Datex AS/3
Anaesthesia Monitor

Service Manual

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All specifications subject to change without notice

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Part I

AS/3 Anaesthesia Monitor

General Service Guide

I INTRODUCTION

Datex AS/3 Anaesthesia Monitor is a cardiac and respiratory monitoring device used during anaesthesia in operating rooms.

The monitor consists of the Central Unit and different modules. Additionally the monitor can be equipped with a secondary display and Anaesthesia Record Keeper.

There are single and double width modules containing one or more parameters. The modules that are placed in the Central Unit can be removed and inserted during operation. The Airway Module, additional display and the Anaesthesia keyboard can only be connected when the monitor is turned off.

1.1 Notes to the Reader

This service manual is intended for service personnel and engineers who will perform service and maintenance procedures on **Datex AS/3 Anaesthesia Monitor**.

This service manual is divided into two parts: **Part I** gives to the reader overview of the **AS/3 Anaesthesia Monitor** and its configuration. **Part II** gives detailed descriptions of each module and component of **AS/3 Anaesthesia Monitor**.

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

Datex assumes no responsibility for the use or reliability of its software on equipment that is not furnished by Datex.

1.2 Symbols

Symbols on Equipment

Pb

This battery contains lead acid and in case of disposal, must be separated from other waste according to local regulations.

Pb

This battery contains Pb and it can be recycled.

Dangerous voltage.

Symbols on Transport Packaging

The contents of the transport package are fragile and it has to be handled with care.

This symbol indicates the correct upright position of the transport package.

The transport package shall be kept in a dry environment.

This symbol is to indicate the temperature limitations within which the transport package shall be kept and handled.

1.3 Related Documents

The following documents are available on and for **Datex AS/3 Anaesthesia Monitor** in addition to this service manual.

Datex AS/3 Anaesthesia Monitor Operator's Manual (p/n 889381)

This manual provides detailed instructions and references for the operating and configuration of the system. Everyday service and maintenance procedures as well as simple troubleshooting hints are also included.

Datex AS/3 Anaesthesia Monitor Installation Manual (p/n 889470)

The installation manual gives clear and comprehensive picture on planning, unpacking, and installing the system.

Datex AS/3 Schematic Diagrams (p/n 886091)

The Schematic Diagrams is the collection of schematic diagrams and part layouts of the Anaesthesia Monitor and other AS/3 Family products (excluded AS/3 Anaesthesia Delivery Unit).

Datex AS/3 Supplies and Accessories (p/n 882300)

Supplies and Accessories is an accessory catalogue in which all the necessary accessories and supplies to the system are listed.

Clinical Applications

The following Datex publications are useful in obtaining information on clinical application.

- **Interpreting the Plethysmographic Pulse Wave, Appliguide**
- **Cardiac Output, Quick Guide**
- **PCWP, Quick Guide**
- **ST Segment Analysis, Quick Guide**

2 SAFETY

2.1 Warnings

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

POWER CONNECTION:

- Before connecting the power cord to the mains outlet, check that the local voltage and frequency rating corresponds with the rating stated on the device plate on the rear panel of Anaesthesia Monitor Frame.
- Connect the monitor to a three-wire, grounded, hospital grade receptacle. Do not remove the grounding prong from the power plug.
- Use intact power cord. Replace the cord if it is cracked, frayed, broken or otherwise damaged.
- Do not apply tension to the power cord. The cord may get broken.
- Do not use extension cords or adapters of any type.

EXTERNAL CONNECTION:

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

FUSE REPLACEMENT:

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

EXPLOSION HAZARD:

- Do not use the monitor in the presence of flammable anaesthetics.

PATIENT SAFETY:

- Do not perform any testing or maintenance on the monitor while it is being used on a patient.
- Use only cables and accessories approved by Datex. Do not modify them. Other cables and accessories may damage the monitor or interfere with measurement.

CLEANING AND SERVICE:

- Only trained personnel with proper tools and test equipment shall perform the tests and repairs described in this manual. Unauthorized service may void the monitor warranty.
- Switch the power off and unplug the power cord before cleaning or service. Get rid of moisture completely before reconnecting it to the mains outlet.
- Do not touch any exposed wire or conductive surface while covers are off and the monitor is energized. The voltages present can cause injury or death.
- Perform electrical safety check and current leakage test to the monitor always after service.

2.2 Cautions

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

INSTALLATION:

- Leave space behind the monitor to allow proper ventilation.

BEFORE USE:

- Allow two minutes for warm-up and note any error messages or deviations from normal operation.
- Clean rear panel fan dust filter once a month or whenever necessary.

AUTOCLAVING, STERILIZING:

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

CLEANING AND SERVICE:

- Do not use ammonia-, phenol-, or acetone-based cleaners. These cleaners may damage the monitor surface.
- Do not immerse the monitor in any liquid. Do not allow liquid to enter the monitor or into modules.
- Electrostatic discharge through the PC boards may damage the components. Before replacing 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.

SPECIAL COMPONENTS:

- There are special components used in this monitor which are vital to assure reliability and safety. Datex assumes no responsibility for damage if replacement components not approved by Datex are used.

- There is a lithium battery on the CPU board. Discard broken IC containing the battery according to local regulations.

BATTERIES

The battery package of the power supply unit in this device contains lead acid (Pb) which is hazardous to environment and thus the battery needs to be disposed of carefully according to local regulations.

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

- Do not short-circuit the battery terminals, short-circuiting the battery may produce a very high current, which damages the battery.

- Do not dispose of the battery into open flame, nor put the battery near fire, as it may explode.

- Do not disassemble the battery. It contains electrolyte, which may damage clothing or cause injury to skin or eyes. If exposed to electrolyte, wash the injured area with plenty of water and contact a doctor.

See also the chapter "Symbols on Equipment".

STORAGE AND TRANSPORT:

- Do not store or transport the monitor outside the specified temperature and pressure range:

Temperature	-10 to +50°C /14 to 122°F.
Ambient pressure	500 to 800 mmHg/660 to 1060 mbar
Humidity	0 to 90 % non-condensing

except LCD Display:

temperature	+5...+35°C/41 to 95°F
humidity	0 to 85 % non-condensing

DISCARD:

- Discard the device and parts thereof according to local regulations. Do not discard to the nature.

The manufacturer accepts no responsibility for any modifications made to the monitor outside the factory.

2.3 Equipment Classification

Classification according to IEC 601-1:

- CLASS 1 equipment according to the type of protection against electrical shock.
- TYPE BF or CF equipment according to the degree of protection against electrical shock is specified in the specifications of each parameter module.
- Degree of protection against the harmful ingress of water as detailed in the IEC 529: IPX0.
- Equipment not suitable for use in the presence of FLAMMABLE ANAESTHETIC MIXTURE with air or with OXYGEN/NITROUS OXIDE.
- CONTINUOUS OPERATION according to the mode of operation.

3 ARCHITECTURE

Datex AS/3™ family builds up to freely configurable modular system. The architecture is designed to enable different module combinations so that the user is able to get the desirable parameter and feature set. Further, the modular approach makes it possible to add new features in the order and pace they are needed.

3.1 Bus structure

The operation of Datex AS/3™ products is based on two communication channels, the **AS/3 Bus** and **Module Bus**. All boards connected to the AS/3 Bus as well as the parameter modules attached to the Module Bus receive their power from the same power supply, which is an integral part of the frame.

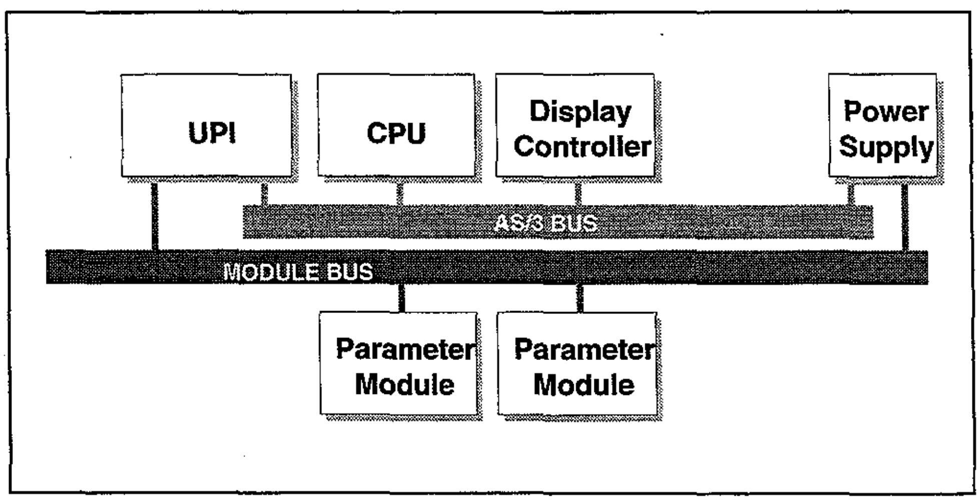


Figure 1 General structure of AS/3 system

The AS/3 Bus is a parallel communication channel used only for internal data transfer between the boards connected to one frame. It is based on the ISA bus used in the IBM PC computers, although it is slightly modified for Datex needs. Data is transferred on this 16 bits wide bus using the CPU clock frequency.

The Module Bus is used to connect the parameter modules to the frame. It is following the widely used industry standard RS-485, which uses differential serial method to transfer the data. This type of bus is quite robust and it allows the modules to be attached or detached on the fly, i.e. when the power is on. The RS-485 type serial communication supports so called *multidrop* or *party line* connections. This means that all modules connected to Module Bus are using the same two physical wires for communication purposes. The advantage is, that all the module bus connectors are identical and the modules can be connected to any order and position. Module Bus is using 500 kbits per second data transfer rate and it can be used for longer distances than the AS/3 Bus, e.g. for external-frame connections.

3.2 Distributed processing

A system put together from AS/3 products is a multiprocessor system. All the modules have their own microprocessor and they are doing the low-level functions such as module key control, waveform filtering, pneumatic control, etc. At the same time the main CPU is doing higher level tasks, e.g. trending and alarm control. While modules and CPU are doing their job, the UPI processor takes care of all functions needed to transfer the data between modules and CPU. And at the same time the processor on display control board is doing pixel calculations for graphics.

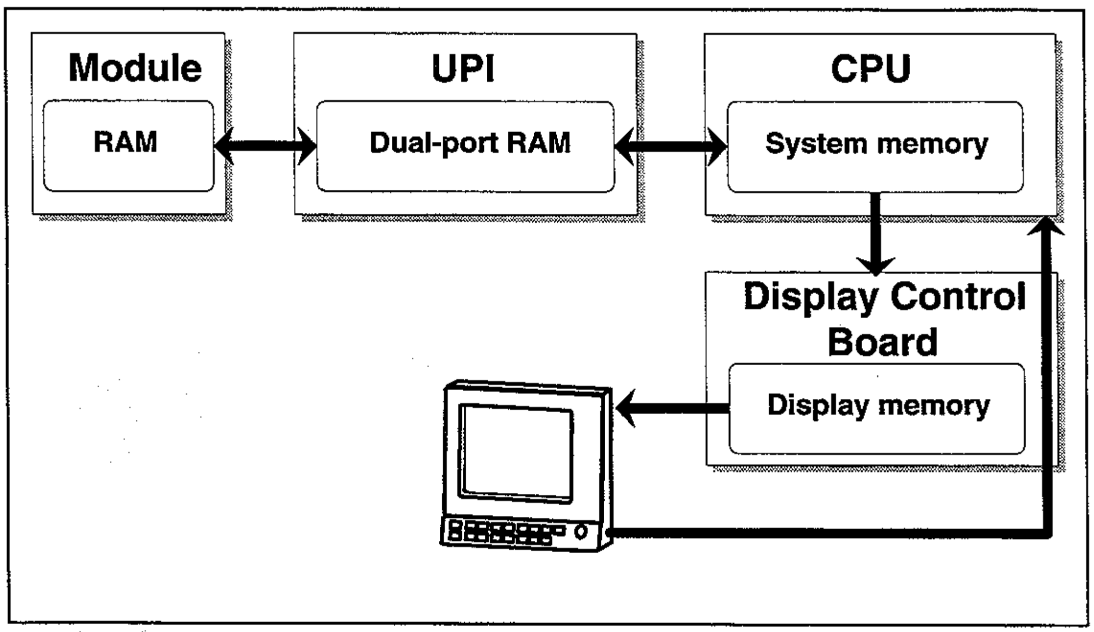


Figure 2 **Distributed processing in AS/3 system**

This kind of parallel processing gives one major advantage to centralised processing: each time new modules or boards are added to the system, the processing power is also increased. As a result the system is not slowing down when new features are added.

3.3 Module Communication

The communication master controlling the data transfer between AS/3 Bus and Module Bus is called UPI (Universal Peripheral Interface) board. It sends information or questions to each module 100 times per second, and if the module is present it replies to each question immediately by sending a data package back to UPI. This communication protocol ensures that the each module receives and sends information every 10 ms, the package length depends on the module type. If the module does not respond, the UPI presumes that the module is not connected.

Each module type has a unique name, which UPI uses to address its messages. If there are two modules of the same type, they both answer at the same time. This results an error and thus two similar modules are not allowed in one frame.

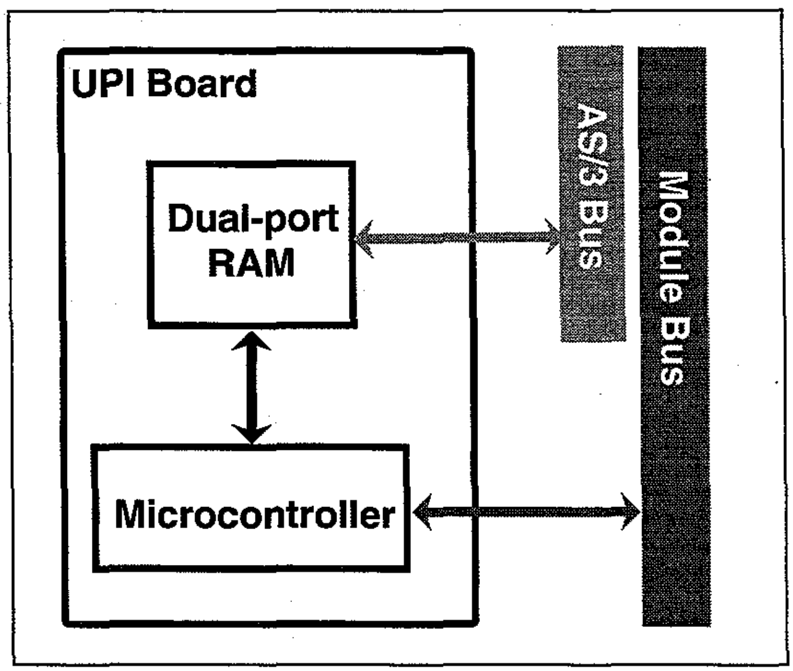


Figure 3 Principle of UPI operation

UPI microprocessor collects all information coming from the modules into a dual-port RAM. This memory is located on UPI board and it is mapped directly to the address space of the main CPU. The main CPU is thus reading information from it's own memory and UPI guarantees that the data is up to date. This operation works also to the other direction, when CPU is filling the dual port RAM with data and UPI processor is distributing it to the modules.

3.4 Software loading

The Software Cartridge attached to the CPU board contains the program for the CPU board as well as for the other boards attached to the AS/3 Bus. When the system is turned on, all processors load their part of the software from the cartridge and after that start to execute their program.

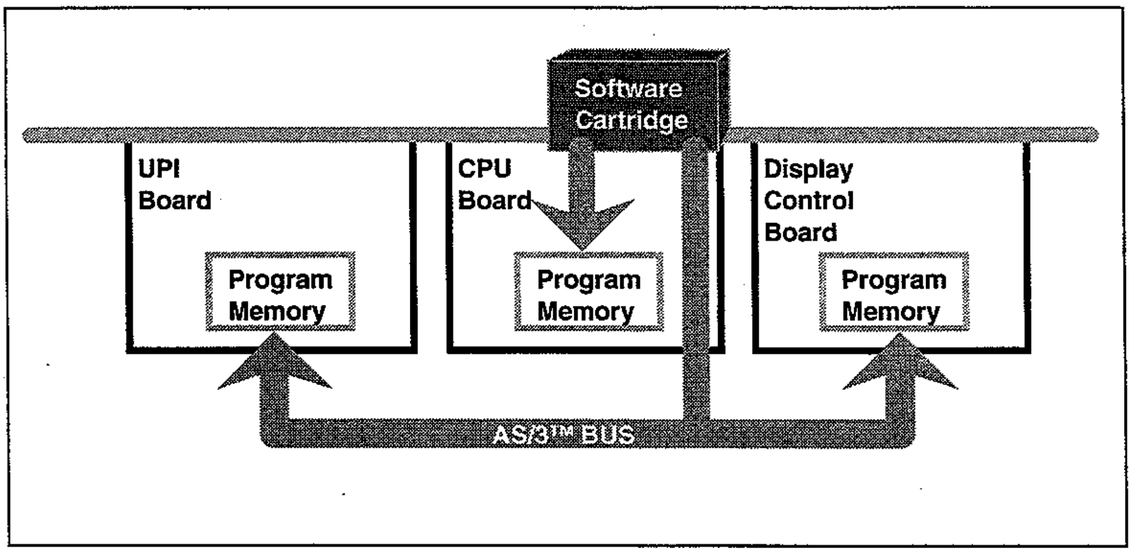


Figure 4 Software loading

3.5 Generic Module

The detailed structure of the modules depends on the specific needs for each individual parameter. Some common parts can be found from inside the modules, however. First of all, the electronics inside the module is usually divided into isolated (floating) and non-isolated sections. Typically the non-isolated part consists only buffers needed to interface the module to Module Bus, the rest of the electronics can be found from the isolated side. This includes the microcontroller together with memory components, the front end analog electronics (amplifiers, etc.) and peripheral drivers to control LEDs, sensors, valves and pumps.

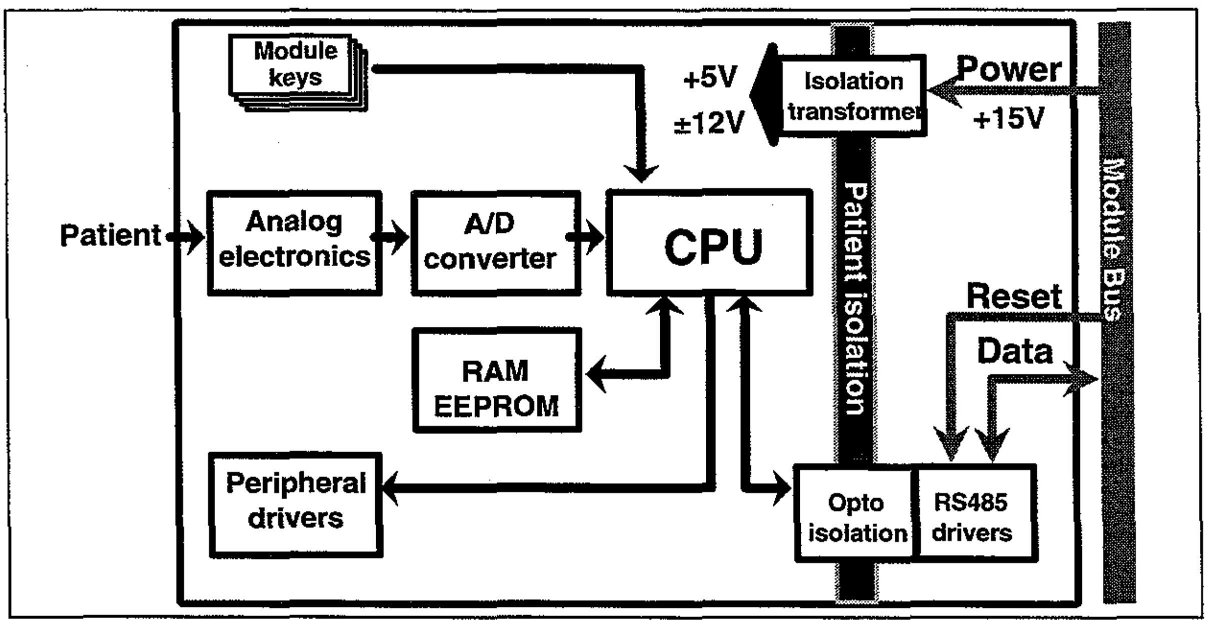


Figure 5 **General structure of parameter modules**

4 CLEANING AND MAINTENANCE

Field service is mostly limited to replacing the faulty circuit boards or mechanical parts. Only the parts listed as Spare Parts of each product are available for field service.

Datex is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

Detailed description of the service procedures and troubleshooting is found in each of the module chapters in the part II, AS/3 Anaesthesia Monitor Product's Service Guide in this manual.

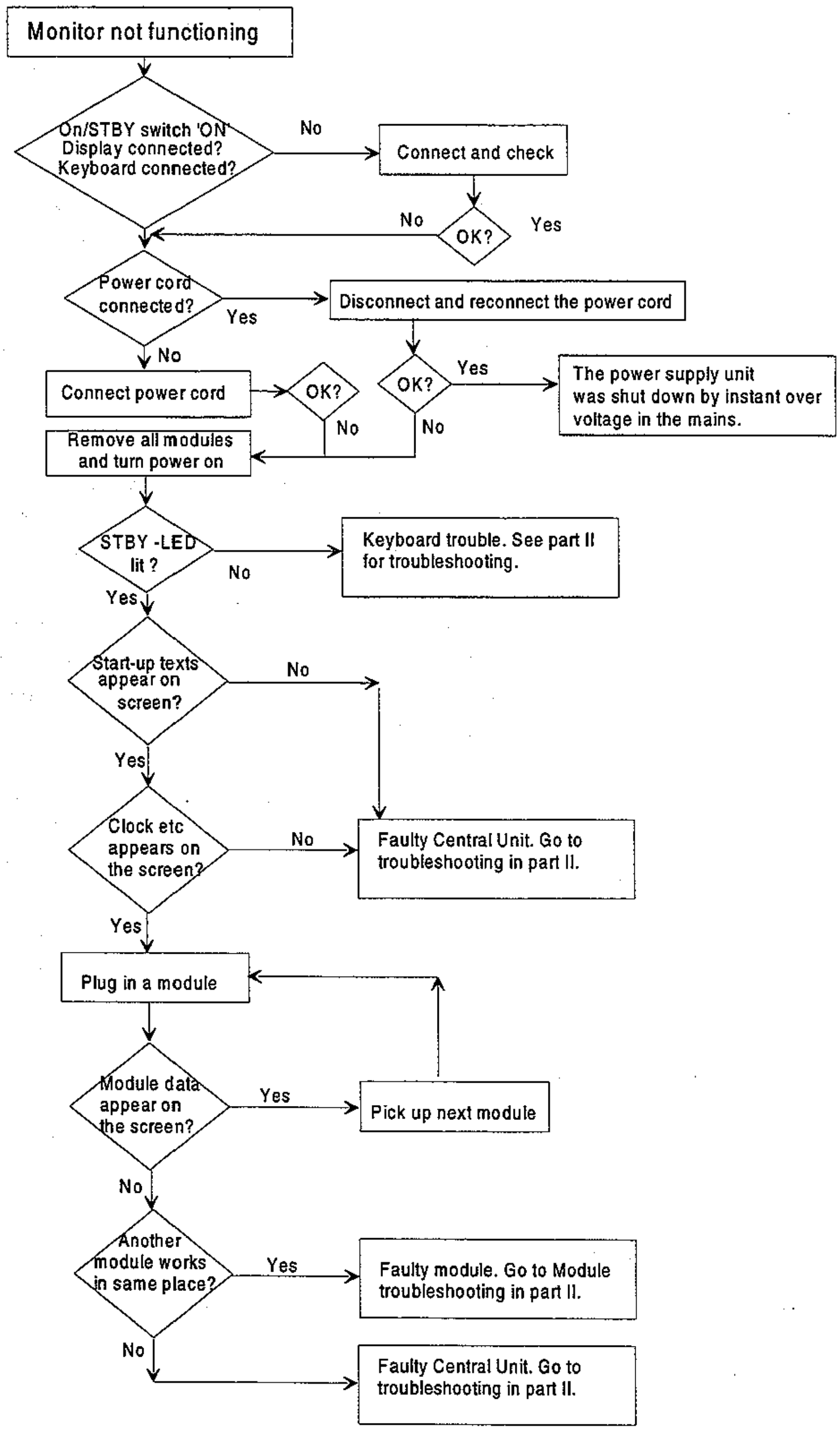
CAUTION: The tests and repairs outlined in this manual should only be attempted by a trained personnel. Unauthorized service may void the warranty of the unit.

The monitor can be cleaned by wiping with a soft cloth moistured with mild detergent solution, and disincfected by wiping with normal disinfectants. The monitor cannot be autoclaved.

Special attention must be paid to fan dust filter and D-fend water trap for their blockage may lead to monitor failure. See Operator's Manual for further instructions.

The LCD Display is a fragile component, please refer to PART II Displays for its cleaning and maintenance.

5 GENERAL TROUBLESHOOTING



Part II

AS/3 Anaesthesia Monitor

Product's Service Guide

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14 Anaesthesia Keyboard, K-ARK, B-ARK
15 Neuro Muscular Transmission Module, M-NMT
16 UPINET Board, B-UPINET

8-Module Frame, F-CU8 (Rev.03)

CPU Board, B-CPU2 (Rev. 01)

CPU Board, B-CPU3 (Rev. 00)

Software Cartridge, S-STD96 or S-ARK96 (Rev. 00)

All specifications subject to change without notice

Doc. no. 885931-2

March, 1996

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Table of Contents

INTRODUCTION

This Service Manual Section provides information on the Datex AS/3 Anaesthesia Monitor's Central Unit. It consists of following products:

- 8-Module Frame, F-CU8 (including UPI or UPINET board and Power Supply Unit)
- CPU Board, B-CPU2 or B-CPU3
- Software cartridge, S-STD96 or S-ARK96

1 SPECIFICATIONS

CENTRAL UNIT

Dimensions	depth	382 mm	(15.0 in)
	width	315 mm	(12.4 in)
	height	128 mm	(5.0 in)
	weight	9.5 kg	(21 lbs)

ELECTRICAL REQUIREMENTS

Power supply	100, 110-120, 220-240 VAC 50/60 Hz 1.2 A (for whole system)
Stability	±10 % of nominal voltage
Power consumption	280 VA
Grounding	Hospital grade
Interruptibility	Data memory and alarm settings are saved during power failures up to 15 minutes

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)
Humidity	0 - 90 % non-condensing (in airway 0 - 100 % condensing)

Analog outputs (+5 V, -5 V) of UPI board

Resolution:	12 bits
Gain error:	+2,5%...-4.5%
+5 V max.:	+5.50 V
+5 V min.:	+4.30 V
-5 V max.:	-4.65 V
-5 V min.:	-5.25 V

2 FUNCTIONAL DESCRIPTION

2.1 8-Module Frame

The center of the Central Unit is the 8-Module Frame, F-CU8, that includes UPI or UPINET Board and Power Supply Unit. To operate AS/3 Anaesthesia Monitor, the following products should be installed into the frame.

CPU board, B-CPU2 or B-CPU3
Display Controller, B-DISP or B-DVGA
Software Cartridge, S-STD96 or S-ARK96

The frame has two sections. The front part is vacant for housing the modules. The rear part is for installation of the AS/3 boards. On the wall between the front and rear parts, there are Module mother board and CPU mother board. The Module mother board connects modules to the system , and the CPU mother board connects boards together.

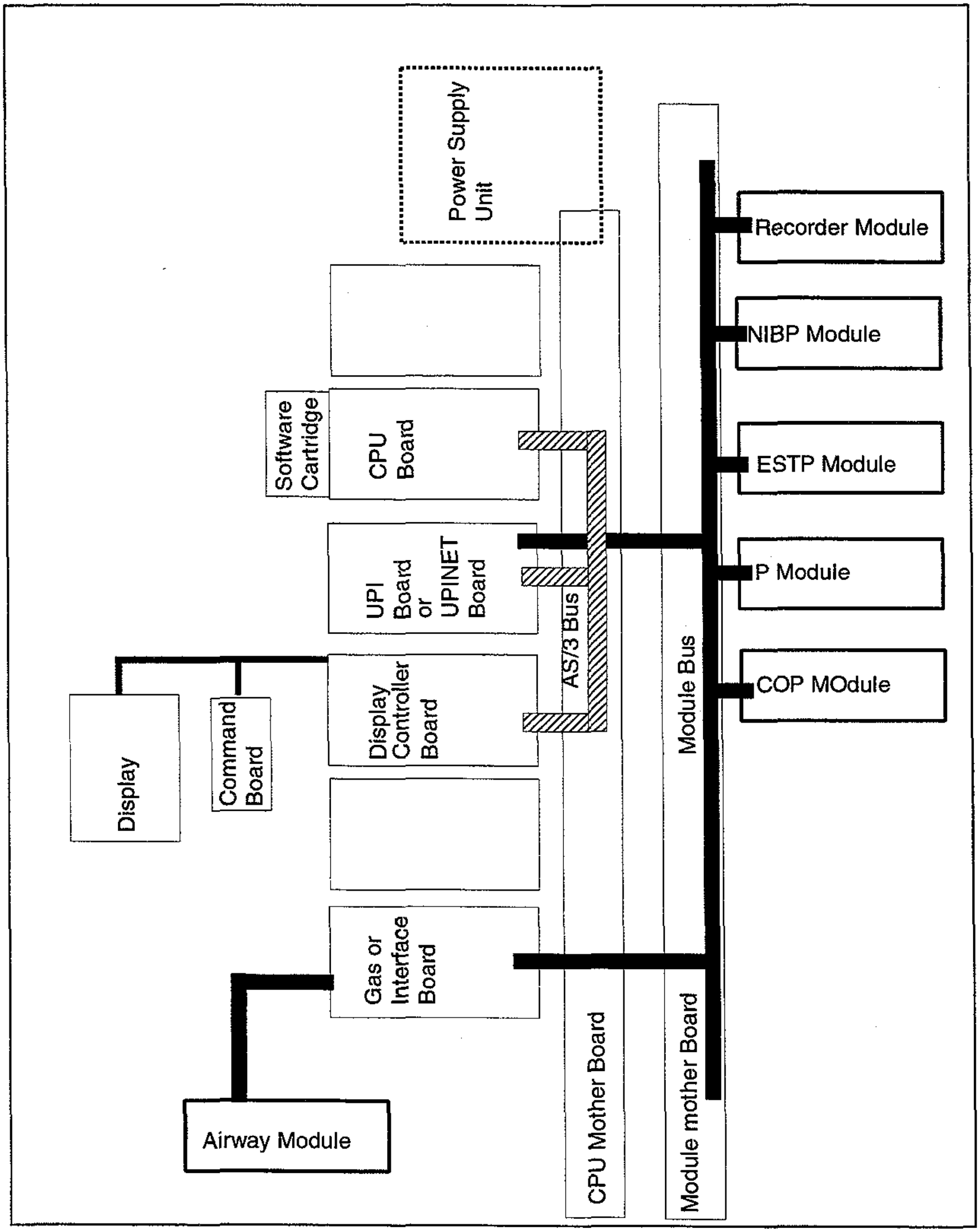


Figure 1 Basic structure of AS/3 Monitor, an example of possible configurations

2.1.1 UPI Board

NOTE: the following information is related only to the UPI board. In case your monitor uses the UPINET board instead, please refer to the corresponding information in the UPINET section of this manual.

The UPI board functions as a general I/O-board. It performs I/O duties assigned to it by the CPU board. The main processor and the processor on the UPI board communicate through a dual-port memory which is located on the UPI board.

Functional blocks

The UPI board contains the external bus interface, a processor, program- and dual-port memories, IO-block, and an isolated serial bus interface.

External bus interface

The UPI board is connected to the CPU mother board. The following signals pass between the UPI and CPU mother board: Data bus, Address bus, Reset, Write and Read signals, and other related signals.

Processor

The processor in the UPI board is an 80C196KC-16, which functions at 16 MHz frequency.

IO-block

IO-block consists of the following units.

- 4 channel 10 bits AD-converter
- 8 channel 12 bits DA-converter
- 5 digital inputs and 4 digital outputs

Isolated and non-isolated serial bus interface

Isolated power supply consists of transformer and other peripheral components. It gives about 100 mA @ 5 V.

There are isolated and non-isolated serial bus interfaces. The latter is connected to module bus through the CPU mother board. The isolated interface is available on rear panel X3 connector.

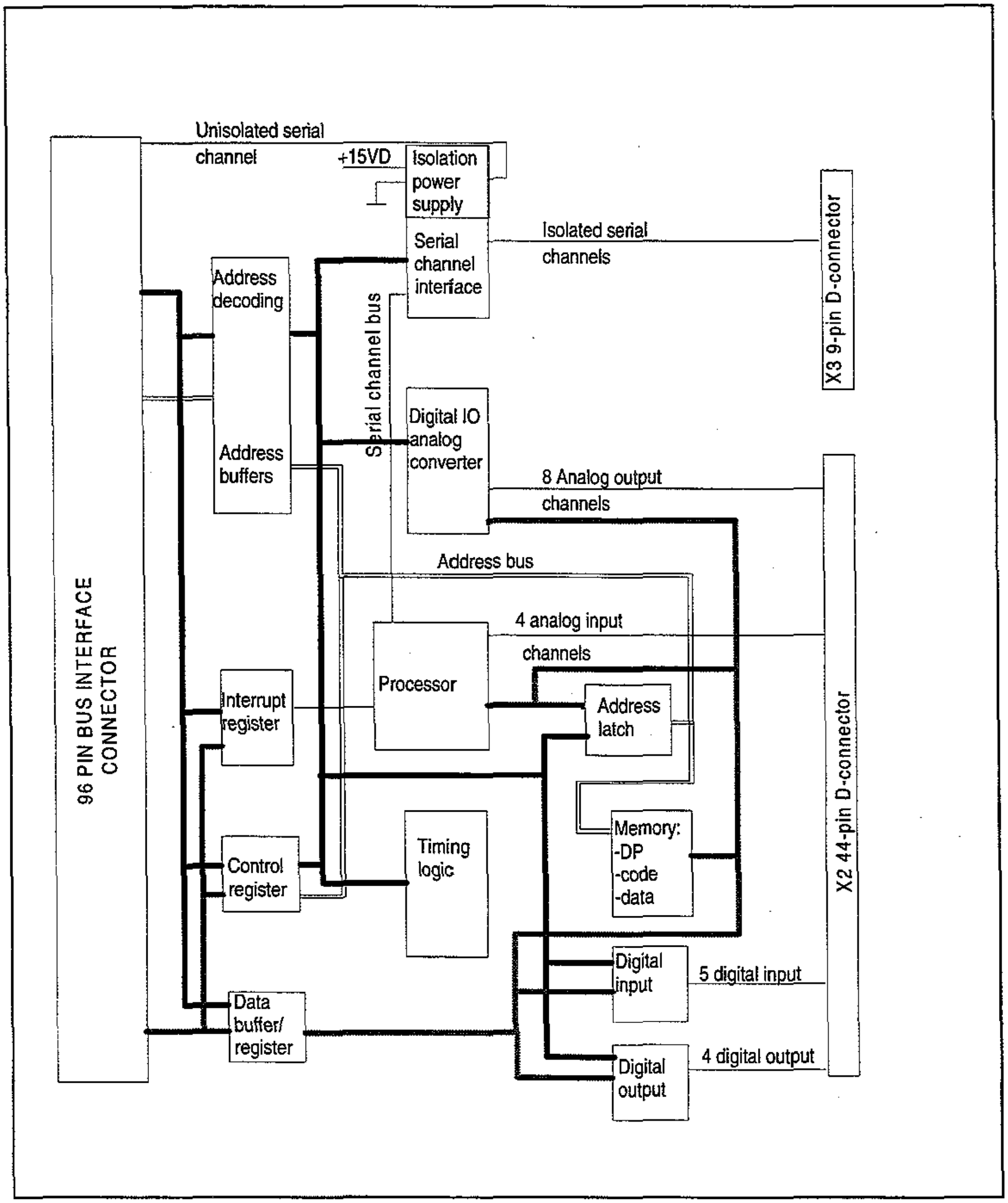
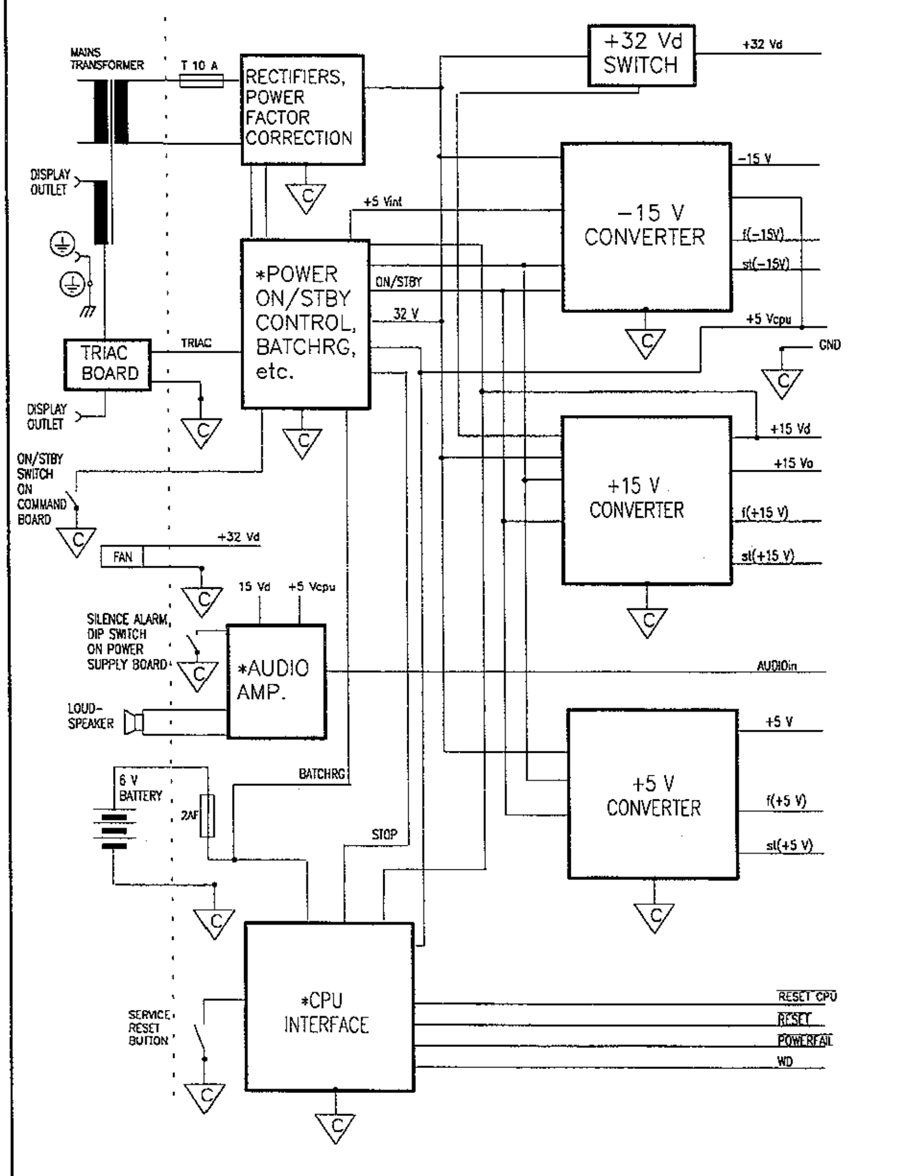


Figure 2 UPI Board Block Diagram

2.1.2 Power supply unit

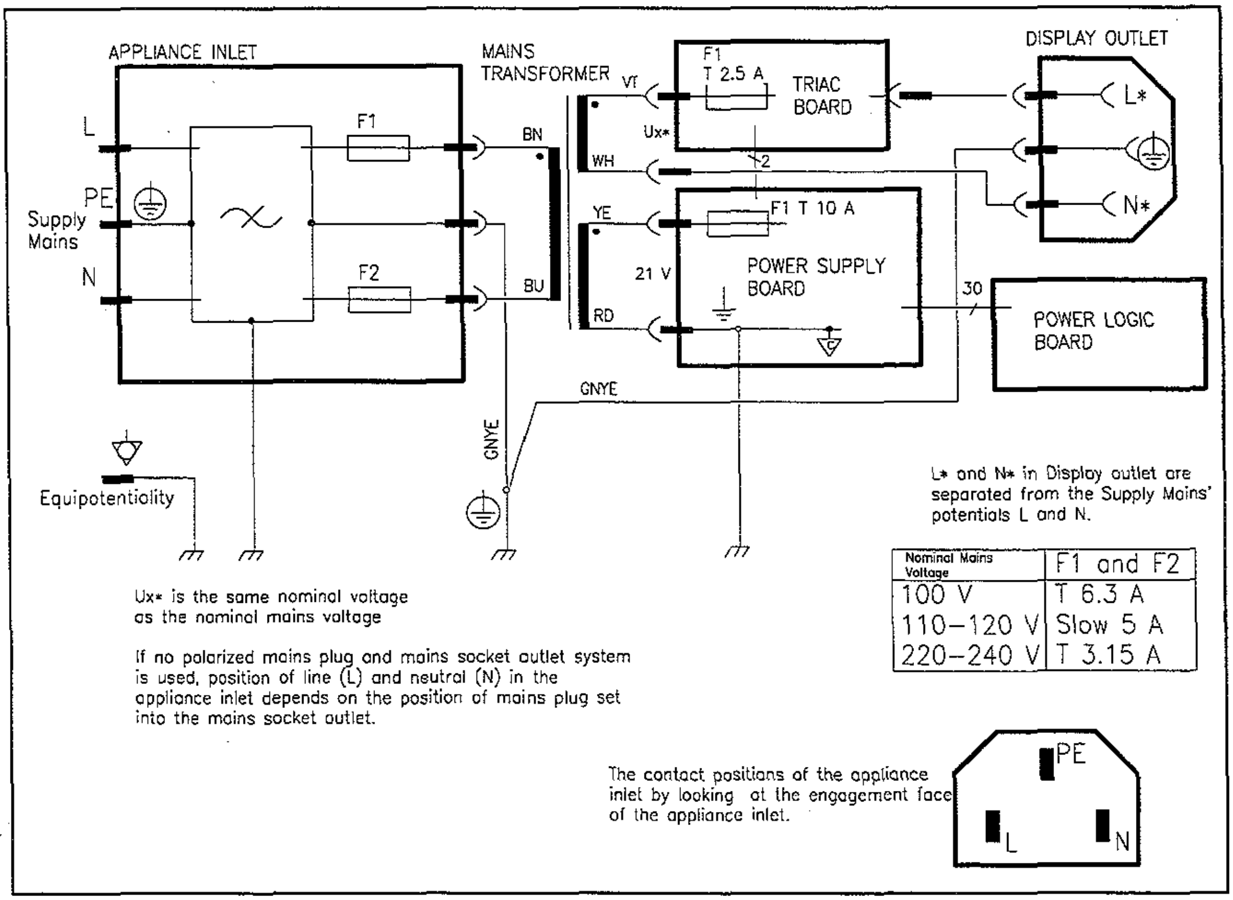
Power supply unit contains three PC boards (Power Supply board, Power Logic board, and Triac board) and four external components (Mains transformer, Fan, Loudspeaker, and lead acid battery).

All the operational controls in the power supply unit are located in the three PC boards.



*POWER ON/STBY CONTROL, AUDIO AMP., and CPU INTERFACE are in Power Logic Board. All other functions are in Power Supply Board.

Figure 3 Power Supply Unit Block Diagram



Nominal Mains Voltage	F1 and F2
100 V	T 6.3 A
110–120 V	Slow 5 A
220–240 V	T 3.15 A

Figure 4 Mains Part and Display Outlet Block Diagram

Power Supply Board

Power Supply board includes:

Rectifiers

Rectifiers processes 21 VAC from the mains transformer.

Power factor correction

Power factor correction is performed in a preregulator. The regulator modifies output current from sinusoidal power lines into sinusoidal form. Its purpose is to boost efficiency of the mains transformer.

Battery charging

Batchrg charges the 6 V battery which maintains the supply voltage of CPU for 15 minutes after the power is cut off. The battery is charged as long as the power cord is connected to the mains outlet.

Supply voltage for pulse width modulators

Supply voltage for pulse width modulators of chopper power supplies is generated by 12 V regulator at power-up and +15 V is short-circuited. Otherwise the supply voltage comes from +15 V.

-15 V converter

-15 V converter is a Flyback-type chopper power supply that generates -15 V analog voltage from +32 V. The load capacity is 1.2 A (18 W). +5 Vcpu is also generated in this converter.

+15 V converter

+15 V converter is a Buck-type chopper power supply that generates +15 V from +32 V.

The output of the power supply is divided into two; +15 Va for analog voltage and +15 Vd for less sensitive components.

+5 V converter

+5 V converter is a Buck-type chopper power supply that generates +5.1 V from +32 V. The load capacity is 8 A (40 W).

+5 V, +15 V, +32 V, and +5 Vcpu checking

Those voltages are checked and if one of them increases more than is allowed, thyristor pulls the rectified +32 V down.

Service reset button

Service reset button is for service purpose. Press this button with an appropriate tool for at least five seconds before you remove the software cartridge, any PC board or the Power supply unit from the rear of the Central Unit.

Before connecting the power cord back and start monitoring, be sure that at least one minute has passed after the service reset button has pressed. Too short time may lead to memory flaw.

Audible Alarm for Power Fail

Under the cover plate of the Power supply unit there are two dip switches. By turning the switches to the right the audio alarm is activated. When mains power fails the audio alarm is generated by the lead-acid battery.

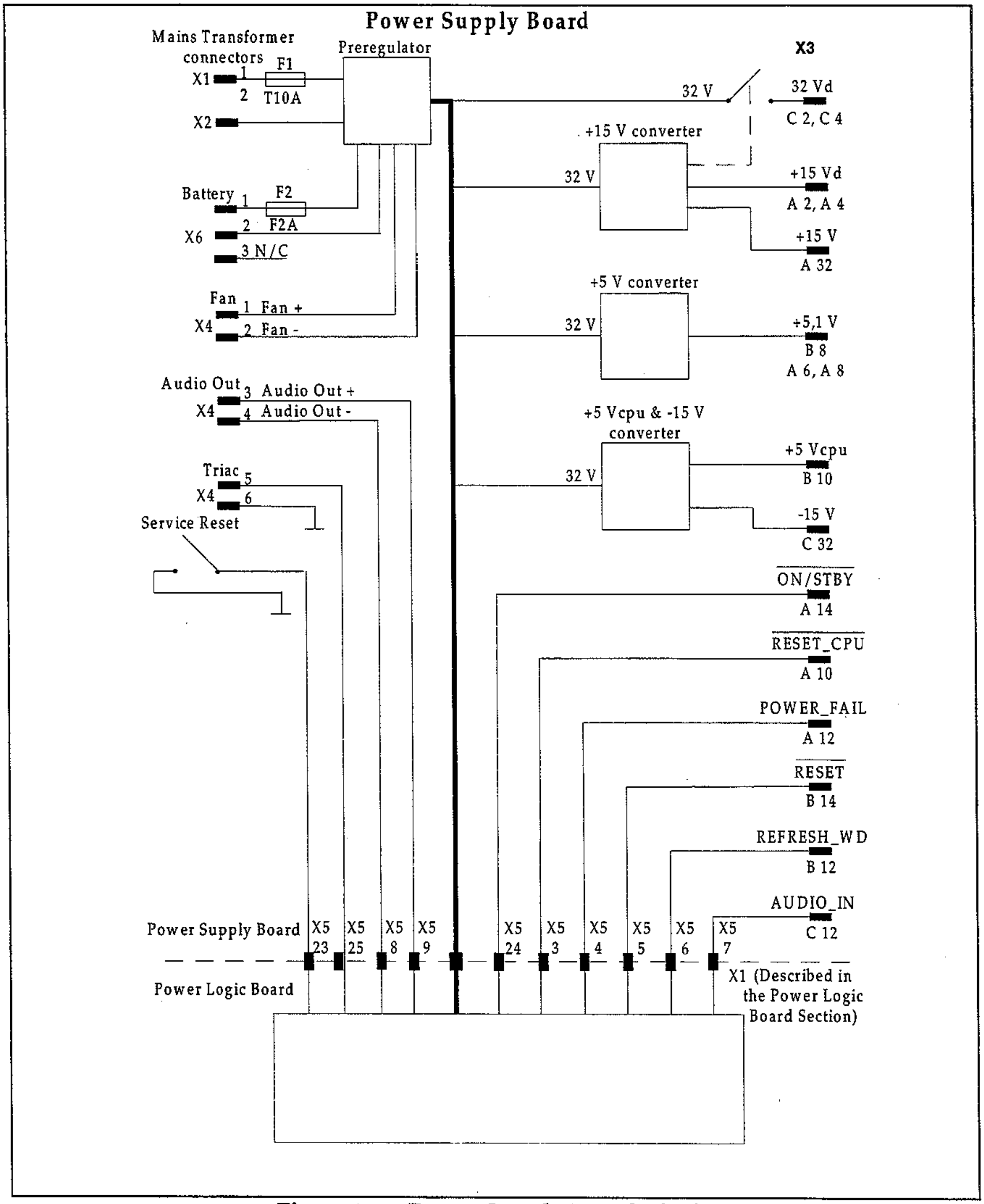


Figure 5 Power Supply Board Block Diagram

Power supply board interface to CPU Mother board

Pin c2,c4: +32 Vd

Rectified and filtered +32 V dirty voltage. This voltage is switched on by pulses of +15 V chopper power supply which turns the switching transistor on with the help of charging pump. The switching transistor is a short-circuit protected MOSFET. The ripple voltage when fully loaded is about 3 Vpp at the frequency of two times mains frequency.

Pin c32: -15 V

Accuracy of -15 V is $\pm$2 %. The load capacity is 1.2 A and the ripple voltage about 30 mVpp at the chopper frequency (200 kHz $\pm$10 %).

Pin c22: f(-15 V)

The chopper frequency measured at the rear panel connector whose pulse ratio corresponds to the pulse width modulator's pulse ratio. For test use only.

Pin c20: st (-15 V)

The chopper can be turned off by connecting this line at the rear panel connector to ground. For test use only.

Pin a2,a4: +15 Vd

Accuracy of +15 V is $\pm$2 %. The load capacity is 6.5 A if +15 Va is not loaded. The ripple voltage about 50 mVpp at the chopper frequency (200 kHz $\pm$10 %).

Pin 32: +15 Va

+15 V for analog voltage. The load capacity is 1.2 A and is passive filtered from +15 Vd. The ripple voltage about 10 mVpp at the chopper frequency (200 kHz $\pm$10 %).

The total load capacity of +15 Va and +15 Vd is about 6.5 A (97.5 W).

Pin b22: f (+15 V)

The chopper frequency measured at the rear panel connector whose pulse ratio corresponds to the pulse width modulator's pulse ratio. For test use only.

Pin b20: st (+15 V)

The chopper can be turned off by connecting this line at the rear panel connector to ground. For test use only.

Pin a6,a8,b8: +5 V

Nominal voltage is 5.1 V and its accuracy is ±2 %. The load capacity is 8 A. The ripple voltage about 50 mVpp at the chopper frequency (200 kHz ±10 %).

Pin a22: f (+5 V)

The chopper frequency measured at the rear panel connector whose pulse ratio corresponds to the pulse width modulator's pulse ratio. For test use only.

Pin a20: st (+5 V)

The chopper can be turned off by connecting this line at the rear panel connector to ground. For test use only.

Pin b10: +5 Vcpu

Supply voltage for the CPU. Nominal voltage is 5.1 V. The accuracy is ±2 % and the load capacity 1 A. The ripple voltage is 50 mVpp. The +5 Vcpu is connected to linearly regulated battery voltage when the choppers are switched off.

Pin b14: -RESET

Signal for the digital boards.

Pin a10: -RESET CPU

Signal for the CPU.

Pin a12: -POWERFAIL

The signal informs about supply voltage failure to the CPU.

Pin b12: WD

Watchdog input signal. The CPU must toggle WD every 1.6 seconds. Otherwise the power supply will generate -RESET and -RESET CPU signals.

Pin c12: AUDIOin

Audio signal which is amplified in Audio-amp. circuit.

Ground

All the signals and lines within the Power supply unit share the common ground which is connected to AS/3 Anaesthesia Monitor chassis.

Power Logic Board

Power Logic board includes:

Power ON/STBY control

Power ON/STBY control includes a logic with which power supply is switched on or off by turning ON/STBY switch.

Reset

-RESET_CPU signal is transmitted to the CPU interface in case the mains voltage fails or the power is cut off.

-RESET signal is also generated for other digital boards.

Audio amp.

Audio signal from the CPU is amplified and filtered for the loudspeaker. Amplification gain is about 5 dB.

CPU interface

All the necessary communications between the Power supply unit and the CPU (Reset-, powerfail-, and watchdog-functions) are realized in this board. Additionally, the block contains a circuit that supervises the maintenance of CPU's supply voltage from the battery for 15 minutes after AS/3 Anaesthesia Monitor is turned off.

Display control

Display control circuit controls Triac board control signal (TRIAC).

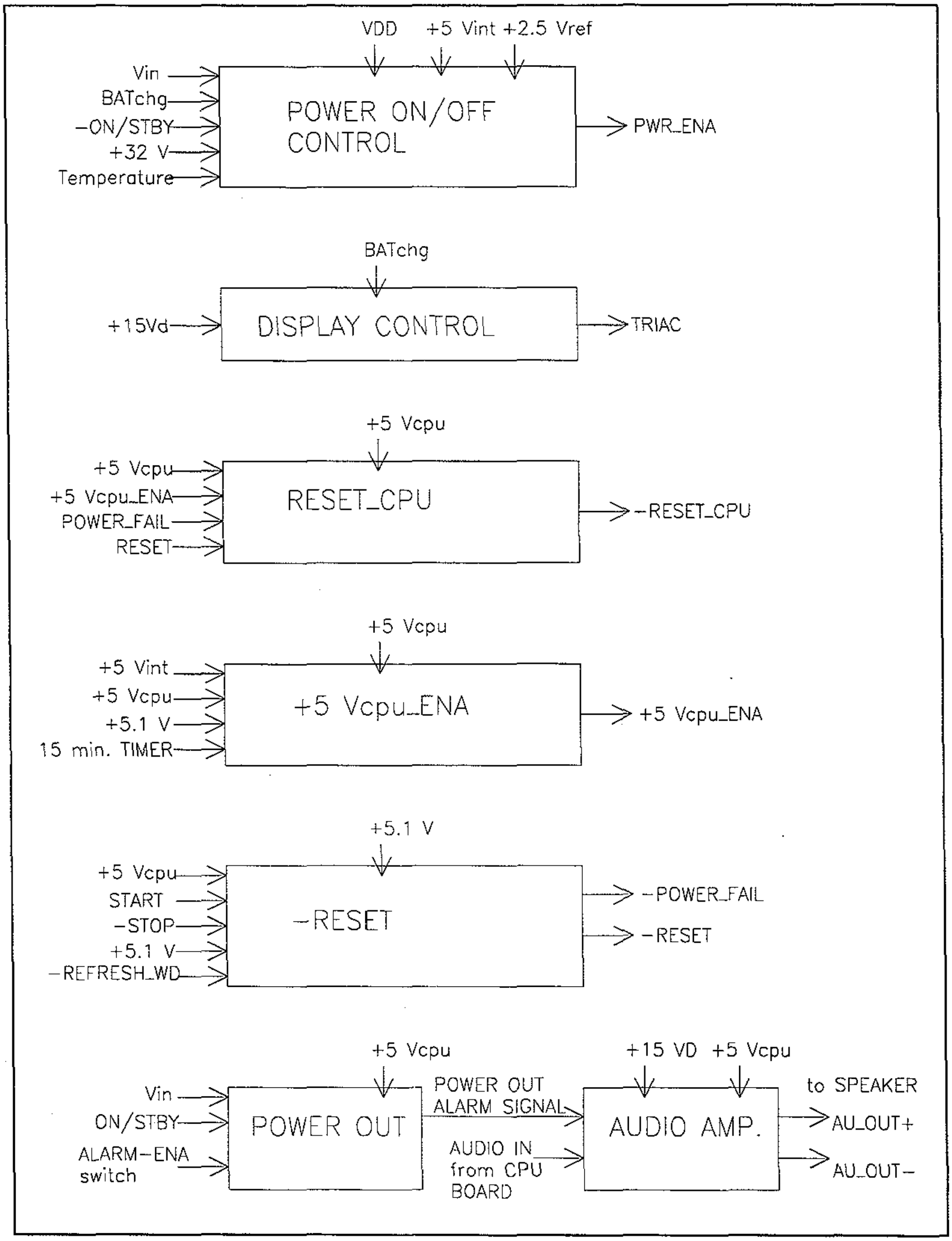


Figure 6 Power Logic Board Block Diagram

Triac Board

Tasks of the Triac board are to supply voltage to the Video display when AS/3 Anaesthesia Monitor is turned on and cut off the voltage when it is turned off. This is done by a solid state relay and peripheral components.

External Components

1. Transformer

The power of the mains transformer is 250 VA. The secondary voltage is 21 VAC and for the display unit it is either 100 VAC, 115 VAC, or 230 VAC.

Depending on the voltage in use, there are three different transformers for the AS/3 Anaesthesia Monitor.

2. Fan

The fan is switched on automatically when +32 Vd is generated.

3. Loudspeaker

The loudspeaker is controlled by the audio-amplifier on the Power Logic board.

4. Battery

6 V, 1.2 Ah sealed lead-acid battery is used to supply power to the CPU board after the power is turned off and the power cord is disconnected.

2.1.3 CPU Mother Board

The CPU mother board connects the CPU board and other AS/3 boards (e.g. UPI and Display controller) and functions as a bus between them.

There are connectors for six AS/3 boards. Four of those are normally occupied (UPI or UPINET, CPU, Display controller and Gas interface or INT boards) and two are reserved for, e.g. B-NET or B-ARK board. AS/3 bus structure is the same in all AS/3 monitors.

ON/STBY-line is connected only to a Display controller connector from where it goes directly to Keyboard and ON/STBY switch. The CPU mother board is connected to Module mother board by 25-pin D-connector.

2.1.4 Module Mother Board

This board connects AS/3 modules and the Anaesthesia Monitor together electrically. Module Bus structure is the same in all the AS/3 monitors. There are connectors for four double-width or eight single-width modules.

2.2 CPU Board, B-CPU2 or B-CPU3

The CPU board takes care of the central processing.

The main features of the CPU board are:
* 80486 processor
* Clock frequency 32 MHz
* Software cartridge interface
* B-CPU2: 2 Mbytes DRAM
* B-CPU3: 8 Mbytes DRAM
* 8 Kbytes static RAM with real time clock
* 32 Kbytes EEPROM memory
* 4 channel UART:
  3 channels with modem signals in AC-logic level
  1 channels without modem signals in RS232-level
* programmable alarm sound generator
* 5 external and 3 internal interrupts

Control logic

IO-decoding and wait state generation takes place in GAL IC and as well as the processor itself. Code memory (EPROM) and working RAM (DRAM) are designed to be linear, and static RAM and EPROM are mapped in I/O space.

Wait state generators

The processor and the GAL IC have internal wait state generators for their predecoded chip select pins. The wait state generator in the GAL IC is used also by the other boards connected to the AS/3 bus.

Halt detection

NMI-interrupt is generated by the power control logic. The interrupt signals in the CPU means that all supply voltages except +5V for the CPU board will be switched off shortly. NMI interrupt service program then saves all necessary parameters in the static RAM before supply voltages fail.

When hardware detects HALT command all signals generated in the CPU board as well as all the outputs to the CPU mother board are left floating in high impedance state; only DRAM refreshment cycle continues to occur. The halt state will continue until a RESET pulse from the power control logic circuit is received.

External Bus

External bus signals are AC logic level signals. Series resistors are used to limit signal ringing when the signals change their states. Additional signal filtering is performed in the CPU mother board.

Software cartridge interface

See chapter "Connectors and signals".

Main peripherals

QUART

Four series channel Quart is used.

SAA1099

IC SAA1099 is used as alarm sound generator.

M48T18

Lithium battery back-up 8 Kbytes static RAM with a real-time clock.

CAUTION: The IC contains a lithium battery. Discard the battery according to local regulations.

Refresh watchdog

The processor has to refresh periodically the watchdog timer in the Power supply unit in order to prevent reset pulse.

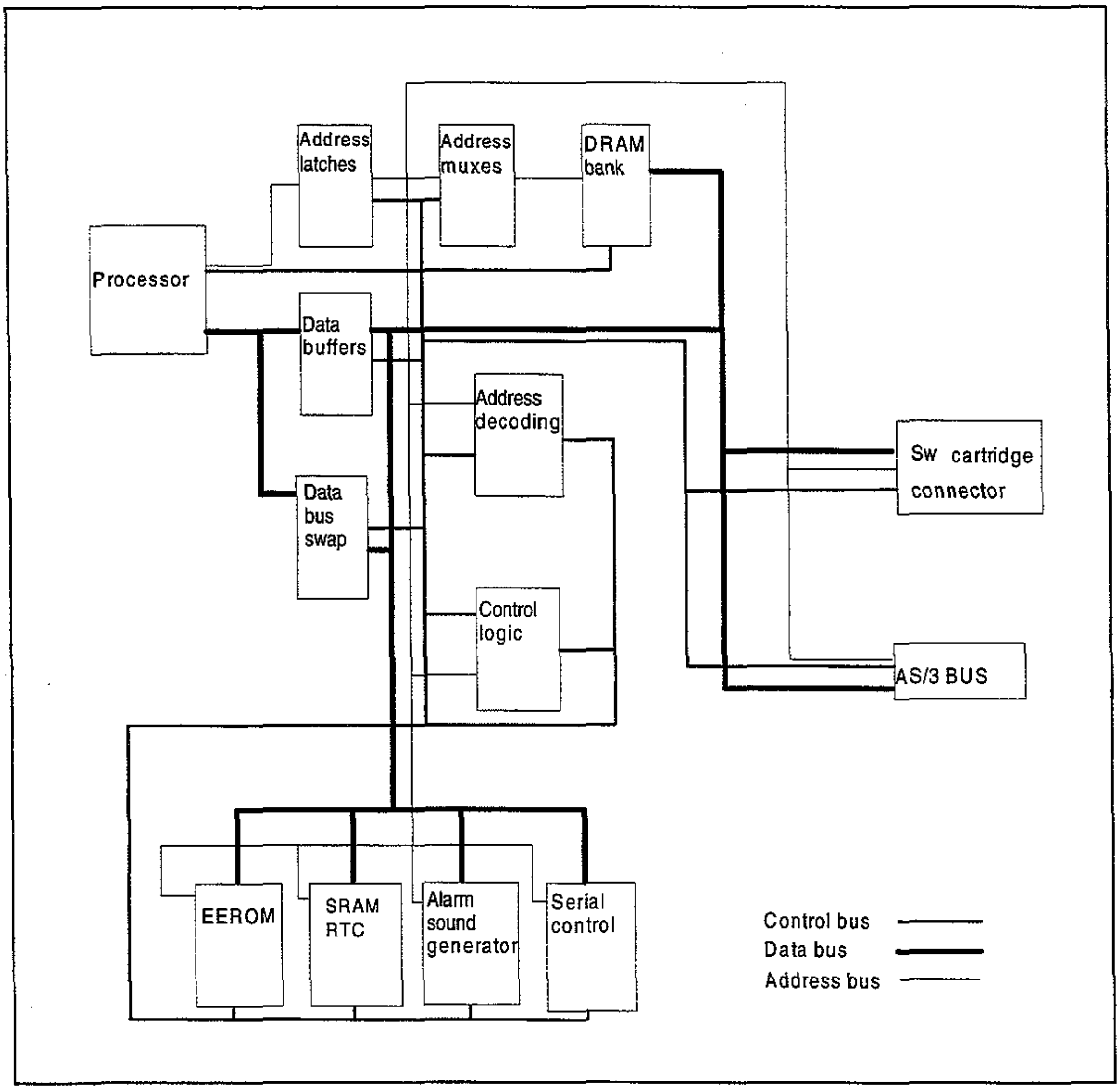


Figure 7 CPU Board Block Diagram

2.3 Software Cartridge, S-STD96 or S-ARK96

CAUTION: The AS/3 Software Cartridge cannot be disassembled. There are no serviceable parts inside.

The Software Cartridge contains the main software, which includes software for the CPU board, Display controller boards, UPI/UPINET board and Network board.

The main software is named S-STD96 or S-ARK96. The software S-ARK96 is needed when the monitor is used for anaesthesia record keeping. Both softwares contain the same monitoring functions.

Software cartridge pin configuration

	A	B
1	GND	+5 V VCC
2	+5V Vpp	EPROM 1
3	-SMEMW	-SMEMR
4	-SBHE	SA0
5	A21/A20	-EPROM0
6	WS 2/4	-EPROM0
7	SA21	-EPROM1
8	SA19	SA20
9	SA17	SA18
10	SA15	SA16
11	SA13	SA14
12	SA11	SA12
13	SA9	SA10
14	SA7	SA8
15	SA5	SA6
16	SA3	SA4
17	SA1	SA2
18	D15	D14
19	D13	D12
20	D11	D10
21	D9	D8
22	D7	D6
23	D5	D4
24	D3	D2
25	D1	D0

2.4 Connectors and Signals

2.4.1 Internal Connectors

Power supply (X3) - CPU mother board connector

	a(a)	b(c)	c (e)
2	+15 VD	GND	+32 VD
4	+15 VD	GND	+32 VD
6	+5 V	GND	GND
8	+5 V	+5 V	GND
10	RESET_CPU	+5 V_CPU	GND
12	POWER_FAIL	REFRESH_WD1	LOUDSPEAKER
14	ON/STBY	RESET	N/C
16	N/C	N/C	N/C
18	GND	GND	GND
20	TEST1 N/C	TEST2 N/C	TEST3 N/C
22	TEST4 N/C	TEST5 N/C	TEST6 N/C
24	TEST7 N/C	TEST8 N/C	TEST9 N/C
26	GND	GND	GND
28	BAT_ON N/C	V_BAT N/C	I_BAT N/C
30	N/C	GND	N/C
32	+15 V	GND	-15 V

CPU mother board - Module mother board connector

Module bus connector

Pin No	I/O	Signal
1	O	RESET_RS485
2	O	-15 VDC
3	O	+15 VDIRTY
4	O	+15 VDC
5	O	-DATA_RS485
6	O	DATA_RS485
7	O	Ground & Shield
8	O	-RESET_RS485
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13	O	Ground & Shield
14	O	+32 VDIRTY
15	O	GroundDIRTY
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20	I	ON/STANDBY
21	I	PWM_ECG
22	I	RXDD_RS232
23	O	TXDD_RS232
24	O	+5 VDC
25	O	+5 VDC

CPU Bus connectors on CPU Mother board

	a	b	c
1	+15 V	AGND	DGND
2	-15 V	BALE	DGND
3	SA0	SA1	DGND
4	SA2	SA3	RESET_RS485
5	SA4	SA5	-RESET_RS485
6	SA6	SA7	DATA_RS485
7	SA8	SA9	-DATA_RS485
8	SA10	SA11	TXDD_RS232
9	SA12	SA13	RXDD_RS232
10	SA14	SA15	PWM_ECG
11	SA16	SA17	BIT1IN
12	SA18	SA19	TXDC
13	SA20	SA21	RXDC
14	SA22	SA23	RTSC
15	-SMEMR	-SMEMW	CTSC
16	-SIOR	-SIOW	TXDB
17	CLK	-RESET	RXDB
18	-IOCHRDY	IRQ10	RTSB
19	N/C_1	IRQ11	CTSB
20	N/C_2	IRQ12	TXDA
21	-SBHE	IRQ15	RXDA
22	SD0	SD1	RTSA
23	SD2	SD3	CTSA
24	SD4	SD5	AUDIO_OUT
25	SD6	SD7	+5 V
26	SD8	SD9	+5 V
27	SD10	SD11	+5 V
28	SD12	SD13	+5 V
29	SD14	SD15	ON/STBY
30	+15 VD	-RESET_CPU	+5 V_CPU
31	+15 VD	+32 VD	REFRESH_WD
32	GNDD	GNDD	POWER_FAIL

2.4.2 External Connectors

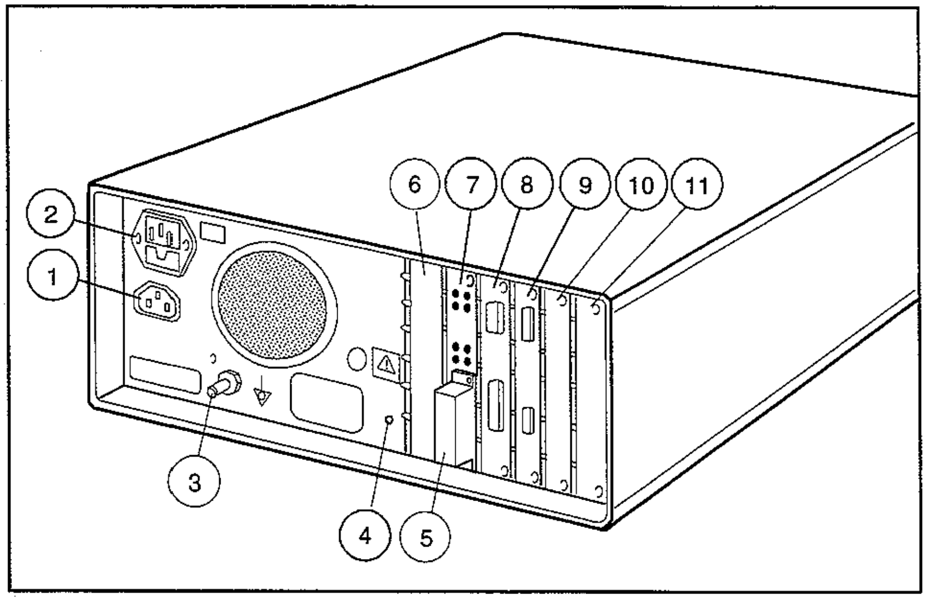


Figure 8 Central Unit Rear Panel

(1) Display power outlet
(2) Mains power inlet
(3) Equipotential connector
(4) Service reset button
(5) Software Cartridge
(6) Network Board/UPINET Board/Keyboard Interface Board
(7) CPU Board
(8) UPI board
(9) Primary Display Controller
(10) Secondary Display Controller/Keyboard Interface Board
(11) Interface Board/Gas Interface Board

NOTE: Your Central Unit may not include all circuit boards listed above.

9-pin D-connector X3 on UPI board for serial data interface

Pin No	I/O	Signal
1		N/C
2	I	RXD (RS)
3	O	TXD (RS)
4	O	+5 V
5	O	GND
6		N/C
7	O	RTS (RS)
8	I	CTS (RS)
9		N/C

44-pin D-connector X2 for digital and analog I/O on the UPI Board

Pin No	I/O	Signal
1	O	GND
2	I	(D) input 3
3	O	Def Sync (D) output 0
4	I	(D) input 2
5	O	Nurse call (D) output 3
6	O	Reserved (D) output 3
7	O	GND
8	O	Pacemaker Sync. (D) output 2
9	I	Reserved (A) CH3
10	O	(A)* CH5
11	O	+15 V
12	O	-15 V
13	I	Reserved (A) CH0
14	O	(A)*CH1
15	O	+5 V
16	O	(A)*CH4
17	O	(A)*CH3
18	I	for monitor interfacing (A)CH1
19	O	(A)*CH2
20	O	(A)*CH0
21	I	Reserved (D) INPUT 4
22	I	for monitor interfacing (A) CH2
23	I	Reserved (D) INPUT5
24	O	(A)*CH6
25	O	(A)*CH7
26		N/C
27		N/C
28		N/C
29		N/C
30		N/C
31		N/C
32		N/C
33		N/C
34		N/C
35		N/C
36		N/C
37		N/C
38	O	Direct ECG (A)
39		N/C
40		N/C
41		N/C
42		N/C
43		N/C
44		N/C

* Analog outputs are selectable.

2.4.3 Serial Data Interface

Serial Data Interface connector

The Serial Data Interface connector is a 9-pin male D-connector (X3) on the rear panel of the UPI board.

Serial interface is RS-232 connection which uses ±12V input/output signals.

2.4.2 Digital and analog I/O connector

The digital and analog I/O connector is a 44-pin female D-connector (X2) on the rear panel of the UPI board.

Digital Inputs

There are 4 separate digital inputs. Each signal uses TTL-level. The inputs and pins are (numbering starts from input 2):

Input 2	pin 4
Input 3	pin 2
Input 4	pin 21
Input 5	pin 23
Ground	pin 7

Digital Outputs

There are 4 separate digital outputs. Each signal uses TTL-level. The outputs and pins are:

output 0 (Defibrillation Sync.)	pin 3
output 1 (Nurse Call)	pin 5
output 2 (Pacemaker Sync.)	pin 8
output 3 (reserved)	pin 6
ground	pin 7,1

Defibrillation Sync indication is generated by ECG. When active, the signal is state 1. After 10 ms the signal is reset to state 0. New Defibrillation Sync is not generated before the indication is deactivated.

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

Pacemaker Sync indication is generated by ECG. When a pacemaker pulse is detected, this signal is set to state 1, then it is reset to state 0. The indication pulse width is between 0.5 ms and 2.5 ms.

The range of state 0 is from 0 to 0.8 V, and range of the state 1 is 2.8 to 5 V.

Analog Inputs

There are 4 separate analog input channels. Each channel accepts voltages between 0 and 5 volts. The resolution consists of 1024 different voltage levels. All signals are read once in 10 ms. The channels and pins are:

channel 0	pin 13
channel 1	pin 18
channel 2	pin 22
channel 3	pin 9
ground	pin 7,1

NOTE: The inputs can be used only for interfacing and each of the channels require a simultaneous serial data interface at UPI board connector X3.

Analog Outputs

AS/3 Anaesthesia Monitor produces analog real-time signals according to measured parameters. Among them is the Direct ECG signal which is available only at pin 38. All other analog signals are selected by the user trough the Analog Outputs menu (Monitor Setup / Install/Service). The selection is automatically stored into permanent memory.

NOTE: When source of the selected analog output becomes invalid (for example, transducer is disconnected), the last valid waveform information remains on the output and the numerical information is no longer valid.

Direct ECG (pin 38)

Delay (max.): 15 ms
Gain ECG (out)/ECG (in): 1 V/1 mV
Frequency band:
ST and diagnostic: 0.5 - 35 Hz
Monitor: 0.9 - 35 Hz

NOTE: Direct ECG is available with frame revision F-CU8-xx-02 or higher, and with M-ESTP revision 02 or higher, and M-ETP/EST module revision 01 or higher or M-ESTPR, M-ETPR or M-ESTR module. The availability differs in other combinations.

There are eight separate analog output channels:

channel 0	pin 20
channel 1	pin 14
channel 2	pin 19
channel 3	pin 17
channel 4	pin 16
channel 5	pin 10
channel 6	pin 24
channel 7	pin 25
ground	pin 7,1

Analog signals

Each signal is scaled in linear way between -5 ... +5 volts. The resolution consists of 4096 different voltage levels. All signal levels are updated once in 10 ms.

NOTE: Output scale -5...+5 volts is available from frame revision F-CU8-xx-02. The older versions use scale 0... 10 volts. See the UPI board information for specification.

OFF: Default state. No signal is present at analog output pin.

HR according to selected source (display value): The original scale 0...300 beats are scaled between 0 and 3 volts.

ECGl, ECG2, ECG3: The original scale -5000 microvolts...+5000 microvolts is scaled between -5 and +5 volts.

P1 lre, P2 lre, P3 lre, P4 lre (Invasive pressure real-time values, low resolution): The original scale -20 mmHg...+320 mmHg is scaled between -0.2 and +3.2 volts.

P1 hre, P2 hre, P3 hre, P4 hre (Invasive pressure real-time values, high resolution): The original scale -20 mmHg...+50 mmHg is scaled between -2 and +5 volts.

Pleth: The original scale -100%...100% is scaled between -5 and +5 volts.

SpO_2>40, SpO_2>60, SpO_2>80 (beat-to-beat, display value, 10 s average): The original scale 40-100% (SpO_2>40), 60-100% (SpO_2>60) or 80-100% (SpO_2>80) is scaled between -5 and +5 volts.

CO_2: The original scale 0%...10% is scaled between 0 and +5 volts. Values greater than 10% are set to 10%. (Airway gas special indications are applied, see also chapter Special Indications).

AA (Anesthesia Agent): The original scale 0%...10% is scaled between 0 and +5 volts. Values greater than 10% are set to 10%. (Airway gas special indications are applied, see also chapter Special Indications).

O_2: The original scale 0%...100% is scaled between 0 and +5 volts. (Airway gas special indications are applied, see also chapter Special Indications).

N_2O: The original scale 0%...100% is scaled between 0 and +5 volts. (Airway gas special indications are applied, see also chapter Special Indications).

Paw (Airway Pressure): The original scale -20 cmH2O...+80 cmH2O is scaled between -5 and +5 volts. (Airway gas sensor failure is applied, see also chapter Special Indications).

Flow: The original scale -100 l/min...+100 l/min is scaled between -5 and +5 volts. (Airway gas sensor failure is applied, see also chapter Special Indications).

Volume: The original scale -2.5 litres...+2.5 litres is scaled between -5 and +5 volts. (Airway gas sensor failure is applied, see also chapter Special Indications).

Resp: The original scale -5000 mohms is scaled between -5 and +5 volts.

RR: RR display 0 to 150 breaths per minute are scaled between 0 and +1.5 volts.

T1, T2, T3, T4 (Temperature): The original scale 0 degrees...50 degrees Celcius is scaled between 0 and +5 volts.

TEST 1: Test signal of a triangle shape with base width of 1 second, min value of 0 volt and max value of 5 volts.

TEST 2: Test signal of a triangle shape with base width of 4 seconds, min value of -5 volts and max value of +5 volts.

TEST SIGNALS -5 V, 0 V, +5 V: Steady signals with one of the listed values.

Special Indications

Start up indication occurs when monitor is started. This can be caused either by power on or by internal restart (caused by a fatal failure). Indication consists of three triangle signals with base width of 1 second, base of 0 volt and height of 5 volts.

Airway Gas Calibration: During calibration of any of gases a square wave is generated: min value 0 volts, max value +2 volts, min phase length equals max phase length and frequency 0.25 Hz.

Airway Gas Zeroing: During zeroing of any of gases a square wave is generated: min value 0 volts, max value +5 volts, min phase length equals max phase length and frequency 0.25 Hz.

Airway Gas Occlusion: During occlusion of any of gases a triangle signal is generated with base width of 4 seconds, min value of 0 volts and max value of +5 volts.

Airway Gas Air Leak: During air leak of any of gases a triangle signal is generated with base width of 3 seconds, min value of 0 volts and max value of +5 volts.

Airway Gas Sensor Failure: During sensor failure a triangle signal is generated with base width of 2 seconds, min value of 0 volts and max value of +5 volts.

3 SERVICE PROCEDURES

3.1 General Service Information

Field service of the AS/3 Anaesthesia Monitor Frame is limited to replacing the faulty circuit boards or mechanical parts. Return the boards to Datex for repair. Only the parts listed as Spare Parts are available for field service.

Datex 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 the appropriate tools and equipment shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Preventive Maintenance

We recommend that you perform these checks after any service and at least once a year to keep the AS/3 Anaesthesia Monitor Central Unit in good condition.

1. Visual inspection

__: Grounding wires and all connectors are properly connected. Check especially rear panel connectors for tight connection.

__: Fan is running and rear panel dust filter is clean (clean it at least once a month).

__: Display screen is not distorted.

__: Real time and date are correct in Monitor Setup menu. If the monitor is used part of the time, replace the lithium battery back-up static RAM MK48T02 (CPU1) every four years and MK48T08 (CPU2), MK48T18 (CPU3) every eight years.

2. Functional checks

__: Check the operation of the loudspeaker with an alarm.

__: Press the key "DISPLAY TRENDS" and check that there are trends data in the memory. Turn the power off and disconnect the power cord. After two minutes, turn the power back on and make sure that the trend data is not erased from the memory. Check also that the real time and date is still correct.

__: Check that the modules operate normally in other slots as well.

CAUTION: The Airway module cannot be connected or disconnected while the power is on.

__: While the power is on, remove M-NIBP or M-ESTP/ETP/P module at a time from the Central Unit. Only the data of the parameters of the module in question should disappear from the display.

__: Reinsert the module to the Central Unit. Within 15 seconds, the data should return to the display.

3.3 Disassembly and Reassembly

To open the monitor enclosure:

The Central unit is disassembled in the following way. See the exploded view of the unit:

a) Disconnect the power cord.

b) Remove all the parameter modules from the front of the Central unit.

c) Press and hold the service reset button on the rear panel of the Power supply unit for at least five seconds (until a soft sound is heard). After this the Power supply unit, Software cartridge, and all the boards are free to be detached from the Central unit.

d) Remove the cross recess screw M6x30 with its support plate from the bottom of the unit.

e) Remove the two screws with star washers which are at the top of the back panel of Power supply unit.

Now the Power supply unit is free. Get hold of the equipotential connector pin and fuse housing, and pull the unit out. Move the unit from side to side if it does not come out smoothly. **Be careful not to damage the speaker attached to the bottom of the unit.**

f) Blank connector plates, Software cartridge, and the boards are pulled off after removing two screws and washers. Notice that the boards can be removed only in certain order.

g) Remove the screws at the Module mother board and one screw from the bottom panel. The metal chassis to which Module mother board and CPU mother board are attached can be pulled out from rear.

h) Module mother board and CPU mother board are attached to the metal chassis with screws. These boards are connected to one another by 25-pin connector.

When reassembling, reverse the order of the disassembling steps as described before. When inserting the metal chassis into the external frame, fasten the screws from the front before fastening the one thick screw on the bottom panel. This way the metal chassis can be attached as close as possible to the inner divider wall. Check that the 25 pin module connectors are exactly in the middle of the openings for the connectors in the plastic frame.

When reinstalling PC boards, push them carefully until they stop before fastening them with screws.

NOTE: When reassembling the boards set them to the slots recommended in the sticker. The boards can only be assembled in certain order.

Power Supply Unit

The Power Supply unit is disassembled by removing four screws from the top cover, disconnecting the cables between the top cover and the Power supply board and then lifting the cover off. Lead-acid battery and Power logic board are attached to the back of the top cover. See the exploded view of the unit, see chapter 6.2 of this section.

Power supply board is attached to the bottom of chassis with three screws. Transformer, loudspeaker, and Triac board are also attached to the bottom. Fan, mains power receptacle, and display power outlet are attached to the rear of the chassis. Rear panel is also attached to the rear of the chassis with three screws.

When reassembling, reverse the order of the disassembling steps as described before. When inserting the Power Supply unit back to the Central unit, make sure that the Power Supply unit is properly attached to the CPU mother board before fastening the screws.

Lead acid battery

The sealed lead-acid battery in the Power supply unit can be used for 3 to 5 years. If the trends are not stored in the memory for 15 minutes after the power is turned off and the power cord is disconnected, the fault is probably in the battery or in the battery fuse.

To change the battery: Remove the screw that holds the battery to the top cover of the power supply unit.

When replacing the battery, make sure the + indicated battery cable is attached to the + pole of the battery

Dispose of the old battery according to the local regulations.

Changing the Software Cartridge

Change the AS/3 Anaesthesia Monitor Software Cartridge according to following procedures. If necessary, save all user default settings into the Memory card of M-MEM or write them down using the Default Configuration Worksheet in the AS/3 Anaesthesia Monitor Installation Manual.

1. Turn off the power to the monitor. Press and hold the SERVICE RESET button on the rear panel for five seconds.
2. Unscrew the two screws that hold the cartridge in place and pull it out.
3. Insert the new cartridge into the CPU board and press it gently until it seats firmly. Secure the cartridge with the two screws removed earlier.
4. Turn the power back on.
5. Perform Factory Reset through the Service Menu. If necessary, restore the previous user default settings.

NOTE: The factory reset restores all user specific configurations back to factory defaults.

Changing and Installing AS/3 Board

Change any of the AS/3 boards according to following procedures.

1. Turn off the power to the monitor. Press and hold the SERVICE RESET button on the rear panel of the monitor for five seconds.

(Before removing the CPU board, remove the software cartridge as explained earlier.)

2. Unscrew the screws that hold the board in place and pull it out.

3. Remove the new board from the protective anti static packaging. Always hold the board by its edges and wear a wrist grounding strap.

CAUTION: The board comprises sensitive integrated circuits that can be damaged by an electrostatic discharge.

4. Insert the board into the slot and press the board gently until it seats firmly. Secure the board with the screws removed earlier.

5. Turn the power to the monitor back on.

Changing fuses

Power supply main fuses are located next to power cord receptacle. The fuse holder can be removed by gently pushing the locking pin above the holder (or the locking pins at both sides) and the same time pulling the holder.

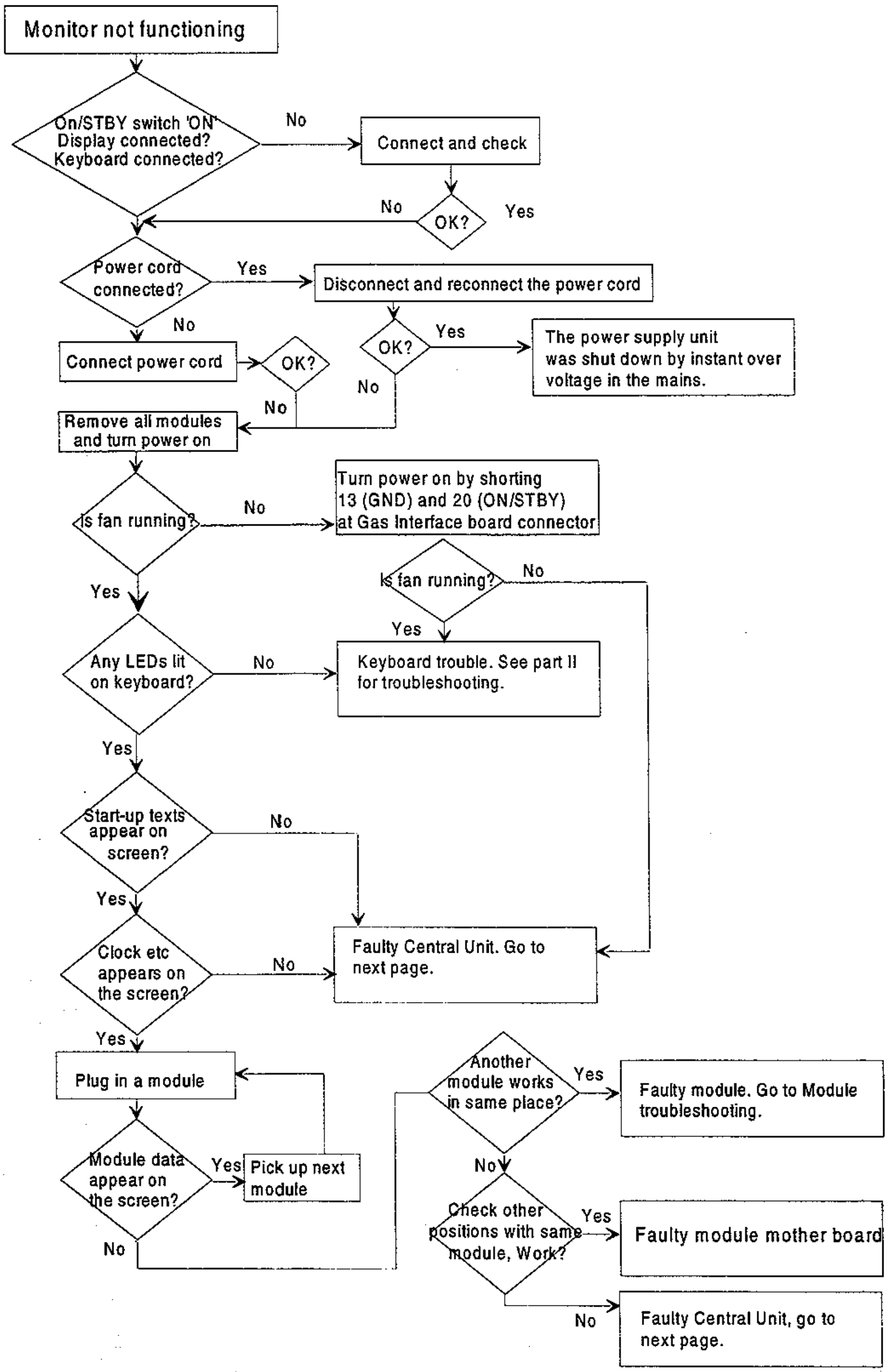
CAUTION: Use only fuses with specified type and ratings.

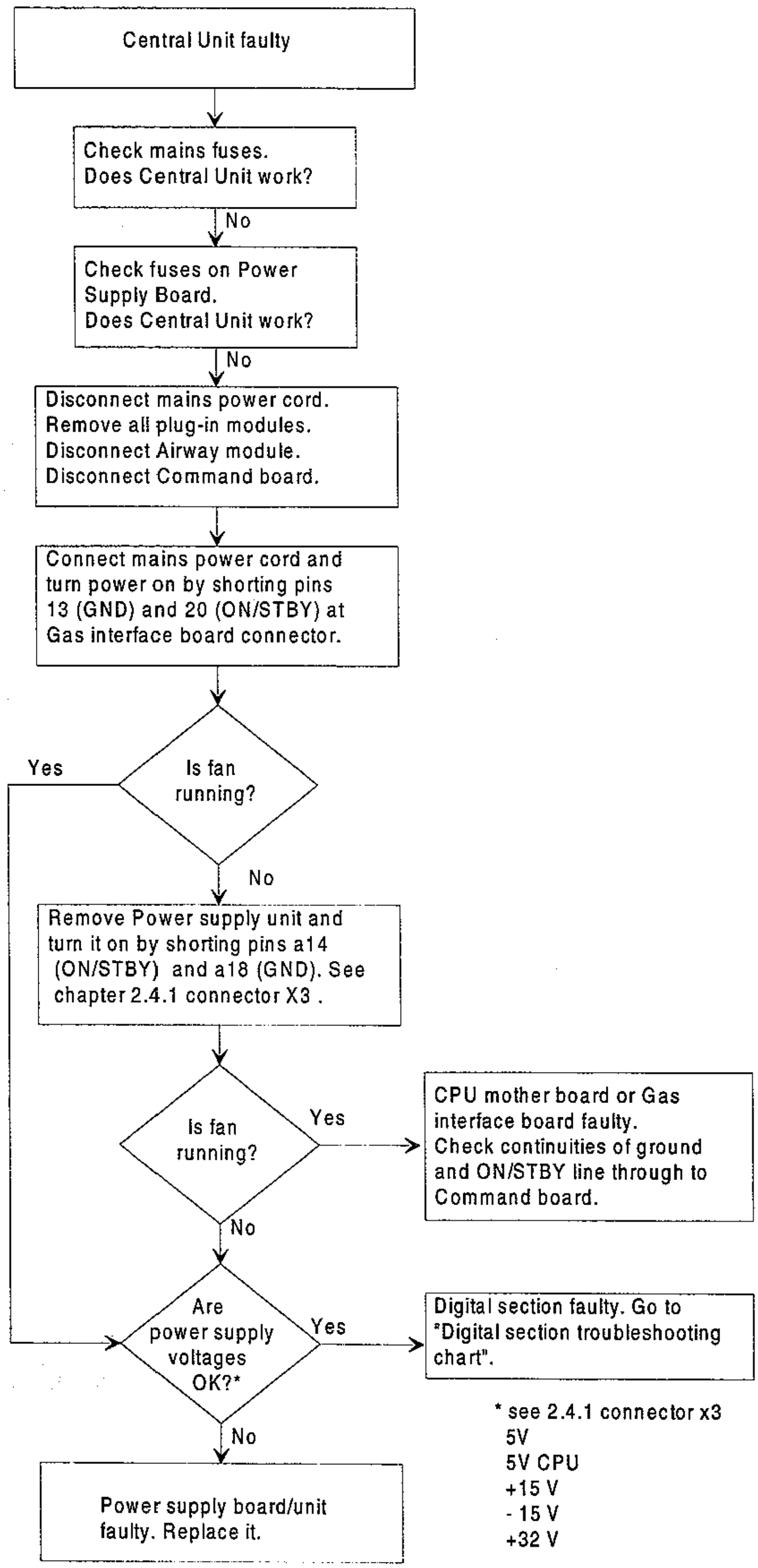
To change the secondary fuse on the power supply board: Remove the rear panel from the power supply unit by removing the two screws at the top and two screws at the bottom of the panel. Replace the fuse placed on the upper right corner.

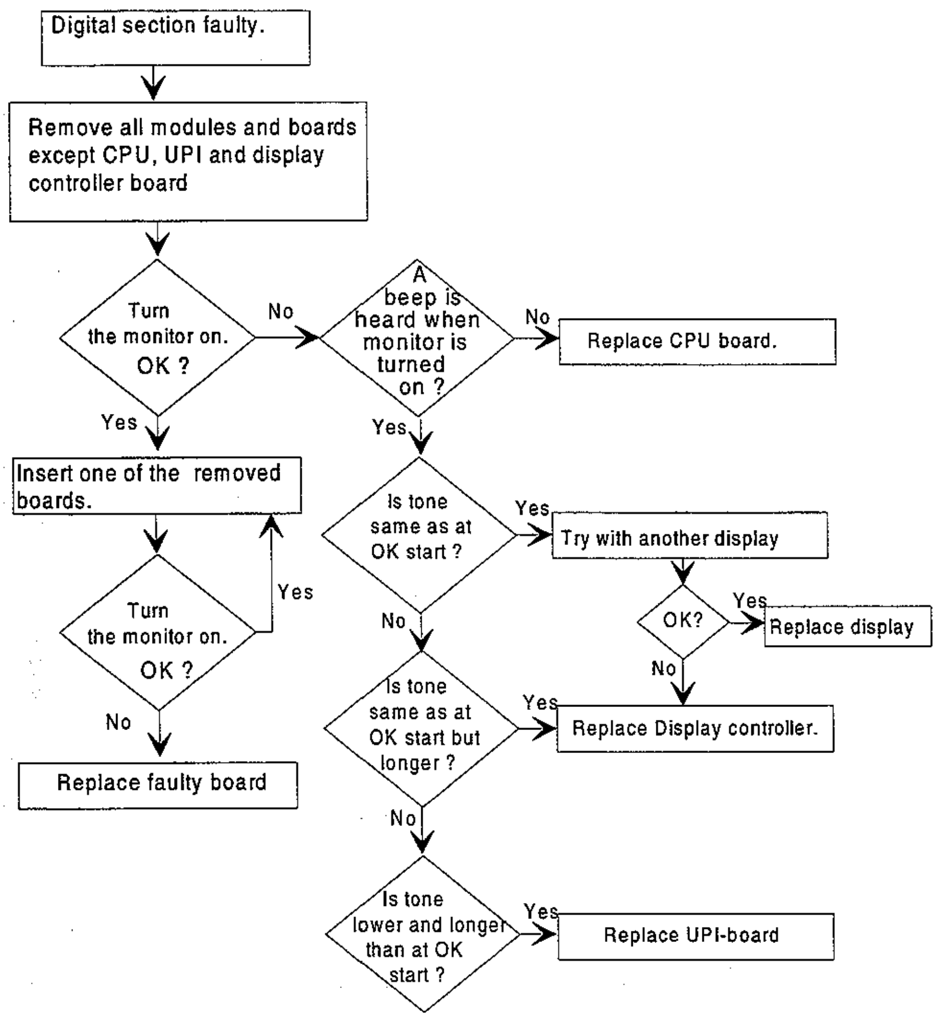
3.4 Adjustments and Calibrations

It is not necessary to do calibrations or adjustments to the Anaesthesia Monitor frame.

4 TROUBLESHOOTING



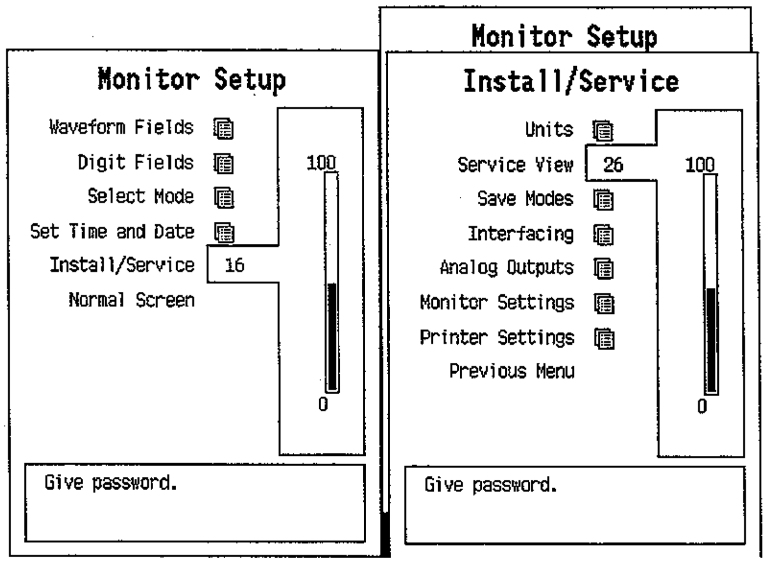

Central Unit faulty
Check mains fuses.
Does Central Unit work?
No
Check fuses on Power
Supply Board.
Does Central Unit work?
No
Disconnect mains power cord.
Remove all plug-in modules.
Disconnect Airway module.
Disconnect Command board.
Connect mains power cord and
turn power on by shorting pins
13 (GND) and 20 (ON/STBY) at
Gas interface board connector.
Is fan
running?
Yes
No
Remove Power supply unit and
turn it on by shorting pins a14
(ON/STBY) and a18 (GND). See
chapter 2.4.1 connector X3 .
Is fan
running?
Yes
CPU mother board or Gas
interface board faulty.
Check continuities of ground
and ON/STBY line through to
Command board.
No
Are
power supply
voltages
OK?*
Yes
Digital section faulty. Go to
"Digital section troubleshooting
chart".
No
Power supply board/unit
faulty. Replace it.
* see 2.4.1 connector x3
5V
5V CPU
+15 V
- 15 V
+32 V


Digital section faulty.
Remove all modules and boards except CPU, UPI and display controller board
Turn the monitor on. OK ?
No
A beep is heard when monitor is turned on ?
No
Replace CPU board.
Yes
Insert one of the removed boards.
Turn the monitor on. OK ?
Yes
No
Replace faulty board
Yes
Is tone same as at OK start ?
Yes
Try with another display
OK?
Yes
Replace display
No
No
Is tone same as at OK start but longer ?
Yes
Replace Display controller.
No
Is tone lower and longer than at OK start ?
Yes
Replace UPI-board

5 SERVICE VIEW

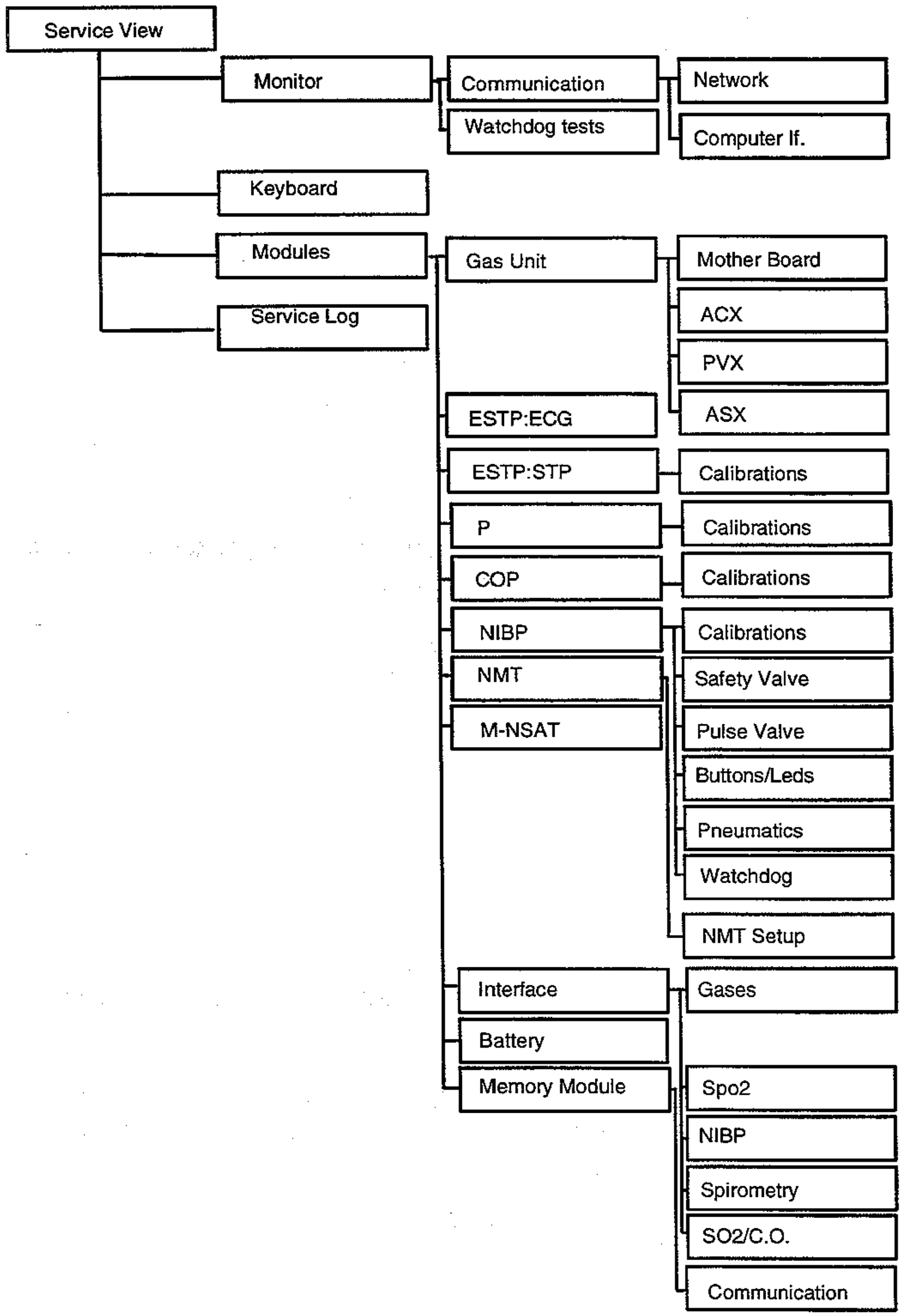
The monitor has Service Menu, which is a useful tool to examine monitor functions and to troubleshoot in case a fault occurs.

5.1 To Enter Service Menu

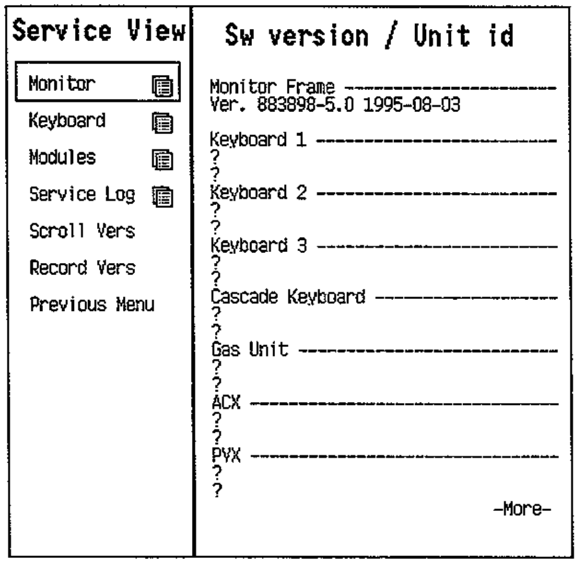


1. Press the MONITOR SETUP key.
   The Setup menu appears.
2. Turn ComWheel to highlight Install/Service and push.
3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.
4. Turn the ComWheel to highlight Service View and push.
5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.
6. Turn the ComWheel to highlight Modules and push.
7. Turn the ComWheel to highlight right module and push.

5.2 Service Menu Structure



5.3 Service View Menu

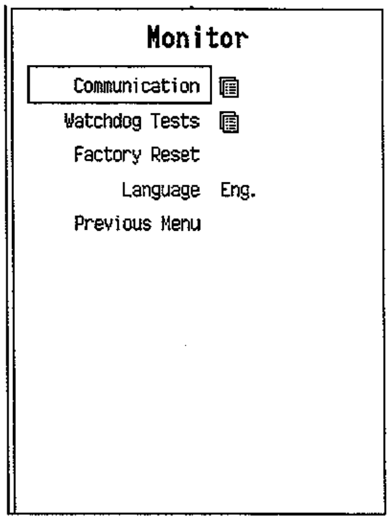


The field on the right shows software versions and their release dates of different parts of the monitor.

The selections in Service View are:

1. Monitor unit service menu.
2. Keyboard service menu.
3. Modules service menu.
4. Error and event history.
5. Scroll Vers enables to scroll the software versions and release dates. "-more-" indicates that there are more lines to be viewed.
6. Record Vers: By choosing this selection, the recorder (M-REC) prints the software versions and other information onto the paper.
7. Return to previous menu.

5.3.1 Monitor Menu



1. Communication service menu. Includes service information on Networking ,please refer to section B-NET and on Computer Interface. From Computer Interface screen you can see In/Out packet and bytes, as well as received errors.

2. Watchdog Tests Service Menu. Watchdog
   Monitor performs a reset after ca. 2 seconds. If watchdog circuit in power supply is faulty, the time is counted on and stops at ">20s".

3. Factory Reset
   Restore factory default settings; clear data memories.

4. Language:
   Select the language used in this monitor.

5. Return to previous menu.

5.4 Keyboard Menu

```
Keyboard          Service Data
                  Message count    0
Upper Led         Leds upper  OFF lower     OFF
Lower Led         Direct action keys
Dummy Press       Silence  Freeze   Mark     Alarms
                  Alarms            Event    Setup
Previous Menu
                  Recorder ECG      NIBP     Invasive
                                             Pressures
                  Normal
                  Screen
                  Help     Reset    Display  Monitor
                           Case     Trends   Setup
                  Patient  Pulse    Airway   Others
                  Data     Oximetry Gas

                  Control wheel
                  Press           0
                  Clockwise       0 Counterclockwise    0
```

1. Silence Alarms upper led (red) check.
2. Silence Alarms lower led (yellow) check.
3. ComWheel pressing check.
4. Return to previous menu.

SERVICE DATA Detailed Description

Message Count counts whenever a function is selected.

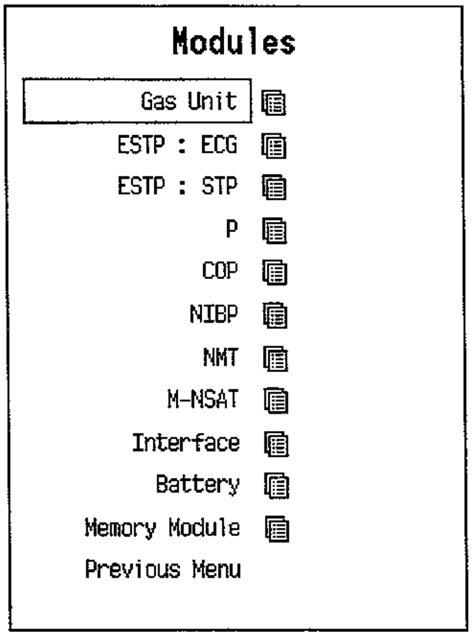
Leds upper and **Leds lower** indicate Silence Alarms leds' state.

Direct action keys' 17 items change its color when the key is pressed. If the color does not change, the key may be mechanically damaged.

In **Control wheel, Press** counts whenever the ComWheel is pushed. **Clockwise** and **Counterclockwise** counts whenever the ComWheel is turned.

NOTE: Counters in this page are automatically zeroed on returning to the previous menu.

5.5 Module Menu

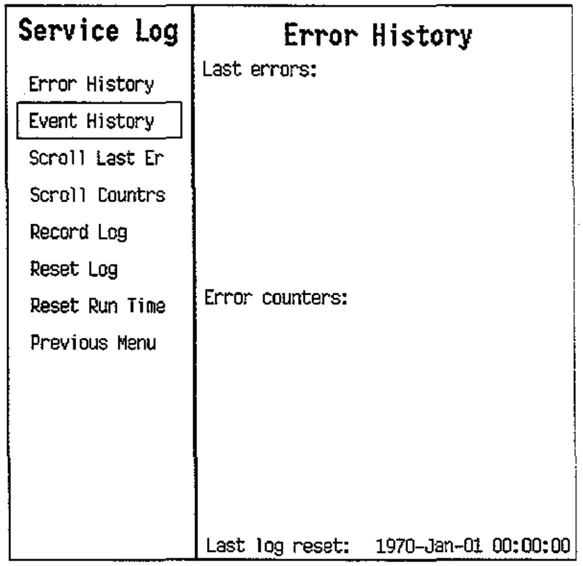


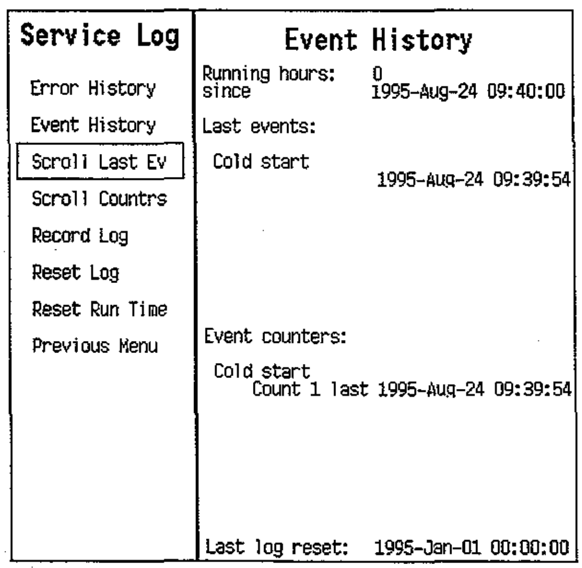
1. Gas unit service functions.
2. ESTPR module ECG board service functions.
3. ESTPR module STP board service functions.
4. P module service functions.
5. COP module service functions.
6. NIBP module service functions.
7. NMT service functions. Not available in earlier software revisions.
8. M-NSAT module service functions
9. Interface service functions
10. Battery service functions only for AS/3 Compact Monitor battery
11. Memory module service functions
12. Return to previous menu.

The module menus are discussed further in the module chapters.

5.6 Service Log Menu

Event and error data is stored on Service Log.





1. Error history is displayed.
2. Event history is displayed.
3. Scroll last events in menu
4. Scroll error events in menu

5. Record both error and event history

6. Reset the whole service log.

7. Reset the run time counter

8. Return to previous menu.

Detailed Description

Cold starts is the number of monitor starts with longer than 15 minutes power off time. **Warm starts** is the number of starts with shorter than 15 minutes power off time. Non-zero counter values does *not* indicate a failure.

Fast cold starts indicates number of erroneous cold starts with power off time less than 20 seconds. The reason can be either failing battery unit or software problem solved by hardware watchdog.

GSP watch-dog time-out and UPI watch-dog time-out indicate erroneous cold restarts controlled by monitor and caused by display controller board, or by the UPI or UPINET board respectively.

6 SPARE PARTS

6.1 Spare Parts list

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

Item numbers refer to the exploded view in the chapter 6.2

8-Module Frame, F-CU8

Rev. 01

Item	Item description	Order No.
4	UPI board, AS/3 AM (Rev. 01)	*(880321) Use 886914
2	CPU mother board, AS/3 AM (Rev. 01-02)	880319
3	Module mother board, AS/3 AM (Rev. 01-02)	880320
9	Frame	879097
5	Metal box, F-CU8 (Rev. 01-02)	880349
12	Rail for PC boards	879257
6	Connector plate, blank/narrow	879393
13	Connector plate, blank/wide	880278
17	Cross recess screw M6x30	61673
18	Support plate for 61673	879502
10	Cross cylinder head screw M5x8	61516
15	Cross cylinder head screw M3x8	61722
14	Star washer M3.2	63611
11	Pad	65144
1	Bronze tap for display screen tray	879476
7	Power supply unit, AS/3 AM (-21-) (Rev. 01-02)	*884588
7	Power supply unit, AS/3 AM (-23-) (Rev. 01-02)	*884589
7	Power supply unit, AS/3 AM (-28-) (Rev. 01-02)	*884590
19	Power supply unit top cover, (Rev. 01-02)	880351
30	Lead-acid battery	17006
24	Power supply board, AS/3 AM (Rev. 01-02)	*(880316) Use 885334
25	Fuse T6.3A	*51128
23	Fuse Miniature T1A	*51062
32	Triac board, AS/3 AM (Rev. 01-02)	*(880317) Use 887364
33	Fuse T2.5A	*51118
33	Fuse T2.5A (USA)	*511181
34	Transformer (110-120 V)	26133
34	Transformer (220-230 V)	26135
34	Transformer (230-240 V)	26134
20	Fan, AS/3 AM	880049
22	Loudspeaker, AS/3 AM (Rev. 01-02)	880048
27	Mains power receptacle	54014
28	Fuse T3.15A	*51119
28	Fuse 5A slow (USA)	*511382
29	Display power outlet	54027
26	Power supply unit chassis, AS/3 AM (Rev. 01-02)	879254
16	Service Reset Switch, AS/3 AM (Rev. 01-02)	881378
	Dust filter	*871558

Rev. 02

Item	Item description	Order No.
4	UPI board, AS/3 AM (Rev. 02-03)	*(882354) Use 886914

Rev. 03

Item	Item description	Order No.
4	UPI board, AS/3 AM (Rev. 03)	*886914
7	Power supply unit, AS/3 AM (-22-) (Rev. 03)	*884591
7	Power supply unit, AS/3 AM (-28-) (Rev. 03)	*884592
7	Power supply unit, AS/3 AM (-31-) (Rev. 03)	*884593
26	Power supply unit chassis, AS/3 AM (Rev. 03)	882337
19	Power supply unit top cover, AS/3 AM (Rev. 03)	882336
24	Power supply board, AS/3 AM (Rev. 03)	*882507
16	Service Reset Switch, AS/3 AM (Rev. 03)	52090
25	Fuse T10A 250 V	*51137
23	Fuse Miniature 2AF	*51063
31	Power logic board, AS/3 AM (Rev. 03)	*882508
32	Triac board, AS/3 AM (Rev. 03)	*(884185) Use 887364
21	Ribbon cable	882520
34	Transformer (100-105 V)	26139
34	Transformer (110-120 V)	26138
34	Transformer (220-240 V)	26137
22	Loudspeaker, AS/3 AM (Rev. 03)	882509
27	Mains power receptacle	540140
28	Fuse T6.3A (JPN)	*51128
2	CPU mother board, AS/3 AM (Rev. 03)	(882953) Use 886331
3	Module mother board, AS/3 AM (Rev. 03)	882954
5	Metal box, F-CU8 (Rev. 03)	882501
6	Connector plate, blank/narrow	879393
36	Grounding plate, blank/narrow	885398
13	Connector plate, blank/wide	880278
37	Grounding plate, blank/wide	885394
	Grounding plate for UPI board	885399

* = the part is recommended for stock

PRODUCTS (related to F-CU8)

NOTE: These products have been launched together with the corresponding frame revisions. Possible spare parts are listed in each product's chapter.

F-CU8 Rev. 01

Item description	Order No.
Gas Interface Board	B-GAS
CPU Board	*B-CPU1
High Resolution Display Controller	*B-DHIGH

F-CU8 Rev. 02

Item description	Order No.
Software Cartridge (all except USA)	S-STD93
Software Cartridge (USA)	S-STD

F-CU8 Rev. 03

Item description	Order No.
CPU Board	*B-CPU2
CPU Board	*B-CPU3
Software Cartridge	S-STD94
Software Cartridge	S-ARK94
Software Cartridge	S-STD95
Software Cartridge	S-ARK95
Software Cartridge	S-STD96
Software Cartridge	S-ARK96
VGA Display Controller	B-DVGA
Display Controller	*B-DISP
Interface Board	B-INT
Network Board	B-NET
UPINET Board	B-UPINET
Keyboard Interface Board	B-ARK

* = the part is recommended for stock

CPU Board, B-CPU1

Item description	Order No.
SRAM 2kx8, Timekeeper	*139423
Grounding plate	885400

CPU Board, B-CPU2 (Rev. 00)

Item description	Order No.
SRAM 8kx8, Timekeeper	*139422
Grounding plate	885400

CPU Board, B-CPU2 (Rev. 01)

Item description	Order No.
Battery for SRAM/Timekeeper	*197230
Grounding plate	885400

CPU Board, B-CPU3

Item description	Order No.
Battery for SRAM/Timekeeper	*197230
Grounding plate	885400

* = the part is recommended for stock

6.2 Exploded View of Anaesthesia Monitor Frame

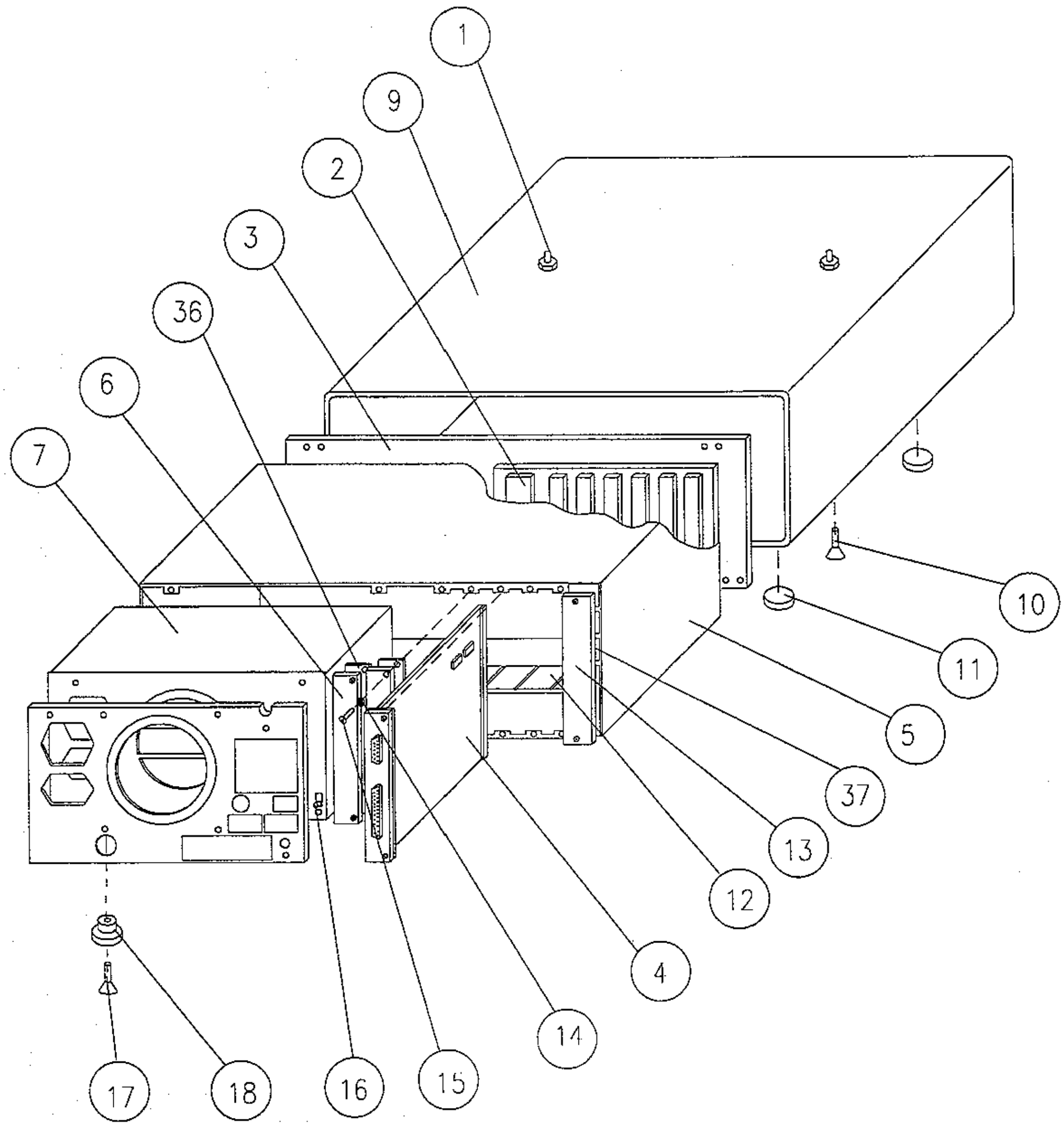


Figure 9 Exploded View of the Central Unit

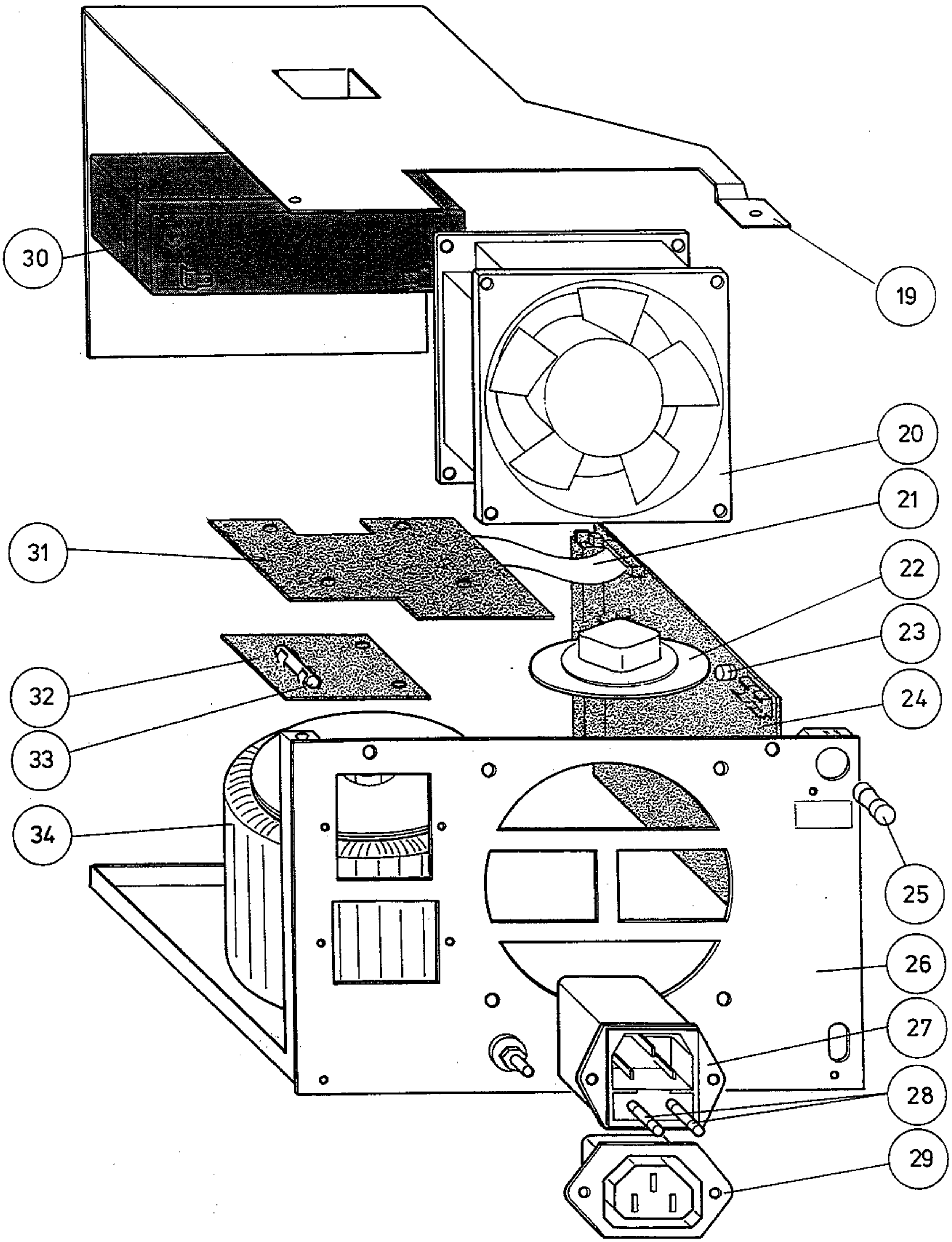


Figure 10 Exploded View of the Power Unit

7 EARLIER REVISIONS

This service manual fully supports earlier revisions except,

8-Module Frame, F-CU8 (rev 01/rev.02), then refer to Service Manual p/n 880850,
CPU Board, B-CPU1 (rev 01), then refer to Service Manual p/n 882580,
Software Cartridge,S-STD/S-STD93, then refer to Service Manual p/n 882580,
Software Cartridge, S-STD94/S-STD94, then refer to Service Manual p/n 885930 and
Software Cartridge, S-STD95/S-STD95, then refer to Service Manual p/n 885930.

Video Display, D-VNC15 (Rev 00)

LCD Display, D-LCC10 (Rev. 03)

VGA Display Controller, B-DVGA (Rev. 03)

Display Controller, B-DISP (Rev. 00)

Command Board, K-VNC15 (Rev. 00)

All specifications subject to change without notice

Document No. 889926

March 1996

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Table of Contents

INTRODUCTION

This section provides information about the maintenance and service of the LCD display (D-LCC10), the Display controller boards (B-DISP, B-DVGA, B-DHIGH), and the Command Boards (K-VNC15, K-VHC14) of the Anaesthesia and Compact Monitors.

Notice that the service information of D-VNC15 (D-VHC14) are delivered on request.

NOTE: The backlight circuit runs on a high voltage. Do not touch the adapter board when powered.

1 SPECIFICATIONS

1.1 LCD Display, D-LCC10

Display size	10.4 in
Display type	Active Matrix 8-colour LCD Display
Resolution	640 x 480 x (R,G,B)

DIMENSIONS

Outline (ComWheel™ included) (W x D x H)	315 x 74 x 265.5 mm/ 12.4 x 2.9 x 10.5 in
Weight	3.5 kg / 7.7 lb

ELECTRICAL REQUIREMENTS

LCD Display, D-LCC10 rev.03, can only be used connected to B-DVGA rev. 03 or B-DISP Display controller boards in the Anaesthesia Monitor.

Power consumption	10 W

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)
Humidity	0-85 % non-condensing

1.2 Display Controller Board, B-DISP

Video output: both connectors and both resolutions, analog RGB, 0.2V - 1.1V, 0,8 V_{pp}, 75 ohm

Output data, B-DISP, High resolution

Resolution: horizontal 1984 pixels, vertical 512 pixels
Frame frequency: 65 Hz
Scan frequency: 34,7 kHz
Dot frequency: 80 MHz max.
Sync polarity: H/negative, V/negative, level TTL
Sync pulse:

	Horizontal	Vertical
Front porch	1.125 us	0.037 ms
Sync period	3.000 us	0.073 ms
Back porch	1.375 us	0.442 ms

Output data, B-DISP, VGA resolution

Resolution: horizontal 640 pixels, vertical 480 pixels
Frame frequency: 60 Hz
Scan frequency: 31.6 kHz
Dot frequency: 25 MHz max.
Sync polarity: H/negative, V/negative, level TTL
Sync pulse:

	Horizontal	Vertical
Front porch	0.640 us	0.349 ms
Sync period	3.520 us	0.063 ms
Back porch	1.920 us	1.019 ms

1.3 Display Controller Board, B-DVGA (B-DHIGH)

Output data, B-DVGA

Video output: 15-pin D-connector: analog RGB, 0.45 V - 1.25 V, 75 ohm. 26-pin D-connector: analog RGB, 0.45 - 1.25 V
Resolution: horizontal 640 pixels, vertical 480 pixels
Frame frequency: 60.125 Hz
Scan frequency: 31.566 kHz
Dot frequency: 25 MHz max.
Sync polarity: H/negative, V/negative, level TTL
Sync pulse:

	Horizontal	Vertical
Front porch	0.640 us	0.349 ms
Sync period	3.520 us	0.063 ms
Back porch	1.920 us	1.019 ms

Output data, B-DHIGH

Video output: both connectors, analog RGB, 0.45 V - 1.25 V, 75 ohm

Resolution: horizontal 1984 pixels, vertical 512 pixels
Frame frequency: 51.987 Hz
Scan frequency: 27.397 kHz
Dot frequency: 32 MHz max.
Sync polarity: H/negative, V/negative, level TTL
Sync pulse:

	Horizontal	Vertical
Front porch	1.125 us	0.037 ms
Sync period	3.000 us	0.073 ms
Back porch	1.375 us	0.442 ms

1.4 Command Board, K-VNC15 (K-VHC14)

Dimensions	
Input voltage	5 V
Power consumption	
Communication protocol	RS-232

NOTE: Power supply from the display controller board only.

2 FUNCTIONAL DESCRIPTION

2.1 LCD Display

LCD Display, D-LCC10 includes LCD Display module, LCD Interface board, and Command Board with keyboard.

The keyboard works independent of the main keyboard of AS/3 monitor.

The LCD Display is connected to B-DVGA or B-DISP Display controller board in the monitor frame with the LCD Display interface cable. The interface cable is available as an accessory. See AS/3 Anaesthesia Monitor Supplies and Accessories Catalogue.

Communication between the Display controller board and the LCD Display takes place in analog form (in 00-02 revisions it was in digital form). Incoming signals are buffered in the interface board and fed forward to the LCD Display module.

Communication between the Display controller board and the Command Board takes place in RS232 serial communication channel D.

NOTE: B-DVGA rev. 01 and rev. 02 do not support D-LCC10-XX-03. D-LCC10-XX-03 requires B-DVGA rev. 03 or B-DISP.

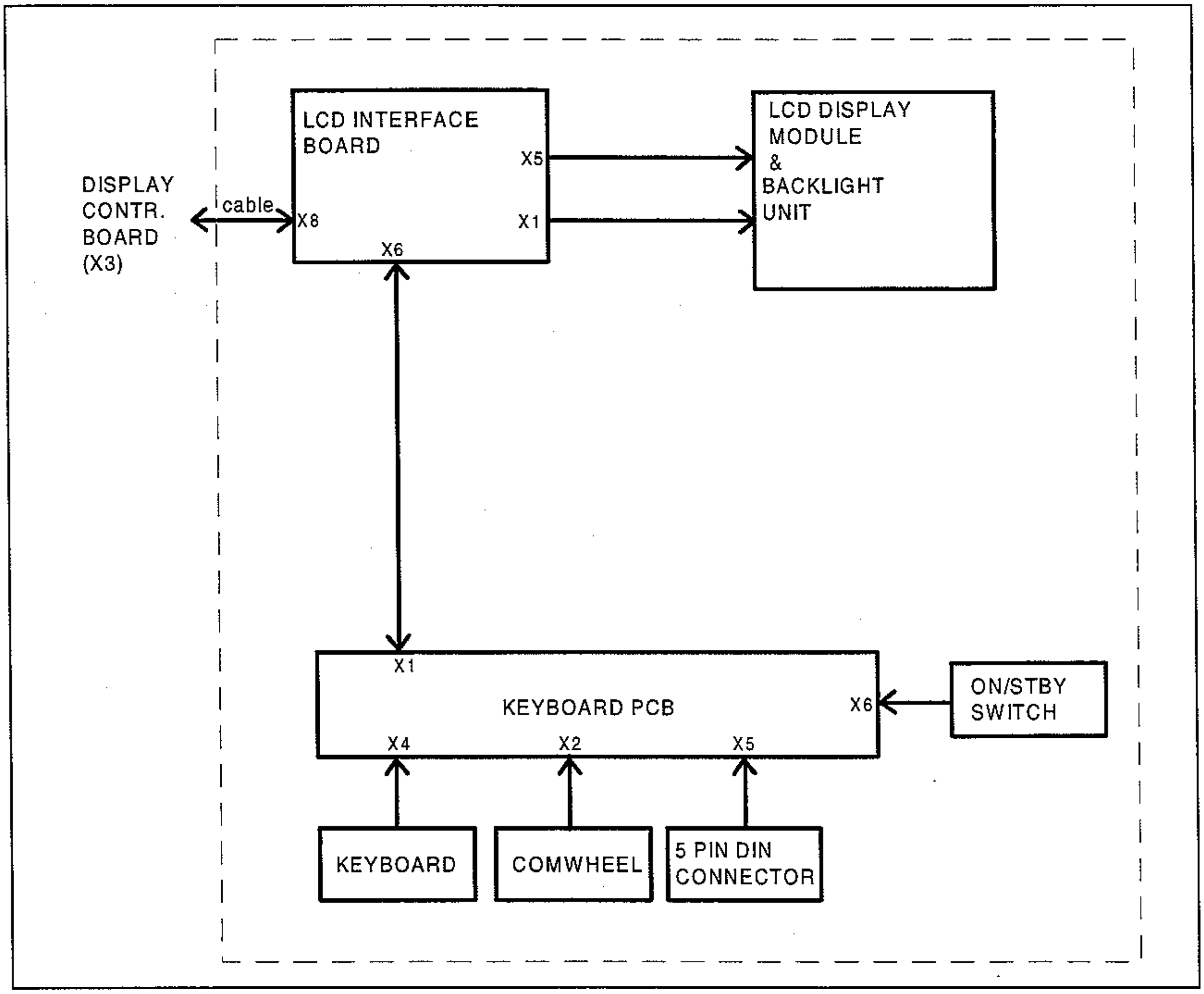


Figure 1 General Block Diagram

2.1.1 LCD Interface Board

In general

The LCD Interface board is the interface between the Display controller board and the LCD Display component. The keyboard is also connected to the Interface board. (See Figure 1)

The incoming signal to LCD Interface board is pure analog VGA - RGB with separate horizontal and vertical synchronisation signals. (See Figure 2) The display element needs digital RGB-signals, HSYNC, VSYNC, DOTCLK and a display timing signal DTMG. The DTMG signal indicates that the digital RGB-signals are active.

The functions of this board are digitalization of the video signals, regeneration of the DOTCLK and generation of the DTMG. The backlight driver is also located on the board.

Power Supply

The DC/DC power supply is an isolated discontinuous mode flyback switcher. It has a current mode PWM circuit and a separate FET switch on the primary side. The transformer has two secondary windings, one for 5V and another for 12V. On the secondary side (5V), there is a separate chip on the feedback path to drive the optoisolator.

Backlight Unit

The backlight unit is integrated to the LCD Display component. The backlight consists of one Cold Cathode Fluorescent Lamp (CCFL), which runs on a high AC voltage. The lamp needs approximately 1400 Volts to lit, but runs on a lower (500-600) voltage when on.

The backlight unit is an irreparable part, therefore only the whole LCD Display component can be replaced. If there is need to replace the LCD Display component please note: that the LCD Display is very sensitive for mistreatment. The service instructions (in Chapter 3) should be followed carefully when handling the component.

NOTE: The LCD Display component and Backlight unit are separate units in the D-LCC10, revision 01 and 02, therefore the units are possible to be replaced separately.

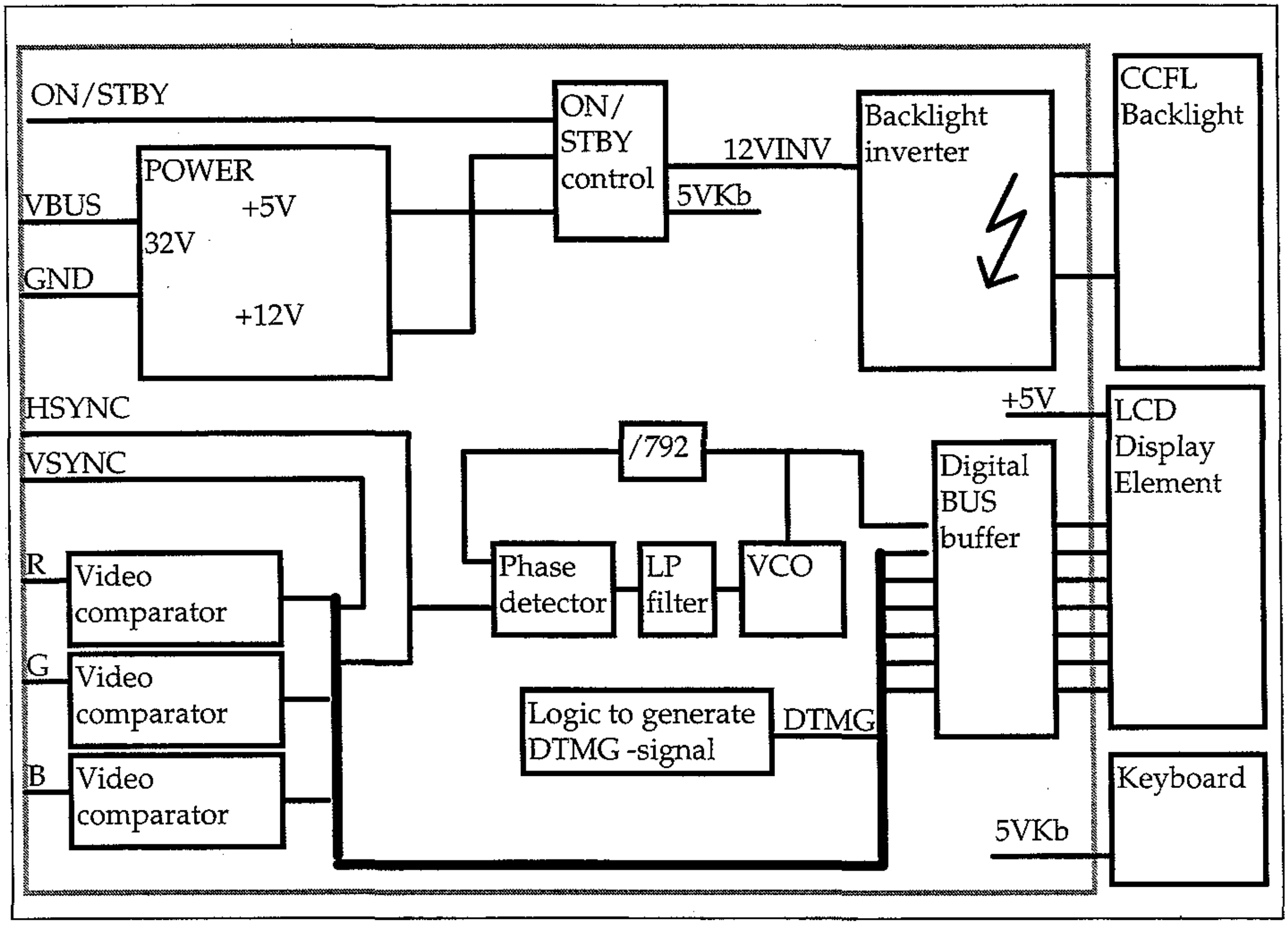


Figure 2 LCD Interface Board Block Diagram

2.1.3 External Connector Configurations

LCD Display, D-LCC10 has two external connectors. Main connector is situated at the back. It is 13 pin Coax D-connector and has pins for operating voltage (+32 Vdc), display signals, and serial communication RS232.

5-pin DIN connector (see the following page) is situated on the right side of D-LCC10.

LCD Display 13 pin Coax D-connector (main connector)

Pin No	I/O	Signal	Notes
1	I	Dirty Ground	
2	I	Intensity	
3	I	Hsync2	horiz. deflect
4	I	Vsync2	vert. deflect
5	I	Contrast	
6	I	+32 Vdd	
7	I	GND	
8	O	RXDD RS232	from keyboard
9	I	TXDD RS232	to keyboard
10	I	ON/STBY	active GND
A1	I	BLUE GND & BLUE VIDEO 2	
A2	I	GREEN GND & GREEN VIDEO2	
A3	I	RED GND & RED VIDEO2	

5-pin DIN connector (PC-connector)

Pin No	I/O	Signal	Notes
1	O	CLK	
2	I/O	DATA	
3		not connected	
4		GND	
5	O	+5 Vdc	

26-pin male D-connector at the end of Interface cable (AS/3, Display controller board side)

Pin No	I/O	Signal	Notes
1	O	RED VIDEO2	
2	O	GREEN VIDEO2	
3	O	BLUE VIDEO2	
4		BLANK	not used
5			
6	O	GND	chassis
7			
8	O	Hsync2	horiz. deflect
9	O	Vsync2	vert. deflect
10	O	RED GND	
11	O	GREEN GND	
12	O	BLUE GND	
13	O	GND	chassis
14	O	DCLK GND	
15		not connected	
16		ON/STBY	active GND
17	O	Dirty GND	
18	O	Dirty GND	
19	I	RXDD RS232	from keyboard
20	O	TXDD RS232	to keyboard
21		not connected	
22		not connected	
23		not connected	
24		not connected	
25	O	+32 Vdd	
26	O	+32 Vdd	

2.2 Display Controller Board: High Resolution Display, B-DISP

2.2.1 Functional Description

B-DISP board is connected to the CPU Mother board. The processor on the CPU board transmits program through the AS/3 bus to B-DISP board.

B-DISP board includes the functions of both B-DHIGH and B-DVGA boards. Thus, B-DISP board supports both high resolution and VGA resolution. The resolution is automatically selected based on monitor ID codes. The resolution is set to 640x480 if a VGA resolution display is used, otherwise the resolution is set to 1984x512.

NOTE: S-STD96 and S-ARK96 softwares support B-DISP, B-DHIGH and B-DVGA boards. If, however, B-DISP board is used to drive D-VHC14 display, a small part of the resulting picture will be clipped.

System Memory

The system memory contains the GSP software code. The memory consists of two 256kx16 memory banks.

Frame Memory

The frame memory contains digital display data. The size of the memory is 1 Mbyte making 1984x512 display resolution with 256 colours possible. The memory consists of four 256kx8 VRAM memory circuits.

Video Interface Palette

The video interface palette reads the digital display data from the frame memory and converts the data into analog RGB-signals. The synchronization signals for the conversion are generated by the GSP.

The video interface palette is clocked by two pixel clocks. A 25 MHz clock is selected for VGA resolution and a 40 MHz clock is selected for high resolution. The 40 MHz clock is internally converted into a 80 MHz clock.

Graphics System Processor (GSP)

There are four 16-bit registers in the GSP, from which the host-processor reads and to which it writes data.

Display Controller Resolution

The resolution of the display controller depends on initialization of the GSP's registers and frequency of the video oscillator.

Reset Signal

Reset signal comes from the Power supply unit through the AS/3 bus.

Monitor ID Register

The monitor ID register contains a three bit (numeric values 0-7) monitor ID code. The register is connected to channels 11-13 of the X3 D-connector. If no display is connected to B-DISP board or if the monitor ID code fails, 111 code is generated by pull-up resistors. If the ID code is 011 or 101, VGA resolution is selected, otherwise high resolution is selected.

2.2.2 Block Diagram

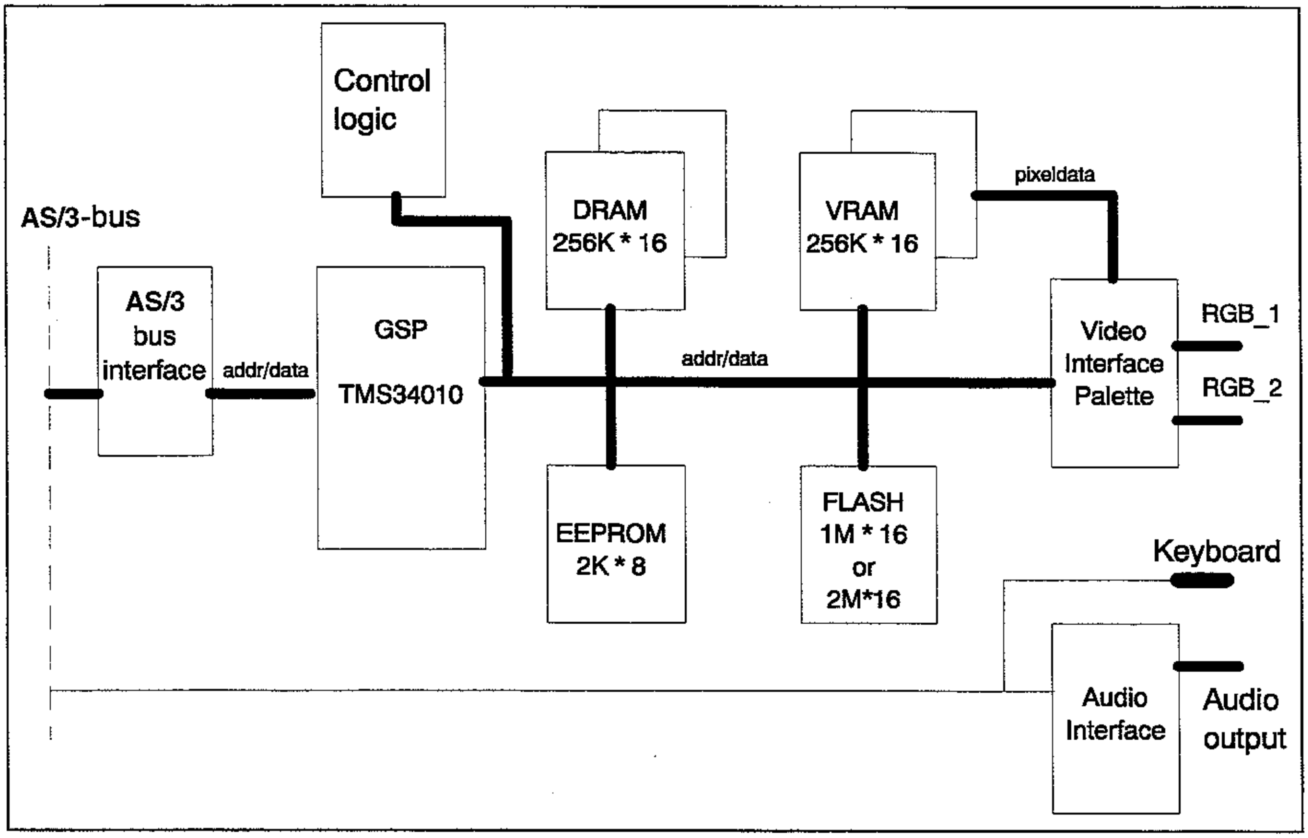


Figure 3 Display Controller Block Diagrams

2.2.3 Jumper Locations

The B-DISP board can be configured as either primary or secondary by shifting the location of J1 jumper (interrupt signal) as shown in figure 4.

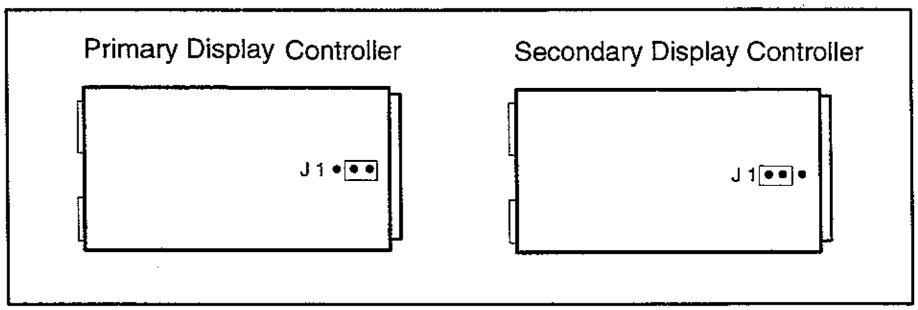


Figure 4 Jumper Locations, B-DISP Board

2.2.4 Connectors and Signals

15-pin D-connector X2 on B-DISP Display controller boards

Pin No	I/O	Signal	Notes
1	O	RED VIDEO 1	analog
2	O	GREEN VIDEO 1	analog
3	O	BLUE VIDEO 1	analog
4		MON1ID2	monitor identification
5	O	GND	
6	O	RED GND	
7	O	GREEN GND	
8	O	BLUE GND	
9		N/C	
10	O	SYNC GND	
11		MON1ID0	monitor identification
12		MON1ID1	monitor identification
13	O	HSYNC 1	TTL, CMOS
14	O	VSYNC 1	TTL, CMOS
15		N/C	

26-pin D-connector on B-DISP Display Controller Boards

Pin No	I/O	Signal
1	O	Red video (analog)
2	O	Green video (analog)
3	O	Blue video (analog)
4	I	MON2ID2
5	I	MON2ID1
6	O	Ground
7	I	MON2ID0
8	O	Horizontal sync
9	O	Vertical sync
10	O	Red ground
11	O	Green ground
12	O	Blue ground
13	O	Ground
14	O	Ground/Sync ground
15	O	+5 V
16	I	ON/STBY
17	O	Ground
18	O	Ground
19	I	RxD RS232
20	O	TxD RS232
21	O	Brightness
22	O	Contrast
23	O	Audbufout
24		Not connected
25	O	+32 Vd
26	O	+32 Vd

2.3 Display Controller Board: VGA Display, B-DVGA (B-DHIGH);

2.3.1 Functional Description

The Display controller board is connected to CPU Mother board. The CPU board's processor transmits program through the AS/3 bus to the Display controller board.

Graphics System Processor (GSP)

There are four 16-bit registers in the GSP, from which the host-processor reads and to which it writes data.

Display Memory

Four memory circuits (256k x 4 bit) are used.

Program Memory

Four memory circuits (256k x 4 bit) are used.

Video Signal

Serial outputs of the frame buffer memory are transferred to two Latch circuits so that two consecutive pixels (8 bits) are fed to one, and the next two consecutive pixels (8 bits) are fed to the other. Those four pixels (16 bits) are multiplexed into two consecutive pixel data bytes of 8 bits each. The data is then fed into the video palette circuit. The RGB signal is sent to the video buffer. The signal can be used with a CRT display.

Display Controller Resolution

The resolution of the display controller depends on initialization of the GSP's registers and frequency of video oscillator. The B-DHIGH board uses a 64 MHz oscillator and the B-DVGA board a 25 MHz oscillator.

Reset Signal

Reset signal comes from the Power supply unit through the AS/3 bus.

2.3.2 Block Diagram

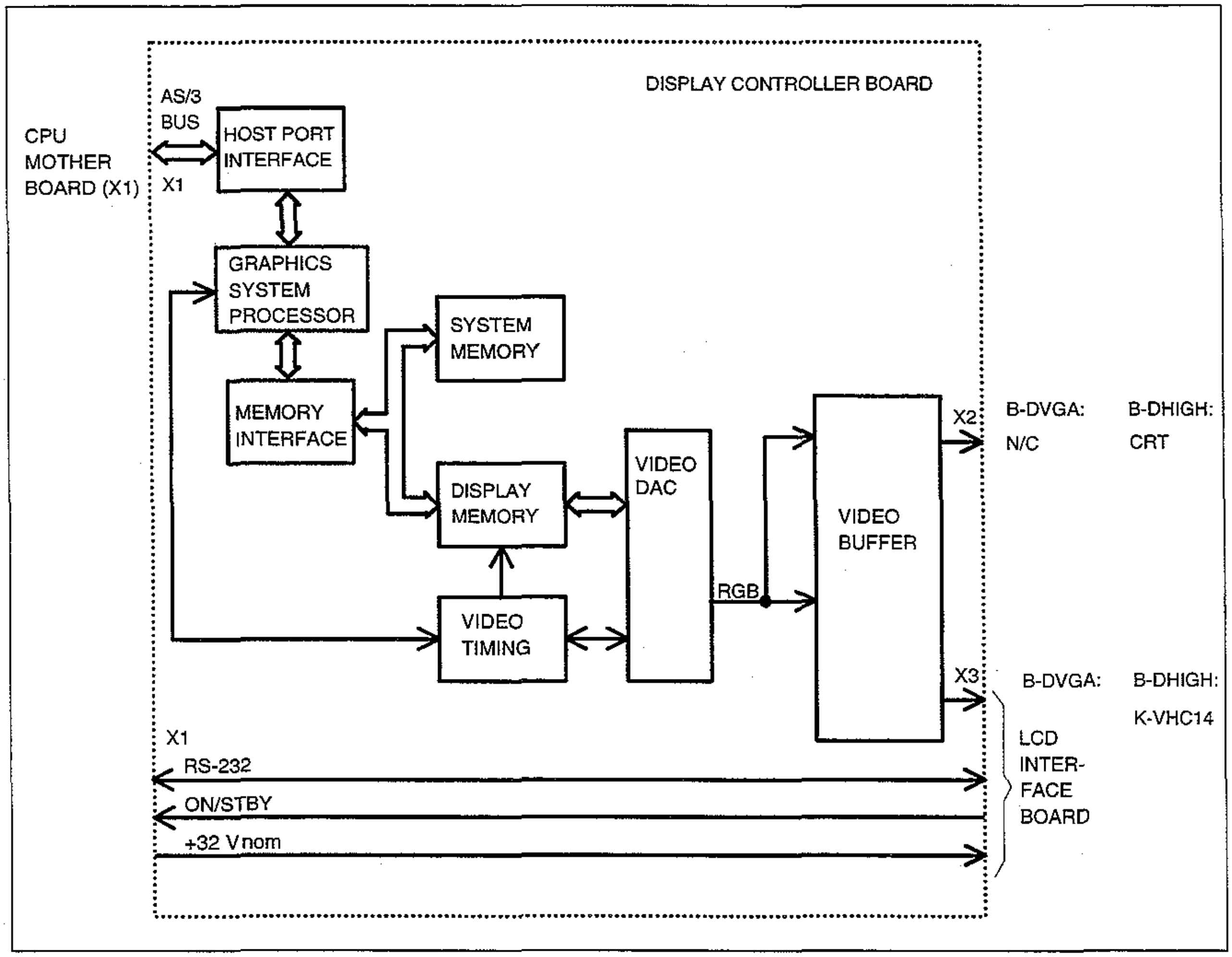


Figure 5 Display Controller Block Diagrams

2.3.3 Jumper Locations

The B-DVGA and B-DHIGH boards can be configured as either primary or secondary by shifting the location of J5 and J2 jumpers (board address and interrupt signal) as shown in figures 6 and 7.

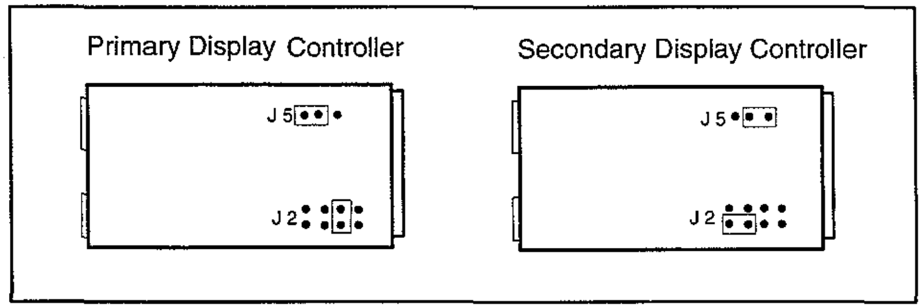


Figure 6 **Jumper Locations, B-DVGA board, revision 01, and B-DHIGH board, revision 01 (s/n < 174671)**

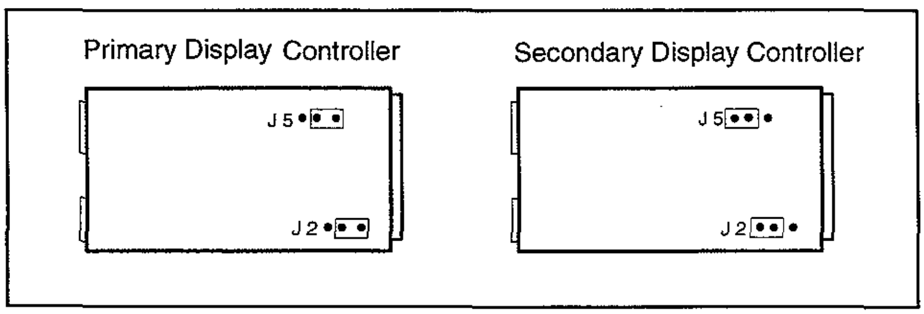


Figure 7 **Jumper Locations, B-DVGA board, revision 01-02, and B-DHIGH board, revision 01-02 (s/n > 174670)**

2.3.3 Connectors and Signals

15-pin D-connector X2 on Display controller boards

Pin No	I/O	Signal	Notes
1	O	RED VIDEO 1	analog
2	O	GREEN VIDEO 1	analog
3	O	BLUE VIDEO 1	analog
4		N/C	
5	O	GND	
6	O	RED GND	
7	O	GREEN GND	
8	O	BLUE GND	
9		N/C	
10	O	SYNC GND	
11		N/C	
12		N/C	
13	O	HSYNC 1	
14	O	VSYNC 1	
15		N/C	

26-pin D-connector on Display controller boards

Pin No	I/O	Signal
1	O	Red video (analog)
2	O	Green video (analog)
3	O	Blue video (analog)
4	O	Not connected/Blank
5		Not connected
6	O	Ground
7		Not conected
8	O	Horizontal sync
9	O	Vertical sync
10	O	Red ground
11	O	Green ground
12	O	Blue ground
13	O	Ground
14	O	Ground
15	O	+5 V
16		ON/STBY
17	O	Dirty ground
18	O	Dirty ground
19		RxD RS232
20	O	TxD RS232
21		Not connected
22		Not connected
23		Not connected
24		Not connected
25		Not connected
26		Not connected

2.4 Command Boards, K-VNC15 (K-VHC14)

The Command board consists of 17 direct function keys, ComWheel, and ON/STBY switch.

2.4.1 Functional Description

Command Board PCB

The Command board PCB is located inside the Command Board. 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 AS/3 bus and module bus. Two signals, TXD and RXD, are in use. No handshaking is used.

The 26-pin subminiature D-connector of the Command Board is connected to a Display controller board.

Serial communication speed is 19.2 KBaud.

ComWheel

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

LEDs

The alarm LEDs are activated by the Command Board PCB under the commands received via serial communication from the CPU board. The red or yellow alarm LED is lit when red or yellow alarm is activated. "STBY" -led is lit when the device is switched to stand-by and connected to mains.

NOTE: If there are two Command Boards connected to the system, the system is ON (STBY LED not lit), when at least one of the switches is positioned ON.

2.4.2 Block Diagram

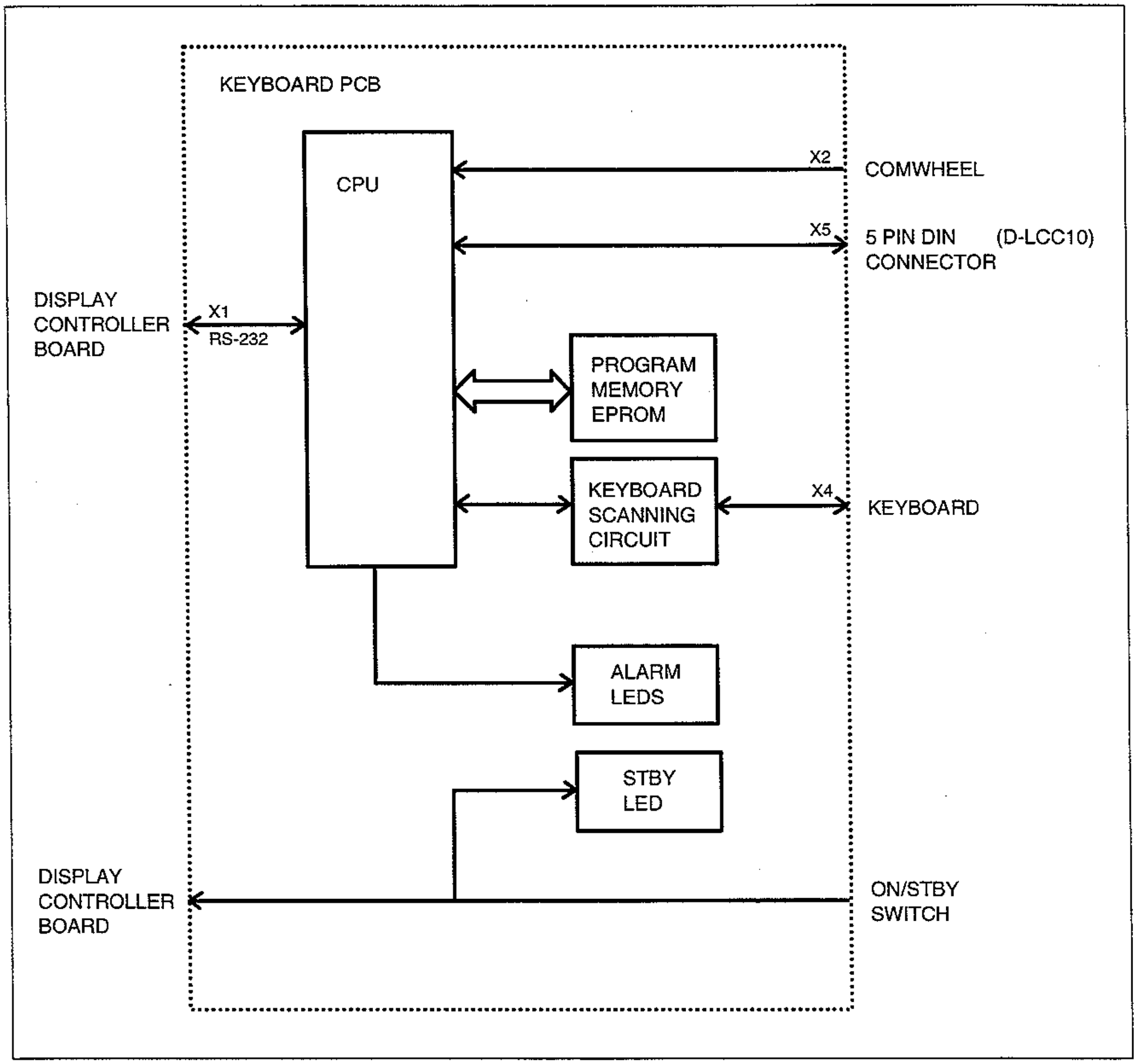


Figure 8 K-VNC15 (K-VHC14) Block Diagram

2.4.3 Connectors and Signals

Command Board 26-pin male D-connector

Pin No	I/O	Signal	Notes
1		Not connected	
2		Not connected	
3		Not connected	
4		Not connected	
5		Not connected	
6	I	GND	
7		Not connected	
8		Not connected	
9		Not connected	
10		Not connected	
11		Not connected	
12		Not connected	
13		Not connected	
14		N ot connected	
15	I	+5 V	
16	O	ON/STBY	
17		Not connected	
18		Not connected	
19	O	TXDD RS232	
20	I	RXDD RS232	
21		Not connected	
22		Not connected	
23		Not connected	
24		Not connected	
25		Not connected	
26		Not connected	

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex for repair.

Datex Technical Services is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

CAUTION: The tests and repairs outlined in this section should only be attempted by trained personnel with the appropriate equipment. Unauthorized service may void warranty of the unit.

3.2 LCD Display

NOTE: The LCD Display component and the backlight lamp are irreparable parts and they should be replaced as a whole unit whenever necessary.

3.2.3 Disassembly and Reassembly

Disassemble the LCD display according to the following procedure. Please refer to the exploded view of the LCD display (chapter 6, spare parts).

NOTE: Wear a static control wrist strap and soft cotton gloves (dust free) when handling the LCD Display parts. Do not touch connector pins.

1. Place the LCD Display on a flat surface the front side downwards.

2. Remove the screws (4) that are located at the corners of the rear panel.

3. Lift the rear panel gently, disconnect the cable(s) and set the rear panel aside.

In normal circumstances it is very difficult to keep the LCD Display component and the LCD Display shield free of dust when those are detached from the LCD Display frame. If dust particles remain on the LCD Display component and LCD Display shield surfaces, those may impair the quality of picture on the screen.

In case you need to detach the LCD Display component for repair, if you can provide a dust free environment, follow the instructions below. Otherwise, you may return the whole LCD Display to be repaired at Datex.

NOTE: If the LCD Display unit is broken, handle it carefully to avoid injury (the LCD Display component and the backlight lamp 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 soft polarizer. Keep the polarizer clean. In case of accidental mishandling see the instructions following this chapter.

1. The Adapter board and its insulation plate can be detached by disconnecting the cable connectors and removing the screws (4).

2. Remove the screws (8) that are located at the back of the LCD Display unit.

3. The following parts can now be lifted off one by one:

- the Adapter unit
- the LCD Display component with the backlight
- the LCD Display shield
- the EMC cover with the LCD Display gasket

4. The Command board PCB can be detached by disconnecting the cable connectors and removing the screws (3).

(D-LCC10 Rev. 00-02)

1. The backlight unit as well as the LCD Display component can be detached by removing the screws (4) at their corners.

2. The Command board PCB can be detached by disconnecting the cable connectors and removing the screws (2).

3. The Power supply board is attached to the rear panel by four (4) screws.

Reassembly of the LCD Display is made in reversed order. Make sure that all connectors are connected properly and cables are not pinched between covers.

NOTE: The backlight unit in D-LCC10, revision 03, cannot be changed and the whole LCD display component must be sent back to the factory for repair.

3.3 Display Controller Boards

The Display controller boards can only be replaced. Please refer to the Installation manual of your monitor for instructions how to remove and replace the boards.

3.4 Command Boards

3.4.1 Preventive Maintenance Check List

We recommend that you perform these checks after any service and at least once every six months.

1. Visual inspection

__: All connectors are properly connected.

2. Functional checks

__: Check the operations of all the keys and ComWheel.

__: Check the alarm operation by changing alarm sound volume.

__: Check alarm LEDs

3.4.2 Disassembly and Reassembly

The Command Board included in the display set is disassembled according to the following procedure. Please refer to the exploded view of the Command Board (chapter 6, spare parts).

Command Board, K-VNC15

1. Disconnect the display power cable, the display data cable and the Command Board cable from the Central Unit.

2. Pull out the display power cable and the display data cable through the hole in the rear panel of the display screen tray. Leave the Command Board cable inside the tray.

3. Turn the display set upside down and unscrew the cross head screw holding the display screen tray to the display. Lift off the tray.

4. Turn the display screen tray upside down and unscrew the two screws holding the Command Board to the tray.

5. Turn the display screen tray right side up and pull off the Command Board.

6. Disconnect the Command Board cable, the wire set from the ON/STBY switch, the wire set from the ComWheel and the flat cable from the membrane keyboard.

7. Detach the Command Board PCB by pressing the two plastic fasteners holding the PCB in place and simultaneously lifting off the PCB.

The Command Board is reassembled by reversing the disassembly procedure.

Command Board, K-VHC14

1. Disconnect the display power cable, the display data cable and the Command Board cable from the Central Unit.

2. Turn the display set upside down and unscrew the cross head screw holding the display screen tray to the display. Lift off the tray.

3. Pull out the display power cable and the display data cable through the slot in the rear panel of the display screen tray.

4. Unscrew the two screws holding the Command Board to the display screen tray. Remove the tray.

5. Unscrew the two screws holding the front cover of the Command Board to the rear cover. Carefully remove the rear cover.

6. Disconnect the Command Board cable, the wire set from the ON/STBY switch, the wire set from the ComWheel and the flat cable from the membrane keyboard.

7. Detach the Command Board PCB by pressing the two plastic fasteners holding the PCB in place and simultaneously lifting off the PCB.

The Command Board is reassembled by reversing the disassembly procedure.

4 TROUBLESHOOTING

4.1 LCD Display

PROBLEM	CAUSE	TREATMENT
No image on screen and no backlight	No power or loose interface cable.	Check LCD - ON/STBY switch position and interface cable
No image on screen, backlight on	Cables may be loose. Display controller board or LCD Interface board failure	Check the items. Replace the board(s) if necessary
Vertical stripes on right side of screen continuously	Jumpers in Display controller board not positioned correctly	Check the jumpers. See Installation Manual for reference.
Only small portion of CRT screen is displayed on LCD display in zoomed-up form	LCD Display defined as High Resolution Display with the B-DVGA.	Use menu (Monitor setup-Install/Service-Screen 2 setup) to change into VGA. In S-STD95/S-ARK95 and S-STD96/S-ARK96 automatic resolution selection.
Unstable image	+5 V unstable. Loose cable. Jumpers in Display controller board not positioned correctly or board failure. LCD Interface board failure	Check cable connections. Check the jumpers. Check the board(s) and replace if necessary
Backlight flickering or dim	Backlight connector failure or lamp/LCD Interface board failure	Check the connector. Check the lamp/ LCD Interface board failure. If faulty lamp, replace the whole LCD unit. See chapter 3.1.

4.2 Display Controller Boards

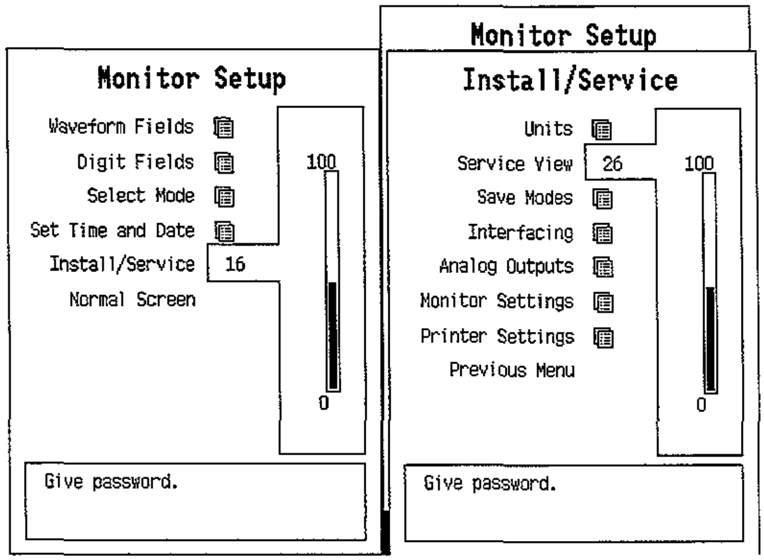
PROBLEM	CAUSE	TREATMENT
No image on the screen	No power Cable or display board loose Board or display faulty	Check power on Check cable and board connections Try with another board and/or display
Regular stripes on the picture	Faulty Display controller board	Replace the board.
B-DHIGH and B-DISP with D-VNC15 only:		
Part of the screen has wrong colours	Triac board failure	Replace triac board, see part II Central Unit, power supply.
Picture disfigured.	Outer magnetic field	Turn the monitor off, wait 10 minutes and turn the monitor on again in order to demagnetize the screen.

4.3 Command Boards

See Keyboard Service Menu in chapter 5, and perform tests available. If any of the tests fail, see explanation below.

PROBLEM	CAUSE	TREATMENT
ON/STBY switch not working	Keyboard cable loose or broken. D-26 connector pin failure. Switch leads broken. Switch connector loose. Switch faulty	Check the items. Replace them if necessary
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. D-26 connector pin failure. RS232 communication failure on CPU board	Check the items. Replace them if necessary.

5 SERVICE VIEW



To enter Service Menu:

1. Press the MONITOR SETUP key. The Setup menu appears.
2. Turn ComWheel to highlight Install/Service and push.
3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.
4. Turn the ComWheel to highlight Service View and push.
5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.
6. Turn the ComWheel to highlight Modules and push.
7. Turn the ComWheel to highlight the right module and push.

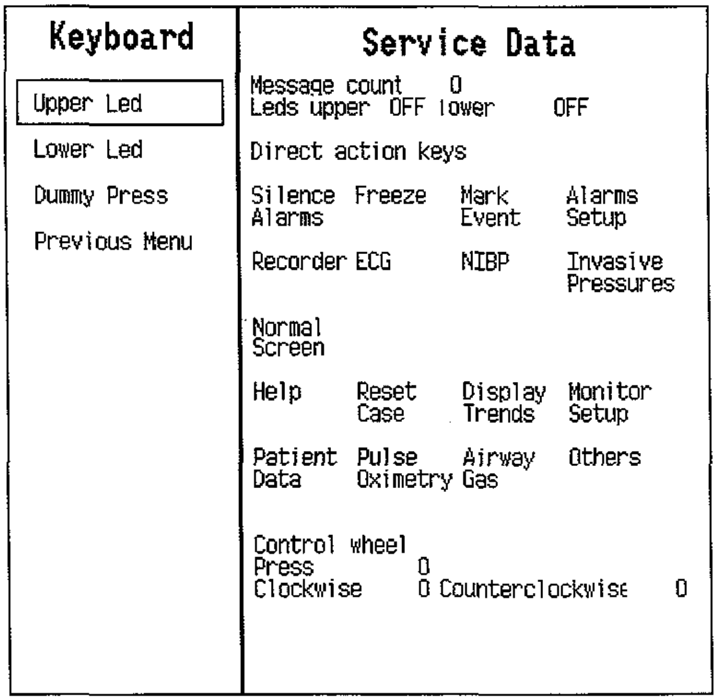
5.1 LCD Display

There is no separate service menu for the LCD Display.

5.2 Display Controller Boards

There is no separate service menu for Display controller boards.

5.3 Command Boards



Menu items:

1. Silence Alarm upper LED (red) check
2. Silence Alarm lower LED (yellow) check
3. ComWheel pressing check
4. Return to previous menu

Service Data

Message count counts whenever a function is selected.

Leds upper and **Leds lower** indicate Silence Alarms leds' state.

Direct action keys: the key item changes its colour when the key is pressed. If not the key may be damaged.

Control wheel: Pressing and turning the ComWheel **Clockwise** and **Counterclockwise** are counted.

All counters are zeroed when the menu is closed.

6 SPARE PARTS

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

* = the part is recommended for stock

Item numbers refer to the exploded view.

6.1 Spare Parts Lists

14" Color Display, D-VHC14

Item description	Order No.
Display cover, D-VHC14 (w/o stickers)	902661
Monitor cable, D-VHC14	*902660
Display power cord, D-VHC14 (EUR/USA)	545581
Service Manual for D-VHC14 (Hitachi)	572772

* = the part is recommended for stock

15" Color Display, D-VNC15

Rev. 00 (see figure 9)

Item	Item description	Order No.
1	Locking washer, D-VNC15	889164
2	Motion limiter for 889164	889165
5	Power cord guard, D-VNC15	889704
	STBY switch cover, D-VNC15	889325
6	Cross cylinder head screw M3x8	61722
3	Cross cylinder head screw M6x16	61775

* = the part is recommended for stock

LCD Display, D-LCC10

Rev. 01 (see figure 10)

Item	Item description	Order No.
6	Power supply board, D-LCC10 (Rev. 01-02)	*881808
3	Command board PCB, D-LCC10 (Rev. 01-02)	*(883022) Use 886821 [1] 887874
2	Membrane keyboard, AS/3 AM/CM	879373
4	LCD Module, AS/3 AM/CM	572770
5	Backlight unit, AS/3 AM/CM	*883929
	Inverter for back light unit, AS/3 AM/CM	*572776
	Adapter board for back light unit, AS/3 AM/CM	883269
10	Rotary wheel	879872
9	ComWheel cover and spring	879191
7	ON/STBY switch	*879871
8	ON/STBY switch protector	881431
1	Front panel sticker, D-LCC10 (Rev. 01) (Eng)	879479
1	Front panel sticker, D-LCC10 (Rev. 01) (Ger)	880469
1	Front panel sticker, D-LCC10 (Rev. 01) (Fre)	880161
11	Internal cable (Power to Keyboard)	881807
12	Internal cable (Power to LCD)	881721
13	Internal cable (Personal Computer)	881826
	External cable 2.5 m (LCD Display to AS/3 AM)	(881966) Use 885517

Rev. 02 (see figure 10)

Item	Item description	Order No.
1	Front panel sticker, D-LCC10 (Rev. 02-03) (Eng)	885878
1	Front panel sticker, D-LCC10 (Rev. 02-03) (Ger)	885879
1	Front panel sticker, D-LCC10 (Rev. 02-03) (Fre)	885880
	External cable 2.5 m (LCD Display to AS/3 AM)	885517
	External cable 6 m (LCD Display to AS/3 AM)	884976

Rev. 03 (see figure 11)

Item	Item description	Order No.
3	Command board PCB, AS/3 AM/CM	*886821
	Command board software	*887874
16	LCD display gasket, AS/3 AM/CM	887719
17	LCD display shield, AS/3 AM/CM	572787
18	LCD display unit, complete, AS/3 AM/CM	887737
19	LCD display (contains the backlight), AS/3 AM/CM	572784
20	Adapter unit, AS/3 AM/CM	887125
21	Flat cable	71409
22	Adapter board, AS/3 AM/CM	887840
23	Insulation plate	887739
24	Connector board (LCD), AS/3 AM/CM	888220
25	Connector board (frame), D-LCC10 (Rev.03)	888222
1	Front panel sticker, D-LCC10 (Rev. 03) (Spa)	886272
1	Front panel sticker, D-LCC10 (Rev. 03) (Swe)	885946
1	Front panel sticker, D-LCC10 (Rev. 03) (Dut)	886043
1	Front panel sticker, D-LCC10 (Rev. 03) (Ita)	886751
1	Front panel sticker, D-LCC10 (Rev. 03) (Fin)	888860
26	Rear cover, D-LCC10 (Rev. 03)	889367
	External cable 2.5 m (LCD Display to AS/3 AM)	888525
	External cable 10 m (LCD Display to AS/3 AM)	888643

* = the part is recommended for stock

[1)] The Command board 886821 can be used as a replacement only with Command board software 887874.

NOTE: If you have to replace rear cover, please remove the type data sticker and send it to us. We will send you a new rear cover with reprinted sticker on it.

Display Controller Boards

Item description	Order No.
Grounding plate	885398

* = the part is recommended for stock

Command Board, K-VHC14 (see figure 12)

Rev. 01

Item	Item description	Order No.
15	Command board PC board, K-VHC14 (Rev. 01)	*(880310) Use 883228
3	ON/STBY switch	*879871
4	ON/STBY switch protector	881431
5	Rotary wheel	879872
2	ComWheel cover and spring	879191
13	Plastic front cover, K-VHC14 (Rev. 01)	879087
14	Plastic rear cover, K-VHC14 (Rev. 01)	879088
1	Front panel sticker, K-VHC14 (Rev. 01) (Eng)	879479
1	Front panel sticker, K-VHC14 (Rev. 01) (Ger)	880469
1	Front panel sticker, K-VHC14 (Rev. 01) (Fre)	880161
16	Keyboard membrane, AS/3 AM/CM	879373
6	Command board cable, K-VHC14 (Rev.01)	*(880358) Use 883229
9	Cross cylinder head screw M3x12	61736
7	Cross cylinder head screw M3x8	61722
11	Star washer M3.2	63611
8	Display screen tray	879474
10	Display rear plug cover	879475

Rev. 02 (see figure 12)

Item	Item description	Order No.
15	Command board PC board, K-VHC14 (Rev. 02)	*883228
6	Command board cable, K-VHC14 (Rev.02)	*883229
13	Plastic front cover, K-VHC14 (Rev. 02)	883178
14	Plastic rear cover, K-VHC14 (Rev. 02)	883177
1	Front panel sticker, K-VHC14 (Rev. 02) (Eng)	885878
1	Front panel sticker, K-VHC14 (Rev. 02) (Ger)	885879
1	Front panel sticker, K-VHC14 (Rev. 02) (Fre)	885880
1	Front panel sticker, K-VHC14 (Rev. 02) (Spa)	886272
1	Front panel sticker, K-VHC14 (Rev. 02) (Swe)	885946
1	Front panel sticker, K-VHC14 (Rev. 02) (Dut)	886043
1	Front panel sticker, K-VHC14 (Rev. 02) (Ita)	886751
1	Front panel sticker, K-VHC14 (Rev. 02) (Fin)	888860

* = the part is recommended for stock

NOTE: Parts listed in Rev.1 and 2 Spare parts lists are not interchangeable

Command Board, K-VNC15

Rev. 00 (see figure 13)

Item	Item description	Order No.
3	Command board PC board, K-VHC14, K-VNC15	*883228
13	ON/STBY switch	*879871
7	ON/STBY switch protector	881431
14	Rotary wheel	879872
18	ComWheel cover	879191
5	Plastic front cover, K-VHC14 (Rev. 02), K-VNC15	883178
6	Keyboard membrane, AS/3 AM/CM	879373
15	Front panel sticker, K-VNC15 (Rev. 00) (Eng)	885878
15	Front panel sticker, K-VNC15 (Rev. 00) (Ger)	885879
15	Front panel sticker, K-VNC15 (Rev. 00) (Fre)	885880
15	Front panel sticker, K-VNC15 (Rev. 00) (Spa)	886272
15	Front panel sticker, K-VNC15 (Rev. 00) (Swe)	885946
15	Front panel sticker, K-VNC15 (Rev. 00) (Dut)	886043
15	Front panel sticker, K-VNC15 (Rev. 00) (Ita)	886751
15	Front panel sticker, K-VNC15 (Rev. 00) (Fin)	888860
2	Command board cable, K-VNC15	*889206
1	Display screen tray, K-VNC15	889162
	Pad	65142
10	Cable clamp	64076
11	Cross cylinder head screw M3x8	61722
4	Bushing	640444

* = the part is recommended for stock

6.2 Exploded Views

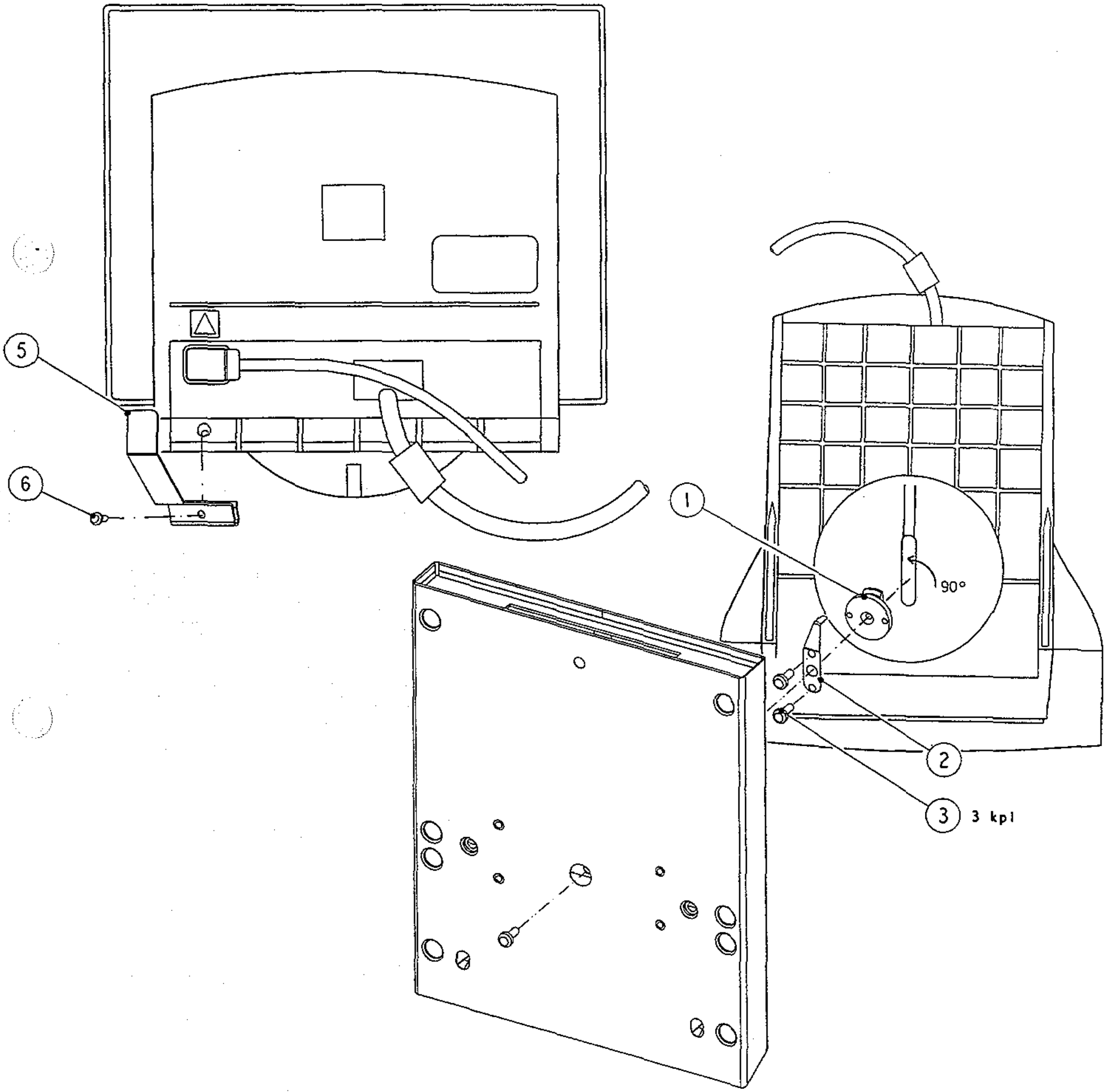


Figure 9 Exploded View of Video Display, D-VNC15

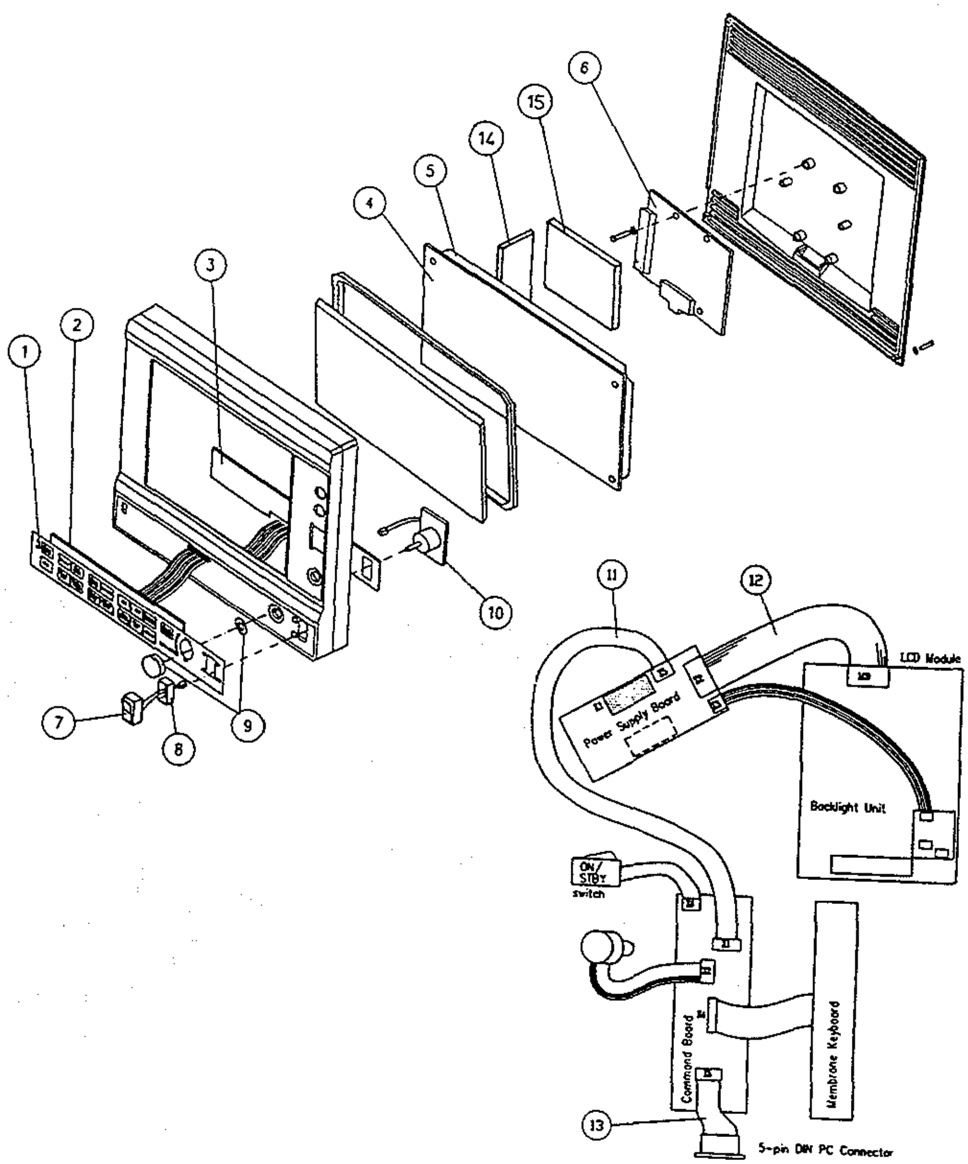


Figure 10 Exploded View of LCD Display (Revisions 01 and 02)

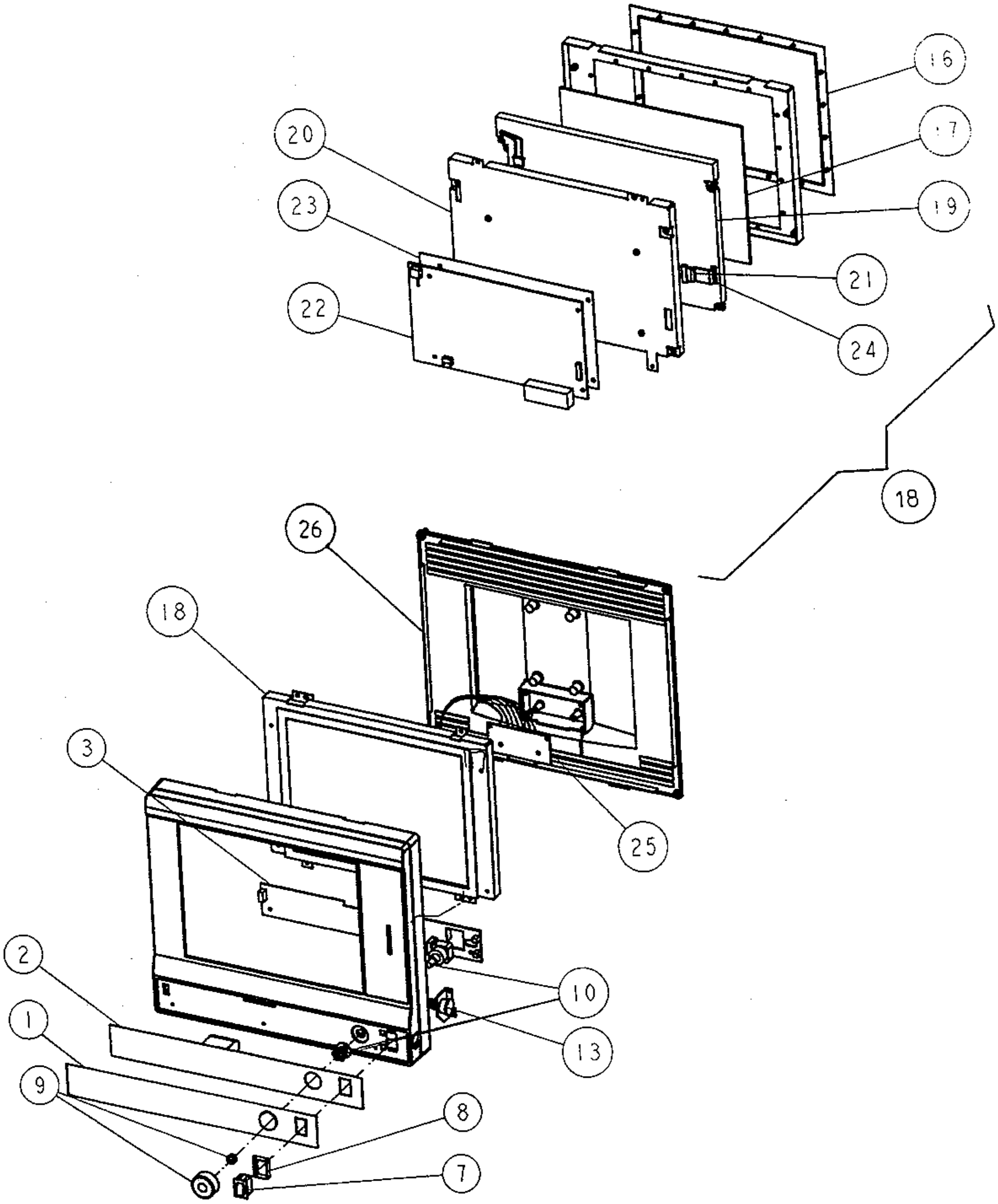
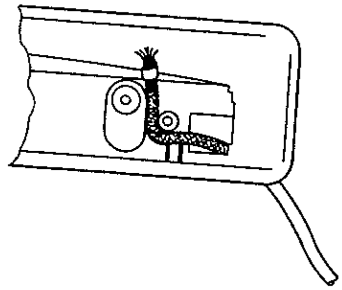


Figure 11 Exploded View of LCD Display (Revision 03)



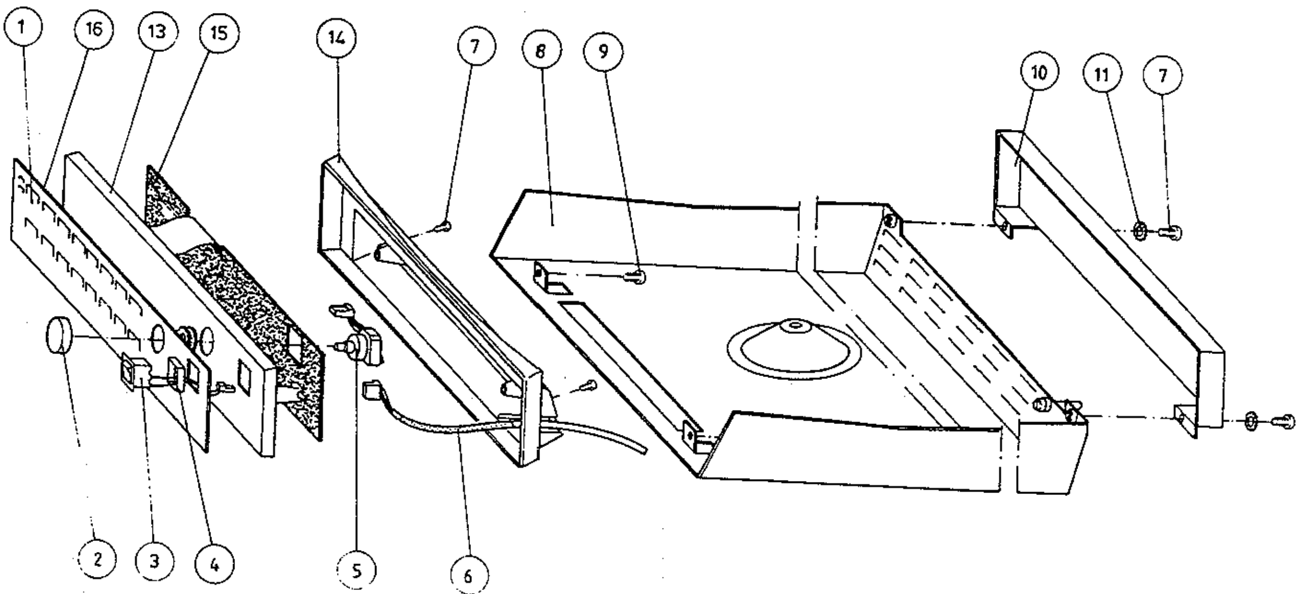


Figure 12 Exploded View of Command Board, K-VHC14

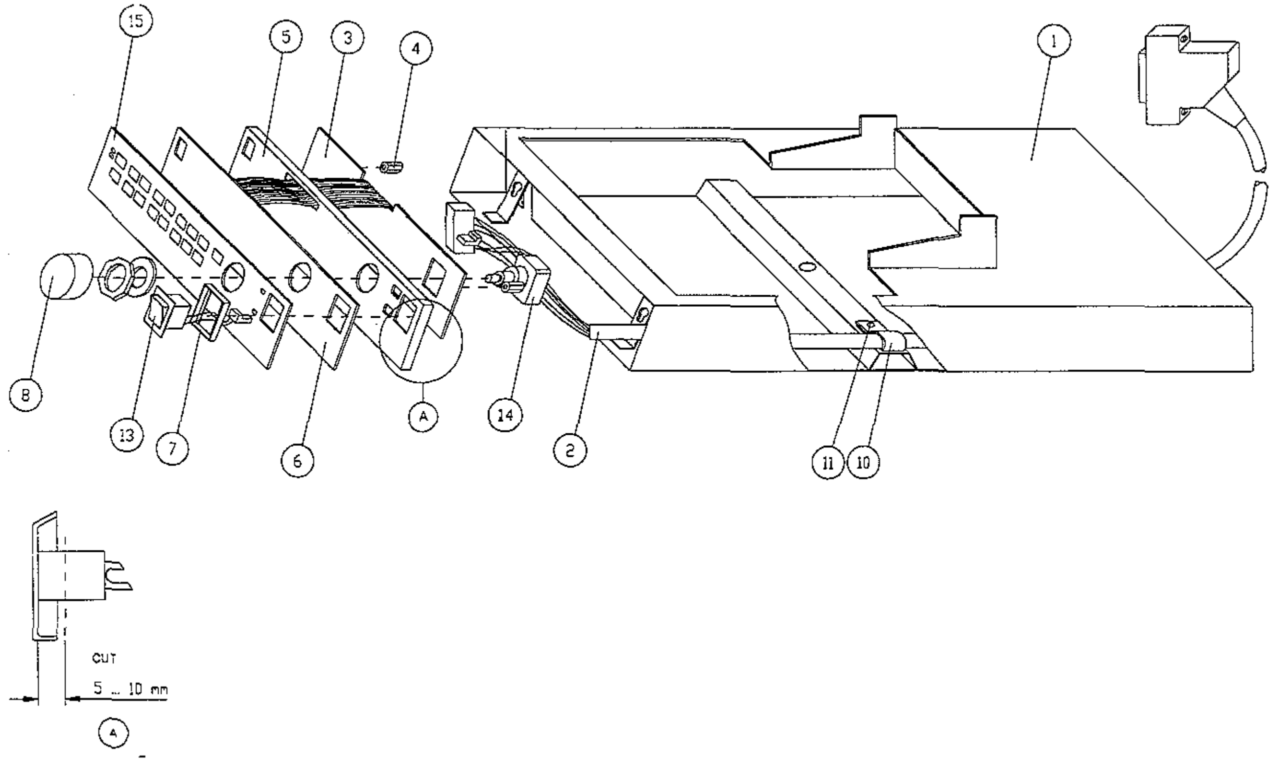


Figure 13 Exploded View of Command Board, K-VNC15

7 EARLIER REVISIONS

For more service information on the earlier revisions, please refer to:

Command Board revision 01	Service Manual p/n 880850
Command Board revision 02	Service Manual p/n 885930
LCD-Display revision 01	Service Manual p/n 882580
LCD-Display revision 02	Service Manual p/n 885930

This manual supports all later revisions.

ESTPR Module, M-ESTPR (Rev. 01)

ETPR Module, M-ETPR (Rev. 01)

ESTR Module, M-ESTR (Rev. 01)

All specifications subject to change without notice

Document No. 885933-4

March, 1996

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Table of Contents

INTRODUCTION

Datex AS/3 Modules M-ESTPR, M-ESTR, and M-ETPR are double width modules that provide general haemodynamic parameters followingly:

M-ESTPR:
ECG with ST-segment analysis, pulse oximetry, two temperatures, two invasive blood pressures and respiration measurement.

M-ESTR:
ECG with ST-segment analysis, pulse oximetry, two temperatures and respiration measurement.

M-ETPR:
ECG with ST-segment analysis, two temperatures, two invasive blood pressure measurements and respiration measurement.

Use this manual with the module revisions M-ESTPR 01, M-ETPR 01, and M-ESTR 01. Information on revisions M-ESTP 04 and 03, M-ETP 03 and 02, and M-EST 03 and 02 is also available, but for older module revisions see other manuals indicated in chapter 7.

1 SPECIFICATIONS

1.1 General Specifications

Module size: W x D x H	75 x 180 x 112 mm 3.0 x 7.1 x 4.4 in
Module weight:	0.6 kg / 1.3 lbs
Power consumption:	6 W
Operation temperature	10..40 °C / 50..104 F °

1.2 Typical Performance

ECG

Lead selection	I, II, III, aVR, aVL, aVF, V
Sweep speeds	12.5, 25, 50 mm/sec
DISPLAY FILTER	
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)
Diagnostic	0.05 to 100 Hz
ST filter	0.05 to 30 Hz (with 50 Hz reject filter) 0.05 to 40 Hz (with 60 Hz reject filter)
HEART RATE	
Range	30 to 250 /min
Accuracy	±5 bpm or ±5 %; whichever is greater
Resolution	1 bpm
Update interval	5 s
Averaging time	10 s
ST LEVELS (in main software)	
ST level range	-6 to +6 mm (-0.6 to +0.6 mV)
Resolution	0.1 mm (0.01 mV)
Averaging	calculated from 16 QRS

In learning mode:	
- update interval	beat to beat
- no averaging	

SYNCHRONIZATION	
Direct ECG	analog output of ECG , 1 V/1 mV
Pacer	5 V pulse 1 ms < 20 ms after pacer peak
Defibrillator synchronization	5 V pulse 10 ms < 35 ms after R-point

Invasive Blood Pressure

MEASUREMENT RANGE:	-40 to 320 mmHg
Zero adjustment range	±150 mmHg
Calibration range	±20 %
Scales	Upper limit is adjustable between 10 and 300 mmHg in steps of 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

HEART RATE FROM ARTERIAL PRESSURE:	
Measurement range	30 to 250 bpm
Resolution	1 bpm
Accuracy	±5 bpm or ±5 % whichever is greater

Temperature

Measurement range 10 to 45 °C (50 to 113 °F)
(In rev. ESTP 03/ EST 02/ETP 02 or earlier 15 to 45 °C (59 to 113 °F))

Display resolution	0.1 °C (0.1 °F)
Temperature test	Automatic (every 10 min.)

YSI 400 probe compatible

Pulse Oximetry

SpO_2:

Measurement range	40 to 100 %
Accuracy	100 to 80 %: ±2 digits
(% SpO_2 ±1 SD) *)	80 to 50 %: ±3 digits
	50 to 0 %: unspecified
Resolution	1 digit = 1 %
Display averaging	20, 10 sec, beat-to-beat
Pulse beep pitch	Varies with SpO_2 level

The monitor is calibrated over the measurement range against functional saturation SpO_2(func)

HEART RATE FROM PLETH:

Measurement range	30 to 250 bpm
Accuracy	30 to 100, ±5 bpm,
	100 to 250, ±5 %
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 SD (standard deviation) = 68 % of all readings in the specified range in stable conditions.

Respiration

Measurement range	4...120 bpm
Accuracy	± 5 bpm or ±5 %
Resolution	1 bpm
Aveaging time	30 s
Update interval	10 s

RESPIRATION WAVEFORM

Sweep Speeds	6.25 mm/s and 0.625 mm/s

1.3 Technical Specifications

ECG

Defibrillation protection	5000 V, 400 J
Recovery time	2 s
Input impedance	g.t. 2.5 Mohms/10Hz
System noise	<10 uV (p-p, RTI)
Allowable offset	±300 mVDC
Gain range	0.2 to 5.0 mV/cm
Pacemaker pulse detection	2 to 500 mV, 0.5 to 2 ms pulses
Protection against electrical shock	Type CF defibrillator proof

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.

Error	±5 % or ±2 mmHg
Transducer and input sensitivity	5 uV/V/mmHg, 5 VDC 20 mA max current
Input resistance	10^{10} ohms
Zero drift	<0.1 mmHg/°C
Nonlinearity	<1 %, 0 to 200 mmHg <2 %, -40 to 0 and 200 to 320 mmHg
Gain drift	<0.05 %f.s./°C
Filter	0 to 4 - 22 Hz adjustable
Zero set accuracy	±1 mmHg
Calibration resolution	±1 mmHg
Zero time	less than 5 sec
Protection against electrical shock	Type CF defibrillation proof

NOTE: The accuracy of the measurement may be different from the specified, depending on transducer/probe used. Please check the transducer/probe specification.

Temperature

Measurement accuracy	±0.1 °C (25.0 to 45.0 °C) ±0.2 °C (10.0 to 24.9 °C)
Amplifier accuracy	±0.1 °C (25.0 to 45.0 °C) ±0.2 °C (10.0 to 24.9 °C)
Sensor accuracy	±0.1 °C (15 to 45 °C) ±0.2 °C (10 to 15 °C)
Protection against electrical shock	Type CF

NOTE: The accuracy of the measurement may be different from the specified, depending on transducer/probe used. Please check the transducer/probe specification.

Pulse Oximetry

Protection against electrical shock	Type BF

Respiration

Excitation frequency	31kHz
Breath detection	automatic, range 0.3..6 ohm manually adjustable minimum detection: 0.2, 0.4, 0.6, 0.8, 1.0
Input dynamic range	0.2..6 Ω
Input impedance range	100..5000 Ω
Waveform frequency	0.1..2 Hz (default), adjustable according to HR
Respiration Rate	min. 4 bpm max. 120 bpm
Lead off detection	> 3 MΩ

2 FUNCTIONAL DESCRIPTION

2.1 Measurement Principle

ECG

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

ECG reflects:
Electrical activity of the heart
Normal/abnormal function of the heart
Effects of anaesthesia on heart function
Effects of surgery on heart function

See the Operator's Manual for electrodes positions and other information.

SpO_2

A pulse oximeter measures the light absorption of blood at two wavelengths, one in the near infrared (about 900 nm) and the other in the red region (about 660 nm) of light spectrum. These wavelengths are emitted by LEDs in the SpO_2 probe, the light is transmitted through peripheral tissue and is finally detected by a PIN-diode opposite to LEDs in the probe. Pulse oximeter derives the oxygen saturation (SpO_2) using 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 the above pulse oximetry principle is that due to only two wavelengths used only two hemoglobin species can be discriminated by the measurement.

The modern Pulse Oximeters are empirically calibrated either against fractional saturation SaO_2frac,

$SaO_2frac = HbO_2/(HbO_2+Hb+Dyshemoglobin)$,

or against functional saturation SaO_2func,

$SaO_2func = HbO_2/(HbO_2+Hb)$,

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

The oxygen saturation percentage SpO_2 measured by Datex AS/3 module is calibrated against the 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 oximeter is not able to correctly measure oxygen content of the arterial blood at elevated carboxyhemoglobin or methemoglobin levels.

Plethysmographic pulse wave

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

Pulse rate

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

Probe

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

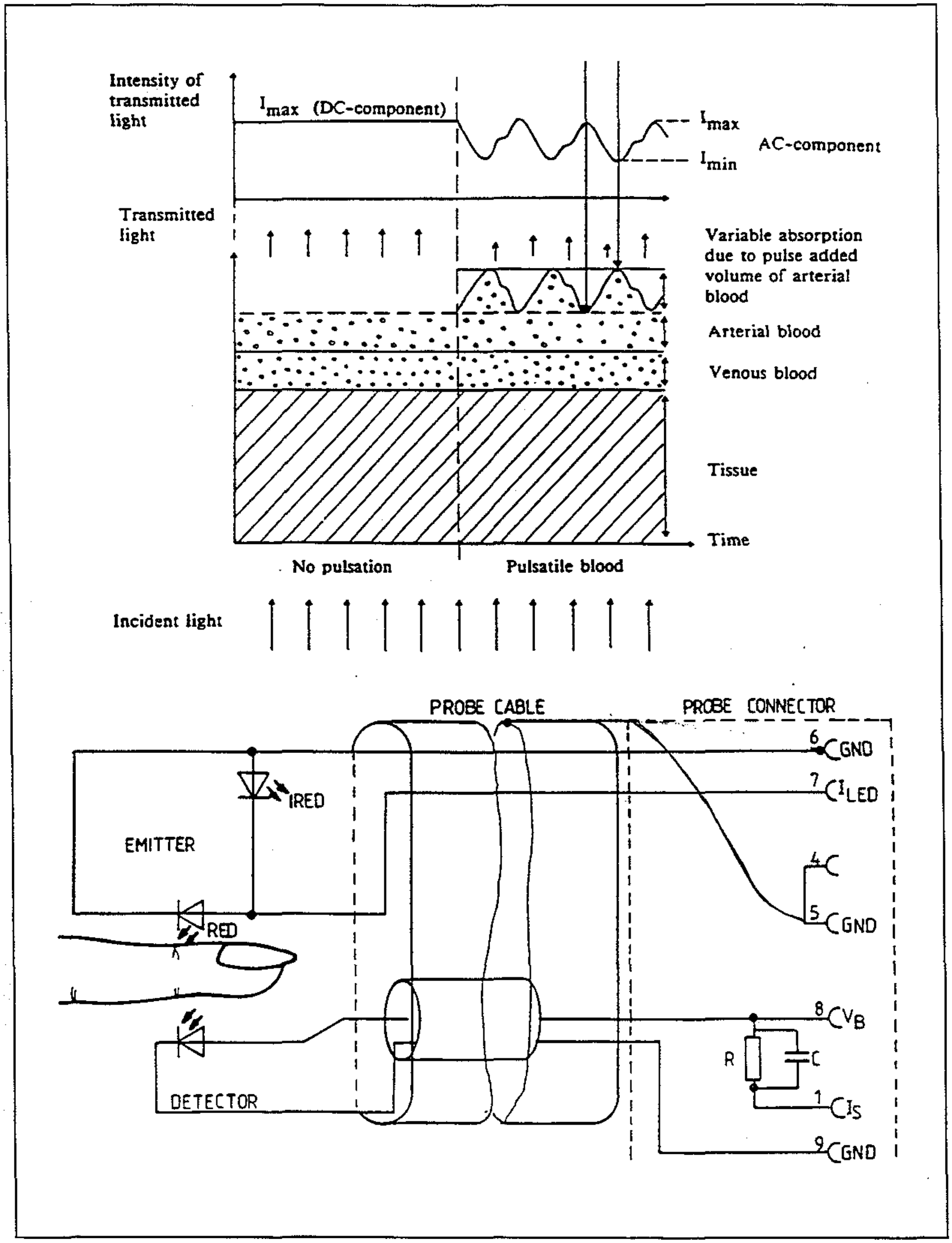


Figure 1 **Absorption of Infrared Light in the Finger and Finger Probe Parts Layout and Schematic diagram.**

Invasive Blood Pressure

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

Temperature

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

The resistance can be measured by two complementary methods:

1. Applying a constant voltage across the resistor and measuring the current that flows through it.
2. Applying a constant current to flow through the resistor and measuring the voltage that is generated across it.

In AS/3 module the two methods are combined in a form of a voltage divider. The NTC-resistor is connected in series with a normal resistor and a constant voltage is applied across them. The temperature dependent voltage can be detected at the junction of the resistors, thus producing the temperature signal from the patient. The signal is amplified by analog amplifiers and further processed by digital electronics.

Respiration

Impedance respiration is measured across the thorax between three ECG electrodes. The signal of the respiration is made by supplying current between two electrodes and by measuring the differential current from the third electrode.

The input current is 200 µA (31kHz). The impedance measured is the impedance change caused by breathing. When the patient is breathing or is ventilated, the volume of the air in the lungs changes, resulting the impedance between the electrodes. From these impedance changes, respiration rate is calculated, and respiration waveform is displayed on the screen.

2.2 Main Components

The **ESTPR/ETPR/ESTR module** contains two main PC boards: the STP board and ECG board. They work independently. Both of them has their own processor and software EPROM. Some components on the boards are not used in ETPR and ESTR modules.

In **ESTPR module**, additionally, there are two small boards, the SP input and ECG input boards, attached to the front panel. The front panel has six connectors and four keys. The connectors are two for temperature measurement, two for invasive blood pressure measurement, one for ECG, and one for SpO_2 measurement. The keys are for ECG lead, Start Wedge, P1 zero, and P2 zero.

In **ETPR module**, there are two small boards: the ECG input board and 2P input board attached to the front panel. The front panel has five connectors and four keys. The connectors are two for temperature measurement, two for invasive blood pressure measurement, and one for SpO_2 measurement. The keys are for ECG lead, Start Wedge, P1 zero, and P2 zero.

In **ESTR module**, there are two small boards: the SP input board and ECG input board, attached to the front panel. The front panel has four connectors and two keys. The connectors are two for temperature measurement, one for ECG, and one for SpO_2 measurement. The keys are for ECG lead and Start Wedge.

NOTE: Revisions M-ESTP rev. 03, M-ETP rev. 02 and M-EST rev. 02 and all earlier revisions had separate T and SP input boards.

2.2.1 STP Board

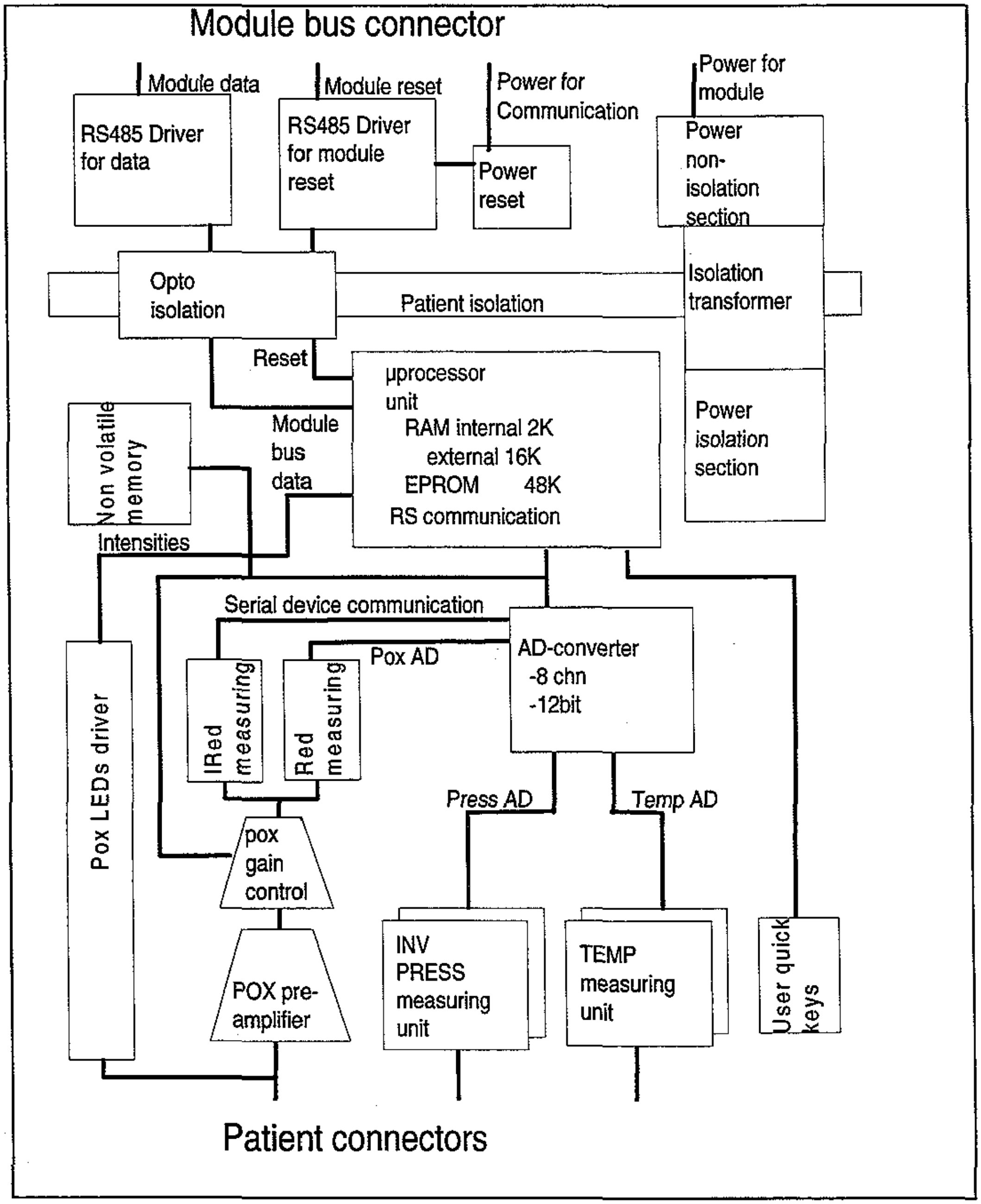


Figure 2 STP Board Block Diagram

Processor section

As processor, Intel's 80C196KC-16 is used. There are external memories, an 8-bit data bus, a 16 MHz oscillator, an open collector reset, and a watchdog timer. Three A/D-converters within the processor are used. The processor's internal UART communicates with the CPU board.

High speed I/O is used to obtain pulse control sequence necessary for pulse oximetry measurement. It gets its timing clock from the oscillator.

Temperature measurement section

Value of NTC-resistor in the probe depends on patient's temperature. It is measured with the following principle.

The temperature signal(s) is produced by voltage dividers, part of which is the patient probe (YSI 400-series thermistor). The output is amplified by the calibrated amplifier(s) whose offset voltage makes its output spread on both sides of zero. Wider output range (measurement range) means better resolution.

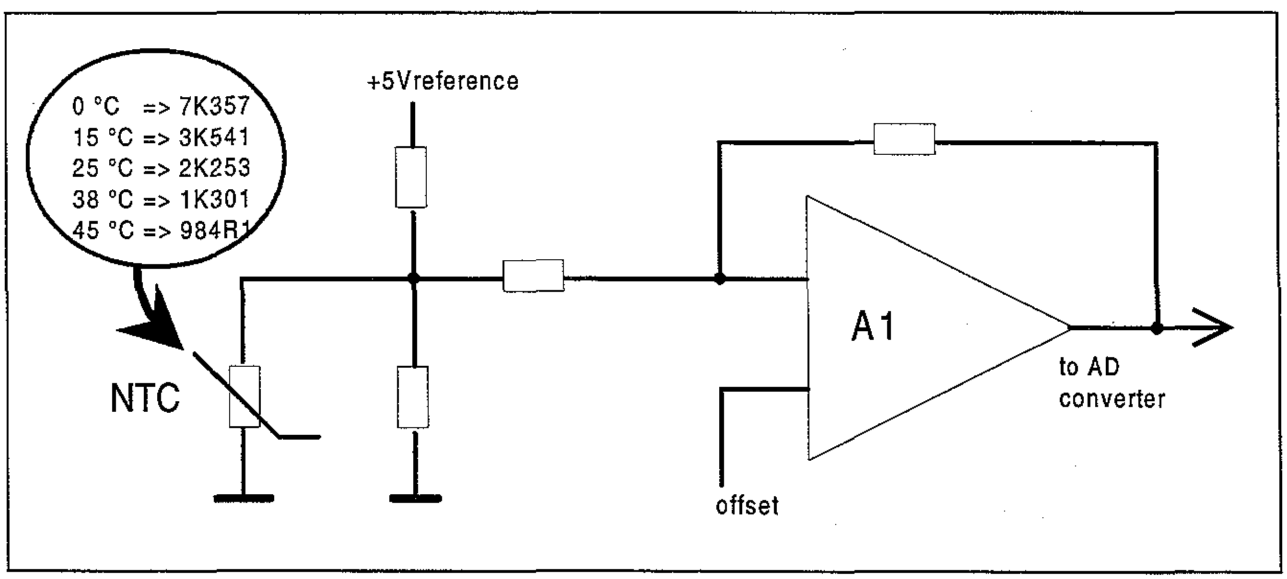


Figure 3 Temperature Measurement Block Diagram

Invasive blood pressure measurement section

Isolated +5 V voltage is supplied to the pressure transducer. From the bridge connection a differential voltage, which depends on pressure and supplied voltage, is calculated (see the formula below).

Uout = Uin x Pressure x 5 V

where Uin = 5 V

Uout = 25 V x Pressure [mmHg]

Pressure amplification is realized in the instrumentation amplifier. Gain of the amplifier is set so that the level of the signal transferred to A/D converter stays 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.

There is also FET switch, which, by cutting the measurement current, detects the existence of the transducer. The existence of the transducer cable is also checked binary by the jumper beside the connector.

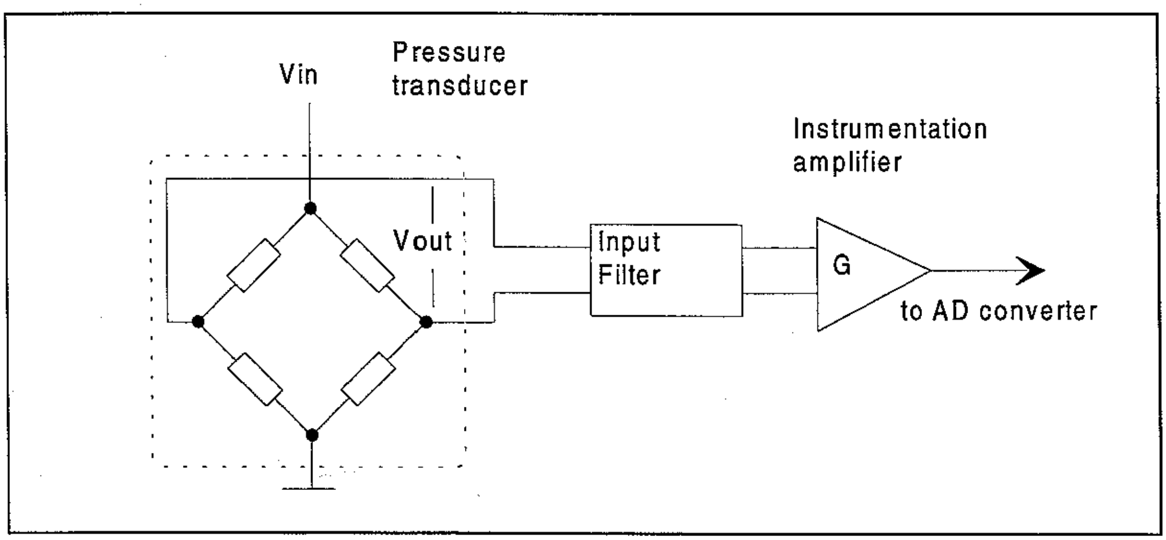


Figure 4 Pressure Transducer Working Principle

Pulse oximetry measurement section

LED control signals

The processor sends pulse width modulated signals, IRED intensity and RED intensity, which are converted to DC voltage and filtered. By switches either RED or IRED intensity is sent forward to amplifier in LED driving circuit.

LED driving circuit

Voltage difference which corresponds to LED current, is measured by the differential amplifier circuit and its output is sent back to the processor in 0 to 5 V level. There are feedback circuits from LED current measurement and LED intensity control.

Background light is measured by picking up a sample from the signal. The sample is modified to 0 to 5 V level and sent to the processor.

Measured signal preamplification

Voltage of -4 V is gained by voltage divider from -12 V and is fed to non-inverted input of current-to-voltage converter amplifier. Thus inverse bias voltage is generated for probe detection. There is a switch, which if closed, a multiple (x30) amplification is resulted (necessary in thin tissue measurement such as earlobe).

Digitally controlled amplifier

D/A converter is a digitally controlled amplifier after which there is another constant amplifier.

Red and Infrared channels' separation

Red and infrared channels are separated from each other by switches. Operational amplifier functions as a buffer and after this infrared DC signal is sent to the processor. A capacitor separates AC signal from it and the AC signal is sent to the processor after amplification. There is a switch to choose the amplification constant.

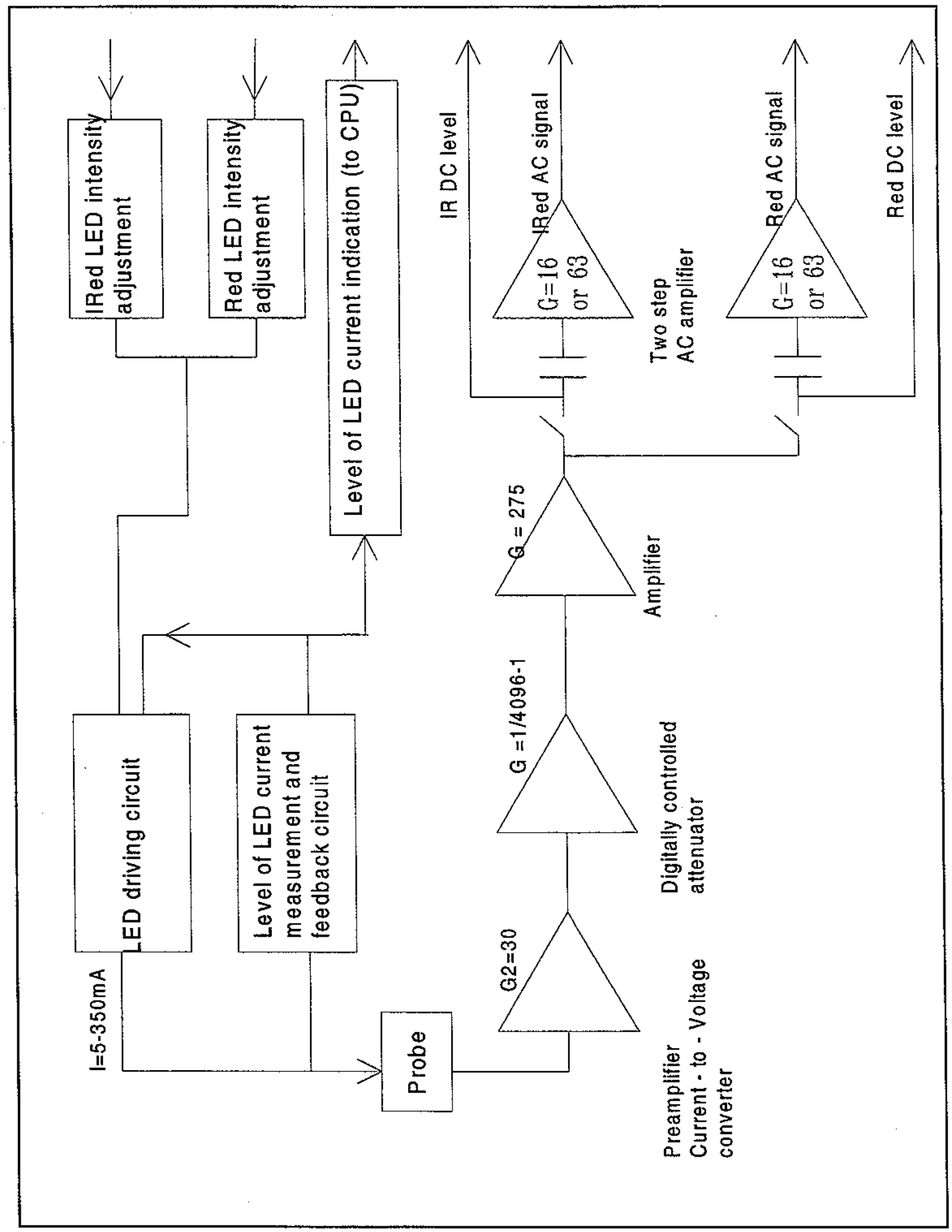


Figure 5 Pulse Oximetry Measurement Block Diagram

Serial communication

Serial communication between the module and the frame is done by RS485 type bus whose buffers get their supply voltage (+5 VDC) from the Frame and in the isolation section get the supply voltage (+5 V) from the isolated power supply.

The buffers of the serial communication are controlled also by Reset-signal so that when the Reset is active, the buffer does not transfer data.

Reset is also RS485 type and additionally, there is an auxiliary logic power reset, which keeps the reset active for about 500 ms despite the state of reset in the module bus. Time constant determines the power-up reset time. There are components to prevent the module from sending data during reset.

Data transmission rate is 500 kbit/s.

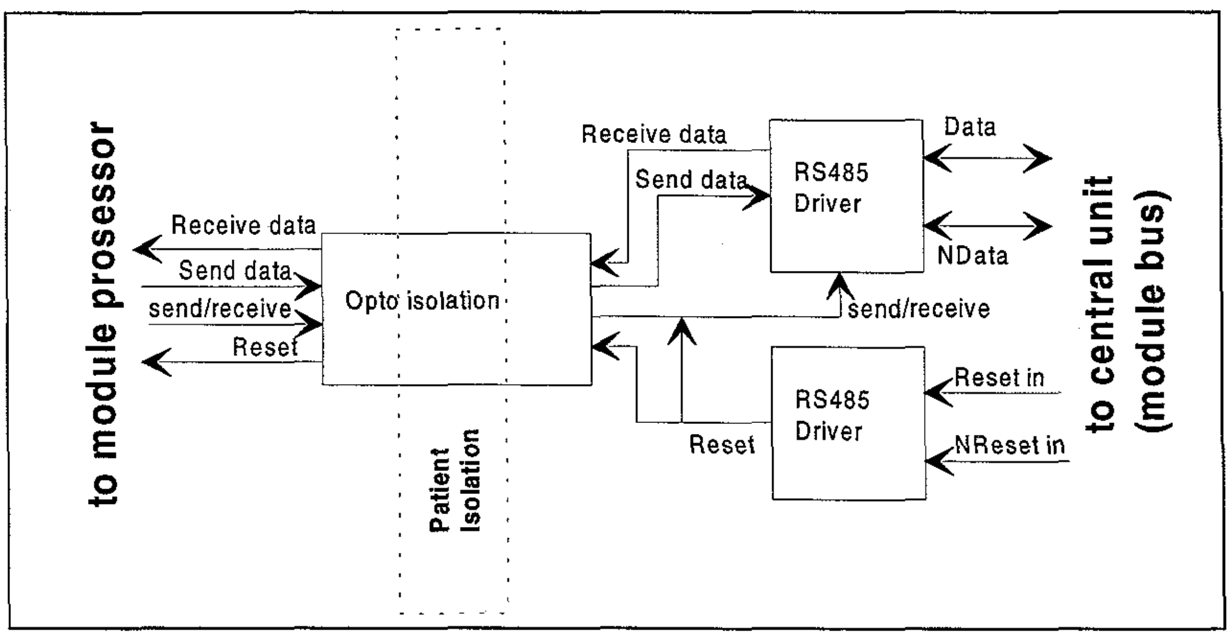


Figure 6 Serial Communication and Opto Isolation

Isolated section

There are two opto isolators. Signal is processed on logical high-low level even though the outputs of the opto isolators are analog signals in the isolated section.

Reset line is an open collector type with a pull-up resistor. Thus the processor is able to use its internal watch-dog function.

Power supply section

Isolated supply voltage of the module is developed from +15 Vdirty voltage from the Central Unit. Power supply is a switched-mode circuit, where FET transistor switch is controlled by an oscillator using bipolar timer. The frequency of the oscillator is about 30 kHz and pulse ratio 50 %. Controlling of the FET switch is slowed to suppress spurious interference.

A special pulse transformer is used in the circuit. In the secondary circuit normal linear regulators are used except for +5 V (low drop type linear regulator).

Input:
+15 Vdirty = +15 V ±0.5 V; 0.3 A

Isolated outputs:
+5 Vref = +5 V ±0.1 V; 100 mA max
+5 V = +5 V ±0.2 V; 100 mA max
+12 V = +12 V ±0.3 V; 70 mA max
-12 V = -12 V ±0.3 V; 70 mA max
-5 V = -5 V ±0.2 V; 20 mA max (STP board only)

Total power:
About 3.5 W
All the voltages are regulated. Isolation primary/secondary 5 kV.

Test points:

There are test pin blocks identical both in STP and ECG boards. Pins and voltages are as follows:

Voltages

X11	pin 1	+5 Vref
	pin 2	+5 V
	pin 3	+12 V
	pin 4	Gnd
	pin 5	-12 V
X12	pin 1	-5 V (STP board only)

2.2.2 ECG Board

Patient signals are connected to overload protection circuits (resistors and gas-filled surge arresters) and analog switches to instrumentation amplifiers. Then the signals are amplified by 480 and limited by slew rate. Then they are A/D-converted, analyzed and transferred to module bus in digital form.

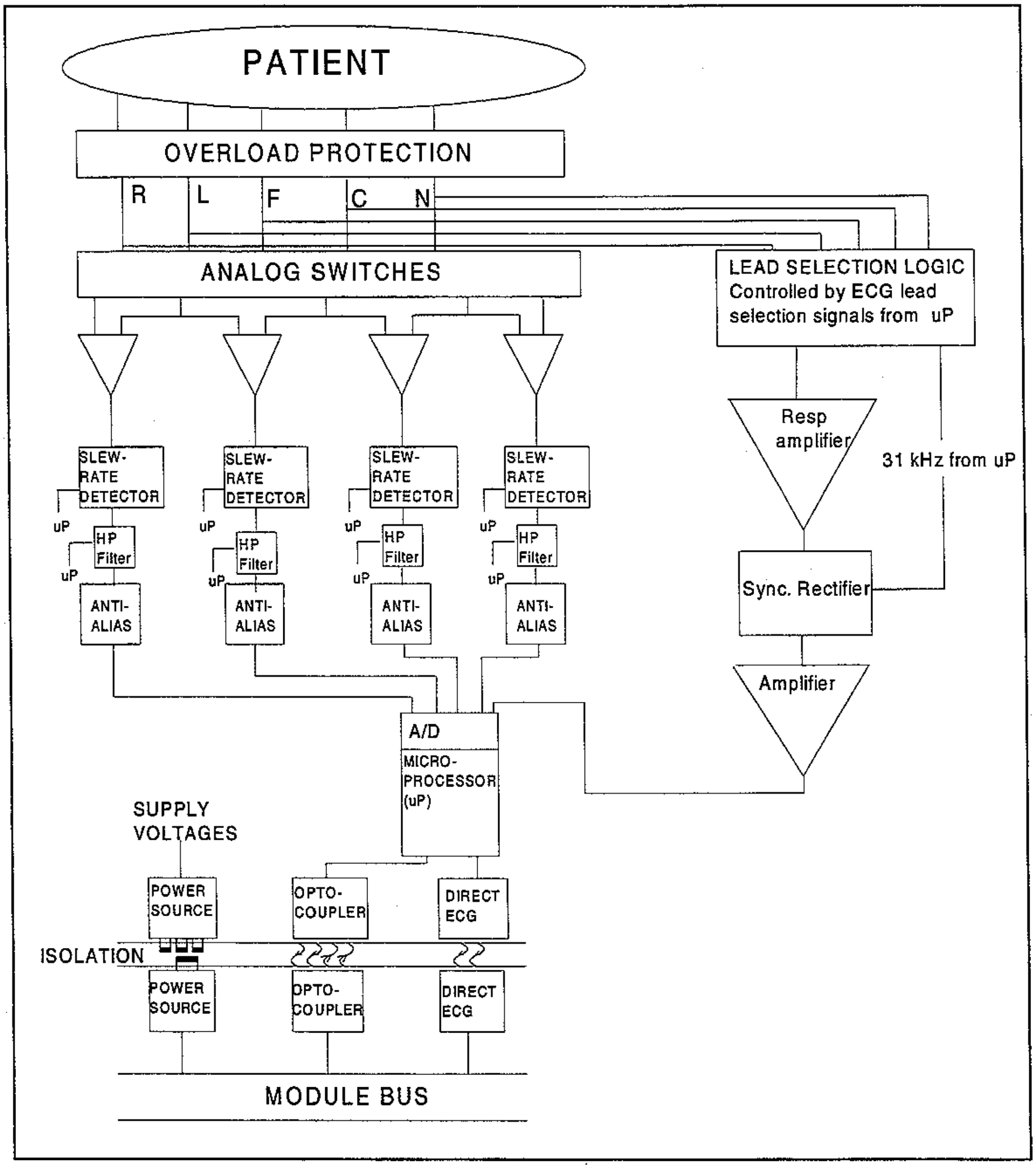


Figure 7 ECG Measurement Block Diagram

Analog ECG section

ECG cable is connected to connector pins E1 to E6 on the input board which contains an overload protection circuit.

Leads are connected to amplifiers via analog switches. State of the switches depend on the cable type.

Lead-off, noise and pacemaker are detected by a slew rate detector.

Cut-off frequency is determined in high pass (HP) filter 0.5 Hz (monitor bandwidth) or 0.05 Hz (diagnostic or ST-bandwidth).

ECG Filtering

The AS/3 monitors have three ECG filtering modes:

MONITORING	0.5 - 30 Hz (-3 dB with 50 Hz reject filter) 0.5 - 40 Hz (-3 dB with 60 Hz reject filter)
DIAGNOSTIC	0.05 - 100 Hz
ST FILTER	0.05 - 30 Hz (with 50 Hz reject filter) 0.05 - 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.

Monitor filter is used in normal monitoring. Diagnostic filter is used if more accurate diagnostic information is needed. 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 hardware. The monitor sends a command to the ESTP(R) 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 (notch type) filters with zero at 50 Hz or 60 Hz correspondingly and they are done with software. They are for the mains supply filtering. When notch filters are used, 3 dB value for low-pass filter is 30 Hz or 40 Hz.

In diagnostic mode software (notch) filters are not used. Then the upper frequency is limited by hardware and the 3 dB frequency is 100 Hz.

Respiration section

The analog switches control the current supply source of the impedance respiration measurement, and the lead selection for the 3-lead cable can be seen from the following table:

Selected lead	Current source between	Signal measured from
I	R - L	N
II	R - N	L
III	L - N	R

When the 5-lead cable is used, the current source is between L-F and the signal is measured from the N, independently on the lead selection.

The respiration amplifier consist of the operational amplifiers, and the components around them. There is a analog switch for controlling the gain of the first stage of the preamplifier.

Synchronous rectifier consist of the analog switches, which are used for detecting the respiration signal from 31 kHz amplitude modulated raw signal.

The amplifier stage consist of the differential amplifier and the last amplifier. The differential amplifier consist of the operational amplifiers and the components around them. This stage is AC-coupled on both sides for minimising the offset voltages.

The last amplifier is used for amplifying the signal derived from differential amplifier stage.

The respiration signal is zeroed at the beginning of the measurement. Zeroing is also used for fast recovering the measurement after the motion artefact. This is done in amplifier section.

Microprocessor section

Microprocessor contains RAM and EPROM memories. The processor uses external EEPROM memory. The microprocessor's internal 8-channel A/D-converter converts the ECG-signals to digital form.

Serial communication

Communication with the module bus is made through RXD and TXD pins. See the serial communication section in STP board description.

Isolated section

The patient isolation of ECG is 5 kV in M-ESTPR rev. 01 and M-ESTR/ETPR rev. 01 modules.
NOTE: The isolation has been changed from the earlier revisions.

WARNING: Do not touch battery operated monitor during defibrillation procedure.

See the isolated section in STP board description.

Power supply section

See the power supply section in STP board description.

There is a test connector (x20) on the board for voltages + 5 VREF, +5V, +12V, GND and -12V.

2.2.3 Module Bus Connector Configuration

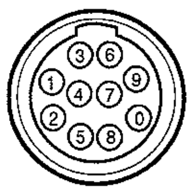
Rear panel 25-pin female D-connector (X1)

Pin No	I/O	Signal
1	I	RESET_RS485*
2	I	-15 VDC
3	I	+15 VDIRTY*
4	I	+15 VDC
5	I/O	-DATA_RS485*
6	I/O	DATA_RS485*
7		Ground & Shield*
8	I	-RESET_RS485*
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13		Ground & Shield*
14	I	+32 VDIRTY
15	I	GroundDIRTY*
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20		ON/STANDBY
21	O	PWM_ECG
22		RXDD_RS232
23		TXDD_RS232
24	I	+5 VDC*
25	I	+5 VDC*

*** Used in the ESTPR, ESTR, and ETPR modules**

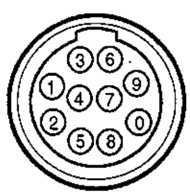
2.2.4 Front Panel Connectors

The pin assignment on the ECG connectors



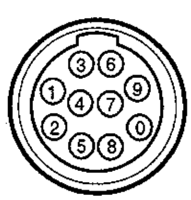
Pin No	Signal
1	Right arm electrode (R)
2	Left arm electrode (L)
3	Right leg electrode (RL)
4	Left leg electrode (F)
5	Chest electrode (C)
6	Cable shield
7	Not connected
8	3/5 lead identification
9	Lead connection check
0	Ground

The pin assignment on the SpO2 Connector:



Pin No	Signal
1	Feedback resistor
2	Ground
3	Not Connected
4	Cable shield + probe identification ground
5	Probe identification
6	LED drive ground
7	LED drive current
8	Input signal current
9	Ground
0	Ground

The pin assignment on the Invasive pressure connector:



Pin No	Signal
1	Pressure +
2	Pressure -
3	Polarisation - (ground)
4	Polarisation +
5	Not connected
6	Not connected
7	Not connected
8	Not connected
9	Ground
0	Cable detection

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex for repair.

Datex 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 shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Preventive Maintenance

Perform these checks after any service and at least once a year to keep the ESTPR/ESTR/ETPR Module in good condition.

1. Visual inspection

___: If the module is disassembled, check that grounding wires and all connectors are properly connected and there is no loose object inside before attaching the module box.

2. Functional checks

Module:

___: Insert the module into frame.

___: Turn the monitor on. Select SpO_2 and Temp to be shown in digit fields. Within 15 seconds, SpO2 and Temp windows should appear on the display. No error message appears.

___: Pull out the module. The SpO2 and Temp windows go blank within 15 seconds.

___: Reinsert the module while the power is still on. The SpO_2 and Temp measurement data appear on the windows again.

___: Connect a finger sensor to the module. The message Probe off should appear on the display. No waveform appears. Attach the sensor to your finger. The reading of 95 to 99 and an SpO_2 waveform should appear.

___: Go to ESTPR:ECG and ESTPR:STP/P Service Menus (Path: Monitor Setup, Install/Service (password 16-4-34), Service View (password 26-23-8), Modules) and check the functions of cables and buttons (ON/OFF test).

ECG Cables:

___: Check the cables visually, and replace if any damages appear.

To test the cable:

___: Check that the following resistances are 4-6 kohm:

Clip to	ECG connector pin
N/RL	3
L/LA	2
R/RA	1
F/LL	4
C/V	5

___: Check that the resistance from a lead to other leads and to the shield (pin no 6) is > 1 Mohm.

If any of the tests fail, replace the cable.

ECG Cables together with Module:

___: Choose a field for ECG waveform (ECG1) in Monitor setup menu. The text 'Leads off' appears. Connect simulator to the module. The heart rate reading appears and the heart symbol starts to blink within 15 seconds. No error messages appear. Press the ECG LEAD key and try all Lead selections.

___: To test all the leads perform following tests:

1. Connect a 3-lead cable to the module.
2. Connect the leads together (e.g. to a screw driver).
3. Select one lead for display.
4. Detach a lead from the screw driver, and see that the module responds as described in the table.
   Connect the lead again.

Lead selection	Lead to be detached	What appears on the screen
Lead I	L/LA	L/LA Off
	R/RA	R/RA Off
	F/LL	Leads off
Lead II	L/LA	Leads off
	R/RA	R/RA Off
	F/LL	F/LL Off
Lead III	L/LA	L/LA Off
	R/RA	Leads Off
	F/LL	F/LL Off

Temperature:

___: Put a temperature test plug into T1 and T2 and make sure that the measured values do not deviate more than $\pm$ 0.1°C. If they do, perform the temperature calibration.

Impedance Respiration

NOTE: The procedure described for the resp check apply to the MedSim 300 patient simulator only.

___: To test impedance respiration

1. Press the **ECG Lead** key on the module. Confirm that the ECG lead selection is displayed, and changes with each key press. Then set the lead selection to Lead II.

2. Press the **Monitor Setup** key and select *Waveform Fields* to get into the corresponding menu. Make sure that the resp waveform is configured to be displayed.

3. Adjust the patient simulator as follows.

* Lead selection to II/RL-LL

* Resp rate to 20

* Ohms to 1.0

4. Press the **Others** key and select *Resp Setup* to get into the corresponding menu. Set the resp rate source to impedance.

5. Press the **Normal Screen** key. Confirm that the resp waveform and the resp rate are displayed after a delay of approximately 30 seconds.

___: To test apnea detection

1. Adjust the patient simulator as follows:

* Select **resp** by pushing the F2 key of the patient simulator

* Select the **apnea** from the patient simulator menu (to get more menu push the arrow key right)

2. Select **cont** from the patient simulator menu, **APNEA** alarm should be displayed on the monitor screen after a delay of approximately 30 seconds.

3.3 Disassembly and Reassembly

Disassemble the ESTPR/ESTR/ETPR module in the following way. See Figure for the exploded view of the module.

a) Remove the two screws from the back of the module.

b) Pull the module box slowly rearwards and detach it from the main body. Be careful with loose latch and spring pin for locking.

c) Two main PC boards will appear. The ECG board is on top of the STP board. The ECG board will be detached by removing four screws one in each corner, disconnecting 9-pin ribbon cable that is connected to the STP board and 2-pin ribbon cable from the front panel. Slide the board rearward to disconnect the fixed 10-pin connector of ECG input board.

d) The STP board can be removed by detaching two screws on the solder side of the board near the front panel and disconnecting the two connectors from the SP input board. The T-input connector cables must be disconnected as well.

CAUTION: When reassembling the module, make sure that the cables are reconnected properly.

3.4 Adjustments and Calibrations

Temperature calibration

NOTE: For the temperature calibration, separate, accurate test plugs (25°C and 45°C) are needed. A test set of two plugs is available from Datex, order code 884515

Calibrate temperature when measured test values deviate more than ±0.1°C from the given value, and always after STP board replacement.

1. Go to ESTPR: STP service page (see Service Menu; Path: Monitor Setup, Install/Service (password 16-4-34), Service View (password 26-23-8), Modules).
2. Go to Calibrations page.
3. Press in the protect button at the bottom of the module and choose OFF in Protect mode. Release the button.
4. Choose Calibrate T1/Calibrate T2.
5. Insert calibration plug (25°C) into T1/T2 connector.
6. Push the ComWheel two times.
7. Insert calibration plug (45°C) into T1/T2 connector.
8. Push the ComWheel two times.
9. Press in the protect button at the bottom of the module and choose ON in Protect mode. Release the button.

Pressure calibration (M-ESTPR/ETPR)

Calibrate pressure when pressure transducer (probe) is replaced by another type, and when STP board is replaced.

1. Go to ESTPR: the STP service page (Path: Monitor Setup, Install/Service, Service View, Modules).
2. Go to Calibrations page.
3. Connect a pressure transducer with a pressure manometer to the front panel P1/P2 receptacle. Choose Calibrate P1 or Calibrate P2. Leave the transducer to room air pressure.
4. Push the ComWheel. The zeroing takes place.
5. Supply pressure of 100 mmHg to 300 mmHg to the transducer. Recommended pressure is 200 mmHg.
6. Set the pressure on the display with the ComWheel to match the pressure reading on the manometer and push the ComWheel. Tolerance of $\pm$1 mmHg is allowed.
7. The text `calibrated' will appear on the display.

4 TROUBLESHOOTING

4.1 Troubleshooting Charts

See also the Operator's Manual for more troubleshooting procedures.

ECG

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

InvBP

TROUBLE	CAUSE	TREATMENT
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 selected pressure waveforms by pressing Monitor Setup key and selecting modify waveforms. Check that pressure transducer open to patient.
	Wrong configuration setting	Check the configuration setting from the ESTPR:STP/Calibrations menu (Monitor Setup / Install/Service / Service View / Modules)
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.

InvBP (continued)

TROUBLE	CAUSE	TREATMENT
Calibration failed-message	Unsuccessful calibrating of P1/P2 (number field), possibly due to pulsating waveform	Turn the transducer to sphygmomanometer and try again (zeroing takes place first). Gain is beyond the limits ($\pm$20 % of the default gain). Replace the transducer.
Out of range $\leq$ 40 mmHg	Measurement pressure is beyond measurement range.	Check transducer level. Zero the channel.
Out of range > 320 mmHg	Measurement pressure is beyond measurement range.	Check 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 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 transducer and its level. Zero the channel.

Temp

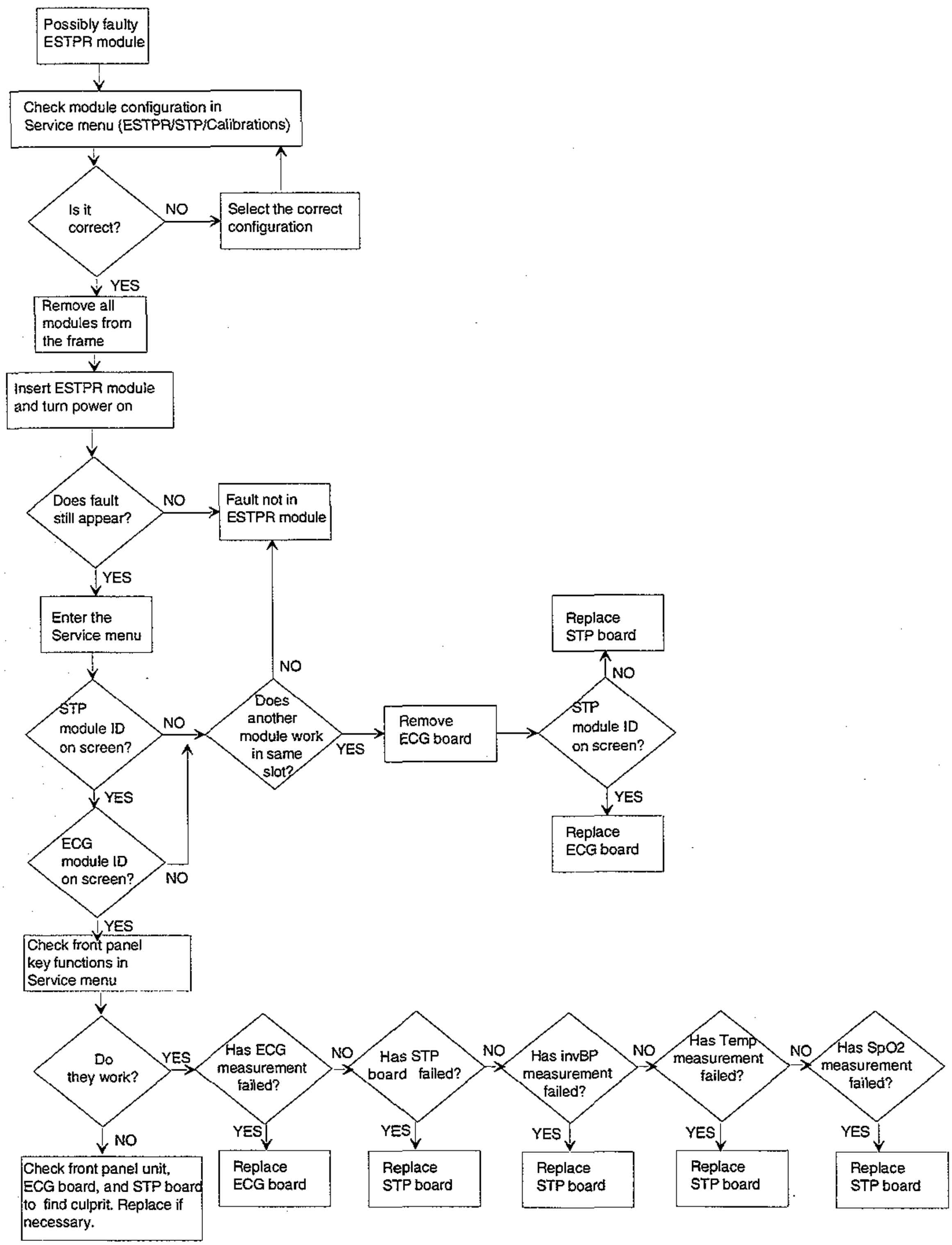
TROUBLE	CAUSE	TREATMENT
Message 'TEMPERATURE ERROR'	Faulty calibration.	Perform calibration. If it does not help, check that front panel connector is properly connected to STP board. Check front panel, SP-input board, or STP board.
No temperature displayed	Wrong type of probe. Temperature out of measurable range.	Use correct probe. The range is between 10 and 45°C. With German monitor software, check that Protection is set to ON in the Service Menu.

SpO_2

TROUBLE	CAUSE	TREATMENT
Message 'NO PROBE'	1. No probe connected to the monitor. 2. Probe faulty.	1. Check probe connections. 2. Change the probe.
Message 'PROBE OFF' though probe properly attached to the patient	1. Unsuitable site. 2. Probe faulty. 3. Probe connection cable not connected to probe.	1. Try another place. 2. Try another probe. 3. Connect the cable to probe.
Finger probe falls off	1. Probe is slippery. 2. Finger is too thin or thick.	1. Wipe with 70 % isopropyl alcohol and allow to dry. 2. Try other fingers, or other probe types.
Weak signal artifacts	1. Poor perfusion. 2. Movement artifacts. 3. Shivering.	Try another place.
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 probe.
Message 'CHECK PROBE'	DC value not in balance.	Try another probe.
Message 'POOR SIGNAL'	Modulation (Red or Ired) < 0.25 %.	Patient may be cold.
Message 'FAULTY PROBE'	Probe is faulty.	Change the probe.
No SpO_2	No waveform selected on screen.	Check selected SpO_2 waveforms by pressing Monitor Setup key and selecting modify waveforms.
	Wrong configuration setting	Check the configuration setting from the ESTPR:STP/Calibrations menu (Monitor Setup / Install/Service / Service View / Modules)

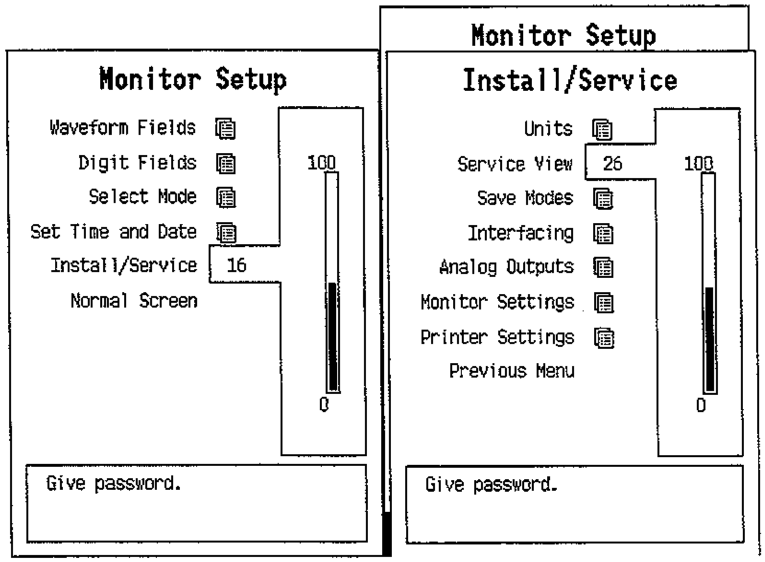
Impedance Respiration

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



ESTPR Module Troubleshooting Chart

5 SERVICE MENU



To enter Service Menu during normal operation:

1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.

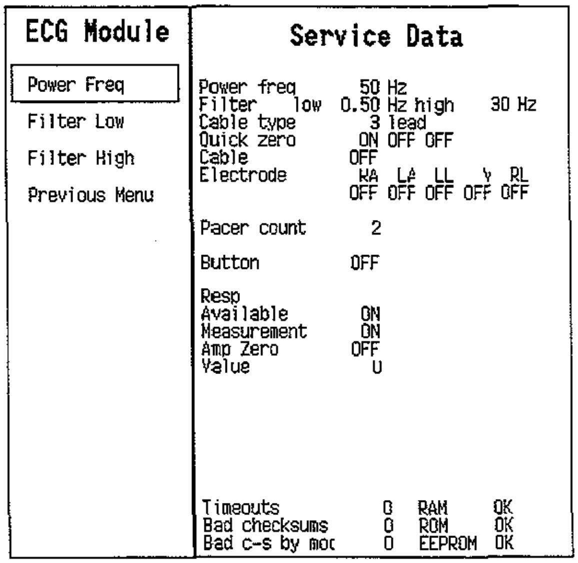
4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

6. Turn the ComWheel to highlight Modules and push.

7. Turn the ComWheel to highlight the right module and push.

5.1 ECG Service Menu



1. Set power frequency (50 Hz/60 Hz).
2. Set filter low frequency (0.05 Hz/0.5 Hz).
3. Set filter high frequency
   (30 Hz (40 Hz if power freq is 60 Hz) /100 Hz).
4. Return to previous menu.

SERVICE DATA Detailed Description

Power freq, and Cable type show the values chosen or detected, **Filter low and high** defines the selected filter (Monitor/Diagnostic/ST).

Quick zero is ON when the signal in any of the three internal amplifier goes beyond scale, and therefore, a capacitor connected to the related channel discharges overvoltage. At least one of **Quick zero** values is OFF when 3-lead cable is used. All three values are OFF when 5-lead cable is used. **Quick zero** also takes place when lead is changed in 3-lead measurement.

Cable shows ON when an ECG cable is connected.

Electrode shows ON when each of these electrodes are connected.

Pacer count is a running number for pacemaker users.

The front panel ECG key function is confirmed by pressing the key and observing OFF turns to ON at **Button**.

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

Measurement shows ON when the respriration measurement is on.

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

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

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 broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The AS/3 Monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per minute) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the external 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).

5.2 STP Service Menu

```
ESTP Module          Service Data

Calibrations              P1    P2    T1    T2
Record Data      Gain    20900 20878 13725 13697
Previous Menu    Zero       -6    -4    85    88
                 Cable     OFF   OFF    ON   OFF
                 Probe     OFF   OFF    ON   OFF
                 Value     ---   --- 20.0[illegible] ---

                 Buttons   OFF   OFF   OFF

                 SpO2      ---   Ired int.    65
                 Modpr     ---   Red int.     65
                 Hr        ---   DC gain      26
                 Cable      ON
                 Probe      ON
                 Probe off

                 Temp error            OFF   OFF


                 Protect key     OFF
                 Protect mode     ON
                 Configuration   STP

                 Timeouts            0  RAM     OK
                 Bad checksums       0  ROM     OK
                 Bad c-s by mod      0  EEPROM  OK
```

1. Enter calibration menu

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

2. Return to previous menu

SERVICE DATA Detailed Description

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 offset compensation value of each parameter in A/D converter. Typically the values for P1 and P2 are within $\pm$1000 and for T1 and T2 between -150 and +300. Calibrate if zero and/or gain value is outside the ranges.

Cable shows ON when a corresponding cable is connected to the front panel and **Probe** shows ON when a corresponding probe is connected to the cable.

Under **Value** the measured numeric values are displayed simultaneously. Pressure values are real time values and shown in mmHg. Temperature values are shown in Centigrade.

SpO_2 shows measured beat-to-beat SpO_2 value. **Modpr** is a modulation % that indicates DC/AC 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 OK, PULSE SEARCH, NO PROBE, PROBE OFF, NO PULSE, ARTEFACT, POOR SIGNAL, or CHECK PROBE.

Balance between leds adjusted by the modules could be done by changing the intensity of red/infrared. Intensity of infrared (**Ired int.**) is in the range of 40..255 and red intensity (**red int.**)is in the range of 40..255.

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

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

Temp error shows the status of the temperature test. No erros found shows the status (OFF) and errors found (ON).

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

Protect mode is normally ON. It turns to OFF when Protect is switched to OFF for the temperature calibration in Calibration Menu.
Configuration shows the chosen module configuration: TP, ST, or STP.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. **Bad checksums** is a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The AS/3 Monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50

per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the external 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).

5.2.1 Calibration Menu

```
Calibrations

   Protection   OFF
   Set Config   STP
 [Calibrate T1]
 Calibrate T2
 Calibrate P1
 Calibrate P2
 Previous Menu

Calibrate temperatures
with calibration plugs
for 25 °C and 45 °C.
```

Protection can be set to ON or OFF only when protect button at the bottom of the module is pressed. **Set Config, Calibrate T1,** and **Calibrate T2** selections are available only when protect mode is off. **Calibrate P1** and **Calibrate P2** are available when pressure transducer is connected to the receptacle on the front panel.

For calibration instructions, please see Chapter 3.4 Adjustments and Calibrations.

6 SPARE PARTS

6.1 Spare Parts List

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

M-ESTP Rev. 01, M-ETP Rev. 00, M-EST Rev. 00

Item	Item description	Order No.
6	STP board, M-ESTP (Rev. 01), M-P (Rev. 00-01)	*880339
7	ECG board, M-ESTP (Rev. 01)	*880338
4	Front panel unit, M-ESTP (Rev. 01)	880337
4	Front panel unit, M-ETP (Rev. 00)	880941
4	Front panel unit, M-EST (Rev. 00)	880946
	Membrane keypad	879374
10	Front panel sticker, M-ESTP (Rev. 01) (Eng)	879481
10	Front panel sticker, M-ESTP (Rev. 01) (Fre)	880158
10	Front panel sticker, M-ESTP (Rev. 01) (Ger)	880552
10	Front panel sticker, M-ETP (Rev. 00) (Eng)	880428
10	Front panel sticker, M-ETP (Rev. 00) (Fre)	880429
10	Front panel sticker, M-ETP (Rev. 00) (Ger)	880560
10	Front panel sticker, M-EST (Rev. 00) (Eng)	880138
10	Front panel sticker, M-EST (Rev. 00) (Fre)	880140
10	Front panel sticker, M-EST (Rev. 00) (Ger)	880453
1	Module box (wide)	886168
3	Latch	879181
2	Spring pin	879182
11	Metal frame	879184
5	Cross recess screw M3x8 black	616215
13	Cross cylinder-head screw M3x6	61721
14	Cross cylinder-head screw M3x12	628700

M-ESTP Rev. 02, M-ETP Rev. 01, M-EST Rev. 01

Item	Item description	Order No.
6	STP board, M-ESTP (Rev. 02)	*(882130) Use 882627 [1] 883367
7	ECG board, M-ESTP (Rev. 02)	*(882025) Use 886748 [2] 883806
4	Front panel unit, M-ESTP (Rev. 02-03)	882127
4	Front panel unit, M-ETP (Rev. 01-02)	882128
4	Front panel unit, M-EST (Rev. 01-02)	882129
15	T-input board, M-ESTP (Rev. 02-03)	*882090
10	Front panel sticker, M-ESTP (Rev. 02-03) (Eng)	881953
10	Front panel sticker, M-ESTP (Rev. 02-03) (Fre)	881954
10	Front panel sticker, M-ESTP (Rev. 02-03) (Ger)	881955
10	Front panel sticker, M-ETP (Rev. 01-02) (Eng)	881956
10	Front panel sticker, M-ETP (Rev. 01-02) (Fre)	881957
10	Front panel sticker, M-ETP (Rev. 01-02) (Ger)	881958
10	Front panel sticker, M-EST (Rev. 01-02) (Eng)	881959
10	Front panel sticker, M-EST (Rev. 01-02) (Fre)	881960
10	Front panel sticker, M-EST (Rev. 01-02) (Ger)	881961

M-ESTP Rev. 03, M-ETP Rev. 02, M-EST Rev. 02

Item	Item description	Order No.
6	STP board, M-ESTP (Rev. 03-04), M-P (Rev. 02)	*882627
D4	STP software	*883367
	EMC plate	884099
7	ECG board, M-ESTP (Rev. 03)	*(883119) Use 886748 [2] 883806
10	Front panel sticker, M-ESTP (Rev. 03-04) (Spa)	884200
10	Front panel sticker, M-ESTP (Rev. 03-04) (Swe)	885857
10	Front panel sticker, M-ESTP (Rev. 03-04) (Dut)	886044
10	Front panel sticker, M-ESTP (Rev. 03-04) (Ita)	886753
10	Front panel sticker, M-ETP (Rev. 02-03) (Spa)	885043
10	Front panel sticker, M-ETP (Rev. 02-03) (Swe)	885856
10	Front panel sticker, M-ETP (Rev. 02-03) (Dut)	886046
10	Front panel sticker, M-ETP (Rev. 02-03) (Ita)	886754
10	Front panel sticker, M-EST (Rev. 02-03) (Spa)	885044
10	Front panel sticker, M-EST (Rev. 02-03) (Swe)	885859
10	Front panel sticker, M-EST (Rev. 02-03) (Dut)	886045
10	Front panel sticker, M-EST (Rev. 02-03) (Ita)	886755

M-ESTP Rev. 04, M-ETP Rev. 03, M-EST Rev. 03

Item	Item description	Order No.
7	ECG board, M-ESTP (Rev. 04)	*886748
	ECG software	*883806
4	Front panel unit, M-ESTP (Rev. 04)	887153
4	Front panel unit, M-ETP (Rev. 03)	887154
4	Front panel unit, M-EST (Rev. 03)	887155
15	T-input connectors, M-ESTP (Rev. 04)	*887152
16	EMC cover	884099

A front panel unit includes all the connectors and input boards.

* = the part is recommended for stock

1) **NOTE:** The STP board 882627 can be used as a replacement only with STP software 883367.

2) **NOTE:** The ECG board 886478 can be used as a replacement only with ECG software 883806

M-ESTPR Rev. 01, M-ETPR Rev. 01, M-ESTR Rev. 01

Item	Item description	Order No.
6	STP board, M-ESTP (Rev. 03-04), M-P (Rev. 02)	*882627
16	EMC cover	884099
7	ECG/RESP board, M-ESTPR (Rev. 01)	*884609
17	EMC cover	886818
4	Front panel unit, M-ESTPR (Rev. 01)	887153
4	Front panel unit, M-ETPR (Rev. 01)	887154
4	Front panel unit, M-ESTR (Rev. 01)	887155
	Membrane keypad	879374
15	T-input connectors, M-ESTP (Rev. 04)	*887152
10	Front panel sticker, M-ESTPR (Rev. 01) (Eng)	886603
10	Front panel sticker, M-ESTPR (Rev. 01) (Ger)	886966
10	Front panel sticker, M-ESTPR (Rev. 01) (Fre)	886963
10	Front panel sticker, M-ESTPR (Rev. 01) (Esp)	886943
10	Front panel sticker, M-ESTPR (Rev. 01) (Swe)	886928
10	Front panel sticker, M-ESTPR (Rev. 01) (Dut)	886937
10	Front panel sticker, M-ESTPR (Rev. 01) (Ita)	886925
10	Front panel sticker, M-ESTPR (Rev. 01) (Fin)	888868

10	Front panel sticker, M-ETPR (Rev. 01) (Eng)	886604
10	Front panel sticker, M-ETPR (Rev. 01) (Ger)	886967
10	Front panel sticker, M-ETPR (Rev. 01) (Fre)	886965
10	Front panel sticker, M-ETPR (Rev. 01) (Esp)	886944
10	Front panel sticker, M-ETPR (Rev. 01) (Swe)	886929
10	Front panel sticker, M-ETPR (Rev. 01) (Dut)	886938
10	Front panel sticker, M-ETPR (Rev. 01) (Ita)	886926
10	Front panel sticker, M-ETPR (Rev. 01) (Fin)	888869
10	Front panel sticker, M-ESTR (Rev. 01) (Eng)	886605
10	Front panel sticker, M-ESTR (Rev. 01) (Ger)	886968
10	Front panel sticker, M-ESTR (Rev. 01) (Fre)	886964
10	Front panel sticker, M-ESTR (Rev. 01) (Esp)	886945
10	Front panel sticker, M-ESTR (Rev. 01) (Swe)	886930
10	Front panel sticker, M-ESTR (Rev. 01) (Dut)	886939
10	Front panel sticker, M-ESTR (Rev. 01) (Ita)	886927
10	Front panel sticker, M-ESTR (Rev. 01) (Fin)	888870
1	Module box (wide)	886168
3	Latch	879181
2	Spring pin	879182
11	Metal frame	879183
5	Cross recess screw M3x8 black	616215
13	Cross cylinder-head screw M3x6	61721
14	Cross cylinder-head screw M3x12	628700

A front panel unit includes all the connectors and input boards.

* = the part is recommended for stock

6.2 Exploded View

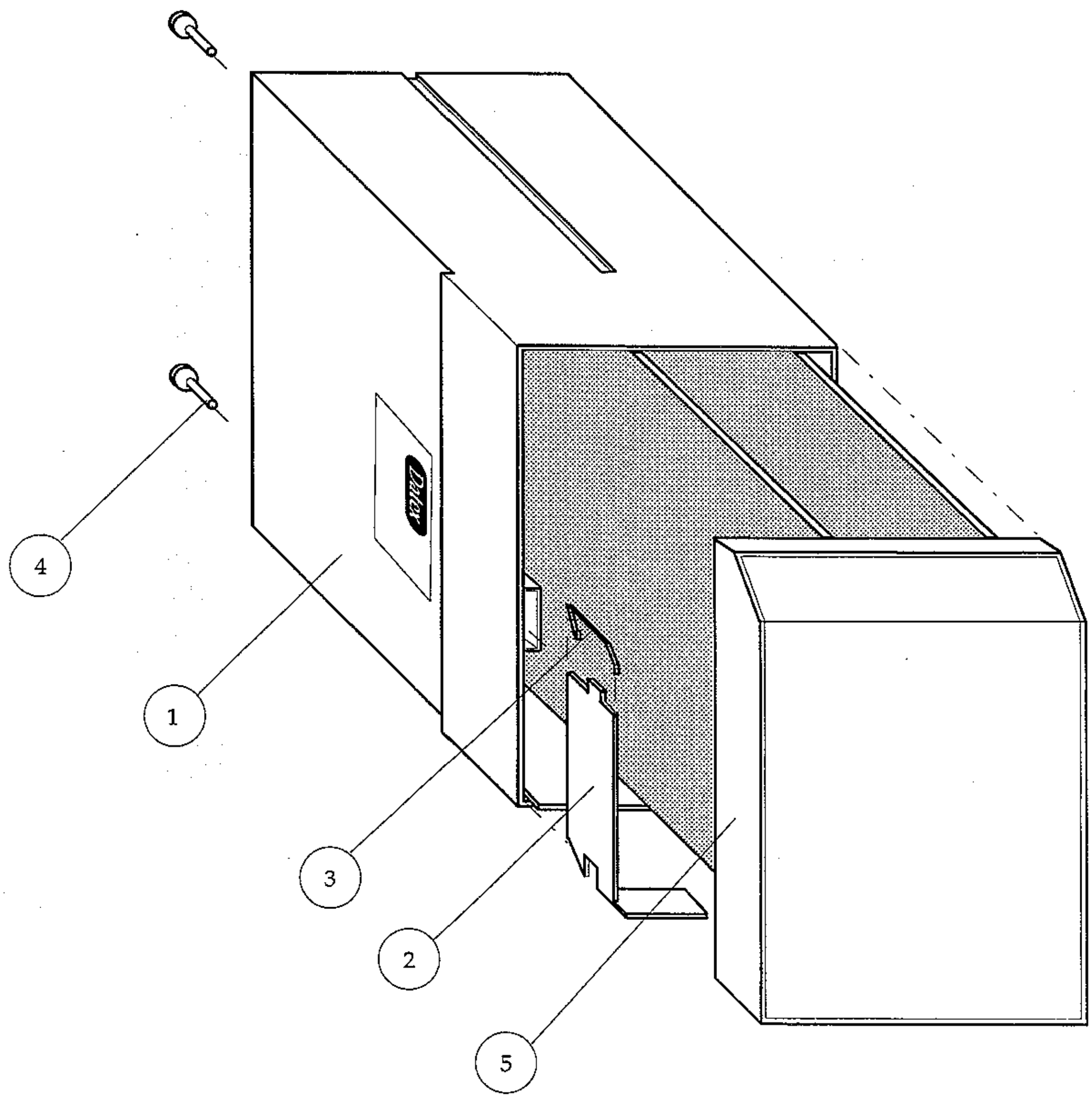


Figure 8 Exploded View of Module Box

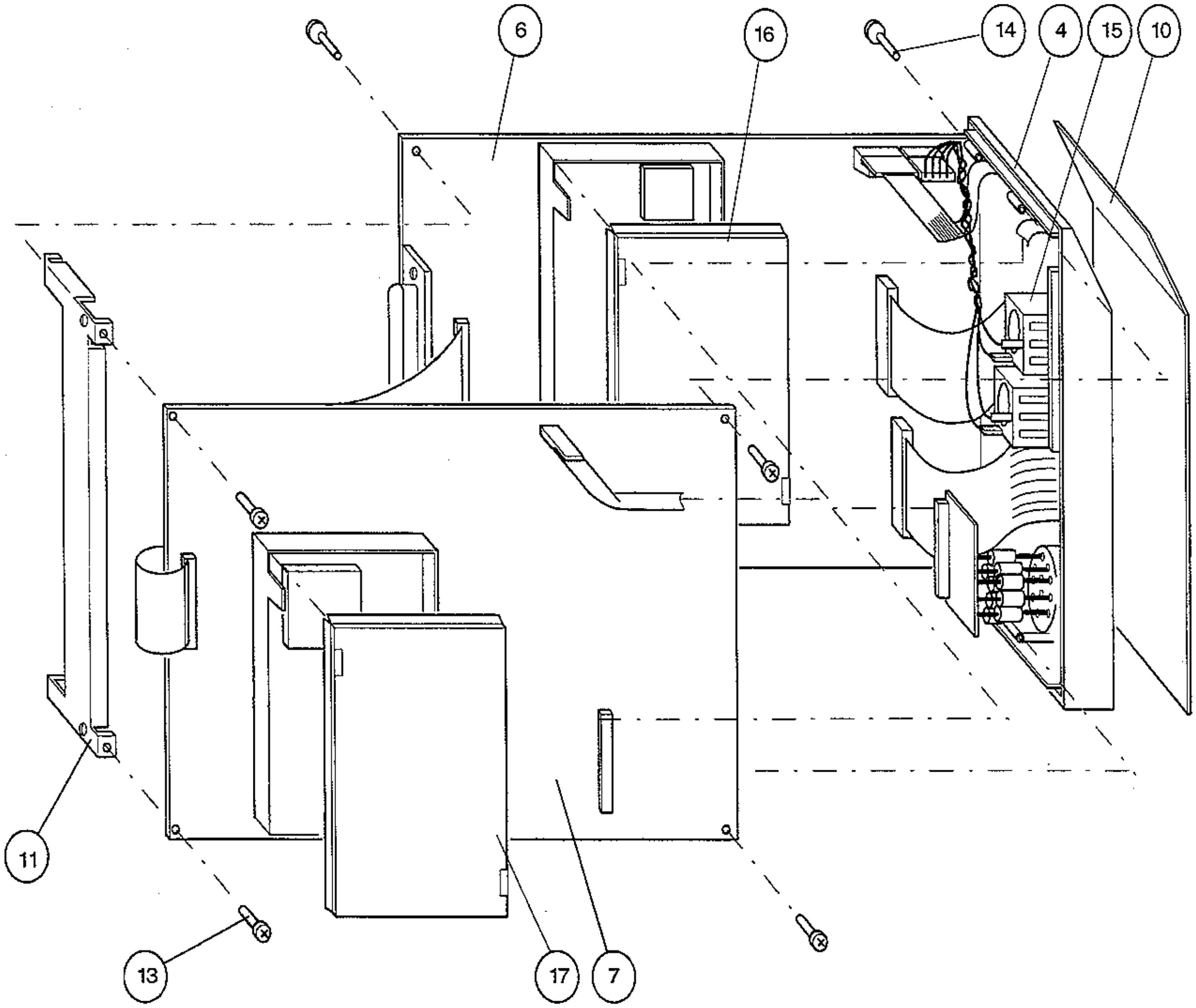


Figure 9 Exploded View of Module

7 EARLIER REVISIONS

For service information on the earlier revisions, please refer to:

ESTP Module revision 01	Service Manual p/n 880850
ETP Module revision 00	-"-
ESTP Module revision 02	Service Manual p/n 882580
ETP and EST Modules revision 01	-"-

ESTP Module revision 03-04, and ETP and EST Modules revision 02-03 are supported by this manual too.

Cardiac Output Module, M-COP (Rev. 02)

Cardiac Output and SvO_2 Module, M-COPSv (Rev. 00)

All specifications subject to change without notice

Document No. 889881

March, 1996

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Table of Contents

INTRODUCTION

Datex AS/3 Cardiac Output Modules, M-COP and M-COPSv are single width plug-in modules for use with the Anaesthesia and Compact Monitors. Both modules provide cardiac output (C.O.), right ventricular ejection fraction (REF) and invasive pressure measurement. Additionally the COPSv module provides venous oxygen saturation (SvO_2) measurement.

NOTE: Do not use identical modules in the same monitoring system. The COP and COPSv modules are considered as identical modules.

1 SPECIFICATIONS

1.1 General Specifications

Module size (W x D x H)	37 x 180 x 112 mm 1.5 x 7.1 x 4.4 in
Module weight	0.35 kg / 0.8 lbs
Power consumption, M-COP	About 3.5 W
Power consumption, M-COPSv	About 5 W

1.2 Typical Performance

C.O.

Measurement range	0.1 to 20 l/min
Display resolution	0.01 l/min
Repeatability	> ±2 % or ±0.02 l/min (measured from electrically generated flow curves)
Max. change in blood temp	2.99°C

Injectate temp range (with Edward's compatible probes)

0 to 25.5°C	±0.3°C
25.5 to 27.0°C	±0.5°C

Blood temp range (with Edward's compatible catheters)

17.5 to 30.9°C	±0.5°C
31.0 to 43.0°C	±0.3°C

Protection against electric shock type CF defibrillation proof

REF

Repeatability (Measuring range 10-60 %)	± 2 %

SvO_2

Accuracy	± 2 %

(Measuring range 30-95 %)
Equals to standard deviation when using in vivo calibration

InvBP

Measurement range	-40 to 320 mmHg
Zero adjustment range	±150 mmHg
Calibration range	±20 %
Scales	Upper limit is adjustable between 10 and 300 mmHg in steps of 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:	
Measurement range	30 to 250 bpm
Resolution	1 bpm
Accuracy	±5 bpm
Respiration artefact rejection	

1.3 Technical Specifications

Digital display averaged over 5 seconds and updated at 5 seconds intervals.

Error	$\pm$5 % or $\pm$2 mmHg
Transducer and input sensitivity	5 µV/V/mmHg, 5 VDC 20 mA max current
Input resistance	10^{10} Ω
Zero drift	<0.1 mmHg/°C
Nonlinearity	<1 %, 0 to 200 mmHg <2 %, -40 to 0 and 200 to 320 mmHg
Gain drift	<0.05 %f.s./°C
Filter	0 to 20 Hz(-3 dB)
Zero set accuracy	$\pm$1 mmHg
Calibration resolution	$\pm$1 mmHg
Zero time	less than 5 sec
Protection against electric shock	type CF defibrillation proof

NOTE: The accuracy of the measurement may be different from the specified accuracy, depending on the transducer/probe used. Please check the transducer/probe specification.

2 FUNCTIONAL DESCRIPTION

2.1 Measurement Principle

Cardiac Output and REF

Cardiac output measurement is made by principle of thermodilution. In measurement the catheter lies in the heart with an injection port in the right atrium (RA) and a thermistor, which is to monitor blood temperature, in the pulmonary artery (PA). A small, known amount of thermal indicator is injected into the RA and is mixed with the blood on its way to the PA. The catheter thermistor measures the decrease in blood temperature as the blood flows past the thermistor in the PA.

The information is stored in the module and cardiac output is calculated from the area beneath the thermal curve.

The area under the time-temperature curve is inversely proportional to the flow rate which corresponds to cardiac output.

Cardiac output is calculated from the equation:

$$C.O. = \frac{1.08\ C_T\ 60\ Vi\ (T_B - Ti)}{T_B\ dt + C}$$

where:

C.O.= cardiac output in liters/minute

1.08 = factor comparing density and specific heat of 5% dextrose solution in water to ones of blood.

C_T = correction factor for the injectate temperature rise as it passes through the catheter and its dead space

60 = seconds/minute

V_i = injectate volume in liters

T_B = baseline blood temperature (°C)

T_i = injectate temperature

$T_B dt$ =area under thermodilution curve between time o and x, where x is the time when the curve has dropped to 30% of its peak value.

C = area beneath thermodilution curve between x and end of the curve.

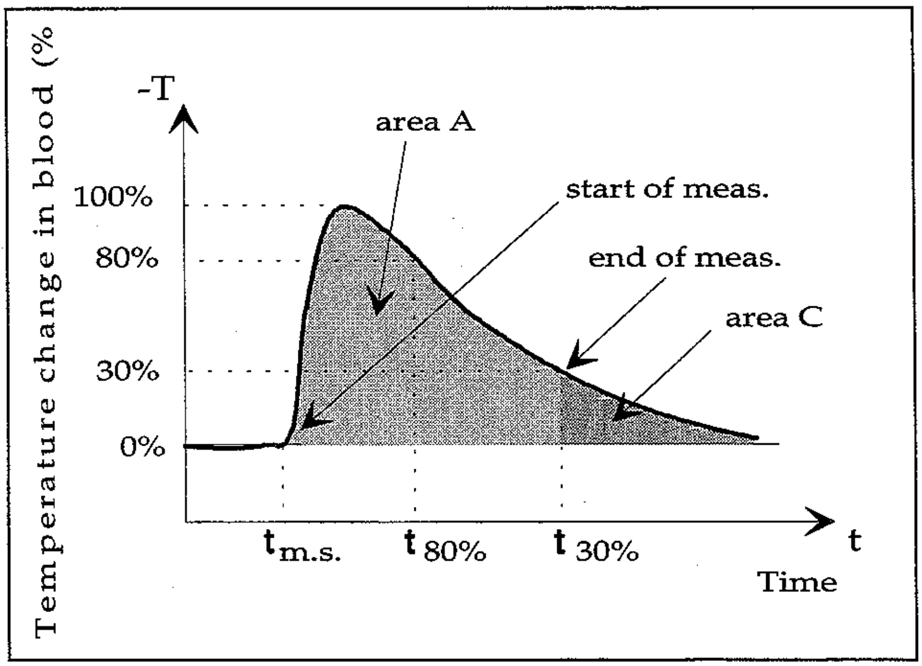


Figure 1 **Cardiac Output Measurement Curve**

A = area derived by integration of the time temperature thermodilution curve

C = area beneath the thermodilution curve between t_{30}% and end of the curve. Computation based upon an exponential fit to the curve between t_{80}% of the peak and t_{30}%.

REF (right ventricular ejection fraction) measurement is a part of the thermodilution cardiac output measurement. Ejection fraction is determined using an exponential technique by synchronizing sensed R-waves with points of temperature changes on the thermodilution curve. Once ejection fraction, cardiac output, and heart rate are known, right ventricular volumes may be calculated. The measurement requires BAXTER Edwards fast response thermistor catheter and also ECG-module to synchronise R-wave detection to the thermodilution curves.

SvO_2 Measurement (COPSv module only)

The COPSv module measures SvO_2 when coupled with Baxter-Edwards OM-2E optical module and Swan-Ganz oximetry catheter. To measure SvO_2, the system utilizes a spectrophotometric technique involving the use of light-emitting diodes (LEDs) that produce red (660 nm) and infrared (810 nm) light. The light is transmitted to the blood through a single plastic optical fiber in the oximetry catheter and reflected back through a separate optical fiber to a photodetector in the optical module. The light is electrically transmitted to the COPSv module and analyzed to determine SvO_2.

The oximetry portion of the system measures SvO2 in the pulmonary artery by detecting colour changes in the red blood cells. When pulses of red and infrared light are transmitted through the oximetry catheter, the light is reflected from the red blood cells and transmitted back through the catheter to the optical module. The amount of light reflected at each wavelength depends primarily on the colour of the blood and the number of red blood cells. Since the number of red blood cells in the blood affects the amount of reflected light, the differences are compensated when the patient's total haemoglobin value is entered. The optical module stores and transfers SvO_2 calibration data. SvO_2 values can be affected by the presence of methemeglobin or carboxyhaemoglobin which imitate the absorption characteristics of HbO_2. Large concentrations of methemeglobin or carboxyhaemoglobin could then cause a falsely elevated SvO_2. In cases where dysfunctional haemoglobins are suspected, SvO_2 should be interpreted with caution.

Invasive Blood Pressure Measurement

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

The COP module consist of the COP board and two input boards, the CO input board and the P input board, attached to the front panel. (The front panel components are shown in figure 2.)

The COPSv module consist of the COPSv board and three input boards, the CO input board, the SvO_2 input board and the P input board, attached to the front panel. The front panel components are shown in figure 2.

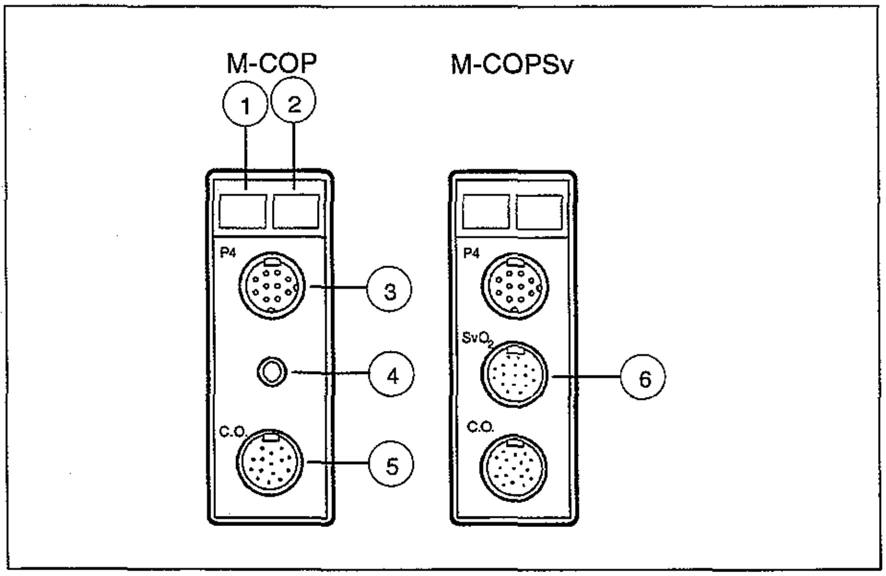


Figure 2 Front Panel Components

(1) Key for pressure zeroing (zero P4)
(2) Key for cardiac output measurement (Start C.O.)
(3) Connector for invasive pressure measurement (P4)
(4) Connector for C.O. self test
(5) Connector for C.O. measurement (C.O.)
(6) Connector for SvO_2 measurement (SvO_2)

2.2.1 COP Board

The COP board consists of the following functional sections.

- Processor section
- Cardiac output measurement section
- Cardiac output self test
- Invasive BP measurement section
- Serial communication
- Isolated section
- Power supply section

Processor section

As the processor, Intel's 80C196KC-16 is used. There are external memories, an 8-bit data bus, a 16 MHz oscillator, and a watchdog timer. Three A/D-converters within the processor are used. The processor's internal UART communicates with the host monitor.

Cardiac output measurement section

The catheter and the probe contain NTC-resistor that reacts to temperature change.

Temperature dependent voltage over the NTC-resistor is amplified and offset value is added to it, then regulated into ±5 V range in voltage slicing and sent to A/D converter.

Because the temperature measurements are calibrated digitally and non-linearity of catheter/probe is compensated by software, ambient temperature change after calibration is the only factor that may have influence upon the measurement.

Cardiac output self test

There is a connector for C.O. test on the module front panel to find out whether the fault is in the catheter or in the module.

When the cable is connected to the self-test connector, processor starts the test program automatically. First, the processor measures 30°C. Then, it activates test circuits and measures 37°C and then 41°C.

If the measured values are correct ('Cable OK' message is displayed) the fault is in the catheter, and if not correct ('Cable fault' is displayed), the fault is either in the module or in the catheter connecting cable.

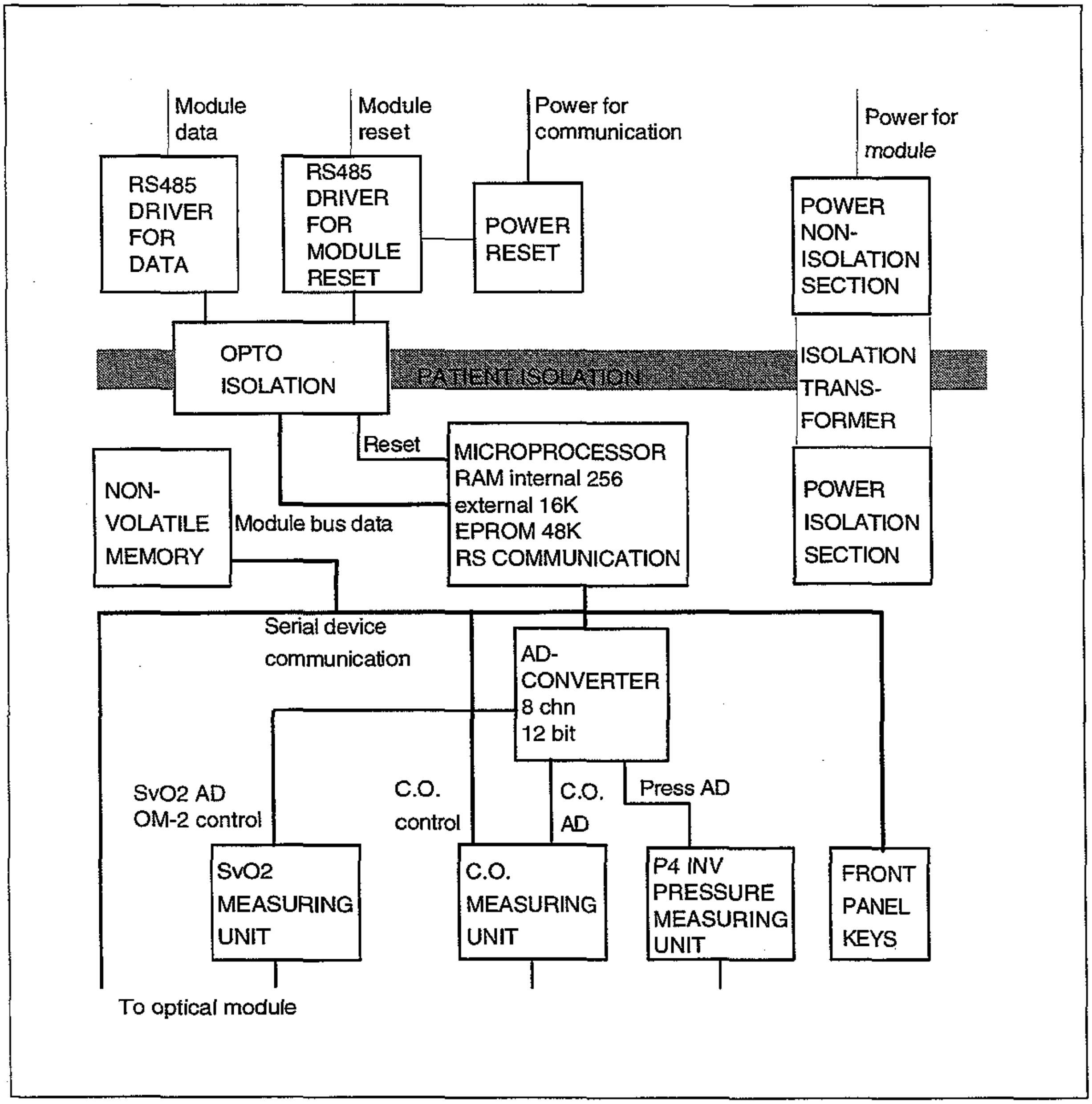


Figure 3 **COPSv Board Block Diagram, in COP Board the SvO_2 Section is Excluded**

Invasive BP measurement section

Isolated +5 V voltage is supplied to the pressure transducer. From the bridge connection a differential voltage, which depends on pressure and supplied voltage, is calculated (see the formula below).

Uout = Uin x Pressure x 5 V

where Uin = 5 V

Uout = 25 V x Pressure [mmHg]

Pressure amplification is realized in the instrumentation amplifier. Gain of the amplifier is set so that the level of the signal transferred to A/D converter stays 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.

There is also FET switch, which, by cutting the measurement current, detects the existence of the transducer. The existence of the transducer is also checked binary by the jumper beside the connector.

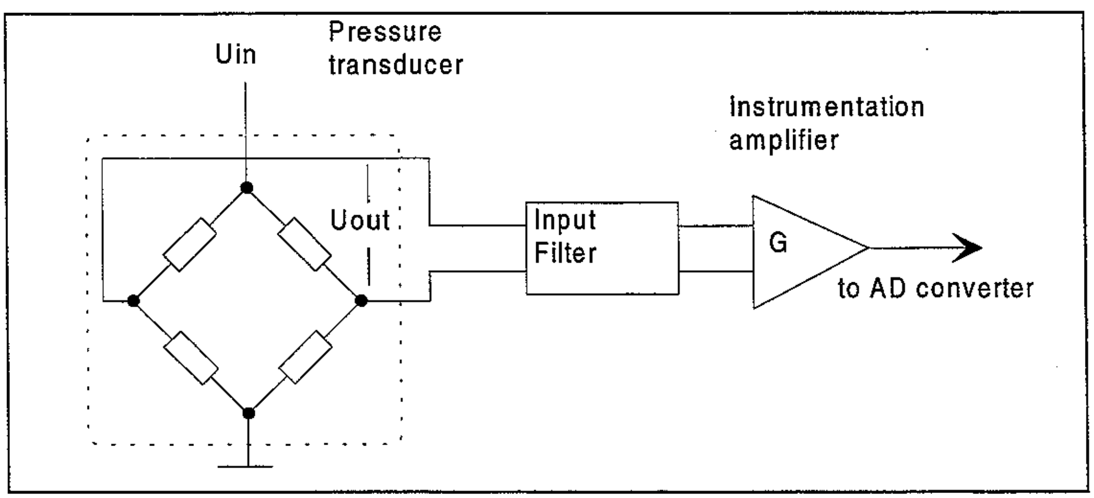


Figure 4 Pressure Transducer Working Principle

Serial communication

Serial communication between the module and the frame is done by RS485 type bus whose buffers get their supply voltage (+5 VDC) from the Central Unit and in the isolation section get the supply voltage (+5 V) from the isolated power supply.

The buffers of the serial communication are controlled also by Reset-signal , when the Reset is active, the buffer does not transfer data.

Reset is also RS485 type and additionally, there is an auxiliary logic power reset, which keeps the reset active for about 500 ms despite the state of reset in the module bus. Time constant determines the power-up reset time. There are components to prevent the module from sending data during reset.

Data transmission rate is 500 kbit/s.

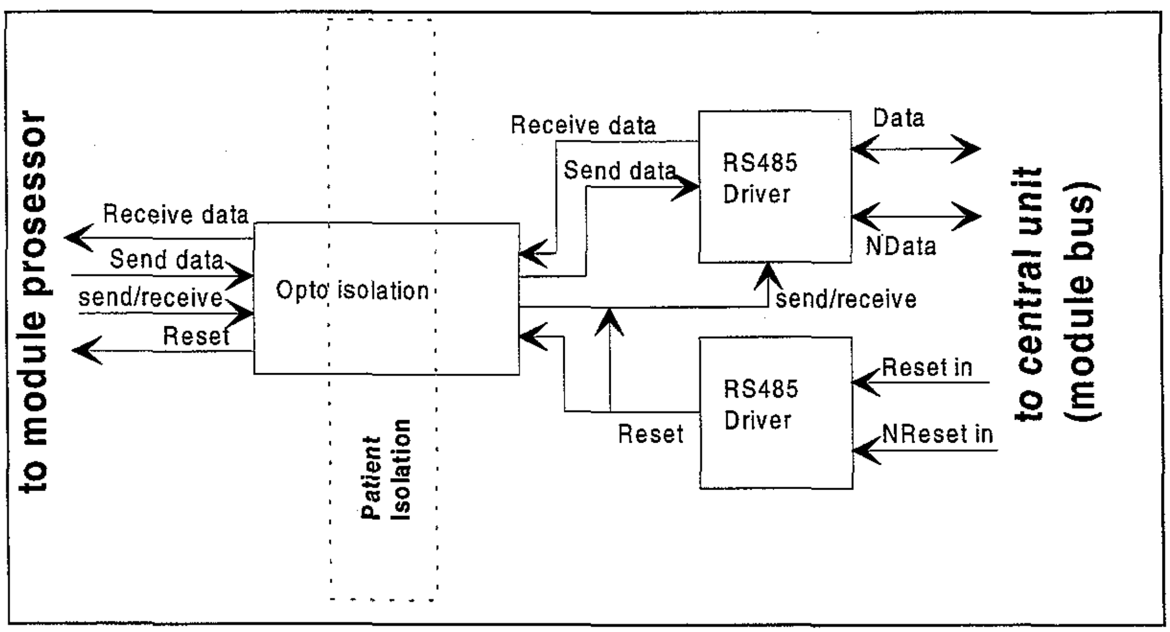


Figure 5 Serial Communication and Opto Isolation

Isolated section

Signal is processed on logical high-low level even though the output of the opto isolators is analog signal in the isolated section.

Reset line is an open collector type with a pull-up resistor. Thus the processor is able to use its internal watch-dog function.

Power supply section

Isolated supply voltage of the module is developed from +15 Vdirty voltage from the host monitor.

Power supply is a switched-mode circuit, where a FET transistor switch is controlled by an oscillator using bipolar timer. Controlling of the FET switch is slowed to suppress spurious interference. A special pulse transformer is used in the circuit. In the secondary circuit normal linear regulators are used except for +5 V (low drop type linear regulator).

2.2.2 COPSv Board

The COPSv board consists of the same functional sections as the COP board, except for the cardiac output self test section. Additionally the COPSv board consists of the SvO_2 measurement section.

SvO_2 Measurement Section

The SvO_2 algorithm is a part of the COPSv module software. The algorithm consists of five different parts; initialization, calibrations, signal processing and SvO_2 calculation, automatic gain control, and signal quality analysis.

Initialization

When the optical module is connected to the COPSv module, a number of start-up procedures are performed prior to normal operation. These procedures include transfer of calibration factors from the optical module to the COPSv module and initialization of LED currents.

Calibration

The system is calibrated according to either in-vitro or in-vivo calibration. In-vitro calibration is performed before the oximetry catheter is removed from the package with the catheter tip still inside the calibration cup. The resulting calibration factor is calculated on the basis of the measured ratio of red and infrared signals and the ideal ratio for the calibration cup. In-vivo calibration is performed when the catheter is inserted into the patient's pulmonary artery. The resulting calibration factor is based on the measured ratio of red and infrared signal and the Hgb and SvO_2 values measured in a laboratory. If the calibration is skipped, the result of an old calibration is used instead and "Not calibrated"-message is displayed in the SvO_2 number field.

Signal Processing and SvO_2 Calculation

The reflected red and infrared signals transferred from the optical module to the COPSv module are filtered, and SvO_2 is calculated on the basis of the ratio of the signals.

Automatic Gain Control

The intensity of the red and infrared signals can be amplified by four different gains. The gain is selected automatically to achieve optimal signal levels.

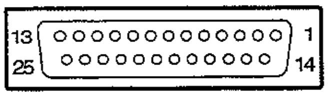
Signal Quality

The reflected red and infrared signals are checked for wall contact artefacts, pulsatility and intensity shifts. An index is calculated to indicate the signal quality. 0 indicates a normal signal, 1 indicates an intermediate signal, 2 indicates a poor signal, and 3 indicates an unacceptable signal. Please refer to the service menu section for more information.

2.3 Connectors and signals

2.3.1 Module Bus Connector Configuration

Rear panel 25-pin female D-connector (X1)

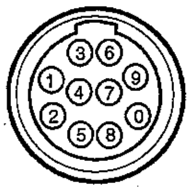


Pin	I/O	Signal
1	I	RESET_RS485*
2	I	-15 VDC*
3	I	+15 VDIRTY*
4	I	+15 VDC*
5	I/O	-DATA_RS485*
6	I/O	DATA_RS485*
7	-	Ground & Shield*
8	I	-RESET_RS485*
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13	-	Ground & Shield*
14	I	+32 VDIRTY
15	I	GroundDIRTY*
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20	-	ON/STANDBY
21	-	BIT0IN
22	-	RXDD_RS232
23	-	TXDD_RS232
24	I	+5 VDC*
25	I	+5 VDC*

*** Used in COP module**

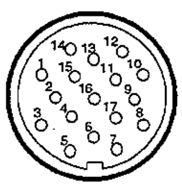
2.3.2 Front Panel Connectors

The pin assignment on the Invasive pressure connector:



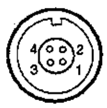
Pin	Signal
1	Pressure 4 +
2	Pressure 4 -
3	Polarisation - (ground)
4	Polarisation +
5	Not connected
6	Not connected
7	Not connected
8	Not connected
9	Ground
0	Cable detection

The pin assignment on the cardiac output connector:



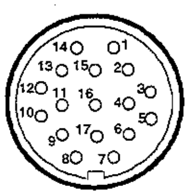
Pin	Signal
1	BAB
2	THB
3	BAC
4	Not connected
5	Shield
6	Not connected
7	THD
8	THA
9	THC
10	BAA
11	Not connected
12	Not connected
13	Not connected
14	FL
15	Not connected
16	Not connected
17	Not connected

The pin assignment on the C.O. Self Test connector:



Pin	Signal
1	CTC
2	CTA
3	CTB
4	CTD

The pin assignment on the SvO_2 connector



Pin	Signal
1	IR_CATHODE
2	CE
3	SK
4	DATA_OUT
5	CHASSIS_GND
6	SVO2_GND
7	HEATER_RTN
8	REMOTE_OUT
9	+V_OPT
10	TEMP_SENSOR
11	HEATER_HI
12	LOCAL_OUT
13	REF_RTN
14	LED_ANODE
15	RED_CATHODE
16	DATA_IN
17	-V_OPT

3 SERVICE PROCEDURES

3.1 General Service Information

Field service of the COP and COPSv modules is limited to replacing faulty mechanical parts. In all other cases, return the faulty module to Datex for repair. The COP board or the COPSv board cannot be replaced, and all calibrations can be done at the factory only.

Datex 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 the appropriate tools and equipment shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Preventive Maintenance Checks

We recommend you to perform these checks at least once a year and after any service.

1. Visual inspection

__: If the module is disassembled, check that all connectors are properly connected and there is no loose object inside the module before attaching the module box.

2. Functional checks

__: Insert the module into monitor frame.

__: Turn the power on by STBY-switch. COP window should appear on the display if selected for display. No error message should appear.

__: Pull out the module. The COP window goes blank within 15 seconds.

__: Reinsert the module while the power is still on. The COP measurement data appear on the window again.

__: Go to Service Menu, Service View, Modules, COP and check the functions of cable and probes. Check buttons (ON/OFF test).

3.3 Disassembly and Reassembly

The COP and COPSv modules are disassembled in the following way. See the exploded view of the module.

a) Remove the two screws from the back of the module.

b) Pull the module box slowly rearward and detach it from main body. Be careful with loose latch and spring pin for locking.

CAUTION: When reassembling the module, make sure that the cables are reconnected properly.

3.4 Adjustments and Calibrations

Adjustments

There are no adjustments in COP module.

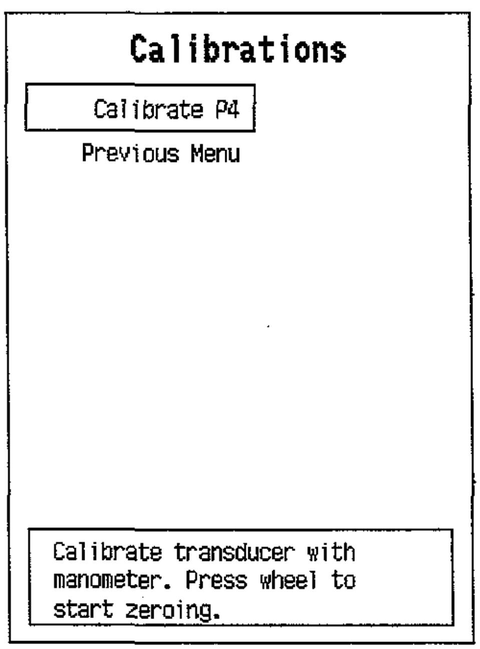
Pressure calibration

Pressure calibration is recommended to be done whenever pressure transducer (probe) is replaced with another type.

1. Go to COP service page. (see chapter 5 Service Menu; Path: Monitor Setup, Install/Service (password 16-4-34), Service View (password 26-23-8), Modules)

2. Go to Calibrations.

3. Connect pressure transducer with a pressure manometer to the front panel P4 receptacle. Choose 'Calibrate P4'. Leave the transducer to room air pressure.



4. Push the ComWheel. The zeroing takes place.

5. Supply pressure of 100 mmHg to 300 mmHg to the transducer. Recommended pressure is 200 mmHg.

6. Set the pressure on the display with the ComWheel to match the pressure reading on manometer and push the ComWheel. Tolerance of ± 1 mmHg is allowed.

7. The text `calibrated' will appear on the display.

Cardiac output calibration

The cardiac output calibration is done only at the factory.

4 TROUBLESHOOTING

Cardiac Output

TROUBLE	CAUSE	TREATMENT
NO CATHETER-message	Catheter or cable not connected.	Connect catheter (cable).
	Catheter or cable faulty.	Check by self-test. Change catheter or cable.
	Blood temp out of range.	Blood temp should be within the range.
Tinj OFF-message	No injectate temp probe.	Connect probe.
	Probe faulty.	Change probe.
	Probe wrong type.	Use Baxter compatible inj. temp probe.
	Temp out of range.	Blood temp should be within range.

SvO_2

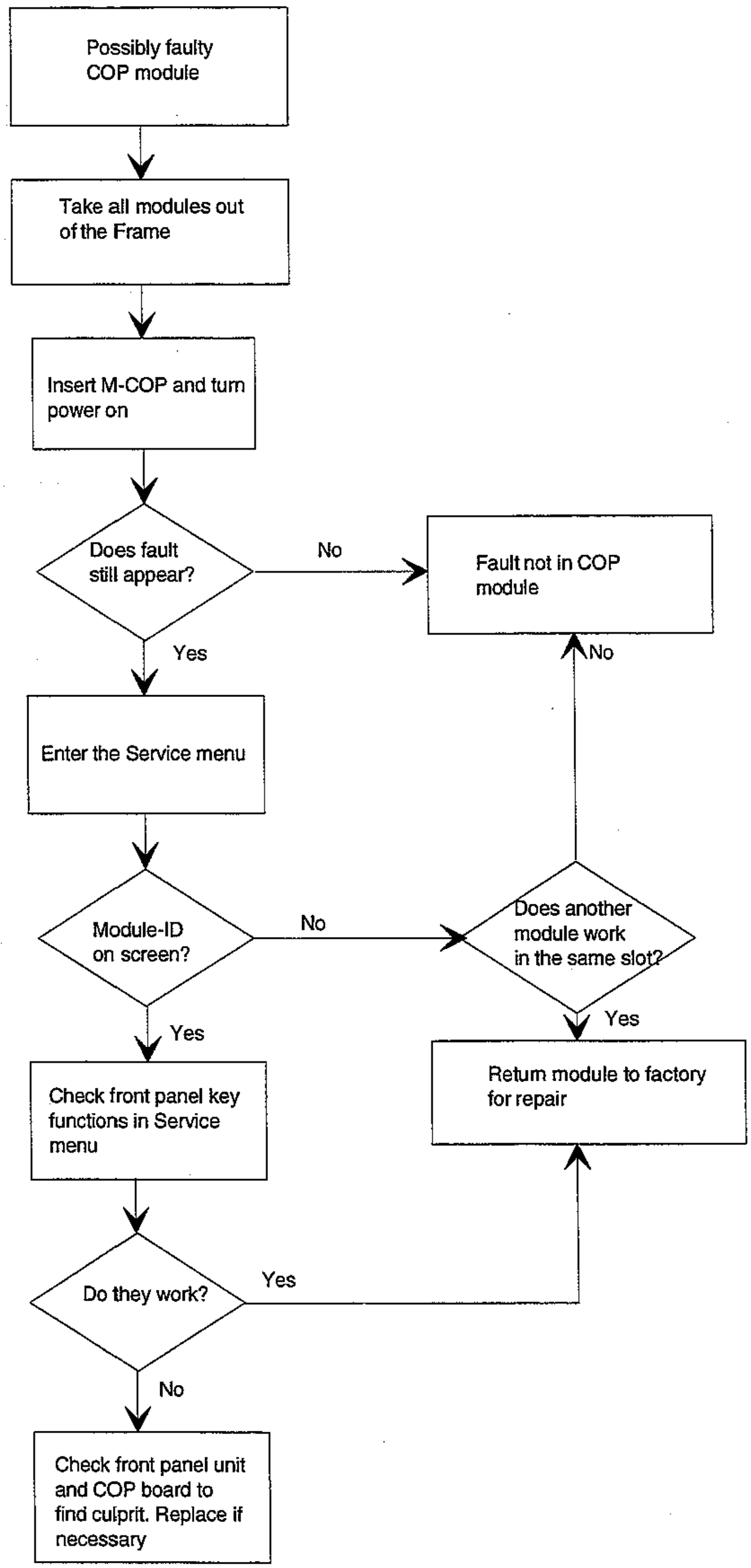
TROUBLE	CAUSE	TREATMENT
Faulty cable	Factory calibration of the optical module corrupted. Red or infrared transmit error, currents cannot be adjusted to factory defaults.	Replace optical module.
No cable	No optical module connected.	Connect optical module.
Insufficient signal	Loose catheter connection. Optical module failure. Catheter kinked or damaged.	Check connection Replace optical module. In vivo calibrate or replace catheter if needed.
Warming up	Temperature of the optical module has not yet reached the optimal value or optical module failure or COPSv module failure.	Please wait. If it takes longer than 20 minutes replace optical module or COPSv module.
Poor SvO2 signal	Signal pulsatility, wall contact or intensity shift signal quality level at 3.	Check number field message which problem "Check catheter position" or "Intensity shift"

Invasive BP

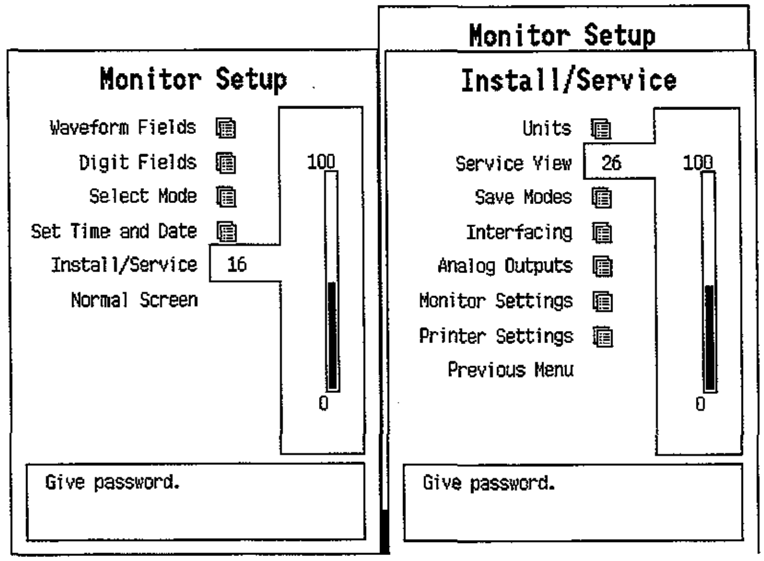
TROUBLE	CAUSE	TREATMENT
Abnormally low pressure	Transducer wrongly positioned.	Check mid-heart level and reposition transducer.
No pressure	Defective transducer. No pressure module plugged in. No waveform selected on screen.	Check transducer. Check the module. To select the desired pressure waveforms press Monitor Setup key and select modify waveforms. Check that pressure transducer is open to patient.
Not zeroed-message	Measurement on, channel not zeroed.	Zero the channel.
Zeroing failed-message	Unsuccessful zeroing of Pi (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 room air and zero the channel. Defective transducer. Replace it and zero the channel.
Calibration failed-message	Unsuccessful calibrating of P4 (number field).	Pulsating waveform. Turn the transducer to sphygmomanometer and try again (zeroing takes place first). Gain is beyond the limits ($\pm$20 % of the default gain) of the module. Replace the transducer.
Out of range $\leq$ 40 mmHg	Measurement pressure is beyond measurement range.	Check transducer level. Zero the channel.

TROUBLE	CAUSE	TREATMENT
Out of range > 320 mmHg	Measurement pressure is beyond measurement range.	Check 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 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 transducer and its level. Zero the channel.

See also the Troubleshooting chart on the next page.


Possibly faulty COP module
Take all modules out of the Frame
Insert M-COP and turn power on
Does fault still appear?
No
Fault not in COP module
Yes
No
Enter the Service menu
Module-ID on screen?
No
Does another module work in the same slot?
Yes
Yes
Return module to factory for repair
Check front panel key functions in Service menu
Do they work?
Yes
No
Check front panel unit and COP board to find culprit. Replace if necessary

5 SERVICE MENU



To enter COP Service Menu during normal operation:

1. Press the MONITOR SETUP key. The Setup menu appears.
2. Turn ComWheel to highlight Install/Service and push.
3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.
4. Turn the ComWheel to highlight Service View and push.
5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.
6. Turn the ComWheel to highlight Modules and push.
7. Turn the ComWheel to highlight COP module and push.

5.1 COP Service Menu

```
COP                 Service Data

Calibrations              P4
Previous Menu     Gain    20921
                  Zero      -13        C.O.
                  Cable     OFF   Catheter  Inj.
                  Probe     OFF    ON        OFF
                  Value     ---   33.53      ---

                           SvO2

                  Meas. state Normal  OM fail     OK
                  Value      ---      OM temp.    OK
                  Gain         3      Pulse SQI   0/3
                  Red int     32      Clipp. SQI  0
                  IRed int    59      Int. SQI    0/3
                  Loc red    371
                  Loc irec   330

                            P4        C.O.
                  Button    OFF       OFF

                  Timeouts               0   RAM     OK
                  Bad checksums          0   ROM     OK
                  Bad c-s by mod         0   EEPROM  OK
```

Selectable menu items:

1. Enter P4 calibration.

2. Return to previous menu.

SERVICE DATA Detailed Description

Zero indicates offset compensation value of each parameter in A/D converter. Usually the value is within ±1000. **Gain** is a coefficient to compensate gain error. Typically the value is between 17000 and 25000. Calibrate if zero and/or gain value is outside the ranges.

Cable shows ON when the corresponding cable is connected to the front panel and **Probe** shows ON when the corresponding probe is connected to the cable.

Under **Value** the measured numeric values are displayed simultaneously. Pressure value is a real time value and shown in mmHg.

At the **Probe** *items* **Catheter** (ON/OFF) and **Inj.** (FT, BATH, or OFF) indicate connections and **Value** indicates measured temperature at 1/100th degrees of Centigrade.

Meas. state: Measurement status: No optical module (No OM) connected, initializing the optical module (Init OM), normal measurement state (Normal) and failed module (OM fail).

Value is a measured SvO_2 value.

Gain is a gain of the remote red and infrared signals (0,1,2 or 3)

Red int: Reflected red intensity

Ired int: Reflected infrared intensity

Loc red: Local red intensity

Loc ired: Local infrared intensity

OM fail: Reason why initialization OK (OK), can't read EEPROM of the optical module correctly (EEPROM), can't adjust led current to get local signal as wanted (Transmit).

OM temp: Temperature of the optical module OK (OK), temp under 43 °C (Under), temp over 47 °C (Over).

Pulse SQI: Signal quality index for pulsing (low pulse/high pulse). 0 indicates a normal signal, 1 indicates an intermediate signal, 2 indicates a poor signal, and 3 indicates an unacceptable signal.

Clipp. SQI: Signal quality index for wall artefact. 0 indicates a normal signal, 1 indicates an intermediate signal, 2 indicates a poor signal, and 3 indicates an unacceptable signal.

Int. SQI: Signal quality index for intensity shift from previous calibration or Hgb update (intensity decreased/increased) 0 indicates a normal signal, 1 indicates an intermediate signal, 2 indicates a poor signal, and 3 indicates an unacceptable signal.

The front panel key function is confirmed by pressing the key and observing OFF turns to ON at **Button**.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.
Bad checksums is also a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per second) during the normal operation indicates either serial communication failure or module not in place.

RAM indicates the state of the external 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).

6 SPARE PARTS

6.1 Spare Parts List

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

Cardiac Output Module, M-COP

Rev. 00

Item	Item description	Order No.
4	Front panel unit, M-COP (Rev. 00-02)	881191
	Membrane keypad	880101
22	C.O. Test connector, M-COP	546215
10	Front panel sticker, M-COP (Eng)	880770
10	Front panel sticker, M-COP (Fre)	881271
10	Front panel sticker, M-COP (Ger)	880978
1	Module box (single width)	886167
3	Latch	879181
2	Spring pin	879182
11	Metal frame	879184
5	Cross recess screw M3x8 black	616215
13	Cross cylinder-head screw M3x6	61721
14	Cross cylinder-head screw M3x12	628700
15	Cross cylinder-head screw M3x16	628710
16	Star washer	63611

Rev. 01

Item	Item description	Order No.
10	Front panel sticker, M-COP (Spa)	884387
10	Front panel sticker, M-COP (Swe)	885871
10	Front panel sticker, M-COP (Dut)	886064
10	Front panel sticker, M-COP (Ita)	886757
10	Front panel sticker, M-COP (Fin)	888871
19	EMC plate	884099
20	Protection plate	883946
21	Insulation plate for 883946	884121

Rev. 02

No new spare parts released.

A front panel unit includes all the connectors and input boards.

* = the part is recommended for stock

Cardiac Output and SvO_2 Module, M-COPSv

Rev. 00

Item	Item description	Order No.
5	Front panel unit, M-COPSv (Rev. 00)	888540
11	Membrane keypad	880101
12	Front panel sticker, M-COPSv (Rev. 00) (Eng)	887376
12	Front panel sticker, M-COPSv (Rev. 00) (Fre)	889551
12	Front panel sticker, M-COPSv (Rev. 00) (Ger)	889550
12	Front panel sticker, M-COPSv (Rev. 00) (Spa)	889555
12	Front panel sticker, M-COPSv (Rev. 00) (Swe)	889553
12	Front panel sticker, M-COPSv (Rev. 00) (Dut)	889552
12	Front panel sticker, M-COPSv (Rev. 00) (Ita)	889556
12	Front panel sticker, M-COPSv (Rev. 00) (Fin)	889554
9	SVO2 cable	888546
8	EMC plate	884099
1	Module box (single width)	886167
2	Latch	879181
3	Spring pin	879182
7	Metal frame	879184
4	Cross recess screw M3x8 black	616215
6	Cross cylinder-head screw M3x6	61721
10	Cross cylinder-head screw M3x12	628700

The front panel unit includes all the connectors and input boards.

* = the part is recommended for stock

6.2 Exploded View

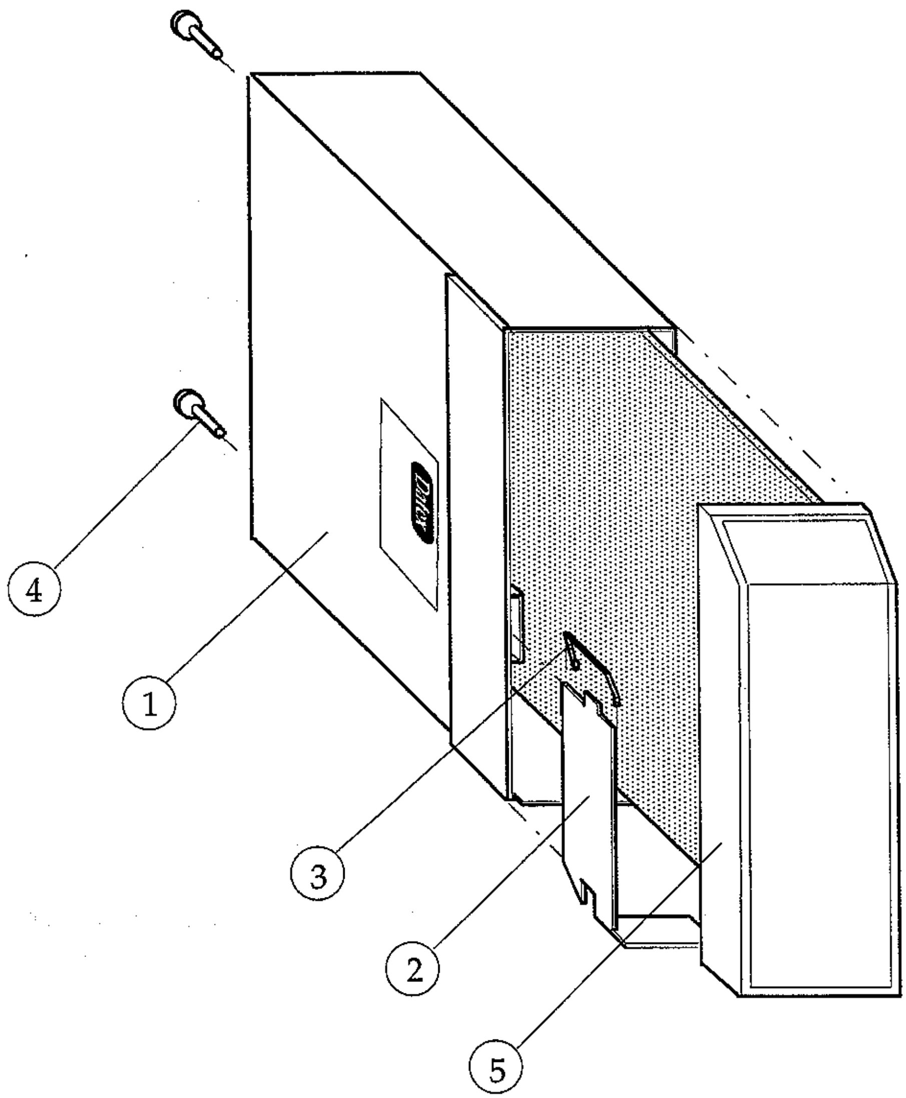


Figure 6 Exploded View of Module Box

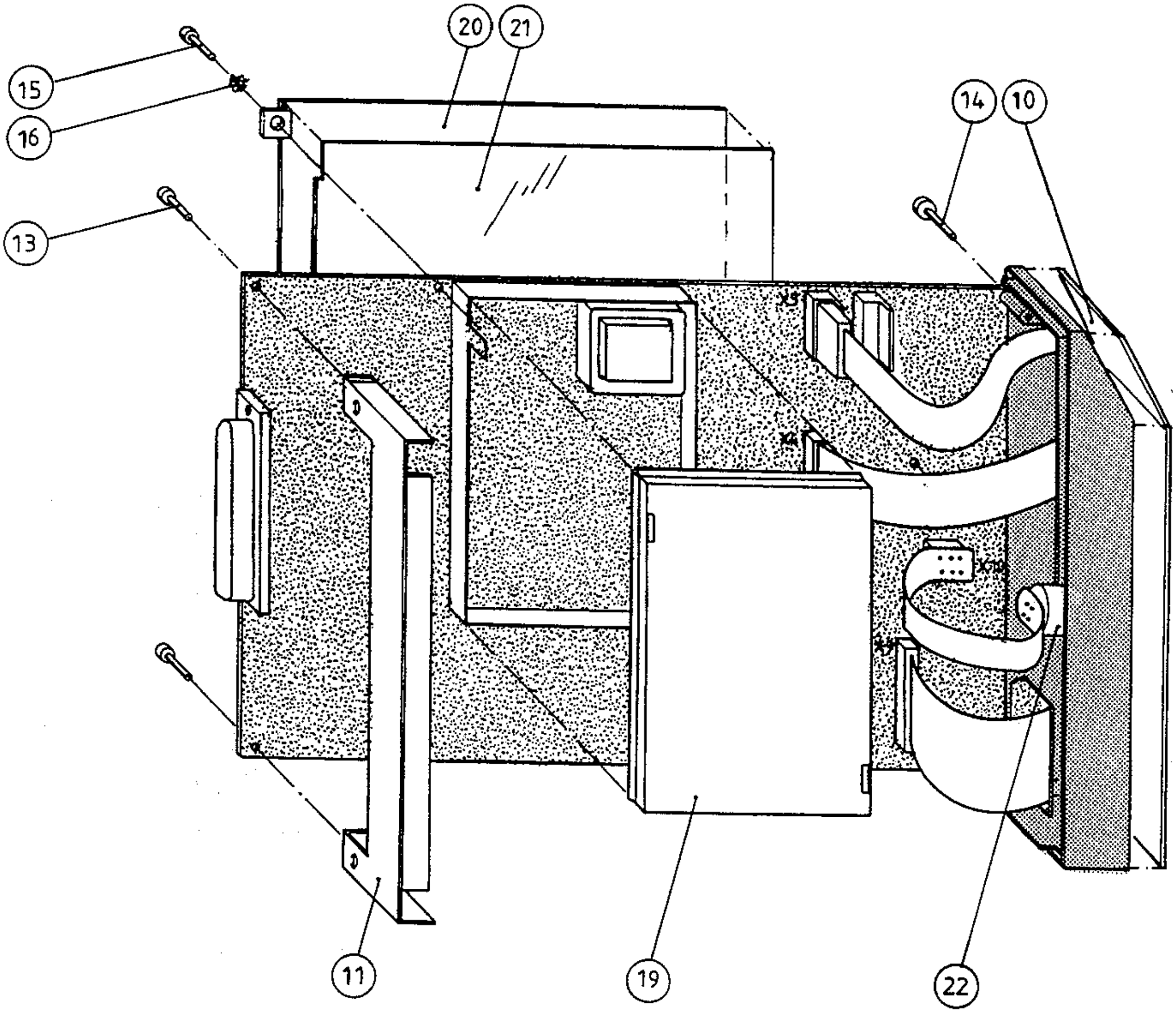


Figure 6 Exploded View of COP Module

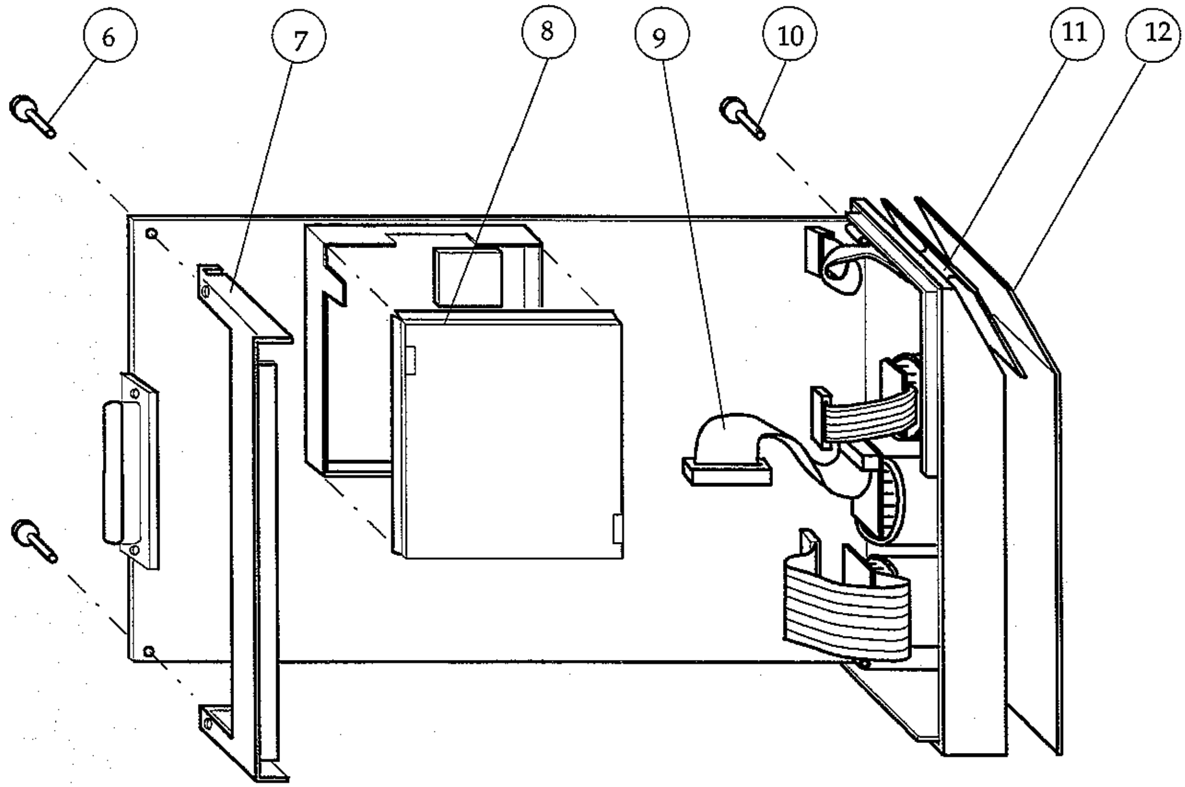


Figure 8 Exploded View of COPSv Module

7 EARLIER REVISIONS

This manual supports all earlier module revisions.

Pressure Module, M-P (Rev. 03)

Pressure Temp Module, M-PT (Rev. 00)

All specifications subject to change without notice

Document No. 885935-2

March, 1996

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Table of Contents

INTRODUCTION

Modules M-P and M-PT are single width plug-in modules for use with the AS/3 Anaesthesia and Compact Monitors. Modules provide the third invasive pressure, and M-PT also temperature channels T3 and T4.

Additionally, the PT-module has a connector for direct ECG and pressure signal output.

NOTE: The modules M-PT and M-P cannot be used simultaneously in the same AS/3 monitor.

1 SPECIFICATIONS

1.1 General Specifications

Module size W x D x H:	37 x 180 x 112 mm 1.5 x 7.1 x 4.4 in
Module weight:	0.35 kg / 0.8 lbs
Power consumption:	About 3.5 W

1.2 Typical Performance

InvBP

MEASUREMENT RANGE:	-40 to 320 mmHg
Accuracy	±5 % or ±2 mmHg
Zero adjustment range	±150 mmHg
Calibration range	±20 %
Scales	Upper limit is adjustable between 10 and 300 mmHg in steps of 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
HEART RATE FROM ARTERIAL PRESSURE:	
Measurement range	30 to 250 bpm
Resolution	1 bpm
Accuracy	±5 bpm or ±5 bpm, whichever is greater

Temperature

Measurement range	10 to 45 °C (50 to 113 °F)
Display resolution	0.1 °C (0.1 °F)
Temperature test	Automatic (every 10 min.)

YSI 400 probe compatible

Signal Output

ECG out	1V/mV
Pressure P3 out	1V/100 mHg (0...300 mmHg)

1.3 Technical Specifications

InvBP

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.

Error	±5 % or ±2 mmHg
Transducer and input sensitivity	5 uV/V/mmHg, 5 VDC 20 mA max current
Input resistance	10^{10} ohms
Zero drift	<0.1 mmHg/°C
Nonlinearity	<1 %, 0 to 200 mmHg <2 %, -40 to 0 and 200 to 320 mmHg
Gain drift	<0.05 %f.s./°C
Filter	0 to 4 - 22 Hz adjustable
Zero set accuracy	±1 mmHg
Calibration resolution	±1 mmHg
Zero time	less than 5 sec
Protection against electrical shock	Type CF defibrillation proof

NOTE: The accuracy of the measurement may be different from the specified, depending on transducer/probe used. Please check the transducer/probe specification.

Temperature

Measurement accuracy	±0.1 °C (25.0 to 45.0 °C) ±0.2 °C (10.0 to 24.9 °C)
Amplifier accuracy	±0.1 °C (25.0 to 45.0 °C) ±0.2 °C (10.0 to 24.9 °C)
Sensor accuracy	±0.1 °C (25 to 45 °C) ±0.2 °C (10.0 to 25.0)
Protection against electrical shock	Type CF

NOTE: The accuracy of the measurement may be different from the specified, depending on transducer/probe used. Please check the transducer/probe specification.

Signal out

Max. delay: ECG1	15 ms Pressure P3 25 ms (0...300 mmHg)
Pressure offset error	max. 10 mmHg

2 FUNCTIONAL DESCRIPTION

2.1 Measurement Principle

Invasive Blood Pressure

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

Temperature

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

The resistance can be measured by two complementary methods:

1. Applying a constant voltage across the resistor and measuring the current that flows through it.

2. Applying a constant current to flow through the resistor and measuring the voltage that is generated across it.

In AS/3 module the two methods are combined in a form of a voltage divider. The NTC-resistor is connected in series with a normal resistor and a constant voltage is applied across them. The temperature dependent voltage can be detected at the junction of the resistors, thus producing the temperature signal from the patient. The signal is amplified by analog amplifiers and further processed by digital electronics.

2.2 Main components and block diagrams

The M-PT module consists of the following main parts:

- PT board
- Two connectors for YSI 400 series temperature probes; temperature channels T3 and T4.
- Nicolay-type connector for an invasive blood pressure sensor; invasive blood pressure channel P3.
- Key for pressure zeroing.
- DIN-type connector for two direct ECG output signals and pressure 3.

NOTE: These output-signals are non-floating

The M-P module consists of the following main parts:

- PT board
- Nicolay-type connector for an invasive blood pressure sensor; invasive blood pressure channel P3.
- Key for pressure zeroing.

Communication between the module and the AS/3 central unit is established through RS485 serial interface.

The power supply voltages to the module are generated in the power supply section of the monitor's Central Unit. All electrical connections between the module and the Central Unit are established via 25-pin D-type connector on the backside of the module.

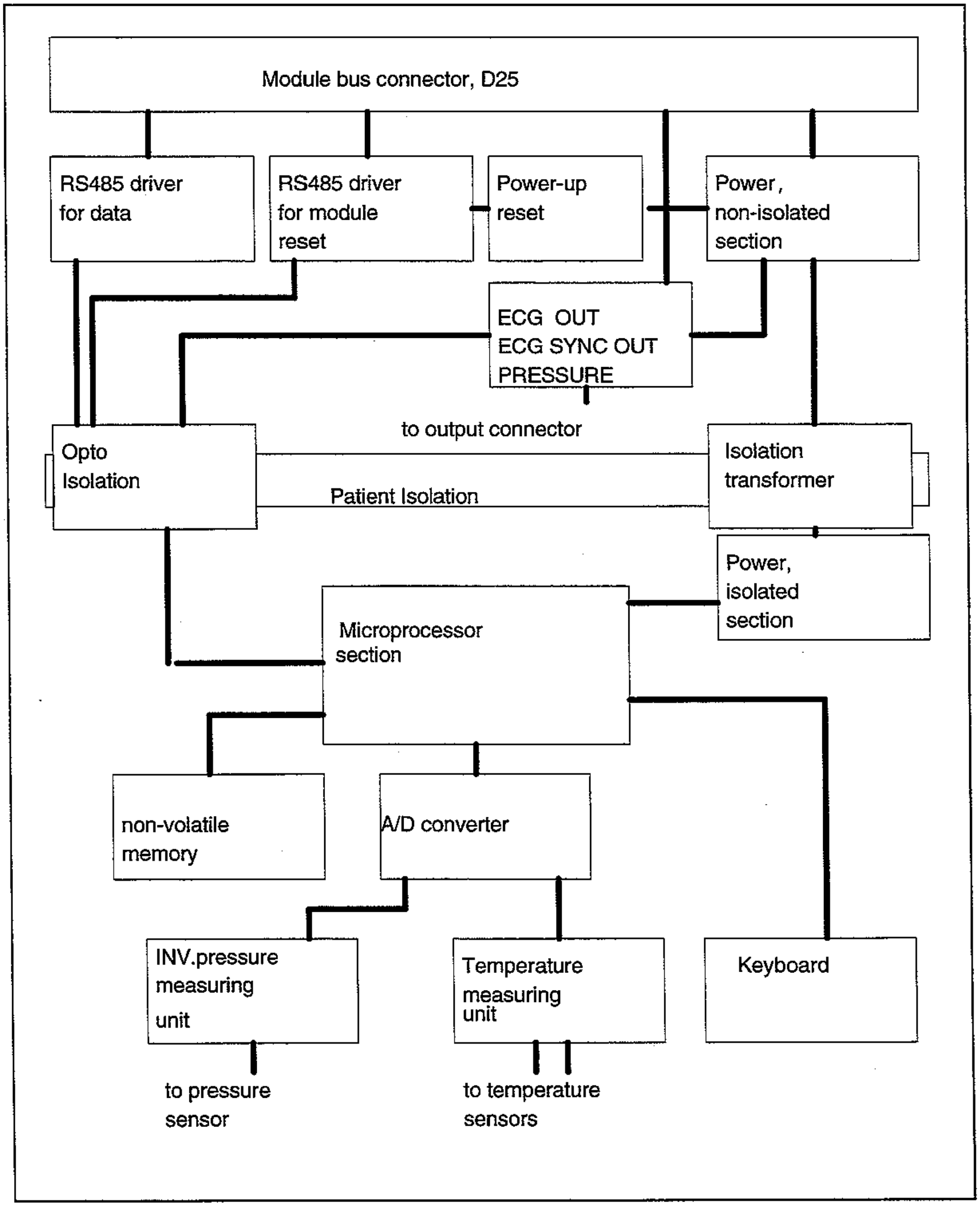


Figure 1 **PT and P Module Block Diagram**

ECG and pressure signal prosessing

The PT-module has the Signal Out connector, for output of analog ECG and pressure signals.

The analog ECG-output signals are made by detecting the pulse-width modulated (PWM) ECG signal of the AS/3 module bus. The module detects the presence of the pacemaker pulses by following the ECG module. Every time the pacer pulse has been detected, the microprocessor of the M-PT module generates a 2,5 ms pacer pulse which is added to the analog ECG signal.

The PRESSURE OUT signal is generated from the P3 invasive pressure signal of the M-PT module. The P3 signal is transmitted as a pulse width modulated (PWM) signal over the patient isolation. The analog signal is generated by low-pass filtering the PWM signal.

2.3 Connectors and Signals

2.3.1 Connectors on the board

The following connectors on the board are used, when the board is configured to M-PT or M-P:

The module bus 25-pin female D-connector (X1):

Pin No	I/O	Signal
1	I	RESET_RS485*
2	I	-15 VDC*
3	I	+15 VDIRTY*
4	I	+15 Vin*
5	I/O	NDATA_RS485*
6	I/O	DATA_RS485*
7		Ground*
8	I	NRESET_RS485*
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13		Ground*
14	I	+32 VDIRTY
15	I	GroundDIRTY*
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20		ON/STANDBY
21	O	PWM_ECG*
22		RXDD_RS232
23		TXDD_RS232
24	I	+5 VDCin*
25	I	+5 VDC*

*** Used in the M-PT modules**

X3, Keyboard connector:

Pin No	Signal	Notes
1	N/C	Not connected
2	COSWITCH	Not used
3	PSWITCH	for zeroing of P3
4	fGND	Floating GND
5	fGND	Floating GND

X4, Pressure sensor connector:

Pin No board	Pin No fr.panel	Signal	Notes
1	0	PCABEL	5V if cable not connected
2	4	PCURRENTPulse d supply to sensor	
3	3,9	P1-	Signal from the sensor
4	1	P1+	Signal from the sensor
5	2	fGND	Floating GND

When the board is configured to be M-PT, there are the following connectors connected on the board in addition to X1 and X4,.

X5, Output connector (Signal out connector on the panel):

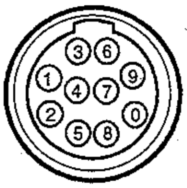
Pin No board	Pin No fr.panel	Signal	Notes
1		ECG OUT	ECG to (e.g.)IABP
2		N/C	Not connected
3	4	GND	+5VDCin GND
4	1	ECG OUT	ECG to (e.g.)defib.
5		N/C	Not connected
6	3	ECG OUT	ECG to (e.g.)IABP
7	2	P OUT	P3 to (e.g.) IABP
8	GND	GND	+5VDCin GND

X8, connector for temperature probes:

Pin No	**Signal**	**Notes**
1	T3	
2	T4	
3	fGND	Floating GND
4	CON	Low if PT
5	fGND	Floating GND
6	GND	Floating GND

2.3.2 Front Panel Connectors

Pressure Connector



Pin No	Signal
1	Pressure 3 +
2	Pressure 3 -
3	Polarisation - (ground)
4	Polarisation +
5	Not connected
6	Not connected
7	Not connected
8	Not connected
9	Ground
10	Cable detection

Signal Out Connector

Pin No	Signal
1	ECG out, 1 V/ 1 mV
2	Pressure out, 1 V/ 100 mmHg
3	ECG out, 1 V/ 1 mV
4	Ground

NOTE: To get the ECG signal out from the Signal out connector, there must be one of the following modules in use: M-ESTPR, M-ESTR, M-ETPR, M-ESTP rev. 02 or later, M-ETP/M-EST rev. 01 or later.

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex for repair.

Datex 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 shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Preventive Maintenance

We recommend you to perform these checks at least once a year and after any service.

1. Visual inspection

__: If the module is disassembled, check that grounding wires and all connectors are properly connected and there is no loose object inside before attaching the module box.

2. Functional checks

__: Insert the module into frame.

__: Turn the power on by ON/STBY-switch. Within 15 seconds, Temp and P3 windows should appear on the display if selected for display. No error message appears.

__: Pull out the module. The windows go blank within 15 seconds.

__: Reinsert the module while the power is still on. The measurement data appear on the windows again.

__: Go to Service Menu (Path: Monitor Setup, Install/Service, Service View, Modules) and check the functions of cables and buttons (ON/OFF test).

__: Put temperature test plug into T3 and T4 and make sure that the measured values do not deviate more than ± 0.1°C. If they do, perform the temperature calibration.

3.3 Disassembly and Reassembly

Disassemble the module in the following way. See Figure for the exploded view of the module.

a) Remove the two screws from the back of the module.

b) Pull the module box slowly backwards and detach it from main body. Be careful with loose latch and spring pin for locking.

c) The PT board will appear. The board is now removed by detaching two screws on the folio side of the board near the front panel and disconnecting the two ribbon cables coming from the front panel.

CAUTION: When reassembling the module, make sure that the cables are reconnected properly.

3.4 Adjustments and Calibrations

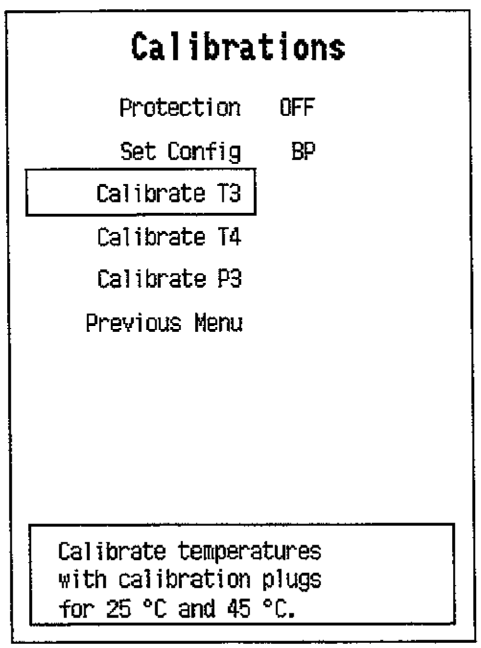
Pressure calibration

Perform pressure calibration whenever pressure transducer (probe) is replaced with another type. The pressure calibration is performed in Service Menu:

1. Go to P/PT service page (See chapter 5 Service Menu; path: Monitor Setup, Install/Service, Service View, Modules).

2. Go to Calibrations page.

3. Connect pressure transducer with a pressure manometer to the front panel P3/P4 receptacle. Choose Calibrate P3. Leave the transducer to room air pressure.



4. Push the ComWheel. The zeroing takes place.

5. Supply pressure of 100 mmHg to 300 mmHg to the transducer. Recommended pressure is 200 mmHg.

6. Set the pressure on the display with the ComWheel to match the pressure reading on manometer and push the ComWheel. Tolerance of ±1 mmHg is allowed.

7. The text `calibrated' will appear on the display.

Temperature calibration (M-PT)

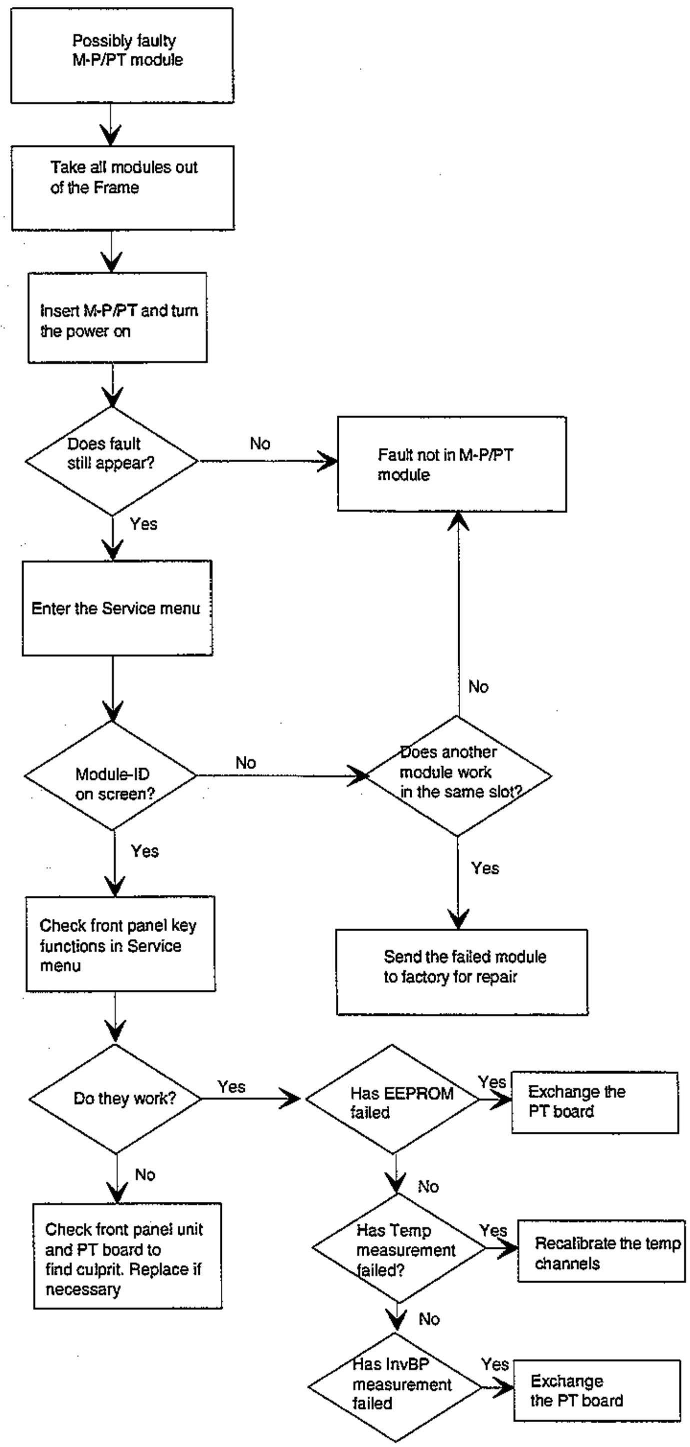
Temperature calibration is performed whenever the measured values deviate more than ±0.1°C when temperature test plug is inserted into T3 and T4 receptacle. The temperature calibration is performed in Service Menu:

NOTE: For the temperature calibration, separate test plugs (25°C and 45°C) are necessary. A test set of two plugs is available from Datex, order code 884515.

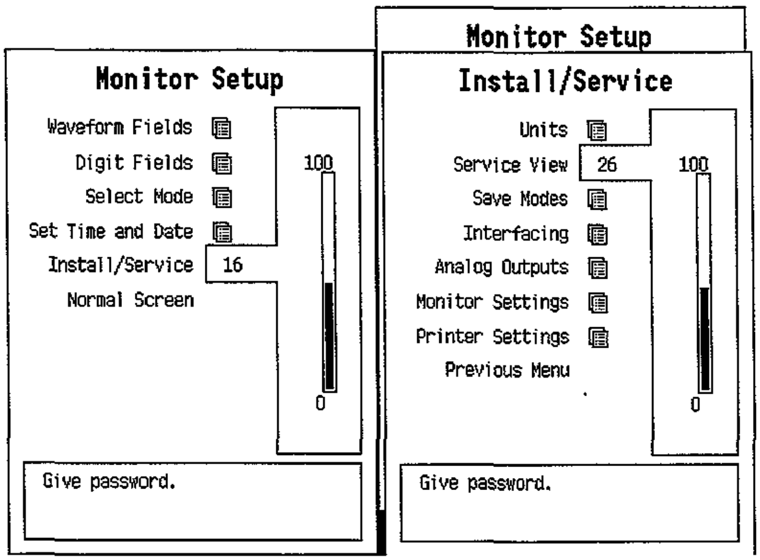
1. Go to P service page (See chapter 5 Service Menu; Path: Monitor Setup, Install/Service (password '10'), Service View (password '1'), Modules).
2. Go to Calibrations page.
3. Press in the protect button at the bottom of the module and choose OFF in Protect mode. Release the button.
4. Choose Calibrate T3/Calibrate T4.
5. Insert calibration plug (25°C) into T3/T4 connector.
6. Push the ComWheel two times.
7. Insert calibration plug (45°C) into T3/T4 connector.
8. Push the ComWheel two times.
9. Press in the protect button at the bottom of the module and choose ON in Protect mode. Release the button.

4 TROUBLESHOOTING

See also the Operator's Manual for more troubleshooting procedures.



5 SERVICE MENU



To enter Service Menu during normal operation:

1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34.
   The Install/Service menu appears.

4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

6. Turn the ComWheel to highlight Modules and push.

7. Turn the ComWheel to highlight P module and push.

```
P                    Service Data
                             P3        T3    T4
Calibrations   Gain       21066     13716 13763
               Zero           1        88    89
Record Data    Cable         ON       OFF   OFF
               Probe         ON       OFF   OFF
Previous Menu  Value       0.10       ---   ---

               Button       OFF

               Temp error             OFF   OFF

               Protect key     OFF
               Protect mode     ON
               Configuration    P1

               Timeouts            0   RAM     OK
               Bad checksums       0   ROM     OK
               Bad c-s by mod      0   EEPROM  OK
```

Selectable menu items:

1. Enter P3 calibration.
2. Return to previous menu.

For calibration instruction, please see chapter 3.4 Adjustments and Calibrations.

SERVICE DATA Detailed Description

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 offset compensation value of each parameter in 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 the corresponding cable is connected to the front panel and **Probe** shows ON when the corresponding probe is connected to the cable.
Under **Value** the measured numeric values are displayed simultaneously. Pressure value is a real time value and shown in mmHg.

The front panel key function is confirmed by pressing the key and observing OFF turns to ON at **Button**.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.
Bad checksums is also a cumulative number that indicates how many times communication from the module to monitor broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per second) during the normal operation indicates either serial communication failure or module not in place.

RAM indicates the state of the external 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).

Temp error shows whether the calibration of the temperature was successful or not.

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

Protect mode is normally ON. It turns to OFF when Protect is switched to OFF for the temperature calibration in Calibration Menu.

Configuration shows the chosen module configuration: BP or PT.

6 SPARE PARTS

6.1 Spare Parts Lists

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

Pressure Module, M-P

Rev. 00/01

Item	Item description	Order No.
6	STP board, M-ESTP (Rev. 01), M-P (Rev. 00-01)	*(880339) Use 885697
4	Front panel unit, M-P	880044
	Membrane keypad	880101
10	Front panel sticker, M-P (Eng)	880139
10	Front panel sticker, M-P (Fre)	880130
10	Front panel sticker, M-P (Ger)	880488
1	Module box (single width)	886167
3	Latch	879181
2	Spring pin	879182
11	Metal frame	879184
5	Cross recess screw M3x8 black	616215
13	Cross cylinder-head screw M3x6	61721
14	Cross cylinder-head screw M3x12	628700
15	Cross cylinder-head screw M3x16	628710
16	Star washer	63611

Rev. 02

Item	Item description	Order No.
6	STP board, M-ESTP (Rev. 03-04), M-P (Rev. 02)	*(882627) Use 885697

Rev. 03

Item	Item description	Order No.
6	PT board, M-PT (Rev. 00), M-P (Rev. 03)	*885697
10	Front panel sticker, M-P (Spa)	884201
10	Front panel sticker, M-P (Swe)	885847
10	Front panel sticker, M-P (Dut)	886063
10	Front panel sticker, M-P (Ita)	886756
10	Front panel sticker, M-P (Fin)	888863
19	EMC plate	884099
20	Protection plate	883946
21	Insulation plate for 883946	884121

The front panel unit includes all the connectors and input boards.

* = the part is recommended for stock

Pressure Temp Module, M-PT

Rev. 00

Item	Item description	Order No.
6	PT board, M-PT (Rev. 00), M-P (Rev.03)	*885697
7	Signal out connector, M-PT	884316
8	T-input connectors	884315
9	P-input connector	884314
17	Membrane keypad	880101
18	Front panel frame, M-PT	883801
10	Front panel sticker, M-PT (Eng)	884004
10	Front panel sticker, M-PT (Ger)	885035
10	Front panel sticker, M-PT (Fre)	885033
10	Front panel sticker, M-PT (Spa)	886193
10	Front panel sticker, M-PT (Swe)	885845
10	Front panel sticker, M-PT (Dut)	886330
10	Front panel sticker, M-PT (Ita)	886758
10	Front panel sticker, M-PT (Fin)	888864
19	EMC plate	884099
20	Protection plate	883946
21	Insulation plate for 883946	884121
1	Module box (single width)	866167
3	Latch	879181
2	Spring pin	879182
11	Metal frame	879184
5	Cross recess screw M3x8 black	616215
13	Cross cylinder-head screw M3x6	61721
14	Cross cylinder-head screw M3x12	628700
15	Cross cylinder-head screw M3x16	628710
16	Star washer	63611

* = the part is recommended for stock

6.2 Exploded View

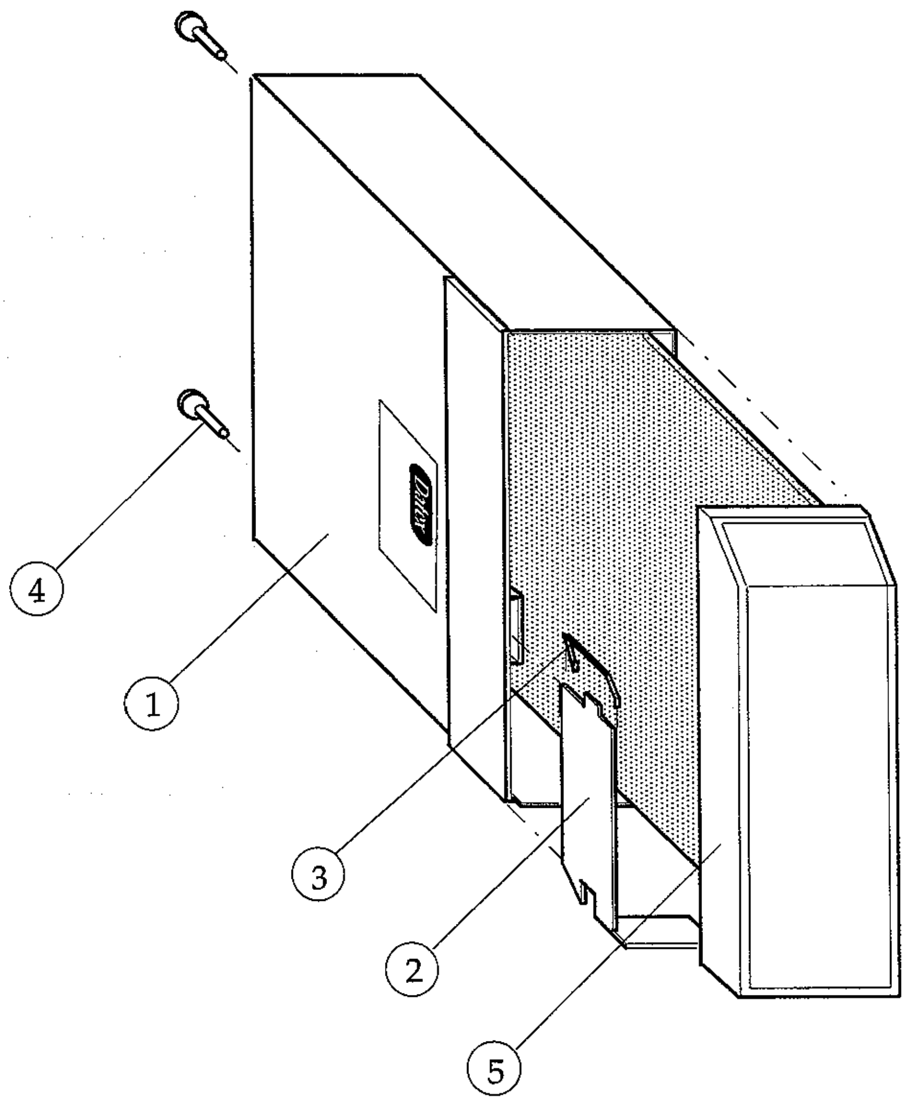


Figure 2 Exploded View of Module Box

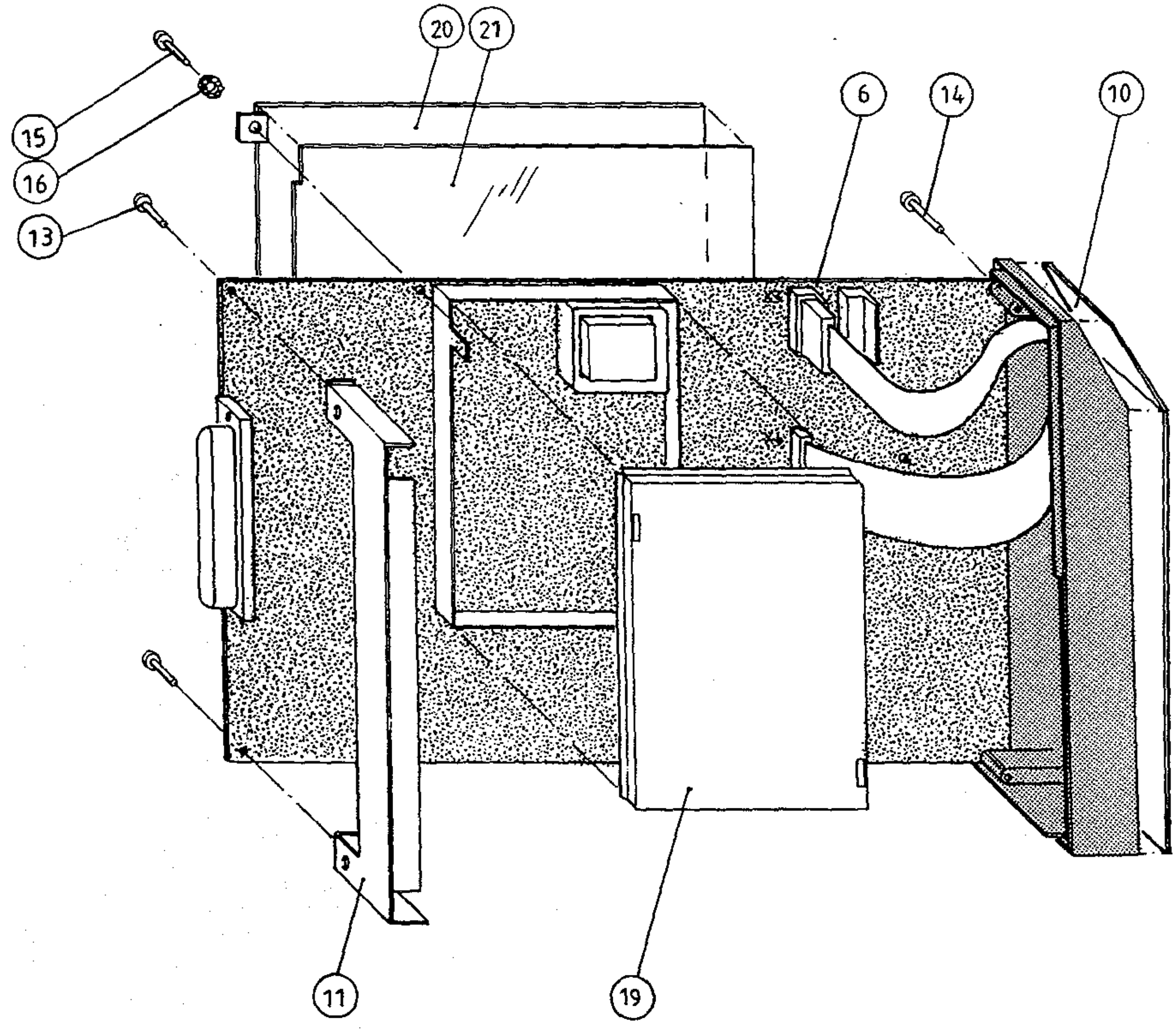


Figure 3 **Exploded View of M-P Module**

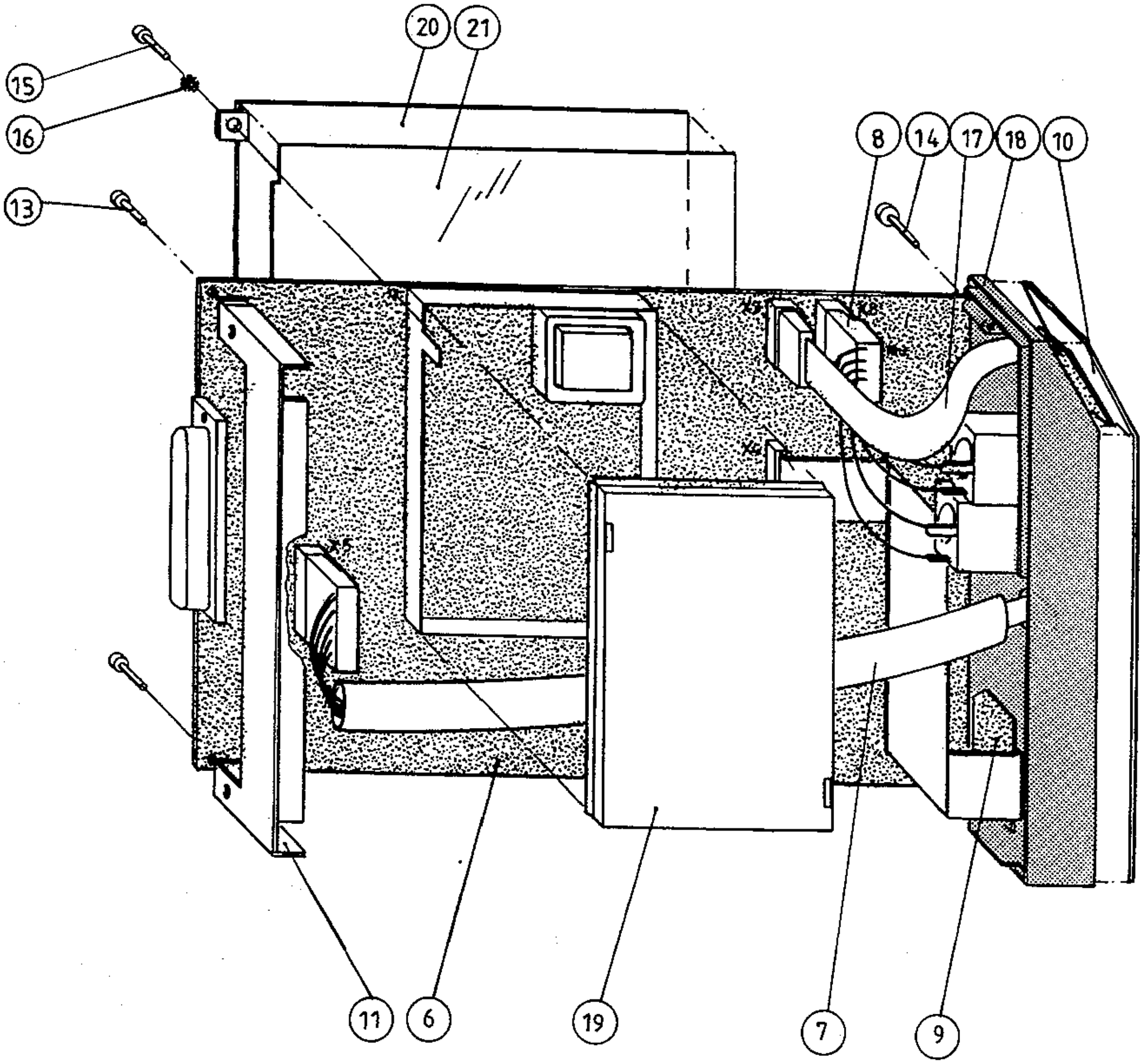


Figure 4 Exploded View of M-PT Module

7 EARLIER REVISIONS

This manual also supports M-P revision 02.

For service information on the earlier revisions, please refer to:

P Module revision 00	Service Manual p/n 880850
P Module revision 01	Service Manual p/n 882580

NIBP Module, M-NIBP (Rev. 03)

All specifications subject to change without notice

Document No. 885936-2

March, 1996

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Table of Contents

INTRODUCTION

The Non-Invasive Blood Pressure Module, M-NIBP, is a double width module that provides non-invasive blood pressure measurement in the AS/3 monitors.

1 SPECIFICATIONS

1.1 General Specifications

Module size W x D x H:	75 x 180 x 112 mm 3.0 x 7.1 x 4.4 in
Module weight:	0.9 kg / 2.0 lbs
Power consumption:	about 4 W

1.2 Typical Performance

Oscillometric measurement principle

Measurement range		
	adult	25 to 260 mmHg
	child	25 to 195 mmHg
	infant	15 to 145 mmHg

Accepted HR	30 to 250 bpm	
Measurement interval	from continuous to 60 min.	
Measurement time, typical	adult	23 s
	infant	20 s
Initial inflation pressure		
	adult	185 ± 10 mmHg
	child	150 ± 10 mmHg
	infant	120 ± 10 mmHg
Venous stasis		
	adult	80 ± 10 mmHg / 2 min.
	child	60 ± 10 mmHg / 2 min.
	infant	40 ± 10 mmHg / 1 min.
Cuff widths	Tall adult	15 cm
	Standard adult	12 cm
	Small adult	9 cm
	Child	6 cm
	Infant	5 cm
	Infant	3 cm

1.3 Technical Specifications

Deflation rate, HR dep.	5 to 13 mmHg/sec
Inflation rate, typical	25 to 35 mmHg/sec (20 to 100 mmHg, adult cuff)

Automatic software control, max. inflation pressure:

adult	280 ± 10 mmHg
child	200 ± 10 mmHg
infant	150 ± 10 mmHg

Over pressure limit, stops measurement after 2 seconds:

adult	320 mmHg
child	220 mmHg
infant	165 mmHg

Mechanical safety valve limits the maximum cuff pressure to 330 mmHg. Independent timing circuit limits pressurizing (>15 mmHg) time to 2 minutes maximum in adult/child mode, and 1 minute 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, inflation pressure is increased typically 50 mmHg.

Max. measurement time:

adult	2 min.
child	2 min.
infant	1 min.

Pressure transducer accuracy is better than ±3 mmHg or ±2 % (whichever is greater). Max. error ±4 mmHg.

Protection against electrical shock	Type BF defibrillation proof

2 FUNCTIONAL DESCRIPTION

2.1 Measuring principle

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

The NIBP measurement uses the oscillometric measuring principle. The cuff is inflated with a pressure slightly higher than the presumed systolic pressure, then deflated at a speed based on the patient's heart rate, collecting data from the oscillations caused by the pulsating artery. Based on these oscillations, the module calculates values for systolic, mean, and diastolic pressures.

The NIBP measuring module is a fully automatic, self-contained non-invasive blood pressure measuring system which communicates with the main CPU via an asynchronous RS-485 serial channel. All NIBP functions are controlled by the NIBP's CPU in the NIBP board.

The following parts are necessary for NIBP measurement:

- NIBP module
- Twin hose (Adult or Infant model)
- Blood pressure cuffs (different sizes)

2.2 Main Components

In general

The NIBP module contains the following main parts:

- NIBP board
- Pneumatics and hosing
- NIBP air pump
- Safety (Over pressure) valve
- Check valve
- Bleed valve
- Exhaust valves (2)
- Pressure transducers (2)
- Module keyboard and status indicator LEDs

Most of the electronic components inside the NIBP module, such as microprocessor, software, and pressure transducers, are on PC board. Pneumatic valves and pump are placed inside the module body.

All connections are established via 25-pin connector (D-type, female). The module needs +5 V, +15 V, and -15 V power supply to operate. The pump and the valves use separate +15 VD (dirty) power line. The supply voltages are generated in the power supply section of the AS/3 Monitor.

Communication between the module and the monitor CPU board is established through RS485 serial interface at 500 kbit/s data transfer rate.

2.2.1 NIBP Board

Pressure transducer

The module contains two pressure transducers. They are of piezoresistive type. One is used for measuring the pressure of the blood pressure cuff and the pressure fluctuations caused by arterial wall movement. The other is used as a second source to measure the pressure of the cuff. This measured value is not used for the actual blood pressure calculation, but for detection of cuff hose type, cuff loose and cuff occlusion situations etc.

The transducers are internally temperature compensated. They are supplied by a constant voltage and their output voltage changes up to 40 mV max. (50 kPa, 375 mmHg).

Signal processing

Two signals from the pressure transducers are amplified and sent to A/D converter. After the converter, digitized signals are sent to microprocessor for data processing. Before the converter, one of the signals is used to adjust the offset to the pressure safety level.

The NIBP module is controlled with 80C51FA microprocessor which uses 16 MHz oscillator frequency.

Memory

NIBP program memory (EPROM) size is 128k x 8. RAM size is 32k x 8 bit and it stores variable values in NIBP measurement. EEPROM is size 64 x 16 bit and is used to store the calibration values for the pressure transducers, the pulse valve constants gained during measurements, the PC board identification, and module serial number.

Control

Software controls valves, pump and LEDs. 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 module is equipped with software independent safety circuit to disconnect supply voltages from the pump and the valves if the cuff has been pressurized longer than preset time. Pressure limit is specified to 15 mmHg. As soon as the cuff pressure rises over 15 mmHg, timer starts counting. The timer is adjusted to stop the pump and open the valves in 2 minutes 10 seconds in adult/child mode and in 1 minute 5 seconds in infant mode.

Pressure safety level check

Pressure safety level detection is checked in Service Menu. When pressure (generated by external pump with manometer) inside module exceeds safety level (adjusted to 14 mmHg) the sign of the signal at AD5 on the NIBP Menu/Pneumatics Service Menu changes from negative to positive value. If the change doesn't occur within 14 ± 5 mmHg, adjust it (see the Chapter 4.3).

NIBP tubing lengths

There are two different tubes inside the module. They are silicon tubes 1.7 x 1 (part number 73373) and 3.18 x 6.35 (73375). When ordering, specify the part number and length(s) required.

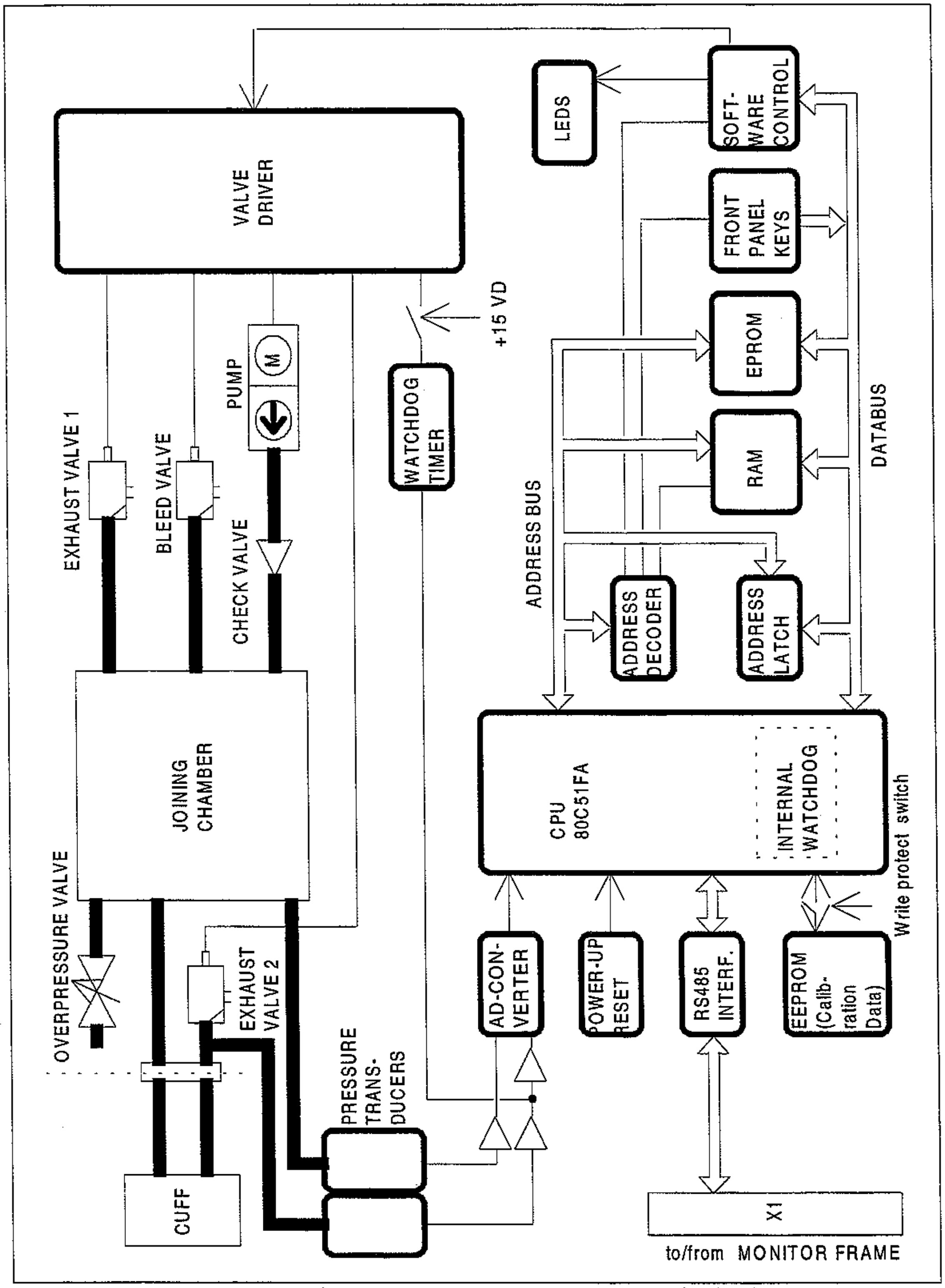


Figure 1 M-NIBP Functional Block Diagram

2.3 Module Bus Connector Configuration

Module rear panel 25-pin female D-connector (X1)

Pin No	I/O	Signal
1	I	RESET_RS485*
2	I	-15 VDC
3	I	+15 VDIRTY*
4	I	+15 VDC
5	I/O	-DATA_RS485*
6	I/O	DATA_RS485*
7	-	Ground & Shield*
8	I	-RESET_RS485*
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13	-	Ground & Shield*
14	I	+32 VDIRTY
15	I	GroundDIRTY*
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20	-	ON/STANDBY
21	-	BIT0IN
22	-	RXDD_RS232
23	-	TXDD_RS232
24	I	+5 VDC*
25	I	+5 VDC*

*** Used in NIBP module**

3 SERVICE PROCEDURES

3.1 General Service Information

Field service of the NIBP module is limited to replacing the faulty circuit boards or mechanical parts. Return the boards to Datex for repair.

Datex 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 the appropriate tools and equipment shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Preventive Maintenance Checks

Perform these checks after any service and at least once a year to keep the AS/3 Anaesthesia Monitor NIBP Module in good condition.

1. Visual inspection

__: If the module is disassembled, check that grounding wires and all connectors are properly connected and there is no loose object inside the module. Check also that tubes are not pinched and there is no sharp bend before attaching the module box.

2. Functional checks

__: Go to Service Menu, NIBP module, and Buttons/LEDs test. Check that all the LEDs can be lit and the keys operate normally.

__: Connect a manometer to the NIBP connector. Go to Service Menu, NIBP module, Calibrations, and choose Active leak test. The module automatically pumps a pressure of about 265 mmHg and the pump stops. Wait for 15 seconds for the pressure to stabilize. Then check that the pressure does not go down more than 5 mmHg per minute. Release the pressure.

__: Go to Service Menu, NIBP module, Calibrations, and Calibration check. Check first zero offsets (z.o.) of both channels, B1 and B2, and write down the values when NIBP connector is open to ambient air. The values should be within ± 10 mmHg.

Connect the manometer to the connector. Check the following pressures.

Manometer display	Allowed values on
100 mmHg	100 + z.o. ± 2 mmHg
200 mmHg	200 + z.o. ± 3 mmHg
260 mmHg	260 + z.o. ± 4 mmHg

Calibrate if not within specification:

__: Go to Service Menu, NIBP module, and Watchdogs. Perform both Adult and Infant watchdog time tests.

__: Go to Service Menu, NIBP module, and Pneumatics. Pump reference pressure (14 mmHg) slowly to the chamber. Check that the value at AD5 toggles from negative to positive value at 14 mmHg ±5 mmHg. A beep sounds to indicate when the pressure crosses this level.

__: **NOTE:** Make sure the manometer you are using can be used to measure pressures over 300 mmHg.

Go to Service Menu, NIBP module, Pneumatics, and Start pump. The opening pressure of Safety valve is displayed at B1 and B2. It should be between 280 and 330 mmHg. Repeat the test for more accurate result.

__: Go to Service Menu, NIBP module, Pneumatics, and Start pump. Let the pressure rise over 250 mmHg then stop the pump. Select Open exh1 and observe the pressure drops to zero within 10 seconds. Select close exh1. Repeat the procedure and select Open exh2. The pressure should drop to zero within 10 seconds.

__: Connect a normal adult cuff to the connector and wrap it around a pipe. Select VENOUS STASIS ON and start the test. The cuff holds a pressure of 70 to 85 mmHg for two minutes and the pump does not start within that time.

__: Wrap the cuff around your arm. Make one measurement. Check that the message ADULT appears at start of the measurement for about 5 seconds in NIBP field on the display. Check that the measurement result also appears.

__: If an Infant cuff hose (white) is available, connect it and the infant cuff and wrap the cuff around a pipe. Check in NIBP Setup Menu that the inflation limit is set to Auto. Start a measurement and check that the message INFANT appears at start of the measurement for about 5 seconds in NIBP field on the display.

3.3 Disassembly and Reassembly

Disassemble the NIBP module in the following way. See the exploded view of the module:

a) Remove the two screws from the back of the module.

b) Pull the module box slowly rearward and detach it from main body. Be careful with loose latch and spring pin for locking.

c) Remove the four corner screws from the back of NIBP board. The NIBP board and the front panel can be detached.

d) To free the front panel and the NIBP board, disconnect tubes and connectors.

e) Remove the five screws and lift off the plastic pump cover. NIBP pump, safety (over pressure) valve, and valve unit which includes two valves, wires and a connector will be exposed. Remove them.

f) Pull out pulse valve from the bottom of the NIBP frame.

g) Reassemble by reversing what was described above.

CAUTION: Before reattaching the module box, make sure that the tubes are not pinched between the NIBP frame and the PC board.

NOTE: Take care that the connectors and especially the tubes are reconnected properly and to the right ports.

3.4 Adjustments and Calibrations

Adjustment

Pressure safety level detection "OFFSET"

Remove two screws at the rear of the module. Take the module box away. Connect first the service cable (e.g. a long Gas Interface Cable) to the module connector inside the monitor frame and then to the rear connector of the module. Go to the NIBP Service Menu and select "Pneumatics". Pump reference pressure (14 mmHg) into the module. Adjust the trimmer R12 so that AD5 signal sign changes from negative to positive at 14 mmHg.

Calibrations

Pressure measurement calibration

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

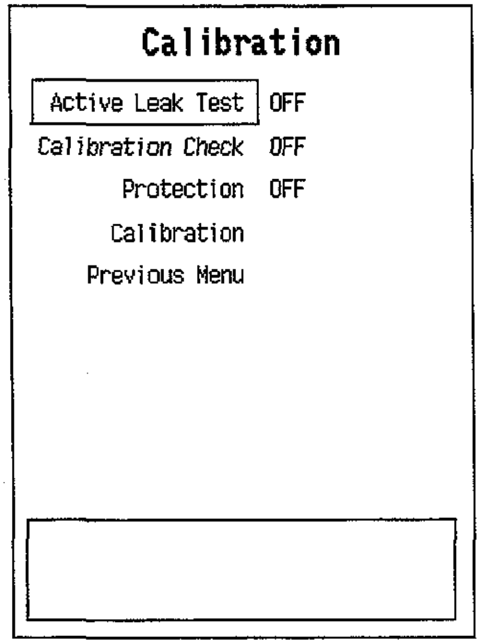
The calibration can be checked and, when necessary, recalibrated in the NIBP Service Menu.

The calibration of the primary pressure channel can also be checked in NIBP Set-up menu by selecting NIBP, NIBP Setup, and Calibration Check. In this case the auto zeroing is performed at start - remove hose before entering to ensure atmospheric pressure to the pressure transducers - the primary pressure is displayed. The zero-offset value should then be zero.

1. Calibration check

For how to reach the Calibration menu, see chapter 5, Service Menu.

1. Enter Calibration menu.



2. Select "Calibration Check" and press the ComWheel.

3. Connect external precision manometer to the module.

4. Pump the following pressures to manometer and check the difference between the manometer and monitor pressure display:

Pressure	**Max. error**	**Example**
0 mmHg	±9 mmHg (=zero offset)	-2
100 mmHg	100 + zero offset ±2 mmHg	98 ± 2
200 mmHg	200 + zero offset ±3 mmHg	198 ± 2

If the error of pressure channel B1 is larger than specified above, the module needs to be re calibrated. The error of B2 is allowed to be even twice as large because it has no effect on blood pressure measurement accuracy. However, it is recommended to re calibrate the module also when the error of B2 is larger than specified above to ensure best possible operation.

2. Calibration

For how to reach the Calibration menu, see chapter 5, Service Menu.

1. Enter "Calibration" in NIBP Service Menu.

2. Remove hoses from 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 off the NIBP module from the monitor frame. The module must be in the frame during the whole procedure.

A. Turn the toggle switch at the bottom of the NIBP module to enable the calibration. Turn the switch to the right by, for example, a sharp pencil. This enables menu selection "Protection". the message "Calibration switch ON!" appears.

B. Select Protection OFF in the Calibration menu and push the ComWheel.

C. Return the toggle switch to the left. Menuselection "Calibration" is now enabled, and "Protection" is disabled. When the calibration is enabled, a message "Calibration not protected" appears.

3. Start Calibration by pushing the ComWheel. Messages "ZEROING" and "ZEROED" will appear in the NIBP message field. After this a pressure bar will appear.

4. Connect an external mercury manometer with pump to module through the both tubes of the hose - both transducers B1 and B2 must be calibrated simultaneously. Pump up to a pressure about 200 mmHg according to the manometer. Calibration is possible in the range 150 to 300 mmHg.

5. 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, press the ComWheel to confirm the calibration. The message "Calibrating" will appear onto the NIBP digit field. After a few seconds it is followed by "Calibrated", which means that the calibration has succeeded, and the new calibration data has been saved into EEPROM.

To set the protection on:

Turn the toggle switch to the right. Select "Protection" ON and push the ComWheel. Then turn the toggle switch back to the left.

6. Remove the module from the frame and plug it back again. Then perform Calibration Check (see the preceding page) to verify the new calibration.

4 TROUBLESHOOTING

4.1 Module Troubleshooting

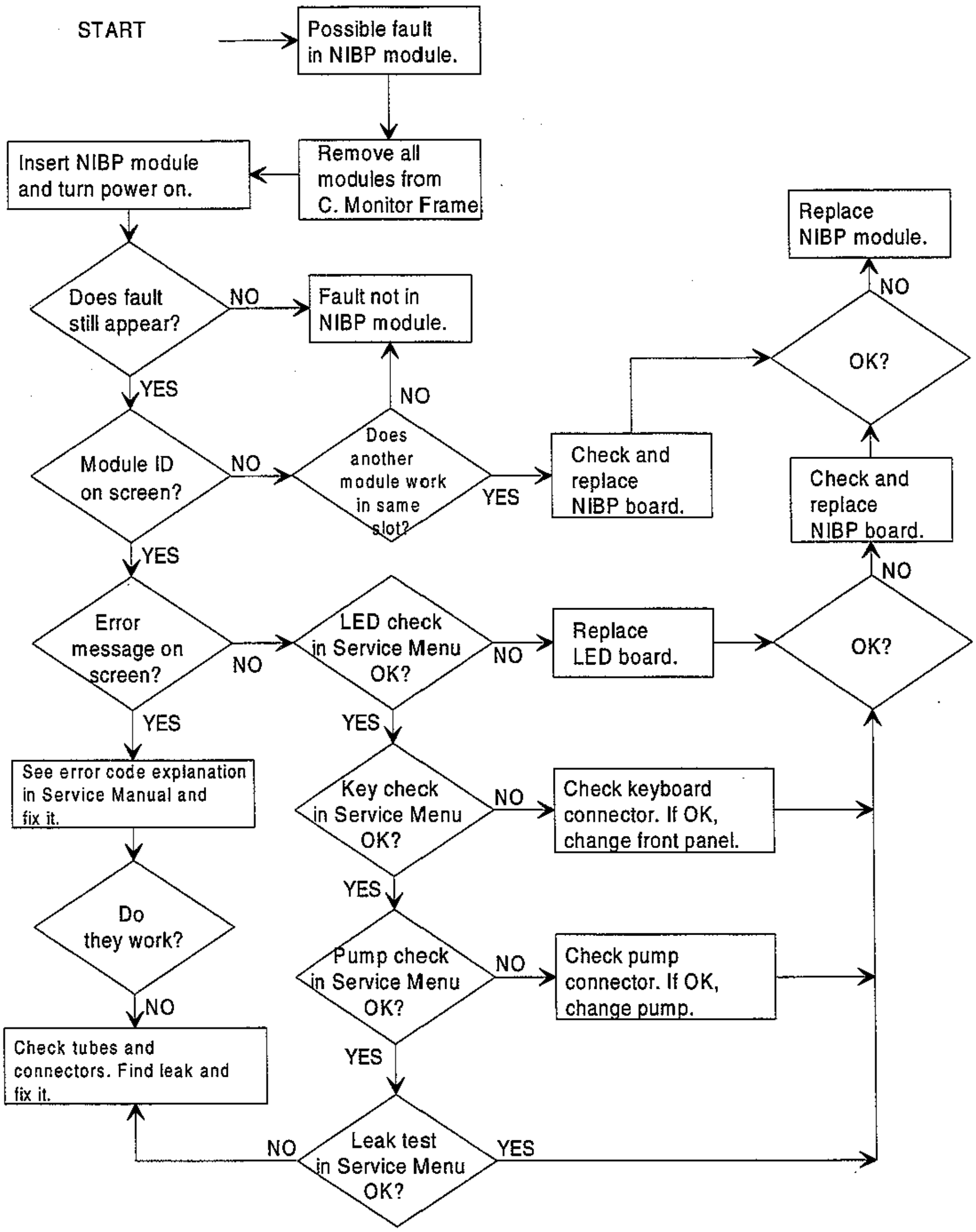


Figure 2 NIBP Module Troubleshooting Flow Chart

4.2 Troubleshooting Chart

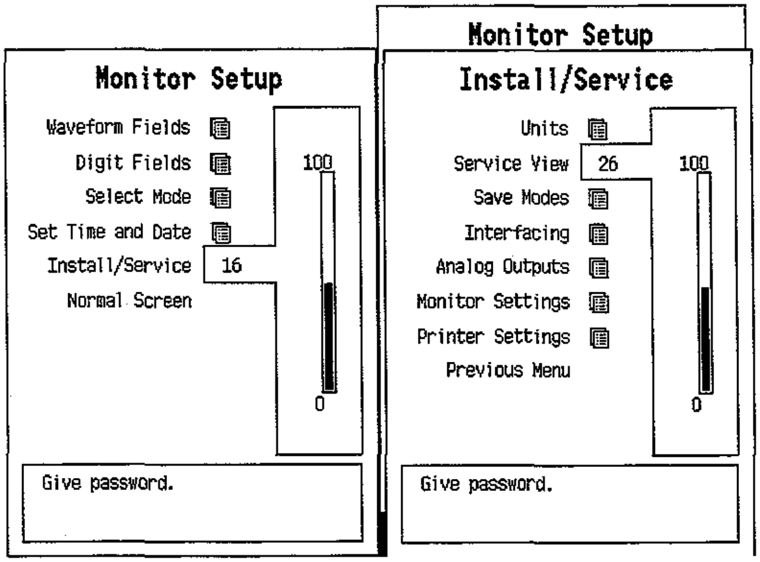
TROUBLE	CAUSE	TREATMENT
No NIBP value displayed	Not selected on screen.	Press Monitor Setup key and select MODIFY NUMBERS.
NIBP menu fading	No NIBP module or module not properly connected.	Plug in the module.
Artifacts-message	Unsuccessful measurement due to patient movements or shivering.	
Weak pulsation-message	Weak or unstable oscillation pulses due to: - artifacts (accurate diastolic pressure difficult to measure). - marked arrhythmia. - marked drop in diastolic pressure. - diastolic pressure difficult to measure. - improper cuff position or attachment. - too few pulses detected. - weak or unusual blood circulation. - may give systolic value.	Check patient condition. Retry. Check any leaks and retry. Use proper size cuff. Check attachment.
Call service. Error X-message	NIBP hardware error. X= error number	See the description of the error message codes, their causes and solutions listed in the next chapter.
Cuff loose-message	(a) Hose and/or cuff detached. (b) Hose and cuff connected. Reason: - cuff loosely wrapped, large volume. - leakage in cuff or hose. - leakage inside module. - pump does not work. - no pulses during the last three measurements.	(a) Connect them. (b) - tighten the cuff. - replace cuff/hose. - check internal tubing and air chamber, and fix if necessary. - check pump connector. If OK, replace pump. - check cuff positioning.

TROUBLE	CAUSE	TREATMENT
Air leakage-message	(a) Hose or cuff leaking. Reason: - cuff damaged. - cuff connector damaged. - O-ring damaged or missing - hose double connector damaged. O-ring damaged or missing. (b) Hose and cuff OK. Reason: - leakage inside the module. - tube disconnected or damaged. - air chamber leaking. - tubes disconnected from valve(s) or valve(s) damaged.	(a) - replace cuff. - replace cuff connector (if the fault is in hose connector, replace hose). - replace O-ring. (b) - connect or replace tube. - replace the whole tubing. - fix connections. Replace valve(s).
Unable to measure Sys-message	Systolic blood pressure probably higher than the maximum inflation pressure.	Automatic retrial with increased pressure.
Cuff occlusion-message	(a) Cuff and/or hose occluded. Reason: - cuff tube kinked. - tube inside module kinked. - occlusion inside/outside module. (b) Cuff, hose, and tubes OK. Reason: - fault in pressure transducer. - fault in A/D converter. - faulty calibration. - missing voltages.	(a) - straighten tube. - remove occlusion. (b) - replace the NIBP board. - check calibration. Re calibrate.
Calibration switch on -message	EEPROM protection switch at the bottom of the module is turned to right.	Enables setting the protection OFF in the Calibration menu. turn switch to left if you are not going to calibrate.
Calibration not protected -message.	Calibration protection is set to OFF.	

4.3 Error Code Explanation

CODE	EXPLANATION
0	RAM failure Memory failure. Change NIBP board.
1	ROM checksum error Memory failure. Change NIBP board.
2	+15V failure Check short circuits. Change NIBP board.
3	-15V failure Check short circuits. Change NIBP board.
4	EEPROM protection switch error. (only with S-STD93) Turn the toggle switch to the left at the bottom of the module.
5	Calibration not protected. (only with S-STD93) Protect calibration by selecting Protection ON in the NIBP calibration menu.
6	ADC error ADC circuit failure. Change NIBP board.
7	Watchdog time too short Change NIBP board.
8	Watchdog time too long Change NIBP board.
9	Watchdog activated Change NIBP board.
10	EEPROM checksum error Memory failure. Change NIBP board.
11	Auto zero range exceeded Calibrate NIBP.
12	Communication break Temporal break down of communication from monitor detected. Automatic recovery.

5 SERVICE MENU



To enter Service Menu during normal operation:

1. 1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.

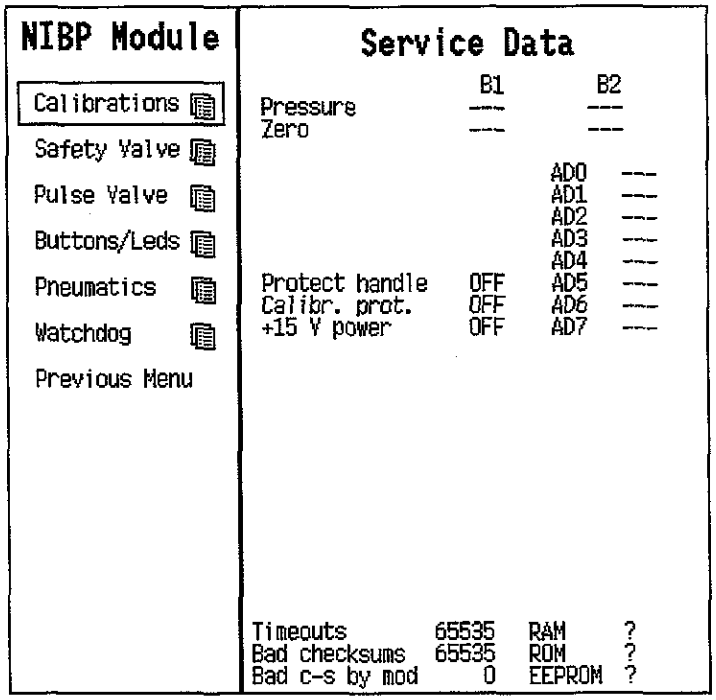
4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

6. Turn the ComWheel to highlight Modules and push.

7. Turn the ComWheel to highlight NIBP module and push.

5.1 NIBP Service Menu



1. Calibration functions.
2. Safety Valve functions.
3. Pulse Valve service functions.
4. Buttons/Leds service functions.
5. Pneumatics service functions.
6. Watchdog functions.
7. Return to previous menu.

SERVICE DATA Detailed Description

Pressure shows measured pressure multiplied by 10.
Zero shows pressure at auto zeroing multiplied by 10 and changes between +20 and -20 mmHg. Absolute pressure is the sum of **Pressure** and **Zero.**

Protect handle indicates hardware protection for EEPROM memory. It should be ON all the time in normal operation. If it is OFF data can not be read from or written to EEPROM, only

the calibration protection can be set or reset by software. It can be turned to OFF by turning the toggle switch to the right at the bottom of the module, which also enables 'Protection ON/OFF' menu selection in the calibration menu.
Calibr. prot. shows software calibration protection and should be OFF to enable calibration.

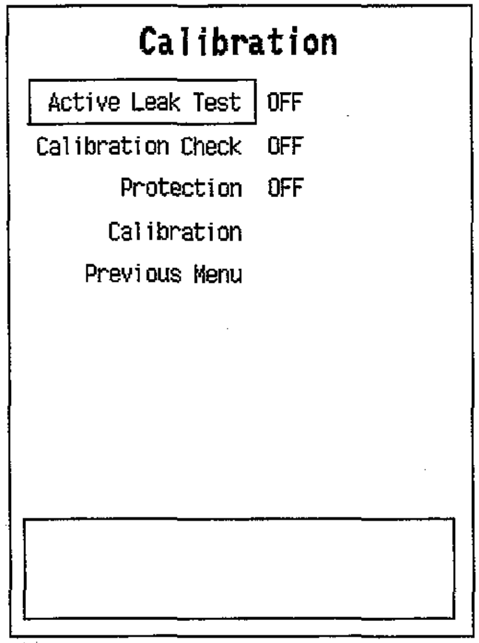
+15 V power indicates the condition of the supply voltage +15 Vdirty for the pump and valves. It exists (ON) or not (OFF) depending on service menu function.

AD0 to **AD7** show the values of each eight channels of A/D converter.

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 broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The AS/3 Monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the external 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).

5.1.1 NIBP Calibration Menu



1. Active leak test selection (ON/OFF)

2. Calibration check selection (ON/OFF)

3. Software calibration protection (ON/OFF). Select OFF when calibrating. Protection can be set to ON or OFF only when the toggle switch at the bottom of the module is set to the right.

4. Calibration. Calibration selection is available only when protection is OFF.

5. Return to previous menu.

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 5 mmHg per minute. If it does, leaking point(s) should be detected and fixed. Cancel the test by selecting Active leak test OFF.

Calibration Check

After the calibration check is selected (ON), manually pump pressure into the module and make sure that the same pressure values are shown both on the display and on manometer. Pressure of both pressure channels B1 and B2 are shown. Note that if the display shows +2 mmHg at zero pressure and if you pumped +200 mmHg into the module, the display should show +202 mmHg.

Calibration

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

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

1. If **Protection** is ON change it to OFF by first turning the toggle switch to the right at the bottom of the module, which enables the **Protection** selection. Then turn the toggle switch to the left to enable **Calibration**.

NOTE : Do not disconnect the module from the frame when turning the switch. The module must be in the frame during the whole procedure.

NOTE: When the switch is at the right, 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.

3. Connect an external mercury manometer with pump to 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. First the message "Calibrating" will appear followed after a few seconds "Calibrated", which means that the calibration data has now been saved.

5. Use the bottom switch to enable **Protection** setting and set it ON, and finally disable **Protection** setting.

5.1.2 NIBP Safety Valve Menu

```
Safety Valve   |        Safety Valve Data
               |                        B1        B2
[Start Test]   |  Pressure          000000    000000
Previous Menu  |  Zero              000005    000006
               |                              AD0    -31
               |                              AD1     10
               |                              AD2    -45
               |                              AD3   1167
               |                              AD4      0
               |  Protect handle        ON    AD5  -1825
               |  Calibr. prot.         ON    AD6     53
               |  +15 V power           ON    AD7  -1153
               |
               |                        B1        B2
               |  Max press            303       302
               |  2 s after stop       290       289
               |
               |  Timeouts               0   RAM     OK
               |  Bad checksums          0   ROM     OK
               |  Bad c-s by mod         0   EEPROM  OK
```

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

2. Return to previous menu.

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

SAFETY VALVE DATA Detailed Description

See NIBP Service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0** to **AD7** as well as **Timeouts etc.**

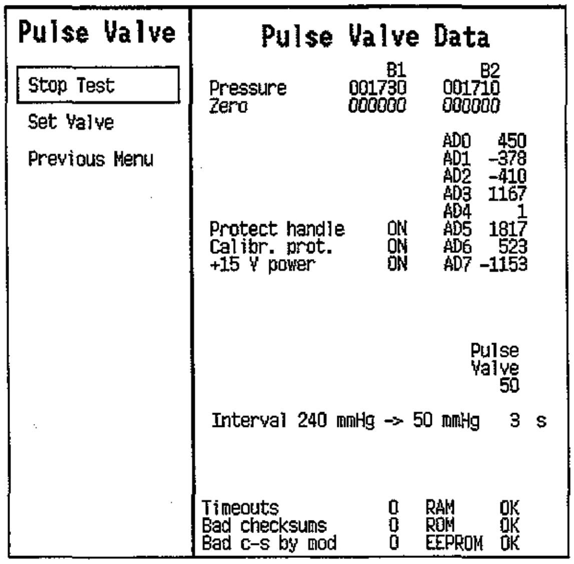
Max. press and **2 s after stop** show the measured values at Safety Valve test.

Safety Valve Test:

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 315 $\pm$15 mmHg. **2 s after stop** indicates the pressure at 2 seconds after the pump has stopped and is normally > 280 mmHg. If the value is less, check leakage by the active leak test (page 27).

5.1.3 NIBP Pulse Valve Menu



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

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

3. Return to previous menu.

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

PULSE VALVE DATA Detailed Description

See NIBP Service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0** to **AD7** as well as **Timeouts etc.**

Pulse Valve Checking:

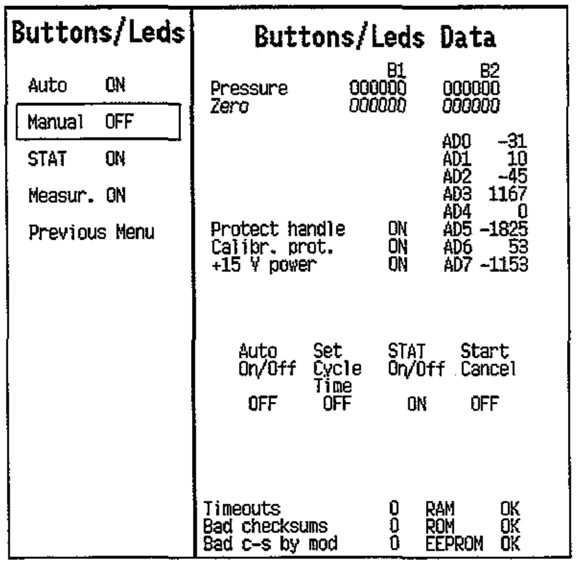
Wrap an adult cuff around a pipe and connect the cuff to the module. Select the **Start test** and push the ComWheel. The pressure rises beyond 240 mmHg and stops. The pulse valve opens. The module counts the time it takes for the pressure to go down from 240 mmHg to 50 mmHg and displays it. The test 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 '50' 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 45.

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

5.1.4 NIBP Buttons/Leds Menu



1 to 4. **Auto, Manual, Stat,** and **Measuring** Led selectors. Select ON and push the ComWheel to light the Led in question.

5. Return to previous menu

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

BUTTONS/LEDS DATA Detailed Description

See NIBP Service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0** to **AD7** as well as **Timeouts etc.**

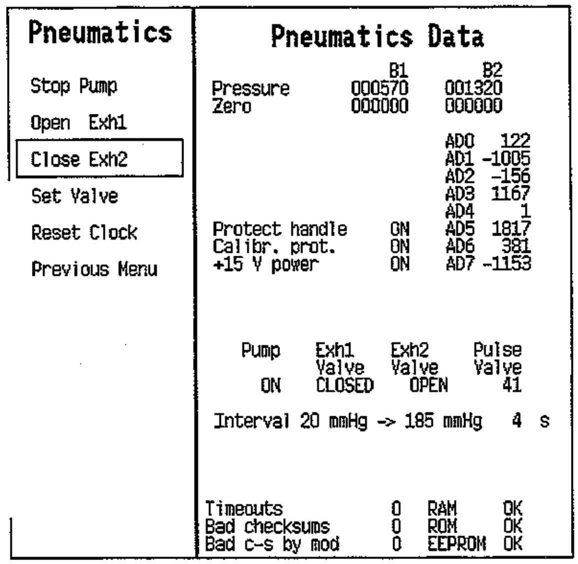
Buttons Checking:

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

LEDS Checking:

The front panel LEDS can be lit by selecting **Auto, Manual, Stat,** or **Measuring**. ON and pushing the ComWheel.

6.1.5 NIBP Pneumatics Menu



1. **Start pump** and **Stop pump** are for the pump.

2. **Open Exh1** is for opening the exhaust valve 1.

3. **Open Exh2** is for opening the exhaust valve 2.

4. With **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 screen and finally push to set the value.

5. **Reset Clock** will zero the time on the display .

6. Return to previous menu

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

PNEUMATICS DATA Detailed Description

See NIBP Service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0** to **AD7** as well as **Timeouts etc.**

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

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

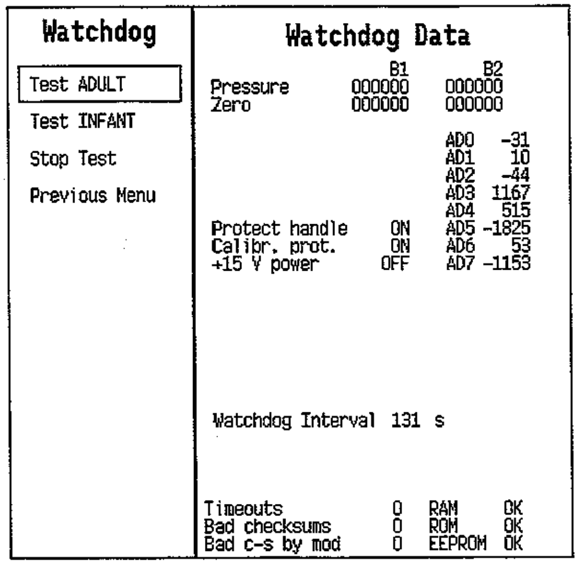
Interval 20 mmHg -> 185 mmHg Checking:

Select the **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 the **STOP PUMP** by pushing the ComWheel.

Watchdog BEEP:

Connect manometer to the front panel and pump pressure into the module. When the AD5 value changes from negative to positive value (at about 15 to 20 mmHg) a beep is heard. This is the watchdog threshold pressure. Beyond this pressure the watchdog is active and cut pressures at about 2 min. (adult).

6.1.6 NIBP Watchdog Menu



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

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

3. **Stop Test** is for stopping the test.

4. Return to previous menu

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

WATCHDOG DATA Detailed Description

See NIBP Service menu in chapter 5.1 for information on general items **Pressure, Zero, Protect handle, Calibr. prot., +15 V power, AD0** to **AD7** as well as **Timeouts etc.**

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

Adult watchdog time testing:

Select Test ADULT and push 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.

Infant watchdog time testing:

Select Test INFANT and push 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.

6 SPARE PARTS

6.1 Spare Part List

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

NIBP Module, M-NIBP

Rev. 01

Item	Item description	Order No.
8	NIBP board, M-NIBP (Rev. 01)	*(880359) Use 883011 1) 883902
11	NIBP frame, M-NIBP	880427
15	Plastic pump cover, M-NIBP	879176
14	NIBP pump, M-NIBP (Rev. 01-02)	*(880363) Use 883346
22	Pulse valve	*880365
21	Magnetic valve	*58534
20	Port plug for magnetic valve	58535
13	Safety valve (overpressure valve)	877109
4	Front panel unit, M-NIBP	881335
	Membrane keypad	879374
16	Front panel sticker, M-NIBP (Eng)	879482
16	Front panel sticker, M-NIBP (Fre)	880159
16	Front panel sticker, M-NIBP (Ger)	880476
17	LED board, M-NIBP	880361
18	Hose connector	64654
1	Module box (wide)	886168
3	Latch	879181
2	Spring pin	879182
5	Cross recess screw M3x8 black	628706
10	Cross cylinder-head screw M3x10	628703
9	Cross cylinder-head screw M3x20	628709
19	Cross cylinder-head screw M2.5x6	628700

Rev. 02

Item	Item description	Order No.
8	NIBP board, M-NIBP (Rev. 02)	*(882418) Use 883011 [1] 883902
23	Check valve	58542

Rev. 03

Item	Item description	Order No.
8	NIBP board, M-NIBP (Rev. 03)	*883011
	NIBP software	*883902
14	NIBP pump, M-NIBP (Rev. 03)	*883346
16	Front panel sticker, M-NIBP (Spa)	884386
16	Front panel sticker, M-NIBP (Swe)	885870
16	Front panel sticker, M-NIBP (Dut)	886124
16	Front panel sticker, M-NIBP (Ita)	886752
16	Front panel sticker, M-NIBP (Fin)	888872

The front panel unit includes all the connectors and input boards.

* = the part is recommended for stock

[1] The NIBP board 883011 can be used as a replacement only with NIBP software 883902.

6.2 Exploded View of Module

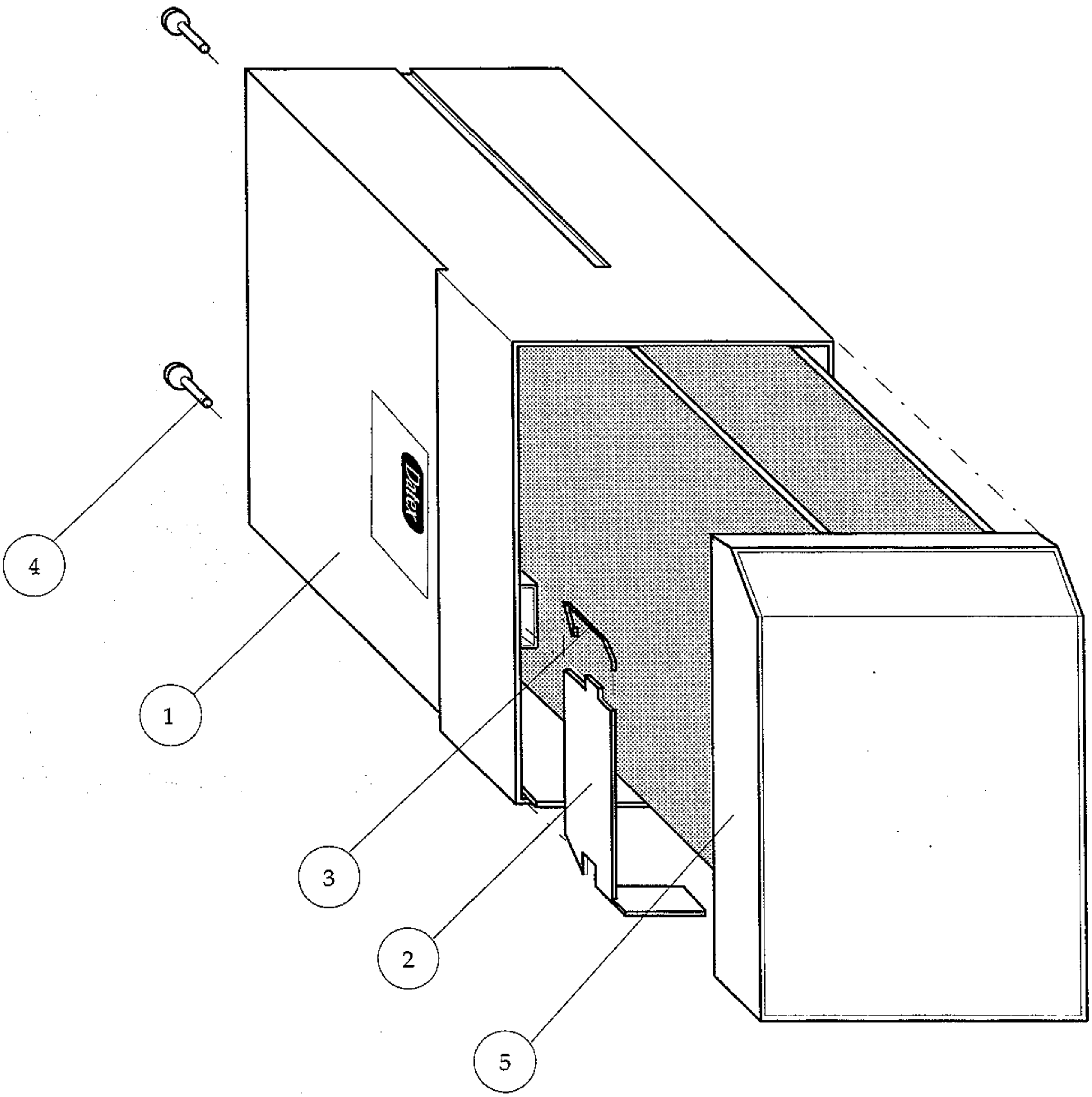


Figure 3 Exploded View of Module Box

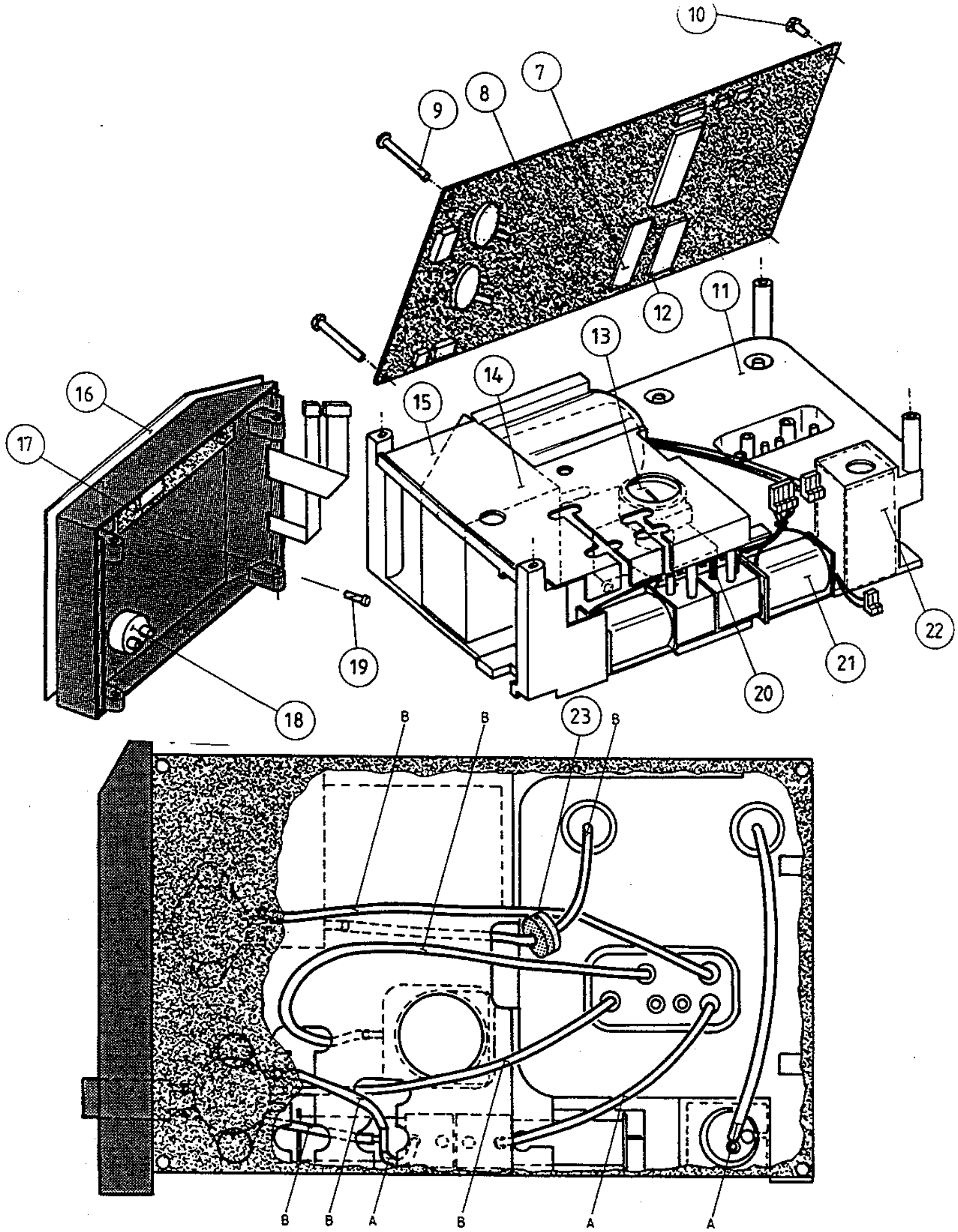


Figure 4 Exploded View of NIBP Module

A = 73373 / 1.7
B = 73375 / 3,18 × 6,35

7. EARLIER REVISIONS

For service information on the earlier revisions, please refer to:

NIBP Module revision 01	Service Manual p/n 880850
NIBP Module revision 02	Service Manual p/n 882580

Recorder Module, M-REC (Rev. 02)

All specifications subject to change without notice

Document No. 885937-3

May, 1996

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INTRODUCTION

The AS/3 Recorder Module, M-REC, and the built-in Recorder, of the AS/3 Compact Monitor, F-CMREC, provide real time printing of waveform and numerical data, and also trend data.

The Recorder module and the built-in Recorder are technically the same, the only difference is that the M-REC is placed in a module box, and the F-CMREC is placed in the AS/3 Compact Monitor frame. In the following they both are referred to as the recorder.

NOTES:

* Printings on thermal paper may be destroyed when exposed to light, heat, alcohol etc. Take a photocopy for archive.

* The Recorder module cannot be used in the Extension Frame, F-EXT4.

1 SPECIFICATIONS

Module size W x D x H	75 x 180 x 112 mm 3.0 x 7.1 x 4.4 in
Module weight	0.9 kg/ 2 lbs
Power consumption	3 W
Principle	Thermal array
Print resolution:	
Vertical	8 dots/mm (200 dots/inch)
Horizontal	32 dots/mm (800 dots/inch) at 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

2 FUNCTIONAL DESCRIPTION

2.1 Recorder Board

In general

The task of the Recorder board inside the Recorder is to connect it to the module bus. Additionally, three front panel keys are connected through the board to the recorder.

In the module the recorder and the Recorder board are connected together with a small connector board and 12-pin fex-strip cable.

External communication

Communication with the host processor takes place in +5 V CMOS-level serial communication B-channel and with RS485-reset.

Reset

Differential RS485-reset from the module bus is transferred to mod-bus-reset signal in the board. Besides, the board has its own power-up-reset, whose time constant is about 0.1 seconds. The RESET-signal is active when either the mod-bus-reset or the power-up-reset is active.

+5 V priority

The recorder supply voltage of +15 VREC is switched on after +5 V is present.

Front panel keys

The recorder can read up to three keys and pass their status on to the host processor in serial communication.

For protecting the key switch signals from static discharges, there are zener diodes and series resistance option. Pull-up resistor is not needed because there are pull-up resistors connecting the key switch signal inputs and +5 V together inside the recorder.

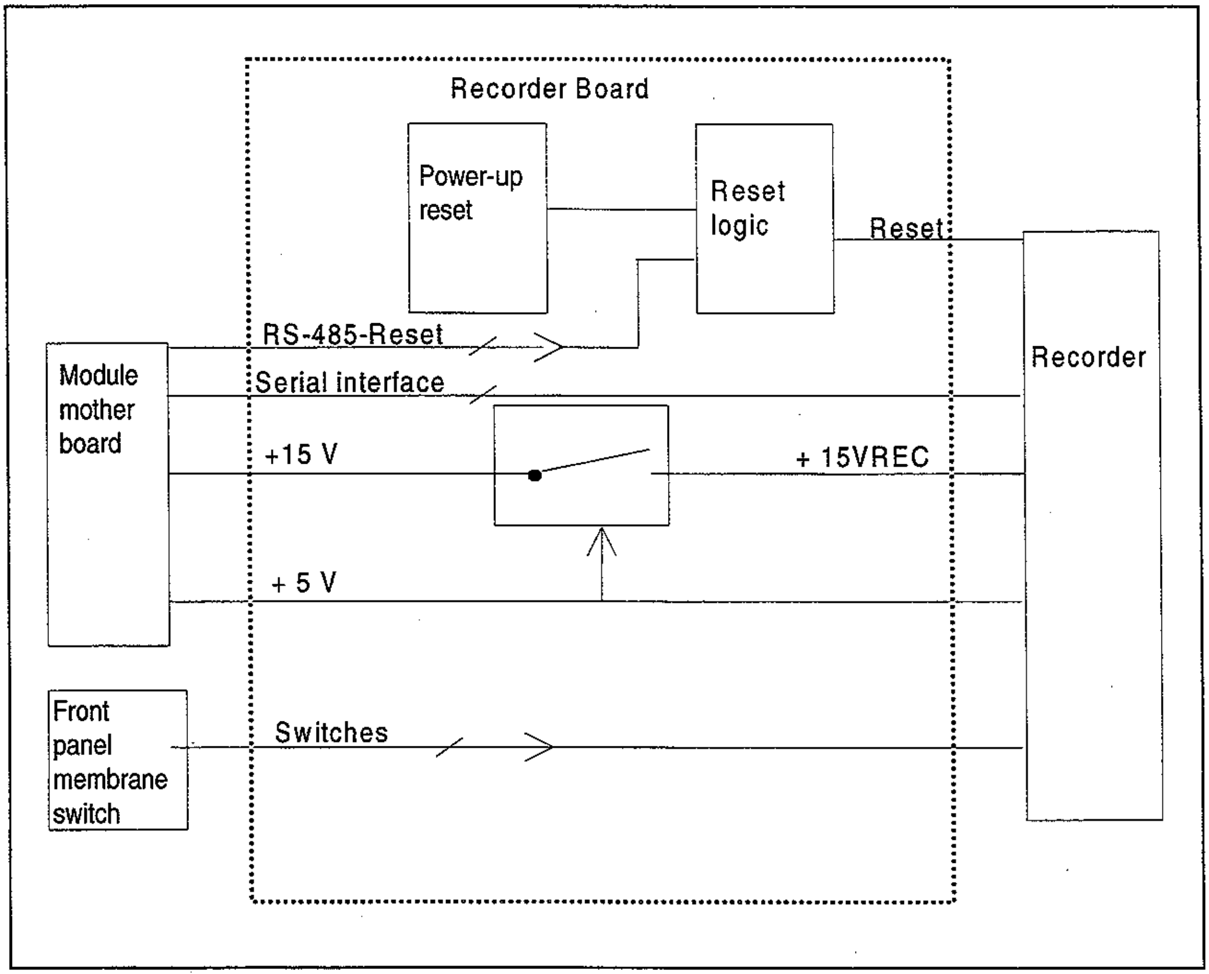

Figure 1 Recorder Board Block Diagram

2.2 Module Bus Connector Configuration

Rear panel 25-pin female D-connector in the M-REC

Pin No	I/O	Signal
1	I	RESET_RS485
2		Not connected
3	I	+15 VDIRTY*
4		Not connected
5		Not connected
6		Not connected
7		Ground & Shield
8	I	-RESET_RS485
9	O	CTSB
10	I	RTSB
11	O	RXDB
12	I	TXDB
13		Ground & Shield
14		Not connected
15	I	GroundDIRTY
16		Not connected
17		Not connected
18		Not connected
19		Not connected
20		Not connected
21		Not connected
22		Not connected
23		Not connected
24	I	+5 VDC
25	I	+5 VDC

I = in, O =out of the Recorder

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service of the Recorder is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex-Engstrom for repair.

Datex-Engstrom 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 shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Preventive Maintenance Checks

Perform these checks after any service and at least once a year to keep the Recorder in good condition.

1. Visual inspection of the module

__: If the module is disassembled, check that grounding wires and all connectors are properly connected and there is no loose object inside the module before attaching the module box.

2. Functional checks (for F-CMREC only steps that are applicable)

__: Insert the module into Frame where there is at least ESTP/EST/ETP module. Turn the power on. No error message appears.

__: Check the functions of the Record Wave and Stop keys.

__: Pull out the module. Reinsert the module while the power is still on. Check the functions of the Record Wave and Stop keys again.

__: Press Recorder and Recorder Setup keys. Choose 20 seconds as recording length and 6.25 mm/s as paper speed. Start printing by Record Wave key. The length of printout should be 12.5 ± 1 cm.

__: Change paper speed to 12.5. The length should be 37.5 ± 3 cm.

__: Change paper speed to 25. The length should be 75 ± 6 cm.

__: Press Recorder key and set up the following with the ComWheel:

Waveform 1	ECG1
Waveform 2	OFF
Waveform 3	OFF

Press Record Wave key. The printout should fill the paper and lines should be unbroken.

3.3 Disassembly and Reassembly

Disassemble the Recorder module in the following way. See the exploded view of the module:

a) Remove the two screws from the back of the module.

b) Pull the module box slowly rearward and detach it from main body. Be careful with loose latch and spring pin for locking.

c) Open paper loading hatch of the recorder. With a long blade screwdriver loosen the two screws at the bottom of the recorder housing.

d) Disconnect 50-pin connector from the back of the recorder and 5-pin ribbon connector of keypad from the Recorder board.

Now the recorder and front panel frame can be pulled out of the main body. The front panel frame is slipped out of the recorder by pulling rearward.

The Recorder board is attached to the metal chassis with four screws.

CAUTION: In the M-REC the Recorder board is fixed to the metal chassis at the factory in a position that gives best contact of the D-connectors. The board and the chassis must not be separated.

Before disassembling the F-CMREC the AS/3 Compact Monitor Frame must be opened, see the corresponding service manual.

4 TROUBLESHOOTING

4.1 Troubleshooting chart

PROBLEM	CAUSE	TREATMENT
Module not responding to front panel keys, but operates through Recorder menu.	Membrane switch cable loose or broken. M-REC: Flex-strip cable broken. M-REC: Bad contact on connector board.	Check the cable. Replace the front panel if necessary. Check the cable. Replace if necessary. Check contact.
Recorder will not start. No error messages shown.	M-REC: Module not properly inserted. M-REC: Flex-strip cable broken. M-REC: Connector board loose. Recorder board faulty. Recorder faulty.	Reinsert the Module properly. Check the cable. Replace if necessary. Check connector board connections. Replace the board. Replace the Recorder.
Recorder works but nothing appears on the paper.	Active side of the paper downwards.* Recorder faulty.	Turn the paper roll. Replace the Recorder.

* To test which side is active: Place the paper on a hard surface and draw a line with a finger nail. On the active (thermal) side appears a dark line.

4.2 Messages

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 correctly.
Recorder: thermal array overheat	Recorder overheated. Stop using and cool it down.
Recorder: input voltage low	+15 Vrec is too low. Check flex-strip cable and connector board.
Recorder: input voltage high	+15 Vrec is too high. Check flex-strip cable and connector board.
Recorder system error 1, 2, 3	System error. Remove the Recorder Module and reinsert it.
Recorder: module removed	Insert the Recorder Module into the Central Unit.

5 SERVICE MENU

There is no service menu for the Recorder module.

6 SPARE PARTS

6.1 Spare Parts List

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

Recorder Module, M-REC

Rev. 00

Item	Item description	Order No.
6	Recorder board, M-REC (Rev.00)	*(880313) Use 883384
7	Recorder	*90350
8	50-pin connector cable, M-REC	879362
4	Front panel unit, M-REC	881328
	Membrane keypad	879372
10	Front panel sticker, M-REC (Eng)	879483
10	Front panel sticker, M-REC (Ger)	880486
10	Front panel sticker, M-REC (Fre)	880172
1	Module box (wide)	886168
3	Latch	879181
2	Spring pin	879182
9	Metal chassis	(879179) Use 883384
5	Cross recess screw M3x8 black	616215

Rev. 01

Item	Item description	Order No.
9	Metal chassis with recorder board	*(881964) Use
883384		

Rev. 02

Item	Item description	Order No.
9	Metal chassis with recorder board	*883384
11	Metal cover plate, M-REC	885292
10	Front panel sticker, M-REC (Spa)	884388
10	Front panel sticker, M-REC (Swe)	885869
10	Front panel sticker, M-REC (Dut)	886066
10	Front panel sticker, M-REC (Ita)	886761
10	Front panel sticker, M-REC (Fin)	888875

* = the part is recommended for stock

6.2 Exploded View of Module

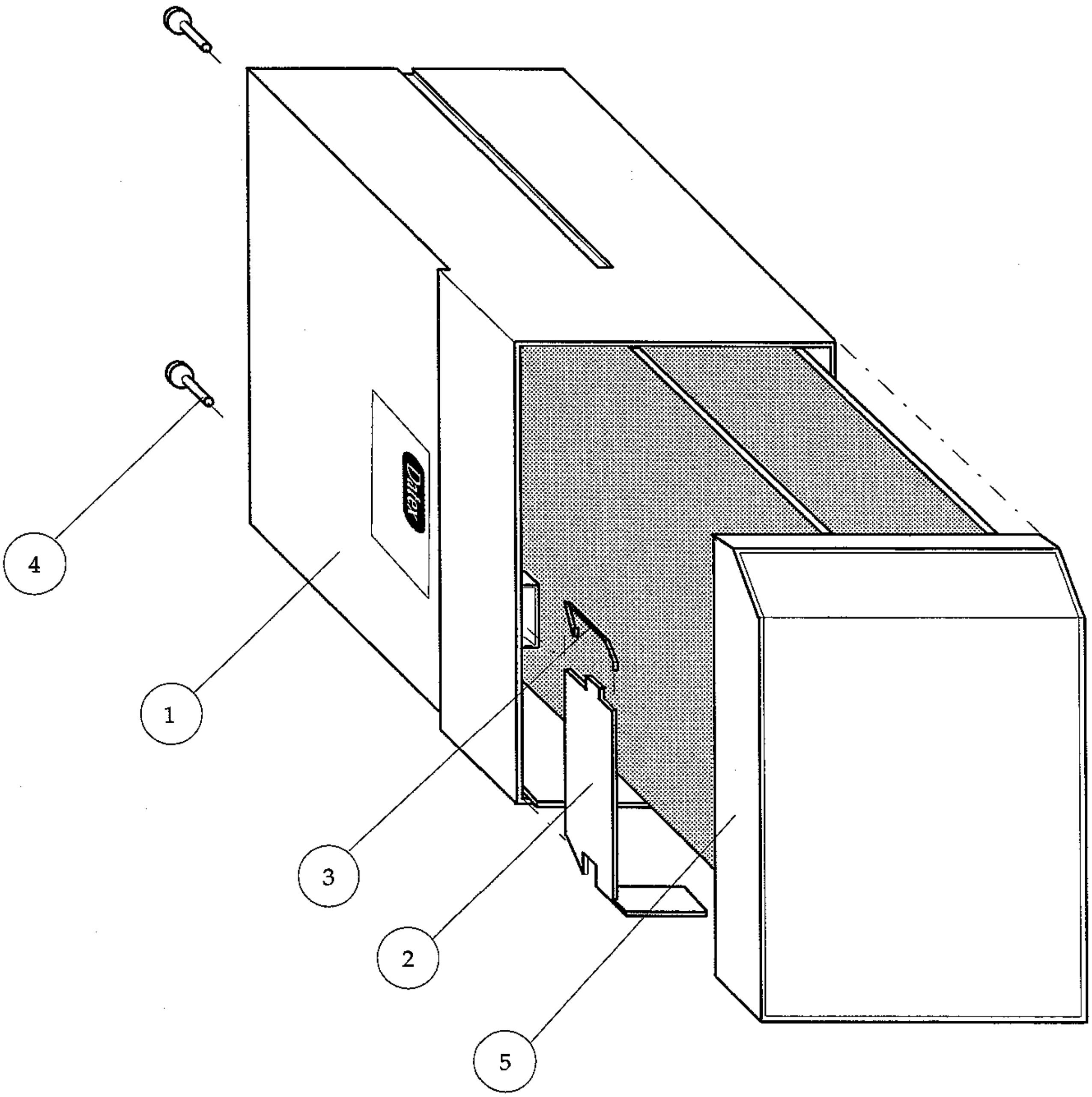

Figure 2 Exploded View of Module Box

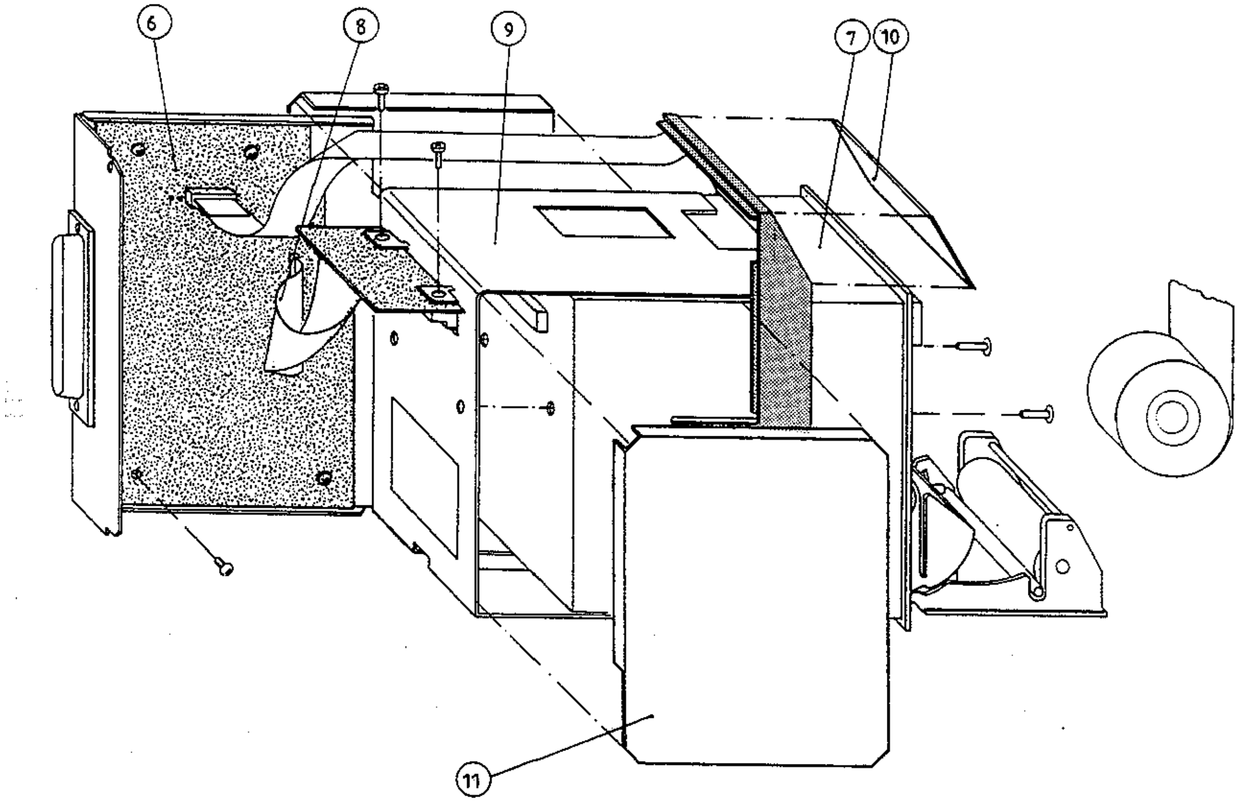

Figure 3 Exploded View of Recorder Module

7 EARLIER REVISIONS

For service information on the earlier revisions, please refer to:

Recorder Module revision 00	Service Manual p/n 880850
Recorder Module revision 01	Service Manual p/n 882580

Extension Frame, F-EXT4 (Rev. 01)

Extension Module, M-EXT (Rev. 00)

All specifications subject to change without notice

Document No. 885938-2

March, 1996

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INTRODUCTION

The Extension Frame provides four additional module slots, and enables taking the measuring modules near to the patient. The Extension Frame is connected to the AS/3 Anaesthesia Monitor with the Extension Module, which reserves one module slot.

NOTE:

* Only one F-EXT4 can be connected to the monitor at a time.
* The Recorder Module, M-REC, and Memory Module, M-MEM cannot be used in the Extension Frame.
* Do not use identical modules simultaneously in the Extension Frame and the monitor.
* When the Extension Frame is used with the AS/3 Anaesthesia Monitor the Central Unit must be of Rev. 03 (F-CU8-XX-03).

1 SPECIFICATIONS

Frame size W x D x H (w/module)	160 x 205 x 137 mm 160 x 228 x 137 mm
Frame weight	1.3 kg
Power consumption:	35 W (max at input voltage of +32 V) with ESTP and NIBP modules inserted and NIBP pump working.
Module size (W x D x H)	37 x 180 x 112 mm 1.5 x 7.1 x 4.4 in

2 FUNCTIONAL DESCRIPTION

The Extension Frame, F-EXT4, contains the Module mother board, Power supply board, and space for four single-width or two double-width AS/3 modules. See figure 1.

The electronic unit receives +32 V from the AS/3 monitor frame and generates from it necessary operational voltages for the inserted AS/3 modules.

The received +32 V is passed through fuse (F1) and filtered and led to power supply components.

There is overvoltage and undervoltage protection for input voltage, the input voltage is set so that it can vary between +18.5 V and +36.0 V.

The purpose of the soft start is to raise input voltage +32 V slowly (about 1 second) to the maximum value so that capacitors in power supply components' circuits have time to get charged. This enables E-EXT4 to be connected to AS/3 monitor frame during operation.

There is also overvoltage protection for outgoing supply voltages. The overvoltage limits are +5.95 V (+5 V) and +17.50 V (+15 Vd).

Signal routes

There are two connectors which are used for data communications (RS485), for supply voltages (+32 V, +15 Vd, +15 Va, and +5 V), for grounds connections (GNDD, GND&SHIELD) between the Power supply board and Module mother board.

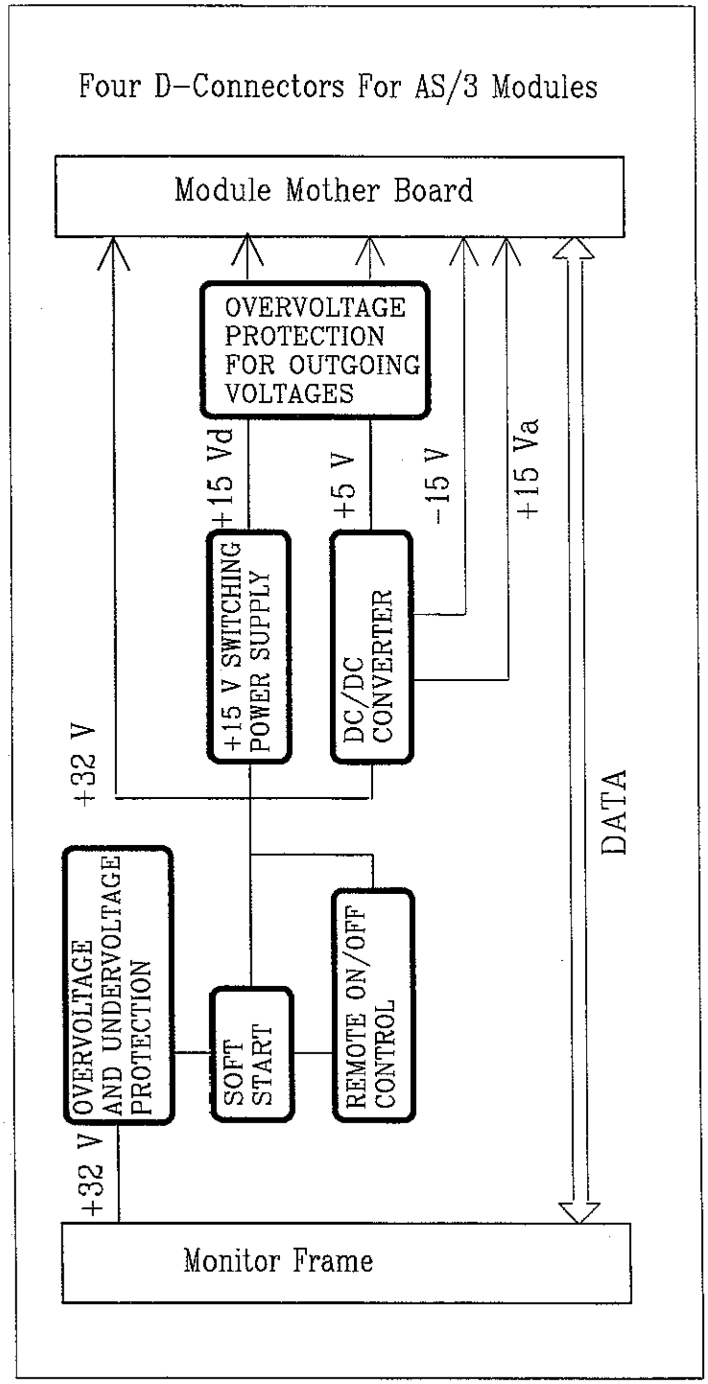
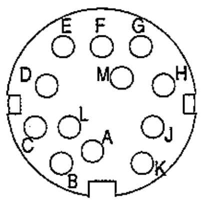


Figure 1 F-EXT Electronics Unit Block Diagram

2.1 External Connector Configuration

Extension Frame Rear panel 12-pin male DIN-connector (X1)



Pin No	I/O	Signal
A	I	RESET_RS485
B	I/O	-DATA_RS485
C	I/O	DATA_RS485
D	I	-RESET_RS485
E		BIT0IN
F		N/C
G	I	+32 VDC
H	I	Gnd and Shield
J		N/C
K		N/C
L		I+32 VDC
M	I	GndD

Extension module rear panel 25-pin female D-connector (X1)

Pin No	I/O	Signal
1	I	RESET_RS485*
2	I	-15 VDC*
3	I	+15 VDIRTY*
4	I	+15 VDC*
5	I/O	-DATA_RS485*
6	I/O	DATA_RS485*
7		Ground & Shield*
8	I	-RESET_RS485*
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13		Ground & Shield*
14	I	+32 VDIRTY*
15	I	GroundDIRTY*
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20		ON/STANDBY*
21		BIT0IN*
22		RXDD_RS232
23		TXDD_RS232
24	I	+5 VDC*
25	I	+5 VDC*

*** Used in the Extension Frame and Module**

3 SERVICE PROCEDURES

Field service of the Extension Frame, F-EXT4, is limited to replacing the faulty circuit boards or mechanical parts. Return the faulty boards to Datex for repair.

Datex 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 the appropriate tools and equipment shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.1 Disassembly and Reassembly

Disassemble the Extension Frame, F-EXT4 in the following way. See the exploded view in chapter 6.2

a) Remove the four screws from the front of the frame. PC boards' block is detached.

b) Remove the four screws from Module mother board with which it is attached to the rear frame.

c) Lift carefully Module mother board and Power supply board attached to it and detach the two connectors under the Power supply board.

3.2 Changing the Fuse

Disassemble as described above. Fuse is located on the Power supply board.

Replace the fuse by the one with the same type and rating.

4 TROUBLESHOOTING

TROUBLE	CAUSE	TREATMENT
F-EXT4 does not work.	Connector not connected properly. Cable /Extension module is faulty.	Check connectors. Check cable/module.
F-EXT4 does not work.	Incoming voltage too high or too low.	Adjust the voltage to within the range. See the voltage limits in the text.
F-EXT4 does not work.	PC board(s) faulty.	Check the fuse on the Power supply board Check the PC boards and their connections. Change Power supply board.
Fuse on Power supply board is blown repeatedly.	Short-circuit in output voltages.	Change the fuse. Remove AS/3 modules and turn power on. If works, AS/3 module is faulty. If not, check the PC boards. Change Power supply board.

5 SERVICE MENU

There is no service menu for Extension frame checking.

6 SPARE PARTS

6.1 Spare Parts List

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

4-Module Extension Frame, F-EXT4

Rev. 01

Item	Item description	Order No.
4	Module mother board, F-EXT4	884839
3	Power supply board, F-EXT4	*884840
5	Frame with rubber pads	881233
10	Pad	65144
1	Rear frame	881234
2	Fuse T2.5A fast	*51118
6	Internal connector cable	884838
7	Cross cylinder-head screw M3x6	61721
9	Cross cylinder-head screw M3x12	61736
8	Nut bushing M3x9	640455

Extension Module, M-EXT

Item	Item description	Order No.
1	Module box (single width)	879095
3	Latch	879181
2	Spring pin	879182
5	Cross recess screw M3x8 black	616215

* = the part is recommended for stock

6.2 Exploded View of Extension Frame

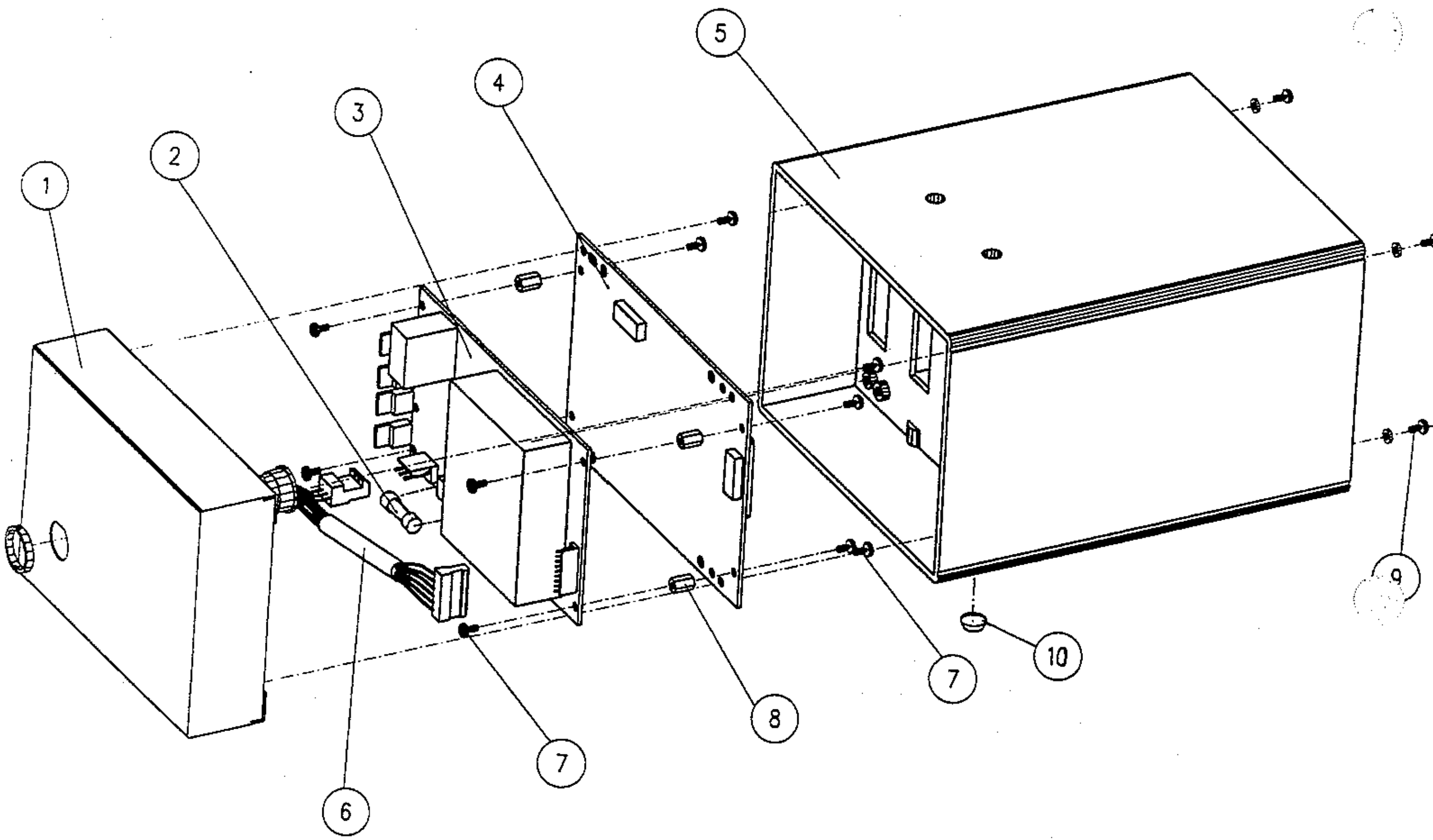


Figure 2 Exploded View of the Extension Frame

7 EARLIER REVISIONS

This manual fully supports earlier revision of F-EXT4.

Memory Module, M-MEM (Rev. 01)

Memory Board, B-CMMEM (Rev. 01)

All specifications subject to change without notice

Document No. 885939-2

March, 1996

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INTRODUCTION

AS/3 Memory Module (M-MEM) is an optional data storage module for AS/3 family monitors. It is used for storing patient related physiological data, discrete record keeping events, menu configurations and user defined monitor configurations in removable PCMCIA[1] compatible memory cards.

Memory module can be utilized in the following applications:

1. As a backup media for patient related physiological and record keeping data.

2. As a local menu server for the monitor it is attached to.

3. A Memory card with its previously recorded patient data can be transported to a new monitor location with the patient enabling continuous data collection.

4. To save and load user defined monitor configurations.

The memory module is available in two versions:

1. Single-width external plug-in Memory Module M-MEM for AS/3 Monitors.

2. Internal memory board B-CMMEM for AS/3 Compact Monitor.

The two versions share the same electronics and software. However, because of the special space requirements of the Compact Monitor, the internal version of the module has different printed circuit board layout and mechanical design.

The internal version of the module will use one PC board slot in the AS/3 Compact Monitor.

Memory module has two card slots, which use rewritable PCMCIA-ATA specification compatible memory cards: Data and Menu MemCards.

The Data card is used for storing patient related data and record keeping events, and the Menu card is used as a storage media for pre-recorded menu configurations and user defined monitor configuration. If the module is used only for data backup and transportation, the Menu card is not necessarily required. Similarly, if only record keeping configurations are needed, Data card does not have to be present. In the latter case, however, no physiological or event data can be stored in a memory card.

Module software runs under MS-DOS[2] compatible operating system provided by Datalight[3] . The files created in Data and Menu MemCards are MS-DOS compatible.

The communication between the monitor CPU and the Memory module is performed through high-speed internal TTL level RS-232 serial interface. Data transfer rate is 76.8 kbits/second.

1 Personal Computer Memory Card International Association
2 MS-DOS is a trademark of Microsoft Corporation
3 Datalight is a trademark of Datalight, Inc.

NOTE: Memory Module, M-MEM, cannot be used in the Extension Frame, F-EXT4.

NOTE: The M-MEM rev. 00 uses Microsoft Dos Flash File System (FFS) compatible cards only.

NOTE: S-STD95/S-ARK95 and later main software revisions support only PCMCIA-ATA cards (used in the M-MEM rev. 01) not Flash File cards.

S-STD94/S-ARK94 software supports Flash File cards (used in M-MEM rev. 00) not PCMCIA-ATA cards.

1 SPECIFICATIONS

1.1 General Specifications

M-MEM

Module size: (W x D x H)	37 x 180 x 112 mm 1.5 x 7.1 x 4.4 in
Module weight:	0.4 kg / 1.0 lbs
Total power:	2 W maximum

B-CMMEM

Module size: (W x D x H)	30 x 170 x 108 mm 1.2 x 6.7 x 4.3 in
Module weight:	0.3 kg / 0.6 lbs
Total power:	2 W maximum

1.2 Technical Specifications

MemCard capacity:	5 Mbytes
Data storage capacity:	5 days of continuous physiological data trends
Operating system:	Datalight ROM-DOS
File system:	MS-DOS compatible
MemCards:	PCMCIA-ATA compatible memory cards

2 FUNCTIONAL DESCRIPTION

The Memory Module **M-MEM** contains MEM PC board and a small LED (light emitting diode) PC board attached to the front panel.

The front panel has a dual PCMCIA card connector for two Datex AS/3 MemCards. Above the card slots there are two push buttons for removing the MemCards from the module, and two memory card specific LEDs. The LEDs are on during memory card read and write operations to notify the user not to remove them until the operation is complete.

The internal module contains B-CMMEM PC board and a connector to a PC board that connects the B-CMMEM to the module bus.

B-CMMEM contains the same components as the MEM PC board with the following differences:

1. B-CMMEM does not contain a module bus connector.

2. B-CMMEM contains a 14-pin connector to a separate connector PC board that is connected directly to the AS/3 bus.

NOTE: Memory Module M-MEM (rev. 00) and B-CMMEM (rev. 00) requires support of Main Software S-STD94 or S-ARK94 and cannot be used together with later main software versions.

2.1 Memory Module M-MEM

2.1.1 Memory Module Board

Processor Section

Basically, Memory module is a single board PC with unnecessary I/O functions removed. The processor is Intel 80C186 compatible and the software runs under DOS operating system. Operating frequency is 16 MHz. The board has 512 kbytes RAM, 448 kbytes ROM, 128 bytes EEPROM and associated buffer circuits for memory operations.

Intel 82365SL compatible PC Card Interface Controller (PCIC) provides all the functions needed in MemCard operations. Serial communication, EEPROM read and write operations and LED control is accomplished through a QUART circuit. In addition, processor board contains circuitry to control reset signals and MemCard programming voltages.

Memory module board block diagram is shown in Figure 1.

PCMCIA Card Interface

MEM has PCMCIA compatible card sockets for two MemCards. Both sockets consist of 60 signal and 8 power connections. MemCards are PCMCIA-ATA compatible, and their memory capacity is 5 Mbytes.

NOTE: Memory Module M-MEM (rev. 00) and B-CMMEM (rev. 00) are not supporting use of PCMCIA-ATA MemCards.

All MemCard read and write operations as well as card power management are controlled by PCIC interface controller.

Card removals and insertions are also detected by the interface controller.

MemCard files are MS-DOS compatible and they can be copied for archival with any MS-DOS compatible computer equipped with PCMCIA-ATA specification compatible card drive.

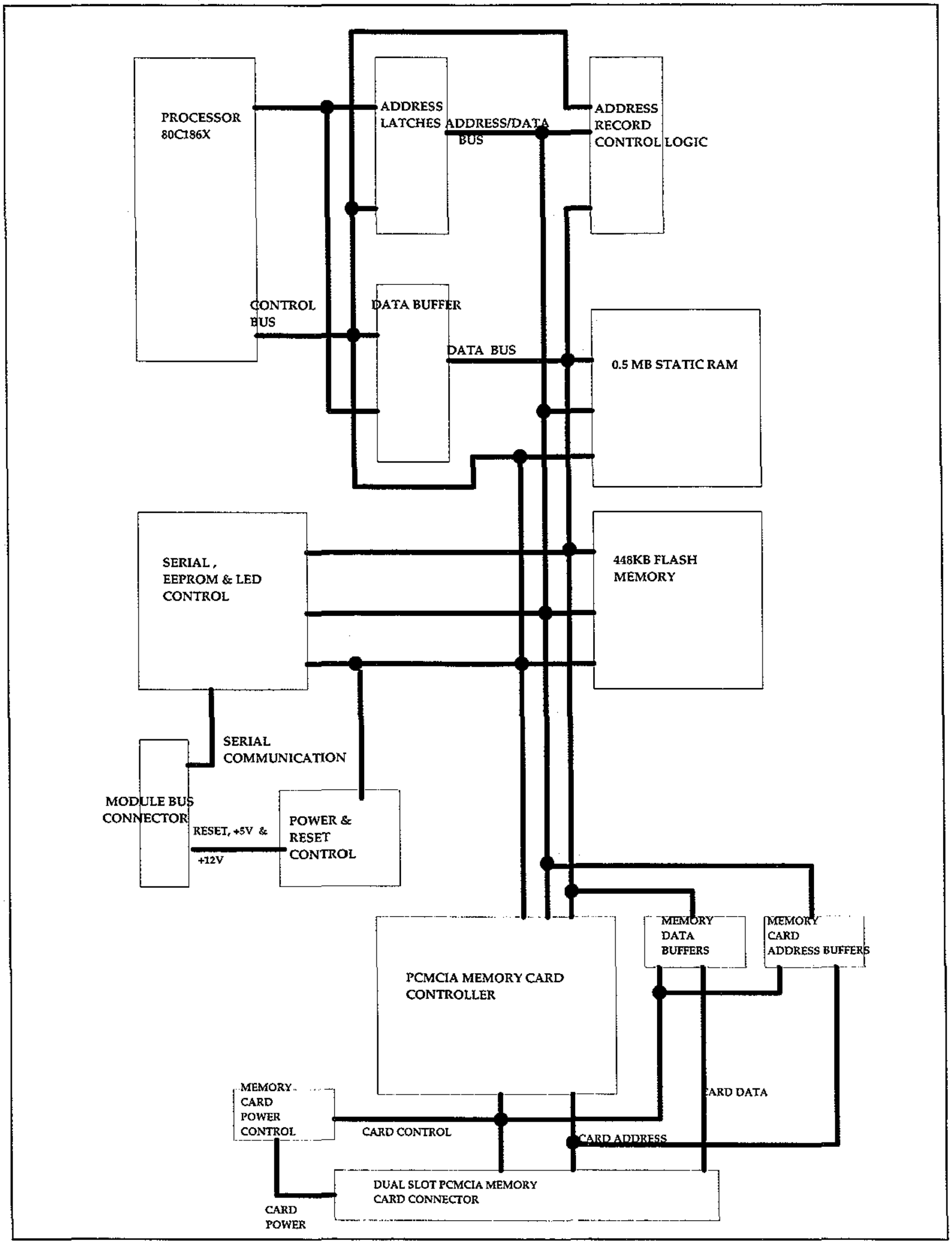


Figure 1 Memory Module Block Diagram

Serial Communication

Serial communication between the module and host monitor is done through module bus TTL-level RS-232 interface. Data transfer rate is 76.8 kbits/second.

RS485 type monitor reset signal is converted to module reset by an interface transceiver, and power reset is generated by a reset circuit.

Power Supply

Module receives its power (+5V, +15V) from the host monitor. PCMCIA card programming voltage + 12V is generated from +15V by voltage regulators. Card programming voltage is controlled by an interface controller. Otherwise, only +5V power is used in the module. Maximum power consumption is 2 Watts.

2.1.2 LED Board

LED board contains only two yellow light emitting diodes and a three-lead cable to the MEM PC board.

2.2 Memory Board, B-CMMEM

2.2.1 B-CMMEM Board

Differences between Memory Module Board and B-CMMEM

Module signals are taken to B-CMMEM through a separate connector board that is connected to the module bus. B-CMMEM is connected to the connector board by a 14-lead connector board cable.

Otherwise Memory module PC board and B-CMMEM PC board have the same components.

2.2.2 Connector Board

B-CMMEM connector board connects B-CMMEM to the AS/3 bus. It contains only CPU bus connector that is connected to the

CPU Mother board, connector to B-CMMEM, and filtering capacitors for +5V and +15V power supply lines.

2.3 Connectors and Signals

Module rear panel 25-pin female D-connector (X1)

Pin No	I/O	Signal
1	I	RESET RS485*
2	I	-15 VDC
3	I	+15 VDIRTY
4	I	+15 VDC*
5	-	-DATA RS485
6	-	DATA RS485
7	-	Ground & Shield*
8	I	-RESET RS485*
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13	-	Ground & Shield*
14	I	+32 VDIRTY
15	I	GroundDIRTY
16	O	CTSC*
17	I	RTSC*
18	O	RXDC*
19	I	TXDC*
20	-	ON/STANDBY
21	-	BIT0IN
22	-	RXDD RS232
23	-	TXDD RS232
24	I	+5 VDC*
25	I	+5 VDC*

* Used in MEM module

LED board connector (X5)

Pin No	I/O	Signal
1	O	+5V
2	O	LED1 control
3	O	LED2 control

Connector board 14-pin connector (X1)

Pin No	I/O	Signal
1	I	Ground & Shield*
2	I	Ground & Shield*
3	I	-RESET RS485*
4	I	+15 VDC*
5	I	RESET RS485*
6	O	CTSC*
7	I	RTSC*
8	O	RXDC*
9	I	TXDC*
10	-	N/C
11	-	N/C
12	-	N/C
13	I	+5 VDC*
14	I	+5 VDC*

3 SERVICE PROCEDURES

3.1 General Service Information

Field service for the Memory module is limited to replacing faulty PC boards, MemCards or mechanical parts. The faulty PC boards and MemCards are then returned to Datex for repair.

Datex 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 the appropriate tools and equipment shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Preventive Maintenance Checks

We recommend you to perform these checks at least once a year and after any service to keep the Memory Module in good condition.

Items marked (M-MEM) are valid for external Memory Module, M-MEM, only.

1. Visual inspection

__: If the module is disassembled, check that all connectors are properly connected and that there are no loose objects inside the module before attaching the module box (M-MEM).

2. Functional checks

__: Insert the module in the monitor frame (M-MEM).

__: Turn the power on by ON/STBY-switch and wait until the waveform fields appear on the screen.

__: Insert MemCard labelled 'Menu' in the left hand side card slot.

__: Confirm that the led above the menu card slot turns briefly on (M-MEM).

__: Confirm that a text 'Menu card inserted' appears on the message field of the monitor display.

__: Confirm that a white menu card symbol appears on the upper right hand corner of the monitor display.(*

__: Insert MemCard labelled 'Data' in the right hand side slot of the module.

__: Confirm that the led above the data card slot turns briefly on (M-MEM).

__: Confirm that a text 'Data card inserted' appears on the message field of the monitor display.

__: Confirm that a green Data card symbol appears on the upper right hand corner of the monitor display.(*

__: Pull out the module. The card symbols disappear within 35 seconds, and a text 'Memory Module removed' appears on the message field of the monitor display (M-MEM).

__: Reinsert the module while the power is still on. 'Memory Module removed' text disappears and card symbols appear again on the display (M-MEM).

__: Go into Service Menu, Service View, Modules, Memory Module, Communication and check the functions.

***NOTE:** Battery symbol will override card symbols in Compact Monitor.

3.3 Disassembly and Reassembly

The Memory module is disassembled in the following way. See section 6.2 for the exploded view of the module.

a) Remove the two screws from the back of the module.

b) Pull the module box slowly to detach it from main body. Be careful with loose latch and spring pin for locking.

c) Remove the two screws that are located on the module bus connector and the screws that connect the front panel frame to the Memory board.

d) Disconnect the LED board cable and remove the front panel frame.

e) Remove the EMC cover carefully from around the Memory board.

f) Reassemble the module in reverse order.

CAUTION: When reassembling the module, make sure the cables, especially the LED board cable, are reconnected properly.

4 TROUBLESHOOTING

4.2 Troubleshooting Charts

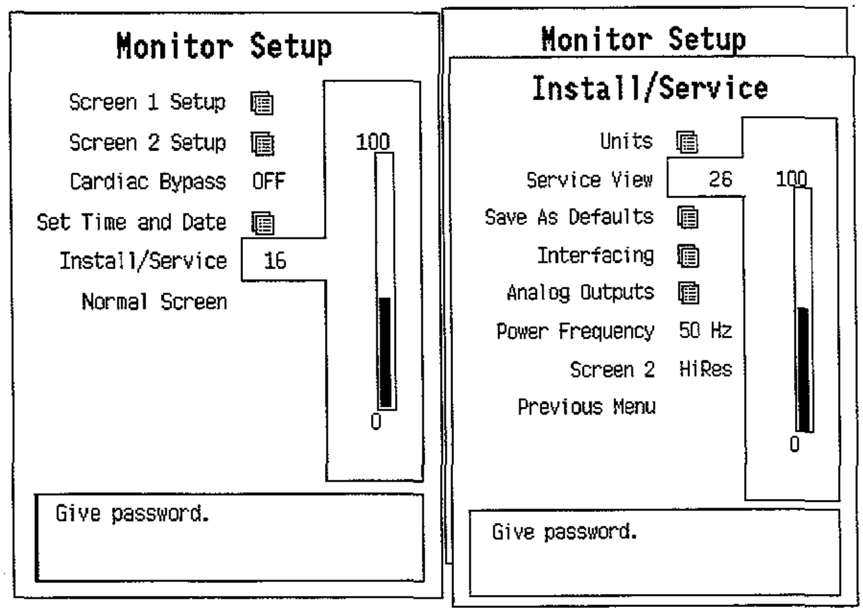
Memory Module

TROUBLE	CAUSE	TREATMENT
Memory module removed -message	Module removed from monitor frame. Possible error in data communication between the module and the monitor.	Insert module in the module frame. Remove module briefly from the monitor. Insert module back to monitor frame.
Memory module error -message	Module has detected an error condition.	If message persists, remove module for repair.
Memory module comm. error -message	Module not properly attached to monitor frame.	Check module attachment.

Memory cards

TROUBLE	CAUSE	TREATMENT
Two Data Cards in mem. module -message	Two Data cards detected.	Remove MemCard from the left hand side slot of the module.
Two Menu Cards in mem. module -message	Two Menu cards detected.	Remove MemCard from the right hand side slot of the module.
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 module.
Faulty Data Card - change card	An error has occurred during Data card read/write operation	Change Data card.
Faulty Menu Card - change card	An error has occurred during Menu card read/write operation	Change Menu card.

5 SERVICE MENU



To enter Service Menu during normal operation:

1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.

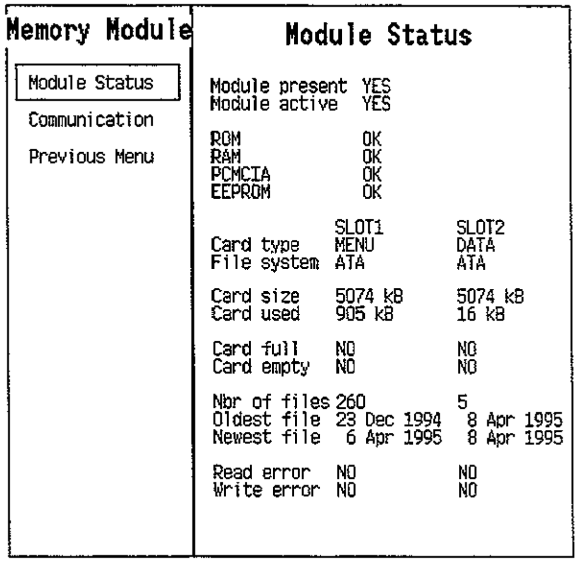
4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

6. Turn the ComWheel to highlight Modules and push.

7. Turn the ComWheel to highlight Memory Module and push.

5.1 Module Status



Detailed Description

Module present indicates whether the module is firmly attached to the monitor. Possible values are YES and NO.

Module active indicates whether the module 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** indicates the left hand slot and the right hand slot , respectively.

Card type indicates whether the card is MENU or DATA card. If duplicated card is inserted, type DUPL.

File system indicates the type of the used memory card. 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 the disk space in the card in kilobytes.

Card used indicates the total amount of the used disk space in the card in kilobytes.

Card full indicates whether the all disc 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.

Nbr of files *tells the amount of the files stored in the card.*

Oldest file tells the date of the oldest file in the card.

Newest file tells the date of the newest file in the card.

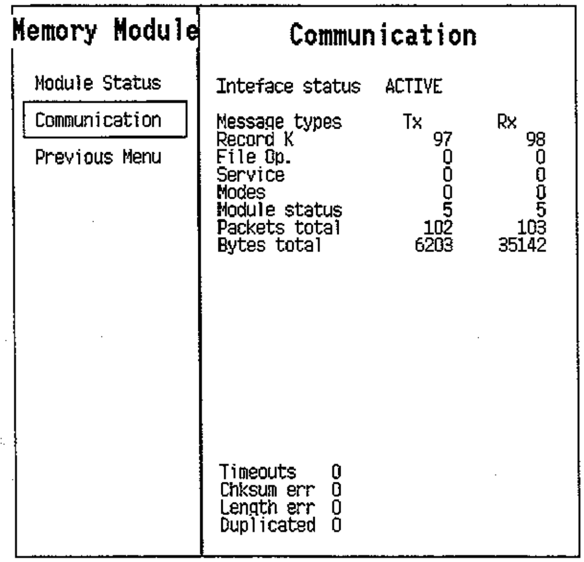
Read error indicates whether the reading from the card has failed. Possible values are YES and NO.

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'.

NOTE: This menu is related to S-STD95/S-ARK95 Main Software. If S-STD94/S-ARK94 Main Software is used, only Communication menu is available (SERVICE VIEW/MONITOR/COMMUNICATION/MEMORY MODULE).

5.2 Communication



Detailed Description

Interface status indicates the status of data link between the monitor and memory module. If memory module is properly attached, the status should always be on ('ACTIVE'). If status blinks between 'ACTIVE' and 'CLOSED', a communications error has occurred: remove module briefly, and insert it back to the monitor frame to check if error disappears.

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.

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

File Operation indicates the operations of Patient data.

Service indicates the Memory Module operations.

Modes indicates the User Mode operations.

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

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

The last four lines indicates transmission errors:

- **Timeouts** indicates the number of time-outs that have occurred in memory module data transmission since last monitor start.
- **Chksum err** indicates the number of checksum errors in data packets from memory module since last monitor start.
- **Lenght err** indicates the number of data packets with erroneous length from the memory module since last monitor start.
- **Duplicated** indicates the number of duplicate data packets from the memory module since last monitor start.

6 SPARE PARTS

6.1 Spare Parts List

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the catalogue AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

Memory Module, M-MEM

Rev. 00

Item	Item description	Order No.
12	Memory board, M-MEM	*883509
6	Front panel sticker, M-MEM	884597
4	Front panel frame, M-MEM	883838
7	LED board, M-MEM	885252
1	Module box (single width)	886167
3	Latch	879181
2	Spring pin	879182
8	Metal frame	879184
5	Cross recess screw M3x8 black	616215
9	Cross cylinder-head screw M3x6	61721
10	Cross cylinder-head screw M3x12	628700
11	EMC cover, M-MEM	885860
13	Insulation plate, M-MEM	886656
14	Slotted cylinder-head screw 4-40 UNCx1/4	61371
	Memory Card, Menu (Eng)	*885195
	Memory Card, Data (Eng)	*885196
	Memory Card, Menu (Fre)	*885552
	Memory Card, Data (Fre)	*885553

Rev. 01

Item description	Order No.
Memory Card, Menu (Eng)	*887044
Memory Card, Data (Eng)	*887045
Memory Card, Menu (Fre)	*887046
Memory Card, Data (Fre)	*887047

NOTE: The memory cards listed above require revision 01 module, and S-STD95/ARK95 or later software.

Memory Board, B-CMMEM

Item description	Order No.
Connection board, B-CMMEM	885680
Memory Card, Menu (Eng)	*887044
Memory Card, Data (Eng)	*887045
Memory Card, Menu (Fre)	*887046
Memory Card, Data (Fre)	*887047

* = the part is recommended for stock

6.2 Exploded View of Module

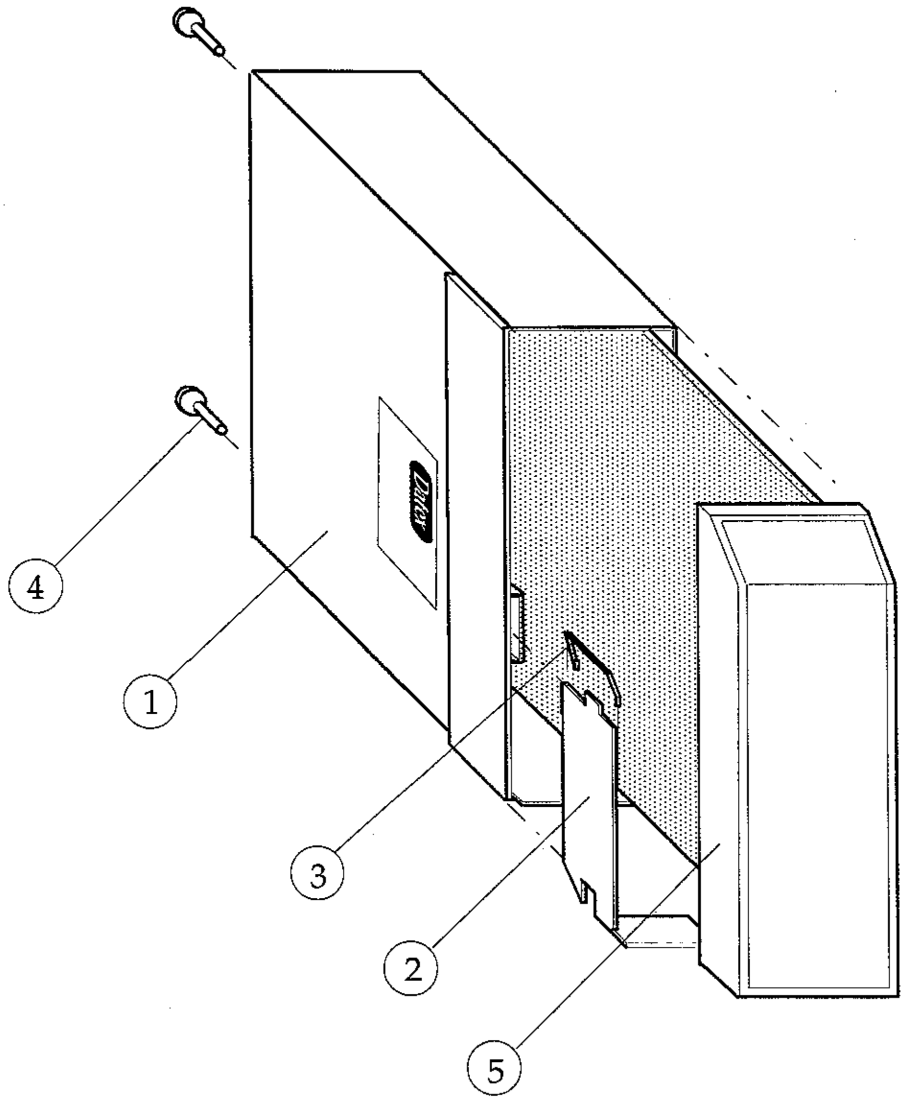


Figure 2 Exploded View of Module Box

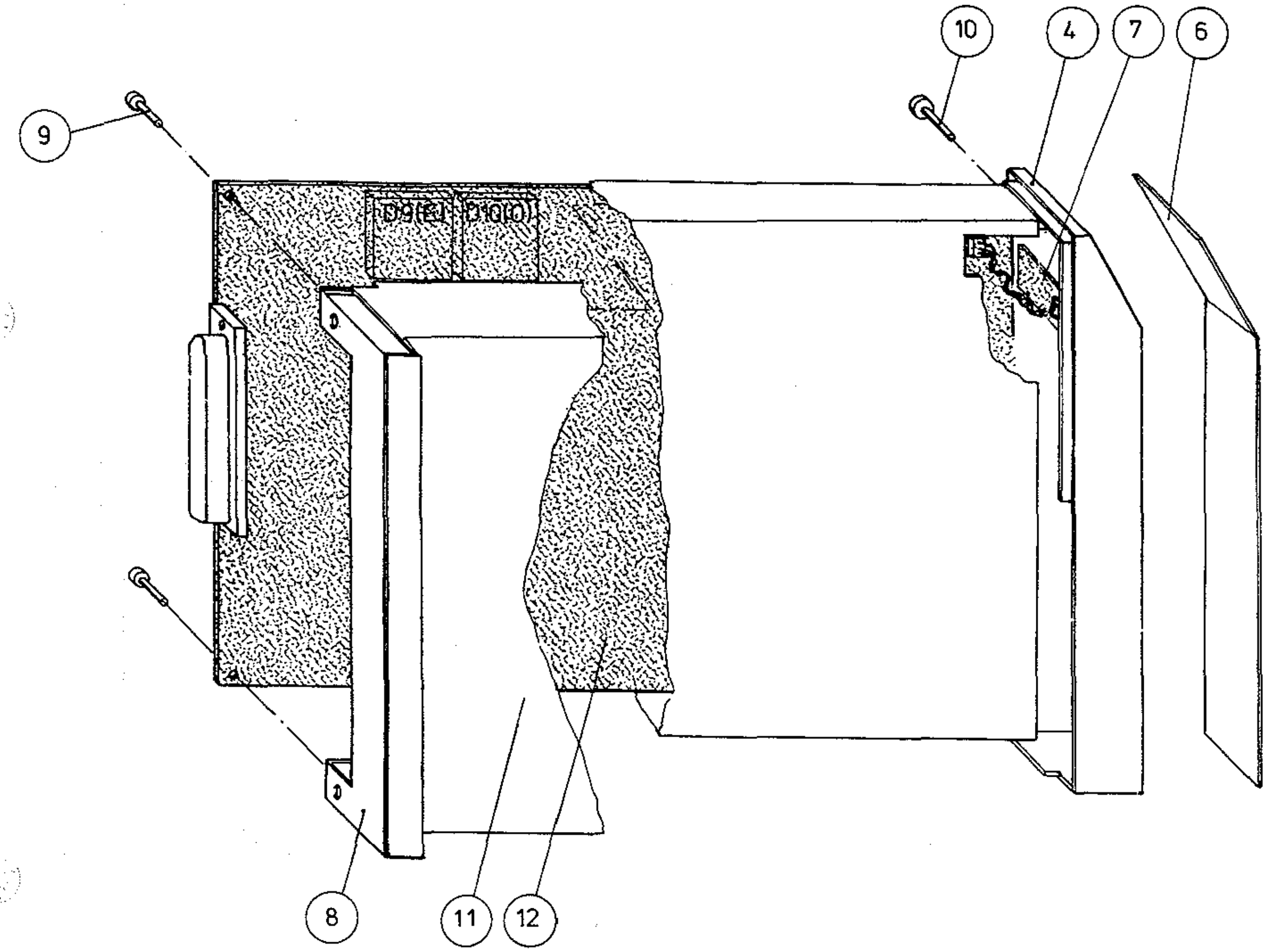


Figure 3 Exploded View of Memory Module, M-MEM

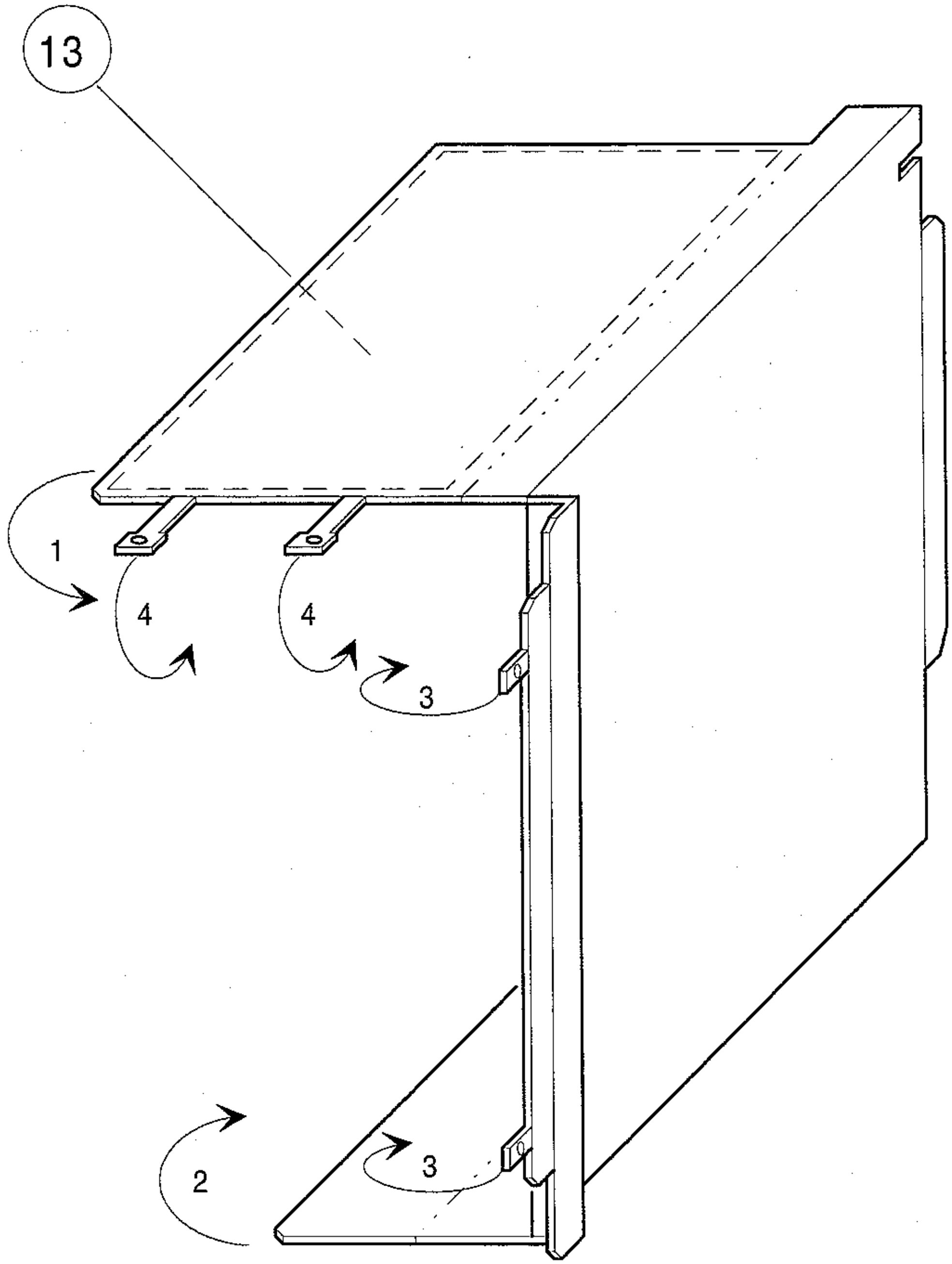


Figure 4 EMC cover

7 EARLIER REVISIONS

All main differences of Memory Module, M-MEM (rev.00) , B-CMMEM (rev.00) and M-MEM (rev.01) , B-CMMEM (rev.01) are noted in this manual.

Nellcor Compatible Saturation Module, M-NSAT (Rev. 01)

All specifications subject to change without notice

Doc. no. 885940-3

March, 1996

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Table of Contents

INTRODUCTION

The Datex AS/3 Nellcor Compatible Saturation Module is a single width plug-in module for use with the AS/3 monitors. The module utilizes Nellcor's pulse oximetry algorithm and is designed to be used with Nellcor's pulse oximetry transducers only. Only one pulse oximetry source at a time is allowed by the AS/3 monitors. If M-ESTPR (or M-ESTR) and M-NSAT modules are plugged in the monitor simultaneously, then M-NSAT overrides M-ESTPR (or M-ESTR) as a pulse oximetry source.

1 SPECIFICATIONS

1.1 General Specifications

Module size: (W x D x H)	37 x 180 x 112 mm 1.5 x 7.1 x 4.4 in
Module weight:	0.4 kg / 1 lbs
Power consumption	3 W

1.2 Typical Performance

SpO_2:

Measurement range	40 to 100 %
Accuracy (% ±1 SD) *)	100 to 80 %: ±2 digits 80 to 50 %: ±3 digits 50 to 40 %: unspecified
Resolution	1 digit = 1 %
Display averaging	5...7 s
Pulse beep pitch	Varies with SpO_2 level

The monitor is calibrated over the measurement range against functional saturation SpO_2(func)

HEART RATE FROM PLETH:

Measurement range	20 to 250 bpm
Accuracy	±3 bpm
Resolution	1 bpm
Display averaging	5...7 s
Adjustable pulse beep volume	

PLETH WAVEFORM:

Scales	Automatic scaling

*) 1 SD (standard deviation) = 68 % of all readings in the specified range in stable conditions.

Protection against electrical shock	Type BF

2 FUNCTIONAL DESCRIPTION

The M-NSAT module contains the following main parts:

- SpO_2 sensor board
- Sensor connector cable
- Nellcor Pulse Oximeter Module MP-203
- NSAT interface board

Sensors can be plugged into the M-NSAT module either directly or using sensor extension cables available from Nellcor. Sensors are plugged into a 9-pin female connector (D-type) on the front panel of the module. This connector is mounted on a small PC board, which is connected by a flat cable to the MP-203.

The MP-203 is a surface mounted PC board manufactured by Nellcor Incorporated. It contains the signal processing electronics and software that are based on Nellcor's stand-alone pulse oximeters. The MP-203 is used with an internal preamplifier.

The measured SpO_2 and pulse rate values, as well as status information, are transferred from the MP-203 to the NSAT interface board. Communication between the MP-203 and NSAT interface board is established through RS232C serial interface. The NSAT interface board, in turn, transmits the measurement information to the module bus of the AS/3 monitor through RS485 serial interface.

The operation of NSAT interface board is illustrated in the block diagram next page.

2.1 NSAT Interface board

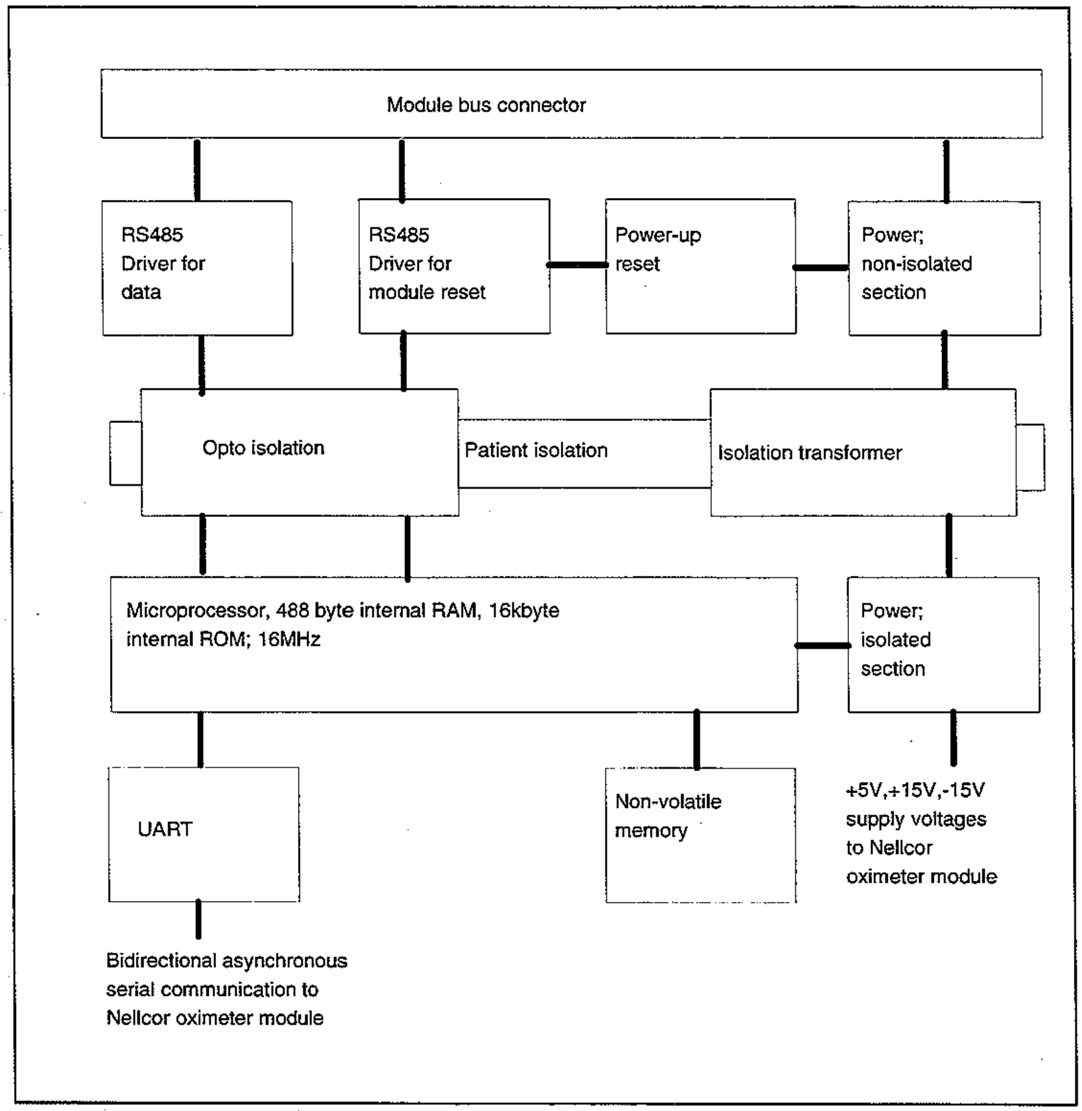


Figure 1 NSAT Interface Board Block Diagram

2.1.1 RS485 drivers

There are drivers for data and for module reset functions.

These drivers are used for driving the RS485 type serial communication bus between the module and the AS/3 Central Unit. Data transmission speed of the bus is 500kbit/s.

In addition to RS485 bus RESET, there is a Power- up reset, which keeps the RESET pin of the CPU active during power up for about 500ms despite of the state at the RS485 bus RESET. This is used to prevent the sending of RS485 data during the RESET of the module.

2.1.2 Power supply, non-isolated section

Power supply is a half bridge type switched mode circuit, where the driver FETs are controlled by a quartz oscillator. The load of the half bridge is the primary of the isolation transformer. The voltage, +15 Vdirty from the AS/3 Central Unit is used as the supply voltage of the switched mode circuit.

2.1.3 Power supply, isolated section

The secondary voltages of the isolation transformer are rectified, filtered and regulated. The voltages can be measured from the test connector X11. See Chapter 2.2.

2.1.4 Opto isolation

The signals of the serial communication bus between the NSAT module and the AS/3 Central Unit are transferred through the patient isolation by the high speed optocouplers.

2.1.5 Microprocessor, UART, Non-volatile memory

The microprocessor with on-chip memory have been used to convert and transfer data from Nellcor pulse oximeter module MP-203 to AS/3 Anaesthesia Monitor.

The communication between MP-203 and the CPU of M-NSAT is realized with the bidirectional asynchronous serial communication via the UART.

The non-volatile memory has been used to store identification information like serial number, control number, date etc.

2.2 Connectors and Signals

Module bus connector

Rear panel 25-pin female D-connector (X1):

Pin No	I/O	Signal
1	I	RESET RS485*
2	I	-15 VDC
3	I	+15 VDIRTY*
4	I	+15 VDC
5	I/O	-DATA RS485*
6	I/O	DATA RS485*
7	-	Ground & Shield*
8	I	-RESET RS485*
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13	-	Ground & Shield*
14	I	+32 VDIRTY
15	I	GroundDIRTY*
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20	-	ON/STANDBY
21	-	BIT0IN
22	-	RXDD RS232
23	-	TXDD RS232
24	I	+5 VDC*
25	I	+5 VDC

*Used in M-NSAT module

Test connector (X11):

Pin No	Voltage	Name	Note
1	+5V	+5VTEST	Supply voltage to NSAT-board
2	+5V	+5Vn	Supply voltage to MP-203 board
3	+15V	+15Vn	Supply voltage to the MP-203 board
4		GND	FGND
5		-15V	-15Vn
6			N/C

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex for repair.

Datex 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 shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

3.2 Visual inspection

If the module is disassembled, check that grounding wires and all connectors are properly connected and there are no loose objects inside the module before attaching the module box.

3.3 Functional checks

_: Insert the NSAT module into the monitor frame

_: Turn the power on by STBY switch. Within 25 seconds, SpO_2 field should appear on the display or replace the SpO_2 field of the plugged ESTPR (or ESTR) module. (If not, select Module to be the SpO_2 source in Interfacing menu (Monitor Setup - Install/ Service) and plug NSAT in again. Check also that pleth is selected on the display.

_: No error message appears.

_: Pull out the module. The SpO_2 field disappears or is replaced by the SpO2 field of the ESTPR (or ESTR) module module within 25 seconds. A message 'M-NSAT module removed' appears.

_: Reinsert the module while the power is still on. The SpO_2 field appears on the display again.

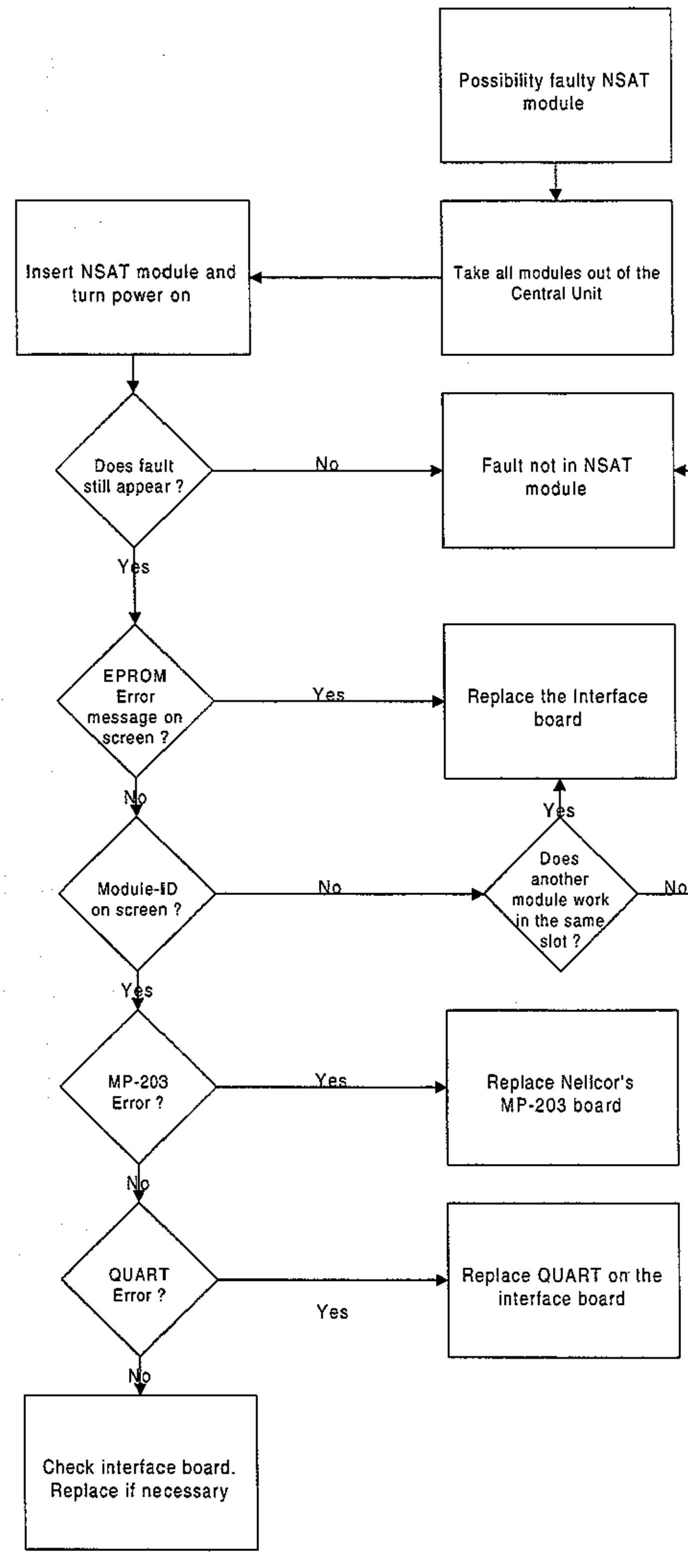
_: Connect a finger probe to the module. The message Pulse search followed by Check probe in 20 seconds should appear on the display. No waveform coming from NSAT appears.

_: Attach the probe to your finger. A reading of 95 to 99 and SpO_2 wave form should appear.

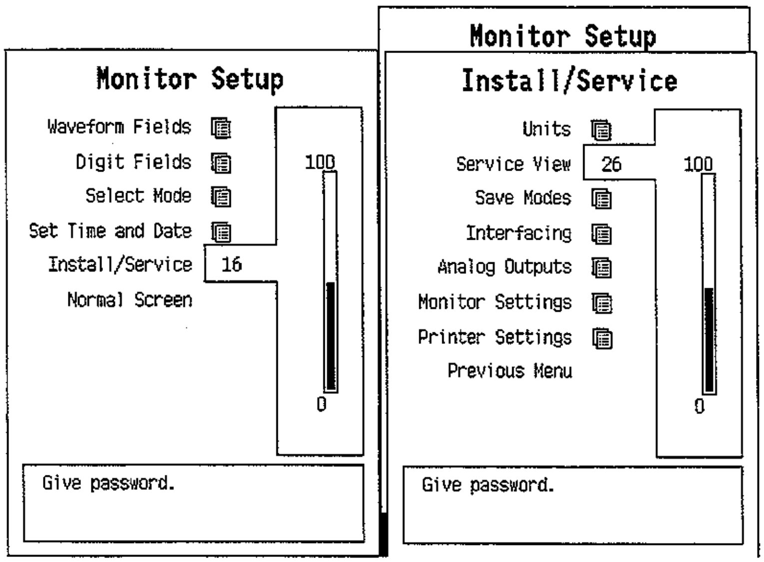
4. TROUBLESHOOTING

PROBLEM	CAUSE	TREATMENT
Message 'No probe'	1. No probe connected to the module 2. Probe faulty 3. Wrong type of probe (not specified to be used with this module)	1. Check probe connections 2. Change probe 3. Change probe (see possible probe types: Operator's Manual)
Message 'Check probe'	1. No probe attached to the patient 2. The extension cable not connected to the probe 3. Unsuitable site 4. Probe faulty 5. Wrong type of probe (not specified to be used with this module)	1. See that the probe is properly attached to the patient 2. Check that the probe is connected to the cable 3. Try another place 4. Change probe 5. Change probe (see possible probe types: Operator's Manual)
Finger probe falls off	1. Probe is slippery 2. Finger is too thin or thick	1. Follow Nellcor's instructions on this matter 2. Try other fingers or other probe types
Weak signal artifacts	1. Poor perfusion 2. Movement artifacts 3. Shivering	Try another place
Message 'No pulse'	Acceptable pulses were present but have now ceased for 10 seconds	Try other fingers

4.1 Troubleshooting chart



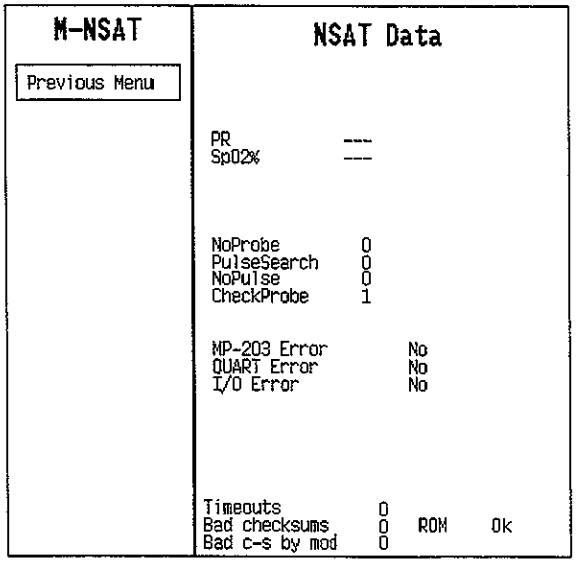
5 SERVICE VIEW



To enter Service Menu during normal operation:

1. Press the MONITOR SETUP key.
   The Setup menu appears.
2. Turn ComWheel to highlight Install/Service and push.
3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.
4. Turn the ComWheel to highlight Service View and push.
5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.
6. Turn the ComWheel to highlight the M-NSAT module and push.
7. Turn the ComWheel to highlight the right module and push.

5.1 M-NSAT Service menu



PR shows the pulse rate value [bpm] calculated from pleth.

SpO_2% shows the oxygen saturation value multiplied by 100.

Next are listed the **messages** that are sent from the module to the monitor. Digit '0' means that the message is not active, '1' is for the active one.

MP-203 Error is set as Yes if any error message is sent by the Nellcor MP-203 board.

QUART Error displays Yes if an error is detected in the data communications device QUART which is located in the Interface board.

The status of **I/O Error** is Yes when an error occurs in the communication between MP-203 and the Interface board.

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 broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The AS/3 Monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a

failure, but the continuous counting (more than 50 per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

ROM indicates whether the checksum in the EPROM is in accordance with the one the software has calculated.
The state is either **OK, Fail** or **?** (module not in place or a communication error).

6 SPARE PARTS

6.1 Spare part lists

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

Nellcor Compatible Saturation Module, M-NSAT

Rev. 00

Item	Item description	Order No.
6	Interface board, M-NSAT	*884383
7	SpO2 measuring board, M-NSAT	*90310
8	Jumper	54091
9	Connector board, M-NSAT	*884950
4	Front panel frame, M-NSAT (Rev. 00)	884012
10	Front panel sticker, M-NSAT (Rev. 00) (Eng)	884424
10	Front panel sticker, M-NSAT (Rev. 00) (Ger)	885779
10	Front panel sticker, M-NSAT (Rev. 00) (Fre)	885780
10	Front panel sticker, M-NSAT (Rev. 00) (Spa)	886192
10	Front panel sticker, M-NSAT (Rev. 00) (Swe)	886126
10	Front panel sticker, M-NSAT (Rev. 00) (Dut)	886125
10	Front panel sticker, M-NSAT (Rev. 00) (Ita)	886759
14	EMC-cover, M-NSAT	884701
12	Insulation plate 1., M-NSAT	884700
13	Insulation plate 2., M-NSAT	884705
1	Module box (single width)	886167
3	Latch	879181
2	Spring pin	879182
11	Metal frame	879184
5	Cross recess screw M3x8 black	616215
13	Cross cylinder head screw M3x6	61721
14	Cross cylinder head screw M3x12	628700
15	Cross cylinder-head screw M3x8	628712
16	Bushing	(640430) Use 63392

Rev. 01

Item	Item description	Order No.
4	Front panel frame, M-NSAT (Rev. 01)	887842
10	Front panel sticker, M-NSAT (Rev. 01) (Eng)	888296
10	Front panel sticker, M-NSAT (Rev. 01) (Ger)	888297
10	Front panel sticker, M-NSAT (Rev. 01) (Fre)	888298
10	Front panel sticker, M-NSAT (Rev. 01) (Spa)	888299
10	Front panel sticker, M-NSAT (Rev. 01) (Swe)	888335
10	Front panel sticker, M-NSAT (Rev. 01) (Dut)	888336
10	Front panel sticker, M-NSAT (Rev. 01) (Ita)	888337
10	Front panel sticker, M-NSAT (Rev. 00) (Fin)	888874
16	Bushing	63392
17	Cable lock, M-NSAT	887706

* = the part is recommended for stock

6.2 Exploded View

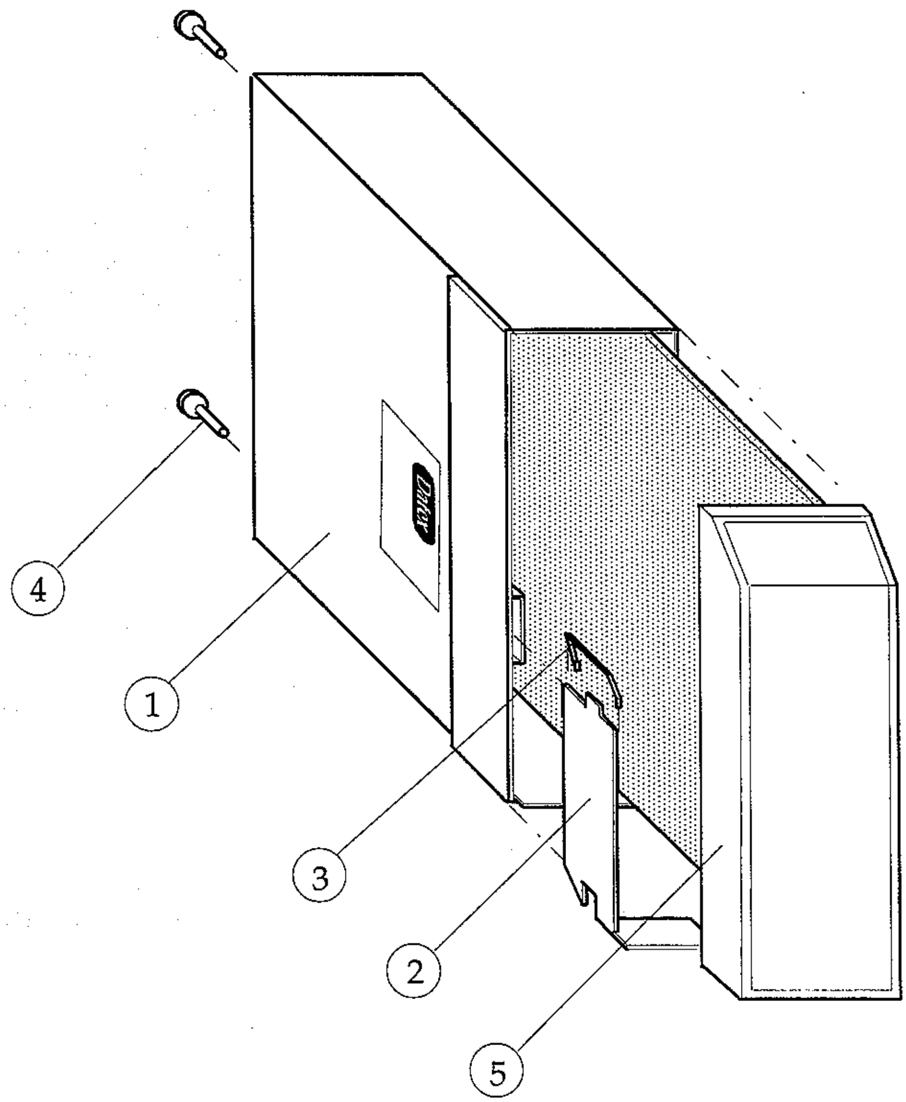


Figure 2 Exploded View of Module Box

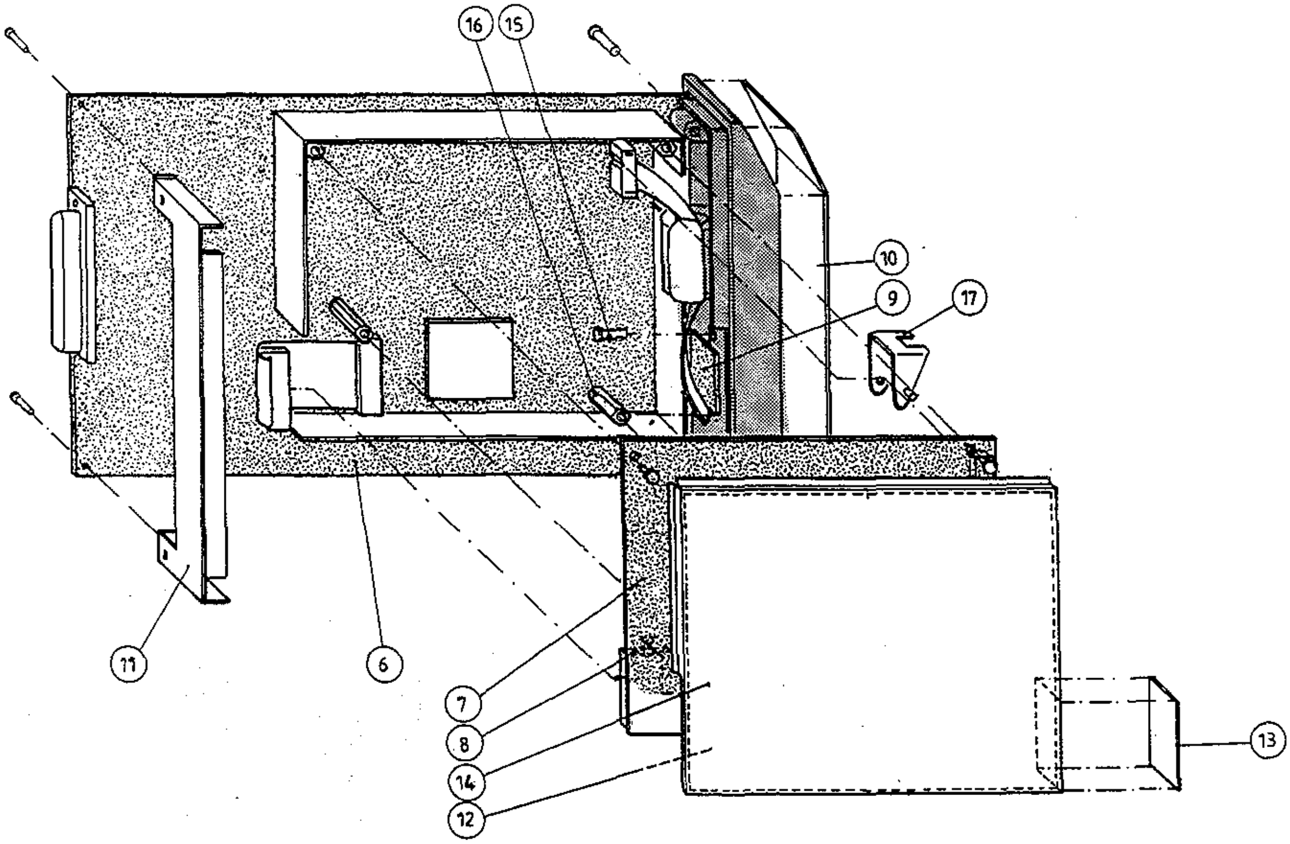


Figure 3 Exploded View of the M-NSAT Module

7 EARLIER REVISIONS

This manual fully supports earlier revision of M-NSAT module.

Network Board, B-NET (Rev. 00)

All specifications subject to change without notice

Document No. 885941-2

March, 1996

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Table of Contents

INTRODUCTION

The Datex AS/3 Network Board enables connecting the AS/3 monitor to the network. For installing the board please refer to the Installation Manual of your monitor.

1 TECHNICAL SPECIFICATIONS

Meets IEEE802.3 specifications (10BASE-T)

Hospital grade approved data transformer

Coding element interface

64 Kbyte linear shared-memory/8x8Kbyte paged shared-memory

Support xxx86 real/protected mode programming

Electrical requirements	+5 Vdc/400 mA

2 FUNCTIONAL DESCRIPTION

2.1 General

The B-NET board block diagram is shown in figure 2-1.

The network interface controller is basically the heart of the B-NET board. The interface controller communicates with the CPU board through the data and address buffering and decoding block, or through the RAM. During the startup sequence the CPU board loads the network communication software into the RAM. The processor then executes the communication software.

The network interface controller transmits data packets to the AS/3 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 interface controller. The LEDs are not visible when the board is installed into the monitor.

The coding element interface block contains a unique network address. The interface block is connected to 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 board through the data and address buffering and decoding block.

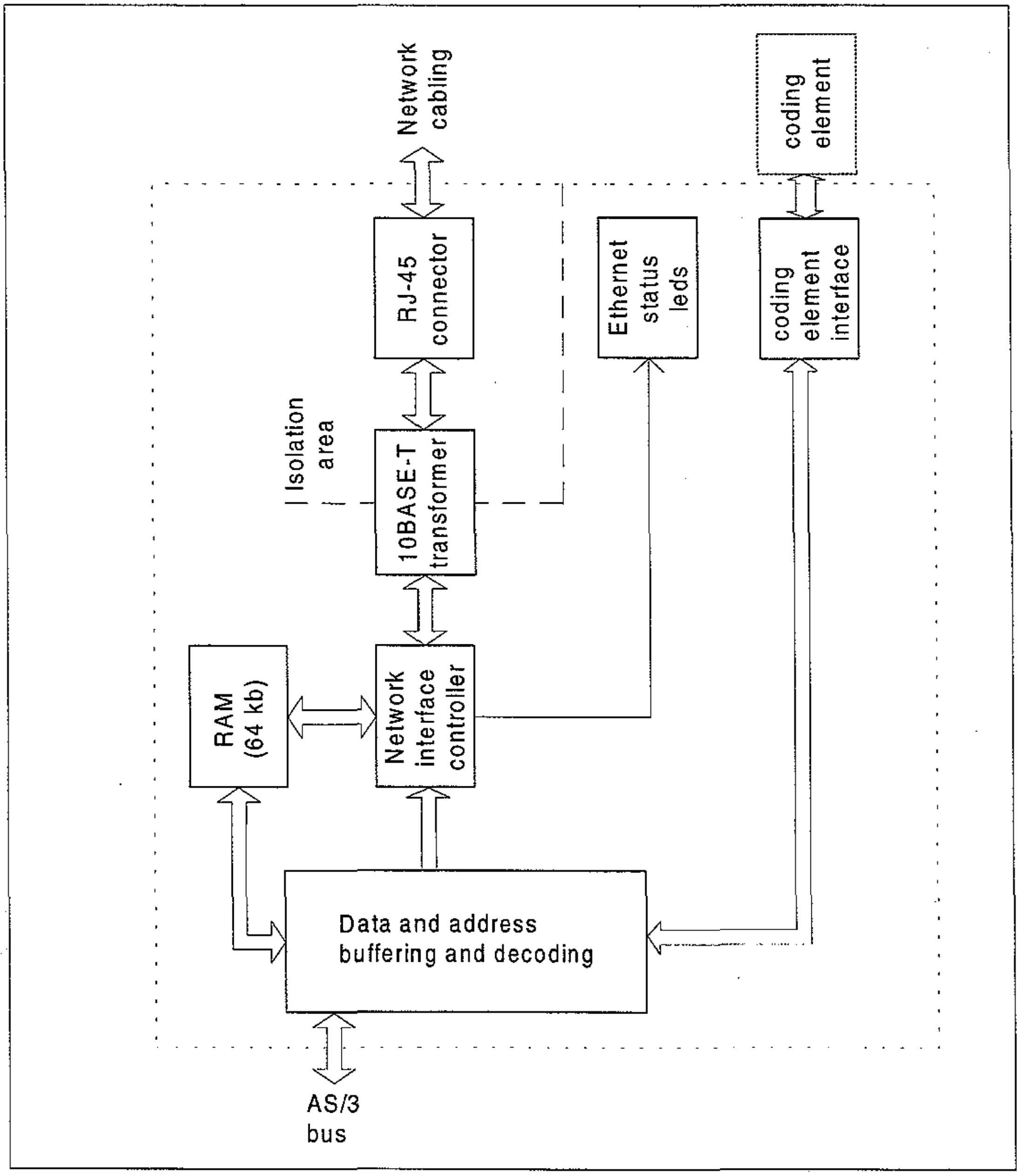


Figure 2-1 B-NET Block Diagram

2.2 Control Logic

Adapter board consists of the following parts:

- IO-decoding
- buffer memory page selection and series EEPROM control register
- memory decoding and interrupt selection register
- memory decoding
- buffer memory page selection and series EEPROM status buffer
- coding element interface
- bus arbitration

2.3 Coding Element Interface

At the edge of the adapter board there is a 9 -pin female D-connector, see Chapter 2.5 Connectors and Signals.

2.4 Ethernet Interfaces

The data transformer is designed by Datex and hospital grade approved.

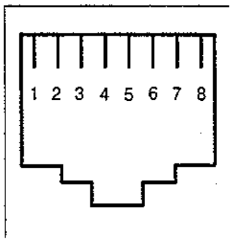
Adapter's 10BASE-T interface is a normal interface with 7-pole butterworth low-pass filter on unisolated transmit side of the transformer and 7-pole butterworth lowpass filter on unisolated receive side of the transformer. On the isolated side of the transformer there is a common mode choke both for transmitting and receiving lines.

There are also two pairs of LEDs indicating following things:

- transmission to Ethernet	(V14)	Green
- receiving from Ethernet	-"-	Yellow
- collision detection	(V15)	Yellow
- good link in 10BASE-T interface	-"-	Green

2.5 Connectors and signals

The pin assignments on the external Network Connector locating on the Network Board are as follows.



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

9-pin female D-connector (X2):

Pin	Signal
1	IDCS1 (chip select)
2	IDCL (clock)
3	IDDI (data in)
4	IDDO (data out)
5	IDPE (protect enable)
6	+5Vdc
7	unused
8	unused
9	gnd

CPU Bus connector (X1):

	a	b	c
1	+15 V	AGND	DGND
2	-15 V	BALE	DGND
3	SA0	SA1	DGND
4	SA2	SA3	RESET_RS485
5	SA4	SA5	-RESET_RS485
6	SA6	SA7	DATA_RS485
7	SA8	SA9	-DATA_RS485
8	SA10	SA11	TXDD_RS232
9	SA12	SA13	RXDD_RS232
10	SA14	SA15	BIT0IN
11	SA16	SA17	BIT1IN
12	SA18	SA19	TXDC
13	SA20	SA21	RXDC
14	SA22	SA23	RTSC
15	-SMEMR	-SMEMW	CTSC
16	-IOR	-IOW	TXDB
17	CLK	-RESET	RXDB
18	-IOCHRDY	IRQ10	RTSB
19	N/C_1	IRQ11	CTSB
20	N/C_2	IRQ12	TXDA
21	-SBHE	IRQ15	RXDA
22	SD0	SD1	RTSA
23	SD2	SD3	CTSA
24	SD4	SD5	LOUDSPEAKER
25	SD6	SD7	+5 V
26	SD8	SD9	+5 V
27	SD10	SD11	+5 V
28	SD12	SD13	+5 V
29	SD14	SD15	ON/STBY
30	+15 VD	-RESET_CPU	+5 V_CPU
31	+15 VD	+32 VD	REFRESH_WD
32	GNDD	GNDD	POWER_FAIL

2.5.1 Extension Lead

Every B-NET Board is equipped with an Extension Lead which facilitates the connecting and disconnecting the cable.

3 SERVICE PROCEDURES

Due to the nature of the Network Board, field service for the board is limited to troubleshooting. The boards are returned to Datex for repair.

Datex 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 tools and equipment are allowed to perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

Please, refer to the Installation Manual of your monitor for information on how to remove the Network Board.

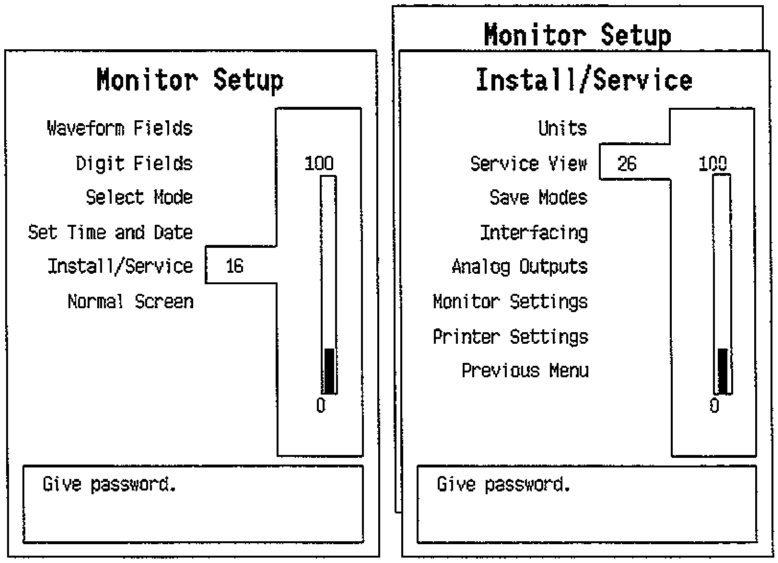
4 TROUBLESHOOTING

Symptom at the monitor end	Problem at	Explanation/correction
Monitor does not connect to network. Monitor connects to 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	HUB not connected to power supply.
	HUB	HUB port closed due to physical layer problems.
	HUB	HUB port temporarily closed and reopened due to physical layer problems.
	HUB	HUB's not properly connected to each other.
	Monitor-Network cable	Cable not properly connected to wallplate or to monitor.
	Monitor-Network cable	Cable or connector defective.
	Network board	The network board is defective. The board cannot be used. See network service page for details.
	Network board EEPROM	The EEPROM of the network board is defective or uninitialized. The board cannot be used. See network service page for details.
	Identification plug	There is no Identification plug properly attached to the monitor.

	Identification plug	The identification plug is defective or uninitialized. The plug cannot be used
"Network EEPROM Error" message shows on the monitor screen	Network board EEPROM	The EEPROM of the network board is defective or uninitialized. The board cannot be used. See network service page for details.
"Check network connectors" message shows on the monitor screen	Monitor-Network cable	Cable not properly connected to wallplate or to monitor.
	Monitor-Network cable	Cable or connector defective.
	Identification plug	There is no identification plug properly attached to the monitor.
	Identification plug	The Identification plug is defective or uninitialized. The plug cannot be used. See network service page for details.
"Network board error" message shows on the monitor screen	Network board	The network board is defective. The board cannot be used. See network service page for details.
	Network board EEPROM	The EEPROM of the network board 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 AS/3 Network Setup to verify current Monitor-to-monitor communication set up.
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 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 AS/3 Network Setup to verify the current set up.

5 SERVICE VIEW



To enter Service Menu during normal operation:

1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.

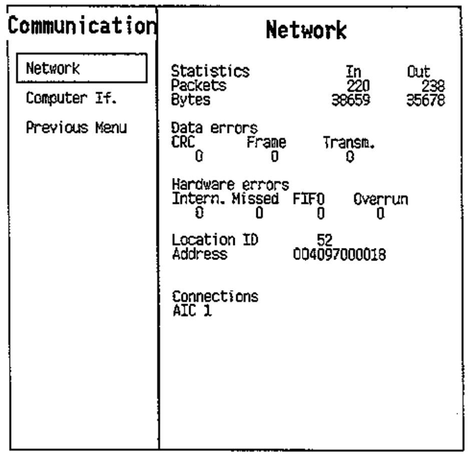
4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

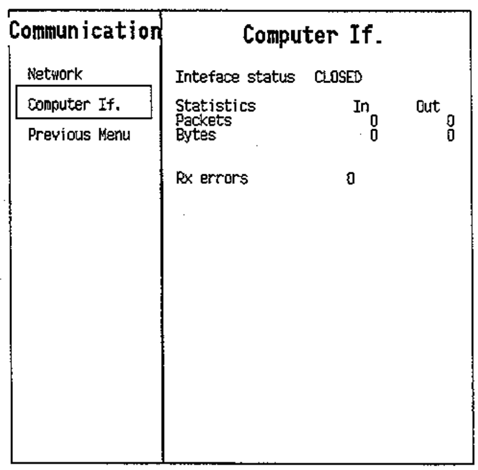
6. Turn the ComWheel to highlight "Monitor" and push.

7. Turn the ComWheel to highlight "Communication" and push.

8. Under Communication there are two service views about networking: Network , and Computer Interface. Highlight the desired one and push ComWheel.



Network displays network related service data. Please see the chart on the next page.



Computer If. displays computer interface related service data.

Interface status indicates if the connection is closed, opened or active. Closed indicates that the necessary hardware is not present or is not available, Opened indicates that the hardware and software for the interface is running, but there is no network connection or that there has been errors in using the interface (e.g., no cable connected), and active indicates that the interface is operating normally.

Rx errors indicates the number of received erroneous packets.

In the Network menu there are additionally following items that describe the communication in the network.

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.
Location ID	Monitor's location given at the setup	
Address	Monitor's ethernet address	
Connections	Names of AICs connected	

6 SPARE PARTS

Network Board, B-NET

Item description	Order No.
Grounding plate	885414
Network cable extension	*713698

* = the part is recommended for stock

7 EARLIER REVISIONS

There are no earlier revisions of B-NET.

Interface Board, B-INT (Rev. 00)

All specifications subject to change without notice

Document No. 885942-2

March, 1996

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Table of Contents

INTRODUCTION

The B-INT board provides an interface between AS/3 Anaesthesia Monitor and other monitors connected to it. It also provides a connection between the monitor frame and the Airway Module.

The list of the monitors that can be interfaced, and parameters available from them, is in the installation manual of your monitor.

1 SPECIFICATIONS

1.1 Serial I/O Definitions

- RS-232 buffered (channels 1-4)
- All standard baud rates are possible from 300 to 115200
- Every interfaced device has fixed baud rate.

1.2 Analog Definitions

- There are four analog inputs available on channel 1 and 2.
- All analog inputs are Op-Amp buffered, with input impedance of 1 MΩ. Each of these analog inputs are also equipped with a 1 MΩ pull-down resistor to -12 V for NC-detection.
- Sampling rate: 10 ms/sample/channel
- Input range: -10 V - +10 V
- Resolution: 10 bits -> 1024 voltage levels in range

2 FUNCTIONAL DESCRIPTION

B-INT detects and identifies the specified monitors connected to its four 9-pin connectors (one D-connector and three pin row connectors). The identification is made by a serial string.

There are three pin row connectors on the board surface. Two for serial and analog connectors (for all interfaces) and one for serial and digital connector.

In the back panel of the board there are two connectors; a 9-pin serial D-connector and a 25-pin D-connector. The 25-pin D-connector is used for connecting the Airway Module (as the Gas interface board is removed when B-INT is installed).

If both numerical and analog real time waveforms are desired, the external monitor can be connected to the serial/analog connectors (X7 and X8) using additionally interface connector cable.

For detailed installation instructions please refer to AS/3 Anaesthesia Monitor Installation Manual.

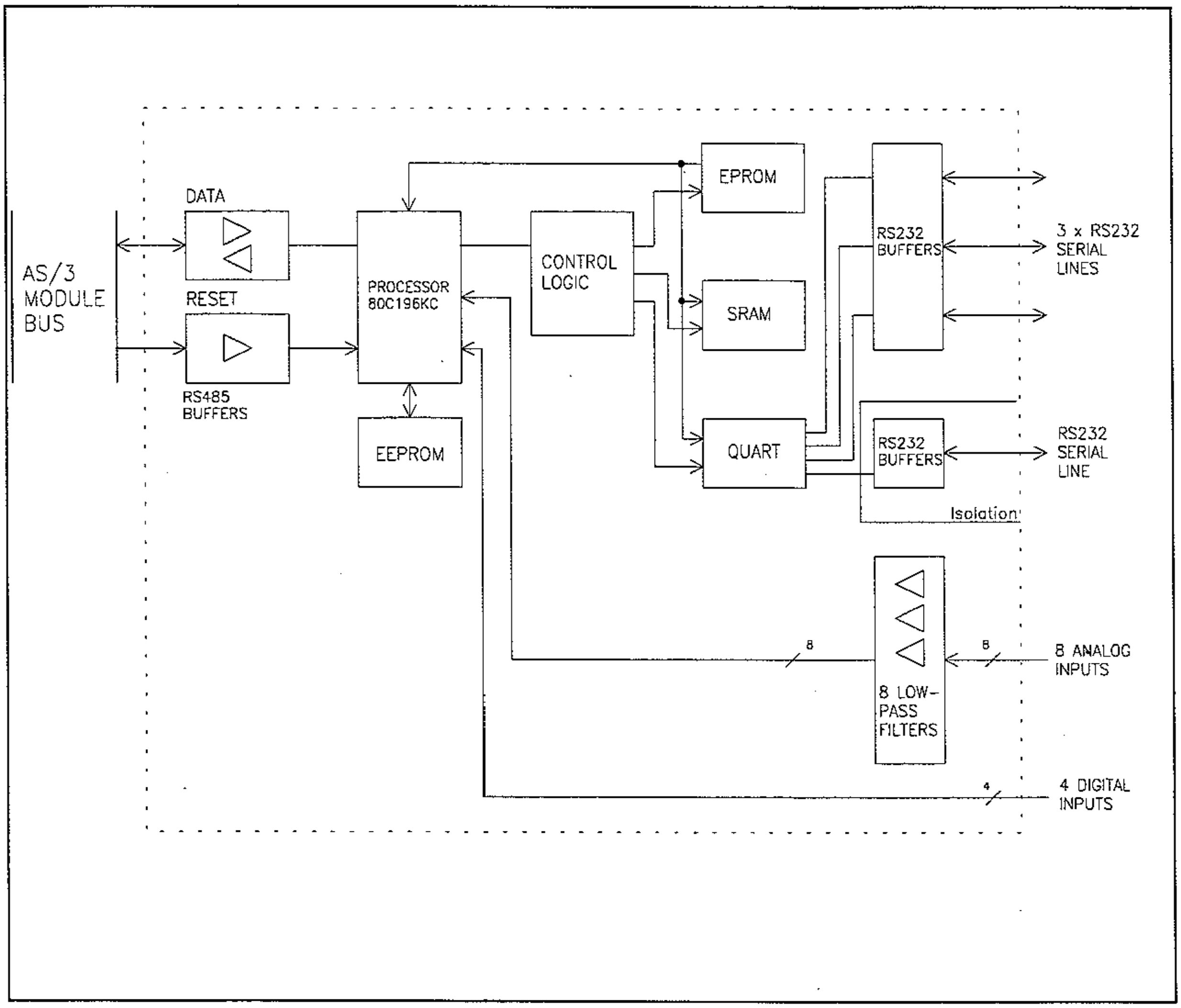


Figure 1 B-INT Block Diagram

2.1 Main Components

In general

The board contains 80C196KC16 (Intel) microcontroller.

External connections

The connectors of the board are:

- 96-pin E-connector to the CPU mother board (X1)
- 25-pin D-connector for an Airway module (X2).
- 9-pin D-connector. It is RS-232 level isolated serial connector (X3). No analog inputs available.

In addition, three connectors on the board make the following connections possible with AS/3 interface connector cable:

- RS-232 level serial and analog connectors for all interfaces (X7, X8).
- RS-232 level serial and digital connector (X9).

X7 and X8 connectors are for analog inputs (four inputs each) and X9 connector is for digital inputs (four inputs). Analog real-time waveforms are interfaced through X7 and X8 connectors. Also X3 and X9 connectors can be used to interface waveforms from Dräger Cato and Cicero.

The board is connected to the AS/3 module bus through the CPU mother board.

Serial communication signals for transmitting (TxD) and receiving (RxD) are sent to the microcontroller ports. The direction of the communication is controlled by REC/SND/ signal at the buffers. RESET/ signal always reset the communication to RxD state.

Reset

The Interface board is resetted when AS/3 Central Unit is reset (MAIN/RESET/) or when the module bus is reset (RESET_RS485).

The RESET/ signal is sent to address decoding GAL circuit, from which it goes to the microcontroller as RESET/Z. When the RESET/ is active (low), the RESET/Z also goes low and resets the microcontroller.

Serial communication channels

For four serial communication channels (TxD, RxD), there is a QUART. The microcontroller is able to reset the QUART any time by pulling QRESET signal high. The QUART is also reset when the microcontroller is reset; the microcontroller pulls all the port 1 signals high when it resets.

Memories

On the board there is static RAM, EPROM, EEPROM and address decoding GAL unit.

The microcontroller communicates with the EEPROM in serial mode.

Digital inputs

Four digital inputs are connected to connector X9 on the board. They are passed through to the microcontroller's high speed pins (DIGBUS). The digital inputs have an overvoltage protection and a pull-up circuit.

Analog inputs

Eight analog inputs are connected to connectors X7 and X8. They are passed through EMI filters and low-pass filters to the microprocessor's port 0.

Power test connector

There is a power test connector X4.

Pin No	Signal
1	+5 Vref
2	+5 V
3	+12 V
4	DGND
5	-12 V
6	NC

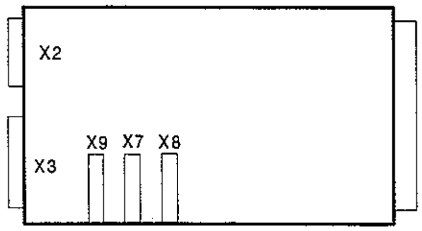
Analog test connector

This connector is for factory tests only.

Fuse

A fuse of 4 A is installed on the board for +24/+32 Vdirty input voltage. This voltage is not used on the board but passed through to 25-pin D-connector on the connector plate for Airway module use.

2.2 Connectors and signals



AS/3 Bus connector (X1):

	a	b	c
1	+15 V	AGND	DGND
2	-15 V	BALE	DGND
3	SA0	SA1	DGND
4	SA2	SA3	RESET_RS485
5	SA4	SA5	-RESET_RS485
6	SA6	SA7	DATA_RS485
7	SA8	SA9	-DATA_RS485
8	SA10	SA11	TXDD_RS232
9	SA12	SA13	RXDD_RS232
10	SA14	SA15	BIT0IN
11	SA16	SA17	BIT1IN
12	SA18	SA19	TXDC
13	SA20	SA21	RXDC
14	SA22	SA23	RTSC
15	-SMEMR	-SMEMW	CTSC
16	-IOR	-IOW	TXDB
17	CLK	-RESET	RXDB
18	-IOCHRDY	IRQ10	RTSB
19	N/C_1	IRQ11	CTSB
20	N/C_2	IRQ12	TXDA
21	-SBHE	IRQ15	RXDA
22	SD0	SD1	RTSA
23	SD2	SD3	CTSA
24	SD4	SD5	LOUDSPEAKER
25	SD6	SD7	+5 V
26	SD8	SD9	+5 V
27	SD10	SD11	+5 V
28	SD12	SD13	+5 V
29	SD14	SD15	ON/STBY
30	+15 VD	-RESET_CPU	+5 V_CPU
31	+15 VD	+32 VD	REFRESH_WD
32	GNDD	GNDD	POWER_FAIL

Rear Panel 9pin male D-connector (X2)

Pin No	I/O	Signal
1		N/C
2	I	RXD RS
3	O	TXD RS
4	O	+5 V
5	O	GND
6		N/C
7	O	RTS RS
8	I	CTS RS
9		N/C

CH 4 (non-floating, off-board D9-connector, X9):

Pin No	Definition
1	D0 digital input
2	RXD
3	TXD
4	D1 digital input
5	GND
6	D2 digital input
7	RTS
8	CTS
9	D3 digital input

Module Bus Connector (X3)

Pin No	I/O	Signal
1	O	RESET_RS485
2	O	-15 VDC
3	O	+15 VDIRTY
4	O	+15 VDC
5	I/O	-DATA_RS485
6	I/O	DATA_RS485
7		Ground & Shield
8	O	-RESET_RS485
9	O	CTSB
10	I	RTSB
11	O	RXDB
12	I	TXDB
13		Ground & Shield
14	O	+32 VDIRTY
15	O	GroundDIRTY
16	O	CTSC
17	I	RTSC
18	O	RXDC
19	I	TXDC
20		ON/STANDBY
21		BIT0IN
22		RXDD_RS232
23		TXDD_RS232
24	O	+5 VDC
25	O	+5 VDC

Connectors for channels 1..4 are 9 pin male D-types, and their pins are described below:

CH 1 (non-floating, off-board D9-connector, X8):

Pin No	Definition
1	A0 analog input
2	RXD
3	TXD
4	A1 analog input
5	GND
6	A2 analog input
7	RTS
8	CTS
9	A3 analog input

CH 2 (non-floating, off-board D9-connector, X7):

Pin No	**Definition**
1	A4 analog input
2	RXD
3	TXD
4	A5 analog input
5	GND
6	A6 analog input
7	RTS
8	CTS
9	A7 analog input

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit board. The board is then returned to Datex for repair.

Datex 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 shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

4 TROUBLESHOOTING

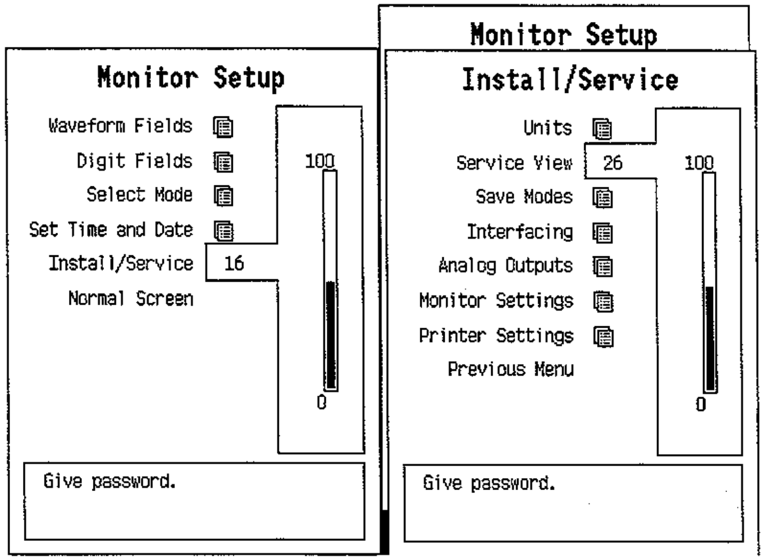
Enter the start Service View, see chapter Service View, 5. Select Scroll Vers and scroll down the SW version/Unit id list. Make sure that the software code and level, control and serial numbers of B-INT are displayed under SIO (B-INT).

If those are not displayed, B-INT is faulty.

TROUBLE	CAUSE	TREATMENT
B-INT not active in the Service View.	Board is not connected properly.	Check that the board is firmly pushed into the connector.
	B-INT faulty	Replace B-INT board and send it for repair.
Measured values from the interfaced monitor do not appear on the display after appr. one minute.	Monitor not selected for interface.	Select right monitor in menu Install Service/Interfacing.
	Poor contact in the interface cables.	Check the cables and connections. Change the cable to another connector.
	Wrong interface cable.	Check cable type and change accordingly.

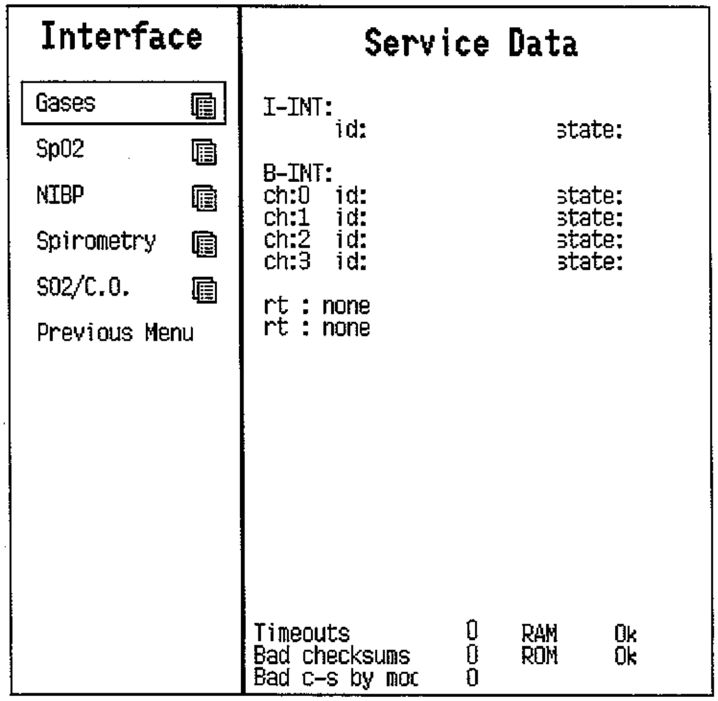
5 SERVICE VIEW

To enter the Service View:



1. Press the MONITOR SETUP key.
   The Setup menu appears.
2. Turn ComWheel to highlight Install/Service and push.
3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34.
   The Install/Service menu appears.
4. Turn the ComWheel to highlight Service View and push.
5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.
6. Turn the ComWheel to highlight Modules and push.
7. Turn the ComWheel to highlight the Interface and push.

Service Data



Gases, SpO_2, NIBP, Spirometry, SO_2/C.O indicates the parameters of which service data is available. The data which can be seen from those pages is raw data of the interfaced monitors, which will be processed for the normal screen.

I-INT Indicates the status of the interface via UPI board.

B-INT Indicates the status of interface via the 4 interface channels of B-INT.

id: The name of the interfaced monitor, e.g. Ultima

state describes the state of the connection, alternatives are:
'init ' -> the channel is initialized
'wait ' -> AS/3 monitor is waiting the external monitor
'online' -> the connection is ready
'search' -> the external monitor is searched

rt: real time values that are available via interface .

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 broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The AS/3 Monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

RAM indicates the state of the external RAM memory.
ROM indicates whether the checksum in the EPROM is in accordance with the one the software has calculated.
The state is either **OK, Fail** or **?** (module not in place or a communication error).

6 SPARE PARTS

NOTE: Accessories are listed in the AS/3 Anaesthesia Monitor Supplies and Accessories.

Interface Board, B-INT

Item description	Order No.
Fuse T4A	*51134
Grounding plate	885404
AS/3 Interface connector cable	*882353

* the part is recommended for stock

7 EARLIER REVISIONS

There are no earlier revision of B-INT, only software changes have been made.

Airway Module, G-O (Rev. 00)

Airway Module, G-OV (Rev. 00)

Airway Module, G-AO (Rev. 04)

Airway Module, G-AiO (Rev. 03)

Airway Module, G-AiOV (Rev. 02)

Airway Module, G-AOV (Rev. 02)

Gas Interface Board, B-GAS (Rev. 01)

All specifications subject to change without notice
Document No. 885944-2

March, 1996

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Table of Contents

GENERAL DESCRIPTION

The AS/3 Airway Modules, G-O, G-OV, G-AO, G-AiO, G-AOV and G-AiOV provide airway and respiratory parameters followingly:

All modules have a side-stream gas sampling system providing measurements of CO_2 and O_2. The G-AO module can also measure N_2O and anaesthetic agents. The modules G-AiO and G-AiOV can additionally identify the anaesthetic agent used. The modules G-OV G-AOV and G-AiOV provide the Side Stream Spirometry measurement which enables the measuring of respiratory parameters near the patient.

Gas Interface Board, B-GAS is used for connecting an Airway Module to the Central Unit. The connection can also be made through the Interface Board, B-INT.

This service manual section provides information required to maintain and repair the Datex AS/3 Anaesthesia Monitor Airway Modules, G-O,G-OV, G-AO, G-AiO, G-AiOV, and G-AOV. This manual is applicable for the current production revision of the modules.

1 SPECIFICATIONS

1.1 General Specifications

Module size W x D x H	135 x 410 x 135 mm 5.3 x 15.0 x 5.3 in
Module weight	6 kg/ 13 lbs

1.2 Typical Performance

Sampling rate	200 ml/min nominal (180 - 220 ml/min)
Display update rate	breath-by-breath

Automatic compensation for pressure, CO_2-N_2O, and CO_2-O_2 collision broadening effect.
Warm-up time 3 min for operation, 30 min for full specifications.

Auto-zeroing is performed at start-up, after 5 min, 5 min., 5 min., 15 min., 15min., 15 min., and after that at 60 min. regular intervals.

CO_2

Measurement range	0 to 10 %, (0 to 10 kPa), (0 to 76 mmHg)
Extended range	10 to 15 %, (10 to 15 kPa), (76 to 114 mmHg)

If CO_2 concentration is below 0.1 %, 0.0 % is displayed.

RESPIRATION RATE

Breath detection	1 % change in CO_2 level
Measurement range	4 to 60 breaths/min

O_2

Measurement range	0 to 100 % O_2

N_2O

Measurement range	0 to 100 % N_2O

HAL, ISO, ENF

Measurement range	0 to 5 %
Extended range	5 to 15 % (unspecified)

SEV

Measurement range	0 to 8 %
Extended range	8 to 15 % (unspecified)

DES

Measurement range	0 to 18 %
Extended range	18 to 25 % (unspecified)

Resolution	two decimals when the AA concentration below 1.0 %

If AA concentration is below 0.10 %, 0.00 % is displayed.

AGENT IDENTIFICATION

Identified agents	HAL, ENF, ISO, SEV, DES
Identification time	30 seconds (typical value with pure agents)
Identification treshold	0.15 vol% (typical)

Mixture warning when minor component concentration > 0.3 vol% and >15 %of total agent concentration

SIDE STREAM SPIROMETRY

Values are valid when:

Respiratory rate adult 4..30 pedi 4..50

I:E ratio is 1:3 - 1:0.5

Inner diameter of ET tube is $\geq$5.5 mm (adult) or 3 to 6 mm (paediatric).

Airway Pressure (Paw)

Accuracy	$\pm$1.5 cmH_2O
Resolution	1 cmH_2O
Measuring range	-20 to +80 cmH_2O

Tidal Volume (TV)

Accuracy (paed)	$\pm$6 % or 30 ml (adult); $\pm$6 % or 4 ml
Resolution	1 ml
Measurement range	150 to 2000 ml (adult) 15 to 300 ml (paed)

Minute Volume (MV)

Resolution	0.1 l/min
Measurement range	2 to 15 l/min (adult)
	0.5 to 5 l/min (paed)

Flow

Measurement range (adult)	1.5 to 100 l/min for both directions
(paed)	0.25 to 25 l/min for both directions

1.3 Technical Specification

CO_2

Measurement rise time	<360 ms (from 10 to 90 %)
Gain stability	<=0.2 %CO_2/24 h (0 to 8 %)
	<=0.4 %CO_2/24 h (8 to 10 %)
Gain temperature drift	<=0.2 %CO_2/10°C (0 to 8 %)
	<=0.4 %CO_2/10°C (8 to 10 %)
Nonlinearity error	<=0.2 %CO_2 (0 to 8 %)
	<=0.4 %CO_2 (8 to 10 %)

O_2

Measurement rise time	<480 ms (from 10 to 90 %)
Gain drift	<=2 % O_2/24 h
Gain temperature drift	<=3 % O_2/10°C
Nonlinearity error	<=2 % O_2

N_2O

Measurement rise time	<360 ms (from 10 to 90 %)
Gain temperature drift	<=3 % N_2O/10°C
Gain drift	<=2 % N_2O/24 h
Nonlinearity error	<=2 % N_2O

AA

Measurement rise time	<520 ms (from 10 to 90 %)
Gain drift	<=0.4 % AA/24 h
Gain temperature drift	<=0.4 % AA/10°C
Nonlinearity error	<=0.2 % AA

Protection against electrical shock   Type BF

2 FUNCTIONAL DESCRIPTION

2.1 Measurement Principle

2.1.1 CO_2/N_2O/AA Measurement

The CO_2, N_2O, and anaesthetic agent gas measurements are based on absorption of infrared light as it passes through the gas sample in measuring chamber in the photometer. The light absorption is measured at three wavelengths using an infrared detector. One of the wavelengths is that of the CO_2 absorption peak at 4.3 micrometers, the second is that of the N_2O absorption peak at 3.9 micrometers, and the third is that of the anaesthetic agent absorption peak at 3.3 micrometers. The signal processing electronics receive the signals from the IR detector and demodulate it to get DC components out of these signals which correspond to the content of each gas in the sample.

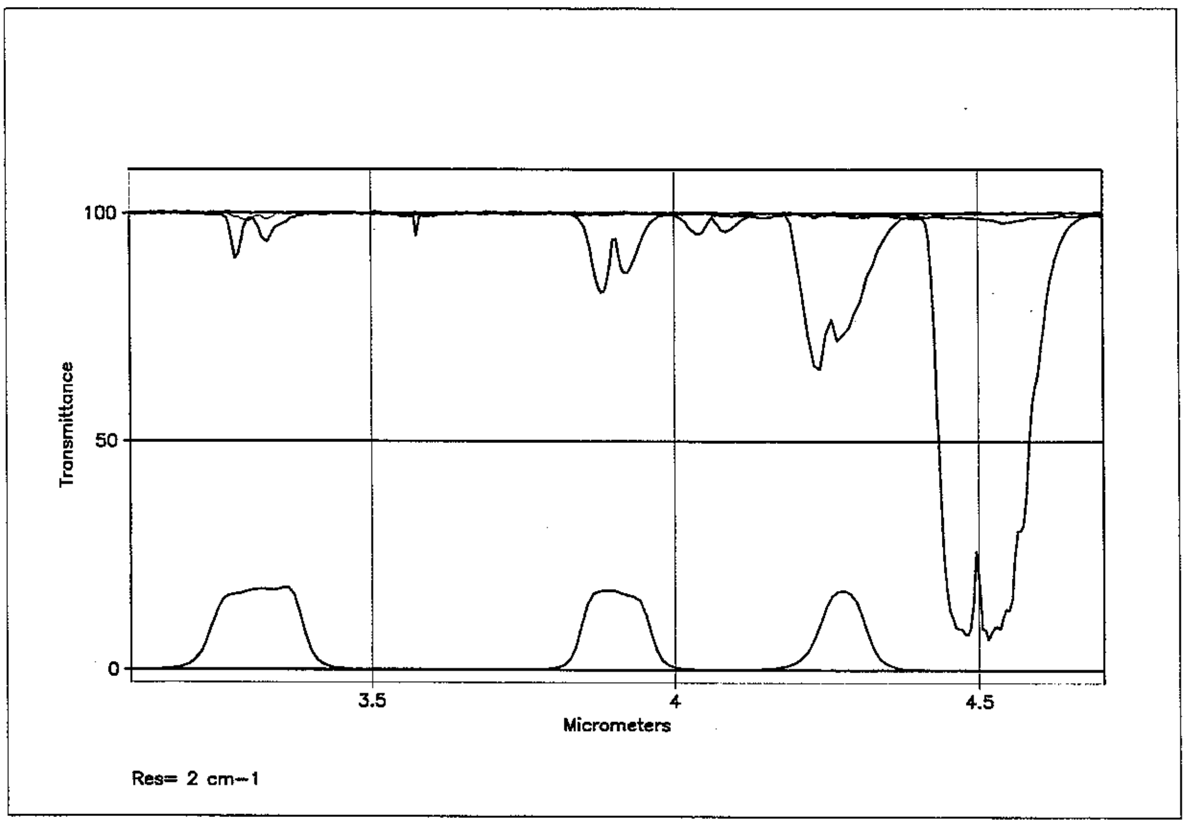


Figure 1 **CO_2/N_2O/AA Gas Absorption Spectra**

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 110Hz. The output signal is a DC voltage proportional to the O_2 concentration difference between the two gases to be measured.

2.1.3 Agent Identification

The anaesthetic agent identification bench identifies Halothane, Enflurane, Isoflurane, Desflurane and Sevoflurane.

The bench measures the spectrum of the gas between 3.24 µm and 3.39 µm. Because the spectrum of each of the anaesthetic agents is different it is possible to identify them.

The bench consists of an infrared source, a measuring chamber, a rotating filter and a detector. The peak wavelength of the narrow bandpass filter changes when the angle between the light path and the filter is changed. When the filter rotates the required spectrum is scanned through. The agent or a mixture of agents is identified by comparing the measured spectrum with stored reference spectra.

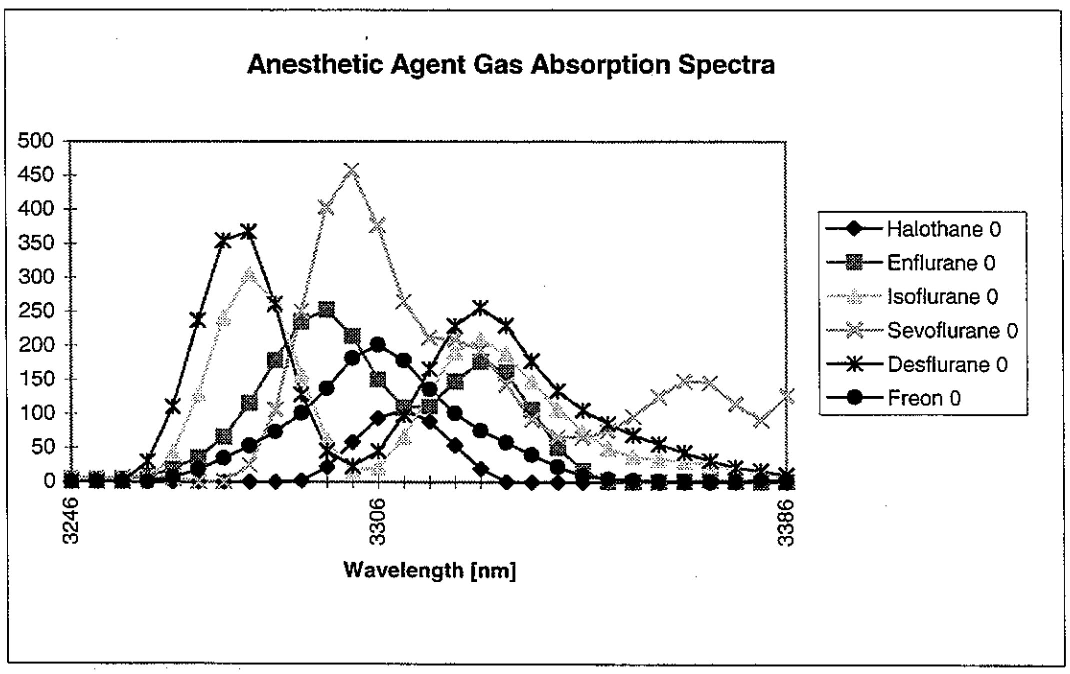


Figure 2 Anaesthetic Agents Gas Absorption Spectra

2.1.4 Side Stream Spirometry

In anaesthesia, CMV (Controlled Mechanical Ventilation) is the mostly used ventilation mode. In this mode, mechanical 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.

Delivery of life support gases is based on pressure. However, without knowing volume measured of exhalation, one cannot be sure that a breath occurred. The ultimate goal of ventilation is to use the least amount of pressure to generate the most appropriate volume for each breath.

The Side Stream Spirometry monitors ventilation in anaesthesia. Both patient breathing circuit and the function of the ventilator are monitored. The following parameters are displayed:

Expiratory and inspiratory tidal volume (TV) in ml.
Expiratory and inspiratory minute volume (MV) in l/min.
Expiratory volume in first second (V1.0) in per cent for adults and in 0.5 seconds for children.
Inspiration/expiration ratio in time (I:E)
Airway pressures: Peak pressure (P_{peak}), End inspiratory pressure (P_{plat}), Positive end expiratory pressure (PEEP), Real time airway pressure waveform (P_{aw})
Flow: Real time flow waveform (V')
Compliance (C)
Pressure volume loop
Flow volume loop

Airway pressure

PEEP, P_{peak}, and P_{plat} are measured by 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 patient circuit and intubation tube.

Airway flow

The measurement is based on measuring the kinetic gas pressure and is performed using Pitot effect. Pressure transducer is used to measure the Pitot pressure. The obtained pressure signal is linearized and corrected according to the density of the gas. Speed of the flow is calculated from these pressure values and TV value is then integrated. MV value is further calculated and averaged using TV and RR (respiratory rate) values.

Side Stream Spirometry Sensor

Side stream spirometry is measured with a specific sensor, D-lite or Pedi-lite. For more information about available sensors, please refer to Datex AS/3 Supplies and Accessories Catalogue.

D-lite and Pedi-lite sensors are designed to measure kinetic pressure by two-sided Pitot tube. The pressure reduction caused by measuring cross is taken into account, too, especially in small flows.

Velocity is calculated from pressure difference according to Bernoulli's law. Flow is then determined using the calculated Velocity.

$v = 2 \times dP / \rho$ (Bernoulli's law)

$F = v \times A$

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 and Block Diagrams

2.2.1 In General

The AS/3 Airway Module contains ACX-200 and OM-101 gas measuring units, ASX-200 agent identification unit (i models), PVX board for measuring airway volume and pressure (V models), tubings, sampling pump, ACX Measuring board and Gas mother board.

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 on the front panel. The pump draws gas through the sampling line to gas measuring units. After the measurements, the gas is exhausted from sample gas out connector on the rear panel of the module.

When Side Stream Spirometry is used, special sensors, D-lite or Pedi-lite, replaces the normal airway adapter in the patient circuit. The spirometry tubing is attached to the two connectors on the sensor and on the module front panel.

The Gas mother board processor controls the module functions, such as power supply to each measuring unit, serial communication between module processor, and ACX Measuring board. There are connectors for the pump, valves, and gas measuring units on the board.

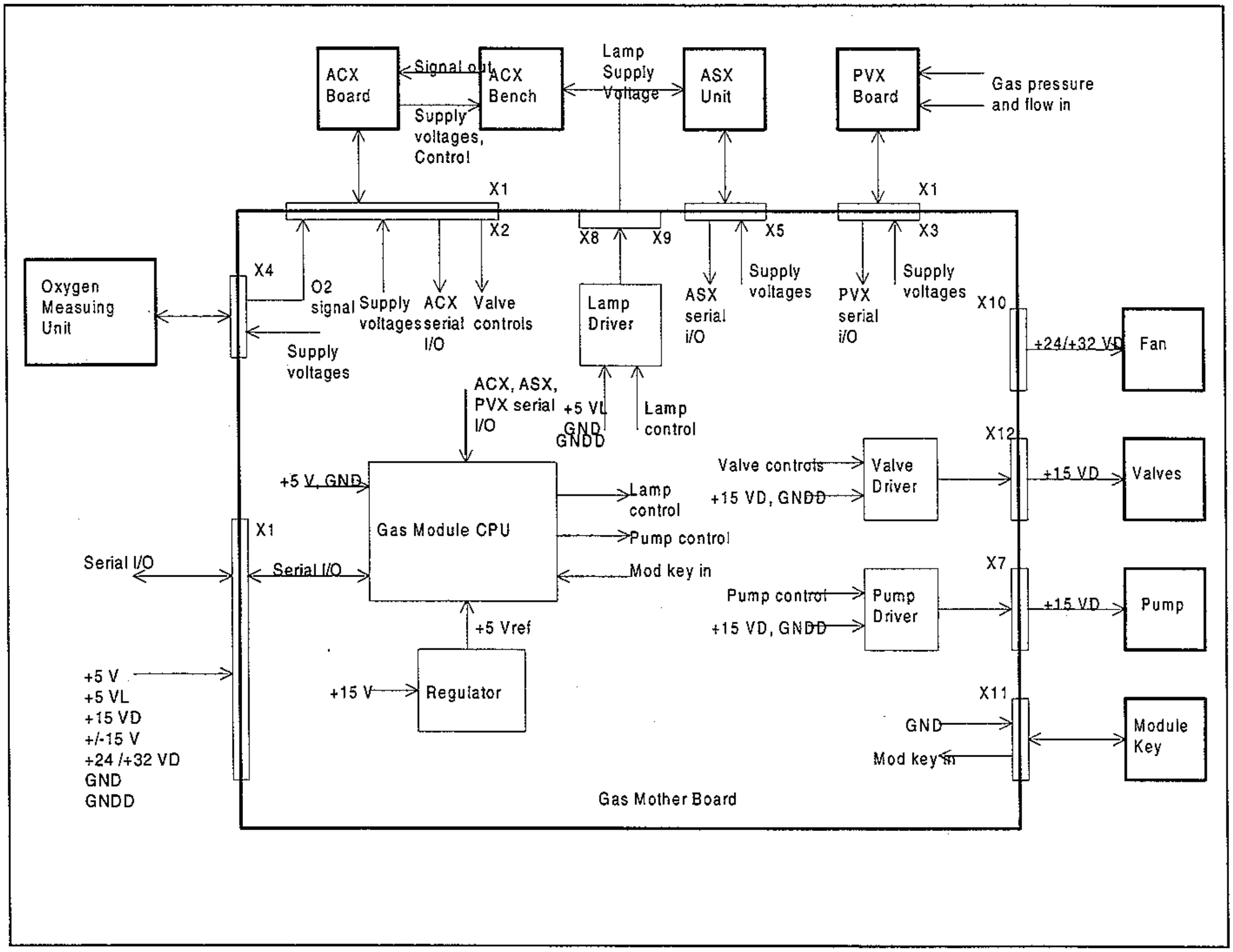


Figure 3 Airway Module Block Diagram

2.2.2 Gas Sampling System

The function of the gas sampling system is to draw sample gas into the monitor gas sensors at a fixed rate and to separate impurities and condensed water from the gas flow.

Water trap

The gas sample enters the monitor through the water trap, where it is divided into two flows, main flow and side flow (see Gas Sampling System Block Diagram). The main flow goes into the measuring system through a hydrophobic filter.

The side flow creates a slight sub-atmospheric pressure within the water trap container. This facilitates cathering the fluid removed by the hydrophobic filter.

Sampling line

The sampling line is an integral part of the total sampling system. The resistance established by the sampling line is significant when the software determines the occlusion and air-leak alarm limits during the turn-on sequence.

The small inner diameter causes fluids such as blood or mucus not to propagate within the tube, so that when the line is clogged, it is replaced.

The Nafion™ tube

A special tube (tubes A or B, and C: see Figure 7) is used 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. It is inserted between the water trap and the zero valve (models with i) or between the zero valve and ACX-200 measuring unit (models without i). The tube is also inserted between the CO_2 absorber and the zero valve.

Nafion is a trade mark of Du Pont.

Zero valve

The main flow passes through a solenoid valve before proceeding to the ACX-200 measuring unit. This valve is activated to establish the zero points for the ACX-200 and O_2 measuring units at start-up, at 5 minutes, and after that at regular intervals. After 1-hour monitoring, the auto-zeroing is performed once an hour. When the valve is activated, room air is drawn through the CO_2 absorber into the internal system and the gas sensors.

Gas measuring units

After the zero valve, the gas passes through the ACX-200 and O_2 measuring units. In the ACX-200 measuring unit, infrared light is passed through chambers containing the main flow gas (measurement) and a chamber containing reference gas. The measurement is made by determining the ratio between the two light intensities.

The oxygen sensor has two inputs. One input accepts the main flow and the other draws in room air for reference. The sensor uses a differential pressure transducer to compare the pressure gradient produced when both gases are exposed to an oscillating magnetic field. Both gas flows exit from a single port.

In i model, the ASX agent identification unit is installed in parallel with the oxygen sensor. The task of the ASX unit is to identify anaesthesia agents by infrared light method used also in the ACX-200 unit.

Pressure valve

The pressure valve is used to measure the pressure gradient between the O_2 measurement flow and the O_2 reference flow. This pressure gradient reflects the condition of the D-fend water trap filter.

Normally the pressure gradient between the O_2 measurement flow and the reference flow is approximately +8 mmHg. If the software detects the gradient to be between 0 and -5 mmHg, the pressure valve will initiate pressure measurement of the reference flow. If the gradient is greater than -5 mmHg, the software triggers the message "REPLACE TRAP".

Flow cassettes

The internal flow rates are set using flow cassettes. These cassettes are used to set the side flow rate and the O_2 reference flow rate, the flow rates through the measuring units and the total flow rate of the sampling system.

Sampling pump and damping chamber

The sampling pump is a vibrating membrane pump driven by a 50 Hz/12 V/0.4 A square wave current.

The damping chamber is used to even out the pulsating flow and silence the exhaust flow.

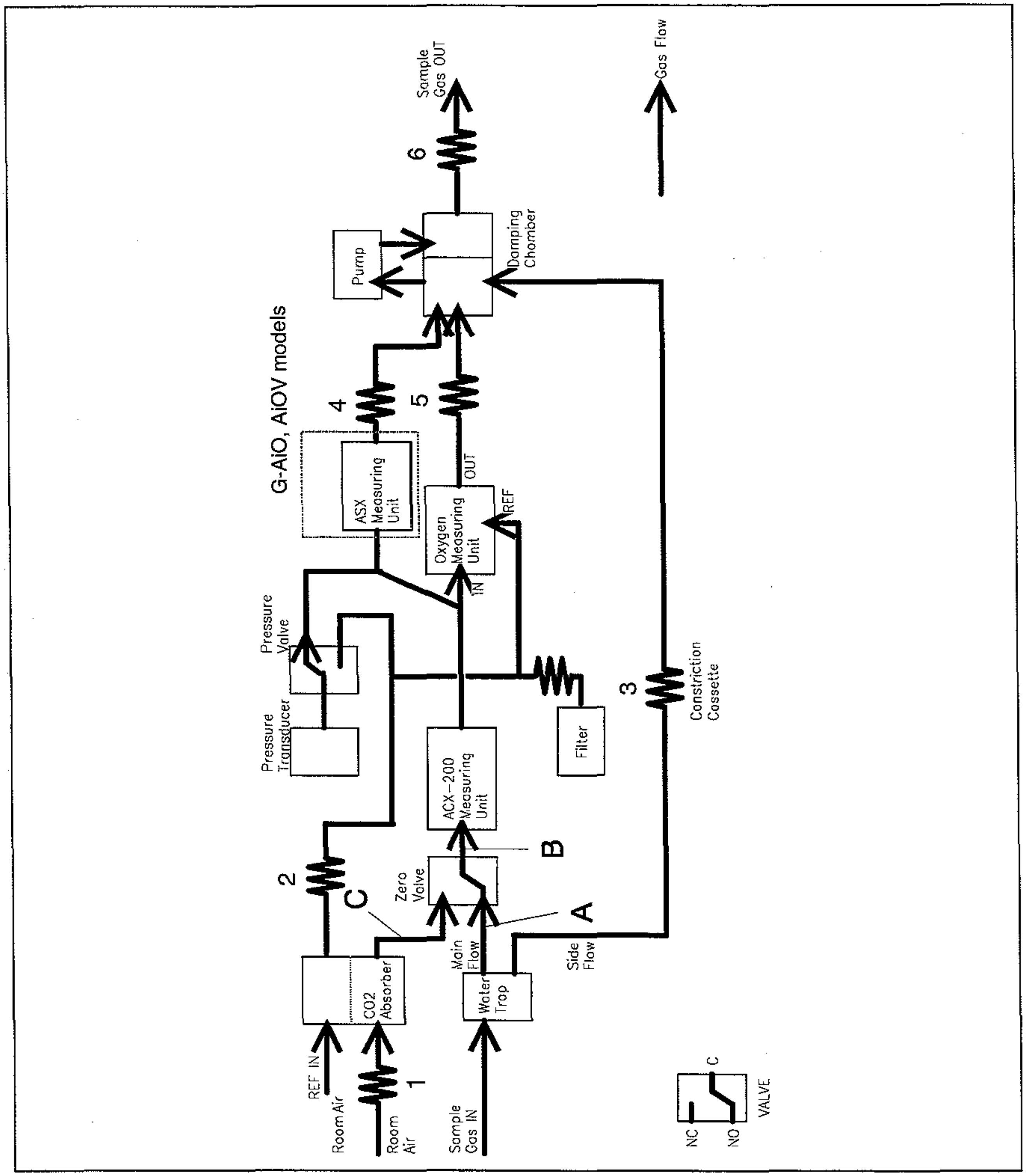


Figure 4 **Gas Sampling System Block Diagram**
In G-AO, AOV models, tube A is Teflon, B and C Nafion.
In G-AiO, AiOV models, tubes A and C are Nafion, B is Teflon.

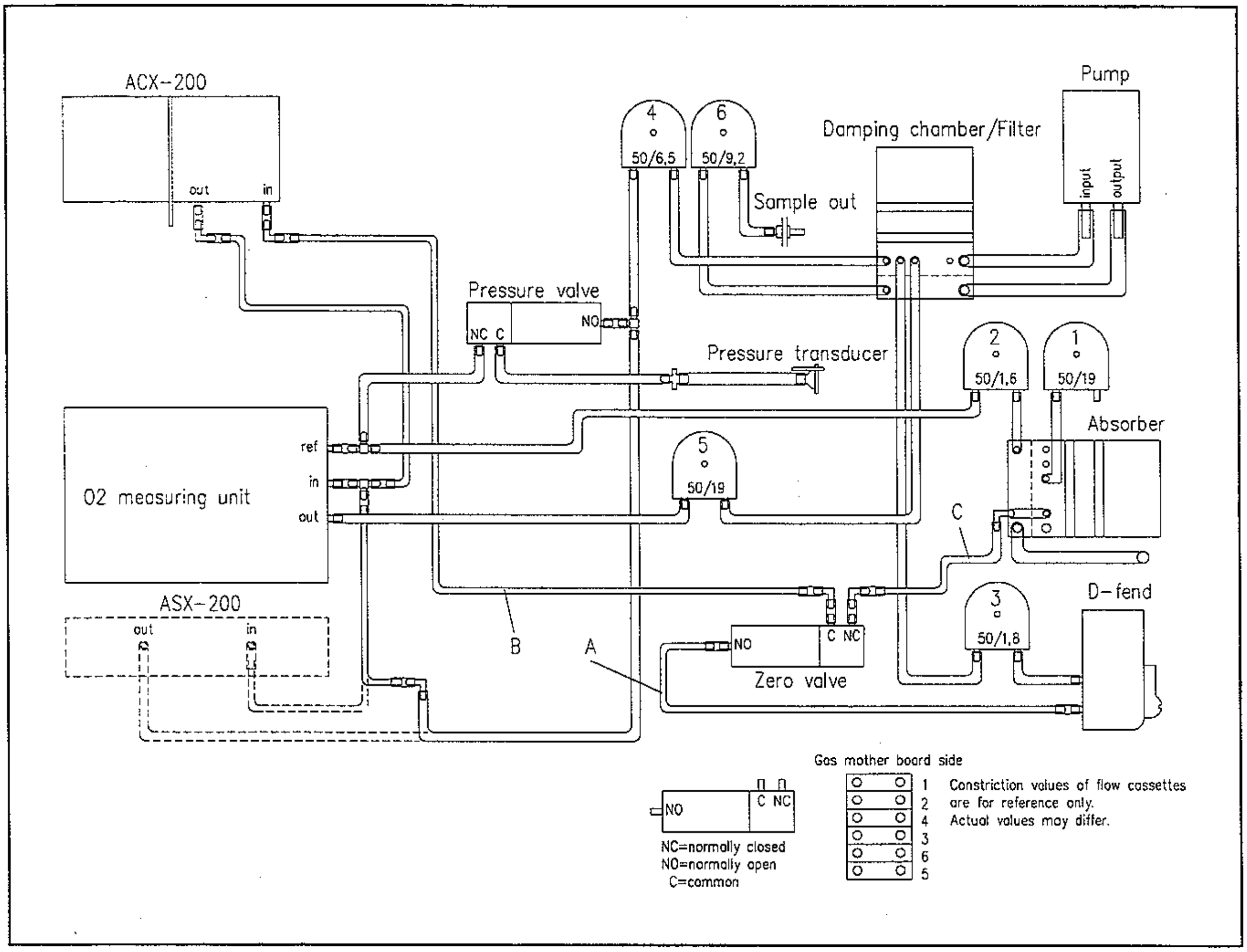


Figure 5 Gas Sampling System Layout

Table 1 Flow Cassettes

FLOW CASSETTE	CODE
50/26.0	878048
50/19.0	873800
50/16.3	878047
50/15.3	873801
50/14.1	878046
50/13.1	873802
50/12.4	878045
50/11.2	874770
50/10.4	873803
50/9.2	874509
50/8.7	873804
50/7.4	873805
50/6.5	878044
50/5.8	873806
50/5.1	878043
50/4.4	873807
50/3.8	878042
50/3.2	873808
50/3.0	878040
50/2.8	878039
50/2.5	878038
50/2.3	873809
50/2.0	878037
50/1.8	873810
50/1.6	878036
50/1.4	873811
50/1.1	873812

NOTE: The number on the cassette represents relative flow when a specific pressure is applied. Therefore 50/26.0 presents the least resistance and 50/1.1 the most.

2.2.3 ACX-200 Measuring Unit

CAUTION: The ACX-200 photometer and its components are repaired/calibrated at the factory. Attempts to repair/calibrate the unit elsewhere will adversely affect operation of the unit. Datex supplies spare ACX-200 photometers. The information provided for the ACX-200 is for reference only.

The ACX photometer is of dual path type. The infrared light beam passes through a measuring chamber containing the gas to be analyzed, and a reference chamber, which is free of CO_2, N_2O, and AA. The measurement is made by determining the ratio between the two light intensities.

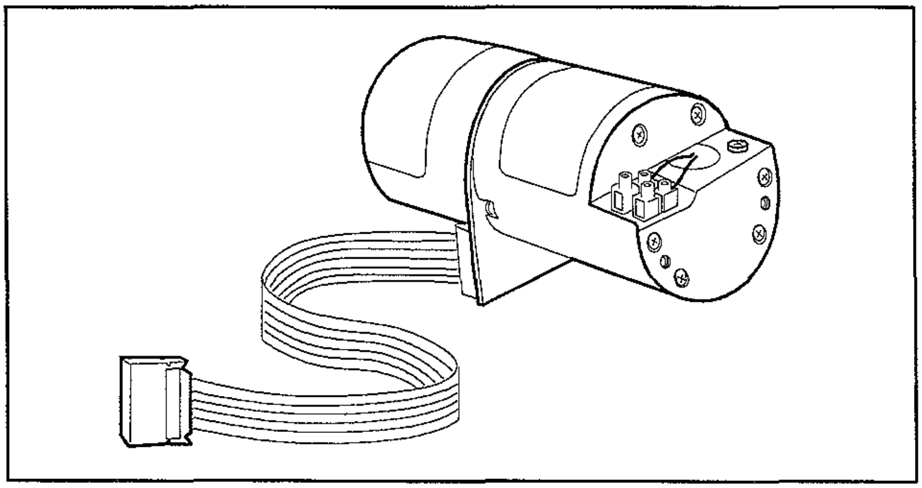


Figure 6 ACX Photometer (ACX-200 Measuring Unit)

A filter wheel is used to control the light from an incandescent lamp that passes through the photometer. The filters are arranged so that the light is passed sequentially:

- first at the CO_2 absorption wavelength through the reference chamber
- then through the measuring chamber
- finally it is blocked completely

The same sequence is repeated at the N_2O and anaesthetic agent gas absorption wavelengths.

After passing through the filters the light is reflected and focused by a mirror onto the infrared detector. This detector measures the three light levels for each gas described above.

There is an optical sensor incorporated in the photometer which detects light from a reflective surface on the filter wheel once every revolution. The pulses from this sensor are used to synchronize the electronics to the signal from the infrared detector. A stabilizing diode measures the temperature, which is needed to compensate for thermal drifts. The infrared detector, the optical sensor and the stabilizing diode are mounted on the preamplifier board.

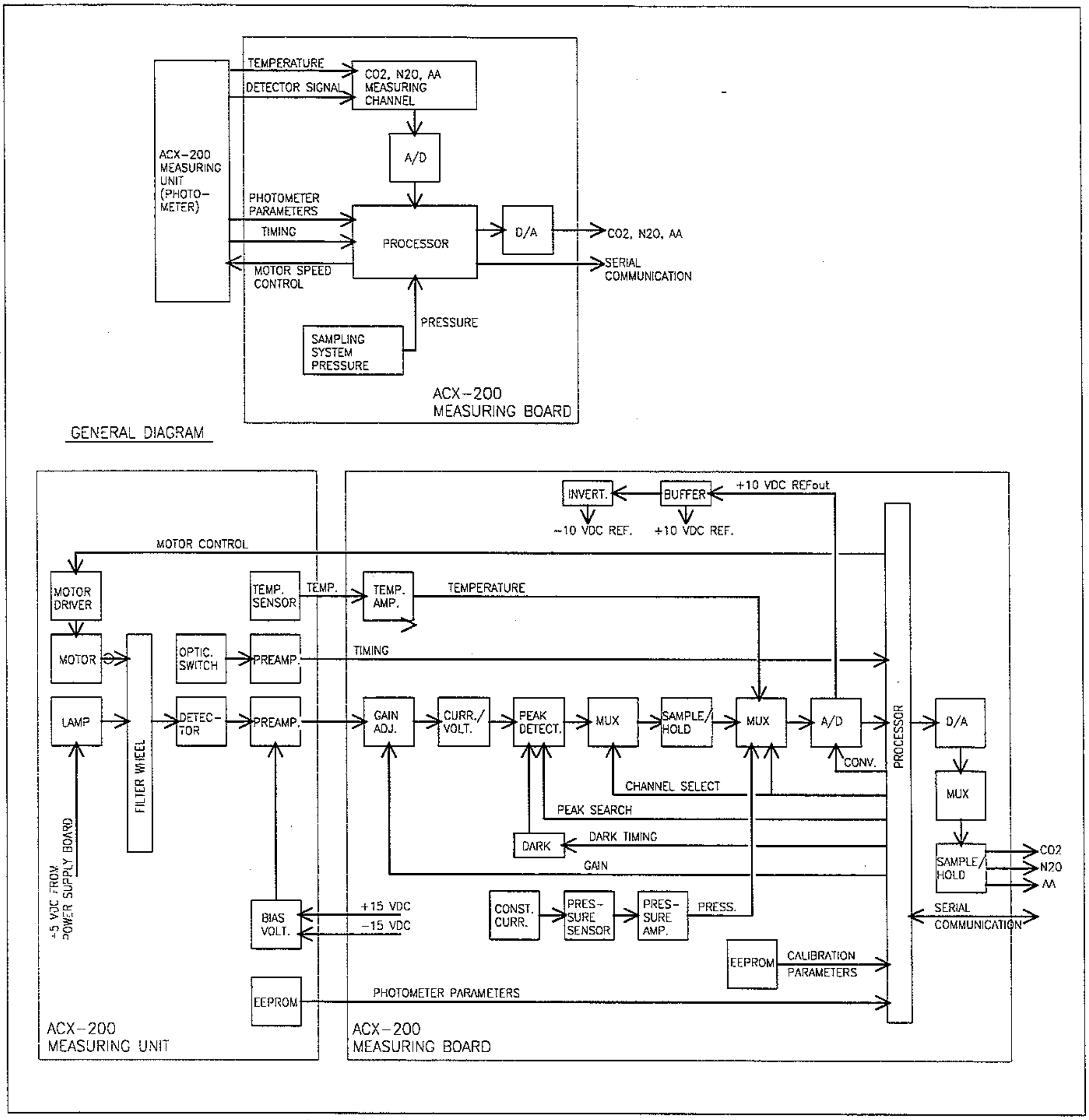


Figure 7 **CO_2/N_2O/AA Measurement Block Diagram**

2.2.4 O_2 Measurement

The oxygen measurement is based on the paramagnetic susceptibility, which is a unique property of oxygen among all gases generally present in a breathing gas mixture. The gas to be measured 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 110 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.

CAUTION: Due to the complicated and sensitive mechanical construction any service inside the O_2 measuring unit should not be attempted.

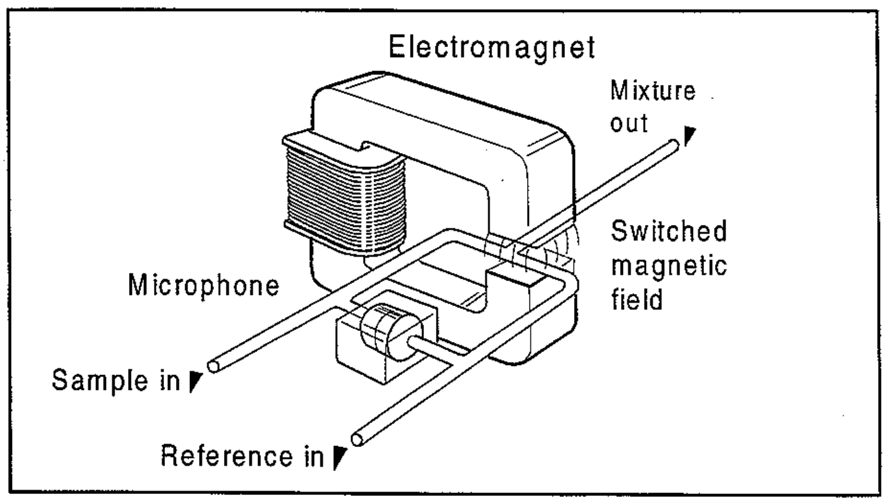


Figure 8 **O_2 Measurement Principle**

2.2.5 ACX Measuring Board

The measuring electronics can be divided into a few functional blocks, which are described below (See the block diagram in Figure 9).

CAUTION: The ACX-200 Measuring board can be repaired and calibrated only at the factory.

The ACX Measuring board controls gas measurements. It converts the photometer signal into digital data, calculates results and transmits it to Gas mother board. The board contains, in addition to the 80C51FA processor, EPROM, RAM, and EEPROM, several analog and digital I/O functions.

Internal and external bus

The processor has access to the Measuring board peripherals (memory, A/D converter, D/A converters, etc) via an internal bus. For communication between the Gas mother board and the Measuring board, there is an external bus in connector X1.

Memory

Memory components include 64k x 8 bit program memory EPROM, 32k x 8 bit low current CMOS RAM powered by a data retention voltage generation circuit in Power supply board, and EEPROM for permanent calibration values and setup memory.

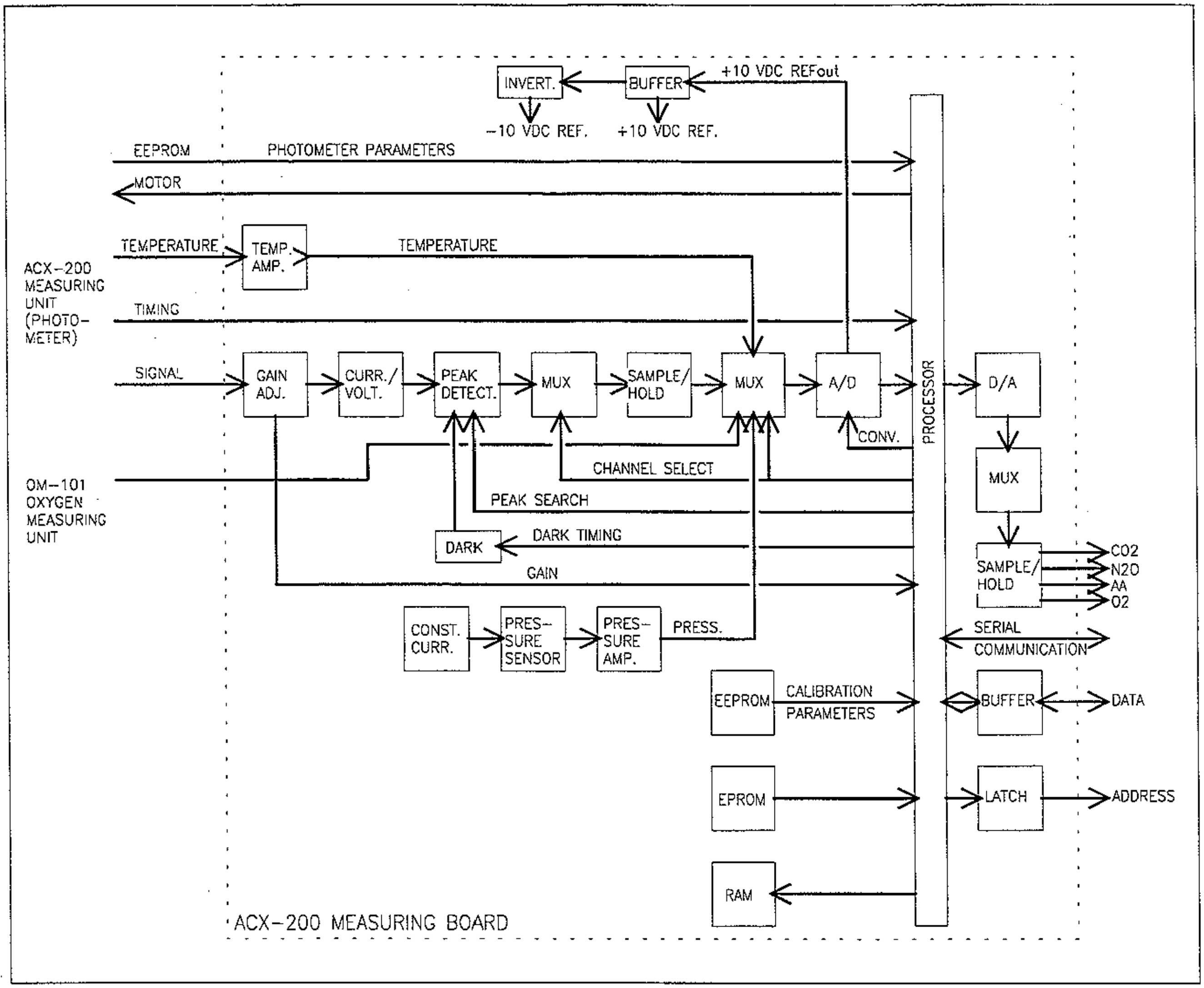


Figure 9 ACX Measuring Board Block Diagram

2.2.6 ASX Agent Identification Bench

The ASX-200 agent identification bench has one measuring chamber. Background compensation is done by subtracting the background spectrum from the measured signal. Background spectrum is measured simultaneously with the zeroing of the ACX-200 unit. The resulting spectrum is analyzed to identify the agent.

The ASX unit requires two calibrations. One is the time between synchronization pulse and measured spectrum (time offset) of the ASX-200 and the other is the peak wavelength of the narrow bandpass filter. The former is calibrated automatically together with the gas calibration of the ACX and the latter is calibrated at the factory.

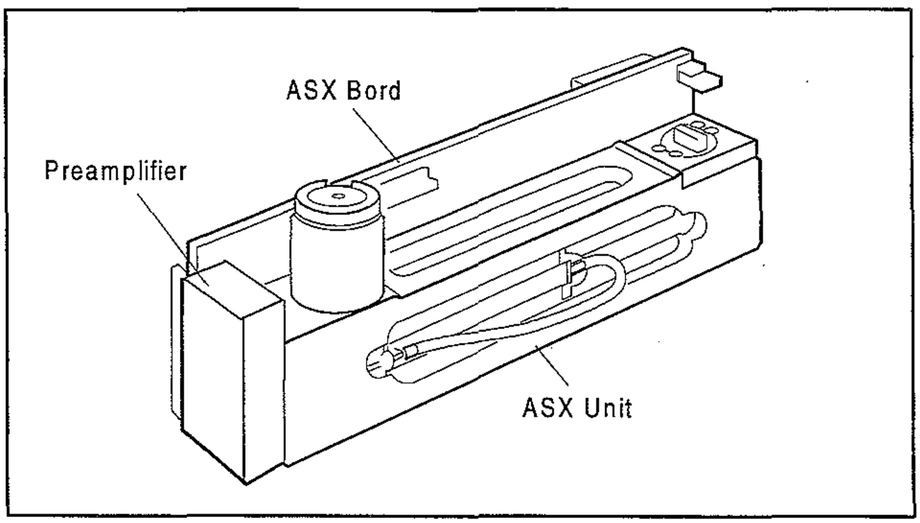


Figure 10 ASX Measuring Unit

ASX Preamplifier Board

The absorption of infrared light is measured with a lead selenide detector. The signal is amplified and then led to the measuring board.

2.2.7 ASX Measuring Board

The measuring electronics can be divided into a few functional blocks, which are described below (See the block diagram in Figure 11).

The ASX measuring board controls the measurement. It converts the ASX photometer signal to digital data, calculates results and communicates with the main CPU through a serial channel. The board contains, in addition to the 80C196 processor, EPROM, RAM, and EEPROM, several analog and digital I/O functions.

Processor section

Processor is a 80C196 and works at 12 MHz. It has an internal A/D-converter with a multiplexer. One channel is used for converting temperature signal. Two others are for the measurement signal from preamplifier board.

The processor uses an internal bus to access EPROM (64k x 8 bit), SRAM (8k x 8 bit) and two D/A-converters. It communicates with the Gas mother board through a serial channel (RXD, TXDB).

EEPROM is a 64 x 16 bit serial chip. It is partly protected so that if jumper X1 is installed the processor can erase or write the protected registers by serial communication commands. The protected section contains permanent factory calibrations.

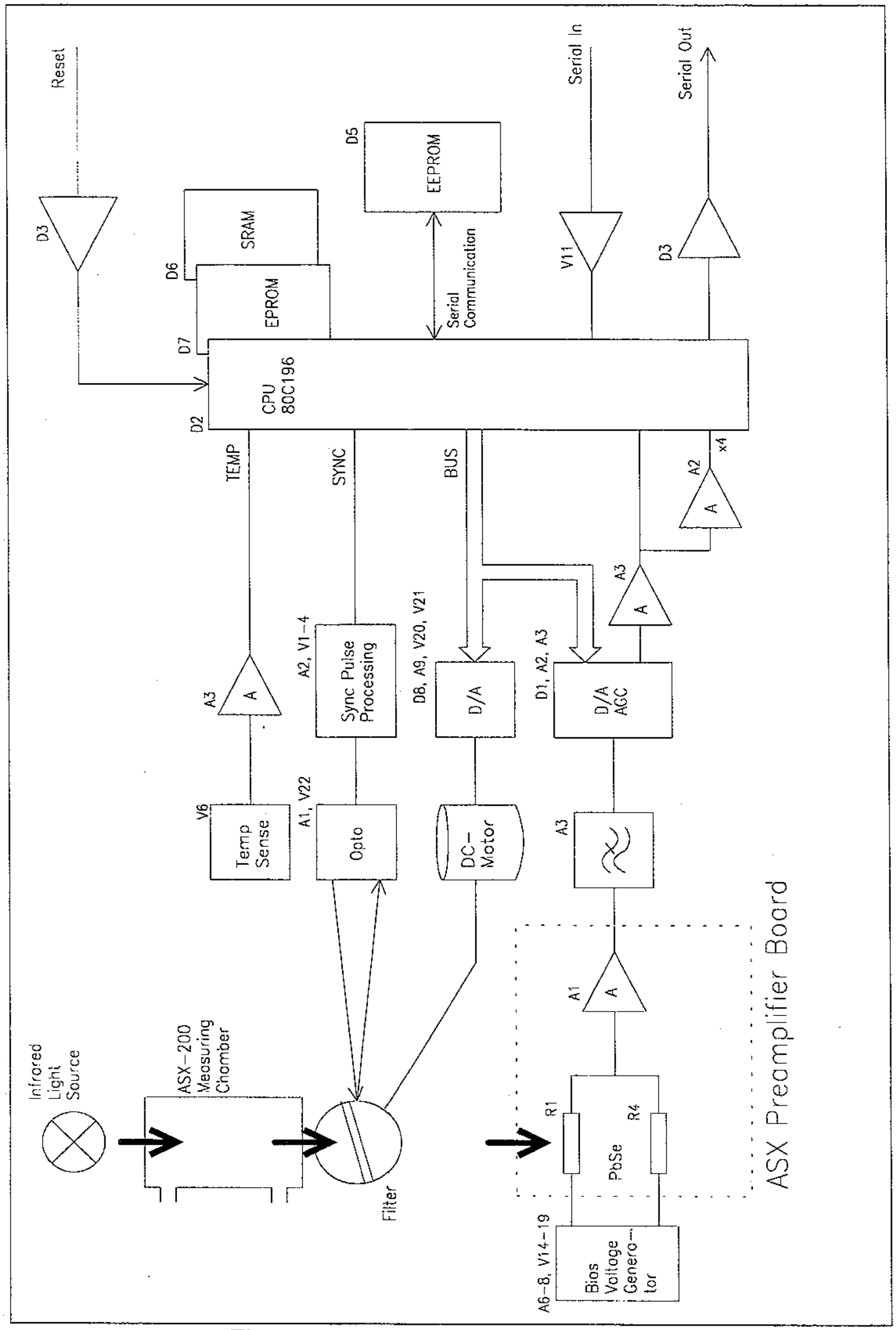


Figure 11 ASX Measuring Board Block Diagram

2.2.8 PVX Board

CAUTION: The PVX-100 measuring unit can be repaired only at the factory.

NOTE: Overpressure or negative pressure of more than 300 cmH_2O to the flow and volume tubing should never be applied.

The board is intended to perform the following tasks

- Measure the pressures in airways and the speed of breathing flow.
- Calculate tidal volume, minute volume, compliance and other useful information on patient lungs.

Pressure transducers

There are two pressure transducers on the PVX board for airway pressure measuring purposes.

The breathing flow of a patient passing through D-lite adapter creates pressure difference. This pressure difference is measured by pressure transducer, B1. Overpressure and negative pressure in airways are measured by another pressure transducer B2.

NOTE: Never apply DIFFERENTIAL pressure higher than 25 cmH_2O to the spirometry tubing. Make sure that both spirometry tubes are always connected.

Temperature compensation

Temperature is measured by B1. This signal is used only for temperature compensation of the pressure transducer B1 on the PVX board.

Data processing

After the multiplexer, the signals, PRESS, FLOW0, FLOW1, and TEMP are A/D converted for data processing.

External communication

Communication between the PVX board and the Gas mother board is established in serial form, using the serial channel (pins 10 and 11) of CPU on the PVX board.

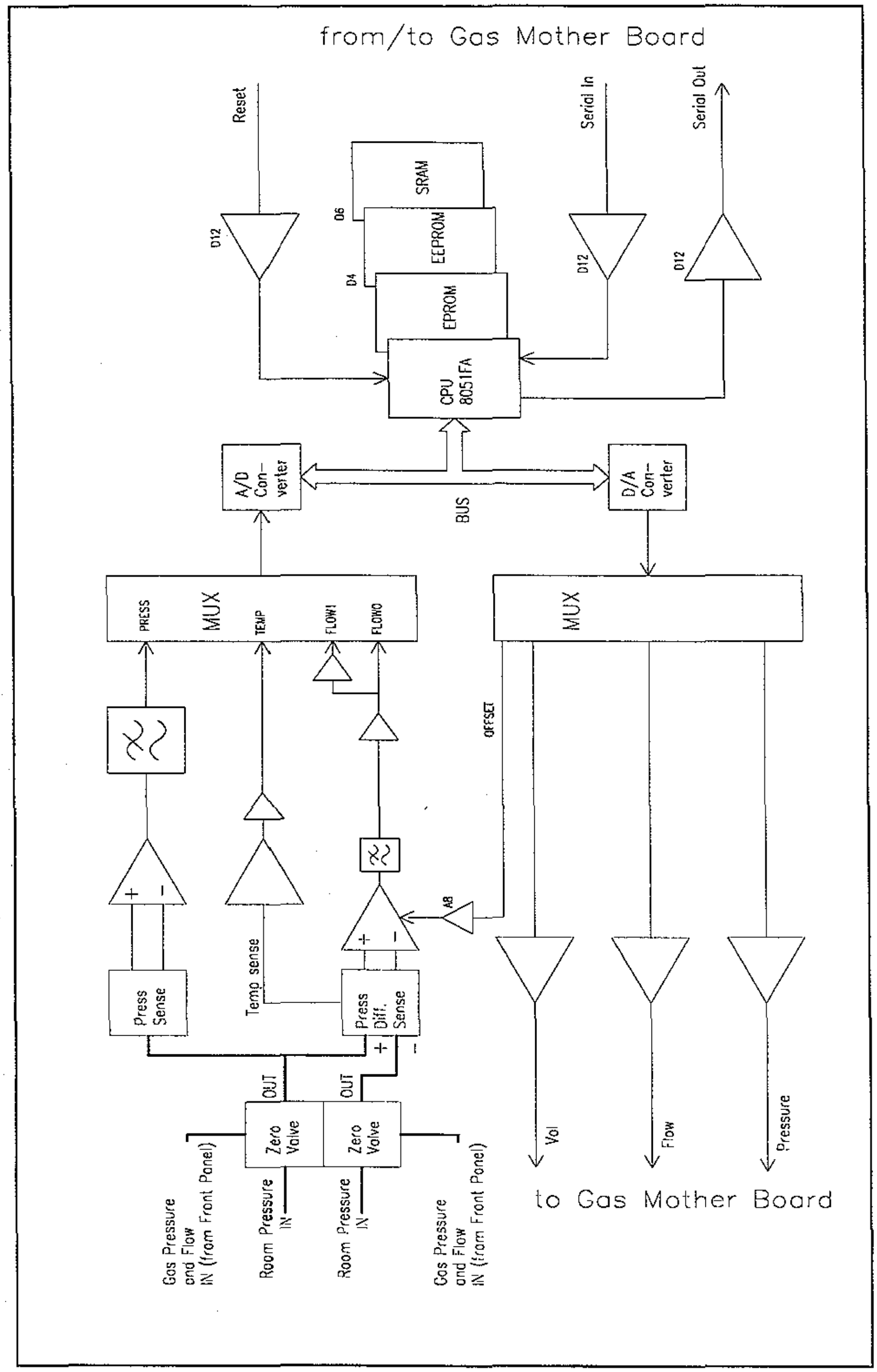


Figure 12 PVX board block diagram

2.2.9 Gas Mother Board

The Gas mother board controls power supply to each measuring unit, as well as the serial communication between the units and the module processor. There are connectors for the pump, valves and gas measuring units on the board. The board contains a processor which controls the functions within the module.

The tasks of the module processor are:

- to receive commands from the main CPU board and pass them on to Measuring boards.
- to gather measurement results from the Measuring boards, analyze them, and transmits data to the main CPU board.
- to control the valves and pump based on the data which ACX Measuring board transmits.

Main parts

- Module processor 80C196KC/16 MHz.
- 16 MHz oscillator.
- EPROM program memory.
- External RAM memory
- EEPROM.
- Address and data bus latch.
- Address decoding GAL-circuit.
- 4-channel serial communication IC (QUART, D4).

External communication

Serial communication bus inside the module processor is used. The bus is connected to module bus via RS-485 buffer. Transmit and reception controls of buffer are controlled by the processor.

Connections to Measuring boards

Data collection from the measuring units takes place in serial communication bus. Serial communication lines of the measuring units are connected to QUART IC on the Gas mother board; Channel 1 - ACX, channel 2 - ASX, channels 3 - PVX, channel 4 - not in use). The transmit side of QUART has a buffer IC and the receipt side has a pull-up resistor.

Valves, pump, and infrared lamps control

Valves are controlled by ACX Measuring board from which the control signals are ran through buffer IC to the valve connector. OCCLUS signal controls the pressure (occlusion) valve and ZERO signal controls the zero valve.

Control signal for the pump comes from the module processor. The signal is 50 Hz pulse-width modulated square wave. Control command is received from ACX Measuring board in serial communication.

Control command (LAMP) of the infrared lamps of the chambers comes from the module processor.

Key push reading

CPU reads the front panel key pushes.

Reset

Voltage supervising circuit performs power-on reset. Reset from the module bus is connected via RS-485 buffer.

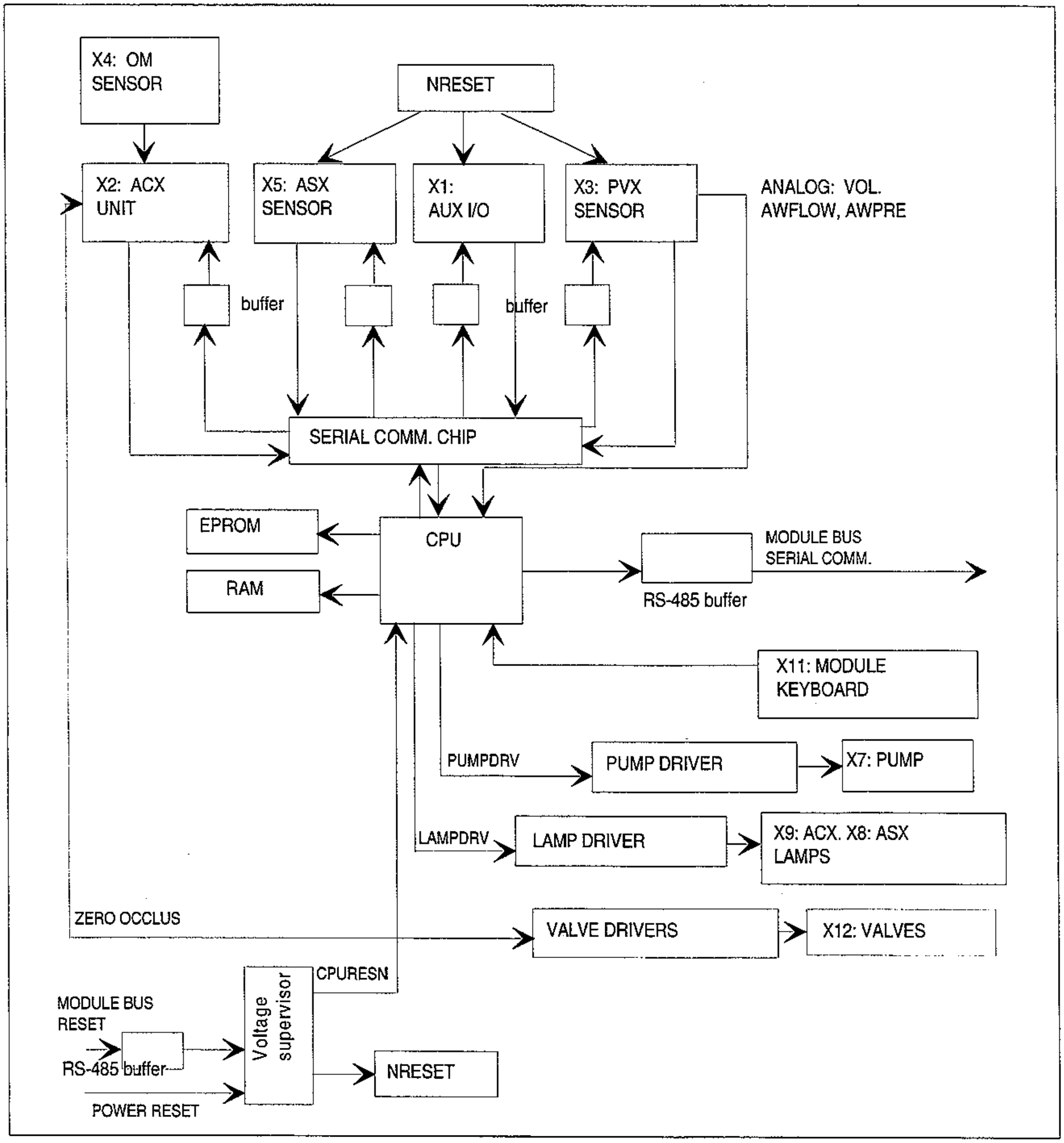


Figure 13 Gas Mother Board Block Diagram

2.2.10 Gas Interface Board

The Gas Interface Board, B-GAS is used for connecting an Airway Module to the Central Unit.

The board connects Airway Module signals to the module bus and supplies voltages from the module bus to the Airway Module.

On the board there is a fuse (T4A) and some capacitors to regulate the power supply.

2.3 Connectors and Signals

Module Bus Connector Configuration

Module Rear Panel 25-Pin Male D-Connector and B-GAS Board Rear Panel Female D-Connector

Pin No	I/O	Signal	Notes
1	I	RESET_RS485	
2	I	-15 VDC	
3	I	+15 VDIRTY	
4	I	+15 VDC	
5	I/O	-DATA_RS485	
6	I/O	DATA_RS485	
7		Ground & Shield	
8	I	-RESET_RS485	
9		n/c	
10		n/c	
11		n/c	
12		n/c	
13		Ground & Shield	
14	I	+24/+32 VDIRTY	Depends on power supply
15	I	GroundDIRTY	
16		n/c	
17		n/c	
18		n/c	
19		n/c	
20	I	GASFR	For factory use only
21	I	CTSD	For factory use only
22	I	TXDD	For factory use only
23	O	RXDD	For factory use only
24	I	+5 VDC	
25	I	+5 VDC DIRTY	for infrared lamps

For B-GAS CPU Mother Board connector, see CPU Bus Connector in the Central Unit Section.

Gas Mother Board Connectors

X1	Module connector. Serial communication bus to the main CPU board. Supply voltages.
X2	ACX Measuring board.
X3	PVX board.
X4	Oxygen measuring unit.
X5	ASX Measuring board.
X7	Sampling pump.
X8, X9	Power supply for infrared lamps (ACX, ASX)
X10	Fan.
X11	Module front panel keys
X12	Valves.

Connector pin configurations

ACX Measuring board (X1) - Gas mother board (X2)

Pin No.	a	b	c
1	+15 V	NC	AGND
2	-15 V	NC	+10 VREF
3	AOUT6	NC	AOUT5 AA
4	AOUT4 VL	NC	AOUT3 CO_2
5	AOUT2 O_2	NC	AOUT1 N_2O
6	DAC1 FLOW	NC	DAC0 PRES
7	AIN7 SAL	NC	ADC6 VOUT R
8	ADC5 AWL	NC	ADC4 VOUT IR
9	ADC3 O_2	NC	ADC2
10	ADC1 AWP	NC	AIN4 SSIGN
11	NC	AGND	NC
12	NC	AGND	NC
13	NC	LAMP	NC
14	NC	PB5	NC
15	NC	SSYNC	NC
16	RBD2	SMOTOR	NC
17	-RESET	-PC0	TO RTSO
18	SEROUT 0	NC	SERIN 0
19	P1.1	PC2 FGAIN 1	P1.0
20	OP0 RTSA	PC3 FGAIN 2	INT0
21	SEROUT 1	PC4 OCCLUS	SERIN 1
22	OP1 RTSB	PC5 PUMPON	IP2 TIMERIN 0
23	SEROUT 2	PC6 ZERO	SERIN 2
24	NC	PC7 RTS0	NC
25	NC	PA0	NC
26	NC	PA1	NC
27	NC	PA2	NC
28	INT1	PA3	INT3
29	+5 V DRV	PA4	+5 V
30	+15 VDIRTY	PA5	+5 V
31	+12 V	PA6	21 VAC
32	GND DIRTY	PA7 ALR CALL	DGND

NC = not connected
AIN is an AD-converter and AOUT is a DA-converter in ACX board.
ADC is an AD-converter and DAC is a DA-converter in the Gas mother board.

ASX board (X5) - Gas mother board (X5)

Pin No.	Signal
1	Analog ground
2	N/C
3	N/C
4	N/C
5	+15 V
6	-15 V
7	DIRB (not used)
8	RXD
9	TXDB
10	N/C
11	-RESET
12	+5 V
13	+15 VDIRTY
14	Digital ground

PVX board (X1) - Gas mother board (X3)

Pin No.	a	b	c
1	+15 V	NC	AGND
2	-15 V	NC	+10 VREF
3	NC	NC	NC
4	NC	NC	NC
5	NC	NC	NC
6	DAC1 FLOWY	NC	DAC0 PRES
7	VOL	NC	NC
8	FLOW	NC	NC
9	NC	NC	NC
10	PRESS	NC	NC
11	NC	NC	NC
12	NC	NC	NC
13	NC	NC	NC
14	NC	NC	NC
15	NC	NC	NC
16	NC	NC	NC
17	-RESET	NC	NC
18	NC	DIR	NC
19	NC	NC	NC
20	NC	NC	NC
21	RxD	NC	TxDP
22	NC	NC	NC
23	NC	NC	NC
24	NC	NC	NC
25	NC	NC	NC
26	NC	NC	NC
27	NC	NC	NC
28	NC	NC	NC
29	NC	NC	+5 V
30	+15 VDIRTY	NC	+5 V
31	NC	NC	NC
32	GND DIRTY	NC	DGND

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex for repair.

Datex 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 shall perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

NOTE: After any component replacement see Chapters Adjustments and Calibrations.

3.2 Preventive Maintenance

We recommend that you perform these checks after any service and at least once a year to keep the AS/3 Airway Module in good condition.

1. Visual inspection

__: Fan is running and rear panel dust filter is clean (clean it at least once a month).

__: If the module is disassembled, check that grounding wires and all connectors are properly connected and there is no loose object inside the module. Check that no tube is in contact with the sampling pump or oxygen measuring unit. Check also that tubes are not pinched and there is no sharp bend before attaching the module box.

2. Functional checks

Use an original Datex sampling line and clean D-fend water trap. Connect the sampling line to the water trap before switching the power on. Wait five minutes for the Airway module to warm-up.

__: As the sampling line is taking in room air, the numeric display of FIO_2 should be 21 $\pm$ 1 after five minutes.

__: Select Enflurane in Agent select menu. Perform gas calibration (see Operator's manual) when at least 10 minutes have passed after the power on. The measured values should be within the tolerance ranges listed below.

Gas	Tolerance range
CO_2	$\pm$0.5 % CO_2 (> 8 % CO_2) or $\pm$0.4 % CO_2 (< 8 % CO_2)
O_2	$\pm$5 % O_2 (about 100 % O_2)
N_2O	$\pm$5 % N_2O (about 100 % N_2O)
ENFL	$\pm$0.6 %

Press Normal screen key to end calibration.

__: Block the sampling line and make sure that the Occlusion warning comes on after 15 seconds.

__: Remove the water trap and make sure that the Air leak warning comes on after 15 seconds.

__: Perform the sampling system leak test (see chapter 4.2).

__: Check the rates of main flow, side flow, and oxygen measurement reference flow.

__: Perform the water separation test (see chapter 4.2).

Go to Service Menu and ACX Service Menu (see chapter 5).

__: Check the functions of zero and occlusion valves, and pump. Additionally key (button) function in AO and AOV models.

__: Check working pressure (Work press). It should be about 700 mmHg. Check also oxygen measurement pressure difference (OMin-OMref). It should be between 5 to 10 mmHg.

Exit the Service Menu.

__: Perform gas calibration again. The measured values should be within the tolerance ranges listed above. If required, perform the adjustments.

Press Normal screen key to end calibration.

3.3 Disassembly and Reassembly

The Airway module (AiOV model) is disassembled in the following way. See chapter 6.1 for the exploded view of the unit:

a) Remove three screws from the rear panel.

b) Remove one thumb screw and one 5 mm cross recess screw from the bottom of the Airway module case.

c) Slide the case rearward and detach it from the module.

d) Lift off the top protection cover.

Now two pc boards are exposed: PVX board (front) and ACX Measuring board (rear).

The PVX board can be detached by pulling sideways after two tubes are disconnected from two valves.

The ACX Measuring board can be detached by pulling sideways after a ribbon cable connector is disconnected and a tube is pulled off from pressure transducer.

e) Remove the bronze plate from the right side of the module by pulling it up.

f) To remove the Gas mother board cover, remove two front panel screws from the side of the module, and the D-connector screws.

g) The front panel can be detached by removing three screws.

h) Tubing system plate with tubes and flow cassettes can be lifted off.

i) Fan can be lifted off after plastic pc board rail is detached.

Gas mother board is attached to the side of the module with screws.

The ASX unit, the ACX Measuring unit, and the O_2 measuring unit are attached to the chassis with two screws each.

The pump and its magnetic shield can be removed from the chassis by unscrewing the two screws beneath two springs at the port side of the pump.

Damping chamber/filter case can be slided out of hooks.

Reassembling is essentially reversing what was described above.

CAUTION: When reassembling the module, make sure that the tubes and cables are not pinched between the boards and the cover.

3.4 Adjustments and Calibrations

See Operator's manual for normal gas calibration instructions.

3.4.1 Gas Sampling System Adjustment

Flow rates should be measured and possibly adjusted under the following conditions:

- After any part within the sampling system has been replaced
- Gas response is slow

NOTE: Adjust the flows with a new, clean D-fend water trap and original Datex sampling line.

NOTE: Before adjusting the flows, make sure that there is no leakage in the sampling system.

NOTE: Let the monitor warm up for 30 minutes before measuring flow rates.

For the flow rate measurements a flowmeter with a low flow resistance and capability to measure low flow rates is required. A normal length of sampling line has to be connected to the monitor as it has a considerable effect on the flow.

The flow rates are adjusted by changing the flow resistance cassettes (constriction cassettes) in the sampling system. See Table 1 in chapter Gas Sampling System for the alternative cassettes.

The adjustments and the respective constrictions to be adjusted are shown in the next figure.

Flow Rate

If any flow rates are not correct, first replace the D-fend water trap. Then recheck the incorrect flows before adjusting the flow rates.

The sampling flow rate is measured by a flowmeter at the sampling line. The rate should be between 180 and 220 ml/min.

The flow rate is adjusted by changing the flow cassette which is located behind the pump (no. 6).

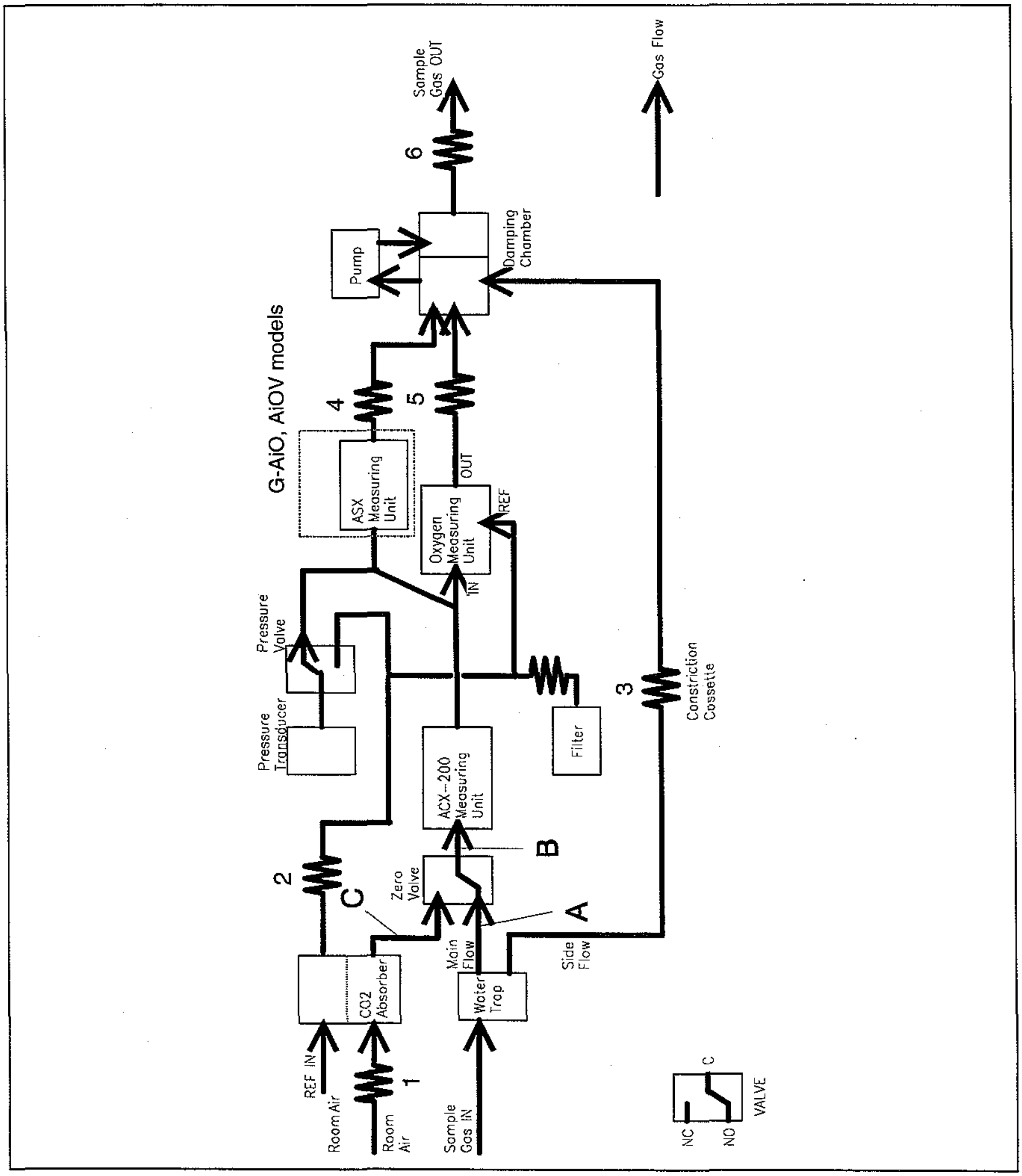


Figure 14 **Gas Sampling System Adjustment Chart**

Rate of the side flow is checked by blocking the side flow after the water trap and measuring the flow rate as above. The rate should decrease by 10 to 27 ml/min.

Measurement flow and reference flow of the oxygen measuring unit are checked as follows:

(a) Connect the flowmeter behind the flow cassette (no. 2) ahead of the oxygen measuring unit REF inlet. The flowmeter should show between 25 and 42 ml/min. The flow rate is adjusted by changing the cassette.

(b) Connect the flowmeter between the oxygen measuring unit IN inlet and the tube which is connected to it. The flow rate should be between 18 and 25 ml/min **larger** than the REF flow. This is adjusted by changing the flow cassettes (no. 4 and 5) which are located between the IN and OUT inlets.

(c) Flow rate of CO_2 absorber is measured by connecting the flowmeter to the unoccupied connector of the flow cassette (no. 1). Make sure that the monitor is in normal situation (APNEA text on the screen). The flow rate should be zero. When the gas zeroing takes place, the rate should be between 180 and 220 ml/min. The gas zeroing can be simulated in the ACX Service Menu manually (pump start, zero valve on). The flow rate is adjusted by changing the cassette (no. 1).

CAUTION: When changing cassettes make sure that the tubes are reconnected properly.

Flow to be adjusted	**Constr. No. (see Figure 14)**	**Nominal value (tolerance) ml/min**
sampling flow	6	200 (180 to 220)
side flow	3	10 to 27
O_2 measurement in	4 and 5	45 to 60
O_2 reference in	2	25 to 42
CO_2 absorber flow	1	180 to 220 when zeroing

NOTE: Changing any of the cassettes will have some effect on the other flow rates. After any adjustments check the other flow rates as well.

O_2 measurement flow pressure measurement

Gradual decrease of main flow rate due to the water trap filter clogging can be checked by measuring pressure difference between the O_2 measurement flow and the O_2 reference flow. Remember that the sampling line should be attached to the water trap before starting the test.

The pressure difference is automatically checked after every gas zeroing.

See ACX Service Menu chapter later in this manual for further information.

3.4.2 Oxygen Measurement Unit Adjustments

The only field service procedures for the O_2 measuring unit are the offset (zero), gain, and frequency adjustments. In case of any other trouble, the measuring unit should be replaced and the faulty one sent to Datex for repair.

Offset (zero) adjustment

Because the oxygen measuring unit is a differential sensor, which actually measures the difference between the O_2 concentrations in the sample and reference gases, its output must be adjusted to equal zero when atmospheric air is present at both inputs.

a) Connect a digital voltmeter to the output of the O_2 measuring unit at pin 7 of connector X4 on the Gas mother board.

b) Let the monitor draw in room air and adjust the voltage to zero with the O_2 measuring unit trim resistor designated 'ZERO' (see Figure 15) in the O_2 module PC board. The potentiometers are located at the same side of the measuring unit as the tubing connectors.

c) Perform gas calibration (refer to Operator's Manual).

Gain adjustment

a) Adjust the O_2 measuring unit offset as described in the previous section.

b) Sample 100 % oxygen and adjust the measuring unit output to between 7.7 V and 8.3 V with the trim resistor designated 'GAIN' (see Figure 15). If the output will not exceed 7.7V, it is acceptable that the output exceeds at least 5 V. At that level software is still able to compensate the output.

c) Check and if necessary readjust the offset and gain until the readings remain stable.

c) Perform gas calibration (refer to Operator's Manual).

Temperature compensation adjustment

Factory calibrated.

Frequency adjustment

The switching frequency of the electromagnet of the O_2 measuring unit has been selected to be 110 Hz to avoid interference from harmonics of both 50 Hz and 60 Hz mains frequency.

Fine adjustment is seldom necessary. However, if you wish to reduce the effects of mechanical resonance peaks of the cabinet which appears as high noise level of the O_2 measuring unit analog output (above 20 mV peak to peak) it is worth of trying the fine frequency adjustment. One turn of trimmer "FREQUENCY" will change the frequency by 1.5 Hz. Try to find minimum noise but do not deviate more than $\pm$5 Hz.

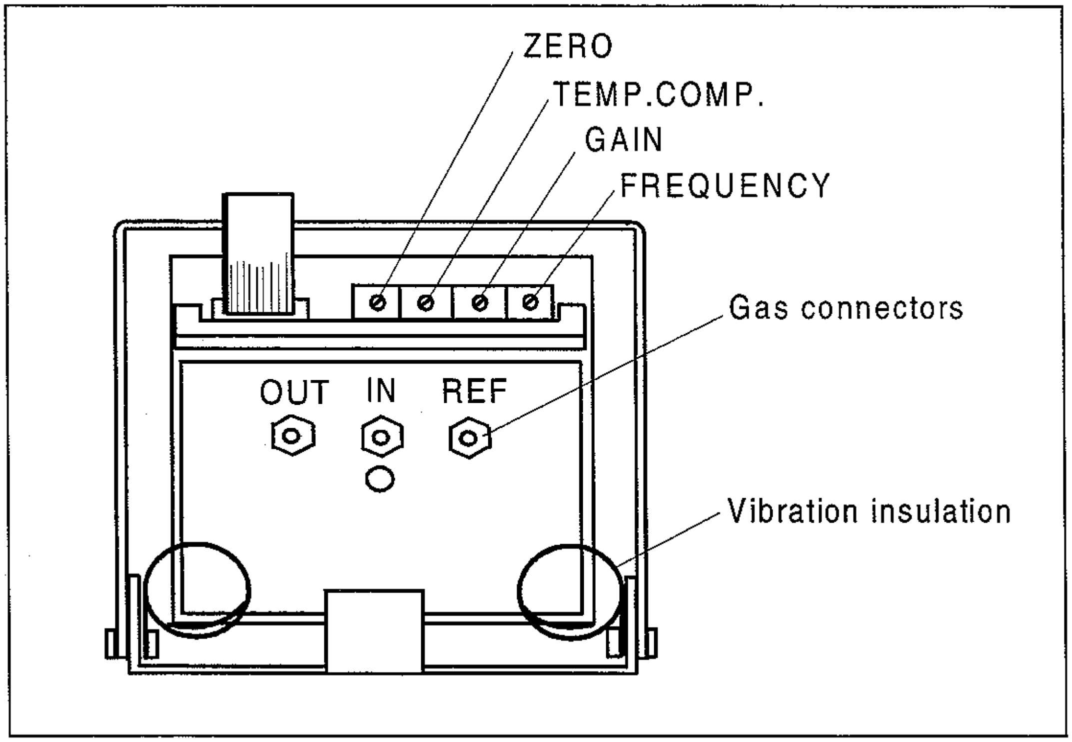


Figure 15 O_2 Measuring Unit Adjustments

3.3.3 Flow Calibration

PVX board is calibrated at the factory and due to the board's design calibration is not regularly needed. The calibration data is saved into the board's EEPROM memory and if the software EPROM of the board is changed the calibration must be performed. It is recommended to perform the calibration both with adult values using the D-lite, and with paediatric values using Pedi-lite.

a) Connect spirometry tube to the Airway module pressure and volume connector, and the D-lite sensor to it. To improve the accuracy, the endotracheal tube and all acessories which are in use with normal monitoring should be attached also during calibration.

b) Go to service menu: Monitor Setup -> Install Service (Password 16 - 4 - 34)-> Service View (26 - 23 - 8) -> Modules -> Gas Unit -> PVX -> Flow Calibration.

c) After the flow is zeroed ('Zero OK' message displayed) attach Calibration Pump or Spirometry Tester (code 884202) to the flow sensor (D-lite or Pedi-lite). To start the calibration select Adult or Paediatric sensor calibration according to the flow sensor used.

d) Set calibration volume for adult 1000 ml and for the pediatric patients 300ml.

e) Work on the calibration pump slowly, appr. 1 pump in 5 seconds, pump until 'adjust'-message appears. If you use the Spirometry Tester, perform the calibration according to the tester instructions.

f) Adjust the reading to match the calibration volume used (1000 ml for the D-lite and 300 ml for the Pedi-lite).

Press Normal Screen to return to waveform display.

4 TROUBLESHOOTING

4.1 General Troubleshooting Chart

TROUBLE	POSSIBLE CAUSE/TREATMENT
No response to breathing	Sampling line or water trap blocked or loose, or improperly attached. Water trap container full. Interface cable to monitor disconnected. See the Gas sampling system troubleshooting.
SENSOR INOP. message	The temperature is too high, check fan and filter at the rear panel Communication error, check timeout and bad checksum values at the service menu Check Airway Module connection cable, and supply voltages. Check ACX measuring board
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.
AIR LEAK-message	Air leak in sampling system. Probably water trap or the sampling line is not attached properly. Gas zero valve failure. Pump failure or gas outlet blockage. Supply voltage missing
REPLACE TRAP-message	Flow resistance increased due to residue built-up on water trap membrane. Replace the water trap.
REBREATHING-message	CO_2 concentration in inspiratory air is too high. Possibly CO_2 absorber in ventilation is saturated. Change the absorber.
OCCLUSION-message	Sampling line or water trap is occluded. Water trap container is full. If occlusion persists check internal tubing for blockages. Check the power supply voltages.
SELECT AGENT-message	No anaesthetic agent is selected though delivery is started. Vaporizer valve is broken. Traces of cleaning or disinfecting agent in the water trap container affecting the readouts. Replace the water trap.
No response to any gas	Sampling line, water trap, or internal tubing blocked or loose, or improperly attached. Pressure valve malfunction. Pump failure. Supply voltage missing. Serial communication error. Check those items.

TROUBLE	POSSIBLE CAUSE/TREATMENT
Sudden increase in gas display	Measuring chamber contamination. ±15 V supply voltages missing. Water trap malfunction. Check all internal tubing and the interior of the water trap for occlusions or leaks. Replace water trap. Check flow rates.
Abnormally high response to all gases (or abnormally low) or sudden occlusion warning	Pressure transducer failure. Exchange the ACX Measuring board.
Random output (resembling noise)	Chopper motor timing pulses out of sync. Chopper motor not running, motor faulty or connection loose. Chopper motor driver transistor C-E open circuit or current limiter short circuit. Exchange the ACX measuring board.
Strong drift in all gases	Leakage in the sampling line or internal tubing (especially in conjunction with too low readings). Exchange the ACX measuring board.

Supply voltage troubleshooting

TROUBLE	POSSIBLE CAUSE	TREATMENT
"Gas module removed" No Gas module exists after turning the monitor on.	+5V lost	Gas module CPU not running. Check Gas Interface cable. Check +5V from module mother board and timeout value from module service page.
Random CO_2 value. No CO_2 or AA response. Abnormal AA mixture messages and AA selections. "Unknown Agent" "Zero error" after zeroing "Calibrate Agent ID" "Sensor Inop"	+5Vdirty lost	Check the IR lamp resistance (approximately 4 Ohm)and the lamp voltage (module mother board connectors X8 and X9) X8 = ASX lamp(i-models) X9 = ACX lamp
"Continuous Occlusion" "Sensor Inop" Random curve trace and gas digit values(resembling noise). Pressure and flow curves extremely low.	+ 15V lost	Check voltage from module mother board X1 pin 4, X2 pin 1a, X3 pin 1a, X4 pin 9 and X5 pin 5.
CO_2 value high. "Air leak" "Sensor Inop" Paw and Flow curves extremely high.	- 15V lost	Check voltage from module mother board X1 pin 2, X2 pin 2a, X3 pin 2a, X4 pin 6 and X5 pin 6.
"Air Leak"-message remains on the screen.	+15V dirty lost	Check voltage from module mother board X1 pin 3, X2 pin30a , X3 pin 30a, X4 pin 1 and X5 pin 13.
Fan Stopped.	+32V lost	Check the fuse on Gas interface board. Check the fan and regulated fan supply voltage from module mother board connector X10.
"Calibrating gas sensor" remains on the screen.	One or more of the voltages lost: +5Vdirty, +15V,-15V, +15Vdirty ACX measuring board not communicating with the Gas mother board. ACX measuring unit badly contaminated.	Check those voltages as above. Check whether the ACX software version is available in the service menu. If not, replace the ACX measuring board. Replace the ACX measuring unit.

4.2 Gas Sampling System Troubleshooting

The faults which can occur in the sampling system are: leaks or blockages in the tubing, failure of the sampling pump or the magnetic valves, or diminishing of the flow rates because of pump aging or dirt accumulating in the internal tubing.

The following checks should help in localizing the fault. Whenever suspecting the sampling system and always after working on the sampling system check and if necessary adjust the flow rates.

The sampling system details are illustrated in Figures 4 and 5.

CAUTION: The special internal sample tube is mechanically fragile. Sharp bends will cause leaks.

NOTE: D-fend water trap should be replaced when the OCCLUSION message appears during the monitor startup.

NOTE: If any liquid has entered the ACX-200 measuring unit due to water trap filter failure, contact Datex Technical Services.

- Connect power cord and sampling line. Turn the power on and wait until the initialization is over.

1. SAMPLING SYSTEM LEAK TEST

1) Choose ACX Service Data page in the Gas Unit Service Menu.

2) Connect a tube to the sample out connector and drop its other end into a glass of water.

3) Block the sample inlet, reference flow of the oxygen measuring unit, and the CO_2 absorber port that draws room air in. Wait for one minute.
There should be less than 1 bubble per 10 seconds coming out of the tube. Bubble should not move upwards more than 11 mm per 30 seconds inside the tube. If it does, there is a leak between the pump and the sample out connector.

4) Perform leak test to the CO_2 absorber by opening zero valve. The maximum permitted leakage is the same as above.

CAUTION: Do not turn the pump off while performing the leak test. Negative pressure in the sampling system will suck in water in the glass.

2. WATER SEPARATION

1) Dip the patient end of the sampling line into water quickly (about a half second) three times at 45 seconds' interval. After that drop the end into water and lift it up when the sampling line is totally filled with water.

2) Check that all the water goes into the trap container and not into the monitor.

3. STEAM TEST FOR THE SPECIAL TUBES

Choose Halothane as anaesthetic agent and let the monitor sample room air. Then quickly feed air of 100 % relative humidity (for instance from a kettle in which you are boiling water) to the monitor. If the digital reading jumps as much as 0.1 % replace the special (Nafion) tubes.

Gas Sampling System Troubleshooting Chart

4.3 O_2 Measurement Troubleshooting

Because of the complex and very sensitive 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, it should be replaced and the faulty unit be sent to Datex 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 message 'O_2 zero error' is displayed check the O_2 measuring unit output voltage on Gas mother board (see Section Offset adjustment).

If the adjustment range of the (software) calibration is insufficient check the O_2 measuring unit output voltage and adjust the gain if necessary (see Section Gain adjustment).

If there are problems with O_2 response time check the O_2 measurement flow rate and adjust it if necessary (see Section Gas Sampling System Adjustments).

If the O_2 signal is noisy, check the measurement unit suspension. Frequency adjustment may help in some cases (see Section Frequency adjustment).

4.4 ACX Troubleshooting

CAUTION: The measuring unit ACX-200 can be repaired and calibrated only at the factory. Due to sensitivity of the measuring chamber surface, the measuring chamber of ACX-200 should not be attempted to clean with any detergent, not even with water.

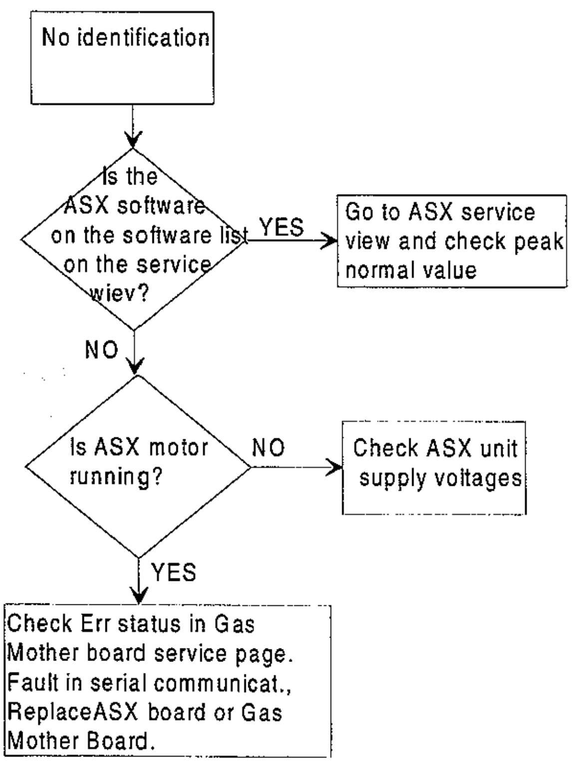
The ACX troubleshooting is carried out in the General Troubleshooting scheme. The ACX testing is explained at the ACX Service Information section, please refer to it.

4.5 ASX Troubleshooting

NOTE: Please read also troubleshooting section in Operator's Manual.

CAUTION: The agent identification bench ASX-200 can only be repaired and calibrated only at the factory.

TROUBLE	POSSIBLE CAUSE/TREATMENT
AGENT MIXTURE-message when calibration gas (Freon) is fed	Repeat calibration. If the module contains ASX-100, it is not capable to identify calibration gas R23, therefore the message. However, the ASX-100 will still calibrate with R23.
No response from ASX	Communication between ASX unit and Central Unit is lost. ASX bench disconnected or faulty. Check that the motor is running.



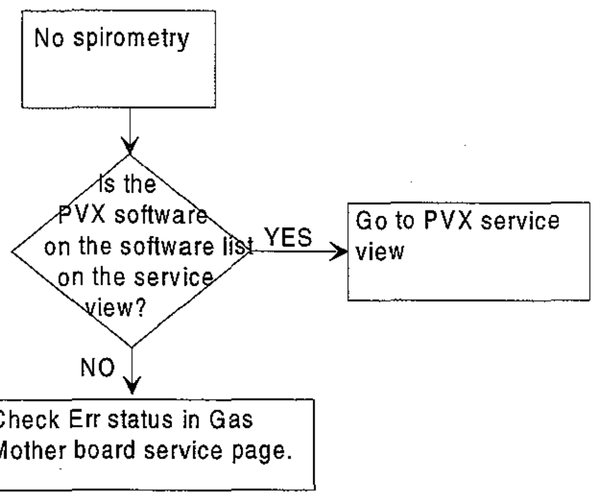
ASX Troubleshooting Chart

4.6 PVX Board troubleshooting

CAUTION: The measuring unit PVX-100 can be repaired and calibrated only at the factory.

NOTE: Never apply DIFFERENTIAL pressure higher than 25 cmH_2O to the spirometry tubing. Make sure that both spirometry tubes are always connected.

NOTE: Never apply overpressure or negative pressure of more than 300 cmH_2O to the spirometry tubing.



NOTE: The PWX software string does not appear onto the list when using the combination of G-AOV module and monitor software S-___94.

4.7 Gas Mother Board Troubleshooting

Due to the complexity of the LSI circuitry there are only a few faults in the CPU digital electronics that can be located without special equipment.

Check that the RAM, EPROM, CPU and other I.C.'s that are on the socket are properly.

See Gas mother board Service pages for more information.

Instructions After Replacing the Software or Gas Mother Board

After replacing the software or Gas mother board board:

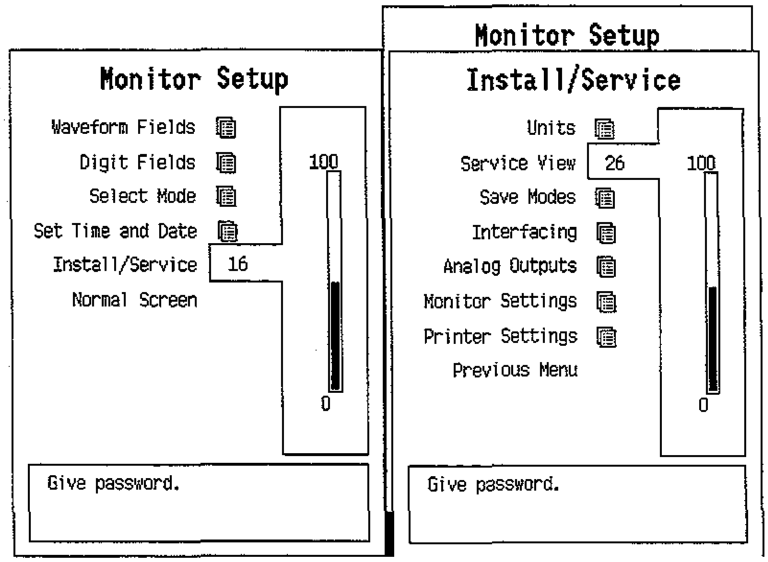
- perform the gas calibration.
- re-establish previously used settings or inform the monitor user that settings are default values.

4.8 Error Messages

MESSAGE	EXPLANATION
Occlusion	The sample tube inside or outside the monitor is blocked or water trap is occluded. If occlusion persists, measured gas values disappear.
Air leak	-the water trap is not connected -the gas outlet is blocked -there is a leak in the sampling line inside the module. If air leak persists measured gas values disappear.
Replace trap	Indicates residue build-up on the water trap membrane. This decreases air flow.
Zero valve error	Opening the valve does not change working pressure enough.
Gas calibration is not available during the first 5 minutes/during occlusion/during air leak	Calibration not allowed during the first 5 minutes after power up and in mentioned situtations.
Select agent	No agent selected
Continuous occlusion. Check sampling lineand water trap.	Occlusion over 40 seconds.
Air leak detected. Check water trap and sample gas out-flow. Press normal screen to continue.	Air leak over 40 seconds

MESSAGE	EXPLANATION
CO_2:	
Zero error	Unsuccessful zeroing
Unstable	Unsuccessful calibration
CO_2 over scale	CO_2 signal exceeds the maximum waveform area
O_2:	
O_2 zero error	Unsuccessful zeroing
O_2 over scale	O_2 signal exceeds the maximum waveform area
O_2 Unstable	Unsuccessful calibration
N_2O:	
N_2O zero error	Unsuccessful zeroing
N_2O Unstable	Unsuccessful calibration
Ane agents:	
AA zero error Zero error	Unsuccessful zeroing
AA unstable Unstable	Unsuccessful calibration
AA over scale	AA signal exceeds the maximum waveform area
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 SERVICE VIEW



To enter Airway Module Service menu:

1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34.
   The Install/Service menu appears.

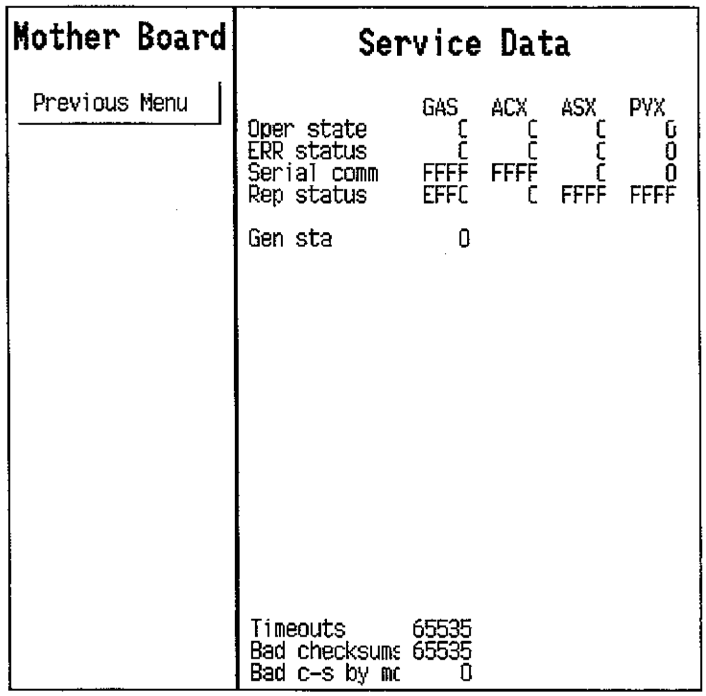
4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

6. Turn the ComWheel to highlight Modules and push.

7. Turn the ComWheel to highlight the Gas Unit and push.

5.1 Gas Mother Board



Service Data

Oper State

Internal operation state of the module:

0...9 function performed, if staying on, failure is indicated
10...29 Initialization
30...39 Normal operation state
40...49 Zeroing
50...59 Calibrating

Err status

Indicates measuring unit malfunction:

GAS: 0 no error
1 error in ACX measuring system
2 error in ACX communication
10 error in ASX measuring system
20 error in ASX communication
40 error in PVX measuring system
80 error in PVX communication
Possible failure source: Gas CPU, ACX, ASX or PVX.

ACX: 0 no error
if not 0, replace ACX unit

ASX: 0 no error
if not 0, replace ASX unit

PVX: 0 no error
if not 0, replace PVX unit

Serial Communication

Serial Copmmunication indicates a state of serial communication between the module processor and a measuring unit.

GAS: FFFF Continuously

ACX: FFFF Continuously

ASX: Value is for factory use only.

PVX: Value is for factory use only.

Rep status

Rep status is a four-digit number, where all digits, abcd , can have different values.

Gas rep status:

a:	0	No sevoflurane or desflurane measurement available
	3	ACX can measure sevoflurane and desflurane
b:	0	No gas measurements available
	F	CO2, O2 N2O and AA measuremnts available
	3	CO2 and O2 available
c.	0	No ACX, ASX, nor PVX board running
	1	ACX board running
	3	ACX and ASX board running
	5	ACX and PVX board running
	7	ACX, ASX and PVX board running
d	0	Normal operation state
	1	Occlusion
	2	Air leak
	4	Other sampling system error
	8	Replace trap

ACX rep status:

a	empty	Normal operation state
	1	ACX initialization
b	empty	Normal operation state
	2	Occlusion
	4	Air leak
c	C	Normal operation state
	others	values used in manuafcture's testing
d	0	Normal operation state
	others	values used in manuafcture's testing

ACX rep status FFFF continuously

PVX rep status FFFF continuously

General Status 0 Normal operation state

8000 Initialization

If not 0 or 8000, replace the Gas mother board.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.
Bad checksums is also a cumulative number that indicates how many times communication from the module to monitor broke down (first line) and from monitor to the module broke down (second line).
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting indicates either serial communication failure or module not in place.

The timeouts etc numbers should not grow faster than 50/s.

5.2 ACX Service menu

```
ACX                 Service Data

Pump ctrl                      CO2    O2   N2O    AA
                  Fall time    280   440   320   400
Zero valve ctrl   Noise  OFF     0     0     0     0
                  Calib zero 28380 16325 46869 25765
Pres valve ctrl         gain  9060  8437  4686 21838
                  Exp            8  2090     0    -2
Noise Meas        Insp           8  2090     0    -2

Fall time Meas    Pressures:         Ambient      765
                  Work press      712 Amb-Work     53
Previous Menu     OM(ref)         703 OM(in-ref)    9
                  Zero chnl       725

                  Pump            ON
                  Zero valve     OFF  Pres valve  OFF
                  ACX temp         32

                  CO2-O2 Delay    400
                  CO2-N2O Delay    80
                  CO2-AA Delay    240
                  ACX_ASX Delay   670


                  Timeouts          0
                  Bad checksums     0
                  Bad c-s by moc    0
```

Menu items:

1. Turn pump on/off
2. Turn zero valve on/off
3. Turn pressure valve on/off
4. Noise measurement
5 Fall time measurement
6 Return to previous menu

Fall time

Fall time indicates the response time of the measuring units. Select 'Fall time meas' from the menu. Notice that text 'feed' appears under each gas. Feed the calibration gas until every 'feed' is replaced by 'start'. Remove the sampling line quickly from the gas source.

Check that fall times are:

O_2 < 480 ms

CO2 < 360 ms
N2O < 360 ms
AA < 520 ms

NOTE: The measurement can be performed only with the modules using module software 884295.

Noise measurement

O2, CO2 and N2O

Feed the calibration gas until the gas values are stabilized on screen. Start the measuring by selecting 'Noise meas' from the menu. After 10 seconds stop measuring by reselecting 'Noise meas'. Close the gas source. Noise values should be: O2< 100, CO2 < 20, N2O< 150.

AA

Select halothane for anaesthetic agent. Feed the room air until gas values are stabilized. Perform the noise measuring as above, the value should be < 20.

NOTE: The measurement can be performed only with the modules using module software 884295.

Calib zero and gain

These values are calibration constants of zero and gain for each gas. The zero values may change at gas zeroing, the gain values at gas calibration.

Exp, Insp

Gas concentration value from the ACX measuring unit

Pressures

Ambient is the ambient pressure measured at the initialization. **Work press** is the internal pressure of sampling system measured by the ACX measuring board pressure transducer. Typically the value is appr. 700 mmHg. The difference between these two pressures is **Amb-Work** and if the pump is functioning, it should be > 40.

OM(in-ref) is a pressure difference between the O_2 measurement flow and the O_2 reference flow. This pressure difference is automatically checked after every gas zeroing and it should be between 5 to 10 mmHg. If the pressure difference turns negative a message 'Replace trap' is displayed when the limit of -5 mmHg is exceeded.

Pump, zero valve, and **pressure valve** are operated manually by highlighting and pushing the ComWheel. During patient monitoring, the valves are in OFF position

ACX temp indicates temperature inside the ACX bench, and the value is typically + 10 °C higher than the prevalent room temperature.

Delays indicate the time delays within or between measuremnt units.

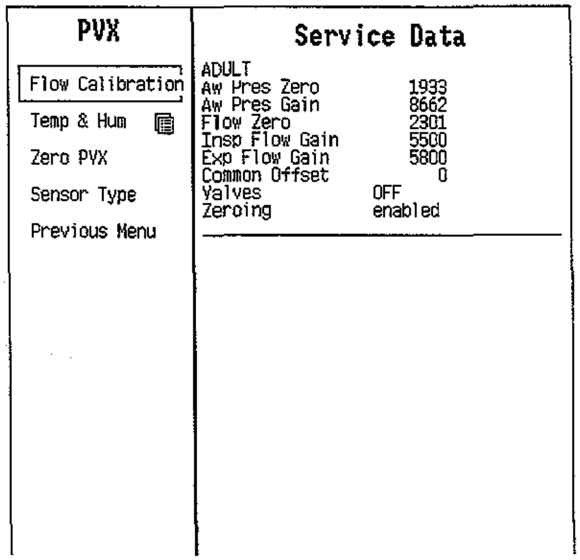
Delays are measured at the same time as fall times.

Check that the ACX_ASX delay is between 400-800.

NOTE: The measurement can be performed only with the modules using module software 884295.

Timeouts is a cumulative number that indicates how many times the module has not responded to the monitor's inquiry.
Bad checksums is also a cumulative number that indicates how many times communication from the module to monitor broke down (first line) and from monitor to the module broke down (second line).
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The monitor starts counting these items at power up and resets to zero at power off. The nonzero values do not indicate a failure, but the continuous counting (more than 50 per second) indicates either serial communication failure or module not in place.

5.3 PVX Service Menu



Menu items:

1 Flow Calibration service data

2 Humidity and temperature service menu

3 PVX zeroing

4 Sensor type selection

5 Return to previous menu

Flow Calibration Service Data

Aw Pres Zero...The value of airway pressure zero is changing within the range of 1000 to 2400.

Aw Pres Gain...Gain of pressure measurement. This value should be fixed to 8662.

Flow Zero....The value corresponds to the pressure transducer B1 output during PVX zeroing. Number 0 corresponds to 0 V and 4095 corresponds to 10 V. The value is typically within the range of 100 to 4000.

Insp Flow Gain...Gain of inspired gas volume. Typically the value is between 5000 and 9000 depending on which sensor is used (adult/pediatric).

Exp Flow Gain...Gain of expired gas volume. Typically the value is between 5000 and 9000 depending on which sensor is used (adult/pediatric).

***Common Offset**...Cancels common error which is caused by pressure from the pressure transducers. This is a transducer's own constant. The value should be between -230 and +230.

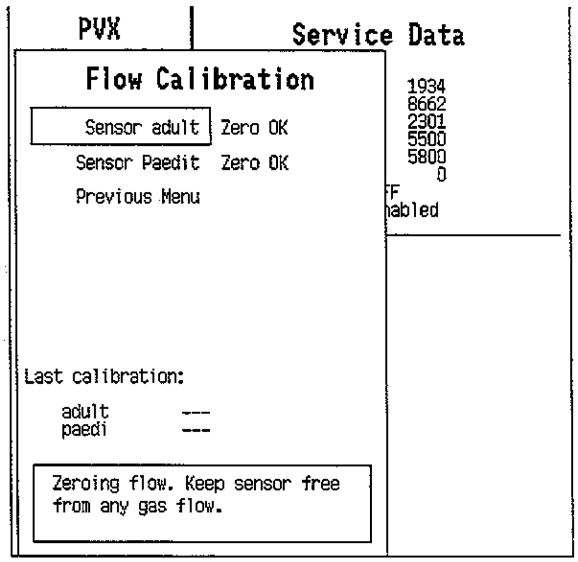
Valves...Position of zero valves.

Zeroing....Automatic zeroing is cancelled (disabled) or active (enabled).

NOTE: Items marked with asterisk (*) are not to be changed.

NOTE: The shown values are for the Adult module only. Changing the mode does not change the values.

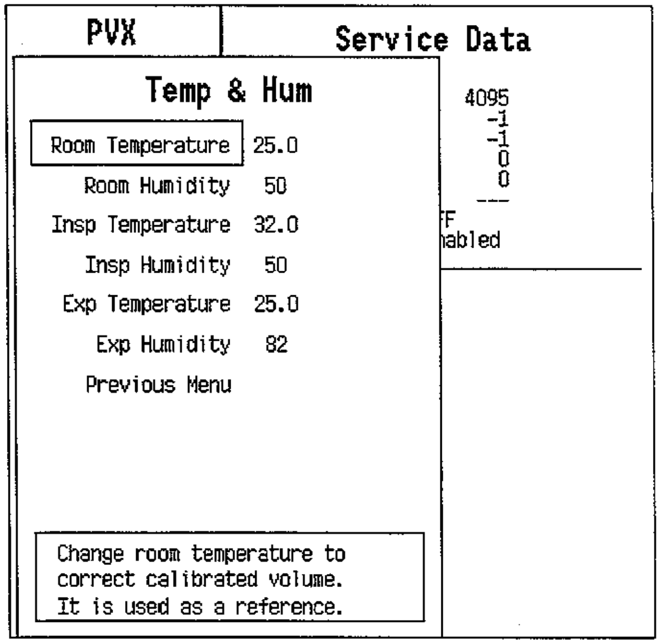
Flow Calibration



For information on the flow calibration, please refer to section 3.3.3, Flow Calibration.

NOTE: The last calibration dates are saved into the main CPU board memories. The information is not saved permanently.

Temp & Hum Service Menu



If circumstances noteceably differ from normal, or additional accuracy is required, the use of Temp & Humidity menu may be advisable.

Especially small errors in tidal values may indicate that temperature and humidity settings of the monitor differ too much from the used system.

Room Temperature and **Humidity:** these are needed only in calibration procedure.

Insp Temperature: The setting regarding the temperature of inspired gas. The value is used in calculations. Change if necessary.

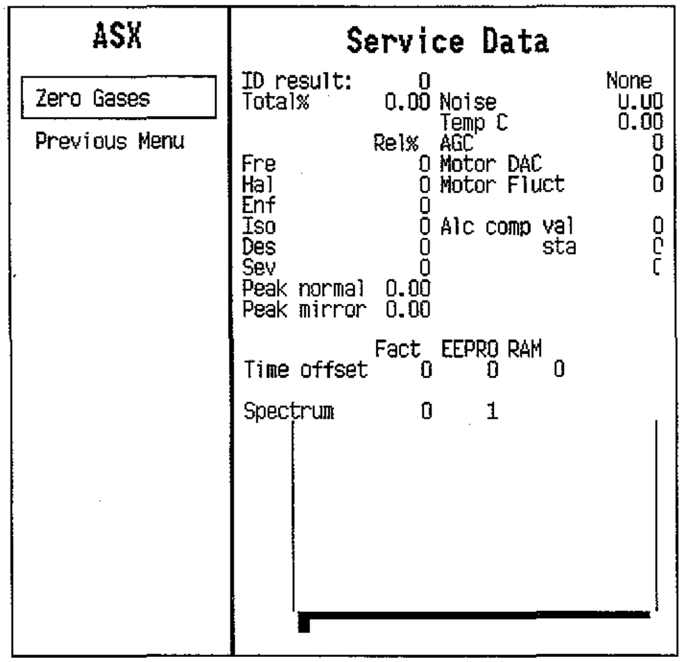
Insp Humidity: The setting regarding the humidity of inspired gas. The value is used in calculations. Change if necessary.

Exp Temperature: The setting regarding the temperature of expired gas. The value is used in calculations. Change if necessary.

Exp Humidity: The setting regarding the humidity of expired gas. The value is used in calculations. Change if necessary.

5.4 ASX Service Menu

NOTE: The ASX Service Menu in monitor software S-___94, S-___95 and S-___96 supports only modules equipped with the ASX-200.



1 Zero gases

2 Return to previous menu

Service Data

ID result displays the identified gas or mixture

Total % is the anaesthetic agent concentration measured by ASX bench.

Rel % is the relative percentage of each measured agent in the mixture.

Noise value should be less than 80. Check the value only when no gas is fed and after a minimum of one minute stabilization time.

Temp C is the temperature inside the ASX unit.

AGC (Automatic Gain Control) should be between 100 and 3500.

Motor DAC is a motor speed control voltage, 100...3900, and **Motor Fluct** is the speed fluctuation, should be < 200.

Alc comp val is the compensation factor for alcohol content measured during halothane, enflurane or isoflurane measuring. **Sta** shows the status of compensation, 0 means off, and 1 means on.

The value without a leading text is for factory use only.

Peak normal, Peak mirror give the place of the spectrum's peak in the channel numbers. The peak normal value should be 10.3-10.7 with calibration gas R23, and 12.9-13.1 with R22. If the value is not within the range, the cas calibration must be performed (see Operator's manual for instructions).

Time offset is the time between motor synchronization pulse and filter 0° angle. **Fact** is the factory value for it, **EEPRO** is the user calibration result, stored in the ASX, and **RAM** is the user calibration result, stored in the gas mother board.

Spectrum values tell about the scales of the spectrum display.

6 SPARE PARTS

6.1 Spare parts list

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

Airway Modules

G-AO Rev. 01, G-AiO Rev. 00

Item	Item description	Order No.
14	Gas mother board, G-AO / G-AiO	*(880352) Use 885174
6	ACX-200 measuring board	*880270
26	ACX-200 measuring unit	*879849
22	ASX-100 agent indentification unit	*881107
21	Lamp, ASX-100/200	*878756
25	Sample pump, Airway module	*881298
23	O2 mesuring unit	*(872898) Use 888511
7	Cover, top protection	878859
12	CO2 Absorber, Airway Module	*880067
13	Damping chamber / Filter	880068
10	Valve, pressure	*58534
9	Valve, zero	58534
11	Internal sampling tubings incl. system plate	*880375
	Nafion tube (A or B, 500 mm: see Serv. Man.)	*733383
	Nafion tube (C, 300 mm)	*733382
	Spring for D-Fend	875598
20	Front panel unit, G-AO	(880374) Use 887477
20	Front panel unit, G-AiO	(881116) Use 887477
	Membrane keypad, G-AO / G-AOV	879371
40	Fitting plate, G-AiO / G-AiOV / G-O / G-OV	880550
19	Plug, tube connector	880294
1	Rear panel sticker, Airway module (Eng)	880460
1	Rear panel sticker, Airway module (Ger)	880462
1	Rear panel sticker, Airway module (Fre)	880461
17	Front panel sticker, small, G-AO / G-AOV (Eng)	880376
17	Front panel sticker, small, G-AO / G-AOV (Ger)	880546
17	Front panel sticker, small, G-AO / G-AOV (Fre)	880454

17	Front panel sticker, small, G-AiO / G-AiOV / G-O / G-OV	880471
18	Front panel sticker, large, G-AO	880377
18	Front panel sticker, large, G-AiO	880472
4	Fan	880049
3	Case, Airway module	878864
24	Grommet for tubes	65094
8	Latch for flow casettes	880343
27	Connector, sample gas out	871981
31	Cross recess screw M6x16	61678
32	Bushing, AS/3 Airway Module	879512
	Thumb screw, AS/3 Airway Module	879511

G-AO Rev. 02, G-AiO Rev. 01, G-AOV Rev. 00, G-AiOV Rev. 00

Item	Item description	Order No.
14	Gas mother board, G-AOV / G-AiOV	*(881775) Use 885174
20	Front panel unit, G-AOV	(880374) Use 888292 [1)]
20	Front panel unit, G-AiOV	(881116) Use 888292 [1)]
37	Repair set for spirometry connectors, AS/3	*886978
28	PVX-100 without software	*881444
29	PVX tubings	882723
30	PVX board support	880435
18	Front panel sticker, large, G-AOV	881300
18	Front panel sticker, large, G-AiOV	881301

G-AO Rev. 03, G-AiO Rev. 02, G-AOV Rev. 01, G-AiOV Rev. 01

Item	Item description	Order No.
14	Gas mother board, AS/3 Airway module	*885174
35	EMC cover, Gas mother board	884116
33	Bronze plate	884117
34	Insulation plate for 884116	879914

G-AO Rev. 04, G-AiO Rev. 03, G-AOV Rev. 02, G-AiOV Rev. 02, G-O Rev. 00, G-OV Rev. 00

Item	Item description	Order No.
22	ASX-200 agent indentification unit	*882718
23	O2 mesuring unit	*888511
36	Grounding spring	885602
20	Front panel unit, G-AO	(885280) Use 887477
20	Front panel unit, G-AiO	(885281) Use 887477
20	Front panel unit with metal SSS -connectors, AS/3	888292 [1)]
20	Front panel unit w/o SSS -connectors, AS/3	887477
38	Spirometry connector, short male	886636
39	Spirometry connector, short female	886638

29	PVX tubings	885867
1	Rear panel sticker, Airway module (Spa)	886187
1	Rear panel sticker, Airway module (Swe)	885984
1	Rear panel sticker, Airway module (Dut)	886123
1	Rear panel sticker, Airway module (Ita)	886762
1	Rear panel sticker, Airway module (Fin)	888879
17	Front panel sticker, small, G-AO / G-AOV (Spa)	884405
17	Front panel sticker, small, G-AO / G-AOV (Swe)	885843
17	Front panel sticker, small, G-AO / G-AOV (Dut)	886065
17	Front panel sticker, small, G-AO / G-AOV (Ita)	886760
17	Front panel sticker, small, G-AO / G-AOV (Fin)	888876
17	Front panel sticker, small, G-AiO /-AiOV / -O / -OV	880471
18	Front panel sticker, large, G-O	885233
18	Front panel sticker, large, G-OV	886972

The Flow cassette's and their order numbers can be found listed in the Gas Sampling System - section of this manual.

* = the part is recommended for stock

[1)] **NOTE:**

In case only the plastic spirometry connectors need repair, or compatibility with adult&paediatric Side Stream Spirometry accessories is needed, the **Repair set for spirometry connectors, order number 886978**, is recommend to be used.

The Front panel unit , order number 888292, does not contain a membrane keypad, fitting plate and small front panel sticker. Those should be added separately according to the Airway module type and revision.

Gas Interface Board, B-GAS

Item description	Order No.
Fuse T4A 250V	*51134
Grounding plate	885404

6.2 Exploded view of the module

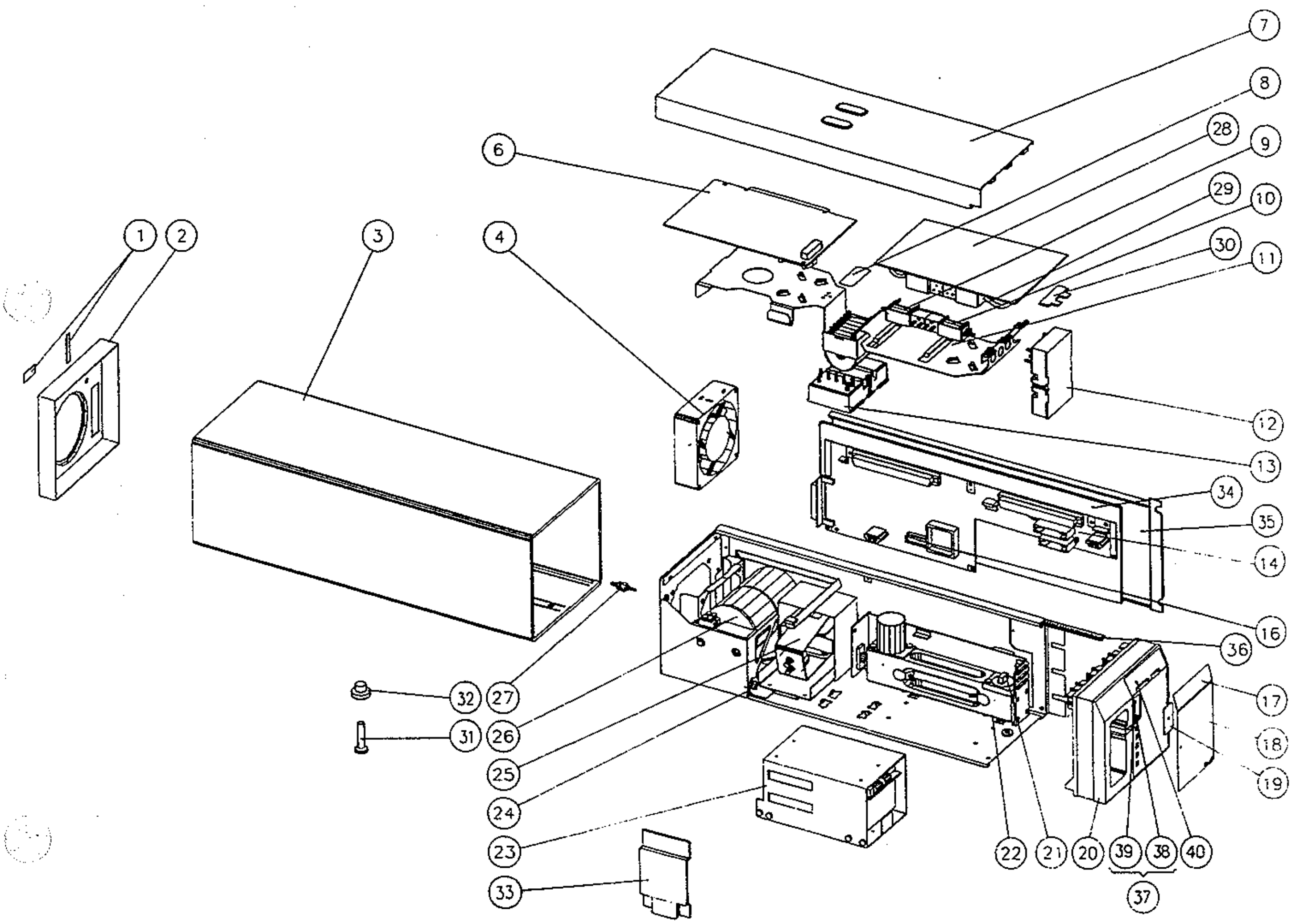


Figure 16 Exploded View of the Airway Module

7 EARLIER REVISIONS

This manual supports all the other Airway Module revisions except the following ones. For further information on those revisions see corresponding manual.

G-AO Module revision 01	Service Manual p/n 880850
G-AiO Module revision 00	-"-
G-AO Module revision 02	Service Manual p/n 882580
G-AiO Modules revision 01	-"-
G-AOV Module revision 01	-"-
G-AiOV Module revision 01	-"-

Anaesthesia Keyboard, K-ARK (Rev. 00)

Keyboard Interface Board, B-ARK (Rev. 00)

All specifications subject to change without notice

Document No. 885943-2

March, 1996

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Table of Contents

INTRODUCTION

This service manual section provides information required to maintain and repair the Datex AS/3 Anaesthesia Monitor Anaesthesia Keyboard, K-ARK and Keyboard Interface Board, B-ARK. The information is applicable for the current production revision of the modules.

1 SPECIFICATIONS

ANAESTHESIA KEYBOARD

Dimensions (W x D x H)	313 x 230,5 x 60 mm/ 12.3 x 9.0 x 2.4 inch
Weight	1,23 kg / 2.7 lb.
Electrical requirements	+ 5V DC +10% -25%, 75 mAmax supplied by Datex AS/3 Monitor
Character set	256 characters ASCII
Communications interface	PC compatible line, AS/3 type serial line

2 FUNCTIONAL DESCRIPTION

The Datex AS/3 Anaesthesia Record Keeper is an automated anaesthesia documentation system. For record keeping the Anaesthesia Keyboard, K-ARK ,and the software S-ARK95/ARK96 (or S-ARK94) are needed.

The Anaesthesia Keyboard, K-ARK is connected to the Anaesthesia Monitor via the Keyboard Interface Board, B-ARK. Alternatively, the Keyboard can be connected to the Command Board connector on the LCD-Display, or on the Display controller board, B-DISP (or B-DHIGH).

K-ARK is connected to the Compact Monitor via the K-ARK connector on the side panel.

The Anaesthesia Record Keeper combines the physiological data measured by the monitor and the information entered via the Anaesthesia Keyboard into a printable anaesthesia record.

The Anaesthesia Record Keeper can be connected to a network, or run in a stand-alone AS/3 Monitor. If a stand-alone monitor is used, the Memory Module, M-MEM (or B-CMMEM) is needed for data storage. To get information of Memory module's maintenance and service, please refer to the Memory module section of this manual.

2.1 Anaesthesia Keyboard, K-ARK

The Anaesthesia Keyboard consists of following main parts: Controller Board, Alphanumeric keyboard and membrane keypads.

2.1.1 Controller Board

The Controller board is located inside the Anaesthesia Keyboard of AS/3 Anaesthesia Monitor. The board reads the status of the front panel keys (including selection and alpha-numeric keys) and the ComWheel on the front panel and forwards the information to the CPU Board, B-CPU2 or B-CPU3, in RS232 serial communication mode.

Additionally, the board's own CPU controls the LEDs on the front panel.

External communication

Communication with the host processor takes place either in RS232 serial communication channel which is available in the AS/3 bus, or, there are also two bidirectional signals (TxD and RxD) for PCKB format communication.

For serial communication, the Anaesthesia Keyboard is connected to the AS/3 Anaesthesia Monitor Central Unit by 9-pin-26-pin interface cable. The cable is connected to Keyboard Interface Board, B-ARK or to Display Controller board, B-DISP (or B-DHIGH), in the Central Unit.

In case of PCKB type communication, the Keyboard can be connected to the AS/3 LCD Display, D-LCC10 or to the Compact Monitor.

CPU

The CPU on the Controller board is of a type 80C51FA and its oscillator's frequency is 11.059 MHz.

There is a power-up-reset whose time constant is about 1 second.

Serial communication

RS232 serial communication IC needs only +5 V supply voltage because it chops the necessary RS-level supply voltages to its external capacitors. There is a diode that allows the use of two keyboards, the pull-down resistor on the CPU board of AS/3 Anaesthesia Monitor is used for pulling the corresponding line to the negative RS-level. The speed of the serial communication is 19.2 kBaud.

LEDs

The CPU on the board drives the alarm LEDs under the commands received from the host processor.

2.1.2 Alpha-numeric Keyboard PC Board

The board reads the status of alpha-numeric keys and forwards the information to the Controller board using the RS232 serial communication.

The board is connected to the Controller board with a 26-pin ribbon cable.

An alpha-numeric keypad can also be connected to the board with PC's access format.

2.1.3 Connectors and Signals

Anaesthesia Keyboard 9-pin male D-connector

Pin No	I/O	Signal
1	I/O	PC KEYBOARD
2	I	RX
3	O	TX
4	I	+5 V
5		GND
6	I	RESET
7		N.C.
8		N.C.
9	I/O	PC KEYBOARD

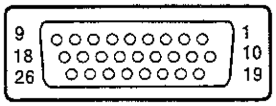
2.2 Keyboard Interface Board, B-ARK

This pc board is installed to the Central Unit of the AS/3 Anaesthesia Monitor. It has a 26-pin female D-connector to which the Anaesthesia Keyboard is connected.

This board has no other functions than letting signals from the Anaesthesia Keyboard pass through to the AS/3 Monitor.

2.2.1 Connectors and signals

The connector located on the Keyboard Interface Board, B-ARK.



Pin No	I/O	Signal
1		N/C
2		N/C
3		N/C
4		N/C
5		N/C
6	O	Ground
7		N/C
8		N/C
9		N/C
10		N/C
11		N/C
12		N/C
13		N/C
14		N/C
15	O	+ 5 V
16		N/C
17		N/C
18		N/C
19	I	RxD RS232
20	O	TxD RS232
21		N/C
22		N/C
23		N/C
24		N/C
25		N/C
26		N/C

The AS/3 bus connector (X1):

	a	b	c
1	+15 V	AGND	DGND
2	-15 V	BALE	DGND
3	SA0	SA1	DGND
4	SA2	SA3	RESET_RS485
5	SA4	SA5	-RESET_RS485
6	SA6	SA7	DATA_RS485
7	SA8	SA9	-DATA_RS485
8	SA10	SA11	TXDD_RS232
9	SA12	SA13	RXDD_RS232
10	SA14	SA15	BIT0IN
11	SA16	SA17	BIT1IN
12	SA18	SA19	TXDC
13	SA20	SA21	RXDC
14	SA22	SA23	RTSC
15	-SMEMR	-SMEMW	CTSC
16	-IOR	-IOW	TXDB
17	CLK	-RESET	RXDB
18	-IOCHRDY	IRQ10	RTSB
19	N/C_1	IRQ11	CTSB
20	N/C_2	IRQ12	TXDA
21	-SBHE	IRQ15	RXDA
22	SD0	SD1	RTSA
23	SD2	SD3	CTSA
24	SD4	SD5	LOUDSPEAKER
25	SD6	SD7	+5 V
26	SD8	SD9	+5 V
27	SD10	SD11	+5 V
28	SD12	SD13	+5 V
29	SD14	SD15	ON/STBY
30	+15 VD	-RESET_CPU	+5 V_CPU
31	+15 VD	+32 VD	REFRESH_WD
32	GNDD	GNDD	POWER_FAIL

3. SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex for repair.

Datex is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

CAUTION: The tests and repairs outlined in this section should only be attempted by trained personnel with the appropriate equipment. Unauthorized service may void warranty of the unit.

3.2 Disassembly and Reassembly

The Anaesthesia Keyboard is disassembled in the following way. See Figure 1 for the exploded view of the module:

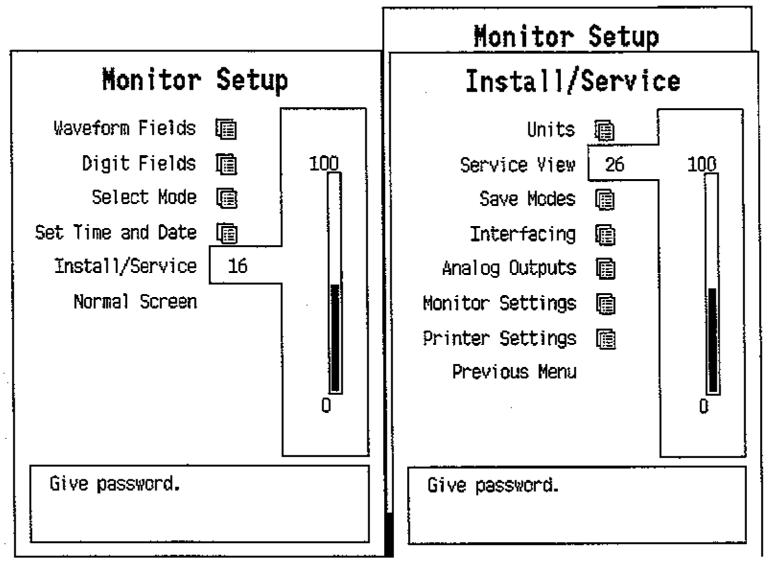
a) Disconnect the interface cable from the 9-pin D-connector of the Anaesthesia Keyboard.

b) Remove four screws from the back of the keyboard and detach the cover from the bottom.

4 TROUBLESHOOTING

PROBLEM	CAUSE	TREATMENT
Power on LED does not light	AS/3 monitor power is off. Cable is not connected or broken. Wrong type of cable is connected.	Turn the power on. Cable to AS/3 Anaesthesia Monitor (p/n 881152) or to LCD Display or Compact Monitor (881154) should be used. Connect right type of cable properly.
Keys have not 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	Switch 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:** Cancel key does not respond if menu is closed. Modify key may not work if there is no even selected.	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.	Check the items. Replace them if necessary.

5 SERVICE VIEW



To enter the Service menu:

1. Press the MONITOR SETUP key.
   The Setup menu appears.

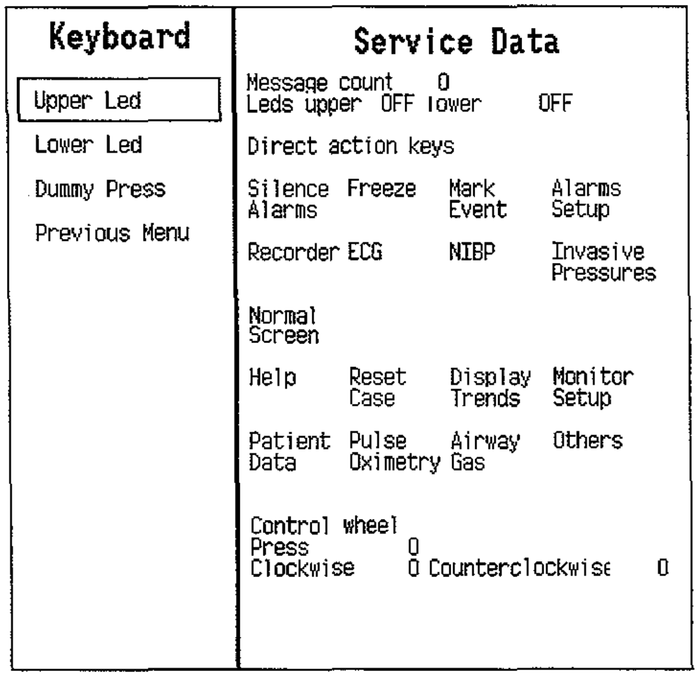
2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.

4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

6. Turn the ComWheel to highlight Keyboard and push.



1. Silence Alarms upper led (red) check.
2. Silence Alarms lower led (yellow) check.
3. ComWheel pressing check.
4. Return to previous menu.

Service Data

Message Count counts whenever a function is selected.

Leds upper and **Leds lower** indicate Silence Alarms leds' state.

Direct action keys' 17 items change its color when the key is pressed. If the color does not change, the key may be mechanically damaged.

In **Control wheel, Press** counts whenever the ComWheel is pushed. **Clockwise** and **Counterclockwise** counts whenever the ComWheel is turned.

NOTE: Counters in this page are automatically zeroed on returning to the previous menu.

6 SPARE PARTS LIST

6.1 Spare Parts list

Item numbers refer to the exploded view in chapter 6.2.

Anaesthesia Keyboard, K-ARK

Rev. 00

Item	Item description	Order No.
3	Controller board, K-ARK (Rev. 00)	*884177
2	Alpha-numeric Keyboard PC board, K-ARK (Rev. 00)	*884178
4	Rotary wheel	879872
5	ComWheel cover and spring	879191
10	Membrane keyboard	879373
8	Membrane keyboard	879964
9	Front panel sticker, K-ARK (Eng)	881648
9	Front panel sticker, K-ARK (Fre)	884731
9	Front panel sticker, K-ARK (Ger)	885140
9	Front panel sticker, K-ARK (Spa)	886200
9	Front panel sticker, K-ARK (Swe)	885915
9	Front panel sticker, K-ARK (Dut)	886162
7	Front panel sticker, K-ARK (Eng)	884017
7	Front panel sticker, K-ARK (Fre)	884406
7	Front panel sticker, K-ARK (Ger)	885133
7	Front panel sticker, K-ARK (Spa)	886198
7	Front panel sticker, K-ARK (Swe)	885916
7	Front panel sticker, K-ARK (Dut)	886282
7	Front panel sticker, K-ARK (Fle)	886161
7	Front panel sticker, K-ARK (Sca)	884632
1	Pad	65142
6	Cross cylinder-head screw M3x6	61721

Keyboard Interface Board, B-ARK

Item description	Order No.
Grounding plate	885398

* = the part is recommended for stock

6.2 Exploded view

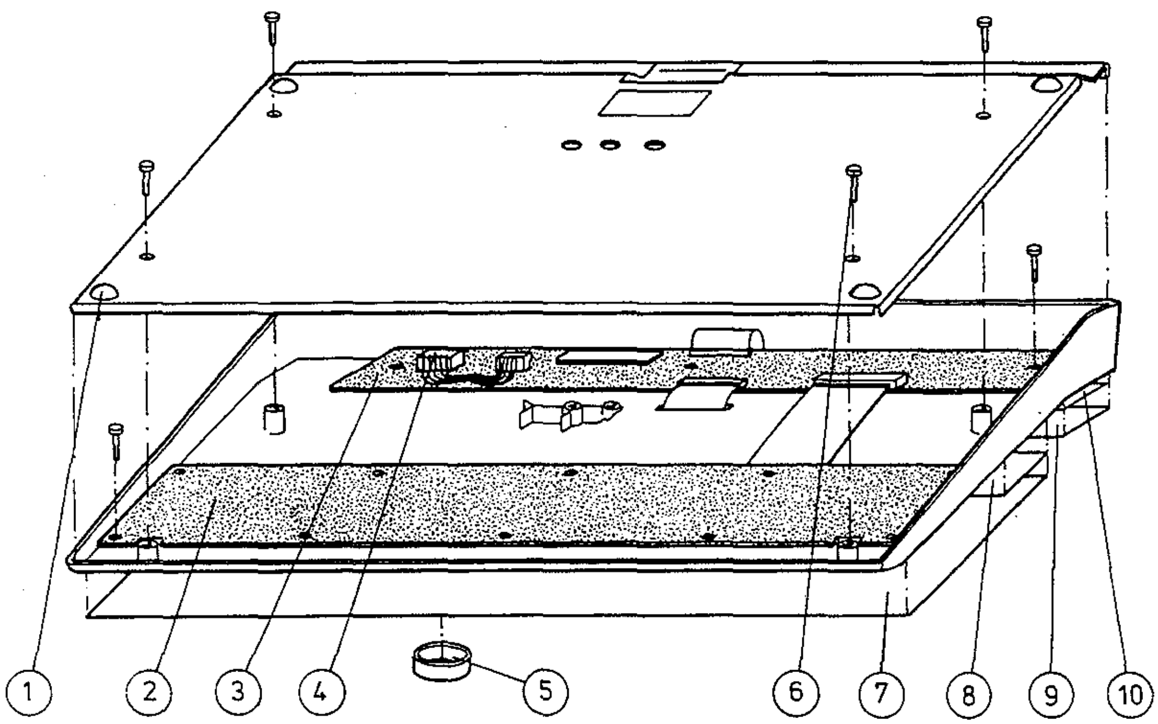


Figure 1 Exploded View of the Anaesthesia Keyboard

7 EARLIER REVISIONS

Rev. 00 is the first revision of the K-ARK, and B-ARK.

Neuro Muscular Transmission Module, M-NMT (Rev. 00)

All specifications subject to change without notice.

Document No. 887780-1

March, 1996

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Table of Contents

INTRODUCTION

The M-NMT module contains peripheral nerve stimulation and response measurement which supports electromyography EMG. Module can be used also as a nerve locator for regional nerve block with Regional block -cable in which case there is no response measurement.

1 SPECIFICATIONS

1.1 General Specifications

Module size W x D x H	37 x 180 x 112 mm 1.5 x 7.1 x 4.4 in
Module weight	0.37 kg /0.8 lbs.
Power consumption	3,8 W

1.2 Technical Specifications

NMT

Stimulation modes	Train of four (TOF) Double burst (3.3) (DBS) Single twitch (ST) 50 Hz tetanus + post tetanic count (PTC)

Measurement intervals for TOF and DBS
Manual, 10 s, 12 s, 15 s, 20 s
1 s, 1 min, 5 min, 15 min

Measurement intervals for ST
Manual, 1 s, 10 s, 20 s

STIMULATOR

Stimulus pulse	Square wave, constant current
Pulse width	100, 200 or 300 µs
Stimulus current range	10 - 70 mA with 5 mA steps

Stimulus current accuracy
10 % or ± 3 mA which ever is greater measured as average

Max load	3 kΩ
Max. voltage	300 V

REGIONAL BLOCK MODE

Stimulation modes	Single Twitch
Intervals	1 s, 2 s, 3 s
Stimulus pulse	Square Wave, constant current
Pulse width	40 µs
Stimulus current range	0 - 5.0 mA with 0.1 mA steps
Stimulus current accuracy	20 % or 0.3 mA which ever is greater measures as average

2.2 Main Components

2.1.1 NMT Board

Module has constant current stimulator, measuring electronics for the EMG signals, a processor part for the stimulation and measuring control and for the counting the measuring results, and it has also a communication part (see the figure). Processor is Intel 80C196KD.

Serial bus speed is 500 kbit/s and the bus itself is half duplex, data can be transferred to both direction but only one way at the time.

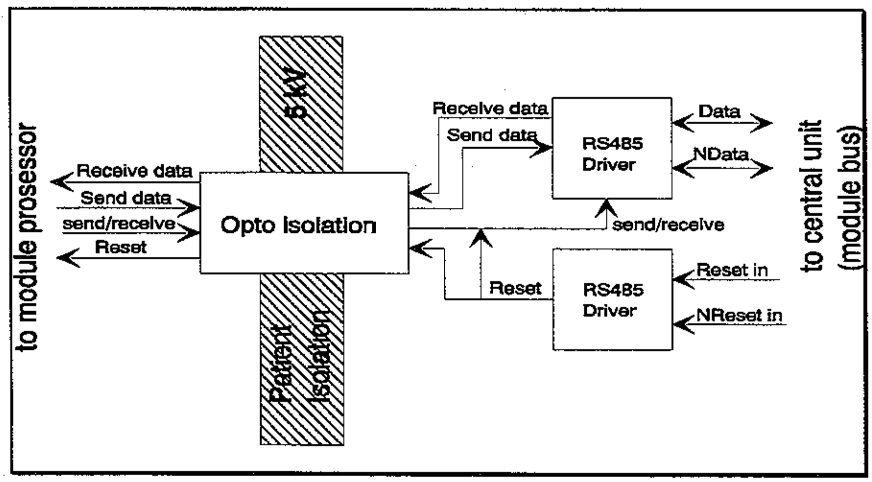


Figure 2 Communication

Stimulator

Constant current stimulator generates pulses, of which amplitude is independent of the load. Main components of the stimulator are transformer, capacitor and transistor. Transformer produces high enough voltage, capacitor charges and transistor adjusts the pulse width and amplitude of the current.

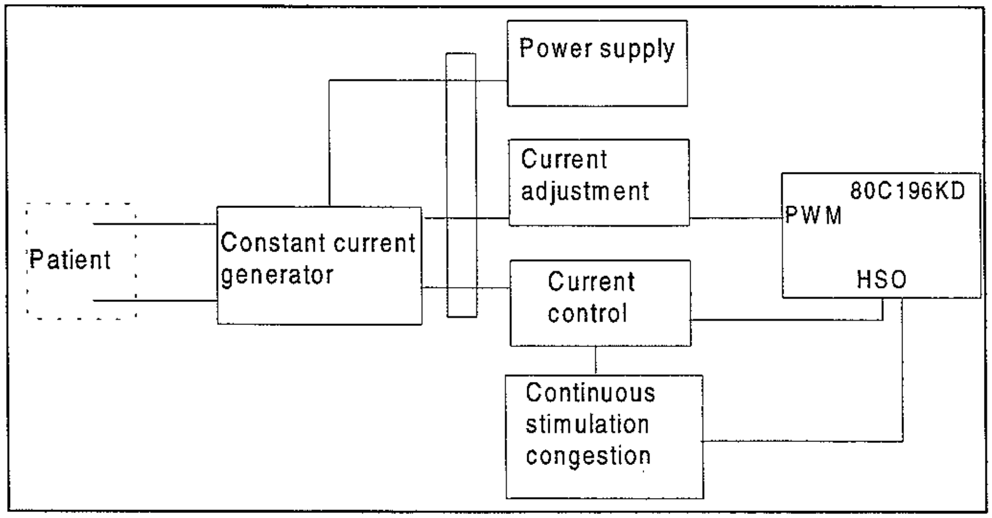


Figure 3 Stimulator Block Diagram

2.1.2 NMT connectors

The pin assignments on the NMT Connector located on the M-NMT module are as follows.

Pin	Signal
1	EMG Signal +
2	EMG Signal -
3	Not Used
4	Stimulus +
5	Stimulus -
6	Ground
7	Not Connected
8	Sensor Identification
9	+5 V
10	Mechanical Signal

Rear panel 25-pin female D-connector (X1)

Pin No	I/O	Signal
1	I	RESET_RS485
2	I	-15 VDC
3	I	+15 VDIRTY
4	I	+15 VDC
5	I/O	-DATA_RS485
6	I/O	DATA_RS485
7		Ground & Shield
8	I	-RESET_RS485
9	I	CTSB
10	O	RTSB
11	I	RXDB
12	O	TXDB
13		Ground & Shield
14	I	+32 VDIRTY
15	I	GroundDIRTY
16	I	CTSC
17	O	RTSC
18	I	RXDC
19	O	TXDC
20		ON/STANDBY
21		PWM_ECG
22		RXDD_RS232
23		TXDD_RS232
24	I	+5 VDC
25	I	+5 VDC

3 SERVICE PROCEDURES

3.1 General Service Information

Usually field service is limited to replacing the faulty circuit boards or mechanical parts. The boards are then returned to Datex for repair.

Datex is always available for service advice. Please provide the unit serial number, full type designation, and a detailed fault description.

Datex NMT Stimulator (order code 871251) is recommended for functional checks.

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

3.2 Preventive Maintenance

Perform these checks after any service and at least once a year to keep NMT Module in good condition.

Visual Inspection

___: If the module is disassembled, check that grounding wires and all connectors are properly connected and there is no loose object inside before attaching the module box.

Functional checks

___: Insert the NMT module M-NMT into the AS/3 monitor. Check visually that the NMT accessories are not damaged.

___: Connect the NMT sensor cable and connect the NMT sensor to the Datex NMT stimulator. Set stimulator controls to "fade off" and max. Push start-up key on the module.

___: Check that no error messages are displayed while the monitor searches for the supramaximal current and the reference level. To discontinue push the Stop/Continue key on the module.

3.3 Disassembly and Reassembly

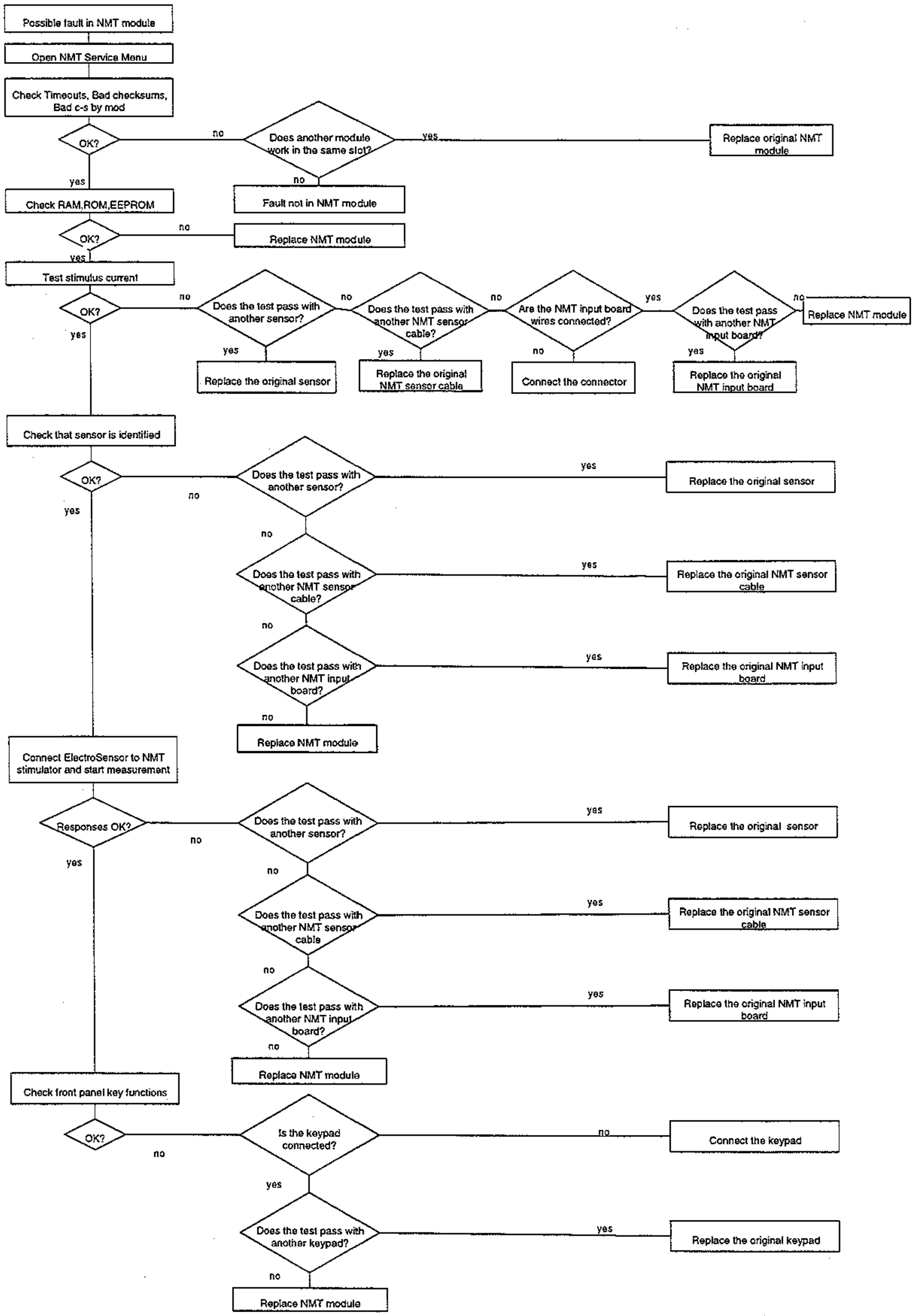
Disassemble the NMT module in the following way. See Figure 4 for the exploded view of the module.

1. Remove the two screws from the back of the module.
2. Pull the module box slowly rearward and detach it from main body. Be careful with loose latch and spring pin for locking.
3. Detach the NMT board by removing the two screws that are located near the front panel frame, disconnect the cables and pull out the front panel frame.

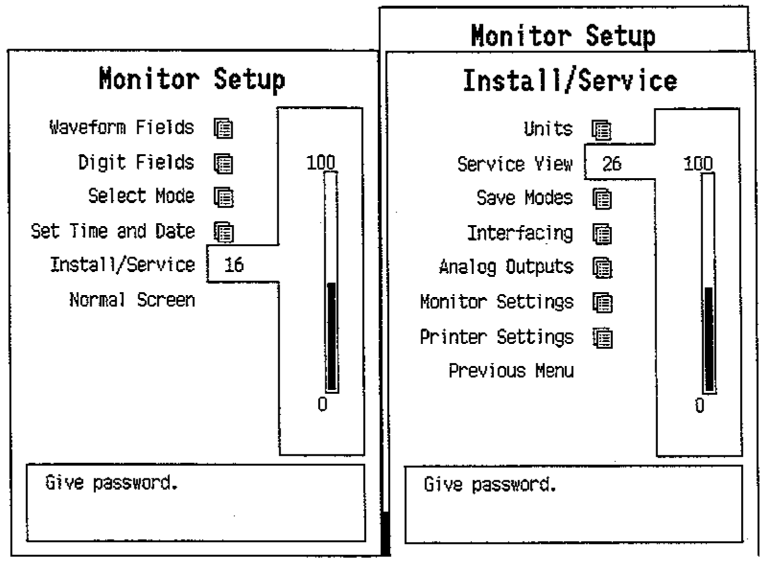
CAUTION: When reassembling the module, make sure that the cables are reconnected properly.

4 TROUBLE SHOOTING

TROUBLE	CAUSE	TREATMENT
Check the stimulus electrodes. EMG electrode off	Loose electrodes or loose stimulus clip.	Change or attach the electrodes or clip.
Supramax. not found	Loose electrodes or loose stimulus clip. Stimulus electrodes attached to wrong place. Patient is relaxated.	Change or attach the electrodes or clip. Change the place of the stim. el.
Response too weak.	Loose stimulus electrodes. Measuring electrodes attached to wrong place. Patient is relaxated.	Change or attach the electrodes. Change the place of the meas. electrodes.
Ref. not stable	Patient is relaxated. Movement artefact.	


Possible fault in NMT module
Open NMT Service Menu
Check Timeouts, Bad checksums, Bad c-s by mod
OK?
no
Does another module work in the same slot?
yes
Replace original NMT module
no
Fault not in NMT module
yes
Check RAM,ROM,EEPROM
OK?
no
Replace NMT module
yes
Test stimulus current
OK?
no
Does the test pass with another sensor?
no
Does the test pass with another NMT sensor cable?
no
Are the NMT input board wires connected?
yes
Does the test pass with another NMT input board?
no
Replace NMT module
yes
Replace the original sensor
yes
Replace the original NMT sensor cable
no
Connect the connector
yes
Replace the original NMT input board
yes
Check that sensor is identified
OK?
no
Does the test pass with another sensor?
yes
Replace the original sensor
no
Does the test pass with another NMT sensor cable?
yes
Replace the original NMT sensor cable
no
Does the test pass with another NMT input board?
yes
Replace the original NMT input board
no
Replace NMT module
yes
Connect ElectroSensor to NMT stimulator and start measurement
Responses OK?
no
Does the test pass with another sensor?
yes
Replace the original sensor
no
Does the test pass with another NMT sensor cable
yes
Replace the original NMT sensor cable
no
Does the test pass with another NMT input board?
yes
Replace the original NMT input board
no
Replace NMT module
yes
Check front panel key functions
OK?
no
Is the keypad connected?
no
Connect the keypad
yes
Does the test pass with another keypad?
yes
Replace the original keypad
no
Replace NMT module

5 SERVICE MENU



To enter Service Menu:

1. Press the MONITOR SETUP key.
   The Setup menu appears.

2. Turn ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.

4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

6. Turn the ComWheel to highlight Modules and push.

7. Turn the ComWheel to highlight the NMT module and push.

5.1 NMT Service Menu

```
NMT                     Service Data

NMT Setup               Cable:      EMG
                        Cable check value:      1
Start Curr. test
                        Module keys:    Start-up     Stop/Cont.
T1%/ref        1
                        Stimulus mode: TOF   Measurement: ON
Previous Menu
                        T1%       1000   Absolute T1   2143
                        T2%        678   Absolute T2   1455
                        T3%        508   Absolute T3   1089
                        T4%        317   Absolute T4    680
                        Ratio%     317   Ref           2143

                        Noise       19
                        Offset     512

                        Current test (mA): 30 ok  50 ok  70 ok
                        Done

                        Curr set   233   Curr meas     268
                        Pulses      60

                        Piezo probe: T1% OFF  Ref.search OFF

                        Timeouts          0   RAM     OK
                        Bad checksums     1   ROM     OK
                        Bad c-s by moc    1   EEPROM  OK
```

1. By selecting **NMT Setup** you can enter the setup menu and change the values needed. Please refer to Operator's Manual for further information.

2. **Start Curr. Test** is a test where the module itself checks the difference between current given and measured. 3 kΩ resistance should be set between the stimulus electrodes before starting the test. All the currents checked will be displayed on the service data screen. After the current value, there is also shown the status of the test. If the test is not passed, send the module back to the factory for calibration.

3. **T1%/ref** not in use.

Service Data Detailed Description

Cable shows the type of cable used at the moment.

Cable check value show the bit amount. From the following chart you can check the values to each cable:

EMG	-100...+100
Cable OFF	>1950

Module Keys checks the function of the module keys. Blue background appears to the back of the text when the keys are pushed more than one second.

Stimulus mode shows the selected stimulus. Stimulus mode can be changed from the NMT Setup menu.

Measurement indicates ON/OFF.

T1%, T2%... shows the measured response. Value 1000 corresponds to 100%.

Absolute T1, T2... shows the voltage measured from the AD converter.

Noise indicates the interference just before the measurement. Typical value is <10.

Offset is an average length of the noise measurement. Typical value is 510.

Curr set is the selected current, value 700 corresponds to 70 mA.

Curr meas is the measured current, value 700 corresponds to 70 mA.

Pulses indicates pulses the module has produced.

Piezo probe T1% and ref. search not in use.

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 broke down.
Bad c-s by mod is a cumulative number that indicates how many communication errors the module has detected.
The AS/3 Monitor starts counting these items at power up and resets to zero at power off. The non-zero values do not indicate a failure, but the continuous counting (more than 50 per second) indicates either serial communication failure, or module not in place. Also other modules can cause communication errors that cause these numbers rise.

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

6 SPARE PARTS

6.1 Spare Part List

NOTE: Only changed part numbers are listed under later revisions. To find the desired part: check first the list of the revision that corresponds your device. If the part is not listed there, check the previous revision, etc. until you find the right number.

NOTE: Accessories are listed in the booklet AS/3 Supplies and Accessories.

Item numbers refer to the exploded view in chapter 6.2.

NMT Module, M-NMT

Rev. 00

Item	Item description	Order No.
8	NMT board, M-NMT (Rev. 00)	*887487
9	EMC cover, M-NMT	886320
5	Front panel unit, M-NMT (Rev. 00)	887186
11	NMT input board	887184
12	Membrane keypad	880101
13	Front panel sticker, M-NMT (Eng)	886002
13	Front panel sticker, M-NMT (Ger)	886003
13	Front panel sticker, M-NMT (Fre)	886004
13	Front panel sticker, M-NMT (Ita)	887542
13	Front panel sticker, M-NMT (Swe)	887369
13	Front panel sticker, M-NMT (Dut)	887370
13	Front panel sticker, M-NMT (Spa)	887498
13	Front panel sticker, M-NMT (Fin)	888873
1	Module box (single width)	886167
2	Latch	879181
3	Spring pin	879182
7	Metal frame	879184
4	Cross recess screw M3x8 black	616215
6	Cross cylinder-head screw M3x6	61721
10	Cross cylinder-head screw M3x12	628700

The front panel unit includes all the connectors and input boards.

* = the part is recommended for stock

6.2 Exploded View of Module

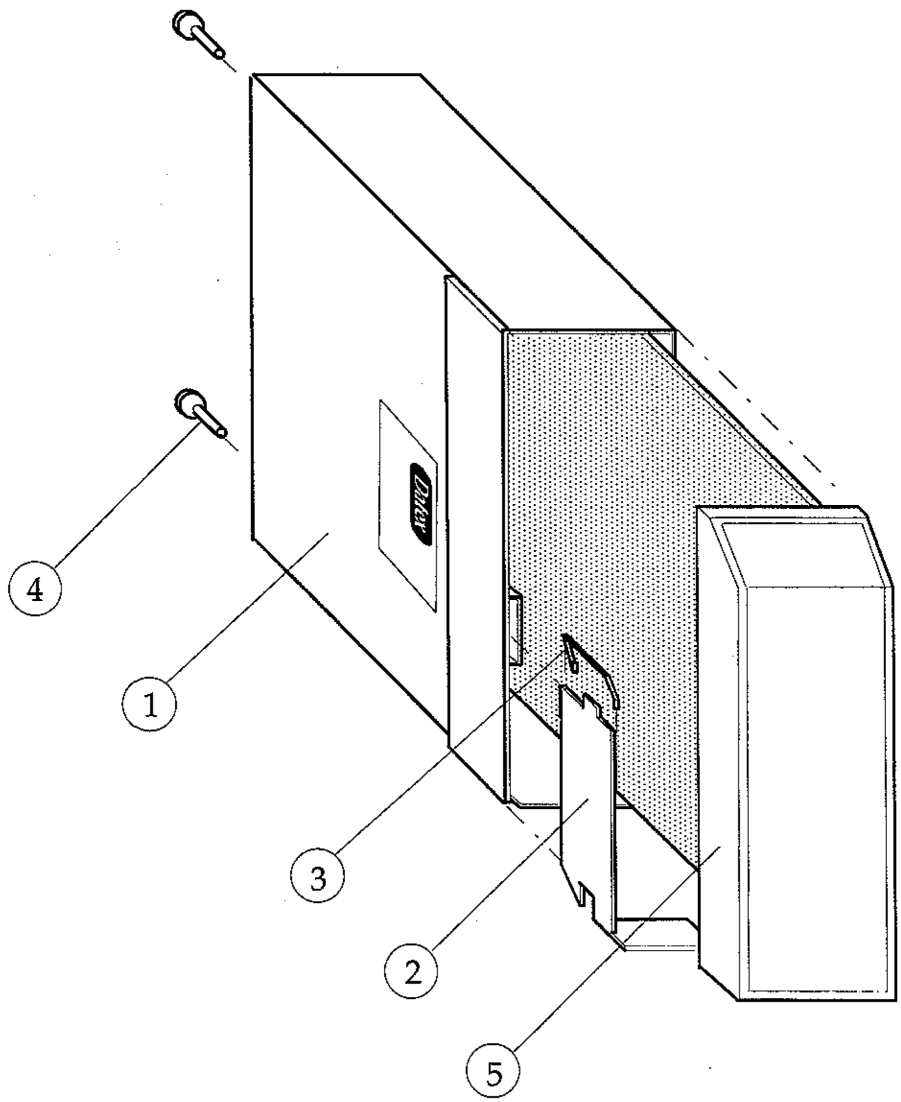


Figure 4 Exploded View of Module Box

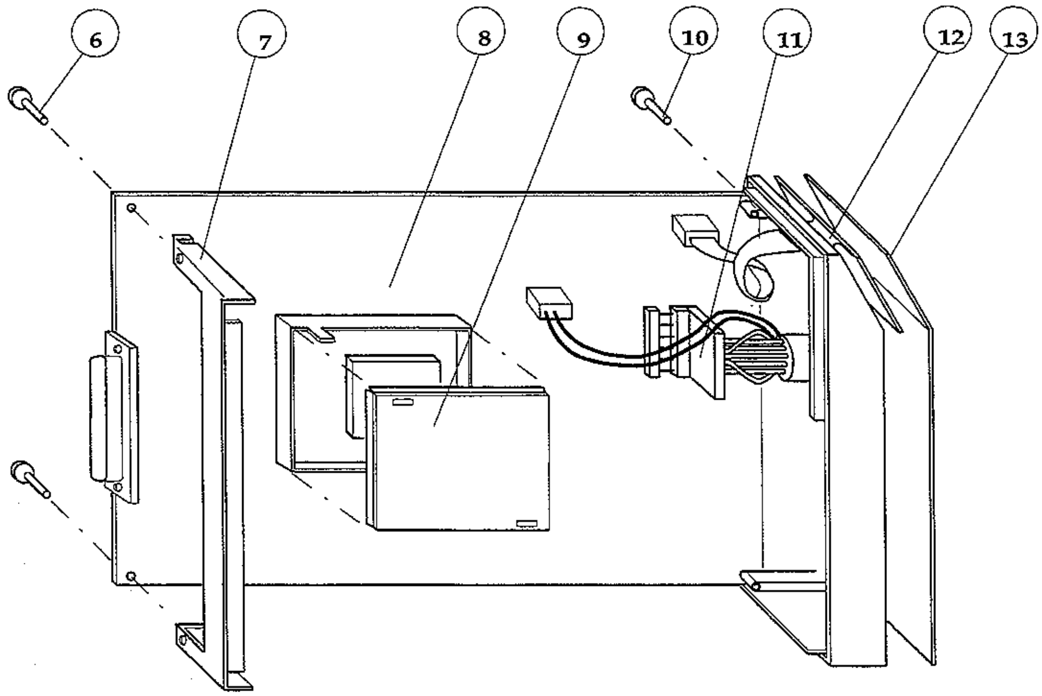


Figure 5 Exploded View of M-NMT Module

7 EARLIER REVISIONS

There are no earlier revisions of M-NMT.

UPINET Board, B-UPINET (Rev. 00)

All specifications subject to change without notice

Document No. 888737

March, 1996

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INTRODUCTION

Datex AS/3 UPINET Board, B-UPINET integrates the UPI board and the Network Board, B-NET.

Compared to a combination of the UPI board and the Network board, the UPINET board has a limited number of input/output signals. There is only one digital output signal and one analog output signal available on the UPINET board.

For installing the board, please refer to the Installation Manual of your monitor.

1 TECHNICAL SPECIFICATIONS

UPINET Board

- Supports xxx86 real/protected mode programming
- JTAG testing and programming
- Voltages used:

+5 V	500 mA
+15 V	20 mA
-15 Vdc	20 mA
+15 VD	50 mA +isolated power supply

Ethernet

- Meets IEEE802.3 specifications (10BASE-T)
- Hospital grade approved data transformer
- Coding element interface
- 64 Kbyte linear shared-memory / 8x8 Kbyte paged shared-memory in world wide format for communication buffer

UPI

- Supports RS-485 bus type 500 Kbit/s communication with 80196KC
- Isolated RS-232 level communication driven by B-CPU2, B-CPU3
- Isolated power supply
- Voltage and temperature measurement
- 32x2 Kbyte paged shared-memory in world wide format for communication buffer

2 FUNCTIONAL DESCRIPTION

2.1 General

2.1.1 UPI Section

The UPI section functions as a general I/O-board. It performs I/O duties assigned to it by the CPU board. The main processor in the CPU board and the processor in the UPI section communicate through a dual-port memory which is located on the UPINET board.

Functional blocks

The UPI section contains the external bus interface, a processor, program- and dual-port memories, I/O-block, and an isolated serial bus interface.

External bus interface

The UPI section is connected to the CPU mother board. The following signals pass on between the UPI section and CPU mother board: data bus, address bus, reset, read and write signals, and other related signals.

Processor

The processor in the UPI section is an 80C196KC-16, which functions at 16 MHz frequency.

Isolated and non-isolated serial bus interfaces

There are isolated and non-isolated serial bus interfaces. The isolated serial bus is connected to the connector X4 and the non-isolated serial bus is connected to the module bus through the CPU mother board.

Isolated power supply consists of a transformer and other peripheral components. It gives about 10 -15V/5 W output.

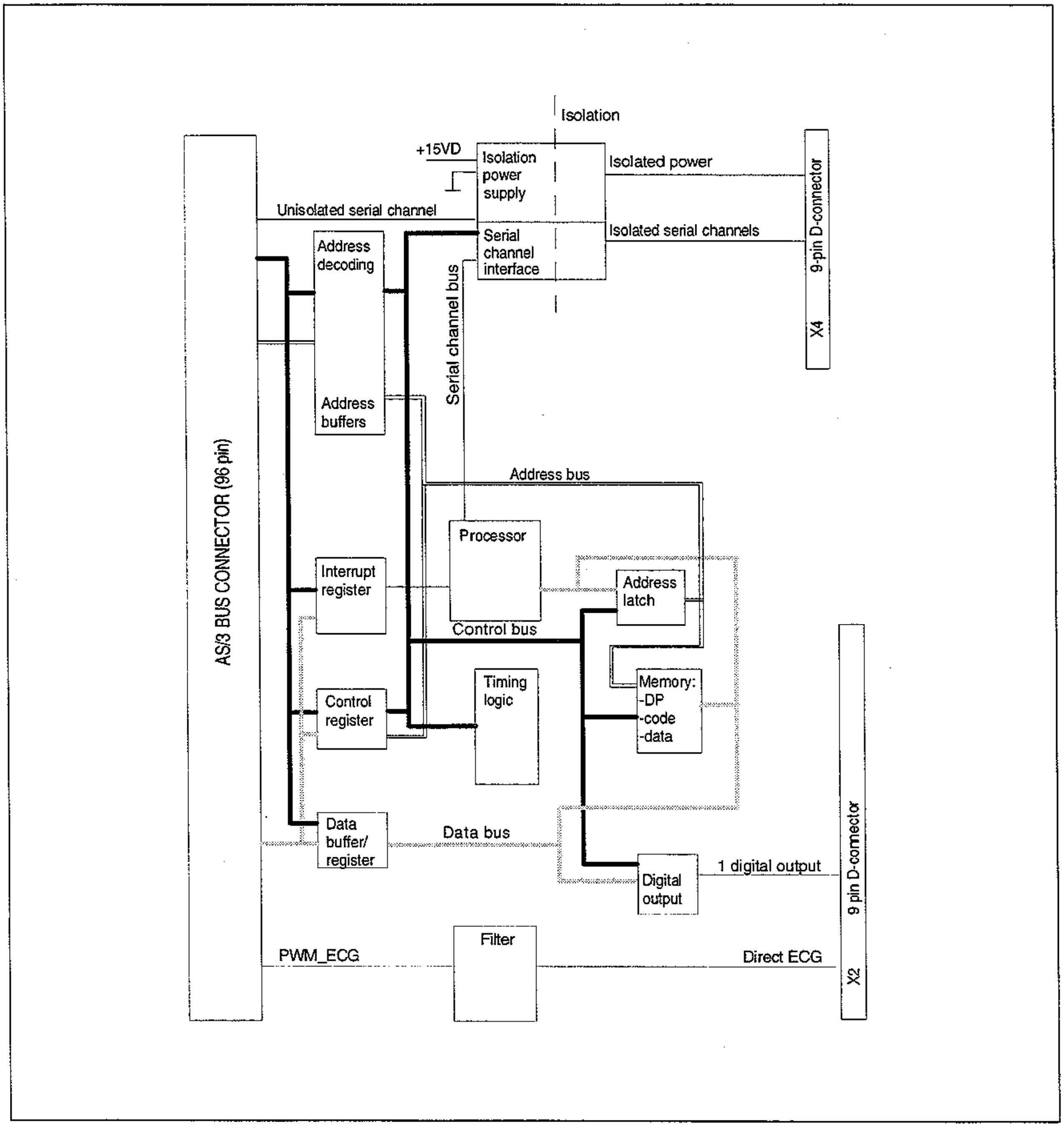


Figure 1 UPI Section Block Diagram

2.1.2 NET Section

The NET section is illustrated in a block diagram shown in figure 2.

The network interface controller is basically the heart of the NET section. The interface controller communicates with the CPU board through the data and address buffering and decoding block, or through the RAM. During the startup sequence the CPU board loads the network communication software into the RAM. The processor then executes the communication software.

The network interface controller transmits data packets to the AS/3 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 interface controller. The LEDs are not visible when the board is installed into the monitor.

The coding element interface block contains a unique network address. The interface block is connected to 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 board through the data and address buffering and decoding block.

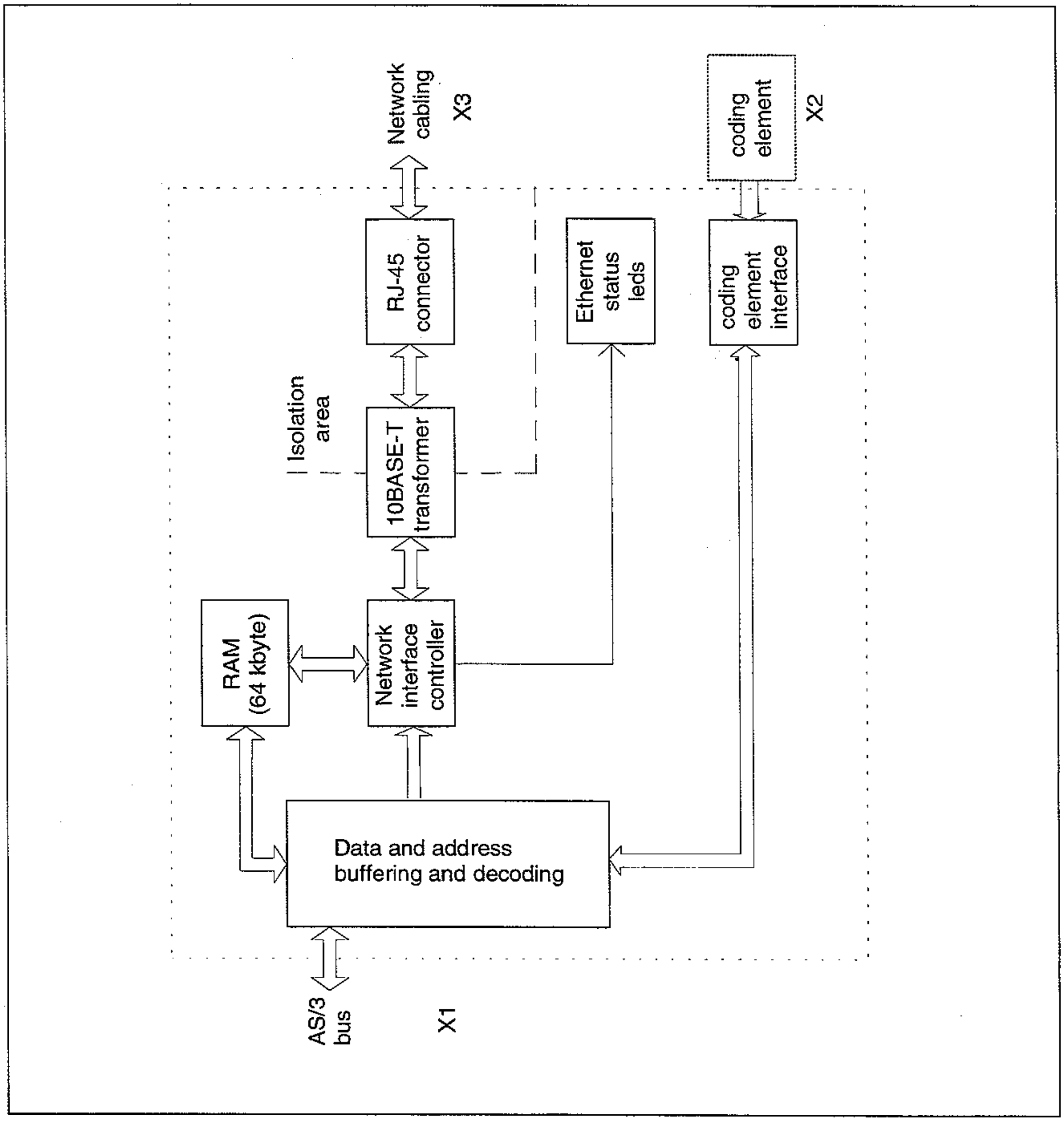


Figure 2 NET Section Block Diagram

2.2 Ethernet Interfaces

The data transformer is designed by Datex and it is hospital grade approved.

Adapter's 10BASE-T is a interface with 7-pole butterworth 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.

There are also four LEDs on the board, which are not seen from the outside, indicating the following things:

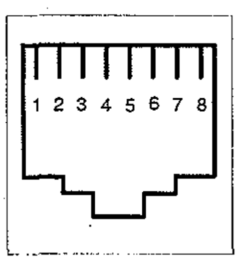
- transmission to Ethernet	V3	Green
- receiving from Ethernet	V2	Yellow
- collision detection	V4	Yellow
- good link in 10BASE-T interface	V5	Green

The transmission LED (V3) flashes when a packet is sent to the AS/3 Network. The reception LED (V2) flashes when a packet is received from the network. The collision detection LED (L4) indicates a packet collision on the network. The collision detection LED should flash only occasionally, otherwise there may be a physical layer problem. The link LED (V5) indicates whether or not the communication link to the HUB is functional. The link LED should always be lit.

2.3 Connectors and signals

2.3.1 Ethernet Network Interface

Network Connector X3

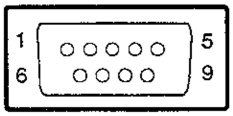


Pin	Signal
1	Tx +
2	Tx -
3	Rx +
4	N/C
5	N/C
6	Rx -
7	N/C
8	N/C

2.3.2 Network Coding Element Interface

Coding Element Connector X2

9 -pin female D-connector



Pin	Signal
1	IDCS1 (chip select)
2	IDCL (clock)
3	IDDI (data in)
4	IDDO (data out)
5	IDPE (protect enable)
6	+5Vdc
7	Fast analog ECG
8	Nurse call
9	gnd

Fast analog ECG (pin 7)

- Delay (max.): 15 ms
- Gain ECG (in)/ECG(out): 1 mV/1V
- Frequency band:
- ST and diagnostic: 0.5 - 35 Hz
- Monitor: 0.9 - 35 Hz

NOTE: Fast analog ECG is available with the Central unit version 02 or higher, and with ESTPR/ESTR/ETPR modules and with ESTP module revision 02 or higher , and ETP/EST module revision 01 or higher .

Nurse Call (pin 8)

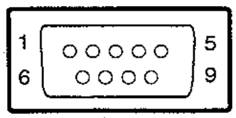
The nurse call signal is generated by the red, yellow and white alarms. When activated, the signal is set to the high state and remains at the high state until the alarm situation is over or the SILENCE ALARM key is pressed. The high state range is from 2.8 to 5 V, while the low state range is from 0 to 0.8 V.

If the output signals are used simultaneously with the coding element, the B-UPINET Y-cable, order number 889308, is recommended to be used.

2.3.3 Serial Data Interface

Serial Data Connector X4

Isolated serial data interface (RS232). The pin assignments are as follows.



Pin	Signal
1	N/C
2	RxD
3	TxD
4	Vout (10-15V)
5	GND
6	N/C
7	RTS
8	CTS
9	N/C

2.3.4 Connection to the AS/3 Bus

AS/3 Bus connector X1

	a	b	c
1	+15 V	AGND	DGND
2	-15 V	BALE	DGND
3	SA0	SA1	DGND
4	SA2	SA3	RESET_RS485
5	SA4	SA5	-RESET_RS485
6	SA6	SA7	DATA_RS485
7	SA8	SA9	-DATA_RS485
8	SA10	SA11	TXDD_RS232
9	SA12	SA13	RXDD_RS232
10	SA14	SA15	BIT0IN
11	SA16	SA17	BIT1IN
12	SA18	SA19	TXDC
13	SA20	SA21	RXDC
14	SA22	SA23	RTSC
15	-SMEMR	-SMEMW	CTSC
16	-IOR	-IOW	TXDB
17	CLK	-RESET	RXDB
18	-IOCHRDY	IRQ10	RTSB
19	N/C_1	IRQ11	CTSB
20	N/C_2	IRQ12	TXDA
21	-SBHE	IRQ15	RXDA
22	SD0	SD1	RTSA
23	SD2	SD3	CTSA
24	SD4	SD5	LOUDSPEAKER
25	SD6	SD7	+5 V
26	SD8	SD9	+5 V
27	SD10	SD11	+5 V
28	SD12	SD13	+5 V
29	SD14	SD15	ON/STBY
30	+15 VD	-RESET_CPU	+5 V_CPU
31	+15 VD	+32 VD	REFRESH_WD
32	GNDD	GNDD	POWER_FAIL

3 SERVICE PROCEDURES

Due to the nature of the UPINET Board, field service is limited only for troubleshooting. Faulty UPINET boards are returned to Datex for repair.

Datex 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 tools and equipment are allowed to perform the tests and repairs outlined in this section. Unauthorized service may void warranty of the unit.

Please, refer to the Installation Manual of your monitor for information on how to remove the UPINET Board.

4 TROUBLESHOOTING

4.1 Troubleshooting for the NET Section

Symptom at the monitor end	Problem at	Explanation/correction
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 wallplate or to the monitor.
	Monitor-Network cable	Cable or connector defective.
	UPINET board	The UPINET board is defective. The board cannot be used. See network service page for details.

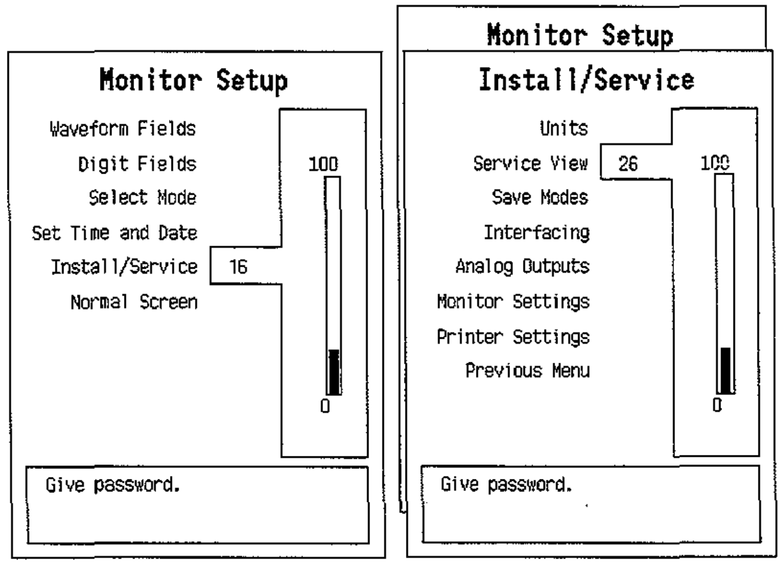
Symptom at the monitor end	**Problem at**	**Explanation/correction**
	UPINET board EEPROM	The EEPROM of the UPINET board is defective or uninitialized. The board cannot be used. See network service page for details.
	Identification plug	There is no Identification plug attached to the monitor.
		The identification plug is defective or uninitialized. The plug cannot be used.
"Network EEPROM Error" message shows on the monitor screen	UPINET board EEPROM	The EEPROM of the UPINET board is defective or uninitialized. The board cannot be used. See Network service page for details.
"Check network connectors" message shows on the monitor screen	Monitor-Network cable	Cable not properly connected to the wallplate or to the monitor.
		Cable or connector defective.
	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.
"Network board error" message shows on the monitor screen	UPINET board	The UPINET board is defective. The board cannot be used. See network service page for details.

Symptom at the monitor end	Problem at	Explanation/correction
	UPINET board EEPROM	The EEPROM of the UPINET board 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 AS/3 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 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 AS/3 Network Setup to verify the current set up.

4.2 Troubleshooting for the UPI section

Please refer to troubleshooting in the central unit section.

5 SERVICE VIEW



To enter the Service Menu:

1. Press the MONITOR SETUP key. The Setup menu appears.

2. Turn the ComWheel to highlight Install/Service and push.

3. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 16 - 4 - 34. The Install/Service menu appears.

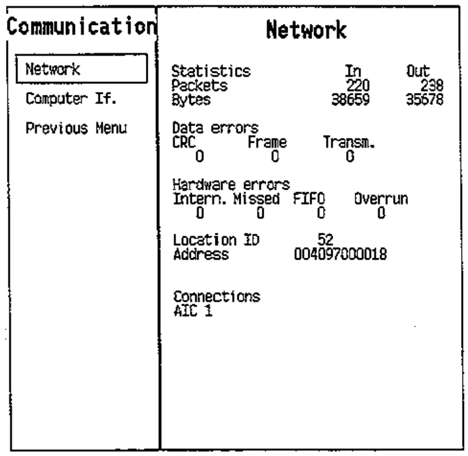
4. Turn the ComWheel to highlight Service View and push.

5. Give the password by turning the ComWheel to display each password number and confirm the number by pushing the ComWheel. Password numbers are 26 - 23 - 8.

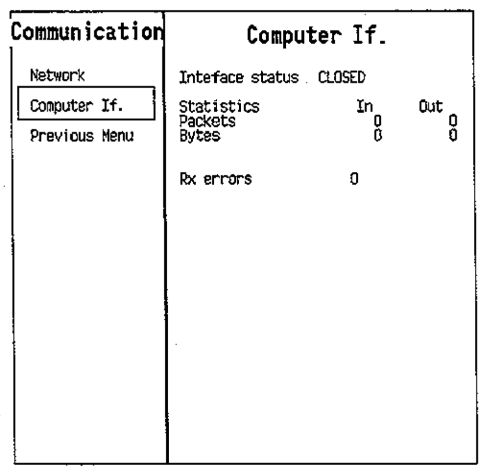
6. Turn the ComWheel to highlight "Monitor" and push.

7. Turn the ComWheel to highlight "Communication" and push.

8. Under Communication there are two service views about networking: Network and Computer Interface. Highlight the desired one and push the ComWheel.



Network displays the network related service data. Please see the chart on the next page.



Computer If. displays monitor computer interface related service data.

Interface status indicates if the connection is closed, opened or active. Closed indicates that the necessary hardware is not present or is not available, Opened indicates that the hardware and software for the interface are running, but there is no network connection or that there has been severe errors in using the interface (e.g., no cable connected), and active indicates that the interface is operating normally.

Rx errors indicates the number of received erroneous data packets.

In the Network menu there are additionally following items that describe the communication in the network.

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 UPINET 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 UPINET board.	Must always be 0.
Overrun errors (Overrun)	Practically same as above.	Must always be 0.
Location ID	Monitor's location given at the setup	
Address	Monitor's Ethernet address	
Connections	Names of AICs to which connected	

6 SPARE PARTS

UPINET Board, B-UPINET

Item description	Order No.
Grounding plate	887930
EMC cover	889296

* = the part is recommended for stock

7 EARLIER REVISIONS

There are no earlier revisions of the UPINET board.