Datex AS/3™
Anaesthesia Monitor
Service Manual

Datex

Datex

DATEX AS/3™

ANAESTHESIA MONITOR

SERVICE MANUAL

All specifications subject to change without notice

Manual No. 880850

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MANUAL INTRODUCTION

This service manual (Doc. No. 880850) and the Hitachi service manual for CM1483ME (available from Datex, order code 572772) provide information required to maintain and repair the Datex AS/3™ Anaesthesia Monitor. This manual is applicable for the current production revision of the units.

The revision of a unit/module is changed when technical changes are made to it resulting in new spare parts that are incompatible with earlier units/modules. The last two digits of the unit type designation denote the revision of the unit (e.g. F-CU8-23-00 is a revision -00 unit).

Functional units in the AS/3™ Anaesthesia Monitor (PC boards) will have ID code stickers indicating the modification level of the production documentation. The code is shown as xxxxxx-y, where the "xx..." represents the part number and "y" the revision level, which is referred to when hardware changes are indicated in this manual.

Please review the Operator's Manual to obtain a clear understanding of the unit.

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

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1 SECTION INTRODUCTION

This service manual section provides information required to maintain and repair the Datex AS/3™ Anaesthesia Monitor Central Unit. This section contains the following products:

8-Module Frame, F-CU8

including UPI Board and Power Supply Unit

CPU Board, B-CPU1

High Resolution Display Controller, B-DHIGH

Gas Interface Board, B-GAS

Software Cartridge, S-STD

This manual is applicable for the current production revision of the units. Differences between unit revisions are summarized in Chapter 9.

F-CU8-xx-01 is the initial production revision of the 8-Module Frame.

2 WARNINGS AND CAUTIONS

A WARNING indicates a potentially harmful situation to yourself or others.

* Before connecting power cord to mains outlet, check local voltage and frequency stated on the device plate on the rear panel of Central Unit.

ELECTRIC SHOCK PREVENTION:

* Connect the Central Unit to a three-wire, grounded, hospital grade receptacle.
* The power cord and plug must be intact and undamaged. Replace the cord if it becomes cracked, frayed, broken or otherwise damaged.
* Do not apply tension to the power cord.
* Do not remove the grounding prong from the power plug. Do not use extension cords or adapters of any type.
* The Video Display Unit line cord is to be connected only to power outlet of the Central Unit. Connecting it to the mains power will sacrifice patient isolation.
* Do not connect any other external equipment to AS/3™ Anaesthesia Monitor than those specified by Datex.
* Make sure that external equipment is hospital grade grounded before connecting to Datex equipment.
* Switch the monitor off before making any connections with external equipment.
* High Voltage is present within the CRT display unit.
* In case of mechanical damage, inspect the integrity of the patient isolation circuits, CRT unit, the power supply transformer and power entry module.

FUSE REPLACEMENT:

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

EXPLOSION HAZARD:

* Do not use this monitor in the presence of flammable anesthetics.

PATIENT SAFETY:

* Do not use an SpO_2 probe that is suspected of being immersed in liquid. It may cause burns during electrosurgery.
* Do not perform any testing or maintenance on medical instruments while they are being used to monitor a patient.
* Constant attention by a qualified individual is needed whenever a patient is under anesthesia or connected to a ventilator. Some equipment malfunctions may pass unnoticed in spite of equipment or monitor alarm.
* Always make sure that alarm limits are set and alarms are on when monitoring a patient.
* PACEMAKER PATIENTS: Rate meters may continue to count the pacemaker rate during occurrences of cardiac arrest or some arrhythmias. Do not rely entirely upon rate meter alarms. Keep pacemaker patients under close surveillance.
* Ensure proper contact of the return electrode of the electrosurgery unit to your patient to avoid possible burns at ECG electrode or other probe sites.
* Use only patient cables and accessories approved by Datex. Do not modify them. Other cables and accessories may damage AS/3™ Anaesthesia Monitor or interfere with measurement.
* Use only specified AS/3™ Anaesthesia Monitor interface cables.
* Use only defibrillation protected invasive pressure sensors on Datex Monitors.

CLEANING AND SERVICE:

* Switch the power off and unplug the power cord off the Central Unit before cleaning or service. Let it dry completely before reconnecting it to the mains outlet.

* Do not touch any exposed wiring or conductive surface while the cover is off and the monitor is energized. The voltages present when the electric power is connected to the monitor can cause injury or death.

* Perform a final electrical safety check and current leakage test after doing any repair or calibration procedure to the monitor.

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

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

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

* The tests and repairs described in this manual should only be done by trained personnel with proper tools and test equipment. Unauthorized service may void the monitor warranty.

* Do not use ammonia-, phenol-, or acetone-based cleaners. These cleaners may damage the monitor surface.

* Electrostatic discharge through the PC boards may damage the components. Before replacing and repairing 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 ECG or STP boards.

* Leave space behind the monitor to allow for proper ventilation.

* Before use, allow two minutes for warm-up and note any error messages or deviations from expected operation. See the Operator's Manual.

* Do not gas sterilize the module.

* Do not autoclave any part of AS/3™ Anaesthesia Monitor. Do not immerse in any liquid or allow liquid to enter the cabinet interior or into modules.

* Do not store the monitor outside the specified temperature range (-10 to +60°C /14 to 140°F).

* Clean rear panel fan dust filter once a month or whenever needed.

* Connect sample gas outlet on the module's rear panel to scavenging system to prevent room air pollution.

* The diameter of the scavenging system tubing must be 2 to 3 times larger than that of sample out tubing to avoid changing the operating pressure within the module. Inaccurate readings or internal damage may result.

* The diameter of the calibration gas delivery tube must be 2 to 3 times larger than that of the sampling line to avoid overpressurization of the sensors. Inaccurate calibration or internal damage of the module may result.

* Check the oxygen sensor after servicing the module. Breathe into the sampling line and confirm that the O_2 waveform changes after each breath.

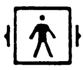
* When removing or inserting any part into the module, be careful not to kink or damage the gas sample tubes. Leakages in the gas sampling system will affect accuracy of measurement and are difficult to detect.

* When servicing the sampling system, make sure not to leave any tubes touching the sampling pump. Abrasion may damage the tubes.

EQUIPMENT SAFETY SYMBOLS

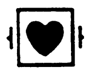
Attention, consult accompanying documents. When this symbol is displayed beside the O_2 valve FiO_2 low alarm limit is set below 21 %.

Type BF (IEC-601-1) protection against electrical shock.



Type BF (IEC-601-1) defibrillator-proof protection against electrical shock.

Type CF (IEC-601-1) protection against electrical shock.



Type CF (IEC-601-1) defibrillator-proof protection against electrical shock.

3 PRINCIPLE OF OPERATION

There are single and double width modules containing one or more parameters. The modules are installed into the Central Unit. They can be removed or inserted during operation.

In addition, there is a gas module which is side-mounted to the Central Unit.

NOTE: Identical modules cannot be used in the same Central Unit. If two or more identical modules are inserted in an error message will follow.

NOTE: Connect only one patient to one AS/3™ Anaesthesia Monitor at the same time.

For the detailed information on each modules and their parameters, please refer to the Operator's Manual.

4 DETAILED DESCRIPTION OF CENTRAL UNIT

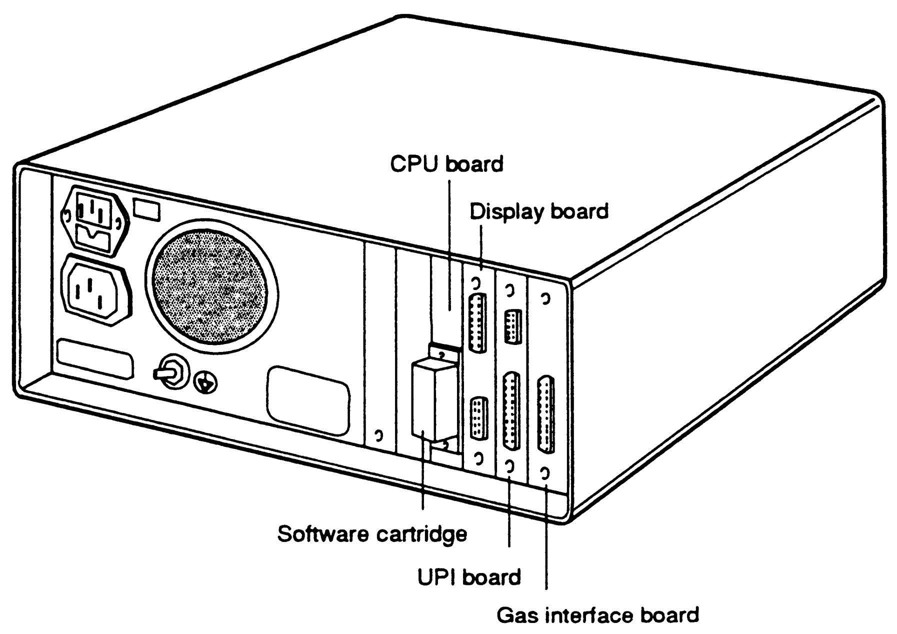
The center of the Central Unit is the 8-Module Frame, F-CU8, that includes UPI Board and Power Supply Unit. To operate the AS/3™ Anaesthesia Monitor, the following products should be installed into the frame.

CPU board, B-CPU1
High Resolution Display Controller, B-DHIGH
Gas Interface Board, B-GAS
Software Cartridge, S-STD

The Frame can be divided into two sections. The front part is vacant for housing the modules. The rear part is for installation of the products listed above. On the wall between the front and rear parts, there are Module Mother board and CPU Mother board that connect together the individual PC boards and the Unit.

The typical installation configuration is shown in the figure below.

See the general block diagram on the following page.



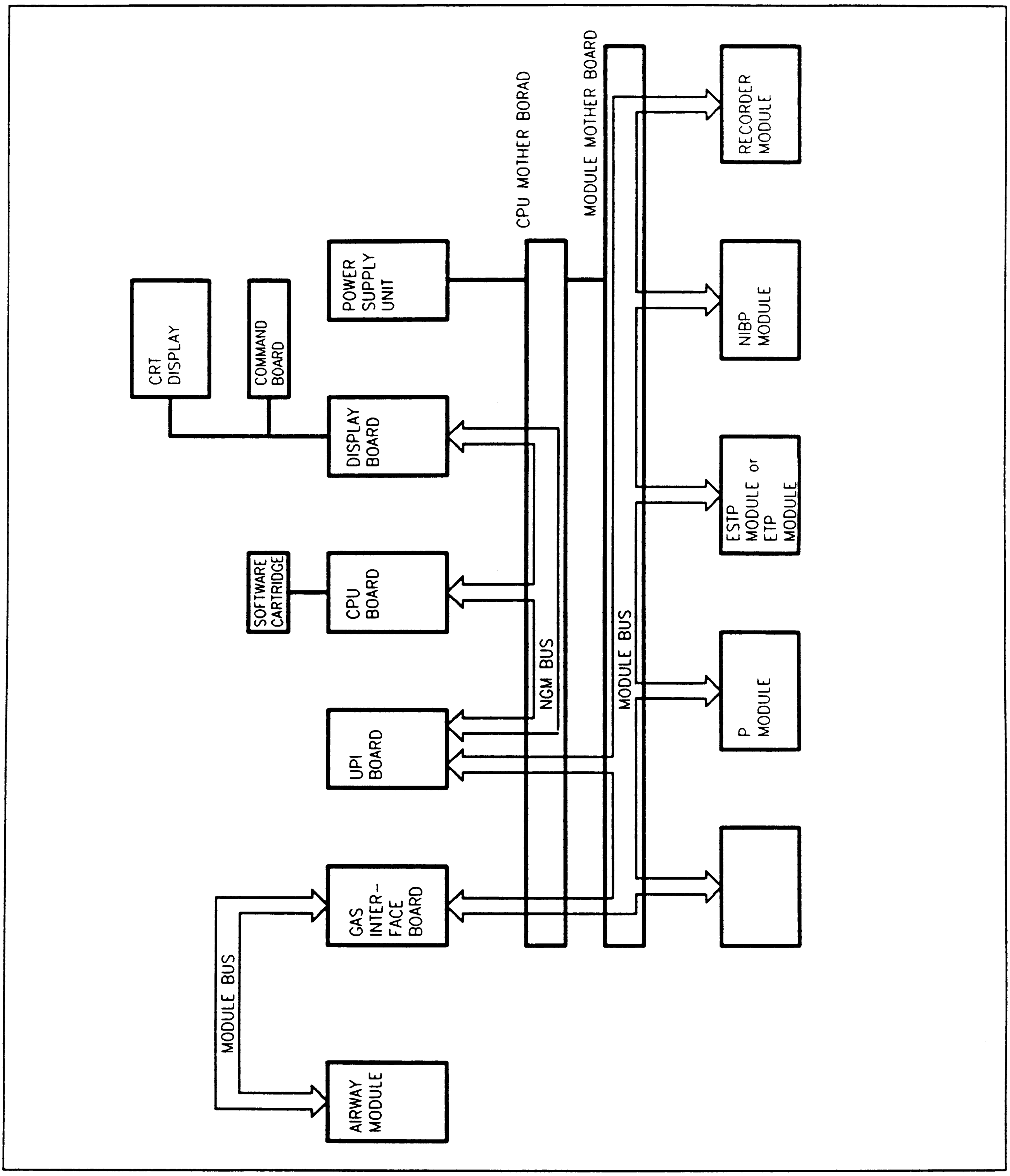


Figure 1 General Block Diagram of AS/3^{TM} Anaesthesia Monitor

4.1 CPU Board, B-CPU1

In general

The CPU board contains 80C186 processor.

The main features of CPU board are:

- 16 MHz and 20 MHz clock speeds
- paged 1 Mbyte EPROM memory with selectable 0/1 wait state
- Software cartridge interface
- 0.5 Mbyte DRAM memory 0-wait state
- 2/8 kbyte static RAM with real time clock
- 32 kbyte EEROM memory
- 4 channel UART:
  - 2 channels with modem signals in AC-logic level
  - 2 channels without modem signals in RS232-level
- programmable alarm sound generator
- 3 external and 1 NMI interrupts

Control logic

IO-map

IO-decoding takes place in D10 GAL IC and also in the processor 80C186 itself. D10 and 80C186 together work as a wait state generator. The reason why 2/8 kbyte static RAM and EEROM are stationed in IO is that code memory (EPROM) and working RAM (DRAM) are designed to be linear without any decoding gaps.

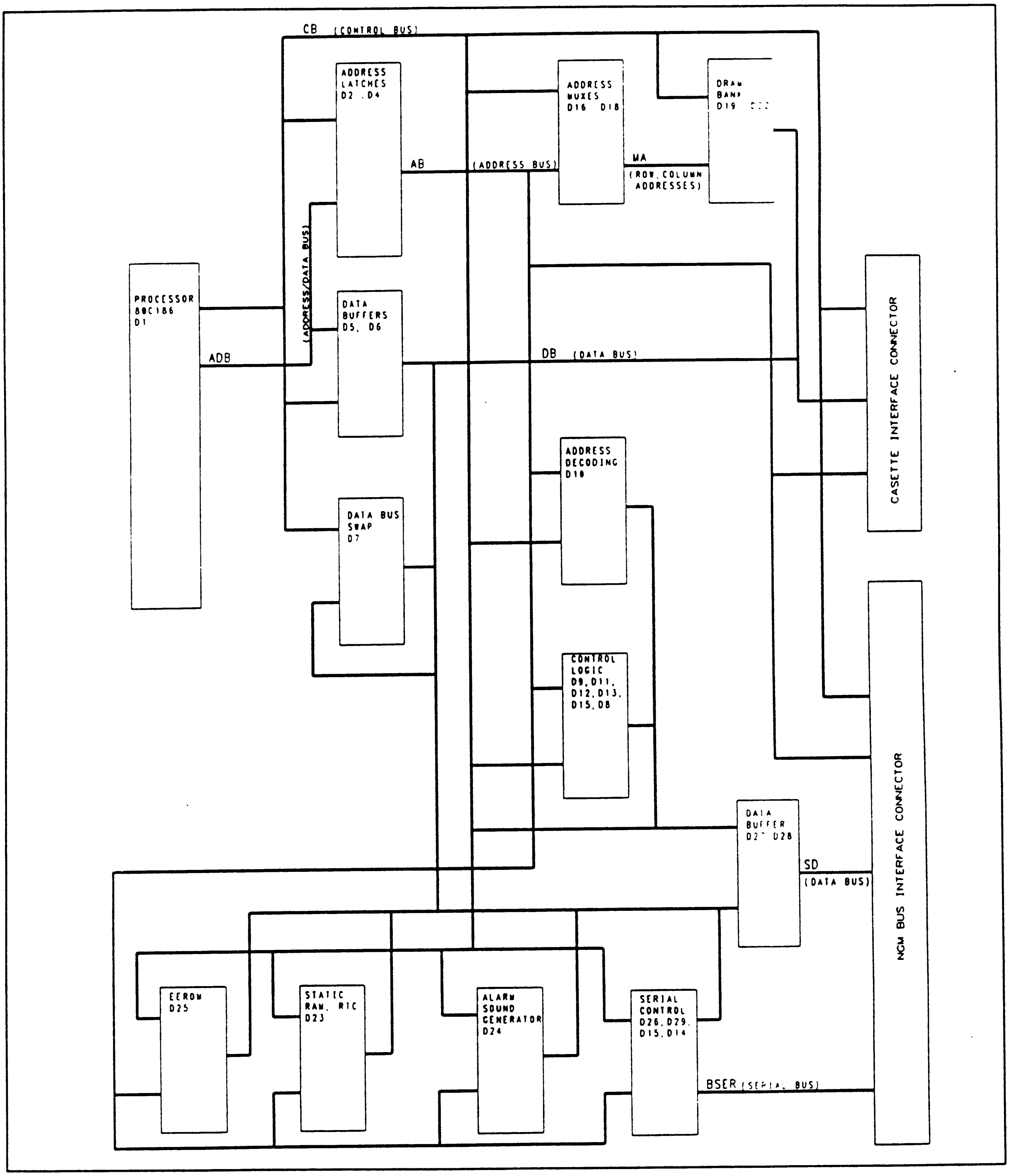


Figure 2 CPU Board Block Diagram

Wait state generators

80C186 has its own wait state generator for its predecoded chip select pins and it is used for those pins which are decoded by 80C186. D10 wait state generator is used for those chip selects decoded by D10 and also for those boards (IO-boards) connected to CPU mother board.

Value for IO-board's default wait state is 2. If IO-board needs more wait states it has to set bus -IORDY signal low by the beginning of T3-state of 80C186 or bus cycle will be ended normally. -IORDY signal goes through synchronizing flip-flop D12B to D10 GAL. From D10 ready signal ARDY goes high it ends 80C186 bus cycle. IO-cycle to IO-boards should not last more than 1.5 μs because of too much delayed DRAM refreshment.

Halt detection

When 80C186 detects NMI-interrupt it is a sign from power supply that all the supply voltages except the CPU board's +5 V are going to be switched off after a certain time. With NMI-interrupt service program all necessary parameters are saved in static RAM. The final command in that program is HALT.

HALT-detection takes place in D9 GAL with signals S2, S1, S0, and ALE. When hardware detects HALT command all signals generated in the CPU board and go to the CPU mother board will be left float in 3-state. Only DRAM refreshment occurs. The only way to get out of that state is RESET pulse from power supply.

Bus swap

D7 performs bus swapping. The idea is that addresses of odd numbers of the 8-bit memory can be used with the 16-bit processor.

External bus

External bus signal are AC-logic level signals. IO-boards are not allowed to load any logic signal with more than 2 AC-logic inputs. Signals generated by the CPU board have 33R series resistor to limit signal ringing when they change their states. The CPU mother board has some snubbers in some signals.

Software cartridge interface

See the following Chapter.

Main peripherals

QUART

Four series channel Quart is used.

SAA1099

IC SAA1099 is used as alarm sound generator.

MK48T02/MK48T08

Lithium battery back-up 2/8 kbyte static RAM.

> CAUTION: The IC contains a lithium battery. Danger of explosion if the IC is incorrectly replaced. Replace only with same or equivalent type recommended by Datex. Discard broken ICs according to manufacturer's instruction.

> NOTE: The life span of the lithium battery is shortened considerably if the AS/3™ Anaesthesia Monitor is used only part of the time. If the monitor is not used full time, we recommend that you replace the static RAM IC (MK48T02/MK48T08) every three years.

Refresh watchdog

80C186 has to refresh periodically watchdog timer which is in power supply unit in order to prevent reset pulse. Refresh watchdog signal goes through D24 mux.

4.2 Software Cartridge, S-STD

> CAUTION: Software Cartridge, S-STD, cannot be disassembled. There is no serviceable parts inside.

Software cartridge pin configuration

	A	B
1	GND	+5 V
2	Vpp	PGM
3	-SMEMW	-SMEMR
4	-SBHE	SA00
5	-PAGEX	-EPROM0
6	-OWS	SA23
7	SA21	SA22
8	SA19	SA20
9	SA17	SA18
10	SA15	SA16
11	SA13	SA14
12	SA11	SA12
13	SA09	SA10
14	SA07	SA08
15	SA05	SA06
16	SA03	SA04
17	SA01	SA02
18	D15	D14
19	D13	D12
20	D11	D10
21	D09	D08
22	D07	D06
23	D05	D04
24	D03	D02
25	D01	D00

4.3 UPI (Universal Peripheral Interface) Board

In general

UPI board functions as a general IO-board in AS/3™ Anaesthesia Monitor. The task of the board is to perform IO duties which the main processor in CPU board assigns. This takes the load of IO functions off the main processor. The main processor and the processor in the UPI board communicates through dual-port memory. The dual-port memory is located in the main processor's IO space and is seen as a 2 kbyte memory window for the processor.

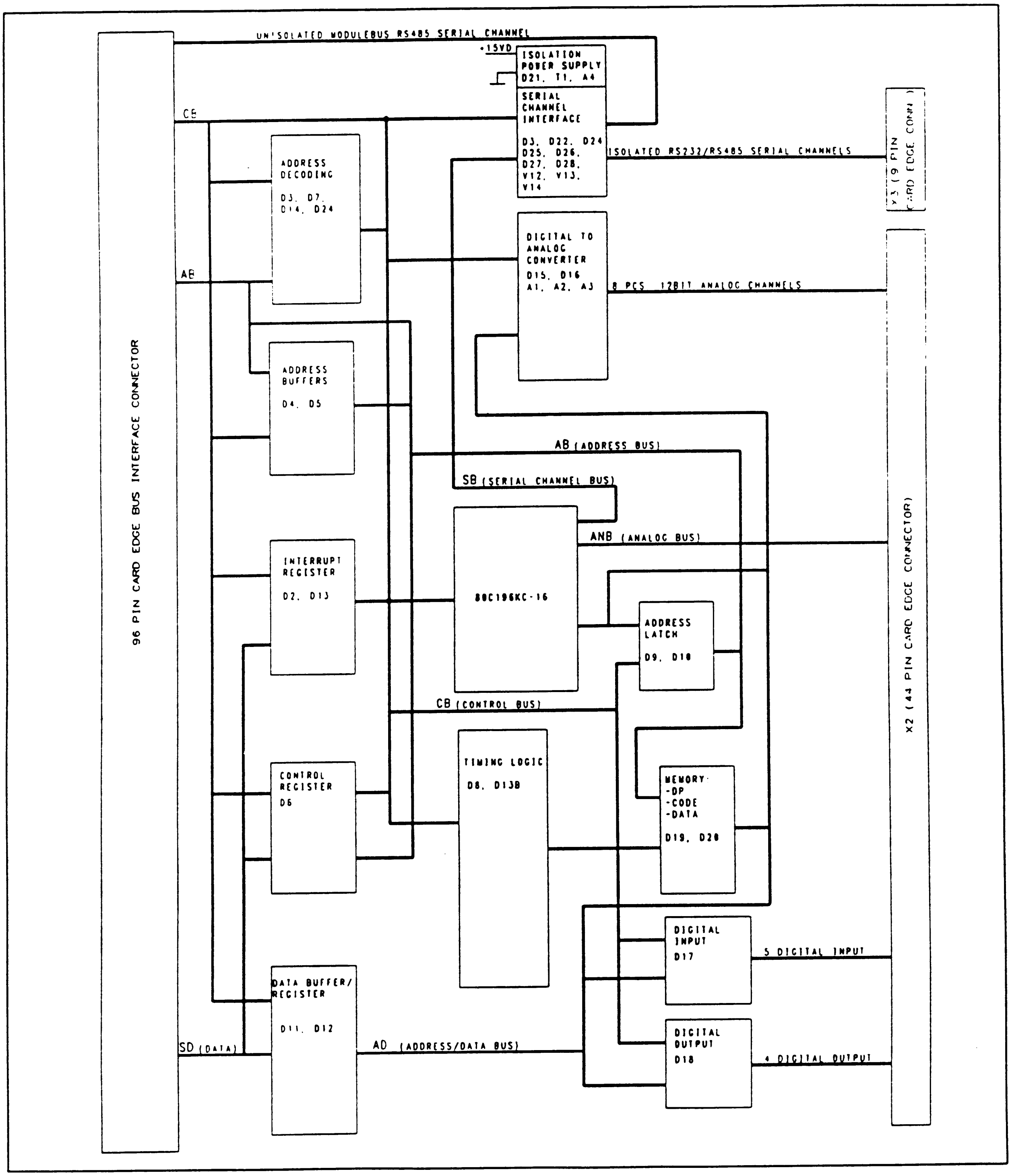


Figure 3 UPI Board Block Diagram

Functional blocks

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

External bus interface

The UPI board is connected to the CPU mother board with E96-connector.

The following signals pass between the UPI and CPU mother board.

- SD0 to SD15	Data bus
- SA0 to SA15	Address bus
- IRQ10 to IRQ12, IRQ15	Interrupt selection jumpers
- BALE	Address latch enable
- -RES	Reset
- -BIOW, -BIOR	Write and read signals
- -IORDY	Bus cycle stretching

Processor

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

Control logic and dual-port memory

The control logic consists of the following components.

- Decoding logic	D7, D3C, D14, D24C, and D24D
- Address buffers	D4 and D5
- Address latch	D9 and D10
- Address register	D6
- Timing logic	D8
- Wait state generator	D13B
- Interrupt control	D13A, D2A, and D2B

IO

IO-block consists of the following units.

- 4 channel 10 bits AD-converter (D1)
- 8 channel 12 bits DA-converter (D15, D16, A1 to A3)
- 5 bits digital-input D18
- 4 bits digital-output D17
- +5 V reference voltage (A3A, V1) for AD-converter in D1
- -10 V reference voltage (A3B, V1) for DA-converter D15

Decoding of the IO-block takes place in D7, D14, D24C and D24D.

Isolated and non-isolated serial bus interface

Isolated power supply consists of D21, T1, A4, and peripheral components. It gives about 100 mA @ 5 V.

Isolated serial bus interface consists of D22, V12 to V14, D25, and D26. Non-isolated serial bus interface consists of D27 and is connected to module bus through the CPU mother board.

4.4 High Resolution Display Controller, B-DHIGH

In general

The display board is connected to host-processor through AS/3™ Anaesthesia Monitor bus, through which the host-processor transmits program to the board. Then the host-processor starts the program and sends data, from which the board draws pictures on the display screen.

The display board is designed to control a color CRT display or color LCD display.

Additionally, there is a 26-pin subminiature female D-connector on the board for Command Board connection.

Graphics System Processor (GSP)

There are four 16-bit registers (HSTADRL, HSTADRH, HSTDATA, and HSTCLT) in the GSP, from which the host-processor reads and to which it writes data. These registers are chosen by HFS0, HFS1, and HCS lines. Data can be read and written in two different bytes. Activity of the low level byte is indicated by -HLDS signal and high level byte by -HUDS signal.

The least significant bit (SA0) in bus address controls the low level byte and -SBHE signal (System Bus High Enable) controls the high level byte.

There are two jumpers (J1, J5) on the board with which four different IO addresses are chosen. For this reason, a maximum of four display boards can be installed into the Central Unit and each one of the boards shows different pictures on display. The decoding is performed in GAL circuit D1 (22V10-15).

IO

IO-block consists of the following units.

- 4 channel 10 bits AD-converter (D1)
- 8 channel 12 bits DA-converter (D15, D16, A1 to A3)
- 5 bits digital-input D18
- 4 bits digital-output D17
- +5 V reference voltage (A3A, V1) for AD-converter in D1
- -10 V reference voltage (A3B, V1) for DA-converter D15

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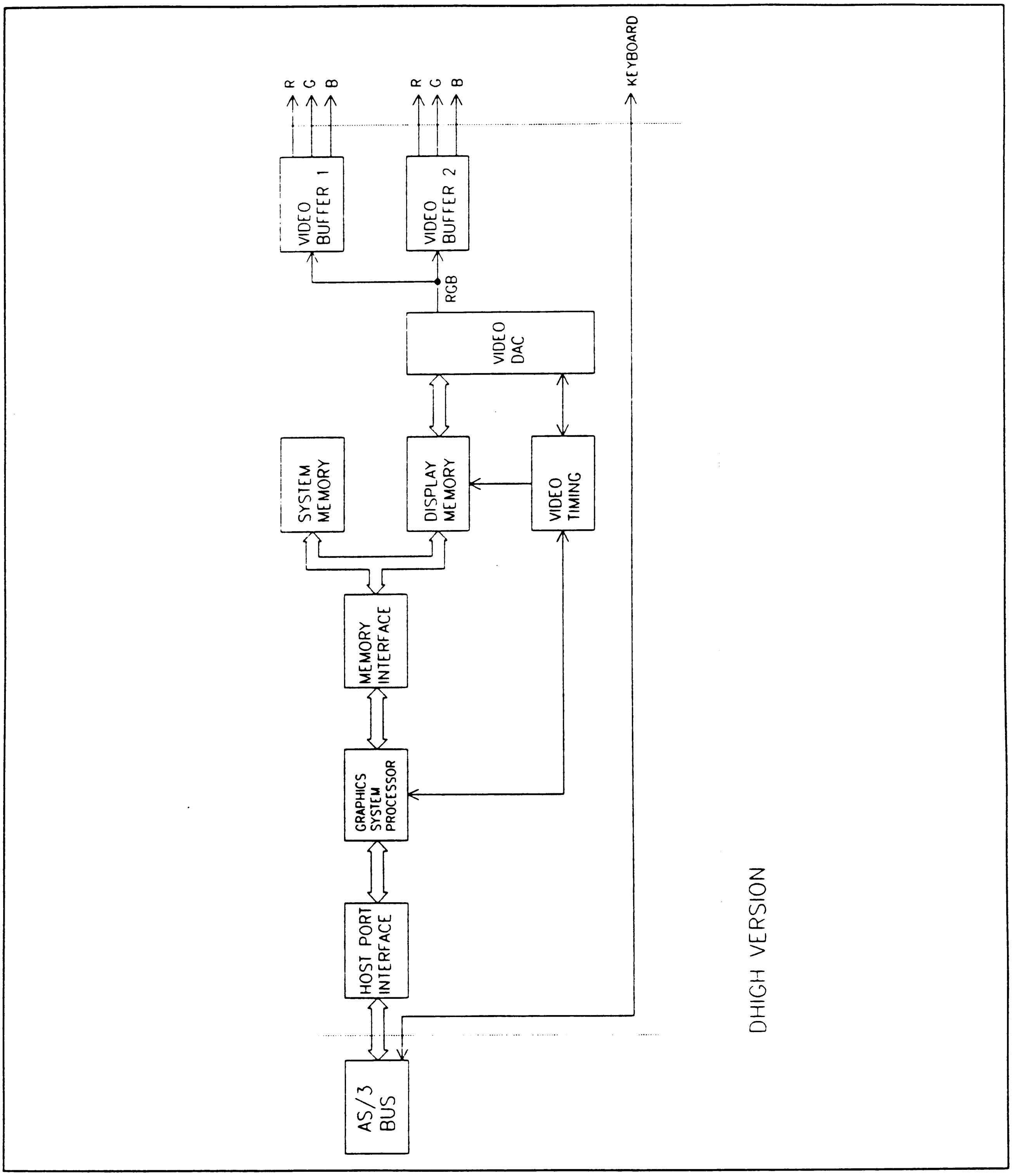


Figure 4 Display Board Block Diagram

Display Memory

For display memory, four memory circuits (256k x 4 bit) TMS44C251-10SD or TMS44C250-10SD are used.

Program Memory

For program memory, four memory circuits (256k x 4 bit) TC514256AZ-80 are used.

Memory Bank Addressing

Memory bank addressing occurs in such a way that the chosen bank receives RAS-signal. RAS0 is the display memory signal and RAS1 program memory signal. Local Address Bits LA25 and LA26 in the address bus are checked and when they are both low, the display memory is addressed (RAS0). When they are both high, the program memory is addressed (RAS1). Address logic of the memories are done in GAL circuit D10 (22V10-15).

Analog Video Signal

Serial outputs (SQ0 - SQ15) of frame buffer memory (D15 - D18) is transferred to two Latch circuits (D19, D29) so that two consecutive pixels (8 bits) are fed to D19. The next two consecutive pixels (8 bits) are fed to D20. Those four pixels (16 bits) are multiplexed into two consecutive pixels data bytes of 8 bits each in D21 and D22. Then data is fed to video palette circuit (D23) and multiplexed into one pixel of 4 bits wide and every pixel is transformed into analog RGB-signal. The RGB-signal is sent to two buffer stages consisting of emitter-follower transistor circuit. Levels of each RED-, GREEN-, and BLUE-signals are increased by two diodes to compensate the voltage loss in base-emitter transition in the transistor. If a digital RGB-signal is desired, the second buffer stage is left unused.

Video Timing

There are many timing clocks for the GSP, video memories, multiplexers, and video palette circuits. Those clocks are generated from:

1. CLKOUT-signal, which is generated in video palette circuit (D23) and is half the frequency of DOTCLK.

2. Flip-flops in D27 and D29, and OR-gate in D25.

3. Using three-bit counters in GAL circuit (D10) to step down CLKOUT to DDIV4, DDIV8, and DDIV16.

4. -BLANK signal

The signals generated are described as follows:

SCLOW...Clock signal for video memory circuits, D15 and D16, used to get the pixels 0 and 1. A clock signal for Latch circuit D19. A clock signal for multiplexers D21 and D22, used for choosing pixel data.

SCHIGH...A clock signal for video memory circuits D17 and D18, to get the pixels 2 and 3. A clock signal for Latch circuit D20.

DATEN...A clock signal for video palette circuit D23, which indicates when the right pixel data arrives. DATEN is the delayed -BLANK signal.

VCLK...A clock signal for GSP, in which VSYNC and HSYNC pulses are generated. VCLK can be chosen by jumper J4, depending on DOTCLK frequency: The DOTCLK frequency can be divided by four (DDIV4), by eight (DDIV8), or by 16 (DDIV16). The VCLK is 7.5 MHz.

Digital Picture Signal

There is a 26-pin miniature D-connector on the board for digital picture signal output which can be used for the LCD screen.

This digital picture signal (DIGR, DIGG, DIGB) is processed from analog video signal in D23 by comparators N1, N2, and N3.

The outputs of D23 change between 0.65 V and 2.3 V. Reference voltage is set by R22 (1.82 k) and R23 (750R) to 1.46 V.

(750 / (1820 + 750)) x 5 V = 1.46 V.

Capacitor C40 stabilizes the reference voltage.

In the software program, the colors in the video palette circuit (D23) is divided into eight basic colors. Then the states of the comparators (D30 to D32) are unambiguous. The resulting signals are buffered in D26 and transferred to connector X3 through matching resistor network R2. The matching resistor is designed for 50 ohm coaxial cable. R2 can be replaced with zero value resistor network if the matching at the other end is preferred.

Display Board Resolution

The resolution of the Display board depends on initialization of the GSP's registers and frequency of video oscillator. The video oscillator's frequency and timing value of synchronization pulse of the monitor are needed to calculate the values of the GSP's registers and refreshment frequency of the screen. Depending on the monitor selected, synchronization times can often be shortened and the monitor is still in synchronization. The refreshment frequency can be increased and flashing decreased.

If the resolution change is desired, the oscillator which sets the video frequency should also be changed.

Reset Signal

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

The memory circuits need eight -RAS-only refreshment pulses which the GSP transmits automatically after the -RESET signal.

The GSP checks whether -HCS signal is high or low immediately after the -RESET signal goes high. If the -HCS signal is high, the GSP is set to Host-Present mode. Then the GSP stays in halt status and waits for comments from the host processor. This is normal and correct situation in AS/3™ Anaesthesia Monitor.

4.5 Power Supply Unit

1. Power supply unit functional blocks

The Power supply unit can be divided into the following six functional blocks.

1. Rectifiers, ON/STBY control, batchrg, etc

This block contains rectifiers which rectify 20 VAC from the mains transformer and filter it with capacitors.

ON/STBY control includes a logic with which power supply is switched on or off by turning ON/STBY switch. The fan is also controlled by this.

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 during the power supply is on.

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

The block transmits signals to CPU interface in case the mains voltage fails or the power is cut off.

The block checks +5 V and +15 V and if either one of them increases more than is allowed, thyristor pulls the rectified +24 V down and the mains fuses are blown. In addition, if +24 V increases over +34 V, the thyristor pulls it down as above. This is the case when 110 V device is connected to 220 V mains outlet.

2. Audio amp.

This block amplifies and filters audio signal from the CPU to suit the loudspeaker. Amplification gain is about 2.3.

3. CPU interface

This block contains all the necessary communications between the power supply unit and the CPU. Reset-, powerfail-, and watchdog-functions are realized in one IC. Additionally, the block contains a circuit that supervises the maintaining of the CPU's supply voltage from the battery for 15 minutes after AS/3^{TM} Anaesthesia Monitor is turned off.

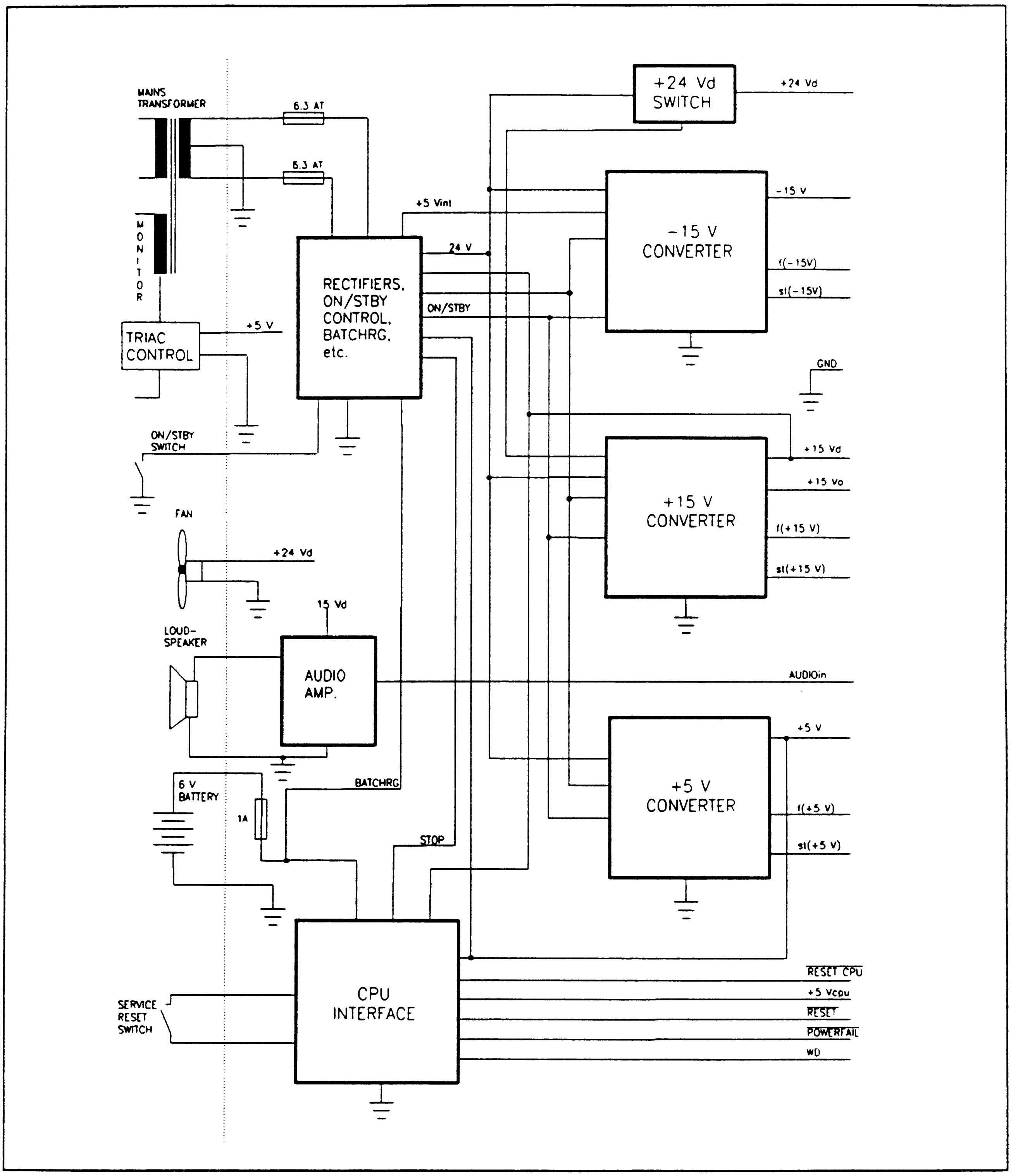


Figure 5 Power Supply Unit Block Diagram

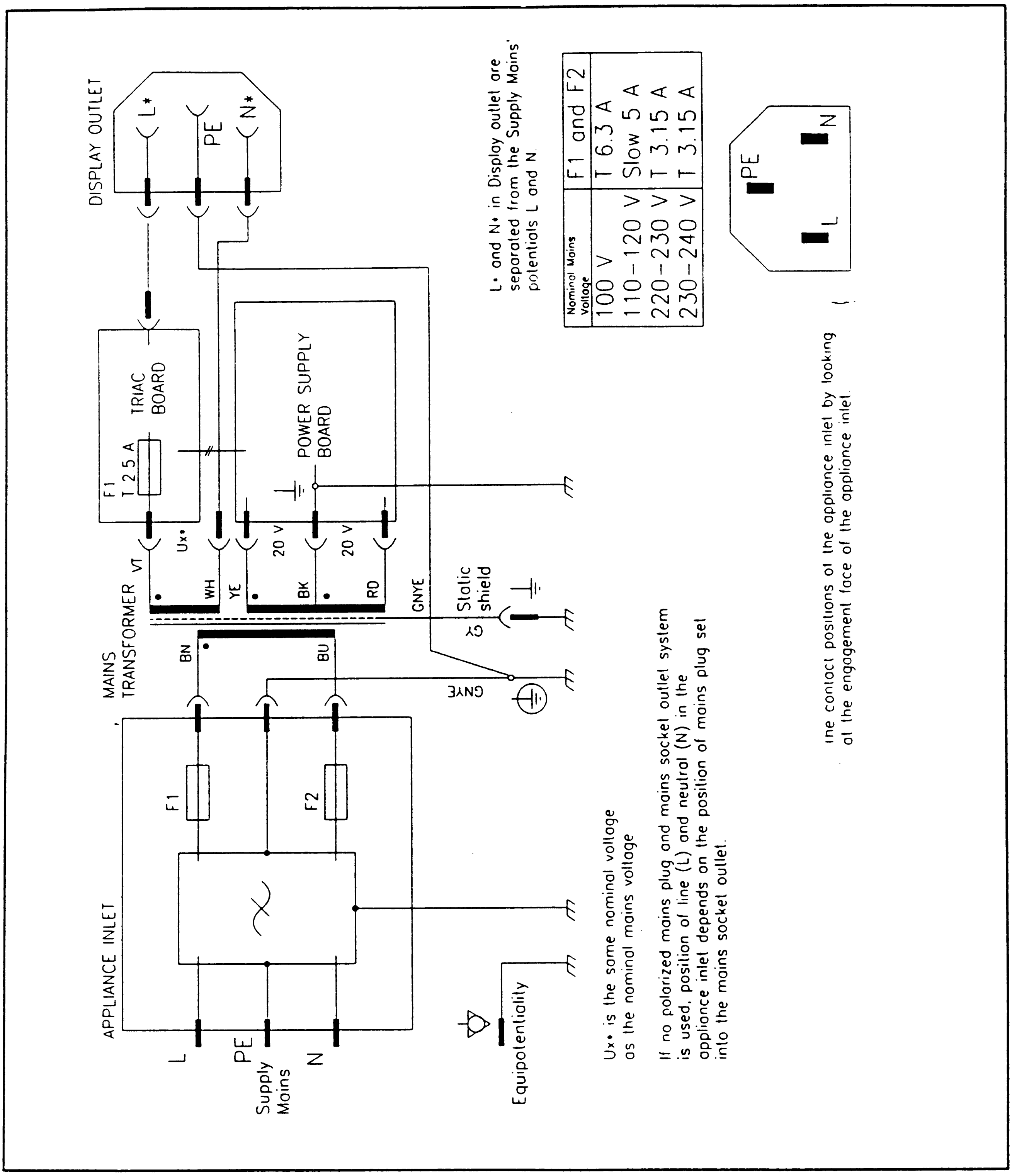


Figure 6 Mains Part Block Diagram

4. -15 V converter

The block contains Flyback-type chopper power supply that generates -15 V analog voltage from +24 V. The load capacity is 1.2 A (18 W).

5. +15 V converter

The block contains Buck-type chopper power supply that generates +15 V from +24 V.

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

6. +5 V converter

The block contains Buck-type chopper power supply that generates +5 V from +24 V. The load capacity is 8 A (40 W).

2. External components of the unit

1. Mains transformer

The power of the mains transformer is 250 VA. The secondary voltage is 2 x 20 VAC and for the display unit it is either 100 VAC, 115 VAC, 225 VAC, or 235 VAC.

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

2. Fan

The fan is switched on automatically when +24 Vd is generated.

3. Loudspeaker

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

4. Battery

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

3. Power supply board interface to AS/3™ Anaesthesia Monitor bus board

1. +24 Vd

Rectified and filtered +24 Vdirty 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.

2. -15 V

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

3. 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.

4. st (-15 V)

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

5. +15 Vd

Accuracy of +15 V is ±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 ±10 %).

6. +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 ±10 %).

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

7. 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.

8. st (+15 V)

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

9. +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 %).

10. 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.

11. st (+5 V)

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

12. +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.

13. -RESET

Signal for the digital boards.

14. -RESET CPU

Signal for the CPU.

15. -POWERFAIL

The signal informs supply voltage failure.

16. WD

Watchdog input signal. The CPU must toggle WD every 1.6 seconds. Otherwise the power supply will generate -RESET and -RESET CPU signals. There is a jumper X8 which, when removed, cancel the Power supply's need for this signal.

17. AUDIOin

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

18. GND

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

4. +5 V and +15 V converters

The basic Buck-type converter consists of a switch, flywheel diode, choke, and filtering capacitor. Generally bipolar or MOSFET transistor is used as the switch. The switch also needs a driver (PWM) to operate. The choke is usually ferrite-cored and the capacitors are special types for the chopper power supply use.

Here the operation of +15 V converter is described in detail. +5 V converter functions in the same way except that there are only two chokes and some components values differ.

1. Chokes

There are three chokes in the +15 V converter. L3 is used for filtering choke for input voltage, L4 is used for the chopper choke, and L5 passive filters +15 Vd to get +15 Va.

2. Switching transistor

As the switching transistor (V38), IRCZ24 Current Sense MOSFET (N-channel) transistor is used. In addition, there is a pair of transistors (V44 and V45) that forms current mirror and measures current flow through V38 from the signal between CS and KS signals.

V38 is driven by pulse width modulator A8 (UC3843) and transistors V40 and V41. In the beginning V38 is in rest position. When the pulse modulator changes its state to high, V41 starts to conduct and then V38 conducts. Next when the modulator changes its state to low, V41 stops conducting and pulls V38 down with the help of V40. Resistors R34 and R75 are for current limiting.

3. Flywheel diode

The flywheel diode (V46) is a Schottky type MBR1045 diode. There is a resistor (R44) and capacitor (C38) in parallel connection with the diode forming a snubber that prevents the diode from ringing.

4. PWM controller

PWM controller, UC3843 Current mode, is used as the pulse modulator (A8). The following components and lines are in the pulse modulator circuit.

- switching transistor driving (V40, V41, C44, R75, R34, V39, V42, R35)
- chopper frequency adjusting (R36, C46)
- PWM's reference voltage filtering (C49)
- internal supply voltage filtering (C50)
- frequency f (+15 V) from pin 22 at the rear panel connector (X3B)
- standby st (+15 V) from pin 20 at the rear panel connector (X3B)
- current feedback circuit (see below)
- voltage feedback circuit (see Chapter Output voltage control)

5. Current measurement

Current is measured by R40, feedback circuit components (R37, C45), and PWM controller. R37 and C45 are used to stabilize the current feedback loop. Components C43, C51, and R41 are for filtering the current measurement. When the certain current limit is crossed, the power supply works as a constant current source and the components are protected.

6. Output voltage control

Output voltage is controlled by the feedback circuit components and Error Amp. in the PWM controller. Feedback looped output voltage is divided by R39 and R43 to 2.5 V and is fed to negative input of the Error Amp. Positive input of the Error Amp. is connected to internal 2.5 V which is obtained from the PWM's internal voltage reference. The PWM controller controls the output voltage with the difference of those two input voltages. To stabilize the voltage feedback loop, C47, C48, and R38 are connected between the output and negative input of the Error Amp.

7. Other components

Capacitors C35, C36, and C37 filter the incoming voltage +24 V. Capacitors C39 and C40 filter the output voltage +15 Vd. Additionally, capacitor C42 filters +15 Va.

5. -15 V converter

The basic Flyback-type converter consists of a switch, Flyback transformer, rectifier diode, and filtering capacitor. Generally, bipolar or MOSFET transistor is used as the switch. The switch also needs a driver (PWM) to operate. The Flyback transformer is an air-gap type where transformer and choke are integrated into one component. The capacitors are special types for the chopper power supply use.

1. Flyback transformer

The Flyback transformer T1 inverts the chopper voltage.

2. Switching transistor

As the switching transistor (V47), IRF640 is used. The switching transistor is driven with the help of pulse width modulator A9 (UC3845) and is protected from ringing by snubber R59 and C54 connected in parallel. Resistor R45 limits the current in the gate drive circuit.

3. Rectifier diode

Type BYV27 is used as the rectifier diode (V48). It is protected from ringing by snubber R60 and C55.

4. PWM controller

PWM controller, UC3845 Current mode, is used as the pulse modulator (A9). The following components and lines are in the pulse modulator circuit.

- switching transistor driving (V47, R45)
- chopper frequency adjusting (R46, C62)
- internal +5 Vint filtering (C64)
- internal supply voltage filtering (C66)
- frequency f (-15 V) from pin 22 at the rear panel connector (X3C)
- standby st (-15 V) from pin 20 at the rear panel connector (X3C)
- current feedback circuit (see below)
- voltage feedback circuit (see Chapter Output voltage control)

5. Current measurement

Current is measured with the help of R52 and PWM controller. Components C65, R48, and R56 are for filtering the current measurement. When the certain current limit is crossed, the power supply works as a constant current source and the components are protected.

6. Output voltage control

Output voltage is controlled by the feedback circuit components and shunt regulator of 2.5 V reference voltage. Feedback looped output voltage is divided by R57 and R58 to 2.5 V and is compared with the 2.5 V which is obtained by the shunt regulator A12 (TL431). The PWM controller controls the output voltage with the difference of those two input voltages. C58, C59, and R50 are included to stabilize the feedback loop. Amplification of the feedback loop can be changed with the values of R49 and R51.

7. Chokes

There are three chokes in the -15 V converter. L6 is used for filtering choke for input voltage. There is an internal choke inside the Flyback transformer. L7 is used for filtering choke of the output voltage.

8. Other components

With the help of FET transistor V16 (BS110) and resistor R55, operation of the PWM controller can be cancelled by pulling START signal down to ground with, for instance, standby signal.

Zener diode V12 prevents the output of the PWM controller from going negative.

Diode V81 (MPTE) is for overvoltage protection. If the output voltage crosses the allowed limit, V81 clumps the voltage. If overvoltage continues, V81 breaks down and -15 V chopper is short-circuited.

Capacitors C52 and C53 filter the incoming voltage +24 V. Capacitors C56, C57, and C60 are filters for the output voltage.

6. Reset and Reset CPU

1. Reset function

A6 (MAX690) is installed as a reset circuit. A6 supervises +5 V and if it decreases below 4.65 V, -RESET will go low.

When AS/3™ Anaesthesia Monitor is turned on and +5 V increases, -RESET will stay low until +5 V voltage has been 50 ms more than 4.65 V. -RESET_CPU will stay low 30 ms after start. If the monitor is switched off or input power is missing, -RESET will go low but -RESET_CPU stays high as long as CPU's voltage is fed from the battery (15 min. max). When the monitor is switched on while CPU's voltage is fed from the battery the -RESET_CPU will be 10 µs long and the -RESET, as normally, 50 ms. This is called warm start. Length of the -RESET_CPU signal is determined by the monostabile multivibrator.

In normal operation for the -RESET signal to stay high, it needs watchdog signal to toggle at least once in every 1.6 s. If watchdog refresh signal is missing the power supply will generate 50 ms long Reset pulse and 10 µs long Reset CPU pulse. The need for watchdog pulse can be cancelled by removing jumper X8.

In addition, the reset circuit supervises the supply voltage and controls the timer function in case of POWERFAIL situation. When the power is turned off or somehow the power disappears, PFI signal generates PFO signal which starts operating the timer's operation.

2. Components in reset

In addition to the reset circuit A6, there are pull-up resistors R20 and +5 V filter capacitor C80 in the reset circuit. The output of the A6 is connected to the timer (A5) and the driving transistor (V26, BSS100) of the monostable multivibrator.

The monostable multivibrator consists of transistors V26 and V27 (2N3906), resistors R77 and R78, and capacitors C70 and C71. At warm start, the components V26, V27, C71, and R77 are in use. At cold start, the components C70 and R78 are also in use.

The outputs of the circuit, -RESET, -POWERFAIL, and -RESET_CPU signals have buffers (D1).

7. CPU's supply voltage maintenance

1. Function

The circuit consists of the timer, linear regulator, and a switch.

In normal operation the CPU gets its supply voltage from +5 V converter. However, in case of power off, the battery supplies the supply voltage to the CPU for 15 minutes.

When the reset circuit learns that the supply voltages are missing (POWERFAIL), it generates a driving signal to the timer circuit. Then +5 Vcpu is connected to linearly regulated battery voltage and the supply voltage is supplied by the battery.

2. Components

A5 (ICM7242; Fixed and Programmable Timer/Counter) is the timer. The length of the timer is adjusted by R18 and C17. After 15 minutes, A5's output (pin 3) goes high and it resets the counter through resistor R19.

The timer is bypassed by pressing the Service reset switch on the rear panel. After pressing the switch for two seconds, the Power supply unit, Software cassette, and other PC boards are elecronically free to be disconnected.

The linear regulator consists of transistors V21 (IRF9532), V80 (BSS100), and V82 (2N3906), and resistors R19, R70, R71, and R72. Reference voltage is obtained by 2.5 V shunt regulator A13 (TL431). C14 is for filtering battery voltage and C15 for filtering the output voltage.

The actual switching transistors which chooses +5 Vcpu either from the +5 V converter or the battery are MOSFET transistor V20 (IRFU024) and V21.

V25 (BSS100) is a transistor which conducts at POWERFAIL and pulls gate voltage of V20 to ground and switches off V20, preventing +5 V of the battery from going to the other 5 V loads than CPU.

8. +24 V function

+24 V from the mains transformer is passed through fuses F1 and F2 to the rectifiers. After which two voltages, +24 V and +24 Vd are separated. C4 and C5 function as filtering capacitors for +24 V and C68 for +24 Vd.

Additionally, overvoltage protection, +24 Vd overheat protection, and generation of the supply voltage for the PWM at power start-up are included in +24 V line.

Fan uses +24 Vd to operate.

1. Overvoltage protection for +5 V, +15 V, and +24 V

The overvoltage protection is made by thyristor V5 (TYP512) and peripheral components.

V5 is triggered when voltage at shunt regulator A1 increases over 2.5 V causing transistor V6 (2N4403) to conduct. Then the fuses are blown. This is the case when an overvoltage situation occurs in one of the supply voltages' lines.

C3 is for filtering input voltage.

2. Overheat protection for +24 Vd

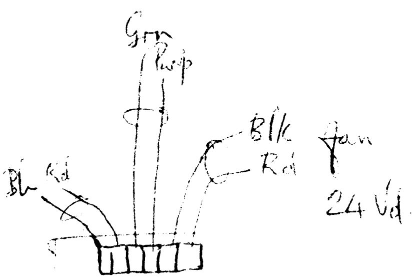
Thermal protected FET transistor V90 (BTS114) is used for the overheat protection. When overheated due to overcurrent, V90's internal protection circuit cuts off +24 Vd line. Charging pump is used for driving V90 in normal operation which generates over 12 V across capacitor C13.

3. Supply voltage for PWM

At power start-up, the PWM gets its supply voltage from +24 V through linear regulator A10 (7812). When the choppers start to operate and +15 V is generated, the PWM gets the supply voltage from +15 V through diode V17.

C7 is filtering capacitor for A10.

A10 generates the supply voltage for the PWM also when +15 V is short-circuited.



9. Battery charging

For the battery charging, the circuit consisting of the adjustable linear regulator A3 (LM317), 2.5 V shunt regulator A4 (TL431), and other associated components are used.

R7 and R66 controls the battery voltage, and R5 and R6 controls the battery current.

C10 is a filtering capacitor.

The desired battery voltage (about 6.8 V) is charged through fuse F3 at 80 mA constant current. The voltage used for charging is +15 V so that the charging is active only when the monitor is on.

10. Audio amplification

Amplification of audio is performed in operational amplifier A11 (L165).

The incoming AUDIOin signal is biased with +5 Vint and led to A11 positive input. DC amplification is done by R47 and R93. AC amplification is done by R17 and C90.

The output of A11 changes around 7.5 V.

Capacitor C94 passes only AC signal on to the loudspeaker.

11. Start-up

At start-up, ON/STBY switch is connected to ground. When it's open, the switch turns off the power supply. Then +24 V should be more than 24.3 V and more than 4.3 V at the base of transistor V55 (2N3906). If the voltage at the base of V55 is less than 4.3 V, then start-up cannot be succeeded. Resistor R79 forms a hysteresis for +24 V, that is, the voltage should be over 24.3 V at start-up and less than 18.3 V when the device turns itself off. In the latter case the hysteresis is about 6 V. Advantages of this are that +24 V can be lower and the device is not so sensitive to overloading.

Comparator A2 (LM393) transmits both START and STOP signals. If the negative input of A2 decreases below 2.5 V, its output goes high (START). The STOP signal is connected to the POWER FAIL input of A6 (pin 4) and will cause POWER FAIL to go low before power supplies are turned off by START signal.

There is an NTC resistor R73 that turns the power supply off in case the temperature inside rises over 65°C (149°F).

12. Triac board

The tasks of the Triac board are to supply supply voltage to video unit when AS/3™ Anaesthesia Monitor is turned on and cut off the voltage when it is turned off. This is done by triac (V1) and a switch consisting of an optically isolated triac controller (V2) and peripheral components.

There is a snubber of resistor and capacitor connected in parallel to the triac to prevent it from ringing.

A fuse of T 2.5 A is installed for incoming AC voltage.

4.6 Gas Interface Board, B-GAS

Gas interface board is used for connecting an Airway Module to the Central Unit.

There are AS/3™ module bus signals in the interface board D-connector (in the rear panel).

On the initial Gas interface board the following fuses are installed in power supply lines. On the current board only F4 is installed.

F1:	T1A,	+15 V
F2:	T1A,	-15 V
F3:	T4A,	+15 VD
F4:	T4A,	+24 VD
F5:	T5A,	+5 V_lamp
F6:	T5A,	+5 V_out

There is also an optional circuit for keyboard prosessor (not used).

4.7 CPU Mother Board

On CPU mother board there are six identical E96-connectors X1 to X6 which form CPU bus and to which CPU board, UPI board, Display board, and Gas interface board are connected. Two connectors are left unused.

Power module is connected to X7 which is a power E48-connector. Another power E32-connector X8 joins the CPU mother board and Module mother board together.

Capacitors C1 to C27 and resistors R1 to R4 form RC snubbers for address signals, IRQ-signals, and reset. Those snubbers filter high spikes in the edges of pulses.

Capacitors C30 to C35 and C37 to C52 are located between connectors X6 and X7. They are for filtering high frequency interference components from signals passing from the CPU mother board to the Module mother board.

4.8 Module Mother Board

There are eight 25-pin male D-connectors for the modules in the Module mother board. They are X1 to X8. Module bus is identical in every D-connector. There are five filtering capacitors C1 to C5 for every supply voltages: +24 VD, +15 VD, +15 V, -15 V, and +5 V.

The Module mother board is connected to the CPU mother board with power E32-connector X9.

4.9 Connector Configurations

Power module - CPU mother board connector

	a	b	c
2	+15 VD	GND	+24 VD
4	+15 VD	GND	+24 VD
6	+5 V	GND	GND
8	+5 V	+5 V	GND
10	RESET_CPU	+5 V_CPU	GND
12	POWER_FAIL	REFRESH_WD/	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

	a		c
2	GNDD		GNDD
4	+15 VD		+24 VD
6	GND		+15 VD
8	-15 V		GND
10	RESET_RS485		+15 V
12	RTSC		CTSC
14	RXDC		-DATA_RS485
16	TXDC		DATA_RS485
18	-RESET_RS485		ON/STBY
20	CTSB		BIT0IN
22	RTSB		RXDD_RS232
24	RXDB		TXDD_RS232
26	N/C		TXDB
28	+5 V		+5 V
30	N/C		N/C
32	GND		GND

CPU bus connector

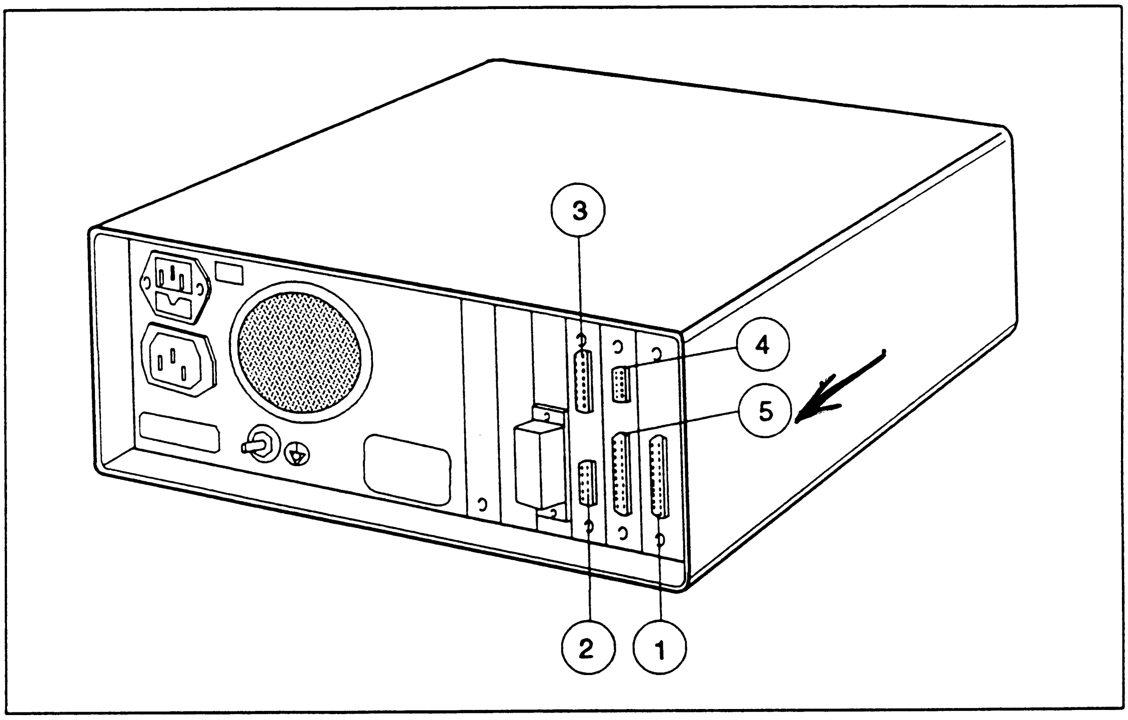
	a	b	c
1	+15 V	AGND	DGND
2	-15 V	BALE	DGND
3	SA0	SA1	DGND
4	SA2	SA3	RESET_RS485
5	SA4	SA5	-RESET_RS485
6	SA6	SA7	DATA_RS485
7	SA8	SA9	-DATA_RS485
8	SA10	SA11	TXDD_RS232
9	SA12	SA13	RXDD_RS232
10	SA14	SA15	BIT0IN
11	SA16	SA17	BIT1IN
12	SA18	SA19	TXDC
13	SA20	SA21	RXDC
14	SA22	SA23	RTSC
15	-SMEMR	-SMEMW	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	+24 VD	REFRESH_WD
32	GNDD	GNDD	POWER_FAIL

Module bus connector (also connector no. 1 in Figure 7)

Pin No	I/O	Signal	Notes
1	O	RESET_RS485	
2	I	-15 VDC	
3	I	+15 VDIRTY	
4	I	+15 VDC	
5	O	-DATA_RS485	
6	O	DATA_RS485	
7		Ground & Shield	
8	O	-RESET_RS485	
9	I	CTSB	
10	O	RTSB	
11	I	RXDB	
12	O	TXDB	
13		Ground & Shield	
14	I	+24 VDIRTY	
15	I	GroundDIRTY	
16	I	CTSC	
17	O	RTSC	
18	I	RXDC	
19	O	TXDC	
20	I	ON/STANDBY	
21	I	BIT0IN	
22	I	RXDD_RS232	
23	O	TXDD_RS232	
24	I	+5 VDC	
25	I	+5 VDC	

Att.
Trevor

Figure 7 Central Unit Rear Panel Connectors



15-pin D-connector on Display control board to Display unit connector (Connector 2 in Figure 7)

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

26-pin D-connector on Display control board to Command board connector
(Connector 3 in Figure 7)

Pin No	I/O	Signal	Notes
1	O	RED VIDEO2	
2	O	GREEN VIDEO2	
3	O	BLUE VIDEO2	
4	O	BLANK	
5	O	DCLK	
6		GND	
7	O	DTMG	
8	O	HSYNC2	
9	O	VSYNC2	
10		RED GND	
11		GREEN GND	
12		BLUE GND	
13		N.C.	
14		DCLK GND	
15	O	+5 V	
16	I	ON/STBY	
17	O	DIRTY GND	
18	O	DIRTY GND	
19	I	RXDD RS232	
20	I	TXDD RS232	
21	I	-DATA RS485	
22	I	DATA RS485	
23	I	-RESET RS485	
24	I	RESET RS485	
25	O	+24 VD	
26	O	+24 VD	

9-pin D-connector on UPI board for serial communication (Connector 4 in Figure 7)

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

44-pin D-connector for digital and analog I/O (Connector 5 in Figure 7)

Pin No	I/O	Signal
1		N/C
2		N/C
3		Not in use
4		N/C
5		N/C
6		N/C
7		GND
8		N/C
9		N/C
10	O	(A)*
11		N/C
12		N/C
13		N/C
14	O	(A)*
15		N/C
16	O	(A)*
17	O	(A)*
18		N/C
19	O	(A)*
20	O	(A)*
21	I	Cardiac output remote control(D)
22	I	CO2 waveform (ULT) (A)
23		N/C
24	O	(A)*
25	O	(A)*
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		N/C
39		N/C
40		N/C
41		N/C
42		N/C
43		N/C
44		N/C

* Analog outputs are chosen from 10 sets of outputs combinations.

4.10 Adjustments and Calibrations

There is neither adjustments nor calibrations in the Central Unit.

5 SERVICE AND TROUBLESHOOTING

5.1 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 Chapter should only be attempted by trained personnel with the appropriate equipment. Unauthorized service may void warranty of the unit.

5.2 Disassembly and Reassembly

The Central Unit is disassembled in the following way. See Figure 11 for the exploded view of the Unit:

a) Disconnect the power cord.

b) Remove all the modules from the front of the Central Unit.

c) **Press and hold down Service reset switch on the rear panel of the Power supply unit for two seconds. After this the Power supply unit, Software cartridge, Display board, CPU board, UPI board, and Gas interface board (if installed) 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 ground connector pin and fuse housing, and pull gently backwards. 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, Display board, CPU board, UPI board, and Gas interface board (if installed) are pulled off after removing two screws and washers.

g) Remove the two screws M3x12 at the center of the inner divider wall and one screw M5x8 from the bottom panel. The metal box 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 box with screws. These boards are connected to one another by 32-pin connector.

Reassembling is essentially reversing what was described above. When inserting the metal box into the external frame, attach the two screws from front before attaching the one thick screw on the bottom panel. This way the metal box is attached closely to the inner divider wall.

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

The Power supply unit is disassembled by removing four screws and lifting off top cover. Lead-acid battery is attached to the back of the top cover. See Figure 12 for the exploded view of the unit.

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 M3x4.

When reinstalling the Power supply unit, push up the transformer and insert the unit gently into external frame. Fasten the two screws at the top of the rear panel before fastening the transformer to the bottom to be sure that the unit is inserted to the end.

5.3 Troubleshooting Chart

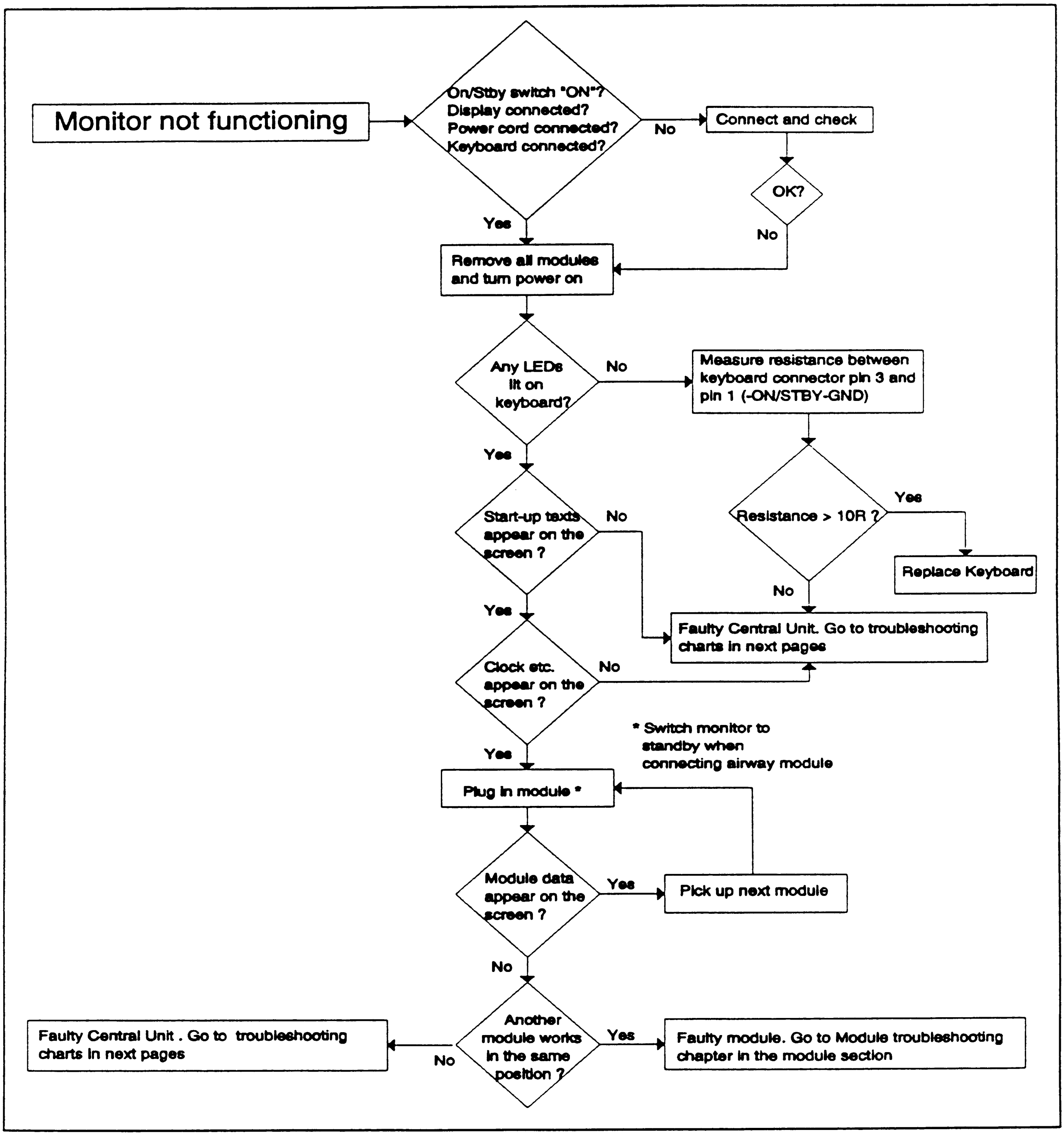


Figure 8 AS/3™ Anaesthesia Monitor troubleshooting chart

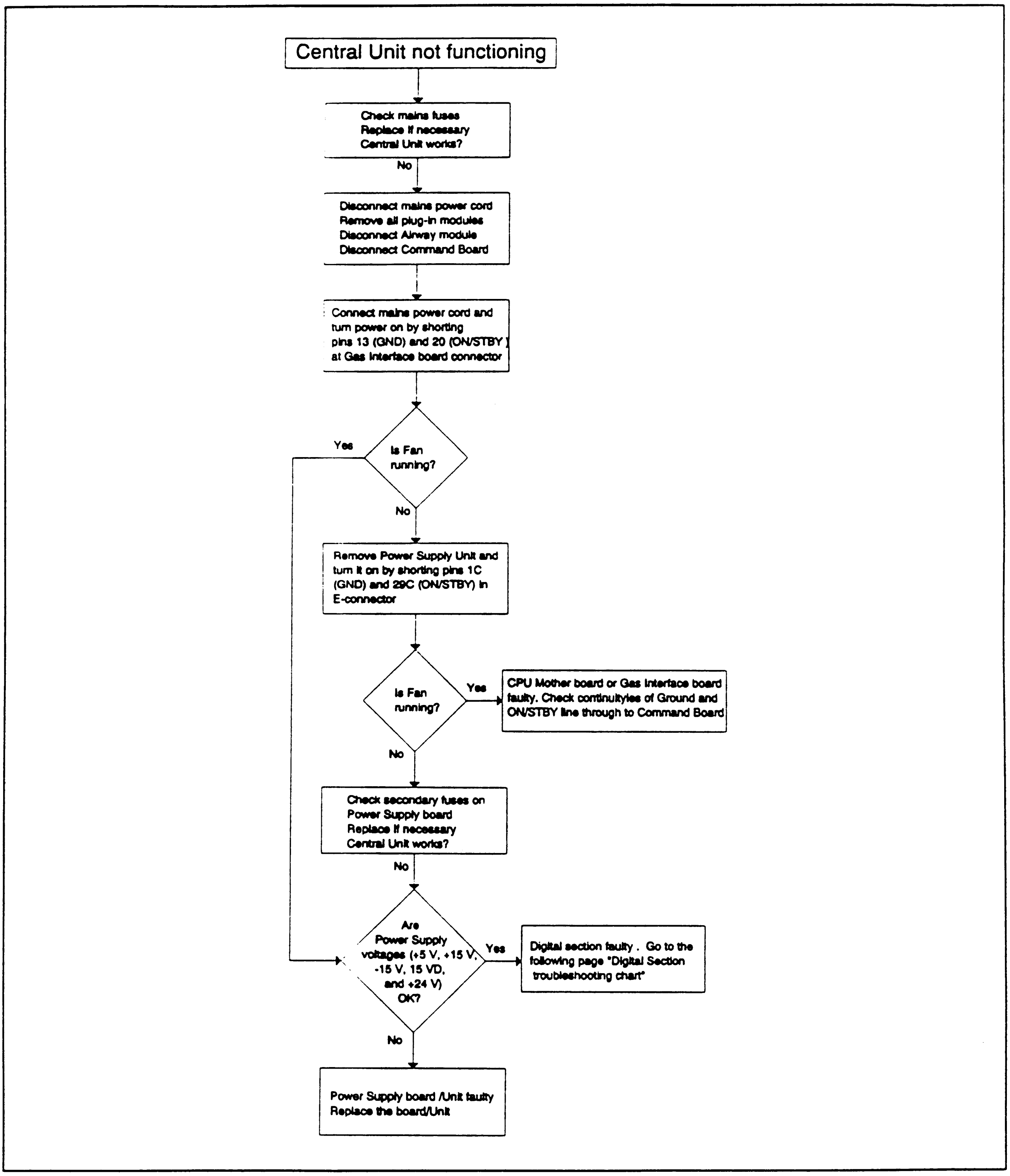


Figure 9 Central Unit troubleshooting chart

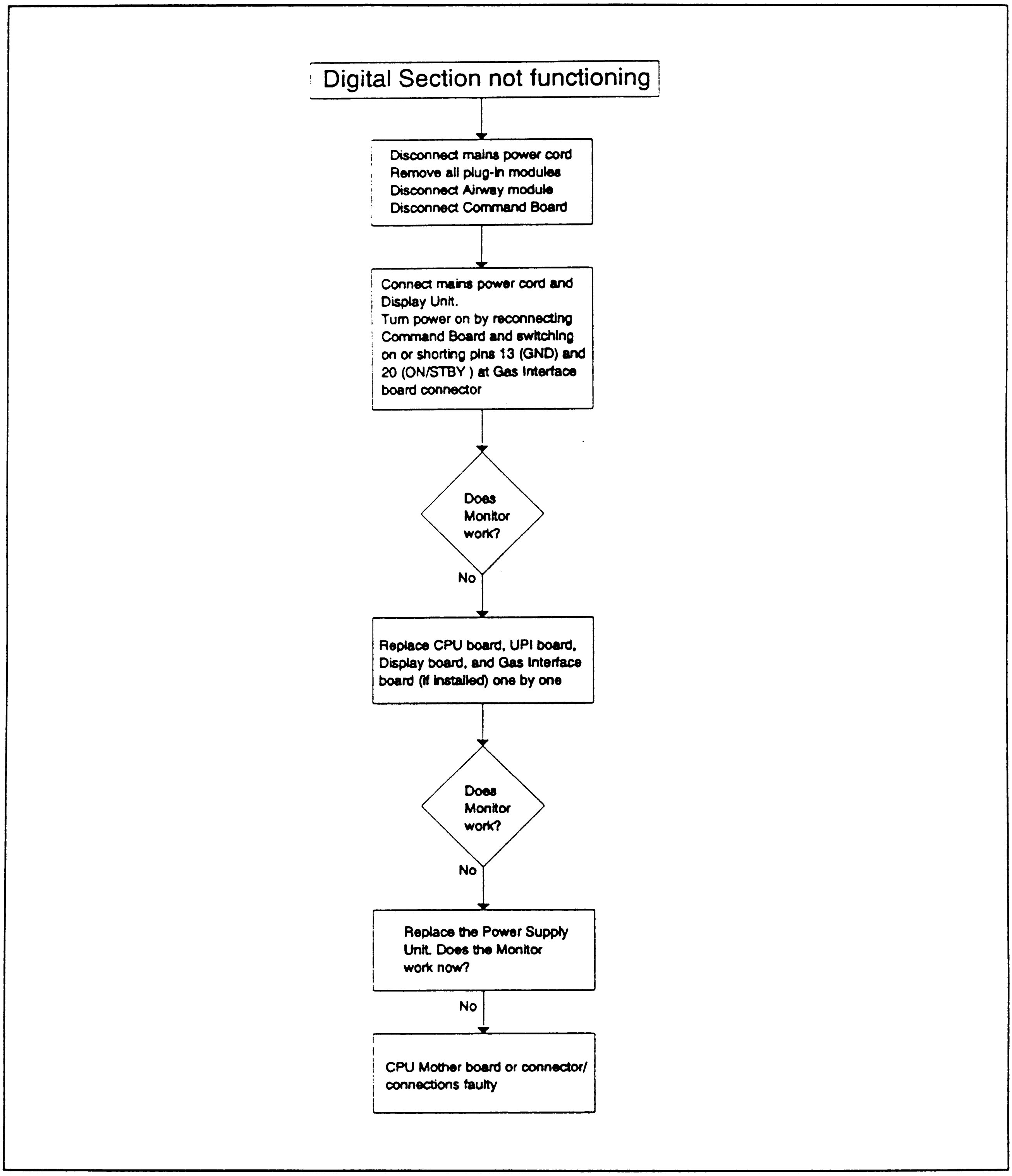


Figure 10 Central Unit digital section troubleshooting chart

5.4 Preventive Maintenance Check List

We recommend that you perform these checks after any service and at least once every six months 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/MK48T08) every four 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, put the power back and make sure that the trends data are not erased from the memory. Check also that the real time and date are not gone wrong.

___: Interchange the modules. Check that they operates normally in a new slot.

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

___: While the power is on, remove NIBP or 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. Otherwise, the Monitor operates normally.

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

6 SPARE PARTS

6.1 Spare Parts List

Item	Item description	Order No.
3	UPI board	*880321
-	GAL D8	879891
-	GAL D7	879892
-	Gas Interface Board	B-GAS
-	Fuse T1A (Gas interface board)	*511394
-	Fuse T4A (Gas interface board)	*51134
-	Fuse T5A (Gas interface board)	*51125
1	CPU mother board	880319
2	Module mother board	880320
4	External frame	879097
5	Metal box	880349
6	Rail for PC boards	879257
7	Connector plate, blank/narrow	879393
8	Connector plate, blank/wide	880278
9	Cross recess screw M6x30	61673
10	Cross cylinder head screw M5x8	61516
11	Cross cylinder head screw M3x8	61722
12	Star washer M3.2	63611
13	Support plate for 61673	879502
14	Pad	65144
15	Bronze tap for display screen tray	879476
16	Rear panel	880350
17	Power supply unit	------

Item number refers to the exploded view in Figure 11.

* = the part is recommended for stock

Item	Item description	Order No.
20	Power supply unit top cover	880351
21	Lead-acid battery	17006
22	Power supply board	*880316
23	Fuse T6.3A (Power supply board)	*51128
24	Fuse T1A (Power supply board)	*51062
25	Triac board 887364	~~*880317~~
26	Fuse T2.5A (Triac board)	*51118
26	Fuse T2.5A (Triac board, USA)	*511181
27	Transformer (100-105 V)	26132
27	Transformer (110-120 V)	26133
27	Transformer (220-230 V)	26135
27	Transformer (230-240 V)	26134
28	Fan	880049
29	Loudspeaker	880048
30	Mains power receptacle	54014
31	Mains fuse T3.15A	*51119
31	Mains fuse 5A (USA)	*511382
32	Display power outlet	54027
33	Power supply unit chassis	879254
34	Service reset switch	881378
-	CPU Board	B-CPU1
-	SRAM (MK48T02/MK48T08)	139423
-	GAL D10	880792
-	GAL D9	880793
-	High Resolution Display Controller	B-DHIGH
-	GAL D1	880380
-	GAL D10	880381
-	Software Cartridge	S-STD

Item number refers to the exploded view in Figure 12.

* = the part is recommended for stock

6.2 Exploded View of Central Unit

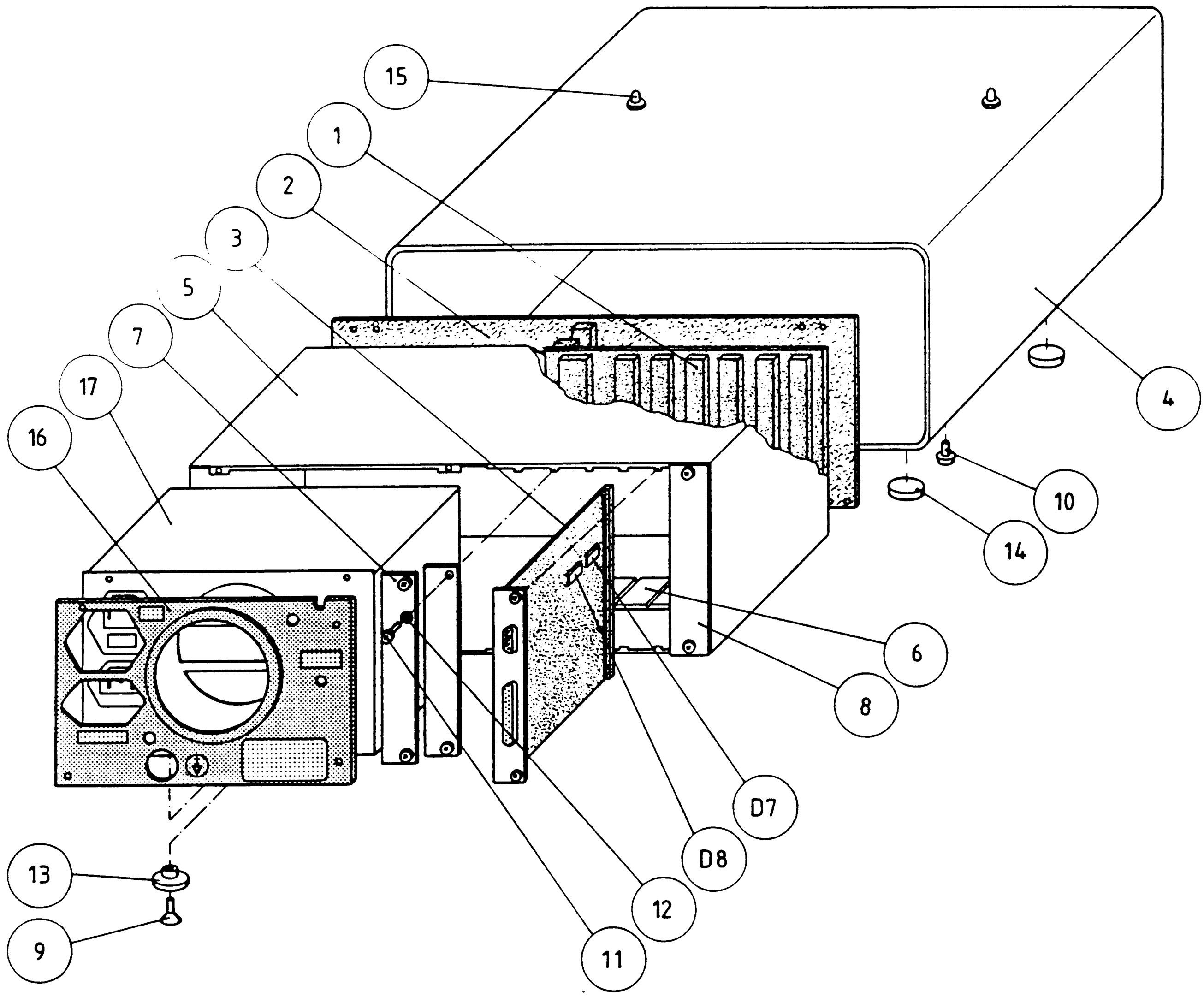


Figure 11 Exploded view of Central Unit

6.3 Exploded View of Power Supply Unit

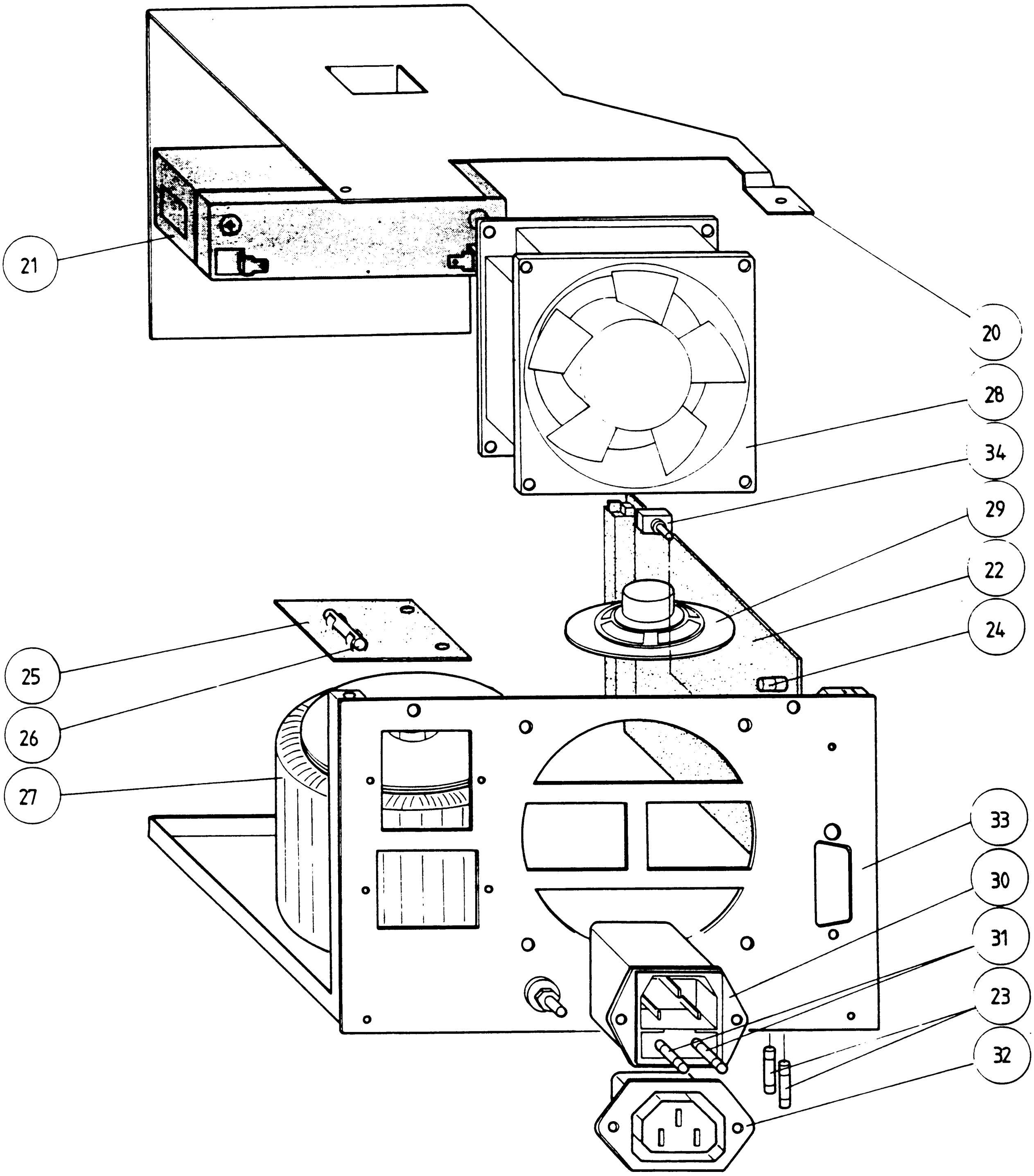


Figure 12 Exploded view of Power Supply Unit

7 CIRCUIT DIAGRAM AND PARTS LAYOUT

Figure 13 CPU Board Parts Layout

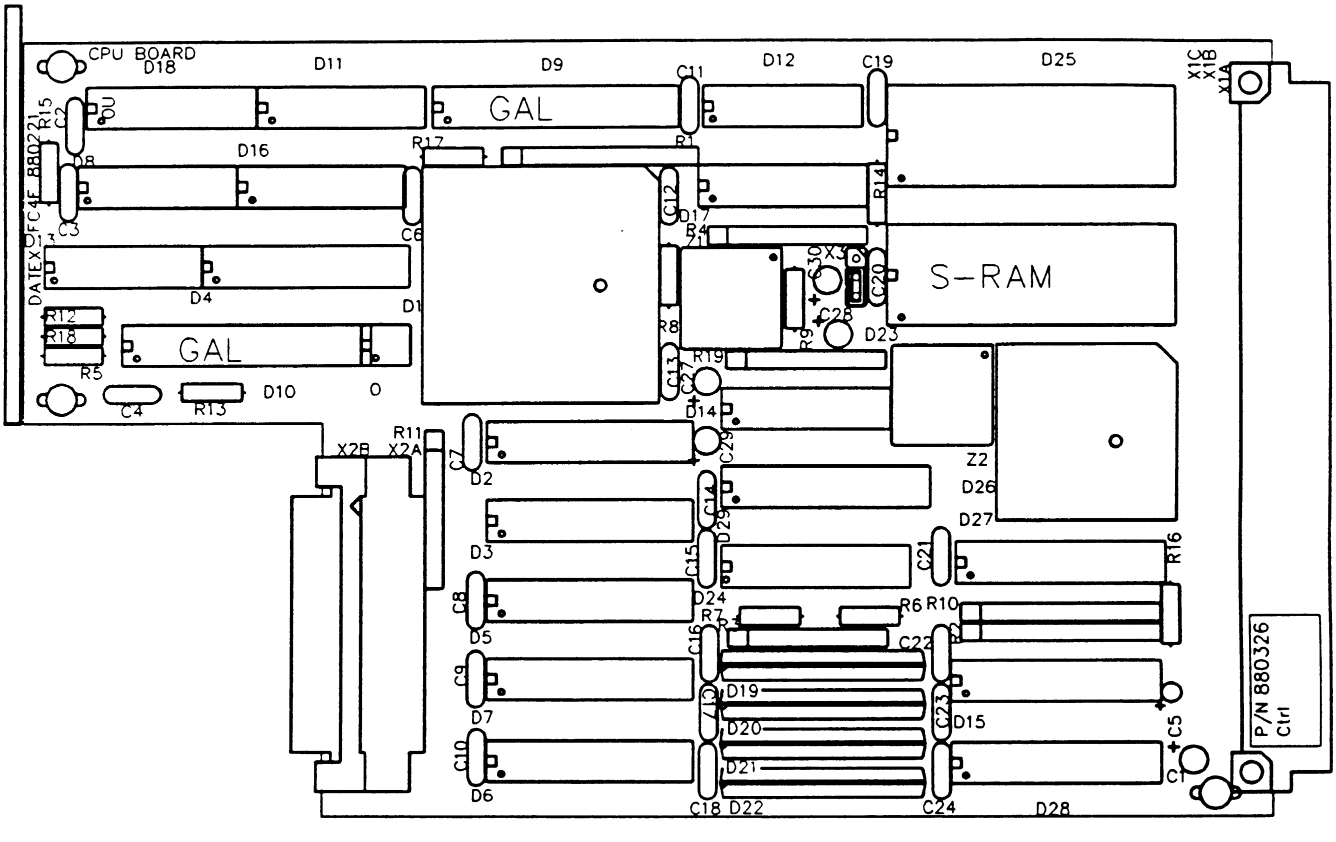
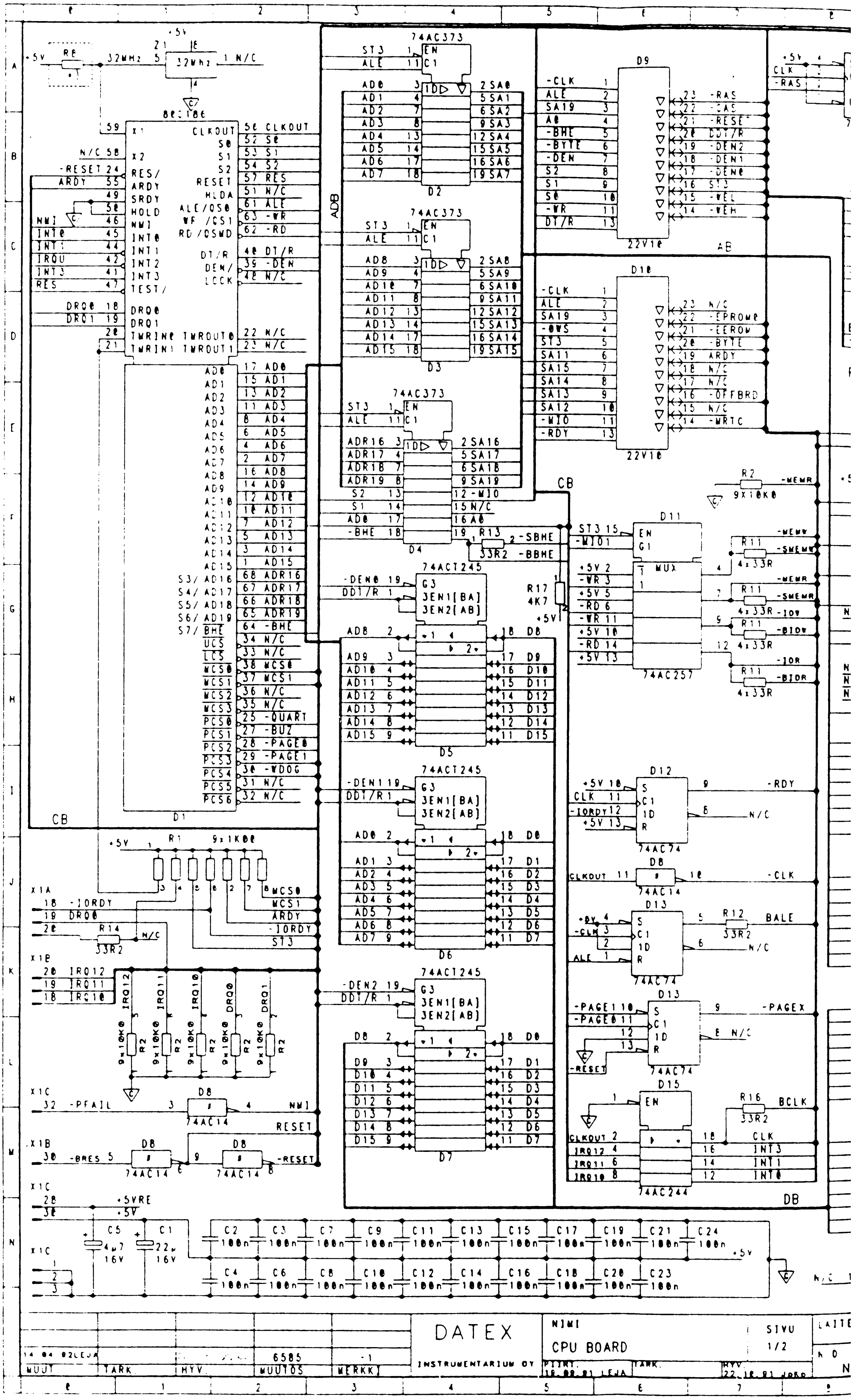


Figure 14 CPU Board Schematic Diagram


DATEX
INSTRUMENTARIUM OY
NIMI
CPU BOARD
SIVU
1/2
LAITE

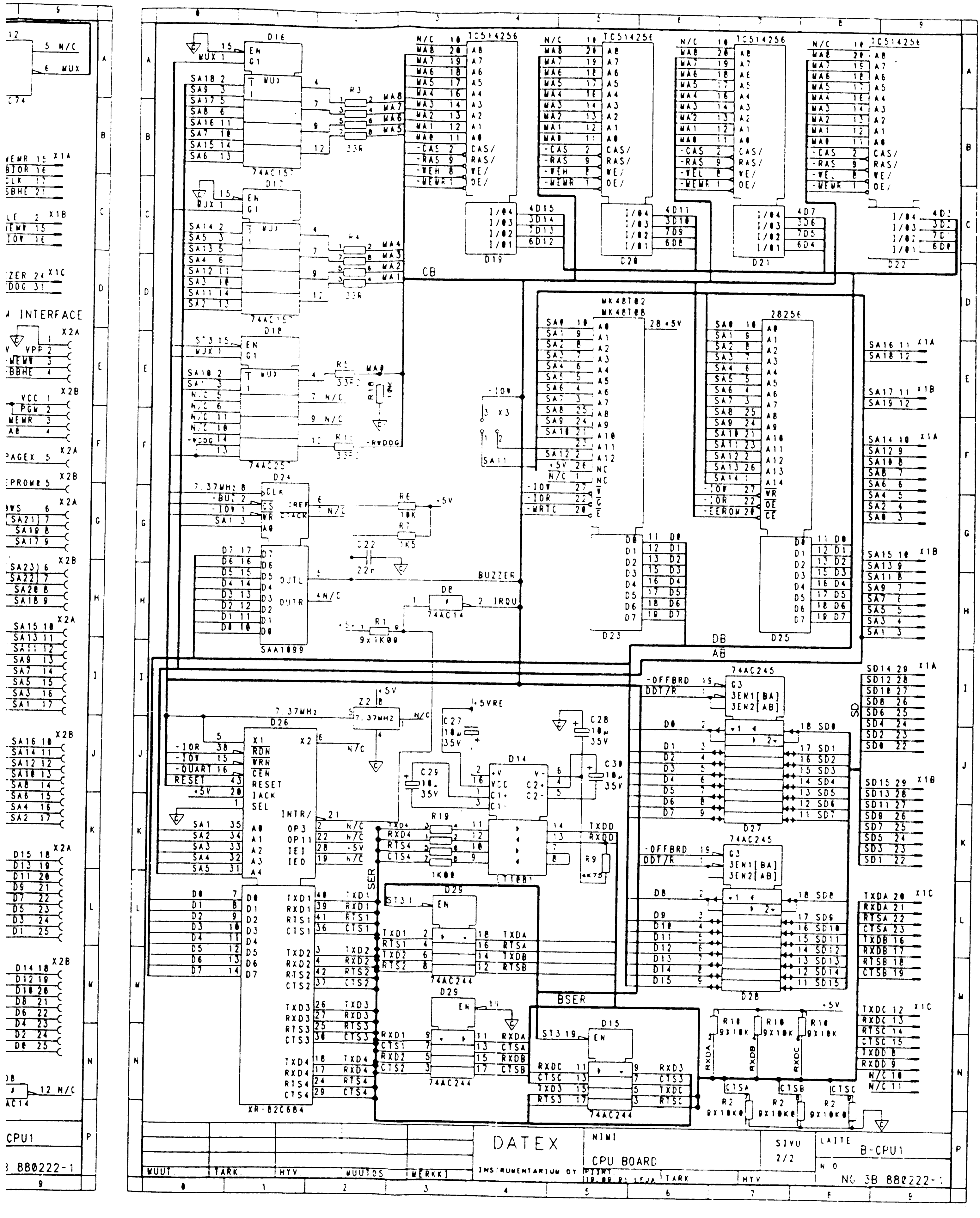
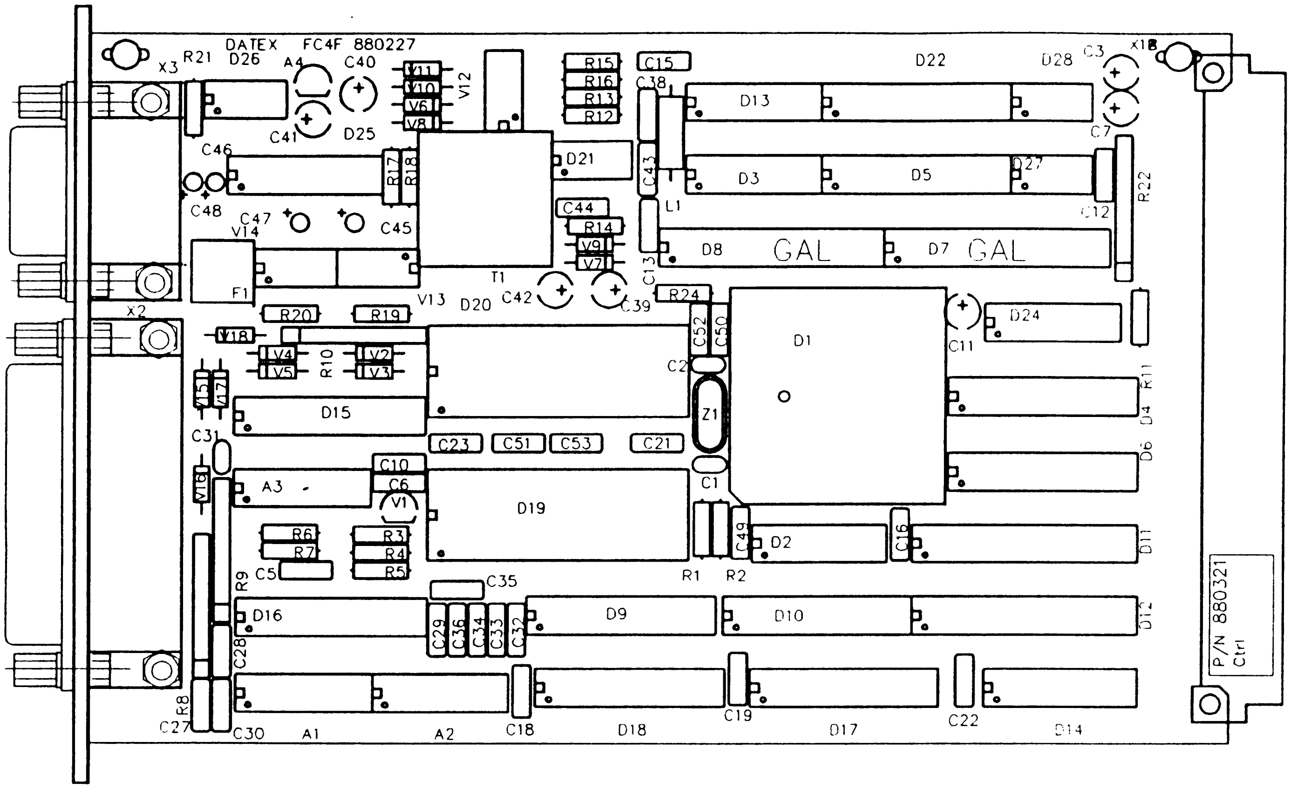

DATEX
INSTRUMENTARIUM OY
NIMI
CPU BOARD
SIVU
2/2
LAITE
B-CPU1
NO. 3B 880222-1
MUUT
TARK
HYV
MUUTOS
MERKKI

Figure 15 UPI Board Parts Layout and Schematic Diagram (Part 1)



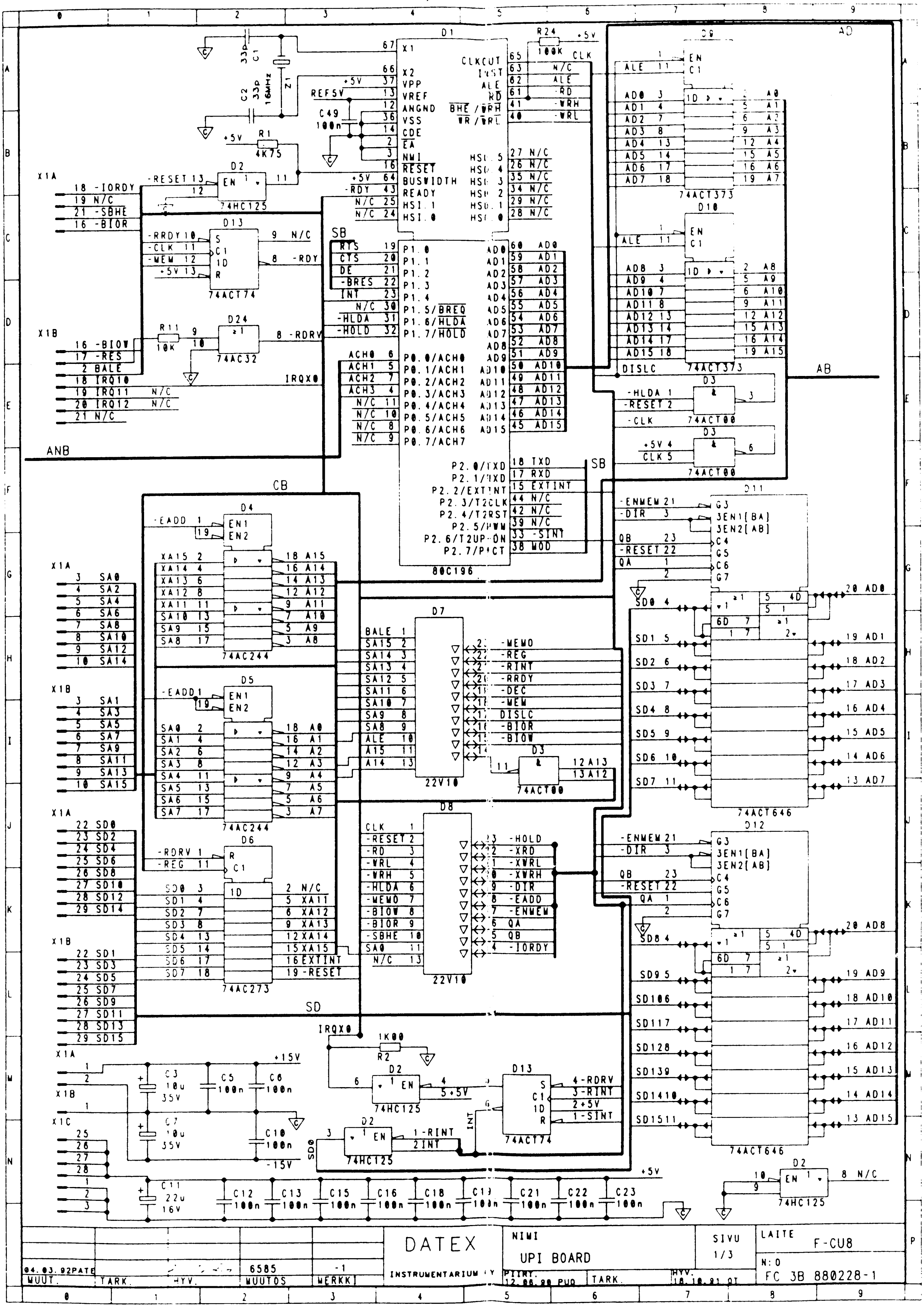
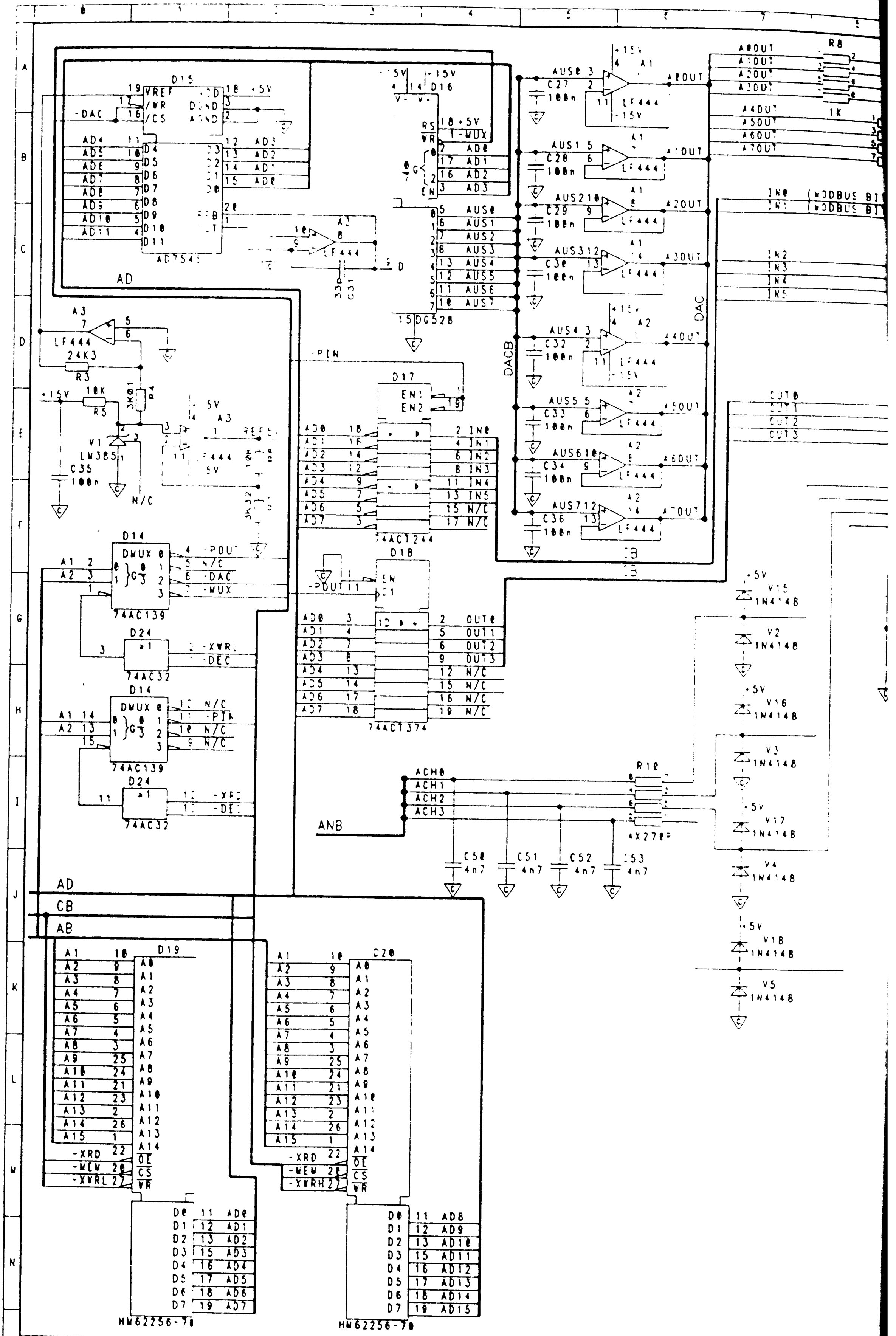

DATEX
INSTRUMENTARIUM OY
NIMI
UPI BOARD
SIVU
1/3
LAITE
F-CU8
N:O
FC 3B 880228-1
6585
-1
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
04.03.92PATE
80C196
74ACT646
74ACT373
74AC244
74AC273
22V10
74HC125
74ACT74
74ACT00
74AC32

Figure 16 UPI Board Schematic Diagram (Part 2)



				DATEX	NIMI: UPI BOARD	SIVU 2/3	LAITE
MUUT.	TARK.	-YV.	MUUTOS	MERKKI	INSTRUMENTARIUM OY	PIIRT. 12.05.88 PVO	TARK.	HYV.	N:O FC 3B

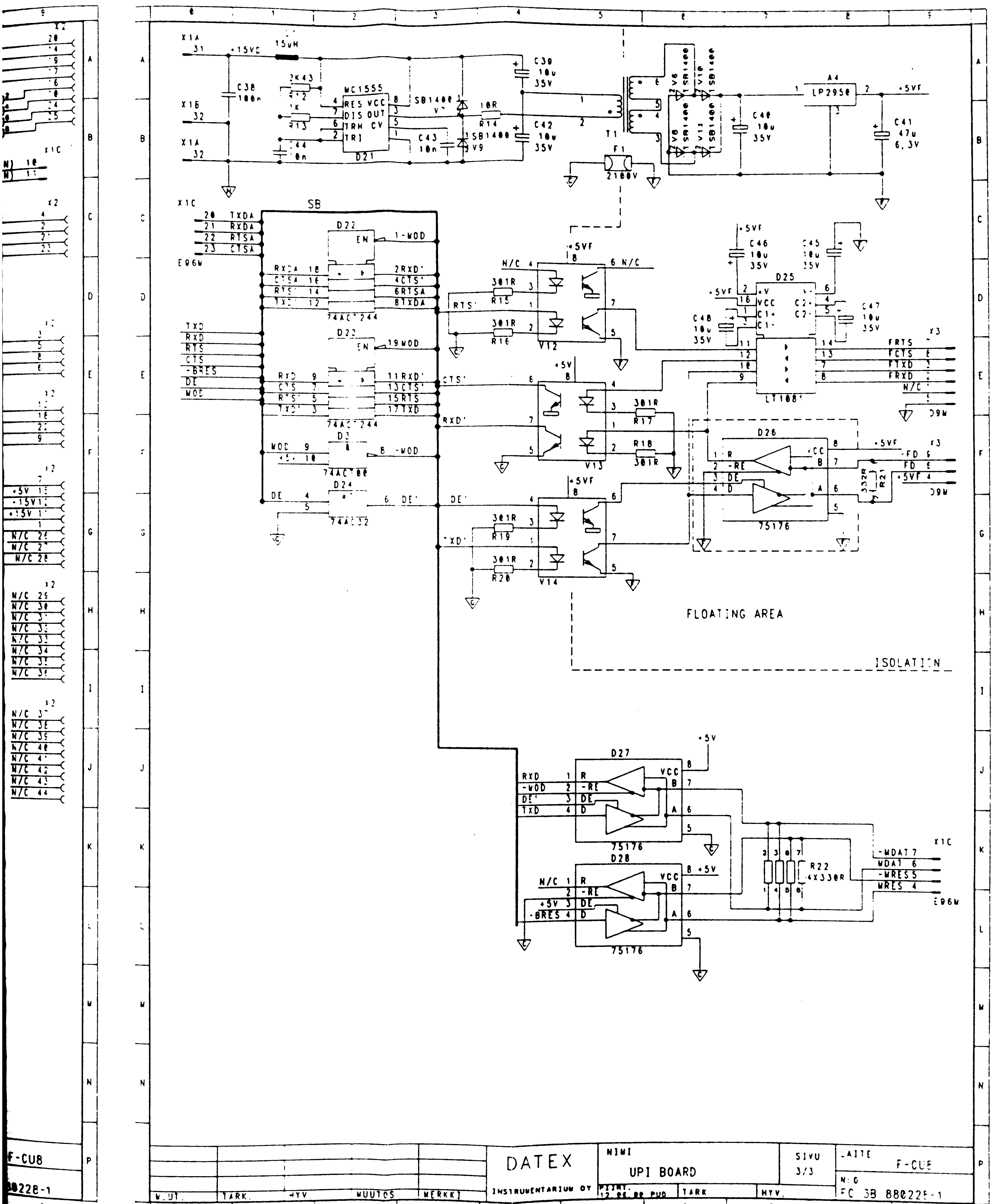
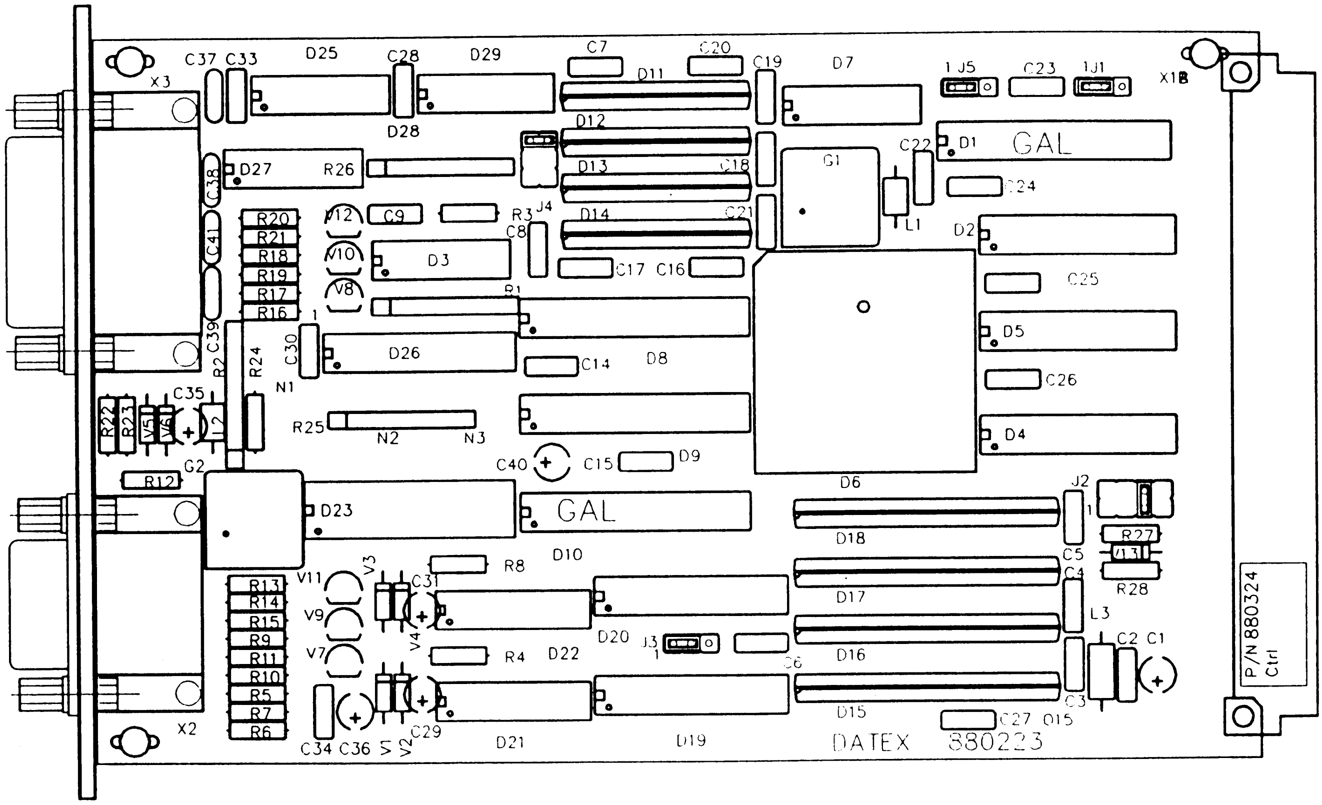
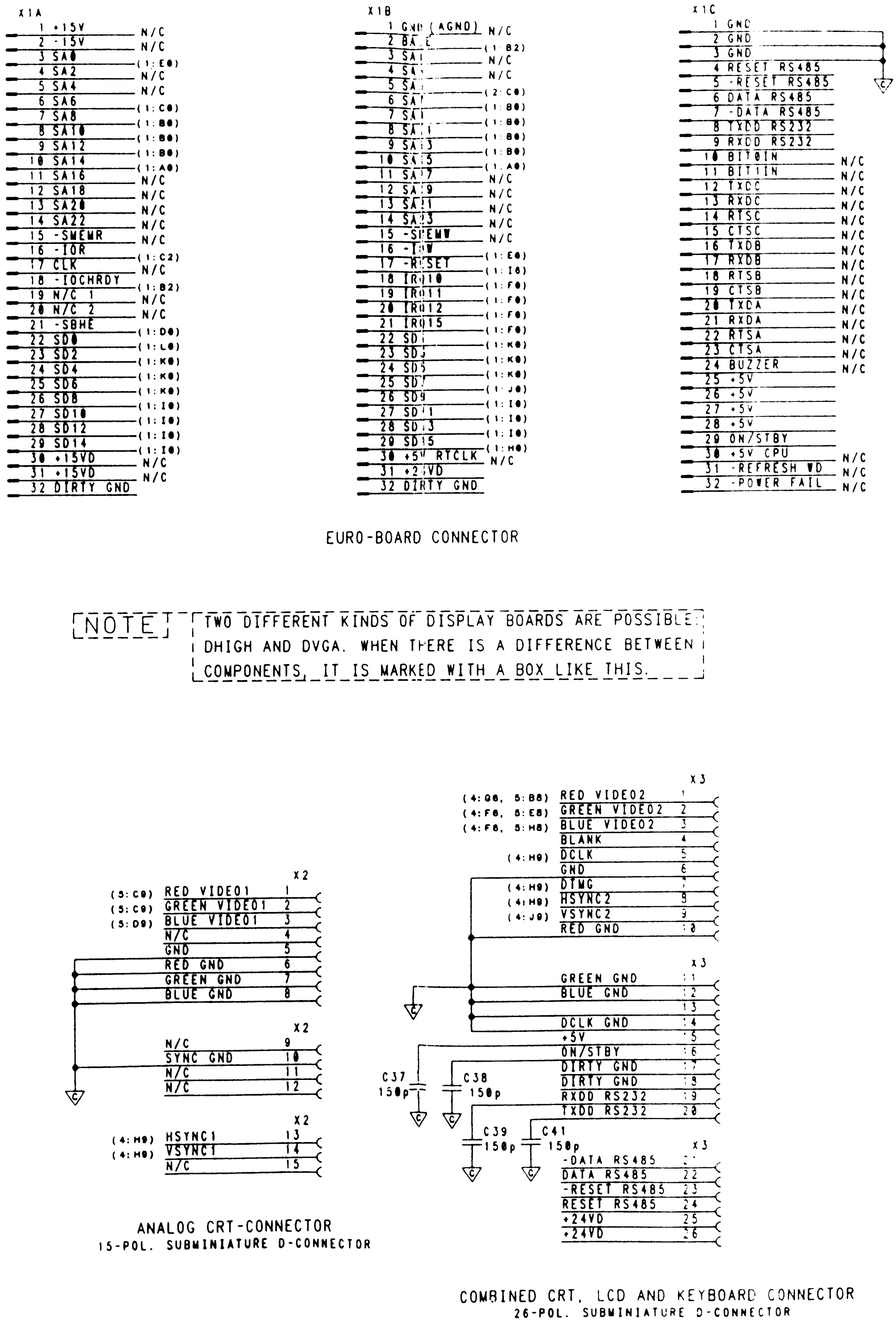

X1A 31
+15VC
15uH
C38 100n
X1B 32
X1A 32
2K43
1K
C44 10n
MC1555
RES VCC
DIS OUT
TRH CV
TRI
D21
SB1400
10R
R14
C43 10n
V9
C39 10u 35V
C42 10u 35V
T1
F1
2100V
A4
LP2950
+5VF
C40 10u 35V
C41 47u 6,3V
X1C
SB
TXDA
RXDA
RTSA
CTSA
E96W
D22
EN
1-MOD
74ACT244
19MOD
D3
74AC00
D24
74AC32
N/C
301R
R15
R16
V12
RTS'
+5V
CTS'
RXD'
R17
R18
V13
DE'
TXD'
R19
R20
V14
C46 10u 35V
C45 10u 35V
D25
C47 10u 35V
C48 10u 35V
LT1081
FRTS
FCTS
FTXD
FRXD
X3
D9W
D26
75176
332R
R21
FLOATING AREA
ISOLATION
D27
D28
RXD
-MOD
TXD
-BRES
R22
4X330R
-MDAT
MDAT
-MRES
MRES
DATEX
INSTRUMENTARIUM OY
NIMI
UPI BOARD
SIVU
3/3
LAITE
F-CUB
N:O
FC 3B 880228-1
M.UT.
TARK.
HYV.
MUUTOS
MERKKI

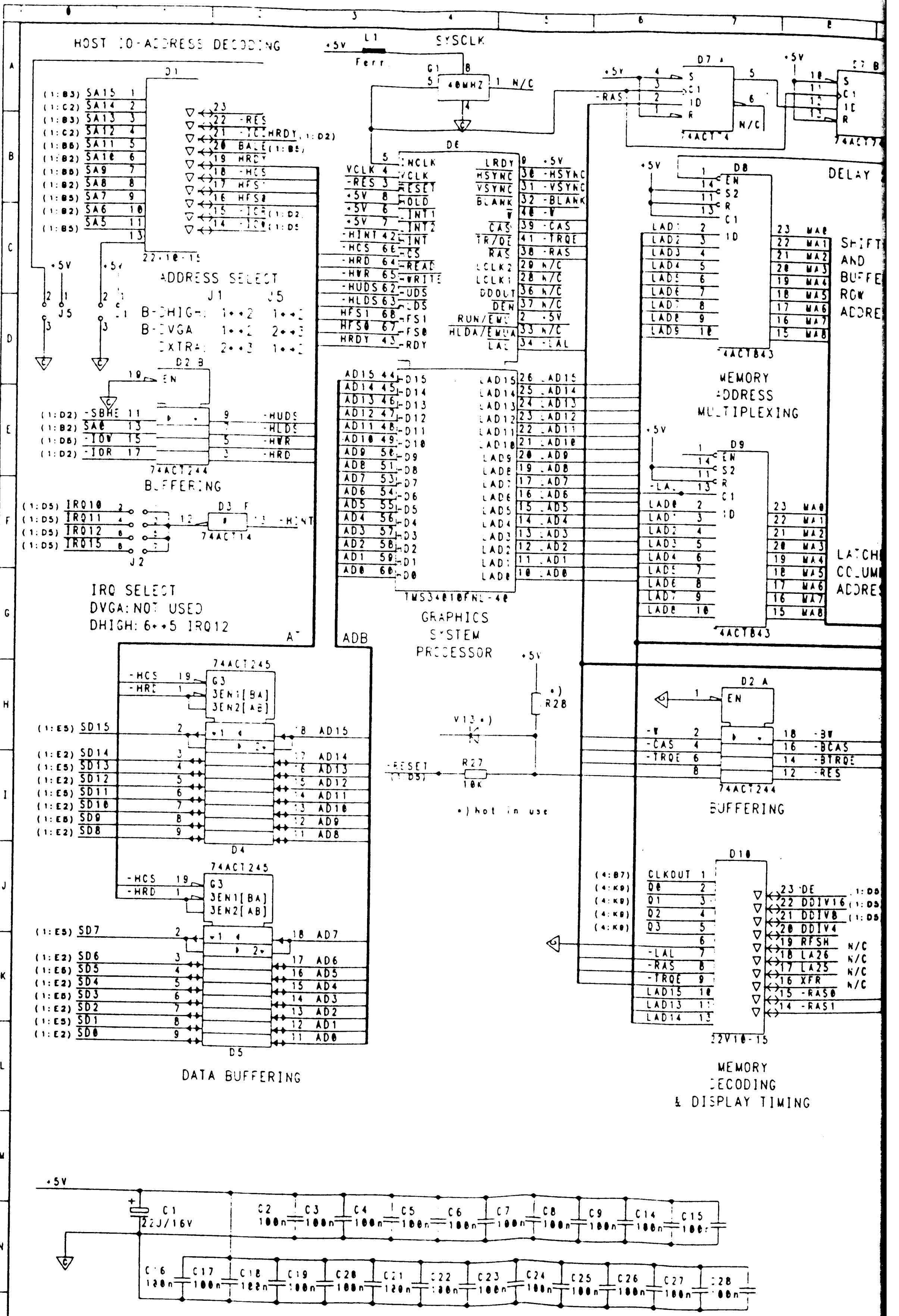
Figure 17 Display Board Parts Layout and Schematic Diagram (Part 1)





04.03.92PATE			6585	-2	DATEX	NIMI: DISPLAY BOARD	SIVU 1/5	LAITE B-DHIGH
05.02.92 EN		10.02.92JOKO	6297 6422	-1	INSTRUMENTARIUM OY	PIIRT. 22.8.88 MALU	TARK.	HYV. 21.12.91 JOKO	N:0 NG 3B 880224-2
MUUT.	TARK.	HYV.	MUUTOS	MERKKI				

Figure 18 Display Board Schematic Diagram (Part 2)



DATEX

INSTRUMENTARIUM OY

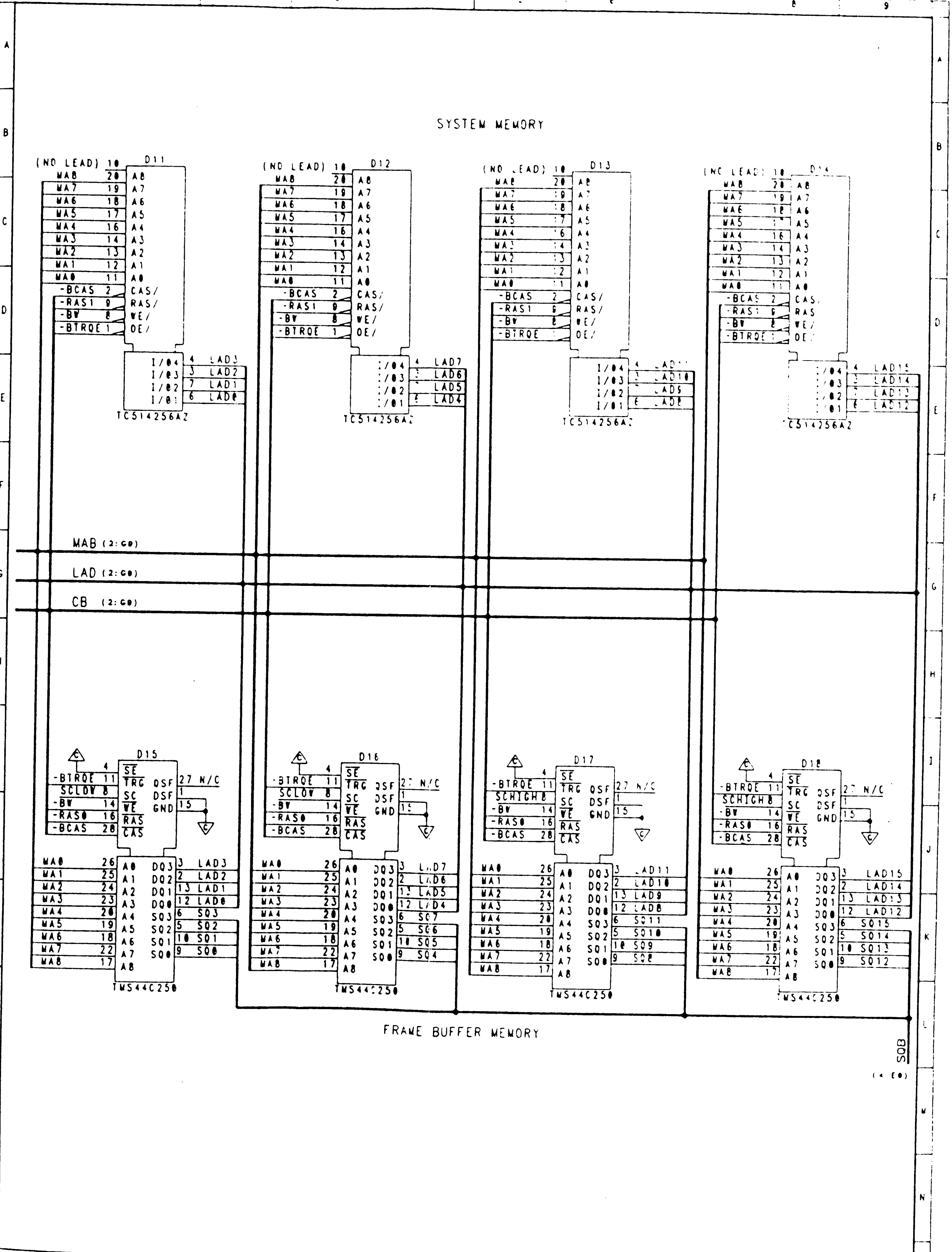
NIMI: DISPLAY BOARD

SIVU 2/5

LAITE B-DHI

NO NC 38 880

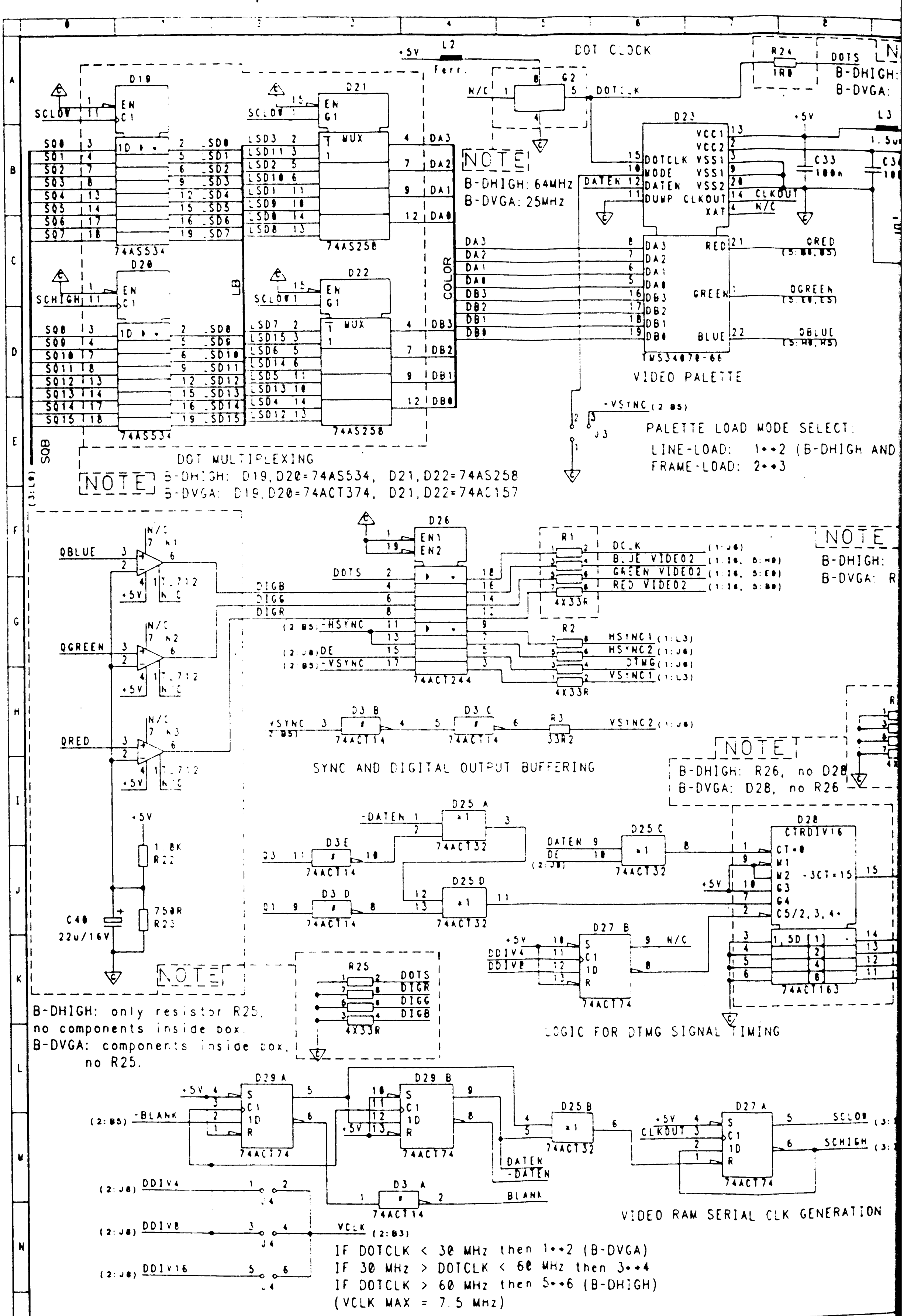
MUUT. | TARK | HYV | MUUTOS | MERKKI | PIIRT. | TARK | HYV



DATEX	NIMI: DISPLAY BOARD
INSTRUMENTARIUM OY	PIIRT. 22.8.88
SIVU: 3/5	LAITE: 5-DHIGH
N:O	NG 3B 880224-2

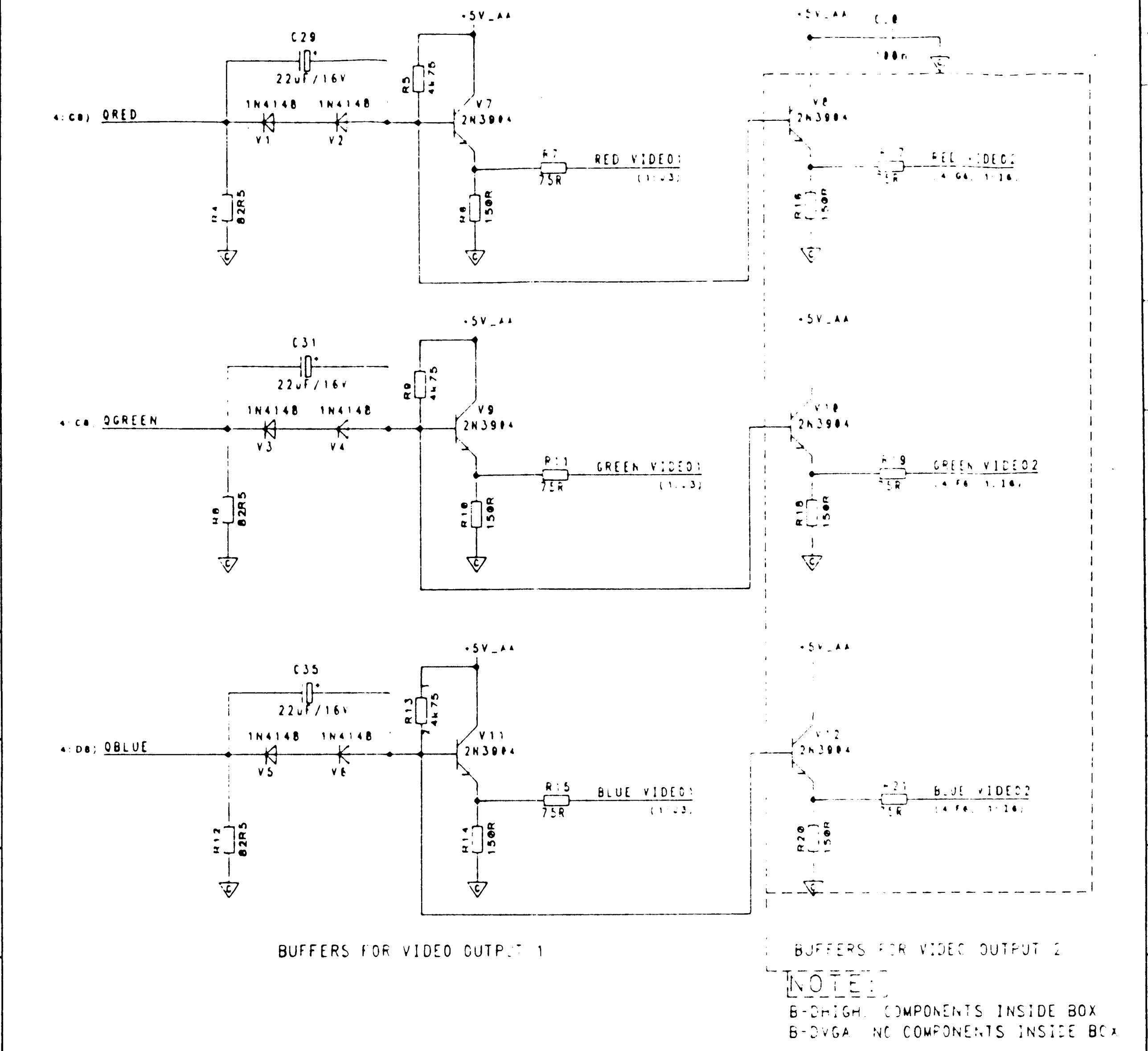
MUUT. | TARK. | HTV. | MUUTOS | MERKKI | TARK | HTV

Figure 19 Display Board Schematic Diagram (Part 3)



DATEX	NIMI: DISPLAY BOARD	SIVU 4/5
INSTRUMENTARIUM OY	PIIRT. 22.8.90 MALU · TARK · HYV	LAITE B-DH… · N:O NG 3B 880…

MUUT. · TARK. · HYV. · MUUTOS · MERKKI



MUUT	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI: DISPLAY BOARD	SIVU 5/5	LAITE B-DHIGH
						PIIRT. 22.8.88	TARK	HYV	N:O NG 3B 880224-2

Figure 20 Software Cartridge Parts Layout and Schematic Diagram

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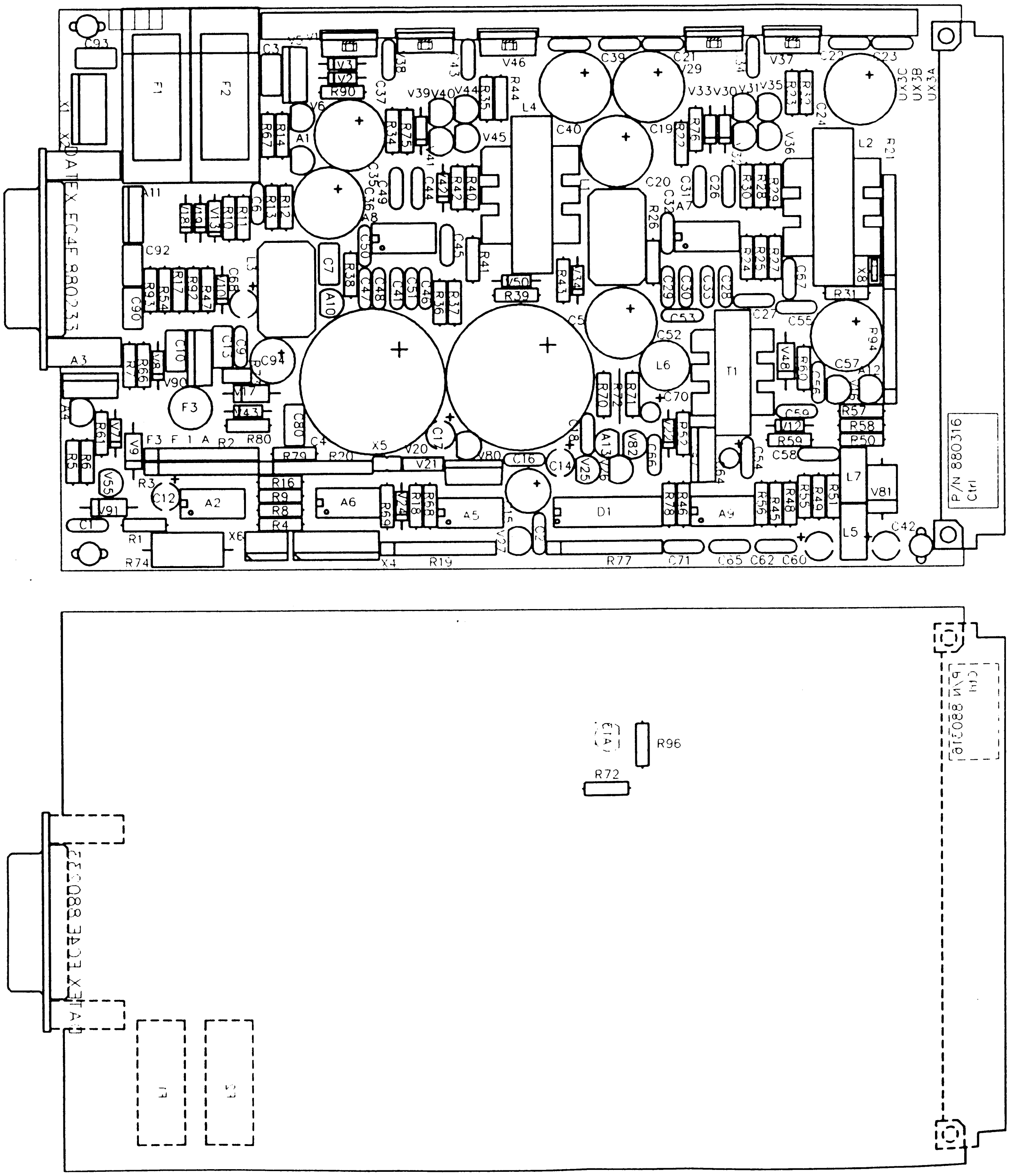
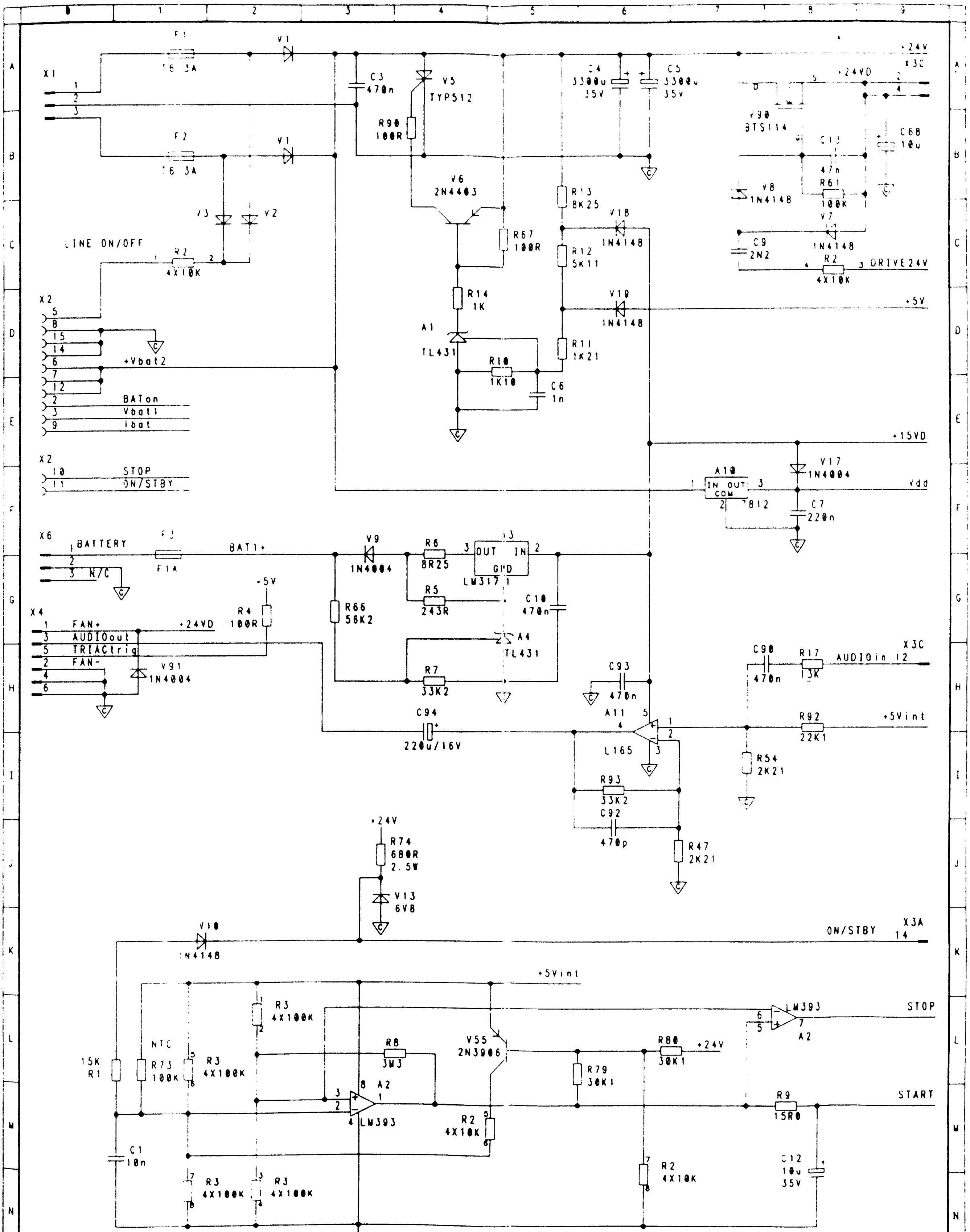
Figure 21 Power Supply Board Parts Layout and Schematic Diagram (Part 1)



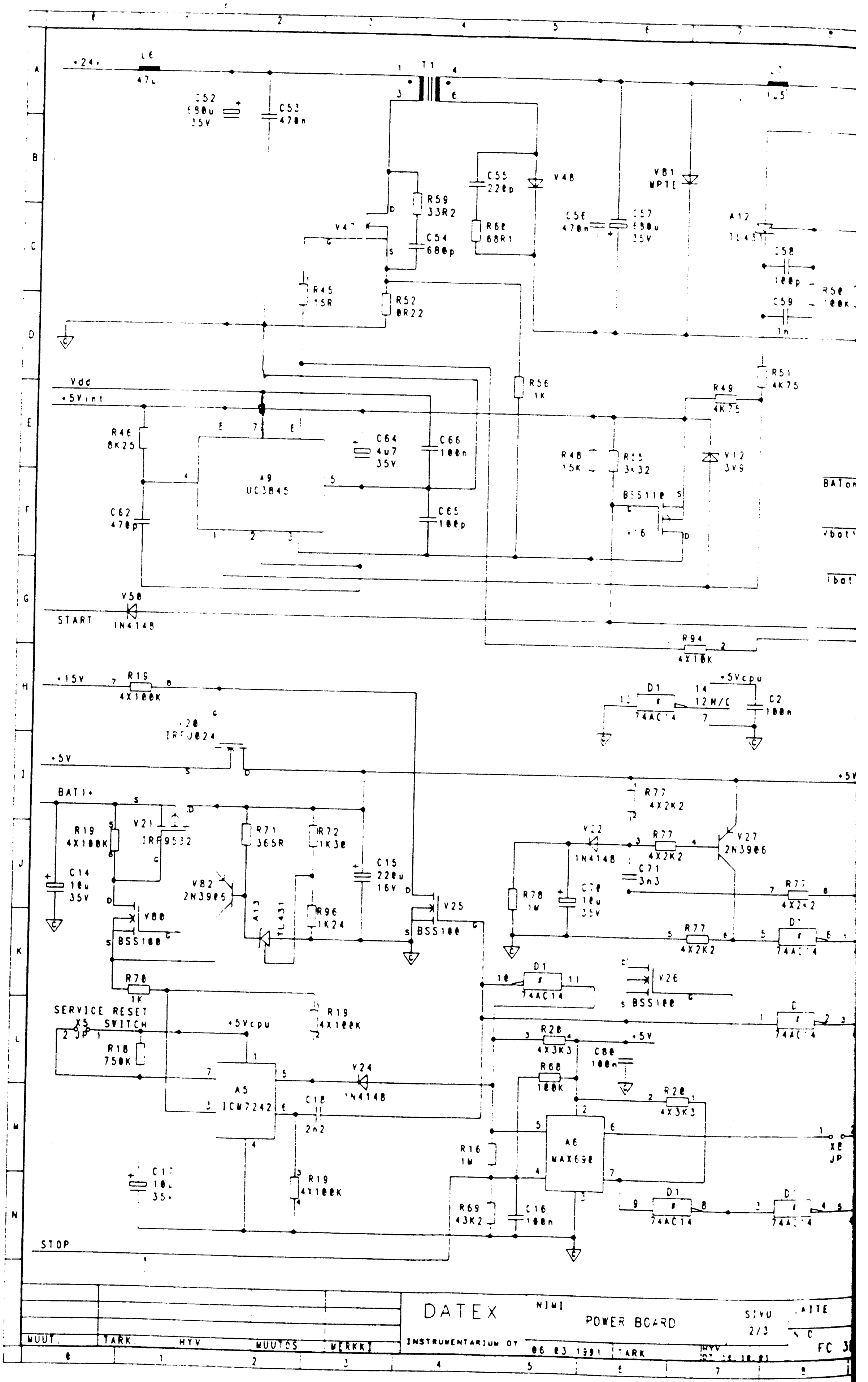


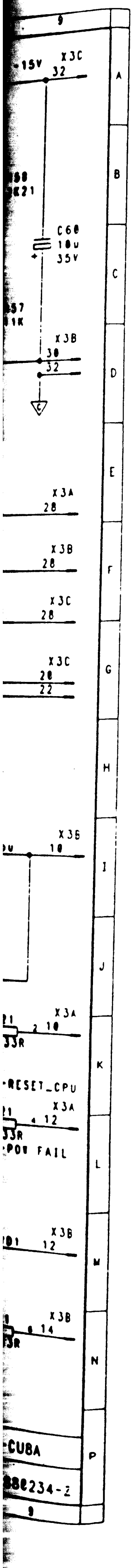
14.04.92LEJA			6585 8630	-2	DATEX	NIMI: POWER BOARD
12.02.92 EN		14.02.92JoKa	6437 6487	-1	INSTRUMENTARIUM OY	SIVU 1/3
MUUT.	TARK.	HYV.	MUUTOS	MERKKI		11.03.1991

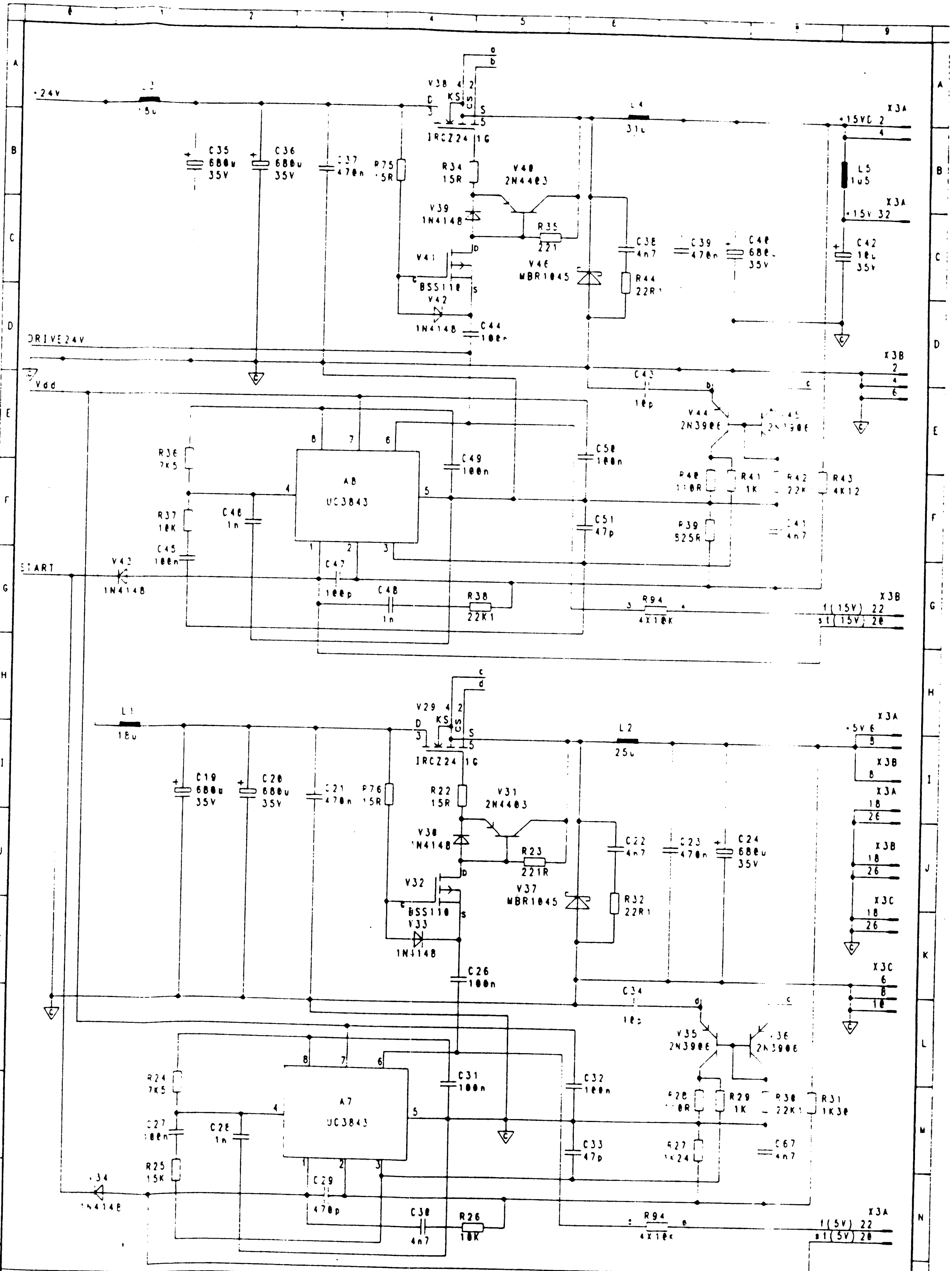
LAITE F-CU8A

N:O FC 3B 880234-2

Figure 22 Power Supply Board Schematic Diagram (Part 2)


+24V
T1
C52 680u 35V
C53 470n
C55 220p
V48
R59 33R2
C54 680p
R60 68R1
C56 470n
C57 680u 35V
V81 MPTE
A12 TL431
C58 100p
C59 1n
V47
R45 15R
R52 0R22
R56 1K
R51 4K75
R49 4K75
Vdc
+5Vint
R46 8K25
A9 UC3845
C64 4u7 35V
C66 100n
C65 100p
C62 470p
R48 15K
R55 3K32
BSS110
V12 3V9
BATon
Vbat
Ibat
V50 1N4148
START
R94 4X10K
+15V
R15 4X100K
D1 74AC14
+5Vcpu
C2 100n
V20 IRFU024
+5V
BAT1+
V21 IRF9532
R19 4X100K
C14 10u 35V
R71 365R
R72 1K30
V82 2N3906
A13 TL431
R96 1K24
C15 220u 16V
V25 BSS100
V80 BSS100
R77 4X2K2
V22 1N4148
V27 2N3906
C71 3n3
R78 1M
C70 10u 35V
V26 BSS100
R70 1K
SERVICE RESET SWITCH
X5 JP
R18 750K
A5 ICM7242
V24 1N4148
C18 2n2
R20 4X3K3
C80 100n
R68 100K
A6 MAX690
R16 1M
R69 43K2
C16 100n
C17 10u 35V
X8 JP
STOP
DATEX
NIMI
POWER BOARD
SIVU 2/3
LAITE
INSTRUMENTARIUM OY
06.03.1991
TARK
HYV
MUUT.
MUUTOS
MERKKI





MUUT.	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI POWER BOARD	SIVU 3/3	LAITE F-CUBA
						06.03.1991 TARK. HYV.		FC 3B 880234-2

Figure 23 Triac Board Parts Layout and Schematic Diagram

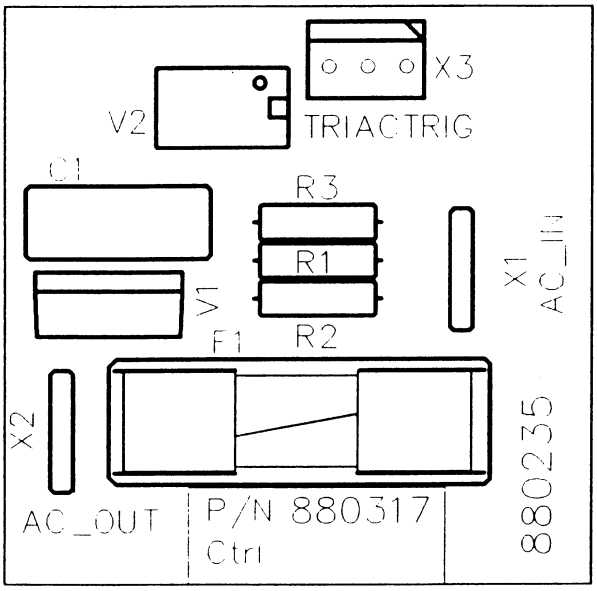
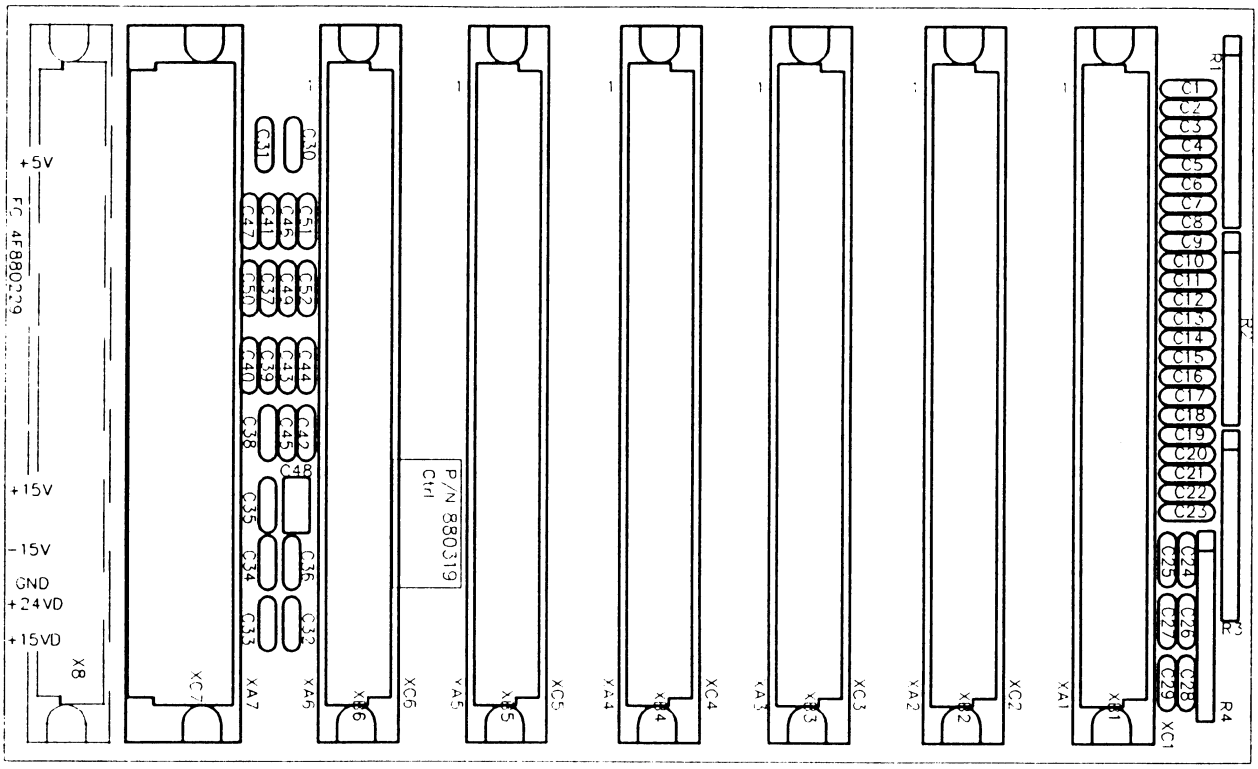


Figure 24 CPU Mother Board Parts Layout and Schematic Diagram (Part 1)



X1, X2, X3, X4 CPU-BUS CONNECTORS

CPU-BUS

Pin	XA1	Pin	XB1	Pin	XC1	Pin	XA2	Pin	XB2	Pin	XC2
1a	+15V	1b	GND (AGND)	1c	GND (DGND)	1a	+15V	1b	GND (AGND)	1c	GND (DGND)
2a	-15V	2b	BALE	2c	GND (DGND)	2a	-15V	2b	BALE	2c	GND (DGND)
3a	SA0	3b	SA1	3c	GND (DGND)	3a	SA0	3b	SA1	3c	GND (DGND)
4a	SA2	4b	SA3	4c	RESET_RS485	4a	SA2	4b	SA3	4c	RESET_RS485
5a	SA4	5b	SA5	5c	-RESET_RS485	5a	SA4	5b	SA5	5c	-RESET_RS485
6a	SA6	6b	SA7	6c	DATA_RS485	6a	SA6	6b	SA7	6c	DATA_RS485
7a	SA8	7b	SA9	7c	-DATA_RS485	7a	SA8	7b	SA9	7c	-DATA_RS485
8a	SA10	8b	SA11	8c	TXDD_RS232	8a	SA10	8b	SA11	8c	TXDD_RS232
9a	SA12	9b	SA13	9c	RXDD_RS232	9a	SA12	9b	SA13	9c	RXDD_RS232
10a	SA14	10b	SA15	10c	BIT0IN	10a	SA14	10b	SA15	10c	BIT0IN
11a	SA16	11b	SA17	11c	BIT1IN	11a	SA16	11b	SA17	11c	BIT1IN
12a	SA18	12b	SA19	12c	TXDC	12a	SA18	12b	SA19	12c	TXDC
13a	SA20	13b	SA21	13c	RXDC	13a	SA20	13b	SA21	13c	RXDC
14a	SA22	14b	SA23	14c	RTSC	14a	SA22	14b	SA23	14c	RTSC
15a	-SMEMR	15b	-SMEMW	15c	CTSC	15a	-SMEMR	15b	-SMEMW	15c	CTSC
16a	-IOR	16b	-IOW	16c	TXDB	16a	-IOR	16b	-IOW	16c	TXDB
17a	CLK	17b	-RESET	17c	RXDB	17a	CLK	17b	-RESET	17c	RXDB
18a	-IOCHRDY	18b	IRQ10	18c	RTSB	18a	-IOCHRDY	18b	IRQ10	18c	RTSB
19a	N/C_1	19b	IRQ11	19c	CTSB	19a	N/C_1	19b	IRQ11	19c	CTSB
20a	N/C_2	20b	IRQ12	20c	TXDA	20a	N/C_2	20b	IRQ12	20c	TXDA
21a	-SBHE	21b	IRQ15	21c	RXDA	21a	-SBHE	21b	IRQ15	21c	RXDA
22a	SD0	22b	SD1	22c	RTSA	22a	SD0	22b	SD1	22c	RTSA
23a	SD2	23b	SD3	23c	CTSA	23a	SD2	23b	SD3	23c	CTSA
24a	SD4	24b	SD5	24c	BUZZER	24a	SD4	24b	SD5	24c	BUZZER
25a	SD6	25b	SD7	25c	+5V	25a	SD6	25b	SD7	25c	+5V
26a	SD8	26b	SD9	26c	+5V	26a	SD8	26b	SD9	26c	+5V
27a	SD10	27b	SD11	27c	+5V	27a	SD10	27b	SD11	27c	+5V
28a	SD12	28b	SD13	28c	+5V	28a	SD12	28b	SD13	28c	+5V
29a	SD14	29b	SD15	29c	ON/STBY	29a	SD14	29b	SD15	29c	ON/STBY
30a	+15VD	30b	-RESET_CPU	30c	+5V_CPU	30a	+15VD	30b	-RESET_CPU	30c	+5V_CPU
31a	+15VD	31b	+24VD	31c	-REFRESH_WD	31a	+15VD	31b	+24VD	31c	-REFRESH_WD
32a	GND (GNDD)	32b	GND (GNDD)	32c	-POWER_FAIL	32a	GND (GNDD)	32b	GND (GNDD)	32c	-POWER_FAIL

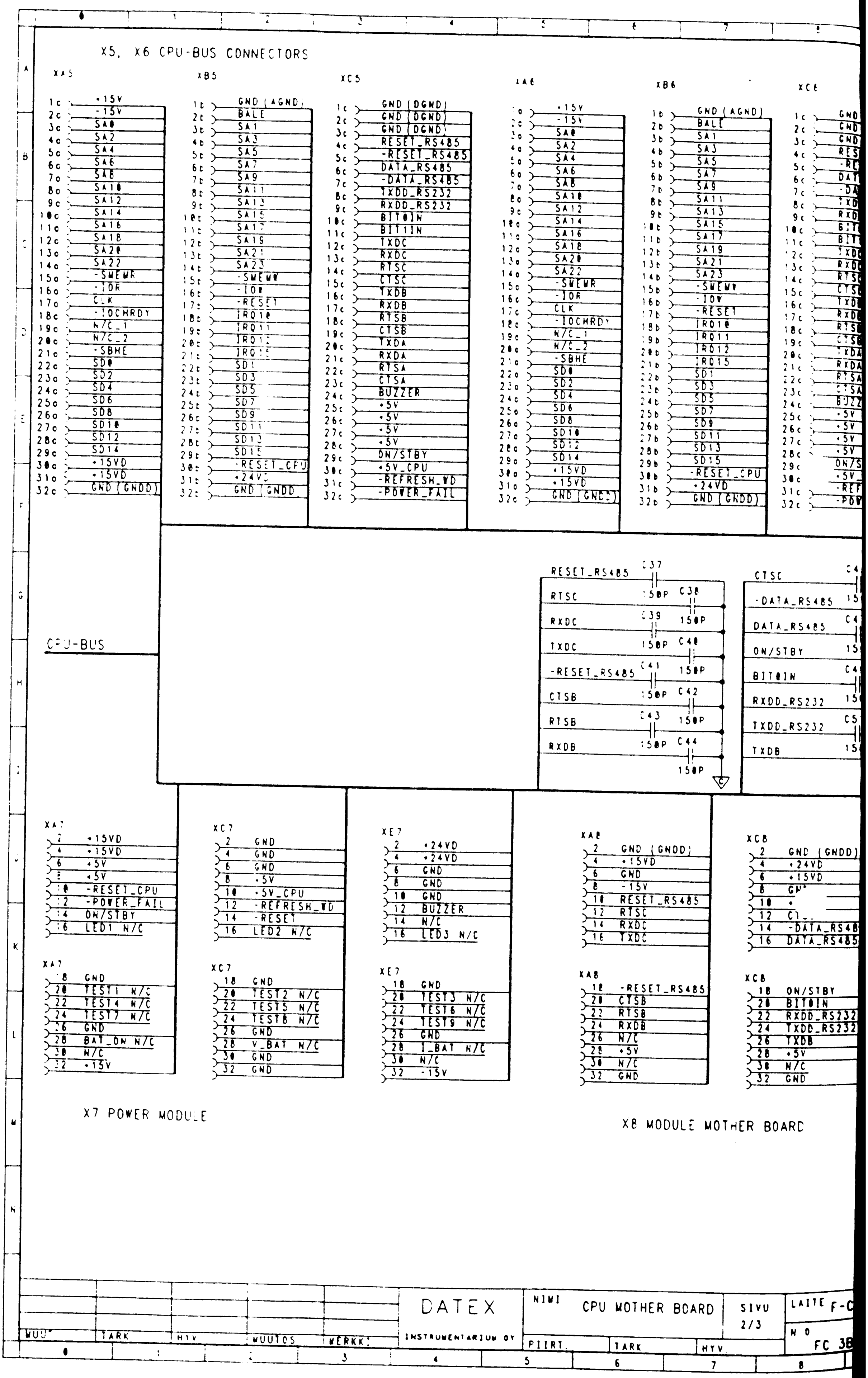
Pin	XA3	Pin	XB3	Pin	XC3	Pin	XA4	Pin	XB4	Pin	XC4
1a	+15V	1b	GND (AGND)	1c	GND (DGND)	1a	+15V	1b	GND (AGND)	1c	GND (DGND)
2a	-15V	2b	BALE	2c	GND (DGND)	2a	-15V	2b	BALE	2c	GND (DGND)
3a	SA0	3b	SA1	3c	GND (DGND)	3a	SA0	3b	SA1	3c	GND (DGND)
4a	SA2	4b	SA3	4c	RESET_RS485	4a	SA2	4b	SA3	4c	RESET_RS485
5a	SA4	5b	SA5	5c	-RESET_RS485	5a	SA4	5b	SA5	5c	-RESET_RS485
6a	SA6	6b	SA7	6c	DATA_RS485	6a	SA6	6b	SA7	6c	DATA_RS485
7a	SA8	7b	SA9	7c	-DATA_RS485	7a	SA8	7b	SA9	7c	-DATA_RS485
8a	SA10	8b	SA11	8c	TXDD_RS232	8a	SA10	8b	SA11	8c	TXDD_RS232
9a	SA12	9b	SA13	9c	RXDD_RS232	9a	SA12	9b	SA13	9c	RXDD_RS232
10a	SA14	10b	SA15	10c	BIT0IN	10a	SA14	10b	SA15	10c	BIT0IN
11a	SA16	11b	SA17	11c	BIT1IN	11a	SA16	11b	SA17	11c	BIT1IN
12a	SA18	12b	SA19	12c	TXDC	12a	SA18	12b	SA19	12c	TXDC
13a	SA20	13b	SA21	13c	RXDC	13a	SA20	13b	SA21	13c	RXDC
14a	SA22	14b	SA23	14c	RTSC	14a	SA22	14b	SA23	14c	RTSC
15a	-SMEMR	15b	-SMEMW	15c	CTSC	15a	-SMEMR	15b	-SMEMW	15c	CTSC
16a	-IOR	16b	-IOW	16c	TXDB	16a	-IOR	16b	-IOW	16c	TXDB
17a	CLK	17b	-RESET	17c	RXDB	17a	CLK	17b	-RESET	17c	RXDB
18a	-IOCHRDY	18b	IRQ10	18c	RTSB	18a	-IOCHRDY	18b	IRQ10	18c	RTSB
19a	N/C_1	19b	IRQ11	19c	CTSB	19a	N/C_1	19b	IRQ11	19c	CTSB
20a	N/C_2	20b	IRQ12	20c	TXDA	20a	N/C_2	20b	IRQ12	20c	TXDA
21a	-SBHE	21b	IRQ15	21c	RXDA	21a	-SBHE	21b	IRQ15	21c	RXDA
22a	SD0	22b	SD1	22c	RTSA	22a	SD0	22b	SD1	22c	RTSA
23a	SD2	23b	SD3	23c	CTSA	23a	SD2	23b	SD3	23c	CTSA
24a	SD4	24b	SD5	24c	BUZZER	24a	SD4	24b	SD5	24c	BUZZER
25a	SD6	25b	SD7	25c	+5V	25a	SD6	25b	SD7	25c	+5V
26a	SD8	26b	SD9	26c	+5V	26a	SD8	26b	SD9	26c	+5V
27a	SD10	27b	SD11	27c	+5V	27a	SD10	27b	SD11	27c	+5V
28a	SD12	28b	SD13	28c	+5V	28a	SD12	28b	SD13	28c	+5V
29a	SD14	29b	SD15	29c	ON/STBY	29a	SD14	29b	SD15	29c	ON/STBY
30a	+15VD	30b	-RESET_CPU	30c	+5V_CPU	30a	+15VD	30b	-RESET_CPU	30c	+5V_CPU
31a	+15VD	31b	+24VD	31c	-REFRESH_WD	31a	+15VD	31b	+24VD	31c	-REFRESH_WD
32a	GND (GNDD)	32b	GND (GNDD)	32c	-POWER_FAIL	32a	GND (GNDD)	32b	GND (GNDD)	32c	-POWER_FAIL

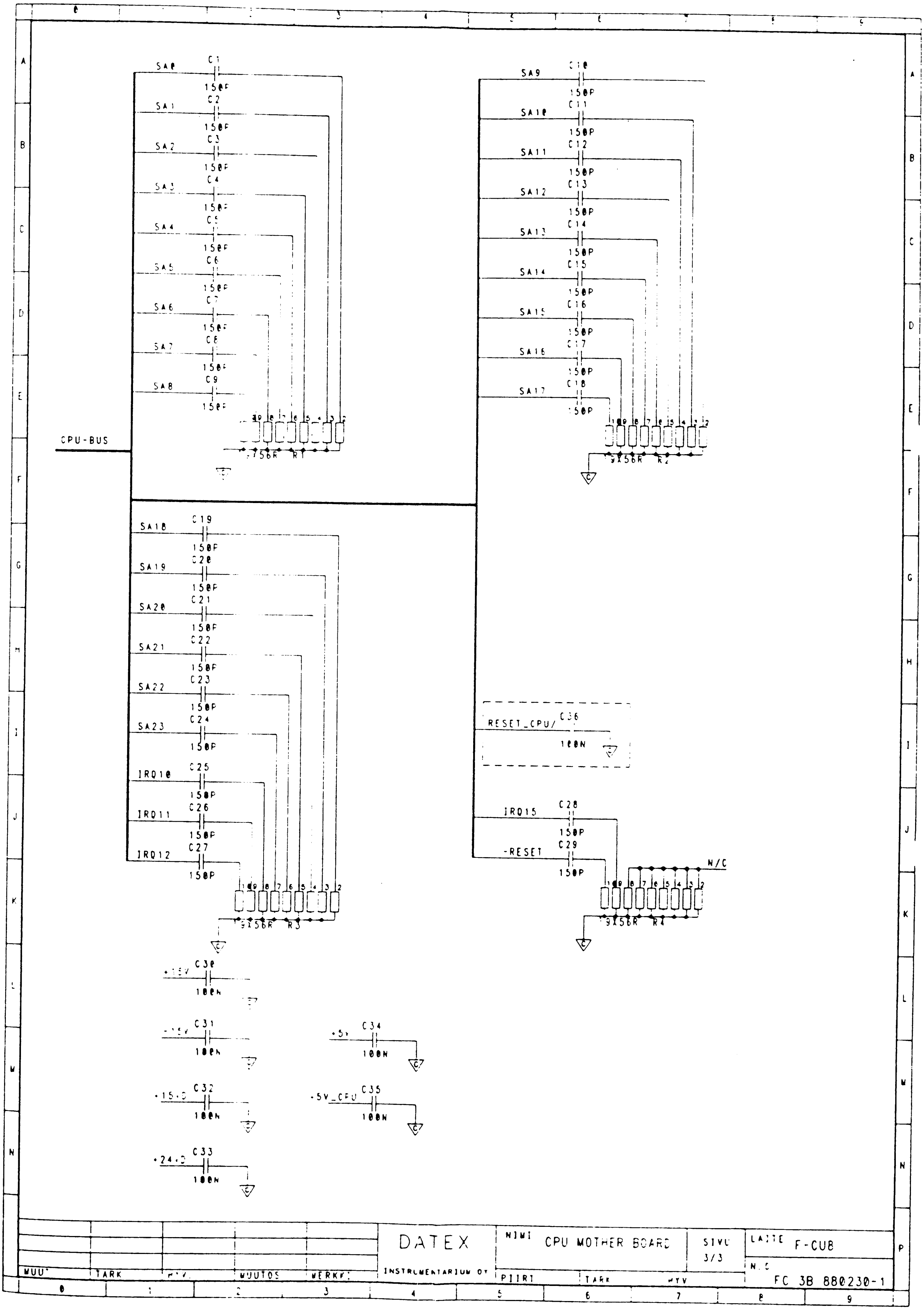
MUUT.	TARK.	HYV.	MUUTOS	MERKKI
14.04.92 OS			6585	-1

DATEX
INSTRUMENTARIUM OY

NIMI: CPU MOTHER BOARD
SIVU: 1/3
LAITE: F-CU8
N:O: FC 3B 880230-1
13.01.92 OS | TARK. 15.01.92 JOKO

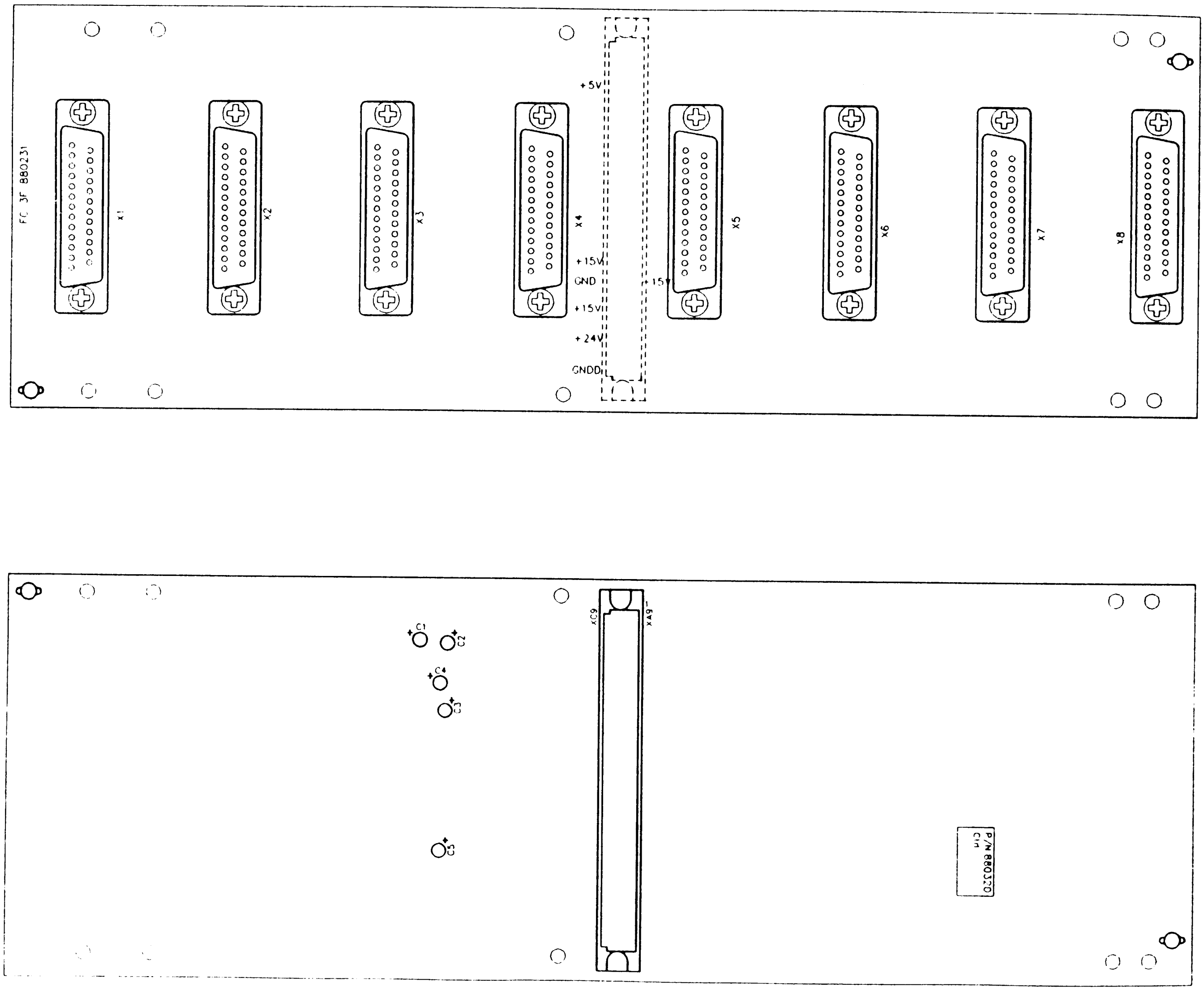
Figure 25 CPU Mother Board Schematic Diagram (Part 2)


X5, X6 CPU-BUS CONNECTORS
XA5
+15V
-15V
SA0
SA2
SA4
SA6
SA8
SA10
SA12
SA14
SA16
SA18
SA20
SA22
-SMEMR
-IOR
CLK
-IOCHRDY
N/C_1
N/C_2
-SBHE
SD0
SD2
SD4
SD6
SD8
SD10
SD12
SD14
+15VD
+15VD
GND (GNDD)
XB5
GND (AGND)
BALE
SA1
SA3
SA5
SA7
SA9
SA11
SA13
SA15
SA17
SA19
SA21
SA23
-SMEMW
-IOW
-RESET
IRQ10
IRQ11
IRQ12
IRQ15
SD1
SD3
SD5
SD7
SD9
SD11
SD13
SD15
-RESET_CPU
+24VD
GND (GNDD)
XC5
GND (DGND)
GND (DGND)
GND (DGND)
RESET_RS485
-RESET_RS485
DATA_RS485
-DATA_RS485
TXDD_RS232
RXDD_RS232
BIT0IN
BIT1IN
TXDC
RXDC
RTSC
CTSC
TXDB
RXDB
RTSB
CTSB
TXDA
RXDA
RTSA
CTSA
BUZZER
+5V
+5V
+5V
+5V
ON/STBY
+5V_CPU
-REFRESH_WD
-POWER_FAIL
XA6
XB6
XC6
CPU-BUS
RESET_RS485 C37
RTSC 150P C38
RXDC C39 150P
TXDC 150P C40
-RESET_RS485 C41 150P
CTSB 150P C42
RTSB C43 150P
RXDB 150P C44 150P
CTSC
-DATA_RS485
DATA_RS485
ON/STBY
BIT0IN
RXDD_RS232
TXDD_RS232
TXDB
XA7
2 +15VD
4 +15VD
6 +5V
8 +5V
10 -RESET_CPU
12 -POWER_FAIL
14 ON/STBY
16 LED1 N/C
18 GND
20 TEST1 N/C
22 TEST4 N/C
24 TEST7 N/C
26 GND
28 BAT_ON N/C
30 N/C
32 +15V
XC7
2 GND
4 GND
6 GND
8 +5V
10 +5V_CPU
12 -REFRESH_WD
14 -RESET
16 LED2 N/C
18 GND
20 TEST2 N/C
22 TEST5 N/C
24 TEST8 N/C
26 GND
28 V_BAT N/C
30 GND
32 GND
XE7
2 +24VD
4 +24VD
6 GND
8 GND
10 GND
12 BUZZER
14 N/C
16 LED3 N/C
18 GND
20 TEST3 N/C
22 TEST6 N/C
24 TEST9 N/C
26 GND
28 I_BAT N/C
30 N/C
32 -15V
XA8
2 GND (GNDD)
4 +15VD
6 GND
8 -15V
10 RESET_RS485
12 RTSC
14 RXDC
16 TXDC
18 -RESET_RS485
20 CTSB
22 RTSB
24 RXDB
26 N/C
28 +5V
30 N/C
32 GND
XC8
2 GND (GNDD)
4 +24VD
6 +15VD
14 -DATA_RS485
16 DATA_RS485
18 ON/STBY
20 BIT0IN
22 RXDD_RS232
24 TXDD_RS232
26 TXDB
28 +5V
30 N/C
32 GND
X7 POWER MODULE
X8 MODULE MOTHER BOARD
DATEX
INSTRUMENTARIUM OY
NIMI
CPU MOTHER BOARD
SIVU
2/3
LAITE
NO
FC 3B
MUUT
TARK
HYV
MUUTOS
MERKKI
PIIRT.
TARK
HYV



SA0 C1 150P
SA1 C2 150P
SA2 C3 150P
SA3 C4 150P
SA4 C5 150P
SA5 C6 150P
SA6 C7 150P
SA7 C8 150P
SA8 C9 150P
9X56R R1
CPU-BUS
SA9 C10 150P
SA10 C11 150P
SA11 C12 150P
SA12 C13 150P
SA13 C14 150P
SA14 C15 150P
SA15 C16 150P
SA16 C17 150P
SA17 C18 150P
9X56R R2
SA18 C19 150P
SA19 C20 150P
SA20 C21 150P
SA21 C22 150P
SA22 C23 150P
SA23 C24 150P
IRQ10 C25 150P
IRQ11 C26 150P
IRQ12 C27 150P
9X56R R3
RESET_CPU/ C36 100N
IRQ15 C28 150P
-RESET C29 150P
N/C
9X56R R4
+15V C30 100N
-15V C31 100N
+15-D C32 100N
+24-D C33 100N
+5V C34 100N
+5V_CPU C35 100N
DATEX
INSTRUMENTARIUM OY
NIMI CPU MOTHER BOARD
SIVU 3/3
LAITE F-CUB
N:O FC 3B 880230-1
MUUT TARK HYV. MUUTOS MERKKI
PIIRT TARK HYV

Figure 26 Module Mother Board Parts Layout and Schematic Diagram



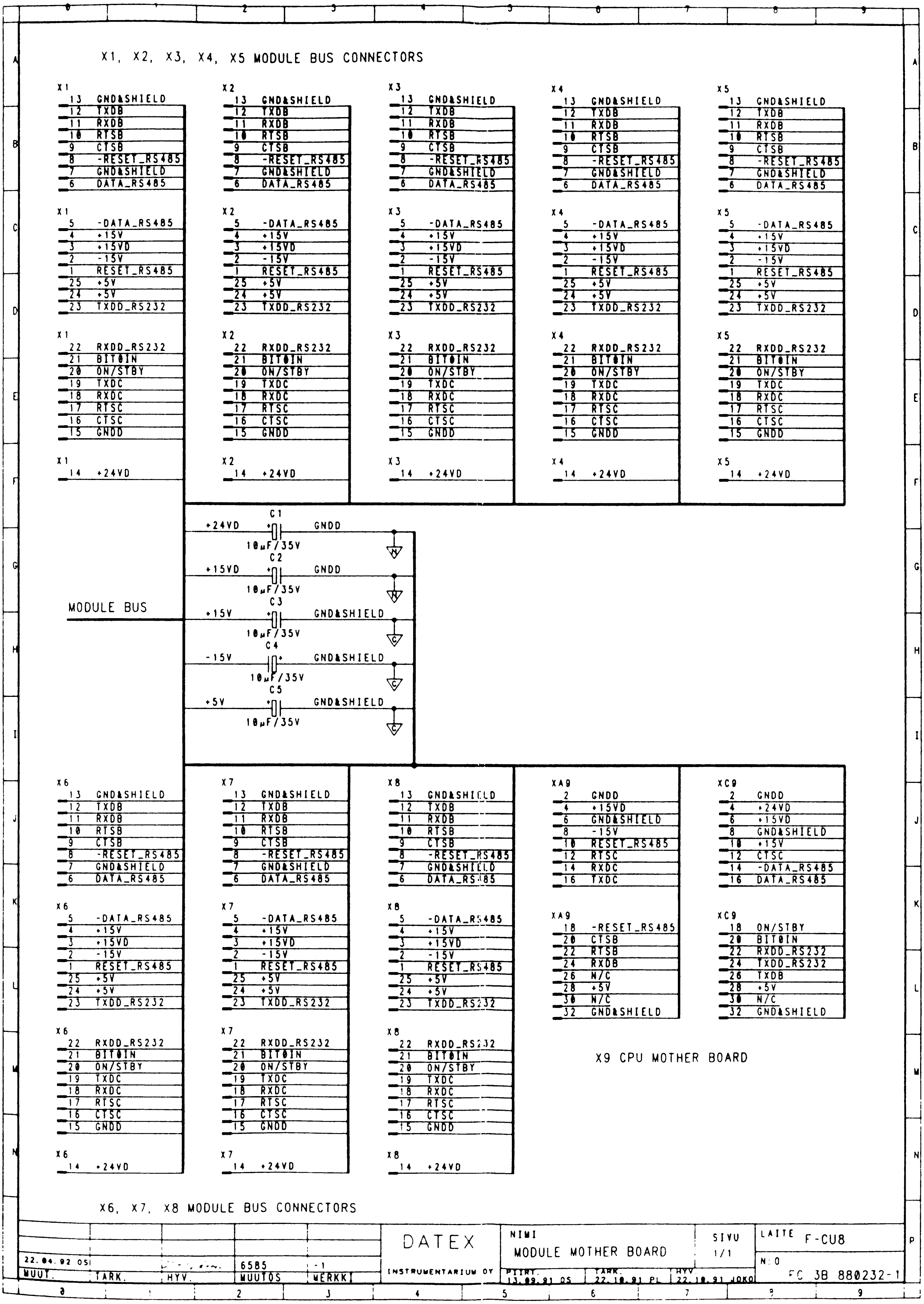
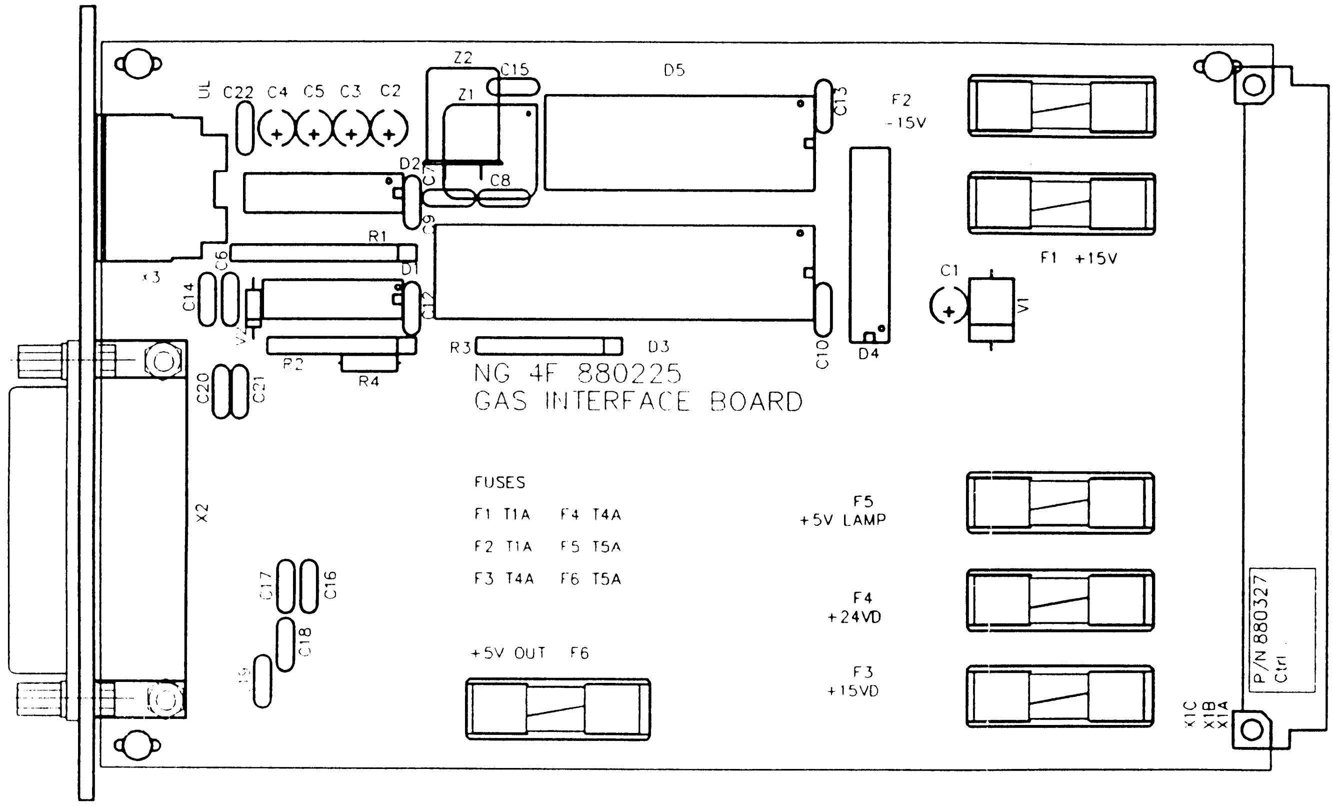
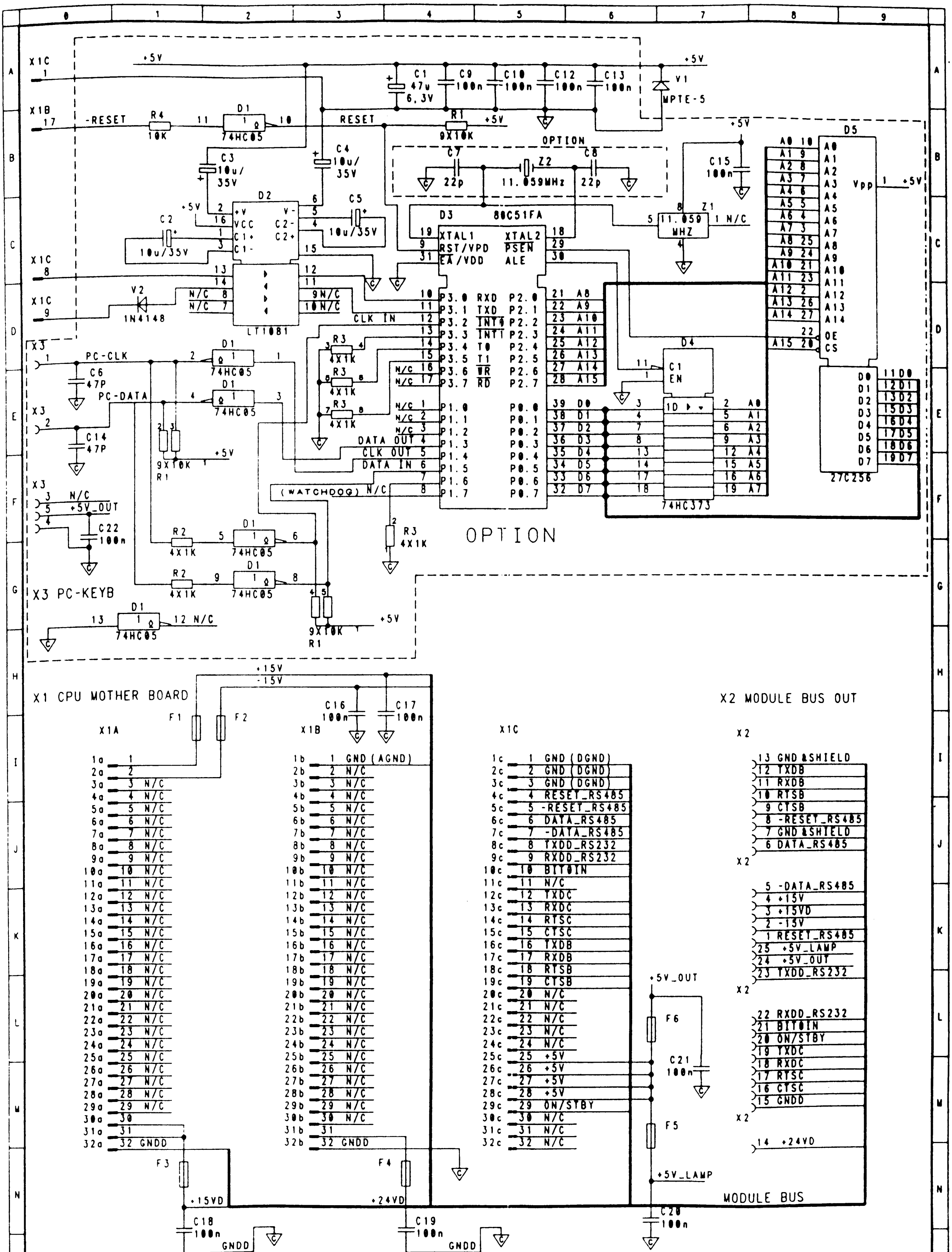

X1, X2, X3, X4, X5 MODULE BUS CONNECTORS
X1
13 GND&SHIELD
12 TXDB
11 RXDB
10 RTSB
9 CTSB
8 -RESET_RS485
7 GND&SHIELD
6 DATA_RS485
5 -DATA_RS485
4 +15V
3 +15VD
2 -15V
1 RESET_RS485
25 +5V
24 +5V
23 TXDD_RS232
22 RXDD_RS232
21 BIT0IN
20 ON/STBY
19 TXDC
18 RXDC
17 RTSC
16 CTSC
15 GNDD
14 +24VD
X2
X3
X4
X5
MODULE BUS
C1
+24VD
GNDD
10µF/35V
C2
+15VD
GNDD
10µF/35V
C3
+15V
GND&SHIELD
10µF/35V
C4
-15V
GND&SHIELD
10µF/35V
C5
+5V
GND&SHIELD
10µF/35V
X6
X7
X8
XA9
2 GNDD
4 +15VD
6 GND&SHIELD
8 -15V
10 RESET_RS485
12 RTSC
14 RXDC
16 TXDC
18 -RESET_RS485
20 CTSB
22 RTSB
24 RXDB
26 N/C
28 +5V
30 N/C
32 GND&SHIELD
XC9
2 GNDD
4 +24VD
6 +15VD
8 GND&SHIELD
10 +15V
12 CTSC
14 -DATA_RS485
16 DATA_RS485
18 ON/STBY
20 BIT0IN
22 RXDD_RS232
24 TXDD_RS232
26 TXDB
28 +5V
30 N/C
32 GND&SHIELD
X9 CPU MOTHER BOARD
X6, X7, X8 MODULE BUS CONNECTORS
DATEX
INSTRUMENTARIUM OY
NIMI
MODULE MOTHER BOARD
SIVU
1/1
LAITE
F-CU8
N:0
FC 3B 880232-1
22.04.92 OSI
6585
-1
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT. 13.09.91 OS
TARK. 22.10.91 PL
HYV. 22.10.91 JOKO

Figure 27 Gas Interface Board Parts Layout and Schematic Diagram





DATEX

INSTRUMENTARIUM OY

NIMI: GAS INTERFACE BOARD

SIVU: 1/1

LAITE: B-GAS

N:O: NG 3B 880226-1

14.04.92 OS		21.4.92 RP.	6585	-1
MUUT.	TARK.	HYV.	MUUTOS	MERKKI

PIIRT. 12.08.91 OS | TARK. | HYV. 21.10.91 RPI

8 SPECIFICATIONS

DIMENSIONS

Central Unit

Depth	382 mm	(15.0 in)
Width	315 mm	(12.4 in)
Height	128 mm	(5.0 in)
Weight	9.5 kg	(21 lbs)

Video Display, D-VHC14

Depth	430 mm	(16.9 in)
Width	358 mm	(14.1 in)
Height	330 mm	(13.0 in)
Weight	16.5 kg	(37 lbs)

Command Board, K-VHC14

Weight	1.44 kg	(3.2 lbs)

ELECTRICAL REQUIREMENTS

Nominal voltage

100, 110-120, 220-230, 230-240 VAC 50/60 Hz

Stability

10 % of nominal voltage

Power consumption

250 VA

Grounding

Hospital grade

Interruptibility

Data memory and alarm settings are saved during power failures up to 15 minutes

9 EARLIER REVISIONS

TABLE OF CONTENTS PAGE

LIST OF FIGURES | PAGE

1 SECTION INTRODUCTION

This service manual section provides information required to maintain and repair the Datex AS/3™ Anaesthesia Monitor Command Board module, K-VHC14. The information is applicable for the current production revision of the modules. Differences between module revisions are summarized in Chapter 7.

K-VHC14-xx-01 is the initial production revision of the Command Board.

2 DETAILED DESCRIPTION OF MODULE

2.1 Command Board PC Board

In general

The Command board PC board is located inside the Command board of AS/3™ Anaesthesia Monitor. The board reads the status of the front panel keys and the ComWheel on the front panel and forwards the information to the CPU board in RS232 serial communication.

An alpha-numeric keypad can also be connected to the board with PC's access format.

Additionally, the board's own CPU controls the LEDs on the front panel.

External communication

Communication with the host processor takes place in RS232 serial communication channel D which is available both in AS/3™ Anaesthesia Monitor bus and module bus. Two signals, TXD and RXD, are in use. There is no handshaking. Beside serial communication, supply voltage of the keypad (+5 V) and -ON/STBY-signal exist in keyboard connector X1.

26-pin subminiature D-connector of the Command board is connected to Display board in the Central Unit.

CPU

The CPU on the Command board pc board is the type 80C51FA and its PCA outputs (programmable counter array) are used for the internal watch dog.

Another reason for using FA-type CPU is the largeness of its internal RAM (256 bytes).

There is a power-up-reset (C6) whose time constant is about 1 second.

The oscillator's frequency is 11.059 MHz.

Program memory

Program memory's (D5, EPROM) size is 32 k x 8 bits. Address lines A0 to A7 are read from data bus in D4 at ALE clock.

Serial communication

RS232 serial communication IC (D2) needs only +5 V supply voltage because it chops necessary RS-level supply voltages to its external capacitors. Diode V3 allows to use two keyboards because there is a pull-down resistor in the corresponding line on the CPU board of AS/3™ Anaesthesia Monitor for pulling to negative RS-level. The speed of the serial communication is 19.2 KBaud.

ComWheel™

The ComWheel™ on the front panel is connected to connector X2. Wheel A and Wheel B signals indicate direction of rotation and number of stops (positions). Wheel SW is short-circuited to ground when the ComWheel™ is pushed in.

Alpha-numeric keyboard

An alpha-numeric keyboard connection (X5) is according to PC's access format. Both data and clock lines are bidirectional. IC D7 is an open-collector type inverter.

Front panel keys

Front panel keys on the front panel are read by ICs D6 and D9.

It is possible to connect 20 keys (4 x 5 matrix) to connector X4.

Key push processing

IC D9 is an analog multiplexer, which connects +5 V to one X-line at a time. The X-line to be connected to +5 V is chosen by three control bits (d5, d6, and d7) which come on data bus through IC D8.

After +5 V is connected to an X-line, IC D6 reads all the Y-lines' status one at a time. IC D6 is a digital selector. The Y-line to be read is chosen by control lines A, B, and C which are connected straight to the ports in the CPU. Signal Yin1 indicates the status of the Y-line to the CPU. A key push connects X- and Y-lines together and the Y-line goes high. Otherwise Y-lines are low due to ground connection via resistor R8.

After all the Y-lines are read, +5 V is switched to the next X-line.

Series resistors R4, R5, R12, and R13 protect the ICs D6 and D9.

LEDs

The LEDs on the front panel are soldered on the soldering side of the Command board pc board. The CPU on the board drives the warning LEDs V4 and V5 through the IC D8 under the commands received via serial communication. LED V6 is lit when +5 V exists, that is, when the device is ON. LED V7 is lit when the device is at Stand-by and there is about 7 V voltage in the line. -ON/STBY signal passes through the board to standby connector X6 where it is short-circuited to ground when switched ON.

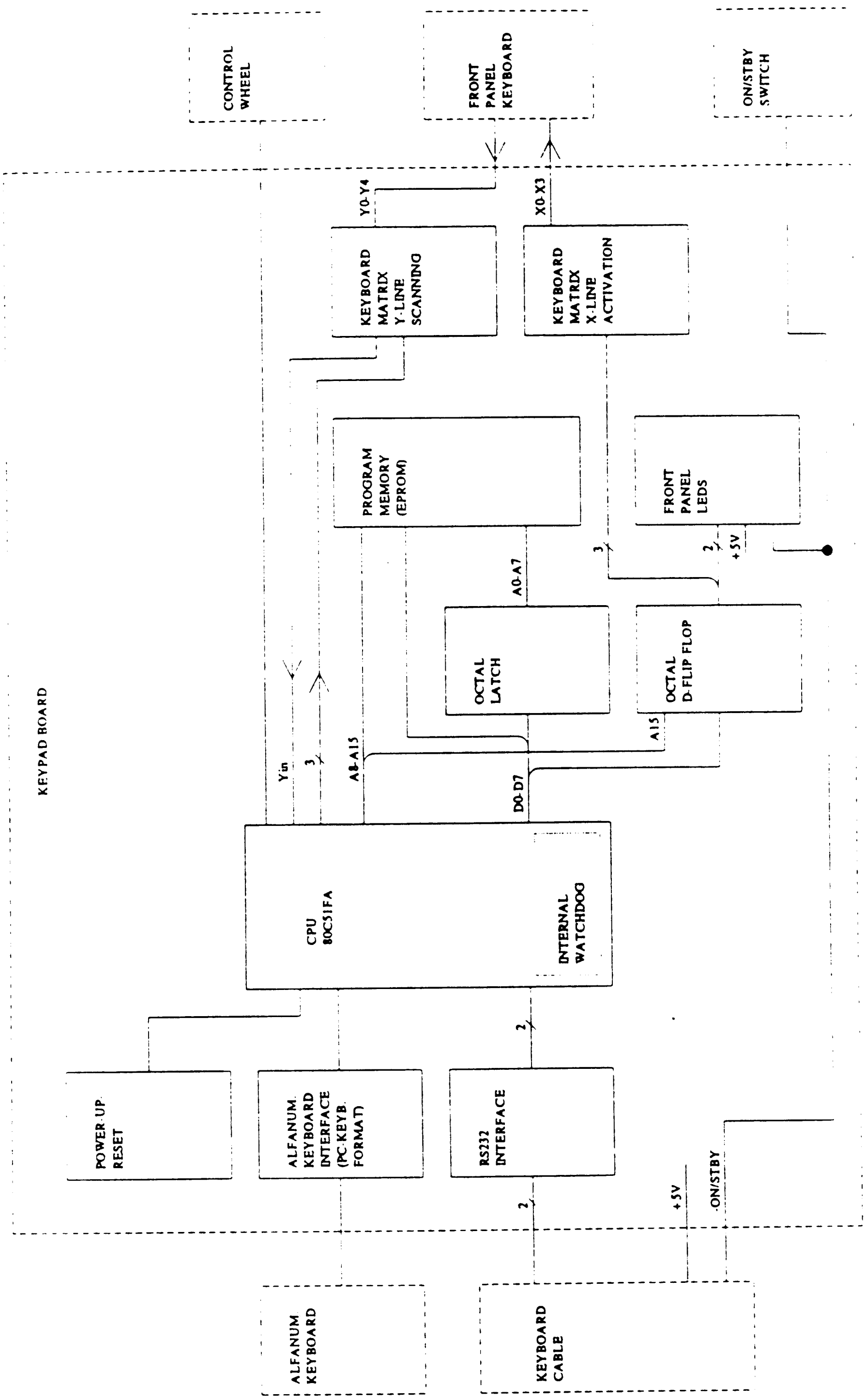


Figure 1 General Block Diagram

2.2 External Connector Configuration

Command board 26-pin male D-connector

Pin No	I/O	Signal	Notes
1	I	RED VIDEO2	
2	I	GREEN VIDEO2	
3	I	BLUE VIDEO2	
4	I	BLANK	
5	I	DCLK	
6		GND	
7	I	DTMG	
8	I	HSYNC2	
9	I	VSYNC2	
10		RED GND	
11		GREEN GND	
12		BLUE GND	
13		N.C.	
14		DCLK GND	
15	I	+5 V	
16	O	ON/STBY	
17	I	DIRTY GND	
18	I	DIRTY GND	
19	O	RXDD RS232	
20	O	TXDD RS232	
21	O	-DATA RS485	
22	O	DATA RS485	
23	O	-RESET RS485	
24	O	RESET RS485	
25	I	+24 VD	
26	I	+24 VD	

3 SERVICE AND TROUBLESHOOTING

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 Disassembly and Reassembly

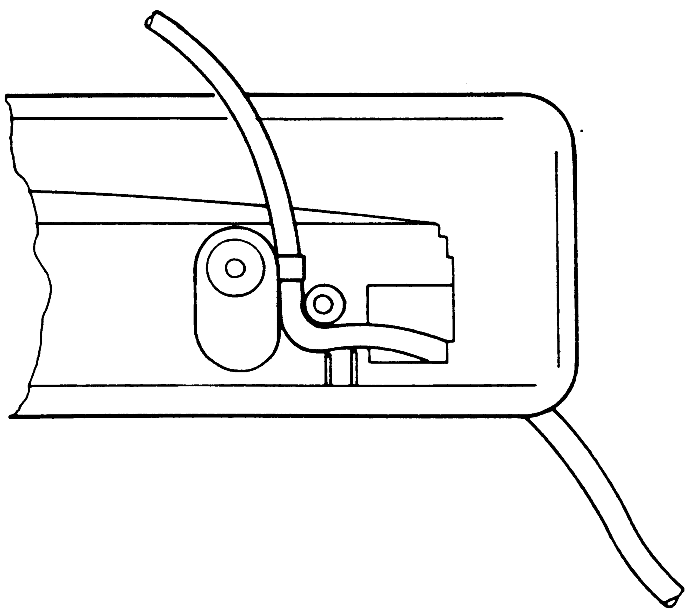
The Command board module is disassembled in the following way. See Figure 2 for the exploded view of the module:

a) Remove the two screws from the back of the module and detach it from display screen tray.

b) Remove the two screws at the bottom of two deep hole. The back cover of the Command board module is detached.

The Command board PC board is attached to the front panel by two hooks.

When putting the front and rear panels together, attach first their lower ends. Pushing keypad ribbon cable inside with a thumb and, making sure that the Command board cable is squeezed into the gap between cylindrical protrudes in the rear panel, close the panels as you close a book. Make sure that the Command board cable is not pinched between the panels. See the illustration below.



3.3 Troubleshooting Chart

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. IC D2 faulty on Command board PC board. RS232 communication failure on CPU board.	Check the items. Replace them if necessary.

3.4 Preventive Maintenance Check List

We recommend that you perform these checks after any service and at least once every six months to keep the Command Board in good condition.

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.

5 SPARE PARTS

5.1 Spare Parts List

NOTE: Accessories are listed in the Operator's Manual.

Item	Item description	Order No.
1	Command board PC board	880310
2	Command board software	880524
3	ON/STBY switch	879871
4	Rotary wheel	879872
5	ComWheel cover and spring	879191
6	Front panel unit	881327
7	Front panel sticker (Eng)	879479
7	Front panel sticker (Ger)	880469
7	Front panel sticker (Fre)	880161
8	Rear panel	879088
9	Cross cylinder head screw M3x12	61736
10	Cross cylinder head screw M3x8	61722
11	Command board cable	880358
12	Taptite screw 2.9 x 6.5	62522
13	Star washer M3.2	63611
14	Display screen tray	879474
15	Display rear plug cover	879475

Item number refers to the exploded view in Figure 2.

4.2 Exploded View of Module

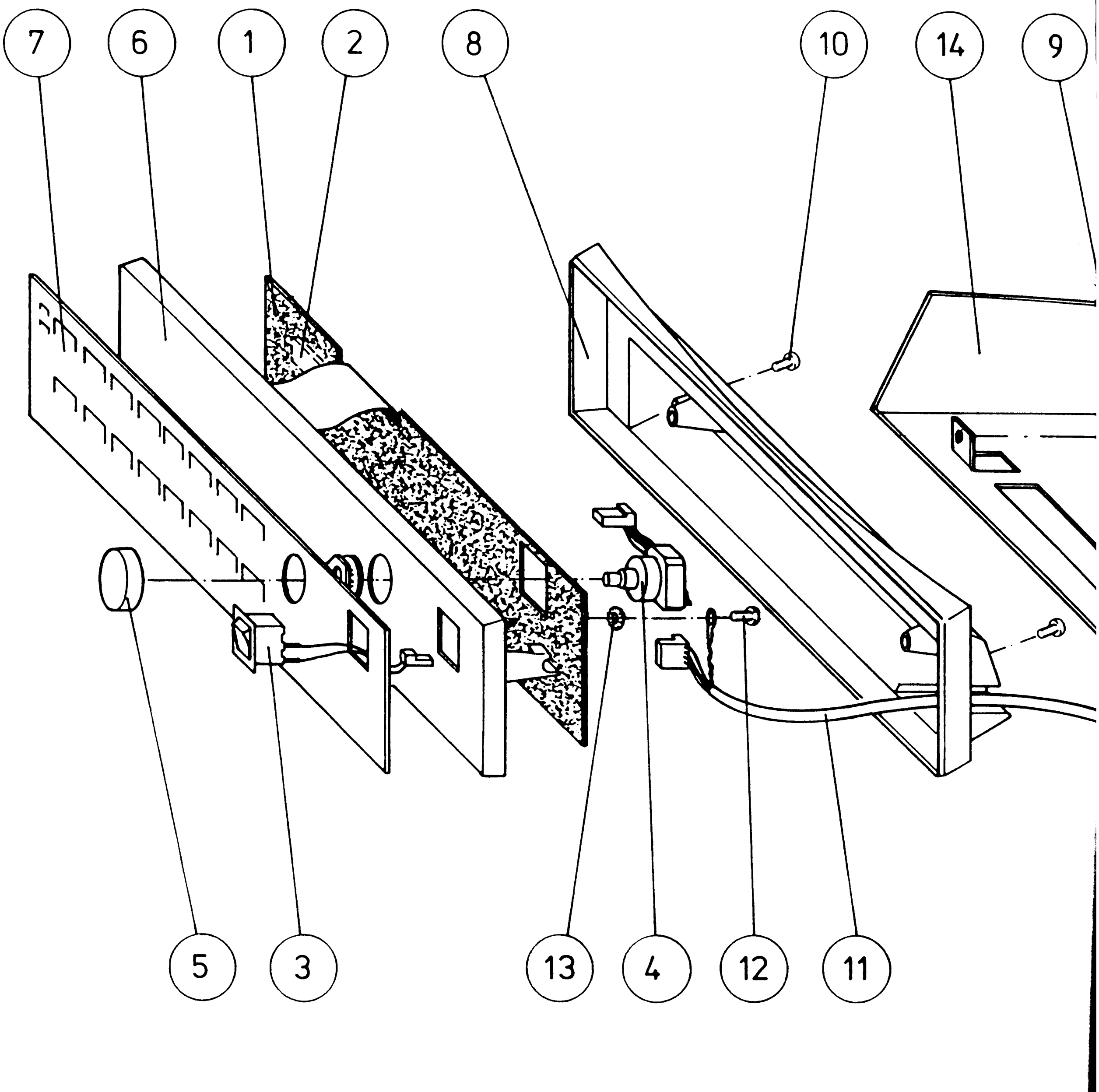
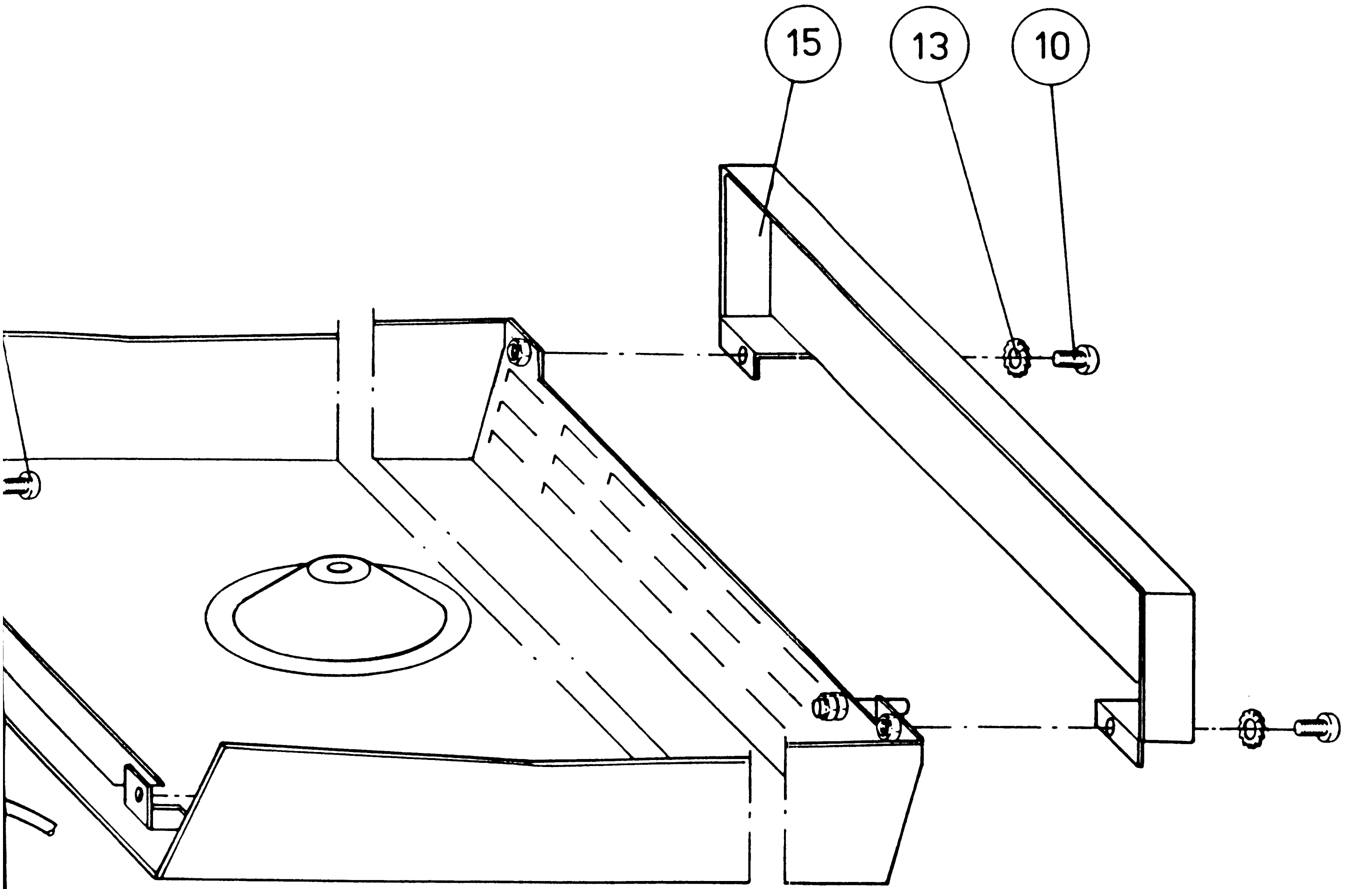
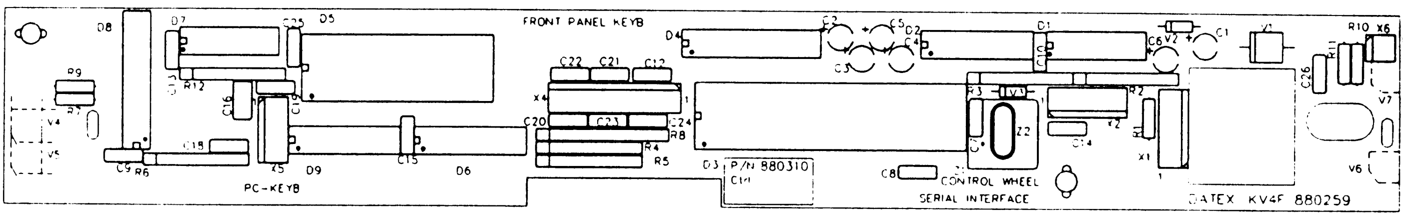


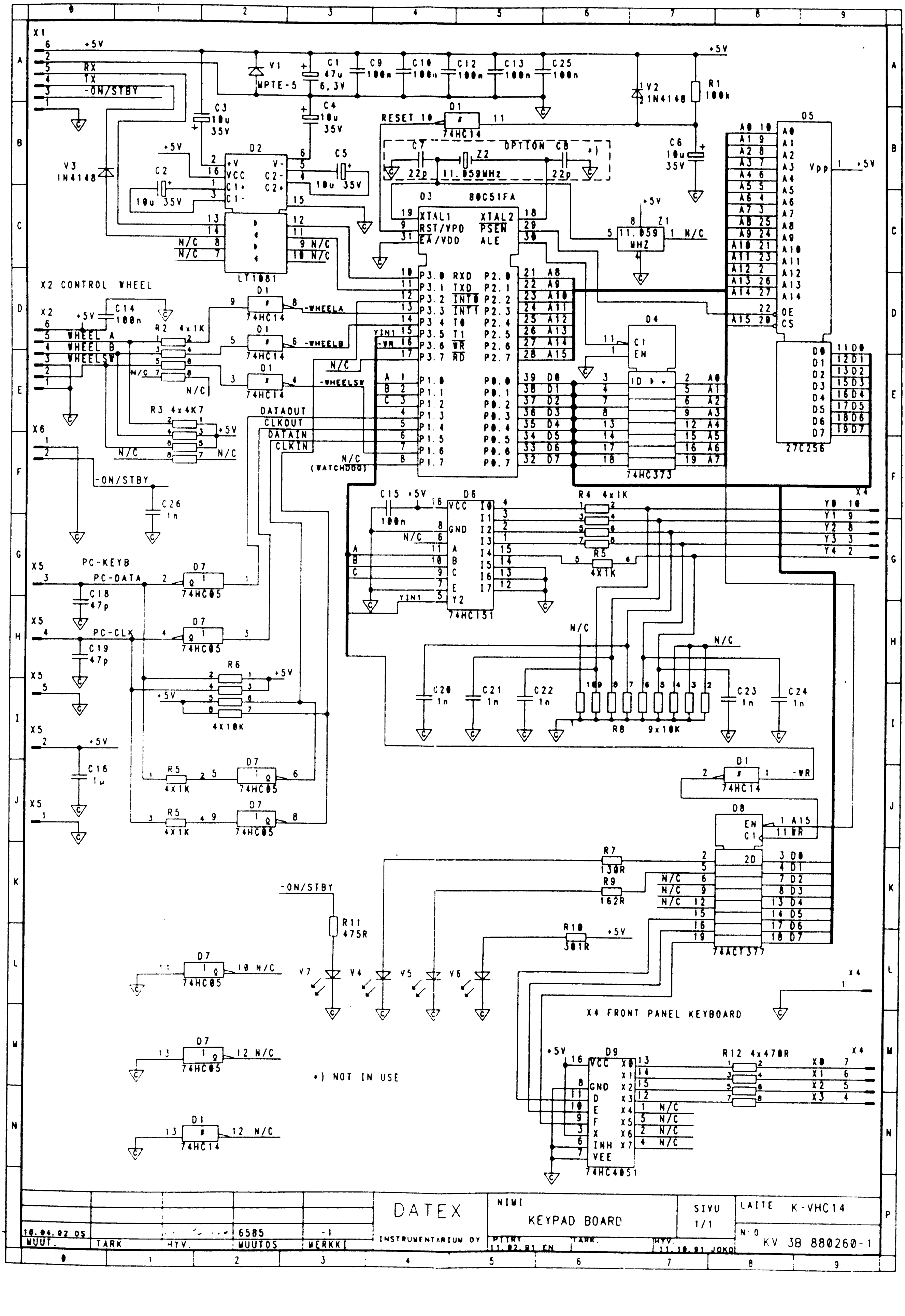
Figure 2 Exploded View of Command Board


15
13
10

5 CIRCUIT DIAGRAM AND PARTS LAYOUT

Figure 3 Keypad Board Parts Layout and Schematic Diagram




X1
X2 CONTROL WHEEL
X4 FRONT PANEL KEYBOARD
PC-KEYB
PC-DATA
PC-CLK
-ON/STBY
RX
TX
WHEEL A
WHEEL B
WHEELSW
-WHEELA
-WHEELB
-WHEELSW
DATAOUT
CLKOUT
DATAIN
CLKIN
(WATCHDOG)
RESET
OPTION
11.059MHz
80C51FA
LT1081
74HC14
74HC05
74HC151
74HC373
74ACT377
74HC4051
27C256
1N4148
MPTE-5
4x1K
4x4K7
4x10K
9x10K
4x470R
*) NOT IN USE
DATEX
INSTRUMENTARIUM OY
NIMI
KEYPAD BOARD
SIVU
1/1
LAITE
K-VHC14
NO
KV 3B 880260-1
10.04.92 OS
6585
-1
MUUT.
TARK
HYV.
MUUTOS
MERKKI
PIIRT
11.02.91 EN
TARK.
HYV.
11.10.91 JOKO

6 EARLIER REVISIONS

ESTP Module, M-ESTP

ETP Module, M-ETP

Presure Module, M-P

TABLE OF CONTENTS PAGE

LIST OF FIGURES PAGE

1 SECTION INTRODUCTION

This service manual section provides information required to maintain and repair the Datex AS/3™ Anaesthesia Monitor ESTP Module, M-ESTP, ETP Module, M-ETP, and Pressure Module, M-P. The information is applicable for the current production revision of the modules. Differences between module revisions are summarized in Chapter 8.

The modules and their measuring parameters are described below.

M-ESTP Double-width module including 3-channel ECG with ST-segment analysis, SpO_2, 2 x temperature, 2 x invasive blood pressure measurements.

M-ETP Double-width module including 3-channel ECG with ST-segment analysis, 2 x temperature, 2 x invasive blood pressure measurements.

M-P Single-width module including one invasive blood pressure measurement.

M-ESTP/ETP/P-xx-01 are the initial production revisions of the modules.

2 PRINCIPLE OF OPERATION

2.1 Principle of ECG Measurement

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

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

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

2.2 Principle of SpO_2 Measurement

SpO_2

Oxygen is the most acutely necessary substrate for survival. A major concern during and after anesthesia is prevention of tissue hypoxia. Pulse Oximetry provides immediate and direct information on tissue oxygenation and, therefore, it is at present seen as a prerequisite of patient safety in anesthesia departments.

Most of oxygen needed by the body is transported bound to hemoglobin. The total hemoglobin of blood is composed of oxygenated oxyhemoglobin (HbO_2), reduced or deoxygenated hemoglobin (Hb), and other forms of hemoglobin such as carboxyhemoglobin (HbCO) and methemoglobin (MetHb).

The absorption of light of normal human blood at different wavelengths is mainly determined by HbO_2 and Hb (see Figure 1). A Pulse Oximeter measures the relative absorption of light 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.

The total relative absorption of blood can be divided into components of tissue, venous blood, arterial blood, and the pulse added volume of arterial blood. See Figure 2.

In order to focus the measurement on the arterial blood and thus 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. In fact, this invention was most essential for Pulse Oxymetry and eventually made feasible the measurement of oxygen saturation noninvasively.

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 Oxymeters 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™ Anaesthesia Monitor 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 Oxymetry is not able to correctly measure oxygen content of the arterial blood at elevated carboxyhemoglobin or methemoglobin levels, which clinically may be harmful for patient.

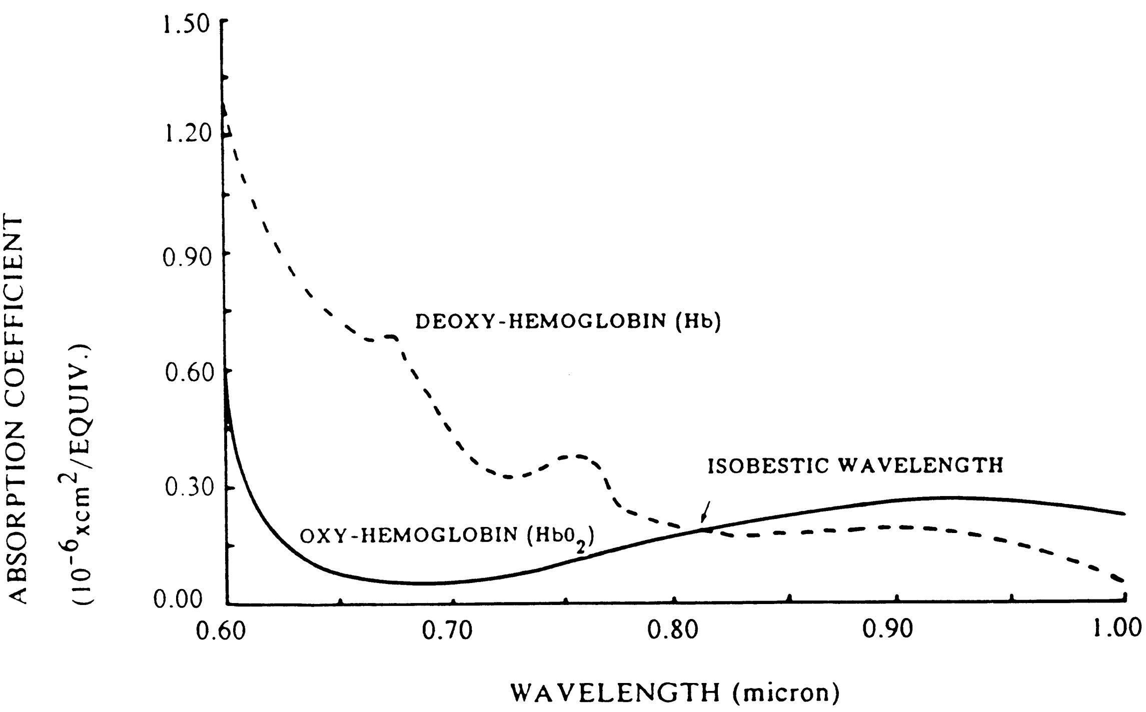


Figure 1 **Absorption Coefficients of Oxy- and Deoxy-Hemoglobin in the Red and Near-Infrared Regions**

Plethysmographic pulse wave

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

Pulse rate

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

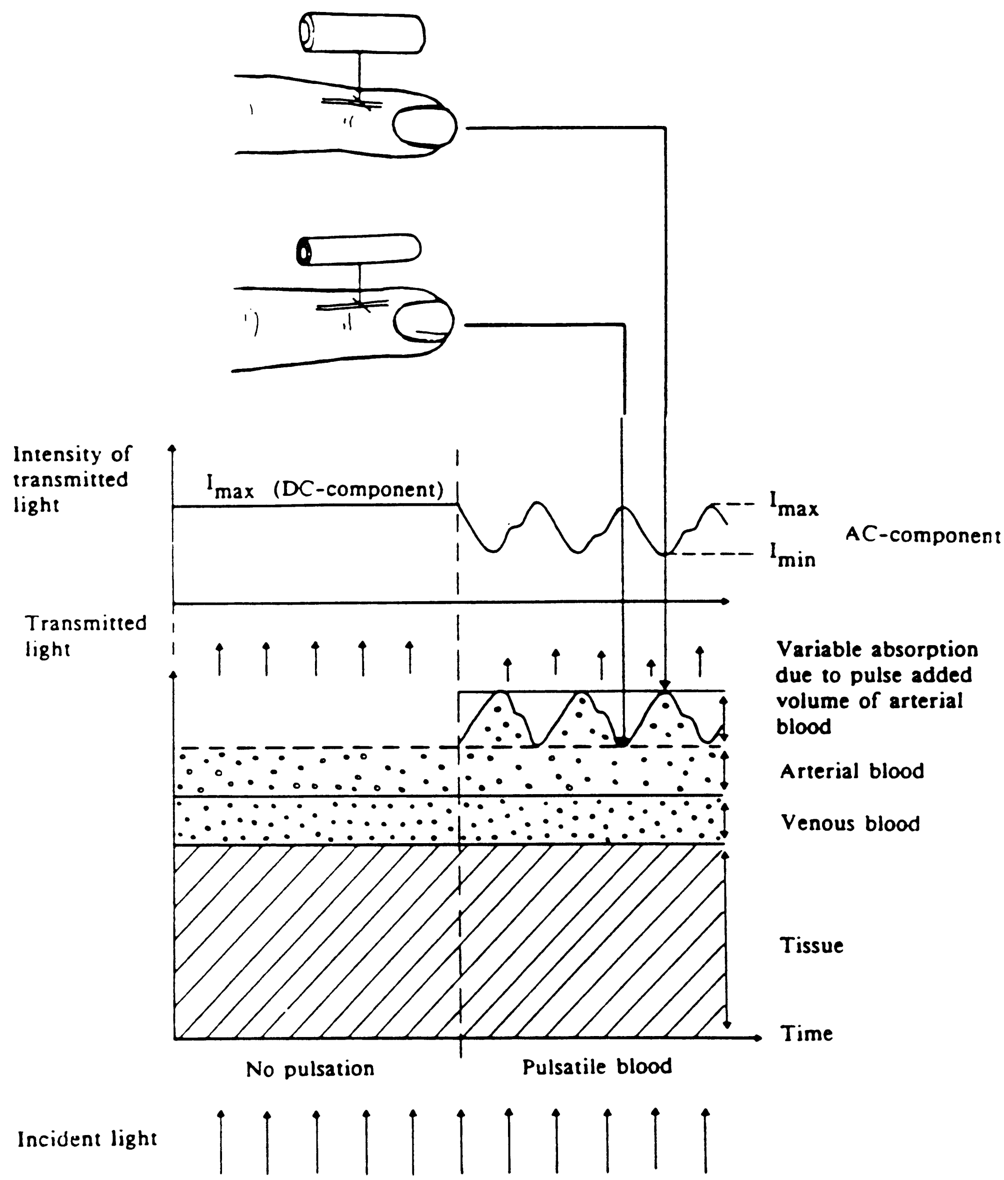


Figure 2 Absorption of Infrared Light in the Finger

Probe

The standard probe is a finger clamp probe which measures through the finger (see Figure 3) and contains the light source LEDs in one half and the photodiode detector in the other half. Different kinds of probe are also available from Datex.

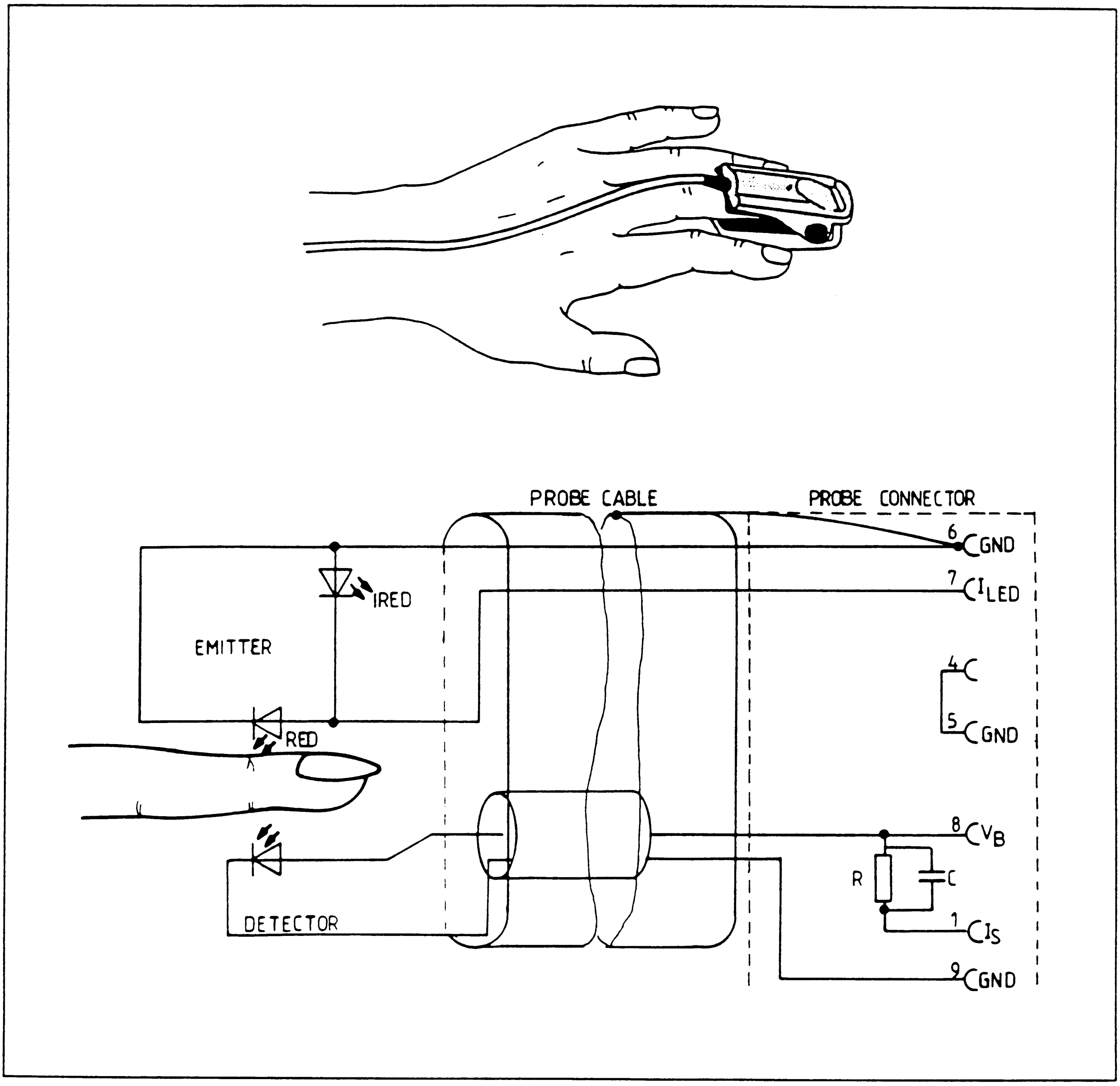


Figure 3 **Cliplite™ Probe Parts Layout and Schematic Diagram**

2.3 Principle of Temperature Measurement

The temperature measurement is based on a component (probe) whose resistance varies when temperature changes. When the temperature goes up, the resistance goes down. This component is called a Negative Temperature Coefficient Resistor, or NTC-resistor. A patient's temperature can be measured by placing the probe on the patient's skin and measuring the resistance of the probe.

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.

   The resistance of the probe can be calculated in both cases by dividing the voltage by the current (Ohm's law).

In AS/3™ Anaesthesia Monitor 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. In this case a temperature dependant voltage can be detected at the junction of the resistors. This is actually the temperature signal from the patient. The signal is amplified by analog amplifiers and further processed by digital electronics and shown in the display in Centigrade or Fahrenheit.

2.4 Principle of 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 after a small amount of blood is allowed to flow out of the catheter to eliminate bubbles. In addition, the connecting tubing and transducer has been flushed and filled with saline to permit a fluid connection from the vessel to the transducer.

The transducer is placed level with the heart. Next, the transducer is electrically zeroed. The stopcock is set so that no pressure is applied to the transducer and the monitor compensates for any signal produced by the transducer, producing a true base line.

If a second calibration point is desired, the bag of saline is inserted into a pressure cuff with a gauge. The cuff is inflated to create a known pressure and the transducer is calibrated by the monitor.

After the transducer has been zeroed (and if desired, calibrated), the stopcock is switched so that the patient catheter is now connected to the transducer.

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.

3 DETAILED DESCRIPTION OF MODULE

3.1 ESTP, ETP, and P Modules

The ESTP module contains two main PC boards: STP board and ECG board. In addition, there are three small input boards: SP input board, ECG input board, and T input board attached to the front panel.

The front panel has six connectors and four keys. The connectors include two for temperature measurement, two for invasive blood pressure measurement, one for ECG, and one for SpO_2 measurements. The keys are for ECG lead, temp test, P1 zero, and P2 zero.

The STP board and ECG board work independently. Each has its own processor and software EPROM.

The ETP module contains also two main PC boards: STP board and ECG board. In addition, there are two small input boards: ECG input board and T input board attached to the front panel. Components for SpO_2 measurements on the STP board are not used in this module.

The front panel has five connectors and four keys. The connectors include two for temperature measurement, two for invasive blood pressure measurement, and one for SpO_2 measurements. The keys are for ECG lead, temp test, P1 zero, and P2 zero.

The single-width P module contains one PC board which is exactly the same STP board in the ESTP or ETP module. Only the components for invasive blood pressure measurement are in use.

The front panel has a P3 connector receptacle for invasive pressure measurement and a key for pressure zeroing (P3).

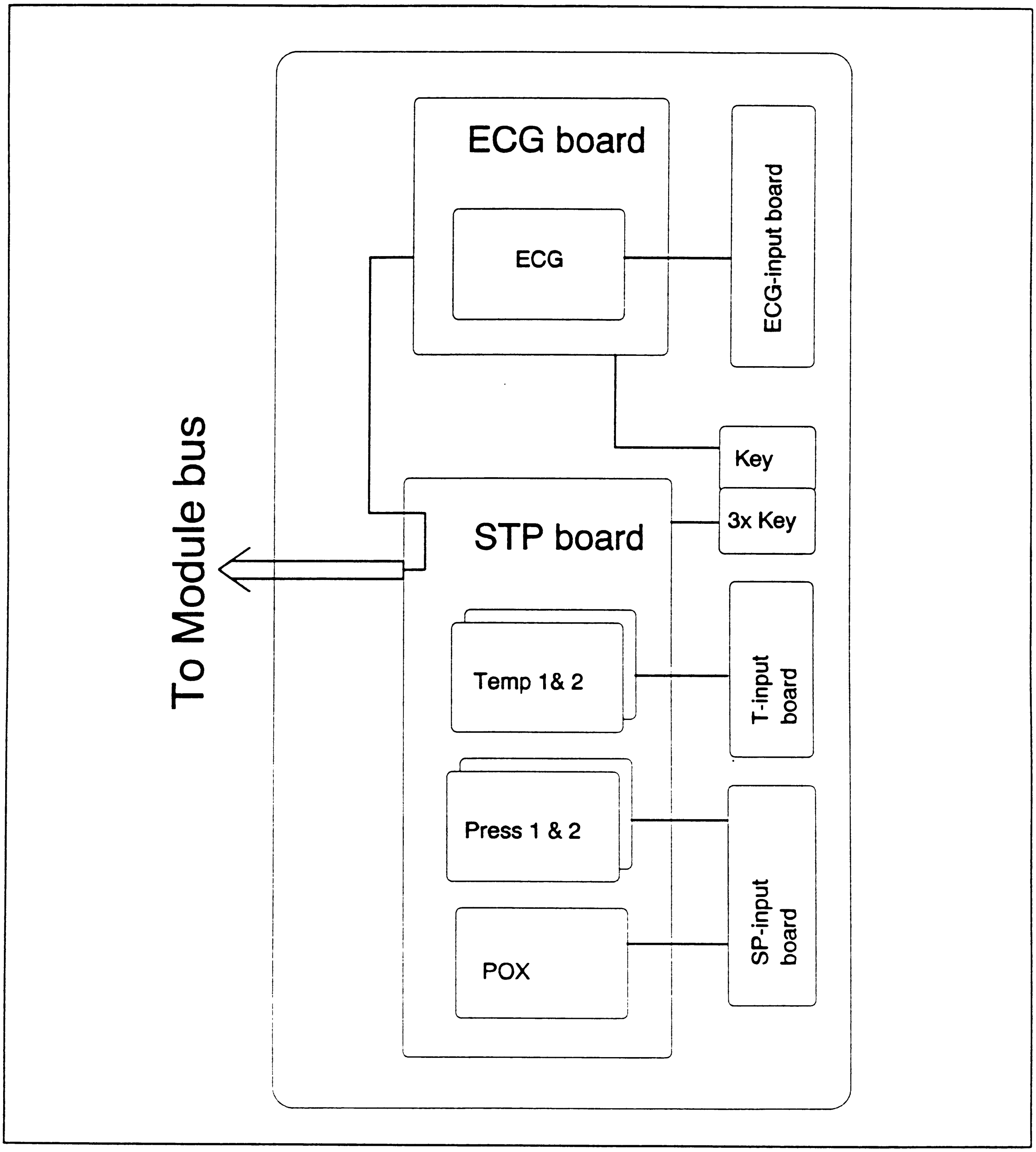


Figure 4 ESTP Module Block Diagram

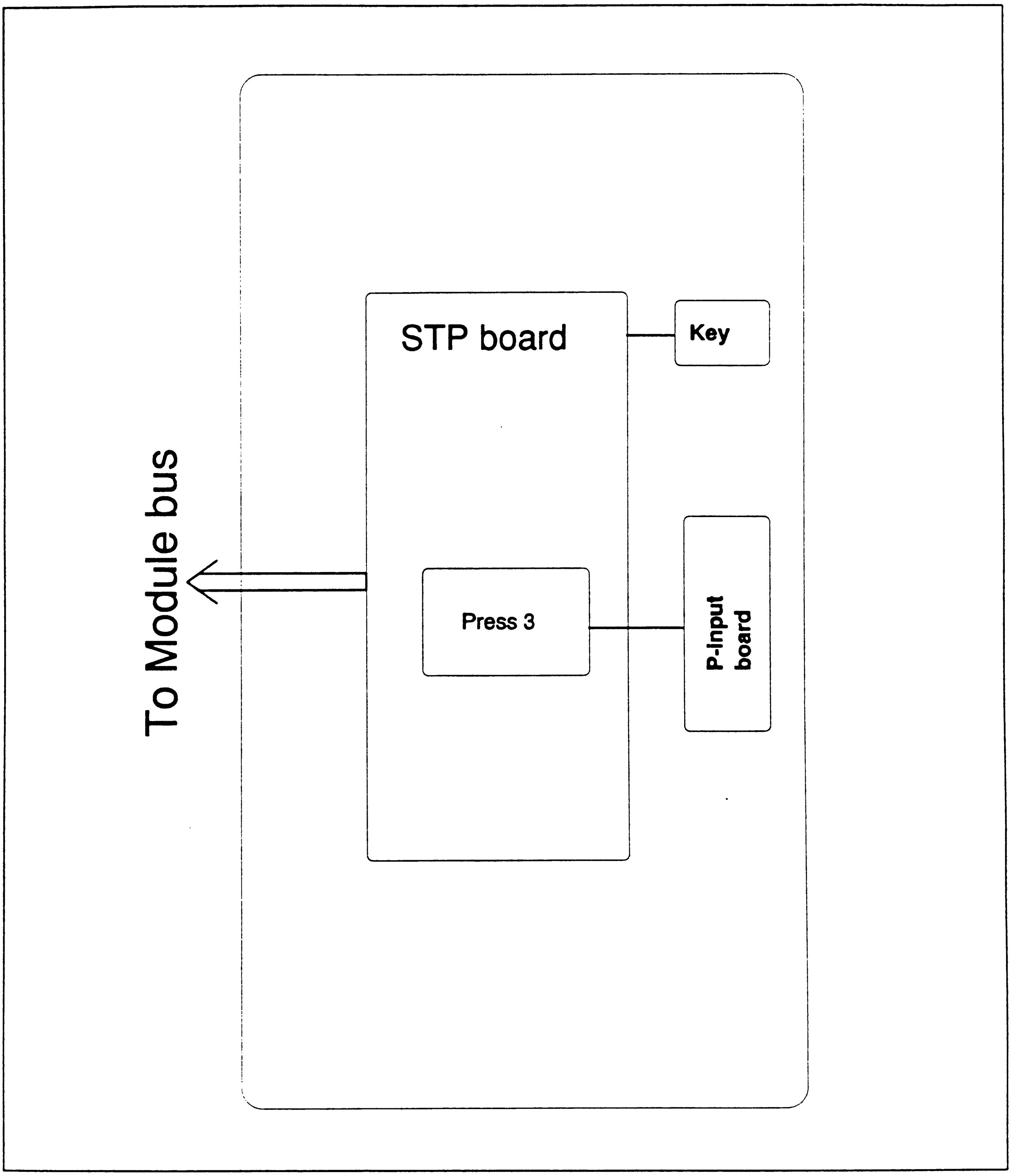


Figure 5 P Module Block Diagram

3.2 STP Board

See the figure below for the STP board block diagram.

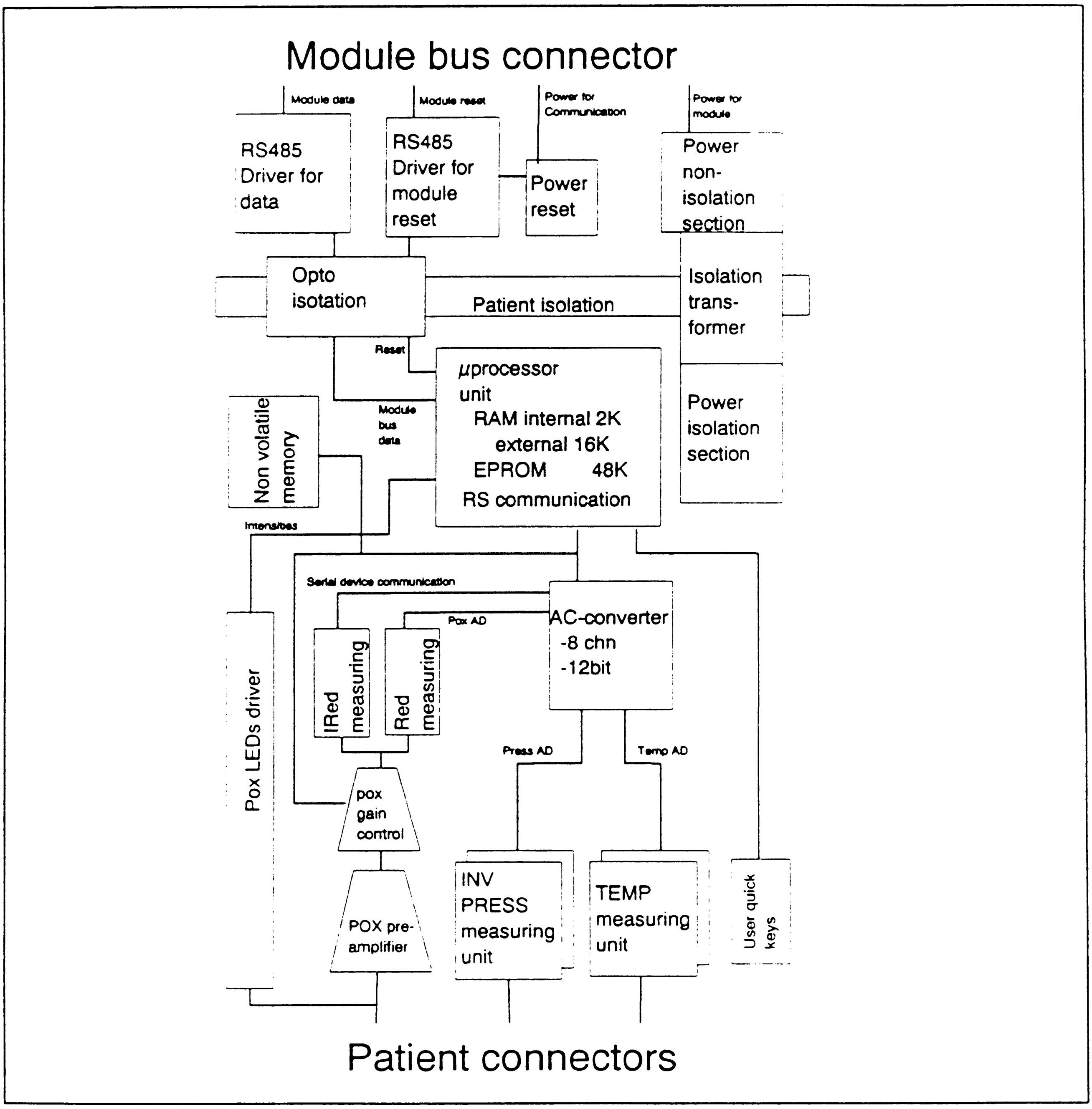


Figure 6 STP Board Block Diagram

Processor section (Circuit diagram page 2)

In general

As the processor, Intel's 80C196KC-16 is used. There are external memories, an 8-bit data bus, a 16 MHz oscillator, a reset open collector, and a watchdog timer. Three A/D-converters within the processor are used. HSO is used for controlling pulse oximetry signals.

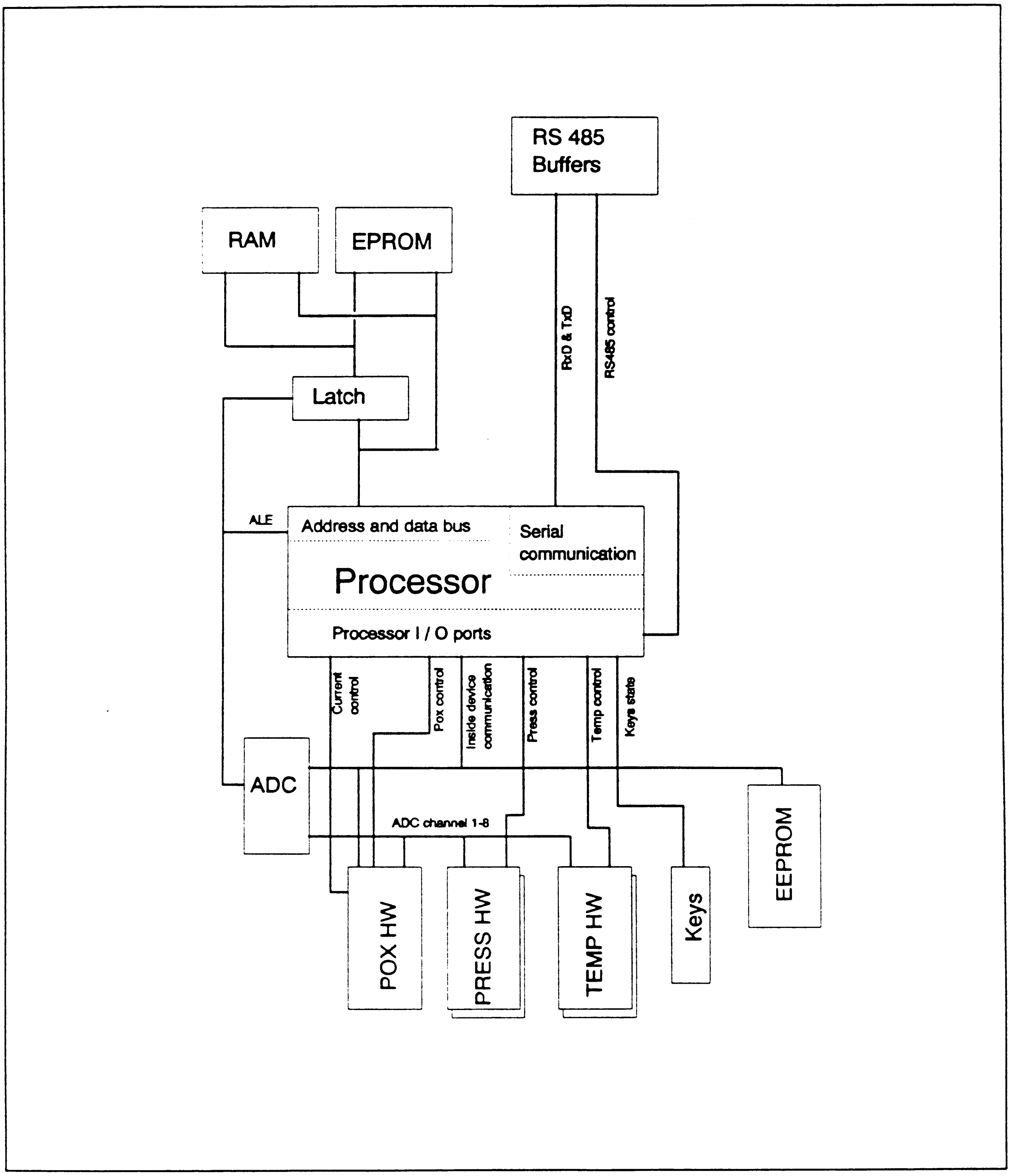


Figure 7 Processor Section Block Diagram

Other functions

The processor's internal UART communicates with the Central unit. Signal at port P1.7 controls the direction of communication in D5 (buffer for RS485 bus).

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

PWM1 and PWM2 control the pulse current for the LED driver.

The rest of the P0, P1, and P2 ports are used as binary ports. P0.4, P0.5, and P0.6 indicate the states of the keys in the module front panel. P2.5 controls the measurement current for pressure transducer. P2.2 and P2.3 indicate the existence of the pressure transducer. HSI0 and HSI1 indicate the existence of the pressure transducer when the current to it is cut off by P2.5. P1.5 and P1.6 control extra gains of pulse oximetry.

Other components:

Z1	Oscillator (DIL-8)
C17 - C21	+5 V buffer capacitors
C22	+5 Vref buffer capacitor
D9	Address latch
RV1	Resistor network 8x10k, prevent the processor from going into Test mode, also used as pull-up resistor for binary inputs
D2A, D2D	Address coding for address lines A14 and A15 (Diagram page 3)
D2B, D2C	Buffers for opto isolators (-"-)
X7, R67	EEPROM overwriting protection
C18	Filter spurious interferences from Reset signal

Temperature measurement section (Circuit diagram page 1)

Value of NTC resister in the probe (depends on patient's temperature) is measured with the following principle (see also T-input board circuit diagram).

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) (A1) whose offset voltage (0.409 V) makes its output spread on both sides of zero. Wider output range (measurement range) means better resolution.

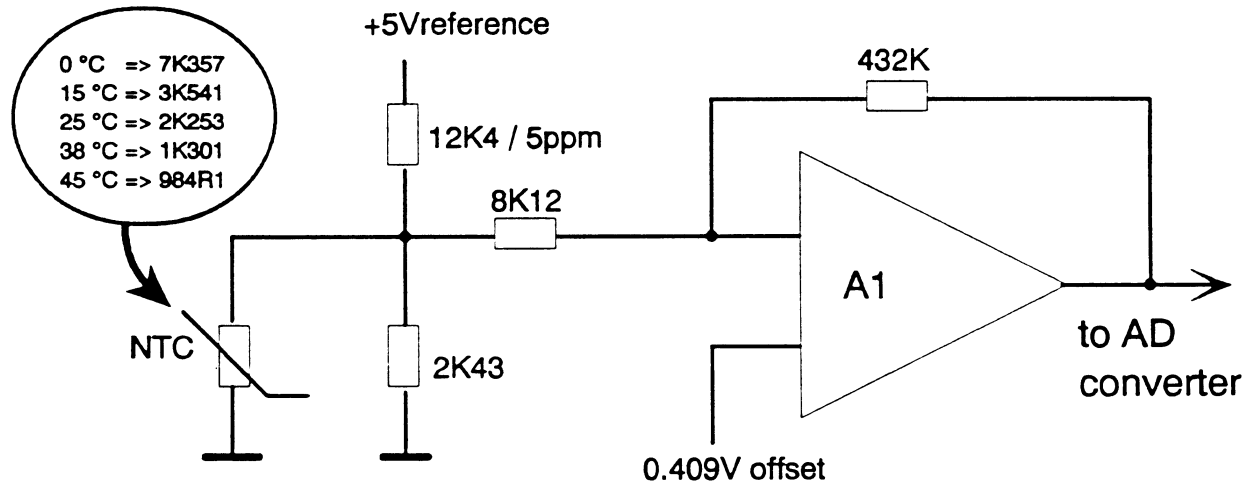


Figure 8 **Temperature Measurement Block Diagram**

The following table shows the relation of temperature, its value in ohm, and other temperature dependent values.

Temp °C	Rtemp ohm	Uamp V (A1 out)	ADC value integrated
15.00	3542	-4.73	-863
25.00	2254	-0.635	-116
27.70	2k00	0.496	90
44.60	1k00	7.08	1320
45.00	984.1	7.36	1345

Components (STP board):

A1	Amplifier (offset = 0.409: gain = -53.08)
R1, R2	Measurement current of probe setting (accuracy 5 ppm resistors)
R1 - R5	Amplification setting
R11, R12	Offset setting for A1
C1, C2, R5	Low pass filter for the measurement
V1	Temperature test relay control activated by keypush

Components (T-input board):

K1	Relay for test temperature displaying
R1 - R4	Test temperature (38.0 °C) setting resistors (accuracy 0.1 %)
C1, C2	Filter capacitors
C3	Filter spurious interference when relay is switched on

Invasive blood pressure measurement section (Circuit diagram page 1)

Isolated +5 V exitation voltage is supplied to the pressure transducer (probe) and from its bridge connection a differential voltage, whose value depends on pressure and supplied voltage, is gained (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 INA101 (DIL-14). 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 probe. There is a filter before the amplifier to attenuate high frequency disturbances (about 23 Hz, 3 dB).

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

Components:

A1, A2 Instrumentation amplifier INA101

R17, C10 - C15
Low pass filter

R13, R15 Amplifier gain adjustment

V3 - V10 Protection from statistic electricity

V11, V12, R14, R16, R19
Probe current cut-off and detection

V13, R19a Pull down TTL signal to suit FET (V11, V12)

R18, R95, R96, C69, C70
Protection and pull-up for probe cable detection

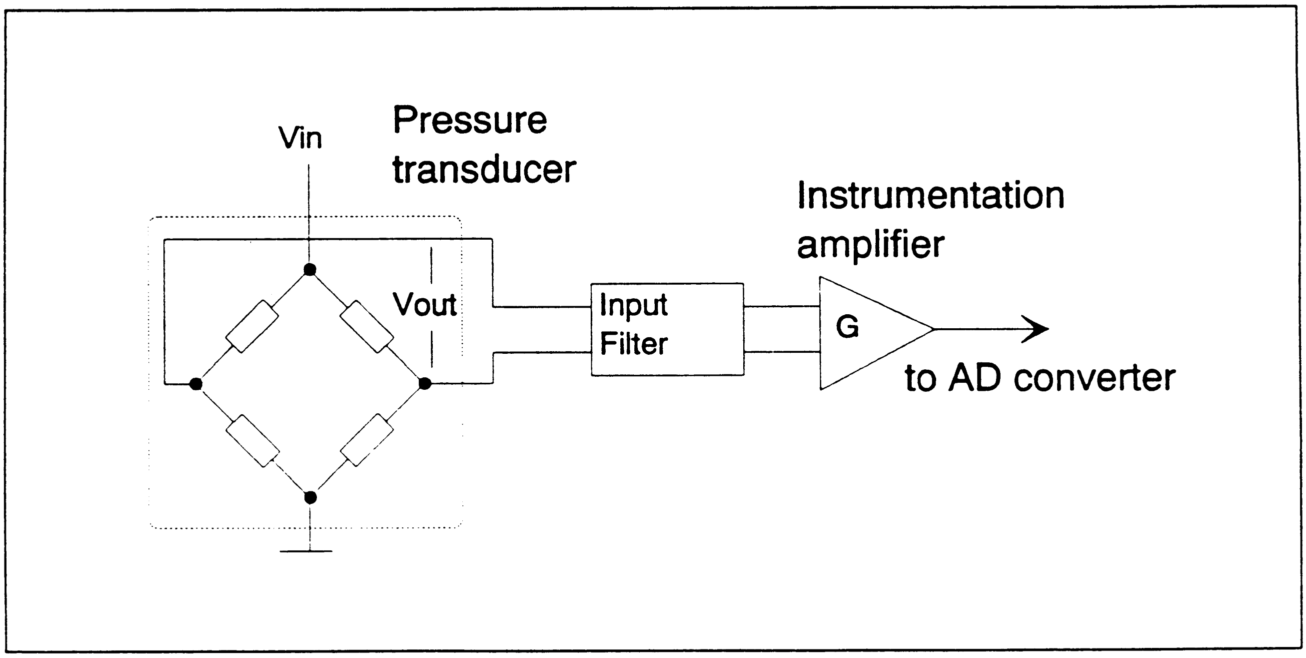


Figure 9 Pressure Transducer Working Principle

Pulse oximetry measurement section (Circuit diagram page 3)

LED control signals

From the processor pulse width modulated signals, one of which includes IRED intensity comes to D1 pin 9 and is changed to DC voltage and filtered by R30 and C24, the other which includes RED intensity comes to D1 pin 16 and is changed to DC voltage and filtered by R35 and C29. With switches D1A and D1B either RED or IRED intensity is sent forward to amplifier in LED driving circuit.

LED driving circuit

Voltage difference over R41 (which corresponds to LED current) is measured by the difference amplifier circuit (A5A, R38, R39, R42, R43) and its output is sent back to the processor through R21 in 0 to 5 V level. Feedback from LED current measurement is connected to amplifier A5B through R40 and feedback from LED intensity control through R56, R32, and C25. R33 and C26 filter interference from the control pulse.

The amplifier A5B controls the LED driving circuit. First a negative pulse comes and V17 conducts, then FET V16 conducts and C28 discharges necessary pulse to the infrared LED.

Correspondingly, the circuit for red LED current consists of V14, V15, R29, and C23. R28 and R36 prevent damage to other components when a short-circuit fault occurs within the LED driving circuit. R29 and R34 are not of same values because amplifications of positive and negative channels' FET are different.

V18 and V19, in addition to LEDs in probe rectify successive positive and negative LED pulses to successive positive pulses.
R70, V21, and C49 are for bias current setting.

Background light is measured by picking up a sample from the signal with D3A to C46. The sample is modified to 0 to 5 V level with R69 and sent to the processor.

Measured signal preamplification

Voltage of -4 V is gained by voltage divider R46 and R48 from -12 V and is fed to non-inverted input of current-to-voltage converter amplifier A6B. Thus inverse bias voltage is generated for probe detection. The switch D3C is normally open. When the switch is closed a multiple (x30) amplification is resulted (necessary in thin tissue measurement such as earlobe).

After the amplifier DC is separated by C33, then inverted and amplified (x2) by A6A, R59, R61, and C40.

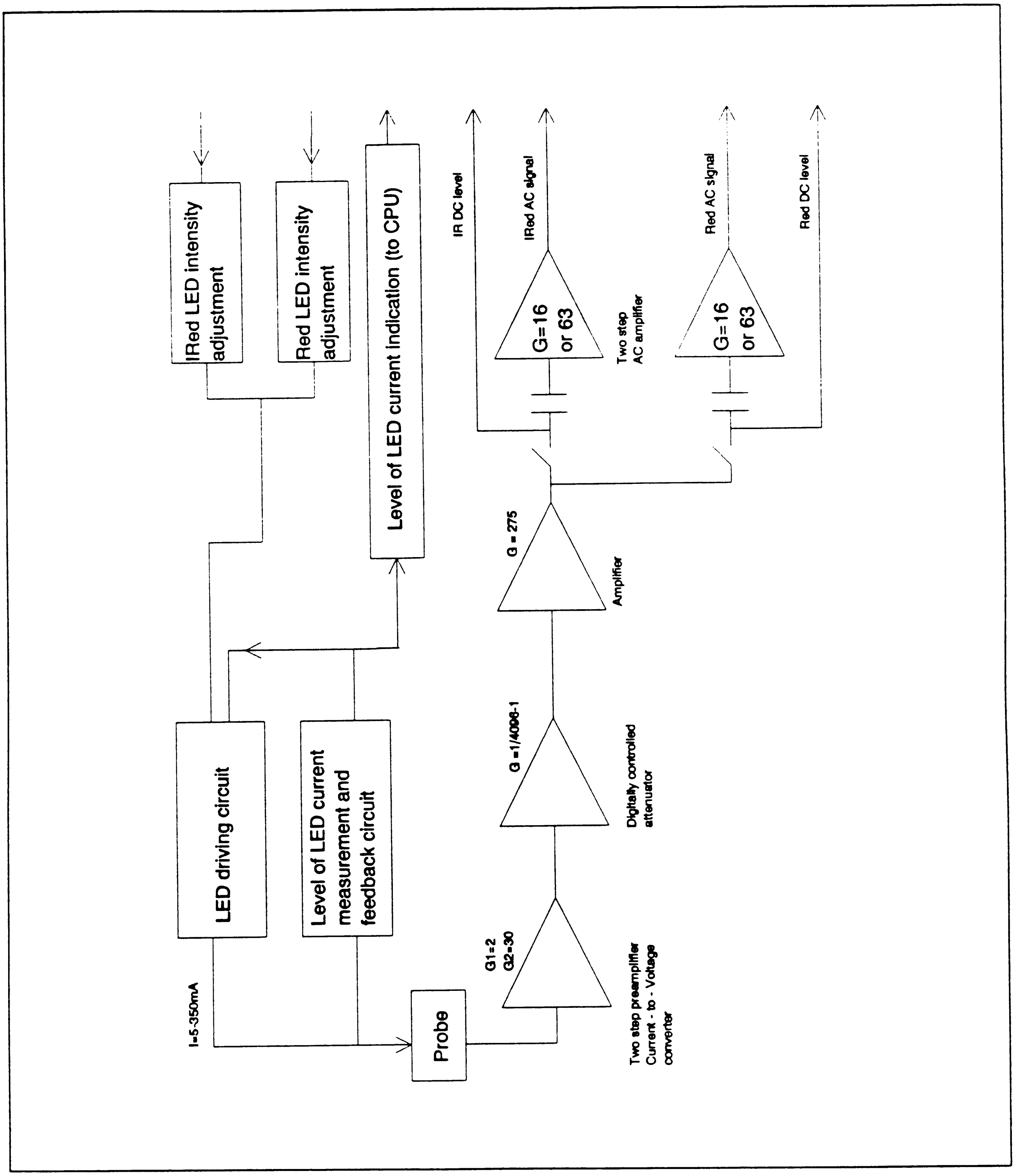


Figure 10 Pulse Oximetry Measurement Block Diagram

Digitally controlled amplifier

D/A converter (D4, A6C) is a digitally controlled amplifier (G = 1/4096 -> 1) after which there is another amplifier A6D, R58, R62 (G = 275).

Red and Infrared channels' separation

Red and infrared channels are separated from each other by the switches D2A and D2C. Operational amplifier A7A functions as a buffer and after this infrared DC signal is sent to the processor. C37 separates AC signal from it and the AC signal is sent to the processor after amplification by A7B. The switch D2B is used to choose the amplification constant (16 or 63).

There is a corresponding circuit for red signal processing.

Serial communication (Circuit diagram page 4)

Serial communication between the module and the Central unit 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 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, R78 and C54, determines the power-up reset time. D15B and D15C prevent the module from sending data during reset.

Data transmission rate is 500 kbit/s.

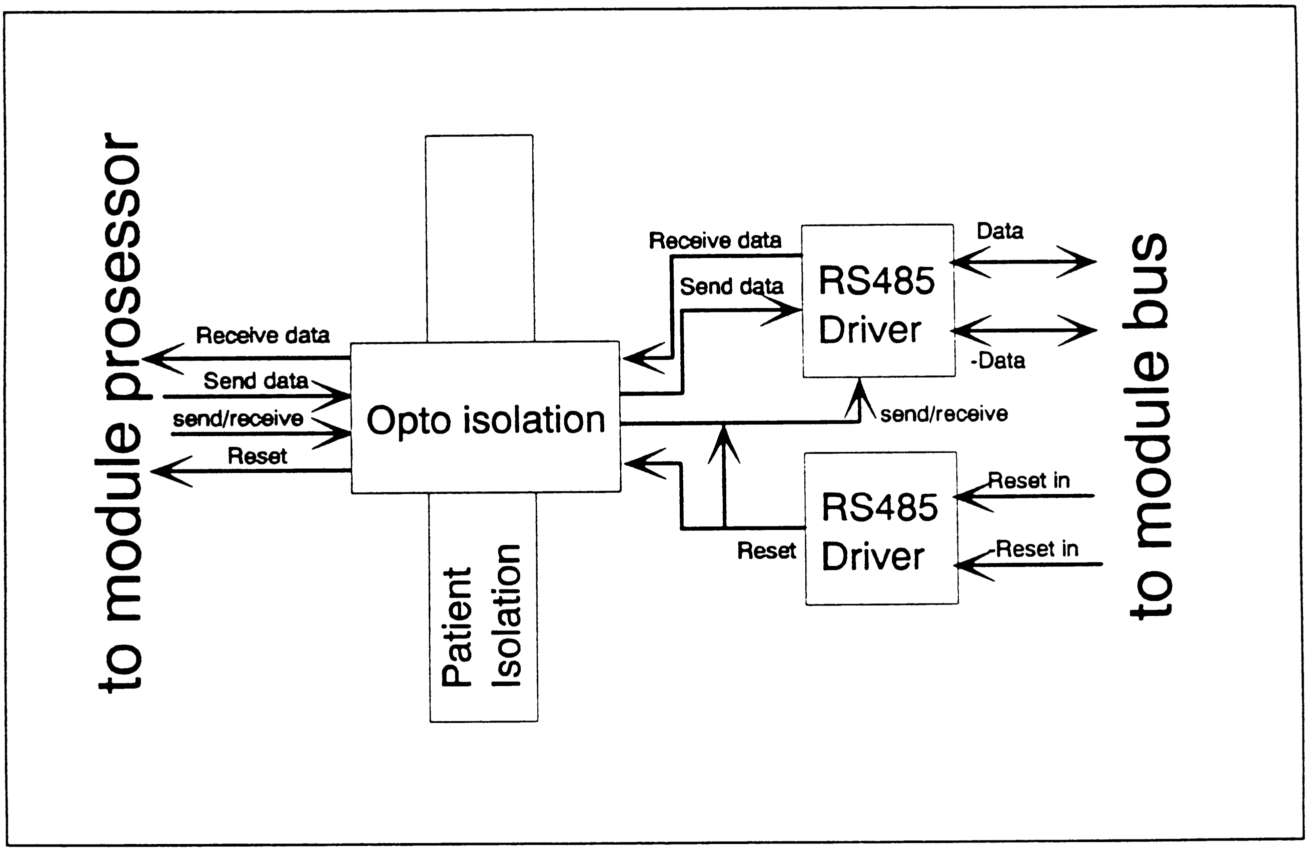


Figure 11 **Serial Communication and Opto Isolation**

Isolated section

V24 and V25 are used as opto isolators.

Signal is processed on logical high-low level even though the output of the opto isolators are analog signal in the isolated section. For this reason the speed of the opto isolators should be fast enough so as to transmit the signal change.

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

Components:

D13, D14	Two-way buffer for the module bus (RS485)
V23, R78, C54	Power reset time constant
D15	Signal adaptation and power reset logic
R79 to R82	Current limiter for opto isolators
R18, R88, R89	Output pull-up resistors of opto isolators
C53, C56	Buffer capacitors

Power supply section (Circuit diagram page 4)

Isolated supply voltage of the module is developed from +15 Vdirty voltage from the Central unit. The module should be switched on independently so ground level is separated from other ground levels.

Power supply is a switched-mode circuit, where FET transistor switch is controlled by an oscillator using bipolar 555 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).

Voltages

Input	+15 Vdirty = +15 V ±0.5 A; 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 2 kV.

Components

C59, L1	Input current filter
D16	Oscillator 555 IC
R85, R87, C67	Oscillator frequency setting: f= 1.44/(R75+R77)xC50; impulse ratio 50 %
R83, R90, V31, V32, V34	Control circuit of half-cycle of transformer input
R84, R90, V28, V33, V36	Control circuit of the other half-cycle of transformer input
T1	Isolation transformer
F1	Overvoltage protector (lightning arrester)
V26, V27, V29, V30, C61	Rectification components for +5 V and +5 Vref
V35, V37, C63	Rectification components for +12 V
V38, V39, C65	Rectification components for -12 V (and -5 V)
A8, C58	+5 Vref regulation
A9, C62	+5 V regulation
A10, C64	+12 V regulation
A11, C66	-12 V regulation
A12, C9	-5 V regulation (Circuit diagram page 1)
X11, X12	Test pins for the voltages

Test points

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

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)

3.3 ECG Board

In general

The general block diagram of the ECG module is shown in Figure 12. The patient signals are connected through overload protection circuits (resistors and gas-filled surge arresters) and analog switches to instrumentation amplifiers. Then the signals are amplified about 480 times and limited by slew rate. After that they are A/D-converted, analyzed digitally and finally transferred to module bus in digital form.

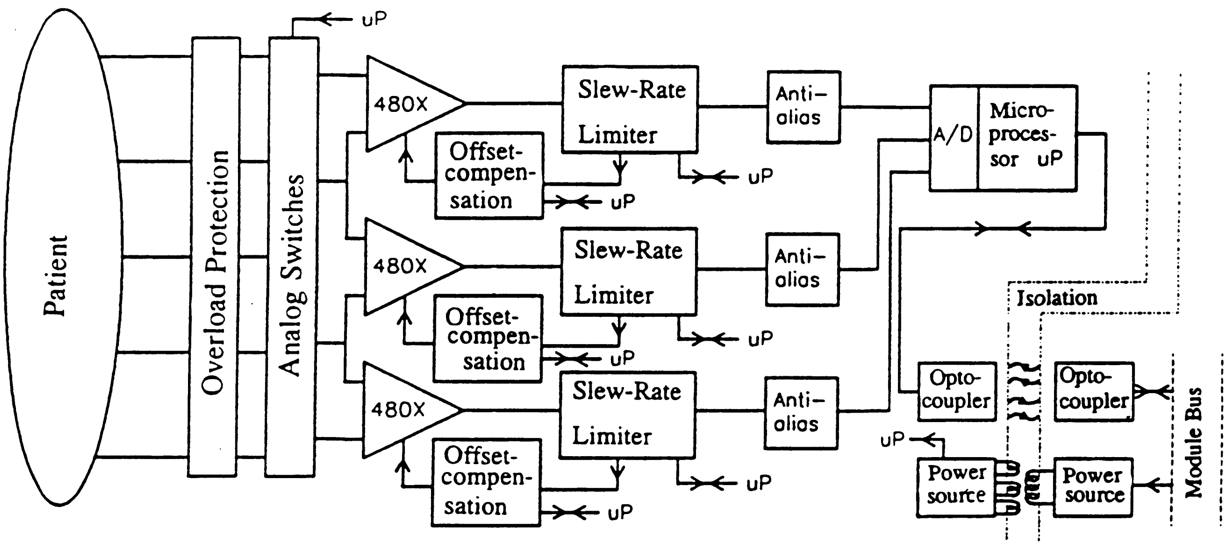


Figure 12 ECG Measurement Block Diagram

Analog section (Circuit diagram page 1)

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

A1A to A1D, A4B, and their surrounding components form a slew rate-limited instrumentation amplifier. This circuit is described below. There are two other instrumentation amplifier circuits identical to this on the board, but they all function in the same way.

Resistors R22, R23, and R24 make up the first stage (A1A and A1C) to amplify the input signal differentially by the factor 32.5 (1 + 2 x R22/R23). The rest of the gain is set by resistors R41 and R42 to 14.7 (1 + R41/R42), therefore the total gain is 478 (32.5 x 14.7). The amplified signal can be detected at the output of A4B. It is connected to processor's A/D-pin 11.

Integrator A4B acts as slew rate-limiter. Its time constant (R34, C23) together with maximum output voltage of A1B determines its slew rate limit.

The time constant (R37||R38, C27) or (R38, C27) of the integrating amplifier A1D determines the lower corner frequency to be correspondingly 0.5 Hz (monitor bandwidth) or 0.05 Hz (diagnostic bandwidth). This amplifier compensates the offset voltage at the amplifier input up to ±340 mV (±11 V/32.5).

The amplifiers may saturate, e.g. when the patient is defibrillated. If it occurs, microprocessor transmits digital high signal to analog switch A6C pin 9 and capacitor C27 is discharged through the switch A6C (signal QZ1 = Quick Zero 1).

Diodes V40 and V41 are the source of the current for lead off sensing.

When the instrumentation amplifier detects a high slew rate signal, its output at amplifier A1B pin 7 saturates. This is detected by window comparator A4A. Its detection limit is about ±9 V. The comparator output is connected to the microprocessor as a signal named HSR (High Slew Rate).

Microprocessor section (Circuit diagram page 2)

Microprocessor's internal 8-channel A/D-converter converts three ECG-signals, four lead off-signals and the power source test signal (POWMON) to digital form.

The reference voltage +5.0 V of A/D-converter is connected to pin VREF.

Analog switches determining the patient connection are controlled by IO port pins P1.0 to P1.4.

The high slew rate signal HSR is connected for pulse detection to pin 38 (T2CAPTURE) and inverted to pin 42 (T2RST).

The microprocessor contains all RAM and PROM memories. The processor uses external EEPROM memory (D3).

Communication with the module bus is made through RXD and TXD pins. Logical zero at pin P1.7 enables data sending.

Cable detection

The existence of the patient cable is detected by the IO port P2.2. Cable type is detected by HSI3 input. The user switch at the front panel is connected to the pin HSI1.

Serial communication (Circuit diagram page 3)

See the serial communication section in STP board circuit description for text and block diagram.

Isolated section

See the isolated section in STP board circuit description for text and block diagram.

Power supply section (Circuit diagram page 3)

See the power supply section in STP board circuit description for text.

Voltages

See the voltages section in STP board circuit description for detail. Note that -5 V is used only in the STP board.

Test points

See the test points section in STP board circuit description for detail. Note that pin X12 exists only in the STP board.

3.4 Module Bus Connector Configuration

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

Pin No	I/O	Signal	Notes
1	O	RESET_RS485*	
2	I	-15 VDC	
3	I	+15 VDIRTY*	
4	I	+15 VDC	
5	O	-DATA_RS485*	
6	O	DATA_RS485*	
7		Ground & Shield*	
8	O	-RESET_RS485*	
9	I	CTSB	
10	O	RTSB	
11	I	RXDB	
12	O	TXDB	
13		Ground & Shield*	
14	I	+24 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 ESTP, ETP and P modules

3.5 Adjustments and Calibration

Temperature calibration

Temperature calibration is performed whenever the measured values deviate more than $\pm$ 0.1°C when temperature test plug is inserted into T1 and T2 receptacle. See temperature calibration in Service Menu.

Pressure calibration

Pressure calibration is recommended to be done whenever pressure transducer (probe) is replaced with another type. See Service Menu for the procedure.

4 SERVICE AND TROUBLESHOOTING

4.1 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.

4.2 Disassembly and Reassembly

The ESTP/ETP module is disassembled in the following way. See Figure 15 for 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) Two main PC boards will appear. ECG board is on top of STP board. The ECG board will be detached by removing four screws at each corner and disconnecting 8-pin ribbon cable that is connected to the STP board and 2-pin ribbon cable that is from the front panel, and sliding the board rearward to disconnect the fixed 10-pin connector of ECG input board.

d) The STP board is now removed by detaching two screws on the folio side of the board near the front panel and disconnecting two connectors from SP input board, one connector from Temp input board, and another connector from the front panel.

Reassembling is essentially reversing what was described above.

The P module is disassembled in the following way.

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) The STP 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 two ribbon cables from the front panel.

Reassembling is essentially reversing what was described above.

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

4.3 Troubleshooting Charts

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

4.3.1 ECG Troubleshooting Chart

PROBLEM	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.	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.
	Improper bandwidth filter.	Check filter.
No ECG trace	Waveform not selected on screen.	Press the Monitor Setup key and make adjustments.
	Module with ECG not plugged in.	Plug in the module.
Noise-message	High frequency or 50/60 Hz noise.	Isolate noise source.

4.3.2 InvBP Troubleshooting Chart

PROBLEM	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.
Not zeroed-message	Measurement on, channel not zeroed.	Zero the channel.
Zeroing failed-message	Unsuccess 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	Unsuccess calibrating of Pi (number field).	Pulsating waveform. Turn the transducer to sphygmomanometer and try again (zeroing takes place first).
		Gain is beyond the limits (±20 % of the default gain) of the module. Replace the transducer.
Out of range ≤ 40 mmHg	Measurement pressure is beyond measurement range.	Check transducer level. Zero the channel.

PROBLEM	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.

4.3.3 Temp Troubleshooting Chart

PROBLEM	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, T-input board, or STP board. In adaptation -70- (Germany) check that Protection is set to ON correctly in Service Menu.
No temperature displayed	Wrong probe.	Use correct probe.
	Temperature out of measurable range.	The range is between 15 and 45°C.

4.3.4 SpO_2 Troubleshooting Chart

PROBLEM	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
Cliplite™ 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

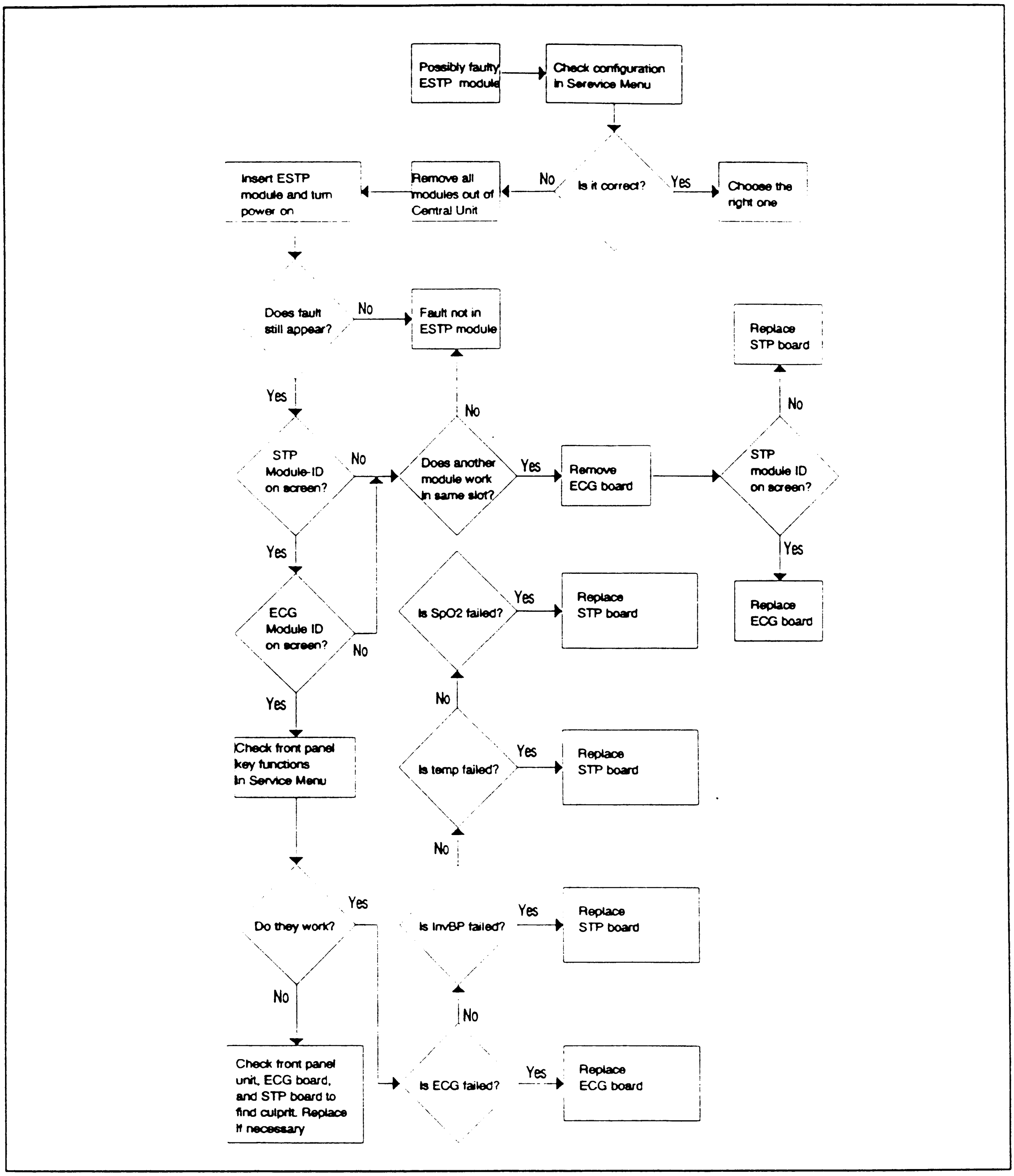


Figure 13 ESTP Module Troubleshooting Chart

4.4 Preventive Maintenance Check List

We recommend that you perform these checks after any service and at least once every six months to keep the AS/3™ Anaesthesia Monitor ESTP/ETP/P 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 before attaching the module box.

2. Functional checks

___: Insert the module into Central Unit where there are NIBP module and Recorder module.

___: Turn the power on by STBY-switch. Within 15 seconds, SpO_2 and Temp windows should appear on the display. No error message appears.

___: Pull out the module. The SpO_2 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 probe to the module. The message Probe off should appear on the display. No waveform appears. Attach the probe to your finger. The reading of 95 to 99 and a correct waveform should appear.

___: Go to Service Menu, Service View, Modules, ESTP:ECG/ESTP:STP/P and check the functions of cables and buttons (ON/OFF test).

___: Choose a field for ECG waveform (ECG1, 3 leads, size 1.0) in Monitor setup menu. The text Leads off appears. Connect simulator to the module. The reading of Heart rate appears and the heart symbol starts to blink within 15 seconds. No error messages appear. Press the ECG LEAD key and try all the selections (Lead I, Lead II, and Lead III).

___: Plug temperature test plug into T1 and T2 and make sure that the measured values do not deviate more than ± 0.1°C. If they do, perform the temperature calibration in Service Menu (see Service Menu section).

5 SPARE PARTS

5.1 Spare Parts List

5.1.1 ESTP-, ETP-Module

NOTE: Accessories are listed in the Operator's Manual.

Item	Item description	Order No.
6	STP board	*880339
7	ECG board	*880338
4	Front panel unit (ESTP)	880337
4	Front panel unit (ETP)	880941
10	Front panel sticker (Eng) (ESTP)	879481
10	Front panel sticker (Fre) (ESTP)	880158
10	Front panel sticker (Ger) (ESTP)	880552
10	Front panel sticker (Eng) (ETP)	880428
10	Front panel sticker (Fre) (ETP)	880429
10	Front panel sticker (Ger) (ETP)	880560
1	Module box (wide)	879096
3	Latch	879181
2	Spring pin	879182
11	Metal frame	879183
8	Software ECG	879525
9	Software STP	880976
12	8-pin ribbon cable	71399
5	Cross recess screw M3x8	61622
13	Cross cylinder-head screw M3x6	61721
14	Cross cylinder-head screw M3x12	628700

Item number refers to the exploded views in Figures 14 and 15.

Front panel unit includes all the connectors and input boards.

* = the part is recommended for stock.

5.1.2 P-Module

Item	Item description	Order No.
-	STP board	*880339
-	Front panel unit	880044
-	Front panel sticker (Eng)	880139
-	Front panel sticker (Fre)	880130
-	Front panel sticker (Ger)	880488
-	Module box (single)	879095
3	Latch	879181
2	Spring pin	879182
-	Metal frame	879184
-	Software P	879792
5	Cross recess screw M3x8	61622
-	Cross cylinder-head screw M3x6	61721
-	Cross cylinder-head screw M3x12	628700

Item number refers to the exploded view in Figure 14. See also Figure 15 for reference to other parts.

Front panel unit includes all the connetors and P Input board.

* = the part is recommended for stock.

5.2 Exploded View of Modules

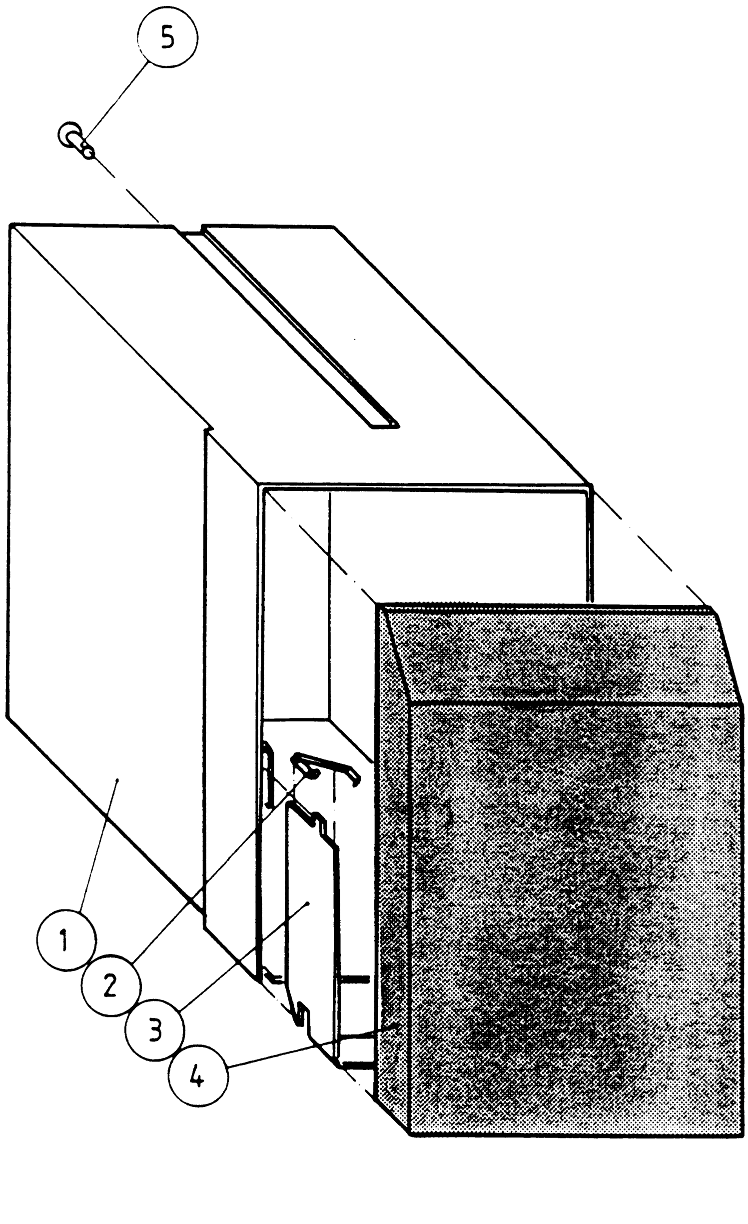


Figure 14 Exploded View of Module Box

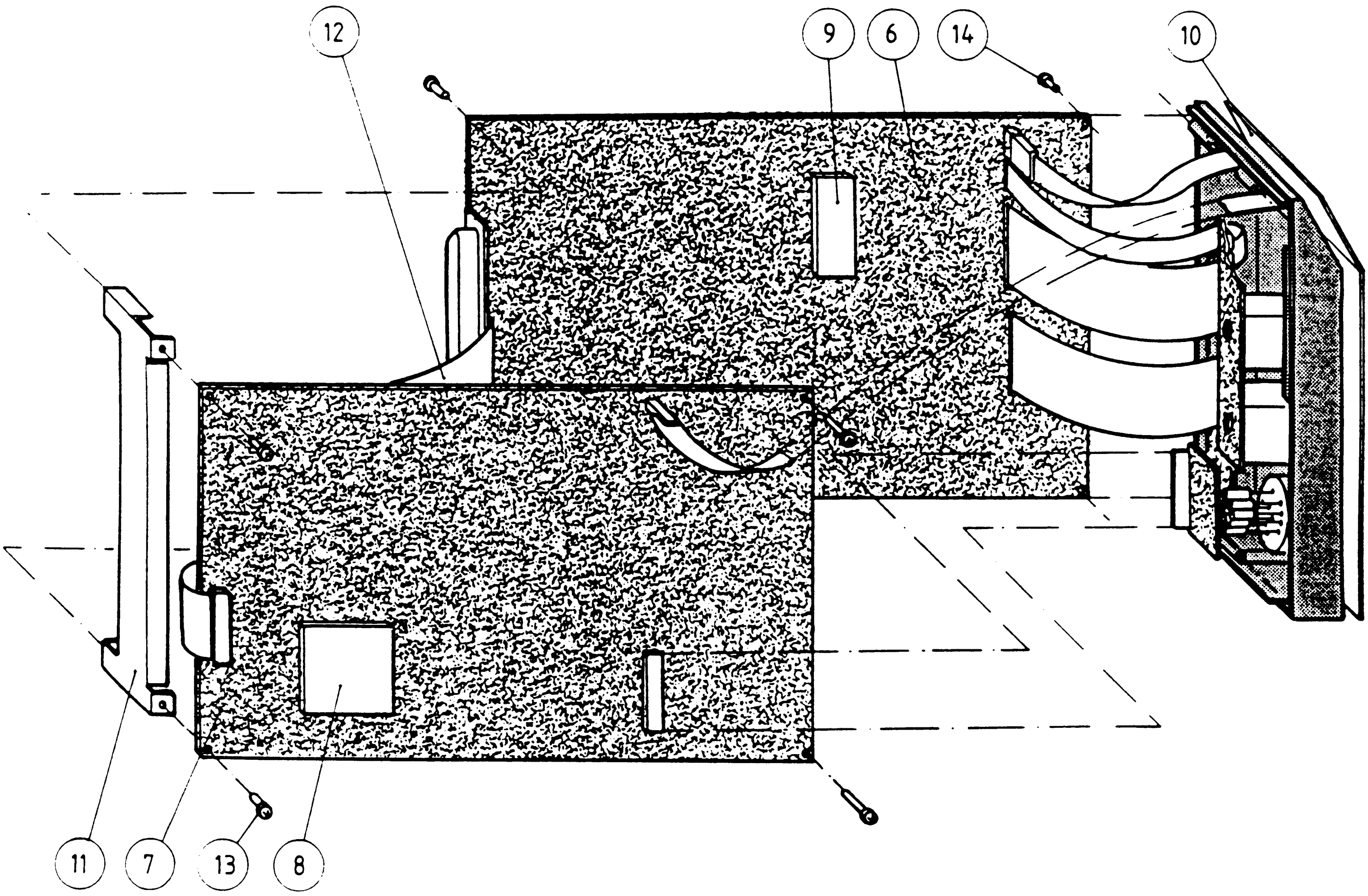
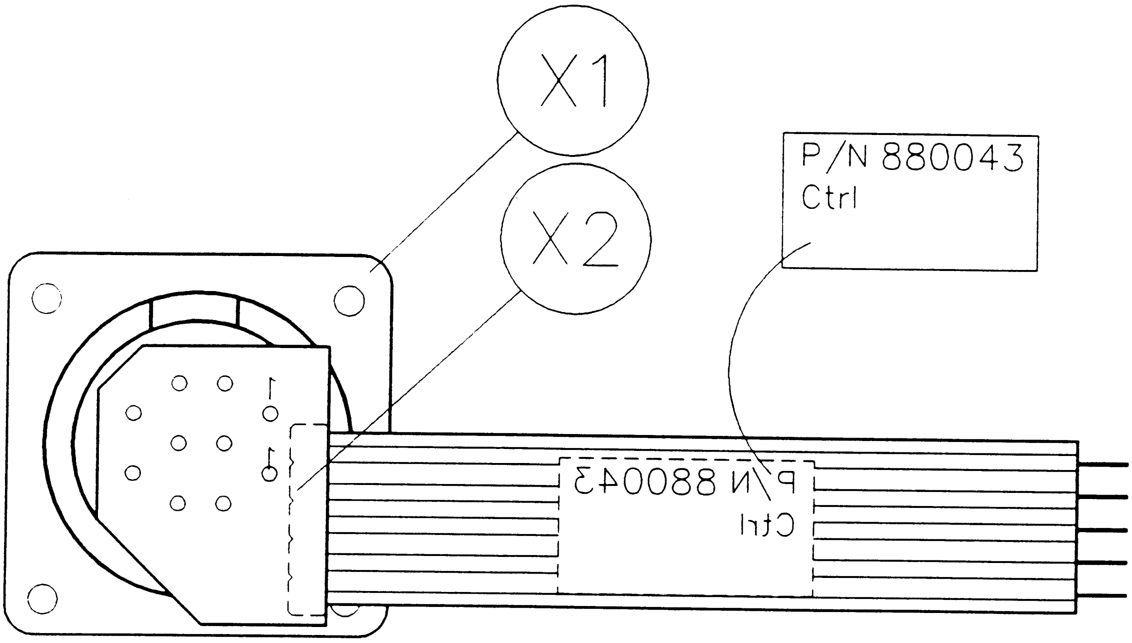
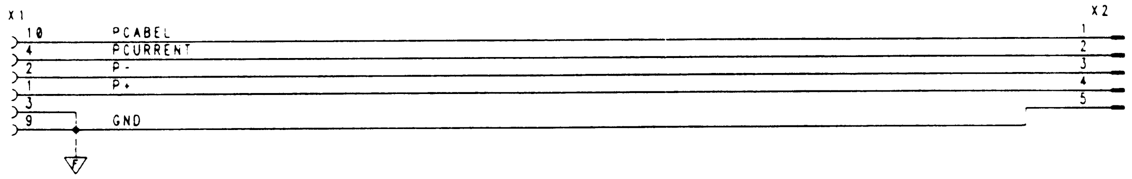


Figure 15 Exploded View of ESTP Module

6 CIRCUIT DIAGRAM AND PARTS LAYOUT

Figure 16 P Input Board Parts Layout and Schematic Diagram





DATEX

INSTRUMENTARIUM OY

NIMI

PRESSURE INPUT BOARD

SIVU 1/1

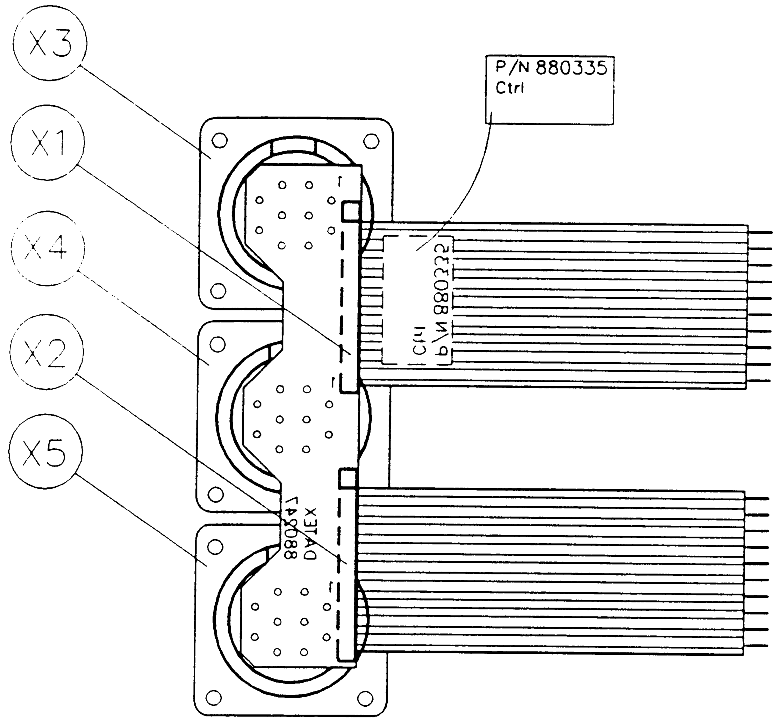
LAITE M-COP

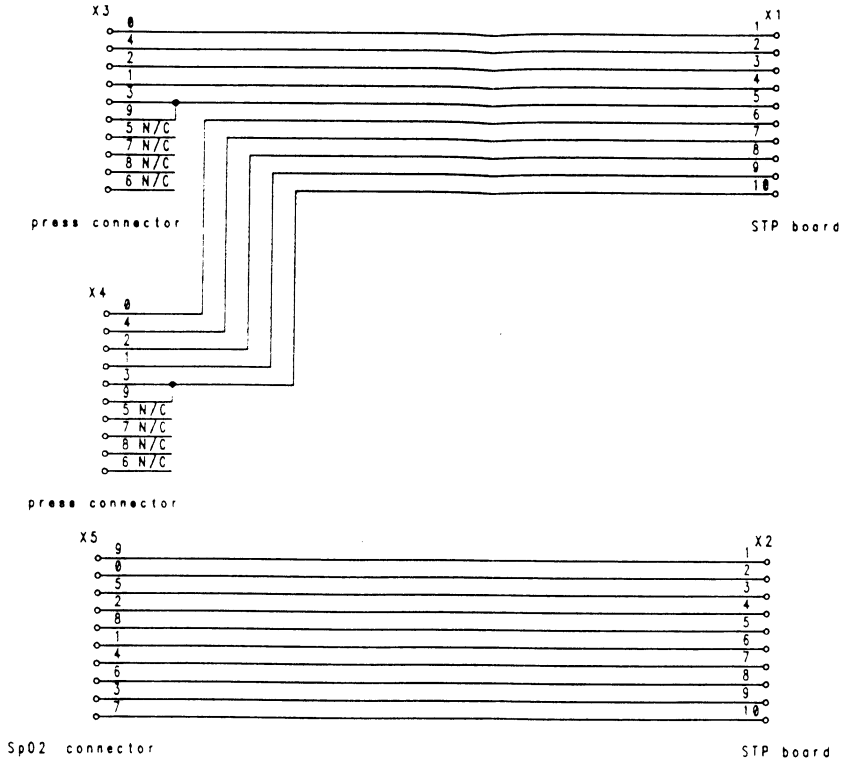
NO MC 3B 880803

15.04.92 OS TARK. HYV

MUUT. TARK. HYV MUUTOS MERKKI

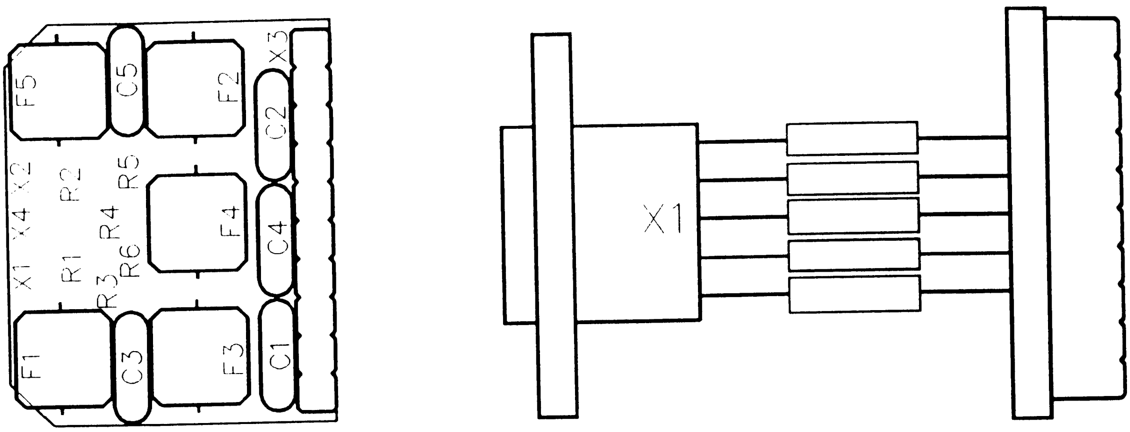
Figure 17 SP Input Board Parts Layout and Schematic Diagram

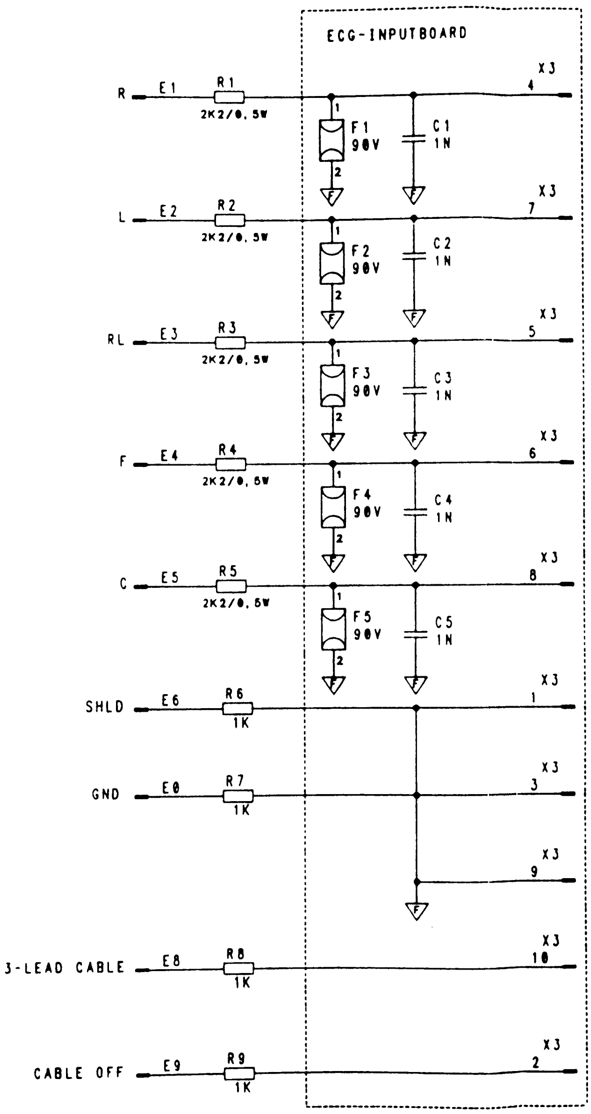




16.04.92PATE		6585	-1	DATEX	NIMI SP INPUT BOARD	SIVU 1/1	LAITE M-ESTP
MUUT.	TARK.	HYV.	MUUTOS	MERKKI	INSTRUMENTARIUM OY	PIIRT. RAHA 1.3.90 / TARK. / HYV. 9.10.91 RaHa	N:O ME 3B 880248-1

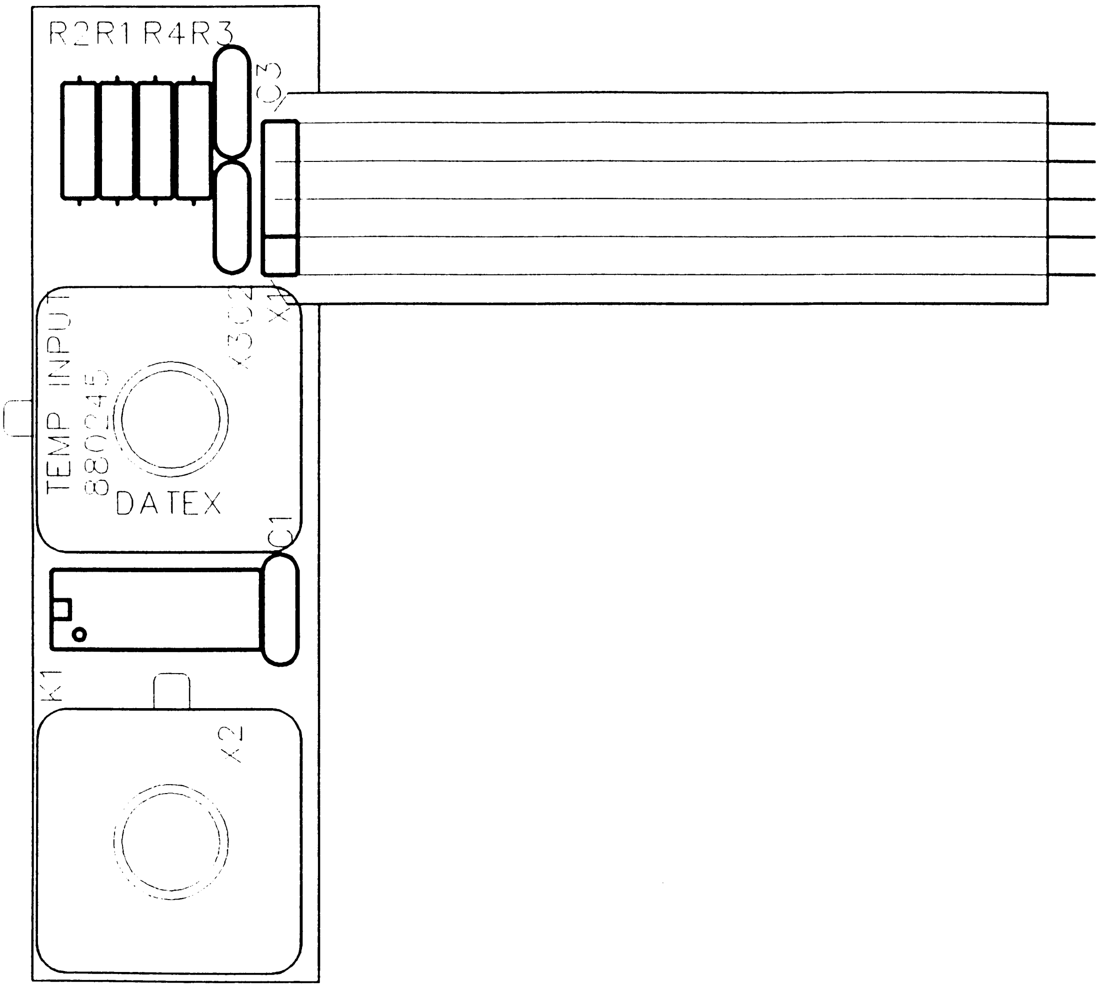
Figure 18 ECG Input Board Parts Layout and Schematic Diagram

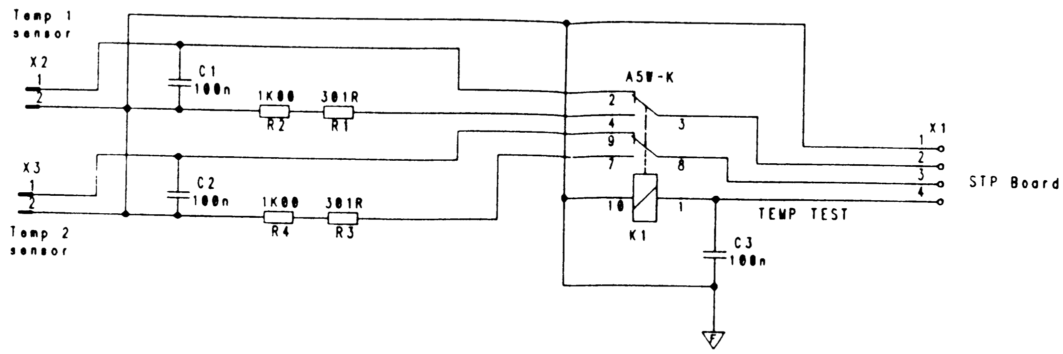




18.04.02PaTe			6585	-1	DATEX	NIMI ECG INPUT BOARD	SIVU 1/1
MUUT.	TARK.	HYV.	MUUTOS	MERKKI	INSTRUMENTARIUM OY	PIIRT. 27.02.01 LEJA / TARK. / HYV. 8.10.01 RaHa	LAITE M-ESTP / N:O ME 3B 880250-1

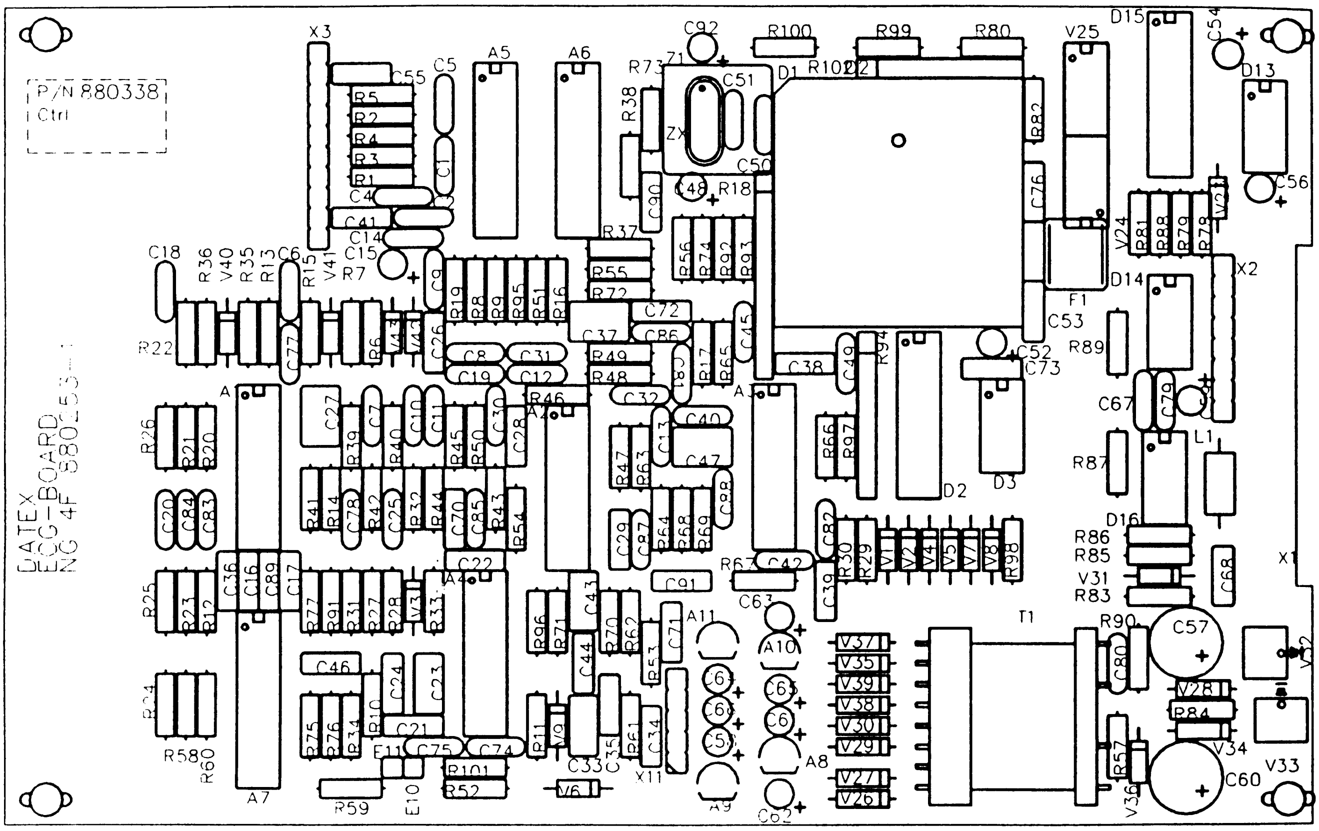
Figure 19 T Input Board Parts Layout and Schematic Diagram





10.04.92 PaHe			6585	-1	DATEX	NIMI TEMP INPUT BOARD	SIVU 1/1	LAITE M-ESTP
MUUT.	TARK.	HYV.	MUUTOS	MERKKI	INSTRUMENTARIUM OY	PIIRT. RAHA 1.3.90 / TARK. / HYV. 9.10.ReHa		N:O ME 3B 880246-1

Figure 20 ECG Board Parts Layout and Schematic Diagram (Part 1)



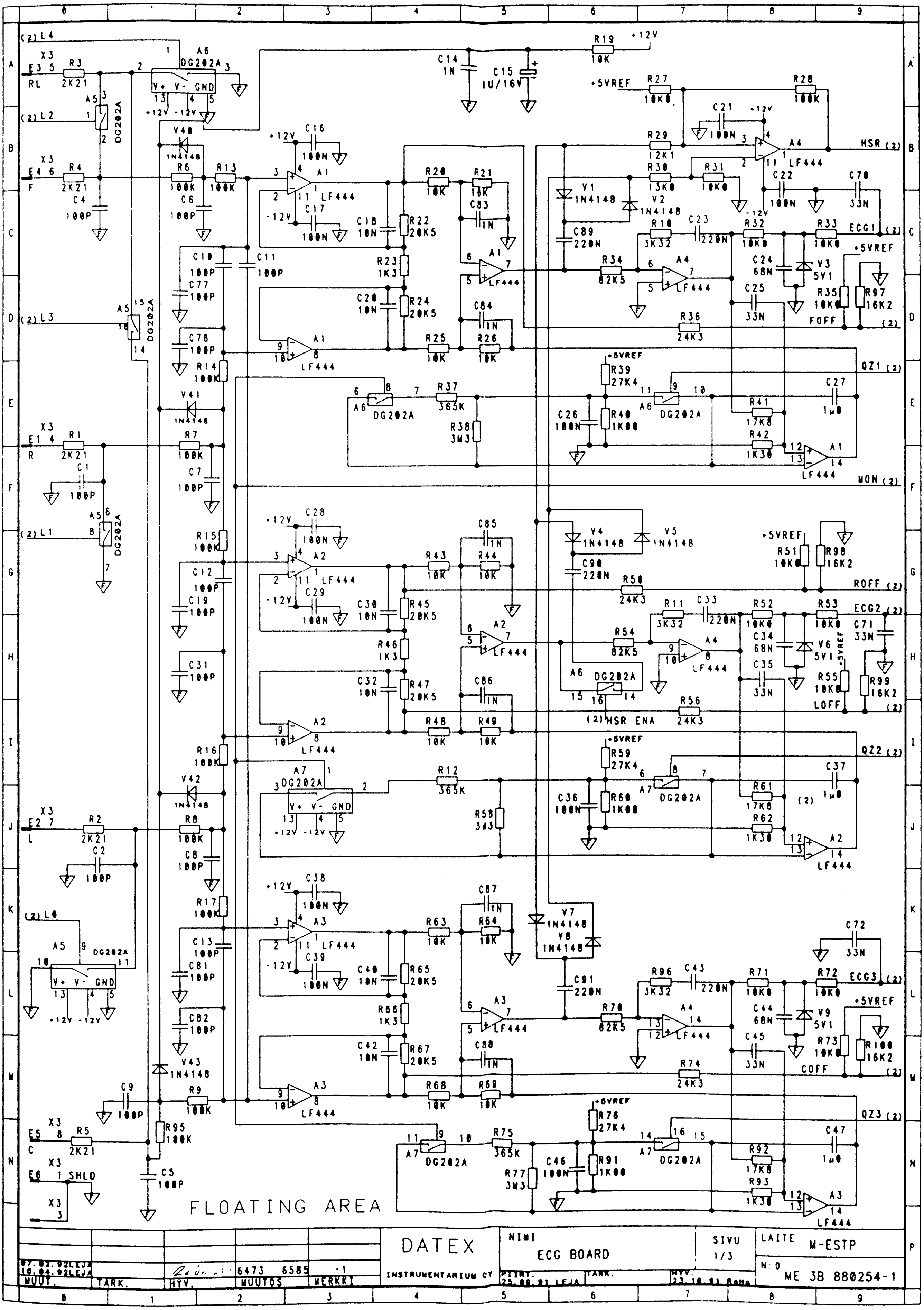
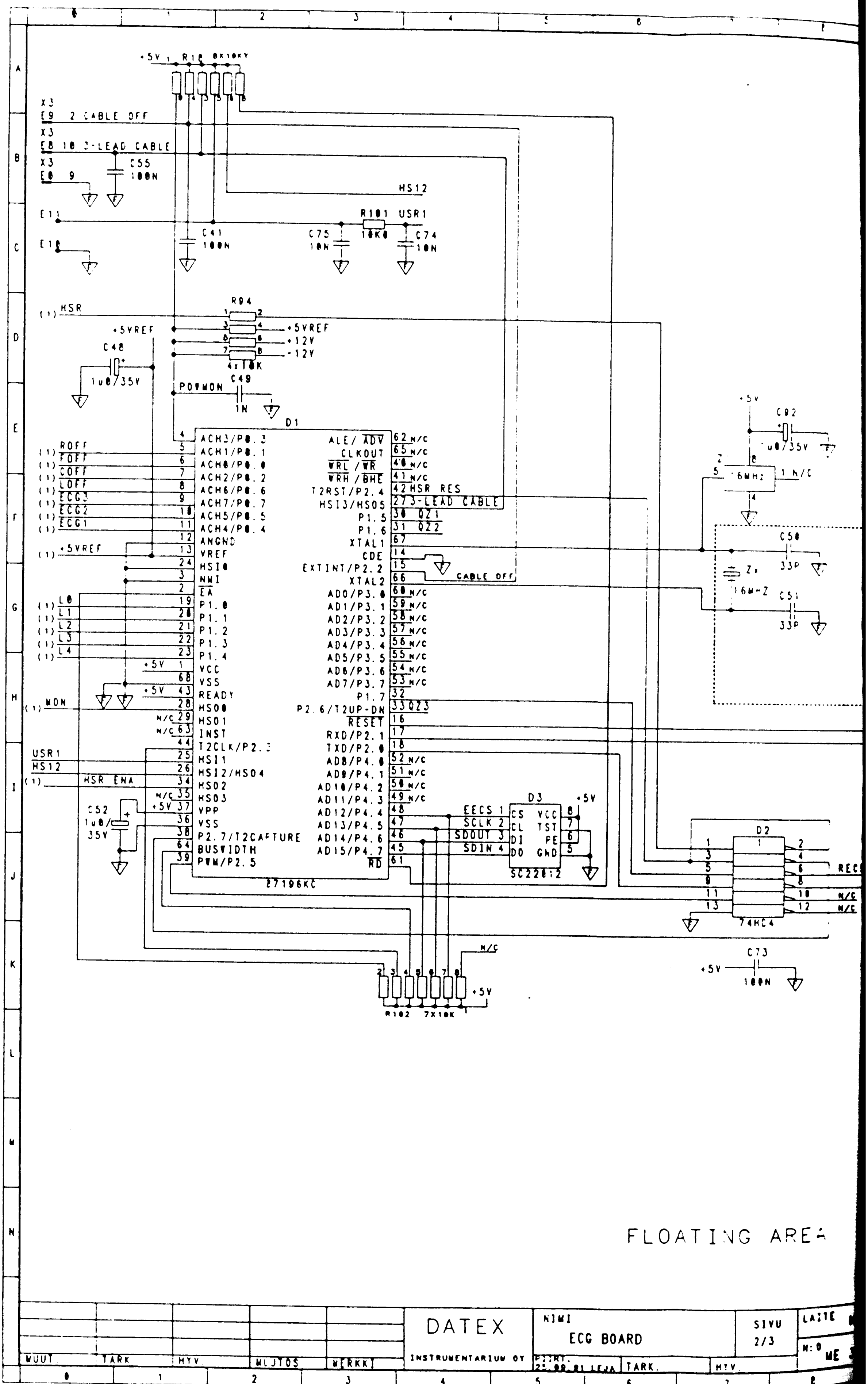
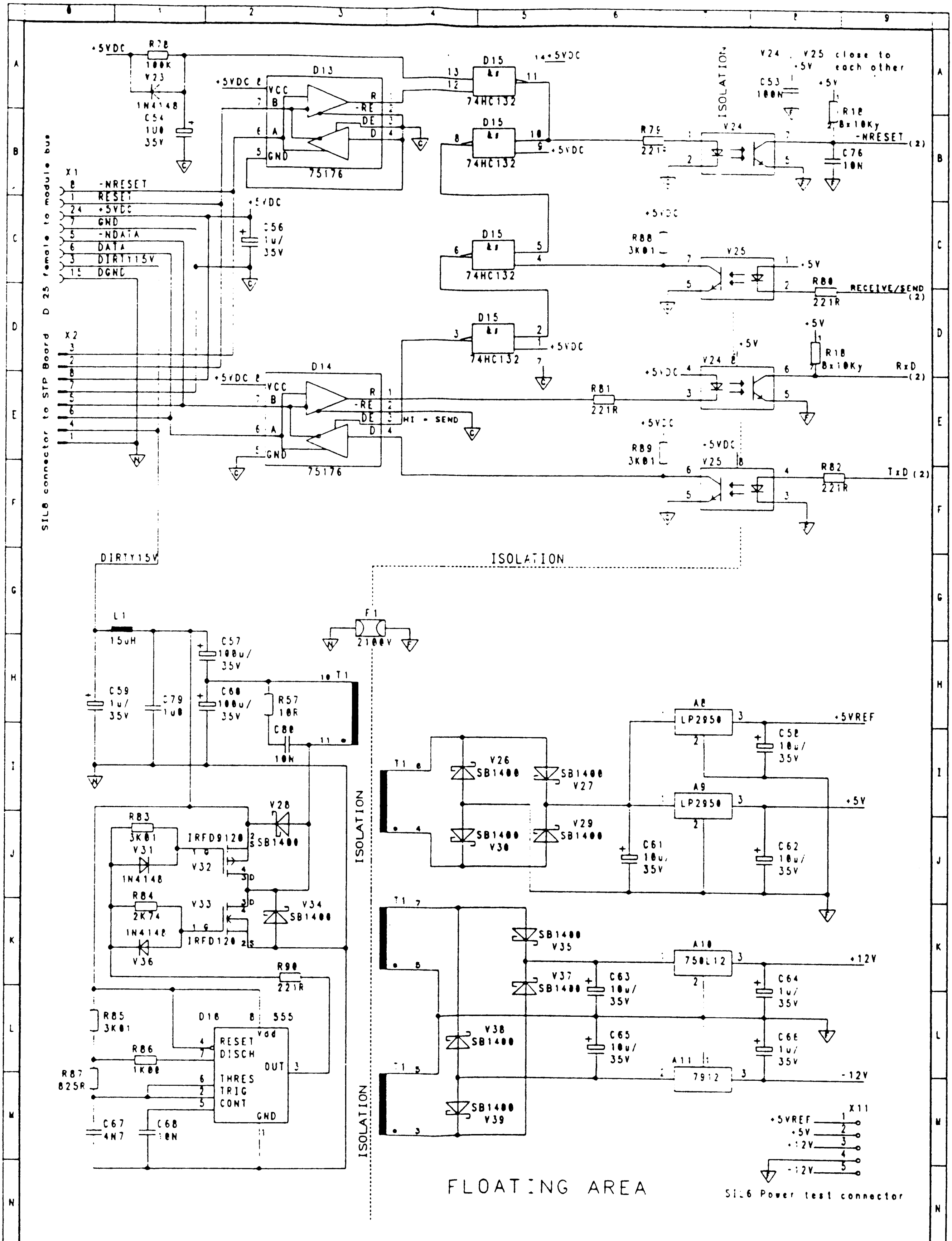

FLOATING AREA
DATEX
INSTRUMENTARIUM OY
NIMI
ECG BOARD
SIVU
1/3
LAITE
M-ESTP
N:O
ME 3B 880254-1
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
6473
6585
HSR (2)
ECG1 (2)
FOFF (2)
QZ1 (2)
MON (2)
ROFF (2)
ECG2 (2)
LOFF (2)
HSR ENA
QZ2 (2)
ECG3 (2)
COFF (2)
QZ3 (2)
+5VREF
+12V
-12V
DG202A
LF444
1N4148

Figure 21 ECG Board Schematic Diagram (Part 2)



D1
27196KC
D2
74HC4
D3
SC22012
R94
4x10K
R102
7X10K
C55
100N
C41
100N
C75
10N
R101
10K0
USR1
C74
10N
C48
1u0/35V
C49
1N
POWMON
C52
1u0/35V
C92
1u0/35V
16MHZ
C50
33P
C51
33P
C73
100N
HS12
HSR
HSR ENA
+5VREF
+12V
-12V
ROFF
FOFF
COFF
LOFF
ECG3
ECG2
ECG1
MON
L0
L1
L2
L3
L4
EECS
SCLK
SDOUT
SDIN
HSR RES
3-LEAD CABLE
CABLE OFF
QZ1
QZ2
QZ3
FLOATING AREA
DATEX
INSTRUMENTARIUM OY
NIMI
ECG BOARD
SIVU
2/3
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
LAITE



MUUT.	TARK	HYV	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI ECG BOARD	SIVU 3/3	LAITE M-ESTP
						PIIRT. 25.08.91 LEJA · TARK. · HYV		N:O ME 3B 880254-1

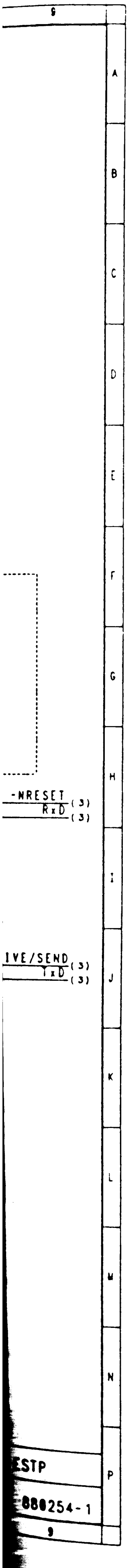


Figure 22 STP Board Parts Layout

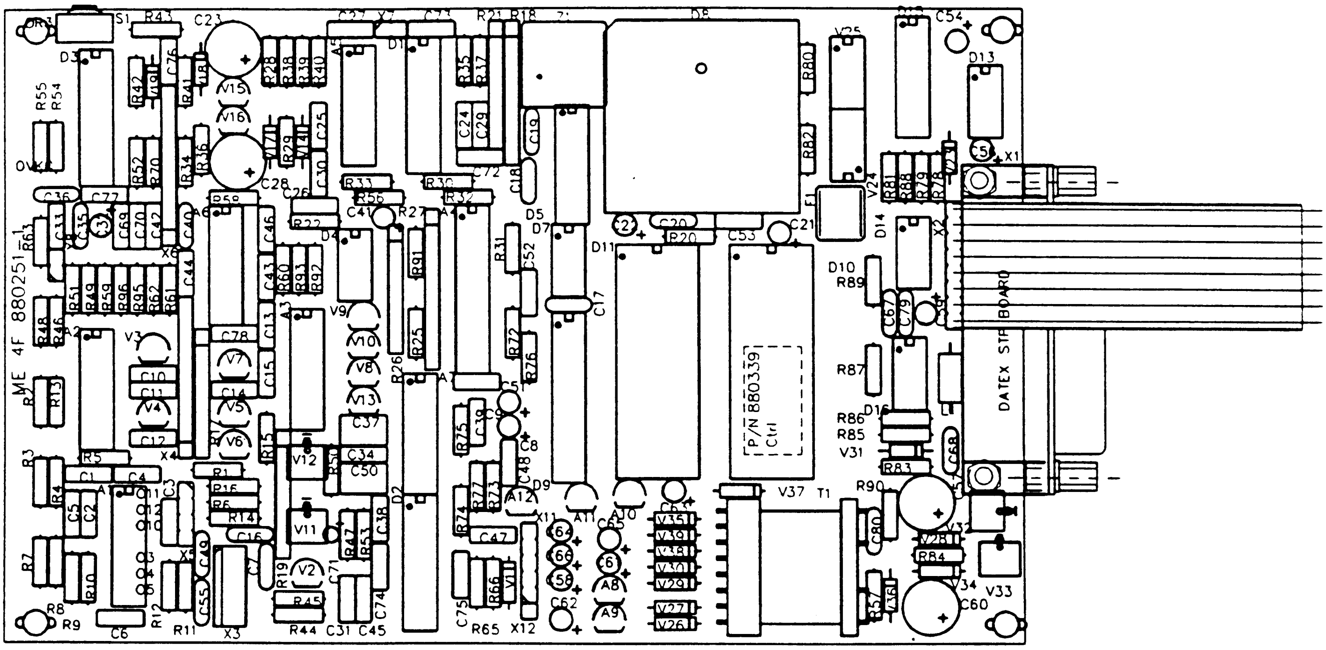
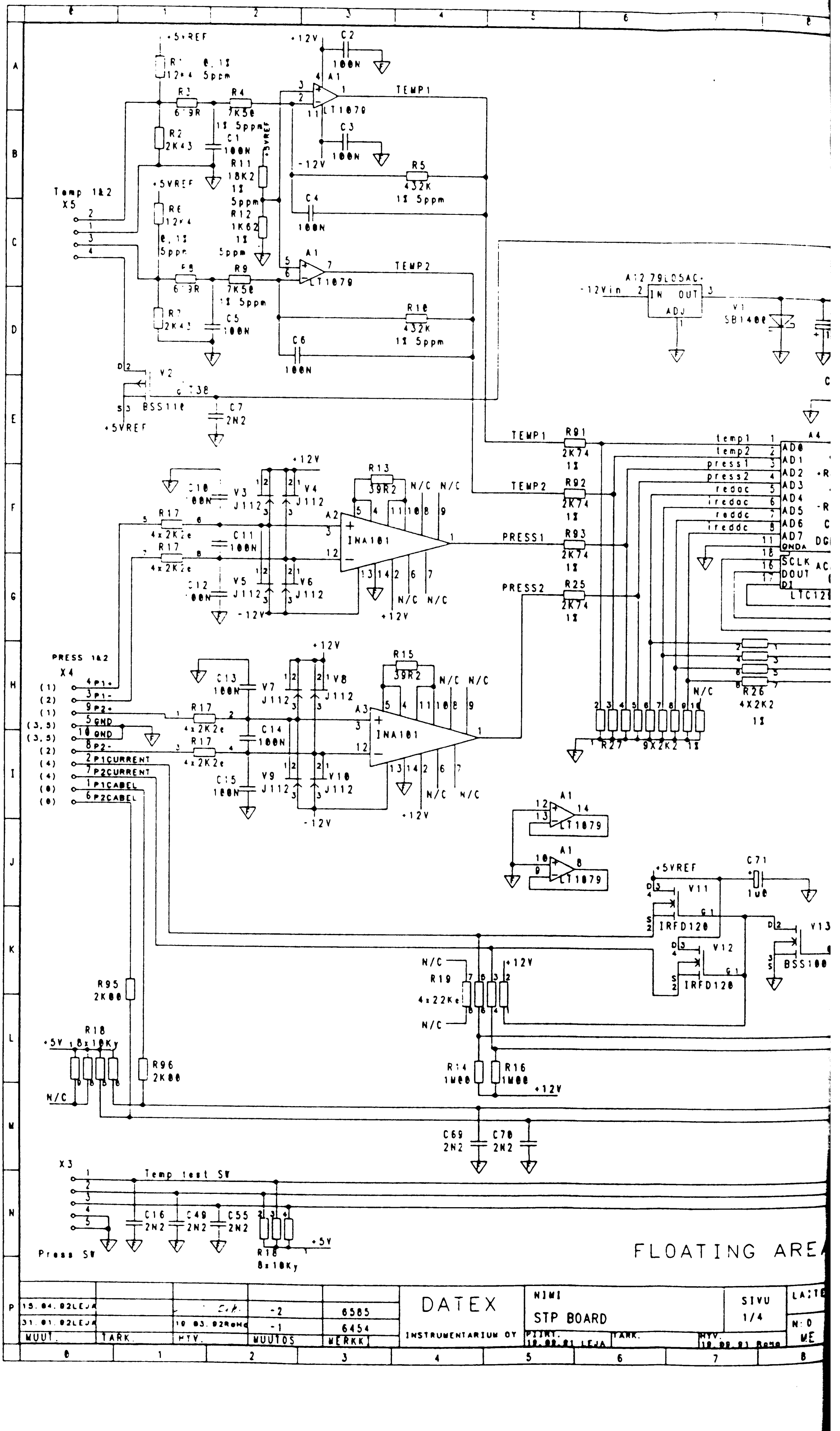
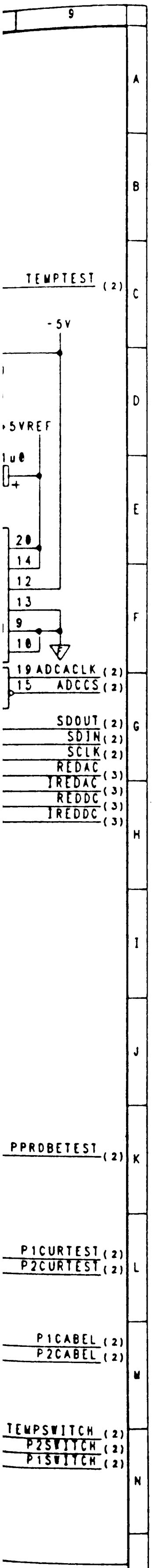
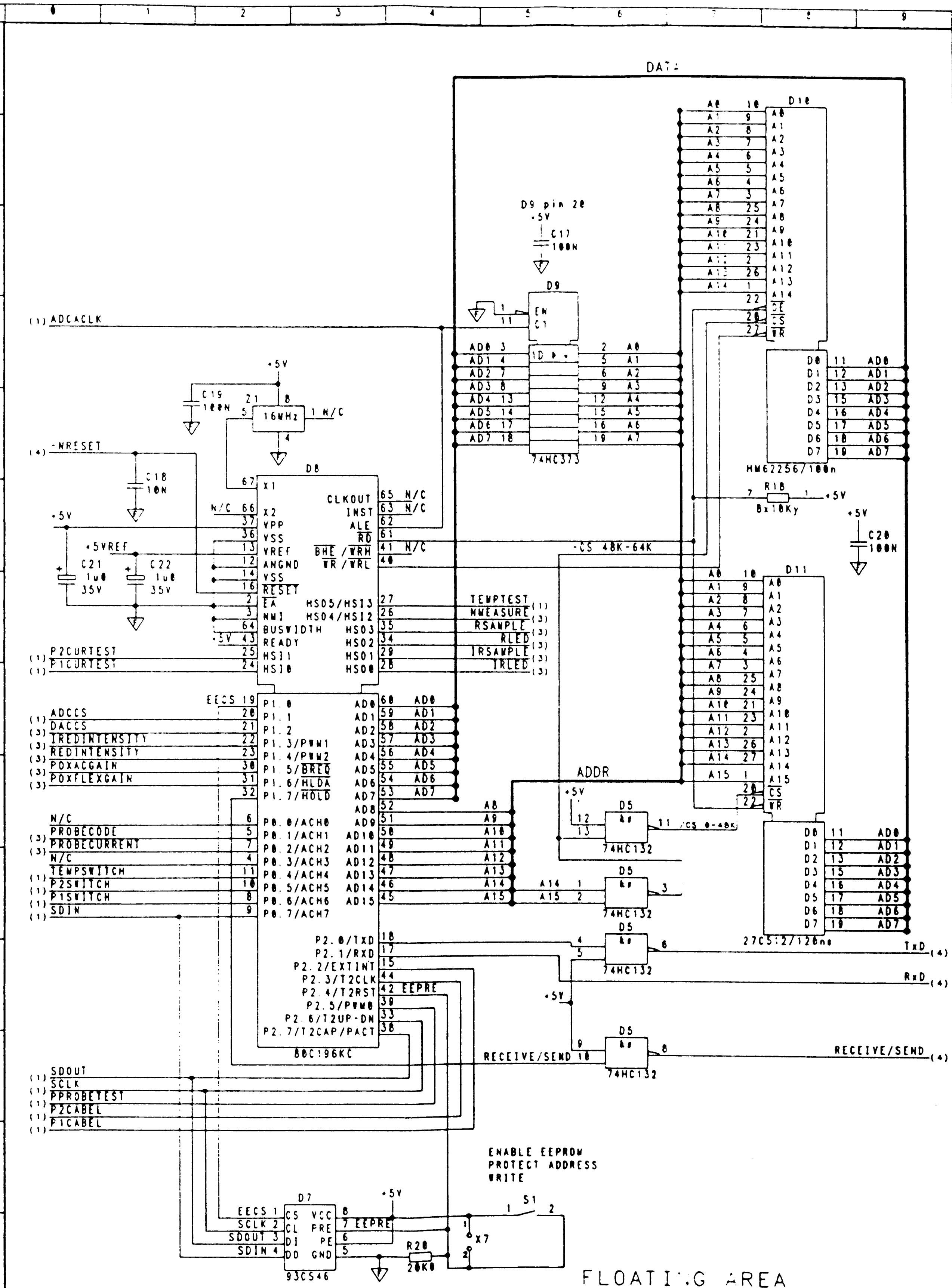


Figure 23 STP Board Schematic Diagram (Part 1)



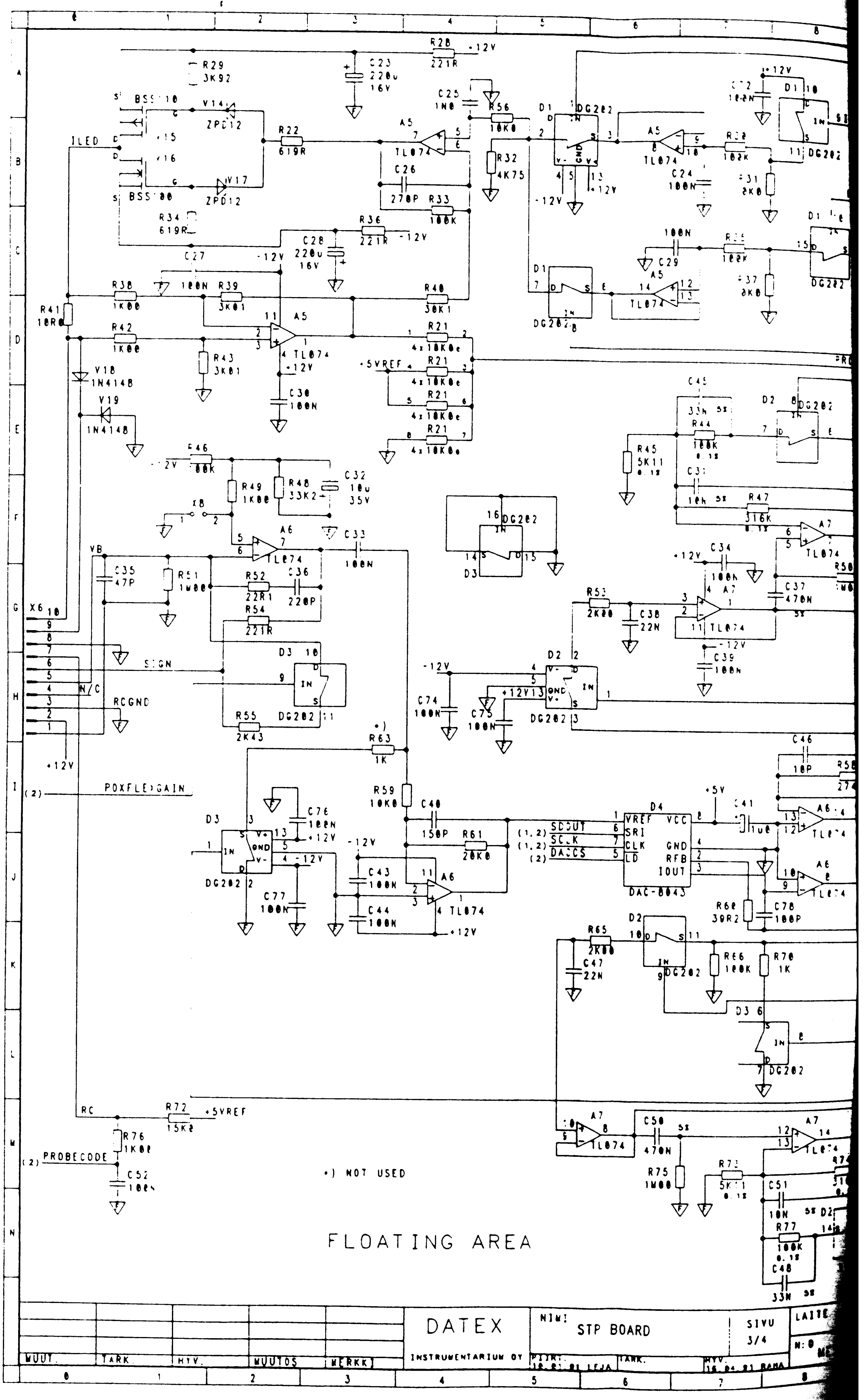
+5VREF
R1 12K4 0.1% 5ppm
R3 619R
R4 7K50 1% 5ppm
R2 2K43
C1 100N
C2 100N
C3 100N
+12V
-12V
A1 LT1079
TEMP1
TEMP2
R5 432K 1% 5ppm
R11 18K2 1% 5ppm
R12 1K62 1%
C4 100N
Temp 1&2
X5
R6 12K4 0.1% 5ppm
R8 619R
R9 7K50 1% 5ppm
R7 2K43
C5 100N
R10 432K 1% 5ppm
C6 100N
V2 BSS110
C7 2N2
A12 79L05AC
-12Vin
IN OUT
ADJ
V1 SB1400
R91 2K74 1%
R92 2K74 1%
R93 2K74 1%
R25 2K74 1%
PRESS1
PRESS2
temp1
temp2
press1
press2
redac
iredac
reddc
ireddc
A4
AD0
AD1
AD2
AD3
AD4
AD5
AD6
AD7
GNDA
SCLK
DOUT
DI
LTC12
R13 39R2
N/C
A2
INA101
R17 4x2K2e
C10 100N
C11 100N
C12 100N
V3 J112
V4 J112
V5 J112
V6 J112
PRESS 1&2
X4
P1+
P1-
P2+
GND
P2-
P1CURRENT
P2CURRENT
P1CABEL
P2CABEL
R15 39R2
A3
INA101
C13 100N
C14 100N
C15 100N
V7 J112
V8 J112
V9 J112
V10 J112
R26 4X2K2 1%
R27 9X2K2 1%
A1 LT1079
C71 1u0
V11 IRFD120
V12 IRFD120
V13 BSS100
R19 4x22Ke
R14 1M00
R16 1M00
R95 2K00
R96 2K00
R18 8x10Ky
+5V
C69 2N2
C70 2N2
X3
Temp test SW
Press SW
C16 2N2
C49 2N2
C55 2N2
FLOATING ARE
15.04.02LEJA
31.01.02LEJA
-2 6585
-1 6454
19.03.02RoHo
MUUT.
TARK.
HTV.
MUUTOS
MERKKI
DATEX
INSTRUMENTARIUM OY
NIMI
STP BOARD
PIIRT. 10.08.01 LEJA
TARK.
HYV. 10.08.01 RoHo
SIVU 1/4
LAITE
N:O
ME



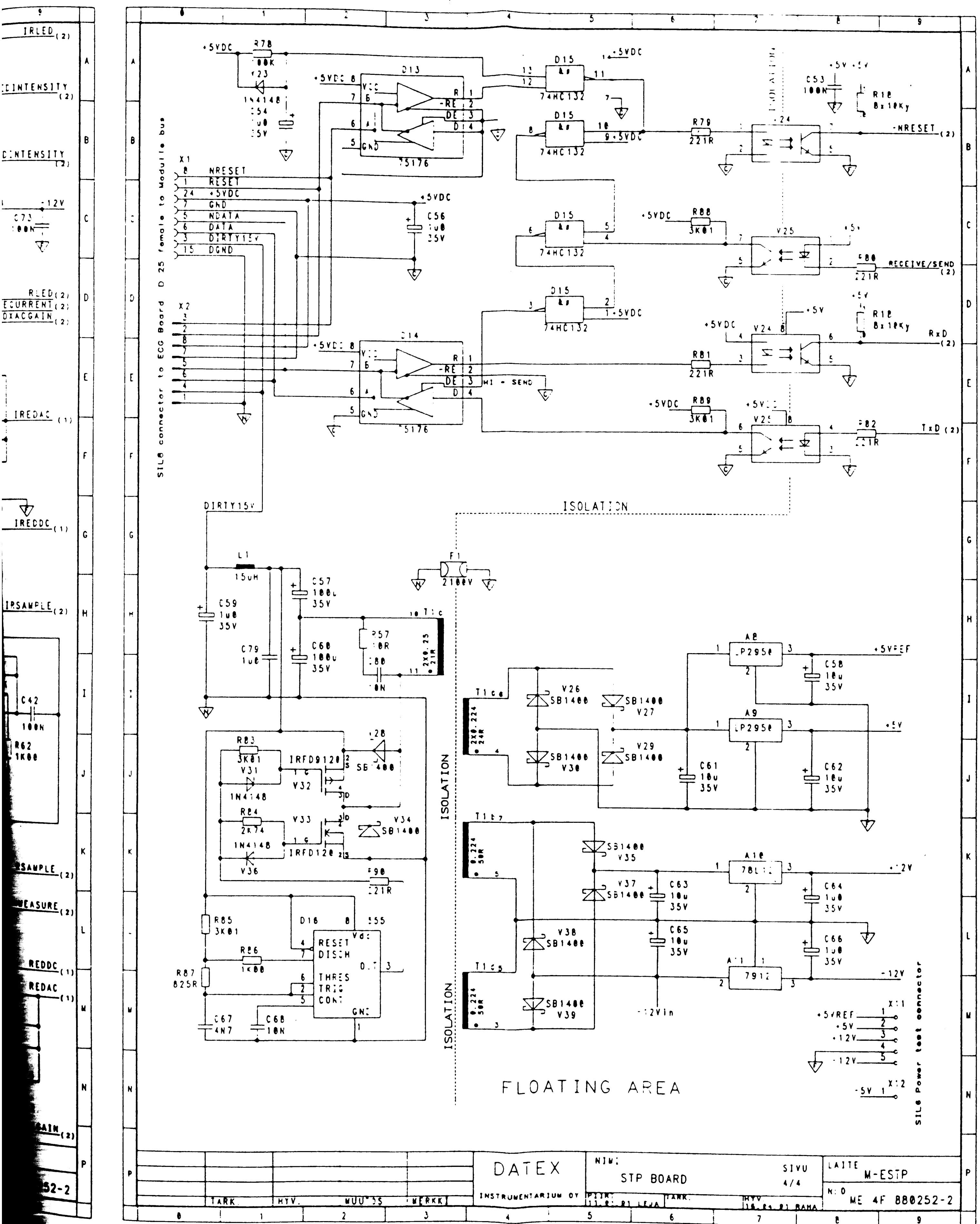


MUUT.	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI STP BOARD	SIVU 2/4	LAITE M-ESTP
						PIIRT. 18.01.91 LEJA / TARK. / HYV. 16.05.91 RAHA		N:O ME 3B 880252-2

Figure 24 STP Board Schematic Diagram (Part 2)



FLOATING AREA
*) NOT USED
DATEX
INSTRUMENTARIUM OY
NIMI
STP BOARD
SIVU
3/4
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
DAC-8043
DG202
TL074
ILED
BSS100
ZPD12
+5VREF
SIGN
RCGND
POXFLEXGAIN
PROBECODE
SDOUT
SCLK
DACCS
X6
VB
RC
+12V
-12V


SIL8 connector to ECG Board D 25 female to Module bus
X1
NRESET
RESET
+5VDC
GND
NDATA
DATA
DIRTY15V
DGND
X2
+5VDC
R78
100K
V23
1N4148
C54
1u0
35V
D13
75176
VCC
GND
R
-RE
DE
D
D15
74HC132
R79
221R
V24
-NRESET (2)
C53
100N
R18
8x10Ky
C56
1u0
35V
R80
3K01
V25
RECEIVE/SEND (2)
R80
221R
D14
R81
221R
RxD (2)
MI - SEND
R89
3K01
R82
221R
TxD (2)
ISOLATION
DIRTY15V
L1
15uH
F1
2100V
C57
100u
35V
C59
1u0
35V
C60
100u
35V
R57
10R
C80
10N
C79
1u0
R83
3K01
IRFD9120
V31
V32
1N4148
SB1400
R84
2K74
V33
V34
IRFD120
V36
R90
221R
R85
3K01
D16
555
RESET
DISCH
THRES
TRIG
CONT
GND
OUT
R86
1K00
R87
825R
C67
4N7
C68
10N
ISOLATION
V26
SB1400
V27
V29
V30
A8
LP2950
+5VREF
C58
10u
35V
A9
LP2950
+5V
C61
10u
35V
C62
10u
35V
ISOLATION
V35
V37
A10
78L12
+12V
C63
10u
35V
C64
1u0
35V
V38
C65
10u
35V
C66
1u0
35V
A11
7912
-12V
V39
-12Vin
+5VREF
+5V
+12V
-12V
X:1
X:2
-5V
SIL6 Power test connector
FLOATING AREA
DATEX
INSTRUMENTARIUM OY
NIMI
STP BOARD
SIVU
4/4
LAITE
M-ESTP
N:O
ME 4F 880252-2
TARK.
HYV.
MUUTOS
MERKKI
PIIR:
11.02.81 LEJA
HYV
IRLED (2)
IRSAMPLE (2)
IREDAC (1)
IREDDC (1)
C42
100N
R62
1K00
52-2

7 SPECIFICATIONS

M-ETP, M-ESTP

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

M-P

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

7.1 ECG Measurement

7.1.1 Typical Performance

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	
Heart rate range	30 to 230 /min
HR Accuracy	±5 bpm or ±5 %; whichever is greater
Resolution	1 bpm
Heart rate update interval	5 s
Averaging time	10 s
ST LEVELS	
ST level range	-6 to +6 mm (-0.6 to +0.6 mV)
Resolution	0.1 mm (0.01 mV)
ST update interval	5 s
Averaging	calculated from 16 QRS
In learning mode:	
- update interval	beat to beat
- no averaging	

7.1.2 Technical Specifications

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

7.2 Invasive Pressure Measurement

7.2.1 Typical Performance

MEASUREMENT RANGE:	-40 to 320 mmHg
Zero adjustment range	±150 mmHg
Calibration range	±20 %
Scales	-20 to 300, -20 to 225, -20 to 150, -20 to 75, -20 to 30, -20 to 15
Sweep speed on 14" screen	12.5, 25, 50 mm/s
DIGITAL DISPLAY:	
Range	-40 to 320 mmHg
Resolution	±1 mmHg
WAVEFORM DISPLAY:	
Range	-20 to 300 mmHg
PURSE RATE:	
Measurement range	30 to 250 bpm
Resolution	1 bpm
Accuracy	±5 bpm
Respiration artifact rejection	

7.2.2 Technical Specifications

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

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 20 Hz(-3 dB)
Zero set accuracy	±1 mmHg
Calibration resolution	±1 mmHg
Zero time	less than 5 sec
Protection against electrical shock	Type CF

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.

7.3 Temperature Measurement

7.3.1 Typical Performance

Measurement range	15 to 45 °C (59 to 113 °F)
Display resolution	0.1 °C (0.1 °F)
Temperature test	Automatic (every 10 min.) or manual
YSI 400 probe compatible	

7.3.2 Technical Specifications

Measurement accuracy	+0.1 °C (25.0 to 45.0 °C) ±0.2 °C (15.0 to 24.9 °C)
Amplifier accuracy	±0.1 °C (25.0 to 45.0 °C) ±0.2 °C (15.0 to 24.9 °C)
Sensor accuracy	±0.1 °C (15 to 45 °C)
Protection against electrical shock	Type CF

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.

7.4 SpO_2 Measurement

7.4.1 Typical Performance

SpO_2:	
Measurement range	30 to 100 %
Accuracy (% SpO_2 ±1 SD) *)	100 to 80 %: ±2 digits 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
PULSE RATE:	
Measurement range	30 to 250 bpm
Accuracy	30-100, ±5 %, 100-250, ±5 bpm
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.

7.4.2 Technical Specification

Protection against electrical shock	Type BF

*) 1 SD = 68 % of all readings in the specified range in stable conditions.

8 EARLIER REVISIONS

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ADRIAN.

NIBP Module, M-NIBP

TABLE OF CONTENTS PAGE

LIST OF FIGURES PAGE

1 SECTION INTRODUCTION

This service manual section provides information required to maintain and repair the Datex AS/3™ Anaesthesia Monitor NIBP module, M-NIBP. This manual is applicable for the current production revision of the modules. Differences between module revisions are summarized in Chapter 8.

M-NIBP-xx-01 is the initial production revision of the NIBP module.

2 PRINCIPLE OF OPERATION

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)

The NIBP module contains the following main parts:

- NIBP board
- Pneumatics and hosing
- NIBP air pump
- Safety (Overpressure) valve
- Bleed valve
- Exhaust valves (2)
- Pressure transducers (2)
- Module keyboard and status indicator LEDs

3 DETAILED DESCRIPTION OF MODULE

In general

Most of the electronic components inside the NIBP module are placed on a single PC board (160x100 mm). Keyboard and LEDs are connected to the front panel of the module, pneumatic valves and pump are placed inside the module body. The rest of the components including pressure transducers, amplifiers, filters, logics, microprocessor, etc. are placed on the board.

All connections are done via single 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 V (dirty) power line. The supply voltages are generated in and received from the power supply section of the AS/3™ Anaesthesia Monitor.

Communication between the module and the Central Unit is established through RS485 serial interface at 500 kbit/s data transfer rate.

3.1 NIBP Module Board

Pressure transducer

The pressure transducers, B1 and B2, are piezoresistive type Motorola MPX2050. B1 is used for measuring the pressure of the blood pressure cuff and the pressure fluctuations caused by arterial wall movement.

B2 is used as a second source to measure the pressure of the cuff. The measured value is not used for the actual blood pressure calculation, but for various tasks in 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).

Amplification

Two separate pressure transducers are used - one for each cuff hose tube. Transducer B1 is followed by amplifiers A2D and A2C, which together form the first differential stage. This DC1 signal can be read from A/D converter. The DC1 signal is also an input to amplifier A1C. This stage is used to adjust the offset to the pressure safety level where comparator A2A toggles. The oscillometric AC signal is separated from DC1 signal by C4 and amplified with A1A. The AC and DC1 signals are used to calculate the final results. The bandwidth of the amplifiers is determined so that pletysmographic pulses are not distorted.

The other pressure transducer, B2, is followed by differential stage (A1D and A1B). Amplification of DC signals is similar in both channels. Nominal sensitivity of the DC signals is 19.6 mV/mmHg and the AC signal 1.29 V/mmHg.

Analog switch D10 is used to ground the input of the AC amplifier (A1A) in order to diminish recovery time after excessive pulses.

The calibration values for each transducer are stored in EEPROM (D6) and handled by software.

Sampling

A/D conversion is done by 12-bit LTC1290 serial converter A3. The positive supply voltage is +5 V and the negative -5 V, measuring range is from -5 V to +5 V. The positive supply voltage is also used as +5 V reference. Because the -5 V supply is generated from +5 Vref in A2B, possible variations in the reference voltage affect equally for both sensitivity and measuring range of the converter. The only uncompensated voltage drift occurs in resistors R100 and R101.

Four of the eight A/D channels are used for pressure sampling, the rest are used for self-check purposes (power supply, safety circuit, etc.)

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 it is allowed. Pressure limit is specified to 15mmHg. The level is set with the trimmer which gives offset level of A1C. The output of A1C is input of comparator A2A. When the cuff pressure is above the threshold limit, timer D12 reset is disabled by comparator A2A. As soon as the pressure rises over 15 mmHg, the 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. Timer test can be done faster by shorting pins 1 and 2 in X7, after which the delay time is divided by 256. The timer can be disabled by switch S1. The switch S1 disables the pump.

Microprocessor

The NIBP module is controlled with 80C51FA microprocessor D1 which uses 16 MHz oscillator frequency. One of the PWM outputs (P1.3) is used to drive the pulse valve, pin P1.7 is reserved for internal watchdog in FA-type processor programmable counter array field.

Current program memory (EPROM, D2) size is 64k x 8 bit but also 128k x 8 bit memories can be used. The additional address line A16 is written via EPLD chip D5. RAM (D3) size is 32k x 8 bit and EEPROM (D6) size 64 x 16 bit. EEPROM can be divided into protected and unprotected areas. The EEPROM 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

Memory map:

0000H	RAM 32k	
8000H	Write register	D7 (Pump, valve and LED control)
8000H	Read register	D8 (Switches)
C000H	Write register	D5 (Memory page, timer control, AC-reset)

In addition to external RS485 reset line the microprocessor system is equipped with its own power-up reset.

Control

Software control of the valves, the pump and the LEDs is done by D7 (74ACT374). In addition to the individual on/off signals for each component there is a common power switch (pow_off) for the valves and the pump that can be used at pump/valve failures. Decoding of the control lines is done with two programmable logic devices (GAL) D8 and D5. D8 is used for address decoding, switch reading, power surveillance, EEPROM write-protect detection and timer mode detection. Similarly, D5 is used to control program page selection (A16), timer reset, pump and valve power control, and AC-channel grounding.

Pressure safety level check

Pressure safety level detection can be checked in Service Menu. When pressure (generated by external manometer) inside module exceeds safety level (adjusted to 14 mmHg) the state of the signal at AD5 on the NIBP Service Menu/Pneumatics Menu should change from negative to positive value. If the change doesn't occur within ± 5 mmHg, the triggering limit value needs to be adjusted. See the following Chapter for the adjustment.

NIBP tubing lengths

There are two different tubes used in the NIBP tubing system. They are silicor tubes 1.7 x 1 (part number 73373) and 3.18 x 6.35 (73375). When ordering, please specify the part number and length(s) required.

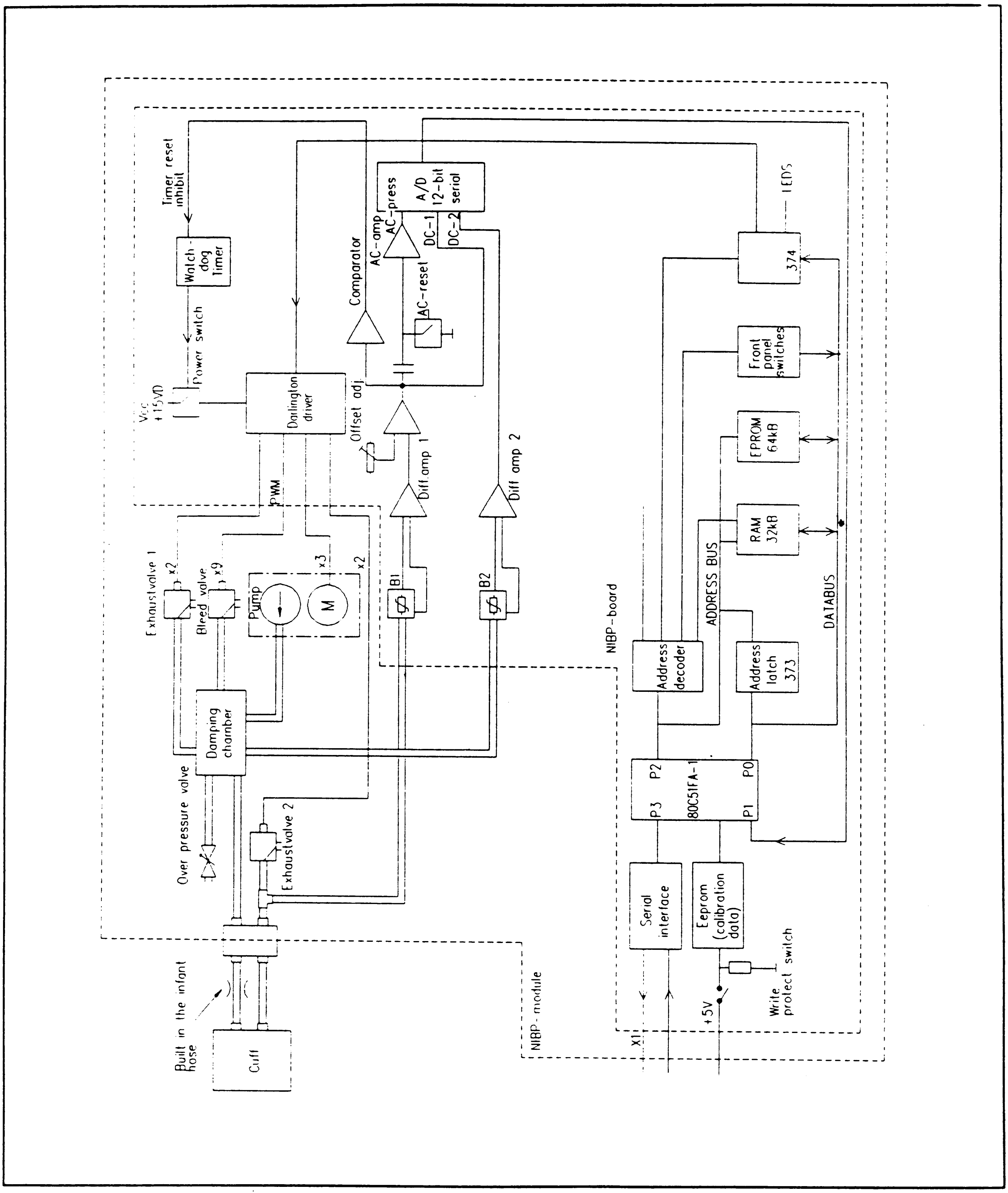

Figure 1 Functional Block Diagram

3.2 Adjustments and Calibrations

3.2.1 Adjustments

Pressure safety level detection "OFFSET"

Remove two screws at the rear of the module. Take the module box away. Connect first the service cable to the module connector inside the Central Unit and then to the rear connector of the module. Go to the NIBP Service Menu and select "Pneumatics". Pump reference pressure (14 mmHg) to the chamber. Adjust the trimmer R15 to position where AD5 signal toggles from negative to positive value.

3.2.2 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 it is allowed, 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.

For adaptation Germany (-70-), the calibration check is also possible in NIBP Set-up menu by selecting NIBP, NIBP-Einstellung, and Kalibr. prüfen. In this case the autozeroing is performed at start - remove hose before entering to ensure atmospheric pressure to the pressure transducers - the primary pressure (B1) is displayed. The zero-offset value should then be zero.

1. Calibration check

1. Enter "Calibration" in NIBP Service Menu.
2. Connect external precision manometer to the module and press the ComWheel.
3. Pump the following pressures to manometer and check the difference between the manometer and monitor pressure display:

Pressure	Max. error
0 mmHg	±9 mmHg (=zero offset)
100 mmHg	100 + zero offset ±2 mmHg
200 mmHg	100 + zero offset ±3 mmHg

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

2. Calibration

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

1. Enter "Calibration" in NIBP Service Menu.

2. Selection "Calibration" is in normal letters.

   In adaptation Germany (-70-), this "Calibration" selection is hazed and disabled. To enable calibration first keep pushing the button (or turn toggle switch to the right) at the bottom of the module. This enables "Protection". Select Protection OFF and give the ComWheel a click. Then release the button (or turn the toggle switch to the left). "Calibration" is now enabled. Calibrate as described in steps 3 to 6. After that, push the button (or switch to the right) and select "Protection" ON by clicking the ComWheel. Finally release the button (or switch to the left).

3. To enable proper zeroing, remove hoses from 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.

4. Connect an external mercury manometer with pump to module and pump up to pressure 200 mmHg according to the manometer. Verify the pressure calibration value in the pressure bar beside the word "Calibration".

5. Adjust, by turning the ComWheel, the calibration value to be equal to the pressure value of the manometer. When the values are equal, click 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.

6. The new calibration can be verified by performing Calibration Check (see the preceeding page).

3.3 Connector Configuration

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

Pin No	I/O	Signal	Notes
1	O	RESET_RS485	
2	I	-15 VDC	
3	I	+15 VDIRTY	
4	I	+15 VDC	
5	O	-DATA_RS485	
6	O	DATA_RS485	
7		Ground & Shield	
8	O	-RESET_RS485	
9	I	CTSB	
10	O	RTSB	
11	I	RXDB	
12	O	TXDB	
13		Ground & Shield	
14	I	+24 VDIRTY	
15	I	GroundDIRTY	
16	I	CTSC	
17	O	RTSC	
18	I	RXDC	
19	O	TXDC	
20	I	ON/STANDBY	
21	I	BIT0IN	
22	I	RXDD_RS232	
23	O	TXDD_RS232	
24	I	+5 VDC	
25	I	+5 VDC	

4 SERVICE AND TROUBLESHOOTING

4.1 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.

4.2 Disassembly and Reassembly

The NIBP module is disassembled in the following way. See Figure 3 for 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 plastic cover can be lifted off. NIBP pump, safety (overpressure) valve, and valve unit which includes two valves, wires and a connector will be exposed. They can be removed.

f) Pulse valve can be pulled out from the bottom of the NIBP frame.

g) Reassembling is essentially reversing what was described above.

NOTE: Care has to be taken that the connectors and especially the tubes are reconnected properly and to the right ports.

CAUTION: Before reattaching the module box make sure that the tubes are not pinched between the NIBP frame and the PC board.

4.3 NIBP Module Troubleshooting Flow Chart

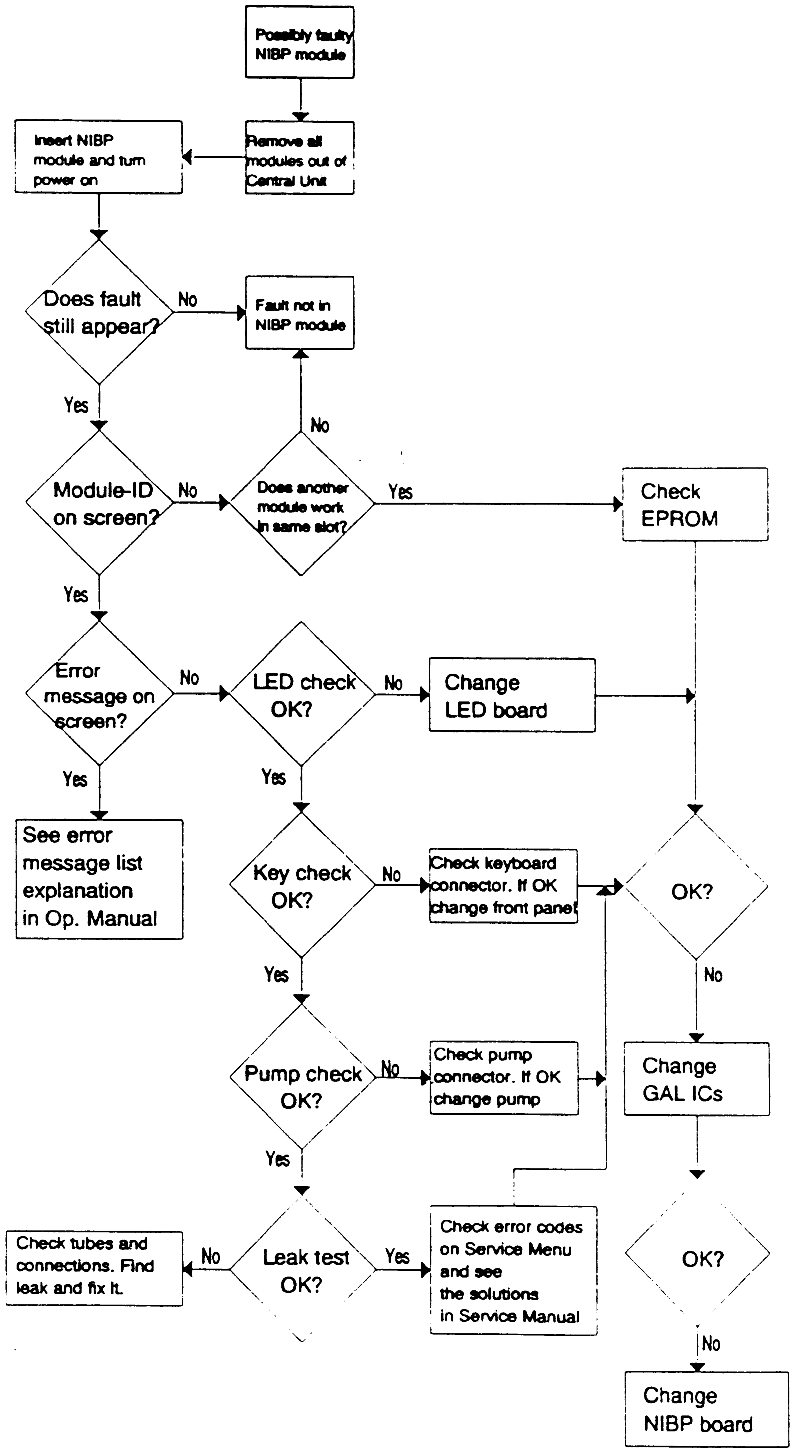

Figure 2 NIBP Module Troubleshooting Flow Chart

4.4 Troubleshooting Chart

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

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.	
Low pulse signal-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.

TROUBLE	CAUSE	TREATMENT
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 pump. - 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.
Inflation limits! Check setup-message	Adult or pediatric cuff is used in infant mode measurement restricts the inflation pressure too low to be able to measure the blood pressure.	Choose proper selections and perform the measurement.
Unstable zero pressure-message	(a) Hose and cuff connected. Reason: - movement artifacts at start of measurement. (b) Hose and/or cuff detached. Reason: - fault in pressure transducer. - fault in A/D converter. - faulty calibration.	(a) - remeasure. (b) - replace the NIBP board. - check calibration. Recalibrate.
Call service. Error X-message	NIBP hardware error. X= error number	See the description of the error message codes, their causes and solutions listed after this chart.

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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).
Systolic not found-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.	(a) - straighten tube. - remove occlusion. (b) - replace the NIBP board. - check calibration. Recalibrate.

ERROR MESSAGE CODES

CODE	EXPLANATION
0	RAM failure Check short circuits in data and address busses. Check/change decoder circuit D8. Check/change RAM circuit D3.
1	ROM checksum error Check/change ROM circuit D2. Check short circuits in the data and address busses.
2	+15V failure Check short circuits. Check/change faulty components.
3	-15V failure Check short circuits. Check/change faulty components.
4	EEPROM protection switch error Check/set jumper to X12. Check/change switch S1.
5	Calibration not protected (in adaptation Germany (-70-) only) Protect calibration by selecting Protection ON in the NIBP Calibration Menu.
6	ADC error Check ADC A3/pin 20 is +5V. Check that a waveform is observed in analog input pin of ADC. Check transistor V111 and resistor R200 are OK. Check/change ADC A3. Check/change prosessor D1.
7	Watchdog time too short Check/change R31 and C28. Check/change timer D12. Check/change GAL D5.
8	Watchdog time too long Check/change R31 and C28. Check/change timer D12. Check/change GAL D5.

9 Watchdog activated

Check/set triggering level of PRESS_ON signal (see Pressure safety level check in Chapter 3: Detailed Description of Module).

Check/change R31 and C28. Check/change timer D12. Check/change GAL D5.

10 EEPROM checksum error

Check/change EEPROM IC D6.

11 Autozero range exceeded

Recalibrate. Check/change pressure transducer(s) B1 and/or B2. Calibrate pressure after changing.

4.5 Error Codes

The error codes are displayed in the Service Menu. They are explained below. **Note that those codes are different from those error message codes appearing on the normal screen.**

Many of the error codes are harmless. However, some of them may indicates problems. The codes over 70 may lead to cancellation of all measurements.

0 = OK
40 = Normal start-up code. OK
50 = Zero error. May be caused from erroneous calibration
51 = Cuff loose
52 = Air leakage
53 = Too long measurement cycle (2/1 minutes)
56 = Overpressure during measurement
59 = Insufficient data for pressure calculation
60 = Low inflation pressure
63 = Diastolic not found
66 = NIBP stopped. Normal after stop command
67 = Cuff occlusion
70 = RAM failure
71 = ROM checksum failure
77 = Watchdog time too short
78 = Watchdog time too long

4.6 Preventive Maintenance Check List

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

___: 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 manometer to the connector. Check the following pressures.

Manometer	Allowed values on display
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 (except for adaptation Germany -70-).

___: Start with zero pressure. Pump pressure of 200 mmHg. As soon as the pressure rises over 15 mmHg, watchdog timer starts counting. After 120 to 140 seconds, the watchdog release the pressure of 200 mmHg to zero. Check the time with a stopwatch.

___: 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.

___: 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, 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. The opening pressure of Safety valve is displayed at B1 and B2 (the shown values are actual pressures multiplied by 10). Stop the pump. Select Open exh1 and observe the pressure drops to zero within 10 seconds. Repeat the procedure and select Open exh2. The pressure should drop to zero within 10 seconds.

___: Connect normal 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.

___: 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.

___: Wrap the normal adult 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.

5 SPARE PARTS

5.1 Spare Parts List

NOTE: Accessories are listed in the Operator's Manual.

Item	Item description	Order No.
8	NIBP board	*880359
7	GAL IC D8	879866
12	GAL IC D5	880864
11	NIBP frame	880427
15	Plastic pump cover	879176
14	Pump	*880363
22	Pulse valve	880365
21	Magnetic valve	58534
20	Port plug for mag valve	58535
13	Safety valve (overpressure valve)	877109
4	Front panel unit	881335
16	Front panel sticker (Eng)	879482
16	Front panel sticker (Fre)	880159
16	Front panel sticker (Ger)	880476
17	LED board	880361
18	Hose connector	64654
1	Module box (wide)	879096
3	Latch for module box	879181
2	Spring pin for module box	879182
6	Software NIBP (Eng)	880399
6	Software NIBP (Germany)	880400
5	Cross recess screw M3x8	61622
10	Cross cylinder-head screw M3x10	628703
9	Cross cylinder-head screw M3x20	628709
19	Cross cylinder-head screw M2.5x6	628707

Item number refers to the exploded view in Figure 3.

See ESTP Section for the exploded view of Module Box.

* = the part is recommended for stock.

5.2 Exploded View of Module

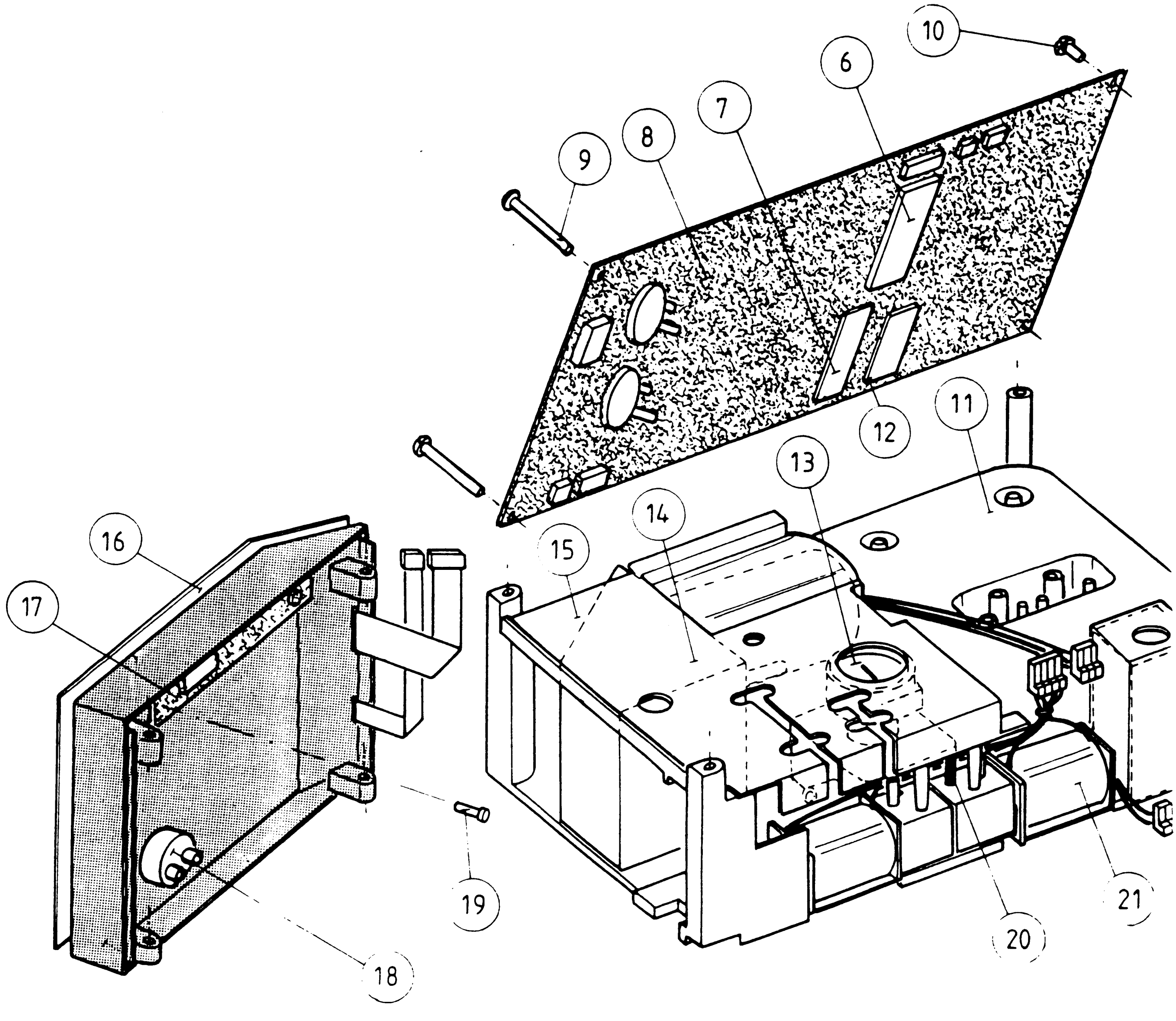


Figure 3 Exploded View of NIBP Module

6 CIRCUIT DIAGRAM AND PARTS LAYOUT

Figure 4 LED Board Parts Layout

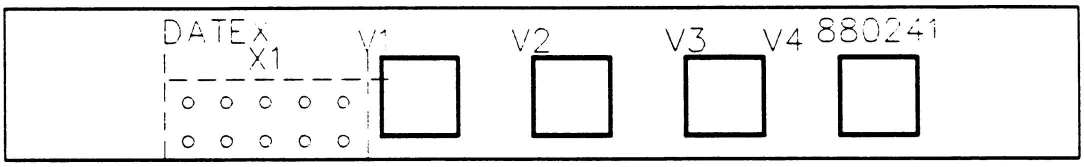


Figure 5 Motor Board Parts Layout

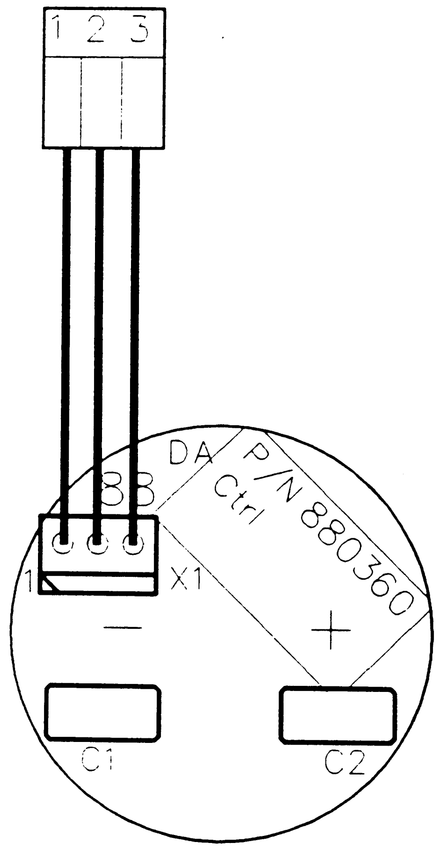
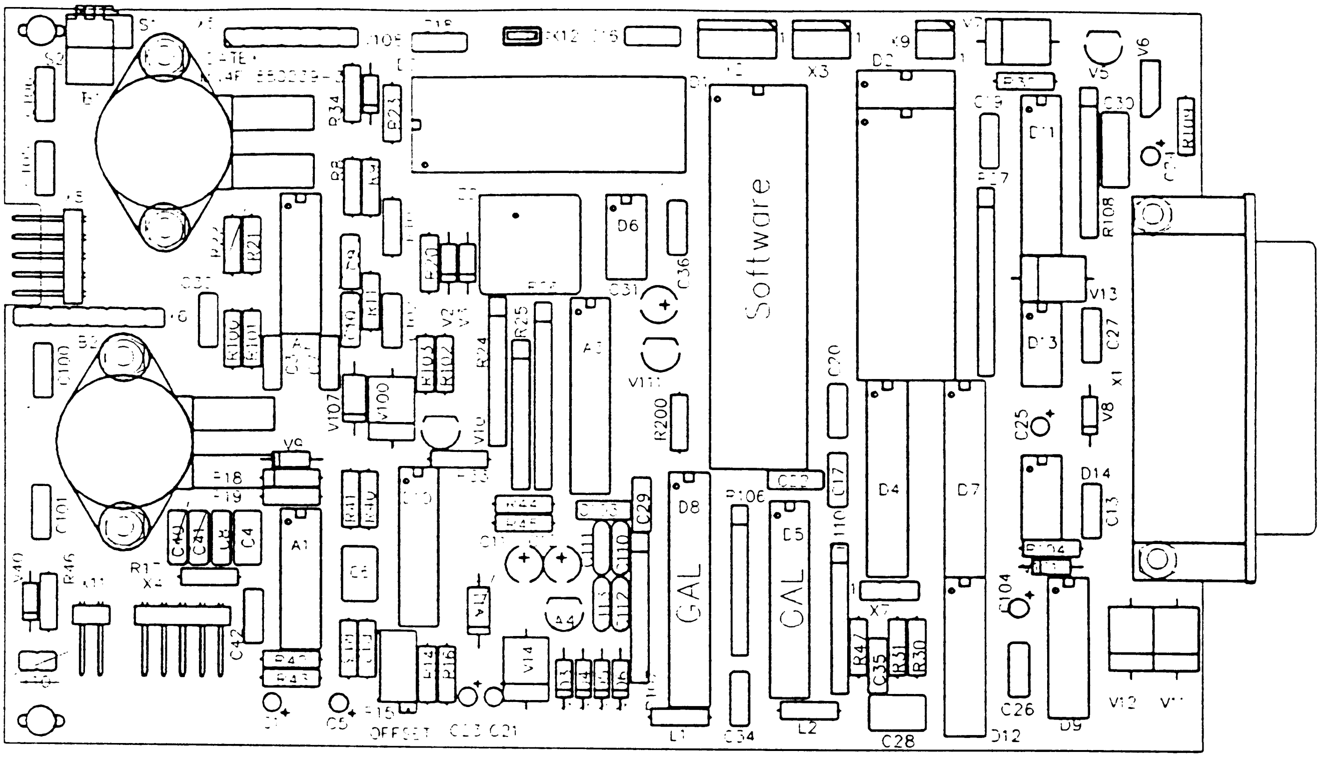
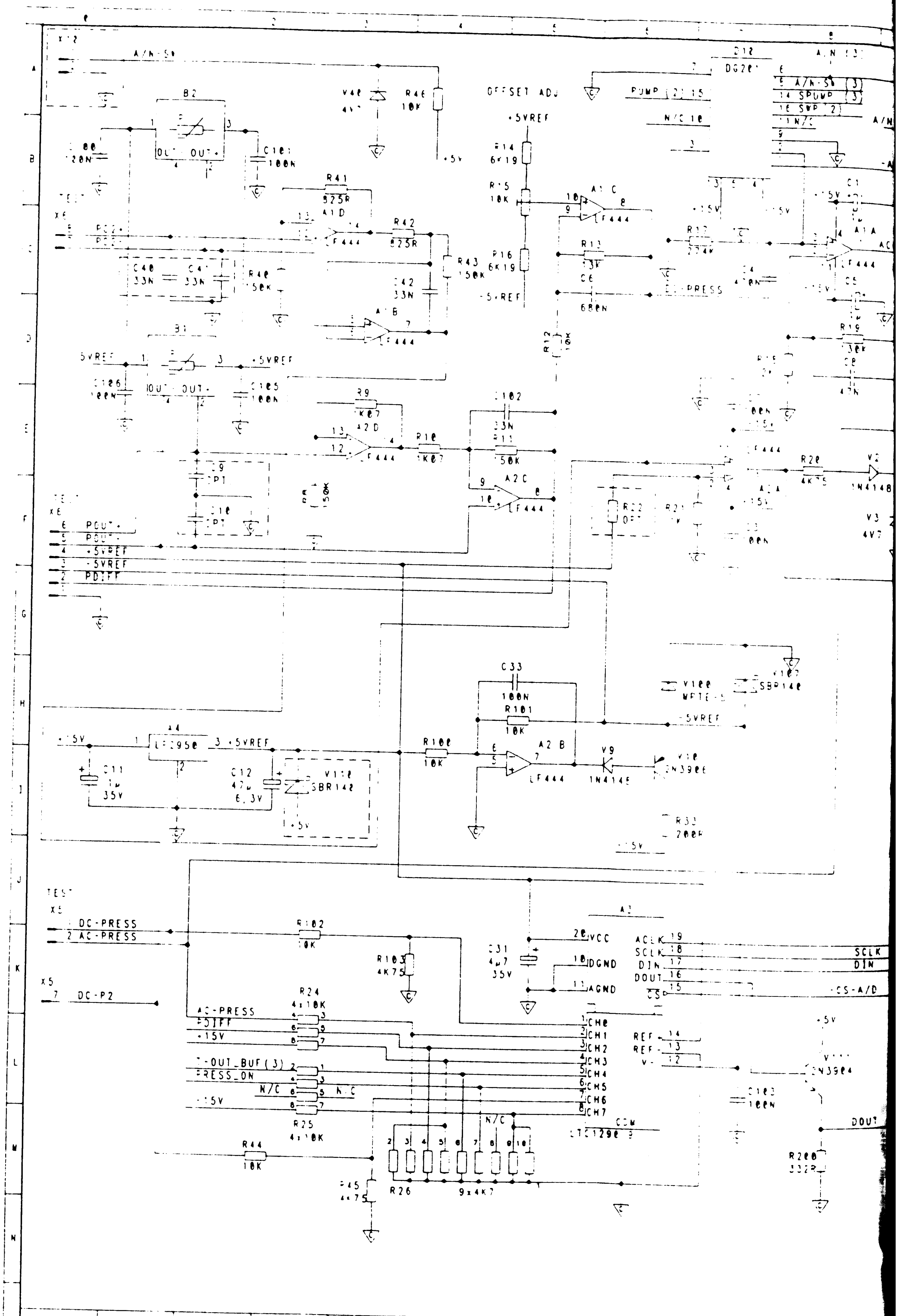


Figure 6 NIBP Board Parts Layout and Schematic Diagram (Part 1)





10.03.92PeIe			6585	-3	DATEX	NIMI	LAITE
24.02.92PeIe		10.3.92Leke	6539	-2		NIBP BOARD	SIVU 1/2
05.02.92PeIe			6488 6331 6386	-1			
MUUT	TARK	HYV	MUUTOS	MERKKI	INSTRUMENTARIUM OY	28.08.86 PT TARK HYV	N:O MN 3B 8

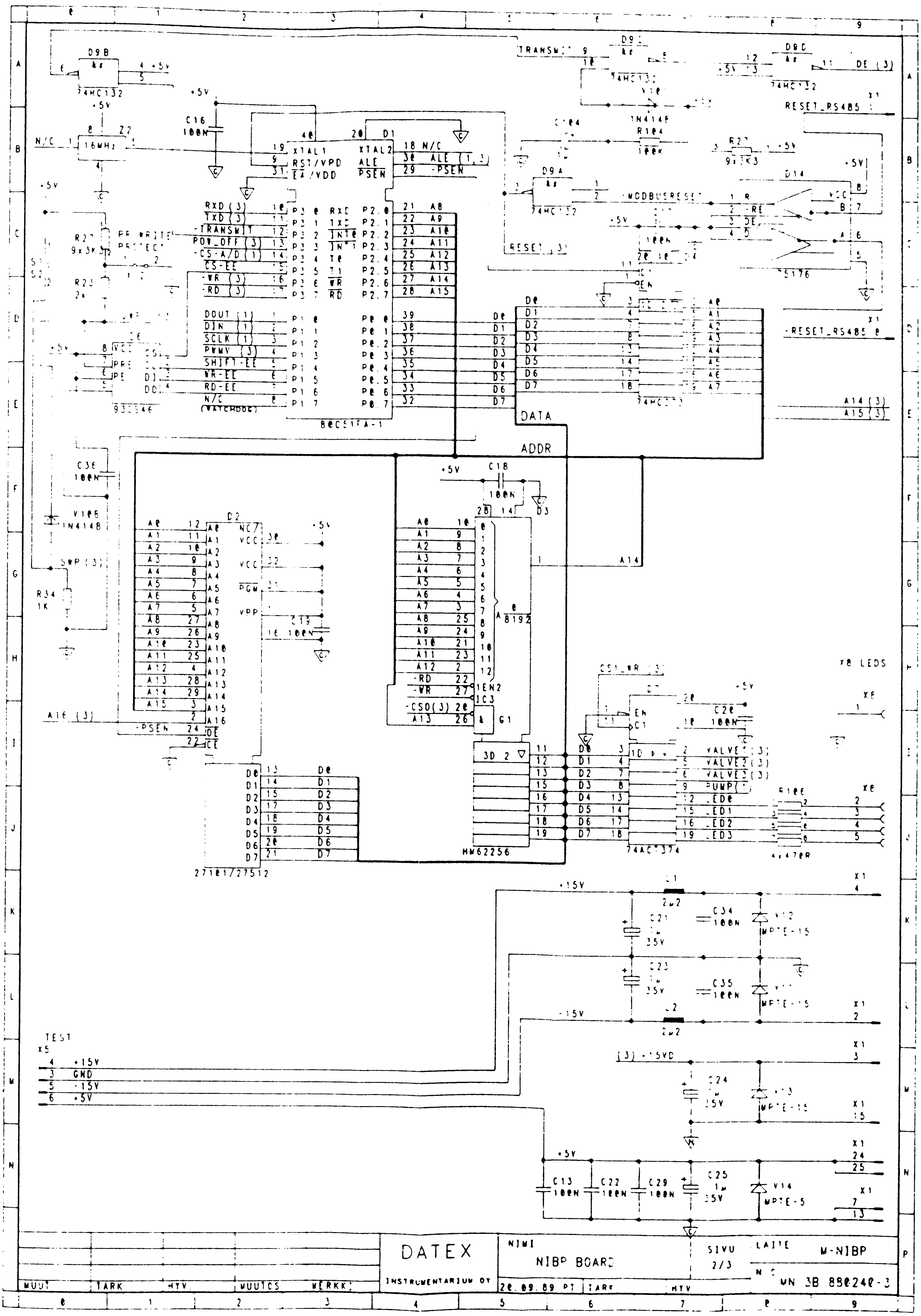
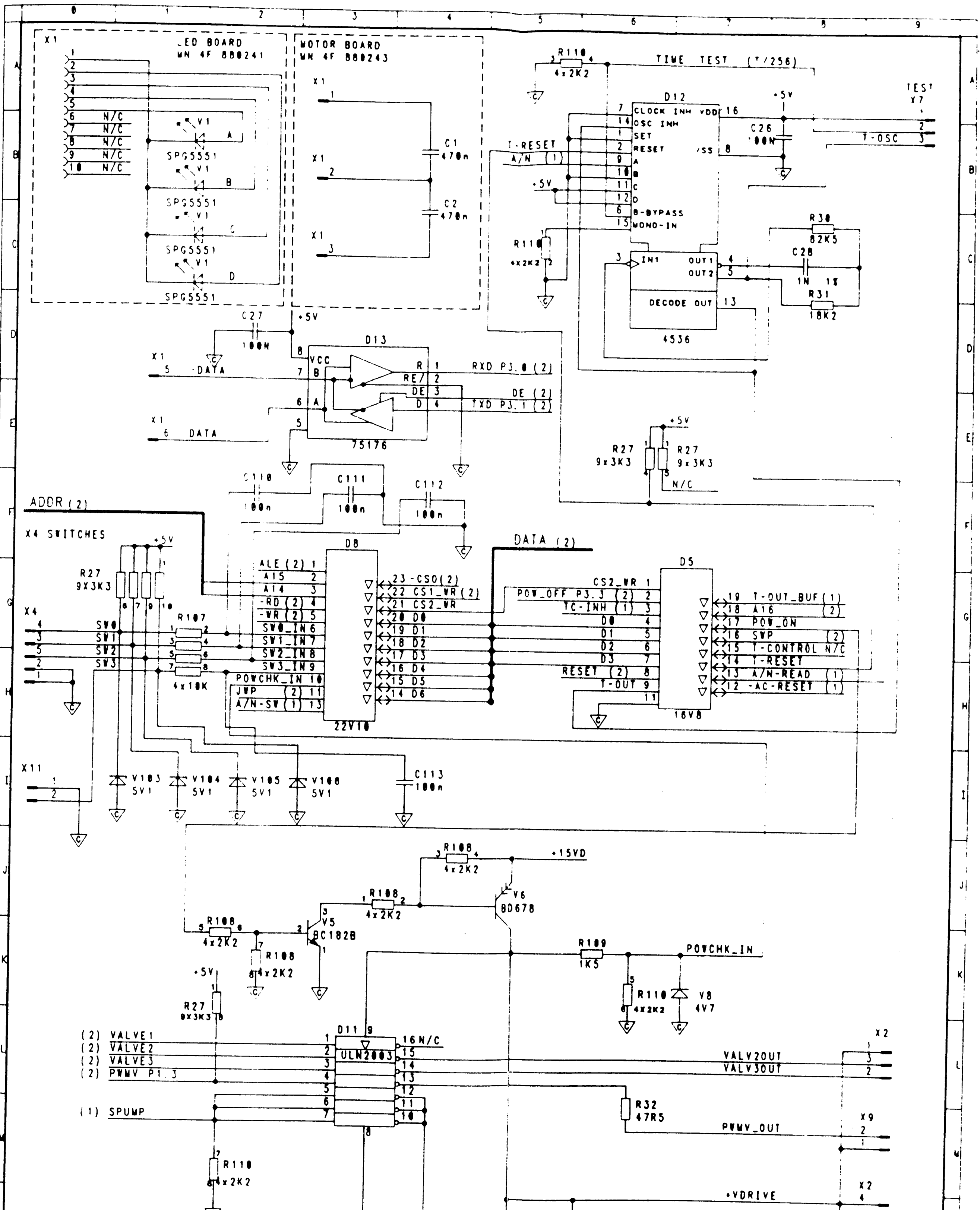

DATEX
INSTRUMENTARIUM OY
NIMI
NIBP BOARD
SIVU
2/3
LAITE
M-NIBP
20.09.89 PT
MUUT
TARK
HTV
MUUTOS
MERKKI
UN 3B 880240-3
80C51FA-1
HM62256
27101/27512
74HC374
74ACT374
74HC132
93C46
75176
16MHz
DATA
ADDR
TEST
X5
+15V
GND
-15V
+5V
X1
X8
X8 LEDS
RESET_RS485
-MODBUSRESET
TRANSMIT
PF WRITE PROTECT
MPTE-5
MPTE-15
1N4148
PRESS_ON

Figure 7 NIBP Board Schematic Diagram (Part 2)



DATEX INSTRUMENTARIUM OY	NIMI NIBP BOARD	SIVU 3/3	LAITE M-NIBP	N:O MN 3B 880240-3
MUUT. / TARK. / HYV. / MUUTOS / MERKKI	20.09.89 PT / TARK. / HYV.			

7 SPECIFICATIONS

7.1 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 mmHg
	child	150 mmHg
	infant	120 mmHg
Venous stasis		
	adult	80 mmHg / 2 min
	child	60 mmHg / 2 min
	infant	40 mmHg / 1 min
Cuff widths	Large adult	15 cm
	Standard adult	12 cm
	Small adult	9 cm
	Child	6 cm
	Infant	5 cm
	Infant	3 cm

7.2 Technical 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
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 mmHg
child	200 mmHg
infant	150 mmHg

Overpressure 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.

Next inflation pressure after a message systolic 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

8 EARLIER REVISIONS

Airway Module, G-AO

Airway Module, G-AiO

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LIST OF FIGURES PAGE

LIST OF TABLES

1 SECTION INTRODUCTION

This service manual section provides information required to maintain and repair the Datex AS/3™ Anaesthesia Monitor Airway Modules, G-AO and G-AiO. This manual is applicable for the current production revision of the modules. Differences between module revisions are summarized in Chapter 8.

G-AO-xx-01 and G-AiO-xx-01 are the initial production revision of the Airway modules.

2 PRINCIPLE OF OPERATION

2.1 Principle of 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 shows the CO_2/N_2O/AA gas absorption spectra.

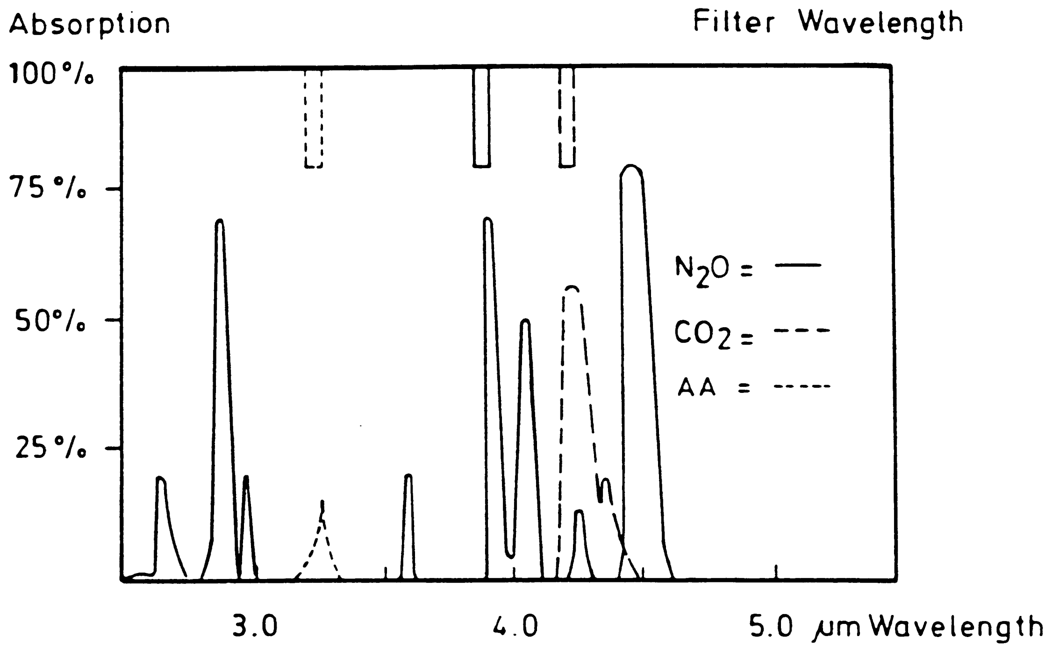


Figure 1 CO_2/N_2O/AA Gas Absorption Spectra

2.2 Principle of O_2 Measurement

The differential oxygen measuring unit uses the paramagnetic principle in a pneumatic bridge configuration. The signal picked up with a differential pressure transducer is generated in a measuring cell with a strong magnetic field that is switched on and off at a frequency of 165 Hz. The output signal is a DC voltage proportional to the O_2 concentration difference between the two gases to be measured.

2.3 Principle of Agent Identification

The anesthetic agent identification bench identifies halothane, enflurane and isoflurane.

The operation of the bench is based on infrared absorption at 3.3 μm range. It measures the spectrum of the gas between 3.24 μm and 3.39 μm. Because the spectrum of each of the anesthetic 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 spectrums.

Figure 2 shows the absorption spectra of anesthetic agents.

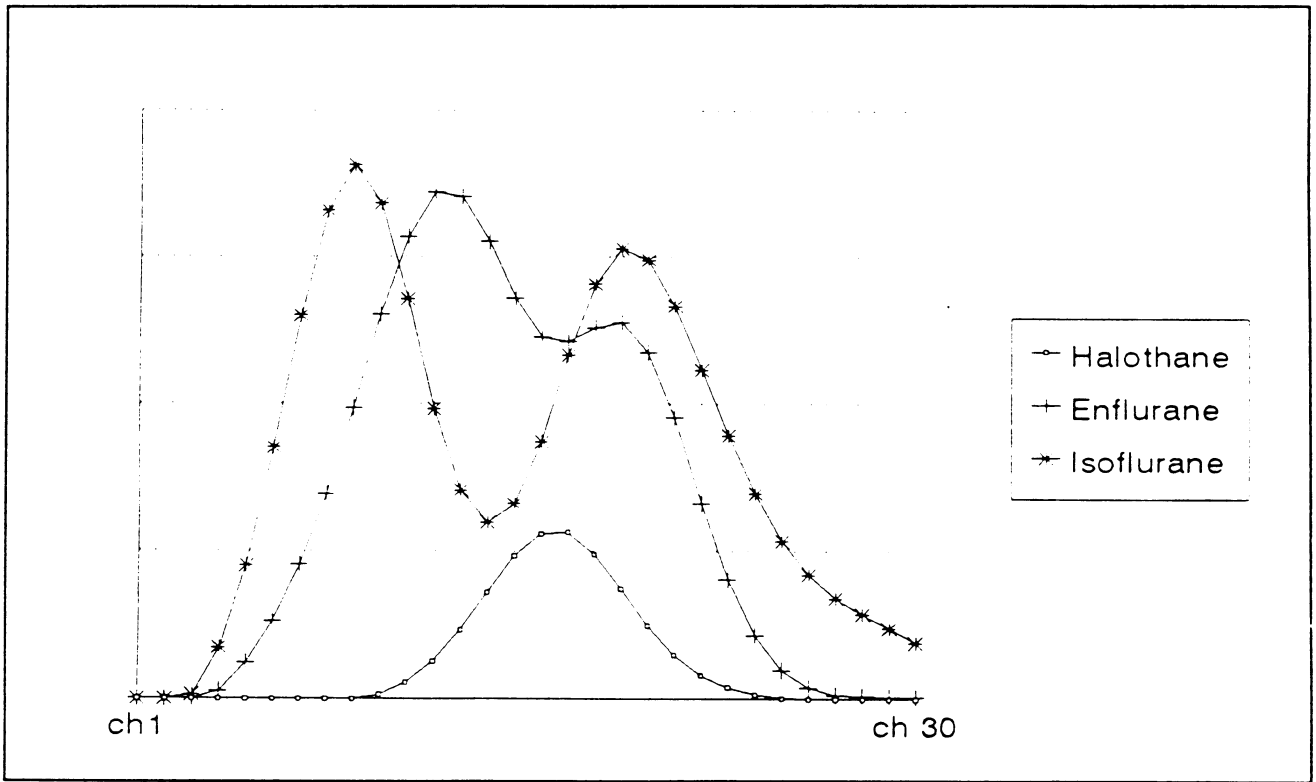


Figure 2 **Anesthetic Agents Gas Absorption Spectra**

3 DETAILED DESCRIPTION OF MODULE

3.1 In General

The Airway module contains ACX-200 and OM-101 gas measuring units, ASX-100 agent identification unit (G-AiO model), tubings, a sampling pump, ACX Measuring board, ASX Measuring board, and Gas Mother board.

A sampling line is connected to the water trap on the front panel. The pump inside the module draws gas from patient circuit 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.

The Gas Mother board contains a processor with which functions within the module are controlled. The board controls power supply to each measuring unit and serial communication between module processor and ACX Measuring board. There are connectors for the pump, valves, and gas measuring units on the board.

ACX-200 Measuring unit transmits gas values measured in its chamber to the module processor. The module processor detects FI- and ET-values from the data and pass them on to the main CPU board.

During gas zeroing, room air is drawn into the ACX measuring unit via zero valve through CO_2 absorber. The module processor performs the gas zero point adjustments.

During calibration, the module processor sets the calibration values given by user.

The module processor controls the sampling pump with 50 Hz pulse-width modulated signal. It also controls infrared lamp inside the ACX-200 and ASX-100 chambers.

ACX Measuring board controls the valves. The module processor is also able to give control commands to the ACX Measuring board.

Communication between the Airway module and the main CPU board takes place in serial communication bus which is connected to module bus via RS-485 bus buffer.

Communication to the measuring units inside the module takes place in 4-channel serial communication IC controlled by the module processor.

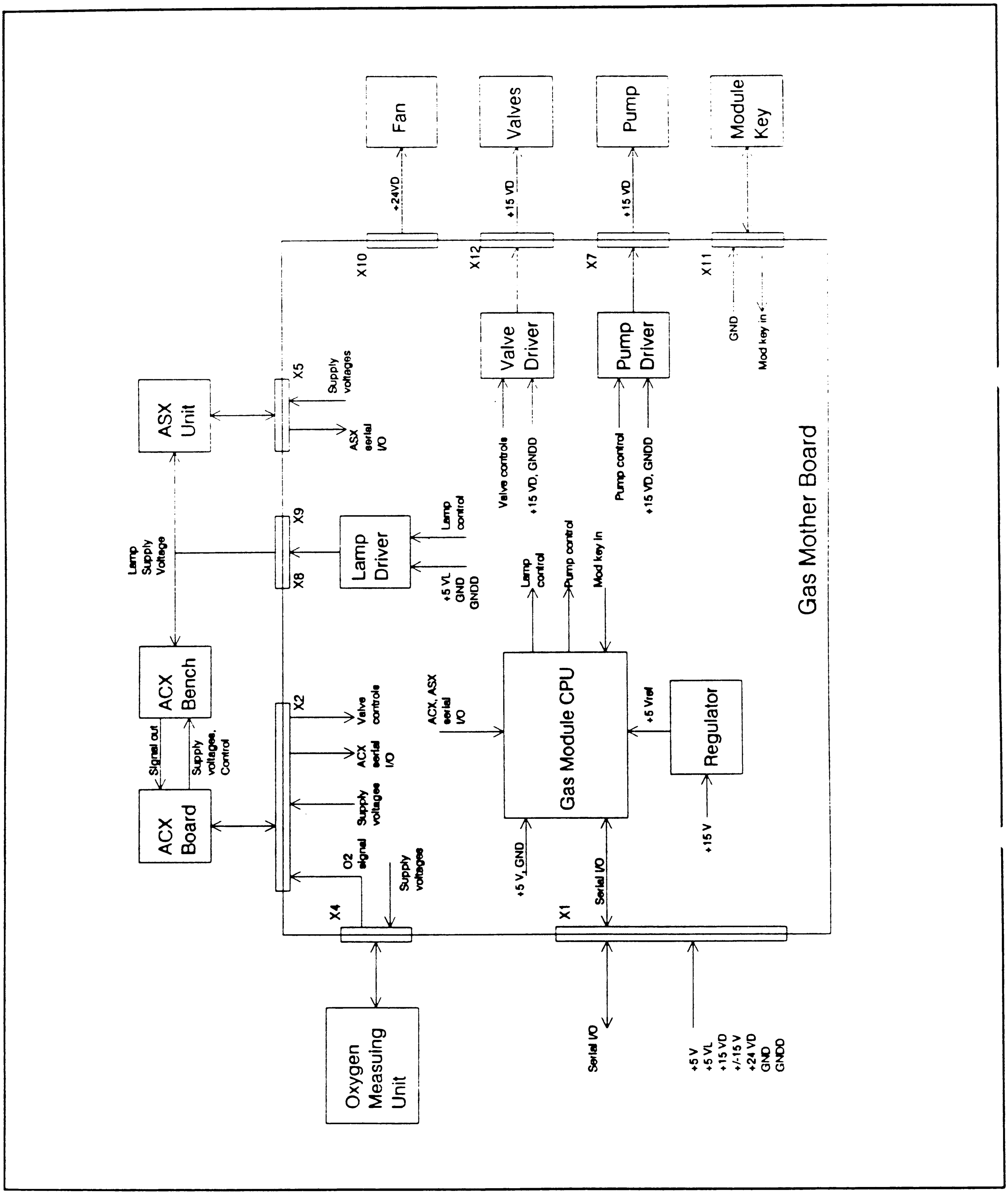


Figure 3 Airway Module Block Diagram

3.2 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 sample gas enters the monitor through the water trap, where it is divided into two flows, main flow and side flow (see Figure 4). The main flow goes into the measuring system (described in Section 3.3). This flow is separated from the sample in flow by a hydrophobic filter.

The side flow creates a slight sub-atmospheric pressure within the collection bottle which causes fluid removed by the hydrophobic filter to collect in the bottle.

Sampling line

The sampling line is an integral part of the total sampling system. The resistance established by the sampling line is used by the software to set the flows and pressures 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 4) 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 (G-AiO) or between the zero valve and ACX-200 measuring unit (G-AO). The tube is also inserted between the CO_2 absorber and the zero valve.

Zero valve

The main flow passes through a magnetic 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 at 30 minutes after start-up. After 1-hour monitoring, the auto-zeroing is performed once an hour. When the valve is activated, room air is drawn 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. See Section 3.3.2 for a detailed description of this unit.

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 pressure differential transducer to compare the pressure gradient produced when both gases are exposed to an oscillating magnetic field. See Section 3.4. Both gas flows exit from a single port.

In G-AiO 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 every 15 minutes. If the gradient is greater than -5 mmHg, the software causes the message "REPLACE TRAP" to be displayed.

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.

Table 1 Flow Cassettes

FLOW CASSETTE	CODE	
50/26.0	878048	$52.36
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 most resistance	873812	$30.38

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.

3.3 CO_2/N_2O/AA Measurements

3.3.1 In General

The measuring electronics block diagram is in Figure 6. The functions are divided between the ACX-200 Measuring unit (photometer) and the ACX Measuring board.

3.3.2 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.

The ACX photometer is shown in Figure 7.

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 anesthetic 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.

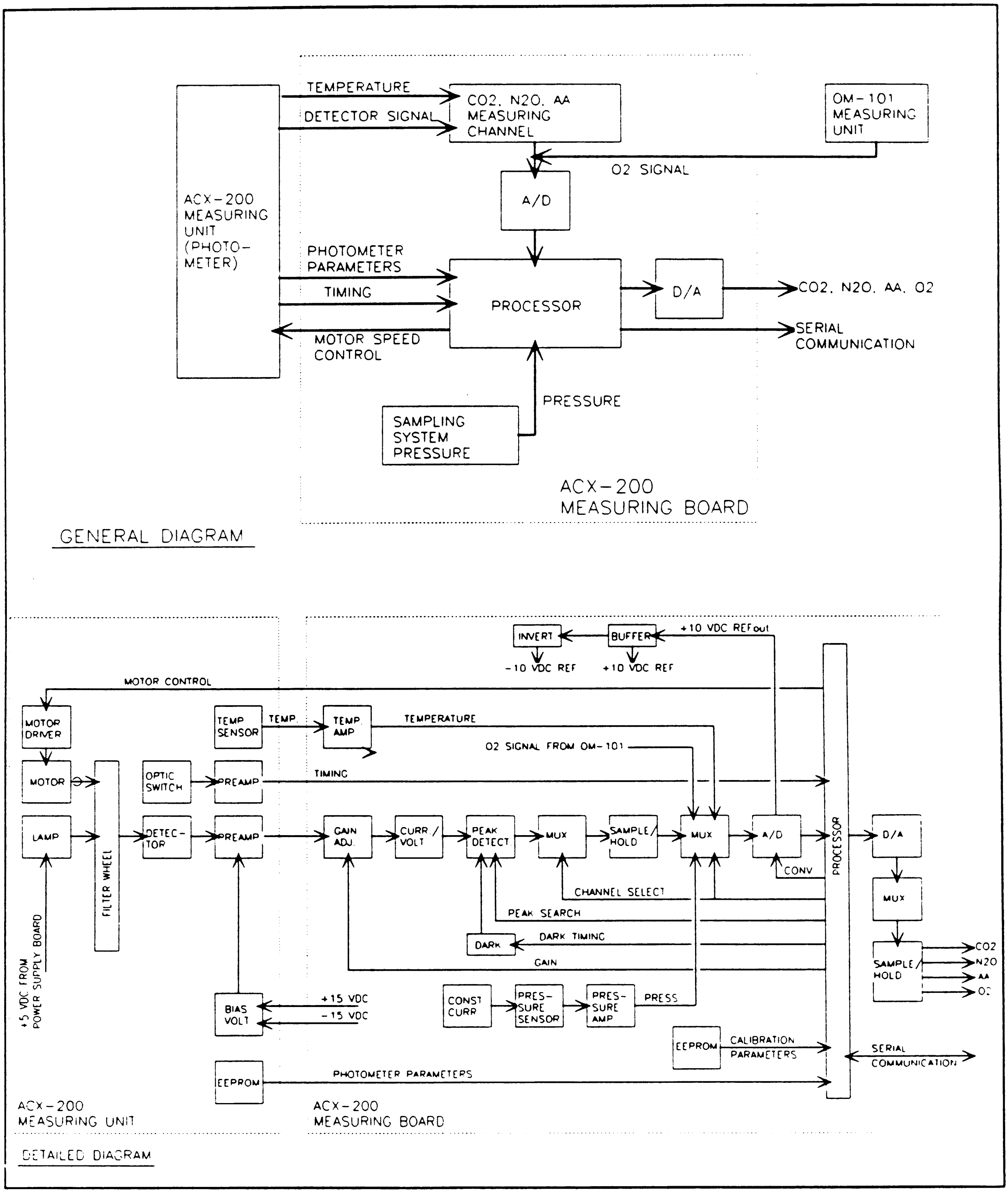


Figure 6 CO_2/N_2O/AA Measurement Block Diagram

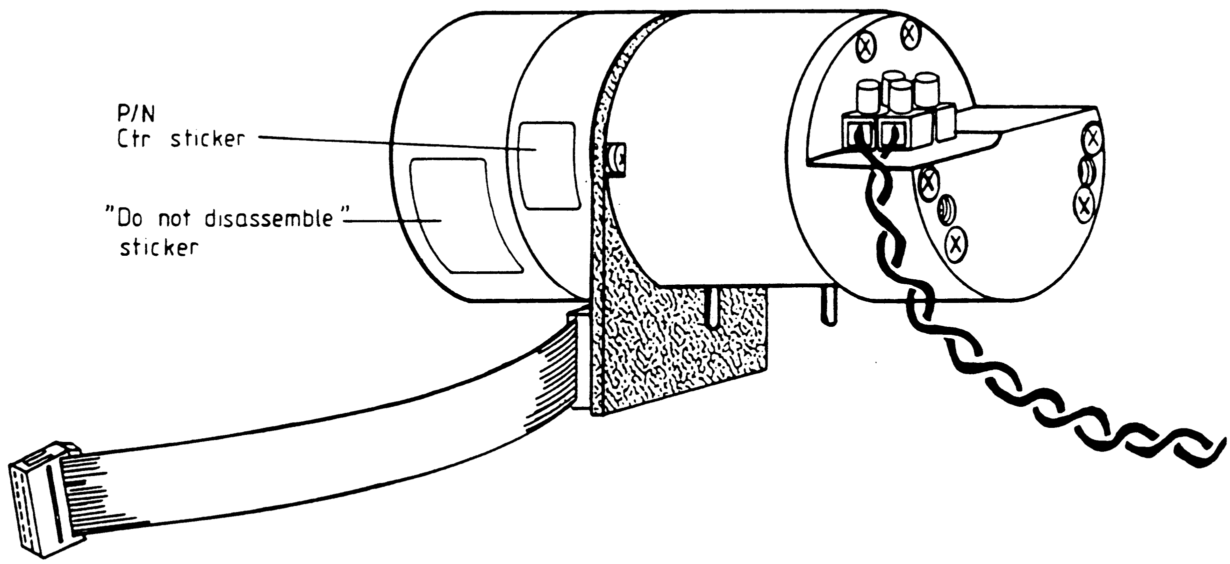


Figure 7 ACX Photometer (ACX-200 Measuring Unit)

3.3.3 ACX Preamplifier Board

Voltage regulation

Voltage regulators A3 and A4 provide regulated ±12 V for the preamplifiers and the detector bias generator.

Preamplifiers

The purpose of preamplification is to amplify the signals from the infrared detector and timing sensor and to convert them into lower impedance level.

The infrared detector (R2) signal is amplified with A2A which is connected as a straightforward non-inverting AC amplifier.

The current signal from the timing optical sensor is converted into voltage with the remaining section of A2.

Detector bias generator

The lead selenide detector is a resistor, whose resistance decreases in infrared light. For this reason it is advantageous to supply the detector with a high bias voltage, as a higher signal is then achieved.

The bias voltage generator utilizes one section of A1, which is a square wave oscillator, and a conventional voltage doubler built of diodes V1, V2, V3, and V5 and capacitors C1 through C4. The circuit produces an output voltage of approximately ±34 V.

Temperature measurement

The voltage across the 2.1 V stabilizing diode V14 decreases as the temperature of the photometer rises. This voltage signal is used for temperature compensation.

EEPROM

EEPROM D1 stores the photometer factory set gain and zero coefficients and compensation factors.

Filter wheel motor control

A stepper motor rotates the filter wheel at approximately 83 revolutions/second. Stepper motor is driven by D2.

3.4 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 165 Hz.

An alternating differential pressure is generated between the sample and reference inputs due to forces acting to the oxygen molecules in a magnetic field gradient.

The pressure is measured with a sensitive differential transducer, rectified with a synchronous detector and amplified to produce a DC voltage proportional to the oxygen partial pressure difference of the two gases.

CAUTION: Due to the complicated and sensitive mechanical construction any service inside the O_2 measuring unit should not be attempted, and therefore the detailed description of the circuitry and layout of the transducer is omitted from this manual.

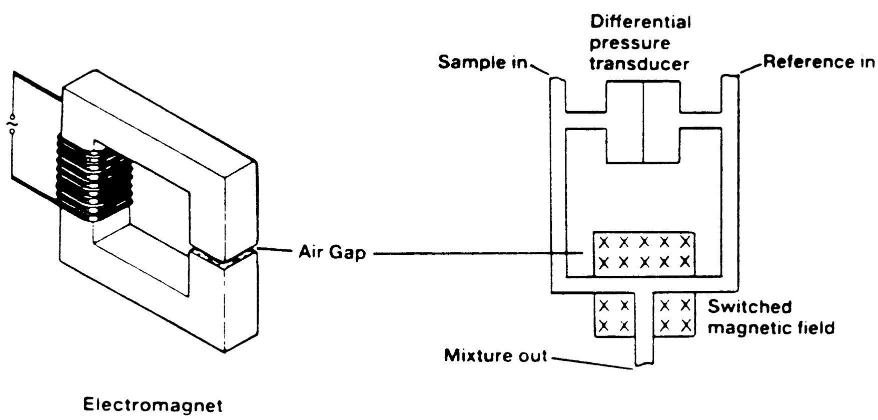


Figure 8 O_2 Measurement Principle

3.5 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: Do not attempt to repair or replace the pressure transducer (B1). Its calibration values are stored in EEPROM (D2) and can be programmed only at the factory.

The ACX Measuring board controls gas measurements. It converts the photometer signal to 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 D1, 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. The external bus is driven by D21 (data lines), D3 (address lines) and D18 (read and write lines).

Memory

Memory components include 64 x 8 kbit program memory EPROM (D4), 32 x 8 kbit low current CMOS RAM (D22) powered by a data retention voltage generation circuit in Power Supply board, and EEPROM (D2) for permanent calibration values and setup memory.

Reference voltages

Reference voltages are established by the A/D-converter (D14) reference voltage output (REFOUT, pin 8). This +10 V voltage is buffered by A2D. -10 V reference voltage is obtained by inverting and buffering +10 V with amplifier A2C.

O_2 measuring electronics

The signal from the O_2 measuring unit is sent to pin a9/X1 and processed in the processor and passes to the Gas Mother board at a5/X1.

CO_2, N_2O, and AA measuring electronics

CO_2, N_2O, and anesthetic agent measurement is accomplished by measuring each of these gases from the reference and measuring chambers of the ACX-200 photometer. The gas signals are transmitted from the ACX-200 photometer assembly through connector X2 pin 2 of the ACX Measuring board and applied to the reference input of a D/A converter (D8). D8 is controlled by the microprocessor and is used for automatic gain control. The output current from D8 is proportional to the incoming signal and the gain is established for each gas (CO_2 reference and measuring, N_2O reference and measuring, and AA reference and measuring) by software.

The signals are converted to a voltage and amplified by A24D, then applied to capacitor C30 which removes the DC offset. The dark level is established on C30 when the synchronous switch A28A is closed.

Each signal is sampled by the peak detection circuit, consisting of A24C, V26, A28B, R97, R201, and C15. When the peak voltage of a signal is sampled, the switch A28B is open, sending the signal through V26, which acts like a diode. The peak signal is then applied to the capacitor C15. C15 is brought down to ground potential between signal peaks when A28B is closed and the dark signal is transmitted to it

The voltage peak of each gas (both measure and reference) is applied to an instrumentation amplifier (A24B) then to the input of a multiplexer (D23). D23 separates the signal to each of its components (CO_2 reference and measuring, N_2O reference and measuring, and AA reference and measuring). For CO_2, the offset voltage is subtracted from the reference signal at A13B. For AA, the offset voltage is subtracted from the reference signal at A12B.

Each gas signal, the temperature compensation signal and the pressure signal are transmitted to D13 which serves as a demultiplexer whose output is applied to an A/D converter (D14) through an instrumentation amplifier.

A/D-conversion

A/D conversion is made with a 12-bit A/D-converter (D14). Input signal is multiplexed with D10 and D13. After conversion is completed, signal ADCRDY rises to +5 V.

D/A-conversion

D/A conversion is made with a 12-bit D/A-converter (D11). D12 multiplexes the analog output to 8 sample and hold circuits. Two of these are used to drive offset voltages for N_2O and CO_2 measurement. The others are used for external analog outputs (CO_2OUT, N_2OOUT, VOLC, O_2OUT etc).

Timing of CO_2, N_2O, and AA signals

A timing pulse is produced when light is reflected to a phototransistor from a reflectorized surface on the filter wheel. The pulse produced is shaped by A28 on the preamplifier board and transmitted to port 3 of the microprocessor on the ACX Measuring board.

The processor produces the necessary address information to cause the PAL (D15) to produce the control pulses for the synchronous switches A28A and A28B (Dark and Clear).

Motor speed control

The speed of the stepper motor in the ACX-200 photometer is controlled with MOTOR-signal from the processor. This signal is buffered by D6.

Pressure measurement

The pressure transducer (B1) measures the sampling system pressure after the photometer. Voltage reference V1, resistors R17, R108, R89 and amplifier A31C supply the pressure measurement bridge with 4 mA current. The pressure signal is amplified with A31A and A31B. The output of A31A corresponds to pressures 400 to 900 mmHg and is within -9.5 V and +9.5 V range.

Temperature measurement

Temperature measurement excitation voltage for photometer stabilizing diode is fed from +10 V through resistor R104. The stabilizing diode voltage is proportional to photometer temperature. This voltage is amplified with A31D.

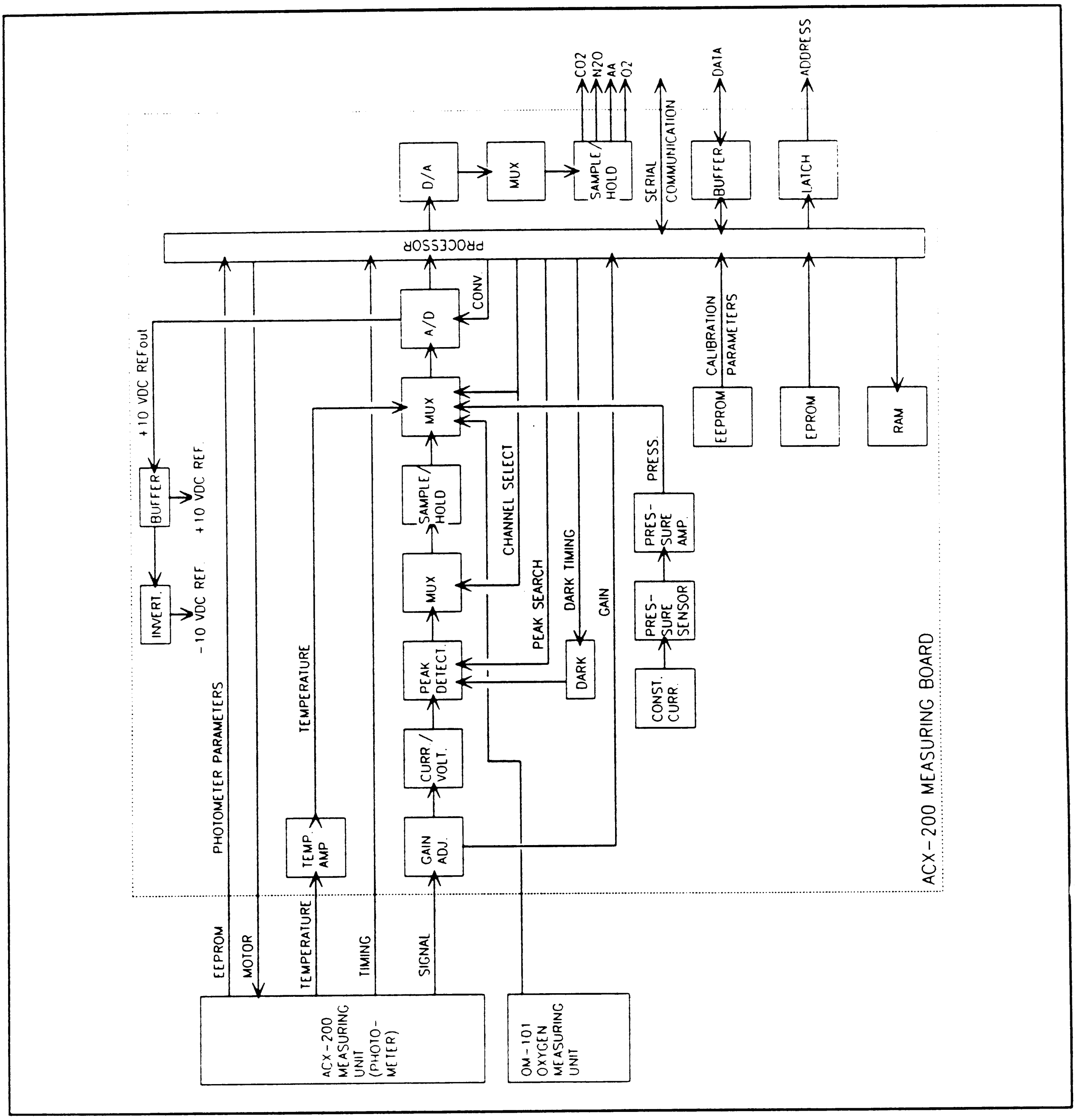


Figure 9 ACX Measuring Board Block Diagram

3.6 ASX Agent Identification Bench

The ASX-100 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-100 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. These calibrations will be made possible in Service Menu in the future.

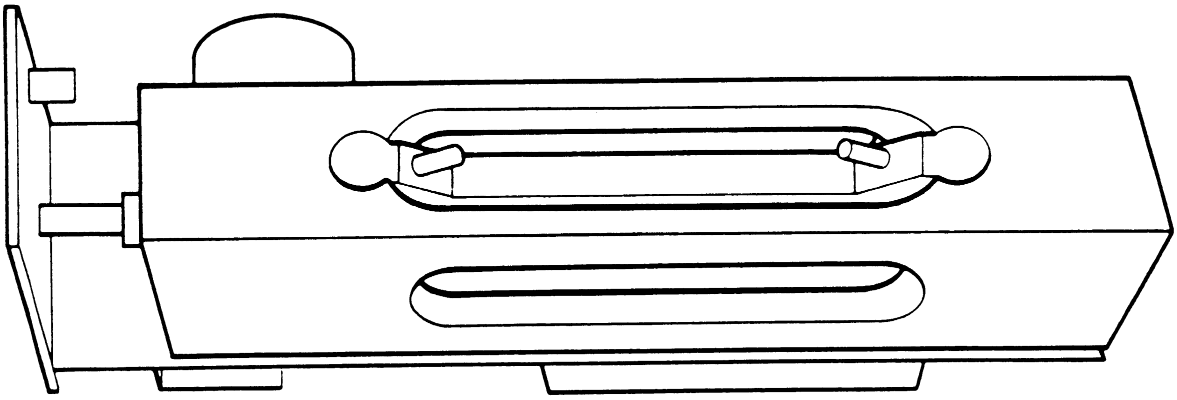


Figure 10 ASX Measuring Unit Layout

3.6.1 ASX Preamplifier Board

The absorption of infrared light is measured with a lead selenide detector R1. The signal is amplified with A1 and then led to the measuring board.

3.7 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 board controls gas measurements. 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 D2 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 D7 (64k x 8bit), SRAM D6 (8k x 8bit) and two D/A-converters. It communicates with the main CPU through a serial channel (RXD, TXDB).

EEPROM D5 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.

Sync-pulse

Sync-pulse is detected with a reflectance sensor A1. A2a converts the output current of the isolator to negative voltage pulse. Its peak voltage is charged to C2. Output of A2b changes from -13 V to +13 V when the pulse's voltage exceeds half of the peak voltage.

The pulse is modulated to TTL-level (5 V pulse) in V1.

V22 controls the LED current in the optical isolator so that the amplitude of the pulse stays constant.

Signal processing

The signal is sent to 8 kHz low-pass filter and then to adjustable amplifier which consists of D1 and A3b.

Bias voltages

Supply voltages of +15 V and -15 V are first regulated by A6 and A8 to +12 V and -12 V to prevent interference in the supply voltages from disturbing the bias voltages. Frequency of A7 oscillator is 200 kHz and amplitude 24 V. When its output is -12 V, C19 is charged up to 24 V. When the output goes up to +12 V, C19 is discharged and charges C20 via diode V15. Thus C20 is charged to about +34 V (12 V + 24 V - threshold voltage of V15). Correspondingly C23 is charged to about -34 V.

Resistors R32 and R35 are both for short-circuit protection and a part of low-pass filter with C6 and C7 on the preamplifier board.

Motor control

The motor is driven by DC voltage generated by D/A converter D8 and operational amplifier A9.

The output of D8 is between 0 to -5 V. With A9b the voltage is inverted to between 5.4 to 7.7 V, suitable to drive the motor. V20 is an emitter-follower which buffers the output of the operational amplifier.

Temperature measurement

Temperature is measured by diode V6 whose threshold voltage changes 6 mV per one degree °C. The signal is amplified by A3d to get suitable level (0 to 5 V) for A/D converter. Diode V7 protects the A/D converter input.

Test point signals

Connector X4 on the board is for test purpose. Note that pin 1 is TP6 and vice versa.

X4	1	TP6	A/D reference, A4
	2	TP5	Motor voltage
	3	TP4	Signal after AGC
	4	TP3	Temperature
	5	TP2	Sync pulse
	6	TP1	Sync test input

Connector pin configurations

ASX preamplifier board (X1) - ASX board (X2)

Pin No.	Signal
1	Ground
2	+12 V
3	-12 V
4	Signal
5	+VBIAS
6	-VBIAS

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

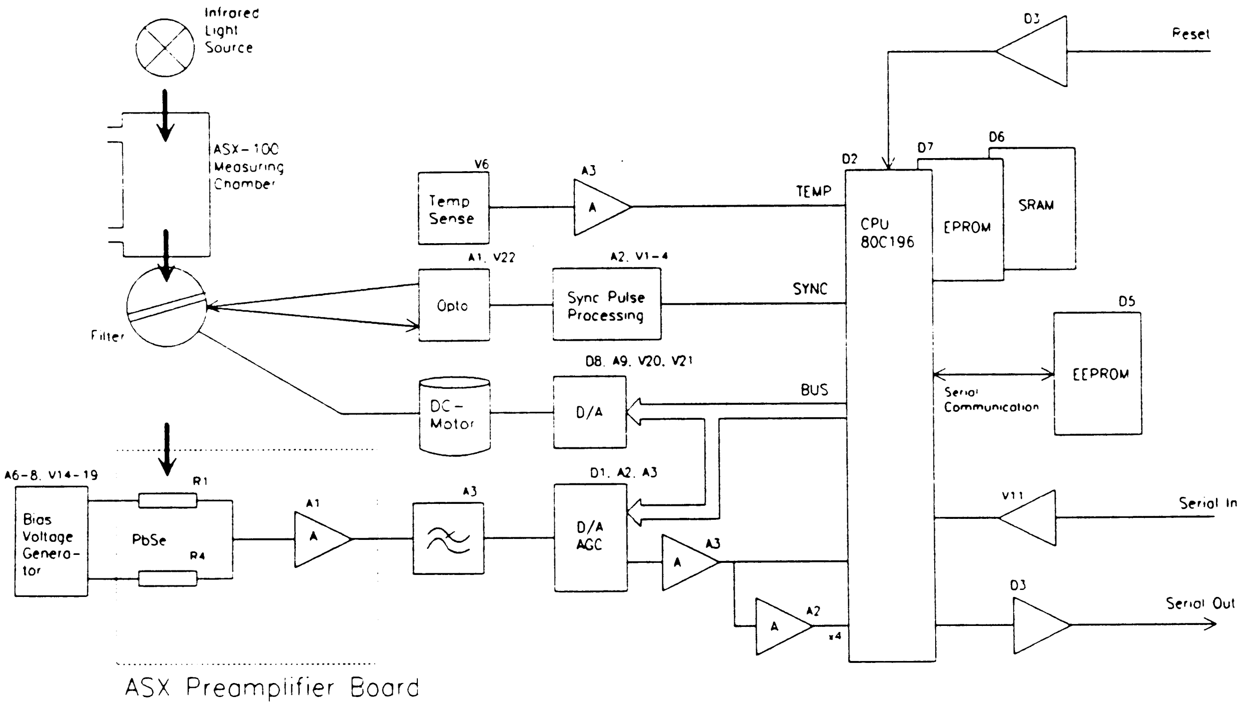


Figure 11   ASX Measuring Board Block Diagram

3.8 Gas Mother Board

The Gas Mother board contains a processor with which functions within the module is controlled. The board controls power supply to each measuring unit and serial communication between module processor and ACX Measuring board. There are connectors for the pump, valves, and gas measuring units on the board.

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 (D1) which includes program memory.
- 16 MHz oscillator.
- External RAM memory (D10) whose addresses E000H to FFFFH are in use.
- EEPROM (D11).
- Address and data bus latch (D2).
- Address decoding GAL-IC (D3).
- 4-channel serial communication IC (QART, D4).

External communication

Serial communication bus inside the module processor (D1) is used. The bus is connected to module bus via RS-485 buffer (D6). Transmit or reception controls of D6 is controlled by processor output pin (D1/pin 32, MODB) through D3. D3 sends the inverted control signal (BDIR) to D6. -RESET signal is also sent to D3. This is because D6 is set to reception mode during reset.

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 QART IC (D4) on the Gas Mother board; Channel 1 - ACX, channel 2 - ASX, channels 3 and 4 - not in use). Transmit side of D4 has a buffer IC (D5) and receipt side has a pull-up resistor (R5).

Valves, pump, and infrared lamps control

Valves are controlled by ACX Measuring board from which the control signals are ran through buffer IC (A1) to the valve connector (X12). OCCLUS signal controls the pressure (occlusion) valve and ZERO signal controls the zero valve.

Control signal for the pump comes from the module processor (D1/pin 28). The signal is 50 Hz pulse-width modulated square wave. Control command is received from ACX Measuring board in serial communication. Level change and buffering of the pump control are performed in IC A1.

Control command (LAMP) of the infrared lamps of the chambers comes to D1 pin 23 and leaves from pin 29 (LAMPDRV) via buffer A1.

Key push reading

D1 reads the front panel key push at pins 19 to 22.

Reset

Voltage supervising circuit D7 performs power-on reset. Reset from the module bus is connected via RS-485 buffer (D8) to D7

Connectors

X1	Module connector. Serial communication bus to the main CPU board. Supply voltages.
X2	ACX Measuring board.
X3	Not in use.
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.

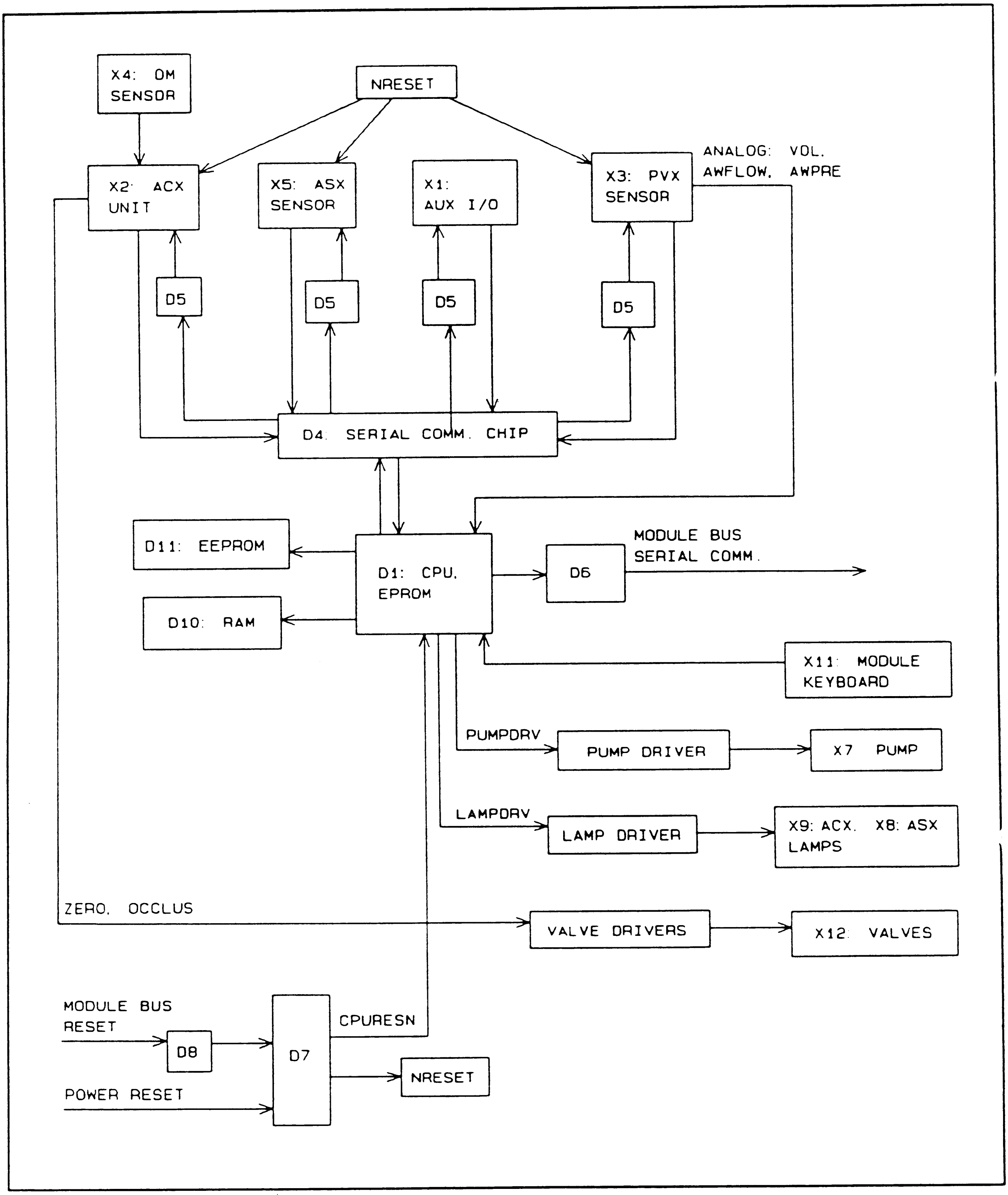


Figure 12 Gas Mother Board Block Diagram

3.9 Module Bus Connector Configuration

Table 2 Rear Panel 25-Pin Male D-Connector

Pin No	I/O	Signal	Notes
1	O	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	O	-RESET_RS485	
9	I	CTSB	
10	O	RTSB	
11	I	RXDB	
12	O	TXDB	
13		Ground & Shield	
14	I	+24 VDIRTY	
15	I	GroundDIRTY	
16	I	CTSC	
17	O	RTSC	
18	I	RXDC	
19	O	TXDC	
20	I	ON/STANDBY	
21	I	BIT0IN	
22	I	RXDD_RS232	
23	O	TXDD_RS232	
24	I	+5 VDC	
25	I	+5 VDC	for infrared lamps

3.10 Adjustments and Calibrations

3.10.1 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: Before adjusting the flows replace the D-FEND™ water trap if necessary.

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. When making measurements 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 for the alternative cassettes.

The adjustments and the respective constrictions to be adjusted are shown in Figure 13.

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.

Total flow rate is measured by rotameter 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).

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 rotameter behind the flow cassette (no. 2) ahead of the oxygen measuring unit REF inlet. The rotameter should show between 25 and 42 ml/min. The flow rate is adjusted by changing the cassette.

(b) Connect rotameter 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 rotameter 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 more than 180 ml/min. The gas zeroing can be staged in the ACX Service Menu (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 13)**	**Nominal value (tolerance) ml/min**
total 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	more than 180 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.

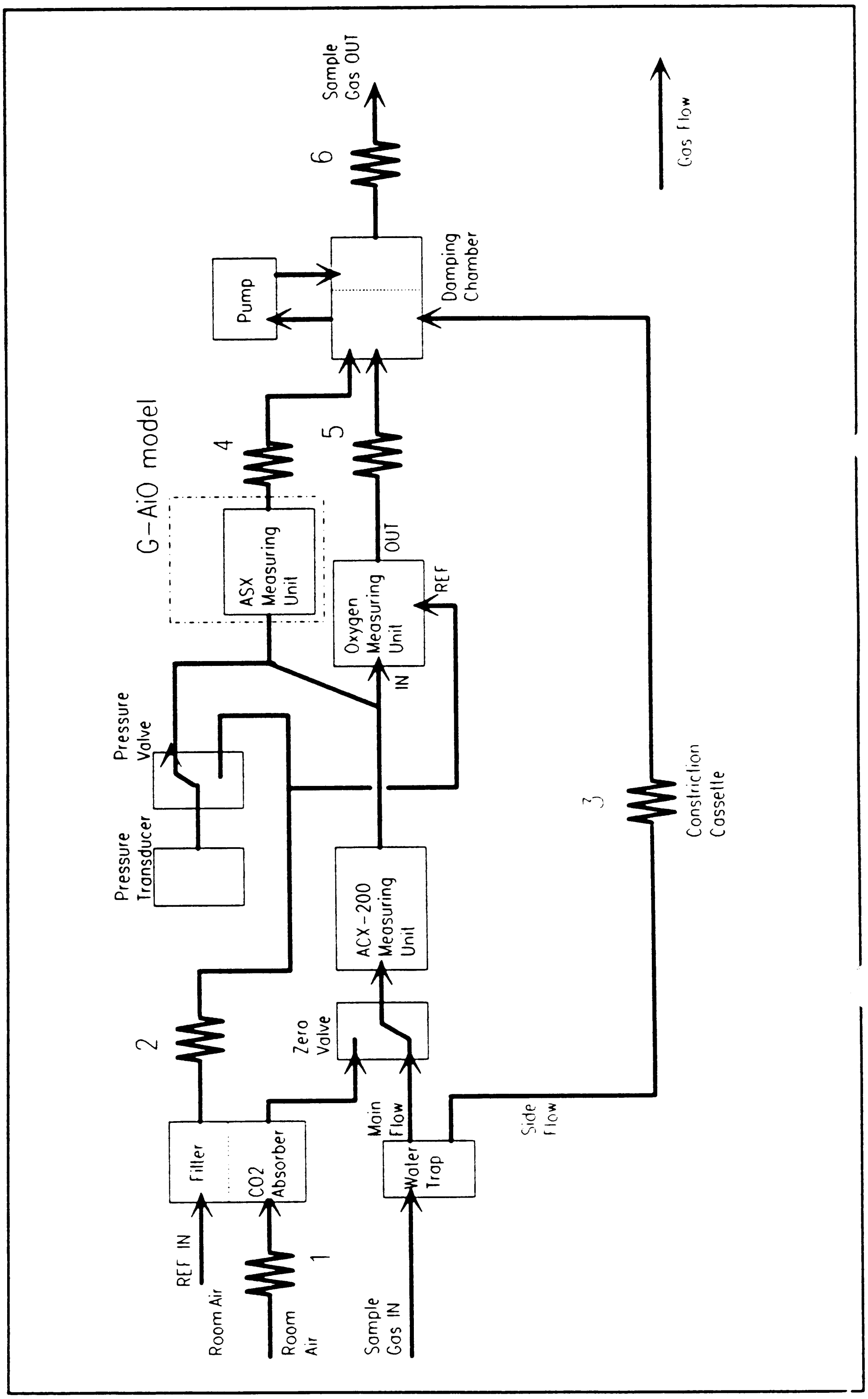


Figure 13 Gas Sampling System Adjustment Chart

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.

The pressure difference can be manually calculated as follows:

Enter ACX Service Data page in Gas Unit Service Menu.

a) Set pump on, both valves closed (OFF, this is the normal operation situation). Check the WORKING PRESS value. It is the pressure of the O_2 sensor measurement flow.

b) Open the occlusion valve (pressure valve). Now the WORKING PRESS value shows the pressure of the reference flow.

c) Subtract the value gained in step 2 from the value gained in step 1 and you will have the pressure difference between the O_2 measurement flow and the O_2 reference flow.

The pressure difference should be between 5 to 10 mmHg (factory adjusted).

If the pressure difference is too large, decrease the measurement flow rate by changing the cassettes no. 4 and 5.

When the pressure difference becomes negative, that is, the pressure in the reference flow gets higher than that of the measurement flow, and reaches -5 mmHg, then during normal monitoring the message "REPLACE TRAP" appears and the audible alarm sounds to indicate that the water trap should be replaced.

3.10.2 Oxygen Measurement 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 5 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 14) 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 software 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 'G' (see Figure 14).

c) Check and if necessary readjust the offset and gain until the readings remain stable.

c) Perform software 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 165 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 "F" will change the frequency by 1.5 Hz. Try to find minimum noise but do not deviate more than ± 5 Hz.

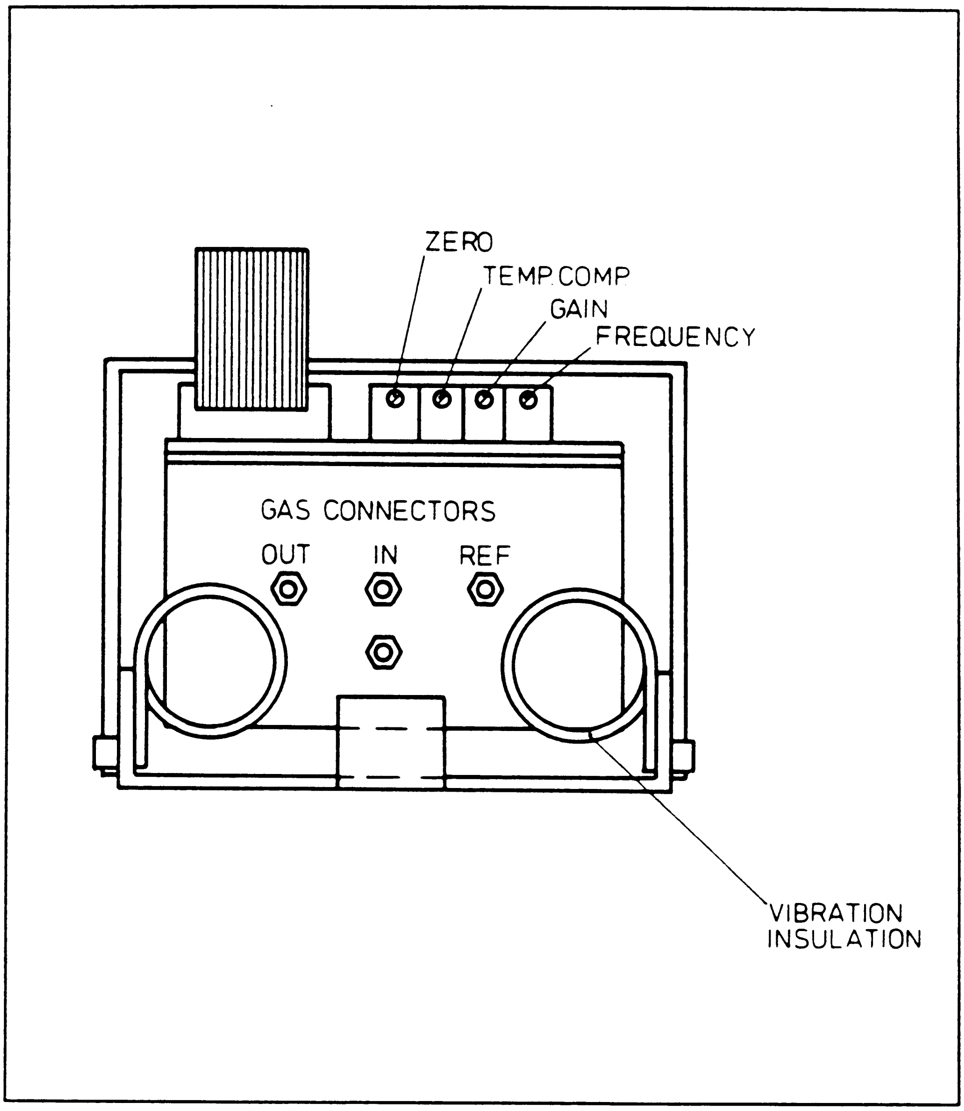


Figure 14 O_2 Measuring Unit Adjustments

4 SERVICE AND TROUBLESHOOTING

4.1 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.

NOTE: After any component replacements see Chapter 3.10 (Adjustments and Calibrations).

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.

4.2 Disassembly and Reassembly

The Airway module is disassembled in the following way. See Figure 17 for the exploded view of the unit:

a) Remove the two cross recess screws from the rear panel. The rear panel can be detached.

b) Slide the Airway module case rearward and detach it from the module.

c) Lift off the top protection cover.

Now the Airway module is exposed. Gas Mother board is attached to the side of the module with screws. ACX Measuring board is located on top of the pump and ACX Measuring unit. The fan can be lifted out of the fan housing.

d) The front panel can be detached by removing three screws.

e) Tubing system plate can be lift off by removing a screw above the ACX Measuring unit.

The ACX Measuring unit is attached to the chassis with two screws. 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. The O_2 measuring unit is attached to the chassis with two screws.

Reassembling is essentially reversing what was described above.

CAUTION: When reassembling the Airway module, make sure that the tubes and cables are not pinched between the boards and the cover.

4.3 Troubleshooting Chart

Table 3 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.
EXTERNAL RAM ERROR-message	RAM read/write problem. Check Gas Mother board (this message possibly appears in start-up).
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.
REPLACE TRAP-message	Flow resistance increased due to residue built-up on water trap membrane. Change the 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.
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. Let the container dry properly after disinfection before use.

4.4 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 troubleshooting chart of the sampling system is shown in Figure 15.

The following checks should help in localizing the fault. Whenever suspecting the sampling system and always after having done any work on the sampling system check and if necessary adjust the flow 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: Datex D-FEND™ water trap should be changed when the occlusion alarm comes on during the monitor startup sequence in normal use.

NOTE: If the ACX-200 measuring unit has got liquid inside the measuring chamber 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

Choose ACX Service Data page in the Gas Unit Service Menu.

Connect a tube to the sample out connector and drop its other end into a glass of water.

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.

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

Dip the patient end of the sampling line into water quickly (about a halt 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.

Check that all the water goes into the trap container and not into the monitor.

3. STEAM TEST FOR THE SPECIAL TUBE

Choose halothane as anesthetic agent and let the monitor sample room air. Then quickly feed air of 100 % relative humidity (for instance from a kettle in which you have boiling water) to the monitor. If the digital reading jumps as much as 0.1 % then replace the special tube.

Table 4 Gas Sampling System Troubleshooting Chart

TROUBLE	POSSIBLE CAUSE/TREATMENT
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.
No response to neither CO_2, N_2O nor AA	Chopper motor not running. IR lamp failure. Check the IR lamp resistance (approximately 3.5 Ohm) and the lamp voltage (4 VDC min). If there is no voltage, check TP4 on the Gas Mother board. If the line is high the MOSFET V12 on the board is faulty, if low, the chopper motor is probably stalled. Check for timing pulses from the preamplifier board. AGC amplifier (A4) faulty. Coarsely erroneous or missing reference voltage. Timing pulses missing.
Either CO_2, N_2O or AA response missing	Analog switch faulty or control pulses missing. Other components fault in the measuring electronics. Check by following the signal with an oscilloscope along the amplifier chain
No O_2 response	O_2 measuring unit tubes loose or blocked. O_2 measuring unit connecting cable loose or faulty. O_2 measuring unit internal tubings blocked by water. Disconnect O_2 measuring unit tubings and try to remove water by pumping air into the connector "OUT". O_2 measuring unit faulty. Replace. Analog multiplexer faulty.
Zeroing of CO_2, N_2O and/or AA fails	Measuring chamber contamination. Replace. ACX Measuring board faulty. Replace.
Strong drift in all gases	Leak in sampling line or internal tubing (especially in conjunction with too low readings). AGC malfunction. Check analog switches and control pulses.

(Continues)

TROUBLE	POSSIBLE CAUSE/TREATMENT
Strong drift of CO_2, N_2O and AA	Fluid or dust in measuring chamber. Electrical connections to IR lamp faulty. Loose screws in measuring unit. AGC circuit faulty (ACX Measuring board).
Strong drift of O_2	Blocked O_2 reference flow. Uneven sample pump function. Replace pump.
Sudden increase in gas display	Measuring chamber contamination. ±15 V supply voltages missing.
The above occurs frequently	Water trap malfunction. Check all internal tubing and the interior of the water trap for occlusions or leaks. Replace water trap. Check flow rates.
CO_2/N_2O/AA software calibration fails	Analog gains out of range. Check the general functioning of the measuring electronics.
O_2 software calibration failure	Adjust the gain trimmer of O_2 measuring unit. If not possible, replace the measuring unit.
CALIBRATING GAS SENSOR-message remains on the screen	±15 V supply voltage missing. Check fuses on Gas interface board. CO_2/N_2O gas analog voltages out of range (over 9 V). Check lamp voltage. > 4V
Impossible to adjust gain	AGC malfunction. Check analog switches and A4 on ACX Measuring board. False reference voltage. Faulty temperature compensation circuit.
Too low response in both CO_2, N_2O, and AA (and possibly O_2)	Leak in water trap, or tubing between the trap and the measuring units. The sample is diluted with air.
Abnormally high response to all gases (or abnormally low) or sudden occlusion warning	Pressure transducer failure.
Random output (resembling noise)	Timing pulses out of sync. Check timing pulses from photometer, pulse shaping circuit, and logic circuitry on the Measuring board. Chopper motor not running Motor faulty or connection loose. Driver transistor C-E open circuit or current limiter short circuit.

4.4.1 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 case of no response to O_2 or strong drift, check the tubing for loose connections, blockages and leaks.

CAUTION: Never apply an overpressure to the O_2 measuring unit as the pressure transducer may be permanently damaged.

If O_2 zero error message is displayed check the O_2 measuring unit output voltage at TP6 on Gas Mother board (see Section 3.10.2 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 3.10.2 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 3.10.1).

If the O_2 signal is noisy, check the measurement unit suspension. Frequency adjustment may help in some cases (see Section 3.10.2 Frequency adjustment).

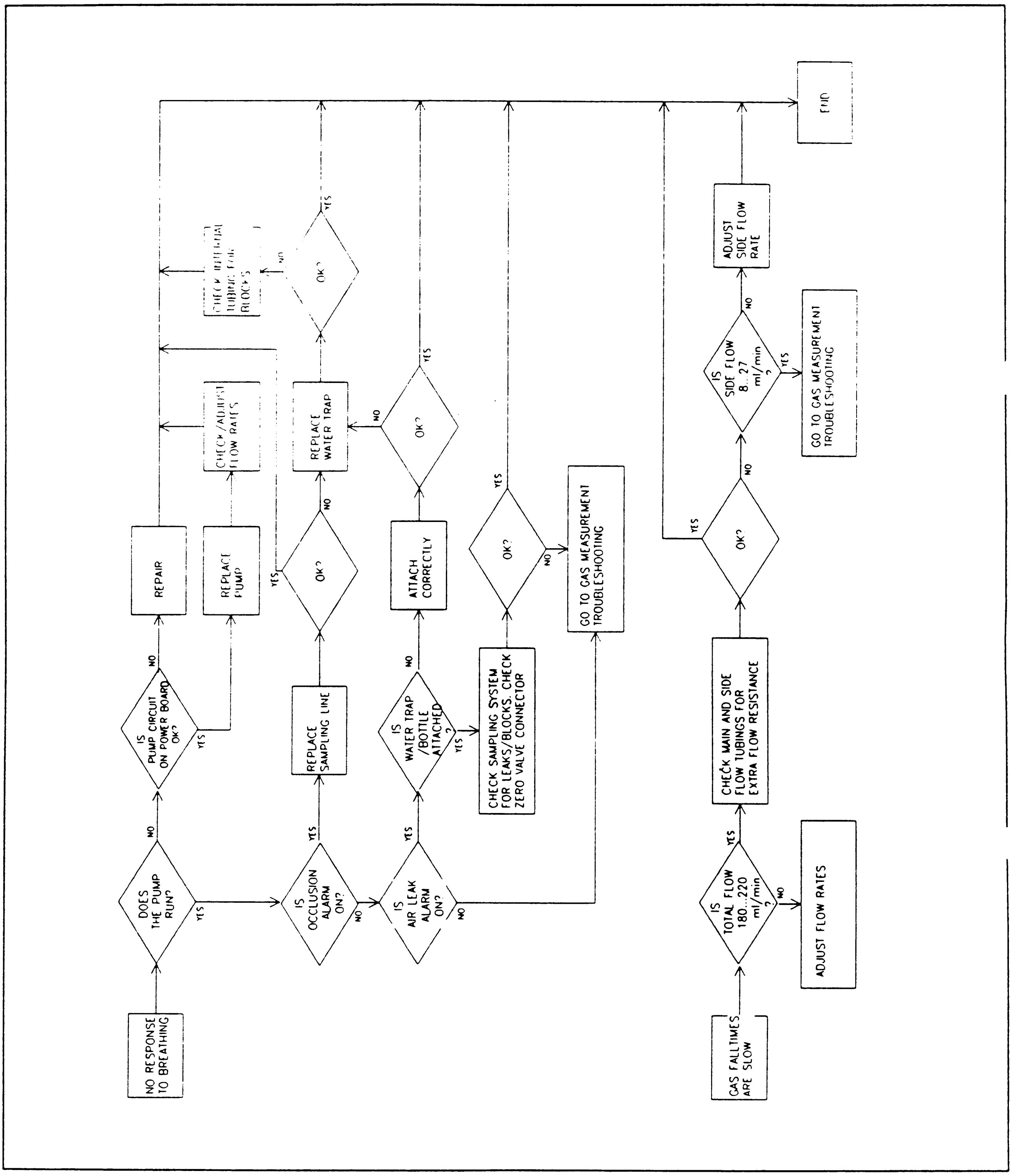


Figure 15 Gas Sampling System Troubleshooting Chart

4.5 ASX Troubleshooting

NOTE: Please read also troubleshooting section in Operator's Manual. The part of this chart is duplicated from it.

CAUTION: The agent identification bench ASX-100 can only be repaired and calibrated at Datex. If the motor assembly, preamplifier board, EEPROM, temperature measuring components or the reflectance sensor A1 has failed the unit must be repaired and recalibrated at the factory. Temperature compensations and temperature zero can only be calibrated at the factory.

Table 5 ASX Troubleshooting Chart

TROUBLE	POSSIBLE CAUSE/TREATMENT
AGENT MIXTURE-message when calibration gas (Freon) is fed	Repeat calibration.
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 TEMP OUT OF RANGE-message	ASX bench is beyond the temperature range (5 to 60 degrees centigrade). It is probably too cold. Warm it up and start the monitor again.
ASX EEPROM OUT OF LIMITS-message	EEPROM contents are false. If the message appears repeatedly, change the ASX unit.
ASX EEPROM WRITE ERROR-message	Write to EEPROM not succeeded. If the message appears repeatedly, change the ASX unit.
ASX ROM CHECK-SUM ERROR-message	EPROM contents are false. Change the component.
ASX AUX RAM ERROR-message	Auxiliary RAM failed. Change the component.

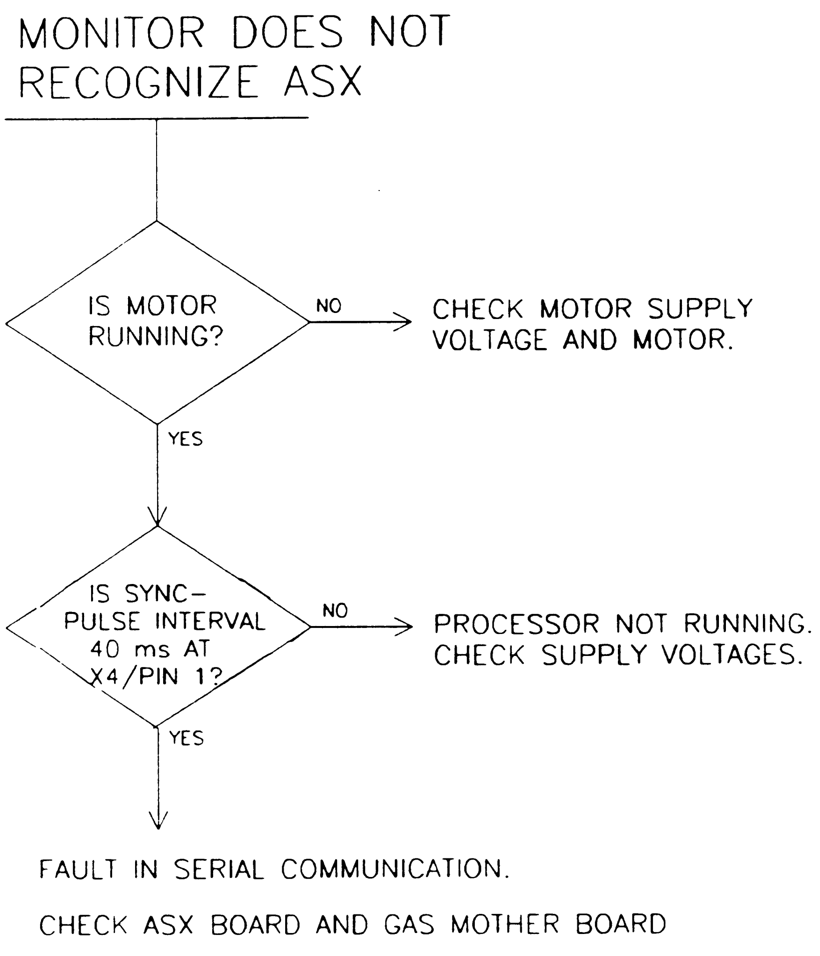


Figure 16 ASX Troubleshooting Chart

4.6 Gas Mother Board Troubleshooting

Due to the complexity of the LSI circuitry there are few faults in the CPU digital electronics that can be located without special equipment. The following checks may be performed:

a) The RAM, EPROM, CPU, and other socketed I.C.'s are properly installed and the memory configuration jumpers are correct.

b) The 16 MHz clock signal exists at the CPU pin 67 (use a high impedance probe to check).

c) ALE (D3 pin 1) shows that CPU is operating. If this line is static, the processor is not running.

d) -RESET (D7 pin 5) is low for a moment after power up. If -RESET is constantly low, check the +5 V supply line for spikes or low voltage.

The analog part is somewhat easier to troubleshoot. The input analog voltages are easily tracked to the MUX input. After the MUX, the voltages are multiplexed so that the resulting waveform is of 200 - 600 Hz frequency.

IR analog output is updated every 10 ms. All other analog output channels are updated every 40 ms. Thus the D/A conversion interval is 5 ms.

4.6.1 Instructions After Replacing the Software or Gas Mother Board

After replacing the software or CPU board:

- perform the gas calibration.
- re-establish previously used settings or inform the monitor user that all other settings are default values.

4.7 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 first 5 minutes/during occlusion/during air leak.	Calibration not allowed during 5 minutes after power up and so on.
Select agent	No agent selected
Continuous occlusion. Check sampling line and 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 Unstable	Unsuccessful calibration
O_2 over scale	O_2 signal exceeds the maximum waveform area
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

4.8 Preventive Maintenance Check List

We recommend that you perform these checks after any service and at least once every six months to keep the AS/3™ Anaesthesia Monitor 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

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 drawing room air, the numeric display of FIO_2 should be 21 ± 1 after five minutes.

___: Select Enflurane in Agent select menu. Perform gas calibration when at least 10 minutes have passed after the power on. The measured values should be within the tolerance ranges listed below. If required, perform the adjustments.

Gas	Tolerance range
CO_2	± 0.5 % CO_2 (> 8 % CO_2) or ± 0.4 % CO_2 (< 8 % CO_2)
O_2	± 5 % O_2 (about 100 % O_2)
N_2O	± 5 % N_2O (about 100 % N_2O)
ENFL	± 0.6 %

Press Normal screen key to end calibration.

___: Block the sampling line and make sure that the Occlusion warning comes on.

___: Remove the water trap and make sure that the Air leak warning comes on.

___: Check the rates of main flow, side flow, and oxygen measurement reference flow (see Chapter 3.10.1).

___: Perform the sampling system leak test (see Chapter 4.4).

___: Perform the water separation test (see Chapter 4.4).

___: Go to Service Menu and ACX Service Menu. Check the functions of zero and occlusion valves, and pump. Additionally key (button) function in G-AO.

___: Check working pressure (Working 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.

5 SPARE PARTS

5.1 Spare Parts List

> **NOTE:** Accessories are listed in the Operator's Manual.

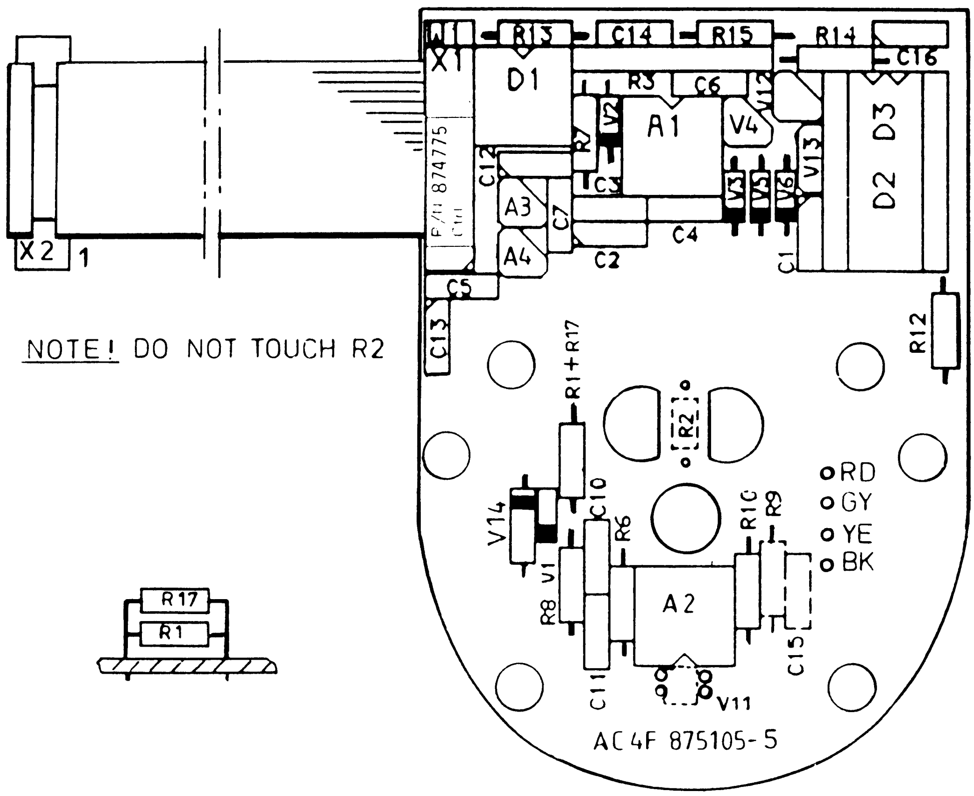
Item	Item description	Order No.
14	PCB, Gas mother	*880352
15	Software, GAS	879528
16	IC, GAL D3	879896
6	PCB, ACX measuring	*880270
5	Software, ACX	879195
26	Bench, ACX-200 measuring	*879849
22	ASX agent identification unit (incl. meas. board, bench, and software)	*881107
21	Lamp, ASX	878756
25	Pump, with mag. shield	*881298
23	O_2 measuring unit	*872898
7	Cover, top protection	878859
12	Absorber	880067
13	Damping chamber/Filter	880068
10	Valve, pressure	*58534
9	Valve, zero	58534
11	Internal sampling tubings incl. tubing system plate	*880375
	Spring, for D-FEND	875598
20	Front panel unit (AO)	880374
20	Front panel unit (AiO)	881116
19	Plug, tube conn., front panel	880294
18	Sticker, front panel (large, AO)	880377
17	Sticker, front panel (small, AO) (Eng)	880376
17	Sticker, front panel (small, AO) (Ger)	880546
17	Sticker, front panel (small, AO) (Fre)	880454
17	Sticker, front panel (large, AiO)	880472
17	Sticker, front panel (small, AiO)	880471
1	Sticker, rear panel (Eng)	880460
1	Sticker, rear panel (Ger)	880462
1	Sticker, rear panel (Fre)	880461
4	Fan	880049
3	Case, airway module	878864
2	Rear panel	880346
24	Grommet, for tubes	65094
8	Latch, for flow cassette	880343
27	Connector, sample gas out	871981

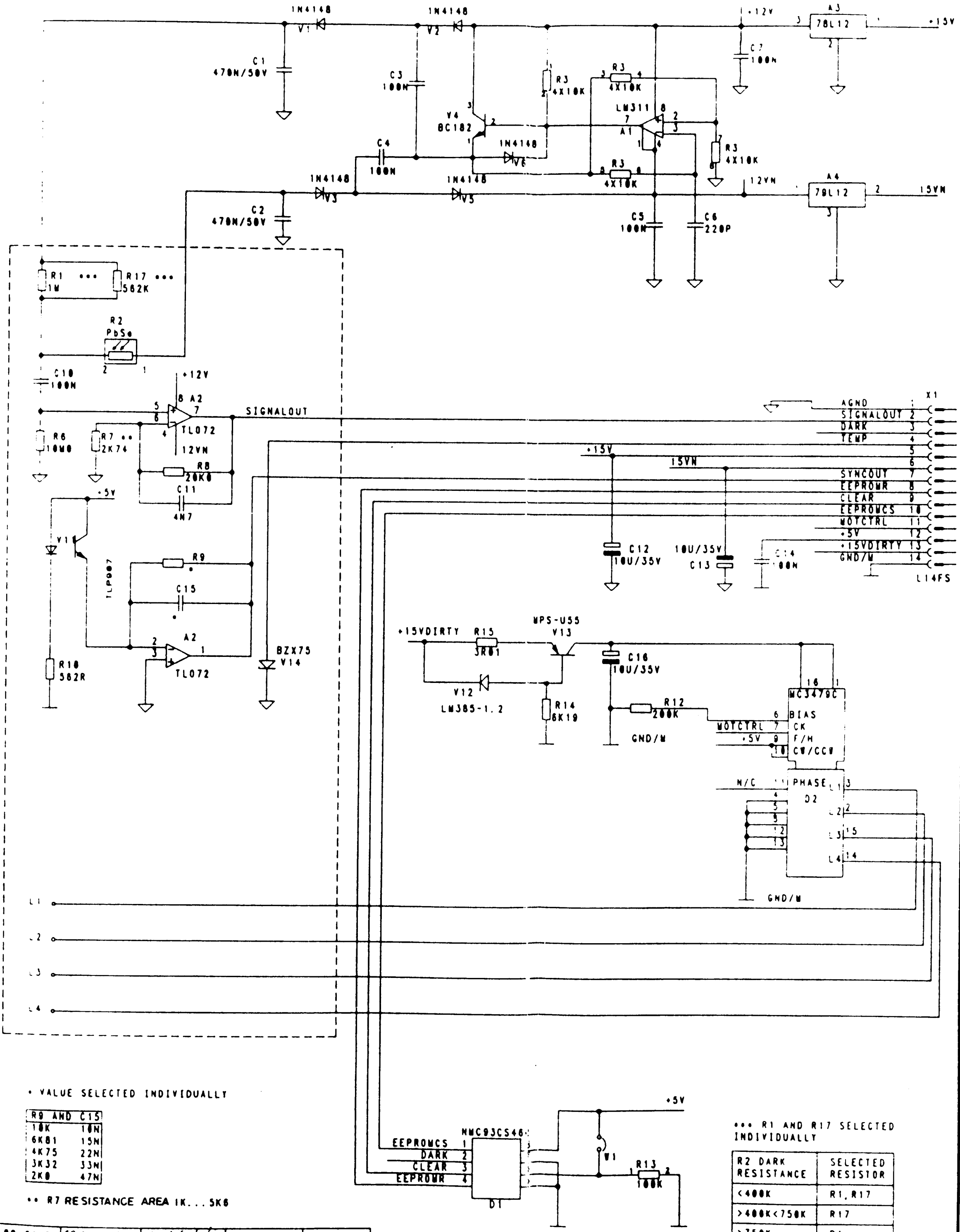
Item number refers to the exploded view in Figure 17.

* = the part is recommended for stock.

6 CIRCUIT DIAGRAM AND PARTS LAYOUT

Figure 18 ACX Preamplifier Board Parts Layout and Schematic Diagram





• VALUE SELECTED INDIVIDUALLY

R9 AND C15	
10K	10N
6K81	15N
4K75	22N
3K32	33N
2K0	47N

•• R7 RESISTANCE AREA 1K...5K6

••• R1 AND R17 SELECTED INDIVIDUALLY

R2 DARK RESISTANCE	SELECTED RESISTOR
<400K	R1, R17
>400K<750K	R17
>750K	R1

24.09.91 OS	19.10.91	19.10.91	6109	-7
17.04.91 OS			5586	-6
21.08.89 OS			4623 4631	-5
13.07.89			4581	-4
25.05.89			4492 4519	-3
17.01.89			4186	-2
26.08.88			3915	-1
MUUT.	TARK.	HYV.	MUUTOS	MERKKI

DATEX
INSTRUMENTARIUM OY

NIMI: ACX ETUVAHVISTIN | SIVU 1/1 | LAITE: ACX-100
PIIR. | TARK. | HYV. | N:O AC 3B 875104-7

Figure 20 ACX Measuring Board Schematic Diagram (Part 2)

Figure 22 ASX Measuring Board Parts Layout

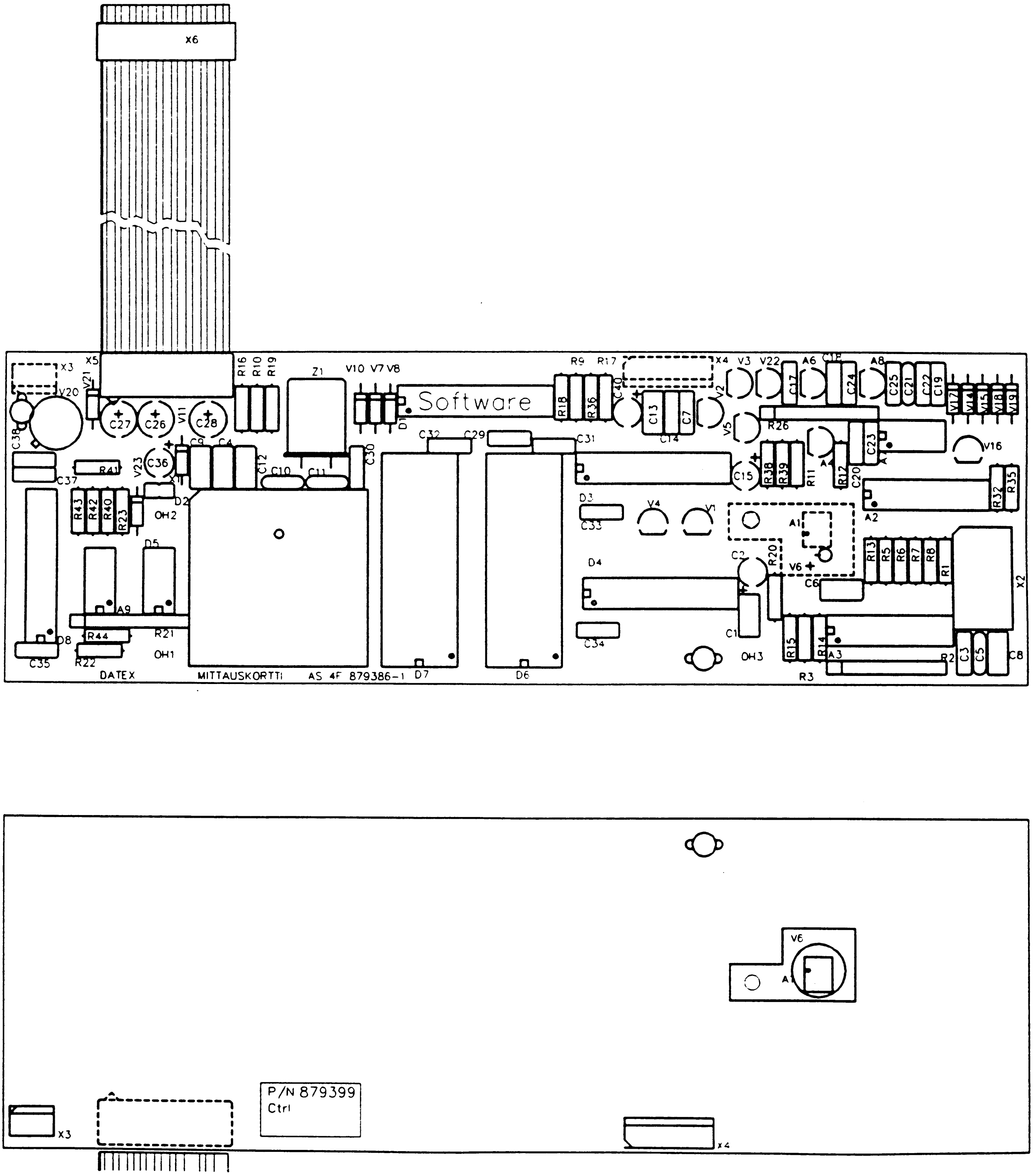


Figure 23 ASX Measuring Board Schematic Diagram

Figure 24 Gas Mother Board Parts Layout

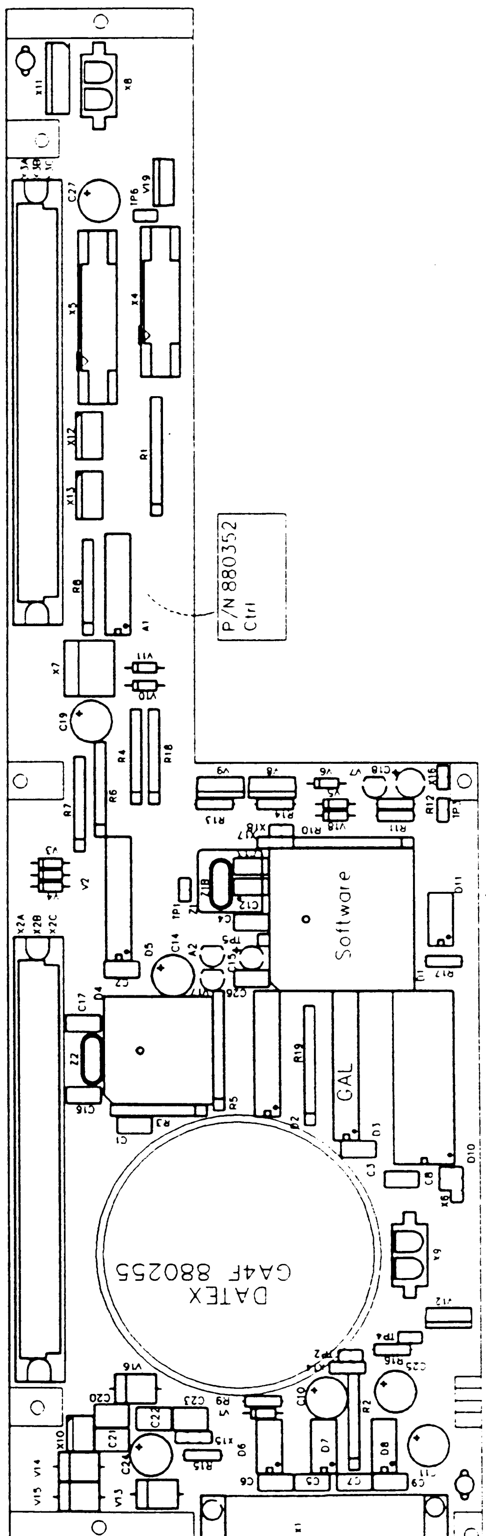


Figure 25 Gas Mother Board Schematic Diagram (Part 1)

Figure 26 Gas Mother Board Schematic Diagram (Part 2)

7 SPECIFICATIONS

7.1 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 2 min for operation, 30 min for full specifications.

Auto-zeroing is performed at start-up, after 5 min, and after 30 min.
After 1-hour monitoring, auto-zeroing is performed once an hour.

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 kPa)

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

AA

Measurement range	0 to 5 %
Extended range	5 to 15 % (unspecified) <1.0 % two decimal digits
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
Identification time	30 seconds (with pure agents)

7.2 Technical Specification

Module size W x D x H	135 x 410 x 128 mm 5.3 x 15.0 x 5.0 in
Module weight	5.2 kg/ 12 lbs

CO_2

Measurement rise time	<360 ms
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	<2 % f.s.
N_2O compensation accuracy	<2 % f.s.

Automatic compensation for pressure (±50 mmHg)

O_2

Measurement rise time	<480 ms
Gain drift	<2 % O_2/24 h
Gain temperature drift	<3 % O_2/10°C
Nonlinearity error	<2 % of f.s.

N_2O

Measurement rise time	<360 ms
Gain temperature drift	<3 % N_2O/10°C
Gain drift	<2 % N_2O/24 h
Nonlinearity error	<2 % of f.s.

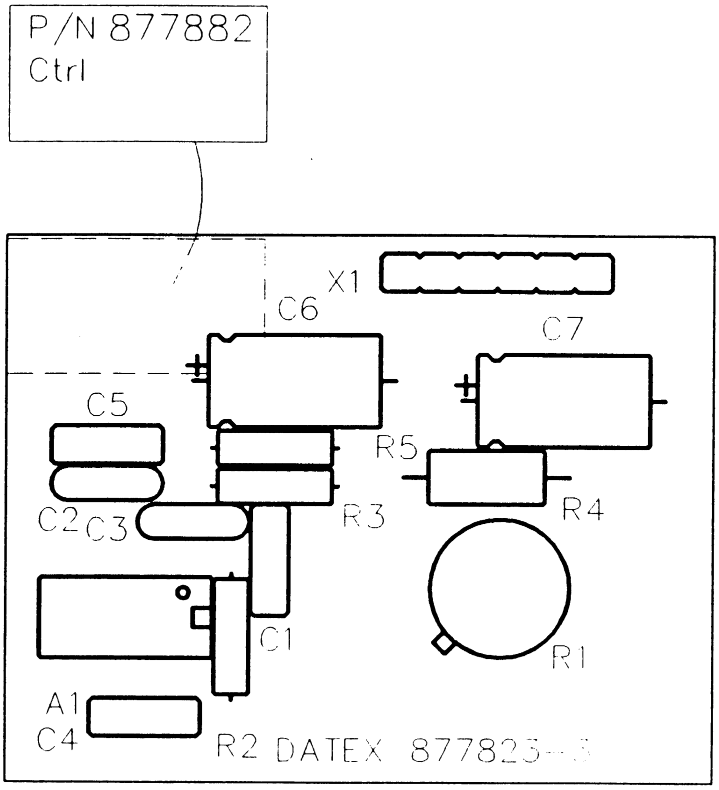
AA

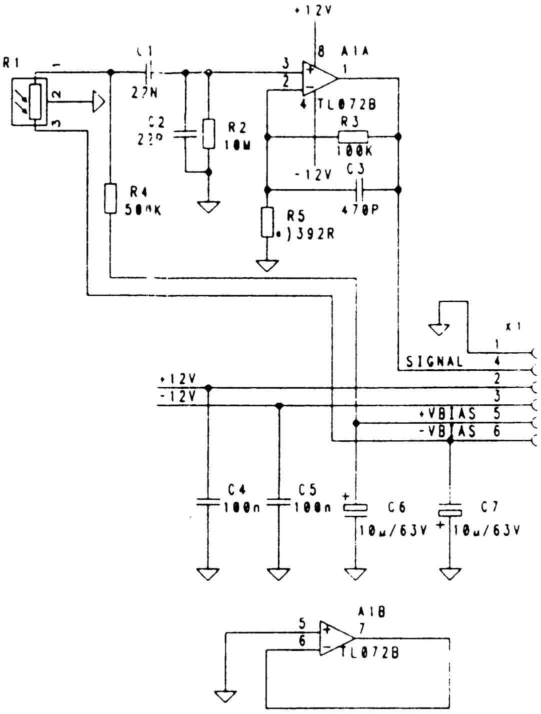
Measurement rise time	<520 ms
Gain drift	<0.2 % AA/24 h
Gain temperature drift	<0.4 % AA/10°C
Nonlinearity error	<2 % of f.s.

Protection against electrical shock — Type B

8 EARLIER REVISIONS

Figure 21 **ASX Preamplifier Board Parts Layout and Schematic Diagram**





*) valitaan tuotannossa
alue 332R...681R

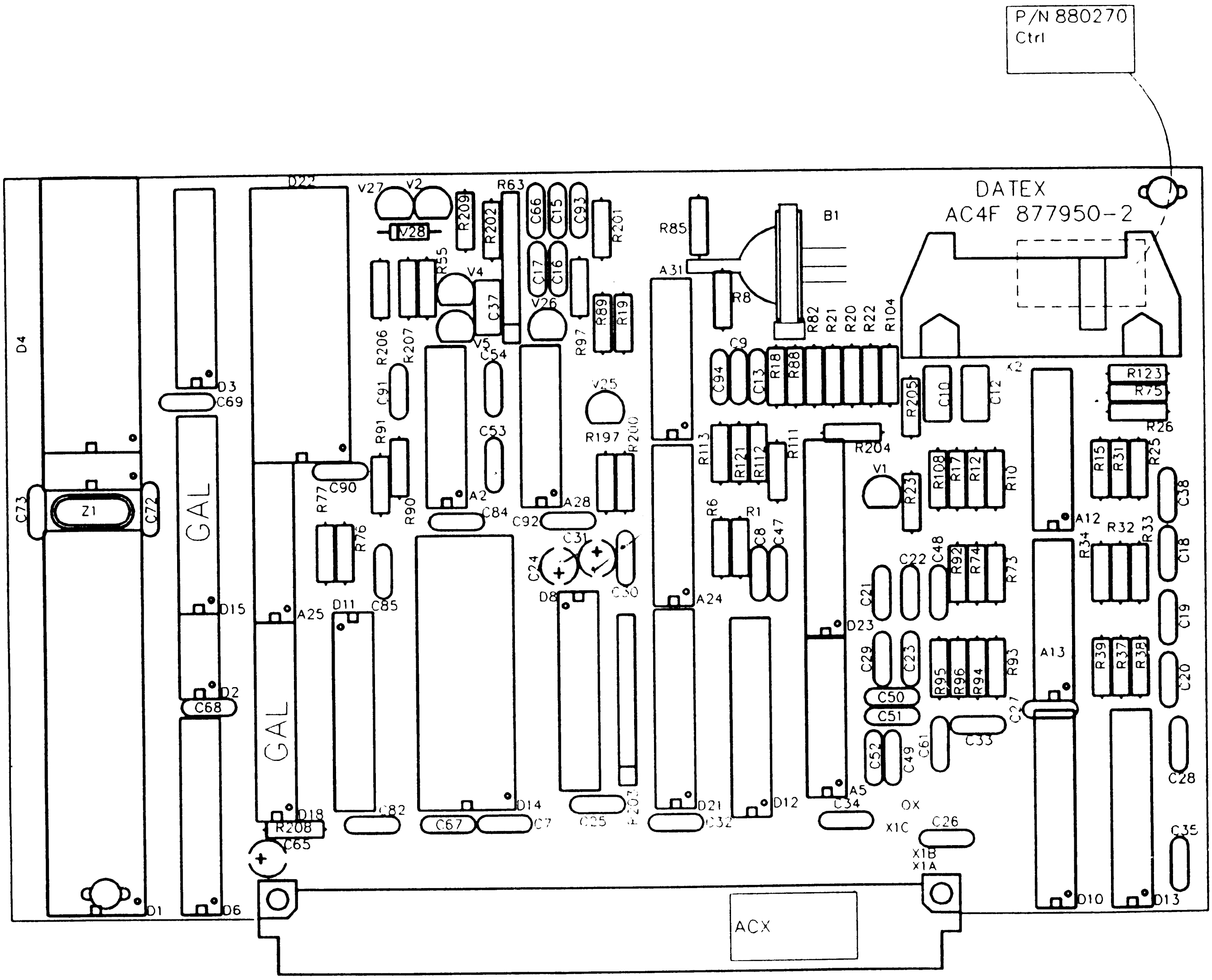
can be 332R...681R

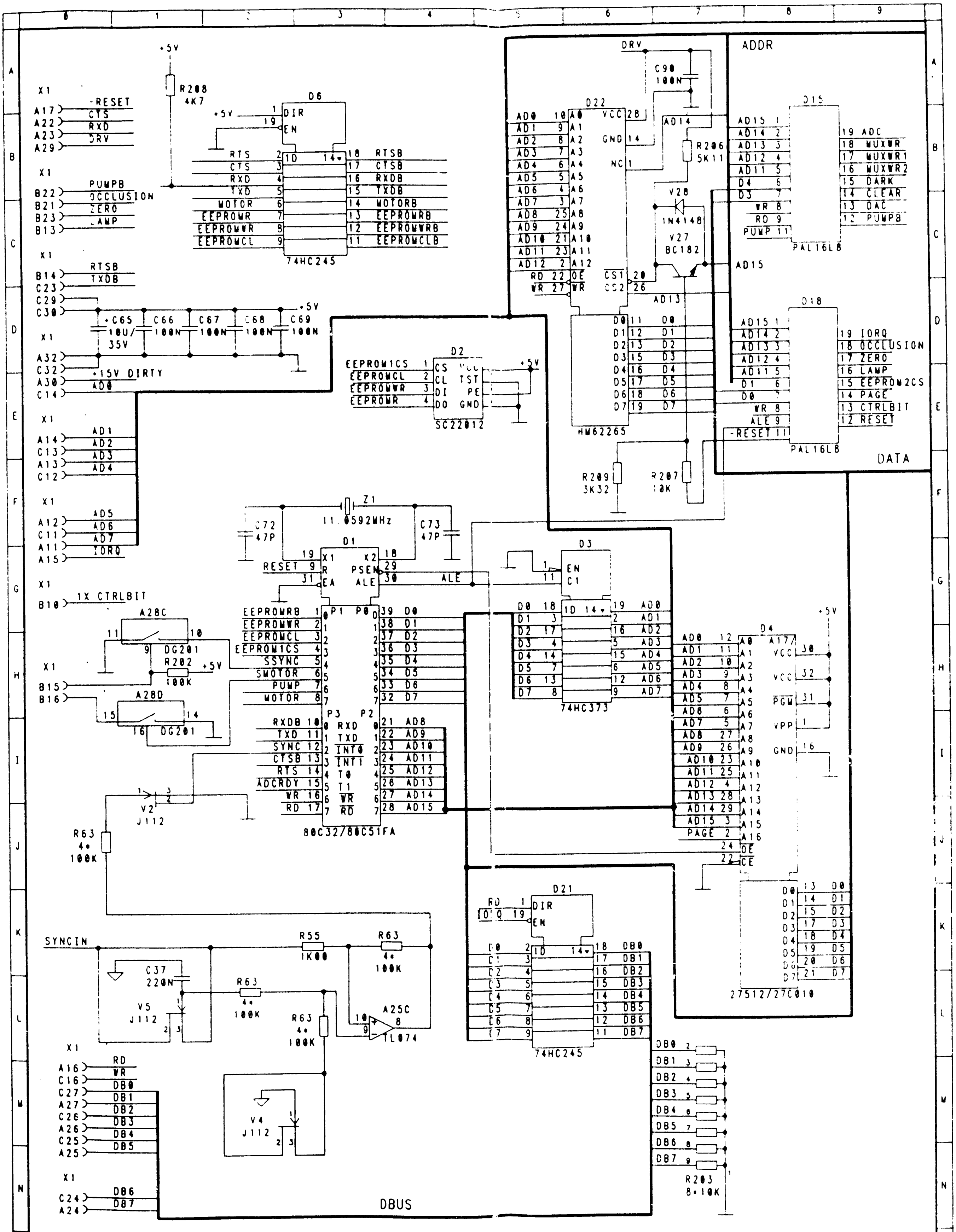
13.04.92 LEJA			6619	-2
08.07.91 EN		16.08.91 MSI	6071	-1
MUUT.	TARK.	HYV.	MUUTOS	MERKKI

DATEX
INSTRUMENTARIUM

NIMI ESIVAHVISTIN
SIVU 1/1
LAITE ASX-100
PIIRT. 26.02.91 EN
TARK
HYV
N:O AS 3B 877824-2

Figure 19 ACX Measuring Board Parts Layout and Schematic Diagram (Part 1)





MUUT.	TARK.	HYV.	MUUTOS	MERKKI

DATEX INSTRUMENTARIUM OY

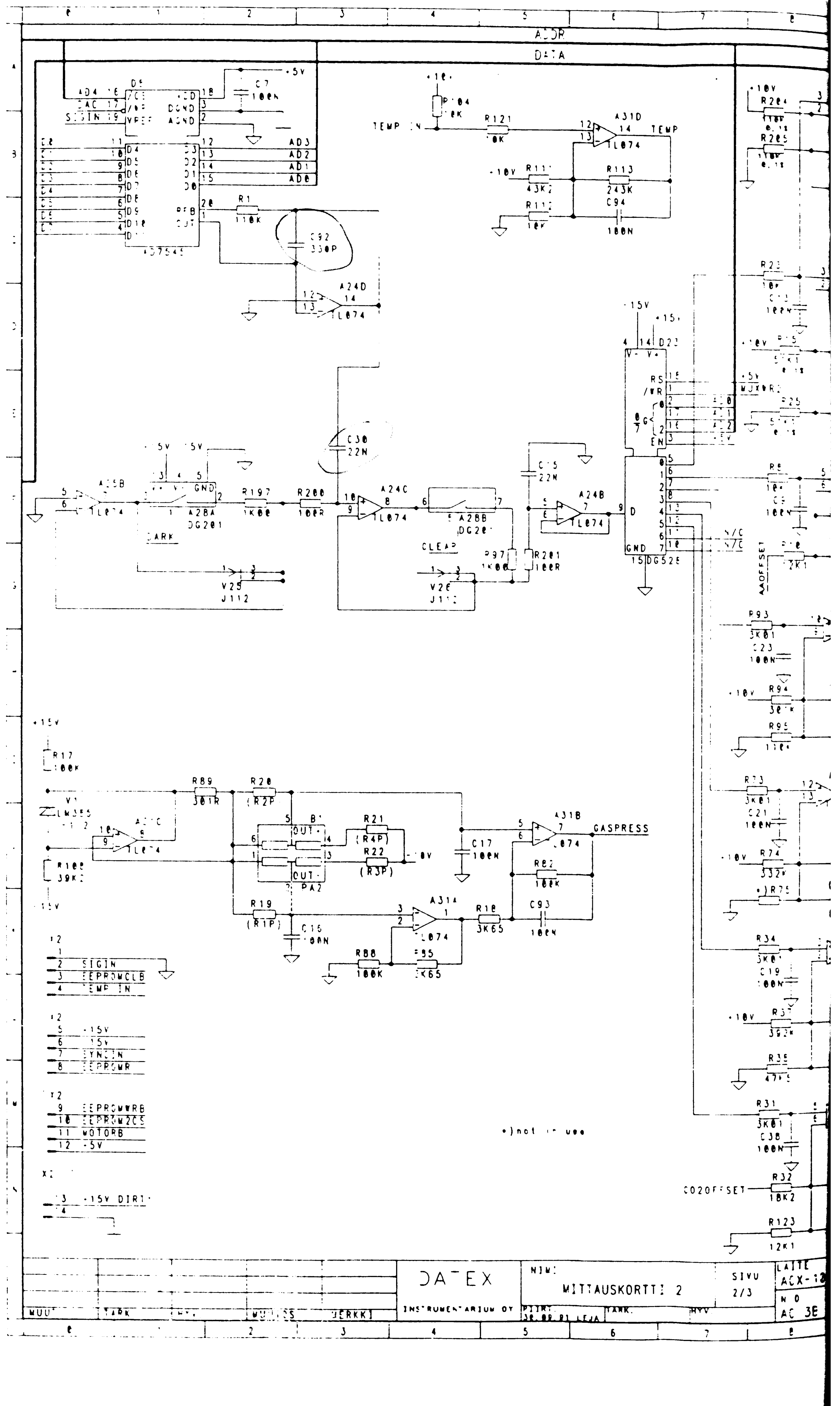
NIMI: MITTAUSKORTTI 2

SIVU: 1/3

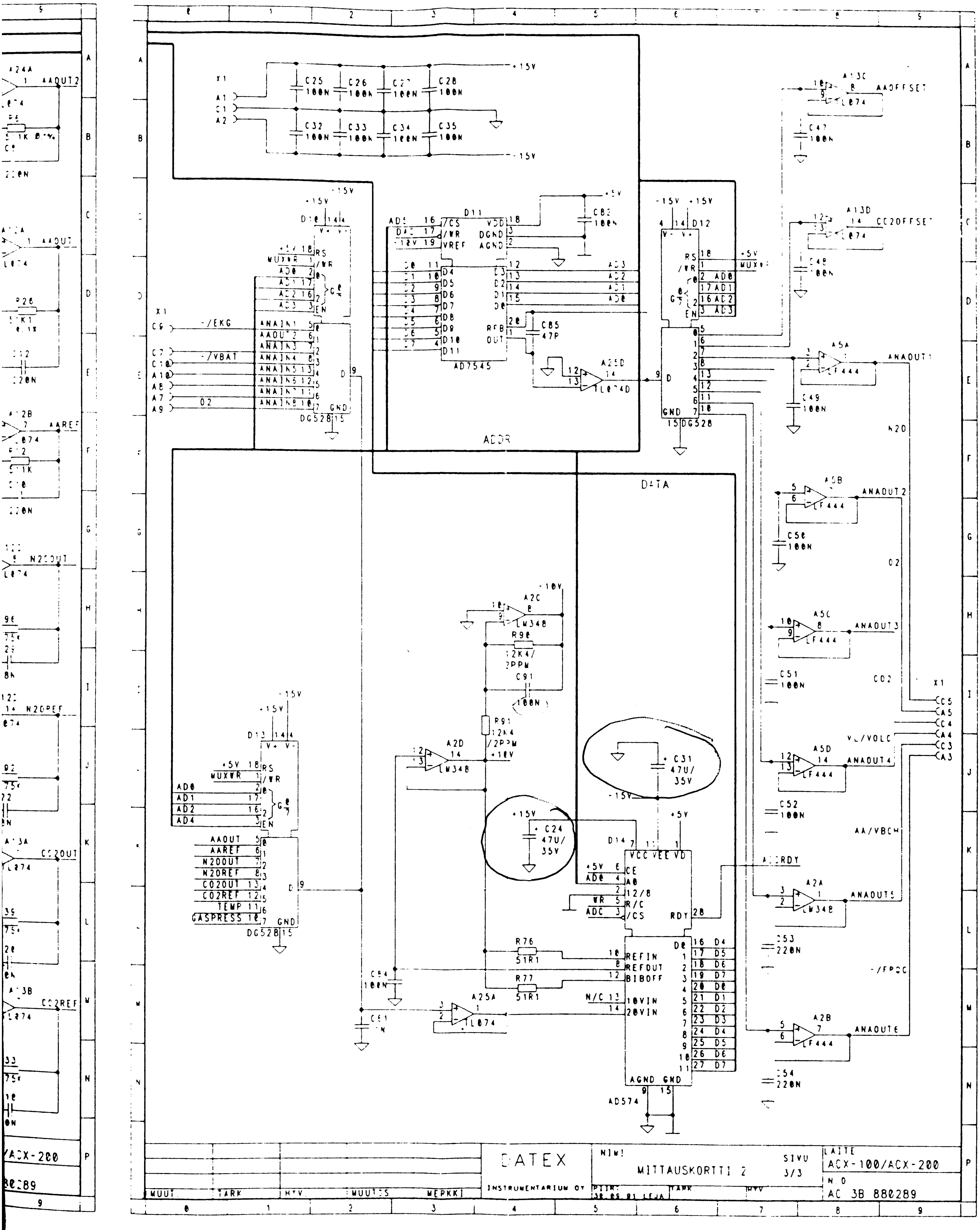
LAITE: ACX-100/ACX-200

PIIRT.: 30.09.91 LEJA

N:O: AC 3B 880289


ADDR
DATA
AD7545
TL074
DG201
DG528
TEMP IN
TEMP
GASPRESS
DARK
CLEAR
SIGIN
EEPROMCLB
SYNCIN
EEPROMR
EEPROMWRB
EEPROM2CS
MOTORB
CO2OFFSET
*)not in use
DATEX
INSTRUMENTARIUM OY
NIMI
MITTAUSKORTTI 2
SIVU
2/3
LAITE
ACX-1
AC 3E

C24
C31


DATEX
INSTRUMENTARIUM OY
NIMI
MITTAUSKORTTI 2
SIVU
3/3
LAITE
ACX-100/ACX-200
NO
AC 3B 880289
MUUT.
TARK
HYV.
MUUTOS
MERKKI
PIIR.
38.05.01 LEJA
ADDR
DATA
AD7545
AD574
DG528
LF444
LM348
TL074
+15V
-15V
+5V
-10V
+10V
ANAOUT1
ANAOUT2
ANAOUT3
ANAOUT4
ANAOUT5
ANAOUT6
AAOFFSET
CO2OFFSET
C24
47U/
35V
C31
47U/
35V
N2O
O2
CO2
VL/VOLC
AA/VBCH
-/FPOC
ADCRDY
ACX-200
880289

5.2 Exploded View of Module

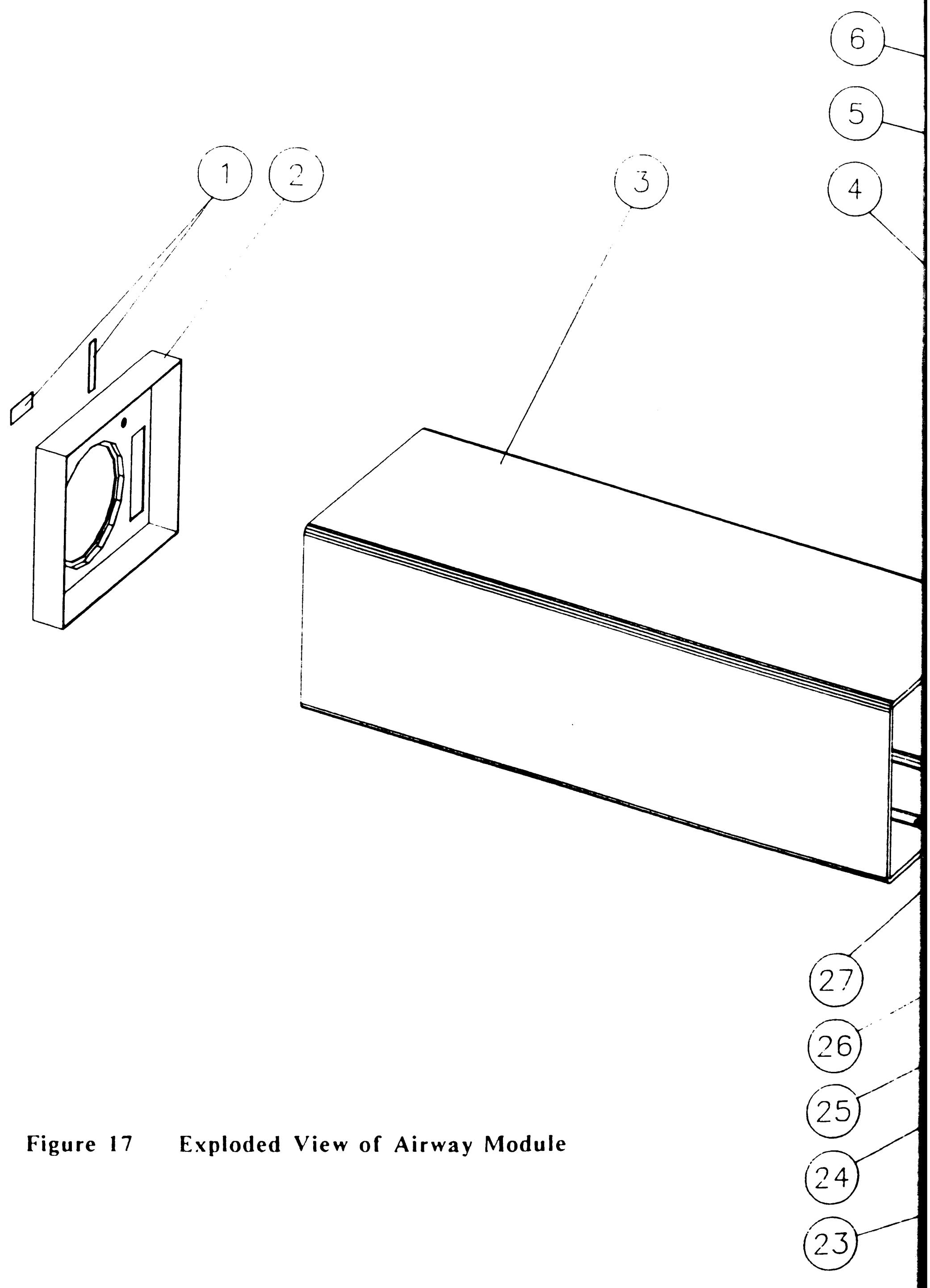
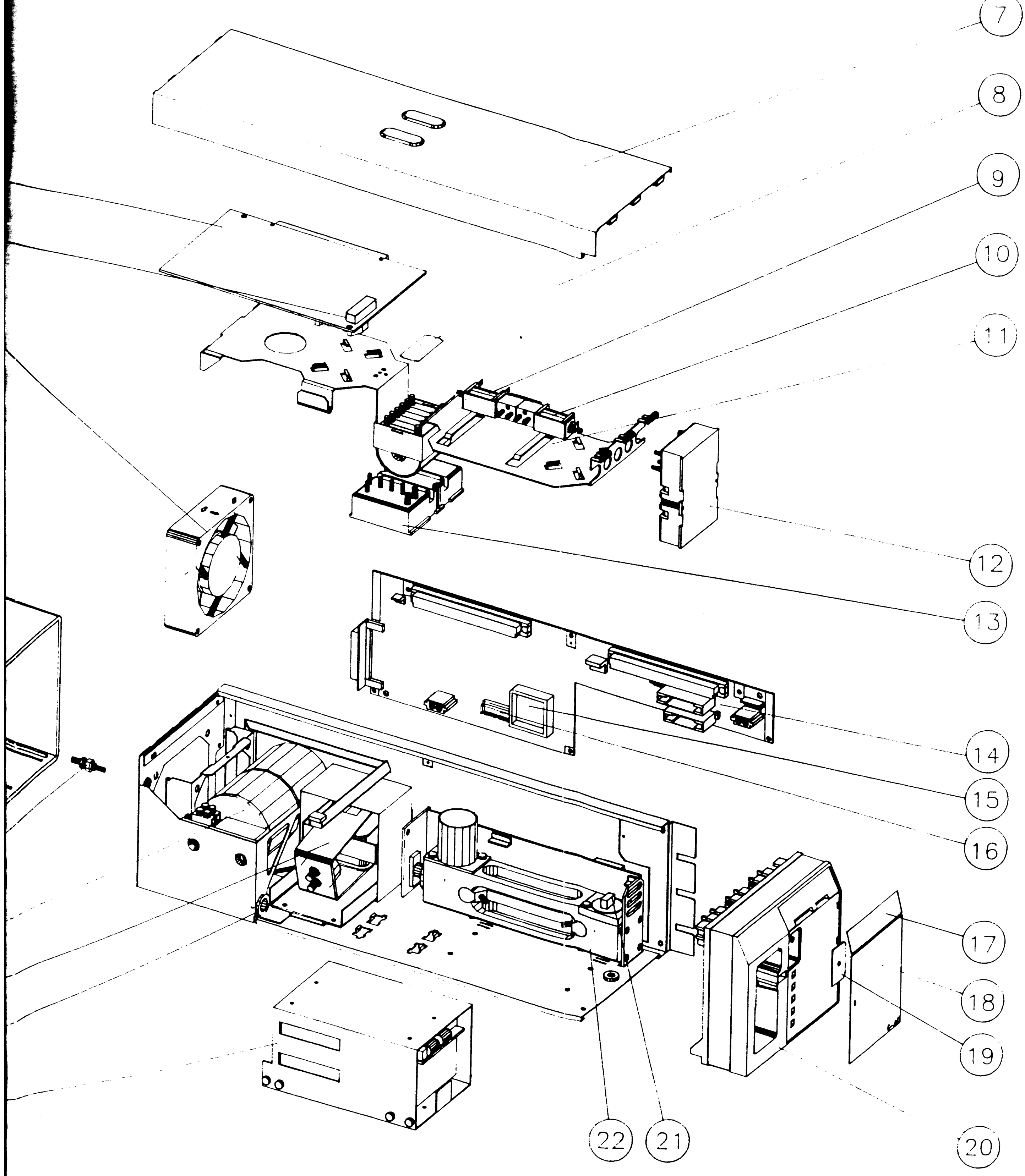


Figure 17 Exploded View of Airway Module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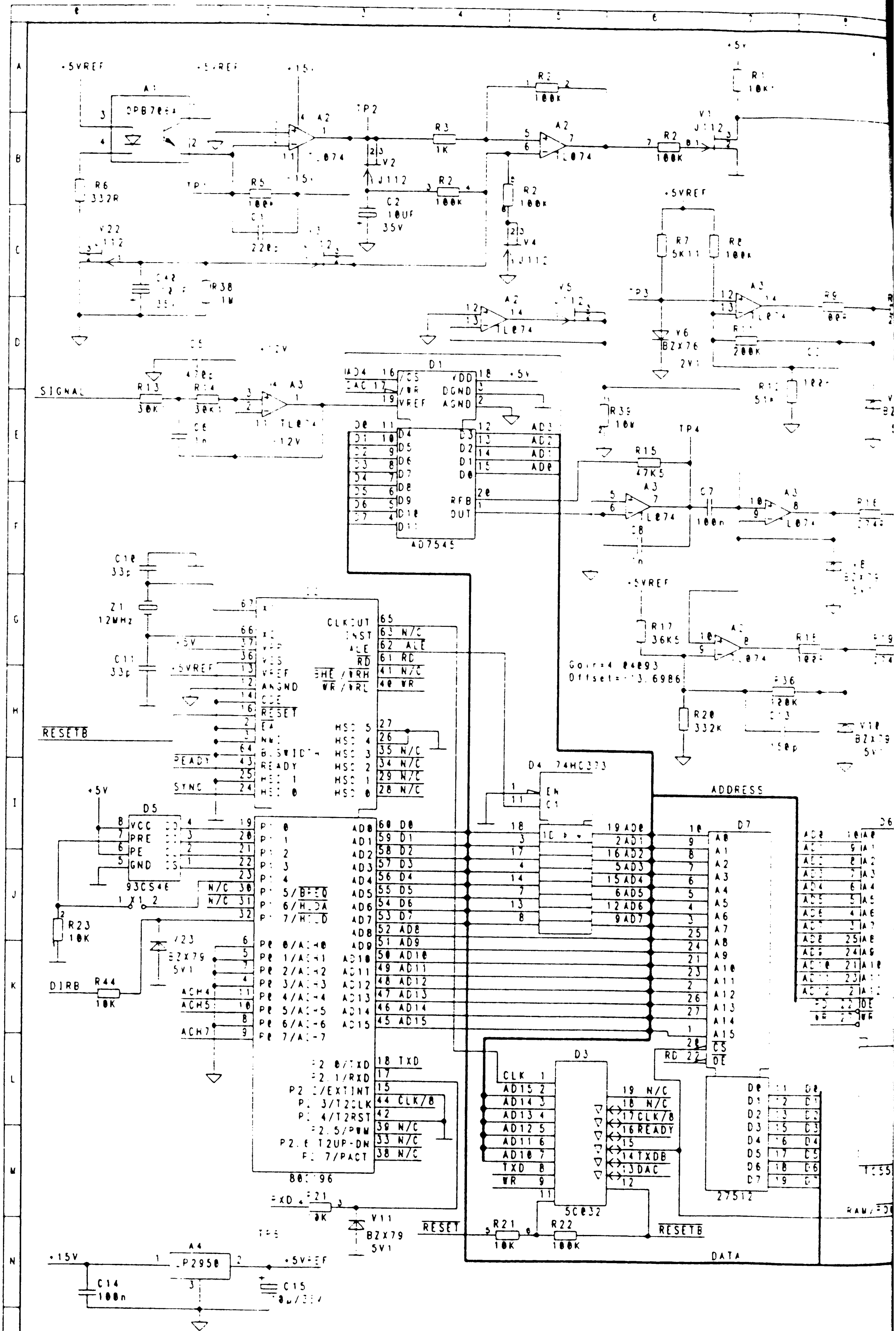

13.04.92LEJA		5619	2	DATEX	NIMI MITTAUSKORTTI	SIVU 1/2
11.06.91LEJA	20.06 91koiK	5014	1			
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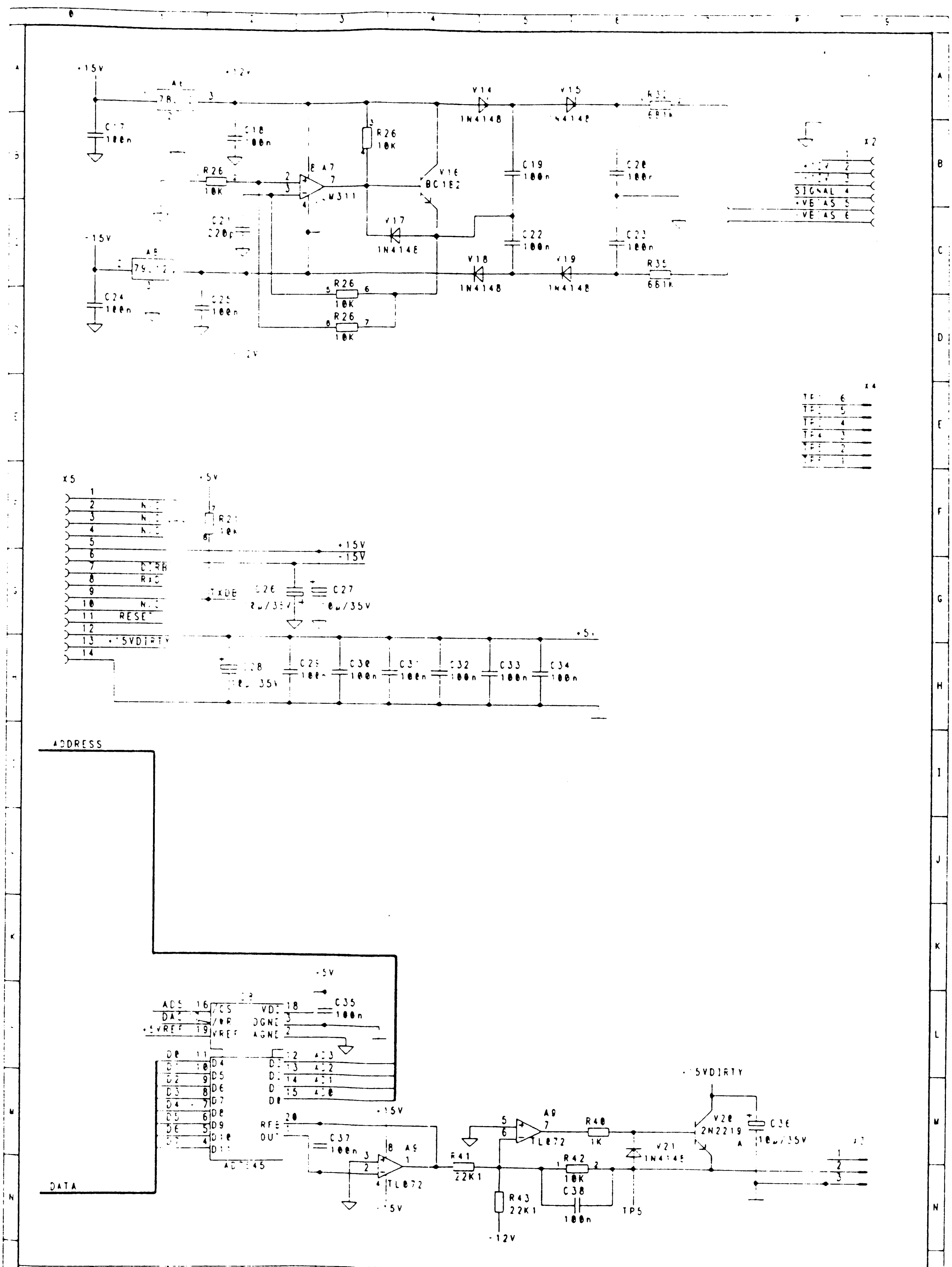

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						PIIRT 24.01.91 AL / TARK / HYV 28.01.91 KeIK		NO AS 3B 879387-2

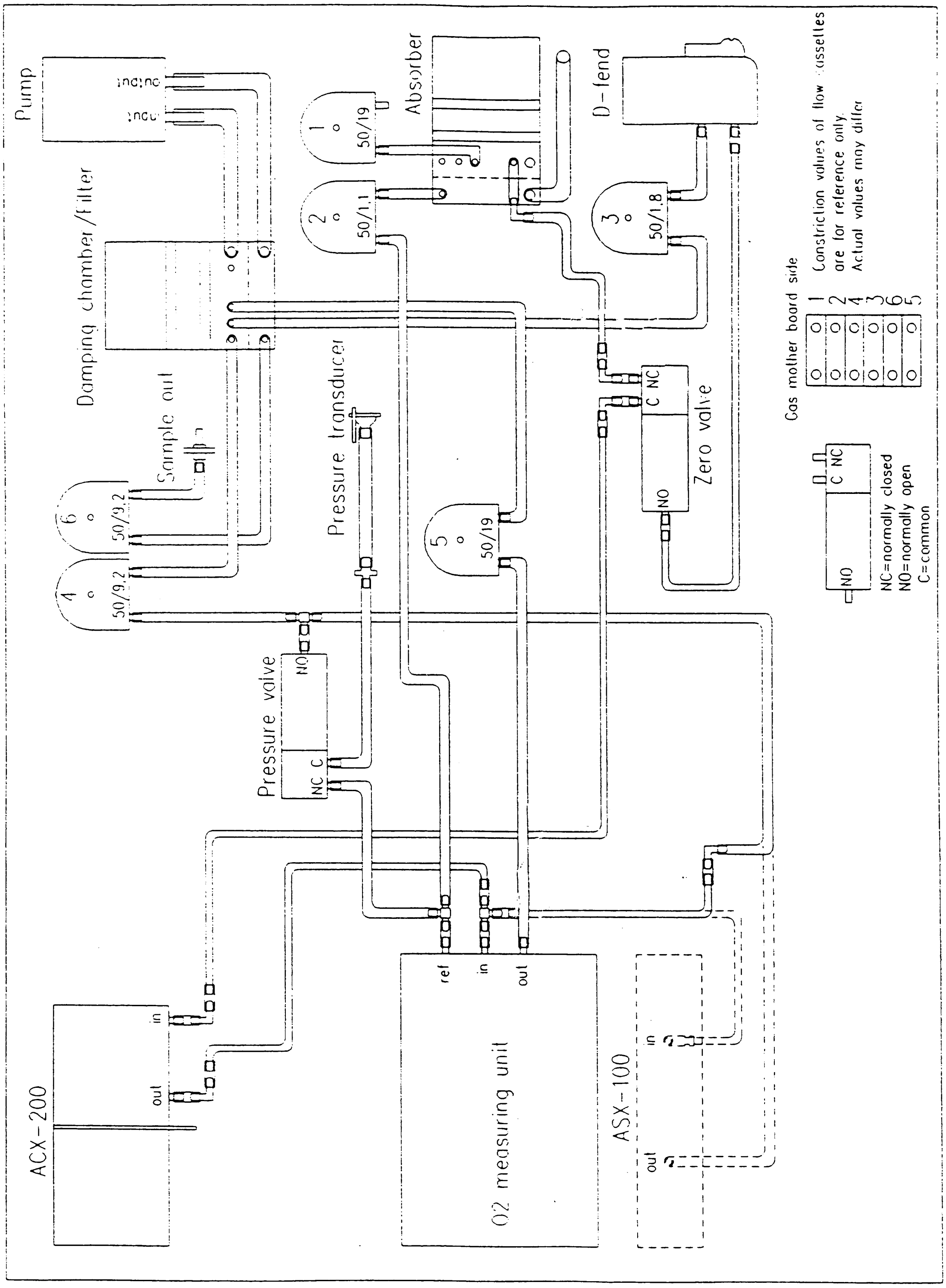
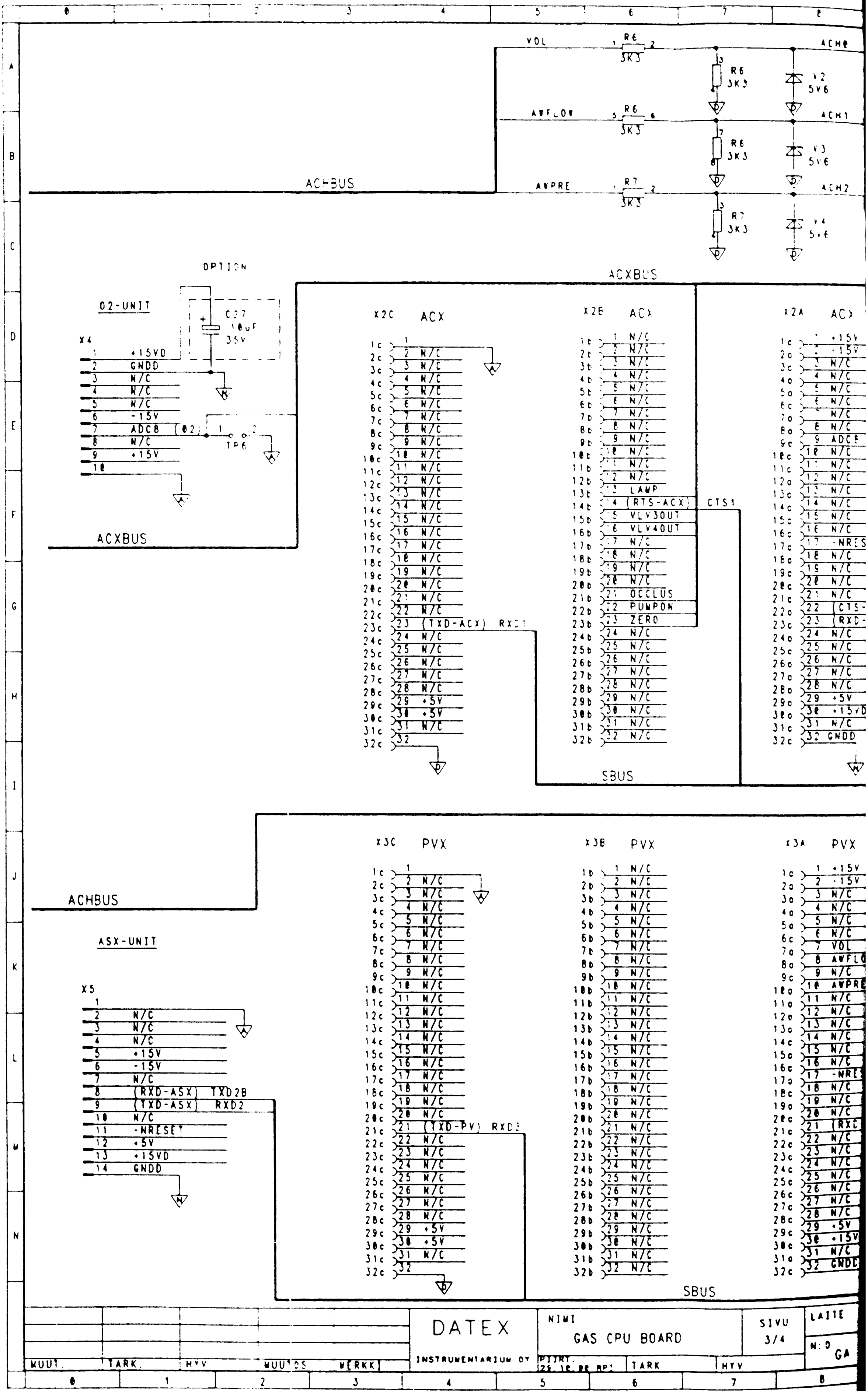
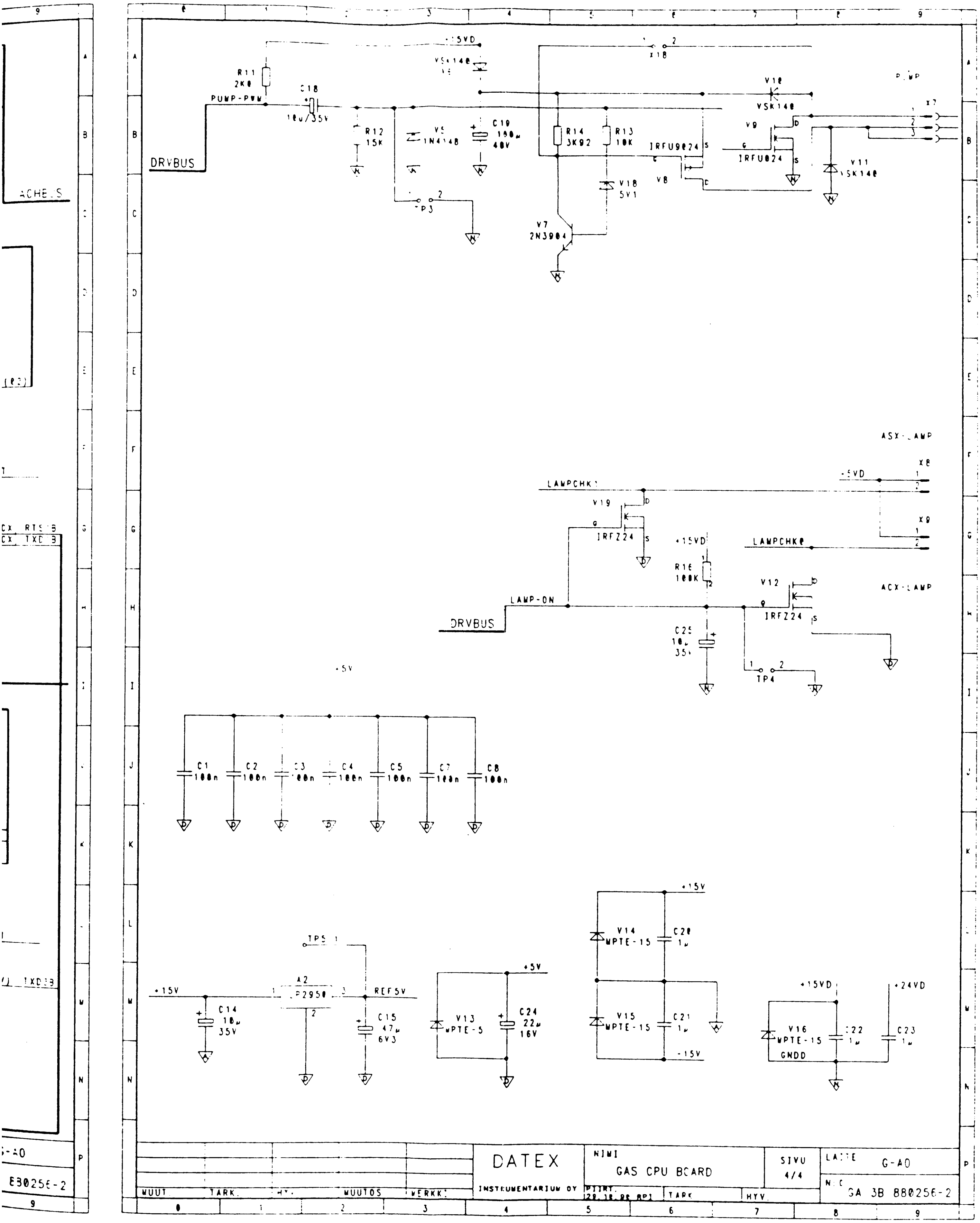


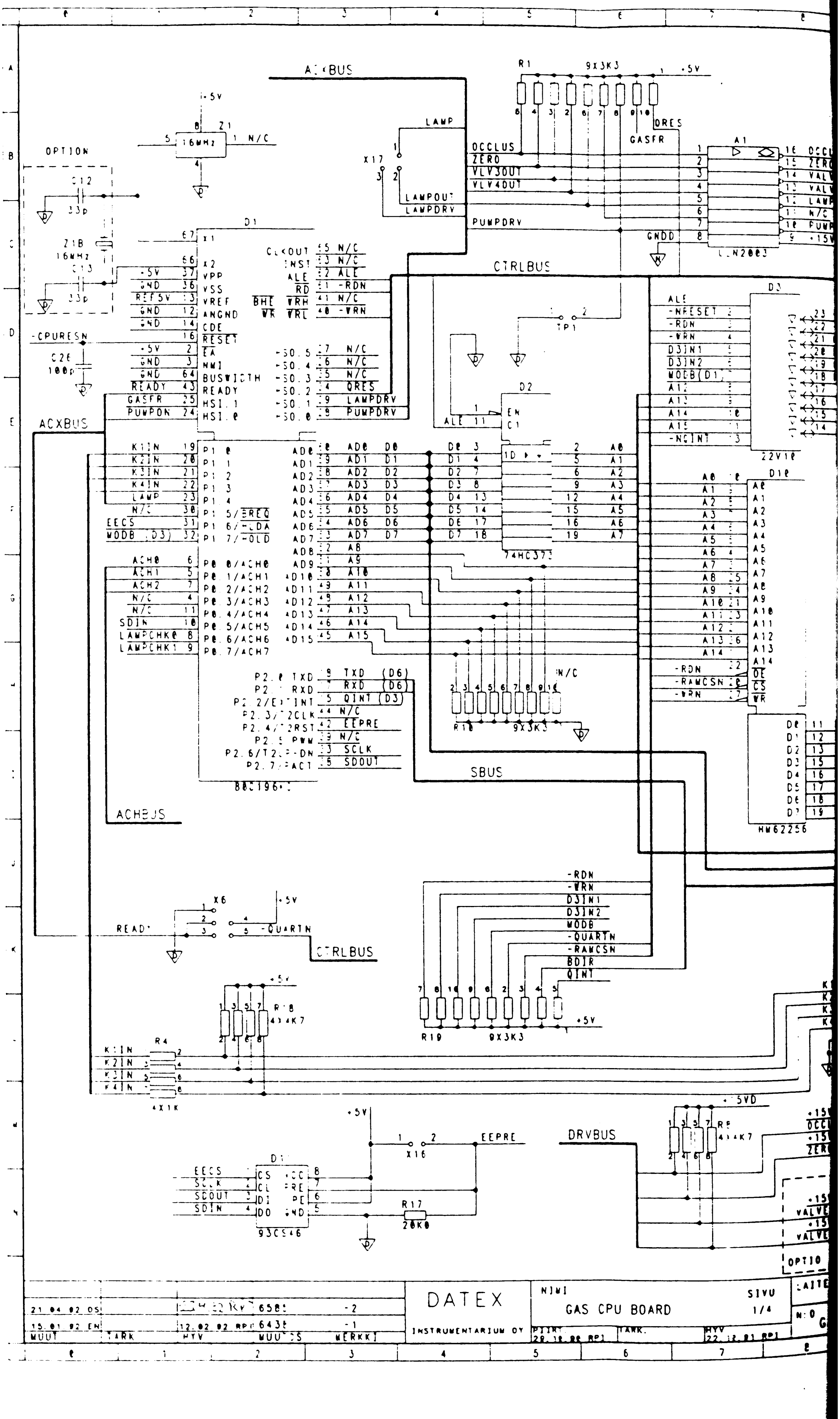
Figure 5 Gas Sampling System Layout



ACHBUS
ACXBUS
SBUS
VOL
AVFLOW
AVPRE
ACH0
ACH1
ACH2
R6 3K3
R7 3K3
V2 5V6
V3 5V6
V4 5V6
OPTION
O2-UNIT
C27 10uF 35V
X4
+15VD
GNDD
ADC8
(O2)
TP6
X2C ACX
X2B ACX
X2A ACX
(TXD-ACX) RXD1
(RTS-ACX) CTS1
LAMP
VLV3OUT
VLV4OUT
OCCLUS
PUMPON
ZERO
ASX-UNIT
X5
(RXD-ASX) TXD2B
(TXD-ASX) RXD2
-NRESET
X3C PVX
X3B PVX
X3A PVX
(TXD-PV) RXD3
DATEX
INSTRUMENTARIUM OY
NIMI
GAS CPU BOARD
SIVU
3/4
LAITE
N:O
GA
PIIRT.
25.10.88 RP
TARK
HYV
MUUT.
MUUT.OS
MERKKI



PUMP-PWM
R11
2K0
C18
10u/35V
+15VD
VSK140
V3
R12
15K
V5
1N4148
C19
100u
40V
X18
TP3
R14
3K92
R13
10K
IRFU9024
V8
V18
5V1
V7
2N3904
V10
VSK140
V9
IRFU024
V11
VSK140
PUMP
X7
DRVBUS
ASX-LAMP
X8
+5VD
LAMPCHK1
V19
IRFZ24
X9
LAMPCHK0
+15VD
R16
100K
V12
IRFZ24
ACX-LAMP
LAMP-ON
DRVBUS
C25
10u
35V
TP4
+5V
C1 100n
C2 100n
C3 100n
C4 100n
C5 100n
C7 100n
C8 100n
+15V
V14
MPTE-15
C20
1u
V15
MPTE-15
C21
1u
-15V
TP5
+15V
A2
LP2950
REFSV
C14
10u
35V
C15
47u
6V3
+5V
V13
MPTE-5
C24
22u
16V
+15VD
+24VD
V16
MPTE-15
C22
1u
C23
1u
GNDD
DATEX
INSTRUMENTARIUM OY
NIMI
GAS CPU BOARD
SIVU
4/4
LAITE
G-A0
NIO
GA 3B 880256-2
MUUT
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
29.10.90 RPJ
TARK
HYV.
ACHEL.S
G-A0
880256-2



ACXBUS
CTRLBUS
SBUS
ACHBUS
DRVBUS
OPTION
C12 33p
Z1B 16MHz
C13 33p
Z1 16MHz
N/C
+5V
X17
LAMP
LAMPOUT
LAMPDRV
PUMPDRV
R1 9X3K3
QRES
GASFR
OCCLUS
ZERO
VLV3OUT
VLV4OUT
GNDD
A1
ULN2003
D1
80C196KC
-CPURESN
C26 100p
D2
74HC373
D3
22V10
D10
HM62256
TP1
R10 9X3K3
X6
READY
-QUARTN
R18 4X4K7
R4 4X1K
K1IN
K2IN
K3IN
K4IN
R19 9X3K3
-RDN
-WRN
D3IN1
D3IN2
MODB
-RAMCSN
BDIR
QINT
X16
EEPRE
D11
93C46
EECS
SCLK
SDOUT
SDIN
R17 20K0
R8 4X4K7
DATEX
INSTRUMENTARIUM OY
NIMI
GAS CPU BOARD
SIVU
1/4
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
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12.02.92 RPI
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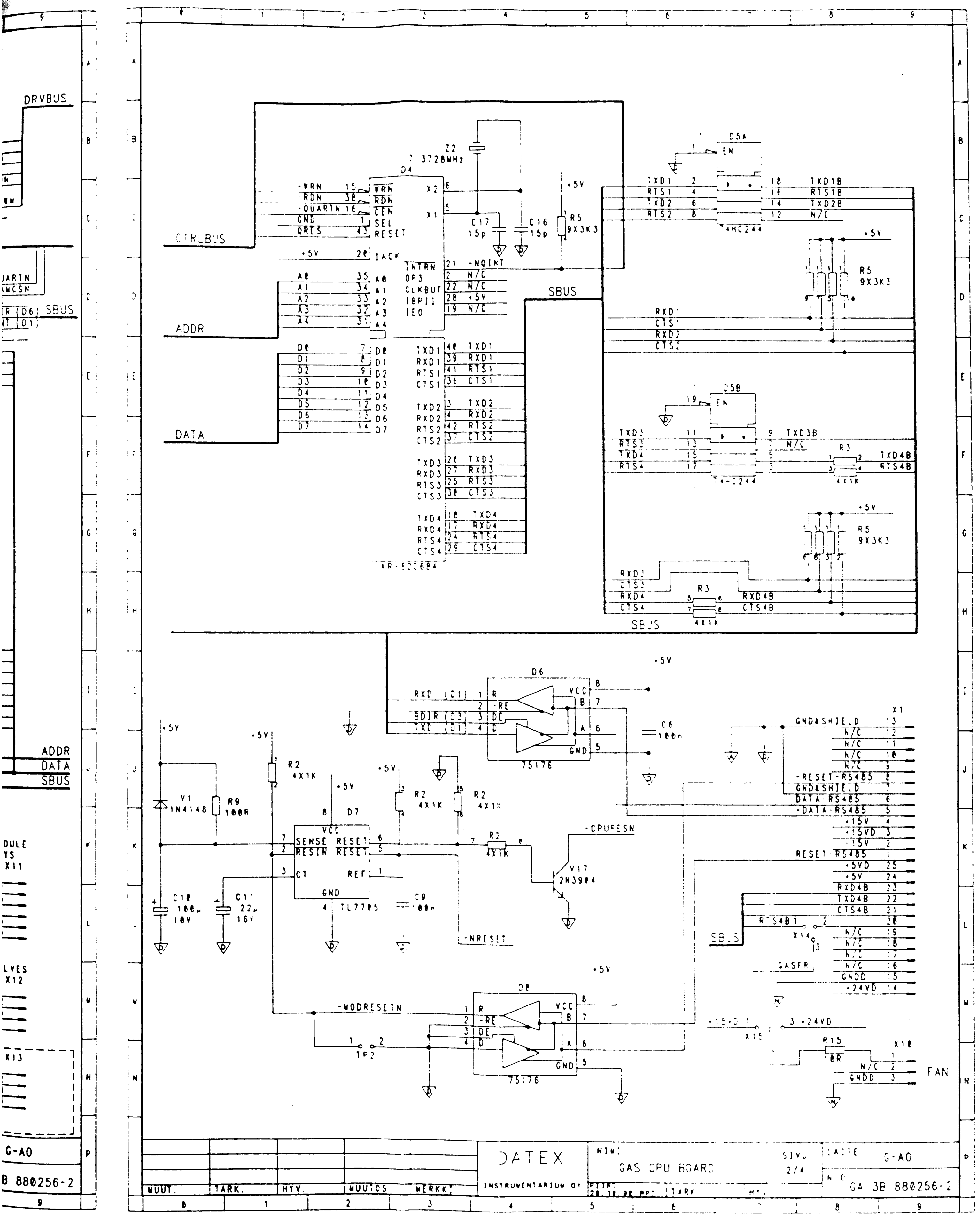
6435
29.10.90 RPI
22.12.91 RPI



DRVBUS
CTRLBUS
ADDR
DATA
SBUS
Z2
7 3728MHz
D4
-WRN
-RDN
-QUARTN
GND
QRES
+5V
A0
A1
A2
A3
A4
D0
D1
D2
D3
D4
D5
D6
D7
WRN
RDN
CEN
SEL
RESET
IACK
INTRN
OP3
CLKBUF
IBPI1
IEO
X2
X1
-NOINT
N/C
TXD1
RXD1
RTS1
CTS1
TXD2
RXD2
RTS2
CTS2
TXD3
RXD3
RTS3
CTS3
TXD4
RXD4
RTS4
CTS4
C17
15p
C16
15p
R5
9X3K3
D5A
EN
TXD1B
RTS1B
TXD2B
74HC244
D5B
TXD3B
TXD4B
RTS4B
R3
4X1K
RXD4B
CTS4B
D6
RXD (D1)
SDIR (D3)
TXD (D1)
R
-RE
DE
D
VCC
GND
75176
C6
100n
X1
GND&SHIELD
-RESET-RS485
DATA-RS485
-DATA-RS485
+15V
+15VD
-15V
RESET-RS485
+5VD
GNDD
+24VD
V1
1N4148
R9
100R
R2
4X1K
D7
SENSE
RESETN
CT
REF
TL7705
C9
100n
C10
100u
16V
C11
22u
16V
-CPURESN
V17
2N3904
-NRESET
-MODRESETN
TP2
D8
X14
GASFR
X15
+24VD
R15
10R
X10
FAN
DATEX
INSTRUMENTARIUM OY
NIMI
GAS CPU BOARD
SIVU
2/4
LAITE
G-A0
NO
GA 3B 880256-2
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
28.10.88 PP.

Recorder Module, M-REC

TABLE OF CONTENTS PAGE

LIST OF FIGURES

PAGE

1 SECTION INTRODUCTION

This service manual section provides information required to maintain and repair the Datex AS/3^{TM} Anaesthesia Monitor Recorder Module, M-REC. This manual is applicable for the current production revision of the modules. Differences between module revisions are summarized in Chapter 7.

M-REC-xx-01 is the initial production revision of the module.

2 DETAILED DESCRIPTION OF MODULE

2.1 Recorder Board

In general

The recorder board is situated inside the Recorder Module. Its task is to connect recorder (General Scanning type AR-42) to module bus. Additionally, three front panel keys are connected through the board to the recorder.

The recorder and the recorder board are connected together with 2 x 25-pin ribbon cable X2. The ribbon cable changes both A- and B-lines' pin numbers to the reverse order: A1 to A25, B1 to B25.

External communication

Communication with the host processor takes place in +5 V CMOS-level serial communication B and RS485-reset. If necessary, SYNC-signal from the recorder can be connected to BIT0IN with jumper X5 for UPI board to read. The jumper is not in use at the moment.

Reset

Differential RS485-reset from the module bus is transferred to mod-bus-reset signal in IC D1. 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 by transistors V3 and V4 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. The keys are connected to connector X3.

For protecting the key switch signals from static discharges, there are zener diodes and series resistance option R4. Pull-up resistor R3 is not needed because there are 47 k pull-up resistors connecting the key switch signal inputs and +5 V together inside the recorder.

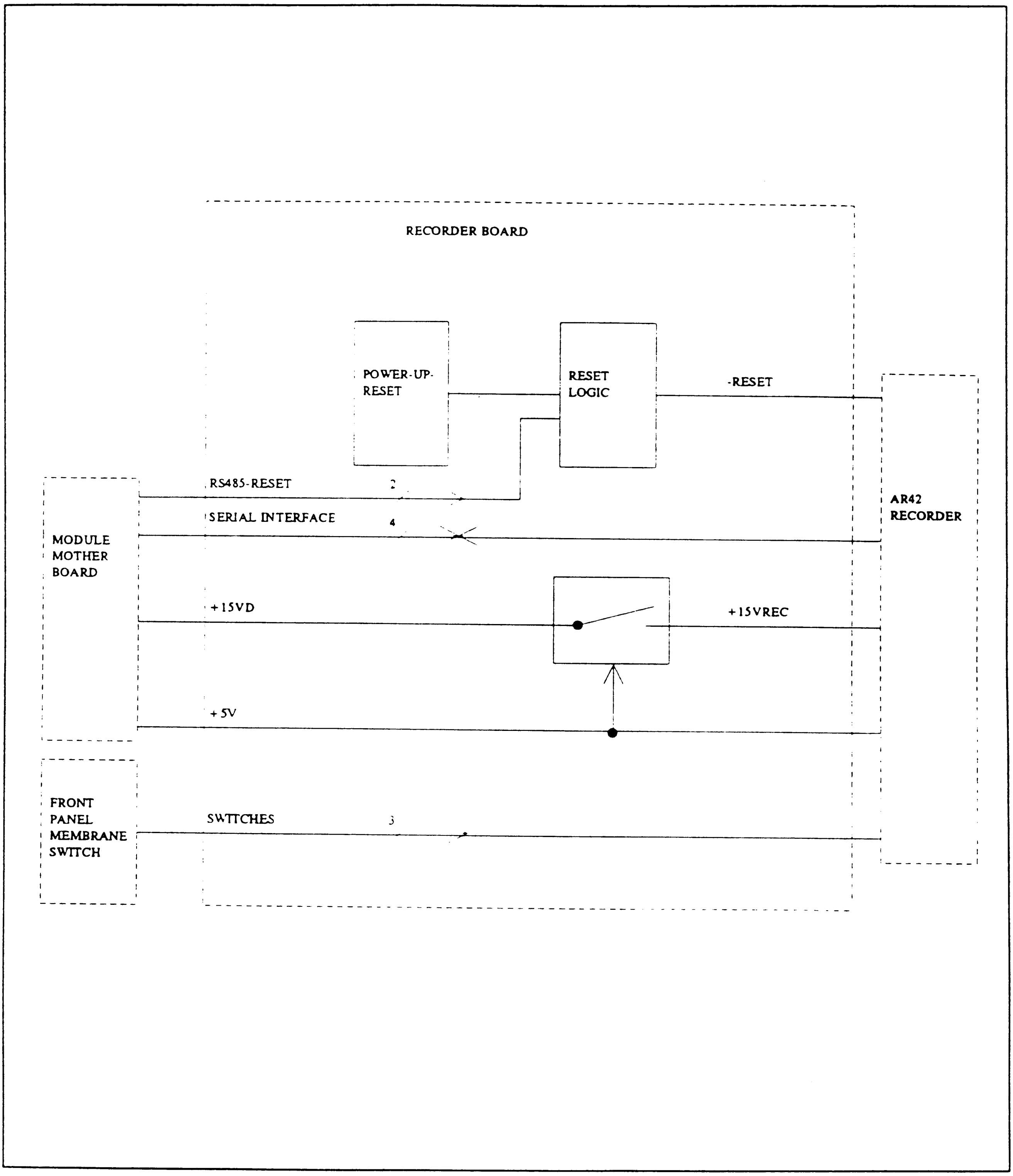


Figure 1 Recorder Board Block Diagram

2.2 Module Bus Connector Configuration

Rear panel 25-pin female D-connector

Pin No	I/O	Signal	Notes
1	O	RESET_RS485*	
2	I	-15 VDC	
3	I	+15 VDIRTY*	
4	I	+15 VDC	
5	O	-DATA_RS485	
6	O	DATA_RS485	
7		Ground & Shield*	
8	O	-RESET_RS485*	
9	I	CTSB*	
10	O	RTSB*	
11	I	RXDB*	
12	O	TXDB*	
13		Ground & Shield*	
14	I	+24 VDIRTY	
15	I	GroundDIRTY*	
16	I	CTSC	
17	O	RTSC	
18	I	RXDC	
19	O	TXDC	
20	I	ON/STANDBY	
21	I	BIT0IN*	
22	I	RXDD_RS232	
23	O	TXDD_RS232	
24	I	+5 VDC*	
25	I	+5 VDC*	

* In use in the Recorder module.

13 ⏚ —
25 — +5
24 — +5
4 — 15 V
3 — +15 V Dirty
2 — +15 "
24 — +24 "

3 SERVICE AND TROUBLESHOOTING

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 Disassembly and Reassembly

The Recorder Module is disassembled in the following way. See Figure 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 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 cable form 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 rearwards.

The recorder board is attached to the metal chassis with four screws.

3.3 Troubleshooting Chart

PROBLEM	CAUSE	TREATMENT
Module not responding to front panel keys, but operates through Recorder menu.	Membrane switch cable loose or broken.	Check the cable. Replace the front panel if necessary.
	50-pin ribbon cable loose or broken.	Check the cable. Replace it if necessary.
Recorder will not start. No error messages shown.	Module not properly inserted.	Reinsert the Module properly.
	50-pin ribbon cable loose or broken.	Check the cable. Replace it if necessary.
	Recorder board D1 or D2 faulty.	Replace them.
	Recorder faulty.	Replace the Recorder.

3.4 Error 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 50-pin ribbon cable. Check V3 and V4 on the recorder board.
Recorder: input voltage high	+15 Vrec is too high. Check 50-pin ribbon cable.
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.

3.5 Preventive Maintenance Check List

We recommend that you perform these checks after any service and at least once every six months to keep the AS/3™ Anaesthesia Monitor Recorder 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 before attaching the module box.

2. Functional checks

___: Insert the module into Central Unit where there is at least ESTP/ETP/P 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 plot length and 6.25 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 25 ± 2 cm.

___: Change paper speed to 25. The length should be 50 ± 4 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 are unbroken.

4 SPARE PARTS

4.1 Spare Parts List

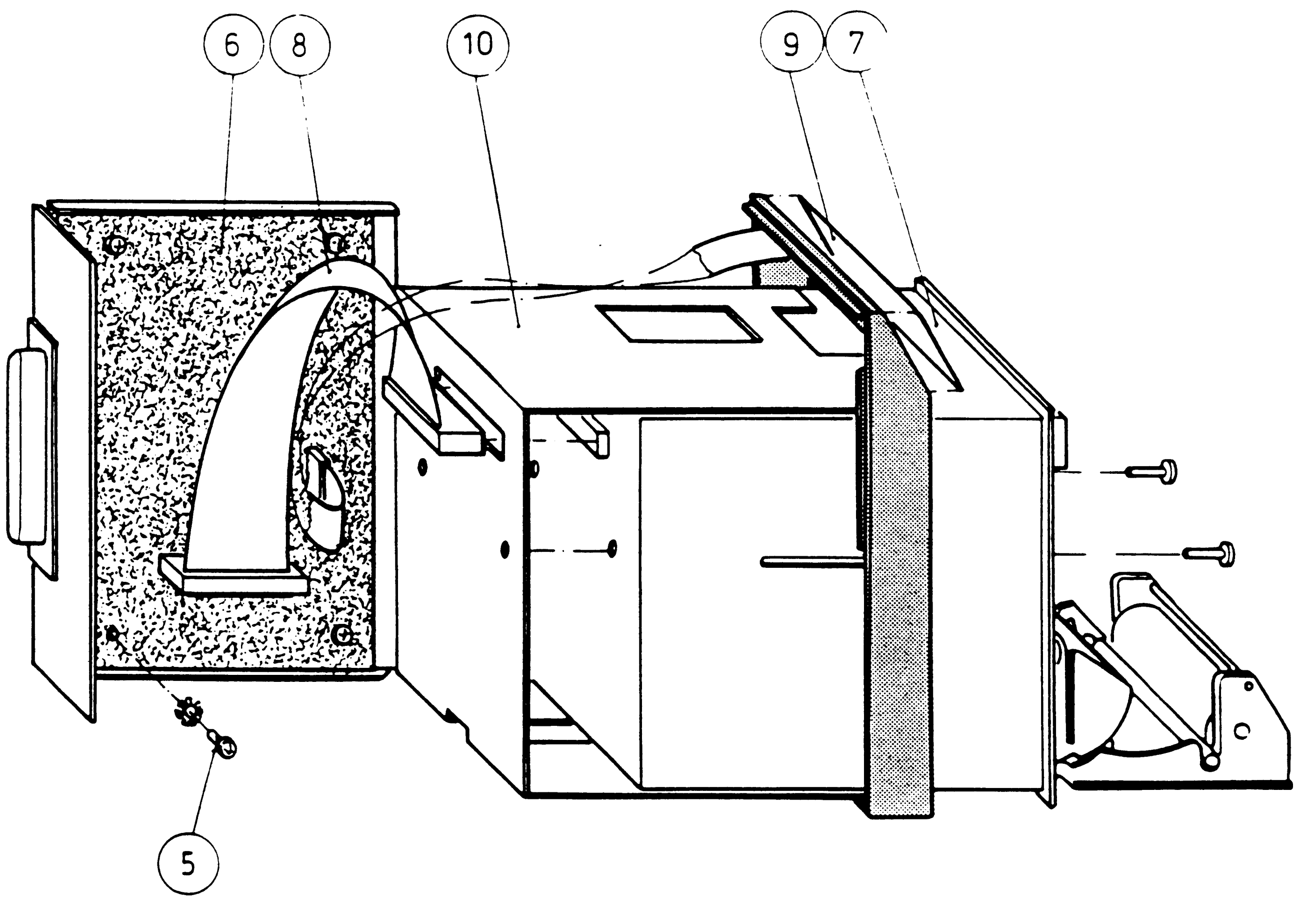
> NOTE: Accessories are listed in the Operator's Manual.

Item	Item description	Order No.
6	Recorder board	880313
7	Recorder	90350
8	50-pin connector cable	879362
9	Front panel sticker (Eng)	879483
9	Front panel sticker (Ger)	880486
9	Front panel sticker (Fre)	880172
1	Module box (wide)	879096
3	Latch	879181
2	Spring pin	879182
10	Metal chassis	879179
5	Cross recess screw M3x8	61622
4	Front panel unit	881328

Item number refers to the exploded view in Figure 2.

See M-ESTP Section for the exploded view of Module Box.

4.2 Exploded View of Module



*) Ground shield of Keyboard cable is
connected to pin 1

Figure 2 Exploded View of Recorder Module

5 CIRCUIT DIAGRAM AND PARTS LAYOUT

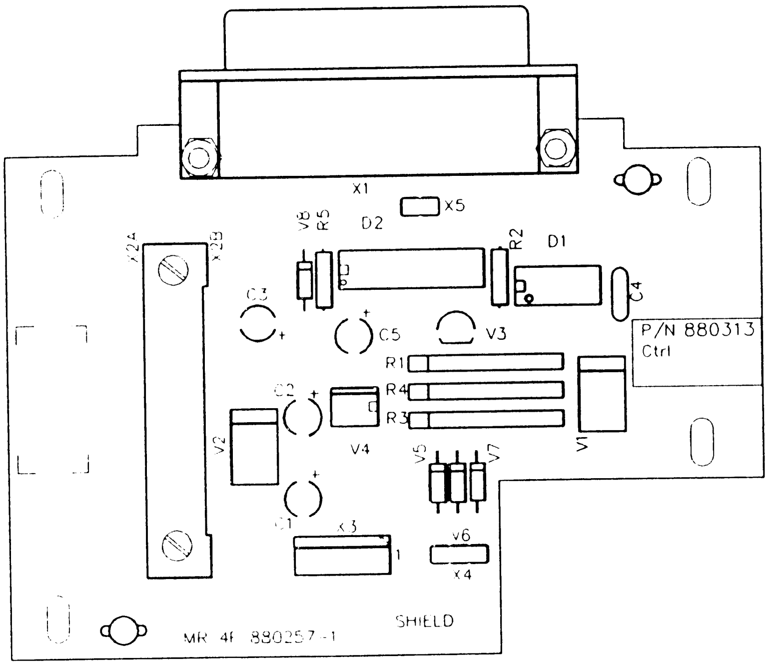
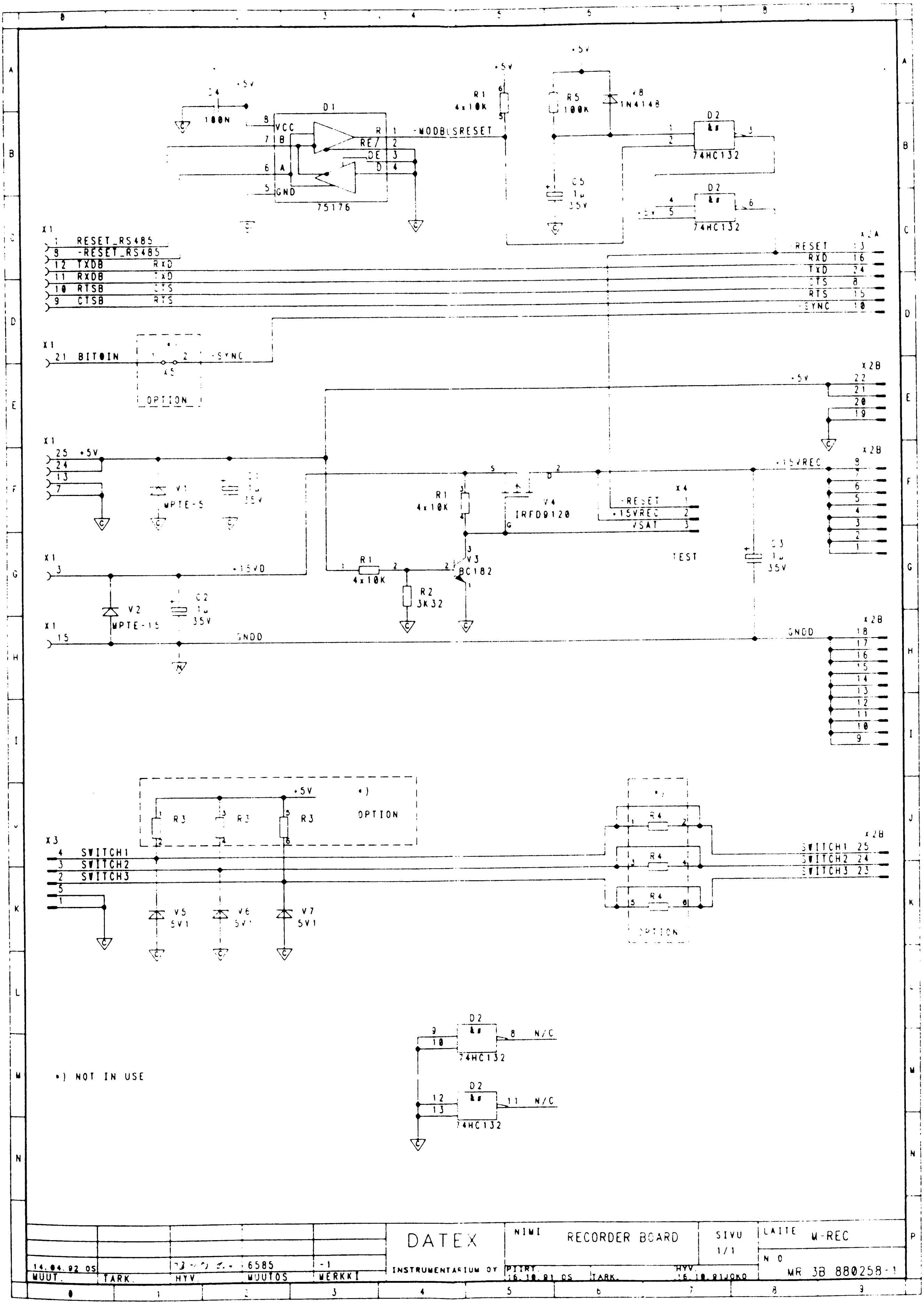


Figure 3 Recorder Board Parts Layout and Schematic Diagram



D1
75176
VCC
GND
RE/
DE
+5V
C4
100N
-MODBUSRESET
R1
4x10K
R5
100K
V8
1N4148
D2
74HC132
C5
1u
35V
X1
RESET_RS485
-RESET_RS485
TXDB
RXDB
RTSB
CTSB
RXD
TXD
CTS
RTS
X2A
RESET
-SYNC
21 BITGIN
OPTION
X2B
25 +5V
V1
MPTE-5
V4
IRFD9120
X4
-RESET
+15VREC
VSAT
TEST
C3
1u
35V
+15VD
R2
3K32
V3
BC182
V2
MPTE-15
C2
1u
35V
GNDD
R3
R4
*)
OPTION
X3
SWITCH1
SWITCH2
SWITCH3
V5
5V1
V6
5V1
V7
5V1
N/C
*) NOT IN USE
DATEX
INSTRUMENTARIUM OY
NIMI
RECORDER BOARD
SIVU
1/1
LAITE
M-REC
NO
MR 3B 880258-1
14.04.92 OS
6585
-1
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
16.10.91 OS
16.10.91JOKO

6 SPECIFICATIONS

6.1 Typical Performance

Paper width	50 mm, printing width 48 mm
Traces	Selectable 1, 2, or 3 traces
Print speed	6.25, 12.5, 25 mm/s

6.2 Technical 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
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

7 EARLIER REVISIONS

Service Menu

TABLE OF CONTENTS PAGE

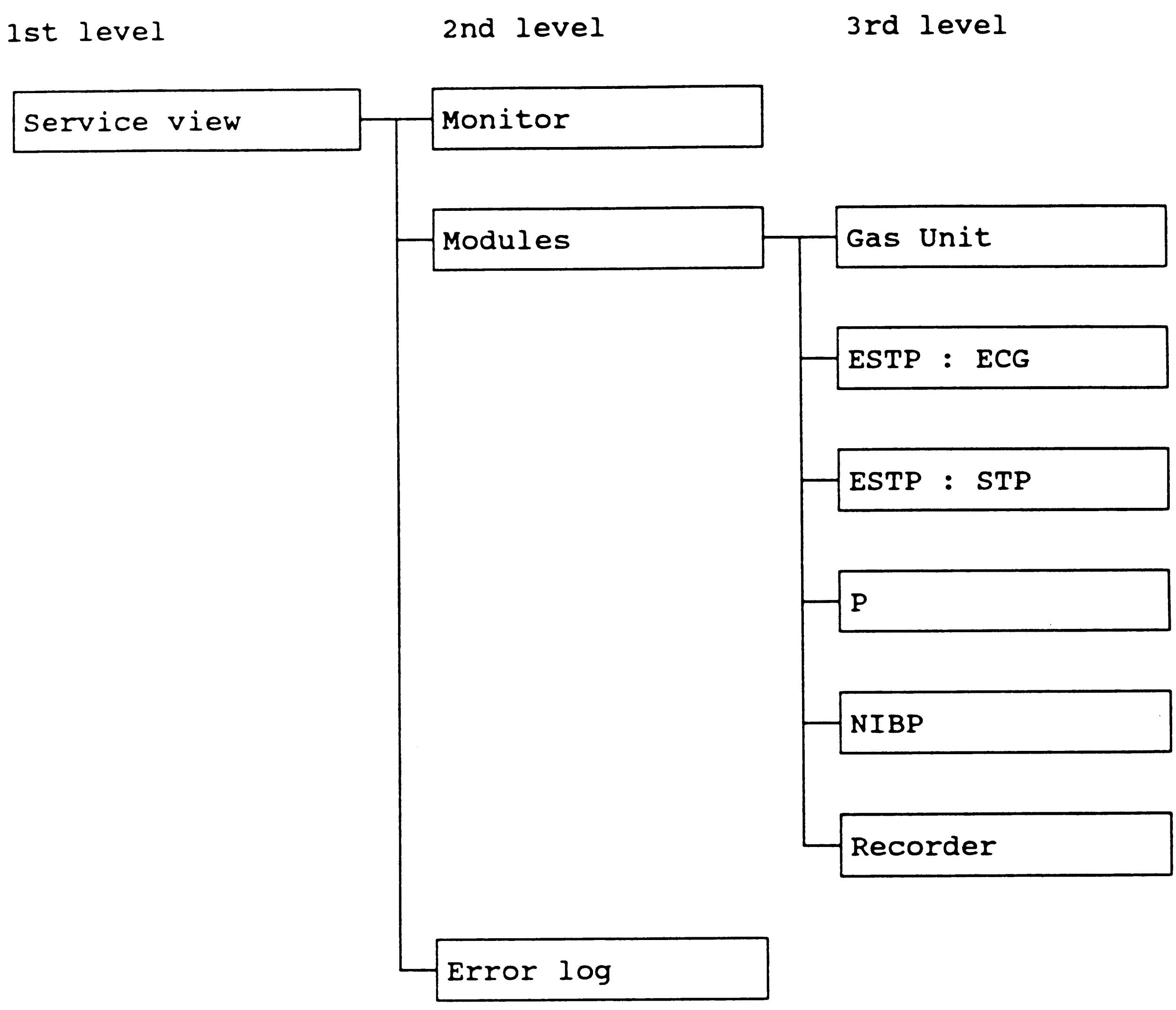
SERVICE MENU

The Datex AS/3™ Anaesthesia Monitor contains software Service Menu, which is a useful tool to examine monitor functions and to troubleshoot in case a fault occurs. Additionally, most of the monitor calibrations can also be performed in the Service Menu.

pass words:

year	Level 1	Level 2
92	1	2 - 2
94	10	1 - 20 - 20
95	16-4-34	26 - 23 - 8

Figure below shows Service Menu structure.



On the left side of the Service View Menu, there are five selections. They are:

1. Monitor unit service functions.

2. Keyboard service functions.

3. Modules service functions.

4. Monitor error history.

5. Return to previous menu.

Highlight Monitor, Keyboard, Modules, or Error log with the ComWheel and give a click to enter their submenus.

In Service View Menu the following colors are used (if not defined otherwise):

Section headers	yellow
First column texts	white
ID text string	yellow

SERVICE DATA Detailed Description

Pump, zero valve, and pressure (occlusion) valve are operated manually by highlighting and clicking each **Pump Start, Zero Valve, and Occl Valve** text. In normal measuring situation, the valves are in OFF position.

Airway module's front panel key function is confirmed by pressing the key and observing OFF turns to ON at **Button**.

Noise indicates maximum noises in gas signals in 30 seconds span.

Calib zero and **gain** indicate calibration constants of zero and gain for each gas. The constants are according to the ACX measuring chamber. The zero constants will change at gas zeroing.

Working press is the internal pressure measured by pressure transducer. Normally it is about 700 mmHg.

Amb press is the ambient pressure.

Amb-Work is a pressure difference between the ambient pressure and the internal working pressure.

OM(in)-OM(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.

ACX temp is temperature measured inside ACX bench.

Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down. **Timeouts** is also a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. The AS/3™ Anaesthesia Monitor starts counting these two items at power up and reset to zero at power off. The nonzero values do not indicate a failure, but the continuous counting during the normal operation indicates either serial communication failure or module not in place.

SERVICE DATA **Detailed Description**

Power freq, Filter low and high, and Cable type shows the values chosen or detected.

Quick zero is ON when signal goes beyond scale and capacitor 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 to the front panel.

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**.

Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down. **Timeouts** is also a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. The AS/3™ Anaesthesia Monitor starts counting these two items at power up and reset to zero at power off. The nonzero values do not indicate a failure, but the continuous counting during the normal operation indicates either serial communication failure or module not in place.

SERVICE DATA Detailed Description

Zero indicates offset compensation value of each parameter in A/D converter. Typically the value is between 17000 and 25000. **Gain** is a coefficient to compensate gain error. Usually the value is within $\pm$1000. 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 heart rate calculated from every beat.

Probe can have one of the values OFF, CHECK and ON. **State** is a message field for SpO_2. It can have at a time two of the messages OK, SEARCH, NO PULSE, ARTEFACT, WEAK SIGNAL, and LOW PLETH.

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

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 calibration in Calibration Menu.

Configuration shows the chosen module configuration: TP, ST, or STP.

Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down. **Timeouts** is also a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. The AS/3™ Anaesthesia Monitor starts counting these two items at power up and reset to zero at power off. The nonzero values do not indicate a failure, but the continuous counting during the normal operation indicates either serial communication failure or module not in place.

Temperature Calibration

1. Go to ESTP: STP service page.
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. Click the ComWheel.
7. Insert calibration plug (45°C) into T1/T2 connector.
8. Click the ComWheel.
9. Press in the protect button at the bottom of the module and choose ON in Protect mode. Release the button.

SERVICE DATA Detailed Description

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

Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down. **Timeouts** is also a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. The AS/3™ Anaesthesia Monitor starts counting these two items at power up and reset to zero at power off. The nonzero values do not indicate a failure, but the continuous counting during the normal operation indicates either serial communication failure or module not in place.

Pressure Calibration

1. Go to P service page.
2. Go to Calibrations page.
3. Connect pressure transducer to the front panel P3 receptacle. The texts Calibration will become vivid. Leave the transducer to room air pressure.
4. Click the ComWheel. The zeroing takes place.
5. Supply pressure of over 100 mmHg to the transducer.
6. Set the pressure on the display with the ComWheel to match the pressure reading on manometer and click the ComWheel.
7. The text 'calibrated' will appear on the display.

SERVICE DATA Detailed Description

Pressure shows measured pressure multiplied by 10. **Zero** shows pressure at autozeroing multiplied by 10 and changes between +20 and -20 mmHg. Absolute pressure is the sum of **Pressure** and **Zero**.

Module exists indicates that the module is recognized (1) or not (0). **Module active** indicates that the module is active in communicating (1) or not (0).

Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down. **Timeouts** is also a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. The AS/3™ Anaesthesia Monitor starts counting these two items at power up and reset to zero at power off. The nonzero values do not indicate a failure, but the continuous counting during the normal operation indicates either serial communication failure or module not in place.

Error code and **Module code** (factory use only) show error codes (see the Service Manual NIBP section Error Codes Chapter for the list).

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 then. It can be turned to OFF by pressing the button (or turning the toggle-switch to the right) at the bottom of the module, which also enables 'Protection ON/OFF' menu selection in calibration menu. **Calibr. prot.** shows software calibration protection and should be OFF to enable calibration. In adaptation Germany this must be set to ON after calibration.

+15 V power indicates that +15 Vdirty power for pump and valves exists (ON).

St1 to **St4** are for factory use only.

AD0 to **AD7** show the values of each eight channels of A/D converter.

Active Leak Test

Wrap normal 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 itself. Wait for several seconds until the pressure stabilizes. Then check that the pressure does not go down 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. Note that if the display shows +2 mmHg at the beginning and if you pumped +200 mmHg into the module, the display should show +202 mmHg at the end.

Calibration

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

1. If **Protection** is ON (adaptation Germany), change it to OFF by first pressing the button (or turning the toggle-switch to the right) at the bottom of the module, which enables the **Protection** selection. Then release the button (turn the toggle-switch to the left) to enable **Calibration**.

2. For proper zeroing to take place, remove hoses from the front panel connector. Select **Calibration** and click 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 and pump up to 200 mmHg pressure according to the manometer. Verify the pressure calibration value in the pressure bar beside the word "Calibration".

4. Adjust, by turning the ComWheel, the calibration value to be equal to the pressure value of the manometer. When the values are equal, click 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. In adaptation Germany use the bottom button/switch to enable **Protection** setting and set it ON, and finally disable **Protection** setting.

PULSE VALVE DATA Detailed Description

Pressure shows measured pressure multiplied by 10. **Zero** shows pressure at autozeroing multiplied by 10 and changes between +20 and -20 mmHg. Absolute pressure is the sum of **Pressure** and **Zero**.

Module exists indicates that the module is recognized (1) or not (0). **Module active** indicates that the module is active in communicating (1) or not (0).

Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down. **Timeouts** is also a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. The AS/3™ Anaesthesia Monitor starts counting these two items at power up and reset to zero at power off. The nonzero values do not indicate a failure, but the continuous counting during the normal operation indicates either serial communication failure or module not in place.

Error code and **Module code** (factory use only) show error codes (see the Service Manual NIBP section Error Codes Chapter for the list).

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 then. It can be turned to OFF by pressing the button (or turning the toggle-switch to the right) at the bottom of the module, which also enables 'Protection ON/OFF' menu selection in calibration menu. **Calibr. prot.** shows software calibration protection and should be OFF to enable calibration. In adaptation Germany this must be set to ON after calibration.

+15 V power indicates that +15 Vdirty power for pump and valves exists (ON).

St1 to **St4** are for factory use only.

AD0 to **AD7** show the values of each eight channels of A/D converter.

Pulse Valve Checking

Select the **Start pump** and click the ComWheel. Let the pressure rise beyond 240 mmHg and select **Stop pump**. Then select either **Test valve 30** or **Test valve 50** and click the ComWheel. The pulse valve is opened. The module measures the time it takes for the pressure to go down from 240 mmHg to 50 mmHg and displays it on the display.

BUTTONS/LEDS DATA Detailed Description

Pressure shows measured pressure multiplied by 10. **Zero** shows pressure at autozeroing multiplied by 10 and changes between +20 and -20 mmHg. Absolute pressure is the sum of **Pressure** and **Zero**.

Module exists indicates that the module is recognized (1) or not (0). **Module active** indicates that the module is active in communicating (1) or not (0).

Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down. **Timeouts** is also a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. The AS/3™ Anaesthesia Monitor starts counting these two items at power up and reset to zero at power off. The nonzero values do not indicate a failure, but the continuous counting during the normal operation indicates either serial communication failure or module not in place.

Error code and **Module code** (factory use only) show error codes (see the Service Manual NIBP section Error Codes Chapter for the list).

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 then. It can be turned to OFF by pressing the button (or turning the toggle-switch to the right) at the bottom of the module, which also enables 'Protection ON/OFF' menu selection in calibration menu. **Calibr. prot.** shows software calibration protection and should be OFF to enable calibration. In adaptation Germany this must be set to ON after calibration.

+15 V power indicates that +15 Vdirty power for pump and valves exists (ON).

St1 to **St4** are for factory use only.

AD0 to **AD7** show the values of each eight channels of A/D converter.

Buttons Checking

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

PNEUMATICS DATA Detailed Description

Pressure shows measured pressure multiplied by 10. **Zero** shows pressure at autozeroing multiplied by 10 and changes between +20 and -20 mmHg. Absolute pressure is the sum of **Pressure** and **Zero**.

Module exists indicates that the module is recognized (1) or not (0). **Module active** indicates that the module is active in communicating (1) or not (0).

Bad checksums is a cumulative number that indicates how many times communication from the module to monitor broke down. **Timeouts** is also a cumulative number that indicates how many times the module has not responded to the monitor's inquiry. The AS/3™ Anaesthesia Monitor starts counting these two items at power up and reset to zero at power off. The nonzero values do not indicate a failure, but the continuous counting during the normal operation indicates either serial communication failure or module not in place.

Error code and **Module code** (factory use only) show error codes (see the Service Manual NIBP section Error Codes Chapter for the list).

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 then. It can be turned to OFF by pressing the button (or turning the toggle-switch to the right) at the bottom of the module, which also enables 'Protection ON/OFF' menu selection in calibration menu. **Calibr. prot.** shows software calibration protection and should be OFF to enable calibration. In adaptation Germany this must be set to ON after calibration.

+15 V power indicates that +15 Vdirty power for pump and valves exists (ON).

St1 to **St4** are for factory use only.

AD0 to **AD7** show the values of each eight channels of A/D converter.

Interval 20 mmHg -> 185 mmHg Checking

Select the **Start pump** at different combinations of the valves open/closed and click the ComWheel. The module measures the time it takes for the pressure to go up from 20 mmHg to 185 mmHg and displays it on the display.

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 10 seconds. The reason can be either failing battery unit or software problem solved by hardware watchdog.

Wd resets by mon, **Wd resets by GSP**, and **Wd resets by UPI** indicate erroneous cold re-starts controlled by monitor and caused primarily by either monitor itself, by video controller, or by IO-controller respectively.

Module bus resets indicates number of erroneous module bus jams solved by monitor itself.