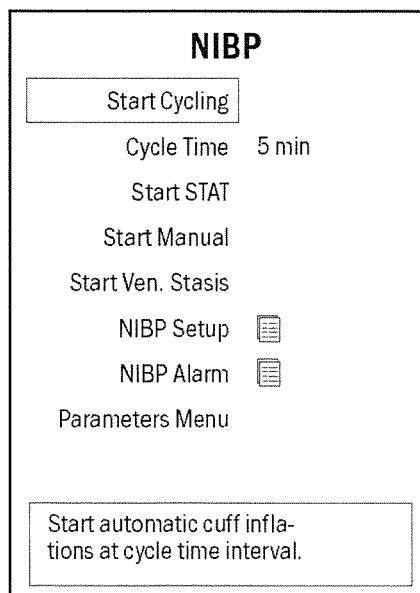
NIBP calibration check

1. Remove the cuff from the connector before entering the NIBP Setup menu.
2. To enter the NIBP Setup menu, press the **NIBP** key and select **NIBP Setup**.
3. Attach an external manometer with pump to the NIBP connector.
4. Pump to about 200 mmHg.
5. Compare the readings of the manometer and the display.

   If the difference is greater than 4 mmHg, calibration by authorized service personnel is recommended.

Starting NIBP measurement

To start a single NIBP measurement:

```
                  NIBP

        ┌─────────────────────┐
        │     Start Cycling    │
        └─────────────────────┘
            Cycle Time    5 min

            Start STAT

            Start Manual

        Start Ven. Stasis

            NIBP Setup    ▤

            NIBP Alarm    ▤

        Parameters Menu


        ┌─────────────────────┐
        │ Start automatic cuff infla-
        │ tions at cycle time interval.
        └─────────────────────┘
```

Press the **NIBP Start/Cancel** key.

or

Press the **NIBP** key and select **Start Manual**.

In the beginning of the measurement, the sys and dia labels are replaced with the inflation limit indication (adult, child, infant) for five seconds. The cuff pressure will be displayed in the mean pressure value field.

If motion artifacts are detected, the monitor automatically holds deflation until the motion stops (maximum of 30 seconds). If the artifacts prevent proper measurement, a new measurement is automatically started.

When the measurement is ready, a short beep appears and result numbers flash.

WARNING: The monitor sets the inflation pressure automatically according to the first measurement. Reset the case to reset the inflation limit before measuring a new patient.

During measurement

Observe the cuffed limb frequently. Measurement may impair blood circulation.

Intervals below 10 minutes and STAT measurements are not recommended for extended periods of time.

Make sure that the tubing is not bent, pressed or stretched. Otherwise, measurement may be impaired.

Blood pressure values may be affected by a change in the patient's position.

Automatic NIBP double-check

If the NIBP value exceeds the alarm limits, a new measurement is taken automatically (immediately, if **Manual** measurement is selected, and after 30 seconds, if **AUTO** measurement is selected). If an alarm situation persists, an alarm will be given.

Canceling a measurement

To cancel any measurement, press the **NIBP Start/Cancel** key.
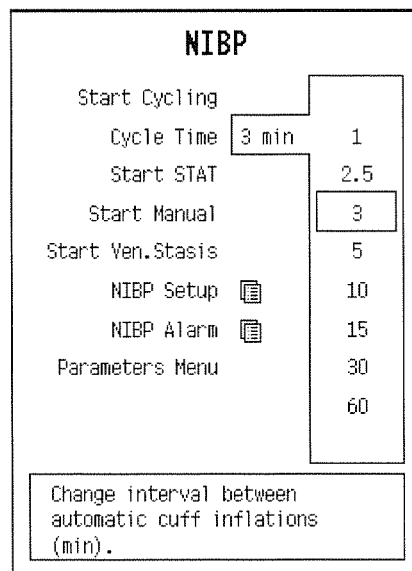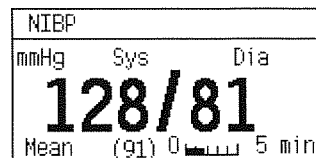
Autocycling

It is possible to set automatic NIBP measurement On and Off at selected intervals. Autocycling is synchronized to real time. For example, if the first measurement is at 12:02 with a 5-minute cycle time, the next measurement will be at 12:05 and again at 12:10, 12:15, etc.

Setting the cycle time

The possible intervals for autocycling are **1**, **2.5**, **3**, **5**, **10**, **15**, **30**, or **60** minutes.

To set the cycle time:

```
                  NIBP

        Start Cycling
          Cycle Time  3 min     1
          Start STAT            2.5
         Start Manual           3
     Start Ven.Stasis           5
          NIBP Setup  ▤         10
          NIBP Alarm  ▤         15
     Parameters Menu            30
                                60


    Change interval between
    automatic cuff inflations
    (min).
```

1. Press the **NIBP** key.
2. Select **Cycle Time** and choose the time.

Starting/stopping autocycling

- To start autocycling, press the **NIBP** key and select **Start Cycling**.

```
  NIBP
  mmHg    Sys         Dia
  128/81
  Mean    (91) 0 ▭▭▭▭  5 min
```

The bar at the bottom of the NIBP display shows the remaining time until the next measurement.

- To stop autocycling:

    Press the **NIBP** key and select **Stop Cycling**.

    or

    If you wish to cancel the present measurement but start a new one after the selected interval time, press the **NIBP Start/Cancel** key.

Starting/stopping a continuous measurement (STAT)

The STAT mode initiates continuous measurement for five minutes. A new NIBP measurement starts immediately after the previous one. After five minutes, the monitor automatically returns to the previously selected cycling interval or to manual mode.

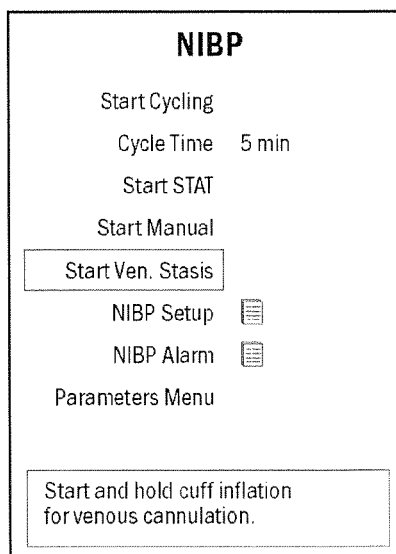- To start a continuous measurement, press the **NIBP** key and select **Start STAT**.

```
NIBP
mmHg    Sys        Dia
129/76
Cuff   79          STAT
```
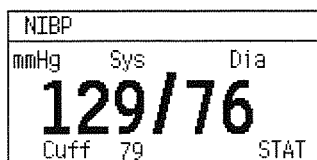
In STAT mode, the earlier systolic value is measured and displayed until the final result of a new one is available.

- To stop a continuous measurement, press the **NIBP Start/Cancel** key.

Using venous stasis

Venous Stasis initiates and holds the pressure in the cuff to help venous cannulation. A constant pressure of 40 (infant), 60 (child), or 80 mmHg (adult) is maintained in the cuff for one (infant) or two minutes (child, adult). The value is selected automatically after the inflation limits (adult, child or infant) are set.

- To start Venous Stasis:

```
            NIBP

        Start Cycling

        Cycle Time    5 min

        Start STAT

        Start Manual

        Start Ven. Stasis

            NIBP Setup      ▤

            NIBP Alarm      ▤

        Parameters Menu


    Start and hold cuff inflation
    for venous cannulation.
```

1. Press the **NIBP** key.

2. Select **Start Ven. Stasis**.

The pressurization time is displayed in the NIBP field and **STASIS** flashes during the last 15 seconds.

```
NIBP

STASIS
Cuff   75   0▭▭  2 min
```
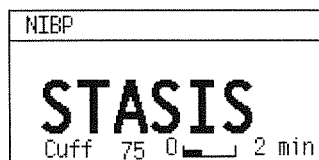
- To release the pressure before two minutes has expired, press the **NIBP Start/Cancel** key before two minutes has expired.

Chapter 14. Invasive Blood Pressure

Table of Figures

14. INVASIVE BLOOD PRESSURE

Overview

The Cardiocap 5 monitor with the Invasive Pressures option (N-XP) enables you to measure and monitor two invasive blood pressures at the same time.

During the invasive blood pressure measurement, the transducer converts the pressure variations into electrical signals. The electrical signals are amplified and displayed as numeric pressure values and waveforms.

WARNING: All invasive procedures involve risks to the patient. Use aseptic technique. Follow catheter manufacturer's instructions.

Invasive blood pressure display

You can display the two invasive pressure waveforms separately (one above the other) or you can combine them. Combining the waveforms increases the size of the waveform.
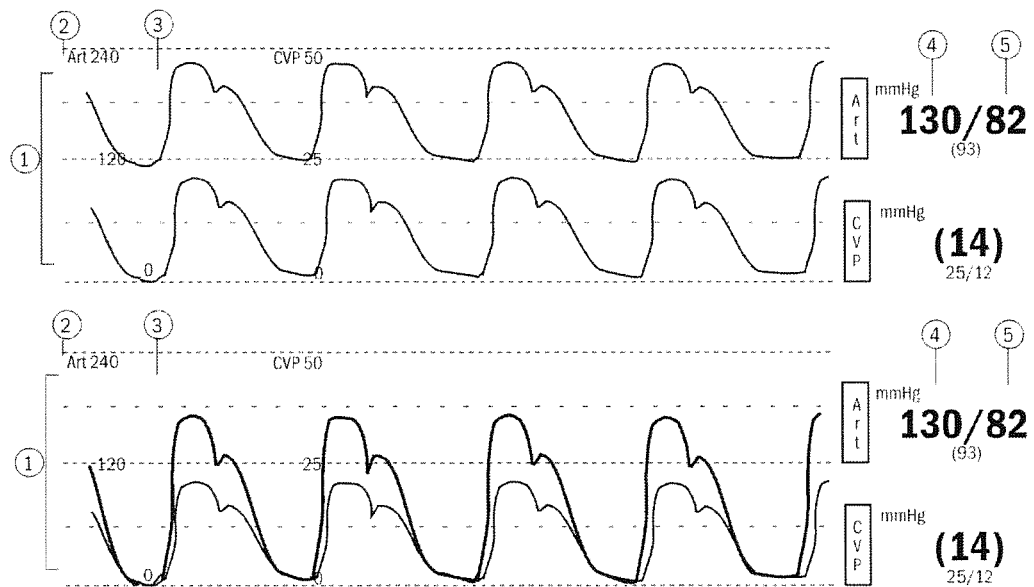
Figure 14-1. Top: Separated waveforms
Bottom: Waveforms combined in several fields

(1) Invasive blood pressure waveforms with zero and reference lines

(2) Selected pressure label

(3) Selected pressure scale

(4) Field for messages and alarm limit settings

(5) Systolic, diastolic and mean pressure values of invasive blood pressures

Displaying a combined pressure waveform

To display combined pressure waveforms:

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.

2. Select **Screen Setup**.

3. Select **Waveform Fields**.

4. Select **Combine Pressures** and **YES**.
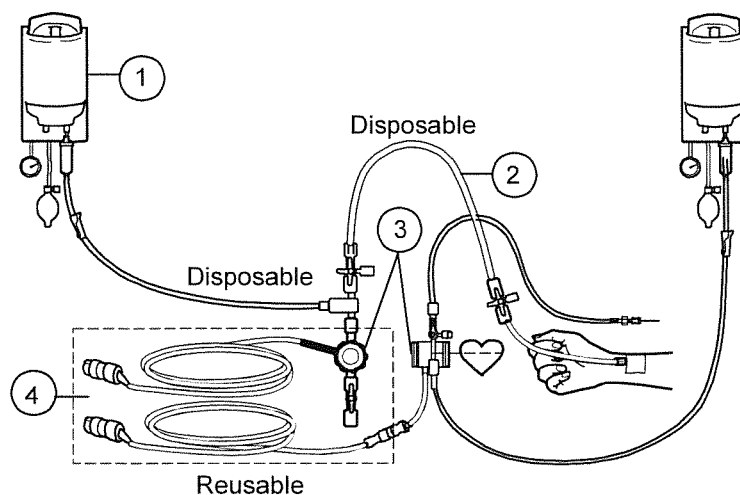
Invasive blood pressure setup

Figure 14-2. Invasive blood pressure setup

(1) Heparinized fluid bag with pressure infusor

(2) Flushing set

(3) Transducer

(4) Adapter cable for using disposable transducers

NOTE: Patient connections made according to the picture above using Datex-Ohmeda specified accessories are defibrillator proof.

Refer to transducer manufacturer's instructions on how to remove trapped air from the transducer.

WARNING: Mechanical shock to invasive blood pressure transducer may cause severe shifts in zero balance and calibration, and cause erroneous readings.

WARNING: Patient Safety: Ensure proper contact of the return electrode of the electrosurgery unit to your patient to avoid possible burns at sensor sites.

WARNING: Make sure that no part of the patient connections touches any electrically conductive material including earth.

WARNING: Use only defibrillator-proof transducers and cables.
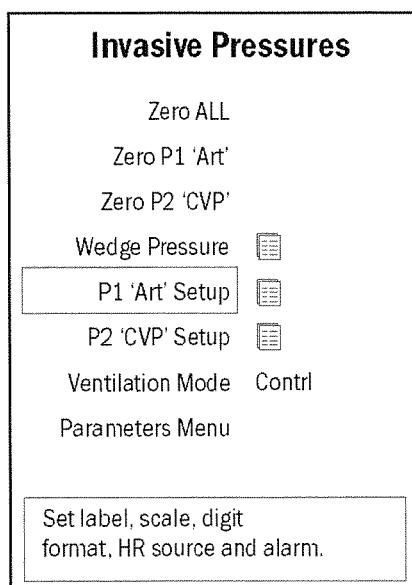

Patient connections

Do the connections as follows:

1. Connect the pressure transducer to the transducer cable and the cable to the monitor's red connector.

2. Prepare the transducer kit according to the manufacturer's instructions. Mount the kit with the transducer zeroing port at mid-heart level.

3. Ensure that there is no air in the transducer dome or in the catheter line. Refer to transducer manufacturer's instructions on how to remove trapped air from the transducer.

4. Connect the patient catheter to the pressure line.

5. Connect the patient catheter to the pressure line.

6. Open the dome stopcock to room air.

7. Zero the transducer. See *Starting with accurate values* later in this chapter.

8. Open the dome stopcock to pressure catheter and check the quality of the waveform.

Invasive Pressures menu

NOTE: Monitors with the NMT option do not have the Invasive Pressures key.

To open the Invasive Pressures menu:

```
           Invasive Pressures

                 Zero ALL
                Zero P1 'Art'
                Zero P2 'CVP'
           Wedge Pressure    ▦
            P1 'Art' Setup   ▦
            P2 'CVP' Setup   ▦
          Ventilation Mode  Contrl
           Parameters Menu

          Set label, scale, digit
          format, HR source and alarm.
```

Press the **Invasive Pressures** key.

or

Press the ComWheel and select **Parameters**. Then select **Invasive Press**.

Wedge Pressure   Used for Pulmonary Capillary Wedge Pressure Measurement (PCWP). See *Measuring Pulmonary Capillary Wedge Pressure* later in this chapter.
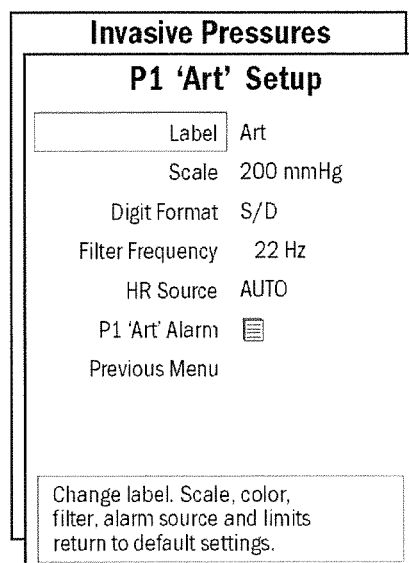
P 1 'Art' Setup and **P2 'CVP' Setup**
     Used to set the label, scale, and other attributes of the P1 or P2 channel. See *Invasive line setup*.

Ventilation Mode   Respiration causes artifacts in invasive pressures. The artifact is smallest at the end of expiration. You can select **Spont** for spontaneous respiration or **Contrl** for controlled ventilation.

Invasive line setup

To open the setup menu for an invasive pressure line:

Invasive Pressures
P1 'Art' Setup
Label Art
Scale 200 mmHg
Digit Format S/D
Filter Frequency 22 Hz
HR Source AUTO
P1 'Art' Alarm ▤
Previous Menu
Change label. Scale, color, filter, alarm source and limits return to default settings.

9. Press the **Invasive Pressures** key.
    or
    Press the ComWheel and select **Parameters**. Then select **Invasive Press**.

10. Select **P1 'Art" Setup** or **P2 'CVP' Setup**.
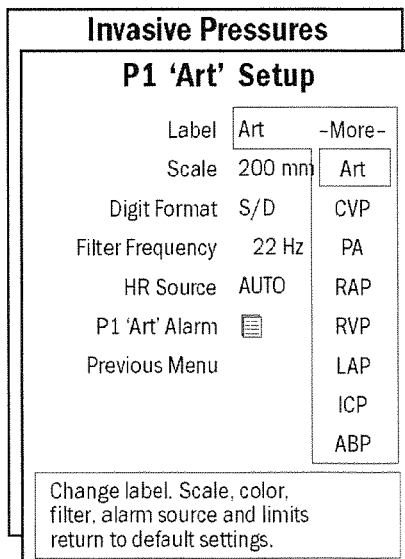
Setup menu options

Label The label sets the features of the pressure channel. See *Labeling the invasive line*.

Scale The scale is assigned when the channel is labeled. The scale can be adjusted from 10 mmHg to 300 mmHg in steps of 10.

Digit Format With the numeric display format, you can choose to display the Systolic/Diastolic (**S/D**) numbers or the **Mean** pressure value in a large font size.

Filter Frequency Filters the measured signal to remove noise and artifacts. The filter can be adjusted from 4 to 22 Hz.

HR Source If the ECG signal is affected by too much noise for a reliable heart rate calculation, heart rate can be calculated mechanically from the pressure (Art) or plethysmographic pulse waveform. The heart rate source is shown above the numerical heart rate display. The color used for the heart rate is the same as the source parameter.

The **AUTO** selection prioritizes the heart rate calculation in a specified order: ECG (the lead with highest R-wave), pressure (Art), and plethysmographic pulse waveform.

P 1 'Art' Alarm Alarms can be adjusted in this menu or in the Alarms Setup menu. See *Adjusting alarm sources and limits* later in this chapter.

Labeling the invasive line

When a pressure channel is labeled, the display scales, waveform color, filter, alarm source, and alarm limits are also changed. The label sets the other features.

To change the label:

Invasive Pressures

P1 'Art' Setup

Label	Art	–More–
Scale	200 mm	Art
Digit Format	S/D	CVP
Filter Frequency	22 Hz	PA
HR Source	AUTO	RAP
P1 'Art' Alarm	▤	RVP
Previous Menu		LAP
		ICP
		ABP

Change label. Scale, color, filter, alarm source and limits return to default settings.

11. Press the **Invasive Pressures** key.
or
Press the ComWheel and select **Parameters**. Then select **Invasive Press**.

12. Select **P1 'Art" Setup** or **P2 'CVP' Setup**.

13. Select **Label** and choose the label.

Invasive blood pressure labels and descriptions

The labels are as follows:

P1, P2   Standard, startup labels

Art   Arterial pressure

CVP   Central venous pressure

PA   Pulmonary arterial pressure

RAP   Right atrial pressure

RVP   Right ventricular pressure

LAP   Left atrial pressure

ICP   Intracranial pressure

ABP   Arterial Blood Pressure

Both Art and ABP labels are available for situations when two arterial lines are desired but you want to use different settings or alarm labels.

Assigning a label automatically changes the other pressure settings as shown below:

LABEL	P1, Art, ABP	P2, CVP	RAP, LAP	ICP	PA	RVP
Scale	200	20	20	20	60	60
Digit Format	Sys/Dia	Mean	Mean	CPP	Sys/Dia	Sys/Dia
Filter	22	9	9	9	9	9
Alarm source	Sys	off	off	off	off	off
Color	Red	Blue	White	White	Yellow	White

Adjusting alarm sources and limits

You can adjust or turn off pressure alarm limits.

To do this:

14. Press the **Invasive Pressures** key.
    or
    Press the ComWheel and select **Parameters**. Then select **Invasive Press**.

15. Select **P1 'Art' Setup** and **P1 'Art' Alarm.**
    or
    Select **P2 'CVP' Setup** and **P2 'CVP' Alarm**.

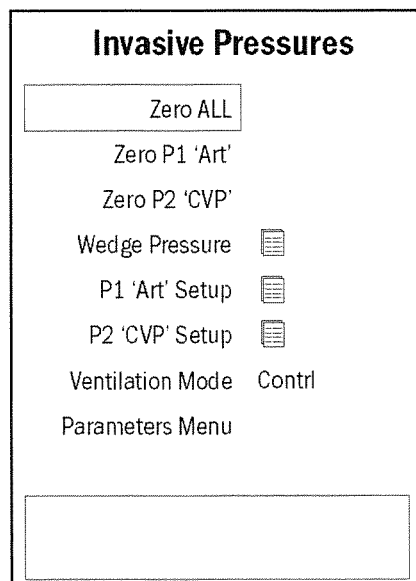   You can choose **Sys** (Systolic), **Dia** (Diastolic), or **Mean** as a source for each pressure channel. The limits are on for only one source at a time.

For more information about alarms, see the *Alarms* chapter.

Starting with accurate values

Pressure transducers generally produce a small signal even when no pressure is applied to them. It is necessary to zero the monitor with the transducer to establish an accurate electrical zero point.

The position of the transducer affects the accuracy of the measurement. An error of 10 mmHg of static pressure will be introduced for every 13.6 cm (5.4 inches) difference in height between the mid-heart and the transducer.

To zero the transducer:

Invasive Pressures
Zero ALL
Zero P1 'Art'
Zero P2 'CVP'
Wedge Pressure ▦
P1 'Art' Setup ▦
P2 'CVP' Setup ▦
Ventilation Mode   Contrl
Parameters Menu

16. Open the transducer to air.

17. Press the **Invasive Pressures** key.
    or
    Press the ComWheel and select **Parameters**. Then select **Invasive Press**.

18. Zero each channel.

    Zero ALL   Zeros all transducers (except ICP) to atmospheric pressure.

    Zero P1 ...   Zeros P1 transducer only.

    Zero P2 ...   Zeros P2 transducer only.

The "Zeroing" message is displayed during the zeroing process. After the transducer has been zeroed, the "Zeroed" message appears in the digit field.

After each channel has been zeroed, the time when zeroing occurred appears in the menu.

NOTE: Check the zero level after power interruptions.

Measuring Pulmonary Capillary Wedge Pressure (PCWP)

Pulmonary capillary wedge pressure (PCWP) is the occlusion pressure of the pulmonary artery. PCWP can be measured with a pulmonary artery flotation catheter. When the balloon at the tip of the catheter is inflated, the pulmonary artery is occluded. The pressure (PCWP) indirectly reflects the filling pressure of the left ventricle.

The monitor uses an algorithm to automatically detect the pressure values at the end of expiration when the artifact caused by respiration is minimal. The mean pressure value is PCWP.
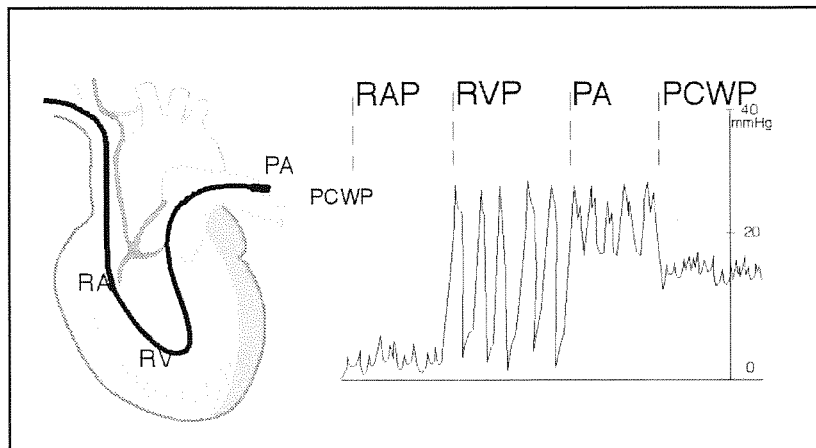
Figure 14-3. Position of Swan-Ganz catheter in pulmonary artery and
Pressure waveforms from balloon-tipped pulmonary catheter during insertion

The speed of the waveforms in the Wedge Pressure menu is 12.5 mm/s.

NOTE: During wedge pressure measurement, PA values are not trended and PA alarms are disabled.

Starting PCWP measurement

NOTE: Because the PCWP measurement site is in an extremely delicate area, only specially qualified medical personnel should perform the insertion of the Swan-Ganz catheter. Follow the catheter manufacturer's instructions.

19. Position the Swan-Ganz catheter in the pulmonary artery. Continuous monitoring of the pressures along the route of the catheter tip will help to identify the location of the tip. Use the distal lumen for the pressure line.

20. PCWP measurement is dedicated to the invasive pressure channel labeled **PA**. To check the label:

    - Press the **Invasive Pressures** key.
      or
      Press the ComWheel and select **Parameters**. Then select **Invasive Press**.

    - Check that the wedge pressure channel is labeled **PA**. If it is not, label the channel as described in *Labeling the invasive line* earlier in this chapter.

21. Check that the monitor has correct ventilation status information for the patient:

    In the Invasive Pressures menu, select **Ventilation Mode** and choose **Spont** (spontaneous) or **Contrl** (controlled).

22. Select **Wedge Pressure**.

23. Select **Measurement**.
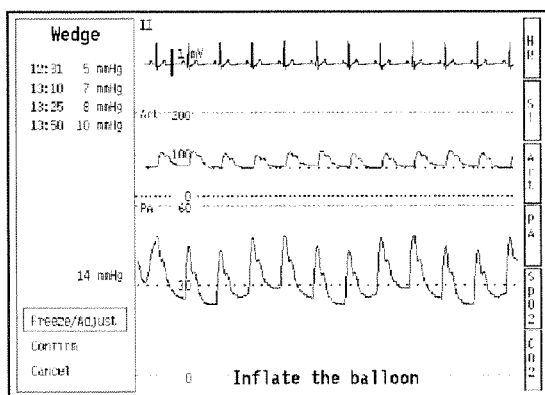
24. Inflate the catheter balloon when the "Inflate the balloon" message is displayed in the PA waveform field.

    The monitor searches the end expiratory mean pressure value. The pressure is displayed in the waveform field and menu. After 20 seconds, the waveform is automatically frozen and the "Deflate the balloon" message is displayed.

25. Deflate the balloon when the "Deflate the balloon" message is displayed in the PA waveform field.

    The pressure waveform will stay frozen until you accept the PCWP level.

26. Adjust the PCWP level by turning the ComWheel. Press the ComWheel to accept the PCWP level that represents the true PCWP level.

    After accepting the PCWP level, normal pressure monitoring continues.

NOTE: You can also manually freeze the waveform before 20 seconds has elapsed by selecting **Freeze/Adjust**.

Adjusting PCWP

To manually adjust the PCWP pressure level:

27. In the Wedge menu, select **Freeze/Adjust**.

28. Turn the ComWheel to move the cursor to a point on the waveform that represents the true PCWP level.
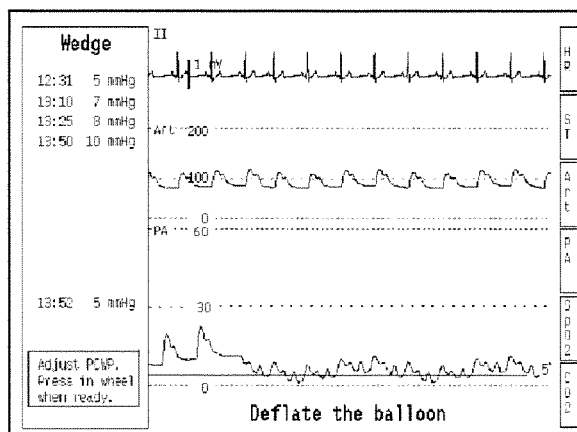
29. Press the ComWheel.

30. Select **Confirm**.

Canceling PCWP measurement

If the measurement did not succeed, select **Cancel**.

This cancels the whole measurement. The first menu appears so you may start a new measurement.

Chapter 15. Temperature

Table of Figures

15. TEMPERATURE

Overview

You can use Datex-Ohmeda temperature probes to measure esophageal, nasopharyngeal, rectal, and skin temperature, for example.

Monitoring perioperative body temperature is recommended when inducing hypothermia or if unexpected temperature changes occur.

WARNING: Patient Safety. To prevent patient injury, use only Datex-Ohmeda temperature probes.
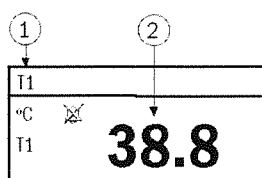
Temperature display

Figure 15-1. Temperature digit display

(1) Label

(2) Temperature measurement value

Automatic temperature test

The temperature measurement function is tested periodically. The "Performing temp test" message appears during the test. If the test fails, an error message is displayed.
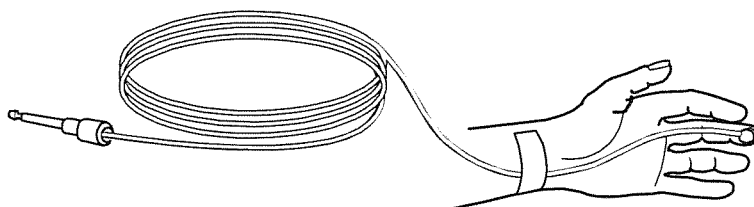
Patient connections

Figure 15-2. Temperature setup

To make the connections:

1. Attach the temperature probe to the patient.

2. Connect the temperature probe to monitor connector T1 or T2.

Temperature menu

You can change the label of the temperature measurement site, the temperature units, and set temperature alarms in the Temp Setup menu.

NOTE; The **Temp Alarms** selection in the Temp Setup menu opens a menu in which you can adjust the temperature alarm limits. For instructions, see the *Alarms* chapter.

Changing the temperature label

1. Press the ComWheel and select **Parameters** from the Main Menu.
2. Select **Temp Setup**.
3. Select **T1 Label**.
   or
   Select **T2 Label**.
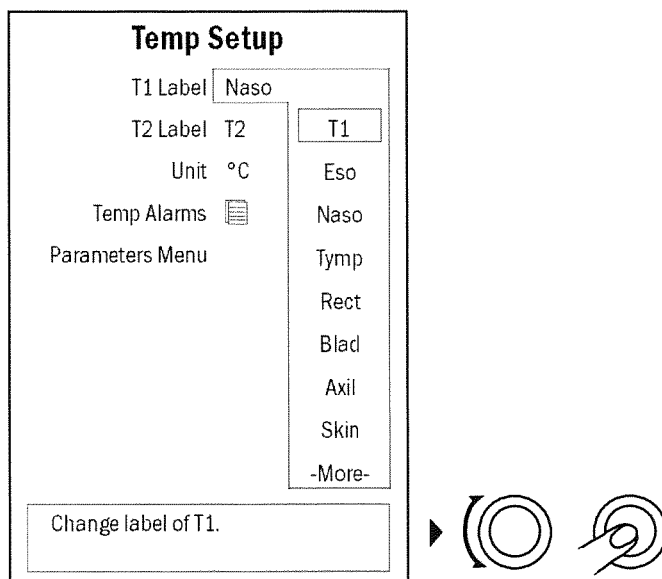
4. Select the label you wish to use for the temperature measurement site:

Eso	Esophageal temperature	**Skin**	Skin temperature
Naso	Nasopharyngeal temperature	**AirW**	Airway temperature
Tymp	Tympanic temperature	**Room**	Room temperature
Rect	Rectal temperature	**Myo**	Myocardial temperature
Blad	Bladder temperature	**Core**	Core temperature
Axil	Axillary temperature	**Surf**	Surface temperature

Changing the temperature units

5. Press the ComWheel and select **Parameters** from the Main Menu.
6. Select **Temp Setup**.
7. Select **Unit** and choose **°C** or **°F.**

Chapter 16. Airway Gases

Table of Figures

16. AIRWAY GASES

Overview

With the Datex-Ohmeda Cardiocap/5, you can measure and monitor the gases delivered to an anesthetized patient and exhaled by the patient through the anesthesia circuit.

Respiratory rate is the frequency of peak (end tidal) CO_2 measurements per minute. A breath is defined as a change in the CO_2 signal that exceeds 1% (8 mmHg). All concentrations are measured and displayed breath by breath.

Display of gases
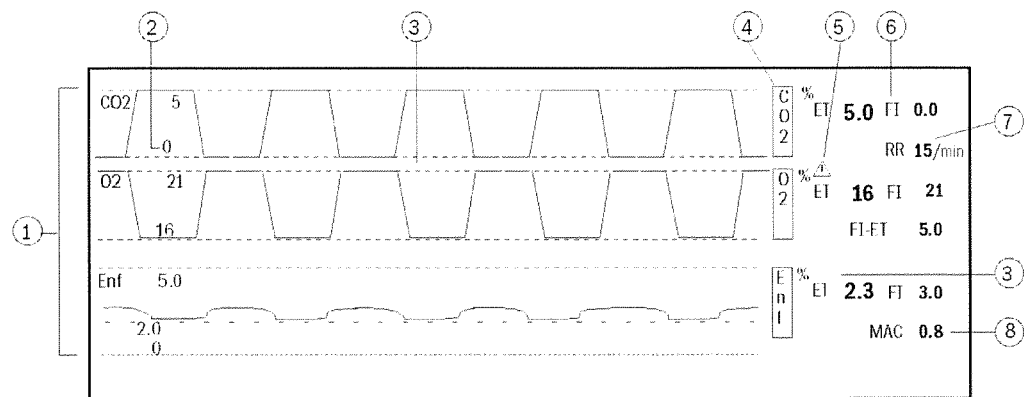
Figure 16-1. Airway gas waveform display

(1) Gas waveforms

(2) Scale

(3) Message field for gases

(4) Gas label

(5) Symbol to indicate that FiO_2 low alarm limit is set below 21%

(6) Digit field for ET and FI gas values, and FI-ET difference

(7) Respiration rate

(8) MAC value, based on measured AA and N_2O ET values

Figure 16-2. Lower digit field for gases

Agent mixture

During an agent mixture situation, the "Agent mixture" message appears in the lower digit field for gases. The labels of both agents and their concentrations are displayed.

Patient connections

CAUTION: Keep the monitor horizontal. Tilting the monitor may cause erroneous results in the readings and damage the monitor.

CAUTION: Use only cables and accessories approved by Datex-Ohmeda. Other cables and accessories may damage the system or interfere with measurement. Single-use accessories are not designed to be reused.

Take the gas sample as close to the patient's airway as possible.

1. Before making patient connections, check that:

    *   The airway adapter connections are tight and the adapter is operating properly.

    *   The D-fend container is empty and properly attached. The container should be changed or cleaned between patients and emptied when it is more than half full.

2. Connect the sample gas outlet to gas scavenging if N_2O or volatile agents are used.

3. Attach the gas sampling line to the connector on the D-fend water trap.

    NOTE: The "Sampling line blocked" message may appear if you attach the sampling line to the water trap after you turn on the monitor.

4. Turn on the monitor. A self-check is performed and automatic agent identification is activated.

5. When the "Calibrating gas sensor" message disappears, make the patient connections as described below.
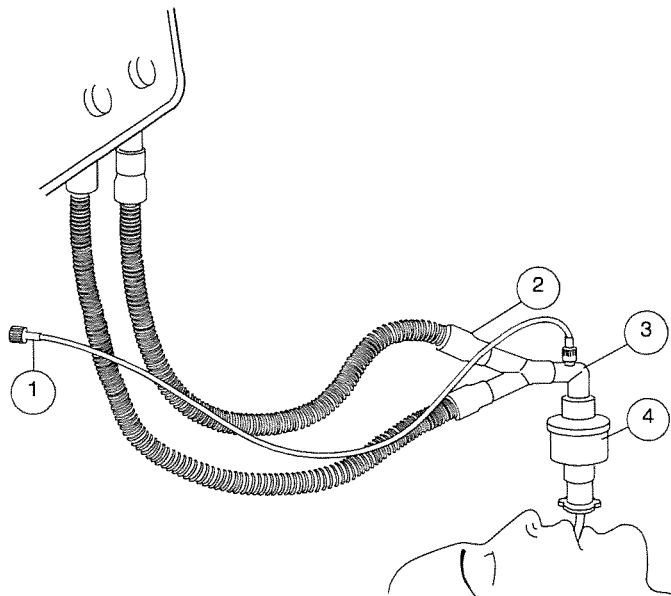
Figure 16-3. Airway gases setup

(1) Gas sampling line	(3) Airway adapter with sampling line connector
(2) Y-piece	(4) Heat and moisture exchanger with filter HMEF

6. Connect the sampling line to the patient's airway adapter. Position the adapter's sampling port upwards to prevent condensed water from entering the sampling line.

NOTE: If you are administering medication using a nebulizer, disconnect the HMEF and airway adapter while the nebulizer is in use.

CAUTION: Remove the airway sampling line from the patient airway while nebulized medications are being delivered.

Airway gases setup alternatives
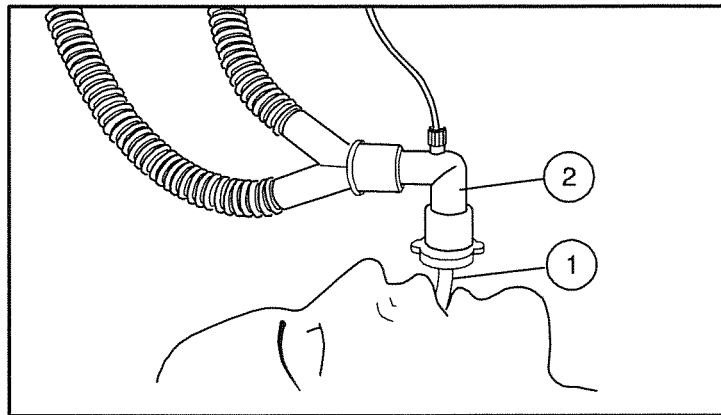
Figure 16-4. Normal endotracheal intubation

(1) Intubation tube with 15 mm connector

(2) Airway adapter
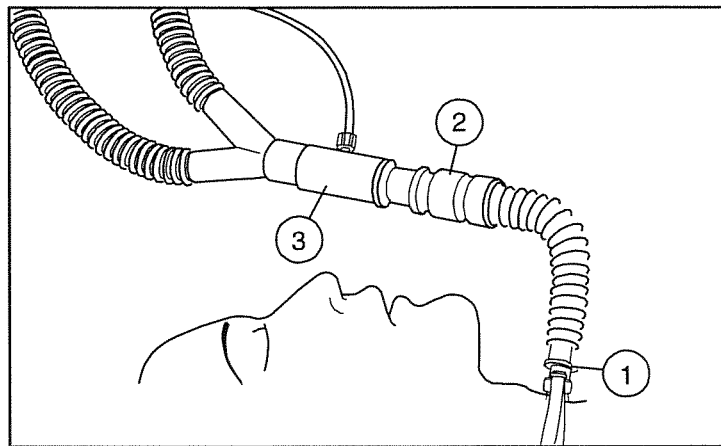
Figure 16-5. Tracheostomy

(1) Tracheostomy tube with 15 mm connector

(2) Heat and Moisture Exchanger (HME)

(3) Airway adapter
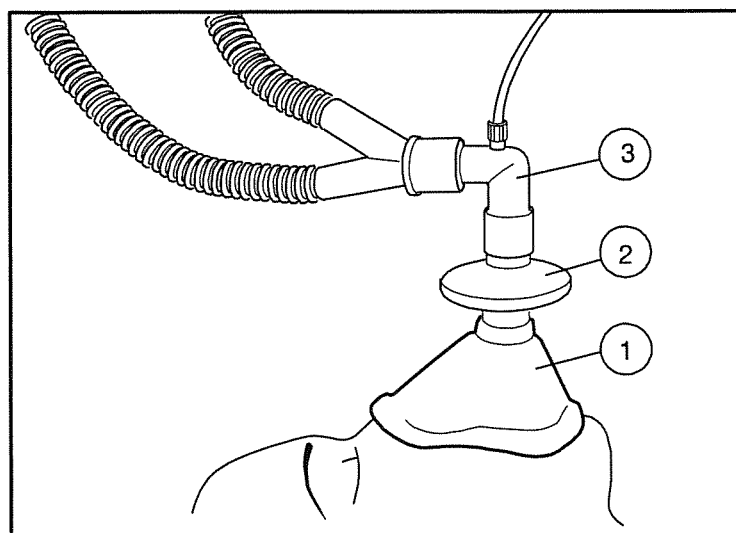
Figure 16-6. Mask ventilation

(1) Mask

(2) Bacteria filter

(3) Airway adapter
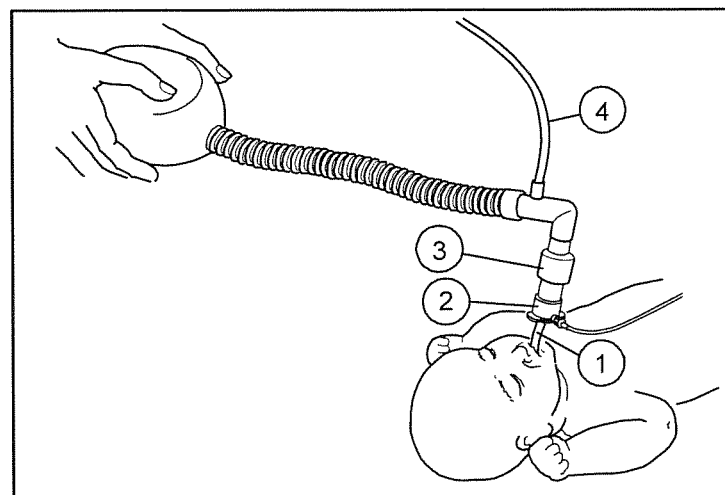
Figure 16-7. Endotracheal intubation of pediatric patients

(1) Endotracheal tube

(2) Pediatric airway adapter (Replaces regular pediatric endotracheal tube connector. For sizes 2.5 to 4.0 endotracheal tubes.)

(3) Pediatric heat and moisture exchanger (HME)

(4) Fresh gas inlet

Sample gas exhaust connections

When N$_2$O or volatile anesthetics are used, pollution of the operation room by these gases should be prevented. Connect the sample gas outlet of the monitor to the scavenging system or return it to the patient circuit.

Connect the sample gas outlet of the monitor to the scavenging system either

- through the ventilator, or

- directly to the vacuum scavenging system.

CAUTION: Strong scavenging suction may change the operating pressure of the monitor and cause inaccurate readings or internal damage.

Connect sample gas outlet only to open scavenging system where gas is removed in room pressure.

Scavenging through the ventilator reservoir

To scavenge through the ventilator reservoir:

1. Connect an exhaust line to the sample gas outlet on the rear panel of the monitor.

2. Attach the other end of the line to the ventilator reservoir. Make sure that the reservoir tube diameter is at least 2-3 times larger than the exhaust line.

Sample Gas Out
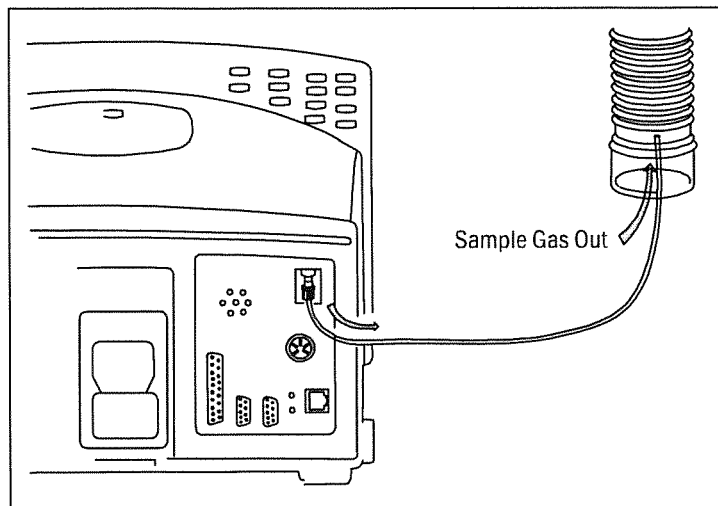
Figure 16-8. Scavenging through ventilator reservoir

Scavenging through the anesthesia gas scavenging system

Anesthesia machines are equipped with an anesthesia gas scavenging system (AGSS), and in some machines you can connect the sample gas outlet directly to that.

For example, connect the sample gas outlet to the Datex-Ohmeda S/5 Avance:
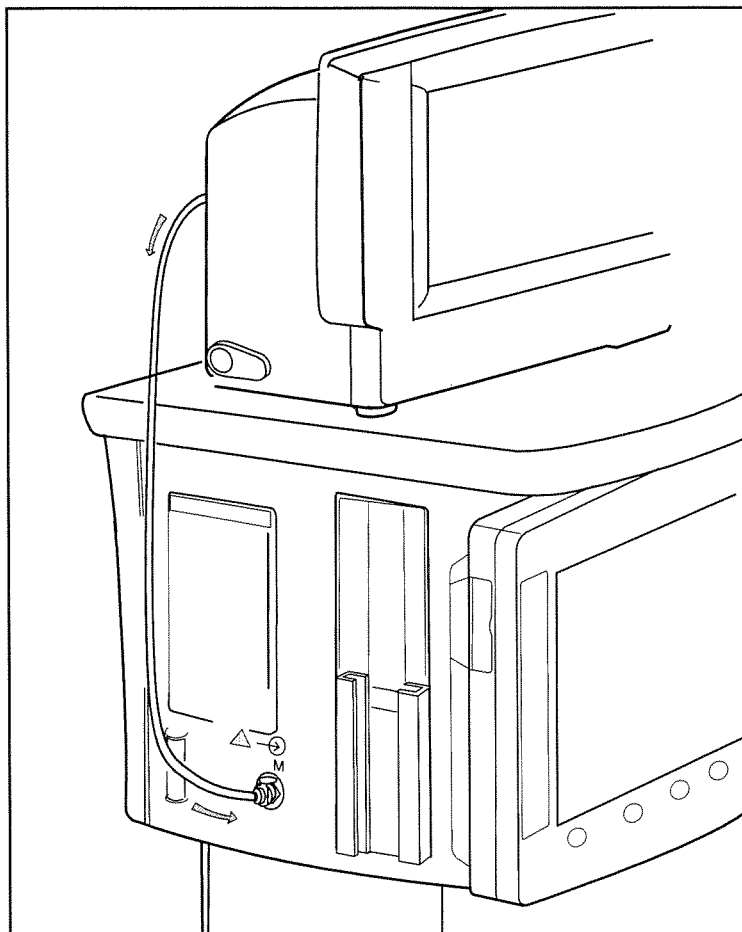
Figure 16-9 Connecting sample gas outlet directly to a anesthesia gas scavenging system

Note: Refer to the anesthesia machine's documentation to find out where and how the sample gas can be connected.

Connecting directly to a vacuum scavenging system

To scavenge through a direct connection:

1. Connect the exhaust line (733195, 5/pkg) to the sample gas outlet on the monitor.

2. Connect the exhaust line only to an open scavenging system where gas is removed at room pressure. Do not connect the monitor directly to a vacuum scavenging system.

Returning gas to the patient circuit

In some anesthesia machines, you can return the sample gas to the patient circuit, refer to the anesthesia machines manuals. For example, if you use the Datex-Ohmeda S/5 Anesthesia Delivery Unit (ADU), connect an optional adapter (881644, 5/pkg) to the patient breathing tubes.
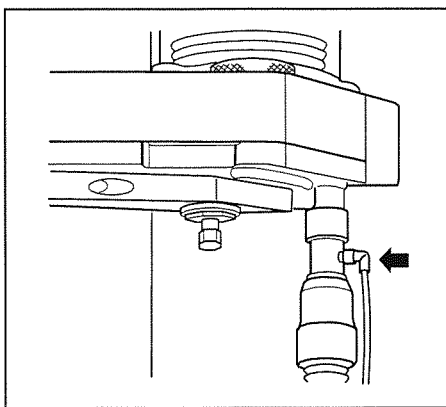
Figure 16-10. Gas return to patient circuit in ADU

CO₂ setup

1. Press the ComWheel and select **Parameters** from the Main Menu.

2. Select **Airway Gas**.

3. Select **CO2 Setup**.

```
┌─────────────────────────────────────┐
│            Airway Gas               │
│  ┌─────────────────────────────────┐│
│  │          CO2 Setup              ││
│  │                                 ││
│  │        Scale │ 6 %              ││
│  │  Resp Rate Source   AUTO│  6%  │││
│  │       CO2 Alarm    ▤     10%    ││
│  │   Resp Rate Alarm  ▤     15%    ││
│  │      Previous Menu       20%    ││
│  │                                 ││
│  │                                 ││
│  │ Change size of CO2 waveform     ││
│  │ by changing scale height.       ││
│  └─────────────────────────────────┘│
└─────────────────────────────────────┘
```
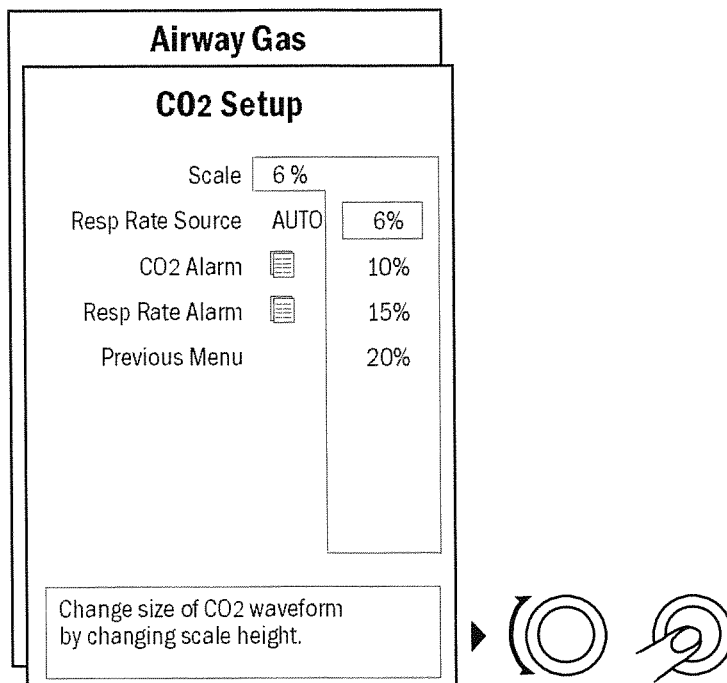
4. To change the scale, select **Scale** and choose the scale.

    The 0 - 6% scale is used in normal situations. The 0 - 10% and 0 - 15% scales are used if hypercarbia is expected.

5. To change the source used for the respiration rate, select **Resp Rate Source**.

    You can choose to have the rate calculated from the ECG or the CO₂ measurement. If **AUTO** is selected, the respiration rate is calculated from CO₂, when CO₂ is measured, and from the ECG measurement otherwise.

    Respiration rate calculation switches back to impedance respiration if you press the **Silence Alarms** key during an Apnea alarm.

6. Select **CO2 Alarm** or **Resp Rate Alarm** to open the corresponding alarms adjustment menu where you can change the CO₂ or respiration rate alarm limits.

O₂ setup

To open the O₂ Setup menu:

1. Press the ComWheel and select **Parameters** from the Main Menu.

2. Select **Airway Gas**.

3. Select **O2 Setup**.

```
┌─────────────────────────────────┐
│         Airway Gas              │
│  ┌──────────────────────────────┼──┐
│  │        O2 Setup               │  │
│  │                               │  │
│  │     Scale │ DIFF6             │  │
│  │                 ┌───────────┐ │  │
│  │  Measurement  ON │  DIFF6   │ │  │
│  │                  │          │ │  │
│  │     O2 Alarm  ▤  │  DIFF10  │ │  │
│  │                  │          │ │  │
│  │  Previous Menu   │  DIFF15  │ │  │
│  │                  │          │ │  │
│  │                  │  DIFF30  │ │  │
│  │                  │          │ │  │
│  │                  │  10-60%  │ │  │
│  │                  │          │ │  │
│  │                  │   100%   │ │  │
│  │                  └───────────┘ │  │
│  │  ┌────────────────────────┐   │  │
│  │  │ Change size of waveform by │  │
│  │  │ changing scale height.     │  │
│  └──┴────────────────────────┴───┘  │
└─────────────────────────────────────┘
```
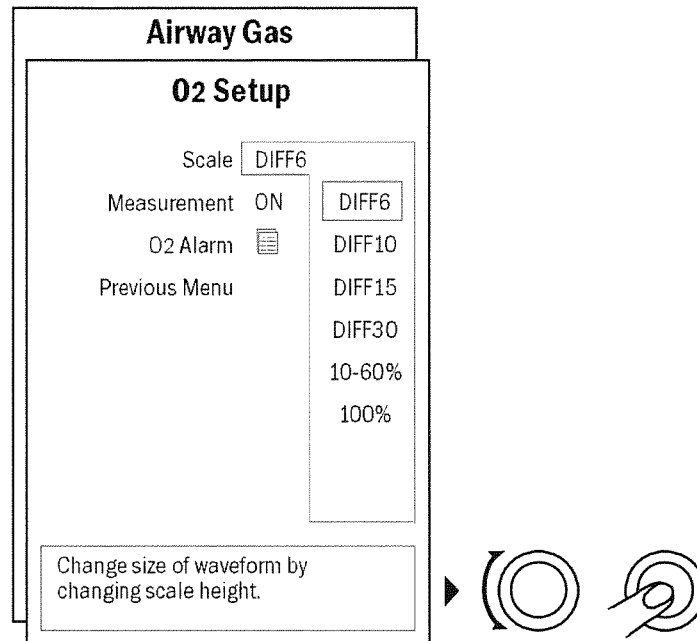
4. To select the scale for the waveform oxygram, select **Scale**.

   The monitor measures inspiratory and expiratory O₂ continuously and displays an O₂ waveform oxygram. It also calculates and displays the difference of inspired and expired O₂. The scale allows you to select the following ranges for oxygram: difference scales **DIFF 6**, **DIFF 10**, **DIFF 15**, **DIFF 30**, **10 - 60%**, **0 - 100%**.

   The monitor determines the maximum measured O₂ concentration and automatically sets the reference level for the difference scales. DIFF 30 and 10 - 60% are used in the recovery room when the patient is oxygenated, for example. Scale 0 - 100% enables you to inspect the full range of O₂. It is used during pre-oxygenation, for example.

5. Select **Measurement** and choose **ON** or **OFF**.

   You can turn off O₂ measurement wen no O₂ alarms or digit information is desired.

   If **OFF** is selected, this symbol is displayed in the digit field and the "Measurement OFF" message is displayed in the O₂ waveform field.

6. Select **O2 Alarm** to open the O₂ Alarms Adjustment menu where you can change the O₂ alarm limits as described in the *Alarms* chapter.
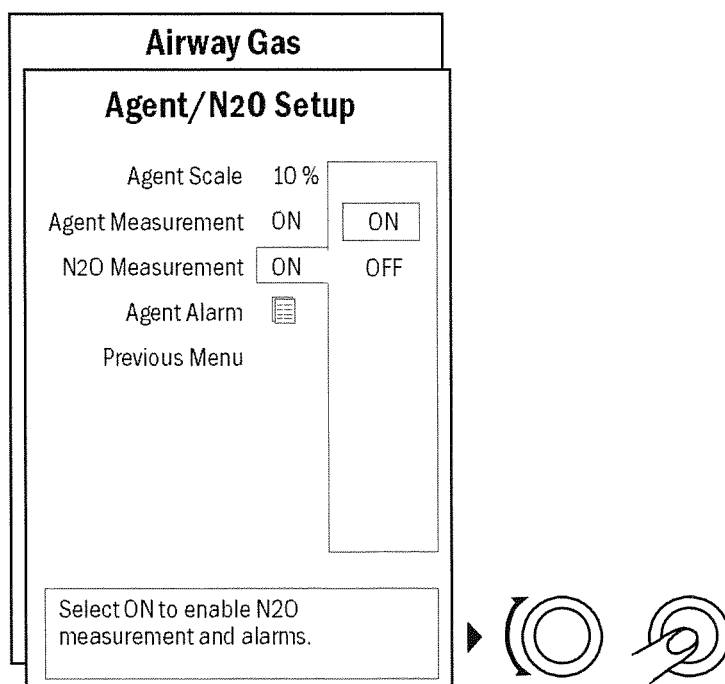
   This symbol is displayed beside the O₂ value when the FiO₂ low alarm limit is set below 21%.

16-9

N₂O setup

NOTE: N₂O and Agent adjustments are made in the same menu. To adjust for agent measurement, see *Agent setup* later in this chapter.

To open the Agent/N₂O setup menu:

1. Press the ComWheel and select **Parameters** from the Main Menu.

2. Select **Airway Gas**.

3. Select **Agent/N2O Setup**.

4. Select **N2O Measurement** and choose **ON** or **OFF**.

```
+-------------------------------------------+
|             Airway Gas                    |
|   +-----------------------------------+   |
|   |        Agent/N2O Setup            |   |
|   |                                   |   |
|   |    Agent Scale    10 %            |   |
|   | Agent Measurement  ON    | ON  |  |   |
|   | N2O Measurement  | ON  |  OFF    |   |
|   |    Agent Alarm    ▤               |   |
|   |    Previous Menu                  |   |
|   |                                   |   |
|   |                                   |   |
|   | Select ON to enable N2O           |   |
|   | measurement and alarms.           |   |
|   +-----------------------------------+   |
+-------------------------------------------+
```

- When the measurement is **ON**, the FiN₂O alarm limit is FI x 82%.

- In cases where no N₂O alarms or digit information is desired, you can turn off the N₂O measurement.
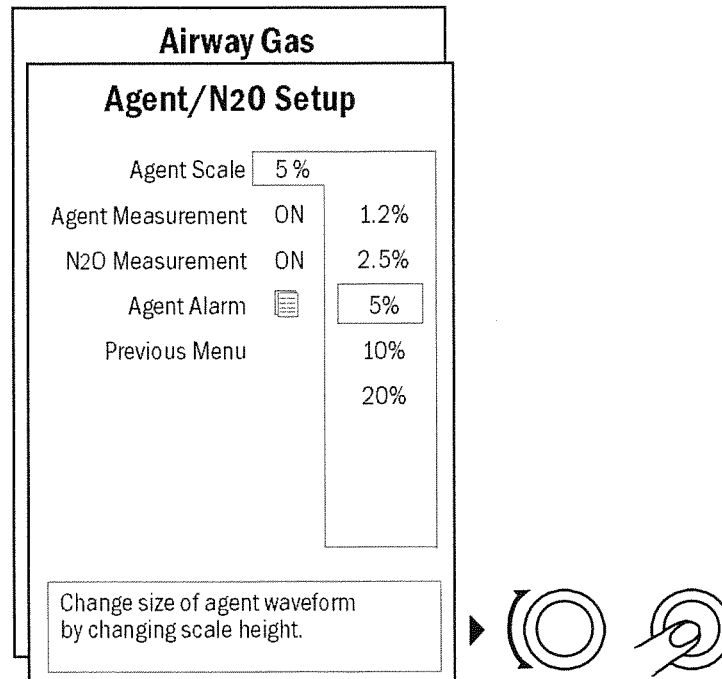
  If **OFF** is selected, this symbol is displayed in the digit field and the "Measurement OFF" message is displayed in the N₂O waveform field.

Agent setup

NOTE: Agent and N_2O adjustments are made in the same menu. To adjust for N_2O measurement, see *N_2O setup* earlier in this chapter.

To open the Agent/N_2O Setup menu:

1. Press the ComWheel and select **Parameters** from the Main Menu.

2. Select **Airway Gas**.

3. Select **Agent/N2O Setup**.

```
┌─────────────────────────────────────┐
│          Airway Gas                  │
│   ┌─────────────────────────────────┐│
│   │      Agent/N2O Setup            ││
│   │                                 ││
│   │  Agent Scale │ 5 %              ││
│   │  Agent Measurement   ON   1.2%  ││
│   │  N2O Measurement     ON   2.5%  ││
│   │  Agent Alarm    ▤  │  5%  │     ││
│   │  Previous Menu           10%    ││
│   │                          20%    ││
│   │                                 ││
│   │  Change size of agent waveform  ││
│   │  by changing scale height.      ││
│   └─────────────────────────────────┘│
└─────────────────────────────────────┘
```

▶ ◎ ◉

4. To select the anesthetic agent waveform scale, select **Agent Scale** and choose **0 - 1.2%, 0 - 2.5%, 0 - 5%, 0 - 10%** or **0 - 20%**.

   Scale 0 - 1.2% is used with concentrations < 1%. Scales 0 - 2.5% and 0 - 5% are normal scales, 0 - 5% being used in induction, for example. The maximum scale is 0 - 20%.

5. Select **Agent Measurement** and choose **ON** or **OFF**.

   You can turn off agent measurement when no agent alarms or digit information is desired.

   If **OFF** is selected, this symbol is displayed in the digit field and the "Measurement OFF" message is displayed in the agent waveform field.

6. Select **Agent Alarm** to open the Agent Alarms Adjustment menu where you can change agent alarms.

MAC values

To display the MAC value on the screen:

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.
2. Select **Screen Setup**.
3. Select **Digit Fields**.
4. Select one of the lower digit fields and choose **MAC**.

1 MAC (Minimum Alveolar Concentration) is the alveolar concentration (end-tidal) of the agent at which 50% of individuals fail to move in response to a noxious stimulus, such as a surgical incision.

WARNING: MAC values are empirical, not absolute. Cardiocap/5 MAC values correspond to those of healthy adults and cannot be applied to children. Age and other individual factors influencing the effect of volatile agents are not taken into account.

The monitor calculates MAC values according to the following formula:

$$MAC(AA) = \frac{\%(EtAA)}{x(AA)} + \frac{\%EtN2O}{100}$$

where x(AA) is Hal=0.75%, Enf=1.7%, Iso=1.15%, Sev=2.05%, Des=6.0%

Table 16-1. MAC numbers of different anesthetics in oxygen [1]

	HAL	ENF	ISO	SEV	DES	N$_2$O
1 MAC	0.75%	1.7%	1.15%	2.05%	6%	100%
2 MAC	1.5%	3.4%	2.3%	4.1%	12%	
3 MAC	2.3%	5.1%	3.45%	6.2%	18%	

Table 16-2. MAC numbers of different anesthetics in 65% N$_2$O [1]

	HAL	ENF	ISO	SEV	DES	N$_2$O
1 MAC	0.3	0.7	0.45	0.8	2.8-4	—

[1] Quasha AL. Eger EI II, Tinker JH. Determination and application of MAC. Anesthesiology 1980; 53: 315.

Automatic agent identification

The agent identification option automatically identifies and selects Halothane, Enflurane, Isoflurane, Sevoflurane and Desflurane on the basis of the identification. Automatic agent identification is activated after power up.

When the monitor identifies and selects the agent, it displays the "XXX selected" message (XXX being HAL, ENF, ISO, SEV or DES). The message is displayed for 60 seconds. The inspiratory and expiratory concentrations of the agent are shown in the digit field.

The minimum concentration for the identification is 0.15 vol%. The agent selection remains active even if the concentration decreases below 0.15 vol% during the case.

Automatic agent identification operates after the normal warm up of the monitor (approximately five minutes).

Agent mixtures

The agent identification warns you if a mixture of anesthetic agents is detected. The mixture warning is activated at the latest when the concentration of the minor agent is greater than 0.3 vol% and more than 15% of the total anesthetic agent concentration.

When a mixed agent is detected, the "Agent mixture" message is displayed and an audible alarm sounds. The message remains active as long as the situation persists.

When there is an agent mixture, the anesthetic agent concentrations and labels of two anesthetic agents are displayed.

When changing the anesthetic agent, the monitor will detect an agent mixture until the first agent is washed out of the patient and the circuit. When the second agent begins to dominate, the measurement is based on the new agent. The "Agent mixture" message disappears when the concentration of the first agent becomes insignificant. When this event occurs, the exact limits depend on the mixture of agents.

Selecting alarm sources

Alarm sources can be selected in the Alarm Sources submenu under the Alarms Setup menu. The selections are **FI** or **ET** as the high- and low- alarm limits. For more information, see the *Alarms* chapter.

Gas calibration

Perform a gas calibration every six months or whenever there are indications of errors in the gas readings. The time of the last calibration is shown at the bottom of the Gas Calibration menu.

Calibration is not available during the first five minutes of monitoring and during a gas sampling warning.

NOTE:

- During gas calibration, % units are always used for CO_2 regardless of selected measuring units.

- Anesthetic agent is always calibrated with Desflurane.

Equipment and use

- Use only Datex-Ohmeda calibration gas to calibrate the gas measurement. Otherwise, the calibration will not succeed.

- The calibration gas container may be used until the pressure indicator reaches the red zone.

- If separate gas containers are used, each gas must be calibrated separately.

- If you use an older brass regulator, the feeding pressure should be adjusted between 5 and 7 psi. The use of an old regulator with the new aerosol containers requires an adapter available from Datex-Ohmeda. For ordering details see the Datex-Ohmeda *Supplies and Accessories Catalog*.

Calibrating the monitor

To calibrate the monitor:

1. Turn on the monitor. For maximum accuracy, let the monitor warm up for 30 minutes.

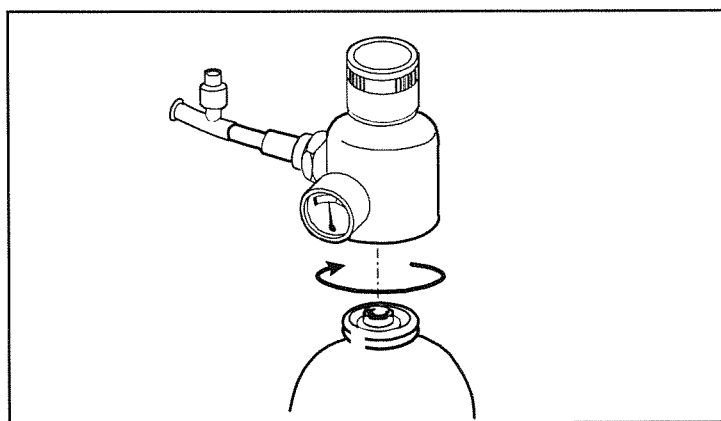2. Attach the regulator to the gas container.

Figure 16-11. Attaching the regulator to the gas container

3. Attach a new sampling line to the water trap. Connect the loose end of the sampling line to the regulator on the gas container.
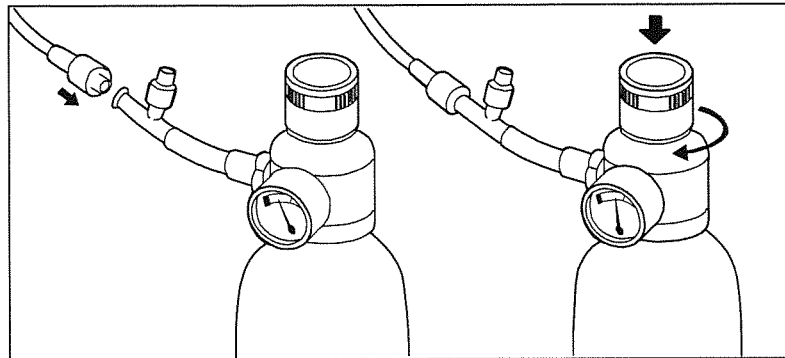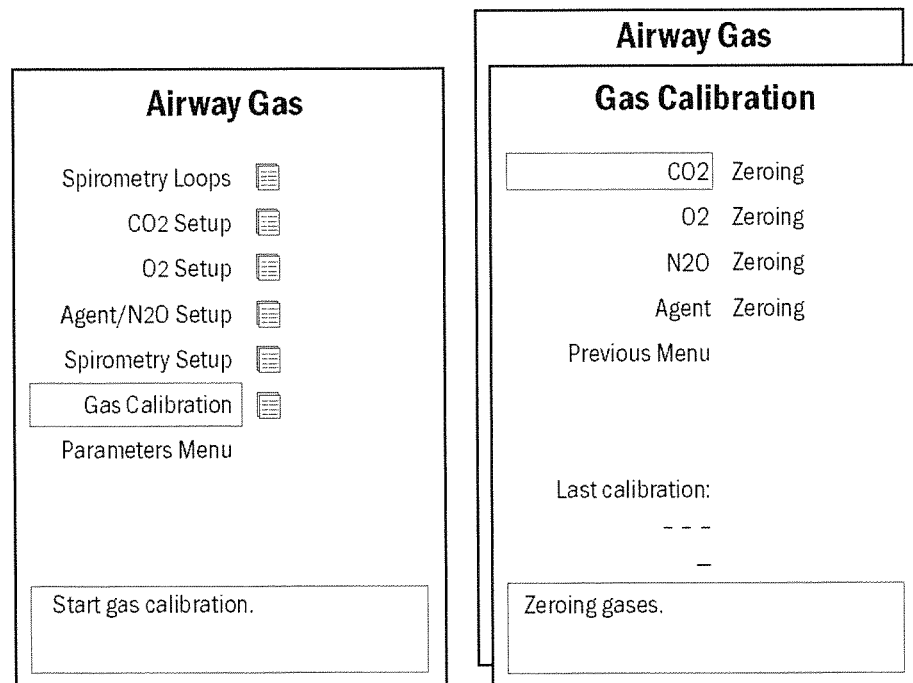

Figure 16-12. Connecting a sampling line to the gas valve and feeding gas

4. Press the ComWheel and select **Parameters** from the Main Menu.

5. Select **Airway Gas**.

   The **Gas Calibration** selection remains gray (inactive) until the "Calibrating gas sensor" message is no longer displayed.

6. Select **Gas Calibration**.

7. Wait until the "Zero ok" and then "Feed gas" messages appear on the screen after each gas.

   If the "Zero error" message is displayed, press the **Normal Screen** key and repeat the calibration procedure. If the problem persists, contact authorized service personnel.

8. Open the regulator and feed the calibration gas until "Adjust" appears, then close the valve.
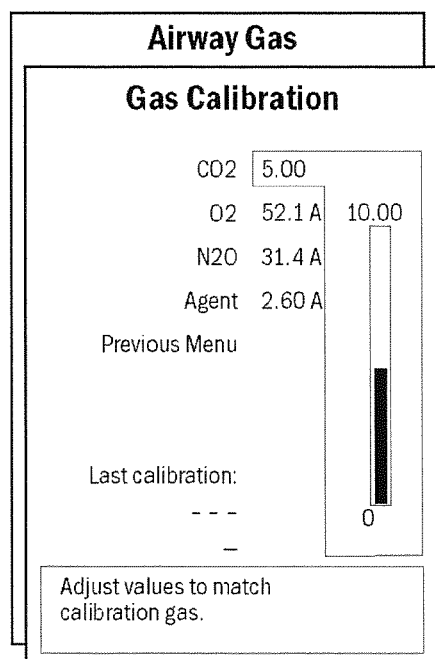
   NOTE: When the monitor is in automatic agent ID mode and it detects a calibration gas and no anesthetic agent (from Datex-Ohmeda Quick Cal calibration gas, for example), the "Cal gas found" message appears. If the identification sensor fails, the "Agent id inop" message will be displayed.

9. Check that the displayed gas values match the values on the calibration gas container.

Calibration adjustments

Calibration adjustments may be required if the gas values displayed during calibration do not match the values on the calibration gas container.

If adjustments are required:

Airway Gas

Gas Calibration

CO2   5.00

O2   52.1 A   10.00

N2O   31.4 A

Agent   2.60 A

Previous Menu

0

Last calibration:

- - -

—

Adjust values to match calibration gas.

10. Select **Gas Calibration** in the Airway Gas menu.

11. Turn the ComWheel to highlight the first gas to be adjusted. Press the ComWheel to open an adjustment window.

12. Turn the ComWheel until the displayed value matches the desired value. Press the ComWheel to confirm the adjustment.

13. Repeat steps 2 and 3 for each gas.

Autozeroing intervals

Autozeroing intervals after startup are: 5 minutes, 5 minutes, 5 minutes, 15 minutes, 15 minutes, 15 minutes, and every hour thereafter. Autozeroing may also occur after agent selection.

Interfering gases

Known effects of gases NOT MEASURED by the monitor:

Helium (He)   Affects the CO_2 measurement, decreases the CO_2 readings.
For example:
5% CO_2, 30% O_2, balance He: CO_2 reading decreases 8.5% relative.

Nitrogen (N_2)   The monitor compensates for the effect of nitrogen in the gas measurement. Nitrogen is used as the balance gas in gas measurement.

Unit conversions

Relationship between gas concentration and its partial pressure:

Reading in mmHg (dry gas) =
(ambient pressure in mmHg * gas concentration in %) / 100.

Reading in mmHg (water vapor saturated gas) =
[(ambient pressure in mmHg – 47 mmHg) * gas concentration in %] / 100.

Reading in kPa (dry gas) =
(ambient pressure in mmHg * gas concentration in %) / 750.

Reading in kPa (water vapor saturated gas) =
[(ambient pressure in mmHg – 47 mmHg) * gas concentration in %] / 750.

NOTE: 47 mmHg is the partial pressure of the saturated water vapor at 37°C.

Other adjustable features

This section describes other adjustable features related to measuring airway gases. A password is required for entering the Install/Service menu where the adjustments are made. If you wish to make changes, we recommend that you contact the person responsible for the entire configuration.

Changing units

To change the CO_2 measurement unit:

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.
2. Select **Install/Service** and enter the password.
3. Select **Installation**.
4. Select **Units**.
5. Select **Parameters**.
6. Select **CO2** and choose the unit (**%, kPa,** or **mmHg**).

Changing parameter colors

You can choose yellow, white, green, red, or blue as the color used in the waveform and digit fields for CO_2, O_2, or agent gas readings. For gases, you can also select orange or violet.

The factory default colors for anesthetic agents are:

Desflurane: **Blue**	Halothane: **Red**	Sevoflurane: **Yellow**
Enflurane: **Orange**	Isoflurane: **Violet**	

To change a color:

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.
2. Select **Install/Service** and enter the password.
3. Select **Colors**.
4. Select **Gases** and choose the color.

For your notes:

Chapter 17. Patient Spirometry

Table of Figures

17. PATIENT SPIROMETRY

Overview

The Patient Spirometry option (N-XV) enables monitoring of the patient's airway pressures, volumes, lung mechanics, and the ventilator operation.

In Patient Spirometry measurement, the airway pressures are measured as close to the patient as possible (between patient circuit and intubation tube), using the D-lite and Pedi-lite sensors. The same sensors are used for gas sampling.

The D-lite and Pedi-lite sensors measure kinetic pressure by a two-sided Pitot tube. Pressure is transferred to the monitor through a spirometry tube and measured by a pressure transducer. The pressure difference across a flow restrictor, together with the gas concentration information, is used to calculate flow. The volume information is obtained by integrating the flow signal.

Measured parameters

- Expiratory and inspiratory tidal volumes (TVinsp/exp)
- Expiratory and inspiratory minute volumes during controlled mechanical ventilation and during spontaneous breathing (MVinsp/exp)
- Airway pressures:

  Peak pressure (Ppeak)

  Plateau pressure (Pplat, plateau)

  Mean pressure (Pmean)

  Real-time pressure waveform (Paw)

- End expiratory pressure (PEEP)
- Flow real-time waveform (Flow)
- Compliance (Compl)
- Airway resistance (Raw)
- Ratio of the inspiratory and expiratory time (I:E)
- Pressure-volume loop (Paw-Vol. loop)
- Flow-volume loop (Flow-Vol. loop)

NOTE: Airway resistance and PEEP are not measured with spontaneous breaths compliance or with pressure-supported breaths.

Measurement principles

Pplat is the pressure at the reversal point of the flow, at the end of the inspiration phase, after the inspiratory pause.

Ppeak is the maximum pressure during one breath.

PEEP is the pressure in the lungs at the end of the expiration, measured at the moment when the expiratory phase changes to inspiratory flow.

Compliance (Compl) tells how big a pressure difference is needed to deliver a certain volume of gas into the patient. Compliance is calculated for each breath from the following equation:

$$Compl = \frac{TV\text{exp}}{Pplat - PEEP}$$

Raw, the airway resistance, is calculated from an equation that describes the kinetics of the gas flow between the lungs and the flow sensor. The pressure at the sensor can be derived at any moment of the breath cycle from the following equation:

$$p(t) = Raw \cdot V'(t) + V(t) / Compl + PEEP$$

where p(t), V'(t) and V(t) are pressure, flow, and volume measured at the sensor at a certain time (t).

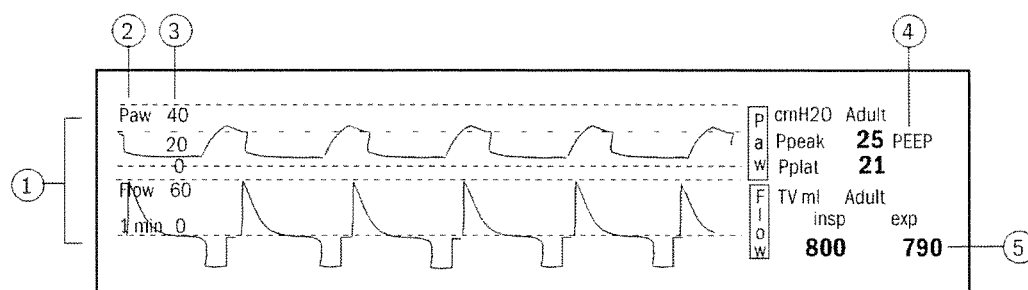# Display of patient spirometry

Continuous waveforms

Figure 17-1. Patient spirometry waveform display

(1) Pressure and flow waveforms

(2) Label

(3) Scale

(4) Digit field for Ppeak, Pplat, and PEEP values

(5) Digit field for tidal or minute volume

Lower digit field display

Figure 17-2. Digit fields for Paw, Paw + TV, Flow, and Compl. + Raw

You can choose to display tidal volume (TV) or minute volume (MV) in the Spirometry Setup menu. This selection also affects the **Spiro1** split screen display (see below).
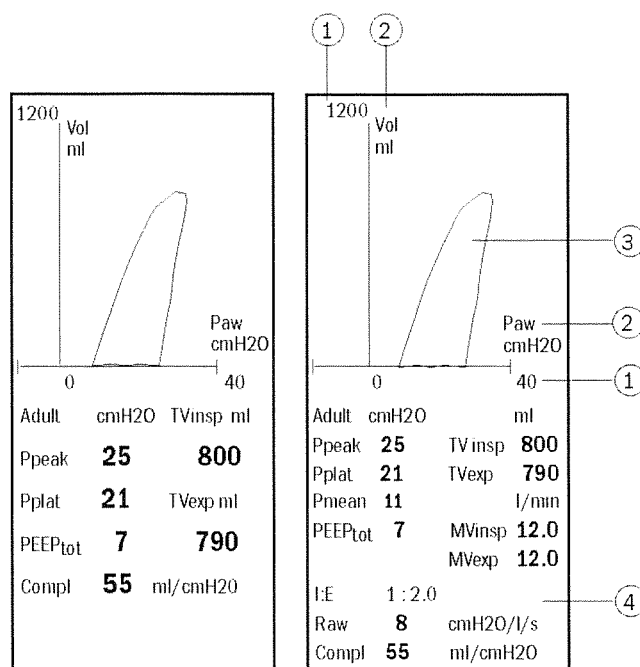
Split screen display

Figure 17-3. Spiro1 (left) and Spiro2 (right) split screen options

(1) Scale   (3) Real-time loop

(2) Label   (4) Digit field

Spiro1, the basic spirometry view, shows Ppeak, Pplat, PEEP, Compliance, TVinsp, Tvexp, MVinsp, and MVexp.

Spiro2 shows the same parameters as the basic view plus Pmean, I:E, and Raw.

For both views, TVinsp/exp and MVinsp/exp values are displayed according to the spirometry setup selections.

To select the spirometry values for the split screen display:

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.

2. Select **Screen Setup**.

3. Select **Split Screen** and choose from the options.

Patient connections

To make the connections:

1. Connect a new spirometry tube to the flow sensor by inserting the angle connectors into the sensor connectors.

2. Connect the other end of the spirometry tube to the pressure connectors on the monitor.

3. Connect a gas sampling line to the luer connector on the other side of the flow sensor.

4. Connect the other end of the gas sampling line to the sampling line connector on the D-fend water trap. Confirm that the connections are secure.

5. Select the type of sensor you use, D-lite (the factory default) or Pedi-lite: Press the ComWheel and select **Parameters**. Then, select **Airway Gases** and **Spirometry Setup**. Select **Sensor Type** and choose the sensor.

6. Complete the other patient connections as shown below.
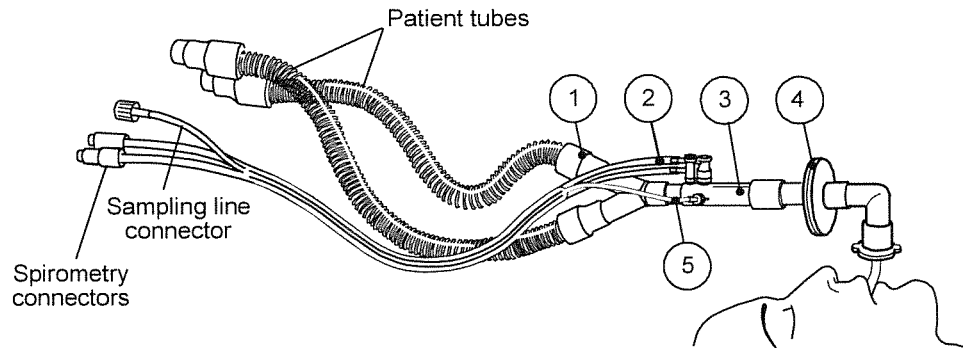
Figure 17-4. Patient spirometry setup

(1) Y-piece

(2) Spirometry tube

(3) D-lite sensor

(4) Bacterial filter

(5) Gas sampling line
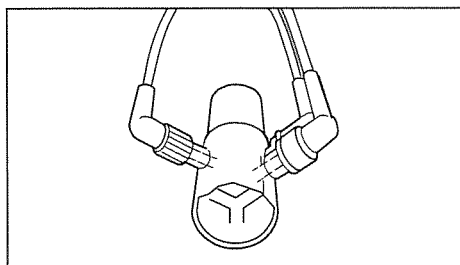

To prevent condensed water from entering the lines, position the gas sampling line and the spirometry tube connections so that they head upward from the patient.

Figure 17-5. Connector positioning

The gas sampling line can be aligned along the groove of the spirometry tube for a more serviceable setup.

NOTE: If you are using a nebulizer to administer medication, disconnect the HME-F filter and the flow sensor while the nebulizer is in use.

NOTE: When using a Bain circuit, the inspiratory volumes are erroneously high. This can be corrected by using a filter.

Selecting the sensor

Adult and pediatric patients are measured with different sensors.

To select the correct sensor type:

7. Press the ComWheel and select **Parameters** from the Main Menu.

8. Select **Airway Gas**.

9. Select **Spirometry Setup**.

10. Select **Sensor Type** and choose **Adult** or **Pedi**.

Both D-lite and Pedi-lite sensors also work as airway adapters with a connector for airway gas monitoring.

Adult D-lite sensor

D-lite sensors are reusable (transparent yellow) or disposable (non-transparent yellow).
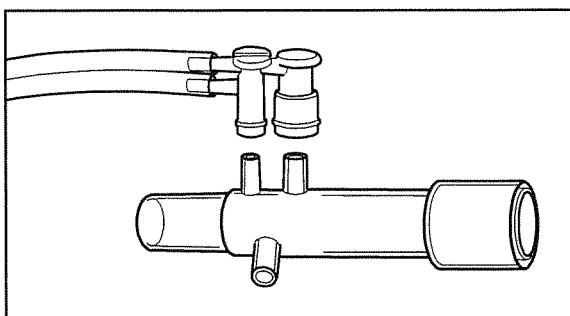
The D-lite sensor is for patients with a tidal volume of 150 to 2000 ml.

The filter smoothes the flow profile and prevents mucus or humidity from entering the D-lite.

The outer diameter of the D-lite at the patient end allows connection of the D-lite sensor to a mask.

Figure 17-6. D-lite sensor

Pediatric Pedi-lite sensor

Pedi-lite sensors are reusable (transparent yellow).

The Pedi-lite sensor is intended for patients having a tidal volume from 15 to 300 ml.
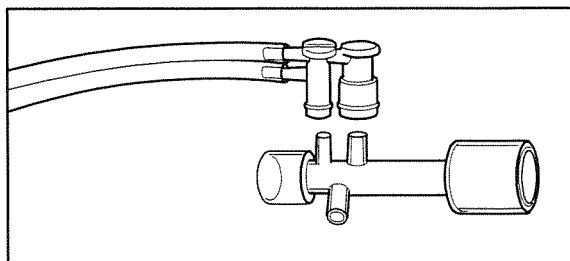
Figure 17-7. Pedi-lite sensor

Spirometry setup

To open the Spirometry Setup menu:

11. Press the ComWheel and select **Parameters** from the Main Menu.

12. Select **Airway Gas**.

13. Select **Spirometry Setup**.

```
┌────────────────────────────────────────┐
│              Airway Gas                 │
│   ┌──────────────────────────────────┐  │
│   │        Spirometry Setup          │  │
│   │                                  │  │
│   │      Scaling   ▤   ┌──────────┐  │  │
│   │   Sensor Type  │Adult│ │ Adult │  │  │
│   │     TV or MV   TV    │ Pedi  │  │  │
│   │   Paw Alarms   ▤     │       │  │  │
│   │  MVexp Alarm   ▤     │       │  │  │
│   │  Previous Menu       │       │  │  │
│   │                      └──────────┘  │  │
│   │  ┌────────────────────────────┐  │  │
│   │  │ Change sensor type:        │  │  │
│   │  │ Adult (D-lite) or          │  │  │
│   │  │ Pediatric (Pedi-lite).     │  │  │
│   │  └────────────────────────────┘  │  │
│   └──────────────────────────────────┘  │
└────────────────────────────────────────┘
```
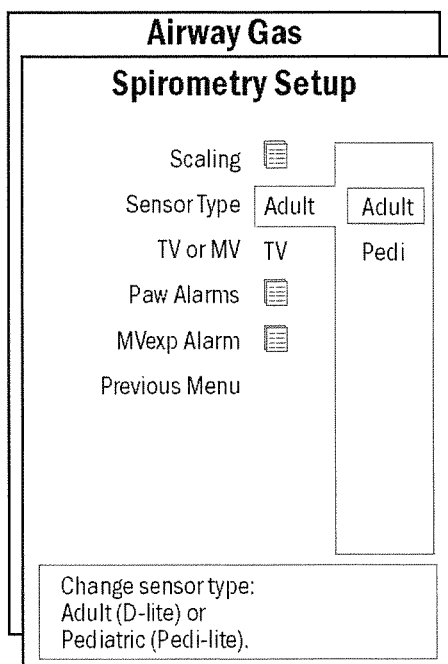
NOTE: For detailed information about the **Scaling** selection, refer to *Scaling of loops and waveforms* later in this chapter.

14. Select **Sensor Type** and choose **Adult** (the factory default) or **Pedi** (pediatric) according to the flow sensor in use.

15. Select **TV or MV** and choose tidal volume (**TV**) or minute volume (**MV**) for display in the digit field. Your selection also affects the Spiro1 Split Screen.

16. Select **Paw Alarms** to open the Paw Alarms Adjustment menu. You can adjust Ppeak and PEEP alarms in the same menu.

17. Select **MVexp Alarm** to open the MVexp Alarms Adjustment menu.
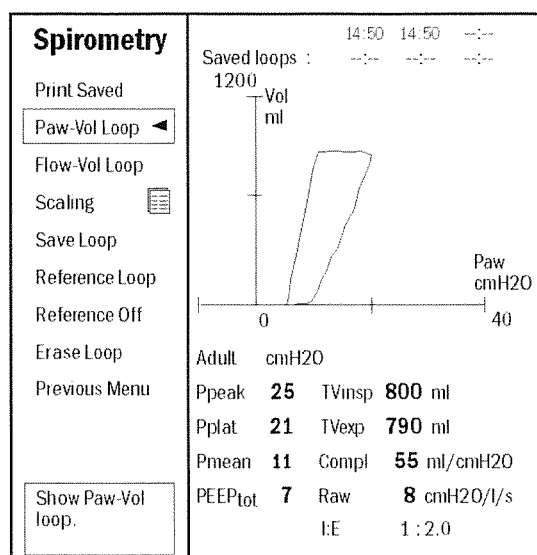
Patient Spirometry

Spirometry loops

Spirometry parameters are viewed in the Spirometry display.

- If CO_2 is detected and the respiration rate is below 15/minute, the loops are updated every breath.

- If no CO_2 is detected or the respiration rate is 15/minute or higher, the loops are updated every other breath.

The values are always updated breath by breath.

To open this menu:

18. Press the ComWheel and select **Parameters** from the Main Menu.

19. Select **Airway Gas**.

20. Select **Spirometry Loops**.

```
Spirometry          14:50  14:50  --:--
                 Saved loops :  --:--  --:--  --:--
Print Saved         1200
                       Vol
Paw-Vol Loop  ◄        ml
Flow-Vol Loop
Scaling      ▤
Save Loop
Reference Loop                          Paw
                                        cmH2O
Reference Off        0              40
Erase Loop       Adult   cmH2O
Previous Menu    Ppeak   25   TVinsp  800 ml
                 Pplat   21   TVexp   790 ml
                 Pmean   11   Compl   55 ml/cmH2O
Show Paw-Vol     PEEPtot  7   Raw     8 cmH2O/l/s
loop.                         I:E     1 : 2.0
```

Spirometry selections

Print Saved   Prints the saved loops.

You can also print all saved loops by pressing the ComWheel and selecting **Record/Print** from the Main Menu. Then select **Print Loops**.

Paw-Vol Loop   Displays the pressure-volume loop. A 45° angle is equal to a compliance of 30 ml/cmH$_2$O for adults and 10 ml/cmH$_2$O for pediatrics.

With pediatric measurement, the ratio of the loop axis is changed to maintain the normalized 45° loop slope also in pediatric measurement.

Flow-Vol Loop   Displays the flow-volume loop.

Scaling   Changes the size of the Paw-Vol and Flow-Vol loops. See *Scaling of loops and waveforms* later in this chapter.

17-7

Save Loop　Saves up to six pairs of reference loops in memory. Both loops are saved at the same time. When more than six pairs are saved, the most recent one is erased from the memory and the "Saving next will override last loop" message is displayed.

The time the saved loop pair is saved appears at the upper right of the spirometry view. A frame around the time of saving indicates which loop is currently displayed.

Reference Loop　Recalls a selected reference loop from memory. One real-time loop and one reference loop are displayed simultaneously.

To recall, highlight the stamp of the loop with the ComWheel and press the ComWheel. The real-time loop is drawn with a blue line, the reference loop is drawn with a white, dotted line.
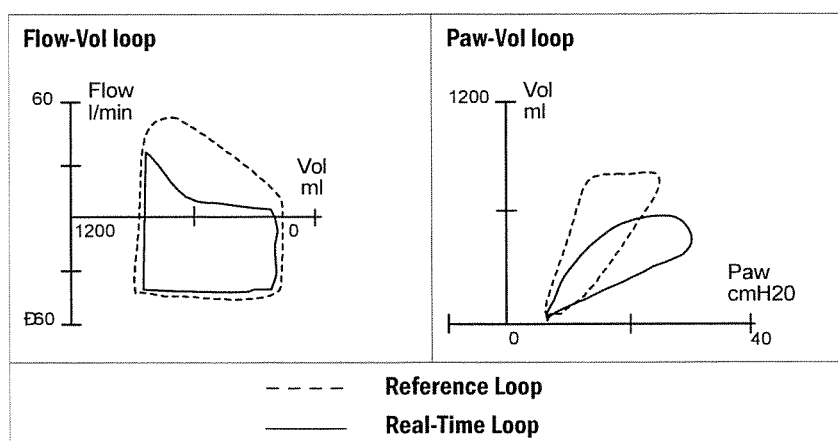
Reference Off　If you do not want the reference loop to be displayed, choose this option.

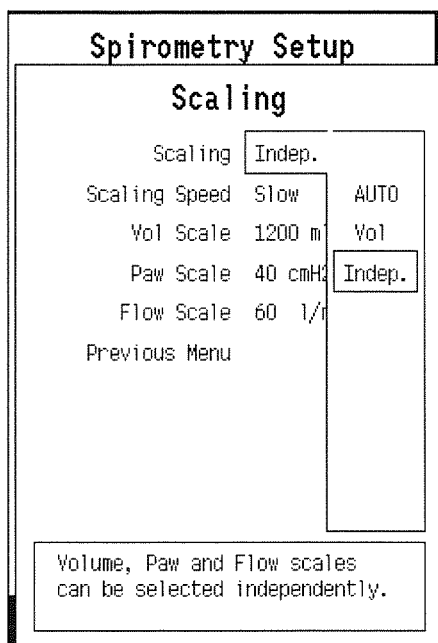**Erase Loop**　Erases the selected reference loop from memory.

To erase, turn the ComWheel to highlight the number of the loop. The loop is drawn with a blue line. Press the ComWheel to erase.

To return to the menu without erasing a loop, select **Exit** instead of the number of the loop.

Scaling of loops and waveforms

If the flow or pressure waveform, or flow, volume, or pressure axis of the loop is not drawn to suit your needs you can change the scaling.

To change the scaling:

```
┌─────────────────────────────────────┐
│        Spirometry Setup          ▓  │
│ ┌─────────────────────────────────┐ │
│ │           Scaling               │ │
│ │                                 │ │
│ │     Scaling │ Indep.         │  │ │
│ │  Scaling Speed  Slow    AUTO   │ │
│ │    Vol Scale  1200 m    Vol    │ │
│ │    Paw Scale  40 cmH┌────────┐ │ │
│ │                     │ Indep. │ │ │
│ │   Flow Scale  60  1/└────────┘ │ │
│ │  Previous Menu                 │ │
│ │                                 │ │
│ │ ┌─────────────────────────────┐ │ │
│ │ │Volume, Paw and Flow scales  │ │ │
│ │ │can be selected independently.│ │ │
│ │ └─────────────────────────────┘ │ │
│ └─────────────────────────────────┘ │
└─────────────────────────────────────┘
```

21.   Press the ComWheel and select **Parameters** from the Main Menu.

22.   Select **Airway Gas**.

23.   Select **Spirometry Loops** or **Spirometry Setup**.

24.   Select **Scaling**.

Scaling   **AUTO** (the factory default) automatically adjusts the scaling of parameters to suit the situation. Complete loops and waveforms are always displayed.

Vol results in interdependent scales. A change to one scale affects the others so that the ratio between pressure and volume and flow and volume scales remains constant.

Indep. allows independent and separate changes to the volume, pressure, and flow scales. A change in one scale does not affect the scaling of other scales. This selection may be needed, for example, with pediatric or ARDS patients whose airway pressure is high but the tidal volume low.

Scaling Speed   Changes the speed at which loops and waveforms are rescaled during **AUTO** scaling.

Slow rescales to a higher scale after two breaths are above the selected scale. Rescaling to a lower scale occurs after four breaths are within the limits of the lower scale.

Fast rescales to a higher scale after one breath is above the selected scale. Rescaling to a lower scale occurs after two breaths are within the limits of the lower scale. For example, select **Fast** as the scaling speed for manual ventilation.

Spirometry Setup		Spirometry Setup		Spirometry Setup	
Scaling		**Scaling**		**Scaling**	
Scaling	Indep.	Scaling	Indep.	Scaling	Indep.
Scaling Speed Slow	300	Scaling Speed Slow	10	Scaling Speed Slow	15
Vol Scale 1200	600	Vol Scale 1200 m	20	Vol Scale 1200 m	30
Paw Scale 40 cmH₂	900	Paw Scale 40	30	Paw Scale 40 cmH₃	45
Flow Scale 60 1/r	1200	Flow Scale 60 1/r	40	Flow Scale 60	60
Previous Menu	1800	Previous Menu	60	Previous Menu	90
	2400		80		120
	ml		cmH20		1/min
Change scale of Volume axis by changing scale height.		Change scale height of Paw axis. Selection also changes size of Paw waveform.		Change scale height of Flow axis. Selection also changes size of Flow waveform.	

Figure 17-8. Vol Scale, Paw Scale, and Flow Scale options

Calibrating

The flow measurement should be calibrated once a year, or when there is a permanent difference between inspiratory and expiratory volume.

Calibration should be performed by trained service personnel using a special spirometry tester designed by Datex-Ohmeda. For more information, see the *Technical Reference Manual.*

Other adjustable features

This section describes other adjustable features related to patient spirometry measurement. A password is required for entering the Install/Service menu where the adjustments are made. If you wish to make changes, we recommend that you contact the person responsible for the entire configuration.

Changing parameter colors

You can choose yellow, white, green, red, or blue as the color used in the waveform and digit fields for CO_2, O_2, N_2O, agent gas readings, Paw, and Flow. You can also select orange or violet for gases.

To change the color:

25. Press the ComWheel and select **Monitor Setup** from the Main Menu.

26. Select **Install/Service** and enter the password.

27. Select **Colors**.

28. Select **Gases** or select **More Parameters** and **Paw** or **Flow**.

29. Choose the color.

Specifying measurement conditions

You can specify measurement conditions of pressure, temperature, and humidity for volume measurement.

30. Press the ComWheel and select **Monitor Setup** from the Main Menu.

31. Select **Install/Service** and enter the password.

32. Select **Installation**.

33. Select **Units.**

34. Select **Parameters.**

35. Select **TV based on** and choose **ATPD**, **NTPD**, **BTPS**, or **STPD**.

TV measuring conditions

Condition	Temperature	Pressure	Relative Humidity
ATPD	Ambient	Ambient	0%
NTPD	20 °C (68 °F)	760 mmHg	0%
BTPS	37 °C (98.6 °F)	Ambient	100%
STPD	0 °C (32 °F)	760 mmHg	0%

For your notes:

Chapter 18. NeuroMuscular Transmission (NMT)

Table of Figures

18. NEUROMUSCULAR TRANSMISSION (NMT)

Overview

The Cardiocap/5 monitor with the N-XNMT option delivers stimulating electrical pulses to a motor nerve and measures the muscle response to these stimulations.

Two electrodes are needed for electrical stimulation of a peripheral nerve. The resulting response can be measured with a MechanoSensor or an ElectroSensor.

- The MechanoSensor is attached between the thumb and index finger. It is easier to use and more suitable for routine clinical use. It measures movements with a piezoelectric wafer.

- The ElectroSensor uses three recording electrodes for electromyography (EMG) and is mainly intended for research purposes.

Displaying NMT

You can choose three different NMT views on the display: current numeric values, waveforms illustrating the progression of the stimulation responses during measuring, and graphical trends.

NOTE: When waveforms are selected for the display, the digit field with the NMT measurement disappears automatically.

Selecting NMT on a digit field

To select an NMT digit field:

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.

2. Select **Screen Setup**.

3. Select **Digit Fields**.

4. Select one of the fields and choose **NMT**.

Selecting NMT on a waveform field

During the NMT stimulation cycle, you can observe the progression of the stimulation responses as waveforms. The waveform display is mainly for research purposes.

To select an NMT waveform field:

1. Press the ComWheel and select **Monitor Setup** from the Main Menu.

2. Select **Screen Setup**.

3. Select **Waveform Fields**.

4. Select one of the fields and choose **NMT**.

The first waveform is saved as a reference waveform automatically. It appears on the background of the display during other measurements. The reference waveform is a different color than the real-time NMT waveform.

Patient connections

Before connecting the electrodes, clean the application site of oil or dirt. Avoid placement over excessive body hair or lesions. Pay attention to the condition and placement of the electrodes. Good signal quality requires good skin contact with the electrodes. Only Datex-Ohmeda NMT electrodes are recommended.

Stimulating electrodes

To stimulate the motor nerve correctly on standard conditions, the stimulating electrodes (white and brown) are recommended to be placed along the ulnar nerve on a site where the nerve is as near to the skin as possible.

To locate the nerve, locate the ulnar artery which runs side by side with the ulnar nerve. The wrist area is the easiest site for locating the artery, and thus the nerve. The wrist area is a site where the nerve is near the skin. Fat or muscle does not hinder detection at this site.
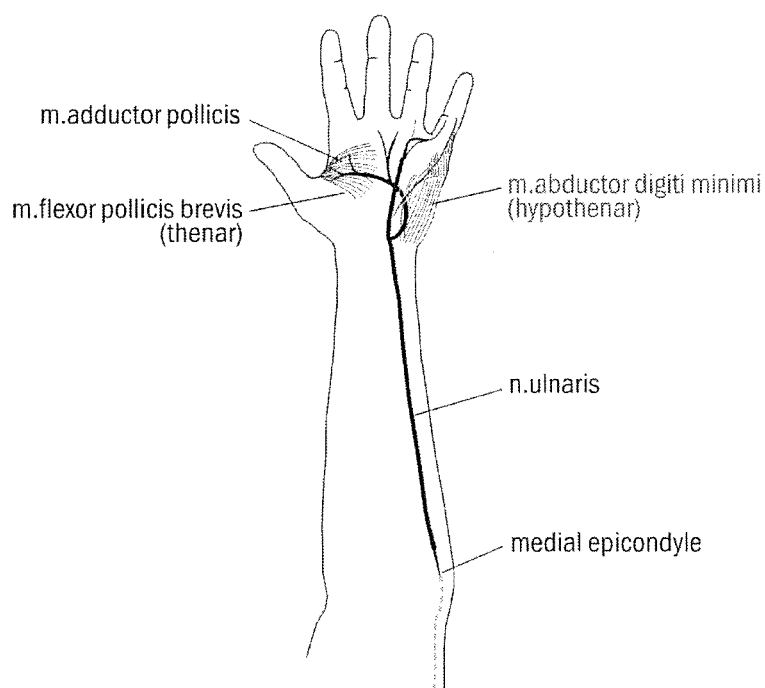

Figure 18-1. Ulnar nerve and the corresponding muscles

WARNING: Electrical Shock Hazard. Do not place the NMT stimulation electrodes on the patient's chest.

WARNING: Electrical Shock Hazard. Always stop the NMT measurement before handling the stimulation electrodes.

WARNING: Patient Safety. Ensure proper contact of the return electrode of the electrosurgery unit to your patient to avoid possible burns at sensor sites.

WARNING: Patient Safety. Make sure that the lead set clips do not touch any electrically conductive material including earth.

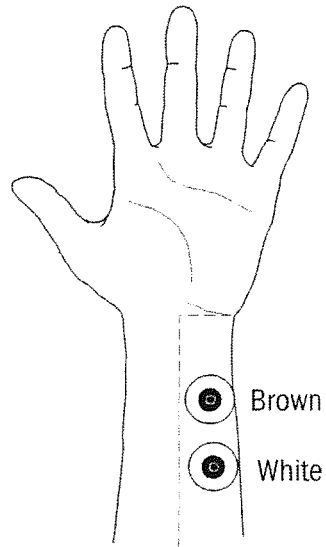The electrodes should not touch each other.

Figure 18-2. Stimulating electrodes

ElectroSensor setup

Grounding electrode

For measuring EMG response, the grounding electrode (black) may be placed where convenient, but placing it between the stimulation and recording electrodes at the palmar groove may reduce stimulation artifact.
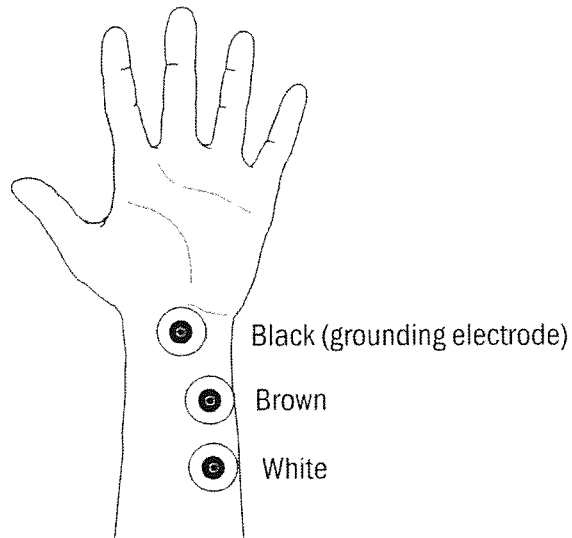

Figure 18-3. Grounding electrode of EMG measurement

Recording electrodes

Place one green recording electrode on the adductor pollicis. Place a second recording electrode on the muscle's tendon or insertion site. The hand should be immobilized.
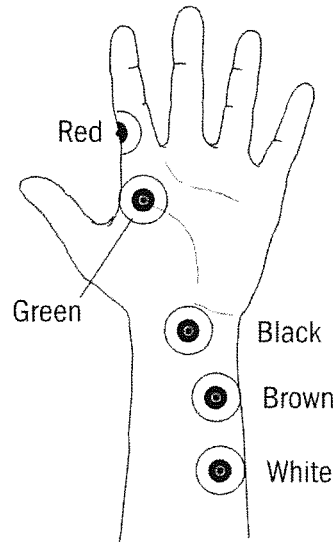
Figure 18-4. Measurement from the adductor pollicis muscle

The adductor pollicis muscle is customarily used for the measurement. When the thenar is preferred, electrode placement becomes crucial. The adductor pollicis and flexor pollicis brevis muscles lie next to each other and may be recorded on the radial surface of the palm between the first and second metacarpals. Interference due to median nerve stimulation is more likely than on the hypothenar side.

Cable set

Figure 18-5. NMT setup with ElectroSensor

(1) NMT sensor cable

(2) ElectroSensor

MechanoSensor setup

The MechanoSensor is attached between the thumb and index finger with a piece of tape. Make sure that the thumb can move freely.
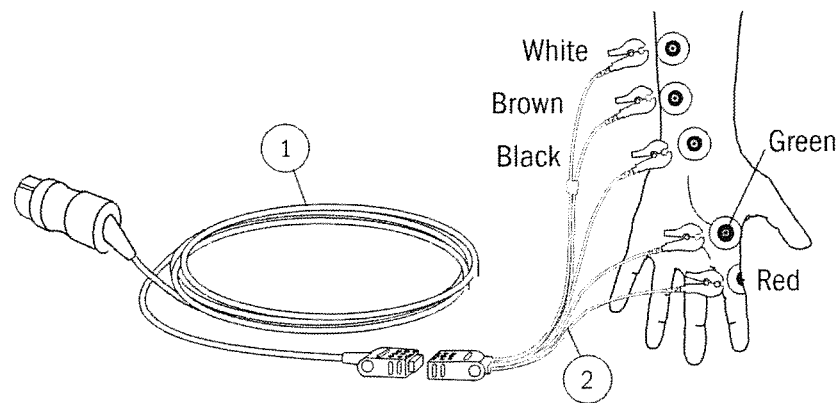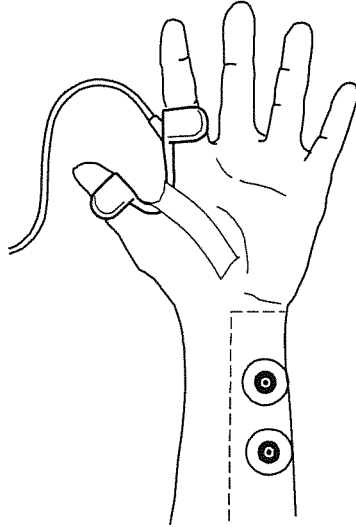

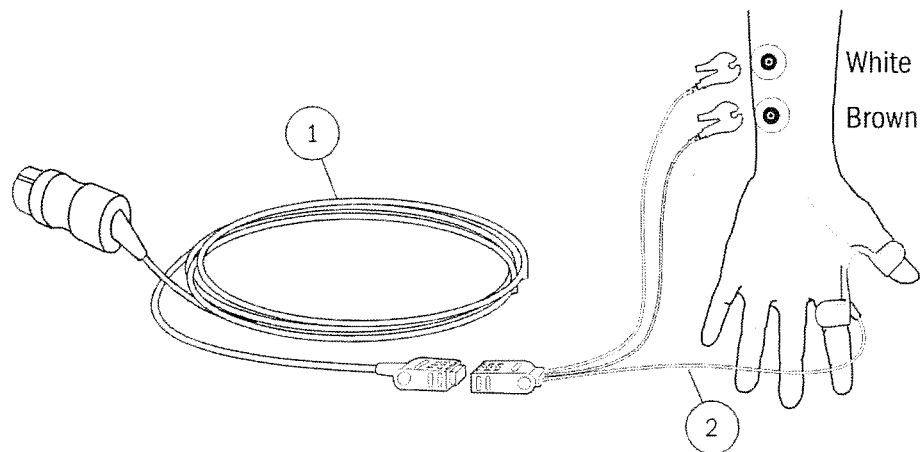**Figure 18-6. MechanoSensor attachment**

Cable set

Figure 18-7. NMT setup with MechanoSensor

(1) NMT sensor cable

(2) MechanoSensor

Starting measurement

NMT monitoring should be started before a muscle relaxant drug is administered. It is, however, advisable to begin after the induction of sleep to prevent voluntary muscle contraction and tension from interfering with the reference search.

If the patient is already relaxed, the reference level is not usually found, however, monitoring can proceed without a reference level. In some cases, the reference level may be found but may be erroneous.

To start a measurement:

5. Press the **NMT** key.

6. Select **Start-Up**.

Supramaximal current search

The monitor begins by searching for the supramaximal stimulation current, which is needed for activating all the fibers of the stimulated (recorded) muscles. When a stimulation pulse is delivered, a star (*) is displayed in the digit field for each pulse. Optionally, a beep will sound at the same time. The delivered stimulus current is measured and the star is displayed if the current is the same as adjusted.

The search for the supramaximal stimulation current begins with a 10 mA stimulus and the response is measured. The current is increased by 5 mA steps until the increase in current does not increase the response. This maximal current is automatically increased by 15%, resulting in a supramaximal current.

NOTE: When the ElectroSensor is used, a reference level for the stimulation responses is determined after the search.

For adults, the supramaximal current is usually between 35 and 55 mA. The current is displayed in the digit field during the search for supramaximal current. It is also displayed in the NMT Setup menu directly after the current selection.

```
┌─────────────────────┐
│ NMT                 │
├─────────────────────┤
│ Supramax search     │
│ TOF%    – – –       │
│ Count   – – –     ▌ │
│         30mA        │
└─────────────────────┘
```

Defasciculating doses of nondepolarizing neuromuscular blocking agents (precurarisation) do not normally affect the supramaximal current or the reference value.

Supramaximal current may not be found if the patient is already relaxed. If the supramaximal current is not found or if the response is too weak for searching a supramaximal current, the current is set to 70 mA.

If the monitor is unable to find the supramaximal stimulation current, the fault is usually in the electrode placement—the nerve is outside the dense current flow or both the ulnar and median nerves are stimulated. Progressively more muscle activity is detected as the increasing stimulation current activates new motor units.

Increasing pulse width

To help find the supramaximal current, you can increase the pulse width to increase the effect of the stimulation:

```
              NMT
          NMT Setup

      Current  S(70MA)
   Pulse Width  200µs
Stim. Beep Volume  0      100 µs
   Previous Menu          200 µs
                          300 µs




   Change stimulation pulse
   width: 100, 200 or 300 µs.
```
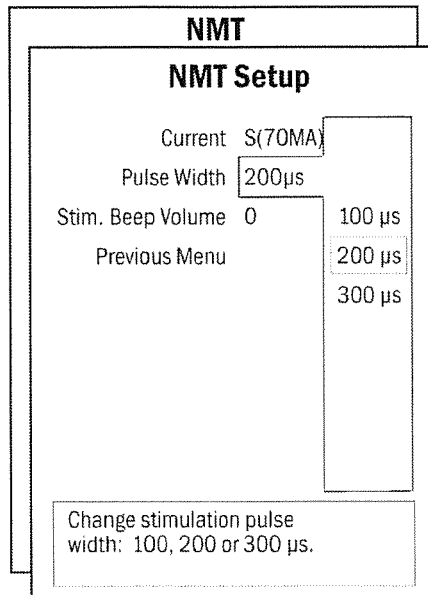
7. Press the **NMT** key.

8. Select **NMT Setup**.

9. Select **Pulse Width** and **300 µs**.

10. To start a new measurement, select **Start-up** in the NMT menu.

Determining response reference level

The supramaximal current search is followed by determination of a response reference level.

The monitor delivers four stimuli of supramaximal current at 1-second intervals. A mean of four stimulation responses is calculated and is determined as a 100% reference level.

- With the ElectroSensor, this reference is used to calculate the T1% (T1/Tref $*$100), the ratio of the first twitch's response to the determined reference level.

- With the MechanoSensor, the reference is used only for scaling the bar graph.

Each stimulation response is displayed as a bar in the digit field. If the bars are not similar, the responses are not repeatable and the reference level will not be accepted.

```
NMT
Setting reference
TOF%
Count      ▮▮▮
     52mA
```
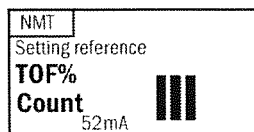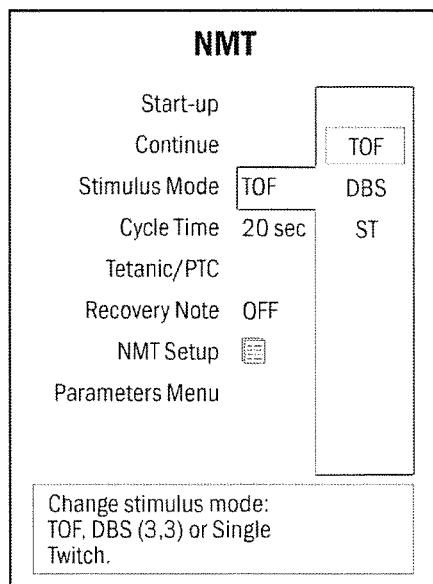
If the patient is paralyzed at the time of start-up, it does not make the measurement impossible or the results useless. When nondepolarizing blocking agents are used, the responses will fade and the reference value is rejected, however, values other than T1% are available.

If the block is depolarizing at start-up, T1% should not be used because the reference level is incorrect.

Changing the stimulus mode

NOTE: To ensure a correct reference value, the stimulus mode should be changed before monitoring starts.

To change the stimulus mode:

NMT
Start-up
Continue
Stimulus Mode
Cycle Time
Tetanic/PTC
Recovery Note
NMT Setup
Parameters Menu

Continue — TOF
Stimulus Mode — TOF / DBS
Cycle Time — 20 sec / ST
Recovery Note — OFF
NMT Setup — 🗒

Change stimulus mode:
TOF, DBS (3,3) or Single
Twitch.

11.   Press the **NMT** key.

12.   Select **Stimulus Mode**.

13.   Select the stimulus
mode (**TOF**, **DBS**, or **ST**).

Train of Four (TOF) stimulation

Train of Four (TOF), the factory default setting, is recommended for most cases.

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

NMT
TOF% 31
Count   4
0 20 sec   T1% 71
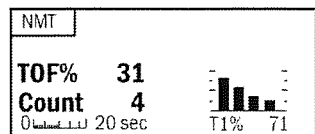
If you use the ElectroSensor, T1% is displayed below the stimulation pulse bars, and a scale is included if the reference is successfully found. Scale markers represent 0%, 25%, 50%, 75% and 100% reference values.

NMT
TOF% 30
Count   4
0   20 sec
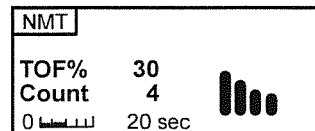
When no reference is available, no T1% is displayed and the displayed bars are not scaled.

NMT
TOF% – – –
Count   2
0 20 sec   T1% 9
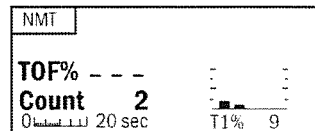
When relaxation deepens, the TOF% declines until the fourth response disappears and no TOF% is calculated.

When no TOF% is available, the degree of neuromuscular block is estimated from the number of responses, or Counts. The Count tells how many responses have been detected to the 4 stimuli. The fewer responses detected, the deeper the relaxation.

Number of responses (Count)	Neuromuscular Block	Muscle Power (% of Control)
1	95%	5%
2	90%	10%
3	85%	15%
4	75%	25%

Perioperatively, this can be seen in the trends where the bars represent the TOF%.
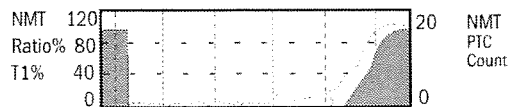
Figure 18-8. Perioperative stimulus response

Adequate clinical recovery from competitive block is normally reached when the TOF% is over 70.

Double Burst Stimulation (DBS)

Double Burst Stimulation (DBS) enables better visual observation of fading responses. It is practical when the MechanoSensor cannot be used with infants, for example.

DBS includes two separate bursts where each burst consists of three pulses directly after each other, at 50 Hz frequency. The response ratio of the second to the first burst is calculated, resulting in DBS%. DBS% is equivalent to TOF%.
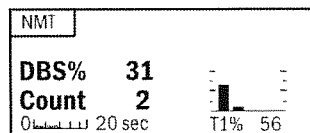
Single Twitch (ST) stimulation

In single twitch stimulation, one pulse is generated and its response is measured. Single Twitch is practical when using depolarizing relaxants, since TOF% does not give additional information about the state of the patient.
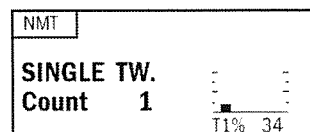
Changing the cycle time

Check that the desired cycle time is selected.

To change the cycle time:

```
              NMT

      Start-up
      Continue           Manual
      Stimulus Mode  TOF   10 sec
      Cycle Time    20 sec  12 sec
      Tetanic/PTC          15 sec
      Recovery Note  OFF    20 sec
      NMT Setup      ▦     1 min
      Parameters Menu      5 min
                           15 min

      Set time interval for
      NMT measurements.
```

14. Press the **NMT** key.

15. Select **Cycle Time**.

16. Select the time interval.

NOTE: The TOF and DBS cycle times are as shown. The ST cycle times are 1, 10, and 20 seconds.

Changing the stimulus current

Check that the correct stimulus current strength is set. The current is either supramaximal (automatic start-up search) or manually selected between 10 and 70 mA. Smaller currents may be desirable for children.

To change the stimulus current:

```
              NMT

           NMT Setup
      Current      S(70MA)
      Pulse Width  200µs    Supra
      Stim. Beep Volume  0   70 mA
      Previous Menu        65 mA
                          60 mA
                          55 mA
                          50 mA
                          45 mA
                          40 mA
                          -More-

      Select supramaximal or
      manual (10 mA - 70 mA) current.
```

17. Press the **NMT** key.

18. Select **NMT Setup**.

19. Select **Current** and choose the current.

Enabling recovery note

The Recovery Note alarms when the count reaches the set value. It indicates that the patient is responding more clearly to the stimuli and the neuromuscular block is decreasing. The note can be used, for example, to help maintain a certain relaxation level.

To make the note operative and set the limit for the alarming count number:

NMT

Start-up		
Continue	1Count	
Stimulus Mode	TOF	2Count
Cycle Time	20 sec	3Count
Tetanic/PTC		4Count
Recovery Note	3Count	OFF
NMT Setup		
Parameters Menu		

Set count number that
activates 'Block recovery'
note.

20.   Press the **NMT** key.

21.   Select **Recovery Note**.

22.   Select the count limit for activating the note.

When the note is activated, you will hear a note sound and a beep. The "Block recovery" message is displayed.

Activation principle

Activation of the note depends on the Count number set as the recovery note and the cycle time.

When the cycle time is less than one minute, the monitor requires that the Count is below the Count limit in two successive measurements before the Recovery Note is enabled. Then, to give the note, the monitor requires that the number of Counts exceeds the limit, or is the same as the limit, twice in one minute. The note disappears when two measurements are below the limit again.

If the cycle time is one minute or more, or if the measurement is done manually, the monitor requires that at least one Count is below the chosen limit before the note is enabled. Then, to give the note, the monitor requires one Count to exceed or to be the same as the Count limit. The note disappears when one measurement is below the limit again.

Stopping and restarting

- To discontinue the NMT measurement, press the NMT key and select **Stop**.

- To continue with same patient, press the NMT key and select **Continue**.

Do not select **Start-up** if you want to preserve the current and reference values.

Measuring deep relaxation with PTC

When neuromuscular block deepens, different parameters are needed to measure the response. At first, when the response to the fourth TOF stimulation pulse disappears, or the first twitch is very weak, the TOF% is not available and only the number of detected counts can be observed.

Relaxation Meter

100	TOF%	20	4	Count	0	10	PTC	0

Light ——————————————————————————————▶ Deep

When stimulation pulses no longer give any stimulation response, the Count is not available either. To monitor the relaxation level, you can start tetanic stimulation and estimate the relaxation level from the Post Tetanic Count (PTC).

Tetanic stimulation is a continuous, 5-second stimulation. The stimulation makes the muscle more responsive. After the tetanic stimulation, single-twitch stimulations are generated. The number of detected responses to the stimulations is counted and expressed as PTC. The fewer responses detected, the deeper the relaxation.

For example, when the patient is relaxed with pancuronium, the TOF response will return in about 5 minutes when PTC is 8, and in 15 minutes when PTC is 5. These values are general guidelines and may differ from case to case.

```
NMT
Measurement OFF
TOF%   - - -     PTC    6
Count  - - -
              T1%  - - -
```

If the responses do not fade away, a maximum of 20 responses are counted and >20 is displayed.

After tetanic stimulation, NMT measurements are stopped for one minute. After this the monitor continues with the previously selected cycle automatically.

Regional block stimulation (Plexus stimulation)

Regional block stimulation is used for locating a nerve.

Regional block requires its own adapter cable. When the regional block adapter cable is connected, the Regional Block menu can be selected from the NMT menu. Once the cable is connected, the digit field displays only the stimulation current value.

The monitor delivers single stimulation pulses at a selected rate until manually stopped. The responses to these stimulations are observable visually, the monitor does not measure them. You adjust the current manually.

To manually adjust the current:

23. Set up the regional block cable, adapter, and needle as shown below.
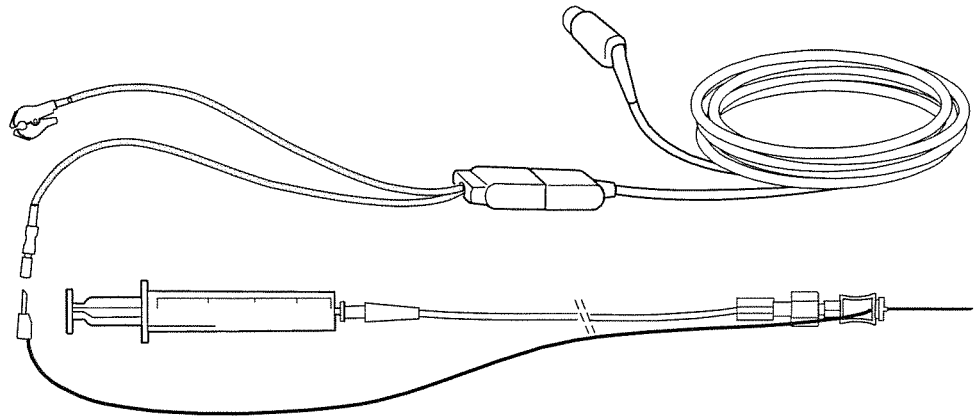

Figure 18-9. Sensor cable, regional block adapter, and needle with syringe

24. Connect the cable to the NMT connector on the monitor.

25. Press the **NMT** key.

26. Select **Cycle Time** and choose the cycle time.

27. Select **Regional Block** to open the Regional Block menu.

28. Select **Run.**
    The monitor is automatically in single twitch mode.

    When the needle approaches the motor nerve, reduce the current so that the response stays small. The closer the needle is to the nerve, the lower the current that is needed to give a response.

    ```
    NMT
    Regional Block
    Current
    2.0    mA
    ```
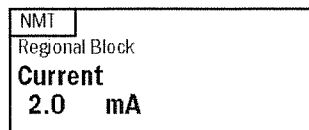
    Note that the pulse width is 40 µs and somewhat higher currents may be needed when compared to other similar systems. However, shorter pulse width is less painful to the patient.

29. To stop the stimulation, select **Stop** in the Regional Block menu.

Measurement limitations and artifacts

Stimulation artifact

If electrodes are placed incorrectly, the wrong nerves are stimulated. Consequently, the wrong muscles are stimulated and the measuring electrodes are improperly placed to measure the stimulation response.

When multiple nerves are stimulated, the measured response may be affected by the electrical activity of other muscles.

If the stimulation electrodes are placed very close to the palm of the hand, the muscles are stimulated directly by the stimulation pulses.

If the current is too strong, the muscles may be stimulated directly by the current.

Movement artifact

All movements of the hand are measured as a response to the stimulation. Therefore, moving or touching the patient during a measurement may cause incorrect results. If possible, immobilize the hand during NMT measurements.

Electrosurgery

The measurement results may be incorrect during electrosurgery.

Verifying reliability

The reliability of the response can be estimated by looking at the bar graph or the NMT trend.

The bars of the graph should be in a smoothly descending order from left to right, and the NMT trend should indicate that the T1% has remained steady. If this is not the case, the newest response is unreliable. Relaxation level does not usually decrease greatly in one minute even with short-acting relaxants.
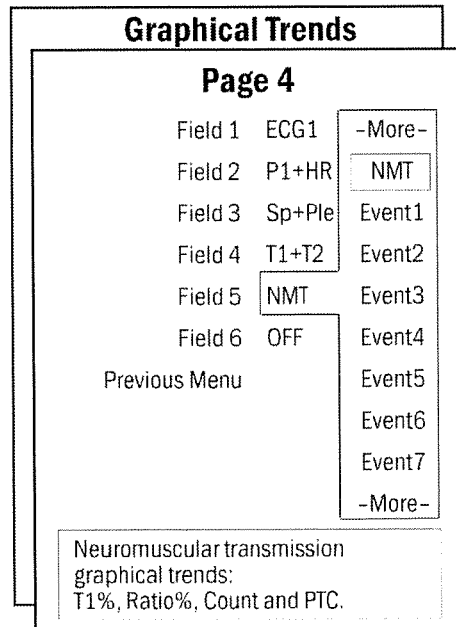
To verify the observations, start a new measurement manually right after completing the previous measurement. Sometimes the selected cycle time has been so long (five minutes, for example) that the relaxation level has changed considerably between the measurements.

Other adjustable features

This section describes other adjustable features related to NMT measurement. A password is required for entering the Install/Service menu where the adjustments are made. If you wish to make changes, we recommend that you contact the person responsible for the entire configuration.

Selecting NMT trend

If you want the NMT trend in a trend field or you want to change the NMT trend page number, do the following:

```
┌─────────────────────────────────────┐
│         Graphical Trends             │
│  ┌─────────────────────────────────┐ │
│  │           Page 4                │ │
│  │                                 │ │
│  │   Field 1  ECG1   -More-        │ │
│  │   Field 2  P1+HR   NMT          │ │
│  │   Field 3  Sp+Ple  Event1       │ │
│  │   Field 4  T1+T2   Event2       │ │
│  │   Field 5  NMT     Event3       │ │
│  │   Field 6  OFF     Event4       │ │
│  │   Previous Menu    Event5       │ │
│  │                    Event6       │ │
│  │                    Event7       │ │
│  │                    -More-       │ │
│  │  Neuromuscular transmission     │ │
│  │  graphical trends:              │ │
│  │  T1%, Ratio%, Count and PTC.    │ │
│  └─────────────────────────────────┘ │
└─────────────────────────────────────┘
```

30. Press the ComWheel and select **Monitor Setup** from the **Main Menu**.

31. Select **Install/Service** and enter the password.

32. Select **Trends & Snapshot**.

33. Select **Graphical Trends**.

34. Select the page you wish.

35. Select the field and choose **NMT**.

For your notes: