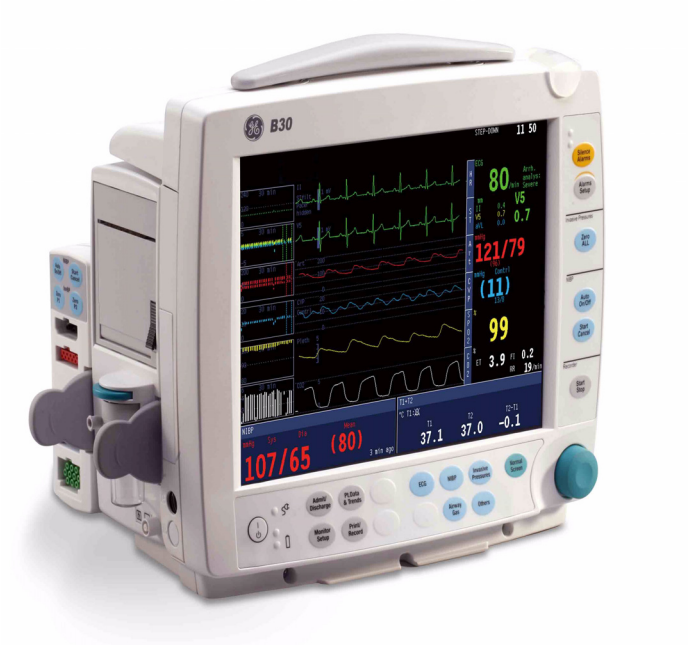
GE Healthcare

B30 Patient Monitor

Technical Reference Manual



B30 Patient Monitor
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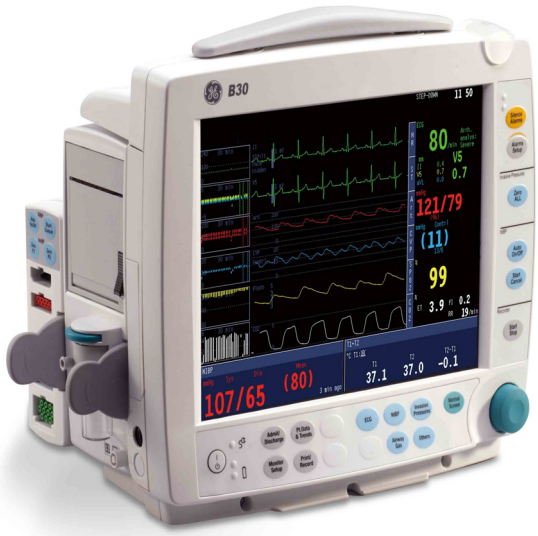

Conformity according to the Council Directive 93/42/EEC concerning Medical Devices

All specifications subject to change without notice.

Order code 2044677-001

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Intended purpose (Indications for use)

The B30 patient monitor is intended for multiparameter patient monitoring. The B30 monitor is indicated for continuous monitoring of hemodynamic parameters (including arrhythmia and ST segment analysis) and respiratory status and creation of limit alarms.

The B30 monitor is intended for all hospital patients and all hospital departments including intra-hospital transport but excluding harsh physical environment like MRI.

The Patient side module E-PSM(P)W and accessories are indicated for monitoring of hemodynamic parameters of all hospital patients. The hemodynamic parameters of the module comprise ECG (including ST-Segment and arrhythmia), impedance respiration, oscillometric NIBP (sys/dia/mean), temperature, SpO_2 (including monitoring during conditions of clinical patient motion), and invasive blood pressure. Impedance respiration measurement is indicated for patients ages three years and up. The NIBP measurement is indicated for patients who weight 5kg (11 lb) or up.The E-PSM(P)W is intended for all hospital departments including intra-hospital transport but excluding harsh physical environment like MRI.

The extension module N-FCREC (option N-FCREC or N-FC) is indicated for monitoring of CO_2 and respiration rate of all hospital patients. CO_2 measurements are indicated for patients who weight over 5 kg (11 lb).

The B30 monitor and N-F(C)(REC) Extension Module and E-PSM(P)W Patient Side Module are indicated for use by qualified medical personnel only.

Classifications

In accordance with IEC 60601-1

CLASS I AND INTERNALLY POWERED EQUIPMENT – the type of protection against electric shock.

TYPE BF or CF equipment. The degree of protection against electric shock is indicated by a symbol on each parameter module.

EQUIPMENT not suitable for use in the presence of a FLAMMABLE ANESTHETIC MIXTURE WITH AIR OR WITH OXYGEN OR NITROUS OXIDE.

CONTINUOUS OPERATION according to the mode of operation.

PORTABLE MONITOR

In accordance with IEC 60529

IPX1 - degree of protection against harmful ingress of water.

In accordance with EU Medical Device Directive

The B30 monitor is classified as IIb.

In accordance with CISPR 11: Group 1, Class B

- 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 B equipment is suitable for use in domestic establishments and in establishments directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

Responsibility of the manufacturer

GE Medical Systems *Information Technologies*, Inc. (GE) is responsible for the effects on safety, reliability and performance of the equipment only if:

- assembly, extensions, readjustments, modifications, servicing and repairs are carried out by personnel authorized by GE.
- the electrical installation of the monitor room complies with appropriate requirements.
- the equipment is used in accordance with the "User's Guide."

Trademarks

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Product availability

Some of the product parts and accessories mentioned in this manual may not be available in all countries.
Please, consult your local representative for the availability.

1 Introduction

2 Installation

3 Maintenance

4 Troubleshooting

5 Service Menu

6 Field replaceable unit

7 Technical specification

8 N-F(C)(REC) Module

1 Introduction

About this manual

Intended audience

This Technical reference manual is meant for service representatives and technical personnel who install, configure, maintain, administer, troubleshoot or repair B30 monitor running the software license *L-DICU08*.

Notes to the reader

As the monitor setup may vary, some functions described may not be available in the monitor you are using.

- The order code for the manual is **2044677-001.**
- Read the manual through and make sure that you understand the procedures described before the installation of the monitor. To avoid risks concerning safety or health, strictly observe the warning indications. If you need any assistance concerning the installation, please do not hesitate to contact your authorized distributor.

The manufacturer reserves the right to change product specifications without prior notice. Although the information in this manual is believed to be accurate and reliable, the manufacturer assumes no responsibility for its use.

Installation and service are allowed by authorized service personnel only.

GE Healthcare assumes no responsibility for the use or reliability of its software in equipment that is not furnished by GE.

Related documentation

For instructions for daily use including cleaning and daily maintenance, clinical aspects and basic methods of measurement see:
B30 patient monitor, User's Guide
B30 patient monitor, User's Reference Manual

Software options and default settings are described in the "Default Configuration Worksheet" delivered with each monitor.

Available accessories are described in the "Supplies and Accessories" catalog delivered with each monitor.

Conventions used

To help you find and interpret information easily, the manual uses consistent text formats:

Sign the check form after performing the procedure.

Hard Keys	Names of the hard keys on the Command Board, side panel and modules are written in the following way: **Others.**
Menu Items	Software terms that identify window parts or menu items are written in bold italic: ***ECG Setup.*** Menu access is described from top to bottom. For example, the selection of the **Monitor Setup** hard key, the ***Screen Setup*** menu item and the ***Waveform Fields*** menu item would be shown as **Monitor Setup - *Screen Setup - Waveform Fields***.
'Messages'	Messages (alarm messages, informative messages) displayed on the screen are written inside single quotes: 'Please wait'.
"Sections"	When referring to different sections in this manual or to other manuals, manual names and section names are enclosed in double quotes: See section "Cleaning and care." Please refer to "User's Reference Manual: Alarms."
Hypertext links	Hypertext links on PDF versions are written in blue color.
WARNING	Warnings are written in the following way:
WARNING	**This is a WARNING.**
CAUTION	Cautions are written in the following way:
CAUTION	This is a CAUTION.
NOTE	Notes are written in the following way:
	NOTE: This is a NOTE.
	In this manual, the word "select" means choosing and confirming.

Illustrations and names

All illustrations in this manual are only examples, and may not necessarily reflect your system settings or data displayed in your system. If a particular selection is not available in your system, the selection is shown grayed.

WARNING **This Technical Reference Manual is available in English only except as otherwise expressly required by local law or agreed to at a local level. If a customer's service provider requires a language other than English, it is the customer's responsibility to provide translation services. Do not attempt to service the equipment unless this Technical Reference Manual has been consulted and is understood. Failure to heed this Warning may result in injury to the service provider, operator or patient from electric shock, mechanical or other hazards.**

1 Overview

The B30 is a modular multiparameter patient monitor. The monitor is especially designed for monitoring in intensive care units. It can also be used during transportation within the hospital.

The modular design makes the system flexible and easy to upgrade.

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

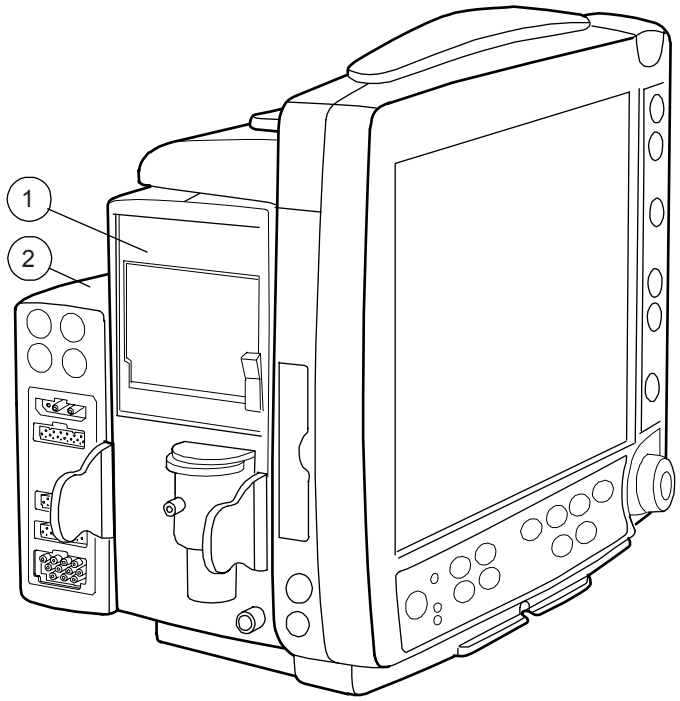


Figure 1 B30 monitor with N-FCREC (1) and E-PSM(P)W (2) modules

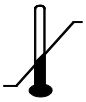
1.1 Symbols

1.1.1 Symbols on transport packaging

The contents of the transport package are fragile and must be handled with care.

Indicates the correct upright position of the transport package.

The transport package must be kept in a dry environment.



Indicates the temperature limitations within which the transport package should be stored.

This package can be recycled.

1.1.2 Symbols on equipment

This battery contains lead and can be recycled.

1.1.3 Equipment safety symbols

- Attention, consult accompanying documents.
- On the modules or frames indicates that modules with identical measurements should not be used in the same monitor. If such modules have been inserted, remove the module that has been most recently connected. You can also remove both modules and reconnect the new module after five second.
- On the N-FC(REC) module indicates that the airway gases should be calibrated every 6 months in normal use and every two months in continuous use to ensure that the measurement accuracy remains within specifications.
- On the E-PSM(P)W module 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.
- On the rear or bottom panel this symbol indicates the following warnings and cautions:
  - Electric shock hazard. Do not open the cover or the back. Refer servicing to qualified service personnel.
  - For continued protection against fire hazard, replace the fuse only with one of the same type and rating.
  - Do not touch a battery-operated monitor during defibrillation procedure.
  - Disconnect from the power supply before servicing.
  - Do not use the monitor without manufacturer approved mounting attached.
  - Do not touch the monitor during defibrillation procedure.
- On top of the monitor beside the battery cover
  - Use manufacturer recommended batteries only. Follow the regional regulations for disposal.

Type BF (IEC 60601-1) protection against electric shock.

Type BF (IEC 60601-1) defibrillator-proof protection against electric shock.

Type CF (IEC 60601-1) protection against electric shock.

Type CF (IEC 60601-1) defibrillator-proof protection against electric shock.

When displayed in the upper left corner of the screen, indicates that the alarms are silenced. When displayed in the menu or digit fields, indicates that the alarm source has been turned off or alarm does not meet the alarm-specific activation criteria.

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. For details, see section "1.2.2. ESD precautionary procedures".

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

1.1.4 Other symbols

Equipotentiality. Monitor can be connected to potential equalization conductor.

Alternating current

Fuse. Replace the fuse only with one of the same type and rating.

SN, S/N

Serial Number

Submenu. Selecting an alternative marked with this symbol in a menu opens a new menu.

Battery operation and remaining capacity. The height of the green bar indicates the charging level.

Battery (A) charging (white bar)

Battery (A) failure

Both batteries have failed

Battery (A) is missing

In the front panel: mains or external DC power

The monitor is connected to Network,

A blinking heart next to the heart rate or pulse rate value indicates the beats detected.

A lung next to the respiration rate value indicates that respiration rate is calculated from the impedance respiration measurement.

Do not reuse.

Use by. Indicates the last use day.

Date of manufacturer

LATEX FREE

Does not contain Latex.

Do not immerse the sensor in liquids.

IPX class: Degree of protection against harmful ingress of water as detailed in the IEC 60529:

IPX0	- Ordinary equipment
IPX1	- Protection against vertically falling water drops.
IPX2	- Protection against vertically falling water drops when enclosure tilted
IPX3	up to 15 °.
IPX4	- Protected against spraying water.
IPX7	- Protected against splashing water.
IPX8	- Protected against the effects of temporary immersion in water. - Protected against the effects of continuous immersion in water.

This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment.

The separate collection symbol is affixed to a battery, or its packaging, to advise you that the battery must be recycled or disposed of in accordance with local or country laws. To minimize potential effects on the environment and human health, it is important that all marked batteries that you remove from the product are properly recycled or disposed. For information on how the battery may be safely removed from the device, please consult the service manual or equipment instructions. Information on the potential effects on the environment and human health of the substances used in batteries is available at this url: http://www.gehealthcare.com/euen/weeerecycling/index.html

This symbol indicates the product contains hazardous materials in excess of the limits established by the Chinese standard SJ/T11363-2006 *Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products*. The number in the symbol is the Environment-friendly Use Period (EFUP), which indicates the period during which the toxic or hazardous substances or elements contained in electronic information products will not leak or mutate under normal operating conditions so that the use of such electronic information products will not results in any severe environmental pollution, any bodily injury or damage to any assets, the unit of the period is "Year".

In order to maintain the declared EFUP, the product shall be operated normally according to the instructions and environmental conditions as defined in the product manual, and periodic maintenance schuedules specified in Products Maintenance Procedures shall be followed strictly.

Consumables or certain parts may have their own label with an EFUP value less than the products.Periodic replacement of those consumables or parts to maintain the declared EFUP shall be done in accordance with the Product Maintenance Procedures.

This product must not be disposed of as unsorted municipal waste, and must be collected separately and handled properly after decommissioning.

This product consists of devices that may contain mercury, which must be recycled or disposed of in accordance with local, state, or country laws. (Within this system, the backlight lamps in the monitor display contain mercury.)

1.2 Safety

The following list contains general warnings and cautions you should know before installing, maintaining or servicing the system. Warnings and cautions specific to the use of the system can be found in the User's Guide and User's Reference Manual.

1.2.1 Safety precautions

Warnings

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

Power connection

- Use only hospital-grade grounded power outlets and power cord. Do not remove the grounding pin from the power plug.
- Use only an intact power cord. Replace the power cord if it is cracked, frayed, broken or otherwise damaged.
- Do not apply tension to the power cord otherwise the cord may get damaged.
- Do not use an additional multiple socket outlet, extension cord or adapters of any kind.
- 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.
- When detaching Patient Side modules, be careful not to drop them. Always support with one hand while pulling out with the other.
- If the integrity of the external protective earth conductor arrangement is in doubt, use the monitor with battery operation.
- To avoid the risk of electric shock, this equipment must only be connected to a supply mains with protective earth.

Installation

- Do not incinerate a battery or store at high temperatures as it will explode.
- 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.
- 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. For details, see section "1.2.2. ESD precautionary procedures"
- After transferring or reinstalling the monitor, always check that it is properly connected and all parts are securely attached. Pay special attention to this in case of stacked mounting.
- Do not use the monitor in high electromagnetic fields (for example, during MRI.)
- Never install the monitor so that it is above the patient.
- If you accidentally drop the monitor, modules or frames, have them checked by authorized service personnel prior to clinical use.

- To avoid explosion hazard, do not use the monitor in presence of flammable anesthetics.The monitor measures only non-flammable anesthetics.
- Do not touch the patient, table, instruments, modules or the monitor during defibrillation.

External connection

- Do not connect any external devices to the monitor other than those specified.

Fuse replacement

- Replace a fuse only with one of the same type and rating.

Explosion hazard

- To avoid explosion hazard do not use the monitor in the presence of flammable anesthetics.
- Do not incinerate a battery or store at high temperatures as it will explode.

Patient safety

- Do not perform any testing or maintenance on the monitor while it is being used on a patient.
- PACEMAKER PATIENTS: The impedance respiration measurement may cause rate changes in Minute Ventilation Rate Responsive Pacemakers. In this case, set the pacemaker rate responsive mode off or turn the monitor impedance respiration measurement off.
- Never install the monitor so that it is above the patient.
- The monitor must not be used without manufacturer approved mounting attached.
- Operation of the monitor outside the specified values may cause inaccurate results.

Cleaning and service

- Only trained personnel with proper tools and test equipment should perform the tests and repairs described in this manual. Unauthorized service may void the monitor warranty.
- Always unplug the monitor before cleaning or service. After cleaning or service ensure that every part of the monitor is dry before reconnecting it to the power supply.
- Do not touch any exposed wire or conductive surface while any cover is removed and the monitor is energized. The voltages present can cause injury or death.
- 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. For details, see section “1.2.2. ESD precautionary procedures”.
- NOTE! The monitor is always internally powered when the batteries are connected.
- Always perform an electrical safety check and a leakage current test on the monitor after service.
- Handle the water trap and its contents as you would any body fluid. Infectous hazard may be present.

Accessories

- Use only accessories, including mounts and batteries, and defibrillator-proof cables and invasive pressure transducers approved by GE Healthcare. For a list of approved supplies and accessories, see the “Supplies and Accessories” catalog delivered with the monitor.

Other cables, batteries, transducers and accessories may cause a safety hazard, damage the equipment or the 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 (SpO2), temperature (T) and invasive pressure (P) measurement.

- Single use accessories are not designed to be reused. Reuse may cause a risk of contamination and/or affect the measurement accuracy.

Cautions

CAUTION A CAUTION indicates a condition that may lead to equipment damage or malfunction.

Installation

- Leave space for air circulation to prevent the monitor from overheating.
- Before connecting the power cord to the power supply, check that the local voltage and frequency correspond with the rating stated on the device plate.

Before use

- Allow two minutes for warm-up and note any error messages or deviations from normal operation.

Autoclaving and sterilizing

- Do not autoclave any part of the monitor.
- Do not gas sterilize the modules.

Cleaning and service

- Do not use hypoclorite, ammonia-, phenol-, or acetone based cleaners. These cleaners may damage the monitor surface.
- Do not immerse any part of the device in any liquid, or allow liquid to enter the monitor or modules.
- Do not apply pressurized air to any outlet or tubing connected to the monitor.
- Electrostatic discharge through the PC boards may damage the components. Before handling PC boards, wear a static control wrist strap. Handle all PC boards by their non-conductive edges and use anti-static containers when transporting them.
- Do not break or bypass the patient isolation barrier when testing PC boards.
- If liquid has accidentally entered the system or its parts, disconnect the power cord from the power supply and have the equipment serviced by authorized service personnel.

Special components

- Special components are used in these monitors that are vital to assure reliability and safety. GE Healthcare assumes no responsibility for damage, if replacement components not approved by GE Healthcare are used.

- A lithium battery on the CPU Board. Dispose of the faulty IC containing the battery according to local regulations.

Batteries

The Lithium Ion batteries are recyclable. Follow your local recycling guidelines.

Refresh the batteries completely every six months.

To replace the batteries safely, please refer to the service instructions in this manual.

- Do not short-circuit the battery terminals, this may produce a very high current, which will damage the battery.
- Do not dispose of the battery into open flame, nor put the battery near fire, as it may explode.
- Do not dismantle the battery.

See also section "Symbols".

Storage and transport

Do not store or transport the monitor outside the specified temperature, pressure and humidity ranges:

Temperature	-20 to +60 °C/-4 to 140 °F
Atmospheric pressure	670 to 1060 hPa/500 to 800 mmHg
Relative humidity	10 to 90% noncondensing

1.2.2 ESD precautionary procedures

- To avoid electrostatic charges building up, it is recommended to store, maintain and use the equipment at a relative humidity of 30% or greater. Floors should be covered by ESD dissipative carpets or similar. 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 equipment, one should touch the metallic frame of the component or a large metal object located close to the equipment. When working with the equipment and specifically when the ESD sensitive parts of the equipment may be touched, a grounded wrist strap intended for use with ESD sensitive equipment should be worn. Refer to the 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 contents 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 an 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.

1.2.3 Disposal

Dispose of the whole device, parts of it and its packing material and manuals in accordance with local environmental and waste disposal regulations.

2 System description

2.1 Introduction

The B30 monitors build up a freely configurable modular system. The architecture is designed to enable different module combinations so that the user is able to get the desirable parameter and feature set. This modular approach makes it possible to add new features when they are needed.

2.2 Bus structure

The operation of B30 is based on two communication channels, the CPU bus and module bus. All units, including the modules, receive power from the same power supply, which is an integral part of the monitor frame.

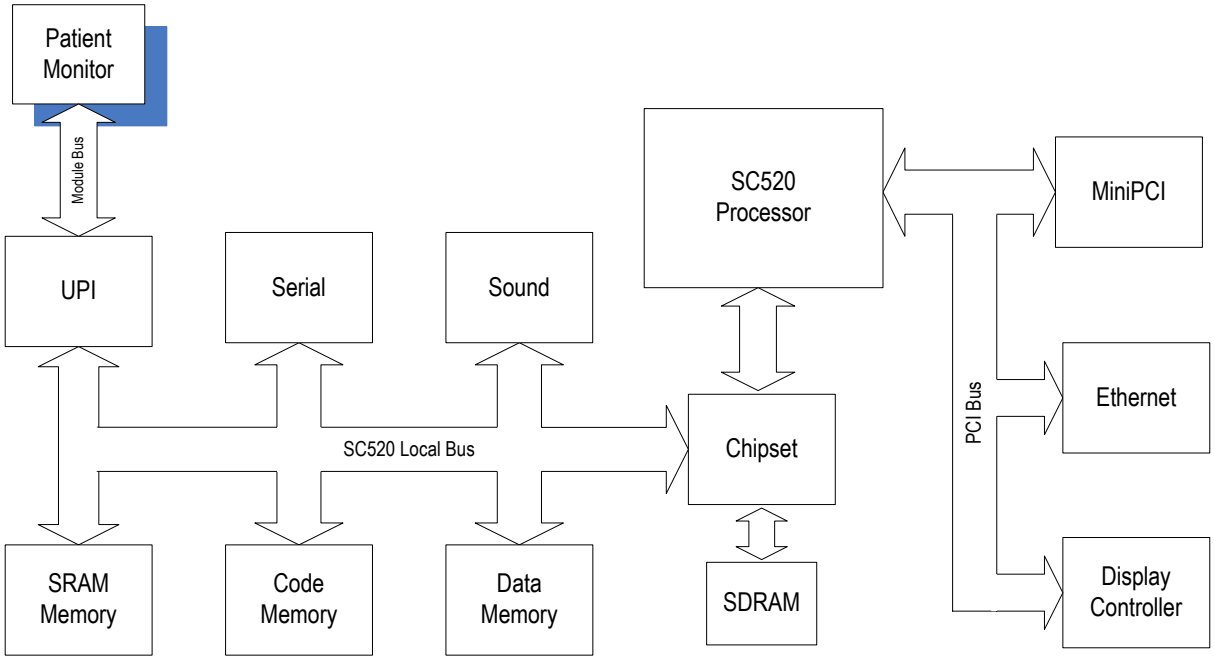


Figure 2 General bus structure of B30 monitor

The CPU bus is a communication channel used only for internal data transfer. It is based on the SC520 local bus and PCI bus. Data is transferred on this 32 bit wide bus using the CPU clock frequency.

The module bus is for the parameter modules. The bus is based on the industry standard RS-485, which uses a differential serial method to transfer data. This type of bus is robust and it allows parameter modules to be inserted or removed while the power is on. The module bus uses a 500 kbps data transfer rate.

The RS-485 type of serial communication supports so-called multidrop or party line connections. This means that all parameter modules connected to the module bus use exactly the same lines for communication. The advantage of this is that all bus connectors are identical and the modules can be connected in any order and position.

2.3 Distributed processing

This is a multiprocessor system. All parameter modules have their own microprocessor, which performs functions such as module key control, waveform filtering, parameter related computing and pneumatic control, etc. At the same time the main CPU performs higher level tasks such as trending and alarm control. While the parameter modules and CPU are performing their tasks, the UPI (Universal Peripheral Interface) microprocessor handles all functions needed to transfer data between the parameter modules and the CPU.

This kind of parallel processing gives one major advantage to centralized processing. When new parameter modules are added to the system, the processing power is increased. As a result, the system does not slow down when new features are added.

2.4 Module communication

The communication master controlling data transfers between the CPU and parameter modules is called UPI processor. It sends data to each connected module 100 times a second. Modules respond to each data request immediately by sending a data package, whose length depends on the type of the module. This communication protocol ensures that each module receives and sends data every 10 ms. If a module does not respond to data requests, the UPI processor presumes that the module is disconnected.

Parameter modules may hold a static (fixed) or dynamic address, which the UPI processor uses when sending out data. Two parameter modules of the same type must not be fitted onto the same monitor since they might reply to a data request simultaneously, thus causing communication errors.

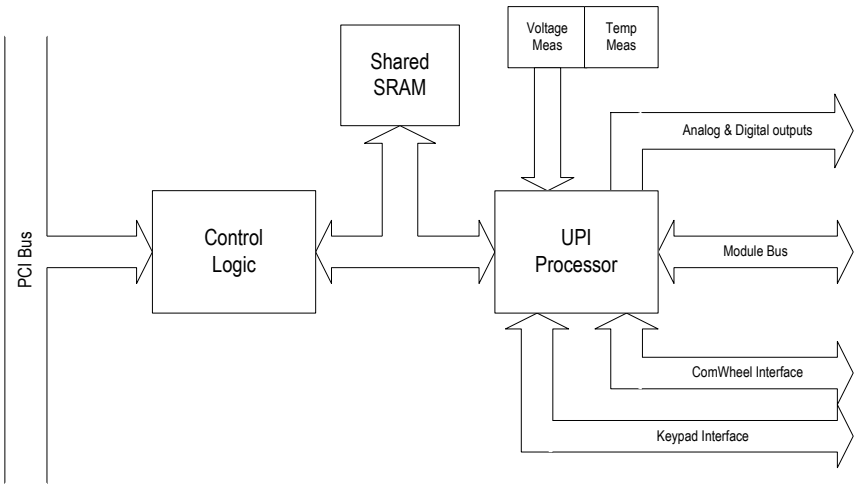


Figure 3 Principle of UPI section operation

The UPI processor collects and stores all data that is received from the parameter modules into a shared SRAM, which is mapped directly to the address space of the main CPU. The main CPU reads data from the memory while the UPI processor guarantees that the data is up to date. This operation also works in the other direction. In this the main CPU fills the shared SRAM with data and the UPI processor distributes it to the parameter modules.

2.5 Software loading

The program memory on the CPU board is loaded with monitor software and selected language files at the factory. The software is used for running all the functions that are integrated into the PC board. For service upgrade main software and language files, please refer to "Software download instruction" in Appendix A or the "B30 Patient Monitor Software download instruction"(PN 2045710-001)

2.6 Parameter modules

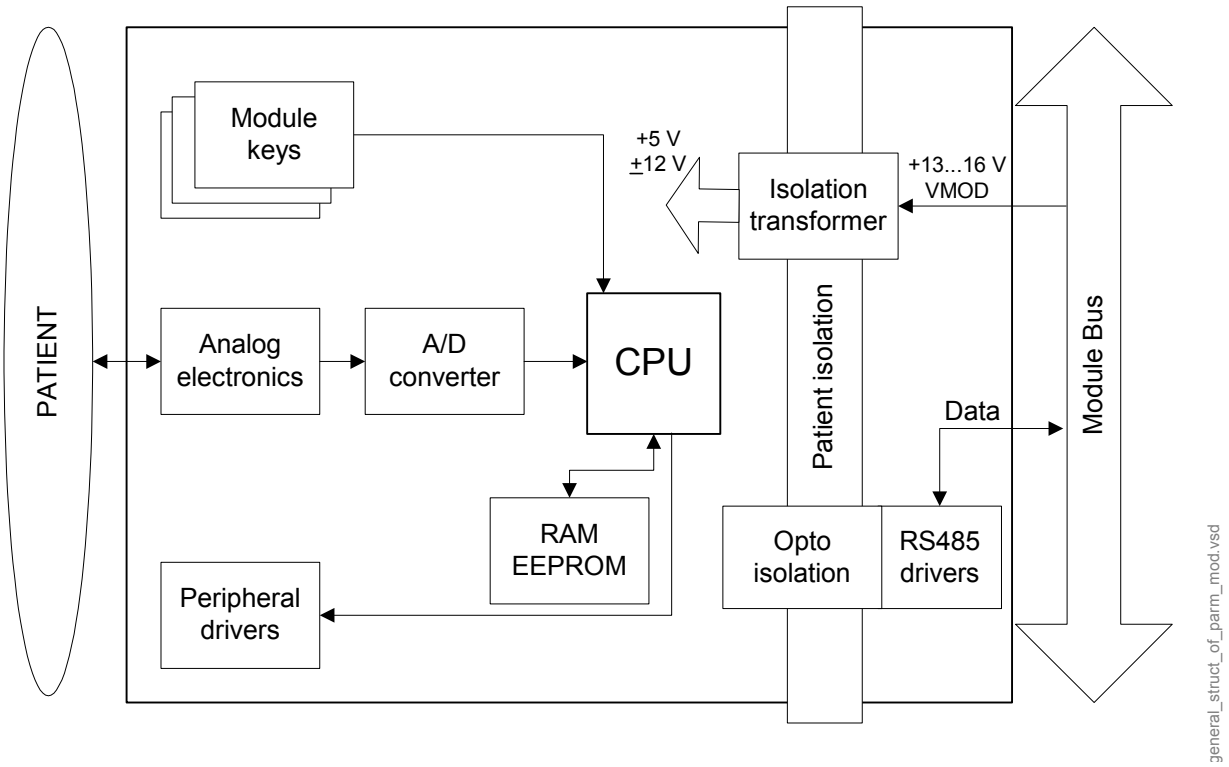


Figure 4 General structure of parameter modules with patient isolation

The detailed structure of a parameter module depends on the specific needs for each individual parameter. However, some common parts are used in the parameter modules. The electronics inside the module is usually divided into isolated (floating) and non-isolated sections. Typically, the non-isolated section consists of buffers to interface the parameter module to the module bus while the rest of the electronics is located in the isolated section. The isolated section includes the microcontroller together with memory components, the front-end analog electronics (amplifiers, etc.) and sensor drivers.

3 Frame functional description

3.1 Main components

3.1.1 Keyboards

User interface parts

Vertical and Horizontal Membrane keypad containing 17 keys. The keypads are foil membrane keypads. The keypads are connected to the UPI section of the CPU board.

ComWheel is used for menu selection.

3.1.2 Display

The 10.4" LCD display with SVGA 800 x 600 resolution has bright long live lamps and a wide viewing angle.

NOTE: The LCD display backlight circuit runs on a high voltage. Do not touch the inverter board or the backlight tube leads when powered.

Backlights

Replaceable backlight lamp unit consists of two integrated cold cathode fluorescent lamps. The backlight lamp unit is driven by a separate inverter board.

B30 Frame Connection Block Diagram

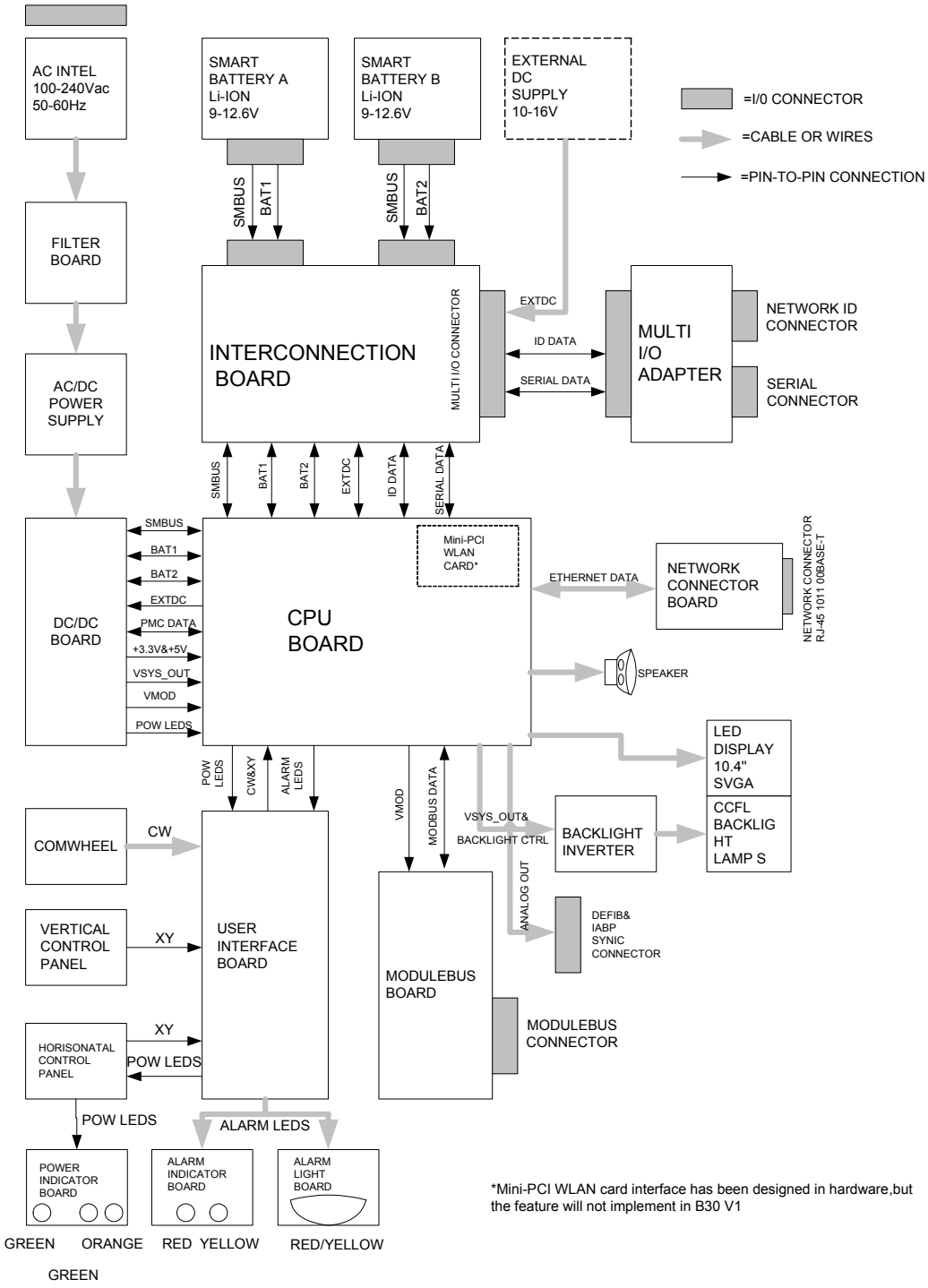


Figure 5 B30 Monitor connection block diagram

3.1.3 CPU board

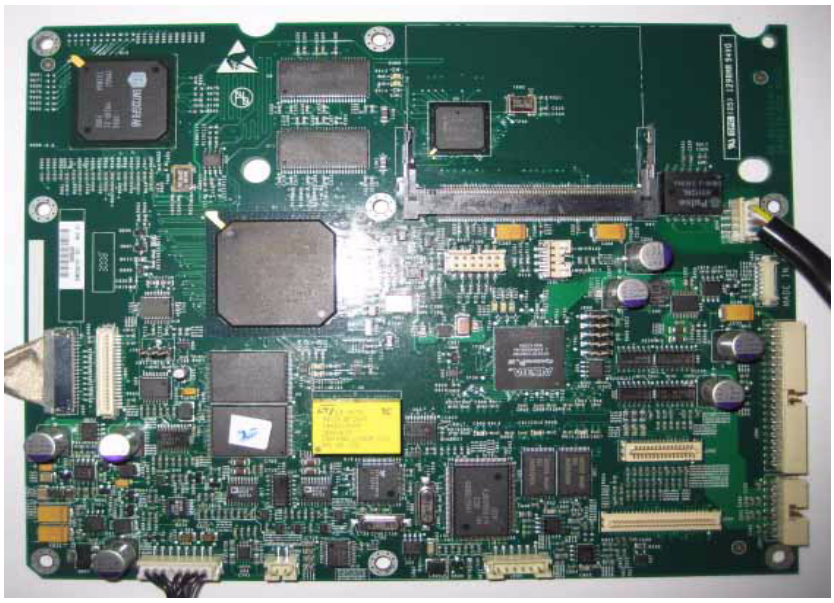


Figure 6 CPU board

The board is based on AMD ELAN SC520 microprocessor. Other features include a flat panel display controller, 10/100 Mbit/s Ethernet interface, Sound system and Hitachi H8S based UPI.

The CPU section takes care of the central processing.

The main features are:

- AMD ELAN SC520
- Internal clock frequency 100MHz
- 64 Mbytes SDRAM
- 16 Mbytes program flash memory
- 32 Kbytes static RAM with real time clock
- 4 channel UART:
  - 2 serial channels with signals in AC logic level
  - 2 serial channel signals in RS232 level
- Programmable alarm sound generator

The SRAM with real-time clock is backed up by a lithium battery.

CAUTION The SRAM/Timekeeper IC contains a lithium battery. Discard the battery according to local regulations.

Connectors

Interconnection board connector

Flat panel connector (to display connection board)

Speaker connector

Analog output board connector (to sync connector board)

Ethernet connector (network cable to network connector board)

System watchdog and voltage supervision

There are two voltage supervision chips that control the system reset signals.

The +3.3V supervision chip outputs reset signals for +3.3V devices. Reset is activated when voltage is below 3.08V. It also has a watchdog that is refreshed in normal operation and in standby.

The +5V supervision chip outputs reset signals for +5V devices. Reset is activated when voltage is below 4.63V. +5V reset causes also +3.3V reset through a FET.

3.1.4 DC/DC board

The DC/DC board converts the output voltage of AC/DC unit, external DC unit or battery voltage to various supply voltages for the electronics of B30 monitor. The DC/DC board takes care of the battery charging.

Figure 7 DC/DC Board

DC/DC board functional blocks

DC/DC board operation is controlled by the PMC (Power Management Controller) CPU. PMC takes care of power path controlling and power supplies' sequencing. It communicates with the main CPU via serial communication. PMC also measures DC/DC board voltages and currents.

High efficiency switching power supplies and power path switches are used on the DC/DC board. This is because of no-fan requirement for FM monitor as well as maximizing the battery time.

Circuit breakers make VSYS and MOD voltages short-circuit protected. Also the battery charger, +5V and +3.3V switchers withstand short-circuit. +5V_OUT is disconnected from +5V by a circuit breaker in case of +5V_OUT overload.

The boost converter can be set to two different output levels. The higher one is used to give the battery charger adequate input voltage when the DC/DC board input comes from an external DC source. The lower one is set in AC/DC use to keep the boost converter enabled but passed by a diode and thus not switching, which minimizes the power loss. When the AC/DC voltage drops, the boost converter starts regulating its output and keeps the MOD voltages at a level a little lower than the one in AC/DC use. In battery use, the lower output voltage yields a little better efficiency, too.

Smart batteries, battery charger and PMC communicate via SMBus (System Management Bus). It is a two-wire interface closely resembling I2C. Smart battery controls the charging and calculates and stores the capacity information as well as other battery related data. Batteries can be charged when external DC or AC/DC voltage is present.

Block diagram of the power supplies is represented in following

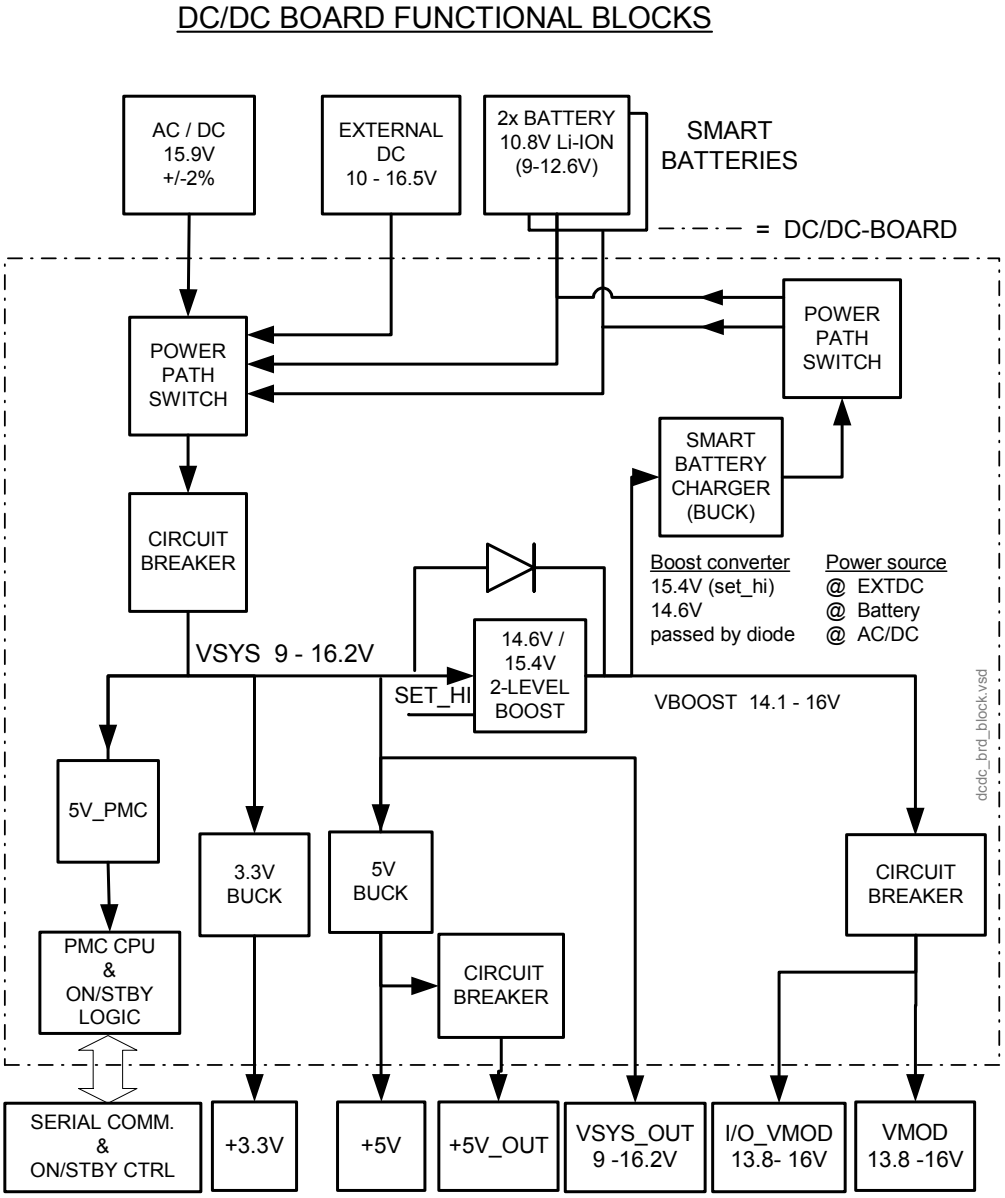


Figure 8 DC/DC board block diagram

Battery charger

Battery charger is a Level 2 Smart Battery Charger. It communicates with the batteries and PMC CPU via SMBus interface. The charger acts as an SMBus slave device that responds to charging current and charging voltage values sent to it by a Smart Battery.

The charger includes an input current limiting feature. In a case where the input current exceeds the limit, the charger reduces the output current to keep the input within the limit. The currents of the MOD voltages (VMOD, I/O_VMOD) are taken through this current measurement

as well. This results that the charger reduces its output current if the sum of the charger input current and MOD currents exceeds the input limit. The purpose of this is to prevent the input power sources from getting overloaded if MOD power is increased during charging.

Power path switching electronics

The power source to be used (batteries, external DC or AC/DC output) is chosen initially by a 'power path controller' inside this block. The PMC CPU has full control over the power path management after the initial choice is made at startup.

3.1.5 AC/DC unit

Figure 9 AC/DC unit

AD/DC unit

The AC/DC unit is a compact medical power supply based on high-efficiency technology. It is designed for 65 watt continuous output power, universal AC input and 15.9V output voltage.

Because FM is convection cooled, AC/DC unit's output is not loaded with full rated power to reduce heat dissipation.

3.1.6 Interconnection board

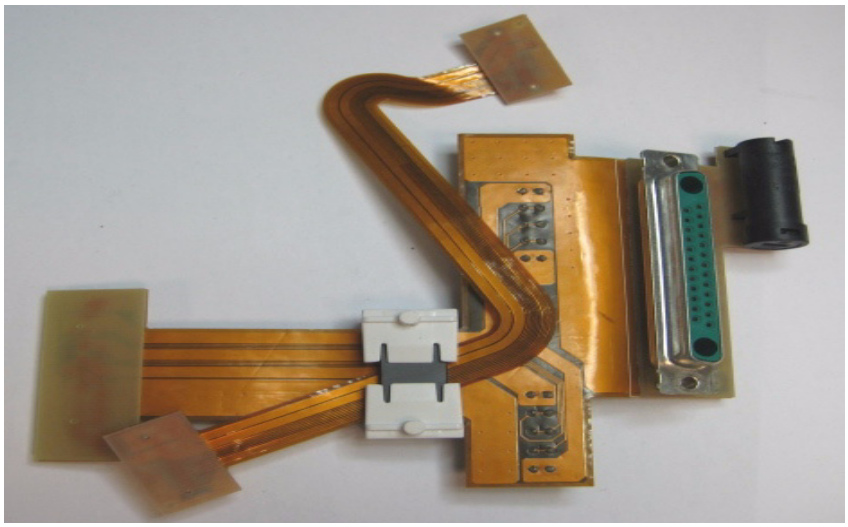


Figure 10 Interconnection and User interface flex board

Interconnection and User interface flex board takes care of most of the monitor internal cabling.

Interconnection board:

CPU board connector

Fuse for External DC input

DC/DC board connector

Multi I/O connector X2

Battery 1 connector

Battery 2 connector

User interface board:

User interface board connector

CPU board connector

3.1.7 Display connection cable

Figure 11 Display connection cable

CPU board connector

Display connector

3.1.8 Front cover parts

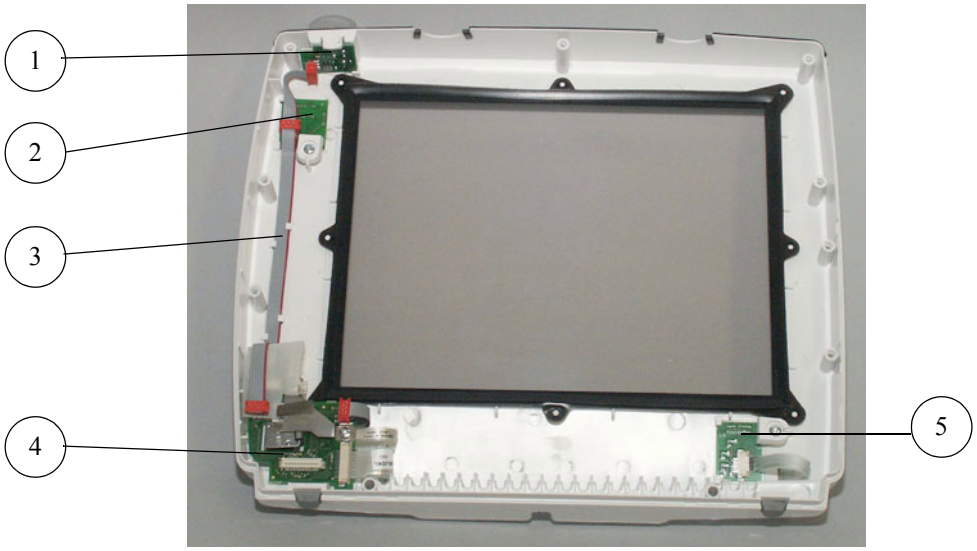


Figure 12 Parts inside Front cover

(1) Alarm light board
(2) Alarm indicator board
(3) Indicator ribbon cable
(4) User interface board
(5) Power indicator board

3.1.9 Batteries

The B30 has two lithium-ion batteries, located in the battery compartment. The DC/DC board connects one of the batteries to be the power source, if no power is received from the AC/DC unit or from an external DC unit. The battery charging is controlled by the DC/DC board.

The batteries can be charged separately, and screen symbols and monitor frame LED indicators indicate their charging level and possible failure.

NOTE: When the monitor is battery powered, the green battery LED is on. When the monitor is mains/external DC powered, the green mains/external DC LED is on.

3.2 Interfacing computer

A computer is connected to the serial port connector on the Multi I/O connector.

Contact your authorized GE Healthcare distributor for further advice on computer interface.

WARNING **Connecting electrical equipment together or using the same extension cord for more than one device may cause their leakage currents to exceed the limits specified in relevant safety standards. Always make sure that the combination complies with the international safety standard IEC 60601-1-1 for medical electrical systems and with the requirements of local authorities.**

WARNING **Connecting the power supply cord of the computer to the wall power outlet may cause the computer leakage current to exceed the limit specified for medical equipment. A computer must be supplied from an additional**

transformer providing at least basic isolation (isolating or separating transformer).

3.3 Connectors and signals

3.3.1 External connectors

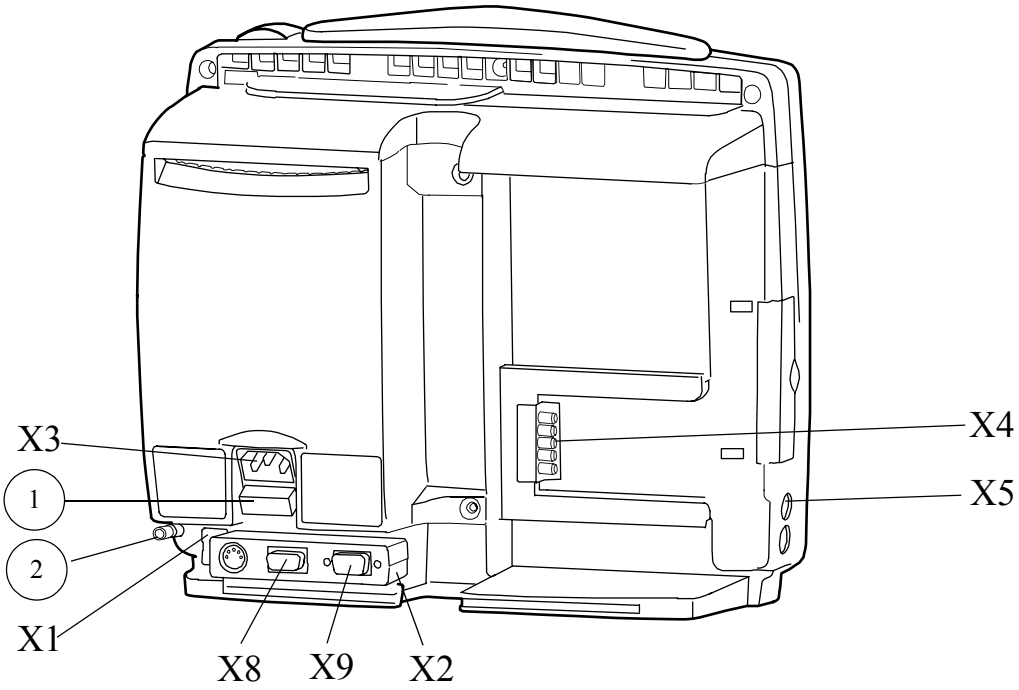
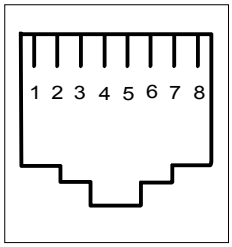


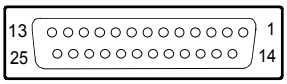
Figure 13 External connectors of Frame for B30

(1) Fuses
(2) Potential equalization connector
X1 NET connector
X2 Multi IO connector
X3 Receptacle for power cord
X4 Module Connector for E-PSM(P)W
X5 Defib & IABP sync connector
X8 NET ID connector
X9 Serial connector

Network connector, X1

RJ45 connector	Pin	Signal
	1 2 3 4 5 6 7 8	Tx + Tx - Rx + N/C N/C Rx - N/C N/C

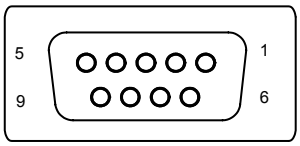
Multi I/O connector X2

25 pin female connector	Pin	Signal
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	GND NET_ID_DO, TTL out. NET_ID_DI, TTL input NET_ID_CLK, TTL out NET_ID_CS, TTL out TXD, RS-232 output RXD, RS-232 input NURSE_CALL, CMOS output reserved Data -, RS-485 I/O CONNECTOR_ID, TTL input EXTDC+, 10-16V, input GND GND Not in use Not in use +5V_OUT, +5V, output CTS#, RS-232 input RTS#, RS-232 output Not in use reserved Data +, RS-485 I/O I/O_VMOD, 13,8 - 16V EXTDC+, 10-16V, input GND

Multi I/O adapter

Figure 14 Multi I/O adapter

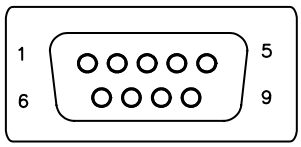
Net ID connector X8

9 pin female connector	Pin	Signal
	1 2 3 4 5 6 7 8 9	NET_ID_CS TTL out NET_ID_CLK TTL out NET_ID_DO TTL out NET_ID_DI TTL input GND +4.75 to +5.25V_out GND (Reserved) Nurse call, CMOS output GND

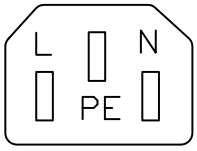
Nurse Call (pin 8)

The nurse call signal is generated by the red and yellow alarms. When activated, the signal is set to the high state and remains at the high state until the alarm situation is over or the SILENCE ALARM key is pressed. The high state range is from 3.5 to 5 V, while the low state range is from 0 to 0.5 V.

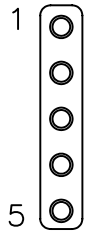
Serial port X9

9 pin male connector	Pin	Signal
	1 2 3 4 5 6 7 8 9	GND RXD, RS-232 input TXD, RS-232 output +4.75 to +5.25V GND N/C RTS#, RS-232 output CTS#, RS-232 input N/C

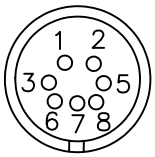
Main power X3

Mains connector	Pin	Signal
	L PE N	Live Protected earth Neutral

Module connector X4

5 pin connector	Pin	Signal
	1 2 3 4 5	GND Vmod 13.8 - 16 V Data + Data - Shield

Defib & IABP sync connector X5

Female mini din7 connector	Pin	Signal
	1 2 3 5 6 7 8	Defib_sync_out Reserved Analog GND Digital GND Blood Pressure Analog out ECG Analog out

DIRECT_ECG: Output signal follows first user lead (ECG1 lead) including augmented leads. If pace is on, there is an enhanced pacer pulse (5 volts at 2 milliseconds) when pacemaker triggering is detected.

In the event of a LEAD FAIL, refer to the following:

Lead Failed	ECG Analog Out
Right arm	III
Left arm	II
Left leg	I
Chest	I

On LEADS OFF situation ECG analog output is flat line (0V).

PRESSURE_OUT: The pressure labeled ART is sent to the analog out. If no pressure is labeled ART, P1 is sent to the analog out. Output is set to flat line (0V) if the pressure channel is not zeroed.

3.3.2 Digital and analog outputs

Digital outputs

There are separate digital outputs. Both signals use TTL-level. The outputs are: Defibrillation Sync. and Nurse Call.

Defibrillation Sync (X5, pin1) indication is generated by ECG. When active, the signal is in state 1. After 10 ms the signal is reset to state 0. New Defibrillation Sync is not generated before the indication is deactivated. The delay from the R wave peak to the start of the signal is maximally 35 ms.

Nurse Call (X8, pin 8) indication is generated by red and yellow alarms. When activated, it is set to state 1 and remains at that state until the alarm situation is over or SILENCE ALARM key is pressed.

The range of state 0 is from 0 to 0.5 V, and the range of state 1 is 3.5 to 5 V.

Analog outputs

The B30 produces two analog real-time signals.

NOTE: When the source of the selected analog output is invalid (e.g. invasive pressure channel is not zeroed), or becomes invalid (e.g. ECG lead is disconnected), the signal on the output is shown as flat line (0 VDC).

Direct ECG (X5, pin 8):

Delay (max.):	15 ms
Gain ECG (out)/ECG (in):	1 V/1 mV ± 10%
Pacer pulse width::	2 ms ± 20%
Pacer pulse amplitude:	5V ± 10%

The signal requires input impedance of 100 kΩ.

Invasive pressure signal (X5, pin 7):

From pressure labelled 'Art'	
Delay (max.):	35ms
Gain Signal (out) / Pressure (in):	10 mV/mmHg
Pressure area	-4 to 320 mmHg

The signal requires input impedance of 100 kΩ.

4 E-PSM(P)W module introduction

The E-PSMW and E-PSMPW modules provide general hemodynamic parameters.

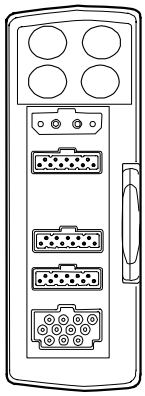


Figure 15 Patient Side Module, E-PSMPW

Table 1 Options of Patient Side Module

Parameter	E-PSMPW	E-PSMW
Two invasive blood pressures	x	
Impedance respiration	x	x
ECG	x	x
Pulse oximetry	x	x
Two temperatures	x	x
NIBP	x	x

4.1 Intended purpose (Indications for use)

The Patient side module E-PSM(P)W is indicated for monitoring of hemodynamic parameters of all hospital patients. The hemodynamic parameters of the module comprise ECG (including ST-Segment and arrhythmia), impedance respiration, oscillometric NIBP (sys/dia/mean), temperature, SpO_2 (including monitoring during conditions of clinical patient motion), and invasive blood pressure. Impedance respiration measurement is indicated for patients ages three years and up. The NIBP measurement is indicated for patients who weight 5kg (11 lb) or up.The E-PSM(P)W is intended for all hospital departments including intra-hospital transport but excluding harsh physical environment like MRI.

4.2 Monitor software compatibility

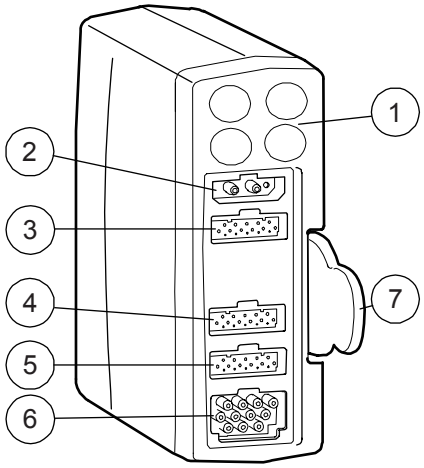
– B30 Patient Monitor using software L-DICU08

4.3 Equipment safety symbols

When displayed on the E-PSM(P)W module, 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

4.4 Main components

4.4.1 E-PSMPW/E-PSMW modules



1. Module keys
2. NIBP connector
3. InvBP connector in E-PSMPW only
4. Temperature connector
5. SpO_2 connector
6. ECG and impedance respiration connector
7. Tab for removing the module

Figure 16 Front panel of E-PSMPW

E-PSMPW and E-PSMW modules contain three main PC boards, the STP board, the ECG board, and the NIBP board. Each of these boards contain a processor and software in the processor flash memory. The boards produce their own supply voltages from the Vmod 13.8-16 V line that is available via the module bus connector. One exception, the NIBP board provides +5V for the ECG and STP board non-isolated side components. The NIBP board provides also the synchronization signal for the ECG and STP board power supplies.

There are two input boards; the STP input board and the ECG input board attached to the front panel of the module. The front panel has five connectors and four keys. There is one connector for two temperature measurements, one for two invasive blood pressure measurements, one for ECG, one for NIBP, and one for SpO_2 measurement. The NIBP connector includes two plungers for NIBP hose identification. The keys are for NIBP Auto On/Off, NIBP Start/Cancel, P1 zero, and P2 zero.

4.4.2 NIBP board

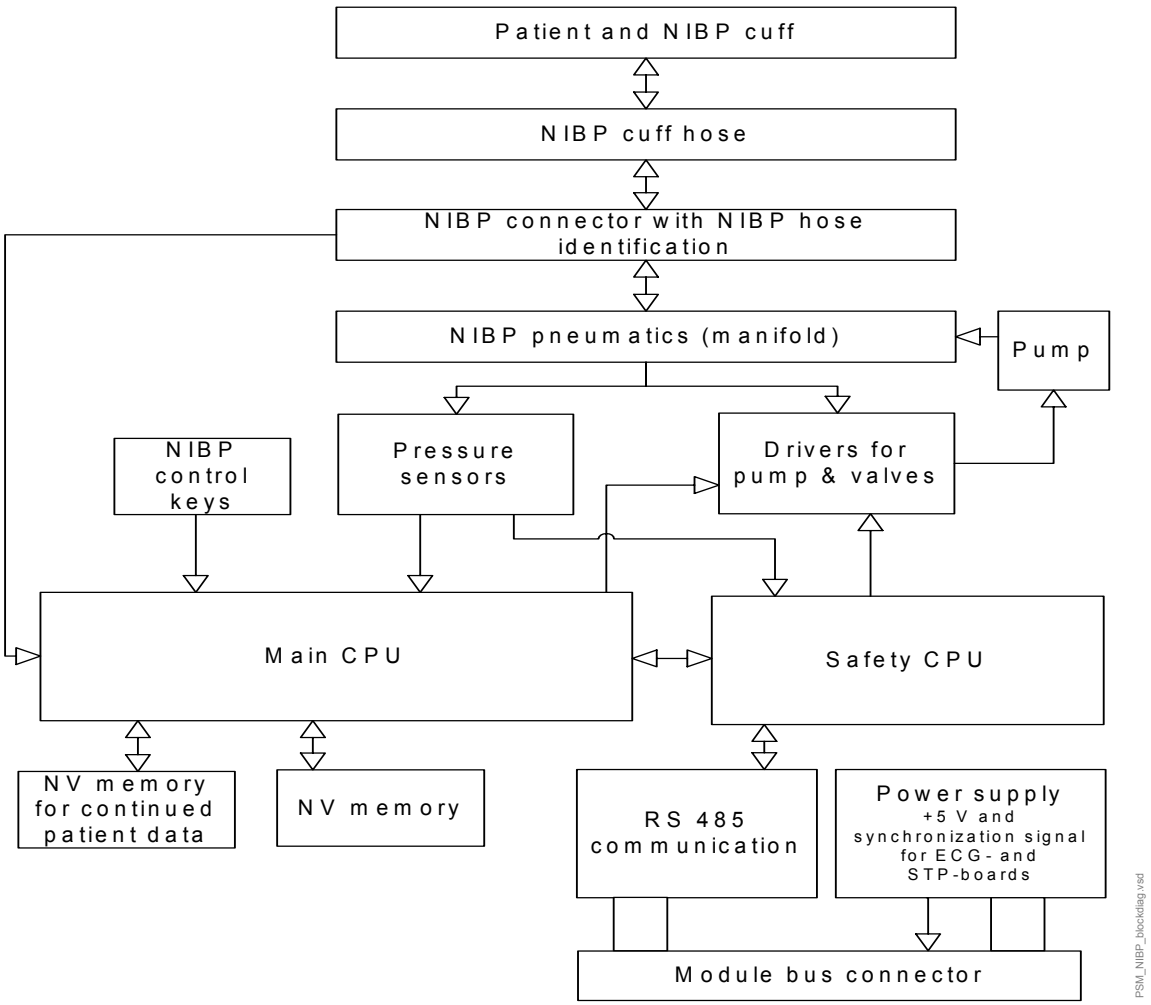


Figure 17 NIBP board functional block diagram

Signal processing

Two signals from the pressure transducers are amplified and sent to the A/D converter. After the converter, digitized signals are sent to the microprocessor for data processing.

The NIBP board is controlled with an H8/3052 microprocessor at 16 MHz oscillator frequency.

Memory

The NIBP program memory (processor flash memory) size is 512k x 8. The processor has 4 kBytes RAM and there is also an external RAM memory, the size of which is 128k x 8. Variable values of the NIBP measurement are stored into the external RAM. The EEPROM size is 512 x 8 and it is used to store the calibration values for the pressure transducers, the pulse valve constants gained during measurements, the PC board identification, and the module serial number.

Software control

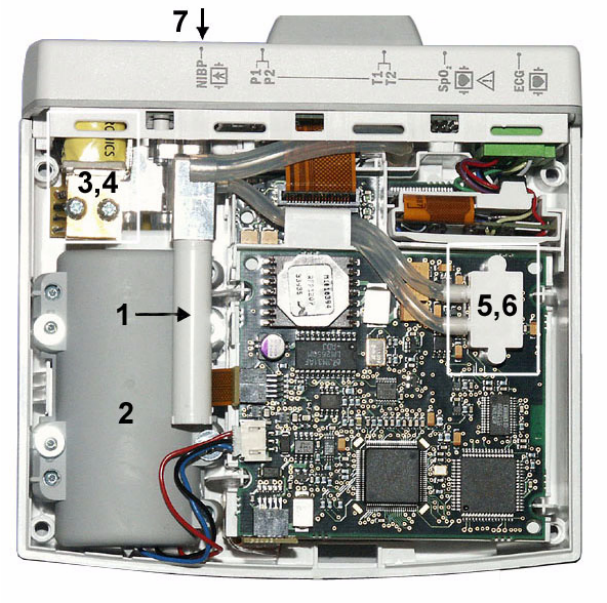
The software controls valves and a pump. In addition to the individual on/off signals for each component there is a common power switch for the valves and the pump that can be used at pump/valve failures.

In addition to external RS485 reset line, the microprocessor system is equipped with its own power-up reset. See the section in the ECG board's description: "RS485 communication"

Safety circuit

The NIBP board is equipped with an independent safety circuit to disconnect supply voltages from the pump and the valves if the cuff has been pressurized longer than the preset maximum measurement time, or if the pressure of the cuff is inflated over the specified pressure limit. The maximum measurement time values and pressure limits for different measurement modes have been specified in the technical specification section of this manual.

Pneumatics



The module has the following pneumatics parts:

1. **Intake air filter**; for preventing dust and other parts from entering the air pump and the valves.
2. **Air pump**; for pumping the measuring pressure of the cuff.
3. **(Pulse) Valve**; for producing a linear pressure fall (bleeding) in order to measure the blood pressure of the patient.
   Note that in the service menu also names **Valve** and **Set valve** have been used for this valve.
4. **Safety valve**; The safety valve is intended to be used for deflating the cuff in single fault case, i.e. to prevent too long a measurement time or too high an inflation pressure of the cuff.
   Note that lso **Exh2 valve** has been used to designate the **Safety valve** in service menu.
5. **Main pressure sensor**; for measuring the pressure of the blood pressure cuff and the pressure fluctuations caused by arterial wall movement.
6. **Safety pressure sensor;** for detecting the , cuff loose, cuff occlusion situations, etc. and for recognizing the pressure sensor fault.
7. **Cuff connector;** for connection and hose identification.

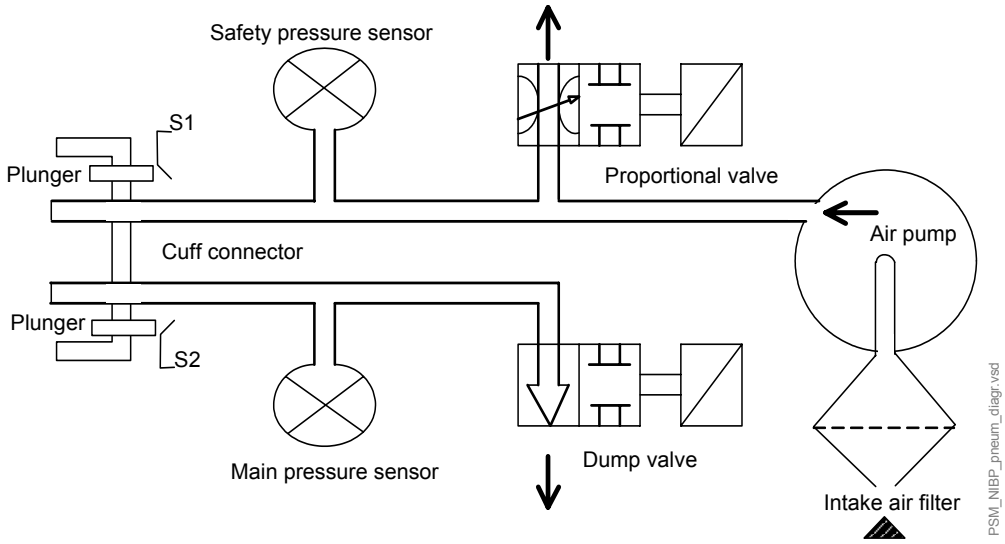


Figure 18 NIBP pneumatics diagram

Power supply section of the NIBP board

All connections are established via a 5-pin connector (female). The module needs a +15 V (dirty) power supply to operate. The supply voltage Vmod 13.8- 16 V is generated in the power supply section of the monitor. The other voltages needed for the operation of the NIBP measurement are made on the NIBP board.

The NIBP power supply synchronizes the ECG and STP isolation power and supplies non-isolated 5 V to the ECG and STP board.

4.4.3 ECG board in 5-lead measurement

The ECG measurement consists of the functions shown in Figure 19. All functions are located in the ECG board except the ECG input unit.

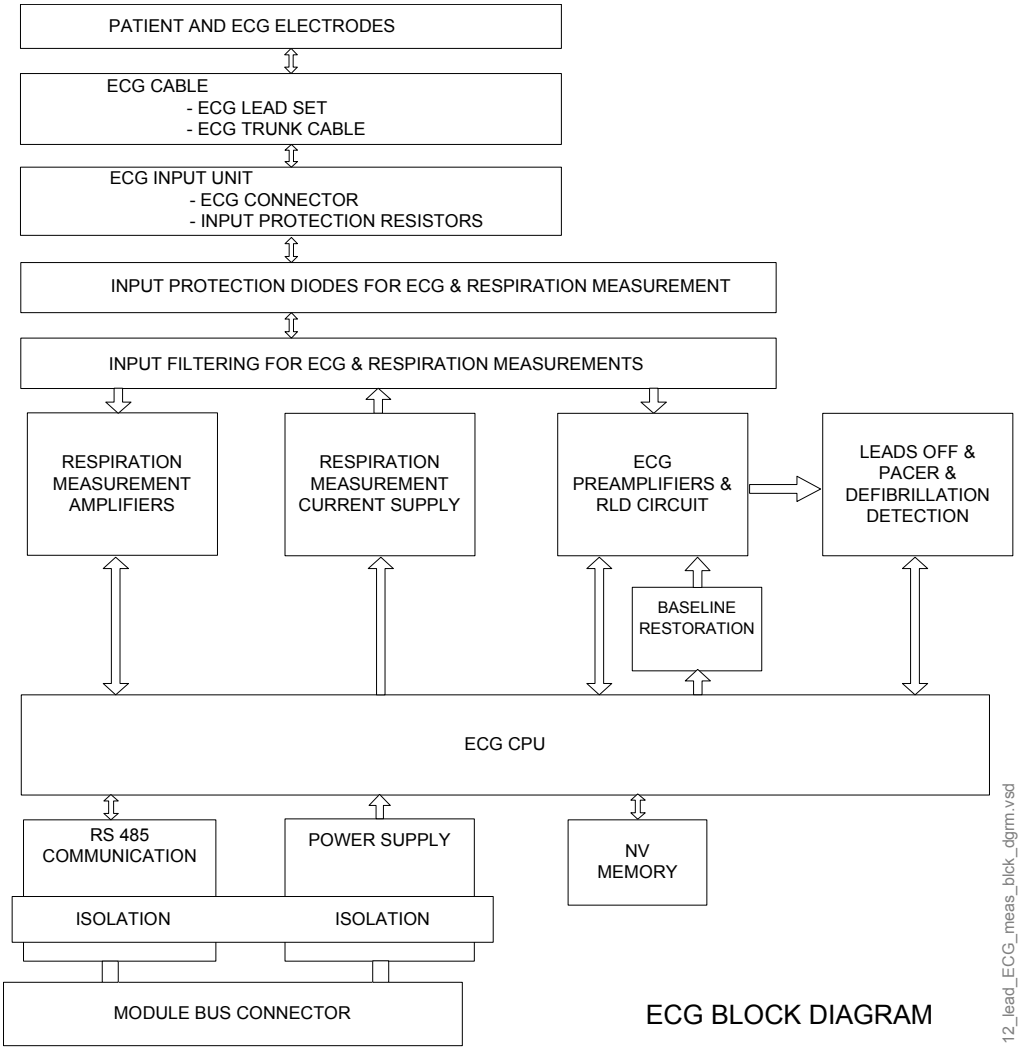


Figure 19 ECG measurement block diagram

ECG input unit

The ECG input unit consists of the front panel connector and the ECG input connector board with the high voltage protection resistors. The connector for the ECG cable is a green 11-pin rectangle shaped connector.

Input protection and filtering

The input protection is implemented with high voltage protection resistors in the ECG input unit and with protection diodes in the ECG board. The input filtering for ECG measurement is done with passive RC filtering.

ECG preamplifiers

The buffer amplifiers are used for each lead. The “Leads off” detection is implemented by measuring the output level of the input buffer amplifiers with the A/D converter of the CPU. The ECG signals are measured using differential amplifiers.

ECG amplifiers and baseline restoration

The function of the ECG amplifiers and baseline restoration is to amplify the signal and to restore the baseline of the signal in the middle of the display after the change of the signal level, e.g. after the change of the DC offset voltage.

Pacer detection

Pacer detection has been made by using four slew rate detector circuits. The pacer detection amplifiers have been realized at the front of the slew rate detectors independently of the ECG measuring channels.

Respiration impedance supply

The 31.25 kHz sine wave generator is used as the respiration measurement signal supply. Analog switches are used for connecting the sine wave to the ECG leads to be measured.

Respiration impedance amplifiers

Buffer amplifiers are used in respiration measurement. Analog switches are used for selecting the measurement leads. There are also additional amplifiers for increasing the respiration signal gain. When ECG measurement is 5-lead, the respiration measurement is always done between R and F, independently on the ECG lead selection. When ECG measurement is 3-lead, then the respiration measurement is happened at the same lead as the ECG measurement (I, II or III).

ECG CPU

The CPU is a 16 bit H8/3052 single-chip microcomputer. It contains 128 kbytes of flash memory and 4 kbytes of RAM. The clock frequency is 16 MHz.

RS485 communication

The communication to the CPU board of the monitor uses RS485 protocol. The RS485 driver circuits are optically isolated from the processor of the module.

Power supply

The ECG board has a driver-controlled half-bridge switching power supply with 5 kV isolation. The supply voltages have been regulated with linear regulators.

4.4.4 ECG filtering

B30 monitors have three ECG filtering modes:

MONITORING	0.5 to 30 Hz (with 50 Hz reject filter) 0.5 to 40 Hz (with 60 Hz reject filter)
DIAGNOSTIC 5-lead ECG	0.05 to 150 Hz
ST FILTER	0.05 to 30 Hz (with 50 Hz reject filter) 0.05 to 40 Hz (with 60 Hz reject filter)

The purpose of filtering is to reduce high frequency noise and low frequency (e.g. respiratory) movement artifacts.

The monitor filter is used in normal monitoring. The diagnostic filter is used if more accurate diagnostic information is needed. The ST filter gives more accurate information of ST segment, but reduces high frequency noise.

The high-pass filters 0.5 Hz and 0.05 Hz are done with software. The monitor sends a command to the hemodynamic module determining which of the corner frequencies 0.5 Hz or 0.05 Hz is to be used.

The 50 Hz and 60 Hz reject filters are both low-pass filters with zero at 50 Hz or 60 Hz correspondingly. They are software based filters used for the mains supply filtering. With these filters the 3 dB value for low-pass filter is 30 Hz or 40 Hz.

In diagnostic mode the upper frequency is 150 Hz and it is limited by software.

4.4.5 STP board

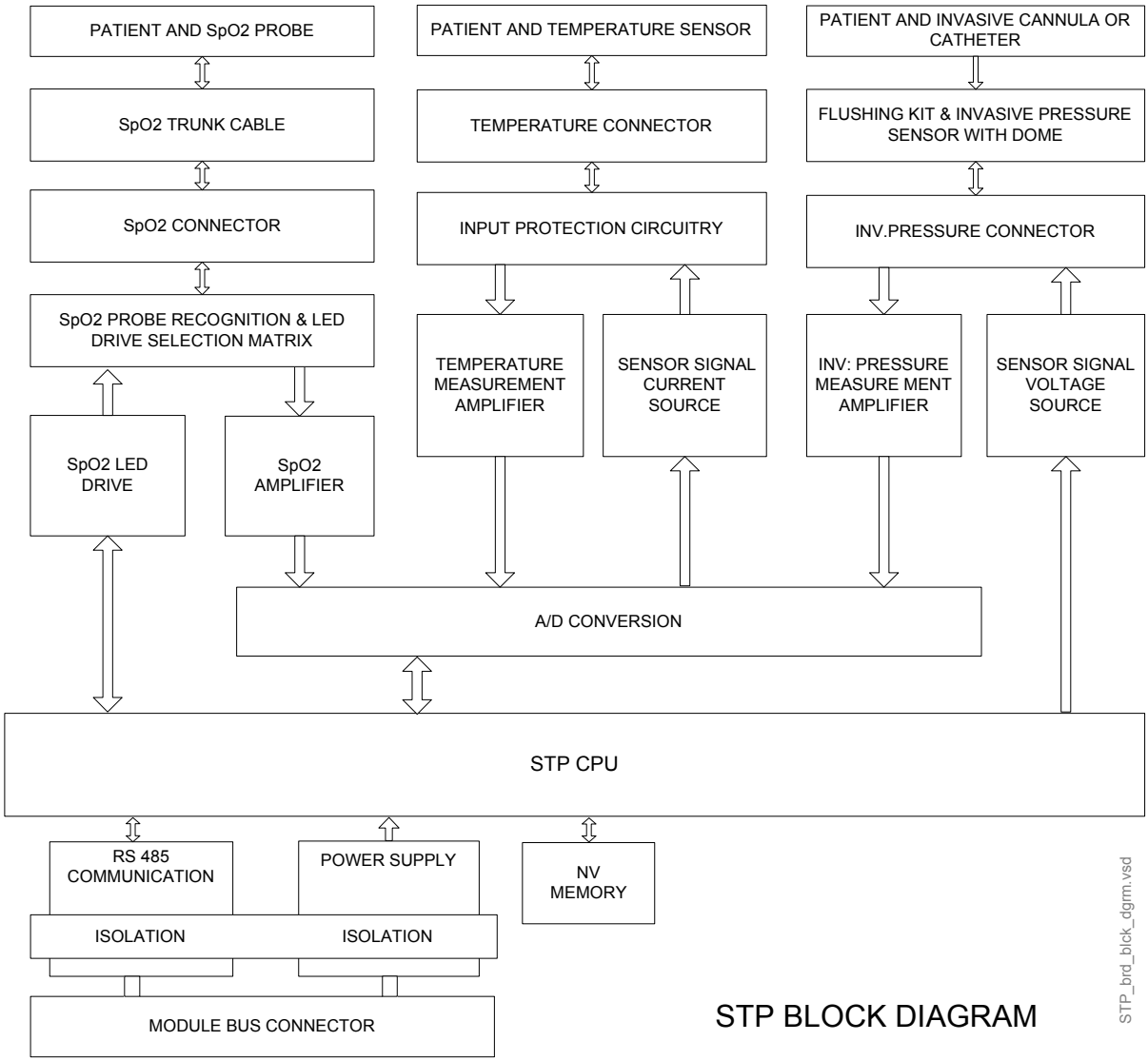


Figure 20 STP board block diagram

Microprocessor unit

The CPU is a 16 bit H8/3052 single-chip microcomputer. It contains 128 kbytes of flash memory and 4 kbytes of RAM. The clock frequency is 16 MHz.

High speed I/O is used to obtain a pulse control sequence necessary for pulse oximetry measurement. Timing for the clock is from the oscillator.

Temperature measurement unit

The NTC-resistor value in the probe depends on the patient's temperature. It is measured with the following principle described below.

The constant current source is supplied about 38 μA current through the temperature sensor (YSI 400-series NTC resistor). The constant current is caused a voltage over the temperature sensor (NTC resistor). The voltage over the temperature sensor is amplified in a differential amplifier stage. The amplified voltage is transferred to a controller of the STP board through an A/D converter.

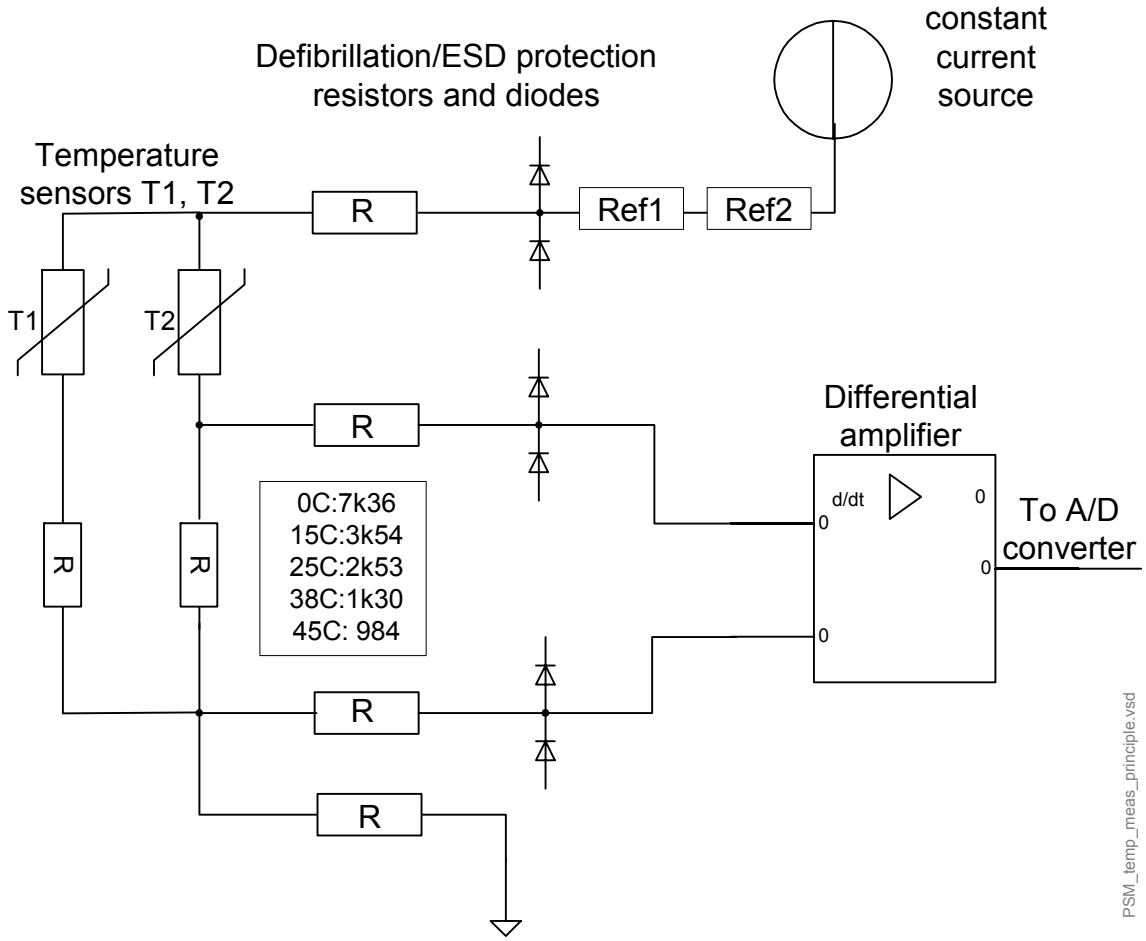


Figure 21 Temperature measurement principle

Invasive blood pressure measurement unit

An isolated +5 V voltage is supplied to the pressure transducer. The differential voltage, which depends on the pressure and the supplied voltage, is calculated from the bridge connection (see the formula below).

$U_{out} = U_{in} \times \text{pressure} \times 5\ \mu V$, where U_{in} is 5 V

$\Rightarrow U_{out} = 25\ \mu V \times \text{pressure [mmHg]}$

Pressure amplification is realized in the instrumentation amplifier. The gain of the amplifier is set to keep the level of the signal transferred to the A/D converter within the measurement range even when there are circumstantial offsets or offsets caused by the transducer. There is a filter before the amplifier to attenuate high frequency disturbances.

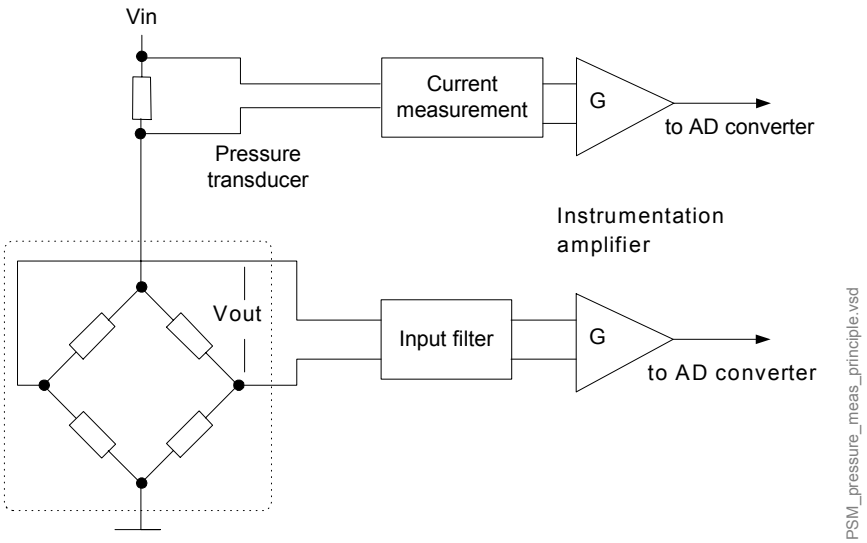


Figure 22 Pressure measurement principle

Pulse oximetry measurement section

LED control signals

The D/A converters of the microcontroller on the STP board set the LED intensity adjustment values for the infrared and red LEDs of the SpO_2 probe. The microcontroller on the STP board switches ON (to the adjusted intensity) and OFF the SpO_2 probe LEDs according to the predetermined sequence.

LED driving circuit

Differential amplifiers measure the LED currents (LED current indication) of the SpO_2 probe over the shunt resistors placed in the LED current paths. The LED driving voltages (LED voltage indication) are measured from the driver circuitry. The LED driving circuits also have MOSFET transistor matrix to enable the use of different probe configurations.

Measured signal preamplification

The preamplifier is a bipolar/single-ended current-to-voltage converter with adjustable gain. A higher gain is used for measuring thin tissue. The preamplification stage has also ambient light reduction and a second amplifier stage.

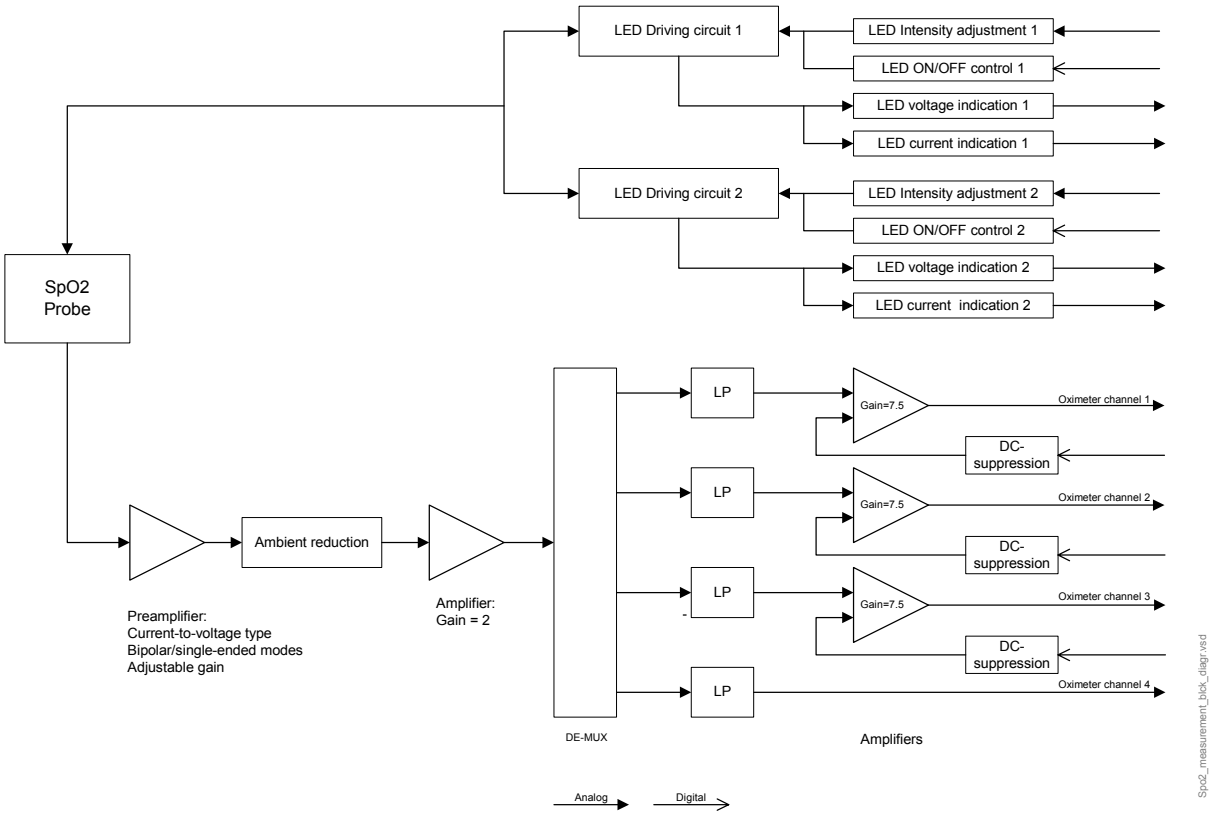


Figure 23 Pulse oximetry measurement block diagram

Red and infrared channel separation

It is possible to multiplex the detector signal to four different channels depending on the content of the signal. The detector signal must at least multiplex into infrared and red signals. Other channels are e.g. for diagnostic purposes.

Serial communication

An RS485 type bus driver makes the serial communication between the module and the frame. The data transmission rate is 500kbps.

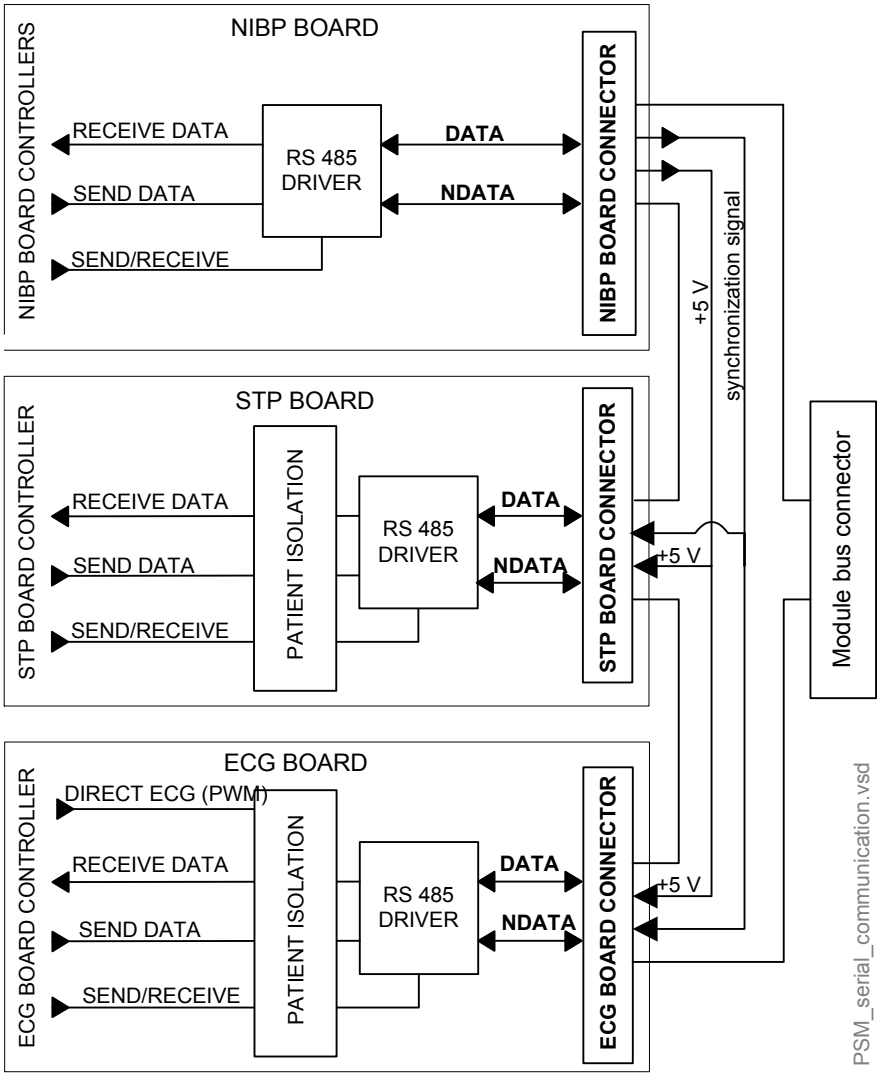


Figure 24 Serial communication of E-PSM(P)W module

Signals and isolation barrier

The communication signals transfer over the isolation barrier by using high isolation voltage (6kV) opto isolators.

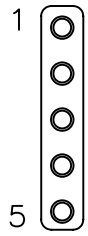
Power supply section

The power for the electronics on the floating part of the STP and the ECG boards is made on each board with the switching power supplies connected to a high voltage isolated transformer. The switching power supplies on the STP and ECG boards are synchronized to the frequency, about 340kHz of the switching power supply on the NIBP board. The NIBP board supplies non-isolated 5 V to the ECG and STP boards. The module uses only Vmod 13.8 - 16 V voltage of the frame. The other voltages of the measuring boards are made by the switching power supplies and regulators or the linear regulators. Each measuring board is protected against overloading with PTC type automatic fuses.

4.5 Connectors and signals

4.5.1 Module bus connector

Table 2 Module bus connector description

5 pin connector	Pin No.	Signal
	1 2 3 4 5	GND Vmod 13.8 - 16 V Data + Data - Shield

4.5.2 Front panel connectors

Table 3 ECG connector

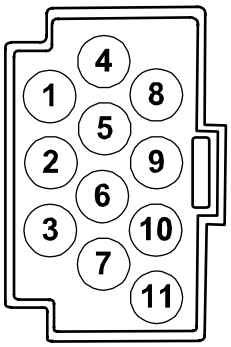
ECG Connector	Pin No.	Signal Name
	1 2 3 4 5 6 7 8 9 10 11	R/RA; Right arm electrode C2/V2; Chest electrode C3/V3; Chest electrode L/LA; Left arm electrode N/RL; Neutral/Right Leg Drive electrode C1/V1; Chest electrode C4/V4; Chest electrode F/LL; Left Leg electrode C6/V6; Chest electrode C5/V5; Chest electrode Cable Shield

Table 4 SpO_2 connector

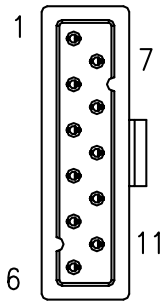
SpO_2 connector	Pin No.	Signal	Description
	1	DET_A	Photodiode anode
	2	DET_C	Photodiode cathode
	3	DATA-	
	4	Wire 1/3	LED connection
	5	IR_C	IR LED cathode
	6	OUTER SHIELD	
	7	DET_SHIELD	
	8	PRB_ID	Bin/ID Resistor+
	9	Wire 3/5	LED Connection
	10	RED_C	RED LED cathode
	11	DATA+	

Table 5 Invasive blood pressure connectors (P1, P2)

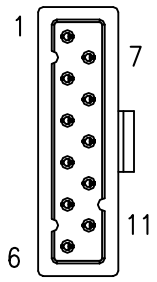
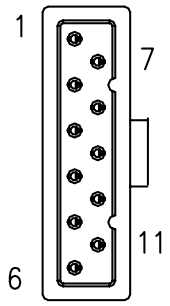
Invasive blood pressure connectors (Dual BP)	Pin No.	Signal	Description
	1	BP_+V_{REF}	BP transducer excitation voltage, channel 1
	2	BP SIG+	BP transducer signal positive (+), channel 1
	3	BP_+V_{REF}	BP transducer excitation voltage, channel 2
	4	AGND	Analog ground
	5	BP SIG+	BP transducer signal positive (+), channel 2
	6	SHIELD	BP cable shield
	7	AGND	Analog ground
	8	BP SIG1	BP transducer signal negative (-), channel 1
	9	BP SIG2	BP transducer signal negative (-), channel 2
	10	BP1_ID	BP1 probe identification
	11	NC	Not connected

Table 6 Temp connector (T1, T2)

Temp connector	Pin No	Signal
	1	Sensor drive current
	2	Input from temperature sensor, channel 1
	3	Not connected
	4	Not connected
	5	Thermistor ID (LOW= Temperature error, HIGH=YSI 400 series)
	6	Cable shield
	7	Analog ground
	8	Input from temperature sensor, channel 2
	9	Not connected
	10	Not connected
	11	Digital ground

4.6 Measurement principle

4.6.1 NIBP

NIBP (Non-Invasive Blood Pressure) is an indirect method for measuring blood pressure.

The NIBP parameter conforms to EN 1060-1:1995 Specification for Non-invasive sphygmomanometers.

The NIBP measurement is performed according to the oscillometric measuring principle. The cuff is inflated with a pressure slightly higher than the presumed systolic pressure, and deflated at a speed based on the patient's pulse, collecting data from the oscillations caused by the pulsating artery. Based on these oscillations, values for systolic, mean, and diastolic pressures are calculated.

The following parts are necessary for the NIBP measurement:

- E-PSM(P)W module
- twin hose (adult or infant model)
- blood pressure cuffs (various sizes)

4.6.2 ECG

Electrocardiography analyzes the electrical activity of the heart by measuring the electrical potential produced with electrodes placed on the surface of the body.

ECG reflects:

- electrical activity of the heart
- normal/abnormal function of the heart

- effects of anesthesia on heart function
- effects of surgery on heart function

See the “User's Guide” or the “User’s Reference Manual” for electrodes’ positions and other information.

4.6.3 Pulse oximetry

A pulse oximeter measures the light absorption of blood at two wavelengths, one in the near infrared (about 940 nm) and the other in the red region (about 660 nm) of the light spectrum. These wavelengths are emitted by LEDs in the SpO_2 probe, the light is transmitted through peripheral tissue and is finally detected by a PIN-diode opposite the LEDs in the probe. The pulse oximeter derives the oxygen saturation (SpO_2) using an empirically determined relationship between the relative absorption at the two wavelengths and the arterial oxygen saturation SaO_2.

In order to measure the arterial saturation accurately, pulse oximeters use the component of light absorption giving variations synchronous with heart beat as primary information on the arterial saturation.

A general limitation of pulse oximetry is that due to the use of only two wavelengths, only two hemoglobin species can be discriminated by the measurement.

The modern pulse oximeters are empirically calibrated either against fractional saturation SaO_2frac;

$$SaO_2frac = \frac{HbO_2}{HbO_2 + Hb + Dyshemoglobin}$$

Formula 1

or against functional saturation SaO_2func;

$$SaO_2func = \frac{HbO_2}{HbO_2 + Hb}$$

Formula 2

Functional saturation is more insensitive to changes of carboxyhemoglobin and methemoglobin concentrations in blood.

The oxygen saturation percentage SpO_2 measured by the Datex-Ohmeda module is calibrated against functional saturation SaO_2func. The advantage of this method is that the accuracy of SpO_2 measurement relative to SaO_2func can be maintained even at rather high concentrations of carboxyhemoglobin in blood. Independent of the calibration method, pulse oximeters are not able to correctly measure oxygen content of the arterial blood at elevated carboxyhemoglobin or methemoglobin levels.

Plethysmographic pulse wave

The plethysmographic waveform is derived from the IR signal and reflects the blood pulsation at the measuring site. Thus the amplitude of the waveform represents the perfusion.

Pulse rate

The pulse rate calculation is done by peak detection of the plethysmographic pulse wave. The signals are filtered to reduce noise and checked to separate artifacts.

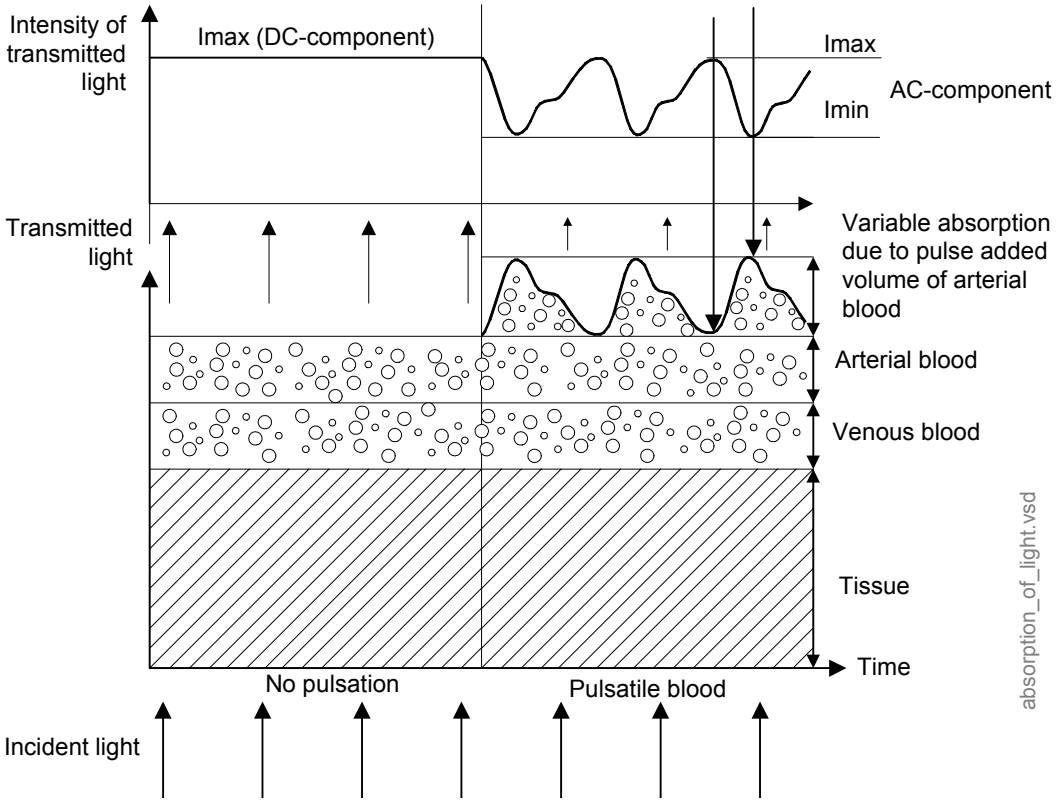


Figure 25 Absorption of infrared light in the finger

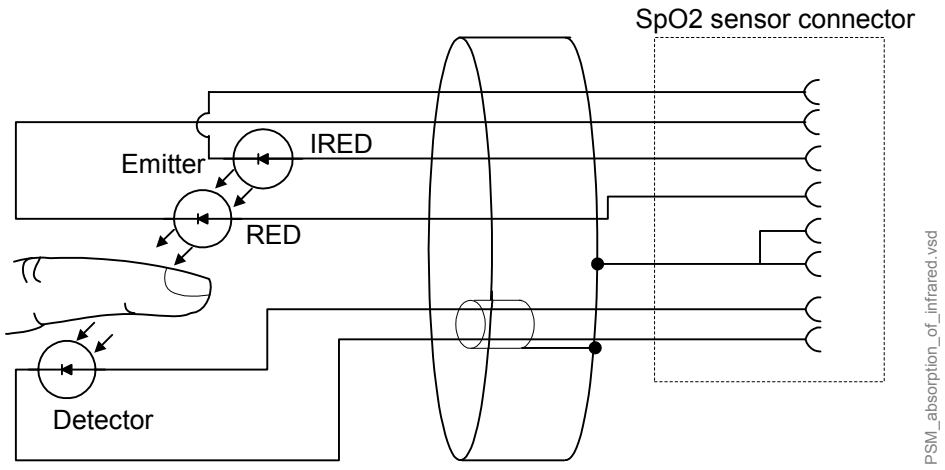


Figure 26 Pulse oximetry probe parts layout and schematic diagram

The standard probe is a finger clamp probe which contains the light source LEDs in one half and the photodiode detector in the other half. Different kinds of probes are available from GE Healthcare.

4.6.4 Temperature

The temperature is measured by a probe whose resistance varies when the temperature changes, called NTC (Negative Temperature Coefficient) resistor.

The resistance can be measured by two complementary methods:

- Applying a constant voltage across the resistor and measuring the current that flows through it.
- Applying a constant current through the resistor and measuring the voltage that is generated across it.

E-PSM(P)W module uses the constant current method. The NTC-resistor is connected in series with a normal resistor and a constant current is applied through them. The temperature dependent voltage can be detected at the junction of the resistors, thus producing the temperature signal from the patient. The signal is amplified by analog amplifiers and further processed by digital electronics.

4.6.5 Invasive blood pressure

To measure invasive blood pressure, a catheter is inserted into an artery or vein. The invasive pressure setup, consisting of a connecting tubing, a pressure transducer, an intravenous bag of normal saline, all connected together by stopcocks, is attached to the catheter. The transducer is placed at the same level with the heart, and is electrically zeroed.

The transducer is a piezo-resistive device that converts the pressure signal to a voltage. The monitor interprets the voltage signal so that pressure data and pressure waveforms can be displayed.

4.6.6 Respiration

Impedance respiration is measured across the thorax between ECG electrodes. The respiration signal is made by supplying current between the electrodes and by measuring the differential current from the electrodes. The signal measured is the impedance change caused by breathing. The respiration rate is calculated from these impedance changes, and the respiration waveform is displayed on the screen.

2 Installation

1 System installation

1.1 Unpacking instructions

1. Confirm that the packing box is undamaged. If the box is damaged, contact the shipper.
2. Open the top of the box and carefully unpack all components.
3. Confirm that all components are undamaged. If any of the components is damaged, contact the shipper.
4. Confirm that all components are included. If any of the components is missing, contact your GE Healthcare distributor.

1.2 Choosing location

Consider the following aspects:

- lighting
- space
- connections
- electromagnetic and radio frequency interference. For details see Appendix B. ElectroMagnetic Compatibility
- environment

WARNING **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.**

CAUTION The monitor display is fragile. Ensure that it is not placed near a heat source or exposed to mechanical shocks, pressure, moisture or direct sunlight.

1.3 Mounting the B30

Mounting of B30 to the Wall Mount, Rollstand, Wall Mount with standard arm or Counter Top Mount is described in a separate instruction sheet delivered with each mount.

WARNING **After transferring or reinstalling the monitor, always check that it is properly connected and all parts are securely attached. Pay special attention to this in case of stacked mounting.**

WARNING **The monitor must not be used without a manufacturer approved mounting attached.**

WARNING **Never install the monitor so that it is above the patient.**

1.3.1 E-PSM(P)W Mounting Accessories

Intended use

The Module Bus Adapter for PSMW is intended for connecting the Pole Mount for PSMW to the B30 monitor.

With Module Bus Adapter, the Pole Mount for PSMW, short or long, can be connected to the B30 monitor . The E-PSM(P)W module can be removed from the B30 monitor and docked to the Pole Mount for PSMW, short or long.

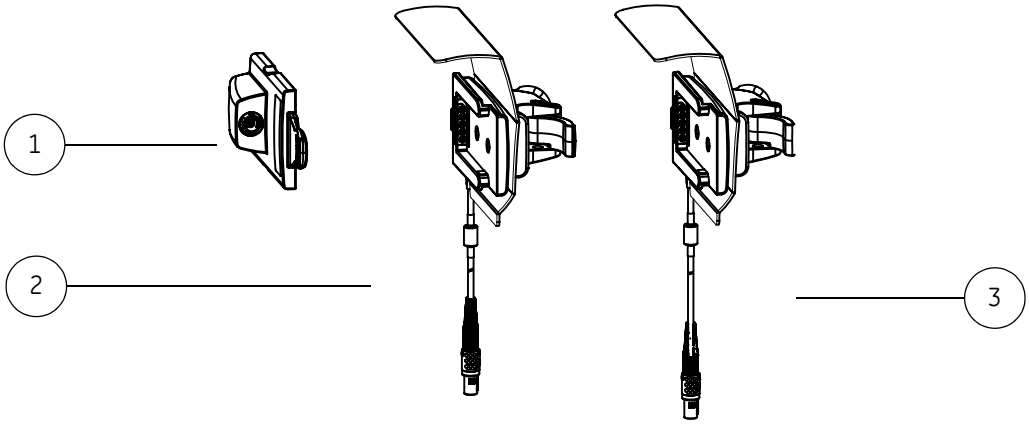
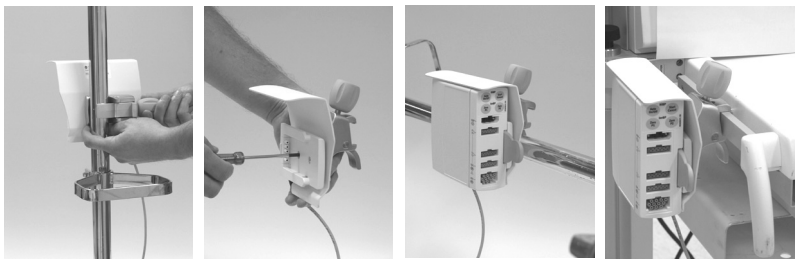


Figure 3 E-PSM(P)W mounting accessories

1. M1051025 Module Bus Adapter for
2. M1049197 Pole Mount for , short
3. M1051023 Pole Mount for , long

WARNING **Make sure that the Pole Mount for PSMW is always used in vertical position to prevent water from entering the E-PSM(P)W module.**

Pole Mount for PSMW – Instructions for connecting to an IV pole, vertical position

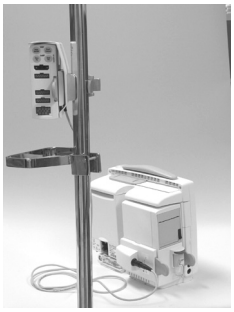


Fasten the Pole Mount for PSMW with the fastening screw of the clamp and tighten properly to an IV pole.

Pole Mount for PSMW - Instructions for installing in horizontal position.

Remove the 2 screws from the clamp, turn the clamp and insert and tighten the screws back. Fasten the Pole Mount for PSMW with the fastening screw of the clamp and tighten properly to a horizontal tube or rail with a diameter of 10 mm*25 mm.

Pole Mount for PSMW – Instructions for connecting to monitor



1. Attach the E-PSM(P)W module to the Pole Mount.
2. Connect the cable of the Pole Mount for PSMW to the B30 monitor with the Module Bus adapter for PSMW (2042772-001).
3. Check the module communication of the E-PSM(P)W module.

1.4 Monitor connections

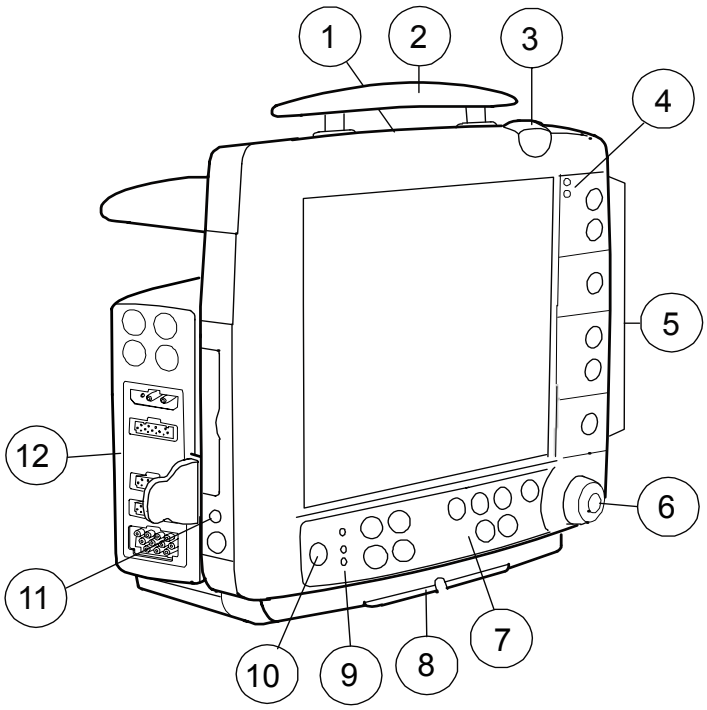


Figure 4 B30 font panel

(1) Battery compartment
(2) Transportation handle
(3) Alarm light
(4) Alarm LED indicators
(5) Side panel keys
(6) The ComWheel
(7) Command Board keys
(8) Guide rail for GCX mounting
(9) Mains power and battery LEDs
(10) ON/standby key
(11) Connector for defibrillator synchronization (X5)
(12) Measurement modules

You can use one E-PSM(P)W and/or one N-F(C)(REC) module in the monitor at a time.

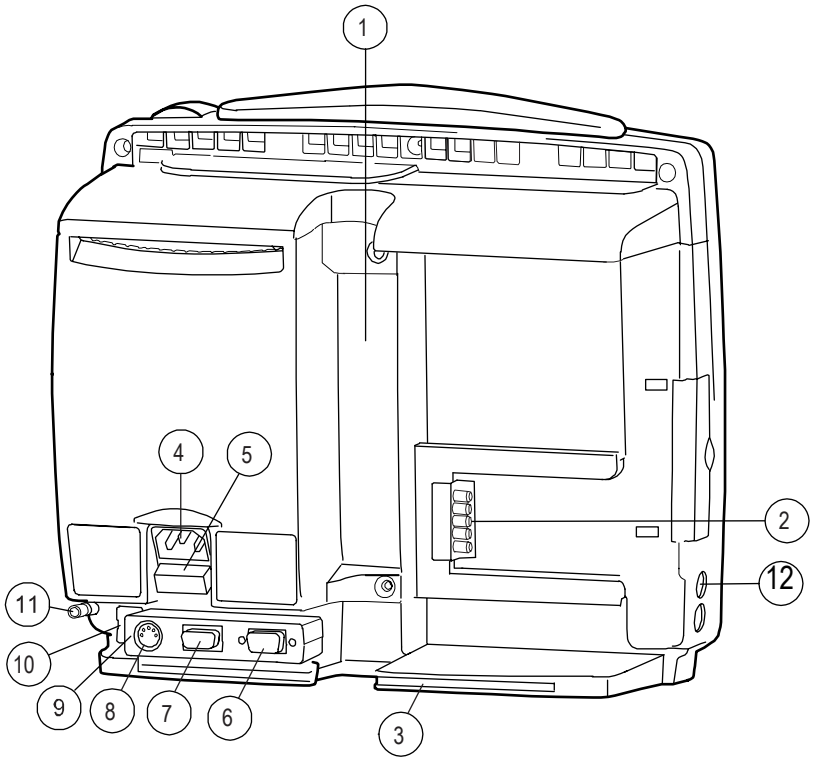


Figure 5 Rear panel connections

(1) Slot for infusion pole mounting
(2) Module connector
(3) Guide rail for GCX mounting
(4) Receptacle for power cord
(5) Fuse holder
(6) Serial port X9
(7) Network ID X8
(8) Connector for future use X7
(9) Optional: Multi I/O adapter incorporating connectors 6 - 8 mentioned above
(10) Network connector X1
(11) Equipotential connector
(12) Defibrillator & IABP sync connector X5

1.5 Connection to mains

Connect the power cord to the mains power inlet (4) at the back of the monitor and to the wall socket.

NOTE: Before taking the monitor into use for the first time, the batteries should be fully charged. Keep the monitor connected to the mains until the Battery charging symbol disappears, or in STBY mode the Orange Battery condition LED is off (may take up to 5 hours if the batteries are fully discharged).

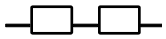
Battery charging

WARNING **The power cord may only be connected to a three-wire, grounded, hospital grade receptacle.**

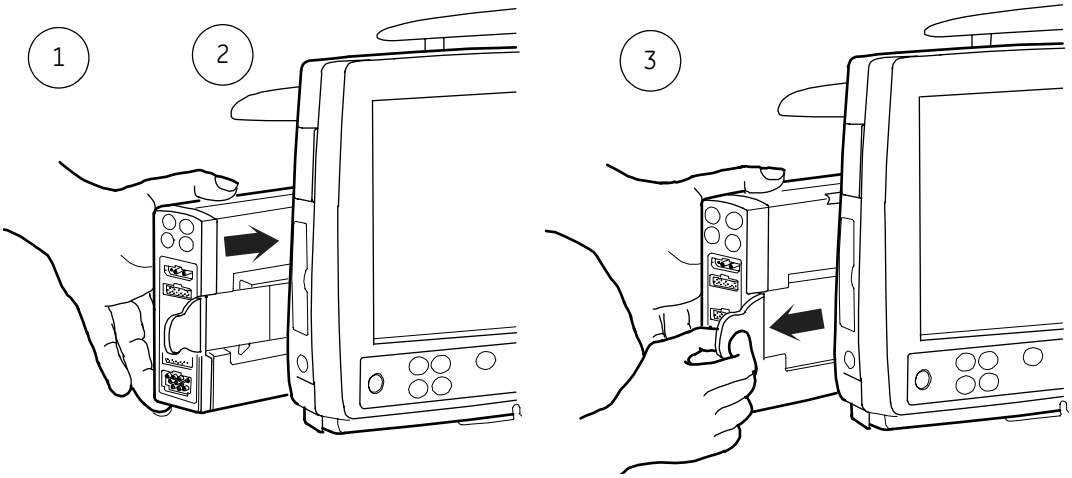
1.5.1 Connection to Network

Use the CAT-5 cable to connect the monitor to the network.

1. Make sure that the power is switched off.
2. Connect the Identification Plug to connector X8; one RJ-45 connector to connector X1 at the back of the monitor.
3. Connect the other RJ-45 connector to the corresponding connector on the wallbox.
4. Switch on the power. Confirm that the network symbol and 'Connected to Network' message are displayed in the upper part of the screen.



1.5.2 Inserting and removing the parameter modules



1. Align the module with the insertion guides
2. Push the module into the monitor frame until it stops.
3. Pull the module outwards. Make sure not to drop it when it comes out.

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

NOTE: Only one E-PSM(P)W module and one N-F(C)(REC) module can be attached to B30.

NOTE: If you want to install both modules, you must install the Extension Module, (N-F(C)(REC) first and attach the E-PSM(P)W module to it.

1.6 Functional check

Refer to the 3. Functional check in Chapter 3 for procedure.

1.7 Visual indicators

Function	Specification	Explanation
External power supply	Green LED	Indicates when monitor is powered from mains or ext. DC
Battery operation	Green LED	Indicates when monitor is powered from internal batteries
Battery condition	Orange LED	Indicates when monitor is charging batteries (solid) or battery failure (flashing).
Alarm LEDs	Red LED	Indicates a life threatening situation
	Yellow LED	Indicates serious but not life threatening problems
Alarm Light	Highly visible Red/ Yellow light	Ease alarm detection from distance. Brightness of the light and enabling the alarm light function are user configurable.

3 Maintenance

1 Instructions

1.1 Introduction

These instructions include procedures of system maintenance for the B30. It's include four sections:

- Electrical safety tests.
- Functional check, which is the quick guide for service check.
- Planned maintenance, which should be performed once a year. It's also the detailed introduction for B30 maintenance.
- Adjustments and calibrations

NOTE: Please filled in the check form when performing the corresponding procedures.

NOTE: For the N-FC(REC) module's maintenance and calibrations, please refer to "8. N-F(C)(REC) Module" or *"S/5 Extension Module for FM, N-FC, N-FCREC, N-FREC Technical Reference Manual Slot"* M1022498-5.

The symbol  in the instructions means that the procedure performed should be signed in the check form.

The procedures should be performed in ascending order, bypassing those that are not applicable for a particular monitor.

All menu selections related to the monitor are written in the following typeface:

e.g. ***Parameters - Gas Unit***

As you enter the service menus, you need following passwords:

Monitor Setup - *Install/Service* (password 16-4-34) **- *Service*** (password 26-23-8)

In case you evaluate the measurement accuracy with a patient simulator, add the simulator's accuracy specification to the one for the monitor.

CAUTION Failure on the part of all responsible individuals, hospitals or institutions, employing the use of this device, to implement the recommended maintenance schedule may cause equipment failure. The manufacturer does not, in any manner, assume the responsibility for performing the recommended maintenance schedule, unless an equipment maintenance agreement exists. The sole responsibility rests with the individuals, hospitals, or institutions utilizing the device.

CAUTION Only trained personnel with appropriate equipment should perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

CAUTION Wear a static control wrist strap when handling PC boards. Electrostatic discharge may damage components on the board.

1.2 Recommended tools

NOTE: Use only properly maintained, calibrated and traceable measurement equipment for the specified calibrations and adjustments to ensure accuracy.

Table 1 Recommended tools

For product(s)	Tool	Order No.
Hemodynamic modules		
E-PSM(P)W	NIBP cuff and adult NIBP cuff hose with cuff ID	2753E (cuff) 2020980-001 (hose)
	Pressure manometer	
E-PSM(P)W	Infant cuff hose with cuff ID	2017009-001
E-PSMPW	InvBP transducer	70077-001
	Multi-Link ECG accessories, IEC	
E-PSM(P)W	- Multi-link 3-lead integrated cable and leadwire	2021141-002
	- Multi-link 5-leadwire set	414556-006
	- Multi-link 3/5-lead ECG trunk cable	2017003-001
or	**Multi-Link ECG accessories, AHA**	
E-PSM(P)W	- Multi-link 3-lead integrated cable and leadwire	2021141-001
	- Multi-link 5-leadwire set	414556-003
	- Multi-link 5-lead ECG trunk cable	2017003-001
E-PSM(P)W	SpO_2 finger probe	OXY-F-UN
	SpO_2 Interconnect Cable	OXY-ES3
E-PSM(P)W	Temperature dual cable	2016998-001
	Temperature probe	M1024254
Airway modules		
N-FC(REC)	CO_2 Sampling line 3m/10 ft	733163
All modules	Torx screwdrivers; T8, T10	

NOTE: For details on recommended accessories see “Supplies and Accessories“ catalog.

Table 2 Patient simulators' compatibility with each hemodynamic module

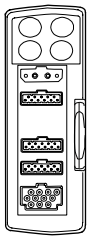
Module	Parameter	Patient simulator		
		M1010831	**MedSim**	**Lionheart & MPS450**
E-PSM(P)W, 	ECG	Cable included	Multilink ECG acc.	Multilink ECG acc.
	T	2016998-001	2016998-001and M1010832	2016998-001 and M1010846
	InvBP	Cable included	M1010858 and 2005772-001	M1010862 and 2005772-001

Table 3 Adapter cables for hemodynamic patient simulators

Patient simulator		
Hemodynamic patient simulator	Dual temperature adapter cable	2016998-001
Hemodynamic patient simulator	Dual Inv.BP adapter cable	2005772-001
Medsim	Temperature adapter cable	M1010832
Medsim	Inv.BP adapter cable	M1010858
Lionheart & MPS450	Temperature adapter cable	M1010846
Lionheart & MPS450	Inv.BP adapter cable	M1010862

Table 4 Recommended parts

Part	**Order No.**	**Notes**
NIBP pump filter	57142	

2 Electrical Safety Tests

2.1 General

Electrical safety tests provide a method of determining if potential electrical health hazards to the patient or operator of the device exist.

2.2 Recommendations

GE recommends that you perform all safety tests presented in this chapter.

- Upon receipt of the device (monitor and its associated equipment).
- Every twelve months thereafter planned maintenance
- Each time the main enclosure is disassembled or a circuit board is removed, tested, repaired, or replaced

These instructions are intended for every component in the system. GE recommends that the qualified personnel performing the tests.

2.3 Test Equipment

The recommended test equipment required to perform electrical safety tests is listed below.

Item	Specification
Leakage Current Tester	Equivalent to the circuits shown
Digital Multimeter (DMM) (optional based on leakage tester used and locality)	AC volts, ohms
Ground Bond Tester	0 – 1 ohm
ECG Test Body	All leads together
GE and Nellcor SPO2 Test Body	2006646-001

Perform electrical safety tests using an electrical safety analyzer per IEC 60601-1, UL 60601-1, EN 60601-1 or CSA C22.2 No. 601.1. The schematics in the section provide a general understanding of the test equipment. Actual configuration of test equipment may vary.

The patient monitor being tested should be placed on an insulating surface.

2.4 Power Outlet Test

Verify that the power outlet is wired correctly per the countryís electrical code standard before starting the following electrical safety tests. The results of the following tests will be inaccurate unless a properly wired power outlet is used. Use only non-isolated power outlets when performing safety tests.

2.5 Power cord and plug

Verify the power cord being used with the patient monitor is good. The following are a couple of things to check for in this regard:

- Failure of the power cord strain relief is very common. Often times users of the equipment pull on the power cord itself, rather than the power cord plug, to unplug the patient monitor from a wall receptacle. If in doubt, test for continuity through each conductor of the power cord connector and plug.
- Verify line, neutral, and earth conductors are properly connected to the power cord plug and are not short-circuited. Replace the power cord, as necessary with a regulatory-approved cord for the country of use.

WARNING **Use only AC power cords recommended or manufactured by GE.**

2.6 Ground (Earth) Integrity

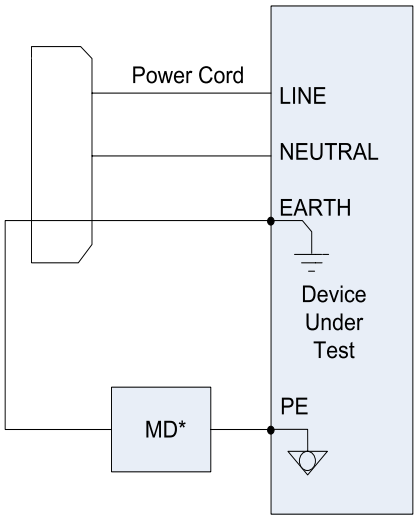
Listed below are two methods for checking the ground (earth) integrity, "Ground Continuity Test" and "Impedance of Protective Earth Connection." These tests determine whether the device's exposed metal and power inlet's earth (ground) connection has a power ground fault condition

Perform the in accordance with your local regulations.

2.6.1 Ground Continuity Test

Refer to the instructions contained with the safety analyzer to perform each test.

The measuring device (MD) in the diagram below may be a DMM or part of a safety analyzer.



NOTE: The measuring device (MD) represents the network and voltage measuring instrument and its frequency characteristics per IEC 60601-1.

2.6.2 Impedance of Protective Earth Connection

This test, unlike a ground continuity test, will also stress the ground system by using special ground bond testers.

This test normally is only required as a manufacturing production test to receive safety agency compliance. Some country agencies do require this test after field equipment repairs (e.g., Germany's DIN VDE 0751 standards). Consult your country/local safety agency if in question.

Compliance is checked by the following steps:

(1) A current of 25A from a current source with a frequency of 50 or 60 Hz with a no-load voltage not exceeding 6 V is passed for at least 5 seconds, but no more than 10 seconds, through the protective earth terminal or the protective earth pin in the mains plug and each accessible metal part which could become live in case of failure in basic insulation.

(2) 2. The voltage drop between the parts described is measured and the impedance determined from the current and voltage drop. It shall not exceed the values indicated.

When taking this measurement, move the unitís power cord around. There should be no fluctuations in resistance.

2.6.3 Acceptance criteria

For equipment without a power supply cord, the impedance between the earth terminal of the (IEC 60320) AC inlet receptacle and the protective earth (PE) terminal (or any accessible metal part which is protectively earthed) shall not exceed 0.1 ohms.

For equipment with a power supply cord, the impedance between the protective earth pin in the mains plug and any accessible metal part which is protectively earthed shall not exceed 0.2 ohms.

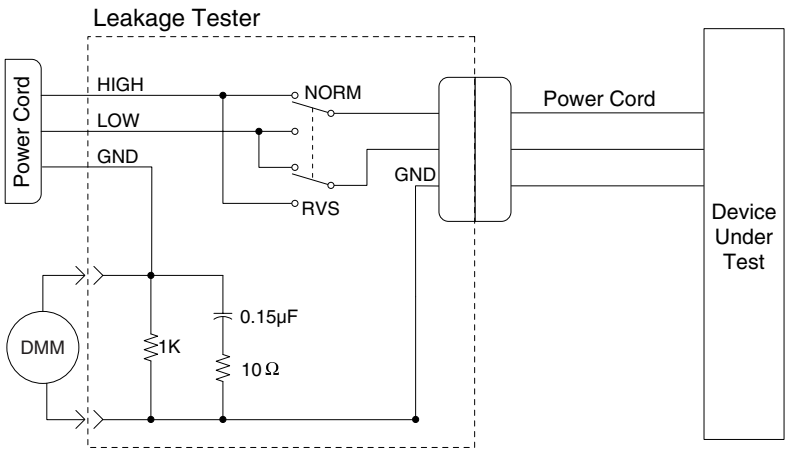
2.7 Ground (earth) wire leakage current tests

Perform this test to measure current leakage through the ground (earth) wire of the equipment during normal operation.

(1) Refer to the instructions contained with the safety analyzer to perform this test.

(2) Configure leakage tester as follows:

- Polarity - NORMAL
- Neutral - CLOSED
- GND (Earth) - CLOSED



DMM set to measure AC voltage

NOTE: The measuring device (MD) represents the network and voltage measuring instrument and its frequency characteristics per IEC 60601-1.

(3) Read and record the current leakage indicated on the tester.

(4) Change leakage tester switches to:

- Polarity - NORMAL

- Neutral - OPEN
- GND (Earth) - CLOSED

(5) Read and record the current leakage indicated on the tester.

(6) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(7) Read and record the current leakage indicated on the tester.

(8) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(9) Read and record the current leakage indicated on the tester.

If measured reading is greater than the appropriate specification below, the device under test fails. Contact GE Technical Support.

2.7.1 Acceptance criteria NC (Normal condition)

- (USA only) 300 µA, and the device under test is powered from 100-120 V/50-60 Hz
- (USA only) 300 µA, and the device under test is powered from a center-tapped 200-240 V/50-60 Hz, single phase circuit (UL Split Phase Exemption)
- 500 µA, and the device under test is powered from a non-centertapped, 200-240 V/50-60 Hz, single-phase circuit

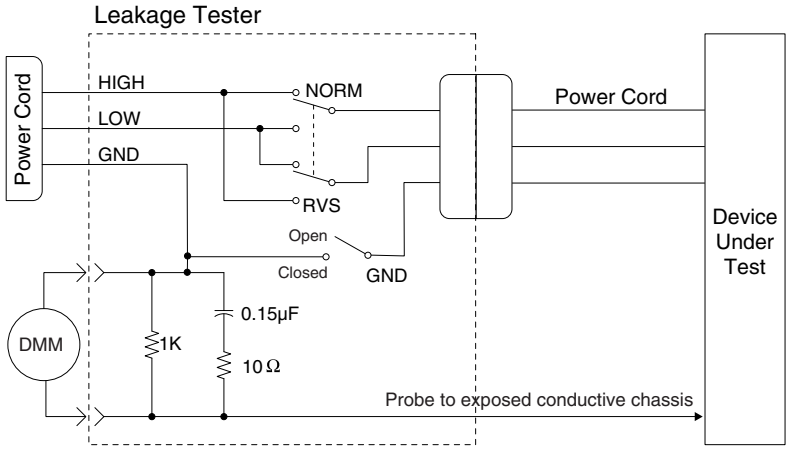
2.7.2 Acceptance criteria SFC (Single fault condition) - ground (earth), line or neutral open

- (USA only) 300 µA, and the device under test is powered from 100-120 V/ 50-60 Hz
- (USA only) 300 µA, and the device under test is powered from a center-tapped 200-240 V/50-60 Hz, single phase circuit (UL Split Phase Exemption)
- 1000 µA

NOTE: Center-tapped and non-center-tapped supply circuits produce different leakage currents and the UL and IEC limits are different.

2.8 Enclosure (Touch) leakage current test

Perform this test to measure current leakage through exposed conductive surfaces on the device under test during normal operation. Refer to the instructions contained with the safety analyzer to perform enclosure leakage current test.



DMM set to measure AC voltage

NOTE: The MD represents the network and voltage measuring instrument and its frequency characteristics per IEC 60601-1.

(1) Configure leakage tester as follows:

- .Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(2) Power on device under test.

(3) Read and record the current leakage indicated on tester.

NOTE: Center-tapped and non-center-tapped supply circuits produce different leakage currents and the UL and IEC limits are different.

(4) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(5) Read and record the current leakage indicated on the tester.

(6) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(7) Read and record the current leakage indicated on the tester.

(8) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN

- GND (Earth) - CLOSED

(9) Read and record the current leakage indicated on the tester.

(10) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(11) Read and record the current leakage indicated on the tester.

(12) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(13) Read and record the current leakage indicated on the tester.

(14) Set the power switch of the device under test to OFF.

If measured reading is greater than the appropriate specification below, the device under test fails. Contact GE Technical Support.

2.8.1 Acceptance criteria NC

- 100 microamperes (0.1 volts on the tester), and the device under test is powered from 100-240 V/50-60 Hz

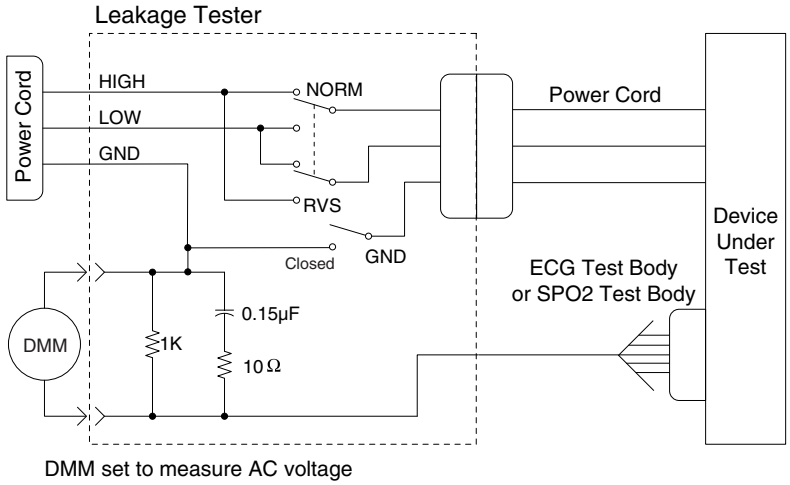
2.8.2 Acceptance criteria SFC ñ ground (earth), line or neutral open

- (USA only) 300 µA, and the device under test is powered from 100-120 V/50-60 Hz
- (USA only) 300 µA, and the device under test is powered from a center-tapped 200-240 V/50-60 Hz, single phase circuit (UL Split Phase Exemption)
- 500 µA, and the device under test is powered from a non-centertapped, 200-240 V/50-60 Hz, single-phase circuit

NOTE: If the reading is greater than the specification below, and the device under test is powered from 100-240 V/50-60 Hz, the device under test fails. Contact GE Technical Support.

2.9 Patient (source) leakage current test

This procedure only applies to Class I (grounded/earthed) equipment, and measures the leakage current from the ECG/RESP connector or the SPO2 connector of the device to ground.



NOTE: The MD represents the network and voltage measuring instrument and its frequency characteristics per IEC 60601-1.

The patient connector test body shorts all signals in the connector together. Refer to the instructions contained with the safety analyzer to perform this test.

(1) Connect the ECG/RESP Test Body to the green connector of the device under test.

(2) Configure leakage tester as follows:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(3) Power on Device under test.

(4) Read and record the current leakage indicated on the tester.

(5) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(6) Read and record the current leakage indicated on the tester.

(7) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(8) Read and record the current leakage indicated on the tester.

(9) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN

- GND (Earth) - CLOSED

(10) Read and record the current leakage indicated on the tester.

(11) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(12) Read and record the current leakage indicated on the tester.

(13) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(14) Read and record the current leakage indicated on the tester.

(15) Set the power switch of the device to OFF.

(16) Repeat the steps in this procedure using the appropriate SPO2 Test Body. Connect the SPO2 Test Body to the blue SPO2 connector of the device under test.

2.9.1 Acceptance criteria NC

With Ground and Neutral CLOSED - If reading is greater than 10 µA, the device under test fails. Contact GE Technical Support

2.9.2 Acceptance criteria SFC - ground (earth), line or neutral open

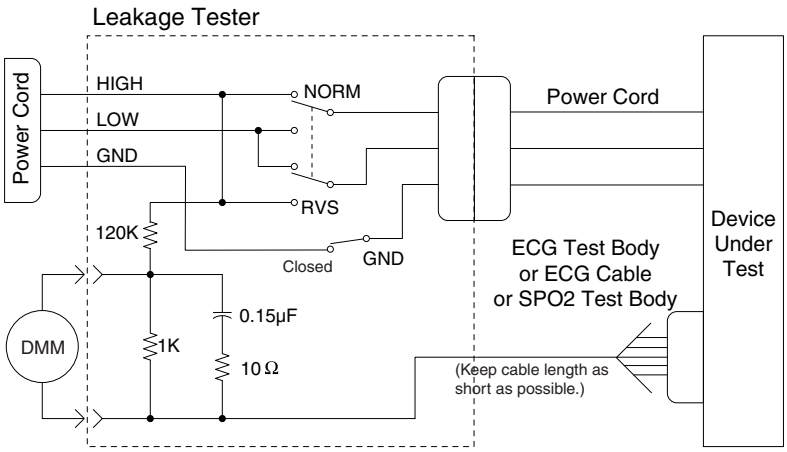
If any reading is greater than 50 µA, the device under test fails. Contact GE Technical Support.

2.10 Patient (sink) leakage current test (mains voltage on the applied part)

This procedure only applies to Class I (grounded/earthed) equipment, and measures the leakage current from a mains voltage source into the ECG/RESP connector or the SpO_2 connector.

The patient connector test body shorts all signals in the connector together. Refer to the instructions contained with the safety analyzer to perform this test. Connect the ECG/RESP Test Body to the green connector of the device under test.

Refer to the instructions contained with the safety analyzer to perform each test.



DMM set to measure AC voltage

NOTE: The MD represents the network and voltage measuring instrument and its frequency characteristics per IEC 60601-1.

NOTE: Per IEC 60601-1, the impedance to protect the circuitry and the person performing the test, but low enough to accept currents higher than the allowable values of the LEAKAGE CURRENT to be measured.

(1) 1. Configure leakage tester as follows:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

WARNING **Shock hazard. The following step causes high voltage at the test body. Do not touch the test body.**

(2) Power on device under test.

(3) Read and record leakage current indicated on the tester.

(4) Change leakage tester switches to:

- Polarity - NORMAL
- Neutral - OPEN
- GND (Earth) - CLOSED

(5) Read and record the current leakage indicated on the tester.

(6) Set the power switch on the device to OFF.

(7) Repeat the steps in this procedure using the appropriate SPO2 Test Body. Connect the SPO2 Test Body to the blue SPO2 connector of the device under test.

2.10.1 Acceptance criteria

If measured reading is greater than the appropriate specification below, the device under test fails. Contact GE Technical Support.

- 50 µA at 120-240 VAC using the ECG cable.

3 Functional check

These instructions include procedures for a functional check for B30 monitor. The functional check is recommended to be performed after monitor installation.

If these check haven't resolved your problem, please refer to the "Planned maintenance" for more detials

These instructions include a "Functional check form, B30" to be filled in when performing the procedures.

An electrical safety check and a leakage current test are recommended to be performed prior to the monitor installation.

3.1 Visual inspection

Make sure that the monitor is switched to standby.

Disconnect the mains power cord from the monitor.

If the monitor is connected to the Network, disconnect the RJ-45 cable from the monitor.

1. Check all units visually

   Check that all parts are intact and that the cables and screws are connected and tightened properly. Especially check the following parts:

   – sampling line is connected to the extension module.

   Check that modules go in smoothly and lock up properly.

3.2 Functional inspection

3.2.1 General

1. Connect the mains power cord to the monitor.

   Check that the Mains power LED is lit.

2. Switch the monitor on.

   Check that the monitor starts up properly, i.e. a normal start-up sound is heard from the loudspeaker, the alarm LEDs turn on and off, and the monitoring screen appears. No error messages should appear on the screen.

3. Configure the screen for the parameters that are connected.

4. Enter the ***Service Menu.***

   When applicable, check from the corresponding ***Parameters*** submenu that the Timeouts, Bad checksums and Bad c-s by mod values of inserted modules are not increasing faster than by 5 per second. Check also that the module memories have passed the internal memory test, i.e. RAM, ROM and EEPROM all state OK.

   If connected, the recorder should record two lines of start-up information.

   Preset the measurement settings for those parameters that are connected, for example:

   Print/Recorder - ***Record Waveforms - Waveform 1 - ECG1***

– ***Waveform 2 - P1***
– ***Waveform 3 - P2***

Invasive Pressures - P1 'ART' Setup - Label - ART
- P2 'CVP' Setup - Label - CVP
Others -SPO2 Setup - Pleth Scale - AUTO

3.2.2 Display

1. Check that the picture on the screen is displayed properly.

3.2.3 Keyboard(s)

Tests with the Command Board:

– Press the **Monitor Setup** key. Turn the ComWheel in both directions and check that the cursor in the menu moves correspondingly. Select ***Normal Screen*** and check that the menu disappears from the screen.

Check the rest of the menu keys by pressing them one by one.

3.2.4 Frame unit

1. Check that the clock on the screen shows correct time. Readjust the time and date, if necessary.

3.2.5 Extension Module with CO_2 measurement

Wait until the message 'Calibrating gas sensor' disappears from the screen.

1. Block the tip of the sampling line with your finger and check that the message 'Sample line blocked' appears on the monitor screen within 30 seconds.
2. Detach the Mini D-fend and check that the message 'Check D-fend' appears on the monitor screen within 30 seconds.

Breathe to the sampling line briefly. Check that the CO2 information is updated on the screen.

3.2.6 Multiparameter Hemodynamic Modules

ECG and RESP measurements

1. Connect an ECG cable to the module. Connect the cable leads to a patient simulator.

Check that all ECG and impedance respiration information is shown on the monitor screen as configured on the simulator.

Turn the simulator off. Check that the ëAsystoleí and ëApneaí messages are displayed.

Temperature measurement

2. Check the temperature channels with a patient simulator.

   Check that temperature measurement information is shown on the monitor screen as configured on the simulator.

Invasive blood pressure measurement

3. Check the function of the module and side panel membrane keys.
4. Check the InvBP channels with a patient simulator.
5. Zero the InvBP channels and check that the values and waveforms correspond to the simulator settings.

SpO2 measurement

6. Connect an SpO2 finger probe to the module. Check that the message *'Probe off'* is shown when the probe is not connected to a finger.
7. Attach the SpO2 probe to your finger. Check that a reading of 95-99 and a pleth waveform appear on the screen

Non invasive blood pressure measurement

8. Check the function of the module and side panel membrane keys.
9. Attach an adult NIBP cuff onto your arm and perform one NIBP measurement. Check that the module identifies the cuff, i.e. the text ëAdultí appears in the NIBP digit field for a short time.

   Check that the module gives a reasonable measured result.

3.2.7 Recorder

1. Press the **Start/Stop** sidepanel key and check that the module starts recording the selected waveforms. Press the **Start/Stop** sidepanel key again to stop recording.
2. Check that the quality of the recordings is acceptable.

3.2.8 Network connection

1. Check that the CAT-5 cable connector is clean and intact, then connect it to the Network connector on the backside of the monitor.

Check that the monitor connects to the network, i.e. the network symbol appears on the upper right-hand corner of the screen. Also a message regarding the connected Central should appear in the message field on the screen.

3.2.9 Final

- Switch the monitor to standby
- Perform final cleaning
- Fill in all necessary documents

4 Planned maintenance

These instructions include procedures for planned maintenance (PM) for the B30. The Planned maintenance should be performed once a year.

These instructions include "Planned maintenance check form, B30", which to be filled in when performing the corresponding procedures.

4.1 Visual inspection/preparation

4.1.1 Before beginning

NOTE: Wear a static control wrist strap when handling PC boards. Electrostatic discharge may damage components on the board.

- Make sure that the monitor is turned off.
- Disconnect the mains power cord.
- If the monitor is connected to the network, disconnect the CAT-5 cable from the monitor.

4.1.2 General

1. Check all the units visually. Check that all parts are intact and that the cables and screws are connected and tightened properly. Check the connector pins are intact
2. Check that the modules go in smoothly and lock up properly.
3. Replace the batteries, if necessary.

   The manufacturer recommendations are:

   – Replace the SRAM/Timekeeper battery on the CPU board every 8 years.

   NOTE: The Factory Reset must be performed if the SRAM/Timekeeper battery is replaced.
4. Check that the fuses are of the correct rating.
5. Check the ventilation holes of the monitor and clean of dust if necessary.
6. Check the battery status from ***Battery setup*** menu: If "failed", renew the battery. If "condition", perform the condition cycle.

NOTE: Batteries are recommended to be conditioned every six months.

NOTE: Check that tubes are not contaminated. Any contamination inside the tubing can increase a risk of faulty operation in valves or sensors. If any contamination inside the tubing is noticed then it is recommended to send the module to factory repair.

4.1.3 E-PSM(P)W Module

1. Check the NIBP pump filter. Replace the filter, if necessary.

   Plug the module back into the frame.
2. Check internal parts:
   – screws are tightened properly
   – connectors are connected properly
   – NIBP tubing is attached properly
   – there are no loose objects inside the module

3. Checnk external parts:
   – the front cover and the front panel sticker are intact
   – all connectors are intact and attached properly
   – the module box and latch are intact
4. Reattach the module cover and check that the latch is moving properly.
5. Module installation

   Plug in the module. Check that it goes in smoothly and locks up properly
6. Module recognition

   Check that the module is recognized, i.e. all the needed parameter information, except invasive blood pressure, starts to show on the screen.

4.2 Functional inspection

4.2.1 General

1. Connect the mains power cord
   Check that the Mains power LED is lit.
2. Switch the monitor on.

   Check that the monitor starts up properly, i.e. the alarm LEDs turn on shortly, normal start-up sound is heard from the loudspeaker and the monitoring screen appears.

   No error messages should appear on the screen.
3. Configure the screen for the parameters that are connected.
   Check that all the connected modules are recognized, i.e. the required parameter information is shown on the screen.

   If connected, the recorder should record two lines of start-up information.

   Preset the measurement settings for those parameters that are connected, for example:

   Print/Recorder - ***Record Waveforms - Waveform 1 - ECG1***
   - Waveform 2 - P1
   - Waveform 3 - P2

   Invasive Pressures - ***P1 'ART' Setup - Label - ART***
   - P2 'CVP' Setup - Label - CVP

   Others - ***SPO2 Setup - Pleth Scale - AUTO***

   Others – ***Resp Setup - Size - 1.0***
   - Resp Rate Source - AUTO
   - Measurement - ON
   - Detection Limit - AUTO
4. Check that the monitor goes to battery use if the main cord is disconnected.

4.2.2 Display

1. Check that the picture on the screen is correct
2. Check the display brightness

   Select

Monitor Setup

Display Brightness
Push the ComWheel and check that the display brightness follows the selected brightness.

4.2.3 Keyboard(s)

1. Tests with the Command Board:
   – Press the **Monitor Setup** key. Turn the ComWheel in both directions and check that the cursor in the menu moves correspondingly. Select ***Normal Screen*** and check that the menu disappears from the screen.
   Check the rest of the menu keys by pressing them one by one.
2. Check that the clock on the screen shows correct time.
   Readjust the time and date, if necessary.
3. Enter the ***Service Log*** service menu.
   Check the content of the Service Log for possible problems.

4.2.4 E-PSM(P)W Module

ECG measurement

1. Module software (serial numbers)
   Enter the service menu:
   Monitor Setup - ***Install/Service*** (password 16-4-34) -
   Service (password 26-23-8)
   Take down the information regarding the module software by selecting ***Scroll Vers*** and turning the ComWheel.

2. Communication and memories
   Enter the ***Parameters - ECG*** service menu.
   Check that the Time-outs, Bad checksums and Bad c-s by mod values are not increasing faster than by 5 per second. Check also that the ECG/RESP board memories have passed the internal memory test, i.e. the RAM, ROM and EEPROM state all OK.

3. Power frequency
   Check that the power frequency value is set according to the current mains power frequency. Change the setting by selecting ***Power Freq***, if necessary.

4. Cable recognition

Connect a 5-lead ECG trunk cable without a lead set to the module. Check that the message 'Leads off' is displayed on the screen.

5. Lead detection

   Connect a 5-leadwire set to the trunk cable. Connect all the leads together, for example to a suitable screwdriver. Check that all the electrodes show ON and the message 'Asystole' appears. Check that the Cable type shows 5 lead.

   Connect the 5-leadwire set to the simulator. Disconnect one of the leads and check that the corresponding electrode in the service menu shows OFF within 10 seconds of the disconnection, and then reconnect the lead. Check the rest of the leads using the same method.

   Connect a 3-leadwire set to the trunk cable. Check that the cable type shows 3 lead in the service menu. Check that all the electrodes show OFF in the service menu and the message 'Leads Off' is shown on the screen.

   NOTE: The asystole and different leads off messages are shown using certain priority, Even though one of the leads is disconnected, the related leads off message may not appear on the screen.

   NOTE: When RL electrode is disconnected, the V electrode shows OFF, the measurement will automatically change to 3 electrode ECG measurement

6. Test with the patient simulator

   Connect the leads to a patient simulator.

   Perform the settings and checks with Dynatech Nevada MedSim 300 Patient Simulator:

   ECG - BASE - BPM - 160
   PACE - WAVE - NSR

   Check that a normal ECG waveform is shown, the HR value is 160 (±5) and the 'Pacer count' -value is not increasing in the service menu.

   ECG - PACE - WAVE - ASNC

   Check that pacemaker spikes are shown on the ECG waveform, the HR value changes to 75 (±5) and the Pacer count value is increasing according to the shown pacemaker spikes.

   Set the pacemaker option off:

   ECG - PACE - WAVE - NSR

Respiration measurement

7. RESP measurement recognition

   Check that 'Resp: Avail' shows '1' and the 'Meas Off' shows '0' in the ECG service menu.

8. Test with patient simulator

   Check the respiration measurement with a patient simulator.

   The settings and checks with Dynatech Nevada MedSim 300 Patient Simulator:

   BASELINE IMPEDANCE -switch - 500
   LEAD SELECT-switch - II/RL-LL

RESP - WAVE - NORM
RATE - 20
OHMS - 1.0
RATIO - 1/1
APNEA - OFF
SHIFT - OFF

Check that the RESP waveform is shown and the RR value is 20 (±5). Change the position of the BASELINE IMPEDANCE switch and check that appropriate RESP waveform and RR value are shown again within 30 seconds.

RESP - APNEA - 32 S

Check that the monitor activates the APNEA alarm.

NOTE: Make sure that only the ECG leads are connected to the simulator during the apnea test. If other cables are connected at the same time, the respiration signal from the simulator may be disturbed, and therefore, the APNEA alarm may not be activated.

NOTE: When you have the ECG service menu open, spikes will appear on the respiration waveform. These spikes represent the threshold level for detecting inspiration and expiration.

Temperature measurement

9. Communication and memories

   Enter the PSM: STP service menu:

   Parameters - STP

   Check that the Time-outs, Bad checksums and Bad c-s by mod values do not increase faster than by 5 per second. Check also that the STP board memories have passed the internal memory test, i.e. the RAM, ROM and EEPROM show all OK.

10. Temperature probe detection

    Check that the 'Cable' and 'Probe' show OFF for both channels, T1 and T2, when no probes are connected.

    Connect the temperature adapter cable to the module temperature connector and a temperature test plug to the adapter cable. Check that the Cable and Probe for T1 show ON and the corresponding temperature value appears on the monitor screen.

11. Calibration check

    Check the temperature calibrations using temperature test plugs.

    If the deviation on a temperature reading on the screen is more than 0.1°C, calibrate the temperature channels according to the instructions in chapter *"Temperature calibration"*."

12. Temp test

Activate the temperature test by selecting ***Temp Test***. When the message 'Performing temp test' disappears from the digit field, check that no error messages appear and Temp error shows OFF for both channels in the service menu.

13. Module configuration

    Check that the module configuration has been set correctly. The configuration in use is shown beside the text Configuration in the service menu and it can be eitherSTP or ST. Change the configuration in the ***Calibrations - Set Config*** menu, if necessary. To activate the change, reset the module communication by removing and inserting the module.

Invasive blood pressure measurement

14. Membrane keys

    Check the front panel membrane keys that are related to the InvBP measurement.

    Press each of the keys for at least one second. Check that the pressed key is identified, i.e. one of the texts for Buttons changes from OFF to ON in the service menu.

15. Cable and transducer detection

    Check that the Cable and Probe for P1 show OFF. Connect the InvBP adapter cable to the module, connect a cable with an invasive blood pressure transducer to the adapter cable and check that the Cable and Probe show ON and the corresponding pressure waveform appears on the screen.

    Perform the same check also for the InvBP channel P2.

16. Calibration

    Calibrate the InvBP channels P1 and P2 according to the instructions in chapter *"Invasive pressure calibration*."

17. Test with patient simulator

    Check the InvBP channels with a patient simulator.

    The settings and checks with Dynatech Nevada MedSim 300 Patient Simulator:

    SENSITIVITY - switch - 5 µV/V/mmHg

    ECG - BASE - BPM - 60 - BP - 1 - WAVE - ATM

    2 - WAVE - ATM

    Restore the normal monitoring screen by pressing the key **Normal Screen**.

    Connect cables from the channels BP1 and BP2 to the module connectors. Zero the InvBP channels by pressing the keys ZERO P1 and ZERO P2 on the module front panel.

    BP - 1 - WAVE - ART

    2 - WAVE - CVP

    Check that appropriate InvBP waveforms are shown and the InvBP values are approximately 120/80 (±3 mmHg) for the channel P1 and 15/10 (±2 mmHg) for the channel P2.

Check that the HR value is calculated from P1, when ECG is not measured (ECG cable disconnected).

SpO_2 measurement

18. SpO_2 probe detection

    Check that the message 'No probe' is shown, when no SpO_2 sensor is connected to the module. Connect an SpO_2 finger probe to the module (with the interconnection cable, if needed). Check that the message 'Probe off' is shown when the probe is not connected to a finger.

19. Test measurement

    Connect the SpO_2 probe onto your finger. Check that the reading of 95-99 and SpO_2 waveform appears. Check that the HR value is calculated from SpO_2 when ECG and InvBP (P1) are not measured.

NOTE: a functional tester cannot be used to assess the accuracy of a pulse oximeter probe or a pulse oximeter monitor

Non Invasive Blood Pressure measurement

20. Communication and memories

    Enter the NIBP module service menu:

    Parameters - NIBP

    Check that the Time-outs, Bad checksums and Bad c-s by mod values are not increasing faster than by 5 per second. Check also that the NIBP board memories have passed the internal memory test, i.e. the RAM, ROM and EEPROM show all OK.

21. Pump and valves

    Check the pump and valves.

    Select ***Pneumatics*** from the NIBP menu. Connect a pressure manometer to the NIBP module cuff connector.

    Select ***Start Pump*** and press the ComWheel. Check that the pump turns on and the pressure inside the tubing system starts to increase. Stop the pump by pressing the ComWheel again when the pressure reaches 280 mmHg.

    Select ***Open Exh2***. Press the ComWheel and check that the pressure inside the tubing system starts to drop, then press the ComWheel again. If necessary, turn the pump on again for a moment to increase the pressure inside the tubing system.

    Select ***Set Valve***. Press the ComWheel and set the value under the text Pulse Valve to number 150 by turning the ComWheel. Press the ComWheel again and check that the pressure inside the tubing system starts to drop. Finish the test by selecting ***Previous Menu***.

22. Leak test

    Check the NIBP tubing system for leakages.

    Select ***Calibrations*** from the NIBP service menu.

    Connect the pressure manometer to the NIBP module cuff connector. Start the active leak test from the menu by pressing the ComWheel. The module pumps a pressure of about 290 mmHg and then the pump stops. The max pressure in Adult mode is about 290 mmHg, but in Infant mode only 140mmHg.

    Wait for 15 seconds for the pressure to stabilize then check that the pressure does not drop more than 6 mmHg per one minute. Release the pressure by pressing the ComWheel once more.

23. Calibration check

    Recalibrate the NIBP measurement according to the instructions in chapter *"NIBP calibrations" on page 3-32*. Remember to set the calibration protection back on after the calibration.

    Disconnect the pressure manometer. Select ***Calibrations*** - ***Calibration Check***. Press the ComWheel and take down the zero offset values for both pressure transducers, B1 and B2. The values should be within ±20 mmHg.

    Connect the pressure manometer to the cuff connector and check the calibration with pressures 100 mmHg, 200 mmHg and 260 mmHg. The zero offset value must be added to the displayed pressure value in order to determine the real pressure.

24. Safety valve functions

    Select ***Safety Valve*** from the NIBP service menu.

    Disconnect the pressure manometer from the NIBP module cuff connector. Connect the NIBP hose and cuff to the NIBP module cuff connector. Perform the check with a standard adult cuff that is connected around some round object, for example a calibration gas bottle."

    Select ***Start Test***. Start the adult safety valve test by pressing the ComWheel. Wait until the pump stops and the pressure is deflated.

    Open cuff connector or disconnect and connect cuff connector from module

    Check the pressure values 'Max press' and '2 s after stop' for both transducers. All the values should be within 270 - 330 mmHg.

    Select ***ADULT***. Press the ComWheel and check that the text changes now to ***INFANT***.

    Select ***Start Test*** and wait until the pump stops and the pressure values on the screen have been updated.

    Open cuff connector or disconnect and connect cuff connector from module

    Check that the values 'Max press' and '2 s after stop' are all now within 135 to 165 mmHg.

    Return to the normal monitoring mode by pressing **Normal Screen**.

    Disconnect the pressure manometer from the NIBP module cuff connector. Connect the NIBP host and cuff to the NIBP module cuff connector.

    Perform the check with a standard adult cuff that is connected around some roundobject, for example a calibration gas bottle.

25. Cuff related messages

    Connect an adult NIBP cuff to the cuff connector and disconnect one of its hoses.

    Start NIBP measurement by pressing the key **Start/Cancel** on the module and check that the message 'Cuff loose' appears on the screen within 70 seconds.

    Reconnect the hose and then bend it with your fingers. Restart the measurement and check that the message 'Cuff occlusion' appears on the screen within 70 seconds.

26. Test measurement

    Check that the automatic inflation limits are in use:

    NIBP - ***NIBP Setup - Inflation Limits - Auto - Previous Menu***

    Connect the cuff onto your arm, select ***Start Ven.Stasis*** in the NIBP menu and press the ComWheel. Check that the module identifies the cuff, i.e. the text Adult appears in the NIBP digit field for a short moment.

    Keep the pressure inside the cuff for about half a minute in order to find out that the cuff is not leaking, then press the ComWheel again. Select **Normal Screen**.

    Disconnect the cuff hose.

27. NIBP hose detection

    Press the **Start/ Cancel** module or side panel key and check that the 'Cuff loose' message appears in the NIBP digit field.
    Attach a NIBP cuff hose without cuff identification and check that the module identifies the hose:

    – The message 'Select inflation limits' appears in the NIBP digit field.
    – When you try to start the measurement, the monitor automatically opens the selections ***NIBP Setup - Inflation Limits.***

4.2.5 Loudspeaker

Check the loudspeaker by setting the alarm volume:

Alarms Setup

Alarm Volume

Test the whole volume scale from 1 to 10 by turning the ComWheel and check that the alarm volume changes correspondingly. The alarm sound should be clear and audible with all the settings.

4.2.6 Monitor software

Enter the service menu:

Monitor Setup

Install Service (Password 16-4-34)

Service (Password 26-23-8)

Take down the information regarding Monitor software.

4.2.7 Content of the service log

Select ***Service Log*** from the menu.

Check the contents of the Service Log for possible problems. If the monitor contains the recorder unit, record the Service Log onto the recorder by selecting ***Record Log***.

4.2.8 Voltages

Check the power supply output voltages through the service menu:

Monitor Setup

Install Service (Password 16-4-34)

Service (Password 26-23-8)

Frame

Power Supply

Check that all the displayed values are within reasonable limits.

4.2.9 Watchdog circuitry

Select:

Monitor Setup

Install Service (Password 16-4-34)

Service (Password 26-23-8)

Set/Test

Perform the tests WATCHDOG and WD BY OVERLOAD. Check that the monitor restarts in each case.

NOTE: When selecting WD BY OVERLOAD, restarting should take place approximately after 15 seconds.

Preset monitor settings:

Record/Print

Record Waveforms

Waveform 1 --> ECG1

Waveform 2 --> P1

Waveform 3 --> P2

Delay --> Off

Paper Speed --> 6.25 mm/s

Length --> 30 s

4.2.10 Alarm LEDs

Enter the ***Keyboard*** service menu:

Monitor Setup

Install Service (Password 16-4-34)

Service (Password 26-23-8)

Keyboard

Select the text ***Upper Led***. Check that the red alarm LED turns on and off when pressing the ComWheel. Check also the yellow alarm LEDby selecting ***Lower Led*** from the menu.

4.2.11 Membrane keys

Press the keys on the monitor command board one by one. Check that each key generates a sound from the loudspeaker. Also, the corresponding text in the menu should change from yellow to red.

Check also the functioning of the side panel keys.

4.2.12 ComWheel

Turn the ComWheel clockwise and counterclockwise and check that each step generates a sound from the loudspeaker and the corresponding values at the bottom of the menu increase.

Select ***Dummy Press***. Push the ComWheel and check that the press generates a sound and the corresponding value in the menu increases.

4.2.13 Module communication

Connect a patient simulator to the module.

Enter the parameter service menus one by one:

Monitor Setup

Install Service (Password 16-4-34)

Service (Password 26-23-8)

Parameters

ECG, STP and NIBP

Check that the 'Timeouts', 'Bad checksums' and 'Bad c-s by mod' values do not increase faster than by 5 per second.

4.2.14 Batteries

1. Check battery limits

   Enter the ***BATTERY*** service menu:

   Monitor Setup

   Install Service (Password 16-4-34)

   Service (Password 26-23-8)

   Frame

   Power Supply

   WPM Battery

   Smart Batt1

   Smart Batt2

   Check that all values are within reasonable limits.

   NOTE: In order to update values for a desired battery, disconnect the other battery shortly.

2. Battery operation

   Disconnect the power cord (without switching the monitor to standby).

   Check that the monitoring continues normally. Check also the Command board LEDs:

   - the green mains power LED is off
   - the green battery LED is on
   - the orange battery LED is off

3. Battery charging

   Reconnect the power cord.

   Check that the monitoring continues without problems. Check also the Command board LEDs:

   - the green mains power LED is on
   - the green battery LED is off
   - the orange battery LED is on or off continuously (not blinking)

4.2.15 Network

1. Connection to network

   Check that the CAT-5 cable connector is clean and intact, then connect it to the monitor.

   Check that the monitor connects to the Datex-Ohmeda Network, i.e. the network symbol appears under the clock in the upper right hand corner of the screen. Also a message regarding the connected Central should appear in the message field of the screen.

   If the message regarding the Central does not appear, check the status of the network.

2. Ethernet address

   Enter the network service menu:

   Monitor Setup

   Install Service (Password 16-4-34)

Service - Frame (Password 26-23-8)

Network- Ethernet

Check that the service menu counters for the received ('In') and transmitted ('Out') data are updated frequently.

3. Data error counters

   Check that the counters for data errors ('BER', 'CRC', 'Frame', 'Transm.') are stable.

   NOTE: The counters may show values higher than 0, however, if any of the values is increasing continuously, it indicates a problem.

4. Hardware error counters

   Check that the counters for hardware errors ('Intern.', 'Missed', 'FIFO', 'Overrun') show all 0. If any of the counters show a value higher than 0, replace the network board.

5. Disconnection recognition

   Disconnect the CAT-5 cable from the monitor. Check that the message 'Network down: appears in the message field within 30 seconds. When the message appears, the service menu values are no longer updated.

   Reconnect the CAT-5 cable and check that the monitor connects to the Datex-Ohmeda Network again.

6. ID-plug recognition

   Switch the monitor to standby. Disconnect the Identification plug from the monitor. Switch the monitor back on and check that the message 'Check network connectors' appears in the message field.

   Reconnect the Identification plug and check that the monitor connects to the Datex-Ohmeda Network.

4.2.16 General test

1. Storing trend data

   Check that the monitor is capable of storing the trend information and temporary settings in a short (max. 15 minutes) standby situation .
   Press the membrane key **Pt.Data & Trends --> *Trends*.** Check that there is trend information available for the monitored parameters.

   Switch the monitor to standby and disconnect the power cord. Wait for two minutes, then reconnect the power cord and switch the monitor back on.

   Check that the trend information is still available.

2. Service reset

   Check the Service Reset. Disconnect the power cord and remove the batteries to reset the monitor. Switch the monitor back on and check that the monitor performs a Cold Start, i.e. all trend information is cleared.

   NOTE: Cold start have three ways:

   - Disconnect all power source and reset the monitor
   - When the monitor power on, hold on the **Power** hardkey 15 seconds
   - Turn off the monitor, waiting for 15 minutes

3. Watchdog

   Enter the ***Set/Test*** service menu and perform ***Watchdog***
   Check that the monitor restarts.

4. Service Log reset

   Enter the ***Service Log*** service menu.

   Clear the content of the Service Log by selecting ***Reset Log*** from the menu.

5. Electrical safety check

   Perform an Electrical safety check and a leakage current test. Check that the monitor and all connected units function normally after the performed test.

6. Final cleaning

   Switch off the monitor and perform final cleaning.
   Fill in all necessary documents.

5 Adjustments and calibrations

NOTE: Use only properly maintained, calibrated and traceable measurement equipment for the specified calibrations and adjustments to ensure accuracy.

5.1 NIBP calibrations

The electronics of the NIBP pressure measurement is calibrated at the factory. The processor automatically maintains the zeroing pressure. If the zero point of the pressure transducer drifts more than specified, an error message is given and the NIBP board should be recalibrated or replaced.

Recalibrate the NIBP measurement once a year. The checking and recalibration can be done in the NIBP service menu.

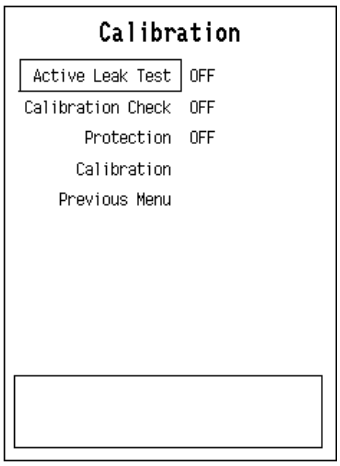
The calibration of the primary pressure channel can also be checked from the NIBP setup menu (***NIBP - NIBP Setup - Calibration Check***). In this case, the auto zeroing is performed at start - remove the hose before entering to ensure atmospheric pressure to the pressure transducers - the primary pressure is displayed. The zero-offset value should then be zero.

Check the intake air filter as part of the calibration check. Change the filter if it is visibly dirty.

Calibration check

1. Enter ***Calibration*** menu:

   Monitor Setup - ***Install/Service*** (password 16-4-34) -***Service*** (26-23-8) - ***Parameters - NIBP - Calibrations***



2. Select ***Calibration Check*** and push the ComWheel.
3. Connect an external precision manometer to the module.
4. Pump the following pressures to manometer and check the difference between the manometer and monitor pressure display (The zeroing offset is automatically subtracted from the pressure readings).

Table 5 NIBP calibration check pressures

Pressure	Max. error	Example
0 mmHg	±5 mmHg (=zero offset)	-1
100 mmHg	100 ±2 mmHg	100 ±2
200 mmHg	200 ±3 mmHg	200 ±3

If the error of pressure channel B1 is larger than specified above, the module should be recalibrated. The error of B2 is allowed to be even twice as large because it has no effect on blood pressure measurement accuracy. However, we recommend recalibrating the module when the error of B2 is larger than specified above to ensure best possible operation.

Calibration

1. Enter ***Calibration*** menu.
2. Remove the hoses from the front panel connector to enable proper zeroing.
3. Select ***Calibration***. If it is not available, perform the steps a, b, and c.

NOTE: Do not pull out the hemodynamic module from the monitor frame. The module must be in the frame during the whole procedure.

a. Press the hemodynamic module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds to enable the calibration. This enables menu selection ***Protection***.

b. Select ***Protection OFF*** in the ***Calibration*** menu and push the ComWheel.

c. Menu selection ***Calibration*** is now enabled, and ***Protection*** is disabled.

- Start calibration by pushing the ComWheel. Messages 'Zeroing' and 'Zeroed' will be displayed in the NIBP message field. After this, a pressure bar and text 'Calibrating' will be displayed.
- Connect an external mercury manometer with a pump to the module through the both tubes of the hose - both transducers B1 and B2 must be calibrated simultaneously. Pump up to a pressure of about 200 mmHg according to the manometer. Calibration is possible in the range of 150 to 250 mmHg.
- Verify that both pressure values in the prompt field match the manometer reading. If not, adjust by turning the ComWheel. When the values of the pressure bar and the manometer are equal, push the ComWheel to confirm the calibration. The message 'Calibrated' will be displayed on the NIBP digit field after a few seconds, which means that the calibration succeeded, and the new calibration data is saved in EEPROM.

NOTE: When calibrating NIBP, always change the displayed pressure value slightly with the ComWheel, even in cases where the value would be correct. For example, change the value one step higher and then back one step lower. 'Calibrated' text should appear in the display. This ensures that the calibration procedure is correctly registered and stored by the module.

- To set the protection on:
  Select ***Protection ON*** and push the ComWheel. Then press NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds.
- Remove the module from the frame and plug it back again. Then perform "Calibration check" (see the preceding page) to verify the new calibration.

5.2 Temperature calibration

NOTE: For the temperature calibration, separate, accurate test plugs (25 °C and 45 °C) are needed. A temperature dual cable order code 2016998-001, a temperature probe order code M1024254 and a Dual temperature adapter cable, order code M1010846 are also required for the temperature calibration.

Calibrate the temperature, when the measured test values differ for more than ±0.1 °C, and always after STP board replacement.

1. Enter STP Module service menu.

   (**Monitor Setup** - ***Install/Service*** (password 16-4-34) - ***Service*** (password 26-23-8) - ***Parameters***).
2. Enter ***Calibrations*** menu.
3. Choose ***Protection OFF*** in protect mode.
4. Select ***Calibrate T1/Calibrate T2***.
5. Insert calibration plug (25 °C) into T1/T2 connector.
6. Push the ComWheel.
7. Insert calibration plug (45 °C) into T1/T2 connector.
8. Push the ComWheel.
9. Choose ***Protection ON*** in protect mode.

5.3 Invasive pressure calibration

NOTE: Before starting invasive pressure calibration, disconnect all patient cables and discharge the patient.

NOTE: For the Invasive pressure calibration a Dual InvBP adapter cable, order code 2005722-001, is needed.

Calibrate the invasive pressure when the pressure transducer (probe) is replaced with a different type of transducer, and when the STP board is replaced.

1. Enter PSM STP service menu.

   (**Monitor Setup** - ***Install/Service*** (password 16-4-34) - ***Service*** (password 26-23-8) - ***Parameters***).
2. Enter ***Calibrations*** menu.
3. Connect a pressure transducer with a pressure manometer to the P1/P2 connector. Choose ***Calibrate P1*** or ***Calibrate P2***. Leave the transducer to room air pressure.
4. Push the ComWheel to start zeroing.
5. Supply a pressure of 100 mmHg to 300 mmHg to the transducer. The recommended pressure is 200 mmHg.
6. Set the pressure on the display to match the pressure reading on the manometer and push the ComWheel. A tolerance of ±1 mmHg is allowed.
7. The message ‘Calibrated’ will be displayed on the display.

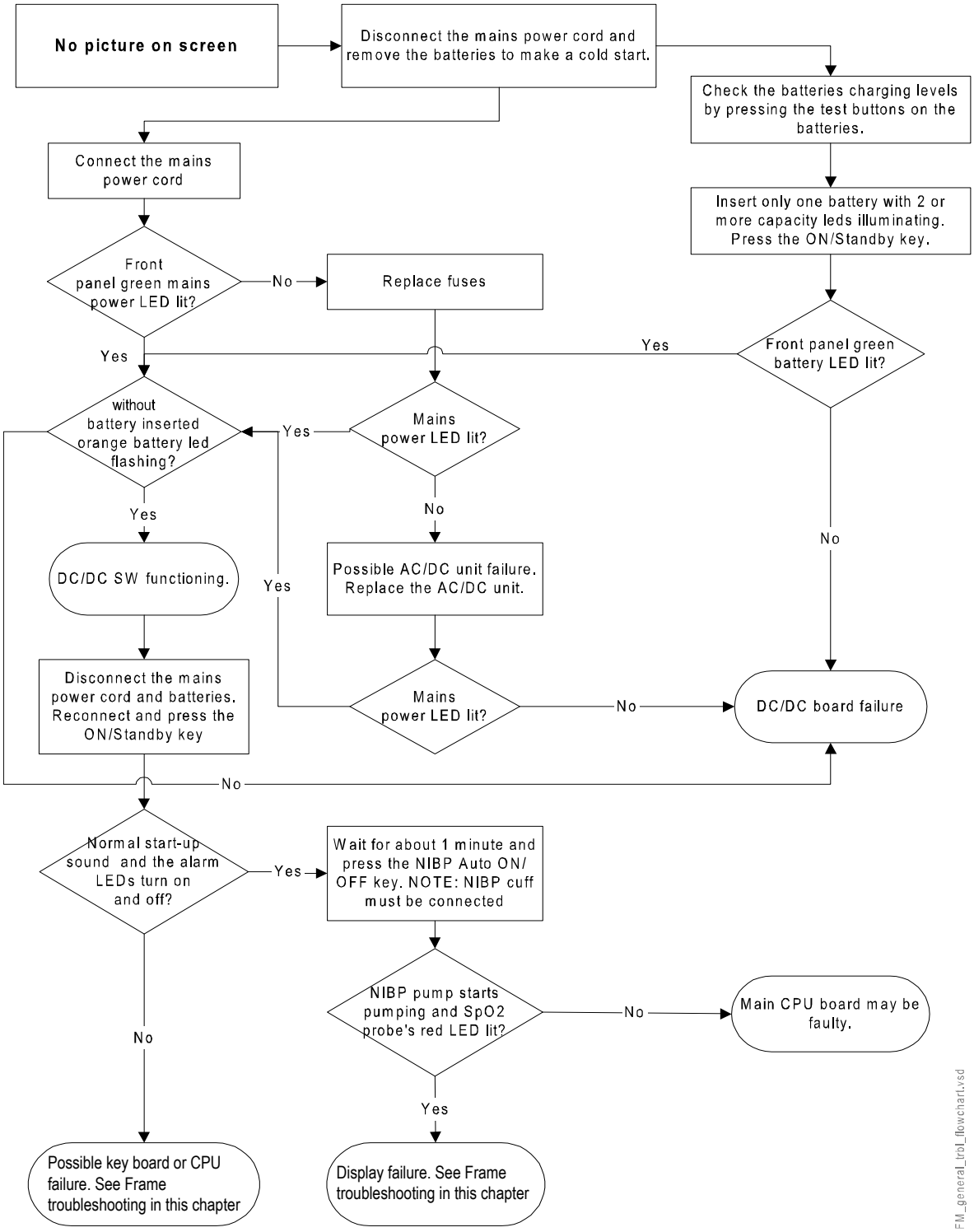
4 Troubleshooting

1 Introduction

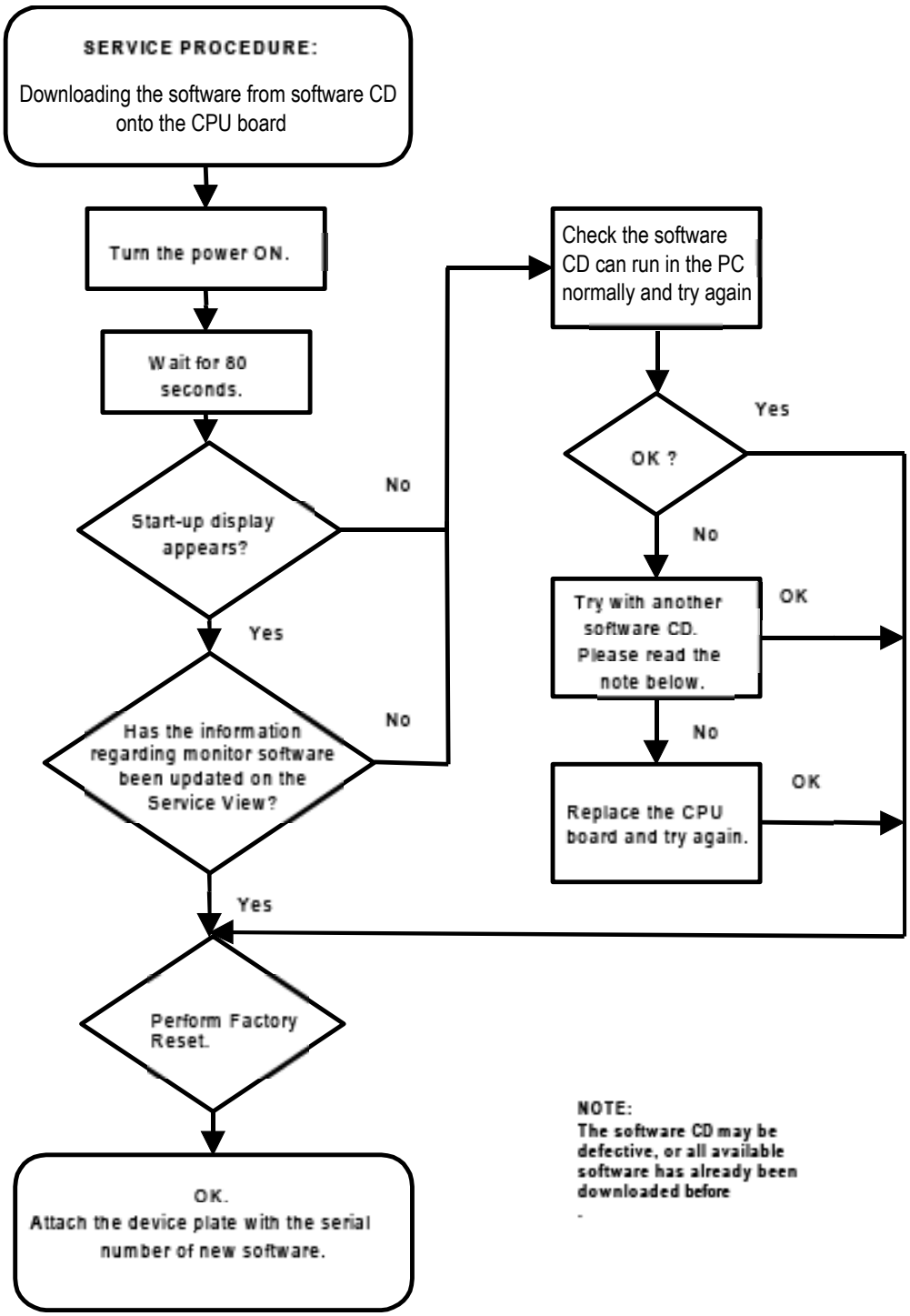
If a problem occurs during the functional examination, check the components of the monitor according to the below troubleshooting table. If the problem persists, please refer to the following detail troubleshootings.

Problem	**What to do**
Nothing functions	Unplug and re-plug the Power Cord. Also confirm that the cable is intact. Confirm that the fuses are intact.
E-PSM(P)W module does not function	Remove and replace the module. Confirm that the desired parameters are configured to be displayed.
N-F(C)(REC) module does not function	Confirm that 'Occlusion' or 'Calibrating Gas Sensor' messages are not displayed. Confirm that a D-fend water trap and a sample tube are attached. Confirm that the desired parameters are configured to be displayed. Remove and replace the module.

1.1 General troubleshooting



1.2 Software troubleshooting chart



2 Frame troubleshooting

Problem	Cause	What to do
Monitor is not starting.	1. The batteries are empty. 2. Fuses may be blown. 3. If power cord connected, AC/DC unit may be faulty. 4. If AC/DC unit is working, the DC/DC board may be faulty. 5. On/Stby key may be faulty.	1. Connect the power cord. 2. Replace fuses. 3. Replace the AC/DC power unit. 4. Replace the DC/DC unit. 5. Replace the command board panel keyboard foil.
Monitor is not starting.	1. The connection between DC/DC board and CPU board may be faulty. 2. Faulty CPU board.	1. Check the connector and the interconnection board. 2. Replace the CPU board.
The monitor starts (alarm leds are lit and a beep is heard), but the display remains black.	1. The LCD display cables are loose. 2. The backlights are not lit.	1. Check the LCD display connection board connectors. 2. Check backlight connector. Check inverter cable. Backlights may be faulty. Replace the backlights. Backlight Inverter may be faulty. Replace the Inverter board.
Display and monitor operating but alarm leds not illuminating in start-up.	1. Loose connectors. 2. Ribbon cable faulty. 3. CPU not working.	1. Check all connectors from CPU to led board. 2. Replace ribbon cable. 3. Replace CPU.
Display and monitor operating but no audible beep in start-up.	1. Loudspeaker connector or wires loose or faulty.	1. Check loudspeaker connector and wires.
Display is too dim.	1. Incorrect brightness adjustment. 2. Backlight faulty. 3. Backlight inverter faulty.	1. Adjust display brightness higher. 2. Replace backlight. 3. Replace backlight inverter.
Stripes or white areas on screen.	1. Loose faulty display connection flexboard connectors in CPU and display.	1. Check display connection flexboard connectors in CPU and display.
Module data disappears from the screen. 'Module power supply overload' message.	Parameter module current (in module bus) too high.	Detach and change parameter module.
Module data disappears.	1. Module bus voltage or signals path broken.	1. DC/DC board module power section may be faulty. Replace the DC/DC board. 2. Replace module bus flex board.
'Battery failure' message on the screen.	1. Problem in communication between battery and DC/DC board. 2. Battery too old or defected. 3. DC/DC board may be faulty.	1. Replace battery. 2. Replace battery. 3. Replace the DC/DC board.

Problem	Cause	What to do
'Frame temperature high' message.	The temperature inside the frame is too high.	Check monitor ventilation holes.
'Battery temperature high' message on the screen.	Battery SMBus temperature is too high.	Check monitor ventilation holes. Replace battery.
After shut off, the trend and patient data does not remain 15 min in the memory.	1. The On/Stby switch has been pressed over 10 s. (= service reset) 2. Empty battery. 3. Only one battery inserted.	1. When switching off, the On/Stby switch has to be pressed less than 10 s. 2. Replace the battery. 3. Use always two batteries.
Keyboard not working, but module communication is OK.	Keyboard cables and connectors, or interconnection board connectors may be faulty.	Check the interconnection board connectors. Check the keyboard cable connection to the user interface board.
Keyboard not working, and module communication not working.	UPI section of the CPU board not functioning normally.	Restart the monitor. Replace the Central Processing Board.
Keyboard partly not working.	1. Keyboard faulty. 2. Keyboard cables and connectors, or interconnection board connectors may be faulty.	1. Replace the keyboard foil. 2. Check the interconnection board connectors. Check the keyboard cable connection to the user interface board.

2.1 NET section troubleshooting

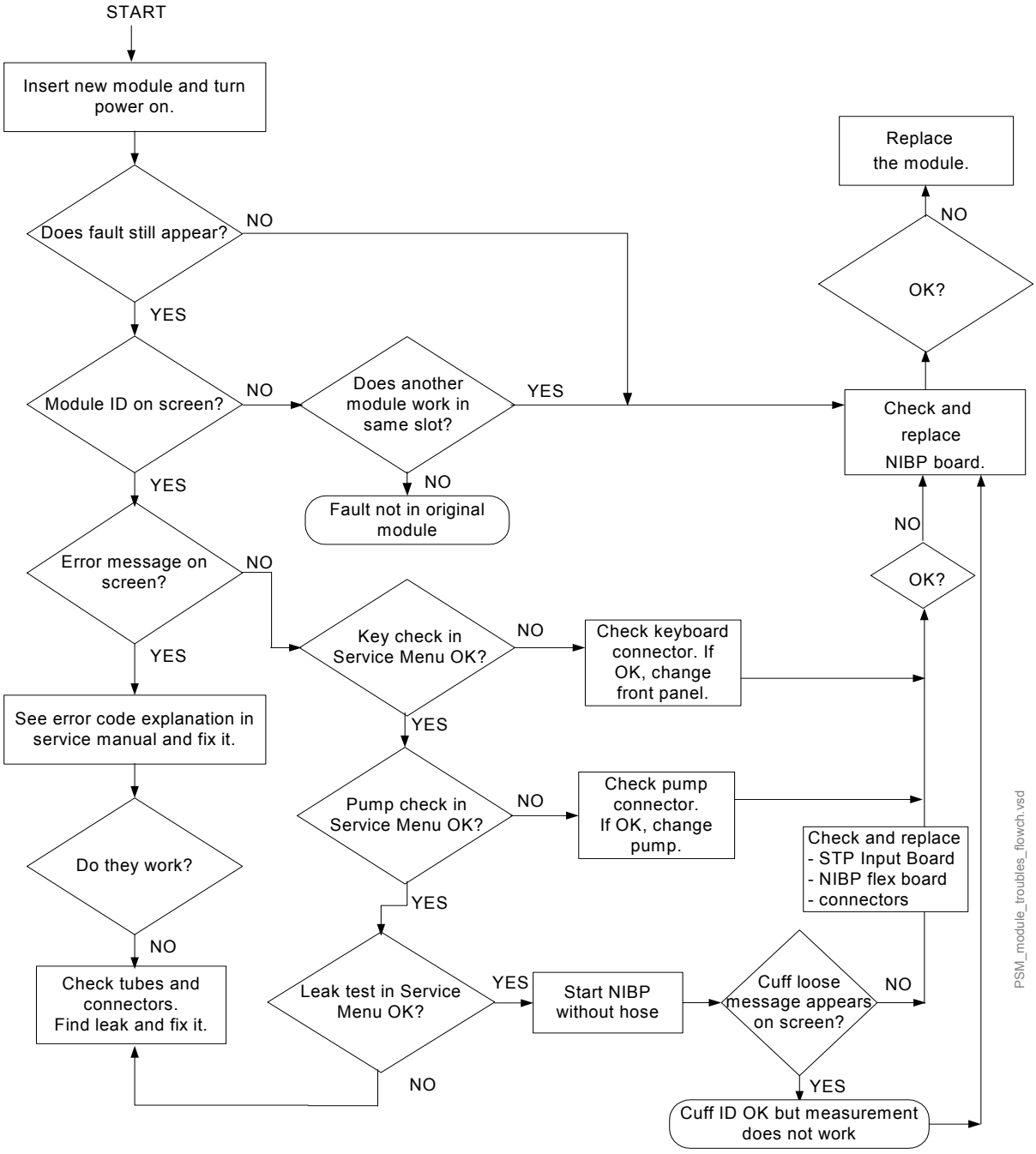
Problem	Cause	What to do
Monitor does not connect to the network. Monitor connects to the network, but disconnects unexpectedly ('Network down: central serve' message on the monitor screen).	Patch panel	Patch cable not connected to HUB or to panel.
	Patch cable	Patch cable or connector defective.
		HUB not connected to power supply.
		HUB port closed due to physical layer problems.
		HUB port temporarily closed and reopened due to physical layer problems.
		Hubs not properly connected to each other.
	Monitor-Network cable	Cable not properly connected to the wallplate or to the monitor.
		Cable or connector defective.
	Network cable (inside the monitor) defective	Replace the Network cable.
	Network Connector Board defective	Replace the Network Connector Board Unit.
	Net section of the CPU board	The NET section is defective. Replace the CPU board.
	NET section memory on the CPU board	The SRAM of the NET section is defective or uninitialized. The NET cannot be used. See network service page for details.
	Identification plug	There is no identification plug attached to the monitor. The identification plug is defective or uninitialized. The plug cannot be used.
	Multi I/O adapter faulty	Replace multi I/O adapter.
'Check network connectors' message shows on the monitor screen	Monitor-Network cable	Cable not properly connected to the wallplate or to the monitor. Cable or connector defective.
	Network cable (inside the monitor) defective	Replace the Network cable.
	Network Connector Board defective	Replace the Network Connector Board Unit.
	Multi I/O adapter faulty	Replace multi I/O adapter.
	Identification plug	There is no identification plug properly attached to the monitor. The identification plug is defective or uninitialized. The plug cannot be used. See network service page for details.

Problem	Cause	What to do
'Network board error' message shows on the monitor screen	NET section on the CPU board NET section memory on the CPU board	The NET section is defective. The board cannot be used. See network service page for details. The SRAM memory of the NET section is defective or uninitialized. The board cannot be used. See network service page for details.
Other Site View shows no waveforms	No waveforms are set up for Monitor-to-Monitor communication	Run Network Setup to verify current Monitor-to-Monitor communication setup.
Network printing fails	Print server is busy Print queue is full Printer is off-line	Network manager's print server is busy at the moment and cannot take more print jobs. Try again after 15 seconds. There are too many unprinted documents waiting in the print queue. Check the printer, as it is not operating properly. Printer cable is loose, printer is out of paper, there is a paper jam or the printer is simply switched to off-line state.

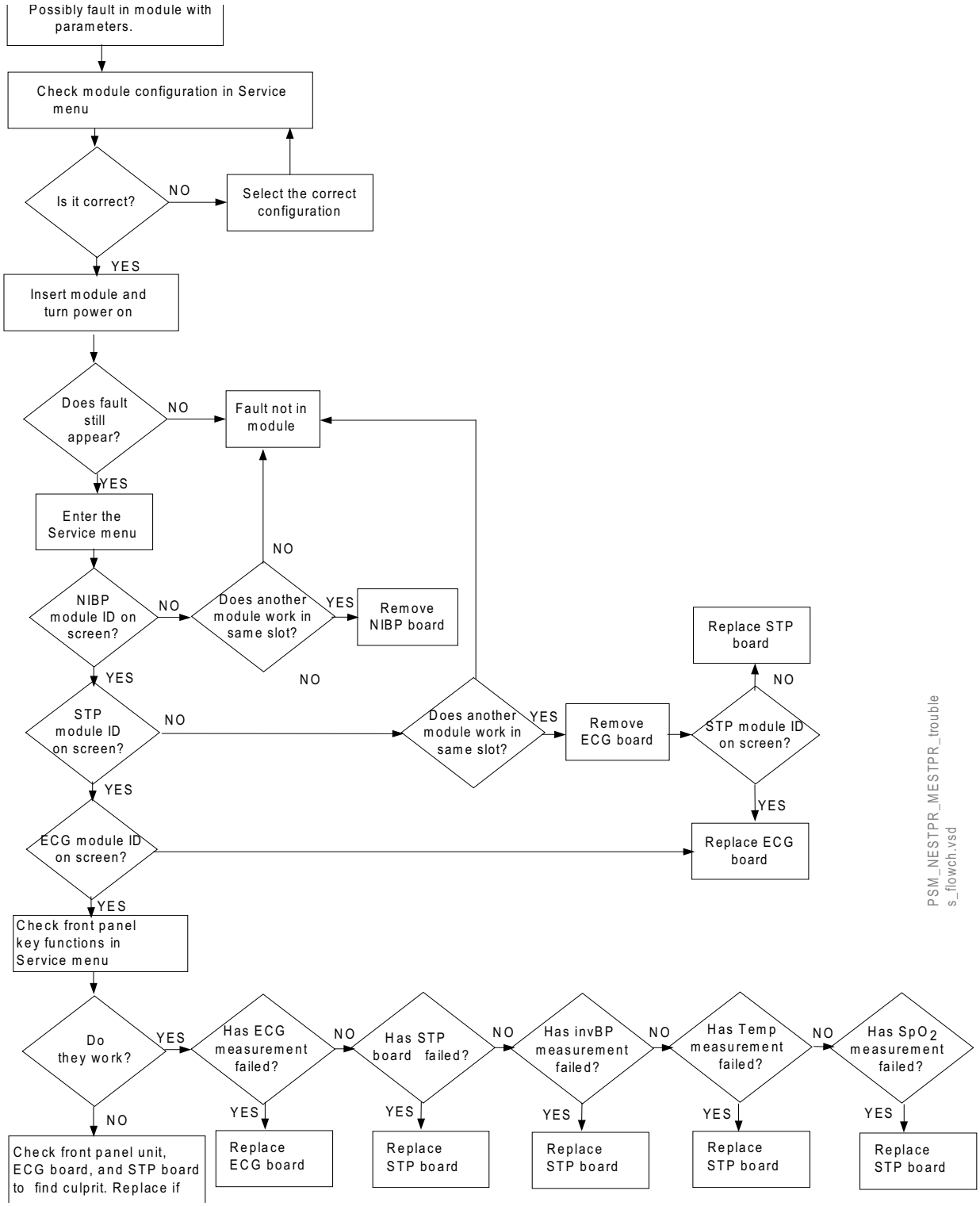
3 E-PSM(P)W Troubleshooting

3.1 Troubleshooting flowcharts

3.1.1 Troubleshooting for NIBP parameter



3.1.2 Troubleshooting for ECG and STP parameters



3.2 NIBP

3.2.1 NIBP toubleshooting

Problem	Cause	What to do
No NIBP value displayed	NIBP not selected on screen.	Check monitor setup.
'Artifacts' message	Unsuccessful measurement due to patient movement, shivering, external artifact or weak signal.	Check the patient status.
'Weak pulsation' message	Weak or unstable oscillation pulses due to: • artifacts • weak pulse pressure due to arrhythmias • improper cuff position or attachment • too few pulses detected • weak or unusual blood circulation • obese patient	Check patient condition and retry. Check any leaks and retry. Use proper size of cuff. Check attachment.
Call service 'Error X' message	NIBP hardware error. X = error number.	See the description of the error message code.
'Cuff loose' message	1. Hose and/or cuff not connected.	1. Connect the hose and the cuff.
	2. Hose and cuff connected. Reasons:	
	- cuff loosely wrapped	- Tighten the cuff.
	- leakage inside the shield, in the Patient connector panel or tubings connecting to the module	- Check the tubings inside the shield and Patient connector panel, fix if necessary.
	- leakage in cuff or hose	- Replace cuff/hose.
	- leakage inside module	- Check internal tubing and fix if necessary.
	- pump does not work	- Check pump connector; if OK, replace the NIBP Pump Unit.

Problem	**Cause**	**What to do**
Cuff ID not working	1. Defective cuff ID holes in the NIBP cuff hose	- Replace NIBP cuff hose.
	2. NIBP flex board connector wrongly connected	- Check that the NIBP flex board connector is properly connected to the STP input board: all pins have to be connected.
	3. Cuff ID switches defective	- To check the switches, attach a NIBP cuff hose without the cuff ID and check that the message 'Select inflation limit' appears. If not, replace the Front Panel Unit.
'Air leakage' message	1. Hose or cuff leaking. Reasons:	1. Replace cuff
	- cuff damaged	- Replace cuff.
	- cuff connector damaged	- Replace cuff connector (if the fault is in hose connector).
	- O-ring damaged or missing	- Replace O-ring.
	- hose double connector damaged	- Replace NIBP cuff hose.
	2. Hose and cuff OK. Reasons:	2. Connect or replace tube
	- leakage in the tubes connecting the patient connector panel and the module	- Check the tubes.
	- leakage inside the module	- Replace the whole tubing.
	- tube disconnected or damaged	- Fix connections.
	- manifold leaking	- Replace the manifold.
	- tubes or valve(s) damaged	- Replace tubes/valve(s).
'Unable to measure Sys' message	Systolic blood pressure probably higher than the inflation pressure or artifacts.	Automatic retrial with increased pressure.

Problem	**Cause**	**What to do**
'Cuff occlusion' message	1. Cuff and/or hose occluded. Reason:	
	- cuff tube kinked	- Straighten tube.
	- tubes inside the shield kinked	- Straighten tubes.
	- tubes inside module kinked	- Straighten tubes.
	- occlusion inside/outside module	- Remove occlusion.
	2. Cuff, hose, and tubes OK. Reason:	
	- fault in pressure transducer	- Replace the NIBP board.
	- fault in A/D converter	- Replace the NIBP board.
	- faulty calibration	- Check calibration.
'Calibration switch on' message	EEPROM protection has been handled by pressing module buttons **Auto ON/OFF** and **Start/Cancel** simultaneously for 3 seconds.	Enables setting the protection OFF in the ***Calibration*** menu. Press the buttons again if you are not going to calibrate.
'Calibration not protected' message.	Calibration protection is set to OFF.	Set the protection ON in the NIBP ***Calibration*** menu.

3.2.2 NIBP error code explanation

Code	Problem	What to do
0	RAM failure; memory failure	Change the NIBP board.
1	ROM checksum error; memory failure	Change the NIBP board.
2	Pump current failure	Check short circuits. Change the NIBP board.
3	Safety CPU internal test failure or pressure sensor reference voltage failure	Change the NIBP board.
4	Calibration switch is ON	Press module buttons **Auto ON/OFF** and **Start/ Cancel** simultaneously for 3 seconds.
5	Calibration not protected	Protect calibration by selecting Protection ON in the NIBP calibration menu.
6	Pressure sensors give different readings	Try to remeasure. If the problem persists, recalibrate. If the problem still persists, change the NIPB board.
7	Calibration failure	Reset the module and recalibrate. If this does not help, change the NIBP board.
8	Exhaust Valve occlusion	Check and clean the tubing and air chamber. If this does not help, change the NIBP board.
9	Measurement related error	Automatic recovery.
10	EEPROM checksum error; memory failure	Change the NIBP board.
11	Auto zero range exceeded	Calibrate the NIBP.
12	Not in use	Not in use
13	Illegal neonate cuff with identifying magnet connected	Remove the cuff.
14	Not in use	Not in use
15	Safety CPU pressure calibration error	Recalibrate. If this does not help, change the NIBP board.
16	Communication error between CPUs	Change the NIBP board.
17	Safety CPU has cut down power from pneumatics due to repeating safety limit violations	Reset the module. If the problem persists, change the NIBP board.

3.3 ECG

Problem	Cause	What to do
HR numerical display shows '---'	No heart rate available.	If no ECG waveform, check LEADS OFF message and connect the leads.
		If ECG waveform exists, check heart rate source e.g. in the ECG Setup menu behind ECG key.
Unacceptable ECG waveform	Poor electrode or poor electrode skin contact.	Electrodes from different manufacturers are used. /Too much/little gel is used.
	Poor electrode condition.	Electrodes are dried out.
	Improper site of electrodes.	Check that electrodes are not placed over bones, active muscles, or layers of fat.
	Improper skin preparation.	Remove body hair. Clean attachment site carefully with alcohol.
	Improper bandwidth filter.	Check filter.
	Faulty/ dirty ECG cable.	Change new cable.
No ECG trace	Waveform not selected on screen.	Press the **Monitor Setup** key and make adjustments.
	Module not plugged in correctly.	Plug in.
Noise-message	High frequency or 50/60 Hz noise.	Isolate noise source.

3.4 Impedance respiration

Problem	Cause	What to do
No resp trace	Waveform not selected on the screen	Press the Monitor Setup key and make adjustments.
	Module not plugged in correctly	Re-plug the module.
Unacceptable resp waveform	Poor electrode or poor electrode skin contact	Electrodes from different manufacturers are used. Too much/little gel is used.
	Poor electrode condition	Electrodes are dried out.
	Improper site of electrodes	Check that electrodes are not placed over bones, active muscles, or layers of fat.
	Improper skin preparation	Remove body hair. Clean attachment site carefully with alcohol.
	Faulty/ dirty ECG cable.	Change new cable.
Message: 'SMALL RESP CURVE'	Respiration signal is very small	With 3-lead cable try another lead connection I, II, III or try 5-lead cable.
Message: 'APNEA ALARM', and respiration waveform normal	Respiration source is CO_2	Check respiration source and change it to correct one.

3.5 Pulse oximetry (SpO_2)

Problem	Cause	What to do
Message 'NO PROBE'	No sensor connected to the module SpO2 connector.	Check sensor connections.
	Sensor faulty.	Change the sensor.
	Flat cable connecting the SpO2 connector to the STP board loosen or broken.	Check the Flat cable, replace if necessary.
Message 'PROBE OFF' though sensor properly attached to the patient	Unsuitable site.	Try another site.
	Sensor faulty.	Try another sensor.
	Sensor connection cable not connected to sensor.	Connect the cable to sensor.
Finger sensor falls off	Sensor is slippery.	Wipe with 70% isopropyl alcohol and allow drying.
	Finger is too thin or thick.	Try other fingers, or other sensor types.
Weak signal artifacts	Poor perfusion.	Try another place.
	Movement artifacts.	
	Shivering.	
Message 'NO PULSE'	Pulse search > 20 sec. and low SpO_2 or low pulse rate.	Try other fingers.
Message 'ARTIFACT'	Pulse modulation exceeds the present scale.	Try another place or another sensor.
Message 'CHECK PROBE'	DC value not in balance.	Try another sensor.
Message 'POOR SIGNAL'	Poor perfusion. Modulation (Red or Ired) < 0.25%	Check that the sensor is positioned correctly to the patient.
Message 'FAULTY PROBE'	Sensor is faulty.	Change the sensor.
No SpO_2	No waveform selected on screen.	Check the selected SpO_2 waveforms by pressing **Monitor Setup** key and selecting ***Screen Setup - Waveform Fields***.
	Wrong configuration setting.	Check the configuration settings from the STP/Calibrations menu (**Monitor Setup – *Install/Service - Service - Parameters***)

3.6 Temperature

Problem	Cause	What to do
Message 'TEMPERATURE ERROR'	Faulty calibration.	Perform calibration. If it does not help, check that front panel connector is properly connected to STP board.
No temperature displayed	Wrong type of probe.	Use correct probe.
	Temperature out of measurable range.	The range is between 10 and 45 °C.
	Temperature calibration not protected.	Set the protection ON in the Service Menu.

3.7 Invasive blood pressure

Problem	Cause	What to do
Abnormally low pressure	Transducer wrongly positioned.	Check mid-heart level and reposition transducer.
No pressure 'Not zeroed' message	Defective transducer.	Check transducer.
	No pressure module plugged in.	Check the module.
	No waveform selected on screen.	Check the selected pressure waveforms by pressing **Monitor Setup** key and selecting ***Screen Setup - Waveform Fields***.
		Check that the pressure transducer is open to the patient.
	Wrong configuration setting	Check the configuration setting from the STP/Calibrations menu (**Monitor Setup** - ***Install/Service - Service - Parameters***).
	Measurement on, channel not zeroed.	Zero the channel.
'Zeroing failed' message	Unsuccessful zeroing of P1 /P2 (number field).	Possibly due to pulsating pressure waveform. Open the transducer to air and zero the channel.
		Offset is > 150 mmHg. Open the transducer to air and zero the channel.
		Defective transducer. Replace it and zero the channel.
'Calibration failed' message	Unsuccessful calibration of P1/P2 (number field), possibly due to a pulsating waveform	Turn the transducer to sphygmomanometer and try again (zeroing takes place first).
		Gain is beyond the limits (± 20% of the default gain). Replace the transducer.

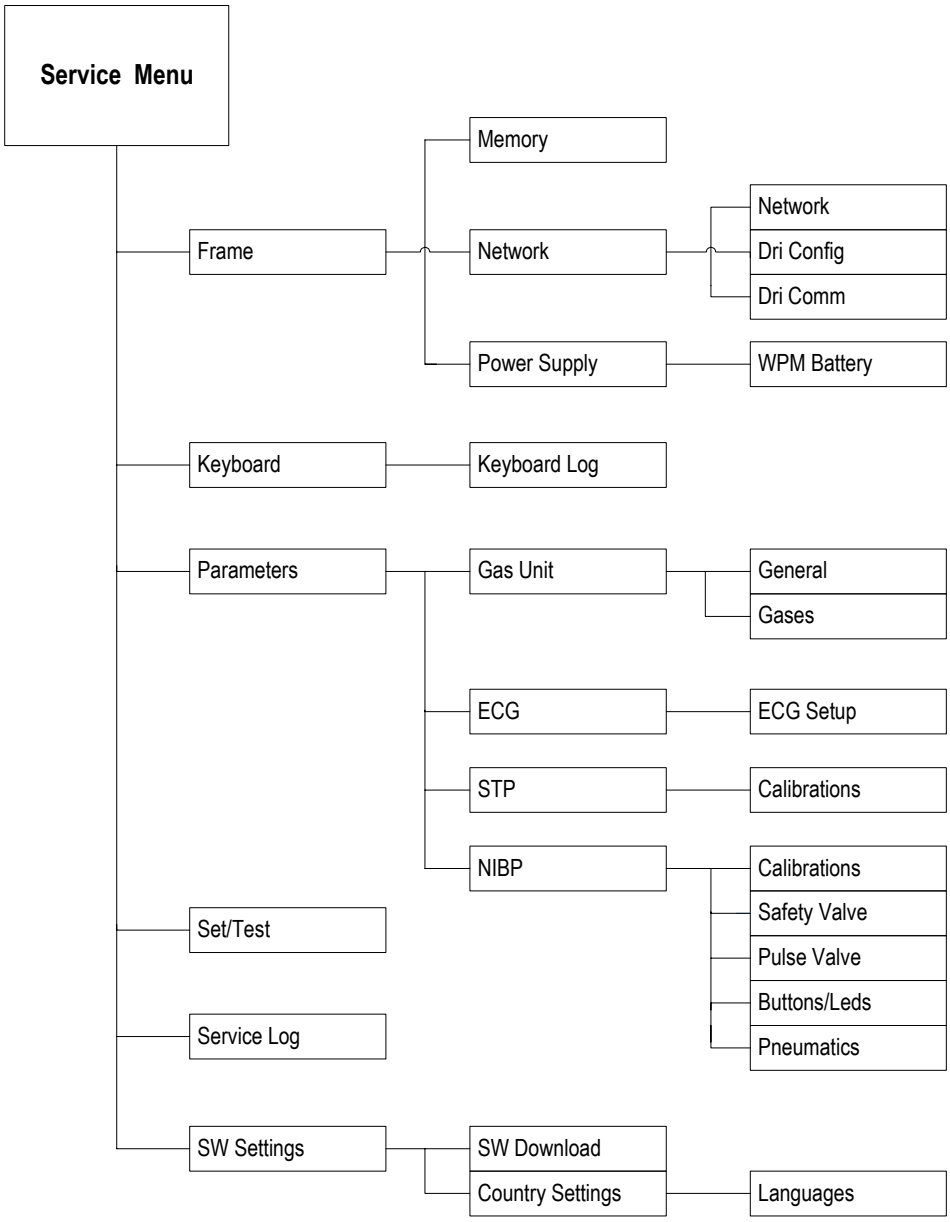
Problem	Cause	What to do
Invasive pressure calibration is not selectable	Patient case is active	Discharge a patient and make sure that the E-PSMPW module does not receive any signals from a simulator
Invasive pressure calibration is not selectable	Patient case is active	Discharge a patient and make sure that the E-PSMP module does not receive any signals from a simulator.
Out of range < 40 mmHg	Measurement pressure is beyond the measurement range.	Check the transducer level. Zero the channel.
Out of range > 320 mmHg	Measurement pressure is beyond the measurement range.	Check the transducer level. Zero the channel. The patient may also have high pressure.
Zero adj. > 100 mmHg	Offset when zeroing is > 100 mmHg (but < 150 mmHg) from the absolute zero of the module (with default gain).	Check the transducer. The waveform may hit the top and the numeric display not shown.
Out of range	Measured pressure is beyond the internal measurement range of the module.	The waveform hits the top and the numeric display not shown. Check the transducer and its level. Zero the channel.

5 Service Menu

1 Introduction

The monitor has a **Service Menu**, which is a useful tool to examine monitor functions and to troubleshoot in case a fault occurs.

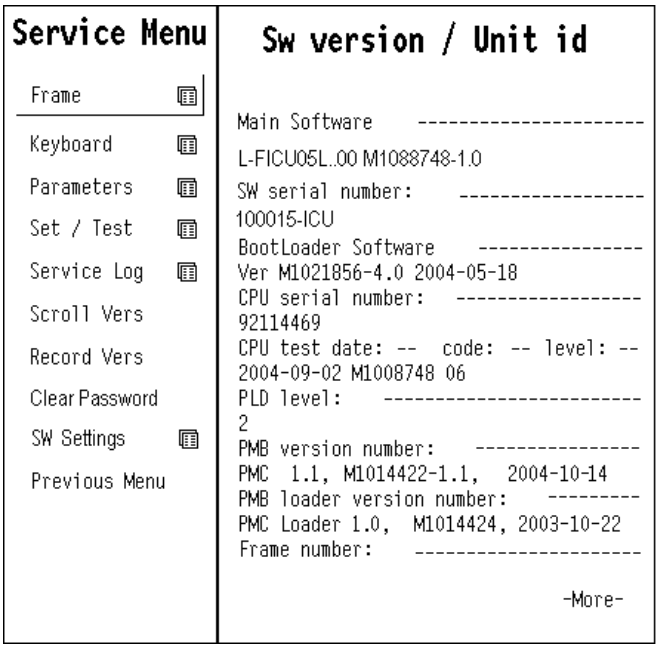
1.1 Service Menu structure



1.2 Service Menu

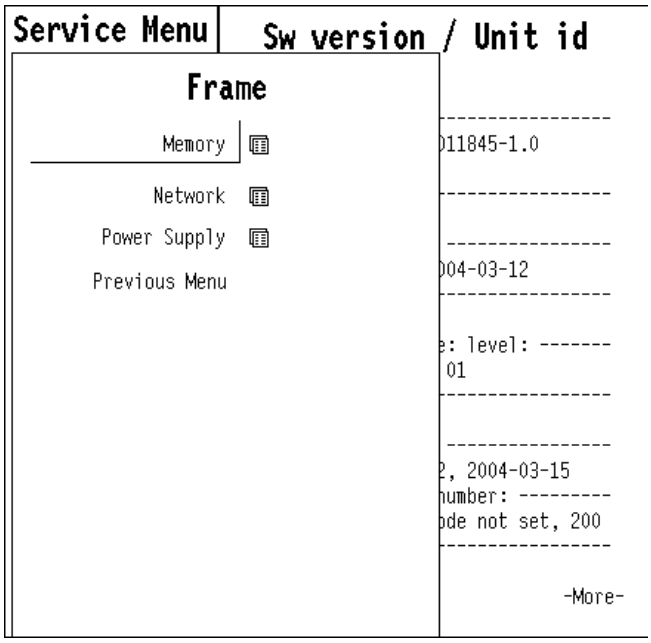
NOTE: The Service Menu pictures are for reference only. Details on the menu page can vary depending on the software version and the module type in use. If a particular selection is not available in your system, the selection is shown grayed.

1. Press the **Monitor Setup** key.
2. Select ***Install/Service*** (password 16-4-34).
3. Select ***Service*** (password 26-23-8).



2 Frame

The Frame menu includes frame-specific service menus.



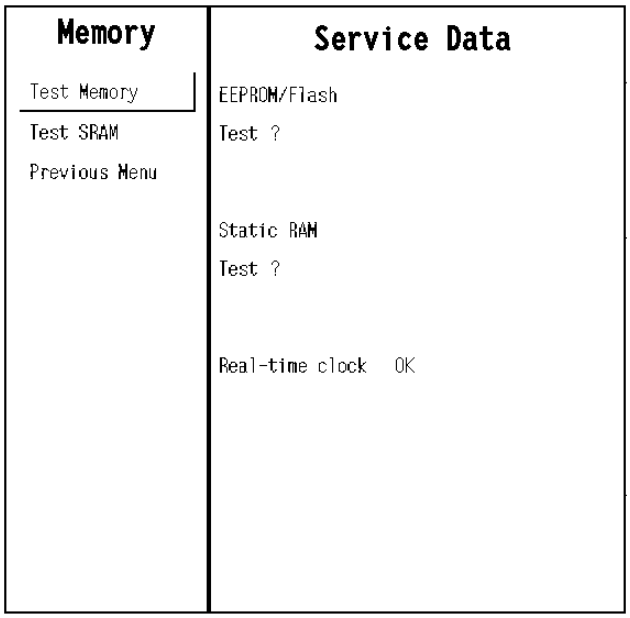
2.1 Memory

A service menu to check the status of the memory used in the CPU board of the monitor.

Test Memory tests the condition of the EEPROM/Flash memory component of the CPU board. If the result of the test is ***Fail***, see section “Error messages” in chapter “CPU.”

Test SRAM tests the Static RAM memory of the CPU board in a similar way as the EEPROM/Flash memory. If the result of the test is ***Fail***, see section “Error messages” in chapter “CPU.”

Real-time clock test is run at every start up and also during the operation of the monitor. If the result of the test is ***Fail***, the battery for the SRAM timekeeper should be replaced.



2.2 Network

2.2.1 Network

Network: For setting the monitor's network mode: S5/Unity

NOTE: Only in Chinese language, Unity mode is available.

2.2.2 Dri Config

The DRI Level: For setting the monitor's network communication. The network communication needs match to the iCentral's configuration

Transfer Mode: For choosing the transfer mode: DRI/ETH or DRI/UDP

Default SLP IP: For R&D purpose only. (DRI/ETH is not in use)

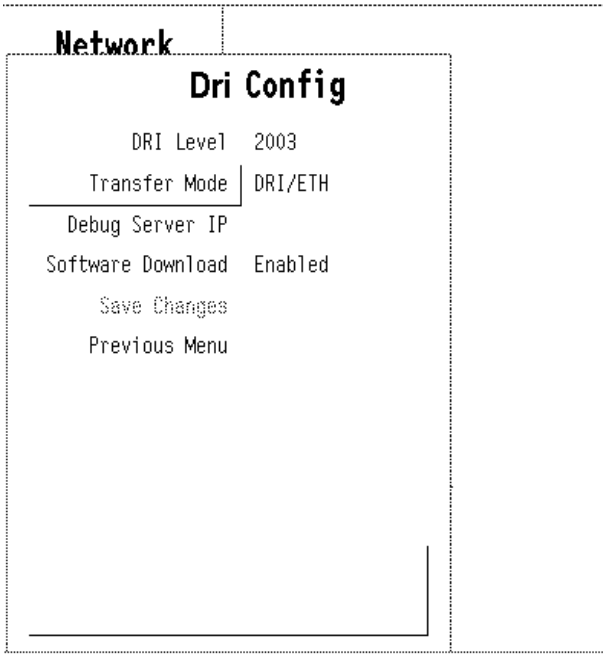
Forced Central IP: For setting IP address, which according to the iCentral's configuration. (DRI/ETH is not in use, it's can capture the IP automatically)

Forced Central Port: For setting port address, which according to the iCentral's configuration. (DRI/ETH is not in use, it's can capture the port automatically)

Debug server IP: For R&D purpose only.

Software download: For setting software download capability.

Save Changes: Select "Save Changes" to take in use changes made in this page.



2.2.3 Dri Comm

Session layer

Dest. name shows the name of the Central the monitor is connected to.

Dest. id shows the Central Subnet.

Dest. address shows the MAC address of the monitor network NIC in Central.

Protocol specific situations:
For R&D purpose only.

Tx resent critical

Rx non-critical duplicate

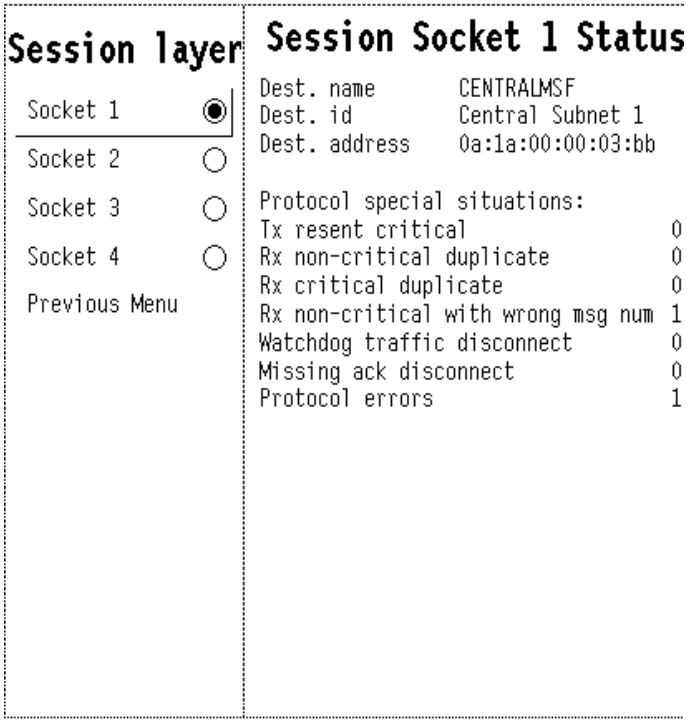
Rx critical duplicate

Rx non-critical with wrong msg num

Watchdog traffic disconnect

Missing ack disconnect

Protocol errors.



Ethernet

The **Ethernet Status** view shows the general status of the ethernet network communication.

Driver: Ethernet chip name (I82551ER).

Cable: Indicates if the ethernet cable is connected.

EthernetAddr: Monitor's ethernet address.

Speed: Indicates the current ethernet communication speed.

The service data related to the ethernet status view is described in the following table.

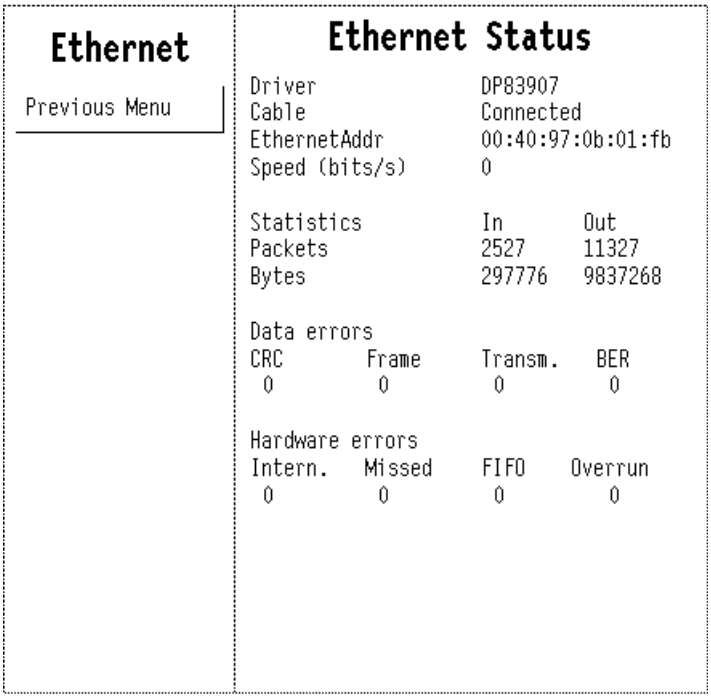
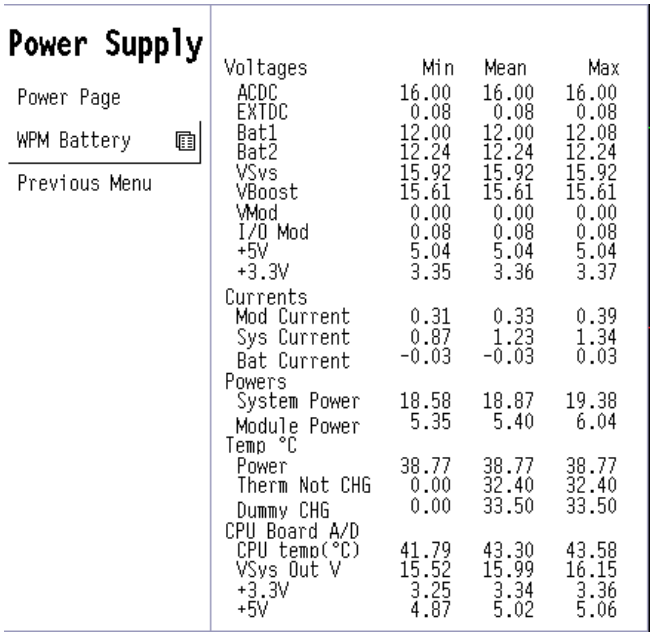


Table 1 Ethernet service data

Value	Usage	Notes
Received packets (***Statistics In/Packets***)	Total number of received packets since last cold start.	
Transmitted packets (***Statistics Out/Packets***)	Total number of transmitted packets since last cold start.	
Received bytes (***Statistics In/Bytes***)	Total number of received bytes since last cold start.	
Transmitted bytes (***Statistics In/Bytes***)	Total number of transmitted bytes since last cold start.	
CRC errors (***CRC***)	Number of received packets with incorrect checksum.	
Frame errors (***Frame***)	Number of received packets with incorrect frame structure.	Refers to physical layer problems. An erroneous packet has often both frame and CRC errors.
Transmission errors (***Transm.***)	Number or errors in packet Transmission.	
BER errors (***BER***)		
Internal errors (***Intern.***)	Internal error of the network board.	Must always be 0.
Missed packets (***Missed***)	Number of received packets lost due to overload.	Must always be 0.
FIFO errors (***FIFO***)	Internal error of the network board.	Must always be 0.
Overrun errors (***Overrun***)	Practically the same as above.	Must always be 0.

2.3 Power supply



The menu shows the voltages and temperature measured by the DC/DC board and CPU board. The values in the column under ***Mean*** are the mean values of last one second, the ***Min*** column shows the minimum mean value, and the ***Max*** column the maximum mean value of the voltages and temperature measured during the current power ON.

The voltages and currents are measured by the DC/DC Board, except the four lowest under heading CPU Board A/D, which are measured by the CPU Board. +5V and +3.3V values come thus both from the DC/DC Board and CPU Board. System power and Module power are calculated by the DC/DC Board.

Voltages

ACDC AC/DC converter's output voltage, used as monitor input voltage when the mains cord is connected. Range when present: 15.25...16.55V (Note: this includes the measurement inaccuracy).

EXTDC External DC input voltage, can be used as monitor input voltage when present, if the mains cord is not connected. Range when present: 10...16.5V

Bat1 Battery A voltage measured at DC/DC Board. Range 9...12.6V for Li-ION battery

Bat2 Battery B voltage measured at DC/DC Board. Range 9...12.6V for Li-ION battery

VSYS System voltage at DC/DC Board. This is the monitor input voltage measured at the DC/DC Board after input voltage selection. Range 9...16.5V.

VBOOST Boost converter's output voltage at DC/DC Board. Boost converter's input is VSYS, which is raised to a higher level for module bus voltage and battery charging, if needed. Range 14...16V.

VMOD Supply voltage for modules. VBOOST is fed through a circuit breaker to VMOD. Range 13.8...16V.

I/O_VMOD Module bus supply voltage that can be connected to Multi I/O Connector at the rear of the monitor. Connecting depends on the DC/DC Board software. Range when connected: 13.8...16V

+5V At DC/DC Board. Range 4.8...5.3V.

+3.3V At DC/DC Board. Range 3.15...3.45V.

Currents

Mod Current Current from module bus voltage VMOD. Depends on the module configuration.

SYS Current Current from system voltage VSYS. Depends on the system configuration and battery charging.

Bat current Current from or to the battery selected (discharge or charge). Measured at DC/DC Board. Depends on the system configuration and battery charging.

Powers

System power Power from VSYS, calculated by DC/DC Board software. System power = VSYS * SYS Current

Module power Power from VMOD, calculated by DC/DC Board software. Module power = VMOD * Mod Current

Temp

Power TempPower supply unit temperature, measured at DC/DC Board.

Therm Not CHGThis is subject to change.

Dummy CHGThis is subject to change.

CPU Board A/D

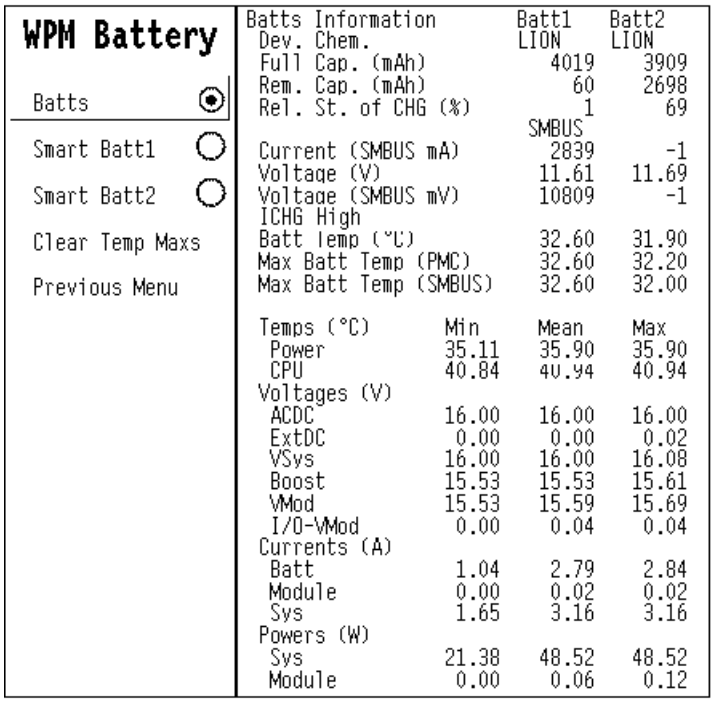
CPU TempTemperature measured at CPU Board.

VSYS_OUTVSYS that is connected to CPU Board and Backlight Inverter by a FET.
Measured at CPU Board. Range 9...16.5V.

+3.3VMeasured at CPU Board. Range 3.15...3.45V.

+5V Measured at CPU Board. Range 4.75...5.25V.

2.3.1 WPM Battery



Batts

This page contains information related to the batteries and power supplies. The power supply part is practically the same as in Power Page. Battery information includes also data measured by the smart batteries themselves and transmitted to the DC/DC Board via SMBus.

SMBus is System Management Bus, a two-wire interface closely resembling I2C. SMBus is used for battery communication.

Batts information section of the page has two columns: Batt1 for battery A data and Batt2 for battery B data.

NOTE: Text 'SMBus' above Current (SMBus mA) line shows which battery is connected to the SMBus.

Battery information

Dev. Chem. Device chemistry. B30 monitor supports only Li-ION batteries.

Full Cap.(mAh) Full charge capacity of the battery; capacity of the battery when it is fully charged.

Rem. Cap. (mAh) Remaining battery capacity.

Rel. St. of CHG (%) Relative state of charge of the battery. Expressed as a percentage of Rem. Cap. (mAh) / Full Cap.(mAh).

Current (SMBus mA) Battery current (discharge or charge) measured by the battery, transmitted via SMBus to DC/DC Board.

Voltage (V) Battery voltage measured at the DC/DC Board

Voltage (SMBus mV) Battery voltage measured by the battery.

ICHG Charging power level for charger hardware, this bit can have values high or low. High is the normal setting, low is used when the DC/DC Board software determines to limit the total power consumption of the monitor by limiting the charging power (i.e. due to high temperature).

Batt Temp (°C) Battery temperature. This is real time data for the battery connected to SMBus.

Max Batt Temp (PMC) This is subject to change.

Max Batt Temp (SMBus) Maximum battery SMBus temperature from entering the service pages. Max values are updated in real time for the battery connected to the SMBus.

Other measurements See explanation in the previous power pages.

Smart Batt1, Smart Batt2

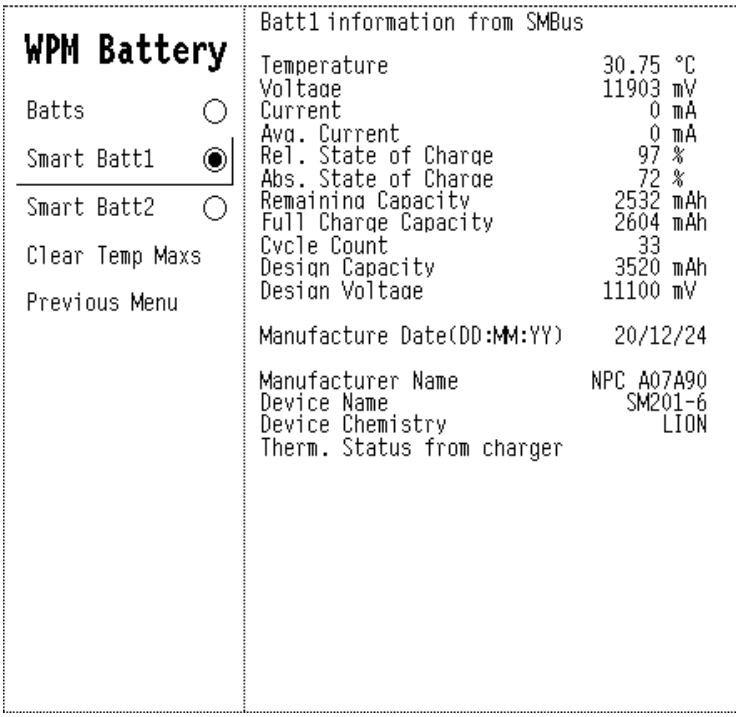
Clear Temp Maxs

This command is useful only when the WPM Battery Batts view is selected.
The Clear Temp Maxs command clears the maximum values of Batt Temp (SMBus) and Batt Temp (PMC).

Note: Power temp and CPU temp maxs are not cleared.

These menus give additional battery information via SMBus. Batt1 stands for Battery A, Batt2 for Battery B. If Smart Battx is selected for the battery connected to the SMBus, the menu contains the following:

Smart Batt1



Battx information from SMBus (this information is received from the battery via SMBus)

Temperature: Battery temperature

Voltage: Battery voltage

***Current*:** Battery current (discharge or charge)

Avg. Current: Rolling average of the battery current

Rel. State of Charge: Relative state of charge of the battery. Expressed as a percentage of Rem. Cap. (mAh) / Full Cap.(mAh).

Abs. State of Charge: Absolute state of charge. Expressed as a percentage of Rem. Cap. (mAh)/ Design Capacity (mAh).

Remaining Capacity: Remaining battery capacity (mAh).

Full Charge Capacity: Capacity of the battery when it is fully charged.

Cycle Count: Number of cycles the battery has experienced. A cycle is an amount of discharge approximately equal to the value of Design Capacity. The exact value of cycle count threshold is stored in the battery permanent memory.

Design Capacity: Theoretical capacity of a new battery.

Design Voltage: Theoretical value for nominal voltage of a new battery.

Manufacture Date (DD:MM:YY) : The date the battery pack was manufactured.

Manufacturer Name: Acronym of the battery pack manufacturer name.

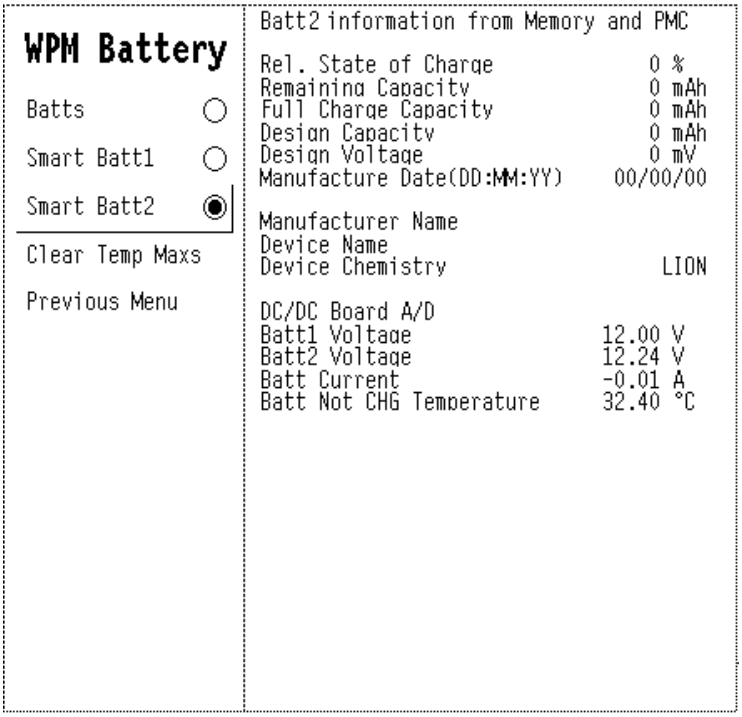
Device Name: Battery pack model name.

Device Chemistry: Battery chemistry of the cells used.

Therm. Status from charger: Status of the battery thermistor or code resistor read by Smart Battery Charger IC. The thermistor or code resistor is always connected to the charger whenever the corresponding battery is connected to the charger and SMBus.

Smart Batt2

If Smart Battx is selected for a battery NOT connected to the SMBus, the menu contains the following:



Battx information from Memory and PMC (This information comes from the DC/DC Board memory or is measured by the DC/DC Board. SMBus data in this menu is not real time, because this battery is not connected to the SMBus).

NOTE: This page may not contain information if SMBus has been connected only to the other battery. Page can be updated by battery disconnection and reconnection, if desired.

Rel. State Charge: Relative state of charge of the battery. Expressed as a percentage of Rem. Cap. (mAh) / Full Cap.(mAh).

Remaining Capacity: Remaining battery capacity (mAh).

Full Charge Capacity: Capacity of the battery when it is fully charged.

Design Capacity: Theoretical capacity of a new battery.

Design Voltage: Theoretical value for nominal voltage of a new battery.

Manufacturer Date (DD:MM:YY): The date the battery pack was manufactured

Manufacturer Name: Acronym of the battery pack manufacturer name.

Device Name: Battery pack model name.

Device Chemistry: Battery chemistry of the cells used.

Batt1 Voltage: Battery A voltage measured at the DC/DC Board.

Batt2 Voltage: Battery B voltage measured at the DC/DC Board.

Batt Current: Battery current (discharge or charge) for the battery connected to SMBus. Measured at the DC/DC Board.

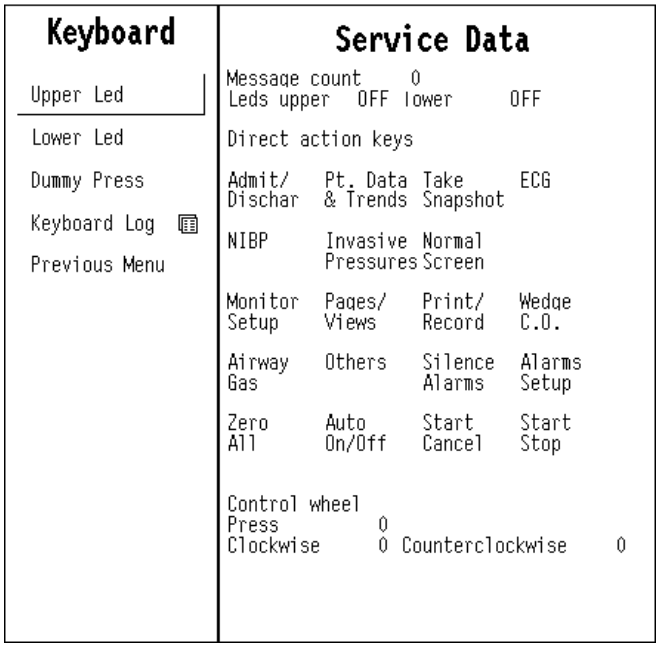
Batt Not CHG Temperature: This is subject to change.

3 Keyboard

Keyboard

The service menu for testing the command board functions.

Upper Led is for testing the upper alarm LED (red) on the command board. When the text is highlighted, the upper alarm LED can be turned on and off by pressing the ComWheel.
Lower Led is for testing the lower alarm LED (yellow) on the command board. When the text is highlighted, the lower alarm LED can be turned on and off by pressing the ComWheel.
Dummy Press is for testing the ComWheel. When the text is highlighted, pressing the ComWheel creates a sound from the loudspeaker and the corresponding number on the service data field increases.



Service Data

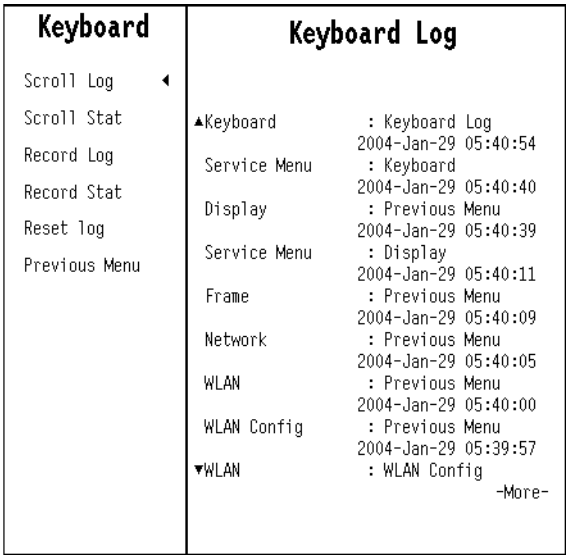
Message Count counts the number of messages that are sent out to the main CPU board.
Leds upper and ***lower*** indicate the states of the alarm LEDs on the command board.
Direct action keys texts are indications to the command board membrane keys. When a key on the command board is pressed, the corresponding text in the menu changes its colour.
Control wheel, Press counts the ComWheel pressings.
Control wheel, Clockwise and ***Counter clockwise*** indicate the ComWheel turnings.

3.1 Keyboard Log

Keyboard Scroll Log

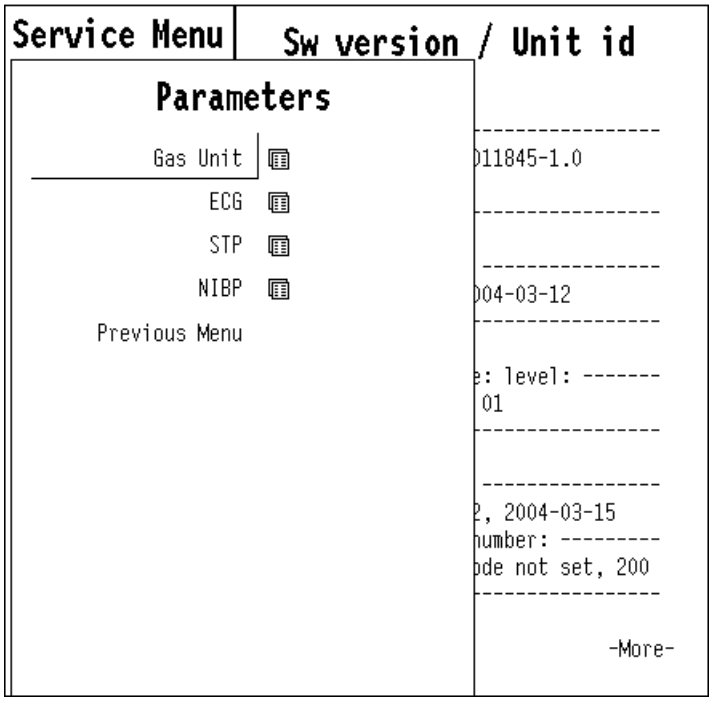
All the keyboard presses and the commands given by the ComWheel are recorded in the Keyboard Log. The keyboard log is saved in the permanent memory of the monitor. The length of the log is 80 events. The log is FIFO type.

Scroll Stat enables to scroll the keyboard events.

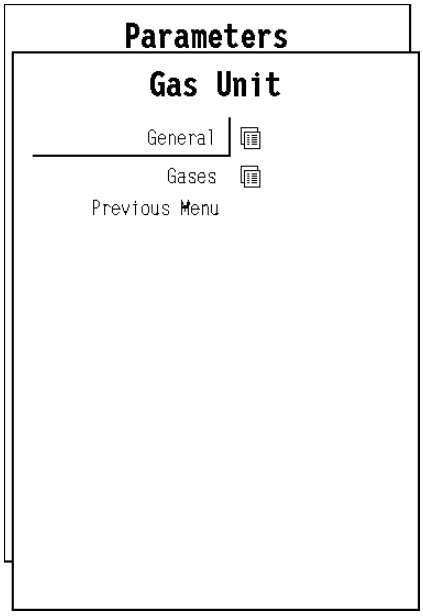


4 Parameters

NOTE: Parameter values in Service Data fields are only for reference in this section.



4.1 Gas Unit



4.1.1 General

Service Data

Module configuration shows which measurement options are available, i.e. are detected by the module.

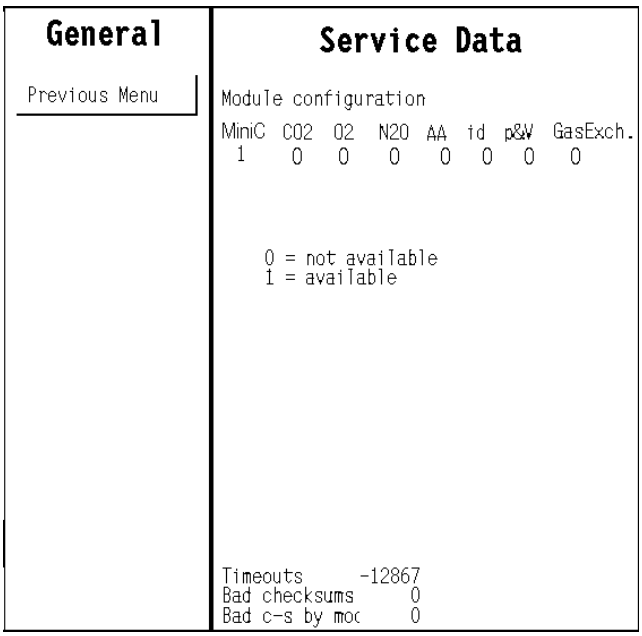
Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.

Bad checksums is a cumulative number that indicates how many times communication from the module to monitor has broken down.

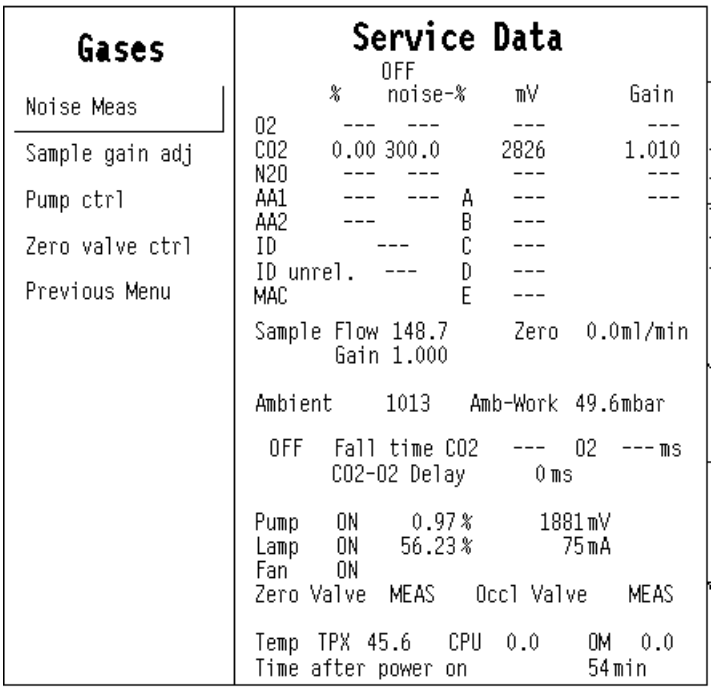
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.

The monitor starts counting these items at power up and resets to zero at power off. The values may also be reset when a module is attached to the monitor frame and be set to 32769 or continuous counting may be started when the module is removed from the monitor frame.

The nonzero values do not indicate a failure, but the continuous counting (more than 5 per second) or value 32769 indicates either a serial communication failure or a module not in place. Also failures in other modules may cause these numbers to rise or be set to 32769.



4.1.2 Gases



Noise Meas activates the noise measurement.

Sample gain adj adjusts the sampling pump gain, i.e. for adjusting the sample flow measurement.

Pump ctrl A manual control for the sampling pump.

Zero valve ctrl A manual control for the zero valve.

Service Data

CO_2% field shows real-time concentrations.

CO_2noise-% is standard deviation of concentration.

CO_2 /channels A-E

mV field: signal is scaled to mV.
Gain: User gain. It is scaled as (User gain)/(Factory gain).

O2, N2O, AA Not in use

ID Not in use

ID unrel. Not in use

MAC Not in use

Sample Flow is calculated from differential pressure and adjusted by the module. **Zero** value as measured during initialization when the pump is off. **Gain**: sample flow measurement can be calibrated by adjusting the gain.

Ambient Ambient pressure is measured continuously. **Amb-Work**: ambient pressure - sampling system internal pressure.

Fall time Not in use

CO_2-O_2 Delay Not in use

Pump Can be toggled ON/OFF. PWM output 0-100% is shown. Pump voltage is also shown.

Lamp The state, PWM control, and current of the lamp are shown.

Fan Not in use

Zero Valve Can be toggled between the measurement state (MEAS) and the zeroing state (ZERO).

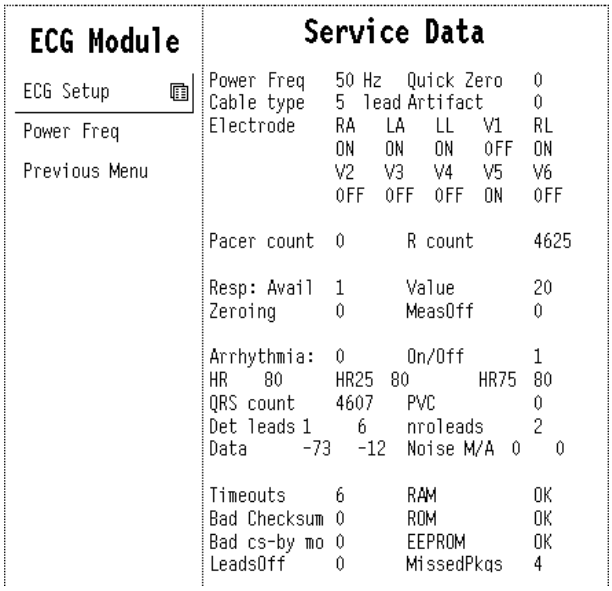
Occl Valve Not in use

Temp Temperatures measured by the module from TPX, CPU, and OM.

Time after power on In minutes after power on.

4.2 ECG Module

Service Data



Power Freq shows the mains frequency selected: 50 Hz / 60 Hz

Cable type shows the leadwire set connected: 3 lead / 5 lead

Quick Zero shows 1 when the ECG signal is beyond scale, and therefore, is quickly returned to the optimal range with fast signal processing methods.

Artifact shows 1 when artifacts are detected.

Electrode shows ON when each of these electrodes is connected.

Pacer count is a running number of detected pacemaker spikes.

R count is a running number of detected R waves.

Resp: Avail shows if a module with impedance measurement is plugged (1) or not plugged (0) into the monitor.

Value shows the measured respiration rate value for impedance respiration.

Zeroing indicates the zeroing status of the respiration measurement: 1 = zeroing, 0 = not zeroing.

MeasOff shows 1 if the respiration measurement is set to OFF, and 0 if the the respiration measurement is set to ON.

Arrhythmia shows an active arrhythmia alarm (VFIB, VTAC, ASY).

On/Off shows 1 if arrhythmia analysis is active and 0 if it is not active.

HR, HR25 and ***HR75*** for R&D purpose only

QRS count shows the running number of detected QRS complexes.

PVC shows the PVCs detected per minute

Det leads shows the leads that are being used for detecting beats and ventricular fibrillation. The selection of user leads (ECG1, ECG2, ECG3) on the monitor affects the leads used for detection. The first lead used for detection is lead either I or II. The algorithm uses the lead appearing first in user leads. The second lead used for detection is one of the precordial leads (V1 - V6): -1 = invalid (not used), 0 = lead I, 1 = II or III; 2 = V1, 3 = V2, 4 = V3, 5 = V4, 6 =V5, 7 = V6

nroleads shows the number of leads that are beign used for detecting beats and ventricular fibrillation. Possible values include: 0 , 1 and 2 (ref. ***Det leads***) analysis.

Data for R&D purpose only

Noise M/A for R&D purpose only

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. ***Bad checksums*** is a cumulative number that indicates how many times communication from the module to the monitor has broken down.

Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The values may also be reset when a module is attached to the monitor frame and be set to 32769 or continuous counting may be started when the module is removed from the monitor frame. The nonzero values do not indicate a failure, but the continuous counting (more than 5 per second) or value 32769 indicates either a serial communication failure or a module not in place. Also failures in other modules may cause these numbers to rise or be set to 32769.

RAM indicates the state of the RAM memory.
ROM indicates whether the checksum at the EPROM is in accordance with the one the software has calculated.
EEPROM indicates if the values stored in the permanent memory are valid.
The state is either ***OK***, ***Fail*** or ? (module not in place or a communication error).
LeadsOff indicates whether the monitor can measure ECG even if one or more leadwires are off: 1 = measurement is not possible, 0 = measurement can be done.

MissedPkgs indicates the number of packages missed.

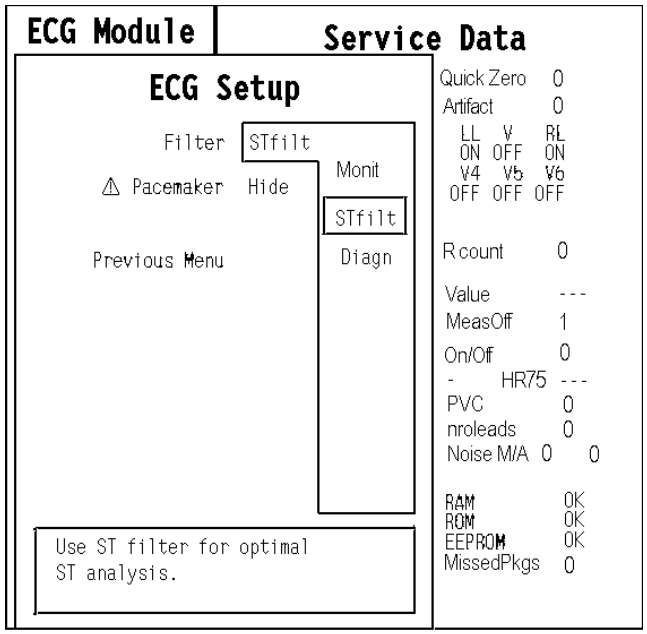
4.2.1 ECG Setup

Filter filters the ECG signal high frequency noise and slow respiratory artifacts:

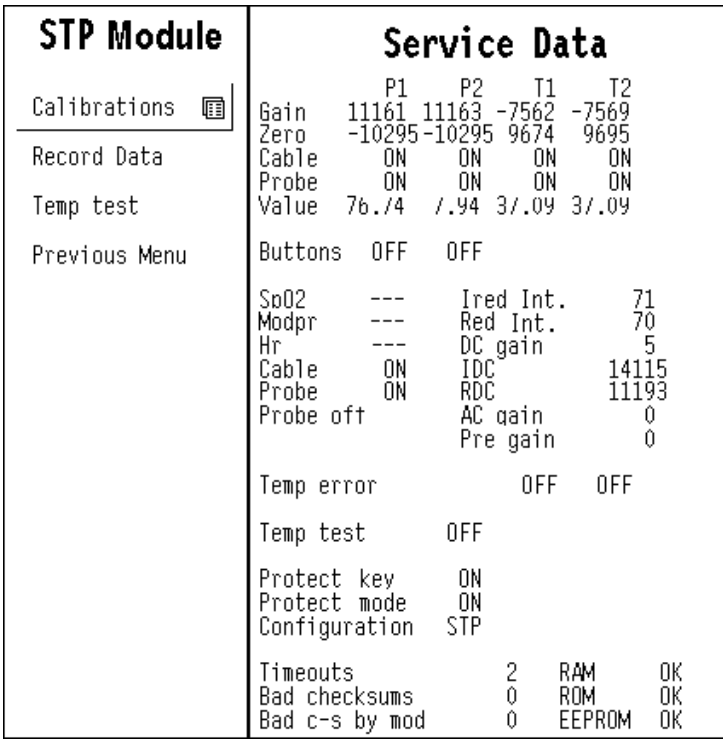
- ***Monit*** (monitor) filter is used in routine monitoring. It effectively filters the artifacts caused by the electrosurgery unit and respiration.
- ***Diagn*** (diagnostic) filter is used if more accurate information of the waveform is needed (e.g. of P-wave or AV block). The diagnostic filter is more susceptible both to high frequencies and baseline wander than the monitor filter.
- ***STfilt*** (ST filter) permits more accurate information of ST segment. It filters the high frequency artifacts caused by the electrosurgery unit, but catches the slow changes in ST segment. The ST filter is more susceptible to baseline wander than the monitor filter.

Pacemaker selects how to display the pacing pulse of cardiac pacemaker. The selections are ***Show***, ***Hide*** and ***Sensit***:

- ***Hide***: the pacing pulse is filtered away from ECG data.
- ***Show***: the pacer pulse is filtered away from ECG data but the pulse is displayed as a constant height marker.
- ***Sensit:*** uses a more sensitive pacemaker detection. Pacemaker spike is displayed on ECG.



4.3 STP Module



Record Data prints out the shown service data and board information (id, serial number and sw id) onto the recorder.

Temp Test activates the automatic temperature test for the temperature channels T1 and T2. The result from the test is shown in the service data field.

NOTE: The Temp Test needs to be selected twice before the test starts.

Service Data field

Gain is a coefficient to compensate gain error. Usually the values for P1 and P2 are between 17000 and 25000 and for T1 and T2 between 13000 and 14300. ***Zero*** indicates the offset compensation value of each parameter in the A/D converter. Typically the values for P1 and P2 are within ±1000 and for T1 and T2 between -150 and +300. Calibrate if zero and/or gain value is outside the ranges.
Cable shows ON when a corresponding cable is connected to the front panel and ***Probe*** shows ON when a corresponding probe is connected to the cable.
Under ***Value***, the measured numeric values are displayed simultaneously. Pressure values are real time values and shown in mmHg. Temperature values are shown in degrees Celsius.

The front panel STP keys functions are confirmed by pressing each key and observing that ***OFF*** turns to ***ON*** at ***Button***.

SpO2 shows the measured beat-to-beat SpO_2 value. ***Modpr*** is a modulation % that indicates the AC/DC ratio in the measured signal. ***Hr*** is a pulse rate calculated from every beat.
Cable and ***Probe*** can be either ***OFF*** or ***ON,*** and these indicate the state PROBE OFF.
Under them there is a message field for SpO_2. It can be OK, PULSE SEARCH, NO PROBE, PROBE OFF, NO PULSE, ARTEFACT, POOR SIGNAL, or CHECK PROBE.

Balance between leds is adjusted by changing the intensity of red/infrared. Intensity of infrared (***Ired Int.***) is in the range of 40 to 255 and red intensity (***Red Int.***) is in the range of 40 to 255.

DC gain shows the gain of DC signal adjusted by the module.

IDC is the value of infrared signal.

RDC is the dc value of red signal.

AC gain is the gain of infrared and red ac signals. AC gain values can be 1 or 0. Value 1 means high ac gain and 0 means low gain.

Pre gain is a preamplifier gain for infrared and red signals. Pre gain values can be 1 or 0. Value 1 means normal operation. Value 0 means that signal levels are very low and extra gain is taken into use.

Temp error shows the status of the temperature test. No errors found show the status (OFF) and errors found (ON).
Protect key and ***Protect mode*** show normally ON but can be turned to OFF for the temperature calibration in Calibration Menu.
Configuration shows the chosen module configuration: TP, ST, or STP.
Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. ***Bad checksums*** is a cumulative number that indicates how many times communication from the module to the monitor has ***broken down.***
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 5 per second) indicates either a serial communication failure, or a module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the RAM memory.
ROM indicates whether the checksum at the EPROM is in accordance with the one the software has calculated.
EEPROM indicates if the values stored in the permanent memory are valid.
The state is either ***OK***, ***Fail*** or ***?*** (module not in place or a communication error).

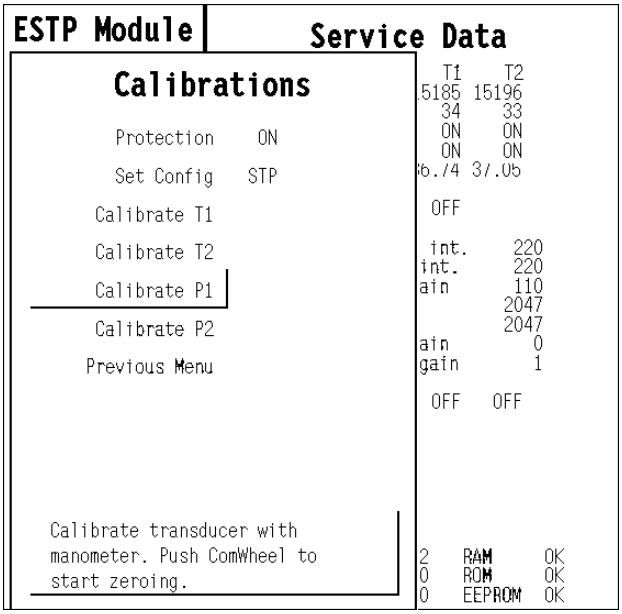
4.3.1 Calibrations

Protection: Protection for the configuration and temperature calibrations can be set ON and OFF.

***Set Config*:** The module configuration should be set according to the module type. The setting is possible only when the protection is set OFF. The available selections are TP, ST or STP. The configuration setting should be checked if the STP board is replaced.

***Calibrate T1 / Calibrate T2*:** The functions are for calibrating the temperature channels T1 and T2.

***Calibrate P1/ Calibrate P2*:** The functions are for calibrating the invasive blood pressure channels P1 and P2.



How to calibrate T1/ T2

The calibrations are possible only when the protection is set ***OFF***. The temperature calibration requires accurate test plugs of value 25 °C and 45 °C.

1. Select ***Calibrate T1/Calibrate T2***
2. Insert the test plug 25 °C into the T1/T2 connector
3. Press the ComWheel
4. Insert the test plug 45 °C into the T1/T2 connector
5. Press the ComWheel

How to calibrate P1/ P2

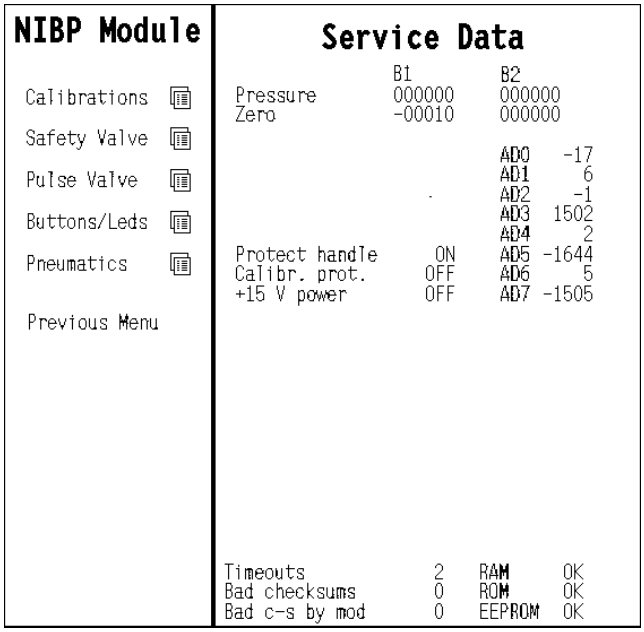
NOTE: Before starting the pressure calibration, disconnect all patient cables and discharge the patient.

The calibrations require a pressure transducer (with appropriate cable) and a pressure manometer.

1. Connect the pressure transducer with the pressure manometer to the P1/P2 connector. Select ***Calibrate P1/Calibrate P2***. Leave the transducer to room air pressure.
2. Press the ComWheel to start zeroing.
3. Supply a pressure of 100 mmHg to 300 mmHg to the transducer. The recommended pressure is 200 mmHg.
4. Set the pressure on the display to match the pressure reading on the manometer and press the ComWheel.

4.4 NIBP Module

Service menu for Non-invasive Blood Pressure Modules.



Service Data

Pressure shows the measured pressure multiplied by 10. This value is automatically zero-drift compensated.

Zero shows the difference between the zeroing value in the permanent memory (stored when the module is calibrated) and the current automatic zero-drift compensation multiplied by 10. The value can change between +20 and -20 mmHg. If the zero drift exceeds ± 10 mmHg, the module should be recalibrated.

Protect handle indicates hardware protection for EEPROM memory. It should be ON all the time in normal operation. If it is OFF data can not be read from or written to EEPROM, only the calibration protection can be set or reset by software. It can be turned to OFF by pressing the the NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds, which also enables ***Protection ON/OFF*** menu selection in the calibration menu.

Calibr. prot. shows software calibration protection and it should be OFF to enable calibration.

+15 V power refers to legacy NIBP modules. Not used in E-PSM(P)W.

AD0 to ***AD7*** show the values of each eight channels of the A/D converter. AD7 is not used in E-PSM(P)W.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.

Bad checksums is a cumulative number that indicates how many times communication from the module to the monitor has broken down.

Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.

The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 5 per second) indicates either a serial communication failure, or a module not in place. Also other modules can cause communication errors that cause these numbers rise.

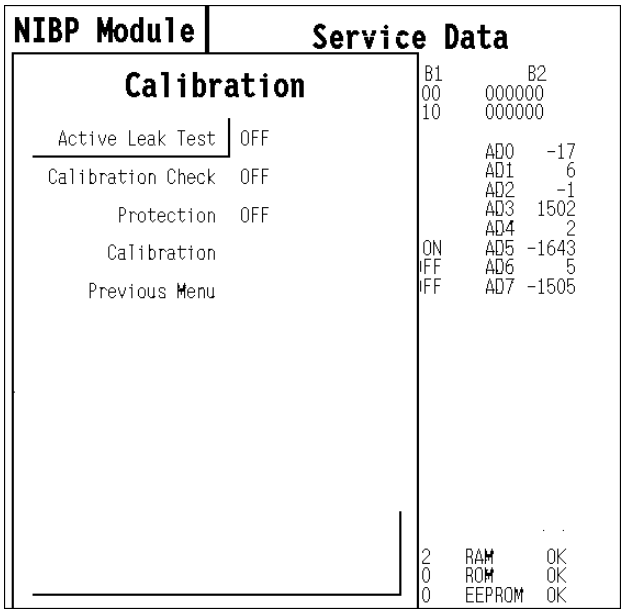
RAM indicates the state of the RAM memory.

ROM indicates whether the checksum in the EPROM is in accordance with the one the software has calculated.

EEPROM indicates if the values stored in the permanent memory are valid.

The state is either ***OK***, ***Fail*** or ***?*** (module not in place or a communication error).

4.4.1 NIBP Calibration



***Active Leak Test*:** Wrap an adult cuff around a pipe and connect the cuff to the module. Select the active leak test (ON). The module automatically pumps a pressure of 280 mmHg into the cuff. Wait for several seconds until the pressure stabilizes. Then check that the pressure reading does not drop more than 5 mmHg per minute. If it does, leaking point(s) should be detected and fixed. Cancel the test by selecting the Active leak test OFF.

***Calibration Check*:** After the calibration check is selected , the module zeroes the pressure transducers at the beginning of the calibration check. Do not pump pressure until the text 'Calibrating' appears in the NIBP digit field or the zeroing will fail. After the zeroing is done, manually pump pressure into the module and make sure that the same pressure values are shown both on the display and on the manometer. Pressure of both pressure channels B1 and B2 are shown. The pressure values are automatically zero-compensated, so the readings of B1 and B2 should be the same as the manometer readings.

Protection*:** Software calibration protection (ON/OFF). Select ***OFF when calibrating. ***Protection*** selection becomes available in the menu after pressing the NIBP module buttons **Auto ON/OFF** and **Start/Cancel** simultaneously for 3 seconds.

How to calibrate

NOTE: Perform NIBP ***Calibration Check*** first to evaluate if calibration is needed or not.

NOTE: Both channels B1 and B2 must be calibrated simultaneously.

NOTE: The module must be in the frame during the whole procedure.

NOTE: Calibration selection is available only when protection is OFF.

1. Press the NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds to enable the ***Protection*** selection - the color of the ***Protection*** selection changes from grey to white.

NOTE: Make sure that you are using the module keys and not the side panel keys of the monitor.

NOTE: When the buttons have been pressed, the message 'Calibration switch on!' is shown in the NIBP digit field.

2. Change the ***protection*** setting from ON to OFF to enable the ***Calibrate*** selection - the color of the ***Calibrate*** selection changes from grey to white.

NOTE: When calibration has been enabled, the message 'Calibration not protected' is shown in the NIBP digit field.

3. Zeroing:
   - Disconnect the NIBP hose from the module connector.
   - Select ***Calibrate*** and push the **ComWheel.**

NOTE: Messages 'Zeroing' and 'Zeroed' is shown in the NIBP message field and next to the ***Calibrate*** selection momentarily. After this, a pressure bar will appear beside the menu and the text 'Calibrating' is shown in the NIBP digit field.

4. Calibration:
   - Connect the NIBP hose to the module connector.
   - Connect an external manometer with a pump to both tubes of the hose.
   - Pump about 200 mmHg pressure.
   - Verify that both pressure values, B1 and B2, shown in the prompt field of the calibration menu match the manometer reading. If not, adjust the by turning the ComWheel.
   - Press **ComWheel** to complete the calibration.

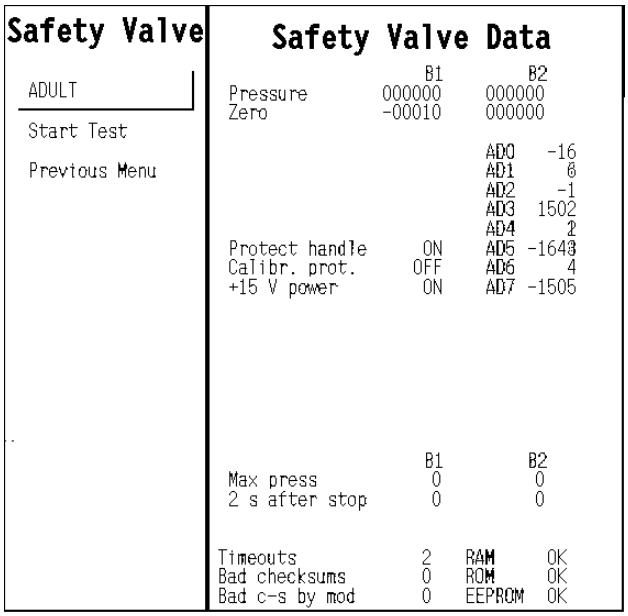
NOTE: Messages 'Calibrating" and 'Calibrated' are shown in the NIBP message field and next to the ***Calibrate*** selection.

NOTE: When calibrating NIBP, always change the displayed pressure value slightly with the ComWheel, even in cases where the value would be correct. For example, change the value one step higher and then back one step lower. The 'Calibrated' text should appear in the display. This ensures that the calibration procedure is correctly registered and stored by the module.

5. Change the ***Protection*** setting from OFF to ON to disable ***Calibrate*** selection - the color of the ***Calibrate*** selection changes from white to grey.
6. Press the NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds. This disables the ***Protection*** selection - the color of the ***Protection*** selection changes from white to grey.

4.4.2 NIBP Safety Valve

Test: ***Start test*** is for starting and ***Stop test*** for stopping the Safety Valve test.



Safety Valve Data:

For information on general items ***Pressure***, ***Zero***, ***Protect handle***, ***Calibr. prot.***, ***+15 V power***, ***AD0*** to ***AD7*** as well as ***Timeouts*** etc., see service data descriptions in section 4.4 NIBP Module.

Max. press and ***2 s after stop*** show the measured values at Safety Valve test.

Safety Valve Test Adult/Infant

Disconnect the pressure manometer from the NIBP module cuff connector. Connect the NIBP hose and cuff to the NIBP module cuff connector. Perform the check with a standard adult cuff that is connected around some round object, for example a calibration gas bottle.

Select ***Start Test***. Start the adult safety valve test by pressing the ComWheel. Wait until the pump stops and the pressure is deflated.

Open the cuff connector or disconnect and connect the cuff connector from the module.

Check the pressure values 'Max press' and '2 s after stop' for both transducers. All the values should be within 270 - 330 mmHg.

Select ***ADULT***. Press the ComWheel and check that the text changes now to ***INFANT***.

Select ***Start Test*** and wait until the pump stops and the pressure values on the screen have been updated.

Open the cuff connector or disconnect and connect the cuff connector from the module.

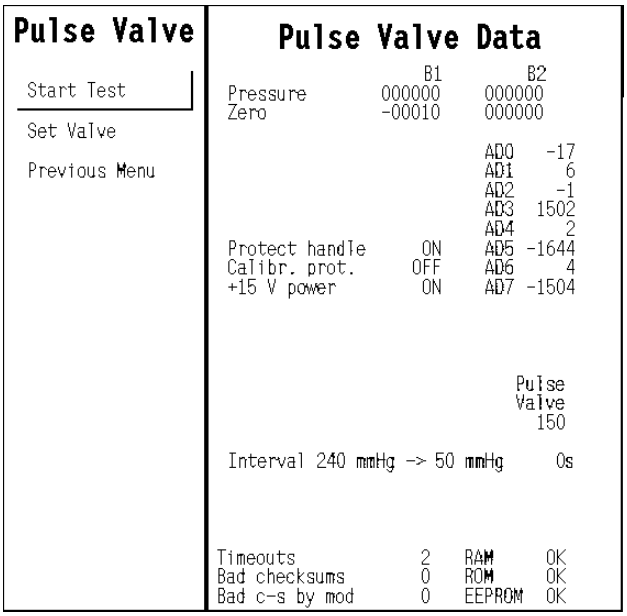
Check that the values 'Max press' and '2 s after stop' are all now within 135 to 165 mmHg.

Return to the normal monitoring mode by pressing **Normal Screen**

4.4.3 NIBP Pulse Valve

Start test is for starting and ***Stop test*** is for stopping the test.

Set Valve lets you adjust the opening of the pulse valve.



Pulse Valve Data

For information on general items ***Pressure***, ***Zero***, ***Protect handle***, ***Calibr. prot.***, ***+15 V power***, ***AD0*** to ***AD7*** as well as ***Timeouts*** etc., see section "NIBP Module."

How to check Pulse Valve

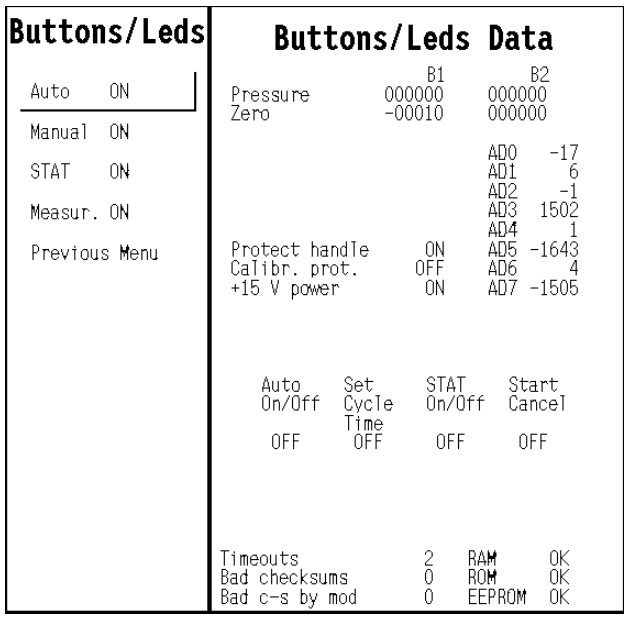
1. Wrap an adult cuff around a pipe and connect the cuff to the module.
2. Select ***Start test*** and push the ComWheel. The pressure rises beyond 240 mmHg and stops. The pulse valve opens. The module counts the time it takes for the pressure to go down from 240 mmHg to 50 mmHg and displays it on the screen.
3. The test can be manually stopped by selecting ***Stop test***.
4. The valve can be adjusted between 0 and 255 (0 for fully closed and 255 for fully open). First select ***Set Valve*** and push the ComWheel. See the pulse valve value and adjust it by turning the ComWheel. Then push the ComWheel to confirm the value.
5. The ***Interval 240 mmHg -> 50 mmHg*** time should be less than 60 seconds when the valve is 150 and less than 10 when fully opened (255). When fully closed (0), the system should be airtight and the pressure should not drop. Depending on the patient, the pulse valve may remain closed up to approximately the value 100.

If the measured time deviates much from those above, the pulse valve or its tubes are faulty.

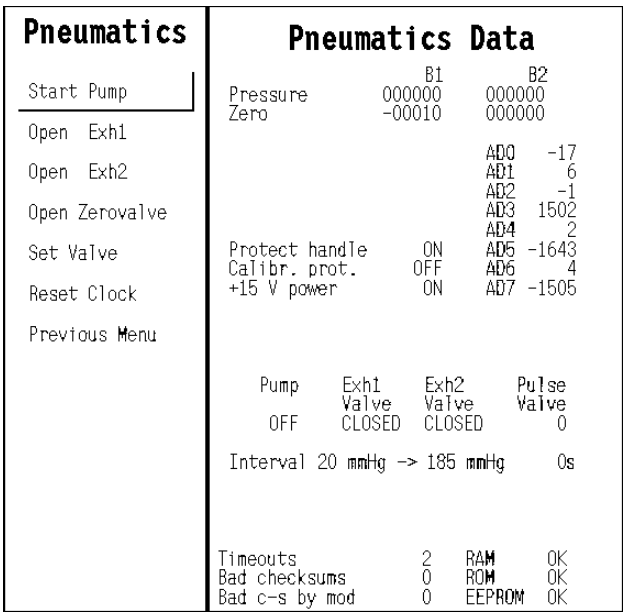
4.4.4 NIBP Buttons/Leds

Buttons/Leds Data

Not in use in B30 Monitor.



4.4.5 NIBP Pneumatics



Start Pump/Stop Pump*:** A manual control for the pump. The selection changes to ***Stop Pump when the pump turns on.

***Open Exh1/Close Exh1*:** This function is not in use with E-PSM(P)W modules.

Open Exh2/Close Exh2*:** A manual control for the exhaust valve 2. The selection changes to ***Close Exh2 when the valve is opened.

***Open Zero valve*:** This function is not in use with E-PSM(P)W modules.

***Set Valve*:** The opening of the pulse valve is adjusted between 0 and 255 (0 for fully closed and 255 for fully open). First push the ComWheel, then turn it to adjust the value on the screen and finally push to set the value.

Reset Clock is not in use with E-PSM(P)W modules.

Pneumatics Data field

For information on general items ***Pressure*, *Zero*, *Protect handle*, *Calibr. prot.*, *+15 V power*, *AD0*** to ***AD7*** as well as ***Timeouts*** etc., see section "NIBP Module."

Pump*, *Exh1 Valve, and ***Exh2 Valve*** show their states.

NOTE: ***Exh1 Valve*** has no effect on the module.

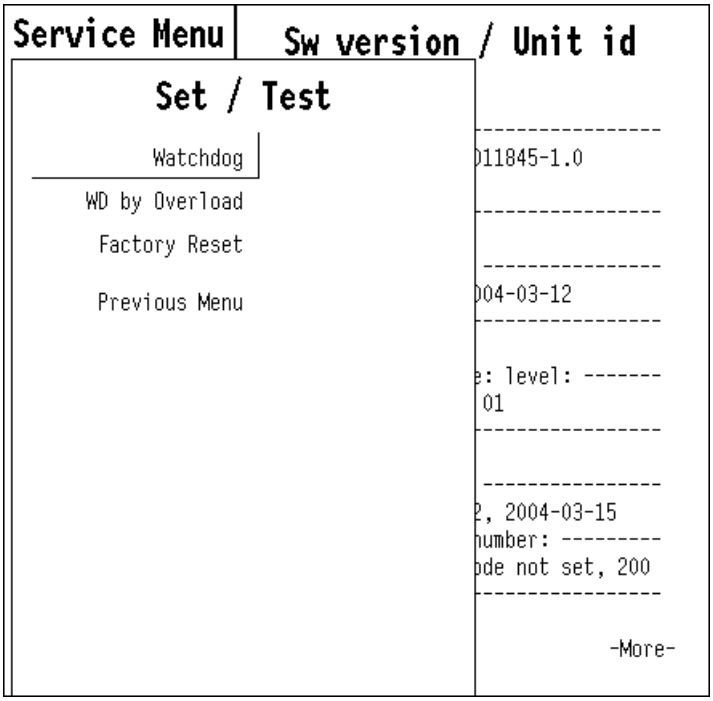
Pulse Valve shows how much the valve is opened (0 to 255) during Valve Setting.

How to check Interval 20 mmHg -> 185 mmHg

Select ***Start pump*** at different combinations of the valves open/closed and push the ComWheel. The module counts the time it takes for the pressure to go up from 20 mmHg to 185 mmHg and displays it. When all the valves are closed, the pump should be able to pump the pressure in about 1 to 4 seconds into an adult cuff wrapped around a pipe. The pump does not stop without selecting ***Stop Pump*** by pushing the ComWheel.

NOTE: To redo the test, must go back to the previous menu.

5 Set/Test



The power supply unit contains a watchdog circuitry, which needs refreshment at every 1.5 seconds. If the refreshment did not occur, the watchdog circuitry will reset the main CPU. In normal operation, the main CPU refreshes the watchdog circuitry at every 0.2 seconds.

The purpose of the watchdog circuitry is to restart the monitor, if there was a serious malfunction. This feature is useful in two cases: when the main CPU is not able to control the monitor, or when the CPU controls the monitor but detects a serious malfunction. Watchdog tests check proper functionality of the watchdog circuitry in various conditions.

Watchdog test ensures directly that the watchdog of the power unit functions properly. Choosing this test prevents the watchdog circuitry from refreshing and shows running seconds with an accuracy of 0.1 seconds.

The test should have the following result when the watchdog circuitry is working properly: The monitor will restart after 1.5 seconds from the start of the test. In malfunction: '>20 s' is displayed, and the test will be interrupted. In this case, the fault is in the watchdog circuitry of the power unit.

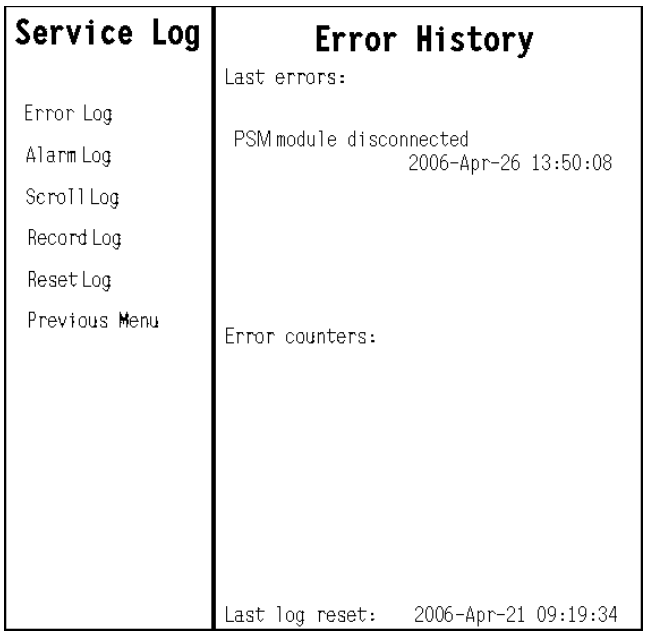
WD by Overload test ensures the functionality of a feature, where the software controls the monitor, but detects an overload situation in the main CPU.

The test should have the following result when the feature is working properly: The monitor will restart after 15 seconds from the start of the test.

Factory Reset restores the factory default settings and clears the data memories. Factory reset should be run if the monitor software is replaced or if the SRAM/Timekeeper battery is replaced.

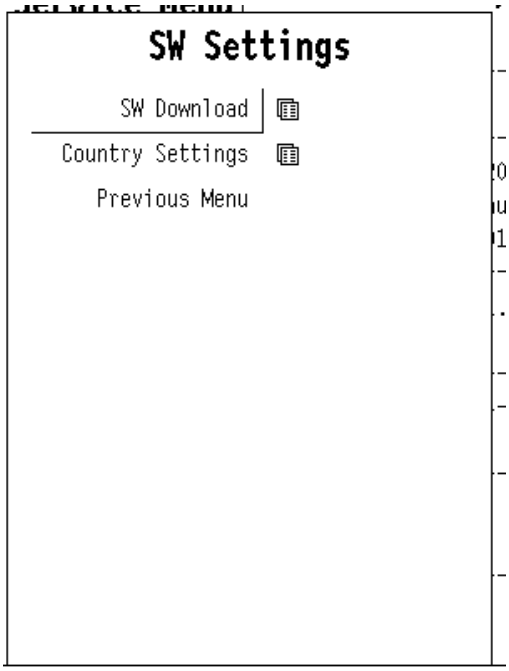
6 Service Log

Error, event and alarm data is stored in the Service Log.
The service log contains information about the occurred monitor errors, events and alarms since the last factory reset or service log reset. The service log is saved in the EEPROM memory of the main CPU board.



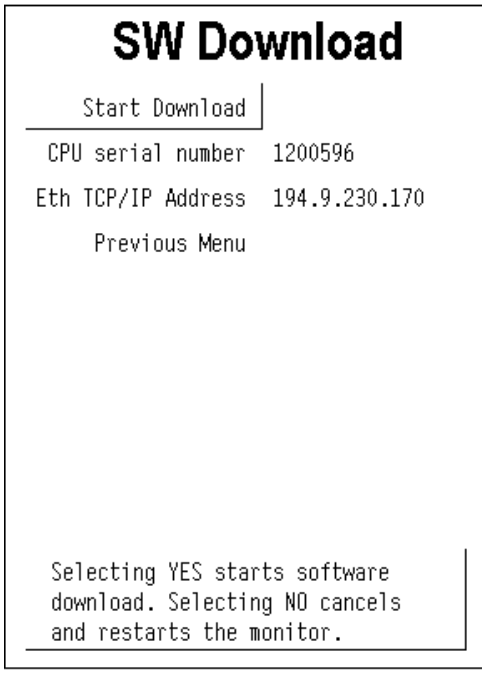
Error Log is for selecting the error history view onto the right side of the menu. Error Log shows also some monitoring events like warm and cold starts.
Alarm Log is for selecting the alarm history view onto the right side of the menu.
Scroll Log is for scrolling the error/alarm information on the right side of the menu.
Record Log is for recording the service log information onto the recorder.
Reset Log is for clearing up the content of the selected service log. This function should be run after a performed maintenance.

7 SW Settings



7.1 SW Download

Menu for downloading monitor software via the network port.



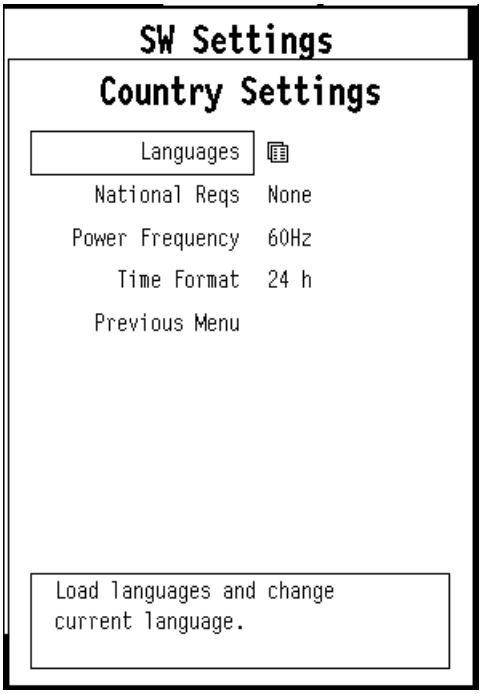
7.2 Country Settings

The language submenu allows you to load, select and delete language files.

National reqs: Select software features that include national requirements.

Power Frequency: Set the power frequency (50/60 Hz). This setting is used to filter out possible power frequency interference from parameter measurements.

Time Format: Set the time format of the real-time clock (12 h or 24 h).



7.2.1 Languages

Language

Select a language to be used during monitoring.

NOTE: Service pages will always appear in English despite of this selection.

NOTE: For language codes, see the table next page.

Load from CD

Load a new language file (.xxx) to the permanent memory of the monitor from a language file in software CD.

Delete Language

Delete a language file from the permanent memory of the monitor.

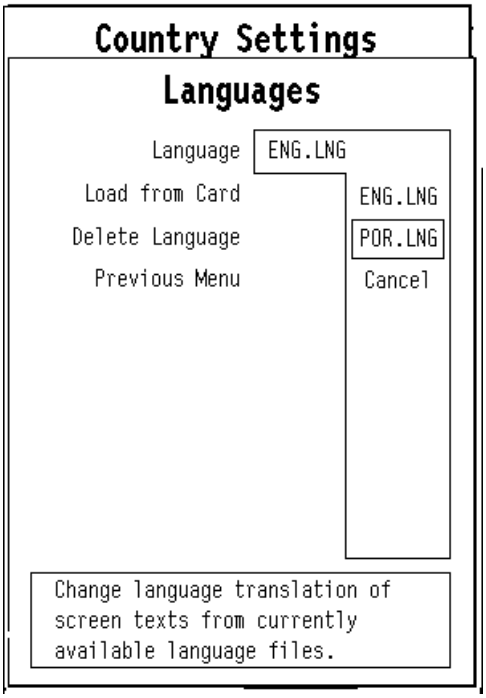


Table 2 Language abbreviations in language file names

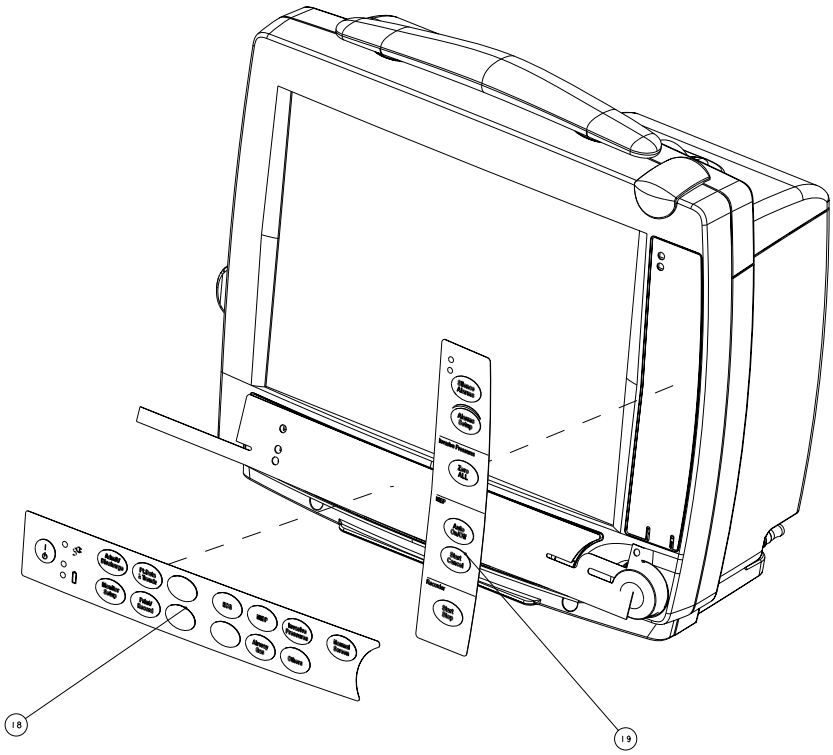
Abbreviation	Language
CHI	Chinese
CZE	Czech
DAN	Danish
ENG	English
FRE	French
GER	German
HUN	Hungarian
ITA	Italian
NLB	Dutch
NOR	Norwegian
POL	Polish
POR	Portuguese
RUS	Russian
SPA	Spanish
SWE	Swedish
TUR	Turkish

6 Field replaceable unit

1 Frame spare part

The following B30 parts will be available as field replaceable spare parts.

1.1 Front panel labeling



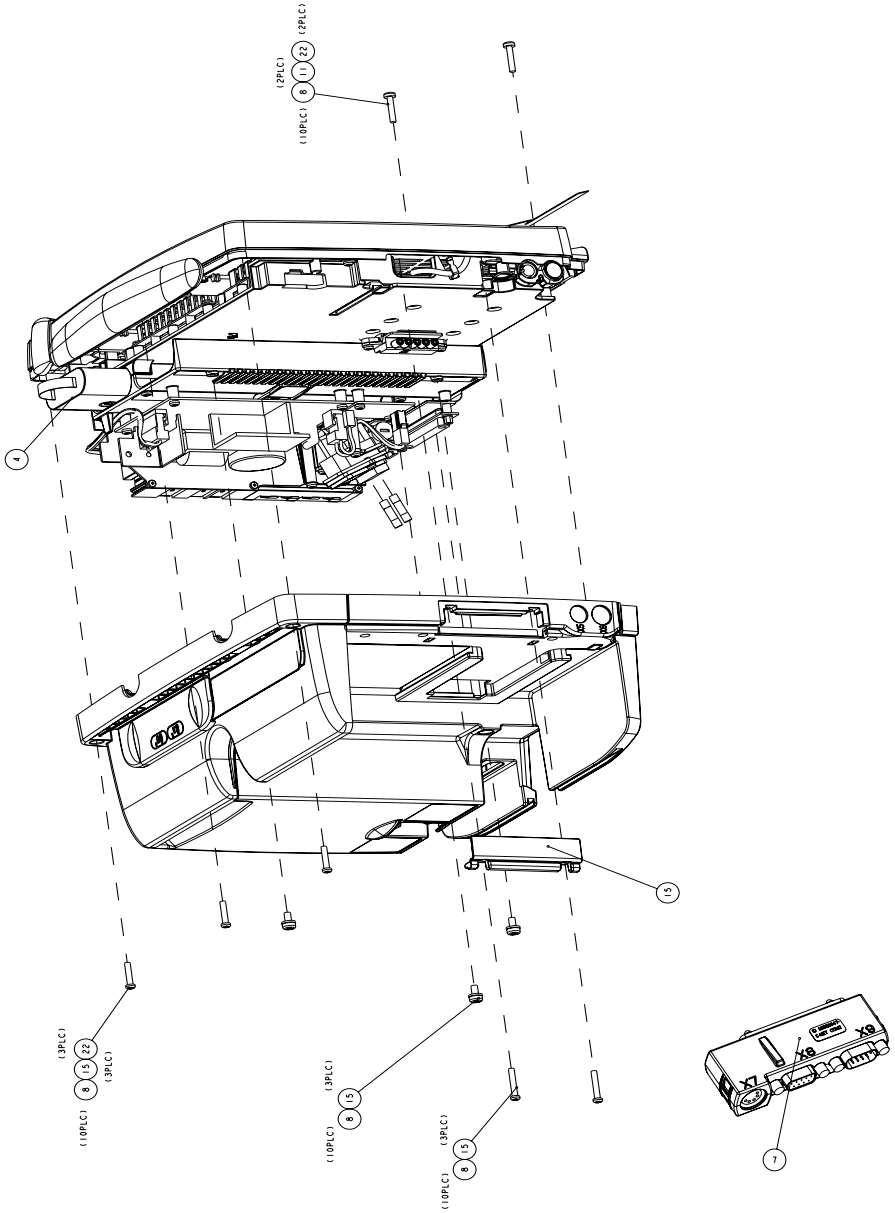
Front panel labeling, B30, monitor

Item	Description	Order Code
18	Dash 2600 KEYBOARD HOR	2044978-018
19	Dash 2600 KEYBOARD VERT	2044978-019

1.2 B30, service software

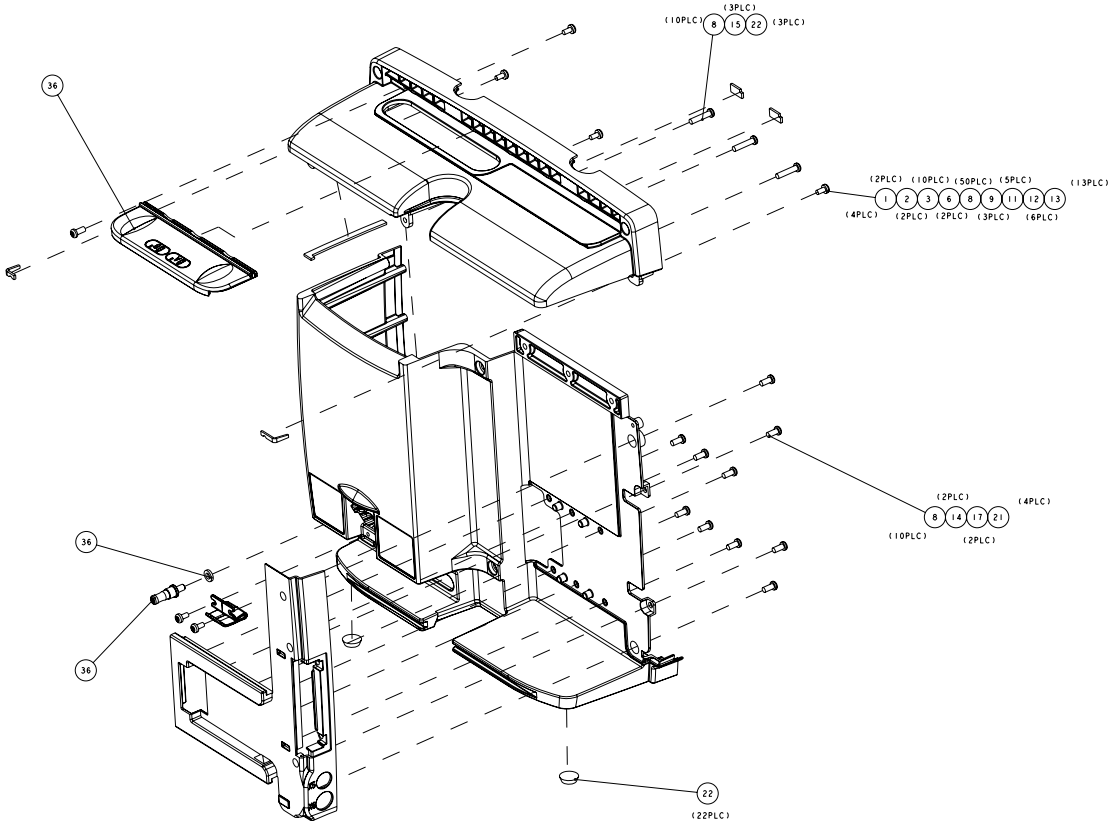
Item	Description	Order Code
	Dash 2600 Software Download CD	2044978-016

1.3 B30, back cover unit



Back cover unit

Item	Description	Order Code
4	Dash 2600 Battery	2044978-004
7	Dash 2600 Multi I/O adapter	2044978-007
8	Dash 2600 Screws	2044978-008
11	Dash 2600 Power supply board	2044978-011
15	Dash 2600 Back Cover Module	2044978-015
22	Dash 2600 FRONT COVER	2044978-022

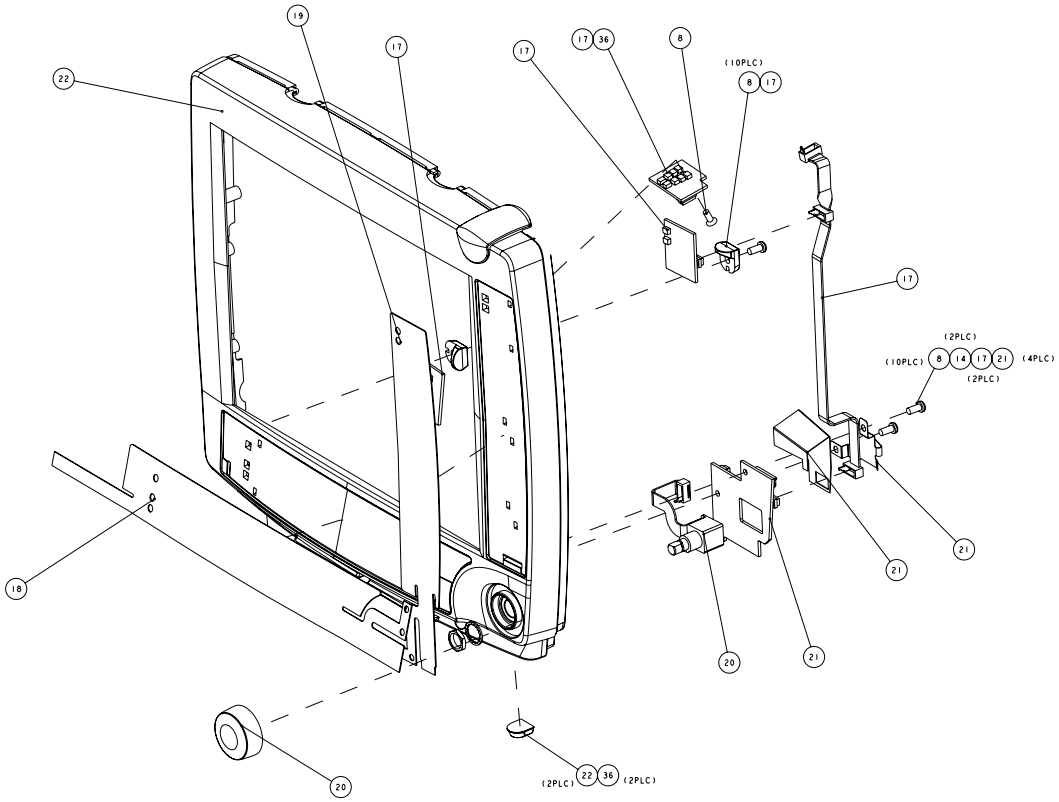


Back cover

Item	Description	Order Code
1	Dash 2600 LCD MODULE	2044978-001
2	Dash 2600 LCD Inverter	2044978-002
3	Dash 2600 Mechinical parts in FRAME CHASSIS	2044978-003
6	Dash 2600 Speaker	2044978-006
8	Dash 2600 Screws	2044978-008
9	Dash 2600 DC-DC Board	2044978-009
11	Dash 2600 Power supply board	2044978-011
12	Dash 2600 AC inlet	2044978-012
13	Dash 2600 CPU board	2044978-013
14	Dash 2600 Handle	2044978-014
15	Dash 2600 Back Cover Module	2044978-015
17	Dash 2600 Front Cover Inidicators	2044978-017

Item	Description	Order Code
21	Dash 2600 USER INTERFACE BOARD	2044978-021
22	Dash 2600 FRONT COVER	2044978-022
36	Frequently defect parts in FM Light	2044978-036

1.4 B30, front cover unit

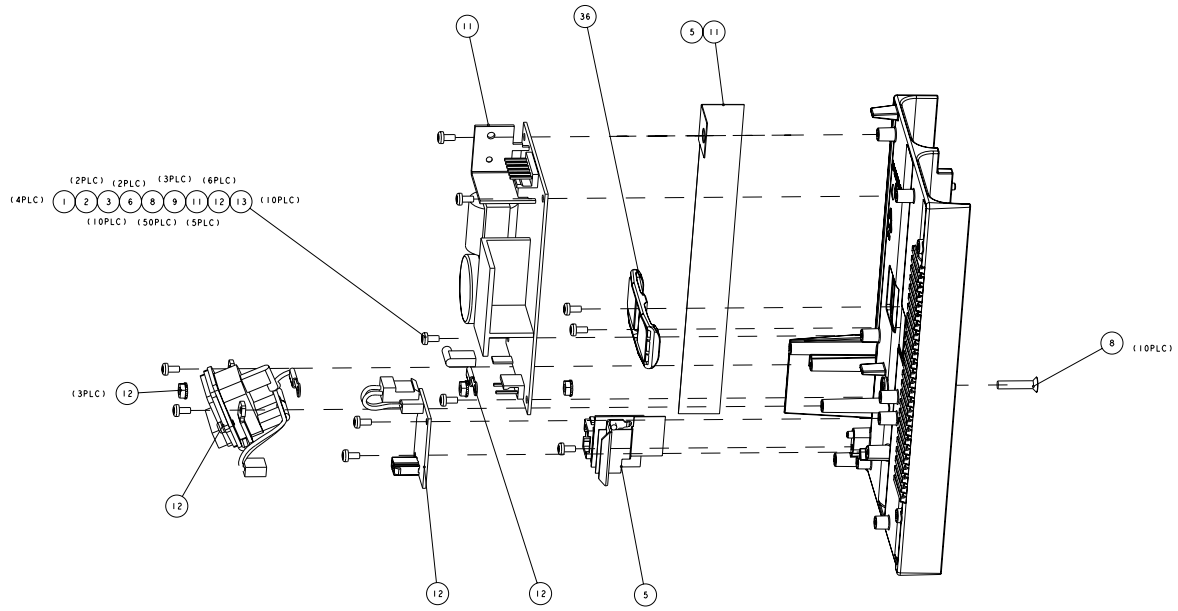


Front cover unit

Item	Description	Order Code
8	Dash 2600 Screws	2044978-008
14	Dash 2600 Handle	2044978-014
17	Dash 2600 Front Cover Inidicators	2044978-017
18	Dash 2600 KEYBOARD HOR	2044978-018
19	Dash 2600 KEYBOARD VERT	2044978-019
20	Dash 2600 ENCDR	2044978-020

Item	Description	Order Code
21	Dash 2600 USER INTERFACE BOARD	2044978-021
22	Dash 2600 FRONT COVER	2044978-022
36	Frequently defect parts in FM Light	2044978-036

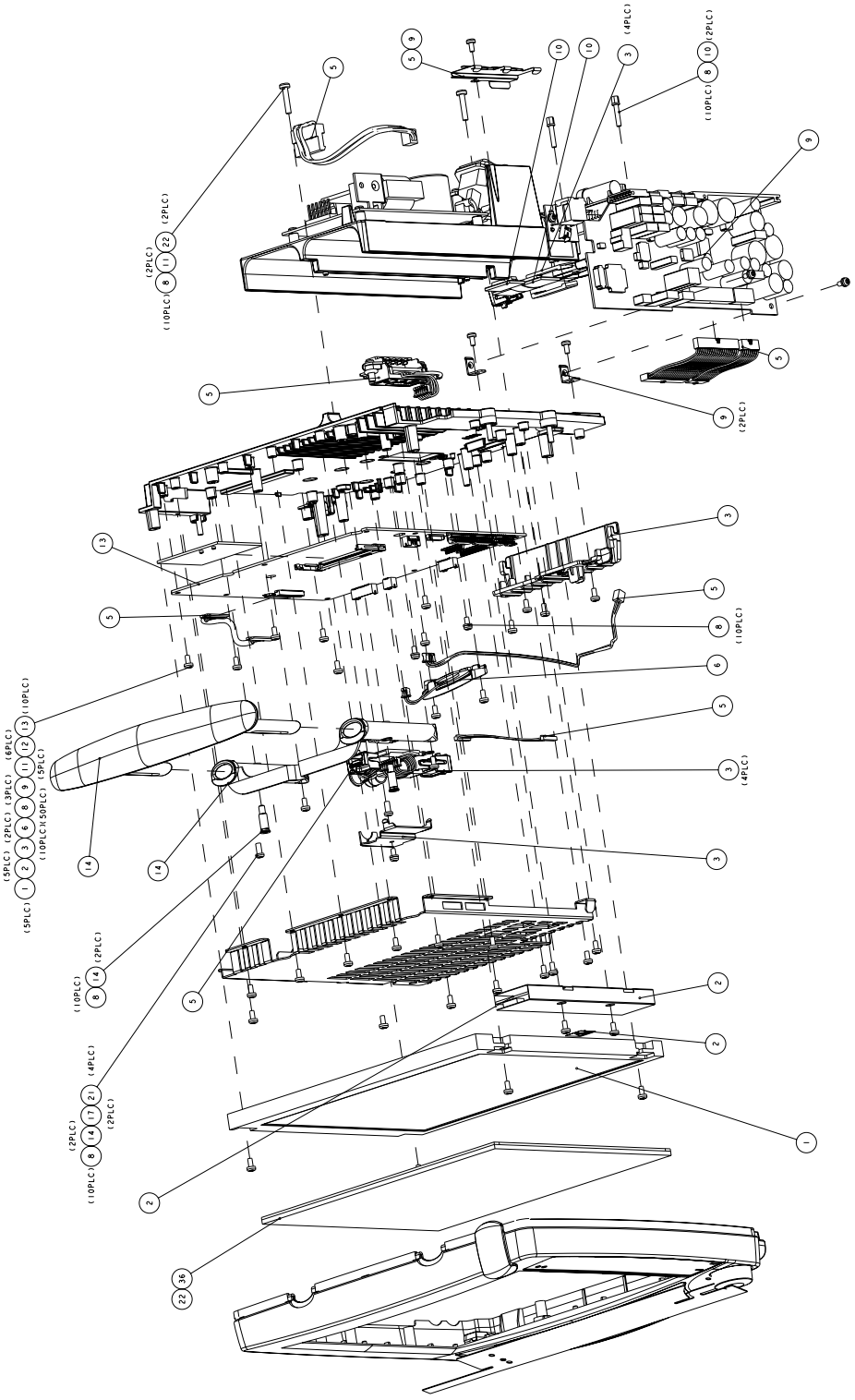
1.5 B30, AC/DC unit



AC/DC unit

Item	Description	Order Code
1	Dash 2600 LCD MODULE	2044978-001
2	Dash 2600 LCD Inverter	2044978-002
3	Dash 2600 Mechinical parts in FRAME CHASSIS	2044978-003
5	Dash 2600 Cables and connector	2044978-005
6	Dash 2600 Speaker	2044978-006
8	Dash 2600 Screws	2044978-008
9	Dash 2600 DC-DC Board	2044978-009
11	Dash 2600 Power supply board	2044978-011
12	Dash 2600 AC inlet	2044978-012
13	Dash 2600 CPU board	2044978-013
36	Frequently defect parts in FM Light	2044978-036

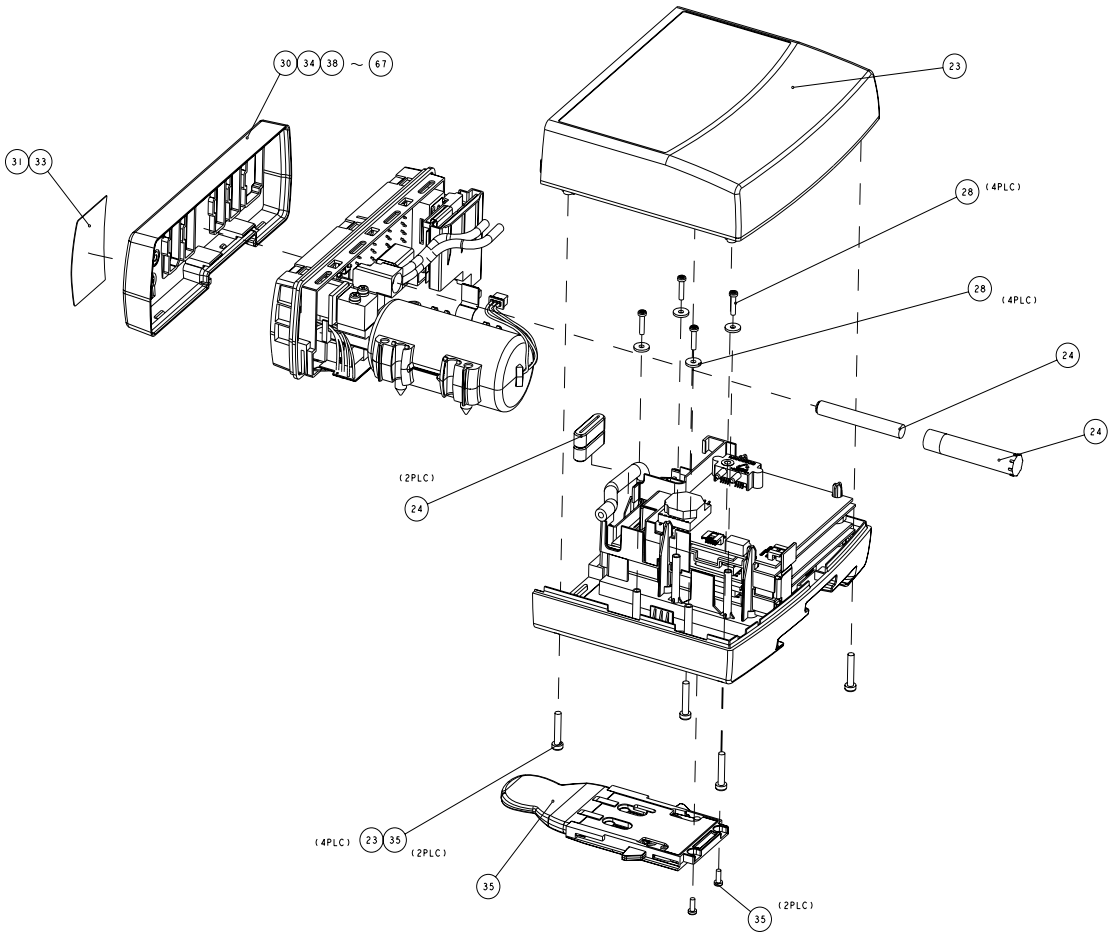
1.6 Frame for B30



Frame for B30

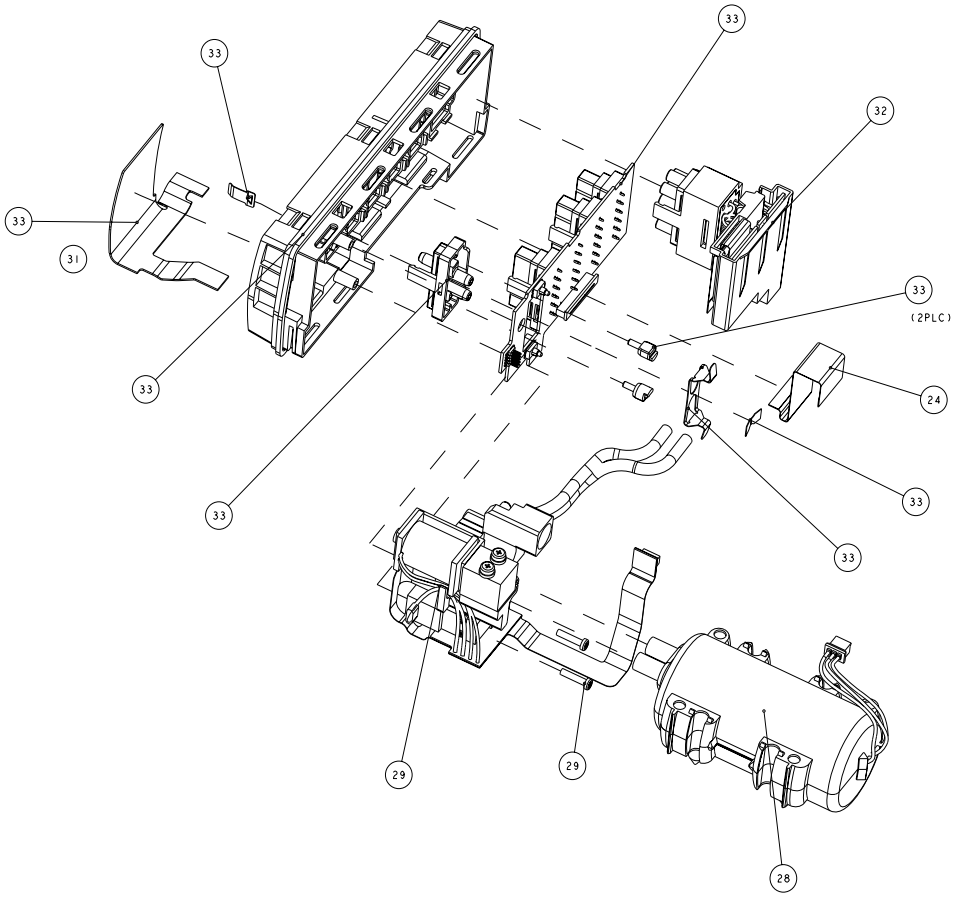
Item	Description	Order Code
1	Dash 2600 LCD MODULE	2044978-001
2	Dash 2600 LCD Inverter	2044978-002
3	Dash 2600 Mechinical parts in FRAME CHASSIS	2044978-003
5	Dash 2600 Cables and connector	2044978-005
6	Dash 2600 Speaker	2044978-006
8	Dash 2600 Screws	2044978-008
9	Dash 2600 DC-DC Board	2044978-009
10	Dash 2600 Connect Flex board	2044978-010
11	Dash 2600 Power supply board	2044978-011
12	Dash 2600 AC inlet	2044978-012
13	Dash 2600 CPU board	2044978-013
14	Dash 2600 Handle	2044978-014
17	Dash 2600 Front Cover Inidicators	2044978-017
21	Dash 2600 USER INTERFACE BOARD	2044978-021
22	Dash 2600 FRONT COVER	2044978-022
36	Frequently defect parts in FM Light	2044978-036

2 E-PSM(P)W spare parts

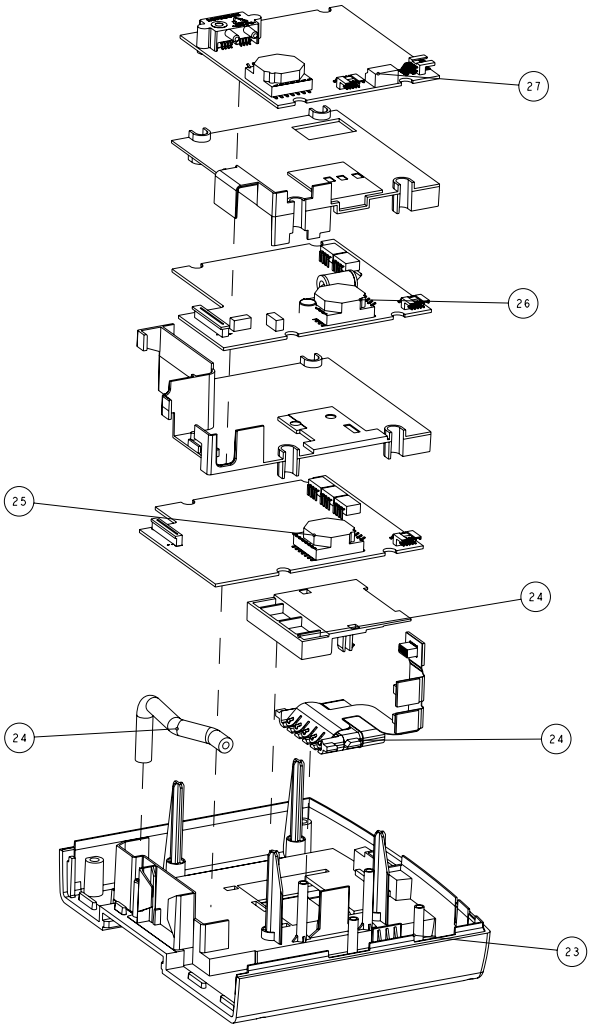


Item	Description	Order No.
23	PSMW Cover	2044978-023
24	PSMW Connecter and Air Filter	2044978-024
28	PSMW NIBP PUMP	2044978-028
30	FRU OUTER MASK WPSM WITHOUT IBP EN&CN	2044978-030
31	PSMW KEYBOARD	2044978-031
33	FRU WPSM FRONT CONNECTOR	2044978-033
34	FRU OUTER MASK WPSM WITHIN IBP EN&CN	2044978-034
35	PSMW LOCK	2044978-035
38	FRU OUTER MASK WPSM WITHIN IBP GER	2044978-038

Item	Description	Order No.
39	FRU OUTER MASK WPSM WITHIN IBP FR	2044978-039
40	FRU OUTER MASK WPSM WITHIN IBP DU	2044978-040
41	FRU OUTER MASK WPSM WITHIN IBP SW	2044978-041
42	FRU OUTER MASK WPSM WITHIN IBP FIN	2044978-042
43	FRU OUTER MASK WPSM WITHIN IBP DAN	2044978-043
44	FRU OUTER MASK WPSM WITHIN IBP NOR	2044978-044
45	FRU OUTER MASK WPSM WITHIN IBP SP	2044978-045
46	FRU OUTER MASK WPSM WITHIN IBP IT	2044978-046
47	FRU OUTER MASK WPSM WITHIN IBP PG	2044978-047
48	FRU OUTER MASK WPSM WITHIN IBP POL	2044978-048
49	FRU OUTER MASK WPSM WITHIN IBP HUN	2044978-049
50	FRU OUTER MASK WPSM WITHIN IBP CZ	2044978-050
51	FRU OUTER MASK WPSM WITHIN IBP TUR	2044978-051
52	FRU OUTER MASK WPSM WITHIN IBP RUS	2044978-052
53	FRU OUTER MASK WPSM WITHOUT IBP GER	2044978-053
54	FRU OUTER MASK WPSM WITHOUT IBP FR	2044978-054
55	FRU OUTER MASK WPSM WITHOUT IBP DU	2044978-055
56	FRU OUTER MASK WPSM WITHOUT IBP SW	2044978-056
57	FRU OUTER MASK WPSM WITHOUT IBP FIN	2044978-057
58	FRU OUTER MASK WPSM WITHOUT IBP DAN	2044978-058
59	FRU OUTER MASK WPSM WITHOUT IBP NOR	2044978-059
60	FRU OUTER MASK WPSM WITHOUT IBP SP	2044978-060
61	FRU OUTER MASK WPSM WITHOUT IBP IT	2044978-061
62	FRU OUTER MASK WPSM WITHOUT IBP PG	2044978-062
63	FRU OUTER MASK WPSM WITHOUT IBP POL	2044978-063
64	FRU OUTER MASK WPSM WITHOUT IBP HUN	2044978-064
65	FRU OUTER MASK WPSM WITHOUT IBP CZ	2044978-065
66	FRU OUTER MASK WPSM WITHOUT IBP TUR	2044978-066
67	FRU OUTER MASK WPSM WITHOUT IBP RUS	2044978-067



Item	Description	Order No.
24	PSMW Connecter and Air Filter	2044978-024
28	PSMW NIBP PUMP	2044978-028
29	PSMW NIBP MANIFOLD	2044978-029
31	PSMW KEYBOARD	2044978-031
32	PSMW ECG INPUT UNIT	2044978-032
33	FRU WPSM FRONT CONNECTOR	2044978-033



Item	Description	Order No.
23	PSMW Cover	2044978-023
24	PSMW Connecter and Air Filter	2044978-024
25	PSMW PCBA ECG	2044978-025
26	PSMW PCBA STP	2044978-026
27	PSMW PCBA NIBP	2044978-027

3 Frame disassembly

WARNING **The B30 is always energized by the internal batteries. A short circuit may cause internal damage. Do not touch any exposed wiring or conductive surface inside, this may cause an electric shock.**

CAUTION Perform leakage current measurement whenever service or repair has been done in the monitor.

NOTE: The backlight circuit runs on high voltage.

Do not touch the inverter board or the backlight tube leads when powered.

NOTE: Field repairs are recommended to the field replaceable unit (FRU) only. Attempting a field repair on a factory sealed component or assembly could jeopardize the safe and effective operation of the Monitor.

3.1 Before disassembly

NOTE: Wear a grounded, antistatic wristband when handling PC boards. Electrostatic discharge may damage components on the board.

Make sure that the monitor is turned off.

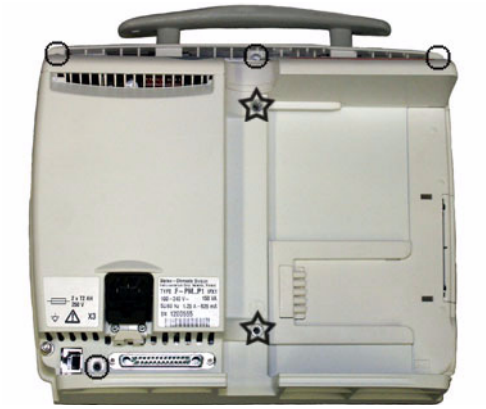
Disconnect the main power cord. If the monitor is connected to the Datex-Ohmeda Network, disconnect the RJ-45 cable.

Tools needed

- screwdrivers, TORX; T8, T10, T15
- crosshead screwdriver; M15
- flat blade screwdriver
- sockets; M4.5, M7, M11
- antistatic wristband

NOTE: GE recommends that you assemble the monitor using the NEW fasteners (screws, washers, etc.) provided in the FRU kits. Some fasteners, like the screws with a thread locking coating, are NOT intended to be re-used more than three times.

To separate the back cover from the monitor frame



1. From the back side of the monitor, remove:

- both batteries
- Multi I/O adapter
- the fuse holder
- three (T8) screws from the top of the back cover
- two (T15) screws with star washers
- one (T15) screw

Notice the places of the star washers.

2. Remove the two (T15) screws from the front side of the monitor.

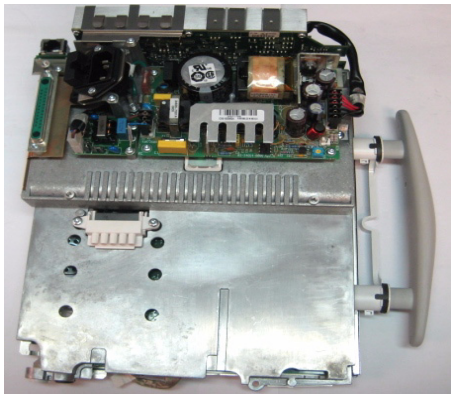
3. Remove the two (T8) screws from the datacard slot.

4. Place the monitor face down on a non-adrasive, static-free surface.

NOTE: Be careful not to damage the ComWheel.

5. Lift the back cover up.

To separate the LCD display from the frame unit



1. Remove the three (T8) screws from the borders of the frame unit, one on the other, two on the other side of the frame).
2. Separate the frame assembly from the front cover unit.

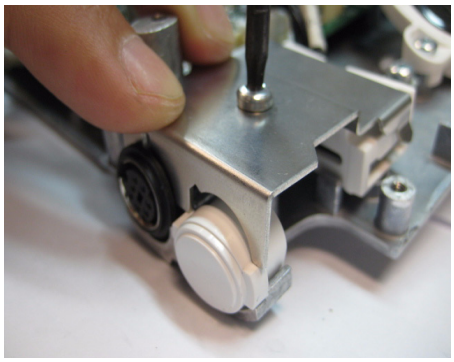
NOTE: The backlight circuit runs on high voltage. Do not touch the inverter board or the backlight tube leads when powered.

3. Disconnect the displayed cable.
4. Remove the four (T10) screws holding the display to the frame unit.
5. Lift the display carefully up.

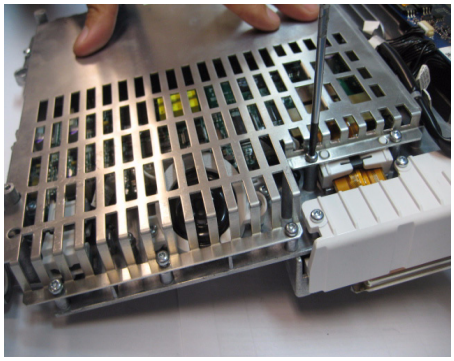
NOTE: When reassembling the LCD display, be careful that no dirt or finger prints are left between the LCD display element and the protection glass window.

NOTE: Do not use excessive force when fastening the display to the frame. Fastening the screws too tightly might bend the display too much and break it. The screws must also be fastened gradually, first fasten all screws slightly, then more tightly.

To remove the EMC shield

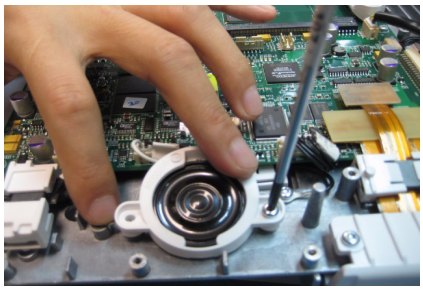


- remove the screw (T10) and lift the Defib sync unit's cover first



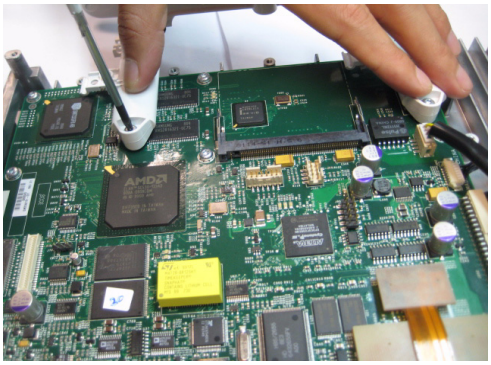
- Remove the 14 screws (T10) holding the shield to the frame unit. Lift the shield carefully up.

To remove the loudspeaker unit



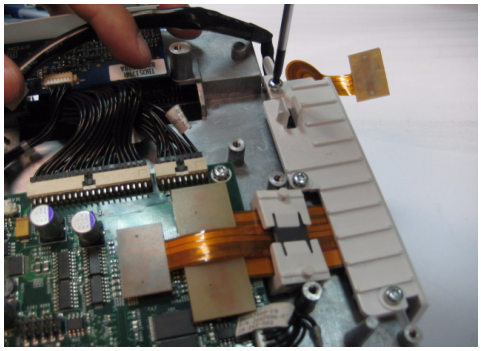
- Remove the two screws (T10) holding the loudspeaker unit to the frame.
- Disconnect the loudspeaker cable from the CPU board.

To remove the handle guide unit



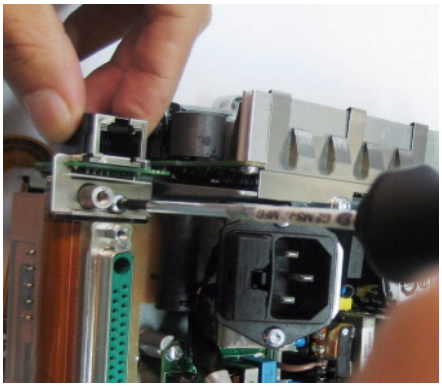
- Remove the two screws (T10) holding the handle guide unit to the frame.

To remove the interconnection and UI board



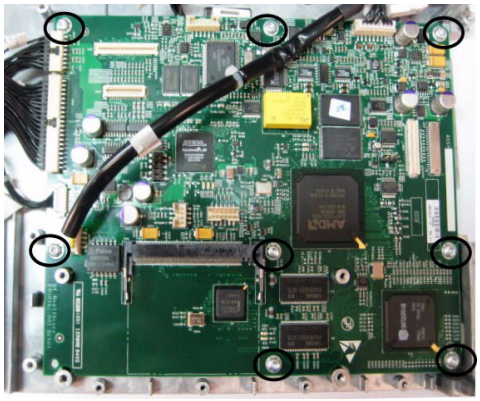
- Remove the three screws (T10) holding the plastic flex board cover.
- Remove the interconnection and UI board carefully from the frame.

To remove the network connector board unit



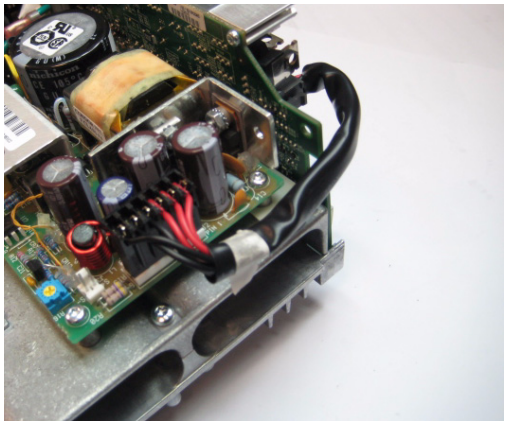
- Remove the screw (T10) holding the unit to the frame.
- Disconnect the cable coming from the Network connector board
- Remove the Network connector board

To remove the CPU board

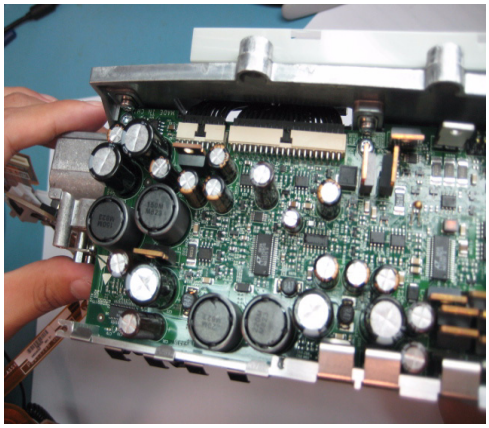


- Disconnect all the rest cables from the CPU board.
- Remove the eight screws (T10) holding the CPU board to the frame.
- Lift the CPU board carefully up and remove it from the frame.

To remove the DC/DC board

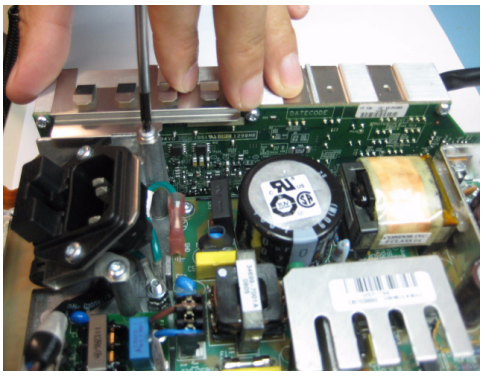


- Disconnect the AC/DC board - DC/DC board cable connector

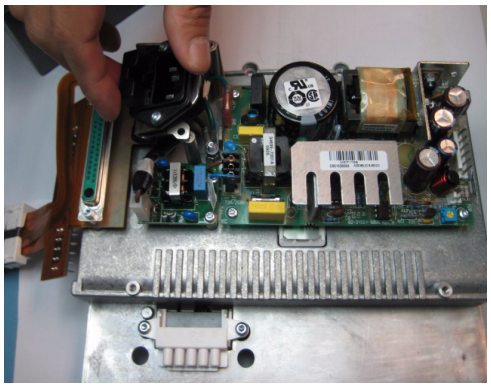


- Remove the screw (T10) and disconnect the DC/DC board from the frame by lifting it up carefully.

To remove the main power connector unit

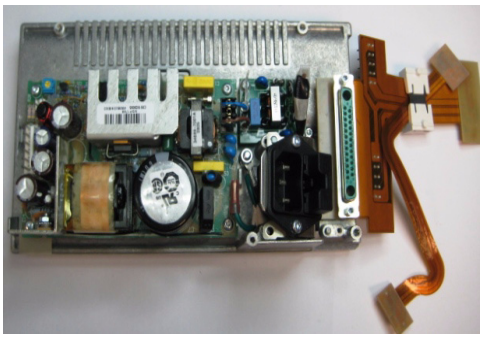


- Remove the cover first
- Remove the two screws (T10) holding the unit to the frame.
- Disconnect the protective earth connector from the receptacle.

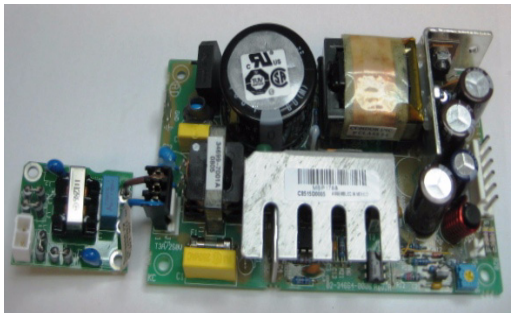


- Lift up the power connector unit

To remove the AC/DC unit and the filter board



- Remove the four screws (T10) in AC/DC unit and the two (T10) screws in filter board
- Lift up these two board



3.2 Handling and storage of LCD display component

Handling of LCD display component and protective window

If the LCD Display component surface becomes dusty, wipe it gently with absorbent cotton, chamois or other soft material. If necessary, breathe onto the display surface and wipe immediately. The display surface 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.

1. Wipe off saliva and water drops as soon as possible. Their prolonged contact with the polarizer cause deformations and color fading.
2. Do not open the component case because internal circuits are sensitive to electrostatic discharges.

Taking a spare part LCD Display component or a display shield into use:

Peel off the protective film slowly (in more than 10 seconds) from the display or protective window surface. Fast peeling may generate enough static electricity to destroy the LCD Display component.

Storaging an LCD display component as a spare part for a long period

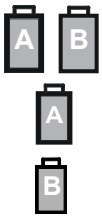
1. Store the display in a dark place. Do not expose it to sunlight or fluorescent light. Keep the temperature between -30 °C and 85 °C / -22 °F and 185 °F at 5% to 95% humidity.
2. The polarizer surface should not come into contact with any other object. It is recommended that the display unit is stored in the container in which it was originally shipped.

3.3 Batteries

3.3.1 Battery indicators

The B30 messages, screen symbols and front panel LED indicators tell the user about the status of the batteries. For screen symbols, see “Part 1 Symbols”. For LED indicators, consult the table below and for messages, see section “Troubleshooting.”

Table 6 Battery indicators

Screen symbol	Explanation	Front panel battery LED indicators	
	Monitor is battery powered. Batteries are fully charged and the size of the green bar indicates the charging level.		green lit orange dark
	Monitor is battery powered. Battery A is empty, battery B is ok.		green lit orange dark
	Monitor is battery powered. Battery A failure, battery B is ok.		green lit orange flashing
	Monitor is mains powered. Battery A is being charged (white bar), battery B is already charged.		green dark orange lit
no screen symbol	Monitor is mains powered. No battery backup: batteries have failed or they are not inserted.		green dark orange flashing

3.3.2 To change the batteries

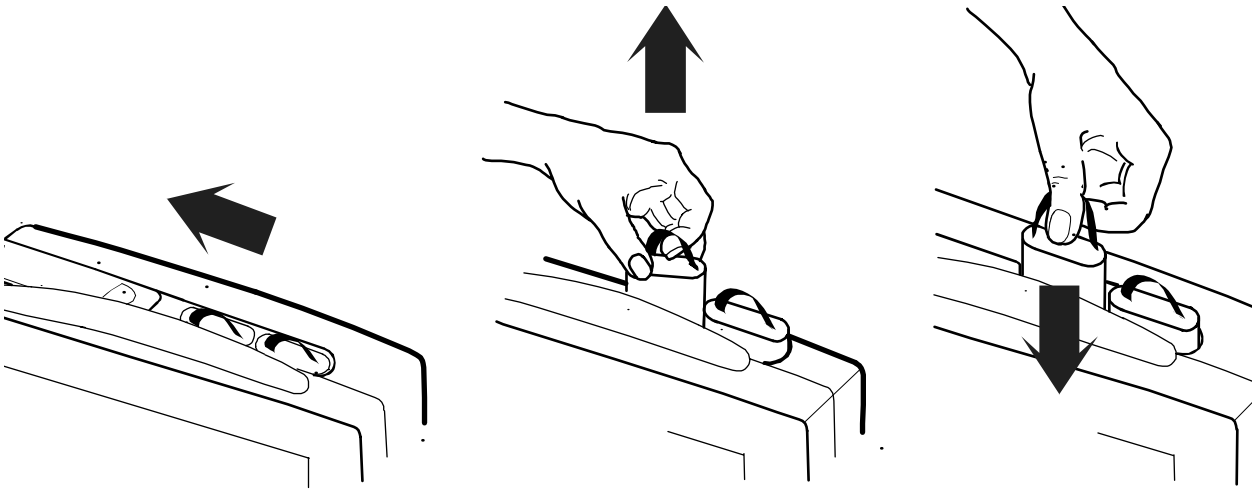


Figure 1 Inserting a battery

(1) Open the lid of the battery compartment located behind the handle by sliding it to the left.

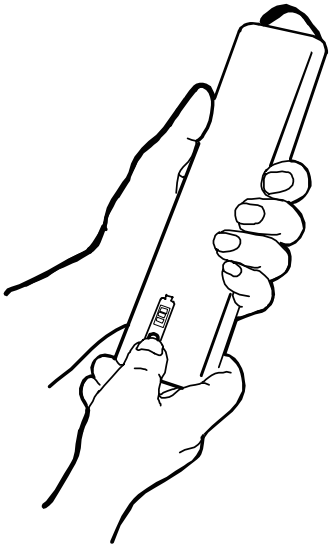
(2) Lift up the battery you want to change. Check the indicators and messages on the screen to make sure that you change the battery with lower charge.

(3) Push in the new battery. Make sure that the charging indicator is facing forward and push the battery down all the way. Check the monitor indicators.

CAUTION After having replaced a battery, always make sure that you close the battery compartment by sliding the lid back to the right until it clicks.

WARNING Do not incinerate a battery or store at high temperatures as it will explode.

3.3.3 To check the battery



Check the battery charging level by pressing the test button on the battery as indicated in the drawing on the left.

The green bar lights up and the number of lit segments indicates the charging level: the more lit segments, the higher the capacity level.

Figure 2 Capacity indicator on the battery

3.3.4 Conditioning the batteries

Condition the batteries regularly to maintain their useful life. Condition a battery every six months or when the message 'Condition Battery x'' appears on the screen. Always observe the messages and symbols on the screen to see the battery status. You can also check the status through **Monitor Setup** - ***Battery Setup***. Conditioning a battery is best done on an external charger. If you do not have an external charger, proceed according to the following instructions.

NOTE: You cannot condition batteries during patient monitoring. Always disconnect the modules first.

1. Continue normal battery use until the green bar of a battery charge indicator is less than 3/4 of the full height. After this, remove the battery. Continue monitoring with one battery until its charge is less than 3/4 of the full capacity.
2. Insert both batteries and connect the monitor to the power supply. The monitor starts charging both batteries, and the capacity indicators scroll accordingly. Keep charging the batteries until both capacity indicators are full height.
3. Continue charging for another two hours. After this, check that the orange battery LED in the front panel is no longer on. If it is, continue charging until it goes off.
4. Disconnect the monitor from the power supply and leave it on until the batteries run out and the monitor switches off. Wait for another 15 minutes.
5. Reconnect the monitor to the power supply and turn it on. Continue charging the batteries until both capacity indicators are full height and no longer scrolling.
6. Keep charging for another two hours. After this, check that the orange battery LED in the front panel is no longer on. If it is, continue charging until it goes off to indicate that the battery conditioning is complete.

3.4 To replace the fuses

3.4.1 Primary fuses

Pull out the fuse holder under the mains connector at the back of the monitor. Replace the fuses with fuses of exactly the same type and rating.

3.4.2 Fuse for external DC

Remove the rear cover. Replace the fuse that is located inside the fuse holder under the receptacle with a fuse of exactly the same type and rating.

3.5 To download the software on CPU board

Refer to the instruction in Software's FRU, follow the instruction for downloading service software.

4 E-PSM(P)W module disassembly

4.1 Before disassembly

NOTE: Wear a grounded, antistatic wristband when handling PC boards. Electrostatic discharge may damage components on the board.

NOTE: Handle all PC boards by their edges.

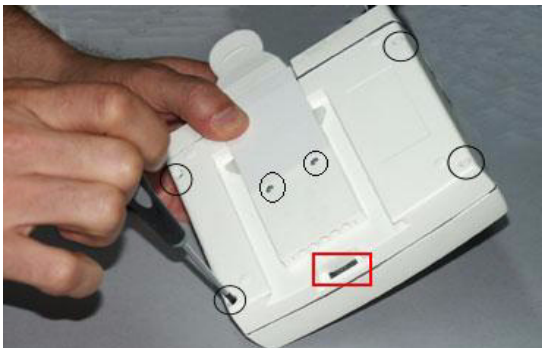
4.2 Tools needed

- torx screwdrivers; T6, T8
- flat blade screwdriver
- pincers
- antistatic wristband

CAUTION When reassembling the module, make sure that all cables are reconnected properly.

4.3 To disassemble the module

To open the E-PSM(P)W module

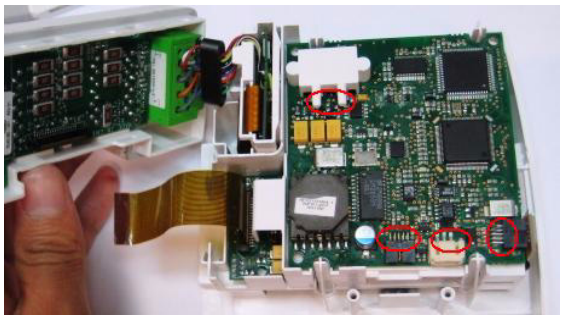


1. Remove the four screws (T8) holding the module cover to the frame from the bottom of the module.
2. Remove the two screws (T6) holding the lock unit to the frame. While pulling the tab push the lockers with a screwdriver to remove the lock unit.
3. Using screwdrivers to push the rubber snap, and open the cover at the same time.

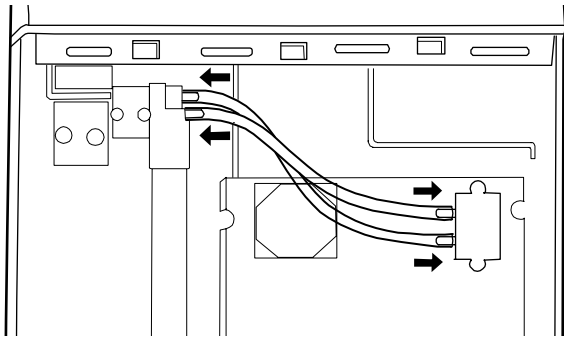
4. Hold the cover from the back corners, lift it about 45° to unlock the snaps from the front unit and pull the cover out backwards.

NOTE: Be careful not to damage the seal. When reassembling the seal may stick to the cover.

To remove the NIBP board

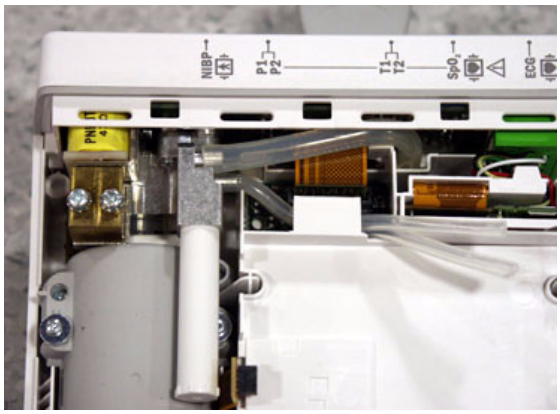


- Disconnect the module bus connector, pump connector and NIBP flex connector.
- Disconnect the hoses (2 pcs) coming from the manifold.
- Lift up the NIBP board.

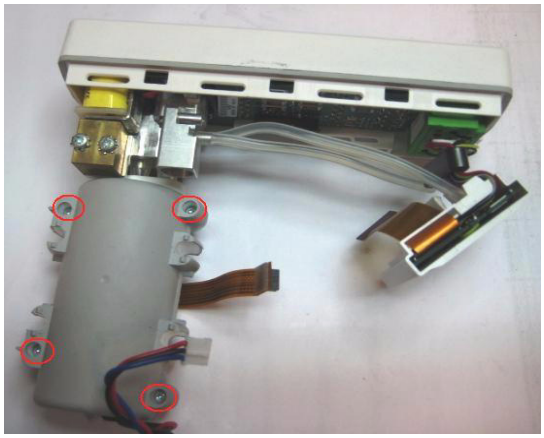


NOTE: Note the positions of the hoses; mark them if necessary to ensure they are replaced correctly.

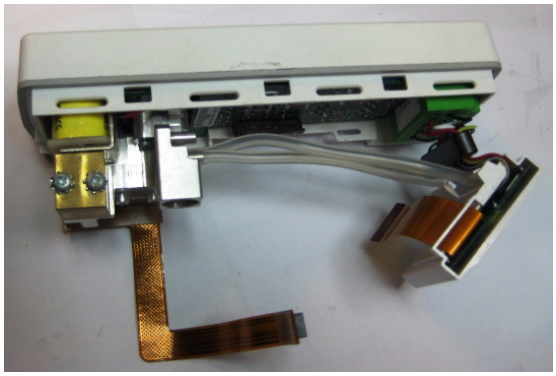
To remove the NIBP pump and the manifold unit



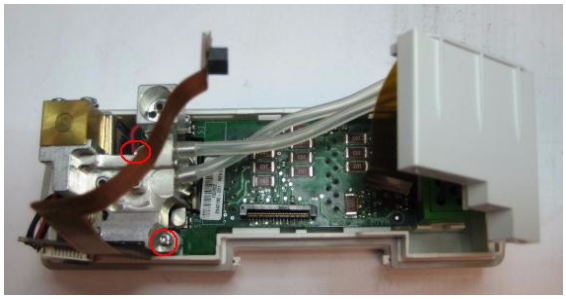
- Disconnect the air intake hose from the NIBP manifold.
- Remove the NIBP filter.



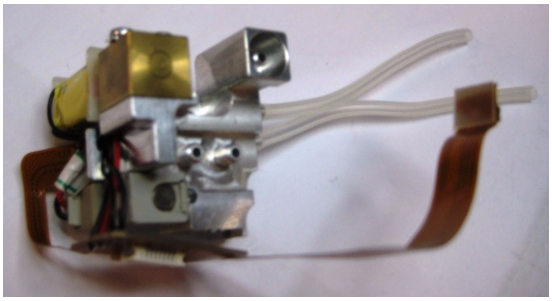
- Remove the four screws (T6) with washers holding the NIBP pump to the frame.
- Carefully remove the front unit together with the NIBP pump.



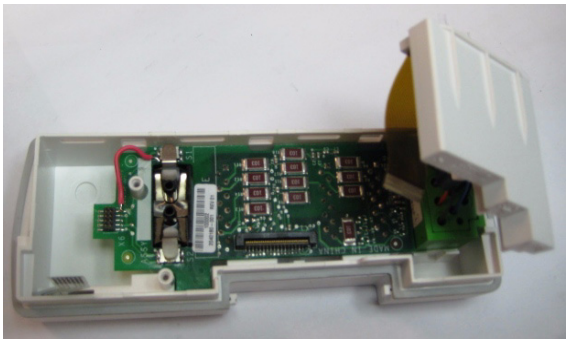
- Disconnect the hoses from the manifold. The hoses follow the pump.
- Remove the NIBP pump.



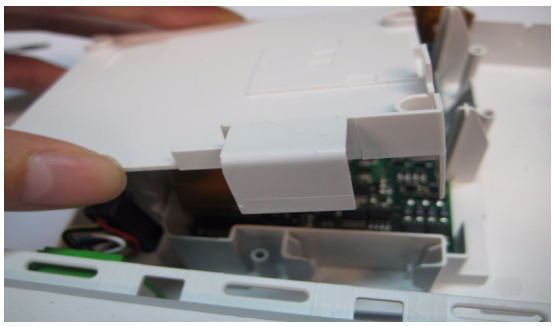
- Disconnect the two (T6) screws holding the manifold to the front cover unit.
- Lift the manifold carefully aside. Be careful not to damage the NIBP flex board. Disconnect the NIBP flex board connector from the STP input board.



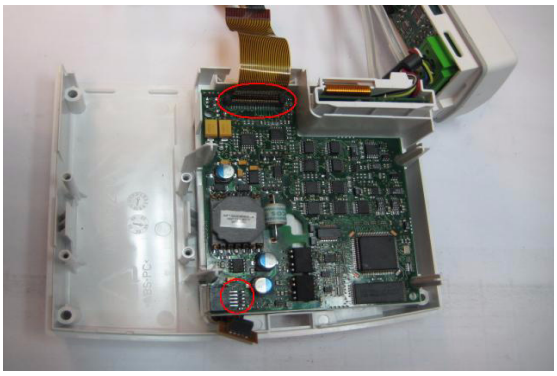
NOTE: When reassembling, make sure that the NIBP flex board connector is connected properly (all pins connected) to the STP input board.



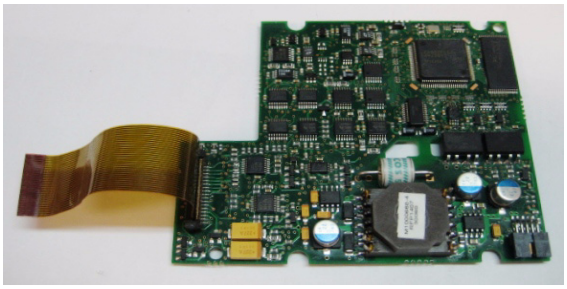
To remove the STP board



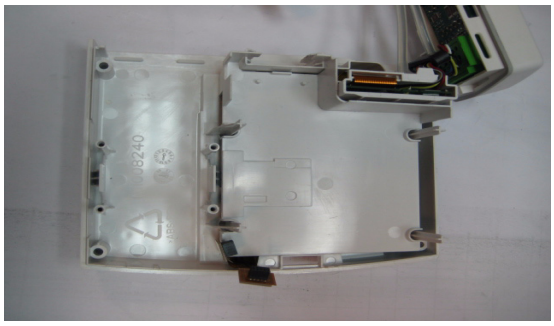
- Lift the NIBP-STP insulator plate carefully up.



- Disconnect the STP input flex connector and the module bus connector.
- Lift up the STP board

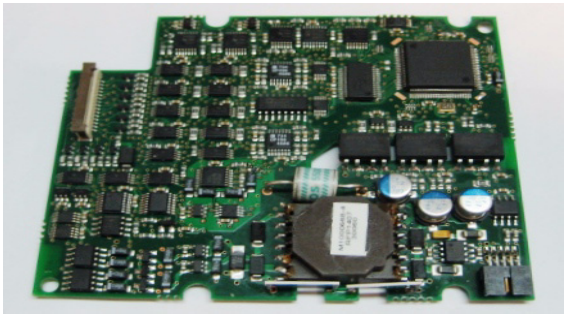


To remove the ECG board

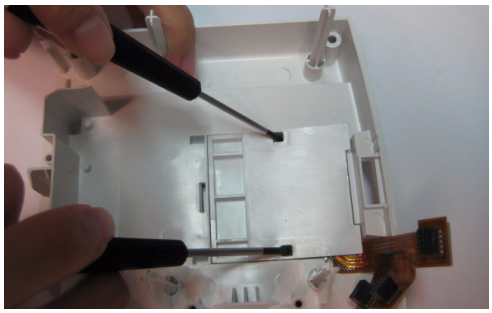


- Lift the STP-ECG insulator plate carefully up.

- Disconnect all the rest connectors.
- Lift up the ECG board

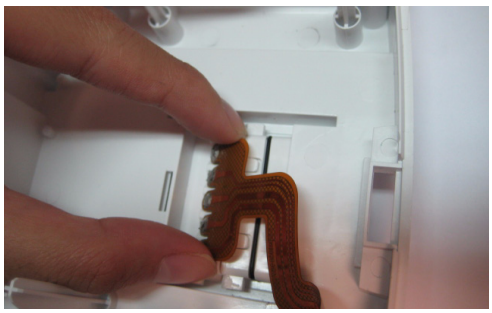


To remove the module bus connector

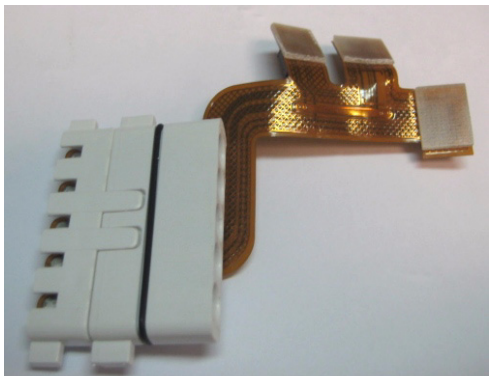


5. Use a flat blade screwdriver to unlock the module bus connector insulator cover.

   Put the screwdriver in the hole and move the blade backwards (away from the flex cable) until the insulator cover unlocks.



6. Pull the module bus connector carefully through the hole in the frame.



Reassemble the module in reverse order.

Always perform the "Functional check" after reassembling the module.

7 Technical specification

1 General Specifications

1.1 Frame

Dimensions

Height	310 mm (12.2 in) Handle Up 280 mm (11 in) Handle Down
Width	310 mm (12.2 in) Without modules 350 mm (13.8 in) With modules
Depth	150 mm (5.9 in) Without extension module 160 mm (6.3 in) With extension module 210 mm (8.3 in) With extension and PSM modules

Weight

B30	5 kg	B30 without modules, batteries included
B30 + E-PSM(P)W	5.8 kg	B30 with WPSM
B30 + N-FCREC + E-PSM(P)W	6.8 kg	B30 with WPSM and extension module with recorder and CO_2

1.1.1 Electrical requirements

Any fluctuations within the specified limits do not affect the performance.

Mains input

Rated voltage	100 - 10% to 240 +10% Vac
Rated frequencies	50/60Hz
Power consumption	150 VA

Ext. DC Input

Voltage	10 - 16V
Current	6 A max

1.1.2 Environmental requirements

Operating temperature		
normal operation	5 to 40°C	41 to 104 °F
while charging batteries	5 to 35°C	41 to 95 °F
Storage temperature	-20 to +60°C	-4 to 140 °F
Relative humidity	10 to 90%. Non-condensing	
Atmospheric pressure	670 to 1060 mbar (500 to 800 mmHg, 670 to 1060hPa)	

1.2 LCD display

Display size	10.4 in (diagonal)
Display type	Active Matrix Color TFT LCD
Resolution	SVGA 800x600
Number of waveforms	Up to 6
Number of digit fields	Up to 4
Display layout and colors	User-configurable
Horizontal viewing angles	Left and right side 50°
Vertical viewing angles	Lower side 45° Upper side 35°
Backlight lifetime	40 000h
Backlight intensity	250 Cd/m^2 typ.

1.3 Batteries

Number of batteries	Support up to 2
Battery type	Exchangeable Lithium-Ion
Voltage	11.1V (nominal)
Capacity	3.5 Ah
Capacity indicator	Fuel gauge on monitor screen and on battery pack
Run time	Up to 2:15 hours per battery pack
Charge time	2 hours per battery pack
Battery life	300 cycles to 50% capacity
Conditioning	Manual

1.4 Network

Connector type	RJ-45
Network type	10/100 Base-T
Isolation	1500 V, 60/50Hz, 1 min.
Network ID	Network ID key
Communication protocol	DRI 01, 02 and 03
Network Connectivity	D-O Central and iCentral

1.5 Analog Outputs, direct ECG and synchronization

ECG	Direct ECG delay	15 ms (max.)
	Gain ECG (in)/ECG(out)	1 mV/1V
	Pacer	5 V and 2 ms pulse
InvBP	InvBP Output	'Art' or P1
	InvBP Delay	35ms (max.)
	Gain InvBP	10mV/mmHg
Defibrillation Synchronization	State 0: 0 - 0.5V;	state 1: 3.5 - 5V
	Delay (max):	< 35 ms from R peak
	5 V and 10 ms pulse	

1.6 Digital outputs

Nurse call	Low State: 0 - 0.5V; High State: 3.5 - 5V
	Generated on red and yellow alarms
Serial Output	Asynchronous
	Serial data interface, uses RS-232 standard

2 E-PSM(P)W Specifications

2.1 General specifications

Module size	55 x 135 (175 w/ tab) x 145 mm
W x D x H	2.2 x 5.3 (6.9 w/ tab) x 5.7 in
Module weight	0.6 kg /1.4 lb.
Operation temperature	5 to 40°C / 41 to 104°F

2.2 Typical performance

2.2.1 NIBP

NOTE: Non-invasive blood pressure measurement is intended for patients weighing over 5 kg (11 lb.)

Oscillometric measurement principle.

Measurement range	adult	25 to 260 mmHg
	child	25 to 190 mmHg
	infant	15 to 140 mmHg
Pulse rate range accepted	30 to 250 bpm	
Typical measuring time	adult	< 30 s
	infant	< 25 s
Inflation limit	adult	280 ±10 mmHg
	child	200 ±10 mmHg
	infant	150 ±5 mmHg
Venous stasis	adult	80 ±5 mmHg / 2 min.
	child	60 ±5 mmHg / 2 min.
	infant	40 ±5 mmHg / 1 min.

Venous stasis pressure may be lower than the values above if the patient has low blood pressure. The venous stasis pressure adapts to the measured mean pressure being the same as mean pressure but always at least the following:

Infant 20 ± 5 mmHg
Child 30 ± 5 mmHg
Adult 40 ± 5 mmHg

2.2.2 ECG

Lead type	3-Lead (I, II, III)
	5-Lead (I, II, III, aVR, aVL, aVF, V)
Sweep speeds	12.5, 25, 50 mm/sec.
Defibrillation protection	5000 V, 360 J
Recovery time	5 s
Input impedance	>2.5 MΩ (10 Hz)
Allowable offset	±1VDC
Gain range	0.2 to 5.0 cm/mV

Display filter

Diagnostic	0.05 to 150 Hz
Monitoring	0.5 to 30 Hz (-3 dB, with 50 Hz reject filter) 0.5 to 40 Hz (-3 dB, with 60 Hz reject filter)

ST filter	0.05 to 30 Hz (-3 dB, with 50 Hz reject filter) 0.05 to 40 Hz (-3 dB, with 60 Hz reject filter)

Heart rate from ECG

Range30 to 250 bpm
Accuracy±5 bpm or ±5%, whichever is greater
Resolution1 bpm

ST levels (in main software)

ST level range-9 to +9 mm (-0.9 to +0.9 mV)
Resolution0.1 mm (0.01 mV)

Pacemaker pulse detection

Detection level	2 to 700 mV
Pulse duration	0.5 to 2 ms

2.2.3 Pulse oximetry

Measurement range	0 to 100%
Calibration range	70 to 100%
Accuracy[1]	100 to 70%, ±2 digits 69 to 0%, unspecified
Display resolution	1 digit = 1% of SpO_2

The monitor is calibrated against functional oxygen saturation SpO_2 func.

Pulse rate from Pleth

Measurement range	30 to 250 bpm
Accuracy	±5 bpm or ±5%, whichever is greater
Resolution	1 bpm
Display averaging	5-20 s

Adjustable pulse beep volume.

Pleth waveform

Scales	2, 5, 10, 20, 50 mod%, Auto

Start up scale is 20 mod% if AUTO is not selected to be the default setting.

2.2.4 Temperature

Measurement range	10 to 45 °C (50 to 113 °F)
Measurement accuracy	±0.1 °C
Display resolution	0.1 °C at 25-45 °C with reusable probes
Temperature test	automatic (every 10 min.)
Probe type	compatible with YSI 400 series

2.2.5 Invasive blood pressure

Measurement range	-40 to 320 mmHg
Measurement accuracy	±5% or ±2 mmHg, whichever is greater
Zero adjustment range	±150 mmHg
Zero time	less than 15 s
Transducer sensitivity	5 µV/V/mmHg

Digital display

Resolution	±1 mmHg

1 Accuracy is based on deep hypoxia studies with volunteered subjects during motion and non-motion conditions over a wide range of arterial blood oxygen saturation as compared to arterial blood CO-Oximetry. Accuracy may depend on the sensor used, please refer to the instructions for use in the accessory package.

Pulse rate from arterial pressure

Measurement range	30 to 250 bpm
Resolution	1 bpm
Accuracy	±5 bpm or ±5% whichever is greater

2.2.6 Respiration

The EMC immunity of the respiration measurement has been tested with 1 Vrms and 1 V/m. This level has been used for optimizing the immunity of the respiration measurement to damp the operating frequency of the electrosurgery equipment.

NOTE: Impedation respiration measurement is intended for patients over three years old.

Measurement range	4 to 120 breath/min
Accuracy	±5 breath/min or ±5%, whichever is greater
Resolution	1 breath/min
Gain range	0.1 to 5cm/ohm

8 N-F(C)(REC) Module

1 Introduction

This chapter provides information for the maintenance and service of the Datex-Ohmeda S/5 Extension Module N-FC, N-FCREC and N-FREC.

N-FREC and N-FCREC provide real time printing of waveform and numerical data, and trend data.

NOTE: Printings on thermal paper may be destroyed when exposed to light, heat, alcohol etc. Take a photocopy for archive.

N-FCREC and N-FC provide CO_2 airway and respiratory measurements.

NOTE: The Extension Modules provide airway and respiratory measurements intended for patients weighing over 5kg (11lb).

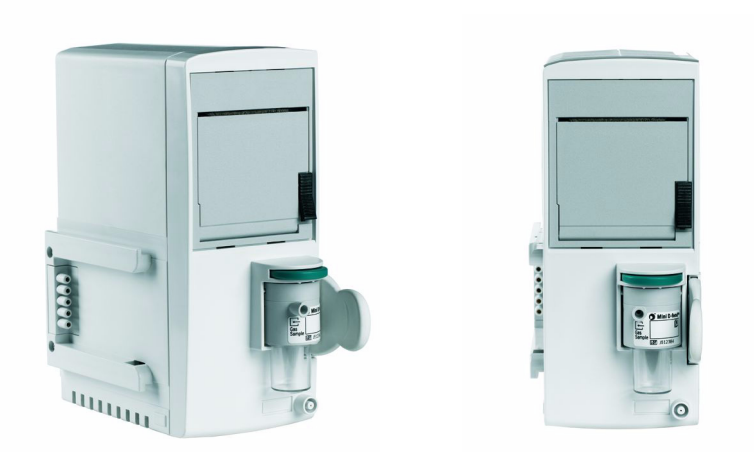


Figure 1 F-FCREC side and front views

Parameters

Module	CO_2	Recorder
N-FC	X	
N-FCREC	X	X
N-FREC		X

2 Specifications

2.1 General specifications

N-FCREC

Module size, W × D × H	90 × 169 × 191 mm, 3.54 × 6.65 × 7.51 in
Module weight	1.0 kg/2.2 lb.
Power consumption	2.7 W standby, 11.5 W printing

N-FREC

Module size, W × D × H	90 × 169 × 191 mm, 3.54 × 6.65 × 7.51 in
Module weight	0.8 kg/1.7 lb.
Power consumption	1.2 W standby, 10 W printing

N-FC

Module size, W × D × H	46 × 169 × 191 mm, 1.81 × 6.65 × 7.51 in
Module weight	0.5 kg/1.1 lb.
Power consumption	1.5 W typical

2.1.1 Environmental specifications

Operating temperature	+10...+40 °C (+50 to 104 °F)
Storage temperature	-20...+60 °C (-4 to +140 °F)
Atmospheric pressure	666...1060 hPa / (67...106 kPa) (500...800 mmHg) (666...1060 mbar)
Humidity	10...95% non-condensing (in airway 0...100%, condensing)
Protection against electrical shock	Type BF

2.1.2 Functional alarms

Funtional alarms for

- Blocked sample line
- D-Fend replacement
- D-Fend check

2.2 CO_2 measurement

2.2.1 Typical performance

$EtCO_2$	End-tidal CO_2 concentration
$FiCO_2$	Inspired CO_2 concentration
Measurement range	0 to 20 vol% (0 to 20 kPa, 0 to 150 mmHg)
Accuracy	
CO_2 concentration 0 to 15 vol%	±(0.2 vol% +2% of reading)
CO_2 concentration 15 to 20 vol%	±(0.7 vol% +2% of reading)
Measurement rise time	< 300 ms with nominal flow

Adjustable low and high limits for $EtCO_2$ and $FiCO_2$.

2.2.2 Technical specifications

Airway humidity	0...100%, condensing
Sampling rate	150 ±25ml/min (sampling line 2 to 3 m, normal conditions)
Sampling delay	2.1 seconds typical with a 3-m sampling line
Total system response time	2.4 seconds typical with a 3-m sampling line, including sampling delay and rise time (typically 3.7 seconds with a 6-m sampling line).

Automatic compensation for barometric pressure, CO_2-NO_2 and CO_2-O_2 collision broadening effect compensation selectable from menu.

Warm-up time	1 min for operation with CO_2, 30 min for full specification
Zeroing interval	4, 15, 30 and 60 minutes after start-up, then every 60 minutes.

2.2.3 Normal conditions

Accuracy specifications apply in normal conditions (after 30 minutes warm-up period):

Ambient temperature	18...28 °C, within ±5°C of calibration
Ambient pressure	500...800mmHg, ±50mmHg of cal.
Ambient humidity	20...80% RH, ±20% RH of cal.

Automatic compensation for barometric pressure.

Non-disturbing gases are those with a maximum effect on the CO_2 reading <0.2 vol%. The effect is valid for specific concentrations shown in parentheses of the non-disturbing gas:

- Ethanol C_2H_5OH (<0.3%)
- Acetone (<0.1%)
- Methane CH_4 (0.2%)
- Nitrogen N_2
- Water vapor
- Dichlorofluromethane (<1%)
- Tetrafluoroethane (<1%)

Disturbing gases and their effect on the CO_2 reading at 5.0 vol% CO_2 are shown below. Errors listed reflect the effect of specific concentrations (shown in parentheses) of an individual disturbing gas and should be combined when estimating the effect of gas mixtures:

- Halotane (4%) increases < 0.3 vol%
- Isoflurane (5%) increases < 0.4 vol%
- Enflurane (5%) increases < 0.4 vol%
- Desflurane (24%) increases < 1.2 vol%
- Sevoflurane (6%) increases < 0.4 vol%
- Helium (50%) decreases < 0.3 vol%
- If O_2 compensation is not activated: O_2 (40 ... 95%) decreases < 0.3 vol%
- If O_2 compensation is activated: O_2 (40 ... 95%) error < 0.15 vol%
- If N_2O compensation is not activated: N_2O (40%) increases < 0.4 vol%
- N_2O (40 to 80%) increases < 0.8 vol%
- If N_2O compensation is activated: N_2O (40 to 80%) error < 0.3 vol%

2.2.4 Conditions exceeding normal

Accuracy specifications under the following conditions ❶❷❸:

❶ Ambient temperature	10...40 °C, within ±5 °C of calibration
Ambient pressure	500...800 mmHg, ±50 mmHg of calibration
Ambient humidity	10...98% RH, ±20% RH of calibration

❷ During warm-up 1 to 10 minutes, under normal conditions

❸ During warm-up 10 to 30 minutes, under normal conditions

	Accuracy under different conditions (see above)	
	Conditions ❶ and ❸	Condition ❷
CO_2 (0 ... 15 vol%)	±(0.3 vol% + 4% of reading) (at 5 vol% error ±0.5 vol%)	±(0.4 vol% + 7% of reading) (at 5 vol% error ±0.75 vol%)
CO_2 (15 ... 20 vol%)	±(0.8 vol% + 4% of reading) (at 5 vol% error ±0.5 vol%)	±(0.9 vol% + 7% of reading) (at 5 vol% error ±0.75 vol%)

2.3 Respiration Rate (RR)

Measurement range	4 to 80 breaths /min
Breath detection	1% change in CO_2 level
Accuracy	±1/min in the range 4 to 20 l/min
	±5% in the range 20 to 80 l/min
Resolution	1/min

Adjustable low and high limits for respiration rate; alarm for apnea.

2.4 Recorder

2.4.1 Typical performance

Principle	Thermal array
Print resolution	
Vertical	8 dots/mm (200 dots/inch)
Horizontal	32 dots/mm (800 dots/inch) at a speed of 25 mm/s and slower
Paper width	50 mm, printing width 48 mm
Print speed	1, 6.25, 12.5, 25 mm/s
Waveform printout	selectable 1, 2, or 3 waveforms
Numerical printout	HR, NIPBP, P1, P2, T1, T2, Tblood, Et/FiCO_2, RR
Tabular Trend printout	HR, SpO_2, P1, NIBP, EtCO_2

3 Functional description

3.1 Measurement principle

3.1.1 CO_2 measurement

MiniC is a side stream gas analyzer, measuring real time concentrations of CO_2. It is a non dispersive infrared analyzer, measuring absorption of the gas sample using an optical narrow band filter.

The infrared radiation detector is thermopile.

Concentration of CO_2 is calculated from absorption measured at 4.2 to 4.3 μm.

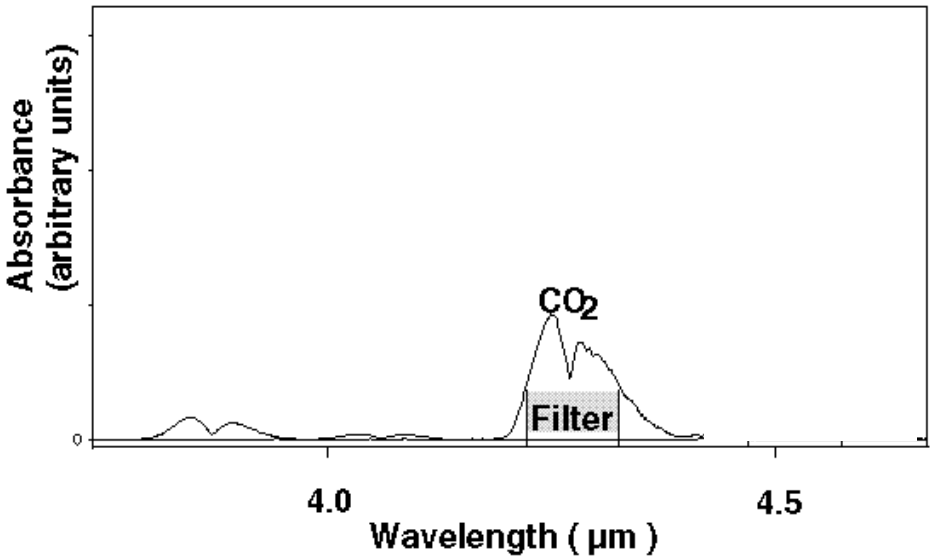


Figure 2 Absorbance of CO_2

3.2 Main components

The miniC unit in N-FC and N-FCREC modules consists of:

- Gas sampling system
- MiniC measuring unit
- CPU board

The recorder unit in N-FREC and N-FCREC consists of:

- Recorder board
- Thermal printer

3.2.1 Gas sampling system

The sampling system draws a gas sample to the analyzer at a fixed rate.

The gas sampling system samples the measured air to the module, and removes water and impurities from it. A sampling line is connected to the water trap. The pump draws gas through the sampling line to the gas measuring unit. After the measurement, the gas is exhausted from the sample gas out connector.

The sample flow is nominally 150 ml/min.

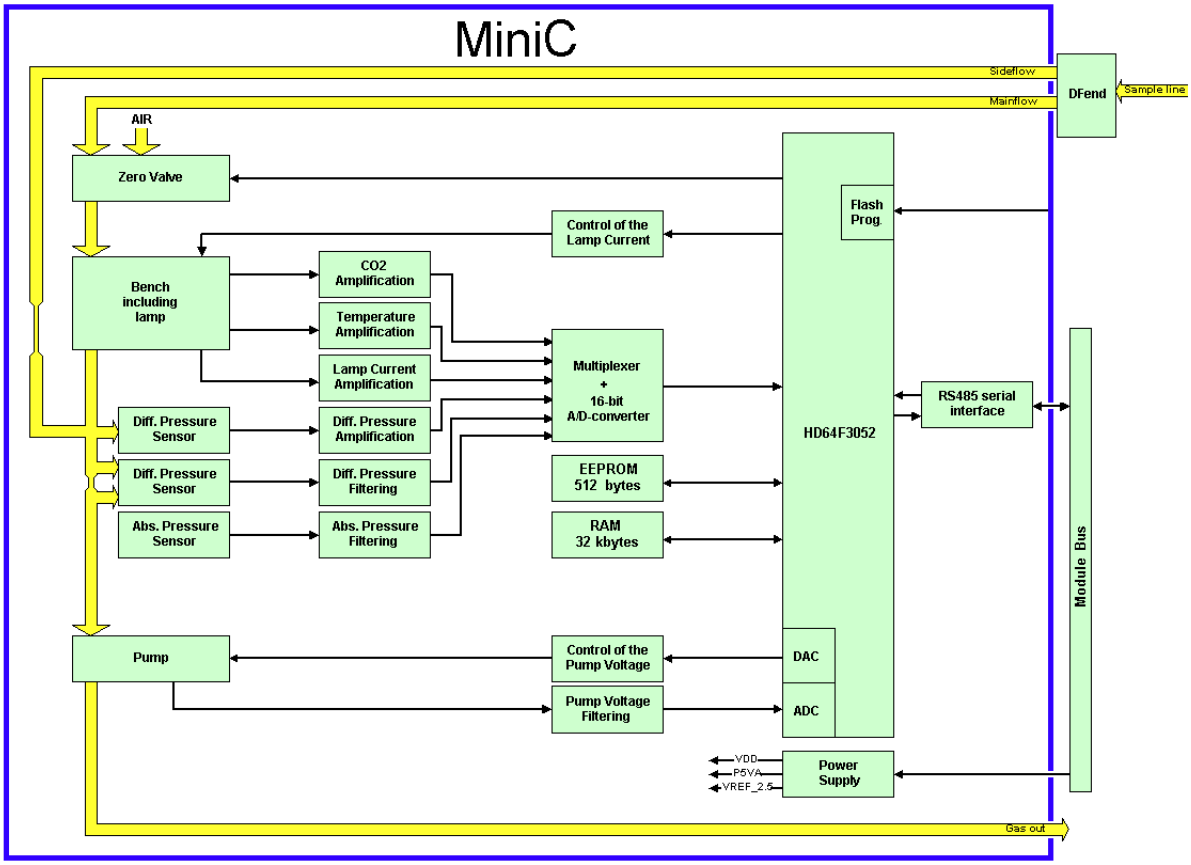


Figure 3 MiniC block diagram

Mini D-fend™

The sample is drawn through the sampling line. The gas then enters the module through the water trap, where it is divided into two flows, a main flow and a side flow. The main flow goes into the analyzer. This flow is separated from the patient side by a hydrophobic filter. The side flow creates a slight subatmospheric pressure within the Mini D-fend water trap which causes fluid removed by the hydrophobic filter to collect in the bottle.

Zero valve

The main flow passes through a magnetic valve before proceeding to the analyzer. This valve is activated to establish the zero point for the MiniC measuring unit. When the valve is activated, room air is drawn through a filter into the internal system and the gas sensor.

Nafion™ tube [1)]

A Nafion tube is used between the water trap and the zero valve to balance the sample gas humidity with that of ambient air. The tube prevents errors caused by the effect of water vapor on gas partial pressure when humid gases are measured after calibration with dry gases.

Gas analyzers

After the zero valve and Nafion tube, the gas passes through the miniC measuring unit.

Sample flow differential pressure transducer

The sample flow differential pressure transducer measures pressure drop across a restrictor and calculates the sample flow from the pressure difference.

Working pressure transducer

The working pressure transducer measures differential pressure between the tubing and ambient air near the miniC measuring unit.

Atmospheric pressure transducer

The atmospheric pressure transducer measures real-time atmospheric pressure. The following messages are based on the obtained pressure values: 'sample line blocked', 'check D-fend', 'replace D-fend' and 'check sample gas outlet'.

Sampling pump and damping chamber

The gas sampling pump is a membrane pump run by a DC-motor. Sample flow is measured with a differential pressure transducer across a known restriction. The motor is automatically controlled to maintain a constant flow even when the D-fend water trap ages and starts to get occluded. It also enables the use of sample tubes with varying lengths and diameters.

NOTE: In no occasion is the flow reversed towards the patient.

1 [1)] Nafion is a trademark of Perma Pure Inc.

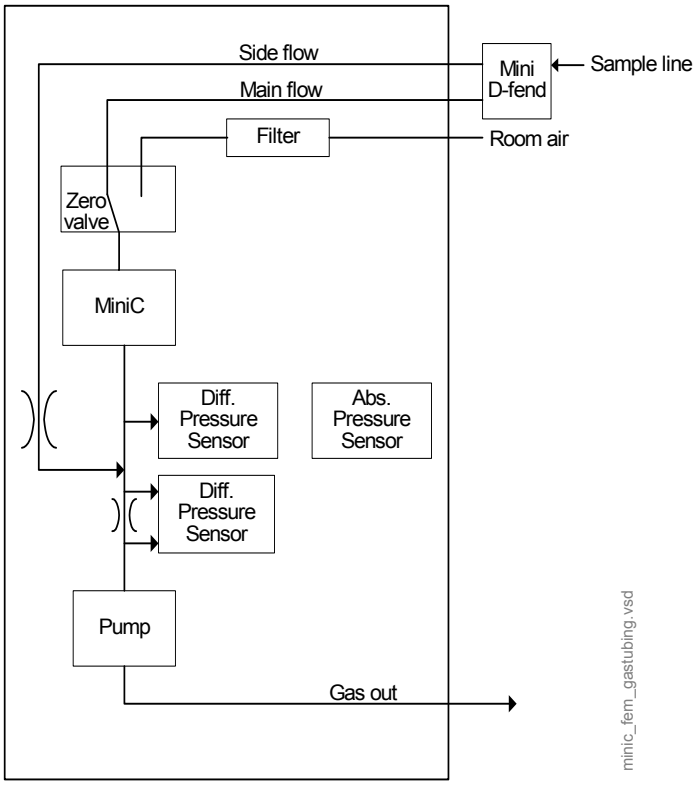


Figure 4 Gas tubing layout

3.2.2 MiniC measuring unit

The miniC measuring unit is a non-dispersive infrared analyzer measuring absorption of the gas sample at 4.2 to 4.3 μm infrared wavelength, which is selected using an optical narrow band filter. The IR lamp is a filament surrounded by thermal isolation. There is a hole in the isolation, passing the radiation to a conical measuring chamber with 3 mm length. From the sample chamber, the radiation goes into a thermopile detector with an optical filter in front of it.

The temperature sensor measures the miniC measuring unit's temperature and it is used for temperature compensation.

The miniC measuring unit includes a miniC flexible board, which connects the thermopile signal and the temperature sensor signal to the CPU board.

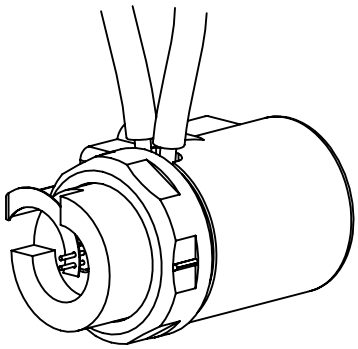


Figure 5 MiniC measuring unit

3.2.3 CPU board

The CPU board contains a processor, memories and all the analog signal processing needed. A MiniC measuring unit is attached to the board with a flexible PCB. Also supply voltage and an RS485 serial channel are connected to the CPU board using another flexible PCB.

Analog signals (CO_2, temperature, absolute and differential pressures and lamp current signals) are fed to the 16-bit A/D converter. The processor controls the A/D converter and calculates the CO_2 percentage and respiration rate from this data.

The processor controls sample flow by adjusting the pump voltage based on the differential pressure signal. The processor also controls the current of the IR source and keeps it constant.

Calibration data is stored on the EEPROM.

3.2.4 Recorder board

The function of the recorder board is to establish an interface between the recorder unit and main CPU board in the monitor. The recorder unit related side panel key is connected to the recorder unit via the recorder board. The recorder unit and the recorder board are connected together with a special connector. The REC board controls the recorder unit communication and power.

The REC board is grounded via the recorder unit. If the recorder unit is not installed, the REC board does not function.

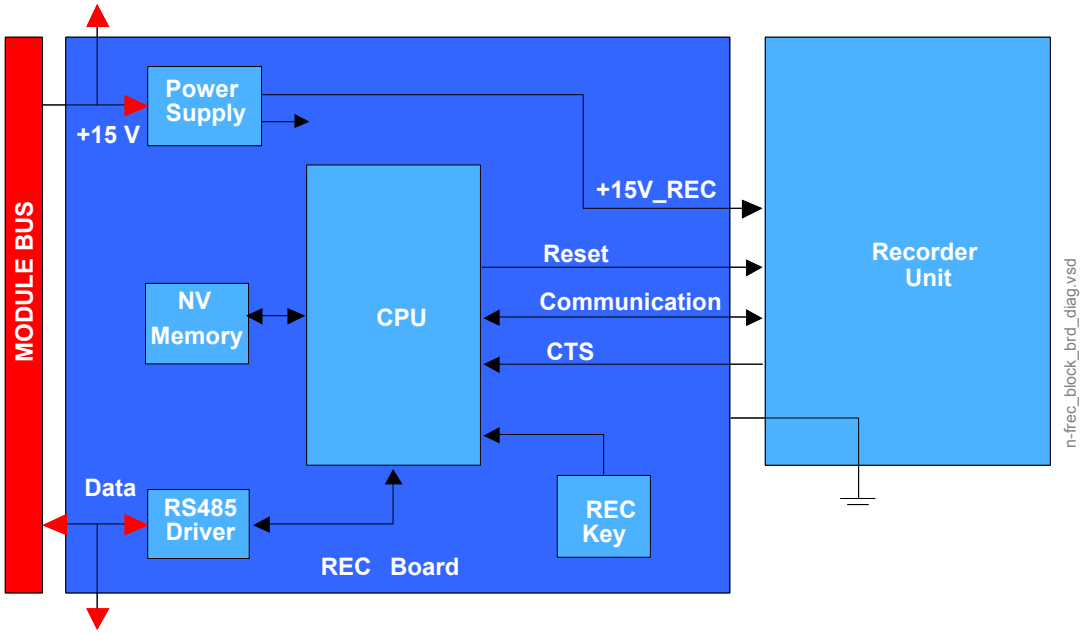


Figure 6 Recorder board block diagram

External Communication

Communication with the main CPU board is established via RS485.

Supply voltage The recorder unit supply voltage, +15V_REC, is provided by the recorder board.

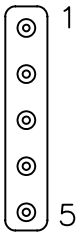
Module Bus Flex board

Module Bus Flex board connects the CPU board of the miniC unit and the recorder board to the module bus.

Figure 7 Module bus flex board

3.3 Connectors and signals

3.3.1 Module bus connector

5 pin female connector	Pin No.	Signal
	1	GND
	2	Vmod 13.8 - 16 V
	3	Data +
	4	Data -
	5	Shield

4 Service procedures

4.1 General service information

The field service of the Extension Modules is limited to replacing faulty circuit boards or mechanical parts. The circuit boards should be returned to GE Healthcare for repair.

GE Healthcare is always available for service advice. Please provide the unit serial number, full type designation and a detailed fault description.

CAUTION Only trained personnel with appropriate equipment should perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

CAUTION The module electronics can only be repaired and calibrated at the factory.

4.1.1 MiniC measuring unit

WARNING The miniC measuring unit and its components are repaired/calibrated at the factory. Attempts to repair/calibrate the unit elsewhere will adversely affect operation of the unit. The information provided is for reference only.

WARNING Handle the water trap and its contents as you would any body fluid. Infectious hazard may be present.

Serviceable parts

- Mini D-fend
- Mini D-fend O-rings
- Nafion tube
- Air filter
- Pump

NOTE: After any component replacement, see chapter "Adjustments and calibrations".

Calibration interval six months. Preventive maintenance once a year including the change of Nafion tube and the O-rings of water separator, pump check and calibration, leak test and absolute pressure sensor check.

4.1.2 Recorder unit

Serviceable or exchangeable parts

- Recorder board
- Thermal plotter

4.2 Service check

These instructions include complete procedures for a service check. The service should be performed after any service repair. Additionally, the service check procedures can also be used for determining possible failures.

The procedures should be performed in ascending order.

The instructions include a check form ("APPENDIX E:") which should be filled in when performing the procedures.

The symbol  in the instructions means that the check form should be signed after performing the procedure.

4.2.1 Recommended tools

Tool	Order No.	Notes
Screwdriver		Pozi-drive, Torx T10
Ambient pressure manometer		Amb. Press. can be checked from local meteorological station
Flowmeter		TSI model 4140 recommended
Flow cassette 50/1.1	873812	
Calibration gas and the regulator	755580* (gas) 755534	Contains 5 CO_2 and air
E-PSMW / E-PSMPW		
Patient simulator		

NOTE: *)Ensure that the calibrating gas and regulator are functioning properly before calibration. Perform annual maintenance on the regulator as required. For more information see "Calibration gas regulator flow check" in the "Gas calibration" chapter.

4.2.2 Recommended parts

Parts	Order No.	Notes
Recorder paper	74205	

Detach the module box cover by removing the five screws from the locking side of the module. Be careful with the flex cable, when opening the cover. Remove the grey plastic shield over the miniC unit.

4.2.3 Inspection

General

1. Check internal parts
   - all screws are tightened properly
   - all cables are connected properly
   - tubes are not pinched and there are no sharp bends on them
   - all tubes are connected properly
   - EMC covers are attached properly
   - there are no loose objects inside the module

N-F(C)REC:

Open the paper compartment hatch and take out the paper roll, if installed.

Remove any paper chaff from the paper compartment.

Clean the thermal printhead and the small glass window in front of the static brush with a cotton swab dipped in isopropyl alcohol. Avoid contact with the rubber paper roller.

NOTE: Be careful to limit the application of alcohol to the thermal printhead and the window.

Leave the paper compartment empty and close the hatch.

2. Check external parts
   - all connectors are intact and attached properly
   - the module box and the locking system are intact

   Reattach the module and check that the locking system moves properly.

CO_2 measurement

3. Check Mini D-Fend

   Detach the Mini D-fend. Check the condition of the rubber O-rings on the metal Mini D-fend connectors, located in the module front cover.

   If necessary, detach the connectors by first disconnecting the tubes, then removing the locking rings from the back of the front cover.

   Replace the Mini D-fend and sampling line with new ones.

NOTE: Use only Datex-Ohmeda sampling lines in order to ensure proper functioning.

Connect the Extension Module, N-FC or N-FCREC to the monitor.

Turn on the monitor.

Configure the monitor screen so that the CO_2 curve is shown, for example as follows:

Monitor Setup - ***Screen 1 Setup - Waveform fields -***
Field 6 - CO2
Digit Fields
Lower Field 1 - Gases

4. Module software

   Wait until the message 'Calibrating gas sensor' disappears from the screen, then enter the service menu.

   Monitor Setup - ***Install/Service*** (password 16-4-34) **-** ***Service*** (password 26-23-8).

   Write down the information regarding the ExtensionModule software.

5. Module bus communication

   Enter the service menu ***General: Parameters - Gas Unit - General***

   Check that the Timeouts, Bad checksums and Bad c-s by mod values are not increasing faster than by 5 per second.

   If one of the values is increasing faster, it indicates a failure in module bus communication.

6. Flow measurement offset

   Enter the service menu ***Gases***:

   Gas Unit - Gases

   Check that the flow measurement offset, i.e. the shown sample Zero value is within ±10 ml/min.

7. Ambient pressure

   Check that the shown Ambient value corresponds with the current ambient pressure (±20 mmHg).

8. Zero valve check

   Feed calibration gas and check that the gas readings in the service menu correspond with the values on the gas bottle sticker. Keep feeding gas, then activate the zero valve from the menu. The CO_2 reading should drop back to near 0%.

9. Nafion tube

   Replace the Nafion tube, if necessary.

NOTE: The Nafion tube should be replaced annually.

10. Leak test

    Perform the sampling system leak test.

    Connect a flow cassette with high flow resistance value (50/1.1) to the end of the sampling line and start following the Amb-Work value in the service menu. When the value exceeds 130 mmHg, connect the other port of the flow cassette to the sample gas out connector and switch off the pump.

    Wait until the pressure inside the sampling system is stabilized, then observe the shown Amb-Work value. The value, i.e. the pressure inside the sampling system should not drop more than 6 mmHg in 20 seconds.

    If the pressure drops more, first check the connections and repeat the test.

11. Check the flow rates

    Wait until the Sample Flow value returns close to 150 ml/min.

    Connect a flow meter to the 3 meter sampling line and check that the flow (the flow meter reading) is within the following range:

Sampling flow (ml/min) 135...165

If necessary, readjust the sampling flow:

Select ***Sample gain adj*** from the menu.

To increase the sampling flow, turn the ComWheel counterclockwise. To decrease the flow, turn the ComWheel clockwise.

A change of 0.050 in the Gain value changes the flow approximately 7.5 ml/min.

After you have changed the gain, wait until the Sample Flow value on the screen returns near to the original, then check the flow meter reading again.

12. Working pressure

    Check that the Amb-Work value in the service menu is within the following range:

    Amb-Work (mmHg) 20...50

13. Gas calibration

    Airway Gas - ***Gas Calibration***

NOTE: The calibration should not be performed before 30 minutes warm-up time.
Use calibration gas 755580 (5% CO_2, about 20% O_2) for calibrating the module with CO_2 measurement.

14. Occlusion detection

    Block the tip of the sampling line with your finger and check that the message 'Sample line blocked' appears on the monitor screen within 60 seconds.

15. Check D-fend

    Detach the mini D-fend and check that the message 'Check D-fend' appears on the monitor screen within 30 seconds.

16. Apnea detection

    Reattach the mini D-fend. Simulate at least 5 breaths by feeding calibration gas into the sampling line. Check that the shown gas information is correct.

    Check that the monitor shows the message 'Apnea' within 30 seconds after you have stopped feeding the gas.

Recorder

17. Paper compartment cleaning

    Open the paper compartment hatch and take out the paper roll, if installed.

    Remove any paper chaff from the compartment.

    Clean the thermal printhead and the small glass window in front of the static brush with a cotton swab dipped in isopropyl alcohol. Avoid contact with the rubber paper roller.

NOTE: Be careful to limit the application of alcohol to the thermal printhead and the window.

Leave the paper compartment empty and close the hatch.

Configure the monitor screen so that all required parameters are shown, for example:

Monitor Setup - ***Screen 1 Setup - Waveform Fields - Field 1 - ECG1***
Field 2 - ECG2
Field 3 - P1
Field 4 - P2
Field 5 - PLETH
Field 6 - OFF

Plug in the Hemodynamic Module. Connect a patient simulator to the module and check that all connected parameters are shown on the screen.

Preset recording settings:

Record/Print - ***Record Waveforms*** - ***Waveform 1 - ECG1***
Waveform 2 - P1
Waveform 3 - P2
Delay - Off
Paper Speed - 6.25 Mm/S
Length --> 30 S
Record Trends - Graphic Trend 1 - Hr
Graphic Trend 2 - P1

Monitor Setup - ***Install/Service*** (password 16-4-34) - ***Installation - Printer & Recorder - Default Trend - Graph.***

Display Trends - Time Scale - 2 h

18. Paper recognition

    Press the **Start/Stop** key on the monitor side panel. Check that the message "Recorder: Out of paper' appears on the screen.

19. Cover state recognition

    Open the paper compartment cover. Check that the previous message changes to 'Recorder: Cover open'.

    Install a paper roll and close the cover. Check that the message 'Recorder: Cover open' disappears from the screen.

20. Quality of recording

    Press the **Start/ Stop** key again and check that the quality of the recordings is acceptable.

21. Recording speed

    Press the **RECORD WAVE** key again and this time wait until the recording stops. Check that the length of the recorded waveform scale is 18.7 cm (±1.5 cm).

    Change the paper speed setting to 1 mm/s:

    Record/Print - ***Record Waveforms - Paper Speed - 1 mm/s***

    Press the **RECORD WAVE** key and wait until the recording stops. Check that the length of the scale is now 3.0 cm (±0.5 cm).

General

22. Electrical safety check

    Perform an electrical safety check and a leakage current test.

23. Functioning after electrical safety check

    Check that the module functions normally after performing the electrical safety check.

24. Final cleaning

    Turn off the monitor, disconnect and clean the module.

- Fill in all necessary documents.

5 N-FCREC Module disassembly and reassembly

CAUTION When reassembling the module, make sure that the tubes and cables are not pinched between the boards and the cover.

5.0.1 Instructions after replacing MiniC unit

After replacing the MiniC unit:

- perform the sampling system leak test
- perform the occlusion test
- perform the gas calibration

5.0.2 Before disassembly

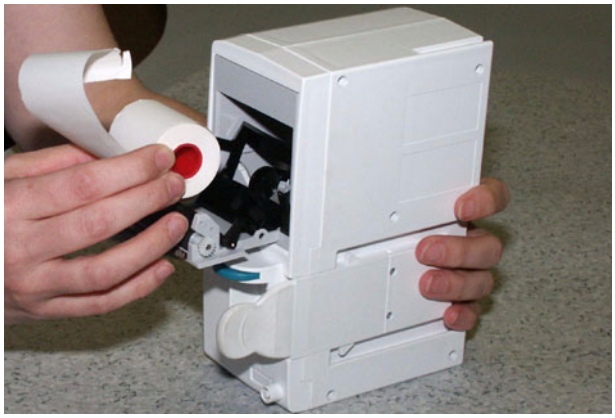
NOTE: Wear a grounded, antistatic wristband when handling PC boards. Electrostatic discharge may damage components on the board.

Disconnect the Extension Module from the monitor.

Tools needed

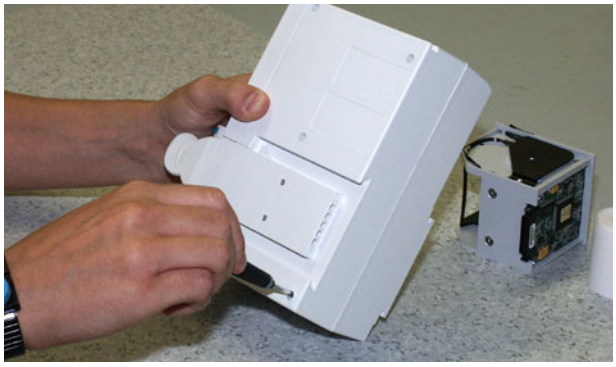
- screwdrivers, TORX; T8, T10, T15
- crosshead screwdriver; M15
- flat blade screwdriver
- pinchers
- antistatic wristband

Disassemble the Extension Module



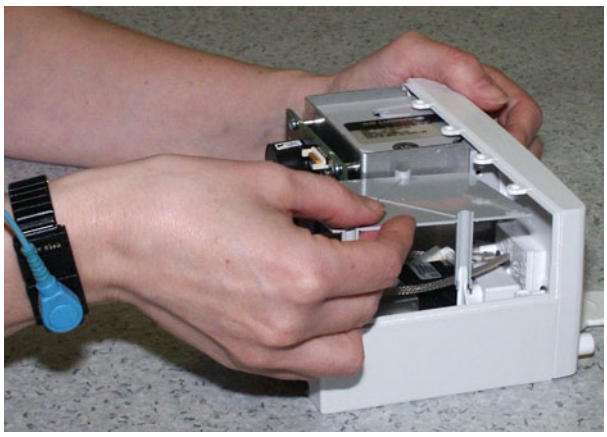
1. Remove the Mini D-fend.
2. Open the recorder unit paper cover and remove the paper roll, if installed.

3. Unscrew the two pozidrive screws inside the recorder unit completely (the screws cannot be removed) and remove the recorder unit.

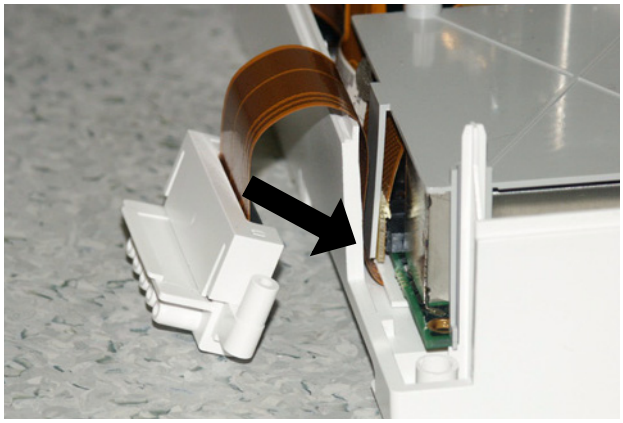


4. Remove the five screws (T8) on the side where the device plate is located.

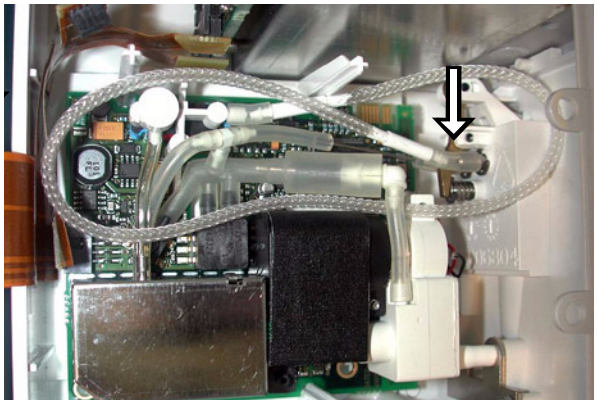
5. Place the N-F(C)(REC) on a table the device plate side down.
6. Remove the two screws (T8) near the module bus connector.



7. Remove the module cover carefully.
8. Remove the EMC-cover and CO_2 unit insulator plate.



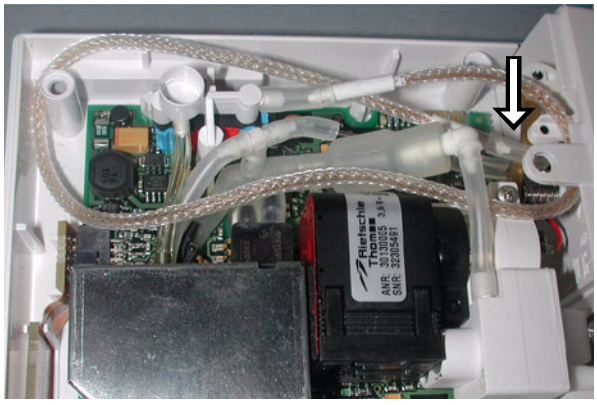
NOTE: The finger of the insulator plate secures the interconnection flex connector. While reassembling the insulator plate ensure that the finger supports the connector correctly.



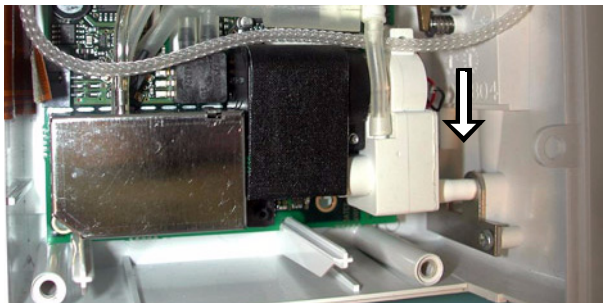
9. Disconnect the Nafion and silicon tubes from the mini D-fend connectors.

NOTE: While reassembling the nafion tube ensure the correct routing for both modules. If the nafion tube is not correctly routed it may get bent or jammed when reassembling the cover. Bent or pinched tube can get permanently blocked. The block may appear later when the tube warms up.

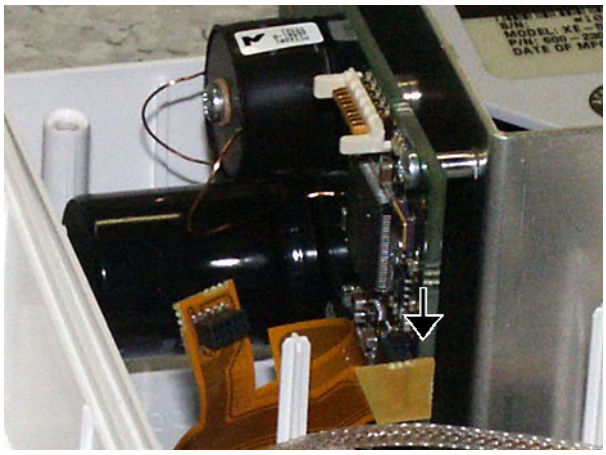
Correct nafion tube routing in **N-FCREC** module, arrow pointing at the mini D-fend connectors.



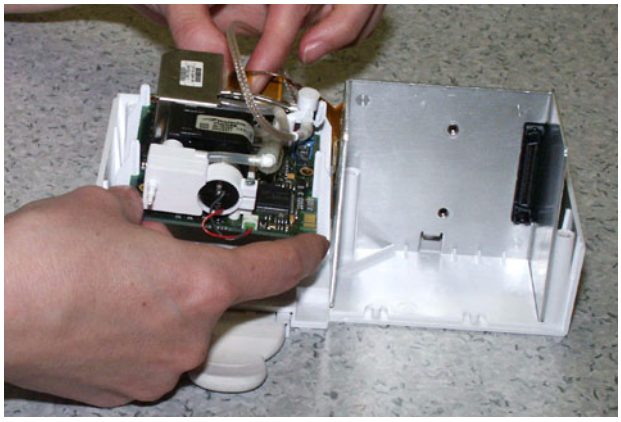
Correct nafion tube routing in **N-FC** module, arrow pointing at the mini D-fend connectors.



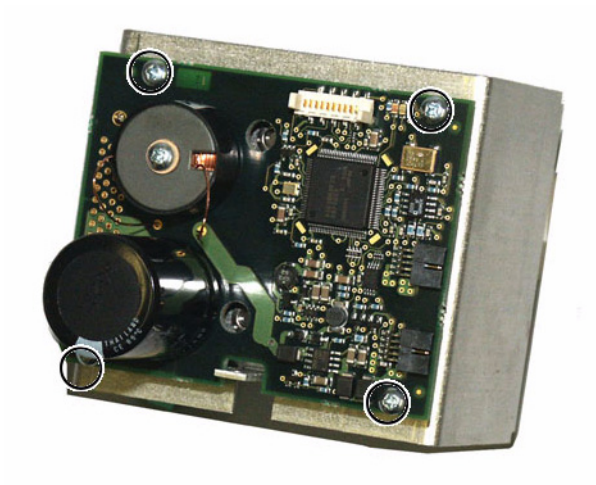
10. Disconnect the gas out tube from the pump unit and remove the front panel unit.



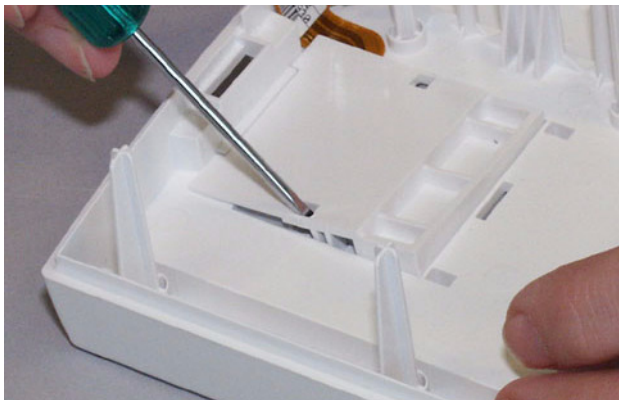
11. Remove the CO2 unit module bus flex cable from the REC board.



12. Lift the CO2 unit up carefully, disconnect the module bus flex cable and remove the unit from the module cover.

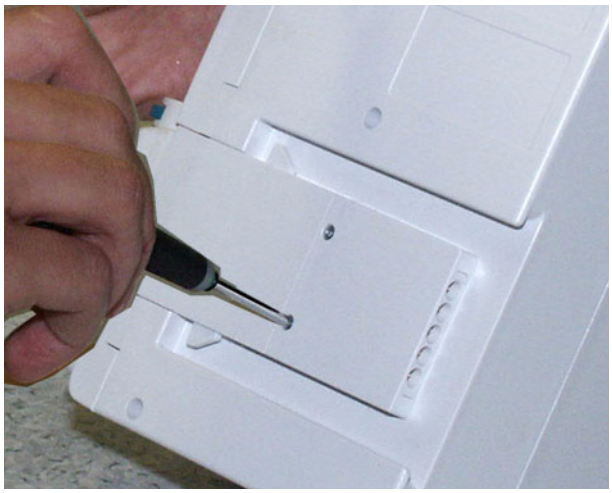


13. Remove the screw (T8) holding the module bus flex cable to recorder unit metal plate and module cover.
14. Disconnect the module bus flex cable from the REC board and remove the REC board with the recorder unit metal plate from the module cover.
15. Remove the four pozidrive screws holding the REC board to the recorder unit metal plate.



16. Use a flat blade screwdriver to unlock the module bus connector insulator cover. Put the screwdriver in the hole and move the blade backwards (away from the module bus flex cable) until the insulator cover unlocks.

17. By assisting with a screwdriver pull the module bus connector through the hole in the module cover.



18. Flip the module cover over and remove the two (T6) screws holding the lock unit to the frame. While pulling the tab push the lockers with a screwdriver to remove the lock unit.

5.1 Adjustments and calibrations

5.1.1 Calibrating

The airway module should be calibrated once every six months or whenever there are indications of errors in the gas readings.

Calibrate the gas measurement with the Datex-Ohmeda calibration gas. Do not use any other calibration gases.

– Use the regulator 755534.

– Use gas 755580 only and set the FiO2 level in the CO2 setup menu to 21-40% ***Airway Gas - CO2 setup.***.O_2 concentration to 20%.

Use only recommended calibration gases to guarantee a successful calibration.

During gas calibration, % units are always used for CO_2 regardless of selected measuring units.

NOTE: Ensure that the calibration gas and regulator are functioning properly before calibration. Perform the annual maintenance on the regulator as required.

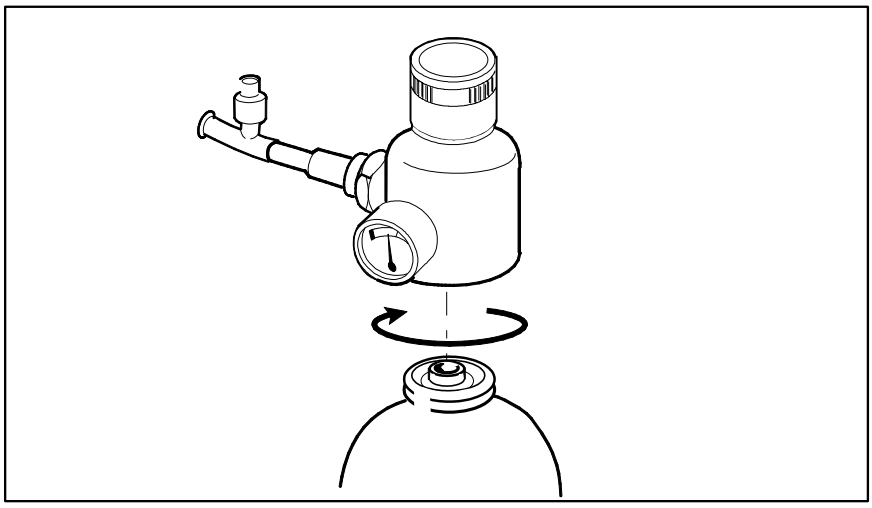


Figure 8 Attaching regulator to the calibration can

1. Attach the regulator to the gas container.
2. Attach a new sampling line to the water trap. Connect the loose end of the sampling line to the regulator on the gas container.

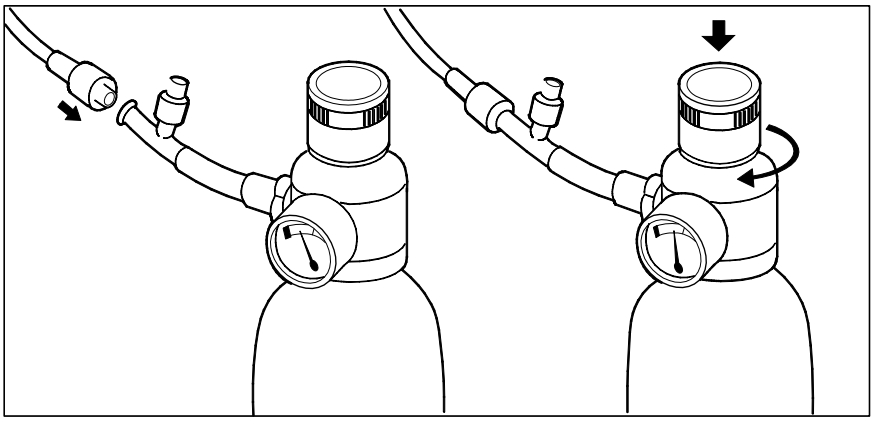


Figure 9 Connecting sampling line to the gas valve and feeding gas

3. For maximum accuracy, let the monitor warm up for 30 minutes. The menu item ***Gas calibration*** remains gray as long as the message 'Calibrating gas sensor' is displayed.
4. Press the **Airway Gas** key and select ***Gas calibration***.
5. Wait until the 'Zero ok' and then the 'Feed gas' messages appear after each gas on the screen.
6. Open the regulator and feed calibration gas until the message 'Adjust' appears, then close the valve.
7. Check that the displayed gas value matches the value on the calibration gas container.

NOTE: Adjust the O_2 percentage according to the calibration gas (for 755580 the right O2 value is 20%).

NOTE: If an error occurs during calibration or if no gas is fed, the text 'Calibr. error' appears. Push the ComWheel to perform a new calibration.

If adjustments are required:

- Turn the ComWheel to highlight the first gas to be adjusted and then push the ComWheel.

Turn the ComWheel until the displayed value matches the desired value in the gas bottle and push it again.

If the message 'Zero error' is displayed, press the **Normal Screen** key and repeat the calibration procedure.

The time of the last calibration is shown at the bottom of the menu page.

5.1.2 Gas sampling system adjustment

For flow rate measurements, a flow meter with a low flow resistance and the capability to measure low flow rates is required. A sampling line of normal length has to be connected to the monitor as it has a considerable effect on the flow.

5.1.3 Flow rate measurement

If any flow rates are not correct, first replace the Mini D-Fend water trap, then recheck the flows.

The sampling flow rate is measured by a flow meter at the sampling line. The flow rate should be between 135 and 165 ml/min. The flow rate is adjusted in the ***Gases*** service menu with ***Sample gain adj***.

5.1.4 Flow rate adjustment

NOTE: Before adjusting the sampling flow, make sure there is no leakage in the sampling system.

Refer to chapter *3.2 Service check,* step 13. Gas calibration.

Wait until the Sample Flow value is back to near 150 ml/min.

Connect a flow meter to the 3 meter sampling line and check that the flow (the flow meter reading) is within the following range:

Sampling flow (ml/min) 135...165

If necessary, readjust the sampling flow:

Select ***Sample gain adj*** from the menu.

To increase the sampling flow, turn the ComWheel counterclockwise.

To decrease the flow, turn the ComWheel clockwise.

A change of 0.050 in the Gain value changes the flow approximately 7.5 ml/min.

After you have changed the gain, wait until the Sample Flow value on the screen returns near to the original, then check the flow meter reading again.

5.1.5 Gas calibration

Gas calibration is performed in the ***Airway Gas*** menu.

Calibration gas regulator flow check

Interval: every 12 months

Regulator flow specification:

REF 755533 & 755534: 260 – 410 ml/min at 1-10 bar cylinder pressure
REF 755530: 260 – 410ml/min at 5-7psi cylinder pressure

Tools needed: calibration gas can, regulator, piece of silicon hose and flow meter. GE Healthcare recommends use of TSI 4140 Flow Meter.

Insert the calibration gas regulator on the gas cylinder. Connect a silicon hose between the regulator and the flow meter. Block the regulator overflow port and open the regulator. Check the flow rate from the flow meter and verify that the flow is within the specification.

6 Extension Modules Spare parts

6.1 Extension Modules, N-FCREC, N-FREC

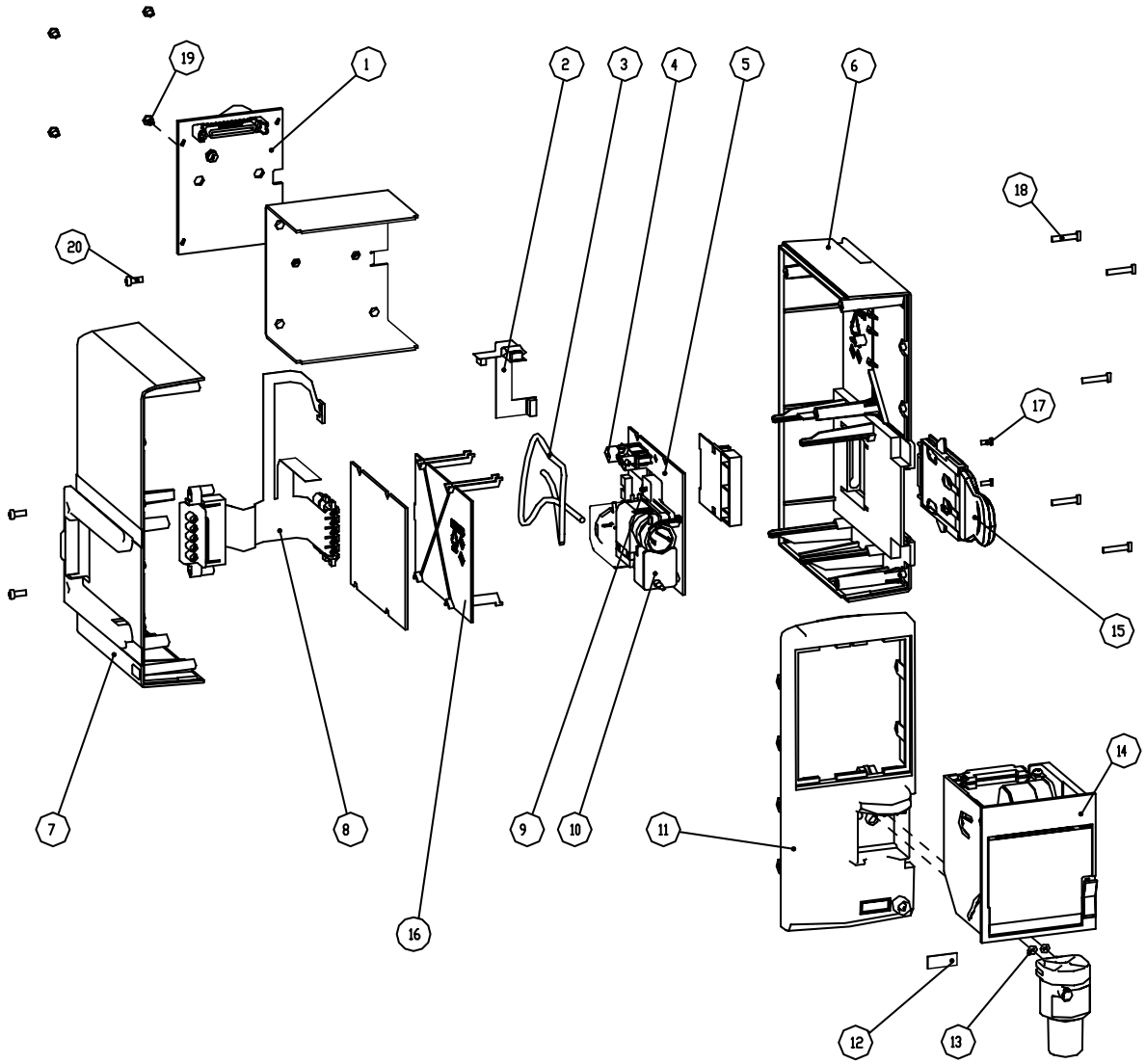


Figure 10 Exploded view of N-FCREC module

Extension Module, N-FCREC, N-FREC

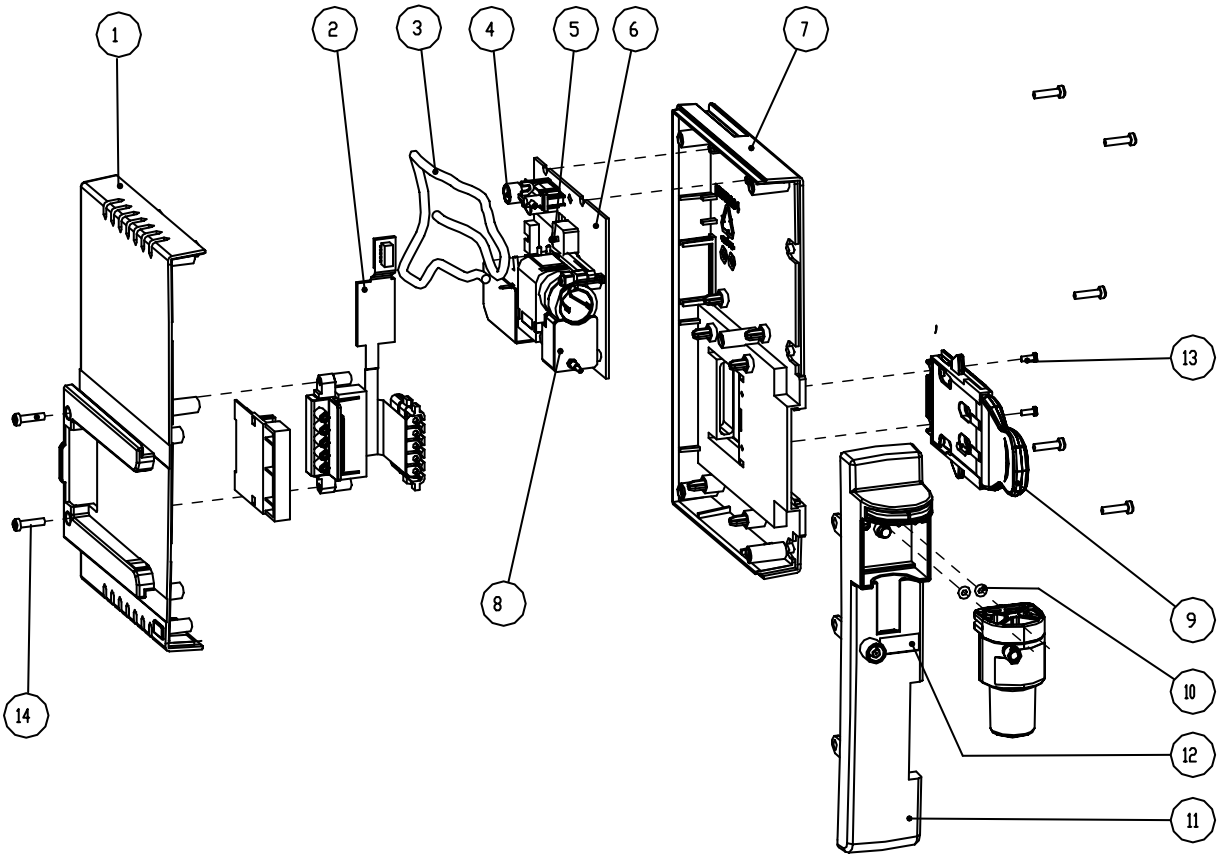
The following N-F(C)(REC) parts will be available as field replaceable spare parts:

Item	Description	Order Code
1	REC Board, N-F(C)REC	M1009960
2	Interconnection flex	M1009962
3	Nafion Tubing	733382
4	Air Filter, N-FC(REC)	M1011471
5	MiniC Unit, N-FC(REC)	M1013204
6	Module cover, right, N-F(C)REC	M1006806
7	Module cover, left, N-F(C)REC	M1006808
8	Module Bus Flex Board Unit, N-F(C)(REC)	M1015109
9	Tubing Unit for miniC, N-FC(REC)	M1013717
10	Pump Unit for miniC, N-FC(REC)	M1013716
11	Front Panel Unit, N-FREC	M1007843
11	Front Panel Unit, N-FCREC	M1015148
13	Mini D-fend O-ring	656565
14	Recorder Unit, N-F(C)REC	M1007853
15	Lock Unit, N-F(C)(REC)	M1011862
16	Insulation plate	M1006816
	Screws	
17	PT2.2x6, TORX	M1010189
18	PT3x16, TORX	M1000523
19	M3x6, POZIDRIVE	61721
20	PT3x8, TORX	628727
	Screw for plastic, PT3.5x7.5mm, pan head, torx /T8	M1013389

6.2 Front panel labeling, N-FC, N-FCREC:

Item	Description	Order Code
12	Gas Exhaust Sticker, N-FC(REC)	M1013819
12	Gas Exhaust Sticker, N-FC(REC) - US	M1025438

6.3 Extension Module, N-FC



N-FC

Item	Description	Order Code
1	Module cover, left, N-FC	M1010206
2	Module Bus Flex Board Unit, N-FC	M1027713
3	Nafion Tubing	733382
4	Air Filter, N-FC(REC)	M1011471
5	Tubing Unit for miniC, N-FC(REC)	M1013717
6	miniC Unit, N-FC(REC)	M1013204
7	Module cover, right, N-FC	M1010204
8	Pump Unit for miniC, N-FC(REC)	M1013716
9	Lock Unit, N-F(C)(REC)	M1011862
10	Mini D-fend O-ring	656565
11	Front Panel Unit, N-FC	M1026296
12	Screw PT2.2x6, TORX	M1010189
13	Screw PT3x12, TORX	628729
14	Screw for plastic, PT3.5x7.5mm, pan head, torx /T8	M1013389

7 Troubleshooting

7.1 Troubleshooting chart for recorder unit

Problem	Cause	What to do
Module not responding to front panel key, but operates through Recorder menu.	Membrane switch cable loose or broken.	Check the cable. Replace the front panel if necessary.
Recorder will not start. No error messages shown.	Recorder: Module not properly inserted.	Re-insert the module properly.
	Recorder: Flex-strip cable broken.	Check the cable. Replace if necessary.
	Recorder board faulty.	Replace the recorder board.
	Recorder unit faulty.	Replace the recorder unit.
Recorder works but nothing appears on the paper.	Active side of the paper downwards.	Turn the paper roll over. To test which side is active: Place the paper on a hard surface and draw a line with a fingernail - a dark line will appear on the active (thermal) side.
	Recorder unit faulty.	Replace the recorder unit.

7.2 Troubleshooting chart for CO_2 measurement

Problem	Cause/What to do
No response to breathing	Sampling line or water trap blocked or loose, or improperly attached. Water trap container full. See the gas sampling system troubleshooting.
'SENSOR INOP.' message	The temperature is too low or high, check the temperature in the service menu. Supply voltage is too low or high, IR source current or voltage is too low or high, check current in the service menu. Pump is not working properly, check sample flow and pump voltage in the service menu. Ambient pressure too low or high, check the ambient pressure in the service menu. Zero valve not working properly, check the functionality by switching zero valve on and off in the service menu.
'ZEROING ERROR' message	Gas zeroing failed. Condensation or residual gases are affecting the zero measurement. Allow the module to run drawing room air for half an hour and calibrate again.
'CHECK D-FEND' message	Amb – Work pressure difference too small. Probably water trap or the sampling line is not attached properly. Gas zero valve failure. Pump failure or gas outlet blockage.

Problem	Cause/What to do
'REPLACE D-FEND' message	Amb – Work pressure difference too big. Indicates residue build-up on the water trap membrane. This decreases air flow. Replace the D-fend.
'SAMPLE LINE BLOCKED' message	Amb – Work pressure difference too big. Sampling line or water trap is occluded. Water trap container is full. If occlusion persists, check internal tubing for blockages.
No response to any gas	Check Sample Gas Out. Amb - Work pressure low, flow too small and pump voltage too high. Sampling line, water trap, or internal tubing is blocked or loose, or improperly attached. Gas out connector or tubing is blocked. Zero valve malfunction. Pump failure or pump is worn. Supply voltage missing. Serial communication error.
Sudden increase in gas display	Water trap malfunction. Check all internal tubing and the interior of the water trap for occlusions or leaks. Replace water trap. Check flow rates.
Abnormally high (or abnormally low response to CO_2 or sudden occlusion warning	Pressure transducer failure. Check the Ambient and Amb – Work pressures in ***Gases*** service menu.
Strong drift in all gases	Leak in sampling line or internal tubing (especially in conjunction with too low readings).

7.2.1 CO_2 measurement

Problem	Cause	What to do
Action too low $ETCO_2$ value	• sudden decrease in circulation • pulmonary embolism • hyperventilation • very large dead-space • large shunting • leak in sampling system • calibration error • high by-pass flow from ventilator	• check all connections • check calibration
too high $ETCO_2$	• hypoventilation • increased metabolism • D-fend contaminated • calibration error	• change D-fend • check calibration
waveform clipped	• incorrect scaling	• change scale

Problem	Cause	What to do
no response to breathing	• apnea • (disconnection) • sampling line or water trap loose or blocked (air leak)	• check all connections
	• sample gas outlet blocked	• check that outlet is open
$ETCO_2$ over scale >20% Shown until 32%, specified range 0...20%	• abnormally high $ETCO_2$ (permissive hypercapnia) • CO_2 sensor contaminated • D-fend malfunction	• let the module run without a sampling line until the CO_2 sensor has dried out • change D-fend
$ETCO_2$>$PaCO_2$	• unit is mmHg or kPa and $ETCO_2$ is close to arterial PCO_2 • "dry gas" as default	• change to "wet gas" by using install/service menu

7.3 Gas sampling system troubleshooting

The faults which can occur in the sampling system are: leaks or blockages in the tubing, failure of the sampling pump or the magnetic valves, or diminishing of the flow rates because of dirt accumulating in the internal tubing.

The following checks should help in localizing the fault. Whenever suspecting the sampling system and always after having done any work on the sampling system, check and if necessary adjust the flow rate.

CAUTION The special internal sample tube is mechanically fragile. Sharp bends will cause leaks.

NOTE: D-fend water trap should be replaced, when the 'REPLACE D-FEND' message appears during the monitor startup.

NOTE: If any liquid has entered the miniC measuring unit due to water trap filter failure, leave the module running without a sampling line for several hours and check the functions after it has dried out.

7.3.1 Sampling system leak test

1. Connect a flow cassette with a high flow resistance value (50/1.1) to the end of the sampling line and start following the 'Amb-Work' value in the service menu. When the value exceeds 130 mmHg, connect the other port of the flow cassette to the sample gas out connector and switch off the pump.
2. Wait until the pressure inside the sampling system is stabilized, then observe the shown Amb-Work value. The value, i.e. the pressure inside the sampling system, should not drop more than 6 mmHg in 20 seconds.
3. If the pressure drops more, first ensure the connections you have made and repeat the test.

7.4 MiniC unit troubleshooting

CAUTION The miniC measuring sensor can only be repaired and calibrated at the factory. In case of failure, the complete miniC unit should be sent to GE Healthcare for factory exchange.

7.5 Error messages

Message	**Explanation**
Occlusion or Sample Line Blocked	The sample tube inside or outside the monitor is blocked or water trap is occluded. If occlusion persists, measured gas values disappear.
Continuous occlusion. Check sample line and D-fend.	Occlusion over 40 seconds.
Check D-fend	- The water trap is not connected - There is a leak in the sampling line inside the module. If air leak persists, measured gas values disappear. Check sample gas out.
(Air leak detected.) Check water trap and sample gas out-flow. Press normal screen to continue.	Air leak over 40 seconds.
Replace D-fend (replace water trap)	Indicates residue build-up on the water trap membrane. This decreases air flow.
Gas calibration is not available during first 5 minutes/during occlusion/during air leak	Entering calibration is not allowed during 5 minutes after power up and during occlusion or air leak.
Gas out blocked	- Gas out connector on the front panel, or the exhaust line connected to it, is blocked. - If the sample gas is returned to the patient circuit, the filter in the return kit may be occluded. - Make sure the sample gas outlet is connected to an open scavenging system only where gas is removed in room pressure.
Recalibration	Time out, fluctuating gases, gain adjusted “over”.
Zero error	Unsuccessful zeroing.
Unstable, Calibr error	Unsuccessful calibration.
Menu messages during calibration:	
Zero error	Unsuccessful zeroing.
Adjust	Calibration gas accepted and monitor is ready for adjusting the gas values to match the calibration gas concentration.
Unstable	Unsuccessful calibration.

APPENDIX A: Software download instruction

Overview

The ProgMon service download tool is a Windows-based software download application that installs the main software and language files for B30 patient monitor.

WARNING **The installation must only be done while the Monitor is not connected to a patient in order to protect the patient and user from electrical shock.**

CAUTION All user settings will be lost after installation of new monitor software. Save user settings before starting software installation.

CAUTION Make sure that the monitor is connected to AC power source, or the batteries are fully charged. Lost of power during software installation may result in software installation failure.

System requirements

- PC with Microsoft Windows XP
- B30 software download CD
  - B30 monitor main software
  - B30 language files
  - ProgMon software download tool
  - B30 software download instruction
- CAT-5 Straight through network cable
- B30 software download license file

Software installation

NOTE: You can save your settings in ***Save Modes*** menu before software installation.

B30 monitor main software installation

1. Connect PC and B30 monitor into the same network with a network cable
2. Close the firewall and set the IP Address as 126.1.1.2, set the subnet mask as 255.0.0.0 in PC
3. Turn on the B30 Monitor and enable software download function

   Monitor Setup

   Install/Service (16-4-34)

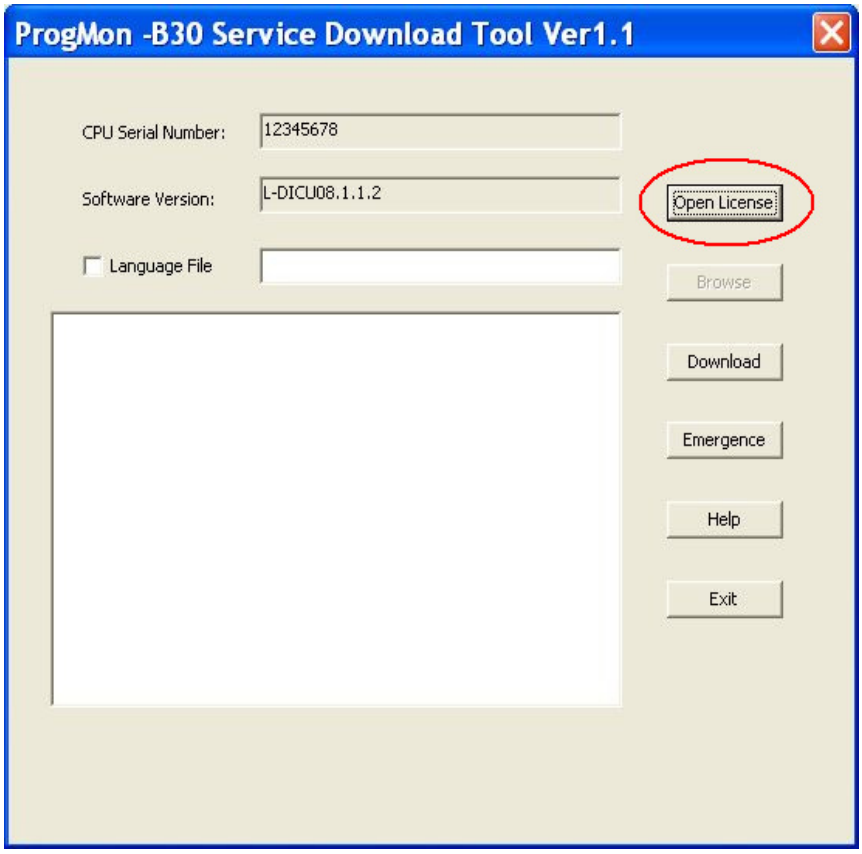
   Service (26-23-8)

   SW Settings

   Set ***SW download*** to ***enable***

   The B30 monitor enters into software download mode.

4. Run ProgMon.exe files in PC.



NOTE: All information in the figure is just for reference.

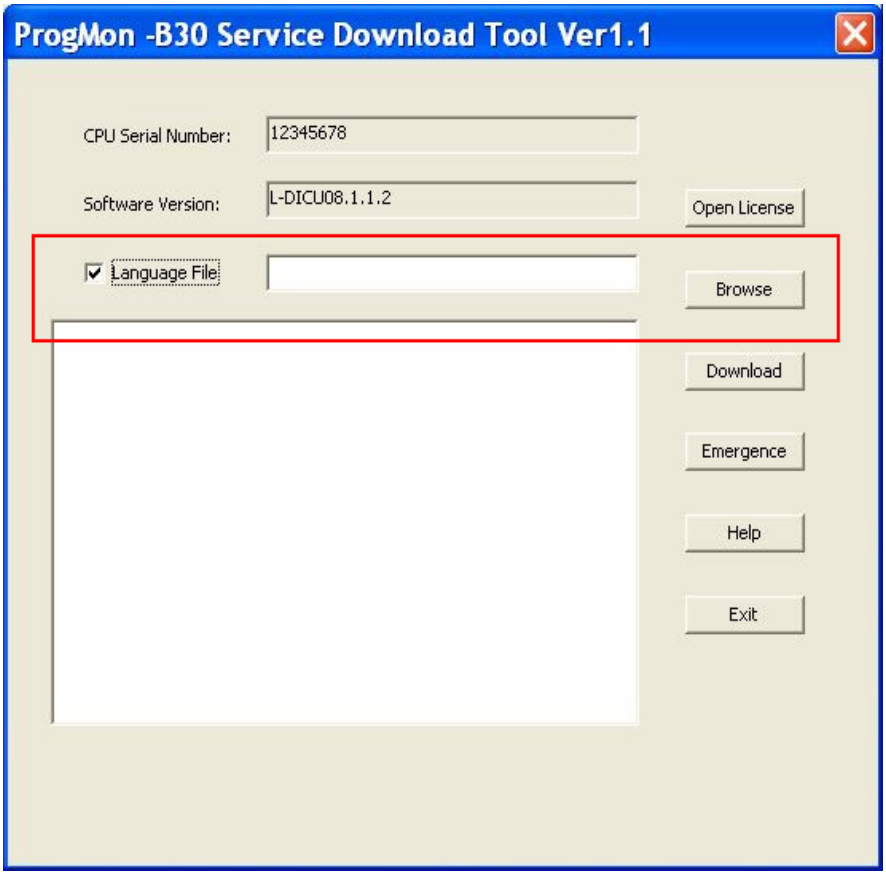
5. Click ***Open License*** button, choose the license file you have. The ***CPU Serial Number*** and ***Software Version*** will be automatically imported through the license file.
6. Press ***Download*** button to start software download.

   NOTE: When the installation is finished, the information *Programming done* will be in the text box. The B30 monitor will restart automatically.

   NOTE: If the CPU serial number is not in accordance with the license file, please update the corresponding license file.

B30 monitor language files installation

1. Follow above steps 1-4 to enter Software download mode.
2. Click the check box beside ***Language File*** to choose the language download option; click the ***Browse*** button to choose the language you want to install.



NOTE: All information in the figure is just for reference.

3. Press ***Download*** button to start language download.

   NOTE: When the installation is finished, the monitor still in the software download mode, you can continue to install another language, or restart the monitor manually.

Emergence download

The emergence download method is intended for the situation when the main software of the monitor is damaged or the monitor can't go to the normal screen.

1. Connect PC and B30 monitor into the same network with a network cable, and make sure the monitor is on.
2. Close the firewall and set the IP Address as 126.1.1.2, set the Subnet mask as 255.0.0.0 in PC.
3. Disconnect the power cord and remove all batteries to reset the monitor. Wait at least for 30 senconds, switch the monitor back on.
4. Open the ProgMon.exe in PC.

5. Click ***Open License*** button, choose the license file you have. The ***CPU Serial Number*** and ***Software Version*** will be automatically imported through the license file.
6. Press ***Emergence*** button to start software download.

NOTE: When the emergence download for the main software is done successfully, waiting for 3 to 5 minutes until the B30 monitor restart automatically.

Verification and configuration

1. Perform Factory Reset.

   Monitor Setup

   Install/Service (16-4-34)

   Service (26-23-8)

   Set/Test

   Factory Reset

   After the Factory Reset is completed, the B30 monitor will restart automatically.
2. Set the time and date.

   Monitor Setup

   Time and Date
3. If necessary, set the monitor's network communication according to the used network software.

   Monitor Setup

   Install/Service (16-4-34)

   Service (26-23-8)

   Frame

   Network

   Dri Config

   DRI level

   Central station software S-CNET01 -> DRI Level = 2001

   Central station software S-CNET02 -> DRI Level = 2002

   Central station software L-NET03 or L-NET05 -> DRI Level = 2003

   NOTE: If the DRI level is changed, the B30 monitor will restart automatically. The change will take effect only after restart.
4. Verify that the software has been installed correctly.

   Monitor Setup

   Install/Service (16-4-34)

   Service (26-23-8)

   SW Version / Unit Id
5. Verify that the active language is installed and activated correctly

   Monitor Setup

   Install/Service (16-4-34)

   Service (26-23-8)

   SW Settings

   Country Settings

Languages

6. Check that there are no error messages on the screen. Perform a functional check, refer to the C. Functional check form, B30 in Appendix C.
7. Restore the original user settings, if necessary.
8. Fill in all necessary service documents with regard to the new monitor software.

NOTE: The next start-up time may be longer right after the monitor software installation.

Troubleshooting

Please refer to the flow chart in 1.1. General troubleshooting if something goes wrong during software installation and configuration.

APPENDIX B: ElectroMagnetic Compatibility

Table 1 Guidance and manufacturer's declaration – electromagnetic emissions

Guidance and manufacturer's declaration – electromagnetic emissions		
The B30 monitor is intended for use in the electromagnetic environment specified below. The customer or the user of the B30 should assure that it is used in such an environment.		
Emissions test	**Compliance**	**Electromagnetic environment - guidance**
RF emissions CISPR 11	Group 1	The B30 uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF emissions CISPR 11	Class B	The B30 is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.

Table 2 Guidance and manufacturer's declaration – electromagnetic immunity

Guidance and manufacturer's declaration – electromagnetic immunity			
The B30 is intended for use in the electromagnetic environment specified below. The customer or the user of the B30 should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment - guidance**
Electrostatic discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast transients/bursts IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines	±2 kV for power supply lines ±1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1 kV differential mode ±2 kV common mode	±1 kV differential mode ±2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply lines IEC 61000-4-11	<5% U_T (>95% dip in U_T) for 0.5 cycle 40% U_T (60% dip in U_T) for 5 cycles 70% U_T (30% dip in U_T) for 25 cycles <5% U_T (>95% dip in U_T) for 5 sec	<5% U_T (>95% dip in U_T) for 0.5 cycle 40% U_T (60% dip in U_T) for 5 cycles 70% U_T (30% dip in U_T) for 25 cycles <5% U_T (>95% dip in U_T) for 5 sec	Mains power quality should be that of a typical commercial or hospital environment. If user of the equipment requires continued operation during power mains interruptions, it is recommended that the equipment be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic field should be at levels characteristic of a typical location in a typical commercial or hospital environment.
NOTE U_T is the a.c. mains voltage prior to application of the test level.			

Table 3 Guidance and manufacturer's declaration – electromagnetic immunity

Guidance and manufacturer's declaration – electromagnetic immunity			
The B30 is intended for use in the electromagnetic environment specified below. The customer or the user of the B30 should assure that it is used in such an environment.			
Immunity test	**IEC 60601 test level**	**Compliance level**	**Electromagnetic environment - guidance**
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms	Portable and mobile RF communications equipment should be used no closer to any part of the equipment, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. **Recommended separation distance** $d = 1.2\sqrt{P}$
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	3 V/m	$d = 1.2\sqrt{P}$ 80 MHz to 800 $d = 2.3\sqrt{P}$ 800 MHz to 2.5 where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and *d* is the recommended separation distance in metres (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey, [a] should be less than the compliance level in each frequency range. [b] Interference may occur in the vicinity of equipment marked with the following symbol: 
NOTE 1 At 80 MHz and 800 MHz, the higher frequency range applies. NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			
[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicated theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the equipment is used exceeds the applicable RF compliance level above, the equipment should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the equipment. [b] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 3 V/m.			

Table 4 Recommended separation distances between portable and mobile RF communications equipment and the B30 monitor

Recommended separation distances between portable and mobile RF communications equipment and the B30.

The B30 monitor is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the equipment can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the equipment as recommended below, according to the maximum output power of the communications equipment.

Rated maximum output power of transmitter W	**Separation distance according to frequency of transmitter** m		
	150 kHz to 80 MHz $d = 1.2\sqrt{P}$	80 MHz to 800 MHz $d = 1.2\sqrt{P}$	800 MHz to 2.5 GHz $d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1 At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

APPENDIX C: Functional check form, B30

Customer	
Service	
Service engineer	Date

Monitor Installation			
L-	E-	N-	

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual Inspection			**OK**	**N.A.**	**Fail**
1. Check all units visually			☐	☐	☐

Functional Inspection		**OK**	**N.A.**	**Fail**
3.2.1. General		☐	☐	☐
3.2.2. Display	S/N	☐	☐	☐
3.2.3. Keyboard(s)	S/N	☐	☐	☐
3.2.4. Frame unit	S/N	☐	☐	☐
3.2.6. Multiparameter Hemodynamic Modules	S/N	☐	☐	☐
. ECG and RESP measurements		☐	☐	☐
. Temperature measurement		☐	☐	☐
. Invasive blood pressure measurement		☐	☐	☐
. SpO2 measurement		☐	☐	☐
. Non invasive blood pressure measurement		☐	☐	☐
3.2.8. Network connection		☐	☐	☐
3.2.9. Final		☐	☐	☐

Functional Inspection		**OK** **N.A.** **Fail**
Notes		

Signature

APPENDIX D: Planned maintenance check form, B30

Customer	
Service	
Service engineer	Date

Monitor Installation			
L-	E-	N-	

Measuring equipment used:				
Equipment / tool:	Manufacturer:	Model/Type/Part Number:	Serial Number / ID:	Calibration Date:

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual Inspection		**OK**	**N.A.**	**Fail**
4.1.2. General		☐	☐	☐
4.1.3. E-PSM(P)W Module	S/N	☐	☐	☐
Notes				

Functional Inspection		**OK**	**N.A.**	**Fail**
4.2.1. General		☐	☐	☐
4.2.2. Display		☐	☐	☐
4.2.3. Keyboard(s)		☐	☐	☐
Notes				

Functional Inspection		OK	N.A.	Fail
4.2.4. E-PSM(P)W Module		☐	☐	☐
. ECG measurement		☐	☐	☐
1. Module software (serial numbers)		☐	☐	☐
3. Power frequency		☐	☐	☐
4. Cable recognition		☐	☐	☐
5. Lead detection		☐	☐	☐
6. Test with the patient simulator		☐	☐	☐
Notes				
. Respiration measurement	S/N	☐	☐	☐
7. RESP measurement recognition		☐	☐	☐
8. Test with patient simulator		☐	☐	☐
Notes				
. Temperature measurement	S/N	☐	☐	☐
9. Communication and memories		☐	☐	☐
10. Temperature probe detection		☐	☐	☐
11. Calibration check		☐	☐	☐
12. Temp test		☐	☐	☐
13. Module configuration		☐	☐	☐
Notes				
. Invasive blood pressure measurement	S/N	☐	☐	☐
14. Membrane keys		☐	☐	☐
15. Cable and transducer detection		☐	☐	☐
16. Calibration		☐	☐	☐
17. Test with patient simulator		☐	☐	☐

Functional Inspection		**OK**	**N.A.**	**Fail**
Notes				
. SpO2 measurement	S/N	☐	☐	☐
18. SpO2 probe detection		☐	☐	☐
19. Test measurement		☐	☐	☐
Notes				
. Non Invasive Blood Pressure measurement	S/N	☐	☐	☐
20. Communication and memories		☐	☐	☐
21. Pump and valves		☐	☐	☐
22. Leak test		☐	☐	☐
23. Calibration check		☐	☐	☐
25. Cuff related messages		☐	☐	☐
26. Test measurement		☐	☐	☐
27. NIBP hose detection		☐	☐	☐
Notes				
4.2.5. Loudspeaker		☐	☐	☐
4.2.6. Monitor software		☐	☐	☐
4.2.7. Content of the service log		☐	☐	☐
4.2.8. Voltages		☐	☐	☐
4.2.9. Watchdog circuitry		☐	☐	☐
4.2.10. Alarm LEDs		☐	☐	☐
4.2.11. Membrane keys		☐	☐	☐
4.2.12. ComWheel		☐	☐	☐
4.2.13. Module communication		☐	☐	☐
4.2.14. Batteries		☐	☐	☐

Functional Inspection		OK	N.A.	Fail
Notes				
4.2.15. Network		☐	☐	☐
1. Connection to network		☐	☐	☐
2. Ethernet address		☐	☐	☐
3. Data error counters		☐	☐	☐
4. Hardware error counters		☐	☐	☐
5. Disconnection recognition		☐	☐	☐
6. ID-plug recognition		☐	☐	☐
Notes				
4.2.16. General test		☐	☐	☐
1. Storing trend data		☐	☐	☐
2. Service reset		☐	☐	☐
3. Watchdog		☐	☐	☐
4. Service Log reset		☐	☐	☐
5. Electrical safety check		☐	☐	☐
6. Final cleaning		☐	☐	☐
Notes				

Used Spare Parts			
Notes			

Signature

APPENDIX E: Service check form, Extension Module, N-FC, N-FCREC, N-FREC

Customer		
Service	Module type	S/N
Service engineer		Date

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

	OK	N.A.	Fail		OK	N.A.	Fail
1. Check internal parts	☐	☐	☐	2. Check external parts	☐	☐	☐
3. Check Mini D-Fend	☐	☐	☐				
Notes							
	OK	N.A.	Fail		OK	N.A.	Fail
4. Module software	GAS						
5. Module bus communication	☐	☐	☐				
6. Flow measurement offset					±10 ml/min		
7. Ambient pressure	☐	☐	☐	8. Zero valve check	☐	☐	☐
9. Nafion tube	☐	☐	☐				
10. Leak test					≤6 mmHg/20 sec		
11. Check the flow rates							
Sampling flow					135...165 ml/min		
12. Working pressure							
Amb-Work					20...50 mmHg		
13. Gas calibration	☐	☐	☐				

14. Occlusion detection	☐	☐	☐	15. Check D-fend	☐	☐	☐
16. Apnea detection	☐	☐	☐				

Recorder

17. Paper compartment cleaning	☐	☐	☐	18. Paper recognition	☐ ☐ ☐
19. Cover state recognition	☐	☐	☐	20. Quality of recording	☐ ☐ ☐
21. Recording speed	☐	☐	☐		
22. Electrical safety check	☐	☐	☐	23. Functioning after electrical safety check	☐ ☐ ☐

General

24. Final cleaning	☐	☐	☐	

Notes

Used Spare Parts			

Signature

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