MRI Monitor

Technical Reference Manual

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

Order Code M1079546
September, 2006
2nd edition

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

Intended purpose (Indications for use)

The MRI Monitor with L-CANE05 or L-CANE05A software, module options E-MRIPSN, E-MRICAiOV, E-MRICAiO, E-MRICO and accessories is indicated for monitoring of hemodynamic (comprising ECG (including heart rate, ST-segment and arrhythmia), NIBP, SpO_2, and invasive blood pressure), respiratory (CO_2, O_2, N_2O, anesthetic agents, anesthetic agent identification, and respiration rate) and ventilatory (comprising airway pressure, volume and flow) status of hospital patients during magnetic resonance scanning.
The NIBP measurement is indicated for patients who weigh 5kg (11 lb) and up. The MRI Monitor with L-CANE05 or L-CANE05A software is also indicated for documenting patient care related information.
The MRI Monitor with L-CANE05 or L-CANE05A software, module options E-MRIPSN, E-MRICAiOV, E-MRICAiO, E-MRICO and accessories is indicated for use in the MR environment up to 300 Gauss with static magnets up to 3.0 Tesla. SpO_2 and ECG monitoring is indicated only with accessories specifically designed for the MR environment.
The MRI Monitor with L-CANE05 or L-CANE05A software is 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.

In accordance with IEC 60529

IPX1 - degree of protection against harmful ingress of water.

In accordance with EU Medical Device Directive

The MRI 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 Healthcare Finland Oy (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."
- manufacturer approved MRI Monitor system components are used.

Trademarks

MRI Monitor

Technical Reference Manual, Order code: M1079546
2nd edition

Part I, General Service Guide

Part II, Product Service Guide

Table of contents

Table of figures

List of tables

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 MRI Monitor running the software license L-CANE05 or L-CANE05A.

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 **M1079546.** This is the second edition.
- Part I gives the reader an overview of the MRI Monitor. It contains the information needed to install, interface and troubleshoot the monitors. Instructions for functional check and planned maintenance are also included. 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.
- Part II contains detailed descriptions of each component of the MRI Monitor system, such as MRI Monitor frame, shield, parameter modules and Active Remote Screen. Service check for each product, service menus and all the spare parts information for MRI Monitor is included.

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 Finland Oy (GE) 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:
MRI Monitor, User's Guide
MRI Monitor, User's Reference Manual

For more information about the iCentral and anesthesia record keeping solution, see the "Technical Reference Manuals" and "User's Reference Manuals" for these products.

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

Available accessories are described in the User's Guide in "MRI accessories" section.

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 Remote Controller, Command Board, Active Remote Screen Command Bar and side panel 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 1 Setup*** menu item and the ***Waveform Fields*** menu item would be shown as **Monitor Setup** - ***Screen 1 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 "iCentral 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.

In this manual, the concept MRI Monitor always refers to the MRI Monitor labeled as N-MRI2.

1 Introduction

1.1 System introduction

The MRI Monitor is a modular multiparameter patient monitor. The monitor is especially designed for multiparameter patient monitoring in MR environment. It can also be used during transportation within the hospital, for example, when transporting the patient from induction to the MR environment.

The modular design makes the system flexible and easy to upgrade. In addition to patient parameter modularity and easy upgrades, the monitor can be upgraded to anesthesia record keeping, wired and wireless networking and memory card operation. Your system may also include Active Remote Screen allowing full remote control over the MRI Monitor. Additionally, external devices can be interfaced to the monitor with interface modules.

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

1.1.1 MRI Monitor system components

Options for the MRI Monitor system

- Built-in recorder, N-CMREC1
- Wireless network option, N-CMW
- Active Remote Screen, N-MRIRemote (includes a fiber optic cable and Remote screen converter)
- Network option, N-MRINET (includes a fiber optic Network cable and a fiber optic converter board, B-FOC)

Possible software options for the MRI Monitor

- MemCard option, N-CMMEM

MRI Monitor frame options

- N-SN (for ECG, SpO2, NIBP)
- N-PSN (for ECG, SpO2, NIBP, InvBP)
- N-PSNG (for ECG, SpO2, NIBP, InvBP, CO2, Patient O2 and N2O)
- N-SNG (for ECG, SpO2, NIBP, CO2, Patient O2 and N2O)
- N-PSNGV (for ECG, SpO2, NIBP, InvBP, CO2, Patient O2, N2O, anesthetic agents, agent identification and patient spirometry)
- N-SNGV (for ECG, SpO2, NIBP, InvBP, CO2, Patient O2, N2O, anesthetic agents, agent identification and patient spirometry)

MR compatible modules

- Hemodynamic MRI Module E-MRIPSN
- MRI Compact Airway Modules E-MRICO, E-MRICAiO and E-MRICAiOV

Active Remote Screen display option with built-in loudspeakers

- 19" LCD display, D-LCC19 - 01

1.1.2 Monitoring in MR room

The MRI Monitor system in the MR room may consist of the elements shown in the picture below.

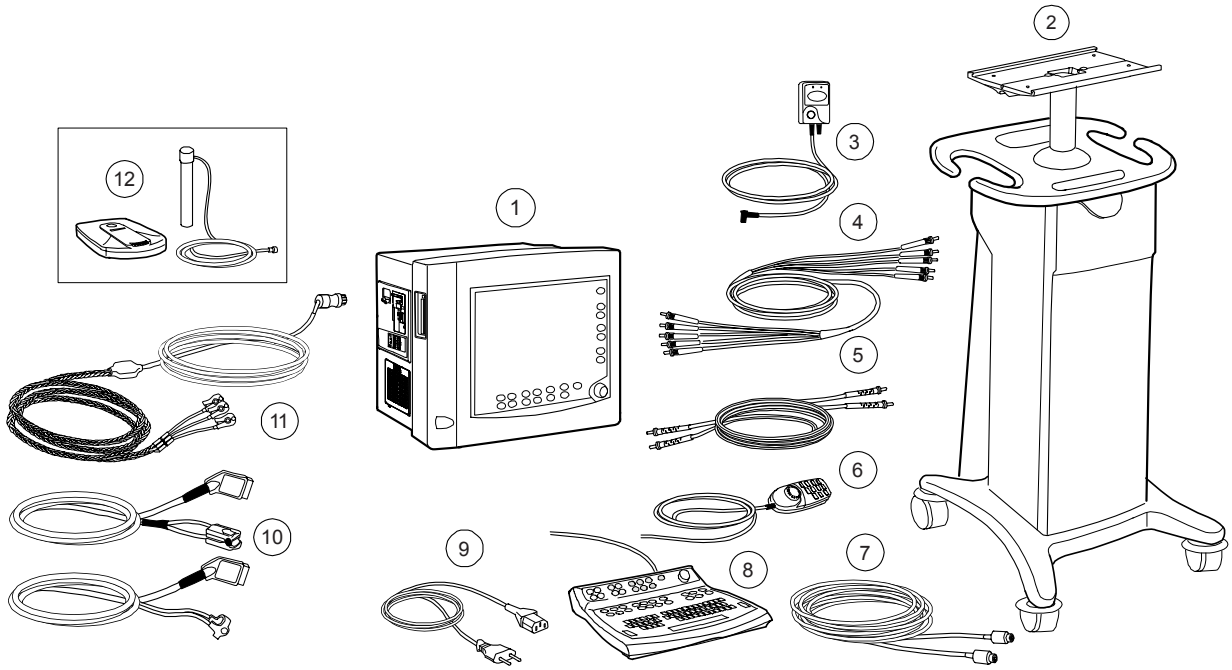


Figure 1 MRI monitoring system components in MR room

(1) MRI Monitor with MR compatible modules inside
(2) MRI Cart. You can also use a wall mount.
(3) Device Interfacing Solution, DIS
(4) Active Remote Screen fiber optic cable
(5) Fiber optic network cable
(6) Remote Controller, K-CREMCO
(7) MR scanner specific cardiac gating cable
(8) Anesthesia record keeping keyboard
(9) Mains power cable
(10) MR-specific SpO2 accessories (OXY-FMR, OXY-WMR)
(11) MR-specific ECG cable
(12) Datex-Ohmeda Wireless Network (WLAN) Access Point, N-WAP, and WLAN antenna

1.1.3 Monitoring in control room

Active Remote Screen is an external surveillance monitor for MRI Monitor. While the MRI Monitor is placed inside the MR examination room, the Active Remote Screen is used outside the MR environment in the control room to monitor the patient. The connection between the MRI Monitor and Active Remote Screen is done over on fiber optic cable, which ensures safe and undisturbed data transmission. The Active Remote Screen has the same functionality as the MRI Monitor and it allows full remote control over the MRI Monitor. However, the MRI Monitor can not be turned on or to standby through the Active Remote Screen.

The possible components are described below.

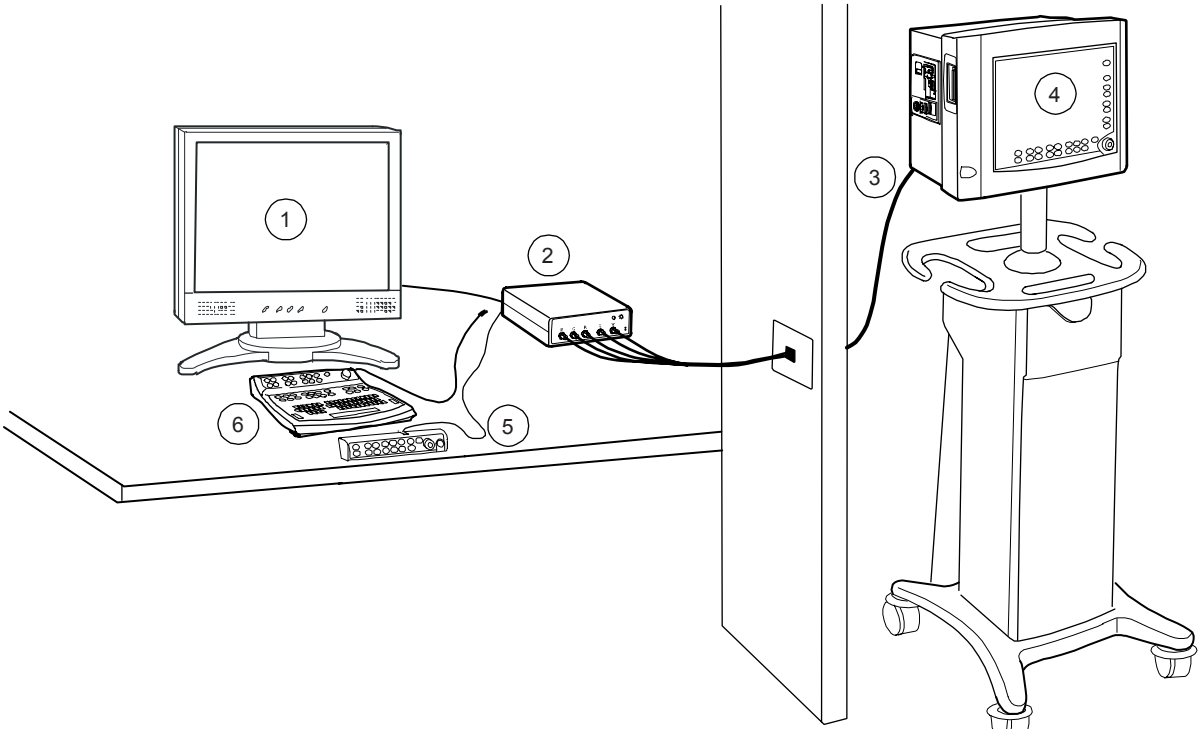


Figure 2 MRI monitoring system components when using Active Remote Screen

(1) Active Remote Screen with built-in loudspeakers.

(2) Remote screen converter. Contains connectors for Active Remote Screen and anesthesia record keeping keyboard or Command Bar K-MRIANEB.

(3) Fiber optic cable

(4) MRI Monitor

(5) Command Bar

(6) Anesthesia record keeping keyboard K-ARKB

1.1.4 MR monitoring in network

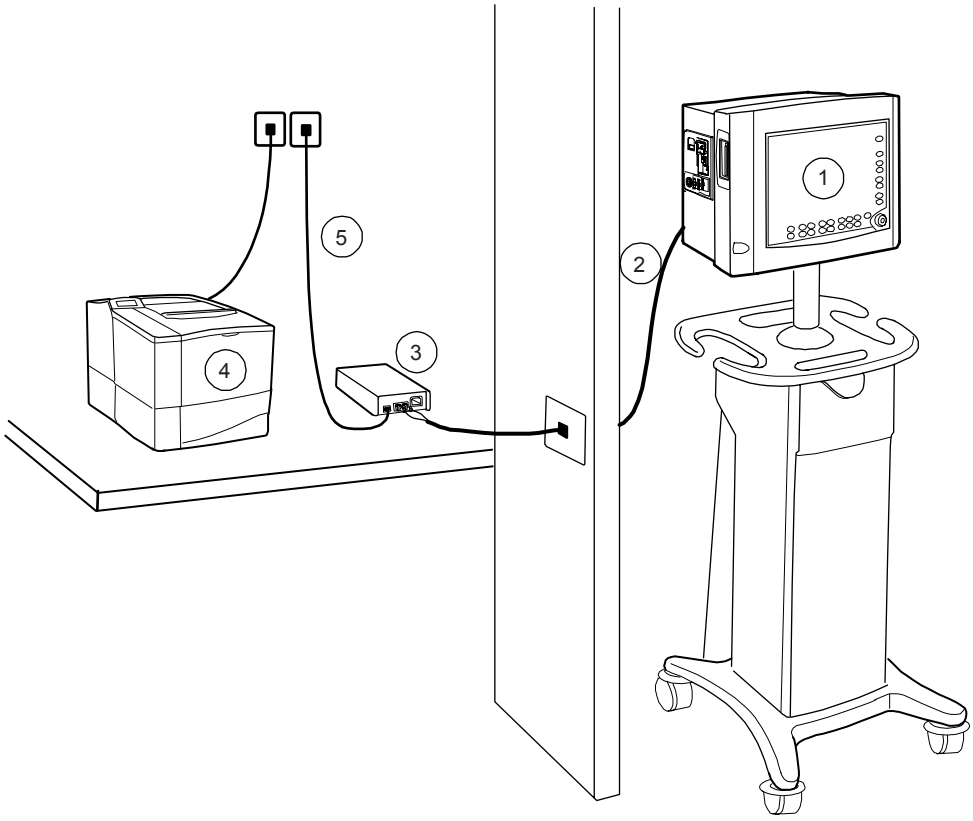


Figure 3 MR monitoring in network

(1) MRI Monitor

(2) Fiber optic Network cable

(3) Fiber optic converter, N-FOC, which connects the monitor to the Datex-Ohmeda Network (wired or wireless)

(4) Network printer

(5) Monitor-Network cable

Communication between monitors

You can use the MRI Monitor as a stand-alone monitor or for

- viewing and receiving data (alarms, vital signs) from other patient monitors
- gathering and storing data during intrahospital transportation.

To view other patient monitors, the monitor needs to be connected to network. To gather, store, and transfer data between different monitors, use the Data Card or network communication.

NOTE: You cannot transfer data to the MRI Monitor from the Data Card; use network for this purpose. The Data Card is for storage and transfer of patient data from the MRI Monitor. The Menu Card is used for storing the anesthesia record keeping menus and configurations, and for loading and storing user modes.

1.1.5 Monitoring in wireless network

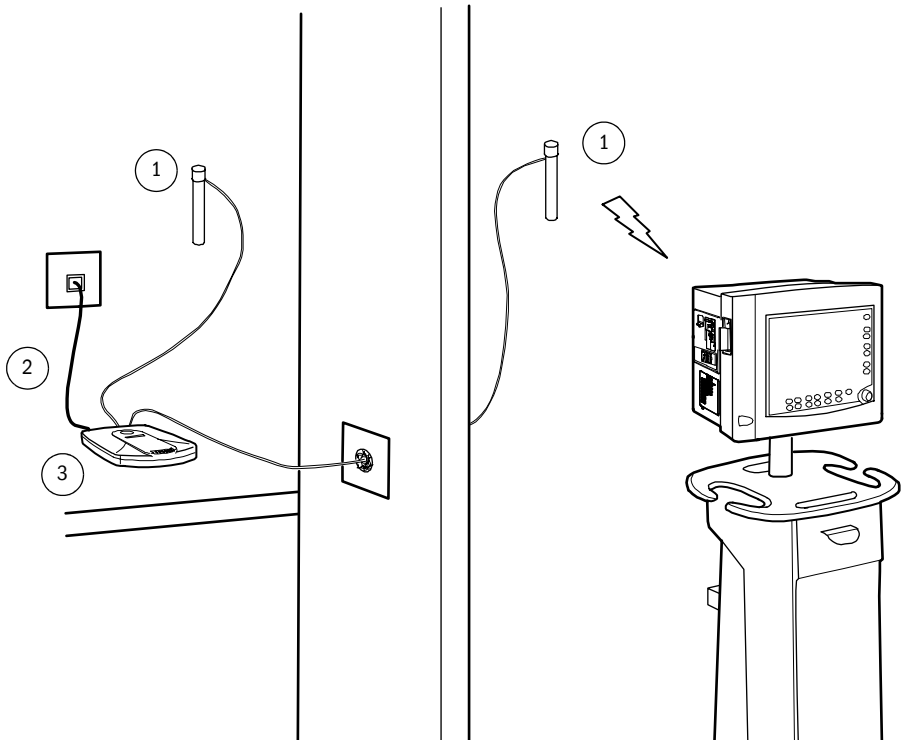


Figure 4 MRI monitoring in wireless network

(1) Antennas

(2) Network cable

(3) Access point.

NOTE: Before installing the wireless monitoring network in the MR environment, the system must be tested to avoid all the interference that it may cause to the MR pictures.

1.2 MRI Monitor introduction

1.2.1 MRI Monitor parts and connections

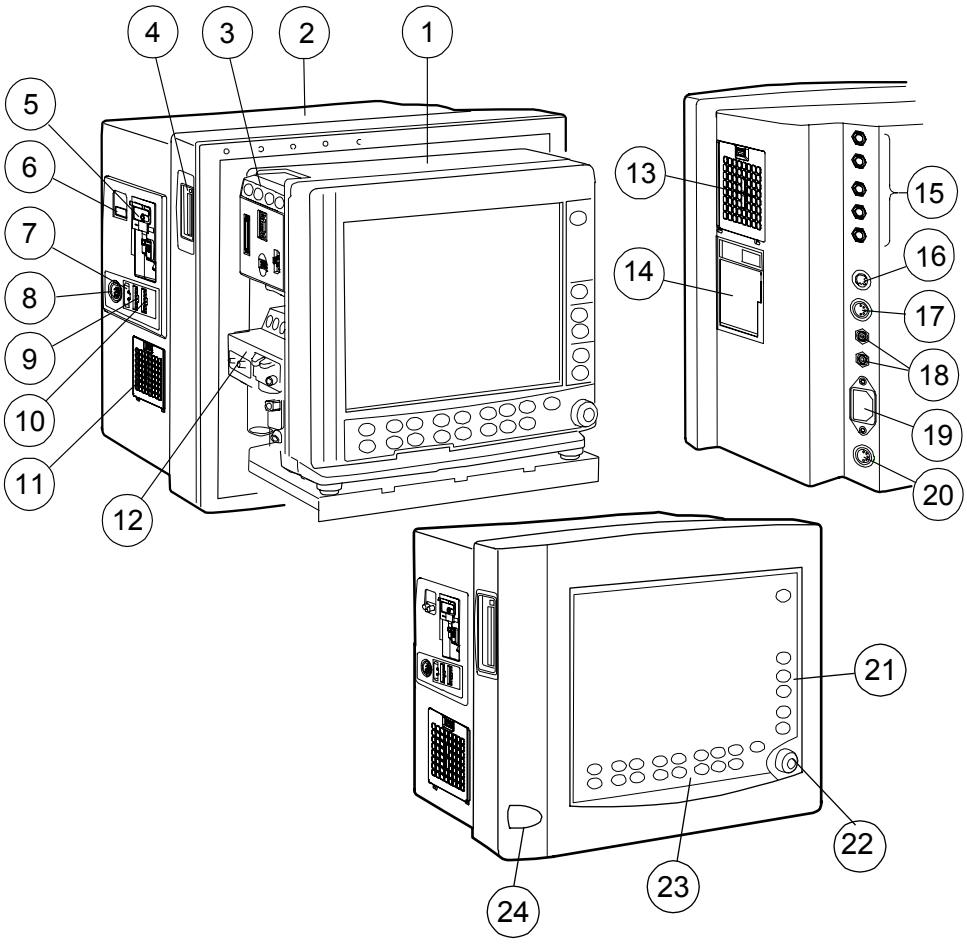


Figure 5 MRI Monitor parts and connections

(1) Frame for MRI Monitor, F-MRICM1
(2) MRI Shield for MRI Monitor, N-MRI2
(3) Hemodynamic MRI module, E- MRIPSN
(4) Slot for memory cards (PCMCIA)
(5) D-fend
(6) Spirometry connectors
(7) NIBP connector
(8) ECG connector
(9) InvBP connector
(10) SpO2 connector
(11) Air filter
(12) MRI Compact Airway Module E-MRICxx
(13) Air filter
(14) Recorder, N-CMREC1
(15) Connectors for Active Remote Screen
(16) Connector for Device Interfacing Solution, DIS
(17) Cardiac (ECG) gating connector
(18) Network connectors
(19) Mains power inlet
(20) Connector for anesthesia record keeping keyboard or K-CREMCO
(21) Side panel keys
(22) ComWheel
(23) Command Board
(24) High magnetic field alarm led

1.2.2 MRI Monitor frame options and modules

The MRI Monitor has the following frame and module options available.

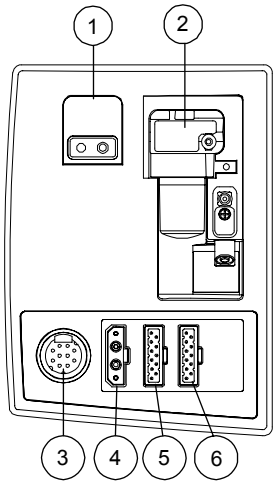
Parameter	Frame options and modules
ECG, SpO_2 and NIBP	• N-SN, N-SNG, N-SNGV, N-PSN, N-PSNG or N-PSNGV • E-MRIPSN module
InvBP (up to 2)	• N-PSN, N-PSNG or N-PSNGV • E-MRIPSN module
CO_2, Patient O_2 and N_2O	• N-PSNG, N-SNG, N-PSNGV or N-SNGV • E-MRICO, E-MRICAiO or E-MRICAiOV
Anesthetic agents, agent identification	• N-PSNG, N-SNG, N-PSNGV or N-SNGV • E-MRICAiO or E-MRICAiOV
Spirometry	• N-PSNGV or N-SNGV • E-MRICAiOV

– Hemodynamic MRI Module E-MRIPSN measures ECG, SpO2, NIBP and InvBP (two pressures, optional).
– MRI Compact Airway Modules E-MRICO, E-MRICAiO and E-MRICAiOV measure CO2 (C), O2 (O), Spirometry (V), anesthetic agents (A) and agent identification (i).

NOTE: The modules are preinstalled inside the shield and they can only be changed by authorized service personnel.

1.2.3 Connector panel

The connectors for the different parameter accessories are located on the connector panel on the left side of the shield. The frame option determines the connectors included in the panel. Below is an example of the connector panel in the frame option N-PSNGV.



(1) Spirometry connectors (optional)
(2) D-Fend with sampling line connector (optional)
(3) ECG connector
(4) NIBP connector
(5) InvBP connector (optional)
(6) SpO2 connector

1.2.4 MRI Cart

MRI Cart has been designed for MR environment. It allows you to move the monitor around the MR room, if necessary.

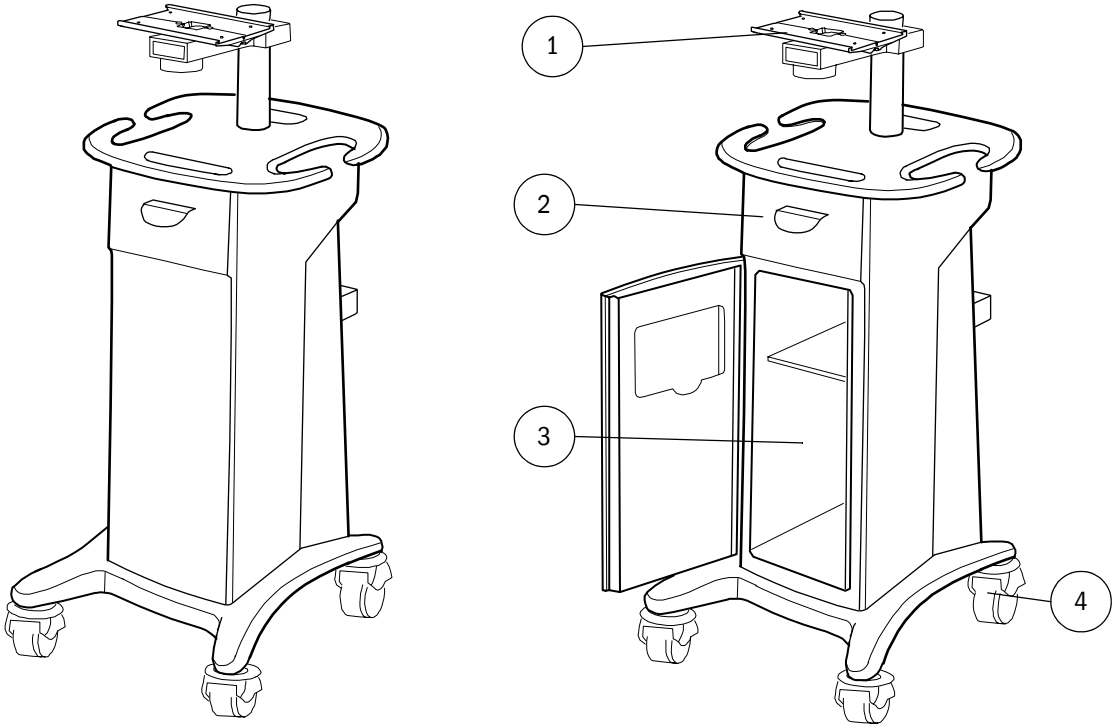


Figure 6 MRI Cart

(1) Mounting plate for the MRI Monitor

(2) Drawer for small MR compatible accessories

NOTE: The maximum load of the MRI Cart drawer is 400 g (0.9 lb).

(3) Compartment for the manuals

(4) Caster brakes

NOTE: The maximum load of the MRI Cart monitor arm is 25 kg (55.12 lb).

1.3 Symbols

1.3.1 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.

1.3.2 Symbols on equipment

1.3.3 Equipment safety symbols

- Attention, consult accompanying documents.
- When displayed next to the O2 value, indicates that the FiO2 low alarm limit is set below 21%.

- On the connector panel this symbol indicates that for pulse oximetry (SpO_2) and invasive pressures (P1-P2), the patient isolation and protection against cardiac defibrillator discharge are based on the SpO_2 and invasive blood pressure accessories.
- On the rear 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.
  * Lithium battery on the CPU board: 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.

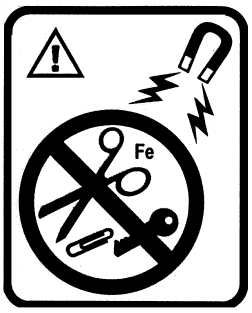
Type CF (IEC 60601-1) defibrillator-proof protection against electric shock.

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 "1.4.2. ESD precautionary procedures".

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

Symbol on the led on the front panel of the shield. The led indicates if the magnetic field is too strong.



Symbol on the MRI Cart drawer cover. Do not place any non-MR-compatible items in the MRI Cart.

1.3.4 Other symbols

Equipotentiality. Monitor can be connected to potential equalization conductor.

Alternating current

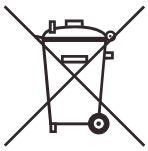
Fuse. Replace the fuse only with one of the same type and rating.

SN, S/N	Serial Number
	Battery operation and remaining capacity (green bar)
	Battery charging (white bar)
	Submenu. Selecting an alternative marked with this symbol in a menu opens a new menu.
	The monitor is connected to the Datex-Ohmeda Network (LAN).
	The monitor is connected to the Datex-Ohmeda Network (WLAN).
	Data Card (green) and/or Menu Card (white) is inserted.
	WLAN signal strength. The number of segments corresponds to the signal strength: four segments indicate strong signal, one segment weak signal. When connection to access point is being searched, the segments scroll from zero to four and back.
	A blinking heart next to the heart rate or pulse rate value indicates the beats detected.
	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 up to 15 °.
IPX3	- Protected against spraying water.
IPX4	- Protected against splashing water.
IPX7	- Protected against the effects of temporary immersion in water.
IPX8	- 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.

1.4 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.

1.4.1 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.
- The Active Remote Screen and printer must be supplied from an additional transformer providing at least basic isolation (isolating or separating transformer).
- 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.
- 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

- The monitor contains some ferromagnetic material.
- Do not install or use the monitor inside the 300 Gauss line. Verify the 300 G line from the safety instructions of the MRI imaging equipment.
- Inside the 300 G line the monitor is subject to the attraction of the magnetic field.
- The MRI Monitor has been designed for MR environment. The MR scanners, however, may be capable of causing injury if the given instructions are not followed, especially with respect to electrically conducting lead positioning and safety distance from the magnet.
- The MRI Monitor has been designed to tolerate high magnetic field strengths over short-term periods. High magnetic field strengths may, however, be destructive to the MRI Monitor electronics. Always keep the MRI Monitor outside the 300 G line.
- The MRI Monitor parameters will be shut down if MRI Monitor is taken to higher magnetic field strengths than 400 G to protect the MRI Monitor electronics. No parameter information can be seen on the monitor screen during this time.

- The MRI Monitor has been validated to tolerate up to 300 G magnetic field strength. Higher field strengths may interfere with the MRI Monitor parameter measurements. Always keep the MRI Monitor outside the 300 G line.
- Use the monitor during Magnetic Resonance Imaging (MRI) only together with MR compatible modules E-MRIPSN, E-MRICO, E-MRICAiO, and E-MRICAiOV.
- Only personnel who are aware of possible risks involved with patient monitoring in the MR environment should perform the monitoring.
- Do not use the system with the MRI devices with static magnetic field stronger than 3 T.
- Do not place the system closer than the 300 G line to the MRI device.
- MRI Monitor is intended to be mounted to a fixed structure if the MRI Cart is not used. Do not use the monitor without manufacturer approved mounting attached.
- Do not tilt the MRI Cart more than 10°.
- The MRI Cart is intended to be used only for the MRI Monitor (labeled as N-MRI2) that can tolerate 300 G magnetic field or less.
- Do not place any non-MR-compatible items in the MRI Cart and not more than 400 g (0.9 lb) of weight in the MRI Cart drawer.
- Keep the MRI Cart outside 300 G line.
- Always keep the caster breaks locked when you are not moving the MRI Cart.
- MRI Cart has been designed for MR environment. The MRI Cart allows you to move the monitor around the MRI room, if necessary. Tie the cart with an inelastic, strong rope to the MR room wall to avoid moving the MRI Monitor unintentionally too close to the magnet.
- 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 “1.4.2. 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.
- If you accidentally drop the monitor, modules or frames, have them checked by authorized service personnel prior to clinical use.

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. The monitor measures only non-flammable anestethics.

Patient safety

- Do not perform any testing or maintenance on the monitor while it is being used on a patient.

- 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.
- Never turn the volume off from Active Remote Screen display. If the volume is silenced from the display, all patient alarms will be silenced and there will be no visible indication of the silenced state.
- If you are using a display that does not have built-in speakers, use external loudspeakers.
- If you are using external loudspeakers, always make sure that audio cables are properly connected.

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 “1.4.2. ESD precautionary procedures”.
- 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 approved cables, mounts, batteries, invasive pressure transducers and MR compatible accessories. For a list of approved supplies, accessories and mounts, see section “MRI accessories” in the User’s Guide or User’s Refence Manual and the "Supplies and Accessories" catalog. Other cables, transducers and accessories may cause a safety hazard, damage the equipment or system, result in increased emissions or decreased immunity of the equipment or system or interfere with the measurement.
- ECG and SpO_2 monitoring requires specific MR compatible accessories. These accessories are made of non-metallic materials, either fiber optic or silicon plastic, and can safely be used in MR environment. All other listed accessories are non-ferrous and designed so that they can be safely used in MR environment. The accessories designed for use with this device are made of biocompatible materials conforming to requirements of the standard EN 30993 Biological Evaluation of Medical Devices and therefore do not contain toxic ingredients or primary skin irritants. The conformity is based either on laboratory testing or material knowledge and the long history of the materials used.
  Please note that some products are not available worldwide. You can check the availability with your local GE Healthcare representative.
- 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.
- Various MRI systems and RF coils feature significant differences in their technical design. The ability of the RF coil and MRI system to tolerate external RF interference may differ from that of the environment where the MRI Monitor was tested. Thus it is recommended that the users run interference tests before taking the MRI Monitor in use to recognize the potential RF interference caused by the MRI Monitor.

Before use

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

MRI Cart

- Rough use of the MRI Cart may cause damage to the Cart. If damage is found, the Cart must be removed from use until it has been serviced by authorized service personnel.

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

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	-10...+50 °C/14...122 °F
Atmospheric pressure	660...1060 hPa/500...800 mmHg/660...1060 mbar
Relative humidity	10...90% noncondensing

1.4.2 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.

1.4.3 Disposal

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

2 System description

2.1 Introduction

MRI Monitor is based on the same system architecture as other modular Datex-Ohmeda monitors. 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

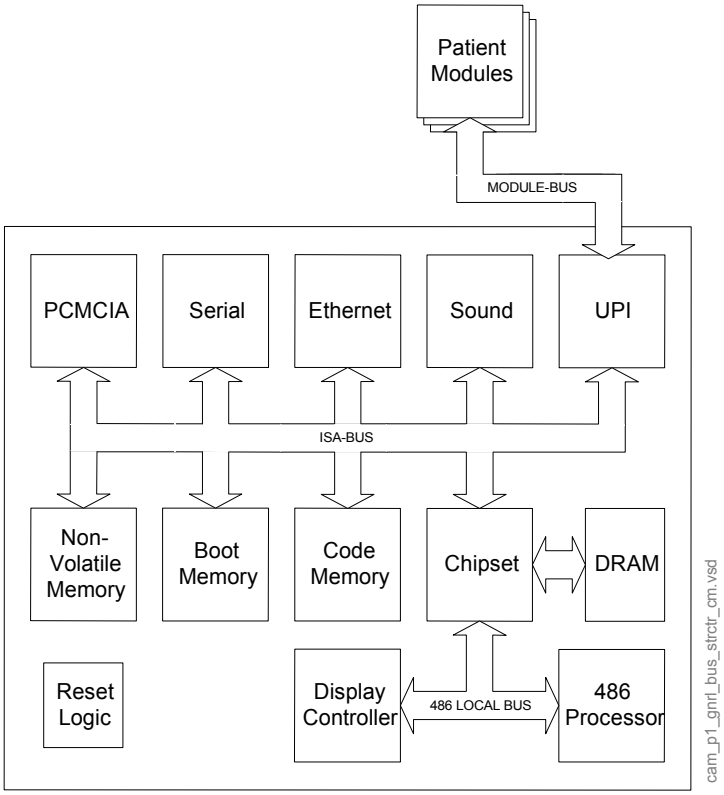


Figure 7 General bus structure of MRI Monitor

The CPU bus is a communication channel used only for internal data transfer. It is based on the ISA bus used in IBM PC computers. Data is transferred on this 16 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.

2.3 Distributed processing

The system 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.

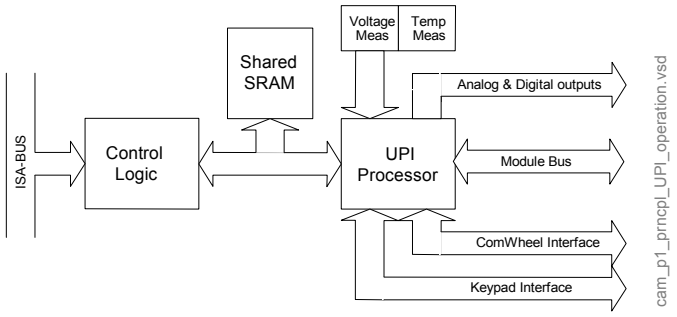


Figure 8 Principle of UPI section operation

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 at the factory. The software is used for running all the functions that are integrated into the PC board. For service and upgrade procedures, the CPU board is fitted with a PCMCIA card drive through which new software can be loaded.

2.6 Parameter modules

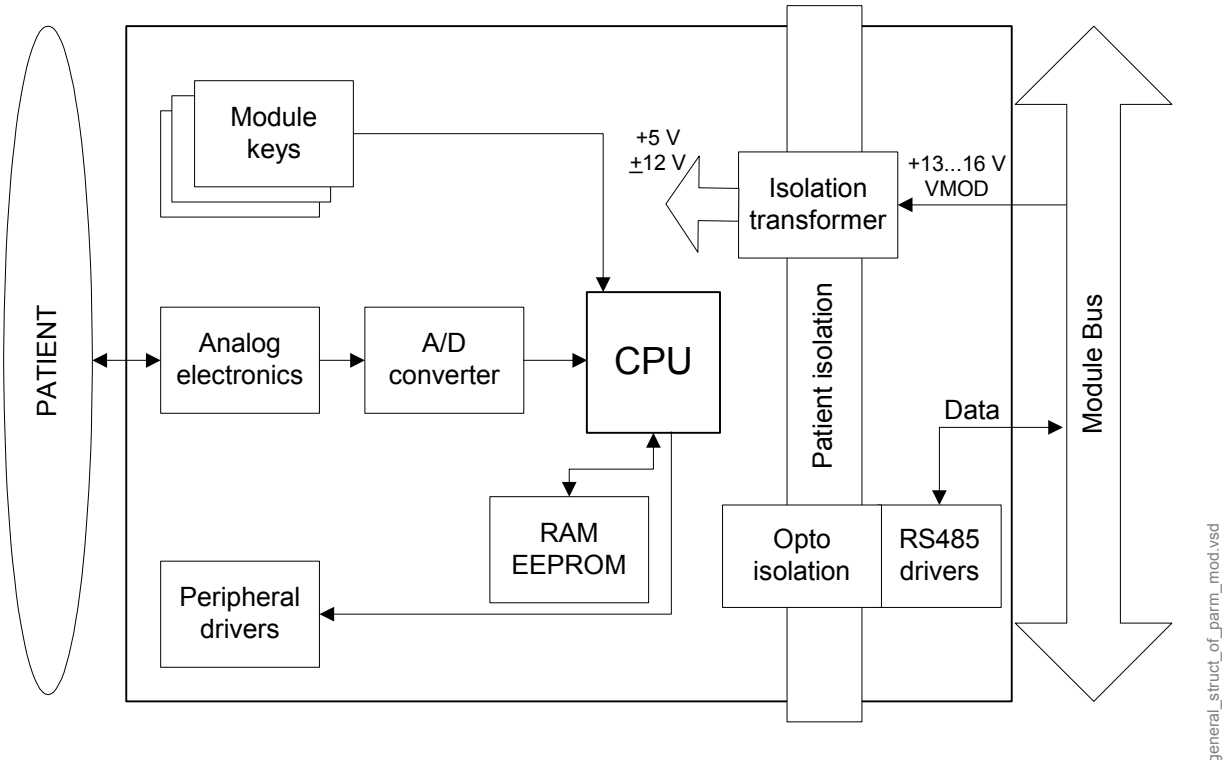


Figure 9 General structure of parameter modules with patient isolation

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.

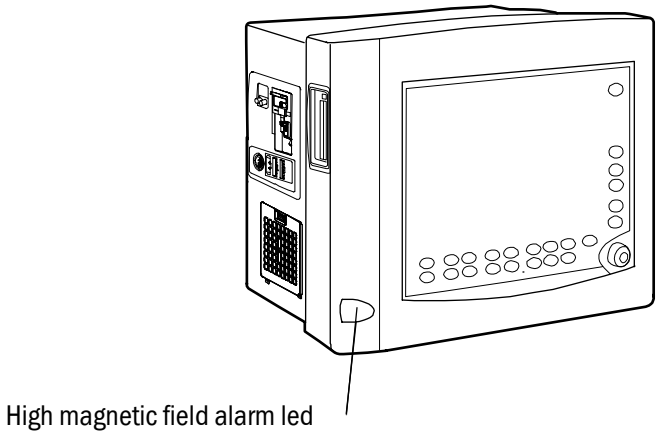
2.7 High magnetic field alarm

When the magnetic field where the MRI Monitor is located gets stronger than 150 G, yellow light is lit in the high magnetic field alarm led on the front panel of the shield. When the magnetic field gets stronger than 250 G, the led starts blinking red and an audible alarm is triggered.

When the monitor is turned on, the high magnetic field alarm alarms once.

NOTE: Noise in the MR Room may be very high. Due to this reason, the MRI Monitor's high magnetic field alarm sound volume is intentionally set very high being more than 80 dB. The alarm sound can only be silenced by moving the MRI Monitor outside the high magnetic field of 250 G.

NOTE: The high magnetic field alarm does not work if the monitor is turned off.



Meaning	Tone pattern	Front panel LED
Magnetic field ≥250 G	Triple + double beep every 5 seconds or continuous beep -- -- -- 5 -- --/ -----	red LED blinking
Magnetic field ≥150 G	No tone	yellow LED lit

3 System installation

3.1 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 are damaged, contact the shipper.
4. Confirm that all components are included. If any of the components are missing, contact your GE Healthcare distributor.

3.2 Choosing location

Consider the following aspects:

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

WARNING **The monitor contains some ferromagnetic material.**

WARNING **Do not install or use the monitor inside the 300 Gauss line. Verify the 300 Gauss line from the safety instructions of the MRI imaging equipment.**

WARNING **Inside the 300 Gauss line the monitor is subject to the attraction of the magnetic field.**

WARNING **The MRI Monitor has been designed for MR environment. The MR scanners, however, may be capable of causing injury if the given instructions are not followed, especially with respect to electrically conducting lead positioning and safety distance from the magnet.**

WARNING **Do not place the system closer than the 300 Gauss line to the MR scanner.**

WARNING **Do not use the system with the MR scanners with static magnetic field stronger than 3 T.**

The allowed cables, transducers, mounts and accessories for the monitor are listed in section “MRI accessories” in the User’s Guide and in the User’s Reference Manual.

3.3 Installing and mounting the monitor

The MRI Monitor is designed to operate with max 3 T MR device. The MRI Monitor is designed to operate as close to the patient as possible. The minimum distance from the magnet must be maintained. The minimum distance depends on the magnetic field and the type of the magnet used. The monitor must be kept outside the 300 Gauss line. The 300 G line should be verified from the safety instructions of the MR scanner.

The built-in magnetic field detector sets a yellow alarm at 150 G and a red alarm at 250 G. Beyond the 300 G line the monitor may be subject to force attraction of the magnetic field.

Mount the monitor to a fixed structure such as a wall mount or MRI compatible cart. If you are using an MRI Cart, make sure to maintain the minimum distance from the magnet.

For a list of mounts, see section “MRI accessories” in the User’s Guide or in the User’s Reference Manual.

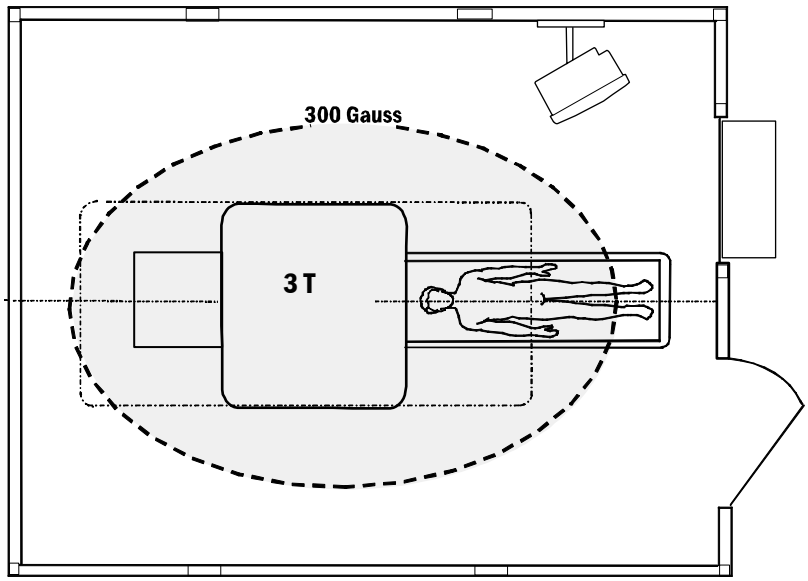


Figure 10 Example of 300 Gauss line distance with a MR scanner.

WARNING **Do not place the MRI Monitor closer than the 300 G line to the MR scanner. Mark the 300 G line on the floor.**

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.**

WARNING **MRI Monitor is intended to be mounted to a fixed structure if MRI Cart is not used. Do not use the monitor without manufacturer approved mounting attached. Mount the monitor to some fixed structure such as a wall mount or MRI Cart.**

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

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 **Use only MR compatible accessories.**

CAUTION The LCD displays used in the control room are fragile. Ensure that they are not placed near a heat source or exposed to mechanical shocks, pressure, moisture or direct sunlight.

CAUTION Rough use of the MRI Cart may cause damage to the Cart. If damage is found, the Cart must be removed from use until it has been serviced by authorized service personnel.

CAUTION Various MRI systems and RF coils feature significant differences in their technical design. The ability of the RF coil and MRI system to tolerate external RF interference may differ from that of the environment where the MRI Monitor was tested. Thus it is recommended that the users run RF interference tests before taking the MRI Monitor in use to recognize the potential RF interference caused by the MRI Monitor.

3.3.1 MRI Monitor parts and connections

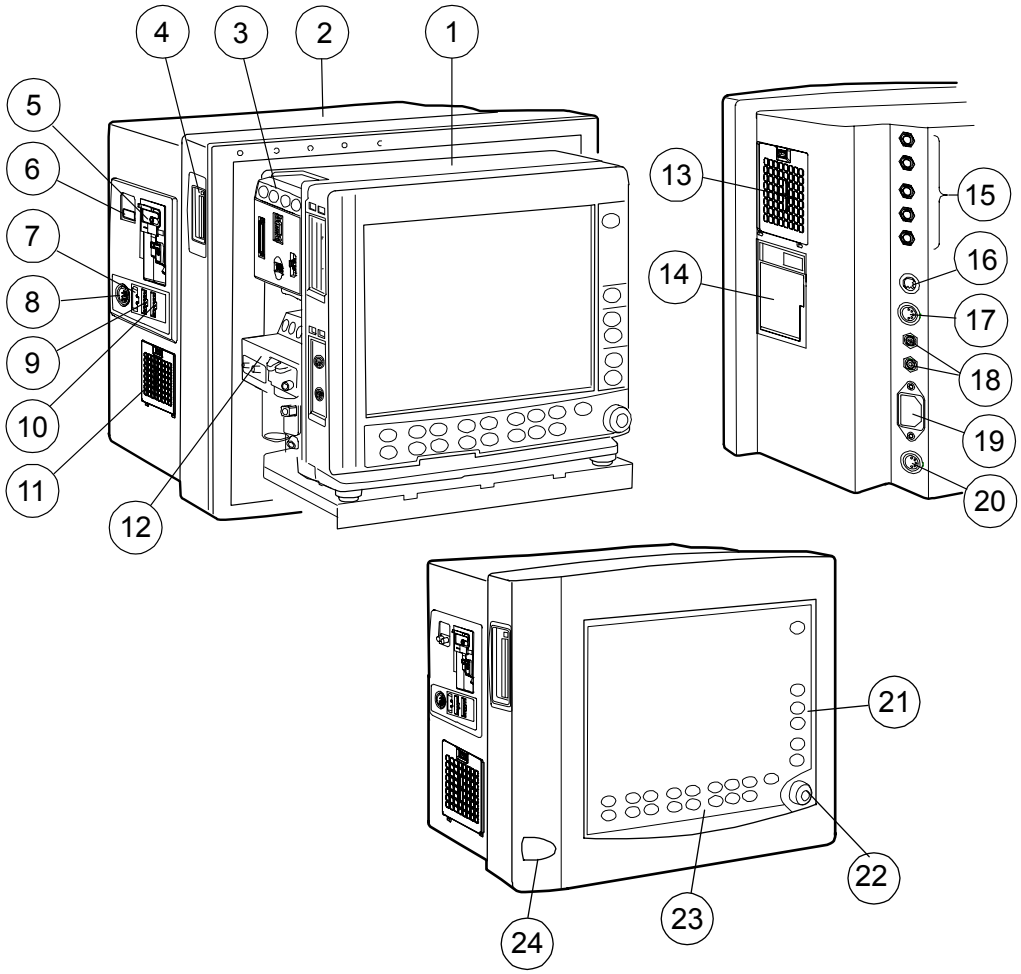


Figure 11 MRI Monitor parts and connections

(1) Frame for MRI Monitor, F-MRICM1
(2) MRI Shield for MRI Monitor, N-MRI2
(3) Hemodynamic MRI module, E- MRIPSN
(4) Slot for memory cards (PCMCIA)
(5) D-fend
(6) Spirometry connectors
(7) NIBP connector
(8) ECG connector
(9) InvBP connector
(10) SpO2 connector
(11) Air filter
(12) MRI Compact Airway Module E-MRICxx
(13) Air filter
(14) Recorder, N-CMREC1
(15) Connectors for Active Remote Screen
(16) Connector X1 for Device Interfacing Solution, N-DIS
(17) ECG gating connector X2
(18) Network connectors
(19) Mains power inlet
(20) Connector X3 for anesthesia record keeping keyboard or K-CREMCO
(21) Side panel keys
(22) ComWheel
(23) Command Board
(24) High magnetic field alarm led

3.3.2 Monitor distance from the magnet bore

SAFETY PRECAUTION: The strength of the magnetic field increases exponentially causing a sudden strong attraction on metallic components. The field strength increases hundreds of Gauss in a very short distance. To ensure safe and reliable monitoring in MR room, it is important to keep the MRI Monitor outside the 300 G line all the time.

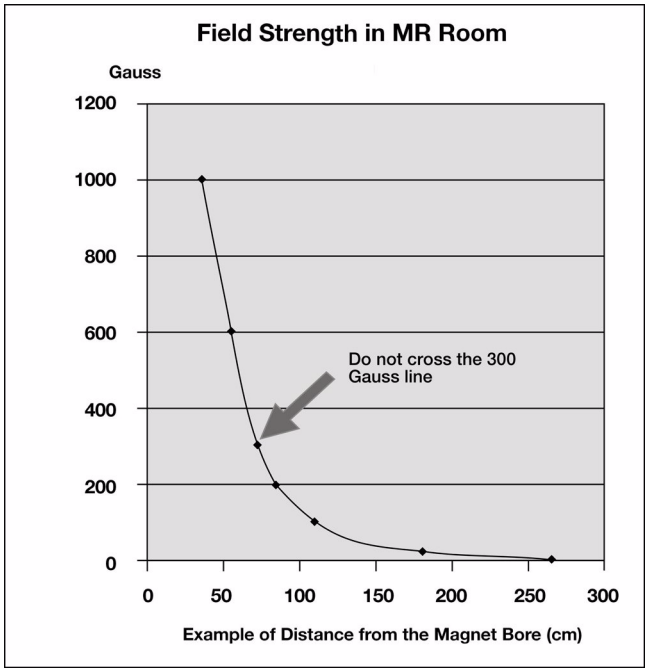


Figure 12 Field strength in MR room

3.3.3 Connecting to mains

Connect the power cord to the mains power inlet of the MRI Monitor and to the wall socket.

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

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

3.3.4 Mounting the MRI Monitor to MRI Cart

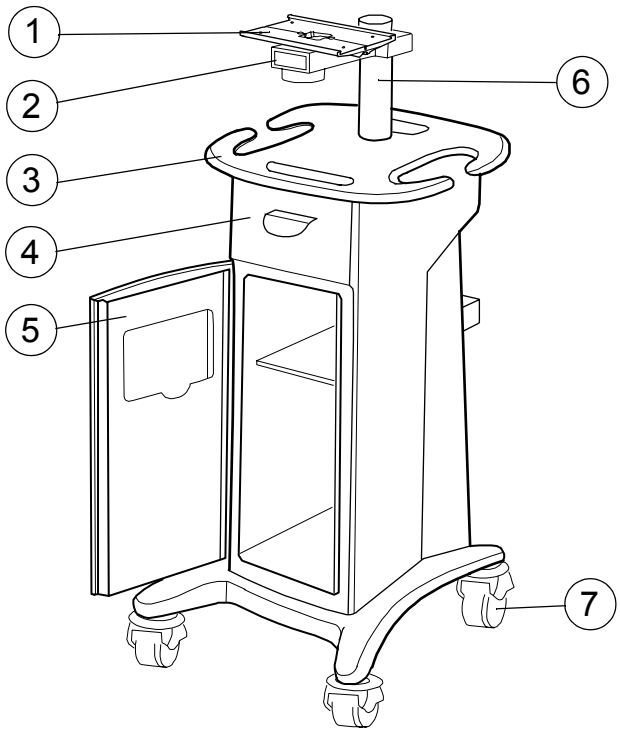


Figure 13 MRI Cart

(1) Mounting plate for the MRI Monitor
(2) Arm
(3) Place for K-ARKB
(4) Drawer for small MR compatible accessories
(5) Front door
(6) Monitor holding bar
(7) Wheels with caster brakes

NOTE: The maximum load for the MRI Cart drawer is 400 g (0.9 lb).

NOTE: The maximum load for the MRI Cart monitor arm is 25 kg (55.12 lb).

WARNING **Do not place any non-MR-compatible items in the MRI Cart.**

WARNING **Do not tilt the MRI Cart more than 10°.**

WARNING **The MRI Cart is intended to be used only for the new MRI Monitor that can tolerate 300 G magnetic field or less.**

WARNING **Keep the MRI Cart outside 300 G line.**

WARNING **Keep the caster breaks always locked when you are not moving the MRI Cart.**

WARNING **MRI Monitor is intended to be mounted to a fixed structure if MRI Cart is not used. Do not use the monitor without manufacturer approved mounting attached.**

WARNING **The MRI Cart has been designed for MR environment. The MRI Cart allows you to move the monitor around the MRI room, if necessary. Tie the cart with an inelastic, strong rope to the MR room wall to avoid moving the MRI Monitor unintentionally too close to the magnet.**

CAUTION Rough use of the MRI Cart may cause damage to the Cart. If damage is found, the Cart must be removed from use until it has been serviced by authorized service personnel.

Before mounting the monitor to the cart

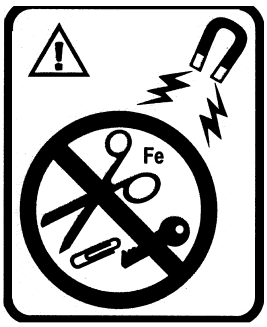


Figure 14 'Do not place any non-MR compatible items' symbol

1. Open the drawer. Check that a label "Do not place any non-MR-compatible items" is attached to the plastic cover of the drawer. Close the drawer again.

NOTE: If the label is missing, the cart must be removed from usage until a new label can be attached.

2. Open the front door. Check that a label "Do not place any non-MR-compatible items" is attached to the inner surface of the door. Close the door again.

NOTE: If the label is missing, the cart must be removed from usage until a new label can be attached.

3. Check that the wheels are clean and intact. Check that the brakes function normally.

NOTE: If any of the brakes is not functioning, the cart must be removed from use until the cart has been serviced.

4. Check that the monitor holding bar is properly tightened. If necessary, open the rear panel of the cart and fix the bar holding screws inside. Check also the screws holding the bar from underneath.
5. Check the arm holding the mounting plate. The arm must be mounted to the upper end of the bar. The arm must be properly tightened. If the arm is loose, tighten the screws holding the bar.
6. Check that the black cover at the upper end of the bar is intact.

Mounting the MRI Monitor to the cart

1. Slide the monitor on the mounting plate and secure it. Check that the locking screw locks properly.
2. Check that the mounting plate tilts properly, and that the monitor can be rotated freely.

CAUTION Pay attention to the attached cables and tubes when tilting or rotating the monitor. The cables and tubes can be damaged if kinked during monitor movement.

Mounting the Anesthesia Record Keeping Keyboard (K-ARKB) to the cart

1. Open the drawer completely and remove it by loosing the 4 screws holding it.
2. Insert the K-ARKB sliding system, and insert the screws holding it. The screws are inserted from inside the cart.
3. Attach the keyboard holder on the sliding system, and secure it with 3 screws.
4. Snap the keyboard to the holder.
5. Connect the keyboard cable to the MRI Monitor connector X3 on the connector panel.

3.3.5 Connecting to Datex-Ohmeda Network

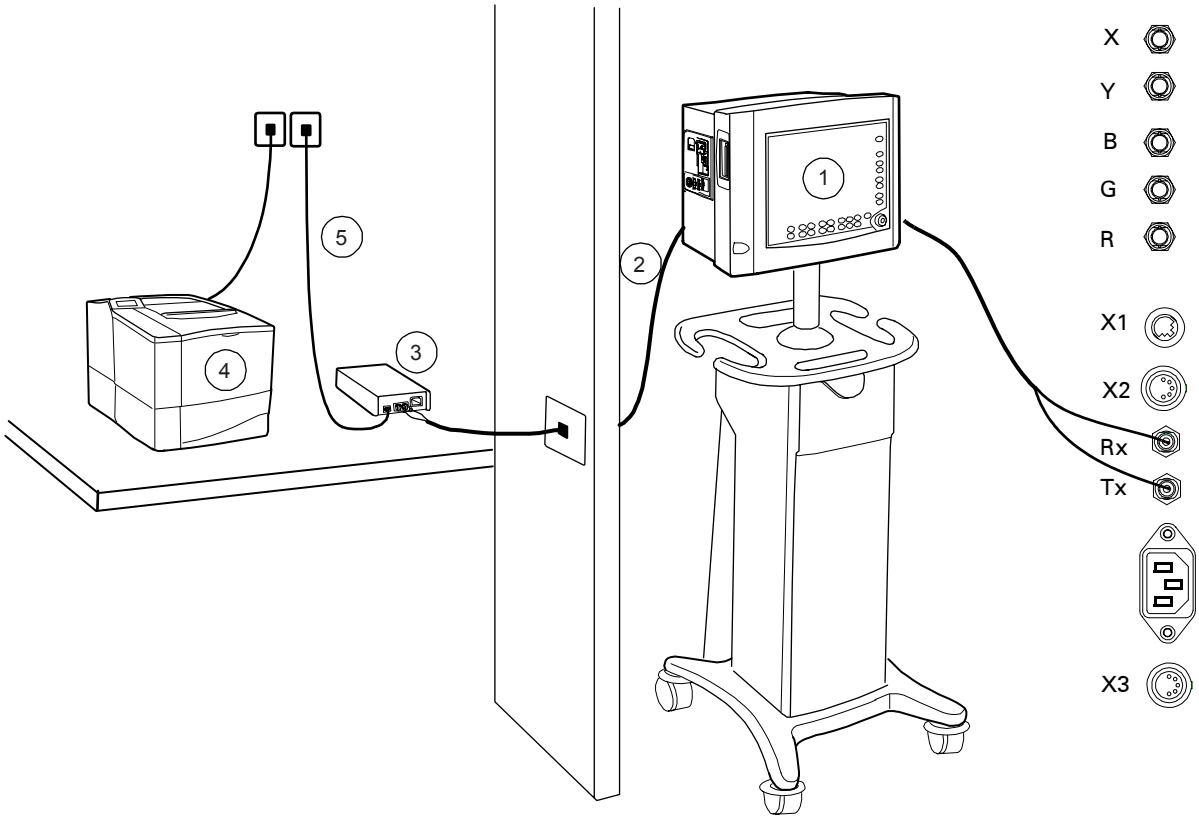


Figure 15 MRI Monitor connected to network

(1) MRI Monitor

(2) Fiber optic Network cable

(3) Fiber optic converter, N-FOC, which connects the monitor to the Datex-Ohmeda Network (wired or wireless)

(4) Network printer

(5) Monitor-network cable

Use the fiber optic network cable and the monitor-network cable to connect the monitor to the network as follows:

1. Make sure that the power to the monitor is turned off. Connect the fiber optic network cables to the MRI Monitor connectors (see Figure 11).

NOTE: The monitor with N-MRINET option already contains the ID plug connected.

2. Connect the other end of the fiber optic network cable to the Fiber Optical Converter (N-FOC) outside the MRI room.
3. Connect the RJ-45 connector of the monitor-network cable to the N-FOC.

NOTE: The ID plug possibly attached to the cable need not be connected.

4. Connect the other RJ-45 connector to the corresponding connector on the wall box.

5. Turn on the power to the MRI Monitor. Enter the ***Network*** service menu:

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

   Make sure that the monitor's network communication has been set according to the used network software:

   Network software S-CNET99 -> DRI Level = 1999

   Network software S-CNET01 -> DRI Level = 2001

   Network software S-CNET02 -> DRI Level = 2001 or 2002 (WLAN)

   Network software L-NET03 -> DRI Level = 2003

   Network software L-NET05 -> DRI Level = 2005

   If necessary, change the monitor's network communication by selecting ***DRI Level*** and turning the ComWheel.

NOTE: The DRI Level 1999 is not selectable in all monitor software versions.

NOTE: If you change the DRI level, the monitor will restart automatically.

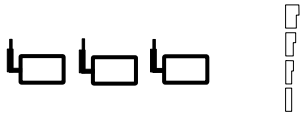
6. Confirm that the network symbol and 'Connected to Network' message are displayed in the upper part of the screen.

3.3.6 Connecting to Wireless LAN network

Make sure that the Datex-Ohmeda Wireless LAN Option, N-CMW is installed. Use the wireless LAN antenna card to connect the monitor to the network.

NOTE: The N-CMW option requires also that either N-CMNET or N-CMMEM option is installed.

1. Make sure that the power is switched off.
2. Connect the wireless LAN antenna card into a free, typically backmost, card drive slot.
3. Switch on the power. Confirm that the wireless LAN network symbol and the wireless LAN signal strenght symbol are displayed in the upper part of the screen.



Recommended installation

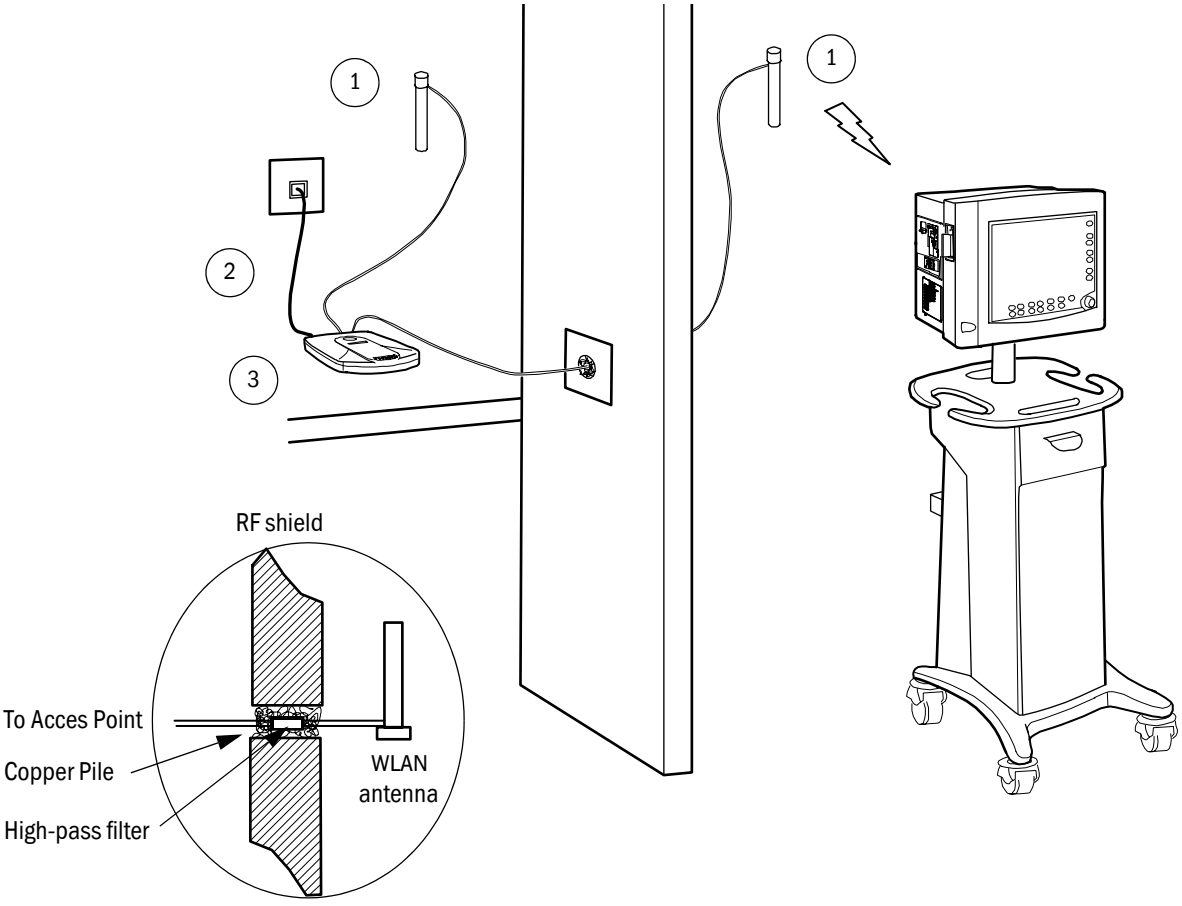


Figure 16 WLAN Acces Point in Control room

(1) Antennas

(2) Network cable

(3) Access point.

Use an appropriate high-pass filter and copper pile for the antenna wire in the wall throughput, if the WLAN access point is located outside the MRI room.

Use high-pass filter that passes through the WLAN signal but attenuates lower frequency noise (for example Mini-Circuits VHP-16 (15542 High Pass Filter w/ cut off frequency 1.9GHz).

NOTE: Required cable adapters must be supplied locally.

Alternative installation

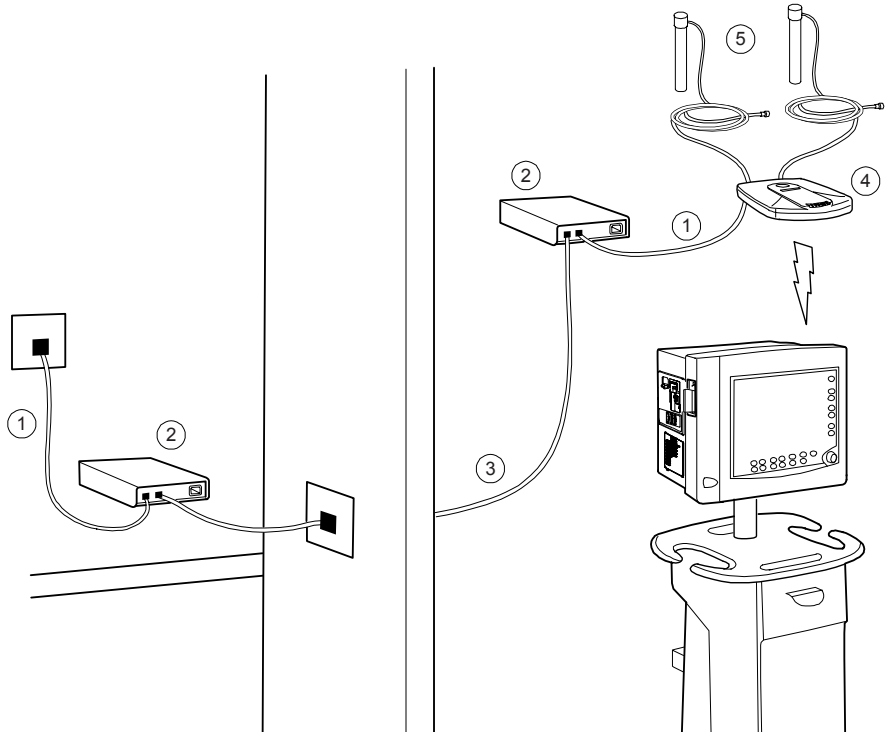


Figure 17 MRI Monitor connected to wireless network

(1) Network cable

(2) Fiber optic converter

(3) Fiber optic cable

(4) Access point. Install the access point in the MR room as far from the magnet as possible.

(5) Antennas

WARNING **The fiber optic converter contains ferrous material. Install it outside the 5 G line.**

NOTE: Before installing the wireless monitoring network in the MR environment, the system must be tested to avoid all the interference that it may cause to the MR pictures. If problems exist, use wired networking.

3.3.7 Device Interfacing Solution, N-DISVENT

Follow the instruction in chapter 4, and in the N-DISVENT Installation Guide.

NOTE: When installing N-DISVENT, make sure to locate the DISVENT module outside 5G line.

3.3.8 Remote Screen installation

The connection between the MRI Monitor and Active Remote Screen is accomplished with a fiber optic cable, which ensures safe and undisturbed data transmission. The available components are described below.

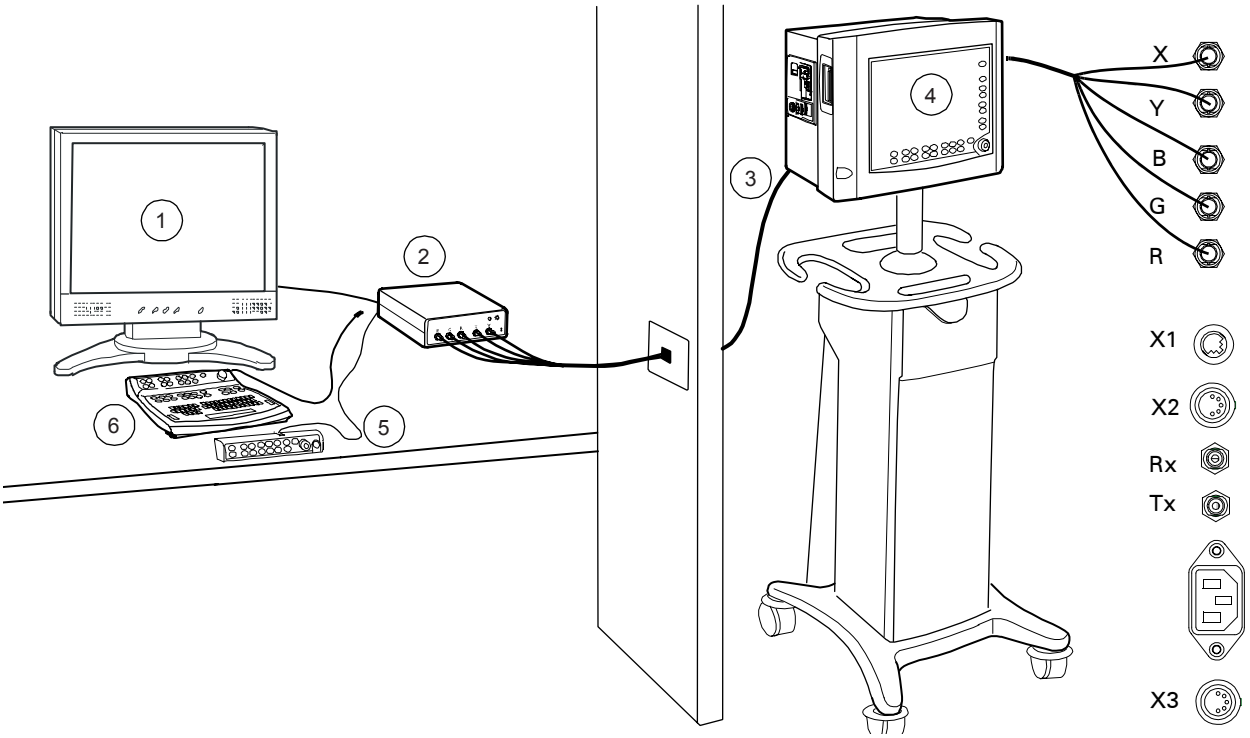


Figure 18 Control room installation

(1) Active Remote Screen with built-in loudspeakers.
(2) Remote screen converter, N-KVM, includes Sound converter, connectors for Active Remote Screen and Command Bar or anesthesia record keeping keyboard.
(3) Fiber optic cable
(4) MRI Monitor
(5) Command Bar K-MRIANEB
(6) Anesthesia record keeping keyboard

Fiber optic cable installation

1. Route the fiber optic cable appropriately from the MR room to the Control room.
2. Connect the fiber optic cable connectors 1,2,3,4 and 5 to the connectors X, Y, B, G and R on the MRI Monitor.
3. Ensure that the fiber optic cable connectors are connected to corresponding connectors on the Remote screen converter, N-KVM.

NOTE: The connecotrs of color signals are marked with R, G and B and the digital signal connectors are marked with X and Y on monitor and on the N-KVM.

Connecting the Command Bar, K-MRIANEB

Connect the command bar to the cable at the back of the Remote screen converter, N-KVM.

NOTE: K-MRIANEB has a special cable that enables the connection to Active Remote Screen converter, K-ANEB cannot be used.

NOTE: If Command Bar is used, the anesthesia record keeping keyboard cannot be used at the same time because they use the same connector.

Display installation

The LCD display (D-LCC19 - 01) is a 19” active matrix LCD display, which is equipped with loudspeakers.

NOTE: As a safety feature the audio volume is set to maximum, and the volume adjustment wheel is disabled from the D-LCC19-01 (M1057466).

NOTE: Please pay attention to any additional instructions that may accompany the displays and / or their installation equipment. The instructions described below in this manual may not contain all the necessary information.

NOTE: When using the display with the desk stand option, it must be placed on a flat surface.

WARNING **The Active Remote Screen must be supplied from an additional transformer providing at least basic isolation (isolating or separating transformer).**

WARNING **Never turn the volume off from the alarm loudspeakers on the display. If the volume is silenced from the display, all patient alarms will be silenced and there will be no visible indication of the silenced state. The volume should only be adjusted through the *Alarm Options* page.**

WARNING **If you are using a display that does not have built-in speakers, use external loudspeakers.**

WARNING **If you are using external loudspeakers, always make sure that audio cables are properly connected.**

WARNING **Always make sure that the audio alarm volume level is adequate in your care environment.**

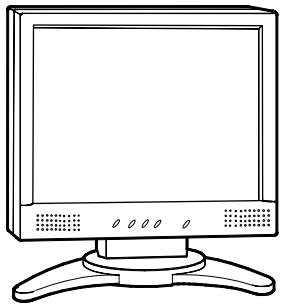
WARNING **After cleaning or if liquid has accidentally entered the display, ensure that every part of the display is dry before reconnecting it to the power supply.**

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

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

CAUTION Make sure that the power adapter of the display is plugged into a grounded power outlet. Do not use the power adapter in the presence of flammable anesthetics.

Display mounting



Mount the LCD Display to a pedestal, wall or ceiling mount, or display arm with appropriate parts. Connect the video cable to the display and tighten the video cable finger screws.

Connection to Remote Screen Converter

1. Make sure that power to the Remote Screen Converter is turned off.
2. Connect the video cable to the the appropriate connector on the Remote Screen Converter. Tighten the finger screws.
3. Connect the display loudspeaker cable to the Remote Screen Converter.
4. Connect the display power cord to the mains outlet.

WARNING **The display must be used only together with the original type of power adapter.**

WARNING **Always make sure that the whole combination complies with the international safety standard IEC 60601-1-1 for medical electrical systems and with the requirements of local authorities.**

Adjustments

Adjust the brightness and contrast using the control keys on the display housing. To perform needed adjustments, please refer to the operations manual of the display.

3.3.9 Parameter modules

The modules are pre-installed inside the MRI Monitor.

Hemodynamic MRI Module E-MRIPSN is needed for measuring ECG, SpO2, NIBP and InvBP (two pressures, optional).

MRI Compact Airway Modules E-MRICO, E-MRICAiO and E-MRICAiOV measure CO2 (C), O2 (O), Spirometry (V), anesthetic agents (A) and agent identification (i).

3.3.10 Downloading Monitor Software

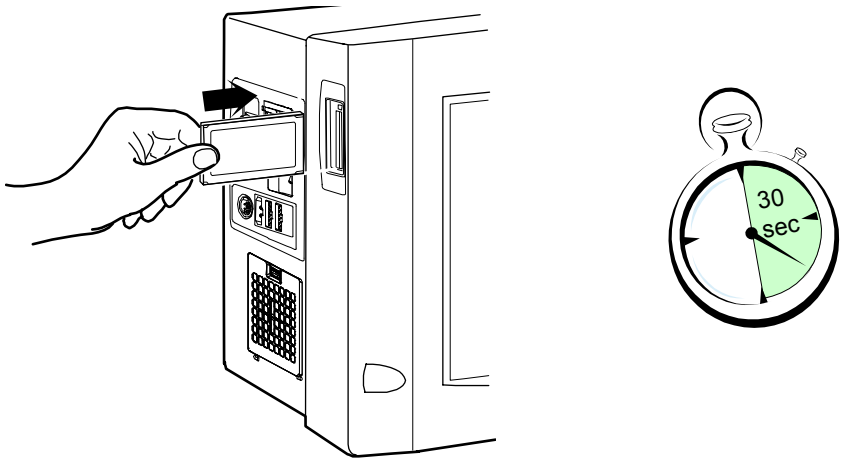
The following instructions apply to downloading of new monitor software in case of upgrade or service. Detailed instructions for downloading software are supplied with software PCMCIA cards.

NOTE: When a new monitor software is downloaded, all user settings will be lost.

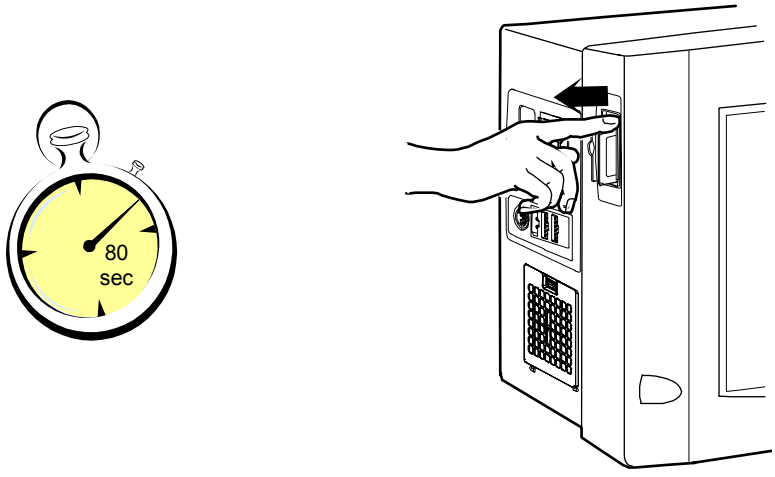
NOTE: When a new monitor software is downloaded, the WLAN encryption key will be lost. Rewrite the encryption key in the ***WLAN Config*** service menu if needed.

NOTE: During the downloading of software, the serial number of the monitor is written on the software card. The software can then be downloaded again in the same monitor, but not in another monitor.

1. Make sure the monitor is switched to standby.



2. Insert the software card into the card drive slot and press the card firmly into its place.
3. Switch the monitor on.
4. Wait for approximately 80 seconds. When the normal screen is displayed, enter the service menu and make sure that the information regarding monitor software has been updated. Memorize the serial number of the new software.



5. Remove the software card.

6. Replace the original device plate for monitor software with the new one supplied with the software card.
7. Perform Factory Reset. Make sure that the monitor functions normally after the restart.
8. Set the time and date.
9. Set the monitor's network communication according to the network software in use, if necessary.

The communication is set in the monitor's ***Network*** service menu.

Network software S-CNET99 -> DRI Level = 1999

Network software S-CNET01 -> DRI Level = 2001

Network software S-CNET02 -> DRI Level = 2001 or 2002 (WLAN)

Network software L-NET03 -> DRI Level = 2003

Network software L-NET05 -> DRI Level = 2005

NOTE: The DRI Level 1999 is not selectable in all monitor software versions.

NOTE: If you change the DRI level, the monitor will restart automatically.

10. Fill out all necessary documentation regarding the new monitor software.

NOTE: The license agreement of the monitor software needs to be in accordance with the monitor software serial number. Make sure you archive the license agreement in a secure location.

NOTE: The first start-up after software loading takes considerably longer than usually.

3.3.11 Performing Factory Reset

NOTE: The factory reset is necessary after downloading of monitor software and after replacing the CPU board or SRAM/Timekeeper battery.

NOTE: The factory reset will restore all customized defaults, including language selection, to factory defaults.

1. Press the **Monitor Setup** key.
2. Select ***Install/Service*** and password (16-4-34).
3. Select ***Service*** and password (26-23-8).
4. Select ***Set/Test*** and perform a Factory Reset.
5. The monitor will perform an automatic restart. After the restart is completed, restart the monitor also manually by pressing the **On/Standby** key.

3.3.12 Performing Service Reset

Perform the service reset always before disassembling or service checking the monitor.

NOTE: The service reset will erase all the trend information.

1. Disconnect the mains power cord.
2. Press the **ON/Standby** key for 10 seconds.

3.4 S/5 Remote Controller, K-REMCO

To connect Remote Controller to MRI Monitor

1. Make sure that the monitor is switched to standby.
2. Connect the Remote Controller cable to the 5 pin connector X3 on the right side of the MRI Monitor.

CAUTION Ensure that the Remote controller is outside the 300Gauss line and that the cable is not in contact with the patient.

3.5 Anesthesia Record Keeping Keyboard, K-ARKB

3.5.1 Connection to MRI Monitor

To connect the K-ARK to MRI Monitor you need ARK Keyboard-LCD Cable 1.5 m/5ft, 881154 or ARK Keyboard-LCD Cable 2.5 m/ 8 ft, 889340.

1. Make sure that the power to the MRI Monitor is turned off.
2. Connect the ARK Keyboard-LCD Cable to the connector X3 on the MRI Monitor, and to the connector on the rear of the keyboard. Alternatively you can connect the cable to a Remote Screen Converter in Control room. Secure the connection with the thumbscrew and slip the cable beneath the fasteners.

CAUTION If you use the anesthesia record keeping keyboard inside the MR scanning room, place the between the keyboard and the monitor outside the 300 Gauss line.

3.6 MRI Airway Module gas scavenging

3.6.1 Sample gas exhaust

Preventing MR room pollution

When N_2O or volatile anesthetics are used, pollution of the MR room by these gases should be prevented. Connect the sample gas outlet of the monitor to the scavenging system.

Connect the sample gas outlet of the monitor to the scavenging system either

- through the ventilator, or
- directly to the scavenging system.

CAUTION Strong scavenging suction may change the operating pressure of the monitor and cause inaccurate readings or internal damage. To prevent this, there must for example be an opening to room air.

Scavenging through the ventilator reservoir

Connect the sample gas outlet only to open scavenging system where gas is removed in room pressure.

1. Connect the exhaust line to the sample gas outlet on the connector panel of the MRI Monitor shield.

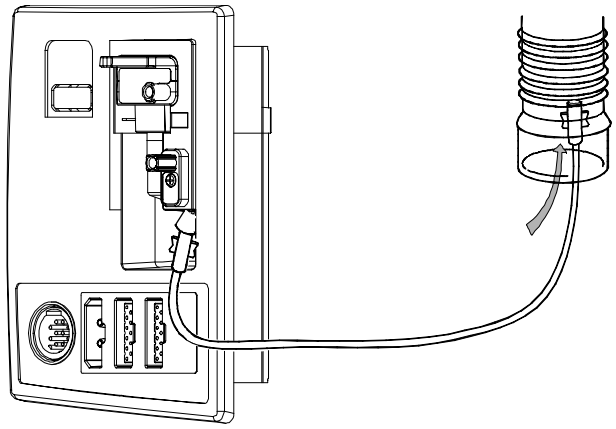


Figure 19 Exhaust to reservoir tube

2. Attach the other end of the line to the ventilator reservoir. Make sure that the reservoir tube diameter is at least 2 - 3 times larger than the exhaust line.

Scavening through the anesthesia gas scavennging system

Anesthesia machines are equipped with an anesthesia gas scavenging system (AGSS), and in some machines you can connect the sample gas outlet directly to that. Refer to the anesthesia machines's user documentation to find out where and how the the sample gas can be connected.

Connecting directly to the scavenging system

1. Connect the exhaust line to the monitor's sample gas outlet.
2. Connect the exhaust line only to an open scavenging system where gas is removed at room pressure.

NOTE: Do not connect the monitor directly to a vacuum scavenging system.

3.7 Troubleshooting

If a problem occurs during a functional examination, check the components of the monitor according to the following troubleshooting chart. If the problem persists, please refer to “6. General troubleshooting” section.

Trouble	**Treatment**
The MRI Monitor does not function.	Unplug the power cord. Check that the cord is intact, then reconnect the cord.
The remote display does not function.	Unplug the display power cord and the display cable. Check that the cord and cable are intact, then reconnect the cord and cable. Unplug the Remote Screen Converter-LCD Display cable. Check that the cable is intact and reconnect the cable. Check that the display brightness is adjusted properly.
A parameter module does not function.	Check that the parameters displayed are configured correctly.
The MRI Compact Airway Module does not function.	Check that the ‘Occlusion’ or ‘Calibrating Gas Sensor’ messages are not displayed. Check that a D-fend water trap and a sampling line are attached. Check that the parameters displayed are configured correctly.
Printer error. Printer is not working properly.	Check that the local or network printer is operational. Central can also start snapshot printing, please refer to the "iCentral User's Reference Manual" for details.

4 Interfacing

The MRI Aestiva/5 can be interfaced with the Device Interfacing Solution.

Printers and computers cannot be directly connected to the MRI monitor, but can be interfaced through the network.

NOTE: The N-DISVENT module must be mounted outside 5G line.

4.1 Interfaced parameters

When you interface Aestiva/5 MRI to the MRI Monitor you will get the following parameters:

Device set values for trends	Measured numeric values	Waveforms	Supported versions
Vent. mode, I:E ratio, RR, TV, PEEP, Pinsp, Insp.pause, Pmax	FiO_2, TVexp, MV, RR, Pmean, Ppeak	Paw, Flow, Vol Loops	with SmartVent 7900: software versions 3.5 and 4.5

4.2 Interfacing external bedside devices via Device Interfacing Solutions, N-DISxxx

The Device Interfacing Solution, N-DISxxx provides means for transferring physiological, waveform and event data from various bedside patient care devices to the Datex-Ohmeda monitoring system. The real-time and trended data can be displayed on the monitor screen and used for record keeping purposes. The interfacing module reads the data coming from the external device, converts it to a suitable format and sends it to the monitor.

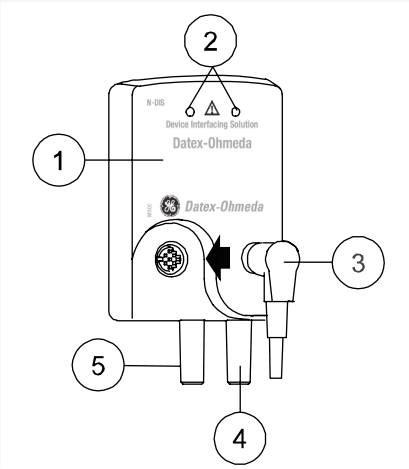
4.2.1 Device Interfacing Solution components

The Device Interfacing Solution consists of:

- a device specific interfacing module
- a device specific cable
- a bus cable
- a connector for another bus cable
- label specifying the external device

4.2.2 Connections

Connect the device specific cable to the external device and the bus cable to the monitor's DIS connector or to another interfacing module.



(1) label specifying the external device

(2) LED indicators

(3) black bus cable from another interfacing module, if needed

(4) grey device specific cable to the communication port of the external device

(5) black bus cable to the monitor's DIS connector (or to another interfacing module)

Figure 20 Connection cables and LED indicators

WARNING The MRI Monitor, interfacing modules and interfaced devices must be situated in the same patient environment (as defined in IEC 60601-1-1).

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 The manufacturer guarantees a reliable functioning of the devices with tested software versions only. Always refer to the Installation guide accompanying the DIS module and verify the compatibility before use.

4.2.3 Mounting

The DIS module can be mounted on the side panel of the external device. Also IV pole placement is possible.

NOTE: As the Device Interfacing Solution works only with the device specified in the label of the interfacing module, it is recommended that the interfacing module always travels along with the external device.

For mounting accessories, please refer to the "Supplies and Accessories" catalog. See the following figure for an example of a device interfacing.

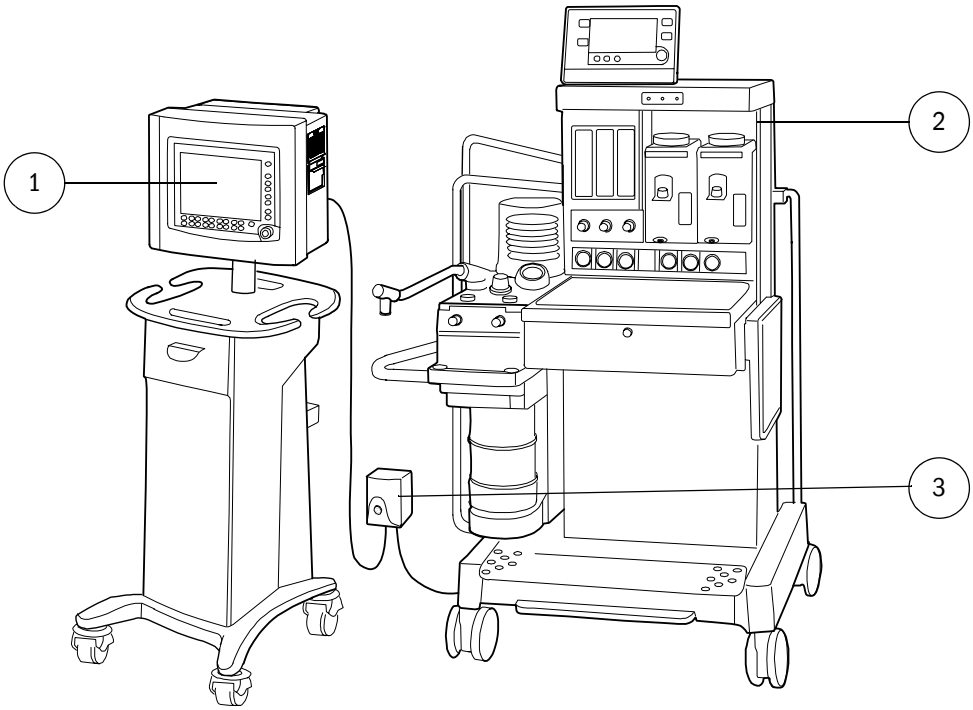


Figure 21 An example of interfacing external devices with Device Interfacing Solution

(1) MRI Monitor (with L-CANE05 or L-CANE05A software license)

(2) Aestiva/5 MRI anesthesia machine

(3) Device specific interfacing module, N-DISVENT

CAUTION Make sure that the interfacing module is always used in vertical position to prevent water from entering the module.

CAUTION Make sure that you are connecting the interfacing module to the device specified in the label.

NOTE: If DIS is used, keep it connected to the MRI Monitor at all times. If the DIS is already connected to the Aestiva/5 MRI that is on, do not connect the DIS to the MRI Monitor that is on.

4.2.4 Selecting the external device

1. Turn off the monitor.
2. Turn off the external device.
3. Connect the interfacing module to the monitor's connector for N-DIS or to another interfacing module.
4. Connect the device specific cable to the external device and turn the external device on.
5. Turn the monitor on. The monitor identifies the connected device automatically.

4.2.5 Functional check

There are two ways to check the function of the Device Interfacing Solution:

1. Press the **Monitor Setup** key.
2. Select ***Interfacing*** and open the ***Status Page*** menu. The status page shows you the current communication status of the interfacing module (1 -).

NOTE: The status message 'Connected' appears on the Status Page after you have connected the external device to the interfacing module and turned it on. Note also that the monitor and the interfacing module must be operational.

- Check the LED indicators on the interfacing module (the green LED indicates physical connections, the yellow LED software selections)

GREEN	YELLOW	INDICATION
lit ●	dark ○	Physical connections between the monitor, interfacing module and external device are in order and the device has been selected in the menu.
dark ○	lit ●	There is something wrong with the physical connections between the monitor, interfacing module and external device. The external device has not been selected in the menu.
lit ●	lit ●	Physical connections between the monitor, interfacing module and external device are in order but the external device has not been selected in the menu.
dark ○	dark ○	The interfacing module is not connected to the monitor.

4.2.6 Selecting the parameter data source

Select the external device via **Monitor Setup - *Interfacing*** menu:

NOTE: The name of the device is visible on the list only if the device is correctly connected.

NOTE: Detailed information about interfacing module related mountings, connections and settings is included in the installation guides that are delivered with the interfacing modules.

4.3 Interfacing printer

The printer can be used through the Central. At the Central you can print patient information, real-time ECG waveforms strips, trends, event history waveforms strips and full disclosure data from the selected monitor location to a .pdf file or to a laser printer, which is either connected to the Central or to the network. You can also print the anesthesia records and critical care reports.
For details please refer to "*iCentral and iCentral Client" manuals.*

WARNING **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 printer to the wall power outlet may cause the printer leakage current to exceed the limit specified for medical**

equipment. A printer must be supplied from an additional transformer providing at least basic isolation (isolating or separating transformer).

4.4 Interfacing computer

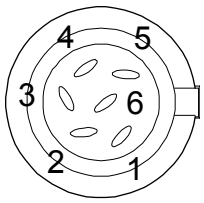
Contact your authorized GE Healthcare distributor for further advice on computer interface.

WARNING **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).**

4.5 Output signals

Cardiac (ECG) Gating connector X2

Connector	Pin	Signal
	1	ECG out
	2	QRS pulse OUT
	3	Reserved for future use
	4	Reserved for future use
	5	+15 VDC
	6	GND

Cardiac Gating

The ECG hardware has an electric output providing analog ECG and QRS triggering pulses.

Analog ECG

Gain	1mV ECG signal is 1 V ± 10 % at the analog output
Delay	< 10 ms
Range	± 8 V
Bandwith	0.5 to 40 Hz

QRS triggering pulse

Pulse width	10 ms positive pulse
Delay	-15 to 15 ms

5 Functional check

These instructions include procedures for a functional check for MRI Monitor. The functional check is recommended to be performed after any monitor installation, either a new monitor or a serviced monitor.

These instructions include a “Functional check form, MRI Monitor” to be filled in when performing the procedures. The symbol  in the instructions means that the performed procedure should be signed in the check form. The procedures should be performed in ascending order, by passing those that are not applicable for a particular monitor.

All menu selections related to MRI Monitor are written in following typeface:
e.g. ***Parameters - Gas Unit.***

As you enter the service menus, you need the 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 simulator’s accuracy specification to the one of the monitor.

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

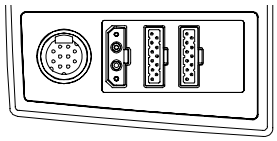
5.1 Recommended tools

For product(s)	Tool	Order No.
Airway Modules		
All MRI Airway modules	Sampling line, 6 m/19.7 ft	73306
All MRI Airway modules w/ (V)	Spirometry tube, 6 m/19.7 ft	891191
	D-lite	733910
Hemodynamic module, E-MRIPSN		
for InvBP	InvBP transducer	70077-001
for ECG	MRI ECG 3-lead set, 6.5 m/20 ft, IEC	897987
	or	
	MRI ECG 3-lead set, 6.5 m/20 ft, AAMI	897986
for SpO_2	Finger MRI sensor for adults	OXY-FMR
	Wrap MRI sensor for pediatrics	OXY-WMR
for NIBP	Adult NIBP cuff hose, 6 m/19.7 ft	2020980-002
	Infant NIBP cuff hose, 6 m/19.7 ft	2017009-004
for InvBP and NIBP	Pressure manometer	

For product(s)	Tool	Order No.
Data Card option	MemCard – Data or Menu	
Network or WLAN option	Datex-Ohmeda Network connection	
	Screwdrivers	See “3.4.2. Tools needed” for the tools needed during the dis-/reassembly.

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.

Patient simulators’ compatibility with MRI hemodynamic module

Module	Parameter	Patient simulator		
		M1010831	MedSim	874027
E-MRIPSN 	ECG InvBP	Not compatible Ok	OK with adapter cable M1010858	Ok Not compatible

Adapter cables for hemodynamic patient simulators

Patient simulator	Adapter cables for simulators	
Hemodynamic patient simulator	- Dual Inv.BP adapter cable	2005772-001
Medsim	- Inv.BP adapter cable	M1010858
Lionheart & MPS450	- Inv.BP adapter cable	M1010862

5.2 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 Datex-Ohmeda Network, disconnect the fiber optic Network cables from the monitor. If the MRIRemote option is connected, disconnect the fiber optic cables from the monitor.

1. External parts and connectors

   Check that all the parts and the connectors are intact. Especially check that:

   – all the screws are tightened properly.

   – the patient cable connectors in the connector panel are intact.

   Connect the sampling line to the connector panel.

5.3 Functional inspection

General

1. Connect the mains power cord.
2. Switch the monitor on.
   Check that the monitor starts up properly, i.e. normal start-up sound is heard, the alarm LEDs turn on and off, also the magnetic field alarm LEDs, and the monitoring screen appears.
   No error messages should appear on the screen.
   Magnetic Field alarm test sound should be heard.
3. Check that the clock on the screen shows correct time. Readjust the time and date, if necessary.
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.

Display(s)

1. Check that the picture on the monitor screen is correct and the monitor screen configuration is appropriate for the parameters in use.

Keyboard(s)

1. 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.

MRI Monitor frame

1. Check that all the monitor fans are running.

MRI Compact Airway Module, E-MRICXXXXX

Wait until the message ‘Calibrating gas sensor’ disappears from the screen.

Perform the sampling system leak test.

Prevent the module from performing the normal occlusion functions, such as controlling the valves, by turning the pump first off, then on again from the menu.

Block the reference gas connector at the module front panel.

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 170 mmHg, connect the other port of the flow cassette to the sample gas out connector and switch the pump off.

Wait until pressure inside the sampling system is stabilized, then notice the shown ***Amb-Work*** value. The value, i.e. the pressure inside the sampling system, should not drop more than 6 mmHg in one minute.

If the pressure drops more, first check the connections and then repeat the test.

2. Flow rates

   Wait until the ***Sample Flow*** value in the service menu is back near 200 ml/min.

   Connect the flowmeter to the reference gas connector, check that the flowmeter reading is within the following range:

Reference flow (ml/min)	30 to 45

MRI Compact Airway Modules with the Patient Spirometry option

3. Flow waveform

   Connect a clean spirometry tube to the module and a clean D-lite to the other end of the tube. Connect the sampling line. Breathe through the wider side of the D-lite. Check that the flow waveform moves downwards when you breathe in and upwards when you breathe out.

4. Spirometry system leak test

   Enter the service menu ***Spirometry***:

   Gas Unit - Spirometry

   Block the D-lite's sampling line port, for example with a Luer stopper.

NOTE: Make sure that the date marking on the D-lite is 10/94 or newer.

Take the D-lite in your hand and occlude both ends tightly with your fingers (or with both hands). Pressing creates a pressure inside the D-lite. Check that a pressure near 5 cmH_2O is generated (the Aw Pressure value in the service menu).

If the system leaks heavily, no pressure will be generated.

If there is a small leak in the connections, the monitor will measure a pressure difference, which is then interpreted as flow and seen on the monitor screen. The pressure waveform (and the Aw Pressure value) decreases slowly and the flow waveform (the Flow value) either goes above or below the zero line, depending on which of the connectors is leaking.

In case of leakage, first check all the connections and try again.

For all MRI Compact Airway Modules

5. Occlusion detection

   Block the tip of the sampling line with your finger and check that the message ‘Sample line blocked’ is displayed on the monitor screen within 30 seconds.

6. D-fend detection

   Detach the D-fend and check that the message ‘Check D-fend’ is displayed on the monitor screen within 30 seconds. Attach the D-fend back to the patient connector panel.

7. CO_2 information

   Breathe to the sampling line briefly. Check that the CO_2 information is updated on the screen.

8. Apnea detection

   Check that the ‘Apnea’ message is displayed on the screen within 30 seconds after you have stopped breathing in the sampling line.

Hemodynamic measurements, E-MRIPSN

ECG measurement

1. Connect an ECG cable to the connector panel. Connect the cable leads to a patient simulator. Check that all ECG information is shown on the monitor screen as configured on the simulator.

   Turn the simulator off. Check that the ‘Asystole’ and ‘Apnea’ messages are displayed.

Invasive blood pressure measurement

1. Check the InvBP channels with a patient simulator.
2. Zero the InvBP channels and check that the values and waveforms correspond to the simulator settings.

SpO_2 measurement

3. Connect an SpO_2 finger probe to the module. Check that the message 'Probe off' is shown when the probe is not connected to a finger.
4. Attach the SpO_2 probe to your finger. Check that a reading of 95 to 99 and a pleth waveform are displayed on the screen.

Non-invasive blood pressure measurement

5. Attach an adult NIBP cuff on your arm and perform one NIBP measurement. Check that the module identifies the cuff, i.e. the text 'Adult' is displayed in the NIBP digit field for a short time.

   Check that the module gives a reasonable measured result.

Data Card function

1. Insert a Data Card in the slot.

   Check that the corresponding symbol appears on the monitor screen.

Recorder

1. Press the **Record Wave** side panel key and check that the recorder starts recording the selected waveforms. Press the **Stop** side panel key to stop recording.
2. Check that the quality of the recordings is acceptable.

Active Remote Screen Option

Reconnect the fiber optic cable to the MRI Monitor. Make sure that the fiber optic cables are connected to the Remote screen converter and this to the remote screen and to the MRI Command Bar or to the Anesthesia record keeping keyboard, K-ARK, if included.

Turn the monitor on.

1. Check that the picture on the remote screen is correct.
2. 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.
3. Create an alarm and check that this alarm is correctly displayed on the remote screen and an alarm sound is heard from the remote screen.

Network connection

1. Reconnect the fiber optic Network cable to the MRI Monitor. Make sure that the fiber optic cables are connected to the Fiber optic converter, N-FOC, and this to the network.

Check that the monitor connects to the network, i.e. the network symbol is displayed 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 on the screen.

Wireless Network Option

1. Check that the WLAN signal strength symbol scrolls between zero and full or stays fixed on the monitor screen.
2. Check that the wireless LAN network symbol is displayed in the upper right-hand corner of the screen when the monitor connects to the Datex-Ohmeda Network.

NOTE: If the monitor does not connect to the Datex-Ohmeda Network, check the WLAN configuration in the monitor and in the network.

Device Interfacing Solution, N-DISVENT

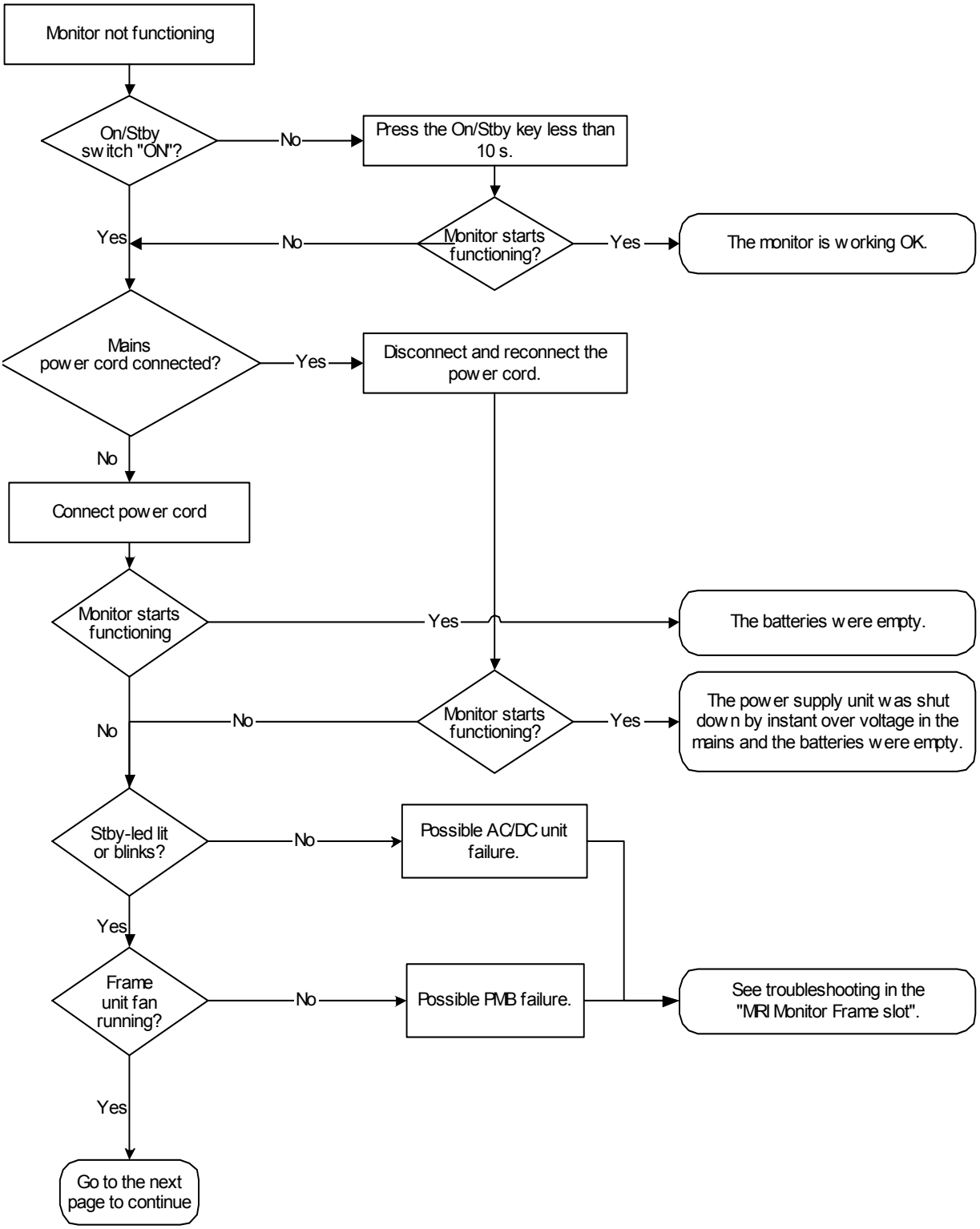
1. Make sure that the monitor receives all necessary parameter data from the connected devices. Check the screen configuration and the related interfacing settings, if necessary.

   Monitor Setup - ***Interfacing - Status Page***

General

- Test the MRI monitor system to avoid all the interference that it may cause to the MR pictures.
- Switch the monitor to standby
- Perform final cleaning
- Fill in all necessary documents

6 General troubleshooting



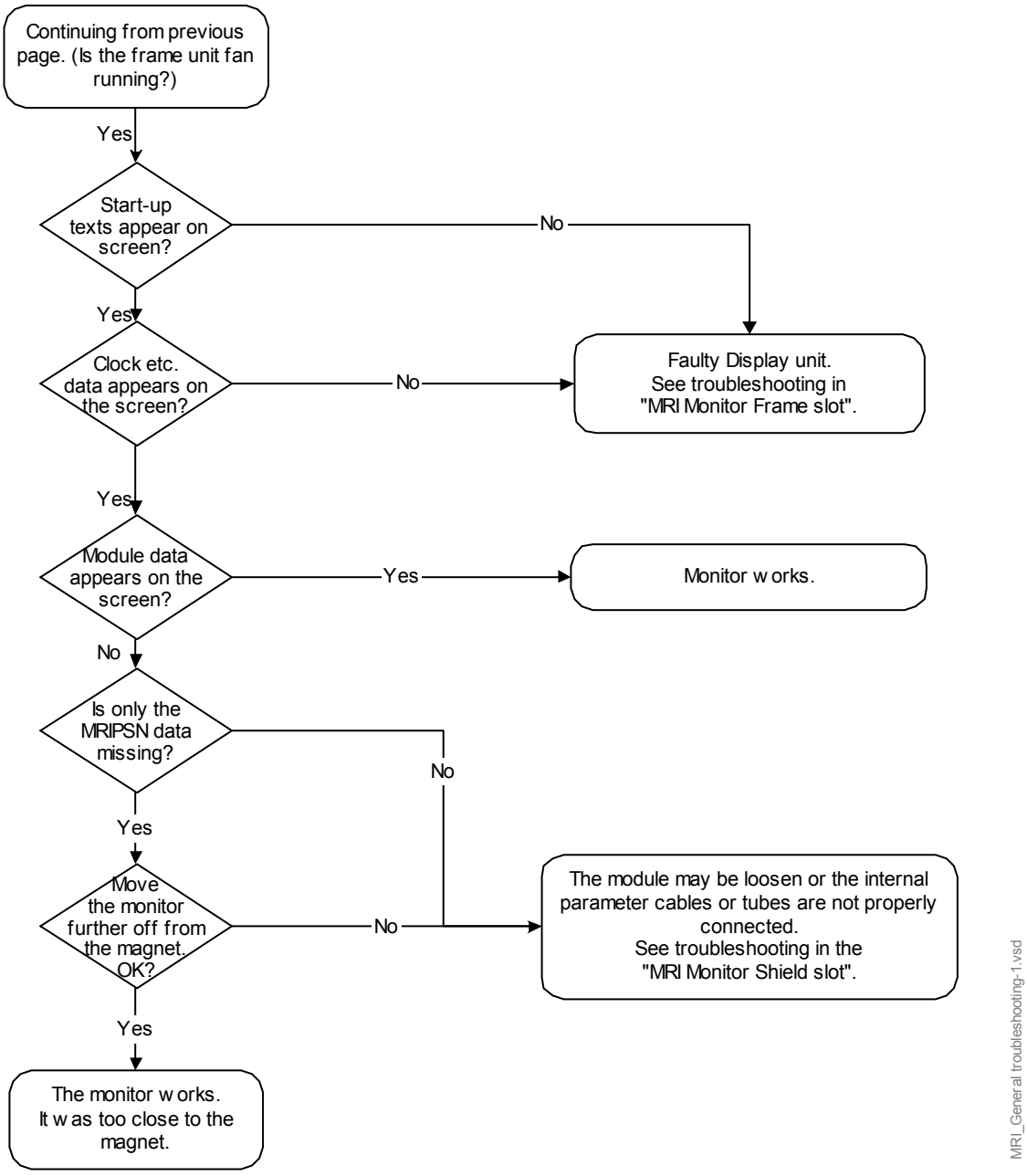


Figure 22 MRI general troubleshooting flowchart

APPENDIX A Functional check form, MRI Monitor

Customer	
Service	
Service engineer	Date

Monitor Installation			
Frame: N-	**System options**	N-	**Modules**
Active Remote Screen	N-	N-	E-MRIPSN
D-	N-	N-	E-MRIC_____
K-	K-	N-	

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual Inspection			**OK**	**N.A.**	**Fail**
1External parts and connectors			☐	☐	☐

Functional Inspection		**OK**	**N.A.**	**Fail**
General	S/N	☐	☐	☐
Display(s)	S/N	☐	☐	☐
Keyboard(s)	S/N	☐	☐	☐
MRI Monitor frame	S/N	☐	☐	☐
Notes				
MRI Compact Airway Module, E-MRICXXXXX	S/N	☐	☐	☐
MRI Compact Airway Modules with the Patient Spirometry option		☐	☐	☐
For all MRI Compact Airway Modules		☐	☐	☐
Notes				
Hemodynamic measurements, E-MRIPSN	S/N	☐	☐	☐

Functional Inspection		**OK**	**N.A.**	**Fail**
ECG measurement		☐	☐	☐
Invasive blood pressure measurement		☐	☐	☐
SpO2 measurement		☐	☐	☐
Non-invasive blood pressure measurement		☐	☐	☐
Notes				
Data Card function	S/N	☐	☐	☐
Recorder	S/N	☐	☐	☐
Active Remote Screen Option	S/N	☐	☐	☐
Network connection	S/N	☐	☐	☐
Wireless Network Option	S/N	☐	☐	☐
Notes				
Device Interfacing Solution, N-DISVENT	S/N	☐	☐	☐
General	S/N	☐	☐	☐
Notes				

Signature

APPENDIX B 1ElectroMagnetic Compatibility

Table 1 Guidance and manufacturer's declaration – electromagnetic emissions

Guidance and manufacturer's declaration – electromagnetic emissions		
The MRI Monitor is intended for use in the electromagnetic environment specified below. The customer or the user of the MRI Monitor should assure that it is used in such an environment.		
Emissions test	**Compliance**	**Electromagnetic environment - guidance**
RF emissions CISPR 11	Group 1	The MRI Monitor uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in the nearby electronic equipment.
RF emissions CISPR 11	Group 2	The MRI Monitor [1] must emit electromagnetic energy in order to perform its intended function. Nearby electronic equipment may be affected.
RF emissions CISPR 11	Class B	The MRI Monitor 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.
Harmonic emissions IEC 61000-3-2	Class A	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

1. MRI Monitor equipped with N-CMW option

Table 2 Guidance and manufacturer's declaration – electromagnetic immunity

Guidance and manufacturer's declaration – electromagnetic immunity			
The MRI Monitor is intended for use in the electromagnetic environment specified below. The customer or the user of the MRI Monitor 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 MRI Monitor requires continued operation during power mains interruptions, it is recommended that the MRI Monitor be powered from an uninterruptible power supply or a battery.
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	10 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 MRI Monitor is intended for use in the electromagnetic environment specified below. The customer or the user of the MRI Monitor 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 MRI Monitor 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 MHz $d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz 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 MRI Monitor is used exceeds the applicable RF compliance level above, the MRI Monitor should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the MRI Monitor.
[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 MRI Monitor

Recommended separation distances between portable and mobile RF communications equipment and the MRI Monitor.

The MRI Monitor is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the MRI Monitor can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the MRI Monitor 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.

For your notes:

Datex-Ohmeda

MRI Monitor

Planned Maintenance Instructions

All specifications are subject to change without notice.

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

M1041747-1
September, 2006

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

Table of contents

1 Planned maintenance instructions

1.1 Introduction

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

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

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.

If you need further information on how to perform a certain Planned maintenance procedure, please refer to the corresponding slot in the Technical Reference Manual.

All menu selections related to the Datex-Ohmeda monitors 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)

NOTE: In case you evaluate the measurement accuracy with a patient simulator, add the simulator's accuracy specification to the one of 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.

WARNING **Planned maintenance requires using tools like calibration gas bottles, that contain ferrous metal, perform the procedure outside the MR environment.**

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

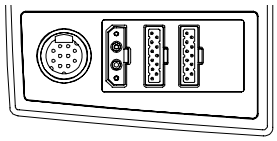
1.2 Recommended tools

.

For product(s)	Tool	Order No.
Airway Modules		
MRI Compact Airway Module, E-MRICAiO(V)	Calibrating gas and regulator	755583/755534*
MRI Compact Airway Module, E-MRICO	Calibrating gas and regulator	755581/755534*
All MRI Airway modules	Sampling line, 6 m/19.7 ft	73306
All MRI Airway modules w/ (V)	Spirometry tube, 6 m/19.7 ft	891191
	D-lite	733910
Hemodynamic module, E-MRIPSN		
for InvBP	InvBP transducer	70077-001
for ECG	MRI ECG 3-lead set, 6.5 m/20 ft, IEC	897987
	or	
	MRI ECG 3-lead set, 6.5 m/20 ft, AAMI	897986
for SpO_2	Finger MRI sensor for adults	OXY-FMR
	Wrap MRI sensor for pediatrics	OXY-WMR
for NIBP	Adult NIBP cuff hose, 6 m/19.7 ft	2020980-002
	Infant NIBP cuff hose, 6 m/19.7 ft	2017009-004
for InvBP and NIBP	Pressure manometer	
Data Card option	MemCard – Data or Menu	
Network or WLAN option	Datex-Ohmeda Network connection	
Active Remote Screen option	Control room setup	
	Screwdrivers	See “3.4.2. Tools needed” for the tools needed during the dis-/reassembly.

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.

Patient simulators' compatibility with MRI hemodynamic module

Module	Parameter	Patient simulator		
		M1010831	**MedSim**	**874027**
E-MRIPSN 	ECG InvBP	Not compatible Ok	OK with adapter cable M1010858	Ok Not compatible

Adapter cables for hemodynamic patient simulators

Patient simulator	Adapter cables for simulators	
Hemodynamic patient simulator	- Dual Inv.BP adapter cable	2005772-001
Medsim	- Inv.BP adapter cable	M1010858
Lionheart & MPS450	- Inv.BP adapter cable	M1010862

1.3 Recommended parts

For	Part	Order No.
MRI Shield and MRI Monitor Frame	Fan filters, 2 pcs	896085
CPU Board,every 8 years	Battery for SRAM/Timekeeper	197230
Recorder	Recorder paper	74205
E-MRI(P)SN	NIBP pump filter	57142-HEL

1.4 Recommended parts for MRI compact airway module

Part	Order No.	Notes
Fan filter	M1028983	
D-fend O-ring (2 pcs)	653125	Replace annually the ones in the Patient connector panel.
Filter (3 pcs)	886136	Replace the occlusion filter annually.
D-fend	876446	
Sampling line, 6 m/19.7 ft	73306	
Nafion tubes (2 pcs)	733382	Replace annually.
Zero Absorber	895933	Replace once every four years.

D-lite / Pedi-lite	733910/73393	
Spirometry tube, 6 m/ 19.7 ft	891191	
Filter assembly	896025-HEL	

For details on recommended accessories see the “Supplies and Accessories” catalog.

2 Planned maintenance check list

2.1 Visual inspection/preparation

2.1.1 General

- Make sure that the monitor is switched to standby.
- Disconnect the mains power cord and all the other external cables connected to the monitor. If the monitor is connected to the Datex-Ohmeda Network, disconnect the fiber optic network cable from the monitor.
- Disconnect all the patient connectors.
- Disassemble the MRI Monitor far enough to be able to remove the MRI Monitor frame from the shield. See MRI Shield slot for the disassembly instructions.
- Remove both modules from the monitor.
- Remove the WLAN antenna card, if the Wireless LAN option is installed. Remove any data cards and the PCMCIA Extender Unit.

1. Replace the SRAM/Timekeeper battery on the CPU board, if necessary. See MRI Monitor frame slot for the disassembly instructions.

   The manufacturer recommendation is to replace the SRAM/Timekeeper battery every 8 years.

   NOTE: The Factory Reset must be performed if the SRAM/Timekeeper battery is replaced.
2. Check all the units visually. Check that all the parts are intact and the cables and screws are connected and tightened properly.

   Especially check the following parts:

   – the display unit locking screw is in a locking position.

   Insert the WLAN antenna card back into the foremost card slot, if the Wireless LAN option is installed.
3. Clean or replace the fan filters in MRI Shield.
4. Check that the fuses are of the correct rating.
5. Check the ventilation holes of the MRI Monitor Shield and clean of dust if necessary.

2.1.2 MRI Compact Airway Module, E-MRICXXXXX

Detach the module box. See MRI Compact Airway Modules slot for the disassembly instructions.

1. Check that all cables and tubes are connected properly and that there are no loose objects inside the module.

   NOTE: The tubes connected to the Oxygen board pressure transducers should not be pressed too deep.

   NOTE: Make sure that the tubes are not in contact with the sampling pump or the O_2 sensor, or its springs.

2. Planned maintenance parts
   - Clean or replace the fan filter.
   - Replace the special tubes (Nafion™).
   - Replace the reference gas filter in the patient connector panel and, if necessary, in the module front cover.
   - Replace the occlusion filter in the pneumatic unit.
   - Check the dummy D-fend O-rings.
   - Check the D-fend O-rings located in the patient connector panel and replace them, if necessary.
   - Replace the old D-fend and the sampling line.

   NOTE: Use only approved sampling lines to ensure proper functioning.
3. CO_2 absorber

   The manufacturer recommendation is to replace the CO_2 absorber every 4 years. Replace the absorber, if necessary.

Insert the MRI Compact Airway Module in to the gas module slot in the MRI Monitor frame.

2.1.3 Hemodynamic MRI module, E-MRI(P)SN

Detach the module box. See Hemodynamic MRI Module slot for the disassembly instructions.

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

   Reassemble the module and insert it back in to the monitor frame.

2.1.4 Recorder Unit

1. Clean the recorder.
   - Open the paper compartment hatch and remove 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, if necessary.

   NOTE: Avoid contact with the rubber paper roller. Be careful to limit the application of alcohol to the thermal printhead and the window.
   - Reinstall the paper roll.

2.1.5 Monitor reassembly

Reassemble the MRI Monitor far enough to be able to connect all the tubes and cables to the MRI Monitor frame, see ”Disassembly and reassembly” in the MRI Shield slot.

NOTE: Leave the MRI Shield front cover still open.

2.2 Functional inspection

2.2.1 General

1. Connect the mains power cord to the MRI Monitor.
   Check that the LED above the mains switch is lit continuously (full charged batteries) or periodically (charging batteries).
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 installed, the recorder should record two lines of start-up information.

   Preset the measurement settings for those parameters that are connected.

2.2.2 Display

1. Check that the picture on the screen is adjusted correctly.

2.2.3 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.

   Tests with the Remote Controller:
   - Enter the ***Keyboard*** service menu.
   - Check the function of the ComWheel.
   - Press all keys. Check that each key produces a sound from the loudspeaker, or the Message count value in the service menu increases.

2.2.4 Display Unit

1. Check that the clock on the screen shows correct time.

   Readjust the time and date, if necessary.
2. Enter the ***Service Log*** service menu.

   Check the content of the Service Log for possible problems.

2.2.5 MRI Monitor Frame Unit

1. Check that the Monitor frame unit fan is running.

2.2.6 MRI Compact Airway Module, E-MRICXXXXX

1. Check that the fan is running.
2. Wait until the message 'Calibrating gas sensor' disappears from the screen, then enter the Compact Airway Module ***General*** service menu.

   Check that the module configuration displayed corresponds to the Compact Airway Module type being used.
3. Check that the Time-outs, Bad checksums and Bad c-s by mod values are not increasing faster than by 5 per second.
4. Enter the ***Gases*** service menu: Check that the 'Ambient' value displayed corresponds with the current ambient pressure (±20 mmHg).
5. Check that the flow measurement offset, i.e. the sample 'Zero' value displayed is within ±10 ml/min.
6. Perform a sampling system leak test.
7. Check the flow rates. Adjust the sampling flow, if necessary.
8. Perform a gas calibration:

   NOTE: For maximum accuracy, a warm-up time of 30 minutes is recommended.

   NOTE: For correct measurement values, modules need different amounts of oxygen in the calibration. If you do not use the recommended calibrating gases, the calibration does not succeed.

Anesthesia Agent

MRI Compact Airway Modules w/ the option

9. Enter the ***Gases*** service menu.

   Feed calibrating gas (order code 755583) continuously for at least 30 seconds and check that the 'ID' in the service menu shows 'DES' and that the value for 'ID unrel.' is lower than 50.

Patient Spirometry

Compact Airway Modules w/ the option

10. Enter the ***Spirometry*** service menu.

    Connect a clean spirometry tube and a D-lite to the module.

    Perform the spirometry leak test.

11. Connect the sampling line. Breathe through the wider side of the D-lite. Check that the flow waveform moves downwards when you breathe in, and upwards when you breathe out.

General

For all MRI Compact Airway Modules [General]

- Switch the monitor to standby and reassemble the module.

  NOTE: Attach the plastic cover to the CPU Board before fitting the module box. Make sure that the grounding claws in the front panel frame make good contact with the module box.

  NOTE: When reassembling the module, make sure that the tubes are not pinched between the module box and internal parts.

  Reassemble the MRI Compact Airway Module back to the monitor frame. Replace the dummy D-fend to the module and the D-fend to the patient connector panel.

  Reassemble the MRI Monitor far enough to be able to connect all the tubes and cables to the MRI Monitor frame.

NOTE: Leave the MRI Shield front cover still open.

Switch the monitor back on and wait until the message ‘Calibrating gas sensor’ disappears from the screen.

12. 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.
13. Detach the D-fend and check that the message ‘Check D-fend’ appears on the monitor screen within 60 seconds.

2.2.7 Hemodynamic measurements

ECG measurement

1. Enter the ***ESTP: 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 that the ECG board memories have passed the internal memory test, i.e. RAM, ROM and EEPROM all state OK.
2. Check that the ‘Power Freq’ value is set according to the mains power frequency. Correct the setting, if necessary.
3. Connect a 3-lead ECG cable to the monitor. Check that the message 'Leads off' is displayed on the screen.
4. Connect the cable leads to a patient simulator. Disconnect one of the leads and check that the corresponding electrode in the service menu shows OFF within 10 seconds from the disconnection, then reconnect the lead.

   Check the rest of the leads using the same method.

   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.

5. Check that all ECG information is shown on the monitor screen as configured on the simulator.
   Turn the simulator off. Check that the 'Asystole' and 'Apnea' messages are displayed.

Invasive blood pressure measurement

6. Check the InvBP channels with a patient simulator.
   Zero the InvBP channels, then check that the values and waveforms correspond to the simulator settings.

SpO2 measurement

7. Check that the message 'No probe' is shown, when no SpO_2 sensor is connected.
   Connect an SpO_2 finger probe to the module. Check that the message 'Probe off' is shown, when the probe is not connected to a finger.
8. Attach the SpO_2 probe to your finger. Check that a reading of 95 to 99 and a pleth waveform appear on the screen.

Non-invasive blood pressure measurement

9. Enter the ***NIBP*** module 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 that the NIBP board memories have passed the internal memory test, i.e. RAM, ROM and EEPROM all show ***OK***.
10. Check the NIBP tubing system for leakages by performing ***Calibrations - Active leak test.***
11. Perform NIBP calibration by selecting ***Calibration.***
12. Enter the ***Pneumatics*** service menu.
    Check the NIBP watchdog timer activation pressure with a pressure manometer.
13. Check the safety valve by performing ***Safety Valve – Adult*** and ***Infant.***
14. Attach an adult NIBP hose and cuff on your arm and perform one NIBP measurement. Check that the module identifies the cuff, i.e. the text 'Adult' appears in the NIBP digit field for a short time.
    Check that the module gives a reasonable measurement result.
15. 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***.

MRI Shield reassembly

Turn the monitor off and disconnect the power cord.

Close the MRI Shield front cover.

NOTE: Remember to reconnect the Alarm board cable.

2.2.8 Magnetic field alarm

1. Connect the mains power cable and other external cables.
2. Turn the monitor ON and check that the Magnetic field alarm LED is lit and the alarm sound is heard for a moment.

2.2.9 Data Card function

1. Enter the ***MemCards*** service menu:

   Check that the Data Card is recognized properly, i.e. Present and Active state YES.
2. Check that the memories and the PCMCIA controller have passed the tests. The status for each should be OK.
3. Select ***Communication***.

   Check that the Interface status states Active continuously and the error counter values on the bottom part of the menu are stable.
4. Select ***Status***.

   Insert Data Card in the slot.

   Wait until the information is fully updated in the service menu, then check that the Card types are correct and the 'File system' states ATA.

   Check that the rest of the information is reliable and no errors have been detected.

2.2.10 Recorder

1. Open the paper compartment cover. Check that the message 'Recorder: Cover open' appears on the screen, then close the cover.
2. Press the **Record Wave** key and check that the module starts recording the selected waveforms. Press the **Start/Stop** key again to stop recording.
3. Check that the quality of the recordings is acceptable.

2.2.11 Electrical safety check

1. Perform an electrical safety check and a leakage current test.
2. Check that the monitor and all connected units function normally after the performed test.
3. Switch the monitor to standby and perform a final cleaning.

MR room and control room installation

Return the monitor back to the MR room to perform the following checks for the whole MRI Monitor installation.

2.2.12 Active Remote Screen Option

Reconnect the fiber optic cable to the MRI Monitor. Make sure that the fiber optic cables are connected to the Remote screen converter and this to the remote screen and to the Command Bar, K-MRIANEB or to the Anesthesia record keeping keyboard, K-ARK, if included.

Turn the monitor on.

1. Check that the picture on the remote screen is correct.
2. 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.
3. Create an alarm and check the alarm is correctly displayed on the remote screen and an alarm sound is heard from the remote screen.

2.2.13 Network Option

1. Check that the network cable connector and the Identification plug are clean and intact, then connect them to the MRI Monitor . Check that the monitor connects to the Datex-Ohmeda Network, i.e. the network symbol is displayed on the upper right-hand corner of the screen. Also a message regarding the connected Central should be displayed in the message field on the screen.

   NOTE: If necessary, reselect the monitor's network communication according to the used network software in the ***Network*** service menu.
2. Enter the service menu:

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

   Check that the counters for hardware errors (Intern., Missed, FIFO, Overrun) all show 0.

2.2.14 Wireless Network Option

1. Check that the green LED on the wireless antenna card blinks and the WLAN signal strenght symbol scrolls between zero and full or stays stable on the monitor screen.
2. Check that the wireless LAN network symbol is displayed in the upper right-hand corner of the screen when the monitor connects to the Datex-Ohmeda Network,

NOTE: If the monitor does not connect to the Datex-Ohmeda Network, check the WLAN configuration on the monitor and on the network.

2.2.15 Device Interfacing Solution, N-DISVENT

1. Enter the ***DIS Interfacing*** service menu:

   Check that the DIS module 'tout' and 'cse' values do not increase faster than by 5 per second. Check also that the DIS module memories have passed the internal memory test, i.e. Ram, Rom and EEPROM state all OK.

2.2.16 General

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 with no power cord.

2. Service reset

   Check the Service Reset. Press the **ON/Standby** key for at least 10 seconds. Switch the monitor back on and check that the monitor performs a Cold Start, i.e. all trend information is cleared.

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.
   Turn the monitor to standby.

   Fill in all necessary documents.

APPENDIX A Planned maintenance check form, MRI Monitor

Customer	
Service	
Service engineer	Date

Monitor Installation			
F-MRICM1	N-MRI2	D-	K-
S-	L-	E-MRIPSN	E-MRIC_ _ _
N-			

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual Inspection		**OK**	**N.A.**	**Fail**
2.1.1. General		☐	☐	☐
2.1.2. MRI Compact Airway Module, E-MRICXXXXX	S/N	☐	☐	☐
2.1.3. Hemodynamic MRI module, E-MRI(P)SN	S/N	☐	☐	☐
2.1.4. Recorder Unit		☐	☐	☐
MRI Monitor reassembly				
Notes				

Functional Inspection		**OK**	**N.A.**	**Fail**
2.2.1. General		☐	☐	☐
2.2.2. Display		☐	☐	☐
2.2.3. Keyboard(s)		☐	☐	☐
2.2.4. Display Unit		☐	☐	☐
2.2.5. MRI Monitor Frame Unit		☐	☐	☐
2.1.2. MRI Compact Airway Module, E-MRICXXXXX		☐	☐	☐

Functional Inspection		**OK**	**N.A.**	**Fail**
. Anesthesia Agent		☐	☐	☐
. Patient Spirometry		☐	☐	☐
. General		☐	☐	☐
Notes				
2.2.7. Hemodynamic measurements		☐	☐	☐
. ECG measurement		☐	☐	☐
. Invasive blood pressure measurement		☐	☐	☐
. SpO2 measurement		☐	☐	☐
. Non-invasive blood pressure measurement		☐	☐	☐
Notes				
MRI Shield reassembly				
. MRI Shield reassembly		☐	☐	☐
2.2.8. Magnetic field alarm		☐	☐	☐
2.2.9. Data Card function	S/N	☐	☐	☐
2.2.10. Recorder	S/N	☐	☐	☐
2.2.11. Electrical safety check		☐	☐	☐
MR room installation				
2.2.12. Active Remote Screen Option	S/N	☐	☐	☐
2.2.13. Network Option	S/N	☐	☐	☐
2.2.14. Wireless Network Option	S/N	☐	☐	☐
2.2.15. Device Interfacing Solution, N-DISVENT	S/N	☐	☐	☐
Notes				

Functional Inspection		**OK**	**N.A.**	**Fail**
2.2.16. General		☐	☐	☐
1. Storing trend data		☐	☐	☐
2. Service reset		☐	☐	☐
3. Watchdog		☐	☐	☐
4. Service Log reset		☐	☐	☐
Notes				

Used Spare Parts			
Notes			

Signature

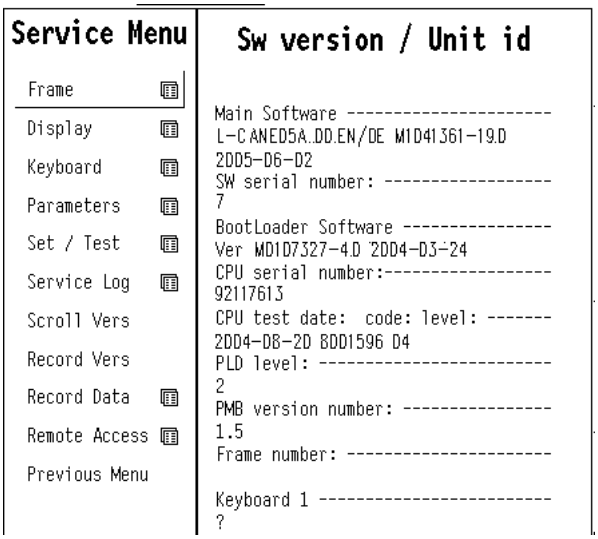
For your notes:

Datex-Ohmeda

MRI Monitor

Monitor Software L-CANE05(A)

Service Menu



All specifications are subject to change without notice.

CAUTION: U.S. Federal law restricts this device to sale by or on the order of a licensed medical practitioner.

Outside the USA, check local laws for any restriction that may apply.

Document no. M1056423

June, 2006

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

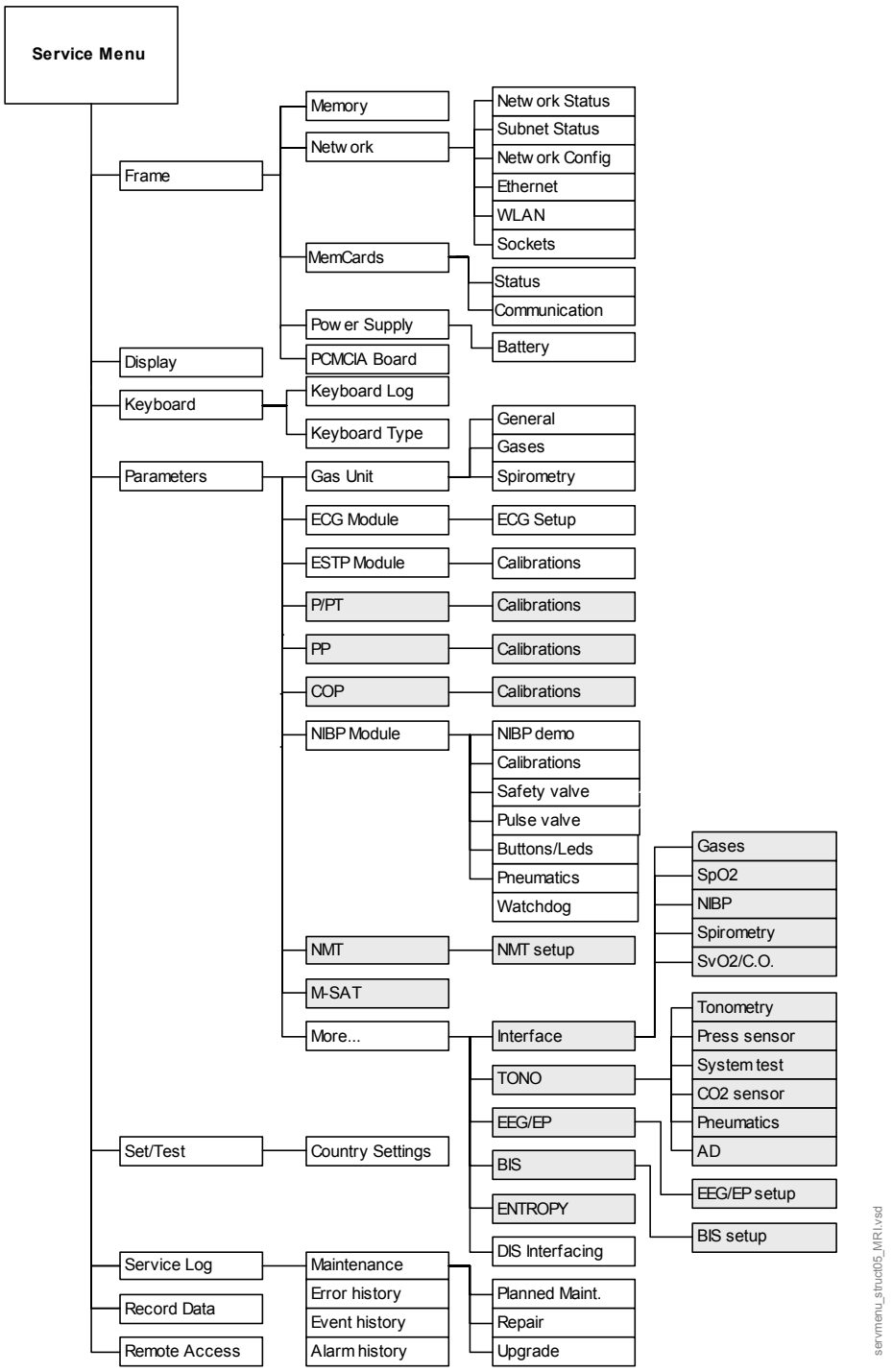
Table of contents

Introduction

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

Service Menu structure

The menus that are shown grayed are not in use in MRI Monitor.

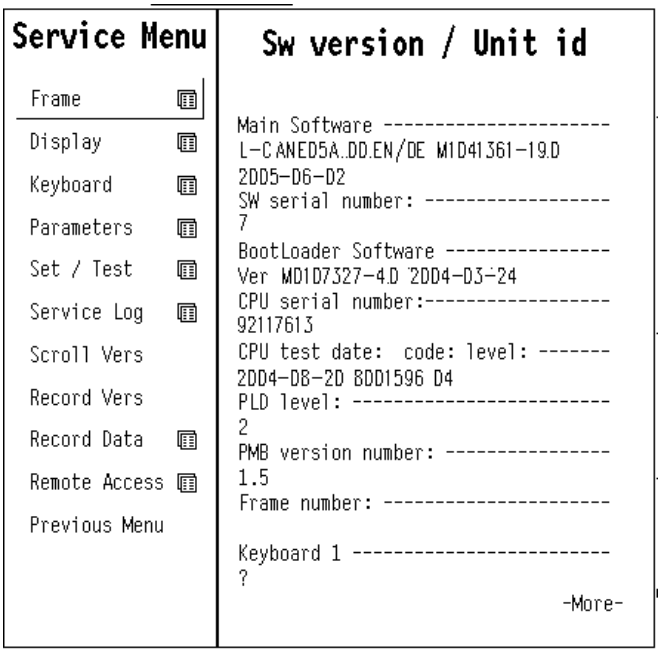


Service Menu

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.

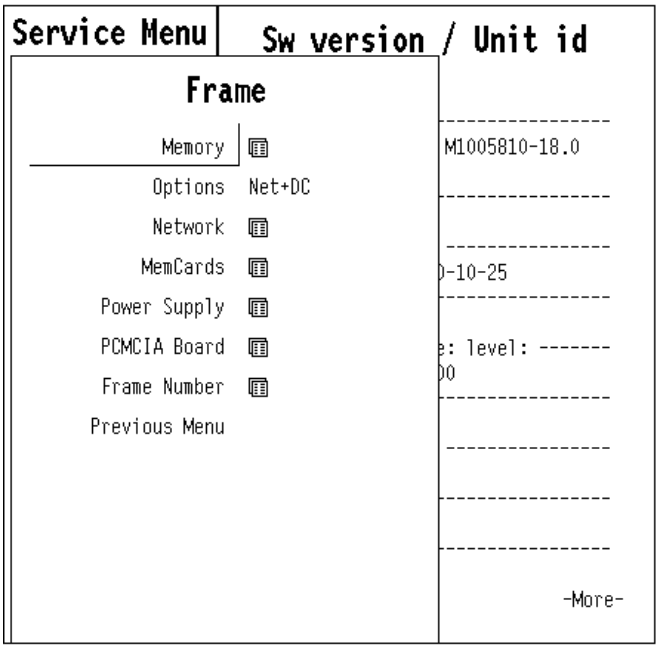
In this manual, the concept MRI Monitor always refers to the MRI Monitor labeled as N-MRI2.

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



1 Frame

The frame menu includes service menus common for the frame.



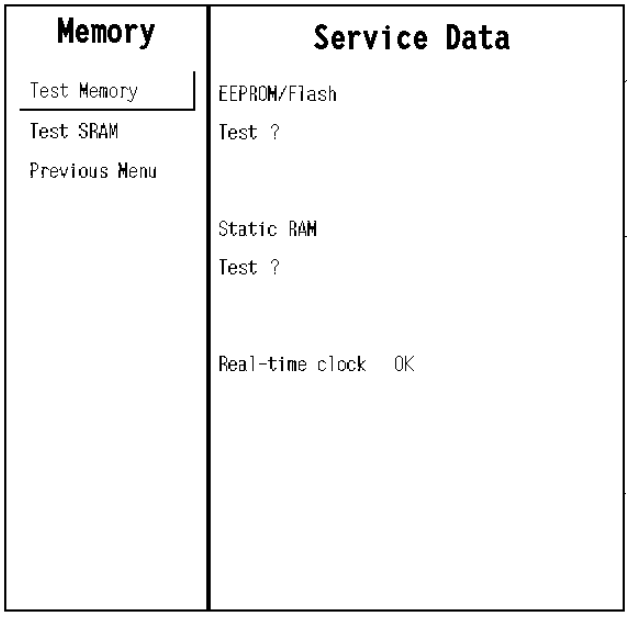
1.1 Memory

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 the MRI Monitor FrameDisplay unit slot.

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 the MRI Monitor FrameDisplay unit slot.

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



1.2 Network

1.2.1 Network Status

The Network Status view shows the general status of the network

Location ID: Monitor's location given at the setup.

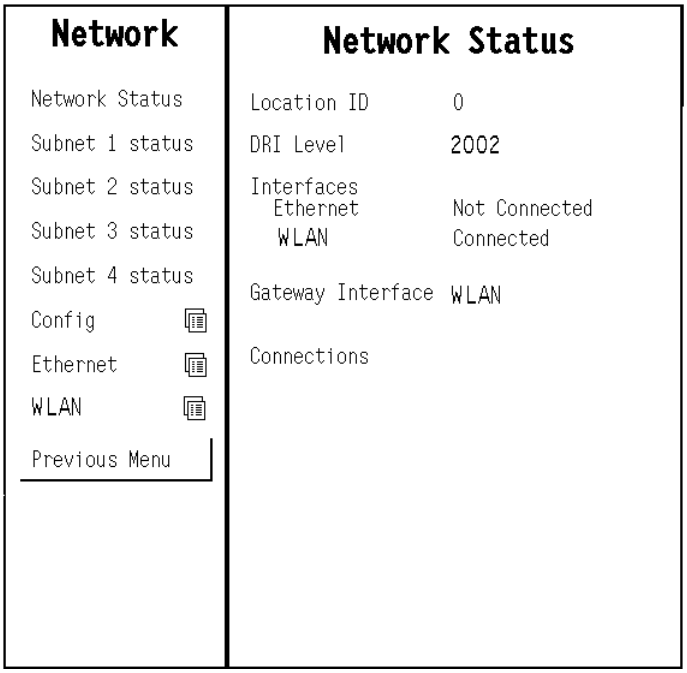
DRI level: Shows the selected level of network communication. The network communication is set according to the network software used (e.g. S-CNET02)

Interfaces: The field indicates if there is a connection to the Datex-Ohmeda Network

Gateway Interface: The field indicates the active network interface (None/Ethernet/WLAN)

Connections: Names of subnet id:s connected

The field represents the subnet status menus, i.e. shows the connected subnets. The three first connections are reserved permanently for Datex-Ohmeda Central, and the fourth is reserved for another subnet, e.g. Datex-Ohmeda S/5 Arrhythmia Workstation.

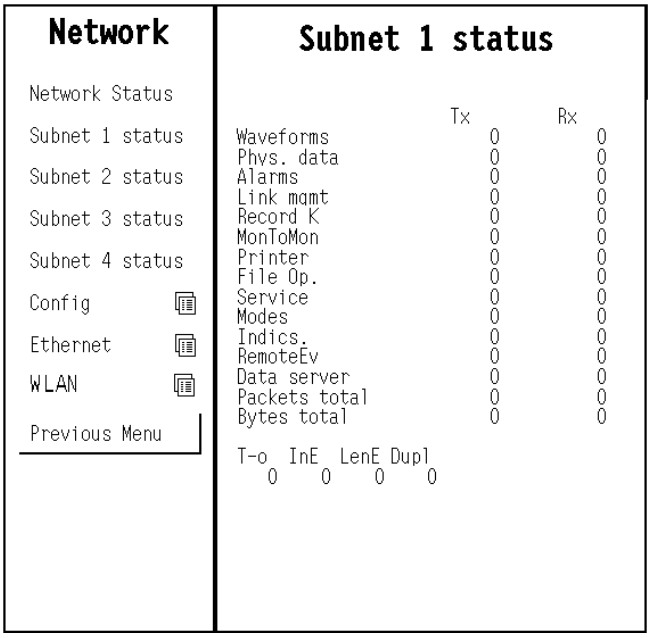


Subnet Status

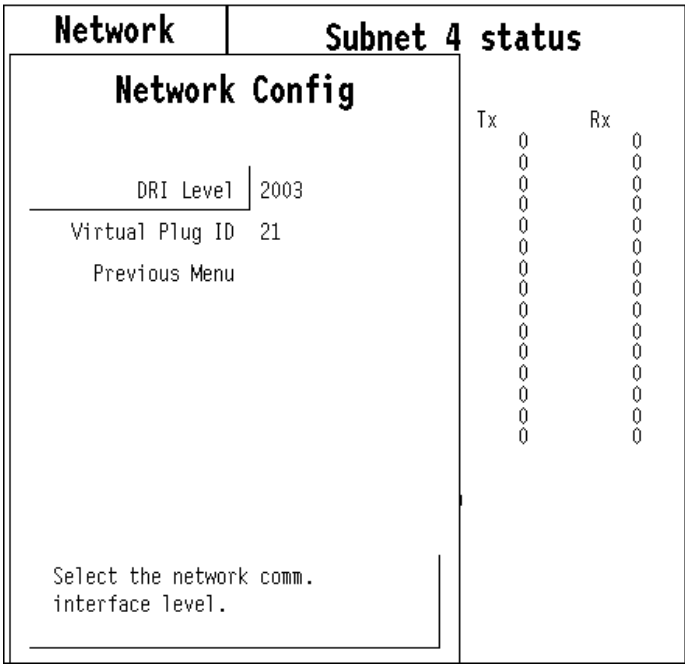
The Subnet status view gives more accurate information of the different subnet id:s connected. All four **Subnet status** menus have a similar structure. The number of different packets transmitted and received by the monitor are shown in the columns below Tx and Rx. The packet types are:

Waveforms: Waveform data
Phys. data: Physiological numerical data
Alarms: Alarms, alarm profiles and alarm limits
Link mgmt: Network management messages
Record K: Record Keeper data
MonToMon: Monitor-to-monitor communication related data
Printer: Printing data and control messages
File Op.: File operation messages, saving and loading of cases
Service: Maintenance and service
Modes: User mode data
Indics.: Remote indications sent to monitor
RemoteEv: Remote events
Data server: Packets of the data server (Arrhythmia Workstation)
Packets total: Total number of packets sent/received
Bytes total: Total number of bytes sent/received

T-o Number or resendings
InE Received faulty packets
LenE Erroneous packet length
Dupl Same packet received as a duplicate



1.2.2 Network Config



The DRI Level is for setting the monitor's network communication. The network communication is set according to the network software used (e.g. S-CNET01).

Network software S-CNET99 -> DRI Level = 1999

Network software S-CNET01 -> DRI Level = 2001

Network software S-CNET02 -> DRI Level = 2001 or 2002 (WLAN)

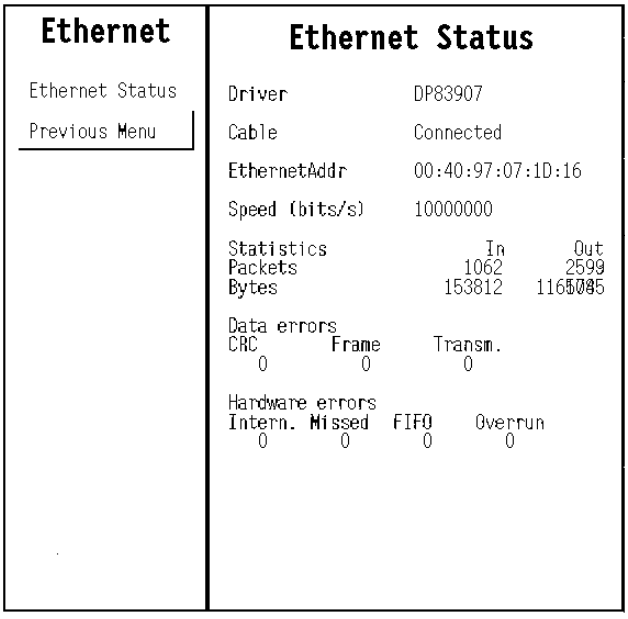
Network software L-NET03 -> DRI Level = 2003

Network software L-NET05 -> DRI Level = 2005

NOTE: The DRI Level 1999 is not selectable in all monitor software versions.

Virtual Plug ID indicates the monitor's location (Network ID). Virtual Plug ID is automatically defined when downloading the WLAN option to the monitor.

1.2.3 Ethernet



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

Driver: Ethernet chip name (DP83902, DP83907)

Cable: Indicates if the ethernet cable is connected.

EthernetAddr: Monitor's ethernet address.

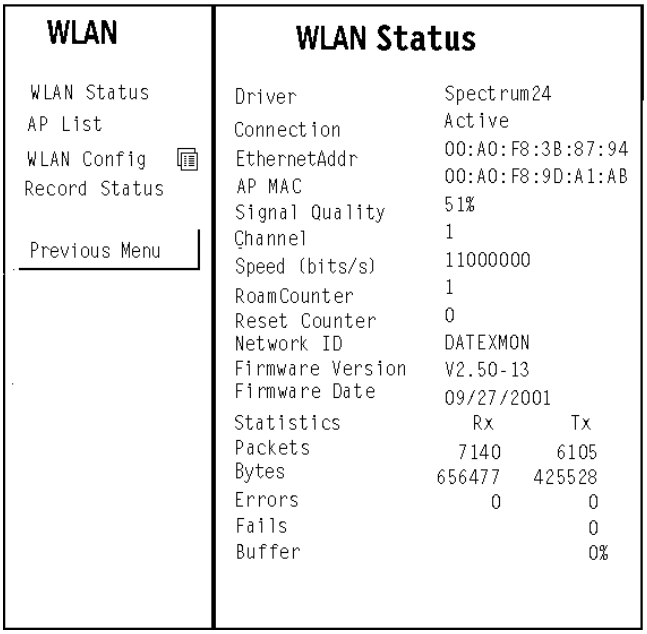
Speed: Indicates the current ethernet communication speed.

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 often has both frame and CRC error.
Transmission errors (Transm.)	Number or errors in packet Transmission.	
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 same as above.	Must always be 0.

1.2.4 WLAN



Driver: WLAN driver chip name.

Connection indicates the state of the WLAN connection.

Ethernet Addr: Ethernet address of the WLAN card used.

AP MAC: Ethernet address of the access point where the monitor is currently connected.

Signal Quality indicates the quality of the radio signal between the monitor and the access point (0...100%).

Channel is the WLAN channel configured to the access point where the monitor is currently connected.

Speed indicates the current communication speed with the access point.

RoamCounter Occurred roamings between access points.

Reset Counter *

Network ID: Identifies the WLAN network used.

Firmware version: *

Firmware date: *

Statistics (Packets, Bytes, Errors, Fails, Buffer) shows the WLAN communication related statistics.

* WLAN PCMCIA card related information

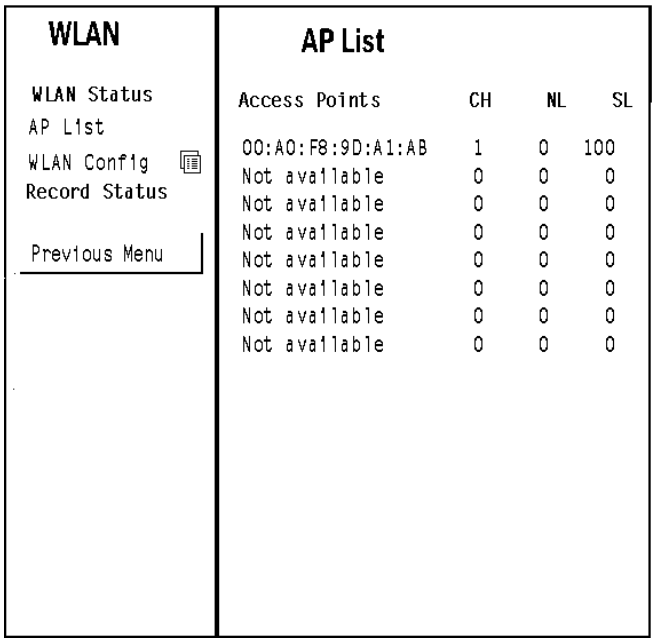
AP List

Access Points: shows the access points (max. eight) which are visible for the monitor.

CH is the WLAN channel configured to this particular access point.

NL indicates the noise level of the channel used (0...100%)

SL indicates the signal level of the channel used (0...100%)



WLAN Config

Network ID is for setting the correct WLAN network ID name.

WEP Algorithm is for setting the level of the encryption (width of encryption key) used for WLAN security (40 bit or 128 bit).

Key ID is for choosing the encryption key used.

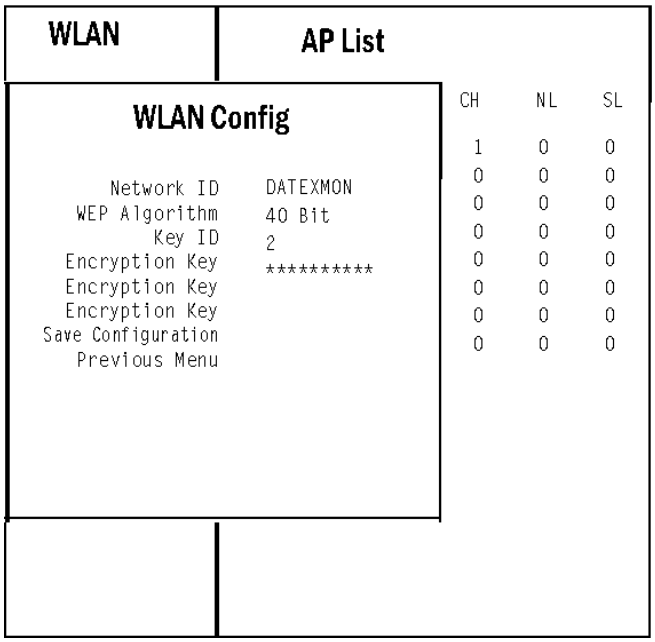
Encryption key is for setting the encryption key.

NOTE: When selecting 40 bit encryption, enter 10 Hex digit characters (divided into 2 fields).

When selecting 128 bit encryption, enter 26 Hex digit characters (divided into 2 fields).

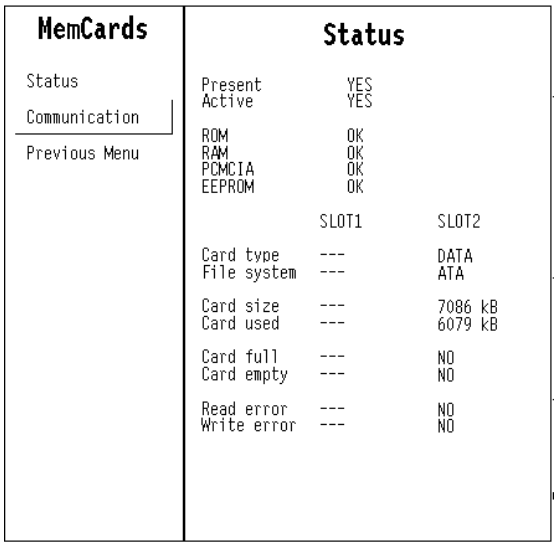
NOTE: Use only hexadecimal characters.

NOTE: For all the monitors and access points in the same WLAN network, the previous parameters must be set to be the same.



1.3 MemCards

1.3.1 Status



Module **Present** indicates whether the MemCard option is installed into the monitor. Possible values are YES and NO.
Module **Active** indicates whether the MemCard services are available. Possible values are YES and NO.

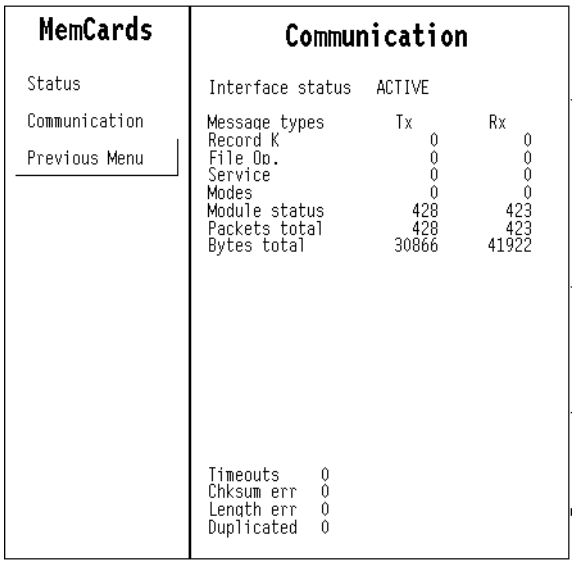
ROM indicates the status of the ROM memory of the module. Possible values are OK and ERR.
RAM indicates the status of the RAM memory of the module. Possible values are OK and ERR.
PCMCIA indicates the status of the PCMCIA controller of the module. Possible values are OK and ERR.
EEPROM indicates the status of the EEPROM memory of the module. Possible values are OK and ERR.

SLOT1 and **SLOT2** indicate the left hand slot and the right hand slot, respectively.

Card type	indicates whether the card is MENU or DATA card. If a duplicated card is inserted, type DUPL.
File system	indicates the type of the memory card in use. The only supported file system is ATA. If a memory card using another file system is used, the message ‘UNKNOWN’ is shown. If the card is poorly attached, the message ‘LOOSE’ is shown.
Card size	indicates the total amount of disk space in the card in kilobytes.
Card used	indicates the total amount of used disk space in the card in kilobytes.
Card full	indicates whether all the disk space in the card is used. Possible values are YES and NO.
Card empty	indicates the lack of menu files in the MENU card or no files in the DATA card. Possible values are YES and NO.
Read error	indicates whether the reading from the card has failed. Possible values are YES and NO.
Write error	indicates whether the writing to the card has failed. Possible values are YES and NO.

All values can be '- - -' to indicate 'No data available'.

1.3.2 Communication



Interface status indicates the status of the data link between the CPU and MEM sections. If the MemCard option is installed, the status should always be on ACTIVE. If the status blinks between ACTIVE and CLOSED, a communications error has occurred.

Message types indicates the type of data packets that have been sent (**Tx**) and received (**Rx**) since last monitor start. Data types are listed on the lines below **Message types** text.

Data types:

Record K indicates the communication between the Monitor and Record Keeper.

File Operation indicates the operations of Patient data.

Service indicates the MEM section operations.

Modes indicates the User Mode operations.

Module status indicates the number of sent/received data packets that relate to the MEM section status.

Packets total indicates the total amount of data packets that have been sent/received since the last monitor start.

Bytes total indicates the total amount of data bytes that have been sent/received since the last monitor start.

The last four lines indicate transmission errors:

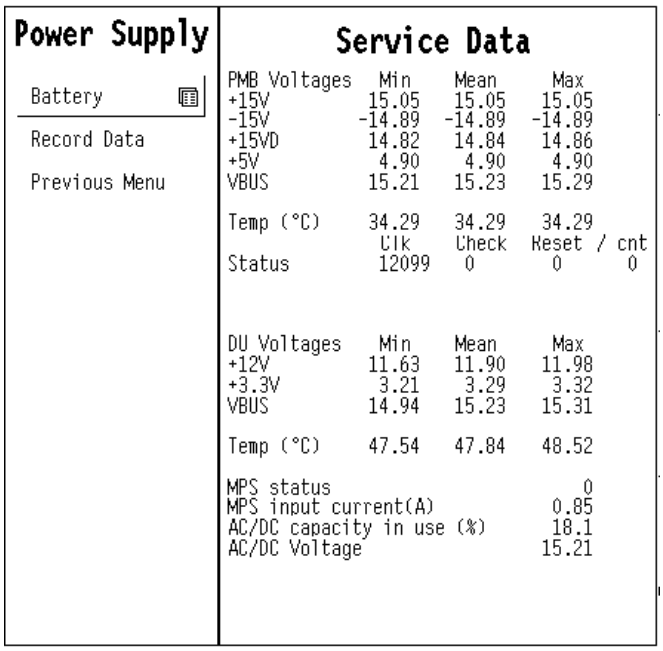
Timeouts indicates the number of timeouts that have occurred in MEM section data transmission since the last monitor start.

Chksum err indicates the number of checksum errors in data packets from MEM section since the last monitor start.

Length err indicates the number of data packets with erroneous length from the MEM section since the last monitor start.

Duplicated indicates the number of duplicate data packets from the MEM section since the last monitor start.

1.4 Power supply



The menu shows the voltages and the temperature measured by the power management board (PMB Voltages) and the main CPU board in the Display unit(DU Voltages). The measurement starts about 100 ms after a start-up. The values in the column under **Mean** are the mean values of the 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 following voltages are measured by the PMB in the Frame Unit:

Raw DC

+15V 14.65....15.35
–15V -14.65...-15.35 V
+15VD 14.65...16.00 V
+5V 4.85...5.25 V

Temp (°C) value corresponds with the Frame Unit internal temperature measured by the PMB.

The numbers on this page are only directive and not absolute values.

The following voltages are measured by the Central Processing Board in the Display Unit:

+12V 11.50...12.50V

+3.3V 3.00...3.60V

VBUS 10.00...17.00V

Temp (°C) value corresponds with the Display Unit internal temperature measured by the Central Processing Board.

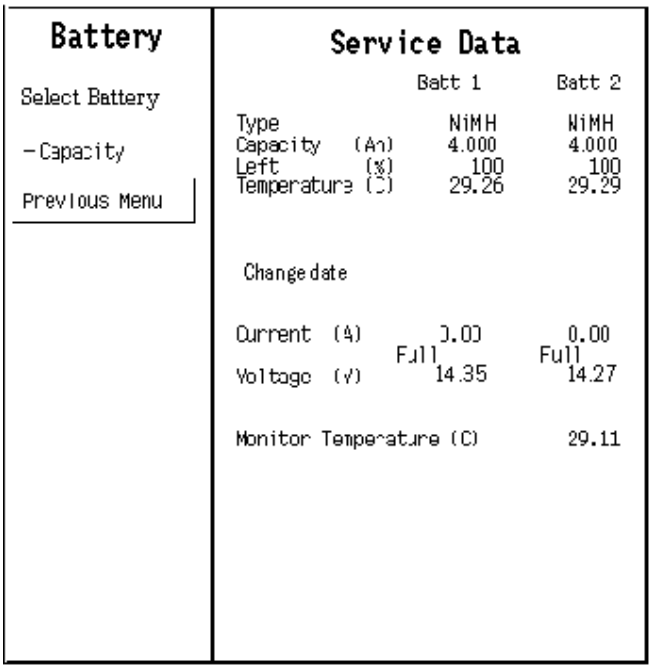
MPS input current is the current fed to the Module Power Supply. The current should be <4A.
AC/DC capacity in use is the capacity information achieved from the AC/DC unit by the PMB.
AC/DC voltage is the AC/DC power unit output voltage measured by the PMB.

1.4.1 Battery

Select Battery: Selection of battery type.

Capacity: Selection of battery capacity.

Previous Menu: Return to the previous menu.



Service Data

Type shows the type of the battery used.

Capacity refers to battery capacity in Ah.

Left [%]: Evaluated capacity left in battery.

Temperature [°C] measured inside the battery.

Current [A] shows the charging state and charging current.

Voltage [V] (Full, Timed, Fast) shows the measured battery voltage.

Monitor Temperature shows the Frame Unit inside temperature measured by the PMB.

1.5 PCMCIA Board

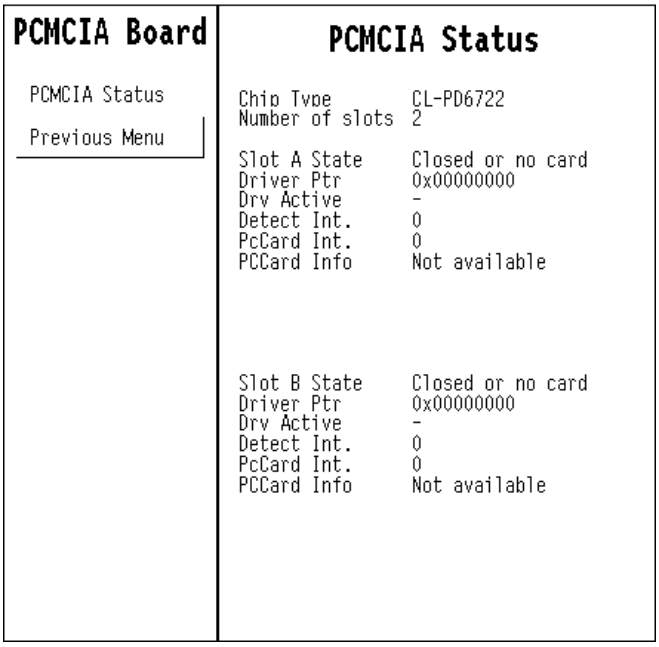
Chip type is the type of the PCMCIA controller chip used.

Number of slots is the number of PCMCIA card slots in use (0, 1 or 2).

Slot A/B State and **Drv Active** indicate if the PCMCIA card slot is active.

Driver Ptr, Detect Int and **PcCard Int**: PCMCIA card driver software related data.

PcCard info: General PCMCIA card related information.

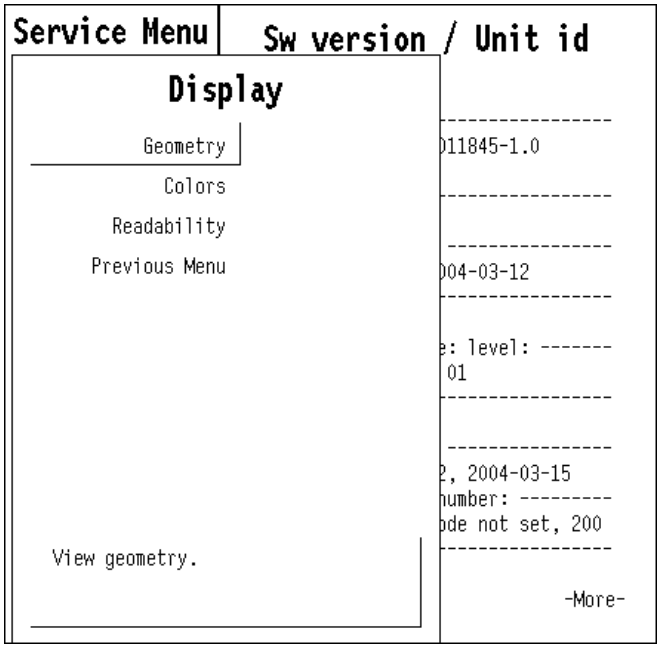


2 Display

Geometry views the geometry of the display.

Colors views the color of the screen.

Readability views the readability of the screen.



3 Keyboard

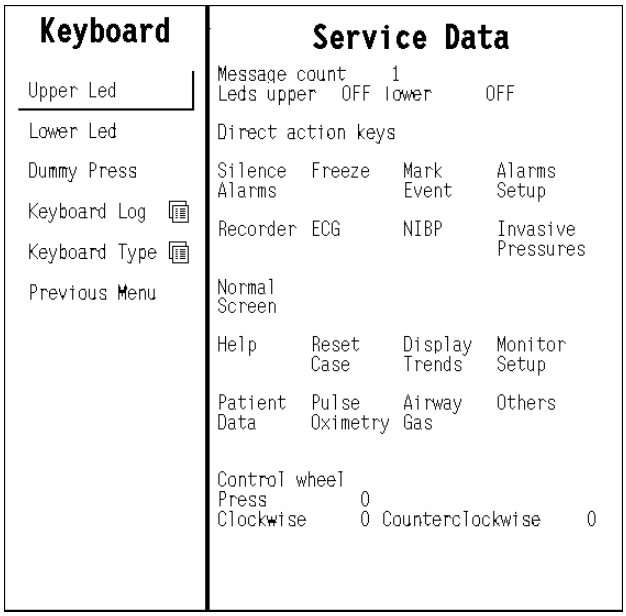
Keyboard

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.

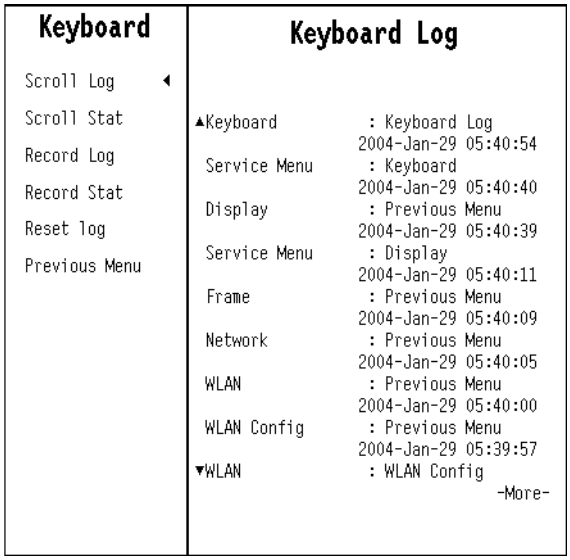
Since shows the date and the time of the last run time reset.

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 1150 events. The log is FIFO type.

Scroll Stat enables to scroll the keyboard events.



3.2 Keyboard Type

Store Mask A selection for the anaesthesia keyboard's language. The selected language determines the outcome of the lower keypad.

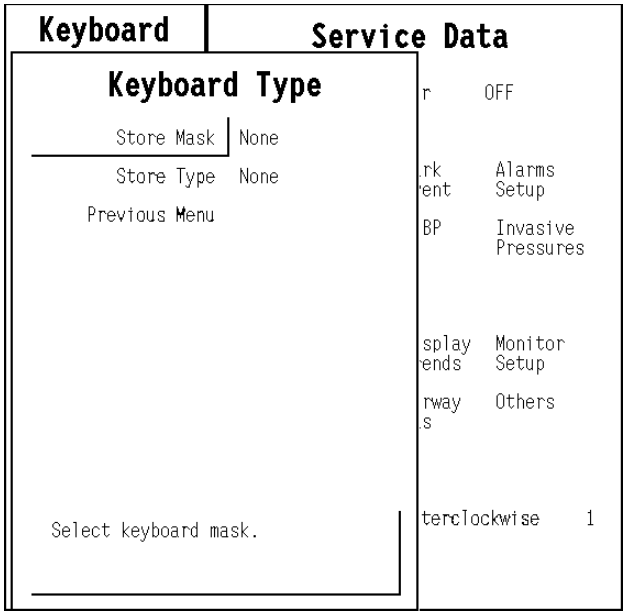
Store Type is for selecting the keyboard;

COM = Command Board

ARK = Anaesthesia Keyboard

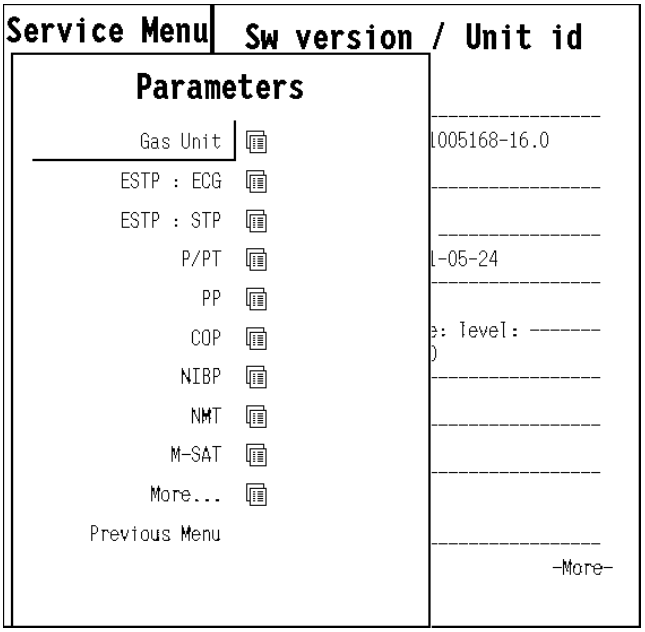
AIC = Information Center Keyboard. Not used in MRI Monitor.

NOTE: The settings should be checked if the controller board is replaced. If settings are changed, the new settings will not be valid until the next start-up.



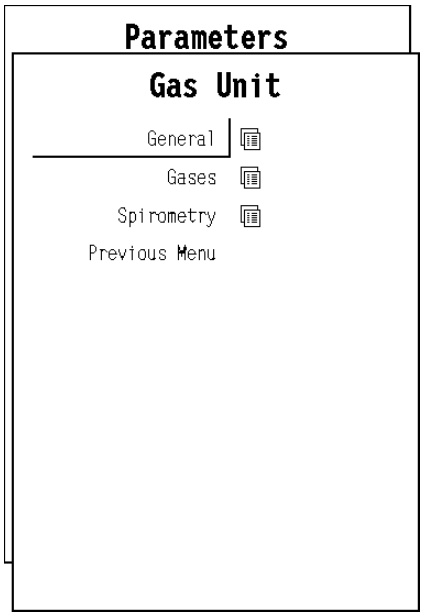
4 Parameters

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



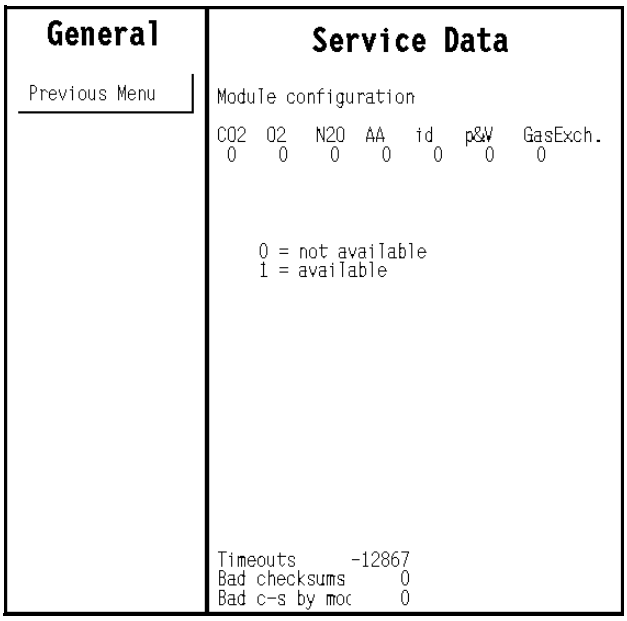
4.1 Gas Unit

Service menu for airway gas modules' communication and airway gas and spirometry measurements.



4.1.1 General

Service Data



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

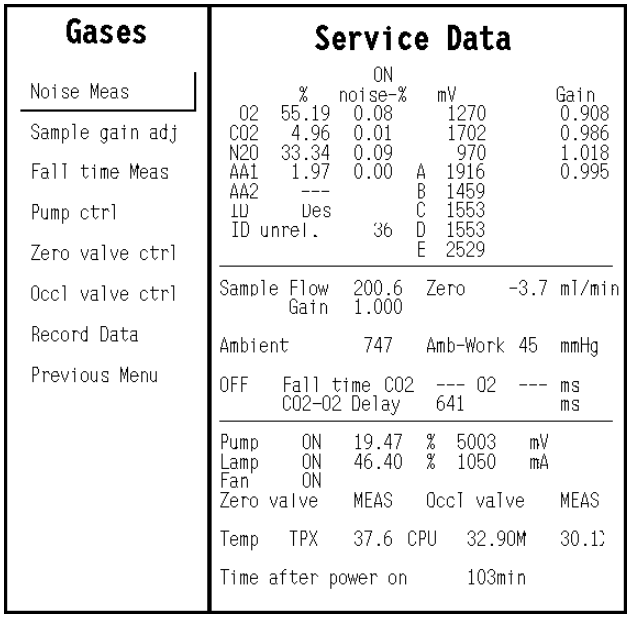
Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.

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.

Fall time Meas * activates the fall time measurement.

Pump ctrl A manual control for the sampling pump.

Zero valve ctrl A manual control for the zero valve.

Occl valve ctrl* A manual control for the occlusion valve.

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

Service Data

O_2, CO_2, N_2O, AA

% field shows real-time concentrations.
noise-% is standard deviation of concentration.

O_2, CO_2, N_2O, AA channels A-E

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

ID* Shows the identified agent.

ID unrel.* The shown value tells how unreliable the identification is. With pure agent the value is typically < 75.

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 in E-miniC. In M-miniC it is measured at least once an hour (during the first running hour during each zeroing process). In M-Gas it is measured once an hour .

Amb-Work: ambient pressure - sampling system internal pressure.

Fall time* CO_2 and O_2 in ms. For N_2O and AA same as CO_2.

CO_2-O_2 Delay* In ms. No delay between CO_2, N_2O, and agents.

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.

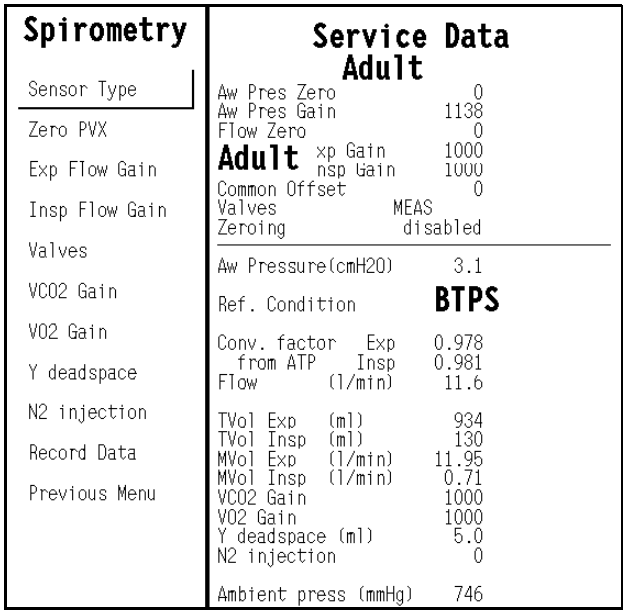
Fan* The state of the fan is shown.

Zero and Occl valve Can be toggled between the measurement state (MEAS) and zeroing/occlusion states (ZERO/OCCL).

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

Time after power on In minutes after power on.

4.1.3 Spirometry



Insp and exp flow gains can be adjusted, if calibration is needed. A calibration pump or spirometry tester is used and readings are observed from the display. If a deviation exists, gains are adjusted accordingly. Gain scaling is 1.000, when the factory settings are in effect.

When the Adjust key is pressed, a separate box for adjusting the value appears. During adjustment calibration, values are sent to the module. When the ComWheel is pressed, the values are permanently stored in EEPROM of the module and the box disappears.

Zero PVX: Start zeroing the pressure sensors. Effects Aw Pres Zero and Flow Zero value.

Exp Flow Gain / Insp Flow Gain: Adjust the Flow sensor gains.

Valves: Switch between MEASUREMENT and ZEROING

VCO2 / VO2 Gain: Adjust the VCO_2 and VO_2 gain. Not used in MRI Monitor.

Y deadspace: Adjust the Y-deadspace. Not used in MRI Monitor.

N2 injection: Select between on (1) and off (0). Not used in MRI Monitor.

Record Data: Record Data prints out the shown service data and board information (id. serial number and software id.) onto the recorder module.

Service Data

Sensor ADULT/PEDIATRIC according to the selected measurement mode (sensor).

Insp/Exp Flow Gains shown apply to the selected sensor.

Aw Press Zero and **Flow Zero** are the result of zeroing in the user service menu. They can be adjusted in the factory calibration menu, but not permanently stored.

Aw Press Gain is directly the value used in sw. It can be adjusted, but not permanently stored.

Exp Flow and **Insp Flow Gains** are scaled as (User gain)/(Factory gain). **Exp** and **Insp Flow Gains** can be adjusted also in the user service menu.

Common Offset is the compensation factor for pressure difference reading of the difference sensor when applying an equal pressure on both sides of the sensor.

Valves can be changed between **MEASUREMENT** and **ZEROING**.

Zeroing automatic zeroing either **ENABLED** or **DISABLED** (only factory service menu).

Aw Pressure shows the real time value of airway pressure.

Condition shows in which reference conditions the results are. With calibration pump or spirometry tester, the results are always in ATP. If breathing is detected ($EtCO_2 > 1.0\%$), the results are according to the **Flow & Vol Setup** selection.

Flow shows the flow measurement value.

TVol Exp, TVol Insp, MVol Exp and **MVol Insp** are shown to ease calibration. The numbers are the same as on the main display. The former pump calibration procedure has been dropped out. We claim that calibration is not needed in routine clinical use, so a separate Flow calibration menu is not needed. Calibration can be done with the pump or spirometry tester. The results must be taken from the screen and gains adjusted accordingly.

VCO_2 and **VO_2 Gain** show a value near 1000, the correct gains have been measured in the factory. Not used in MRI Monitor.

Y deadspace is the geometric volume in ml between the Y-piece and the D-lite. Default is 5 ml for a standard Y-piece (as delivered with Siemens 900C ventilators). Used for VCO_2 and VO_2 delay time corrections. Not used in MRI Monitor.

Set **N_2 injection** to 1 during laboratory tests with a Spirometry tester and injection of N_2 gas (for scientific validations use only). At power on of the module, the value is always zero. Not used in MRI Monitor.

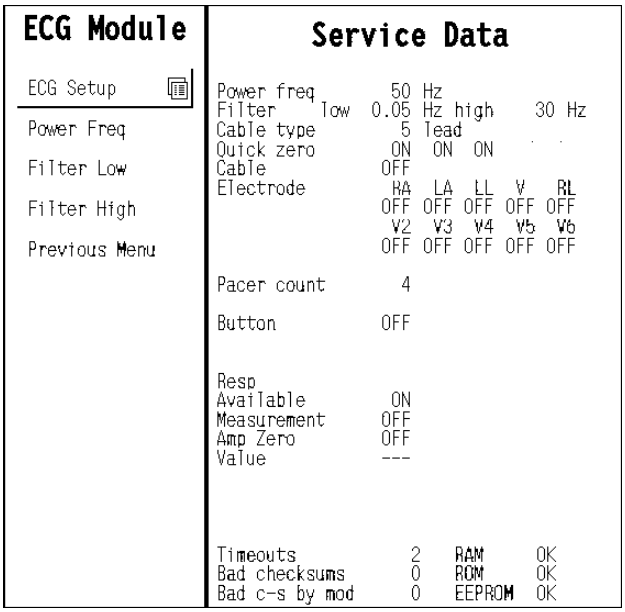
Ambient pressure value measured by the module.

4.2 ECG Module

Power freq: Set power frequency; 50 Hz/60 Hz.

Filter low: Set filter low frequency; 0.05 Hz/0.5 Hz.

Filter high: Set filter high frequency; 30 Hz (40 Hz if power freq is 60 Hz) /150 Hz.



Service Data

Power freq, and Cable type show the values chosen or detected, **Filter low and high** defines the selected filter (Monitor/Diagnostic/ST).
Quick zero at E-MRIPSN module is ON when the ECG signal is beyond the scale, and therefore, is quickly returned to optimal range using fast signal processing methods. All the **Quick zero** bits are ON at the same time.
Cable shows ON when ECG cable is connected.

Electrode shows ON when each of these electrodes are connected.

Pacer count is a running number for pacemaker users.*

Button No effect on the module.

Resp Available indicates that ECG hardware is capable of measuring impedance respiration.*

Measurement shows ON when the respiration measurement is on.*

Amp zero shows ON when zeroing of the respiration amplifier takes place.*

Waveform **VALUE** will be updated in one second interval.*

* Not in use in the MRI monitor.

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).

4.2.1 ECG Setup

Filter filters the ECG signal high frequency noise and slow respiratory artefacts.

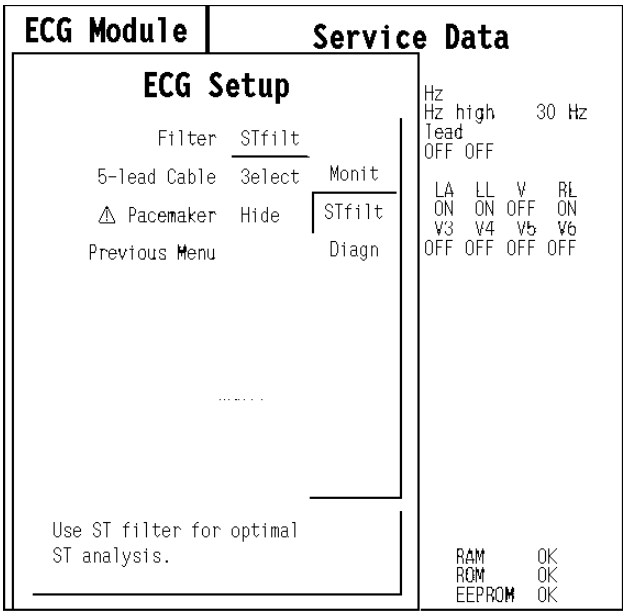
Monit (monitor) filter is used in routine monitoring. It effectively filters the artefacts caused by the electrosurgery unit and respiration.

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.

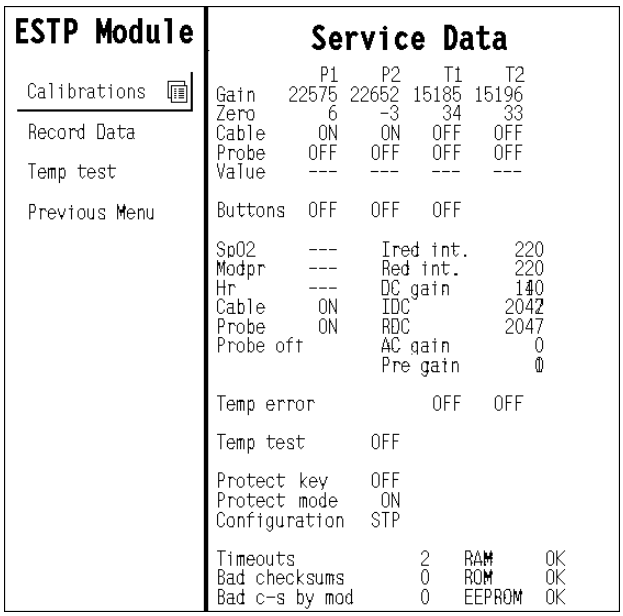
STfilt (ST filter) permits more accurate information of ST segment. It filters the high frequency artefacts caused by the electrosurgery unit, but catches the slow changes in ST segment. The ST filter is more susceptible to baseline wander than the monitor filter.

5-lead cable selects five or three electrodes. With the 12-lead ECG the selection is automatic. Not in use in the MRI monitor.

Pacemaker is not in use in the MRI monitor.



4.3 ESTP Module



Service menu for the multiparameter hemodynamic module's oxygen saturation and invasive pressure measurements.

Calibrations opens a submenu for pressure (P1, P2) calibrations. See section "Calibrations".

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

Temp Test is not in use in the MRI monitor.

Service Data

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.

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

SpO_2 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.

Protect key shows normally OFF, but turns to ON when the button at the bottom of the module is pressed.

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 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).

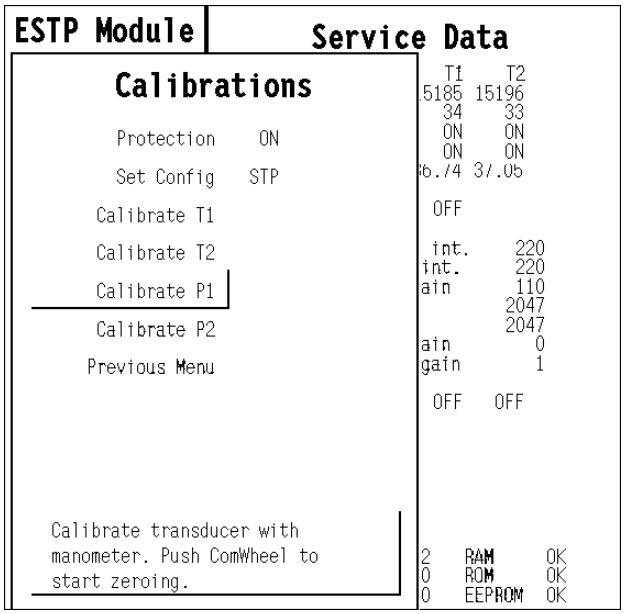
4.3.1 Calibrations

Protection: Protection for the configuration 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: is not in use in the MRI monitor.

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



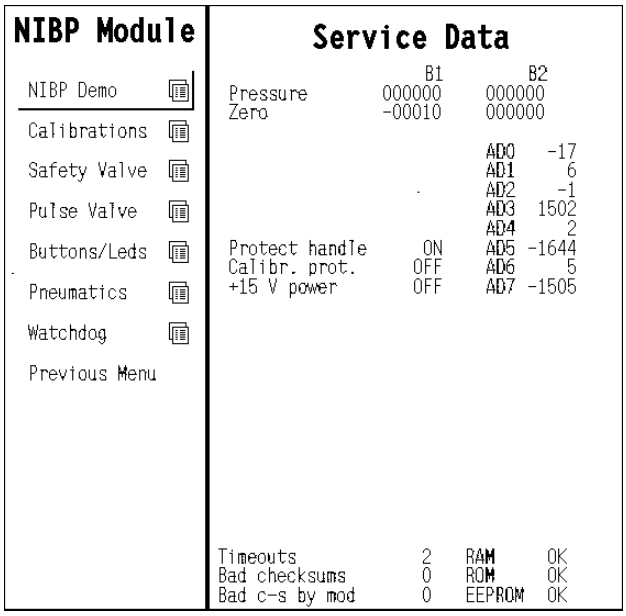
How to calibrate P1/ P2

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 measurement.



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 cannot 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 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 Not used in MRI Monitor.

AD0 to **AD7** show the values of each eight channels of the A/D converter. AD7 is not used in MRI Monitor.

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 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).

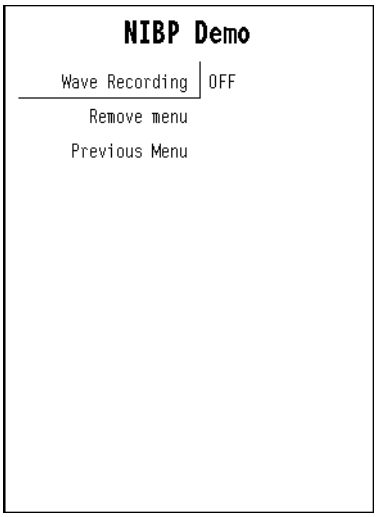
4.4.1 NIBP Demo

A service menu for demonstrating the oscillometric method of NIBP measurement. The menu shows the real-time pressure signals that are measured from the NIBP cuff. The measurement result is shown in the adjoining digit field.

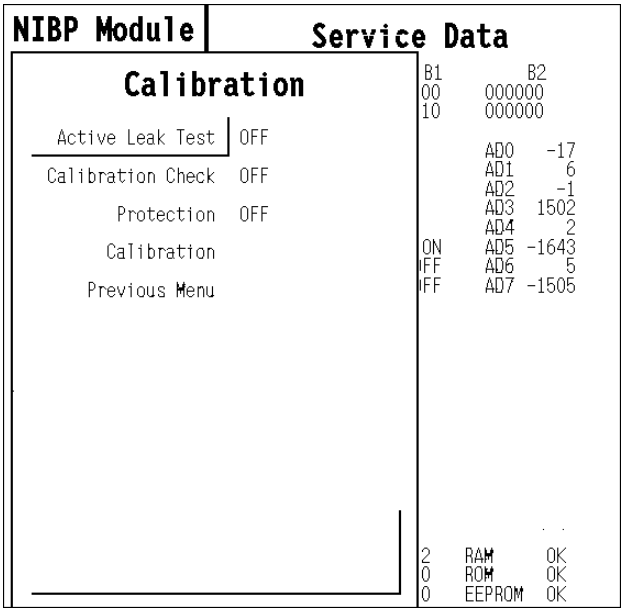
Wave Recording is for selecting the recording option. If ON is selected, the pressure signals are printed out in real-time on the recorder.

Remove menu widens the displayed waveform area.

The menu can be closed by selecting the **Previous Menu** or just by pressing the ComWheel if the **Remove menu** was selected.



4.4.2 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 260 mmHg into the cuff. Wait for several seconds until the pressure stabilizes. Then check that the pressure reading does not drop more than 6 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 (ON), 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

Calibration selection is available only when protection is OFF.

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

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

NIBP calibration can be performed in the NIBP Service menu as follows:

1. If ***Protection*** is ***ON***, change it to ***OFF*** by pressing the NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds, which enables the ***Protection*** selection. Then press the buttons again for 3 seconds to enable ***Calibration***.

NOTE: When the buttons have been pressed, the NIBP field shows an error message 'Calibration switch on!'.

NOTE: When calibration is enabled, a message 'Calibration not protected' appears.

2. For proper zeroing to take place, remove the hose from the front panel connector. Select ***Calibration*** and push the ComWheel. Messages 'Zeroing' and 'Zeroed' will appear in the NIBP message field. After this, a pressure bar will appear beside the menu and the text 'Calibrating' will appear in NIBP digit field.
3. Connect an external mercury manometer with a pump to the module through the both tubes of the hose. Pump up to about 200 mmHg pressure (range of 150 to 300 mmHg allowed)

according to the manometer. Verify that both pressure values in the prompt field match the manometer reading. If not, adjust by turning the ComWheel.

4. When the values are equal, push the ComWheel to confirm the calibration. After a few seconds the 'Calibrated' message will appear in the NIBP digit field, which means that the calibration data has now been saved.

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. Use the module buttons again to enable **Protection** setting and set it ON, and finally disable **Protection** setting.

4.4.3 NIBP Safety Valve

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

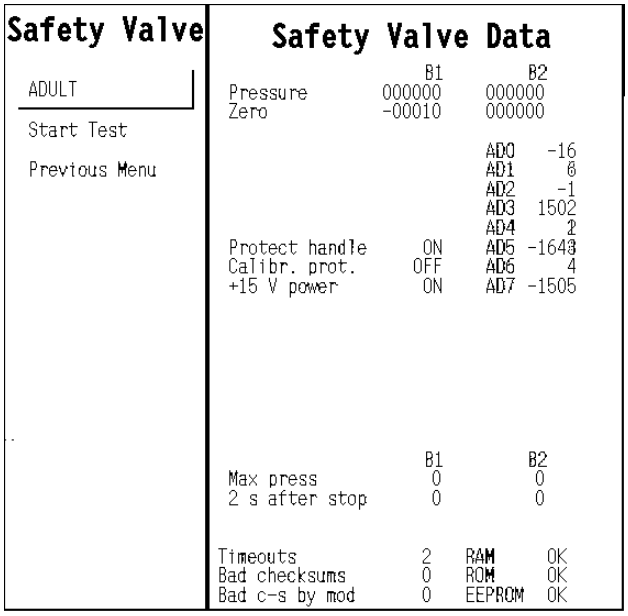
Safety Valve Data:

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
Wrap an adult cuff around a pipe and connect the cuff to the module. Highlight **Start test** and give the ComWheel a push. The test ends automatically or when **Stop test** (appears in place of **Start test**) is pushed.

Max. press indicates the pressure at which the safety valve opens and is normally 300 ±15 mmHg for adult and 150 mmHg ±15 mmHg for infant.

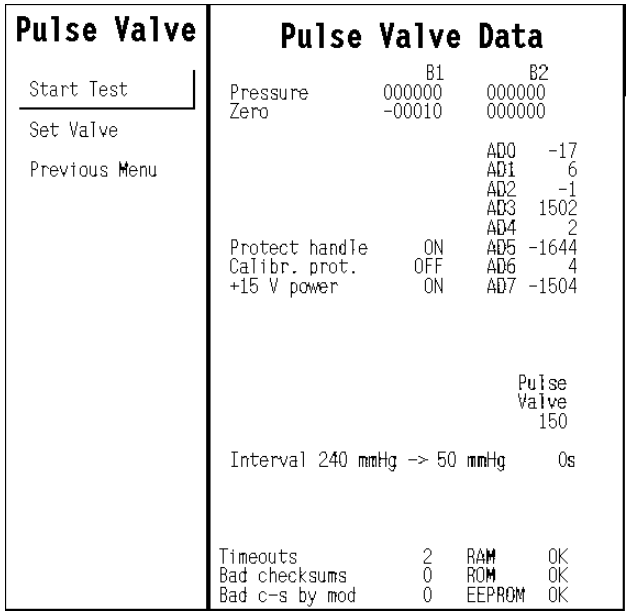


2 s after stop indicates the pressure at 2 seconds after the pump has stopped and is normally > 270 mmHg for adult and > 130 mmHg for infant. If the value is less, check leakage by the active leak test.

4.4.4 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 "4.4 NIBP Module".

How to check Pulse Valve

Wrap an adult cuff around a pipe and connect the cuff to the module. 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. The test can be manually stopped by selecting **Stop test**.

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.

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 does not drop. Depending on an individual, the pulse valve may remain closed up to approx. value 100.

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

4.4.5 NIBP Buttons/Leds

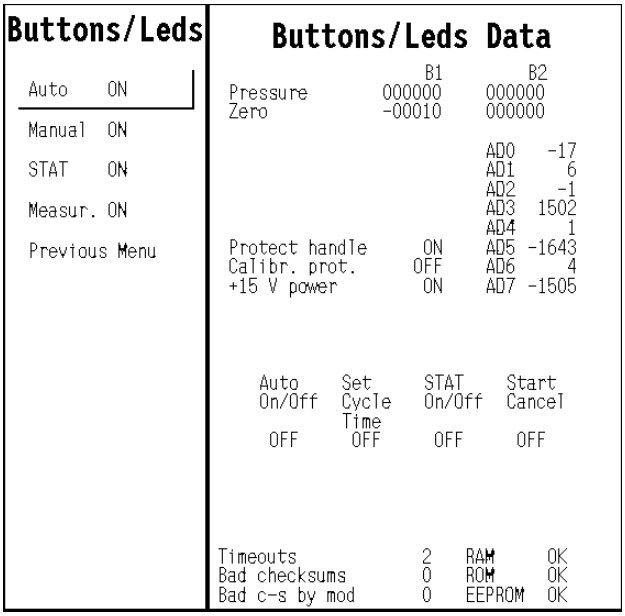
The selections ***Auto ON/OFF, Manual ON/OFF***, ***STAT ON/OFF***, and ***Measur. ON/OFF*** are not in use in MRI Monitor.

Buttons/Leds 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 "4.4 NIBP Module".

Buttons Checking

The front panel keys function is confirmed by pressing and releasing the key and observing that **OFF** turns to **ON** at **Auto On/Off**, and **Start Cancel**.



4.4.6 NIBP Pneumatics

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

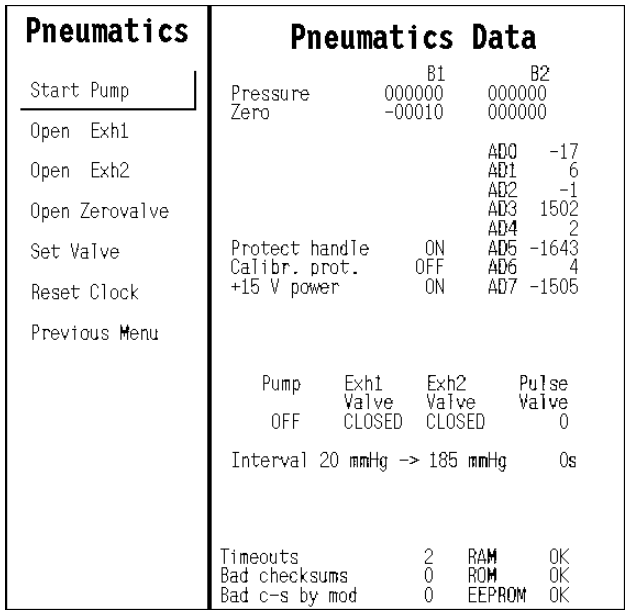
Open Exh1/Close Exh1: A manual control for the exhaust valve 1. The selection changes to **Close Exh1** when the valve is opened. This function is not used with the E-MRIPSN module.

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: A manual control for the zero valve. This function is not in use with the E-MRIPSN module.

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 will zero the time on the display. This function is not in use with the E-MRIPSN module.



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 "4.4 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.

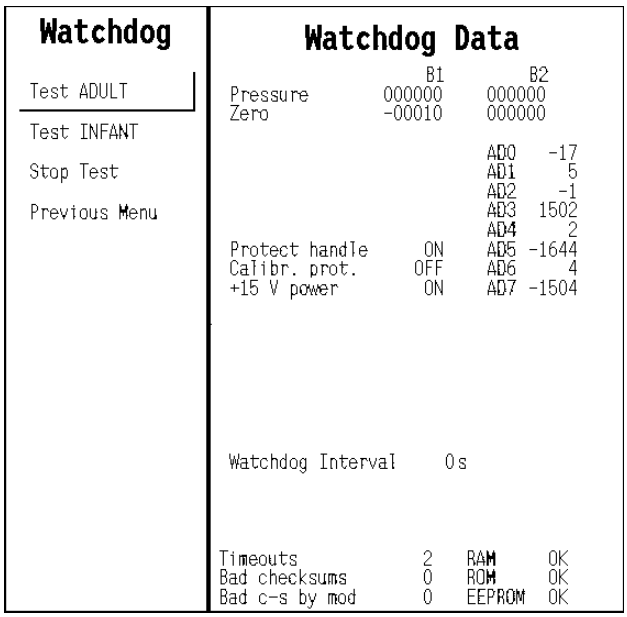
4.4.7 NIBP Watchdog

These menu items have only effect on the M-NIBP modules. They do not effect other NIBP modules.

Test ADULT: is to test watchdog timer in adult mode (120 to 140 seconds).

Test INFANT: is to test watchdog timer in infant mode (about 60 to 70 seconds).

Stop Test: is for stopping the test.



Watchdog 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 "4.4 NIBP Module".

Watchdog Interval: shows the time the +15 Vdirty stays on during the test.

How to test Adult watchdog time

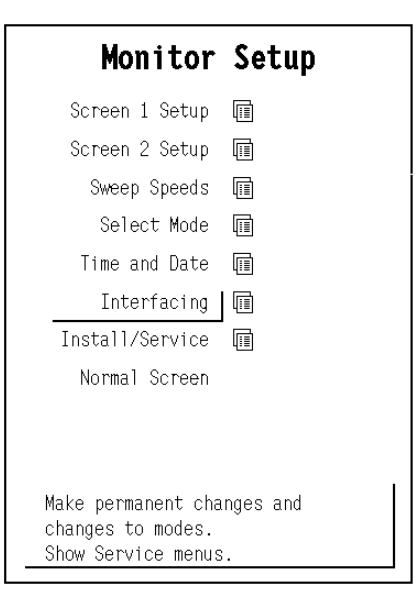
Select Test ADULT and press the ComWheel. Watchdog interval starts counting up seconds and keeps on counting as long as the +15 Vdirty is on. The time should be 120 to 140 seconds.

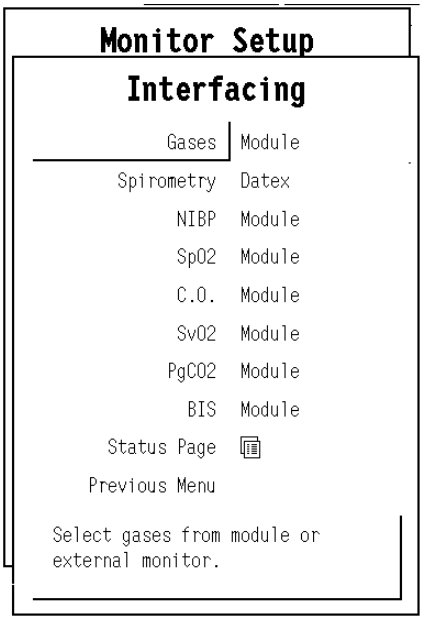
How to test Infant watchdog time

Select Test INFANT and press the ComWheel. Watchdog interval starts counting up seconds and keeps on counting as long as the +15 Vdirty is on. The time should be 60 to 70 seconds.

4.5 DIS Interfacing

4.5.1 Interfacing





How to interface

To select the parameter data source:

- Press the **Monitor Setup** and select ***Interfacing***.
- Select the desired measurement parameter, for example ***Gases***.
- Select the desired source by name, for example ***Aest***.

NOTE: The name of the device is visible on the list only if the device is correctly connected to the module.

4.5.2 Status Page

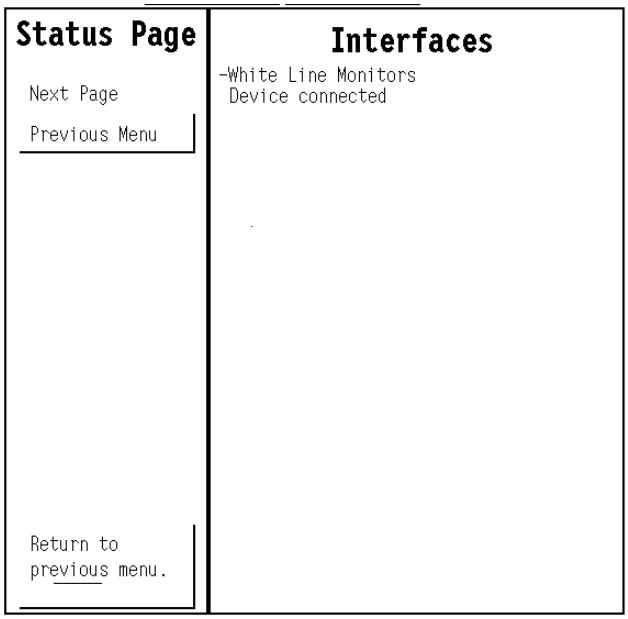
Access via **Monitor setup - *Interfacing.***

The selection **Next page** is available, if more than 8 DIS modules are connected to the DIS bus simultaneously.

Interfaces

The menu displays a list of all connected DIS modules and the statuses of the corresponding external devices.

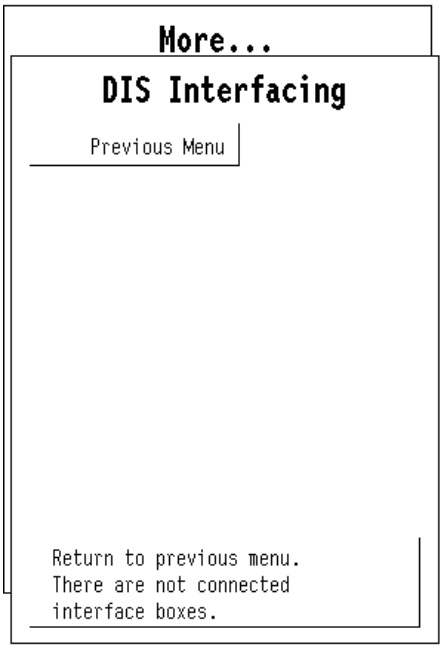
If the bus voltage is too low, you cannot add more devices. ‘DIS module bus voltage low. Do not add more devices or reduce cable length’ message appears.



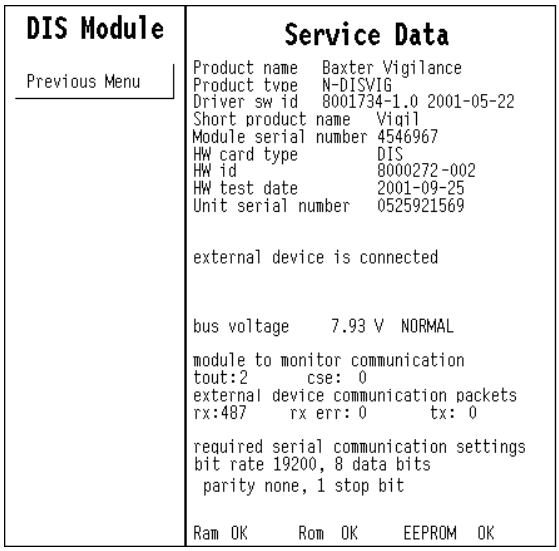
4.5.3 DIS Interfacing

DIS Interfacing

The menu displays submenus for all connected DIS modules.



DIS Module specific page



Service Data

Product name: DIS module name.
Product type: DIS module type.
Driver sw id: DIS module software and its release date.
Short product name: DIS module name.
Module serial number: DIS module serial number.
HW card type: PCB type.
HW id: DIS module PCB identification number.
HW test date: DIS module PCB testing date.
Unit serial number: DIS module PCB serial number.

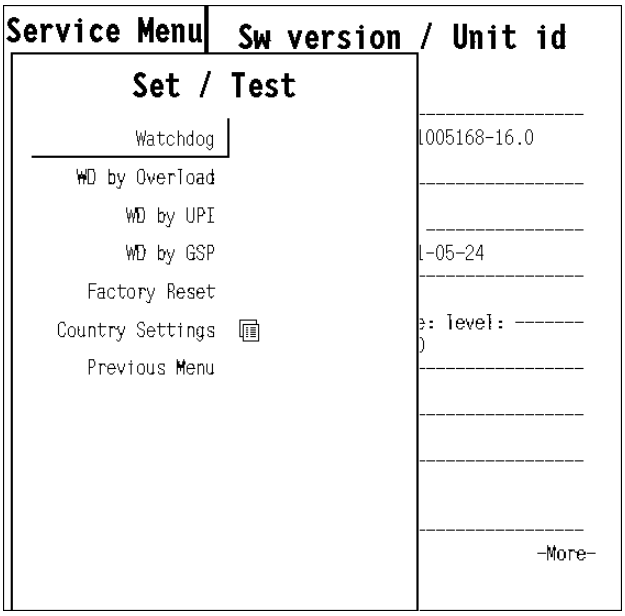
Comment field: Indicates the status of the external device.

bus voltage: DIS bus voltage, measured by the Central Processing Board in S/5 Compact Monitor. The value should normally be within 6...8 V.

tout: DIS module timeouts, seen by the monitor. The value should not increase more than by 5 per second.
cse: DIS module checksum errors, seen by the monitor. The value should not increase more than by 5 per second.
rx: The number of data packets from the external device received by the DIS module.
rx err: The number of data errors from the external device received by the DIS module.
tx: The number of data packets to the external device sent by the DIS module.

Ram: Status of DIS module RAM memory.
Rom: Status of DIS module ROM memory.
EEPROM: Status of DIS module EEPROM memory.

5 Set/Test



In the power supply unit, there is a safety element, which needs refreshing at least every 1.5 seconds. If the main CPU's software will not refresh, safety element gives reset to main CPU. In normal operation the main CPU's software refreshes safety element every 0.2 seconds.

The purpose of the safety element is to restart the monitor if there is a serious malfunction. This feature is useful in two cases: when the main CPU's software is not able to control the monitor, and when the software controls the monitor but detects a serious malfunction.

Watchdog tests ensure the proper functionality of the safety element's various sections.Watchdog test ensures directly that the watchdog of the power unit functions properly. Choosing this test prevents safety element from refreshing and shows running seconds with an accuracy of 0.1 seconds.

The test should have the following result when the safety element 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 interrupt. In this case, the fault is in the safety element 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.

WD by UPI test ensures the functionality of a feature, where the software controls the monitor, but detects a malfunction at the UPI section. The test will prevent the UPI processor from functioning during the test.

Immediately after the test starts the plotting stops. The test should have the following result when the feature is working properly: The monitor will restart the UPI section without any visual effects.

WD by GSP ensures the functionality of a feature, where the software controls the monitor, but detects a malfunction at the GSP section. The test will prevent GSP processor from functioning during the test.

The test should have the following result when the feature is working properly: The monitor will restart the GSP section without any visual effects.

Factory Reset restore factory default settings and clear data memories. Factory reset should be run if monitor software is replaced or if the SRAM/Timekeeper IC, or its battery is replaced.

5.1 Country Settings

Language

Select the software language.

National Reqs

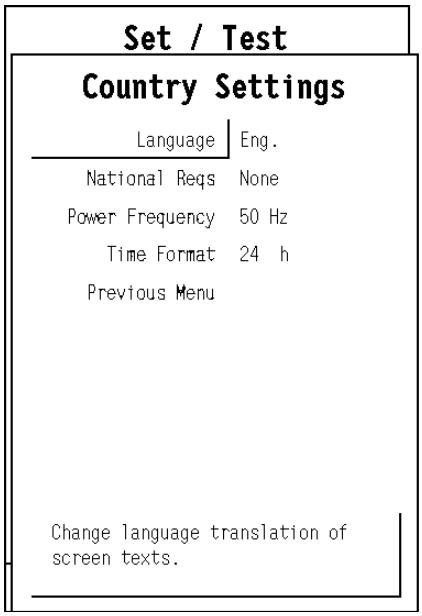
Select the software features, which include national requirements.

Power Frequency

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

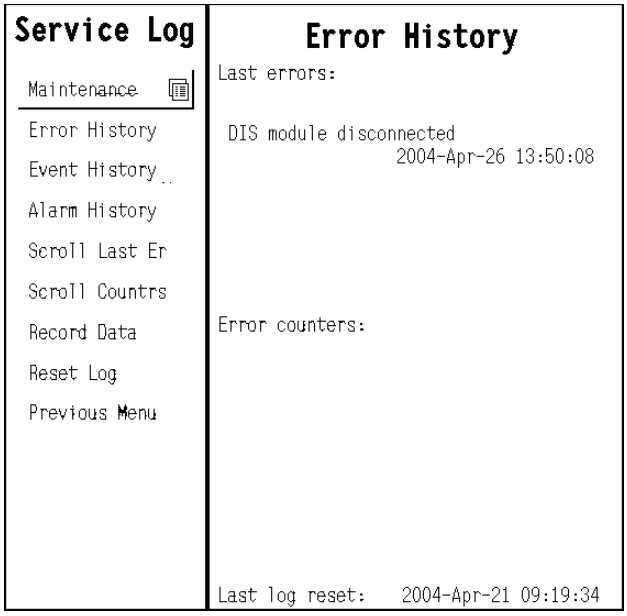
Time format

Set the time format of the real time clock (24 h/12 h).



6 Service Log

Error, event, alarm and maintenance data is stored in 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. The user can also store different maintenance events in the maintenance log.



Maintenance menu is for setting and viewing the maintenance information of the monitor.

Error History is for selecting the error history view onto the right side of the menu.

Event History is for selecting the event history view onto the right side of the menu.

Alarm History is for selecting the alarm history view onto the right side of the menu.

Scroll Last Er (Ev) is for scrolling the error / event / alarm information on the right side of the menu.

Scroll Counters is for scrolling the error / event / alarm counters on the right side of the menu.

Record Data is for recording the service log information onto the recorder.

Reset Log is for clearing up the content of the service log. This function should be run after a performed maintenance. In Error/Event history view, the Reset Log command clears up both the error and the event log. In the Alarm History view, the Reset Log command resets only the alarm history log.

6.1 Maintenance

The Maintenance History Log gives the user a possibility to store the maintenance history of the monitor. The user can store different planned maintenance (PM) events, repairs and upgrades in the maintenance history log.

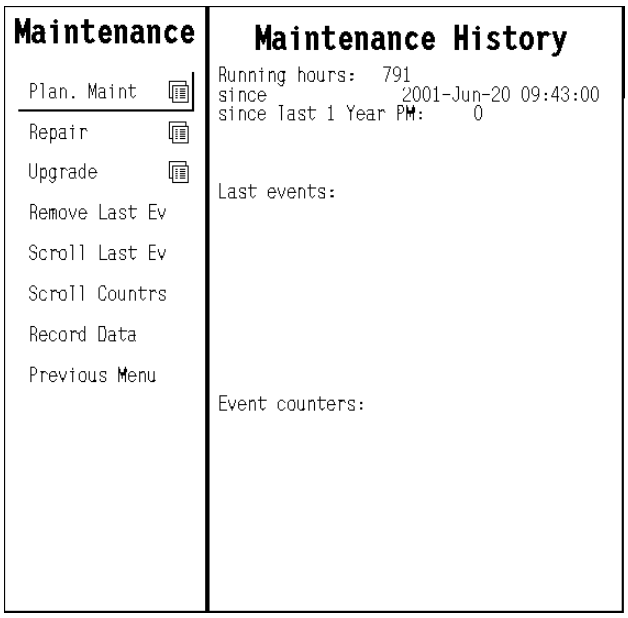
Running hours: shows how many hours the monitor has been on. User cannot reset this value.

since This date and time is set at the factory and it shows the manufacturing date and time. User cannot reset this date and time.

since last 1 year PM: shows the running hours since the last 1 year PM storing.

Last events: The section shows the last maintenance events and the time of their occurrence.

Event counters: The section contains counters for each different maintenance events. The time of occurrence of the last event is shown beside each counter.

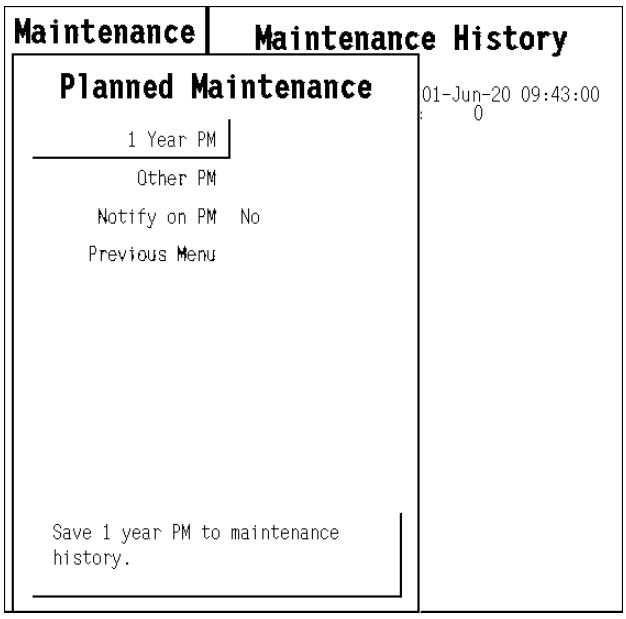


6.1.1 Planned Maintenance

1 Year PM gives you the possibility to store a 1 year PM event in the maintenance history log.

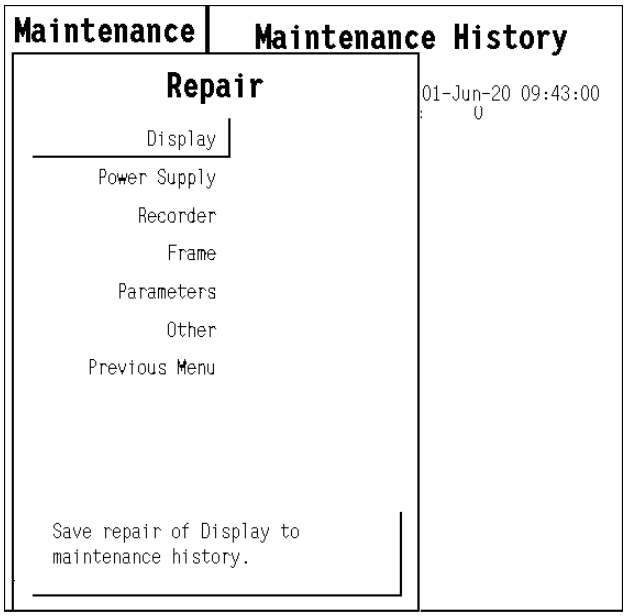
Other PM gives you the possibility to store another PM event in the maintenance history log.

Notify on PM This feature is for future purposes.



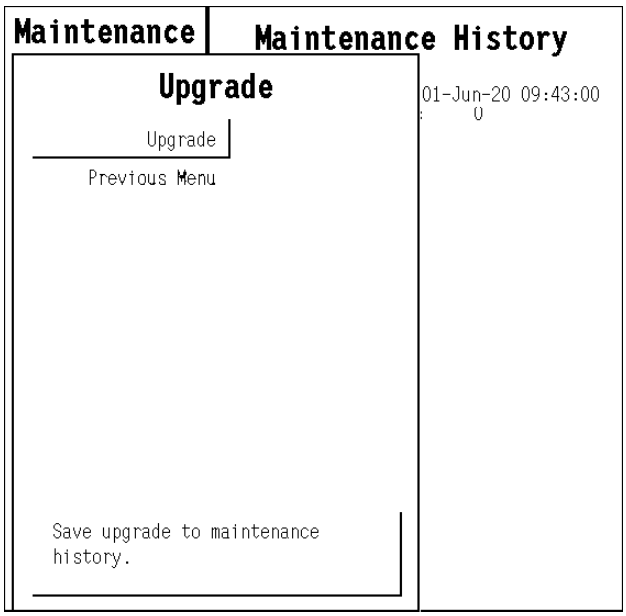
6.1.2 Repair

The repair menu gives the user a possibility to store repair events in the maintenance history log. The different repairs that can be saved are: **Display, Power Supply, Recorder, Frame** (e.g. board in the frame), **Parameters** (e.g. a board in the parameter module) or **Other** (a miscellaneous repair not specified by previous options).

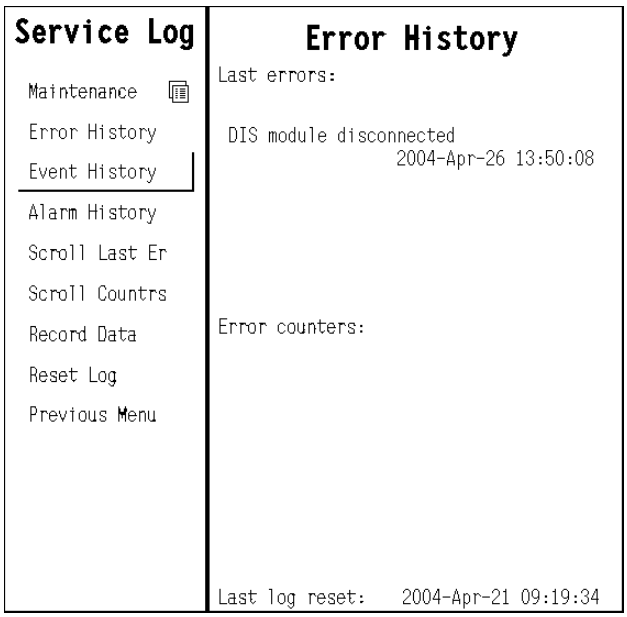


6.1.3 Upgrade

The upgrade menu gives the user a possibility to store the upgrades in the maintenance history log.



6.2 Error History



Last Errors: The section shows the last monitor errors and the time of their occurence.

Error counters: The section contains counters for each different (detected) monitor error. The time of occurrence of the last error is shown beside each counter.

Last log reset: The date and time of the last Error/Event log reset.

Possible errors:

Fast cold start indicates the number of erroneous cold starts with power off time less than 20 seconds. The reason can be either a failing lead acid battery or a software problem that was solved by the hardware watchdog circuitry located in the monitor's power supply unit.

GSP watch-dog timeout indicates an erroneous restart controlled by the main CPU board and caused by the display controller board. The restart is listed as a fast cold start.

UPI watch-dog timeout indicates an erroneous restart controlled by the main CPU board and caused by the UPI section. The restart is listed as a fast cold start.

6.3 Event History

Last events: The section shows the last events and the time of their occurrence.

Event counters: The section contains counters for each different (detected) event. The time of occurrence of the last event is shown beside each counter.

Last log reset: The date and time of the last Error/Event log reset.

Possible events:

Cold start is a start-up with power off time more than 15 minutes. The trend memory is cleared and monitoring starts with the user default settings.

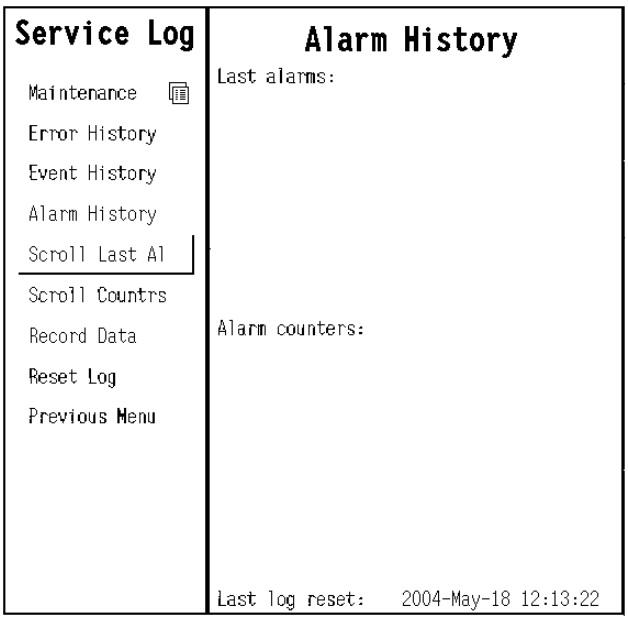
Warm start is a start-up with power off time less than 15 minutes. The trend information and possible temporary settings are still available.

6.4 Alarm History

Last alarms: The section shows the last events and the time of their occurrence.

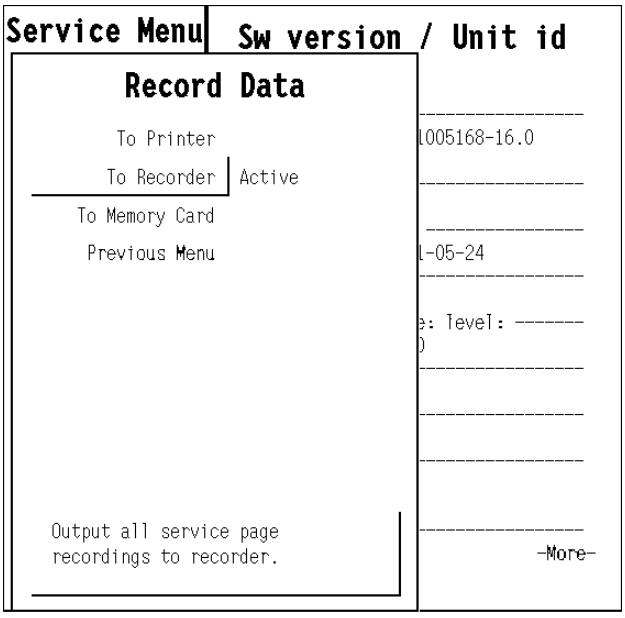
Alarm counters: The section contains counters for each different (detected) event. The time of occurrence of the last event is shown beside each counter.

Last log reset: The date and time of the last alarm log reset.



7 Record Data

In this menu, the user can specify where to print from any service menu. The setting goes into the permanent memory of the monitor. Only one option can be chosen at a time. The options where to print are: **To Printer, To Recorder** and **To Memory Card**. Only the option **To Recorder** can be selected.

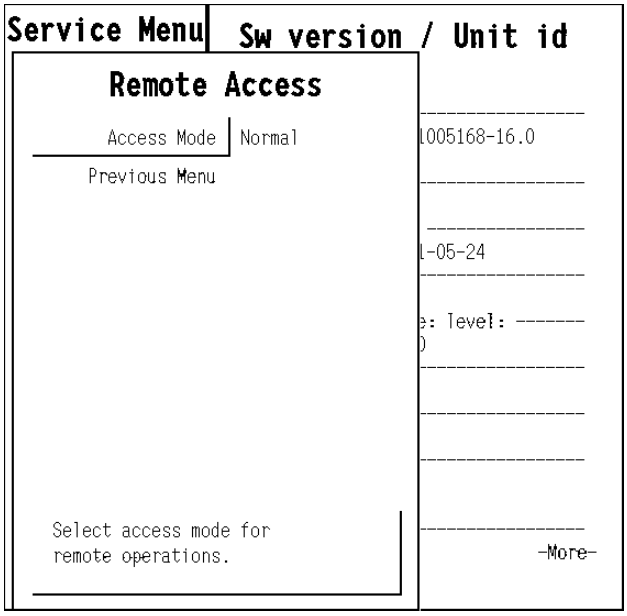


8 Remote Access

Remote Access menu is for setting the interface with an external PC that runs the Virtual Support software, which is a service diagnostic tool for remote diagnostics purposes.

When the access mode is set to **Normal** (the default), the PC can only read service menu data from the monitor. With the access mode **Extended,** the PC can also activate the monitor's service menu functions.

NOTE: Patient monitoring is not possible, when the access mode Extended is selected. The access mode turns back to Normal, if the monitor is restarted or if the service menu is closed.



MRI Monitor

Shield for MRI Monitor, N-MRI2 Rev. 01 including ECG Board
MRI Net Option, N-MRINET
Remote Screen Option, N-MRIREMOTE including
19” LCD Display, D-LCC19-01
Command Bar, K-MRIANEB

Technical Reference Manual Slot

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

Document no. M1084164-1
September, 2006

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

Table of contents

Table of figures

Introduction

This section provides information about the maintenance and service of the following parts:

- Shield for MRI Monitor, N-MRI2
- Active Remote Screen, N-MRIREMOTE
- LCD Display, D-LCC19-01
- Command Bar for MRI2, K-MRIANEB

The following components are included in the N-MRIREMOTE option: Remote screen extender, Fiber Optic Cable and Command Bar for MRI Monitor, K-MRIANEB.

The LCD display, D-LCC19-01 is a standard 19” active matrix LCD display, which is equipped with loudspeakers.

K-MRIANEB is intended for use with the MRI Monitor.

NOTE: For information about Remote screen and sound converter see “APPENDIX D. ”.

All the service menus related to the monitor are described in a separate “Service Menu” slot and the spare part lists in the “MRI Monitor Spare Parts” slot.

Figure 1 Shield for MRI Monitor

1 Specifications

1.1 Shield for MRI Monitor, N-MRI2

Dimensions and weight

D x W x H	455 x 300 x 372 mm (17.9 x 11.8 x 14.7 in)
Weight	
shield without options	4.0 kg (8.8 lb.)
(with F-MRICM1 frame and N-PSN)	15.3 kg (33.7 lb.)
(with F-MRICM1 and N-PSNGV	18.0 kg (40 lb.)
(with F-CMRICM1, N-PSNGV and N-MRIREMOTE	25 kg (46 lb.)

Power supply

Any fluctuatuations within the specified limits do not affect the performance.

Rated voltages and frequencies	100 to 240 V, 50/60 Hz
Maximum power consumption	140 VA, max.
Protection class	Class I
Grounding	Hospital grade
Allowed Voltage fluctuation	±10%

Battery

Type	Built-in NiMH battery
Capacity	Up to 1h typical on full range at 23°C /73°F
Recharging	When connected to mains power
Charging time	10 hours to full capacity
Battery operation alarm	
Early warning	‘Battery low’ note
Final warning	‘Battery low’ alarm
Battery state indicator	Capacity bar displayed on the screen
Interruptibility	Data memory and alarm settings are saved up to 15 minutes after monitor standby

Environmental Requirements

Operating temperature	+10 to +35 °C / 50 to 95 °F
Storage temperature	-10 to +50 °C / 14 to 122 °F
Humidity	10 to 90% non-condensing
Atmospheric pressure	660 to 1060 mbar (550 to 800 mmHg)

The MRI Cart complies with the safety standard IEC 60601-1-1.

1.2 ECG measurement

1.2.1 Typical performance

Measurement method	3 lead and 5 lead ECG
Lead selection	I, II, III, aVR, aVL, aVF and one V lead
Sweep speeds	12.5, 25, 50 mm/sec.

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

Range	30 to 250 bpm
Accuracy	±5 bpm or ±5%, whichever is greater
Resolution	1 bpm
Update interval	5 s
Averaging time	5 s

ST levels (in main software)

ST level range	-9 to +9 mm (-0.9 to +0.9 mV)
Resolution	0.1 mm (0.01 mV)
Averaging	calculated from 8 QRS complexes

Pacemaker pulse detection

No pacemaker pulse detection

Synchronization- signal to the module bus

Direct ECG	analog output of ECG, 1 V/1 mV
Pacer	5 V and 0.5 to 2.5 ms pulse, < 30 ms after pacer peak
Defibrillator	5 V and 10 ms pulse, < 35 ms after R-point synchronization

1.2.2 Technical specifications

Defibrillation protection	5000 V, 360 J
Recovery time	5 s
Input impedance	>2.5 MΩ (10 Hz)
CMRR	>90 dB at 50/60 Hz (with lead balance)
System noise	<30 mV (p-p, RTI)
Allowable offset	±1VDC
Gain range	0.2 to 5.0 cm/mV
Protection against electrical shock	Type CF defibrillator-proof

1.3 MRI Network option, N-MRINET

Fiber Optic Cable

850 nm full duplex multimode fiber, ST type connectors.

Fiber Optic Converter (N-FOC)

McBasic 10 Mbps Ethernet media converter

Dimensions	120 x 115 x 42 mm (4.7 x 4.5 x 1.6 in)
Weight	0.7 kg (1.6 lb.)

Regulatory Approvals	FCC Class A · UL/cUL, CSA, CE
Operating Temperature	0° to 40°C / 32° to 104°F
Storage Temperature	-20° to +70°C / 0° to 160°F
Humidity	5 – 95% non-condensing

1.4 Active Remote Screen, N-MRIREMOTE

KVM Extender

Power supply voltage	8 to 28 V, 8 W (typical), internally powered
Interface	
Video Source / Monitor	VGA up to 1280 x 1024 at 75 Hz
Keyboard	PS2
Mouse	PS2 a / 3 button and wheel mice
Optical elements	
Wavelength	850 nm
Optical power	40 µW in 50µm cable (typical)
Max. optical loss	4 dB
Optic cable	50/125 µ gradient type or 62.5/125 µ gradient type
Extender dimensions	
Weight	1.5 kg (3.31 lb.)
Length/width/height	190 x 160 x 55 mm (7.5 x 6.3 x 2.2 in)

1.5 LCD Display, D-LCC19-01

Display size	19 in diagonal
Display type	Active Matrix Color TFT LCD Display
Resolution	SXGA, 1280 x 1024

NOTE: As a safety feature, the audio volume is set to maximum, and the volume adjustment wheel is disabled in the D-LCC19-01 (M1057466).

Dimensions

W × D × H	422 x 210 x 418.5 mm (16.6 x 8.3 x 16.5 in)
Weight	5.8 kg (12.8 lb) with desk stand

Electrical requirements

The LCD display is connected to the MRI Monitor and the mains power.

See power connection requirements related to MRI system in *Part I/Installation.*

Rated voltage range	100 ... 240 V, 50 ... 60 Hz
Power consumption:	
ON	46 Wmax
Stand-by	5 W
Suspend	5 W

Environmental Requirements

Operating temperature	+5...+40°C (+41...+104°F)
Storage temperature	-20...+60°C (-4...+140°F)
Atmospheric pressure	660...1060 hPa (660...1060 mbar)

Relative humidity:	
Operating	20%...80%
Non operating	5%...85%

1.6 Command Bar, K-MRIANEB

Dimensions, W × D × H	282 × 26 × 54 mm
Weight (inc. cable)	0.4 kg
Input voltage	5 V
Power consumption	350 mW max
Communication protocol	RS-232

NOTE: Power supply from the KVM Extender Remote Unit only.

1.7 Output signals

Cardiac Gating

Analog ECG	
Gain	1mV ECG signal is 1 V ± 10 % at the analog output
Delay	< 10 ms
Range	± 8 V
Bandwith	0.5 to 40 Hz
QRS triggering pulse	
Pulse width	10 ms positive pulse
Delay	-15 to 15 ms

2 Functional description

The MRI Shield minimizes electromagnetic noise from the monitor. The MRI Shielding includes the MRI electronics.

The MRI Monitor Shield includes the following parts:

- The Shield front cover and back case
- MRI ECG board
- Patient Connector Panel
- Active Remote Screen Sound and screen converter board
- Network board, Fiber optic converter
- The mains power filter and Keyboard filter board
- Remote power and connector board

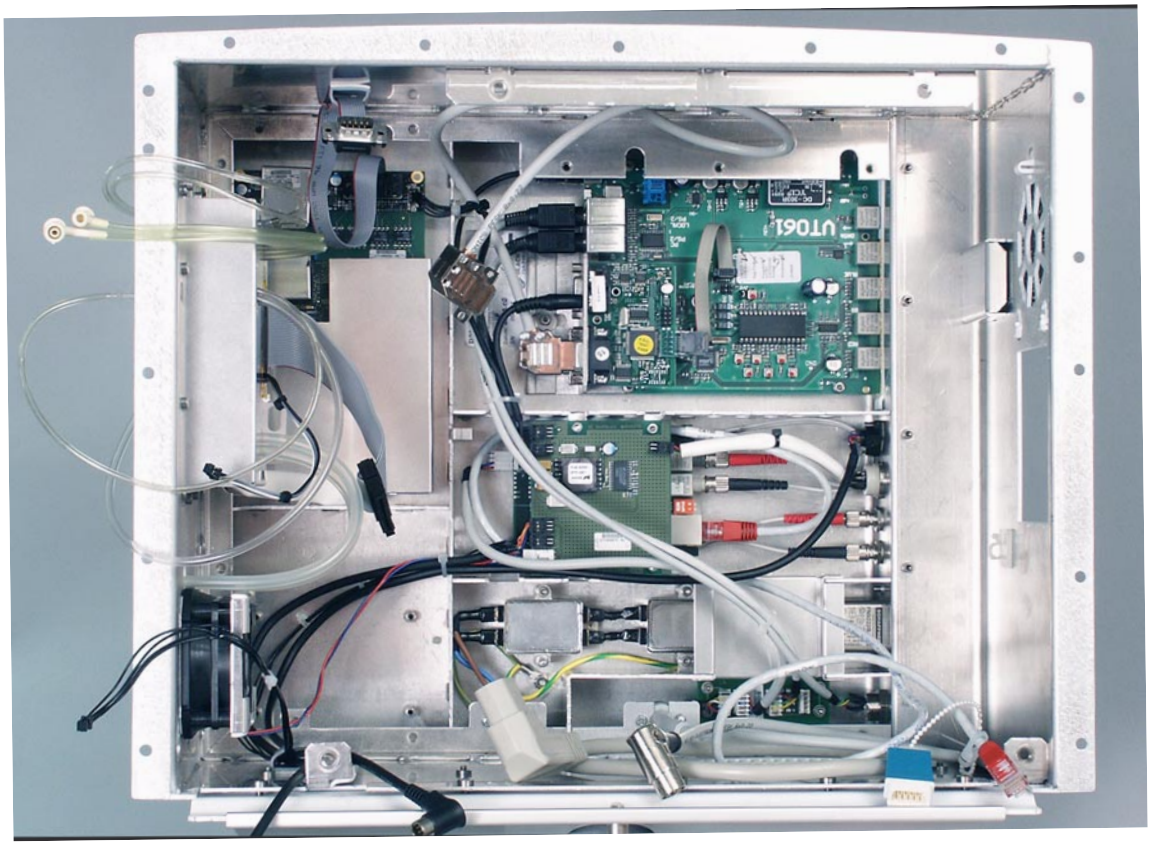


Figure 2 Back case of the MRI Shield

2.1 The MRI Shield

The monitor shield has been designed to minimize the EMC noise that is emitted from the monitor, modules and power. Otherwise the electronic device might cause artifacts to the MRI pictures. The shield also protects the monitor electronics from RF and gradient pulses.

The quality of monitored patient signals is maximized through dedicated filtering boards.

The shield has two openings for fans. The shield fan is at the left side and the monitor frame fan is at the right side of the MRI Monitor shield.

Front cover

Alarm led for magnetic field, horizontal and vertical keyboards and ComWheel are located on the Front cover. The screen is an anti-reflective and anti-scratch PC screen. Slot for one PCMCIA card is located on the left side of the monitor front cover.

Magnetic alarm board

The high magnetic field alarm was developed to increase the safety in MRI.

When the monitor is turned on, the high magnetic field alarm alarms once. The MRI Monitor measures the magnetic field strength continuously and alarms if limits are exceeded.

When the magnetic field gets stronger than 150 G, yellow light is lit in the high magnetic field alarm led on the front panel of the shield. When the magnetic field gets stronger than 250 G, the led starts blinking red and an audible alarm is triggered.

For safety reasons, continuous alarm starts alarming already at 250 G line, even though the monitor is validated to tolerate 300 G magnetic fields. The monitor will not stop alarming until you move it away from the high magnetic field.

The field strength is measured continuously with Hall sensors placed on the ECG board.

	Meaning	**Tone pattern**	**Front panel LED**
	Magnetic field ≥400 G	Smart Automatic Shut Down Measurement feature	
	Magnetic field ≥250 G	Triple + double beep every 5 seconds or continuous beep -- -- -- 5 -- --/ -----	**red LED blinking**
	Magnetic field ≥150 G	No tone	yellow LED lit

Figure 3 High magnetic field alarms

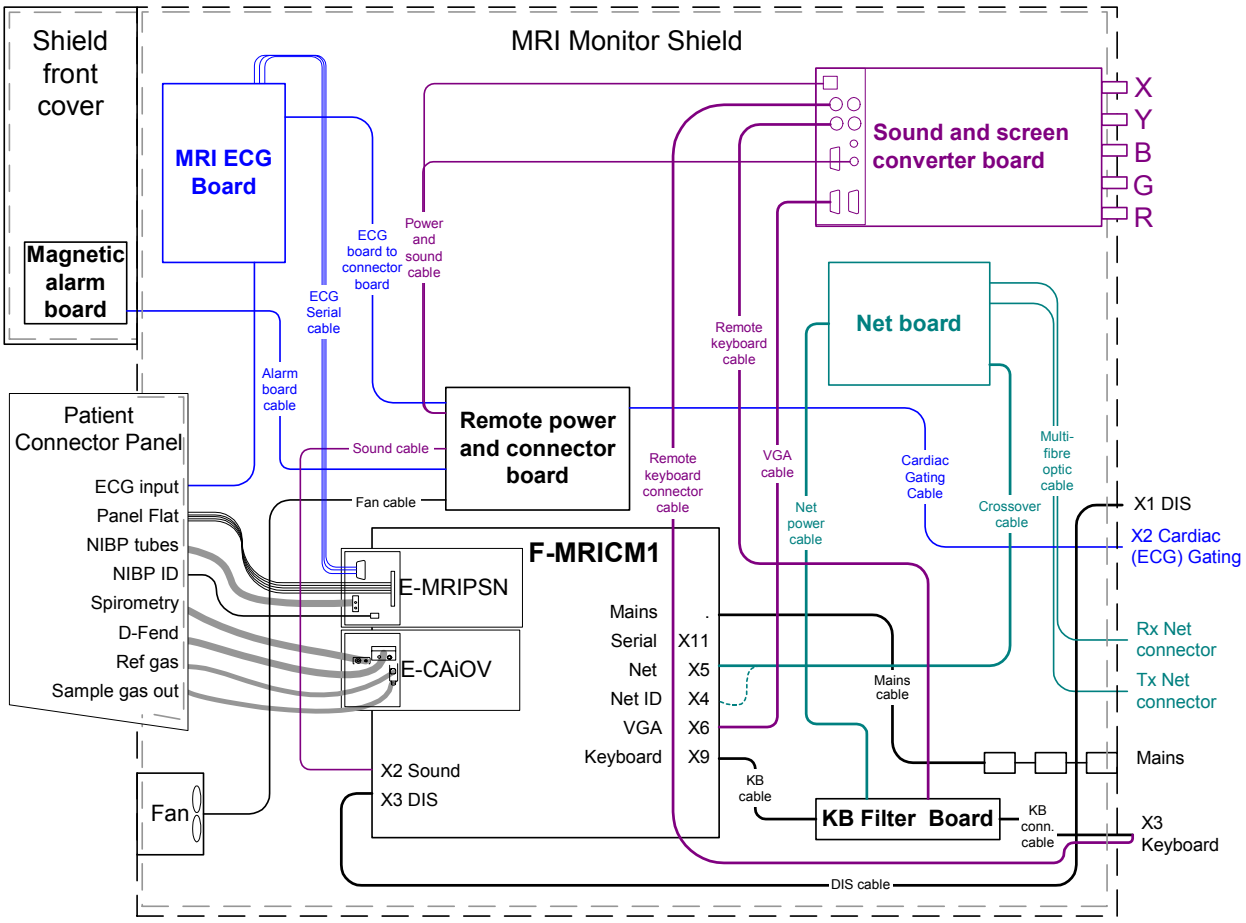


Figure 4 Connections inside the MRI Shield

2.2 Patient connector panel

The MRI Monitor Patient connector panel contains the following connectors:

- ECG
- invasive pressure, InvBP
- SpO_2
- NIBP hose
- D-Fend
- spirometry sample gas tubes

Invasive pressure and gas sprirometry measurements are options. The whole input unit is covered by EMC shield cover.

Behind the ECG connector are the defibrillation resistors and connector board. The connector board has connector for the isolated flat cable that connects the signals of the ECG board to the ECG measurement board.

The NIBP identification switches, the invasive pressure connector (option) and the SpO_2 connector are connected on the input board behind the connectors. The input board has cable connector for the NIBP switches and a flat cable connector for the invasive pressure and SpO_2 signals. Those signals are connected via the cables to the front panel of the E-MRIPSN module. The NIBP hose connector is connected from the patient connector unit to the E-MRIPSN module via the tubing.

The Patient connector panel also contains an optional D-fend housing and connectors for reference gas, and gas exhaust and optional connectors for the spirometry measurement. All the connectors are connected to the E-MRICAiOV gas module via the gas tubing inside of the MRI Monitor Shield.

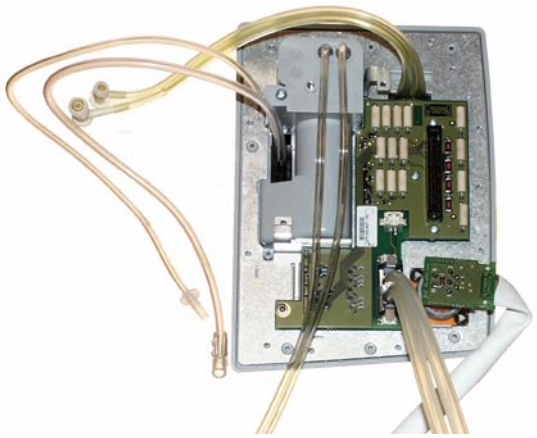


Figure 5 Patient connector panel, back cover removed.

2.3 MRI ECG measurement

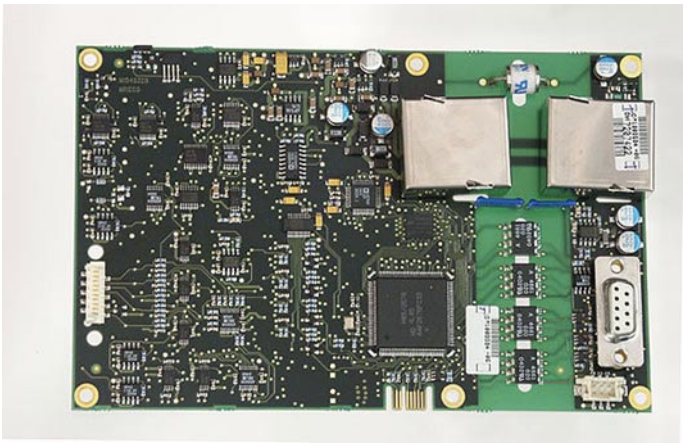


Figure 6 MRI ECG board

MRI ECG measurement functions are shown in the Figure 7. The functions are mainly located on the MRI ECG board inside the shield back cover. The input board and the patient connector are in the Patient connector panel at the side of the monitor.

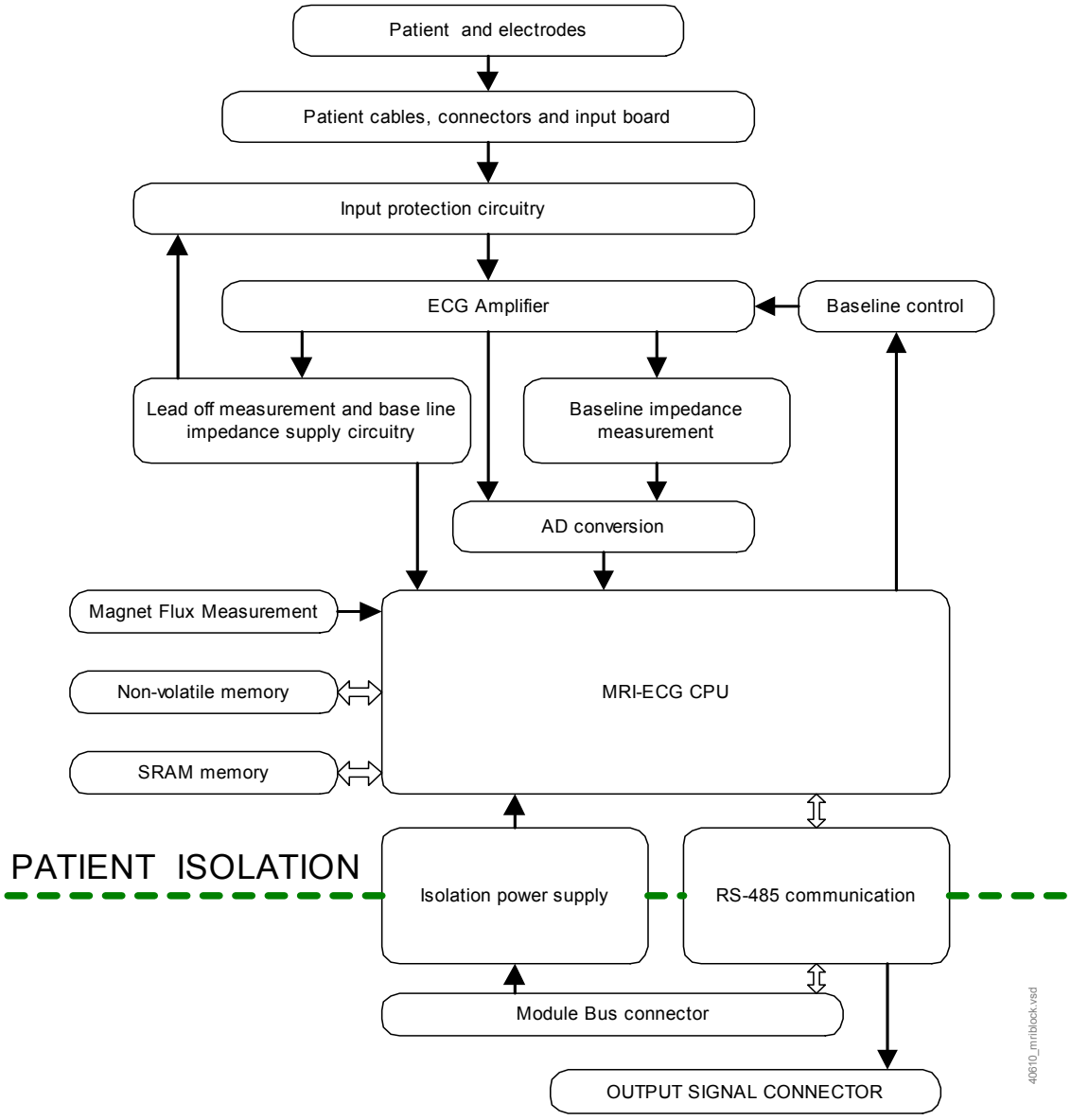


Figure 7 MRI ECG measurement

Patient and electrodes

Standard ECG electrodes contain ferrous metal and cannot be used in MR environment. Therefore MRI ECG monitoring requires special, metal free MRI compatible electrodes.

Patient cables, connectors and input board

Patient cables must also be MR compatible. The input board routes the signals from the patient connector to the MRI ECG board.

Input protection circuitry

The protection against defibrillation is provided by using the resistance of the MR compatible cables to limit the current and by using protection diodes on the MRI ECG board to cut the voltage.

ECG Amplifier

There is a buffer amplifier for each ECG lead on the board. The ECG signal is routed further to the differential amplifier stage before AD conversion. At the differential stage, single-end ECG lead wire signals are changed to normal differential ECG lead signals, Lead I, II, III, etc.

Lead-off measurement and base line impedance supply circuit

The output levels of the buffer amplifiers are used for Lead-off detection. The output level signals are routed through a multiplexer to the AD converter of the microcontroller.

The impedance supply circuit supplies an AC signal for measuring the base line impedance between R/RA and another multiplexer selectable ECG lead wire (L/LA, F/LL, N/RL).

Baseline impedance measurement

Baseline impedance is measured differentially between the R/RA lead wire and the multiplexer selected ECG lead wire (see section "Lead-off measurement and base line impedance supply circuit" above). When the signal is measured differentially, it is routed to the full wave rectifier for converting to DC signal, which is routed to the AD converter of the microcontroller.

AD conversion

There are two separate AD converters on the board. The ECG signals are processed by the AD converter, which is connected to the data bus of the microcontroller. The other AD converter, which is connected via a serial bus to the microcontroller, is reserved for future use.

Baseline control

The baseline control consists of DA converters, which are used through amplifiers for removing the offset voltage between the ECG lead wires. This method of offset removal reduces the resolution requirement of the AD converter to a 16-bit level.

MRI ECG CPU

There is a 16-bit microcontroller manufactured by Renesas on the MRI ECG board. The microcontroller has also some digital signal processing features.

Magnet flux measurement

The magnet flux measurement is performed three dimensionally (X, Y and Z) to detect the outside flux density. If the flux density inside the monitor is too high, the microcontroller on the board will activate an alarm signal at the output signal connector (see section "ECG gating connector" below). The measurement is performed by linear Hall sensors, which are integrated circuits able to deliver analog signals proportional to the flux density for the AD converter of the microcontroller.

Non-volatile memory

The non-volatile memory is for storing serial and ID numbers of the board. The non-volatile memory is an EEPROM circuit, which is connected via I square C bus to the microcontroller.

SRAM memory

The SRAM 4MB memory is for storing and measuring calculated provisional results during signal processing of the ECG signals.

RS-485 communication

The main tasks of this block are to transmit measurement and status information to the microprocessor of the MRI Monitor and to receive instructions via an RS485 bus. In addition, this block contains also other signal transmission through an isolation barrier of 4 kV. The other signal transmission tasks are:

1. Send an ECG signal from the microcontroller of the MRI ECG board through the isolation barrier as a PWM coded signal and decode it to an analog ECG signal.
2. Send a QRS pulse signal as a digital 2 ms pulse through the isolation barrier.
3. Send two magnetic flux density alarm signals from the microcontroller of the MRI ECG board through the isolation barrier. A yellow alarm signal means that the MRI Monitor is inside a high magnetic field and there is a risk that the monitor does not operate correctly. A red alarm signal means that the MRI Monitor is inside too high a magnetic field and the monitor does not operate correctly.

Isolation power supply

The isolation power supply transfers energy through the isolation barrier to the floating side of the MRI ECG board. There is a push-pull type transformer driver circuit on the non-floating side to generate the transferred AC energy for the transformer. There are linear regulators on the secondary (floating) side of the board for the power supply voltages of the microcontroller and other signal processing circuits.

Module bus connector

The module bus connector is of a female 9-pin D-type. In addition to two RS485 module communication pins, there are also pins for 15 V power supply voltage, ground and isolation power supply synchronization.

ECG gating connector

The six-pin Hirose connector, located at the connector panel, is intended for the following straight output signals:

1. Analog ECG output
2. QRS pulse out
3. Magnetic flux density; yellow alarm
4. Magnetic flux density; red alarm

2.3.1 ECG filtering

MRI Monitor has 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)
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.

2.4 PC boards and components

2.4.1 Remote Power and Connector board

The inboard DC/DC-converter on the Remote Power and Controller board provides supply voltage to the KVM extender Local unit. The board also acts as a lead-through board for Cardiac gating-, Sound- and Alarm board -signals, and for fan supply voltage. The Remote Power and Connector board is supplied via ECG board and E-MRIPSN module.

When the N-MRIREMOTE option is not included, the DC/DC-converter operation is disabled with jumper connection.

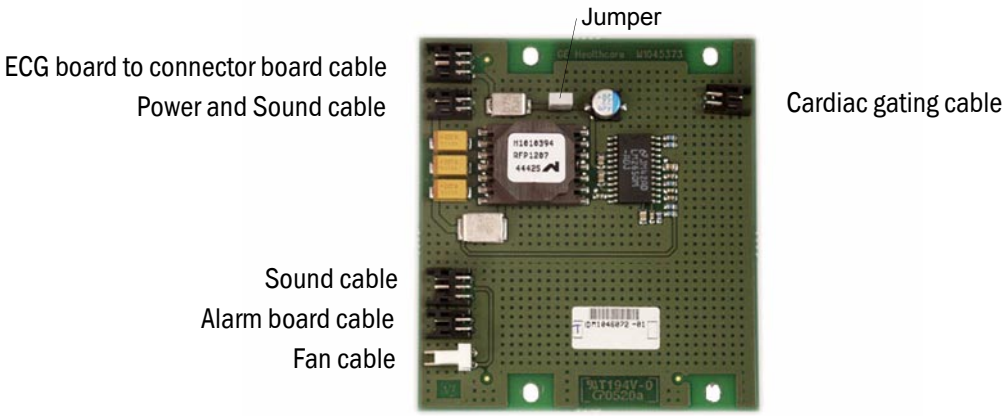


Figure 8 Remote power and connector board

2.4.2 Keyboard filter board

N-MRI2 has an additional filter board for an external keyboard. The Keyboard filter board consists of four (4) passive EMI-filters for each line of keyboard data communication. The board is connected between the Keyboard cable from the MRI Monitor Frame and the Keyboard connector cable to keyboard connector in the shield. The Net board is supplied with 0.5 W from the Keyboard filter board.

When the MRIREMOTE option is in use, the board is connected to the KVM extender Local unit's keyboard input connector. The Shield keyboard connector is then connected to the KVM extender Local unit's keyboard output connector.

Figure 9 Keyboard filter board

2.4.3 Mains power filtering

MRI Shield, N-MRI2, contains three filters for mains power. The filters minimize electromagnetic noise from mains power cord. Mains power is connected to the MRI Monitor Frame with a 30 cm long power cord. The mains power plug is in the rear of the MRI Shield.

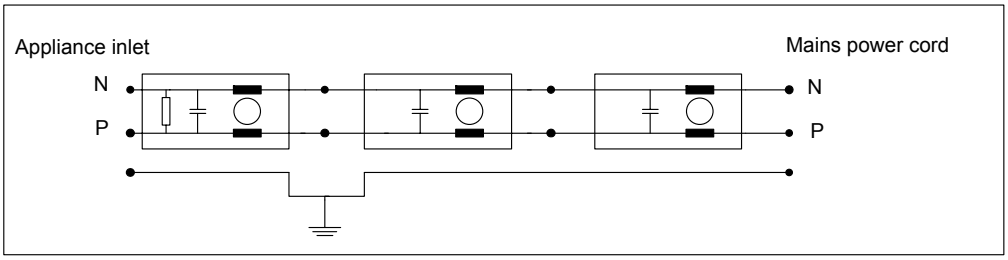


Figure 10 Mains power filters

2.5 MRI Network option, Fiber optical network

MRI Monitor can be connected to Datex-Ohmeda Network by optic cables.

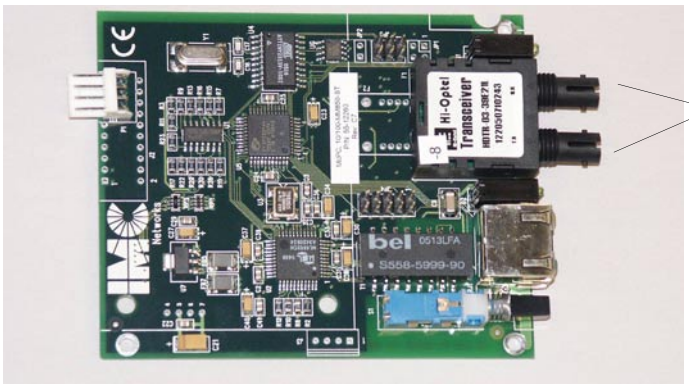


Figure 11 Net board, Fiber optic converter

MRI Monitor has an Ethernet media converter board that converts electrical ethernet-signal into optical (10Base-FL 850 nm multimode). The board is located under the Remote power and connector board on the back wall of the MRI Shield. The board is connected to the MRI Monitor Frame F-MRICM1 by category 5 RJ-45 cable. There are two female ST type connectors in the right side of the shield for optic cables. Converter board requires additional power (0.5 W/100 mA@5 VDC) which is taken from the Keyboard filter board.

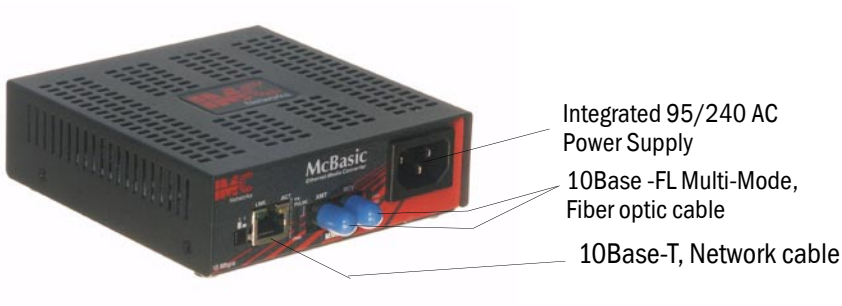


Figure 12 Fiber optic converter, N-FOC

With this configuration an additional media converter N-FOC is needed. Converter has one RJ-45 port and two ST connectors. N-FOC converts optical ethernet signal to electrical outside MRI room. Ethernet signal is coupled to HUB by additional communication cable. Basic installation is shown below. The converter includes fixed, internal AC power.

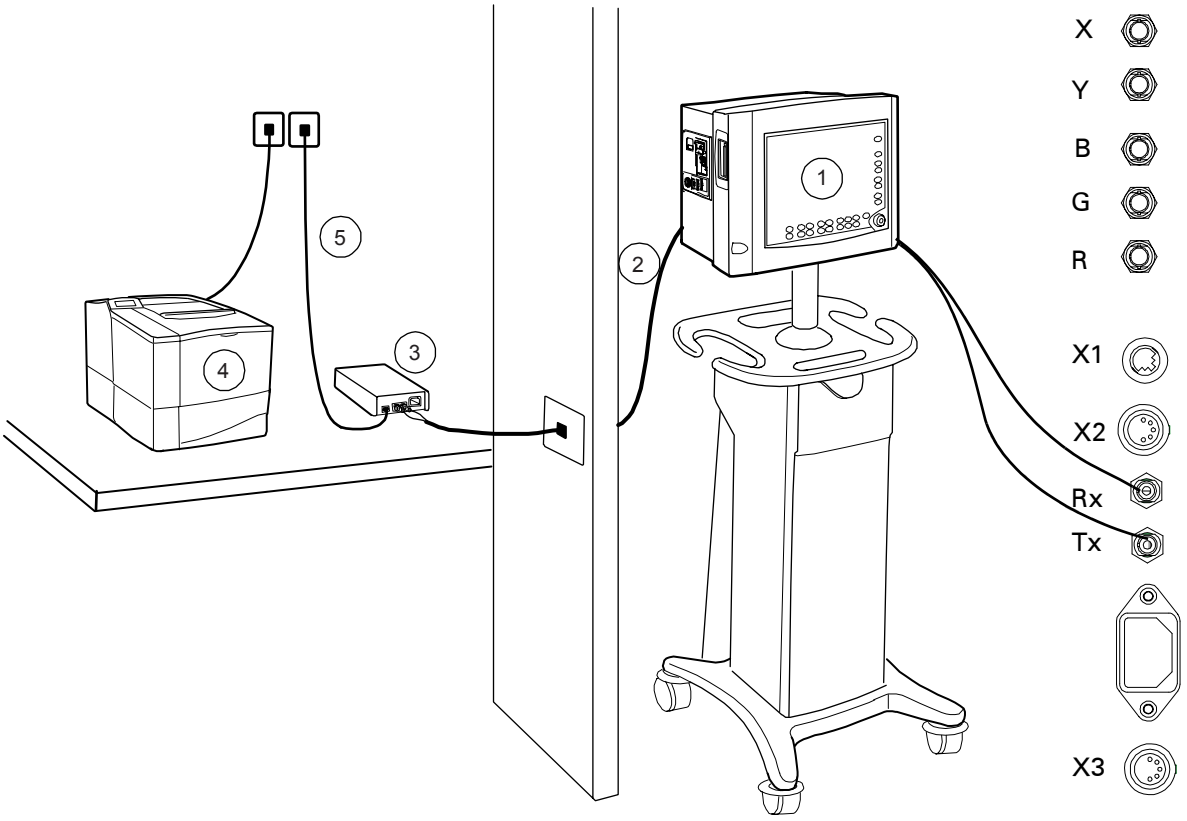


Figure 13 MRI Monitor connected to network

(1) MRI Monitor

(2) Fiber optic Network cable

(3) Fiber optic converter, N-FOC, which connects the monitor to the Datex-Ohmeda Network (wired or wireless)

(4) Network printer

(5) Monitor-Network cable

2.6 Active Remote Screen option, N-MRIREMOTE

Active Remote Screen is an external surveillance monitor for the MRI Monitor. While MRI Monitor is inside the MR scanning room, the remote screen is used outside in the control room to monitor the patient.

The connection between the MRI Monitor and Active Remote Screen is done over on a fiber optic cable, which ensures safe and undisturbed data transmission.

The Active Remote Screen has the same functionality as the MRI Monitor and it allows full remote control over the MRI Monitor.

Sound and screen converter, KVM extension system comprises a Local unit (transmitter) and a Remote unit (receiver). The Local unit has been placed inside the MRI Monitor Shield. In the control room, the Command Bar or the Anesthesia Record Keeping Keyboard and a Remote Display can be attached to the Remote unit. Remote and Local units communicate along the interconnecting Fiber optic cable.

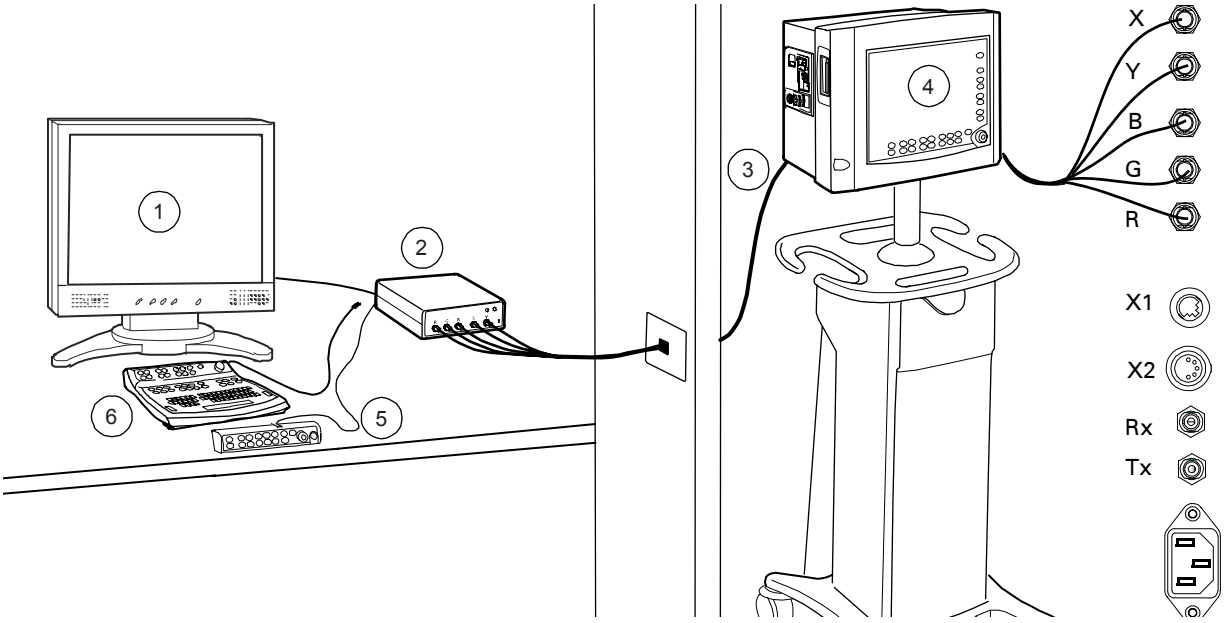


Figure 14 Active Remote Screen Option in control room

Components in control room:

1) LCD display, D-LCC19-01 with integrated loudspeakers

2) KVM converter, Remote Unit

Optional:

5) CommandBar, K-MRIANEB

6) anesthesia record keeping keyboard (only one keyboard) i.e. CommandBar or Anesthesia Record keeping cannot be used at the same time.

Components in MRI room

3) 5 pin fiber optic cable (one end connected to the MRI Monitor and the other end to the converter box placed in the control room)

4) KVM converter, Local Unit in the MRI Monitor

For more detailed information about the KVM Extender refer to “APPENDIX D”.

2.6.1 KVM Extender, Sound and screen converter

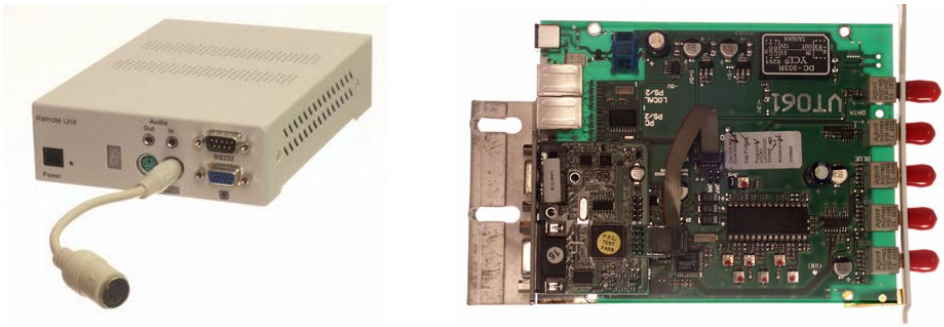


Figure 15 KVM Extender and the Sound and screen converter board

The KVM extender, Remote unit, is located in the control room. The Remote and Local units communicate along the interconnecting fiber optic cable. The Remote unit has ports for keyboard, VGA and sound.

Sound and screen converter board, Local unit, is located on the back wall of the MRI Shield. The board is supplied from the Remote power and connector board. The sound signal is routed from the MRI Monitor Frame via Remote power and connector board to the Sound and screen converter board.

2.6.2 19” LCD Display, D-LCC19-01

The D-LCC19-01 is intended for an active remote screen use with MRI Monitor.

The D-LCC19-01 is a non-medical grade product. Display D-LCC19-01 does not have a top spill shielding. The D-LCC19-01 does not contain a place for the Command Bar.

Audio

The LCD Display, D-LCC19-01 includes an LCD display module and LCD interface board and integrated loudkeepers. As a safety feature the audio volume is set to maximum and the volume adjustment wheel is disabled. The headphone connector is disabled as well.

Communication

The LCD Display is connected to the Remote Unit where the signal is transmitted via fiber optic cable to the Local Unit inside the MRI Monitor shield. The Local Unit is connected to the MRI Monitor Frame with VGA cable.

Video signalling between the Remote Unit and the LCD Display takes place in analog form. Incoming signals are buffered in the Interface board, converted into digital form, and fed forward to the LCD Display module. The Remote Unit sends video signals in analog form.

Communication between the Remote Unit and the keyboard is in RS232 serial format.

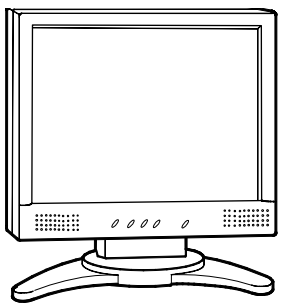


Figure 16 LCD Display, D-LCC19-01

2.6.3 Command Bar, K-MRIANEB

The Command Bar consists of 17 direct function keys and ComWheel.

NOTE: On/Stby switch does not function in K-MRIANEB.

Command Board/Bar PCB

The PCB is located inside the Command Bar. The board reads the status of the front panel keys and the ComWheel and forwards the information to the CPU board.

External communication

Communication with the host processor takes place in RS232 serial communication channels which are available in both the CPU bus and the module bus. Two signals, TXD and RXD, are in use. No handshaking is used. The connector of the Command Bar is connected to the Remote Unit. Serial communication speed rate is 19.2 kbps.

ComWheel

The ComWheel on the front panel is used for menu selection.

LEDs

The LEDs on K-MRIANEB are “Power On” LEDs. The LEDs are lit continuously when power is on.

Alarms are visible on the display and audible from loudspeakers.

2.7 Connectors and signals

2.7.1 External connectors

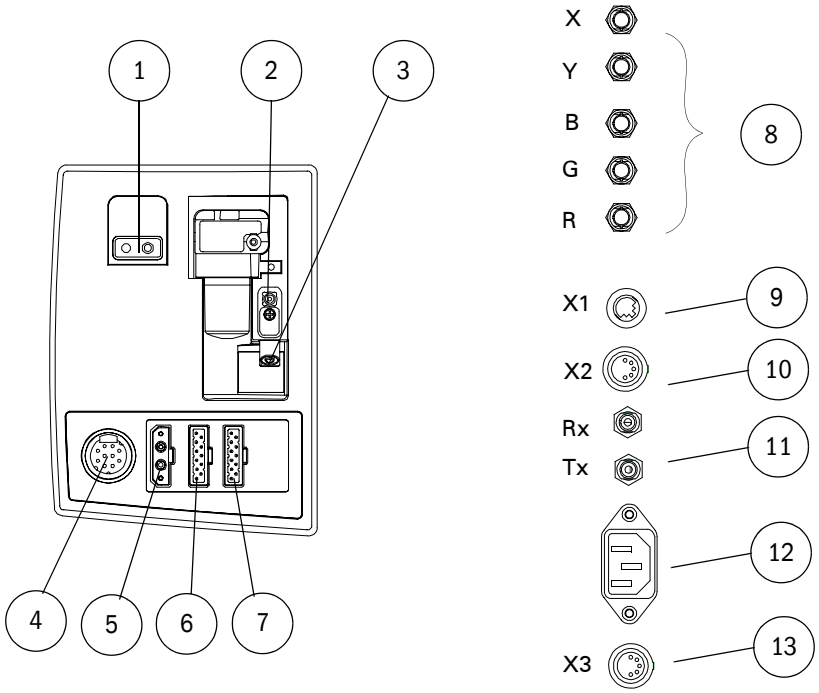


Figure 17 External connections of MRI Monitor shield

(1) Spirometry connectors
(2) Reference gas
(3) Exhaust gas
(4) ECG connector
(5) NIBP connector
(6) SpO2 connector
(7) InvBP connector P1, P2
(8) Fiber optic connectors for Remote Screen, X, Y, R, G, B (optional)
(9) Connector for Device Interfacing Solution, X 1
(10) Gating connector, X 2
(11) Fiber optic NET connectors, Rx, Tx (optional)
(12) Receptacle for power cord
(13) Connector for external keyboard, X 3

Patient connector panel

Table 1 ECG connector

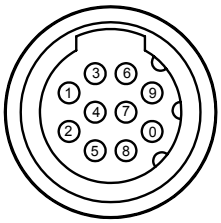
ECG Connector	Pin No.	Signal Name
	1 2 3 4 5 6 7 8 9 10	Right arm electrode (R) Left arm electrode (L) Right Leg Drive electrode (RL) Left Leg electrode (F) Chest electrode (C) Cable Shield Not connected 3/5 lead identification Lead connection check Ground

Table 2 SpO_2 connector

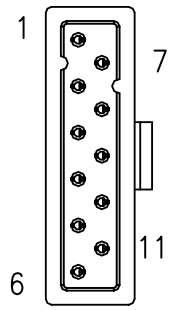
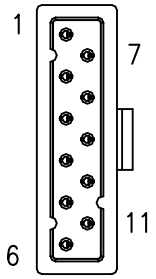
SpO_2 connector	Pin No.	Signal	Description
	1	DET_A	Photodiode anode
	2	DET_C	Photodiode cathode
	3	DATA-	
	4	Wire 1/3	LED connection
	5	IR_C	IR LED cathode
	6	OUTER SHIELD	
	7	DET_SHIELD	
	8	PRB_ID	Bin/ID Resistor+
	9	Wire 3/5	LED Connection
	10	RED_C	RED LED cathode
	11	DATA+	

Table 3 Invasive blood pressure connectors (P1, P2)

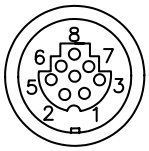
Invasive blood pressure connectors (Dual BP)	Pin No.	Signal	Description
	1	BP_+VREF	BP transducer excitation voltage, channel 1
	2	BP SIG+	BP transducer signal positive (+), channel 1
	3	BP_+VREF	BP transducer excitation voltage, channel 2
	4	AGND	Analog ground
	5	BP SIG+	BP transducer signal positive (+), 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

Connector panel for Remote option

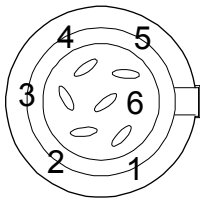
X, Y, connectors for horizontal/vertical synchronization signals

B, G, R connectors for color signals

DIS connector, X1 DIS interface

8 -pin female mini DIN connector	Pin	Signal
	1 2 3 4 5 6 7 8	DIS_out + DIS_out - 15V_DIS GND 8V_DIS GND DIS_in + DIS_in -

ECG Gating connector, X2

6-pin DIN connector	Pin	Signal
	1	ECG out
	2	QRS pulse OUT
	3	Reserved for future use
	4	Reserved for future use
	5	+15 VDC
	6	GND

Cardiac Gating

Analog ECG

Gain	1mV ECG signal is 1 V ± 10 % at the analog output
Delay	< 10 ms
Range	± 8 V
Bandwith	0.5 to 40 Hz

QRS triggering pulse

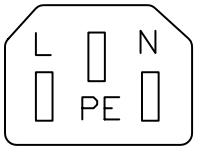
Pulse width	10 ms positive pulse
Delay	-15 to 15 ms

Network connectors

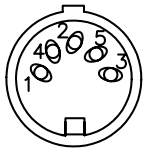
Rx, Tx

Power receptacle

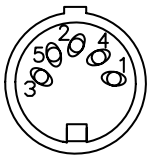
Table 4 Main power

Mains connector	Pin	Signal
	L	Live
	PE	Protective earth
	N	Neutral

Keyboard connector X3

5 pin DIN connector	Pin	Signal
	1	KB_CLK
	2	KB_DATA
	3	not in use
	4	GND
	5	+4.75 - +5.25V

Command Bar, K-MRIANEB

5-pin DIN connector	Pin No	I/O	Signal
	**1** 2 3 4 5	 I I O	KB_CLK KB_DATA not in use GND +4.75 - +5.25V

Connectors on display:

Information on the connectors can be found in the documents delivered with the display.

Connectors on Sound and Screen converter

For information on the connectors refer to “APPENDIX D”

3 Service procedures

3.1 General service information

The field service of the MRI Monitor Shield and Command Bar, K-MRIANEB, is limited to replacing faulty PC boards and mechanical parts that are listed in the corresponding spare part lists.The maintenance of the 19" LCD Display is limited to basic adjustments with the display keyboard.

Return the faulty PC boards and displays 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.

NOTE: Read the disassembly instructions in the MRI Shield slot through before servicing the monitor. It is essential to understand the MRI Monitor structure to be able to service the monitor effectively.

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.

WARNING **If a service procedure requires using tools that contain ferrous metal, perform the procedure outside the MR environment.**

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

3.2 About service checks

These instructions include complete procedures for a service check for "MRI Monitor Shield service check", "LCD Display, D-LCC19-01 service check"and "Command Bar, K-MRIANEB, 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 A"), which should be filled in when performing the procedures.

The symbol  in the instructions means that the check list should be signed after performing the procedure.

3.3 MRI Monitor Shield service check

3.3.1 Recommended tools

.

For product(s)	Tool	Order No.
All	MRI Monitor	
for ECG	MRI ECG 3-lead set, 6.5 m/20 ft, IEC	897987
	or	
	MRI ECG 3-lead set, 6.5 m/20 ft, AAMI	897986
Data Card option	MemCard – Data or Menu	
Network or WLAN option	Datex-Ohmeda Network connection	
Active Remote Screen option	Control room setup	
	Screwdrivers	See “3.4.2. Tools needed” for the tools needed during the dis-/reassembly.

NOTE: A MRI Monitor (the original or a replacing one) is needed for this service check.

3.3.2 Recommended parts

Part	Order No.	Notes
Filter (Side fan), F-CM1	896085	2 pcs needed for MRI Monitor
D-fend O-ring (2 pcs)	653125	Replace annually the ones in the Patient connector panel.
Recorder paper	74205	for recorder unit

3.3.3 Before beginning

- Perform the service reset for the MRI Monitor by pressing the **ON/Standby** key for at least 10 seconds.
- If the monitor is connected to the Datex-Ohmeda Network, disconnect the network cable from the monitor.
- Disconnect all the patient connectors.
- Disconnect all external cables connected to the monitor.
- Take out the Data Card if installed.

- Follow the MRI Shield disassembly instructions far enough to be able to remove the back cover plate covering the printed circuit boards (MRI ECG Board, Remote Power and connector board, etc.), see "Disassembly and reassembly" page 39.

3.3.4 Visual inspection

1. MRI ECG board

   Check that:

   - all the connectors are clean and intact
   - all the screws are tightened properly

2. Sound and screen converter board

   Check that:

   - all the connectors are clean and intact
   - all the screws are tightened properly

3. NET board

   Check that:

   - all the connectors are clean and intact
   - all the screws are tightened properly

4. Remote power and connector board

   Check that:

   - all the connectors are clean and intact
   - all the screws are tightened properly

5. MRI2 Keyboard filter board

   Check that:

   - all the connectors are clean and intact
   - all the screws are tightened properly

6. Patient connector panel

   Check that:

   - the panel is clean and intact
   - all the connectors are clean and intact

7. Mechanical parts
   Check that:
   - the mechanical parts are intact and attached properly

8. Cables
   Check that:
   - all the cables are intact and connected properly

9. Front cover; MRI2 Magnet field alarm board
   Check that:
   - the board is intact
   - all the screws are tightened properly

10. External parts; MRI Shield
    Check that:
    - the shield cover is clean and intact
    - the external connectors are clean and intact

11. External parts; Front cover
    Check that:
    - the stickers are intact
    - display screen is intact
    - the ComWheel is intact

3.3.5 Field replaceable parts

1. MRI Shield fan filters
   Clean or replace the MRI Shield fan filters (2 pieces)

2. D-fend O-rings

   Detach the D-fend. Check the condition of the rubber O-rings on the metal D-fend connectors, located in the patient connector panel.

   Replace if necessary: remove the old O-rings and press the new ones around the connectors.

NOTE: The O-rings are recommended to be replaced annually.

3.3.6 Monitor reassembly

Reassemble the MRI Monitor far enough to be able to connect all the tubes and cables to the MRI Monitor frame, see "Disassembly and reassembly" page 39.

NOTE: Leave the MRI Shield front cover still open.

3.3.7 Functional inspection

MRI Monitor frame

1. Stand-by LED

   Connect the power cord.

   Check that the standby LED starts blinking or is on continuously, if the batteries do not need charging.

2. Start-up

   Switch the monitor on.

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

   No error messages should appear on the screen.

   If the monitor contains the recorder unit, two lines of start-up information should be recorded.

3. Monitor screen configuration

   Check that the parameter information is shown on the screen.

NOTE: InvBP waveforms are not shown without a patient simulator. Do no connect the simulator to the monitor at this stage.

4. 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 and Power management board software.

5. Content of 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 on the recorder by selecting ***Record Log***.

ECG measurement

1. ECG board 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 ECG 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. Lead detection

   Connect a MRI ECG cable to the monitor. Check that all the electrodes show OFF in the service menu and the message ‘Leads Off’ is shown on the screen.

   Connect all the leads together, for example to a suitable screwdriver. Check that all the electrodes show ON and the message ‘Asystole’ appears.

   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.

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.

5. 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

   Check that the pacemaker option is off:

   ECG - PACE - WAVE - NSR

   Check that a normal ECG waveform is shown and the HR value is 160 (±5).

3.3.8 MRI Shield reassembly

- Turn the monitor off and disconnect the mains power cord. Remove the ComWheel.
- Close the MRI Shield front cover, see "Disassembly and reassembly" in the MRI Shield slot.

NOTE: Remember to reconnect the Alarm board cable.

Magnetic field alarm

1. Connect the mains power cord and other external cables.
2. Turn the monitor ON and check that the magnetic field alarm LED is lit and the alarm sound is heard for a moment.

MRI Monitor front panel

1. 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(s) is turning on and off when pressing the ComWheel. Check also the yellow alarm LED(s) by selecting ***Lower Led*** from the menu.

2. Membrane keys

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

   Check also the functioning of the side panel keys.

3. ComWheel

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

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

Data Card function

1. Insert a Data Card in the slot.

   Check that the corresponding symbol appears on the monitor screen.

Recorder

1. Press the **Record Wave** side panel key and check that the recorder starts recording the selected waveforms. Press the **Stop** side panel key to stop recording.
2. Check that the quality of the recordings is acceptable.

Network option

NOTE: The following steps are applicable only when the Network option is installed in the monitor.

1. Connection to Network

   Reconnect the fiber optic Network cable to the MRI Monitor. Make sure that the fiber optic cables are connected to the Fiber optic converter, N-FOC, and this to the network.

   Check that the monitor connects to the Datex-Ohmeda Network, i.e. the network symbol is displayed 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.

   NOTE: The battery symbol overrides the network symbol in MRI Monitor.

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

2. Ethernet address

   Enter the network board service menu:

   Monitor Setup
   Install Service (Password 16-4-34)
   Service - Frame (Password 26-23-8)
   Network

   Take down the monitor's Ethernet address, which is shown beside the text Address.

3. Data counters

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

4. Data error counters

   Check that the counters for data errors (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.

5. 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.

6. Disconnection recognition

   Disconnect the Fiberoptical Network cable from the MRI Monitor. Check that the message 'Network down:' is displayed in the message field within 30 seconds. When the message is displayed, the service menu values are stopped updating.

   Reconnect the Mon-Net cable and check that the monitor connects to the Datex-Ohmeda Network again.

Wireless LAN option

1. Signal strenght

   Check that the WLAN signal strength symbol scrolls between zero and full or stays fixed on the monitor screen.

2. Connection to the Network

   Check that the wireless LAN network symbol is displayed in the upper right-hand corner of the screen when the monitor connects to the Datex-Ohmeda Network.

NOTE: If the monitor does not connect to the Datex-Ohmeda Network, check the WLAN configuration in the monitor and in the network.

Device Interfacing Solution, N-DISVENT

1. Make sure that the monitor receives all necessary parameter data from the connected devices. Check the screen configuration and the related interfacing settings, if necessary.

   Monitor Setup - ***Interfacing - Status Page***

Active Remote Screen Option

Connect the fiber optical cable to the MRI Monitor. Make sure that the fiber optical cables are connected to the Remote screen converter and this to the remote screen and to the Command Bar, K-MRIANEB or to the Anesthesia record keeping keyboard, K-ARK, if included.

Turn the monitor on.

1. Check that the picture on the remote screen is correct.
2. Press the **Monitor Setup** key on the remote keyboard. 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.
3. Create an alarm and check the alarm is correctly displayed on the remote screen and the alarm sound is heard from the remote screen.

General

1. Electrical safety check

   Perform an electrical safety check and a leakage current test.

   Check that the monitor functions normally after the performed electrical safety check.

2. Service Log reset

   Enter the ***Service Log*** in the service menu:

   Monitor Setup

   Install Service (Password 16-4-34)

   Service (Password 26-23-8)

   Service Log

   Clear the content of the Service Log by selecting RESET LOG from the menu.

3. Final cleaning

   Switch the monitor to standby, disconnect the power cord and perform final cleaning.

   Turn the monitor to standby.

- Fill in all the necessary documents.

3.4 After service check

After the MRI Shield service check, either reassemble the MRI Monitor with the original parts or continue to perform the functional check.

3.4.1 MRI Monitor reassembly

Reassemble the monitor according to the “Disassembly and reassembly” instructions in the MRI Shield slot.

3.4.2 Functional check

Perform the Functional Check after installing a serviced MRI Monitor, see chapter “5 Functional check” in the first part of the manual.

3.5 LCD Display, D-LCC19-01 service check

Tools needed

- Keyboard K-MRIANEB
- Remote option, N-MRIREMOTE
- MRI Monitor
- a screwdriver

Visual inspection

1. Interface cable

   Disconnect and check the LCD display interface cable:

   The KVM Extender side connector:

   – the connector pins are clean and straight and at about the same height
   – the locking screws are intact

   The display side connector:

   – the screw(s) on the casing is tightened properly
   – the connector pins are clean and intact
   – the locking screws/claws are intact

   Check also that the cable itself is intact.

2. Check external parts

   – the outer cover is intact
   – the display screen is intact
   – the block screws for the cable are in place and are tightened properly (if installed)
   – the block screw threads are intact (if installed)

Functional inspection

1. Power cord

   Connect and lock the LCD interface cable to the LCD display and to the KVM Extender.

   Check that the display power cord is intact and properly in place.

   – Turn the monitor ON.
   – Turn the display ON.

2. LCD display picture

   Wait until the normal monitoring screen appears in the LCD display.

   Check that the picture on the LCD display screen is clear and stable.

NOTE: If the picture on the screen is not clear, try first the Auto Adjust feature on the display. Please refer to the display's user documentation.

3. Contrast and brightness adjustments

NOTE: The control keys can be unlocked/ locked by pressing the middle keys simultaneously. These keys are not available in all display types simultaneously.

Perform the contrast and brightness adjustments if needed. Please refer to the display's user documentation.

4. Position adjustments

Perform the vertical and horizontal adjustments if needed. Please refer to the display's user documentation.

5. Color temperature adjustments

Perform the color adjustments if needed. Please refer to the display's user documentation.

Go back to the normal screen.

6. Electrical safety check

Perform an electrical safety check and a leakage current test.

7. Functioning after safety check

Check that the LCD display functions normally after the electrical safety check.

8. Final cleaning

Clean the LCD display with a suitable detergent.

- Fill in all necessary documents.

3.6 Command Bar, K-MRIANEB, service check

Tools needed

- Remote option, N-MRIREMOTE
- MRI Monitor
- a screwdriver

Visual inspection

- Turn the monitor to STBY.

1. Cable

   Disconnect the Command Bar cable from the KVM Extender.

   Check that the connector pins of the cable are clean, straight and at about the same height. Check that the cable is intact. Check that the locking screws inside the connector case are intact.

   Leave the cable disconnected.

2. Front cover and front panel sticker

   Check that the plastic front cover and the front panel sticker are intact.

3. ComWheel cover

   Check that the ComWheel cover is intact and attached properly.

4. Stand-by LED

   Reconnect and lock the Command Bar cable to the KVM Extender.

   Check that the stand-by LED is lit up.

   NOTE: If the Command Bar is connected to the KVM Extender, the ON/STDBY switch is not functional and the alarm LEDs are always lit.

Functional inspection

- Turn the monitor on and enter the service menu with the remote keyboard:
  Monitor Setup - *Install/Service* (password 16-4-34) **- *Service*** (password 26-23-8)

1. Command bar software

   Take down the information regarding keyboard software.

2. Membrane keys

   Press the keys one by one. Check that each key generates a sound from the loudspeaker and the corresponding text in the menu changes from yellow to red.

3. ComWheel

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

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

4. Electrical safety check

   Perform an electrical safety check and a leakage current test.

5. Functioning after electrical safety check

   Check that the Command Bar functions normally after the performed electrical safety check.

6. Final cleaning

   Clean the Command Bar.

- Fill in all necessary documents.

3.7 Disassembly and reassembly

3.7.1 Before disassembly

CAUTION Wear a grounded, antistatic wristband when handling PC boards. Electrostatic discharge may damage components on the board.

CAUTION Handle all PC boards by their edges.

CAUTION Turn the power off, disconnect the mains power cord and perform the service reset by pressing the **ON/Standby** key 10 seconds before starting to disassemble the monitor.

3.7.2 Tools needed

- crosshead screwdriver, Pozidrive M3
- ballpoint Allen hex keys: 2, 2.5, 3, 5 mm
- hex key with angle
- pincers
- side-cutting pliers
- cable ties
- screws
- antistatic wristband
- antistatic gloves when handling PC boards

CAUTION When reassembling the monitor, make sure that all cables are reconnected properly.

3.7.3 Field replaceable parts that can be changed without opening the shield

– REC
– filters in the shield unit

To remove the recorder

- Open the Recorder EMC cover.

- Open the paper roll compartment cover and take the paper roll out.
- Unscrew the two crosshead screws inside the recorder completely (the screws cannot be removed).

- Remove the recorder with the EMC cover.

NOTE: When reassembling make sure that the EMC gasket strips are in place and all fingers are intact.

3.7.4 To disassemble the shield

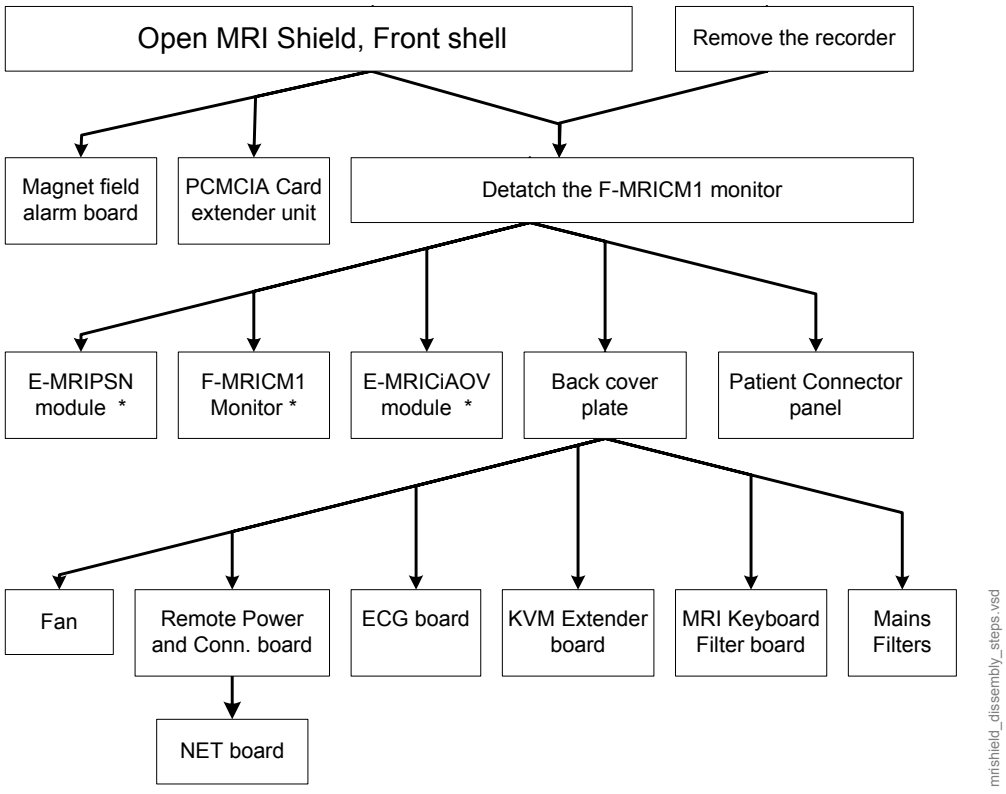


Figure 18 MRI Monitor service workflow

*To continue the disassembly follow the disassemble instructions in the relevant manual slot.

To remove the MRI Monitor from the cart/ mounting plate

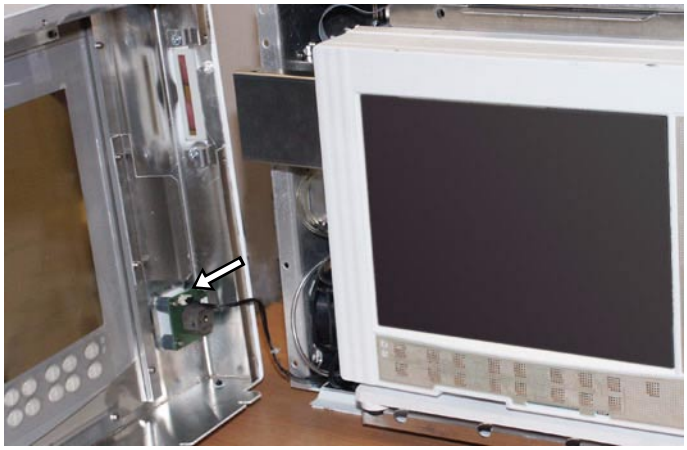
Pull the locking screw in the middle of the mounting plate and slide the monitor carefully away from the mounting plate.

NOTE: While reassembling, check that the locking screw locks properly.

To open the MRI Shield

- Remove the ComWheel carefully.
- Unloosen five hexagonal screws (M4×10mm) from the front edge at bottom of the shield.

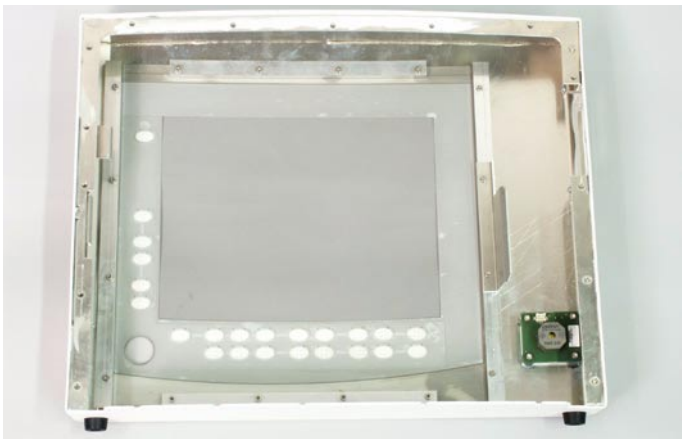
- Remove 14 hexagonal screws (M4×8mm) and washers - on each three sides of the shield and one sunk screw near the recorder.



- Open the shield door to the left, be careful not to damage the Alarm board cable.
- Disconnect the Alarm board cable (41).

NOTE: While reassembling, make sure to reconnect the Alarm board cable.

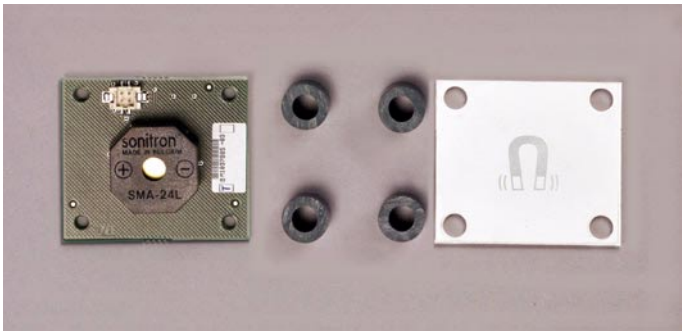
- Remove the shield door.



To replace the following field replaceable parts, follow the instructions below:

- "To remove the Magnet field alarm board or the LED cover plate:" on page 42
- "To remove the PCMCIA Card extender unit:" on page 43

To continue to disassemble the monitor, jump to the step "To continue to disassemble the monitor" on page 43



To remove the Magnet field alarm board or the LED cover plate:

- Unscrew the four hex screws (M3×12 mm) and washers holding the parts on the shield.

NOTE: While reassembling make sure to reassemble the spacers between the LED cover plate and the board.

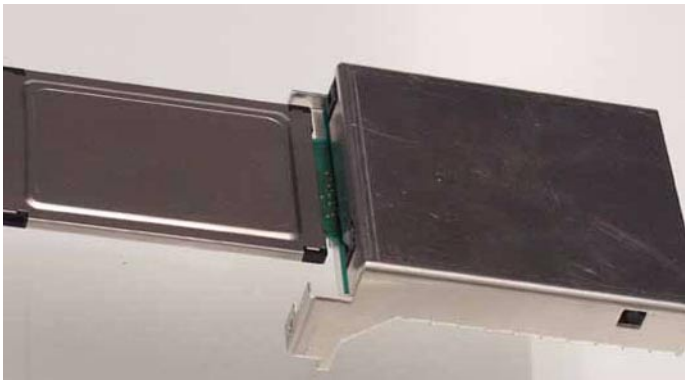
To remove the PCMCIA panel:

- Unscrew the two plastic screws (Torx 8, M3×10mm) and washers holding the panel on the shield.

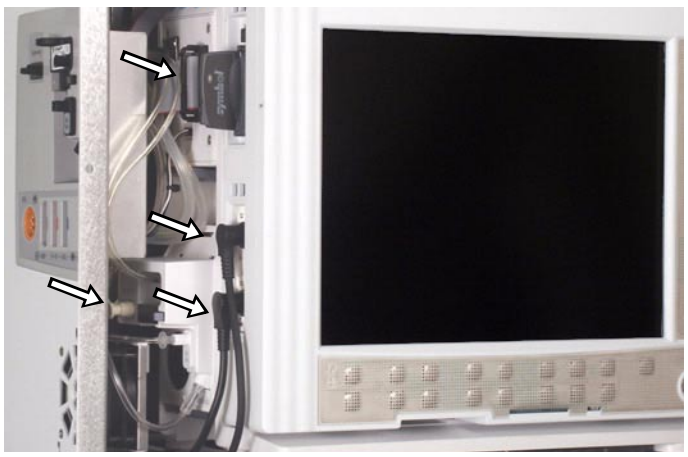
To remove the PCMCIA Card extender unit

1. To remove the PCMCIA Card extender unit:
- Unscrew the two hex screws (M3×5 mm) holding the unit on the monitor frame and pull the unit carefully out.
2. To remove the WLAN card:
- Pull the release button to remove the WLAN card.

The PCMCIA Card extender unit

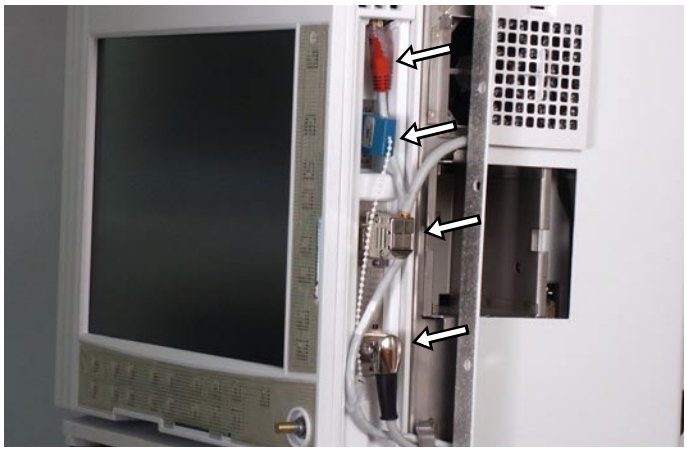


To continue to disassemble the monitor



Disconnect the following cables and tubes from the left side of the monitor:

- The Panel flat cable from the E-MRIPSN module
- Sound cable
- DIS cable
- Spirometry tubes from the gas module



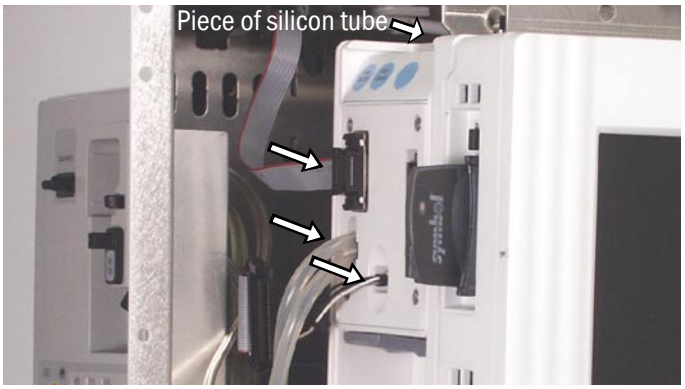
Disconnect and release from the holders on the right side of the monitor:

- Crossover cable
- NET ID plug
- VGA cable
- Keyboard cable

NOTE: To enable the WLAN option with the older version of the NET board, the Crossover cable and the NET ID plug must be disconnected from the MRI Monitor frame.

- Remove the four hex screws (M6×18 mm) and washers: two from the upper edge and the other two from the bottom corners of the monitor.

To remove the E-MRIPSN module



Pull the monitor carefully out just enough to access the modules.

To remove the E-MRIPSN module:

- Disconnect the ECG cable, NIBP ID switch cable and the NIBP tubes.

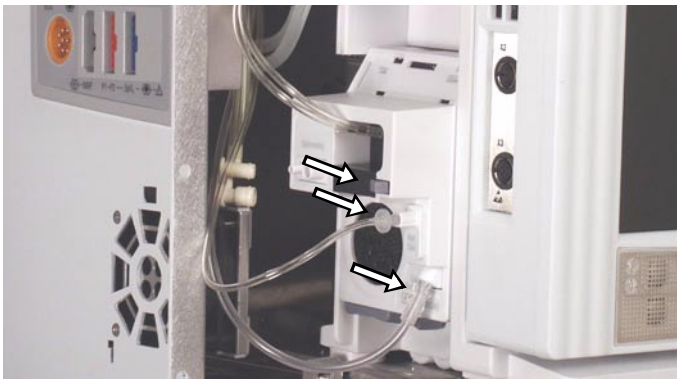
NOTE: Notice the position of the tubes, mark them if necessary to ensure that they are replaced correctly.

- Pull the module release latch and remove the module.

NOTE: Take away a piece of silicon tube from above the module to replace it when reassembling.

See the E-MRIPSN slot for the hemodynamic module disassembly instructions.

To remove the airway gas module



To remove the airway gas module:

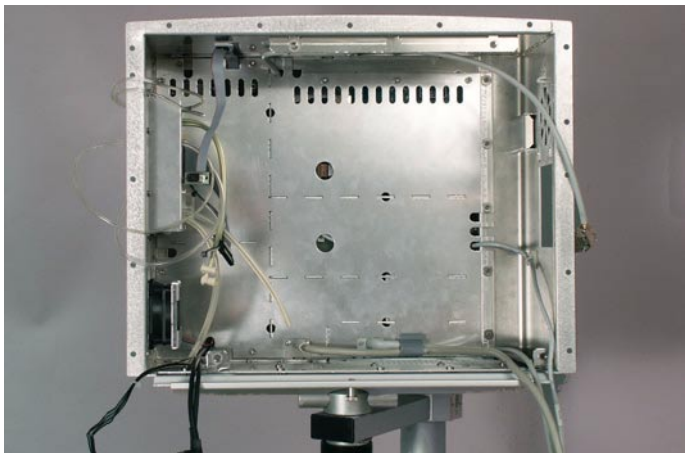
- Pull the monitor further out enough to access the gas module.
- Disconnect the dummy D-fend, reference gas line and sample gas outlet.

- Disconnect the power cable from the upper right-hand side of the monitor frame.
- Pull the monitor out from the shield to be able to remove the gas module.
- Unscrew the outer hex screw (M4×6 mm) and loosen the other screw to release the gas module holder, press the release latch and pull the module out.

NOTE: Remember the washer while reassembling.

See the Airway gas module slot for the module disassembly instructions.

You may now remove the shield from the cart to gain better access to the parts inside the shield.



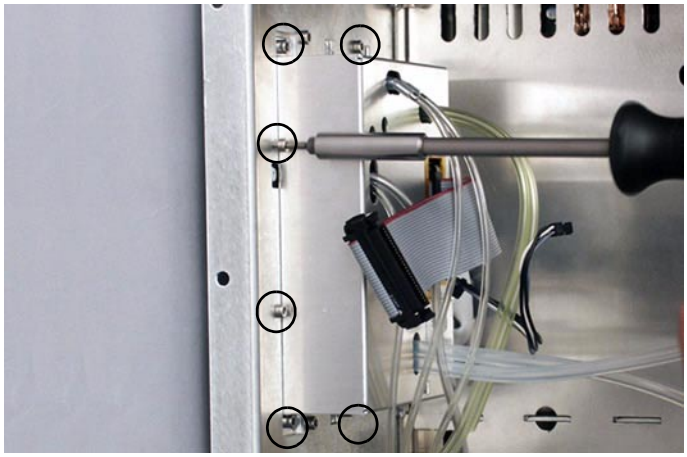
To replace the following field replaceable parts or to continue the disassembly, follow the instructions below:

- “To remove the Patient Connector Panel unit” on page 46
- “To remove the fan” on page 48
- “To continue to disassemble the shield” on page 47

To remove the Patient Connector Panel unit

Tools needed:

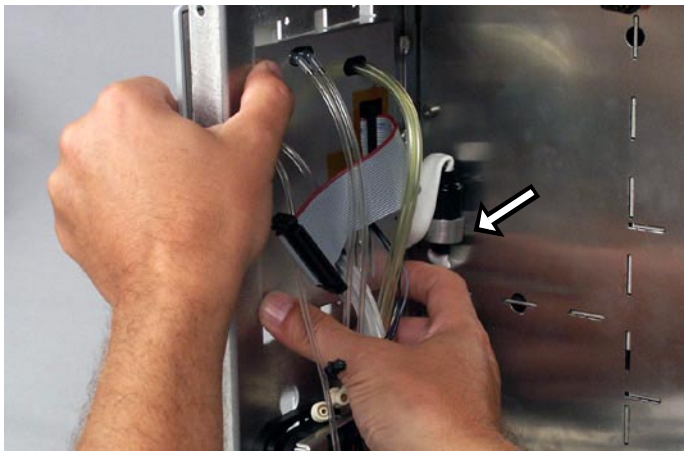
- a cable tie



To remove the Patient Connector Panel unit

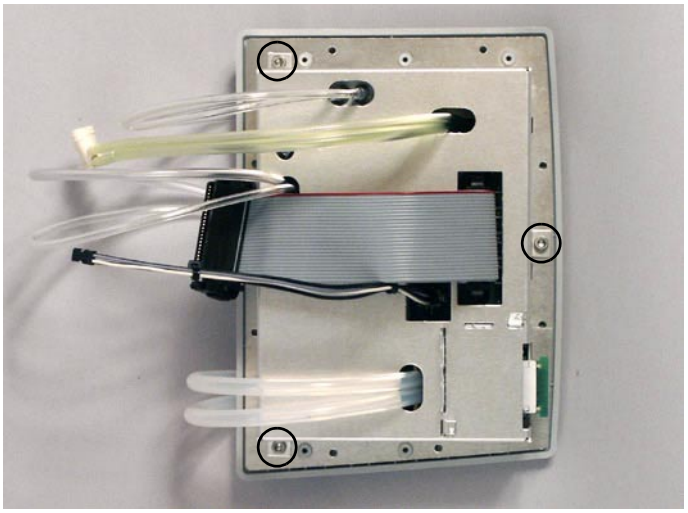
- Remove the eight hex screws (M3×5 mm) - two on each side of the panel - holding the panel unit to the shield.

NOTE: Be careful not to damage the ECG input cable.



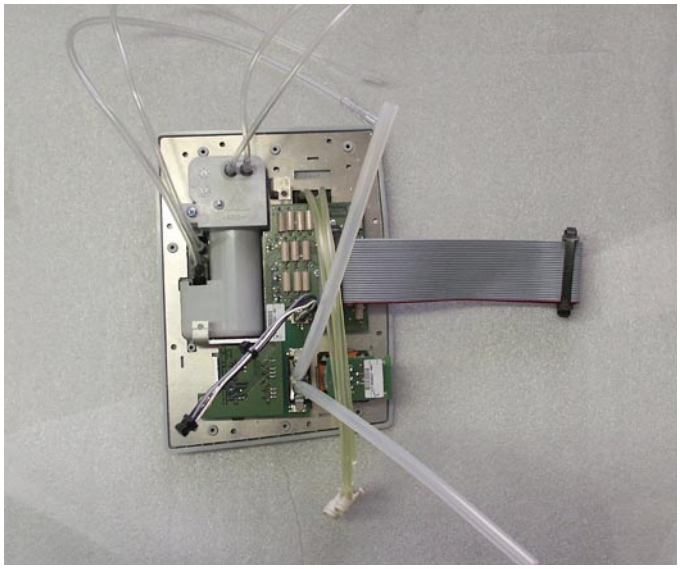
- Turn the Patient Connector Panel unit carefully out backwards to get access to the ECG input connector.
- Cut the cable tie securing the ECG input connector carefully off.
- Disconnect the connector and pull the unit out.

NOTE: When reassembling, remember to secure the ECG input cable connector with a new cable tie to ensure proper functioning.



To replace the tubes or cables inside the Patient Connector Panel unit:

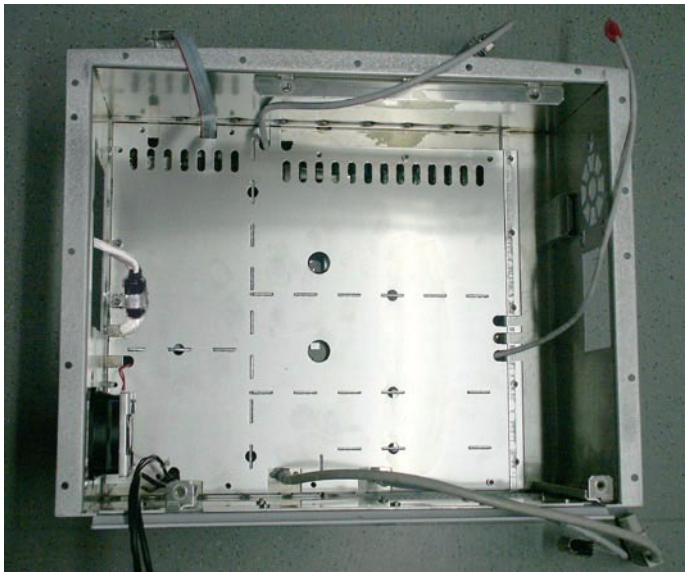
- Remove the three hex screws (mm) holding the Patient Connector Panel unit back cover.
- Lift the back cover up. Be careful not to damage the cables and tubes.



Now you can replace the following field replaceable parts:

- NIBP ID switch cable
- NIBP tubes
- Panel flat cable
- the sampling line, reference gas line, sample gas outlet and the spirometry tube

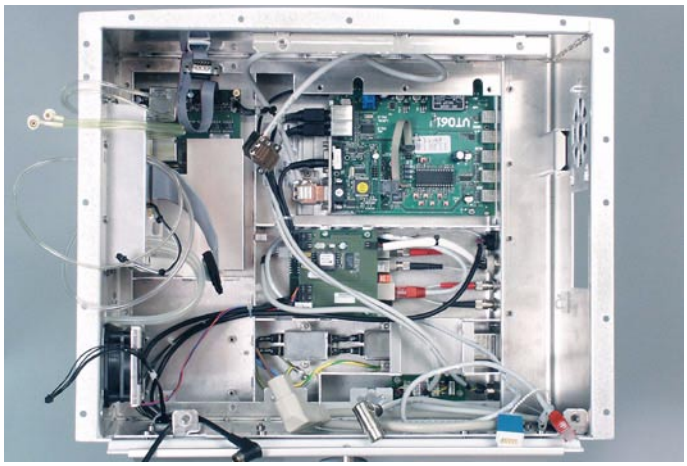
To continue to disassemble the shield



- Remove the five hexagonal socket screws (M3×5 mm) from the right side of the back cover plate.
- Remove the other 14 hexagonal socket screws (M4×8 mm) holding the back cover plate to the shield and one (M4x16 mm) holding the ferrite coil of the ECG input cable.

NOTE: If you did not remove the side panel, use a hexagonal socket key with angle to remove the screws on the left side.

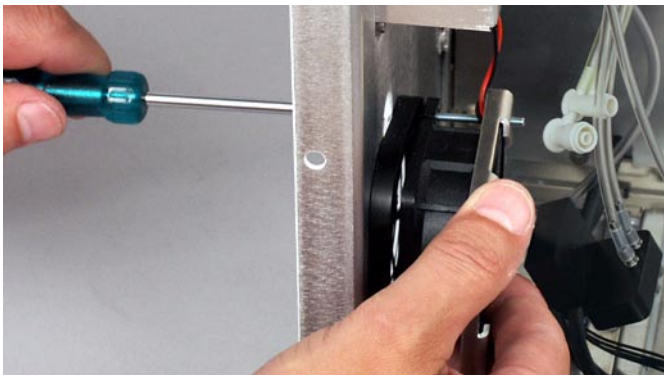
- Remove the cover plate right side ahead.
- When reassembling the back cover plate, guide the cables through the right holes and attach the ECG input cable ferrite coil with a screw.



To replace the following field replaceable parts or to continue the disassembly, follow the instructions below:

- "To remove the fan" on page 48
- "To remove the Remote power and connector board" on page 49
- "To remove the MRI ECG board" on page 51

To remove the fan



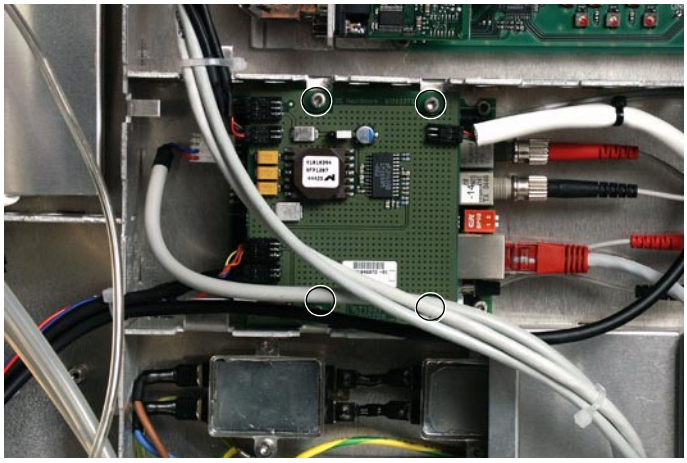
- Disconnect the fan cable from the Remote power and connector board.
- Cut the cable tie holding the cables together.
- Open the filter bracket.
- Unscrew the four hex screws holding the fan assembly to the shield.
  N-MRI2 Rev. 00 screws M3×35mm
  N-MRI2 Rev. 01 screws M3×45 mm

NOTE: When reassembling notice the position of the fan: the arrow points to the inside of the shield.

To reassemble the module, reverse the order of the disassembly steps. Pay special attention to the NOTES during the reassembling.

Always perform appropriate part of the "MRI Monitor Shield service check" after reassembling the monitor.

To remove the Remote power and connector board



Disconnect the following cables from the board:

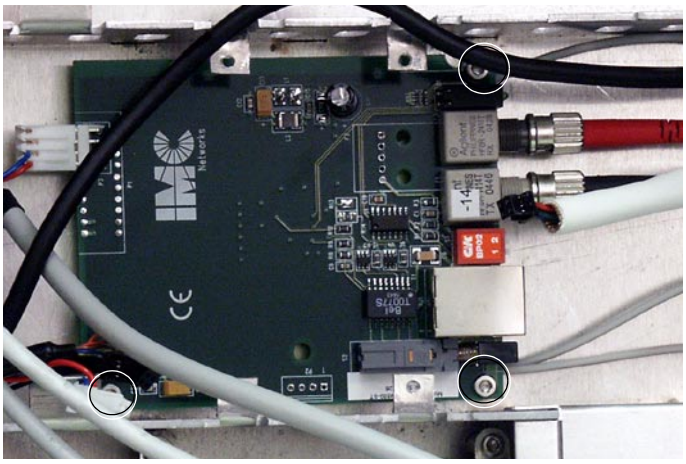
- Cardiac gating cable)
- Power and sound cable
- ECG board to Connector board cable
- Sound cable
- Alarm board cable
- The fan cable

Remove the four hex screws (M3×5 mm) holding the board to the shield.

Lift the Remote power and connector board out.

NOTE: The jumper is installed if the N-MRIREMOTE option is assembled.

To remove the NET board



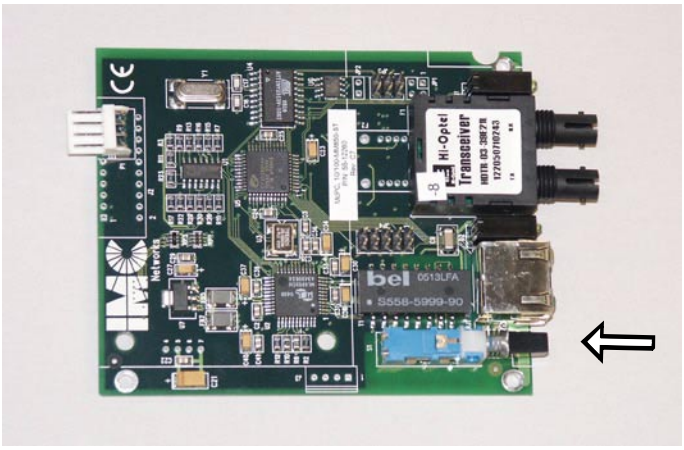
Disconnect the following cables from the board:

- NET Power cable
- The multi fiber optic cables: The connectors are ST type. Release the cables by pulling and turning the connectors a quarter.

NOTE: Notice the position of the fiber optic cables: the red connector is connected to the upper connector on the board.

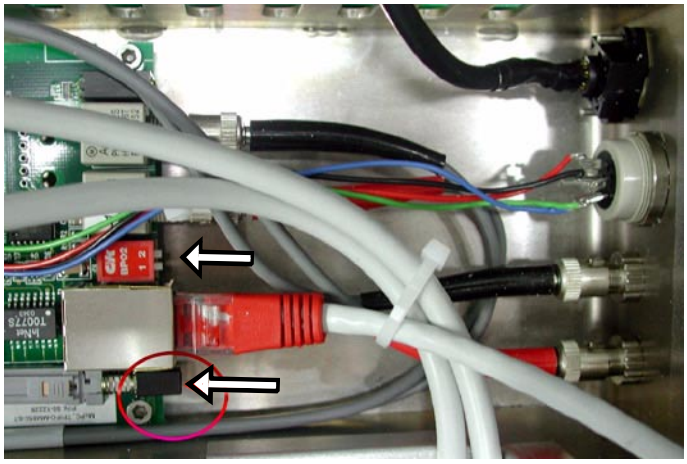
- Cross over cable

Remove the three screws (M2.5) holding the board to the shield.



Lift the NET board carefully out.

NOTE: Notice the position of the push-button switch on the board: the push button is OUT. When reassembling, make sure the switch is in the right position.



Older version

Lift the NET board out.

NOTE: Notice the position of the DIP switch and the push-button switch on the board. When reassembling make sure the switches are in the right position.

- The DIP switches are in lower position.
- The bush button is OUT.

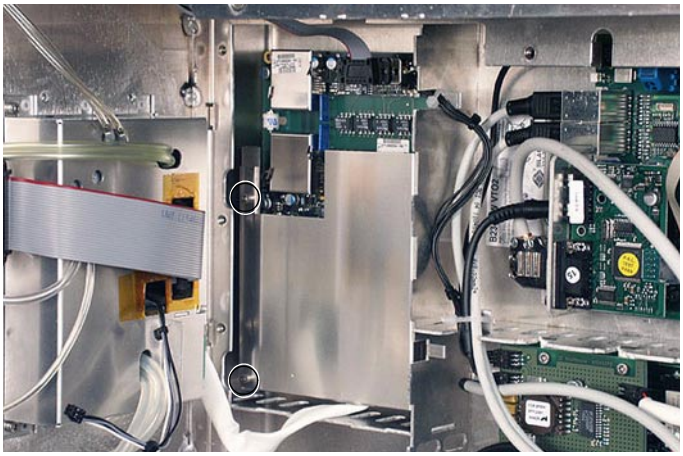
NOTE: To enable the WLAN option with the older version of the NET board, the Crossover cable and the NET ID plug must be disconnected from the MRI Monitor frame.

Reassemble the monitor in reverse order.

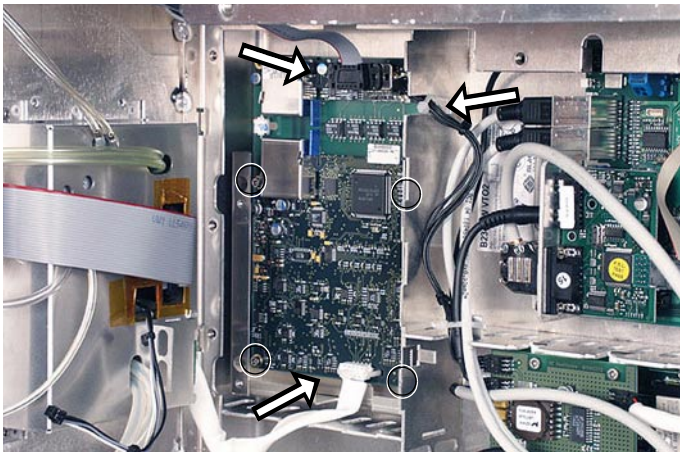
Always perform the “MRI Monitor Shield service check” after reassembling the monitor.

To remove the MRI ECG board

NOTE: Wear antistatic gloves (ESD) when handling PC boards. Electrostatic discharge may damage components on the board.



- Remove the two screws (M2.5) holding the ECG top cover plate. Shift the cover plate a little to the right and lift it up.



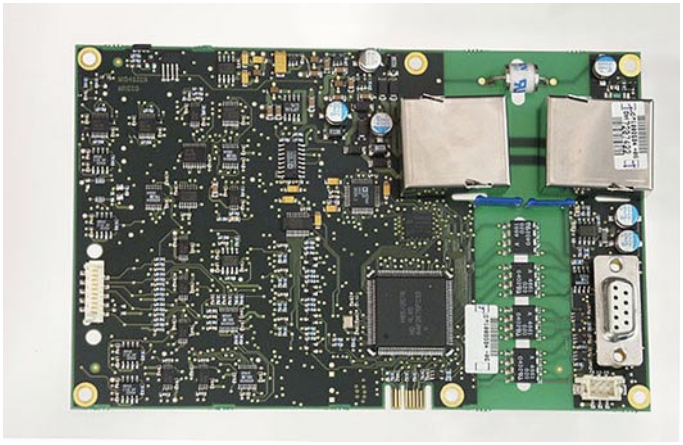
Disconnect the following cables:

- ECG input cable: Cut the cable tie securing the ECG input cable connector to the board.

NOTE: When reassembling, make sure to reassemble the cable tie.

- ECG serial cable
- ECG board to connector board cable

Unscrew the four (M2.5) screws holding the board to the shield.



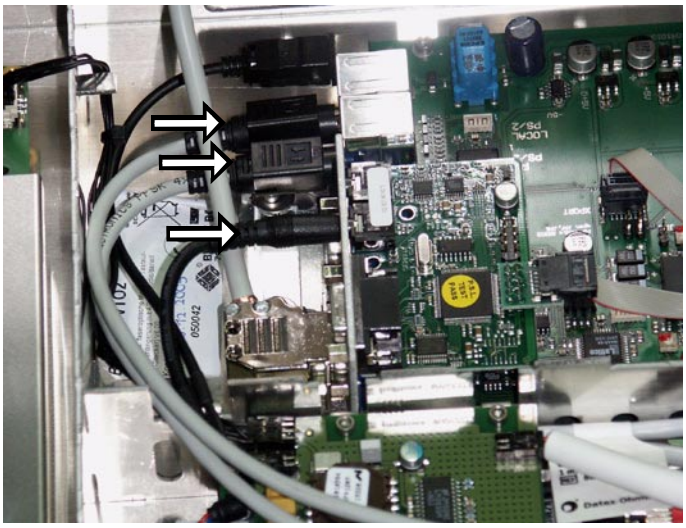
Lift the ECG board out.

Reassemble the monitor in reverse order.

Always perform the "MRI Monitor Shield service check" after reassembling the monitor.

To remove the KVM extender

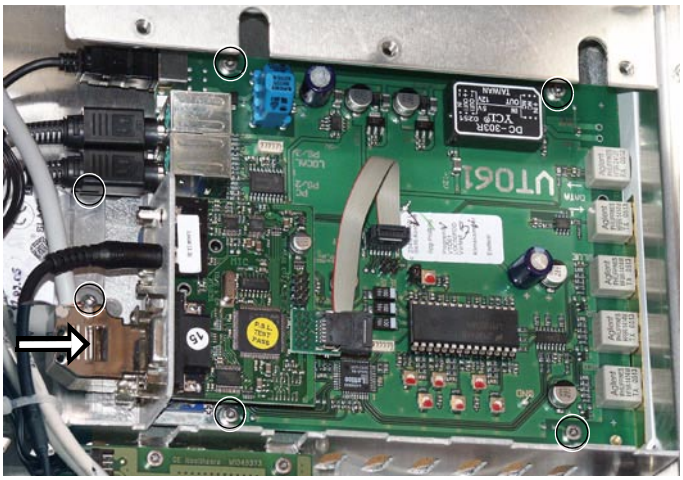
NOTE: Wear antistatic gloves (ESD) when handling PC boards. Electrostatic discharge may damage components on the board.



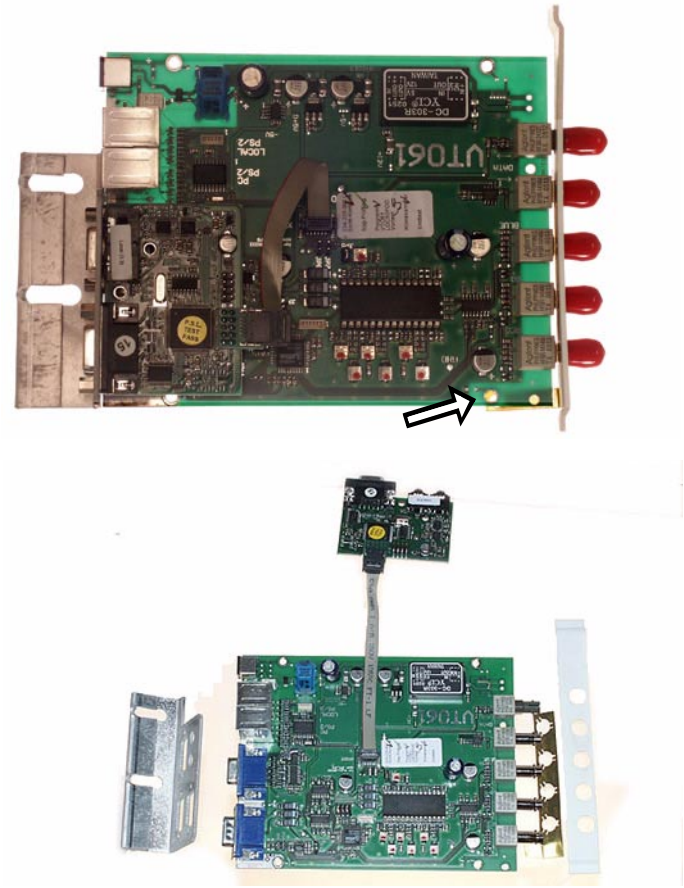
Disconnect the following the cables:

- Power and Sound cable (two connectors)
- Remote Keyboard connector cable
- Remote keyboard cable

When reassembling, plug the cables in the lower connectors.

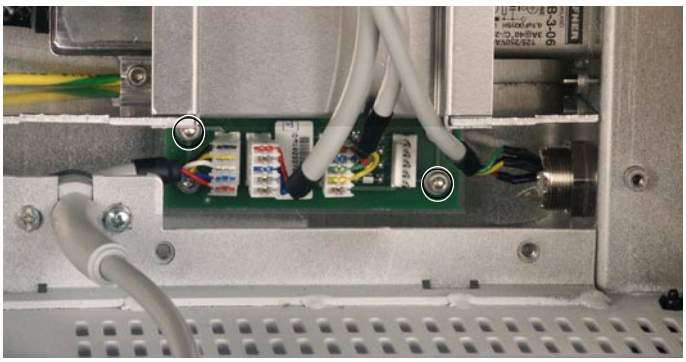


- Unscrew the six screws (M3×5mm) holding the KVM extender board.
- Lift the boards up.
- Unscrew the hex screw (M5.5) securing the VGA cable connector and disconnect the cable.



NOTE: When reassembling the board make sure to reassemble the grounding plate and secure it with the screw.

To remove the N-MRI2 Keyboard filter board



Disconnect the following cables:

- Keyboard cable
- NET Power cable
- Remote Keyboard cable/ Keyboard cable

Unscrew the two screws (M3×5 mm) holding the board to the shield.

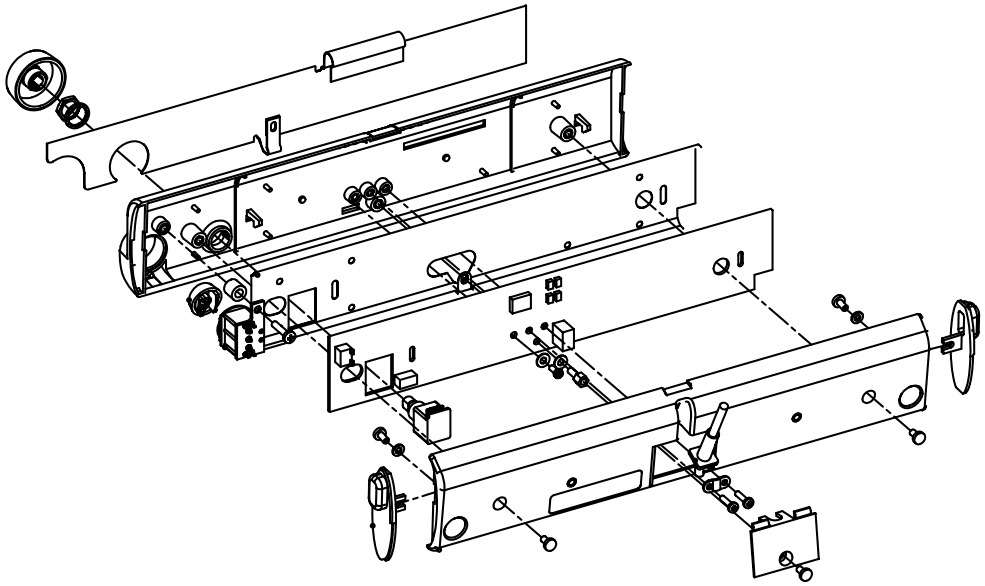
Reassemble the monitor in reverse order.

Always perform the "MRI Monitor Shield service check" after reassembling the monitor.

3.7.5 LCD Display, D-LCC19-01

Do not disassemble.

3.7.6 Command Bar, K-MRIANEB



The Command Bar is disassembled according to the following procedure. Please refer to the exploded view of the Command Bar.

1. Disconnect the Command Bar cable from the Remote Unit.
2. Unscrew the three screws holding the front cover of the Command Bar to the rear cover. Carefully remove the rear cover.
3. Disconnect the Command Bar cable, the wire set from the ON/STBY switch and the flat cable from the membrane keyboard.
4. Detach the Command Bar PCB by pressing the two plastic fasteners holding the PCB in place and simultaneously lifting off the PCB.
5. The Command Bar is reassembled by reversing the disassembly procedure.

4 Troubleshooting

4.1 General (MRI Shield and Monitor Frame)

Trouble	Cause	What to do
Monitor is not starting	**On/Stby** key pressed too long.	**On/Stby** key may be pressed for less than 10 s.
	The batteries are empty.	Connect the power cord.
	On/Stby key may be faulty.	Replace the Display Unit side panel keyboard foil.
	If power cord connected. If the On/Stby LED is lit or blinks. AC/DC power unit may be faulty.	Replace the AC/DC power unit.
	If the Frame unit fan is running. If AC/DC power unit is working, the PMB in the Frame Unit may be faulty.	Replace the PMB.
Monitor is not starting, the Frame Unit back panel LED is lit. (NOTE: The LED is inside the MRI shield, not visible.)	The connection between Frame Unit and Display Unit may be faulty.	Check the connector and the cables between Display Unit and Frame Unit.
	Display Unit voltages are not OK.	Replace the Display Unit DC/DC power board.
	Faulty Central Processing Board.	Replace the Central Processing Board.
The monitor starts (Frame Unit back panel LED is lit and a beep is heard), but the display remains black. (NOTE: The LED is inside the MRI shield, not visible.)	The MRI Frame Unit LCD display cables are loose.	Check the LCD cables and connectors on the Central Processing Board and in the Front Unit.
	The backlights are not lit.	Connector Board cable may be loose. Check the cable. Backlights may be faulty. Replace them. Backlight inverter may be faulty. Replace the inverter.
Module data disappears from the screen.	Parameter module current (in PMB) too high.	Detach and change the parameter module. PMB module power section may be faulty. Replace the PMB.
E-MRIPSN module data disappears from the screen.	The monitor is too close to the magnet.	Move the monitor further off from the magnet.
Keyboard not working, but module communication is OK.	Keyboard cables and connectors, or Connector Board cable and connector may be faulty.	Check the Connector Board cable and connector. Check the keyboard cable connection to the connector board.

Trouble	Cause	What to do
Keyboard not working, and module communication not working.	UPI section of the Central Processing Unit not functioning normally.	Restart the monitor. Replace the Central Processing Board.
Keyboard partly not working.	One or many buttons from the shield keyboard missing.	Check that the keyboard buttons are in place inside the Front cover of shield.
Keyboard partly not working.	Faulty keyboard.	Replace the keyboard foil.
	Faulty Connector Board.	Replace the Connector Board.
'Battery failure' message on the display.	Problem in communication between Display Unit and Frame Unit (the PMB serial number and other data faulty in Service View).	Check the connectors and cables between Display Unit and Frame Unit of the F-MRICM1 Monitor.
	PMB in Frame Unit may be faulty.	Replace the PMB.
'Battery temperature high' and 'Check dust filter' messages.	The temperature of the batteries is more than 53°C.	Check and change the dust filters if necessary.
'Display temperature high' and 'Check dust filter' messages.	The temperature inside the Display Unit has been more than 55°C for two minutes at the minimum.	Check and change the dust filter if necessary.
'Frame temperature high' and 'Check dust filter' messages.	The temperature inside the frame is more than 55°C.	Check and change the dust filters if necessary.
Display Unit is too warm. Temperature is high.	Display Unit Fan is not working.	Check that the Fan cable is connected to the correct connector.
	Shield Fan is not working.	Check that the Fan cable is connected to the correct connector.
	One of the fans may be assembled in wrong position.	Check that the fan blows the air towards the inside of the monitor.
Recorder is not working properly.	Recorder communication problem.	Check the connectors and cables between Display Unit and Frame Unit.
	Problem in voltages in Frame Unit.	Check the Frame Unit voltages from the service menu. If not OK, replace the PMB.
After shutdown, the trend and patient data does not remain 15 min in the memory.	The On/Stby switch has been pressed for over 10 s. (= service reset)	When switching off, the On/Stby switch has to be pressed for less than 10 s.
	Faulty PMB.	Replace the PMB.

4.2 Software License (service software)

Trouble	Cause	What to do
New software is not downloaded or Start-up display does not appear in 80 seconds.	The software card is not inserted properly.	Check the software card's connection in drive.
	The software card does not contain correct software.	Check that correct software card is inserted in drive.
The software serial number in the Service view is not correct after downloading.	The software has not been downloaded correctly.	Check the software card's connection in drive. Try downloading once again. Try with another software card.

NOTE: You can download the software only on one monitor. During the software downloading the serial number of the monitor is written automatically on the software card. If the loading for some reason failed, the software could be downloaded again on the same monitor, but not on another monitor.

4.3 ECG measurement

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 the heart rate source e.g. in the ECG Setup menu behind the 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. Check that the electrodes are placed as close to each other as possible, in line, as close to the center point of the imaging area as possible.
	Improper skin preparation.	Remove body hair. Clean the attachment site carefully with alcohol.
	Improper bandwidth filter.	Check the filter.
	Faulty/ dirty ECG cable.	Replace the cable.
No ECG trace	Waveform not selected on screen.	Press the **Monitor Setup** key and make adjustments.
	Module not plugged in correctly.	Plug in.
	ECG board signal cables loosen	Connect the ECG board cables properly.
"Noise" message	High frequency or 50/60 Hz noise.	Isolate noise source.

4.4 Memory Option

Trouble	Cause	What to do
'No menus in Menu Card' message	There are no menus in the Menu card.	Insert a Menu Card with valid menu configuration files in the slot.
'Faulty Data Card - change card' message	An error has occurred during Data Card read/write operation	Change Data Card.
'Faulty Menu Card - change card' message	An error has occurred during Menu Card read/write operation	Change Menu Card.

4.5 Recorder Unit

Problem	Cause	What to do
Recorder will not start. No error messages shown.	Connector board loose.	Check connector board connections.
	Recorder board faulty.	Replace the recorder board.
	Recorder unit faulty.	Replace the recorder unit.
Recorder works but nothing is printed on the paper.	Active side of the paper is 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.

Message	Explanation
Recorder: out of paper	Release paper jam or insert a roll of paper into the recorder.
Recorder: cover open	Close the recorder cover properly.
Recorder: thermal array overheat	Recorder overheated. Stop using and allow it to cool down.
Recorder: input voltage low	+15 Vrec is too low. Check the connectors and connector board.
Recorder: input voltage high	+15 Vrec is too high. Check the connectors and connector board.
Recorder system error 1, 2, 3	System error. If the problem persists, replace the recorder unit.
Recorder: module removed	A communication error due to a fault in the recorder or in the Central Processing Board.

4.6 Troubleshooting for the NET section

Symptom at the monitor end	Problem at	Explanation/What to do
Monitor does not connect to the network. Monitor connects to the network, but disconnects unexpectedly ('Network connection down' 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 wall plate or to the monitor.
	Monitor-Network cable	Cable or connector defective.
	NET section of the CPB	The NET section is defective. The board cannot be used. See network service page for details.
	NET section memory of the CPB	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.
	Virtual ID	The virtual ID is corrupted.
Monitor does not connect to the Network	No Network or WLAN Option in the monitor.	Download the Network or WLAN Option from the appropriate software card.
	Network Converter Board problem -connections and cables loosen -board faulty Optical cable problem	Check the cables and replace if needed. Check the board and replace if needed. Check the fiber optic cable and replace if needed.
	With WLAN option the monitor may be in shadow region and not conected to the network.	Check the signal strength. Check that the Central is not shut down. Check that the WLAN card is in its place.

Symptom at the monitor end	**Problem at**	**Explanation/What to do**
'Check network connectors' message shows on the monitor screen	Monitor-Network cable	Cable not connected properly to the wall plate or to the monitor.
		Cable or connector defective.
	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.
	Virtual ID	The virtual ID is corrupted
'Network board error' message shows on the monitor screen	NET section of the CPB	The NET section is defective. The board cannot be used. See network service page for details.
	NET section memory of the CPB	The SRAM 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	Network manager's print server is busy at the moment and cannot take more print jobs. Try again after 15 seconds.
	Print queue is full	There are too many unprinted documents waiting in the print queue. Check the printer, as it is not operating properly.
	Printer is off-line	Printer cable is loose, printer is out of paper, there is a paper jam or the printer is simply switched to off-line state.
Record keeper menus are blank	There are no menus for the record keeper	Run Network Setup to verify the current set up.

4.7 19” LCD Display, D-LCC19-01

Please refer also to the display’s user documentation.

Trouble	Cause	What to do
Picture is unclear. Colors are not perfect.	The display is faulty.	Replace the display.
	The connection to the remote extender is not proper.	Connect the display cables properly to the remote extender.
	The remote extender settings are wrong.	See the troubleshooting and settings in the remote extender manual (Appendix D of this TRM)
	The fiber optic cable is defective.	Replace the fiber optic cables.
	The remote extender board is defective.	Replace the remote extender board.
	The Display cable is defective.	Replace the Display cable.

4.8 Command Bar, K-MRIANEB

See Keyboard Service Menu in “Service Menu Slot”, and perform the tests available. If any of the tests fail, see explanation below.

Problem	Cause	What to do
ON/STBY switch not working	In K-MRIANEB the ON/STBY key is not intended to work.	In K-MRIANEB it is OK.
ComWheel not working	ComWheel leads broken or connector loose. ComWheel faulty.	Check the items. Replace the ComWheel if necessary.
Membrane key not working	Switch cable loose or broken. Keyboard cable loose or broken. Cable connector pin failure. RS232 communication failure on CPU board.	Check the items. Replace them if necessary.
	Fiber-optic cable loose or broken.	Check the cable, Replace if necessary.
	Failure on Power and connection board	Check the jumper position is OK. Check the board. Replace if necessary.
	Failure on the KVM extender or Sound and screen converter or loose connections, power off.	Check the connections. See Appendix D for KVM extender: troubleshooting and seven digit segment display diagnostics.

4.9 Sound

Trouble	Cause	What to do
Alarm sound not working on the remote display.	Remote screen sound cable not connected properly.	Connect the remote screen cable properly.
	Sound and screen converter faulty.	Replace the Sound and screen converter.
	Fiber optic remote cable is defective.	Replace the fiber optic remote cable.
	Sound cable to sound and screen converter inside the shield not attached properly.	Connect the cables properly.

5 Earlier revisions

This manual fully supports the earlier revisions of:
MRI Monitor Shield, N-MRI2

There are no earlier revisions of the following products:
MRI Net Option, N-MRINET
Active Remote Screen Option, N-MRIREMOTE
19” LCD Display, D-LCC19-01 (M1057466)
Command Bar, K-MRIANEB

APPENDIX A Service check form; Shield for MRI Monitor, N-MRI2

Customer		
Service	Module type	S/N
Service engineer		Date

Monitor Installation			
F-	E-	E-	
S-	E-	M-	
L-	M-	N-	

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual inspection	**OK**	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. MRI ECG board	☐	☐	☐	2. Sound and screen converter board	☐	☐	☐
3. NET board	☐	☐	☐	4. Remote power and connector board			
5. MRI2 Keyboard filter board	☐	☐	☐	6. Patient connector panel	☐	☐	☐
7. Mechanical parts	☐	☐	☐	8. Cables	☐	☐	☐
9. Front cover; MRI2 Magnet field alarm board	☐	☐	☐	10. External parts; MRI Shield	☐	☐	☐
11. External parts; Front cover	☐	☐	☐				
Field replaceable parts							
1. MRI Shield fan filters	☐	☐	☐	2. D-fend O-rings	☐	☐	☐
Notes							

Functional inspection							
	OK	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Stand-by LED	☐	☐	☐	2. Start-up	☐	☐	☐

3. Monitor screen configuration	☐	☐	☐	4. Monitor software	☐	☐	☐
5. Content of service log	☐	☐	☐				
Notes							

ECG measurement				S/N			
1. ECG board software (serial numbers)							
	OK	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
2. Communication and memories	☐	☐	☐	3. Power frequency	☐	☐	☐
4. Lead detection	☐	☐	☐	5. Test with the patient simulator	☐	☐	☐
Notes							

MRI Shield reassembly		**OK**	**N.A.**	**Fail**
Magnetic field alarm		☐	☐	☐
MRI monitor front panel				
1. Alarm LEDs		☐	☐	☐
2. Membrane keys		☐	☐	☐
3. ComWheel		☐	☐	☐
Data Card function	S/N	☐	☐	☐
Recorder	S/N	☐	☐	☐

Network Option				**S/N**			
	OK	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Connection to Network	☐	☐	☐	2. Ethernet address	_____		
3. Data counters	☐	☐	☐	4. Data error counters	☐	☐	☐

5. Hardware error counters	☐	☐	☐	6. Disconnection recognition	☐	☐	☐
Notes							

Wireless LAN option				**S/N**			
	OK	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Signal strenght	☐	☐	☐	2. Connection to the Network	☐	☐	☐
Notes							

Device Interfacing Solution, N-DISVENT	**S/N**	☐	☐	☐
Active Remote Screen Option		☐	☐	☐

Front panel			
2. Membrane keys	☐	☐	☐
3. ComWheel	☐	☐	☐
General			
1. Electrical safety check	☐	☐	☐
2. Service Log reset	☐	☐	☐
3. Final cleaning	☐	☐	☐
Notes			

Used spare parts			

Signature

For your notes:

APPENDIX B Service check form, LCD Display, D-LCC19-01

Customer		
Service	Display type and revision	S/N
Service engineer		Date

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual inspection	**OK**	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Interface cable	☐	☐	☐	2. Check external parts	☐	☐	☐
Notes							

Functional inspection	**OK**	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Power cord	☐	☐	☐	2. LCD display picture			
3. Contrast and brightness adjustments	☐	☐	☐	4. Position adjustments	☐	☐	☐
5. Color temperature adjustments	☐	☐	☐				
Notes							

6. Electrical safety check	☐	☐	☐	7. Functioning after safety check	☐	☐	☐
8. Final cleaning	☐	☐	☐				

Notes

Used spare parts			

Signature

For your notes:

APPENDIX C Service check form, Command Bar, K-MRIANEB

Customer		
Service	Keyboard type	S/N
Service engineer		Date

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual inspection	**OK**	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Cable	☐	☐	☐	2. Front cover and front panel sticker	☐	☐	☐
3. ComWheel cover	☐	☐	☐	4. Stand-by LED	☐	☐	☐
Notes							

Functional inspection			
1. Command bar software	KB		
2. Membrane keys ☐ ☐ ☐		3. ComWheel ☐ ☐ ☐	
Notes			

4. Electrical safety check	☐	☐	☐	5. Functioning after electrical safety check	☐	☐	☐
6. Final cleaning	☐	☐	☐				

Notes

Used spare parts			

Signature

For your notes:

APPENDIX D

KVM Extender

http://www.ihse.de

http://www.ihse.com/pdf/b235-9w_e.pdf

Quick Setup

Installation

Adjustment

Monitor Setup

Troubleshooting

Fiber-optical Converter FOC

http://www.imcnetworks.com

http://www.imcnetworks.com/Adocs/Support/55-80226-01-A0.pdf

Installation Guide:

Installation

LED operation

Troubleshooting

Welcome to the VTO2/VRO2 V6.00 KVM-Extender Family!

Thank you for purchasing a VTO2/VRO2 V6.00 KVM-Extender model. We appreciate your business, and we think you'll appreciate the many ways that your enhanced keyboard/video/mouse system will save you money, time, and effort.

That's because our VTO2/VRO2 V6.00 KVM-Extender not only allows you to remotely locate a console (Monitor, Keyboard, Mouse + optional serial/audio devices) over great distances without any loss in signal quality (up to 1000m/3250ft) but also to do this in an EMI hazardous environment.

Wherever you have great distances: airports, roller plants, distributed data centres; or in a range of applications where you have large electromagnetic generators or loads, magnetic resonance tomographs, induction furnaces, current generators; the VTO2/VRO2 V6.00 KVM-Extender is a solution for remotely locating your console. Three different models cover a range of applications: a VGA-only extender – for when you just need a remote display screen; a KVM extender for a standard remote console – Monitor, Keyboard and Mouse; and a third unit with KVM extension and additional serial and bi-directional audio support. This device is also suitable for computers equipped with a serial mouse or touch screen.

This manual will tell you all about your new VTO2/VRO2 V6.00 KVM-Extender, including how to install, operate, and troubleshoot it. For an introduction to the Extender, see **Chapter 2**. The Extender product codes covered in this manual are:

K234-9W: KVM-Extender for VGA, PS2-Keyboard/Mouse + Serial/Audio

K235-9W: KVM-Extender for VGA, PS2-Keyboard/Mouse

K236-9W: Extender for VGA only

Copyrights and Trademarks

Information in this document is subject to change without notice and the manufacturer shall not be liable for any direct, indirect, special, incidental or consequential damages in connection with the use of this material.

All trademark and trade names mentioned in this document are acknowledged to be the property of their respective owners.

Disclaimer

While every precaution has been taken in the preparation of this manual, the manufacturer assumes no responsibility for errors or omissions. Neither does the manufacturer assume any liability for damages resulting from the use of the information contained herein. The manufacturer reserves the right to change the specifications, functions, or circuitry of the product without notice.

The manufacturer cannot accept liability for damage due to misuse of the product or due to any other circumstances outside the manufacturer's control (whether environmental or installation related). The manufacturer shall not be responsible for any loss, damage, or injury arising directly, indirectly, or consequently from the use of this product.

Cautions and Notes

The following symbols are used in this guide:

CAUTION. This indicates an important operating instruction that should be followed to avoid any potential damage to hardware or property, loss of data, or personal injury.

NOTE. This indicates important information to help you make the best use of this product.

EUROPEAN UNION DECLARATION OF CONFORMITY

This is to certify that, when installed and used according to the instructions in this manual, together with the specified cables and the maximum cable length <3m, the Units:

K234-9W

K235-9W

K236-9W

are shielded against the generation of radio interferences in accordance with the application of Council Directive 89/336/EEC as well as these standards:

EN 55022:	1999	Class B
EN 55024:	1999	
IEC 61000-4-2:	2001	
IEC 61000-4-3:	2001	
IEC 61000-4-4:	2001	
EN 61000-3-2	2001	
EN 61000-3-3	2002	

The device was tested in a typical configuration with PC.

CE

Safety Precautions and Installation Guidelines

To ensure reliable and safe long-term operation, please note the following installation guidelines:

- Only use in dry, indoor environments.
- The Remote unit, Local unit and any power supplies can get warm. Do not locate them in an enclosed space without any airflow.
- Do not place a power supply directly on top of a unit.
- Do not obstruct a unit's ventilation holes.

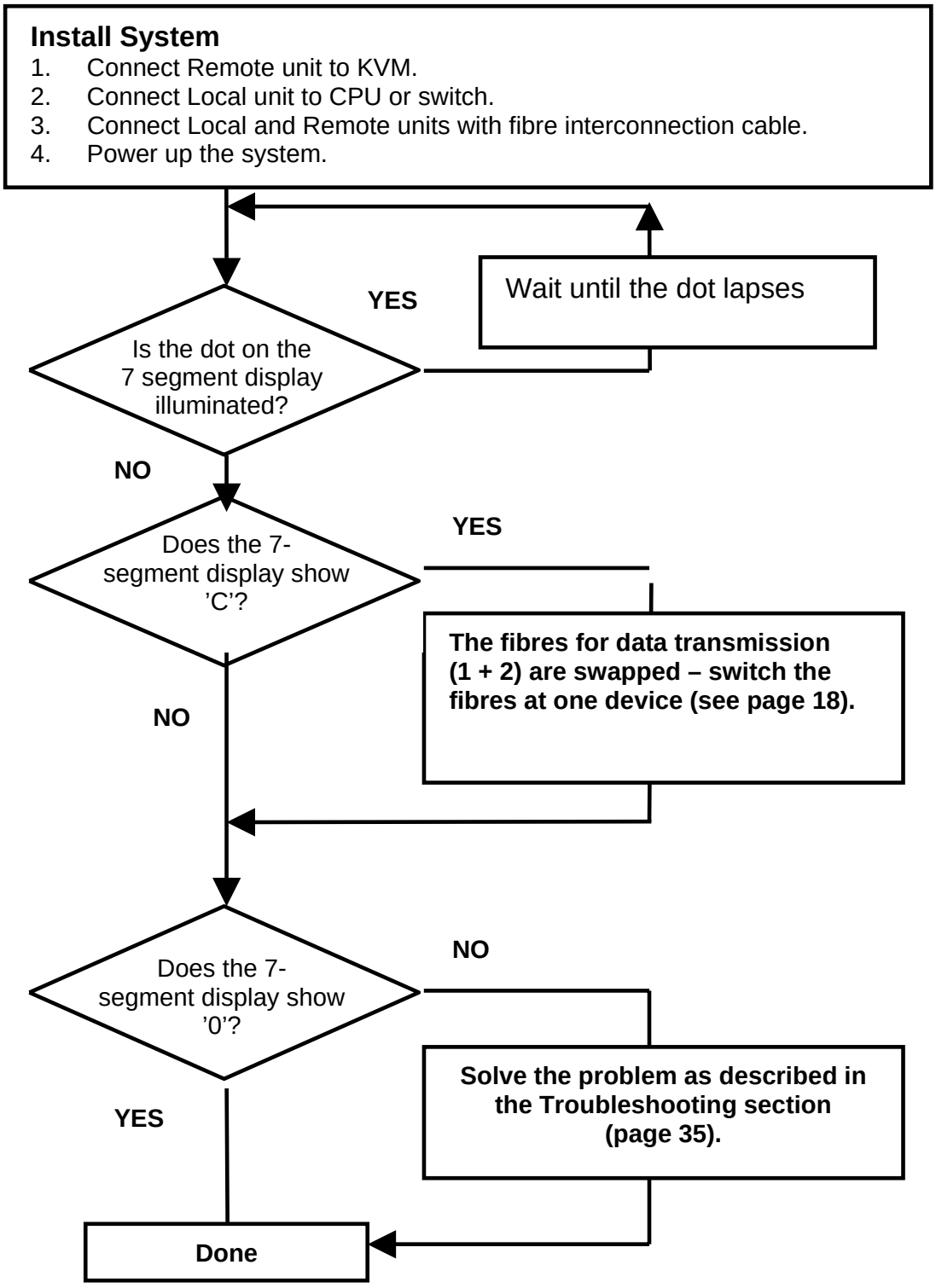
To safeguard against personal injury and avoid possible damage to equipment or property, please observe the following:

- Only use power supplies originally supplied with the product or manufacturer-approved replacements. Do not attempt to dismantle or repair any power supply. Do not use a power supply if it appears to be defective or has a damaged case.
- Connect all power supplies to grounded outlets. In each case, ensure that the ground connection is maintained from the outlet socket through to the power supply's AC power input.
- Do not attempt to modify or repair this product

Contents

1. Quick Setup

This section briefly describes how to install your KVM extender system and optimise the video signals. Unless you are an experienced user, we recommend that you follow the full procedures described in the rest of this manual.



2. Overview

2.1 Introduction

With a fibre KVM Extender you can dramatically increase the maximum distance between a CPU and its Console – the keyboard/mouse and monitor (+ serial/audio devices). In addition, they are essential for installations in hazardous EMI environments. Normal keyboard/mouse/monitor extender cables (and Extenders using regular cables) have lower extension capabilities and EMI interference may further reduce the maximum distance and reliability. The VTO2/VRO2 fibre optical KVM Extender System has none of these limitations. Locate your CPU in a secure cabinet or data centre and access it remotely from a distance of up to 1000m.

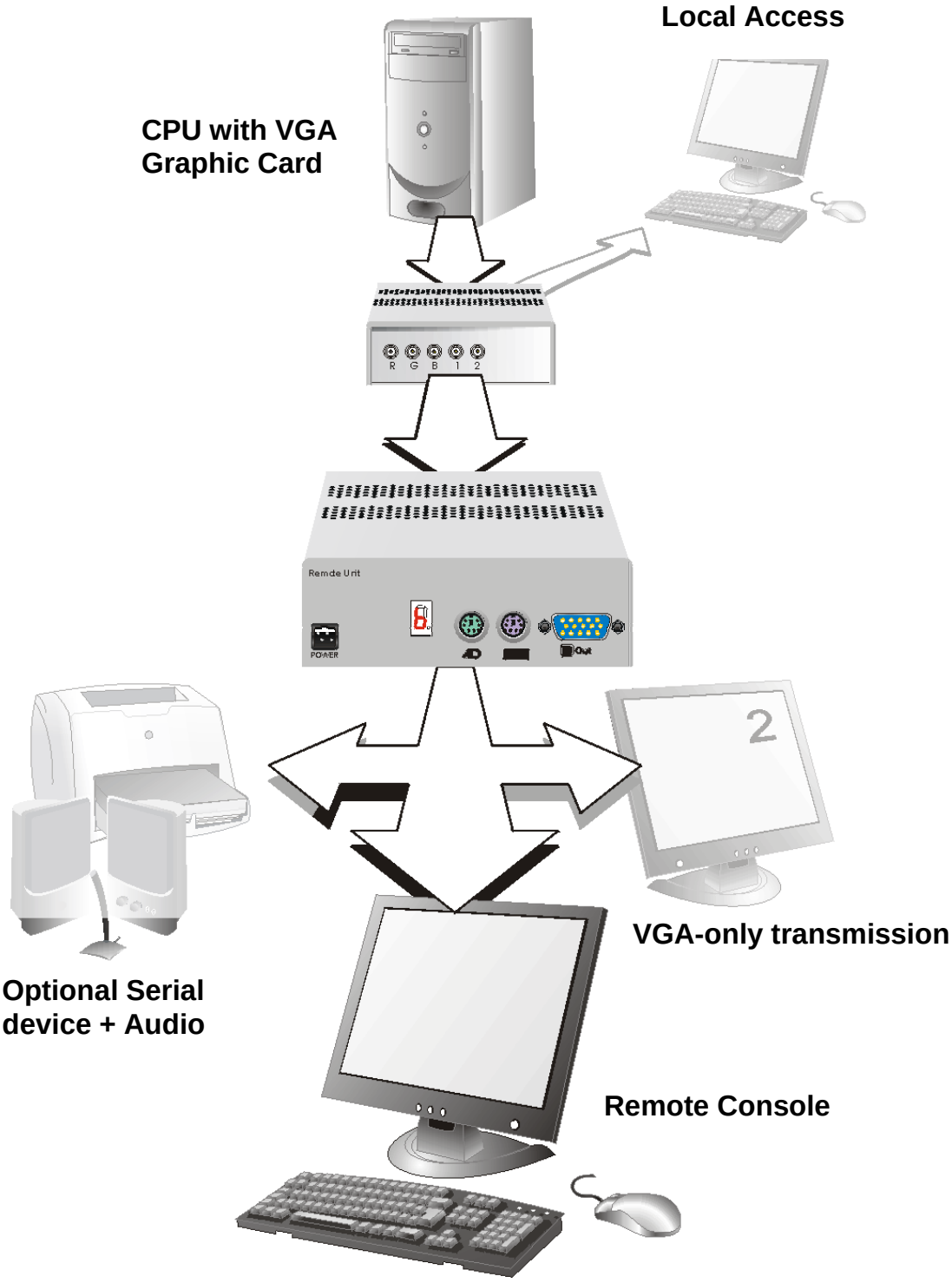
A basic KVM extension system comprises a *Local* unit (transmitter) and a *Remote* unit (receiver). The Local unit connects directly to the computer (or a KVM switch system) using the supplied cable(s). The user *console* (keyboard, mouse and monitor) attaches to the Remote unit. The Remote and Local units communicate video and data information along the interconnecting cable. Local units offer dual access, allowing the connection of a second user console close to the computer. With the optional upgrade kit, you can also use the units to communicate stereo audio and serial port signals.

2.2 Glossary

The following terms are used in this guide:

Multimode	Any multimode 3/5-fibre cable 50/125µ or 62.5/125µ (depending on device type)
PSU	The desktop power supply connected to the Local/Remote unit.
KVM	Keyboard, Video (monitor) and Mouse.
Console	A keyboard, monitor, and mouse, plus optional serial/audio devices.
Dual Access	A system allowing connection of Local and Remote user consoles.
RGB	Video signal, consisting of R (red) G (green) and B (blue) signals. The signals have a level of 0.7Vpp. The Green-Signal also carries the (composite) synchronisation signals.
RGBS	Video signal, consisting of R (red) G (green) and B (blue) signals and the additional (composite) SYNC signal. All signals have 0.7Vpp.
VGA (also called RGBHV)	Video signal, consisting of R (red) G (green) and B (blue) signals and the additional horizontal/vertical synchronisation signals. The colour signals have a level of 0.7Vpp, the synchronisation TTL (5Volts).

VTO2/VRO2 KVM-Extender System



2.3 Features

The VTO2/VRO2 V6.00 KVM-Extenders offer the following features:

- Support for VGA Graphic Cards (all models).
- Support for PS2-Keyboard and PS2-Mouse. Intelligent PS/2 keyboard and mouse emulation ensures PCs do not lock up and allows peripherals to be hot-plugged (K235-9W and K234-9W only).
- Transparent serial port (on K234-9W only) enables any serial device to be extended (up to 19.2K Baud). The serial port may be used to extend one device (requiring handshaking lines) or up to three simple serial devices (no handshaking).
- Bi-directional stereo audio (16-bit digitised) support (K234-9W only) enables high-quality, low-noise, audio extension.
- Maximum Resolution:
  VGA: 1280x1024@75Hz.
- Status indicator LED on each device.
- 7-Segment diagnostic display on Remote Unit aids troubleshooting.
- Small footprint chassis.
- Rack mount options available.
- CPU KVM-cable (1.8m) + universal PSU included.

2.4 Product Range

There are three products in the range and various mounting options:

VTO2/VRO2 - Extender	
K234-9W	KVM-Extender for VGA, PS2-Keyboard/Mouse Serial/Audio
K235-9W	KVM-Extender for VGA, PS2-Keyboard/Mouse
K236-9W	Extender for VGA only
Upgrade Kits	
437-1G	19”/1U Rack Mount Kit (RMK) to mount up to 3 devices in a 1U rack space
285-2K	Mounting brackets to mount by screws
286-2K	Mounting brackets to mount by snap-on

2.5 Compatibility

Interface Compatibility

- **VGA (also called RGBHV):** Video signal, consisting of R (red) G (green) and B (blue) signals and the additional horizontal/vertical synchronisation signals. The colour signals have a level of 0.7Vpp, the synchronisation TTL (5Volts).
- **RGB:** Video signal, consisting of R (red) G (green) and B (blue) signals. The signals have a level of 0.7Vpp. The Green-Signal also carries the (composite) synchronisation signals.
- **PS/2 Keyboard:** Compatible with all standard keyboards. Certain keyboards with enhanced features may also be supported with custom firmware.
- **PS/2 Mouse:** Compatible with all standard 2-button, 3-button and wheel mice.
- **Audio:** Input and output are line-level. Amplified speakers are required. A microphone may be directly connected to the Remote unit (optional pre-amplification).
- **Serial:** Transparent up to 19.2K Baud. The following serial signals are extended: TX, RX, RTS, CTS, DTR, DSR. In rare cases, a wiring adaptor may be required to transfer RI and DCD.

2.6 How to Use This Guide

This guide describes the installation and configuration of the VTO2/VRO2 V6.00 KVM-Extender Series. Although the connection and operation of the system is relatively straightforward, you should consider the following before getting started:

Connection & Compatibility

If you have purchased a *VTO2/VRO2 V6.00 KVM-Extender Kit,* this will contain all the cables required to connect the Local unit to your PC or KVM switch. The Remote console (keyboard, monitor and mouse) and any audio and serial equipment connect directly to the Remote unit.

For information about connection and installation, see ***Installation***, page 13.

Graphic Source (RGB or VGA)

The device can transmit RGB signals as well as VGA. In addition, it is able to convert from VGA to RGB as well as from RGB to VGA.
Factory setting: **VGA** (see page 28).

Fibre Cable (50µ or 62,5µ)

The VTO2/VRO2 V6.00 KVM-Extender can be used with 50µ or 62,5µ fibre cable. The transmission power must be adjusted to the type of cable.
Factory setting: **50µ** (see page 28)

Automatic Gain Control (AGC)

In some applications (e.g. RGB Signals) it may be necessary to switch off the Automatic Gain Control.
Factory setting: Automatic Gain Control **ON** (see page 28)

Compatibility

The devices in version 6.00 are NOT compatible with previous versions.

3. Installation

For first-time users, we recommend that you carry out a test placement, confined to a single room, before commencing full installation. This will allow you to identify and solve any cabling problems, and experiment with the KVM extender system more conveniently.

3.1 Package Contents

You should receive the following items in your extender package:

- VTO2/VRO2 V6.00 KVM-Extender Local Unit
- VTO2/VRO2 V6.00 KVM-Extender Remote Unit
- VGA CPU cable, ZIP type 1,8m (HD15 male / HD15 female, 2 x PS2 male / PS2 male)
  Models K234-9W and K235-9W
- VGA CPU-cable 1,8m (HD15 male / HD15 female)
  Model K236-9W only
- Audio CPU-cable 1,8m (3,5mm Stereo Jack / 3,5mm Stereo Jack)
  Model K234-9W only
- Serial CPU-cable 1,8m (DB9 female / DB9 male)
  Model K234-9W only
- 2 x 6V DC universal PSU
- 2 x power cord
- Manual (Quick Setup)
-

If anything is missing, please contact Technical Support (see **Appendix D – Technical Support**).

3.2 Interconnection Cable Requirements

CPU/Local Unit Connections

To connect the Local unit to your graphic source you will need:

- **VGA (K236-9W):** Connect the supplied VGA CPU-cable 1,8m (HD15 male / HD15 female) to the CPU (KVM - Switch, etc.). Please ensure that the connection is tension-free.
- **VGA, Keyboard, Mouse (K234-9W + K235-9W):** Connect the supplied VGA CPU cable, ZIP type 1,8m (HD15 male / HD15 female, 2x PS2 male / PS2 male) to the CPU (or KVM Switch). Please ensure that the connection is tension-free.

Power Supplies

Connect the supplied 6V/DC power supplies to the ***Plug*** terminals on the rear of both the Local and Remote units.

Local Unit/Remote Unit Connection

To connect the Local and Remote units you will need:

- **Multimode Fibre Cable:** 3 Fibres 50µm or 62.5µm – ST-plugs. (K236-9W)
- **Multimode Fibre Cable:** 5 Fibres 50µm or 62.5µm – ST-plugs. (K234-9W+K235-9W)

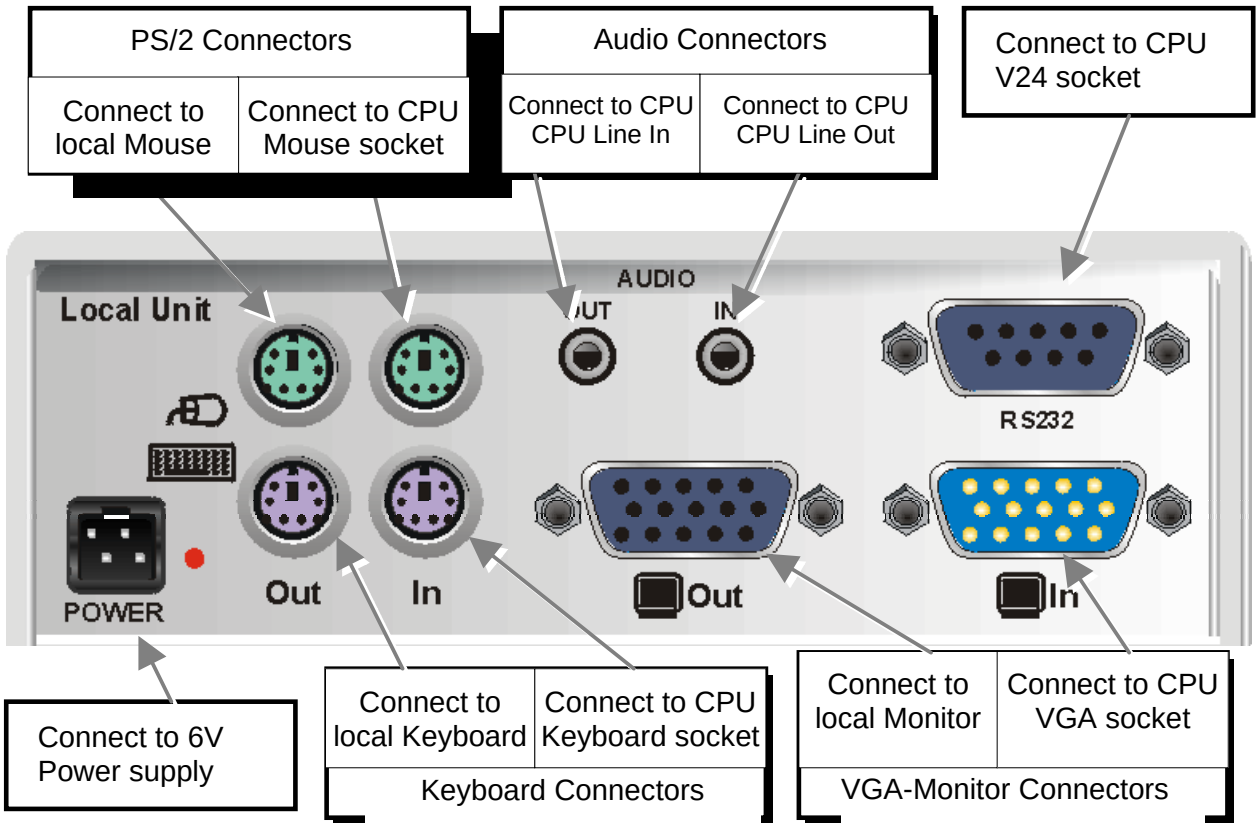
3.3 System Setup

To install your VTO2/VRO2 V6.00 KVM-Extender system:

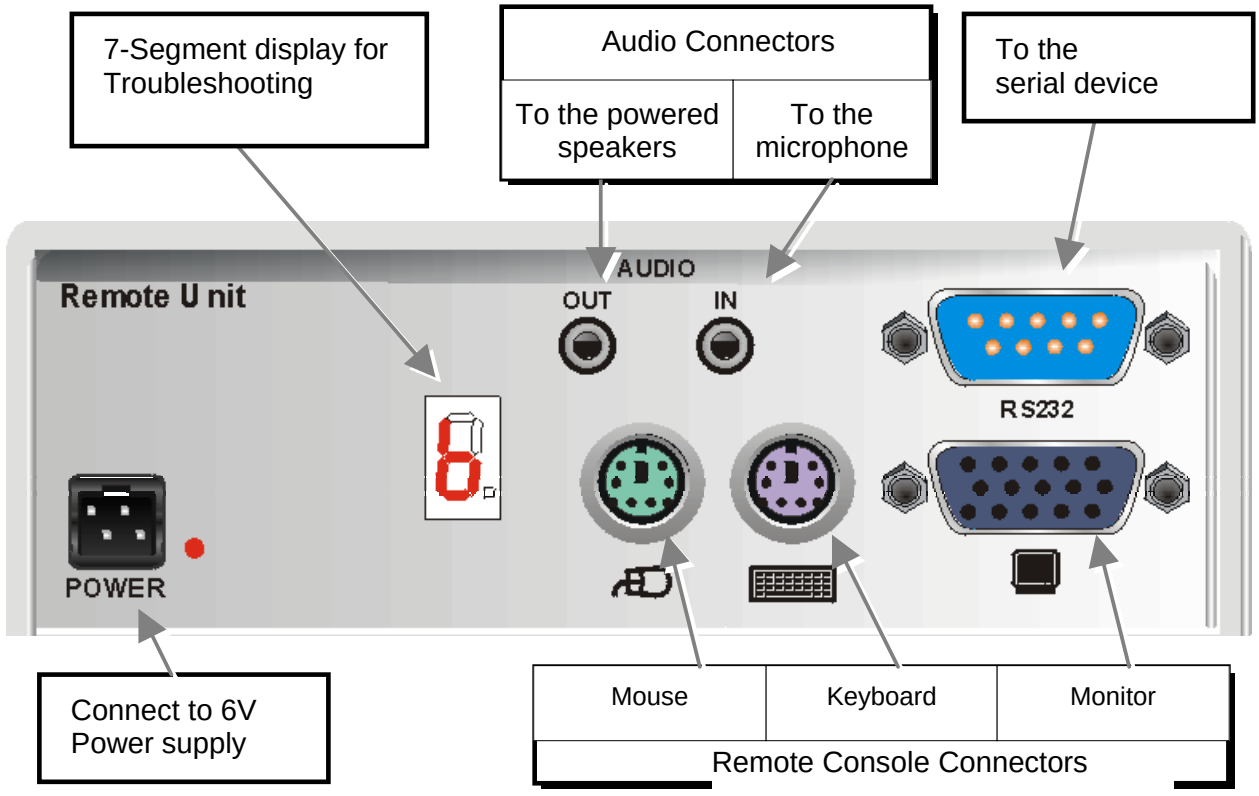
1. Switch off all devices.
2. Connect your keyboard, monitor, mouse, audio device and serial device to the Remote unit (depending on type of device). Ensure that you attach the keyboard and mouse connectors to the correct ports. The keyboard connector is purple; the mouse connector is green.
3. Connect the CPU to the Local Unit, using the supplied CPU cable. Ensure that you attach the keyboard and mouse connectors to the correct ports. The keyboard connector is purple; the mouse connector is green.
4. Connect the 6V power supplies to the Local and Remote units.

Only use the power supply originally supplied with this equipment or a manufacturer-approved replacement.

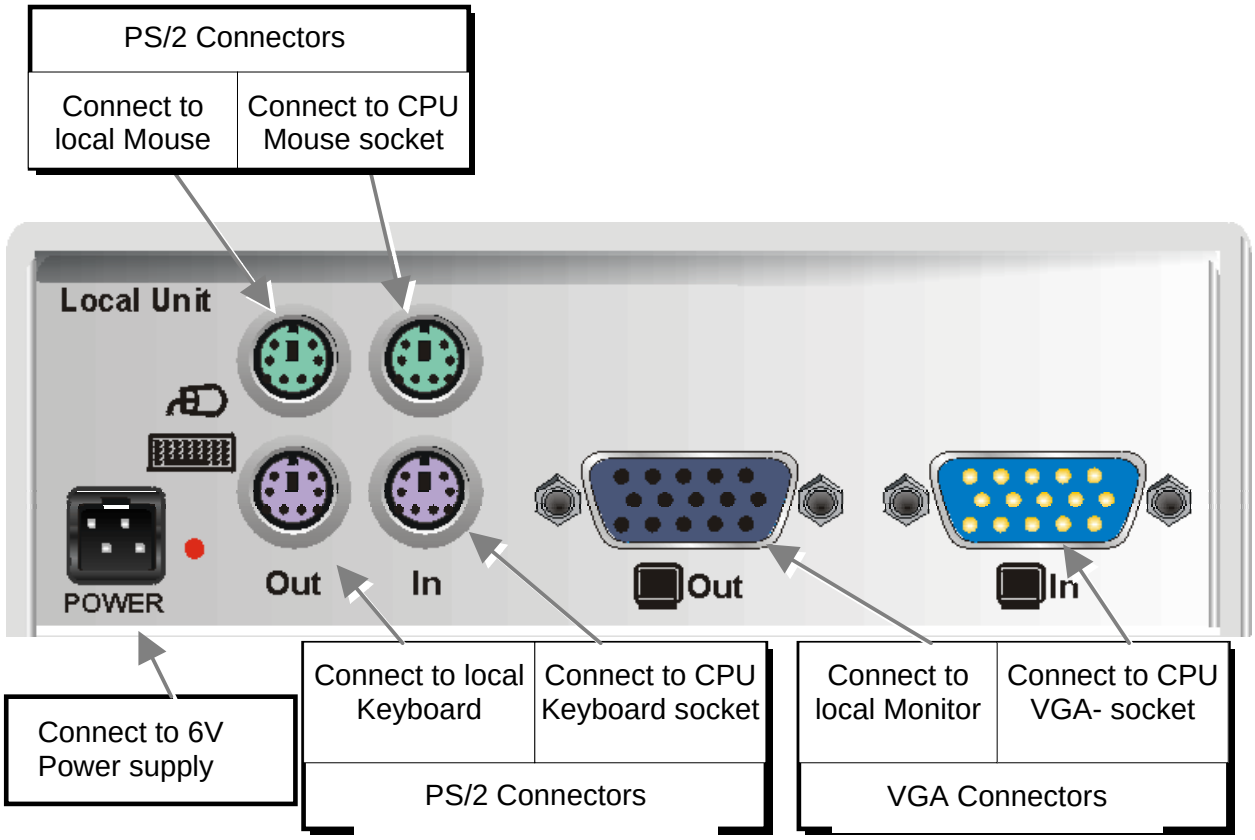
5. For a dual access system, connect the keyboard, mouse and monitor for the Local console to the appropriate ports on the Local unit. The ports may also be used to feed into a KVM switch.
6. Connect the Interconnection cable (Multimode Fibre Cable) from the Remote unit to the Local unit. Ensure that you attach the fibre connectors to the correct ports. R goes to R, G to G, B to B, 1 to 1 and 2 to 2.
7. Power up the system.



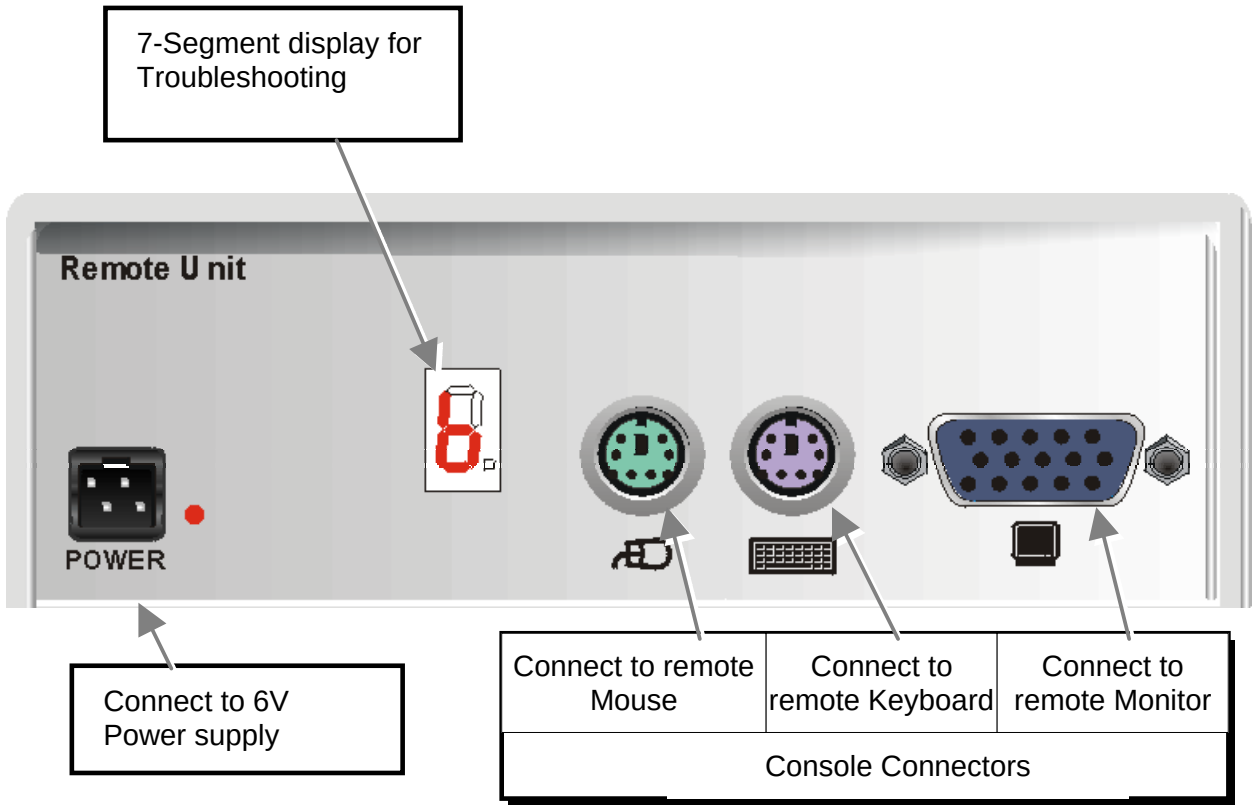
VTO2/VRO2 V6.00 KVM-Extender Type K234-9W Local Unit



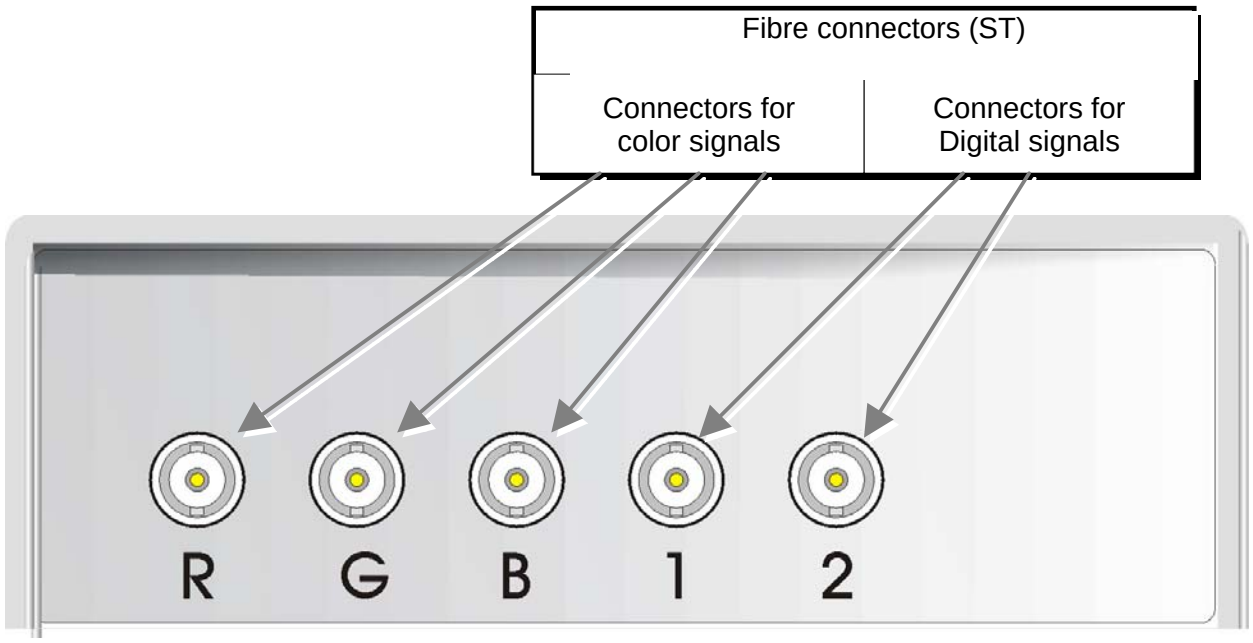
VTO2/VRO2 V6.00 KVM-Extender Type K234-9W Remote Unit



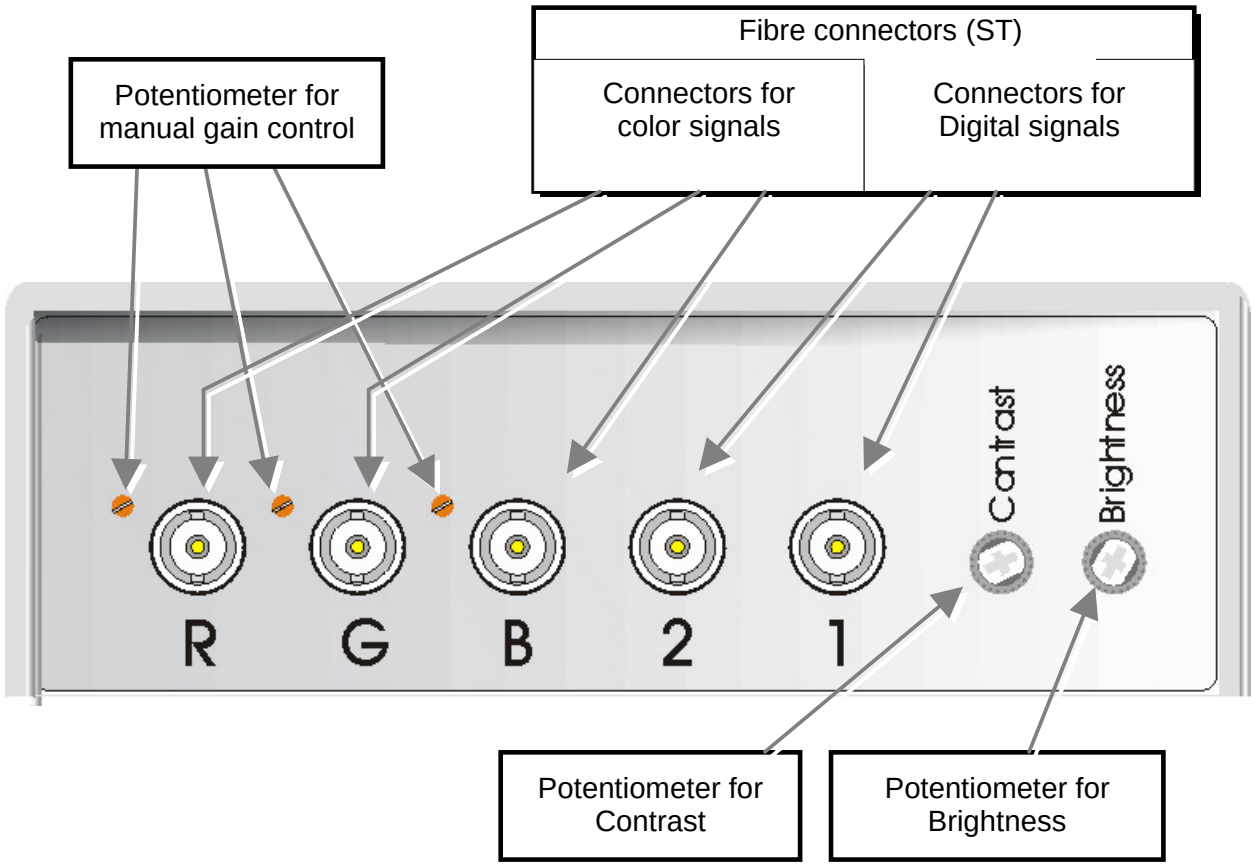
VTO2/VRO2 V6.00 KVM-Extender Type K235-9W Local Unit



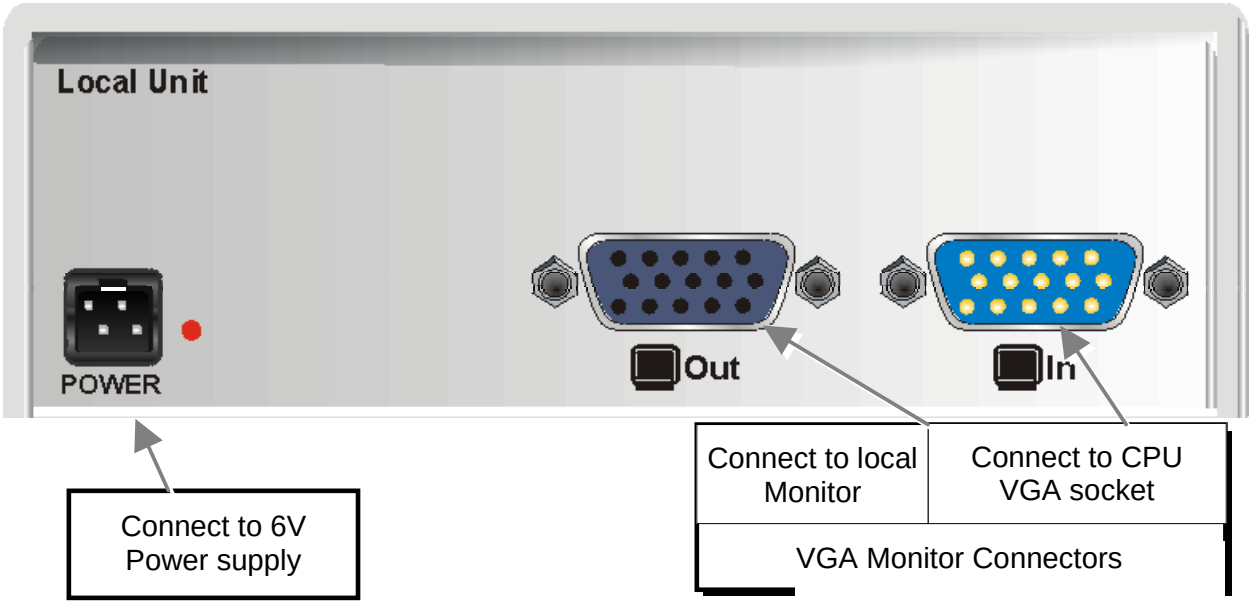
VTO2/VRO2 V6.00 KVM-Extender Type K235-9W Remote Unit



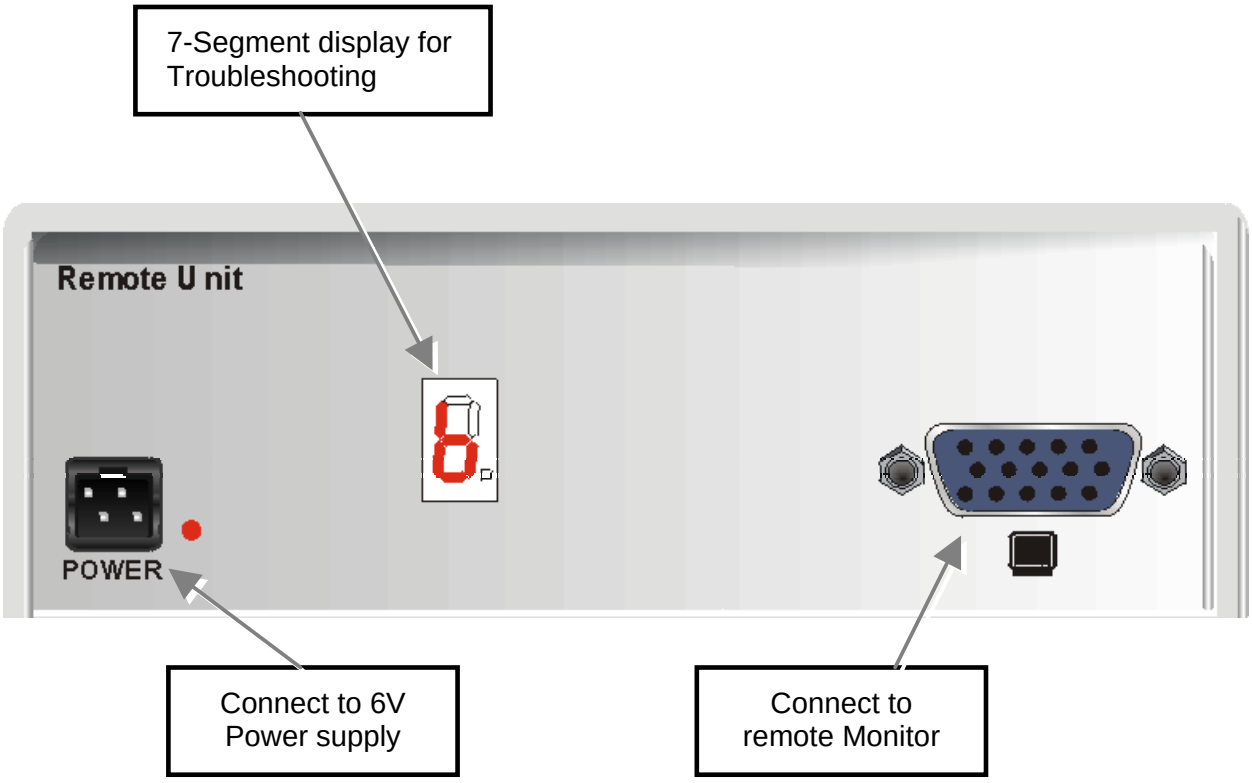
VTO2/VRO2 V6.00 KVM-Extender Type K234-9W + K235-9W Local Unit



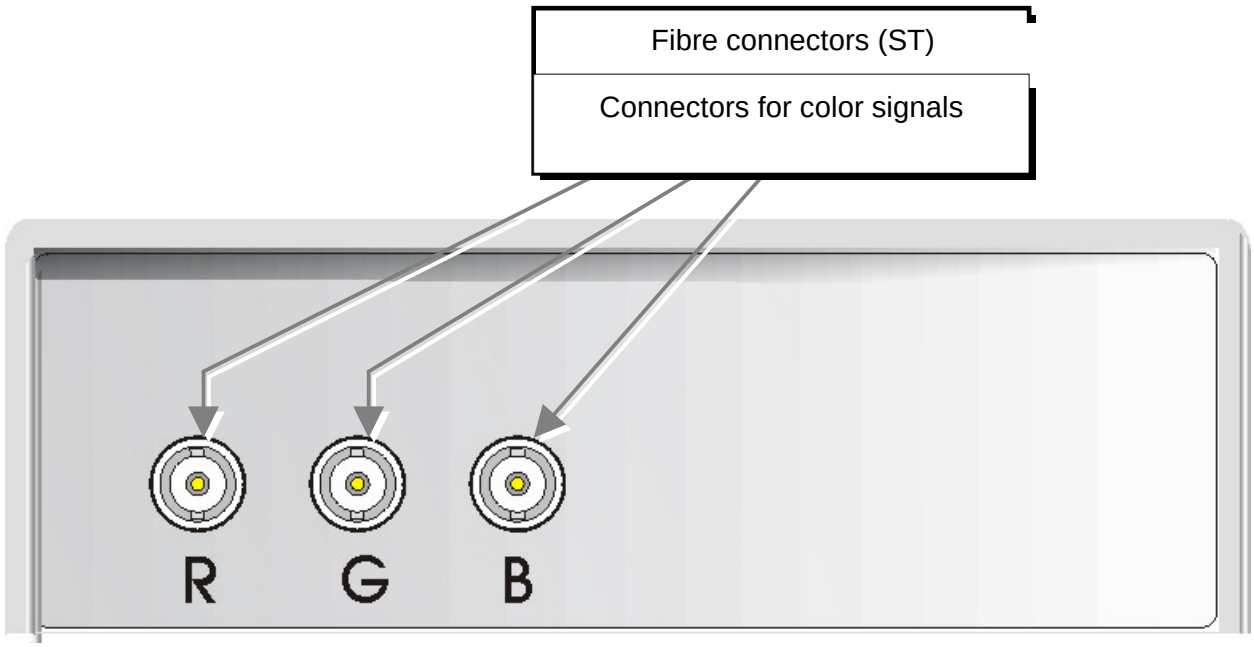
VTO2/VRO2 V6.00 KVM-Extender Type K234-9W + K235-9W Remote Unit



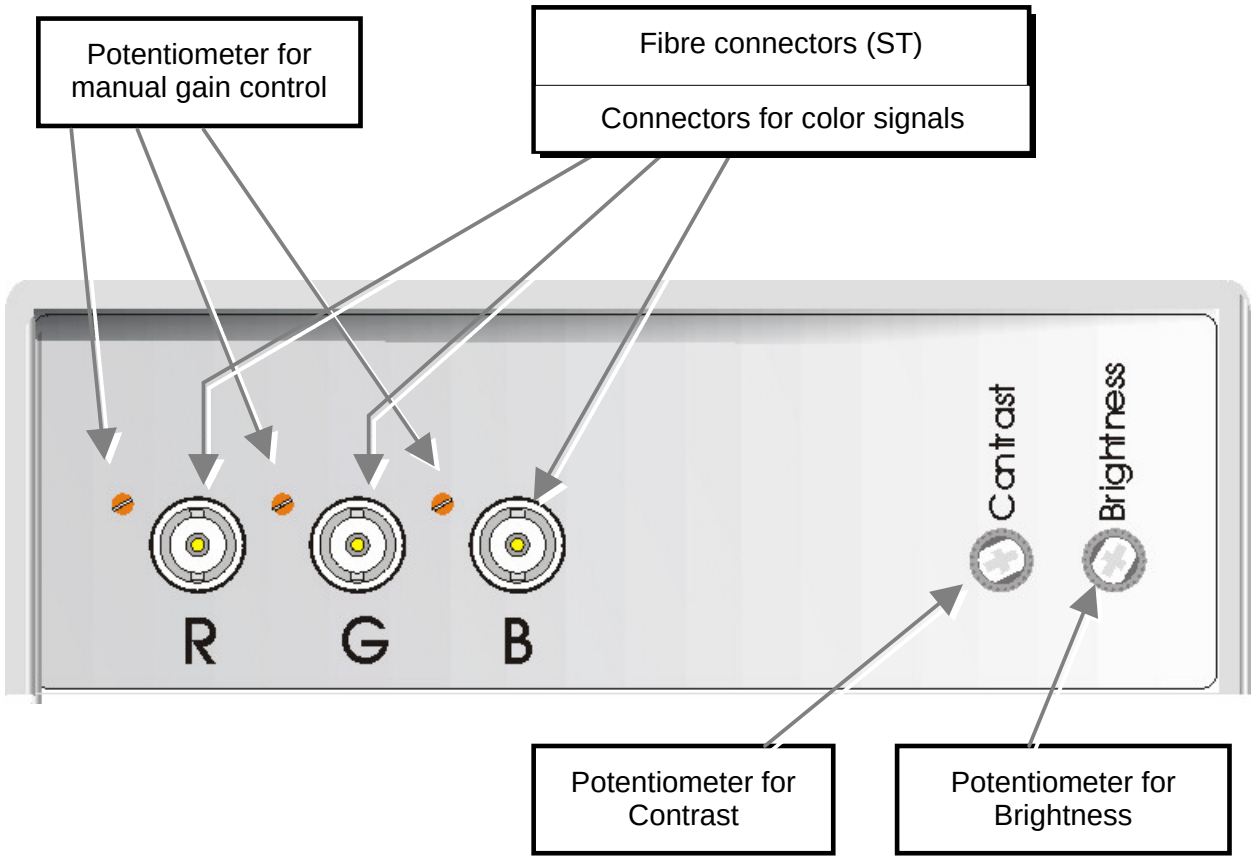
VTO2/VRO2 V6.00 KVM-Extender Type K236-9W Local Unit



VTO2/VRO2 V6.00 KVM-Extender Type K236-9W Remote Unit



VTO2/VRO2 V6.00 KVM-Extender Type K236-9W Local Unit



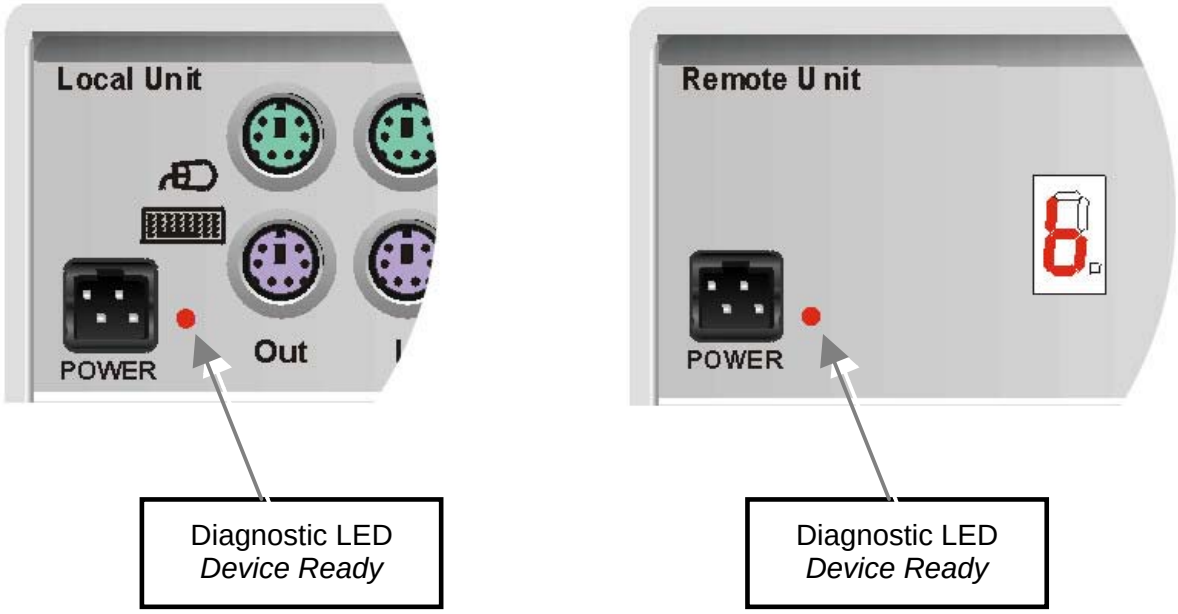
VTO2/VRO2 V6.00 KVM-Extender Type K236-9W Remote Unit

3.4 Diagnostic and Adjustments

Each VTO2/VRO2 V6.00 KVM-Extender is fitted with an indicator LED *Device Ready* and a 7-Segment display for enhanced troubleshooting: The *Device Ready* LEDs are next to the power sockets. The 7-Segment display is next to the power socket of the remote unit.

On each VTO2/VRO2 V6.00 KVM-Extender you can adjust Brightness and Contrast manually. In addition, each colour can be adjusted manually (only with automatic gain control – AGC = OFF). The potentiometers to adjust Brightness and Contrast are to the right of the fibre connectors on the Remote unit. The 7- Segment display is next to the Power socket of the Remote unit.

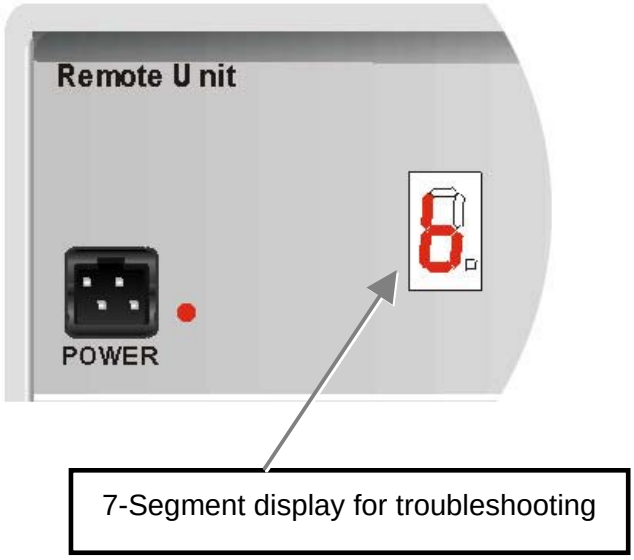
The location of the LEDs is shown below:



Diagnostic LEDs on VTO2/VRO2 Extender

LED	*Appearance*	*Diagnostics*
Device Ready (Red LED)	Off	Device not ready
	On	Device ready

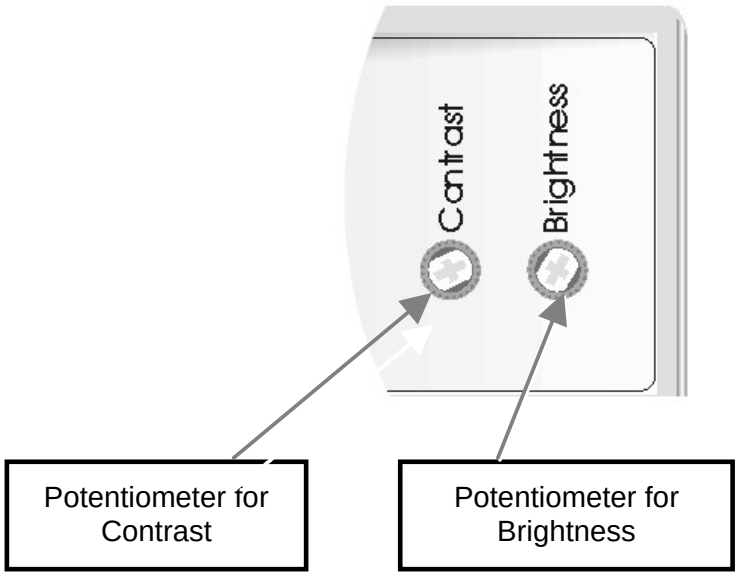
The location of the 7- Segment display is shown below:



7-Segment display on VTO2/VRO2 Extender

7-Segment display	*Diagnostics*	*Possible cause of fault*
0	Only in mode “AGC-ON” NO error	**NO** error detectable
0.	Only in mode “AGC-ON” illuminated	**NO** error detectable: Processor adjusts color amplifying (AGC)
b	Blank-pulse is missing	Problem with the GREEN fibre
C	Data interface (receiving) deranged	Problem with the 1-Fibre Problem with the Local Unit 1-Fibre and 2-Fibre swapped
F	Contrast is adjusted too high	The gain of the contrast potentiometer is adjusted too high. Automatic Gain Control (AGC) is no longer possible. Please re-adjust to lower gain.
H	HSYNC signal is missing	Problem with the GREEN fibre Problem with the CPU cables Wrong jumper setting in the Local unit
U	VSYNC signal is missing	Problem with the BLUE fibre Problem with the CPU cables Wrong jumper setting in the local unit

The location of potentiometers for brightness/contrast control is shown below:

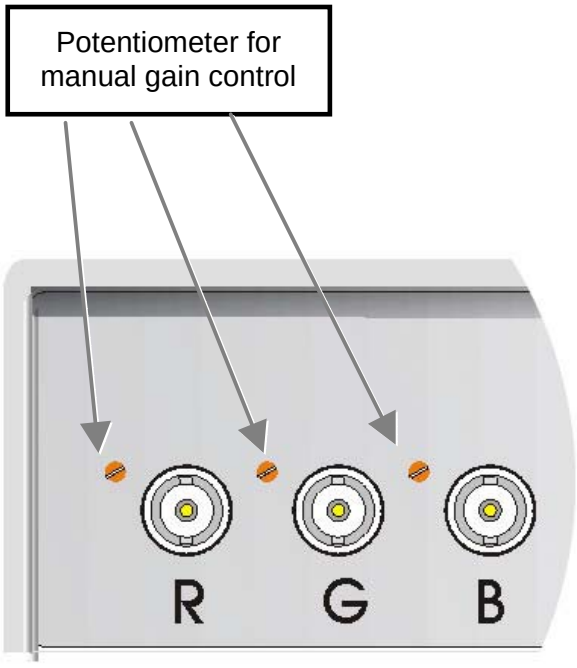


Brightness/Contrast controls on VTO2/VRO2 – Extender

On each VTO2/VRO2 V6.00 KVM-Extender you can adjust Brightness and Contrast manually. You'll find the potentiometers to the right hand of the fibre connectors on the Remote unit. Please use these potentiometers for adjustment of all colours simultaneously.

If the gain of the contrast potentiometer is adjusted too high, Automatic Gain Control (AGC) is no longer possible. Please readjust to lower gain until the 'F' on the 7- Segment display lapses.

The location of potentiometers for manual gain control is shown below:



Potentiometer for manual gain control on VTO2/VRO2 – Extender

On the front panel of the Remote unit there are potentiometers to adjust the gain of each colour signal. In the mode 'With AGC', these potentiometers have no function. In the mode 'Without AGC' you can adjust the factory setting for the gain of each single colour. This may be necessary if there is a different attenuation between the three lines. This could result in chromatic aberrations on screen.

Use the AGC Mode 'Automatic Gain Control = OFF' only if there are problems that you can't solve with 'AGC = ON'.

In mode 'AGC = ON' the gain of each colour signal is fixed, since all have the same white level (0.7Vpp). The individual color potentiometers do not function. Use the brightness and contrast controls to achieve the best screen display.

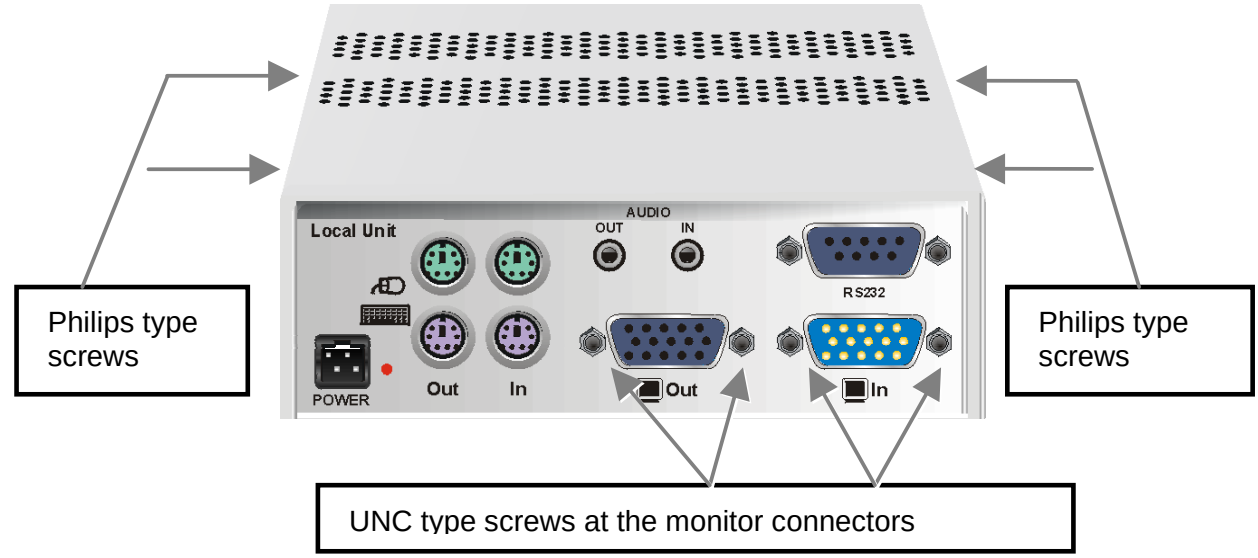
Use mode 'AGC = OFF' if you see chromatic aberrations on the screen. Each colour has to be adjusted by using the appropriate potentiometer. You can adjust by visual comparison or use an oscilloscope to get the best results. Brightness and contrast control allow further control of the screen display. Please do not select this mode unless you have problems with your display (see also above).

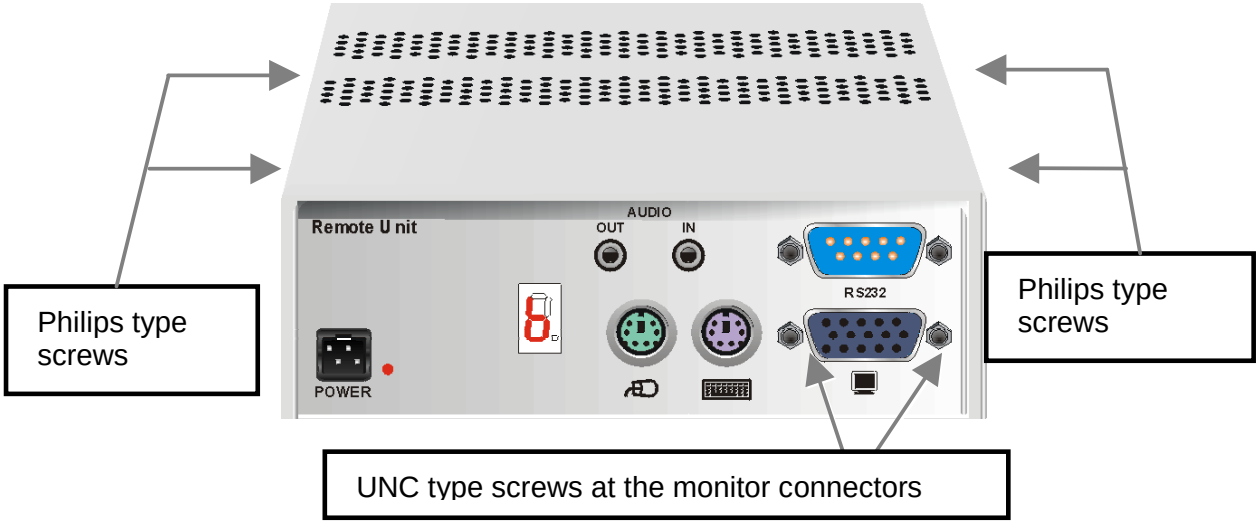
4. Adjustments

For most applications, you shouldn't need not to make any adjustments to set up your VTO2/VRO2 V6.00 KVM-Extender.

For some applications, you may need to open the Local Unit and/or the Remote Unit. Unscrew the Philips-type screws at both sides of the device. Unscrew the UNC type screws at both sides of the monitor connectors. Carefully displace the lower and upper shells of the case.

Model K234-9W carries a Serial/Audio daughter board connected through a flat cable to the main board. Please remove the upper shell carefully to avoid damaging the flat cable.

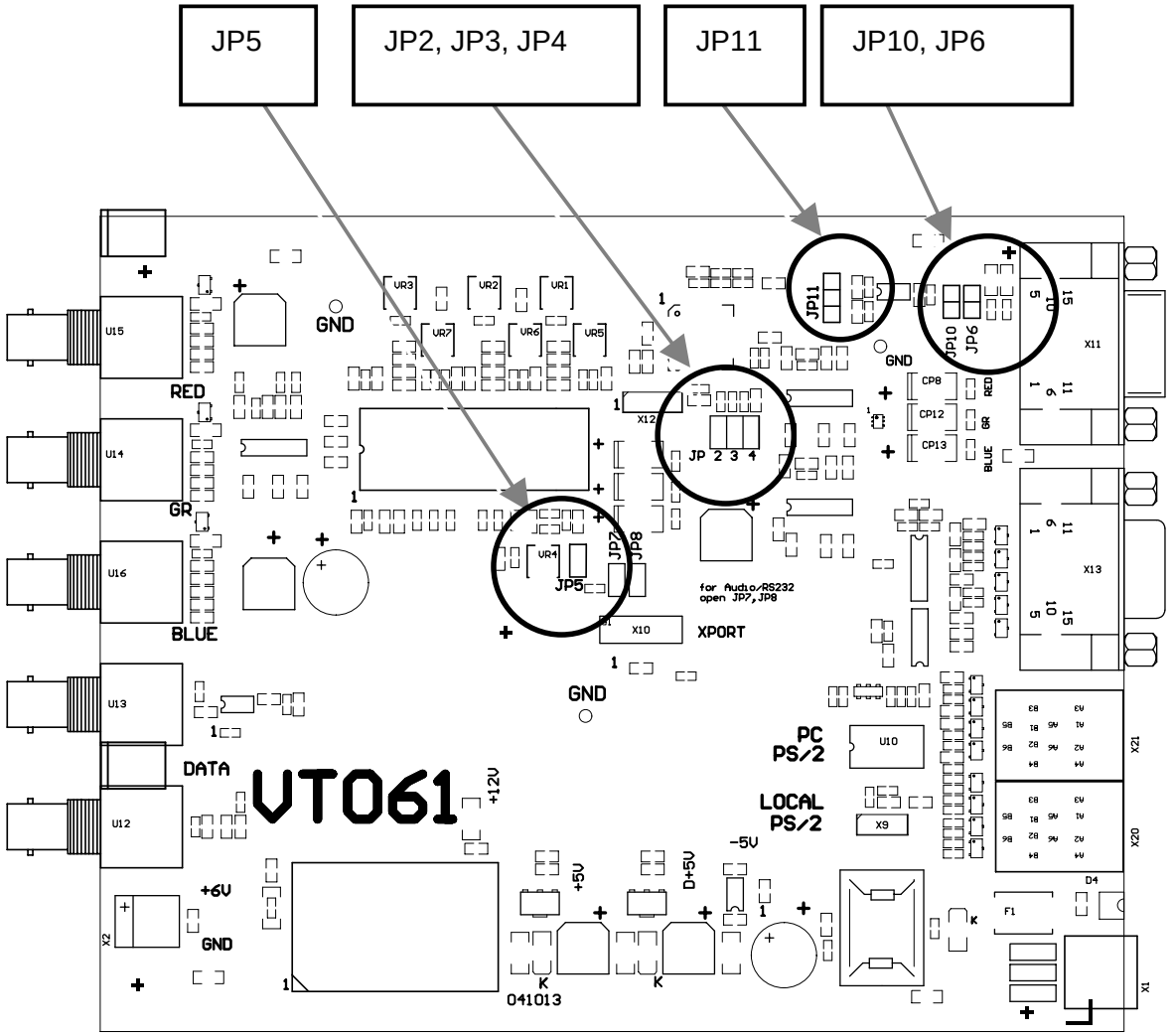




4.1 Jumper Location in the Local Unit

After unscrewing and opening the upper shell, please place the device in this orientation: with the fibre connectors to the left and the electrical connectors to the right.

The main PCB then will look like this:

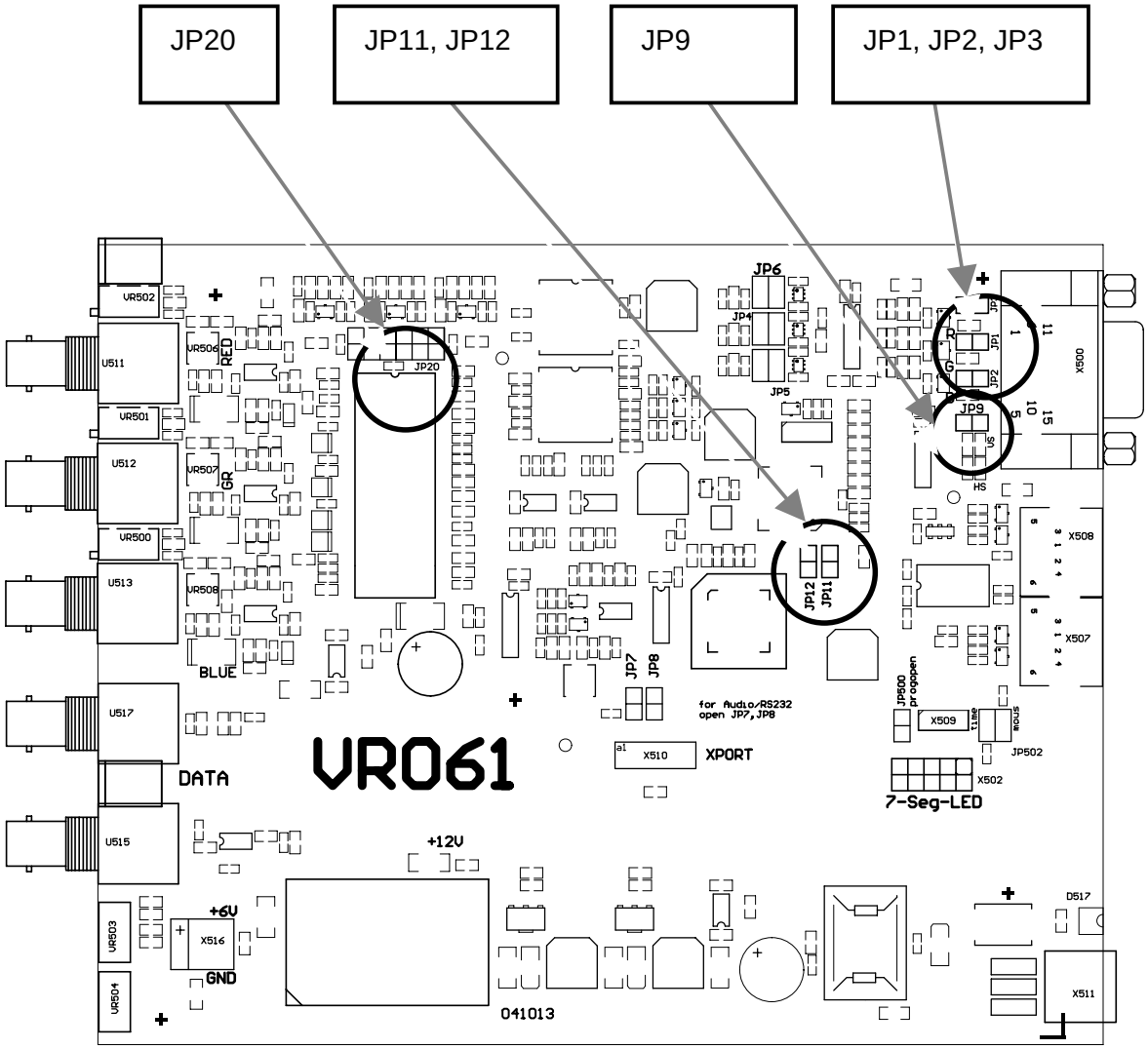


Use the diagram to locate jumpers JP2, JP3, JP4, JP5, JP6, JP10, and JP11.

4.2 Jumper Location in the Remote Unit

After unscrewing and opening the upper shell, please place the device in this orientation: with the fibre connectors to the left and the electrical connectors to the right.

The main PCB then will look like this:



Use the diagram to locate jumpers JP1, JP2, JP3, JP9, JP11, JP12 and JP20.

4.3 Customization

You can make the following application-specific adjustments:

Changing the graphic source (RGB or VGA)

This device can transfer RGB as well as VGA signals. In addition, it is able to do a signal conversation while transferring the signals from RGB to VGA, or from VGA to RGB.
Factory setting: **VGA in – VGA out**

 = open  = shorted

Local Unit Jumpers:		**VGA Source VGA Monitor**	**VGA Source RGB Monitor**	**RGB Source VGA Monitor**	**RGB Source RGB Monitor**
	JP2				
	JP6				
	JP10				
	JP11				
Pins 13&14 (HS, VS) from CPU		connected	connected	open	open
Remote Unit Jumpers					
	JP1, 2, 3				
	JP9				
	JP12				
Pins 13&14 (HS, VS) to Monitor		connected	open	connected	open
Use Remote Unit's controls?					
	Contrast	if necessary	if necessary	if necessary	if necessary
	Brightness	no	if necessary	no	if necessary

Using 62.5µ fibre cable

You can use this device with both types of multimode fibre: 62.5µ as well as with 50µ (factory setting). However, the output power has to be adapted to the type of cable.

Fibre Type	**Jumper JP5 in Local Unit**
50µ (Factory setting)	 (short)
62.5µ	 (open)

Switch OFF the Automatic Gain Control (AGC)

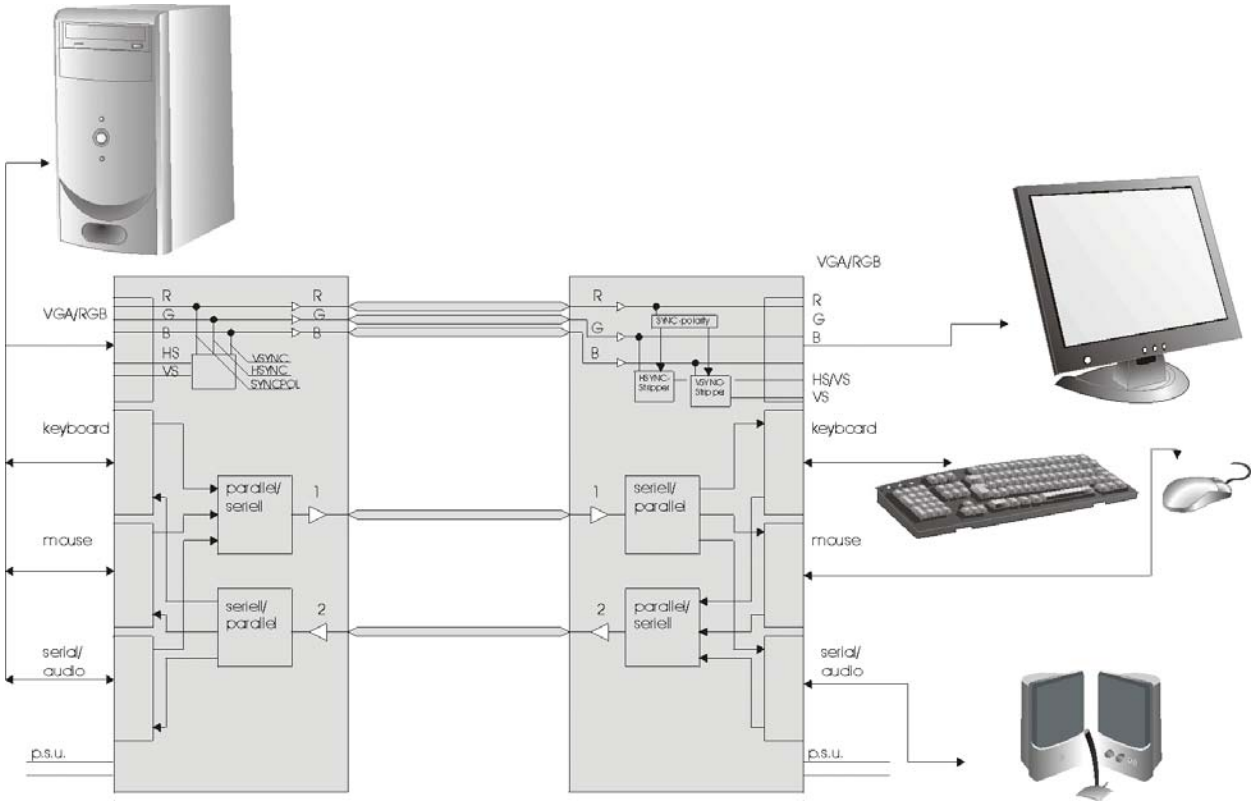
With AGC = ON, the gain of each color signal is fixed so that all have the same white level (0,7Vpp). The potentiometers are without function. Use the brightness and contrast control to adjust the screen display.

With AGC = OFF: each color has to be adjusted by using the appropriate potentiometer. You can adjust by visual comparison or use an oscilloscope to get best results. Brightness and contrast control allow private adaptation to desired screen display. Please do not select this mode unless you have problems, such as chromatic aberration, with your display. Factory setting: Automatic Gain Control **ON**

AGC	**JP3 in Local Unit**	**JP20 in Remote Unit**
ON (Factory setting)		
OFF		

5. Monitor Setup

This schematic diagram shows the principles of data transmission through the extender system:



Normally you should not need to make any modifications. However, under some circumstances, you may want to customize the extenders:

Changing the Graphics

The factory setting for our devices is to transmit VGA signals to a VGA screen (VGA in/VGA out). By changing the appropriate jumper settings the units can also be used for:

- **VGA in/RGB out**: RGB monitor displaying output from a VGA graphics card
- **RGB in/RGB out**: RGB monitor displaying output from an RGB graphics card
- **RGB in/VGA out**: VGA monitor displaying output from an RGB graphics card

VGA in/RGB out

This application uses the extender as a VGA/RGB Converter. The attached monitor must be able to display an RGB signal with the provided frequencies.

You can only use an RGB Monitor with a VGA-Signal if the Monitor is able to process the SYNC frequencies (for example, a monitor with HSYNC = 40-90 kHz may not work from VGA with 640x480 = 31,5 kHz).

RGB in/RGB out

The attached monitor must be able to display an RGB signal with the provided frequencies. In this mode, it might be necessary to switch off the automatic gain control (AGC) if your monitor does not blank the 'white pulse'.

RGB in/VGA out – SYNC Stripper

In this mode, the remote unit works as an additional SYNC stripper – the SYNC signals are stripped off from green, separated and presented as TTL-signals.

Depending on the technical design of the units, you receive at HSYNC-output a CSYNC signal (HSYNC and VSYNC mixed) and at the VSYNC-output a VSYNC-signal. Some types of VGA-monitors show distorted pictures, while receiving both CSYNC on HS and an additional VSYNC on VSYNC.

If you have a monitor that shows distorted pictures in this configuration, you can suppress the VSYNC -signal by removing jumper JP9 on the Remote unit (VRO). All monitors that show distorted pictures, because of this double signal, work well with a pure composite-signal (VSYNC disconnected).

A VGA-monitor only works as an RGB graphic adapter if the monitor is able to process the synchronization frequency of the video source (e.g. a multi sync-monitor with horizontal bandwidth of 30-90 kHz may not work with a WF470 graphic adapter with 15.625 kHz).

It is not possible to generate the special phase relations (of the VGA-standard) that are required by some types of dual scan monitors (LCD-panels, for example). In this mode, you may have to switch off AGC if your monitor does not blank out the WRI (White Reference Impulse) and shows it on screen.

RGB signals have a lot of different types of signal forms and combinations. For further information please contact our Technical Support. We will help you to find a solution for your application.

5.1 TFT Monitors

Use this procedure to correct for discrepancies in the video signal due to analog/digital video conversion by a TFT monitor. You do not need to follow this procedure if you have a CRT monitor connected because the video format is not converted.

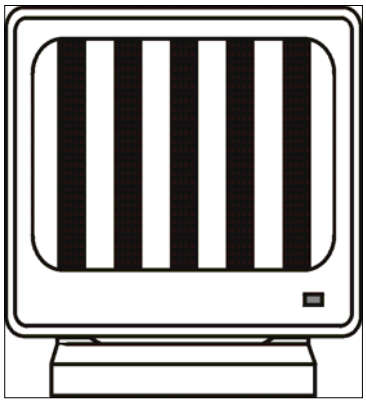
1. Connect the Extender system and display the regular desktop in the desired screen resolution. Monitor Setup may vary depending on screen resolution and/or refresh rate. For different screen resolutions and/or refresh rates it might be necessary to follow this procedure several times.
2. Depending on the type of TFT, press the 'AUTO' Button on the monitor control panel or select *Auto Adjust* in the TFT Setup Menu. Refer to the manual supplied with your monitor for more information.
3. If the picture quality is not acceptable after the automatic adjustment, you might get enhanced results using an applicable test pattern display: go to Step 4. If the vertical stripes are sharp and without jitter or smearing, the adjustment has been successful. The setup is completed.
4. Download the test pattern from: **http://www.ihse.de/images/burst.htm** and store this file in a directory of your choice.
5. Select this graphic for the desktop background:
   Start / Settings / Control Panel / Display / Backgrounds
6. Select it as a *tiled* display. Your desktop should now show fine, black and white, vertical stripes over the total background.
7. Depending on the type of TFT, press the 'AUTO' Button on the monitor control panel or select *Auto Adjust* in the TFT Setup Menu. Refer to the manual supplied with your monitor for more information.
8. If the vertical stripes are sharp and without jitter or smearing, the adjustment has been successful. Go to Step 10.
9. If the picture quality is not acceptable after the automatic adjustment, you will have to manually adjust the pixel clock and pixel phase (in this order). Please follow the instructions in your monitor's user manual.
10. Select a graphic of your choice for the desktop background:
    Start / Settings / Control Panel / Display / Backgrounds

The Setup is complete.

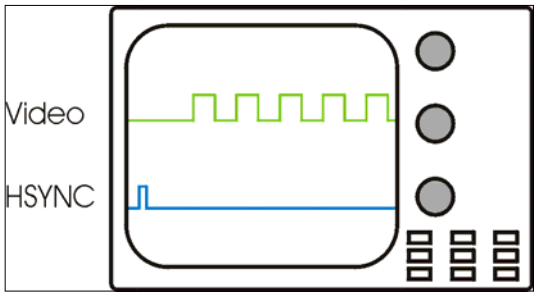
5.2 Hints for Pixel Clock and Pixel Phase

Why do you need to adjust Pixel clock and Pixel phase (always in this order) when you are using a TFT screen?

This can be explained by means of a 'virtual' reduced system, which has only a few pixels and lines displaying a burst pattern (see above). The system would look like:



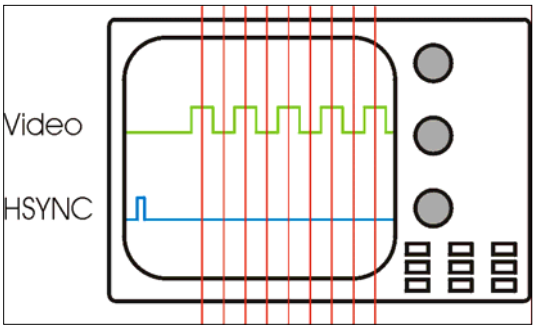
On the Oscilloscope

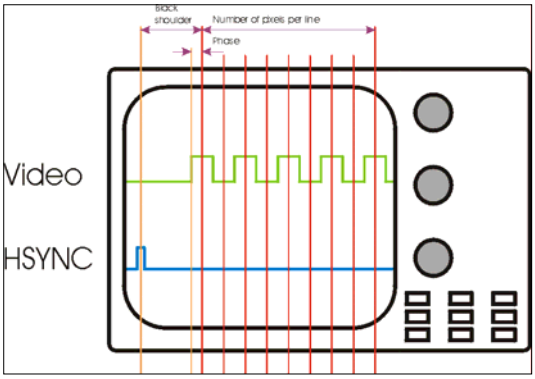


To display an analog picture correctly, the TFT must know Pixel Clock and Pixel Phase. To define these, it needs to calculate:

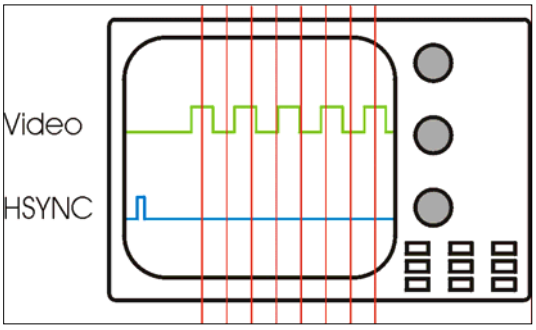
The exact center of each Pixel...

... the black 'shoulder' (the beginning of the picture), the number of pixels per line and the Pixel Phase (Middle of each Pixel)

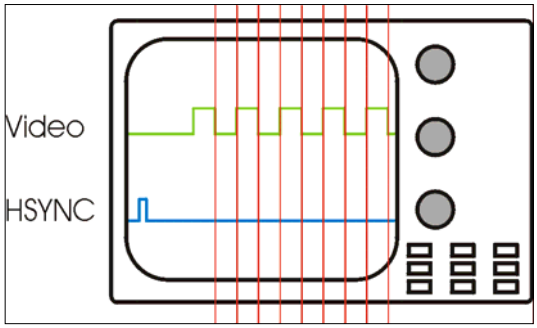




Wrong Pixel Clock



Wrong Pixel Phase

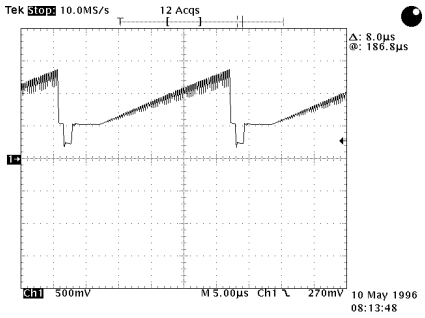


5.3 Manual Adjustment of Video Signals

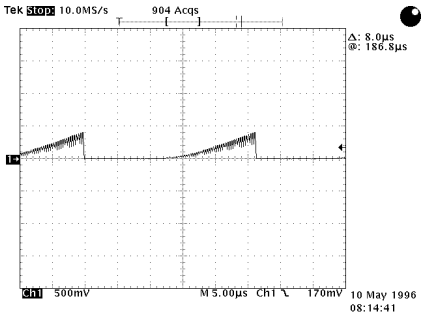
CAUTION: This procedure applies to Remote Unit only with AGC=OFF! – do not attempt any adjustment of the Local Unit.

The level of the three video signals may be simultaneously adjusted with the Brightness control. If you open too far to “brighten”, the video signal increases on oscilloscope-CRT, and a part of the SYNC signals appears in the video signal, as shown in (a).

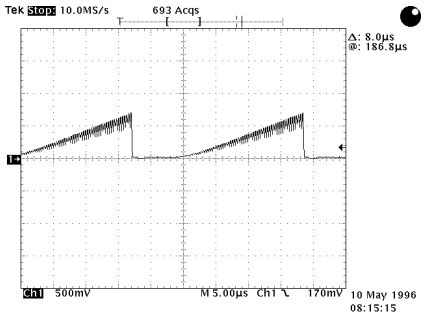
(a) Signal too light



(b) Signal too dark



(c) Signal OK



If you close too far to “dark”, the video signal decreases on the oscilloscope-CRT and a part of the signal is cut: see (b).

Adjust the brightness control so that it falls just before the signal: see (c).

Adjustment of amplitude

The amplitude of the colour channels depends on:

- The attenuation of the optical fibre
- The attenuation of the FO-connectors
- The position (gain) of the color control trimmer.

You may correct up to a 20% difference in signal amplitude in the three colour channels by setting the gain with the colour control trimmer. Adjust all channels (R, G, B) to the same value (amplitude app. 0.7Vpp...0.8Vpp = white). Since the attenuation exceeds, you may adjust the amplitude for all channels together, using the Contrast control (see above)

A difference greater than 20% indicates either a broken fibre or FO-connector.

6. Troubleshooting

There isn't a picture

Check the power supply connection at the Local unit. Is the *Device Ready* (Red LED) at the Local and Remote unit illuminated? If not, the internal power-supply may be damaged or there may be an internal error (see page 21).

Check that the Interconnection cable is connected at the Local Unit and the Remote Unit. Check the 7-segment display for error codes (see page 22).

There may be one or more broken fibres. Do NOT look into a fibre's end directly while it is connected to a Local or Remote unit! Check for broken fibres using a flashlight.

Are the cables of the recommended fibre type? If you used your own fibre optical cable (not supplied by us), please ensure that you have used 50µ or 62.5µ fibres. Other fibre-types and poly-fibres are not supported. Be sure, to have the Cable type jumper (see page 29) set accordingly.

Either HSYNC or VSYNC is missing; because of this, the power save function is enabled (EPA or TCO): Are the fibres for R, G, B swapped?

Running picture

The Monitor does not synchronize: are the fibres for R, G, B swapped?

Keyboard, as well as Mouse does not work

You have swapped the 1- and 2-fibre.

The fibres 1 and/or 2 are not connected to the Local or Remote unit.

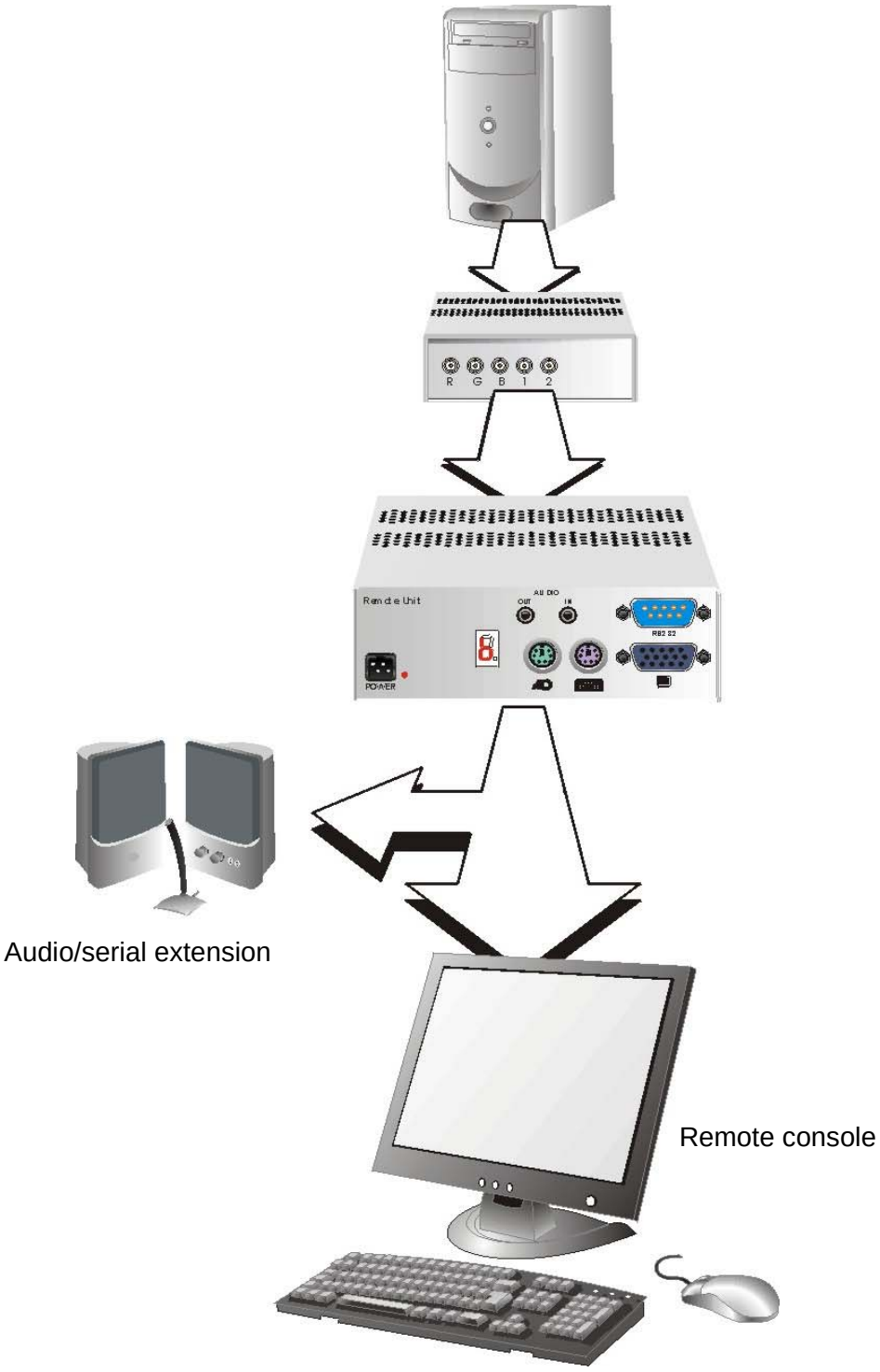
There may be one or more broken fibres. Do NOT look into a fibre's end directly while it is connected to a Local or Remote unit! Check for broken fibres using a flashlight.

Are the cables of the recommended fibre type? If you used your own fibre optical cable (not supplied by us), please ensure that you have used 50µ or 62.5µ fibres. Other fibre-types and poly-fibres are not supported. Be sure, to have the Cable type jumper (see page 29) set accordingly.

Appendix A: Example Applications

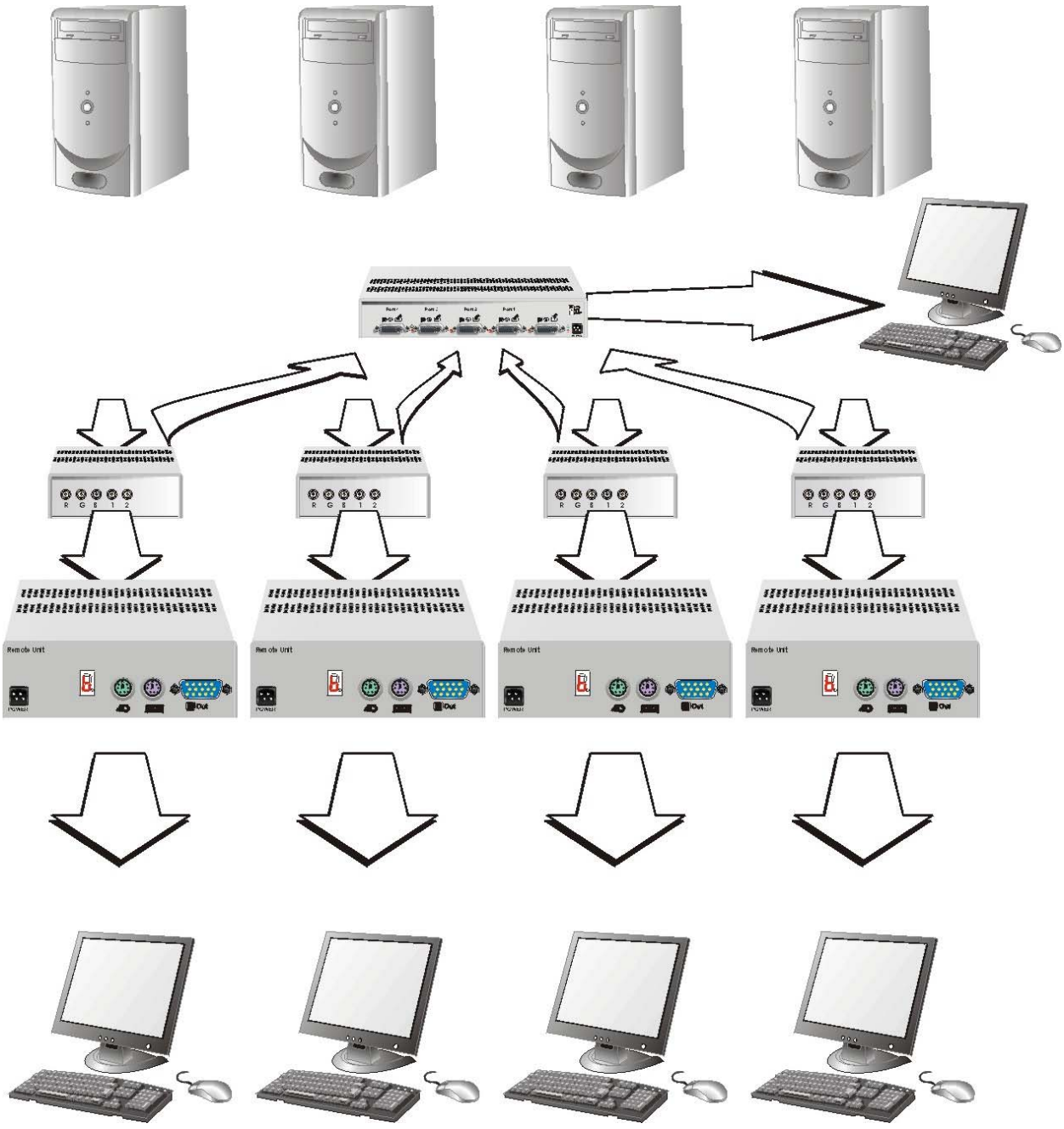
This section illustrates some specific applications using Extender units:

- VTO2/VRO2 V6.00 KVM-Extender with speaker and microphone.



VTO2/VRO2 V6.00 KVM-Extender with speaker and microphone

- 4 CPU's – local outputs managed through a KVM- Switch and a single console. Remote Consoles up to 1000m away

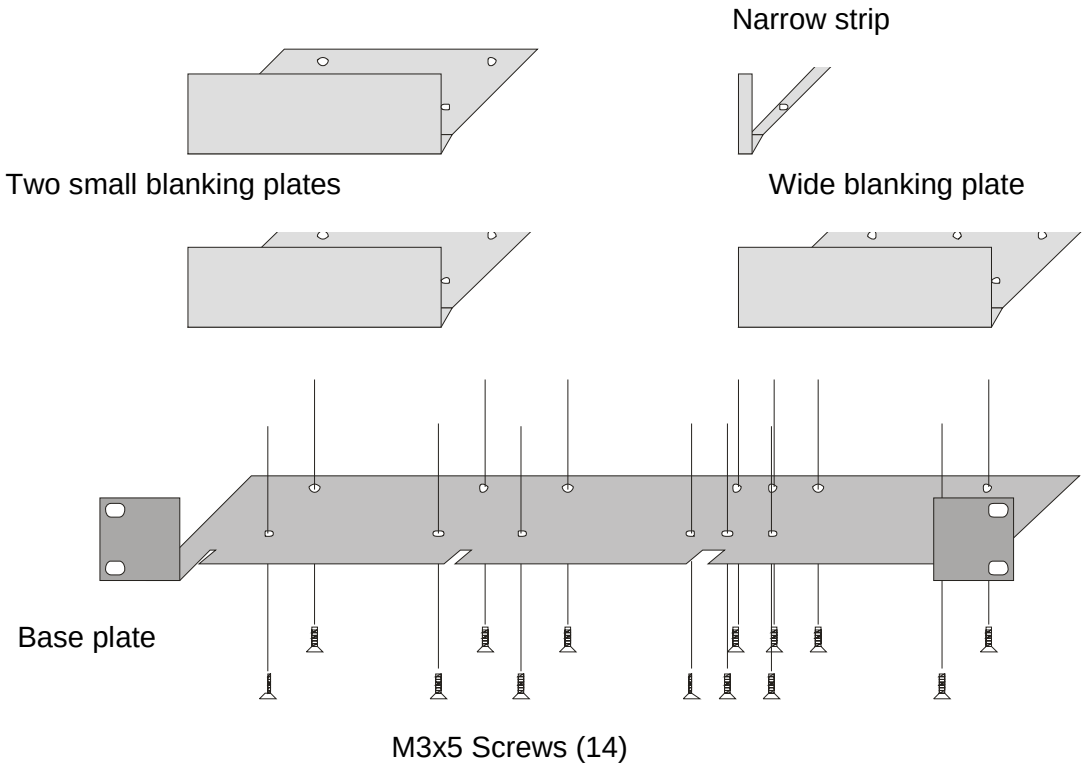


VTO2/VRO2 V6.00 KVM-Extender – local Consoles through a KVM- Switch

Appendix B: 19” Rack Mount Options

The VTO2/VRO2 V6.00 KVM- Extender units can be mounted in a 19” rack using the DDXi mounting kit.

This contains the following parts:



19” Rack Mounting Kit

To mount a unit:

1. Align the holes on the base plate with the vacant screw holes on the base of the VTO2/VRO2 V6.00 KVM extender unit.
2. Fasten the base of the unit to the plate of the mounting kit using the supplied screws.

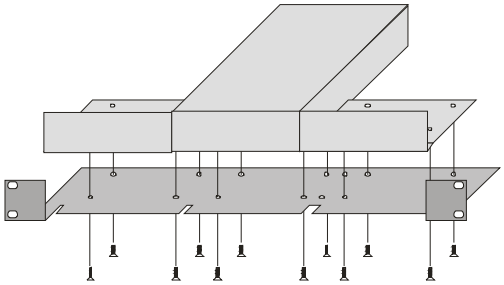
   Only use the supplied short screws; longer screws may cause damage to the PCBs.

3. Close the remaining gaps with blanking plates.

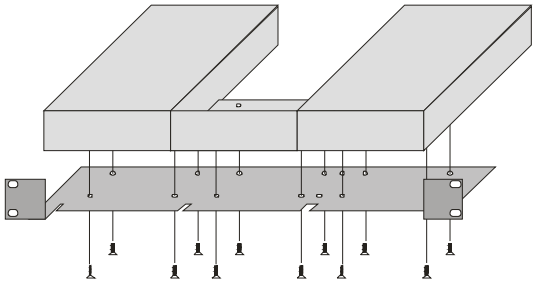
APPENDIX B: 19” RACK MOUNT OPTIONS

The kit allows you to mount various combinations of regular and double width housings. The VTO2/VRO2 V6.00 KVM-Extender comes in a single wide housing, so you can use one of the mounting options 1, 2 or 3:

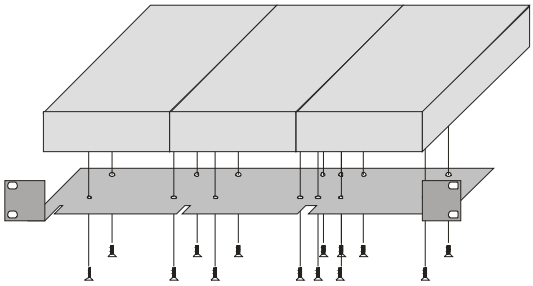
1. One regular unit (using two small plates)



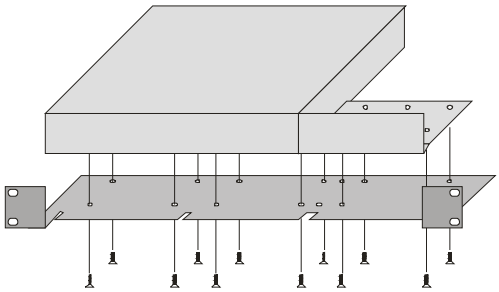
2. Two regular units (using one small plate)



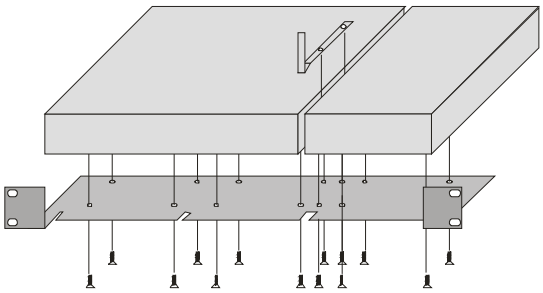
3. Mounting of three regular units



4. Mounting of one double width unit (using wide plate)



5. Mounting of double width and regular units (using narrow strip)



Appendix C: Audio/Serial Upgrade

The Audio/Serial Upgrade option consists of daughter boards that allow bi-directional stereo audio and a full-duplex serial data link to be sent across the regular interconnection cable in addition to keyboard, mouse and VGA/DVI video.

To set up the extender's audio and serial link, please follow all of the instructions detailed in this appendix. If you have any questions, contact Technical Support.

Serial Interface - Set Up and Operation

No setting up or user adjustments are required. Please note that on the Dual Access model, the serial link is always active.

Please bear in mind that the Remote Unit's serial port is wired as DTE (the same as that on a PC). To connect a serial printer (or other DTE rather than DCE device) to the Remote Unit, you will need a Null-Modem (crossover) cable between the Remote Unit and the printer.

A serial touch screen may be plugged directly into the Remote Unit.

Serial Interface - Handling Multiple Serial Devices

The extender's serial interface transmits/receives six signals (3 signals in each direction). Normally four of these signals are used for hardware handshaking (in addition to TX & RX). However, because each handshaking line can support signals up to 19,200 Baud it is possible to configure the serial interface to handle up to three simple 2-wire (Tx/Rx only) serial links. Select Xon/Xoff software flow control on the remote device and PC.

To do this you will need to construct a custom breakout cable. Please contact technical support for further information.

Audio Interface - Set Up and Operation

The audio interface is line-level and is designed to take the output from a sound card (or other line-level) source and be connected to a set of powered speakers at the other end of the link. Stereo audio may be transmitted either way across the link (simultaneously). No set up is required unless a microphone is connected to the remote unit.

Connect up the extender as follows:

1. Take the line-level output from your sound card (green connector) and connect to ‘Line In’ on the extender's Local Unit.
2. Connect a set of powered speakers to ‘Line Out’ on the Extender's Remote Unit.

Audio Interface - Using a Microphone

A microphone may be plugged into the ‘Line In’ connector on the Remote Unit.

There are two ways of setting up a microphone:

- The Local Unit’s ‘Line Out’ connection should normally be wired to the microphone input (Red) on your sound card. The sound card should then be set up to provide additional amplification (+20dB). This is the preferred connection method.
- Alternatively, the Remote Unit itself can provide microphone amplification. To set this, open up the Remote Unit and locate the jumper labelled ‘MIC’ on the daughter board. Connect this jumper across the pins. The Local Unit’s ‘Line Out’ connection should then be wired to ‘Line In’ (Blue) on your sound card.

If your microphone is already amplified, follow the second method but DO NOT install the amplification jumper in the Remote Unit.

Appendix D: Technical Support

If you determine that your VTO2/VRO2 V6.00 KVM Extender is malfunctioning, ***do not attempt to alter or repair it***. It contains no user-serviceable parts. Contact Technical Support.

Before you do, make a record of the history of the problem. We will be able to provide more efficient and accurate assistance if you have a complete description, including:

- The firmware-revision level printed on the bottom of the Extender (very important, especially for keyboard and mouse problems); The VTO2/VRO2 KVM extender's firmware revision level:

  - **Version Number Format:**
    Board: ***xxLO/RE Myyy Pzzz Auuu Gvvvvvv***
    Transceiver: ***C/M/S xx Pyy Mzz***
    Keyboard/Mouse: ***P/U xx Vyyy***

- The nature and duration of the problem.
- When the problem occurs.
- The components involved in the problem—that is, what type of computers, what type of keyboard, brand of mouse, make and model of monitor, type and make of cable, etc.
- Any particular application that, when used, appears to create the problem or make it worse.
- The results of any testing you've already done.

To solve some problems, it might be necessary to upgrade the Extender's firmware. If this turns out to be the case for your difficulty, our Technical Support technicians will arrange for you to receive the new firmware and will tell you how to install it.

Shipping and Packaging

If you need to transport or ship your VTO2/VRO2 KVM Extender:

- Package it carefully. We recommend that you use the original container.
- If you are shipping it for repair, please include the Unit's external power supplies. If you are returning it, please include everything you received with it. Before you ship the Extender back to the manufacturer for repair or return, contact us to get a Return Authorization (RA) number.

Appendix E: Specifications

Power Requirements

Voltage	PSU: 90..240VAC-0.5A-47..63Hz/6VDC-2000 mA
Power required	Local Unit: approx. 8W Remote Unit without keyboard: approx. 8W Remote Unit with keyboard: approx. 9.5W

Interface

(Depending on type of device)

Video Source/Monitor		VGA up to 1280x1024@75Hz
Keyboard		PS2
Mouse		PS2 2-/3-button and wheel mice
Serial	***Speed***	Up to 19200BAUD
	Data format	Format Independent, transparent
	Handshake	RTS, CTS, DTR, DSR are sent across link
Audio	***Description***	Bi-directional stereo audio link
	Transmission Method	Digitised virtually CD quality audio (16-bit, 38.4KHz)
	Signal Levels	Line-Level (5 Volts Pk-Pk maximum) @ 47kOhm
	Connectors	Local Unit: 2 x 3.5mm stereo jack socket (Line In & Line Out) 2 x 3.5mm stereo jack socket (Line/Mic In& Line Out)
	Microphone Support	A microphone may be connected to the Remote Unit. Pull-up resistor provides bias for condenser microphone. Option to set microphone amplification to +17dB.

Maximum Length of Interconnection Cable

50µm Multimode	3250ft (1000m)
62.5µm Multimode	3250ft (1000m)

Type of Interconnection Cable

K236-9W	3 Fibres Multimode, e.g. I/AD(ZN)H 4G50 (In-house OR Outdoor Breakout cable)
K234-9W / K235-9W	5 Fibres Multimode, e.g. A/DQ(ZN)B2Y 4G62,5 (Outdoor Breakout cable with protection against rodent)

Optical Elements

Center Wavelength	850nm
Optical budget total (typical)	-5 dBm

Size and Shipping Weight

VTO2/VRO2 – V 6.00	Remote/Local Unit: 7.1”x5.2”x1.7” (180x133x44mm) Weight: 2.6lb (1.2kg) each
Shipping box	Shipping Box: 18.1”x9.8”x4.7” (460x250x120mm) Weight: 9.5lb (4.3kg)

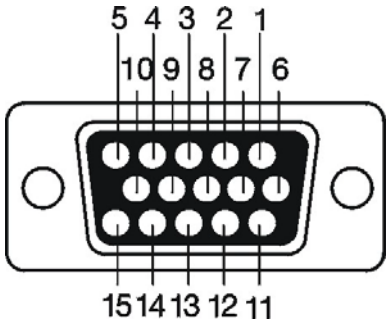
Environmental

Operating Temperature	41 to 113°F (5 to 45 °C)
Storage Temperature	-13 to 140°F (-25 to 60 °C)
Relative Humidity	max. 80% non-condensing

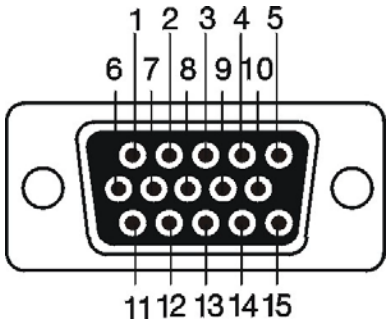
Appendix F: Connectors

VTO2/VRO2 V6.00 KVM-Extender Connector Pin outs

VGA female (Signal Output)

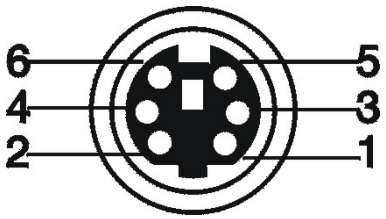


VGA male (Signal Input)



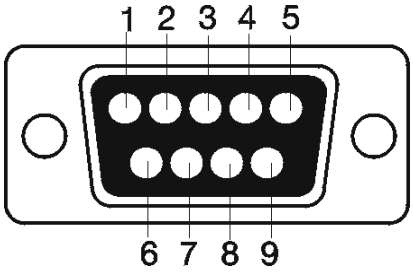
Pin	*Signal*	*Pin*	*Signal*	*Pin*	*Signal*
1	RED-	6	RED GND	11	
2	GREEN	7	GREEN GND	12	
3	BLUE	8	BLUE GND	13	HSYNC
4		9		14	VSYNC
5		10	SYNC GND	15	

Keyboard/Mouse female (Signal Input/Output)

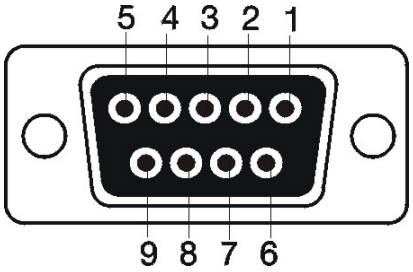


Pin	*Keyboard*	*Pin*	*Mouse*
1	KBD-DATA-	1	MOUSE-DATA-
2		2	
3	KBD-GND	3	MOUSE-GND
4	VCC (+5V)	4	VCC (+5V)
5	KBD-CLCK	5	MOUSE-CLCK
6		6	

RS232 (only device K234-9W with serial/Audio Upgrade)



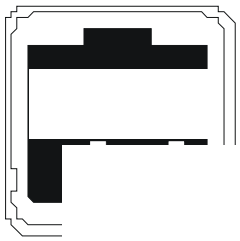
9 pin DSUB female (Local Unit)



9 pin DSUB male (Remote Unit)

Pin	*Signal*
1	Not connected
2	RxD
3	TxD
4	DTR
5	GND
6	DSR
7	RTS
8	CTS
9	Not connected

Power



Pin	*Signal*
1	GND
2	Earth
3	n.c.
4	+6VDC
Housing	Shield

NOTES

NOTES

Installation Guide

McBasic TP/FO
McBasic TP/BNC

About McBasic

QUICK START	
Introduction	1
Installation	1
Configuration	2
Crossover/Pass-Through	2
LinkLoss & Pulsing FiberAlert	2
LED Operation	4
Technical Support	6
Warranty	7
Safety Certifications	8

The McBasic series consists of low-cost, IEEE 802.3 single-conversion, 1U high, standalone media converters. McBasic TP/FO converts 10Base-T twisted pair to 10Base-FL multi-mode or single-mode fiber and includes one RJ-45 connector and one pair of ST or SC connectors. McBasic TP/BNC converts 10Base-T twisted pair to 10Base-2 thin coax and includes one RJ-45 connector and one BNC connector. Each *McBasic* includes diagnostic LEDs and an internal 100/240 VAC power supply.

McBasic TP/BNC (left) and McBasic TP/FO (right)

Installing McBasic

McBasic comes ready to install; configure after installation. To install *McBasic*, first make sure that the unit is placed on a suitable flat surface. Attach the cables between the *McBasic* and each device that will be interconnected, then plug the unit into a reliable, filtered power source.

IMPORTANT INSTALLATION INFORMATION!

McBasic TP/FO does not auto-negotiate, therefore IMC Networks does NOT recommend connecting it to a switch, media converter or other device that ONLY auto-negotiates; connect to a device that is 10 Mbps or to a device that you can force to 10 Mbps.

Configuring McBasic

Once installed, configure *McBasic TP/FO* for the following:

- A crossover or pass-through connection for the twisted pair port
- *Pulsing FiberAlert*

Once installed, configure *McBasic TP/BNC* for the following:

- A crossover or pass-through connection for the twisted pair port
- BNC port termination (default = Enabled)

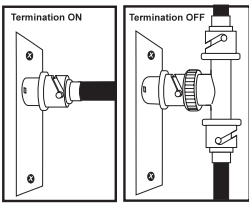
Twisted Pair Crossover/Pass-Through Switch

The twisted pair port on *McBasic TP/FO* and *McBasic TP/BNC* features a push-button switch, located next to the twisted pair connector, for selecting a crossover workstation connection or pass-through repeater/hub connection.

Select a pass-through connection by pressing the push-button IN. A crossover connection is selected when the push-button is OUT. If uncertain whether a crossover or pass-through connection is needed, set the push-button to the position that makes the TP LNK (link) LED glow.

BNC Port Termination

McBasic TP/BNC features a 2-position switch next to the BNC connector that allows a thin coaxial segment to be terminated at the port without an additional 'T' connector and terminator.



If *McBasic TP/BNC* is attached to a mid-point of a thin Ethernet segment, attach a 'T' connector to the BNC port. Termination must be OFF (disabled). Termination is disabled when the switch is in the left position. If a thin Ethernet segment is to be terminated at the *McBasic TP/BNC*, attach the cable directly to the BNC connector and set the termination switch to ON (enabled – factory default) by moving the switch to the right position.

LinkLoss and Pulsing FiberAlert

LinkLoss and *Pulsing FiberAlert* are advanced troubleshooting features from IMC Networks that can help you locate "silent failures" on your network.

It is vital that you understand exactly how *Pulsing FiberAlert* and *LinkLoss* work and how they will react in your network configuration before attempting to install the enclosed unit.

Installing media converters without understanding the effects of Pulsing FiberAlert can cause perfectly functioning units to appear flawed or even dead!

If you are unfamiliar with *Pulsing FiberAlert* and *LinkLoss*, IMC Networks strongly encourages you to read the following information. Contact IMC Networks technical support at (800) 624-1070 (U.S./Canada), +32-16-550880 (Europe) or techsupport@imcnetworks.com for more information and assistance.

About Link Integrity

During normal operation, link integrity pulses are transmitted by all point-to-point Ethernet devices. When an IMC Networks media converter receives valid link pulses, it knows that the device to which it is connected is up and sending pulses, and that the copper or fiber cable coming from that device is intact. The appropriate "LINK" LED is lit to indicate this. The IMC Networks media converter also sends out link pulses from its copper and fiber transmitters, but normally has no way of knowing whether the cable to the other device is intact and the link pulses are reaching the other end. The combination of *FiberAlert* and *LinkLoss* allows this information to be obtained, even when physical access to a remote device (and its link integrity LED) is not available.

What Is FO LinkLoss?

FO LinkLoss is a troubleshooting feature. When a fault occurs on the fiber segment (receive side) of a conversion, *FO LinkLoss* detects the fault and passes this information to the twisted pair segment. If a media converter is not receiving a fiber link, *FO LinkLoss* disables the transmitter on the media converter's twisted pair port. This results in a loss of link on the device connected to the twisted pair port.

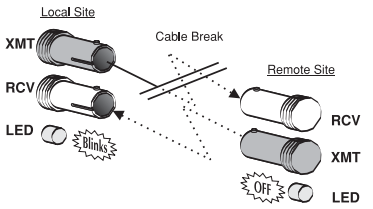
What Is TP LinkLoss?

TP LinkLoss is another troubleshooting feature. When a fault occurs on the twisted pair segment of a conversion, *TP LinkLoss* detects the fault and passes this information to the fiber segment. If a media converter is not receiving a twisted pair link, *TP LinkLoss* disables the transmitter on the media converter's fiber port. This results in a loss of link on the device connected to the fiber port.

Configuring LinkLoss: *TP LinkLoss* and *FO LinkLoss* are always enabled on *McBasic TP/FO*.

What Is Pulsing FiberAlert?

Pulsing FiberAlert minimizes the problems associated with the loss of one strand of fiber. If a strand is unavailable, the IMC Networks device at the receiver end notes the loss of link. The device will stop transmitting data and start sending link pulses. Until a valid link is received, the fiber link LED will be



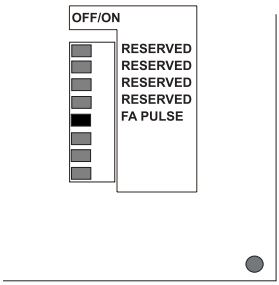
**Product with Pulsing *FiberAlert* enabled —
Remote Site stops transmitting
Local Link LED blinks, indicating a break in the fiber loop**

OFF on the device on the receiver side of the fiber strand with the fault while the fiber Link LED on the other unit will blink. *Pulsing FiberAlert* notifies a local site administrator of a fault, allowing quick determination of where a cable fault resides.

NOTE: *You can enable Pulsing FiberAlert on BOTH sides of a conversion.*

CONFIGURING PULSING FIBERALERT

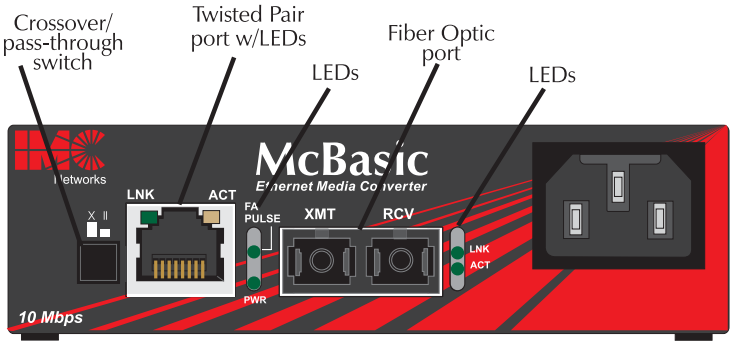
McBasic TP/FO features an 8-position DIP switch located on the bottom of the unit for configuring *Pulsing FiberAlert* after installation. To enable *Pulsing FiberAlert*, move the switch labeled "FA Pulse" to the ON position. After configuring the DIP switch, power down the unit and then power up again for the changes to take effect. The default setting for the this feature is shown to the right. Switches 6-8 are factory-configured; DO NOT change.



If unsure of how to best implement these features in your configuration, please contact IMC Networks Technical Support at (800) 624-1070 (U.S. and Canada); +32-16-550880 (Europe).

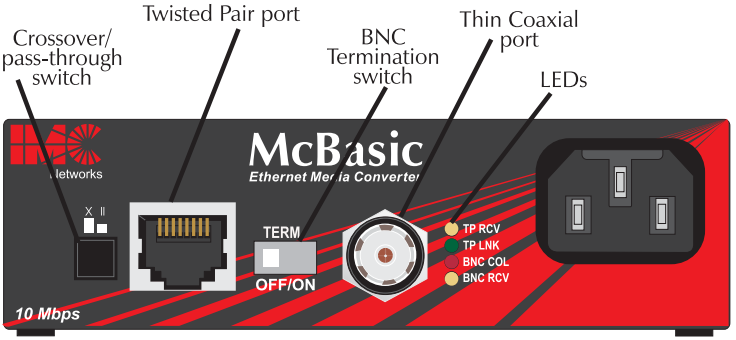
LED Operation

Each *McBasic* features diagnostic LEDs. The following illustrations show the location of the LEDs, and other features, on *McBasic TP/FO* and *McBasic TP/BNC*.



The LED functions for *McBasic TP/FO* are as follows:

TP LINK	Glows green if link is established on the TX port.
TP ACT	Glows amber when data is being passed on the TX port.
FA PULSE	Glows green when *Pulsing FiberAlert* is enabled.
PWR	Glows green when unit has power.
FO LINK	Glows green when link is established on the FX port.
FO ACT	Glows green if data is being passed on the FX port.



The LED functions for *McBasic TP/BNC* are as follows:

TP RCV	Flickers amber when twisted pair port is receiving data.
TP LNK	Glows green when a twisted pair link is established.
BNC COL	Flickers red in normal operation indicating normal collisions are being detected on the BNC segment.
BNC RCV	Flickers amber when BNC port is receiving data.

(***Note**: On a -20 McBasic TP/BNC, the TP RCV and BNC RCV LEDs flicker at a rate proportional to rate that data being passed on the ports. Under low traffic conditions, the LEDs flicker visibly, while they appear to glow under high traffic conditions.*)

Installation Troubleshooting

- During installation, first test your fiber and twisted pair connections with all troubleshooting features disabled. Then enable these features, if desired, just before final installation. This will reduce the features' interference with testing.
- To test *McBasic TP/FO* by itself, you must have an appropriate fiber patch cable. First, connect *McBasic TP/FO* to the twisted pair device with a twisted pair cable and establish valid link. Next, loop a single strand of fiber from the transmit port to the receive port of your media converter. Finally, verify that you have both twisted pair and fiber link on your media converter.
- Make sure that you are using the appropriate twisted pair cable or have the crossover/pass-through button on the media converter set correctly.
- Interconnection between the Next Generation of *McBasic TP/FOs, iMcV-PIM TP/FOs* and *McPIM TP/FOs* and their Legacy counterparts is possible. Where possible, however, use Legacy with Legacy product, or Next Generation with Next Generation product.

General Information

IMC Networks Technical Support

TEL: (949) 465-3000; (800) 624-1070 (in the U.S. and Canada); +32-16-550880 (Europe)

FAX: (949) 465-3020

E-Mail: techsupport@imcnetworks.com

Web: www.imcnetworks.com

Specifications

Environmental

Operating Temperature: 32° - 104° F (0° - 40° C)

Storage Temperature: 0° - 160° F (-20° - 70° C)

Humidity: 5 - 95% (non-condensing)

Power

AC Input Load: 100/240V±10% ~ 50/60 Hz, 0.1/0.05A

Dimensions

McBasic TP/FO 1.64"H x 4.75"W x 4.95"D (4.17cm x 12.07cm x 12.57cm)

McBasic TP/BNC 1.64"H x 4.75"W x 4.54"D (4.17cm x 12.07cm x 11.53cm)

Shipping weight: 1.3 lbs. (0.6 kg)

Fiber Optic Specifications

For fiber optic specifications, please visit our Web site at:

http://www.imcnetworks.com/adocs/fcs.asp.

Fiber Optic Cleaning Guidelines

Fiber Optic transmitters and receivers are extremely susceptible to contamination by particles of dirt or dust, which can obstruct the optic path and cause performance degradation. Good system performance requires clean optics and connector ferrules.

1) Use fiber patch cords (or connectors, if you terminate your own fiber) only from a reputable supplier; low-quality components can cause many hard-to-diagnose problems in an installation.
2) IMC Networks installs dust caps to ensure factory-clean optical devices. Do not be remove these protective caps until the moment of connecting the fiber cable to the device. Assure that the fiber is properly terminated, polished and free of any dust or dirt, and that the location is as free from dust and dirt as possible.
3) Store spare caps in a dust-free environment such as a sealed plastic bag or box so that when reinstalled they do not introduce any contamination to the optics.
4) Should it be necessary to disconnect the fiber device, reinstall the protective dust caps.
5) If you suspect that the optics have been contaminated, alternate between blasting with clean, dry, compressed air and flushing with isopropyl alcohol to remove particles of dirt.

ELECTROSTATIC DISCHARGE PRECAUTIONS

Electrostatic discharge (ESD) can cause damage to your add-in modules. Always observe the following precautions when installing or handling an add-in module or any board assembly.

1) Do not remove unit from its protective packaging until you're ready to install it.
2) Wear an ESD wrist grounding strap before handling any module or component. If you do not have a wrist strap, maintain grounded contact with the system unit throughout any procedure requiring ESD protection.

WARNING! Integrated circuits and fiber optic components are extremely susceptible to electrostatic discharge damage. Do not handle these components directly unless you are a qualified service technician and use tools and techniques that conform to accepted industry practices.

3) Hold boards by the edges only; do not touch the electronic components or gold connectors.
4) After removal, always place the boards on a grounded, static-free surface, ESD pad or in a proper ESD bag. Do not slide the board over any surface.

WARRANTY

IMC Networks warrants to the original end-user purchaser that this product, EXCLUSIVE OF SOFTWARE, shall be free from defects in materials and workmanship under normal and proper use in accordance with IMC Networks' instructions and directions for a period of six (6) years after the original date of purchase. This warranty is subject to the limitations set forth below.

At its option, IMC Networks will repair or replace at no charge the product which proves to be defective within such warranty period. This limited warranty shall not apply if the IMC Networks product has been damaged by unreasonable use, accident, negligence, service or modification by anyone other than an authorized IMC Networks Service Technician or by any other causes unrelated to defective materials or workmanship. Any replaced or repaired products or parts carry a ninety (90) day warranty or the remainder of the initial warranty period, whichever is longer.

To receive in-warranty service, the defective product must be received at IMC Networks no later than the end of the warranty period. The product must be accompanied by proof of purchase, satisfactory to IMC Networks, denoting product serial number and purchase date, a written description of the defect and a Return Merchandise Authorization (RMA) number issued by IMC Networks. No products will be accepted by IMC Networks which do not have an RMA number. For an RMA number, contact IMC Networks at PHONE: (800) 624-1070 (in the U.S and Canada) or (949) 465-3000 or FAX: (949) 465-3020. The end-user shall return the defective product to IMC Networks, freight, customs and handling charges prepaid. End-user agrees to accept all liability for loss of or damages to the returned product during shipment. IMC Networks shall repair or replace the returned product, at its option, and return the repaired or new product to the end-user, freight prepaid, via method to be determined by IMC Networks.

IMC Networks shall not be liable for any costs of procurement of substitute goods, loss of profits, or any incidental, consequential, and/or special damages of any kind resulting from a breach of any applicable express or implied warranty, breach of any obligation arising from breach of warranty, or otherwise with respect to the manufacture and sale of any IMC Networks product, whether or not IMC Networks has been advised of the possibility of such loss or damage.

EXCEPT FOR THE EXPRESS WARRANTY SET FORTH ABOVE, IMC NETWORKS MAKES NO OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, WITH RESPECT TO THIS IMC NETWORKS PRODUCT, INCLUDING WITHOUT LIMITATION ANY SOFTWARE ASSOCIATED OR INCLUDED. IMC NETWORKS SHALL DISREGARD AND NOT BE BOUND BY ANY REPRESENTATIONS OR WARRANTIES MADE BY ANY OTHER PERSON, INCLUDING EMPLOYEES, DISTRIBUTORS, RESELLERS OR DEALERS OF IMC NETWORKS, WHICH ARE INCONSISTENT WITH THE WARRANTY SET FORTH ABOVE. ALL IMPLIED WARRANTIES INCLUDING THOSE OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY LIMITED TO THE DURATION OF THE EXPRESS WARRANTY STATED ABOVE.

Every reasonable effort has been made to ensure that IMC Networks product manuals and promotional materials accurately describe IMC Networks product specifications and capabilities at the time of publication. However, because of ongoing improvements and updating of IMC Networks products, IMC Networks cannot guarantee the accuracy of printed materials after the date of publication and disclaims liability for changes, errors or omissions.

Federal Communications Commission Radio Frequency Interference Statement

This equipment has been tested and found to comply with the limits for a Class A computing device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which the user will be required to correct the interference at his own expense.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

The use of non-shielded I/O cables may not guarantee compliance with FCC RFI limits.

This digital apparatus does not exceed the Class A limits for radio noise emission from digital apparatus set out in the Radio Interference Regulation of the Canadian Department of Communications.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de classe A prescrites dans le Règlement sur le brouillage radioélectrique publié par le ministère des Communications du Canada.

Safety Certifications

UL/CUL: Listed to Safety of Information Technology Equipment, Including Electrical Business Equipment.

CE: The products described herein comply with the Council Directive on Electromagnetic Compatibility (89/336/EEC) and the Council Directive on Electrical Equipment Designed for use within Certain Voltage Limits (73/23/EEC). Certified to Safety of Information Technology Equipment, Including Electrical Business Equipment. For further details, contact IMC Networks.

LISTED SM80
ITE
E156766

Class 1 Laser product, Luokan 1 Laserlaite,
Laser Klasse 1, Appareil A'Laser de Classe 1

Questions or Comments about this manual? Contact documentation@imcnetworks.com

Visit www.mediaconverter.com for a complete overview of media conversion products available from IMC Networks.

ISO 9001 REGISTERED

IMC Networks

Made in USA

19772 Pauling • Foothill Ranch, CA 92610-2611 USA
TEL: (949) 465-3000 • FAX: (949) 465-3020
www.imcnetworks.com

Document Number 55-80226-01 A0 February 2005

MRI Monitor

MRI Monitor Frame, F-MRICM1 (Rev.00)
Display Unit
Frame Unit
AC/DC Power Supply Unit

Software License, L-CANE05/A

Technical Reference Manual Slot

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

Document no. M1056422-2
September, 2006

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

Table of contents

Table of figures

Introduction

This section provides information about the maintenance and service of the following products:

- MRI Monitor Frame, F-MRICM1, Display Unit (including UPI function, LCD display, Command board function, Display Controller function, NET function, MEM function, DIS function, Display Unit power supply unit).
- Software Licenses L-CANE05, L-CANE05A.
- MRI Monitor F-MRICM1 including the AC/DC power unit, battery, recorder and Power Management Board.

All the service menus related to the monitor are described in a separate “Service Menu” slot and the spare part lists in the “MRI Monitor Spare Parts” slot.

NOTE: Printings on thermal paper may be destroyed when exposed to light, heat, alcohol, etc. Take a photocopy for archive.

Figure 1 MRI Monitor Frame, F-MRICM1

1 Specifications

1.1 MRI Monitor Frame, F-MRICM1

Dimensions

W x D x H	455 x 300 x 372 mm / 17.9 x 11.8 x 14.7in
Weight (without modules)	10.3 kg (22.7 lbs)

Electrical Requirements

Power supply	
Rated voltage range and frequencies	100 to 240 VAC 50/60 Hz (limits 90-264 VAC)
Stability	±10 % of nominal voltage
Power consumption	140 VA (max)
Fuses	2x2A, T/SLOW, 250 V
Grounding	Hospital grade
Interruptability	Data memory and alarm settings are saved up to 15 minutes after monitor standby

Environmental Requirements

Operating temperature	10 - 35 °C / 50 - 95 °F
Storage temperature	-10 - 50 °C / 14 - 122 °F
Atmospheric pressure	500 - 800 mmHg (660 - 1060 mbar, 66 - 106kPa)
Humidity	10 - 90 % non-condensing

1.1.1 Battery

Battery type	NiMH, 3.5Ah
Battery charging time	10 hours to full capacity
Battery operation	up to 1 hours typical on full charge at 23 °C / 73 °F
Recharging	when connected to mains power
Battery operaton alarm	
early warning	'Battery low' note
final warning	'Battery low' alarm
Battery state indicator	Capacity bar displayed on the screen

1.1.2 In-built recorder option

Power consumption	3 W
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
Traces	Selectable 1, 2, or 3 traces

Print speed	1, 6.25, 12.5, 25 mm/s

1.1.3 Display Unit

Dimensions,

D x W x H	55 x 335 x 270 mm (2.2 x 13.2 x 10.6 in)

Electrical Requirements

Power supply	10...17 VDC (supplied by Frame Unit VBUS voltage)
Stability	±10% of nominal voltage
Power consumption	27.5 VA, max. 2 A
Grounding	Hospital grade
Interruptibility	Data memory and alarm settings are saved up to 15 minutes after monitor standby

LCD Display

Display size	12.1 in (diagonal)
Display type	Active Matrix Color TFT LCD
Resolution	SVGA 800x600

1.1.4 MemCard option

MemCard capacity	6 MB minimum
Data storage capacity	2 days of continuous physiological data trends
Operating system	Datalight ROM-DOS
File system	MS-DOS compatible
MemCards	PCMCIA-ATA compatible memory cards

1.1.5 Network option

Meets IEEE802.3 specifications (10BASE-T)
Hospital grade approved data transformer
Coding element interface

1.1.6 Wireless LAN option

Type	PC card (PCMCIA) Spectrum24(R) High Rate LA 41X1, manufactured by Symbol Technologies, Inc. With integrated antenna
Frequency range	Worldwide product covering 2.4 to 2.5 GHz, programmable for different country regulations
Data rate	11 Mbps per channel (max.)
Output power	100 mW
Data transmission	IEEE 802.11b compliant, Direct Sequence Spread Spectrum (DSSS)
Roaming	Automatic roaming between the Datex-Ohmeda Central's Access Points
Security	Wired Equivalent Privacy (WEP) 40 and 128 bit encryption
Certificates	Wi-Fi certified

1.1.7 Digital outputs of Display Unit

Nurse call	Low State: 0-0.8V; High State: 2.8-5V Generated on red and yellow alarms

Display controller

Video output	analog RGB, 0.3V - 1.1V, 0.8V_{pp}, 75 ohm

Output data

SVGA resolution

Resolution	800 × 600 pixels
Frame frequency	60 Hz
Scan frequency	37.9 kHz
Dot frequency	40 MHz
Sync polarity	H/positive, V/positive, level TTL

Sync pulse:

	Horizontal	**Vertical**
Front porch	1 µs	0.027 ms
Sync pulse	3.2 µs	0.105 ms
Back porch	2.2 µs	0.612 ms
Sweep time	26.39 µs	16.67 ms

Sound out

Sound out	+8V, signal

2 Functional description

2.1 Display Unit functional description

The MRI Monitor Frame Display Unit includes the following parts:

- Central Processing Board: includes Display Controller, UPI, CPU and optionally Network and MemCard functions
- Color LCD display and its backlight inverter
- Connector board
- Command board
- Display Unit DC/DC power supply
- Fan and loudspeaker

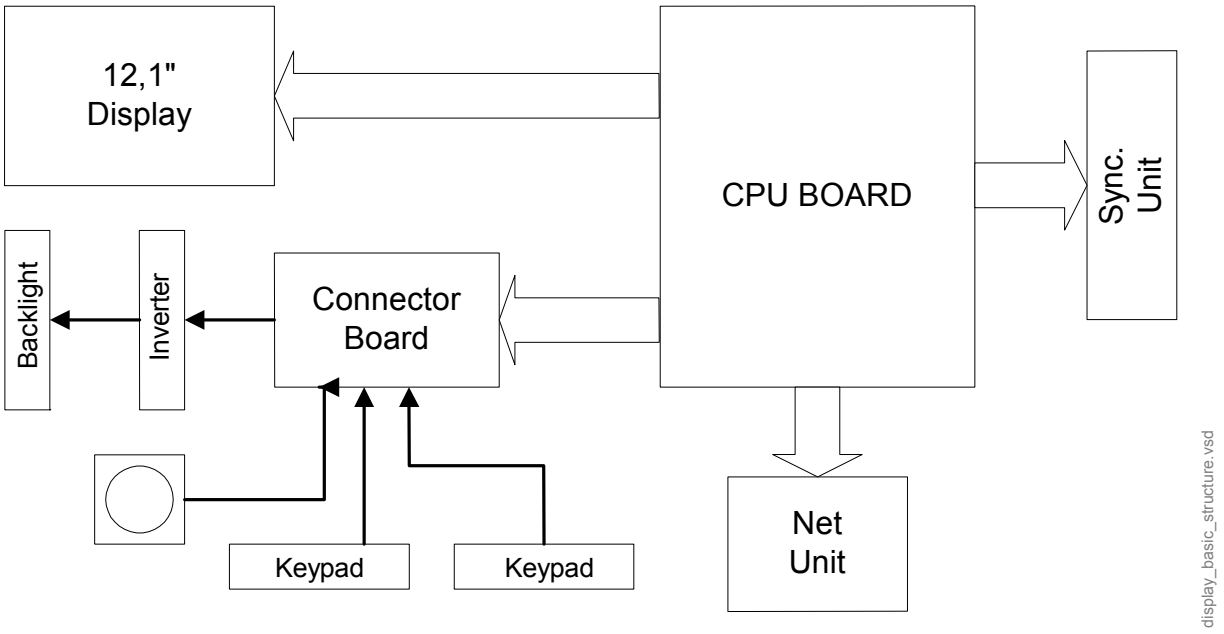


Figure 2 Basic structure of Display Unit

2.1.1 CPU section

The CPU section takes care of the central processing.

The main features are:

- 486 processor
- Internal clock frequency 100 MHz
- 32 Mbytes DRAM
- 8 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
- PC card slot for software updates

Standby and Display Unit power down

When the monitor is turned to standby, NMI interrupt is generated by the control logic. The interrupt signal in the Central Processing Board means that all the outputs from the Central Processing Board are switched off (i.e. display, alarm leds, etc.). The CPU section processor enters the HALT state.

During the Halt state the DRAM refreshing cycle continues to occur, thus saving trend and patient data and user settings stored in the DRAM. After 15 min the Power Management Board (in the Frame Unit) cuts of the Display Unit voltage.

If the monitor is restarted within 15 min of the last power off, a Warm Start is performed (trends and temporary settings will be available). If the monitor is restarted after 15 min of the last power off, a Cold Start is performed (trends and temporary settings will be erased).

Watchdogs

There are certain watchdog functions to ensure the monitor's performance. The UPI interrupts the CPU continuously in order to tell that everything runs smoothly. If this watchdog fails, the UPI section is initialized. The monitor is not reset.

The CPU section has its own watchdog in order to ensure that the main software functions normally. In software overload situation the watchdog is not refreshed, and the monitor is reset.

The Central Processing Board (the CPU section) communicates with the Power Management Board in the Frame Unit. This communication is also used as a watchdog signal between Central Processing Board and PMB.

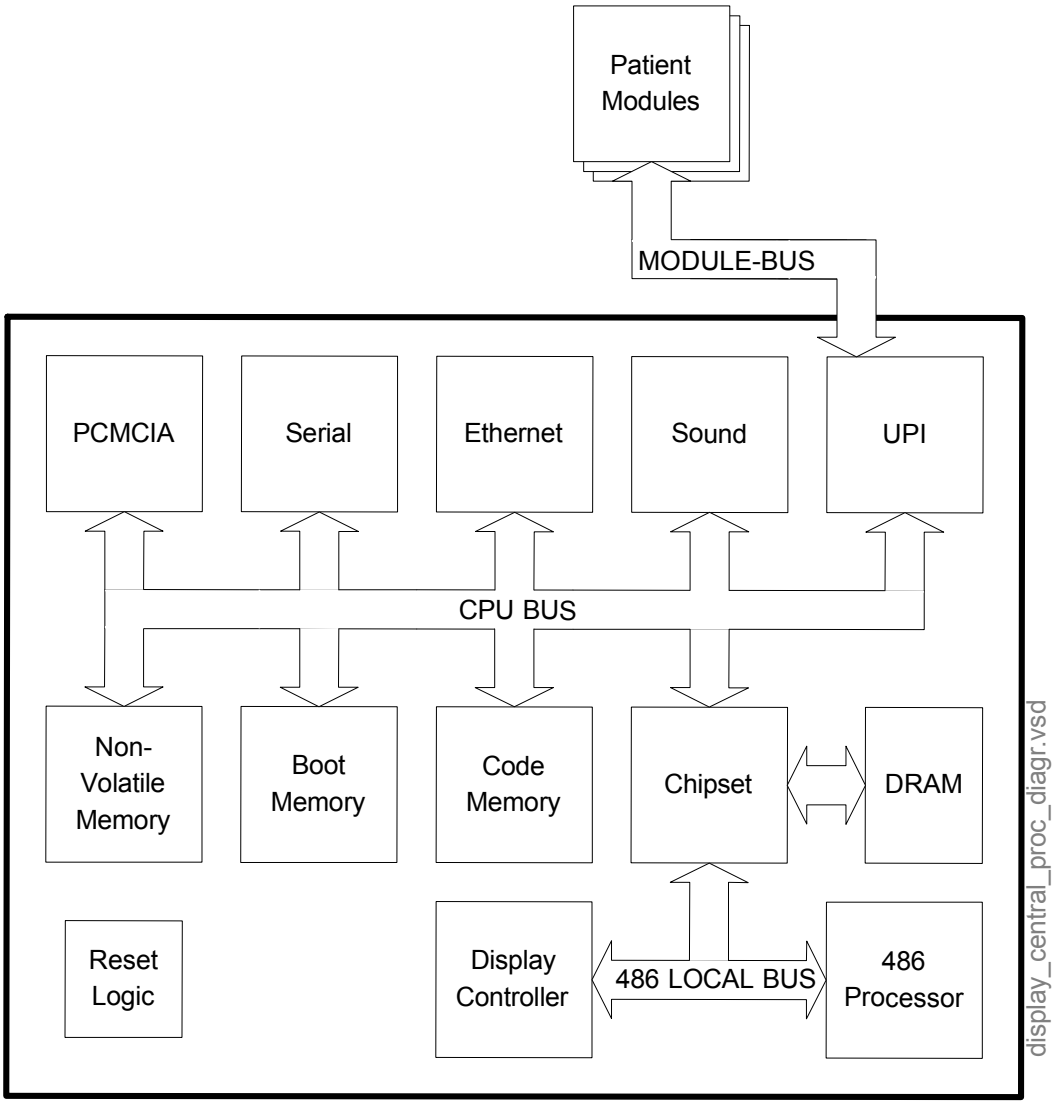


Figure 3 Central Processing Board Block Diagram

SRAM MT48T37V

The lithium battery back-up is a 32 Kbytes static RAM with a real-time clock.

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

2.1.2 UPI section

The UPI functions as a general I/O section. It performs I/O duties assigned to it by the CPU. The main processor and the processor on the UPI communicate through a dual-port memory (shared RAM), which is located on the UPI section.

Functional Blocks

The UPI section contains the CPU bus interface, a processor, program and dual-port memories, I/O block, and serial bus interface.

CPU Bus Interface

The UPI section is connected to the CPU section by CPU (ISA) bus. The following signals pass between the UPI and CPU: data bus, address bus, reset, write and read signals.

Processor

The processor of the UPI section is a Hitachi H8S/2655, which functions at 16 MHz frequency.

Serial Bus Interface

The serial bus interface of the UPI section contains Module Bus RS485, serial RS232 and RS422 interfaces.

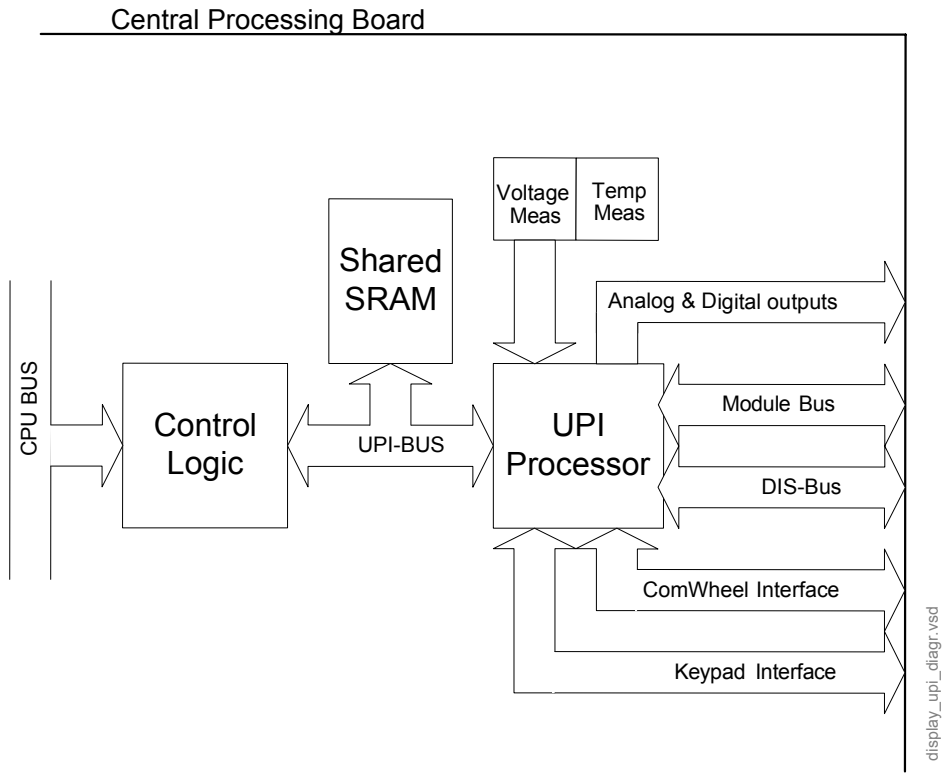


Figure 4 UPI Section Block Diagram

2.1.3 PCMCIA card extender

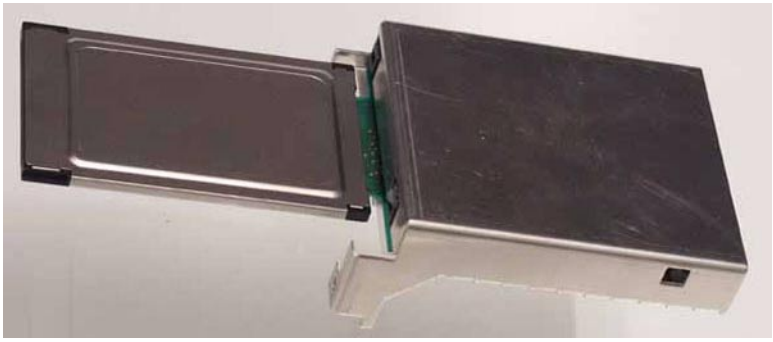


Figure 5 PCMCIA card extender

The cardslot in the MRI shield contains a PCMCIA extender. The extender is placed in the MRI Monitor Frame's card slot and it opens up one card slot extension in the shield.

The other card slot in the MRI Monitor Frame is for WLAN card. The card slot in the shield is for Data Card or for software downloading.

2.2 Software License, L-CANE05, L-CANE05A

L-CANE05/L-CANE05A software is developed for anesthesia monitoring. Anesthesia record keeping capability is included in the software as standard. The software L-CANE05A includes extended arrhythmia analysis.

L-CANE05/L-CANE05A is a license software. The license agreement that is delivered with the software should be archived in a secure location. A relevant license number may have to be referred when contacting GE Healthcare service/support. The license number is needed also for future software upgrades.

Each of the above listed monitor software is loaded on the Central Processing Board at the factory, i.e. they are not available separately.

The L-CANE05(A)S software is used for service purposes only and is stored on a separate Software Card (PCMCIA, 8 MB). See section "Downloading the software on empty Central Processing Board".

CAUTION The software card is not write-protected. For safety reasons do not use software cards for any other purpose or on any other platforms than they are designed for.

2.3 Display controller section

The display controller is integrated to the Central Processing Board. The processor on the CPU section transmits graphics information through the CPU bus to the display memory on the Display Controller section.

The Display Controller section supports SVGA resolution. The resolution is automatically selected for the LCD display in use. The resolution is set to 800 x 600.

Display memory

The Display memory contains digital display data. The size of the memory is 1 Mbyte making an 800 x 600 display resolution with 256 colors possible. The memory consists of a 1 Mbyte DRAM.

Display controller resolution

The resolution of the display controller is set to SVGA, i.e. 800x600 resolution.

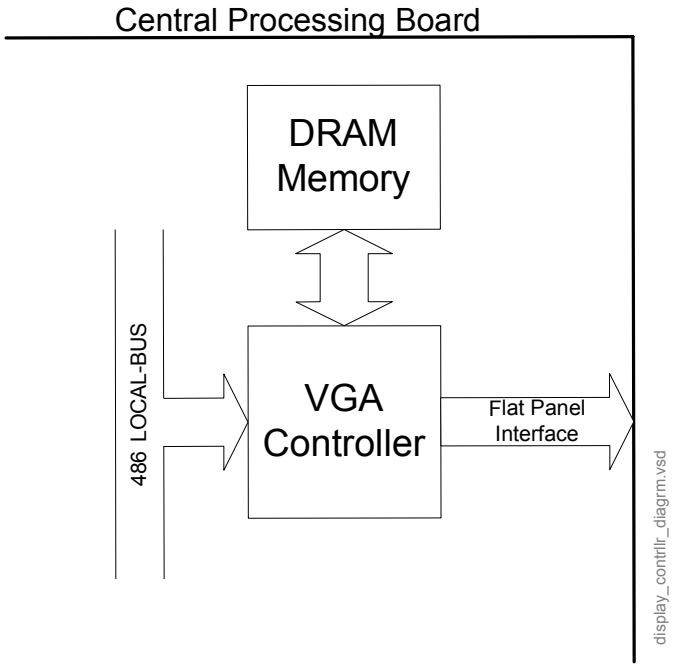


Figure 6 Display Controller Block Diagram

2.4 MEM section

Memory Card interface

The memory interface consists of a PD6722 controller and two PCMCIA compatible card sockets. Both sockets consist of 60 signal and 8 power connections. The controller communicates with the CPU. Card insertions and removal are also detected by the controller.

The MemCards are PCMCIA-ATA compatible. The MemCard files are MS-DOS compatible, and they can be copied for archiving with any MS-DOS compatible computer equipped with PCMCIA-ATA specification compatible card drive.

The MemCard function is optional. The operation requires a software option.

The monitor software can be downloaded to the monitor Flash memory through the memory interface.

Power supply

The memory section receives its power (+5V, +12V) from the Central Processing Board. PCMCIA card programming voltage is +12V. The card programming voltage is controlled by the interface controller.

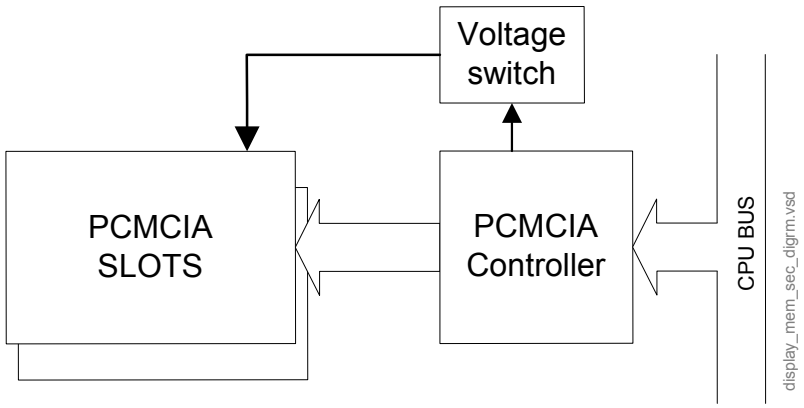


Figure 7 Memory Section Block Diagram

2.5 NET section

The Ethernet interface controller is basically the heart of the NET section. The interface controller communicates with the CPU section through the CPU bus. The section also contains a 4k SRAM memory.

The network interface controller transmits data packets to the Datex-Ohmeda Network and receives data packets from the network through the 10BASE-T transformer. The transformer filters and transforms the data and also provides the isolation.

The Ethernet status LEDs indicate the status of the network communication. The status LEDs are controlled by the network controller. The LEDs are located on the Central Processing Board.

The PLD interfaces the coding element. The coding element contains information on the monitor location. The network address and the monitor location information are transmitted to the CPU section directly through the CPU bus.

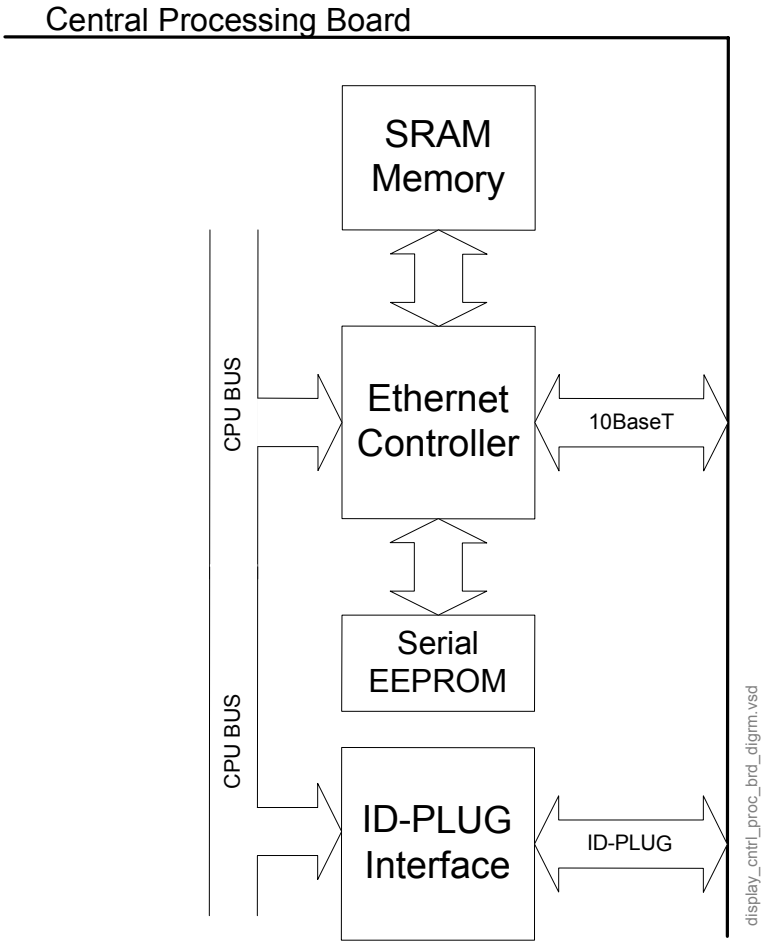


Figure 8 Central Processing Board, block diagram

Ethernet interface

The data transformer is designed by Datex-Ohmeda and it is hospital grade approved.

Adapter's 10BASE-T is an interface with low-pass filters on the unisolated side of the transformer. On the isolated side there is a common mode choke for both transmitting and receiving lines.

The three LEDs on the board, which are not seen from the outside, indicate the following things: activity on the network, collision detection and a good link in 10BASE-T interface.

The activity LED flashes when communication packets are detected in the Datex-Ohmeda Network. The collision detection LED indicates a packet collision on the network. The collision detection LED should flash only occasionally, otherwise there may be a physical layer problem. The good link LED indicates whether or not the communication link to the HUB is functional. The good link LED should always be lit.

2.6 Wireless LAN

Wireless Network is an extension to, or an alternative for, a wired Monitor Network. It provides same network services as the wired Monitor Network.

The Monitor Network is a local area network based on standard Ethernet technology. The Monitor Network is formed by connecting one Central and up to 32 bedside monitors together.

The Central and the bedside monitors are connected to a 10 Mbps hub. The hub works as a multiport repeater and controls the information flow between all the devices connected to the Monitor Network.

The communication protocol for the monitor network is GE Healthcare specific.

Wireless bedside monitors can use both the wired and wireless network. If the network cable is connected, the wired Datex-Ohmeda Network is used.

For using Wireless LAN connection, the monitor requires Symbol24 Wireless LAN antenna card.

For configured parameters please refer to the Datex-Ohmeda Network Installation Guide.

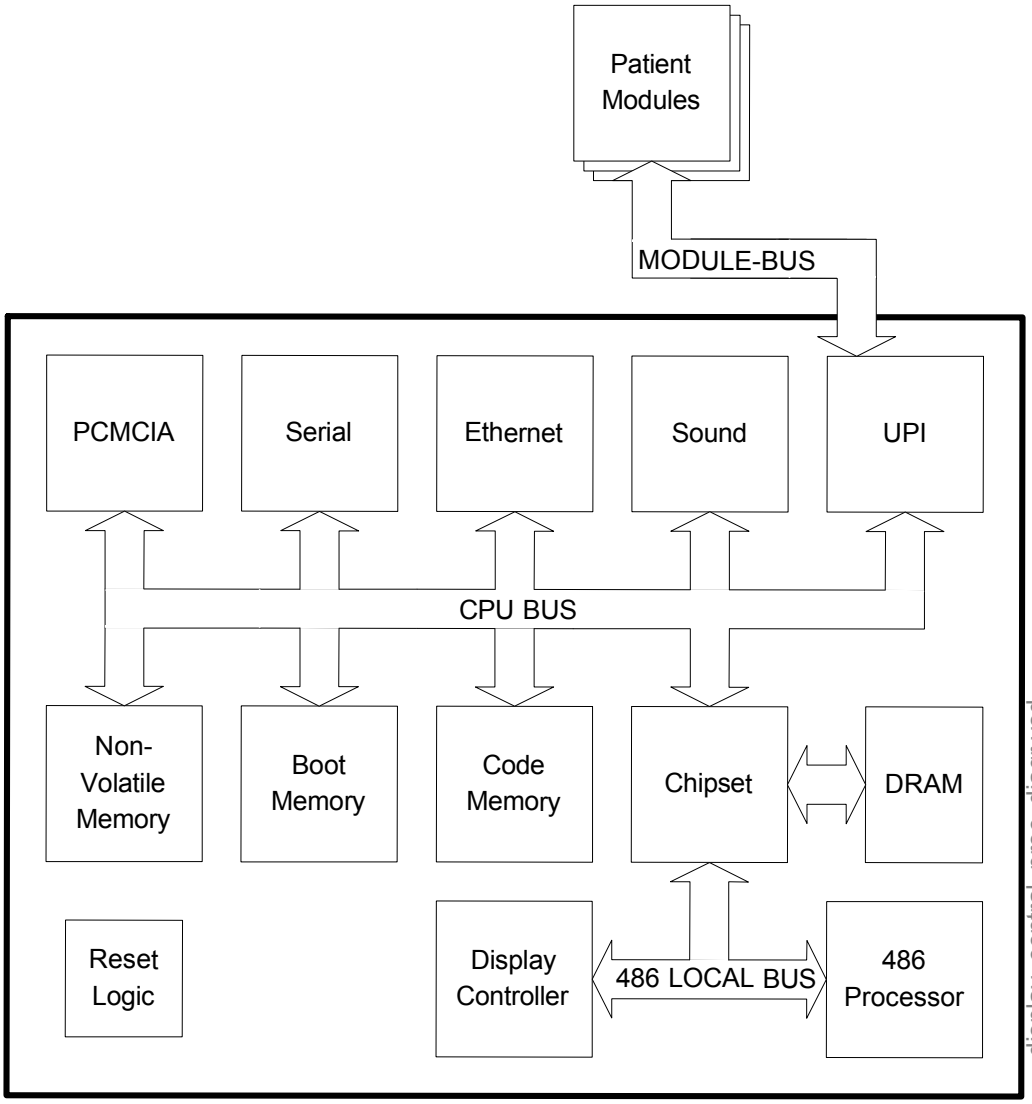


Figure 9 Central Processing Board parts

2.7 Front Unit

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

Front Unit includes an LCD display component, Inverter Board, Connector board and Keyboard.

The Front Unit is connected to the Central Processing Board with two cables: video signal cable and Connector Board cable. The video signal cable transmits the video signal from the Central Processing Board to the LCD display. Video signalling between the Display Controller on the Central Processing Board and the Front Unit is analogic.

Backlight power, keyboard and ComWheel signals are routed through the Connector Board Cable.

Backlights

The backlight consists of two replaceable cold-cathode fluorescent tubes driven by a separate inverter board.

Connector board

The connector board is used for connecting the backlight power, keyboard and ComWheel signals between the Central Processing Board and the Front Unit.

Keyboard

There are two keyboards in the Display Unit Front Unit: front panel and side panel keyboards. The keyboards are foil membrane keypads. There is no separate processor for the keyboards. The keyboards are connected to the UPI section of the Central Processor Board through Connector Board.

2.7.1 Display Unit DC/DC power supply

This DC/DC converter board transforms primary voltage of between +10 and +18 VDC to +3.3V, +5V, and +12 V secondary voltages. All the output voltages have common ground.

The DC/DC power supply is powered by Vbus voltage generated by the Frame Unit AC/DC converter (mains). If the mains power fails, the DC/DC power supply is powered by batteries.

Turn-on and shut-down sequences of the DC/DC power supply are controlled by a logic on the DC/DC board and by the Central Processor Board software. If overvoltage occurs at an output line, the converter turns itself off automatically.

The Display Unit DC/DC converter supplies also a Display Unit fan.

2.8 Frame unit

The Frame Unit consists of the following parts:

- PMB (Power Management Board)
- PMB connector board(s)
- connector board PMB-REC (in the side frame unit)
- two batteries
- AC/DC power unit
- optionally in-built recorder

The left side of the Frame Unit has places for two MR specific double-width modules.

The network signals are led through their own cables to the Frame Unit. The connectors are located on the left side of the Frame Unit.

The serial data interface is led through the Frame Unit to the MR specific AC/DC power unit. The serial connector is located at the side of the AC/DC power unit.

The MRI Monitor frame F-MRICM1 is modified from the standard Compact Monitor with following differencies:

- removed handle to save space
- modified electronics to get signal for external display and sound
- modified back plate to get space for MR specific gas modules
- side frame unit is modified to extend the recorder and fan to the shield level
- minimized ferrous metal to enable better MR compatibility
- modified power to enable operation in high magnetic field

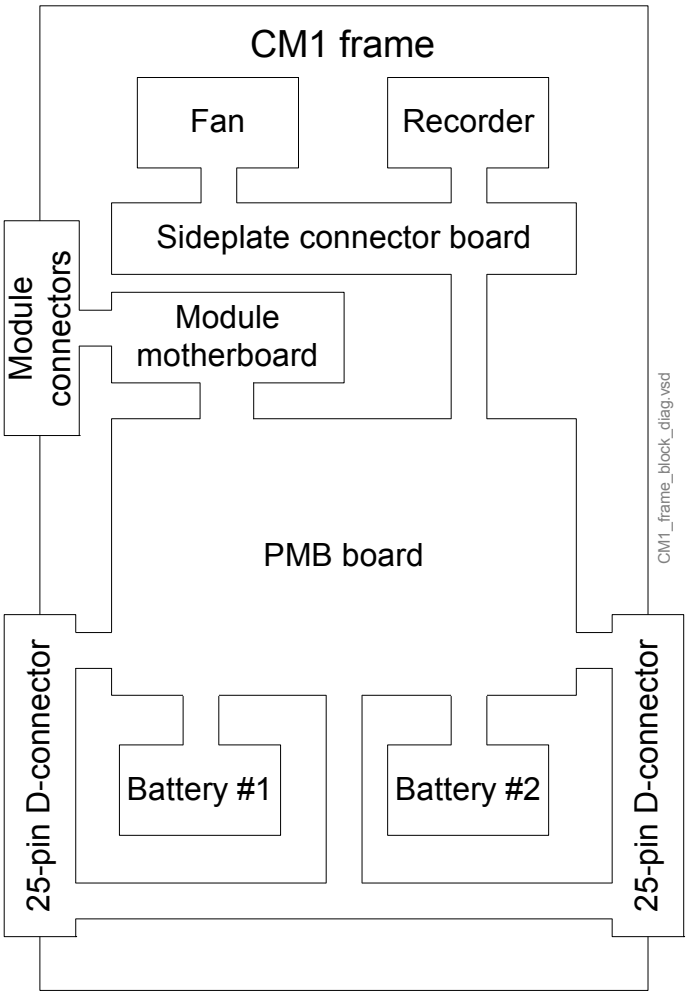


Figure 10 Frame block diagram

2.8.1 PMB connector board

The PMB connector boards are small boards connected together by a ribbon cable and are both equipped with the D-25 connectors, one for AC/DC unit and the other for the Display Unit. The board with the Display Unit connector has also a 16-pin connector for the PMB board.

The PMB connector boards route signals between the AC/DC unit, PMB board and Display Unit. Signals are transferred via a ribbon cable between the D-connector boards (connected to the AC/DC and DU). Power lines are transferred separately through the PMB.

2.8.2 Connector board PMB-REC

The connector board PMB-REC is the one mounted in the Side Frame unit, and connected to the PMB board via a 15-pin D-connector when inserted into the frame. The connector board PMB-REC routes operating voltage and signals for the frame cooling fan and for the recorder unit (optional).

2.8.3 PMB (Power Management Board)

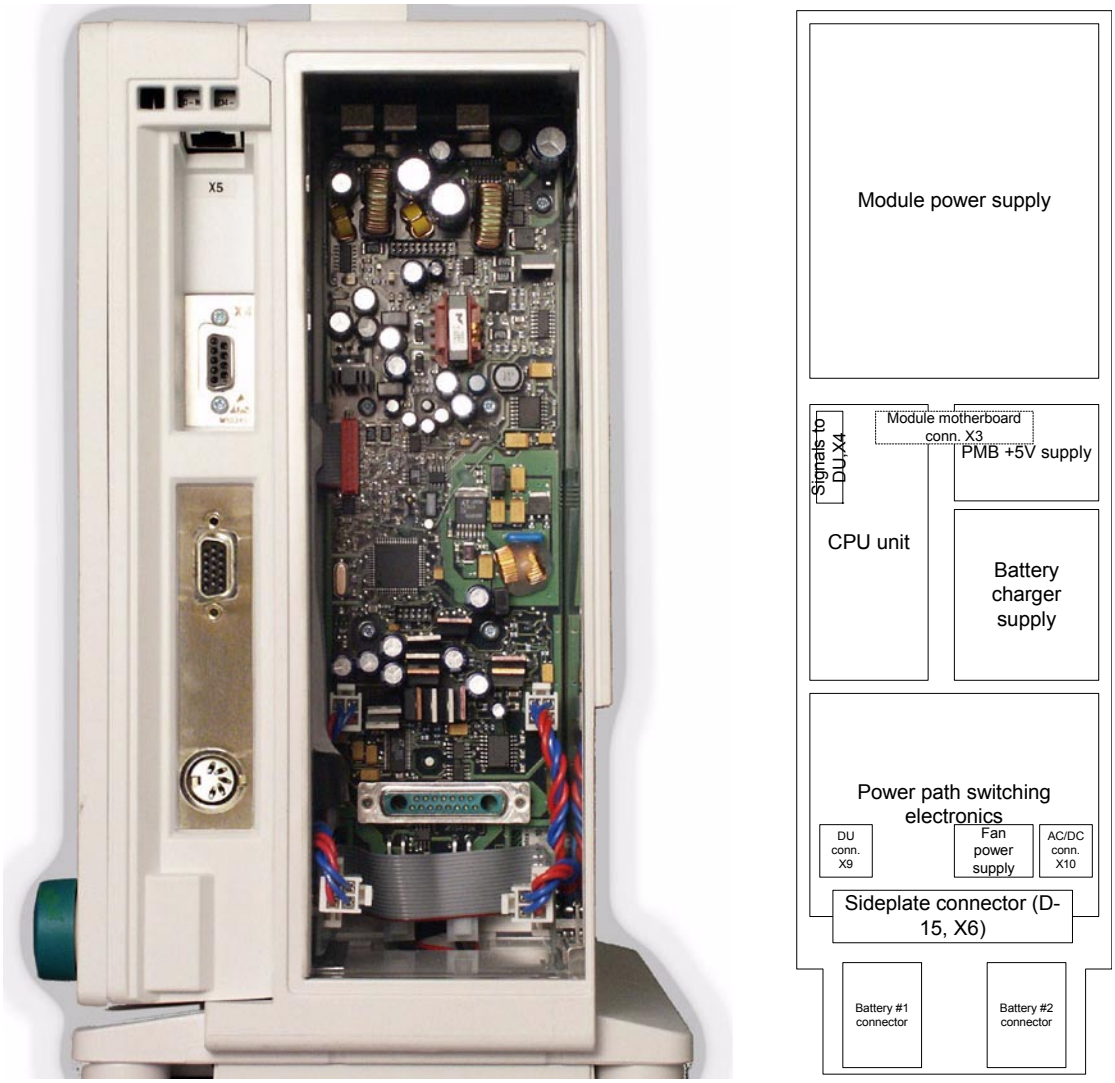


Figure 11 Location of the Power Management Board (side frame panel removed) and the PMB block diagram

The Power Management Board (PMB) is responsible for distributing DC current for the rest of the frame. The power source can be the AC/DC unit or one of the internal batteries, and the chosen power line is referred to as 'VBUS'. The voltage of VBUS is 10-17V. PMB also controls the fan voltage and battery charging.

The blocks in "Figure 11" represent different functions on the board.

Module power supply

This block generates the voltages needed for the parameter modules from the selected power source (VBUS), and delivers those to the module motherboard through connector X3. These voltages are +5V, +15V, -15V and +15Vdirty.

PMB CPU unit

The CPU unit controls all other functions of the board. The functions include:

- Battery current monitoring
- Battery capacity calculations
- Battery temperature monitoring
- Battery charger control
- Frame fan voltage control
- Level-change of recorder serial line signals
- Module power supply measurements (voltages & input current)
- Module power supply start-up and shutdown
- Power path management (choosing the correct supply source)
- Monitor start-up and shutdown control

PMB +5V supply

This unit provides the PMB CPU and other PMB electronics +5V power supply. Input either internal battery or AC/DC output, output +5V.

Battery charger supply

The charger generates the desired charge current for the batteries from the AC/DC output voltage. At fast charge rate the current is 1A, at timed charge the current is 500mA for 1/3rd of the time and at trickle charge rate the current is 500mA for 7/500th of the time. The charge rate is controlled by the CPU block.

Power path switching electronics

The power source to be used (batteries or AC/DC output) is chosen initially by a 'power path controller' inside this block. The CPU unit has full control over the power path management after the initial choice is made at start-up. In addition to the power path, the charge current path is also chosen by the CPU and driven by the power path controller.

WARNING **For as long as the AC/DC unit or either one of the two internal batteries is connected, the open metal surfaces in this area contain approximately 15V voltages. An accidential touch of a screwdriver or anything else conductive may short-circuit the power lines and destroy PMB electronics.**

Frame fan power supply

This unit drives the fan (mounted in the side frame unit). It is controlled by the CPU unit, and driven according to AC/DC current information and frame temperature.

2.8.4 Module motherboard

The module motherboard routes signals from the PMB to the module slots. Signals include power supplies and module data buses.

2.8.5 AC/DC Power Supply Unit

The universal AC/DC power supply provides an isolated 15.5 V supply for the MRI Monitor. The power unit is attached to the Frame Unit by four screws and a power-D25 connector.

The MRI specific AC/DC power supply unit has been designed to have improved tolerance for high magnetic field strengths over short-term periods.

The cooling air for the AC/DC unit is from the Frame Unit fan through cooling holes in the Frame Unit back plate. The power unit generates a load signal, which is read by the PMB board in the Frame Unit.

The AC/DC power supply is protected by an overvoltage protection. If the output voltage increases over 17V, the protection is activated and the AC/DC power supply unit does not return to normal operation until the power cord is briefly disconnected.

CAUTION The MRI Monitor has been designed to tolerate high magnetic field strengths over short-term periods. High magnetic field strengths may, however, be destructive to the MRI Monitor electronics. Always keep the MRI Monitor outside the 300 G line.

2.8.6 Batteries

There are two NiMH batteries attached to the bottom of the Frame Unit. The PMB board connects one of the batteries to be the power source, if no power is received from the AC/DC power supply.

The battery charging is controlled by PMB. The normal charge current for the batteries is 170mA RMS. When the batteries are full, the charging is continued by a 10mA current (trickle charge) to avoid self-discharge of the batteries.

2.8.7 Frame Unit Fan

The Frame Unit Fan is used for cooling the Frame Unit electronics, the modules and the AC/DC power unit. The fan is controlled by the PMB. The rotation speed of the fan is adjusted according to the frame temperature and AC/DC power unit load. At monitor start-up, the fan is briefly run at full speed to ensure its operation.

2.8.8 In-built Recorder Unit

The recorder unit is located in the Side Frame Unit, and it is connected to the Connector Board PMB-REC with a small connector board and 12-pin flex-strip cable.

External Communication

Communication with the monitor Central Processing Board takes place via the Connector Board PMB-REC, PMB, the Connector Board to Display Unit and the Display Unit DC/DC power unit.

The communication uses +5 V CMOS level RS232 serial interface with an RS485 reset.

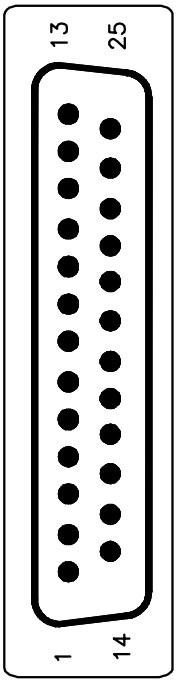
Reset The differential RS485 reset from the module bus generates a Recorder Unit reset signal on the Recorder Board. The Recorder Board also generates a power-up-reset, whose time constant is approximately 0.1 second. The Recorder Unit reset signal is therefore active when either the Module Bus RS485-reset or the power-up-reset is active.

+5 V priority The recorder unit supply voltage, +15 VREC is switched on after +5 V is present.

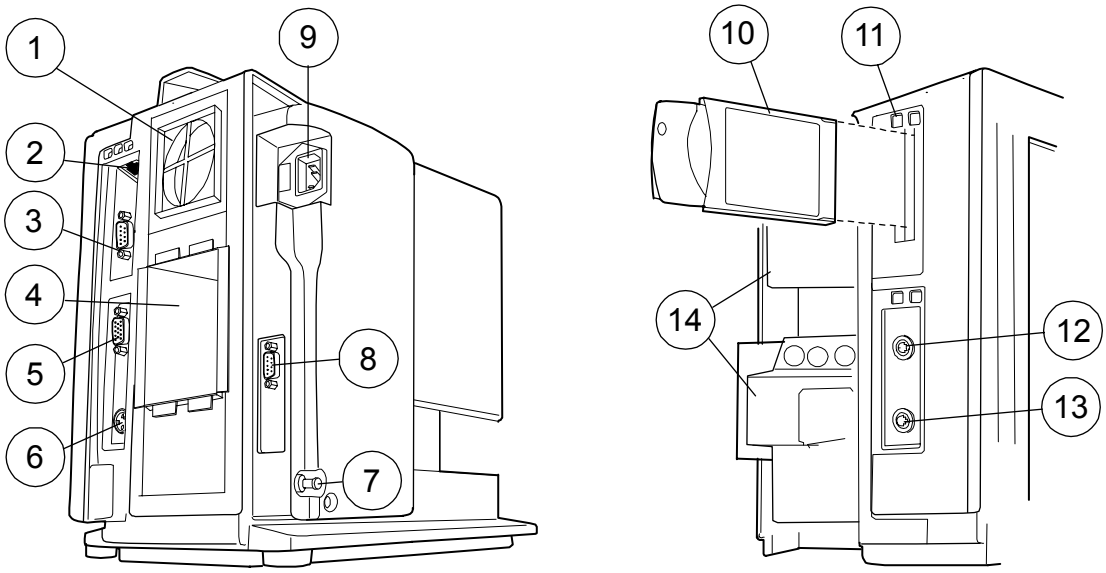
2.9 Connectors and signals

Module motherboard

Table 1 Module connector pinout (X1-X4):

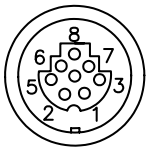
25 pin male D-connector	Pin No.	Signal
	1	Reset_485
	2	-15V
	3	15Vdirty
	4	+15V
	5	Data_485_
	6	Data_485
	7	GND
	8	Reset_485_
	9	CTSB
	10	RTSB
	11	RXDB
	12	TXDB
	13	GND
	14	NC
	15	GND
	16	CTSC
	17	RTSC
	18	RXDC
	19	TXDC
	20	NC
	21	PWM_ECG
	22	RXD_RS232
	23	TXD_RS232
	24	+5V
	25	+5V

2.9.1 External connectors

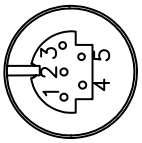


(1) Fan
(2) NET connector for Crossover cable X5
(3) NET ID connector X4 (not used with N-CMW)
(4) Recorder (optional)
(5) VGA connector X6
(6) Connector for external keyboard X9 (anesthesia record keeping keyboard or K-CREMCO)
(7) Potential equalization
(8) Serial port X11 (for service purposes)
(9) Receptacle for power cord
(10) WLAN PC card
(11) Slot for WLAN PC card and PCMCIA card extender
(12) Connector for Sound cable X2
(13) Connector for DIS (Device Interfacing Solution) X3
(14) Modules

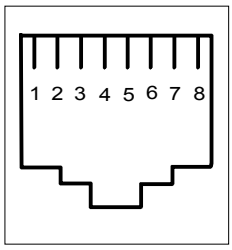
DIS connector, X3 DIS interface

8 -pin female mini DIN connector	Pin	Signal
	1 2 3 4 5 6 7 8	DIS_out + DIS_out - 15V_DIS GND 8V_DIS GND DIS_in + DIS_in -

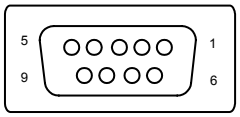
Sound connector X2

5 pin mini DIN connector	Pin No.	Signal
	1 2 3 4 5	NC GND 8V_DIS AUDIO_IN+ AUDIO_IN -

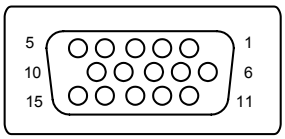
Network connector, X5

RJ45 connector	Pin No.	Signal
	1 2 3 4 5 6 7 8	Tx + Tx - Rx + N/C N/C Rx - N/C N/C

Coding element connector, X4

9 pin female D-connector	Pin	Signal
	1 2 3 4 5 6 7 8 9	IDCS1 (chip select) IDCL (clock) IDDI (data in) IDDO (data out) IDPE (protect enable) +5Vdc Direct ECG Nurse call GND

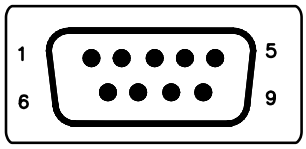
VGA connector X6

15 pin female D-connector	Pin No.	Signal
	1 2 3 4 5, 6,7,8 9 10 11,12 13 14 15	RED_VIDEO GREEN_VIDEO BLUE_VIDEO NC GND NC GND NC HSYNC VSYNC NC

Keyboard connector, X9

5 pin DIN connector	Pin	Signal
	1 2 3 4 5	KB_CLK KB_DATA not in use GND +4.75 - +5.25V

RS232 Serial data connector X11

9 pin male D-connector	Pin No.	Signal
	1 2 3 4 5 6 7 8 9	GND RxD TxD NC GND N/C RTS CTS N/C

3 Service procedures

3.1 General service information

The field service of the MRI Monitor is limited to replacing faulty printed circuit boards or mechanical parts. Return the faulty PC boards 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.

NOTE: Read the disassembly instructions in the MRI Shield slot through before servicing the monitor. It is essential to understand the MRI monitor structure to be able to service the monitor effectively.

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.

WARNING **If a service procedure requires using tools that contain ferrous metal, perform the procedure outside the MR environment.**

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

3.2 About service check

These instructions include complete procedures for a service check for the MRI Monitor Frame, F-MRICM1. The service check should be performed after any service repair. Additionally, the service check procedures can also be used for troubleshooting.

The procedures should be performed in ascending order.

The instructions include a check form (“APPENDIX A”), which should be filled in when performing the procedures.

The symbol  in the instructions means that the check list should be signed after performing the procedure.

3.2.1 Recommended tools

For product(s)	Tool	Order No.
All	MRI Monitor	
Data Card option	MemCard – Data or Menu	
Network or WLAN option	Datex-Ohmeda Network connection	
Active Remote Screen option	Control room setup	
	Screwdrivers	See “3.4.2. Tools needed” for the tools needed during the dis-/reassembly.

NOTE: A MRI Monitor Shield and either a MRI Hemodynamic Module or a MRI Gas Module are needed for this check.

3.2.2 Recommended parts

Part	Order No.	Notes
Recorder paper	74205	for recorder unit

3.3 Before beginning

- Perform the service reset for the MRI Monitor by pressing the **ON/Standby** key for at least 10 seconds.
- If the monitor is connected to the Datex-Ohmeda Network, disconnect the network cable from the monitor.
- Disconnect all the patient connectors.
- Disconnect all external cables connected to the monitor.
- Take out data card, if installed.

Follow the disassembly instructions far enough to be able to remove the MRI Monitor Frame, F-MRICM1 from the MRI shield. See MRI Shield slot for the disassembly instructions.

Detach the PCMCIA extender.

3.4 Service check

3.4.1 Visual inspection

Display unit

- Detach the Display Unit from the Frame Unit.
- Open the Display Unit by detaching the Front Unit.

Internal parts

1. DC/DC power supply board

   Disconnect the DC/DC power supply board. Check the Display Unit – Frame Unit connector under the board:

   – Screws are tightened properly.
   – The connector is clean and intact.

2. Central Processing Board

   Check the Central Processing Board in the Display Unit:

   – Screws are tightened properly.
   – Cables are connected properly.

3. DC/DC power board

   Reconnect and check the DC/DC Power Board:

   – Screws are tightened properly.
   – All connectors are clean and intact.
   – The cables are attached properly.

4. Net Connection unit and Sync Connection unit.

   Check that:

   – Screws are tightened properly.
   – The connector pins are intact.

5. Front Unit

   Check that:

   – The Connector Board screws are tightened properly and the cable connectors are clean and intact.
   – The Inverter Board screws are tightened properly and the cable connectors are clean and intact.
   – The Backlight cables are intact and attached properly.
   – The keyboard foil cables are intact and attached properly to the connectors on the Connector Board.
   – The Connector Board foil cable is intact and attached properly to the connector on the Central Processing Board.
   – The video signal foil cable is intact and attached properly to its connector on the Central Processing Board.

Display unit reassembly

- Reattach the Front Unit to the Back Unit.

External parts

Check external parts of the Display Unit:

– All stickers are intact.
– The LCD display screen is intact.
– The ComWheel shaft is intact.
– All mechanical parts are functioning properly.

Frame unit

- Remove the AC/DC Power Unit.
- Disassemble the Side Frame Unit.
- Detach the bottom plate.
- Remove the batteries and disconnect the battery cables from the Power Management Board (PMB).

1. Battery slot:
   – Check that there are no loose objects inside the battery slot.

2. Side Frame Unit
   Check the Side Frame Unit:
   – Screws are tightened properly.
   – Cables are connected properly.
   – Connectors are clean and intact.

3. PMB and the Connector Boards
   Check the Frame Unit from inside, the PMB and the Connector Boards:
   – There are no loose objects inside the Frame Unit.
   – All screws are tightened properly.
   – All connectors are clean and intact.
   – Cables are connected properly.

Frame Unit reassembly

- Reconnect the battery cables, reassemble the batteries and reattach the bottom plate.
- Reattach the Side Frame Unit.
- Reattach the AC/DC power unit.

NOTE: Make sure that all the insulation plates are placed correctly.

3.4.2 MRI Monitor Frame reassembly

- Attach the Display Unit to the Frame Unit.

External parts

Check the external parts:
– The four rubber pads under the monitor are all in place.
– All stickers are intact.
– The Display Unit is attached properly.

- All mechanical parts are functioning properly.
- The service reset switch is intact.
- The handle is attached properly.
- The monitor frame is intact.

1. PCMCIA exterder

   Insert and connect the PCMCIA extender to the foremost card slot.

   Check that the PCMCIA extender is clean and intact.

2. Inserting a module

   Check that the used modules go in smoothly and lock up properly in both module slots.

   Leave the modules inserted.

3. Recorder

   Clean the recorder unit, if installed:

   - Open the paper compartment cover and take out the paper roll.
   - Clean the paper compartment off of possible paper chaff.
   - Clean the thermal printhead 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.

   Attach a new paper roll into the recorder and close the cover. Attach the recorder in to the MRI Monitor Frame for the time of the functional inspection.

4. Primary fuses

   Disconnect the primary fuse holder. Check that:

   - The fuse compartment, the fuse holder and the fuses are clean and intact.
   - The fuses are of the correct rating.

   Reconnect the fuse holder and check that it locks up properly.

NOTE: Do not reassemble the MRI Monitor further yet.

3.4.3 Functional inspection

MRI Monitor Frame

Attach the ComWheel knob for the functional inspection.

1. Stand-by LED

   Connect the mains power cord.

   Check that the standby LED starts blinking or is on continuously, if the batteries do not need charging.

2. Start-up

   Turn the monitor on.

   Check that the monitor starts up properly, i.e. the alarm LEDs turn blank, the start-up sound is heard and the normal monitoring screen is displayed.

   No error messages should appear on the screen.

   If the monitor contains the recorder unit, two lines of start-up information should be recorded.

3. Mark Event or Take Snapshot

   Push the menu keys ***Help*** and ***Mark Event***, or ***Take Snapshot.***

   Check that the picture on the LCD display screen is straight, clear and stable.

4. Time and date

   Check that the time and date are correct, adjust them if necessary.

   Monitor Setup

   Set Time and Date

NOTE: The selection SET TIME AND DATE cannot be accessed if a case is started, or a patient has been admitted.

NOTE: If the clock shows time 0:00 continuously (at successive start-ups), the SRAM/TIMEKEEPER battery needs to be replaced.

The FACTORY RESET should be performed after the battery replacement, see '3.6.4. Performing Factory Reset'.

5. Loudspeaker

   Check the loudspeaker by adjusting 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.

6. Display brightness

   Check the display brightness control:

Monitor Setup

Display Brightness

Press the ComWheel and check that the display brightness follows the selected brightness.

7. 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 and Power Management Board software.

8. Content of 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***.

9. Power supply output voltages

   Check the power supply unit output voltages through the service menu:

   Monitor Setup

   Install Service (Password 16-4-34)

   Service (Password 26-23-8)

   Frame

   Power Supply

   The voltages should meet the following ranges:

+15 V	14.50...15.50 V
-15 V	-14.50...-15.50 V
+15 VD	14.50...15.50 V
+5 V	4.80...5.30 V
VBUS	10.00...17.00 V
+12V	11.50...12.50 V
+3.3 V	3.00...3.60 V
Vbus	10.00...17.00V
	Depends on the power source

10. Watchdog circuitry

    Test the watchdog circuitry:

    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

11. Module communication

    Enter the ESTP: STP service menu:

    Monitor Setup
    Install Service (Password 16-4-34)
    Service (Password 26-23-8)
    Parameters
    ESTP: STP

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

12. Battery

    Enter the ***Battery*** service menu:

    Monitor Setup
    Install Service (Password 16-4-34)
    Service (Password 26-23-8)
    Frame
    Power Supply
    Battery

    Check that the information on the page is correct.

13. Battery voltage

    Check that the shown Battery Voltage value is within 10 – 17V.

14. Monitor temperature

    Check that the shown Monitor Temperature value is within 20 - 40.

15. Battery operation

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

    Check that the monitoring continues normally. The battery indicator should appear on the upper right hand corner of the screen.

16. Reconnecting the mains power cord

    Reconnect the mains power cord.

    Check that the monitoring continues without problems. The battery indicator should be replaced by the text CHARGE.

Recorder Unit

1. Cover open recognition

   Open the recorder unit cover. Check that the message 'Recorder: Cover open' appear on the screen, then close the cover.

2. Recording

   Press the key **Record Wave** and check that the module starts recording the selected waveforms. Press the key **Stop** on the module to stop recording.

NOTE: InvBP waveforms are not recorded without a patient simulator.

NOTE: ECG waveforms are recodred only when the monitor frame is assembled in the shield.

NOTE: If nothing is recorded, check that the paper roll is installed in a correct way. Only one side of the paper is printable.

3. Paper speed

   Press the key **Record Wave** 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 key **RECORD WAVE** and wait until the recording stops. Check that the length of the scale is now 3.0 cm (± 0.5 cm).

4. Quality of recording

   Check that the quality of the recording is acceptable.

VGA Connector

Connect an external VGA display to the VGA connector and check the picture.

Memory Card option

NOTE: The following steps are applicable only when the MemCard option is installed in the monitor.

1. Memory option recognition

   Enter the ***Memory Card*** service menu:

   Monitor Setup

   Install Service (Password 16-4-34)

   Service (Password 26-23-8)

   Frame

   MemCards

   Check that the memory option is recognized properly, i.e. Present and Active state YES.

2. Memories and PCMCIA controller test

   Check that the Memory board memories and the PCMCIA controller have passed their tests. The status for each should be OK.

3. Interface status

   Select ***Communication***. Check that Interface status states ACTIVE continuously and the error counter values at the bottom part of the menu are stable.

4. Menu Card recognition

   Select ***Module Status***. Insert a Memory card labelled Menu in the left hand side memory card slot. Check that the message 'Menu Card inserted' is displayed in the message field and the white menu card symbol on the upper right hand corner of the screen within 1 minute.

NOTE: The battery symbol overrides the memory card symbols.

5. Card type recognition

   Wait until the information regarding SLOT1 is fully updated in the service menu, then check that the Card type states MENU and the File system states ATA.

   Check that the rest of the information for SLOT1 is reliable and no errors have been detected.

6. Data Card recognition

   Insert a memory card labelled Data in the right hand side memory card slot. Check that the message 'Data Card inserted' is displayed in the message field and the green Data Card symbol in the upper right hand corner of the screen within 1 minute.

   Wait until the information regarding SLOT2 is fully updated in the service menu, then check that the Card type states DATA and the File system states ATA.

   Check that the rest of the information for SLOT2 is reliable and no errors have been detected.

7. Save and Load Modes

   Enter the ***Save Modes*** menu:

   Monitor Setup

   Install Service (Password 16-4-34)

   Save Modes (Password 13-20-31)

   Save the current modes into the Menu Card by selecting

   Load Modes

   To Memory Card --> Save.

   Wait until the text 'Saved' is displayed, then return to the previous menu.

   Change the name for the mode number 1:

   Select the mode number 1, press the ComWheel and select ***-Name.*** Select suitable characters from the list by turning and pressing the ComWheel, then confirm the new name by selecting ***End.***

   Load the original modes from the Menu Card by selecting

   Load Modes

   From Memory Card --> Load.

   Wait until the text 'Loading' changes to 'Loaded' (may take a couple of minutes), then return to the previous menu.

   Check that the mode number 1 has got back its original name.

8. Data Card functions

   Press the membrane key **Display Trends** or **Pt.Data & Trends --> *Trends***. Check that there is trend information available for the monitored parameters.

   Erase the trends:

   Reset Case
   Reset All --> Yes

   Check that the trends have been erased.

   Reload the trends from the Data Card by pressing the key **Patient Data**, selecting ***Patient from Card***, pressing the ComWheel on the last saved file (the file information is shown at the bottom of the menu) and selecting ***Load***.

   Wait until the message 'Loading from Mem. Module' disappears, then check that the original trends are available again.

Network option

NOTE: The following steps are applicable only when the Network option is installed in the monitor.

1. Connection to Network

   Check that the Mon-Net cable connector is clean and intact, then connect it to the network connectors on the Frame Unit.

   Check that the monitor connects to the Datex-Ohmeda Network, i.e. the network symbol is displayed 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.

   NOTE: The battery symbol overrides the network symbol in MRI Monitor.

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

2. Ethernet address

   Enter the network board service menu:

   Monitor Setup
   Install Service (Password 16-4-34)
   Service - Frame (Password 26-23-8)
   Network

   Take down the monitor's Ethernet address, which is shown beside the text Address.

3. Data counters

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

4. Data error counters

   Check that the counters for data errors (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.

5. 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.

6. Disconnection recognition

   Disconnect the Mon-Net cable from the Frame Unit. Check that the message 'Network down:' is displayed in the message field within 30 seconds. When the message is displayed, the service menu values are stopped updating.

   Reconnect the Mon-Net cable and check that the monitor connects to the Datex-Ohmeda Network again.

7. ID-plug recognition

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

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

   NOTE: If the WLAN option with virtual ID is installed, the virtaul ID is always used.

Wireless LAN option

1. Signal strength

   Check that the green LED on the wireless antenna card blinks and the WLAN signal strength symbol roams or stays fixed on the monitor screen.

2. WLAN configuration

   Configure one access point appropriately. Bring the MRI Monitor to good WLAN coverage area. Check that the field level indicator stops scrolling.

   Go to the ***WLAN Status page (... Service -> Frame -> Network -> WLAN - WLAN Status).***

   Check that the Connection is active, AP MAC address is recognized and the connection Speed is at least 2 Mbits/s.

3. Connection to the network

   Make sure that the monitor's wireless LAN antenna card is in line of sight with a wireless LAN access point antenna. Check that the monitor connects to the Datex-Ohmeda Network, i.e. the wireless LAN network symbol is displayed in the upper right-hand corner of the screen.

Device Interfacing Solution, N-DISVENT

1. Enter the ***DIS Interfacing*** service menu:

   Check that the DIS module 'tout' and 'cse' values do not increase faster than by 5 per second. Check also that the DIS module memories have passed the internal memory test, i.e. Ram, Rom and EEPROM state all OK.

General

1. Trend retaining

   Check that the monitor is capable of storing the trend information and temporary settings in a short (max. 15 minutes) standby.

   Press the membrane key **Trends.** Check that there is trend information available for the monitored parameters.

   Turn the monitor to standby and disconnect the mains power cord. Wait for two minutes, then reconnect the mains power cord and turn the monitor back on.

   Check that the trend information is still available.

2. Service reset switch check

   Turn the monitor to standby and disconnect the mains power cord. Press the service reset switch for at least five seconds. Check that the LED next to the switch turns off, and also the fan turns off.

   Reconnect the mains power cord and turn the monitor back on. Check that all trends have now been erased.

3. Battery capacity

   Test the batteries by performing the following:

   – Detach all modules.
   – Keep the monitor connected to the mains power until the batteries are fully charged.
   – Install the Hemodynamic MRI Module and disconnect the mains power cord.
   – Notice the time the monitor stays on with batteries.

   Replace the batteries, if the time was less than 45 minutes.

4. Battery charging

   Reconnect the mains power cord, turn the monitor on and enter the ***Battery*** service menu:

   Monitor Setup

   Install/Service (Password 16-4-34)

   Service (Password 26-23-8)

   Frame

   Power Supply

   Battery

   Check that the monitor starts charging one of the batteries and all data is reasonable.

3.4.4 Monitor reassembly

- Turn the monitor off and disconnect the mains power cord. Remove the recorder.
- Reassemble the MRI Monitor, see “Disassembly and reassembly” in the MRI Shield slot.

NOTE: Remember to reconnect the Alarm board cable.

Magnetic field alarm

1. Connect the mains power cord and other external cables.
2. Turn the monitor ON and check that the magnetic field alarm LED is lit and the alarm sound is heard for a moment.

MRI monitor front panel

1. 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(s) is turning on and off when pressing the ComWheel. Check also the yellow alarm LED(s) by selecting ***Lower Led*** from the menu.

2. Membrane keys check

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

   Check also the functioning of the side panel keys.

3. ComWheel check

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

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

General

1. Electrical safety check

   Perform an electrical safety check and a leakage current test.

2. Functioning after electrical safety check

   Check that the module functions normally after the electrical safety check.

3. Service Log reset

   Enter the ***Service Log*** in the service menu:

   Monitor Setup
   Install/Service (Password 16-4-34)
   Service (Password 26-23-8)
   Service Log

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

   Turn the monitor to standby.

4. Final cleaning

   Clean the monitor with a suitable detergent.

- Fill in all necessary documents.

3.5 After service check

After the MRI Monitor Frame service check, either reassemble the MRI Monitor with the original parts or continue to perform the functional check.

3.5.1 MRI Monitor reassembly

Reassemble the monitor according to the “Disassembly and reassembly” instructions in the MRI Shield slot.

3.5.2 Functional check

Perform the Functional Check after installing a serviced MRI Monitor, see chapter “5 Functional check” in the first part of the manual.

3.6 Disassembly and reassembly

- Perform the service reset for the MRI Monitor by pressing the **ON/Standby** key for at least 10 seconds.
- If the monitor is connected to the Datex-Ohmeda Network, disconnect the network cable from the monitor.
- Disconnect all the patient connectors.
- Disconnect all external cables connected to the monitor.
- Take out memory card, if installed.

Follow the disassembly instructions far enough to be able to remove the MRI Monitor Frame, F-MRICM1 from the from the MRI shield. See MRI Shield slot for the disassembly instructions.

Detach the PCMCIA extender.

CAUTION Wear a grounded, antistatic wristband when handling PC boards. Electrostatic discharge may damage components on the board.

CAUTION Handle all PC boards by their edges.

CAUTION Turn the power off, disconnect the mains power cord and perform the service reset by pressing the **ON/Standby** key 10 seconds before starting to disassemble the monitor.

CAUTION When reassembling the monitor, make sure that all cables are reconnected properly.

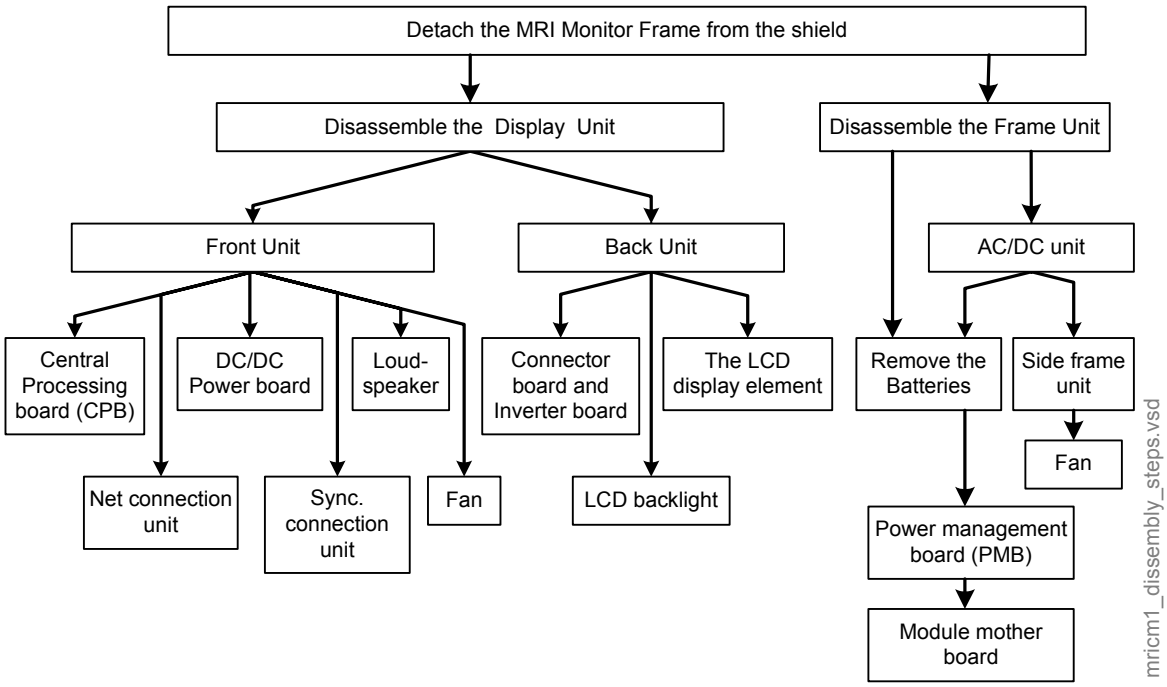


Figure 12 MRI Monitor Frame, F-MRICM1 disassembly steps

WARNING **The MRI Monitor Frame is always energized by the internal battery. 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 a high voltage. Do not touch the inverter board or the backlight tube leads when powered.

3.6.1 To disassemble the Display Unit, F-MRICM1

See the exploded view of the MRI Monitor Display Unit in the 'Spare Parts' slot to get quick understaning of the structure.

1. Set the MRI Monitor frame lying on its rear side.
2. Turn the quick lock screw at the bottom of the Display Unit counter clockwise to release it.
3. Pull the Display Unit carefully upwards.
4. Set the Display Unit lying on its front side; be careful not to damage the ComWheel plastic shaft or the LCD screen.
5. Open and detach the four screws with the washers at the corners of the Display Unit.

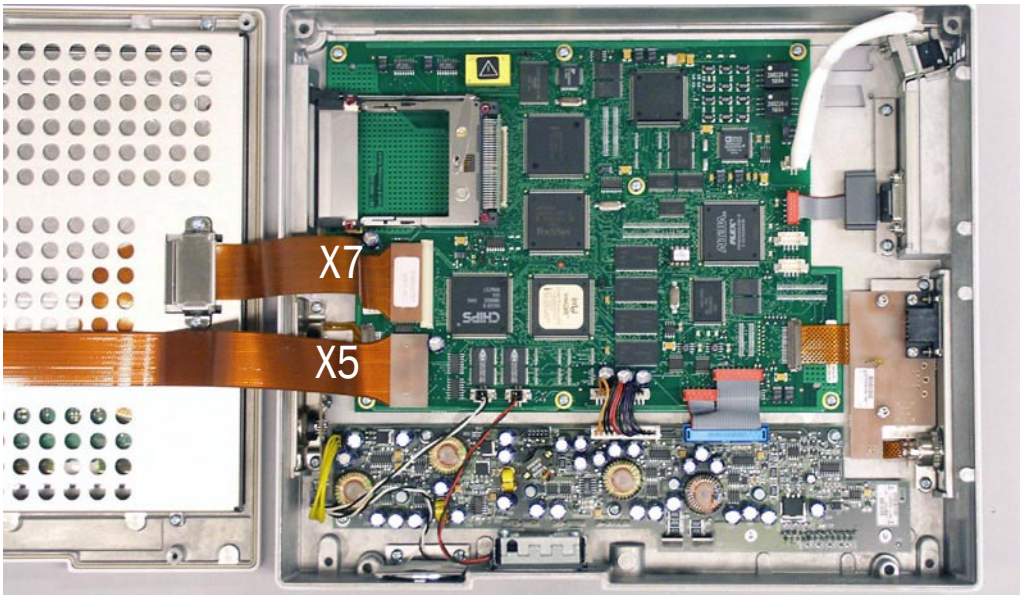


Figure 13 An opened Display unit

6. Lift the Display Unit carefully from the side of the unit (Note that the Front Unit is connected with flat cables to the Central Processing Board). Detach the two flat cables from the Central Processing Board X7 and X5 connectors. Please note that the connectors are fragile; do not bend them while disconnecting the cables.
7. Lay the Display Unit carefully on the table.

To remove the Central Processing Board from the Display Unit Back Unit

1. Disassemble Display Unit.
2. Detach the fan and loudspeaker/sound cables from the Central Processing Board, connectors X17 (loudspeaker/sound) and X16 (fan).
3. Detach the power cables coming from the DC/DC board, connector X10.
4. Detach the Signal cables (two) coming from the DC/DC board, connectors X23 and X19.
5. Detach carefully the Synchronization board foil cable by opening the lock at the connector X9 and pulling the foil out.
6. Detach the NetID cable from the Central Processing Board, connector X8.
7. Detach the Network cable from the Central Processing Board, connector X20.
8. Open the seven screws holding the Central Processing Board.
9. Lift the Central Processing Board carefully from the Display Unit.

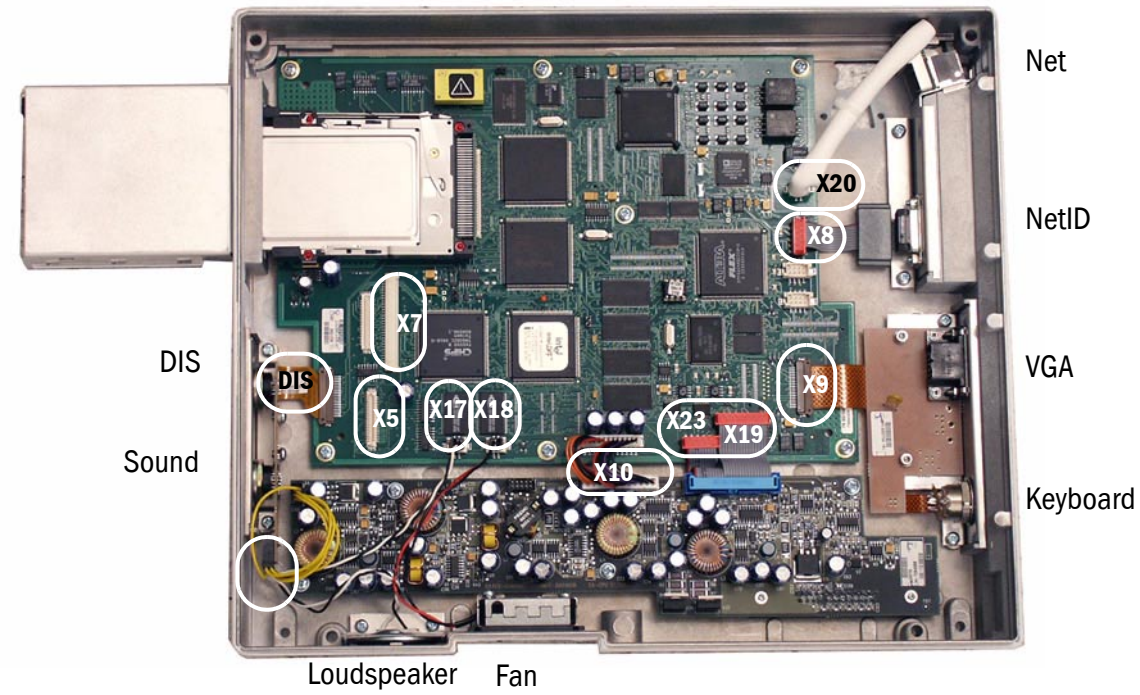


Figure 14 Back unit of the Display unit

To remove the Display Unit DC/DC power board

1. Disassemble the Display Unit.
2. Detach the fan and loudspeaker/sound cables from the Central Processing Board, connectors X17 and X16.
3. Detach the power cables leading to the Central Processing Board.
4. Detach the signal cables leading to the Central Processing Board.
5. Open the four screws holding the DC/DC power board.
6. Lift the DC/DC power board carefully from the Display Unit.

To remove the Synchronization Unit

1. Disassemble the Display Unit.
2. Detach carefully the Synchronization board foil cable by opening the lock at the connector X9 and pulling the foil out.
3. Open the two screws holding the whole unit in the Display Unit back cover.

NOTE: Do not open the screws holding the Synchronization board in the Synchronization Unit.

To remove the Net Unit

1. Disassemble the Display Unit.
2. Detach the NetID and Network cables from the Central Processing Board, connectors X8 and X20 respectively.
3. Open the two screws holding the Net Unit in the Display Unit cover.
4. Open the two screws holding the ID connector in the Display Unit back cover (from the outer side of the cover).

To remove the loudspeaker

1. Disassemble the Display Unit.
2. Detach the loudspeaker cable from the DIS (and sound) connector board and the extesion cable from the Central Processing Board connector X17.
3. Open the screws holding the loudspeaker.
4. To change the loudspeaker detach the extension cable from the loudspeaker cable's connetor by pulling carefully out the crimps.

NOTE: When reassembling, be sure to connect the cables correctly to the connector, #3 is white and #4 is black.

To remove the fan

1. Disassemble the Display Unit.
2. Detach fan cable from the Central Processing Board, connector X16.
3. Open the screws holding the fan.

NOTE: When ressembling the fan push it on the edges not on the center of it.

Disassembling the Connector Board and Inverter Board

1. Disassemble the Display Unit.
2. Set the Front Unit carefully lying with the LCD screen downwards.

NOTE: Be careful not to damage the LCD screen or the ComWheel.

3. Detach carefully the lower keyboard flat cable from the Connector Board.
4. Detach carefully the side panel keyboard flat cable from the Connector Board.
5. Detach the Connector Board – Inverter Board cable.
6. Detach the ComWheel cable.
7. Open the four screws holding the Connector board and remove it.
8. Detach the backlight cables from the Inverter Board.
9. Open the three screws holding the Inverter Board.

NOTE: The Inverter Board is sensitive to bending.

NOTE: When replacing the Inverter Board, fasten the inverter screws gently, using only as much force as necessary to fasten the board firmly enough in place. The screws must not be fastened so tightly that the board will be bent around the screws. Also, do not bend or twist the Inverter Board during the assembly.

To Disassemble the LCD Display Element, F-MRICM1

NOTE: Wear a static control wrist strap and soft cotton gloves (dust free) when handling the LCD display parts. Hold them by their corners or edges. Do not touch the connector pins.

In normal circumstances it is very difficult to keep the LCD Display component and the display shield surfaces free of dust when the LCD Display unit package is opened and they are exposed to room air. If dust particles remain on the LCD Display component and the display shield surfaces, they may impair the picture quality on the screen.

In case you need to detach the LCD Display component for repair, you may return it to be repaired at GE Healthcare. If you can provide a dustfree environment, follow the instructions below. See also Exploded view of the Display Front Unit, F-MRICM1 in the 'Spare Parts' slot.

1. Disassemble the Display Unit.
2. Detach carefully the lower keyboard flat cable from the Connector Board.
3. Detach carefully the side panel keyboard flat cable from the Connector Board.
4. Detach the ComWheel cable.
5. Detach the backlight cables from the Inverter Board.
6. Open the four screws holding the metal EMC cover in the Display Unit front cover.
7. Open the two screws covering the video flat cable and ferrite in the LCD Display element.
8. Lift the EMC cover carefully up.
9. Open the four screws holding the LCD element in the Display Unit front cover.
10. Lift the LCD Display element carefully up.

NOTE: Do not use excessive force when fastening the display component to the metal frame. Fastening the screws too tightly might bend the display module too much and break it. The screws must also be fastened gradually: first fasten all screws slightly, then more tightly.

NOTE: When reassembling the LCD Display component, be careful that no dirt or finger prints are left between the LCD element and the protection glass window.

NOTE: If the LCD Display unit is broken, handle it carefully to avoid injury (the LCD Display component and the backlight lamp(s) are made of glass). Wash your hands if you touched liquid crystal, which may flow out from a broken LCD Display component.

NOTE: Do not touch, push or rub the exposed display module surface. Keep the surface clean. In case of accidental mishandling, see "Handling and storage of LCD Display component".

Changing the LCD backlight, F-MRICM1

1. Disassemble the Display Unit.
2. Detach carefully the lower keyboard flat cable from the Connector Board.
3. Detach carefully the side panel keyboard flat cable from the Connector Board.
4. Detach the ComWheel cable.
5. Detach the backlight cables from the Inverter Board.

6. Open the four screws holding the metal EMC cover in the Display Unit front cover.
7. Open the two screws covering the video flat cable and ferrite in the LCD Display element
8. Lift the EMC cover carefully up.
9. Detach the screw holding the backlight tube set in place.
10. Detach the backlight tube set by pulling it to the left.

NOTE: Do not bend the backlight tube.

NOTE: Do not touch the backlight tube with your hands.

3.6.2 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 on 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 5 °C and 35 °C at normal 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.

3.6.3 Downloading the software on empty Central Processing Board

In case of a faulty Central Processing Board refer first to chapter ". To remove the Central Processing Board from the Display Unit Back Unit" and then follow the instructions for downloading service software below.

NOTE: All user settings will be lost after downloading of a new monitor software.

NOTE: You can download the software only on one monitor. During the software download the serial number of the monitor is written on the software card. If the loading for some reason failed, the software could be downloaded again on the same monitor, but not on another monitor.

1. Make sure that the monitor is switched to standby. Press and hold the service reset button on the rear panel for at least five seconds or until the service reset indicator LED turns off.
2. Open the cover for card drive slots, if installed. Insert the software card in one of the card drive slots and press the software card firmly in place.
3. Make sure that at least 30 seconds has passed since the service reset, then switch the monitor on.

4. Wait for approximately 80 seconds. After the start-up screen appears, enter the Service View and make sure that the information regarding the monitor software has been updated. Memorize the serial number of the new software.
5. Remove the software card.
6. Replace the original device plate for monitor software with the new one supplied with the software card.
7. Perform Factory Reset. Make sure that the monitor functions normally after the restart.
8. Set the time and date.
9. Set the monitor's network communication according to the used network software, if necessary.

The communication is set in the monitor's ***Network*** service menu.

Network software S-CNET99 -> DRI Level = 1999

Network software S-CNET01 -> DRI Level = 2001

Network software S-CNET02 -> DRI Level = 2001 or 2002 (WLAN)

Network software L-NET03 -> DRI Level = 2003

Network software L-NET05 -> DRI Level = 2005

NOTE: The DRI Level 1999 is not selectable in all monitor software versions.

NOTE: If the DRI level is changed, the monitor will restart automatically.

Fill in all necessary documentation regarding the new monitor software.

NOTE: The license agreement of monitor software needs to be in accordance with the monitor software serial number. Make sure you archive the license agreement in a secure location.

NOTE: The first start-up after software loading takes considerably longer.

See also the troubleshooting chart for the software card if necessary.

3.6.4 Performing Factory Reset

NOTE: The factory reset is necessary after replacing monitor software.

NOTE: The factory reset will restore all customized defaults, including language selection, to factory defaults.

1. Press the **Monitor Setup** key.
2. Select ***Install/Service*** and password (16-4-34).
3. Select ***Service*** and password (26-23-8).
4. Select ***Set/ Test*** and ***Factory Reset***.
5. The monitor will perform an automatic restart. After the restart is completed, restart the monitor also manually.

After performing Factory Reset

- Reconfigure the display configuration.

1. Remove T1 and T2 fields and move Gases to Field 3.
2. Press the **Monitor Setup** key.
3. Select ***Screen 1 Setup***
   Digit Fields

Lower Field 2 select ***OFF***

4. Select ***Lower Field 3*** select ***Gases,***
   the ***Lower field 4*** will automatically change to state ***OFF***.
5. To save the selection go back to ***Monitor setup menu*** (press twice ***Previous Menu***).
6. Select ***Install/Service*** and password (16-4-34).
7. Select ***Save Modes*** and password (13-20-31).
8. Select ***General*** and ***Save***.

- Check / Set the ***Language*** and ***Power Frequency*** settings

1. Go back to ***Install/Service*** (press twice ***Previous Menu***).
2. Select ***Service*** and password (26-23-8).
3. Select ***Set/ Test*** and ***Country settings*** and ***Language***.
4. Choose the correct language.
5. Go back to ***Country Settings.***
6. Select ***Power Frequency*** and choose the correct frequency.

3.6.5 To disassemble the Frame unit

See the exploded view of the MRI Monitor Frame Unit in the 'Spare Parts' slot to get quick unerstaning of the structure.

To remove the batteries

1. Open the Bottom Plate of the Frame Unit by opening the eight screws.
2. Detach the battery cables and remove the batteries.

NOTE: Remember the order of the batteries connected to the PMB board.

To remove the AC/DC Unit

1. Open the four screws holding the unit at the back of the MRI Monitor Frame.
2. Pull the AC/DC Unit carefully to avoid damaging the connector.

NOTE: It is not allowed to repair the AC/DC power unit in the field.
Return the faulty AC/DC power unit to GE Healthcare for service.

To disassemble the Side Frame Unit

1. Detach/remove the AC/DC Unit.
2. Open the three screws from the left side of the Frame Unit back plate.
3. Loosen the long screw in the upper left corner of the Frame Unit.
4. Open the two screws on the bottom left side of the Frame Unit.
5. Disconnect the Side Frame Unit from the PMB Board connector by carefully pulling it out of the frame.

NOTE: When reassembling the Side Frame Unit, be careful not to damage the components on the PMB Board.

To detach the Side Frame Unit fan

1. Detacht the Side frame unit.
2. Detach four screws and disconnect the fan cable.

NOTE: When reassembling notice the position of the fan: the arrow points to the inside of the monitor.

To detach/remove the PMB Board (Power Managemet Board)

NOTE: It is important to remove the batteries before starting to remove the PMB Board!

NOTE: Remember the order of batteries connected to the PMB Board.

1. Disassemble the Side frame unit.
2. Open the Bottom Plate of the Frame Unit by opening the eight screws and remove the batteries.
3. Open the two screws holding the connector to the AC/DC Unit.
4. Open the two screws holding the connector to the Display Unit.
5. Detach the Power and Data cables from the PMB Board.
6. Open the eight screws holding the PMB Board.
7. Pull the PMB Board carefully to detach it from the Module Mother Board.

To detach/remove the Module Mother Board

1. Detach/remove the PMB Board.
2. Unscrew the spacers to remove the Module Mother Board.

– Be carefull not to damage the service reset switch.

3.6.6 Reassembling

Before reassembling the MRI Monitor frame to the Monitor Shield notice the following:

– Secure the gas module is with the gas module holder and two screws with washers.
– Insert the PCMCIA extender and connect it with two screws.
– Remove the recorder.
– Remove the ComWheel if connencted.

3.7 Adjustments and calibrations

It is not necessary to perform calibrations or adjustments on MRI Monitor Frame.

3.8 Internal battery

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

The monitor can be run either on mains power or on internal battery. Battery operation is initiated when the power cord is disconnected or when the mains power is lost during monitoring.

The internal battery capacity is up to 1 hour with fully charged batteries.

NOTE: Before using the monitor for the first time, charge the battery to its full capacity (charging time 10 hours).

3.8.1 Battery time

A symbol on the monitor screen indicates the remaining operating time of the battery.

When about 10 minutes of battery operating time is left, a 'Batt low' alarm is activated and the monitor makes one beep.

When about two minutes of operating time is left, a new alarm 'Batt empty' is activated.

3.8.2 Refreshing the batteries

The battery is automatically charged when the monitor is connected to mains power. Charging the battery depends on the discharge level of the battery. Battery charging time is ten hours to full capacity.

If the monitor is used mainly with the mains power, refresh the battery by charging and discharging the battery completely once a month to slow down loss of battery capacity.

To refresh:

1. Connect the monitor power cord to power outlet for at least ten hours.
2. Remove the power cord, and turn on the monitor and let it turn off by itself (it takes about 1.5 hours). Wait for 15 minutes.
3. Reconnect the power cord to power outlet and charge the battery for at least ten hours.

NOTE: Inadequate maintenance will decrease the battery capacity and the monitor's operation time on batteries.

When charging, a charging symbol is displayed.

During battery charging, the standby led is blinking. It lights up when the batteries are fully charged.

3.8.3 Replacing the batteries

1. Open the Bottom Plate of the Frame Unit by opening the eight screws.
2. Detach the battery cables and remove the batteries.
3. Insert new batteries and connect the battery cables.

NOTE: Remember the order of the batteries connected to the PMB board.

4 Troubleshooting

4.1 General

Trouble	Cause	What to do
Monitor is not starting	**On/Stby** key pressed too long.	**On/Stby** key may be pressed for less than 10 s.
	The batteries are empty.	Connect the power cord.
	On/Stby key may be faulty.	Replace the Display Unit side panel keyboard foil.
	If power cord connected. If the On/Stby LED is lit or blinks. AC/DC power unit may be faulty.	Replace the AC/DC power unit.
	If the Frame unit fan is running. If AC/DC power unit is working, the PMB in the Frame Unit may be faulty.	Replace the PMB.
Monitor is not starting, the Frame Unit back panel LED is lit.	The connection between Frame Unit and Display Unit may be faulty.	Check the connector and the cables between Display Unit and Frame Unit.
	Display Unit voltages are not OK.	Replace the Display Unit DC/DC power board.
	Faulty Central Processing Board.	Replace the Central Processing Board.
The monitor starts (Frame Unit back panel LED is lit and a beep is heard), but the display remains black.	The MRI Frame Unit LCD display cables are loose.	Check the LCD cables and connectors on the Central Processing Board and in the Front Unit.
	The backlights are not lit.	Connector Board cable may be loose. Check the cable. Backlights may be faulty. Replace them. Backlight inverter may be faulty. Replace the inverter.
Module data disappears from the screen.	Parameter module current (in PMB) too high.	Detach and change the parameter module. PMB module power section may be faulty. Replace the PMB.
Keyboard not working, but module communication is OK.	Keyboard cables and connectors, or Connector Board cable and connector may be faulty.	Check the Connector Board cable and connector. Check the keyboard cable connection to the connector board.
Keyboard not working, and module communication not working.	UPI section of the Central Processing Unit not functioning normally.	Restart the monitor. Replace the Central Processing Board.

Trouble	Cause	What to do
Keyboard partly not working.	Faulty keyboard.	Replace the keyboard foil.
	Faulty Connector Board.	Replace the Connector Board.
'Battery failure' message on the display.	Problem in communication between Display Unit and Frame Unit (the PMB serial number and other data faulty in Service View).	Check the connectors and cables between Display Unit and Frame Unit of the F-MRICM1 Monitor.
	PMB in Frame Unit may be faulty.	Replace the PMB.
'Battery temperature high' and 'Check dust filter' messages.	The temperature of the batteries is more than 53°C.	Check and change the dust filters if necessary.
'Display temperature high' and 'Check dust filter' messages.	The temperature inside the Display Unit has been more than 55°C for two minutes at the minimum.	Check and change the dust filter if necessary.
'Frame temperature high' and 'Check dust filter' messages.	The temperature inside the frame is more than 55°C.	Check and change the dust filters if necessary.
Display Unit is too warm. Temperature is high.	Display Unit Fan is not working.	Check that the Fan cable is connected to the correct connector.
Recorder is not working properly.	Recorder communication problem.	Check the connectors and cables between Display Unit and Frame Unit.
	Problem in voltages in Frame Unit.	Check the Frame Unit voltages from the service menu. If not OK, replace the PMB.
After shutdown, the trend and patient data does not remain 15 min in the memory.	The On/Stby switch has been pressed for over 10 s. (= service reset)	When switching off, the On/Stby switch has to be pressed for less than 10 s.
	Faulty PMB.	Replace the PMB.

4.2 Software License (service software)

Trouble	Cause	What to do
New software is not downloaded or Start-up display does not appear in 80 seconds.	The software card is not inserted properly.	Check the software card's connection in drive.
	The software card does not contain correct software.	Check that correct software card is inserted in drive.
The software serial number in the Service view is not correct after downloading.	The software has not been downloaded correctly.	Check the software card's connection in drive. Try downloading once again. Try with another software card.

NOTE: You can download the software only on one monitor. During the software downloading the serial number of the monitor is written automatically on the software card. If the loading for some

reason failed, the software could be downloaded again on the same monitor, but not on another monitor.

4.3 Error messages

Message	Explanation
SRAM Error	The SRAM memory is located on the CPU board. The SRAM Error is due to memory malfunction. Restart the monitor. If the problem persists, replace the SRAM/Timekeeper battery. Remember to perform factory reset after the replacement.
EPROM Error	The EPROM Error message is displayed due to problems in the communication between the CPU board and the software flash memory. Replace the CPU board. Remember to perform factory reset after the replacement.
EEPROM Error	The EEPROM memory is located on the CPU board. The EEPROM Error message is displayed due to memory malfunction. Perform factory reset. If the problem persists, replace the CPU board. Remember to perform factory reset after the replacement.
RAM Error	The RAM memory is located on the CPU board. The RAM Error message is displayed due to memory malfunction. Replace the CPU board. Remember to perform factory reset after the replacement.

4.4 Recorder Unit

Problem	Cause	What to do
Recorder will not start. No error messages shown.	Connector board loose.	Check connector board connections.
	Recorder board faulty.	Replace the recorder board.
	Recorder unit faulty.	Replace the recorder unit.
Recorder works but nothing is printed on the paper.	Active side of the paper is 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.

Message	Explanation
Recorder: out of paper	Release paper jam or insert a roll of paper into the recorder.
Recorder: cover open	Close the recorder cover properly.
Recorder: thermal array overheat	Recorder overheated. Stop using and allow it to cool down.

Recorder: input voltage low	+15 Vrec is too low. Check the connectors and connector board.
Recorder: input voltage high	+15 Vrec is too high. Check the connectors and connector board.
Recorder system error 1, 2, 3	System error. If the problem persists, replace the recorder unit.
Recorder: module removed	A communication error due to a fault in the recorder or in the Central Processing Board.

5 Earlier revisions

There is no earlier revisions of the MRI Monitor Frame.

APPENDIX A Service check form, MRI Monitor Frame

Customer	
Service	
Service engineer	Date

Monitor Installation			
Frame: N-	**System options**	N-	**Modules**
Active Remote Screen	N-	N-	E-MRIPSN
D-	N-	N-	E-MRIC_____
K-	K-	N-	

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual inspection	**OK**	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
Display unit							
1. DC/DC power supply board	☐	☐	☐	2. Central Processing Board	☐	☐	☐
3. DC/DC power board	☐	☐	☐	4. Net Connection unit and Sync Connection unit.	☐	☐	☐
5. Front Unit	☐	☐	☐				
Display unit reassembly					**OK**	**N.A.**	**Fail**
External parts					☐	☐	☐
Notes							
Frame unit					**OK**	**N.A.**	**Fail**
1. Battery slot:	☐	☐	☐	2. Side Frame Unit	☐	☐	☐
3. PMB and the Connector Boards	☐	☐	☐				
Notes							

MRI Monitor Frame reassembly									**OK**	**N.A.**	**Fail**
External parts									☐	☐	☐
1. PCMCIA exterder	☐	☐	☐			2. Inserting a module			☐	☐	☐
3. Recorder	☐	☐	☐			4. Primary fuses			☐	☐	☐

Functional inspection	**OK**	**N.A.**	**Fail**				**OK**	**N.A.**	**Fail**
1. Stand-by LED	☐	☐	☐			2. Start-up	☐	☐	☐
3. Mark Event or Take Snapshot	☐	☐	☐			4. Time and date	☐	☐	☐
5. Loudspeaker	☐	☐	☐			6. Display brightness	☐	☐	☐
7. Monitor software	L					Power Management board software			
8. Content of service log	☐	☐	☐						

9. Power supply output voltages		
+15 V		14.50...15.50 V
-15 V		-14.50...-15.50 V
+15 VD		14.50...15.50 V
+ 5 V		4.80...5.30
VBUS		10.00...17.00
+12 V		11.50...12.50 V
+3.3 V		3.00....3.60 V
Vbus		10.00...17.00

	OK	**N.A.**	**Fail**				**OK**	**N.A.**	**Fail**
10. Watchdog circuitry	☐	☐	☐			11. Module communication	☐	☐	☐
12. Battery	☐	☐	☐						
13. Battery voltage							10...17 V		
14. Monitor temperature							20...40 C		
15. Battery operation	☐	☐	☐			16. Reconnecting the mains power cord	☐	☐	☐
Notes									

Recorder unit							
	OK	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Cover open recognition	☐	☐	☐	2. Recording	☐	☐	☐
3. Paper speed	☐	☐	☐	4. Quality of recording	☐	☐	☐
Notes							
VGA Connector					☐	☐	☐

Memory Card Option				**S/N**		
	OK	**N.A.**	**Fail**	**OK**	**N.A.**	**Fail**
1. Memory option recognition	☐	☐	☐	2. Memories and PCMCIA controller test	☐	☐	☐
3. Interface status	☐	☐	☐	4. Menu Card recognition	☐	☐	☐
5. Card type recognition	☐	☐	☐	6. Data Card recognition	☐	☐	☐
7. Save and Load Modes	☐	☐	☐	8. Data Card functions	☐	☐	☐
Notes							

Network Option				**S/N**		
	OK	**N.A.**	**Fail**	**OK**	**N.A.**	**Fail**
1. Connection to Network	☐	☐	☐	2. Ethernet address	_____	
3. Data counters	☐	☐	☐	4. Data error counters	☐	☐	☐
5. Hardware error counters	☐	☐	☐	6. Disconnection recognition	☐	☐	☐
7. ID-plug recognition	☐	☐	☐				
Notes							

Wireless LAN option					**S/N**		
	OK	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Signal strength	☐	☐	☐	2. WLAN configuration	_____		
3. Connection to the network	☐	☐	☐				
Notes							

Device Interfacing Solution, N-DISVENT	**S/N**	☐	☐	☐

Functional inspection							
General	**OK**	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Trend retaining	☐	☐	☐	2. Service reset switch check	☐	☐	☐
3. Battery capacity	☐	☐	☐	4. Battery charging	☐	☐	☐
Notes							

Monitor reassembly		**OK**	**N.A.**	**Fail**
Magnetic field alarm		☐	☐	☐
MRI monitor front panel				
1. Alarm LEDs		☐	☐	☐
2. Membrane keys check		☐	☐	☐
3. ComWheel check		☐	☐	☐
General				
1. Electrical safety check		☐	☐	☐
2. Functioning after electrical safety check		☐	☐	☐
3. Service Log reset		☐	☐	☐
4. Final cleaning		☐	☐	☐
Notes				

Used spare parts			

Signature

Hemodynamic MRI Module, E-MRIPSN (Rev. 00)

Technical Reference Manual Slot

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

M1041750-1
September, 2006

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

Table of contents

Table of figures

Introduction

This Technical Reference Manual Slot provides information for the maintenance and service of the Hemodynamic MRI Module, E-MRIPSN. The E-MRIPSN module is a double width hemodynamic module designed specially for the MRI Monitor to be used in the MR environment to measure pulse oximetry, NIBP and two invasive blood pressures. The module is preinstalled inside the shield and it can only be changed by authorized service personnel.

The ECG board is located inside the MRI shield back shell to minimize the electromagnetic interference emitted from the system. For all ECG measurement related information see “MRI Shield slot”.

The patient connectors are located in the Patient connector panel at the side of the monitor. For detailed information about the connectors see “MRI Shield slot”.

Figure 1 Hemodynamic MRI Module, E-MRIPSN

Table 1 Frame options for hemodynamic configurations

	Parameter	N-PSN	N-SN
P	Two invasive blood pressures	x	
E	ECG	x	x
S	Pulse oximetry	x	x
N	NIBP	x	x

Equipment safety symbols

On the connector panel this symbol indicates that for pulse oximetry (SpO_2) and invasive pressures (P1-P2), the patient isolation and protection against cardiac defibrillator discharge are based on the SpO_2 and invasive blood pressure accessories.

1 Specifications

1.1 General specifications

Module size (W×D×H)	75 x 186 x 112 mm 3.0 x 7.3 x 4.4 in
Module weight	0.7 kg / 1.5 lb.
Power consumption	about 6 W

1.2 Typical performance

1.2.1 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 195 mmHg
	infant	15 to 145 mmHg
Pulse rate range accepted	30 to 250 bpm	
Measurement interval	from 1 min. to 4h or continuous STAT mode	
Typical measuring time	adult	23 s
	infant	20 s
Initial inflation pressure	adult	170 ±10 mmHg
	child	150 ±10 mmHg
	infant	120 ±10 mmHg
Maximum venous stasis inflation limit / Venous stasis time		
	adult	80 ±5 mmHg / 2 min.
	child	60 ±5 mmHg / 2 min.
	infant	40 ±5 mmHg / 1 min.
Cuff widths	see “User’s Guide”	

1.2.2 Pulse oximetry

Automatic scaling of plethysmographic waveform.

SpO_2 monitoring is indicated only with use of the MRI SpO_2 sensors OXY-WMR and OXY-FMR.

SpO_2

Measurement and display range	0 to 100%
Calibration range	70 to 100%
Measurement accuracy[1]	100 to 70%, ±2 digits ±3 digits during patient motion 69 to 0%, unspecified
Display update time monitor	5 seconds continuous, defined by the main software of the
Display averaging time	Slow (20 s), Normal (10 s), beat-to-beat

1. Accuracy is based on deep hypoxia studies with volunteered subjects 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. The accuracy is expressed as rms. This means that approximately two-thirds of the data will fall within the accuracy range. The accuracy is expressed as rms. This means that approximately two-thirds of the data will fall within the accuracy range.

Display resolution	1 digit = 1% of SpO_2
Pulse beep pitch	varies with SpO_2 level

The monitor is calibrated against functional oxygen saturation SpO_2 func.

Pulse rate from Pleth

Measurement and display range	30 to 250 bpm
Accuracy[1]	±5% or ±5 bpm, whichever is greater
Resolution	1 bpm
Display averaging	10 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.

1.2.3 Invasive blood pressure

Measurement range	-40 to 320 mmHg
Measurement accuracy	±5% or ±2 mmHg
Zero adjustment range	±150 mmHg
Calibration range	±25%
Scales	upper limit is adjustable between 10 and 300 mmHg in steps or 10. Lower limit is 10% of selected upper limit below zero.
Sweep speed	12.5, 25, 50 mm/s

Digital display

Range	-40 to 320 mmHg
Resolution	±1 mmHg

Waveform display

Range	-30 to 300 mmHg

Pulse rate from arterial pressure

Measurement range	30 to 250 bpm
Resolution	1 bpm
Accuracy	±5 bpm or ±5% whichever is greater

1.3 Technical specifications

1.3.1 NIBP

Deflation rate, PR dep.	3 to 8 mmHg/s
Inflation time	20 to 185 mmHg, 1 to 5 s

Automatic software control, max. inflation pressure

adult	280 ±10 mmHg
child	200 ±10 mmHg
infant	145 ±5 mmHg

1. The reported SpO_2 pulse rate accuracy is the product specification. SpO_2 pulse rate accuracy tests with a simulator yielded a PR error of less than 2 bpm (rms) over the whole measurement range.

Over pressure limit, stops measurement after 2 seconds

adult	320 mmHg
child	220 mmHg
infant	160 mmHg

The safety circuit limits the maximum cuff pressure to 320 mmHg in adult/child mode or to 160 mmHg in infant mode. Independent timing circuit limits the pressurizing (>15 mmHg) time to 3 minutes maximum in adult/child mode, and to 90 seconds at (>5mmHg) in infant mode.

Zeroing to ambient pressure is done automatically.

Inflation pressure is adjusted according to the previous systolic pressure, typically 40 mmHg above. If the systolic pressure is not found, the inflation pressure is increased typically 50 mmHg.

Max. measurement time	adult	120 s
	child	120 s
	infant	75 s

Pressure transducer accuracy is better than ±3 mmHg or ±2% whichever is greater.
Max. error ±4 mmHg.

Protection against electrical shock	Type BF defibrillator-proof

1.3.2 Pulse oximetry

Wavelength of SpO_2 sensor LEDs:

Infrared LED	940 nm
Red LED	660 nm

Maximum energy of SpO_2 sensor LEDs:

Infrared LED	42 µJ/pulse
Red LED	62 µJ/pulse

Protection against electrical shock	Type CF defibrillator-proof

1.3.3 Invasive blood pressure

Digital display averaging

Digital displays Art and P1 are averaged over 5 seconds and updated at 5 seconds intervals. All other pressures have respiration artifact rejection.

Accuracy	±5% or ±2 mmHg, whichever is greater
Transducer and input sensitivity	5 µV/V/mmHg
Filter	0 to 4 - 22 Hz adjustable
Zero set accuracy	±1 mmHg
Calibration resolution	±1 mmHg
Zero time	less than 15 s
Protection against electrical shock	Type CF defibrillator-proof

NOTE: The accuracy of the measurement may be different from the specified, depending on the transducer/sensor used. Please refer to the transducer/sensor specification.

2 Functional description

2.1 Measurement principle

2.1.1 NIBP

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

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.

2.1.2 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 sensor, the light is transmitted through peripheral tissue and is finally detected by a PIN-diode opposite the LEDs in the sensor. 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.

NOTE: A functional SpO2 tester cannot be used to assess the accuracy of a pulse oximeter probe or monitor. However, if there is independent demonstration that a particular calibration curve is accurate for the combination of a pulse oximeter monitor and a pulse oximeter probe, then a functional tester can measure the contribution of a monitor to the total error of a monitor/probe system. The functional tester can then measure how accurately a particular pulse oximeter monitor is reproducing that calibration curve

NOTE: also: If, however, a particular calibration curve is accurate for the combination of a pulse oximeter monitor and probe, then a functional tester can measure the contribution of a monitor to the total error of a monitor/probe system. The functional tester can then measure how accurately a particular pulse oximeter monitor is reproducing that calibration curve.

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.

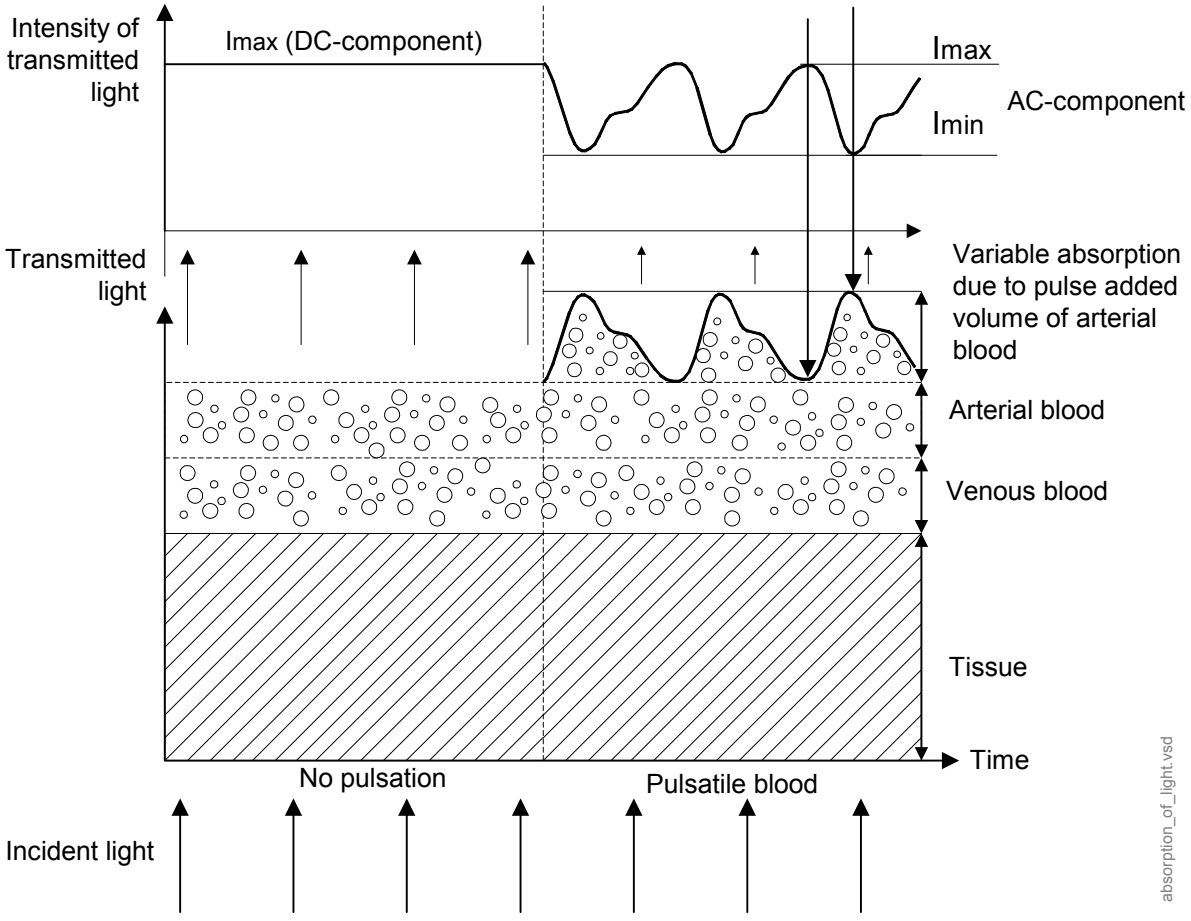


Figure 2 Absorption of infrared light in the finger

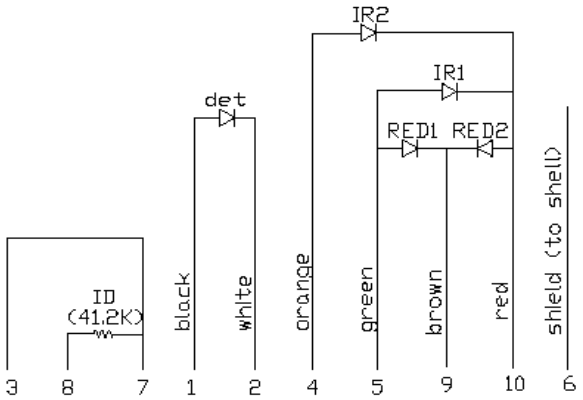


Figure 3 MRI pulse oximetry sensor schematic diagram

In the MRI specific pulseoximetry sensors all the electronic components are inside the sensor connector. Red and IR light emitted from the LEDs is transmitted to the measurement site via an optic fiber and the light transmitted through the tissue is guided via another optic fiber further to the detector inside the connector.

2.1.3 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.

2.2 Main components

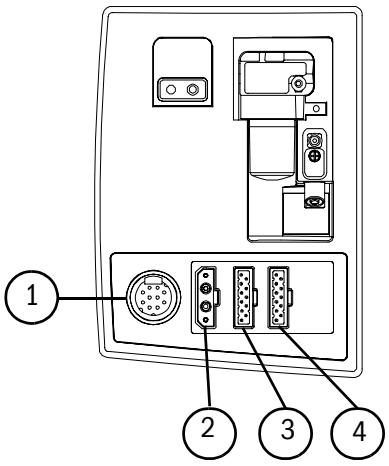
The E-MRIPSN module contains two main PC boards, the STP board and the NIBP board. Both of these boards contain a processor and software in the processor flash memory. The boards produce their own supply voltages from the Vmod 13.8-16 V line that is available via the module bus connector. One exception, the NIBP board provides +5 V 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. For the ECG board these signals are routed via the dummy ECG board and the ECG serial cable.

In addition to these boards the module contains a dummy ECG board which only task is to transfer the signals between the real ECG board and the module bus. The real ECG board is located inside the back shell unit to minimize the electromagnetic interference emitted from the monitor.

A Hall sensor board measures the magnetic field strength and interrupts the NIBP measurement to protect the electronics for too high magnetic field strength.

There are three input boards in the monitor; the MRIPSN input board attached to the front panel of the module and the ECG input board and input board, N-MRI2 attached to the patient connector panel.

2.2.1 Patient connector panel



1. ECG connector
2. NIBP connector
3. InvBP connector
4. SpO_2 connector

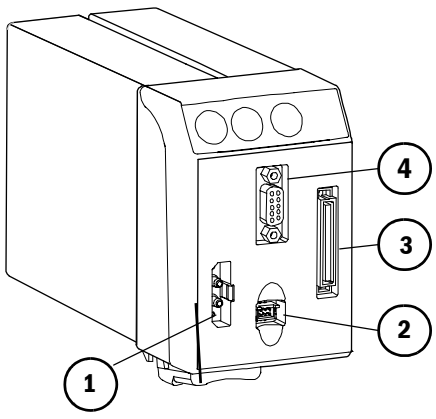
Figure 4 Hemodynamic patient connectors in the Patient Connector Panel

The patient connectors are located in the patient connector panel. For detailed description about the patient panel connectors see “MRI Shield slot”.

From the patient connector panel the SpO_2 and InvBP signals are routed to the module via a panel flat cable, whereas the ECG signal is routed for processing to the ECG board inside the MRI shield back shell. The communication between the ECG board and the monitor module bus is routed via the ECG serial cable connected to the module front panel and the dummy ECG board inside the module.

The NIBP connector contains two plungers for NIBP hose identification. The NIBP hose identification signal is routed via the NIBP cable connected to the NIBP ID switch connector.

2.2.2 E-MRIPSM module front panel connectors



1. NIBP tubes connector
2. NIBP ID switch connector
3. SpO_2 and InvBP input - panel flat cable connector
4. ECG serial cable connector

Figure 5 E-MRIPSN module front panel connectors

2.2.3 NIBP board

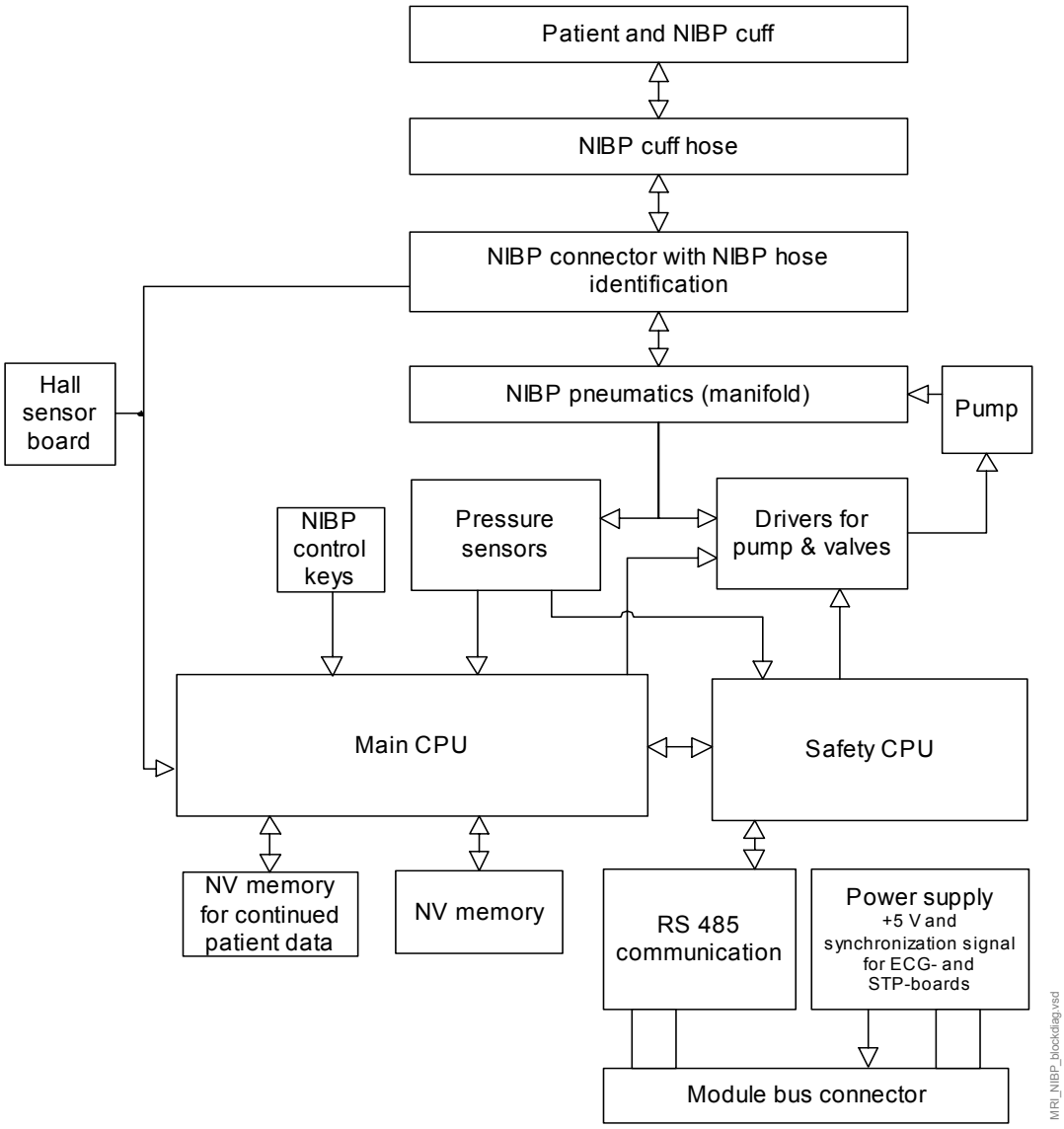


Figure 6 NIBP board functional block diagram

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 kilobytes 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 512k 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 the valves and the 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.

Safety circuit

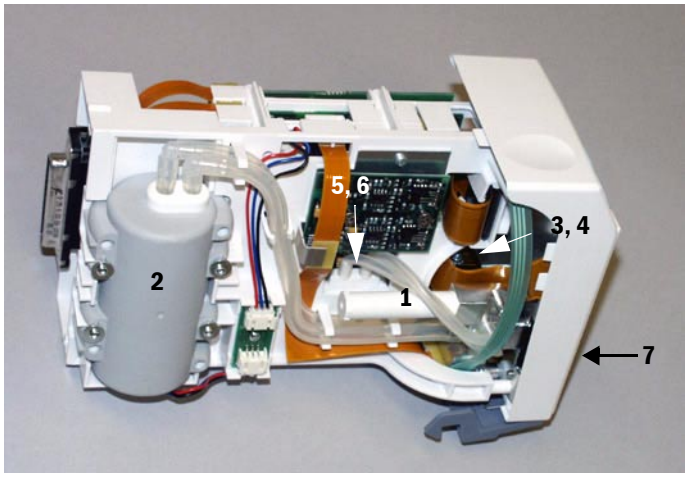
The NIBP board is equipped with an independent safety circuit to disconnect supply voltages from the pump and the valves if the cuff has been pressurized longer than the preset maximum measurement time, or if the pressure of the cuff is inflated over the specified pressure limit. The maximum measurement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

Hall sensor board

MRI Monitor includes Smart Automatic Measurement Shut Down feature. This means that if the monitor is placed in a too high magnetic field strength, the NIBP measurement is automatically shut down to protect the measurement electronics. No NIBP measurement data can be seen on the screen.

This feature is realized using a Hall sensor board. The Hall sensor board contains three hall sensors located so that they measure the magnetic field strength in each of the three dimensions. If the magnetic field strength measured by any of the sensors is higher than 250 gauss (typical), the NIBP measurement is interrupted. As soon as the monitor is placed outside the 250 gauss line the NIBP measurement continues.

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**

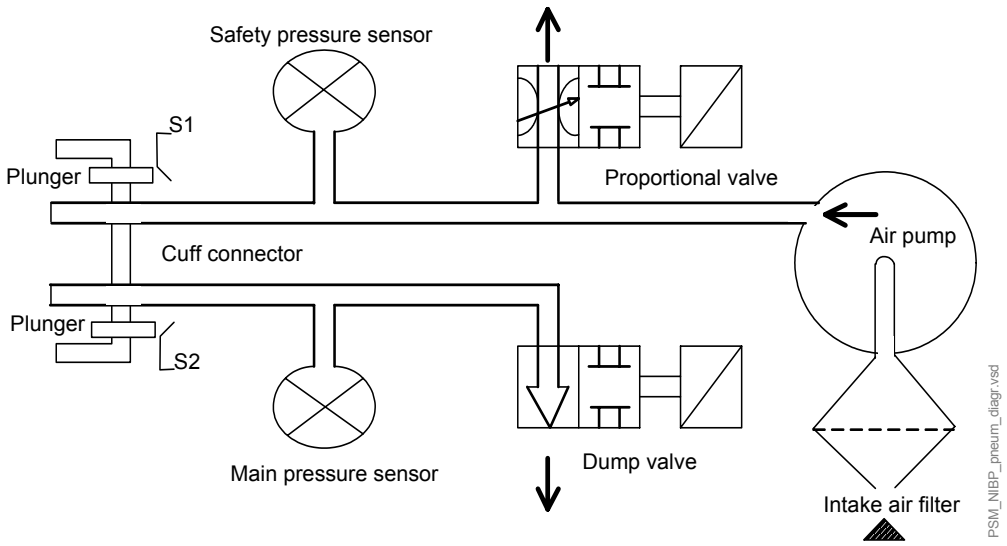


Figure 7 NIBP pneumatics diagram

Power supply section of the NIBP board

All connections are established via a 25-pin connector (D-type, female). The module needs a +15 V (dirty) power supply to operate. The supply voltage (+15V) is generated in the power supply section of the MRI Monitor. The other voltages needed for the operation of the NIBP measurement are made on the NIBP board.

2.2.4 STP board

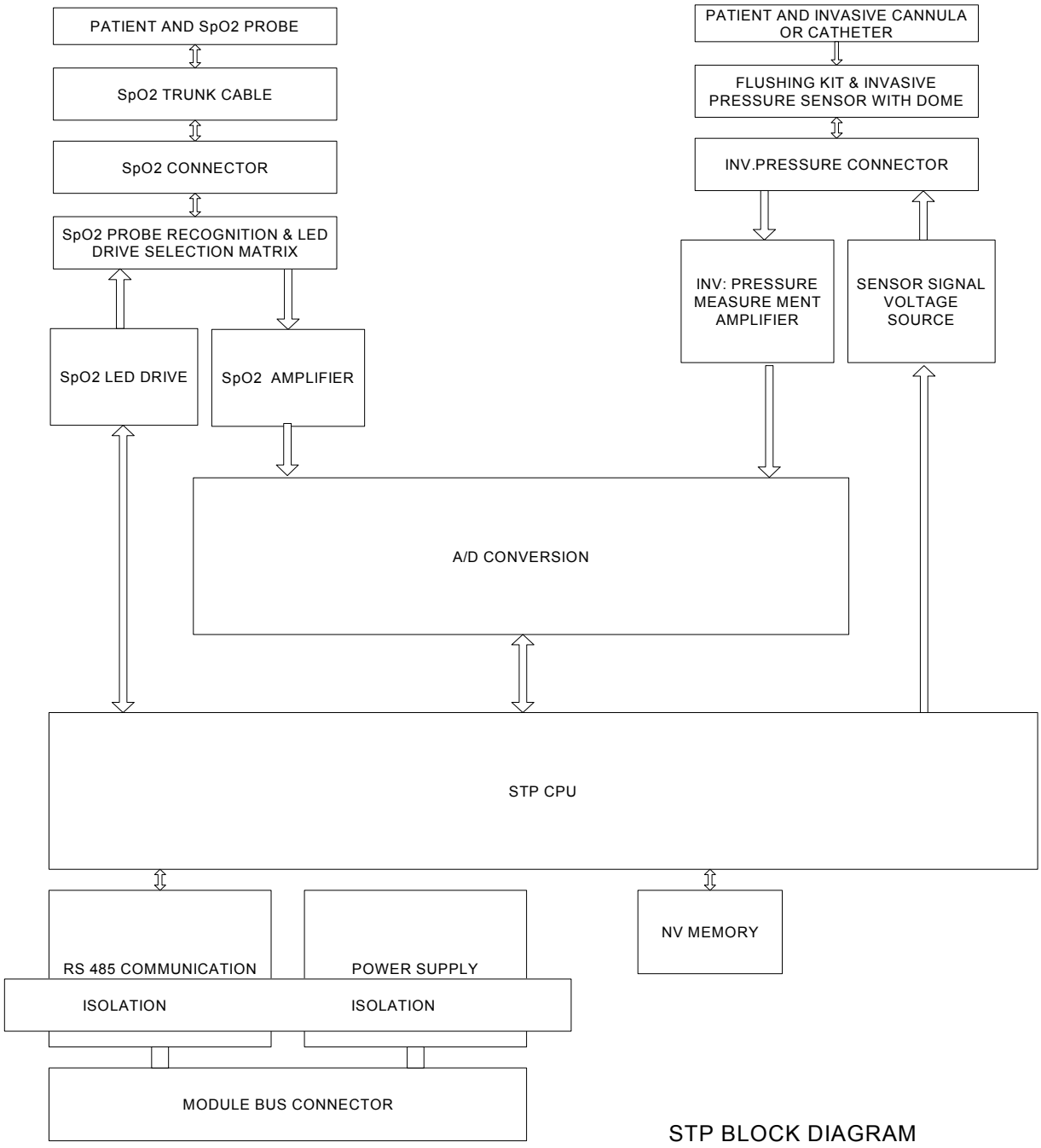


Figure 8 STP board block diagram

Microprocessor unit

The CPU is a 16 bit H8/3052 single-chip microcomputer. It contains 128 kilobytes of flash memory and 4 kilobytes 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.

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.

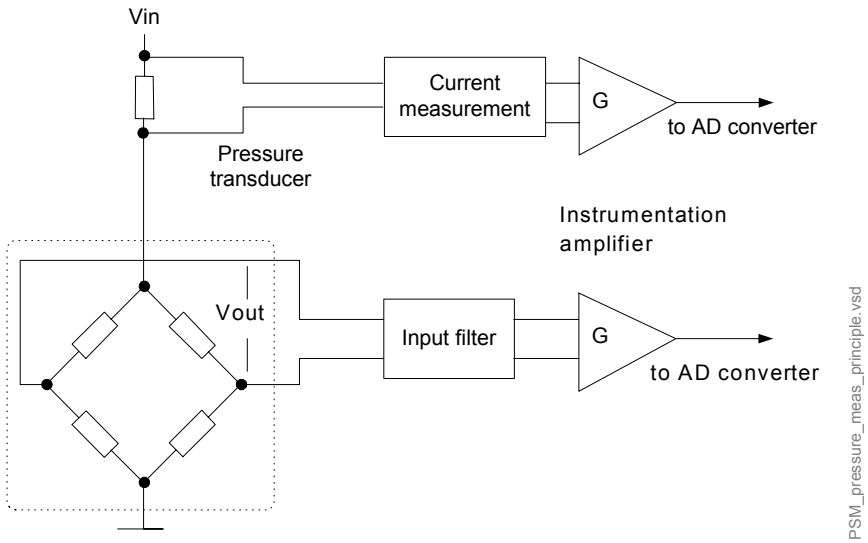


Figure 9 Pressure measurement principle

Pulse oximetry measurement section

LED control signals

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

LED driving circuit

Differential amplifiers measure the LED currents (LED current indication) of the SpO_2 sensor 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 sensor 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.

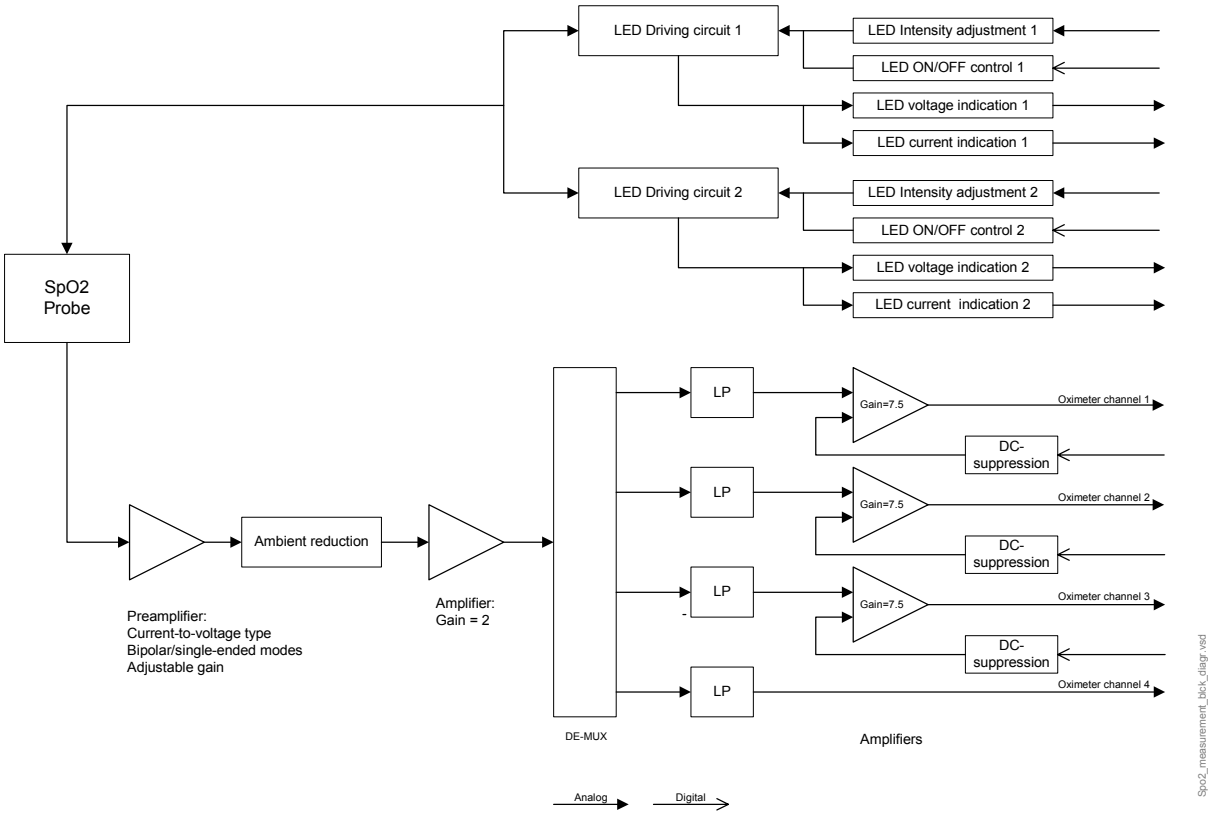


Figure 10 Pulse oximetry measurement block diagram

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.

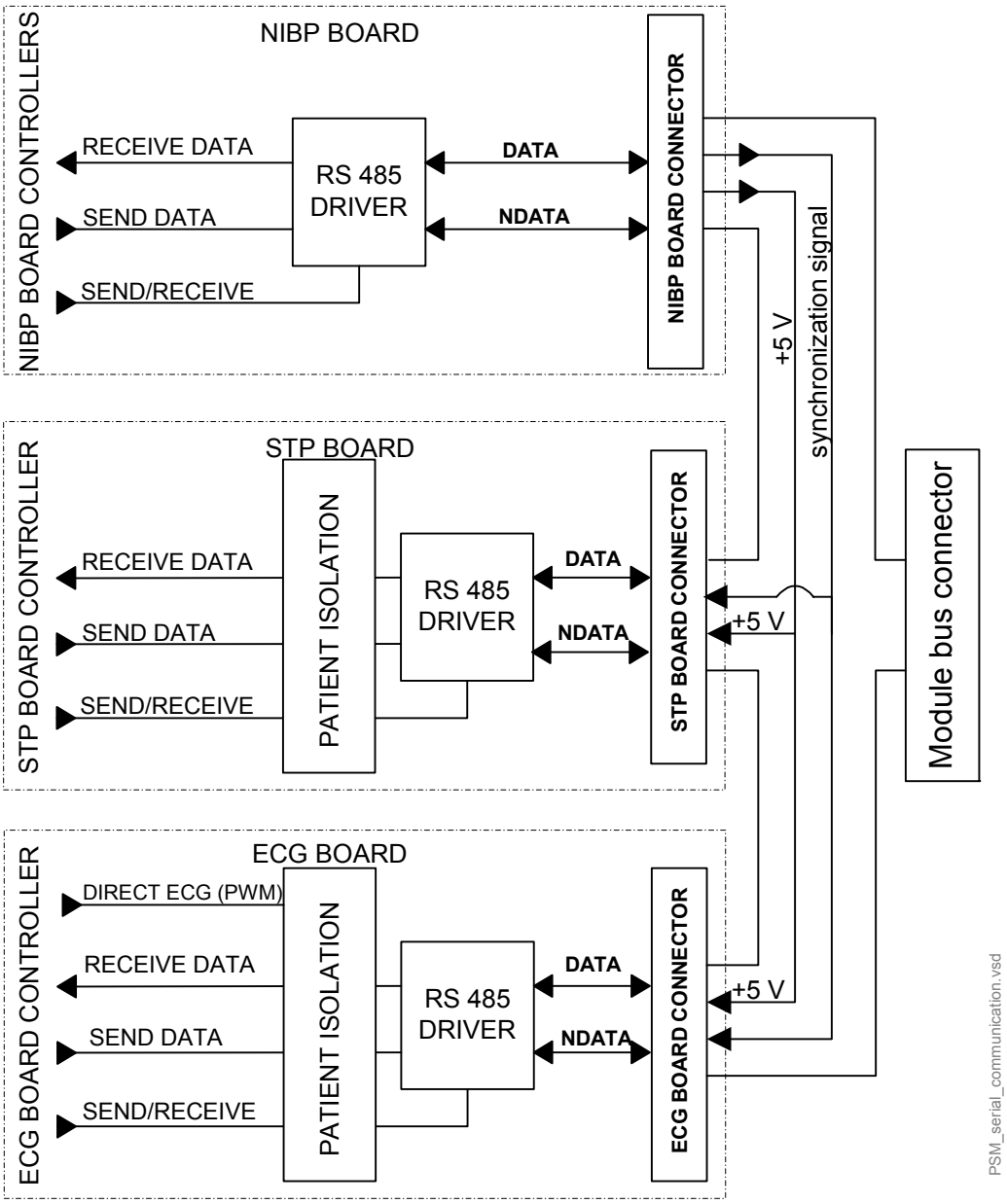


Figure 11 Serial communication of E-MRIPSN module and ECG board

Signals and isolation barrier

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

Power supply section

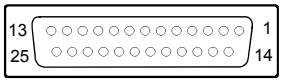
The power for the electronics on the floating part of the STP and the ECG boards is made on each board with the switching power supplies connected to a high voltage isolated transformer. The switching power supplies on the STP and ECG boards are synchronized to the frequency, about

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.

2.3 Connectors and signals

2.3.1 Module bus connector

Table 5 Module bus connector (X1) description

25-pin female D-connector	Pin No.	I/O	Signal
	1 - 2	I	Not connected
	3	I	+15 VDIRTY
	4	I	Not connected
	5	I/O	NDATA_RS485
	6	I/O	DATA_RS485
	7		Ground & Shield
	8 - 12	I	Not connected
	13		Ground & Shield
	14	I	Not connected
	15	I	GroundDIRTY
	16 - 20	I	Not connected
	21	O	PWM_ECG
	22 - 25		Not connected

3 Service procedures

3.1 General service information

The field service of the Hemodynamic MRI Module, E-MRI(P)SN is limited to replacing faulty printed circuit boards or mechanical parts. Return the faulty PC boards to GE Healthcare for repair.

WARNING **To prevent erroneous readings, do not use physically damaged SpO_2 sensors or sensor cables. Discard a damaged SpO_2 sensor or sensor cable immediately. Never repair a damaged SpO_2 sensor or sensor cable; never use a SpO_2 sensor or cable repaired by others. A damaged SpO_2 sensor or a sensor soaked in liquid may cause burns during electrosurgery.**

GE Healthcare is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

NOTE: Read the disassembly instructions in the MRI Shield slot through before servicing the monitor. It is essential to understand the MRI Monitor structure to be able to service the monitor effectively.

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.

WARNING **If a service procedure requires using tools that contain ferrous metal, perform the procedure outside MR environment.**

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

3.2 About service check

These instructions include complete procedures for a service check for the Hemodynamic MRI Module. In the MRI Monitor the ECG board is located inside the MRI shield back shell. For all ECG measurement related information see “MRI Shield slot”.

The service check 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 A”) which should be filled in when performing the procedures.

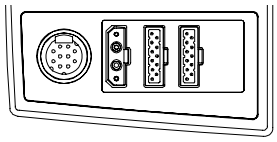
The symbol  in the instructions means that the check form should be signed after performing the procedure.

3.2.1 Recommended tools

Table 6 Recommended tools

For product(s)	Tool	Order No.
All Hemodynamic MRI modules	MRI Monitor	
Hemodynamic module, E-MRIPSN		
for InvBP	InvBP transducer	70077-001
for ECG	MRI ECG 3-lead set, 6.5 m/20 ft, IEC	897987
	or	
	MRI ECG 3-lead set, 6.5 m/20 ft, AAMI	897986
for SpO_2	Finger MRI sensor for adults	OXY-FMR
	Wrap MRI sensor for pediatrics	OXY-WMR
for NIBP	Adult NIBP cuff hose, 6 m/19.7 ft	2020980-002
	Infant NIBP cuff hose, 6 m/19.7 ft	2017009-004
for InvBP and NIBP	Pressure manometer	
	Screwdrivers	See “3.4.2. Tools needed” for the tools needed during the dis-/reassembly.

Patient simulators’ compatibility with MRI hemodynamic module

Module	Parameter	Patient simulator		
		M1010831	**MedSim**	**874027**
E-MRIPSN 	ECG	Not compatible	OK	Ok
	InvBP	Ok	with adapter cable M1010858	Not compatible

Adapter cables for hemodynamic patient simulators

Patient simulator	Adapter cables for simulators	
Hemodynamic patient simulator	- Dual Inv.BP adapter cable	2005772-001
Medsim	- Inv.BP adapter cable	M1010858
Lionheart & MPS450	- Inv.BP adapter cable	M1010862

3.2.2 Recommended parts

Table 7 Recommended parts

Part	Order No.	Notes
NIBP pump filter	57142-HEL	

3.3 Before beginning

- Perform the service reset for the MRI Monitor by pressing the **ON/Standby** key for at least 10 seconds.
- If the monitor is connected to the Datex-Ohmeda Network, disconnect the network cable from the monitor.
- Disconnect all the patient connectors.
- Disconnect all external cables connected to the monitor.

Follow the disassembly instructions so far that you are able to remove the module from the monitor, see “Disassembly and reassembly” in the MRI Shield slot.

3.4 Service check

3.4.1 Visual inspection

Detach the module box by removing the two screws from the back of the module.

Check:

1. Internal parts
   - screws are tightened properly
   - connectors are connected properly
   - NIBP tubing is attached properly
   - there are no loose objects inside the module

2. Module external parts
   - the module front cover is intact
   - all connectors are intact and attached properly
   - the module box and latch are intact

Field replaceable parts

3. NIBP pump filter

   Replace the NIBP pump filter, if necessary.

3.4.2 Module reassembly

Reattach the module cover and check that the latch is moving properly.

Clean the module with suitable detergent.

3.4.3 Module installation

Plug in the module to the MRI Monitor frame. Check that it goes in smoothly and locks up properly.

Reassemble the MRI Monitor far enough to be able to connect all the tubes and cables to the MRI Monitor frame, see"Disassembly and reassembly" in the MRI Shield slot.

NOTE: Leave the MRI Shield front cover still open.

Connect the mains power cord to the MRI Monitor and switch the monitor on.

3.4.4 Functional Inspection

Non-invasive blood pressure measurement

Perform these NIBP measurement checks after servicing NIBP measurement.

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

1. 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.

2. Membrane keys

   Check the module front panel membrane keys.

   Select ***Buttons/Leds***.

   Press each of the NIBP related membrane keys for at least one second. Check that the pressed key is identified, i.e. the corresponding text changes from OFF to ON in the menu, when the key is released back up again.

3. 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 push the ComWheel. Check that the pump turns on and the pressure inside the tubing system starts to increase. Stop the pump by pushing the ComWheel again when the pressure reaches 280 mmHg.

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

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

4. 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 pushing the ComWheel. The module pumps a pressure of about 265 mmHg and then the pump stops.

   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 pushing the ComWheel once more.

5. Calibration check

   Recalibrate the NIBP measurement according to the instructions in chapter “NIBP calibrations” on page 39. Remember to set the calibration protection back on after the calibration.

   Disconnect the pressure manometer. Select ***Calibrations*** - ***Calibration Check***. Push 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.

6. Safety valve functions

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

   Keep the pressure manometer connected to the cuff connector.

   NOTE: Make sure your pressure manometer can be used to measure pressures over 300 mmHg. If such a pressure manometer is not available, perform the check with an 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 pushing 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***. Push 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**.

7. 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 side panel and check that the message 'Cuff loose' is displayed 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' is displayed on the screen within 70 seconds.

8. Test measurement

   Check that the automatic inflation limits are in use:

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

   Wrap the cuff around your arm, select ***Start Ven.Stasis*** in the NIBP menu and push the ComWheel. Check that the module identifies the cuff, i.e. the text Adult is displayed 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 push the ComWheel again. Select ***Normal Screen***.

   Disconnect the cuff hose.

9. NIBP hose detection

   Press the **Start/ Cancel** side panel key and check that the 'Cuff loose' message is displayed 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' is displayed in the NIBP digit field.
   – When you try to start the measurement, the monitor automatically opens the selections ***NIBP Setup - Inflation Limits.***

Invasive blood pressure measurement

1. 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 is displayed on the screen.

Perform the same check also for the InvBP channel P2.

2. Calibration

   Calibrate the InvBP channels P1 and P2 according to the instructions in chapter “Invasive pressure calibration” on page 50.“

3. 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 **Invasive Pressures** key and selecting ***Zero Pressures*** - ***Zero P1 -’Art’*** and ***Zero P2 ‘CVP’***.

   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

1. SpO_2 sensor detection

   Check that the message ‘No probe’ is shown, when no SpO_2 sensor is connected to the monitor. Connect an SpO_2 finger sensor to the monitor. Check that the message ‘Probe off’ is shown when the sensor is not connected to a finger.

2. Test measurement

   Connect the SpO_2 sensor on your finger. Check that the reading of 95 to 99 and SpO_2 waveform is displayed. Check that the HR value is calculated from SpO_2 when ECG and InvBP (P1) are not measured.

General

1. Electrical safety check

   Perform an electrical safety check and a leakage current test.

2. Functioning after electrical safety check

   Check that the module functions properly after the electrical safety tests.

- Fill in all necessary documents.

3.5 After service check

After the module service check, either remove the module or reassemble the monitor according to the service situation.

3.5.1 MRI Monitor reassembly

Reassemble the monitor according to the “Disassembly and reassembly” instructions in the MRI Shield slot.

NOTE: After servicing the Hemodynamic MRI Module check the following parts of the patient connector panel during the monitor reassembly:

- patient panel cover is clean and intact
- all connectors are intact and attached properly
- the NIBP tubes and cables coming from the patient connector panel to the module are clean and intact

3.5.2 Functional check

Perform the Functional Check after installing a serviced MRI Monitor, see chapter “5 Functional check” in the first slot of the manual.

3.6 Disassembly and reassembly

3.6.1 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.

3.6.2 Tools needed

- torx screwdrivers; T6, T8
- crosshead screwdriver
- metric ballpoint hex key
- pincers
- antistatic wristband

CAUTION When reassembling the module, make sure that all cables are reconnected properly.

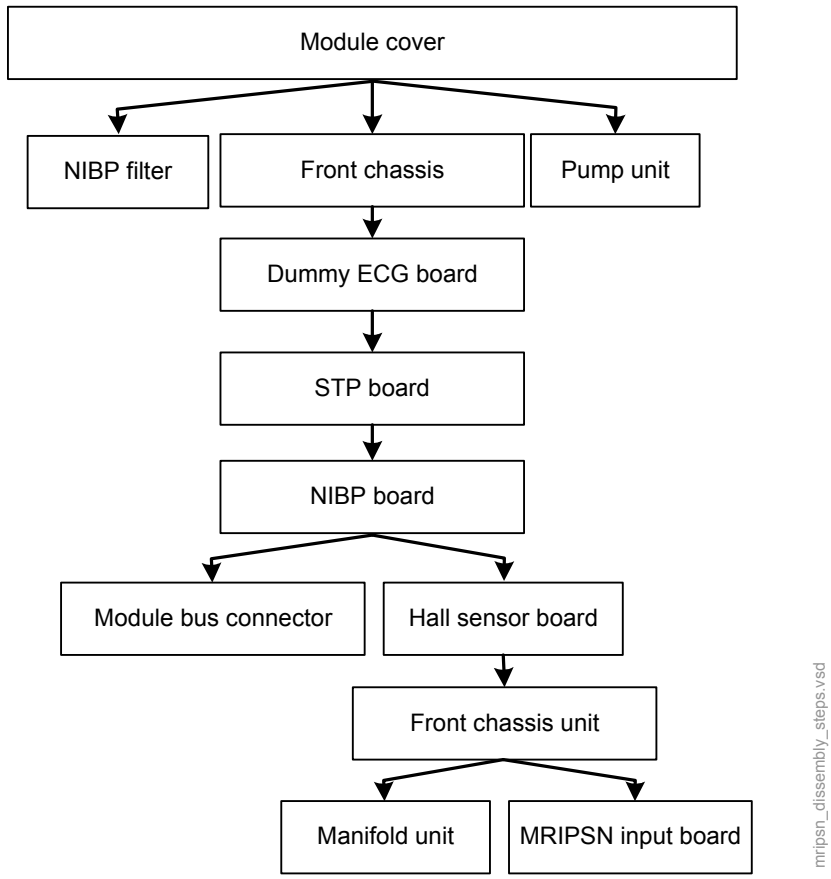


Figure 12 E-MRIPSM module disassembly steps

3.6.3 To disassemble the module

To remove the module from the monitor, see the disassemble instructions in the “MRI Shield slot”.

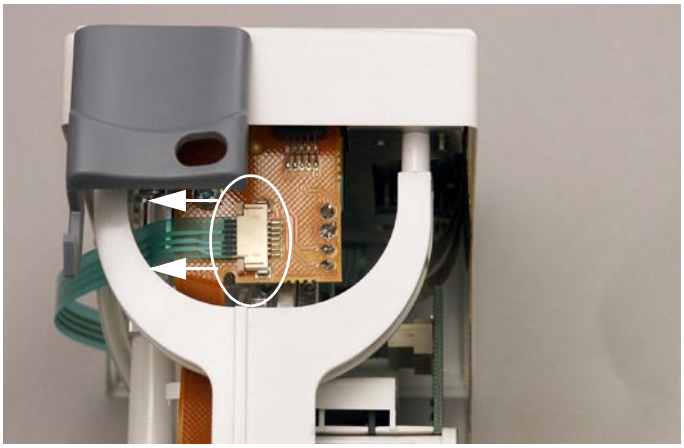
To remove the module cover

1. Remove the two screws (T8) holding the module cover to the module frame from the back of the module.

2. While pressing the release latch, pull the module cover slowly backwards and remove it from the main body.

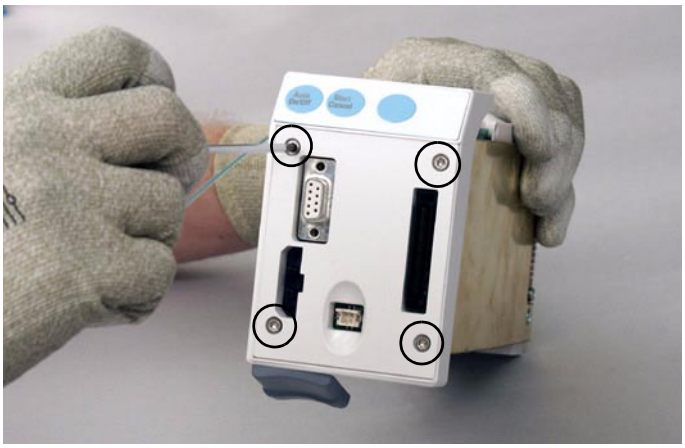
NOTE: When reassembling, be carefull not to damage the membrane keyboard flex. Guide the flex inside the frame and the module casing.

To remove the Front Chassis



3. Open the connector lock at the NIBP flex board and disconnect the membrane keyboard flex.

- NOTE: While reassembling remember to lock the connector.



4. Remove the four screws (T8) holding the front chassis to the module frame.
5. Detach the front chassis from the module frame. Be careful not to damage the NIBP flex board or the membrane keyboard flex.

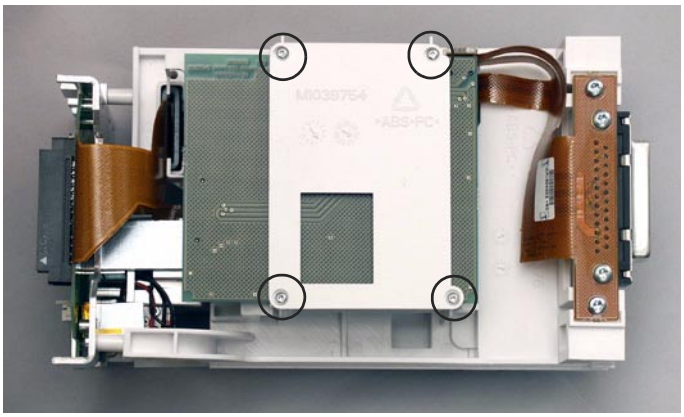
NOTE: While reassembling be careful not to drive the screws too tight. This might cause NIBP measurement leakage.

To replace the following field replaceable parts, follow the instructions below:

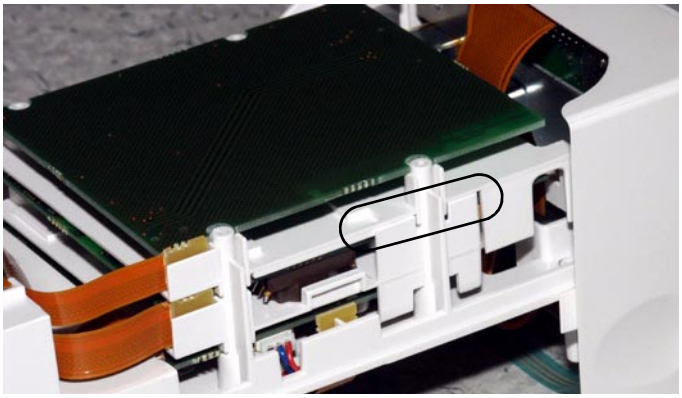
- “To remove the Dummy ECG board” on page 28
- “To remove the pump unit” on page 37
- “To replace the NIBP filter” on page 38

To remove the Dummy ECG board

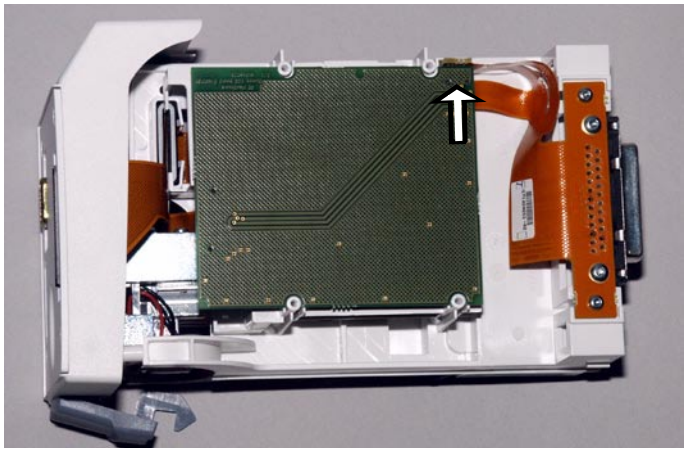
6. Remove screws holding the EMC shield: two M3x6 acid proof screws in the front and two UNC screws attached to the module bus connector.



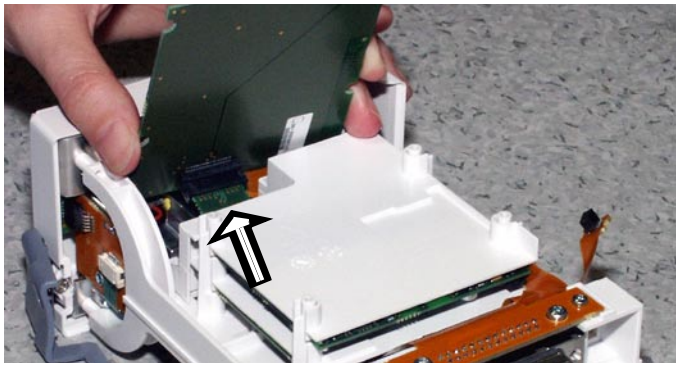
7. Remove the four screws (T6) holding the insulator cover and lift the cover up.



NOTE: When reassembling, push the ECG board a little to ensure that the insulator plates are correctly reassembled. Guide the upper plate inside the lips of the lower plate.



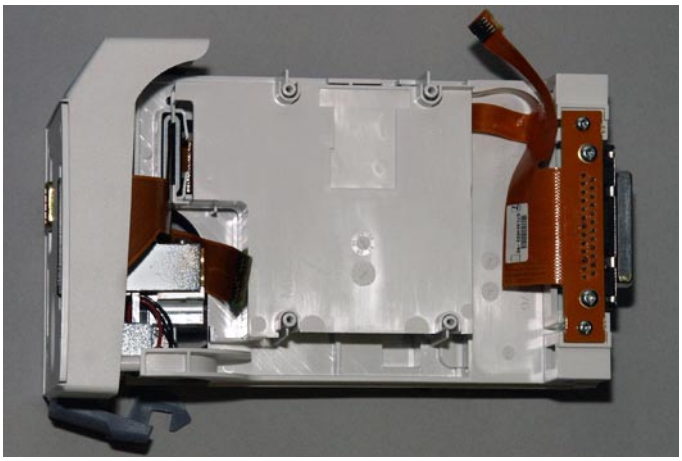
8. Lift the Dummy ECG board a little and disconnect the module bus connector from the board.



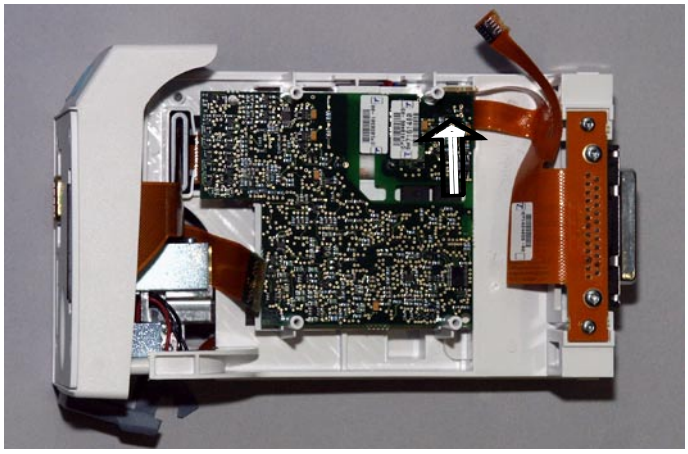
9. Disconnect the ECG input flex connector from the board. Be careful not to damage the flex.

- Lift the board up.

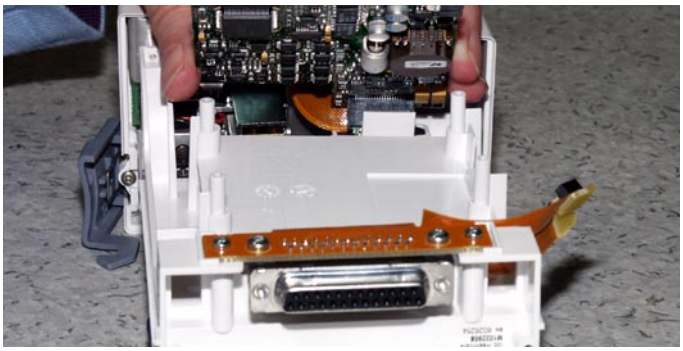
To remove the STP board



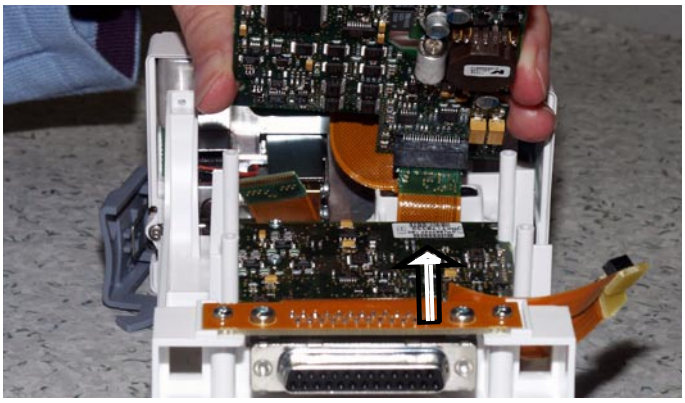
10. Lift the insulator plate up.



11. Disconnect the module bus connector from the STP board.



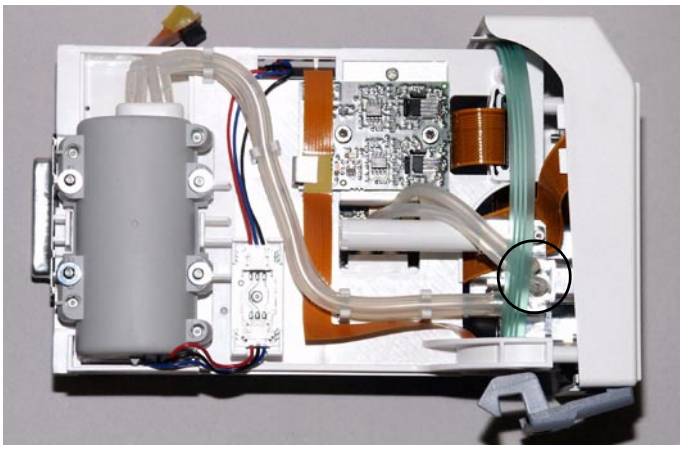
12. Lift the STP board and remove the STP-NIBP board insulator plate to get better access to the STP board input connector.



13. Disconnect the STP board input connector.
- Remove the STP board.

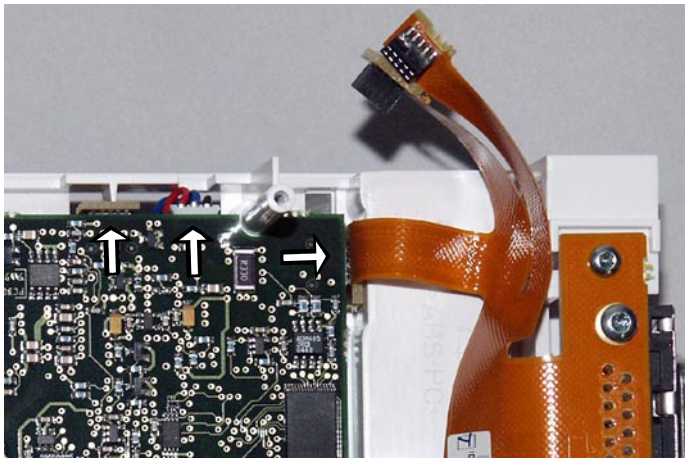
NOTE: When reassembling, be carefull not to damage the STP input flex cable. Make sure the STP input flex connector is properly connected.

To remove the NIBP board



14. Flip the module over and disconnect the hoses (2 pcs) coming from the manifold.

NOTE: Notice the positions of the hoses; mark them if necessary to ensure they are replaced correctly.

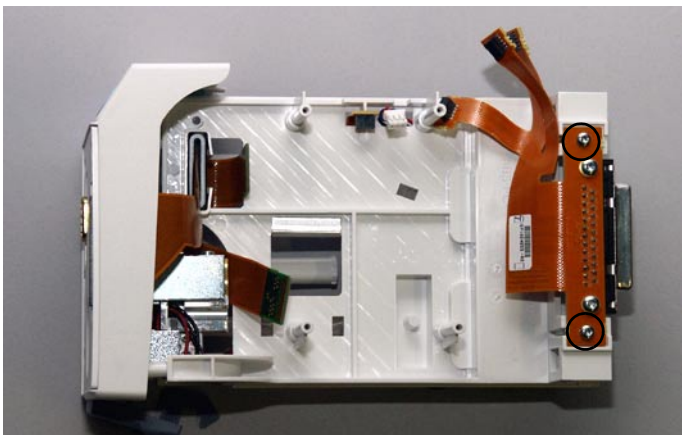


15. Flip the module over again. Lift the NIBP board carefully and disconnect:
- flex connector
- pump connector
- the module bus connector

Remove the NIBP board.

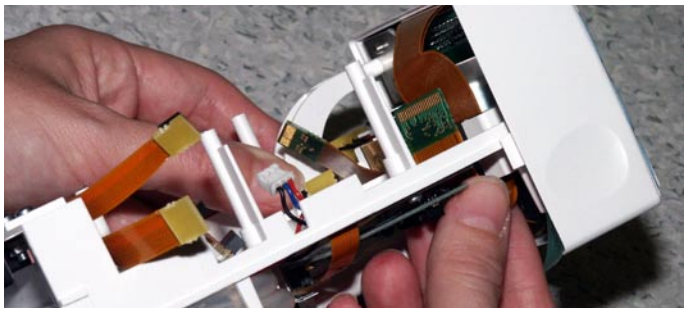
To continue to disassemble the module follow the instructions:
- "To remove the module bus connector"
- "To remove the Front Chassis Unit"

To remove the module bus connector



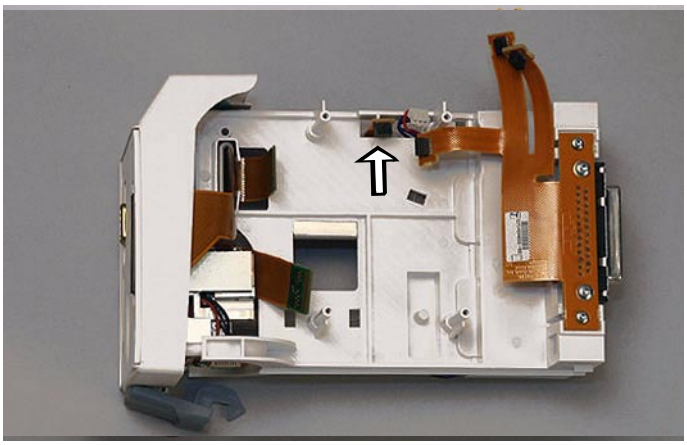
16. Remove the two screws (T8) holding the connector to the frame.

To remove the Front Chassis Unit



1. Carefully thread the STP input flex cable through the ferrites to the other side of the frame.

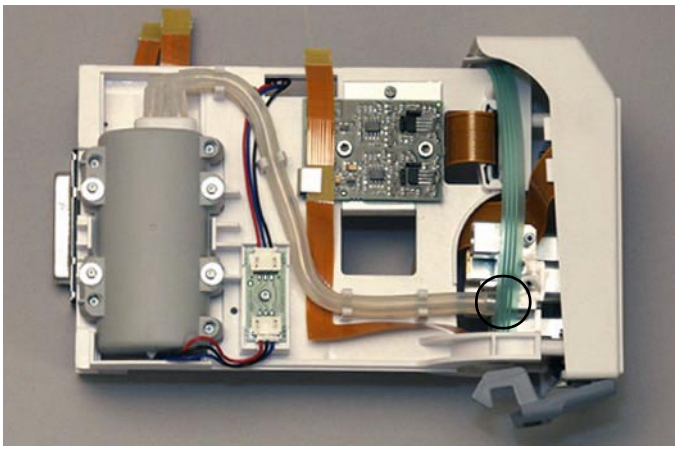
NOTE: The ferrites should stay in place, if not, remember to reassemble them.



2. Release the NIBP flex board by pulling the NIBP flex board connector carefully through the frame.

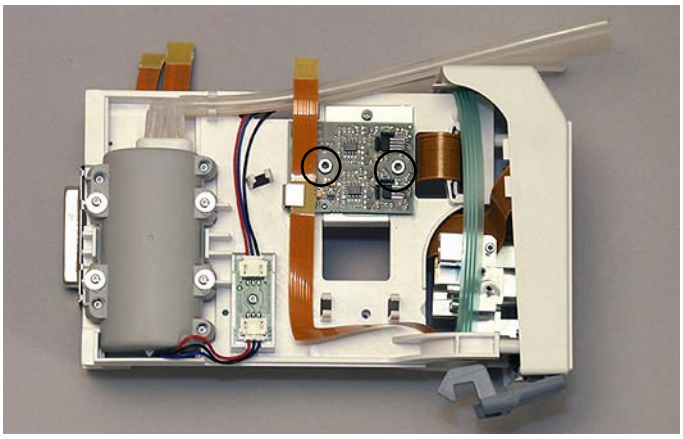
NOTE: Be careful not to damage the NIBP flex board.

To remove the Hall sensor board

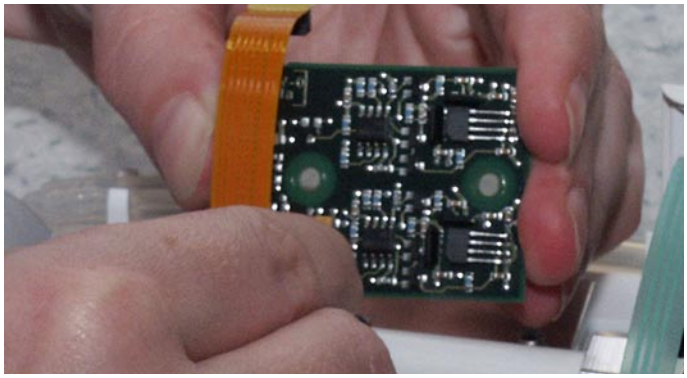


3. Flip the module over. Disconnect the hoses (2 pcs) from the manifold and lift them up from the holders (to allow the NIBP flex some movement).

NOTE: Note the positions of the hoses; mark them, if necessary, to ensure they are replaced correctly.

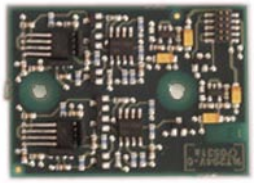


4. Remove the two hexagonal screws holding the Hall sensor board to the mounting plate. Carefully slide the board aside from under the mounting plate.



5. Lift the board and disconnect the NIBP flex board connector.

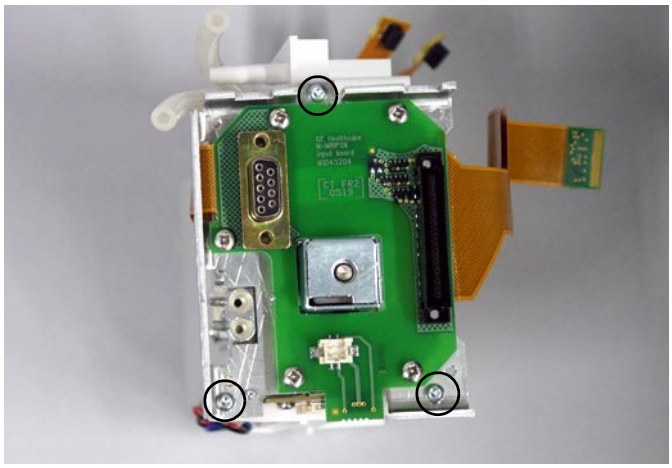
The Hall sensor board



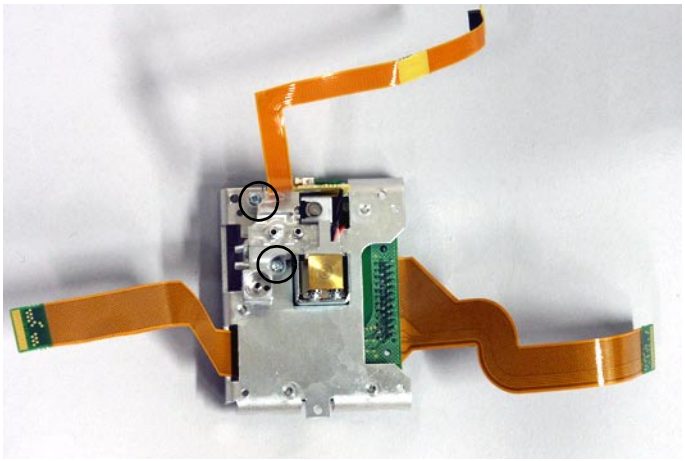
To continue to disassemble the module follow the instructions:

- “To remove the manifold unit”
- “To remove the MRIPSN input board” on page 36

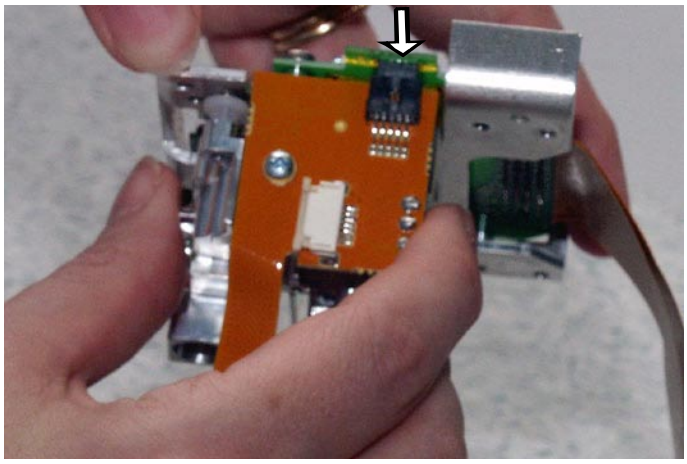
To remove the manifold unit



1. Remove the three plastic screws (T8) holding the input board mounting plate to the module frame.

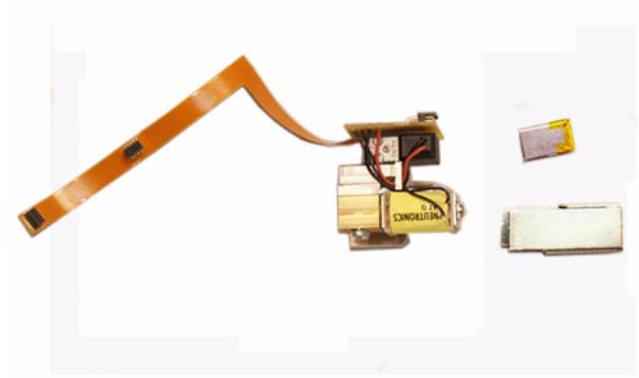


2. Remove the two crosshead screws (T6) holding the manifold to the mounting plate



3. Carefully pull the manifold unit to disconnect the NIBP flex board connector from the input board.

NOTE: When reassembling, make sure that the NIBP flex board is properly connected (all pins connected and the connector pressed deep enough) to the input board.

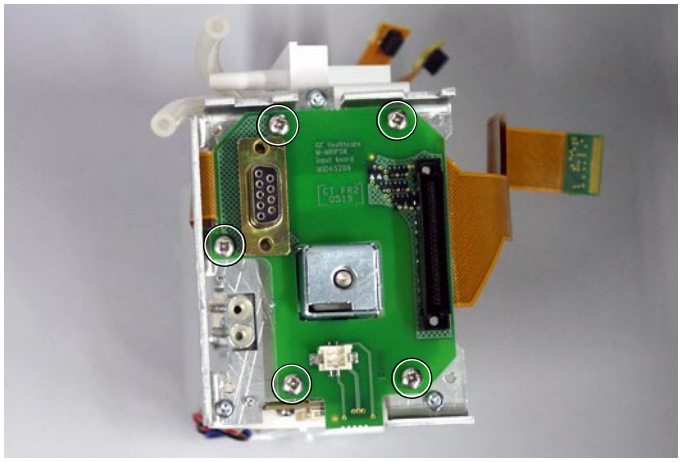


4. Remove the manifold unit and remove the metal shields around the valves.

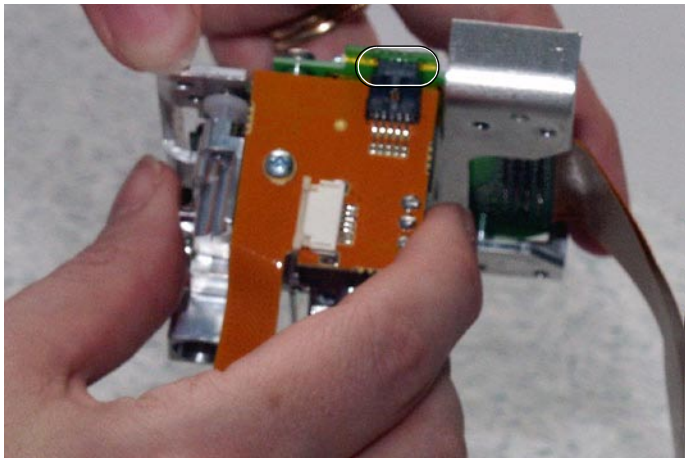
NOTE: When reassembling the shield, be careful not to pinch the valve cables.

NOTE: Be careful not damage the tapes around the smaller shield.

To remove the MRIPSN input board

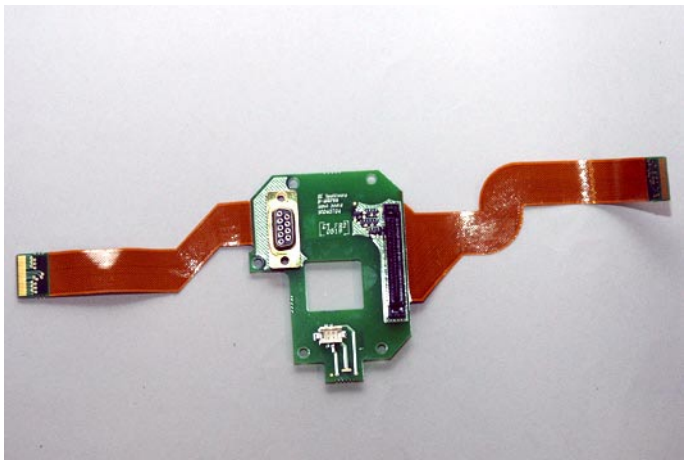


1. Remove the five crosshead screws holding the input board to the mounting plate.

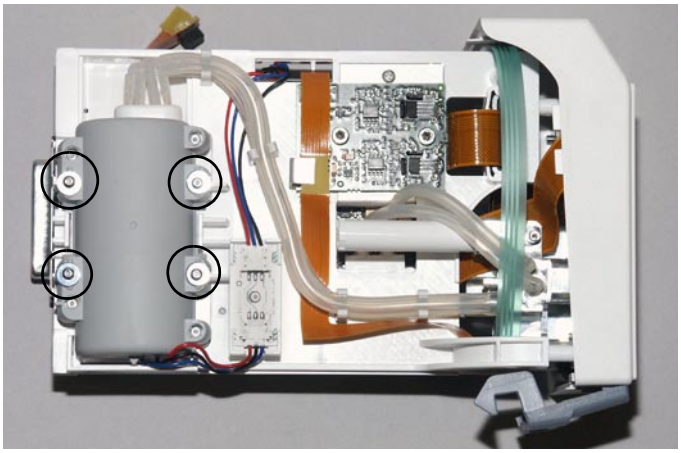


2. Pull the input board to disconnect the NIBP flex board connector from the input board. Be careful not to damage the flex boards.

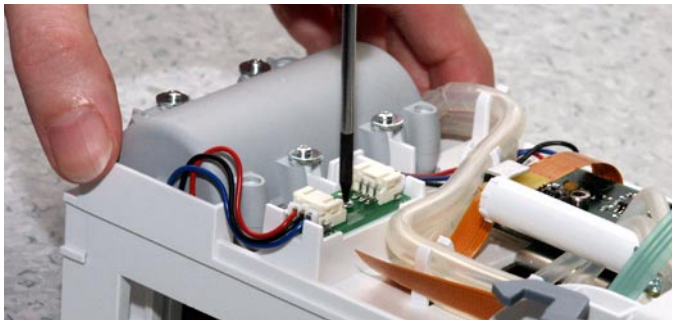
- NOTE: When reassembling, make sure that the NIBP flex board is properly connected (all pins connected) to the input board.



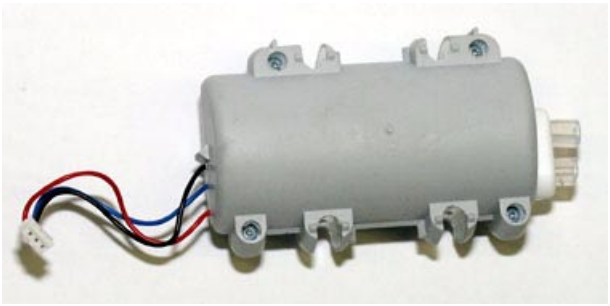
To remove the pump unit



1. Follow the disassembly instruction steps 1 and 2.
2. Remove the four screws (T6) with washers holding the NIBP pump to the frame.



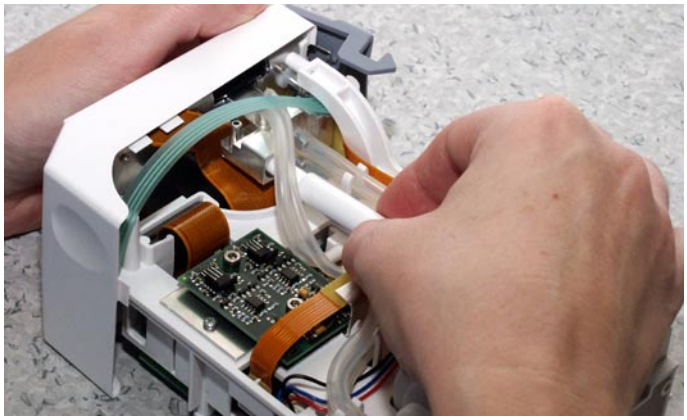
3. Remove the screw (T6) holding the pump connector board to the insulator plate and lift the board up. Disconnect the pump connector.



4. Disconnect the hoses and remove the pump unit.

NOTE: Notice the positions of the hoses; mark them, if necessary, to ensure they are replaced correctly.

3.6.4 To replace the NIBP filter



1. Follow the disassembly instruction steps 1 and 2.
2. Remove the NIBP filter cover and replace the filter.

3.6.5 Monitor reassembly and service check

- Reassemble the module in reverse order. Pay special attention to the NOTES during the reassembly.
- Perform the “Visual inspection” on page 20 during the module reassembly.
- After reassembling the module continue to reassemble the monitor according to the instructions in “MRI Shield slot”.
- Complete the service check during the monitor reassembly according to the instructions in the “Service check” on page 20.

3.7 Adjustments and calibrations

3.7.1 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.

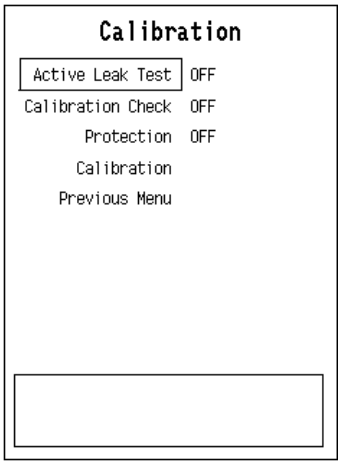
The calibration of the primary pressure channel can also be checked from the NIBP setup menu (***NIBP - NIBP Setup - Calibration Check***). In this case, the auto zeroing is performed at start - remove the hose before entering to ensure atmospheric pressure to the pressure transducers - the primary pressure 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 3 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

NOTE: Before the calibration, disassemble the MRI Monitor far enough to be able to press the hemodynamic module keys during the NIBP calibration. See MRI Shield slot for the monitor disassembly instructions.

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***. The message 'Calibration switch ON!' is displayed.

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

c. Press the buttons again for 3 seconds. Menu selection ***Calibration*** is now enabled, and ***Protection*** is disabled. When the calibration is enabled, a message 'Calibration not protected' is displayed.

- 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:
  Press NIBP module buttons **Auto ON/OFF** and **Start Cancel** simultaneously for 3 seconds. Select ***Protection ON*** and push the ComWheel. Then press the buttons again for three 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.

3.7.2 Invasive pressure calibration

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 ESTPR: the 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

4.1 Troubleshooting charts

See also the “User’s Reference Manual” for more troubleshooting procedures.

4.1.1 NIBP

Problem	Cause	What to do
No NIBP value displayed	NIBP not selected on screen.	Check monitor setup.
No NIBP parameter field	Monitor in too high magnetic field strength.	Place the monitor outside the 250 gauss line. See “Hall sensor board” description.
‘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 , the causes and the solutions listed in the “NIBP error code explanation” chapter.
‘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.
	4. NIBP ID switch cable (between patient connector panel and the module) broken or poorly connected	- Check the cable, fix if necessary.
'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.

4.1.2 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	EEPROM protection error	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	Communication break; temporal break down of communication from monitor detected	Automatic recovery.
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.

4.1.3 Pulse oximetry (SpO_2)

Problem	Cause	What to do
Message 'NO PROBE'	No sensor connected to the MRI Monitor patient connector panel.	Check sensor connections.
	Sensor faulty.	Change the sensor.
	Flat cable connecting the patient connector panel to the module 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 1 Setup - Waveform Fields***.
	Wrong configuration setting.	Check the configuration settings from the STP/Calibrations menu (**Monitor Setup - *Install/Service* - *Service* - *Parameters***)

4.1.4 Invasive blood pressure

Problem	Cause	What to do
Abnormally low pressure	Transducer wrongly positioned.	Check mid-heart level and reposition transducer.
No pressure	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 1 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***).
	Flat cable connecting the patient connector panel to the module loosen or broken.	Check the Flat cable, replace if necessary.
'Not zeroed' message	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.
Out of range < 40 mmHg	Measurement pressure is beyond the measurement range.	Check the transducer level. Zero the channel.

Problem	**Cause**	**What to do**
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.

4.2 Troubleshooting flowcharts

4.2.1 Troubleshooting for NIBP parameter

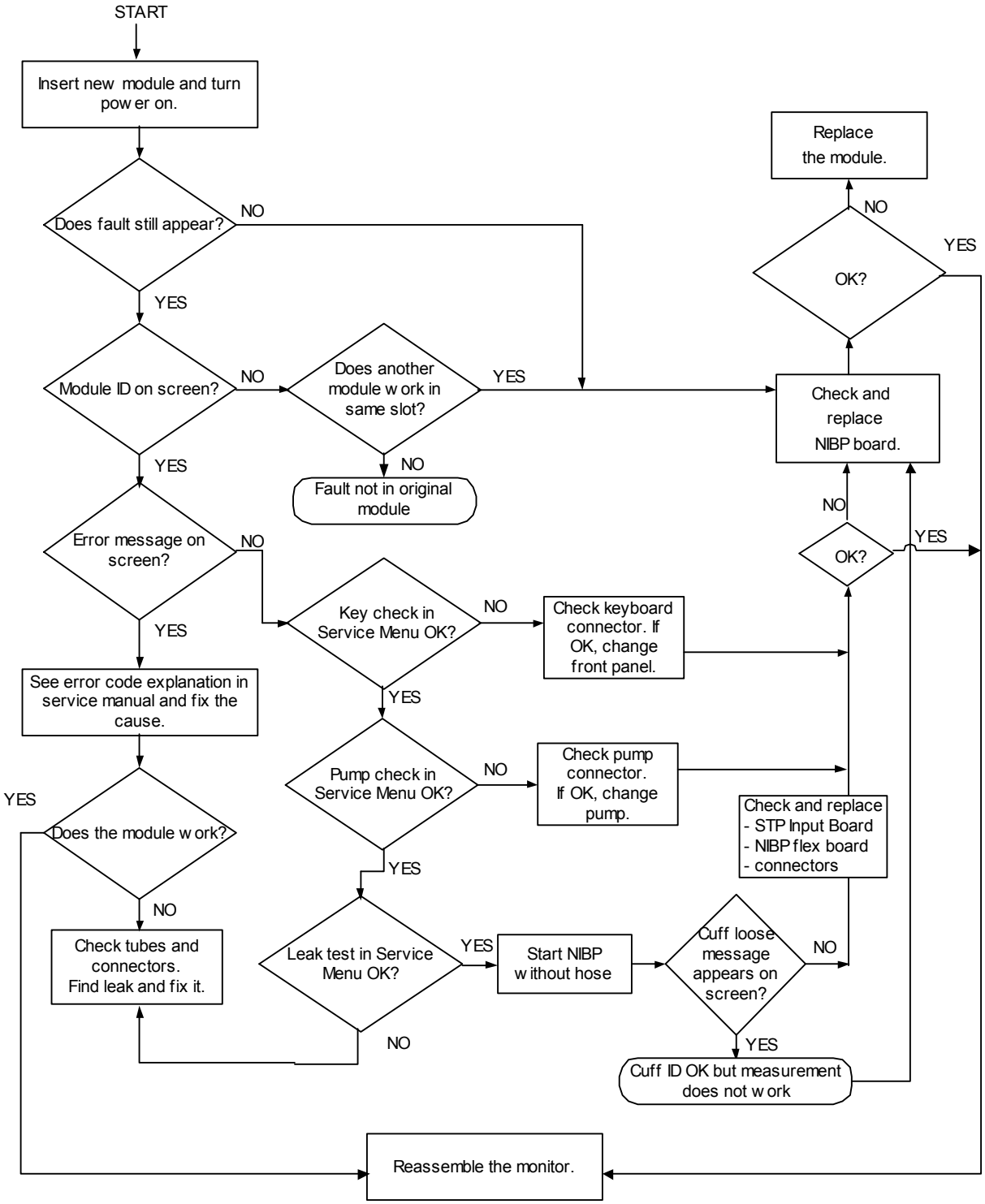


Figure 13 Troubleshooting flowchart for NIBP parameter

4.2.2 Troubleshooting for ESP parameters

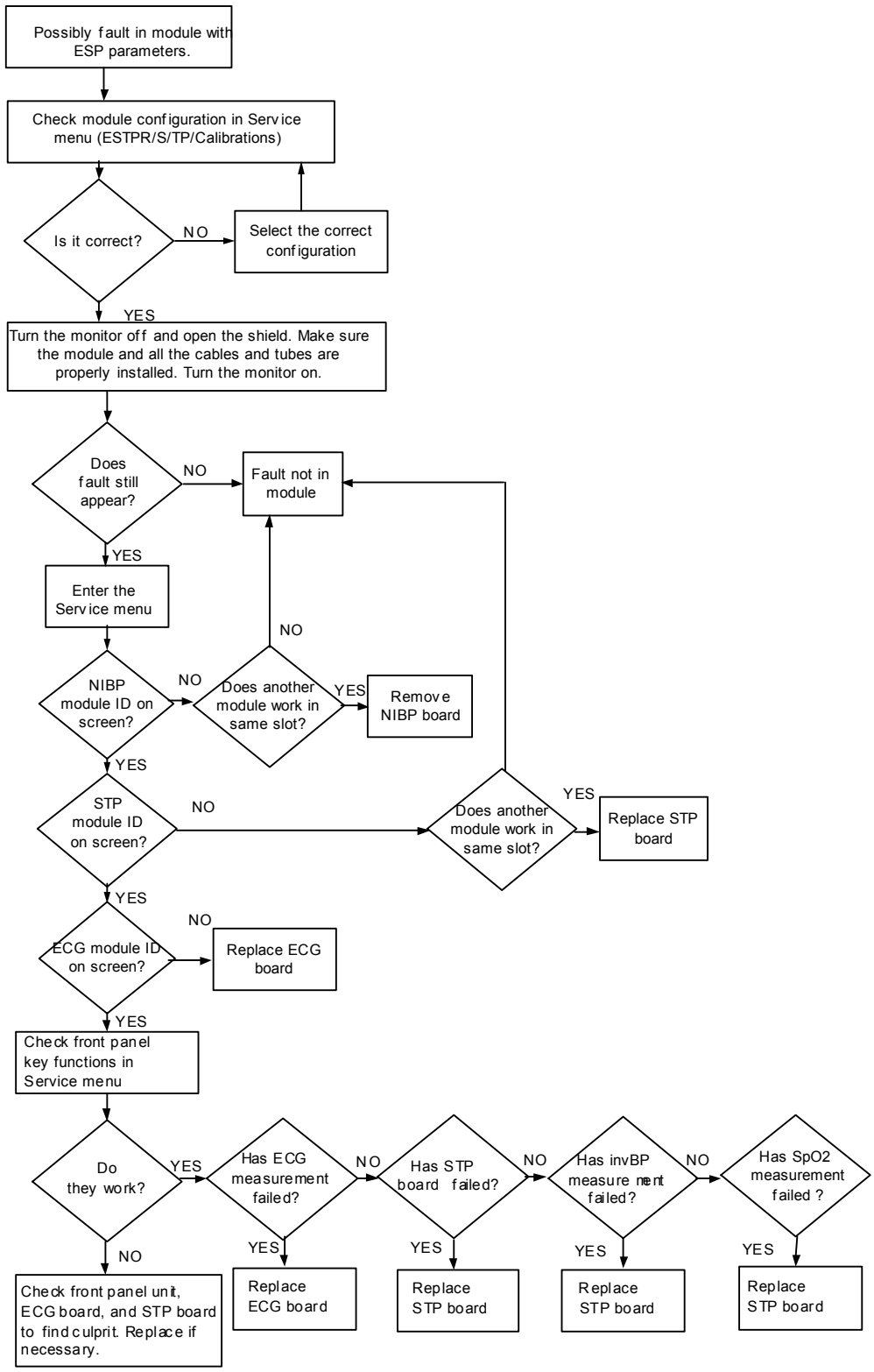


Figure 14 Troubleshooting flowchart for ESP parameters

5 Earlier revisions

There are no earlier revisions of the Hemodynamic MRI Module, E-MRIPSN or E-MRISN.

APPENDIX 1 Service check form, Hemodynamic MRI Module

Customer		
Service	E-MRI_____	S/N
Service engineer		Date

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual inspection			**OK**	**N.A.**	**Fail**
1. Internal parts			☐	☐	☐
2. Module external parts			☐	☐	☐
Notes					
Field replaceable parts					
3. NIBP pump filter			☐	☐	☐
Notes					
Module reassembly					
Module installation			☐	☐	☐
NIBP measurement inspection			**S/N**		
1. Communication and memories			☐	☐	☐
2. Membrane keys			☐	☐	☐
3. Pump and valves			☐	☐	☐
4. Leak test			☐	☐	☐
5. Calibration check	Measured B1	Measured B2	Allowed range		
0 mmHg			±9 mmHg		
100 mmHg			100 ±2 mmHg		
200 mmHg			200 ±3 mmHg		

260 mmHg			260 ±4 mmHg
6. Safety valve functions	Measured B1	Measured B2	Allowed range
			270...330 mmHg
			270...330 mmHg
			130...165 mmHg
			130...165 mmHg
			OK **N.A.** **Fail**
7. Cuff-related messages			☐ ☐ ☐
Notes			

InvBP measurement	**S/N**
	OK **N.A.** **Fail**
1. Cable and transducer detection	☐ ☐ ☐
2. Calibration	☐ ☐ ☐
3. Test with patient simulator	☐ ☐ ☐
Notes	

SpO2 measurement	**S/N**
	OK **N.A.** **Fail**
1. SpO2 sensor detection	☐ ☐ ☐
2. Test measurement	☐ ☐ ☐
Notes	

General		**OK**	**N.A.**	**Fail**
1. Electrical safety check		☐	☐	☐
2. Functioning after electrical safety check		☐	☐	☐
Notes				

Used spare parts			

Signature

MRI Compact Airway Modules

Compact Airway Module, E-MRICAiOV (Rev. 00)
Compact Airway Module, E-MRICAiO (Rev. 00)
Compact Airway Module, E-MRICO (Rev. 00)

Technical Reference Manual Slot

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

M1041752-2
September, 2006

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

Table of contents

Table of figures

Introduction

This Technical Reference Manual slot provides information for the maintenance and service of the MRI Compact Airway modules. The MRI Compact Airway modules are double width plug-in modules with extension cover of special metal for paramagnetic O2 sensor. E-MRICO, E-MRICAiO and E-MRICAiOV are designed for use with the MRI Monitors only.

The service menu is described in a separate “Service Menu“ slot and the spare part lists in the “MRI Monitor Spare Parts” slot.

The MRI Compact Airway modules provide airway and respiratory measurements.

Letters in the module name stand for:

C = CO_2 and N_2O, O = patient O_2, V = patient spirometry, A = anesthetic agents, and i = agent identification

Table 1 Options for MRI Compact Airway modules

Modules	**Parameters / measurements**					
	CO_2	**N_2O**	**O_2**	**Anesthetic agents**	**Agent ID**	**Spirometry**
E-MRICAiOV	X	X	X	X	X	X
E-MRICAiO	X	X	X	X	X	
E-MRICO	X	X	X			

1 Specifications

1.1 General specifications

Module size, W × D × H	121 x 228 × 112 mm, 4.6 × 9.0 × 4.4 in
Module weight:	
E-MRICAiOV	2.2 kg/4.8 lb
E-MRICAiO	2.2 kg/4.8 lb
E-MRICO	1.6 kg/3.5 lb
Operating temperature	+10...+40 °C
Storage temperature	-25...+70 °C
Atmospheric pressure	666...1060 hPa / (67...106 kPa) (500...800 mmHg) (666...1060 mbar)
Humidity	10...95% non-condensing (in airway 0...100%, condensing)
Power consumption	12.6 W P_{rms}, 14.6 W momentary
Protection against electrical shock	Type BF

1.2 Typical performance

CO_2

Measurement range	0...15 vol% (0...15 kPa, 0...113 mmHg)
Measurement rise time	< 400 ms typical
Accuracy	≤ 0.2 vol% +2% of reading)
Gas cross effects	< 0.2 vol% (O_2, N_2O, anesthetic agents)

If CO_2 concentration is below 0.1%, 0.0% is displayed.

O_2

Measurement range	0 to 100 vol%
Measurement rise time	< 400 ms typical
Accuracy	± (1 vol% + 2% of reading)
Gas cross effects	< 1 vol%; anesthetic agents < 2 vol%; N_2O
O_2 Fi-Et difference	resolution 0.1 vol%

N_2O

Measurement range	0 to 100%
Measurement rise time	< 450 ms typical
Accuracy	± (2 vol% + 2% of reading)
Gas cross effects	< 2 vol%; anesthetic agents

Respiration Rate (RR)

Measurement range	4...60 breaths/min
Detection criteria	1% variation in CO_2

Anesthetic Agents (AA)

Measuring range	
Hal, Enf, Iso	0 to 6 vol%
Sev	0 to 8 vol%
Des	0 to 20 vol%
Measurement rise time	< 400 ms typical
Accuracy	±(0.15 vol% +5% of reading)
Gas cross effects	< 0.15 vol% N_2O

Resolution is two digits, when the AA concentration is below 1.0 vol%.
If AA concentration is below 0.1 vol%, 0.0% is displayed.

Identification threshold	0.15 vol% typical
Identification time	< 20 s (for pure agents)
Mixture identification threshold for 2. agent:	
	0.2 vol% +10% of total conc.

1.3 Gas specifications

Airway humidity	0...100%, condensing
Sampling rate	200 ±20 ml/min. (sampling line 2-3 m, normal conditions)
Sampling delay	2.5 seconds typical with a 3 m sampling line 3.4 seconds typical with a 6 m sampling line
Total system response time	2.9 seconds typical with a 3 m sampling line, including sampling delay and rise time 3.8 seconds typical with a 6 m sampling line, including sampling delay and rise time
Display update rate	breath-by-breath
Warm up time	2 min. for operation with CO_2, O_2, and N_2O 5 min. for operation of anesthetic agents 30 min. for full specifications

Gas values are measured in ATPD conditions (ambient temperature and pressure, dry). When CO2 is displayed as a partial pressure (kPa, mmHg), the value can be alternatetively shown as wet (BTPS, body temperature and pressure saturated).

Automatic compensation for athmospheric pressure variation (500...800 mmHg), temperature and CO_2/N_2O and CO_2/O_2 collision broadening effect.

Auto zeroing interval	Immediately after calibrating the gas sensor and 2, 5, 10, 15, 30, 45, 60 minutes after start-up, then every 60 minutes

1.3.1 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...800 mmHg, ±50 mmHg of cal.
Ambient humidity	20...80% RH, ±20% RH of cal.
Non-disturbing gases	
Ethanol C_2H_5OH	< 0.3%
Acetone	< 0.1%
Methane CH_4	< 0.2%
Nitrogen N_2	
Carbon monoxide CO	
Nitric Oxide NO	< 200 ppm
water vapor	
Maximum effect on readings	
CO_2	< 0.2 vol%
O_2, N_2O	< 2 vol%
anesthetic agents	< 0.15 vol%
Effect of Helium	decreases CO_2 readings < 0.6 vol% typically

1.3.2 Conditions exceeding normal

Accuracy specifications under the following conditions; ❶❷❸❹:

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 2 to 10 minutes (anesthetic agents 5-10 minutes), under normal conditions

❸ During warm-up 10 to 30 minutes, under normal conditions

❹N2O > 85%, under normal conditions

	Accuracy under different conditions (see above)		
	Condition ❶ and ❸	Condition ❷	Condition ❹
CO_2	±(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%)	
O_2	(2 vol% + 2% of reading)	±(3 vol% + 3% of reading)	
N_2O	±(3 vol% + 3% of reading)	±(3 vol% + 5% of reading)	± (2vol% + 8% of reading)
Agents: Hal, Enf, Iso, Sev, Des	±(0.2 vol% + 10% of reading)	±(0.3 vol% + 10% of reading)	

1.4 Patient spirometry specifications

1.4.1 Normal conditions

Accuracy specifications apply in normal conditions (after 10 minutes warm-up period):

Ambient temperature	10...40 °C
Ambient pressure	500...800 mmHg
Ambient humidity	10...98% RH

Airway humidity	10…100% RH
Respiration rate	4…35 breaths/min (adults)
	4…50 breaths/min (pediatric)
I:E ratio	1:4.5…2:1
Intubation tube	5.5…10 mm (adults), 3…6 mm (pediatric)

Airway pressures (P_{aw}, P_{peak}, P_{plat}, $PEEP_e$, $PEEP_{iStat}$, $PEEP_{iDyn}$, P_{mean})

Measurement range	-20…+100 cmH_2O
Resolution	0.5 cmH_2O
Accuracy	±1 cmH_2O

Airway flow

Measurement range	1.5…100 l/min (adults)
(for both directions)	0.25…25 l/min (pediatric)

Tidal volume

Measurement range	150…2000 ml (adults), 15…300 ml (pediatric)
Resolution	1 ml
Accuracy	±6% or 30 ml (adult), ±6% or 4 ml (pediatric)

Minute volume

Measurement range	2…20 l/min (adults), 0.5…5 l/min (pediatric)
Resolution	0.1 l/min

Compliance

Measurement range	4…100 ml/cmH_2O (adult), 1…100 ml/cmH_2O (pediatric)
Resolution	1 ml/cmH_2O (adult), 0.1 ml/cmH_2O (pediatric)

Airway resistance

Measurement range	0…40 cmH_2O/ l/s
Resolution	1 cmH_2O/ l/s

Other parameters

Specifications apply in conditions listed in patient spirometry specifications.

Dead space of the sensor

9.5 ml (adult), 2.5 ml (pediatric)

Resistance of the sensor

0.5 cmH_2O at 30 l/min (adult), 1.0 cmH_2O at 10 l/min (pediatric)

1.4.2 Conditions exceeding normal

Accuracy specifications under the following condition (during warm-up 2 to 10 minutes):

Airway Pressure (P_{aw})

Accuracy	±2 cmH_2O

Tidal volume

Accuracy	±10% or 100 ml (adult), ±10% or 10 ml (pediatric)

2 Functional description

2.1 Measurement principle

2.1.1 CO_2, N_2O, and agent measurement

TPX is a side stream gas analyzer, measuring real time concentrations of CO_2, N_2O and anesthetic agents (Halothane, Enflurane, Isoflurane, Desflurane, and Sevoflurane).

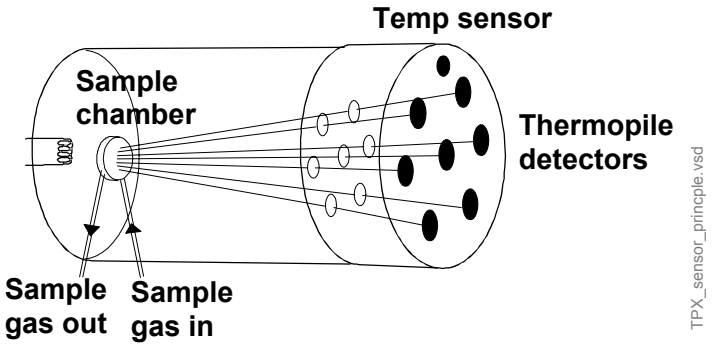


Figure 1 TPX sensor principle

Anesthetic agents or mixtures of two anesthetic agents are automatically identified and concentrations of the identified agents are measured. TPX also detects mixtures of more than two agents and issues an alarm.

TPX is a non dispersive infrared analyzer, measuring absorption of the gas sample at seven infrared wavelengths, which are selected using optical narrow band filters.

The infrared radiation detectors are thermopiles.

Concentrations of CO_2 and N_2O are calculated from absorption measured at 3-5 μm.

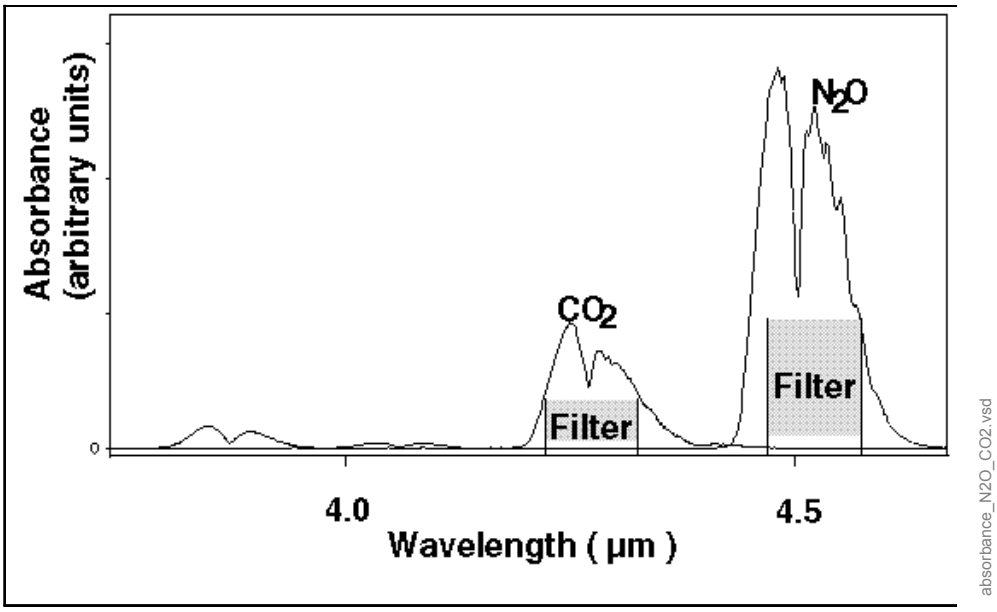


Figure 2 Absorbance of N_2O and CO_2

Identification of anesthetic agents and calculation of their concentrations is performed by measuring absorptions at five wavelengths in the 8-9 µm band and solving the concentrations from a set of five equations.

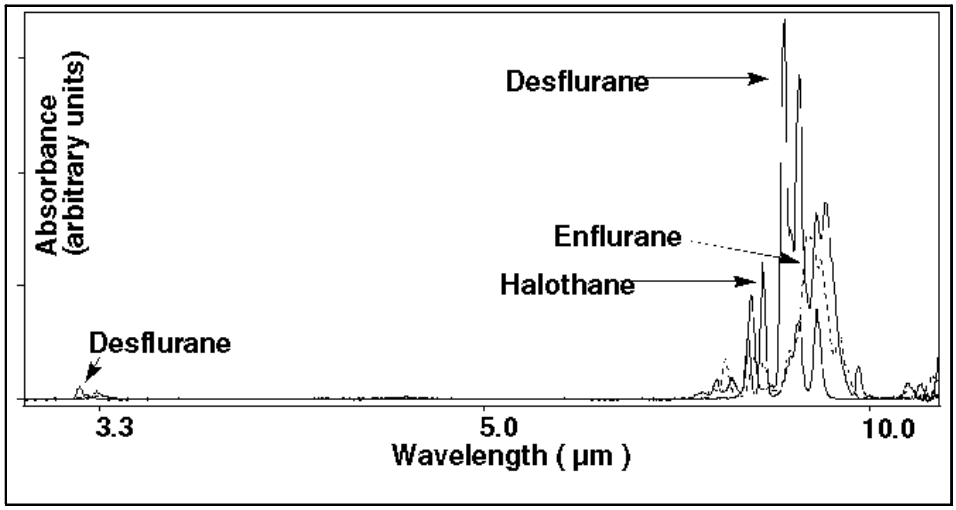


Figure 3 Infrared absorbance of AAs

The measuring accuracy is achieved utilizing numerous software compensations. The compensation parameters are determined individually for each TPX during the factory calibration.

2.1.2 O_2 measurement

The differential oxygen measuring unit uses the paramagnetic principle in a pneumatic bridge configuration. The signal picked up with a differential pressure transducer is generated in a measuring cell with a strong magnetic field that is switched on and off at a frequency of 165 Hz. The output signal is a DC voltage proportional to the O_2 concentration difference between the two gases to be measured.

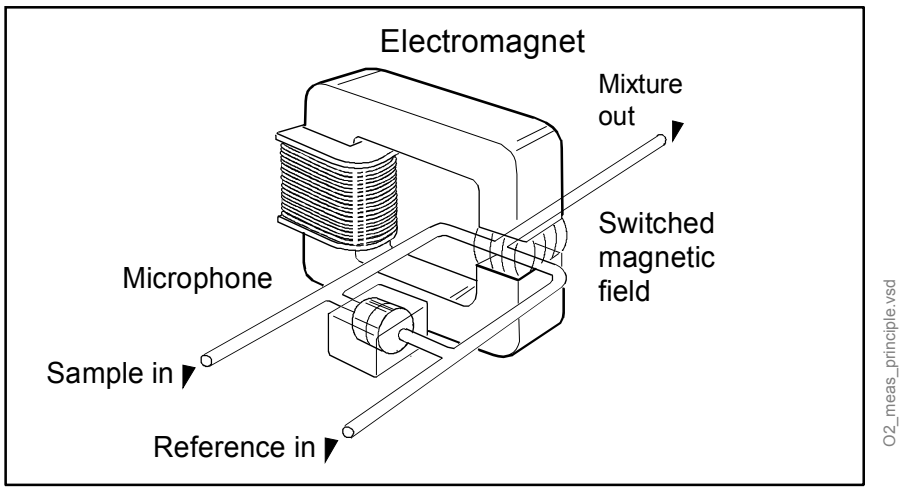


Figure 4 O_2 measurement principle

2.1.3 Patient spirometry

In mechanical ventilation, breaths are delivered to the patient by a ventilator with a proper tidal volume (TV), respiration rate (RR), and inspiration / expiration ratio in time (I:E) determined by the settings of the ventilator.

The Patient Spirometry monitors patient ventilation. The following parameters are displayed:

- Expiratory and inspiratory tidal volume (TV) in ml
- Expiratory and inspiratory minute volume (MV) in l/min
- Expiratory spontaneous minute volume in l/min
- Inspiration/expiration ratio (I:E)

Airway pressure

- Peak pressure (P_{peak})
- End inspiratory pressure (P_{plat})
- Total positive end expiratory pressure ($PEEP_{tot}$)
- Real time airway pressure waveform (P_{aw})

PEEP, P_{peak}, P_{mean}, and P_{plat} are measured by a pressure transducer on the PVX board. Atmospheric pressure is used as a reference in measurement. The pressure measurement is made from the airway part that is closest to the patient between the patient circuit and intubation tube.

$PEEP_i$=intrinsic PEEP, $PEEP_{tot}$-$PEEP_e$

Static pressure measurement maneuvers are automatically identified based on an increased zero flow period at the end of the inspiration or expiration.

Static Compliance is calculated, if Static PEEP and Static P_{plat} measurements were made within a 2 minute period.

Airway flow

- Real time flow waveform (V')
- Compliance (Compl)
- Airway resistance (Raw)
- Pressure volume loop
- Flow volume loop

The measurement is based on measuring the kinetic gas pressure and is performed using the Pitot effect. A pressure transducer is used to measure the Pitot pressure. The pressure signal obtained is linearized and corrected according to the density of the gas. Speed of flow is calculated from these pressure values and the TV value is then integrated. The MV value is calculated and averaged using TV and RR (respiratory rate) values.

Compliance and airway resistance

Compliance is calculated for each breath from the equation

$$Compl = \frac{T_{exp}}{P_{plat} - PEEP_i - PEEP_e}$$ **Formula 2**

Compliance describes how large a pressure difference is needed to deliver a certain amount of gas to the patient.

The airway resistance, Raw, is calculated using an equation that describes the kinetics of the gas flow between the lungs and the D-lite. The equation states that the pressure at the D-lite can at any moment of the breath be approximated using the equation

$$\frac{P(t) = Raw \times V'(t) + V(t)}{Compl + PEEP_e + PEEP_i}$$ **Formula 3**

where P(t), V'(t) and V(t) are the pressure, flow and volume measured at the D-lite at a time t, Raw is the airway resistance, Compl is the compliance and $PEEP_e$+$PEEP_i$ is the total positive end expiratory pressure ($PEEP_{tot}$).

D-lite

Patient Spirometry uses specific sensors called D-lite+/D-lite and Pedi-lite+/Pedi-lite flow sensors. Different types of sensors are available: adult sensor for measuring adults and pediatric sensor for children. Both are available as reusable and disposable versions.

D-lite and Pedi-lite adapters are designed to measure kinetic pressure by a two-sided Pitot tube. Velocity is calculated from pressure difference according to Bernoulli's equation. Flow is then determined using the calculated velocity.

$$v = \sqrt{\frac{2 \times dP}{\rho}}$$ (from Bernoulli's equation) **Formula 4**

$$F = v \times A,$$

where:

F = flow (l/min), v = velocity (m/s), A = cross area (m^2), dP = pressure difference (cmH_2O), ρ = density (kg/m^3)

Finally the volume information is obtained by integrating the flow signal.

2.2 Main components

The compact airway modules consist of:

- Gas sampling system
- TPX measuring unit
- OM measuring unit
- PVX measuring unit
- CPU board
- OM board
- PVX board

2.2.1 Gas sampling system

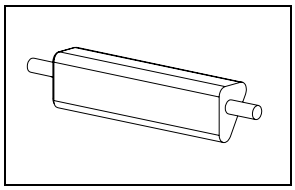
The sampling system takes care of drawing a gas sample into the analyzers at a fixed rate.

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 gas measuring units. After the measurements, the gas is exhausted from the sample gas out connector.

D-fend™

The sample is drawn through a sampling line. Then gas enters the monitor through the water trap, where it is divided into two flows, a main flow and a side flow. The main flow goes into the analyzers. This flow is separated from the patient side by a hydrophobic filter. The side flow creates a slight subatmospheric pressure within the D-fend water trap, which causes fluid removed by the hydrophobic filter to collect in the bottle.

Zero valve and absorber



The main flow passes through a magnetic valve before proceeding to the analyzers. This valve is activated to establish the zero points for the TPX and OM units. When the valve is activated, room air is drawn through the absorber into the internal system and the gas sensors. Paralyme is used as an absorbent.

Figure 5 Absorber

Nafion™ tubes [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 will prevent errors caused by the effect of water vapor on gas partial pressure, when humid gases are measured after calibration with dry gases. Another Nafion tube is used between the absorber and the pneumatic unit to prevent humidity caused by the absorption of CO_2.

Gas analyzers

After the zero valve and Nafion tube, the gas passes through the TPX and OM units. The oxygen sensor has two inputs. One input accepts the main flow and the other draws in room air for reference. Both gas flows exit from a single port.

Sample flow differential pressure transducer

The sample flow differential pressure transducer measures pressure drop across an OM inlet restrictor and calculates sample flow from the pressure difference.

Working pressure transducer

The working pressure transducer measures absolute working pressure between the TPX unit and OM unit. It is used for messages: ‘Sample line blocked’, ‘Check D-fend’, ‘Replace D-fend’ and ‘Check sample gas outlet’.

Pneumatic unit

The pneumatic unit contains a zeroing valve, occlusion valve and tubing connections. There is a series of restrictors and chambers forming a pneumatic filter to prevent pressure oscillations from the pump to reach the measuring units. The occlusion valve connection to room air includes a dust filter and the zero valve connection to room air includes an absorber.

1. [1)] Nafion is a trademark of Perma Pure Inc.

Connection block

The connection block contains a sample gas outlet connector and an OM unit reference gas inlet. The inlet is equipped with a dust filter.

Occlusion valve

The valve is activated, when the sampling line gets occluded. The main flow is then diverted to the side flow of the D-fend water trap to faster remove the occlusion.

Sampling pump and damping chamber

The gas sampling pump is a membrane pump that is run by a brushless 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 use of sample tubes with varying lengths and diameters.

The damping chamber is used to even out the pulsating flow and silence the exhaust flow.

NOTE: In no occasion is the flow reversed towards the patient.

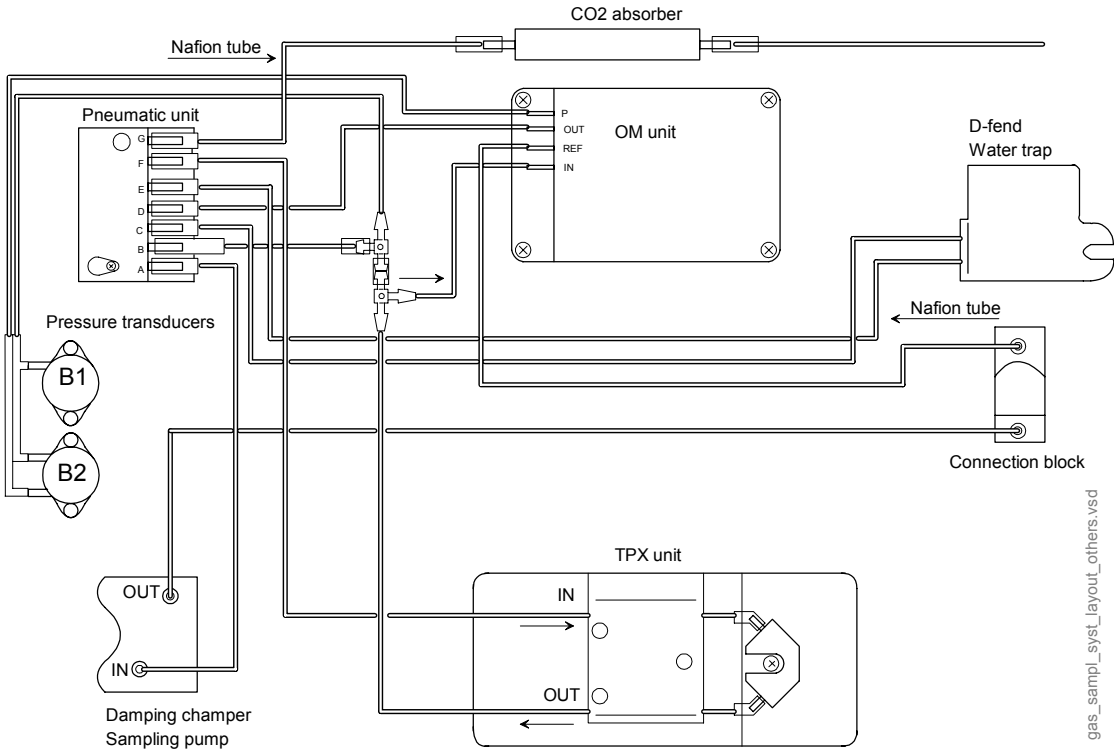


Figure 6 Gas sampling system layout, E-MRICAiOV, E-MRICAiO, E-MRICO

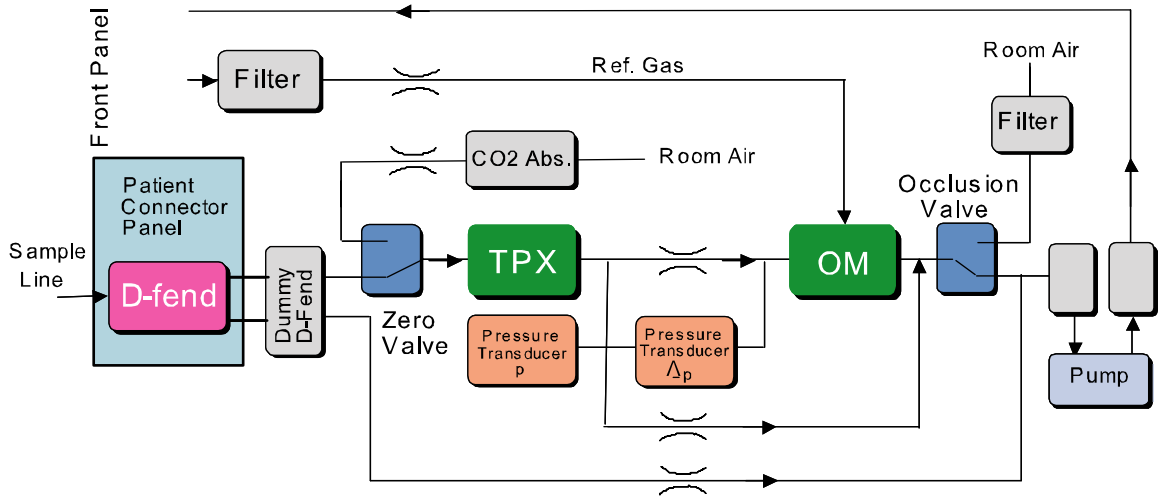


Figure 7 Gas tubing layout E-MRICO, E-MRICAiO, E-MRICAiOV

2.2.2 TPX measuring unit

The TPX unit is a non dispersive infrared analyzer, measuring absorption of the gas sample at seven infrared wavelengths, which are selected using optical narrow band filters. The IR lamp is a 4 W filament, surrounded by thermal isolation. There is a hole in the isolation, passing the radiation to a conical measuring chamber with 4 mm length.

From the sample chamber, radiation goes into seven tubular light guides with reflective inner surfaces. At the other end of each light guide, there is a thermopile detector with an optical filter in front of it.

The Temp sensor measures the TPX units' temperature and it is used for temperature compensation.

The TPX unit includes a TPX board located at the end of the unit. Its function is to connect the 7 thermopile signals and the temperature sensor signal to the CPU board.

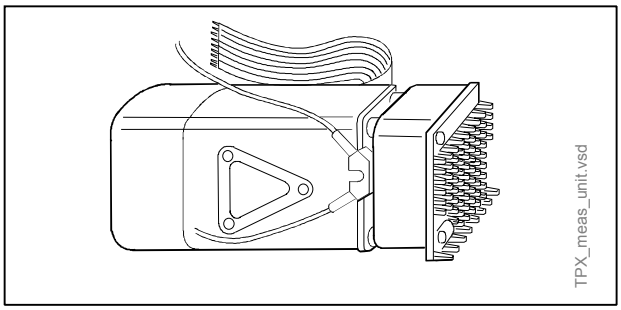


Figure 8 TPX measuring unit

OM measuring unit

The oxygen measurement is based on paramagnetic susceptibility. The gas and the reference gas, which usually is room air, are conducted into a gap in an electromagnet with a strong magnetic field switched on and off at a frequency of approximately 165 Hz.

An alternating differential pressure is generated between the sample and reference inputs due to forces acting to the oxygen molecules in a magnetic field gradient.

The pressure is measured with a sensitive differential transducer, rectified with a synchronous detector and amplified to produce a DC voltage proportional to the oxygen partial pressure difference of the two gases.

The special metal cover over the OM sensor in MRI airway modules eliminates the effect of the high magnetic field in the MRI environment.

Figure 9 OM measuring unit

2.2.3 PVX measuring unit

NOTE: Never apply overpressure or negative pressure of more than 300 cmH_2O to the flow and volume tubing. Differential pressure max 25 cmH_2O on one port at a time e.g. when connecting tubes.

When Patient Spirometry is used, a special sensor, D-lite, replaces the normal airway adapter in the patient circuit. A double lumen tubing is attached to the two connectors on the adapter and on the module front panel.

The Patient Spirometry provides patient respiration monitoring capabilities using the D-lite and Pedi-lite flow sensors.

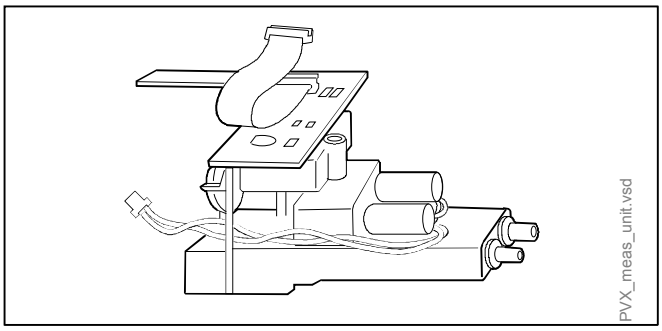


Figure 10 PVX measuring unit

The measurement is based on measuring the kinetic gas pressure and is performed using the Pitot effect. A pressure transducer is used to measure the Pitot pressure. The signal is then linearized and corrected according to the density of the gas. Speed of the flow is calculated from the pressure and TV is integrated from it.

Patient Spirometry consists of airway connections, two pressure transducers, valves and preamplifiers. The preamplifiers are connected to the A/D-converter on the module main CPU.

The breathing flow of a patient passing through the D-lite adapter creates a pressure difference. This pressure difference is measured by a pressure transducer, B1. Overpressure and negative pressure in airways are measured by another pressure transducer, B2.

2.2.4 CPU board

The CPU board contains the processor and memories and A/D-converters that are common to the whole module. The CPU board also contains preamplifiers of TPX-sensor and drivers for valves, fan, pump and lamp. The module is connected to the module bus through an RS-485 serial channel.

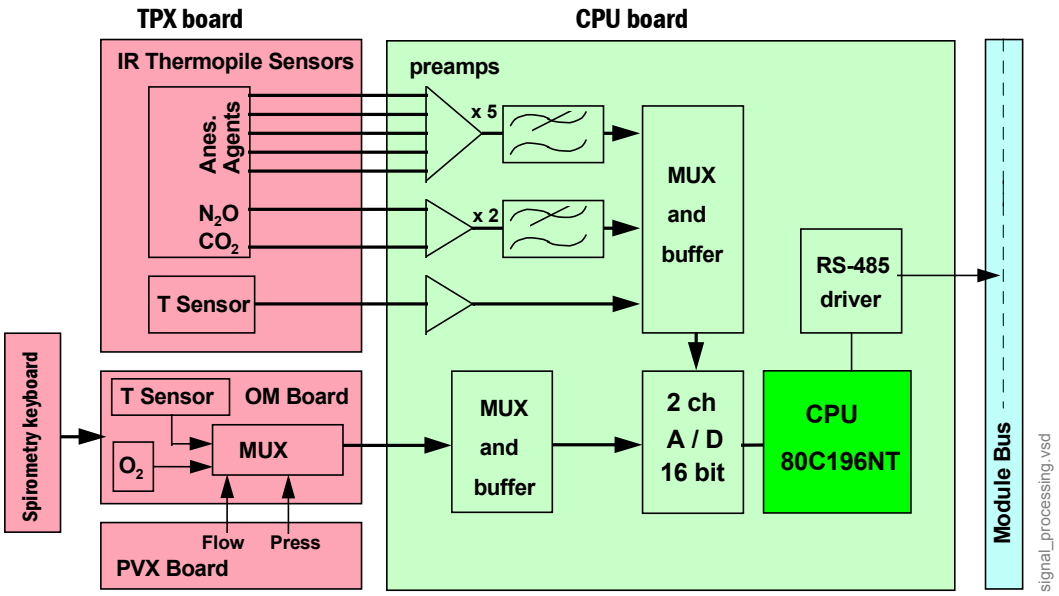


Figure 11 Signal processing

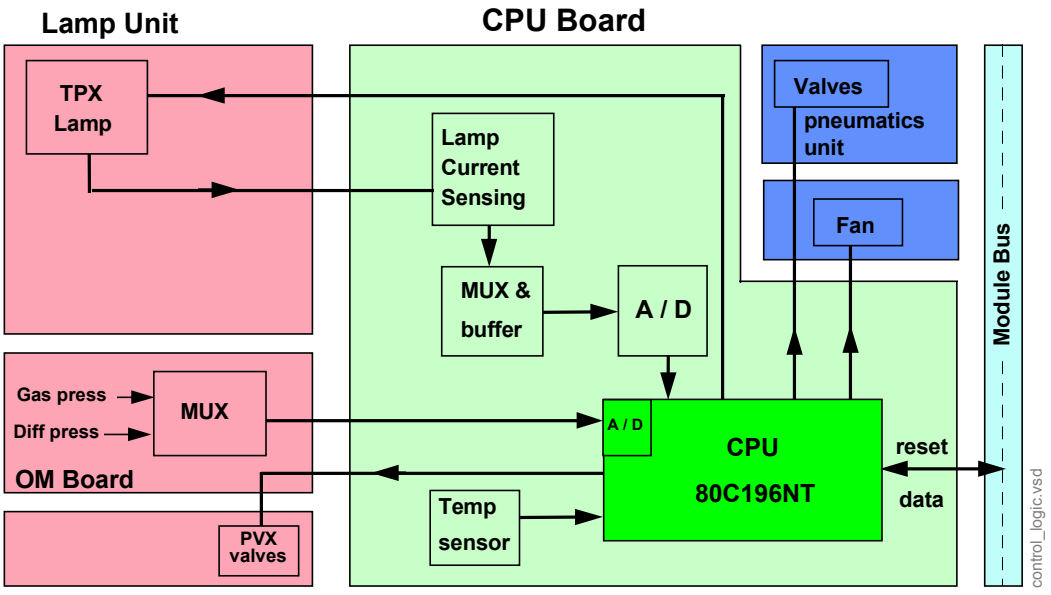


Figure 12 Control logic

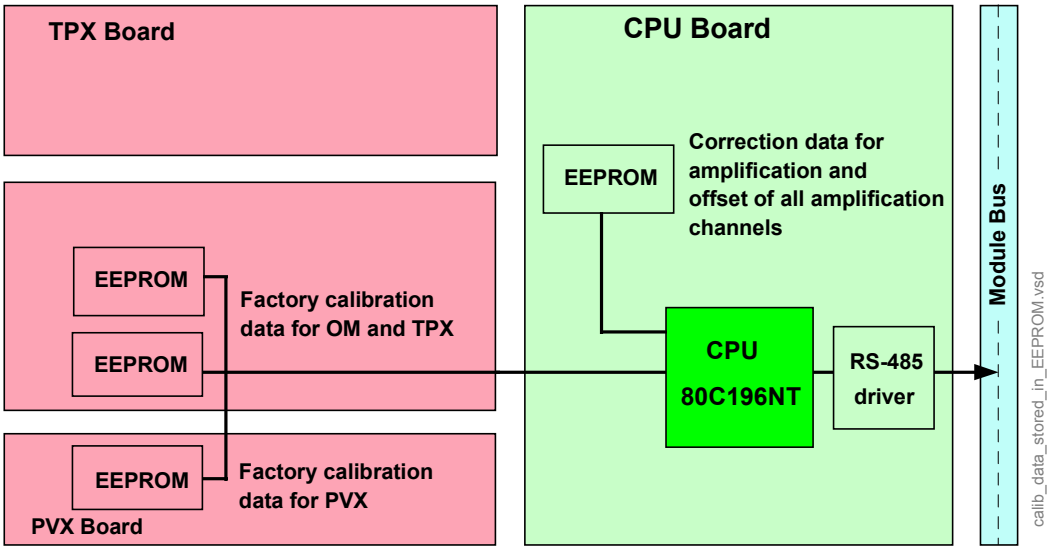


Figure 13 Calibration data stored in EEPROM

2.2.5 OM board

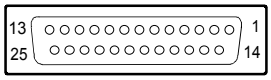
The Oxygen board contains the specific electronics for the oxygen sensor. Sample flow measurement and sampling system pressure sensors are on this board. It also contains EEPROMs that store calibration data of both TPX and OM sensors. The spirometry keyboard connection is on this board.

PVX board

The Spirometry board is connected to the oxygen board. It contains pressure sensors for airway pressure and flow measurement differential pressure and preamplifiers for those. Calibration data of spirometry is stored on its own EEPROM.

2.3 Connectors and signals

2.3.1 Module bus connector pin description

25 pin female D-connector	Pin No.	I/O	Signal
	1	I	RESET RS485
	2	I	-15 VDC
	3	I	+15 VDIRTY
	4	I	+15VDC
	5	I/O	-DATA RS485
	6	I/O	DATA RS485
	7		Ground and Shield
	8	I	-RESET RS485
	9		n/c
	10		n/c
	11		n/c
	12		n/c
	13		Ground and Shield
	14	I	+24/+32 VDIRTY depends on power supply (not used)
	15	I	Ground DIRTY
	16		n/c
	17		n/c
	18		n/c
	19		n/c
	20	I	GASFR (not used)
	21	I	CTSD (not used)
	22	I	TXDD (not used)
	23	O	RXDD (not used)
	24	I	+5 VDC
	25	I	+5 VDC DIRTY, for infrared lamps

3 Service procedures

3.1 General service information

The field service of the MRI Compact Airway 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.

NOTE: Read the disassembly instructions in the MRI Shield slot through before servicing the monitor. It is essential to understand the MRI Monitor structure to be able to service the monitor effectively.

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.

WARNING **If a service procedure requires using tools like calibration gas bottles, that contain ferrous metal, perform the procedure outside the MR environment.**

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

3.1.1 OM, TPX, and PVX measuring units

CAUTION The OM, TPX, and PVX measuring units can only be repaired at the factory.

CAUTION Due to the complicated and sensitive mechanical construction of the O_2 measuring unit, no repairs should be attempted inside the unit.

CAUTION The TPX photometer 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.

For the module disassembly instructions see "Disassembly and reassembly" page 26.

After any component replacement, see chapter 3.7. Adjustments and calibrations.

3.2 About service check

These instructions include complete procedures for a service check for the MRI Compact Airway Modules. 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 A") 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.

3.2.1 Recommended tools

For product(s)	Tool	Order No.
All MRI Airway modules	MRI Monitor or F-CM1	
MRI Compact Airway Module, E-MRICAiO(V)	Calibrating gas and regulator	755583/755534*
MRI Compact Airway Module, E-MRICO	Calibrating gas and regulator	755581/755534*
All MRI Airway modules	Sampling line, 6 m/19.7 ft	73306
All MRI Airway modules w/ (V)	Spirometry tube, 6 m/19.7 ft	891191
	D-lite	733910
	Ambient pressure manometer	
	Flowmeter	TSI 4140 or 41403
	Flow cassette 50/1.1	873812
	Extra silicon tubing	
	Gas Interface Cable 2.5 m / 8 ft	884299
	Spirometry tester	884202
	Screwdrivers	See “3.4.2. Tools needed” for the tools needed during the dis-/reassembly.

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.

3.2.2 Recommended parts

Part	Order No.	Notes
Fan filter	M1028983	
D-fend O-ring (2 pcs)	653125	Replace annually the ones in the Patient connector panel.
Filter (3 pcs)	886136	Replace the occlusion filter annually.
D-fend	876446	
Sampling line, 6 m/19.7 ft	73306	anesthesia gas sampling line
Nafion tubes (2 pcs)	733382	Replace annually.

Part	Order No.	Notes
Zero Absorber	895933	Replace once every four years.
D-lite / Pedi-lite	733910/73393	
Spirometry tube, 6 m/ 19.7 ft	891191	
Filter assembly	896025-HEL	

3.3 Before beginning

- Perform the service reset for the MRI Monitor by pressing the **ON/Standby** key for at least 10 seconds.
- If the monitor is connected to the Datex-Ohmeda Network, disconnect the network cable from the monitor.
- Disconnect all the patient connectors.
- Disconnect all external cables connected to the monitor.

Follow the disassembly instructions far enough to be able to remove the gas module from the monitor. See MRI Shield slot for the disassembly instructions.

3.4 Service check

3.4.1 Visual inspection

Detach the module box by removing the two screws from the back of the module.

1. Internal parts

   Check that:

   - 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
   - the front cover grounding pins are not bent against the CPU board
   - there are no loose objects inside the module

NOTE: Make sure not to press too deep the tubes that are connected to the Oxygen board pressure transducers, i.e. the pressure transducer port must not touch the back wall of the L-shaped tube connector.

NOTE: Make sure that tubes are not in contact with the sampling pump or the O_2 sensor or its springs.

2. External parts

   Check that:

   - the module front panel cover and the stickers are intact

- all connectors are intact and attached properly
- the D-fend latch is moving properly
- the module box and latch are intact
- the tubes coming from the patient connector panel to the module are clean and intact

3.4.2 Field replaceable parts

1. Fan filter

   Clean or replace the fan filter.

2. Dummy D-fend O-rings

   Detach the D-fend. Check the condition of the rubber O-rings on the metal D-fend connectors. Replace if necessary: remove the old O-rings and press the new ones around the connectors.

3. Other filters

   Check that the air flow through the occlusion filter in the pneumatic unit and the filters in the reference gas connection block in the patient connector panel and the module front panel are not obstructed.

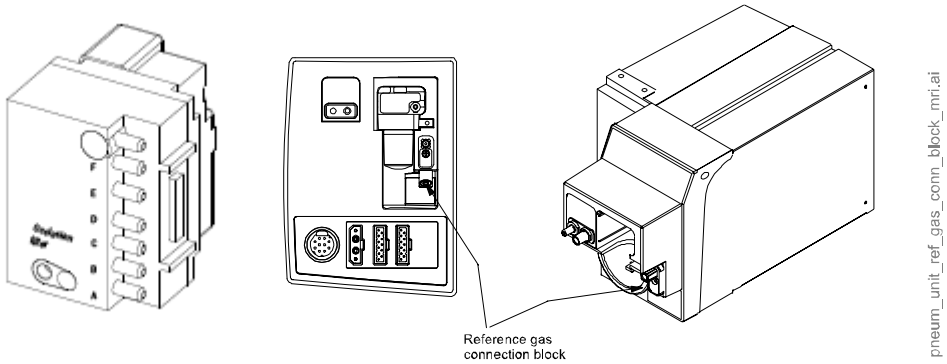


Figure 14 Filters in the pneumatic unit and in the reference gas connection blocks

NOTE: The filters should be replaced annually.

4. Special tubes and the zeroing absorber

   Replace the Nafion tubes and the CO_2 absorber, if necessary.

NOTE: The Nafion tubes should be replaced annually.

NOTE: The Zeroing absorber should be replaced once every four years. If you replace the absorber, you should also replace the Nafion tube.

- Replace the old D-fend and sampling line with new ones. Remove the dummy D-fend from the module and attach the new D-fend to the module to perform the functional checks for the module only. Connect the new sampling line to the D-fend.

NOTE: Use only approved sampling lines to ensure proper function.

- Connect the MRI Compact Airway Module to a module slot using a Gas interface cable (the grounding plates of the cable should be removed).

3.4.3 Module functional inspection

Turn the monitor on.

Configure the monitor screen so that all the needed parameters are shown, for example as follows:

Monitor Setup - ***Screen 1 Setup*** - ***Waveform Fields*** - ***Field 1 - Paw***
Field 2 - Flow
Field 3 - Off
Field 4 - O2
Field 5 - AA
Field 6 - CO2
Digit Fields
Lower Field 1 - Gases

Preset the following gas measurement settings (if available):

Airway Gas - ***Spirometry Setup*** - ***Scaling Vol***
Paw Scale - 20
Flow Scale - 15

1. Fan

   Check that the module fan is running.

2. 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)

   Take down the information regarding MRI Compact Airway Module software.

3. Module configuration

   Enter the Compact Airway Module service menu.

   Parameters - Gas Unit - General

   Check that the displayed module configuration corresponds the used Compact Airway Module type.

4. Module bus communication

   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.

5. Flow measurement offset

   Enter the ***Gases*** service menu:

   Gas Unit - Gases

   Check that the flow measurement offset, i.e. the shown sample ***Zero*** value is within ±20 ml/min.

   If the value is not within the limits, turn the power off and on again and check the value again.

6. Ambient pressure

   Check that the shown ***Ambient*** value corresponds the current ambient pressure (±20 mmHg).

7. Zero valve

   Feed calibration gas and check that the gas readings in the service menu correspond the values on the gas bottle sticker. Keep feeding gas, then activate the zero valve from the menu. The CO_2 and N_2O (AA) readings should drop back near 0%, the O_2 reading near 21%.

8. Sampling system leak test

   Prevent the module from performing the normal occlusion functions, such as controlling the valves, by turning the pump first off, then on again from the menu.

   Block the reference gas connector at the module front panel.

   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 170 mmHg, connect the other port of the flow cassette to the sample gas out connector and switch the pump off.

   Wait until pressure inside the sampling system is stabilized, then notice the shown ***Amb-Work*** value. The value, i.e. the pressure inside the sampling system should not drop more than 6 mmHg in one minute.

   If the pressure drops more, first ensure the made connections and repeat the test.

9. Flow rates

   Wait until the ***Sample Flow*** value in the service menu is back near 200 ml/min.

   Connect a flowmeter to the sampling line and check that the flowmeter reading is within the following range:

Sampling flow (ml/min)	180...220

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 10 ml/min.

After you have changed the gain, wait until the ***Sample Flow*** value on the screen gets back near the original, then check the flowmeter reading again.

Connect the flowmeter to the reference gas connector, check that the flowmeter reading is within the following range:

Reference flow (ml/min)	30...45

Activate the zero valve on from the service menu. The ***Sample Flow*** value should not change more than 30 ml/min.

10. Working pressure

    Check that the Amb-Work value in the service menu is within the following range:

Amb-Work (mmHg)	75...120

11. Gas calibration

    Perform the gas calibration.

    Airway Gas - ***Gas Calibration***

NOTE: Calibration is not recommended until 30 minutes warm-up time has elapsed.

Use calibration gas 755583 (2% Desflurane, 5% CO_2, 33% N_2O, 55% O_2, balance N_2) for E-MRICAiOV/ E-MRICAiO and calibration gas 755581 (5% CO_2, 40% N_2O, 55% O_2) for calibrating E-MRICO.

NOTE: You can calibrate the E-MRICO module with the same calibration gas as the E-COVX module.

NOTE: For correct measurement values, modules need different amounts of oxygen in the calibration mixture. Use only recommended calibration gases to ensure a successful calibration.

12. Fall time measurement

    Perform the fall time measurement in the ***Gases*** service menu.

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

    Activate the measurement by selecting ***Fall Time Meas*** from the service menu. Feed calibration gas until the message 'Feed' near the fall time values changes to 'READY'. If necessary, repeat the same procedure to get all the values on the screen.

    Check that the measured values are within the following ranges:

CO_2 fall time	< 400 ms
O_2 fall time	< 400 ms

CO_2-O_2 delay < 800 ms

Anesthesia Agent measurement

13. ID unrel.

    Agent ID reliability.

    Feed calibration gas (order code 755583) continuously for at least 30 seconds and check that the ID in the service menu shows DES and that the value for ID unrel. is lower than 50.

    If the value is higher, repeat the gas calibration and check the value again.

Patient Spirometry measurement

14. Flow waveform

    Connect the D-lite to the sampling line. Breathe through the wider side of the D-lite. Check that the flow waveform moves downwards when you breathe in, and upwards when you breathe out.

15. Spirometry tester

    If possible, check the side stream spirometry measurement also with the Spirometry Tester (order code 884202). Follow the instructions that are supplied with the tester.

3.4.4 Reassembly and cleaning

Module reassembly

- Remove the D-fend and attach it to the patient connector panel. Attach the dummy D-fend to the module.
- Turn the monitor off, disconnect the Gas interface cable and reassemble the module.

NOTE: When reassembling the module, pay special attention to the notes in the “Disassembly and reassembly” on page 26

Reattach the module cover and check that the latch is moving properly.

1. Module installation

   Insert the module. Check that it goes in smoothly and locks up properly. Fasten the screws locking the gas module holder.

General

1. Electrical safety check

   Perform an electrical safety check and a leakage current test.

2. Functioning after electrical safety check

   Check that the module functions normally after the electrical safety check.

- Fill in all necessary documents.

3.5 After service check

After the module service check, either remove the module or continue to reassemble the monitor according to the situation.

3.5.1 MRI Monitor reassembly

Reassemble the monitor according to the “Disassembly and reassembly” instructions in the MRI Shield slot.

NOTE: After servicing the MRI Compact Airway Module check the following parts of the patient connector panel during the monitor reassembly:

- Patient panel cover is clean and intact.
- All connectors are intact and attached properly.
- The D-fend lath is moving properly.
- The tubes coming from the patient connector panel to the module are clean and intact.

3.5.2 Functional check

Perform the Functional Check after installing a serviced MRI Monitor, see chapter “5 Functional check” in the first slot of the manual.

3.6 Disassembly and reassembly

3.6.1 Notes to remember

CAUTION Wear a grounded, antistatic wristband when handling PC boards. Electrostatic discharge may damage components on the board.

CAUTION Handle all PC boards by their edges.

3.6.2 Tools needed

- torx screwdrivers; T6, T8
- flat blade screwdriver
- pincers
- antistatic wristband
- pliers

3.6.3 During reassembly

CAUTION Make sure that the tubes and the cables are not pinched between the boards and the cover and that all the cables are reconnected properly.

CAUTION Make sure that the tubes are not in contact with the sampling pump or the O_2 sensor or its springs.

Always perform the "About service check" after reassembling the module.

3.6.4 To disassemble the module

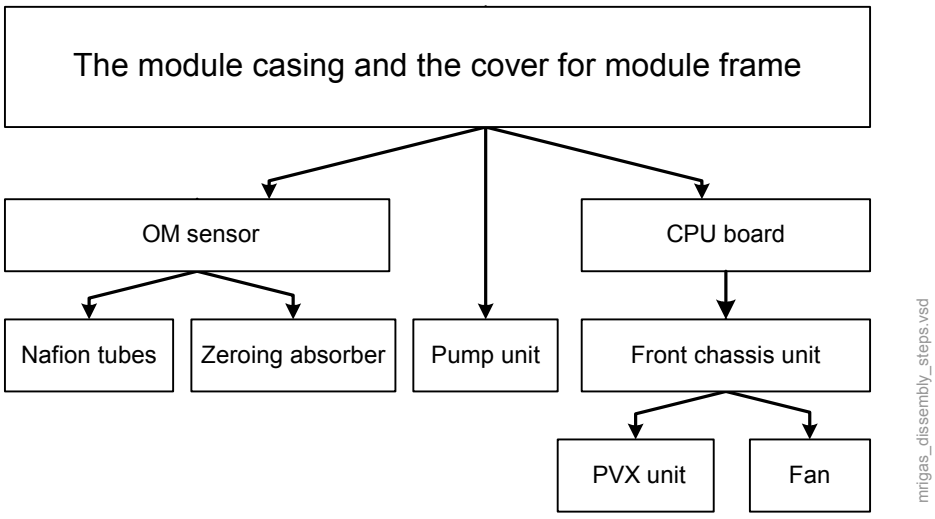
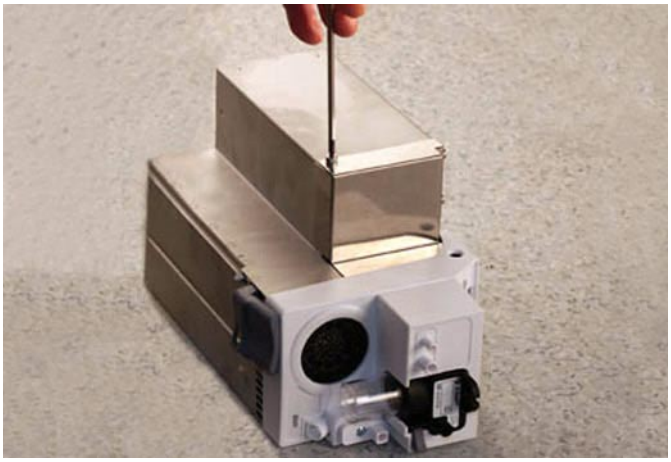


Figure 15 E-MRICAiOV module disassembly steps

To remove the module casing and the cover for module frame

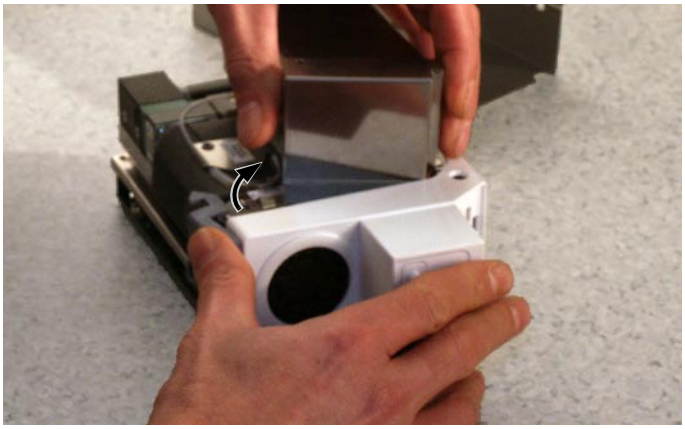


1. Remove three screws (hex) from the module frame cover and the two screws (hex allen) from the back of the module casing.

2. Press the release latch. Pull the module casing slowly backwards and remove it from the main body.

NOTE: While reassembling, press the release latch while guiding the module casing back in place. If necessary, guide the module in place holding on to the module bus connector.

Check that the release latch moves properly.



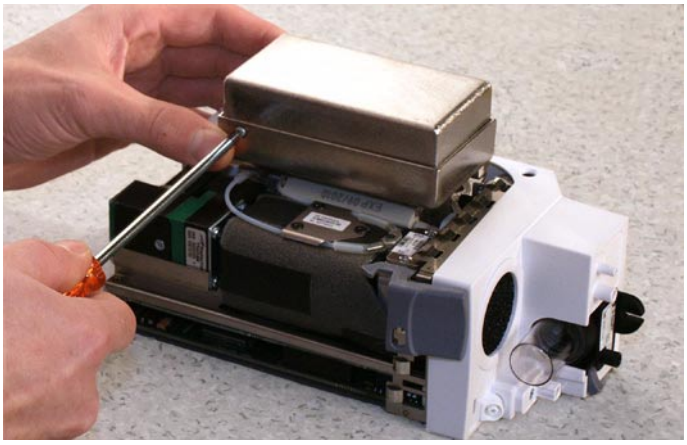
3. Turn and remove the cover for module frame.

NOTE: While reassembling be careful not to damage the grounding fingers.

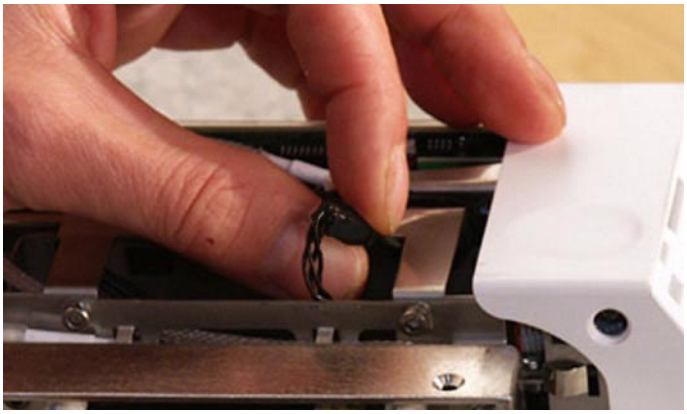
To continue to disassemble the module follow the instructions:

- “To detach the OM sensor” on page 28
- “To change the pump unit” on page 33
- “To detach the front chassis unit” on page 37

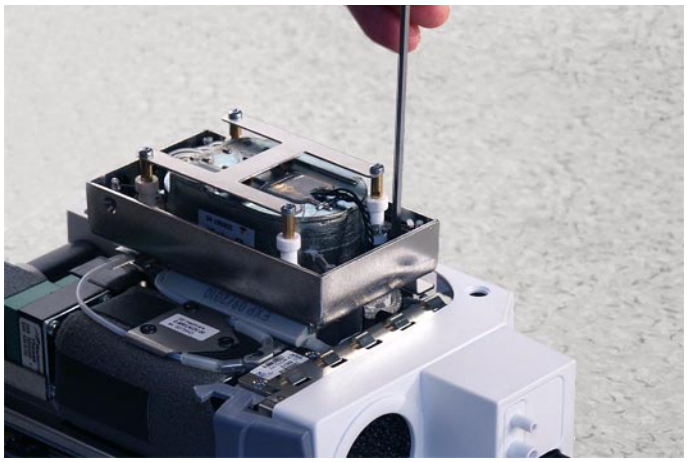
To detach the OM sensor



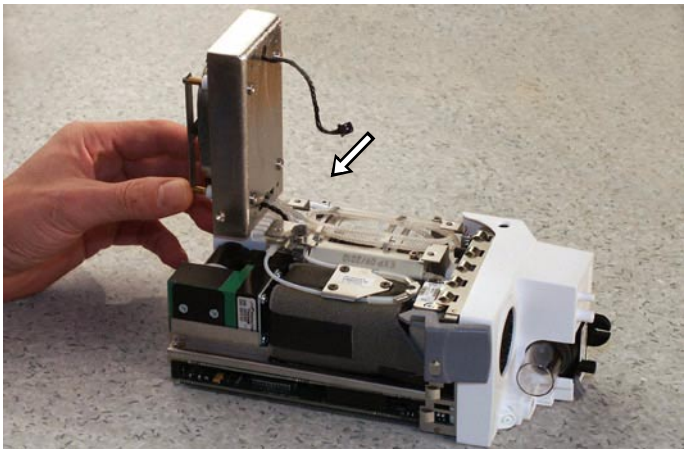
1. Remove the two cross head screws from both sides of the OM unit and remove the OM sensor cover.



2. Remove the connector of the coil wires from the extension wire (under the connector cover).

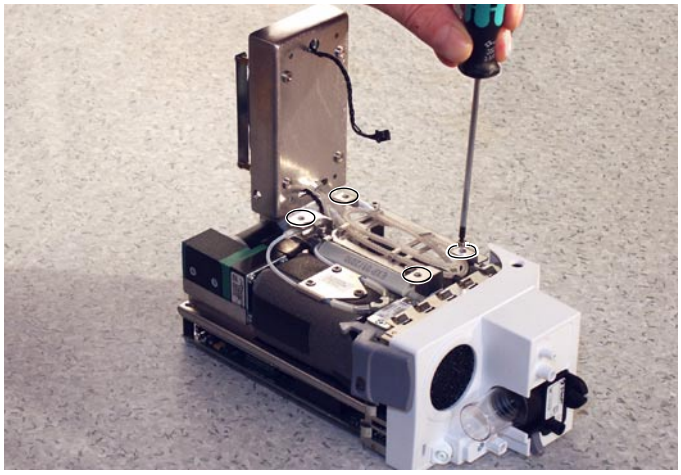


3. Remove the four screws of the OM sensor bottom cover and stand the OM sensor with the bottom cover on the pneumatic block.



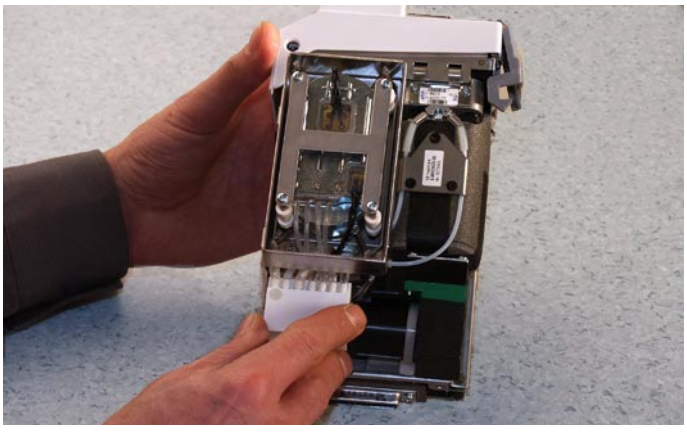
4. Ensure that the OM cover will not fall off the pneumatic block, to protect the thin tubes from being destroyed.

NOTE: The thin tubes from the OM sensor will brake if the OM unit falls off.



5. Loosen the four screws from OM Protection.

To reassemble the OM sensor, reverse the order of the disassembly steps.



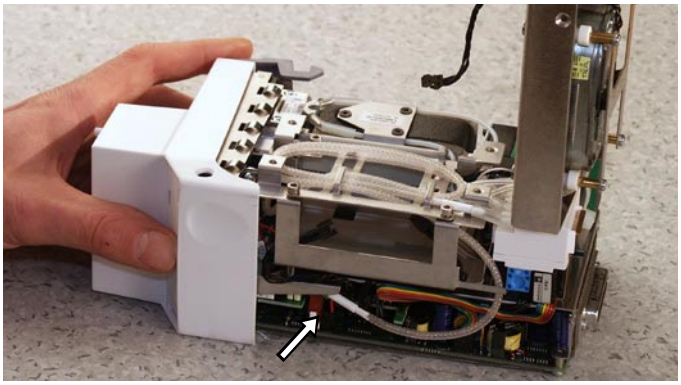
NOTE: Check that the tubes are neatly side by side, not bent or pinched before reassembling the cover.

NOTE: Check that the extension wire is not pinched with the cover.

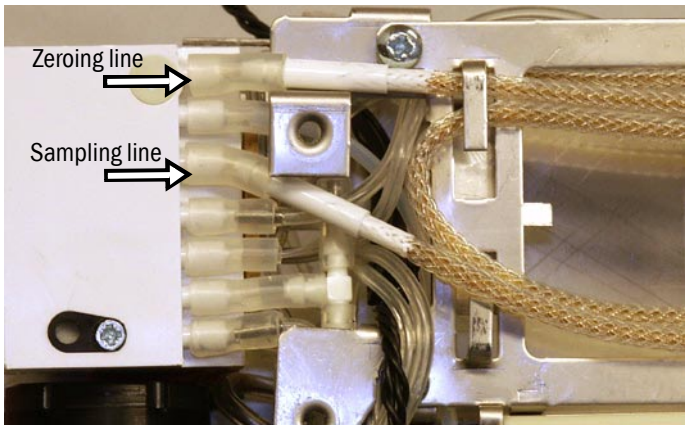
To change the Nafion tubes

Continue from step "To detach the OM sensor" on page 28.

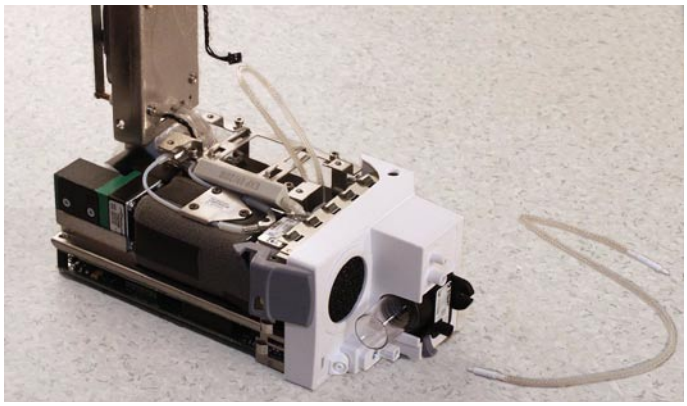
1. The sampling line Nafion tube



1. Detach the sampling line Nafion tube at the top side of the module.

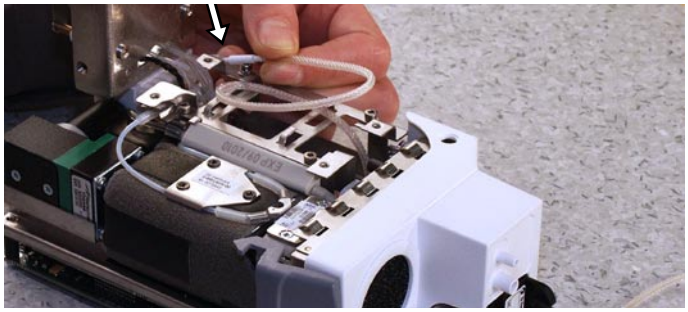


2. Detach the Nafion tube from the guides on the OM protection and from the pneumatic block.

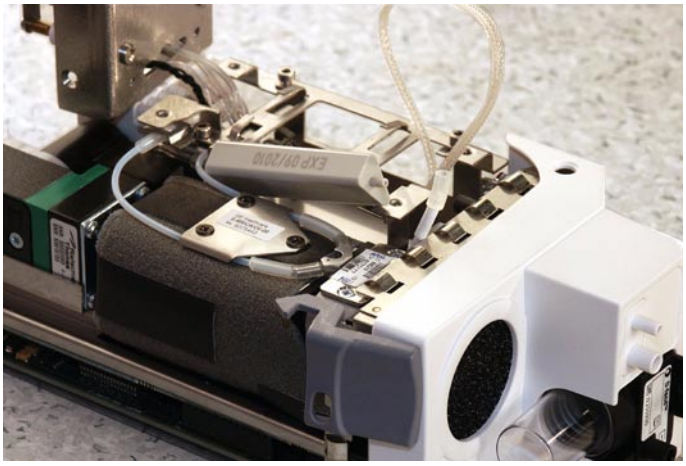


3. Change one tube at a time to avoid mixing the connections.

2. The Nafion tube for zeroing



4. Detach the other Nafion tube (zeroing) from the pneumatic block.

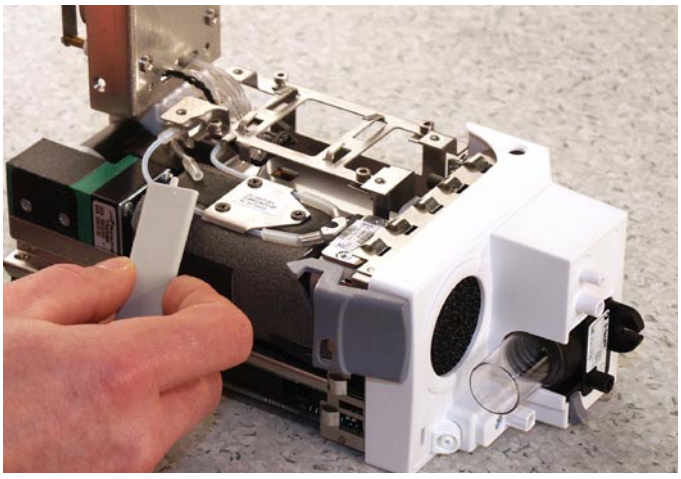


5. Lift the Zeroing absorber up and detach the Nafion.

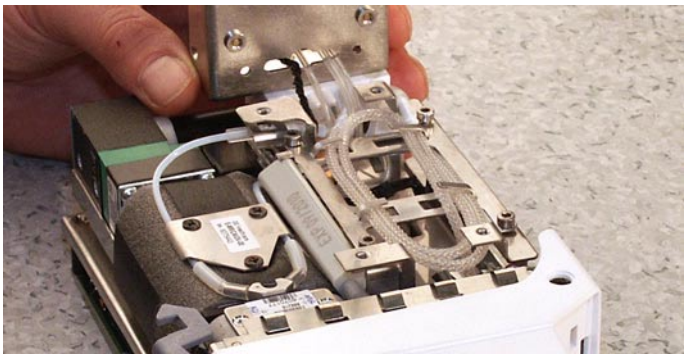
To reassemble the Nafion tubes and the OM sensor, reverse the order of the disassembly steps.

To change the Zeroing absorber

Continue from step "To detach the OM sensor" on page 28.



1. Detach the tube from the other end of the zeroing absorber.



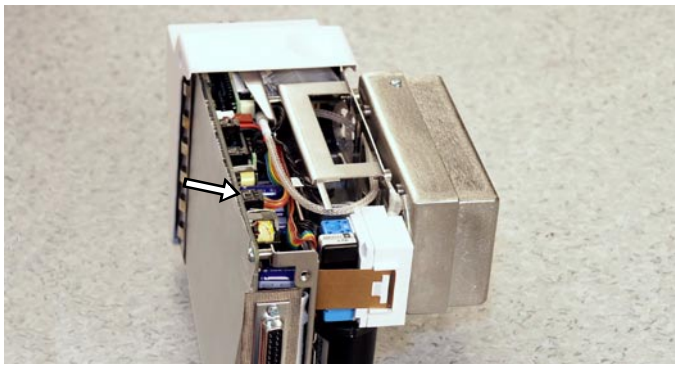
2. Guide the tube correctly back to its place.

To reassemble the Zeroing absorber and the OM sensor, reverse the order of the disassembly steps.

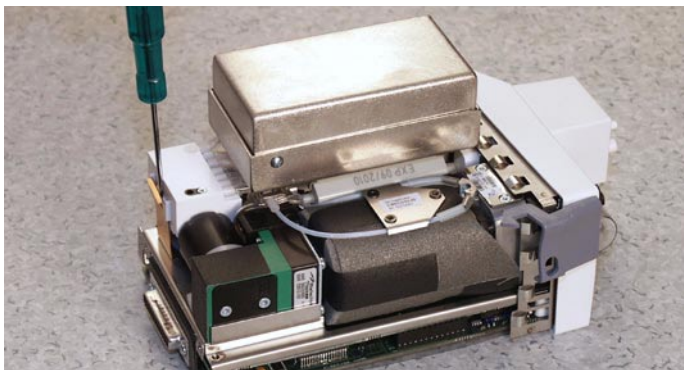
To change the pump unit

Tools needed: a new cable tie

Continue from step "To remove the module casing and the cover for module frame" on page 27

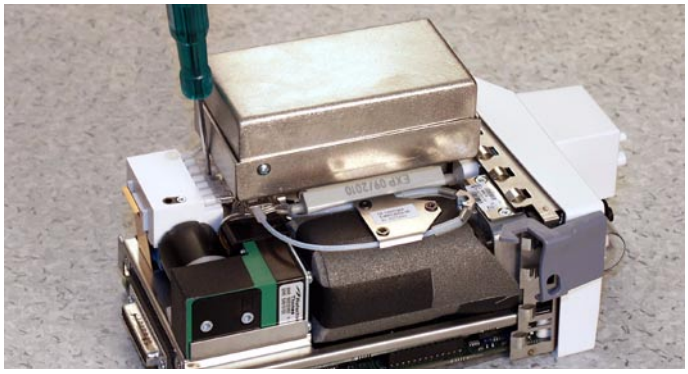


1. Disconnect the pump cable from the CPU board.



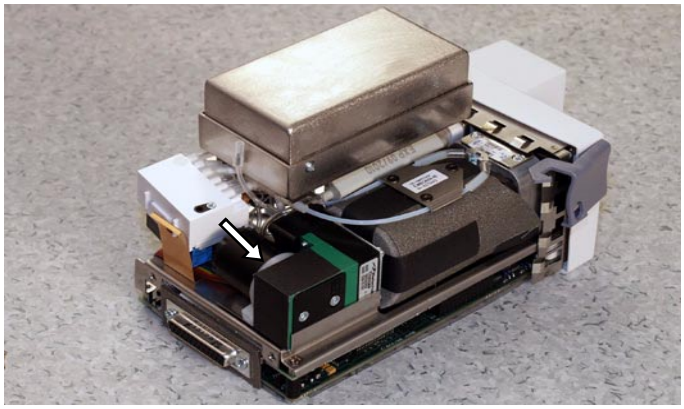
2. Use a flat blade screwdriver to release the pneumatics from the holders, lift the pneumatics up.

NOTE: When reassembling, press the pneumatics down in place until the holders click.



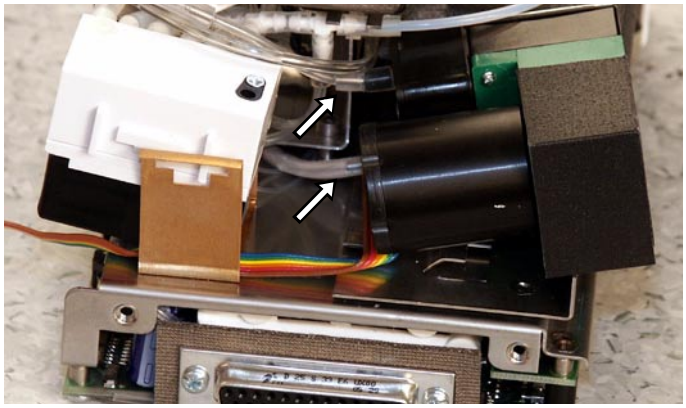
3. Use a small flat blade screwdriver to unplug the lower hose of the pump.

NOTE: Notice the position of the hoses. Mark them if necessary to ensure that they are properly reassembled.



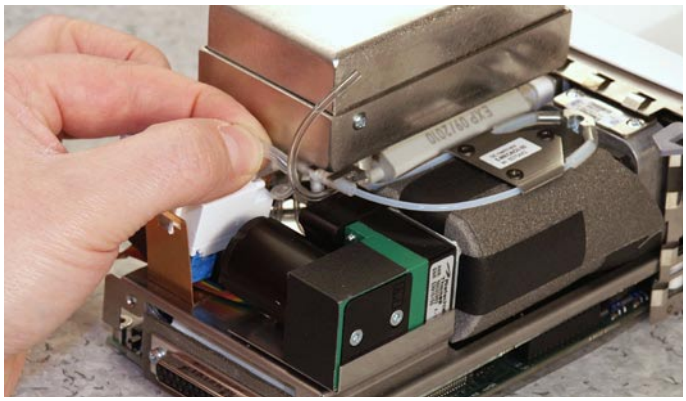
4. Cut off the cable tie securing the pump.

NOTE: Fasten the pump with a new cable tie while reassembling.

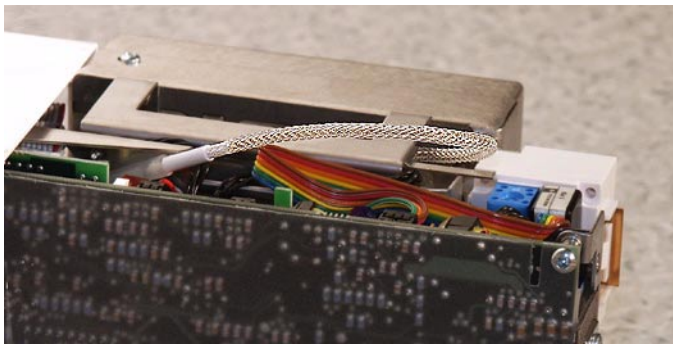


5. Detach the tubes from the pump.

Pass the cable under the pneumatic unit by lifting it.



NOTE: When reassembling, insert the free end of the absorber zero line hose carefully inside the module. Make sure the tube is not squeezed.



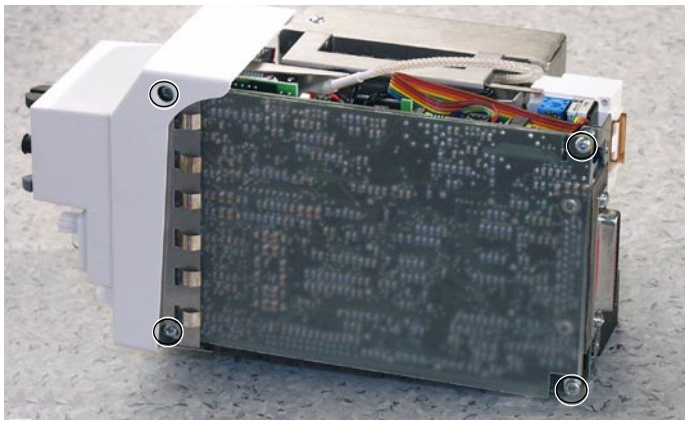
NOTE: When reassembling, guide the flat cable carefully in place between the printed circuit boards.

6. Bend the flat cable according to the photo before assembling a new pump.

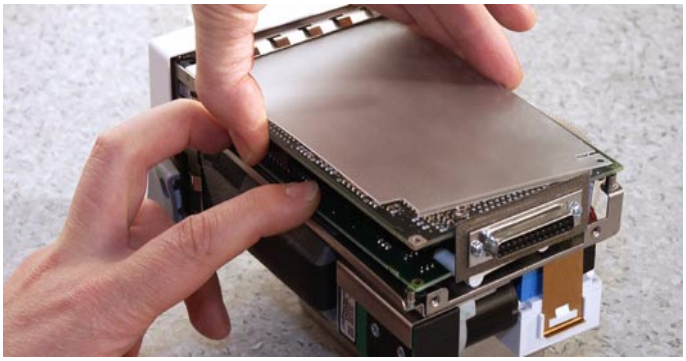
To reassemble the module, reverse the order of the disassembly steps.

To change the CPU board

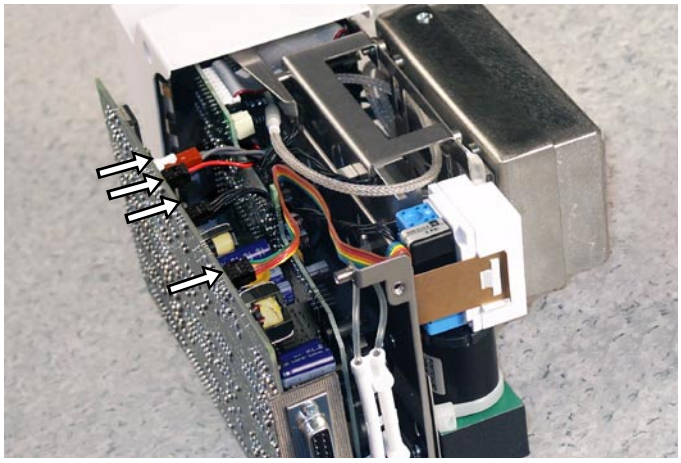
Continue from step "To remove the module casing and the cover for module frame" on page 27. .



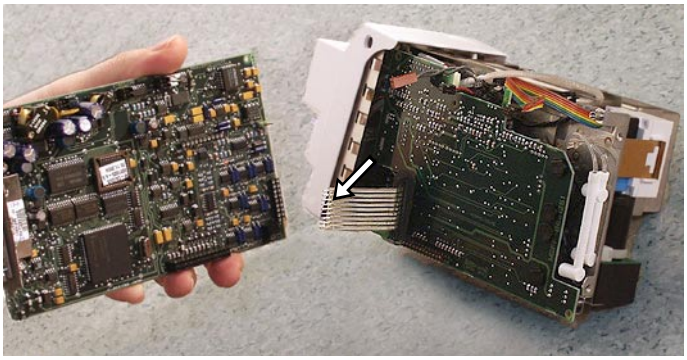
1. Detach the four screws (cross head) on the CPU board.



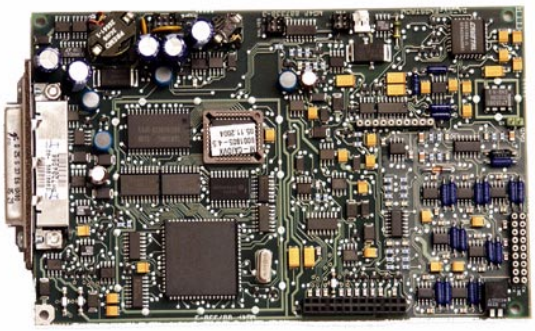
2. Hold the OM board and detach the CPU board from the OM board connector. Leave the Cover plate for Gas Units in place to protect the CPU board.



3. Disconnect the TPX unit cable, fan cable, pneumatics unit cable and the pump cable from the CPU board.



4. Detach the TPX flat cables (2 pcs).



5. Detach the CPU board together with the cover plate.

To reassemble the CPU board and the module casing, reverse the order of the disassembly steps.

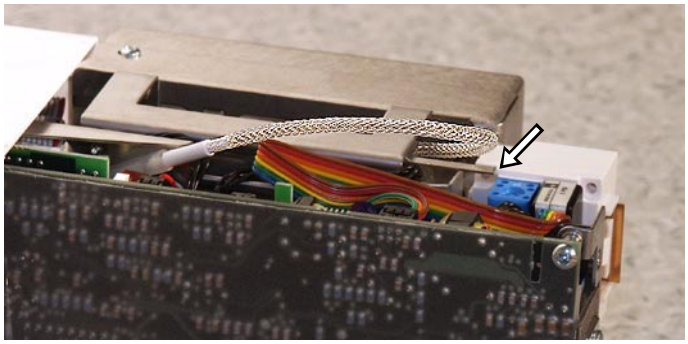
Instructions after replacing the CPU board

After replacing the CPU board:

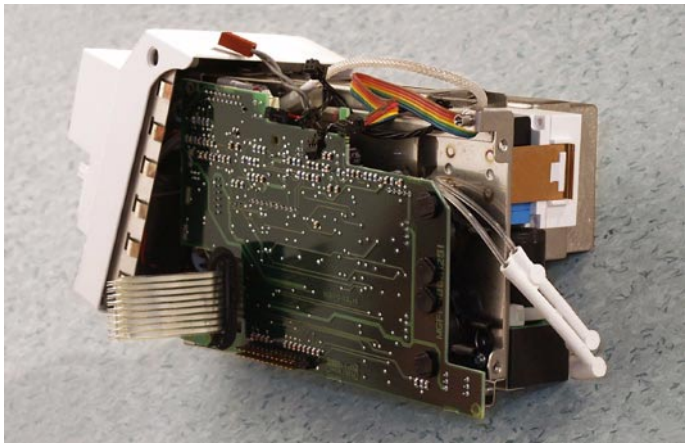
- perform “Sampling system leak test” on page 49
- perform the occlusion test
- perform “Gas calibration” on page 43
- perform the fall time measurement

To detach the front chassis unit

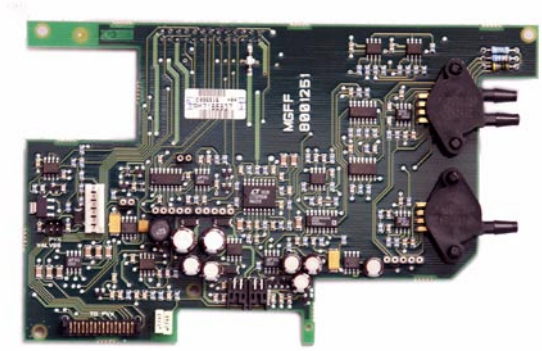
Continue from step "To change the CPU board" on page 35.



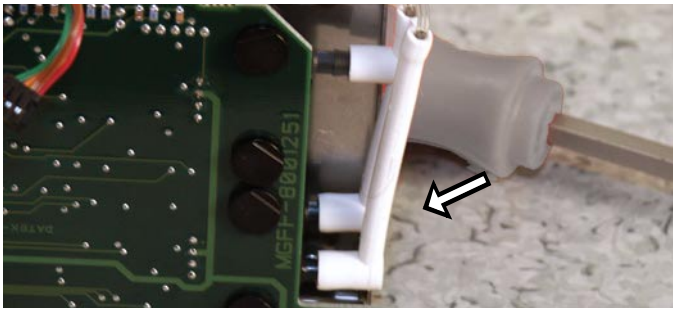
1. Loosen the Nafion tube behind the guide.



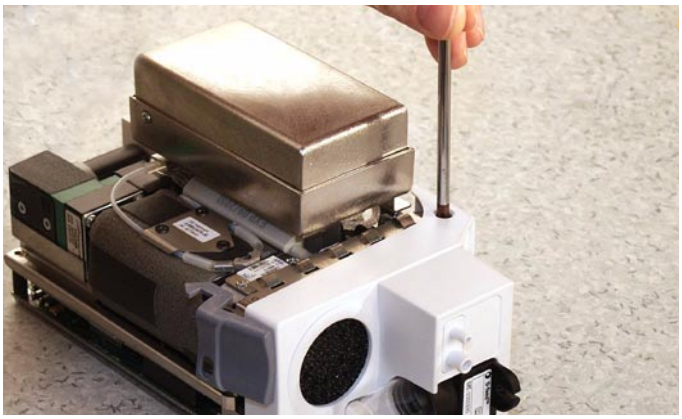
2. Disconnect from the OM board:
- the OM unit's cables
- spirometry keyboard cable
- PVX unit's flat cable
- zeroing cable
- the pressure sensor tubes



3. Detach the OM board.



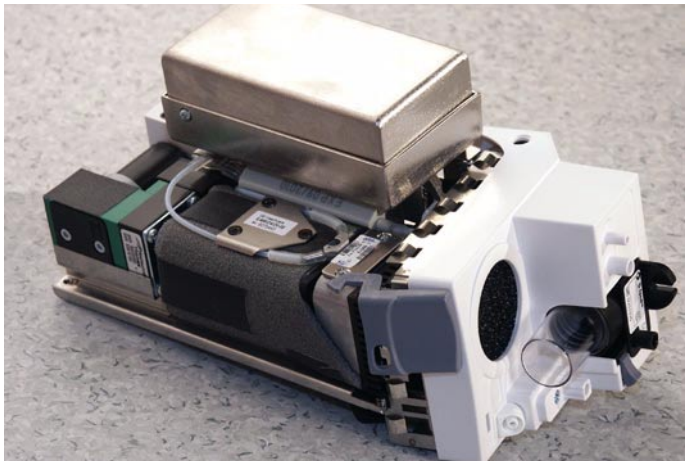
When reassembling, place the tubing correctly. NOTE: Make sure not to press too deep the tubes that are connected to the Oxygen board pressure transducers, i.e. the pressure transducer port must not touch the back wall of the L-shaped tube connector.



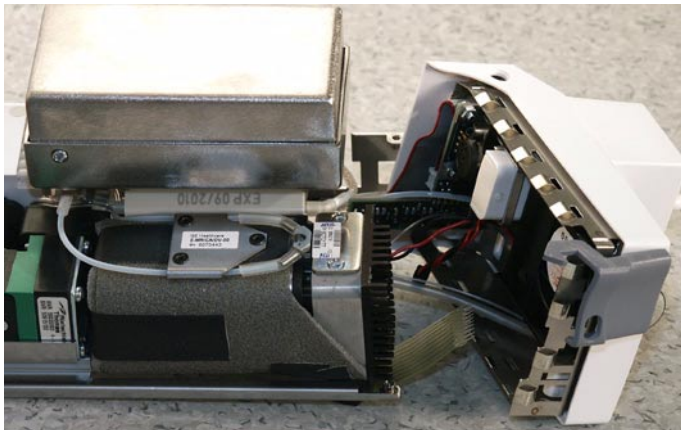
4. Remove the filler plugs from both side of the front chassis unit to remove the screws behind them.

In case you are changing the reference gas filter frame:

- Remove the screw from the reference gas filter frame located on the front of the module.



NOTE: Handle the module extra carefully after removing all the front panel screws. Be careful not to damage the thin tubes.



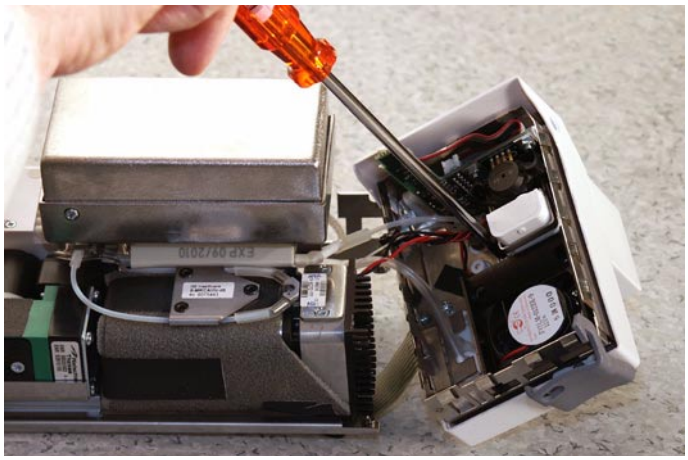
NOTE: Notice the routing of the Nafion tubes when removing the front chassis unit. Reassemble the tubes in the same way.

To continue to disassemble the module follow the instructions:

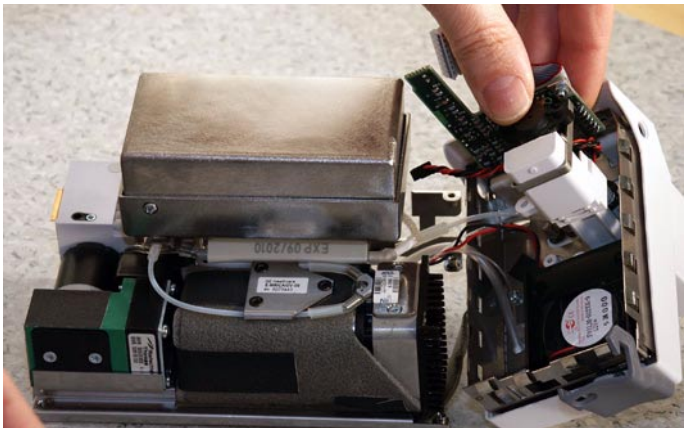
- “To change the PVX unit” on page 39
- “To change the fan” on page 41

To change the PVX unit

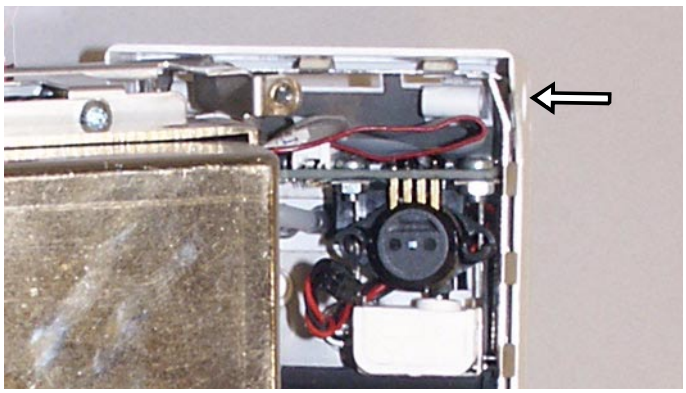
Continue from step "To detach the front chassis unit" on page 37



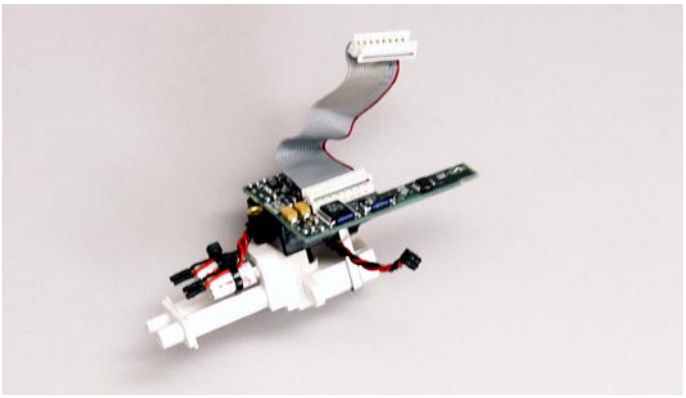
1. Slide the front chassis unit slowly from the module chassis.
2. Unscrew the screw holding the PVX unit to the front chassis unit.



3. Detach the PVX unit lovated on the front panel.

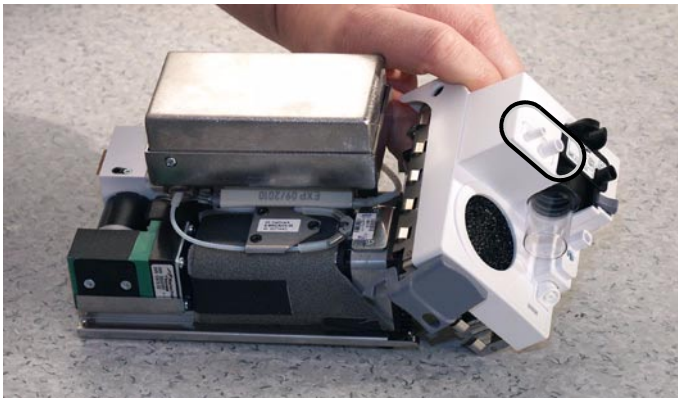


NOTE: While reassembling, make sure that the gray PVX flat cable is not pinched between the front chassis unit and the screw coming to the corner of the front chassis.

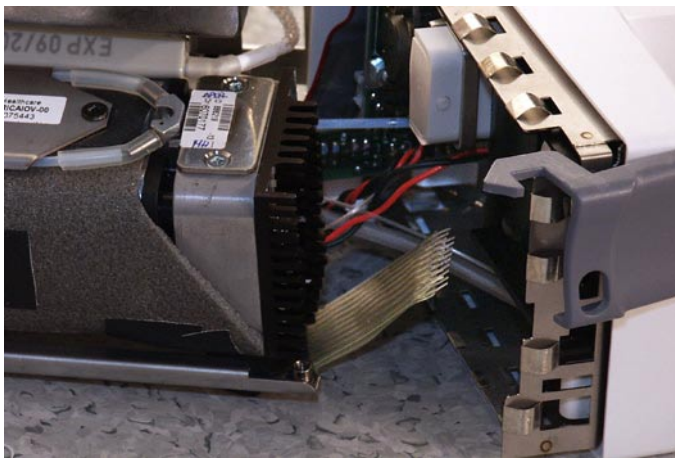


The PVX unit

NOTE: To make it easier to assemble a new PVX unit, bend the flat cable according to the old one before assembling the new unit.



NOTE: When reassembling make sure that the PVX connector is in place before tightening the screw.



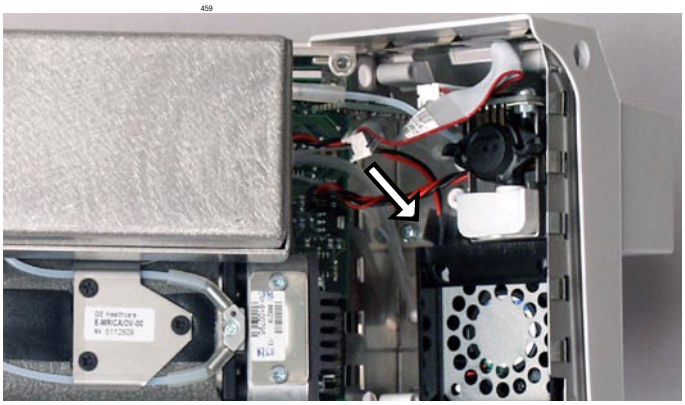
NOTE: When reassembling make sure that the thin tubes will not get pinched.

To reassemble the PVX unit, reverse the order of the disassembly steps.

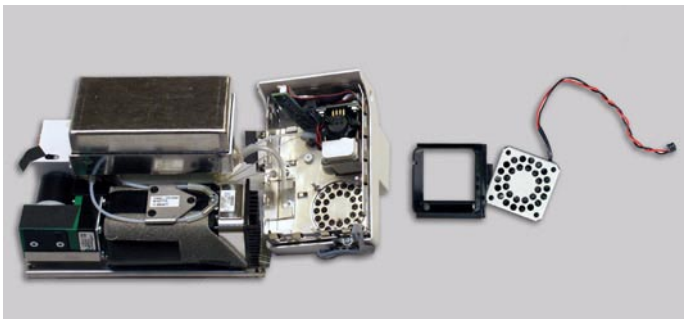
To change the fan

Tools needed: a piece of tape

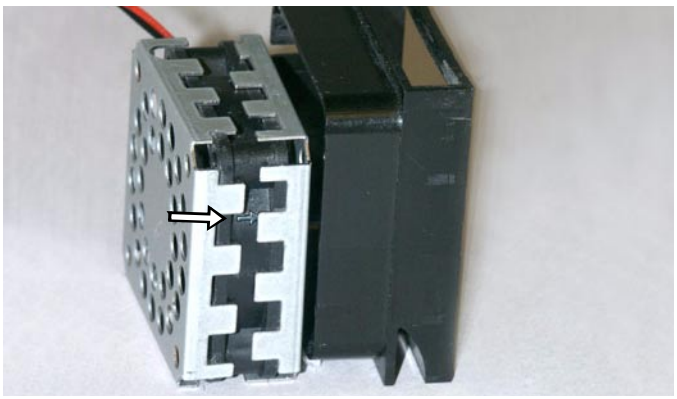
Continue from step "To detach the front chassis unit" on page 37



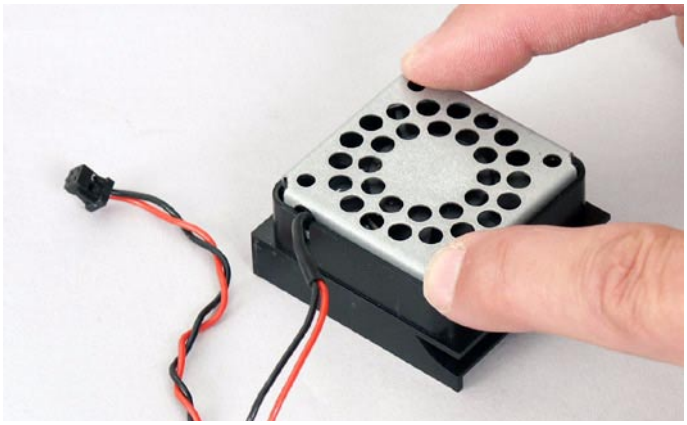
1. Remove the piece of tape attaching the wire to the front mask.



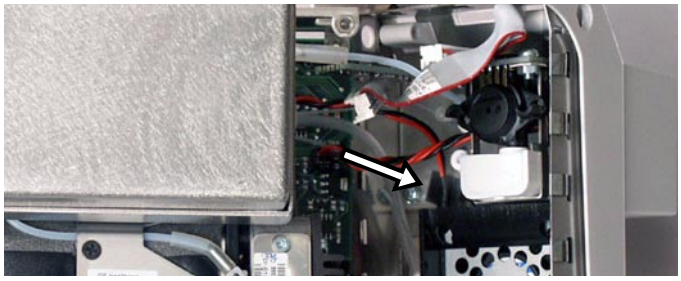
2. Remove the fan and the air deflector.



3. When reassembling, Notice the direction of the fan: the arrow points to the inside of the module.



4. Push the fan down on the edges (not on the center of the fan) to the air deflector.



5. Attach the wire to the front mask with a new piece of tape to ensure it will stay in place.

To reassemble the module, reverse the order of the disassembly steps.

3.7 Adjustments and calibrations

See “User’s Reference Manual” for normal gas calibration instructions.

3.7.1 Gas sampling flow rate measurement

NOTE: Let the monitor run for 15 minutes before measuring flow rates.

For the flow rate measurements, a flowmeter with a low flow resistance and capability to measure the specified air flow measurement range is required. Use recommended sampling lines, because the length of the sampling line has a considerable effect on the flow.

If any flow rates are not correct, first replace the D-fend water trap. Then recheck the incorrect flows.

The sampling flow rate is measured by a rotameter at the sampling line. The rate should be between 180 and 220 ml/min. The flow rate is adjusted in the ***Gases*** service menu with ***Sample gain adj***.

The reference flow of the oxygen measuring unit is checked as follows:

Connect the rotameter to the Gas Ref. inlet on the front panel. The flow rate should be between 31 and 45 ml/min. The flow rate is not adjustable.

3.7.2 Gas sampling flow rate adjustment

NOTE: Before adjusting the sampling flow, make sure there is no leakage in the sampling system.

Refer to chapter 3.4. Service check, step 9. Flow rates.

3.7.3 Gas calibration

NOTE: Ensure that the calibration gas and the regulator are functioning properly before calibration. Perform annual maintenance on the regulator as required.

WARNING **Calibration gas bottles and their regulators contain ferrous material. Perform the calibration outside the MR environment.**

The gas calibration is performed in the ***Airway Gas*** menu. See “User’s Guide” for gas calibration instructions.

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

Tools needed: calibration gas can, regulator, piece of silicon hose and flow meter. GE Healthcare recommends use of TSI 4140 or 41403 flow Meter.

Attach the calibration gas regulator to 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.

Flow calibration

The PVX measuring unit is calibrated at the factory and due to the unit’s design, calibration is not regularly needed. The calibration data is saved into the board’s EEPROM. In case calibration is needed, it is recommended to perform the calibration both with adult values using the D-lite, and with pediatric values using the Pedi-lite.

1. Connect a spirometry tube with a D-lite sensor to the compact airway module. To improve the accuracy, the endotracheal tube and all accessories which normally are in use should be attached also during the calibration.
2. Enter the ***Gas Unit*** service menu: **Monitor Setup** - ***Install Service*** - ***Service*** - ***Parameters***. Enter the ***Spirometry*** menu.
3. After the flow is zeroed ('Zero OK' message displayed), attach a spirometry tester to the flow sensor (D-lite or Pedi-lite). Select the sensor type.
4. Perform the calibration according to the tester instructions. Observe the values of inspired and expired tidal volumes.
5. Adjust the reading to match the calibration volume (about 1000 ml for the D-lite and 300 ml for the Pedi-lite). Adjust ***Exp Flow Gain*** and ***Insp Flow Gain*** values in proportion to the difference between the measured values and the spirometry tester reading.

4 Troubleshooting

4.1 Troubleshooting charts

Problem	Cause / What to do
No response to breathing	Sampling line or water trap blocked or loose, or improperly attached. Water trap container full. Tubings connecting the module and the patient connector panel are leaking or not attached properly. See the gas sampling system troubleshooting.
'SENSOR INOP.' message	The temperature is too high, check fan and filter at the monitor side and at the module front panel. Communication error, check timeout and bad checksum values at the service menu.
'xx ZEROING ERROR' message	Gas zeroing failed. Condensation or residual gases are affecting zero measurement. Allow module to run drawing room air for half an hour and calibrate again.
'CHECK D-FEND' message	Probably the water trap or the sampling line is not attached properly. Gas zero valve failure. Pump failure or gas outlet blockage. Tubings connecting the module and the patient connector panel are leaking or not attached properly.
'REPLACE D-FEND' message	Indicates residue build-up on the water trap membrane. This decreases air flow. Replace the D-fend.
'REBREATHING' message	CO_2 concentration in inspiratory air is too high. CO_2 absorber in ventilation may be saturated. Change the ventilation absorber.
'SAMPLE LINE BLOCKED' message	Sampling line or water trap is occluded. Water trap container is full. If occlusion persists, check internal tubings for blockages.
No response to any gas	Sampling line, water trap or internal tubing blocked or loose, or improperly attached. Occlusion or zero valve malfunction. Pump failure. Supply voltage missing. Serial communication error.
Sudden increase in gas display	Water trap malfunction. Check all internal tubings and the interior of the water trap for occlusions or leaks. Replace water trap. Check flow rates.
Abnormally high response to all gases (or abnormally low) or sudden occlusion warning	Pressure transducer failure.

Problem	Cause / What to do
Strong drift in all gases	Leak in sampling line or internal tubings (especially in conjunction with too low readings). Tubings connecting the module and the patient connector panel are leaking or not attached properly.
'MVexp << MVinsp' message	Leak in patient circuit between patient and D-lite or in the patient's lungs, or leak in tubes from D-lite to module. Check D-lite connection and D-lite tubings.
Low volumes	Too small tidal volumes for accurate measurement (not shown during Apnea). Gas sampling is working correctly. Check D-lite connections and D-lite tubing.

4.1.1 CO_2 measurement

Problem	Possible clinical cause	Possible technical cause	What to do
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
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
$ETCO_2$ overscale >15% (>20%) Shown until 32%, specified range 0…15%	▪ abnormally high $ETCO_2$ (permissive hypercapnia)	▪ CO_2 sensor contaminated ▪ D-fend malfunction	▪ call service technician ▪ 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

4.1.2 Patient spirometry

Problem	Possible clinical cause	Possible technical cause	What to do
insp TV>exp TV	▪ leak in lungs ▪ ET tube cuff leak	▪ spirometry tube leak ▪ water inside D-lite or tubings ▪ another side stream gas sampling between D-lite and patient ▪ D-fend leaks ▪ dummy D-fend leaks	▪ check leakages -- perform leak test ▪ change tubings and D-lite ▪ do not use active humidification ▪ connect gas sampling only and always to D-lite ▪ check D-fend ▪ check Dummy D-fend
exp TV> insp TV		▪ spirometry tube leak	▪ check leakages -- perform leak test
		▪ water inside D-lite or tubings	▪ change tubings and D-lite ▪ do not use active humidification
loop overscale monitored volumes < set volumes		▪ wrong scale selected ▪ leak between ventilator and D-lite	▪ change scaling ▪ check ventilator connections
strongly vibrating loop	▪ mucus in ET tube	▪ - ▪ water or secretions in hoses or D-lite	▪ check the patient status ▪ change dry D-lite and/or empty the water from hoses
too large or too small volumes		▪ wrong mode vs. sensor selection ▪ incorrect sensor type selection	▪ check mode and sensor - D-lite for adult - Pedi-lite for pediatric

Problem	Possible clinical cause	Possible technical cause	What to do
fluctuating Raw	▪ mucus in airways or tubings ▪ breathing effort against the ventilator ▪ patient triggered breathes	▪ ventilator exp. valve causes fluctuations during exp. flow	▪ check the tubings and D-fend ▪ check the patient status
too high Raw Raw value invalid	▪ kink in tubing ▪ mucus ▪ asthmatic patient ▪ bronchospasm ▪ spontaneous breaths ▪ breathing efforts against the ventilator ▪ patient triggered breaths		▪ check the tubing ▪ check the patient status
too high Ppeak	▪ bronchospasm ▪ patient is coughing ▪ patient breaths against the ventilator ▪ obstruction in airways ▪ HME obstructed		▪ check the patient status ▪ check the patient circuit status
Compl value invalid	▪ spontaneous breaths		▪ compliance cannot be calculated

4.2 Gas sampling system troubleshooting

Faults that may occur in the sampling system include: leaks or blockages in the tubings, failure of the sampling pump or the magnetic valves or diminishing of the flow rates because of dirt or other matter accumulating in the internal tubing.

The following checks should help in locating the fault. Whenever suspecting the sampling system and always after having done any work on the sampling system, check and adjust the flow rate, if necessary.

CAUTION The special internal sample tube is mechanically fragile. Sharp bends will cause leaks.

NOTE: The D-fend water trap should be replaced when the ‘REPLACE D-FEND’ message appears during monitor startup.

NOTE: If any liquid has entered the TPX measuring unit due to water trap filter failure, contact GE Healthcare Technical Services.

4.2.1 Sampling system leak test

1. Prevent the module from performing the normal occlusion functions, i.e. controlling the valves, by turning the pump first off, then on again from the menu.
2. Block the reference gas connector on the patient connection panel.
3. 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 170 mmHg, connect the other port of the flow cassette to the sample gas out connector and switch the pump off.
4. Wait until the pressure inside the sampling system is stabilized, then notice the shown Amb-Work value. The value, i.e. the pressure inside the sampling system should not drop more than 6 mmHg in one minute.
5. If the pressure drops more, first ensure the connections you have made are correct and repeat the test.

4.3 OM measuring unit troubleshooting

CAUTION Due to the complicated and sensitive mechanical construction of the oxygen measuring unit, no repairs should be attempted inside the unit. Instead, if the fault has been found in the measuring unit itself, the entire module should be replaced and the faulty module be sent to GE Healthcare for repair.

In cases of no response to O_2 or strong drift, check the tubing for loose connections, blockages and leaks.

CAUTION Never apply overpressure to the O_2 measuring unit, as the pressure transducer may be permanently damaged.

If the O_2 signal is noisy, check the measurement unit suspension.

4.4 TPX measuring unit troubleshooting

CAUTION The TPX measuring unit can only be repaired and calibrated at the factory. In case of failure, the entire module should be replaced and the faulty module be sent to GE Healthcare for repair.

4.5 PVX measuring unit troubleshooting

In case of failure, the PVX unit can be replaced.

NOTE: Never apply overpressure or negative pressure of more than 300 cmH_2O to the flow and volume tubing. Also never apply differential pressure of more than 25 mmHg on one PVX connection at a time.

4.5.1 Spirometry tubing leak test

1. Select airway pressure (Paw) and flow waveforms (Flow) on the monitor screen.
2. Connect a clean spirometry tube to the module and a clean D-lite to the other end of the tube. Block the D-lite's sampling line port, for example with a luer stopper.

NOTE: Make sure that the date marking on the D-lite is 10/94 or newer.

3. Take the D-lite in your hand and occlude both ends tightly with your fingers (or with both hands). Pressing firmly with the fingers creates a pressure inside the D-lite.
4. Check that a pressure of at least 5 cmH_2O is generated. If the system leaks heavily, no pressure will be generated. If there is a small leak in the connections, the monitor will measure a pressure difference which is then interpreted as flow and seen on the monitor screen. The pressure waveform decreases slowly and the flow waveform either goes above, or below the zero line, depending on which of the connectors is leaking.

4.6 CPU board troubleshooting

Due to the complexity of the large scale integrated circuitry, there are few faults in the CPU digital electronics that can be located without special equipment.

Check only that RAM, EPROM, CPU, and other socketed ICs are properly installed.

4.7 Error messages

Message	**Cause**
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 sampling 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. -The dummy D-fend not connected to the module.
Air leak detected. Check water trap and sample gas out-flow. Press normal screen to continue.	Air leak over 40 seconds.
Gas calibration is not available during the 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 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.
Failure in Agent ID (unknown agent)	The agent ID has failed (due to a third agent).
Overrange	FiO_2 >100% measured.
Recalibration	Time out, fluctivating gases, gain adjusted “over”.
C02, 02, AA, N20	

Message	**Cause**
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.

5 Earlier revisions

There are no earlier revisions of the MRI Compact Airway Modules, E-MRICAiOV, E-MRICAiO or E-MRICO.

APPENDIX A Service check form, MRI Compact Airway Modules

Customer		
Service	E-MRIC_____	S/N
Service engineer		Date

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual inspection	**OK**	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Internal parts	☐	☐	☐	2. External parts	☐	☐	☐
Notes							
Field replaceable parts							
1. Fan filter	☐	☐	☐	2. Dummy D-fend O-rings	☐	☐	☐
3. Other filters	☐	☐	☐	4. Special tubes and the zeroing absorber	☐	☐	☐
Notes							
Functional inspection							
1. Fan	☐	☐	☐	2. Module software	GAS		
3. Module configuration	☐	☐	☐	4. Module bus communication	☐	☐	☐
				Measured value	Allowed range		
5. Flow measurement offset					±20 ml/min		
6. Ambient pressure	☐	☐	☐	7. Zero valve	☐	☐	☐
8. Sampling system leak test					≤6 mmHg/min		
Notes							

9. Flow rates	Measured value	Allowed range
Sampling flow		180...220 ml/min
Reference flow		30...45 ml/min
Zeroing flow		±30 ml/min
10. Working pressure：Amb-Work		75...120 mmHg
Notes		

	OK	N.A.	Fail
11. Gas calibration	☐	☐	☐

12. Fall time measurement	Measured value	Allowed range
CO_2 fall time		< 400 ms
O_2 fall time		< 400 ms
CO_2-O_2 delay		< 800 ms

AA option	S/N
13. ID unrel.	< 50

Patient spirometry option				S/N		
	OK	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
14. Flow waveform	☐	☐	☐	15. Spirometry tester	☐	☐	☐
Notes							

Module reassembly	**OK**	**N.A.**	**Fail**
1. Module installation	☐	☐	☐
Notes			

General		**OK**	**N.A.**	**Fail**
Electrical safety check		☐	☐	☐
Functioning after electrical safety check		☐	☐	☐
Notes				

Used spare parts			

Signature

Datex-Ohmeda

Remote Controller

S/5™ Remote Controller, K-REMCO (Rev. 01)
S/5™ Remote Controller, K-CREMCO (Rev. 00)

Technical Reference Manual Slot

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

M1027838-5
May, 2006

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

Table of contents

Introduction

This Technical Reference Manual slot provides information for the maintenance and service of the Datex-Ohmeda S/5 Remote Controllers, K-REMCO and K-CREMCO. The Remote Controllers are designed for use with the Datex-Ohmeda modular monitors. Later in this manual the remote controllers may be referred to without S/5 for simplicity.

The service menu is described in a separate “Service Menu“ slot and the spare part lists in the “Spare Parts” slot.

The Remote Controller, K-REMCO/K-CREMCO, brings the Command Bar/ monitor keyboard functions near to the user and allows access to the same menus as the Command Bar/ monitor keyboard.

- Remote Controller, K-REMCO for Anesthesia Monitor and Critical Care Monitor
- Remote Controller, K-CREMCO for Compact Monitors and S/5 FM.
- Only Remote Controller, K-CREMCO is compatible with the MRI Monitor, N-MRI2.

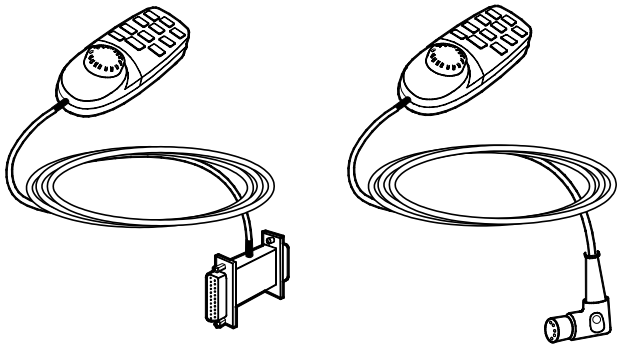


Figure 1 K-REMCO and K-CREMCO

Monitor software compatibility

K-REMCO and K-CREMCO require monitor software version 97 or later.

1 Specifications

1.1 Remote Controller, K-REMCO, K-CREMCO

Dimensions (without cable)	150 × 60 × 50 mm
Weight (incl. cable)	0.5 kg
Cable length	6 m
Input voltage	5 V
Power consumption	180 mW
Communication protocol	RS-232

NOTE: Power supply from the monitor only.

2 Functional description

2.1 Remote Controller, K-REMCO/ K-CREMCO

The Remote Controller consists of 12 direct function keys and the ComWheel.

2.1.1 K-REMCO/ K-CREMCO PCBs

The K-REMCO/ K-CREMCO has two PCBs located inside the Remote Controller. One board has only the push button switches of the keys. The other board reads the status of the keys and the ComWheel and forwards the information to the CPU board.

2.1.2 External communication

K-REMCO Rev.00-01

Two signals, TXD and RXD in RS232 format are in use. No handshaking is used. Serial communication speed is 19.2 kbps. The 26-pin subminiature D-connector of the Remote Controller is connected to the Display Controller Board, B-DISP.

K-REMCO Rev.00 with optional Remote Controller - Compact Monitor cable or K-CREMCO Rev.00

Two signals, TXD and RXD in RS232 format are in use. No handshaking is used. Serial communication speed is 19.2 kbps.

In Compact Monitors, the DIN 5 connector is connected to the keyboard connector X9.

In S/5 FM, the DIN 5 connector is connected to Multi IO adapter X7.

In MRI Monitor, N-MRI2, the DIN 5 connector is connected to the keyboard connector X3 in the MRI Monitor.

2.1.3 ComWheel

The ComWheel is used for menu selection.

3 Service procedures

3.1 General service information

The field service of the remote controllers 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 the warranty of the unit.

3.2 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 A”) 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.

3.2.1 Recommended tools

Tool	Order No.	Notes
Screwdriver		

3.2.2 Visual inspection

Turn the monitor to STBY.

Disconnect the remote controller cable from the monitor.

Detach the remote controller upper cover and the keypad cover by removing the screws (7 pcs) from the bottom.

1. Internal parts

   Check that:

   - cables are connected properly
   - the remote controller cable is fastened to the bottom cover with screws
   - the keypad switches are intact
   - the software EPROM under the keypad is attached properly

2. External parts

   Check that:

   - the upper and bottom covers are intact
   - the keypad cover is intact
   - the ComWheel cover is intact and attached properly

   Reassemble the remote controller.

3. Cable

   Check the remote controller cable:

   - the cable is intact
   - the cable connector is intact
   - the connector pins are clean, straight and at about the same height
   - the locking screws inside the connector case are intact

3.2.3 Functional inspection

Reconnect the cable to the monitor and turn the monitor ON.

4. Monitor picture

   Wait until the normal monitoring screen appears, then check that the picture on the screen is displayed with correct resolution.

5. Command board software

   Enter the service menu:

   Menu (on the remote controller keypad) **- Monitor Setup** - ***Install/Service*** (password 16-4-34) **-** ***Service*** (password 26-23-8)

   Take down the information regarding the remote controller software.

   Select the menu ***KEYBOARD***:

   Service - Keyboard

6. Remote controller keys

   Press the keys one by one. Check that each key generates a sound from the loudspeaker.

7. ComWheel

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

   Select DUMMY PRESS. Push the ComWheel and check that the push generates a sound and the corresponding value in the menu increases.

8. Electrical safety check

   Perform an electrical safety check and a leakage current test.

9. Functioning after electrical safety check

   Check that the remote controller functions normally after the electrical safety check.

10. Final cleaning

    Clean the remote controller and the cable.

- Fill in all necessary documents.

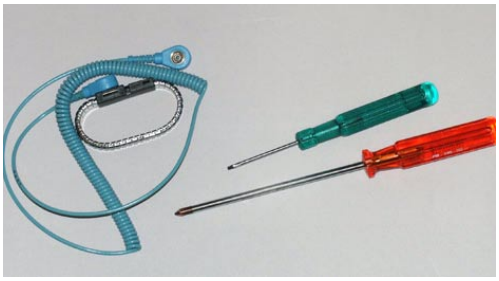
3.3 Disassembly and reassembly

3.3.1 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.

3.3.2 Tools needed



- screwdriver
- flat blade screwdriver
- antistatic wristband

3.3.3 To disassemble Remote Controller K-REMCO / K-CREMCO

To disassemble the Remote Controller (see Figure 2):

1. Disconnect the K-REMCO/ K-CREMCO cable from the monitor.
2. Pull out the knob of the ComWheel.
3. Open the nut on the shaft of the ComWheel.
4. Open the three cross head screws on the bottom of the K-REMCO/ K-CREMCO.
5. Remove the top cover.
6. Open the four screws on the bottom of the K-REMCO/ K-CREMCO.
7. Remove the keyboard cover.
8. Disconnect the K-REMCO/ K-CREMCO cable and the wire set from the Comwheel.
9. Remove the PCBs.

For more information on the spare parts, see the “Spare parts” slot.

In reassembly, remember to put the reinforcing cord of the cable around the screw on the metal bridge before tightening the screw.

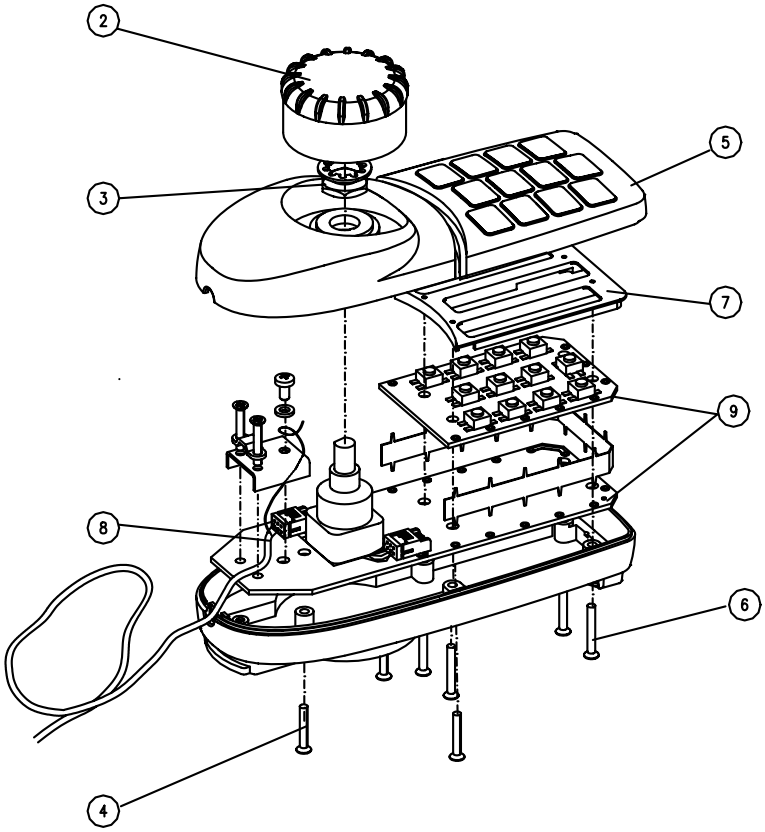


Figure 2 K-REMCO, K-CREMCO disassembly and reassembly

To reassemble the module, reverse the order of the disassembly steps.

In reassembly, remember to put the reinforcing cord of the cable around the screw on the metal bridge before tightening the screw.

CAUTION When reassembling the remote controller make sure that the cables are reconnected properly.

Always perform the "Service check" after reassembling the remote controller.

4 Troubleshooting

4.1 K-REMCO, K-CREMCO

See Keyboard Service Menu in the “Service Menu“ slot and perform tests available. If any of the tests fail, see explanation below.

Problem	**Cause**	**What to do**
ComWheel not working	ComWheel leads broken or connector loose. ComWheel faulty.	Check the items. Replace the ComWheel if necessary.
Membrane key not working	Switch cable loose or broken. Keyboard cable loose or broken. Cable connector pin failure. RS232 communication failure on CPU board.	Check the items. Replace them if necessary.

APPENDIX A Service check form, Remote Controllers K-REMCO (Rev. 01) and K-CREMCO (Rev. 00)

Customer		
Service	Keyboard type	S/N
Service engineer		Date

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual inspection	**OK**	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Internal parts	☐	☐	☐	2. External parts	☐	☐	☐
3. Cable	☐	☐	☐				
Notes							
Functional inspection							
4. Monitor picture	☐	☐	☐				
5. Command board software	KB						
6. Remote controller keys	☐	☐	☐	7. ComWheel	☐	☐	☐
Notes							
8. Electrical safety check	☐	☐	☐	9. Functioning after electrical safety check	☐	☐	☐
10. Final cleaning	☐	☐	☐				

Notes

Used spare parts			

Signature

For your notes:

Datex-Ohmeda

Anesthesia Record Keeping Keyboard, K-ARKB

Technical Reference Manual Slot

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

Document no. M1072254-1
September, 2006

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

Table of contents

Introduction

This Technical Reference Manual slot provides information for the maintenance and service of the Anesthesia Record Keeping Keyboard. The information is applicable for the current production revisions of the devices.

The service menu is described in a separate “Service Menu“ slot and the spare part lists in the “Spare Parts” slot.

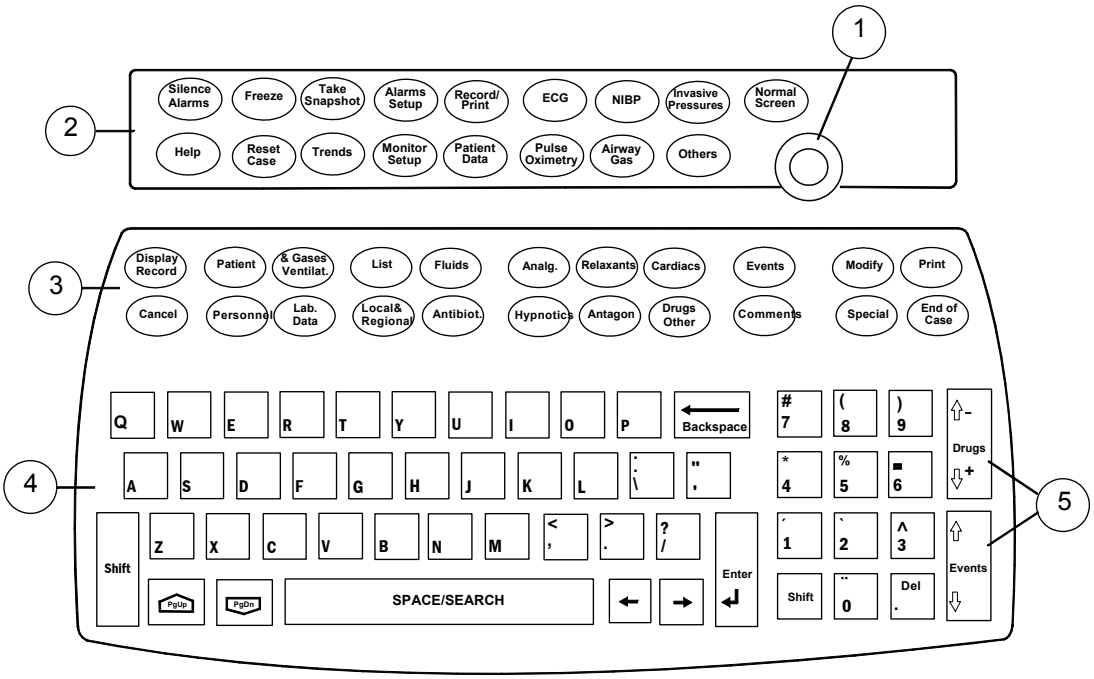


Figure 1 Anesthesia Record Keeping Keyboard, K-ARKB (English version)

(1) The ComWheel

(2) Keys that function as the monitor’s command bar. The power switch is in the monitor’s Command Bar.

(3) Keys for record keeping control.

(4) Letter and number keys for typing in information that is not listed in the menus.

(5) Arrow keys (Drugs, Events) for moving up or down the Event list and Event trend when the record is on the display.

Monitor software compatibility

The K-ARKB keyboard is compatible with MRI Monitor, monitor software versions :L-CANE04(A) and later.

Related documents

For more information about...	See
Technical issues	“Technical Reference Manual” of the MRIMonitor, Part I
Configuration	Anesthesia Record Keeping Solution, user documentation
Contents of the menus in your hospital	Contact the personnel responsible for the menu configurations in the hospital
Monitor, parameters, physiological trends, general messages and symbols on the display	“MRI Monitor, User’s Guide” and “User’s Reference Manual”
Printer	The printer manual

1 Specifications

1.1 General specifications

1.1.1 Keyboard, K-ARKB

Dimensions (W × D × H)	328 × 232 × 61 mm/12.9 × 9.1 × 2.4 in
Weight	1.3 kg/3.8 lbs.
Power	+5 V DC ±10%, 70 mA max, supplied from MRI Monitor or KVM Extender Remote Unit
Character set	ASCII
Communication interface	PC compatible serial line plus S/5 type serial line
Environmental requirements:	
Operating temperature	+10...+35 °C/+50...+95 °F
Storage temperature	-10...+45 °C/+14...+113 °F
Humidity	10...90% non-condensing

2 Functional description

2.1 Introduction

The Anesthesia Record Keeping Solution is an automated anesthesia documentation system. For the Anesthesia Record Keeping Solution, the record keeping configurations from the network and a memory option, and optionally the keyboard, K-ARKB, are needed.

The Anesthesia Record Keeping Solution is connected to the network, and runs in MRI Monitor. The Memory Option, N-CMMEM is needed for backup data storage.

The Anesthesia Record Keeping Solution combines the physiological data measured by the monitor, information automatically integrated from external devices such as Aestiva/5 MRI, and the information manually entered into a printable anesthesia record using the menus. The record can be stored in electronic format for later review/printing and for statistical analysis.

2.2 Anesthesia Record Keeping Keyboard, K-ARKB

The Anesthesia Record Keeping Keyboard, K-ARKB, consists of a controller board, alphanumeric keyboard and membrane keyboard.

2.2.1 Controller board

The controller board reads the status of the keyboard keys and the ComWheel, and forwards the information to the CPU board in the monitor through an RS232 serial interface.

Additionally, the board controls the LEDs on the K-ARKB front panel.

External communication

Communication with the CPU board takes place in the RS232 serial communication channel which is available on the CPU bus. There are also two bidirectional signals (Data and Clock) for PCKB format communication.

In case of PCKB type communication, the Keyboard can be connected to the MRI Monitor or to the KVM Extender Remote Unit.

CPU

The CPU on the controller board is of type 80C51FA and the oscillator frequency is 11.059 Mhz. There is a power-up-reset whose time constant is about 1 second.

Serial communication

The RS232 serial communication IC needs only +5 V supply voltage, because it chops the necessary RS-level supply voltages to its external capacitors. A diode allows the use of two keyboards, and a pull-down resistor on the CPU board is used for pulling the corresponding line to the negative RS-level. The speed rate of the serial communication is 19.2 kbps.

LEDs

The CPU on the controller board controls the alarm LEDs according to commands received from the main CPU board.

2.2.2 Alpha-numeric keyboard

The controller board reads the status of the keys on the alphanumeric keyboard. The boards are connected together with a 26-pin ribbon cable.

2.2.3 Membrane keyboard

The controller board reads the status of the keys on the membrane keyboards. The membrane keyboard and the controller board are connected together with a ribbon cable.

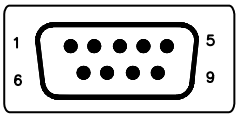
2.3 Connectors and signals

2.3.1 Connectors on the Anesthesia Record Keeping Keyboard, K-ARKB

Barcode Reader 5-pin connector

Pin No.	Signal
1	PC-CLOCK
2	PC-DATA
3	N.C.
4	GND
5	+5 V

Anesthesia Record Keeping Keyboard 9-pin connector

	Pin No.	I/O	Signal
	1	I/O	PC-DATA
	2	I	RX
	3	O	TX
	4	I	+5 V
	5		GND
	6	I	RESET
	7	-	GND
	8	-	N.C.
	9	I/O	PC-CLOCK

3 Service procedures

3.1 General service information

The field service of the K-ARKB Keyboard 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 the warranty of the unit.

3.2 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 A") 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.

3.2.1 Recommended tools

Tool	Order No.	Notes
Screwdriver		
ARK Keyboard-LCD Cable 1.5 m/5ft, or ARK Keyboard-LCD Cable 2.5 m/ 8 ft,	881154 889340	

3.2.2 Visual inspection

1. Cable

   Disconnect the interface cable from the Anesthesia Record Keeping Keyboard, K-ARKB, and check the cable:

   - the connector pins are clean and straight and at about the same height
   - the locking screws are intact
   - the cable is intact

   Leave the cable disconnected.

2. Internal check

Detach the bottom cover and check internal parts:

- all screws are tightened properly
- the block screws for the interface cable are in place and tightened properly
- the block screw threads are intact
- the interface cable connector is clean and intact
- all internal cables are connected properly
- all IC's that are on sockets are attached properly
- there are no loose objects inside

Reattach the bottom cover, reconnect and lock the interface cable to the Anesthesia Record Keeping Keyboard, K-ARKB.

3. External check

   Check that:

   - the Anesthesia Record Keeping Keyboard, K-ARKB, plastic frame is intact
   - the front panel stickers are intact
   - the ComWheel cover is intact and attached properly
   - all four rubber pads are in place on the bottom cover

3.2.3 Functional inspection

4. ON LED

   Switch the monitor on. Check that the LED on the upper right hand corner of the Anesthesia Record Keeping Keyboard, K-ARKB, is lit up.

5. Software

   Enter the service menu:

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

   Take down the information regarding the Anesthesia Record Keeping Keyboard, K-ARKB, software.

6. ComWheel

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

7. Membrane keys

   Check the membrane keys of the Anesthesia Record Keeping Keyboard, K-ARKB.

   Press the keys on the upper part of the Anesthesia Record Keeping Keyboard, K-ARKB, one by one. Check that each key generates a sound from the loudspeaker and the corresponding text in the menu changes from yellow to red.

   Press the keys on the lower part, all except the keys **Modify** and **Print**. Check that each key generates a sound from the loudspeaker, or at least the Message count value increases in the service menu.

   Press the keys **Modify** and **Print** and check that the corresponding menus open on the screen.

8. Electrical safety check

   Perform an electrical safety check and aleakage current test.

9. Functioning after electrical safety check

   Check that the Anesthesia Record Keeping Keyboard, K-ARKB, functions normally after the performed electrical safety check.

10. Final cleaning

    Clean the Anesthesia Record Keeping Keyboard, K-ARKB, with suitable detergent.

- Fill in all necessary documents.

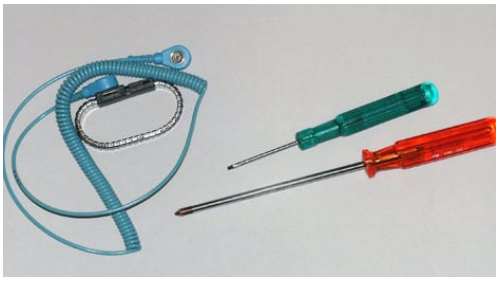
3.3 Disassembly and reassembly

3.3.1 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.

3.3.2 Tools needed



- screwdriver
- flat blade screwdriver
- antistatic wristband

3.4 To disassemble the keyboard

To disassemble the Anesthesia Record Keeping Keyboard, K-ARKB (see the exploded view of the K-ARKB keyboard in the “Spare parts” slot):

1. Disconnect the ARK keyboard - monitor cable (ARK keyboard - LCD display cable).
2. Remove the four screws from the bottom of the keyboard, and detach the cover plate from the bottom plate.

4 Troubleshooting

4.1 Troubleshooting charts

4.1.1 Anesthesia Record Keeping Keyboard, K-ARKB

Problem	**Cause**	**What to do**
Keys have no effect on the display.	Cable is not connected or broken. Wrong type of cable is connected. Loose connector inside. Component failure inside.	Connect right type of cable properly (see above). Detach the bottom plate and check connectors and components.
Membrane key not working.	Ribbon cable loose or broken. Keyboard cable loose or broken. D-connector pin failure. IC failure on the Controller board. RS232 communication failure on the main CPU board. NOTE: The cancel key does not respond if the menu is closed. The modify key may not work if there is no selection.	Check the items. Replace them if necessary.
Led does not light at alarm or stays lit after alarm is over.	Cable loose or broken. LED broken. Component failure on the Controller board. The K-ARKB is connected to the KVM Extender, Remote Unit.	Check the items. Replace them if necessary. The alarm LED is not intended to light at alarm when connected to KVM Extender in N-MRIREMOTE use.

See more troubleshooting items in “User’s Guide”.

5 Earlier revisions

There are no previous versions of the Anesthesia Record Keeping Keyboard, K-ARKB.

APPENDIX A Service check form, Anesthesia Record Keeping Keyboard, K-ARKB (Rev. 00)

Customer		
Service	Keyboard type	S/N
Service engineer		Date

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual inspection	**OK**	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Cable	☐	☐	☐	2. Internal check	☐	☐	☐
3. External check	☐	☐	☐				
Functional inspection							
4. ON LED	☐	☐	☐				
5. Software	KB						
6. ComWheel	☐	☐	☐	7. Membrane keys	☐	☐	☐
8. Electrical safety check	☐	☐	☐	9. Functioning after electrical safety check	☐	☐	☐
10. Final cleaning	☐	☐	☐				

Notes

Used spare parts			

Signature

For your notes:

GE Healthcare

S/5™ Device Interfacing Solution, N-DISVENT (Rev. 02) ref. M1079877

Technical Reference Manual Slot

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

Document no. M1056425-1
September, 2006

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

Table of contents

Table of figures

Introduction

This “Technical Reference Manual” slot provides information for the maintenance and service of the Datex-Ohmeda S/5 Device Interfacing Solution, N-DISVENT, ref. M1079844. Later in this manual the module may be referred to without S/5 for simplicity.

Please also refer to the “Installation Guide” accompanying the module.

The service menu is described in a separate “Service Menu“ slot and the spare part lists in the “MRI Spare Parts” slot.

The purpose of the Device Interfacing Solution is to produce a data connection between an external bedside device and the MRI Monitor.

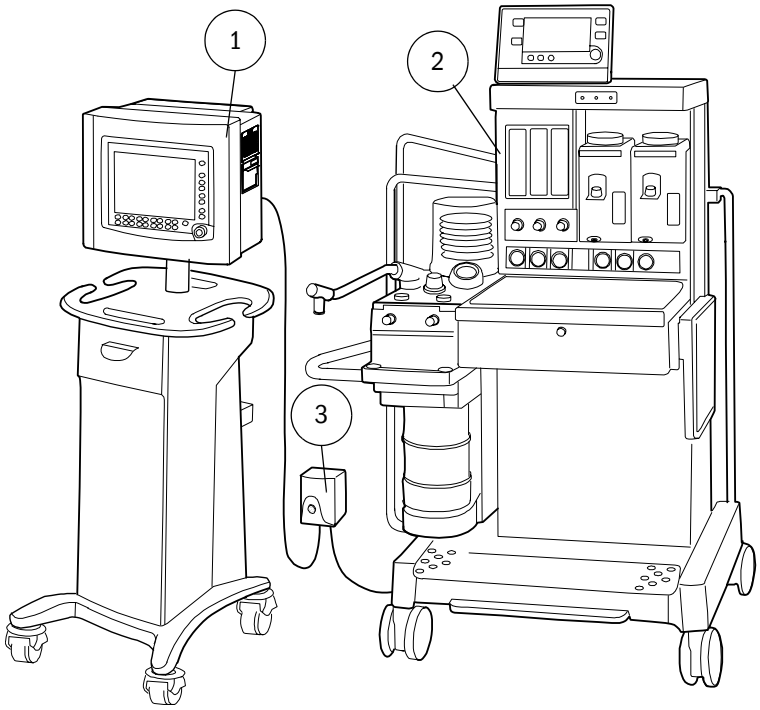


Figure 1 An example of interfacing external devices with Device Interfacing Solution

(1) MRI Monitor (with L-CANE04 or L-CANE04A and later software licenses)

(2) Aestiva/5 MRI anesthesia machine

(3) Device specific interfacing module, N-DISVENT

1 Specifications

1.1 Environmental specification

Operating temperature	+10...+35 °C (50...95 °F)
Storage and transport temperature	-10...+50 °C (14...122 °F)
Relative humidity	10...90% (non condensing)
Atmospheric pressure	660...1060 hPa (66...106 kPa/660...1060 mbar/500...800 mmHg)

1.1.1 Protection against ingress of liquids

According to IEC/EN 60592 class IPX 1.

The DIS module must always be used in vertical position to prevent water from entering the module.

1.2 Technical specifications

1.2.1 General

Module

Size (W × D × H)	60 × 27 × 85 mm/2.4 × 1.1 × 3.4 in
Weight	0.1 kg/0.2 lb.

Bus cables

8-pin Hirose HR12/HR212 connector

Material	black PVC
Length/Weight	1 m/47 g (39 in/3.3 ft./0.104 lb.) 2 m/85 g (79 in/6.6 ft./0.187 lb.) 6 m/220 g (236 in/19.7 ft./0.485 lb.)

Device cables

Depends on device.

Material	elastollan
Length	0.5...1 m (19...39 in/1.6...3.3 ft.)
Weight	40...70 g (0.088...0.154 lbs.)

1.3 Electrical specification

There is no isolation in the DIS module. The interfaced device, DIS module and the monitor must be situated in the same patient environment (as defined in IEC 60601-1-1).

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

1.4 Maximum power consumption

450 mW (30 mA @ 15 V) 900mW peak.

1.5 Module communication

Bus communication speed is 500 kbps. RS422 implementation.

Device communication speed depends on the interfaced external device. RS232 implementation.

CAUTION If N-DISVENT is used in MRI environment run the coherent noise test or equal test of the MRI system to ensure that there is no RF interference on the MR images.

2 Functional description

The S/5™ Device Interfacing Solution, N-DISVENT, provides a seamless link between Aestiva/5 MRI and the MRI Monitor.

When you interface Aestiva/5 MRI to the MRI Monitor you will get the following parameters:

Device set values for trends	Measured numeric values	Waveforms	Supported versions
Vent. mode, I:E ratio, RR, TV, PEEP, Pinsp, Insp.pause, Pmax	FiO_2, TVexp, MV, RR, Pmean, Ppeak	Paw, Flow, Vol Loops	with SmartVent 7900: software versions 3.5 and 4.5

WARNING **The manufacturer guarantees a reliable functioning of the devices with tested software versions only. Always refer to the Installation guide accompanying the DIS module and verify the compatibility before use.**

2.1 Main components

The implementation of Device Interfacing Solution, N-DISVENT, can be divided into five parts:

- Device specific software
- Device specific module
- Device specific cable
- Bus cable
- Software in MRI Monitor

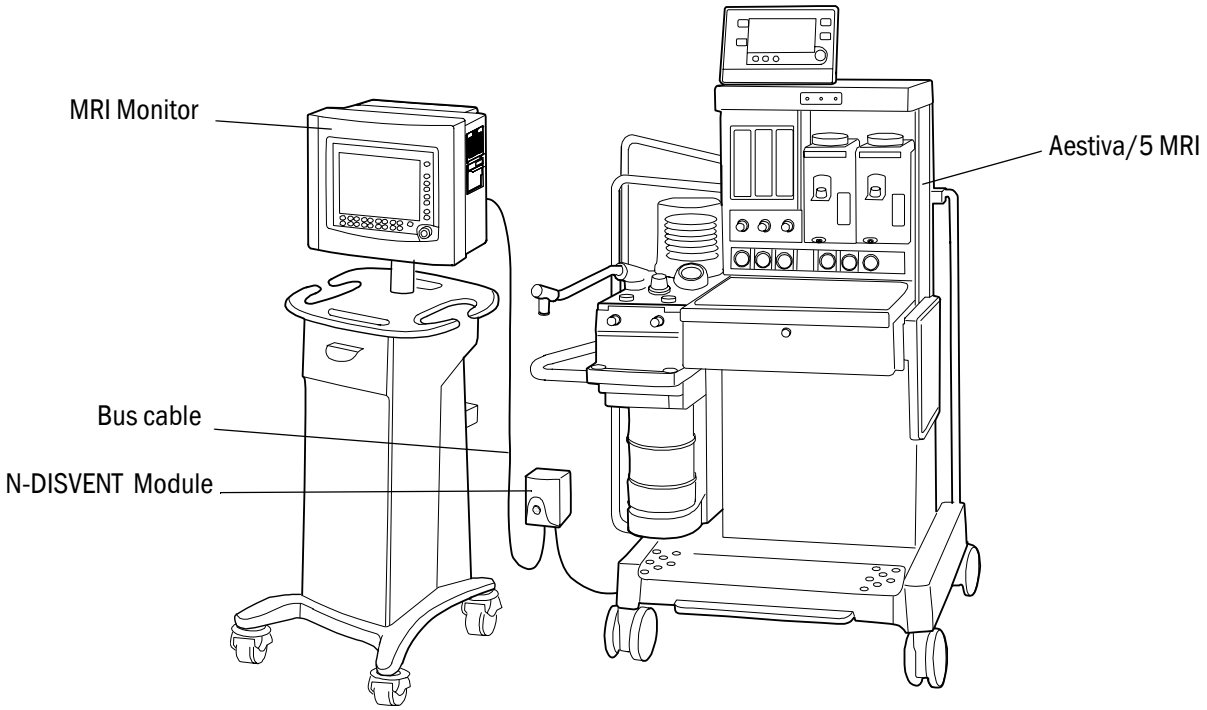


Figure 2 Implementation of Device Interfacing Solution

2.2 DIS module

The DIS module receives data from an external device, converts the data to a suitable format for the monitor and then sends the data to the monitor. The main board contains the power supply with a current limiter, microcontroller, reset circuits, memory and serial communication buffers. The board communicates with the MRI Monitor through the DIS bus.

The DIS module consists of:

- Power supply with current limiter and reset circuit parts
- Microcontroller H8, internal and external RAM, non volatile memory, etc.
- Programming connection
- Device communication connection and RS232 driver
- Bus communication connection and RS422 driver
- LEDs that indicate the status of the communication
- Device specific software

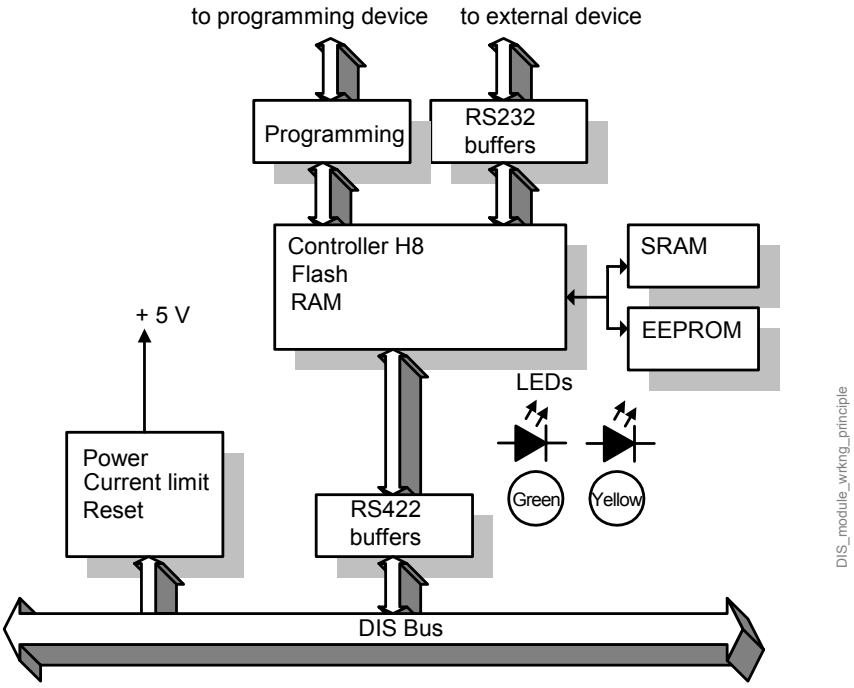
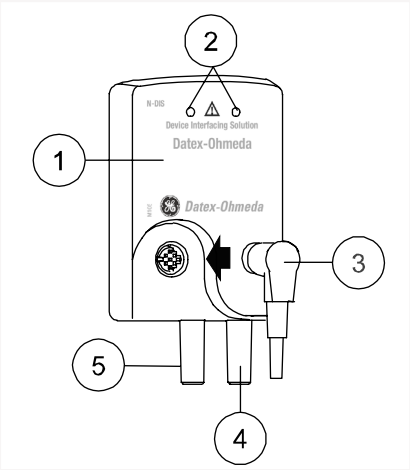


Figure 3 DIS module working principle diagram

2.3 Connections

Connect the device specific cable to the external device and the bus cable to the MRI Monitor's DIS connector.



(1) label specifying the external device

(2) LED indicators

(3) black bus cable from another interfacing module, if needed

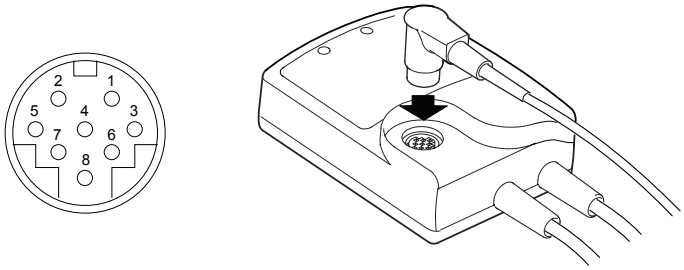
(4) grey device specific cable to the communication port of the external device

(5) black bus cable to the monitor's DIS connector (or to another interfacing module)

Figure 4 Connection cables and LED indicators

2.4 Connectors and signals

2.4.1 Male bus cable connector



Pin No.	Signal	Color
1	Data from UPI +	brown
2	Data from UPI -	red
3	VDD 9 V to 18 V (max 1 A)	orange
4	GND	yellow
5	VCC 7 V to 8 V (max 1 A)	blue
6	GND	grey
7	Data to UPI +	white
8	Data to UPI -	black

2.5 Interfaced devices

For specific information on parameters transferred from the interfaced device to the MRI Monitor and the applicable software versions of the device, refer to the Installation guide accompanying the N-DISVENT module.

N-DISVENT can be interfaced with the Aestiva/5 MRI.

3 Service procedures

3.1 General service information

The field service of the Device Interfacing Solution, N-DISVENT, is limited to replacing faulty cables 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 the warranty of the unit.

3.2 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 A”) 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.

3.2.1 Recommended tools

Tool	Order No.	Notes
Screwdrivers		

3.2.2 Recommended parts

No recommended parts.

3.2.3 Visual inspection

Disconnect the DIS module from the DIS bus and from the interfaced external device.

1. Internal check
   - Disassemble the DIS module.
   - Make sure that there are no loose parts inside the DIS module.
   - Check that the screws holding the PC board are tightened properly.
   - Check that the cables are attached properly and the connectors are intact.

2. External check
   - Check that the DIS module case and label are clean and intact.
   - Reassemble the DIS module.
   - Check that the screws for the DIS module case are secured properly.
   - Check that the bus cable connector is intact.
   - Check that the DIS bus and device specific cables are intact.

3.2.4 Functional inspection

3. DIS module interface status

   Connect the DIS module to the DIS bus and to the external device that is specified in the DIS module label. Turn on the interfaced external device.

   Check that no error messages are displayed on the monitor screen.

   Check via the ***Interfacing*** menu that the connected DIS module status is correct:

   Monitor Setup - ***Interfacing - Status Page***

   Check that the waveforms and numeric data are transferred to the monitor according to the configuration.

4. Recognition of interface

   Disconnect the DIS bus cable and check that the '[device name] module removed' message appears on the monitor screen. Reconnect the cable.

   Turn off the external device (if possible) and check that the '[device name] disconnected from module' message appears on the screen. Turn the external device back on again.

5. DIS module service menu

   Enter the service menu:

   Monitor Setup – ***Install/Service*** (password 16-4-34) –
   Service (password 26-23-8) –
   Parameters – More – DIS Interfacing

   Check that the menu displays submenus for the connected DIS module.

   Enter the DIS module service menu and check that the displayed information corresponds to the information on the DIS module label.

   Check that the DIS bus voltage is between 6.00 ...8.00 V.

   Check that the DIS module time-out and checksum error values do not increase more than by 5 per second.

   Check that the status of the DIS module memory indicates OK.

6. Electrical safety check
   Perform the electrical safety test and leakage current test.

7. Functioning after electrical safety check
   Check that the DIS module functions normally after the tests.

8. Final cleaning
   Clean the DIS module, bus cable and device specific cable with a suitable detergent.

- Fill up all the necessary documents.

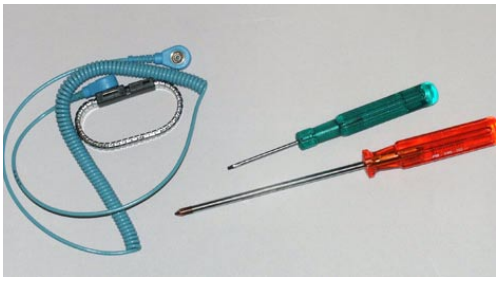
3.3 Disassembly and reassembly

3.3.1 Before disassembly

NOTE: Wear a grounded, antistatic wristband when handling PC boards. Electrostatic discharge may damage components on the board.

NOTE: Handle the PC board by its edges.

3.3.2 Tools needed



- screwdriver
- flat blade screwdriver
- antistatic wristband

3.4 To disassemble the module

To disassemble the N-DISVENT module (see the exploded view of the module in the “MRI Spare parts” slot):

1. Remove the two screws from the back of the module.
2. Loosen the two strain-relief threads and after that disconnect the cables from the connectors.

To remove the Module Front Cover from the module, release the snaps that hold the front cover to the front chassis.

To reassemble the module, reverse the order of the disassembly steps.

CAUTION When reassembling the module, make sure to reconnect the cables properly.

Always perform the “Service check” after reassembling the module.

4 Troubleshooting

4.1 LED indicators

Figure 5 LED indicators

4.1.1 Green LED

The green LED indicates that the communication between the monitor and DIS module and the communication between the DIS module and external device is working properly. When the cables are connected and the connected devices are on, the green LED should be lit continuously.

4.1.2 Yellow LED

The yellow LED alerts the user. The yellow LED is lit when any of the following conditions becomes true:

1. The DIS module is connected to the DIS bus, but the external device is not connected.
2. The external device is in power off state.
3. The external device is not selected from the interfacing menu as an active source of data.

NOTE: The meaning of the yellow LED varies with some external devices. See the “Installation Guide” delivered with the DIS module.

4.2 Quick functional check

You have two ways for checking the function of the Device Interfacing Solution:

- Press the **Monitor Setup** key, select ***Interfacing*** and open the ***Status Page*** menu. The status page shows you the current communication status of the interfacing module connected to the bus.

NOTE: The status message 'Connected' appears on the monitor screen after you have connected the external device to the DIS module and turned it on, if the monitor and DIS module have already been initialized.

- Check the LED indicators on the DIS module (the green LED indicates the physical connections, the yellow LED software selections):

GREEN	YELLOW	INDICATION
lit ●	dark ○	Physical connections between the monitor, DIS module and external device are in order and the device has been selected in the menu.
dark ○	lit ●	There is something wrong with the physical connections between the monitor, interfacing module and external device. The external device has not been selected in the menu.
lit ●	lit ●	Physical connections between the monitor, DIS module and external device are in order, but the external device has not been selected in the menu (see the "User's Reference Manual" of the monitor).
dark ○	dark ○	The DIS module is not connected to the monitor.

5 Earlier revisions

This manual supports N-DISVENT revisions 01 and 02.

APPENDIX A Service check form, Device Interfacing Solution, N-DISVENT (Rev. 01 ... 02)

Customer		
Service	Module type	S/N
Service engineer		Date

OK = Test OK **N.A. = Test not applicable** **Fail = Test failed**

Visual inspection	**OK**	**N.A.**	**Fail**		**OK**	**N.A.**	**Fail**
1. Internal check	☐	☐	☐	2. External check	☐	☐	☐
Notes							
Functional inspection							
3. DIS module interface status	☐	☐	☐	4. Recognition of interface	☐	☐	☐
5. DIS module service menu	☐	☐	☐	6. Electrical safety check	☐	☐	☐
7. Functioning after electrical safety check	☐	☐	☐	8. Final cleaning	☐	☐	☐

Notes

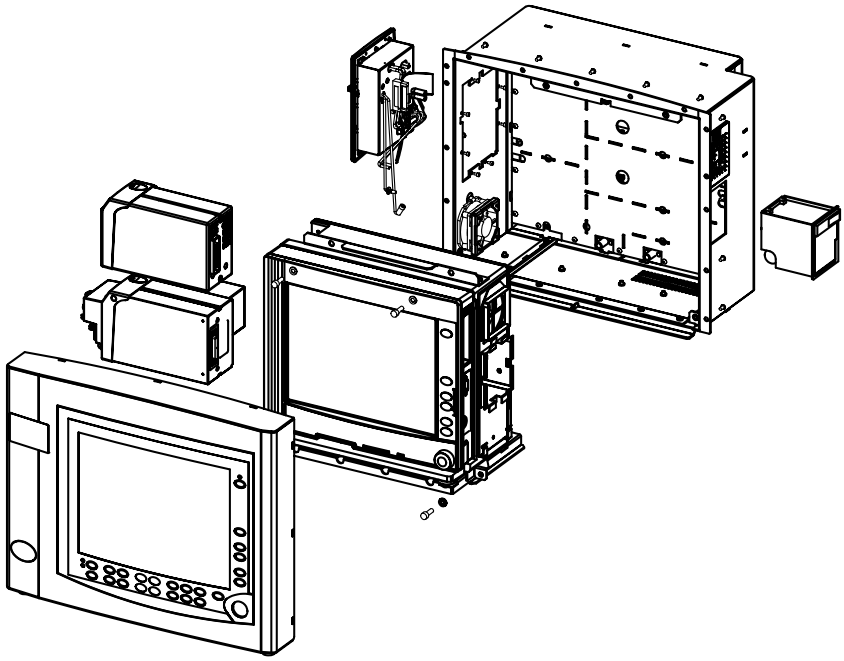
Used spare parts			

Signature

For your notes:

MRI Monitor

Spare Parts



All specifications are subject to change without notice.

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

Document no. M1041753-2
September, 2006

Datex-Ohmeda Inc.
P.O. Box 7550
Madison, WI 53707-7550, USA
Tel: +1 608 221 1551
Fax: +1 608 222 9147

GE Healthcare Finland Oy
Helsinki, Finland
P.O. Box 900
FI-00031 GE, FINLAND
Tel: +358 10 39411
Fax: +358 9 1463310
www.gehealthcare.com

Table of contents

Table of figures

1 Parts of the MRI Monitor

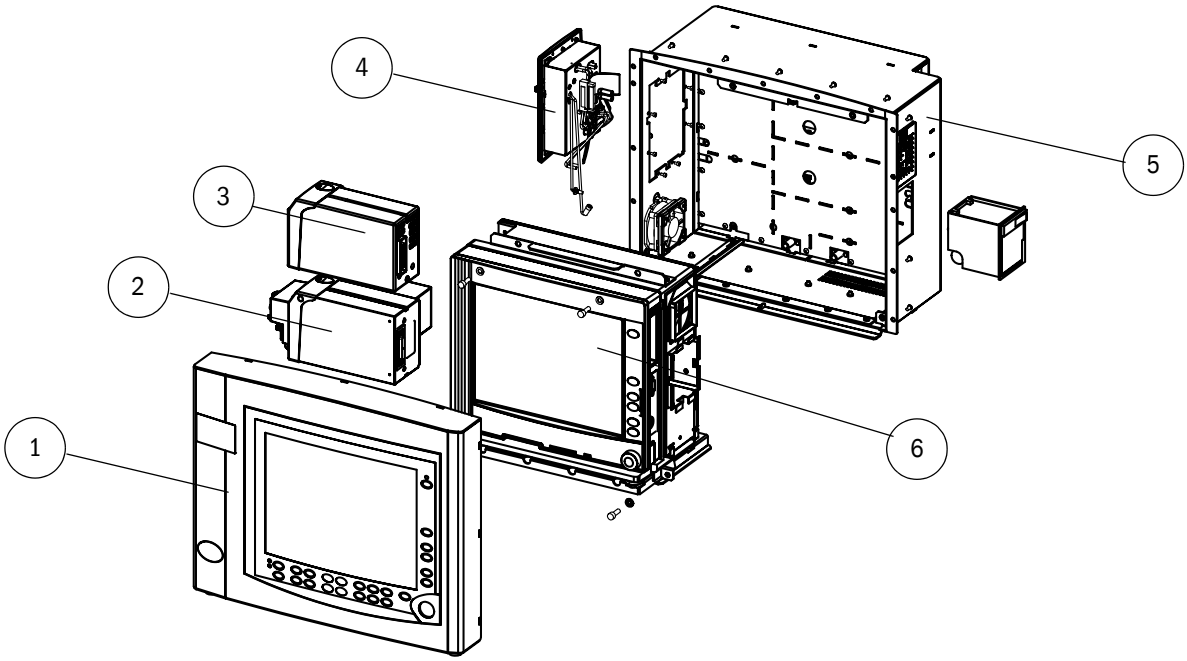


Figure 1 Parts of the MRI Monitor

Item	Description
1	MRI Shield Front Shell
2	MRI Compact Airway Module, E-MRICiAOV
3	MRI Hemodynamic Multiparameter Module, E-MRIPSN
4	Patient Connector Panel
5	MRI Shield Back Shell
6	MRI Monitor Frame F-MRICM1

2 MRI shield

2.1 Language specific parts with labeling

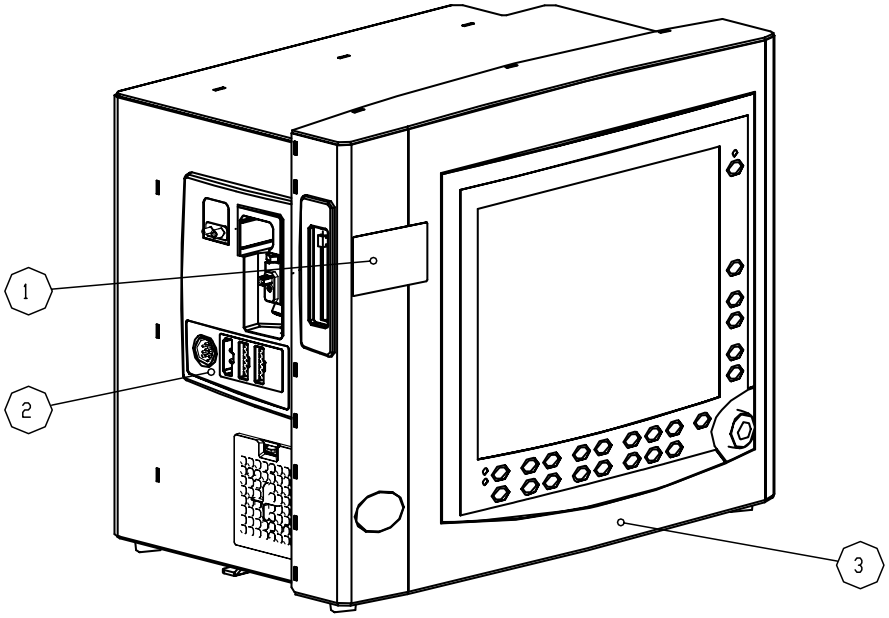


Figure 2 MRI Monitor labeling

Item	Description	Order No.	Replaced by
1	Warning Sticker, N-MRI2, CS	M1063598	
1	Warning Sticker, N-MRI2, DA	M1037631	
1	Warning Sticker, N-MRI2, DE	M1037615	
1	Warning Sticker, N-MRI2, EN	M1037377	
1	Warning Sticker, N-MRI2, ES	M1037617	
1	Warning Sticker, N-MRI2, FI	M1037624	
1	Warning Sticker, N-MRI2, FR	M1037611	
1	Warning Sticker, N-MRI2, HU	M1054269	
1	Warning Sticker, N-MRI2, IT	M1037619	
1	Warning Sticker, N-MRI2, JA	M1037633	
1	Warning Sticker, N-MRI2, NL	M1037613	
1	Warning Sticker, N-MRI2, NO	M1037628	
1	Warning Sticker, N-MRI2, PL	M1037636	
1	Warning Sticker, N-MRI2, PT	M1037621	
1	Warning Sticker, N-MRI2, SV	M1037626	

Item	Description	Order No.	Replaced by
2	Labels for Patient Connector Panel, N-MRI2, CS	M1063595	
2	Labels for Patient Connector Panel, N-MRI2, DA	M1037685	
2	Labels for Patient Connector Panel, N-MRI2, DE	M1037667	
2	Labels for Patient Connector Panel, N-MRI2, EN	M1035644	
2	Labels for Patient Connector Panel, N-MRI2, ES	M1037673	
2	Labels for Patient Connector Panel, N-MRI2, FI	M1037679	
2	Labels for Patient Connector Panel, N-MRI2, FR	M1037669	
2	Labels for Patient Connector Panel, N-MRI2, HU	M1049147	
2	Labels for Patient Connector Panel, N-MRI2, IT	M1037675	
2	Labels for Patient Connector Panel, N-MRI2, JA	M1037687	
2	Labels for Patient Connector Panel, N-MRI2, NL	M1037671	
2	Labels for Patient Connector Panel, N-MRI2, NO	M1037683	
2	Labels for Patient Connector Panel, N-MRI2, PL	M1037689	
2	Labels for Patient Connector Panel, N-MRI2, PT	M1037677	
2	Labels for Patient Connector Panel, N-MRI2, SV	M1037681	
3	Front Cover, CS, N-MRI2	M1075434	
3	Front Cover, DA, N-MRI2	M1040385	
3	Front Cover, DE, N-MRI2	M1040386	
3	Front Cover, EN, N-MRI2	M1040327	
3	Front Cover, ES, N-MRI2	M1040387	
3	Front Cover, FI, N-MRI2	M1040388	
3	Front Cover, FR, N-MRI2	M1040389	
3	Front Cover, HU, N-MRI2	M1054268	
3	Front Cover, IT, N-MRI2	M1040390	
3	Front Cover, JA, N-MRI2	M1040391	
3	Front Cover, NL, N-MRI2	M1040392	
3	Front Cover, NO, N-MRI2	M1040393	
3	Front Cover, PL, N-MRI2	M1040394	
3	Front Cover, PT, N-MRI2	M1040395	
3	Front Cover, SV, N-MRI2	M1040396	

2.2 N-MRI2 Shield

2.2.1 MRI Shield, Front shell unit

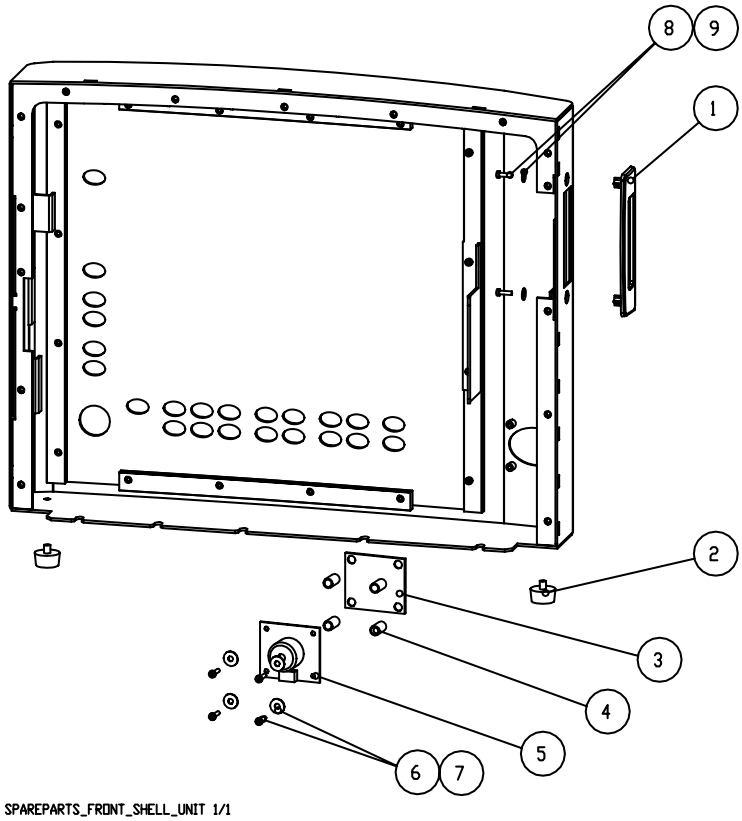


Figure 3 Exploded view of the MRI Shield, Front shell

Item	Description	Order No.	Replaced by
1	PCMCIA panel, N-MRI2	M1030481	
2	SUPPL-PART, rubber feet, OD=20.5mm, h=10.5mm	M1040925	
3	Magnetfield Alarm Board	M1037985	
4	Round plastic spacer, OD=12.7mm, ID>6mm, L=12.7mm	M1041188	
5	LED Plate with printing	M1035894	
6	SCREW, hex, pan head M3x12, acid proof	619092	
8	SCREW, for plastic PT, M3x10mm, WN1452, pan head, steel, zinc, head Torx 8, head max 5mm	628728	
9	WASHER, A2, fender	M1041198	

2.2.2 MRI Shield, N-MRI2 Rev. 00... 01, Back shell unit opitonal parts

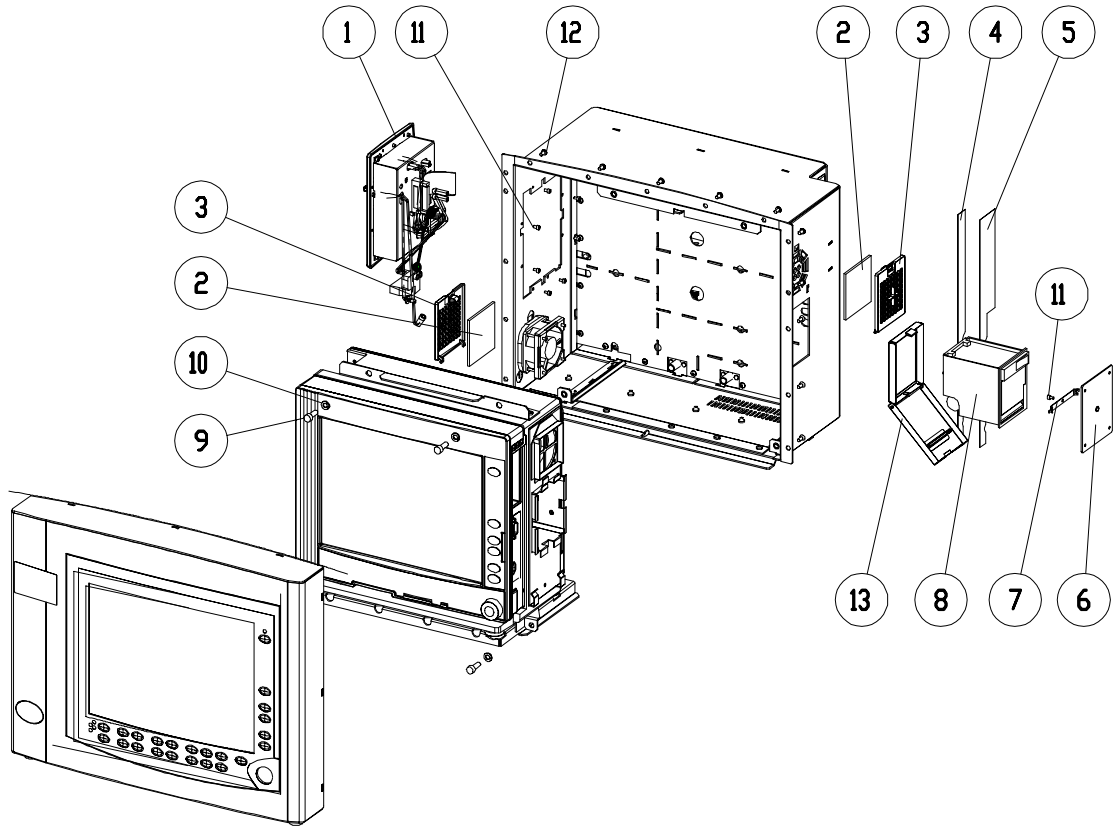


Figure 4 Exploded view of the MRI Shield, Back shell unit and optional parts

Item	Description	Order No.	Replaced by
1	Patient Connector Panel Unit, N-PSNGV-00	M1024047	
2	Filter (Side fan), F-CM1	896085	
3	Filter Bracket (Side fan), F-CM1	896086	
4	Connector panel, N-MRI2	M1032771	
5	Connector panel without MRIREMOTE, N-MRI2	M1041276	
6	Recorder Cover Plate, N-MRI2 (rev.00)	M1040300	
7	Cover Plate Bracket, N-MRI2	M1044516	
9	SCREW, MC6S M6X18 A2	61922	
11	SCREW, machine screw, M3x5mm, DIN912, ISO4762, hexagonal socket, cylinder head, acid proof steel (AISI316)	619061	
12	SCREW, machine, M4x8mm, ISO 7380, hexagonal socket, button head, stainless steel (AISI304)	M1041096	
13	Printer EMC shield N-MRI2 (rev. 01)	M1080575	

2.2.3 MRI Shield, N-MRI2 Rev. 01, Back shell

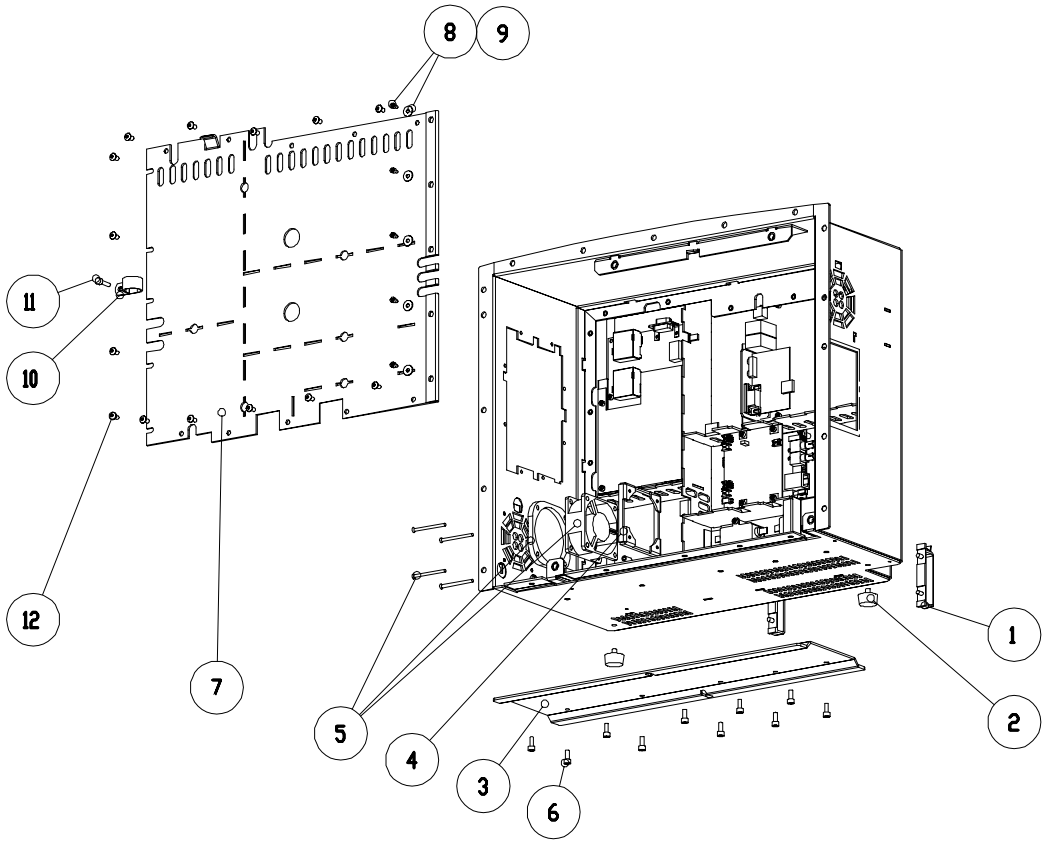


Figure 5 Exploded view of the MRI Shield, N-MRI2 Rev. 01, Back shell unit

Item	Description	Order No.	Replaced by
1	Flat cable clamp, max cable width 53.5mm, snap in	M1040895	
2	Rubber feet, OD=20.5mm, h=10.5mm	M1040925	
3	Fixing Plate, N-MRI2	M1030168	
4	Fan Holder, N-MRI2, Sheet metal	M1034881	
5	Fan Unit, back shell, N-MRI2 (inc.Fan spacer and screws 3x40)	M1080698	
6	Screw, M4x10, DIN 912, A2	M1040598	
7	Back Cover, N-MRI2	M1034877	
8	SCREW, machine screw, M3x5mm, DIN912, ISO4762, hexagonal socket, cylinder head, acid proof steel (AISI316)	619061	
9	Washer, A2, fender	M1041198	

Item	Description	Order No.	Replaced by
10	Cable clamp, aliminium	M1080762	
11	SCREW, machine, M4x16mm, DIN912, A2	619120	
12	SCREW, machine, M4x8mm, ISO 7380, hexagonal socket, button head, stainless steel (AISI304)	M1041096	

2.2.4 MRI Shield, N-MRI2 Rev. 00, Back shell

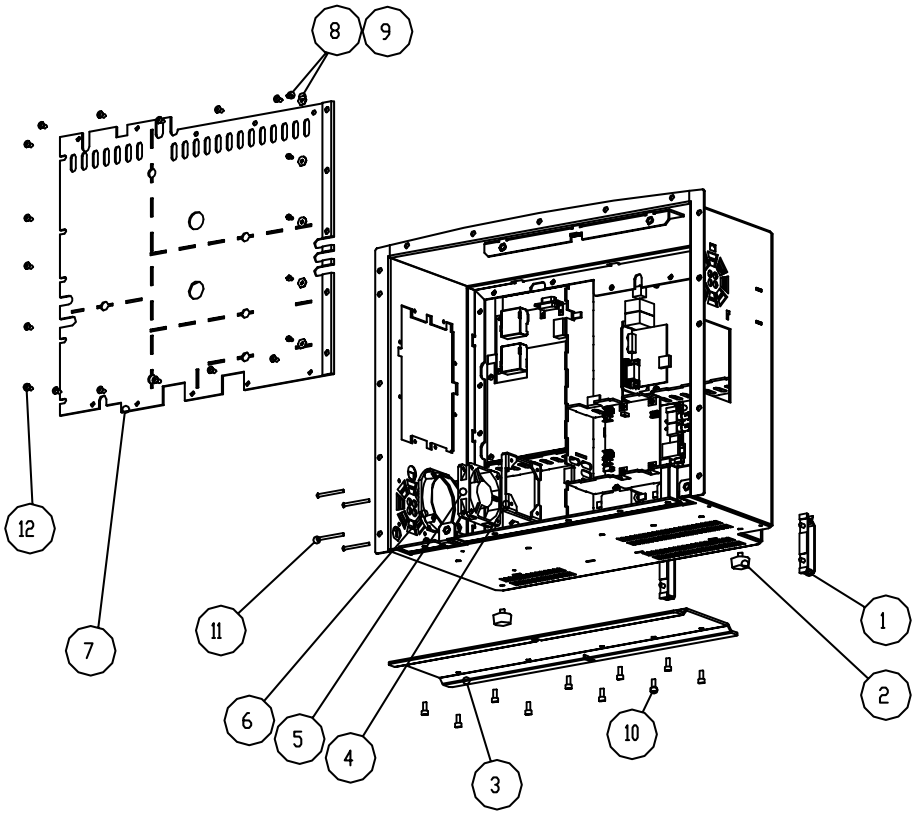


Figure 6 Exploded view of the MRI Shield, N-MRI2 Rev. 00, Back shell unit

Item	Description	Order No.	Replaced by
1	Flat cable clamp, max cable width 53.5mm, snap in	M1040895	
2	Rubber feet, OD=20.5mm, h=10.5mm	M1040925	
3	Fixing Plate, N-MRI2	M1030168	
4	Fan Holder, N-MRI2, Sheet metal	M1034881	
5	Fan F-LM1	892539	M1080698
6	FAN RAISING (SIDE), F-CM1, Injection molded	897888	
7	Back Cover, N-MRI2	M1034877	
8	SCREW, machine screw, M3x5mm, DIN912, ISO4762, hexagonal socket, cylinder head, acid proof steel (AISI316)	619061	

Item	Description	Order No.	Replaced by
9	Washer, A2, fender	M1041198	
10	SCREW, machine, M4x10mm, DIN912, hexagonal socket, cylinder head, stainless steel (AISI304), A2	M1040598	
11	SCREW, machine, M3x35mm, DIN7991, hexagonal socket, flat countersunk head, stainless steel (AISI304), A2	M1040610	
12	SCREW, machine, M4x8mm, ISO 7380, hexagonal socket, button head, stainless steel (AISI304)	M1041096	

2.2.5 MRI Shield, N-MRI2 Rev. 00...01 , spare parts in the Back shell

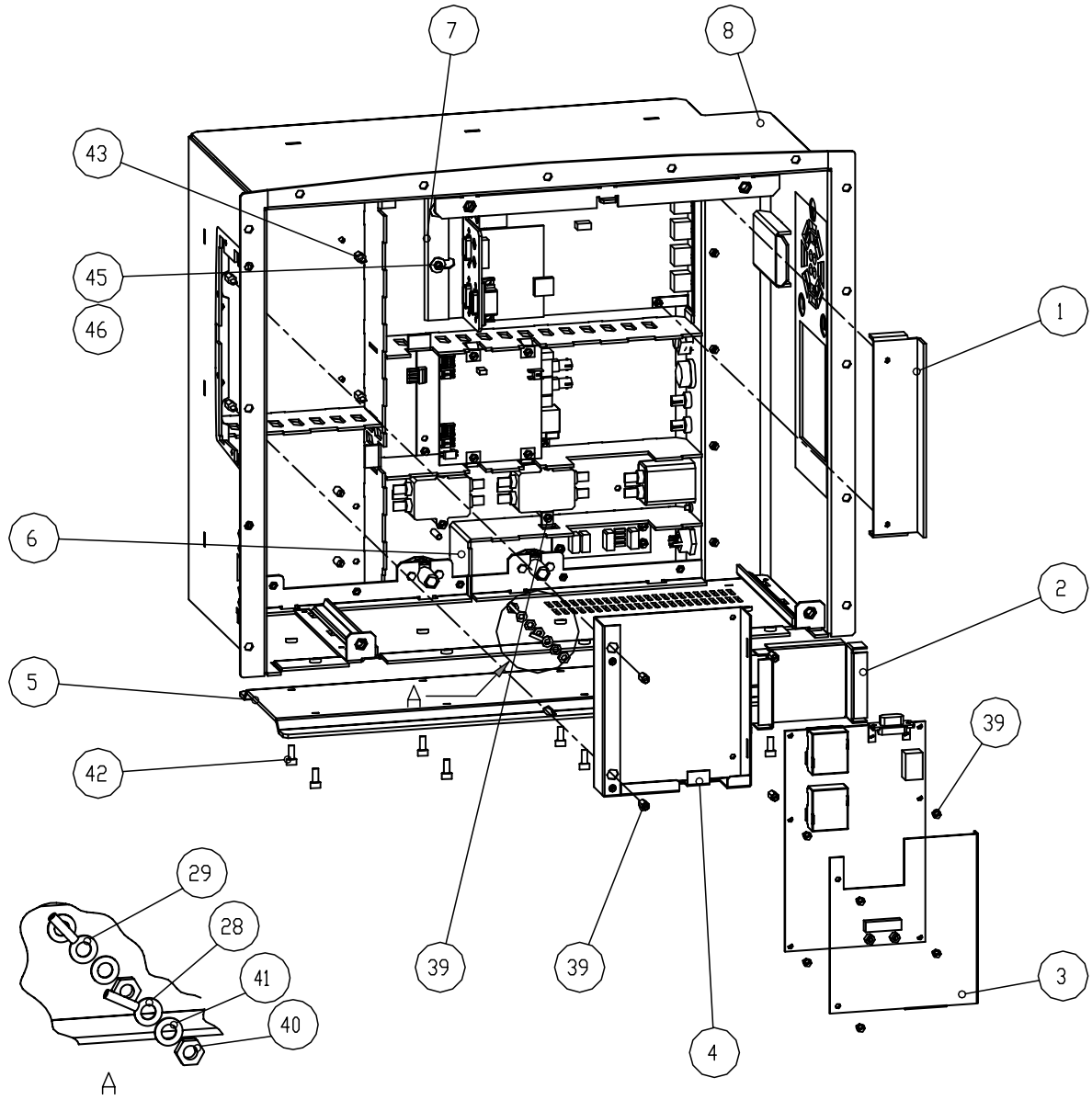


Figure 7 Exploded view of the MRI Shield, Back shell

Item	Description	Order No.	Replaced by
1	KVM cover plate support, MRI2	M1050047	
2	Cable channel, N-MRI2	M1030405	
3	ECG cover top, N-MRI2	M1030467	
4	ECG cover bottom, N-MRI2	M1030465	
5	Fixing plate, N-MRI2	M1030168	
6	Protective wall, N-MRI2	M1030171	
7	KVM holder	M1044493	
8	Back case	M1024058	
28	Mains cable, N-MRI2	M1035791	
29	Main Unit Wires	M1035787	
39	Screw, M3x5mm, MC6S 3X5 A4, DIN912, ISO4762	619061	
40	Nut, M4, DIN 943, (AISI316)	63119-HEL	
41	Washer, M4, DIN6798A	M1041147	
42	Screw, machine, 4x10mm, DIN912, hexagonal socket, cylinder head...	M1040598	
43	Hexagonal threaded spacer, L-9mm, D=6mm, M3	M1040914	
44	Screw, M3x10mm, MFS 3x10 A4, DIN965, ISO7046	616233	
45	Screw, screw-mach, hex-socket, Cyl head, M3x6...	61921	
46	Washer	M1041198	

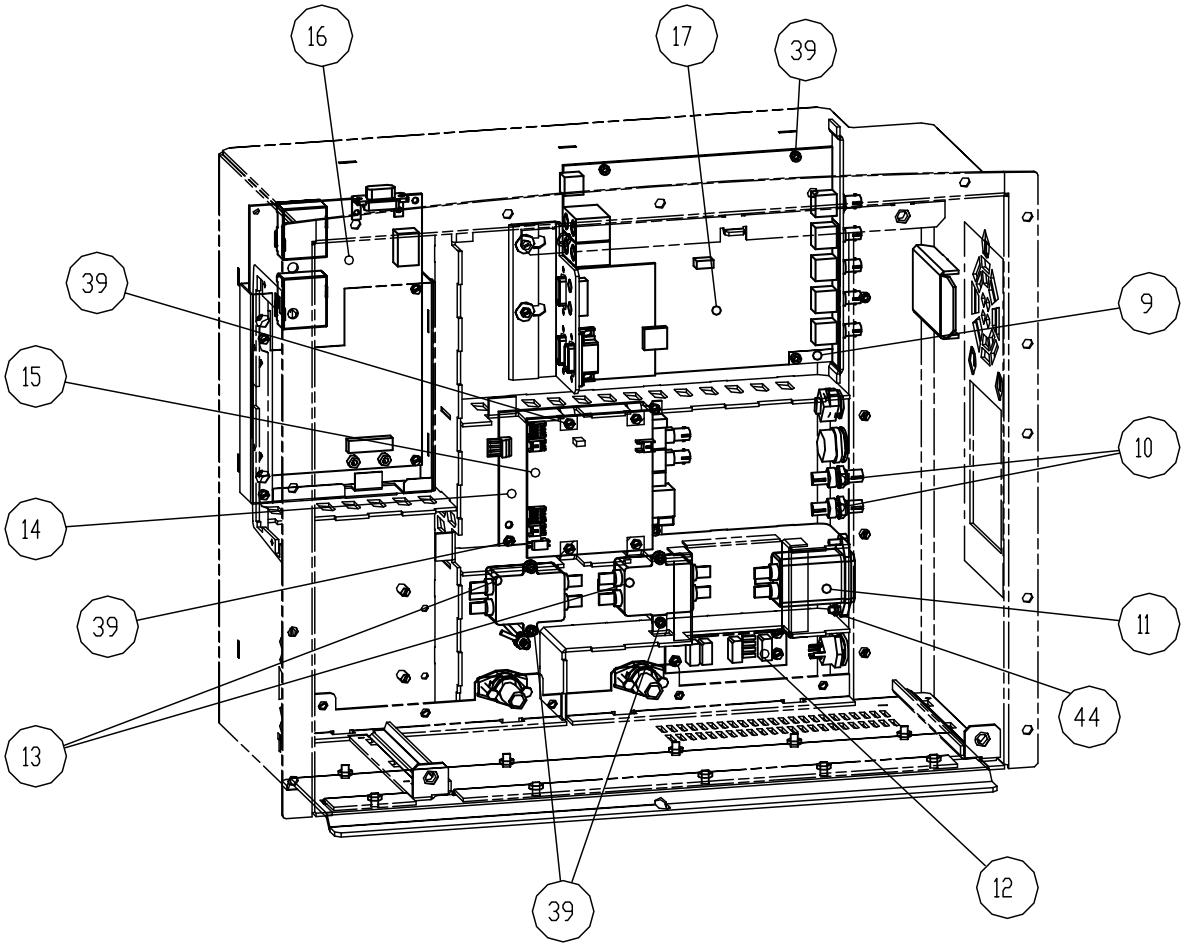


Figure 8 Exploded view of the MRI Shield, Back shell, PC boards and components

Item	Description	Order No.	Replaced by
9	Grounding plate	M1047724	
10	Conn., fiberoptic connector, single / multimode...	56000	
11	Filt mains, 50Hz, 250V, panel mount, 3A	540144	
12	MRI2 Keyboard filter board,...	M1029370	
13	Filt mains, 3A, 250V, Low leakage current	26906	
14	10Base-T to fiberoptic converter	90340-HEL	
15	Remote power and connector board, MRI2	M1046072	
16	MRI ECG board	M1009594	
17	Sound and screen converter, KVM-extender with fiber optical cable, VGA(1024x768/75Hz), AT-keyboard, mouse, centronics-printer, +keyboard adapter	M1041646	
39	Screw, M3x5mm, MC6S 3X5 A4, DIN912, ISO4762	619061	
44	Screw, M3x10mm, MFS 3x10 A4, DIN965, ISO7046	616233	

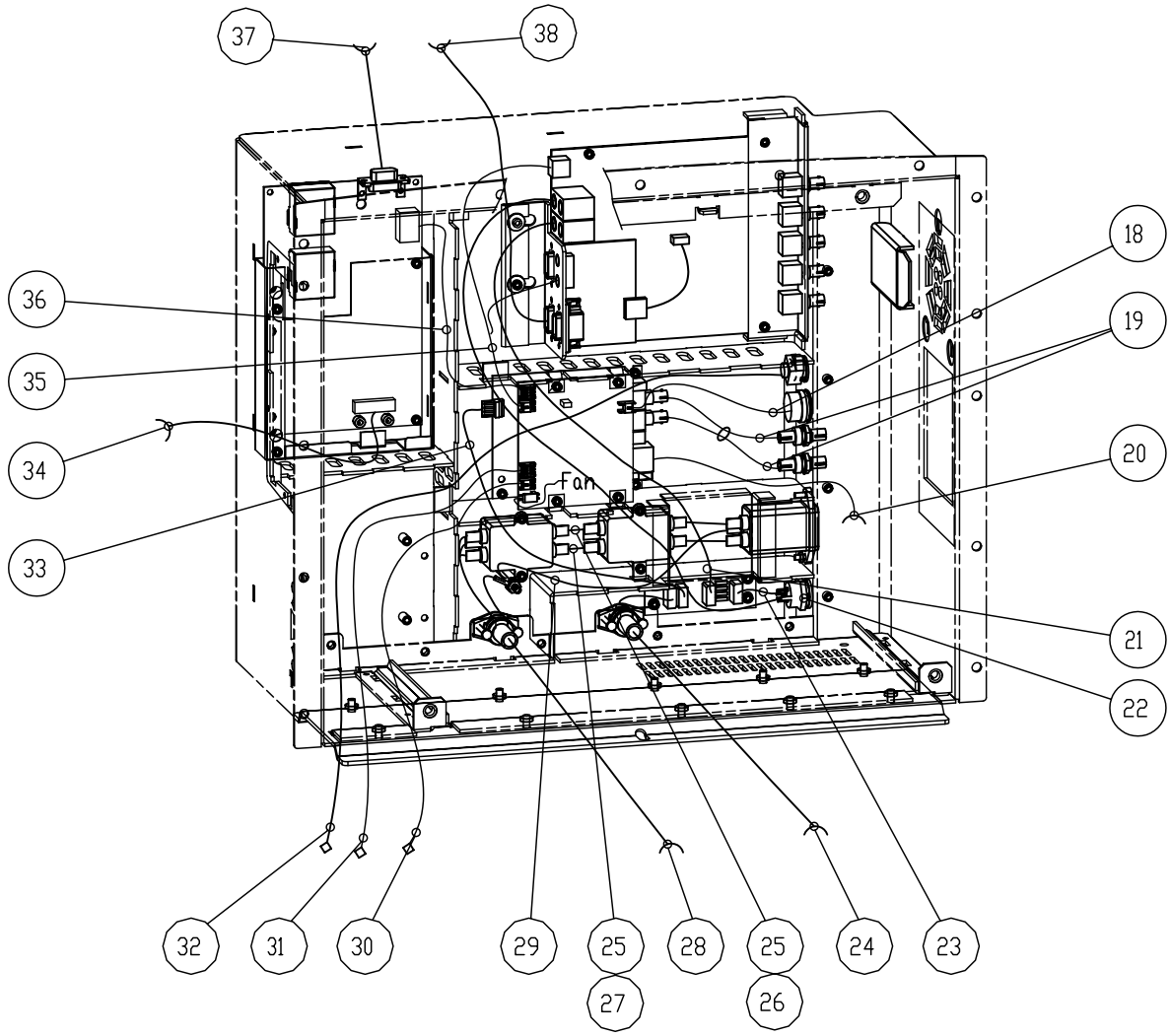


Figure 9 Exploded view of the MRI Shield, Back shell, Cables

Item	Description	Order No.	Replaced by
18	Cardiac gating cable, N-MRI2	M1035803	
19	Multifibre optic wire, 850nm, 62.5/125um, 2xST connector	54574	
20	Crossover cable, 1m	885266	
21	Remote keyboard cable, N-MRIREMOTE	M1040036	
22	Remote keyboard connector cable, N-MRIREMOTE	M1048099	
23	Keyboard connector cable, N-MRI2	M1035799	
24	Keyboard cable, N-MRI2	M1035795	
25	Insul-shrinktube, 6.4mm/3.2mm, 0.6mm, black	73860-HEL	
26	Wire, 18A WG(0.9mm2)	71336-HEL	

Item	Description	Order No.	Replaced by
27	Wire, 0.9mm2, 18A WG, blue	71337-HEL	
28	Mains cable, N-MRI2	M1035791	
29	Main Unit Wires	M1035787	
30	Alarm board cable, N-MRI2	M1045509	
31	Sound cable 0.4m for MRI2	M1042223	
32	DIS cable 0.65m for MRI2	M1042153	
33	NET Power cable, N-MRI2	M1035807	
34	MRI ECG input cable, N-MRI2	M1044942	
35	Power and sound cable 0.18m for MRI2	M1047687	
36	ECG board to connector board, MRI2	M1045510	
37	ECG Serial cable, N-MRI2	M1036032	
38	VGA cable, N-MRIREMOTE	M1039434	

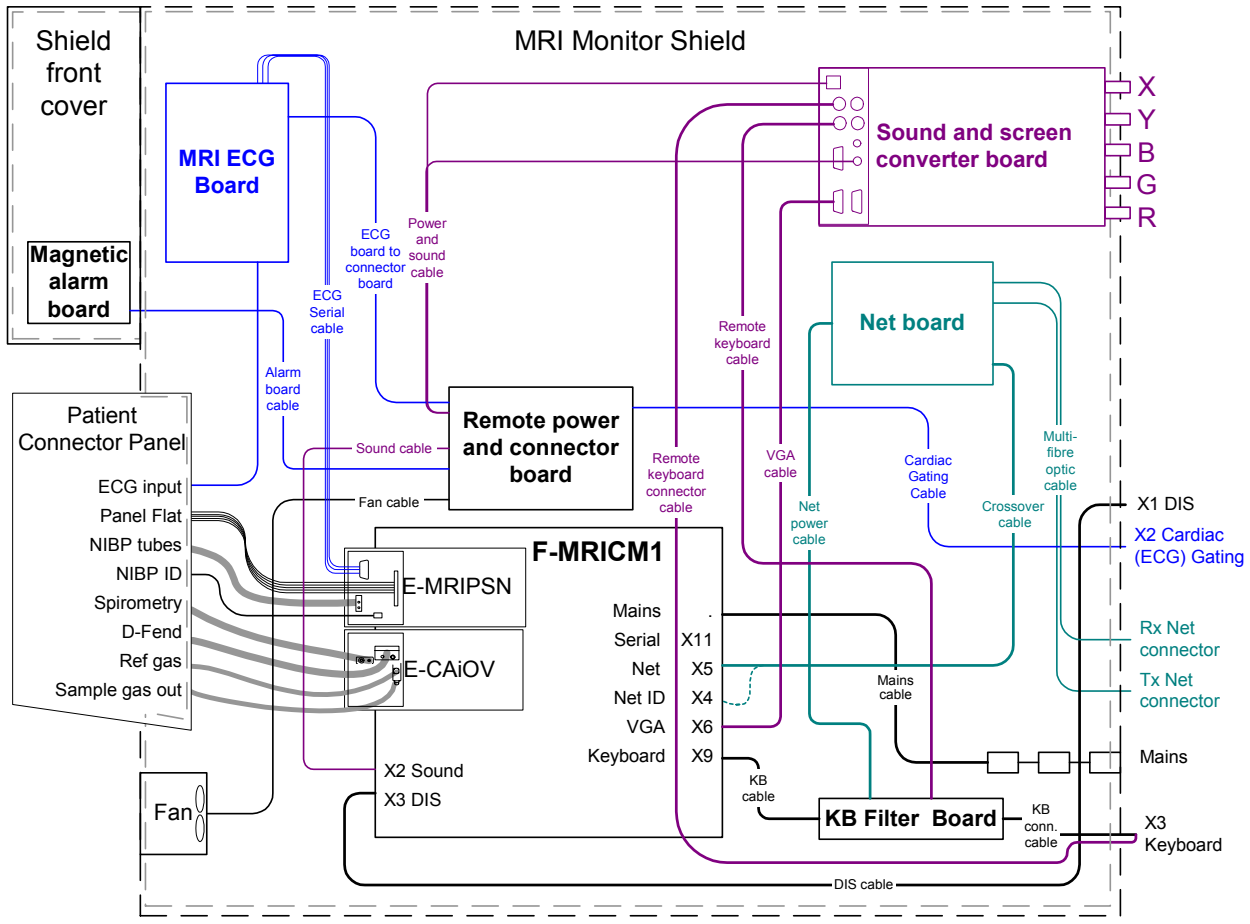


Figure 10 Connections inside the MRI Monitor Shield

2.2.6 MRI Monitor Frame and external parts

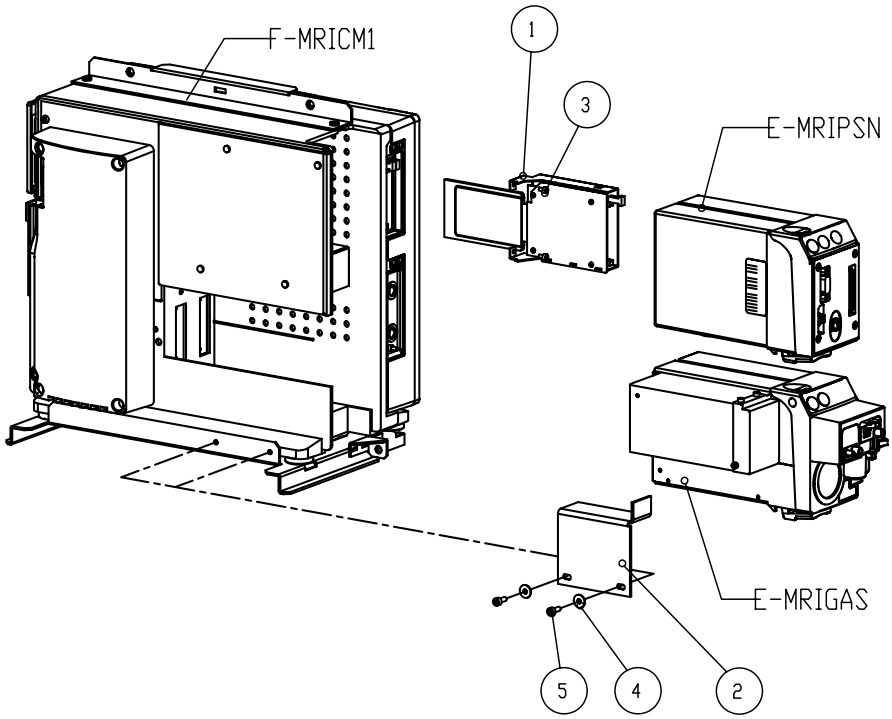


Figure 11 PCMCIA card extender and safety catch for gas module

Item	Description	Order No.	Replaced by
1	PCMCIA Card Extender Unit	M1027777	
2	Safety Catch	M1046487	
3	SCREW, machine screw, M3x5mm, DIN912, ISO4762, hexagonal socket, cylinder head, acid proof steel	619061	
4	WASHER, M4, DIN 9021B, ISO 7093, stainless steel (AISI304), A2, fender	M1041198	
5	SCREW, machine screw, M4x6mm, DIN912, ISO4762, hexagonal socket, cylinder head, stainless steel (AISI304)	619101-HEL	

2.3 Power cords for MRI Monitor

Item	Description	Order No.	Replaced by
	Power cord, USA	86236	
	CABLE-MAINS,EU,3x1.0mm2/3.5m,GRAY,STR DUAL GND PLUG(CEE7),R ANGLE FEM(IEC320,VDE	54563	
	Power cord, UK	545571	

2.4 Patient Connector panel, N-(P)SN, N-(P)SNG, N-(P)SNGV

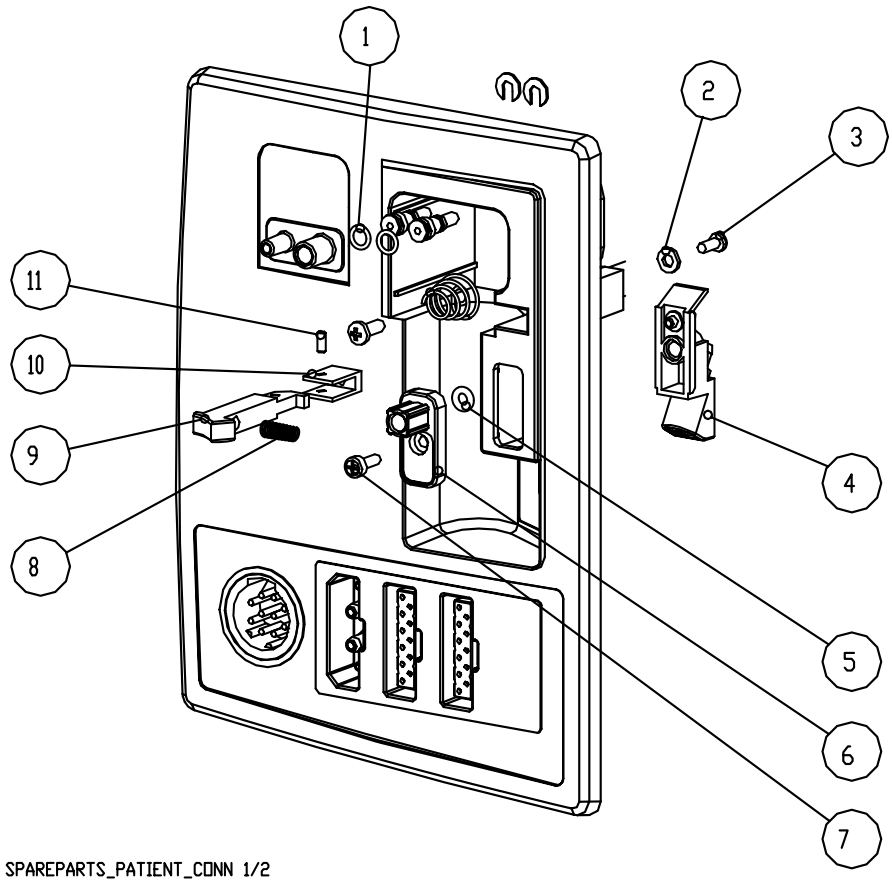


Figure 12 Exploded view of the Patient Connector Panel

Item	Description	Order No.	
	D-fend Latch Assembly, Spare Part Assembly	M1039037	
1	O-RING, 4.0x1.0, NBR, SHORE 70	653125	
2	WASHER, STZN, M2.7	63608	
3	SCREW, machine screw, M2.5x6mm, DIN7985 ISO7045, Pozidrive, pan head, steel, zinc	617120-HEL	
4	Filter Base (black), E-MRIGAS	M1037527	
5	O-ring, 2.8x1.6	65340	
6	Ref. Gas Filter and Frame	896025-HEL	
7	SCREW, machine screw, M2.5x8mm, DIN7985, ISO7045, Pozidrive, pan head, steel, zinc, StZn	61714	
8	SPRING, 0.4x2.5x10 SF-TF SS1774-04 TAI SS2331-06	64242	

Item	Description	Order No.	
9	LATCH, M-CAiOV	885493	
10	Hinge, M-CAiOV	886235	
11	PIN, M-CAiOV	887005	

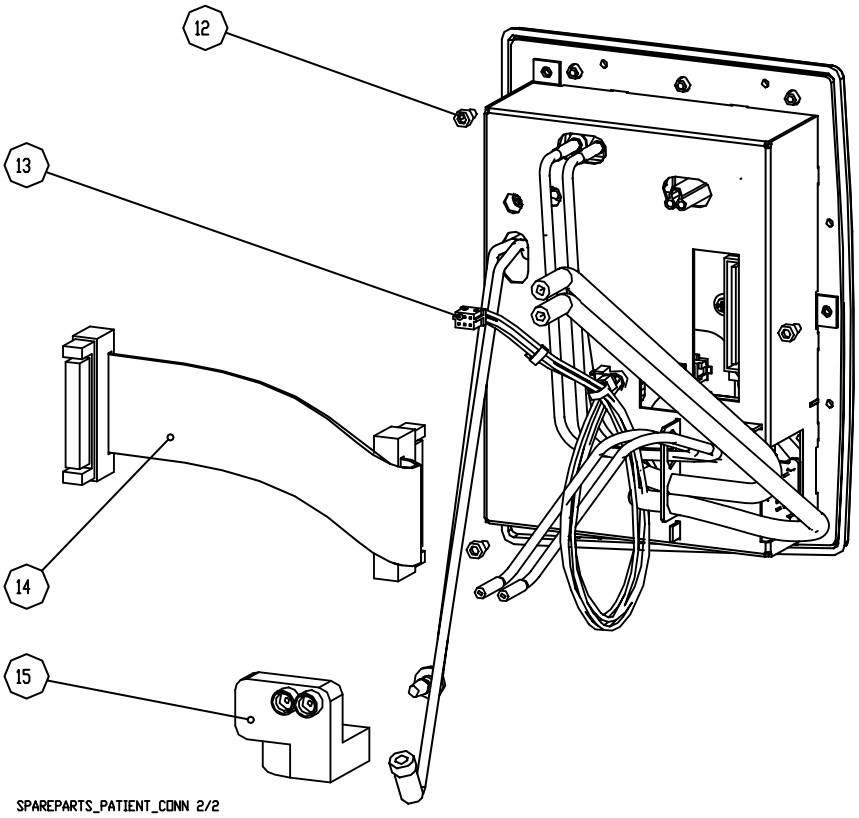


Figure 13 Patient Connector Panel, tubing and cables

Item	Description	Order No.
12	SCREW, machine screw, M3x5mm, DIN912, ISO4762, hexagonal socket, cylinder head, acid proof steel (AISI316)	619061
13	NIBP Cable, N-PSNGV	M1037021
14	Panel Flat Cable, N-PSNGV	M1037020
15	Dummy D-Fend, E-MRIGAS	M1053048

3 Software, Upgrades and Options

3.1 Software licenses

Description	Order No.	Note
Service Software Licence, anesthesia	L-CANE05S	
Service Software Licence, anesthesia	L-CANE05AS	

3.2 Upgrade Kits

Description	Order No.	Note
Datex-Ohmeda Network and MemCard Upgrade	U-CMMEM	
Wireless Network Upgrade for Compact Monitor	U-CMW	
Recorder Option Upgrade	U-CMREC1	

3.3 Remote Screen Option, N-MRIREMOTE

Part number	Description
M1041646	KVM-extender, VGA(1024x768/75Hz), AT-keyboard, mouse, centronics-printer, +keyboard adapter
M1042232	Fiber optical cable with ST-connectors,20m (5-fiber)

3.4 19" LCD display, D-LCC19-01

Part number	Description
M1010081	VGA video cable for D-CFLT17 and D-LCC19 (with audio)

3.5 Command Bar, K-MRIANEB, rev.00

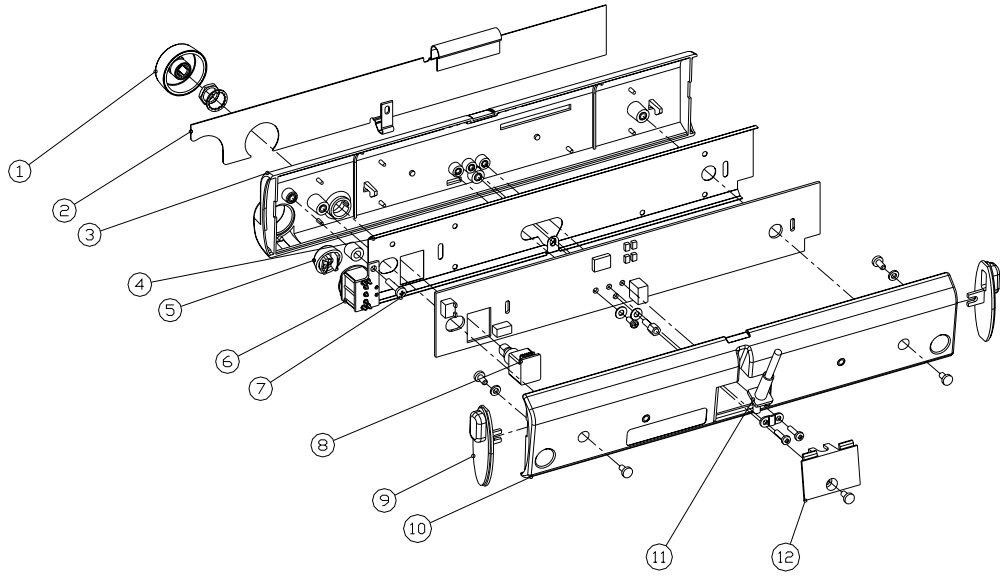


Figure 14 Exploded view of Command Bar, K-MRIANEB

Item	Description	Order no.	Replaced by
1	ComWheel; S/5	898794	
2	Membrane keypad, K-ANEB	898255	
3	Front cover, K-ANEB	897980	
4	EMC plate, K-ANEB	8000225	
5	Bushing	640453	
6	ON/STBY-switch, K-ANEB	8001395	
7	Command board PC board	898007	
8	Opto-encoder, rotary switch,16-positions, push button, metal shaft, 4inch ribbon cable and connector	113291	
9	Closing cover, K-ANEB, K-ICUB	897983	
10	Back cover, K-ANEB	897981	
11	Command bar cable, K-MRIANEB	M1049946	
12	Cable plate, K-ANEB	897982	
13	Front Panel sticker, CS; K-ANEB; S/5	M1062307	
13	Front Panel sticker, DA; K-ANEB; S/5	898093	
13	Front Panel sticker, DE; K-ANEB; S/5	898084	
13	Front Panel sticker, EN; K-ANEB; S/5	898083	

Item	Description	Order no.	Replaced by
13	Front Panel sticker, ES; K-ANEB; S/5	898087	
13	Front Panel sticker, FI; K-ANEB; S/5	898090	
13	Front Panel sticker, FR; K-ANEB; S/5	898085	
13	Front Panel sticker, HU; K-ANEB; S/5	M1042430	
13	Front Panel sticker, IT; K-ANEB; S/5	898088	
13	Front Panel sticker, JA; K-ANEB; S/5	898094	
13	Front Panel sticker, NL; K-ANEB; S/5	898086	
13	Front Panel sticker, NO; K-ANEB; S/5	898092	
13	Front Panel sticker, PT; K-ANEB; S/5	898089	
13	Front Panel sticker, SV; K-ANEB; S/5	898091	

4 MRI Monitor

4.1 Monitor Frame, F-MRICM1

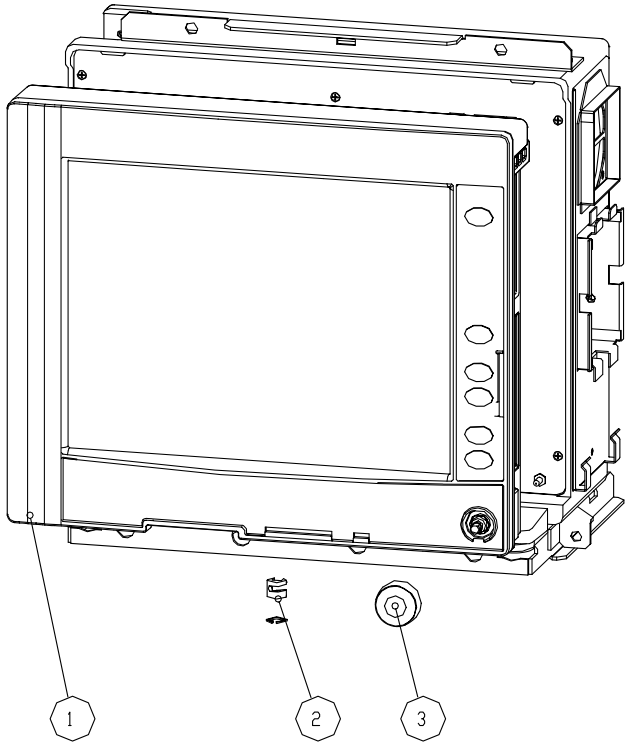


Figure 15 Exploded view of the Display Unit and labels

Item	Description	Order No.	Replaced by
1	Complete front unit, F-MRICM1	M1050395	
2	Locking set, F-CM1, SPARE PART	8001522	
3	ComWheel; S/5	898794	

4.2 MRI Monitor Frame, F-MRICM1, Frame Unit

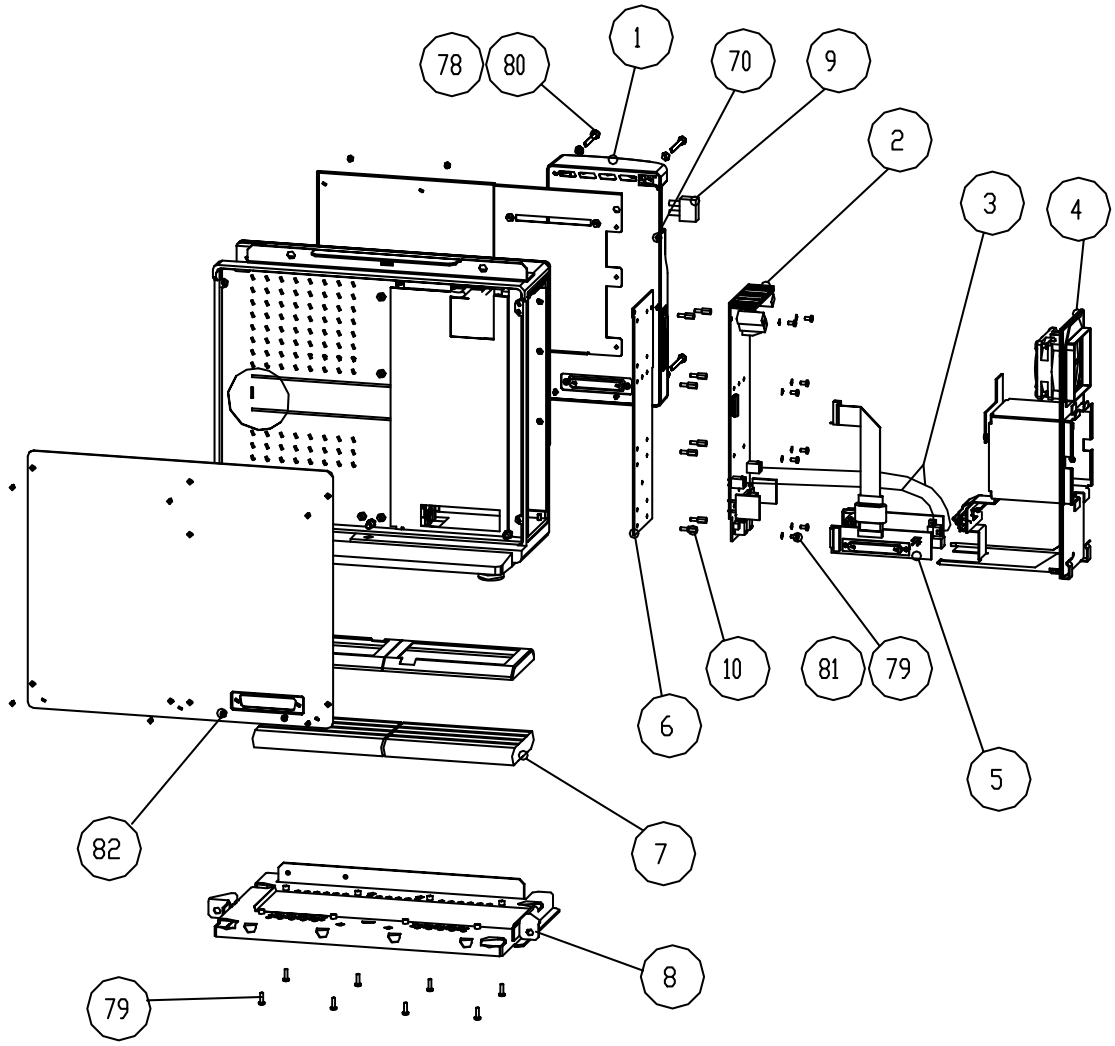


Figure 16 Exploded view of MRI Monitor Frame

Item	Description	Order No.	Replaced by
1	AC/DC Power supply, PFC, +15,5V,75W	M1043472	
2	Power management board	8005308	
3	Power cable	898313	
4	Side frame unit	M1036591	
5	PMB-connector board	898108	
6	Module mother board	8000426	
7	Battery-NiMH,12V,3.5Ah,10x1.2V	17014	
8	Bottom plate	M1034569	
9	Fuse / AH / 250V, 5x20mm	511200	

Item	Description	Order No.	Replaced by
10	Spacer, hexagon bar, M3x8,5AV5MSN	640459	
70	Screw-cross rec. c/s h, stzn, M3x6	61620	
78	Tooth washer	63615	
79	Cross cyl. head screw M3x6 tufflock	617210	
80	Screw-cross rec.cylind.h.stzn,M4x40	61761	
81	Washer-spring, M3,stzn(FZB),DIN127	634101	
82	Screw of D25 connector	897531	

4.2.1 Side frame unit for N-MRI2 Rev. 01

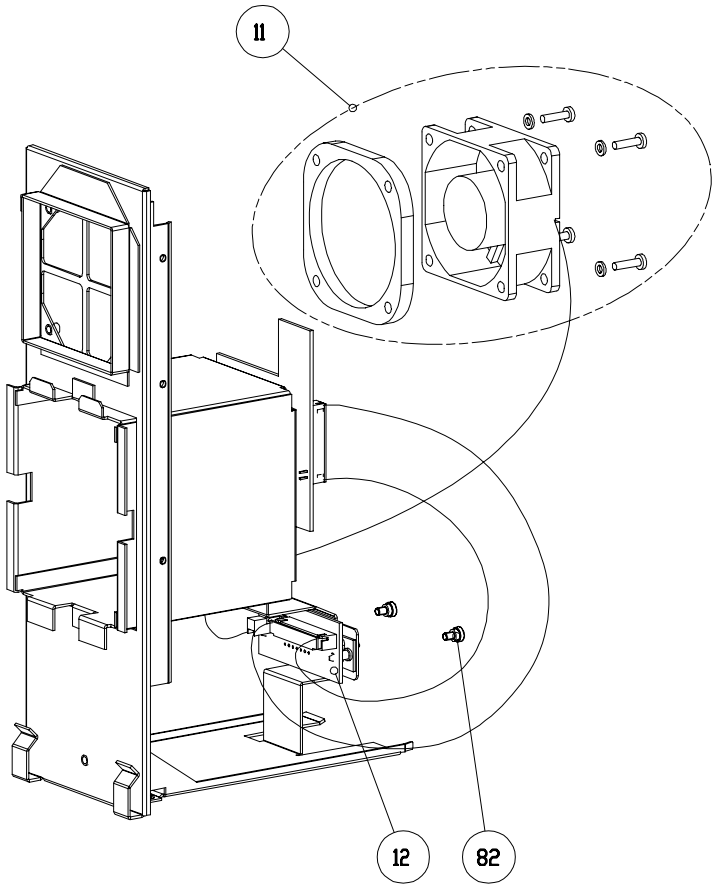


Figure 17 Exploded view of the side frame unit

Item	Description	Order No.	Replaced by
11	Fan Unit (side frame), F-MRICM1, (inc. fan, fan spacer, screws m3x12, washers)	M1080102	
12	Connector board PMB-REC	896894	
82	Screw of D25 connector	897531	

4.2.2 Side frame unit for N-MRI2 Rev. 00

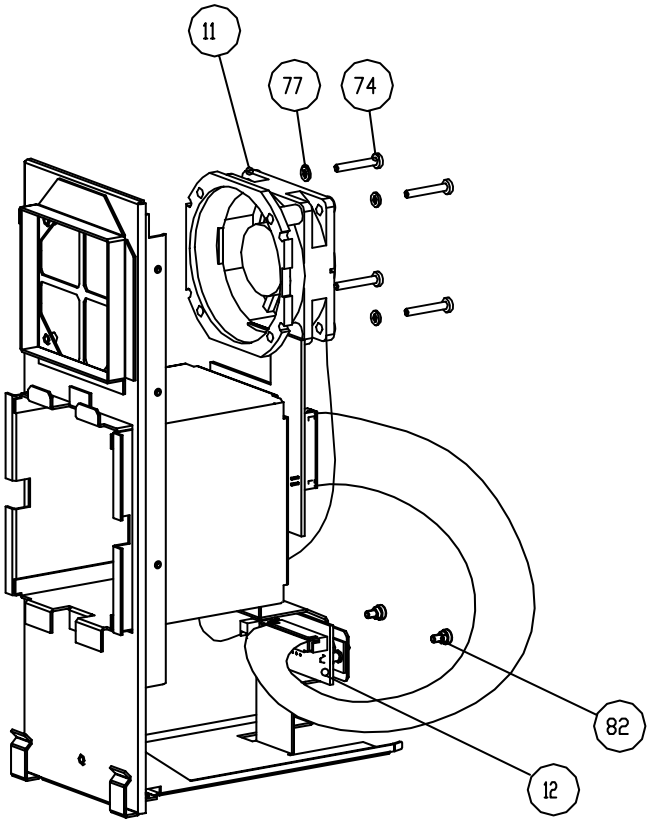


Figure 18 Exploded view of the side frame unit

Item	Description	Order No.	Replaced by
11	Fan Unit, F-MRICM1	M1037010	M1080102
12	Connector board PMB-REC	896894	
74	Cross cyl. rec.cylind.h.stzn, m3x6	61737	
77	Shakeproof washer, m3.2	63611	
82	Screw of D25 connector	897531	

4.3 MRI Monitor Frame, F-MRICM1, Display Unit

4.3.1 Front unit, F-MRICM1

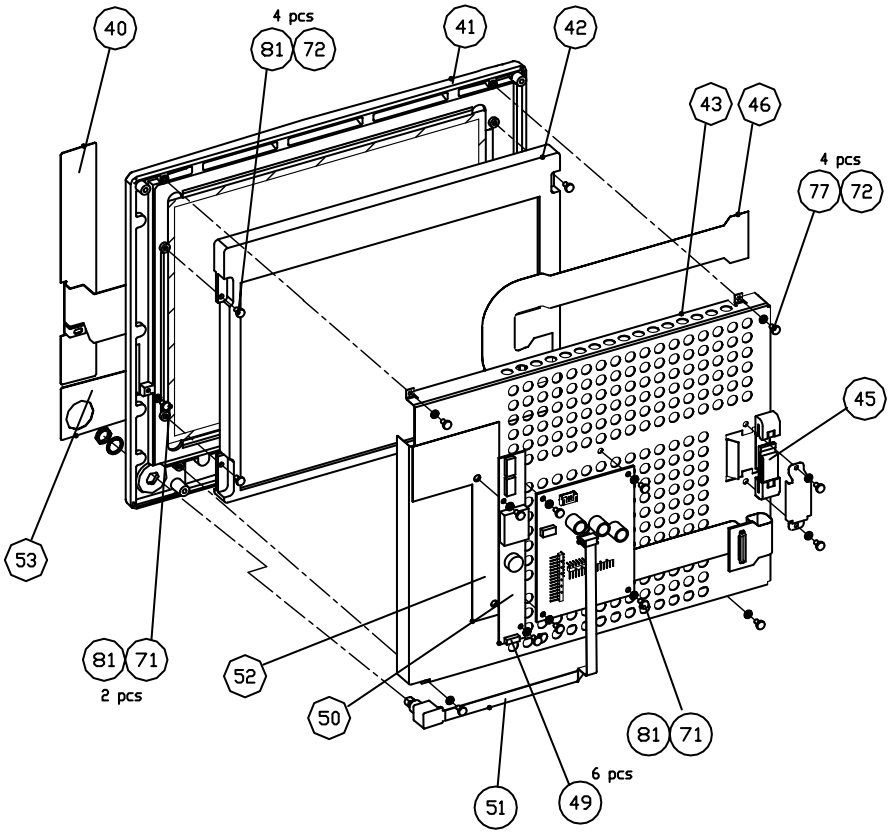


Figure 19 Exploded view of the Display Front Unit

Item	Description	Order No.	Replaced by
	Complete front unit, F-MRICM1	M1050395	
	Backlight for display, F-CM1 rev.03	M1014385	
40	Membrane keyboard, VERT., F-CM1	895686	
41	Front cover for display unit, F-CM1 rev.01	8004620	
42	Display-LCD,	M1012542	
43	EMC Cover (Display), F-CM1 rev.01	M1014033	
45	EMI-filter, split ferrite core for flat cable 26mm	304514	
46	Display cable board, F-CM1 rev.01	8003727	
48	Connection board (DU), F-CM1	896465	
49	Inverter cable (SHARP), F-CM1 rev 01	8004022	
50	12V inverter for LCD display M1012542	M1013813	

Item	Description	Order No.	Replaced by
51	Opto-encoder, rotary switch, 16-postions, push button, plastic shaft, 10inch Ribbon cable and connector	M1048396	
52	Insulator for Inverter, F-CM(C)(REC)1...01	8004024	
53	Membrane keyboard, HORIS., F-CM1	895685	
54	Wire clamp	M1015333	
71	Cross cylinder-head screw M3x6	61721	
72	Cross cylinder head screw M3x8	61722	
73	Screw-cross rec.cylind.h. stzn,m3x10	61735	
77	Shakeproof washer m3.2	63611	
81	Washer-spring, M3,STZN(FZB),DIN127	634101	

4.3.2 Central Processing Board

Item	Item description	Order No.
-	Battery for SRAM/Timekeeper	197230

4.3.3 Display unit, bottom unit, F-MRICM1

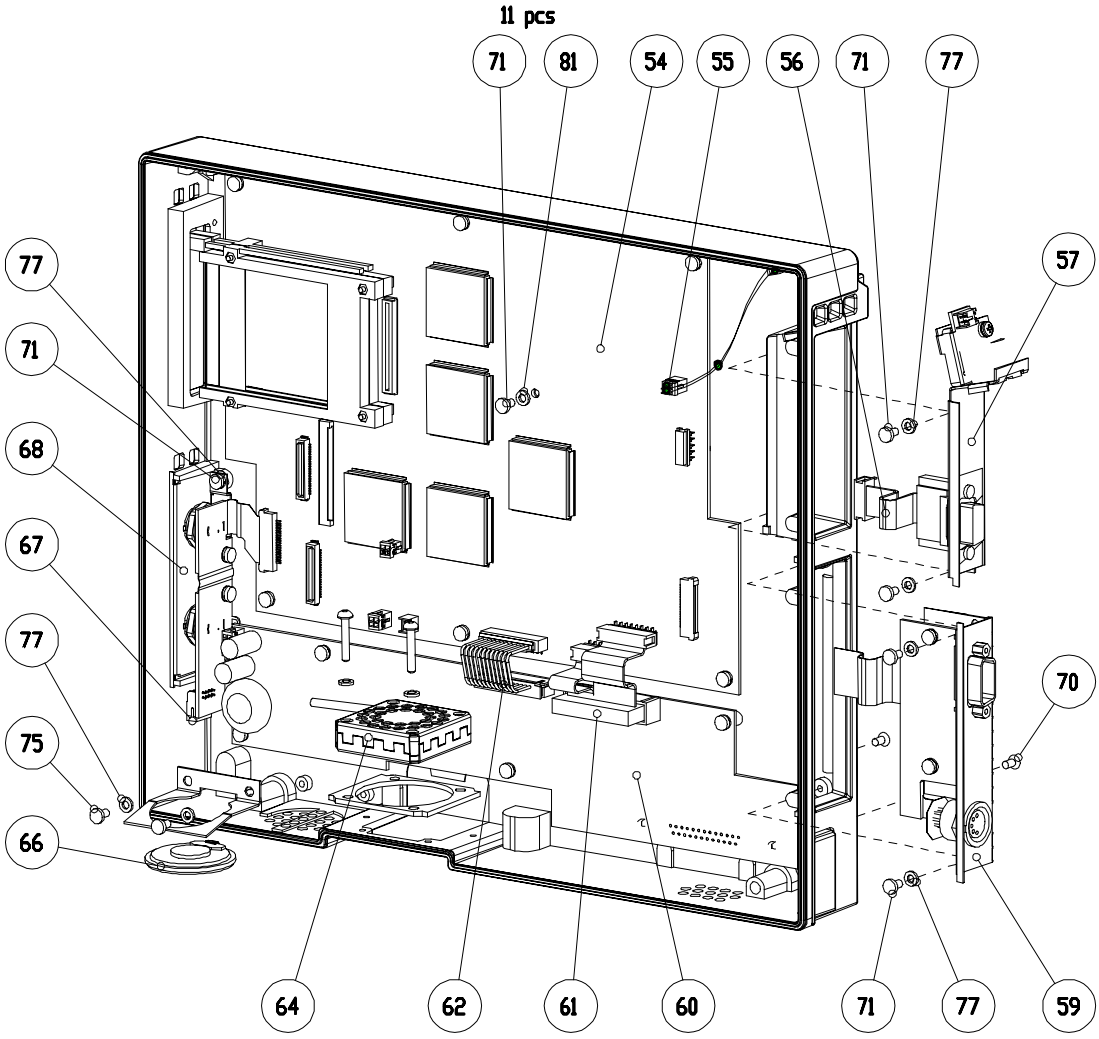


Figure 20 Exploded view of the Display Unit, bottom unit

Item	Description	Order No.	Replaced by
54	Central Processing Board, F-CM1	8001596	
55	NET cable, F-CM1	896527	
56	NET Smart key cable, F-CM1	896528	
57	Connector unit, NET, F-CM1	M1035234	
59	Connector unit, SYNC, F-MRICM1	M1036734	
60	DC/DC-board, F-CM1	896705	
61	Central Processing Board-DC/DC SIGNAL CABLE, F-CM1	8000023	
62	Central Processing Board-DC/DC POWER CABLE, F-CM1	8000004	
64	Fan unit, F-MRICM1 (incl. magnetic shield)	M1036960	

Item	Description	Order No.	Replaced by
64	Fan unit (DU), F-CM1	896555	M1036960
66	Loudspeaker unit, F-CM1	896109	
67	DIS power cable, F-CM1	8000007	
68	Connector unit, DIS, F-CM1	M1036735	
70	Screw-cross rec. c/s h, stzn, m3x6	61620	
71	Cross cylinder-head screw M3x6	61721	
75	Cross cylinder head screw M3x18 FZB DIN7985	61739	
77	Shakeproof washer m3.2	63611	
81	Washer-spring, M3,STZN(FZB),DIN127	634101	

5 MRI Compact Airway Module, E-MRICAiOV, E-MRICAiO, E-MRICO

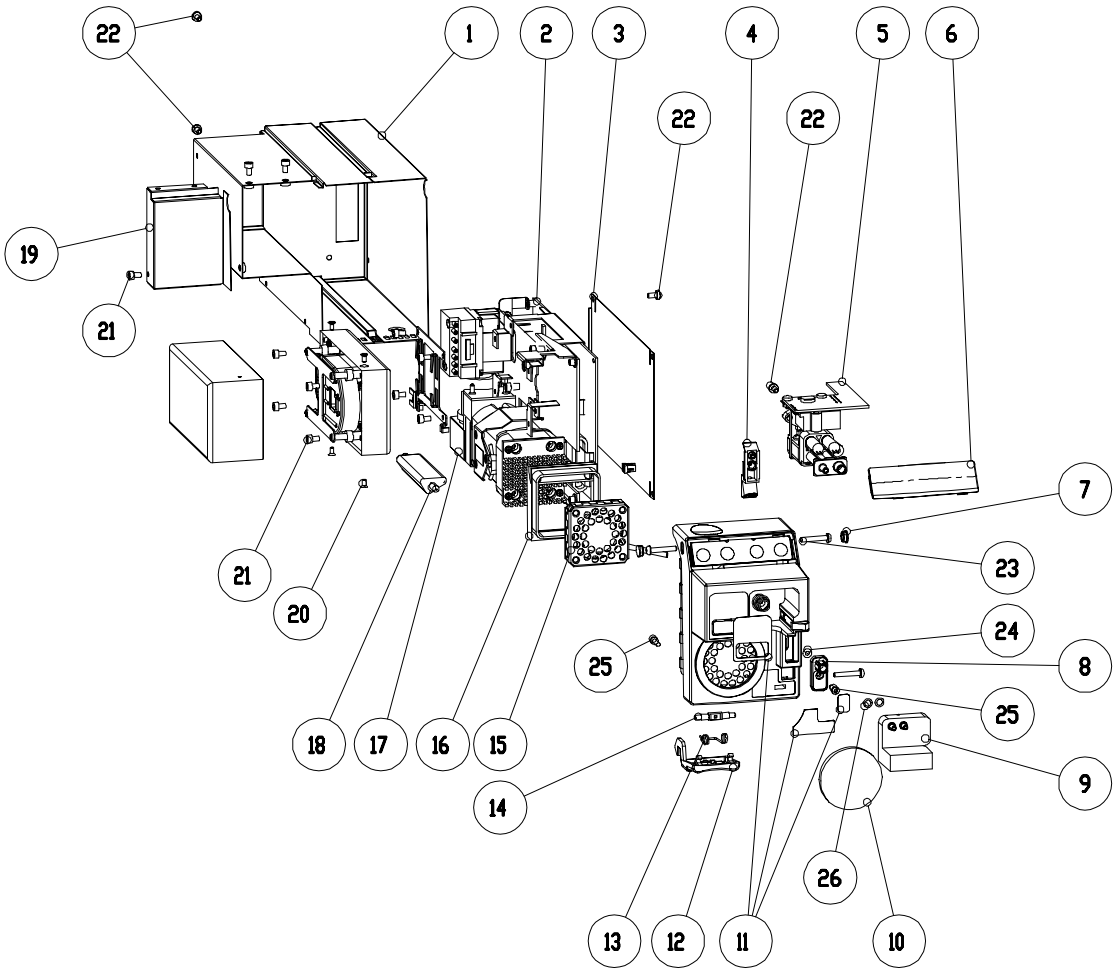


Figure 21 Exploded view of the MRI Compact Airway Module

Item	Description	Order No.	Replaced by
	Nafion tubing 300mm	733382	
	OM Extension wires for OM Unit, E-MRIGAS	M1037511	
1	Casing	M1029732	
2	CPU Board	8001806	
3	Cover plate for Gas Units	M1029000	
4	Filter base	M1021041	
5	PVX Unit	M1029209	

Item	Description	Order No.	Replaced by
6	Key plate (no buttons)	M1024362	
7	Filler plug	M1024364	
8	Ref. gas filter and frame	M1028983	
9	Dummy D-Fend	M1053048	
10	Fan filter	M1028987	
11	Front panel sticker, EN, E-MRIGAS	M1039925	
12	Latch	M1021039	
13	Torsion spring	M1024356	
14	Joint	M1023087	
15	Fan,M-CAiOV	886213	M1076190
15	Fan Unit for E-MRICAiOV (incl. magnetic shield)	M1076190	
16	Air deflector	886239	
17	Electric Pump, 0V, 10V, Air pump, max 0.39l/min., 10VDC	57313-HEL	
18	Zero absorber	895933	
19	Cover for module frame	M1029791	
21	SCREW, machine screw, M3x5mm, DIN912, ISO4762,	619061	
22	Screw, M3x6mm, DIN7985, ISO7045	61721	
23	Screw, M3x18mm, DIN7985, ISO7045	61739	
24	O-ring, 2.8x1.6	65340	
25	Screw, M2.5x10mm, DIN7985, ISO7045	61715	
26	O-ring, 4.0x1.0, NBR, Shore 70	653125	

5.1 D-FEND latch

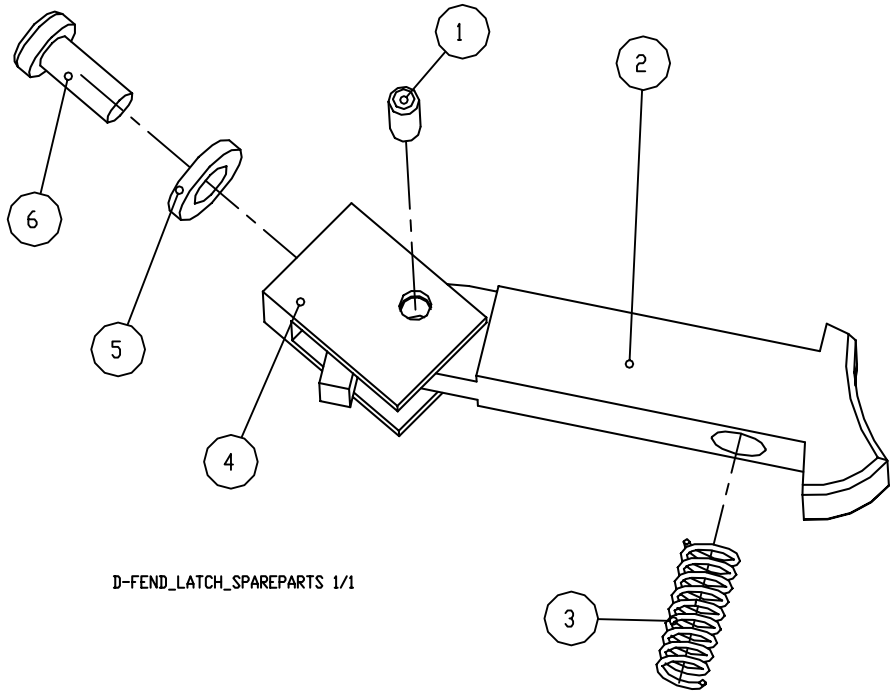


Figure 22 Exploded view of the D-Fend latch

Item	Description	Order No.
	D-fend Latch Assembly, Spare Part Assembly	M1039037
1	Pin, M-CAiOV	887005
2	Latch, D-Fend	M1028985
3	Spring 0.4x2.5x10	64242
4	Hinge, M-CAiOV	886235
5	Washer STZN, M 2.7	63608
6	Screw M2.5x6 mm, DIN7985 ISO7045, Pozidrive	617120-HEL

6 Hemodynamic Modules

6.1 E-MRIPSN

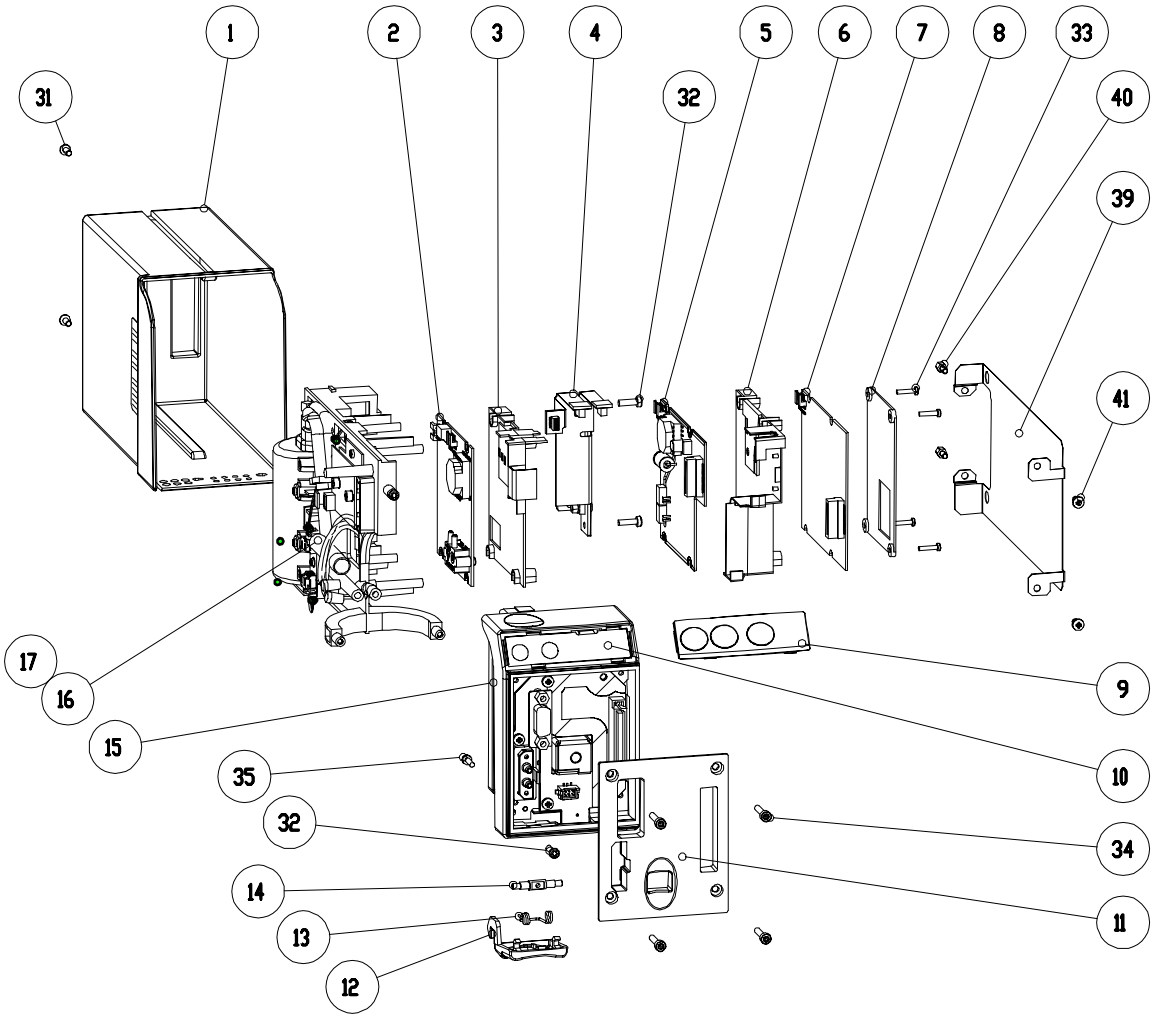


Figure 23 Exploded view of the Hemodynamic Module E-MRIPSN

Item	Description	Order No.	
1	Module casing	M1021037	
2	NIBP Board PSM	M1007747	
3	STP - NIBP Insulator	M1008207	
4	E-PRESTN Module bus connection board	M1024653	
5	STP Main Assembly for STP board	M1038301	
6	ECG STP Insulator, E-PSM(P)	M1008205	

Item	Description	Order No.	
7	Dummy ECG Board, E-MRIPSN...	M1035322	
8	Board cover	M1038754	
9	Front Cover, EN, ...	M1041516	
10	Membrane Keyboard, E-MRIPSN	M1040960	
11	Front Cover, E-MRIPSN	M1021059	
12	Latch	M1021039	
13	Torsion spring	M1024356	
14	Joint	M1023087	
15	Front chassis, E-REC	M1021043	
16	Filter cover	M1020996	
17	Filter, air filter, 30um, HDPE, D=6.5mm, d=3.3mm, L=46mm	57142-HEL	
18	Frame for E-(P)RE(S)TN	M1023076	
19	FILT-EMI, low pass, soft ferrite for 16way flat cable, solid	304508	
20	Front Chassis Unit, E-MRIPSN, Phantom	M1035811	
21	NIBP Switch housing	M1018468	
22	Mounting Plate for Hall Sensor Board, E-MRIPSN, Sheet metal	M1045260	
23	Hall sensor board, E-MRIPSN, Printed Circuit Assembly - Buy	M1047321	
24	E-PRESTN NIBP pump connection board	M1024369	
25	NIBP Pump Unit, E-PSM(P)	M1011858	
26	NIBP Pump Extension Wires, E-PRESTN	M1027664	
27	Tube connector, L-piece 3mm, white	73381	
28	Tube silicon 3,18x6,35	73375	
29	NIBP Manifold Unit, E-MRIPSN	M1045186	
30	Angled hose, E-(P)RE(S)TN	M1023083	
31	Screw, M3x8mm, WN1423, torx head	M1027118	
32	SCREW, for plastic PT, M3x10mm, WN1452, pan head, steel, zinc, head Torx 8, head max 5mm	628728	
33	SCREW, PT, 2.2mmx10mm, torx head, pan head, steel, zinc coated	M1010187	
34	SCREW, machine screw, M3x16mm, DIN912, ISO4762, hexagonal socket, cylinder head, acid proof steel (AISI316)	619216-HEL	
35	SCREW panhead. M2.5x10 A2(RST) DIN7985(ISO7045	61852	
36	SCREW M3x5mm, DIN912, ISO4762, hexagonal socket, cylinder head, acid proof steel (AISI316)	619061	

Item	Description	Order No.	
37	SCREW-PT, CROSS/PAN-HEAD, POZIDRIVE, 2.5x20mm, POINT WITH ALIGNING ZONE, FeZn, WN1412	628718	
38	PART, Washer 2.5x7.5x1 mm, Sheet metal	M1010176	
39	EMC Shield, E-MRIPSN	M1084909	
40	SCREW, STZN 4-40 UNCx1/4”	61841	
41	SCREW, machine screw, M3x6mm, DIN7985, ISO7045, Pozidrive, pan head, acid proof steel (AISI316), SCREW-MACH, PAN-HEAD, CROSS HEAD POZ., M3x6, ACIDPROOF(A4-70), DIN7985(ISO7045)	617211	

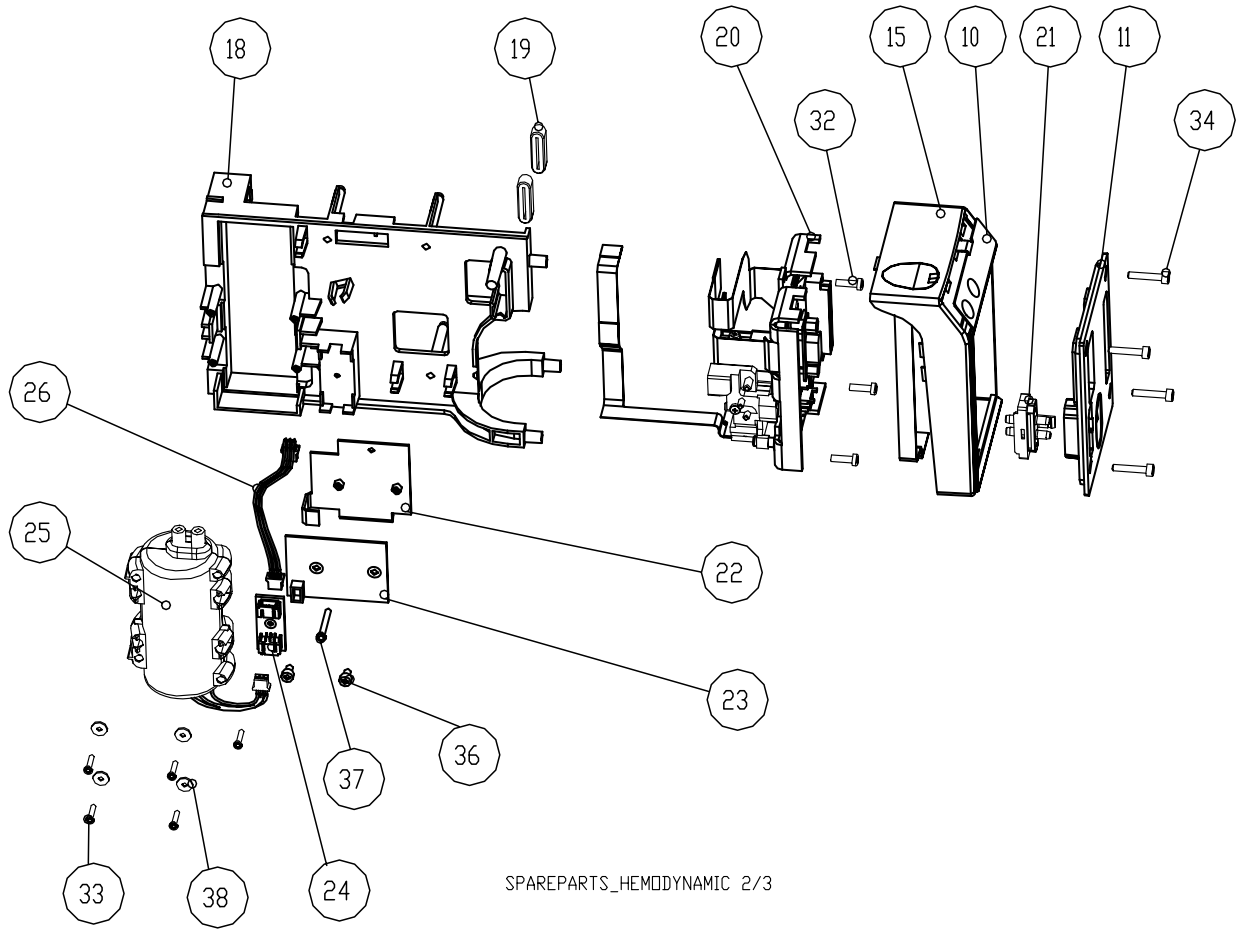


Figure 24 Exploded view of the inner parts of the Hemodynamic Module

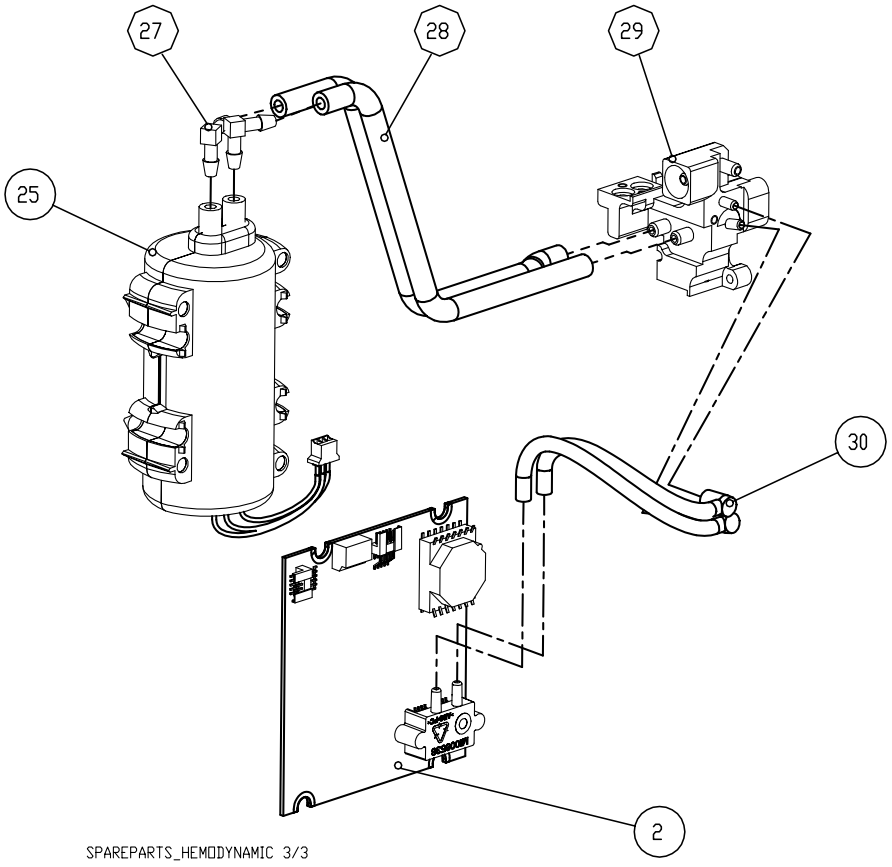


Figure 25 NIBP tuging

7 Device Interfacing Solution, N-DISVENT (rev.01 ... 02, M1079844)

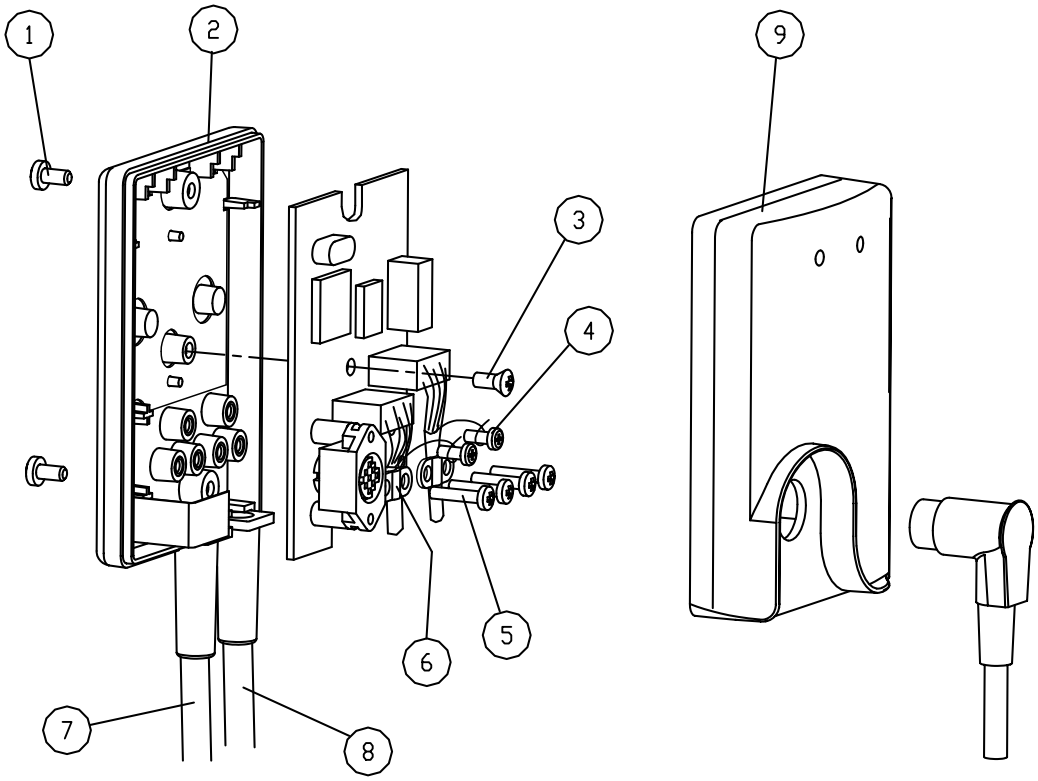


Figure 26 Exploded view of the Device Interfacing module, N-DISVENT

Item	Description	Order No.
1	Screw for the DIS module case	617210
2	DIS module case, rear	896930
3	Screw for the PC board, MFX M2.5X5 STZN	61209
4	Screw, STZN M3x6 TUFFLOCK	617120
5	SCREW, machine screw, M2.5x10mm, DIN7985, ISO7045, Pozidrive, pan head, steel, zinc coated	61715
6	Strain relief, N-DIS	897443
7	Bus cable, 1 m	900501
7	Bus cable, 2 m	900502
7	Bus cable, 6 m	900503

Item	Description		Order No.
	Device specific cables:		
8	Cable for Datex-Ohmeda anesthesia systems and critical care ventilators	N-DISVENT	M1023823
	DIS module case with labeling:		
9	Front cover for Datex-Ohmeda anesthesia systems and critical care ventilators	N-DISVENT	M1057871

8 Remote controller, K-CREMCO, rev. 00, 01

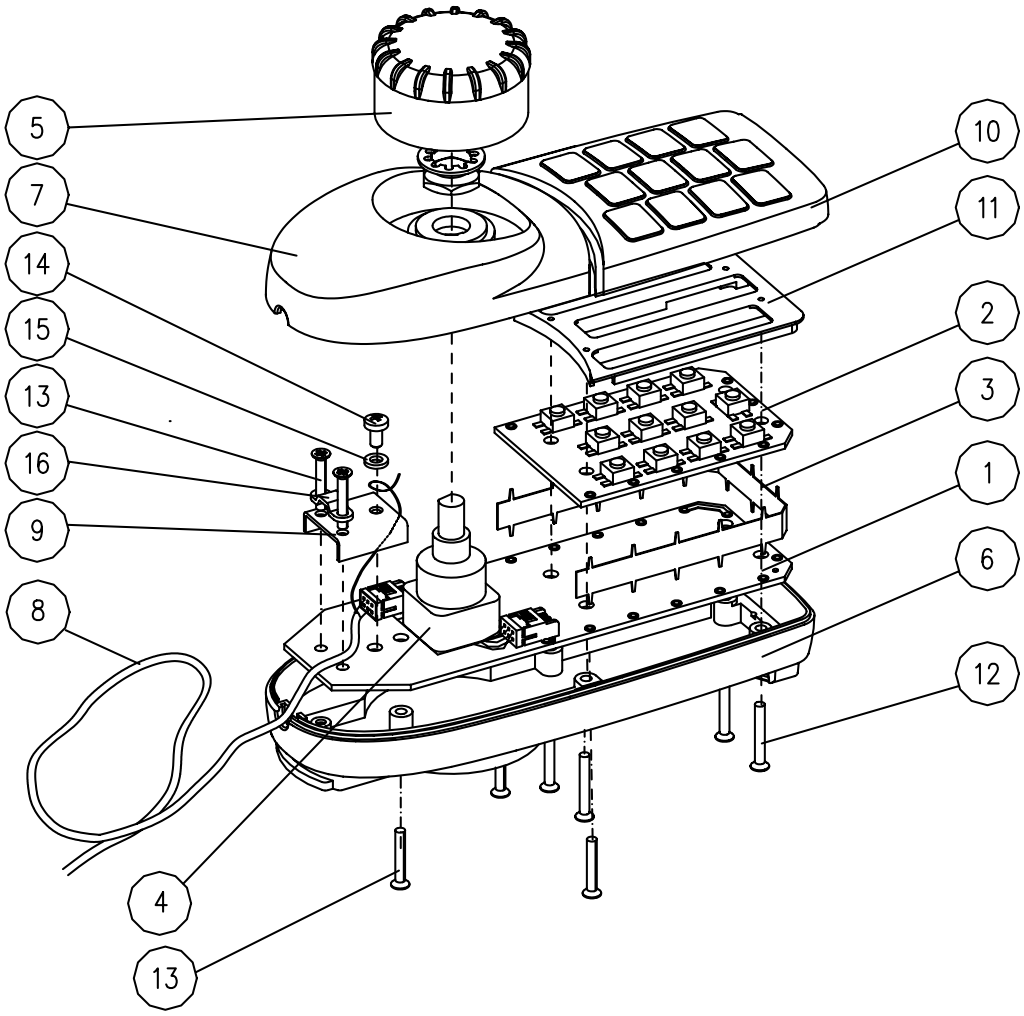


Figure 27 Exploded view of the Remote Controller

Item	Description	Order No.	Replaced by
1	CPU board, K-REMCO	890368	
2	Keyboard PCB, K-REMCO	890371	
3	Connecting plate	891427	
4	Rotary wheel	891036	
5	ComWheel (green); K-REMCO; S/5	898940	
6	Bottom (Munsell N9); K-REMCO; S/5	898938	
7	Cover (Munsell N9); K-REMCO; S/5	898939	
8	K-REMCO - CM cable	891965	

Item	Description	Order No.	Replaced by
9	Bridge for cable	893235	
10	Front Panel sticker, DA; K-REMCO (rev.00), (rev.01; S/5)	892203	
10	Front Panel sticker, DE; K-REMCO (rev.00), (rev.01; S/5)	892312	
10	Front Panel sticker, EN; K-REMCO (rev.00), (rev.01; S/5)	891425	
10	Front Panel sticker, ES; K-REMCO	892315	
10	Front Panel sticker, FI; K-REMCO (rev.00), (rev.01; S/5)	892317	
10	Front Panel sticker, FR; K-REMCO (rev.00), (rev.01; S/5)	892313	
10	Front Panel sticker, IT; K-REMCO (rev.00), (rev.01; S/5)	892316	
10	Front Panel sticker, JA; K-REMCO (rev.01) S/5	894962	
10	Front Panel sticker, NL; K-REMCO (rev.00), (rev.01; S/5)	892314	
10	Front Panel sticker, NO; K-REMCO (rev.00), (rev.01; S/5)	893553	
10	Front Panel sticker, PT; K-REMCO (rev.01); S/5	895233	
10	Front Panel sticker; SV; K-REMCO (rev.00), (rev.01; S/5)	892318	
10	PANEL, Printing of the keyboard, K-REMCO, HU	M1060080	
11	Front panel framework	891426	
12	Slotted recess screw M2.5x22	61218	
13	Cross recess PT-screw M2.5x16	628719	
14	Cross cylinder-head screw M3x6	61721	
15	Shake proof washer m3.2	63611	
16	Cable binder	546454	

9 Anesthesia keyboards, K-ARKB

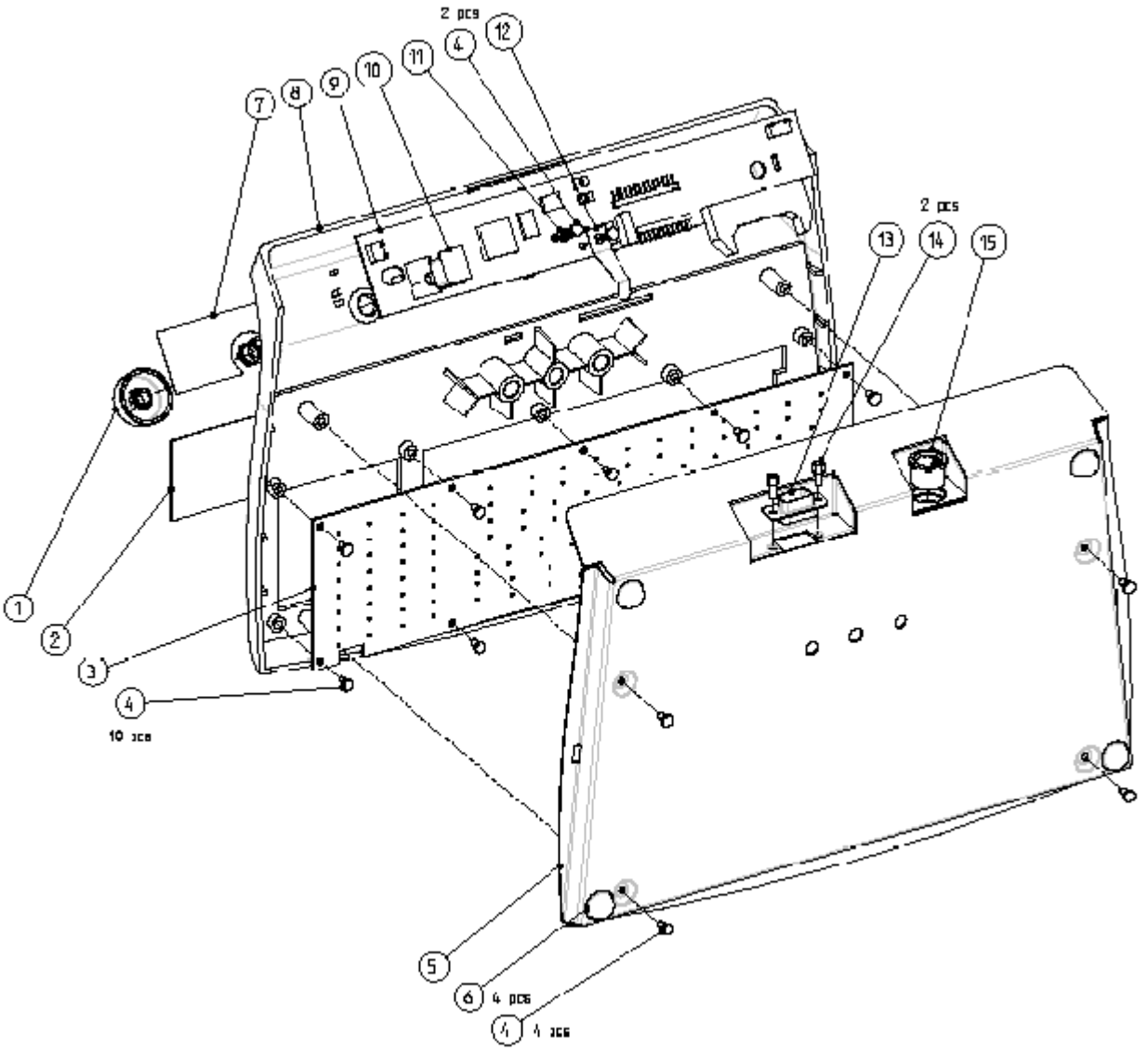
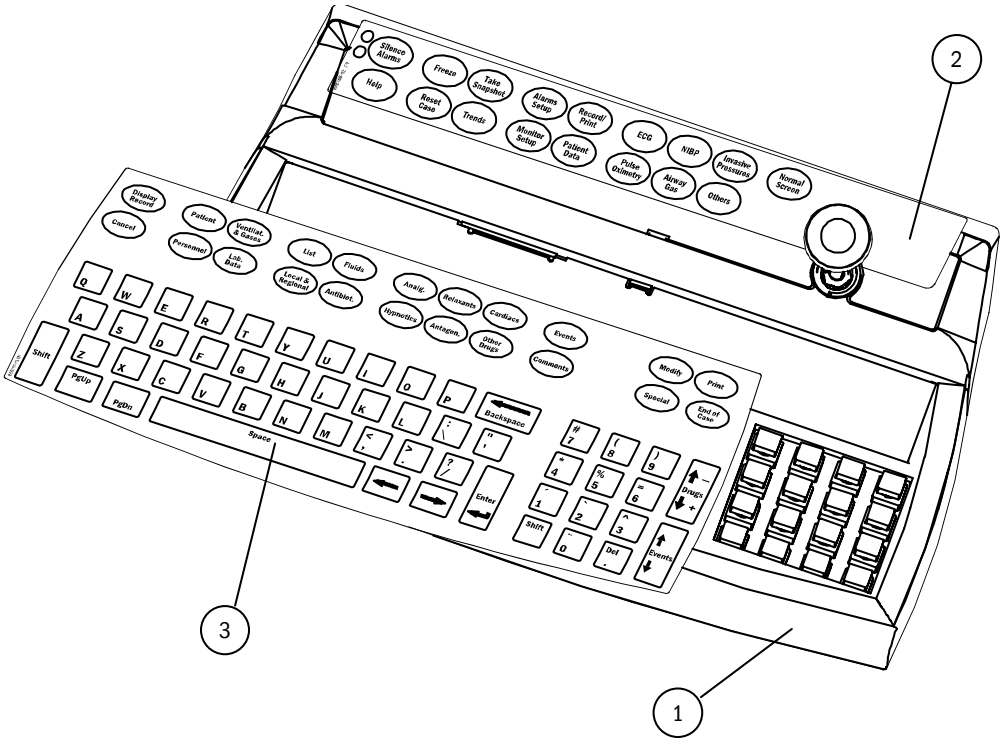


Figure 28 Exploded view of the Anesthesia Record Keeping Keyboard

Item	Description	Order No.	Replaced by
1	ComWheel; S/5	898794	
2	Membrane keypad, lower, K-ARKB; S/5	8000006	
3	Alpha-numeric Keyboard PC-board, K-ARK (rev.00-01), K-CENTRALB	884178	
4	Cross cylinder-head screw M3x6	61721	
5	Bottom plate, K-ARKB; S/5	898392	
6	Sticker-pad,diam 16,height 8	65142	
7	Membrane keypad, K-ARKB; S/5	8000050	

Item	Description	Order No.	Replaced by
8	Keyboard casing, K-ARKB; S/5	898391	
9	Command bar board, K-ARKB; S/5	8000054	
10	Opto-encoder, rotary switch,16-positions, push button, metal shaft, 4inch ribbon cable and connector	113291	
11	Shake proof washer m3.2	63611	
12	Emc plate, K-ARKB; S/5	8000960	
13	Output connector cable, K-ARKB; S/5	8000098	
14	D-female screw lock	640624	
15	Connection cable PC-KB, K-ARKB;S/5	8000097	



K-ARKB S/5 front panel stickers

Item	Description	Order No.	Replaced by
1	Keyboard casing, K-ARKB; S/5	898391	
2	Upper Front Panel sticker, DA; K-ARKB (rev.00); S/5	898369	
2	Upper Front Panel sticker, DE; K-ARKB (rev.00); S/5	898378	
2	Upper Front Panel sticker, EN; K-ARKB (rev.00); S/5	898368	
2	Upper Front Panel sticker, EN; K-ARKB (rev.00); S/5	898368	
2	Upper Front Panel sticker, ES; K-ARKB (rev.00); S/5	898372	

2	Upper Front Panel sticker, FI; K-ARKB (rev.00); S/5	898375	
2	Upper Front Panel sticker, FR; K-ARKB (rev.00); S/5	898370	
2	Upper Front Panel sticker, IT; K-ARKB (rev.00); S/5	898373	
2	Upper Front Panel sticker, JA; K-ARKB (rev.00); S/5	8000373	
2	Upper Front Panel sticker, NL; K-ARKB (rev.00); S/5	898371	
2	Upper Front Panel sticker, NL; K-ARKB (rev.00); S/5	898371	
2	Upper Front Panel sticker, NO; K-ARKB (rev.00); S/5	898377	
2	Upper Front Panel sticker, PT; K-ARKB (rev.00); S/5	898374	
2	Upper Front Panel sticker, SV; K-ARKB (rev.00); S/5	898376	
3	Front Panel sticker, lower, BE, NL; K-ARKB; S/5	898797	
3	Front Panel sticker, lower, DA; K-ARKB (rev.00); S/5	898390	
3	Front Panel sticker, lower, DE; K-ARKB (rev.00); S/5	898381	
3	Front Panel sticker, lower, EN; K-ARKB (rev.00); S/5	898380	
3	Front Panel sticker, lower, ES; K-ARKB (rev.00); S/5	898384	
3	Front Panel sticker, lower, FI; K-ARKB (rev.00); S/5	898387	
3	Front Panel sticker, lower, FR; K-ARKB (rev.00); S/5	898382	
3	Front Panel sticker, lower, IT; K-ARKB (rev.00); S/5	898385	
3	Front Panel sticker, lower, JA; K-ARKB (00); S/5	8000374	
3	Front Panel sticker, lower, NL; K-ARKB (rev.00); S/5	898383	
3	Front Panel sticker, lower, NO; K-ARKB (rev.00); S/5	898389	
3	Front Panel sticker, lower, PT; K-ARKB (rev.00); S/5	898386	
3	Front Panel sticker, lower, SKAND; K-ARKB; S/5	898796	
3	Front Panel sticker, lower, SV; K-ARKB (rev.00); S/5	898388	

GE Healthcare

Service Manual Language Information

WARNING (EN)	This service manual is available in English only. • 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 service 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.
ПРЕДУПРЕЖДЕНИЕ (BG)	Това упътване за работа е налично само на английски език. • Ако доставчикът на услугата на клиента изиска друг език, задължение на клиента е да осигури превод. • Не използвайте оборудването, преди да сте се консултирали и разбрали упътването за работа. • Неспазването на това предупреждение може да доведе до нараняване на доставчика на услугата, оператора или пациент в резултат на токов удар или механична или друга опасност.
VAROVÁNÍ (CS)	Tento provozní návod existuje pouze v anglickém jazyce. • V případě, že externí služba zákazníkům potřebuje návod v jiném jazyce, je zajištění překladu do odpovídajícího jazyka úkolem zákazníka. • Nesnažte se o údržbu tohoto zařízení, aniž byste si přečetli tento provozní návod a pochopili jeho obsah. • V případě nedodržování této varování může dojít k poranění pracovníka prodejního servisu, obslužného personálu nebo pacientů vlivem elektrického proudu, respektive vlivem mechanických či jiných rizik.
ADVARSEL (DA)	Denne servicemanual findes kun på engelsk. • Hvis en kundes tekniker har brug for et andet sprog end engelsk, er det kundens ansvar at sørge for oversættelse. • Forsøg ikke at servicere udstyret medmindre denne servicemanual har været konsulteret og er forstået. • Manglende overholdelse af denne advarsel kan medføre skade på grund af elektrisk, mekanisk eller anden fare for teknikeren, operatøren eller patienten.
WARNUNG (DE)	Diese Serviceanleitung ist nur in englischer Sprache verfügbar. • Falls der Kundendienst eine andere Sprache benötigt, muss er für eine entsprechende Übersetzung sorgen. • Keine Wartung durchführen, ohne diese Serviceanleitung gelesen und verstanden zu haben. • Bei Zuwiderhandlung kann es zu Verletzungen des Kundendiensttechnikers, des Anwenders oder des Patienten durch Stromschläge, mechanische oder sonstige gefahren kommen.
ΠΡΟΕΙΔΟΠΟΙΗΣΗ (EL)	Το παρόν εγχειρίδιο σέρβις διατίθεται στα αγγλικά μόνο. • Εάν το άτομο παροχής σέρβις ενός πελάτη απαιτεί το παρόν εγχειρίδιο σε γλώσσα εκτός των αγγλικών, αποτελεί ευθύνη του πελάτη να παρέχει υπηρεσίες μετάφρασης. • Μην επιχειρήσετε την εκτέλεση εργασιών σέρβις στον εξοπλισμό εκτός εαν έχετε συμβουλευτεί και έχετε κατανοήσει το παρόν εγχειρίδιο σέρβις. • Εαν δε λάβετε υπόψη την προειδοποίηση αυτή, ενδέχεται να προκληθεί τραυματισμός στο άτομο παροχής σέρβις, στο χειριστή ή στον ασθενή από ηλεκτροπληξία, μηχανικούς ή άλλους κινδύνους.
ADVERTENCIA (ES)	Este manual de servicio sólo existe en inglés. • Si el encargado de mantenimiento de un cliente necesita un idioma que no sea el inglés, el cliente deberá encargarse de la traducción del manual. • No se deberá dar servicio técnico al equipo, sin haber consultado y comprendido este manual de servicio. • La no observancia del presente aviso puede dar lugar a que el proveedor de servicios, el operador o el paciente sufran lesiones provocadas por causas eléctricas, mecánicas o de otra naturaleza.

HOIATUS (ET)	Käesolev teenindusjuhend on saadaval ainult inglise keeles. • Kui klienditeeninduse osutaja nõuab juhendit inglise keelest erinevas keeles, vastutab klient tõlketeenuse osutamise eest. • Ärge üritage seadmeid teenindada enne eelnevalt käesoleva teenindusjuhendiga tutvumist ja sellest aru saamist. • Käesoleva hoiatuse eiramine võib põhjustada teenuseosutaja, operaatori või patsiendi vigastamist elektrilöögi, mehaanilise või muu ohu tagajärjel.
VAROITUS (FI)	Tämä huolto-ohje on saatavilla vain englanniksi. • Jos asiakkaan huoltohenkilöstö vaatii muuta kuin englanninkielistä materiaalia, tarvittavan käännöksen hankkiminen on asiakkaan vastuulla. • Älä yritä korjata laitteistoa ennen kuin olet varmasti lukenut ja ymmärtänyt tämän huolto-ohjeen. • Mikäli tätä varoitusta ei noudateta, seurauksena voi olla huoltohenkilöstön, laitteiston käyttäjän tai potilaan vahingoittuminen sähköiskun, mekaanisen vian tai muun vaaratilanteen vuoksi.
ATTENTION (FR)	Ce manuel technique n'est disponible qu'en anglais. • Si un service technique client souhaite obtenir ce manuel dans une autre langue que l'anglais, il devra prendre en charge la traduction et la responsabilité du contenu. • Ne pas tenter d'intervenir sur les équipements tant que le manuel technique n'a pas été consulté et compris. • Le non-respect de cet avertissement peut entraîner chez le technicien, l'opérateur ou le patient des blessures dues à des dangers électriques, mécaniques ou autres.
UPOZORENJE (HR)	Ove upute za servisiranje dostupne su samo na engleskom jeziku. • Ukoliko korisnički servis zahtijeva neki drugi jezik, korisnikova je odgovornost osigurati odgovarajući prijevod. • Nemojte pokušavati servisirati opremu ukoliko niste konzultirali i razumjeli ove upute. • Nepoštivanje ovog upozorenja može rezultirati ozljedama servisnog osoblja, korisnika ili pacijenta prouzročenim električnim udarom te mehaničkim ili nekih drugih opasnostima.
FIGYELMEZTETÉS (HU)	Ez a szerviz kézikönyv kizárólag angol nyelven érhető el. • Ha a vevő szerviz ellátója angoltól eltérő nyelvre tart igényt, akkor a vevő felelőssége a fordítás elkészíttetése. • Ne próbálja elkezdeni használni a berendezést, amíg a szerviz kézikönyvben leírtakat nem értelmezték és értették meg. • Ezen figyelmeztetés figyelmen kívül hagyása a szerviz ellátó, a működtető vagy a páciens áramütés, mechanikai vagy egyéb veszélyhelyzet miatti sérülését eredményezheti.
PERINGATAN (ID)	Manual servis ini hanya tersedia dalam Bahasa Inggris. • Jika penyedia jasa servis pelanggan memerlukan bahasa lain selain dari Bahasa Inggris, merupakan tanggung jawab dari penyedia jasa servis tersebut untuk menyediakan terjemahannya. • Jangan mencoba melakukan servis pada perlengkapan kecuali telah membaca dan memahami manual servis ini. • Mengabaikan peringatan ini bisa berakibat cedera pada penyedia servis, operator, atau pasien, karena terkena kejut listrik, bahaya mekanis atau bahaya lainnya.
AÐVÖRUN (IS)	Þessi þjónustuhandbók er eingöngu fáanleg á ensku. • Ef að þjónustuveitandi viðskiptamanns þarfnast annas tungumáls en ensku, er það skylda viðskiptamanns að skaffa tungumálaþjónustu. • Reynið ekki að afgreiða tækið nema að þessi þjónustuhandbók hefur verið skoðuð og skilin. • Brot á sinna þessari aðvörun getur leitt til meiðsla á þjónustuveitanda, stjórnanda eða sjúklings frá raflosti, vélrænu eða öðrum áhættum.
AVVERTENZA (IT)	Il presente manuale di manutenzione è disponibile soltanto in Inglese. • Se un addetto alla manutenzione richiede il manuale in una lingua diversa, il cliente è tenuto a provvedere direttamente alla traduzione. • Si proceda alla manutenzione dell'apparecchiatura solo dopo aver consultato il presente manuale ed averne compreso il contenuto. • Il non rispetto della presente avvertenza potrebbe far compiere operazioni da cui derivino lesioni all'addetto, alla manutenzione, all'utilizzatore ed al paziente per folgorazione elettrica, per urti meccanici od altri rischi.

警告 (JA)	このサービスマニュアルは英語版しかありません。 ・ サービスを担当される業者が英語以外の言語を要求される場合、翻訳作業はその業者の責任で行うものとさせていただきます。 ・ このサービスマニュアルを熟読し、十分に理解した上で装置のサービスを行ってください。 ・ この警告に従わない場合、サービスを担当される方、操作員あるいは患者が、感電や機械的又はその他の危険により負傷する可能性があります。
경고 (KO)	본 서비스 지침서는 영어로만 이용하실 수 있습니다 . • 고객의 서비스 제공자가 영어 이외의 언어를 요구할 경우 , 번역 서비스를 제공하는 것은 고객의 책임입니다 . • 본 서비스 지침서를 참고했고 이해하지 않는 한은 해당 장비를 수리하려고 시도하지 마십시오 . • 이 경고에 유의하지 않으면 전기 쇼크 , 기계상의 혹은 다른 위험으로부터 서비스 제공자 , 운영자 혹은 환자에게 위해를 가할 수 있습니다 .
ĮSPĖJIMAS (LT)	Šis eksploatavimo vadovas yra prieinamas tik anglų kalba. • Jei kliento paslaugų tiekėjas reikalauja vadovo kita kalba – ne anglų, numatyti vertimo paslaugas yra kliento atsakomybė. • Nemėginkite atlikti įrangos techninės priežiūros, nebent atsižvelgėte į šį eksploatavimo vadovą ir jį supratote. • Jei neatkreipsite dėmesio į šį perspėjimą, galimi sužalojimai dėl elektros šoko, mechaninių ar kitų pavojų paslaugų tiekėjui, operatoriui ar pacientui.
BRĪDINĀJUMS (LV)	Šī apkalpotāju rokasgrāmata ir pieejama tikai angļu valodā. • Ja apkalpošanas sniedzējam nepieciešama informācija citā, nevis angļu, valodā, klienta pienākums ir nodrošināt tās tulkošanu. • Neveiciet aprīkojuma apkopi, neizlasot un nesaprotot apkalpotāju rokasgrāmatu. • Šī brīdinājuma neievērošana var radīt elektriskās strāvas trieciena, mehānisku vai citu risku izraisītu traumu apkopes sniedzējam, operatoram vai pacientam.
WAARSCHUWING (NL)	Deze service manual is alleen in het Engels verkrijgbaar. • Indien het onderhoudspersoneel een andere taal nodig heeft, dan is de klant verantwoordelijk voor de vertaling ervan. • Probeer de apparatuur niet te onderhouden voordat deze service manual geraadpleegd en begrepen is. • Indien deze waarschuwing niet wordt opgevolgd, zou het onderhoudspersoneel, de gebruiker of een patiënt gewond kunnen raken als gevolg van een elektrische schok, mechanische of andere gevaren.
ADVARSEL (NO)	Denne servicehåndboken finnes bare på engelsk. • Hvis kundens serviceleverandør trenger et annet språk, er det kundens ansvar å sørge for oversettelse. • Ikke forsøk å reparere utstyret uten at denne servicehåndboken er lest og forstått. • Manglende hensyn til denne advarselen kan føre til at serviceleverandøren, operatøren eller pasienten skades på grunn av elektrisk støt, mekaniske eller andre farer.
OSTRZEŻENIE (PL)	Niniejszy podręcznik serwisowy dostępny jest jedynie w języku angielskim. • Jeśli dostawca usług klienta wymaga języka innego niż angielski, zapewnienie usługi tłumaczenia jest obowiązkiem klienta. • Nie należy serwisować wyposażenia bez zapoznania się i zrozumienia niniejszego podręcznika serwisowego. • Niezastosowanie się do tego ostrzeżenia może spowodować urazy dostawcy usług, operatora lub pacjenta w wyniku porażenia elektrycznego, zagrożenia mechanicznego bądź innego.
AVISO (PT-BR)	Este manual de assistência técnica só se encontra disponível em inglês. • Se o serviço de assistência técnica do cliente não for GE, e precisar de outro idioma, será da responsabilidade do cliente fornecer os serviços de tradução. • Não tente reparar o equipamento sem ter consultado e compreendido este manual de assistência técnica. • O não cumprimento deste aviso pode por em perigo a segurança do técnico, operador ou paciente devido a choques elétricos, mecânicos ou outros.

AVISO (PT-PT)	Este manual técnico só se encontra disponível em inglês. • Se a assistência técnica do cliente solicitar estes manuais noutro idioma, é da responsabilidade do cliente fornecer os serviços de tradução. • Não tente reparar o equipamento sem ter consultado e compreendido este manual técnico. • O não cumprimento deste aviso pode provocar lesões ao técnico, ao utilizador ou ao paciente devido a choques eléctricos, mecânicos ou outros.
AVERTISMENT (RO)	Acest manual de service este disponibil numai în limba engleză. • Dacă un furnizor de servicii pentru clienți necesită o altă limbă decât cea engleză, este de datoria clientului să furnizeze o traducere. • Nu încercați să reparați echipamentul decât ulterior consultării şi înțelegerii acestui manual de service. • Ignorarea acestui avertisment ar putea duce la rănirea depanatorului, operatorului sau pacientului în urma pericolelor de electrocutare, mecanice sau de altă natură.
ПРЕДУПРЕЖДЕНИЕ (RU)	Настоящее руководство по обслуживанию предлагается только на английском языке. • Если сервисному персоналу клиента необходимо руководство не на английском, а на каком-то другом языке, клиенту следует обеспечить перевод самостоятельно. • Прежде чем приступать к обслуживанию оборудования, обязательно обратитесь к настоящему руководству и внимательно изучите изложенные в нем сведения. • Несоблюдение требований данного предупреждения может привести к тому, что специалисты по обслуживанию, операторы или пациенты получат удар электрическим током, механическую травму или другое повреждение.
VAROVANIE (SK)	Tento návod na obsluhu je k dispozícii len v angličtine. • Ak zákazníkov poskytovateľ služieb vyžaduje iný jazyk ako angličtinu, poskytnutie prekladateľských služieb je zodpovednosťou zákazníka. • Nepokúšajte sa o obsluhu zariadenia skôr, ako si neprečítate návod na obsluhu a neporozumiete mu. • Zanedbanie tohto varovania môže vyústiť do zranenia poskytovateľa služieb, obsluhujúcej osoby alebo pacienta elektrickým prúdom, mechanickým alebo iným nebezpečenstvom.
OPOZORILO (SL)	Ta servisni priročnik je na voljo samo v angleškem jeziku. • Če ponudnik storitve stranke potrebuje prirocnik v drugem jeziku, mora stranka zagotoviti prevod. • Ne poskušajte servisirati opreme, če tega prirocnika niste v celoti prebrali in razumeli. • Če tega opozorila ne upoštevate, se lahko zaradi elektricnega udara, mehanskih ali drugih nevarnosti poškoduje ponudnik storitev, operater ali bolnik.
UPOZORENJE (SR)	Ovo servisno uputstvo je dostupno samo na engleskom jeziku. • Ako klijentov serviser zahteva neki drugi jezik, klijent je dužan da obezbedi prevodilacke usluge. • Ne pokušavajte da opravite uredaj ako niste procitali i razumeli ovo servisno uputstvo. • Zanemarivanje ovog upozorenja može dovesti do povredivanja servisera, rukovaoca ili pacijenta usled strujnog udara ili mehanickih i drugih opasnosti.
VARNING (SV)	Den här servicehandboken finns bara tillgänglig på engelska. • Om en kunds servicetekniker har behov av ett annat språk än engelska ansvarar kunden för att tillhandahålla översättningstjänster. • Försök inte utföra service på utrustningen om du inte har läst och förstår den här servicehandboken. • Om du inte tar hänsyn till den här varningen kan det resultera i skador på serviceteknikern, operatören eller patienten till följd av elektriska stötar, mekaniska faror eller andra faror.
UYARI (TR)	Bu servis kilavuzunun sadece ingilizcesi mevcuttur. • Eğer müşteri teknisyeni bu kilavuzu ingilizce dişinda bir başka lisandan talep ederse, bunu tercüme ettirmek müşteriye düşer. • Servis kilavuzunu okuyup anlamadan ekipmanlara müdahale etmeyiniz. • Bu uyariya uyulmamasi, elektrik, mekanik veya diğer tehlikelerden dolayi teknisyen, operatör veya hastanin yaralanmasina yol açabilir.

ЗАСТЕРЕЖЕННЯ (UK)	Дане керівництво з сервісного обслуговування постачається виключно англійською мовою. • Якщо сервісний інженер потребує керівництво іншою мовою, користувач забов'язаний забезпечити послуги перекладача. • Не намагайтеся здійснювати технічне обслуговування даного обладнання, якщо ви не читали, або не зрозуміли інформацію, надану в керівництві з сервісного обслуговування. • Недотримання цього застереження може призвести до травмування сервісного інженера, користувача даного обладнання або пацієнта внаслідок електричного шоку, механічного ушкодження або з інших причин невірного обслуговування обладнання.
CẢNH BÁO (VI)	Tài Liệu Hướng Dẫn Sửa Chữa chỉ có bản tiếng Anh. • Nếu các đơn vị cung cấp dịch vụ cho khách hàng yêu cầu một ngôn ngữ nào khác tiếng Anh, thì khách hàng sẽ có trách nhiệm cung cấp các dịch vụ dịch thuật. • Không được sửa chữa thiết bị trừ khi đã tham khảo và hiểu Tài liệu Hướng dẫn Sửa chữa. • Không tuân thủ những cảnh báo này có thể dẫn đến các tổn thương cho người thực hiện sửa chữa, người vận hành hay bệnh nhân, do sốc điện, các rủi ro về cơ khí hay các rủi ro khác.
警告 (ZH-CN)	本维修手册仅提供英文版本。 • 如果维修服务提供商需要非英文版本，客户需自行提供翻译服务。 • 未详细阅读和完全理解本维修手册之前，不得进行维修。 • 忽略本警告可能对维修人员，操作员或患者造成触电、机械伤害或其他形式的伤害。
警告 (ZH-TW)	本維修手冊只提供英文版。 • 如果客戶的維修人員有英語以外的其他語言版本需求，則由該客戶負責提供翻譯服務。 • 除非您已詳閱本維修手冊並了解其內容，否則切勿嘗試對本設備進行維修。 • 不重視本警告可能導致維修人員、操作人員或病患因電擊、機械因素或其他因素而受到傷害。