CARDIOCAP™ II
CH-SERIES

SERVICE MANUAL

All specifications subject to change without notice

Document No. 878910- 1

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List of Figures PAGE

2 WARNINGS AND CAUTIONS

WARNINGS

> A WARNING indicates that there is a possibility of injury to yourself or others.

PROPER GROUNDING: For protection against shock hazards:

a) Connect this monitor to a three-wire, grounded, hospital grade receptacle.

b) The power cord and plug must be intact and undamaged.

Do not remove the grounding prong from the power plug. Do not use extension cords or adapters of any type.

Replace the power cord if it becomes cracked, frayed, broken or otherwise damaged.

c) Confirm that AC-operated equipment used with the monitor is properly grounded.

d) Do not perform any testing or maintenance on medical instruments while they are being used to monitor a patient.

e) Do not break or bypass the patient isolation barrier when testing ECG, Invasive-Pleth-Temp or SpO_2 measuring boards.

Use only defibrillation protected invasive pressure sensors on DATEX-ENGSTROM Monitors.

EXPLOSION HAZARD: Do not use this monitor in the presence of flammable anesthetics.

FUSE REPLACEMENT: Replace the fuse with a fuse of the same type and with the same rating.

PATIENT SAFETY: Do not modify patient cables.

Use only patient cables and accessories approved by DATEX-ENGSTROM. Other cables and accessories may damage the monitor or interfere with measurement.

Do not use ECG during MRI.

ELECTRIC SHOCK HAZARDS:

a) High Voltage is present within the CRT display unit.

b) In case of mechanical damage, inspect the integrity of the patient isolation circuits, CRT unit, the power supply transformer and power entry module.

c) Do not immerse the monitor in any liquid.

d) Do not immerse the SpO_2 sensor in any liquid.

Do not use a sensor that is suspected of being immersed in liquid. It may cause burns during electrosurgery.

e) Switch the power off and unplug the power cord before cleaning or service.

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.

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

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

CAUTIONS

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

a) 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.

b) Check the rear panel voltage setting before connecting the monitor to AC mains power outlet.

c) Leave space behind the monitor to allow for proper ventilation.

Clean or replace the fan filter regularly.

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

e) Switch the monitor off before making any connections with external equipment.

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

g) 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.

h) Do not apply tension to the power cord.

i) Do not autoclave the monitor nor sensors.

j) Do not gas sterilize the monitor.

3 INTRODUCTION AND APPLICABILITY OF THIS MANUAL

3.1 Introduction and applicability of this manual

This service manual (Doc. No. 878910) provides information required to maintain and repair the DATEX-ENGSTROM CARDIOCAP™ II CH-series monitors. This manual is applicable for the current production revision of the monitors. Differences between monitor revisions are summarized in Section 3.2 and the technical details of earlier revisions given in Chapter 11. Section 3.3 lists the hardware changes made to the monitor and Section 3.4 the software changes.

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

Major parts, assemblies, and 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.

The following list shows the models and their monitoring parameters.

MODEL	MONITORING PARAMETERS
CH	ECG, NIBP, Temp
CH-2	ECG, NIBP, Temp, 2 x invBP
CH-R	ECG, NIBP, Temp, Resp*)
CH-1R	ECG, NIBP, Temp, invBP, Resp*)
CH-S	ECG, NIBP, Temp, SpO_2
CH-2S	ECG, NIBP, Temp, SpO_2, 2 x invBP
CH-RS	ECG, NIBP, Temp, SpO_2, Resp
CH-1RS	ECG, NIBP, Temp, SpO_2, invBP, Resp

*) Manufacturing discontinued from revision -04 on.

This manual describes all the functions offered by the CARDIOCAP™ II CH-series monitors. Some of the functions may not be available in the monitor you are using.

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

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.

3.2 Summary of revision changes

Revision -00

Initial production revision of the monitor.

Revision -01

The main differences to the revision -00 are:

- Main software

- NIBP software

- SpO_2 software

- NIBP tubing redesigned

- One of the NIBP measurement patient groups, NEONATAL is changed to INFANT. The specification of INFANT is 5 kg or more, one to twelve months old.

Revision -02

Current production revision of the monitor. The main differences to the revision -01 are:

- Main software

- NIBP software (except for Germany)

- SpO_2 software

- High speed main CPU board (p/n 880523) installed to replace the existing board (p/n 878822)

- Enlarged fan airway inlet and larger dust filter

- Power supply board modified

- ECG board modified

- NIBP pneumatic unit modified

Revision -03

The main differences to the revision -02 are:

- Main software

- SpO_2 software

- SpO_2 measuring board

Revision -04

Current production revision of the monitor. The main differences to the revision -03 are:

- CE approval and marking accordingly

- Improved EMC protection including new ECG board, IPT board and SpO_2 board. The main mechanical modifications have been made on the rear panel, which now has a transformer case and a new mains switch.

- Video control board has been replaced by video ASIC board.

3.3 Manual updates

3.3.1 CARDIOCAP™ II CH-series service manual changes

This is update number 3. We have made the following changes to this manual:

- started printing on both sides of pages to decrease manual thickness.

- gave up costly extensive pages.

Carry out the update by making the changes shown under this update number in the list below:

- replace pages which already exist in the manual.

- insert pages which do not exist yet in the manual after the previous entry in numerical or an alphabetical order.

- of all the pages removed from the manual, the following pages should be filed in chapter 11. All other pages are thrown away.

5-5, 5a, 11, 11a, 15, 16, 33, 33a, 33b, 34, 34a, 34b, 37, 37a, 42, 45, 52

After having made the changes required, replace Section 3.3.1 of the manual with this one and sign the record of updates in Section 3.3.2.

No	Page	Change	Date
1	3-3	Revision 01 introduced.	September 2nd, 1991
	3-7,8	Revision 01 software added.	
	4-1...6	Typical performance revised.	
	4-12	Note on neonatal changed.	
	4-16	Figures changed.	
	5-16	A7 pin 15 corrected to pin 16.	
	5-24	Neonatal changed to infant.	
	5-25	Program Eprom text location corrected.	
	5-27...29	Neonatal changed to infant.	
	5-42	CPU board jumper table revised.	

	5-50	Power supply board schematic diagram replaced.	
	6-6	Cuff occlusion message added.	
	9-1...4	Spare parts list revised.	
	9-7	Pneumatic unit illustration changed.	
	12-3	Status string corrected.	
	12-4	Capnomac text deleted.	
2	3-3	Revision 02 introduced.	20th March 1992
	3-7, 9...11	Text revised. Revision 02 software described.	
	4-6	Trends table revised.	
	4-12...14	Principles of measurement revised.	
	4-22	Pin order table revised.	
	5-4	ECG board modified.	
	5-29	Pediatric cuff renamed to Child.	
	5-38...42	High speed CPU board introduced.	
	5-49, 50	Power supply board modified.	
	6-15	CPU board troubleshooting text revised.	
	7-4	R31 corrected to R6 in NIBP board adjustment	
	7-5	CPU board adjustment text revised.	
	9-1...4	Spare parts list revised.	
	9-7	Pneumatic unit parts layout changed.	
	12-1...6	Appendices pages revised. Page 12-5 removed.	
3	1-1...8	Contents revised.	10th December 1993
	3-3a	Revision 03 added.	
	3-7, 9, 12	Text revised. Revision 03 software described.	
	4-3...6	Text revised.	
	4-5	Max. cuff pressure limited to 330 mmHg.	

4-16	Text and figure revised.
4-21	Table 4.4 revised.
4-22, 23	Tables revised.
4-24	Page removed.
5-4...4a	Page layout changed.
5-5...5a	ECG board parts layout and schematic diagram updated. Page layout changed
5-11	RESP board schematic diagram updated.
5-15...16	IPT board parts layout and schematic diagram updated. Page layout changed.
5-24	Text and figure revised.
5-25...26a	Page layout changed.
5-28	Safety valve check added.
5-30...31	Text revised.
5-32...34a	SpO_2 measuring board changed. Page layout changed.
5-36...37	SpO_2 processor board parts layout and schematic diagram updated. Page layout changed.
5-38...39	Text revised.
5-40...42	Jumper position changed. Page layout changed.
5-44...45	Video control board parts layout, timing diagram and schematic diagram updated. Page layout changed.
5-48...50	Page layout changed.
5-52	Mother board parts layout schematic diagram updated.
5-55, 56	Tables revised.
5-63	Table 5.15 revised.
6-1	Text revised.
6-5...6	Error messages added.
6-11...12	Text revised.
6-15	Text added.
6-19	Service mode introduced.

9- 1...4	Spare parts added.
9-5	Figure revised. Page layout changed.
12-1...4	Text revised. The status characters of the standard string and status code interpretation added.
12-16...17	Page layout changed.
12-21	Trilingual list of error messages added.
	Company name & phone info changed. 22nd March 1996
1-1	Table of Contents updated
1-4	List of Figures updated
1-7	List of Tables updated
2-1	ECG/MRI warning added to Patient Safety
3-1	Panasonic Service Manual deleted
3-2	Note “Manufacturing discontinued...” added.
3-3a	Revision 04 introduced
3-4c	Revision 04 manual changes introduced
3-5	Revision 04 introduced
3-12	Word “current” deleted
3-13	New page added for 04 softwares
4-5	Word “Germany” replaced by
	“in adaptation 70 monitors”.
4-10	Power req. changed from 100/115/220/240
	to 100/115/220-240
4-16,17	Probe changed to sensor
4-21	Table 4.2: Pins 6-8 to not connected
	Pin 9 to P Ground
5-4,4a	ECG board parts layout and schematic changed

5-5,5a	ECG board parts layout and schematic changed
5-12,13	IPT Board text revised
5-14...16	IPT board artworks changed
5-32...34	SpO2 meas. board artworks changed.
5-39	Caution text revised.
5-43	Video control board changed to Video ASIC board, text revised
5-44,45	New artworks for Video ASIC board
5-46	Supply voltage changed from +15 V to +5 V.
5-47	Power supply board block diagram changed
5-48	Transformer diagram changed
5-62	Video control board changed to Video ASIC board
5-63	Probe changed to sensor
6-6	New message “NIBP INACTIVE ? SELF CHECKING... and explanation added
6-16	Video control board changed to Video ASIC board, text revised
7-6	New section 7.7 Video Display Unit (Philips) Adjustments and one new artwork
9-1...5	Spare parts list and exploded monitor parts pictures updated
12-6	CCK-104 Keyboard chapter deleted, old appendix D (Trilingual list of error messages) becomes appendix C.

3.3.2 Record of manual updates carried out

Update number	Carried out by Name	Date
1	DATEX	September 2nd, 1991
2	DATEX	March 20th, 1992
3	DATEX	December 10th, 1993
4	DATEX-ENGSTROM	March 22nd, 1996
5		
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20		

3.4 Software changes

The software code (six numbers) and revision number (if other than initial revision) are displayed on the screen during the startup sequence.

The initial production software versions are as follows.

ITEM DESCRIPTION		ORDER No.
CPU board		
Software EPROM	(-, 2, R, 1R) (English)	878107
	(-, 2, R, 1R) (German)	878108
	(-, 2, R, 1R) (French)	878109
	(-, 2, R, 1R) (Germany)	878110
	(S, 2S, RS, 1RS) (English)	878111
	(S, 2S, RS, 1RS) (German)	878112
	(S, 2S, RS, 1RS) (French)	878113
	(S, 2S, RS, 1RS) (Germany)	878114
NIBP board		
NIBP software	EPROM	877039
	EPROM (Germany)	877040
SpO_2 processor board		
SpO_2 software EPROM		875360

The production revision 01 softwares are as follows.

ITEM DESCRIPTION		ORDER No.
CPU board		
Software EPROM	(-, 2, R, 1R) (English)	879425
	(-, 2, R, 1R) (German)	879426
	(-, 2, R, 1R) (French)	879427
	(-, 2, R, 1R) (Germany)	879428
	(S, 2S, RS, 1RS) (English)	879529
	(S, 2S, RS, 1RS) (German)	879430
	(S, 2S, RS, 1RS) (French)	879431
	(S, 2S, RS, 1RS) (Germany)	879432
NIBP board		
NIBP software	EPROM	879808
	EPROM (Germany)	879809
SpO_2 processor board		
SpO_2 software EPROM		878105

The following changes have been made to the initial software version.

Main software

- Graphic trends are available in two pages:
  First page: HR, SpO_2, NIBP, invBP1, invBP2
  Second page: SpO_2, RR

- 4 and 8 hour trends added. Trends also in numeric form (HR, NIBP, invBP1, SpO_2).

- Numeric trends printed in CCP printer.

- Real time ECG waveform displayed while viewing the trend.

- PROBE OFF/NO PROBE alarm sequences revised.

- Audible ECG leads off alarms added.

- Return from deeper menu levels to the first menu level can be short cut by hitting the respective menu hardkey.

- Straight access from a parameter menu to another is possible without pressing the RETURN TO MONITOR key.

- ECG displayed in cascade form if pleth waveform is selected to the lowest display field.

- CO_2 waveform from DATEX-ENGSTROM Ultima monitor can be displayed on the third display field.

- Audible indication of NIBP measurement readiness is available.

NIBP software

- NIBP autocycling mode is interrupted if a cuff loose state is detected.

- Cuff occlusion alarm is added.

SpO_2 software

- Two level measuring light intensity adjustment is done automatically.

- Averaging time is selectable between 5 and 10 seconds.

NOTE: To upgrade CARDIOCAP II monitors from 00 to 01 revision, all three new software (CPU, NIBP, and SpO_2) should be installed simultaneously because none of the revision 00 software is compatible with revision 01 software.

NOTE: All three new software (CPU, NIBP, and SpO_2) can be installed in revision 00 monitors simply by replacing the software EPROMs and shorting the jumper X2 pins 1 and 2 on the CPU board.

The production revision 02 softwares are as follows.

ITEM DESCRIPTION		ORDER No.
CPU board		
Software EPROM	(-, 2, R, 1R) (English)	880788
	(-, 2, R, 1R) (German)	880789
	(-, 2, R, 1R) (French)	880790
	(-, 2, R, 1R) (Germany)	880791
	(S, 2S, RS, 1RS) (English)	880784
	(S, 2S, RS, 1RS) (German)	880785
	(S, 2S, RS, 1RS) (French)	880786
	(S, 2S, RS, 1RS) (Germany)	880787
NIBP board		
NIBP software	EPROM	879808
	EPROM (Germany)	879809
SpO_2 processor board		
SpO_2 software EPROM		878105

The following changes have been made to the revision 01 software version.

<u>Main software</u>

- More complete numeric trends presentation

- More complete real time waveform presentation

- Capable of recognizing the hardware and software levels of the main CPU board, NIBP and SpO_2 modules of the monitor:

* 16 MHz CPU board or 11.7 MHz CPU board

* NIBP hardware of CARDIOCAP II or NIBP of CARDIOCAP I

* SpO_2 hardware of CARDIOCAP II or SpO_2 of CARDIOCAP I

- Automatically, when setting the system up, adjusts the intermodular communication protocols and menu structures on the screen accordingly. That is why this software can be installed also into CARDIOCAP II revisions 00 and 01 units as well as into CARDIOCAP I units (with the main CPU board p/n 878822).

- The patient group PEDIATRIC is renamed to CHILD.

> **NOTE:** This new software can be installed into all CARDIOCAP II revision 01 units without any modifications. Note that some new features need the new high speed main CPU board to be activated.

> **NOTE:** This new software can be installed into all CARDIOCAP II revision 00 units with main CPU board jumper modifications (pins 1 and 2 shorted in jumpers X2 and X4).

NIBP software

- Improved performance in cases like small children, moving and shivering patients, high blood pressures, low blood pressures, strong and weak pulses.

> **NOTE:** This new software can be installed into all CARDIOCAP II revision 00 and 01 units without any modifications.

SpO_2 software

- Improved performance in NO PROBE conditions.

> **NOTE:** This new software can be installed into all CARDIOCAP II revision 01 units without any modifications.

> **NOTE:** This new software can be installed into all CARDIOCAP II revision 00 units together with rev 01 or 02 main software after the CPU board jumper modifications (pins 1 and 2 shorted in jumpers X2 and X4).

Upgrading

To upgrade CARDIOCAP II units from 00/01 to 02 revision, all three new software (CPU, NIBP, and SpO_2) should be installed simultaneously as well as the high speed CPU board.

If the new high speed CPU board is not desired, the three new softwares can simply be installed into CARDIOCAP II units 01 revision monitors. All three new softwares (CPU, NIBP, and SpO_2) should be installed simultaneously.

If the new high speed CPU board is not desired, the three new softwares can be installed into CARDIOCAP II units 00 revision monitors with the CPU board jumper modification. All three new software (CPU, NIBP, and SpO_2) should be installed simultaneously.

NOTE: All three new softwares have to be installed at the same time. None of the previous revision softwares are compatible with the new softwares.

The production revision 03 softwares are as follows.

ITEM DESCRIPTION			ORDER No.
CPU board			
	Software EPROM	(-, 2, R, 1R) (English)	882597
		(-, 2, R, 1R) (German)	882598
		(-, 2, R, 1R) (French)	882599
		(-, 2, R, 1R) (Germany)	882600
		(S, 2S, RS, 1RS) (English)	882593
		(S, 2S, RS, 1RS) (German)	882594
		(S, 2S, RS, 1RS) (French)	882595
		(S, 2S, RS, 1RS) (Germany)	882596
NIBP board			
	NIBP software	EPROM	879808
		EPROM (Germany)	879809
SpO_2 processor board			
	SpO_2 software EPROM		882881

The following changes have been made to the revision 02 software version.

Main software

- Automatically, when starting up the monitor the real-time clock and the EEPROM are checked. A warning message "MEMORY CIRCUIT FAILURE / CALL SERVICE" will be displayed if:
- The real-time clock is in disorder or has stopped.
- A fault has been detected in the memory circuit D4.

- If the temperatures or the invasive pressures have not been calibrated after a factory reset the following messages will be displayed:
- TEMPERATURE NOT CALIBRATED, RECALIBRATE
- INVASIVE BP NOT CALIBRATED, RECALIBRATE

The production revision 04 softwares are as follows.

ITEM DESCRIPTION		ORDER No.
CPU board		
Software EPROM	(-, 2) (English) 882597	
	(-, 2) (German) 882598	
	(-, 2) (French) 882599	
	(S, 2S, RS, 1RS) (English)	882593
	(S, 2S, RS, 1RS) (German)	882594
	(S, 2S, RS, 1RS) (French)	882595
NIBP board		
NIBP software	EPROM	879808
	EPROM (Germany)	879809
SpO_2 processor board		
SpO_2 software EPROM		882881

4 GENERAL DESCRIPTION

4.1 Typical performance of CARDIOCAP™ II CH-SERIES monitor

ECG

Measurement method

3-lead ECG
5-lead ECG (not with Respiratory rate measurement)

Lead selection

I, II, III with standard 3-lead cable
V connection with optional 5-lead cable (not with Respiratory rate measurement)

Measuring range

QRS detection	0.5 - 5 mV, 40 - 200 ms
Allowable offset	±300 mV

Waveform display

Frequency response	0.5 - 30 Hz
Sweep speeds	12.5 and 25 mm/s
Gain range	0.2 - 4.0 mV/cm

Numerical display (heart rate)

Range	30 - 230 beats/min
Accuracy	±1 %
Resolution	1 beat/min
Averaging	10 s
Update interval	5 s

Alarms

Asystole		no QRS detected in 7 s
Heart rate		
	high limit	adjustable 30 - 250 beats/min
	low limit	adjustable 30 - 250 beats/min
	alarm delay	10 s after limit violation

RESPIRATION

Measurement method

Transthoracic impedance

Measuring range

0.3 - 3 ohm (dynamic), max. transthoracic impedance 3 kohm

Waveform display

Frequency response	0.1 - 3 Hz (-3 dB)
Sweep speed	6.25 mm/s
Length of trace	approx. 16 s

Numerical display (respiratory rate)

Range	0, 2 - 180 breaths/min
Accuracy	±3 breaths/min
Resolution	1 breath/min
Averaging	30 s
Update interval	2 s

Alarms

Apnea		no breath detected during time specified by apnea alarm limit (3 - 30 s)
Respiratory rate		
	high limit	adjustable 2 - 180 breaths/min, OFF
	low limit	adjustable 2 - 180 breaths/min, OFF
	alarm delay	10 s after limit violation

INVASIVE BLOOD PRESSURE

Measurement method	Transducer 50 uV/cmHg/V, 20 mA max. current
Measuring range	-40 - 260* mmHg
Zero adjustment range	±100 mmHg
Calibration range	±50 %
Waveform display	
Frequency response	0 - 20 Hz
Sweep speeds	12.5 or 25 mm/s
Scales	-5 - 32 mmHg -10 - 65 mmHg -20 - 130 mmHg -40 - 260* mmHg
Numerical display	
Range	-40 - 260* mmHg
Resolution	1 mmHg
Averaging	10 s
Update interval	5 s
Alarms	
Systolic pressure	
high limit	adjustable -40 - 260* mmHg
low limit	adjustable -40 - 260* mmHg
alarm delay	10 s after limit violation

*** 230 mmHg in Germanv**

TEMPERATURE

The temperature channel is YSI 400 series sensors compatible

Numerical display in °C or °F

Update interval	24 s
Amplifier accuracy	±0.1°C (25.0 - 45.0°C) / ±0.2°F (77.0 - 113.0°F) ±0.2°C (15.0 - 24.9°C) / ±0.4°F (59.0 - 76.8°F)
Sensor accuracy (YSI 400 series)	±0.1°C (15 - 45°C)/ ±0.2°F (59.0 - 113.0°F)

NON-INVASIVE BLOOD PRESSURE

Measurement method: Oscillometric

Measuring range:

Adult	25 to 260* mmHg
Pediatric	25 to 195 mmHg
Infant	15 to 145 mmHg

Accuracy

Compared to auscultatory method in adults (slow deflation speed):
systolic ±5 mmHg, STD < 8 mmHg, diastolic ±5 mmHg, STD < 8 mmHg

Compared to auscultatory method in neonates (normal deflation speed):
systolic ±5 mmHg, STD < 8 mmHg, diastolic ±5 mmHg, STD < 8 mmHg

Accepted heart rate: 30 to 250 beats/min

Measurement intervals: manual, continuous for 5 min, 1, 2, 3, 5, 10, 15, 30, 60 min

Measurement time

typical	adult	infant
slow mode	35 s	30 s
normal mode	25 s	20 s
fast mode	20 s	15 s

Safety Limits

	Adult	Pediatric	Infant
Max. measurement time	2 min	2 min	1 min
Max. inflation pressure	280 mmHg	200 mmHg	150 mmHg
Overpressure limit, stops measurement	320 mmHg	220 mmHg	165 mmHg
Initial inflation pressure	185 mmHg	185 mmHg	120 mmHg
Successive infl. pressures	syst + 40	syst + 40	syst + 40
Next infl. pressure after 'low infl press' message	+50 mmHg	+50 mmHg	+40 mmHg
Stasis time	2 min	2 min	1 min
Stasis pressure	80 mmHg	60 mmHg	40 mmHg

Mechanical safety valve limits max. cuff pressure to 330 mmHg. Independent timing circuit limits pressurization to max. 5 min.

Alarms

Systolic pressure
high limit OFF, adjustable 30 - 260* mmHg
low limit OFF, adjustable 30 - 260* mmHg

*** 230 mmHg in adaptation 70 monitors**

OXYGEN SATURATION

Measurement method: Red and infrared light absorption

Numerical display

Range	40 - 100 %
Accuracy	100 - 80 %, ±2 % SpO_2 (±l STD)
Resolution	1 %
Averaging	6 s (rev 00), 5 s/10 s (01)
Update interval	2 s

Alarms

SpO_2
high limit adjustable 40 - 99 %, OFF
low limit adjustable 40 - 99 %
alarm delay 10 s after limit violation

Pulse beep pitch corresponds to SpO_2 level

PLETH

Automatic scale setting when sensor is attached.
User-adjustable scale during operation.

Heart rate

Range	30 - 250 bpm
Accuracy	±1 %, ±1 bpm
Resolution	1 bpm
Averaging	5 s or 10 s (selectable)
Update interval	5 s

Alarms

Heart rate

high limit	adjustable 30 - 250 beats/min
low limit	adjustable 30 - 250 beats/min
alarm delay	< 3 s after limit violation

TRENDS

Revision 00

2 hours graphic trends of Heart Rate, Respiration Rate, Systolic and Diastolic Pressures, SpO_2, and Pleth Amplitude. Sampled every 10 s except NIBP.

Revision 01 and up

0.5, 2, 4, 8 hours of graphic and numerical trends of Heart Rate (0.5 hour trend Revision 02 and up), Respiration Rate, Systolic and Diastolic Pressures, SpO_2, and Pleth Amplitude. Sampled as follows except NIBP.

Trend Time	Sampling Rate	Display Rate
0.5 h	HR (10 s), RR (20 s)	every 10 s
2 h	SpO_2 (30 s) Pleth (30 s)	every 10 s value
4 h	P1 (40 s, 20 s if no P2)	every 20 s average
8 h	P2 (40 s)	every 40 s average

4.2 Technical specifications of CARDIOCAP™ II CH-SERIES monitor

Subject to change without notice

ECG

Defibrillation protection	5000 V, 400 J
Input impedance	>2.5 Mohms/10 Hz
System noise	<40 μV (p-p, RTI)
Allowable offset	±300 mV DC
Gain range	0.2 to 4.0 mV/cm
Display bandwidth	0.4 to 30 Hz (-3dB)
Pacemaker pulse detection	5 - 500 mV, 0.5 - 2 ms pulses

The ECG channel features an integral electrosurgery filter, defibrillator protection and pacemaker pulse detection and rejection.

Patient Safety	Type CF isolation

RESPIRATION

Input impedance	6.4 Mohm at 10 Hz 1.3 Mohm at 50 Hz
Sensitivity	1 V/ohm
Excitation signal frequency	48.3 kHz (nominal)
Auxiliary patient current	<100 μA

The EGG/ Respiration channel features an integral electrosurgery filter, defibrillator protection and pacemaker pulse detection and rejection.

Patient Safety	Type CF isolation

INVASIVE BLOOD PRESSURE

Amplifier

Transducer and Input sensitivity	50 µV/cmHg/V, 5 Vdc 20 mA maximum current
Input resistance	10^{10} ohms
Zero drift	<1 mmHg/10°C
Zero drift (pressure channel 2 only)	<2 mmHg/10°C
Nonlinearity	<1 %, 0-200 mmHg
Gain drift	<0.5 % f.s./10°C
Bandwidth	0 to 20 Hz (-3dB)
Zero adjustment range	±100 mmHg
Calibration range	±50 %
Zero set accuracy	±1 mmHg
Calibration resolution	±1 mmHg

Patient Safety — Type CF isolation

TEMPERATURE

The temperature channel is YSI 400 series sensors compatible

Amplifier accuracy	±0.1°C (25.0 - 45.0°C) / ±0.2°F (77.0 - 113.0°F) ±0.2°C (15.0 - 24.9°C) / ±0.4°F (59.0 - 76.8°F)
Sensor accuracy (YSI 400 series)	±0.1°C (15 - 45°C) / ±0.2°F (59.0 - 113.0°F)
Patient Safety	Type CF isolation

NON-INVASIVE BLOOD PRESSURE

Pressure transducer accuracy	better than ±3 mmHg or ±2 % (whichever greater)
Patient Safety	Type BF isolation

OXYGEN SATURATION

The pulse oximeter accuracy measurements are statistically derived and correlated to simultaneous SpO_2 measured on an Instrumentation Laboratory IL/282 CO-oximeter.

Accuracy	100 - 80 %, ±2 % SpO_2 (±1 STD) 80 - 50 %, ±3 % SpO_2 (±1 STD) 50 - 40 %, unspecified
Patient Safety	Type BF isolation

PLETH

Automatic scale setting when sensor is attached.
User-adjustable scale during operation.

Amplifier Bandwidth	0.8 to 15 Hz (-3 dB)
Patient Safety	Type BF isolation

ALARMS

Adjustable audio alarm sound, rear panel loudspeaker (approximately 900 Hz)
Adjustable high/low alarm limits for heart rate, systolic pressures, SpO_2, respiratory rate
Adjustable alarm for apnea
Alarm for asystole

DISPLAY

9” green monochrome picture tube
Resolution 1024 x 256 pixels

Clock

GENERAL DATA

Safety standard fulfilled	IEC 601-1, Safety class I CSA C22.2 No.125-M1584
Operating temperature	10 to 35°C / 50 to 95°F
Storage temperature	-5 to 50°C / 23 to 122°F
Power requirements	100/115/220-240 V 50/60 Hz 120 W, 600 mA
D x W x H	340 x 330 x 210 mm 13.4 x 13.0 x 8.3 inches
Weight	12 kg / 26 lbs

EXTERNAL CONNECTIONS

Serial data output for computer interface (SERIAL & ANALOG I/O connector) and graphics printer (AUX I/O connector)
Composite video output
ECG, PLETHYSMOGRAPH or PRESS1, PRESS2 analog waveform output (SERIAL & ANALOG I/O connector)
ECG test signal
AC, DC power supply connection
Alarm signal (Nurse call)

4.3 Principle of operation

4.3.1 Principle of ECG measurement

Electrocardiography is the process of analysing 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.

4.3.2 Principle of Respiratory rate measurement

Impedance Respiration is a technique of monitoring respiratory rates of a patient based on fractional changes in thoracic impedance between two electrodes. These electrodes are the same electrodes used for ECG measurement.

When monitoring ECG and respiratory rates simultaneously the position of the electrodes is crucial. See the Operator's Manual for more information.

4.3.3 Principle of NIBP measurement

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 slowly 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 monitor calculates values for systolic, mean, and diastolic pressures.

The NIBP measuring unit is a fully automatic, self-contained non-invasive blood pressure measuring system which communicates with the main CPU via an asynchronous serial channel. All NIBP functions are controlled by the NIBP's CPU in the NIBP board. The NIBP system contains the following main parts:

- NIBP board
- Pneumatic
- NIBP air pump
- Safety valve
- NIBP tubing
- Twin hose
- Blood pressure cuff

The NIBP board contains the pressure transducer, bleed and exhaust valves, and electronic parts of the system.

The pneumatic contains two damping chambers, two magnetic valves, and tubes (see Figure 9.3).

4.3.4 Principle of SpO_2 measurement

SpO_2

Oxygen is the most acutely necessary substrate for survival. A major concern during anesthesia is the prevention of tissue hypoxia. Thus immediate and direct information about tissue oxygenation is needed. When oxygen diffuses from the alveolus into the blood it dissolves into the plasma and binds to hemoglobin. Most of the oxygen needed by the body is transported bound to hemoglobin. The total hemoglobin in the blood is composed of oxygenated oxyhemoglobin (HbO_2), reduced or deoxygenated hemoglobin (Hb) and other forms of hemoglobin such as Dyshemoglobins: carboxyhemoglobin (HbCO) and methemoglobin (MetHb).

Pulse Oxymetry determines noninvasively the oxygen saturation of hemoglobin (SpO_2) on the basis of light absorption at only two wavelengths. The limitation is that correspondingly only two hemoglobin species can be discriminated by the measurement. In principle, Pulse Oxymetry can be 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 less sensitive to changes of Dyshemoglobin concentrations in blood.

The oxygen saturation percentage measured by the DATEX-ENGSTROM CARDIOCAP II monitor is calibrated against the functional saturation SaO_{2func}. The advantage of this method is that the accuracy of SpO_2 measurement 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 Dyshemoglobin levels, which clinically may be harmful for patient.

The absorption of light of normal human blood at different wavelengths is mainly determined by oxygenated oxyhemoglobin and by deoxygenated deoxyhemoglobin (see Figure 4.2). The monitor measures the relative absorption of light 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 and detected by a PIN-diode in the sensor. The total absorption can be divided into components of arterial blood. Only the last component gives variations synchronous with heart beat into the transmitted light intensity. This fact is most essential for Pulse Oxymetry and eventually makes feasible the measurement of oxygen saturation noninvasively.

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.

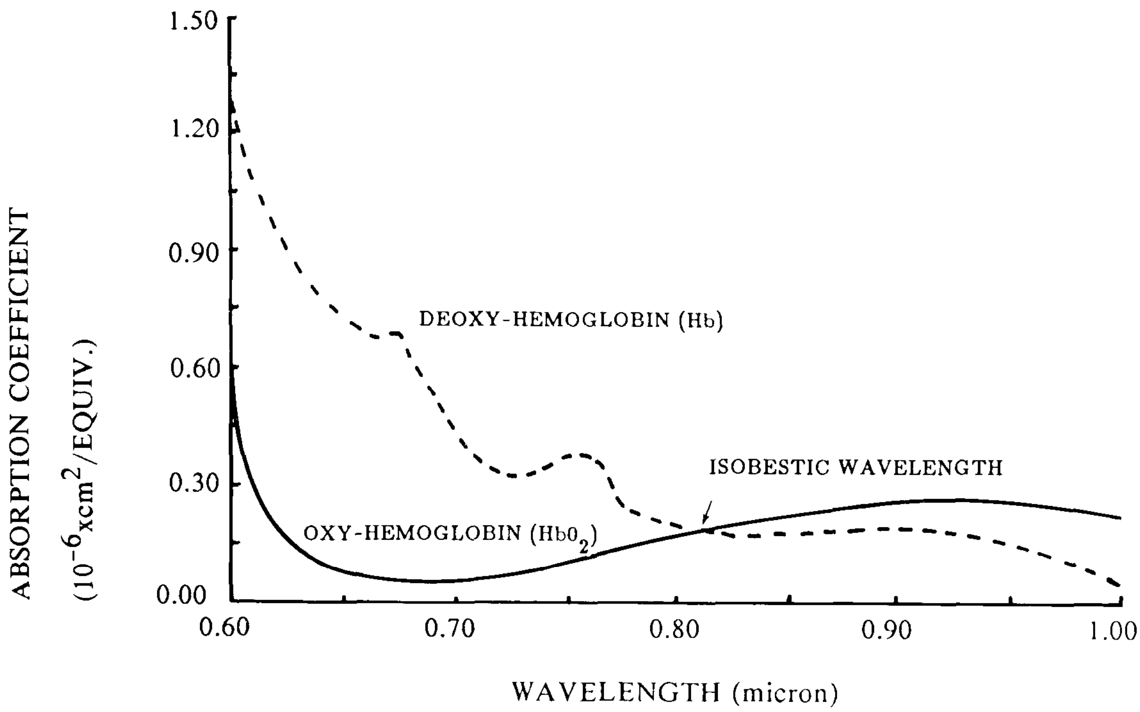


Figure 4.1 Absorption coefficients of oxy- and deoxy-hemoglobin in the red and near-infrared regions

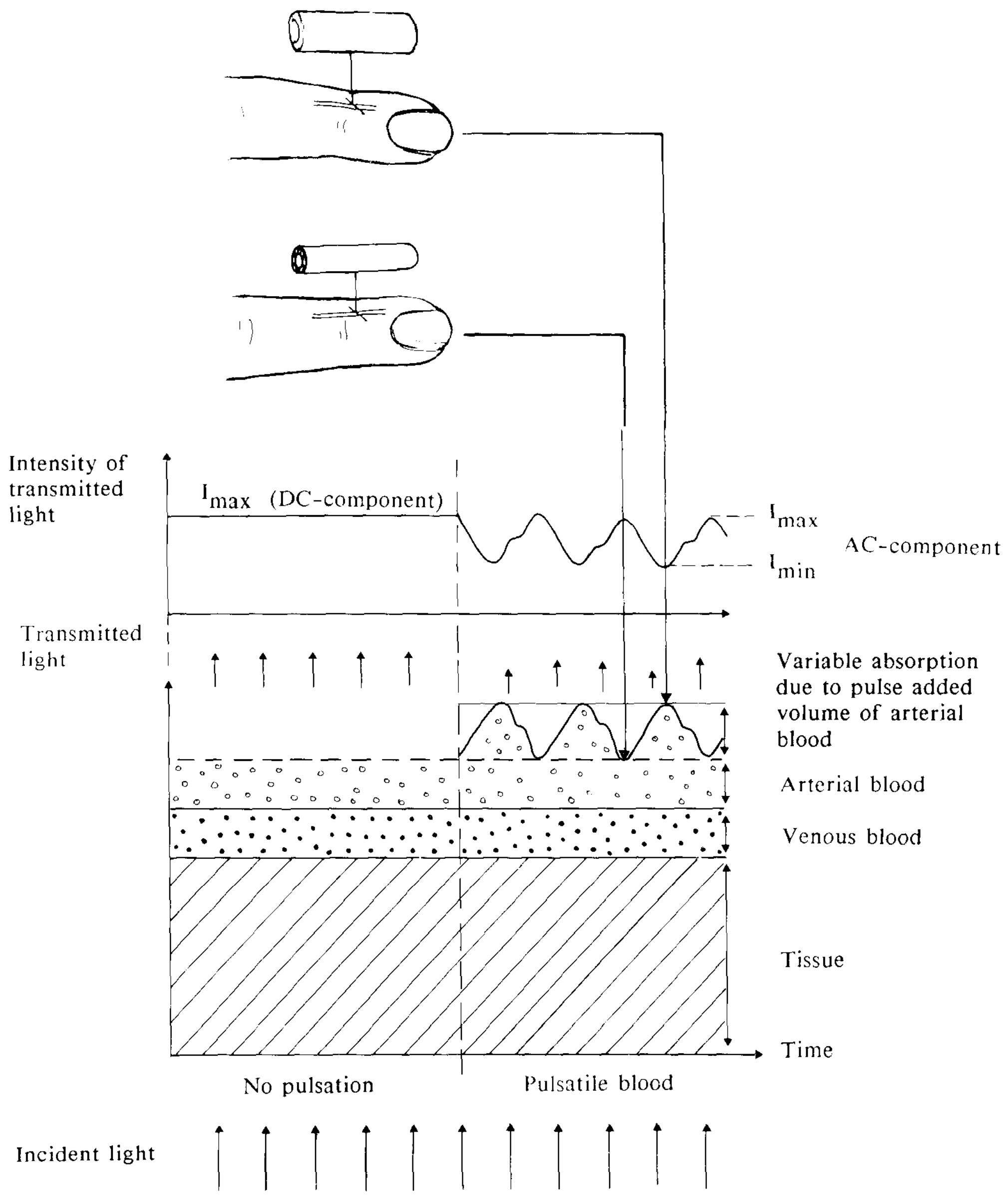
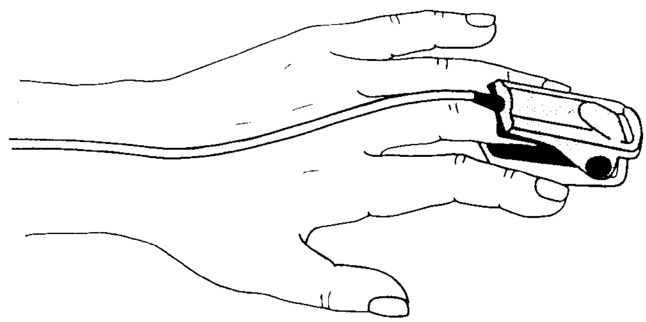


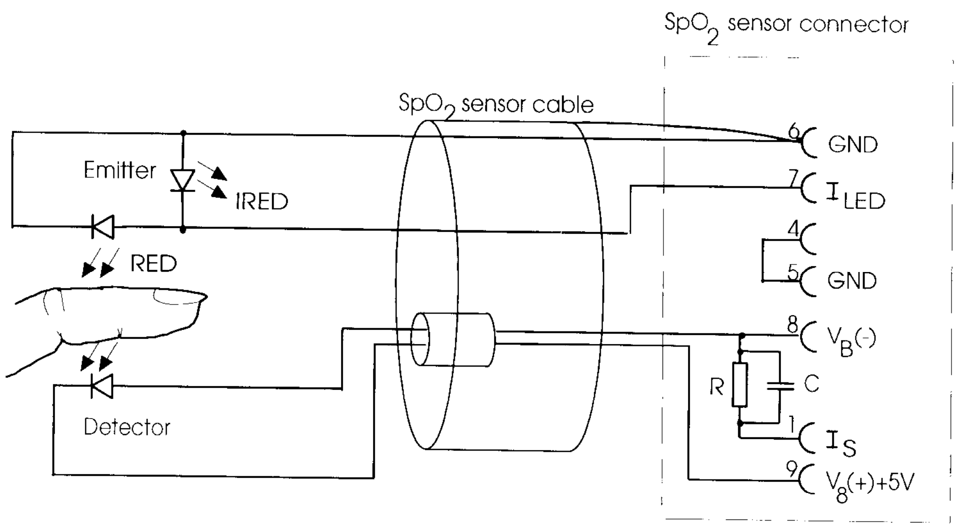
Figure 4.2 Absorption of infrared light in the finger

Sensor

The standard sensor is a finger clamp sensor which measures through the finger (see Figure 4.3) and contains the light source LEDs in one half and the photodiode detector in the other half. Different kinds of sensors are also available from DATEX-ENGSTROM.

Figure 4.3 Finger sensor parts layout and schematic diagram





4.4 General block diagram

The monitor consists of the following modular parts (see page 3-2 for the parts included in the monitor you are using):

- ECG and respiration measuring electronics
- NIBP measuring electronics, pump, and tubing
- Invasive BP and temperature measuring electronics
- Sensor and SpO_2/pulse oximeter measuring board
- Main processor board including analog signal multiplexer, A/D converter, and real time clock
- Video ASIC board to convert the CPU commands into video signal
- Video display module
- Transformer and power supply board to generate necessary voltages and I/O functions
- Mother board including signal buses and analog input signal buffers
- Tactile membrane keyboard
- Loudspeaker unit

See Figure 4.4 for the monitor block diagram.

For monitor parts locations see the exploded view (Figure 9.1) in Chapter 9.

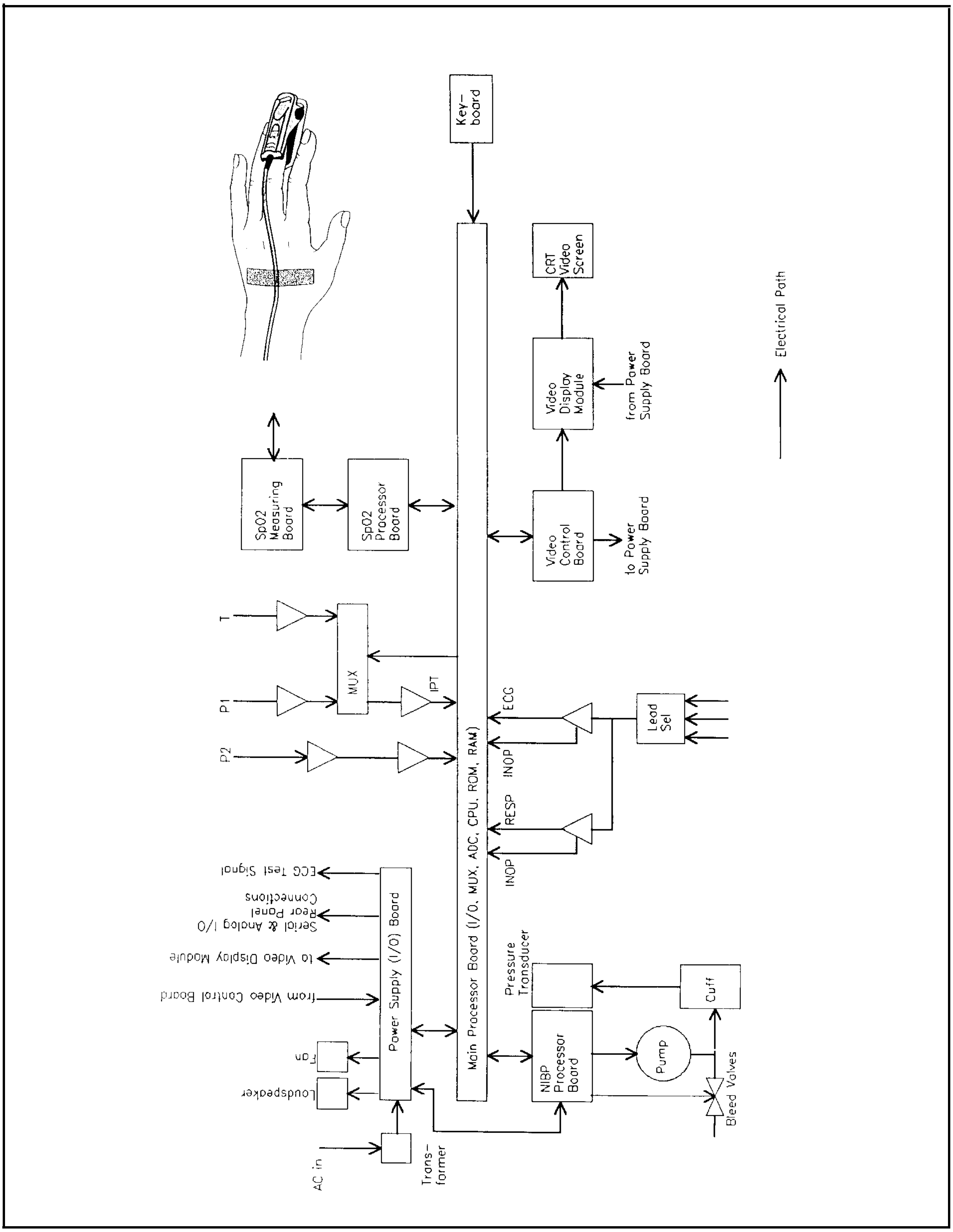
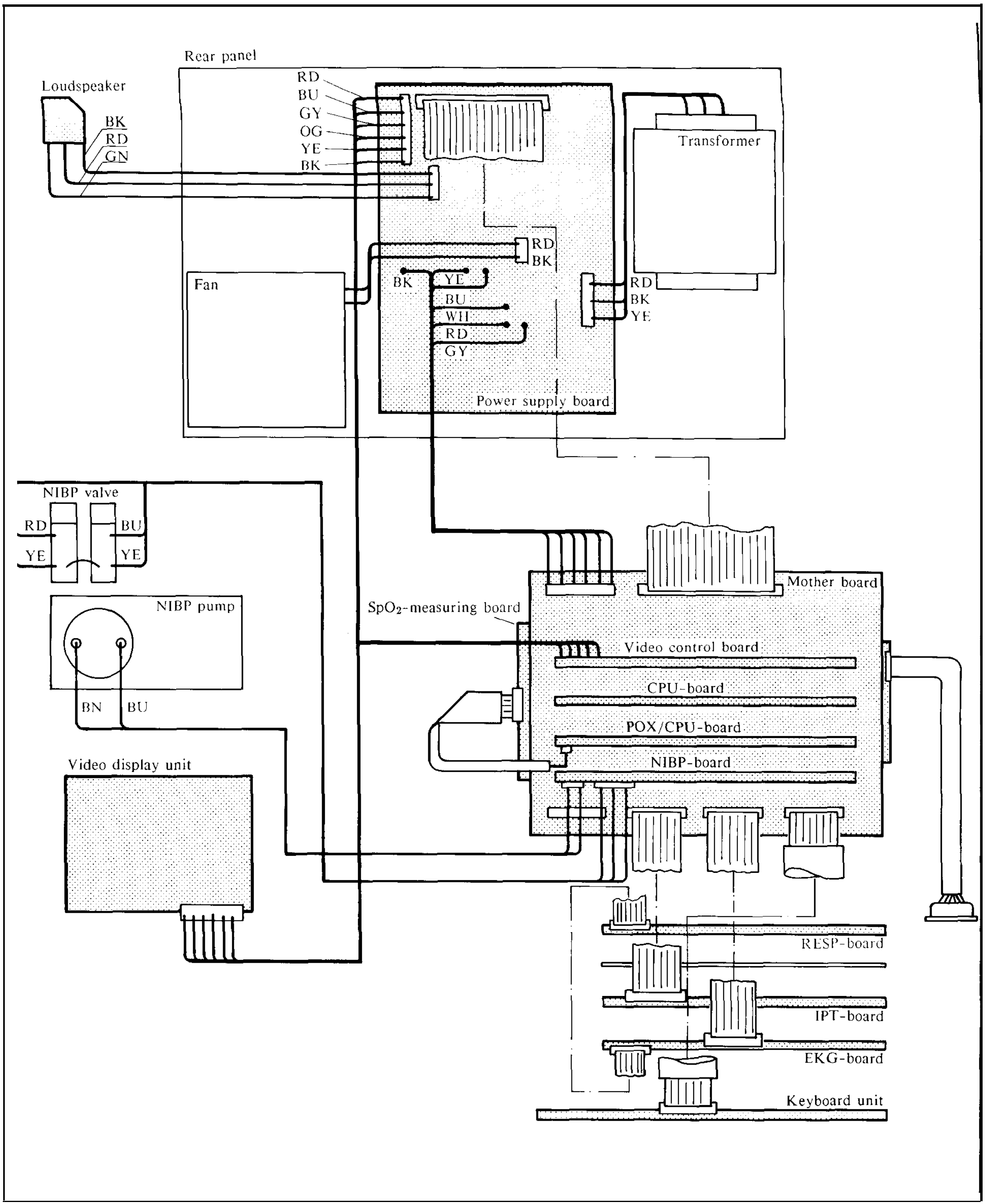


Figure 4.4 General block diagram

4.5 Wiring **diagram**



4.6 External connector configurations

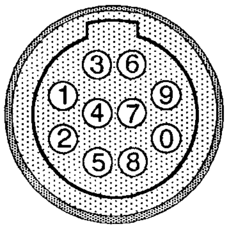
4.6.1 Input/Output specifications

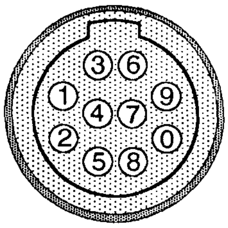
Serial data output for computer interface (SERIAL & ANALOG I/O connector)
Serial Output for Graphics Printer (AUX I/O connector)
Composite video output

ECG, PLETHYSMOGRAPH or PRESS1, PRESS2 analog waveform output (SERIAL & ANALOG I/O connector)
ECG test signal
AC, DC power supply connection
Alarm signal (Nurse call)

4.6.2 Connectors

Table 4.1 Pin order of the ECG connector

	PIN	SIGNAL (IEC standard)
Front view	1	R
	2	L
	3	N (I, II, III) or N (V-5)
	4	F (V-5)
	5	C (V-5)
	6	Cable shield
	7	not connected
	8	not connected
	9	not connected
	0	not connected

	PIN	SIGNAL (AAMI)
Front view	1	RA
	2	LA
	3	LL (I, II, III) or RL(V-5)
	4	LL (V-5)
	5	V (V-5)
	6	Cable shield
	7	not connected
	8	not connected
	9	not connected
	0	not connected

5-lead cable ECG measurement not with Respiratory rate measurement.

Table 4.2 Pin order of the invasive pressure connector (PRESSURE 1)

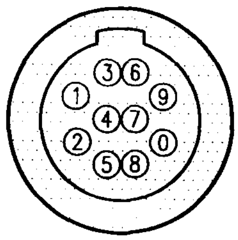
	PIN	SIGNAL
Front view 	1	P+
	2	P-
	3	Excitation voltage -
	4	Excitation voltage +
	5	not connected
	6	not connected
	7	not connected
	8	not connected
	9	P Ground
	0	-InvBPflg

Table 4.3 Pin order of the invasive pressure connector (PRESSURE 2)

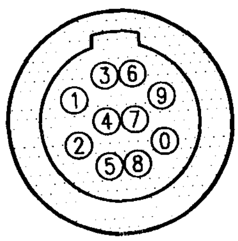
	PIN	SIGNAL
Front view 	1	P+
	2	P-
	3	Excitation voltage -
	4	Excitation voltage +
	5	not connected
	6	not connected
	7	not connected
	8	not connected
	9	P Ground
	0	-InvBPflg

Table 4.4 Pin order of the pulse oximeter sensor connector (SpO_2)

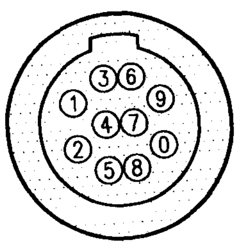
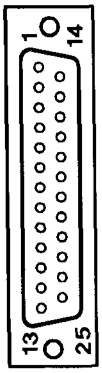
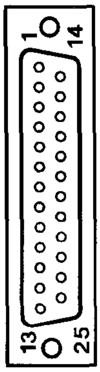
	PIN	SIGNAL
Front view 	1	Is
	2	Ib
	3	no connection
	4	Probe identification
	5	Probe identification
	6	Ground
	7	Iled
	8	$V_{B(-)}$ (+0.8V)
	9	$V_{B(+)}$ (+5V)
	0	Ground

Table 4.5 Pin order of the SERIAL & ANALOG connector



PIN NO	I/O	SIGNAL
1		Protective ground
2	O	TXD0 (RS232)
3	I	RXD0 -"-
4	O	RTS0 -"-
5	I	CTS0 -"-
6	I	Gas freeze (TTL) (Do not connect)
7		Signal ground
8	I	Test (TTL) (Do not connect)
9		+12 VDC 50 mA max
10		-12 VDC -"-
11		+15 VDC 100 mA max
12		-15 VDC -"-
13		not for use
14		not for use
15		5 VDC 500 mA max
16	O	SpO_2 10 V = 100 %
17	O	Inv. BP2 255 mmHg approx. 10 V
18	O	ECG Gain = 1660
19	O	Inv. BP 255 mmHg approx. 10 V/Pleth
20	O	CO_2 10 V = 10 % (if available)
21		+26 VDC 1 A max
22	I	(ADC7) Aux input
23		-26 VDC 1 A max
24		22 VAC 1 A max
25		22 VAC 1 A max

Table 4.6 Pin order of the AUX I/O connector



PIN NO.	I/O	SIGNAL
1		Protective ground
2	O	TXD1 (RS 232)
3	I	RXD1 -"-
4	O	RTS1 -"-
5	I	CTS1 -"-
6	I	(PB1)
7		Signal ground
8	I	(PBO)
9		+12 VDC
10		-12 VDC
11		Not connected
12		Not connected
13	I	CTS2 (TTL) (not used)
14	O	TXD2 (TTL) (CPU -> NIBP)
15		+5 VDC
16	O	RXD2 (TTL) (NIPB -> CPU)
17	O	(PA5)
18	O	(PA6)
19	O	RTS2 (TTL) (not used)
20	O	(PA7) (Alarm)
21		+26 VDC 1 A max
22		not connected
23		-26 VDC 1 A max
24		22 VAC 1 A max
25		22 VAC 1 A max

5 DETAILED DESCRIPTION OF MODULES

5.1 ECG Board

The ECG board is an isolated amplifier that accepts the low level (approx. 1 mV) signal from the patient cable via the protection circuitry and the lead selector. The signal is filtered and amplified to A/D-conversion levels.

ECG input

The input circuit has a four position switch for selecting the desired patient lead configuration and directing the signal into the preamplifier input. In models which include RESP measurement, the switch is limited to three positions.

Defibrillation and ESU protection

Input protection against defibrillation pulses (typically 5 kV/400 J) is established by 4.7 kOhm/1 W resistors and 6800 uH coils in each patient cable lead and by the spark gap F2.

> **NOTE:** In CARDIOCAP™ II models which include the RESP board, the defibrillation pulse protection circuits are located on the ECG board.

At the input there is also the electrosurgery interference (ESU) filter (R22, R23, R28, R29 and C6-C8) and a diode circuit that serves as input limiter and provides input amplifier saturation bias if the patient connection is broken, (LEADS OFF).

The patient isolation section is shielded by a metal enclosure to prevent high frequency ESU interference. A second spark gap is connected across the isolation barrier to allow a controlled passage for static voltages which otherwise would destroy the isolation components.

Amplification

Each input is amplified by standard non-inverting amplifiers which drive a differential amplifier, whose output is sent to a pulse width modulator operating at approximately 5 kHz. The pulse width modulated signal drives an optocoupler that transmits the ECG signal across the isolation barrier.

ECG output

The output stage consists of a pulse width demodulator, low pass filter and an adjustable 50/60 Hz notch filter. The signal is demodulated, filtered and sent to an analog multiplexer on the CPU board.

Leads off/Pacemaker pulses

Input amplifier saturation caused by a lead off or by a high slew rate pulse is detected by the IN-OP comparators. In case of LEADS OFF, the INOP output is a steady low voltage state. When a pacemaker pulse is detected, a fast (0.5 - 2 ms) low pulse is produced.

These signals are transmitted across the isolation barrier using an optocoupler. The signals are sent to port C of the 8255 PPI on the CPU board. The constant low signal will produce the LEADS OFF message on the display and output data string and pacemaker pulse will be clipped from the ECG waveform.

ECG power supply

Isolated power is generated by a small 75 kHz switching converter (D1, V24, V25 and T1) the output of which is a regulated +/- 12 V, using zener diodes.

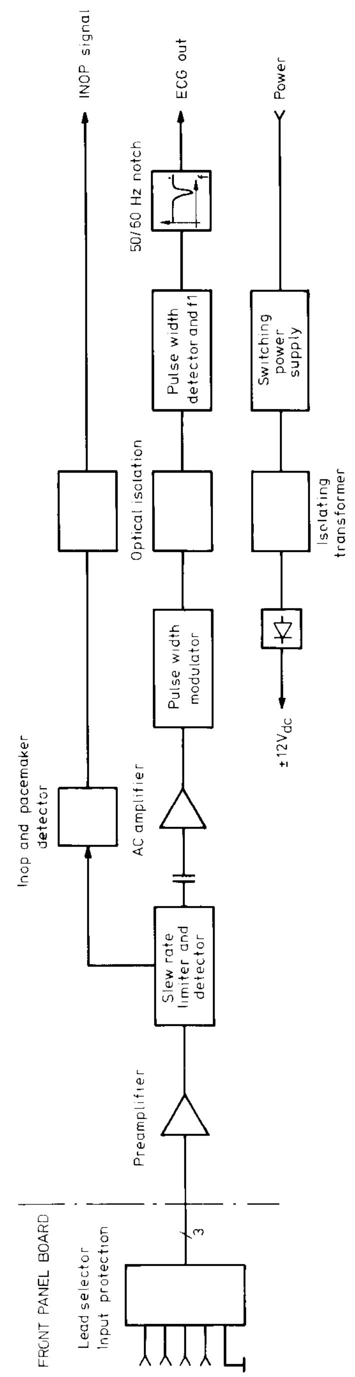
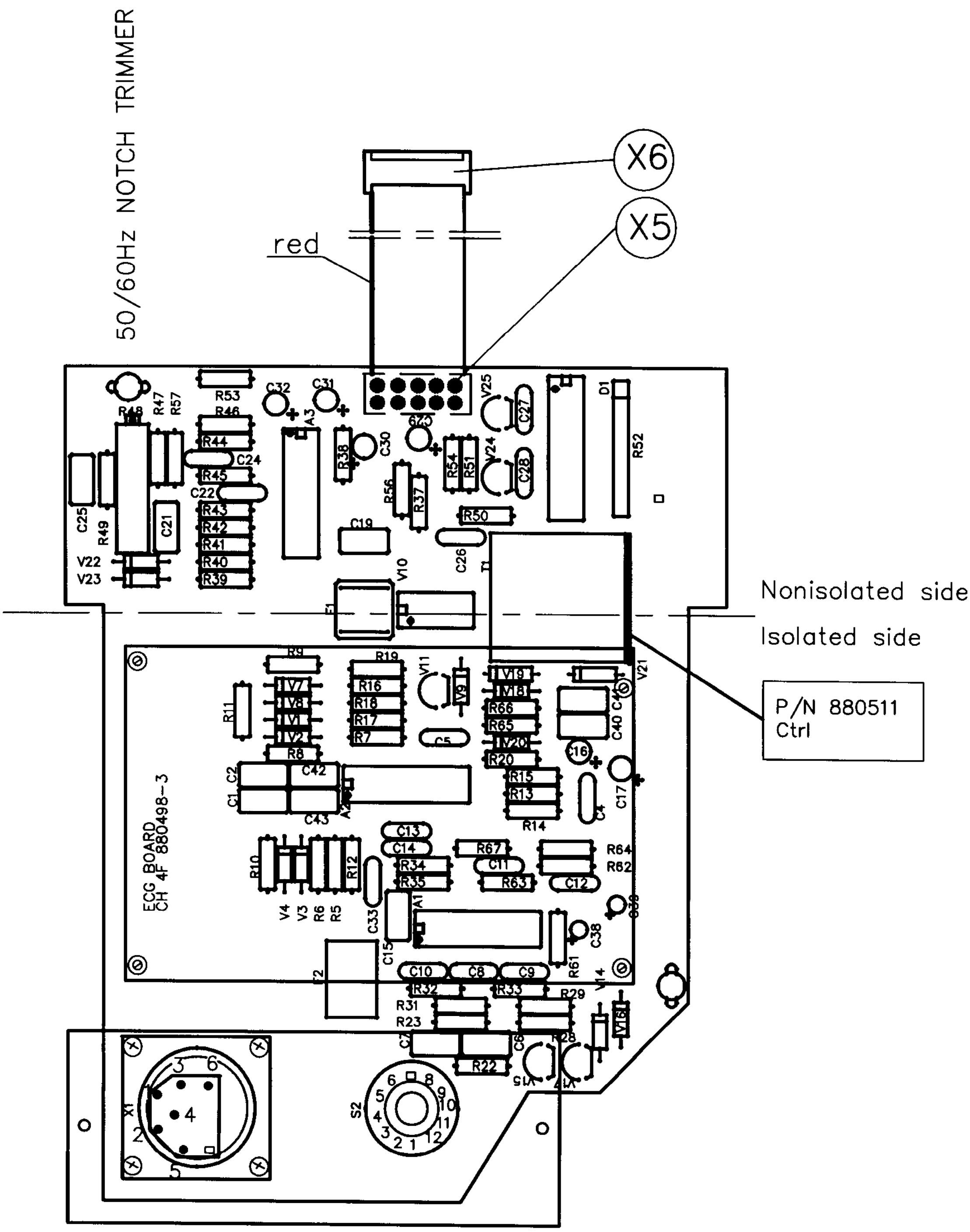
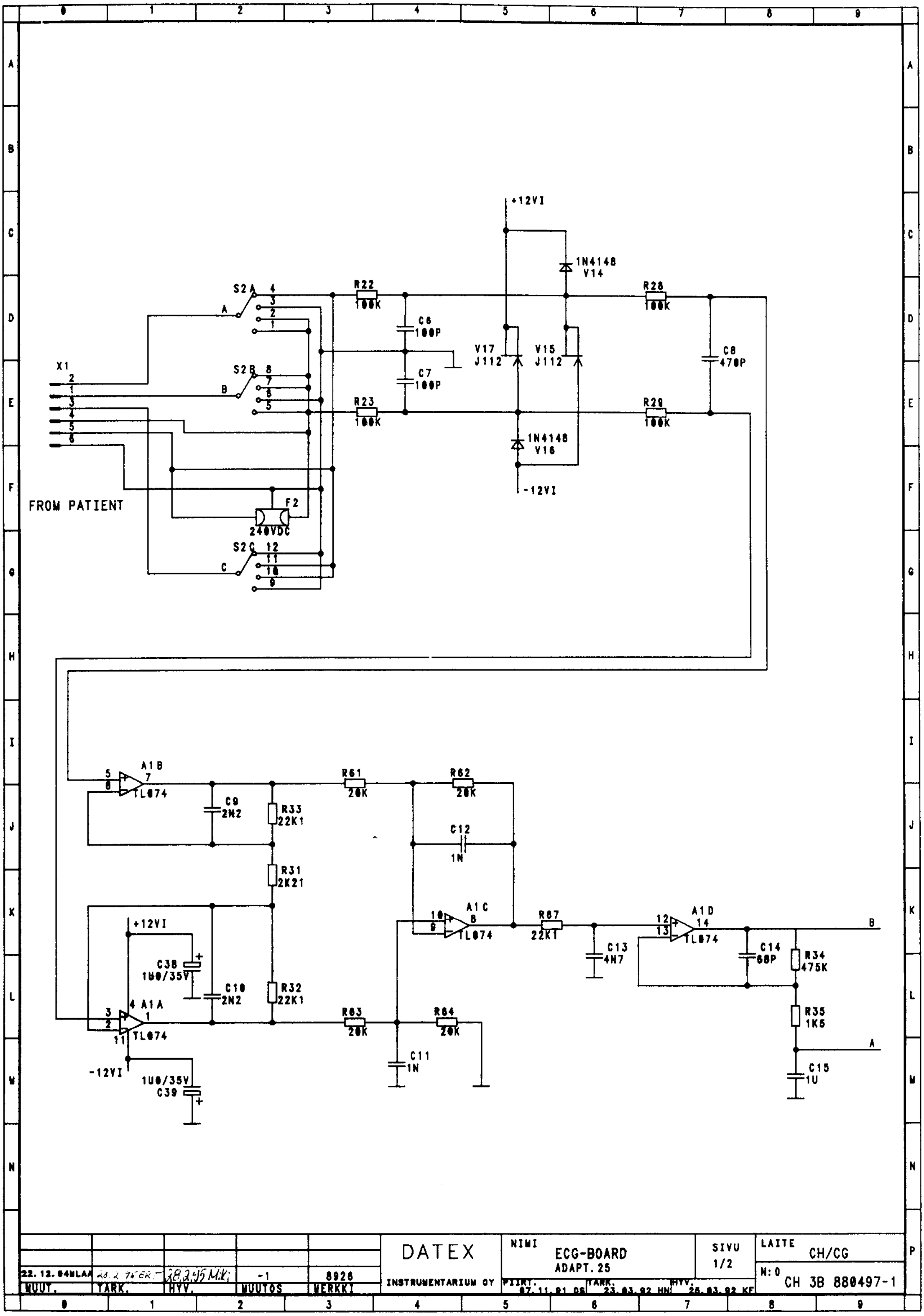


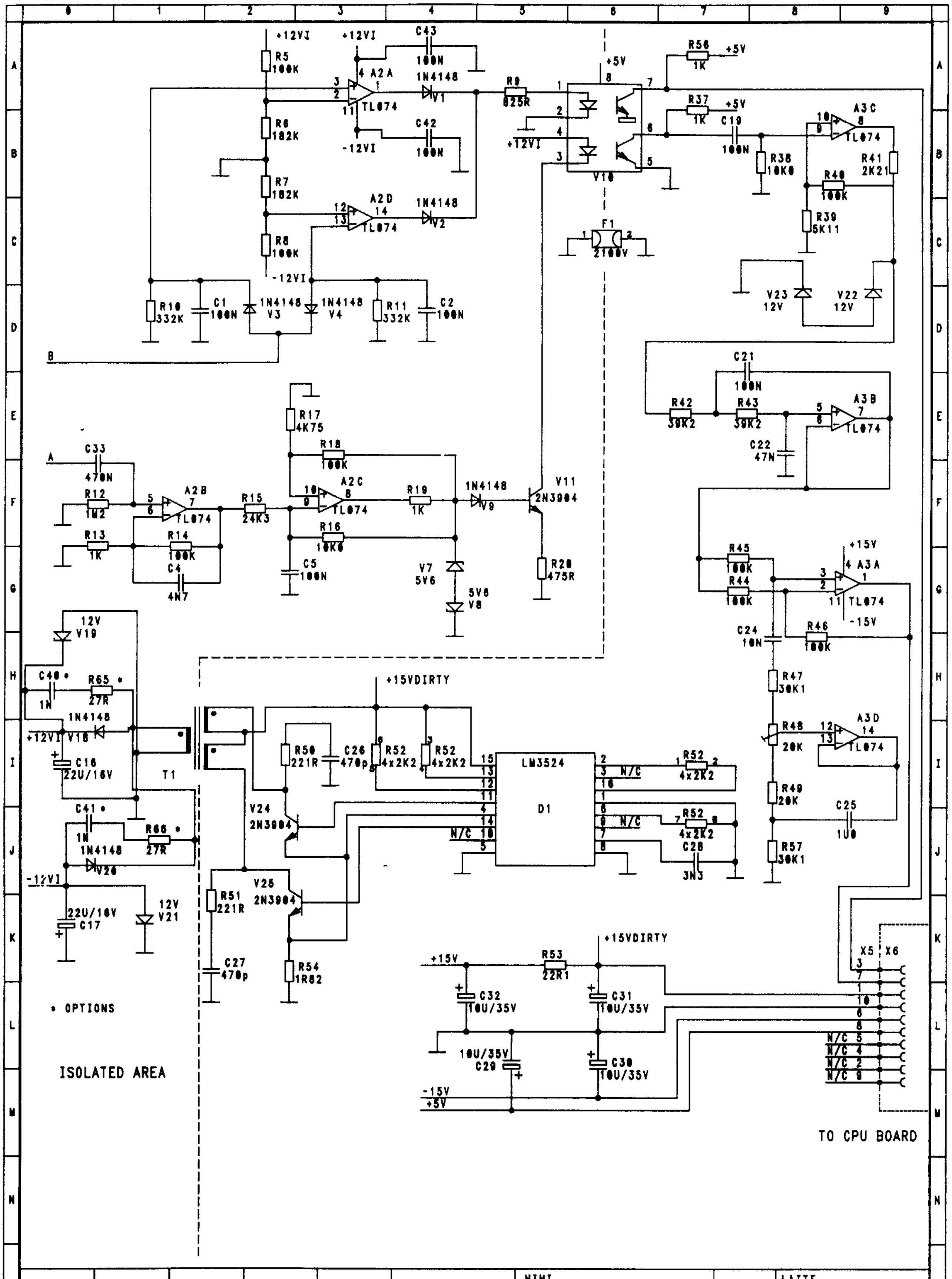
Figure 5.1 ECG board block diagram

Figure 5.2 ECG board parts layout (CH, CH-2, CH-S, CH-2S)

Figure 5.2a (on the next page) ECG board schematic diagram (CH, CH-2, CH-S, CH-2S)



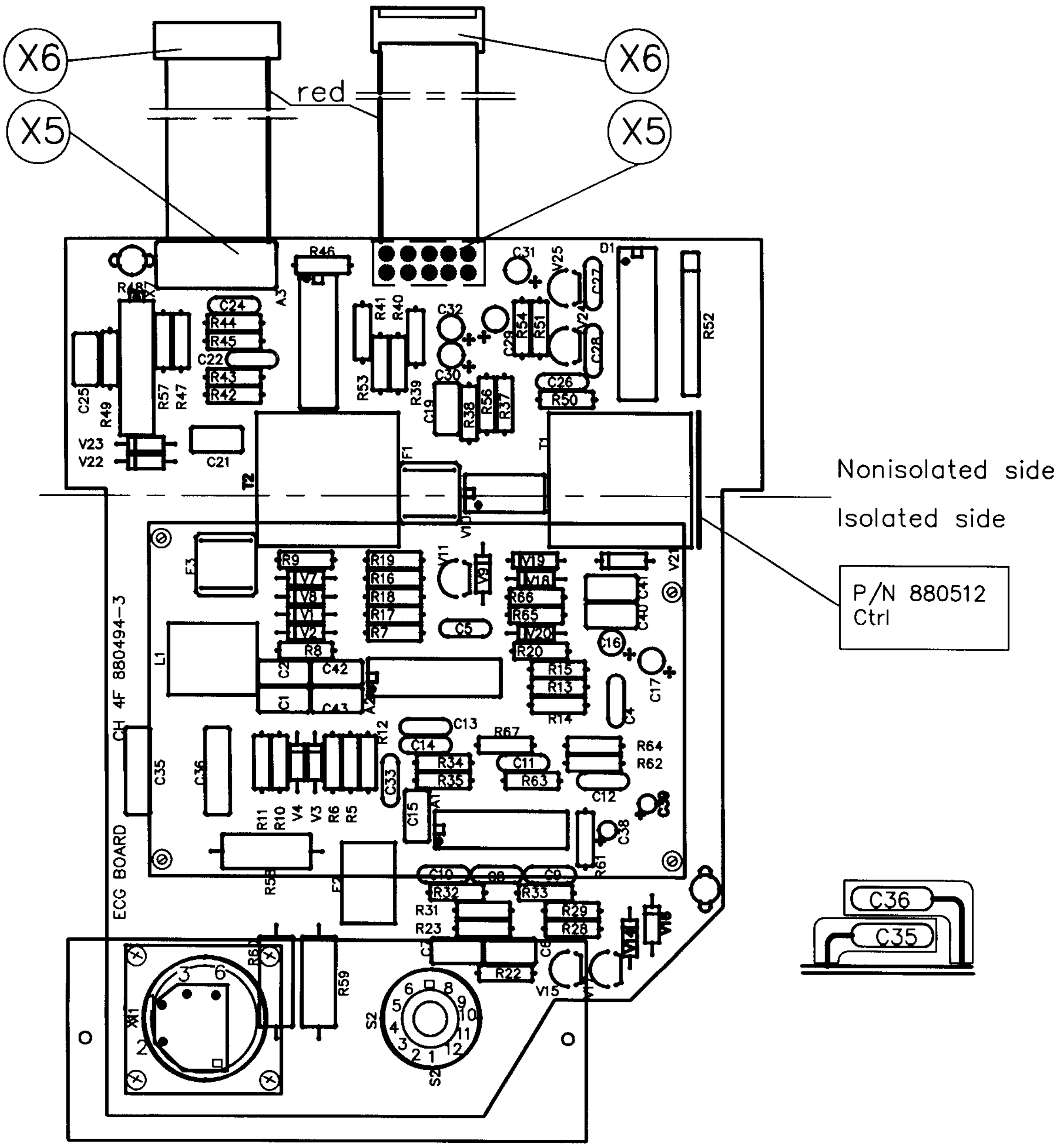

+12VI
1N4148
V14
S2A
R22
100K
R28
100K
C6
100P
C7
100P
V17
J112
V15
J112
C8
470P
X1
S2B
R23
100K
R29
100K
1N4148
V16
-12VI
FROM PATIENT
F2
240VDC
S2C
A1B
TL074
C9
2N2
R33
22K1
R61
20K
R62
20K
C12
1N
R31
2K21
A1C
TL074
R67
22K1
C13
4N7
A1D
TL074
C14
68P
R34
475K
+12VI
C38
100/35V
C10
2N2
R32
22K1
R35
1K5
A1A
TL074
R63
20K
R64
20K
C11
1N
-12VI
1U0/35V
C39
C15
1U
DATEX
INSTRUMENTARIUM OY
NIMI
ECG-BOARD
ADAPT.25
SIVU
1/2
LAITE
CH/CG
CH 3B 880497-1
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
8926

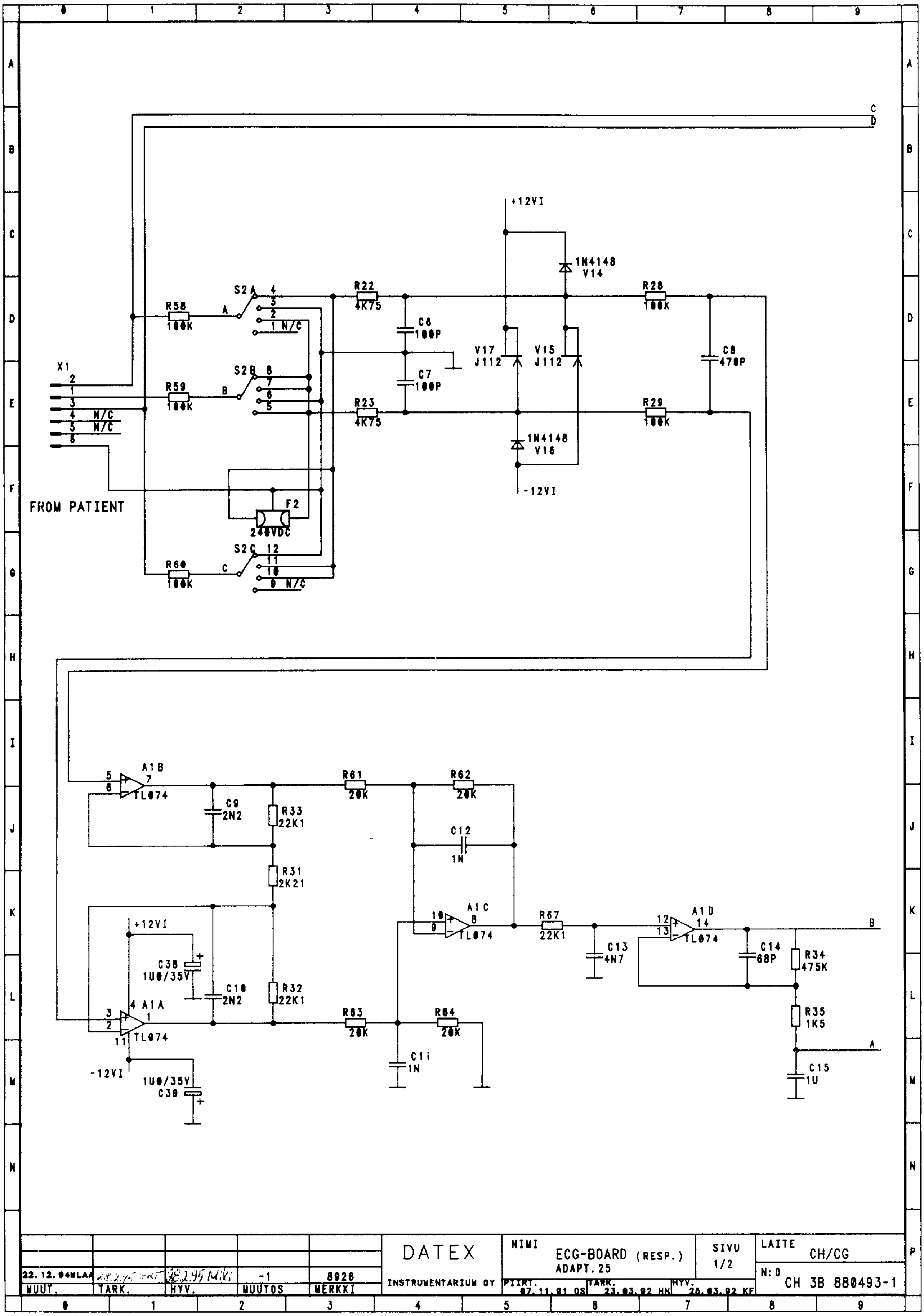


					DATEX	NIMI ECG-BOARD ADAPT. 25	SIVU 2/2	LAITE CH/CG
MUUT.	TARK.	HYV.	MUUTOS	MERKKI	INSTRUMENTARIUM OY	PIIRT. TARK. HYV.		N:O CH 3B 880497-1

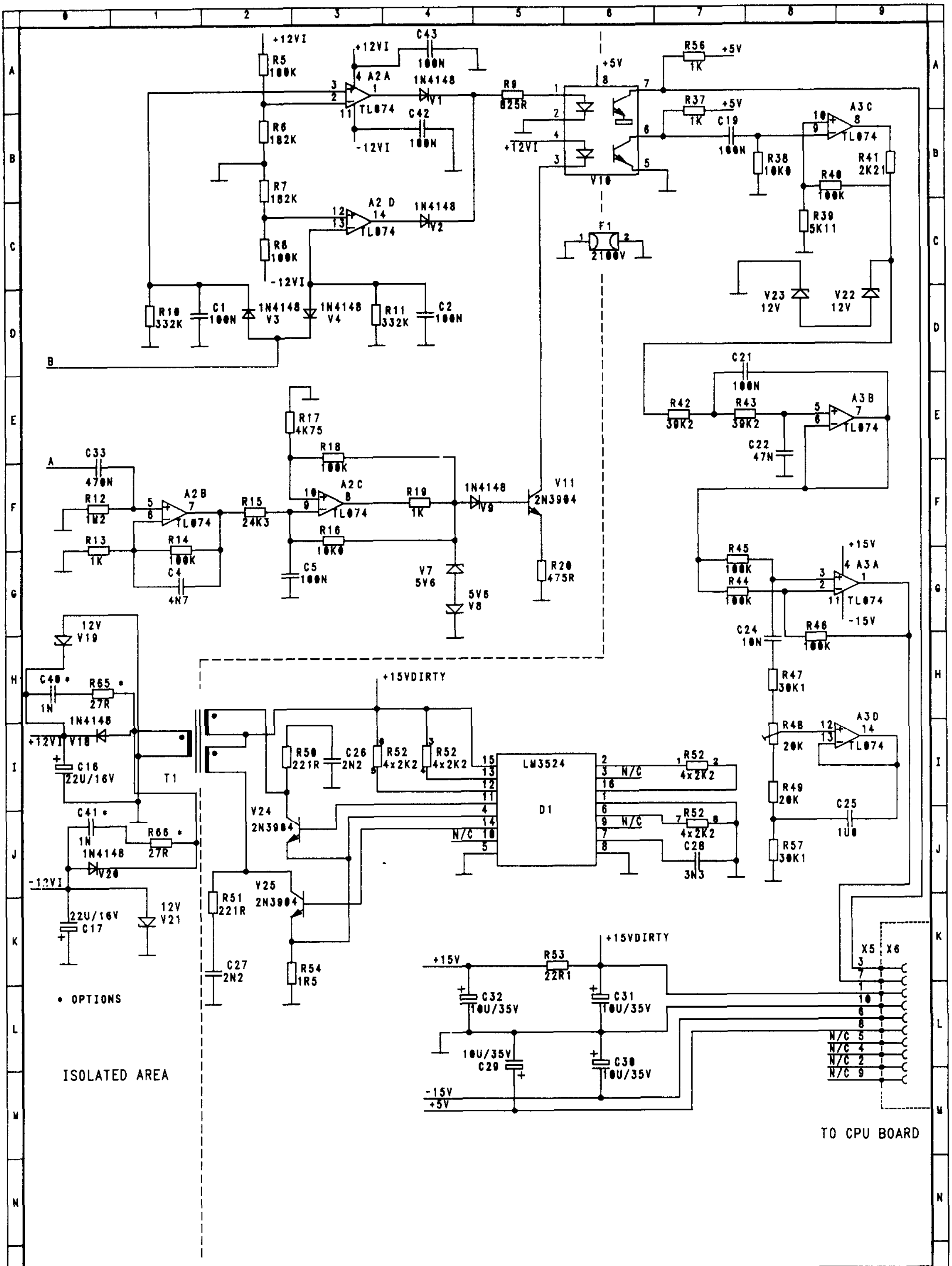
Figure 5.3 ECG board parts layout
(CH-R, CH-1R, CH-RS, CH-1RS)
(board modification level 5 and higher)

Figure 5.3a (on the next page)
ECG board schematic diagram
(CH-R, CH-1R, CH-RS, CH-1RS)
(board modification level 5 and higher)





X1
FROM PATIENT
N/C
R58 100K
R59 100K
R60 100K
S2A
S2B
S2C
1 N/C
9 N/C
F2
240VDC
R22 4K75
R23 4K75
C6 100P
C7 100P
+12VI
-12VI
1N4148 V14
1N4148 V16
V17 J112
V15 J112
R28 100K
R29 100K
C8 470P
C
D
A1B TL074
C9 2N2
R33 22K1
R31 2K21
R32 22K1
C10 2N2
C38 10U/35V
C39 10U/35V
A1A TL074
R61 20K
R62 20K
C12 1N
R63 20K
R64 20K
C11 1N
A1C TL074
R67 22K1
C13 4N7
A1D TL074
C14 68P
R34 475K
R35 1K5
C15 1U
B
A
DATEX
INSTRUMENTARIUM OY
NIMI
ECG-BOARD (RESP.)
ADAPT. 25
SIVU 1/2
LAITE CH/CG
N:O CH 3B 880493-1
PIIRT. 07.11.91 OS
TARK. 23.03.92 HN
HYV. 25.03.92 KF
22.12.94MLAA
-1
8926
MUUT.
TARK.
HYV.
MUUTOS
MERKKI



				DATEX INSTRUMENTARIUM OY	NIMI ECG-BOARD (RESP.) ADAPT.25	SIVU 2/2	LAITE CH/CG
MUUT.	TARK.	HYV.	MUUTOS	MERKKI	PIIRT. / TARK. / HYV.	N:O CH 3B 880493-1

5.2 RESP Board

The RESP board measures the respiratory rate of a patient based on fractional changes in thoracic impedance between two electrodes.

An oscillator produces a 48 kHz signal at a constant voltage that is applied to the input of a preamplifier whose input impedance varies with respiration. The output of the amplifier is rectified and filtered producing a signal where a 1 Vpp change represents a 1.0 ohm change in the thoracic impedance of the patient.

The dynamic measuring range of the amplifier is 0.1 to 3.0 ohm, with a frequency response of 0.2 to 3.0 Hz corresponding to respiratory rate of 12 to 180 per minute.

The AC amplifier produces a signal from which respiratory rate data is displayed. it operates within an impedance window established by the static impedance level (approx. 3 kohms) and the voltage peak to peak limit of the AC amplifier. If a limit is exceeded, an IN-OP switch is activated which effectively turns off the AC amplifier. An error message will be displayed.

The RESP board (connector Xl) is connected to the ECG board (connector X8) with flexible cable.

The RESP board is included in models 1R, 1RS, R, and RS.

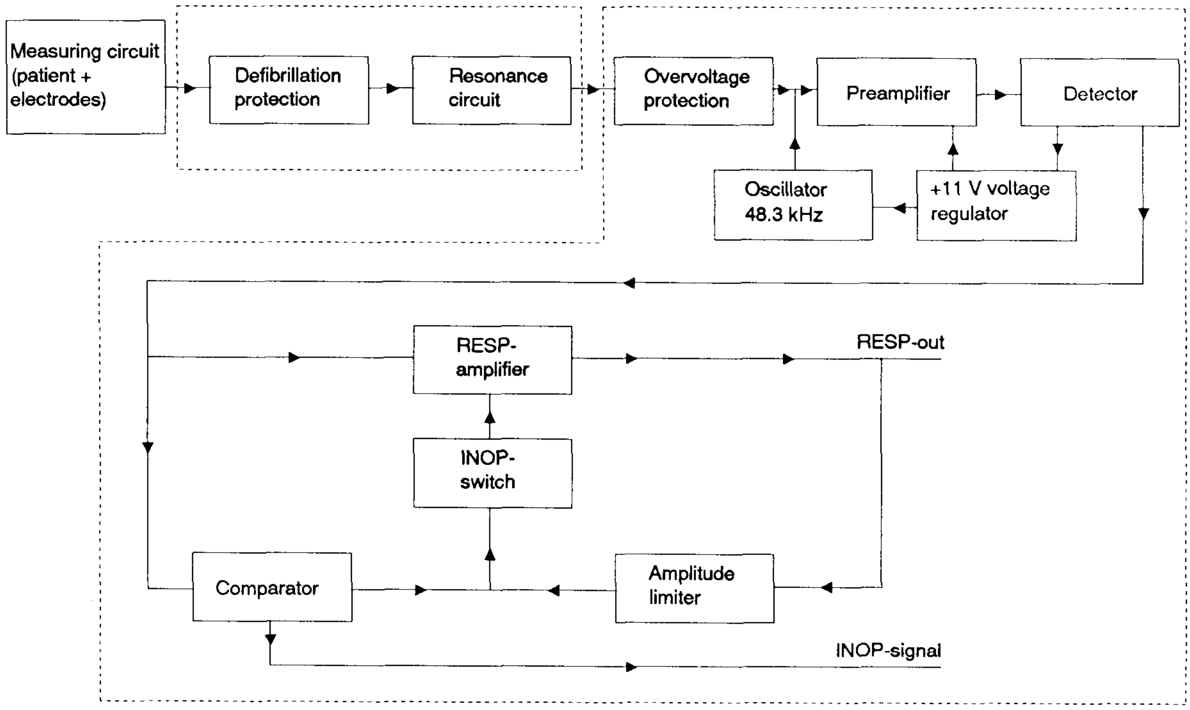


Figure 5.4 RESP board block diagram

Patient hook up

The electrodes are placed on the patient in such a manner to provide a static impedance of up to 3 kohms. As the patient breathes, this impedance will change fractionally.

This variable patient or base impedance becomes part of the preamplifier input circuit.

Resonant circuit

The resonant circuit consisting of the base impedance, transformer T2, high voltage capacitors C35 and C36, choke L1 and a spark gap F3. Transformer T2, provides the necessary patient isolation as well as stepping up the impedance of the resonant circuit. The effect is that small changes in the base impedance caused by respiration, produce larger changes to the preamplifier input impedance.

Choke L1, matches the resonant circuit so that its resonant frequency is not dependant on the base impedance. The input impedance of the preamplifier is approximately 1.3 Mohm at 50 Hz and 6.4 Mohm at 10 Hz.

This circuit is located on the ECG board.

Oscillator

A1B is an oscillator whose frequency is adjusted by trimmer R54 to 48.3 kHz. Output waveform is sinusoidal with some limit applied to the peaks.

Preamplifier

The output of the oscillator is applied to the input of the preamplifier Al A. The amplifier has a gain of 4, but the actual signal strength produced will vary as the input impedance varies.

Detector

The output of the preamplifier is split so that some of the signal is processed by the amplifier A1C and diodes V3 and V4 (which form a full wave rectifier). This rectified signal is summed with the non-rectified signal through R5, then low-pass filtered by A1D. The result of which is to produce a low-frequency AC signal with a DC component.

* The DC-component is produced from the static base impedance.

* An AC-component is the result of the impedance variation of the base impedance caused by respiration.

RESP amplifier

The AC-component of the detected signal is amplified by an AC amplifier A2A and A2B (RESP-amplifier), then transmitted to the amplitude limiter.

Amplitude limiter

Operational amplifiers A2C and A2D monitor the output signal of the RESP-amplifier. If the output signal exceeds a pre-established point, the INOP-switch is activated when the signal is rectified by the limiter circuit and applied A3B.

The voltage applied through D1 is established by a pull-up resistor at +15 V. When the inverted voltage from A3B is applied to D1, the output of the RESP-amplifier becomes 0 volts.

The output of the amplitude limiter is also transmitted to the analog multiplexer on the CPU board via the ECG board. Respiratory rate is then calculated and displayed.

Comparator

The DC signal is applied to a comparator circuit (A3A). The voltage is directly proportional to the impedance in the patient circuit. The comparator has a threshold level of about 4.2 V (corresponding to impedance of 3 kohm). When the voltage at the input exceeds this level (that is, the base impedance has exceeded 3 kohms), the comparator output changes state (+15 V). This voltage is applied through diode V13, amplified and inverted by A3B.

In addition, the comparator output is transmitted to port B of the 8255 PPI on the CPU via the ECG board. The change in state causes an interrupt to be produced resulting in an error message to be displayed.

Defibrillation protection

The defibrillation protection is realized by five resistors (R58 through R62) in the ECG board.

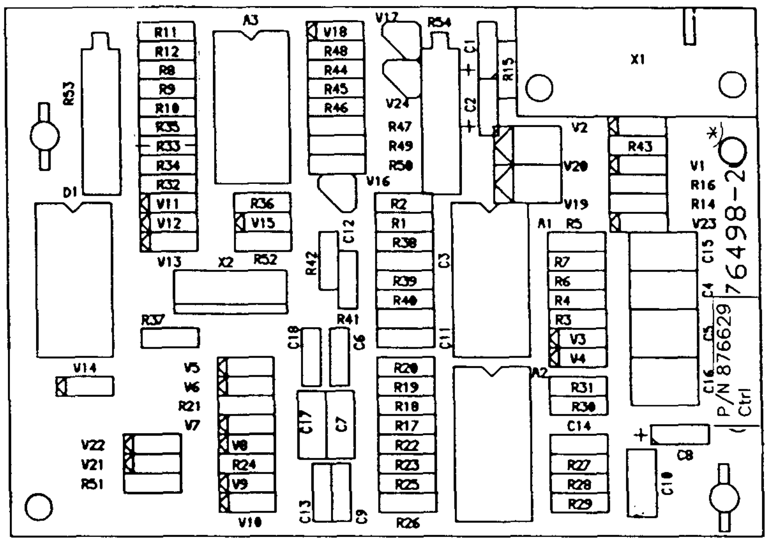
Over voltage protection

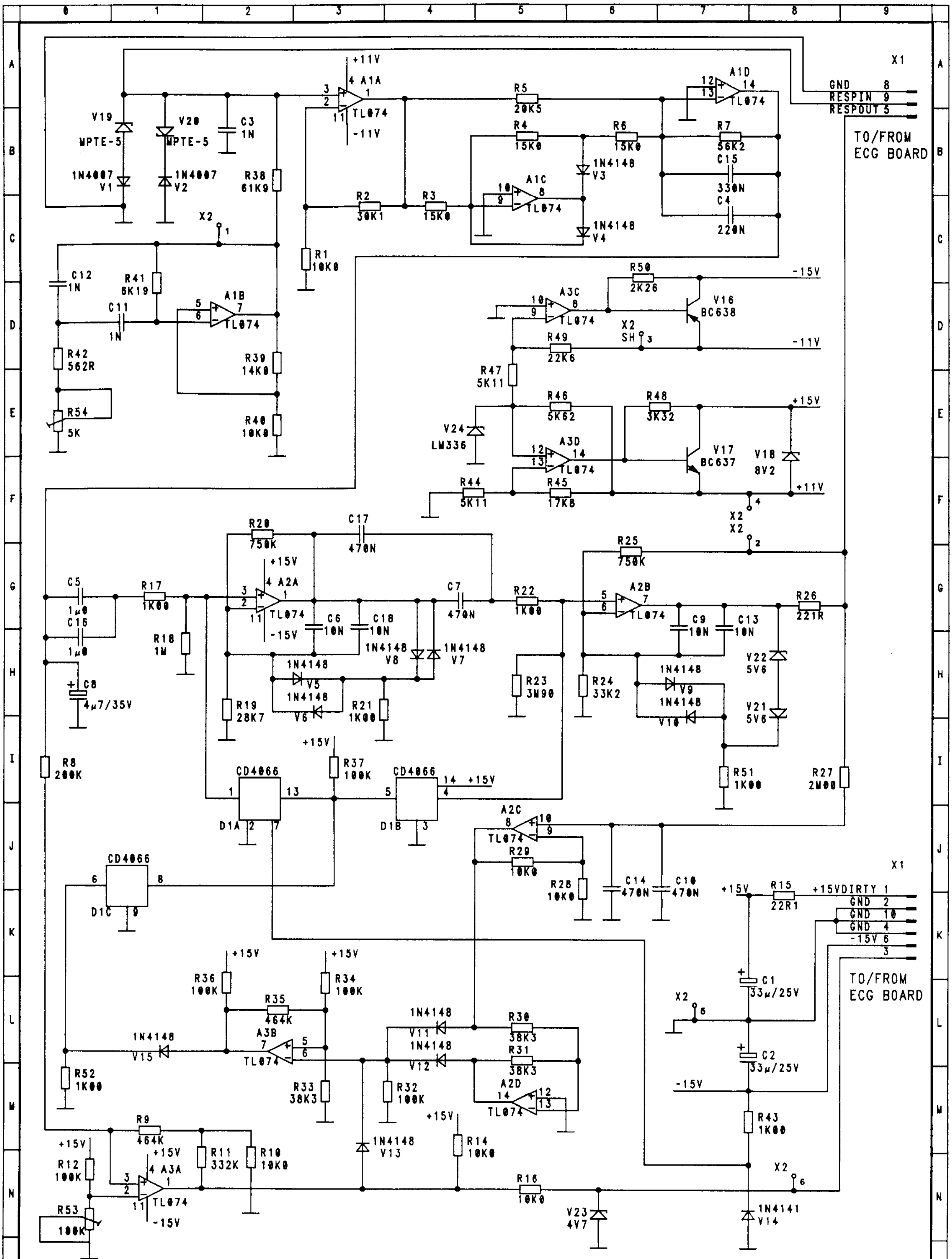
Transient suppressor diodes VI, V2, V19, and V20 protect the measuring amplifier against an Over voltage pulse which might pass through the transformer.

Voltage regulator

The operating voltage of oscillator, preamplifier, and detector is regulated and stabilized with A3C and A3D. This reduces noise in the first stages of the amplifier and keeps the amplitude of the oscillator constant.

Figure 5.5 RESP board parts layout and schematic diagram (board modification level 5 and higher)





08.04.93 OS		21.4.93 [illegible]	7239	-3	DATEX	NIMI: RESP BOARD	SIVU 1/1	LAITE CH
19.06.90 OS		21.6.90JoKo	5257 5347	-2				
04.01.90 OS		12.1.90JoKo	4939	-1	INSTRUMENTARIUM OY	04.09.89 OS / TARK. / HYV.		N:O CH 3B 876497-3
MUUT.	TARK.	HYV.	MUUTOS	MERKKI				

5.3 IPT (Invasive-Pleth-Temperature) Board

The IPT board is designed to support two pressure channels and one temperature channel. However, in models CH-1R and CH-1RS, only one pressure channel is available. In models CH, CH-R, CH-S, and CH-RS, no invasive pressure channels are provided.

The boards have two common features with the ECG board; the isolating power switcher and the pulse width modulator/ optoisolator/ demodulator chain.

The two-pressure channel IPT board generates two real time waveforms:

1. Invasive pressure P1 waveform.

2. Invasive pressure P2 waveform.

Temperature

The temperature signal is produced by a voltage divider, part of which is the patient sensor (YSI 400-series thermistor). The output is amplified by the calibrated amplifiers. Offset adjustment and linearization is done by software.

Invasive pressure

The monitor provides +5 V excitation voltage and a ground reference. The transducer output is sent to a single differential amplifier IC. The excitation voltage is sourced from the isolated power supply on the IPT board and all variations in this voltage are compensated for by software.

The Cardiocap senses when a pressure sensor has been inserted into a connector by providing a line on each connector that is held high (pressure flag) by a pull-up resistor. The line is shorted to ground when a pressure transducer is plugged into the monitor. The pressure flag lines are polled by the multiplexer and when the CPU senses the line is grounded, the pressure display is activated.

Signal output

The following signals are multiplexed to a pulse width modulator:

- the temperature channel
- two pressure flags
- zero and +5 V reference
- pressure differential signal

The multiplexer control is provided by the CPU.

If a second pressure is provided, its differential output is directed to its own pulse width modulator.

After all signals are transmitted across the isolation barrier, they are demodulated, low-pass filtered and transmitted to the analog multiplexer resident on the CPU board.

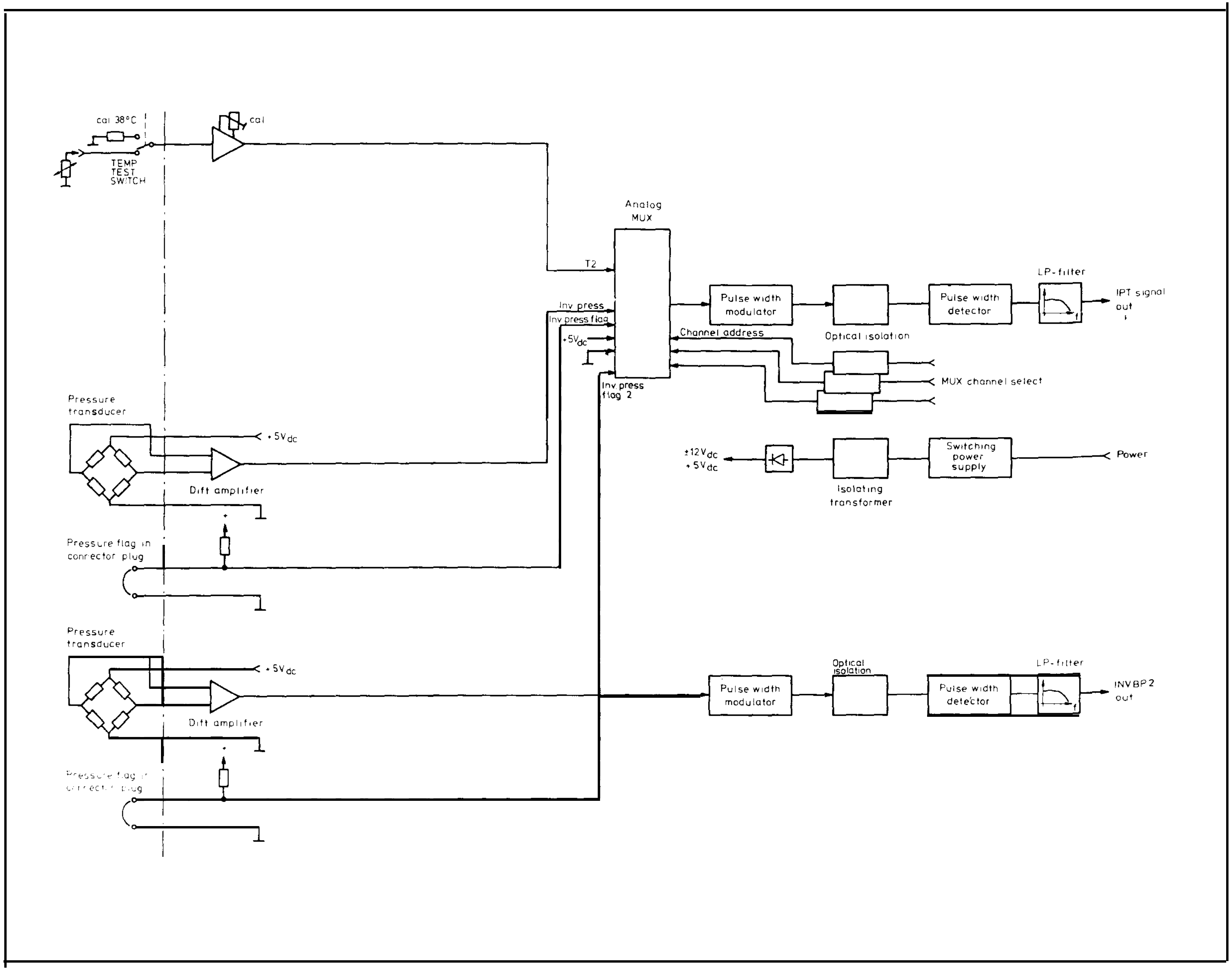
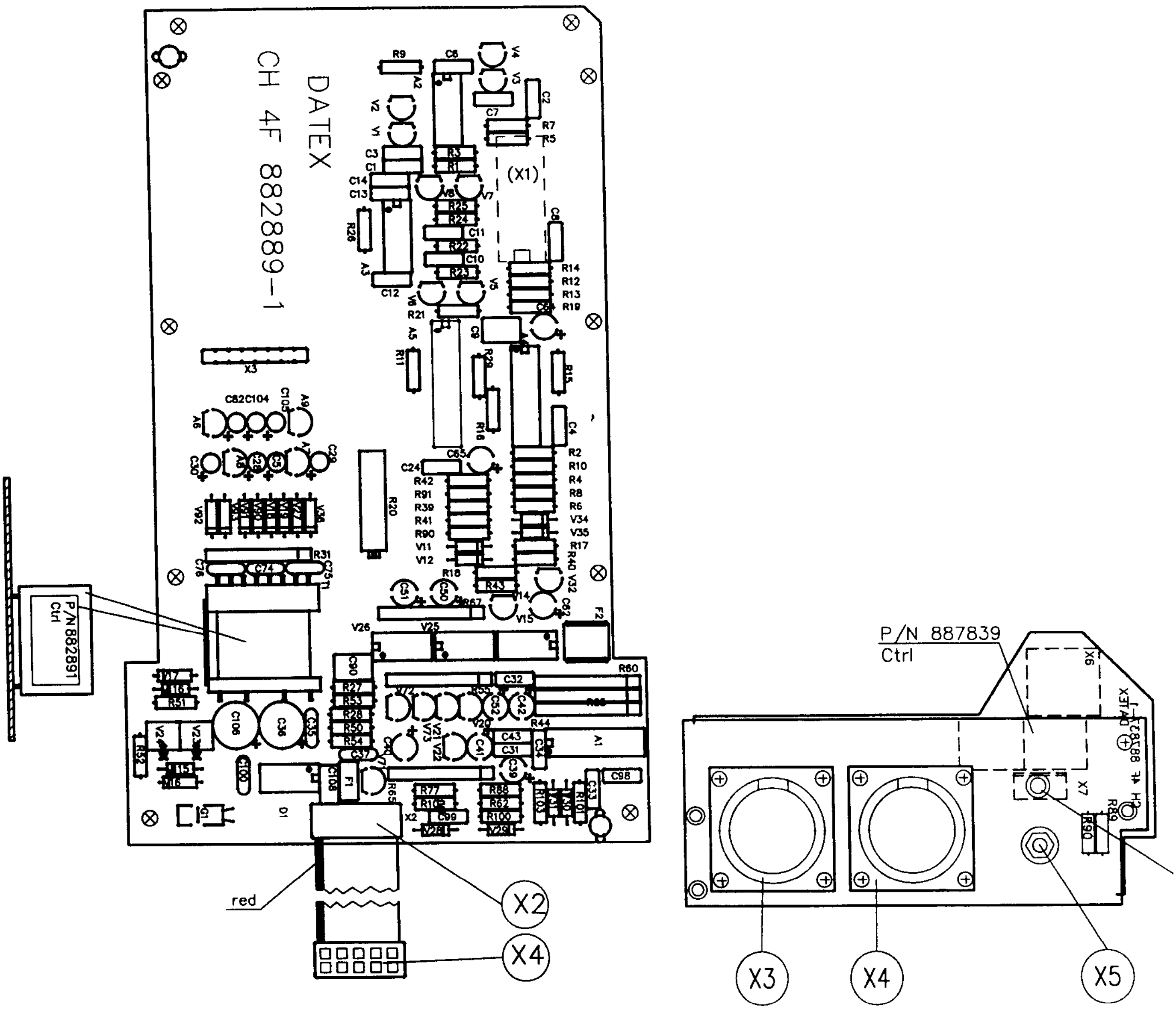


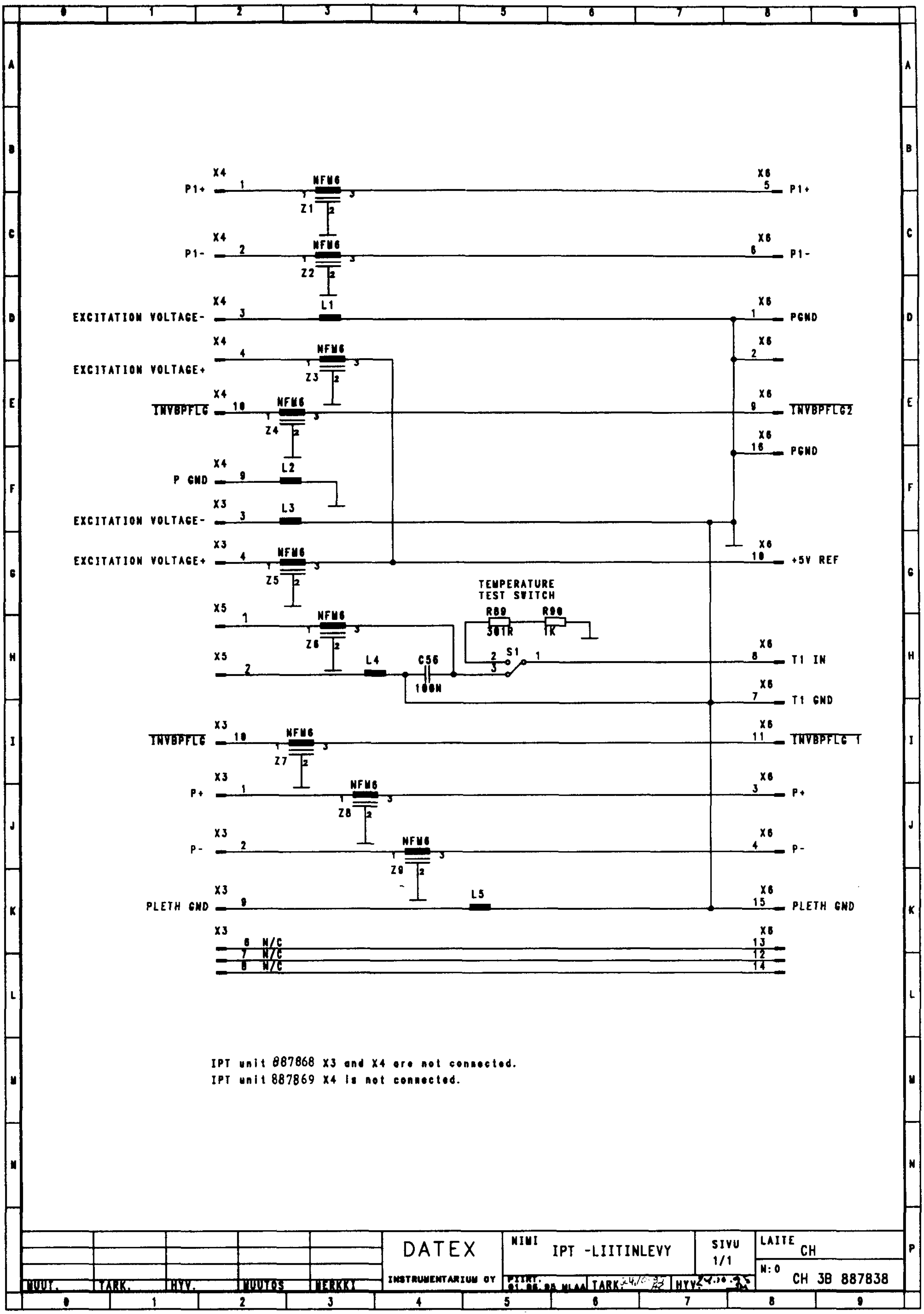
Figure 5.6 IPT board block diagram

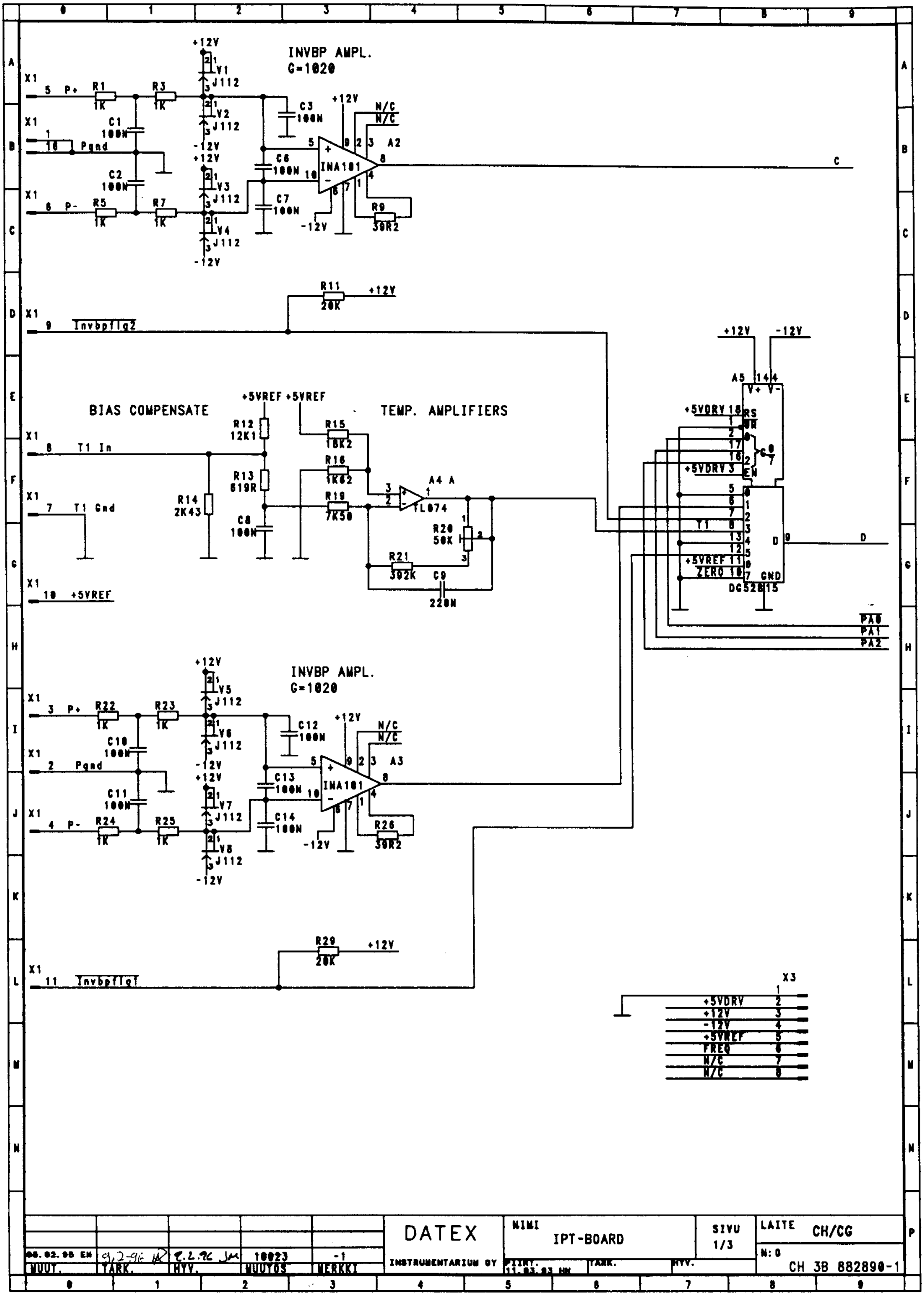
Figure 5.7 **IPT board (board modification level 4 and higher) and IPT connector board parts layouts and IPT connector board schematic diagram**

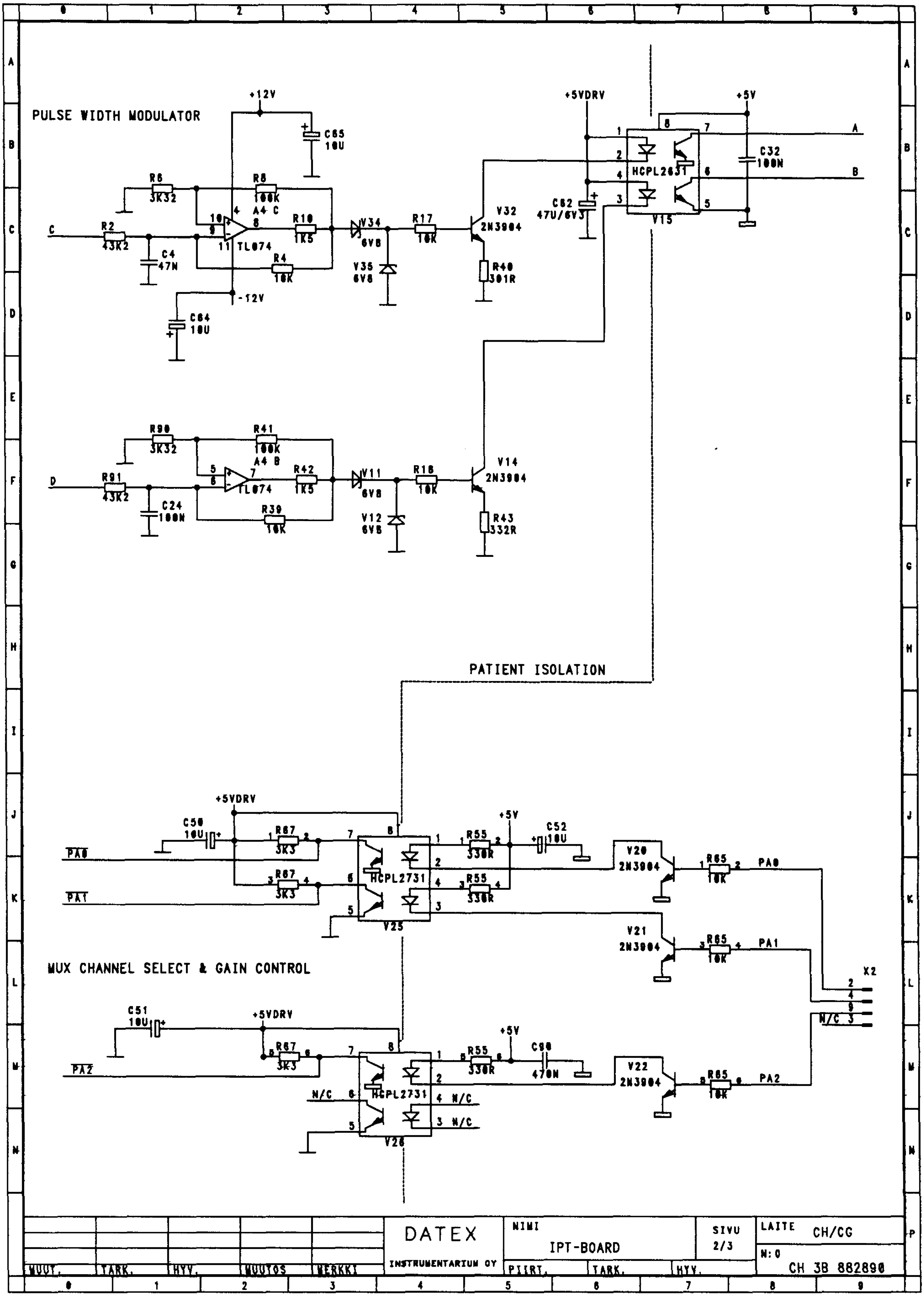
Figure 5.8 (on the next page)
IPT board schematic diagram
(board modification level 4 and higher)m

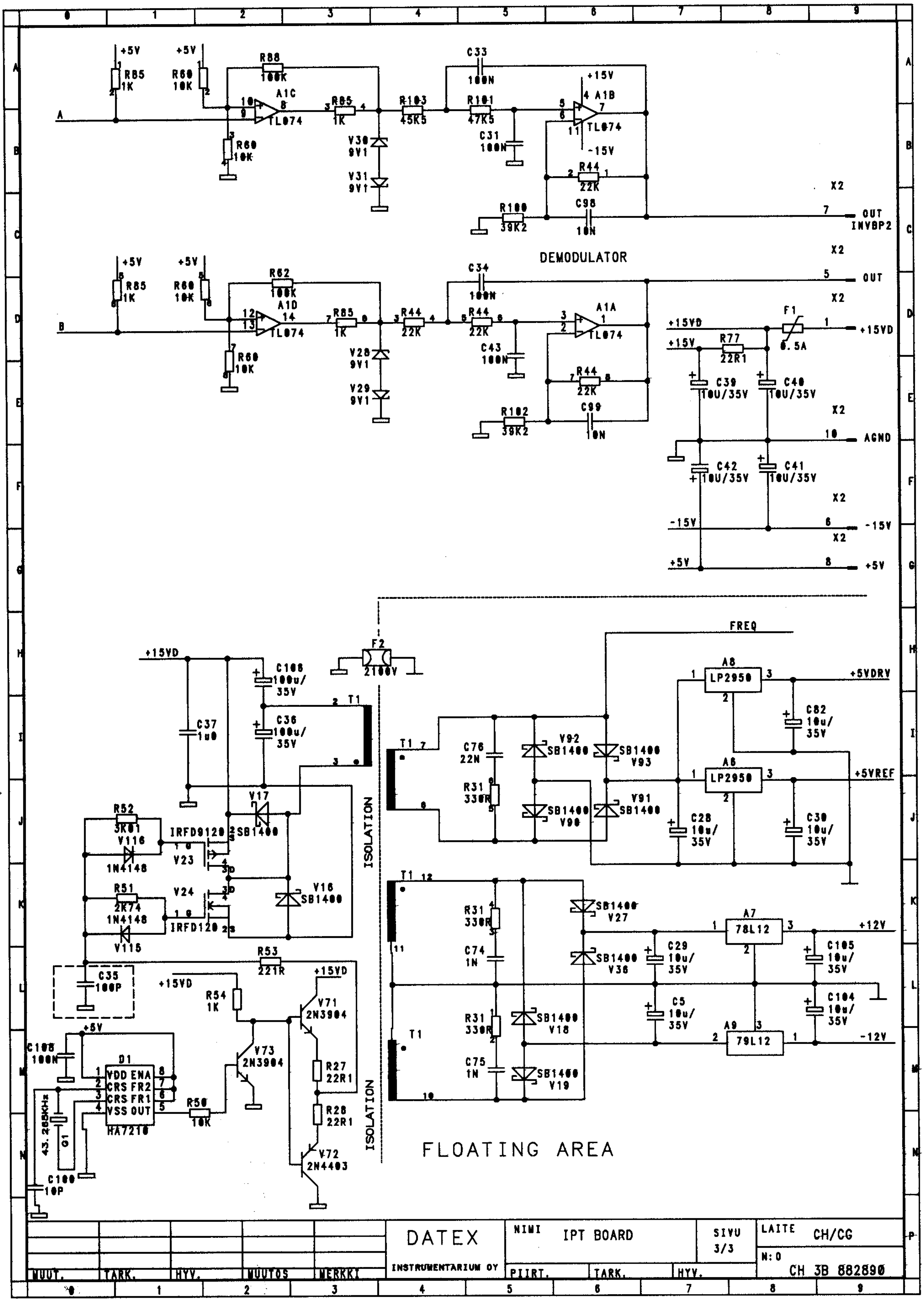


(Connector X4 or both X3 and X4 not included in some models)


P1+
P1-
EXCITATION VOLTAGE-
EXCITATION VOLTAGE+
INVBPFLG
P GND
EXCITATION VOLTAGE-
EXCITATION VOLTAGE+
X4
X3
X5
NFM6
Z1
Z2
Z3
Z4
Z5
Z6
Z7
Z8
Z9
L1
L2
L3
L4
L5
TEMPERATURE
TEST SWITCH
R89
301R
R90
1K
S1
C56
100N
INVBPFLG
P+
P-
PLETH GND
N/C
X6
P1+
P1-
PGND
INVBPFLG2
PGND
+5V REF
T1 IN
T1 GND
INVBPFLG 1
P+
P-
PLETH GND
IPT unit 887868 X3 and X4 are not connected.
IPT unit 887869 X4 is not connected.
DATEX
INSTRUMENTARIUM OY
NIMI
IPT -LIITINLEVY
SIVU
1/1
LAITE
CH
N:O
CH 3B 887838
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
TARK.
HYV.


INVBP AMPL.
G=1020
BIAS COMPENSATE
TEMP. AMPLIFIERS
INA101
TL074
DG528
X1
X3
+5VDRV
+12V
-12V
+5VREF
FREQ
N/C
PA0
PA1
PA2
DATEX
INSTRUMENTARIUM OY
NIMI
IPT-BOARD
SIVU
1/3
LAITE
CH/CG
CH 3B 882890-1


PULSE WIDTH MODULATOR
+12V
C65 10U
R6 3K32
R8 100K
A4 C
R10 1K5
V34 6V8
R17 10K
V32 2N3904
C
R2 43K2
C4 47N
TL074
R4 10K
V35 6V8
R40 301R
-12V
C64 10U
+5VDRV
+5V
HCPL2631
C62 47U/6V3
V15
C32 100N
A
B
R90 3K32
R41 100K
A4 B
R42 1K5
V11 6V8
R18 10K
V14 2N3904
D
R91 43K2
C24 100N
TL074
R39 10K
V12 6V8
R43 332R
PATIENT ISOLATION
+5VDRV
C50 10U
R67 3K3
PA0
PA1
HCPL2731
V25
R55 330R
+5V
C52 10U
V20 2N3904
R65 10K
V21 2N3904
X2
N/C
MUX CHANNEL SELECT & GAIN CONTROL
C51 10U
+5VDRV
PA2
V26
C90 470N
V22 2N3904
DATEX
INSTRUMENTARIUM OY
NIMI
IPT-BOARD
SIVU 2/3
LAITE CH/CG
N:0
CH 3B 882890
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.


DEMODULATOR
FLOATING AREA
ISOLATION
FREQ
OUT INVBP2
OUT
+15VD
AGND
-15V
+5V
+5VDRV
+5VREF
+12V
-12V
DATEX
INSTRUMENTARIUM OY
NIMI IPT BOARD
SIVU 3/3
LAITE CH/CG
N:0
CH 3B 882890
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.

5.4 NIBP Measurement

5.4.1 NIBP board

PNEUMATIC SYSTEM

The NIBP board consists of the following pneumatic parts:

- Pressure transducer
- Bleed system
- Exhaust valve

See Figures 5.10 and 5.11 for NIBP board parts layout and schematic diagram.

Pressure transducer

The piezoresistive pressure transducer (B1) is connected to the cuff. It measures the absolute pressure of the blood pressure cuff and the pressure fluctuations caused by arterial wall movement.

Bleed system

Bleed valve (Y2) releases the cuff pressure. The opening of the valve is pulse-width controlled between 100% and 0%. When the pulse-width ratio is 100% the signal is constantly high and the valve is open all the time. When the ratio is 0% the signal is constantly low and the valve is closed all the time. The driving signal frequency is 40 Hz.

Exhaust valve

Valve Y1 is used as an exhaust valve to quickly deflate the cuff.

ANALOG CIRCUITS

Pressure transducer excitation

The pressure transducer B1 is excited by a 4 mA constant current source. This is produced by floating constant voltage of 1.200 V that is produced by the voltage reference diode V7. Operational amplifiers **A5A** and A5B are used as voltage followers. The voltage difference through resistor R5 (TP X8/7, X8/8) is 1.200 V, producing a current of 4 mA through the resistor for the pressure transducer. The excitation voltage of B1 is about 12 V (TP X8/8, X6/5).

Differential amplifier

The output of the pressure transducer B1 is a differential signal between the midpoints of the pressure sensing resistor bridge legs (TP X8/2, X8/3). This signal is fed to a differential amplifier (operational amplifiers A4A and A4B, and resistors R12, 13, 14, and 15) that produces a gain of 31.1 (TP X8/4).

Pressure zero and gain control

At zero pressure, the output voltage difference of the pressure transducer B1 may be up to 100 mV. This zero pressure voltage is compensated for by R6 (TP X8/5) in the amplifier stage A4C. This stage is an inverting amplifier with unity gain and low-pass filtering.

The next stage, A4D, is an inverting amplifier whose gain can be adjusted with trimmer R11. The gain is adjusted to compensate for pressure transducer gain differences, so that a linear signal is produced throughout the transducers range (TP X8/6).

Pressure DC channel range and bias circuits

The DC channel is used to measure the static or non-oscillating pressure of the blood pressure cuff. The static signal from A4D has a 5 V range (0 to -5 V). This voltage is sent to A2A which limits the voltage range to 1 V (+0.755 V to -0.755 volts) for the A/D converter.

Two input ports of the analog multiplexer (A3) are dedicated to the DC channel. The microprocessor selects the desired port depending on the cuff pressure required for best resolution. If the cuff pressure is between 0 and 255 mmHg the signal produced by A2A is sent directly to the multiplexer port 6, because the pressure corresponds directly to the 8 bit range of the A/D converter.

If the cuff pressure exceeds 255 mmHg, the signal is directed through a voltage divider network (R30/1-2 and R30/3-4) to port 5 of the multiplexer. This doubles the pressure range represented by the 1 volt signal and since the voltage measured at the divider is referenced to ground the pressures represented are between -128 and +382 mmHg.

To allow for a certain amount of zero pressure drift, the pressure zero points are actually set at 0 to 235 mmHg and -108 to 362 mmHg respectively.

Pressure AC channel filters

The AC component of the cuff pressure data is amplified to allow the processor to analyze the small cuff pressure fluctuations which are used as a basis for blood pressure determination. This additional amplifier is AC coupled. The first stage, A2B, is a second order high-pass filter to effectively block out the DC component of the pressure data (TP X9/2). The second stage, A2C, is the amplifier stage (G = 73) and low-pass filter (TP X9/3). The third stage A2D blocks the offset voltages of the previous two stages (TP X9/4).

AC reset

During cuff inflation or if an abnormal situation arises, the AC signal is sent to ground through D6A and D6B with AC reset signal P16 from the processor.

AC channel range selection

The output from A2D is connected to a voltage divider chain (R24 through 28). The 5 outputs of this resistor chain make up a binary division chain. The division ratio is selected by the analog multiplexer (A3). If voltage at the beginning of the chain is 1 volt the following outputs have voltages 1/2, 1/4, 1/8 and 1/16 volts. The processor selects the proper division ratio according to the incoming signal level. This effectively extends the dynamic range of the A/D converter from 8 bits to 12 bits.

Multiplexer and A/D converter

The analog multiplexer circuit A3 is used to select either the DC or AC channel to the A/D converter. The same multiplexer is also used to select suitable ranges for both channels. As described previously, the DC channel has two different ranges and the AC channel has 5 different ranges. The multiplexer inputs are allocated according to the following table.

INPUT DESCRIPTION	DIVISION RATIO
0 AC component	1/16
1 "	1/8
2 "	1/4
3 "	1/2
4 "	1/1
5 DC component	1/2
6 "	1/1
7 (not in use)	---

The operational amplifier A1C is a non-inverting gain stage (G = 6.62), which amplifies the incoming signals to -5 V to +5 V level (TP X9/5). Resistor network R30/5-6 and 7-8 shifts the -5 to +5 V range to 0 - 5 V for the A/D converter U1. U1 is an 8 bit successive approximation A/D converter. The converter is timed by its own internal clock (TP X6/2), the conversion rate is determined by the external RC circuit (R29, C34), conversion time is about 200 us. The converted signal is led to buffer D13 output when ADCRD-signal is activated. Decoder D5 activates the ADCRD-signal when Al 5 and RD-signal are active.

Reference voltage source

The reference voltages are generated with the reference diode V6 and operational amplifiers A5C and A5D. The reference voltages are typically +5.30 V (TP X6/4) and -10.6 V (TP X6/5).

JUMPERS

The NIBP board contains two jumpers.

Jumper X13 selects the watchdog time. Normally the time is adjusted to 5 minutes (no jumper). In test purpose the time can be changed to 5 seconds (X13 short-circuited).

Jumper X10 selects the RAM memory capacity used.

PIN	RAM CAPACITY SELECTED
1-2	32 kbytes
2-3	8 kbytes

PUMP AND VALVE DRIVERS

The magnetic valves and the air pump are controlled by the open collector darlington driver circuit D11. A separate power source (+15 V) is used to drive these circuits. An additional power switch (V1, V3), controlled by the processor, connects power to valve circuits. The watchdog timer prevents a prolonged inflation.

SAFETY CIRCUITS

Pressure control switch

A comparator circuit A1A compares cuff pressure to a fixed reference level. If cuff is inflated the circuit prevents CPU from zeroing the watchdog circuit (TP X9/6).

Watchdog timer

The watchdog timer circuit (D8, D9) controls the power of the magnetic valves and the air pump. Normally, power to the valves is not connected. The CPU is able to reset the watchdog circuit and connect power to the pump only when the cuff is not inflated. If the cuff is inflated, the CPU cannot control the watchdog circuit, which will deflate the cuff after 5 minutes.

PROCESSOR CIRCUITS

The NIBP board contains its own 8051FA CPU and memory circuits to allow independent operation. The 64 kbyte code memory resides in D2 (EPROM) and the 8 kbyte data memory in D3 (RAM). Ports P3 and P1 are used to control directly various operations of the NIBP.

Port P3 also provides RS-232 output which is used to transmit NIBP data to the main CPU.

Memory organization

The code memory and the external data memory both start from zero. The decoded address space is 64 kbytes.

ADDRESS RANGE	FUNCTION
0000 - 7FFF	32 kbyte external data memory
8000 -	A/D converter

CPU Control ports

CPU ports P3 and P1 are used to directly control several NIBP functions.

PORT P3	FUNCTION
P 3.0	RXD/
P 3.1	TXD/
P 3.2	Mux address 0
P 3.3	Mux address 1
P 3.4	Mux address 2
P 3.5	15 V power sense
P 3.6	WR
P 3.7	RD/

PORT P1	FUNCTION
P 1.0	Shunt valve I
P 1.1	Shunt valve II
P 1.2	Exhaust valve
P 1.3	Bleed valve
P 1.4	Pump control
P 1.5	Watchdog reset
P 1.6	AC reset
P 1.7	+15 V power control

Reset circuit

The reset line is connected to the common reset line RESET to guarantee simultaneous resetting with the main processor at power down conditions.

TEST POINT SIGNALS

PIN	SIGNAL
X8/1	AGND
/2	Differential output of pressure
/3	transducer
/4	Differential output (A4) output
/5	Used for pressure zeroing
/6	Used for pressure gain adjustment
/7	Voltage difference depending on
/8	pressure transducer current
	(4 mA = 1.20 V)

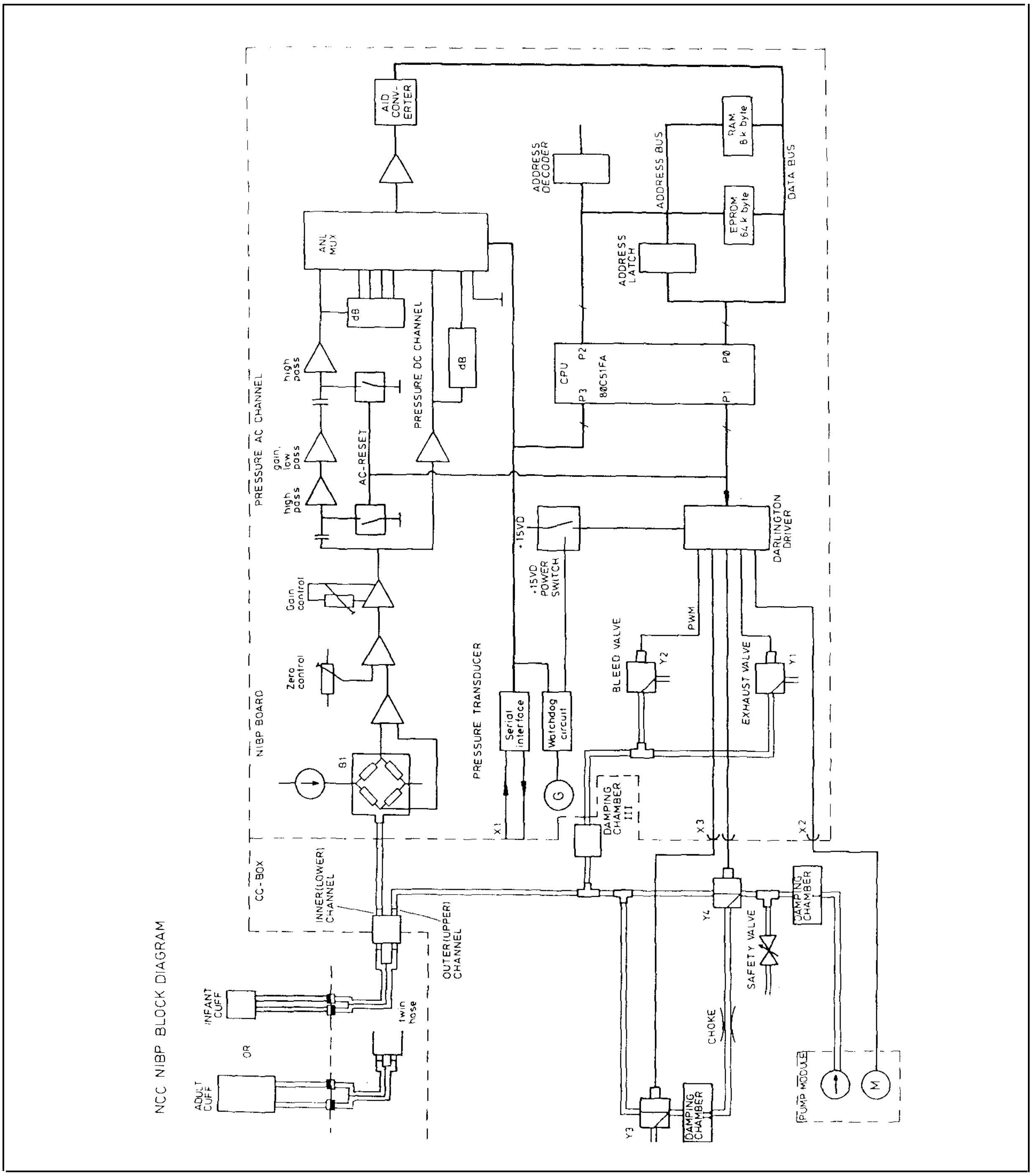
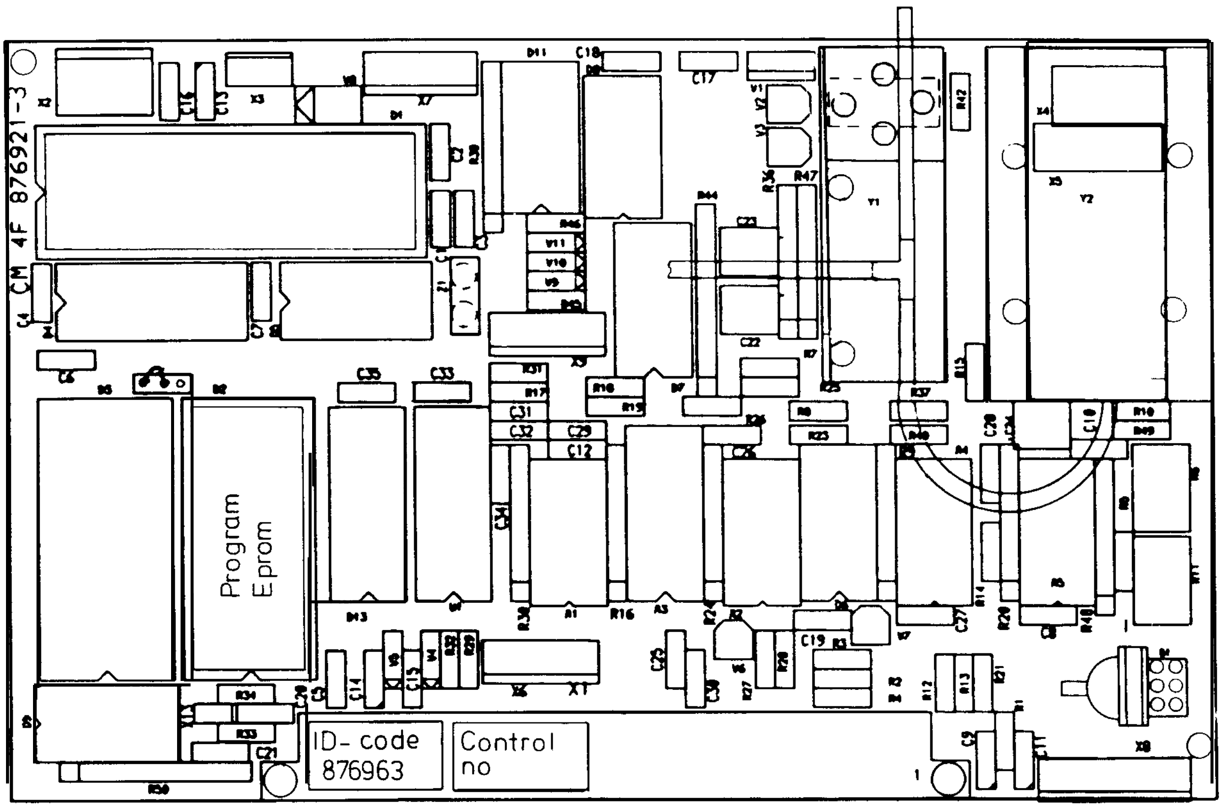


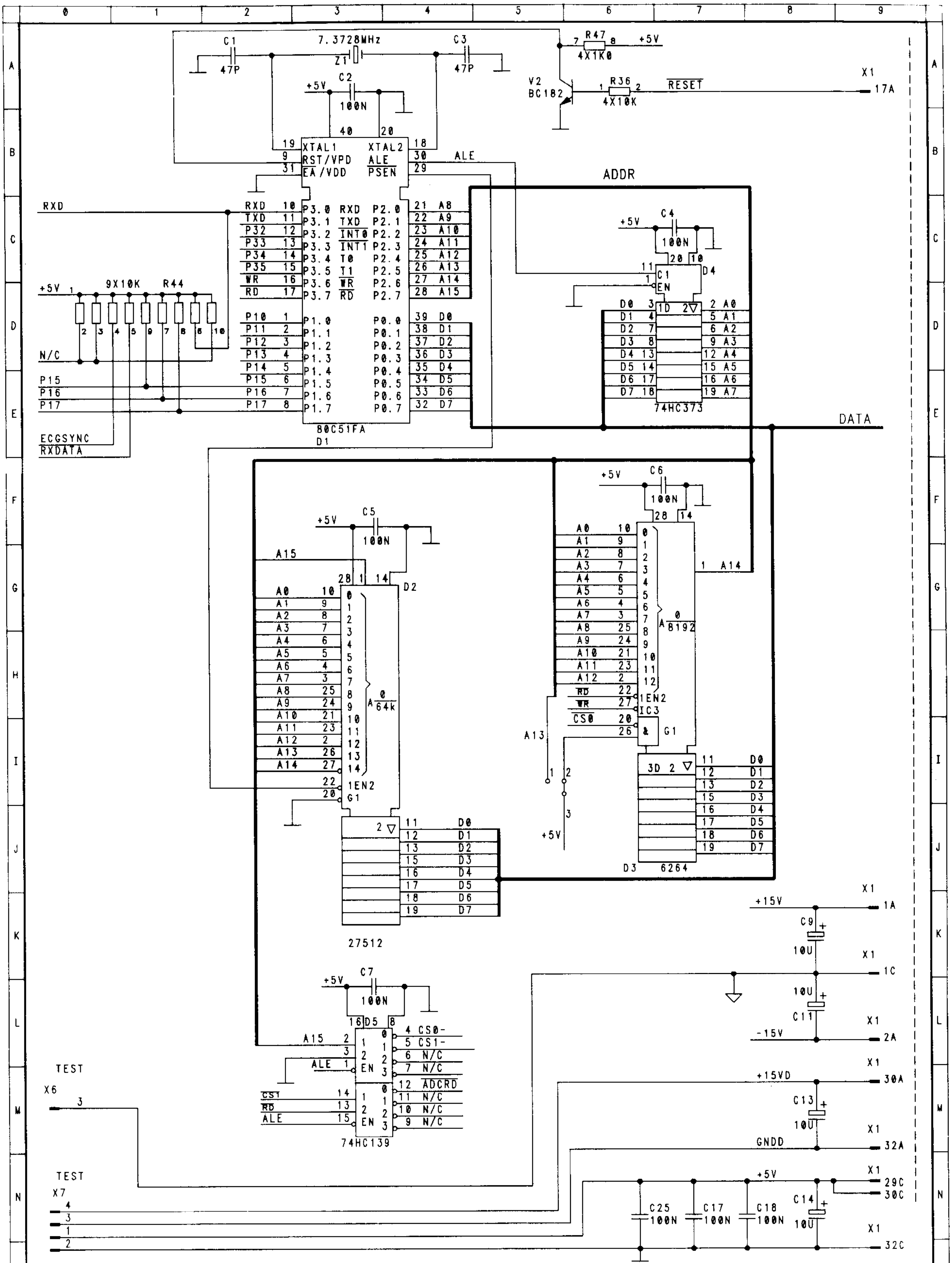
Figure 5.9 Block Diagram of NIBP System

Two different kinds of twin hose are used: one for standard adult cuff and another which contains a built-in choke for infant cuff.

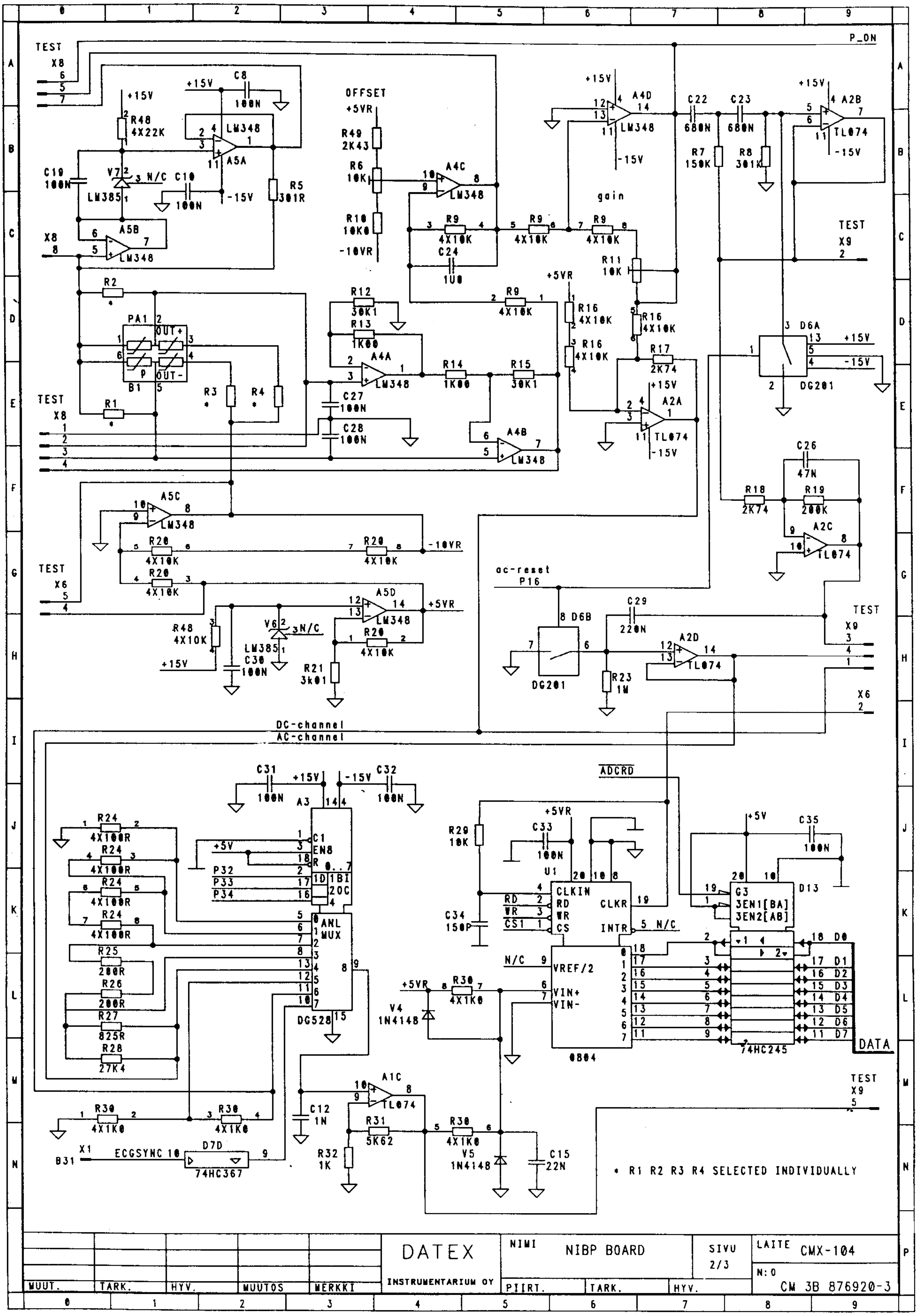
Figure 5.10 NIBP board parts layout and schematic diagram (part 1) (board modification level 4 and lower)

Figure 5.10a (on the next page)
NIBP board schematic diagram (part 2)
(board modification level 4 and lower)





14.08.90LEJA		15.8.90 JoKo	5432	-3	DATEX	NIMI NIBP BOARD	SIVU 1/3	LAITE CMX-104
01.06.90 OS		5.6.90 JoKo	5170	-2				N:0
16.01.90 OS		13.3.90JOKO	4899 4940	-1	INSTRUMENTARIUM OY	21.09.89 OS TARK.	HYV.	CM 3B 876920-3
MUUT.	TARK.	HYV.	MUUTOS	MERKKI				


TEST
X8
P_ON
OFFSET
gain
TEST
X9
ac-reset
P16
TEST
X6
DC-channel
AC-channel
ADCRD
DATA
ECGSYNC
B31
* R1 R2 R3 R4 SELECTED INDIVIDUALLY
DATEX
INSTRUMENTARIUM OY
NIMI
NIBP BOARD
SIVU
2/3
LAITE
CMX-104
N:O
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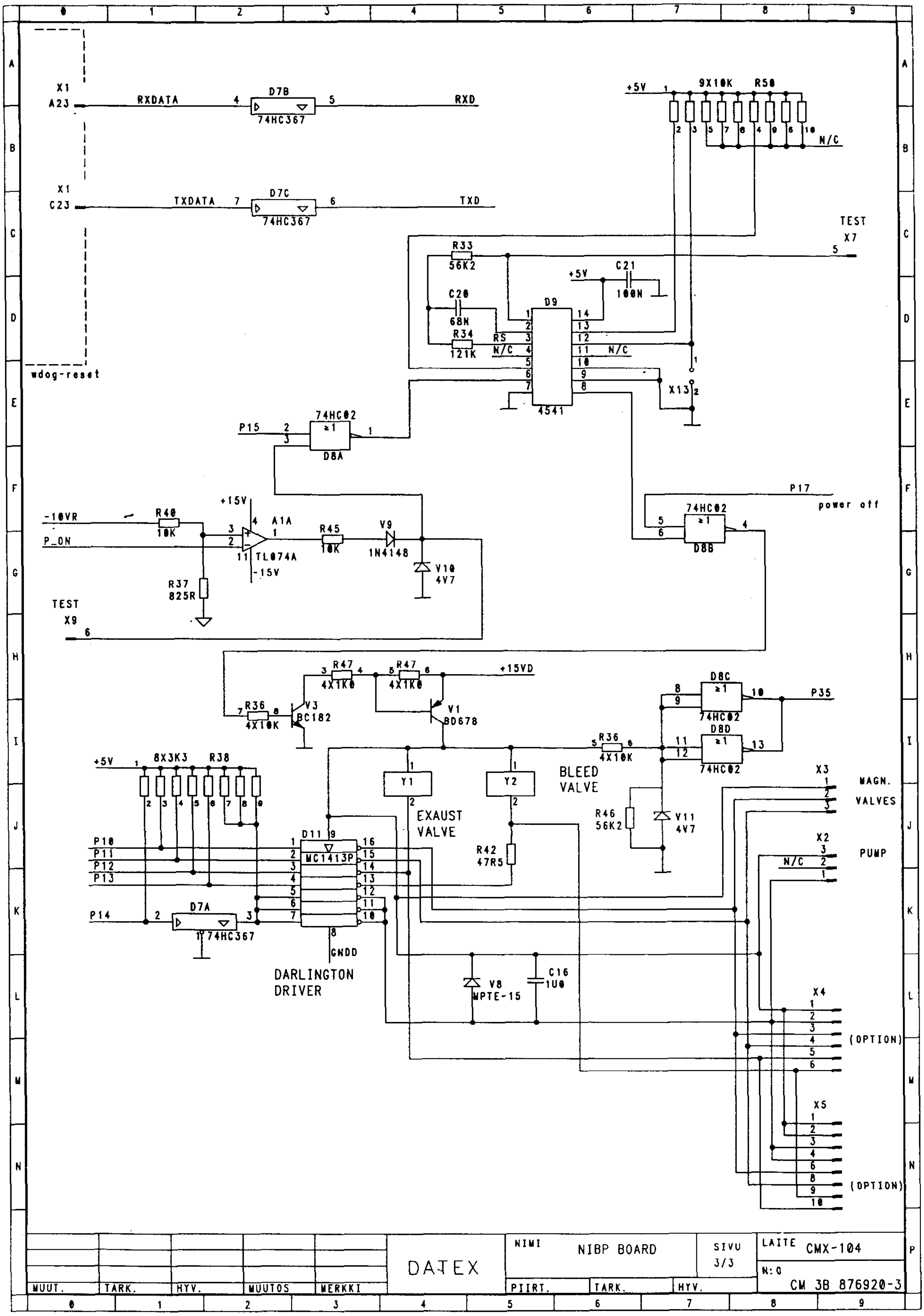
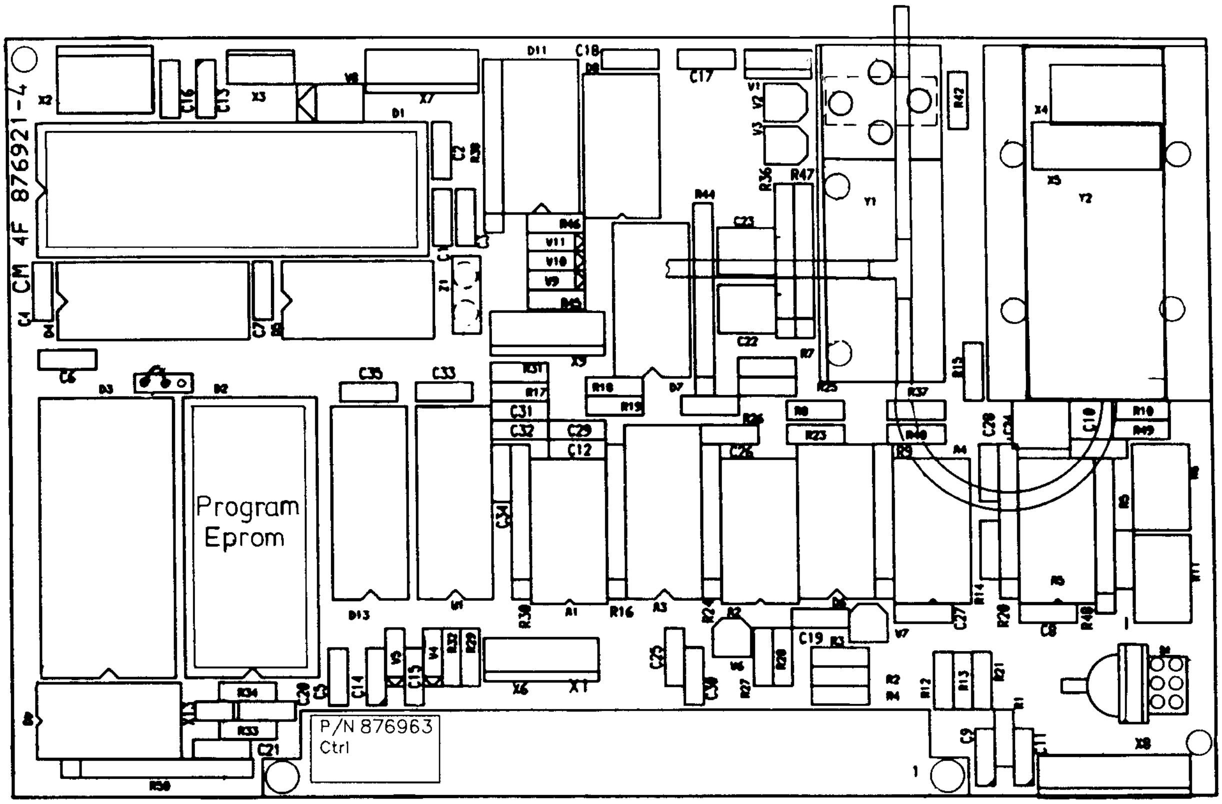
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
TARK.
HYV.

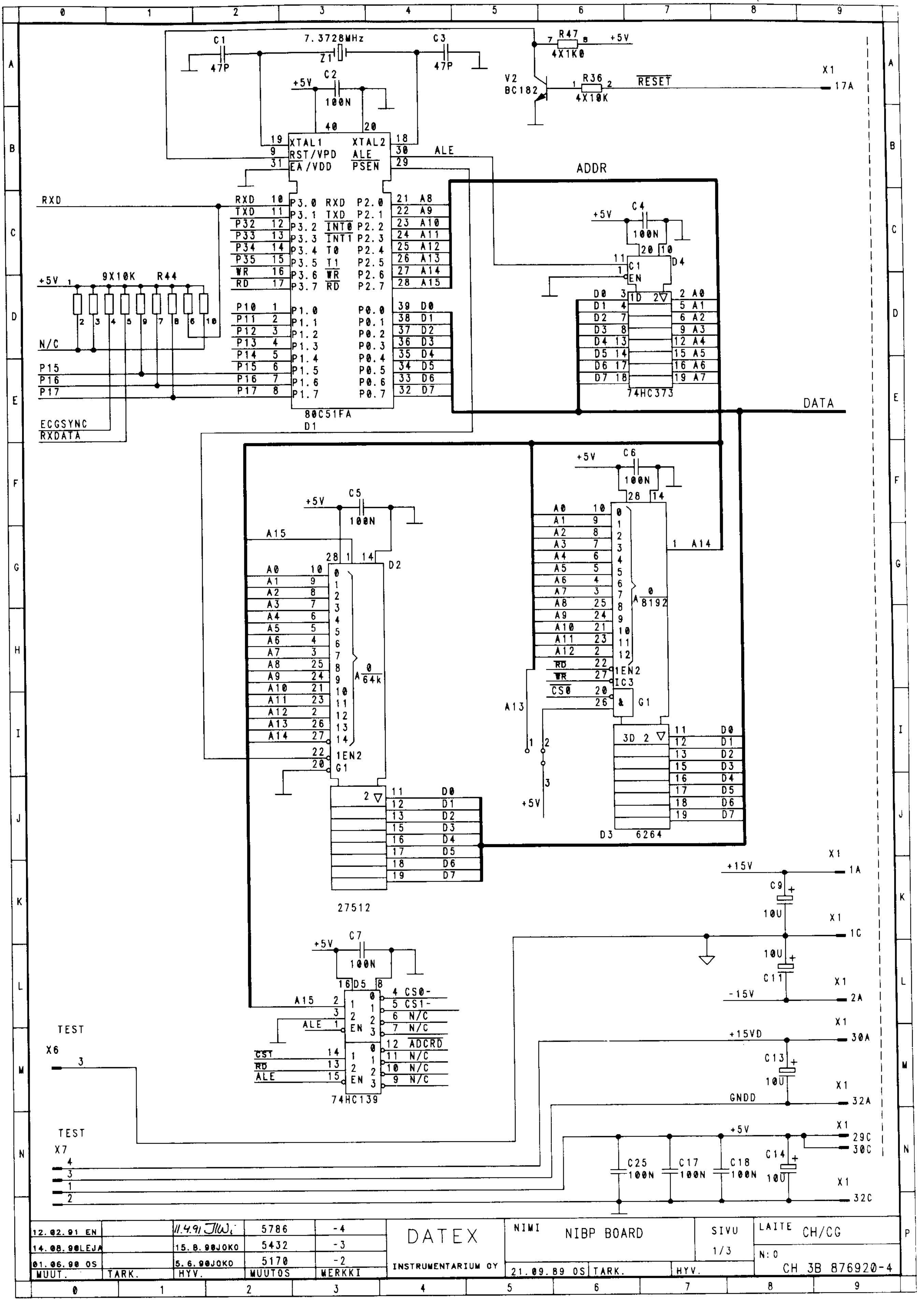


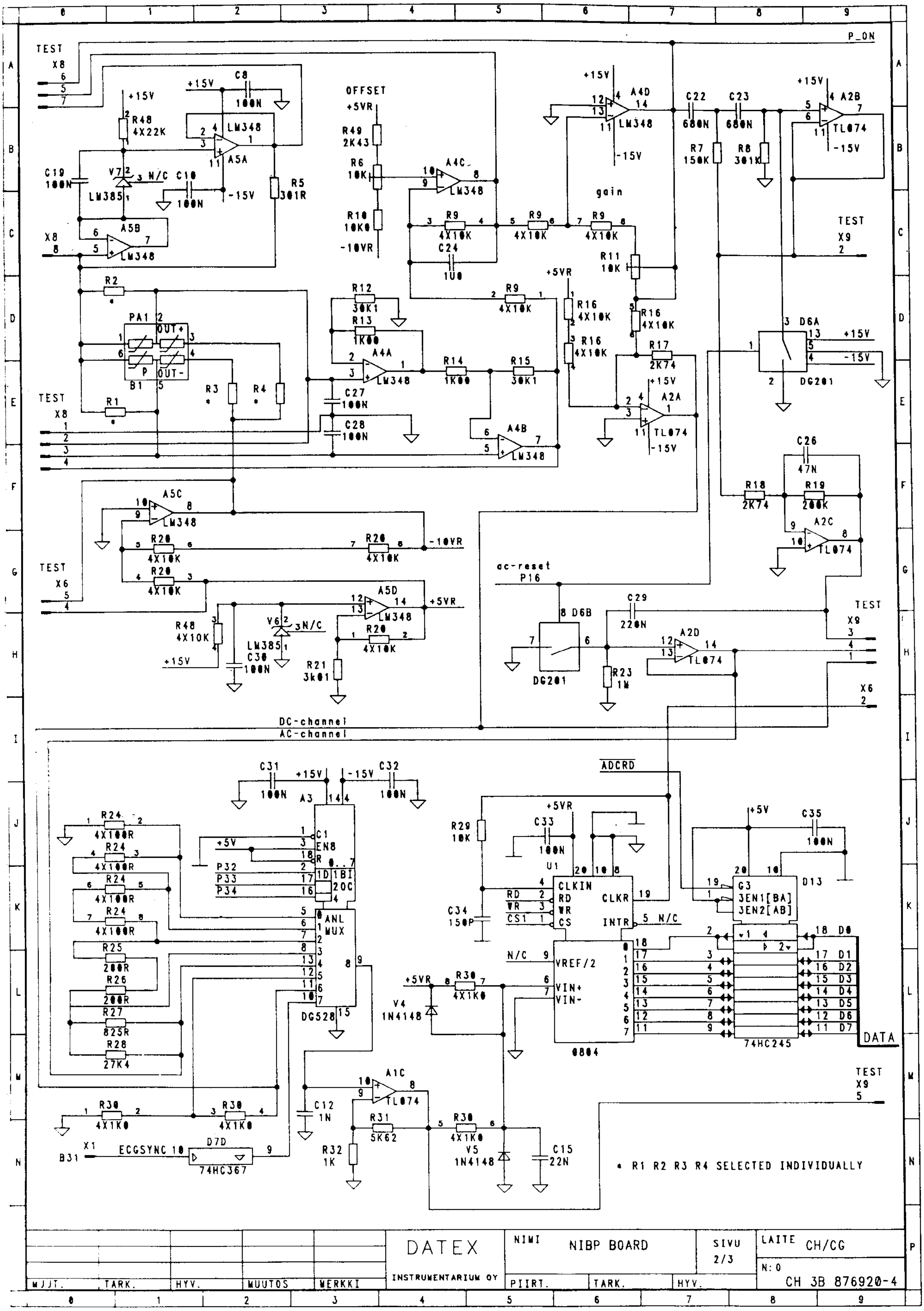
X1 A23
RXDATA
D7B
74HC367
RXD
X1 C23
TXDATA
D7C
74HC367
TXD
wdog-reset
+5V
9X10K
R50
N/C
TEST
X7
R33
56K2
C21
100N
C20
68N
R34
121K
RS
N/C
D9
4541
X13
74HC02
P15
D8A
-10VR
R40
10K
P_ON
+15V
A1A
TL074A
-15V
R45
10K
V9
1N4148
V10
4V7
R37
825R
TEST
X9
P17
power off
74HC02
D8B
R47
4X1K0
+15VD
R36
4X10K
V3
BC182
V1
BD678
D8C
74HC02
P35
D8D
74HC02
+5V
8X3K3
R38
Y1
Y2
EXAUST
VALVE
BLEED
VALVE
R46
56K2
V11
4V7
X3
MAGN.
VALVES
X2
PUMP
N/C
P10
P11
P12
P13
P14
D11
MC1413P
R42
47R5
D7A
74HC367
GNDD
DARLINGTON
DRIVER
V8
MPTE-15
C16
1U0
X4
(OPTION)
X5
(OPTION)
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
DATEX
NIMI
NIBP BOARD
PIIRT.
TARK.
HYV.
SIVU
3/3
LAITE
CMX-104
N:O
CM 3B 876920-3

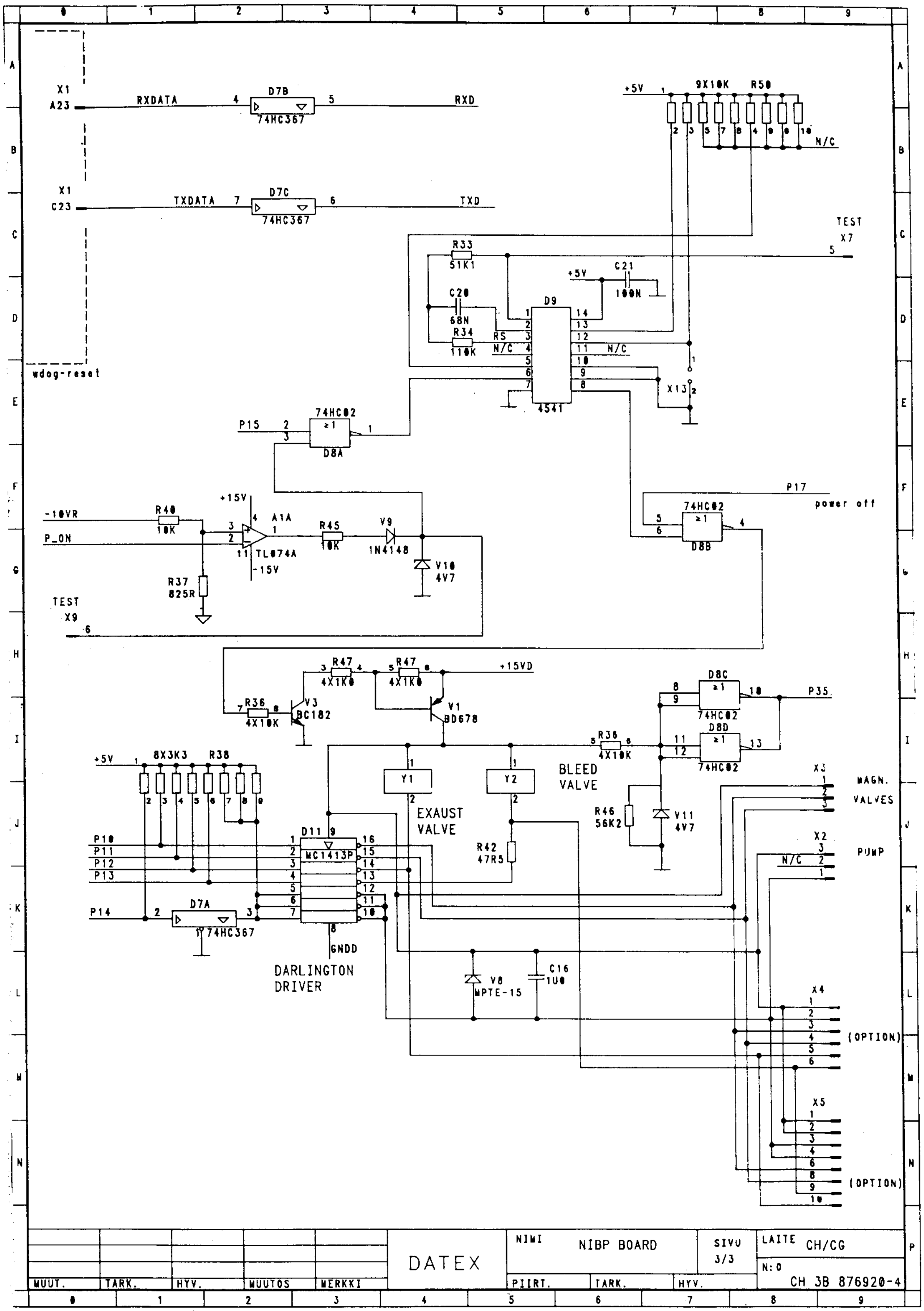
Figure 5.11 **NIBP board parts layout and schematic diagram (part 1) (board modification level 5 and higher)**

Figure 5.11a (on the next page)
NIBP board schematic diagram (part 2)
(board modification level 5 and higher)




7.3728MHz
C1
47P
C3
47P
Z1
C2
100N
+5V
R47
4X1K0
V2
BC182
R36
4X10K
RESET
X1
17A
XTAL1
XTAL2
RST/VPD
ALE
EA/VDD
PSEN
ADDR
RXD
TXD
P32
P33
P34
P35
WR
RD
9X10K
R44
N/C
P15
P16
P17
ECGSYNC
RXDATA
80C51FA
D1
C4
100N
74HC373
D4
DATA
C6
6264
D3
C5
A15
A14
A13
D2
27512
C7
74HC139
D5
CS0-
CS1-
ADCRD
CST
TEST
X6
X7
+15V
C9
10U
1A
1C
C11
-15V
2A
+15VD
30A
C13
GNDD
32A
29C
30C
C25
C17
C18
C14
32C
12.02.91 EN
14.08.90LEJA
01.06.90 OS
MUUT.
TARK.
15.8.90JOKO
5.6.90JOKO
HYV.
5786
5432
5170
MUUTOS
-4
-3
-2
MERKKI
DATEX
INSTRUMENTARIUM OY
NIMI
NIBP BOARD
21.09.89 OS
SIVU
1/3
LAITE
CH/CG
N:O
CH 3B 876920-4


P_ON
TEST
OFFSET
gain
DC-channel
AC-channel
ac-reset
ADCRD
ECGSYNC
DATA
* R1 R2 R3 R4 SELECTED INDIVIDUALLY
DATEX
INSTRUMENTARIUM OY
NIMI
NIBP BOARD
SIVU
2/3
LAITE
CH/CG
N:O
CH 3B 876920-4
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.



X1 A23
RXDATA
D7B
74HC367
RXD
X1 C23
TXDATA
D7C
74HC367
TXD
wdog-reset
+5V
9X10K R50
N/C
TEST X7
R33 51K1
C20 68N
R34 110K
RS
N/C
+5V
C21 100N
D9
4541
X13
74HC02
P15
D8A
P17
power off
74HC02
D8B
-10VR
P_ON
R40 10K
+15V
A1A
TL074A
-15V
R45 10K
V9 1N4148
V10 4V7
R37 825R
TEST X9
R47 4X1K0
R47 4X1K0
+15VD
R36 4X10K
V3 BC182
V1 BD678
D8C 74HC02
P35
R38 4X10K
D8D 74HC02
+5V
8X3K3 R38
Y1
Y2
BLEED VALVE
EXAUST VALVE
X3 MAGN. VALVES
R46 56K2
V11 4V7
X2 PUMP
N/C
P10
P11
P12
P13
P14
D11
MC1413P
R42 47R5
D7A
74HC367
GNDD
DARLINGTON DRIVER
V8 MPTE-15
C16 1U0
X4 (OPTION)
X5 (OPTION)
DATEX
NIMI NIBP BOARD
SIVU 3/3
LAITE CH/CG
N:O
CH 3B 876920-4
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
TARK.
HYV.

5.4.2 Pneumatic unit

The pneumatic unit includes three damping chambers and two magnetic valves.

Damping chamber I

The damping chamber I prevents a rapid increase of pressure caused by the pump.

Choke

A choke is used to slow down the pressure change in infant measurement.

Damping chamber II

The damping chamber II is used with small cuff sizes to increase volume so that the pressure can be precisely adjusted.

Damping chamber III

The damping chamber III smooths down rapid pressure pulses caused by the bleed valve.

Shunt valves

If the cuff volume is too small, the two shunt valves open and connect damping chamber II to the blood pressure circuit.

5.4.3 NIBP air pump

The NIBP air pump module contains a membrane type pump and a DC motor. The module is enclosed in a separate foam rubber-filled case to attenuate noise.

5.4.4 Safety valve

The NIBP is equipped with a separate mechanical safety valve to prevent accidental cuff over-pressurization. The valve operates nominally at 330 mmHg.

The safety valve is checked by connecting a hand pump with a manometer to it and pumping slowly until the valve opens. It should open at 300-330 mmHg.

5.4.5 NIBP tubing

The pneumatic components are assembled together as shown in Figure 9.3.

WARNING: PATIENT SAFETY: It is important to attach the tube from pressure transducer to the inner connector of the NIBP-connector and the tube from the pneumatic unit is attached to the outer connector of the NIBP-connector. Reversing the tubes will inhibit deflation of the infant cuff.

5.4.6 Twin hose

The twin hose is used to connect cuffs to the monitor. The choke which is designed for infant measurement is located in the infant adapter (USA) or inside the input port of the infant twin hose (all others). The monitor automatically detects the hose type in use.

5.4.7 Blood pressure cuff

The NIBP measuring unit is designed to operate with seven different standard blood pressure cuffs. The cuff sizes are as follows:

CUFF SIZE	CUFF
LARGE ADULT	15 cm
NORMAL ADULT	12 cm
SMALL ADULT	9 cm
CHILD	6 cm
INFANT	5 cm
INFANT	3 cm

5.5 SpO_2 Measurement

SpO_2 measurement is included in models 2S, RS, 1RS, and S.

5.5.1 SpO_2 Measuring Board

The board is intended to perform the following tasks:

Control the LED light sources of the sensor.

Amplify the signal coming from the detector and separate the red and infrared signal components to respective channels.

Multiplex in both channels the alternating component of the signal (plethysmographic pulse) with the signal proportional to the total intensity measured with the respective wavelength.

Provide isolated output from the multiplexer channels (red channel and IR channel) to the SpO_2 Processor board.

Power supply

The isolated power supply consists of the following functional blocks:

- 32,768 Hz oscillator.
- Half-bridge converter with isolation transformer.
- Stabilization and filtering of the output voltages with linear regulators.
- Protection of the overloading with PTC-type thermistor.

Timing/LED control

The timing pulses are produced by a PAL (Programmable Array Logic) D3. The input signal for D3 (SYNC.) is taken from the switching power supply as a 32,768 Hz square wave. All timing signals are synchronized at this switching frequency. The timing circuit controls the LED driver circuitry (signals LED_R and LED_{IR}), the RC time constants in amplifier chain (MEASURE) and sampling ($SAMPLE_R$, $SAMPLE_{IR}$) (Figure 5.14).

Referring to Figures 5.13 and 5.14, the LEDs in the sensor are driven with constant current pulses, (90 or 300 mA). The pulse duration and duty cycle can be seen in timing diagram in Figure 5.13. A positive voltage pulse at 1/X1 corresponds to the red LED current and a negative one to the IR-LED, respectively.

Detector signal processing

The signal produced by the detector is a current. The first amplifier stage is a current-to-voltage converter. A signal current passes through the resistors between pins 13 and 14 of A3 and produces a negative voltage pulse at 14/A3. Notice that the part of the feedback resistance is located in the sensor connector.

The bias voltage of the detector (4.2V) is the voltage difference between the connector pins 3/X1 (5V) and 5/X1 (0.8V).

At 8/A3 the detected voltage pulses are inverted to positive value.

The digitally controlled amplifier is a Digital to Analog Converter (DAC), D5. The signal is fed to the reference input of D5. The 8-bit digital control word is transferred over the patient isolation barrier in serial mode (PA2) and is converted into parallel mode by a shift register D4. The signal level at the output, 7/A3, is adjusted to 3 to 8 V by the CPU.

The amplified signal pulses are separated to red and infrared channels by sample-and-hold circuitry (S/H). Voltages VR and VIR are proportional to the total intensity of the light detected at the respective wavelength. VR_{ac} and VIR_{ac} are the amplified alternating components (plethysmographic pulses).

The signals are multiplexed into two channels by a 2 x 4 MUX, A5. Also +5 V and GND are connected to MUX input. The value of the resistor R_C in the sensor connector can be read through the red channel, if needed.

The two output channels of MUX A5 are transferred across the patient isolation by two identical pulse width modulator/optoisolator/demodulator-chains. The frequency of the pulse width modulator is about 20 kHz. The demodulated signal is inverted.

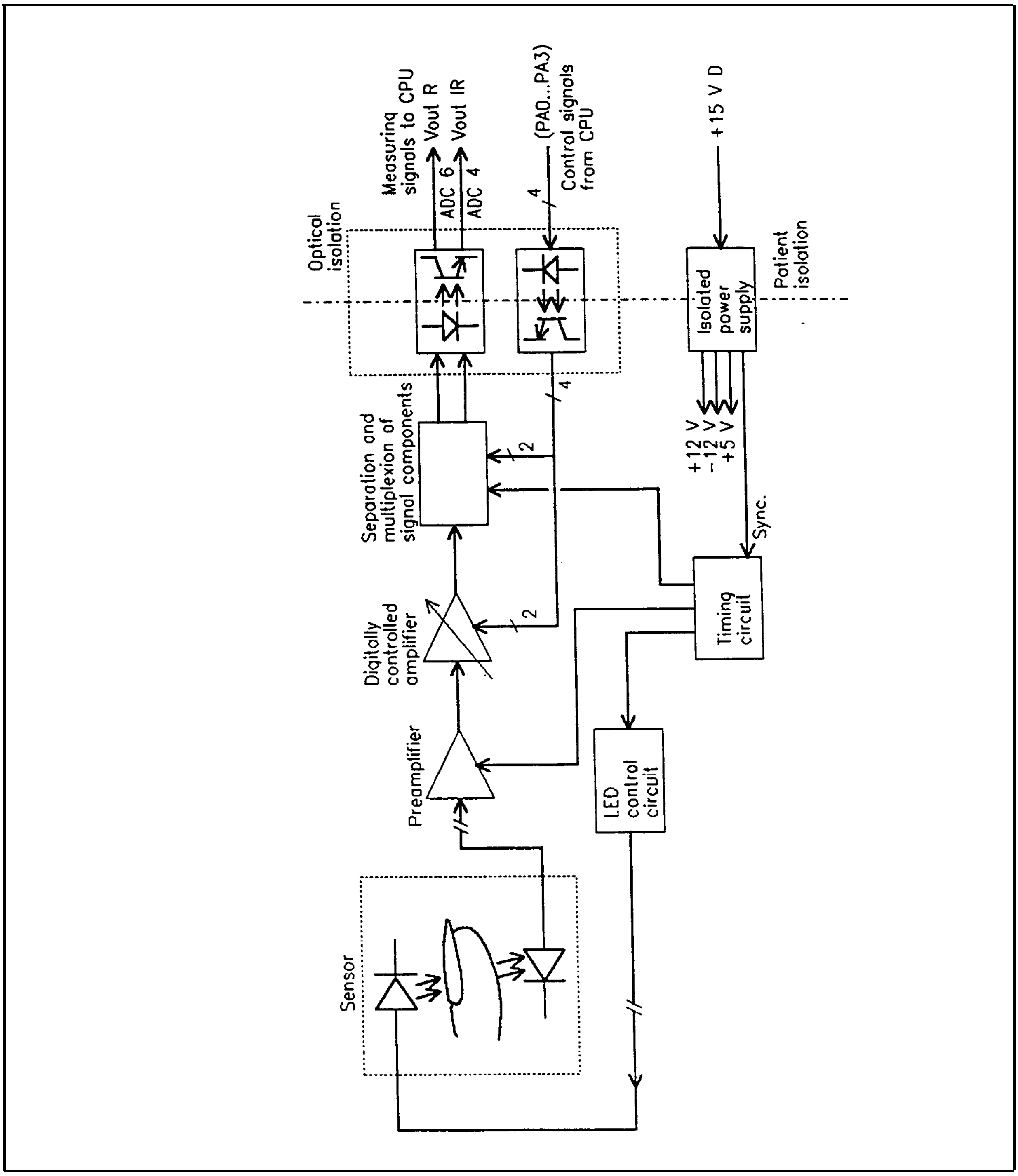
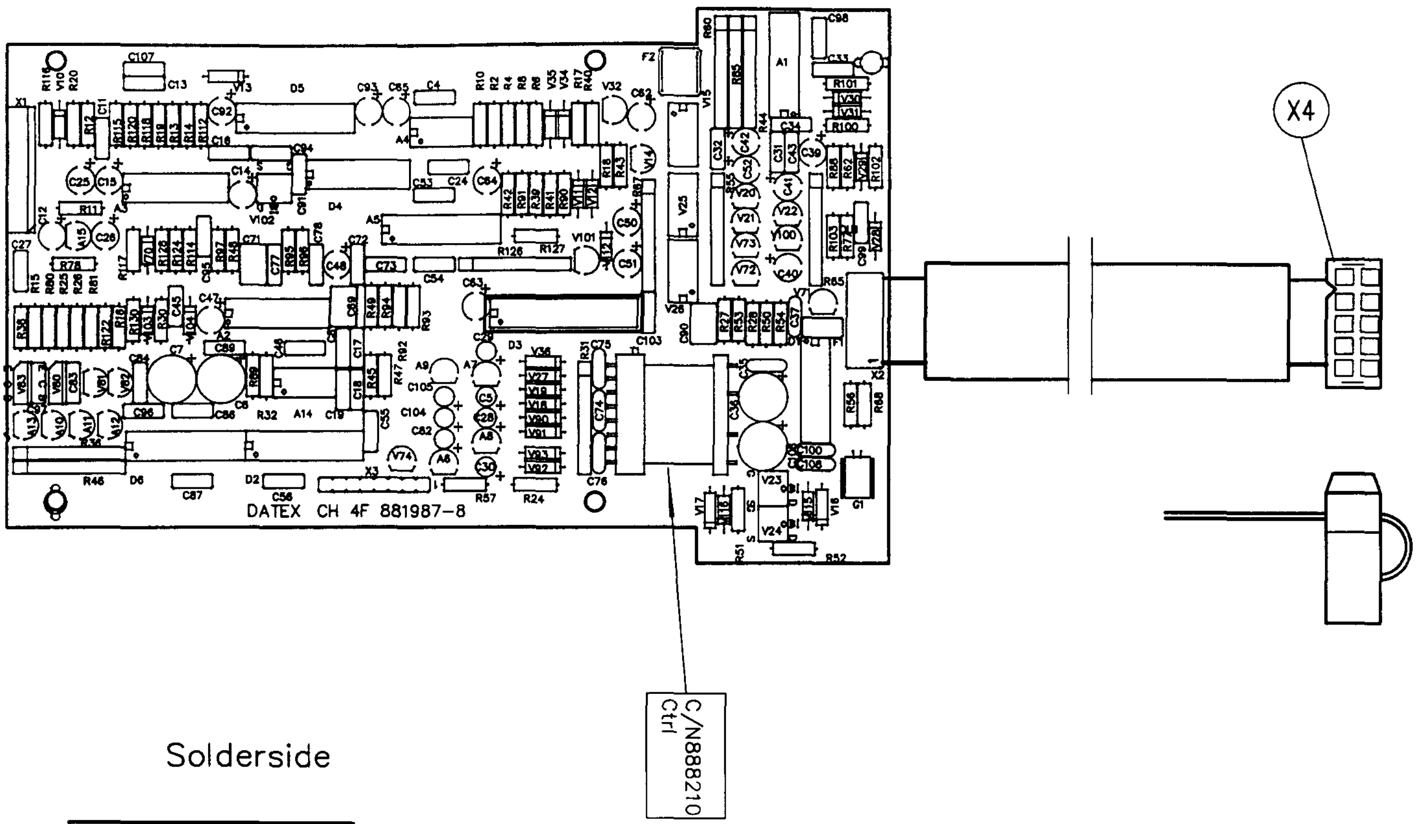
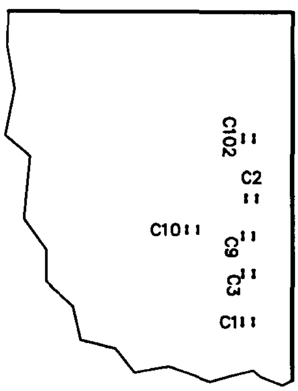


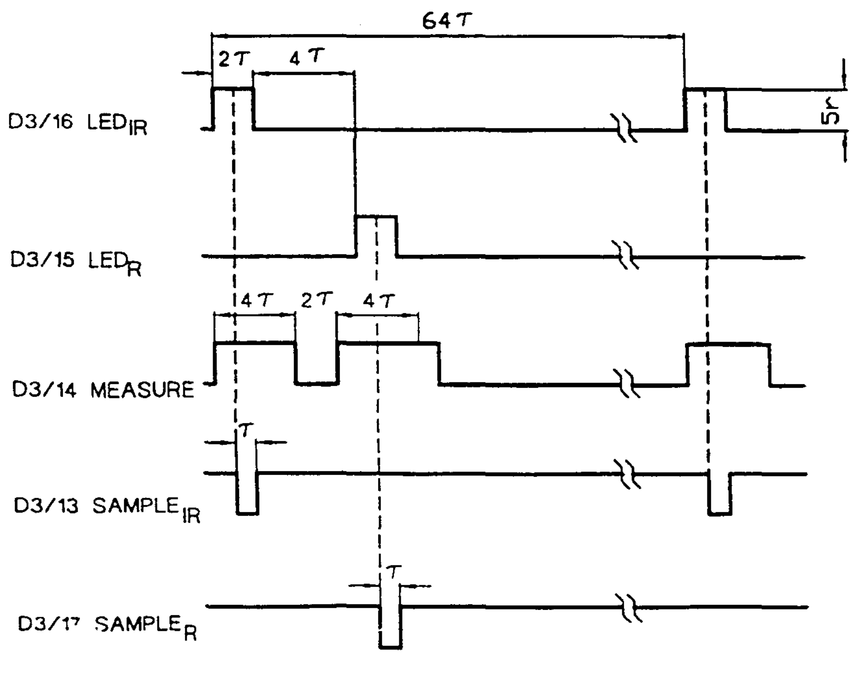
Figure 5.12 SpO_2 measuring board block diagram, parts layout and timing diagram

Figure 5.13 (on the next pages) SpO_2 measuring board schematic diagram

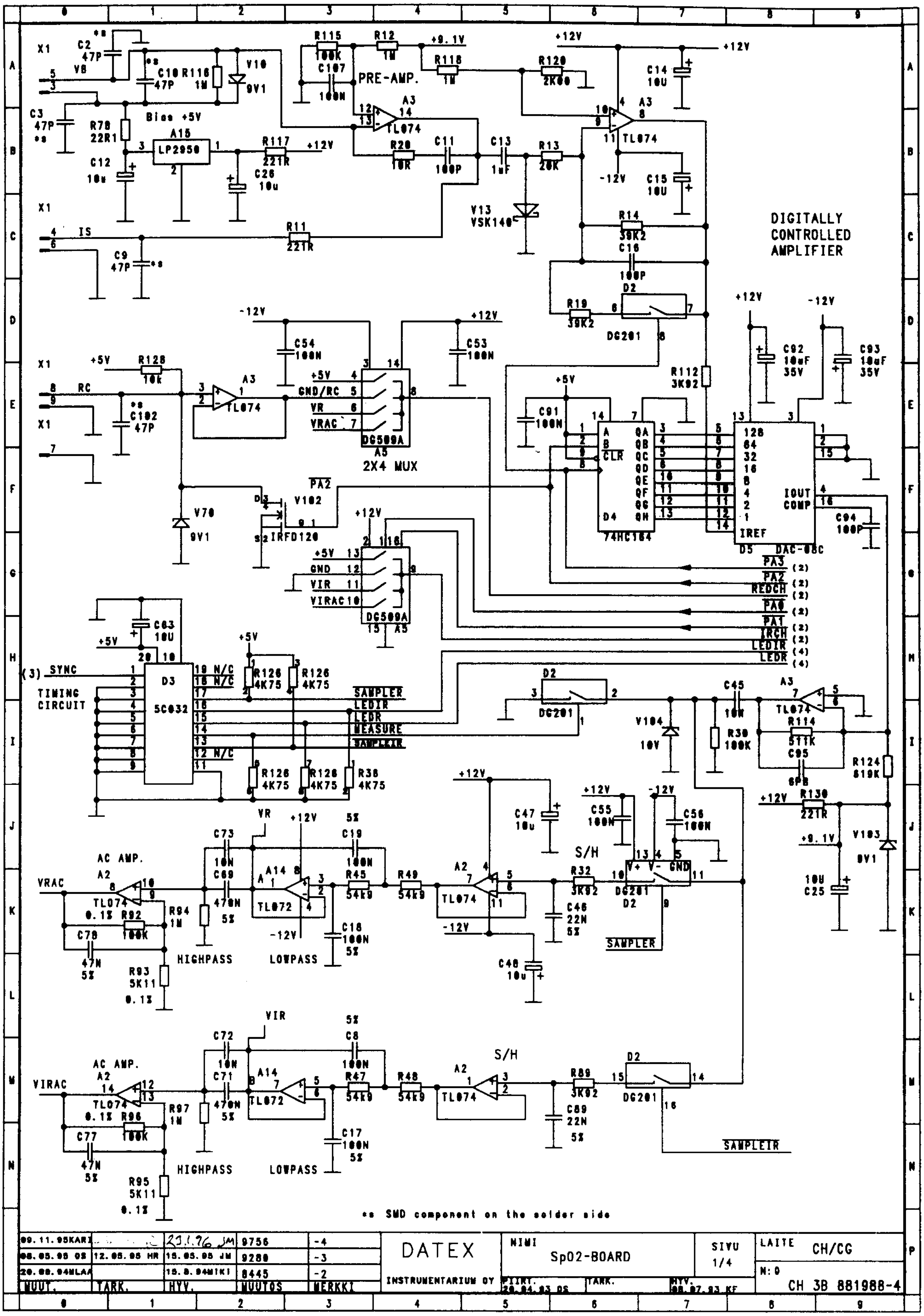


Solderside

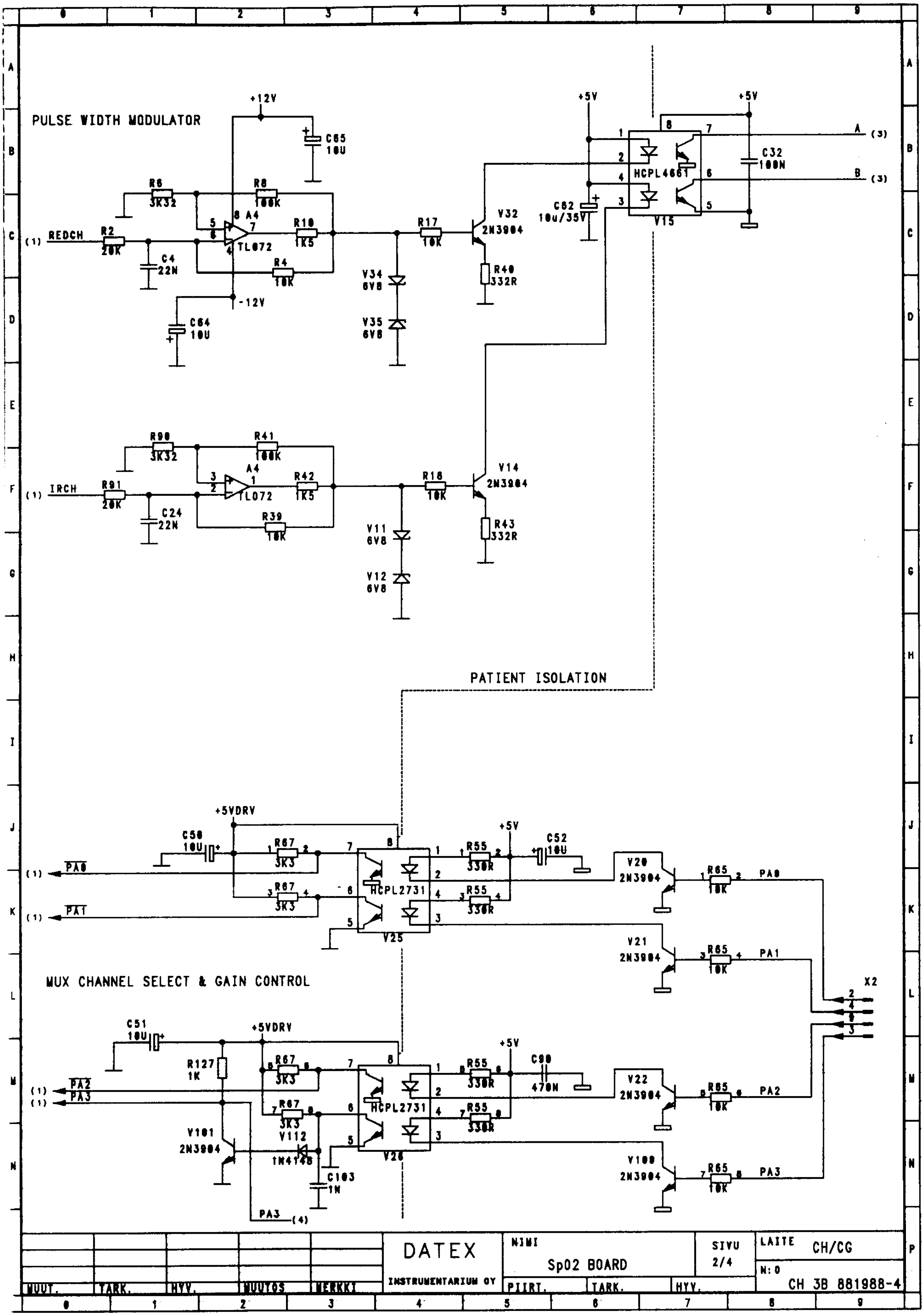


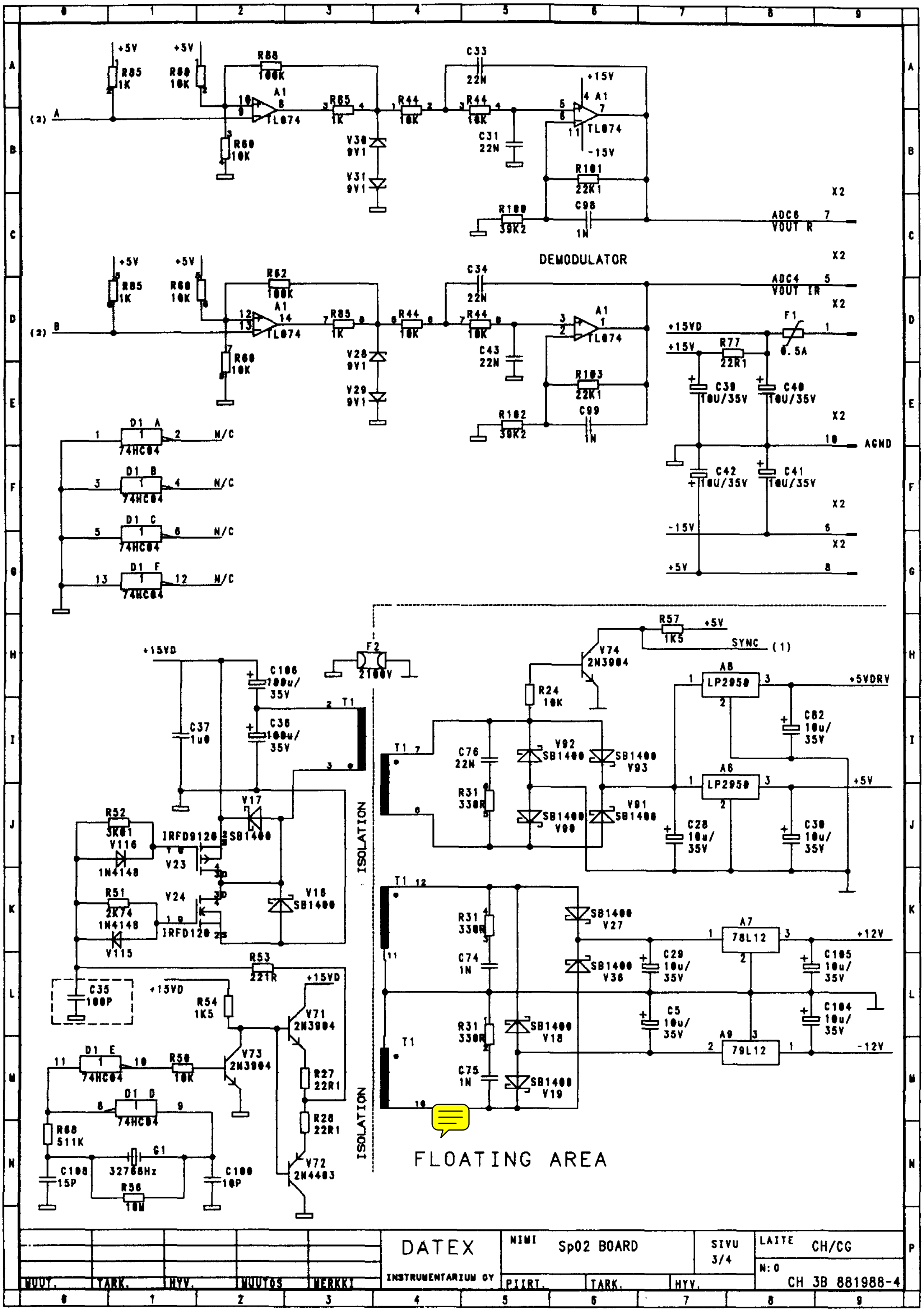


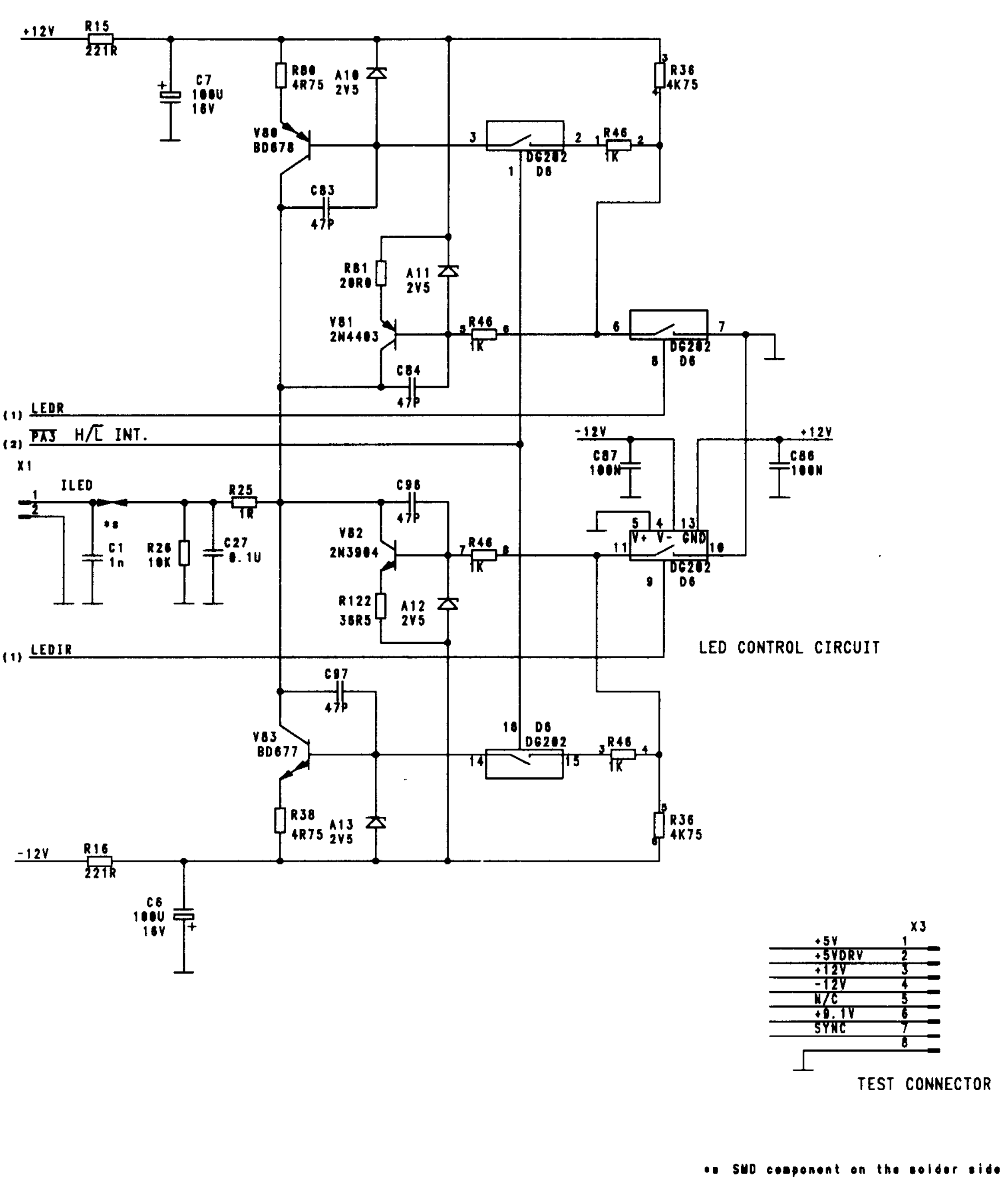
τ = 30,5µs



PRE-AMP.
DIGITALLY
CONTROLLED
AMPLIFIER
2X4 MUX
TIMING
CIRCUIT
AC AMP.
HIGHPASS
LOWPASS
S/H
*s SMD component on the solder side
DATEX
INSTRUMENTARIUM OY
NIMI
SpO2-BOARD
SIVU
1/4
LAITE
CH/CG
CH 3B 881988-4


PULSE WIDTH MODULATOR
REDCH
IRCH
TL072
2N3904
HCPL4661
PATIENT ISOLATION
MUX CHANNEL SELECT & GAIN CONTROL
HCPL2731
+5VDRV
DATEX
INSTRUMENTARIUM OY
NIMI
SpO2 BOARD
SIVU
2/4
LAITE
CH/CG
N:0
CH 3B 881988-4
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.

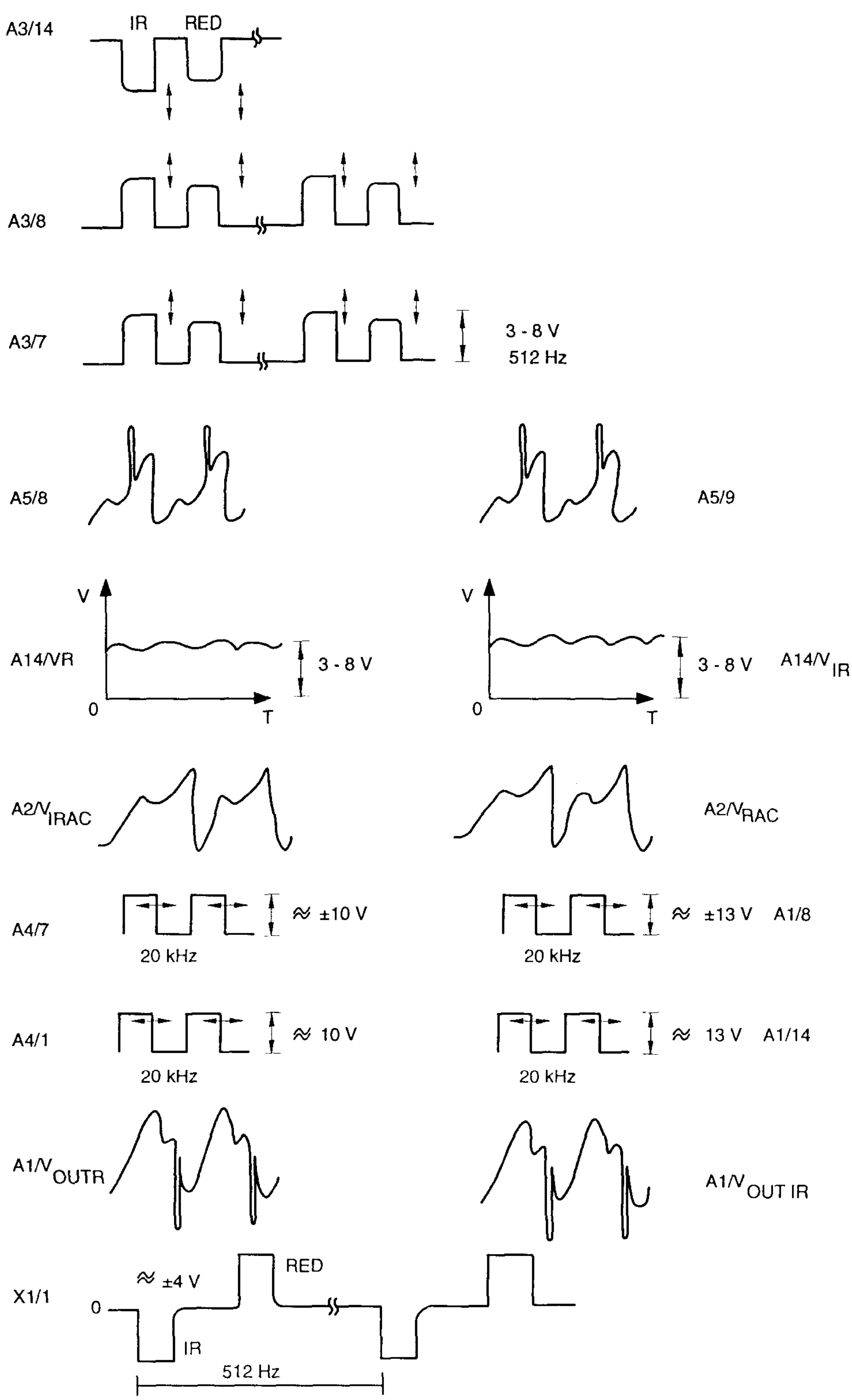

DEMODULATOR
ISOLATION
FLOATING AREA
DATEX
INSTRUMENTARIUM OY
NIMI Sp02 BOARD
SIVU 3/4
LAITE CH/CG
N:0
CH 3B 881988-4



*s SMD component on the solder side

MUUT.	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI Sp02 BOARD	SIVU 4/4	LAITE CH/CG
						PIIRT. TARK. HYV.		N:O CH 3B 881988-4

Figure 5.14 SpO_2 measuring board signal waveforms



5.5.2 SpO_2 Processor Board

The SpO_2 processor board accepts the multiplexed signal from the SpO_2 measuring board, converts the signal to digital data, processes the information and transmits the data to the main CPU.

The SpO_2 processor board (see Figure 5.15) contains, the 8031 CPU, EPROM, RAM, the parallel interface circuit, analog multiplexer/demultiplexer, and the analog/digital converter.

The CPU uses the internal bus to access most of the peripheral circuits. CPU port 1 is used to control the analog multiplexer (A3). The serial channel 0 (ASCII computer output) is not used on this board.

The two memory chips are jumper selected for 27256 program EPROM, 8 x 8 kbit low current CMOS RAM 5564 powered by the data retention voltage.

SpO_2 input

The analog signals from the SpO_2 measuring board are sent to an analog MUX, A3 that is used as a demultiplexer. The output goes to a sample/hold circuit and then transmitted to the A/D converter, the output of which is put on to the data bus.

SpO_2 processor board output

The SpO_2 data is transmitted to the main CPU through the 8255 PPI. In addition, the measuring board MUX and DAC control signals are also sent through the PPI.

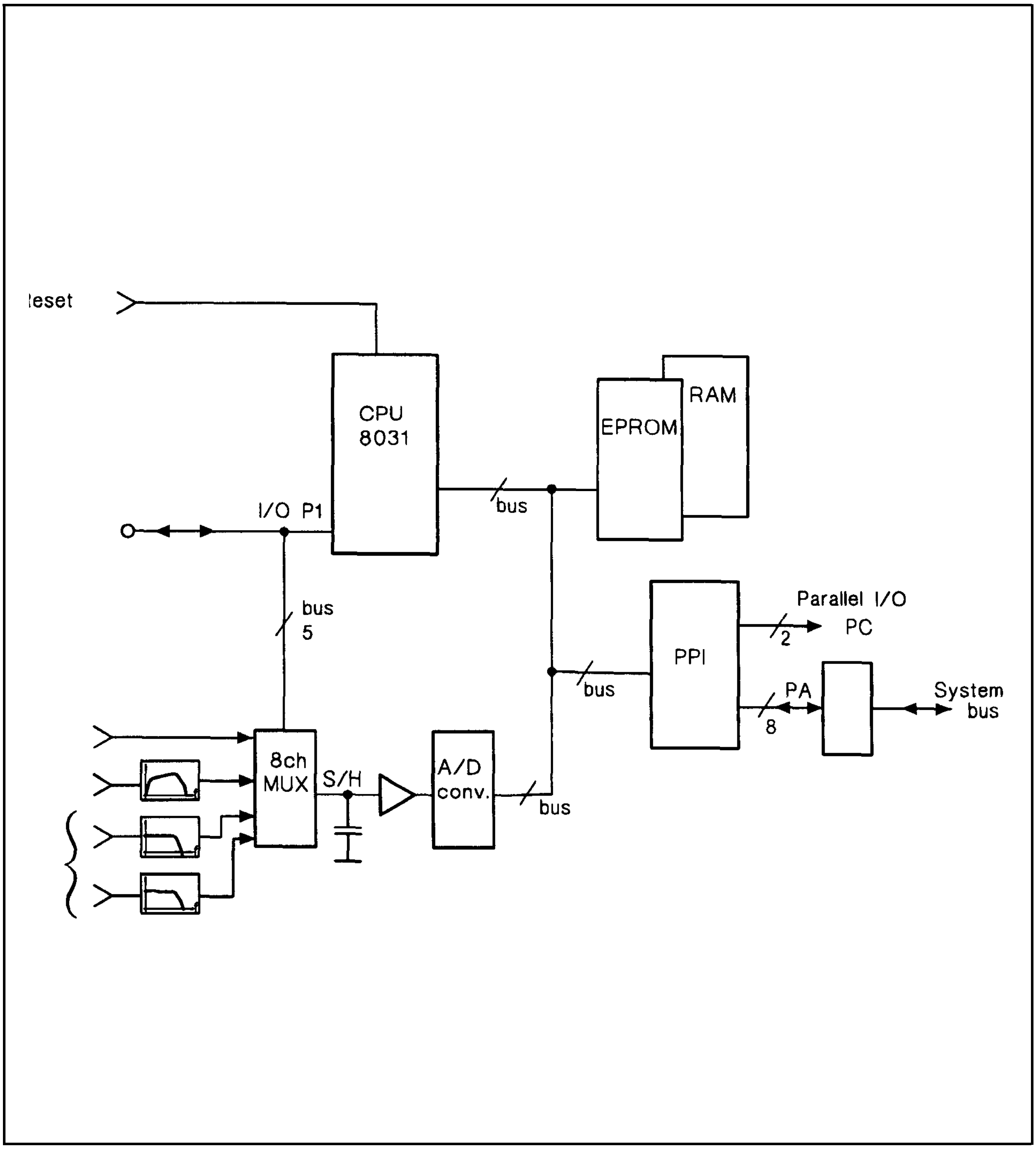
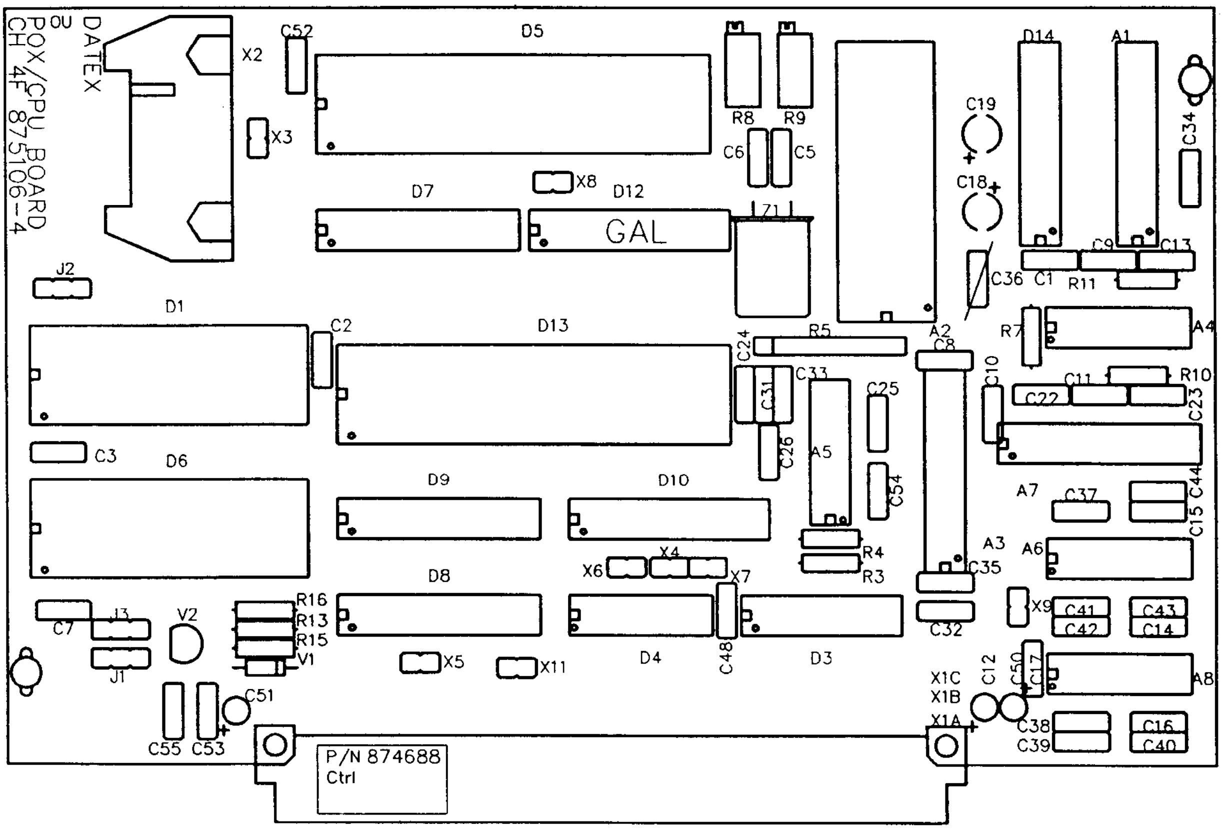
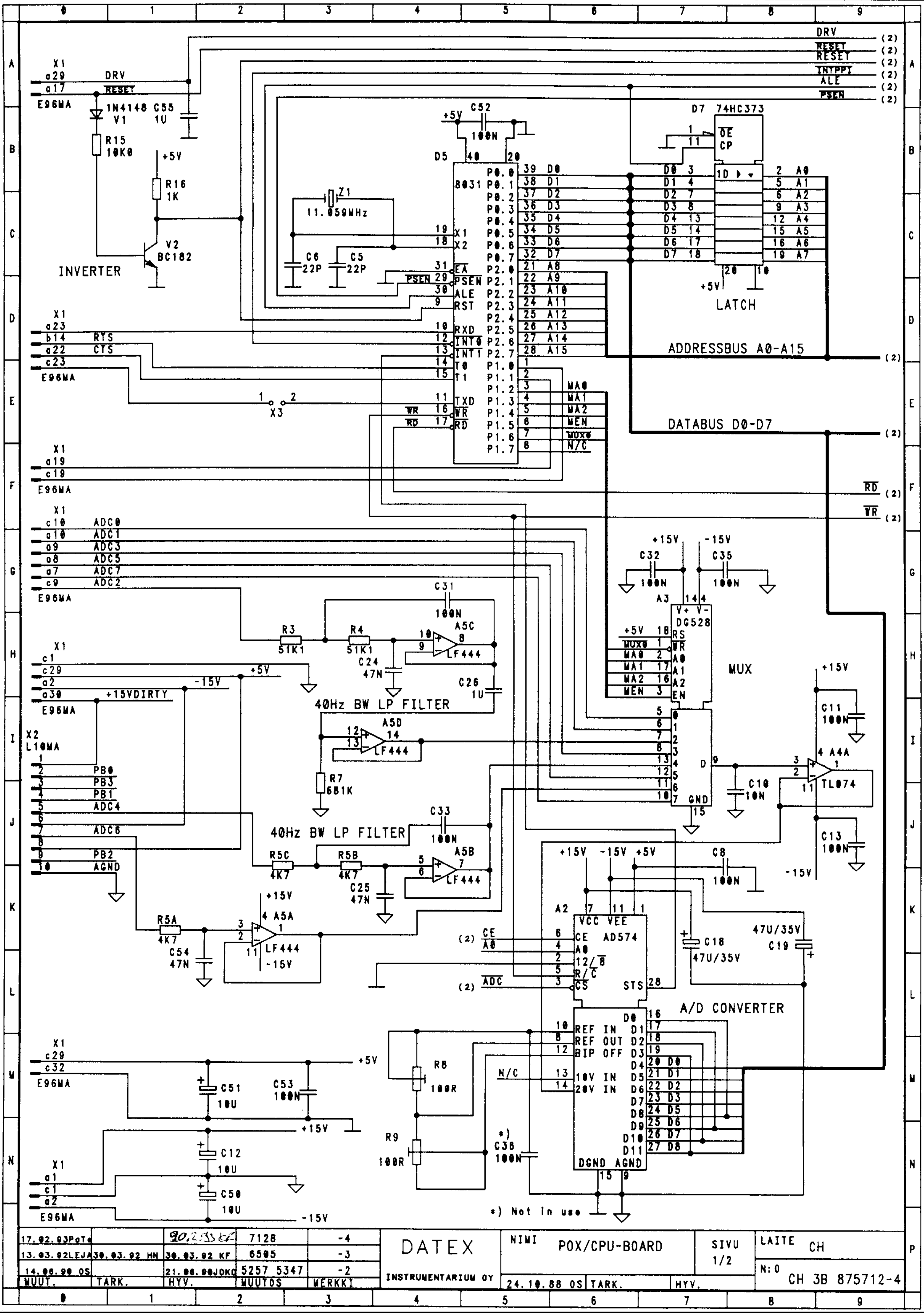


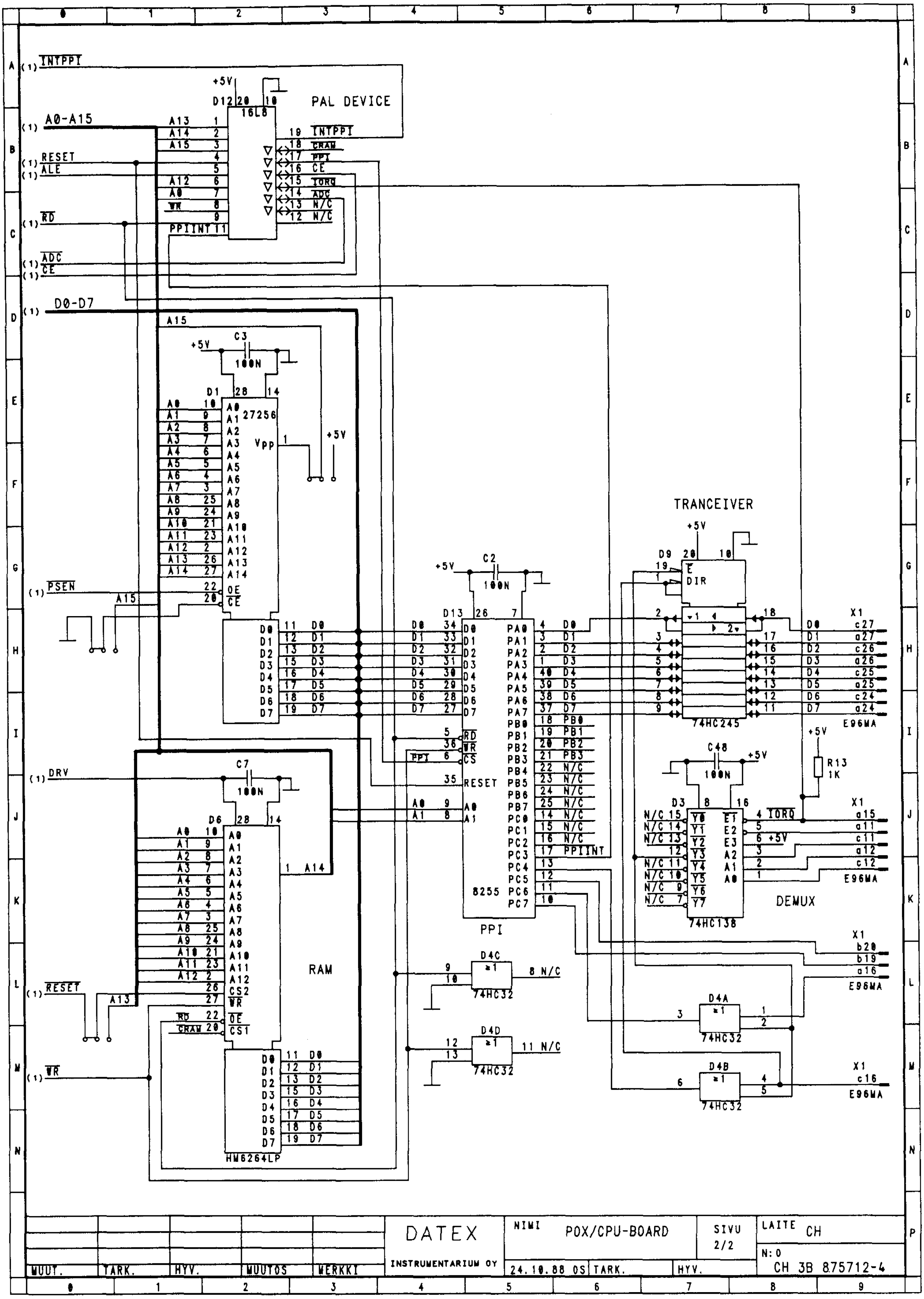
Figure 5.15 SpO_2 processor board block diagram and parts layout (board modification level 6 and higher)

Figure 5.16 (on the next page)
SpO_2 processor board schematic diagram
(board modification level 6 and higher)



DATEX
POX/CPU BOARD
CH 4F 875106-4
OU
P/N 874688
Ctrl
GAL


DATEX
INSTRUMENTARIUM OY
NIMI POX/CPU-BOARD
SIVU 1/2
LAITE CH
N:O CH 3B 875712-4
24.10.88 OS
ADDRESSBUS A0-A15
DATABUS D0-D7
LATCH
MUX
A/D CONVERTER
INVERTER
40Hz BW LP FILTER
*) Not in use



PAL DEVICE
16L8
D12
INTPPI
A0-A15
RESET
ALE
RD
ADC
CE
D0-D7
PPIINT
CRAM
PPI
IORQ
N/C
27256
D1
C3
100N
+5V
Vpp
PSEN
A15
D13
C2
8255
PPI
RESET
TRANCEIVER
D9
DIR
74HC245
X1
E96MA
C48
R13
1K
D3
74HC138
DEMUX
DRV
C7
D6
RAM
HM6264LP
WR
A13
A14
D4C
D4D
D4A
D4B
74HC32
DATEX
INSTRUMENTARIUM OY
NIMI
POX/CPU-BOARD
SIVU
2/2
LAITE
CH
N:0
CH 3B 875712-4
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
24.10.88 OS

5.6 CPU Board

The high speed CPU board contains 16 MHz oscillator to replace that of 11,059 MHz. Serial I/O signals that used the CPU's own channel in the previous CPU board are changed and they occupy one channel in QUART.

The board contains, in addition to the 80C32 CPU, the standard EPROM, SRAM, and several analog and digital I/O functions. See the CPU board block diagram.

The CPU (D5, refer to Figure 5.18) uses the CPU board internal bus to access most of the peripheral circuits. Processor port 1 is used to control the analog multiplexers (MUX).

Communication with the NIBP board is established in serial mode through QUART (D15) pins 4 (in) and 3 (out).

There are three memory chips on the CPU board. The EPROM D1, 1M bit or 4M bit, is jumper selected, see table 5.19, 32 x 8 kbit low current CMOS SRAM (D6) powered by the data retention voltage, and battery back-up 8 kbit SRAM (D4) for permanent calibration value memory. This IC has also a built-in Real Time Clock. The lifetime of the battery inside the IC is minimum 10 years. If the SRAM is defective or the battery is dead the monitor gives warnings every 30 seconds. Please refer to section 6, Troubleshooting in general. See the jumper configuration.

The 16 MHz oscillator clock is first passed through control logic circuit (D2, D16, and D19), which is for wait state control, and fed to the CPU.

When a key is pressed (short-circuit) keyboard scanner (D9) interrupts the microprocessor and this reads from the scanner which key was pressed.

Input signal processing

The analog input signals from the IPT, ECG, and RESP (if used) boards are read through the multiplexer (A3) to a sample and hold circuit and to the A/D-converter A2.

Output signal processing

Up to eight analog signals are sent to the output connectors. Digital patient data is sent to a D/A converter A1 and after conversion, sent to the demultiplexer A7. The eight analog signals produced are sent to sample and hold circuits and then transmitted to the power supply board and the connectors in the back of the monitor.

Control signals of MUX are in port 1 on the microprocessor as follows:

P1	pins 3-5 pin 6 pin 7 pin 8 ADC 0 ADC 2 ADC 4 ADC 6 ADC 7 DAC 2 DAC 4 DAC 5 DAC 6 DAC 7	MUX A0-A2 (both) MUX enable (both) MUX 0 Write (ADC) MUX 1 Write (DAC) IMP. RESP ECG IPT signal PB2 signal EXT INPUT IPT signal ECG TEST Loudspeaker volume PB2 signal Loudspeaker pitch

Ports on the PPI is used for as follows:

PA (output)	PB (input)	PC (low input,high output)
PA0: IPT control	PB0: not used (AUX)	PC0: -ECG INOP
PA1: IPT control	PB1: not used (AUX)	PC1: PB2 INOP
PA2: IPT control	PB2: RESP INOP	PC2: not used
PA3: not used	PB3: CD	PC3: Normocap signal
PA4: not used	PB4: DSR	PC4: RESP identification
PA5: not used (AUX)	PB5: CTSB (AUX)	PC5: not used
PA6: not used (AUX)	PB6: CTSA (AUX)	PC6: not used
PA7: Nurse call (AUX)	PB7: RESP ident.	PC7: not used

When a key is pressed (short-circuit) keyboard scanner (D9) interrupts the microprocessor and this reads from the scanner which key was pressed.

The 16 MHz oscillator clock is first passed through control logic circuit (D2, D16, and D19), which is for wait state control, and fed to the CPU.

Because of slowness of the some internal peripheral circuits, their bus (IODATA) is separated from the high speed bus (DATA) by D18. Function of real time clock is included in battery back-up SRAM (D4).

Software features are described in the Operator's Manual and main differences between software revisions in Section 3.4.

CAUTION: The SRAM IC (D4) contains a lithium battery. Danger of explosion if IC is incorrectly replaced. Replace only with same or equivalent type recommended by DATEX-ENGSTROM. Do not dispose of faulty IC:s in fire. IC should be disposed of according to local regulations.

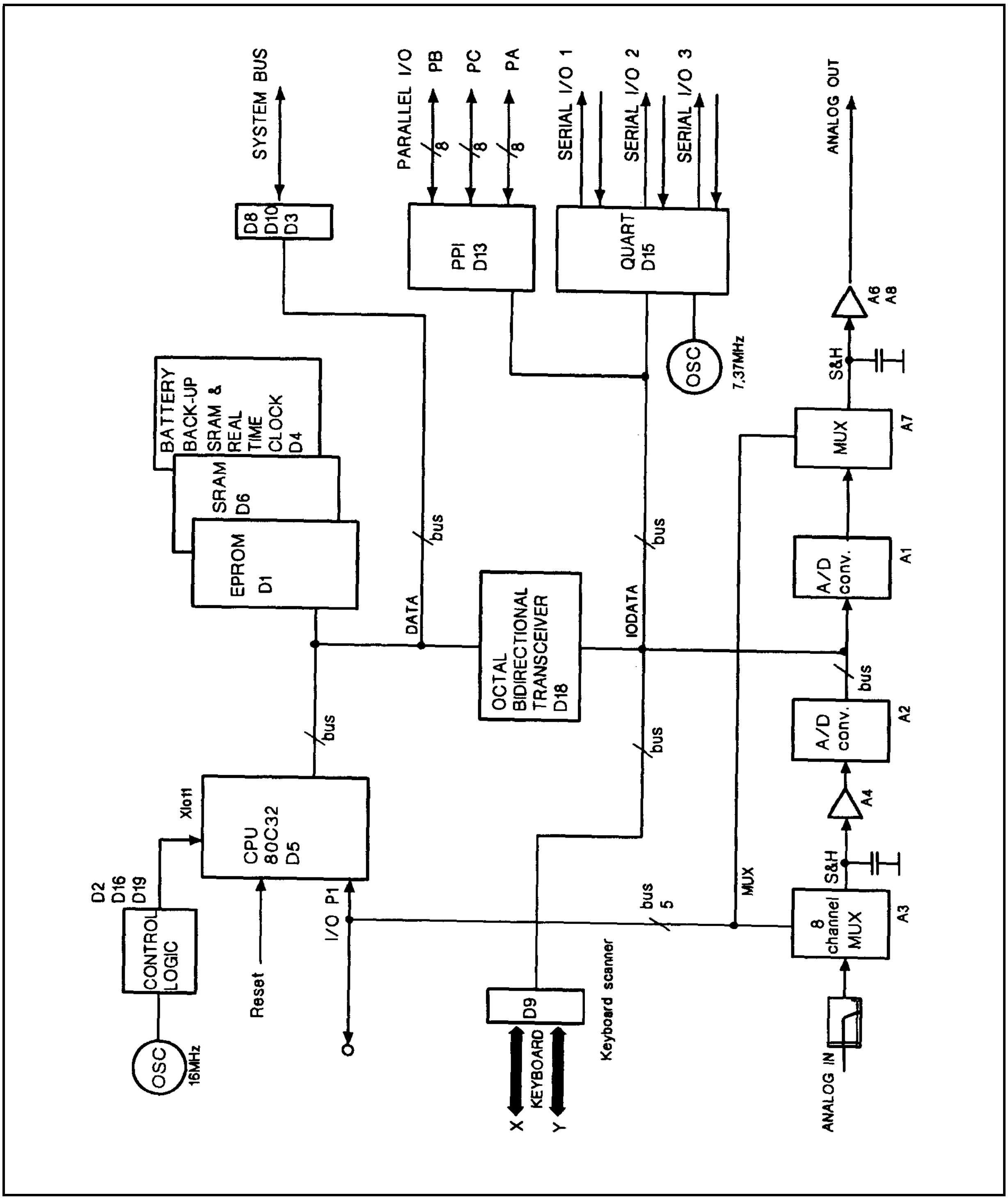
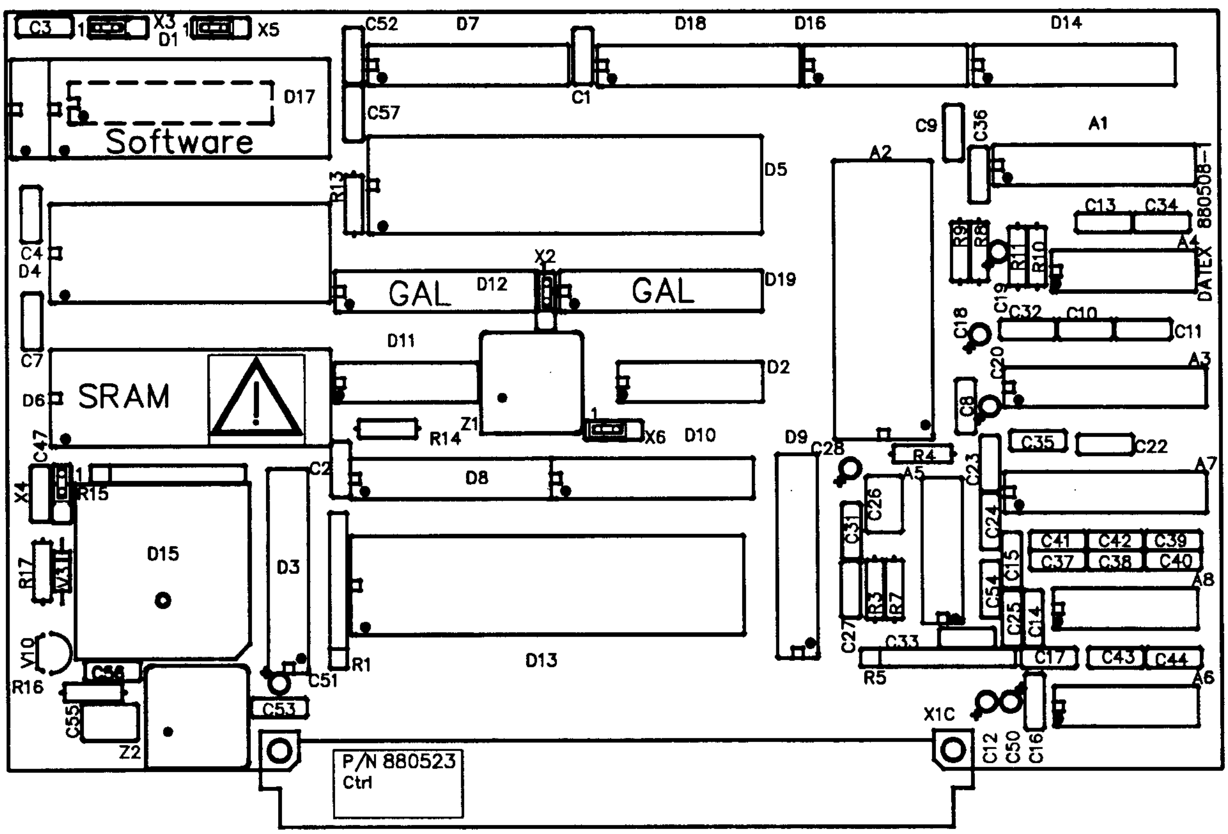
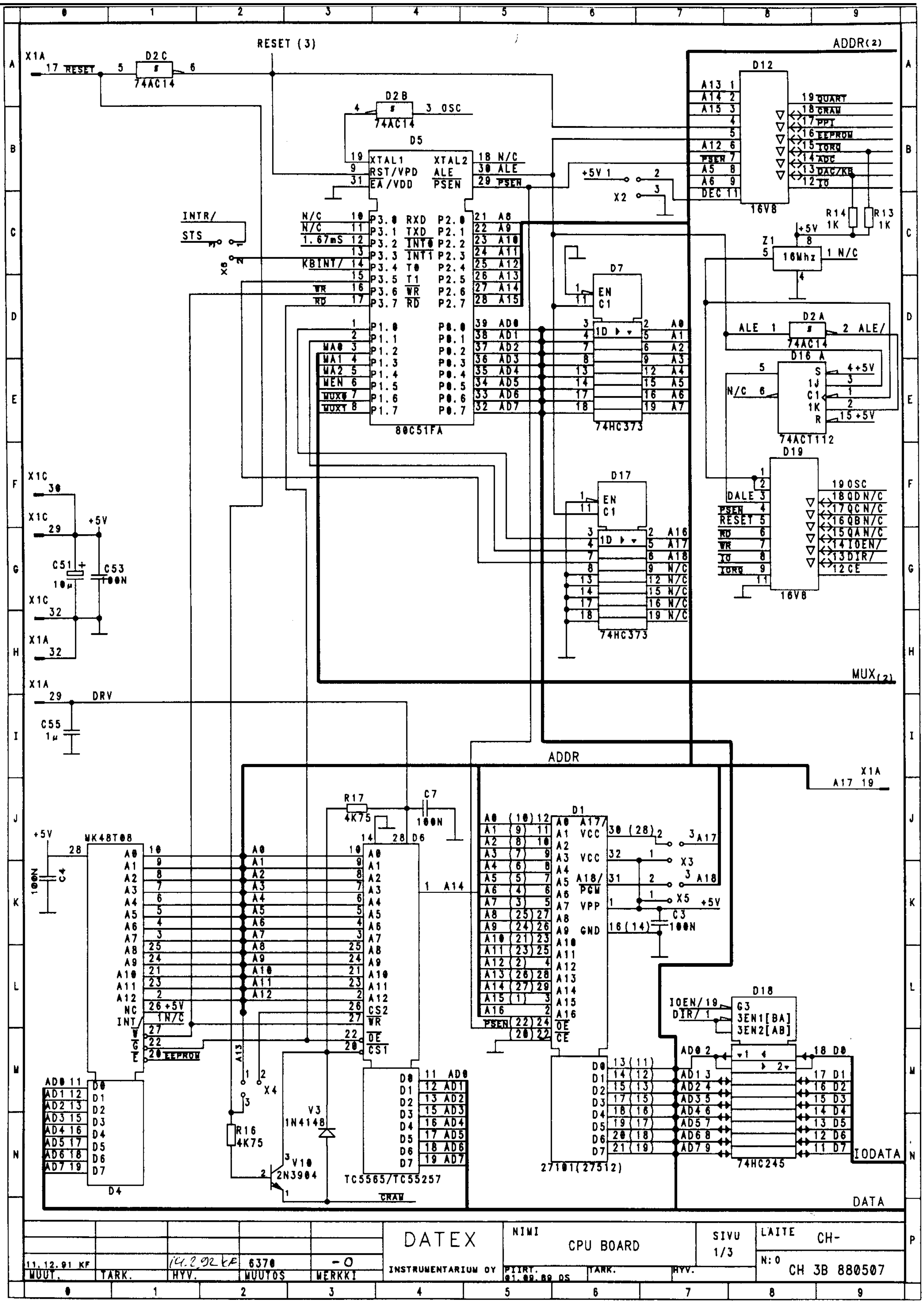


Figure 5.17 CPU board block diagram and parts layout

Figure 5.18 (on the next page)
CPU board schematic diagram (part 1)


Software
SRAM
GAL
GAL
P/N 880523
Ctrl
DATEX 880508-1


DATEX
INSTRUMENTARIUM OY
NIMI CPU BOARD
SIVU 1/3
LAITE CH-
N:O CH 3B 880507
80C51FA
74HC373
16V8
74ACT112
MK48T08
TC5565/TC55257
27101(27512)
74HC245
ADDR
MUX
IODATA
DATA

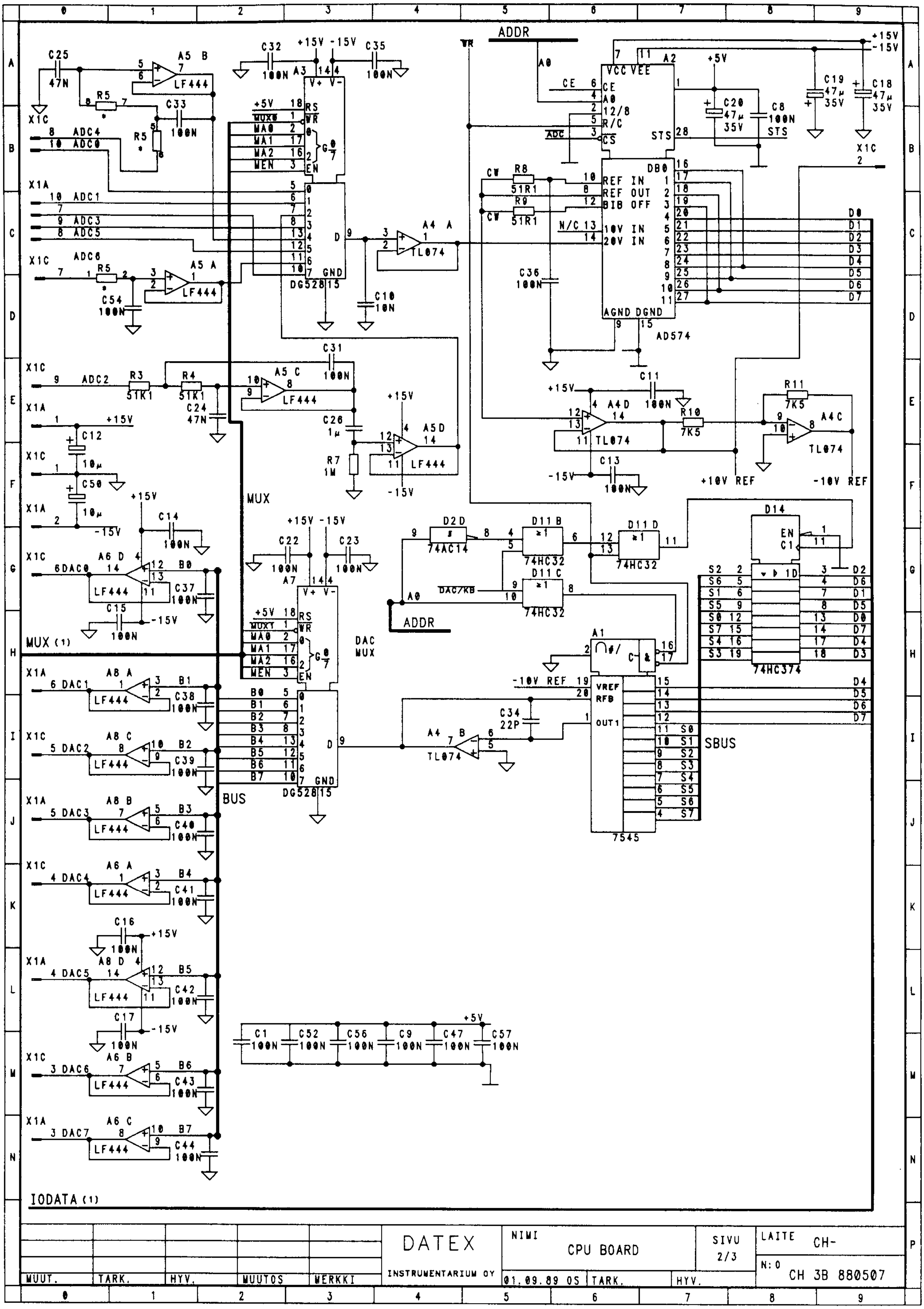
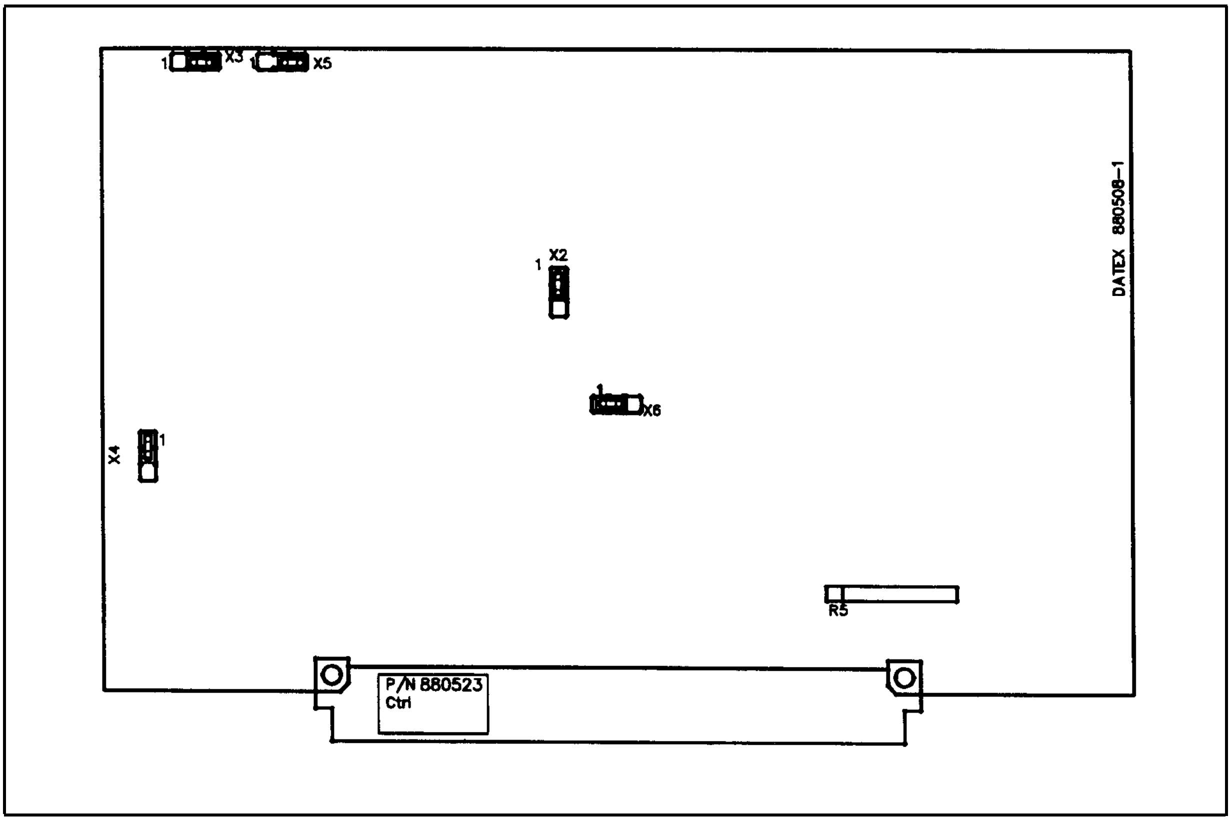
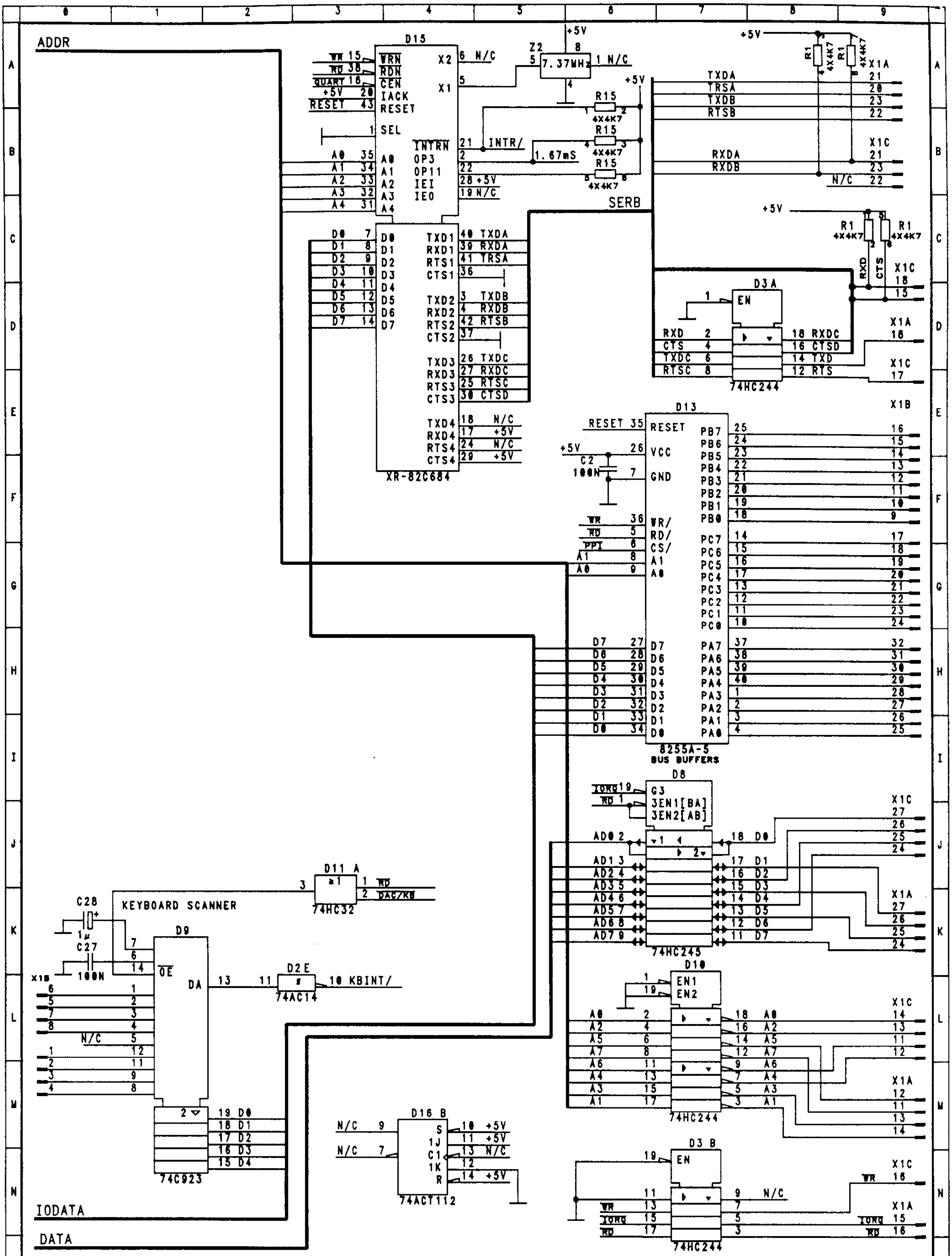

ADDR
AD574
DG528
A3
A7
DAC MUX
MUX
BUS
SBUS
7545
74HC374
74HC32
74AC14
LF444
TL074
+10V REF
-10V REF
MUX (1)
IODATA (1)
DATEX
INSTRUMENTARIUM OY
NIMI
CPU BOARD
SIVU
2/3
LAITE
CH-
N:O
CH 3B 880507
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
01.09.89 OS

Figure 5.19 CPU board jumper configuration and schematic diagram (part 2)

CONNECTOR	JUMPER	MEMORY TYPE
X2 (IO address setting)	1-2	EEPROM (6000H-7FFFH), CRAM (8000H-FFFFH), IORQ (0000H-0FFFH), ADC (1000H-1FFFH), DACKB (2000H-2FFFH), PPI (4000H-4FFFH), QUART (5000H-5FFFH)
	2-3	not used in 16 MHz CPU
X3 (Code memory)	1-2	D1 : 128k x 8 EPROM
	2-3	D1 : 256k x 8, 512k x 8 EPROM
X4 (Static RAM)	1-2	D6 : 32k RAM
	2-3	D6 : not used in 16 MHz CPU
X5 (Code memory)	1-2	D1 : 128k x 8, 256k x 8 EPROM
	2-3	D1 : 512k x 8 EPROM
X6 (Interrupt select)	1-2	QUART interrupt
	2-3	ADC interrupt



The value of resistor network R5 is 4 x 47k.



MUUT.	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI CPU BOARD PIIRT. 01.09.89 OS	TARK.	HYV.	SIVU 3/3	LAITE CH- N:0 CH 3B 880507

5.7 Video ASIC Board

The video ASIC board replaces video control board from revision 04 on. ASIC board includes ASIC IC and some other components. Due to the number of components we recommend changing the complete board in case of failure.

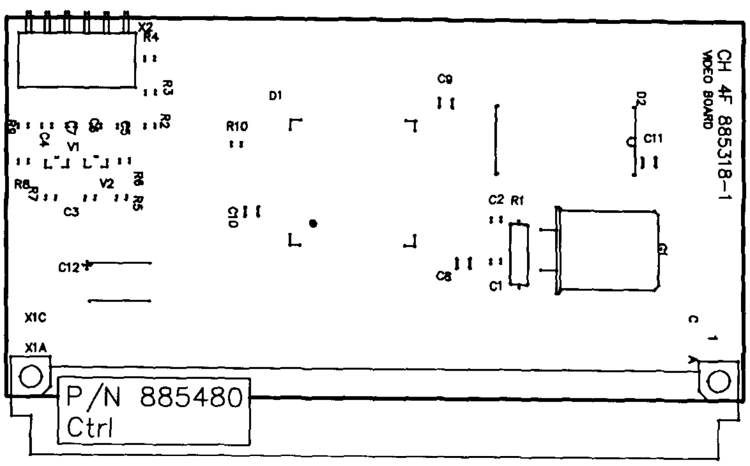
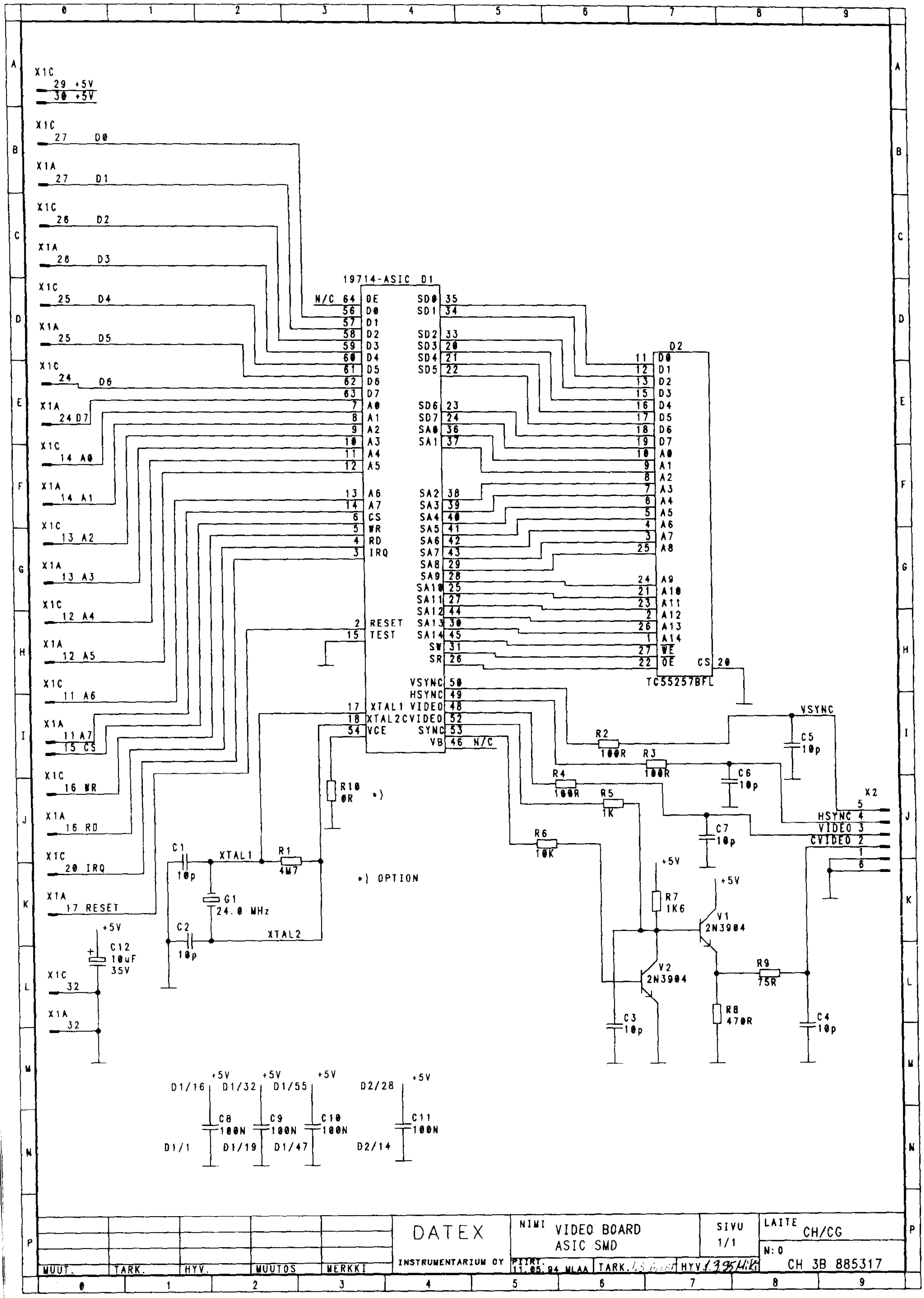


Figure 5.20 Video ASIC board parts layout

Figure 5.21 (on the next page)
Video ASIC board schematic diagram


19714-ASIC D1
D2
TC55257BFL
XTAL1
XTAL2
24.0 MHz
*) OPTION
VSYNC
HSYNC
VIDEO
CVIDEO
2N3904
DATEX
INSTRUMENTARIUM OY
VIDEO BOARD
ASIC SMD
CH/CG
CH 3B 885317

5.8 Power Supply Board

The primary of the power supply is designed to double insulation requirements for added safety. There are two fuses. The primary operating voltage is factory selected by insulating and folding the unused primary leads inside the additional insulation tube.

The mains transformer is magnetically shielded to minimize screen disturbance.

The power supply board contains basically four DC sources:

+5 V switched, for the digital circuitry.

+15 V switched, for valves, pump and other components.

+/-15 V regulated for the analog amplifiers.

Data retention voltage generation circuit supplies +5 V DRV voltage for memory from switched +5 V supply.

Also, +12 V/1 A for the CRT unit and serial drivers/receivers is derived from the +15 V switched voltage. The -12 V for the serial I/O is derived from -15 V.

In addition to the power supply functions the board contains drivers for two serial channels (including the modem control signals CTS and RTS), a RESET control, which generates a 200 ms reset pulse to the CPU if the +5 V line goes below 4.75 V, and miscellaneous I/O functions like a loudspeaker driver. Some signals from the mother board are passed directly to the rear panel connectors.

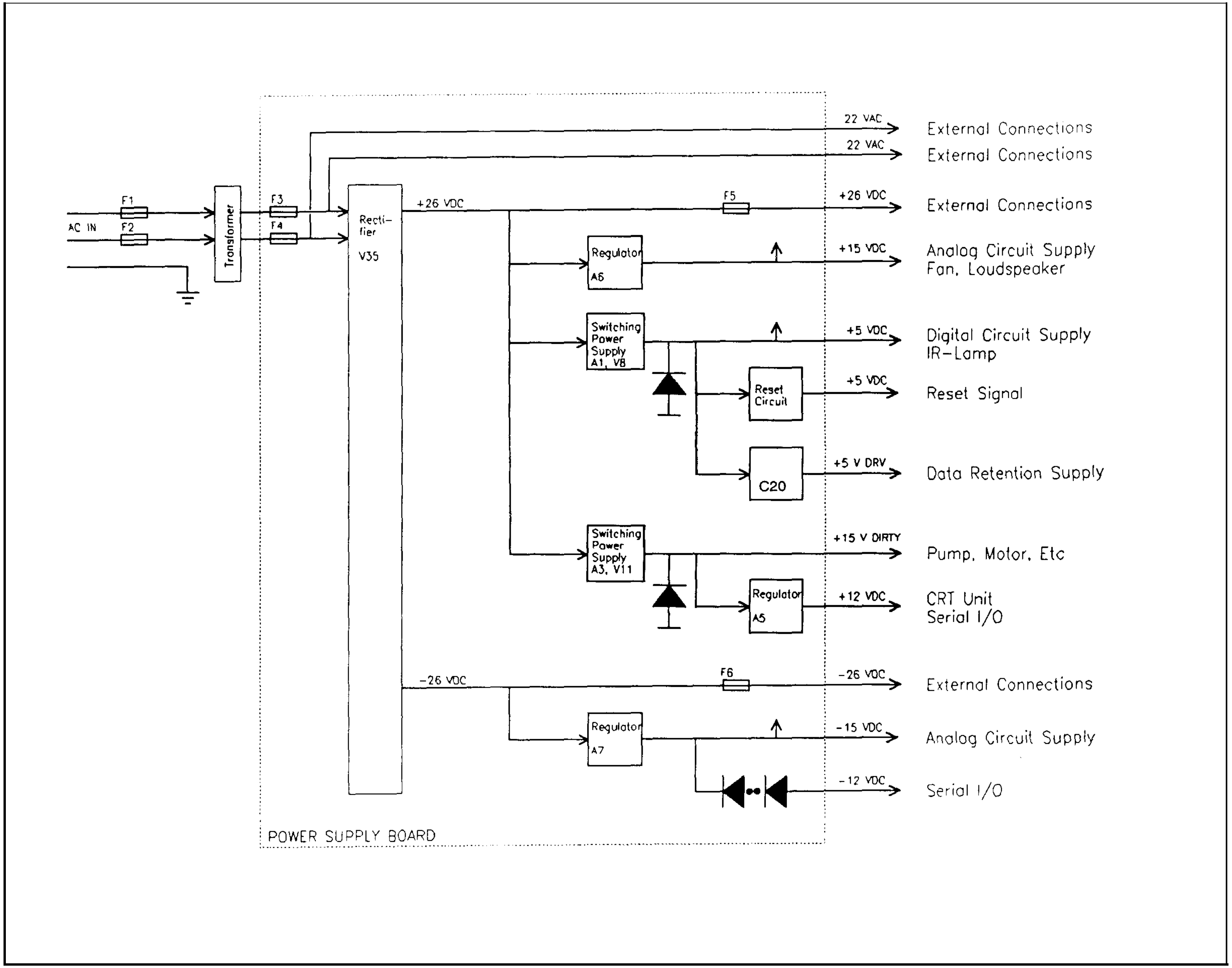
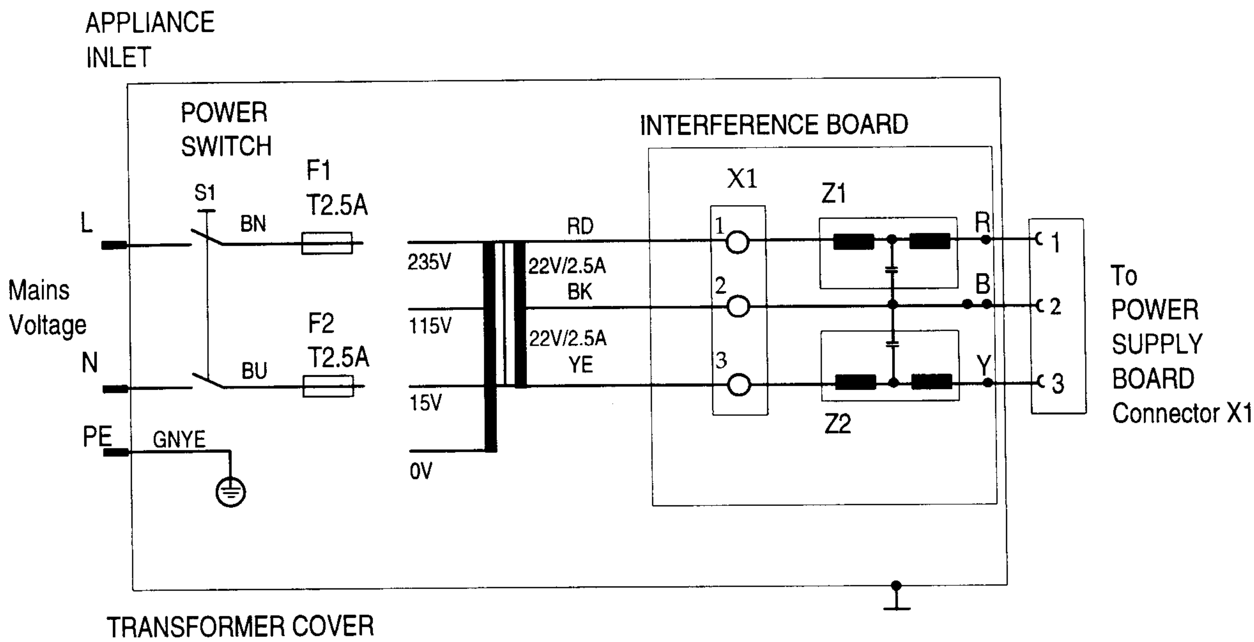
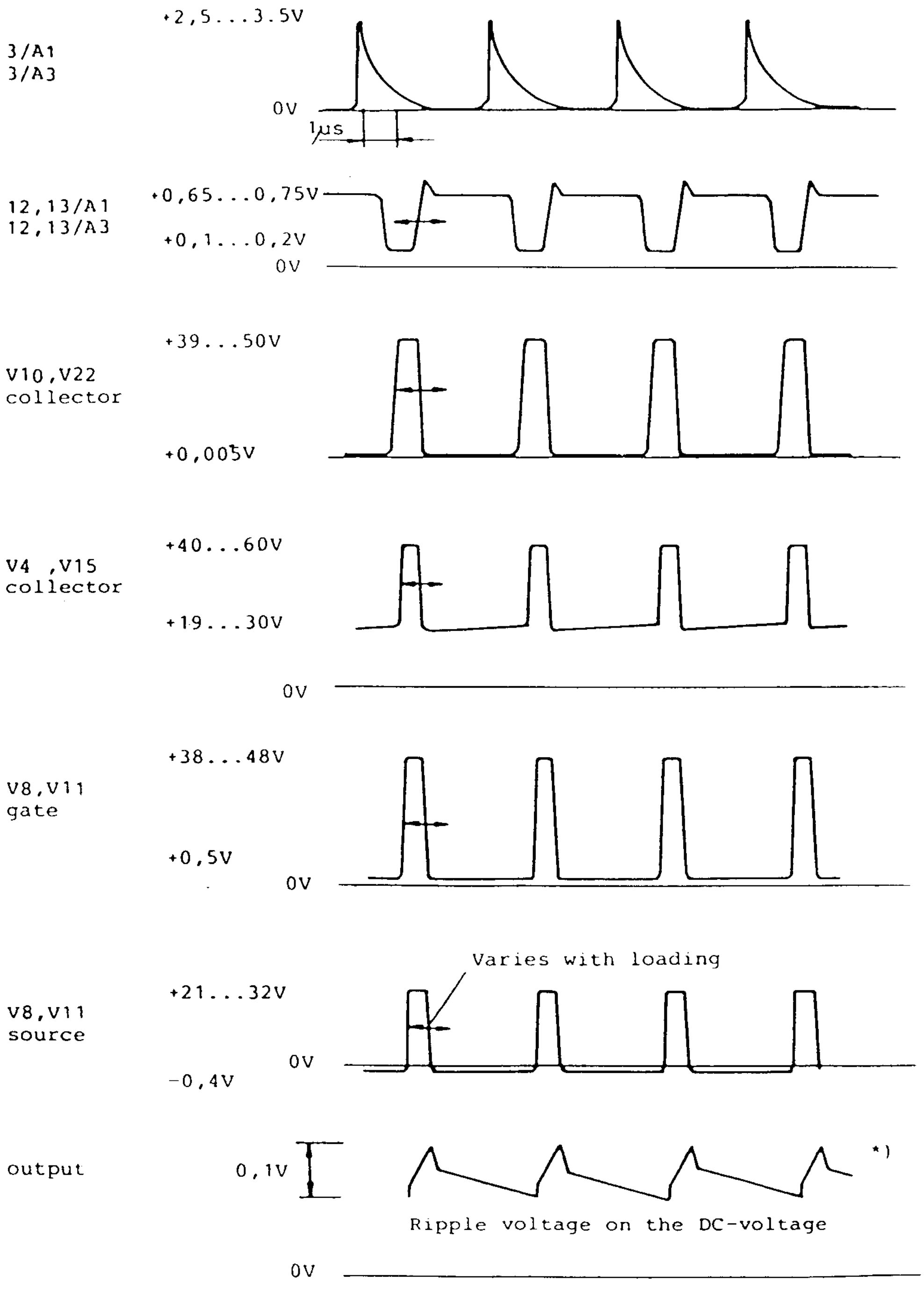


Figure 5.22 Power supply board block diagram

Figure 5.23 Transformer diagram and power supply board signal waveforms



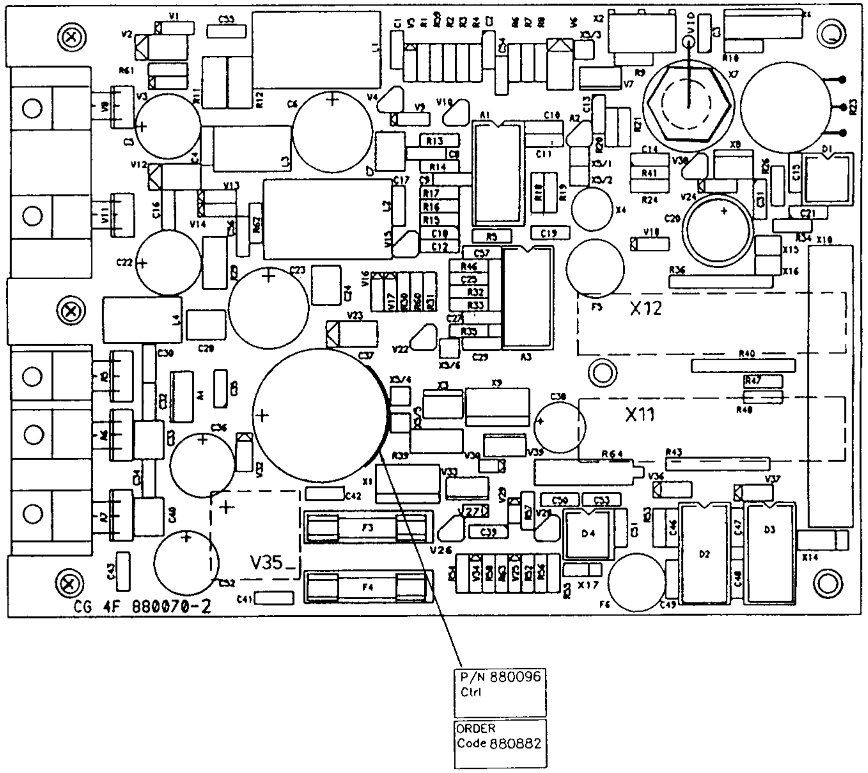
ADAPTIONS	WIRING
22, 33, 43, 60	BN to 235V, BU to 0V
27, 28, 29	BN to 115V, BU to 0V
30, 32	BN to 115V, BU to 15V

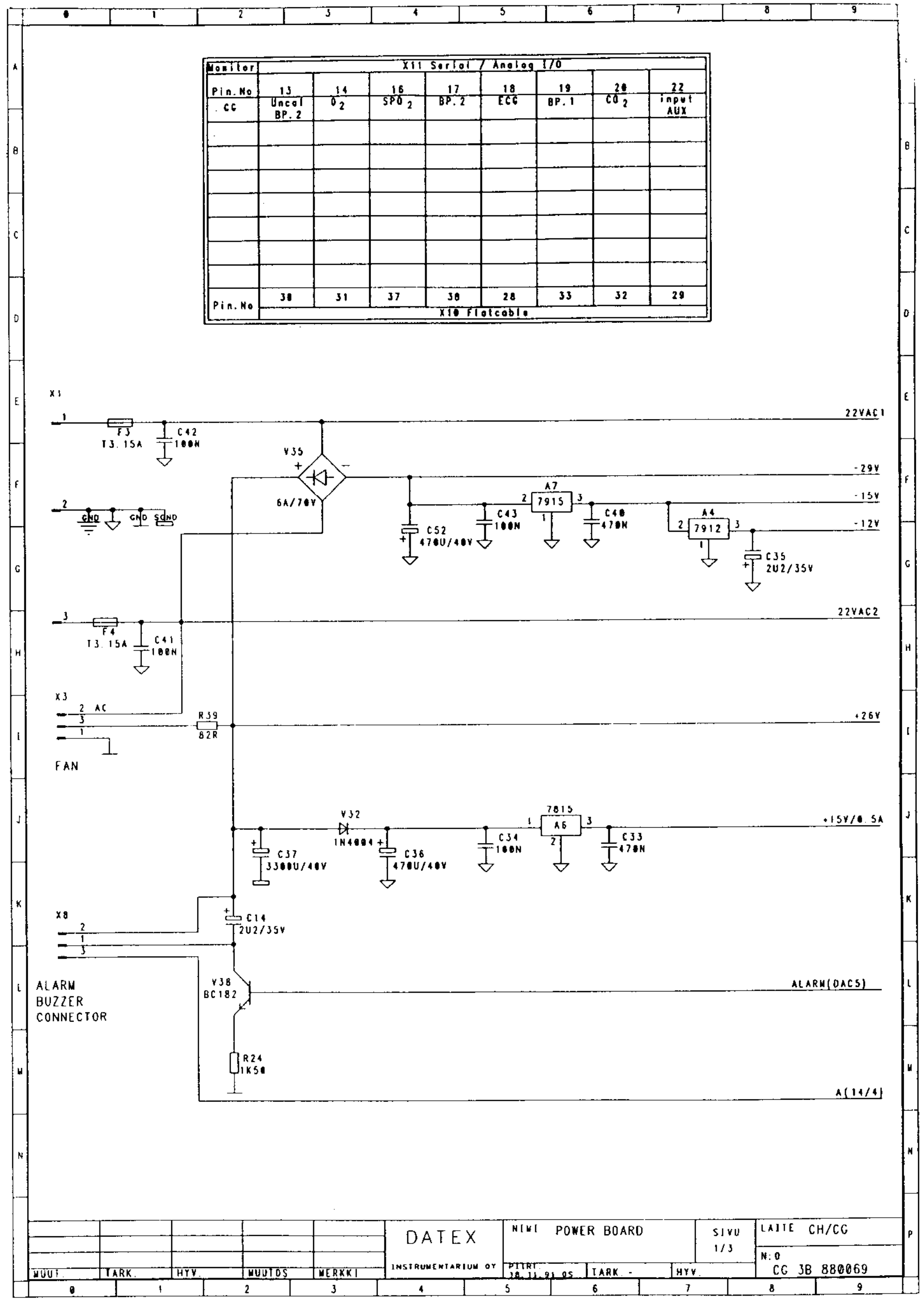


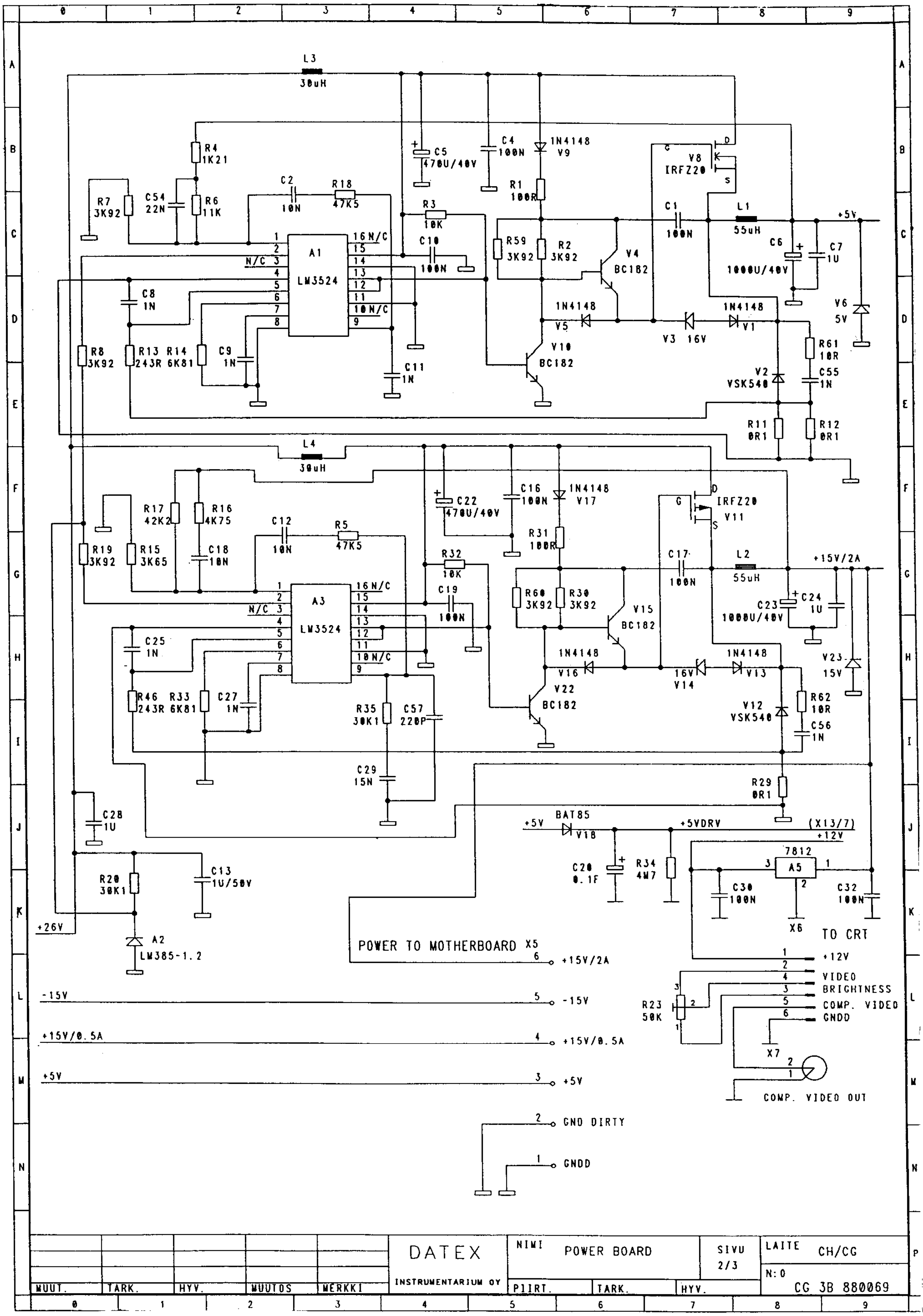
*) The ripple on the 12V voltage may be higher because of the uneven loading

Figure 5.24 Power supply board parts layout and schematic diagram (part 1)

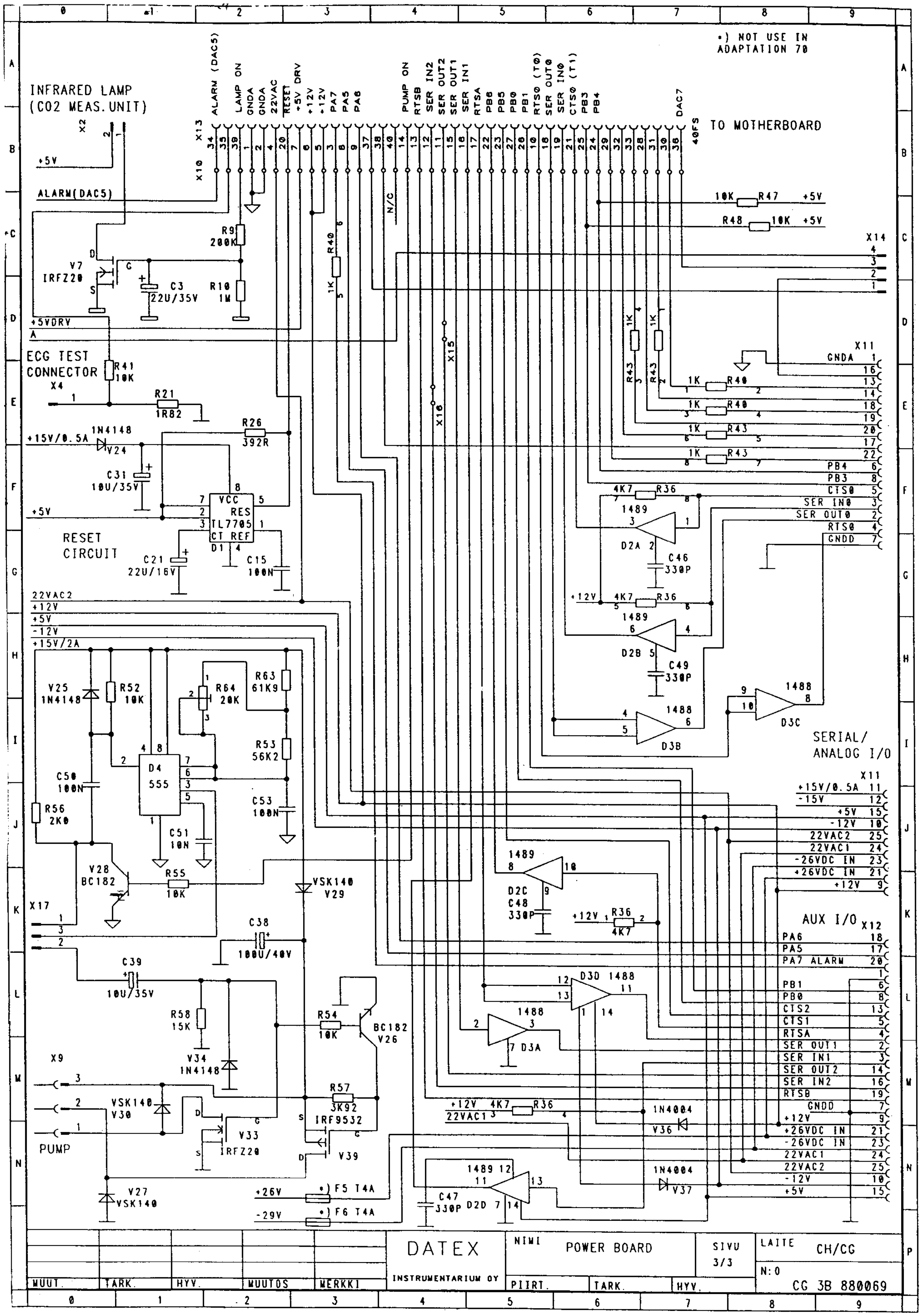
Figure 5.25 (on the next page) Power supply board schematic diagram (part 2)







L3
30uH
R4
1K21
R7
3K92
C54
22N
R6
11K
C2
10N
R18
47K5
C5
470U/40V
C4
100N
1N4148
V9
V8
IRFZ20
R1
100R
R3
10K
C1
100N
L1
55uH
+5V
A1
LM3524
C10
100N
R59
3K92
R2
3K92
V4
BC182
C6
1000U/40V
C7
1U
C8
1N
1N4148
V5
V3 16V
1N4148
V1
V6
5V
R8
3K92
R13
243R
R14
6K81
C9
1N
C11
1N
V10
BC182
R61
10R
V2
VSK540
C55
1N
R11
0R1
R12
0R1
L4
30uH
R17
42K2
R16
4K75
C22
470U/40V
C16
100N
1N4148
V17
IRFZ20
V11
C12
10N
R5
47K5
R31
100R
R19
3K92
R15
3K65
C18
10N
R32
10K
C17
100N
L2
55uH
+15V/2A
A3
LM3524
C19
100N
R60
3K92
R30
3K92
V15
BC182
C23
1000U/40V
C24
1U
C25
1N
1N4148
V16
16V
V14
1N4148
V13
V23
15V
R46
243R
R33
6K81
C27
1N
R35
30K1
C57
220P
V22
BC182
V12
VSK540
R62
10R
C56
1N
C29
15N
R29
0R1
C28
1U
+5V
BAT85
V18
+5VDRV
(X13/7)
+12V
7812
A5
R20
30K1
C13
1U/50V
C20
0.1F
R34
4M7
C30
100N
C32
100N
+26V
A2
LM385-1.2
X6
TO CRT
POWER TO MOTHERBOARD X5
+15V/2A
+12V
VIDEO
BRIGHTNESS
COMP. VIDEO
GNDD
-15V
-15V
R23
50K
+15V/0.5A
+15V/0.5A
X7
+5V
+5V
COMP. VIDEO OUT
GND DIRTY
GNDD
DATEX
INSTRUMENTARIUM OY
NIMI
POWER BOARD
SIVU
2/3
LAITE
CH/CG
N:O
CG 3B 880069
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
TARK.
HYV.



•) NOT USE IN ADAPTATION 70
INFRARED LAMP (CO2 MEAS. UNIT)
TO MOTHERBOARD
ALARM (DAC5)
LAMP ON
GNDA
22VAC
RESET
+5V DRV
+12V
PA7
PA5
PA6
PUMP ON
RTSB
SER IN2
SER OUT2
SER OUT1
SER IN1
RTSA
PB6
PB5
PB0
PB1
RTS0 (T0)
SER OUT0
SER IN0
CTS0 (T1)
PB3
PB4
DAC7
X13
X10
X14
X11
X12
X15
X16
X17
X9
X4
X2
ECG TEST CONNECTOR
RESET CIRCUIT
TL7705
555
IRFZ20
IRF9532
BC182
1N4148
1N4004
VSK140
1489
1488
SERIAL/ ANALOG I/O
AUX I/O
PUMP
+26V
-29V
F5 T4A
F6 T4A
+15V/0.5A
-15V
+5V
-12V
22VAC2
22VAC1
-26VDC IN
+26VDC IN
+12V
CTS0
SER IN0
SER OUT0
RTS0
GNDD
PA7 ALARM
CTS2
CTS1
DATEX
INSTRUMENTARIUM OY
NIMI
POWER BOARD
SIVU 3/3
LAITE
CH/CG
N:0
CG 3B 880069
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.

5.9 Mother Board

The mother board contains mainly the system bus interconnections and connectors. Also on the board are power bypass capacitors and driver transistors for the sampling system magnetic valves (gas zero and pressure valves; not used in Cardiocap II CH-series monitors).

For signals in each bus, see Table 4.7.

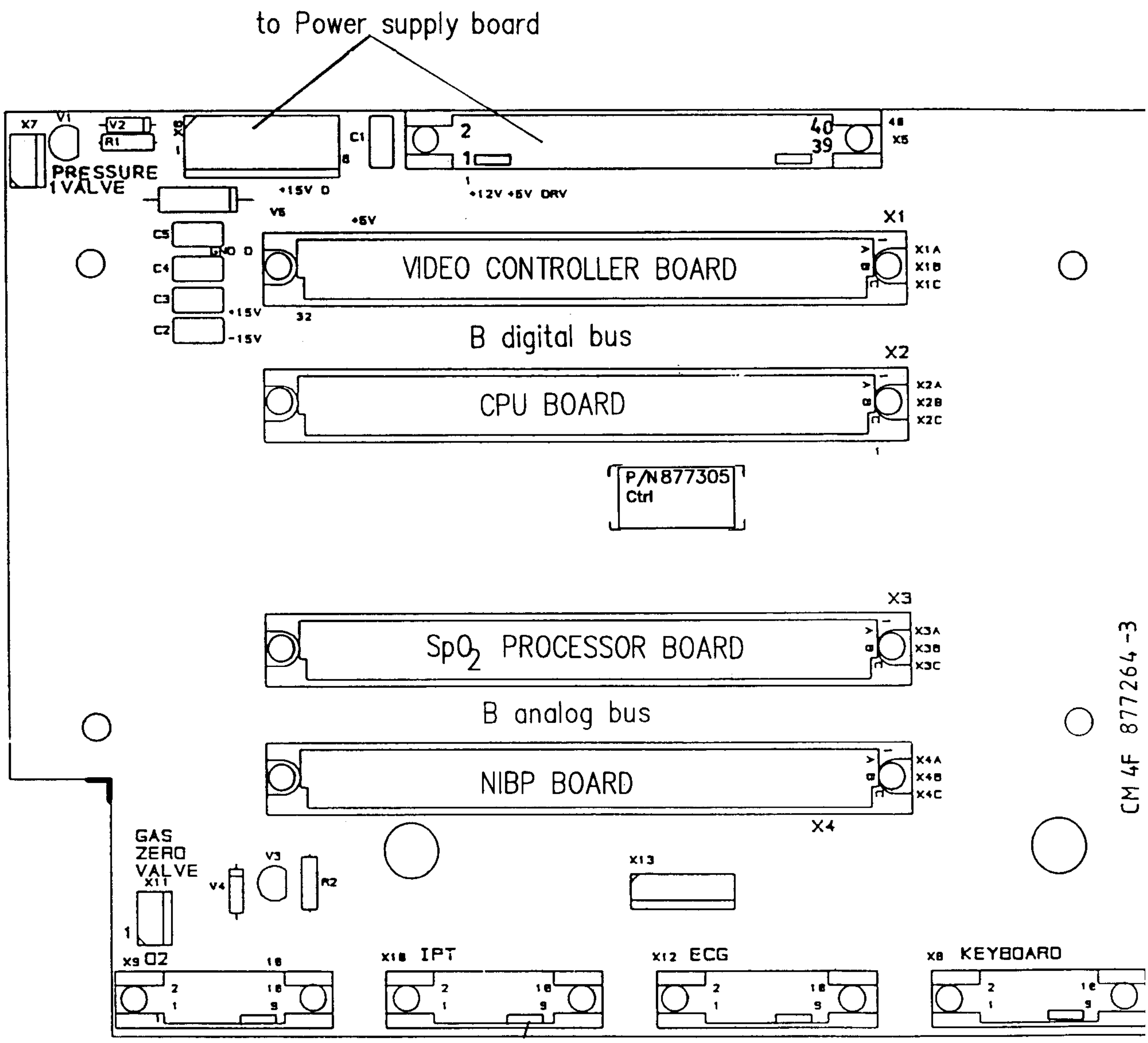
5.10 Keyboard

The keypad pcb is a simple 4x4 matrix which is scanned by the keyboard controller on the CPU board.

5.11 Loudspeaker Unit

Audible alarms and beeps are generated by a separate loudspeaker unit. It contains an 8 ohm/0.4 W speaker and the associated driving circuitry.

Figure 5.26 Mother board parts layout and schematic diagram (board modification level 3 and higher)



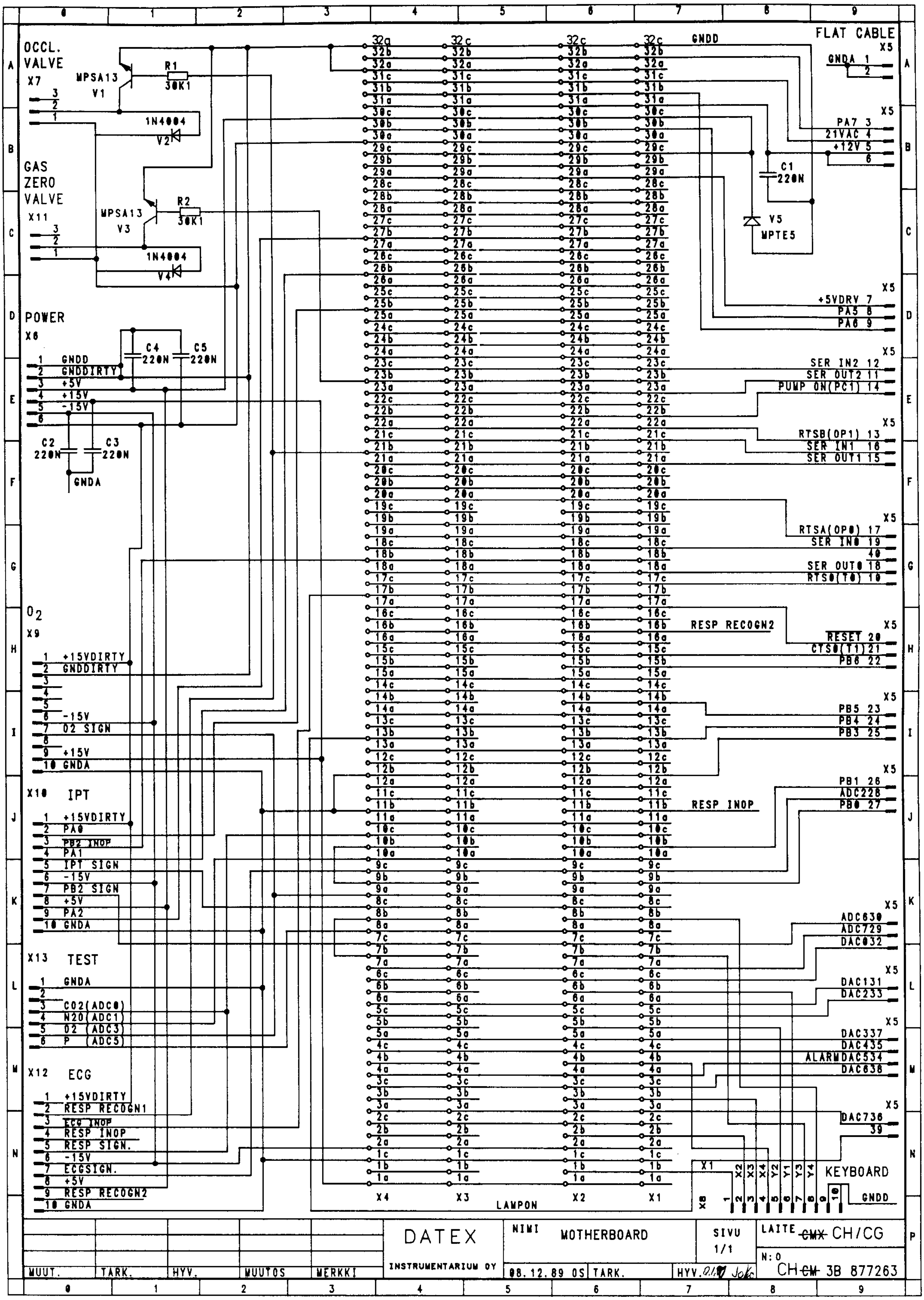
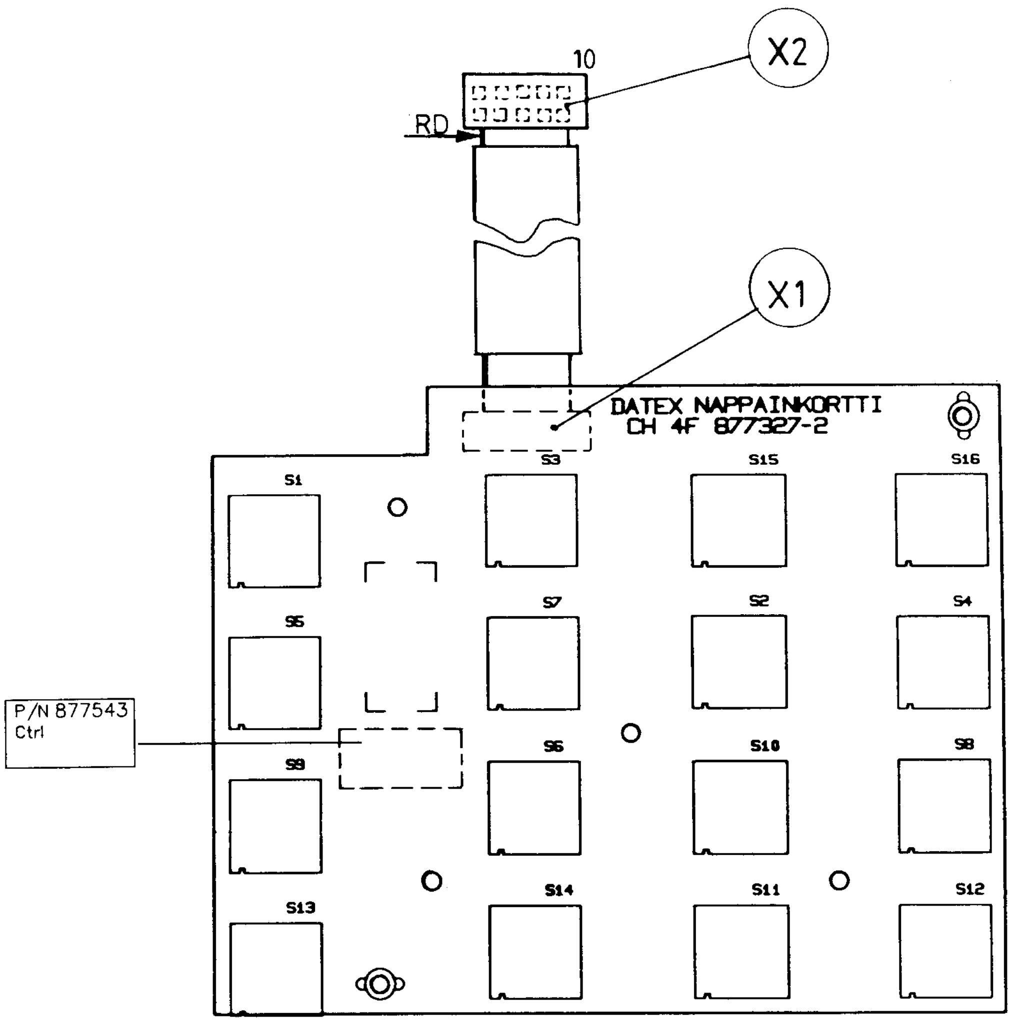
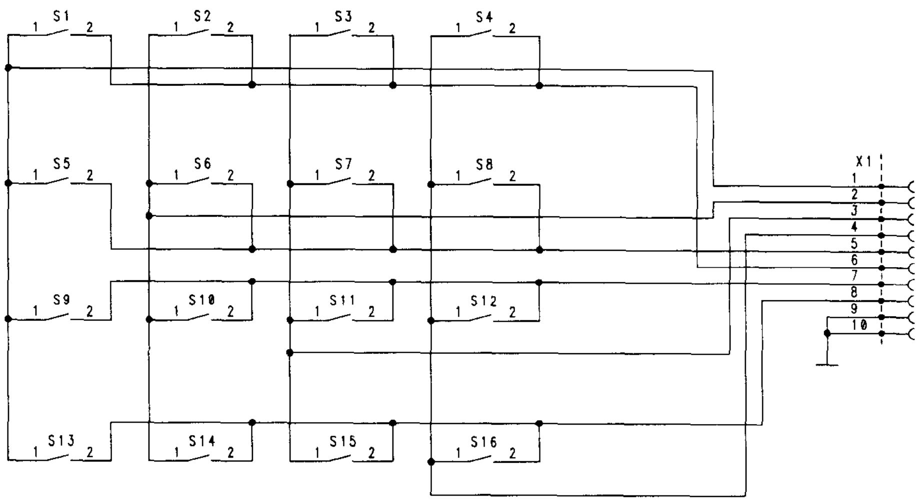

OCCL. VALVE
X7
MPSA13
V1
R1
30K1
1N4004
V2
GAS ZERO VALVE
X11
MPSA13
V3
R2
30K1
1N4004
V4
POWER
X6
GNDD
GNDDIRTY
+5V
+15V
-15V
C4 220N
C5 220N
C2 220N
C3 220N
GNDA
O2
X9
+15VDIRTY
GNDDIRTY
-15V
O2 SIGN
+15V
GNDA
X10 IPT
+15VDIRTY
PA0
PB2 INOP
PA1
IPT SIGN
-15V
PB2 SIGN
+5V
PA2
GNDA
X13 TEST
GNDA
CO2(ADC0)
N2O(ADC1)
O2 (ADC3)
P (ADC5)
X12 ECG
+15VDIRTY
RESP RECOGN1
ECG INOP
RESP INOP
RESP SIGN.
-15V
ECGSIGN.
+5V
RESP RECOGN2
GNDA
X4
X3
X2
X1
LAMPON
GNDD
FLAT CABLE
X5
GNDA 1
2
PA7 3
21VAC 4
+12V 5
6
C1 220N
V5 MPTE5
+5VDRV 7
PA5 8
PA6 9
SER IN2 12
SER OUT2 11
PUMP ON(PC1) 14
RTSB(OP1) 13
SER IN1 16
SER OUT1 15
RTSA(OP0) 17
SER IN0 19
40
SER OUT0 18
RTS0(T0) 10
RESP RECOGN2
RESET 20
CTS0(T1) 21
PB6 22
PB5 23
PB4 24
PB3 25
PB1 26
ADC228
RESP INOP
PB0 27
ADC630
ADC729
DAC032
DAC131
DAC233
DAC337
DAC435
ALARMDAC534
DAC638
DAC736
39
X1
X2
X3
X4
Y2
Y1
Y3
Y4
KEYBOARD
X8
GNDD
DATEX
INSTRUMENTARIUM OY
NIMI
MOTHERBOARD
SIVU
1/1
LAITE CMX CH/CG
N:O
CH CM 3B 877263
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
08.12.89 OS
TARK.
HYV.

Figure 5.27 Keyboard parts layout and schematic diagram





MUUT.	TARK.	HYV.	MUUTOS	MERKKI

DATEX

INSTRUMENTARIUM OY

NIMI KEYBOARD NAPPAINKORTTI

SIVU 1/1

LAITE CH / CG

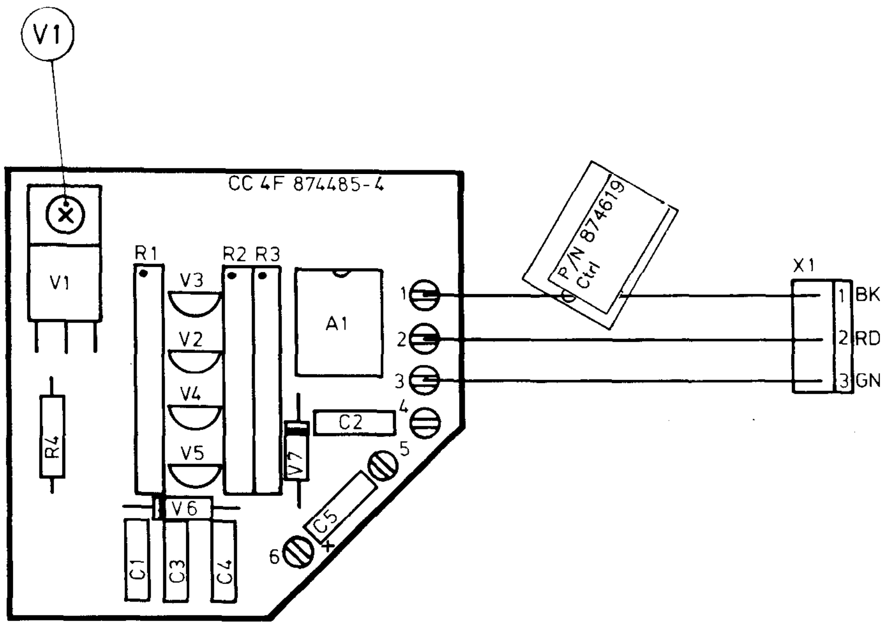
N:0 CH 3B 877328

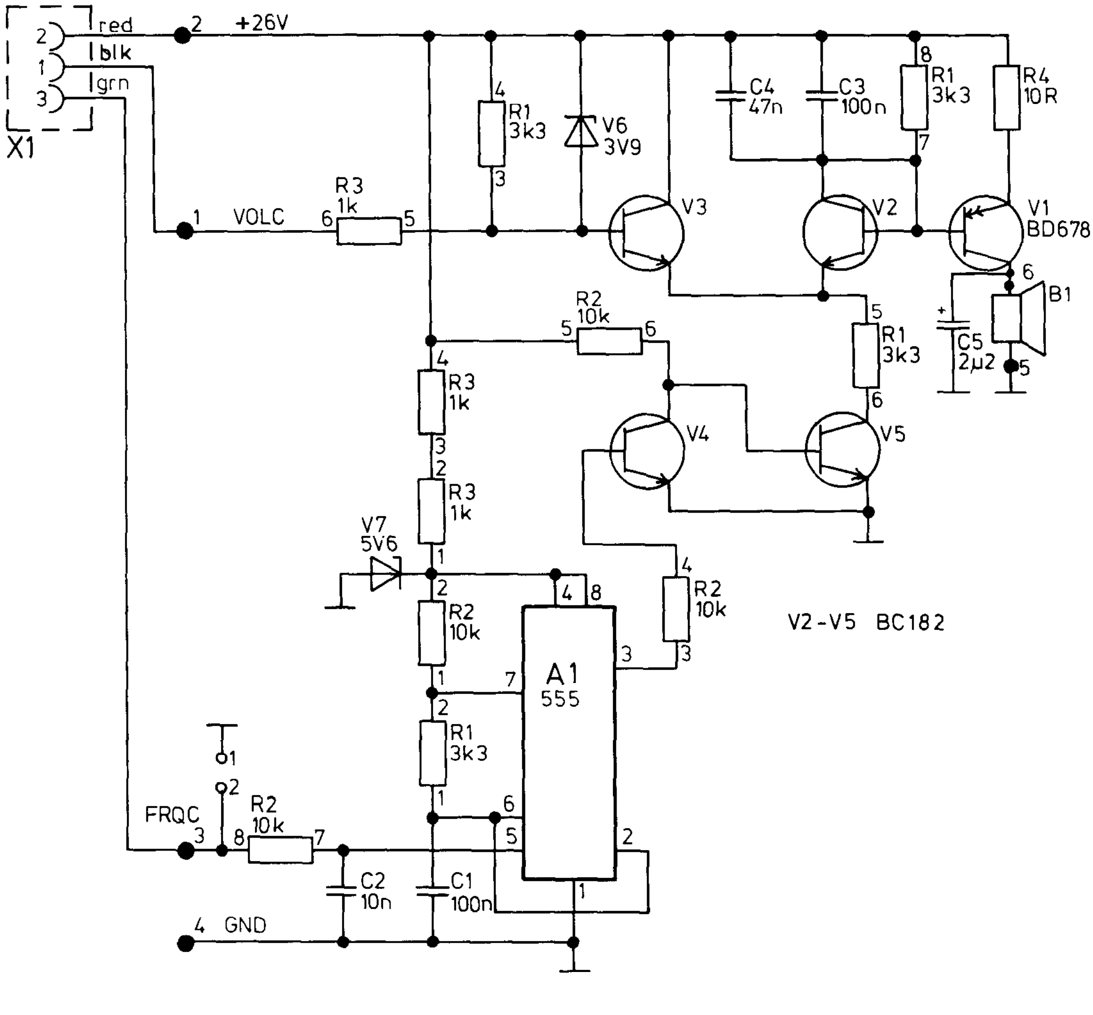
PIIRT. 13.12.88 LEJA

TARK.

HYV.

Figure 5.28 Loudspeaker unit parts layout and schematic diagram





X1
red
blk
grn
+26V
VOLC
FRQC
GND
R1 3k3
R2 10k
R3 1k
R4 10R
C1 100n
C2 10n
C3 100n
C4 47n
C5 2µ2
V1 BD678
V2
V3
V4
V5
V6 3V9
V7 5V6
B1
A1 555
V2-V5 BC182

5.12 Internal connector configurations

Table 5.1 Video ASIC board (X1) - Mother board (X1)

PIN NO.	a	b	c
1	+15 V	NC	AGND
2	-15 V	NC	+10 V REF
3	DAC7 ALR ADJ	NC	DAC6 PB2
4	DAC5 ALARM	NC	DAC4 ECG test
5	NC	NC	DAC2 IPT signal
6	DAC1	NC	DAC0
7	SAL	NC	ADC6 PB2 signal
8	ADC5	NC	ADC4 IPT signal
9	ADC3	NC	ADC2 ECG
10	ADC1	NC	IMP RESP
11	A7	NC	A6
12	A5	NC	A4
13	A3	NC	A2
14	A1	NC	A0
15	-10RQ	NC	T1 CTS0
16	RDB1	NC	-WR
17	-RESET	NC	TO RTS0
18	SEROUT 0	NC	SERIN0
19	P1.1	NC	P1.0
20	OP0 RTSA	NC	INT0
21	SEROUT1	NC	SERIN1
22	OP1 RTSB	NC	IP2 TIMERIN0
23	SEROUT2	NC	SERIN2
24	D7	NC	D6
25	D5	NC	D4
26	D3	NC	D2
27	D1	NC	D0
28	INT1	NC	INT3
29	+5 V DRV	NC	+5 V
30	+15 VDIRTY	NC	+5 V
31	+12 V	NC	21 VAC
32	GND DIRTY	NC	DGND

NC = not connected
AIN is an AD-converter in and AOUT is a DA-converter out
ADC is an AD-converter and DAC is a DA-converter

Table 5.2 Main CPU board (X1) - Mother board (X2)

PIN NO.	a	b	c
1	+15 V	X1	AGND
2	-15 V	X2	+10 V REF
3	DAC7 ALR ADJ	X3	DAC6 PB2 signal
4	DAC5 ALARM	X4	DAC4 ECG TEST
5	NC	Y2	DAC2 IPT signal
6	DAC1	Y1	DAC0
7	SAL	Y3	ADC6 PB2 signal
8	ADC5	Y4	ADC4 IPT signal
9	ADC3	PB0 not used (AUX)	ADC2 ECG
10	ADC1	PB1 not used (AUX)	ADC0 IMP RESP
11	A7	PB2 RESP INOP	A6
12	A5	PB3 CD	A4
13	A3	PB4 DSR	A2
14	A1	PB5 CTSB (AUX)	A0
15	-10RQ	PB6 CTSA (AUX)	CTS
16	RDB1	PB7 RESP identification	-WR
17	-RESET	PC0 -ECG INOP	RTS
18	TXD	PC1 BP2 INOP	RXD
19	P1.1	PC2 not used	P1.0
20	RTSA	PC3 Normocap	INT0
21	TXDA	PC4 RESP identification	RXDA
22	RTSB	PC5 not used	NC
23	TXDB	PC6 not used	RXDB
24	D7	PC7 not used	D6
25	D5	PA0 IPT control	D4
26	D3	PA1 IPT control	D2
27	D1	PA2 IPT control	D0
28	INT1	PA3 not used	INT3
29	+5 V DRV	PA4 not used	+5 V
30	+15 VDIRTY	PA5 not used (AUX)	+5 V
31	+12 V	PA6 not used (AUX)	21 VAC
32	GND DIRTY	PA7 nurse call	DGND

NC = not connected
AIN is an AD-converter in and AOUT is a DA-converter out
ADC is an AD-converter and DAC is a DA-converter

Table 5.3 SpO_2 processor board (X1) - Mother board (X3)

PIN NO.	a	b	c
1	+15 V	NC	AGND
2	-15 V	NC	+10 V REF
3	AOUT6	NC	AOUT5
4	AOUT4	NC	AOUT3
5	AOUT2	NC	AOUT1
6	DAC1	NC	DAC0
7	AIN7 SAL	NC	ADC6 PB2 signal
8	ADC5	NC	ADC4 IPT signal
9	ADC3	NC	ADC2 ECG
10	ADC1	NC	AIN4 SSIGN
11	NC	AGND	NC
12	NC	AGND	NC
13	NC	LAMP	NC
14	NC	PB5	NC
15	NC	SSYNC	NC
16	RDB2	SMOTOR	NC
17	-RESET	-PC0 -ECG INOP	TO RTSO
18	SEROUT 0	NC	SERIN0
19	P1.1	PC2	P1.0
20	OP0 RTSA	PC3 Normocap	INT0
21	SEROUT1	PC4 RESP	SERIN1
22	OP1 RTSB	PC5	IP2 TIMERIN0
23	SEROUT2	PC6	SERIN2
24	NC	PC7	NC
25	NC	PA0 IPT	NC
26	NC	PA1 IPT	NC
27	NC	PA2 IPT	NC
28	INT1	PA3	INT3
29	+5 V DRV	PA4	+5 V
30	+15 VDIRTY	PA5	+5 V
31	+12 V	PA6	21 VAC
32	GND DIRTY	PA7 ALR CALL	DGND

NC = not connected
AIN is an AD-converter in and AOUT is a DA-converter out
ADC is an AD-converter and DAC is a DA-converter

Table 5.4 NIBP board (Xl) - Mother board (X4)

PIN NO.	a	b	c
1	+15 V	NC	AGND
2	-15 V	NC	NC
3	NC	NC	NC
4	NC	NC	NC
5	NC	NC	NC
6	NC	NC	NC
7	NC	NC	NC
8	NC	NC	NC
9	NC	NC	NC
10	NC	NC	NC
11	NC	NC	NC
12	NC	NC	NC
13	NC	NC	NC
14	NC	NC	NC
15	NC	NC	NC
16	NC	NC	NC
17	-RESET	NC	NC
18	NC	NC	NC
19	NC	NC	NC
20	NC	NC	NC
21	NC	NC	NC
22	NC	NC	NC
23	RXD	NC	SERIN2
24	NC	NC	NC
25	NC	NC	NC
26	NC	NC	NC
27	NC	NC	NC
28	NC	NC	NC
29	NC	NC	+5 V
30	+15 VDIRTY	NC	+5 V
31	NC	ECGSYNC	NC
32	GND DIRTY	NC	DGND

NC = not connected

Table 5.5 Power supply board (X10) - Mother board (X5)

PIN NO.	SIGNAL	PIN NO.	SIGNAL
1	AGND	2	AGND
3	PA7 ALR CALL	4	21 VAC
5	+12 V	6	+12 V
7	+5 V DRV	8	PA5
9	PA6	10	T0 RTS0
11	SEROUT2	12	SERIN2
13	OP1 RTSB	14	PC5
15	SEROUT1	16	SERIN1
17	OP0 RTSA	18	SEROUT0
19	SERIN0	20	-RESET
21	T1 CTS0	22	PB6
23	PB5	24	PB4 DSR
25	PB3 CD	26	PB1
27	PB0	28	DAC1
29	DAC6 PB2	30	DAC0
31	AOUT2	32	AOUT3
33	DAC2 IPT	34	DAC5 ALARM
35	DAC4 ECG TEST	36	DAC7 ALR ADJ
37	AOUT1	38	AOUT5
39	LAMPON	40	NC

NC = not connected
AIN is an AD-converter in and AOUT is a DA-converter out
ADC is an AD-converter and DAC is a DA-converter

Table 5.6 SpO_2 measuring board (X2) - SpO_2 processor board (X2)

PIN NO.	SIGNAL
1	+15 VDIRTY
2	PA0
3	PA3
4	PA1
5	ADC 4 VOUT IR
6	-15 V
7	ADC 6 VOUT R
8	+5 V
9	PA2
10	AGND

Table 5.7 Keyboard (X1) - Mother board (X8)

PIN NO.	SIGNAL	
1	X1	X1 row
2	X2	X2 row
3	X3	X3 row
4	X4	X4 row
5	Y2	Y2 column
6	Y1	Y1 column
7	Y3	Y3 column
8	Y4	Y4 column
9	GND	
10	GND	

Table 5.8 ECG board - Mother board (X12)

PIN NO.	SIGNAL
1	+15 VDIRTY
2	RESP RECOGN 1
3	-ECG INOP
4	RESP INOP
5	RESP SIGN
6	-15 V
7	ECG OUT
8	+5 V
9	RESP RECOGN 2
10	AGND

Table 5.9 IPT board - Mother board (X10)

PIN NO.	SIGNAL
1	+15 VDIRTY
2	PA0 IPT control
3	NC
4	PA1 IPT control
5	Signal out
6	-15 V
7	InvBP2 out
8	+5 V
9	PA2 IPT control
10	AGND

Table 5.10 Power supply board - Mother board (X6)

PIN NO.	SIGNAL
1	DGND
2	GND DIRTY
3	+5 V
4	+15 V
5	-15 V
6	+15 VDIRTY

Table 5.11 ECG board - RESP board (X7)

PIN NO.	SIGNAL
1	+15 VDIRTY
2	GND
3	NC
4	GND
5	RESP OUT
6	-15 V
7	NC
8	GND
9	RESP IN
10	AGND

Table 5.12 Mother board test connector (X13)

PIN NO.	SIGNAL
1	AGND
2	ADC4
3	ADC0
4	ADC1
5	ADC3
6	ADC5

Table 5.13 Video ASIC board (X2) - Video unit main pc board (X13)

PIN NO.	SIGNAL
1	GND
2	Comp. Video signal
3	Video
4	HSYNC
5	VSYNC
6	GND

Table 5.14 Front panel SpO_2 connector - SpO_2 measuring board (X1)

PIN NO.	SIGNAL
1	Is
2	Ib
3	NC
4	Sensor identification
5	Sensor identification
6	Ground
7	Iled
8	Vb (-4 ±0.3 V)
9	Ground
0	+12 Vp

Table 5.15 Power supply board (X1) - Line transformer

PIN NO.	SIGNAL	
1	22 VAC	secondary voltage of
3	22 VAC	the line transformer
2	GND	

Table 5.16 Power supply board (X3) - Fan

PIN NO.	SIGNAL	
1	GND	
2	NC	
3	+26 V	supply voltage for fan

Table 5.17 Power supply board (X6) - Video unit main pc board

PIN NO.	SIGNAL
1	+12 V
2	Video brightness control
3	Video brightness control
4	Video brightness control
5	Comp video
6	DGND

Table 5.18 Power supply board (X8) - Loudspeaker

PIN NO.	SIGNAL
1	DAC5 ALARM
2	+26 V power for loudspeaker
3	DAC7

Table 5.19 NIBP board (X2) - NIBP Pump

PIN NO.	SIGNAL
1	GND
2	NC
3	+15 V supply voltage for pump

6 SERVICE AND TROUBLESHOOTING

6.1 General service information

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

DATEX-ENGSTROM is always available for service advice. Please provide the unit serial number, full type designation, program revision (displayed at monitor startup) and a detailed fault description.

NOTE: After any component replacements see Section 7.1 (Adjustments) and after any service perform the functional field check procedure in Chapter 8.

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.

6.2 Disassembly and reassembly

The monitor is disassembled in the following way (see page 3-2 for the parts included in the monitor you are using). See Figure 9.1 for the exploded view of the monitor:

a) Disconnect the power cord.

b) Remove the upper two galvanized screws on the side panels and lift off the top cover.

c) Remove the lower two screws and detach the side panels.

Now the interior of the monitor is exposed. The pneumatic unit for the NIBP measurement is located on the left side and printed circuit boards are located on the right side of the monitor.

d) Video screen frame can be removed. Keyboard pc board with plastic key panel is attached to the front plate. It can be removed by detaching the ECG lead selector knob and disconnecting X8 connector on the mother board.

e) Behind the Keyboard pc board an assembly of pc boards is located. They are (front to rear) the ECG board, IPT board, a supporting board, and the Respiration board. The connector board (no.2) with pressure and temperature connectors is attached to the IPT board, beneath the ECG board. This whole assembly can be detached by removing 6 supporting screws on the front plate (two on top and one on each side of two connector openings) and disconnecting X10 and X12 connectors after the Keyboard pc board is removed. Each board can now be detached from the assembly by removing the screws and spacers.

f) Four boards are attached to the mother board on the right half of the chassis: (moving front to rear) the NIBP processor board, the SpO_2 processor board, the CPU board, and the Video ASIC board. These boards are removed by pulling upwards.

Beneath the mother board the intermediary bottom plate houses SpO_2 measuring board.

g) Power supply board is attached to the rear plate with four screws.

h) Transformer, power cord receptacle block, loudspeaker, fan and dust filter, fuse housing(s), NIBP cuff connector, and ECG test signal connector are all attached to the rear panel.

The rear panel can be tilted back by first detaching the power cord receptacle block and removing the two screws beside the fan which are keeping the rear panel in the upright position and sliding the panel in sideways.

i) The main PC board for the picture tube, NIBP pump and vertically positioned supporting plate, and NIBP safety valve are attached to the bottom plate with screws.

Two magnetic valves, damping chambers II and III, and a choke are screwed to the horizontally positioned plate, which in turn, is attached to the vertically positioned supporting plate.

CAUTION: When the pneumatic unit is disassembled, make sure that the tubes are reconnected properly.

The picture tube unit is screwed to the front plate.

Most parts can be removed by loosening the appropriate screws.

j) Reassembling is essentially reversing what was described above.

CAUTION: When attaching the top cover, make sure that the tubes and cables are not pinched between the boards and the cover.

6.3 Troubleshooting

6.3.1 Monitor start-up sequence

After the monitor is switched on

- Fan on the rear panel starts to run.
- The self test text appears on the screen. All the memory in the monitor is checked. Program code and the date of its completion are also displayed.
- Within a half minute fields for waveforms and numeric values will appear as horizontally running straight lines and dashes on the screen. The real time clock also appears. If SpO_2 sensor is not connected to the monitor, the message "no probe" appears. If the sensor is connected to the monitor but not to the patient, the message "probe off appears. When the sensor is connected to the patient, the message "pulse search" appears and shortly pulse waveform appears on the screen.
- The NIBP software is performing its own selfcheck. If the selfcheck is completed with no error detected, the program code for NIBP appears in the lower left corner of the screen.
- The monitor is ready for use.

6.3.2 Troubleshooting in general

NOTE: Please read "Troubleshooting and Displayed Messages" in the Operator's Manual first. The part of this chart is duplicated from it.

Table 6.1 General troubleshooting chart

SYMPTOM	POSSIBLE CAUSE/REMEDY
No response when power is turned on	Power cord disconnected or not connected properly. Fuse blown. If they get blown repeatedly, go on to the electronics troubleshooting sections.
No picture	Adjust the brightness control. The primary, secondary or video fuse possibly blown. The CPU board or the power supply board faulty. If the keyboard response beep is heard, the video ASIC board or CRT unit can be faulty.
EXTERNAL RAM ERROR message	Check CPU board; RAM read/write problem. (This message possibly appears in startup). Go on to the following electronics trouble-shooting sections.
ROM CHECKSUM ERROR message	Check CPU board; EPROM read error. (This message possibly appears in startup). Go on to the following electronics troubleshooting sections.
MEMORY CIRCUIT FAILURE/CALL SERVICE message	The software, CPU board or memory IC D4 on the CPU board has been changed. Go on to section 6.3.9.1. The memory IC D4 on the CPU board is defective. Replace D4. The +5 V supply is below +4.75 V. This is an automatic power-failure protection on D4.
LOW PLETH SIGNAL message	The signal quality is poor and the measure-ment may be inaccurate. Probably no equipment malfunction. (Often occurs in patients with low perfusion).
ARTIFACT message	There is a very strong occasional AC component in the measured pleth signal. (Probably because of patient movement or vibration).
Bad or missing SpO_2 waveform and reading	Faulty SpO_2 probe. If not, faulty SpO_2 measuring or processor board.
NO PROBE message	No probe connected to the monitor. Probe faulty. Check probe connections.
NIBP INACTIVE ? SELF CHECKING... message	Timeout in Host/NIBP communication. If NIBP doesn't answer, NIBP is dropped out by main CPU. Start communication again by resetting the machine with software or by switching power off/on.

SYMPTOM	POSSIBLE CAUSE/REMEDY
PROBE OFF-message though probe properly attached to the patient	Unsuitable site. Try different site. Probe faulty.
CHECK PROBE-message	An appropriate DC level has not been found in probe signal. (Possibly because of LED in probe failure). Change the probe.
ECG problems. Constant leads off message, noise, bad trace or no pacemaker detection.	Lead selector in V-position, ECG board connector loose, faulty board.
Bad or missing plethysmogram.	Faulty transducer, faulty IPT board.
Bad or missing pressure trace.	Faulty pressure transducer or IPT board.
Erroneous or missing temperature (38°C).	Erroneous software zero set (TEMP CAL in engineering menu), bad IPT board.
Nonlinear temperature or errors at temperatures other than 38°C (Temp test button).	Bad calibration of temp trimmer cal., bad IPT board.
TEMPERATURE NOT CALIBRATED, RECALIBRATE-message	The temperatures have not been calibrated. (This message possibly appears after a factory reset). Perform calibration.
NO NIBP-message	No NIBP installed.
INVASIVE BP NOT CALIBRATED, RECALIBRATE-message	The invasive pressures have not been calibrated. (This message possibly appears after a factory reset). Perform calibration.
CUFF OCCLUSION-message	The remaining cuff pressure is more than 20 mmHg over 20 seconds after the last NIBP measurement. Automatic cycling is placed in standby mode. Cuff itself or cuff hose possibly occluded.

6.3.3 ECG board troubleshooting

In troubleshooting the ECG board it is important to note that the isolated ground has no connection to the system electronics ground. Also, if the problem is excessive high frequency noise, it may be that altering the normal ground by connecting an oscilloscope ground to the isolated ground may cancel the noise.

When checking ECG board problems, confirm that the isolated power (±12 V) is available and stable. The waveform at the secondary of T1 should be 100 kHz square wave, 50 % duty cycle and 25 - 30 Vpp.

Table 6.2 ECG board troubleshooting chart

SYMPTOM	POSSIBLE CAUSE/REMEDY
No ECG signal, 'LEADS OFF'	ECG amplifier connector loose, input amplifier or diodes blown, intermediate amplifier or pulse width modulator blown.
No ECG signal, no 'LEADS OFF'	No isolated power.
50/60 Hz noise	Notch trim error (R48).

6.3.4 RESP board troubleshooting

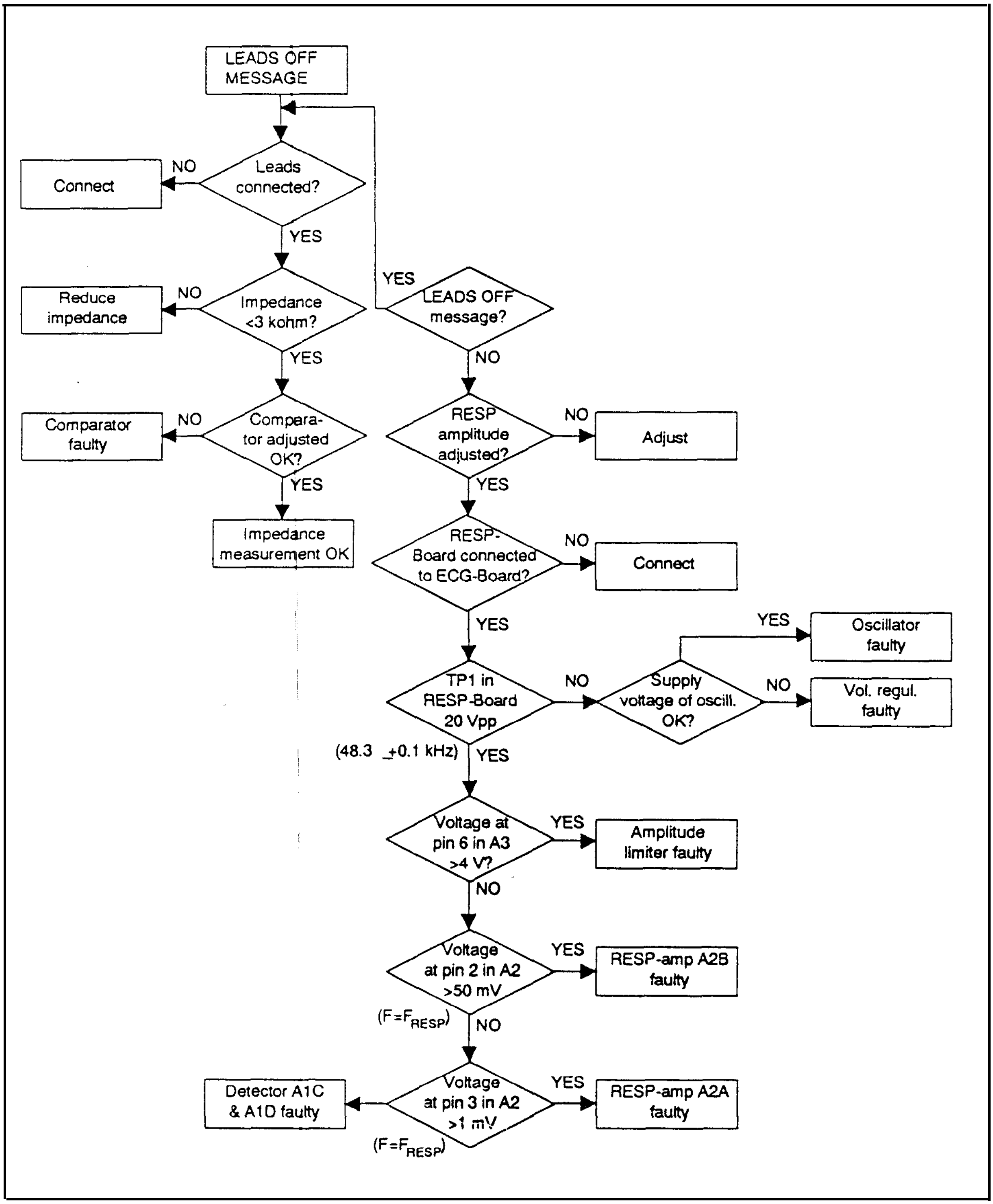


Table 6.3 RESP board troubleshooting chart

6.3.5 IPT board troubleshooting

Table 6.4 IPT board troubleshooting chart

SYMPTOM	POSSIBLE CAUSE/REMEDY
No transducers recognized, no temperature display when temp test button is depressed.	IPT board connector loose, faulty board, no isolated power mux blown, common channel blown, mux address select optoisolator blown, CPU board PPI output blown.
One transducer error.	Specific preamplifier blown, transducer blown.

6.3.6 NIBP board troubleshooting

The NIBP board has its own diagnostics software that tests the NIBP hardware every time the monitor is switched on. Should there be any trouble with the NIBP, the monitor should be switched off and on again and check for a display of a NIBP error message. If the NIBP unit is ok it will display the NIBP VER X.X. message.

Table 6.5 NIBP board troubleshooting chart

SYMPTOM	POSSIBLE CAUSE/REMEDY
NIBP HW ERR 1	External RAM error. Check that D3 is properly in place. Replace D3. Check the operation of the decoder circuit D5. Che for short circuits in the internal bus.
NIBP HW ERR 2	ROM checksum error. Replace program EPROM D2. Check for short circuits in the internal bus.
NIBP HW ERR 3	Power switch error. Check the +15 VD power switch (V1, V3). Check that +15 VD power is on (TP X7/4).
NIBP HW ERR 4	A/D converter error. Check that converter clock is running (U1/19, TP X6/2). Check that a waveform is seen on the input pin U1/6. Voltage levels should be between 0 and +5 V. Check that a waveform is show pin U1/5, if not CPU is not reading the converter or the conve is faulty. Check that the analog circuitry is operating properly and all voltages are present.
NIBP HW ERR 5	Analog zero point ERROR. Check that all voltages are present. Check circuits A4, A3, A2, A1 and U1.

SYMPTOM	POSSIBLE CAUSE/REMEDY
NIBP HW ERR 6 NIBP HW ERR 7	Pressure DC-channel zero is above or under the specified limit. Check that the pressure transducer B1 is operating. Check that all voltages are present. Check analog circuitry. Go to calibration mode and adjust trimmers R6 and R11. (refer to Chapter 7.4). **NOTE:** If the pressure transducer has drifted more than 20 mmHg the transducer is probably faulty and should be replaced.
NIBP HW ERR 8	NIBP HW-timer check. Too short time. Check watchdog circuit.
NIBP HW ERR 9	NIBP HW-timer check. Too long time. Check watchdog circuit
NIBP text is not shown at power up	NIBP CPU has not started or serial interface is not working, replace the NIBP board.
NIBP does not start	NIBP is not selected.
CUFF LOOSE message is shown	Check that cuff and hose connectors are tightly connected. Check that cuff is tightly wrapped around the arm. Check internal tubing for loose connections.
NIBP AIR LEAKAGE message is shown	Check cuff and hose connectors for air leakage. Use STASIS mode to pump 80 mmHg pressure. If pressure continuously falls close the tubing at different locations to find the leaking component.
NIBP ZERO ERROR	Unstable zero pressure due to arm movement or DC-channel zero has been drifted above or under the specified limit. May require recalibration.
Extra NIBP ARTIFACT messages	Check for air leakage.
Pressure does not rise to 270 mmHg.	Confirm that the safety valve is not operating at pressures lower than 270 mmHg.

6.3.7 SpO_2 measuring electronics troubleshooting

In troubleshooting the measuring board it is important to note that the isolated ground has no connection to the system electronics ground. Also, if the problem is excessive high frequency noise, it may be that altering the normal ground by connecting an oscilloscope ground to the isolated ground may cancel the noise.

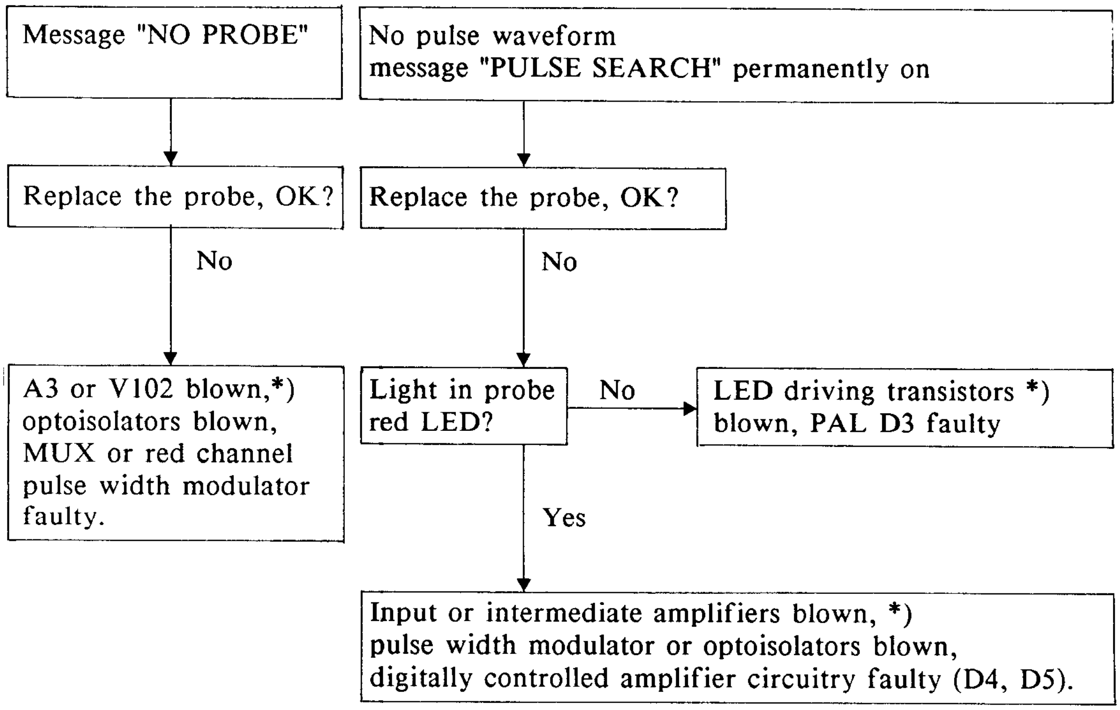
When checking measuring board problems first confirm that the isolated DC power (+12 V, -12 V, and +5 V) are present and are stable.

The troubleshooting chart of the measuring electronics is shown in Table 6.6.

For the parts layout and schematic diagram of the SpO_2 measuring board see Section 5.

Table 6.6 SpO_2 measuring electronics troubleshooting chart

Finger in probe and connected to CARDIOCAP™



*) see Figure 5.14 for signal waveforms.

NOTE: When doing any work on the measuring board care has to be taken that the patient isolation is not violated.
NOTE: When reassembling the measuring board see Figure 9.1 for the proper placement of the shields.

6.3.8 SpO_2 processor 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, however, be performed:

a) All integrated circuits are properly inserted into the sockets.

b) The 11.059 MHz clock signal at the CPU pins 18 and 19 (use a high impedance sensor to check).

c) PSEN (CPU pin 29) shows that instructions are being fetched. If this line is static, the processor is not running.

d) RESET (CPU pin 9) is normally low but pulled up to +5 V for a moment after power up. If RESET is constantly high, check the +5 V supply line for spikes or too low level.

The analog part is easier to debug. The input analog voltages are easily tracked to the MUX input. After the MUX, the voltages are multiplexed so that the resulting waveform frequency is at 200 - 600 HS.

6.3.9 CPU 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 (see Figure 5.19).

b) The 16 MHz (revision 02 and up) or 11.059 MHz clock signal at the CPU pins 18 and 19 (use a high impedance sensor to check).

c) PSEN (CPU pin 29) shows that instructions are being fetched. If this line is static, the processor is not running.

d) RESET (CPU pin 9) is normally low, but pulled to +5 V for a moment after power up. If RESET is constantly high, check the +5 V supply line for spikes or low voltage.

The analog sections are 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 frequency is at 200 - 600 HS.

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

6.3.9.1 Instructions after replacing the software or CPU board

After replacing the software, the CPU board or the memory IC D4 on the CPU board the monitor displays "MEMORY CIRCUIT FAILURE / CALL SERVICE". The content of D4 is incorrect. Performing factory reset will set the content correct.

a) Perform factory reset in the engineering menu (see the Operator's Manual Section 2).

b) Re-establish previously used settings or inform the monitor user that all other settings are default values.

6.3.10 Video ASIC board troubleshooting

Due to the number of components in video ASIC board, we recommend changing the complete board in case of failure.

6.3.11 Power supply board troubleshooting

The following troubleshooting chart will help in pinpointing a malfunctioning component. The only part that requires good understanding of operating principles are the switching supplies. Consult the IC data sheet for more information on the LM 3524 switcher controller.

Table 6.7 Power supply board troubleshooting chart

SYMPTOM	POSSIBLE CAUSE/REMEDY
No voltages.	Secondary fuses F3 and F4 blown. NOTE: They usually get blown at the same time.
Both switcher voltages missing.	Voltage reference (A2) blown, L3 blown.
One switcher voltage missing.	Faulty switcher IC (A1 or A3), power FET, bipolar trans. NOTE: If the FET is shorted it usually shorts the Transzorb zener (V6, V23) and blows the secondary fuses.

6.3.12 Mother board/Keyboard troubleshooting

Fault finding on the mother board/Keyboard is reduced to:

- visual inspection of board surface and connectors
- continuity and short circuit testing with an ohmmeter
- measuring of power supply voltages.

6.3.13 Loudspeaker /troubleshooting

Loudspeaker can be evaluated by checking its supply voltage (red wire), volume (black), and pitch (green) signals. The measurement can be performed easily by detaching the loudspeaker from the rear panel.

6.4 Service mode

The service mode is designed originally for factory use. However some simple checks can be done in the service mode to ensure the proper operation of the monitor without having to disassembly it.

Enter the service mode as follows:

a) Turn on the monitor and allow it to go into normal monitoring mode.

b) Press the softkeys 1, 2, 3, and 4 in order and then immediately press and hold down the NORMAL SCREEN key

The character 'S' blinks and the text 'SERVICE MODE ON' appears to indicate that you have entered the service mode.

c) Press soft key 4. The service mode menu will appear.

The menu is:
STAND BY
INFO
SERVICE OFF

Press the soft key 1 to move the box from selection to another. Press the NORMAL SCREEN key to enter the menu.

In STAND BY, normal monitoring can be continued even though you are in service mode.

In info, the revision and the date of the program, the date of the last factory reset performed and a list of observed faults can be seen.

7 ADJUSTMENTS

7.1 ECG board adjustment

The only adjustment on the ECG board is the 50/60 Hz notch. This is also the only difference between 50/60 Hz monitors.

To adjust the notch, feed a 1 - 10 mV 50/60 Hz signal into the ECG input, between LA and RA in LEAD 1 configuration, either through a resistive divider from system bus pin 31c (22 Vac) or from a signal generator. Adjust R48 (accessible from top of the ECG board) to minimize the displayed amplitude (fast speed).

WARNING: When doing any work on the ECG and IPT boards, care has to be taken that the patient isolation is not violated.

7.2 RESP board adjustment

Test equipment

* Oscilloscope 10 mV/div.
* Frequency counter

Oscillator adjustment

Connect oscilloscope and frequency counter to test point TP1 (pin 1 in connector X2). A nearly sinusoidal signal of amplitude almost +10 V should be seen on the oscilloscope.

Adjust the frequency to 48.3 kHz ±100 Hz with trimmer R54.

LEADS OFF threshold adjustment

Connect 3 kohm resistor between yellow and black patient cables.

Turn trimmer R53 counter-clockwise until the message LEADS OFF appears on the screen of the host monitor. Turn the trimmer carefully and slowly clockwise until the message disappears.

Remove the 3 kohm resistor and make sure that the message returns to the screen.

Connect the cables together and see that the message disappears.

Confirm that the message does not appear when a resistor whose value is less than 3 kohm is connected between the cables.

7.3 IPT board adjustment

The only adjustments on the IPT board are the temperature gain set trimmers, which are adjusted as follows:

a) Set the 38°C TEMP CAL via the engineering menu. To enter the engineering menu keep MARK RESET softkey depressed during power up until the menu appears. With temperature measuring jack disconnected choose CALIBRATE and TEMP CAL, depress the TEMP TEST button and adjust the reading to 38.0°C.

b) Insert a plug with a precision resistor listed below into the jack receptacle and adjust R11 to show the correct temperature. The trimmers are accessible from above without removing the IPT-ECG board assembly.

YSI 400 series temperature-resistance table:

°C	Ohms
15	3539
20	2814
25	2253
30	1815
35	1471
38	1301
40	1200
44	1024

NOTE: For temperature gain calibration use a precision resistor between 3539 and 2000 ohms.

WARNING: When doing any work on the ECG and IPT boards, care has to be taken that the patient isolation is not violated.

7.4 NIBP board adjustment

The NIBP board automatically performs all adjustments except pressure calibration, which must be done manually. Pressure zero is automatically maintained by the processor. If the zero point drifts too much NIBP transmits an error message. Normally zero point trimmer R6 should not be touched.

CALIBRATION

NIBP calibration can be performed as follows:

a) Enter engineering menu by pressing MARK RESET key during power up. Keep the key down until the “STARTING” sequence has been completed.

b) Press soft key 2 to enter calibration mode.

c) Press soft key 2 again to enter NIBP calibration.

d) In the calibration mode, the automatic zero adjustment is not operating to allow the adjustment of the pressure channel zero trimmer R6 (upper trimmer on the NIBP board). Adjust R6 until the mean pressure value M is zero. Make sure that the upper pneumatic connector is not connected to a pressure source to allow proper zeroing.

e) Remove the female connector from an adult cuff and connect it to the male connector in the twin hose. Connect an external pump and mercury manometer to it and pump the pressure up to 200 mmHg and adjust the calibration trimmer R11 (lower trimmer on the NIBP board) until the mean value M shows 200.

f) Repeat steps d) and e) until zero and 200 mmHg readings are both correct.

g) Check the linearity of the pressure transducer at the pressure of 100 mmHg.

h) Press “RETURN TO MONITOR” to enter normal operating mode.

NOTE: In the normal operating mode the zero pressure drift is compensated by software and this drift does not affect the accuracy of the device. If zero drift is more than ±20 mmHg NIBP issues an error message, see troubleshooting chart.

7.5 SpO_2 processor board adjustment

There are only two adjustments on the SpO_2 processor board:

1) A/D-converter zero (R9).

2) A/D-converter 10 V reference (R8).

The A/D-converter adjustments are performed only at the factory.

7.6 CPU board adjustment

There is one adjustable capacitor on the CPU board for real time clock oscillator frequency. It is factory adjusted, but may need to be readjusted if some components are replaced.

Real time clock oscillator frequency

The real time clock oscillator frequency is set by connecting a counter to pin 15 of D16 and adjusting C49 to read 256.00 Hz corresponding to a cycle time of 3906.25 us.

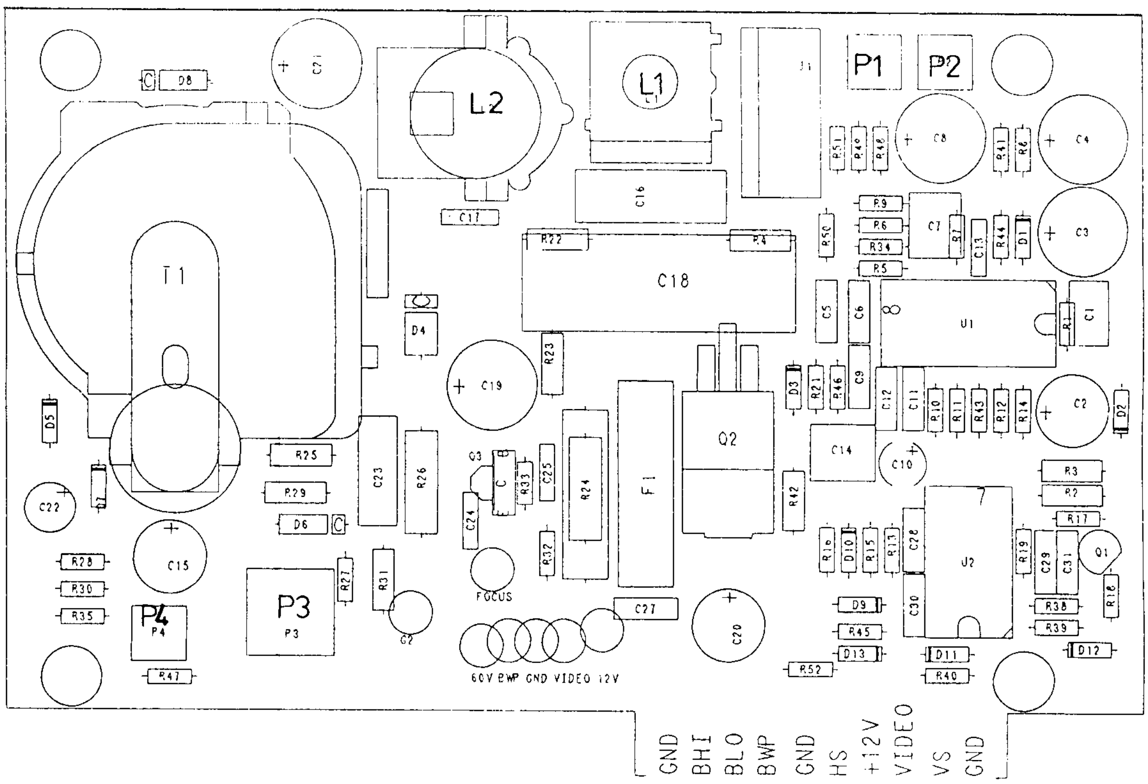
NOTE: The high speed CPU board does not require any adjustments.

7.7 Video Display Unit (Philips) Adjustments

The following adjustments can be done in the Philips CRT display board:

Basic brightness adjustment	Trimmer potentiometer P4
Horizontal width	Trimming indutance L1
Vertical height	Trimmer potentiometer P2
Horizontal positioning	Trimmer potentiometer P1
Horizontal linearity	Trimmer magnet L2
Focus	Trimmer potentiometer P3

Figure 7.1 Video Display Unit Adjustment



8 FUNCTIONAL FIELD CHECK PROCEDURE

8.1 Preoperative check list

Perform the following tests daily to assure proper operation of the monitor.

> **WARNING:** If the monitor fails to respond as described, stop using the monitor, troubleshoot, and correct the situation.

Power up

Turn the power on. The monitor performs a start-up and self test procedure.

Confirm that no error messages appear.

ECG Check

a) Plug an ECG cable into the ECG connector receptacle on the front panel.

b) Connect the ECG lead wires to the clip-on connectors on the monitor's rear panel according to the letter codes.

c) Turn the lead selector to position I.

The ECG waveform should display a train of 1 mV pulses with a frequency of 60 ±1 bpm.

Confirm that the QRS indicator '*' is flashing to the left and above the ECG channel.

d) Remove the ECG leads from the test pins. Ensure that the message 'LEADS OFF' appears in the upper right corner of the screen.

NIBP Check

a) Assemble the blood pressure cuff with the cuff hose and connect it to the NIBP connector on the rear panel.

b) Attach the cuff to your arm.

c) Take a blood pressure measurement by pressing the START key. Confirm that the pump inflates the cuff. Confirm that the cuff pressure is displayed during measurement and that final systolic, diastolic, and mean values are displayed.

SpO_2 Check

a) Connect the pulse oximeter sensor to the monitor. The message 'NO PROBE' is replaced by 'PROBE OFF'.

b) Confirm that the red light is seen from the sensor, and that the sensor surface is undamaged.

c) Attach the pulse oximeter sensor to your finger.

Wait for the pulse search to be completed and readings to stabilize. Verify that the SpO_2 readings are in the expected range and that the plethysmographic pulse waveform is regular.

8.2 Checks after component replacements

The following test should be performed after any service to ensure proper operation of the monitor.

a) Check visually that tubes, valves, and pump are properly connected. Tubes are not pinched, clogged, or jammed. There should be no sharp bends either.

b) Connect power cord and switch the monitor on.

c) Check that no error messages are shown.

d) Check the operation of the real time clock:
- Verify the date (use engineering menu).
- Verify time.
- Check that the clock is running.

e) Connect the ECG cable to the rear panel test connectors. Verify that the test signal is shown on the display. Heart rate display should read 60 ±1.

f) Connect the invasive blood pressure transducer(s) to the front panel connector(s) PRESSURE 1 (and 2). Zero the sensor(s) by pressing PRESSURE key and soft key 1 (and 2). Verify proper operation by connecting a manometer and hand pump in series with the transducer(s). Check calibration at 200 mmHg pressure.

g) Connect the NIBP cuff. Perform one measurement with yourself. Verify operation. Perform venous stasis (see the Operator's Manual Section 7) and check for leaks. Check NIBP calibration (see Section 7.4).

h) Check temperature channel by pressing the TEMP TEST switch. Reading should be 38.0 ±0.1°C (100.4 ±0.2°F).

i) Connect the SpO_2 sensor and observe the message PULSE SEARCH followed by PROBE OFF. Put the sensor on your finger and keep the hand still.

The message PULSE SEARCH should appear first.

A numeric value should appear next in the SpO_2 field (normally between 94 and 98 in non-anesthetized people).

The plethysmographic pulse waveform from SpO_2 sensor should be shown on the screen,

j) Keep the SpO_2 sensor on your finger for several minutes. Press the TRENDS key and check that the measurement results are enough to draw trend waveform.

k) Check the operation of the loudspeaker by creating an alarm state.

l) Connect serial printer to serial & analog I/O connector on the rear panel of the monitor. Turn the power on and check that the printer prints data correctly.

m) Reset the monitor by pressing the MARK RESET key for about five seconds.

n) Check the leakage current of the unit. Check the condition of all cables and connectors.

o) Disconnect power cord for 30 minutes. Then connect it back and turn the monitor on. When the initialization is over, make trend displayed on the screen. The trend which had been measured before the power cut-off should be displayed.

p) Check that there are no dirt stains in the monitor. Top cover, side panels, and bottom plate are properly attached with screws.

8.3 Preventive maintenance check list

We recommend that you perform these checks at least once every six months to keep the monitor in good working condition.

1. VISUAL INSPECTIONS **OK**

a) Remove the top cover and check internal tubing system for sharp bends and dirt. ☐

b) Rear panel dust filter (clean at least once a month). ☐

c) Screen for distortion (adjust if necessary). ☐

d) Software version numbers (update if necessary). ☐

2. MAIN FUNCTIONAL CHECKS **OK**

e) Check ECG functions (see Section 8.2 step e)). ☐

f) Check invasive blood pressure measurement (see Section 8.2 step f)). ☐

g) Check NIBP operation (see Section 8.2 step g)). ☐

h) Check temperature (see Section 8.2 step h)). ☐

i) Check Pulse oximeter functions (see Section 8.2 step i)). ☐

j) Check date in the engineering menu. ☐

k) Check real time in SETUP menu. ☐

l) Check the function of the loudspeaker in SETUP menu. ☐

9 SPARE PARTS

9.1 Spare parts

For the locations of the main parts see Figure 9.1.

ITEM	ITEM DESCRIPTION	ORDER NO.
21	Lithium battery 3.4 V, 650 mAh (rev 00 and 01)	17503*
13	Fuse 4 A, slow miniature (for 880882)	51060*
56	Fuse holder	51179
2	Fuse 2.5 A, slow	51118*
2	Fuse 2.5 A, slow UL/CSA approved	511181*
14	Fuse 3.15 A, slow (for 880882)	51119*
6	Loud-speaker	874619
48	Switch cable	52118
16	Power cord receptacle block	52124
10	Mains cable (USA)	86236*
10	Mains cable (EUR)	54563*
	Mains filter	26906
48	Mains switch	52128
57	Mains switch cable	52130
44	Video display unit, complete	875244
39	Foot front	65160
11	Foot rear	65161
7	Fan	870641
3	Dust filter	871558**
	Dust filter (rev 02 and up)	880832**
1	Dust filter holder	871559
	Dust filter holder (02 and up)	880833
53	Bar for filter holder	873085
53	Bar for filter holder (02 and up)	877337
54	Holder plate for fan (02 and up)	879253
4	Wire net	871684
38	Keyboard	877543
31	Mother board	877305
18	ASIC video control board	885480*
58	Transformer housing unit	888597
20	CPU board, without software	878822*
21	SRAM MK48T08, Timekeeper (high speed CPU)	139422
19	Software (-, 2, R, 1R) (English) (rev 00)	878107
19	Software (-, 2, R, 1R) (German) (00)	878108
19	Software (-, 2, R, 1R) (French) (00)	878109
19	Software (-, 2, R, 1R) (Germany) (00)	878110
19	Software (S, 2S, RS, 1RS) (English) (00)	878111
19	Software (S, 2S, RS, 1RS) (German) (00)	878112
19	Software (S, 2S, RS, 1RS) (French) (00)	878113
45	Video frame	877591

ITEM	ITEM DESCRIPTION	ORDER NO.
19	Software (S, 2S, RS, 1RS) (Germany) (00)	878114
19	Software (-, 2, R, 1R) (English) (rev 01)	879425
19	Software (-, 2, R, 1R) (German) (01)	879426
19	Software (-, 2, R, 1R) (French) (01)	879427
19	Software (-, 2, R, 1R) (Germany) (01)	879428
19	Software (S, 2S, RS, 1RS) (English) (01)	879429
19	Software (S, 2S, RS, 1RS) (German) (01)	879430
19	Software (S, 2S, RS, 1RS) (French) (01)	879431
19	Software (S, 2S, RS, 1RS) (Germany) (01)	879432
20	High speed CPU board, without software	880523*
19	Software (-, 2, R, 1R) (English) (rev 02)	880788
19	Software (-, 2, R, 1R) (German) (02)	880789
19	Software (-, 2, R, 1R) (French) (02)	880790
19	Software (-, 2, R, 1R) (Germany) (02)	880791
19	Software (S, 2S, RS, 1RS) (English) (02)	880784
19	Software (S, 2S, RS, 1RS) (German) (02)	880785
19	Software (S, 2S, RS, 1RS) (French) (02)	880786
19	Software (S, 2S, RS, 1RS) (Germany) (02)	880787
19	Software (-, 2, R, 1R) (English) (rev 03)	882597
19	Software (-, 2, R, 1R) (German) (03)	882598
19	Software (-, 2, R, 1R) (French) (03)	882599
19	Software (-, 2, R, 1R) (Germany) (03)	882600
19	Software (S, 2S, RS, 1RS) (English) (03)	882593
19	Software (S, 2S, RS, 1RS) (German) (03)	882594
19	Software (S, 2S, RS, 1RS) (French) (03)	882595
19	Software (S, 2S, RS, 1RS) (Germany) (03)	882596
12	Power supply board	880882*
28	Pump unit for NIBP, complete	877607*
29	Pneumatic unit	879537
	Pneumatic tubing	879536
	Shunt valves (I and II)	876964
	Damping chamber III	879535
	Damping chamber III (02 and up)	880798
36	IPT board (1-press.)	883067
36	IPT board (2-press.)	882891
36	IPT board (2-press. 1-temp)	877545*
36	IPT board (1-press. 1-temp)	877606*
36	IPT board (0-press. 1-temp)	877605*
36	IPT board (1-press. 1-temp) (Fin)	879700
36	IPT board (0-press. 1-temp) (Fin)	879701
36	IPT board (2-press. 1-temp) (Fin)	879702
46	Pleth/pressure cable connector	874785
37	ECG amplifier board	880509*
37	ECG amplifier board (Fin)	880511*
37	ECG amplifier board (ready for RESP board)	876628*
37	ECG amplifier board (ready for RESP board) (Fin)	879350
37	ECG amplifier board with RESP measurement	885012

ITEM	ITEM DESCRIPTION	ORDER NO.
35	RESP board	876629*
59	Connector board (1-press.)	887836
59	Connector board (2-press.)	887839
40	NIBP safety valve	877109*
34	NIBP board, without software	876963*
34	NIBP board, without software (Germany)	878513*
33	NIBP software	879808
33	NIBP software (Germany)	879809
32	NIBP pressure transducer	16533*
15	NIBP magnetic valve unit	877038
55	Interference filter	881940
5	Cuff connector	64654
9	Mains transformer, 100 V	878451
9	Mains transformer, 115 V	878452
9	Mains transformer, 220 V	878453
9	Mains transformer, 220 V (France)	878454
9	Mains transformer, 240 V	878455
50	Front plate	877429
51	Front panel plate	877501
49	Front panel (-) (English)	877626
49	Front panel (-) (German)	877674
49	Front panel (-) (French)	878363
49	Front panel (R) (English)	877627
49	Front panel (R) (German)	878515
49	Front panel (R) (French)	878476
49	Front panel (1R) (English)	877629
49	Front panel (1R) (German)	878516
49	Front panel (1R) (French)	878514
49	Front panel (2) (English)	877628
49	Front panel (2) (USA)	877653
49	Front panel (2) (German)	878152
49	Front panel (2) (French)	878283
49	Front panel (S) (English)	877623
49	Front panel (S) (USA)	877642
49	Front panel (S) (German)	878101
49	Front panel (S) (French)	878282
49	Front panel (2S) (English)	877625
49	Front panel (2S) (USA)	877644
49	Front panel (2S) (German)	877671
49	Front panel (2S) (French)	877854
49	Front panel (RS) (English)	877622
49	Front panel (RS) (German)	878369
49	Front panel (RS) (French)	878329
49	Front panel (1RS) (English)	877624
49	Front panel (1RS) (USA)	877645
49	Front panel (1RS) (German)	877675
49	Front panel (1RS) (French)	877669

ITEM	ITEM DESCRIPTION	ORDER NO.
8	Rear panel / CH (English)	887898
8	Rear panel / CH (German)	887897
8	Rear panel / CH (French)	887896
24	Top cover	872894
27	Enclosure bottom	877532
25	Side cover	872893
26	Side panel screw	61655
52	Hole covering pad (1-press. 1-temp)	877761
52	Hole covering pad (2-press. 1-temp)	877762
52	Hole covering pad (0-press. 1-temp)	877770
41	Instruction sheet 1, (-, 2, S, 2S) English	878090
41	Instruction sheet 1, (R, 1R, RS, 1RS) English	878087
42	Instruction sheet 2, (-, R) English	878091
42	Instruction sheet 2, (2, 1R) English	878092
42	Instruction sheet 2, (S, RS) English	878093
42	Instruction sheet 2, (2S, 1RS) English	878088
43	Instruction sheet 3, English (rev 00)	878089
43	Instruction sheet 3, English (01 and up)	879543
41	Instruction sheet 1, (-, 2, S, 2S) German	878434
41	Instruction sheet 1, (R, 1R, RS, 1RS) German	878431
42	Instruction sheet 2, (-, R) German	878435
42	Instruction sheet 2, (2, 1R) German	878436
42	Instruction sheet 2, (S, RS) German	878437
42	Instruction sheet 2, (2S, 1RS) German	878432
43	Instruction sheet 3, German (00)	878433
43	Instruction sheet 3, German (01 and up)	879544
41	Instruction sheet 1, (-, 2, S, 2S) French	878498
41	Instruction sheet 1, (R, 1R, RS, 1RS) French	878495
42	Instruction sheet 2, (-, R) French	878499
42	Instruction sheet 2, (2, 1R) French	878500
42	Instruction sheet 2, (S, RS) French	878501
42	Instruction sheet 2, (2S, 1RS) French	878496
43	Instruction sheet 3, French (00)	878497
43	Instruction sheet 3, French (01 and up)	879545
30	SPO_2 board (rev 04 and up)	888210
30	SpO_2 measuring board (rev 00, 01 and 02)	875842*
30	SpO_2 measuring board (rev 03 and up)	881989
23	SpO_2 processor board	874688*
47	SpO_2 panel connector with int. cable	874689
22	SpO_2 software (rev 00)	875360
22	SpO_2 software (01 and 02)	878105
22	SpO_2 software (03 and up)	882881

In your rear panel or front panel order, please specify the serial number and the full monitor code as found in the type shield on the rear panel.

* = The part is recommended for stock.

** = The part is sold as an accessory.

9.2 Service accessories

ITEM DESCRIPTION	ORDER NO.
Extension board (lifts the board above the stack of boards to allow measurements)	872930
Cardiocap simulator (for a quick check of the monitor functions)	874027
Temperature calibration test plug set	874876

Figure 9.1 Exploded pictures of the monitor

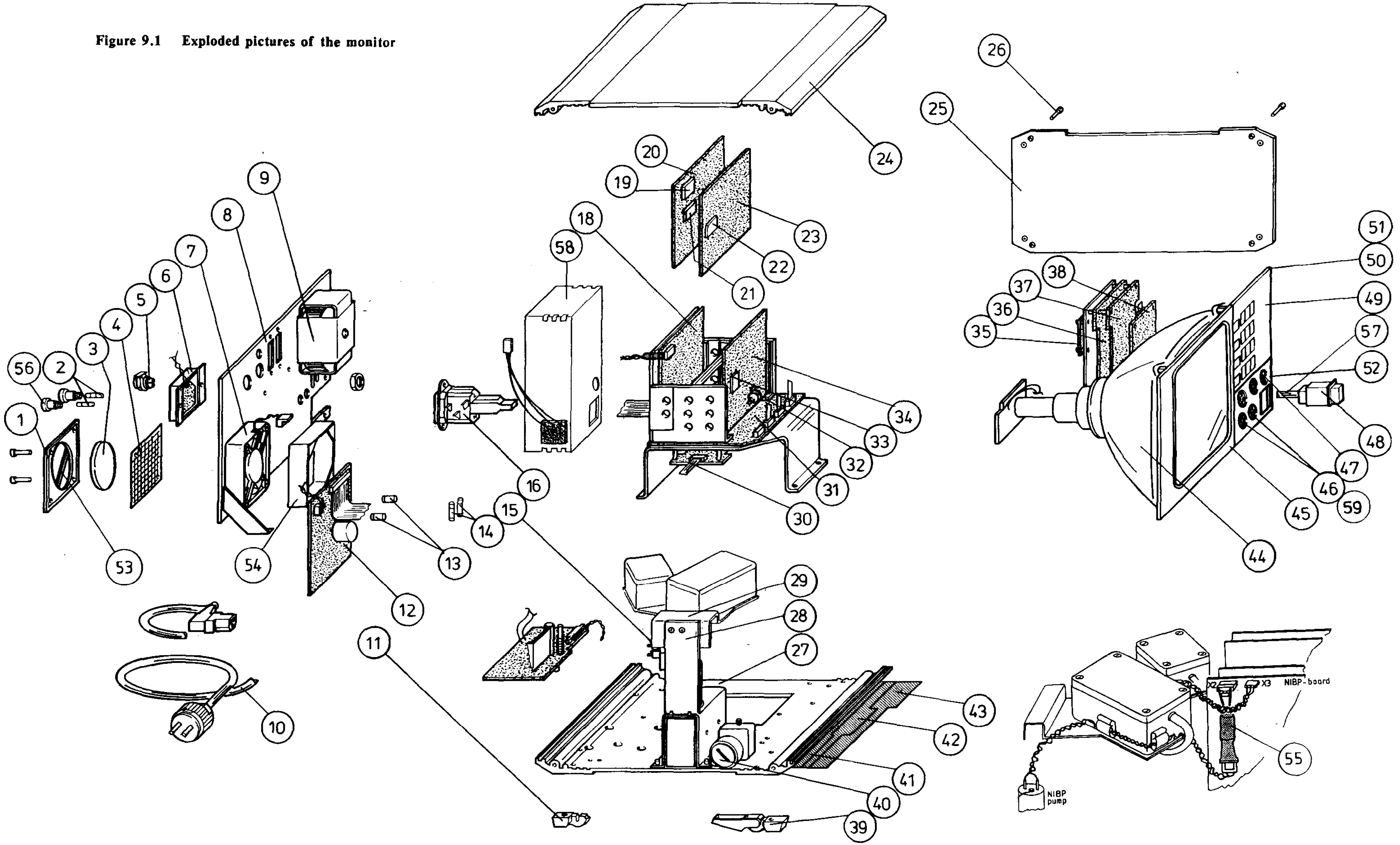
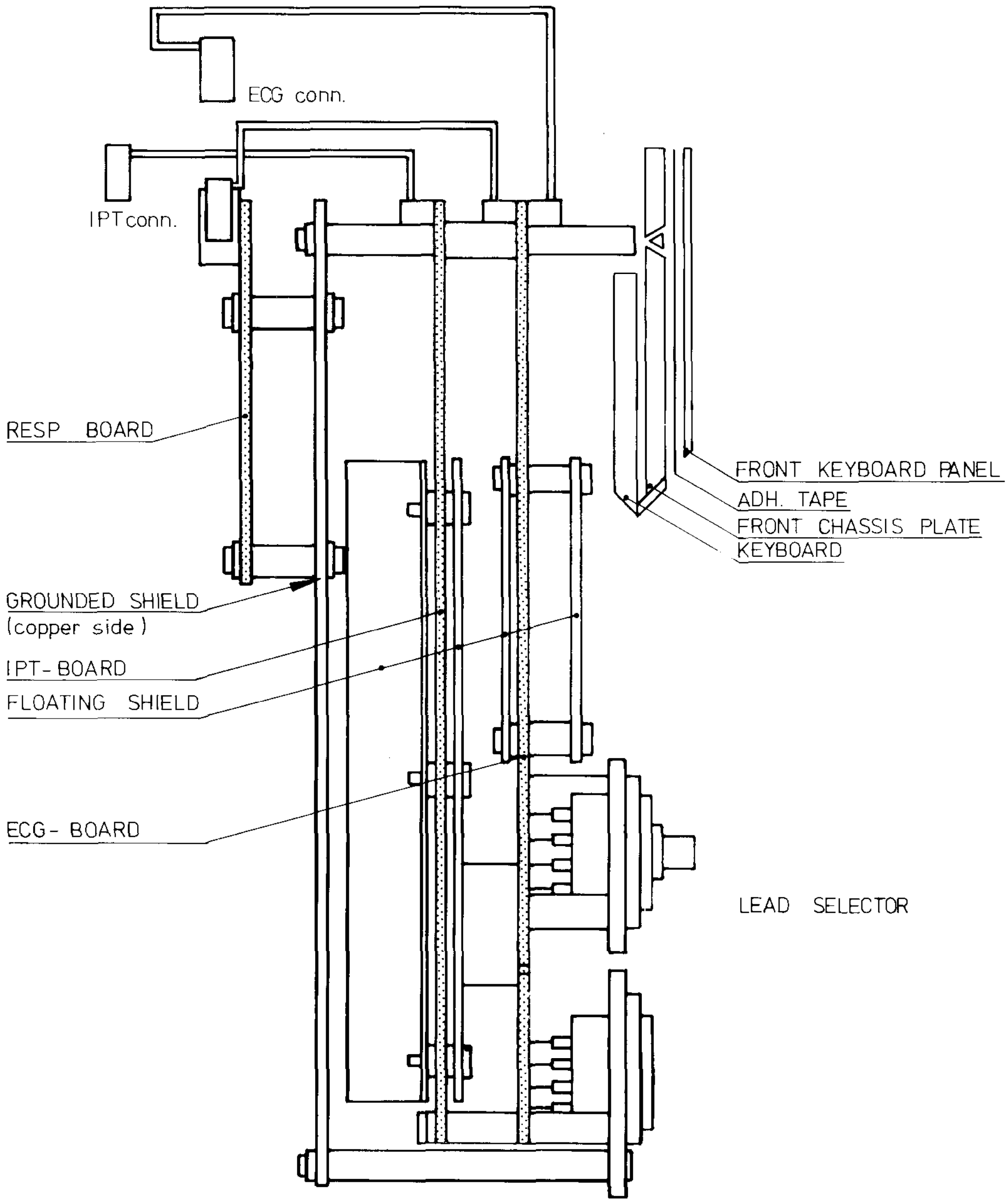


Figure 9.2 ECG, IPT, and RESP board assembly



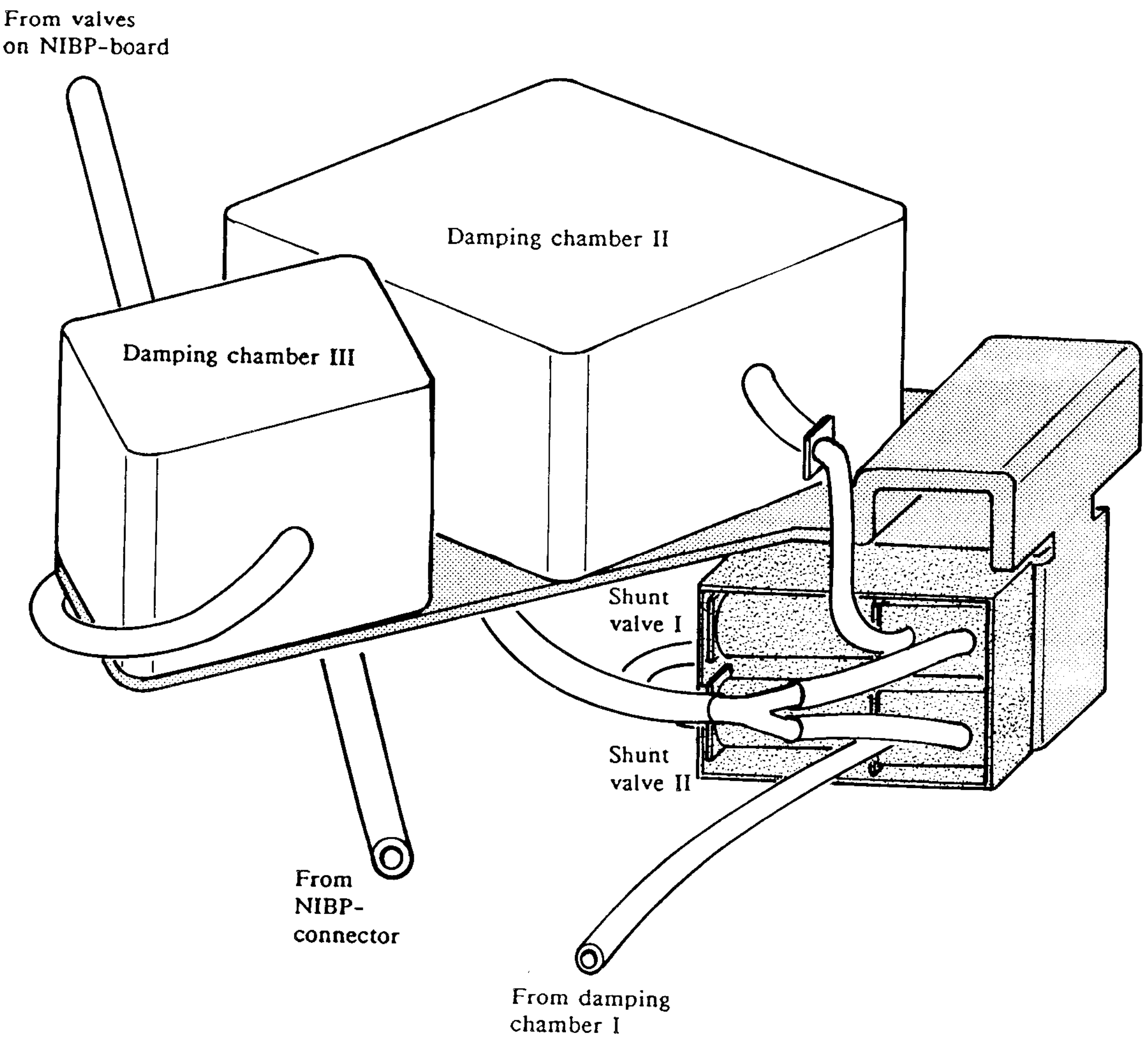


Figure 9.3 Pneumatic unit parts layout

Figure 5.2 ECG board parts layout (CH, CH-2, CH-S, CH-2S)

Figure 5.2a (on the next page) ECG board schematic diagram (CH, CH-2, CH-S, CH-2S)

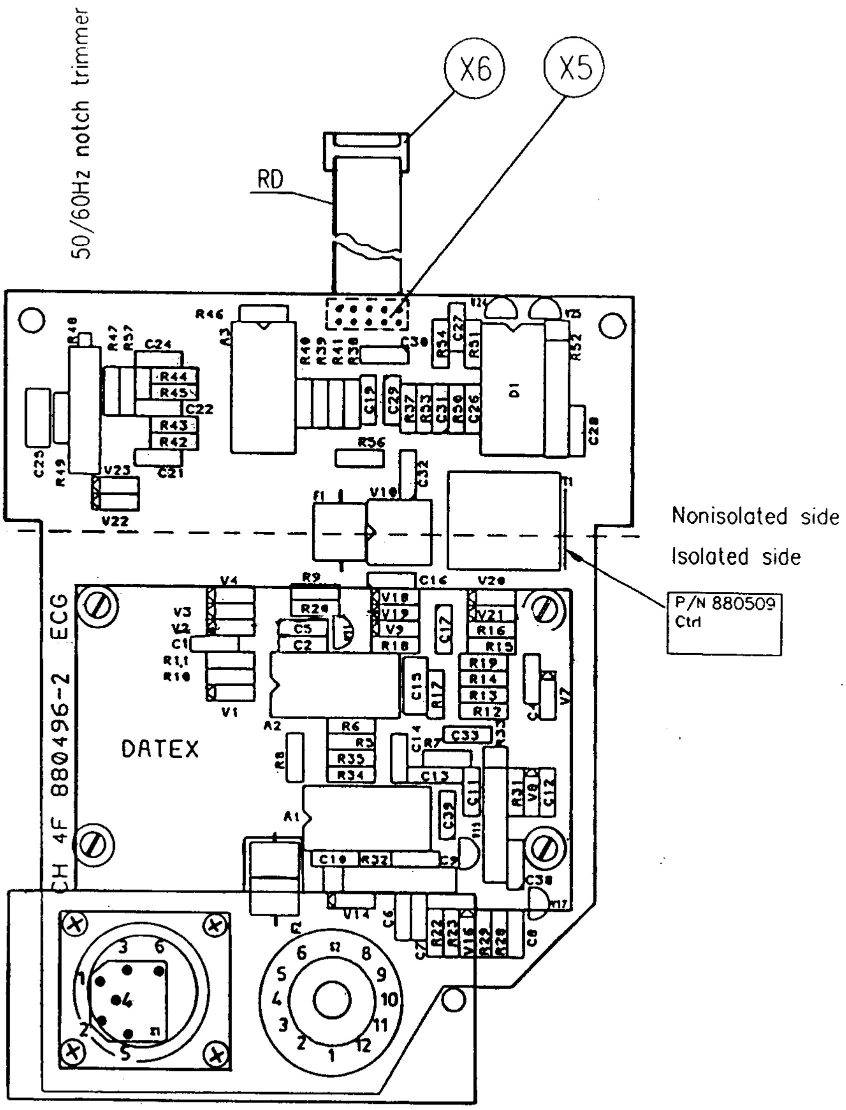
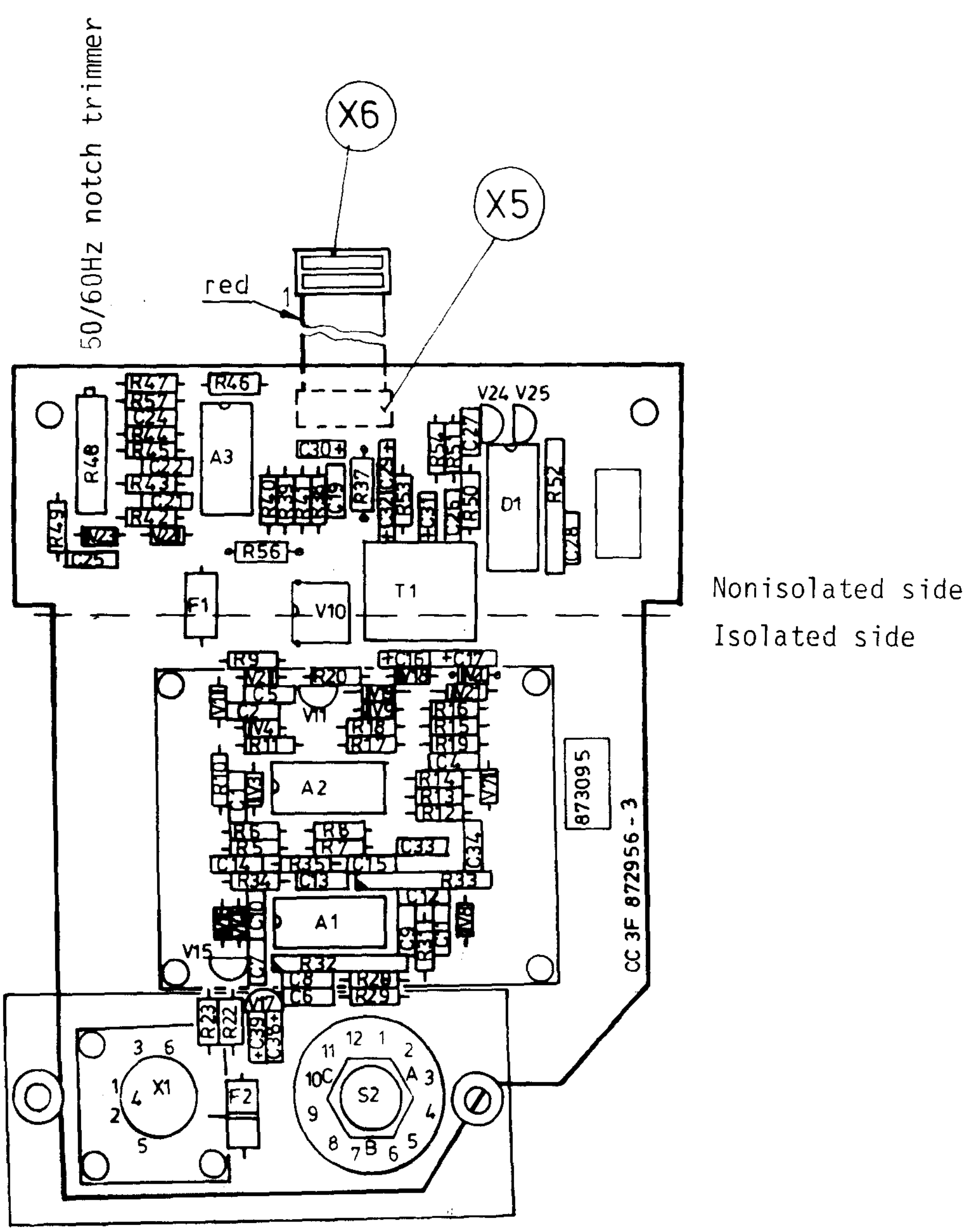
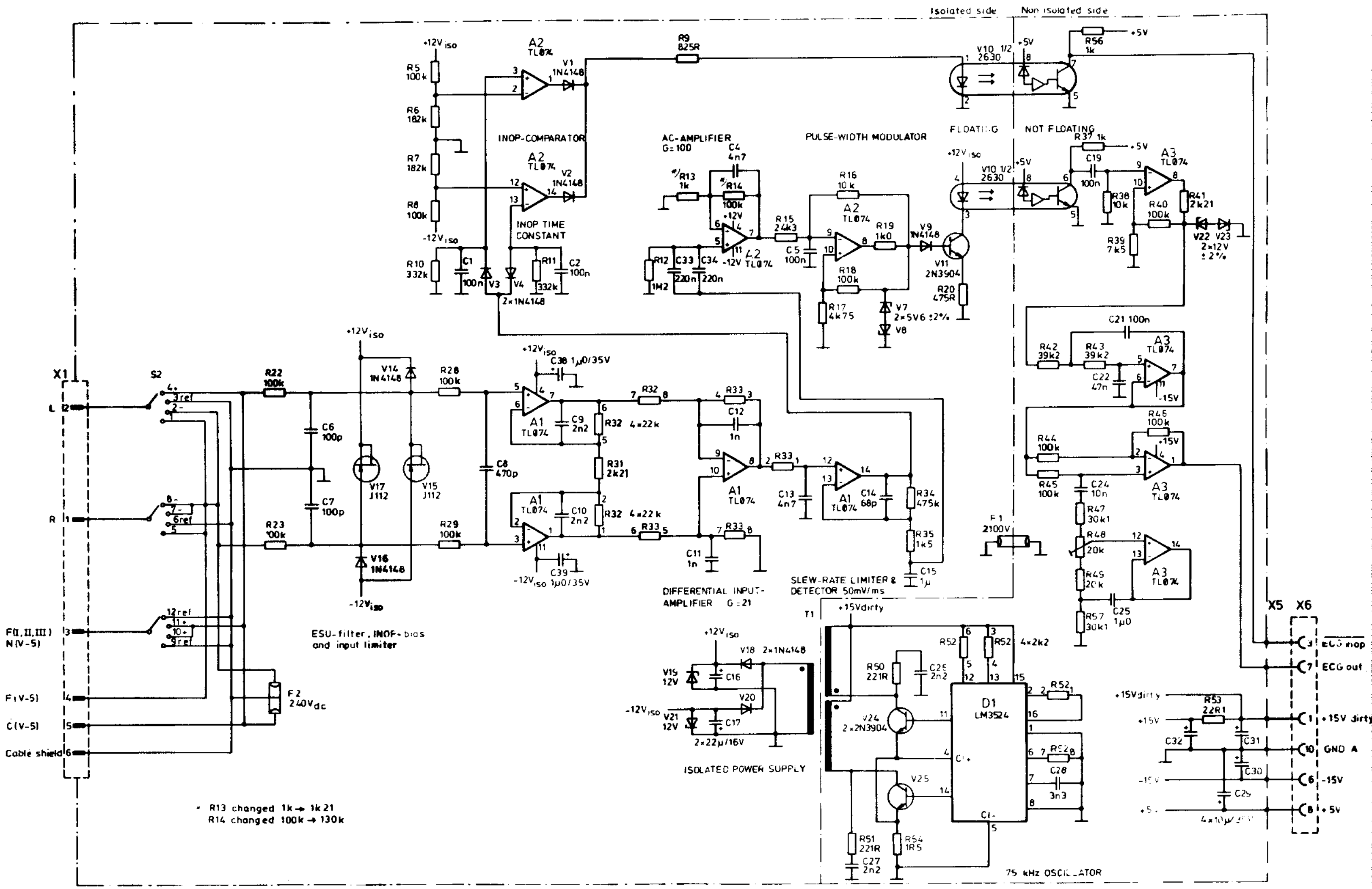
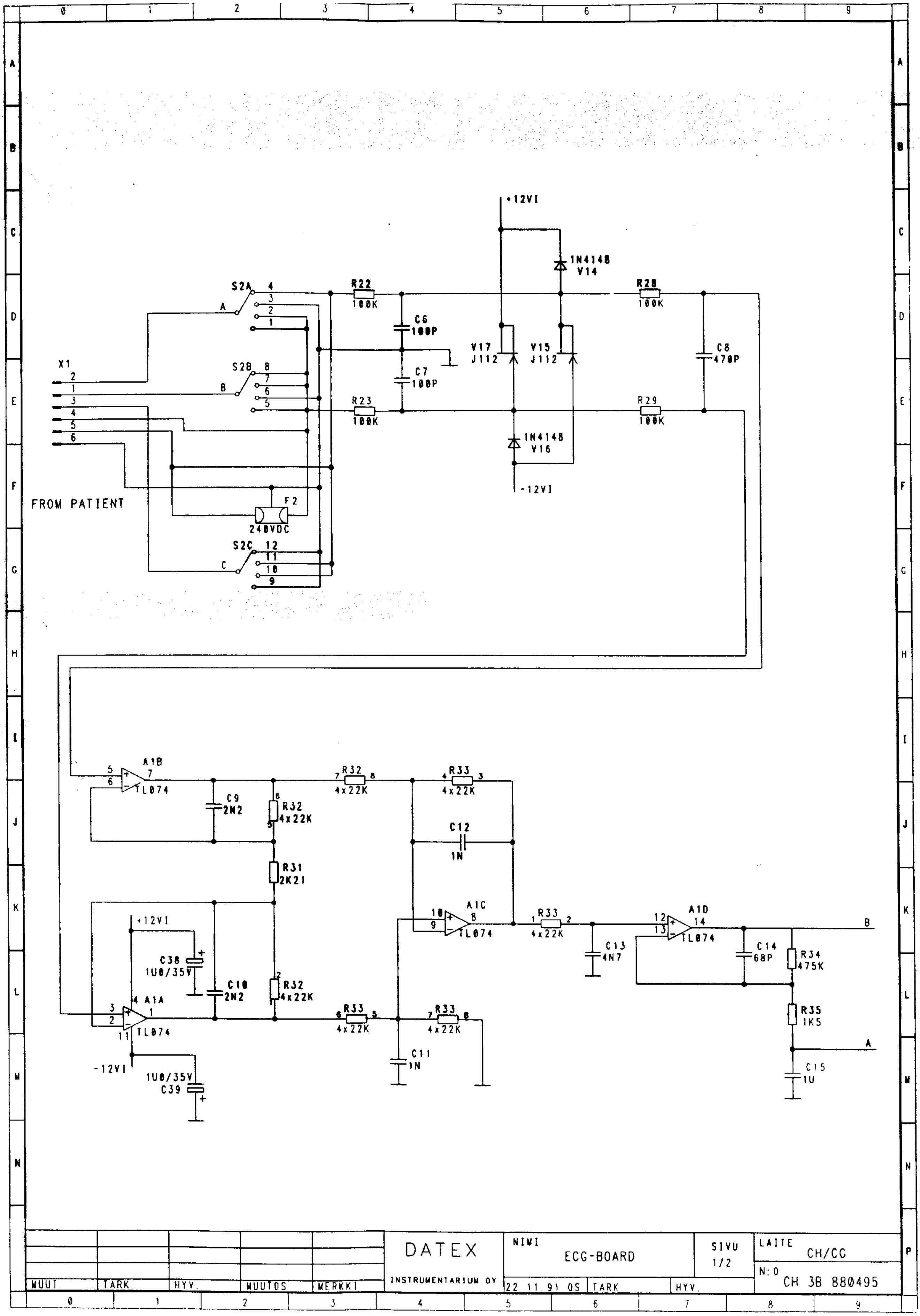


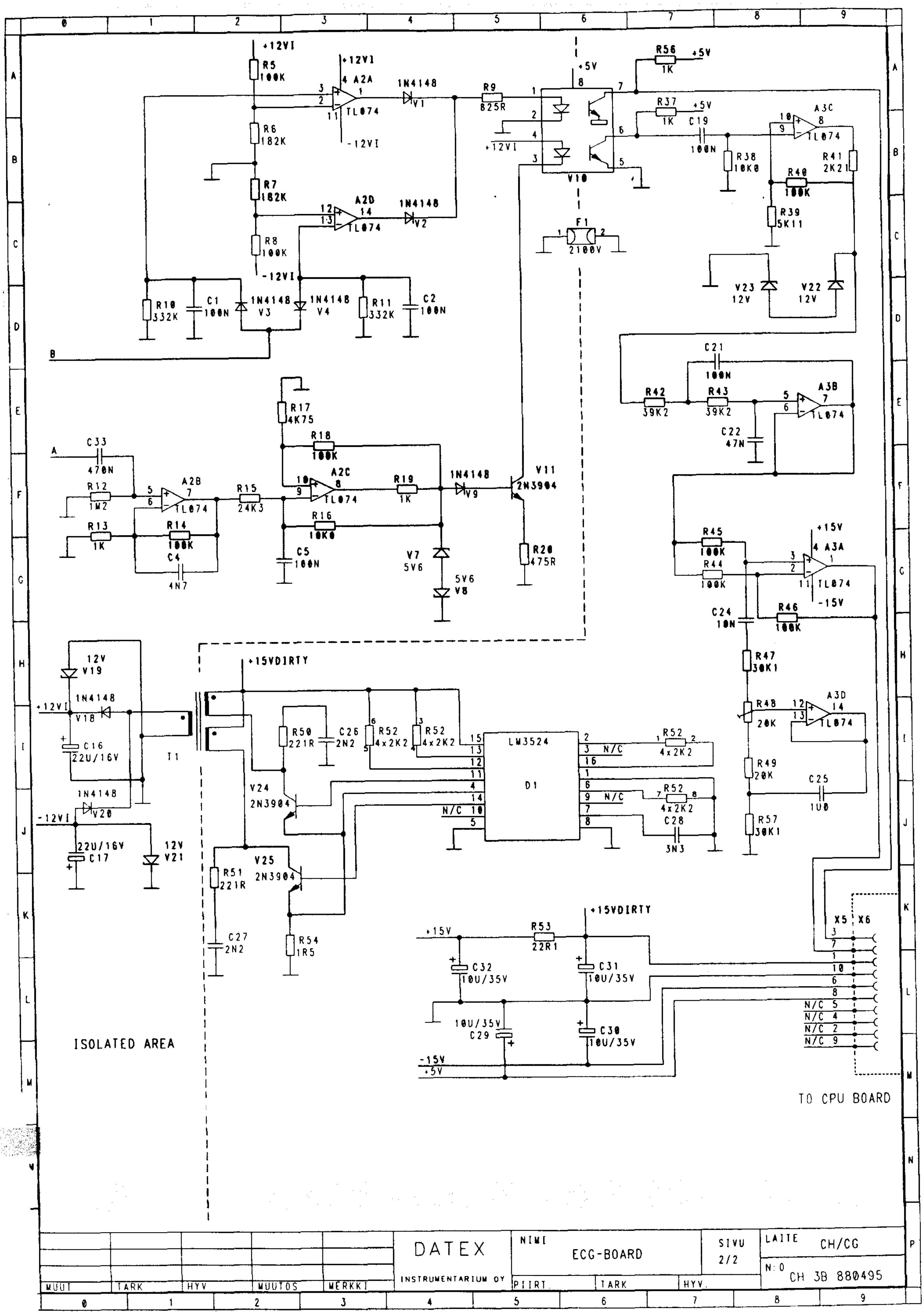
Figure 5.2 ECG board parts layout.
(CH, CH-2, CH-S, CH-2S)
(board modification level 9 and lower)

Figure 5.2a (on the next page)
ECG board schematic diagram.
(CH, CH-2, CH-S, CH-2S)
(board modification level 9 and lower)




Isolated side
Non isolated side
INOP-COMPARATOR
INOP TIME CONSTANT
AC-AMPLIFIER G=100
PULSE-WIDTH MODULATOR
FLOATING
NOT FLOATING
ESU-filter, INOP-bias and input limiter
DIFFERENTIAL INPUT-AMPLIFIER G=21
SLEW-RATE LIMITER & DETECTOR 50mV/ms
ISOLATED POWER SUPPLY
75 kHz OSCILLATOR
X1
X5
X6
S2
L
R
F(I, II, III) N(V-5)
F(V-5)
C(V-5)
Cable shield
F2 240Vdc
F1 2100V
T1
D1 LM3524
V10 1/2 2630
ECG inop
ECG out
+15V dirty
GND A
-15V
+5V
* R13 changed 1k → 1k21
R14 changed 100k → 130k

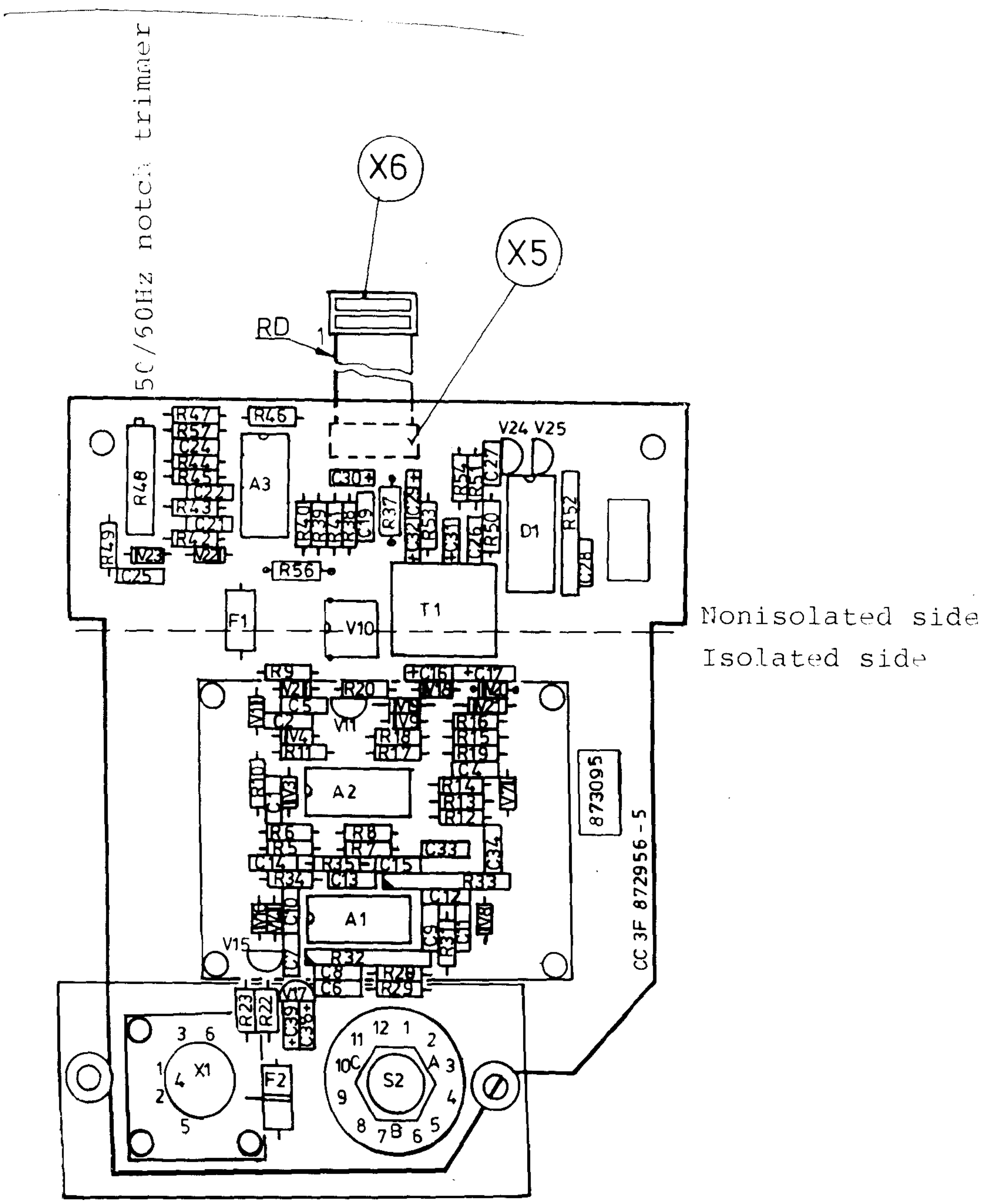

+12VI
1N4148
V14
S2A
R22
100K
R28
100K
C6
100P
V17
J112
V15
J112
C8
470P
X1
S2B
C7
100P
R23
100K
R29
100K
1N4148
V16
-12VI
FROM PATIENT
F2
240VDC
S2C
A1B
TL074
R32
4x22K
R33
4x22K
C9
2N2
C12
1N
R31
2K21
A1C
TL074
A1D
TL074
+12VI
C38
1U0/35V
C10
2N2
C13
4N7
C14
68P
R34
475K
A1A
TL074
C11
1N
R35
1K5
C15
1U
-12VI
1U0/35V
C39
DATEX
INSTRUMENTARIUM OY
NIMI
ECG-BOARD
SIVU
1/2
LAITE
CH/CC
N:O
CH 3B 880495
MUUT
TARK
HYV.
MUUTOS
MERKKI
22 11 91 OS



+12VI
R5 100K
R6 182K
R7 182K
R8 100K
A2A TL074
A2D TL074
1N4148 V1
1N4148 V2
-12VI
R9 825R
+5V
V10
F1 2100V
R56 1K
R37 1K
C19 100N
R38 10K0
A3C TL074
R40 100K
R41 2K21
R39 5K11
V23 12V
V22 12V
R10 332K
C1 100N
1N4148 V3
1N4148 V4
R11 332K
C2 100N
C21 100N
R42 39K2
R43 39K2
A3B TL074
C22 47N
C33 470N
R12 1M2
A2B TL074
R13 1K
R14 100K
C4 4N7
R15 24K3
R17 4K75
R18 100K
A2C TL074
R19 1K
R16 10K0
C5 100N
1N4148 V9
V11 2N3904
R20 475R
V7 5V6
5V6 V8
+15V
R45 100K
R44 100K
A3A TL074
-15V
C24 10N
R46 100K
R47 30K1
R48 20K
A3D TL074
R49 20K
C25 1U0
R57 30K1
12V V19
1N4148 V18
C16 22U/16V
T1
1N4148 V20
22U/16V C17
12V V21
+15VDIRTY
R50 221R
C26 2N2
R52 4x2K2
LM3524
D1
N/C
C28 3N3
V24 2N3904
V25 2N3904
R51 221R
C27 2N2
R54 1R5
R53 22R1
C32 10U/35V
C31 10U/35V
C29 10U/35V
C30 10U/35V
-15V
+5V
X5 X6
TO CPU BOARD
ISOLATED AREA
DATEX
INSTRUMENTARIUM OY
NIMI ECG-BOARD
SIVU 2/2
LAITE CH/CG
N:O CH 3B 880495
MUUT
TARK
HYV
MUUTOS
MERKKI
PIIRT.
TARK
HYV.

Figure 5.2 ECG board parts layout.
(CH, CH-2, CH-S, CH-2S)
(board modification level 10 and higher)

Figure 5.2a (on the next page)
ECG board schematic diagram.
(CH, CH-2, CH-S, CH-2S)
(board modification level 10 and higher)



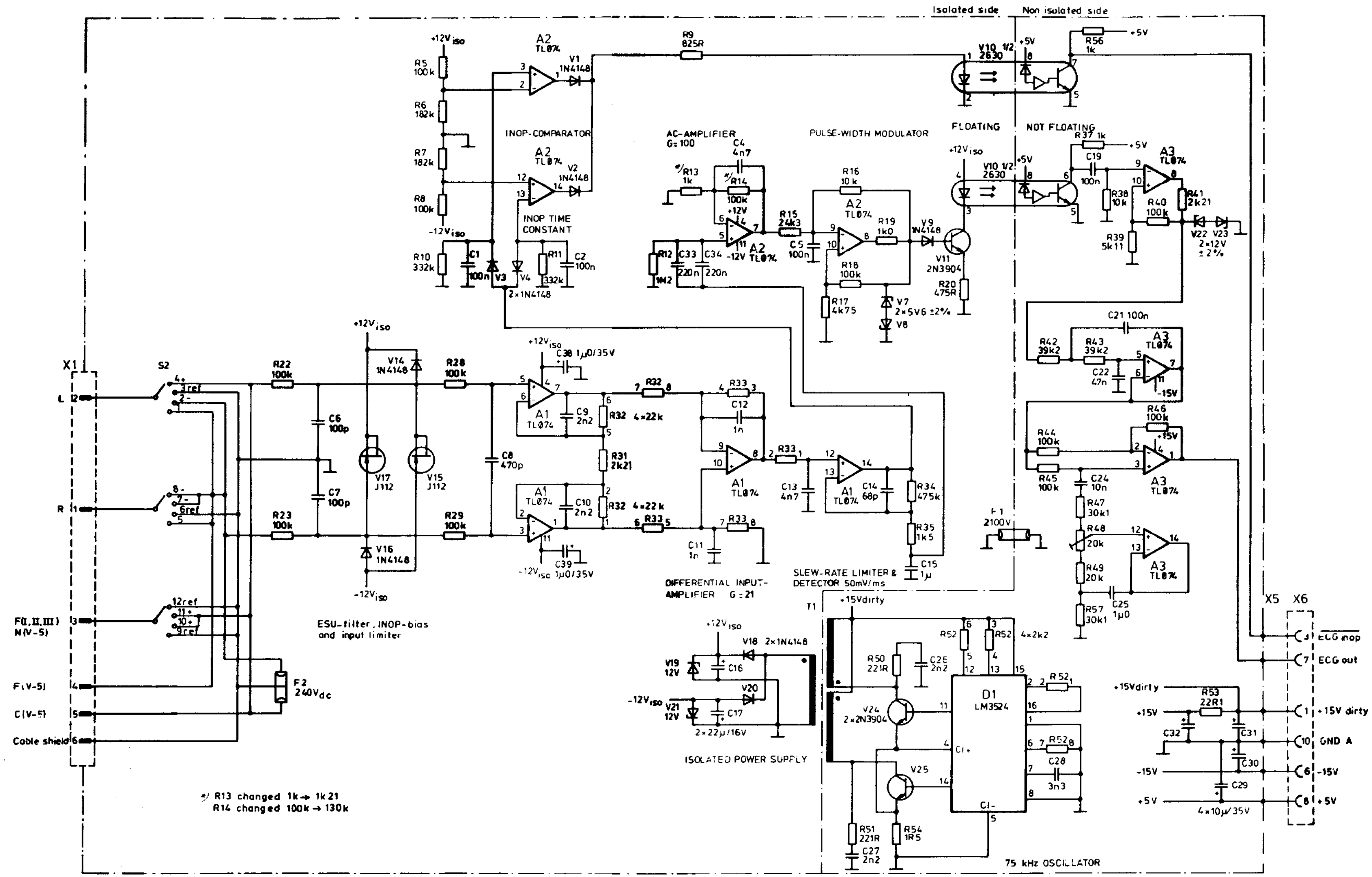

Isolated side
Non isolated side
INOP-COMPARATOR
INOP TIME CONSTANT
AC-AMPLIFIER G=100
PULSE-WIDTH MODULATOR
FLOATING
NOT FLOATING
ESU-filter, INOP-bias and input limiter
DIFFERENTIAL INPUT-AMPLIFIER G=21
SLEW-RATE LIMITER & DETECTOR 50mV/ms
ISOLATED POWER SUPPLY
75 kHz OSCILLATOR
ECG inop
ECG out
+15V dirty
GND A
-15V
+5V
Cable shield
*) R13 changed 1k → 1k21
R14 changed 100k → 130k

Figure 5.3 ECG board parts layout
(CH-R, CH-1R, CH-RS, CH-1RS)
(board modification level 5 and higher)

Figure 5.3a (on the next page)
ECG board schematic diagram
(CH-R, CH-1R, CH-RS, CH-1RS)
(board modification level 5 and higher)

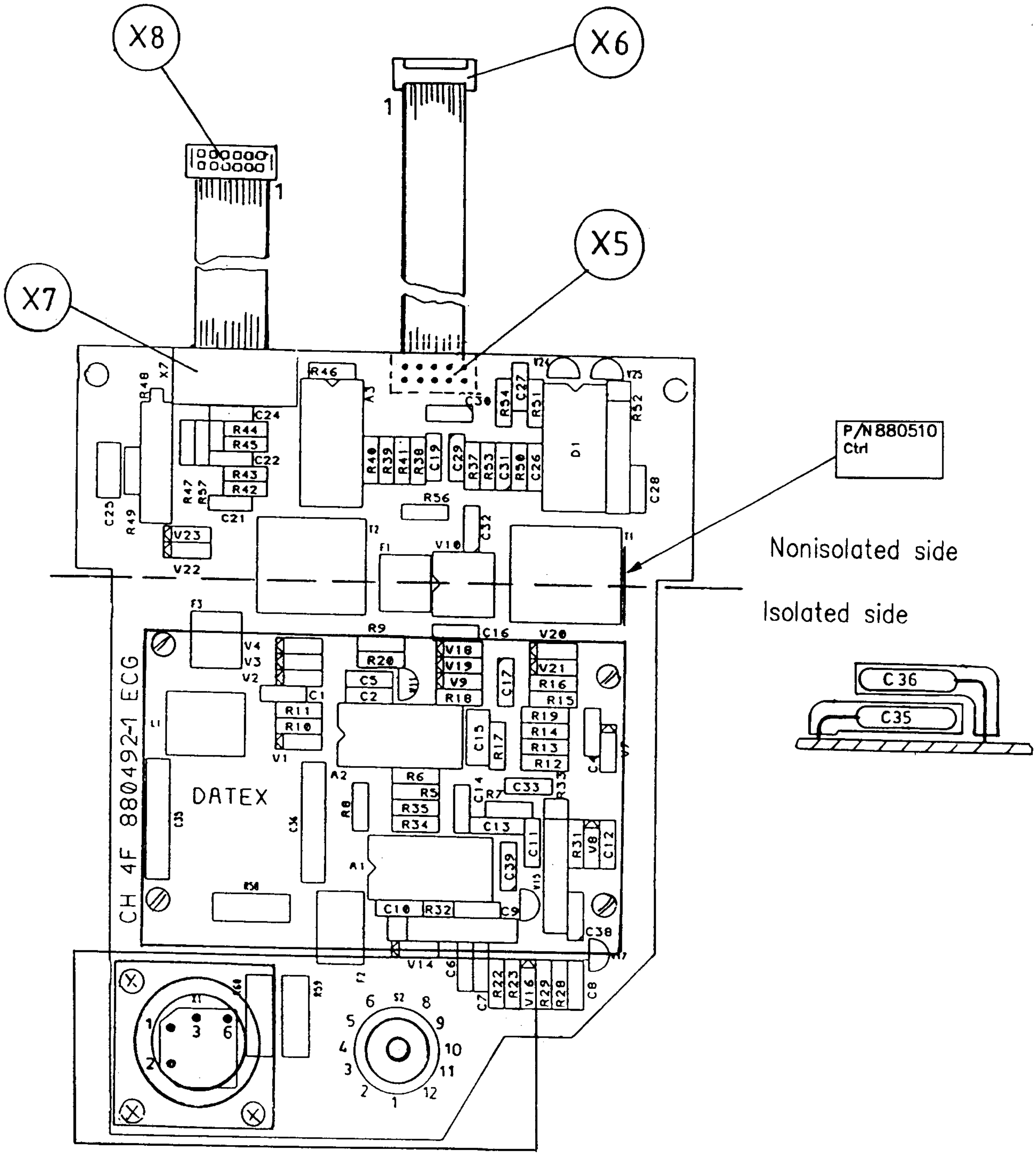
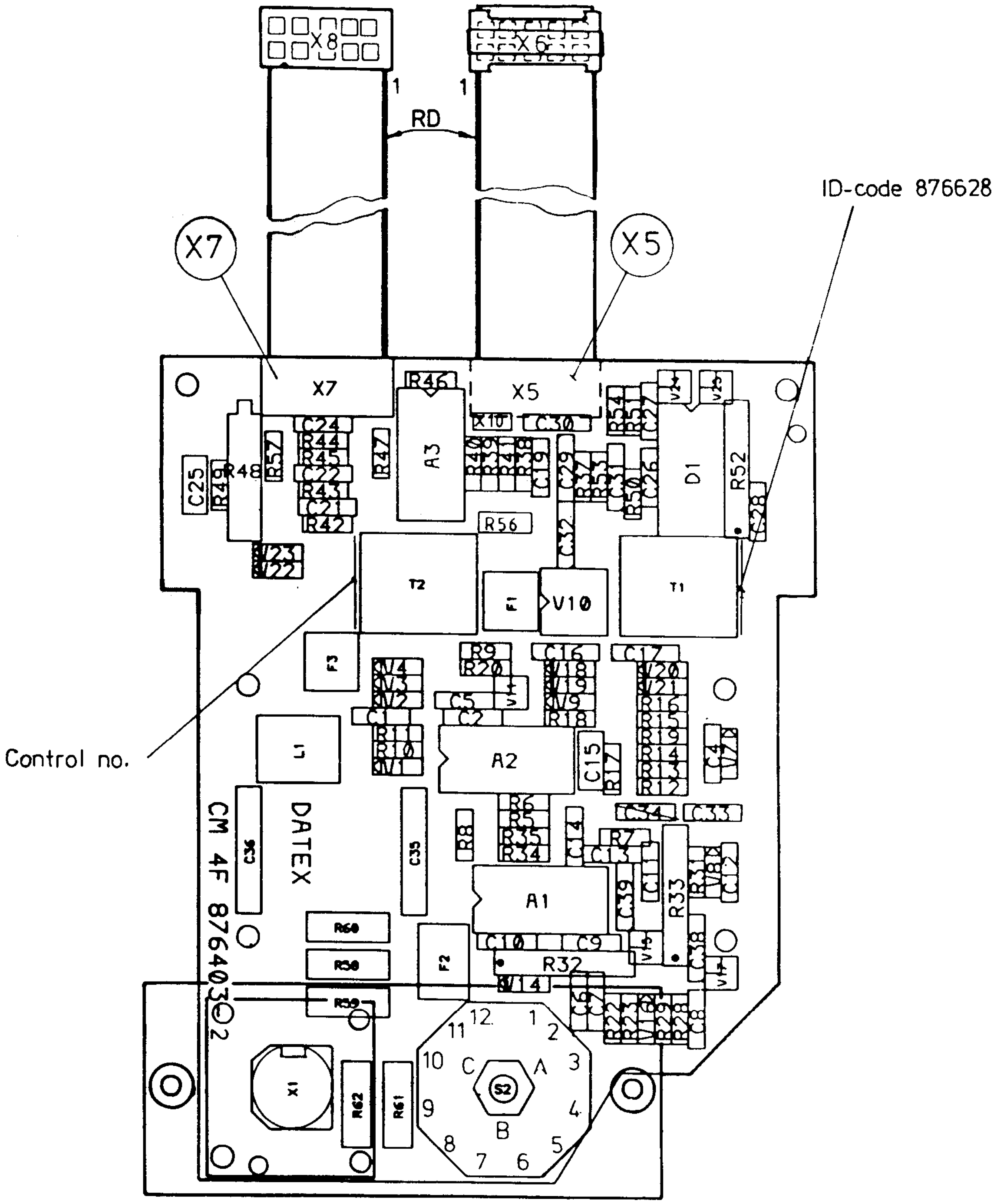
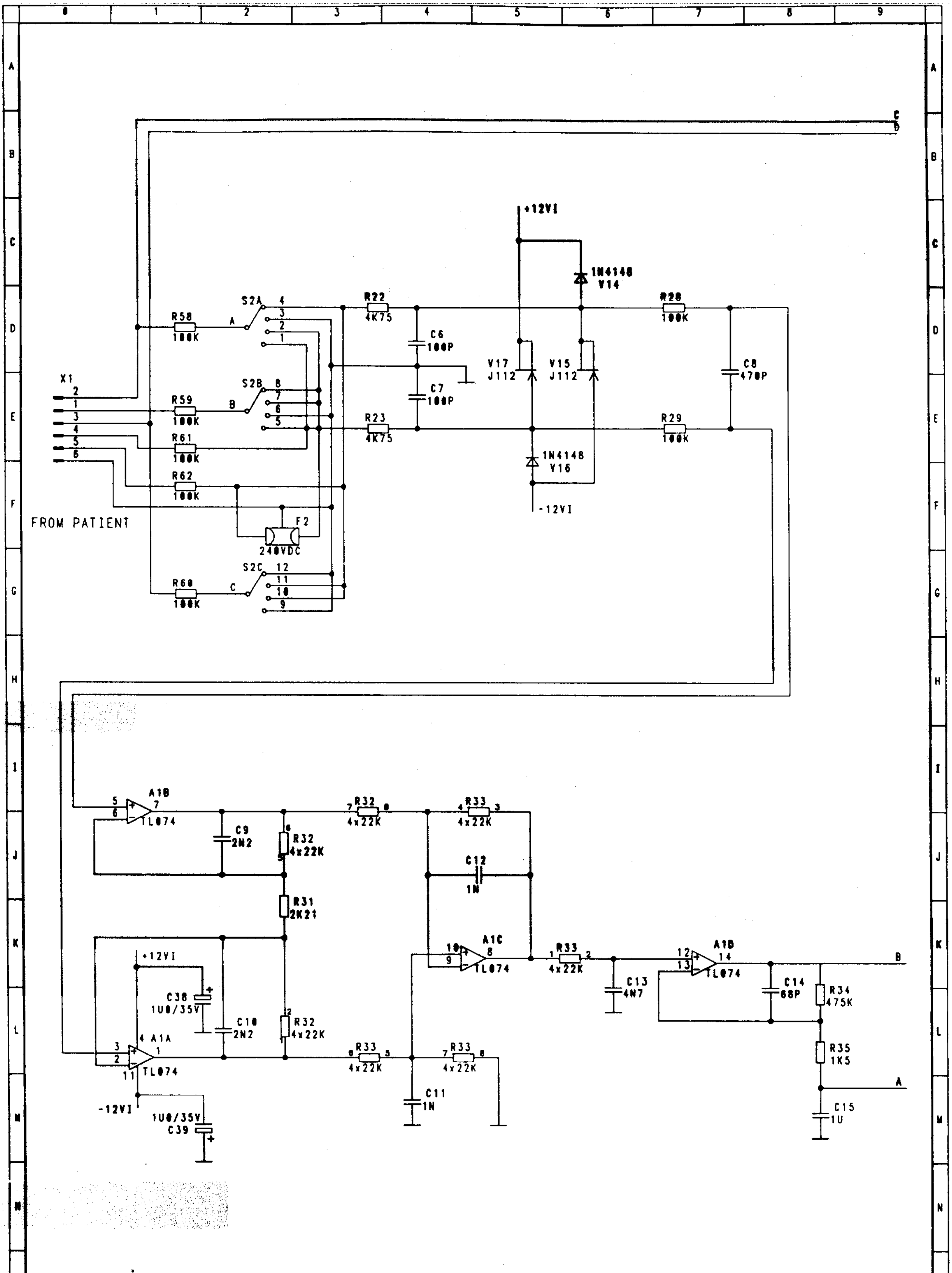


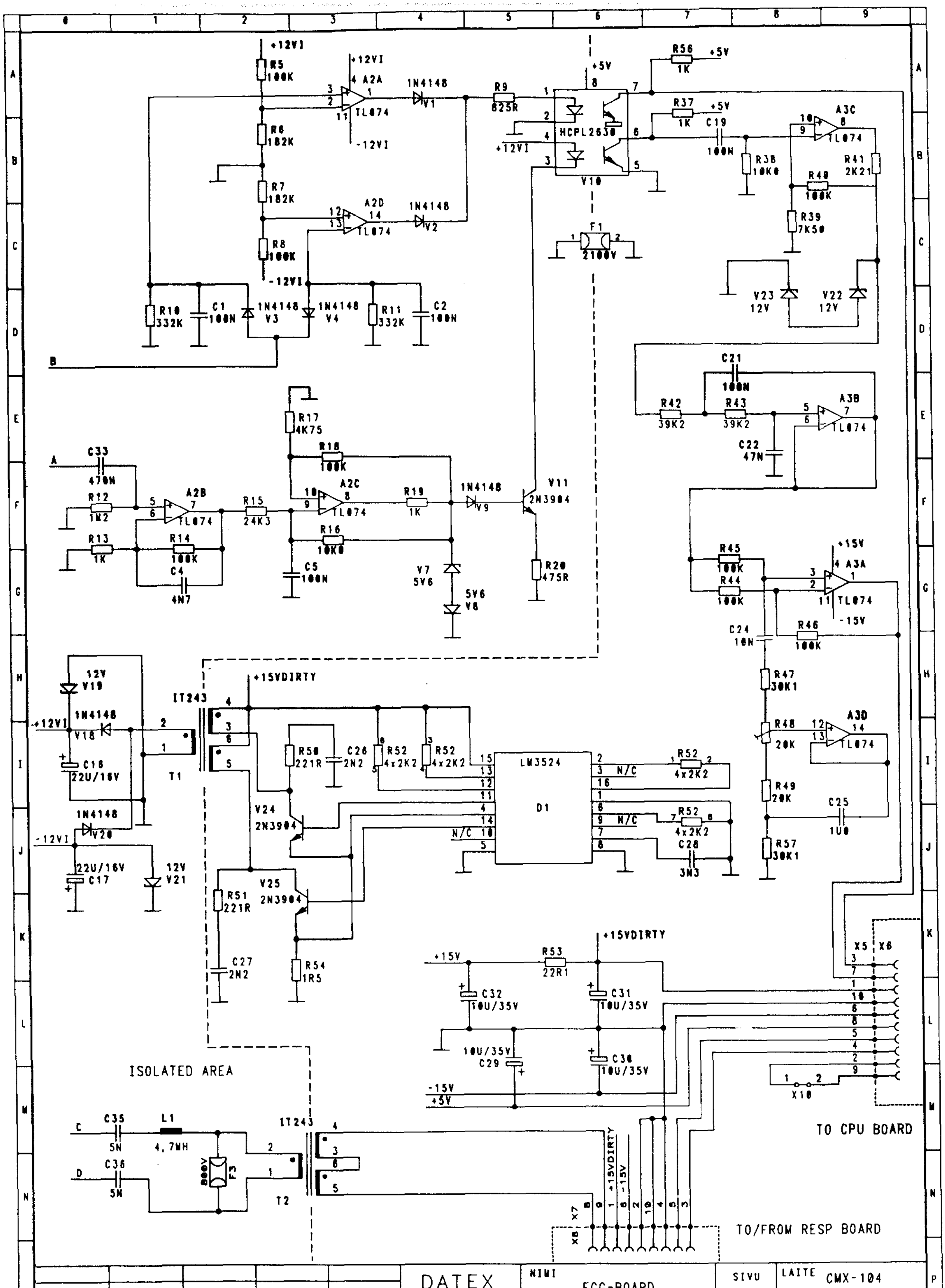
Figure 5.3 ECG board parts layout and schematic diagram (CH-R, CH-1R, CH-RS, CH-1RS) (board modification level 4 and lower)



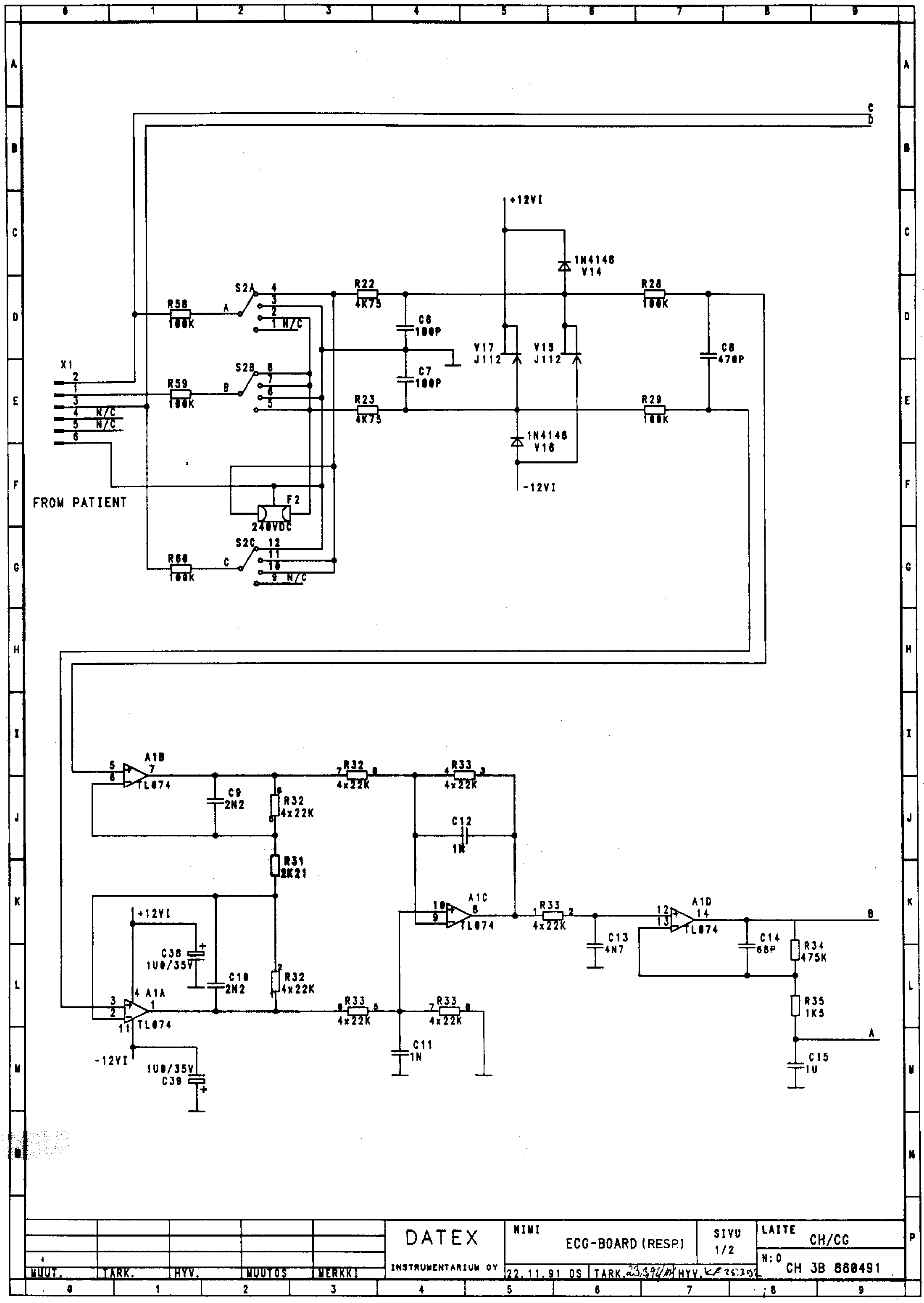


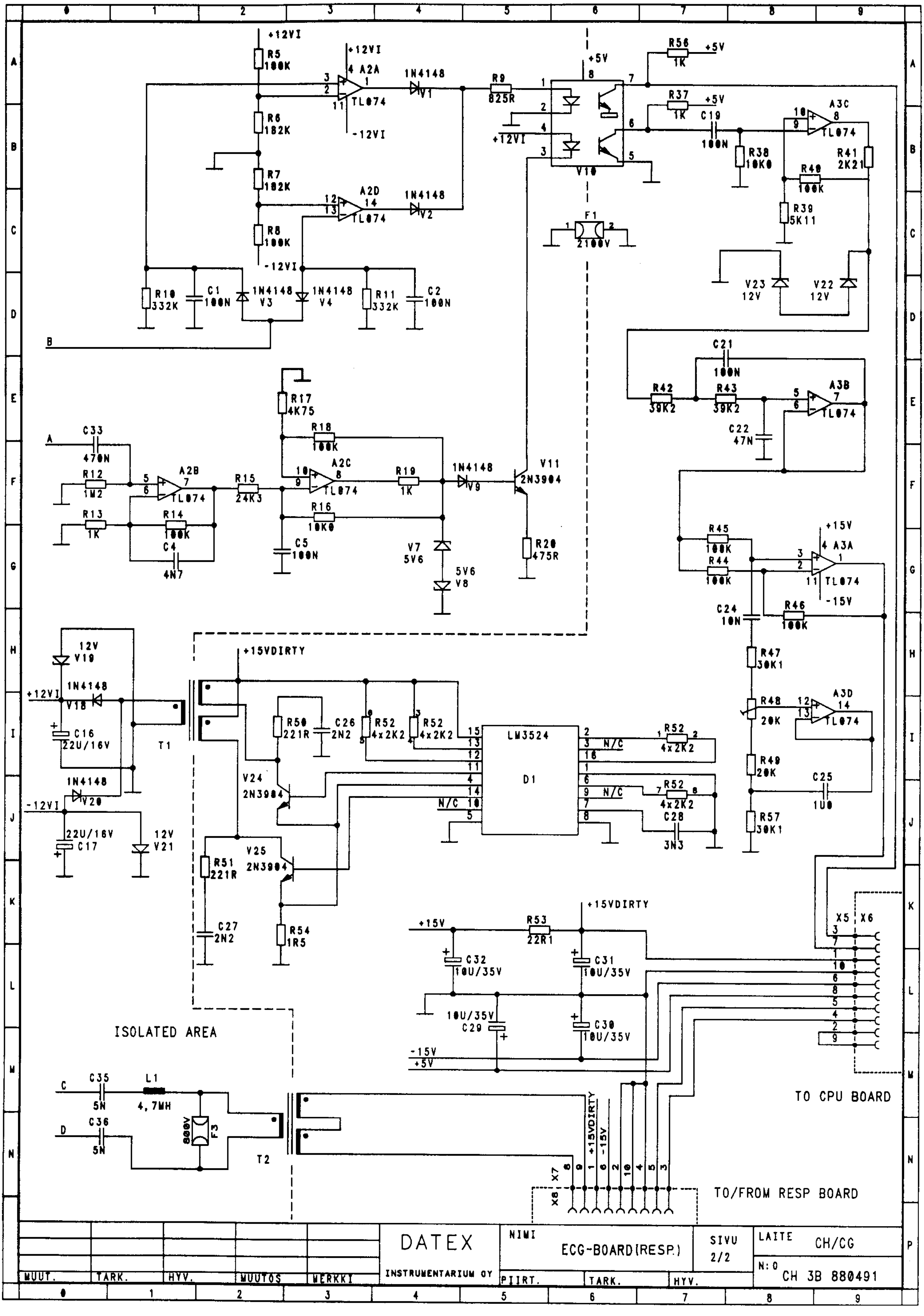
15.03.90 OS		150390	5009	-2	DATEX	NIMI ECG-BOARD	SIVU 1/2	LAITE CMX-104
04.01.90 OS		150390	4900 4939	-1	INSTRUMENTARIUM OY	14.9.89 TARK.	HYV. 050390	N:O CM 3B 876402-2
MUUT.	TARK.	HYV.	MUUTOS	MERKKI				

Figure 5.3 ECG board schematic diagram (part 2)



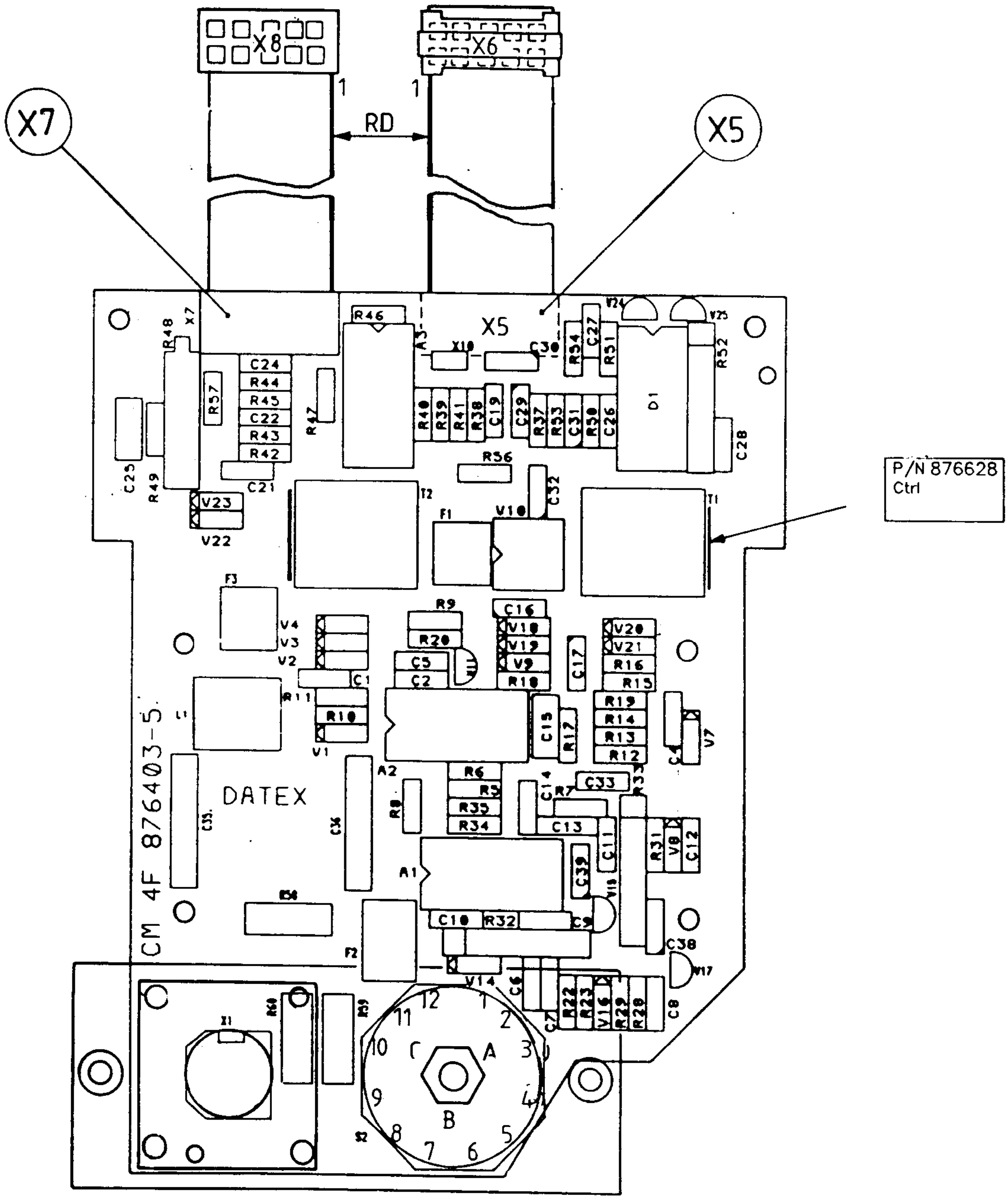
				DATEX INSTRUMENTARIUM OY	NIMI ECG-BOARD	SIVU 2/2	LAITE CMX-104
MUUT.	TARK.	HYV.	MUUTOS	MERKKI	14.9.89 TARK. HYV.		N:O CM 3B 876402-2

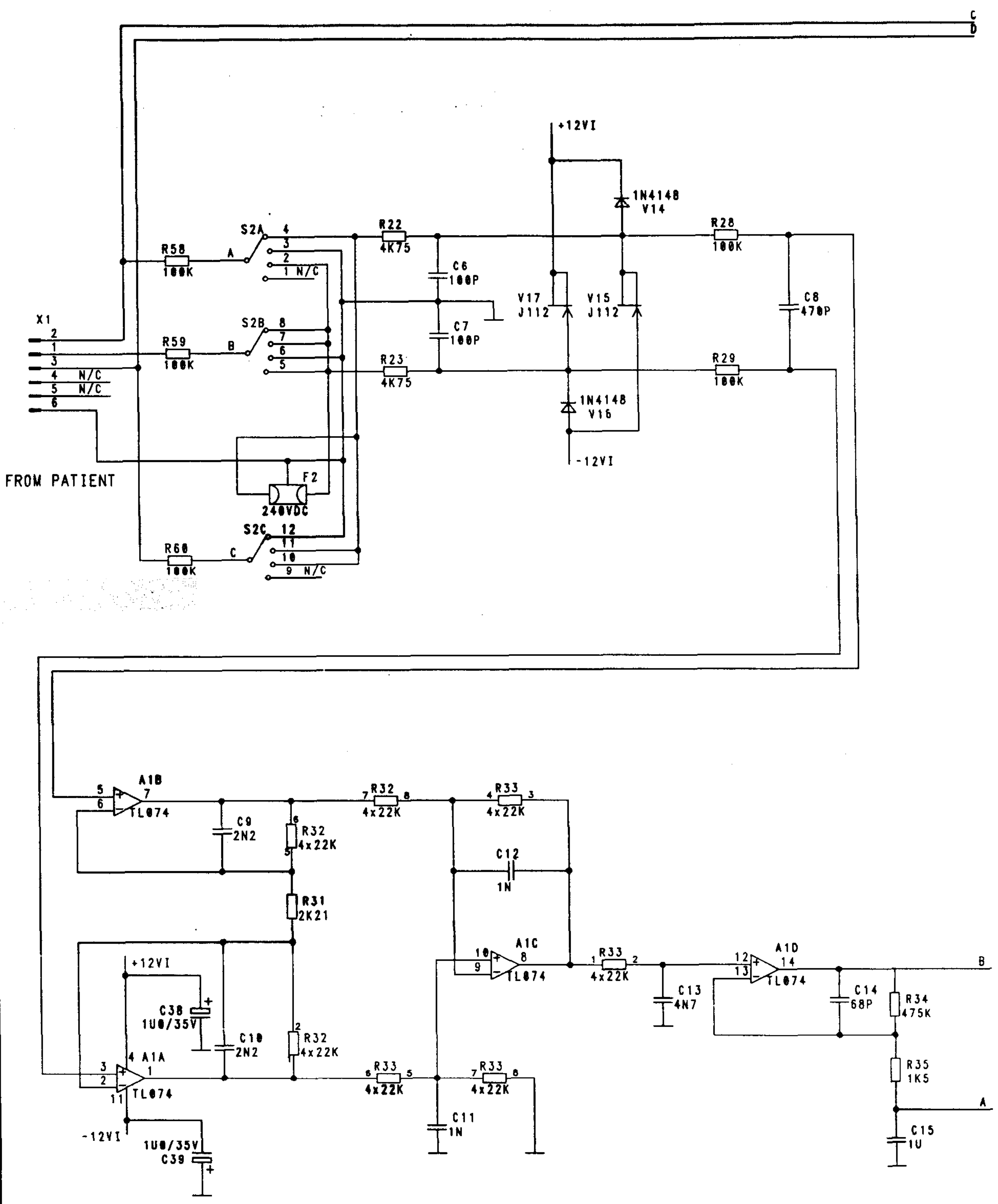

FROM PATIENT
X1
S2A
S2B
S2C
R58 100K
R59 100K
R60 100K
R22 4K75
R23 4K75
R28 100K
R29 100K
C6 100P
C7 100P
C8 470P
F2 240VDC
+12VI
-12VI
1N4148 V14
1N4148 V16
V17 J112
V15 J112
A1B TL074
A1A TL074
A1C TL074
A1D TL074
C9 2N2
C10 2N2
R32 4x22K
R33 4x22K
R31 2K21
C12 1N
C11 1N
C13 4N7
C14 68P
R34 475K
R35 1K5
C15 1U
C38 1U0/35V
C39 1U0/35V
DATEX
INSTRUMENTARIUM OY
NIMI
ECG-BOARD (RESP.)
SIVU 1/2
LAITE CH/CG
N:O CH 3B 880491
MUUT. TARK. HYV. MUUTOS MERKKI
22.11.91 OS



+12VI
R5 100K
R6 182K
R7 182K
R8 100K
A2A TL074
-12VI
1N4148 V1
A2D TL074
1N4148 V2
R9 825R
+5V
V10
+12VI
F1 2100V
R56 1K
R37 1K
C19 100N
R38 10K0
A3C TL074
R41 2K21
R40 100K
R39 5K11
V23 12V
V22 12V
R10 332K
C1 100N
1N4148 V3
1N4148 V4
R11 332K
C2 100N
B
R17 4K75
C21 100N
R42 39K2
R43 39K2
A3B TL074
C22 47N
A
C33 470N
R12 1M2
A2B TL074
R15 24K3
A2C TL074
R18 100K
R19 1K
1N4148 V9
V11 2N3904
R13 1K
R14 100K
C4 4N7
R16 10K0
C5 100N
V7 5V6
5V6 V8
R20 475R
+15V
R45 100K
R44 100K
A3A TL074
-15V
C24 10N
R46 100K
R47 30K1
R48 20K
A3D TL074
R49 20K
C25 1U0
R57 30K1
12V V19
+12VI
1N4148 V18
C16 22U/16V
T1
1N4148 V20
-12VI
22U/16V C17
12V V21
+15VDIRTY
R50 221R
C26 2N2
R52 4x2K2
R52 4x2K2
LM3524
D1
N/C
R52 4x2K2
N/C
R52 4x2K2
C28 3N3
V24 2N3904
N/C
V25 2N3904
R51 221R
C27 2N2
R54 1R5
+15V
R53 22R1
+15VDIRTY
C32 10U/35V
C31 10U/35V
10U/35V C29
C30 10U/35V
-15V
+5V
X5
X6
ISOLATED AREA
C
C35 5N
L1 4,7MH
800V F3
D
C36 5N
T2
+15VDIRTY
-15V
X7
X8
TO CPU BOARD
TO/FROM RESP BOARD
DATEX
INSTRUMENTARIUM OY
NIMI
ECG-BOARD(RESP.)
SIVU 2/2
LAITE CH/CG
N:O CH 3B 880491
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
TARK.
HYV.

Figure 5.3 ECG board parts layout and schematic diagram (CH-R, CH-1R, CH-RS, CH-1RS) board modification level 5 and higher)





08.02.91 OS			5764	-4	DATEX	NIMI	SIVU	LAITE CH
07.01.91 EN		8.1.91 ILWI	5699	-3		ECG-BOARD	1/2	
15.03.90 OS		15.3.90 JOKO	5009	-2	INSTRUMENTARIUM OY	14.9.89 TARK.	HYV.	N:0 CH 3B 876402-4
MUUT.	TARK.	HYV.	MUUTOS	MERKKI				

Figure 5.3 ECG board schematic diagram (part 2)

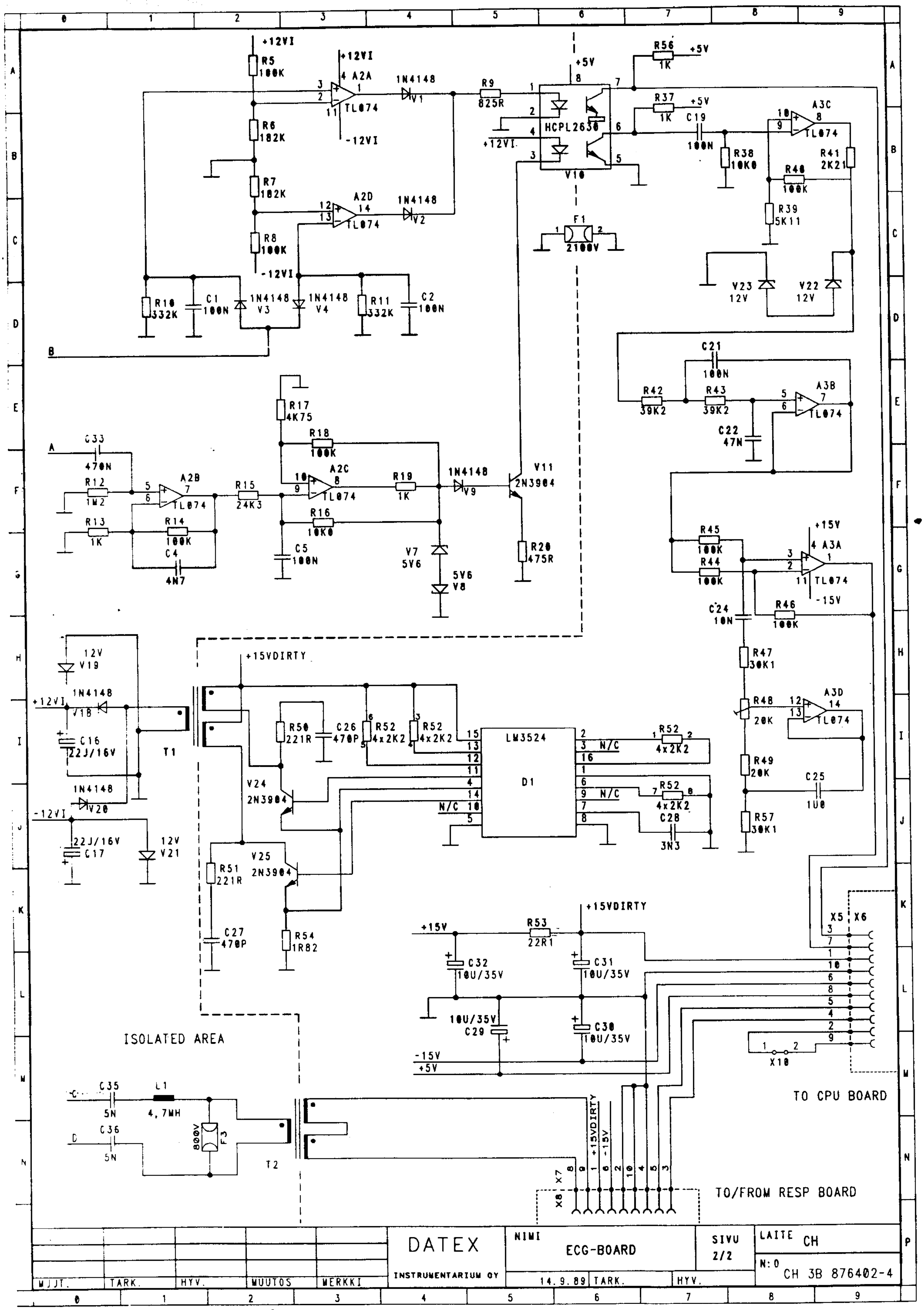
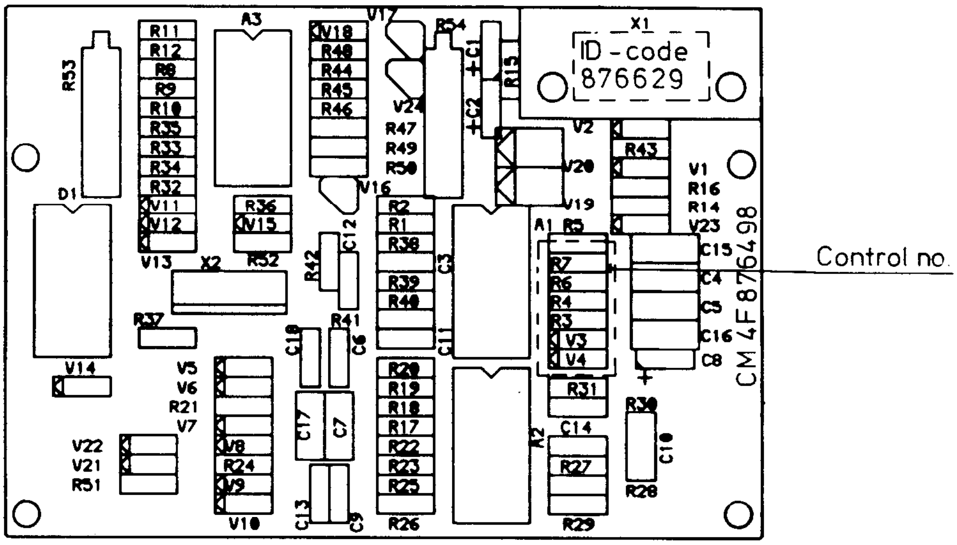
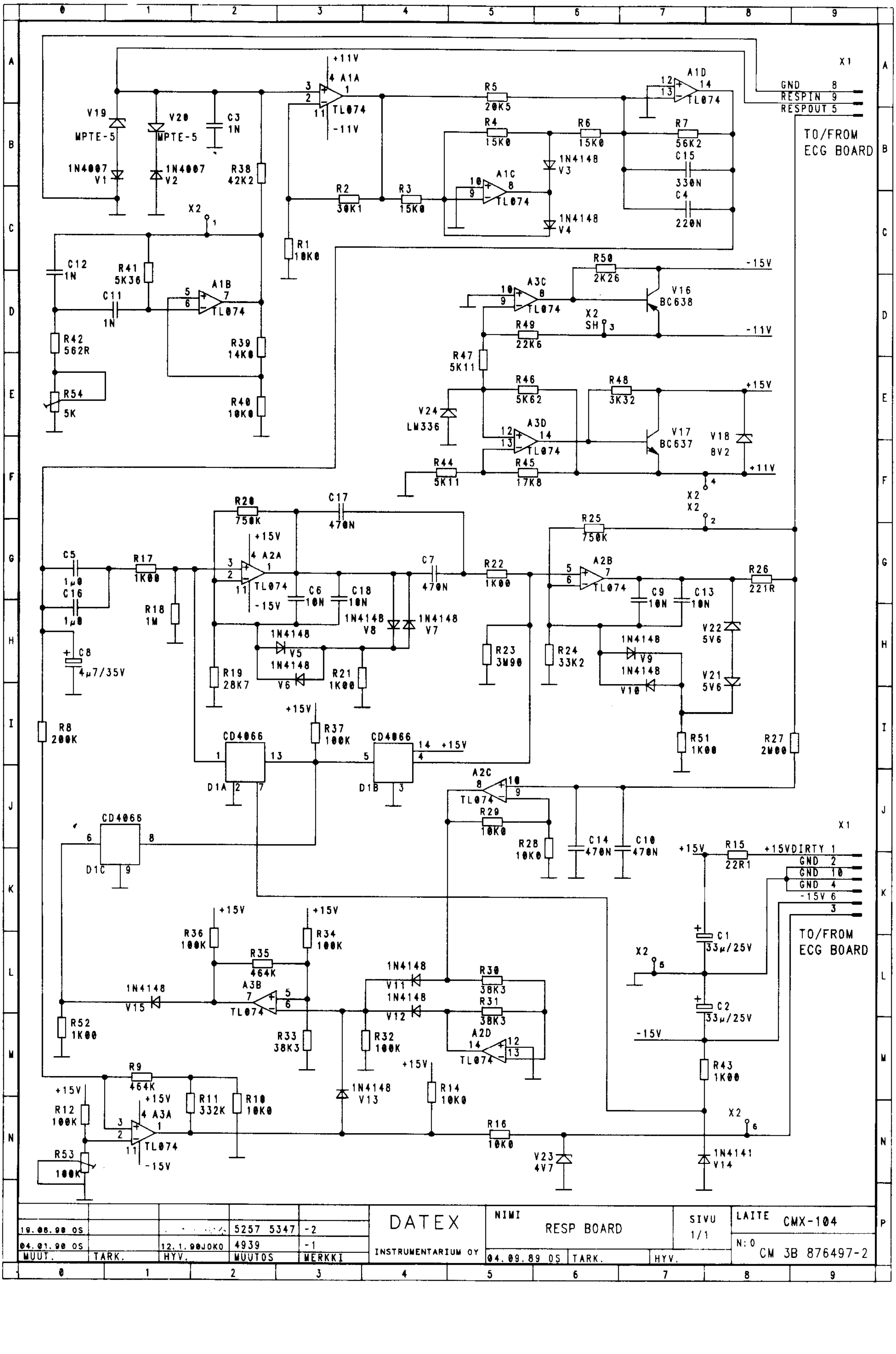
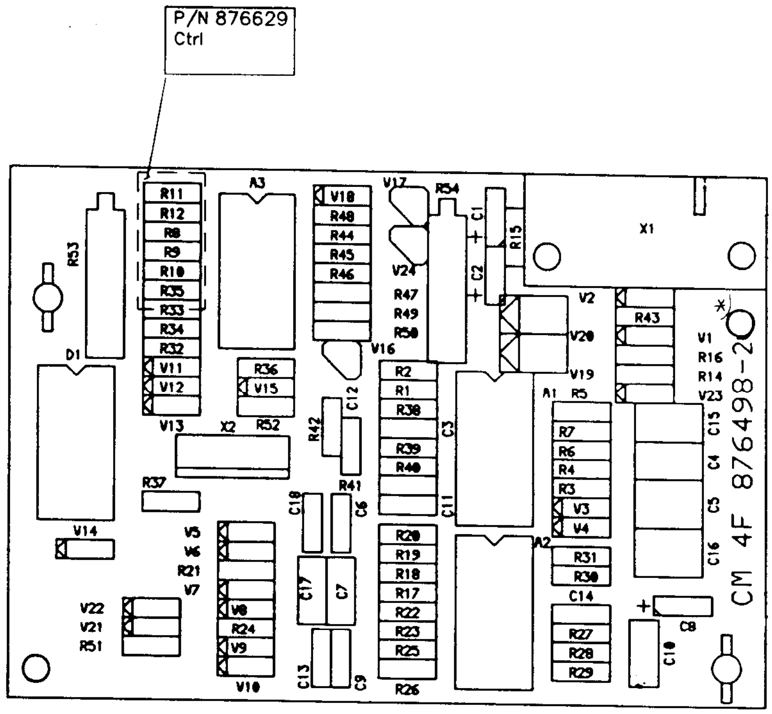

+12VI
R5 100K
R6 182K
R7 182K
R8 100K
-12VI
A2A TL074
A2D TL074
1N4148 V1
1N4148 V2
R9 825R
+5V
HCPL2630
V10
R56 1K
R37 1K
C19 100N
R38 10K0
A3C TL074
R41 2K21
R40 100K
R39 5K11
F1 2100V
V23 12V
V22 12V
R10 332K
C1 100N
1N4148 V3
1N4148 V4
R11 332K
C2 100N
B
C21 100N
R42 39K2
R43 39K2
A3B TL074
C22 47N
A
C33 470N
R12 1M2
R13 1K
A2B TL074
R14 100K
C4 4N7
R15 24K3
R17 4K75
R18 100K
A2C TL074
R16 10K0
C5 100N
R19 1K
1N4148 V9
V7 5V6
5V6 V8
V11 2N3904
R20 475R
R45 100K
R44 100K
+15V
A3A TL074
-15V
C24 10N
R46 100K
R47 30K1
R48 20K
A3D TL074
R49 20K
C25 1U0
R57 30K1
12V V19
1N4148 V18
+12VI
C16 22J/16V
T1
1N4148 V20
-12VI
22J/16V C17
12V V21
+15VDIRTY
R50 221R
C26 470P
R52 4x2K2
LM3524
D1
N/C
V24 2N3904
V25 2N3904
R51 221R
C27 470P
R54 1R82
C28 3N3
R53 22R1
C32 10U/35V
C31 10U/35V
10U/35V C29
C30 10U/35V
-15V
+5V
X5 X6
X10
TO CPU BOARD
ISOLATED AREA
C35 5N
L1 4,7MH
C36 5N
800V F3
T2
X7 X8
TO/FROM RESP BOARD
MUUTOS
MERKKI
DATEX
INSTRUMENTARIUM OY
NIMI
ECG-BOARD
14.9.89
TARK.
HYV.
SIVU 2/2
LAITE CH
N:0 CH 3B 876402-4

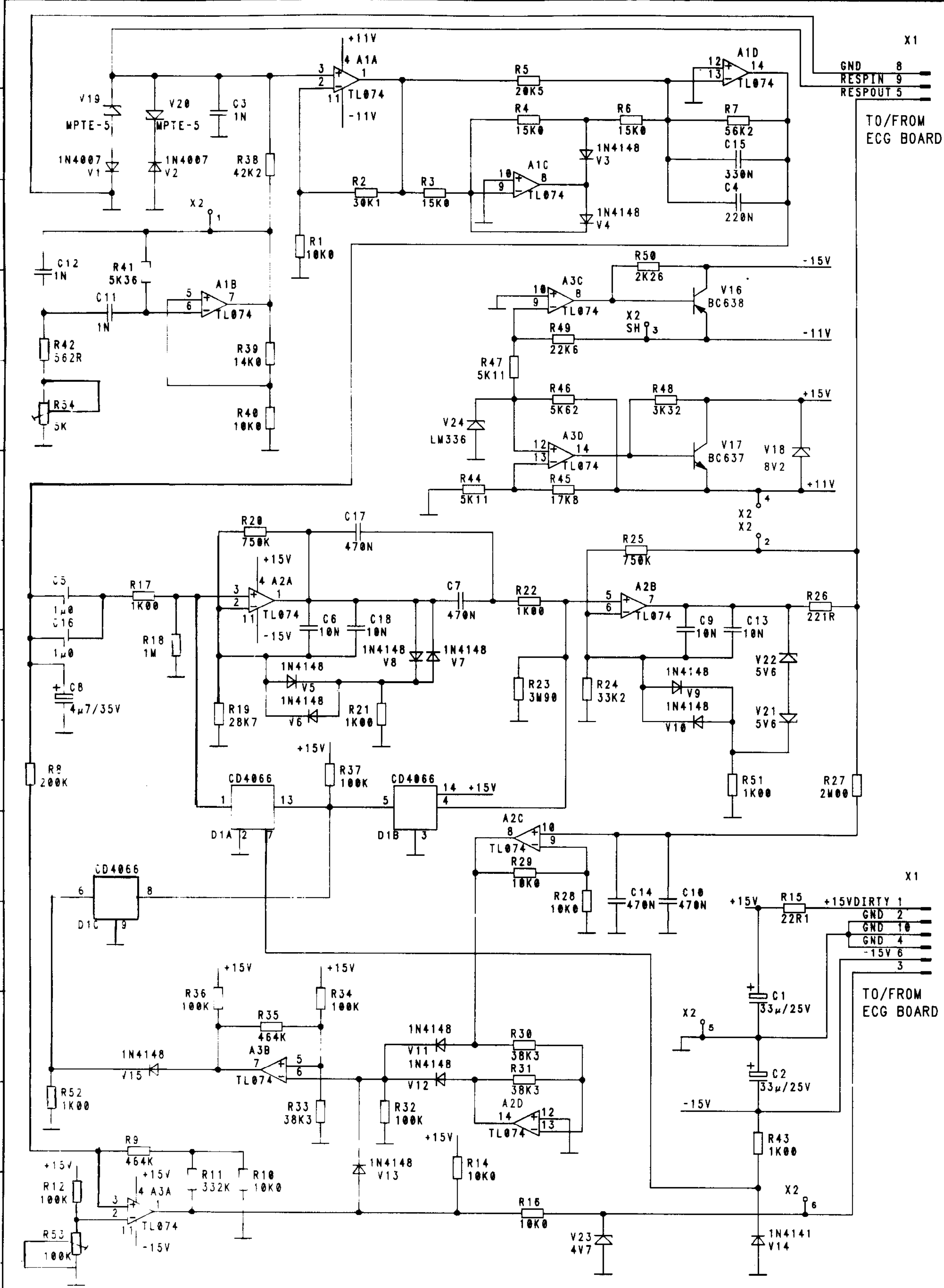
Figure 5.5 RESP board parts layout and schematic diagram (board modification level 2 and lower)





X1
GND 8
RESPIN 9
RESPOUT 5
TO/FROM ECG BOARD
+11V
A1A
TL074
-11V
A1D
R5 20K5
R4 15K0
R6 15K0
R7 56K2
C15 330N
C4 220N
1N4148 V3
1N4148 V4
A1C
R2 30K1
R3 15K0
R1 10K0
V19 MPTE-5
V20 MPTE-5
1N4007 V1
1N4007 V2
C3 1N
R38 42K2
X2
C12 1N
R41 5K36
C11 1N
A1B
R42 562R
R54 5K
R39 14K0
R40 10K0
R50 2K26
-15V
A3C
V16 BC638
SH
R49 22K6
-11V
R47 5K11
R46 5K62
R48 3K32
+15V
V24 LM336
A3D
V17 BC637
V18 8V2
R44 5K11
R45 17K8
+11V
R20 750K
C17 470N
+15V
A2A
C5 1µ0
C16 1µ0
R17 1K00
R18 1M
C6 10N
C18 10N
1N4148 V8
1N4148 V7
1N4148 V5
1N4148 V6
C8 4µ7/35V
R19 28K7
R21 1K00
C7 470N
R22 1K00
R23 3M90
R25 750K
A2B
C9 10N
C13 10N
R26 221R
V22 5V6
V21 5V6
R24 33K2
1N4148 V9
1N4148 V10
R51 1K00
R27 2M00
R8 200K
CD4066
D1A
R37 100K
D1B
A2C
R29 10K0
R28 10K0
C14 470N
C10 470N
D1C
+15V
R15 22R1
+15VDIRTY 1
GND 2
GND 10
GND 4
-15V 6
3
C1 33µ/25V
C2 33µ/25V
TO/FROM ECG BOARD
R36 100K
R34 100K
R35 464K
A3B
1N4148 V15
R52 1K00
R33 38K3
1N4148 V11
1N4148 V12
R30 38K3
R31 38K3
R32 100K
A2D
R43 1K00
R9 464K
A3A
R11 332K
R10 10K0
R12 100K
R53 100K
1N4148 V13
R14 10K0
R16 10K0
V23 4V7
1N4141 V14
19.06.90 OS
04.01.90 OS
12.1.90JOKO
5257 5347
4939
-2
-1
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
DATEX
INSTRUMENTARIUM OY
NIMI
RESP BOARD
04.09.89 OS
SIVU 1/1
LAITE CMX-104
N:O CM 3B 876497-2


P/N 876629
Ctrl
CM 4F 876498-2



16.06.90 OS		5257 5347	-2	
04.01.90 OS	12.1.90JOKO	4939	-1	
MUUT.	TARK.	HYV.	MUUTOS	MERKKI

DATEX

INSTRUMENTARIUM OY

NIMI RESP BOARD

SIVU 1/1

LAITE ~~CMX-104~~ CH

N:O CH ~~CM~~ 3B 876497-2

04.09.89 OS | TARK. | HYV.

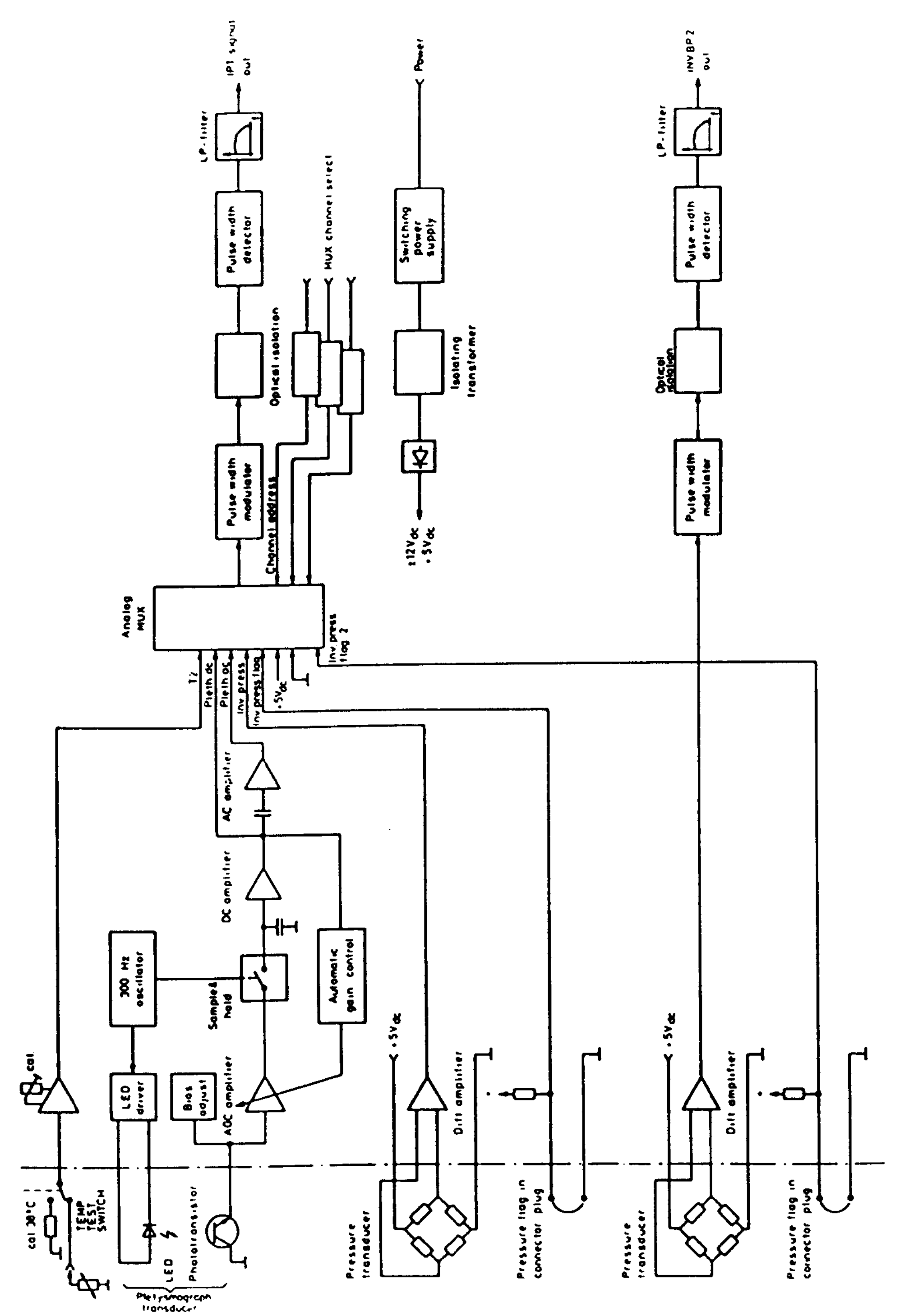
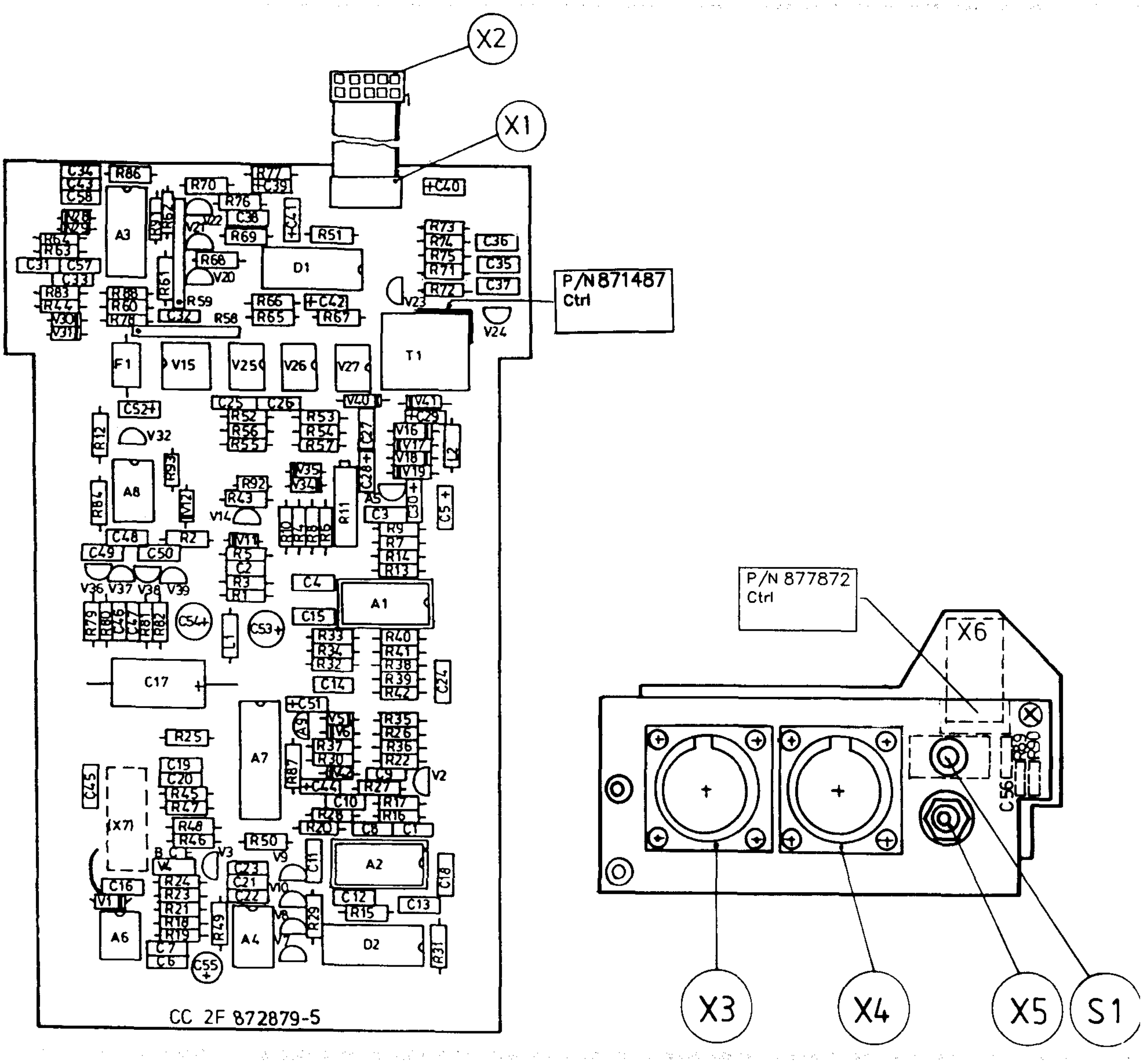


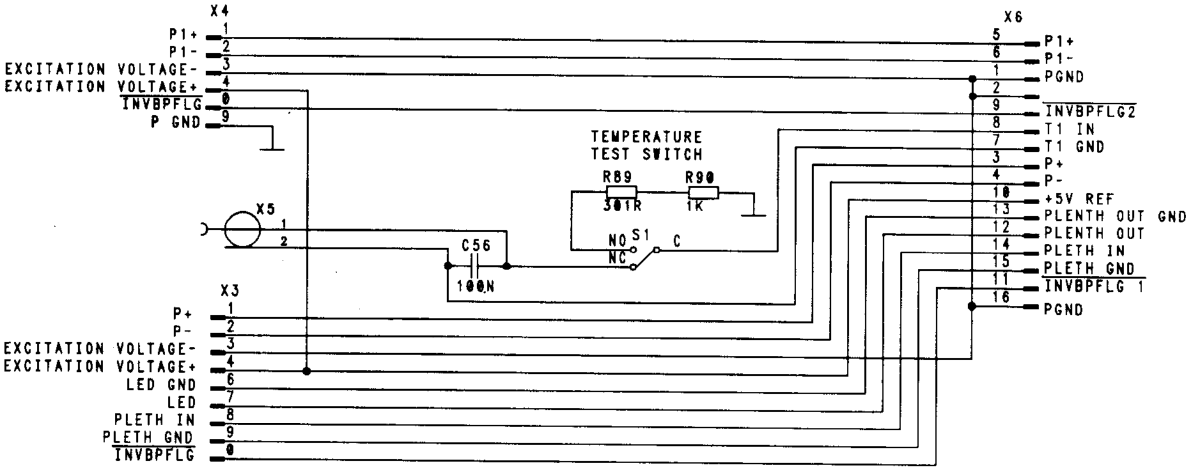
Figure 5.6 IPT board block diagram

Figure 5.7 **IPT board (board modification level 4 and higher) and IPT connector board parts layouts and IPT connector board schematic diagram**

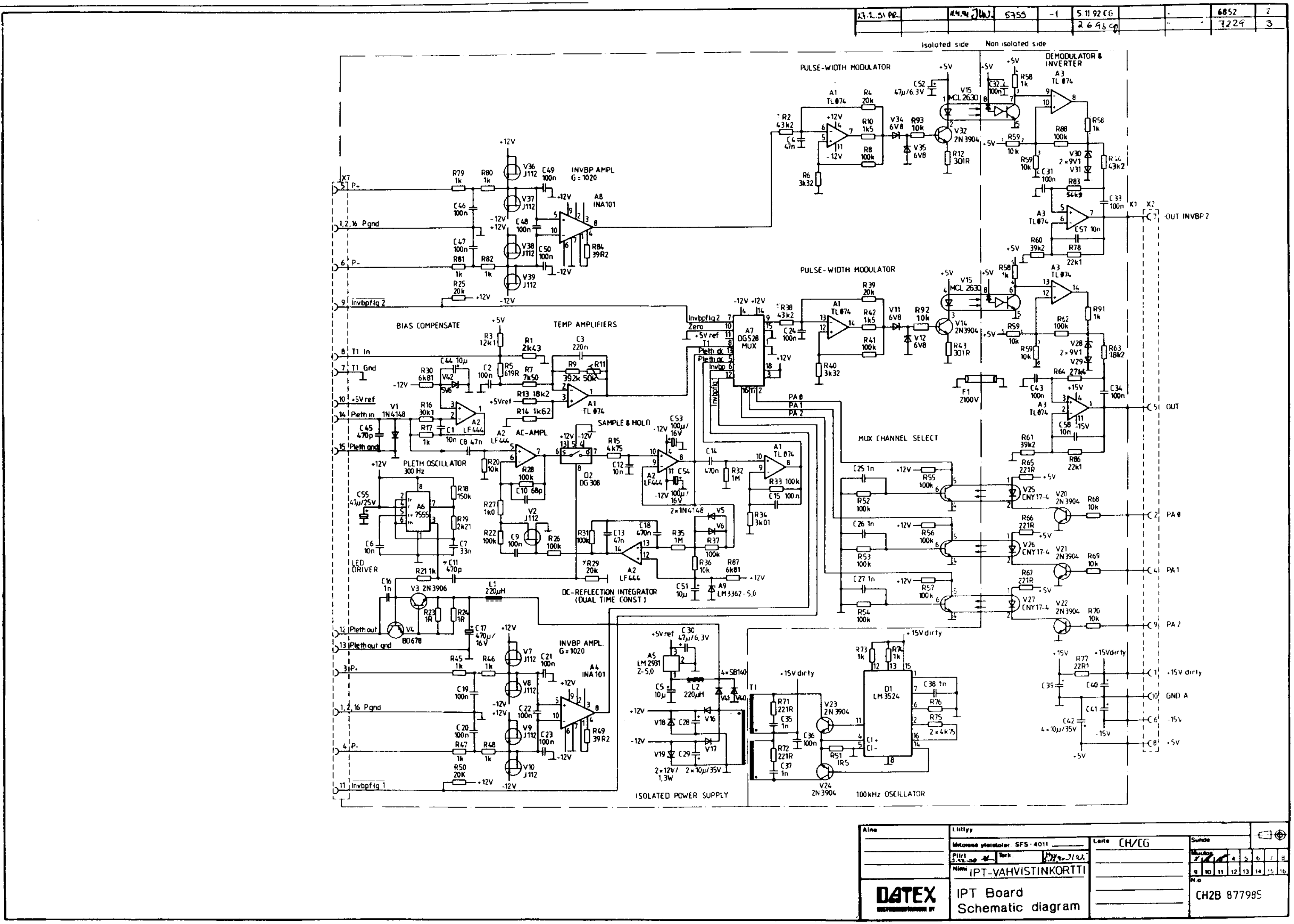
Figure 5.8 (on the next page)
IPT board schematic diagram
(board modification level 4 and higher)



(Connector X4 or both X3 and X4 not included in some models)



IPT unit 877605 X3 and X4 are not connected.
IPT unit 877606 X4 is not connected.


Isolated side
Non isolated side
PULSE-WIDTH MODULATOR
DEMODULATOR & INVERTER
INVBP AMPL G=1020
A8 INA101
BIAS COMPENSATE
TEMP AMPLIFIERS
SAMPLE & HOLD
AC-AMPL
PLETH OSCILLATOR 300 Hz
A6 7555
LED DRIVER
DC-REFLECTION INTEGRATOR (DUAL TIME CONST)
A7 DG528 MUX
MUX CHANNEL SELECT
INVBP AMPL. G=1020
A4 INA101
ISOLATED POWER SUPPLY
100kHz OSCILLATOR
D1 LM3524
OUT INVBP 2
OUT
PA 0
PA 1
PA 2
+15V dirty
GND A
-15V
+5V
P+
1,2,16 Pgnd
P-
invbpfig 2
T1 In
T1 Gnd
+5Vref
Pleth in
Pleth gnd
Pleth out
Pleth out gnd
invbpfig 1
Laite CH/CG
IPT-VAHVISTINKORTTI
DATEX
IPT Board
Schematic diagram
CH2B 877985

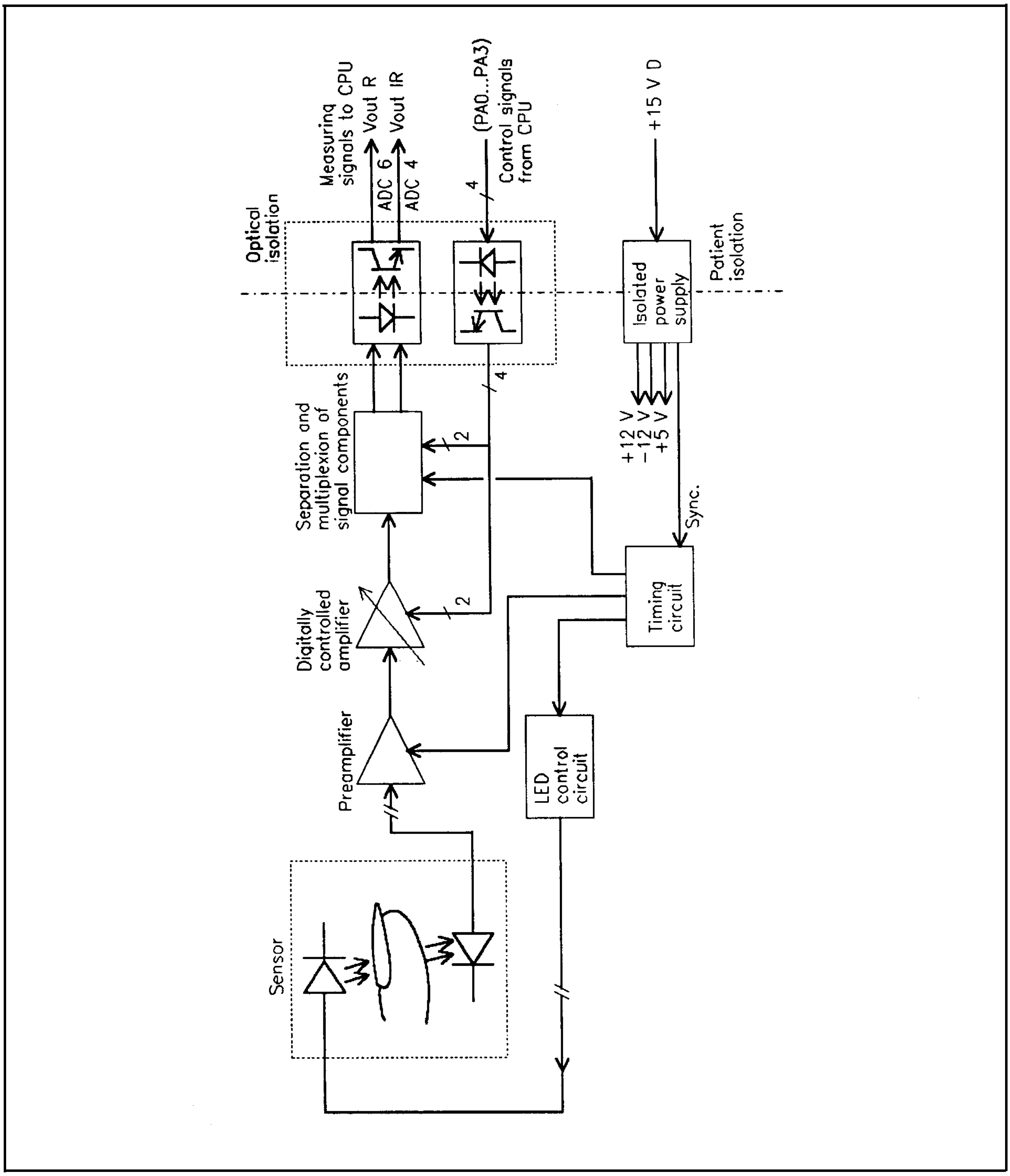
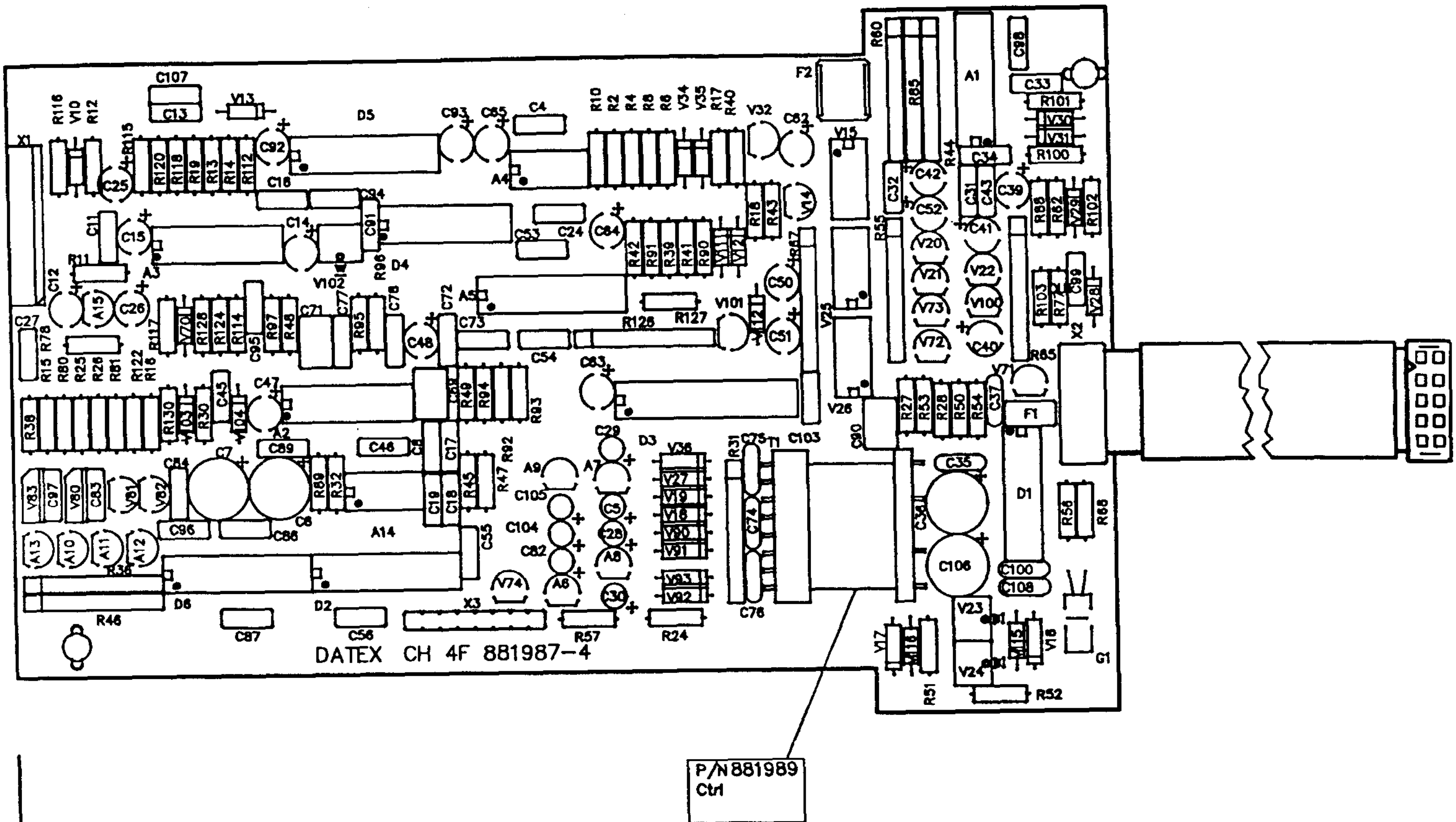
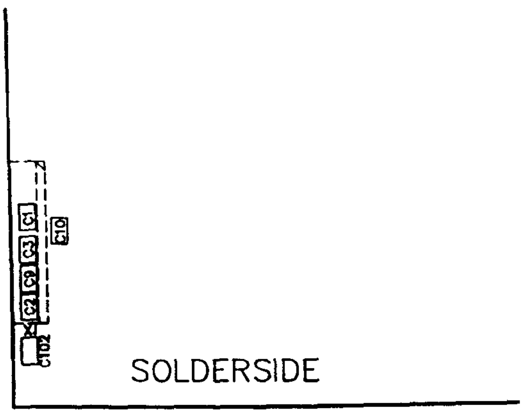
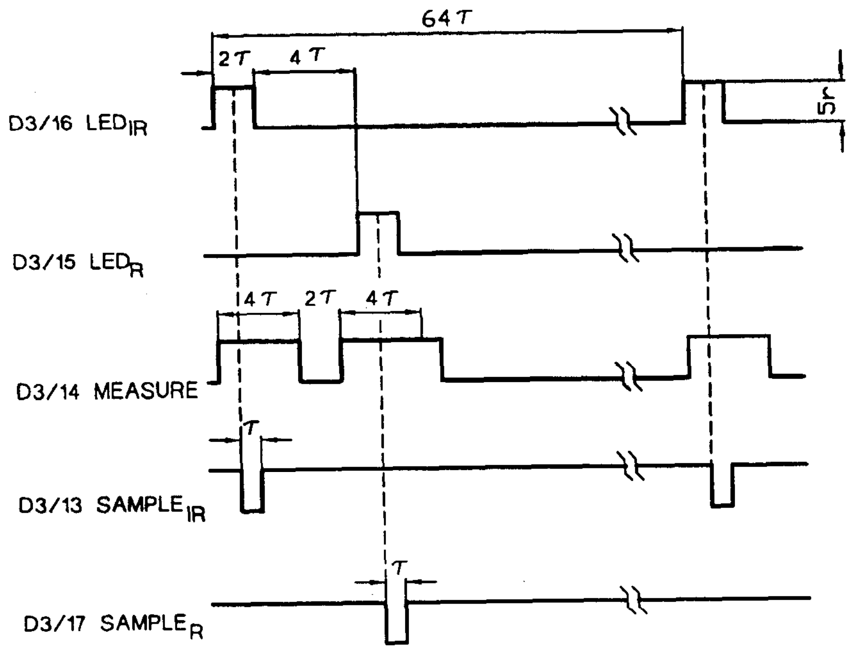


Figure 5.12 SpO_2 measuring board block diagram, parts layout and timing diagram

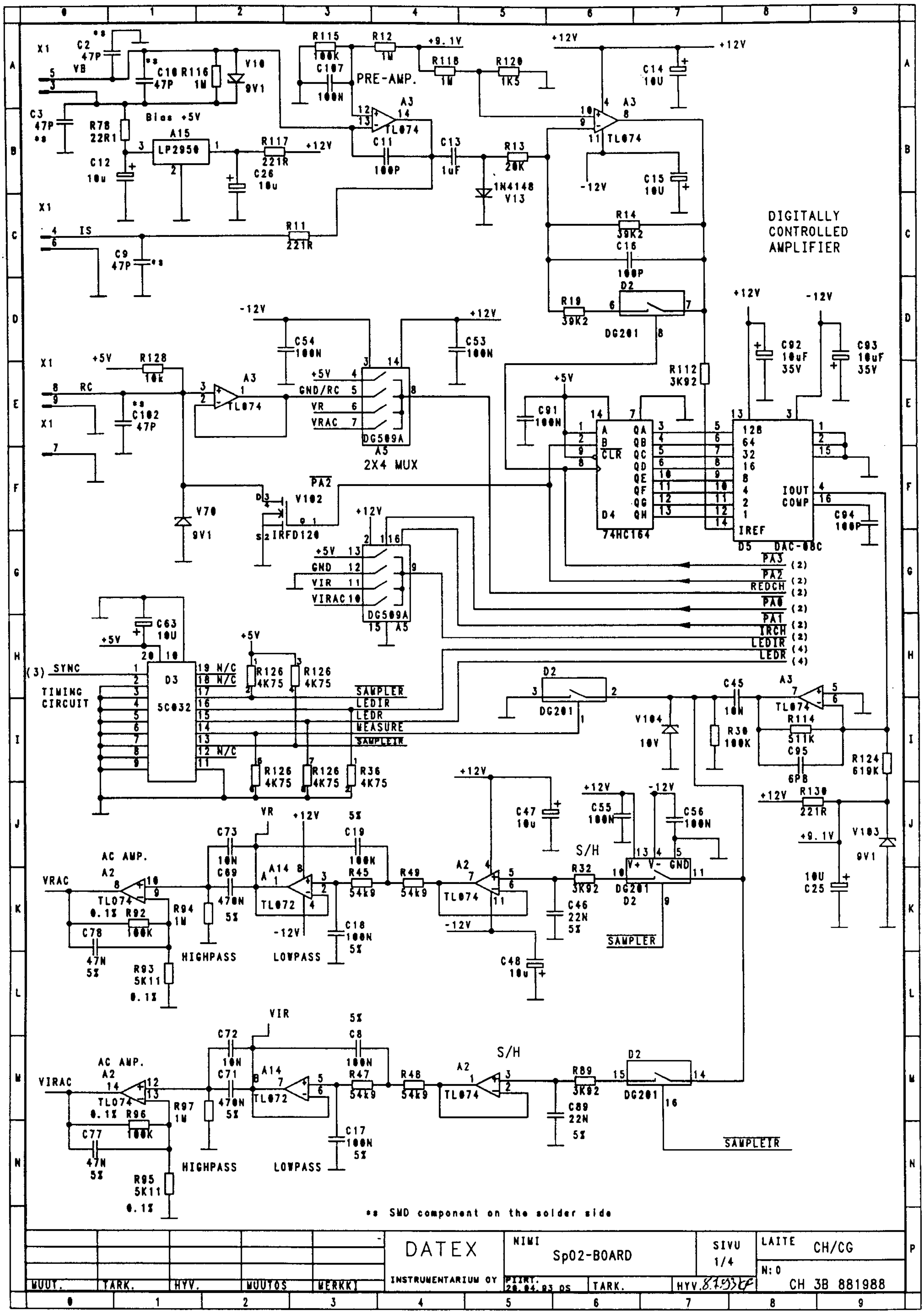
Figure 5.13 (on the next pages) SpO_2 measuring board schematic diagram

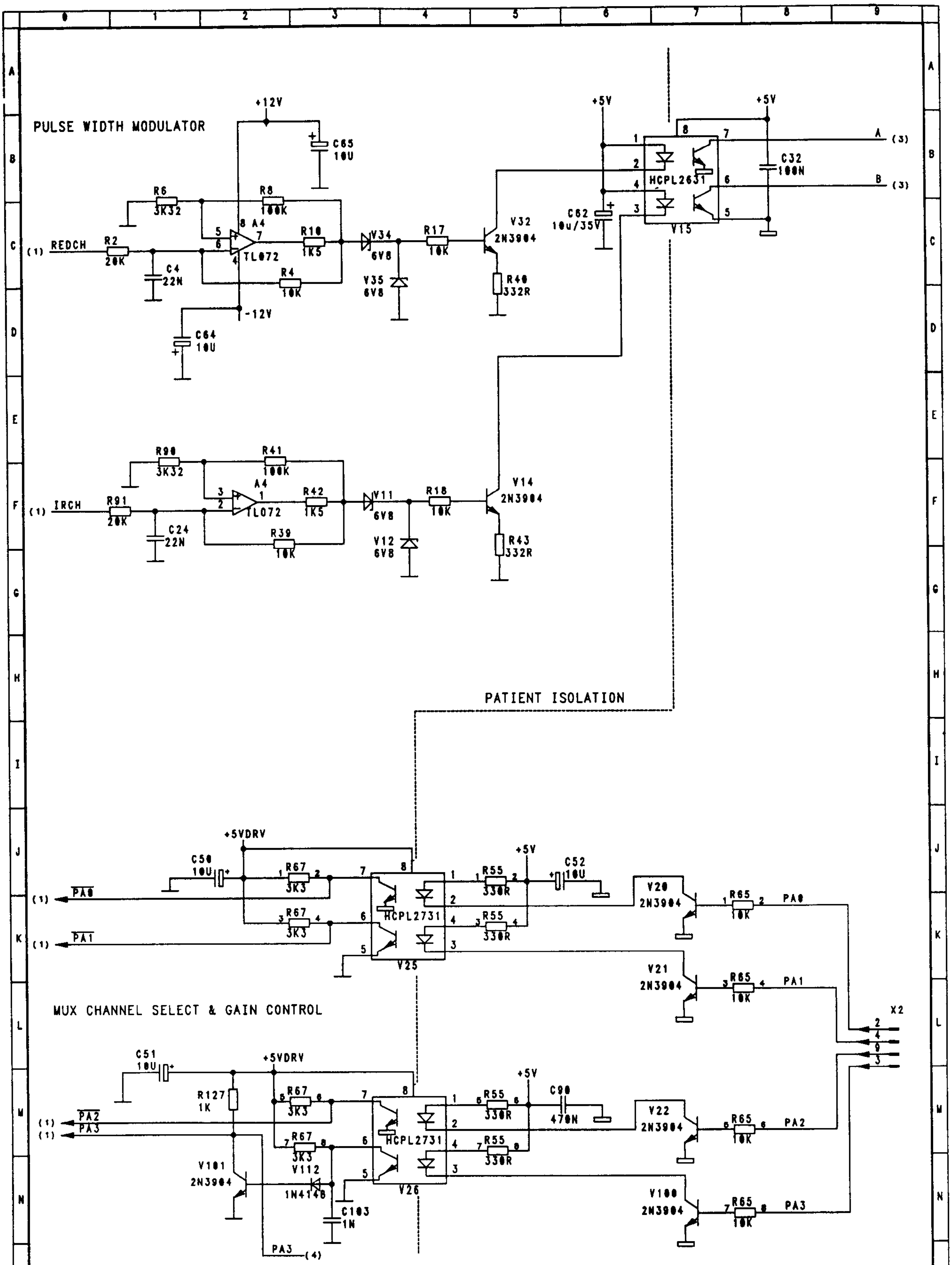

DATEX CH 4F 881987-4
P/N 881989
Ctrl


SOLDERSIDE


64 T
2 T
4 T
D3/16 LED IR
D3/15 LED R
4 T
2 T
4 T
D3/14 MEASURE
T
D3/13 SAMPLE IR
T
D3/17 SAMPLE R

τ = 30,5 μs

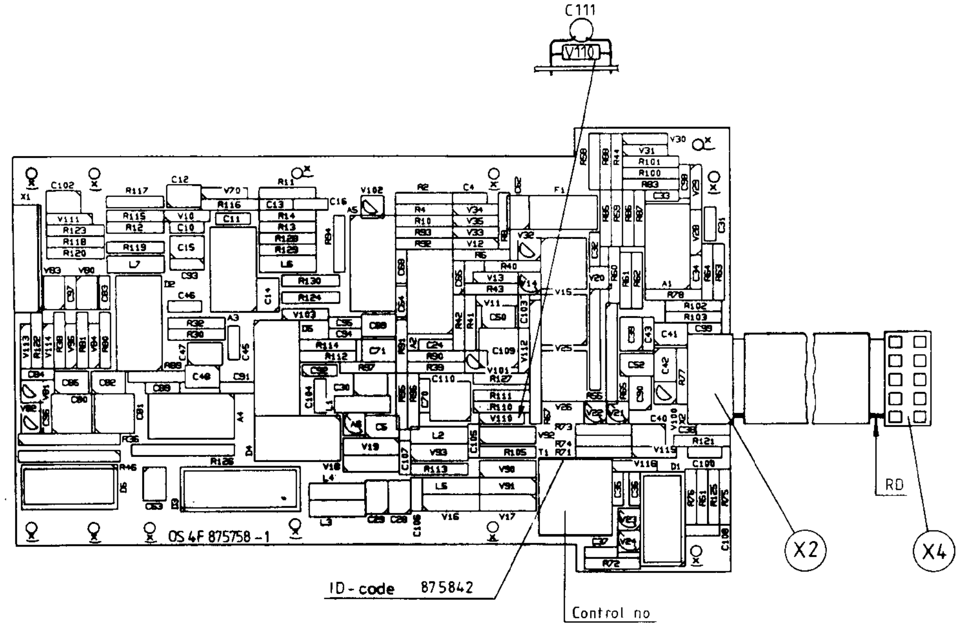

PRE-AMP.
DIGITALLY
CONTROLLED
AMPLIFIER
2X4 MUX
TIMING
CIRCUIT
AC AMP.
HIGHPASS
LOWPASS
S/H
*s SMD component on the solder side
DATEX
INSTRUMENTARIUM OY
NIMI
SpO2-BOARD
SIVU
1/4
LAITE
CH/CG
CH 3B 881988

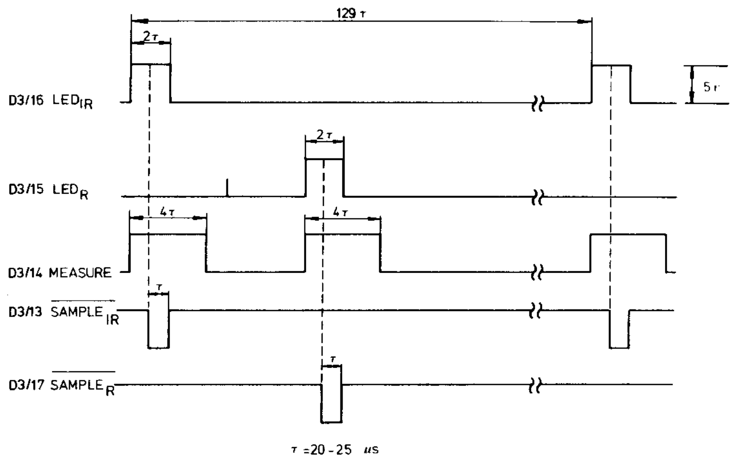


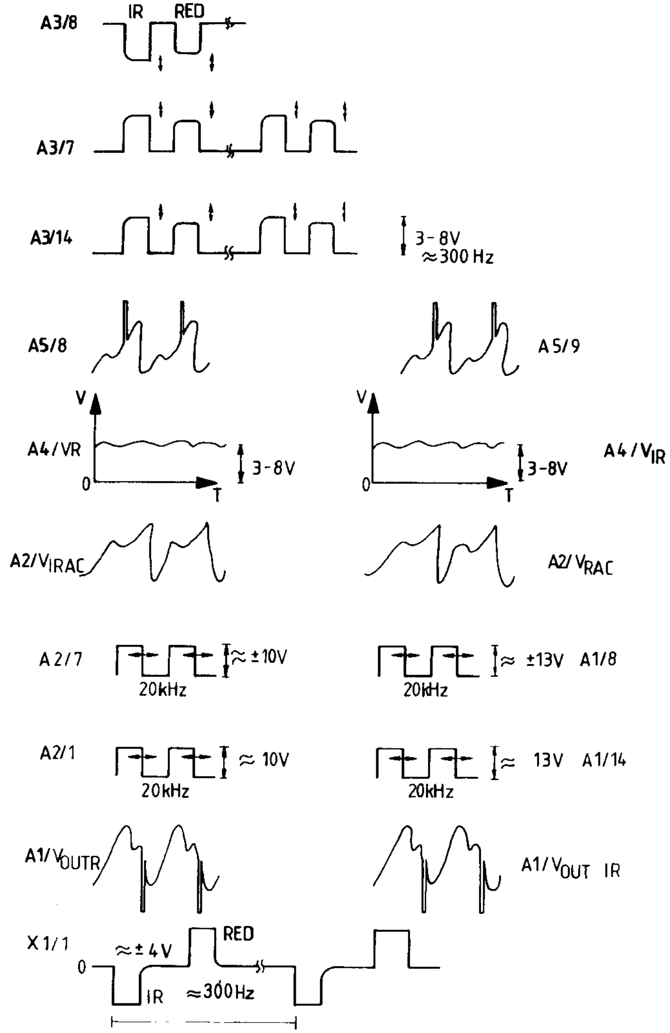
					DATEX	NIMI Sp02 BOARD	SIVU 2/4	LAITE CH/CG
MUUT.	TARK.	HYV.	MUUTOS	MERKKI	INSTRUMENTARIUM OY	PIIRT. TARK. HYV.	N:0 CH 3B 881988

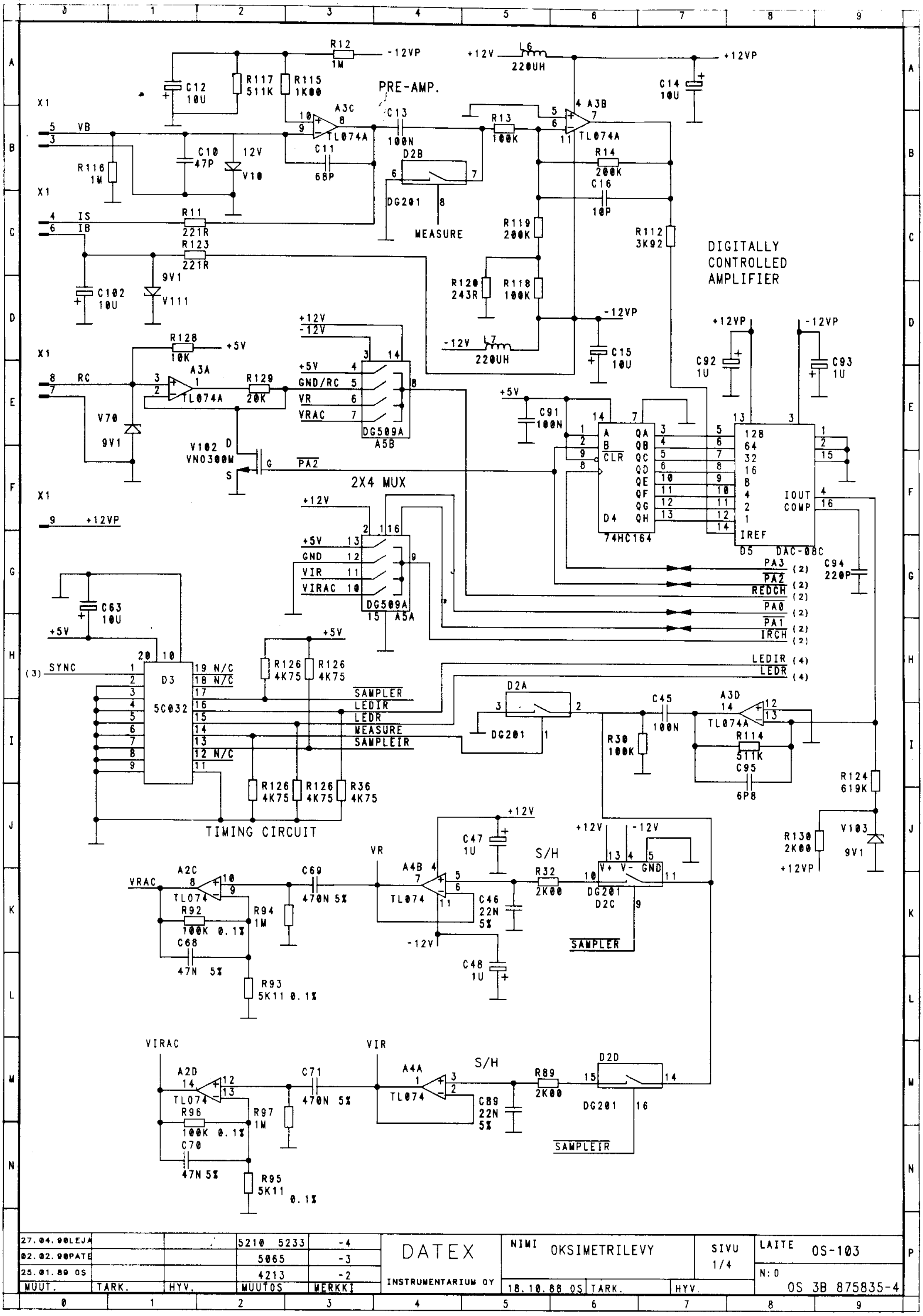
Figure 5.13 SpO_2 measuring board parts layout, timing diagram and signal waveforms. (board modification level 6 and lower).

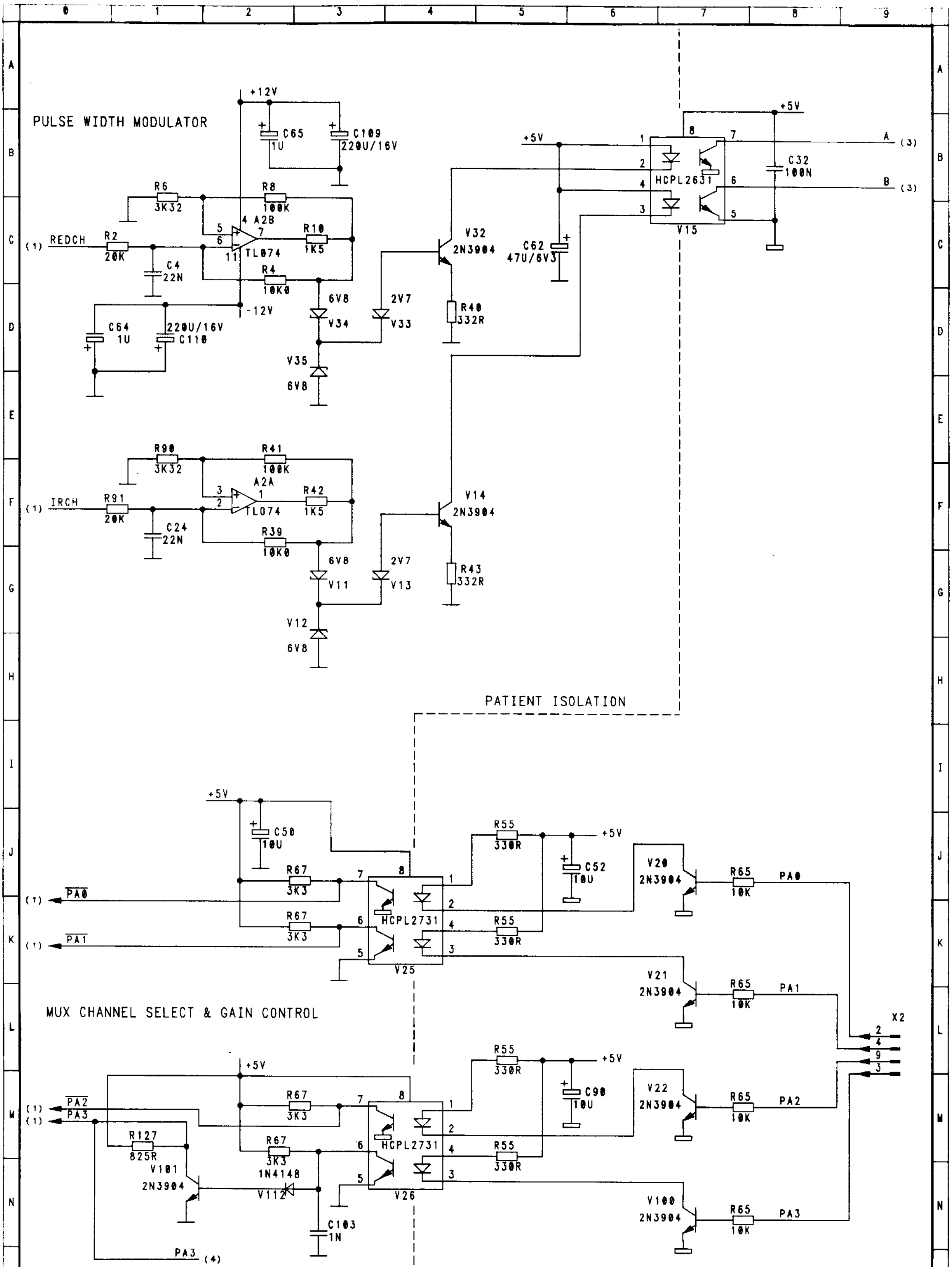
Figure 5.14 (on the next pages) SpO_2 measuring board schematic diagram. (board modification level 6 and lower).



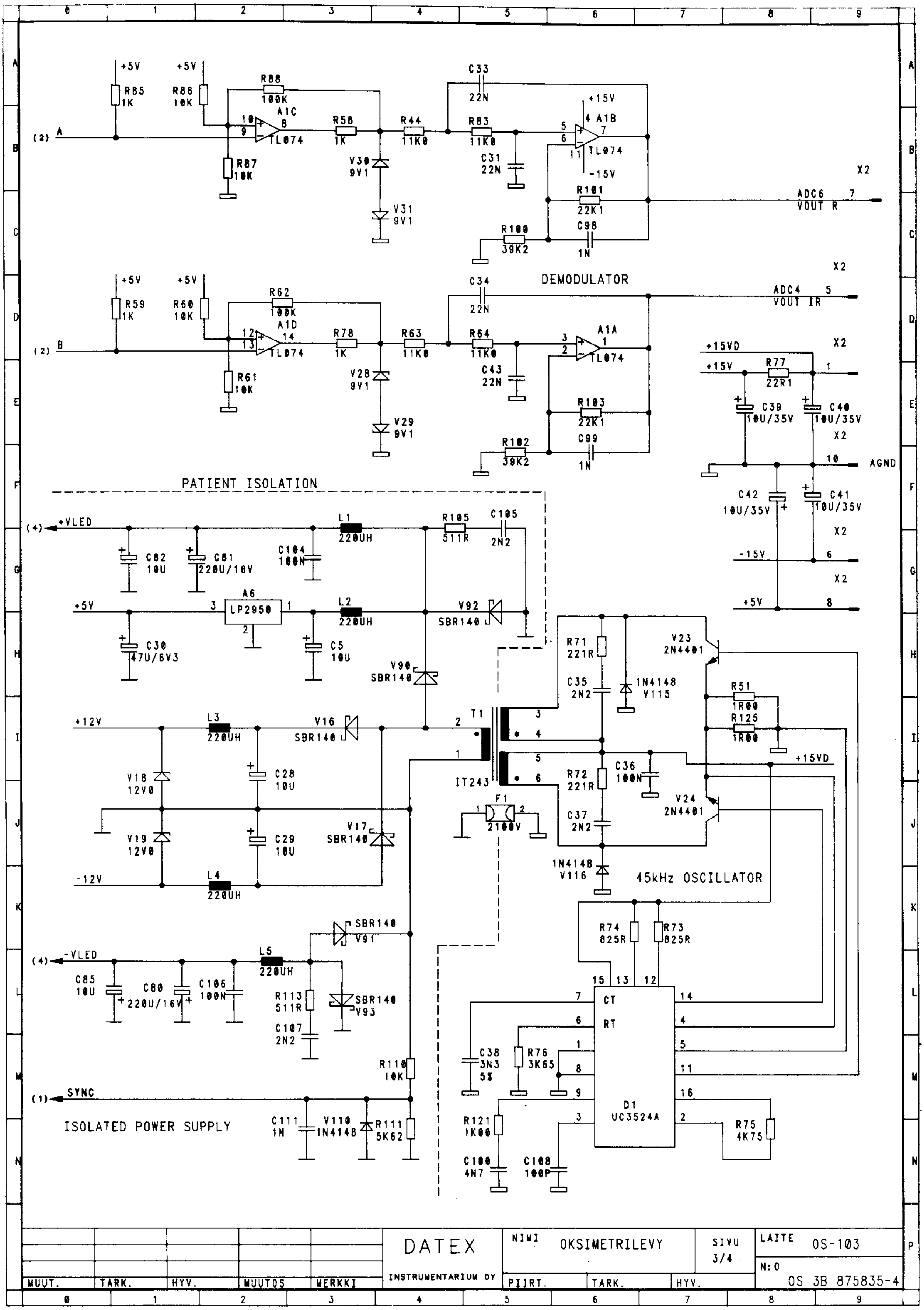


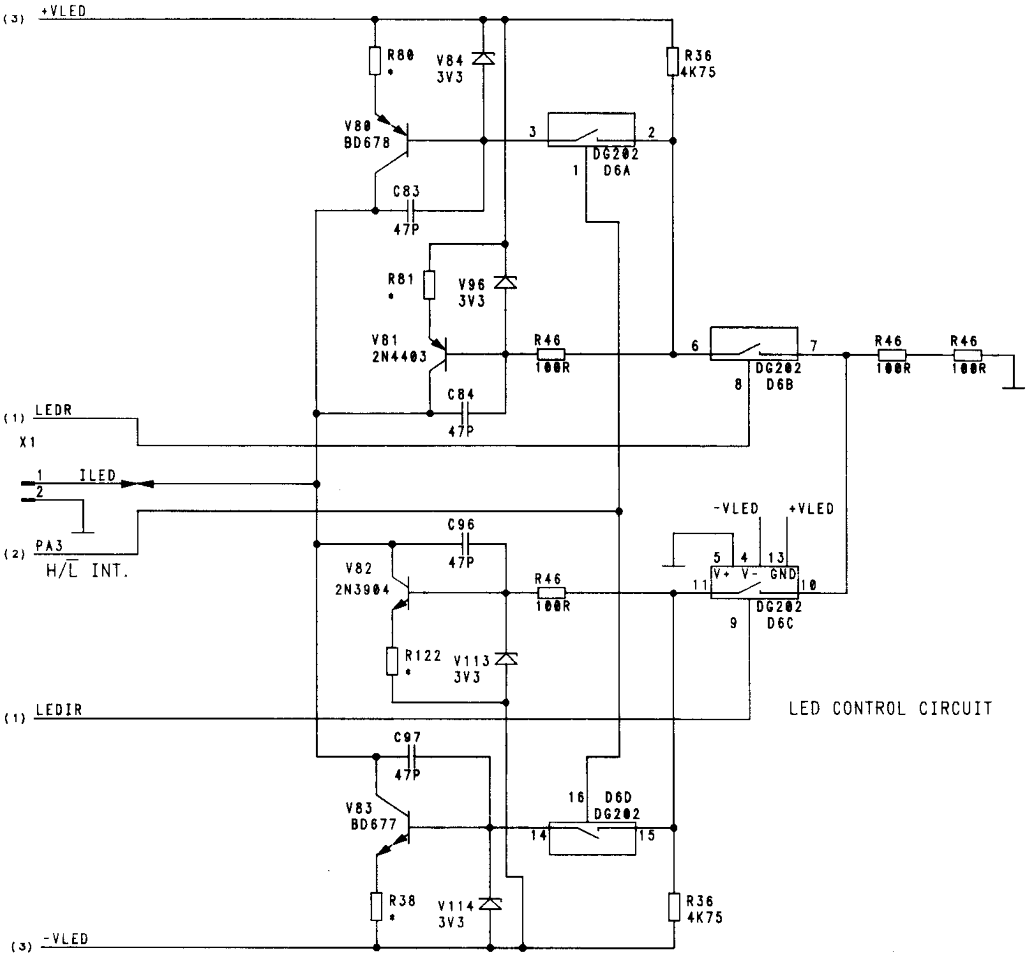



PRE-AMP.
DIGITALLY
CONTROLLED
AMPLIFIER
2X4 MUX
TIMING CIRCUIT
S/H
S/H
MEASURE
DG201
DG509A
A5B
A5A
74HC164
DAC-08C
5C032
TL074A
TL074
VN0300M
SYNC
SAMPLER
LEDIR
LEDR
MEASURE
SAMPLEIR
PA3
PA2
REDCH
PA0
PA1
IRCH
VB
IS
IB
RC
VR
VIR
VRAC
VIRAC
+12VP
-12VP
DATEX
INSTRUMENTARIUM OY
NIMI OKSIMETRILEVY
SIVU 1/4
LAITE OS-103
N:0
OS 3B 875835-4
27.04.90LEJA
02.02.90PATE
25.01.89 OS
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
5210 5233 -4
5065 -3
4213 -2
18.10.88 OS



					DATEX INSTRUMENTARIUM OY	NIMI OKSIMETRILEVY	SIVU 2/4	LAITE OS-103
MUUT.	TARK.	HYV.	MUUTOS	MERKKI		PIIRT. / TARK. / HYV.		N:0 OS 3B 875835-4


DEMODULATOR
PATIENT ISOLATION
45kHz OSCILLATOR
ISOLATED POWER SUPPLY
DATEX
INSTRUMENTARIUM OY
NIMI OKSIMETRILEVY
SIVU 3/4
LAITE OS-103
N:O OS 3B 875835-4
MUUT. TARK. HYV. MUUTOS MERKKI
PIIRT. TARK. HYV.

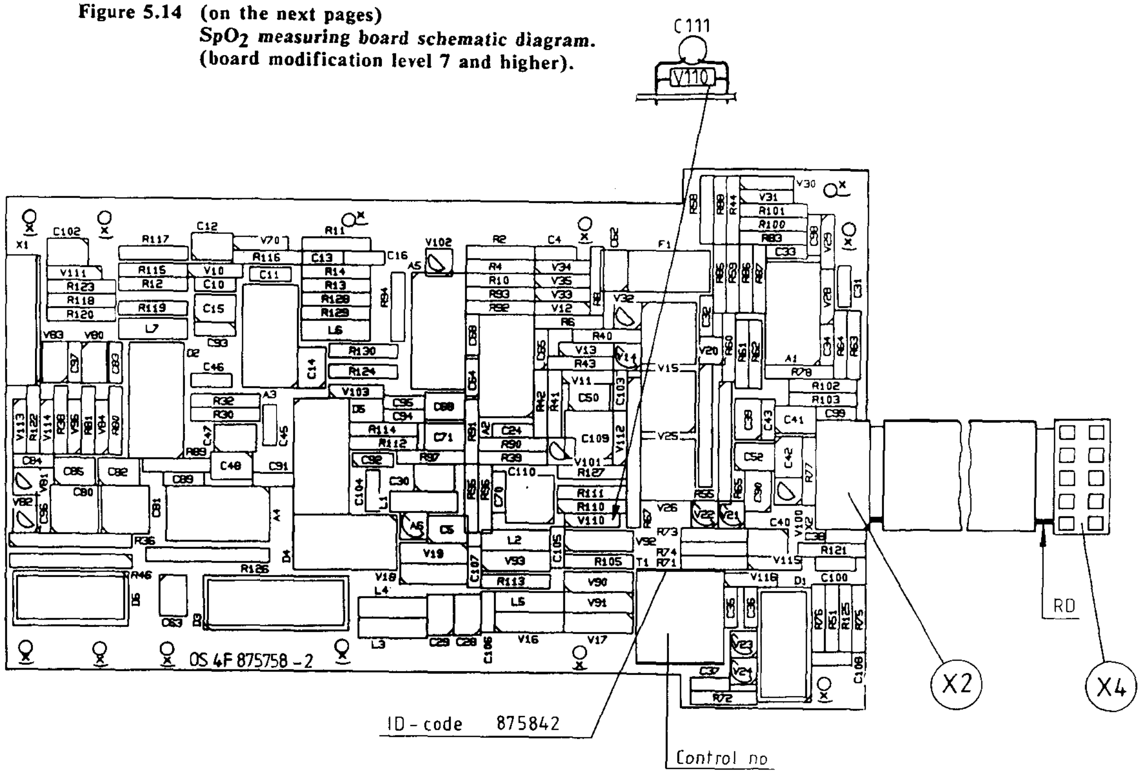


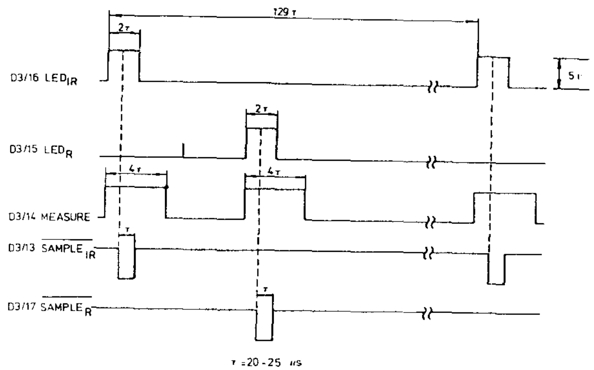
* RESISTORS INDIVIDUALLY SELECTED OF VALUES
R38,R80: 8R25,8R66,9R09
R81: 90R9,100R,110R
R122: 274R,301R,332R

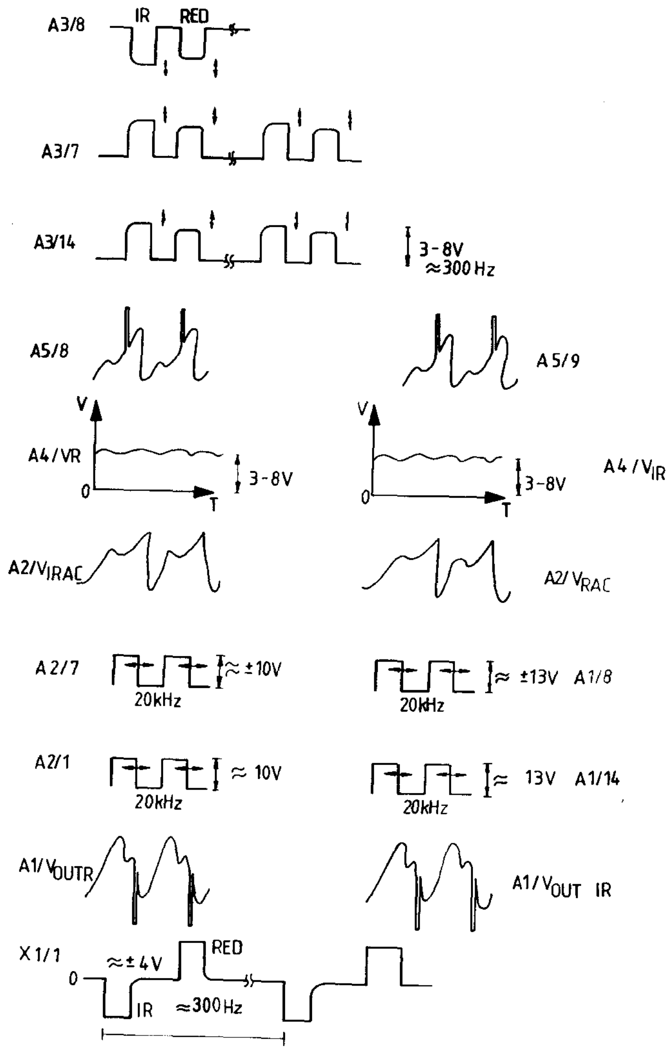
MUUT.	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI OKSIMETRILEVY	SIVU 4/4	LAITE OS-103
						PIIRT. / TARK. / HYV.		N:0 OS 3B 875835-4

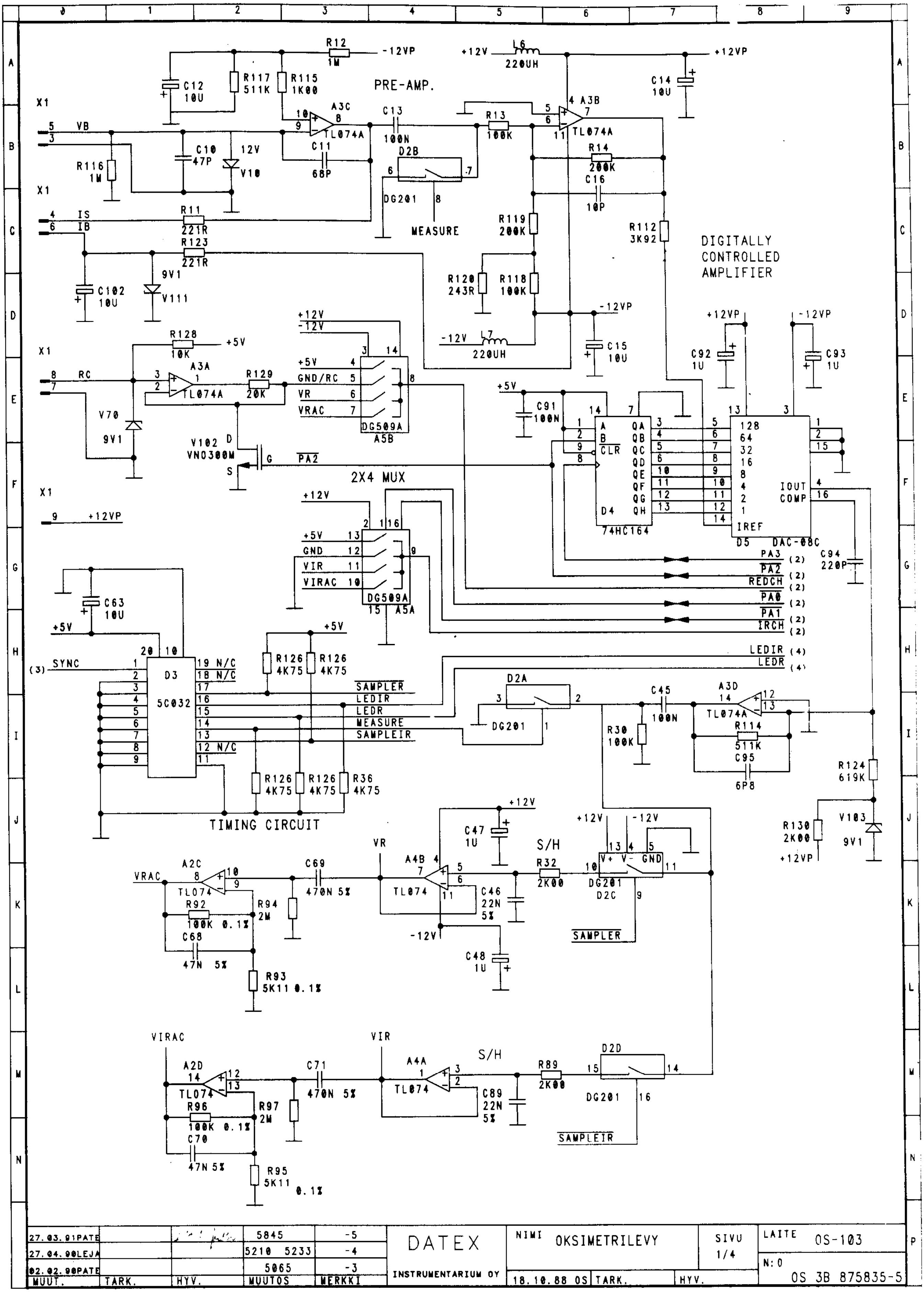
Figure 5.13 SpO_2 measuring board parts layout, timing diagram and signal waveforms.
(board modification level 7 and higher).

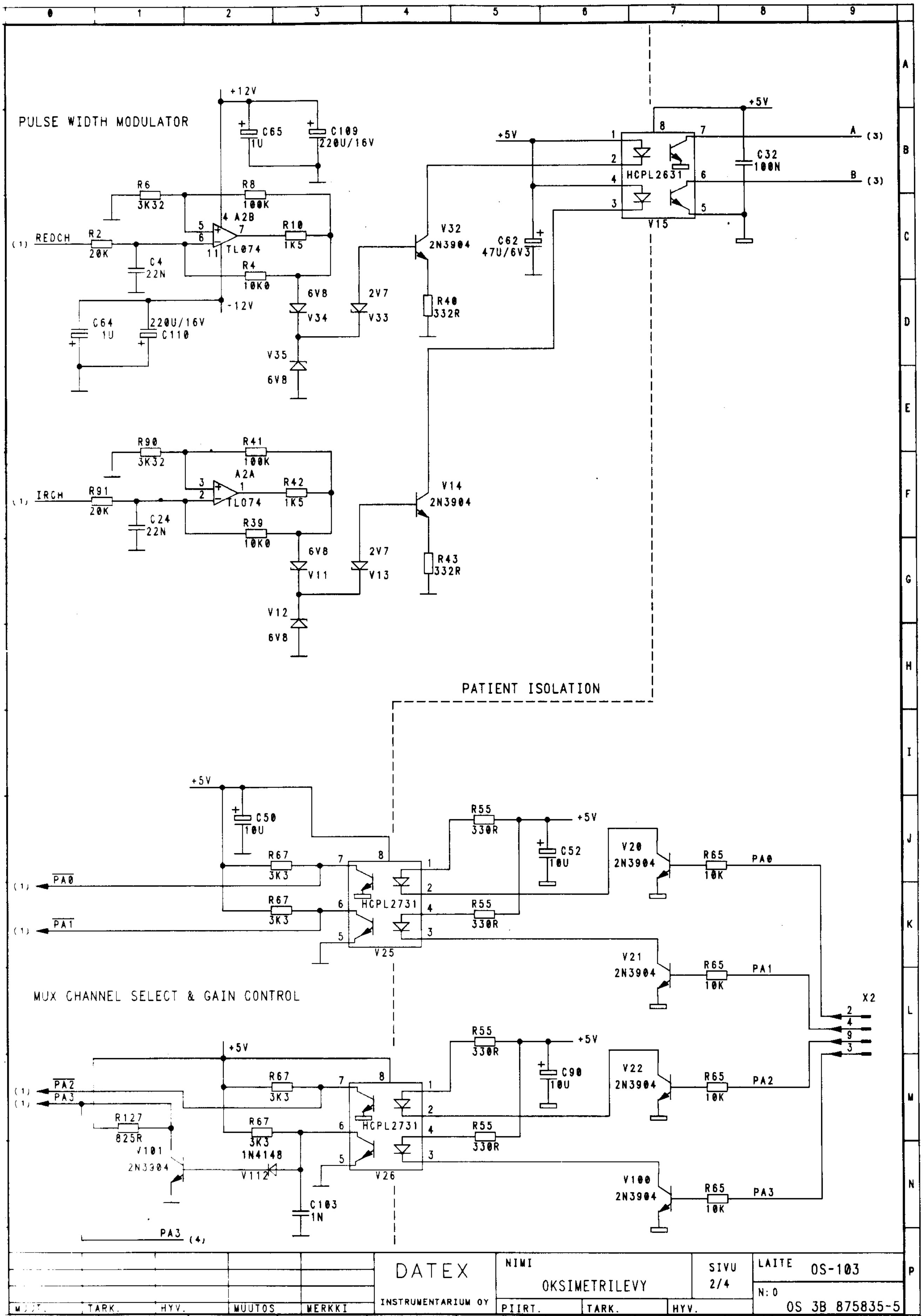
Figure 5.14 (on the next pages)
SpO_2 measuring board schematic diagram.
(board modification level 7 and higher).

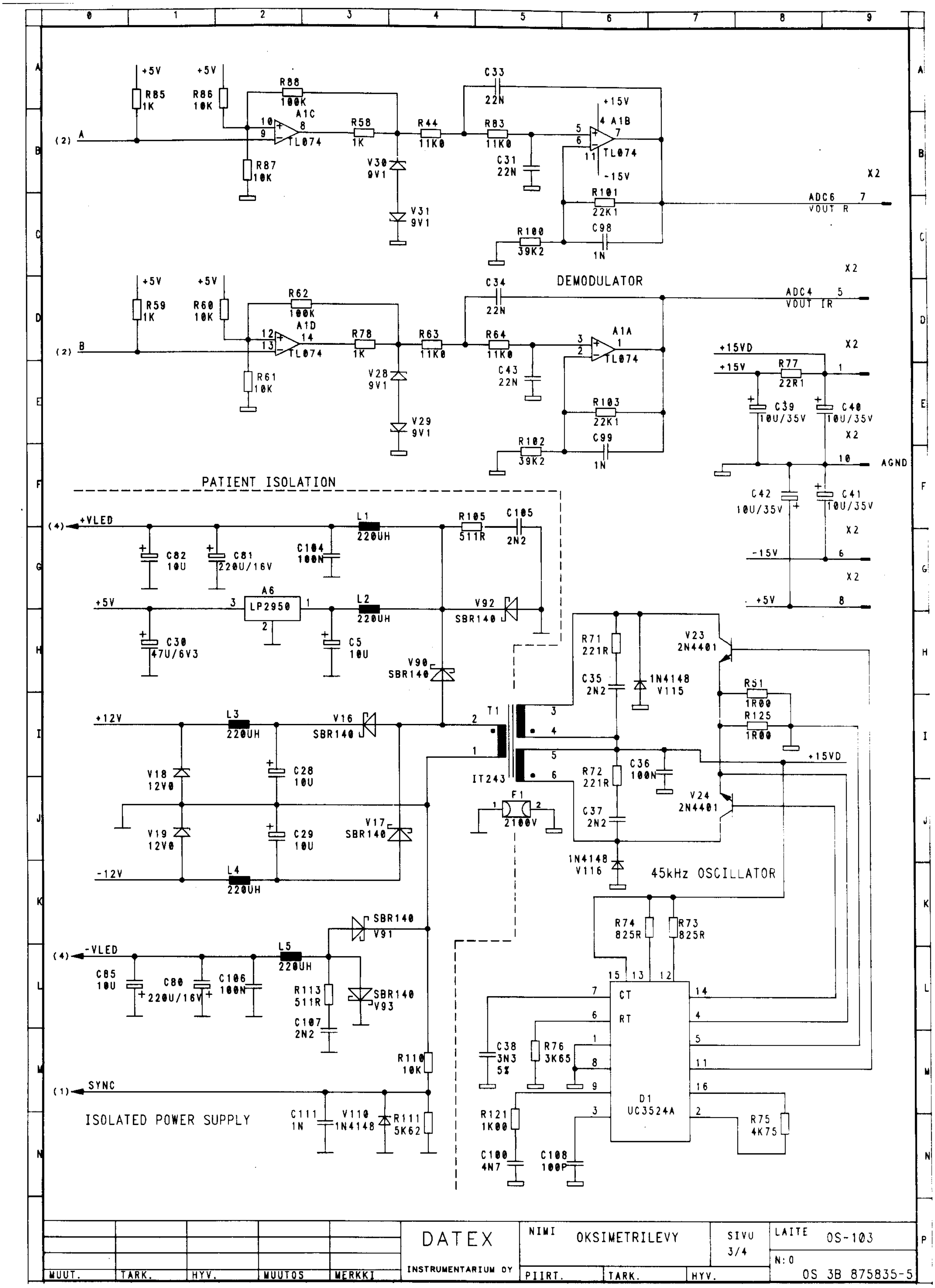


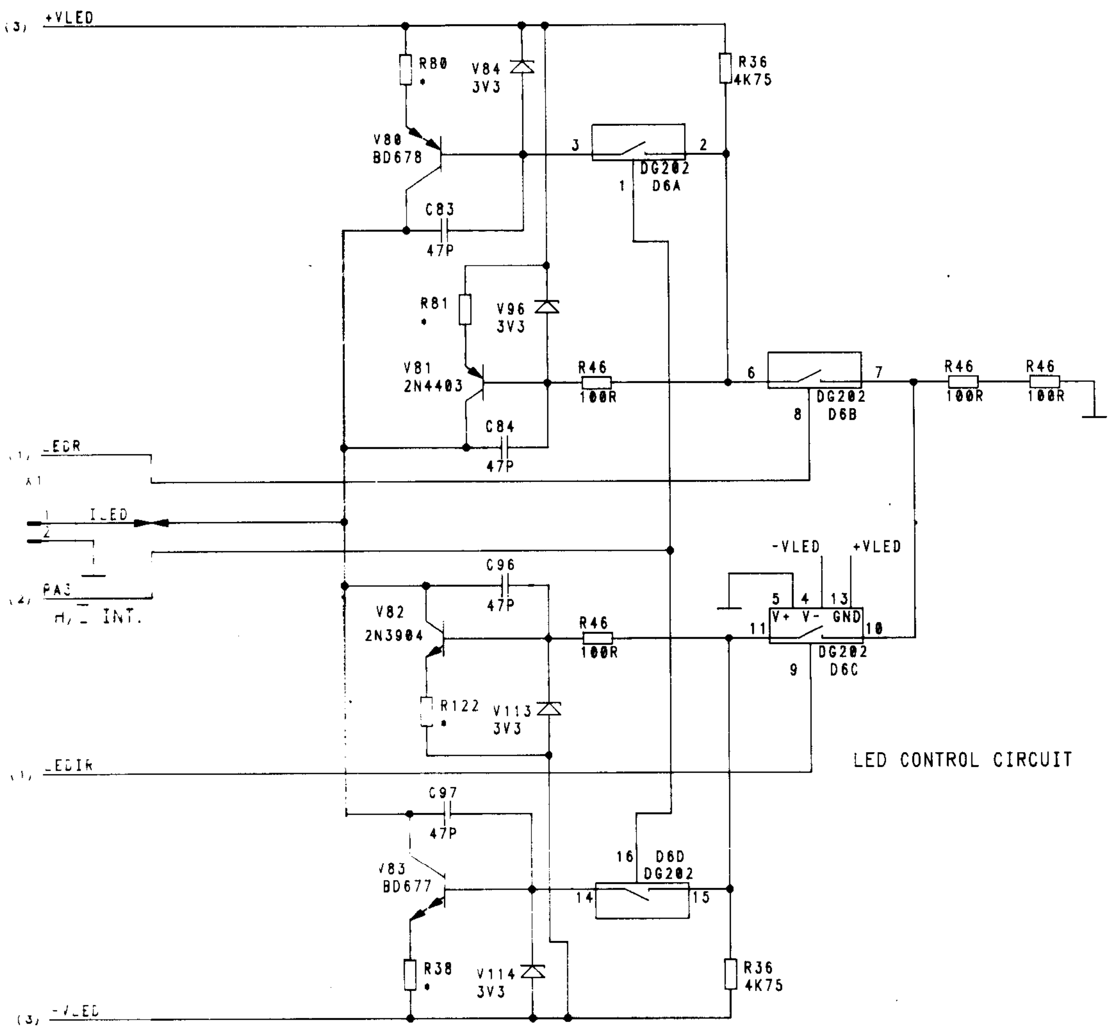





PRE-AMP.
DIGITALLY
CONTROLLED
AMPLIFIER
2X4 MUX
TIMING CIRCUIT
S/H
S/H
MEASURE
SAMPLER
LEDIR
LEDR
MEASURE
SAMPLEIR
PA3
PA2
REDCH
PA0
PA1
IRCH
TL074A
DG201
DG509A
74HC164
DAC-08C
5C032
VN0300M
VRAC
VIRAC
VR
VIR
SYNC
27.03.91PATE
27.04.90LEJA
02.02.90PATE
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
5845
5210 5233
5065
-5
-4
-3
DATEX
INSTRUMENTARIUM OY
NIMI
OKSIMETRILEVY
SIVU
1/4
LAITE
OS-103
N:0
18.10.88 OS
OS 3B 875835-5


PULSE WIDTH MODULATOR
+12V
C65 1U
C109 220U/16V
R6 3K32
R8 100K
A2B
TL074
REDCH
R2 20K
C4 22N
R10 1K5
R4 10K0
-12V
C64 1U
220U/16V C110
6V8 V34
V35 6V8
2V7 V33
V32 2N3904
R40 332R
+5V
HCPL2631
V15
C62 47U/6V3
C32 100N
A (3)
B (3)
R90 3K32
R41 100K
A2A
IRCH
R91 20K
C24 22N
R42 1K5
TL074
R39 10K0
6V8 V11
V12 6V8
2V7 V13
V14 2N3904
R43 332R
PATIENT ISOLATION
C50 10U
R67 3K3
PA0
PA1
HCPL2731
V25
R55 330R
C52 10U
V20 2N3904
R65 10K
V21 2N3904
MUX CHANNEL SELECT & GAIN CONTROL
X2
PA2
PA3
R127 825R
V101 2N3904
1N4148 V112
C103 1N
V26
C90 10U
V22 2N3904
V100 2N3904
PA3 (4)
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
DATEX
INSTRUMENTARIUM OY
NIMI
OKSIMETRILEVY
PIIRT.
TARK.
HYV.
SIVU 2/4
LAITE OS-103
N:O
OS 3B 875835-5


DEMODULATOR
PATIENT ISOLATION
45kHz OSCILLATOR
ISOLATED POWER SUPPLY
ADC6 VOUT R
ADC4 VOUT IR
AGND
+VLED
-VLED
SYNC
DATEX
INSTRUMENTARIUM OY
NIMI OKSIMETRILEVY
SIVU 3/4
LAITE OS-103
N:O OS 3B 875835-5
MUUT. TARK. HYV. MUUTOS MERKKI
PIIRT. TARK. HYV.

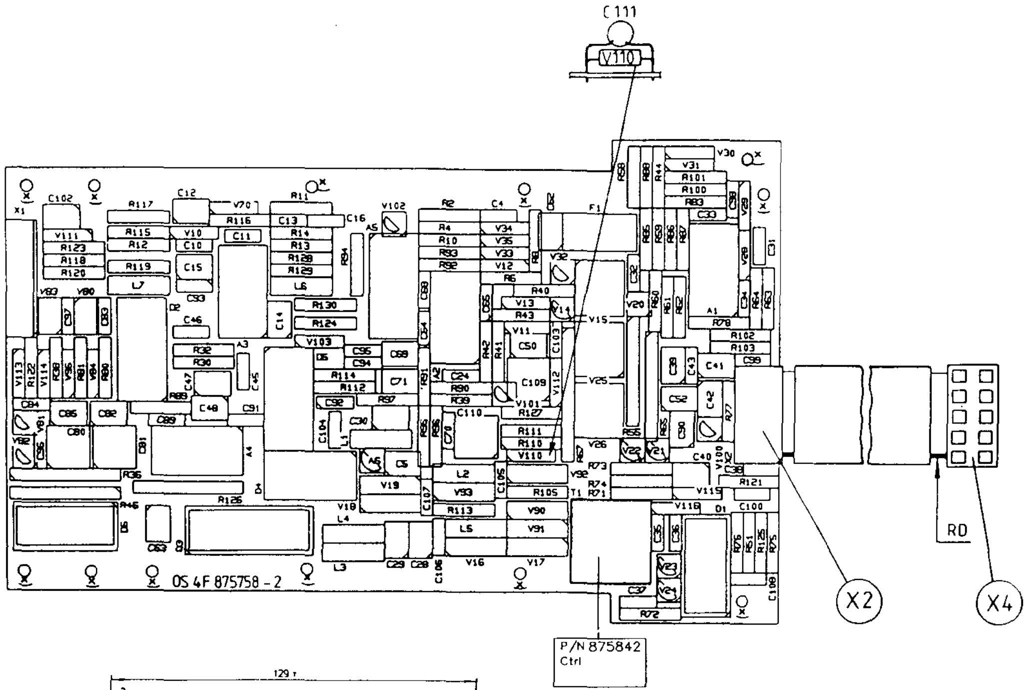


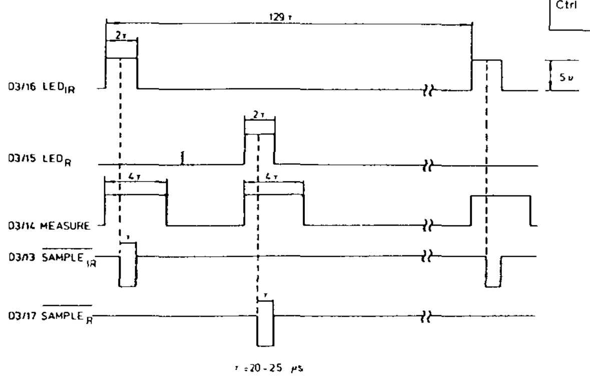
• RESISTORS INDIVIDUALLY SELECTED OF VALUES
R38, R80: 8R25, 8R66, 9R09
R81: 90R9, 100R, 110R
R122: 274R, 301R, 332R

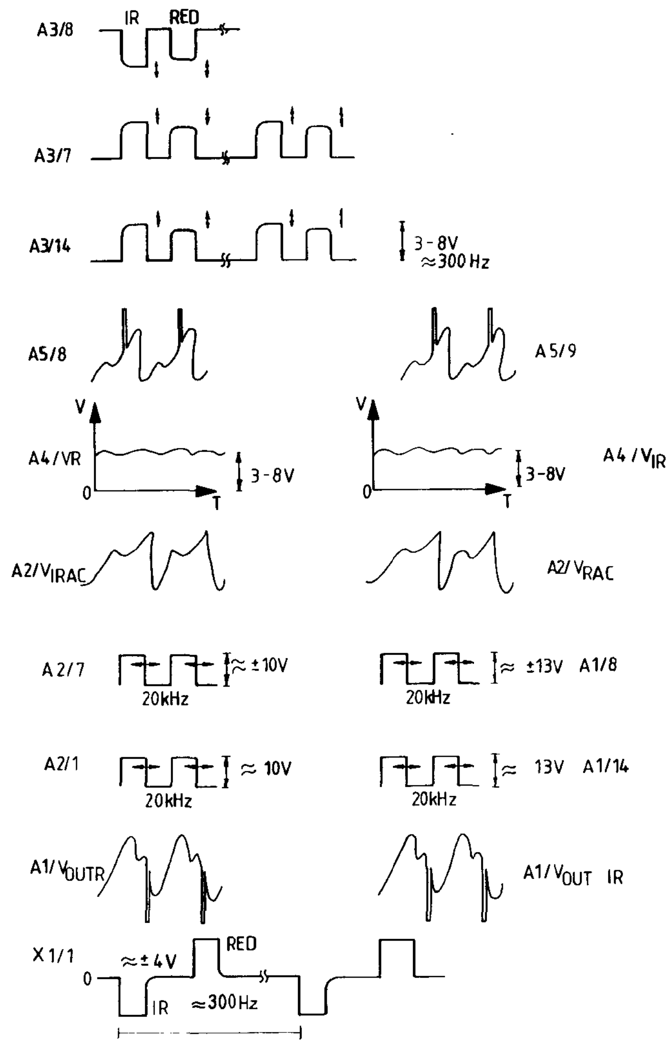
MUUT.	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI OKSIMETRILEVY	SIVU 4/4	LAITE OS-103
						PIIRT. / TARK. / HYV.		N:O OS 3B 875835-5

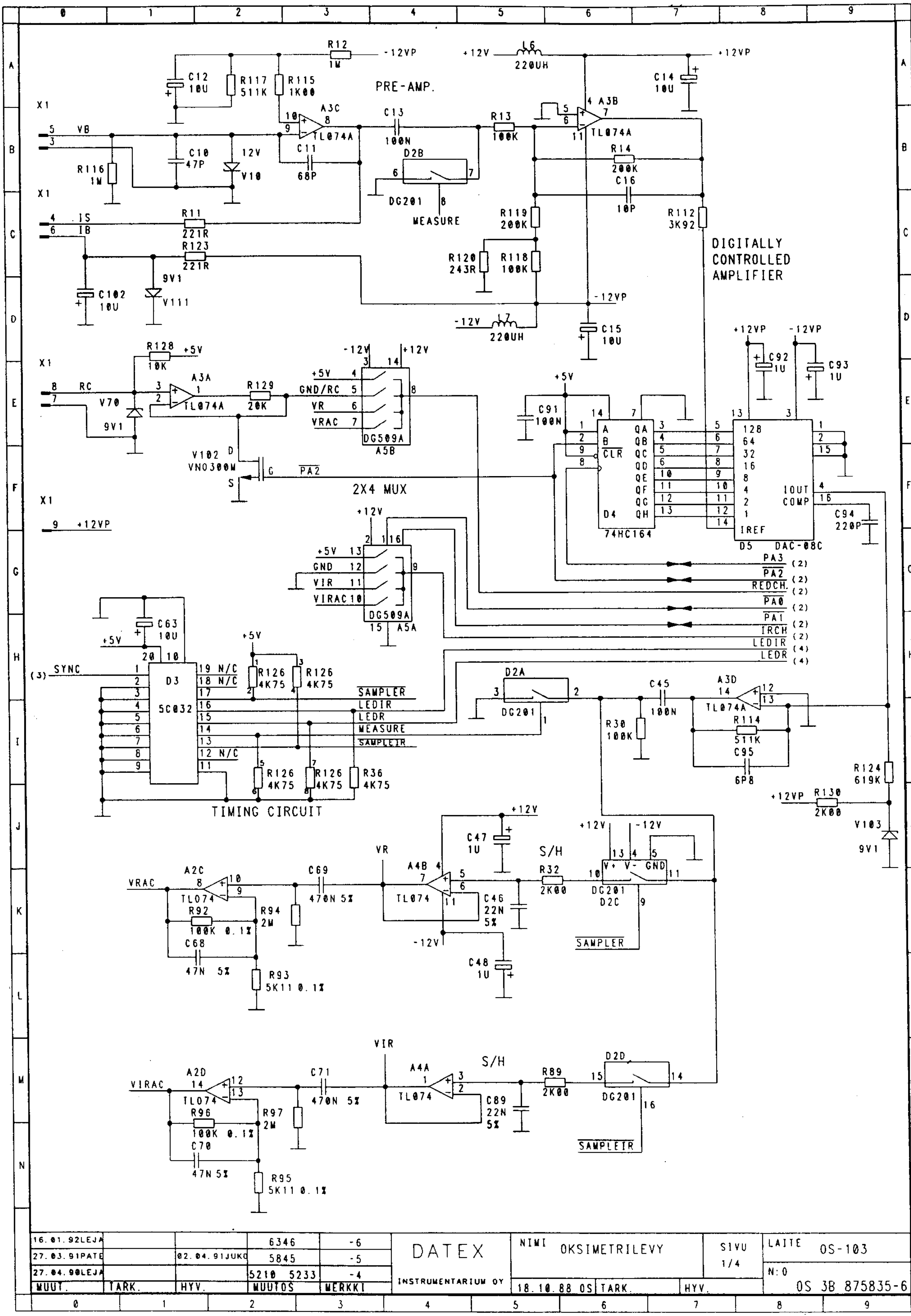
Figure 5.13b SpO_2 measuring board parts layout, timing diagram and signal waveforms.
(board modification level 8 and higher).

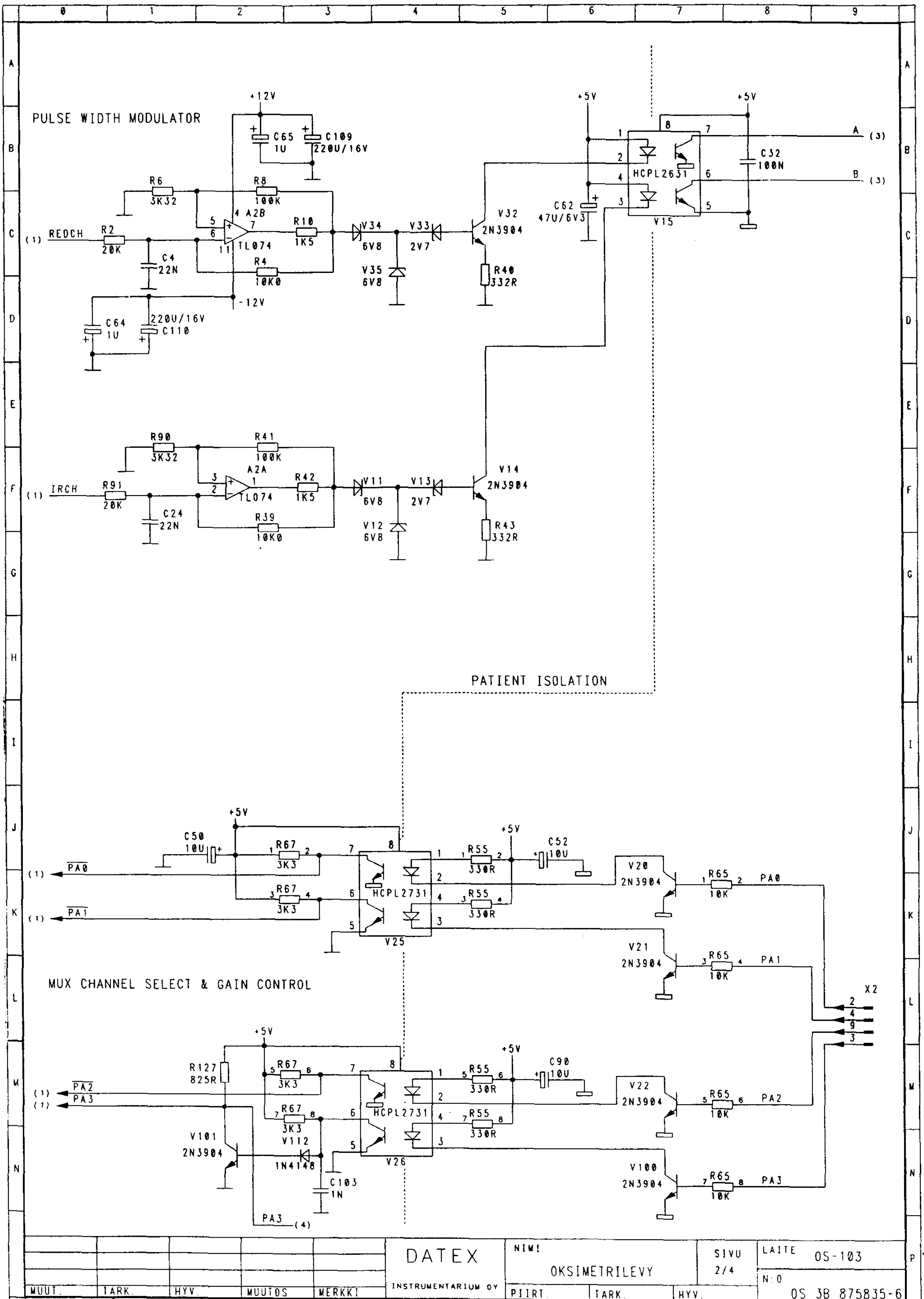
Figure 5.14b (on the next pages)
SpO_2 measuring board schematic diagram.
(board modification level 8 and higher).



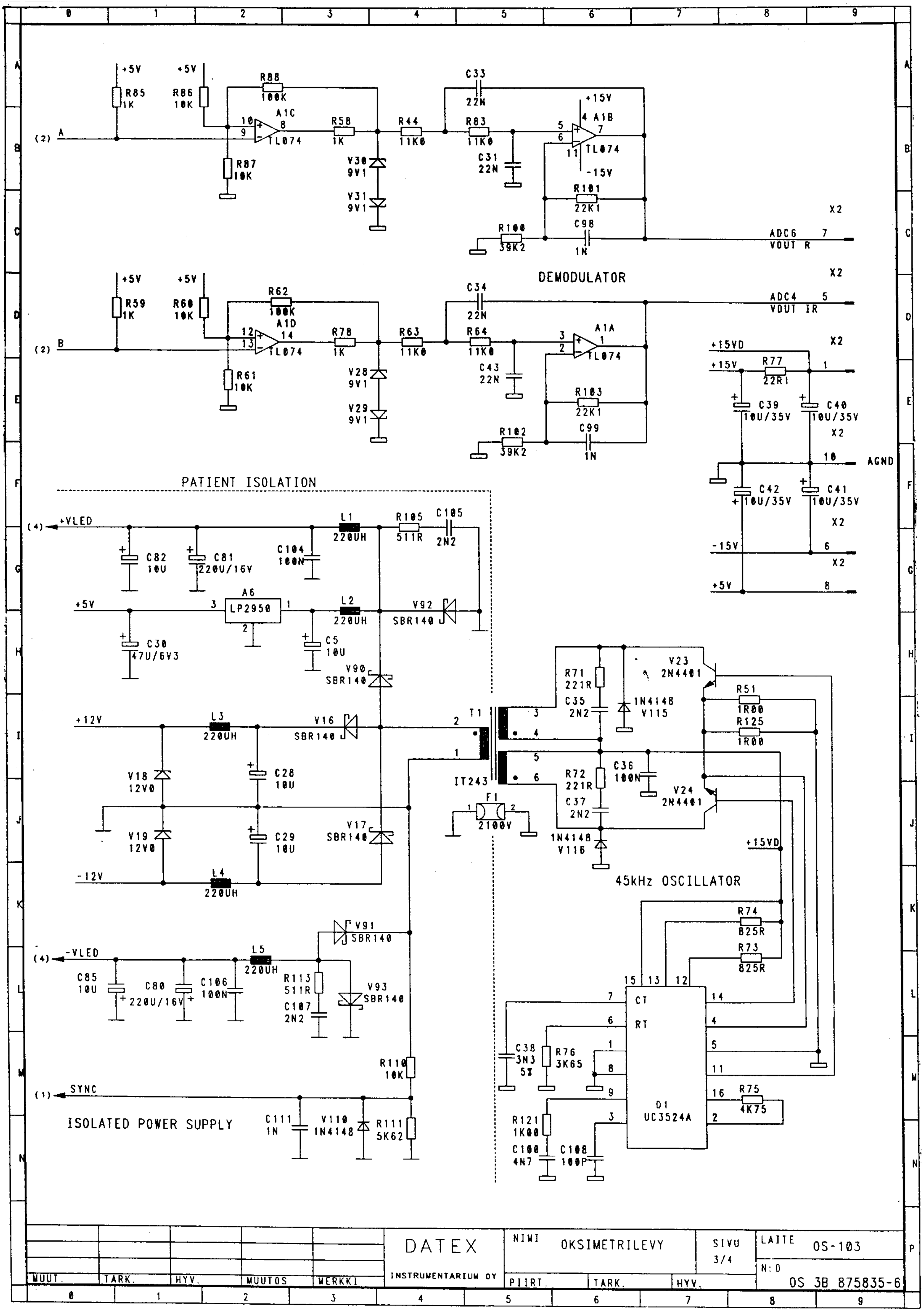


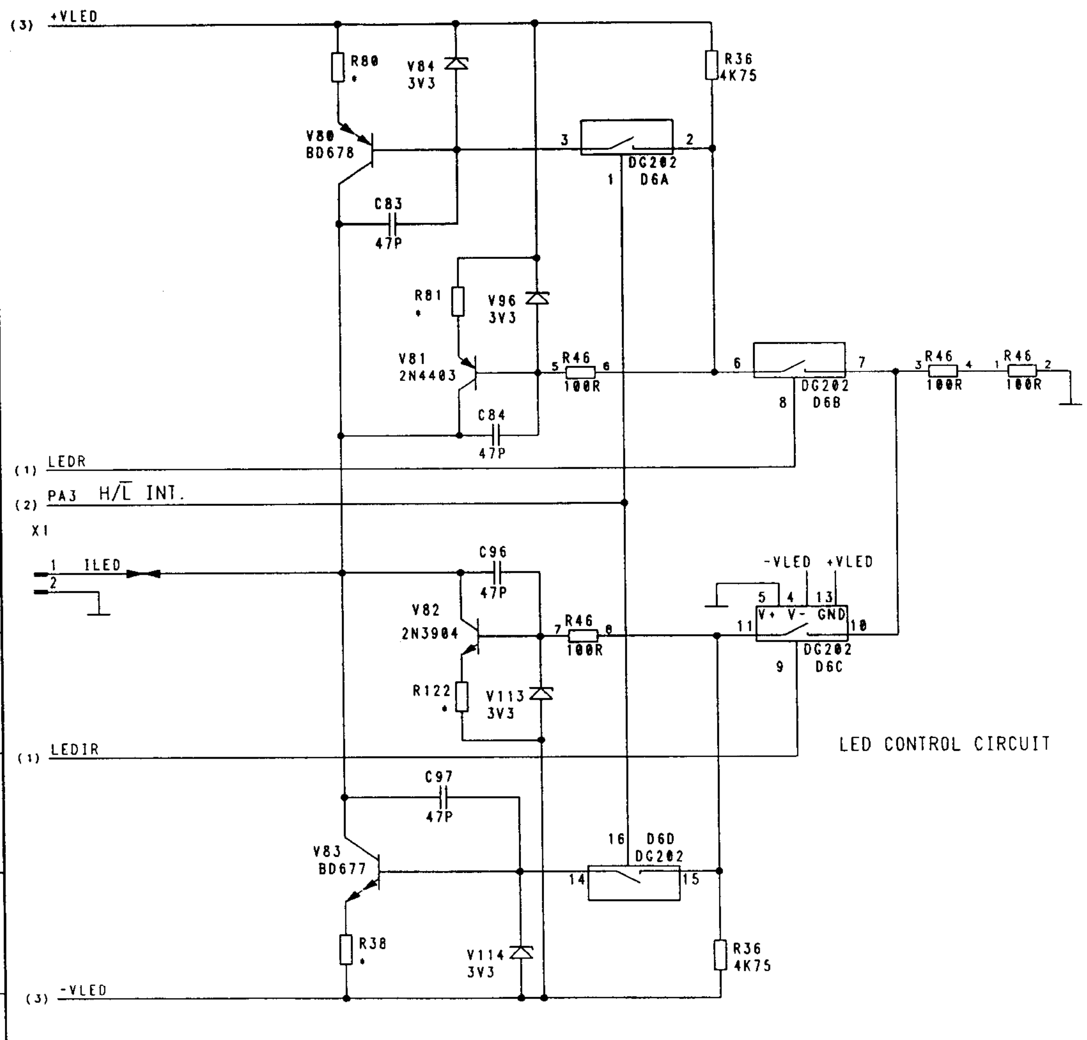



PRE-AMP.
DIGITALLY
CONTROLLED
AMPLIFIER
2X4 MUX
TIMING CIRCUIT
S/H
S/H
DATEX
INSTRUMENTARIUM OY
NIMI OKSIMETRILEVY
SIVU 1/4
LAITE OS-103
OS 3B 875835-6



MUUT.	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI OKSIMETRILEVY	SIVU 2/4	LAITE OS-103
						PIIRT. / TARK. / HYV.		N:O OS 3B 875835-6


DEMODULATOR
PATIENT ISOLATION
45kHz OSCILLATOR
ISOLATED POWER SUPPLY
ADC6 VOUT R
ADC4 VOUT IR
AGND
+VLED
-VLED
SYNC
DATEX
INSTRUMENTARIUM OY
NIMI OKSIMETRILEVY
SIVU 3/4
LAITE OS-103
N:O OS 3B 875835-6
MUUT. TARK. HYV. MUUTOS MERKKI
PIIRT. TARK. HYV.

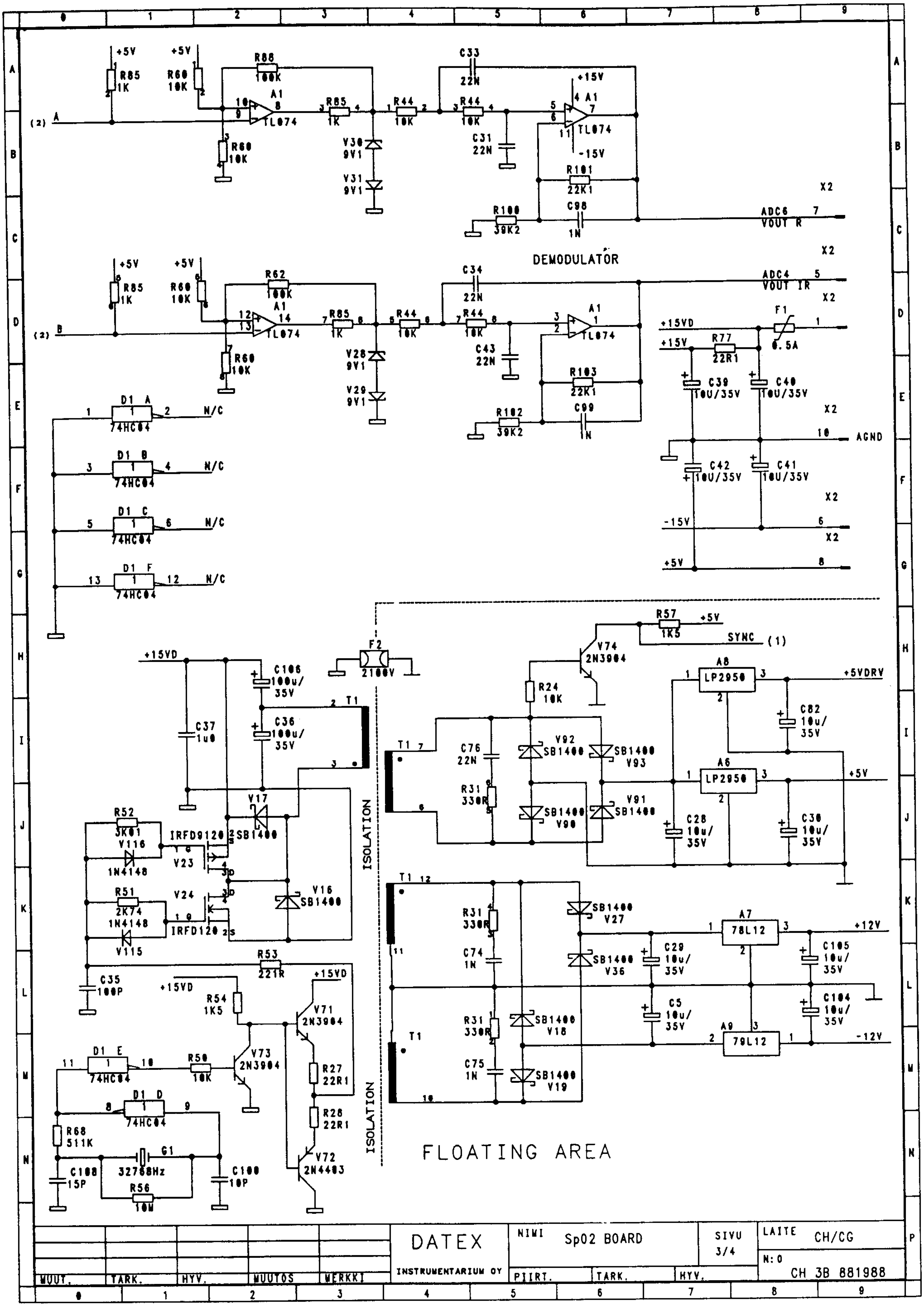


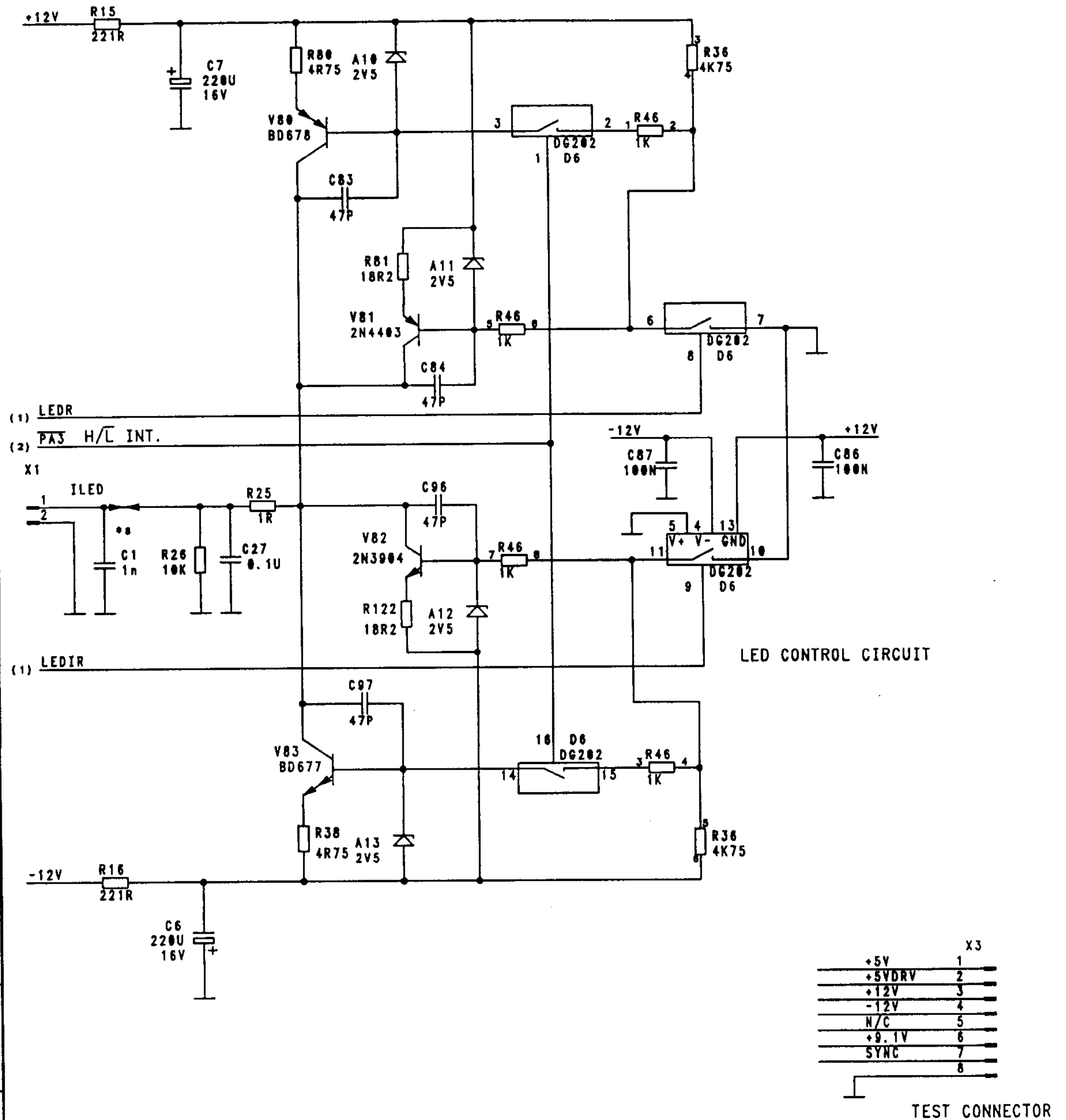
LED CONTROL CIRCUIT

RESISTORS INDIVIDUALLY SELECTED OF VALUES

R38, R80: 8R25, 8R66, 9R09
R81: 68R1, 75R0, 82R5
R122: 75R0, 82R5, 90R9

MUUT.	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI OKSIMETRILEVY	SIVU 4/4	LAITE OS-103
						PIIRT. TARK. HYV.		N:0 OS 3B 875835-6

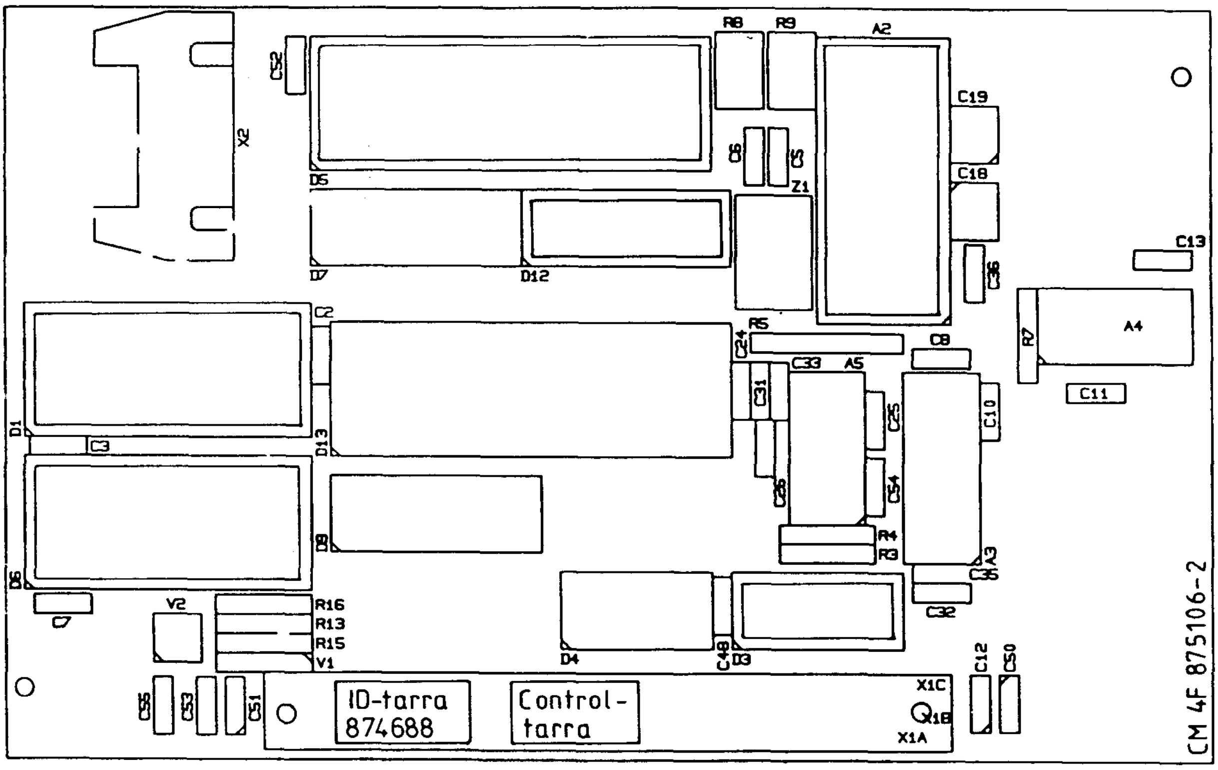

DEMODULATOR
ADC6 VOUT R
ADC4 VOUT IR
X2
AGND
+15VD
+15V
-15V
+5V
N/C
74HC04
TL074
SYNC (1)
+5VDRV
LP2950
78L12
79L12
+12V
-12V
ISOLATION
FLOATING AREA
DATEX
INSTRUMENTARIUM OY
NIMI Sp02 BOARD
SIVU 3/4
LAITE CH/CG
N:0
CH 3B 881988
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.
TARK.
HYV.



*s SMD component on the solder side

MUUT.	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI Sp02 BOARD	SIVU 4/4	LAITE CH/CG
						PIIRT. / TARK. / HYV.		N:0 CH 3B 881988

Figure 5.16 SpO_2 processor board parts layout and schematic diagram (modification level 4 and lower)



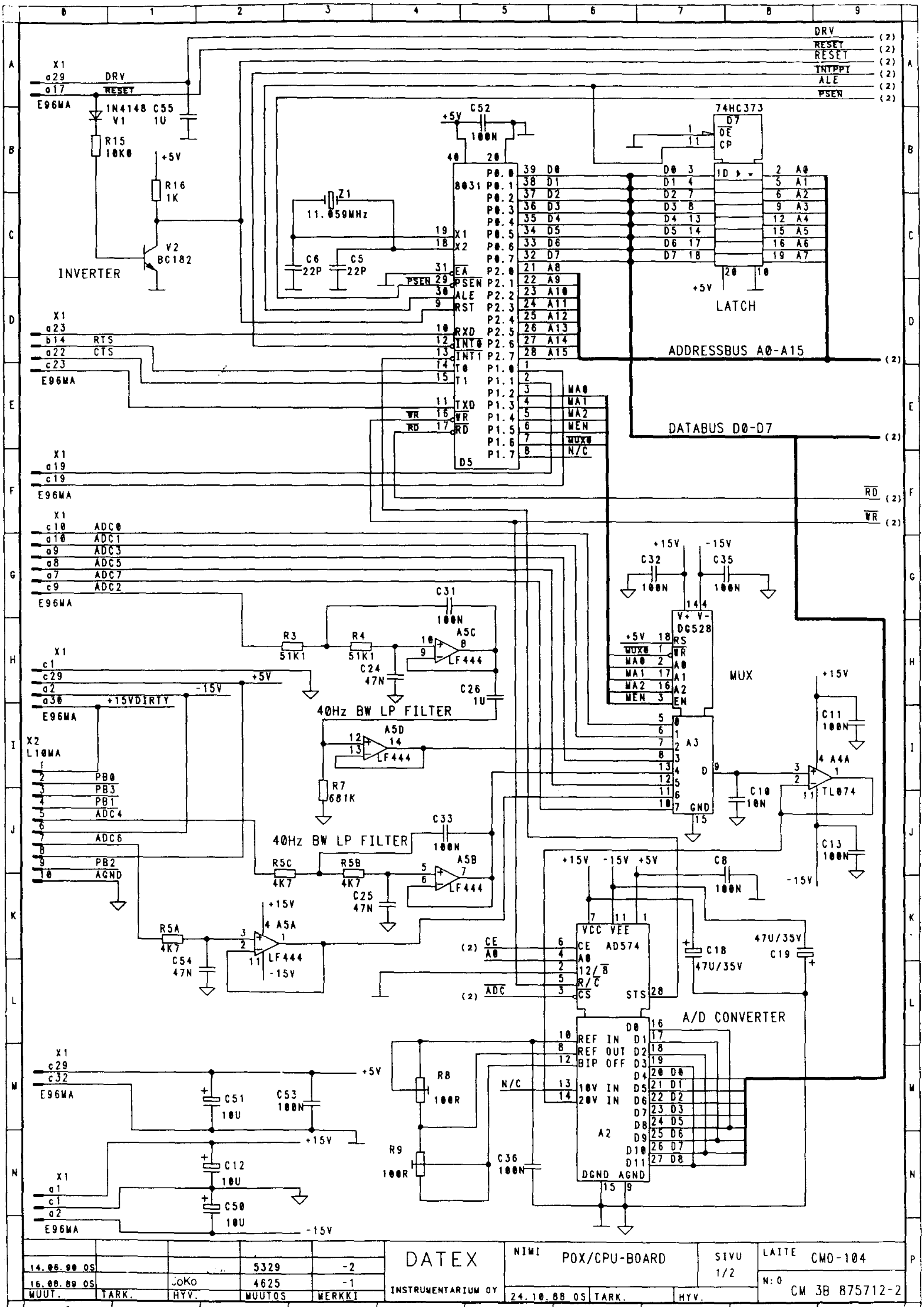
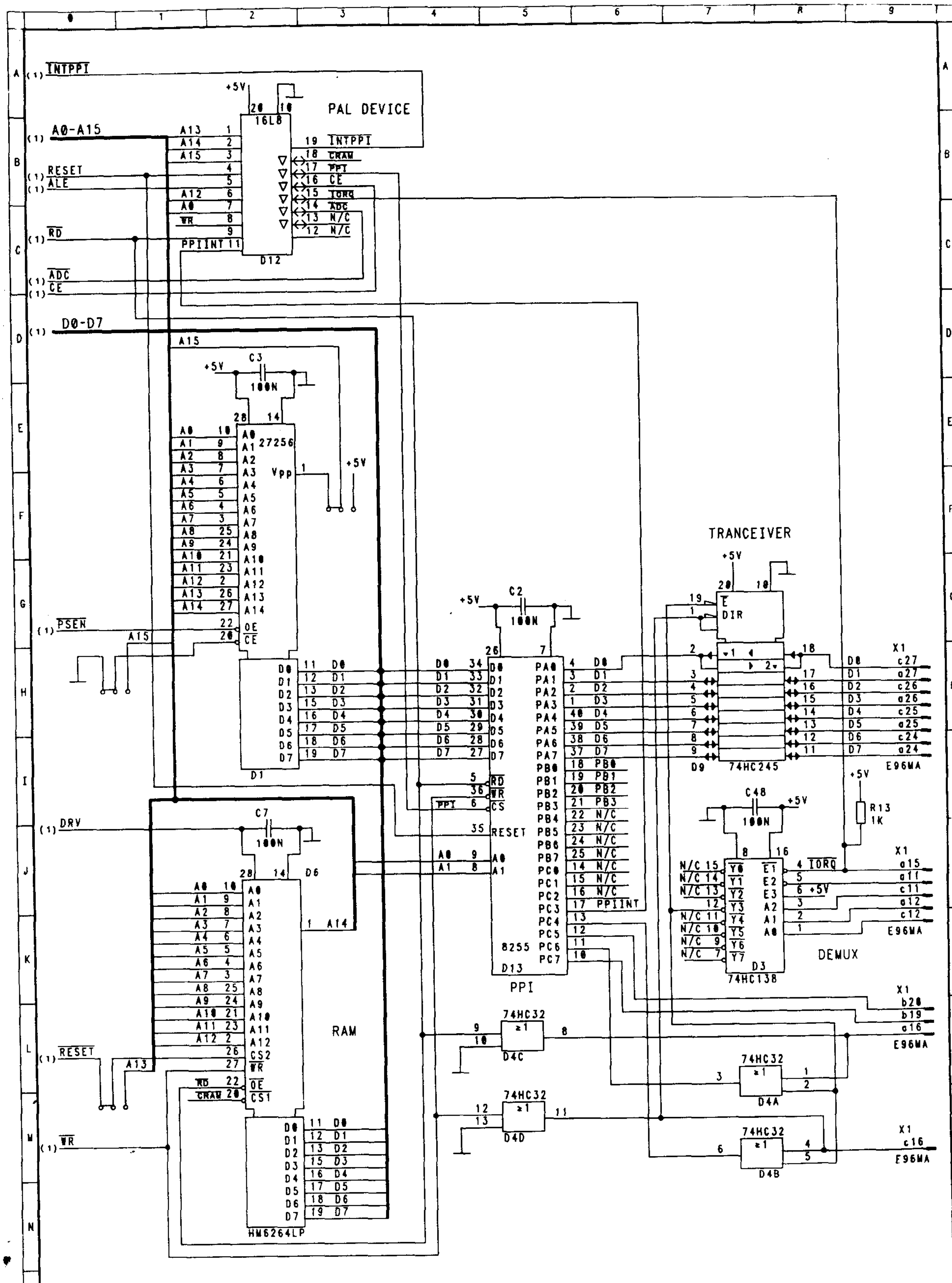
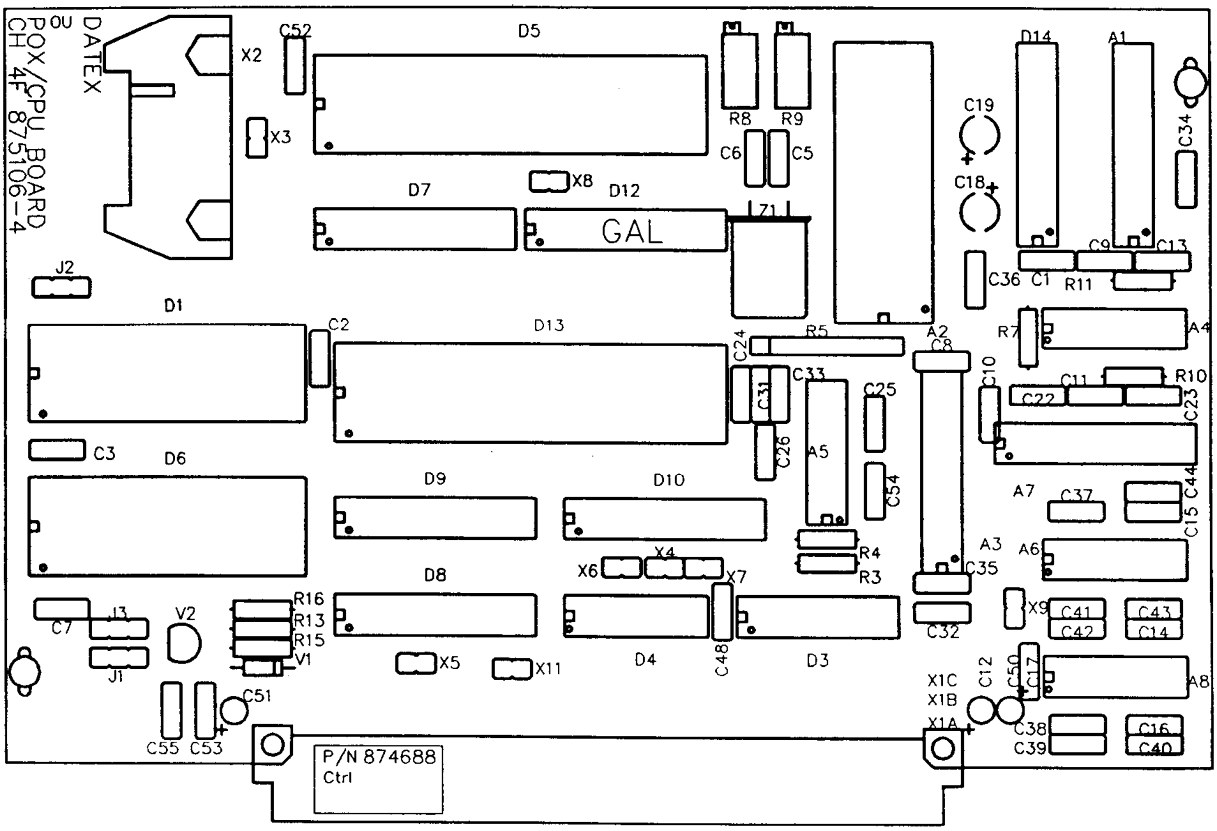

DRV
RESET
RESET
INTPPI
ALE
PSEN
X1
a29
a17
E96MA
1N4148
V1
C55
1U
R15
10K0
+5V
R16
1K
V2
BC182
INVERTER
+5V
C52
100N
40
20
8031
74HC373
D7
OE
CP
1D
Z1
11.059MHz
C6
22P
C5
22P
P0.0
P0.1
P0.2
P0.3
P0.4
P0.5
P0.6
P0.7
P2.0
P2.1
P2.2
P2.3
P2.4
P2.5
P2.6
P2.7
P1.0
P1.1
P1.2
P1.3
P1.4
P1.5
P1.6
P1.7
X1
X2
EA
PSEN
ALE
RST
RXD
INT0
INT1
T0
T1
TXD
WR
RD
D5
LATCH
ADDRESSBUS A0-A15
DATABUS D0-D7
RTS
CTS
MA0
MA1
MA2
MEN
MUX0
N/C
ADC0
ADC1
ADC3
ADC5
ADC7
ADC2
C31
100N
R3
51K1
R4
51K1
A5C
LF444
C24
47N
C26
1U
40Hz BW LP FILTER
+15VDIRTY
-15V
+5V
X2
L10MA
PB0
PB3
PB1
ADC4
ADC6
PB2
AGND
A5D
LF444
R7
681K
C33
100N
40Hz BW LP FILTER
R5C
4K7
R5B
4K7
A5B
C25
47N
R5A
4K7
C54
47N
A5A
+15V
-15V
C32
100N
C35
100N
DG528
MUX
RS
EN
A3
GND
C10
10N
A4A
TL074
C11
100N
C13
100N
C8
100N
VCC VEE
AD574
CE
A0
12/8
R/C
CS
STS
C18
47U/35V
C19
47U/35V
A/D CONVERTER
REF IN
REF OUT
BIP OFF
10V IN
20V IN
A2
DGND AGND
R8
100R
R9
100R
C36
100N
C51
10U
C53
100N
C12
10U
C50
10U
14.06.90 OS
16.08.89 OS
MUUT.
TARK.
JoKo
HYV.
5329
4625
MUUTOS
-2
-1
MERKKI
DATEX
INSTRUMENTARIUM OY
NIMI
POX/CPU-BOARD
SIVU
1/2
24.10.88 OS
TARK.
HYV.
LAITE
CMO-104
N:O
CM 3B 875712-2

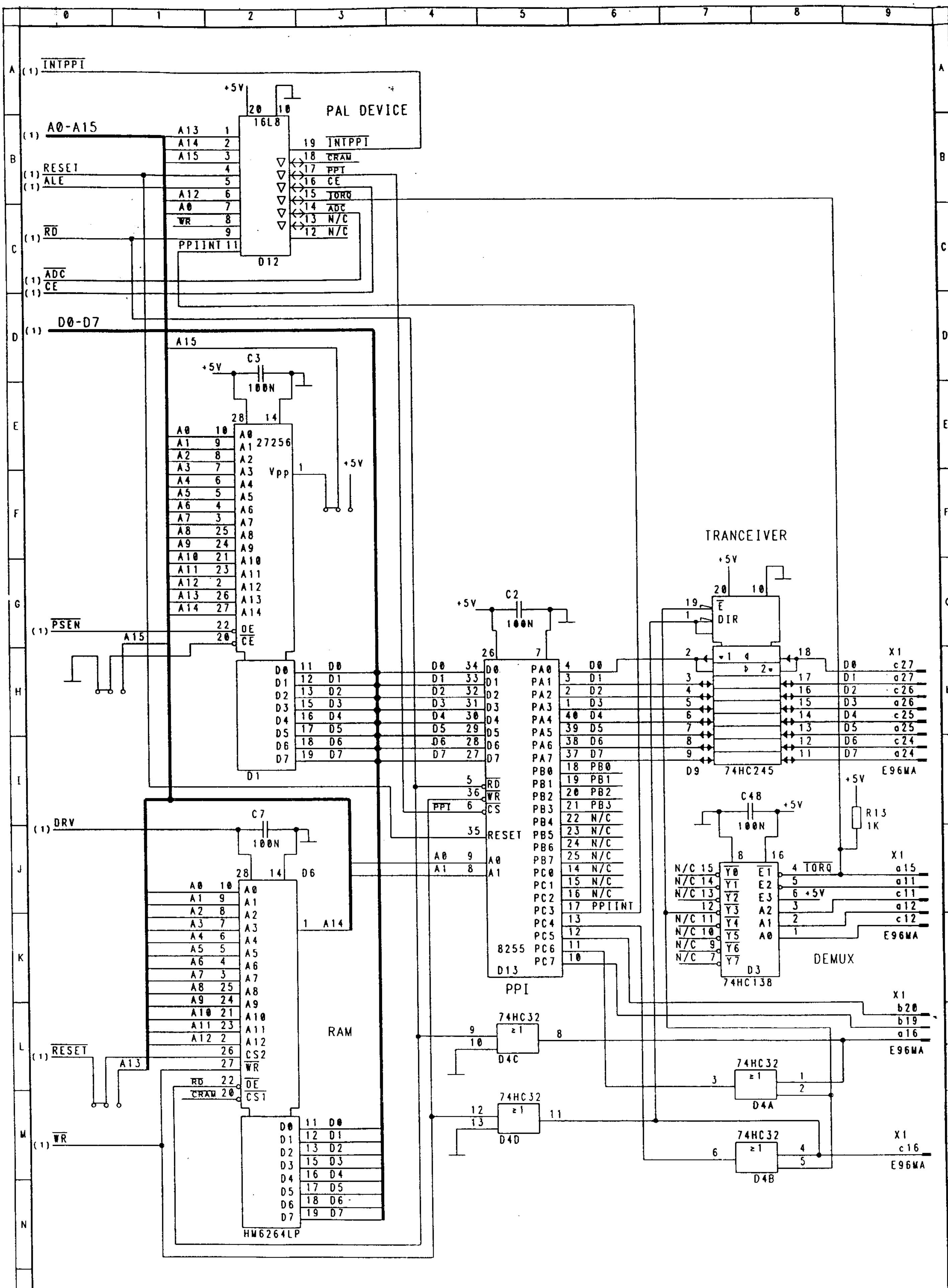
Figure 5.16 SpO_2 Processor board schematic diagram (part 2)



MUUT.	TARK.	HYV.	MUUTOS	MERKKI	DATEX INSTRUMENTARIUM OY	NIMI POX/CPU-BOARD 24.10.88 OS	TARK. HYV.	SIVU 2/2	LAITE CMO-104 N:O CM 3B 875712-2

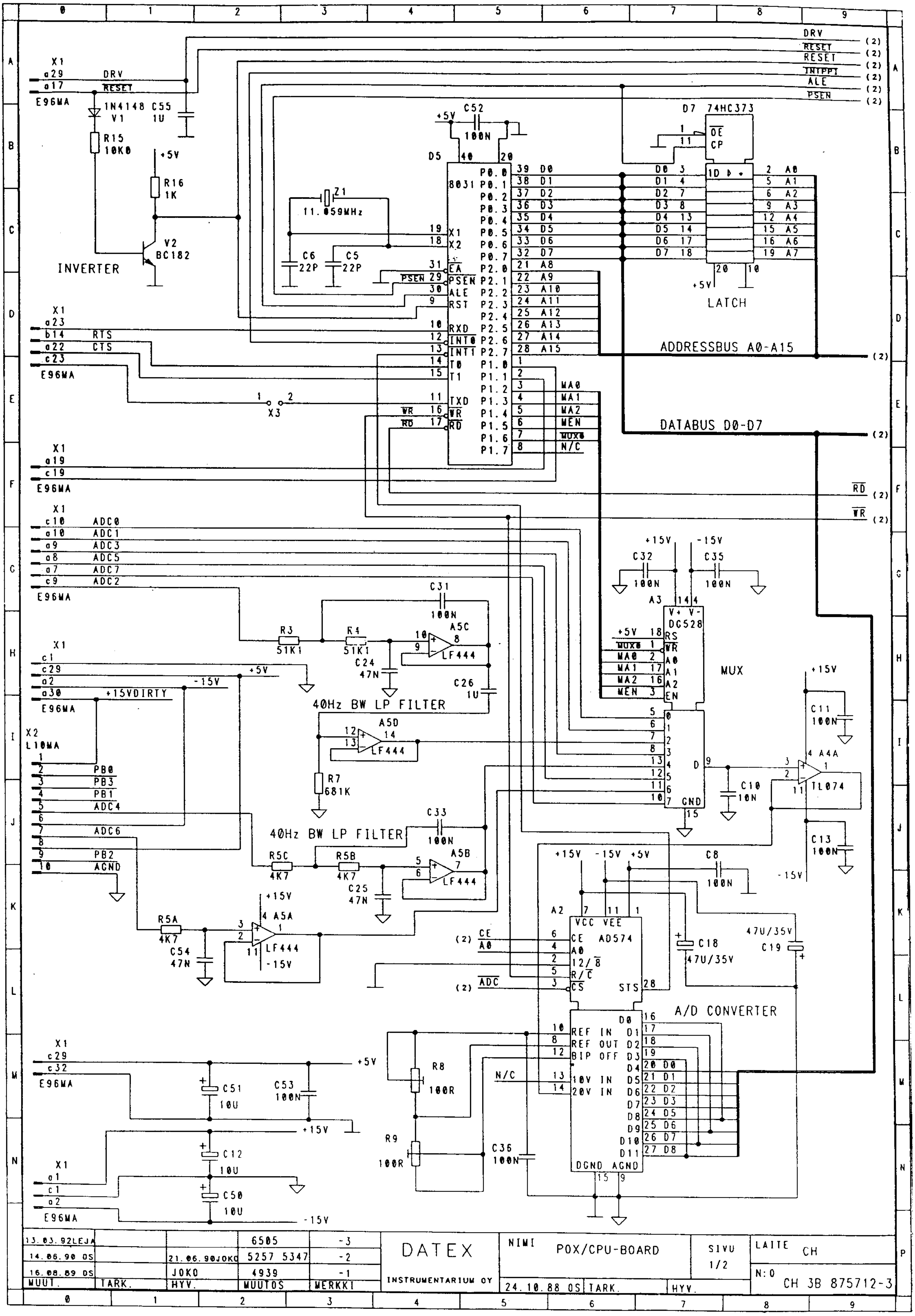
Figure 5.16a SpO_2 processor board parts layout and schematic diagram (modification level 5 and higher)





					DATEX INSTRUMENTARIUM OY	NIMI POX/CPU-BOARD	SIVU 2/2	LAITE CM0-104
MUUT.	TARK.	HYV.	MUUTOS	MERKKI		24.10.88 OS TARK. HYV.		N:0 CM 3B 875712-2

Figure 5.16 SpO_2 Processor board schematic diagram (part 2)


DRV
RESET
INTPPI
ALE
PSEN
(2)
X1
E96MA
1N4148 V1
C55 1U
R15 10K0
R16 1K
+5V
V2 BC182
INVERTER
C52 100N
D5
8031
Z1 11.059MHz
C6 22P
C5 22P
EA
PSEN
ALE
RST
RXD
INT0
INT1
T0
T1
TXD
WR
RD
P0.0 P0.1 P0.2 P0.3 P0.4 P0.5 P0.6 P0.7
P2.0 P2.1 P2.2 P2.3 P2.4 P2.5 P2.6 P2.7
P1.0 P1.1 P1.2 P1.3 P1.4 P1.5 P1.6 P1.7
D0 D1 D2 D3 D4 D5 D6 D7
A8 A9 A10 A11 A12 A13 A14 A15
MA0 MA1 MA2 MEN MUX0 N/C
RTS
CTS
X3
D7 74HC373
OE
CP
LATCH
A0 A1 A2 A3 A4 A5 A6 A7
ADDRESSBUS A0-A15
DATABUS D0-D7
ADC0 ADC1 ADC3 ADC5 ADC7 ADC2
+15V -15V
C32 100N
C35 100N
A3
DG528
MUX
R3 51K1
R4 51K1
C31 100N
A5C
LF444
C24 47N
C26 1U
+15VDIRTY
40Hz BW LP FILTER
A5D
LF444
R7 681K
X2
L10MA
PB0 PB3 PB1 ADC4 ADC6 PB2 AGND
C11 100N
A4A
TL074
C10 10N
C13 100N
C33 100N
R5C 4K7
R5B 4K7
A5B
LF444
C25 47N
R5A 4K7
A5A
LF444
C54 47N
C8 100N
A2
AD574
VCC VEE
CE
A0
12/8
R/C
CS
STS
ADC
C18 47U/35V
C19 47U/35V
A/D CONVERTER
REF IN
REF OUT
BIP OFF
10V IN
20V IN
DGND AGND
R8 100R
R9 100R
C36 100N
N/C
C51 10U
C53 100N
C12 10U
C50 10U
13.03.92LEJA
14.06.90 OS
16.08.89 OS
21.06.90JOKO
JOKO
6505
5257 5347
4939
-3
-2
-1
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
DATEX
INSTRUMENTARIUM OY
NIMI
POX/CPU-BOARD
24.10.88 OS
SIVU 1/2
LAITE CH
N:0
CH 3B 875712-3

5.6 CPU Board

The CPU board contains, in addition to the 8051FA CPU and the standard EPROM, RAM, and EEPROM, several analog and digital I/O functions. See the CPU board block diagram.

The CPU (D5, refer to Figure 5.18) uses the CPU board internal bus to access most of the peripheral circuits. Processor port 1 is used to control the analog multiplexers (MUX).

Communication with the NIBP board is established in serial mode through DUART (D15) pins 7 (in) and 8 (out).

The three memory chips are jumper selected for 1M bit program EPROM (D1), 32 x 8 kbit low current CMOS RAM (D6) powered by the data retention voltage, and EEPROM (D4) for permanent calibration value memory. See the jumper configuration.

Input signal processing

The analog input signals from the IPT, ECG, and RESP (if used) boards are read through the multiplexer (A3) to a sample and hold circuit and to the A/D-converter A2.

Output signal processing

Up to eight analog signals are sent to the output connectors. Digital patient data is sent to a D/A converter A1 and after conversion, sent to the demultiplexer A7. The eight analog signals produced are sent to sample and hold circuits and then transmitted to the power supply board and the connectors in the back of the monitor.

Control signals of MUX are in port 1 on the microprocessor as follows:

P1	pins 3-5	MUX A0-A2 (both)
	pin 6	MUX enable (both)
	pin 7	MUX 0 Write (ADC)
	pin 8	MUX 1 Write (DAC)
	ADC 0	IMP. RESP
	ADC 2	ECG
	ADC 4	IPT signal
	ADC 6	PB2 signal
	ADC 7	EXT INPUT
	DAC 2	IPT signal
	DAC 4	ECG TEST
	DAC 5	Loudspeaker volume
	DAC 6	PB2 signal
	DAC 7	Loudspeaker pitch

Ports on the PPI is used for as follows:

PA (output)	PB (input)	PC (low input,high output)
PA0: IPT control	PB0: not used (AUX)	PC0: -ECG INOP
PA1: IPT control	PB1: not used (AUX)	PC1: PB2 INOP
PA2: IPT control	PB2: RESP INOP	PC2: not used
PA3: not used	PB3: CD	PC3: Normocap signal
PA4: not used	PB4: DSR	PC4: RESP identification
PA5: not used (AUX)	PB5: CTSB (AUX)	PC5: not used
PA6: not used (AUX)	PB6: CTSA (AUX)	PC6: not used
PA7: Nurse call (AUX)	PB7: RESP identification	PC7: not used

When a key is pressed (short-circuit) keyboard scanner (D9) interrupts the microprocessor and this reads from the scanner which key was pressed.

Real time clock (D16) is powered by a 3.4 V lithium battery G1. Oscillator frequency of the clock is adjusted with trimmer capacitor C49.

Software features are described in the Operator's Manual. Main differences between software revisions are described in Section 3.4.

CAUTION: The board contains a lithium battery. Danger of explosion if the battery is incorrectly replaced. Replace only with same or equivalent type recommended by DATEX. Discard used batteries according to manufacturer's instruction.

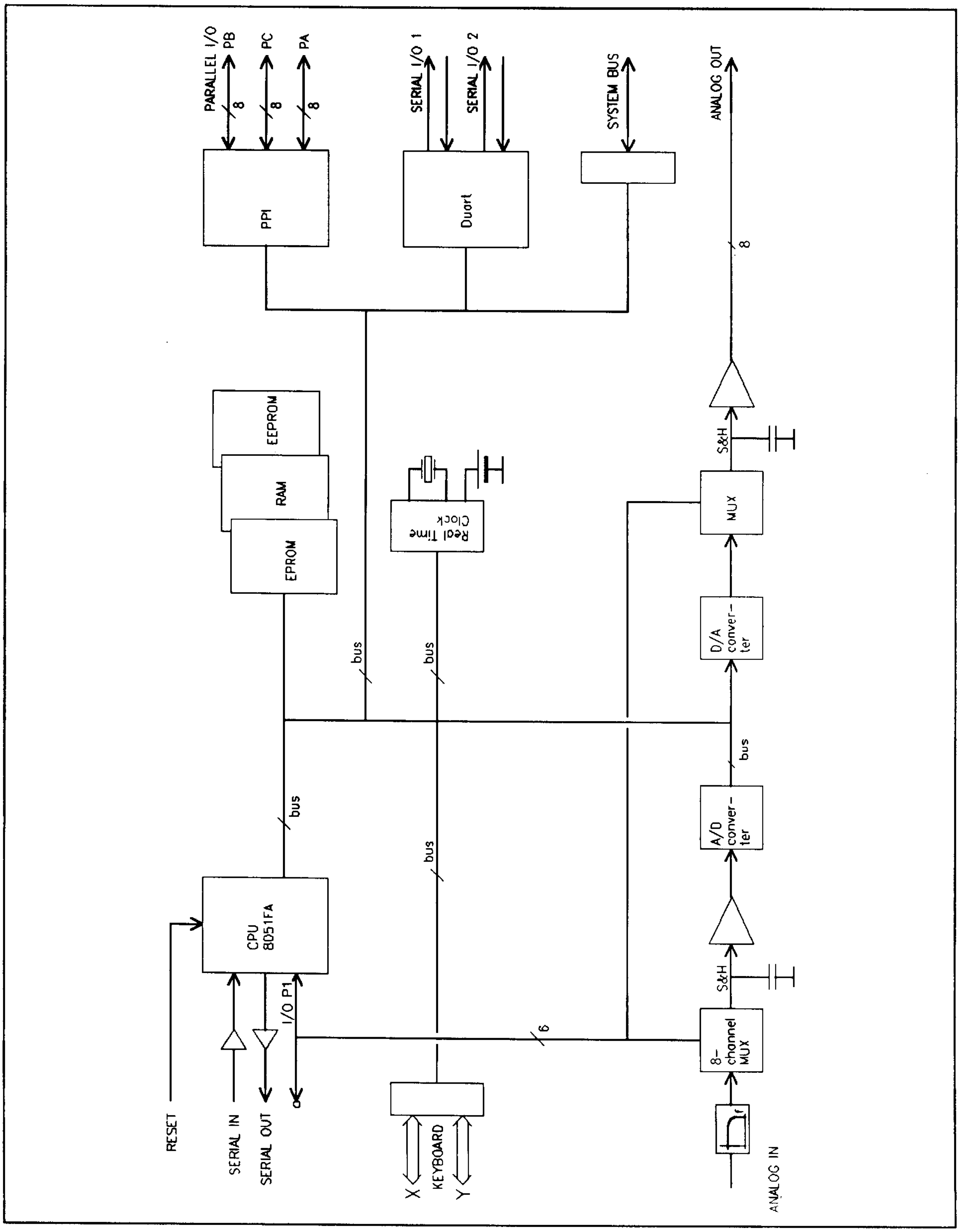
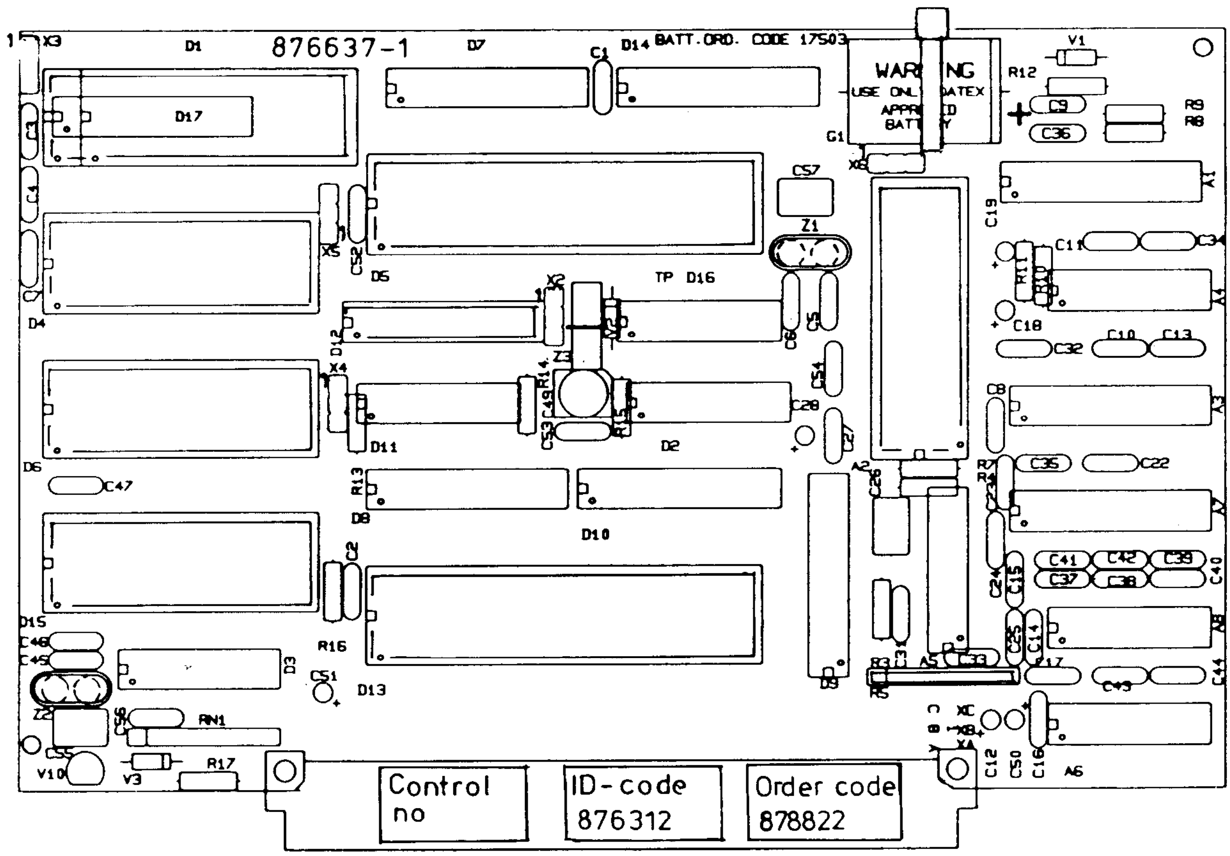
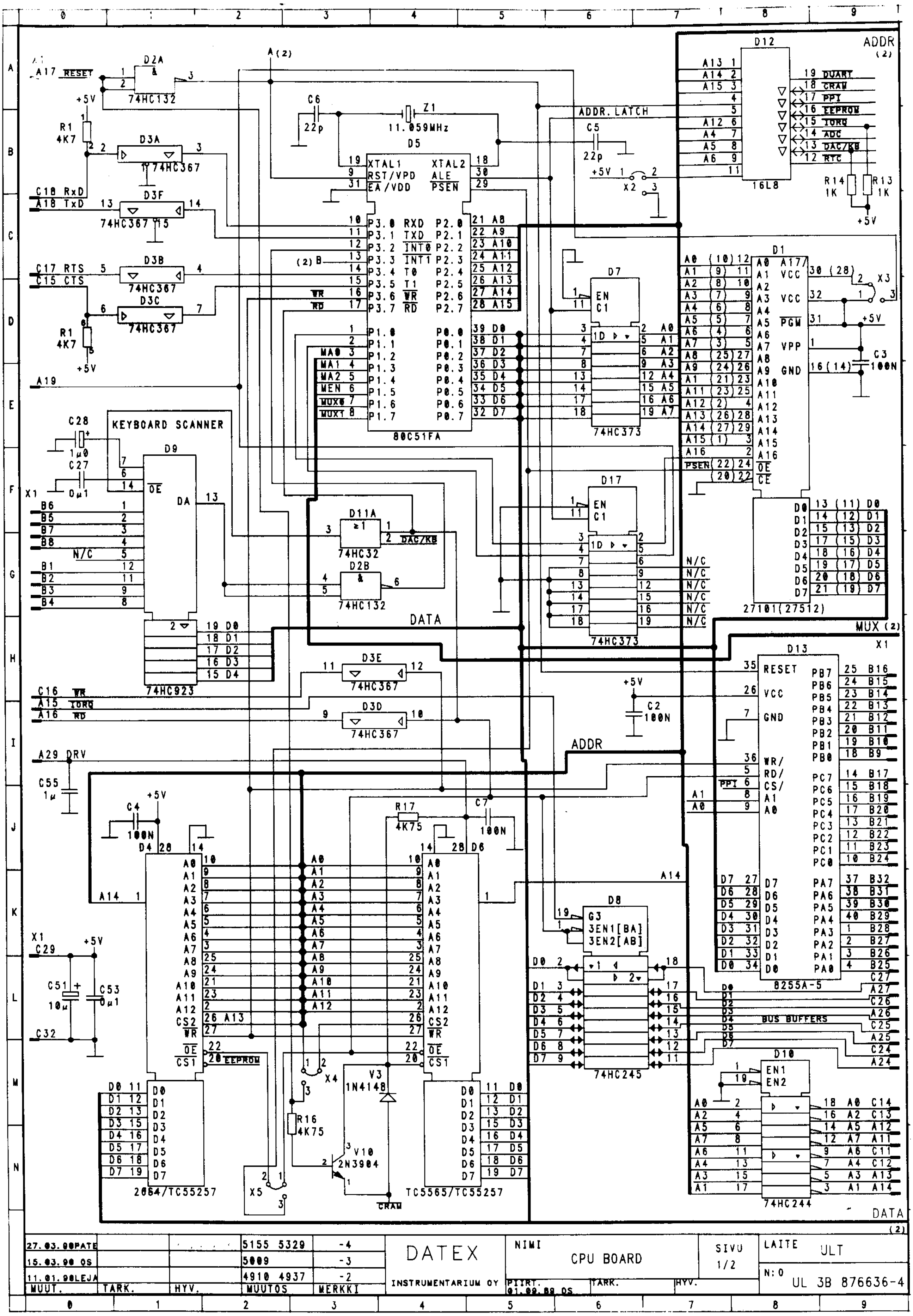


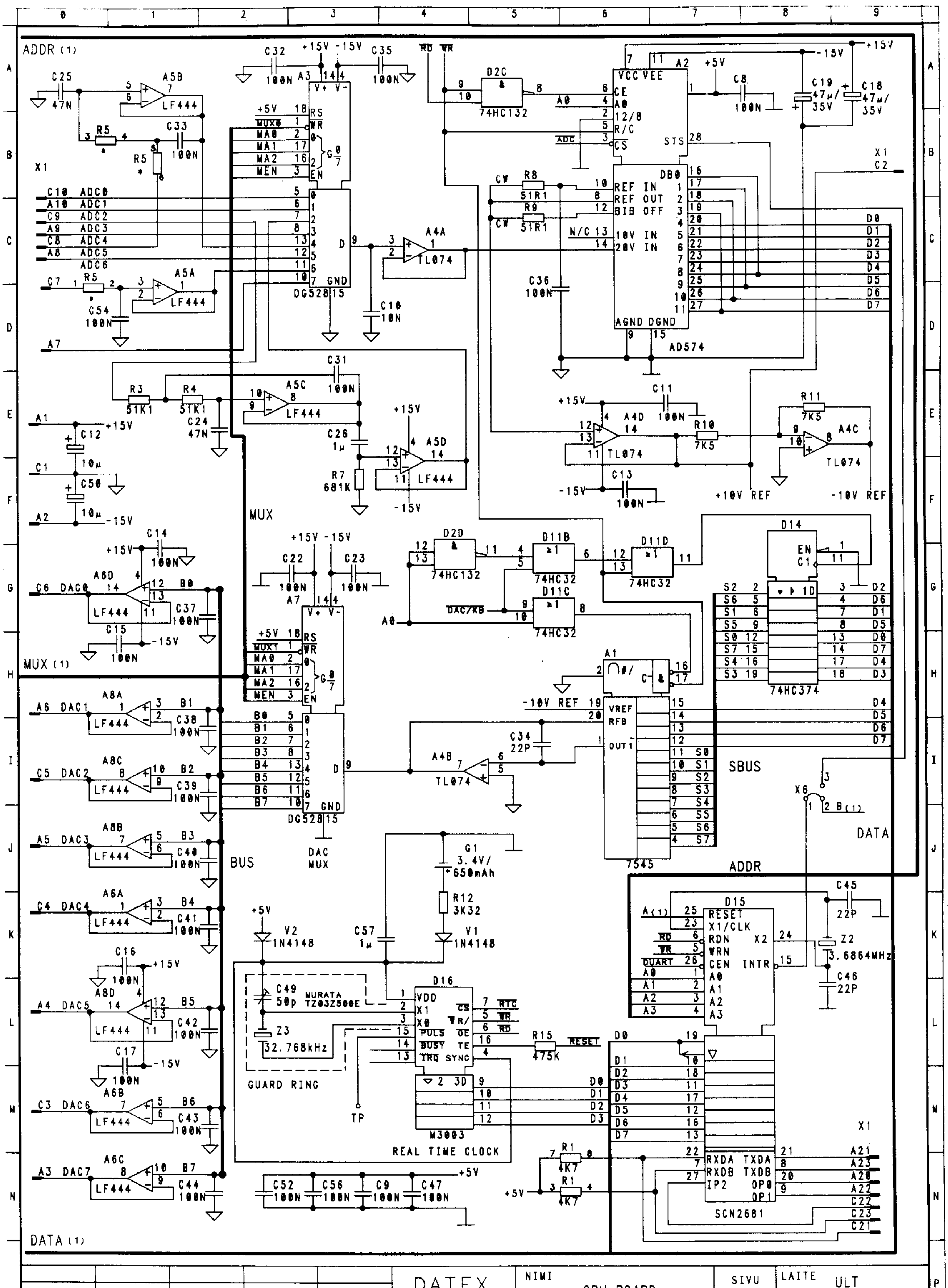
Figure 5.17 CPU board block diagram

Figure 5.18 CPU board parts layout.

Figure 5.18a (on the next page)
CPU board schematic diagram.




ADDR (2)
D12
16L8
DUART
CRAM
PPI
EEPROM
IORQ
ADC
DAC/KB
RTC
D2A
74HC132
D3A
74HC367
D3F
D3B
D3C
C6 22p
Z1 11.059MHz
D5
80C51FA
ADDR.LATCH
C5 22p
X2
D7
74HC373
D1
27101(27512)
X3
C3 100N
KEYBOARD SCANNER
D9
74HC923
D11A
74HC32
D2B
DATA
D17
MUX (2)
D13
8255A-5
D3E
D3D
C2 100N
ADDR
A29 DRV
C55 1µ
C4 100N
D4
2064/TC55257
R17 4K75
C7 100N
D6
TC5565/TC55257
D8
74HC245
BUS BUFFERS
D10
74HC244
X4
X5
R16 4K75
V3 1N4148
V10 2N3904
C51 10µ
C53 0µ1
DATA (2)
27.03.90PATE
15.03.90 OS
11.01.90LEJA
5155 5329
5009
4910 4937
-4
-3
-2
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
DATEX
INSTRUMENTARIUM OY
NIMI
CPU BOARD
PIIRT. 01.09.88 OS
SIVU 1/2
LAITE ULT
N:O UL 3B 876636-4



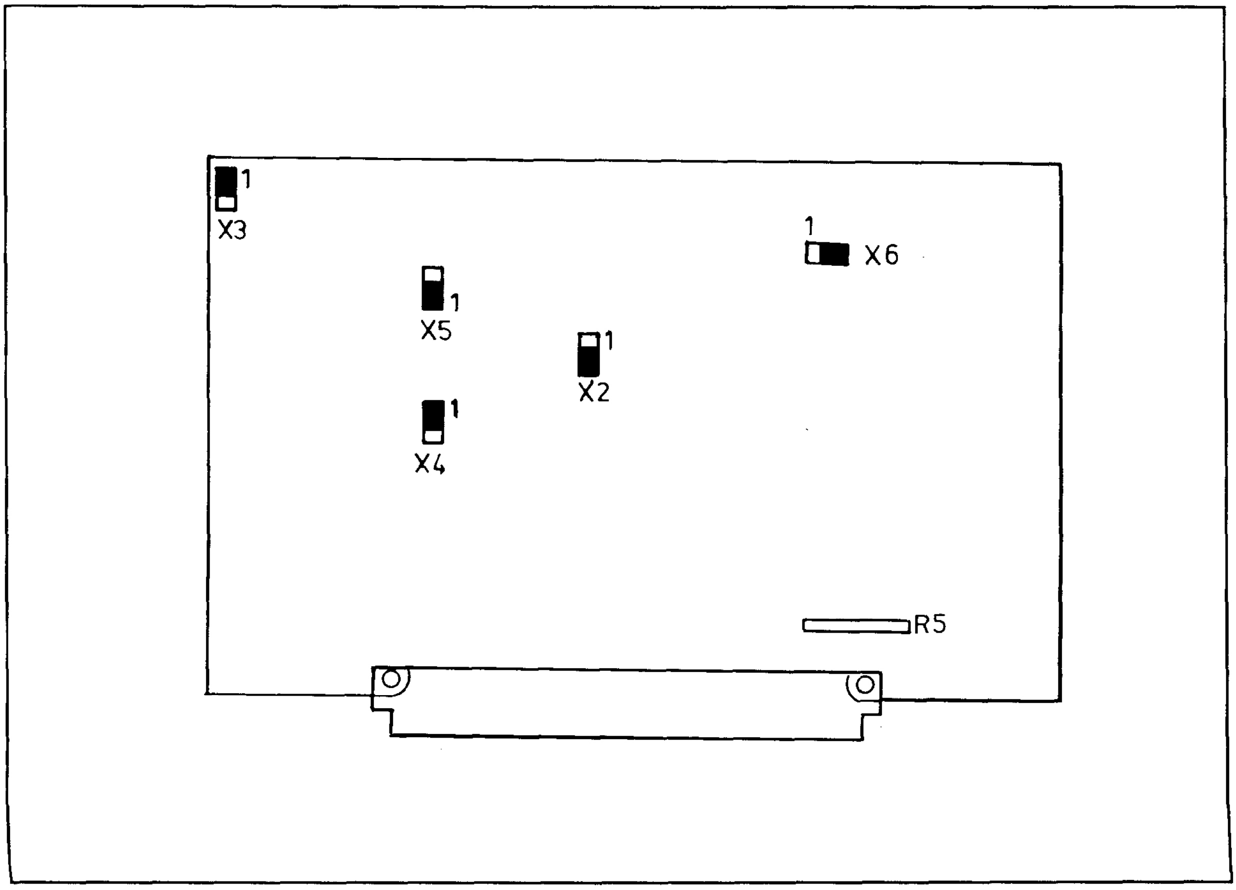
11.01.90LEJA			4910 4937	-2	
MUUT.	TARK.	HYV.	MUUTOS	MERKKI	

DATEX
INSTRUMENTARIUM OY

NIMI: CPU BOARD
SIVU: 2/2
LAITE: ULT
N:0 UL 3B 876636-4
01.09.89 OS | TARK. | HYV.

Figure 5.19 CPU board jumper configuration

CONNECTOR	JUMPER	MEMORY TYPE
X2	1-2	RAM area 32k (FFFF-8000) (rev 01)
	2-3	RAM area 8k (FFFF-C000) (rev 00)
X3	[1-2]	D1 : 512k, 1M EPROM
	2-3	D1 : 2M, 4M EPROM
X4	[1-2]	D6 : 32k x 8 RAM
	2-3	D6 : 8k x 8 RAM
X5	[1-2]	D4 : E2PROM, RAM
	2-3	D4 : EPROM
X6	1-2	Norm
	2-3	Test



The value of resistor network R5 is 4 x 47k.

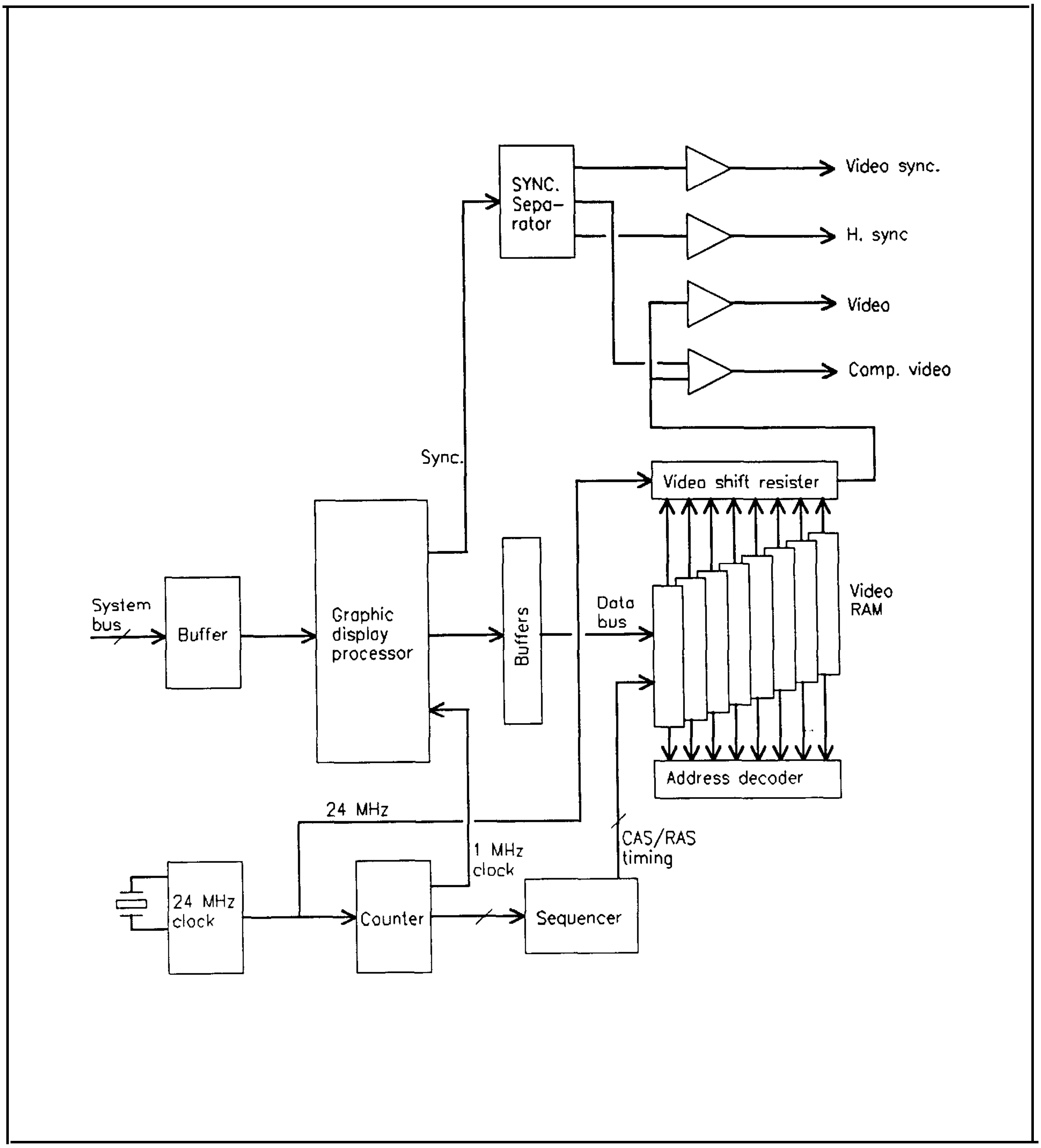
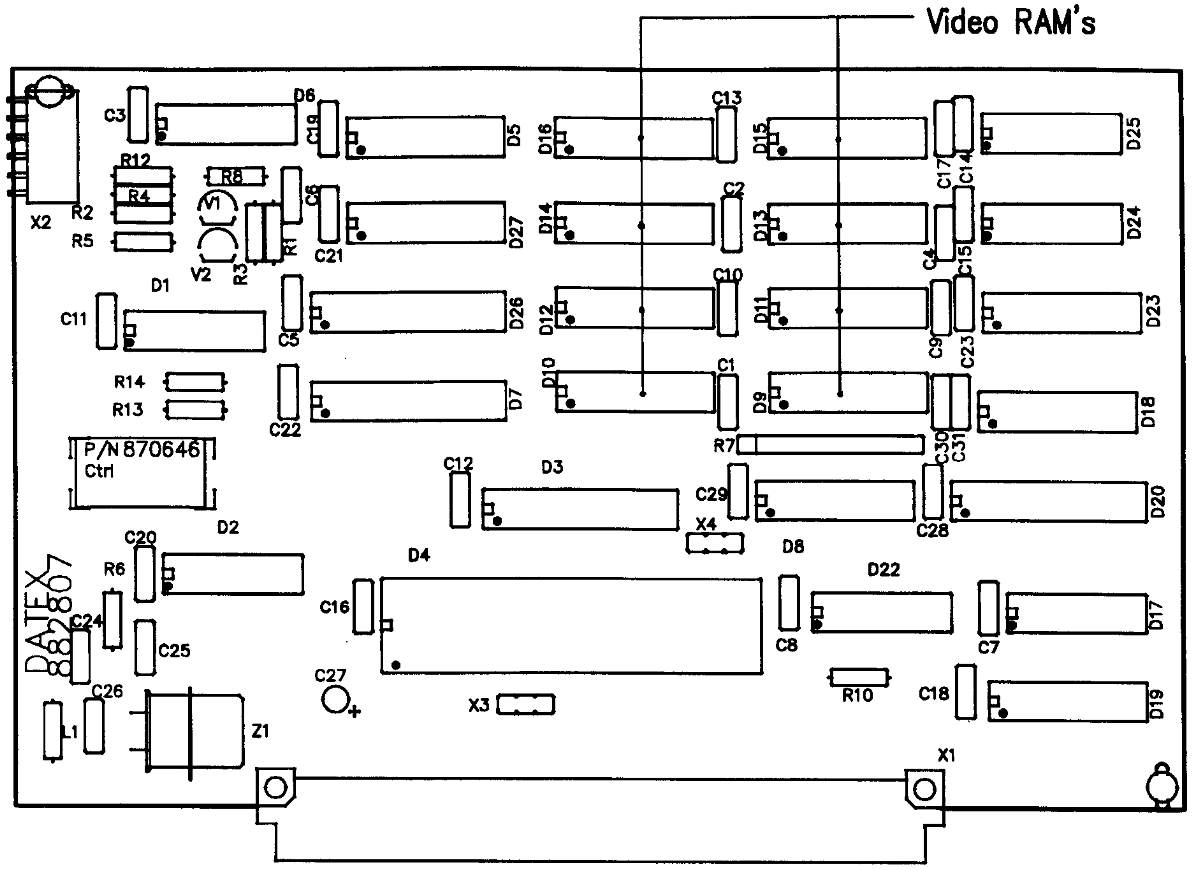
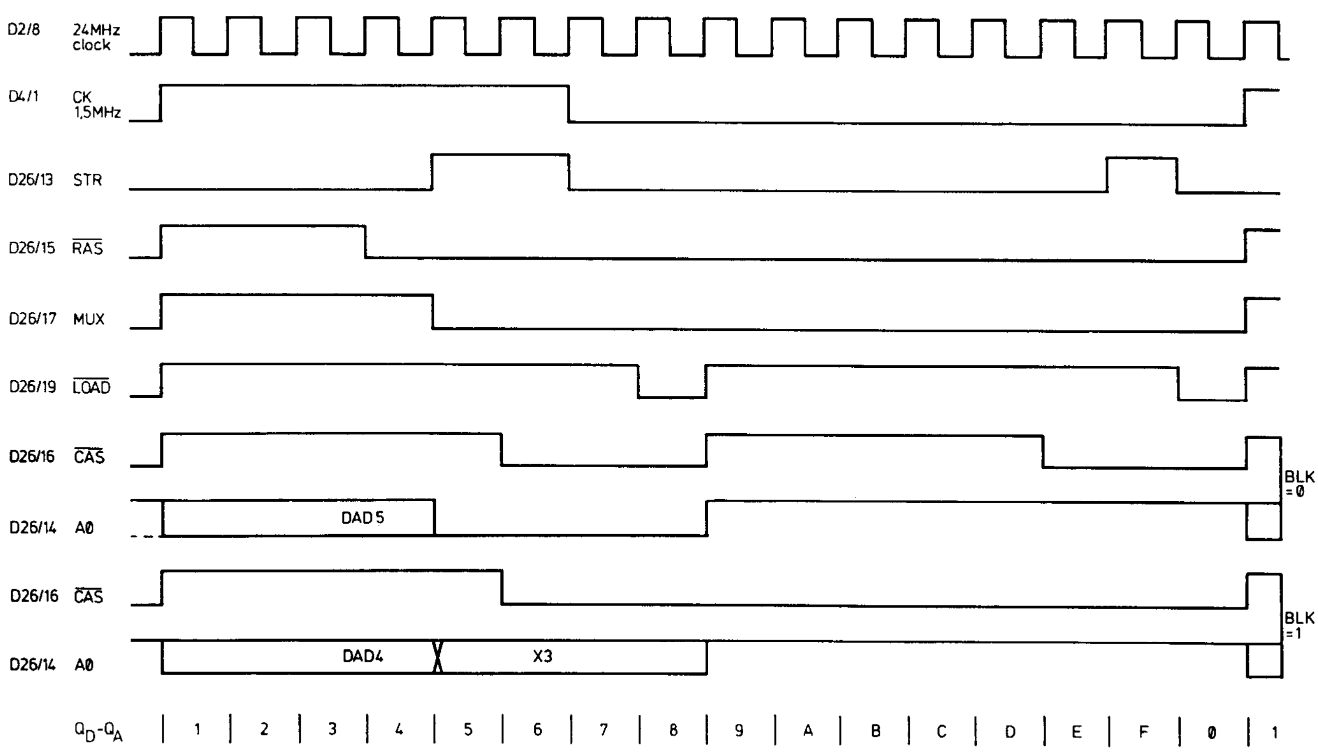


Figure 5.20 Video control board block diagram, parts layout and timing diagram (board modification level 9 and higher)

Figure 5.21 (on the next page) Video control board schematic diagram (board modification level 9 and higher)





VIDEO CONTROL BOARD
TIMING DIAGRAM

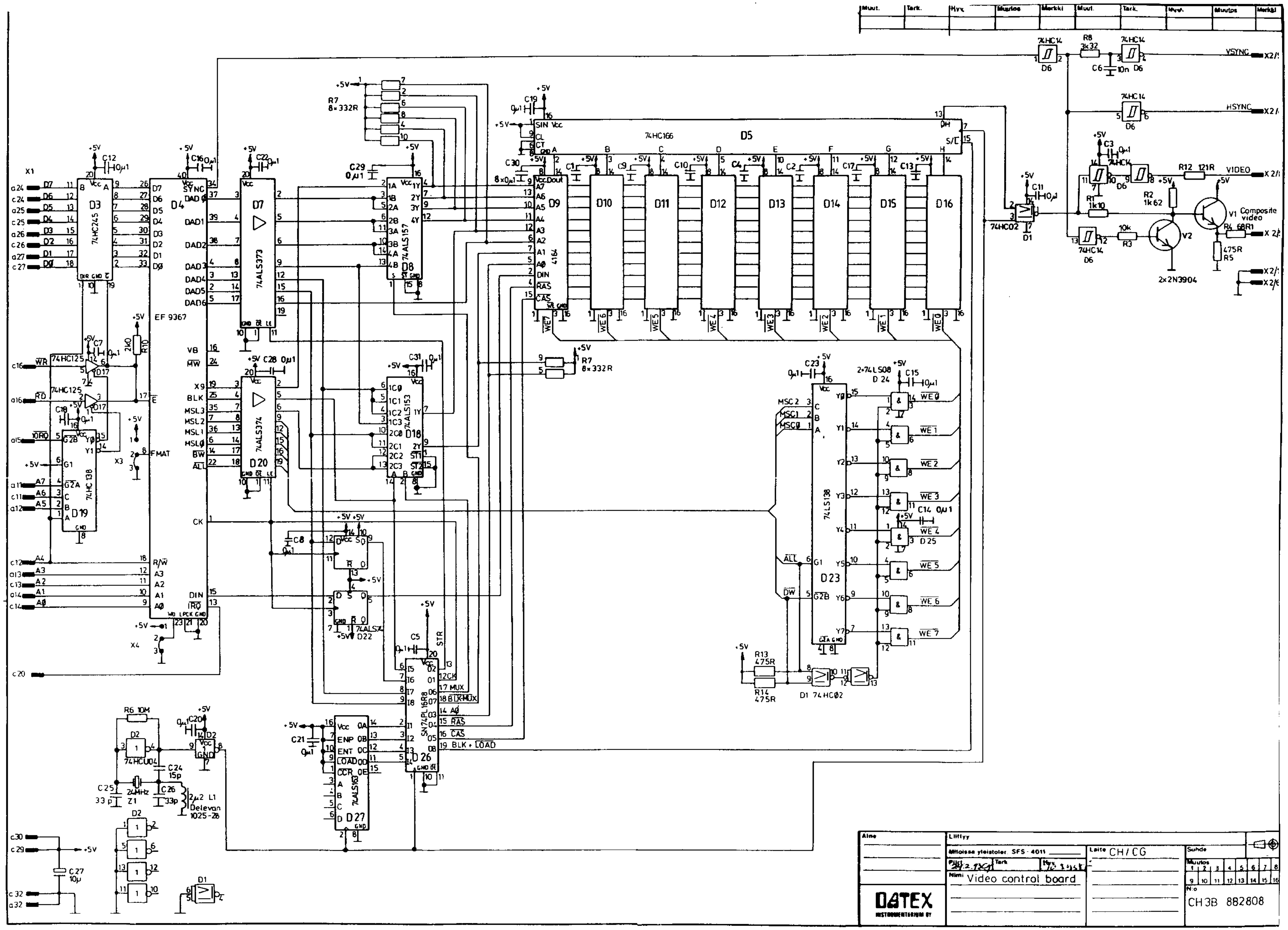
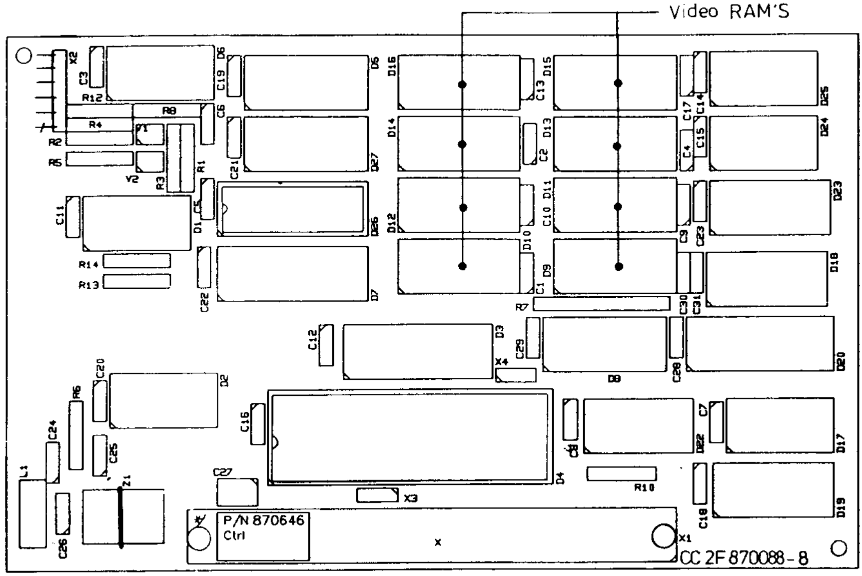
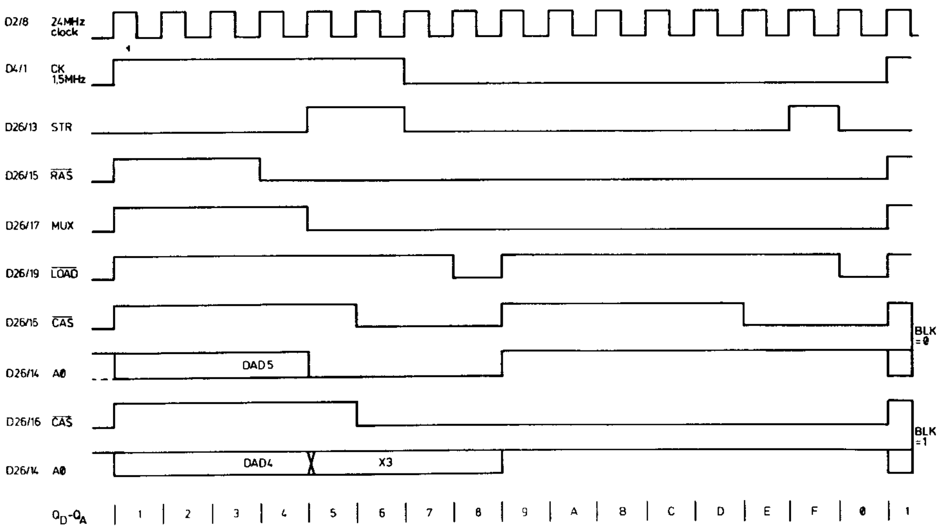
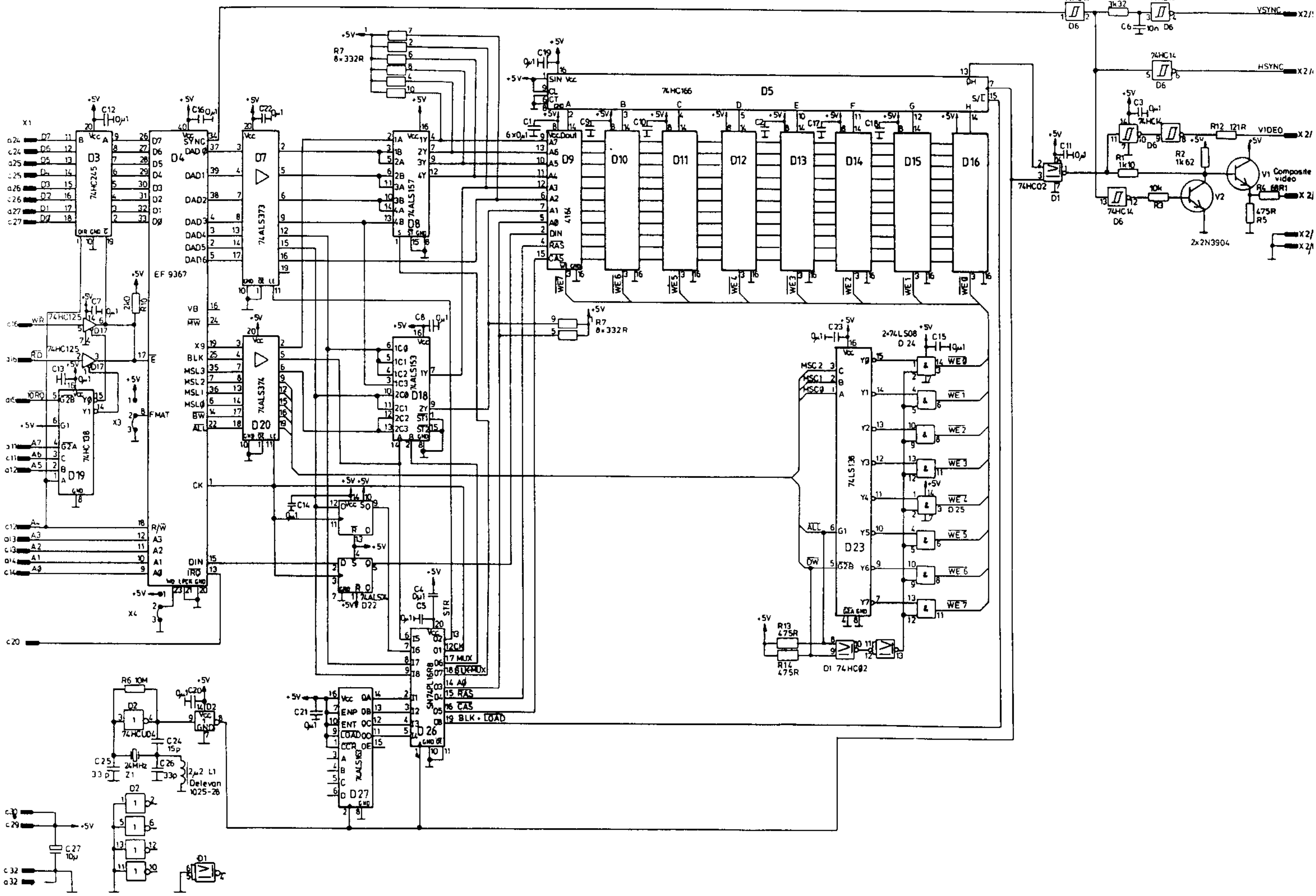

Video control board
CH/CG
CH3B 882808
DATEX

Figure 5.21 Video control board parts layout, timing diagram, and schematic diagram





VIDEO CONTROL BOARD
TIMING DIAGRAM



74HC245
D3
EF 9367
D4
74ALS373
D7
74ALS157
D8
74ALS374
D20
74ALS153
D18
74HC166
D5
4164
D9
D10
D11
D12
D13
D14
D15
D16
74HC138
D19
74HC125
D17
74LS138
D23
2×74LS08
D 24
D 25
74HC02
D1
74HC14
D6
74ALS74
D22
74ALS163
D27
SN74PL16R8
D 26
74HCU04
D2
24MHz
Z1
L1
Delevan
1025-28
R7
8×332R
VSYNC
HSYNC
VIDEO
Composite video
2×2N3904
V1
V2
R1
1k10
R2
1k62
R3
10k
R4
68R1
R5
475R
R6
10M
R8
3k32
R12
121R
R13
475R
R14
475R
C27
10µ
STR
MUX
CK
CAS
RAS
BLK + LOAD
FMAT
X1
X3
X4

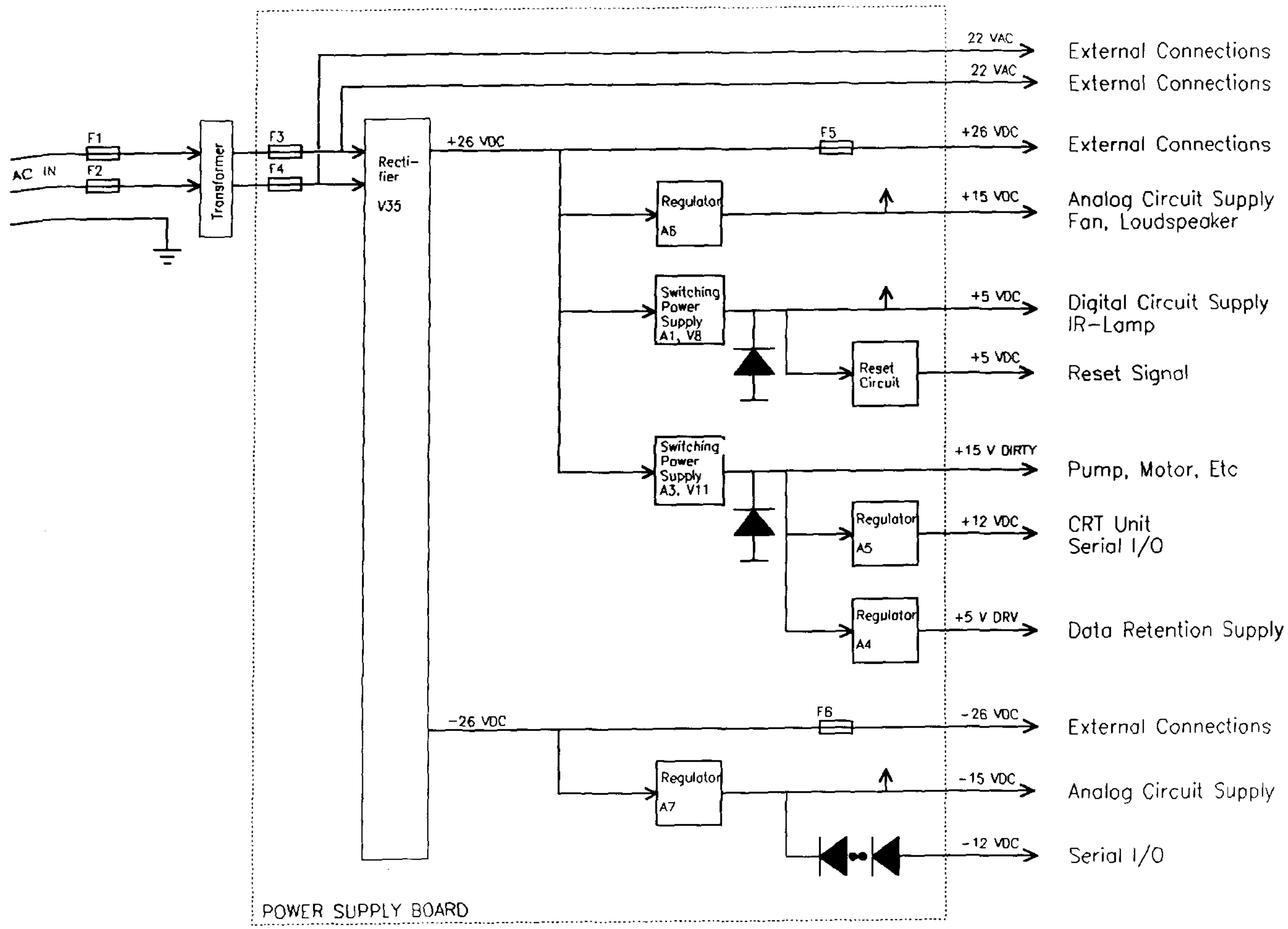
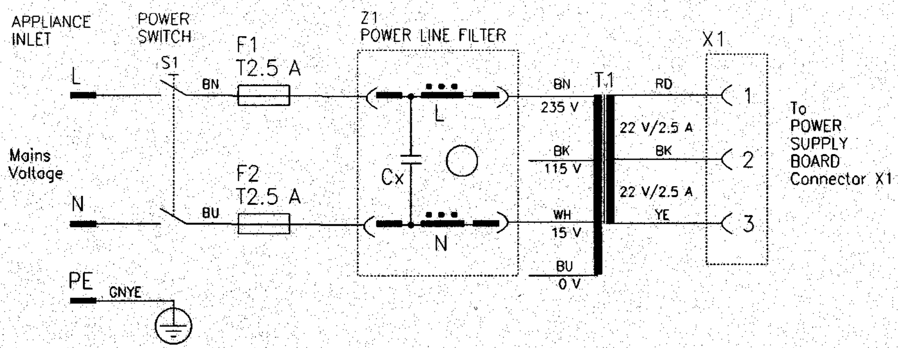
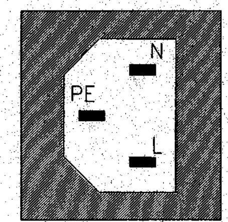


Figure 5.22 Power supply board block diagram

Figure 5.23 Transformer diagram and power supply board signal waveforms



If no polarized mains plug and mains socket outlet system is used, position of line (L) and neutral (N) in the appliance inlet depends on the position of mains plug set into the mains socket outlet.



The contact positions of the appliance inlet by looking from outside of the equipment.

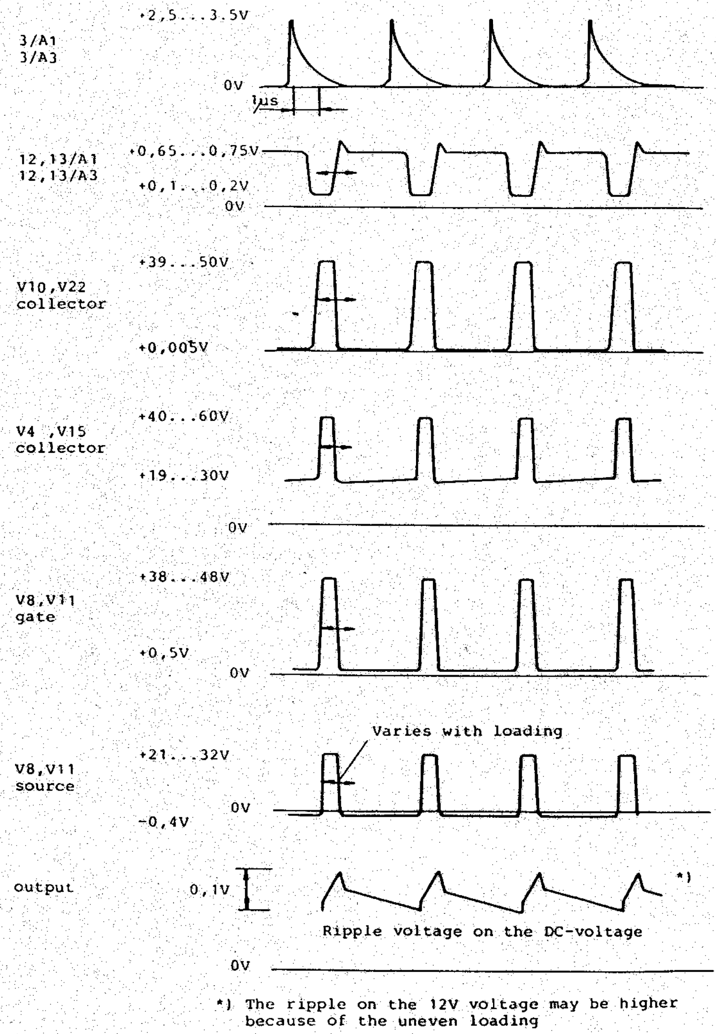


Figure 5.24 Power supply board parts layout

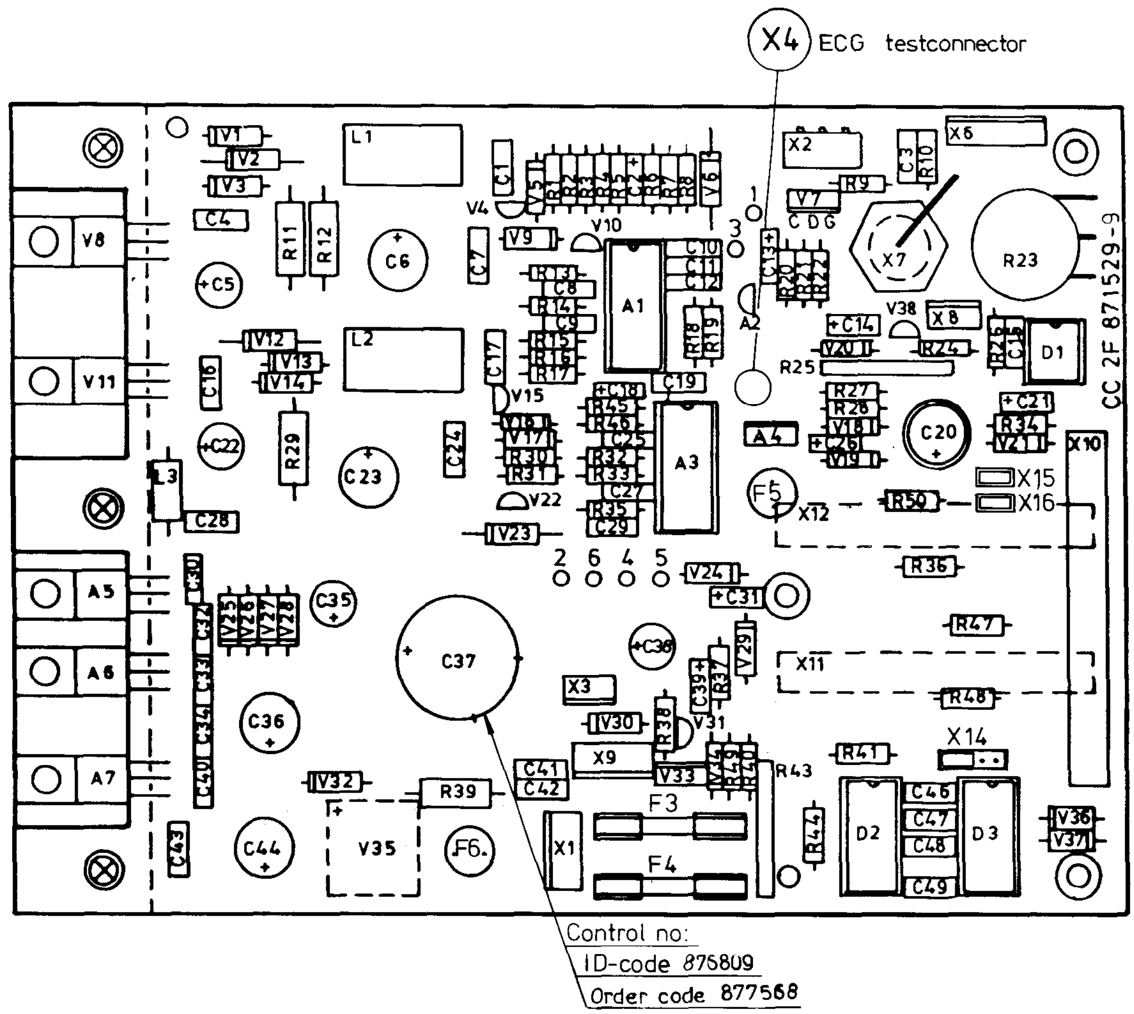
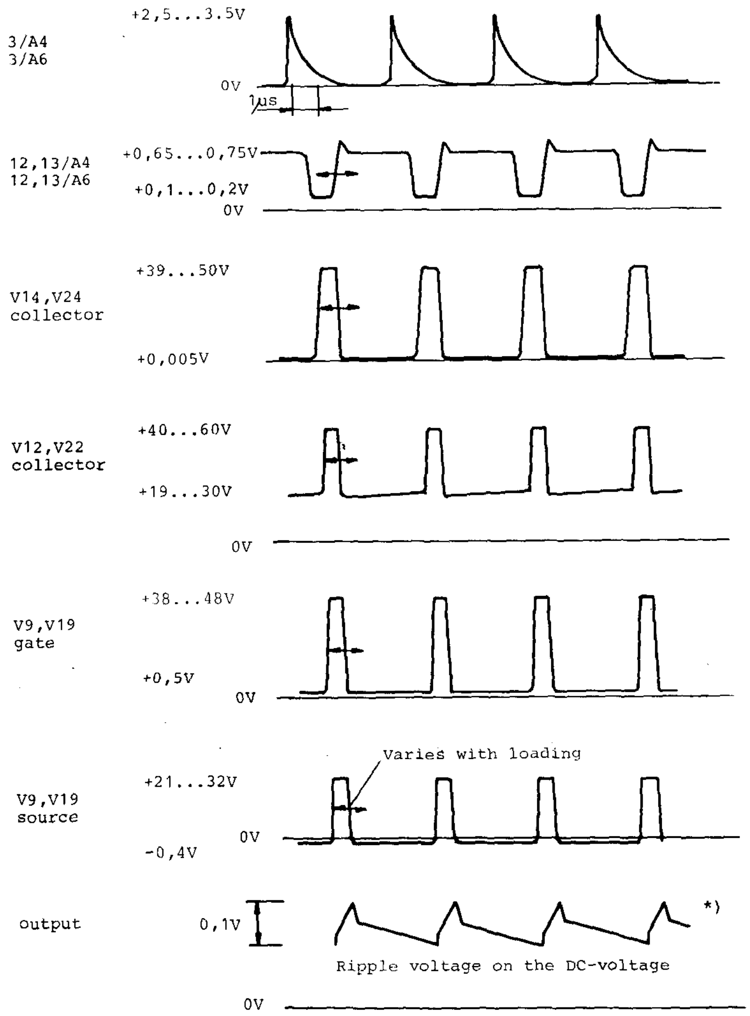


Figure 5.25 Power supply board signal waveforms.

Figure 5.25a (on the next page)
Power supply board schematic diagram.



*) The ripple on the 15V voltage may be higher because of the uneven loading

Monitor	X11 Serial / Analog I/O							
Pin No.	13	14	16	17	18	19	20	22
CH	uncal PB.2	-	-	PB.2	ECG	SpO2/ PB.1	-	input AUX
ULT	-	O2	N2O	AA	-	SpO2	CO2	pleth
SCO-123	R	O2	-	-	N2O	SpO2	CO2	IR
SC-123	R	-	-	-	N2O	SpO2	CO2	IR
MBM-100	-	O2	self test	alarm freq	-	low O2	CO2	-
OSE-123	R	input O2	ECG	input AA	input N2O	SpO2	input CO2	IR
Pin No	30	31	37*)	38	28	33	32	29
	X10 Flat cable							

*) MBM-100 Pin No 36

**)

Monitor	Places of the jumpers in X14
OSE-123	1-2 and 3-4
ULT	1-2 and 3-4
CH	3-4
MBM-100	2-3
SC-123	3-4
SCO-123	3-4

***)

Monitor	Fuses F3 and F4
OSE-123	T 1.6 A
ULT	T 3.15 A
CH	T 3.15 A
MBM-100	T 3.15 A
SC-123	T 2.5 A
SCO-123	T 3.15 A

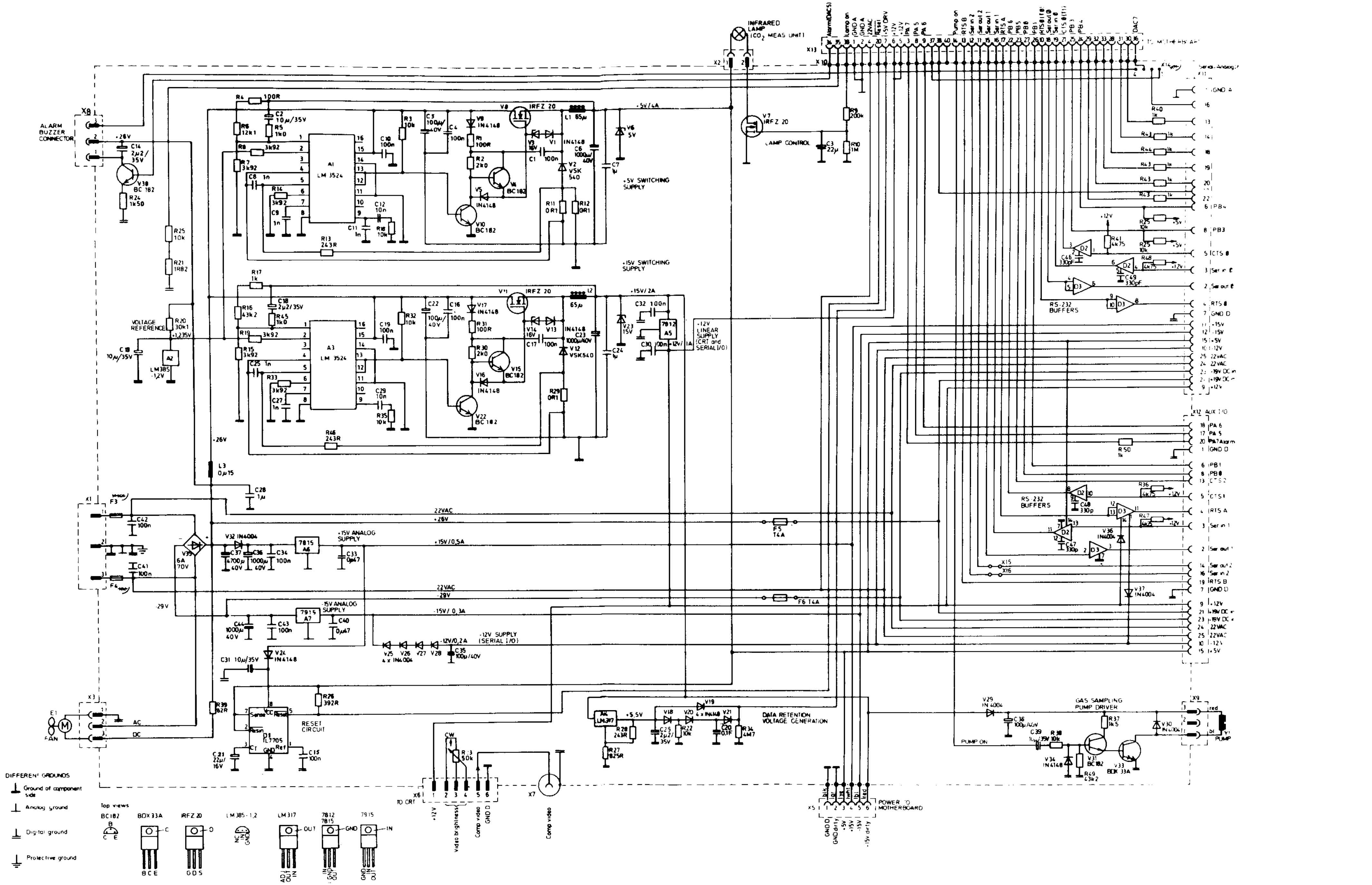

INFRARED LAMP (CO2 MEAS UNIT)
TO MOTHERBOARD
ALARM BUZZER CONNECTOR
LAMP CONTROL
+5V/4A
+5V SWITCHING SUPPLY
+15V SWITCHING SUPPLY
+15V/2A
+12V LINEAR SUPPLY (CRT and SERIAL I/O)
VOLTAGE REFERENCE
RS-232 BUFFERS
AUX I/O
+15V ANALOG SUPPLY
+15V/0,5A
-15V ANALOG SUPPLY
-15V/0,3A
-12V SUPPLY (SERIAL I/O)
22VAC
+26V
-29V
RESET CIRCUIT
DATA RETENTION VOLTAGE GENERATION
GAS SAMPLING PUMP DRIVER
PUMP ON
PUMP
FAN
TO CRT
POWER TO MOTHERBOARD
DIFFERENT GROUNDS
Ground of component side
Analog ground
Digital ground
Protective ground
Top views

Figure 9.1 Exploded pictures of the monitor

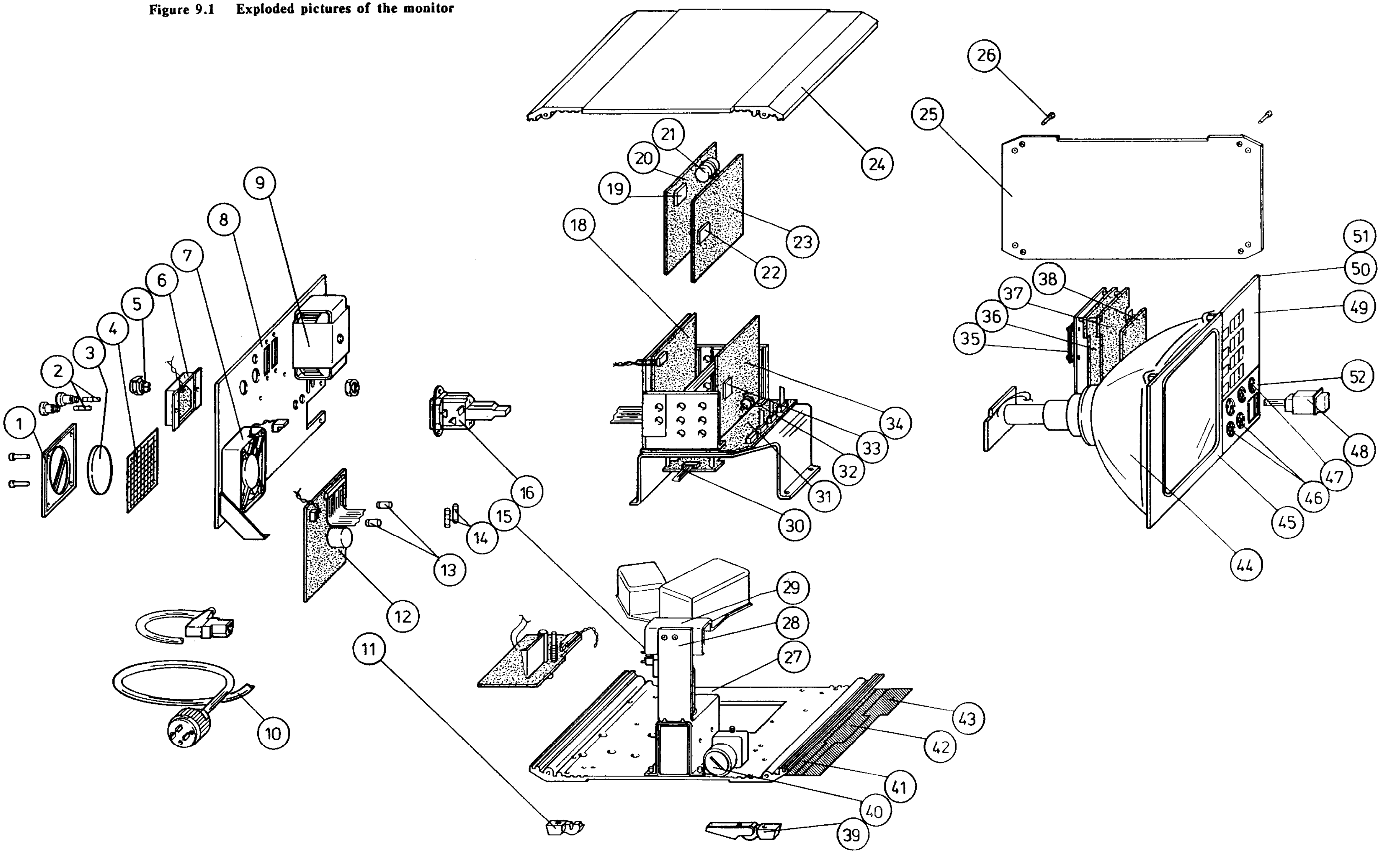
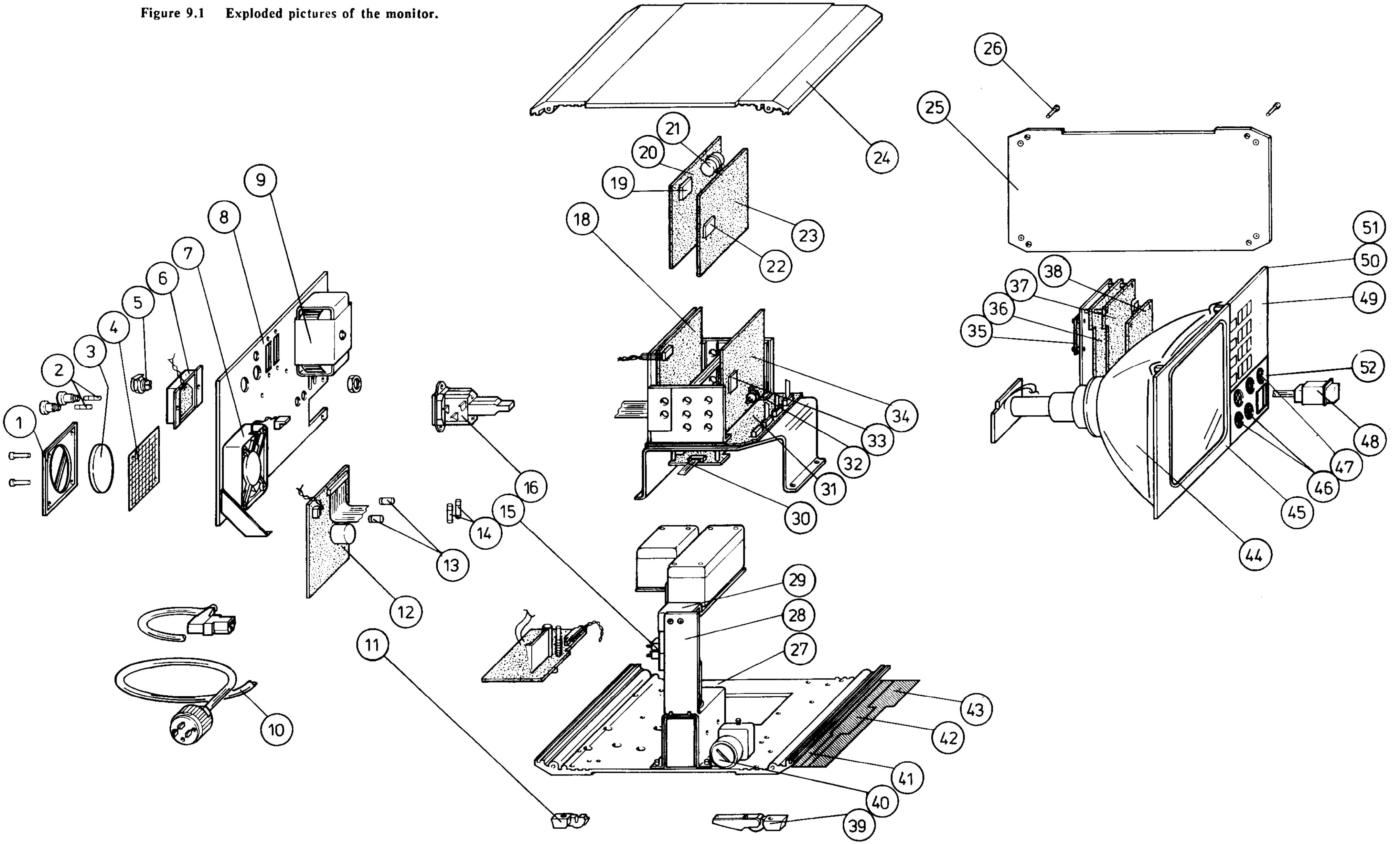


Figure 9.1 Exploded pictures of the monitor.



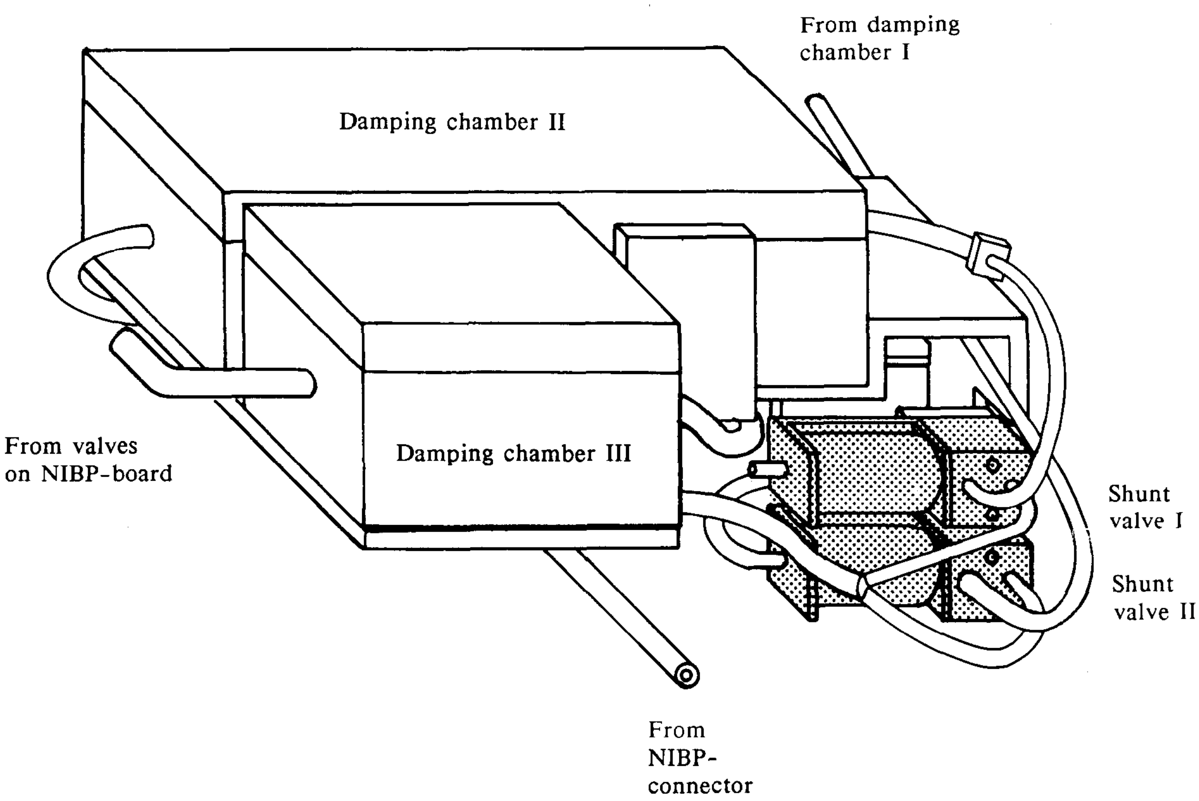


Figure 9.3 Pneumatic unit parts layout

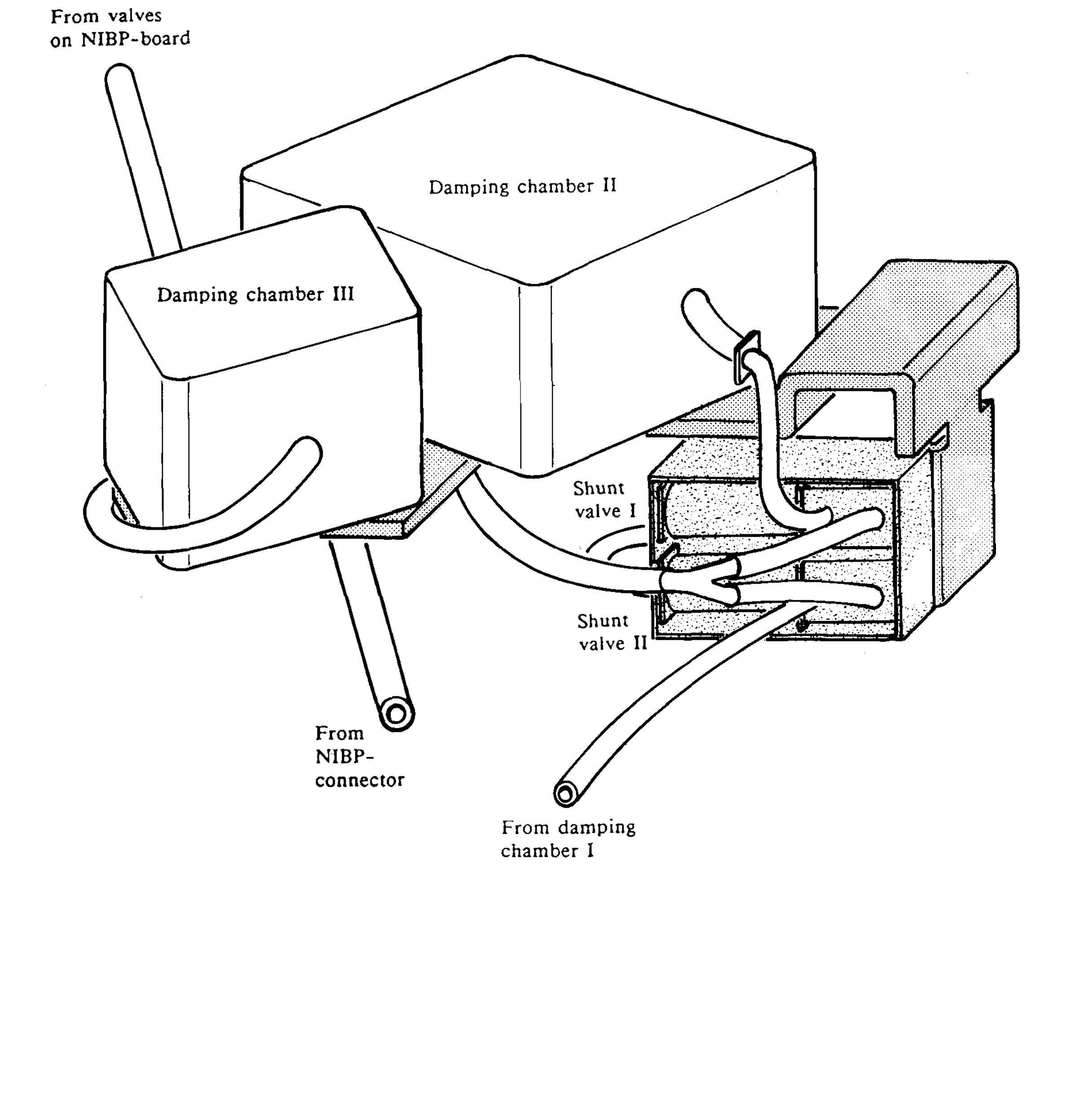


Figure 9.3 Pneumatic unit parts layout

C CCK-104 KEYBOARD

C.1 GENERAL DESCRIPTION

C.1.1 Specifications

Character set	256 character ASCII
Communications interface	RS 232C compatible
Baud rate	1200 Bd
Power requirements	+5 V 300 mA, ±12 V 40 mA (supplied by the host monitor)
Dimensions (WxDxH)	380 x 180 x 45 mm
Weight	1.4 kg approximately

C.1.2 Principle of operation

The keyboard lets anesthesia personnel key in details of an operation to produce a complete anesthesia record using the CCP-104 graphics printer (see Figure C.1 for an example of anesthesia record).

When the information is keyed in, it can be observed on the screen. The keyboard has preprogrammed and programmable function keys to facilitate operation.

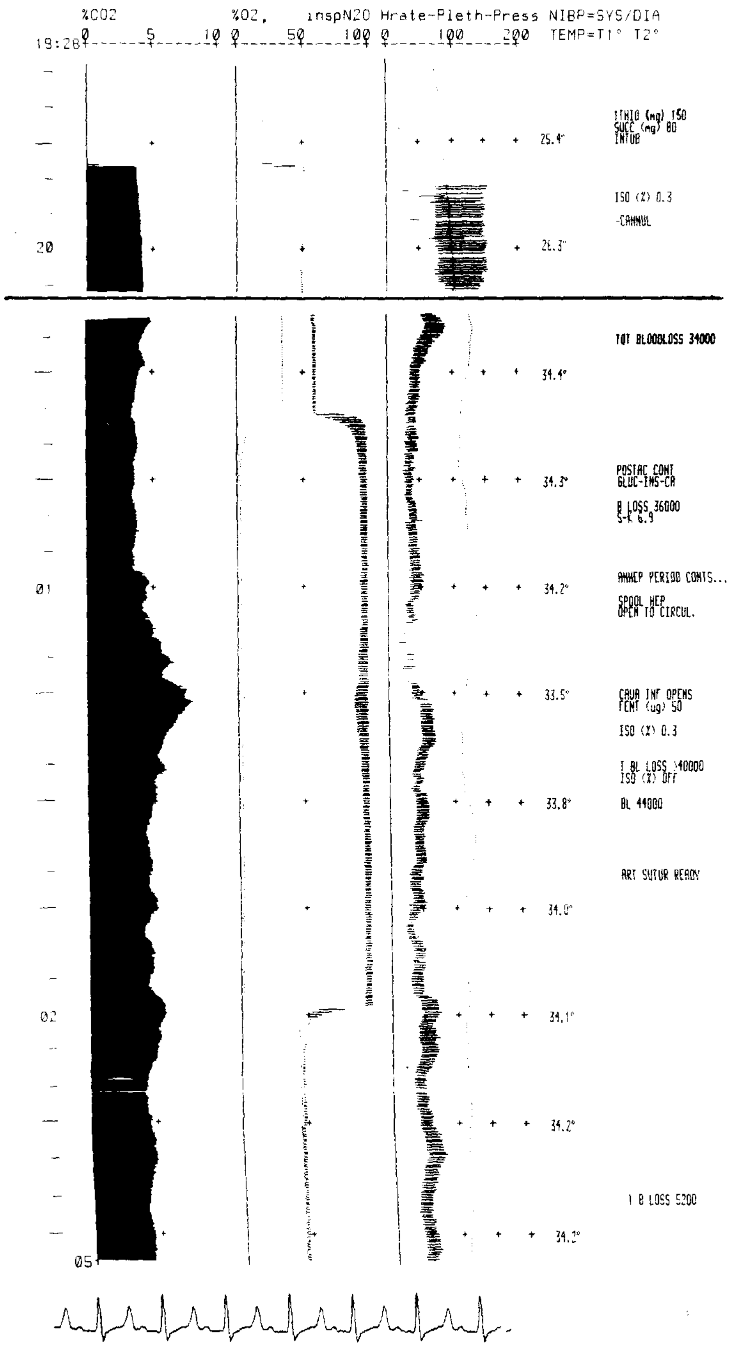
> **NOTE:** The LED's are only for production testing.

Figure C.1 Example of anesthesia record produced with CCK-104 keyboard and CCP-104 printer

A N E S T H E S I A   R E C O R D

PATIENT NAME N.N.
PATIENT ID NUM 112233-1234
DIAGNOSIS HEPATIC CIRRHOSIS
OPERATION LIVER TRANSPLANTATION
AGE [YRS] 36   WEIGHT [KG] 74   LENGTH [CM] 182   ASA 3
REMARKS -

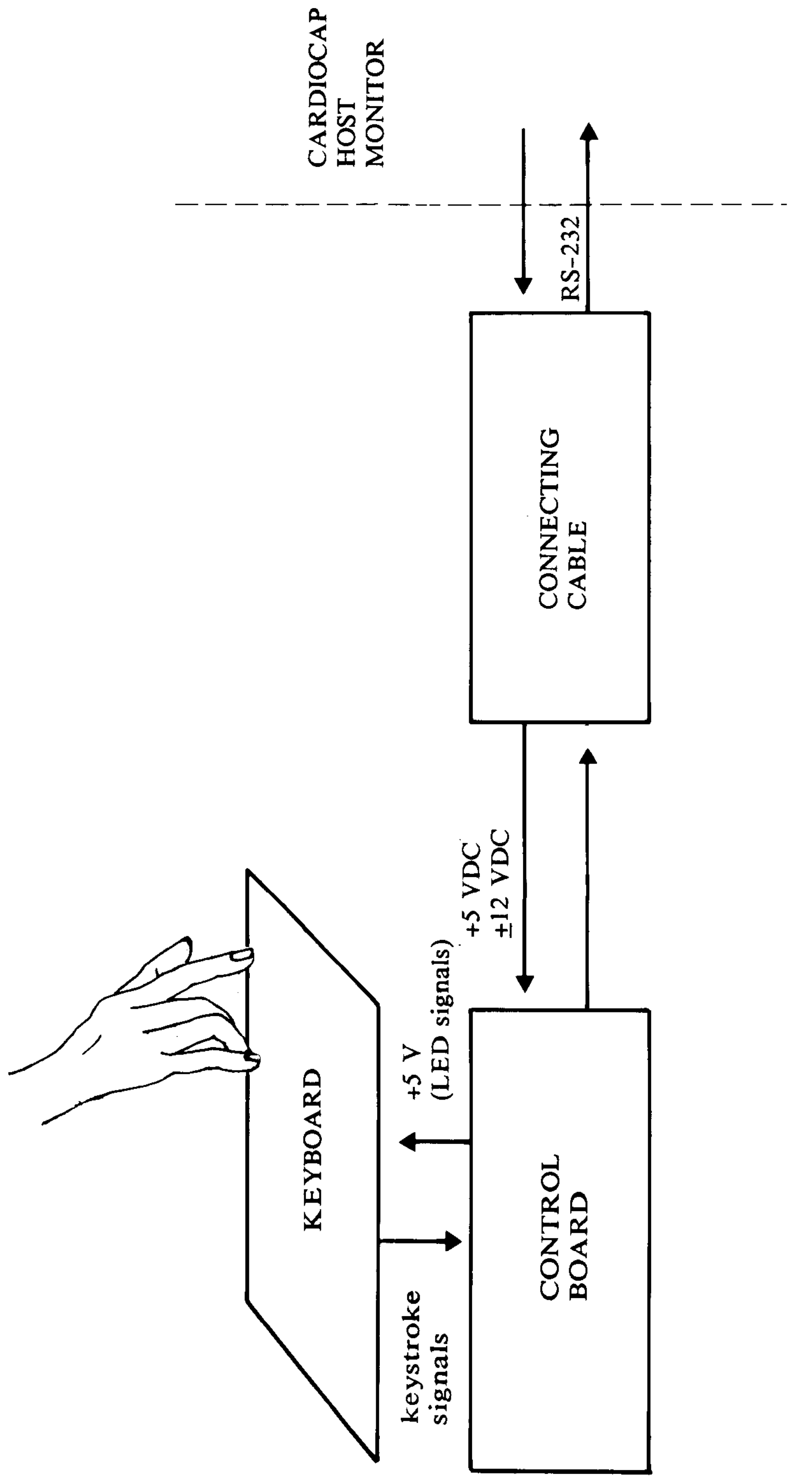
Date, Cardiocap. Prog. rev. CC/CCK/TEST 4 06/03/87



DURATION SURGERY 5H 15 MIN   ANESTHESIA 7H
TOTAL BLOOD LOSS 56.000 ML
SURGEONS C.C. T.T.
ANESTHETISTS B.B.
POSTOPER ANALGETICS SEE ICU RECORD
COMMENTS INTUB TO ICU [IMV BIRD]

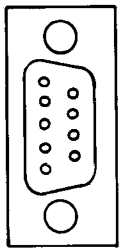
C.1.3 General block diagram

Figure C.2 CCK-104 block diagram



C.1.4 Connector configurations

Keyboard connecting cable connector



PIN NO.	SIGNAL	
1	-12 V	
2	NC	not connected
3	TXD	serial output
4	+5 V	
5	+5 V	
6	+12 V	
7	GND	
8	GND	
9	GND	

For connecting cable pin configuration see Figure C.8.

C.2 DETAILED DESCRIPTION OF MODULES

C.2.1 Keyboard

The keyboard contains 79 keys for entering data and LED's for informing the user of selected operations.

C.2.2 Control board

The control board block diagram is shown in Figure C.3. The board is intended to perform the following tasks:

- provide the +5 V for the keyboard
- provide the ±12 V for the RS-232 line drivers
- read the keyboard strokes, convert them to ASCII code and transmit the serial data to the host monitor
- control the keyboard LED's
- control the keyboard loud-speaker

The keyboard scan drivers, the loud-speaker and the led drivers are selected with address bits A8 and A3.

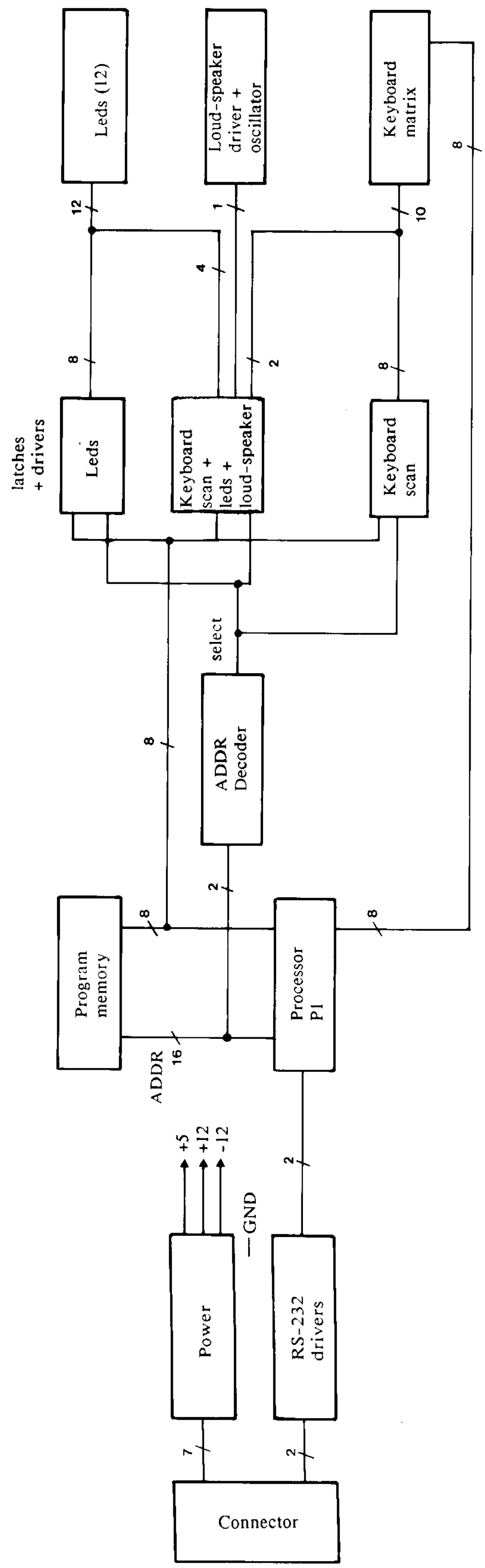
All the drivers are darlington transistor arrays.

The RS 232 transmitter consists of an op-amp and two smith triggers and receiver with one smith trigger.

The loud-speaker oscillator is based on RC-oscillator with the frequency of approximately 800 Hz.

The processor controls the keyboard scanning, the ASCII conversion of pressed keys and the serial communication to the host monitor.

Figure C.3 Control board block diagram



C.3 SERVICE AND TROUBLESHOOTING

C.3.1 Disassembly and reassembly

See the exploded view in Figure C.9 for the mechanical construction of CCK-104.

C.3.2 General troubleshooting

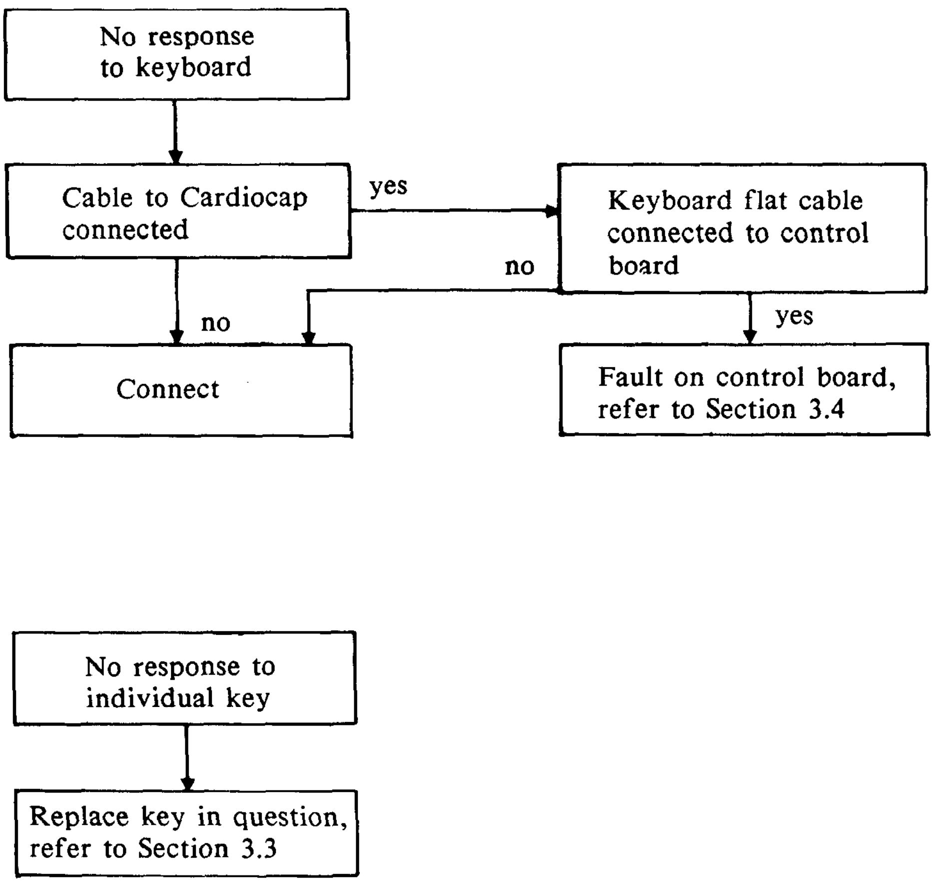


Figure C.4 General troubleshooting chart

C.3.3 Keyboard troubleshooting

See Figure C.5 for keyboard parts layout schematic diagram.

C.3.3.1 Keyboard test mode

Keyboard test mode is initiated by pressing the CTRL-key and simultaneously typing the code 874733. While in the test mode the serial interface is switched off so the keyboard does not send any characters to the monitor.

The test procedure checks all the keys in the keyboard rows one by one. All the LEDs in keys S1 through S12 are switched on at the beginning of the test. A blinking LED indicates the row under test (see the table below):

S1 blinking=test S1 through S12-keys(default when entering the test mode)
S2 blinking=test F1 through F12-keys
S4 blinking=test number row (1, 2, 3...)
S6 blinking=test upper character row (ESC, Q, W...)
S8 blinking=test middle character row (CTRL, A, S...)
S10 blinking=test lower character row (SHIFT, Z, X...)
S12 blinking=test SPACEBAR

Every LED indicates one key in a row to be tested. The LEDs S1 to S12 indicate the keys from left to right (or the key itself in case of the keys S1 through S12). Test the keys in a row by pressing them one by one. When a key passes the test the corresponding LED is switched off (the blinking LED is not switched off). When all the keys in a row are tested the test immediately moves to the next row. After the last row (i.e., the SPACEBAR) is tested the software automatically returns to normal mode. CTRL- and SHIFT-keys are tested by pressing two keys simultaneously:

Test CTRL-key	: press CTRL and 'A'-key.
Test left SHIFT-key	: press SHIFT and 'Z'-key.
Test right SHIFT-key	: press SHIFT and '?'-key.

The test does not automatically move to the next row unless all the keys in the row pass the test. You can select the row you wish to test by pressing simultaneously the CTRL-key and the green S-key corresponding to the row you wish to test (according to the list on top). Keyboard is turned to normal mode by pressing simultaneously CTRL and 'C'-keys.

C.3.4 Control board troubleshooting

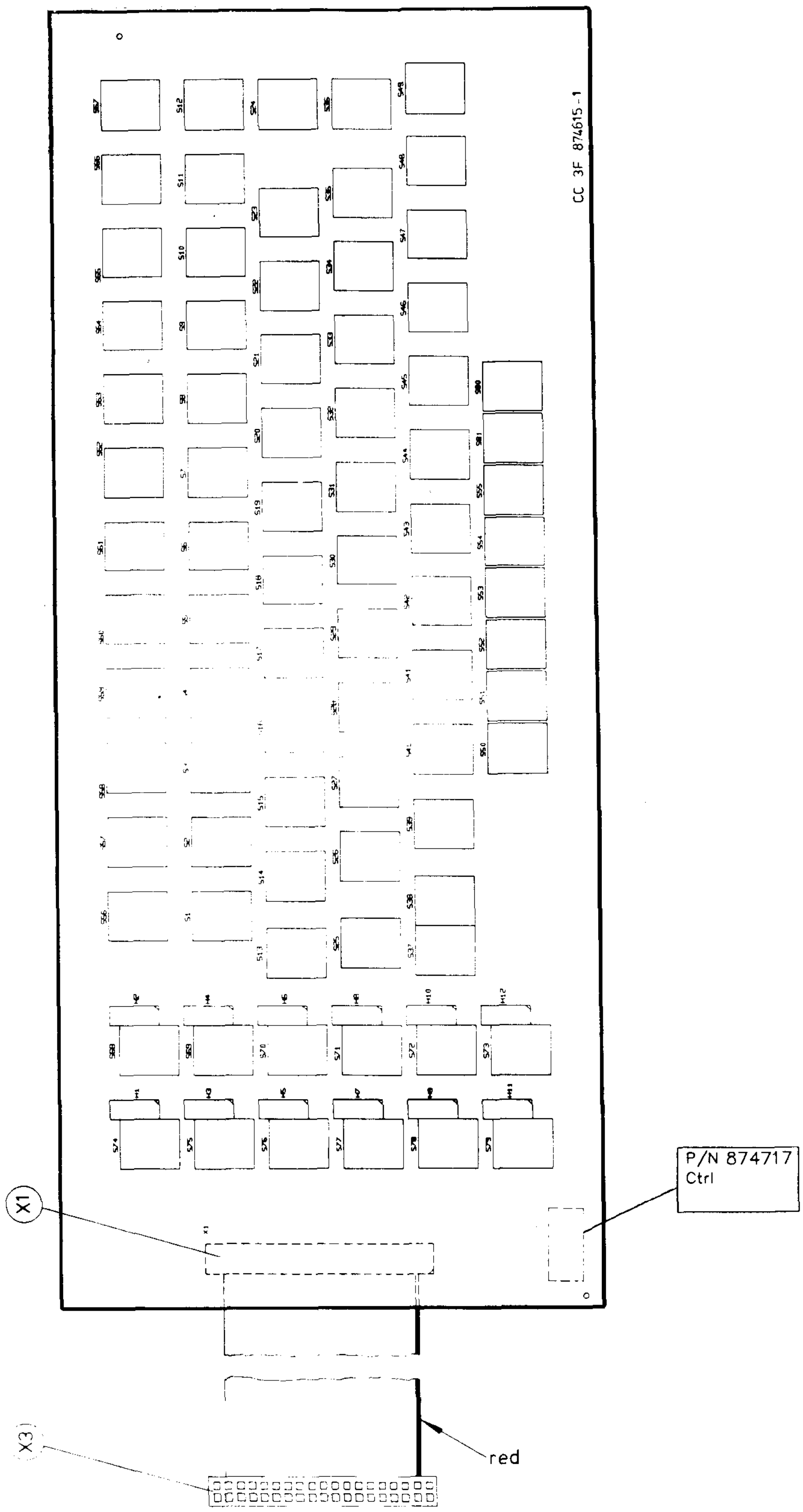
See Figure C.6 for control board troubleshooting. The parts layout and schematic diagram are given in Figure C.7.

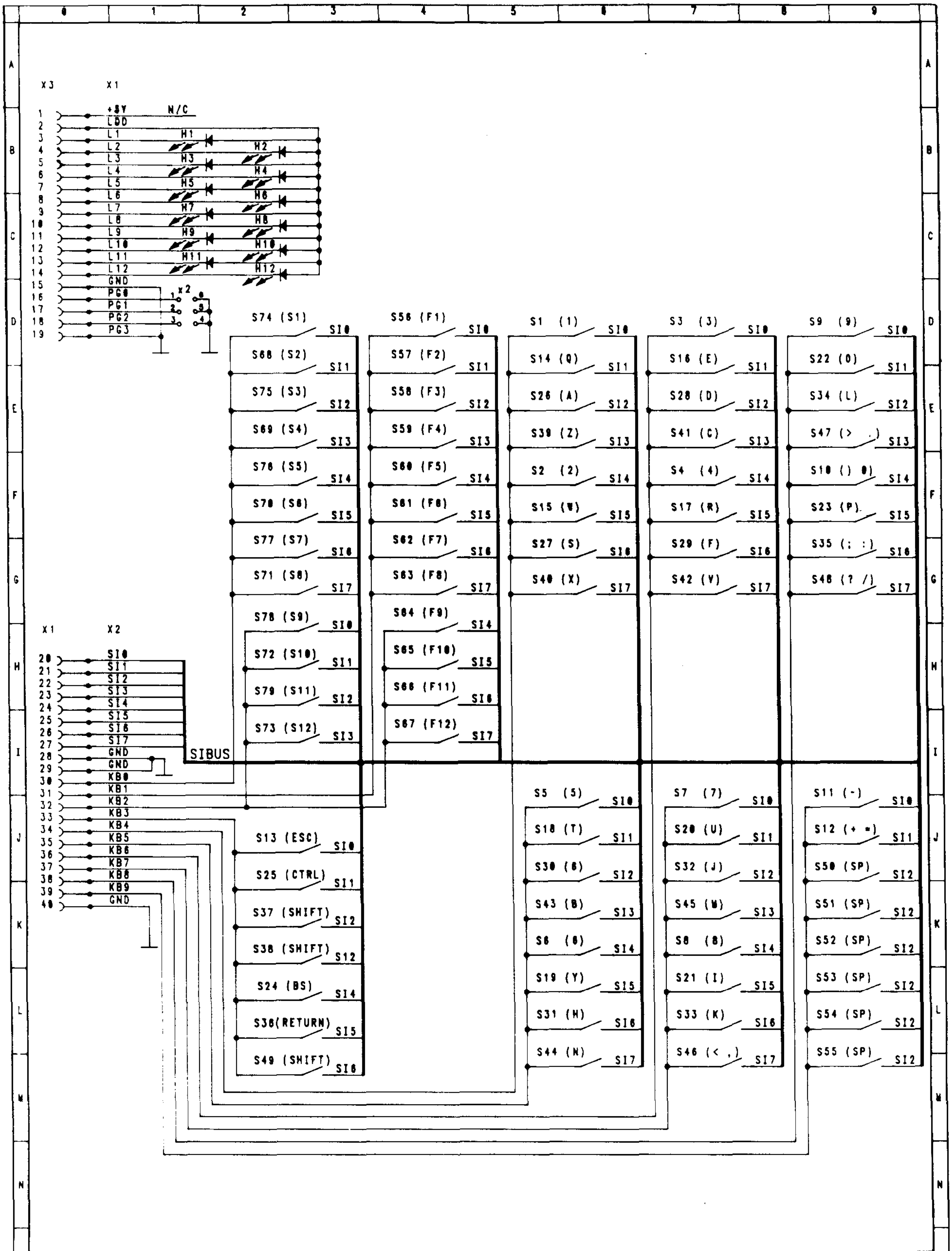
NOTE: First check supply voltages of all the circuits.

C.3.5 Connecting cable troubleshooting

See Figure C.8 for connecting cable schematic diagram.

Figure C.5 Keyboard parts layout and schematic diagram

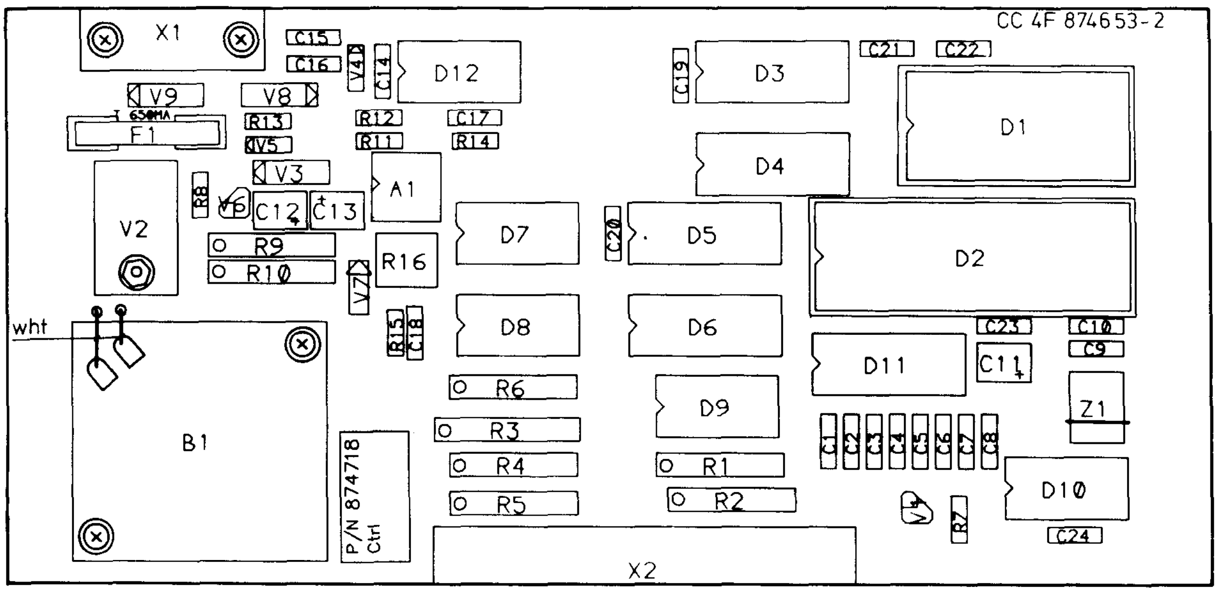




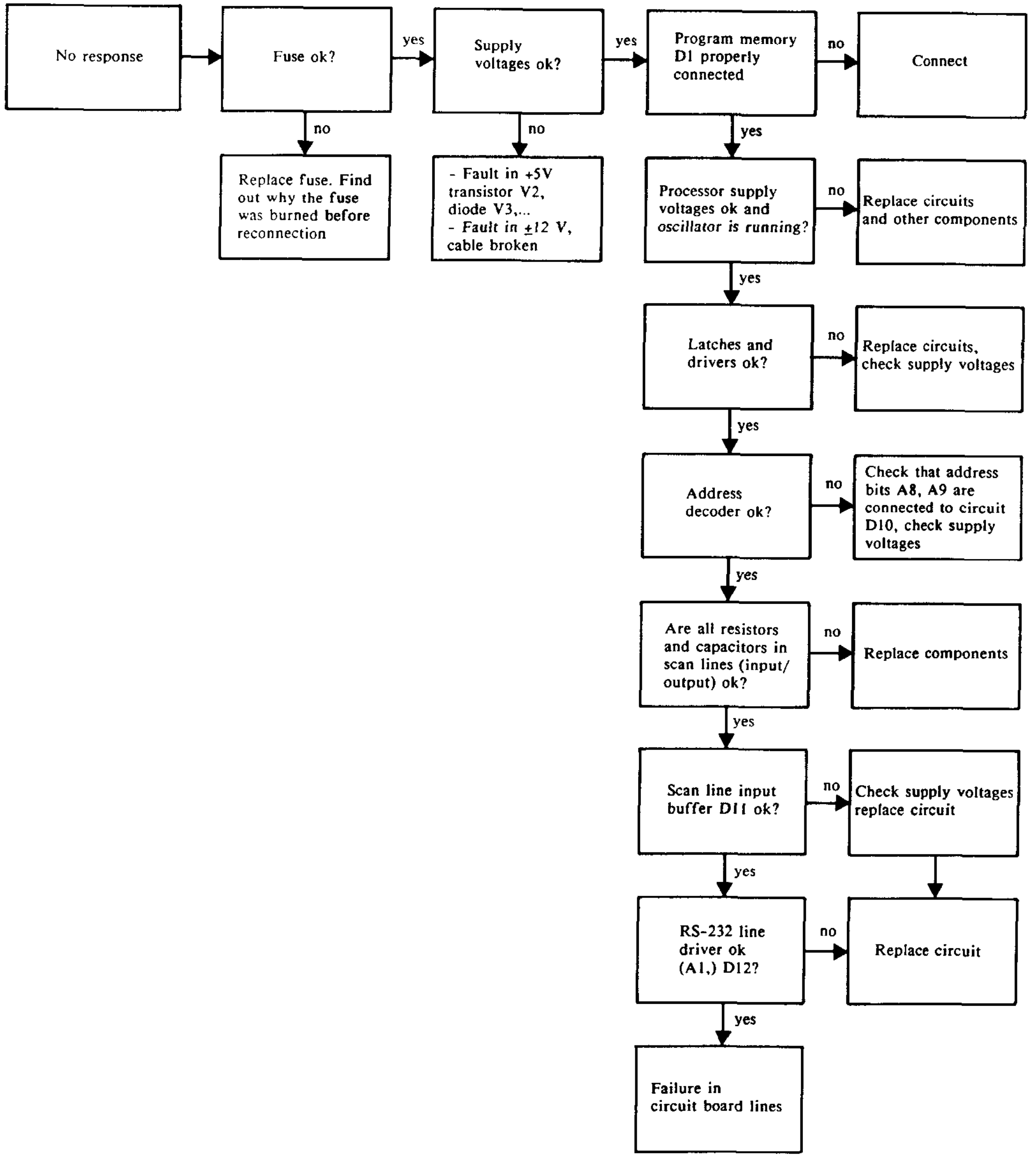
9.3.89 SAHE			4264	-2	DATEX INSTRUMENTARIUM OY	NIMI KEYBOARD	SIVU 1/1	LAITE CCK-104
MUUT.	TARK.	HYV.	MUUTOS	MERKKI		PIIRT. TARK. HYV.		N:O CC 3B 874659-2

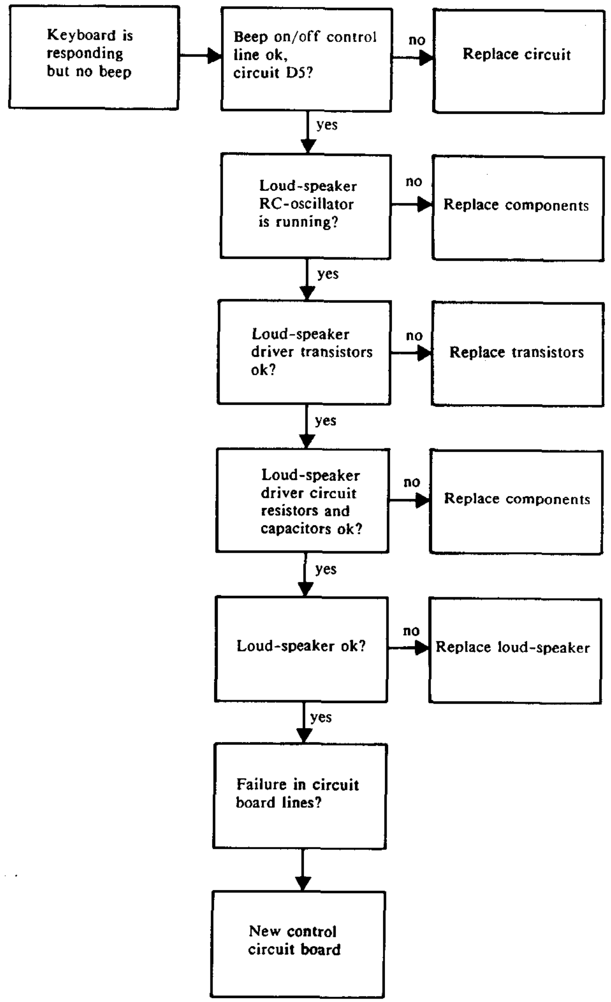
Figure C.6 Control board parts layout and troubleshooting chart

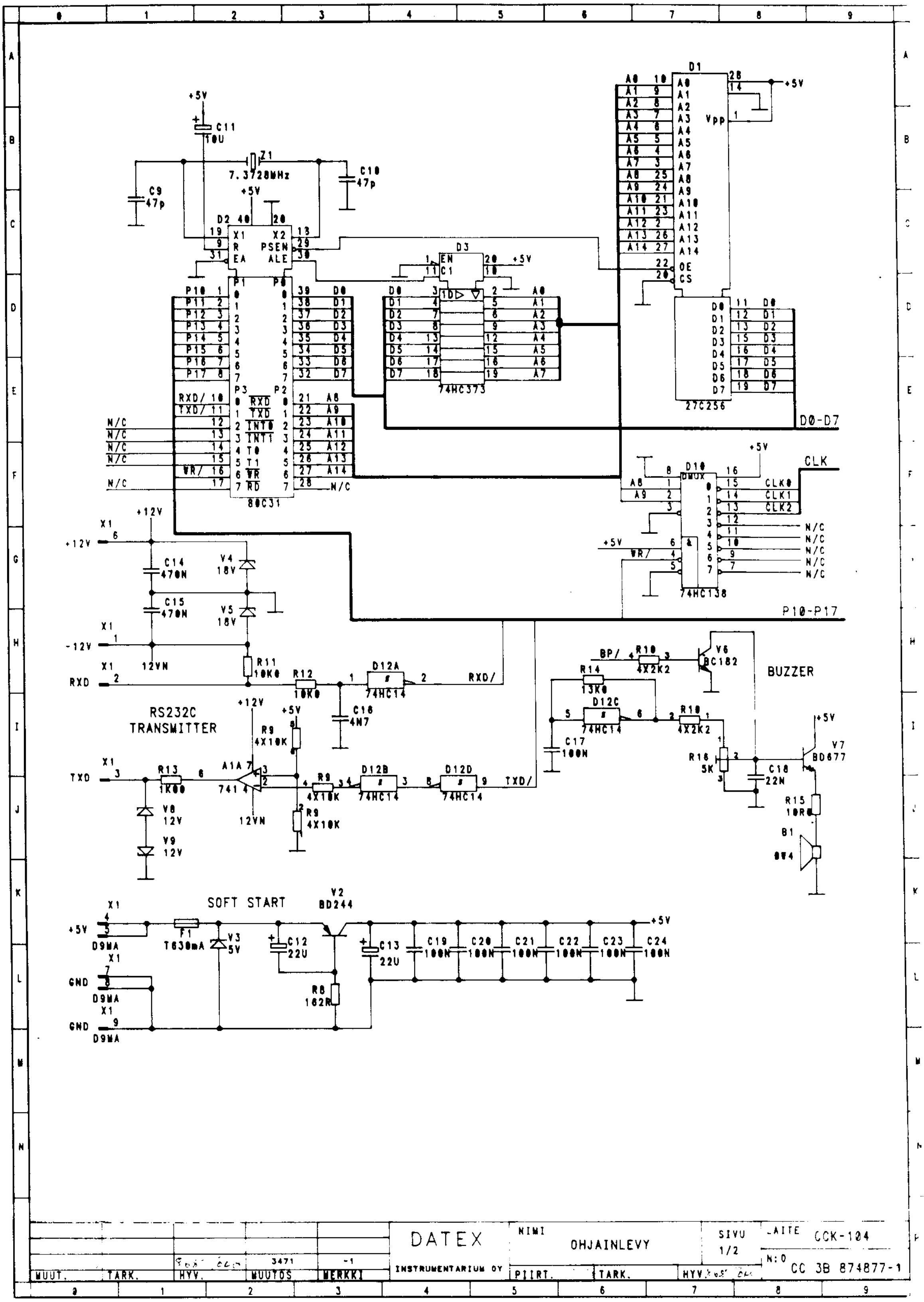
Figure C.7 (on the next page)
Control board schematic diagram

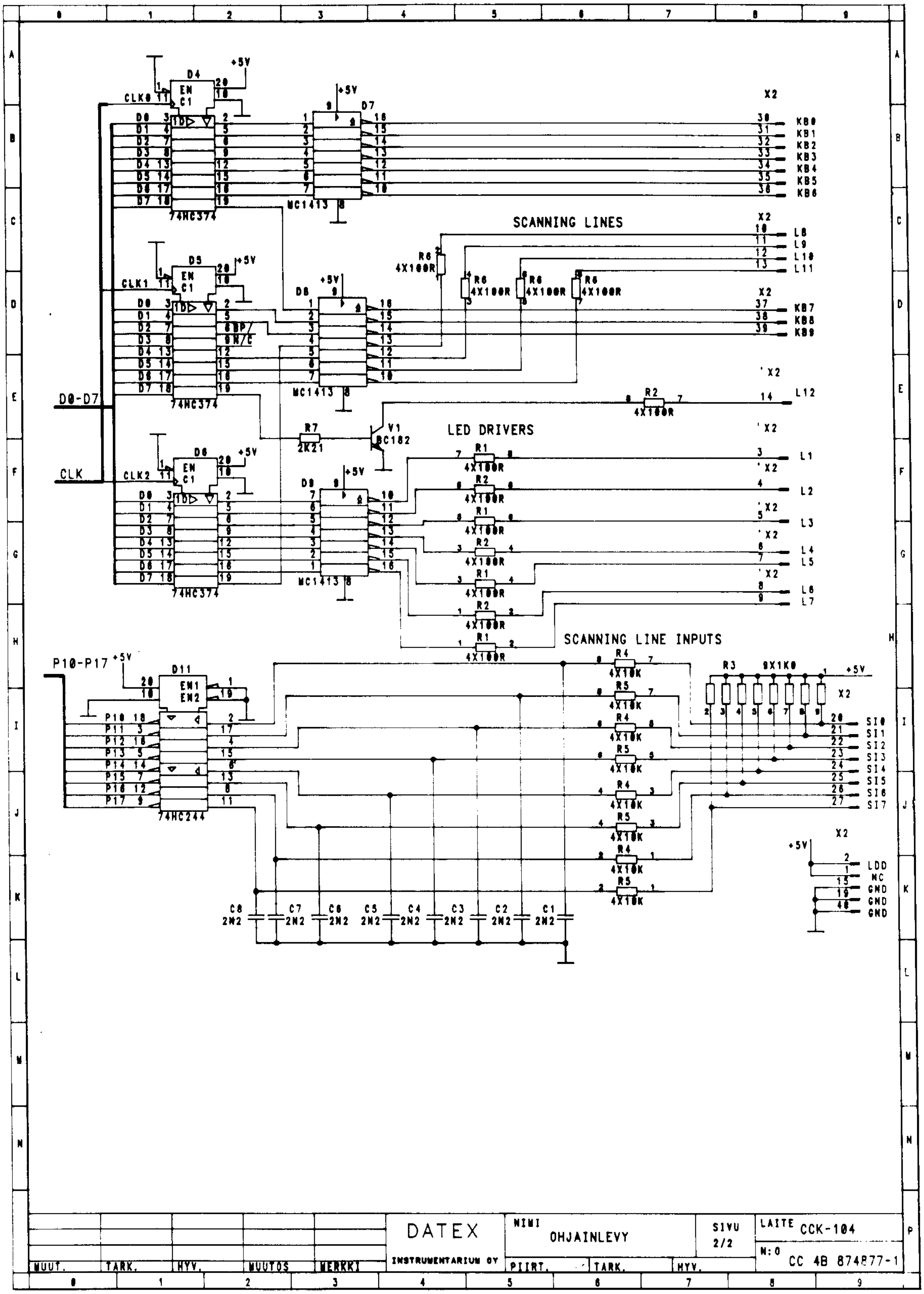


***NOTE:** First check supply voltages of all the circuits*



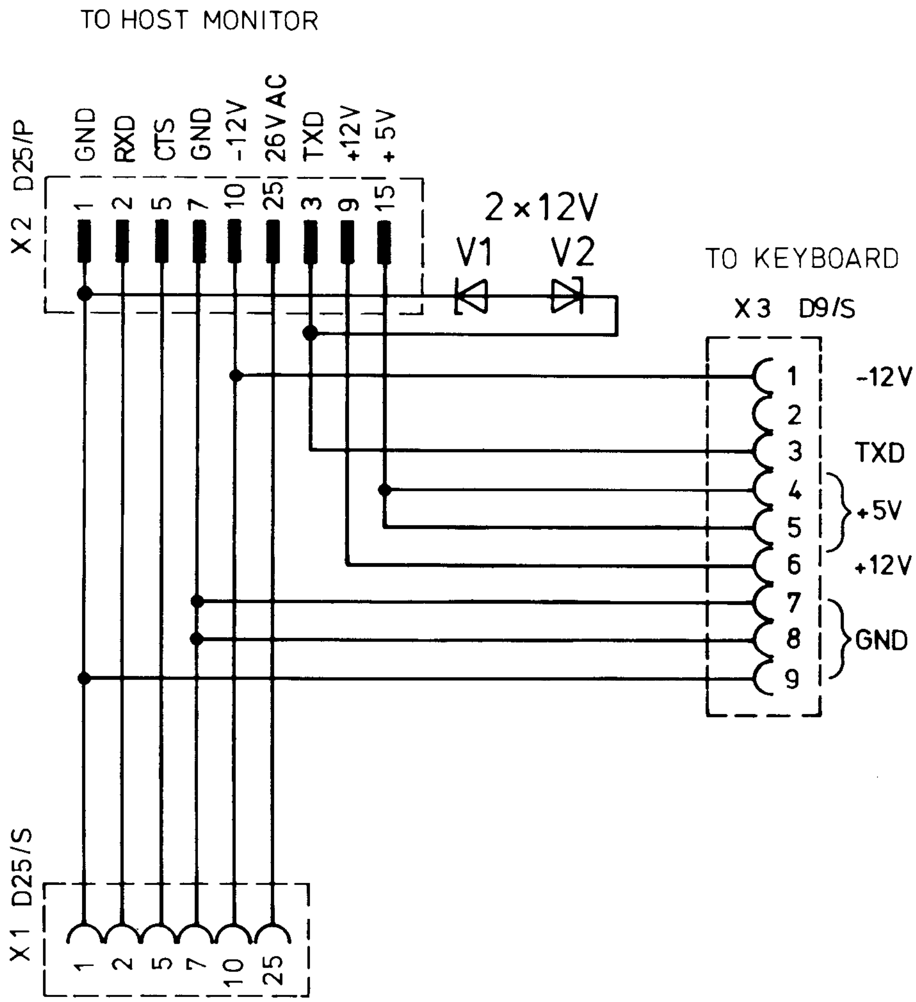



D1
27C256
D2
80C31
D3
74HC373
D10
74HC138
7.3728MHz
RS232C
TRANSMITTER
SOFT START
BUZZER
D0-D7
P10-P17
CLK
DATEX
INSTRUMENTARIUM OY
OHJAINLEVY
CCK-104
CC 3B 874877-1



D4
74HC374
CLK0
D7
MC1413
X2
KB0
KB1
KB2
KB3
KB4
KB5
KB6
SCANNING LINES
L8
L9
L10
L11
R6
4X100R
D5
CLK1
D8
KB7
KB8
KB9
D0-D7
CLK
L12
R2
R7
2K21
V1
BC182
LED DRIVERS
D6
CLK2
D9
R1
L1
L2
L3
L4
L5
L6
L7
SCANNING LINE INPUTS
P10-P17
D11
EN1
EN2
74HC244
R4
R5
4X10K
R3
9X1K0
SI0
SI1
SI2
SI3
SI4
SI5
SI6
SI7
C1
C2
C3
C4
C5
C6
C7
C8
2N2
+5V
LDD
NC
GND
DATEX
INSTRUMENTARIUM OY
NIMI
OHJAINLEVY
SIVU
2/2
LAITE
CCK-104
N:O
CC 4B 874877-1
MUUT.
TARK.
HYV.
MUUTOS
MERKKI
PIIRT.

Figure C.8 Connecting cable schematic diagram



C.4 SPARE PARTS

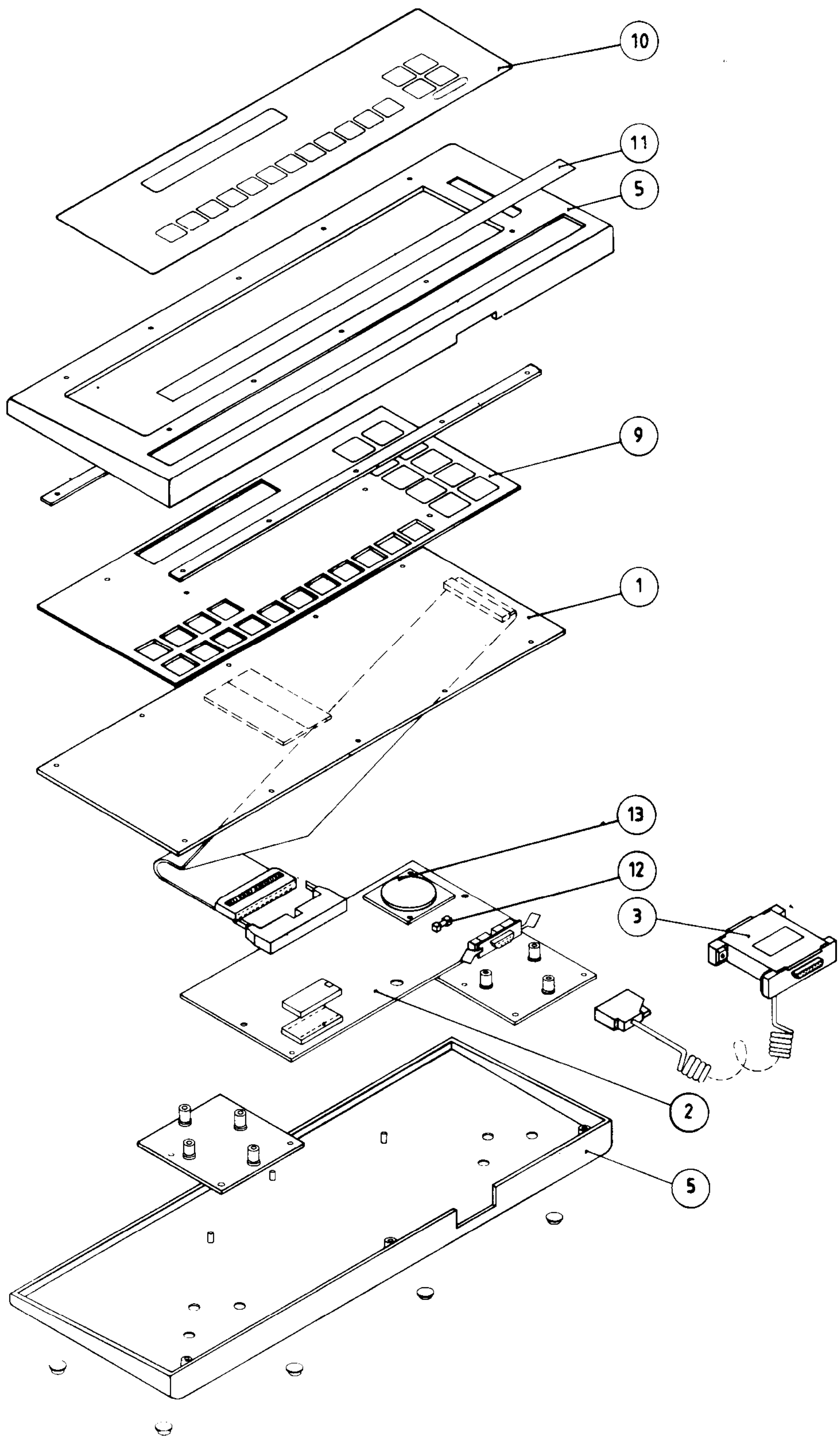
C.4.1 Spare parts

ITEM	ITEM DESCRIPTION	ORDER NO.
1	Keyboard	874717
2	Control board	874718*
3	Connecting cable	874720
5	Enclosure, complete	874723
9	Keyboard support plate	874727
10	Plastic keyboard panel	874598*
11	Plastic function key advisory	874732
12	Fuse 630 mA	51114*
13	Loud-speaker	51448
	Keyboard key	52042*

Item number refers to the exploded view in Figure C.9.

* = the part is recommended for stock

Figure C.9 Exploded view of CCK-104 Keyboard


10
11
5
9
1
13
12
3
2
5

12 APPENDICES

A COMPUTER OUTPUT (Serial & Analog I/O Connector)

Transmission rate 1200 Baud. One series of output strings in 10 seconds except NIBP string which comes out immediately after NIBP measurement. 8 data bits, no parity. 1 start bit and 1 stop bit. Each parameter has 3 digits. Parameters are separated by commas.

10 sec

NIBP string:

```
C01,000,129,099,084,000,019,000
```

NIBP string	
Status	000
Systolic	129
Mean	099
Diastolic	084
(000)	000
(pzero)	019
(000)	000

Basic strings (C03) and SpO2 strings (C04):

```
C03,000,010,031,000,000,000,000,000,000,000,043,064,042,026,384,005,002,001,422
C04,000,000, ,043,000,000,000,255,780
C03,000,010,031,000,000,000,000,000,000,000,043,063,042,026,384,005,002,001,513
C04,000,000, ,043,000,000,000,255,780
C03,000,010,031,000,000,000,000,000,000,000,043,064,042,026,384,005,002,001,600
C04,000,000, ,043,000,000,000,013,700
C03,000,010,032,000,000,000,000,000,000,000,043,064,041,026,384,005,002,001,100
C04,000,000, ,043,097,012,006,013,700
C03,000,010,032,000,000,000,000,000,000,000,043,064,042,026,384,005,002,001,200
C04,000,000, ,043,097,008,005,013,700
```

SpO2 string	Basic string
---	Marker number
---	Hours
---	Minutes
Pulse rate (1/min)	---
SpO_2 %	---
Iredmod	---
Redmod	---
Gain	---
*	---
	Respiration rate (1/min)
	Heart rate (1/min)
	P1 syst
	P1 mean
	P1 diast
	Temp (x 10)
	P2 syst
	P2 mean
	P2 diast
	Status

* Alternately status code and 6xx (xx = amplitude factor of pleth)

See pages 12-3a/b for status codes explanation

If DATEX-ENGSTROM gas monitor CAPNOMAC™ II is connected to CARDIOCAP™ II monitor (see the preceding page for NIBP string):

10 sec

```
C03,000,014,052,047,002,021,016,001,001 ,018,068,143,111,082,375,016,013,010,300
C04,000,000,C02,068,096,053,032,005,605
C03,000,014,052,049,002,021,016,001,001 ,015,064,144,110,080,375,017,013,009,422
C04,000,000,    ,064,095,027,018,005,700
C03,000,014,053,048,001,021,016,001,001 ,016,067,143,112,082,375,017,013,010,513
C04,000,000,C02,067,000,035,024,005,605
C03,000,014,053,048,001,021,016,001,001 ,016,065,144,111,081,375,017,013,009,E00
C04,000,000,    ,065,095,035,022,005,700
C03,000,014,049,052,001,021,015,001,001 ,009,066,144,111,082,375,017,013,010,300
C04,000,000, AA,066,096,019,011,005,605
C03,000,014,049,052,001,021,015,001,001 ,009,066,144,111,082,375,017,013,010,422
C04,000,000,ISO,066,096,013,006,005,700
```

SpO₂ string fields	Basic string fields
SpO_2 string	Basic string
ETAA % x 100	Marker number
FIAA % x 100	Hours
*	Minutes
Pulse rate (1/min)	$ETCO_2$ % x 10
SpO_2 %	$FICO_2$ % x 10
Iredmod	FIO_2 (0-100 %)
Redmod	ETO_2 (0-100 %)
Gain	FIN_2O (0-100 %)
**	ETN_2O (0-100 %)
	Respiration rate (1/min)
	Heart rate (1/min)
	P1 syst
	P1 mean
	P1 diast
	Temp (x 10)
	P2 syst
	P2 mean
	P2 diast
	Status

* Alternately selected anesth. (HAL, ENF, ISO or blank when not selected) and selected analog output: AA, CO_2, O_2, N_2O, ALL

** Alternately status code and 6xx (xx = amplitude factor of pleth)

See pages 12-3a/b for status codes explanation

The status data are followed by: CR (Carriage return, hex D) LF (Line feed, hex A)
Iredmod = Infrared amplitude modulation-% x 10
Redmod = Red amplitude modulation-% x 10

If DATEX-ENGSTROM gas monitor CAPNOMAC ULTIMA™ is connected to CARDIOCAP™ II monitor (depending on the Ultima in use, some strings may not be available:

(See the preceding pages for NIBP, SpO_2, and basic strings).

U01 string	U03 string	U04 string
String type	String type	String type
Marker no.	MV exp (0.1 1/min)	$ETCO_2$
ETO_2 (% x 10)	MV insp (0.1 1/min)	$FiCO_2$
FiO_2 (% x 10)	TV exp high (1)	CO_2 unit
ET balance gas	TV exp low (ml)	
Fi balance gas	TV insp high (1)	
ASX status	TV insp low (ml)	
Automatically identified gas	V1.0 (%) for adults or V0.5 (%) for paediatrics	
Reserved	Compliance	
ET (primary gas, 10=1%)	Ppeak	
ET (secondary gas)	Pplat	
Fi (primary gas)	PEEP	
Fi (secondary gas)	I : E	
MAC (x 10)	Reserved	
Pulse rate	Reserved	
SpO_2	Reserved	
Ired ampl.	Reserved	
Red ampl.	Recorder output	
Gain	Units status	
Status	Status	

U03-string comes out when CAPNOMAC ULTIMA™ monitor includes V-option.
See operator's manual for strings' interpretation.
The status data are followed by: CR (Carriage return, hex D) LF (Line feed, hex A)

The Status Characters of the Standard String

1st chr	2nd character	3rd character	Explanation
0	undefined	undefined	
1	b3 <occl> b2 <O_2 inop> b1 <zero valve error> b0 <air leak>	b3 <CO_2 zero error> b2 <O_2 zero error> b1 <N_2O zero error> b0 not used	Gas status bits
2	b3 <apnea> b2 <rebreath> b1 <CO_2 high> b0 <CO_2 low>	b3 <O_2 high> b2 <O_2 low> b1 <SpO_2 high> b0 <SpO_2 low>	Resp alarm bits
3	b3 <asy> b2 <ECG leads off> b1 <hr high> b0 <hr low>	b3 <p1/NIBP Sys high> b2 <p1/NIBP Sys low> b1 <p2 Sys/mean high> b0 <p2 Sys/mean low> *)	Circulatory alarm bits
4	ECG size number N = 99 (0.2 mV/cm) down to N = 5 (4 mV/cm) with 19 = mV/cm (Size = 1/(0.051 (N-5) + 0.25) in mV/cm)		
5	(BP1) 0 = no PB1 1 = 100 mmHg ref 2 = 50 mmHg ref 3 = 25 mmHg ref 4 = zero error 5 = 150 mmHg ref	(BP2) 0 = no PB2 1 = 100 mmHg ref 2 = 50 mmHg ref 3 = 25 mmHg ref 4 = zero error 5 = 150 mmHg ref 6 = 12.5 mmHg ref	Invasive blood pressure scale (= REF scales)
6	Pleth size 1 - 99 with 16 = default or SpO_2 modulation % in decimal format (02, 05, 10, 20, or 50)		
7	b3 <no probe> b2 <probe off> b1 <pulse search> b0 <poor sig quality>	b3 <high SpO_2> b2 <low SpO_2> b1 <no pulse> b0 <not used>	Pleth/SpO_2 status and alarm

*) Mean alarm when p2 scale = 12.5 mmHg

Status Code Interpretation

Bit no. \ digits:	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
No error	·															
b3									·	·	·	·	·	·	·	·
b2					·	·	·	·					·	·	·	·
b1			·	·			·	·			·	·			·	·
b0		·		·		·		·		·		·		·		·

· = digit is 1 = item is active

For example:

740

7 (first character) indicates that the status code is about Pleth/SpO_2 status and alarm (see the table on the preceding page).

4 (second character) indicates bit b2 is active (see the table above). It is “probe off” according to the table on the preceding page.

0 (third character) indicates that there is no error among the items listed in the third character box in the same table.

So the status code 740 indicates “probe off”.

Alarm Activation/Deactivation String

Alarm activation string appears immediately when an alarm is given.

```
C99, P2, 024, > , 020
C99, P1
C99, SAO         *Gas
C99, CO2         *Gas
C99, O2
C99, HR
C99, OGC   Open gas circuit = Air leak   *Gas
C99, OCC   Occlusion                     *Gas
C99, REB   Rebreath alarm                *Gas
C99, APN   Apnea                         *Gas
C99, ELO   ECG leads OFF
C99, ASY   Asystole
```

<=====	CARDIOCAP™ monitor alarm activation string identification
<=====	Alarm parameter
<=====	Alarm activation value
<=====	< or > depending on whether low or high limit
<=====	Limit

```
C98, P2,
C98, P1
C98, SAO         *Gas
C98, CO2         *Gas
C98, O2
C98, HR
C98, OGC         *Gas
C98, OCC         *Gas
C98, REB         *Gas
C98, APN         *Gas
C98, ELO
C98, ASY
```

<=====	CARDIOCAP™ alarm deactivation string identification
<=====	Alarm parameter

*) When Capnomac Ultima™ is connected

Command/Info String

```
C97, RES
```

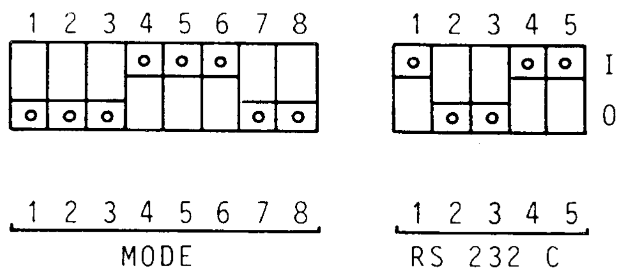
<=====	CARDIOCAP™ command/ info string identification
<=====	RES for reset, POW for power-up
<=====	Program code

B CCP-104 GRAPHICS PRINTER

The CCP-104 is an HP ThinkJet graphics printer. Earlier printers (CCP-104-xx-00, see the type plate on the bottom of the unit) require an isolated connecting cable (P/N 873152) to satisfy medical electronics safety requirements. Printers currently in production (CCP-104-xx-01) are IEC 601-1 class II devices and do not require an isolated cable. The non-isolated connecting cable's part number is 875370. Due to mechanical changes the isolated connecting cable can not be connected to the current printers.

For troubleshooting the printer please refer to the HP ThinkJet service manual.

See figure below for the correct DIP switch settings in the printer.



C TRILINGUAL LIST OF ERROR MESSAGES

Listing of error messages in English, German and French.

English version	German version	French version
ARTIFACT	ARTEFAKT	ARTEFACT
CHECK PROBE	CHECK SENSOR	VERIF CAPTEUR
CUFF LOOSE	MANSCH. LOCKER	BRASSARD LACHE
CUFF OCCLUSION	MAN. OCCLUSION	OCCL BRASSARD
EXTERNAL RAM ERROR	EXTERN. RAM FEHLER	ERREUR DE RAM
INVASIVE BP NOT CALIBRATED, RECALIBRATE	INVASIVER DRUCK NICHT KALIBRIERT, NEU-KAL	PRESS. INV. NON ETALONNEE, RE-ETALONNER
LEADS OFF	EKG AUS	ECG INOP
LOW PLETH SIGNAL	GERINGES PULS-SIGNAL	SIGNAL PLETH PEU FIABLE
MEMORY CIRCUIT FAILURE/CALL SERVICE	SPEICHER-FEHLER/ SERVICE ERFORDERLICH	ERREUR CIRCUIT MEMOIRE/APPELER SERVICE
NIBP AIR LEAKAGE	NIBD UNDICHT	FUITE AIR BRAS
NIBP ARTIFACT	NIBD ARTEFACT	ARTEFACT PNI
NIBP HW ERR X	NIBD HW FEHL X	PNI HW ERR X
NTBP ZERO ERROR	NIBD NULL FEHLER	ERREUR 0 PNI
NO NIBP	KEIN NIBD	PAS DE PNI
NO PROBE	KEIN SENSOR	PAS DE CAPTEUR
PROBE OFF	SENSOR LOSE	CAPTEUR DECONN.
ROM CHECKSUM ERROR	ROM CHECK FEHLER	ERREUR DE ROM
TEMPERATURE NOT CALIBRATED, RECALIBRATE	TEMPERATUR NICHT KALIBRIERT, NEU-KALIBR.	TEMPERATURE NON ETALONNEE, RE-ETALONNER