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1 INTRODUCTION

1.1 The scope of this manual

This manual provides information for the maintenance and service of both the PV 501 and PV 501-2 ventilators. The PV 501-2 is a further development of the PV 501. The main differences are that the PV 501-2 delivers a maximum patient pressure of 60 mbar (compared to the PV 501's 50 mbar) and that the Trigger setting is adjustable between -2 to 6 mbar (compared to the PV 501's -4 to 6 mbar).

The PV 501 and PV 501-2 are designed to give many years of trouble-free breathing assistance to the user provided that preventative maintenance is done at the specified intervals described in this manual. Correctly performed maintenance will increase the ventilator's service life considerably.

All points to be checked and service instructions for the PV 501 and the PV 501-2 are described in this manual. Where information is only relevant to one of the models it is clearly marked which model the text/figure refers to, otherwise all information is valid for both models.

It is also important that any peripheral equipment is checked at the same time as the maintenance service is done.

Also included is a reference copy of the Operation Manual.

1.2 Intended use of the ventilator

PV 501 and the PV 501-2 are volume-controlled, pressure-limited ventilators, specially designed for long term ventilator assistance at home.

The internal batteries are connected automatically should the mains supply fail or is disconnected. Fully-charged batteries will give a running time of 4 hours.

Thanks to its design, the PV 501 and the PV 501-2 are easy to operate. It does not require any gas, and together with its low weight, it is ideal for breathing therapy both in hospital and while travelling.

The PV 501 and the PV 501-2 are not intended for intensive care and are aimed for adults and children weighing about 30 kg or more.

1.3 Design and function of the ventilator

The PV 501 and the PV 501-2 are built around a bellows that is compressed and drawn out by a ball screw driven by an electronically controlled servo motor. The micro-processor controlled electronics calculate the correct speed and running time for the motor by reading the settings for tidal volume, frequency and the I/E-relationship. The setting limits for pressures and the trigger level are monitored. If the mains supply or the external battery supply should fail during operation, the internal batteries are automatically connected and an indication of this is given on the front panel. If the battery supply voltage drops too low, both audible and visual alarms are given. The ventilator's modular design makes maintenance easy.

1.4 Intended audience

This Service Manual is intended for technicians who have medical/technical training and knowledge about the construction and function of the ventilator.

It is not intended for clinic personnel or patients.

Breas Medical reserves the right to make changes to the product and the contents of this manual without prior notice.

1.5 Service personnel's training requirements

Thanks to their simple construction using a modular system, no special competence is required other than general medical technical training on ventilators.

Always contact BREAS MEDICAL if there are any questions or if training is required.

All service must, however, be performed according to the instructions in this manual.

3 MAINTENANCE SERVICE INSTRUCTIONS

All routine maintenance checks and additional service instructions for the PV 501 and PV 501-2 are described in this chapter. For information about fault-tracing, detailed drawings, board schematics, spare parts etc, please refer to the respective chapters in this Service Manual.

The checks described in the Patient Instruction delivered with the ventilator should be followed by the patient and/or care providers.

3.1 Verifying the components and software installed

Check the Engineering Change History document in the Appendices section (Chapter 10) for a history of all the changes made and at which serial No they were introduced.

If in any doubt, read the component designation on the motor unit, circuit boards and PROMs as upgrades can have been made but not recorded.

3.2 Maintenance Service Schedule

IMPORTANT!

A complete maintenance service (as described in this chapter) must be done every 12th month. If the ventilator is used for continuous operation (24 hours per day) a complete maintenance service must be done every 6th month.

Interval	Action
At every 500th operation hour or more frequent if necessary (especially in town environments).	Replace the patient air inlet filter. Done by the patient/care provider. Replace during maintenance service.
Every 6 months if the ventilator is used for continuous operation i.e. 24 hours per day, otherwise every 12th month.	Complete maintenance service according to this instruction.
Additional service action (when required)	
At 20.000 running hours	Replace motor unit and hoses.
The internal batteries should be replaced every 24 months. <ul style="list-style-type: none"> • Replace the alarm batteries every 5th year counted from date of delivery or when required. 	Replace the internal batteries Replace the alarm batteries.

Every 12th month or every 6th month if the ventilator is used for continuous operation (24 hours per day)	See Ch./ Section No.
Replace the patient air inlet filter.	2
Clean the ventilator air intake filter	2
Motor Unit	
Lubricate the ball screw	7.2
Replace the check valve membranes in bellows end cover	7.3
Leakage test of motor unit and tubes	7.4
Electronics	
Checking the pressure sensor offset and gain.	8.5.1
Check operation using internal battery	8.9
Check operation using external battery	2
Check electrical safety levels	8.13
Internal Batteries (lead-acid)	
The internal batteries should be replaced every 24 months or when necessary.	8.10
Alarm Batteries	
Replace every 5th year counted from date of delivery or when last replaced.	8.11
Accessories (where applicable)	
Inspect patient circuit	2
Replace membrane in exhalation valve	2
Clean PEEP adapter, replace O-ring	2
Every 20000 operation hours	
Replace the complete Motor unit	6.6

3.3 Special safety precautions

- Avoid working with the mains connected when the casing is removed. Always test run using internal battery power.
- Insulate the wires for the internal batteries when they are disconnected to prevent short circuits.
- Explosive gases or liquids must not be kept or used close to the ventilator.
- Always follow good ESD practices when working with the ventilator.

3.4 Equipment required

- Test lung (1L) with exhalation valve.
- Measuring equipment for tidal volume and minute volume/frequency. (Timer, Spirometer or equivalent).
- Voltmeter.

3.5 Replacement parts required

Have the following spare parts at hand:

<u>Part No.</u>	<u>Description</u>
000 139	Internal battery (lead)
000 036	Alarm battery (Ni-Cd)
001 141	Motor unit, BEI
000 557	Grease (BREAS 283 AZ)
000 004	Motor unit, Maxon
000 248	Filter, patient air
002 123	Service kit, check valves
002 178	Membrane kit, exhalation valve

3.6 Maintenance instructions

3.6.1 Registration

- Fill out the registration part of the Service Record. Check that the following markings can be read:
 - Make, model designation and serial number.
 - All warning texts on labels.
 - Any inventory control markings.
- Document the current patient settings.
- Note the number of running hours. Does the motor unit need to be replaced?
- Check any comments or events made on the previous service record.

3.6.2 Information from the user

- Before starting the service request the following information from the patient:
- Has the ventilator functioned problem-free, such as running failure?
- How does the patient check the function of the ventilator? How often?
- How often is the filter changed?
- What is the patient's need of filters until the next service point?

3.6.3 Validity of documentation

- Check that the patient instructions are up-to-date.
- Check if any modification or update of the ventilator is to be performed during the service.

3.7 External checks

3.7.1 External damage and wear

- Clean the surface with a mild detergent.
- Clean the filter for the machine ventilator air inlet. Use a vacuum cleaner or wash and dry the filter before fitting.
- Check that there is no visible damage on the surfaces and other components.
- Check that all texts for controls etc. are readable.
- Turn all knobs and check that their operation feels OK.
- Check that nothing is loose, (including the handles).
- Check that the cover for the adjustment panel is secured properly.

3.7.2 Power cables and plugs

- Check the power cable and its plugs, and the power socket in the rear panel.
- Check that the cable securing clamp is undamaged.
- Check other external battery cables, where applicable.

3.7.3 Minimum function check

- Connect the ventilator to the mains and check that the LED for Mains/Charging is lit.
- Start the ventilator and check that it operates normally and no abnormal noise is heard. Check that the lighting for the pressure gauge is on.
- Check the condition of the internal batteries. They should, when fully charged, be able to run the PV 501 for at least 2 hours. If not they must be replaced.

3.8 Internal Checks

3.8.1 Open hood and rear panel

- Remove the mains power cable.
- Open the hood and rear panel. Remove stabiliser bar, see chapter 6.

3.8.2 Cleaning

- Remove any dirt or dust that has collected in the ventilator, also from the folds in the bellows.

3.8.3 Cables and connectors

- Check all cables and their connectors for any damage. Check at the front and rear panels where cables can be pinched.

3.8.4 Component fastening

- Check that the batteries are properly fastened.
- Check that the motor unit is properly fastened.
- Check that all parts on the front and rear panels are properly fastened.

3.8.5 Mains supply

- Check that the power inlet socket is undamaged and that it is properly fastened.
- Check that the touch protection cover is undamaged and that it is properly fastened over the power inlet socket.
- Check that the transformer is properly fastened.
- Check the wiring to the transformer.

3.8.6 Remove and check / replace the motor unit.

The motor unit must be checked at each service. At 20.000 running hours the entire motor unit assembly must be replaced. See Chapter 6 for removing the motor unit.

Checking the motor unit

- Check that the motor is properly fastened.
- Check that the shaft coupling screws are properly tightened.
- Check that the encoders are undamaged and properly fastened.

3.8.7 Grease the ball screw

Use only BREAS grease type 283 AZ. See chapter 7.

3.8.8 Replace the membranes in the check valves

- The membranes must be changed at each maintenance service. See chapter 7.

3.8.9 Leakage check of hoses and bellows

- Check the function of the outlet check valves. See chapter 7.

3.8.10 Reassemble the motor unit

Before reassembling the motor unit, check if the internal batteries need to be replaced as this is best done with the motor unit removed, see 3.8.6.

- Reassemble the motor unit. See Chapter 6.

3.8.11 Checking the offset and gain of the pressure transducer

- See Chapter 8, Section 8.5.1 for detailed information.

3.8.12 Checking the instrument accuracy

- Check using a manometer connected to the exh. valve connection that the indicating instrument gives the correct indication and that the needle moves "softly". See Chapter 8, Section 8.5.1.1.

NOTE! Make small pressure changes, the indicating instrument should be "slower" compared with the manometer.

3.8.13 Internal battery test

The internal batteries should be fully charged or charged for at least 12 hours with the ventilator turned off before this test is carried out. The batteries, when fully charged, should operate the PV 501 for at least 2 hours, if not the batteries must be replaced. See Chapter 8, Section 10.

3.8.14 Reassemble the casing

See Chapter 6 for information.

3.9 Electrical safety

Follow the instructions for the following checks in Chapter 8.

- Check mains supply value
- Check isolation against the value obtained at the delivery inspection
- Check leakage current. Do not forget to reverse the polarity.
- Check patient leakage current.
- Leakage current at mains voltage at patient connected part

3.10 Final checks before delivery

3.10.1 Function check/leakage

- Start the ventilator with the patient circuit and reservoir bag connected as shown in the figure below. Check that everything seems normal. Create a pressure of approximately 30 cm H₂O and listen for any leakage.

3.10.2 Check the tidal volume/frequency

Set: Tidal volume: 1L
 Frequency: 12
 I/E: 1:2

- Measure the tidal volume and that the volume per minute is correct. (Accuracy ± 10%).

When checking using a volume monitor, an exhalation valve with a peep valve connector can be required. The volume monitor is then connected to the peep valve outlet on the exhalation valve.

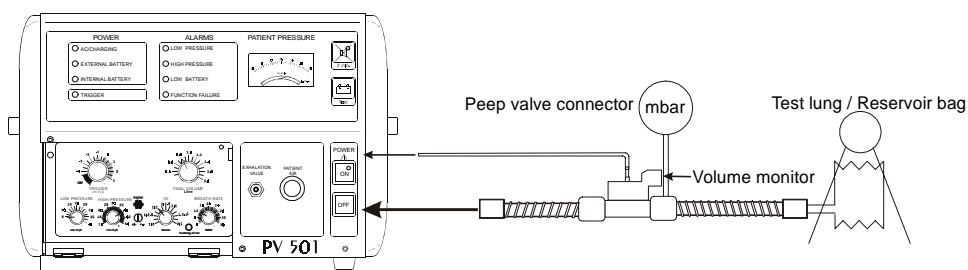


Fig. 3-1 Tidal volume check

3.10.3 Calculating the tidal volume/patient pressure

The tidal volume delivered is always slightly less than the tidal volume setting. This difference is due to the effect of the patient pressure on the compliance of the bellows.

The diagram below shows these differences at different patient pressures.

Settings: I/E = 1:2, Breath rate = 15 breaths/min. with the patient circuit connected.

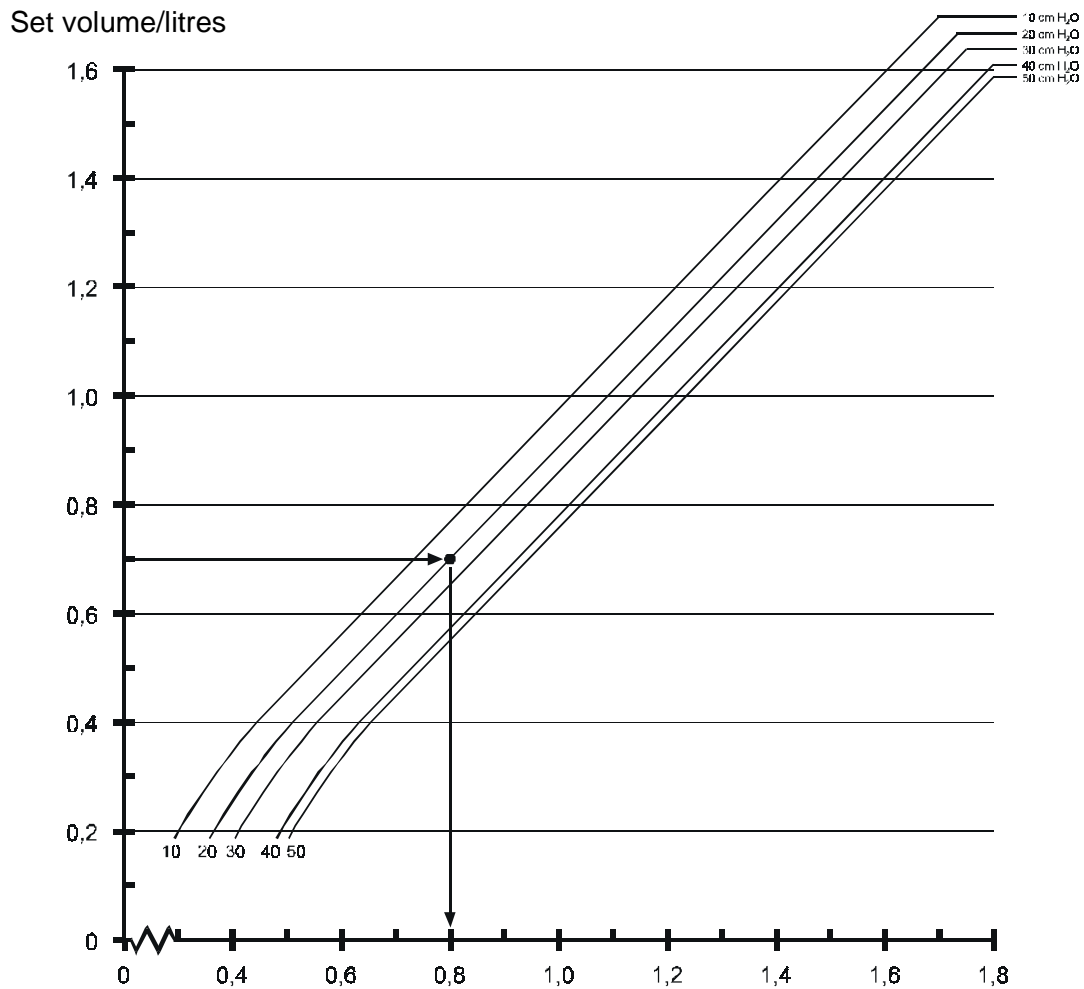


Fig. 3-2 Volume/Patient pressure diagramme

Example:

A patient needs a tidal volume of 0,7 litres and has an airway pressure of 20 cm H₂O. Start from 0,7 on the axis for "Delivered volume". Draw a horizontal line until it crosses the line for 20 cm H₂O patient pressure. From this point, go straight down and read off the value the tidal volume setting should be. In this case the ventilator setting is 0.8 litres.

3.10.4 Checking the pressure limit

Set: Low pressure 10 cmH₂O
 High pressure 40 cmH₂O

- Check the accuracy ($\pm 10\%$). Check that LED indication is given as well as an audible alarm.
- Also check that the solenoid valve for high pressure "clicks". You can clearly hear the solenoid valve activate at the following inhalation.

3.10.5 Checking low pressure alarm/alarm mute

- Turn the ventilator on without anything connected to the patient air outlet. Wait 15 sec until the alarm for "Low pressure" is activated. Press the alarm mute button and check that the alarm is heard again after approx. 2 min.

3.10.6 Trigger

- Set the trigger knob to -1 cm H₂O. Create a negative pressure and check that there is a triggered inhalation. The green LED should light.

3.10.7 Battery operation

- Disconnect the mains cable while the ventilator is running. Check that the ventilator automatically changes over to internal battery and an alarm is given.
- Reconnect the mains power and check that indication "MAINS" comes on.

3.10.8 Checking accessories

Patient circuit

- Inspect the patient circuit and replace it if necessary.

Replacing the membrane assembly in the exhalation valve

This instruction applies to BREAS exhalation valves, see figure below.

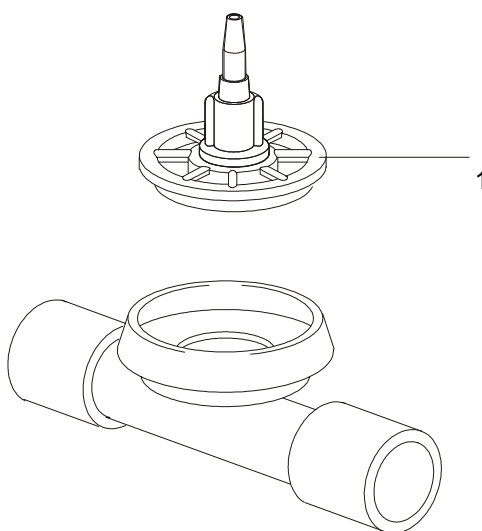


Fig. 3-3 Mounting the exhalation valve

- Remove the PEEP adapter, if installed. See "Cleaning the PEEP adapter".

- Unscrew and remove the complete membrane assembly (1).
- Clean the inside of the exhalation valve using a moist rag or wash in hot water using a washing-up liquid. Let it air dry.
- Screw on the new membrane assembly
- If a PEEP valve is to be used, fit the O-ring seal for the PEEP valve as shown in fig. 3-5.
- Connect the exhalation valve to a test lung. Check that no leakage occurs during the exhalation phase.

3.10.9 Cleaning the PEEP adapter

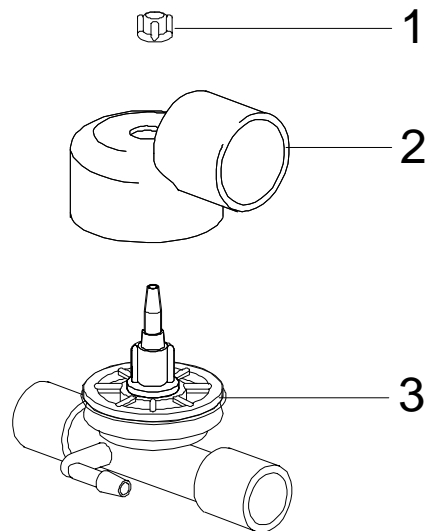


Fig. 3-4 Mounting the exhalation valve with PEEP adapter

- Remove the plastic nut (1) holding the PEEP adapter.
- Pull the adapter (2) up from the exhalation valve.
- Clean using a moist rag or wash in hot water using a washing-up liquid. Let the adapter air dry.
- Check that the O-ring seal (3) is properly in place on the exhalation valve (under the edge of the membrane assembly cover as shown in the figure below).

Note! Do not fit the O-ring to the membrane assembly before screwing it on.

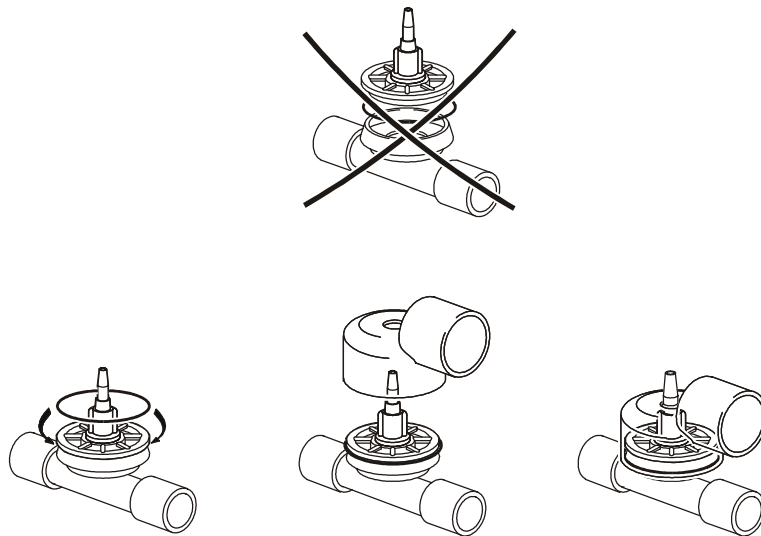


Fig. 3-5 Mounting the O-ring for the PEEP adapter

- Fit the PEEP adapter to the exhalation valve and screw on the plastic nut
- Check any other accessories.

3.10.10 Set the correct values for the patient

- Adjust the settings to the prescribed values for the patient.
- Change the air filter. Check that the patient has enough filters to last until the next service.

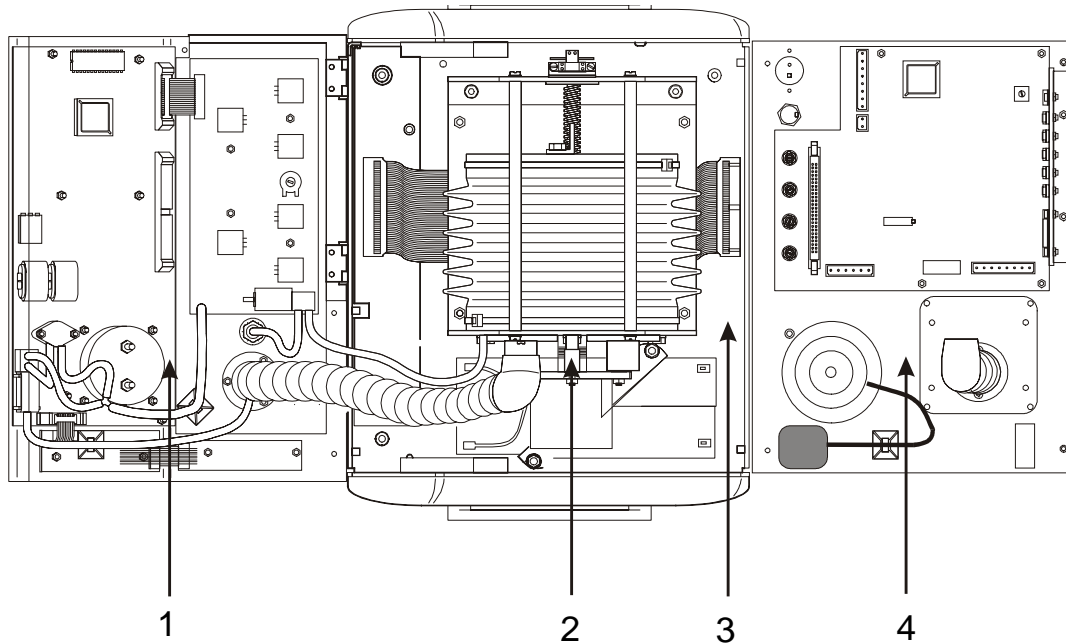
The patient settings should be checked by a physician at least once a year.

4 REPLACEMENT PARTS

4.1 OVERVIEW DIAGRAM

The illustration below shows the PV501/PV501-2, seen from above, with the hood and rear panel unscrewed and laid flat against the work surface.

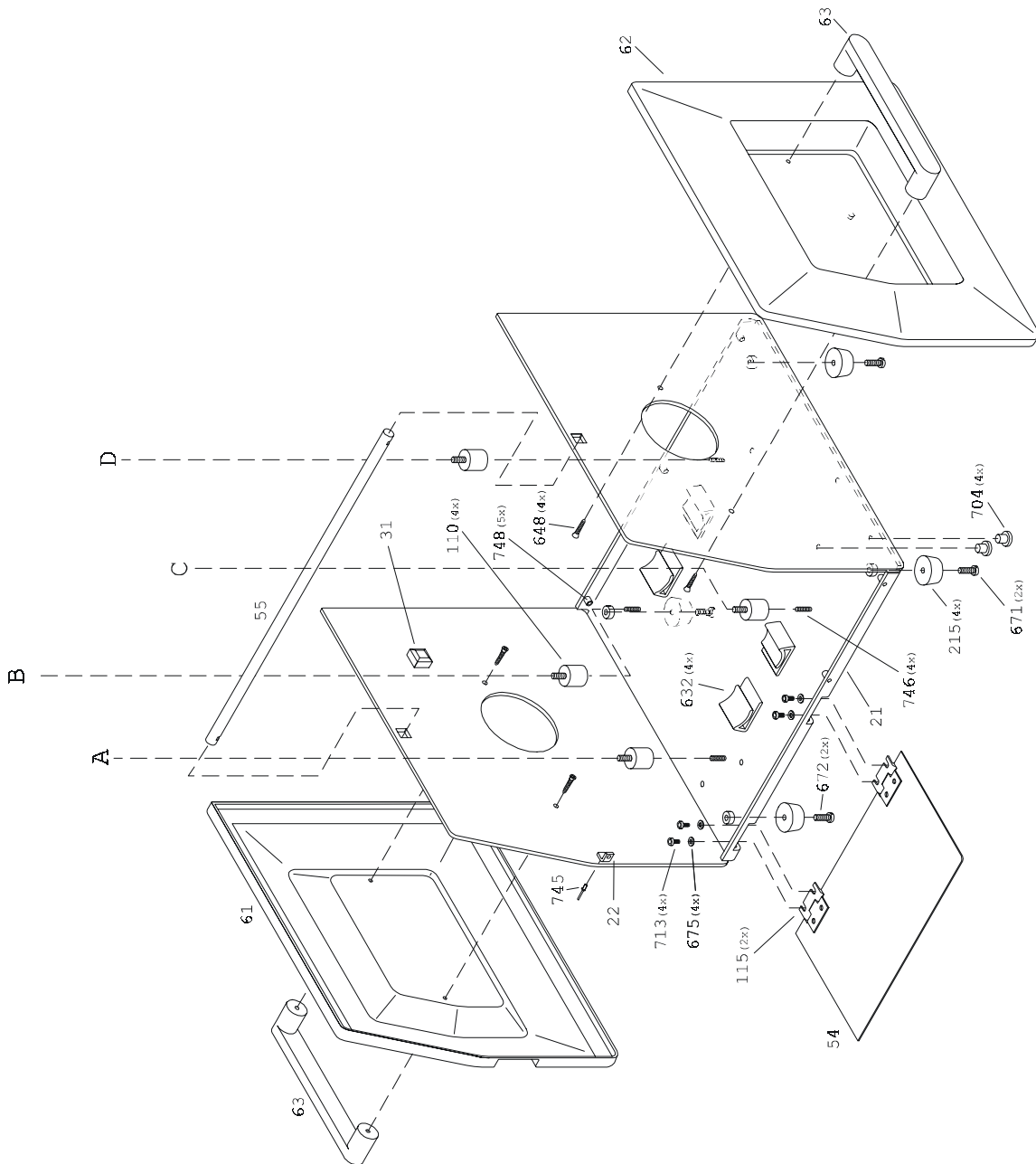
The figure below shows the main units making up the PV501/PV501-2. The following pages contain detailed exploded drawings for each of the main units and model. Last in this chapter is a complete list of part numbers.



<u>Pos. No.</u>	<u>Component</u>
1	Hood assembly
2	Motor unit
3	Base plate assembly
4	Rear panel assembly

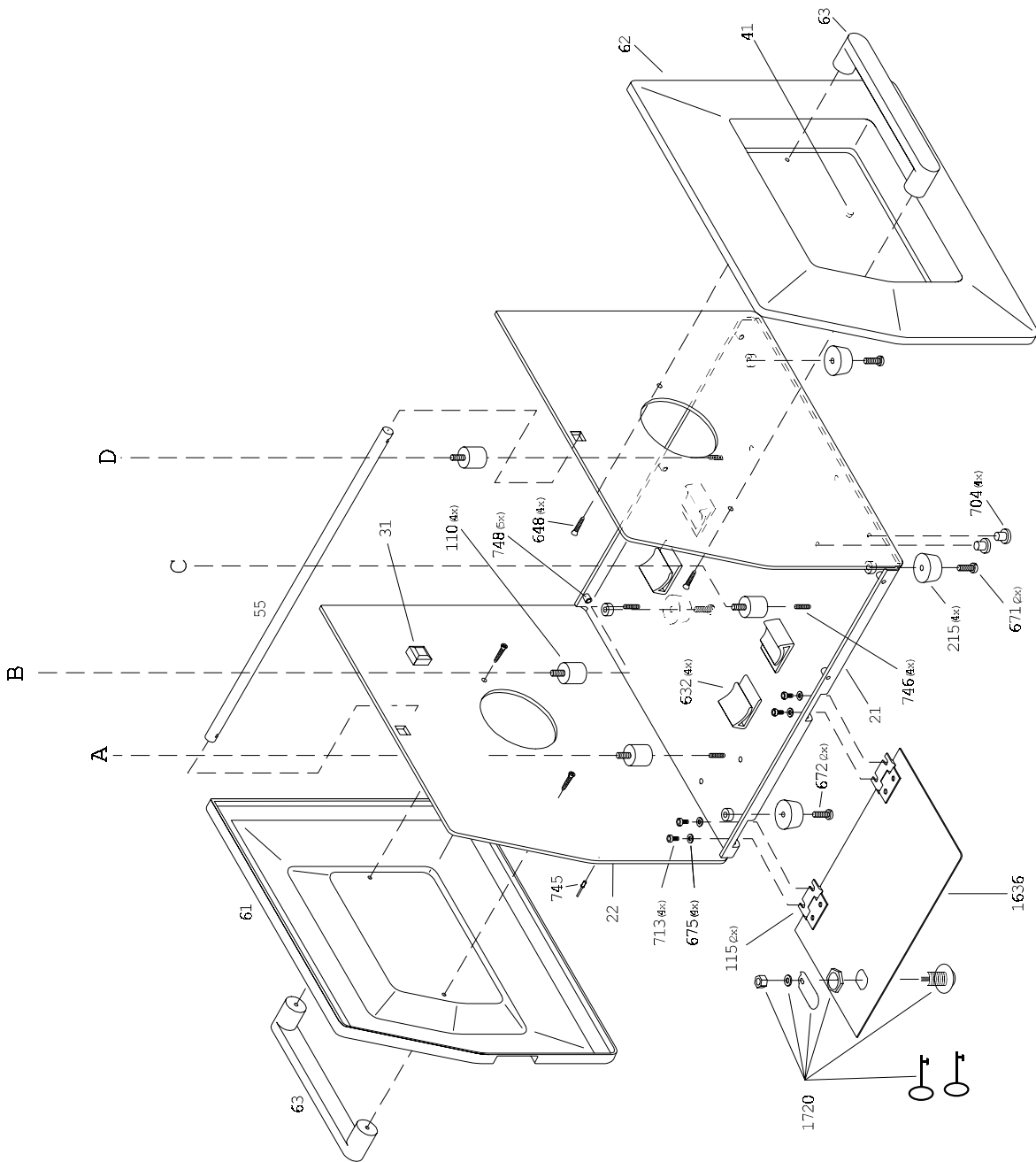
4.2 Exploded drawing, Base Plate Assembly PV 501

BREAS PV501
A v1.4
BREAS MEDICAL AB © Breas / 1501/1501-2 1998

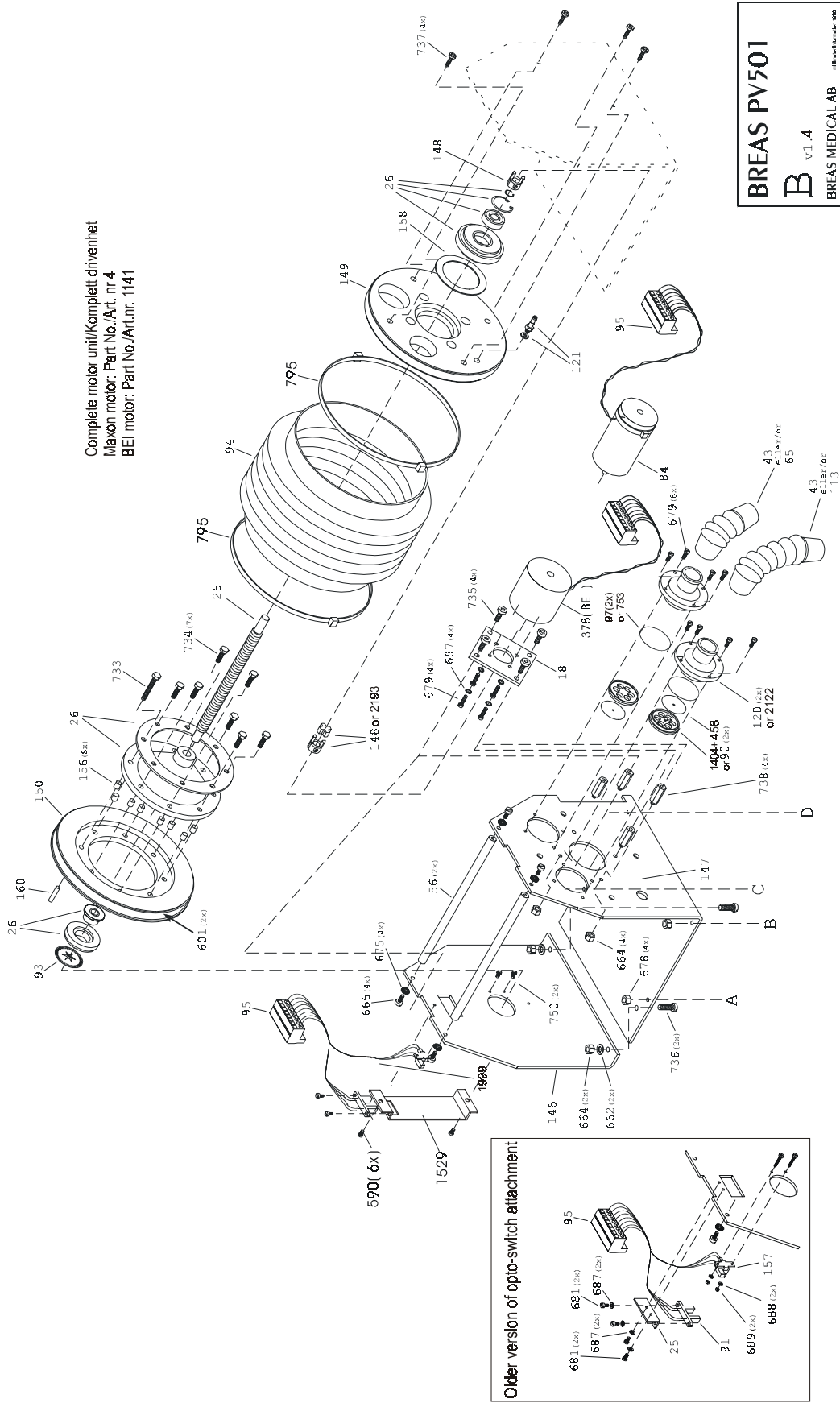


4.3 Exploded drawing, Base Plate Assembly PV 501-2

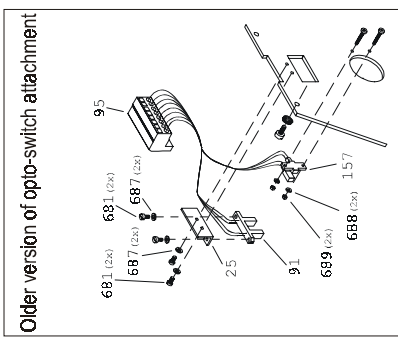
BREAS PV501-2
A v1.0
BREAS MEDICAL AB
S 02 2000



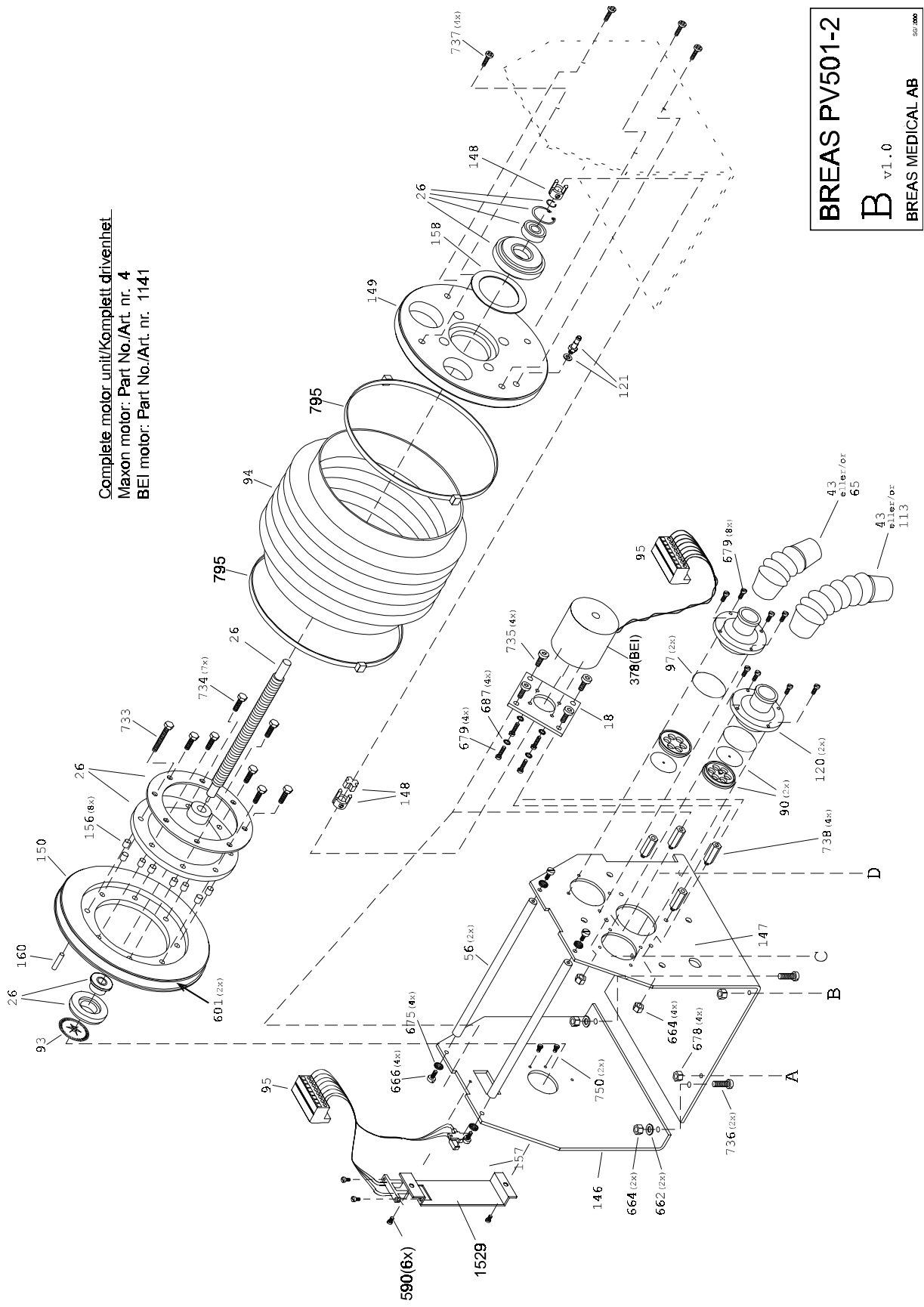
4.4 Exploded drawing, Motor Unit Assembly PV 501



Complete motor unit/Komplett drivenhet
 Maxon motor: Part No./Art. nr 4
 BEI motor: Part No./Art.nr. 1141



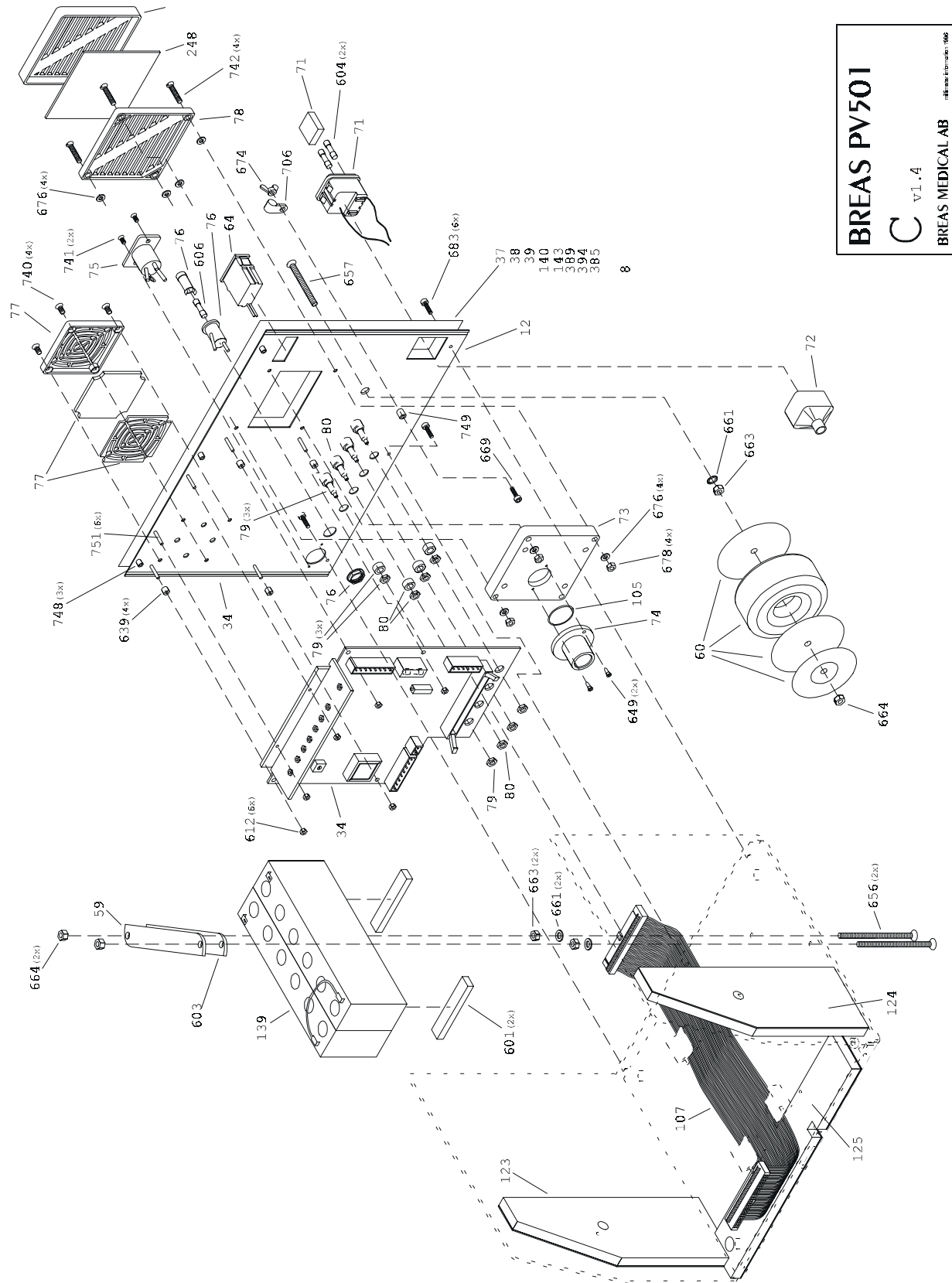
4.5 Exploded drawing, Motor Unit Assembly PV 501-2



Complete motor unit/Komplett drivenhet.
 Maxon motor: Part No./Art. nr. 4
 BEI motor: Part No./Art. nr. 1141

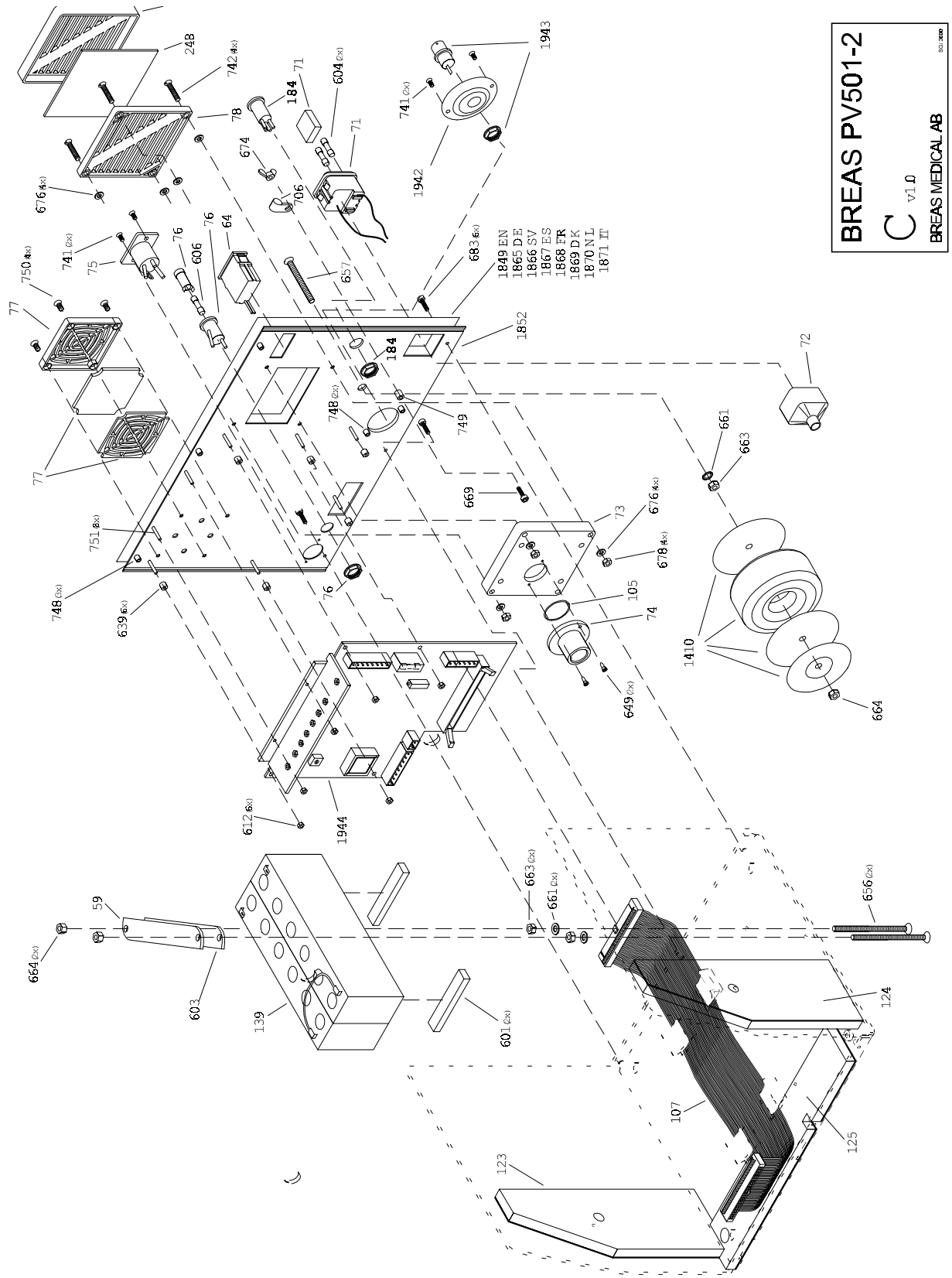
BREAS PV501-2
B v1.0
 BREAS MEDICAL AB 800 000

4.6 Exploded drawing, Rear Panel Assembly PV 501

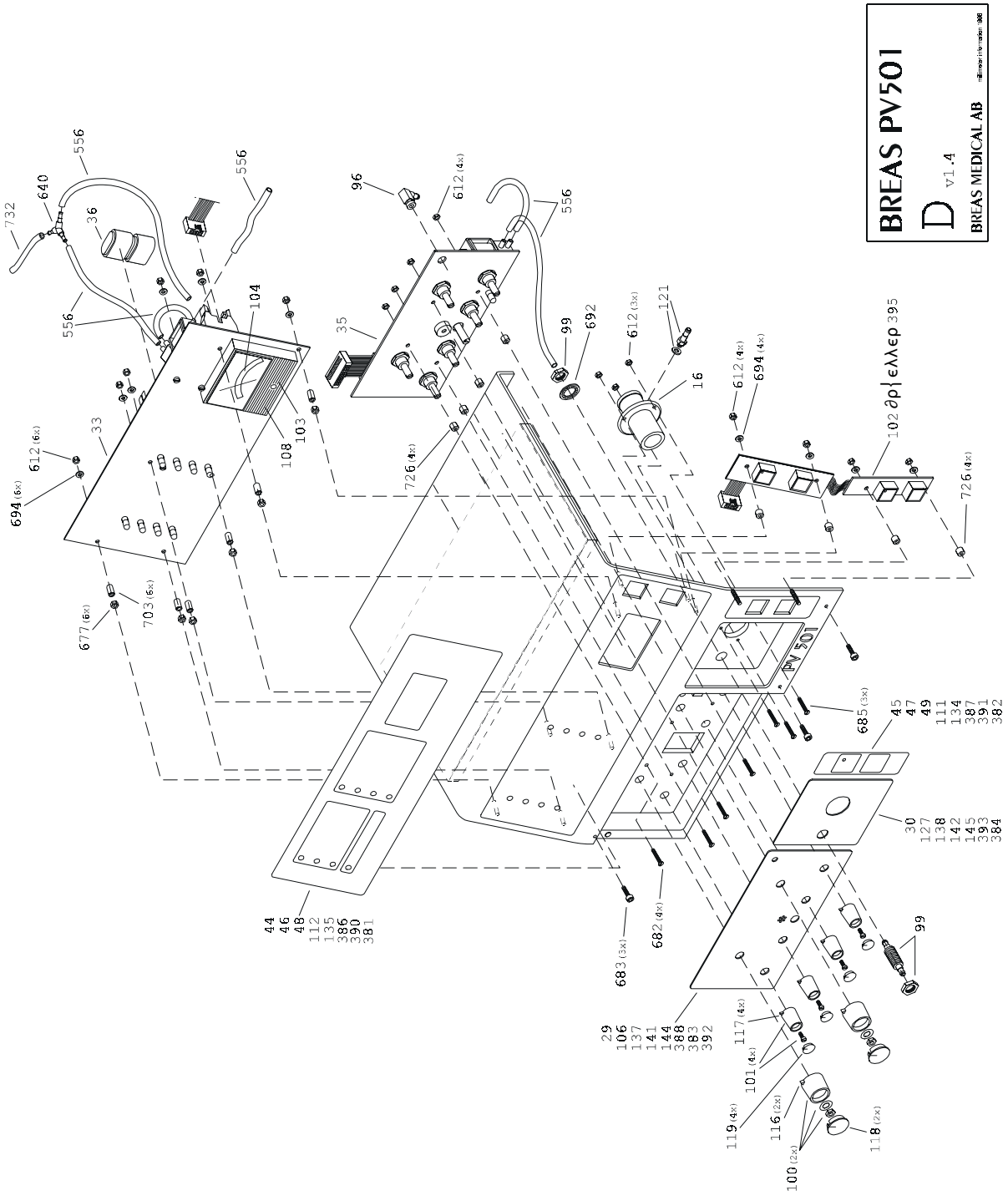


BREAS PV501
C v1.4
BREAS MEDICAL AB
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4.7 Exploded drawing, Rear Panel Assembly PV 501-2

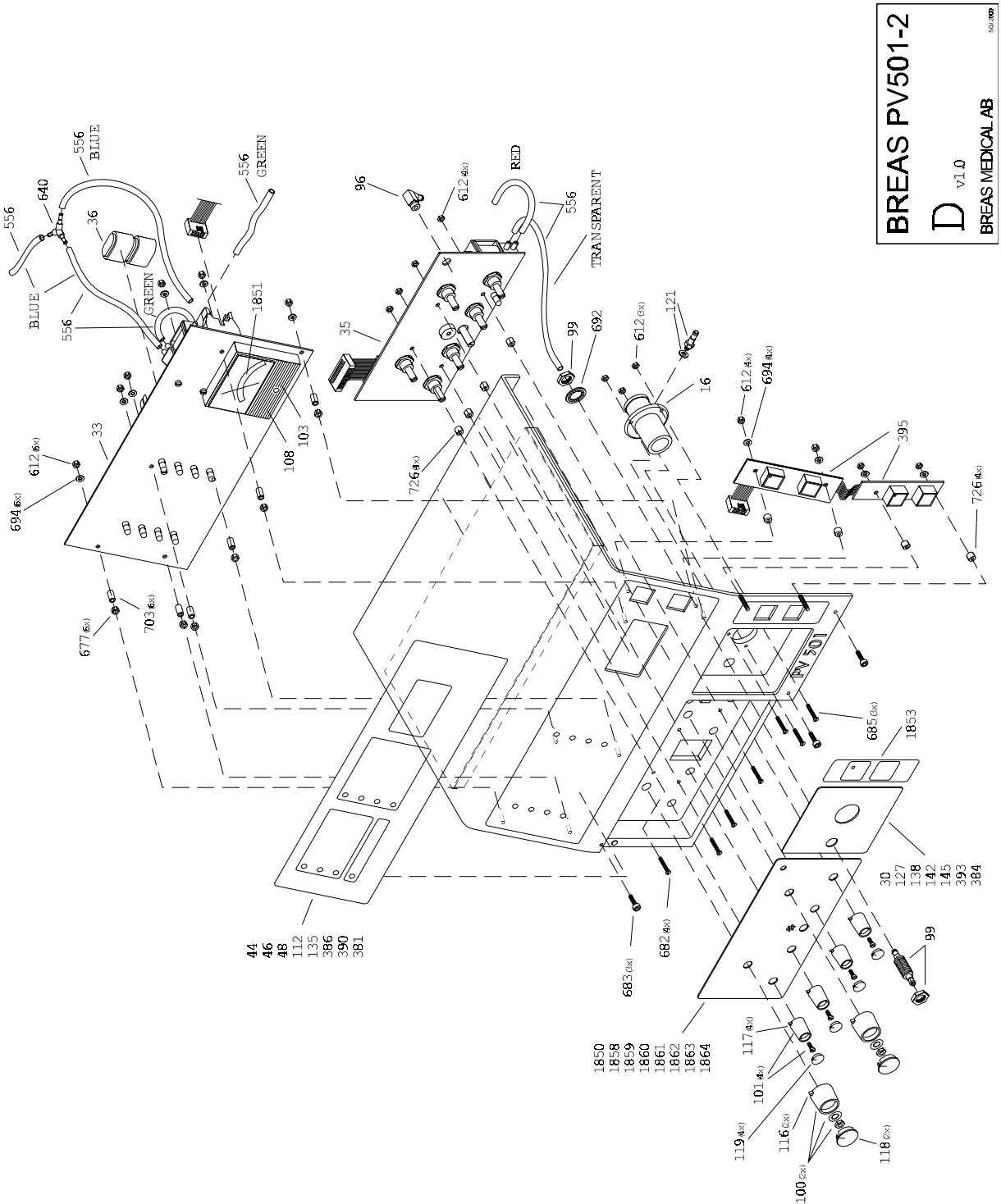


4.8 Exploded drawing, Hood Assembly 501



BREAS PV501
D v1.4
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4.9 Exploded drawing, Hood Assembly 501-2



BREAS PV501-2
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 6501000

4.10 Part Number List

<u>Part No.</u>	<u>Description</u> <u>Notes</u>
2	Base plate, complete
4	Motor unit, Maxon - complete
5	Hood, complete, SE
6	Complete, Eng
7	Complete, Ger
8	Rear panel, complete, Eng
9	Rear panel, complete, Ger
10	Hood, complete, Eng
11	Hood, complete, Ger
12	Rear panel, blank
13	Potentiometer box
14	Magnet - potentiometer box
15	Air-hose connection - patient exhale
17	Side unit - motor bracket
18	Motor plate
19	Rear panel - Swedish text
20	Hood
21	Bottom plate
22	Angle bracket - front / hood
24	Cooler angle element
25	Angle bracket - reading prong (limit position)
26	Ball screw - complete
27	Motor bracket
29	Panel - potentiometer panel Swedish text
30	Panel - patient air Swedish text
31	Rubber mount, shock absorbing (opto-switch)
32	Pressure sensor
33	Circuit board - CPU, PV501
34	Circuit board- MDA, PV501
35	Circuit board- potentiometer board
36	Battery Ni/Cd or Ni/Mh alarm back-up
44	Decal - "PATIENT PRESSURE"
45	Decal - "ON / OFF"
50	Cylomer - G12
51	Cable marking - plus
52	Cable marking - minus
53	Transformer - 115V
54	Opening - front
55	Cross bar
56	Spacing- motor bracket
57	Software

58	Battery - large 24 V lead
64	Hour counter - 24V
65	Flexible tube - inlet (2.5")
66	WAGO - 6-pole angled
67	WAGO - 2-pole angled
68	Reference pressure - valve
70	Reference pressure - reducer sleeve
71	Mains inlet
72	Touch protection
73	Air-filter box
74	Air-hose connection - inhale
75	Chassis pinning device XLR
76	Fuse holder
77	Screen guard - 60x60
78	Filter holder
79	Contact housing - black
80	Contact housing - red
82	Marking point - black
83	Marking point - red
84	Motor
85	Motor connection
86	Angle bracket- reading prong (column plate)
87	Air-hose connection - drive pack
88	Bellows side unit - fixed
89	Angle element - limit position (plastic)
90	Non-return valve
91	Opto switch - limit position
92	Opto switch - column plate
93	Column plate
94	Bellows
95	WAGO - 8-pole angled
96	Nipple - LCN-M5-PK3
97	O-ring - air-hose connection drive pack
98	Bellows side unit - moveable
99	Nipple - SCN-M10-PK4
100	Guide - large
101	Guide - small
102	Push-button board - on / off
103	Push-button board - battery test
104	Scale - graduated
105	O-ring - air-hose connection inlet
106	Panel - potentiometer panel English text
107	Ribbon cable
108	Instrument

109	Magnetic valve
110	Cyl, isolator
111	Decal - "ON / OFF"
112	Decal - "PATIENT PRESSURE"
113	Flexible tube - out (5")
114	Angle pipe - out
115	Pivot
116	Arrow - large guide
117	Arrow - small guide
118	Cover - large guide
119	Cover - small guide
121	Nipple - CN-M5-PK3
122	Rear panel - English text
123	Insulation - side unit left
124	Insulation - side unit right
125	Insulation - bottom
126	Insulation - hood
127	Panel - patient air English text
128	Mains cable
130	Packing - bellows side unit
134	Decal - "EIN / AUS"
135	Decal - "BEATMUNGSDRÜCK"
136	Rear panel - German text
137	Panel - potentiometer panel German text
138	Panel - patient air German text
139	Battery pack, complete
140	Text plate (IT)
141	Panel, pot. panel (IT)
142	Panel, patient air (IT)
143	Text plate (SP)
144	Panel, pot. panel (SP)
145	Panel, patient air (SP)
146	End cover for motor console, new version
147	Motor console, new version
148	Motor coupling, Rotex
149	Bellows end cover fixed, new version
150	Bellows end cover moving, new version
156	Spacer sleeve, moving end cover
157	Opto-switch, Optek
158	Seal
160	Shrink tubing - end position
184	115/230 switch, PV501-2
215	Rubber foot
220	Hook - WAGO-terminal block

248	Filter, air (5 pcs/packet)
287	Patient circuit (L-C)
378	Motor (BEI)
381	Decal "Pression de service" Fr
382	Decal "Reglage/Arret" Fr
383	Panel, pot. panel (Fr)
384	Panel, patient air (Fr)
385	Text plate (Fr)
386	Decal "PATIENTTRYK" DK
387	Decal "TIL/FRA" DK
388	Panel, pot. panel (Dk)
389	Text plate (DK)
390	Decal "PATIENT DRUK" NL
391	Decal "TIL/FRA" NL
392	Panel, pot. panel (NL)
393	Panel, patient air (NL)
394	Text plate (NL)
395	Bearing sleeve (PUR drive screw)
396	Bearing sleeve for bearing (drive screw)
397	Flange (PUR drive package)'
398	Flange (drive package)
458	Membrane, check valve
515	Serial No. decal with EAN code
516	Filter for machine ventilation
600	Tape - potentiometer box
601	Cellular rubber border
602	Air-hose 4 x 6 - frosted
604	Fuse TT 315mA
605	Fuse - T160mA
606	Fuse - F3,15A
611	M3 x 8 with washer
612	M3 - tooth nut
613	Heat conducting paste - HTC10S
614	Shrink tubing - 6.4 mm
615	Shrink tubing- 3.2 mm
616	Shrink tubing - 2.4 mm
617	Shrink tubing - 12.7 mm
618	Shrink tubing- 1.6 mm
632	Clips for ribbon cable
633	Strain relief - 4 mm
634	Strain relief - 3.5 mm
635	Cable tie brace
636	Cable tie- 8"
637	Cable tie- 4"

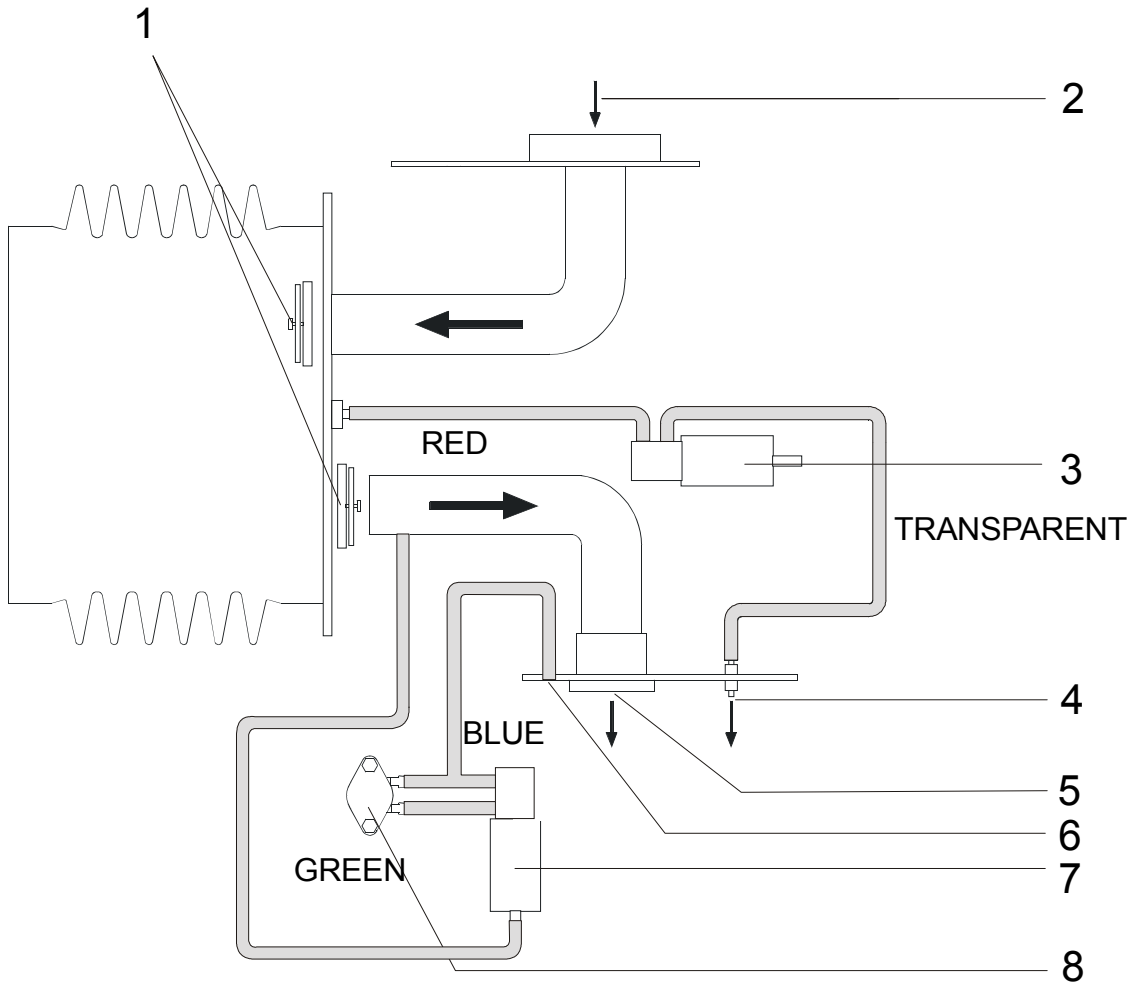
638	Cable tie- 14"
639	5 mm plate spacing
640	Y-connection
641	Blue Festo tubing
642	Mains cable straps
643	Black screw 201 - RXS 3.5 x 19
644	Clear tubing 9 x 12
645	Clear tubing 4 x 7
646	Clear tubing 3 x 6
647	Clear tubing 3 x 5
648	SPAX 4 x 20
649	SPAX 3 x 12
650	SGA 22
651	Seeger - AK-26 , or Sgh 32
652	M6 x 25 - bolt
653	M6 x 22 - washer
654	M6 - flat washer
655	M6 - locking nut
656	M5 x 80 F
657	M5 x 50 F
658	M5 x 20 socket head cap screw
659	M5 x 16 F
660	M5 x 16
661	M5 - toothed plate connector
662	M5 - flat washer
663	M5 - nut
664	M5 - locking nut
665	M4 x 8 F
666	M4 x 8
667	M4 x 45
668	M4 x 30
669	M4 x 20
670	M4 x 16 F
671	M4 x 16
672	M4 x 12
673	M4 x 10 F
674	M4 - wing nut
675	M4 - toothed plate connector
676	M4 - flat washer
677	M4 - nut
678	M4 - locking nut
679	M3 x 8
680	M3 x 6 F
681	M3 x 6

682	M3 x 16 F
683	M3 x 12 black socket head cap screw
684	M3 x 12
685	M3 x 10 F
686	M3 x 10
687	M3 - toothed plate connector
688	M3 - flat plate
689	M3 - nut
690	M3 - threaded bar
691	M2 x 10
692	M10 - toothed plate connector
693	KFXS 2.9 x 9.5 F
694	Fibre washer
699	Hook - for WAGO-terminal block
700	Packing - battery base
701	Plastic spacing - 4 x 15
702	Plastic spacing - 4 x 10
703	Plastic spacing - 3 x 10
704	Blind plug - angle bracket hole
705	Double-sided tape
706	Mains cable discharger
708	O-ring - potentiometer board
709	Fuse - 1.25 A
711	Cable tie - mini
713	M4 x 6 socket head cap screw
714	IC - MDA
716	Pressure sensor
723	Magnetic strip (0.01 m)
727	Cable tie, driller
740	Screw MFZ steel M4*10 Black, chrome Poz
741	M3 x 6 F - black, PV501-2
753	O-ring, check valve
795	Metal cable tie
796	Washer, support washer (drive unit)
797	Sliding bearing sleeve (drive unit)
798	Sliding bearing sleeve (PUR drive unit)
799	Spacer sleeve (drive unit)
800	Seal (drive unit)
1141	Drive unit complete (BEI)
1145	Rubber washer for transformer
1146	Metal washer for transformer
1410	Transformer, PV501-2
1636	Opening front, PV501-2
1720	Lock/keys, PV501-2

1850	Panel - potentiometer panel English text, PV501-2
1851	Scale for manometer 0-60mbar, PV501-2
1852	Rear panel plate, PV501-2
1858	Panel - potentiometer panel German text, PV501-2
1859	Panel - potentiometer panel Swedish text, PV501-2
1860	Panel - potentiometer panel Spanish text, PV501-2
1861	Panel - potentiometer panel French text, PV501-2
1862	Panel - potentiometer panel Danish text, PV501-2
1863	Panel - potentiometer panel Dutch text, PV501-2
1864	Panel - potentiometer panel Italian text, PV501-2
1865	Text plate German, PV501-2
1866	Text plate Swedish, PV501-2
1867	Text plate Spanish, PV501-2
1868	Text plate French, PV501-2
1869	Text plate Danish, PV501-2
1870	Text plate Dutch, PV501-2
1871	Text plate Italian, PV501-2
1942	Mount for BNC, PV501-2
1943	BNC connector, PV501-2
1944	Circuit board - MDA, PV501-2
2220	Circuit board - CPU, PV501-2

5 FUNCTIONAL DIAGRAMS

5.1 Pneumatic diagram



1. Check valves
2. Air intake for patient air
3. Magnetic valve: normally powered, see fig. 1.
4. Control pressure for the exhalation valve
5. Patient air outlet
6. Air intake for ambient air pressure
7. Magnetic valve: normally not powered see fig. 2.
8. Pressure sensor

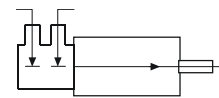


Fig. 1

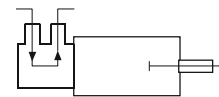
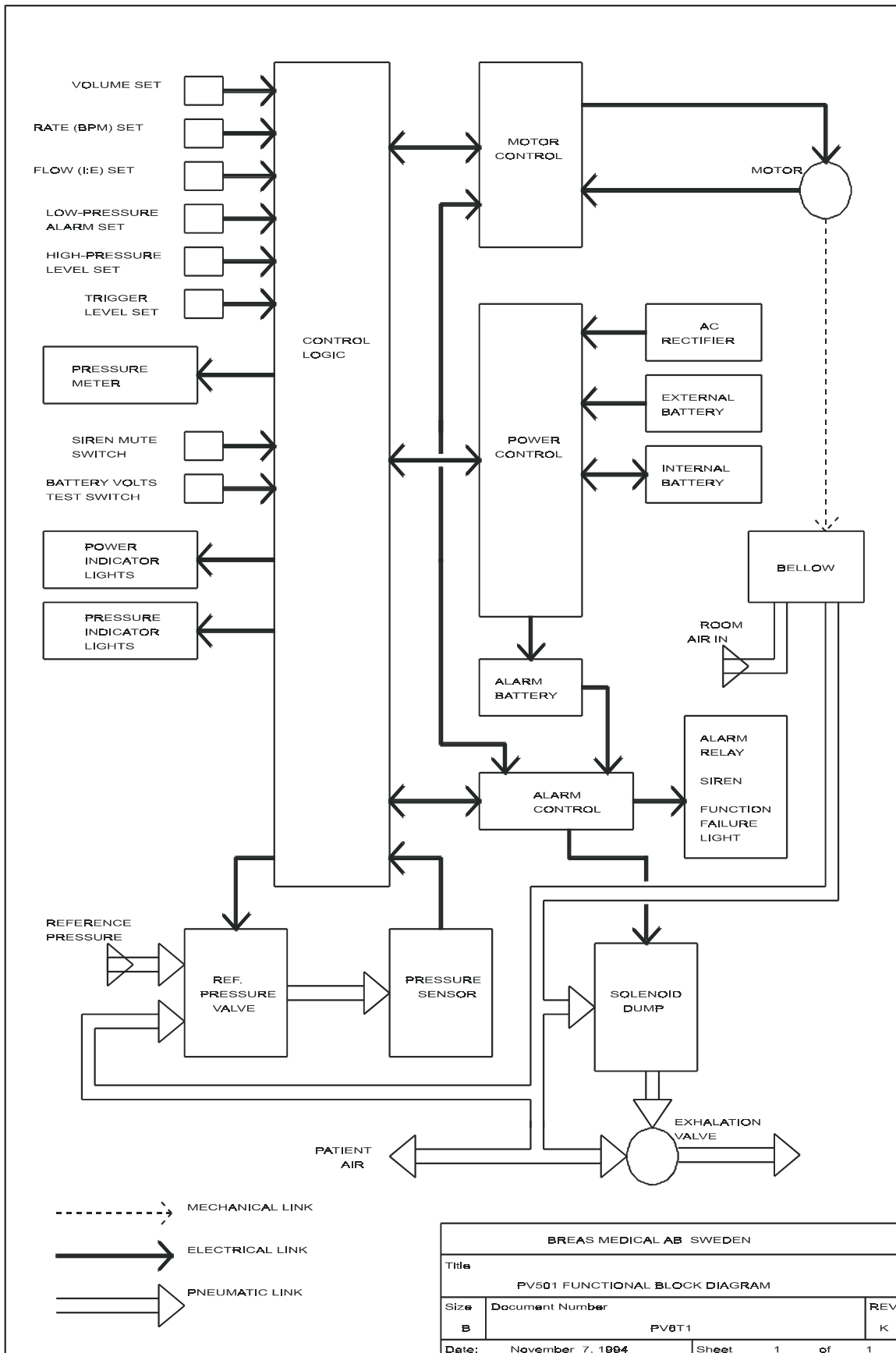


Fig. 2

5.2 Functional block diagram



6 DISMANTLING AND ASSEMBLING THE PV 501/PV501-2

6.1 Opening the hood

- Remove the mains power cable.
- Loosen the three screws at the top of the rear panel and the three screws at the front, see figure below.

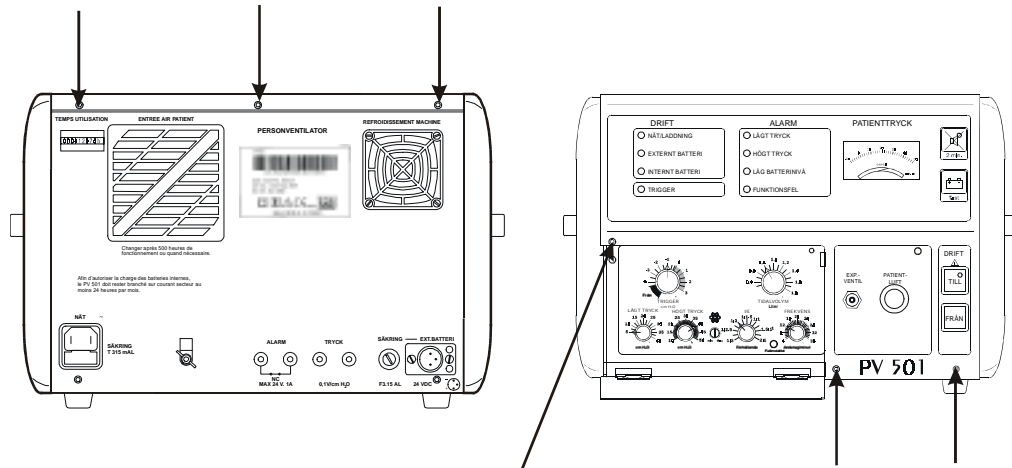


Fig. 6-1 The screw positions that hold the hood

- Lift the hood slightly upwards at the rear so that the angled part of the hood clears the rear panel. Move the hood forward approx. 20 mm and angle the hood up. Disconnect the hose from the patient air outlet.

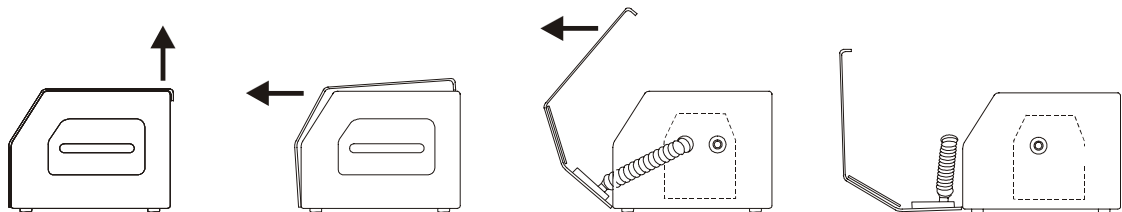


Fig. 6-2 Opening the hood

- Lay the hood down flat against the work surface. It is not necessary to loosen the other tubes and cables to the front panel.
- Disconnect the white patient inlet air hose from the end cover of the bellows.

6.2 Replacing pushbutton boards

- Disconnect the ribbon cable (1) from the CPU board.
- Cut the cable tie (2) holding the green air tube (see figure).
- Remove the four nuts that hold the two boards (indicated by arrows) and move the black ground wire terminal (3) to one side.
- Install the new boards in the reverse order.

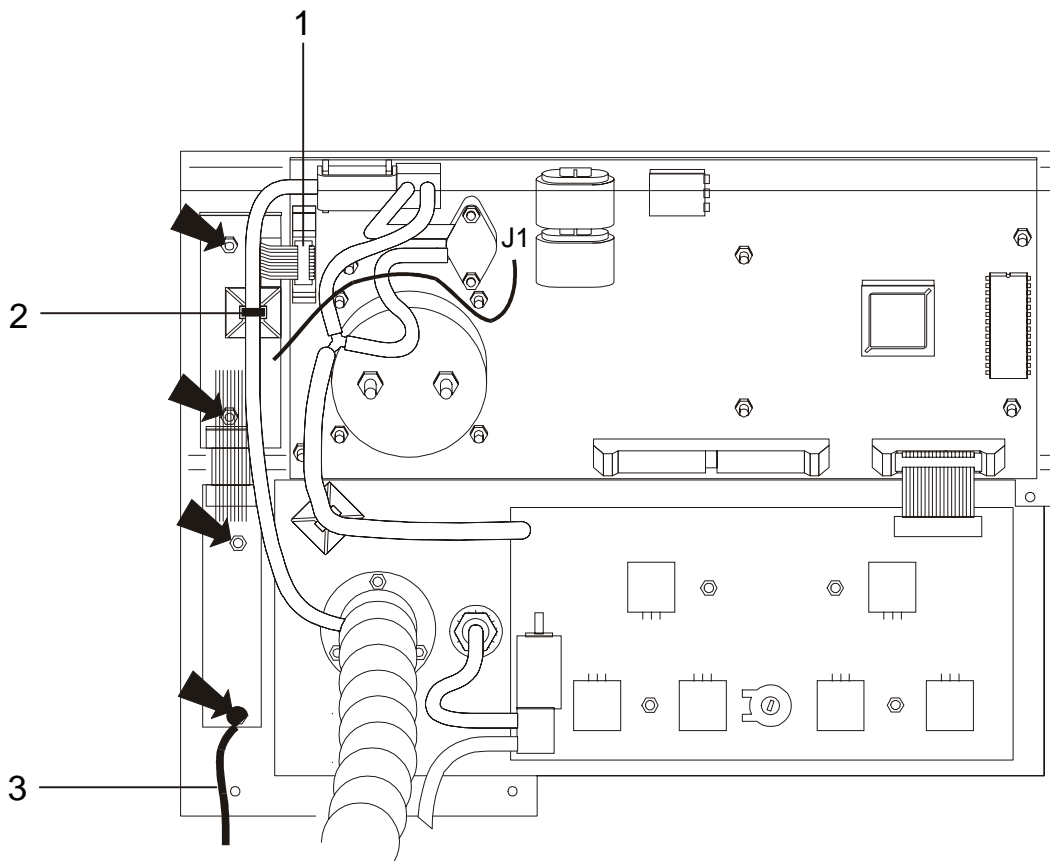


Fig. 6-3 Removing the On/Off board

Installing a new ON/OFF board with 2 sec delay in units with a Serial No. lower than 5925

Connect a wire from new board to J1.

Place "ON/OFF 2 sec delay" sticker above on/off switches on PV501.

NOTE! Disregard the text "CUT WIRE WHEN USING CABLE WITH CPU-CARD REV.B OR OLDER" on the On/Off board. **Do not cut any wire on the On/Off board if it is Rev C.**

6.3 Replacing the CPU board

- Disconnect the three ribbon cable connectors (indicated by arrows in the figure below).

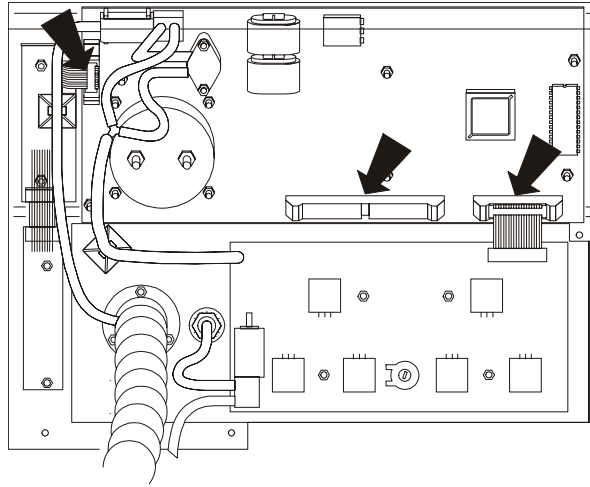


Fig. 6-4 Removing the CPU board

- Disconnect the air hose from the magnetic valve. NOTE! Exercise care. Do not pull too hard towards the valve without providing a counterhold for the valve. It may be better to cut the hose.
- Disconnect the lower hose from the Y-connector.

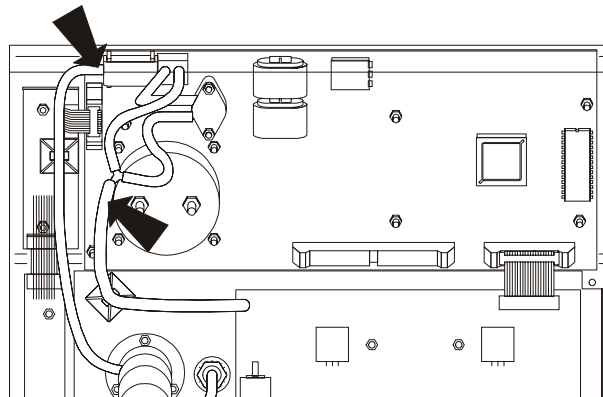


Fig. 6-5 Removing the CPU board

- Unscrew the 6 nuts that hold the board.

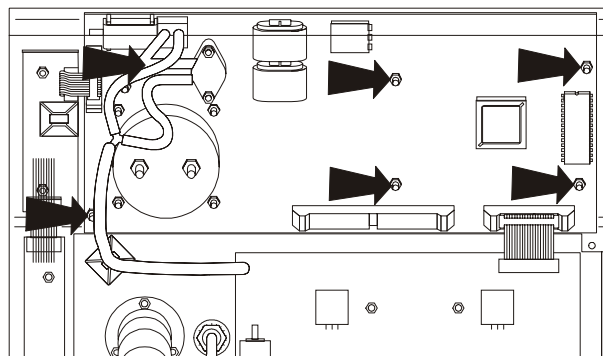
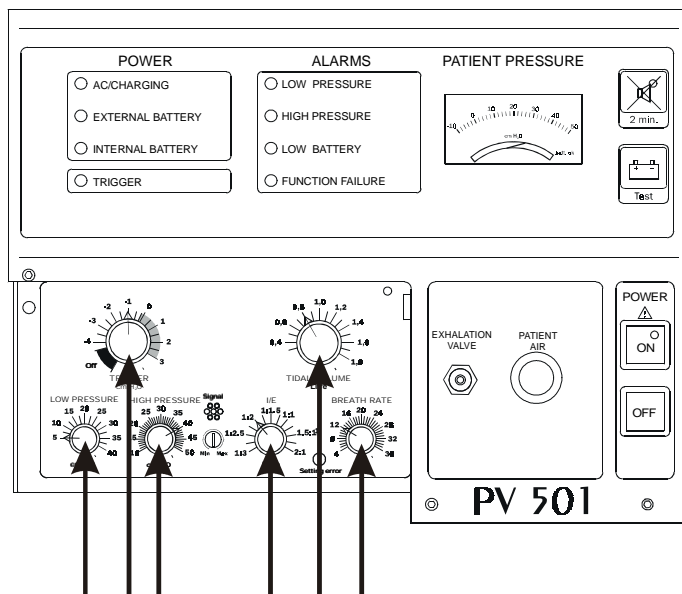


Fig. 6-6 Removing the CPU board

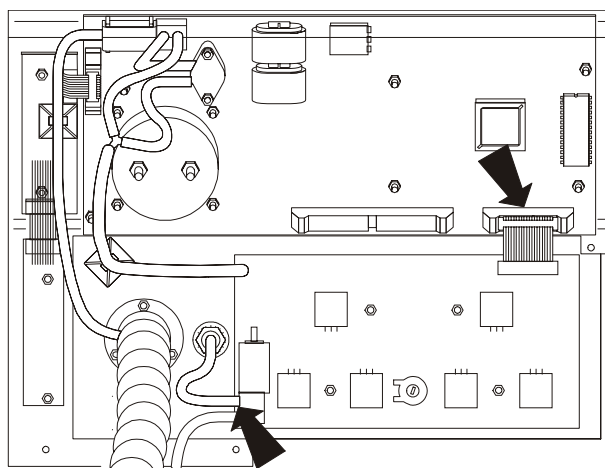
- Lift out the board.
- Reassemble in reverse order.

6.4 Replacing the potentiometer board

- Remove the six setting knobs by first removing the plastic cap for the knob and then, for the two large knobs unscrew their retaining nuts, and for the smaller knobs unscrew the screws.

*Fig. 6-7 Removing the setting knobs*

- Disconnect the ribbon cable from the CPU board.
- Disconnect both the air tubes from the magnetic valve.

*Fig. 6-8 Removing the Potentiometer board*

- Unscrew the 4 nuts holding the board.

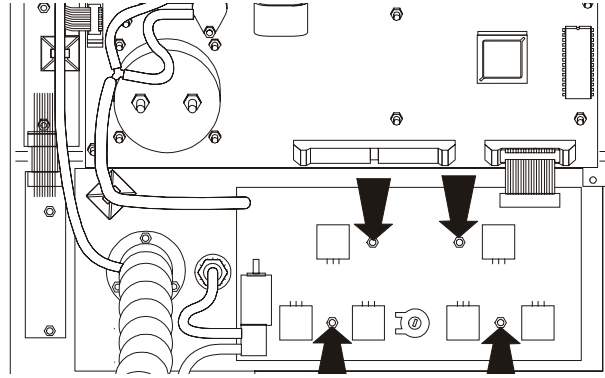


Fig. 6-9 Removing the Potentiometer board

- Lift out the board.
- Reassemble in the reverse order.

6.5 Opening the rear panel

- Open the hood, if not already opened.
- Remove the three screws at the bottom of the rear panel and carefully lower it down onto the work surface.
- Release the two securing locks for the ribbon cable connector and disconnect it.
- Disconnect the air inlet hose from the motor unit.

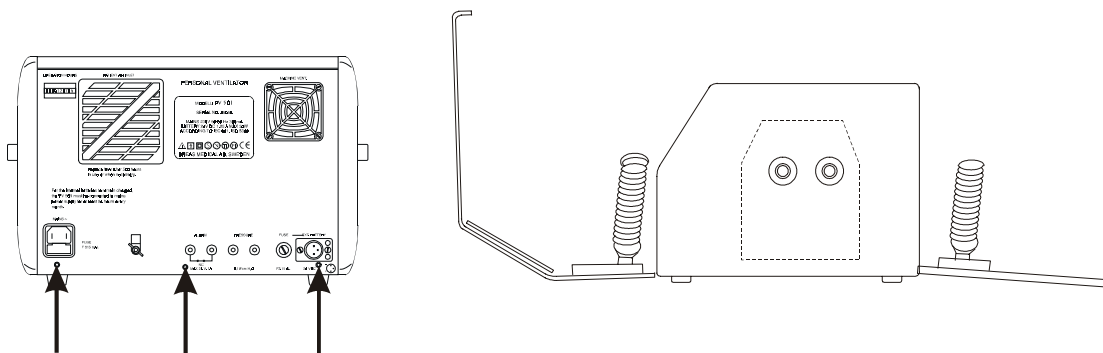


Fig. 6-10 Opening the rear panel

- To remove the cross bar for the side panels, first pull it up a little and then turn it so that the slots disengage. Loosen the rod from one side panel at a time.

6.6 Replacing the MDA board

- Open the hood and rear panel.
- Disconnect the CN6, CN7, CN8, CN9, CN10 connectors.

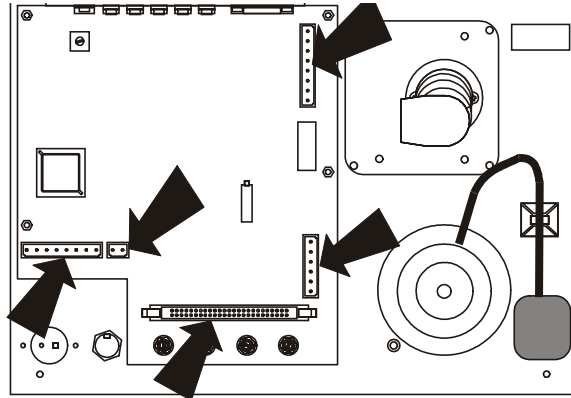


Fig. 6-11 Removing the MDA board

- Unscrew the 6 M3 and the 4 M8(on PV501) nuts while holding the board.

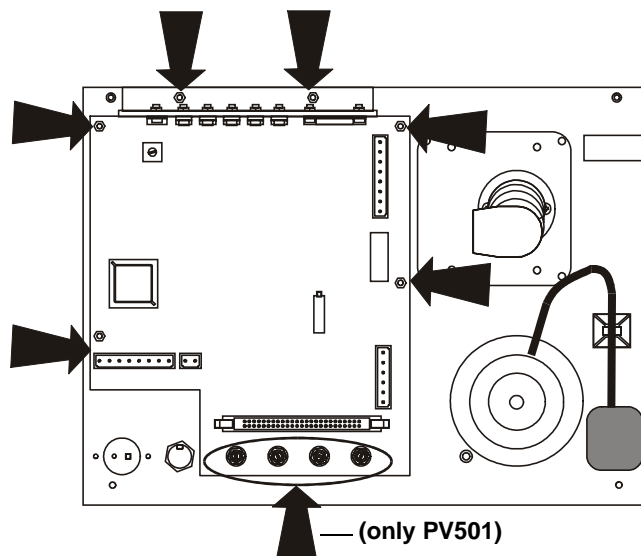


Fig. 6-12 Removing the MDA board

- Lift out the board.
- Reassemble in reverse order.

6.7 Removing the motor unit

- Open the hood and rear panel.

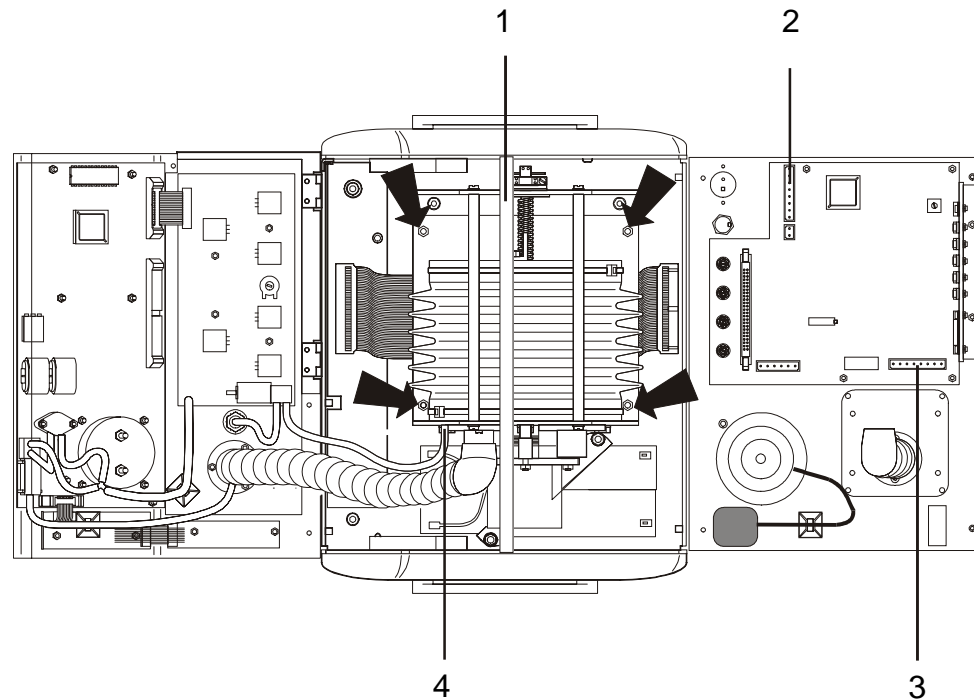


Fig. 6-13 Removing the motor unit

- Remove the cross bar (1 in figure).
- Disconnect the air hoses from the bellows end cover.
- Loosen the encoder cable connector (2) from the MDA circuit board inside the rear panel.
- Loosen the motor cable connector (3) from the MDA circuit board inside the rear panel.
- Disconnect the red tube (4) to the exhalation valve on the motor unit.
- Loosen the four nuts (M4) (indicated by the four bold arrows in the figure) from the motor unit's base plate.
- Lift the motor unit straight up.

6.8 Reassembling the motor unit

- Before reassembling the motor unit, check if the internal batteries need to be replaced as this is best done with the motor unit removed, see 3.8.13.
- Mount the motor unit and fasten it with the four nuts (M4) at the bottom of the motor unit.
- Connect the encoder cable connector to the MDA circuit board.
- Connect the motor cable connector to the MDA circuit board.
- Connect the red tube to the exhalation valve on the motor unit.
- Start the ventilator.
- Check that everything functions normally.

6.9 Assembling the hood and rear panel

- Fit the cross bar between the side panels.

- Raise the rear panel and fasten it with the lower screws. Check that no cables or hoses are pinched. Do not forget to connect the ribbon cable.
- Fit the air inlet hose between the rear panel and motor unit.
- Move the hood up so that the patient outlet air hose can be fitted to the motor unit.
- Check that the ribbon cable does not lay against the bellows. If necessary, press the ribbon cable down at the back and front.
- Insert the screws in the front panel but do not tighten yet.
- Tighten the top screws for the rear panel.
- Tighten the screws on the front panel at the same time as the hood is pressed downwards.
- Check that everything is assembled correctly.

7 MOTOR UNIT

7.1 Construction

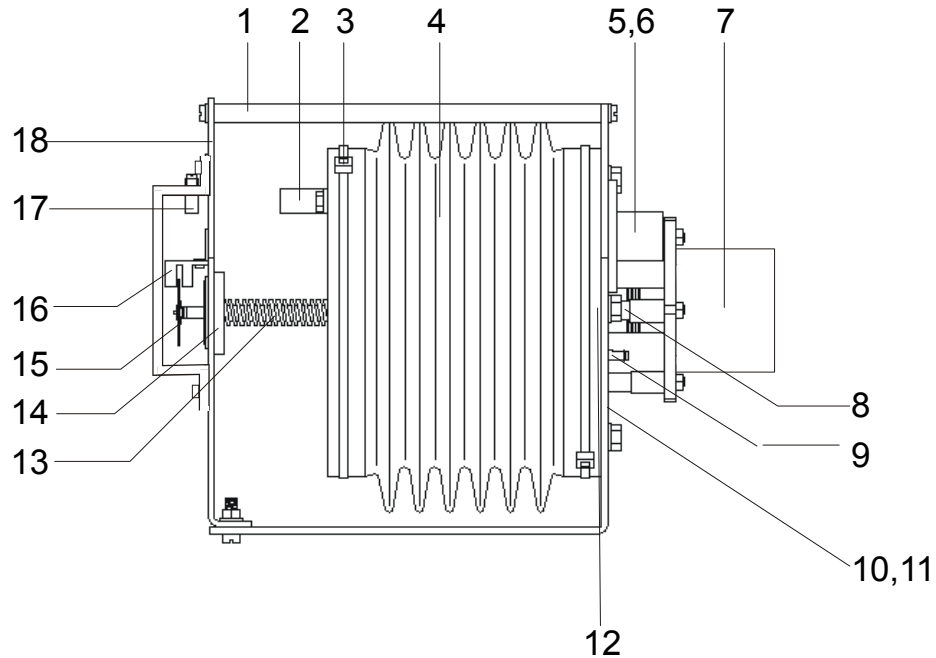


Fig. 7-1 Main parts of the motor unit

Pos. No. Description

- (1) Motor bracket spacer bar
- (2) Angle element-limit position
- (3) Bellows clamp (steel hose clamp)
- (4) Bellows
- (5) Patient air inlet, and check valve
- (6) Patient air outlet, and check valve
- (7) Motor
- (8) Motor connection
- (9) Air nipple
- (10) Rubber suspension for ball bearings
- (11) Ball bearings
- (12) Motor bracket
- (13) Ball screw complete with bearing
- (14) Oil bronze bearing with rubber suspension
- (15) Slotted disc
- (16) Opto-switch (encoder)
- (17) Opto-switch (limit position sensor)
- (18) Side plate

See also exploded diagrams in Chapter 4.

7.2 Lubricating the ball screw

- Turn the ball screw with the fingers, this is easiest done at the screw/motor connection (1 in figure). Keep turning until the bellows is completely compressed.
- Wipe off the old grease from the ball screw (2) if necessary e.g. if it is dirty.

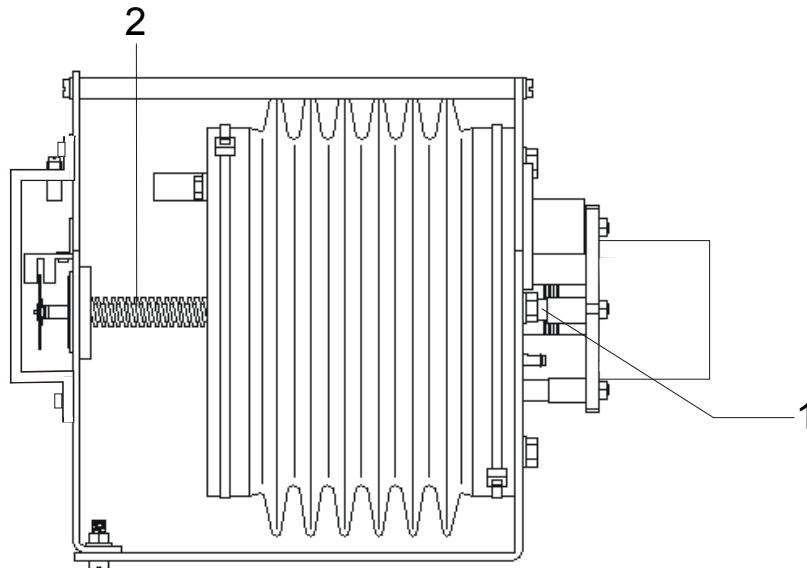


Fig. 7-2 Lubricating the ball screw

- Apply a thin layer of grease over the entire length of the screw. Use only BREAS grease type 283 AZ, part no. 000 557.
- Run the motor a couple of cycles to work the grease into the unit. Remove any excess grease.
- If necessary, repeat greasing once more.

7.3 Replacing the membranes in the check valves

- The membranes must be changed at each maintenance service.

Material required:

Service kit for check valves part. no: 002 123, which contains: 2 membranes and 2 O-rings.

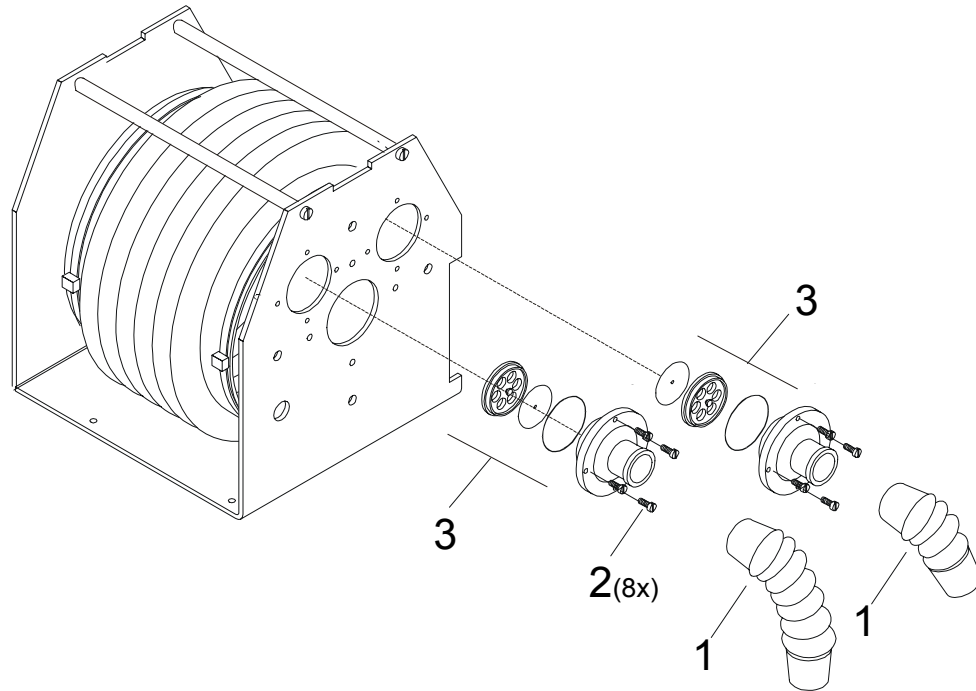


Fig. 7-3 Replacing the check valves

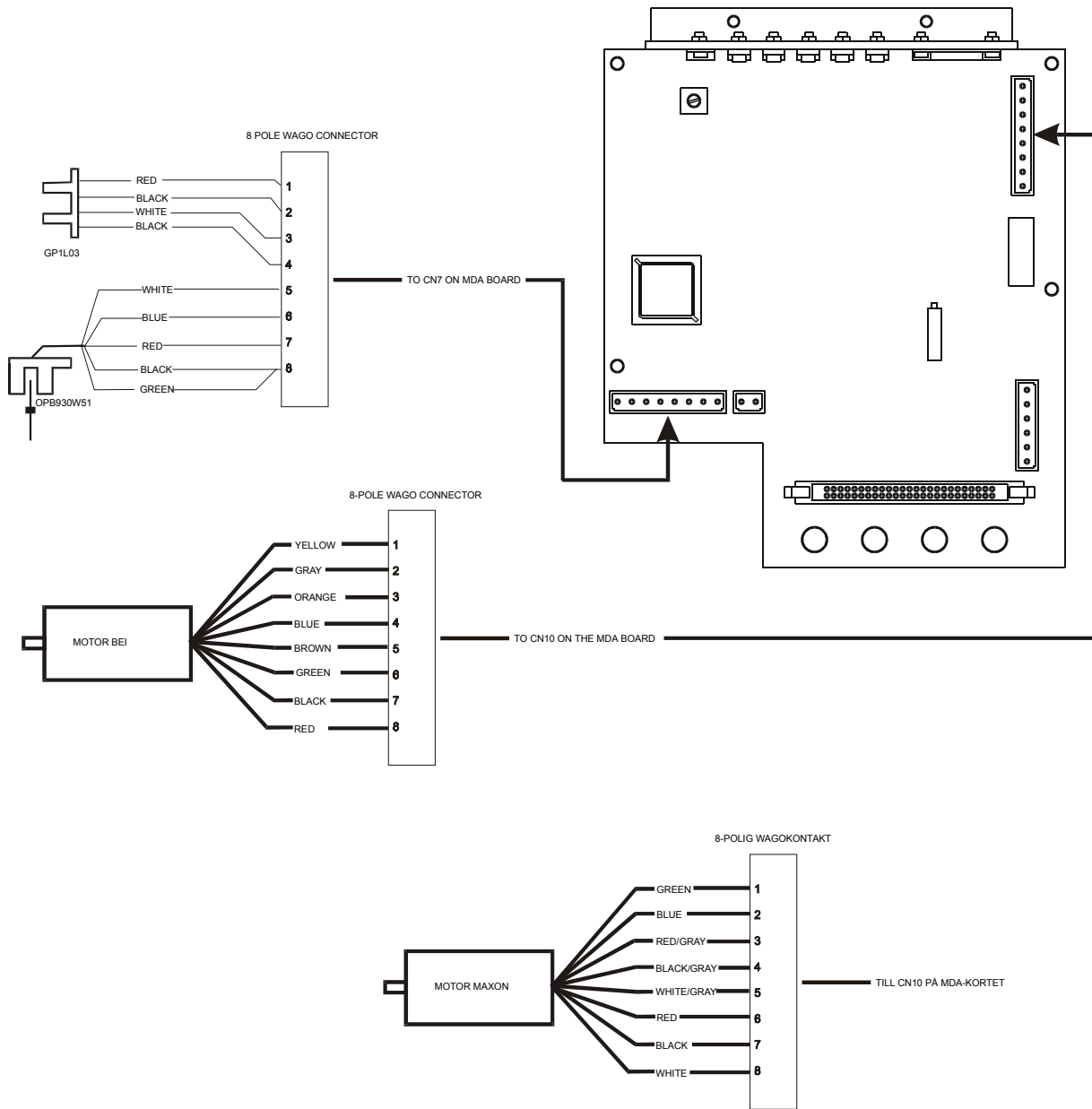
- Remove the hoses (1).
- Remove the four screws (2) (M3x8) holding each hose connection.
- Remove the old membranes together with the valve seats and O-rings (3).
- Wipe the valve seats in the end cover clean using a damp cloth.
- Carefully assemble the new membranes.
- Make sure that the new membranes lay flat against their seats.
- Fit new O-rings.
- Fit the hose connections.
- Check the function of the check valves by creating a negative pressure in the inlet hose and a positive pressure in the outlet hose. No air should be able to pass. (Do not forget to plug the tube connector for the exh. valve).

7.4 Hoses and bellows, leakage check

Check the function of the outlet check valves by creating a positive pressure in the exhalation hose (do not forget to block the tube nipple).

Plug the hose for air outlet and the small tube connector. Create a pressure in the inlet hose, approx. 40 cm H₂O. Check that no leakage is heard. Measure the time for the pressure to drop from 40 to 20 cm H₂O, it should take at least 10 sec. If not, check for leakage or replace the motor unit.

7.5 Wiring diagram, Motor unit



8 ELECTRONICS

8.1 Function, Construction

The electronics, mechanics, pneumatics and opto-electronics are fully integrated in the PV 501/PV 501-2 ventilators.

To understand the function of the electronics included in the Breas PV 501 you must be able to operate the ventilator, have studied the air flow diagram and acquainted yourself with its mechanical construction.

The following block diagram (PV6T1) outlines how the electronic system is constructed and how it is connected to the other components.

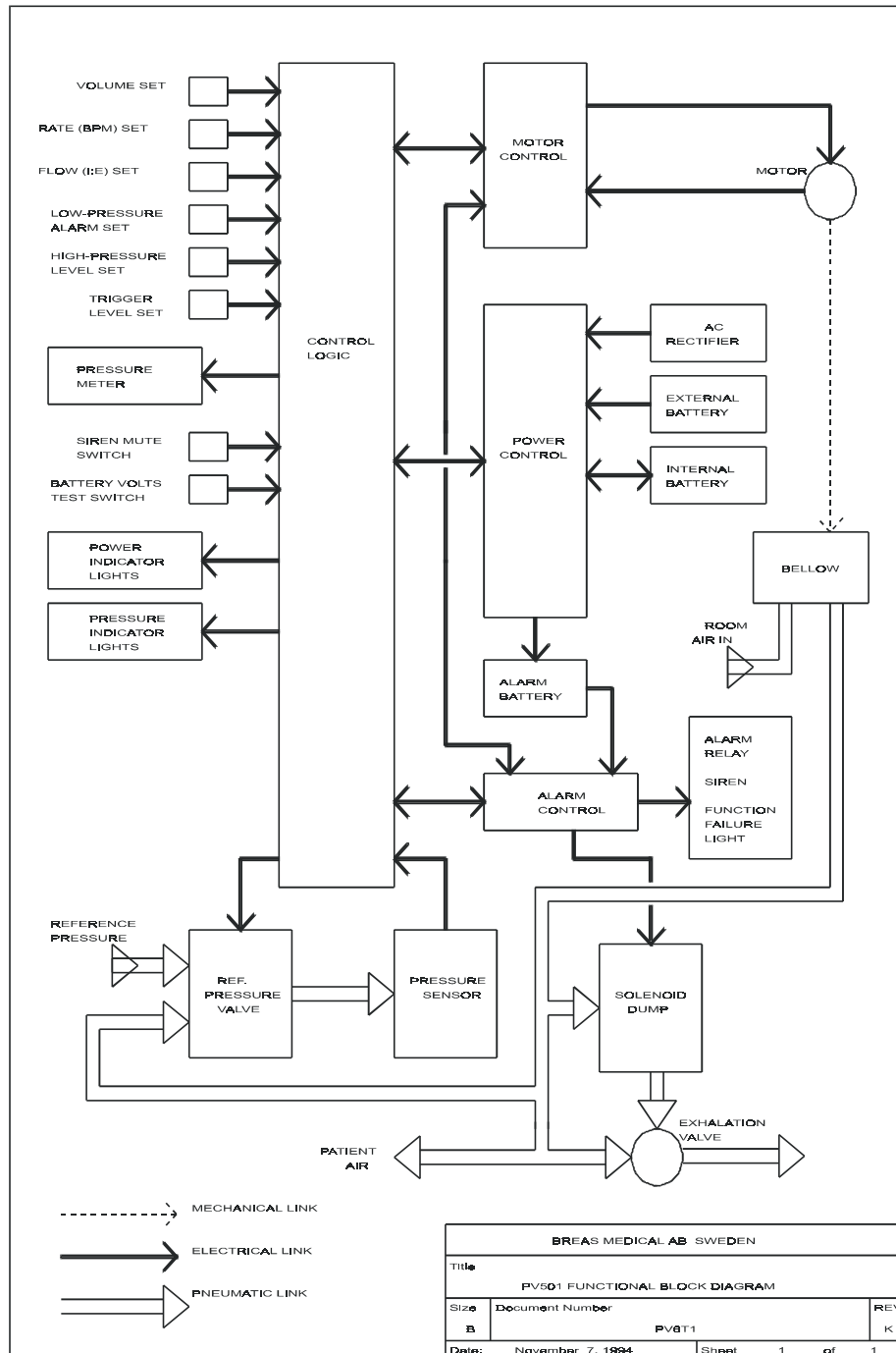


Fig. 8-1 Functional Diagram

8.2 PV 501/PV 501-2's circuit boards

The PV 501/PV 501-2's electronics comprises 5 circuit boards:

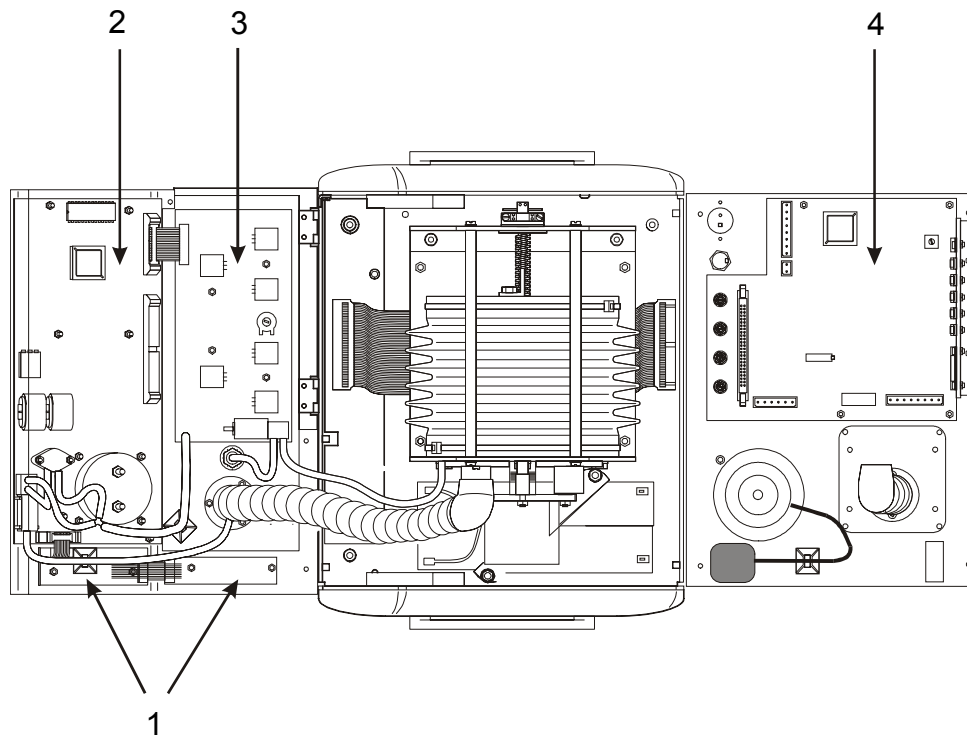


Fig. 8-2 Location of the circuit boards

Pos. No. Location:

- 1 Pushbutton board "On/Off buttons"
- 1 Pushbutton board "Mute/Battery test buttons"
- 2 CPU board "front panel"
- 3 Pot. board "front inside opening"
- 4 MDA-board "rear panel"

8.3 Pushbutton board

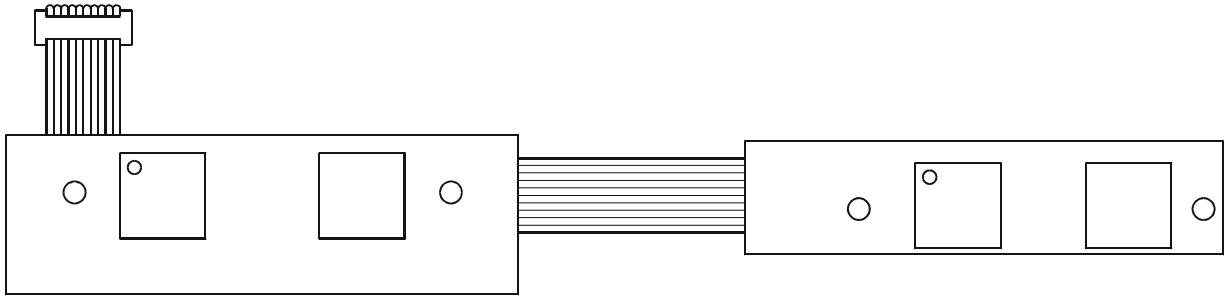


Fig. 8-3 Pushbutton board

The membrane switches for ON, OFF, Alarm mute and Battery test are located on the pushbutton board together with LEDs that indicate that the ventilator is switched ON and that Alarm mute has been activated.

8.4 Potentiometer board

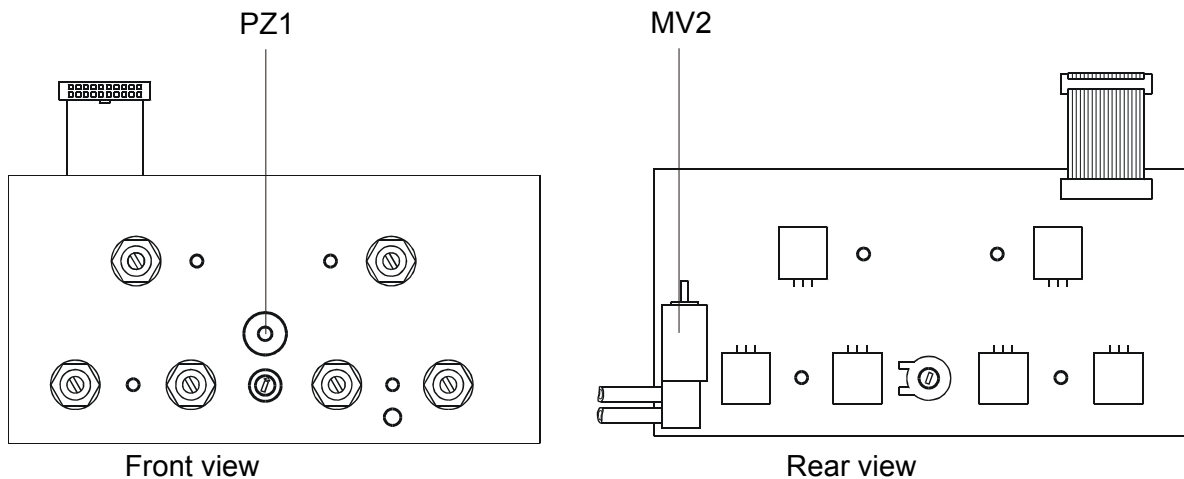


Fig. 8-4 Potentiometer board

The potentiometers (P1 - P6) are located here. They are used for setting the volume, I/ E, frequency, trigger, high pressure, low pressure and alarm volume. The alarm buzzer PZ1 is also located here, along with the MV2 magnet valve which is normally powered, but switches if the high pressure alarm is activated. The exhalation valve then opens as a safety precaution. See the air flow diagram.

8.5 MDA board

The MDA board handles the voltage supply, motor control and the charging of the internal battery.

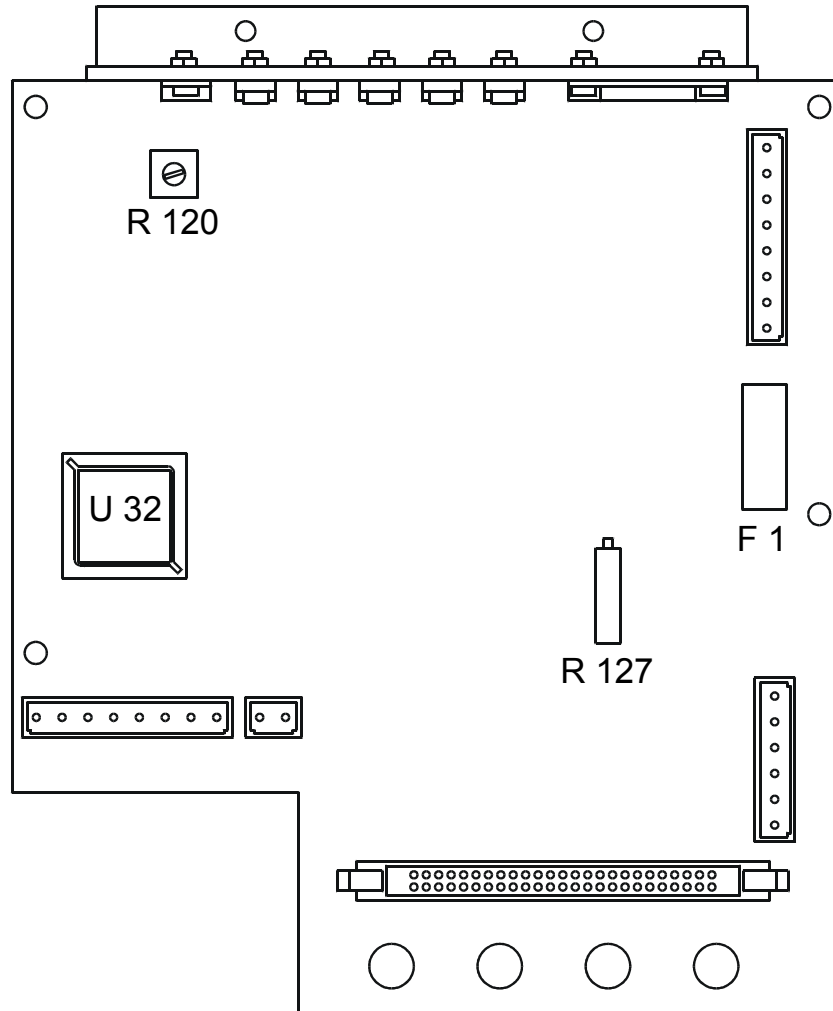


Fig. 8-5 MDA board

The MDA board is supplied with 24 V AC via CN5 from the toroidal core transformer. The current is rectified in B1 and supplies the voltage regulators U36 and U39 with voltage. At power on, the other regulators are supplied via the K2 relay.

The motor is a brushless DC motor. The U34 and U35 circuits produce current and voltage for the motor's three windings causing it to rotate. The maximum motor current is limited by R120. To keep track of the number of rotations and how fast the motor is running, a pulse sensor has been mounted on the ball screw, which is an extension of the motor shaft. (The pulse sensor consists of a slotted disk with 96 slots and an opto-switch).

The U32 microprocessor receives information from the pulse sensor, and regulates the velocity and the number of rotations the motor is running at. The home position of the moving end of the bellows unit is also registered by U32 with the help of an opto-switch.

The internal batteries are connected to the MDA board. Fuse F1 protects these batter-

ies.

The internal battery (lead) charger consists of a voltage regulator U36, where the charge voltage is regulated by R127 and a current limiter equipped with transistors Q25 and Q27. When the battery voltage drops below 22.7 V during operation, the low battery level alarm is activated. If the battery level reaches 30 VDC, a thyristor connects the battery to ground until fuse F1 blows. This prevents the battery from creating explosive gas.

The ventilator stops and sounds an alarm when the voltage drops below 22.0 V and the bi-stable relay K5 cuts out. The ventilator must then be connected to the mains in order for K5 to switch back again, and for the batteries to recharge.

When the external battery voltage drops below 22.5 V during operation, the ventilator switches over to internal battery power and gives a short warning alarm.

8.5.1 Checking the pressure transducer offset and gain

Connect a voltmeter to the pressure outlet on the rear panel, see Op. manual. Range: 0-2 VDC. Set the frequency to 9 breaths/min and start the ventilator. Wait approx. 10 min for the pressure to stabilise. Adjust the offset between inhalations to 1,00-1,01 volt with the trim pot R21 marked OFFS. Do not connect a "counter pressure" to the patient air outlet. The trigger's offset reference automatically follows the adjustment of the pressure transducers offset level in order to always calculate the adjustment of the trigger setting.

The R24 potentiometer is used to adjust the gain which should be 4.0 V at 30 mbar.

Note! If it was necessary to adjust the gain, then re-check the offset again.

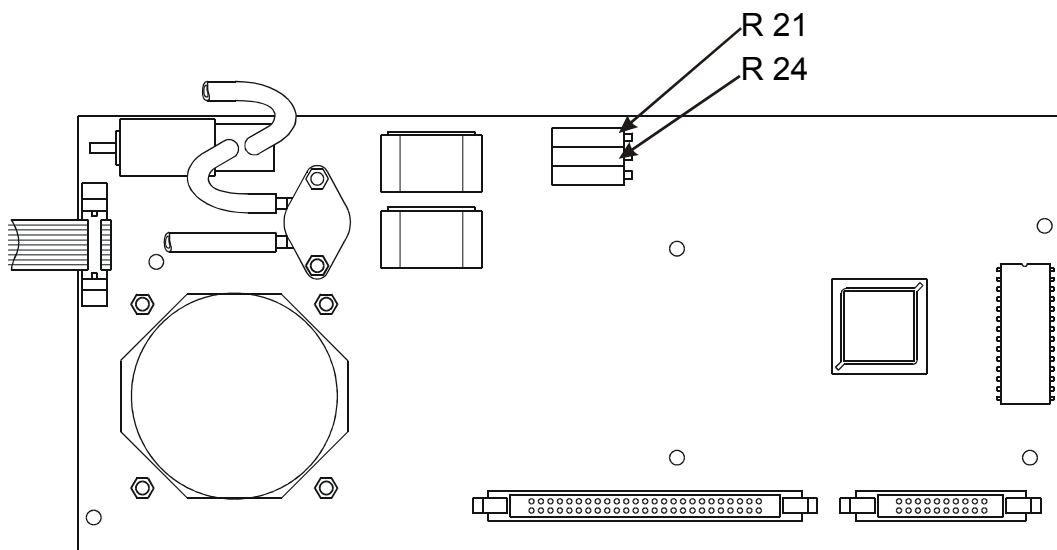


Fig. 8-6 Adjusting the offset and gain

8.5.2 Checking the instrument accuracy

Check, using a manometer connected to the exh. valve connection, that the indicating instrument gives the correct indication and that the needle moves "softly".

NOTE! Make small pressure changes, the indicating instrument should be "slower" compared with the manometer.

8.6 CPU board

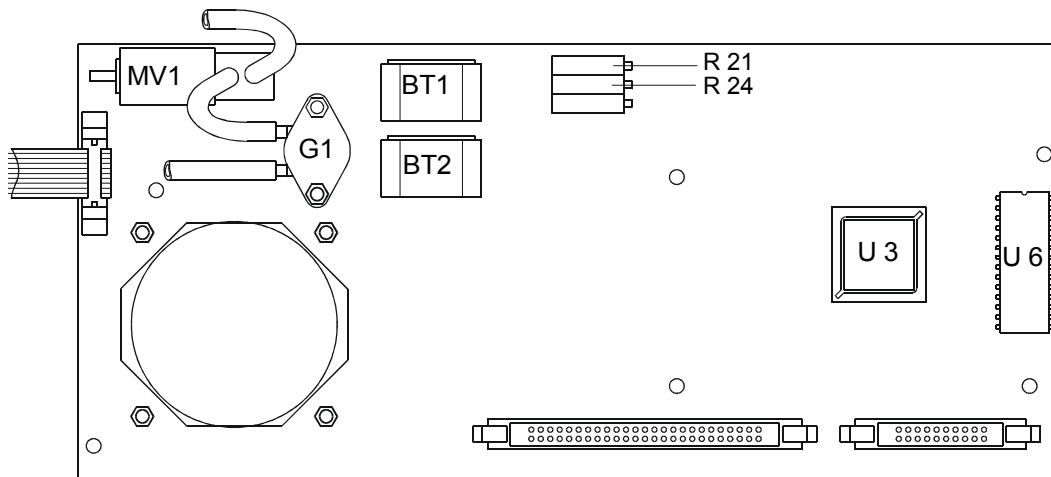


Fig. 8-7 CPU board

The “master” microprocessor U3 and its software capsule EPROM U6 are located on the CPU board together with the pressure gauge, the pressure sensor, the LEDs indicating the voltage source as well as the alarm, alarm battery and magnetic valve MV1.

U3 takes a reading from the potentiometers on the potentiometer board for frequency, volume, I/E, trigger and alarm limits. It also reads the “alarm mute” button, patient pressure and the voltages for internal battery DC, external DC, alarm battery DC and the DC generated by the mains voltage.

U3 then controls and monitors the ventilator including the LEDs at the front, the form of breathing cycle and all the alarms. Besides the pressure and voltage monitoring alarms, there is also a system for monitoring communication between U3 and U32, e.g. that inhalation occurs within a specified time, and that failure to do so causes an alarm. Many of these alarms come in the form of a combination of the LEDs in the front panel lighting. For more information, see Chapter 9 Fault tracing.

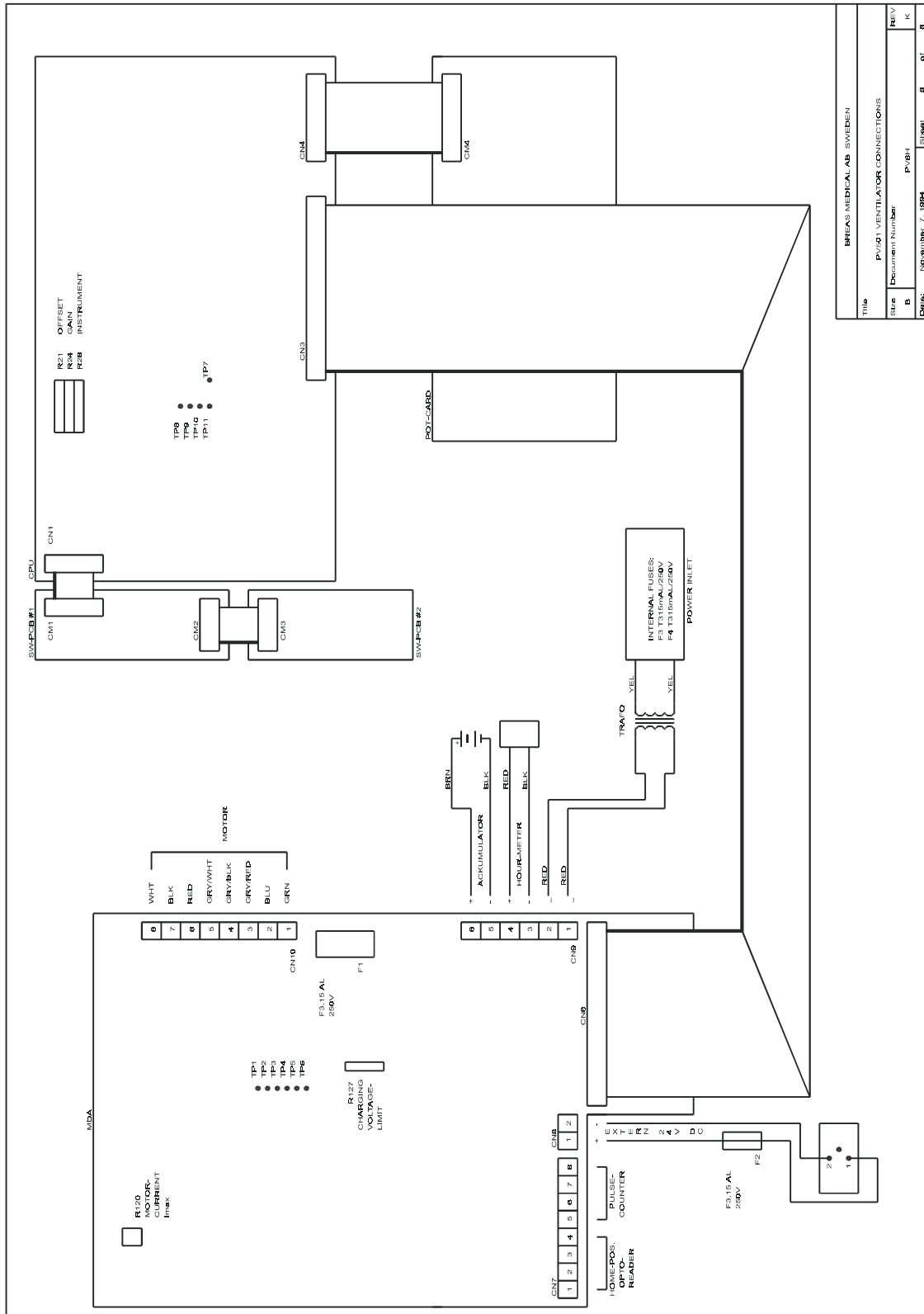
The display instrument for patient pressure is a moving coil instrument. It operates quite slowly (having a certain inertia) which means the display is slow to react when very fast changes in pressure occur. When servicing and fault tracing it is advisable to use an analogue manometer.

The G1 pressure sensor is a semiconductor and the signal emitted is amplified by U14. The R24 potentiometer adjusts the amplification and R21 adjusts the offset.

The magnetic valve MV1 is used to connect the two outlets on the pressure sensor with reference pressure outlet on the rear panel (or front panel from serial no 5204). When the trigger is activated, a zero pressure calibration is implemented between each inhalation for the first five minutes, and then once every minute with the help of MV1. See the pneumatic diagram.

The BT1 & BT2 alarm batteries are of the Ni/CD or Ni/Mh type and are monitored by U3. If are dead or out of function, the ventilator would not start without sounding an alarm and displaying an error code, see Chapter 9. The batteries are charged as soon as the ventilator is connected to mains supply.

8.7 Terminal diagram, test points



Title		BREAS MEDICAL AB SWEDEN	
Size		PV501 VENTILATOR CONNECTIONS	
Document Number		PV501	
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B	K	B	8
Doc. No.: 1523EN		Issue: N-1	

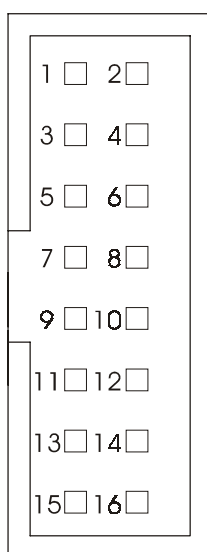
Fig. 8-8 Test points

MDA board, PV 501

<u>Test point</u>	<u>Voltage name</u>	<u>Status</u>	<u>Measured value</u>	<u>Adj. pot.</u>
TP 1	GND			
TP 2	Unregulated	on	24-38 VDC	–
TP 3	Int. Pb battery charge	off, mains	28.2 VDC	R127
TP 4	24 V	on	24 VDC	–
TP 5	12 V	on	12 VDC	–
TP 6	5 V	on	5 VDC	–

MDA board, PV 501-2

<u>Test point</u>	<u>Voltage name</u>	<u>Status</u>	<u>Measured value</u>	<u>Adj. pot.</u>
TC 1:1	Internal battery raw		28V	–
TC 1:2	Int. Pb battery charge	off, mains	28.2 VDC	–
TC 1:3	DC transf. after relay K6	on	30-40 VDC	–
TC 1:4	DC transf. before relay K6	on	30-40 VDC	–
TC 1:5	Over current limit	on	0-7 VDC	–
TC 1:6	24 V stab (+24)	on	24 VDC	–
TC 1:7	Ground via 10k pressure -	on	0 VDC	–
TC 1:8	Pressure +	on	0-8 VDC	–
TC 1:9	Direction motor	on	0-5 VDC	–
TC 1:10	Alarm relay	on	0-24 VDC	–
TC 1:11	Encoder signal (count)	on	0-5 VDC	–
TC 1:12	Homeposition motorunit	on	0-5 VDC	–
TC 1:13	5 V stab (+5s)	on	5 VDC	–
TC 1:14	External battery (Extcdc)	on	24 VDC	–
TC 1:15	Gnd	–	–	–
TC 1:16	Gnd	–	–	–



CPU board, PV 501/PV501-2

<u>Test point</u>	<u>Voltage name</u>	<u>Status</u>	<u>Measured value</u>	<u>Adj. pot.</u>
TP 7	GND			
TP 8	9 V	on	9 VDC	–
TP 9	Alarm battery	off, mains	8.2 VDC	–
		off, no mains	7	–
TP 10	5 V	on	5 VDC	–
TP 11	Pressure amplifier	on P=0 mbar	1.0 VDC	R21, (R24)
		P=30 mbar	4.0 VDC	

8.8 Measuring points on the motor unit

The motor unit's electronic components consists of a motor and two opto-switches.

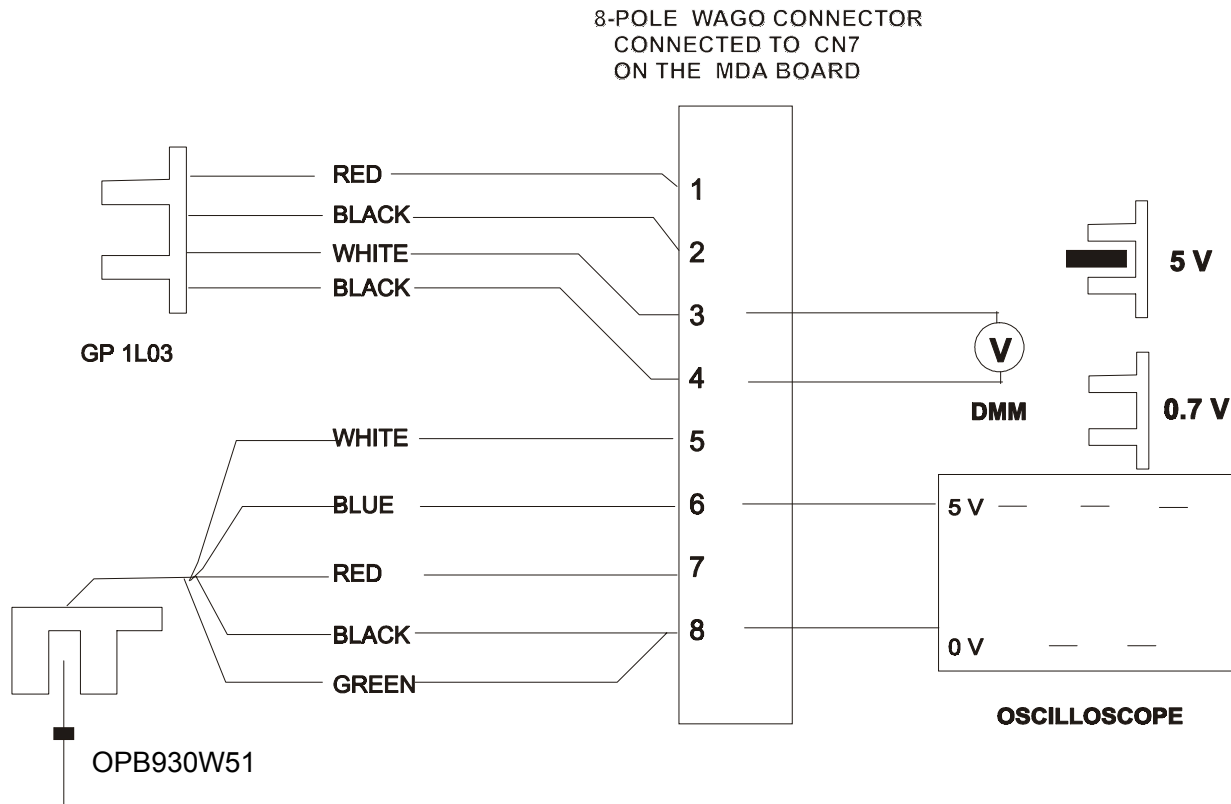


Fig. 8-9 Measuring points on the motor unit

The above diagram shows how the function of the opto-switch can be measured.

Opto-switch limit

4.

Connect a DMM (digital multi meter) between pins 3 &

Start the ventilator.

At limit position: approx. 5 V

Non limit position: approx. 0.7 V

Opto-switch pulse sensor

Connect an oscilloscope between pins 6 & 8 on PV 501 or on TC1 between pin 11 & 16 on PV 501-2.

Set the ventilator as follows:

Tidal volume: 1.2 l

Frequency: 12

I/E 1:2

Trigger -1

Set the oscilloscope to 1 V/div. and 0.2 ms/div.

Start the ventilator.

8.9 Internal Battery test

The batteries should be fully charged or charged for at least 12 hours with the ventilator turned off before this test is carried out. The batteries, when fully charged, should operate the PV 501/501-2 for at least 2 hours, if not the batteries must be replaced.

Adjust the settings to:

Tidal volume:	0,8L
Frequency:	14
I/E:	1:2

Connect a 1 litre test lung to the exhalation valve.

Note the time on the running time meter.

Turn the ventilator on, check that the LED for "Internal battery" is flashing.

If necessary adjust the tidal volume to allow the patient pressure to reach approx. 20 cm H₂O.

Let the ventilator run until the battery charge drops too low. Check that alarm for "Low battery level" is given for 15 minutes before the ventilator switches off.

Check that the alarm continues to sound 5 minutes after the ventilator has switched off.

With the ventilator turned off, charge the battery for at least 12 hours. Check that the batteries are fully charged by pressing "Batt. test" (with the ventilator running and the mains disconnected). The needle should indicate in the upper part of the green sector.

8.10 Replacing the internal power batteries (lead acid cells)

The internal power batteries must be replaced:

- If the ventilator is often run from the internal batteries, they should be replaced every 24 months or when required.
- If the batteries, when fully charged, fail to run the ventilator for at least 2 hours.
- Remove the motor unit by loosening the four nuts holding the base plate.
- Disconnect the connector to the encoders on the rear panel.
- Loosen the motor cable connector.
- Loosen the thin red tube for the exhalation valve.
- Lift the motor unit straight up.
- Remove the two nuts for the battery fastening bar. Only disconnect the two cables from the battery that are connected to the circuit board.
- Lift out the batteries.
- Install the new batteries in place and the fastening bar.
- Connect the wires from the circuit board.
- Install the motor unit.
- Make a test start and check that everything appears to function normally. Turn off the ventilator.
- Charge the batteries for at least 12 hours and then perform a battery test, see Section 8.9.

8.11 Replacing the alarm batteries (Ni-Cd)

The alarm batteries are contained on the CPU board in the hood (see figure). The internal batteries normally provide power for the alarm function, but should they become discharged, the alarm battery will provide back-up power. The alarm battery must be replaced every 5th year counted from date of delivery or when it was last replaced.

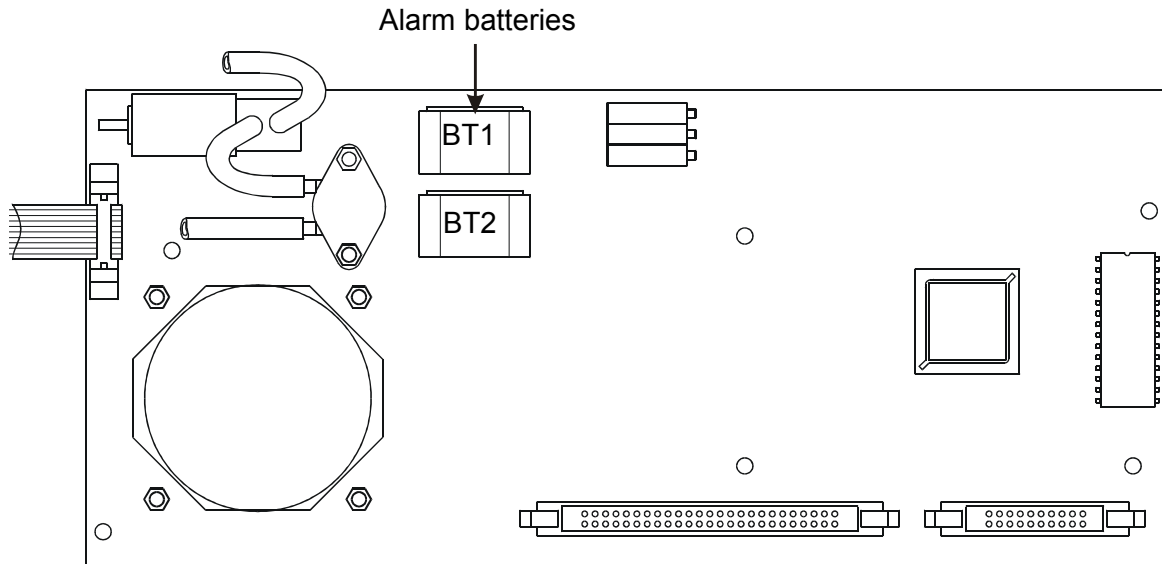


Fig. 8-10 Replacing the alarm batteries

To replace the alarm batteries:

- Open the connector locks and disconnect the three ribbon cables from the CPU board.
- Mark the hoses A, B and C using a marker pen, then disconnect these.
- Remove the five nuts that hold the board.
- Remove the board.
- Cut the two "pins" on battery marked "Y", closest to the edge board. Unsolder the "Y"-battery from the minus pole.
- Cut the other battery pin.
- Remove the old battery pins.
- Assemble the new batteries and solder these in place.
- Reassemble the circuit board, hoses, cable ties and ribbon cables.
- Make a test start. PV 501 checks at each start cycle the condition of the alarm batteries. If there is a fault with the alarm battery, the ventilator will not start and the LEDs for "FUNCTION FAULT" and "TRIGGER" will light. If this happens after replacing the battery, let the ventilator remain connected to the mains for a few hours for the battery to be charged. Thereafter, make a new test start.

8.12 Electrical safety

Electrical safety measurements should be performed according to IEC 601, but the isolation resistance can be measured instead of the current test as according to the stipulated requirements in the standard.

The measurements can be performed with an automatic electricity safety tester. All tests shall be performed according to class II type BF.

8.12.1 Mains

Register the mains value. As the current is directly dependant of the mains outlet being used it is necessary to register the mains at each maintenance. This allows values registered from the same machine to be compared at different occasions.

8.12.2 Isolation

The isolation resistance is measured with 500 VDC current source. Preferably, the plus is connected to both mains pins and minus to the exterior or patient connections. The measurement performed at the delivery check gives the reference value that maintenance measurements are compared with. If this has not be done, the value of the isolation resistance should be $> 20M$.

8.12.3 Leakage current

Leakage current is registered from various parts of the machine through a RC-circuit to earth. Measurements are made in normal cases (NC) and at single fault condition (SFC). Reverse voltage polarity mains and note the lowest value.

Leakage to the earth should not exceed the stated limit value.

8.12.4 Leakage current from the cabinet

Leakage current from the cabinet.

Measure at an unvarnished part, i.e. a screw head.

Limit value:	NC	$< 0,1mA$
	SFC	$< 0,5mA$

Break neutral for SFC.

8.12.5 Patient leakage

Measured between patient connection and earth.

Limit value:	NC.	$< 0,1mA$
	SFC.	$< 0,5mA$

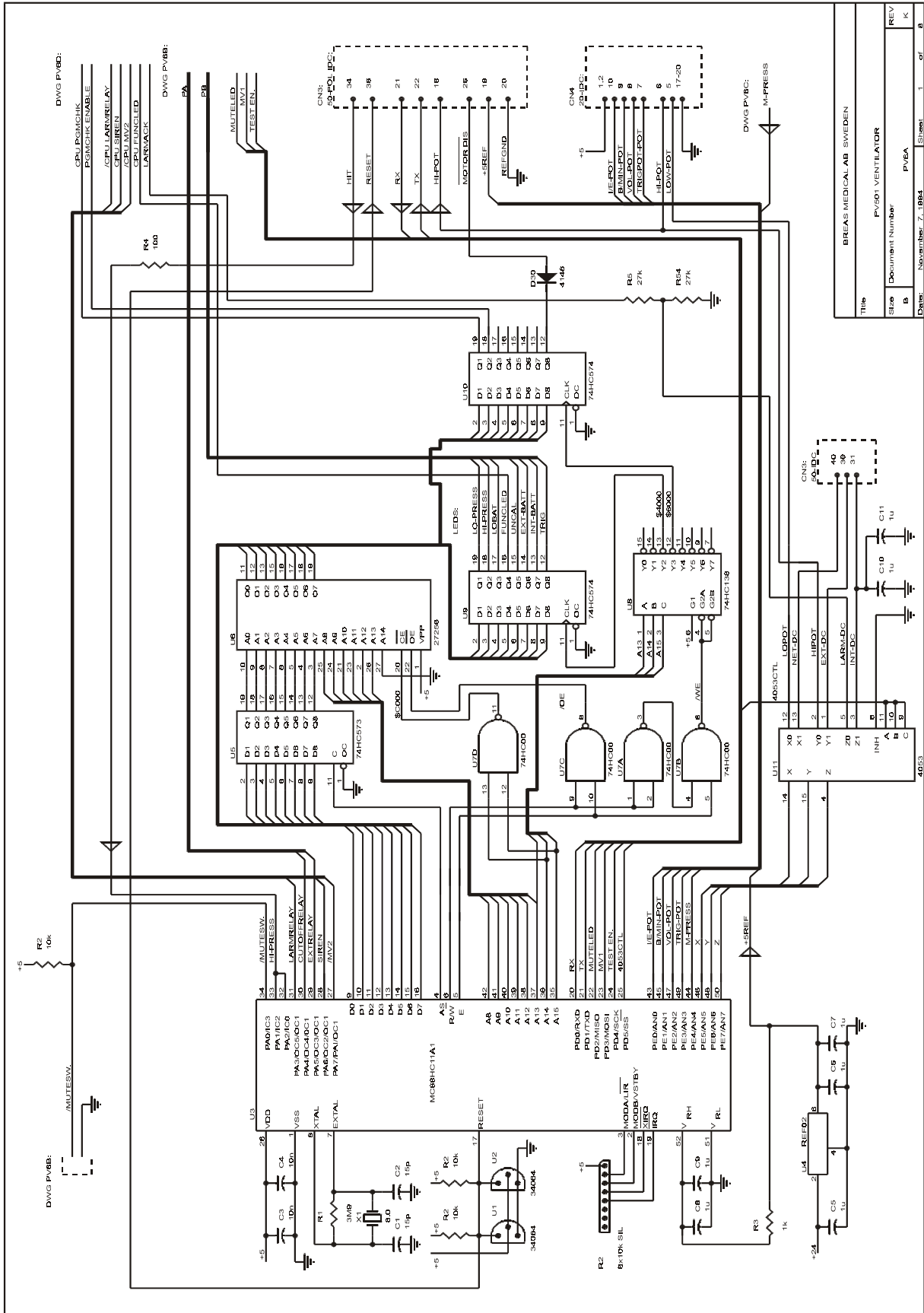
Break neutral for SFC.

8.12.6 Leakage current at mains voltage at patient connected part

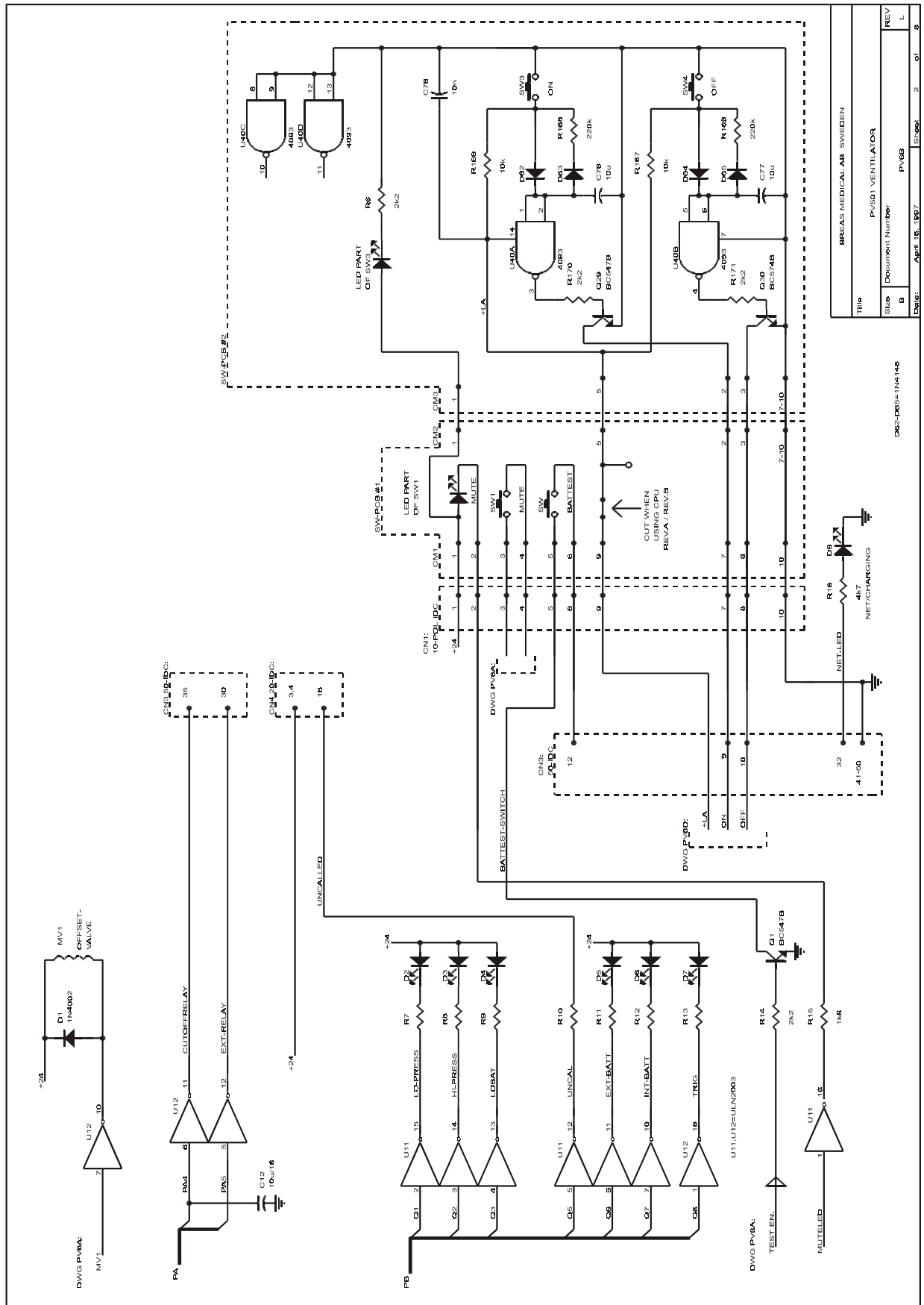
This test should only be performed with the automatic electrical safety tester. See the testing security instruction.

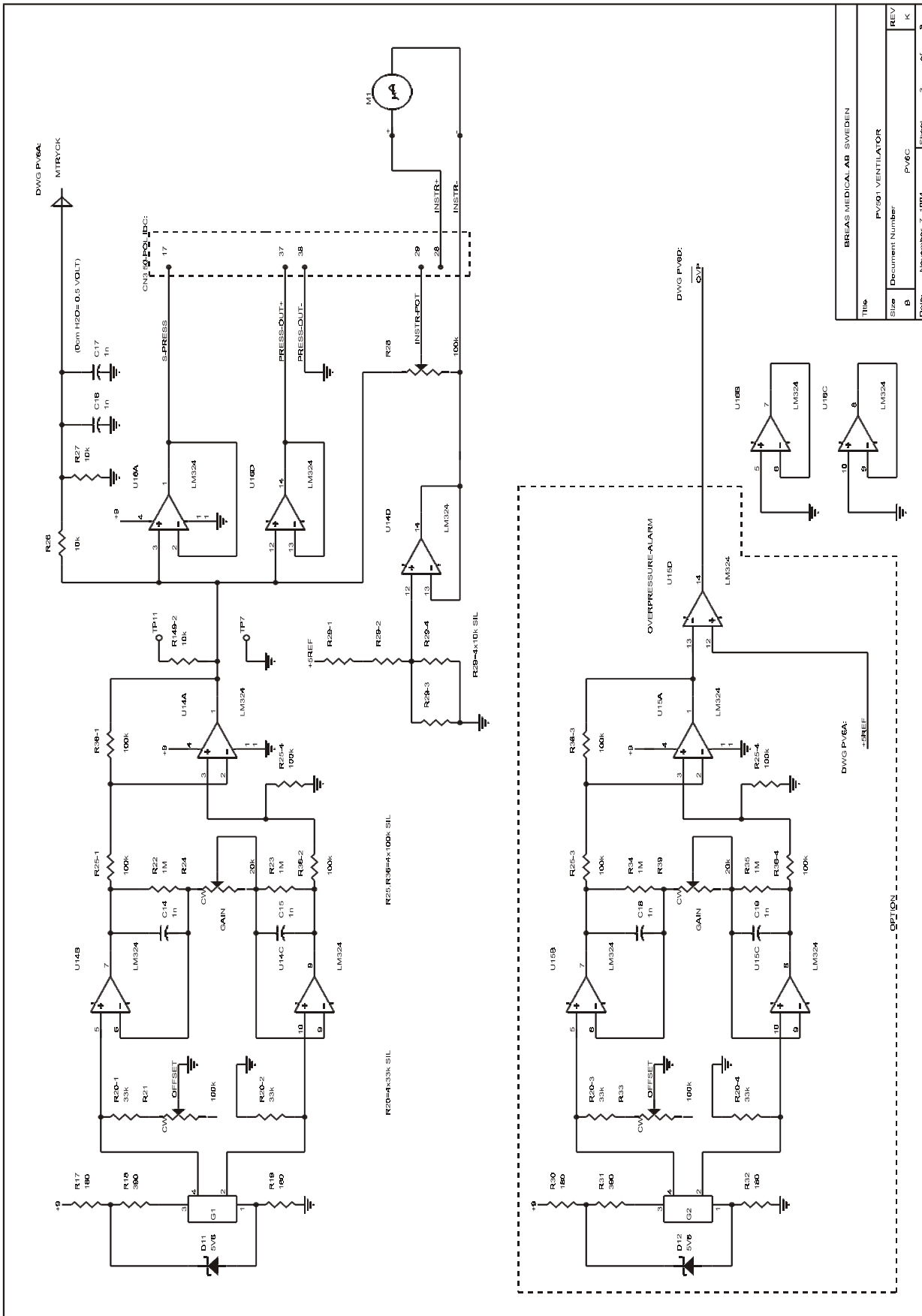
Limit value:	SFC.	$< 5mA$
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8.13 Wiring Diagrams PV 501/501-2

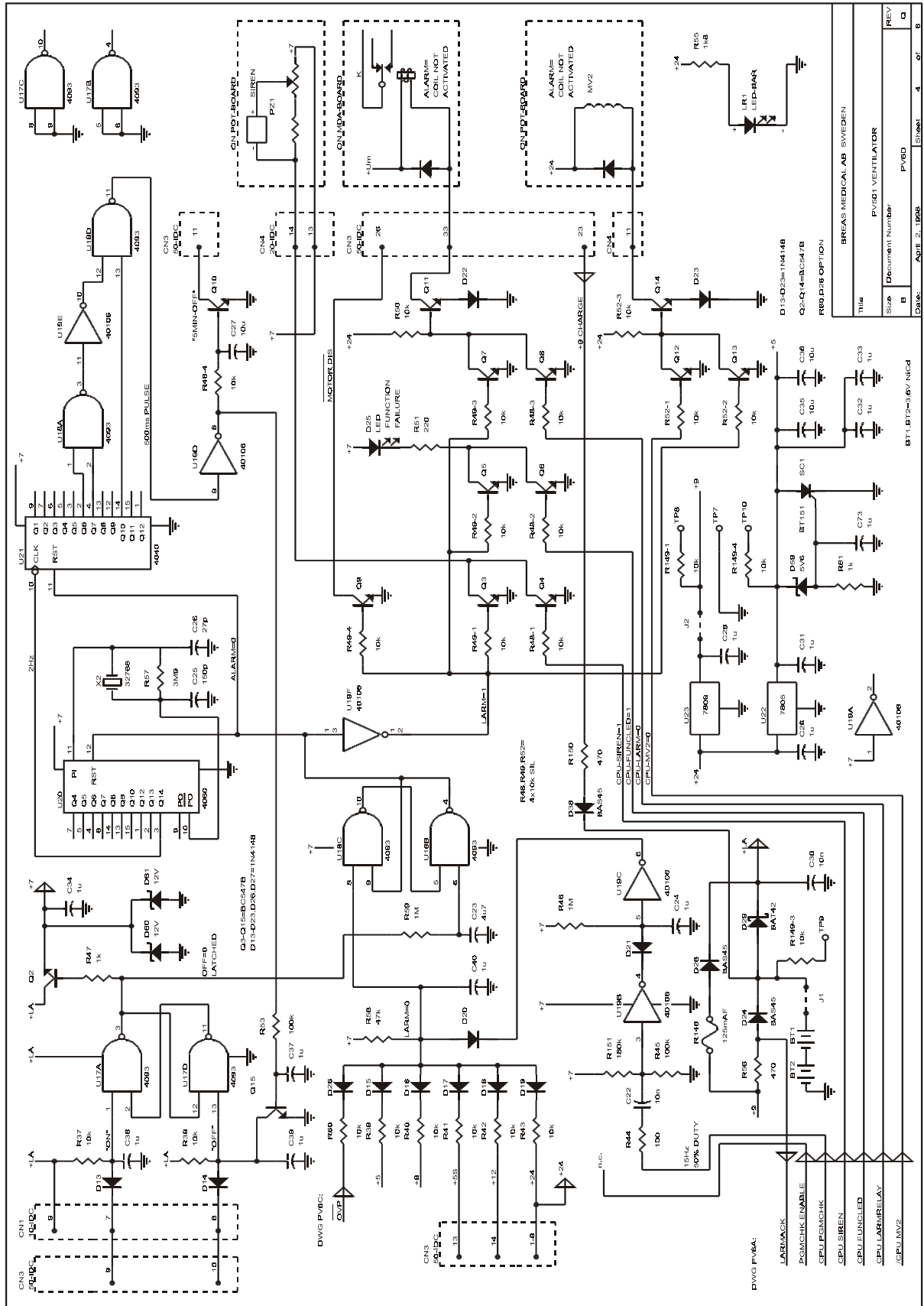


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Date:	November 7, 1994	Sheet	1 of 8



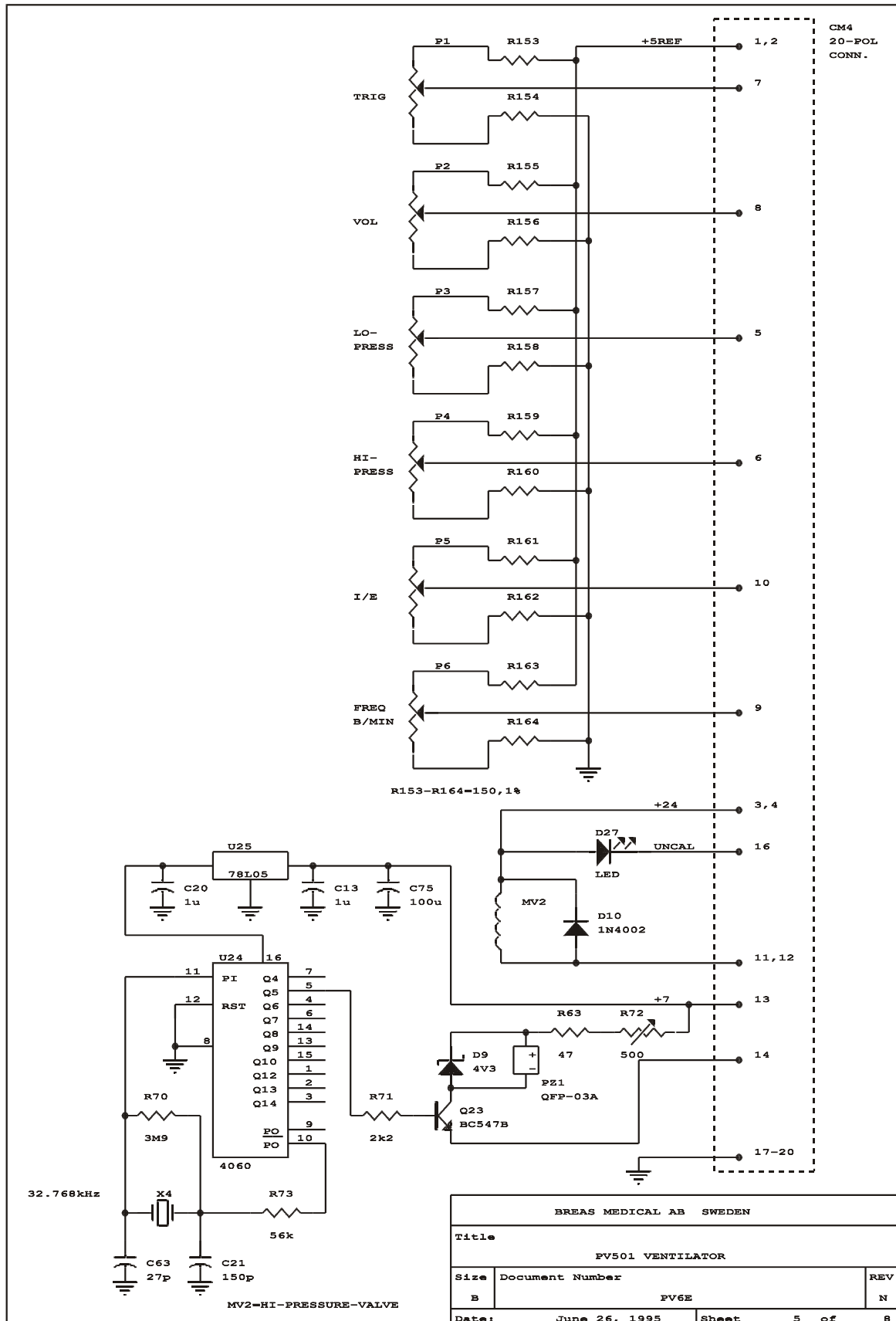


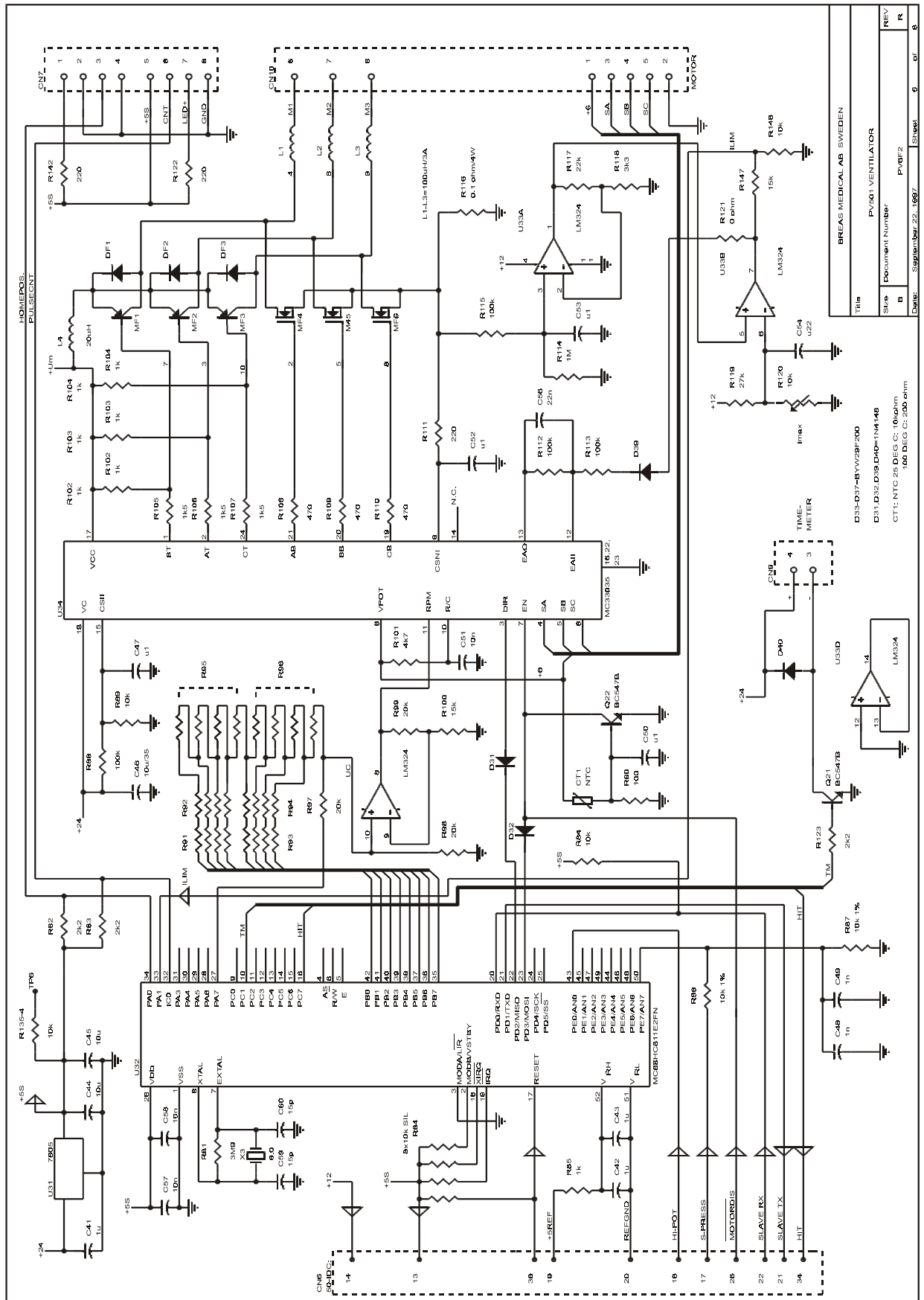
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Doc	8

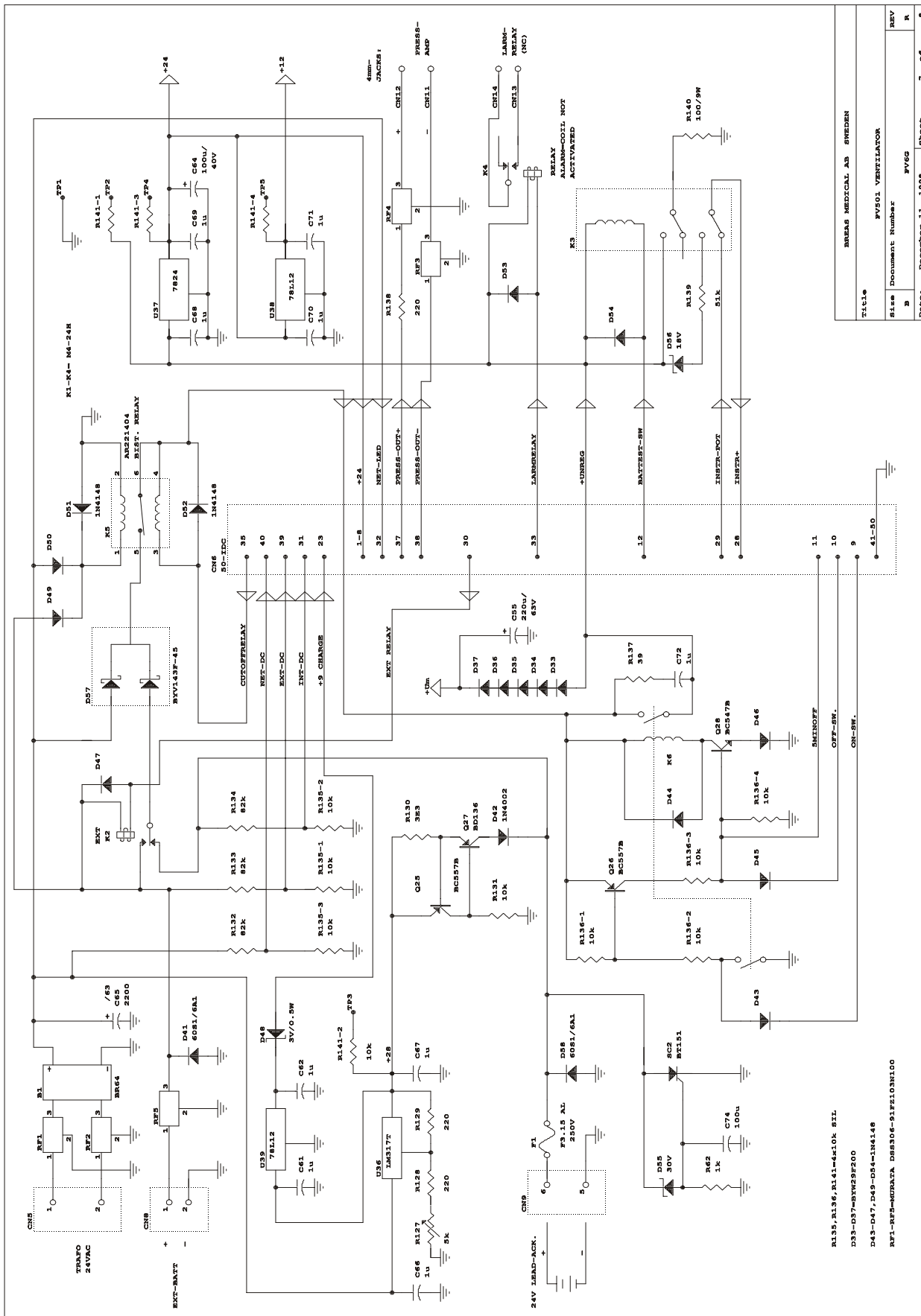




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Document Number	PV501-2
REV	R

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 CT1: NTC 25 DEG C: 10kOhm
 100 DEG C: 200 Ohm

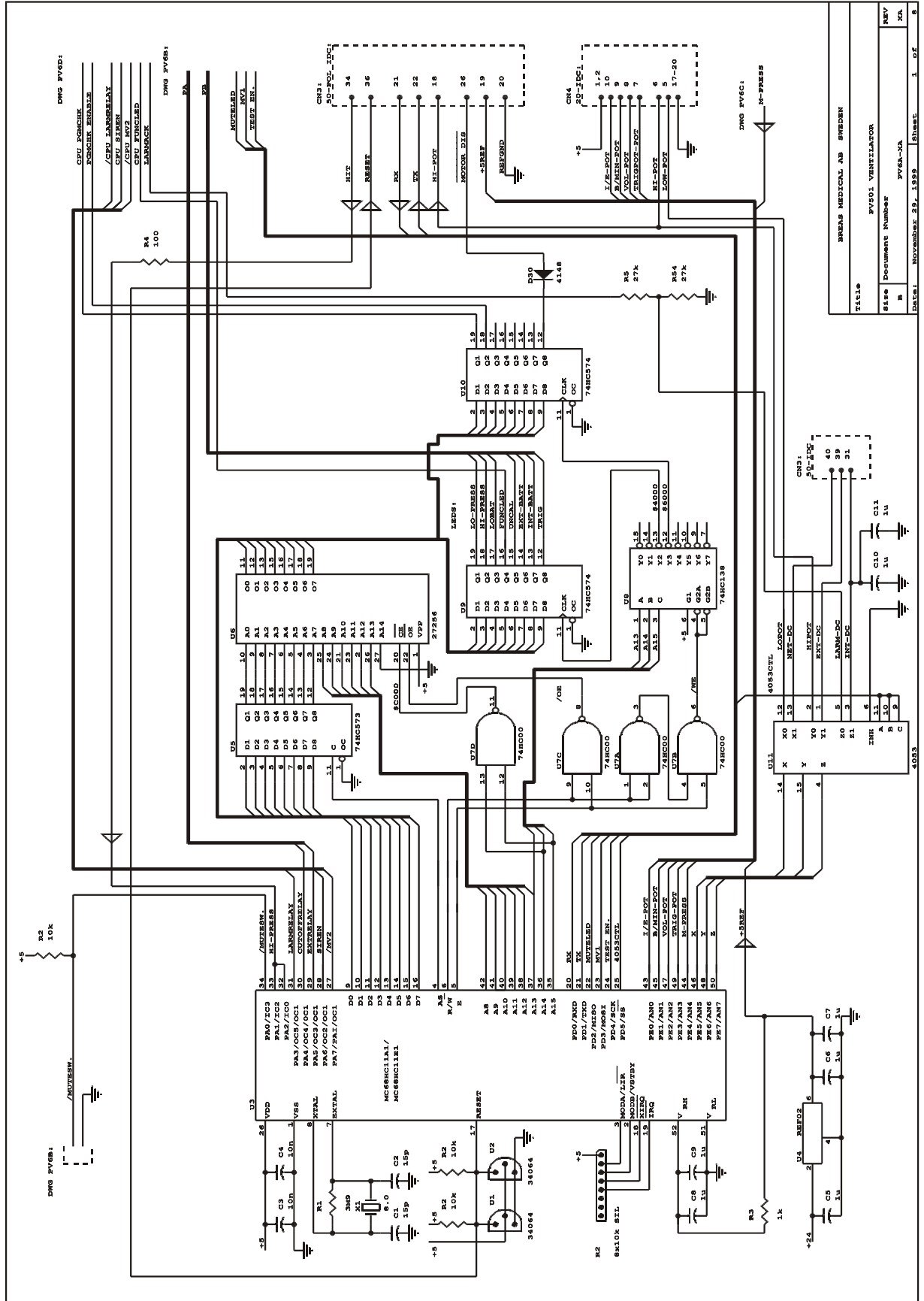
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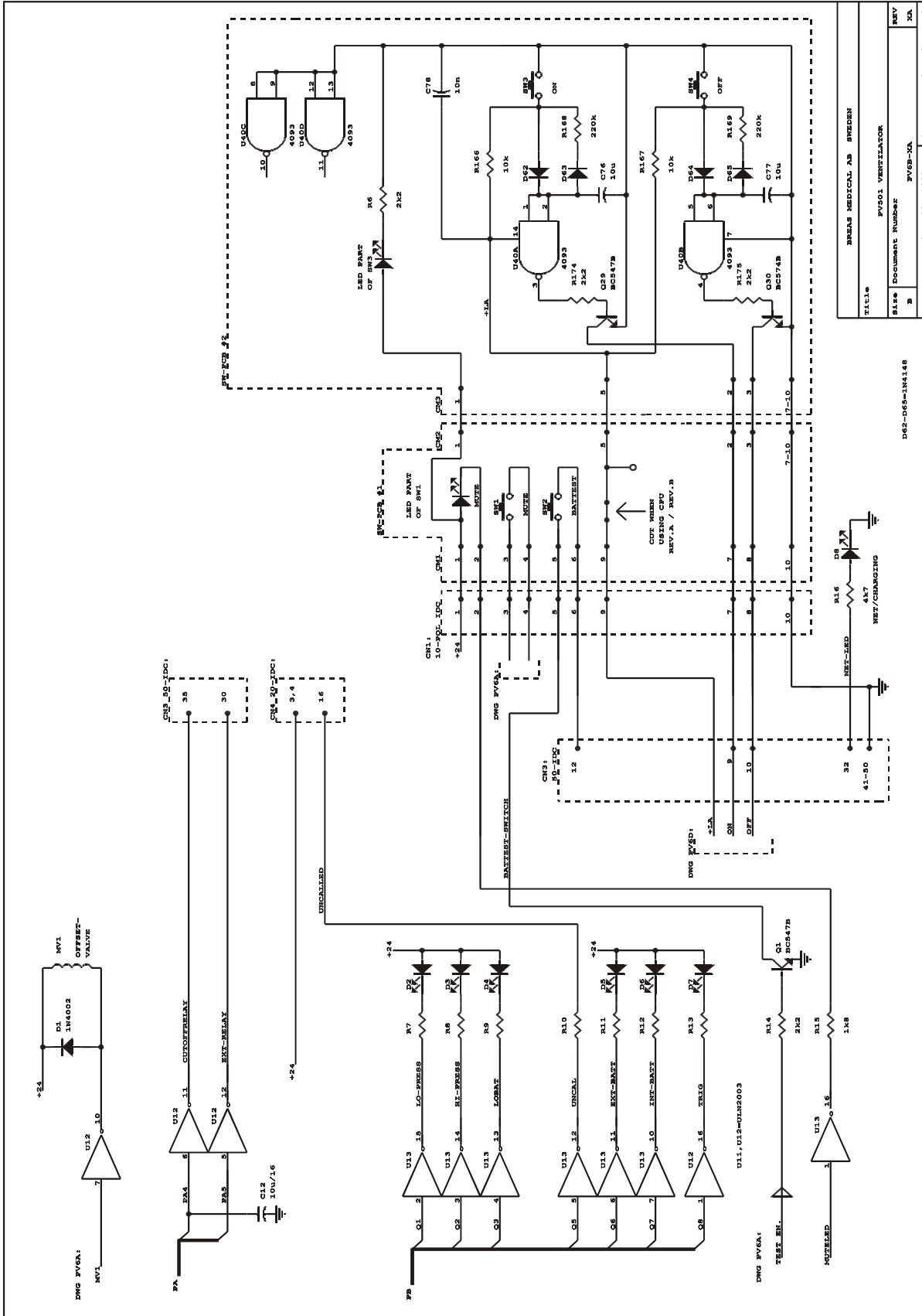
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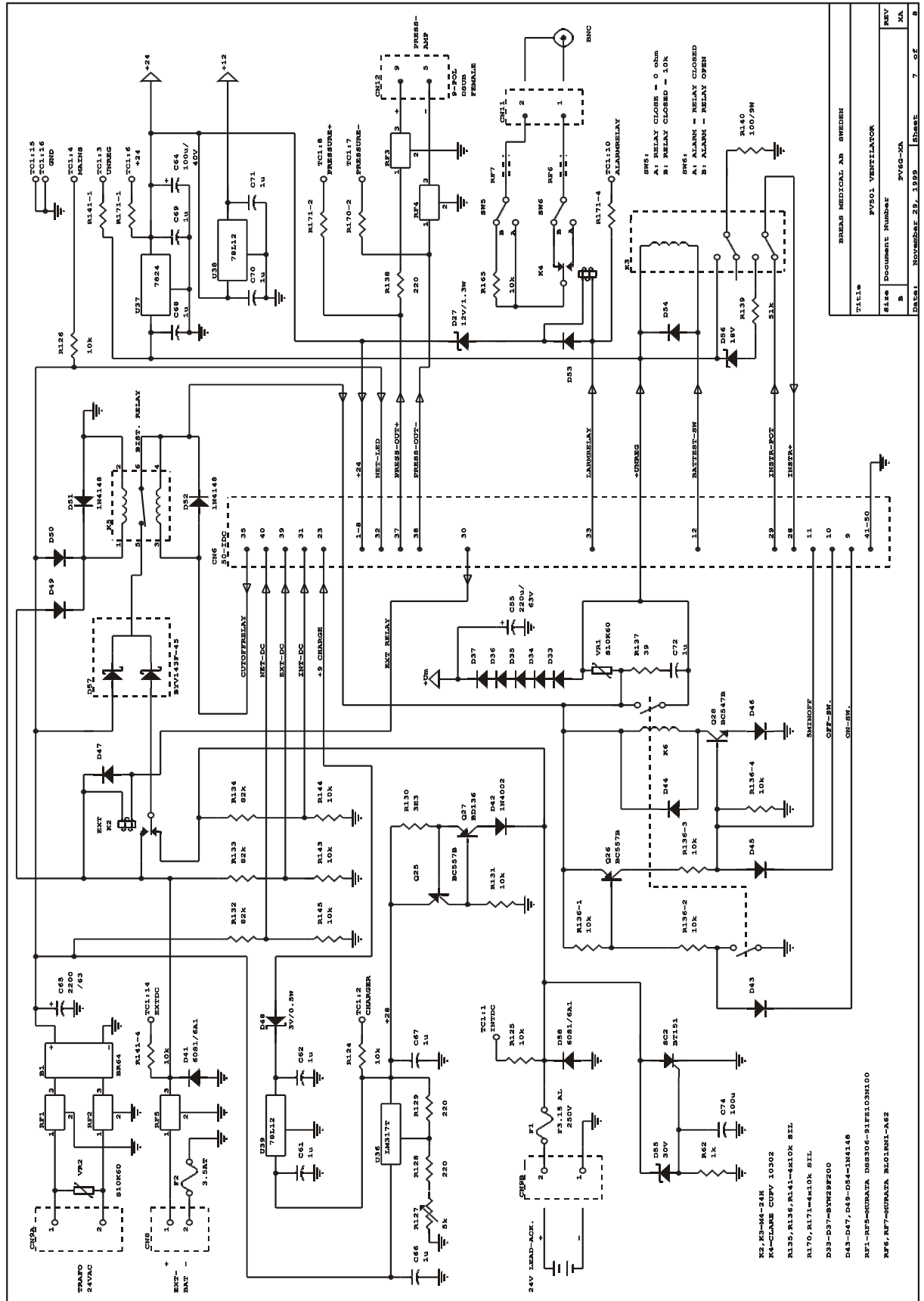
R135, R136, R141-4x10K SIL
 D53-D57-BXW29F200
 D43-D47, D49-D54-1M4148
 R11-RF5-MTRACA D88506-S1F1D3N100

PV 501-2

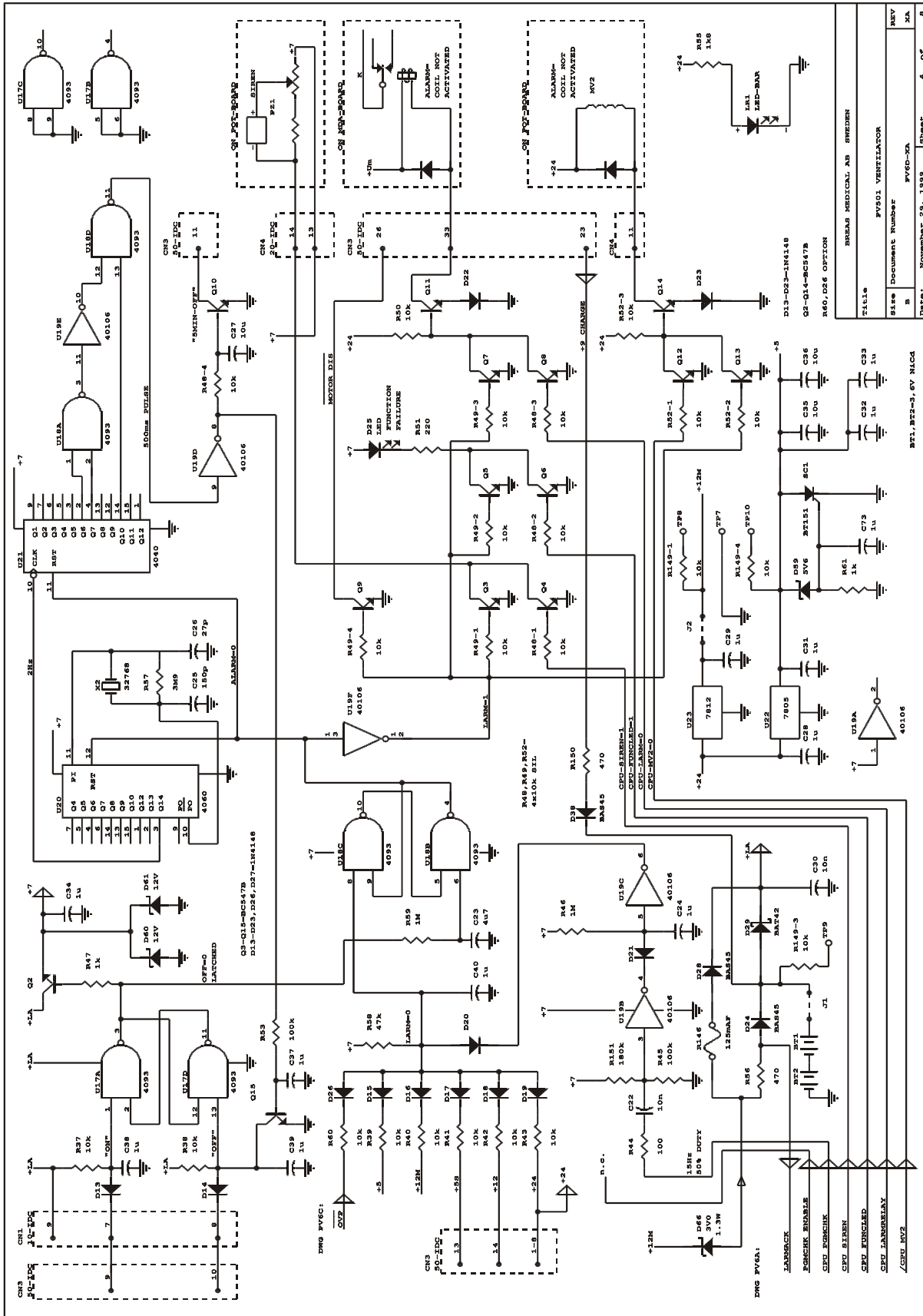


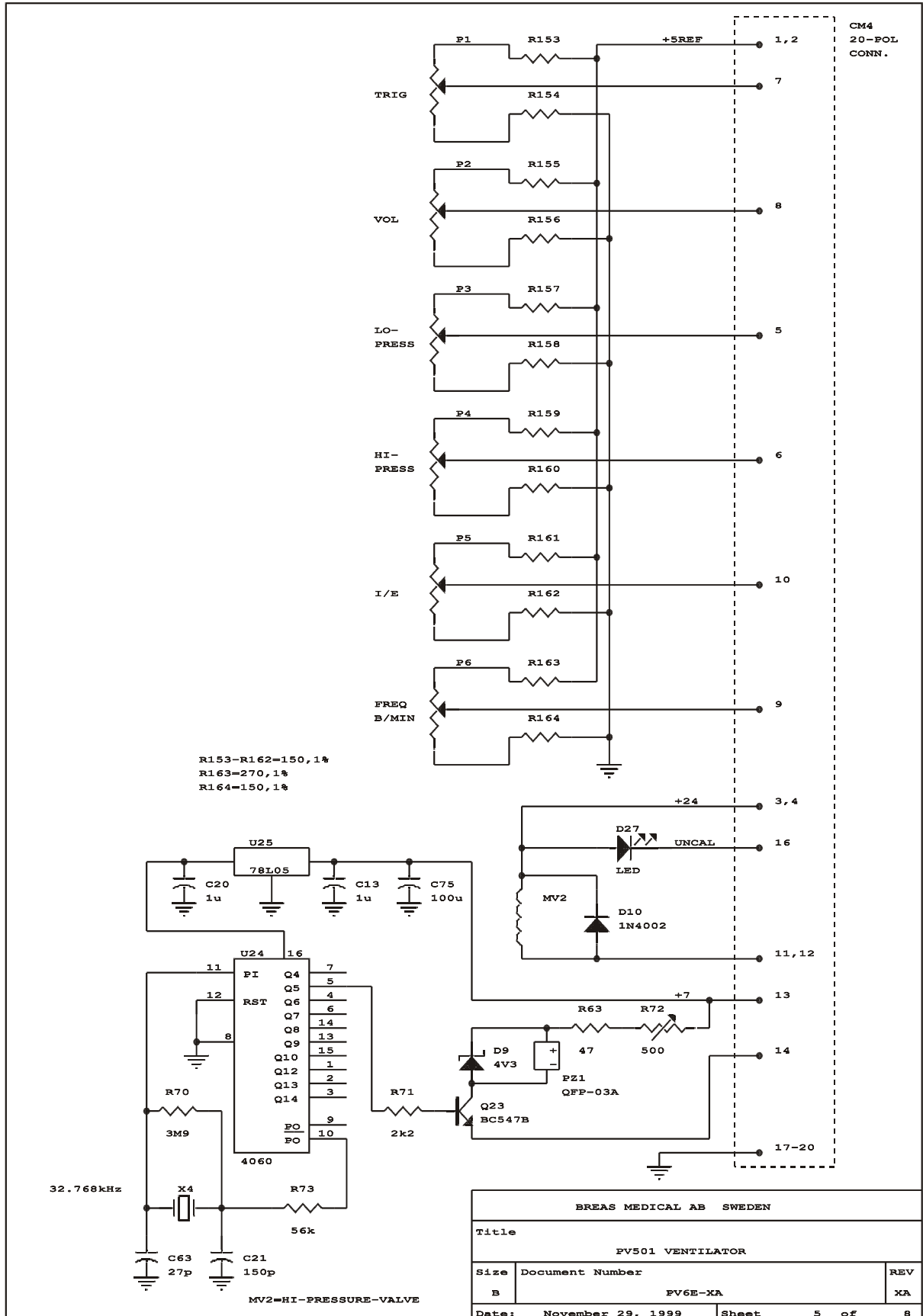
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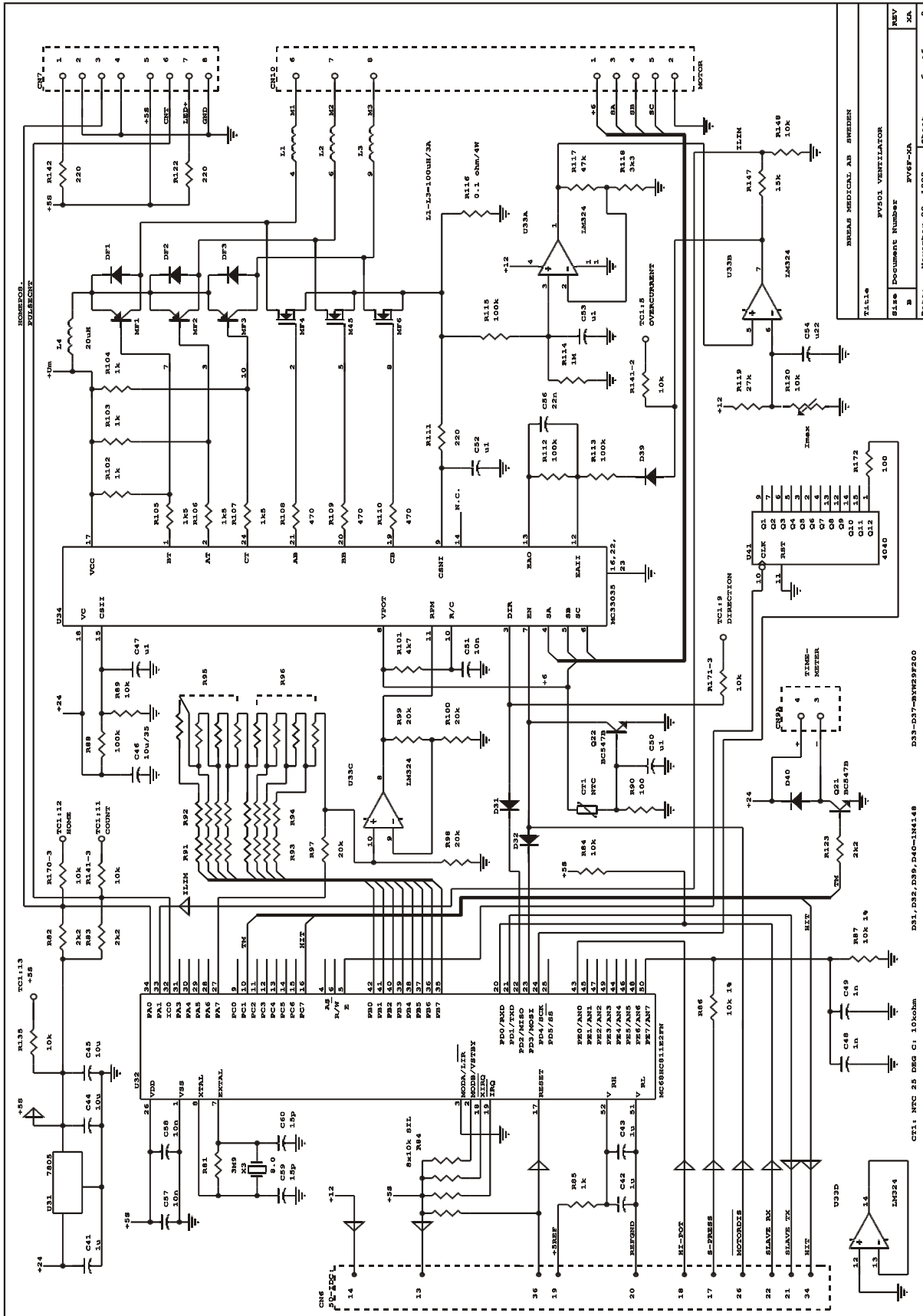


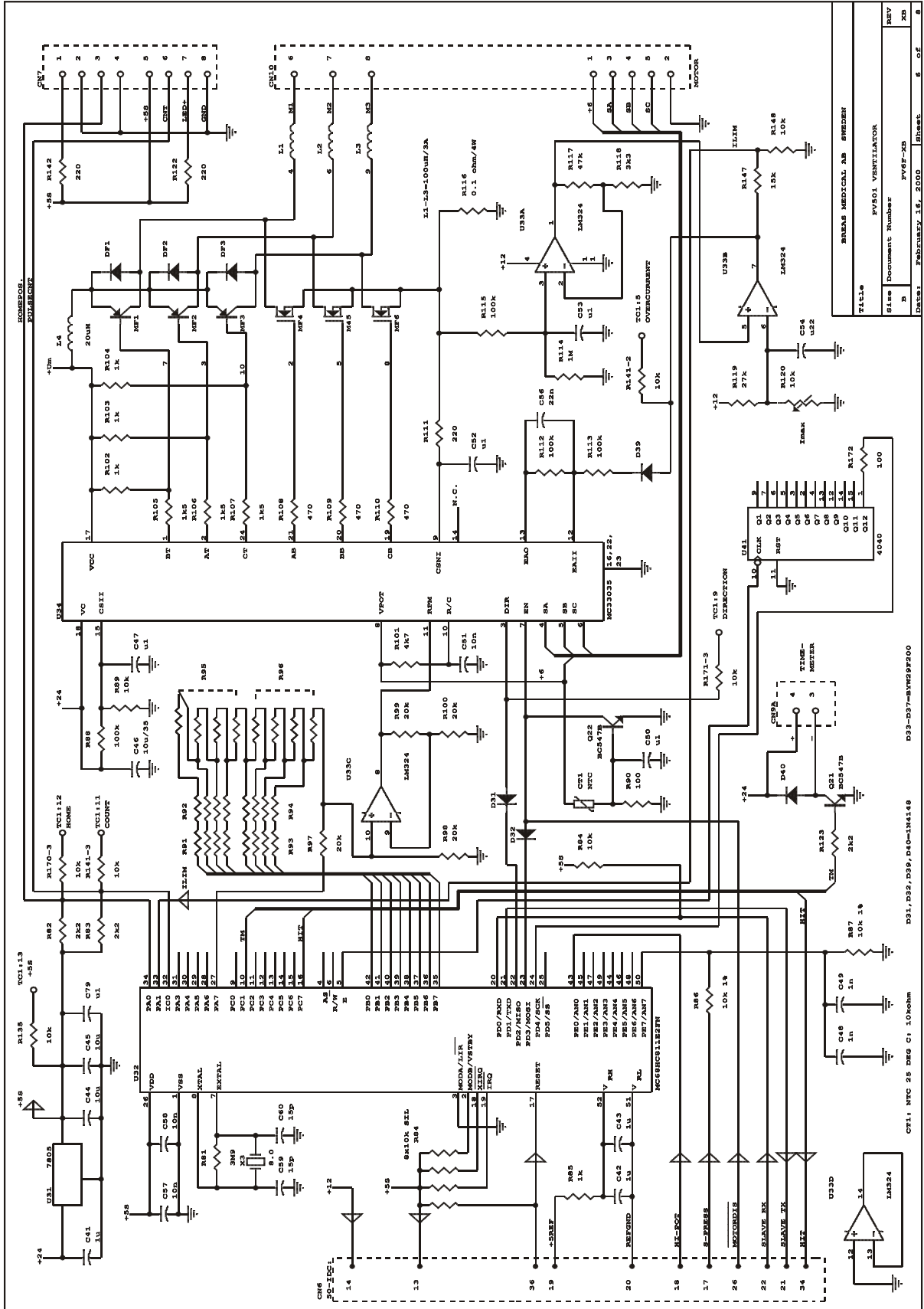


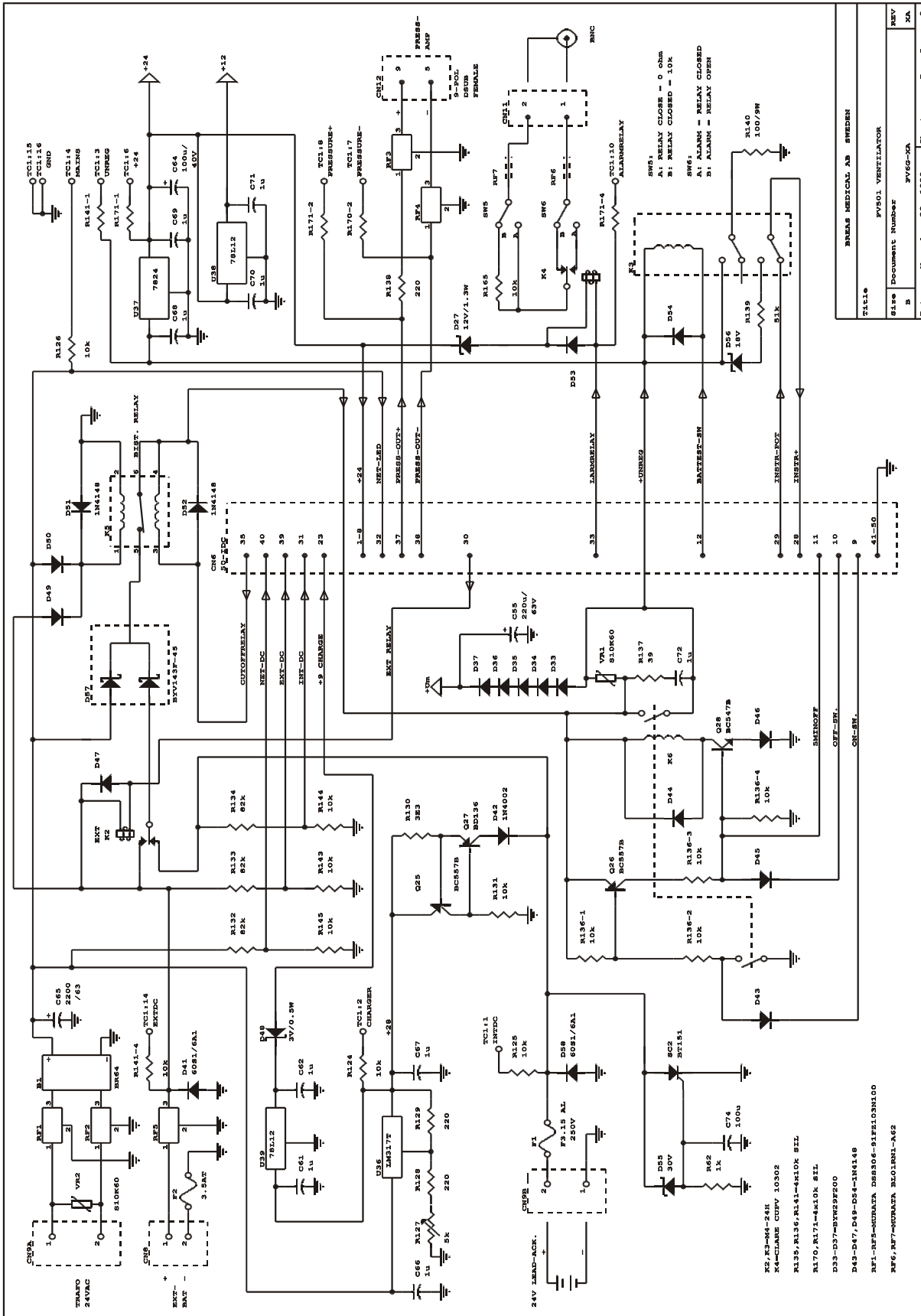
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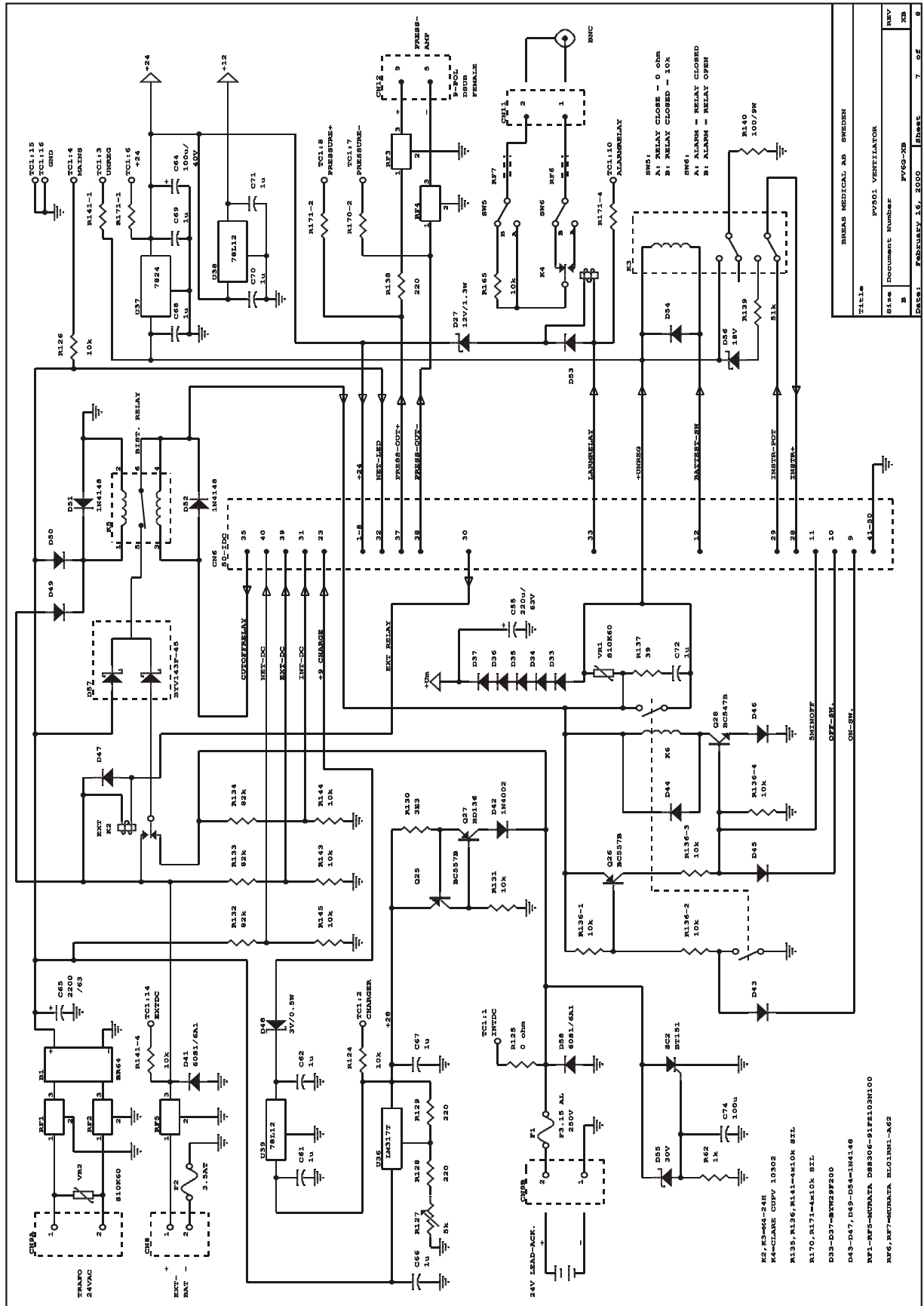






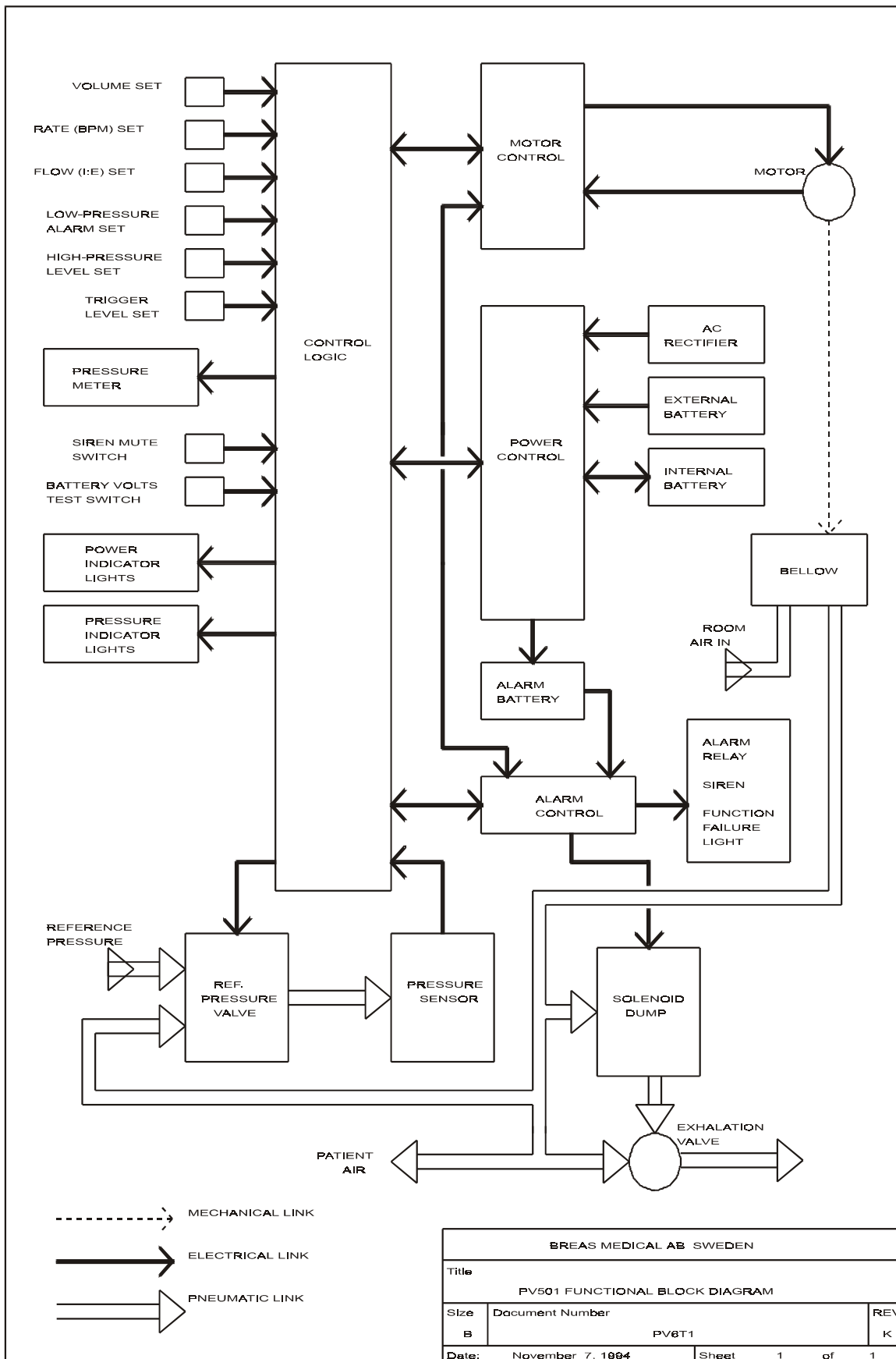


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DATE: NOVEMBER 29, 1999		SHEET	7 OF 8



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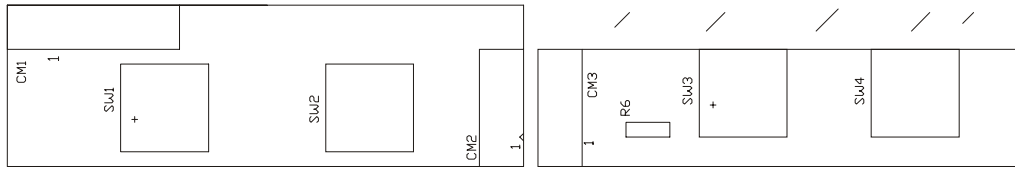
8.14 Functional block diagram PV6 T1



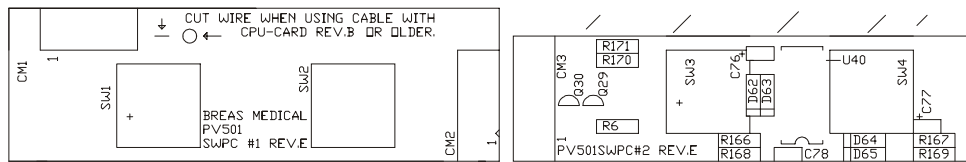
8.15 COMPONENT LOCATION DRAWINGS PV 501

8.15.1 Pushbutton Boards PV 501, Versions B & E

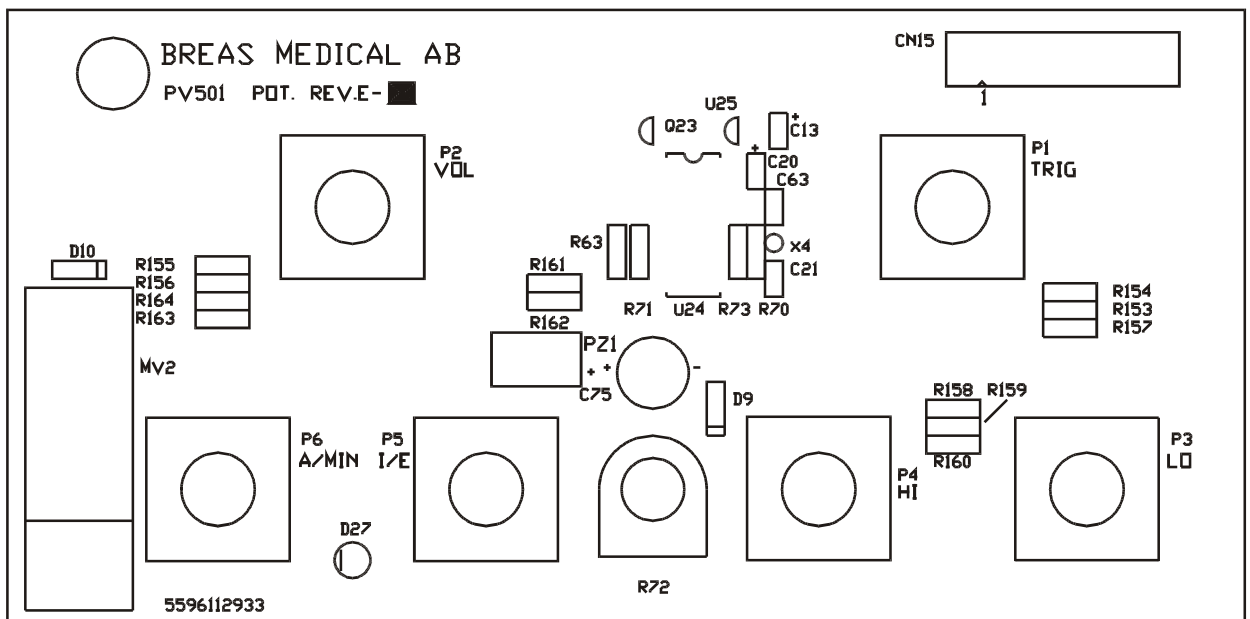
Push button board Rev B



Push button board Rev E

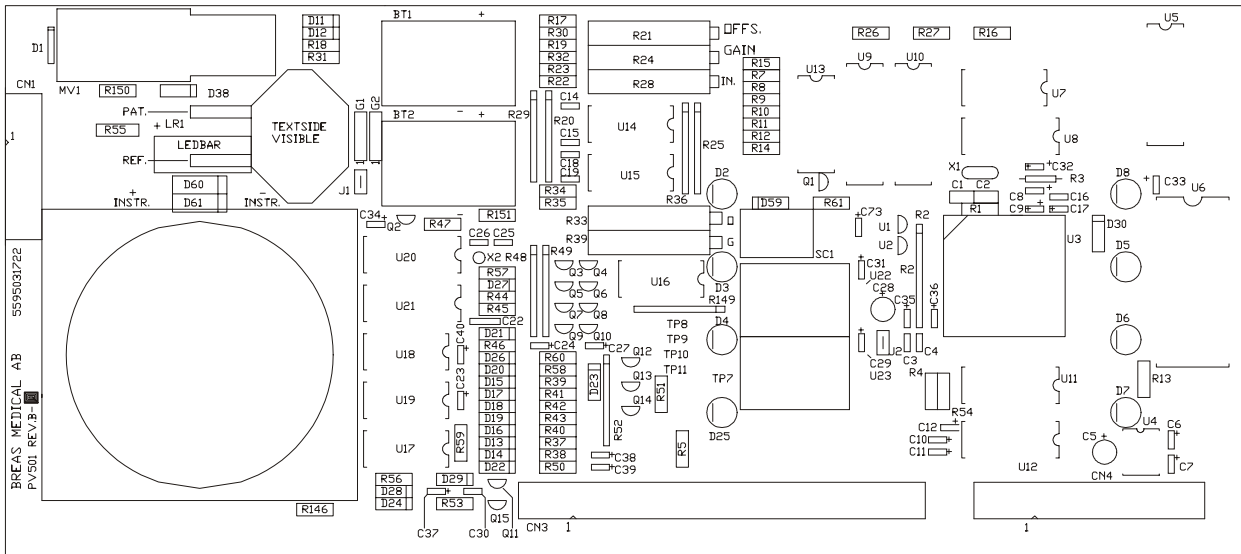


8.15.2 Potentiometer Board PV 501

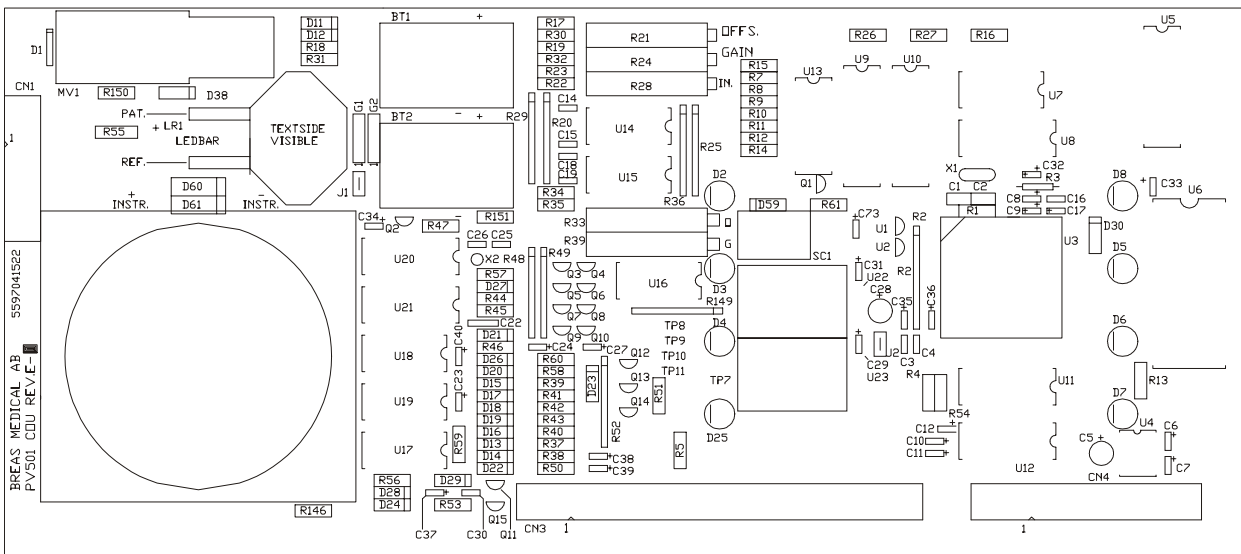


8.15.3 CPU Boards PV 501, Version B & E

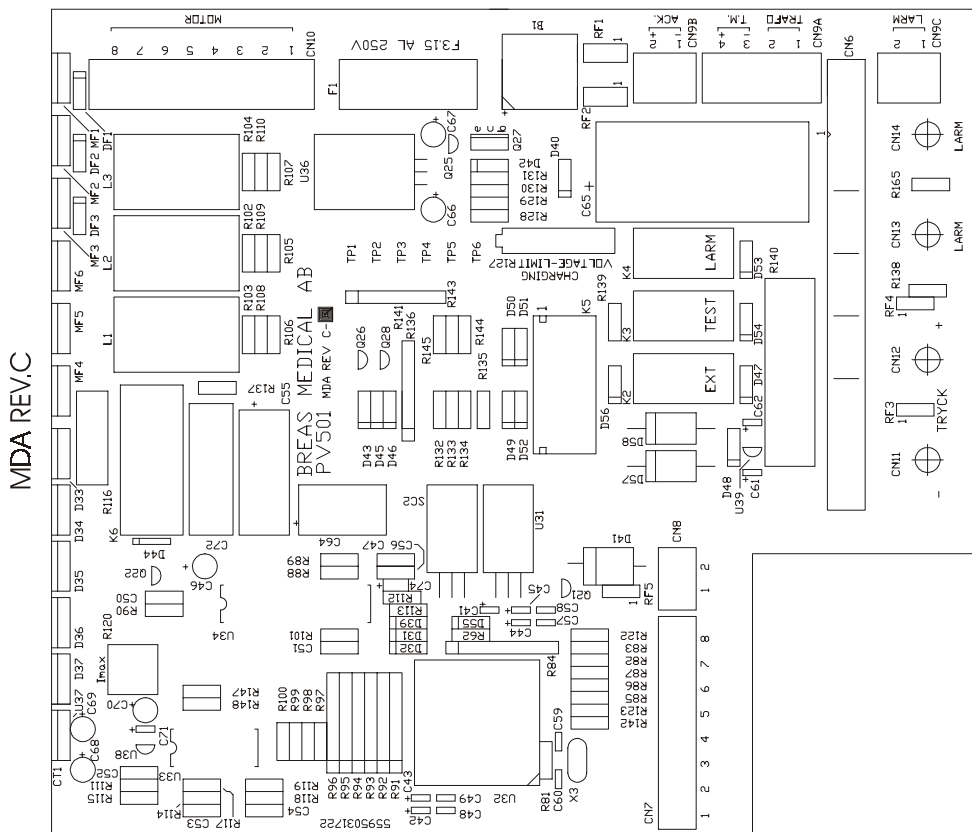
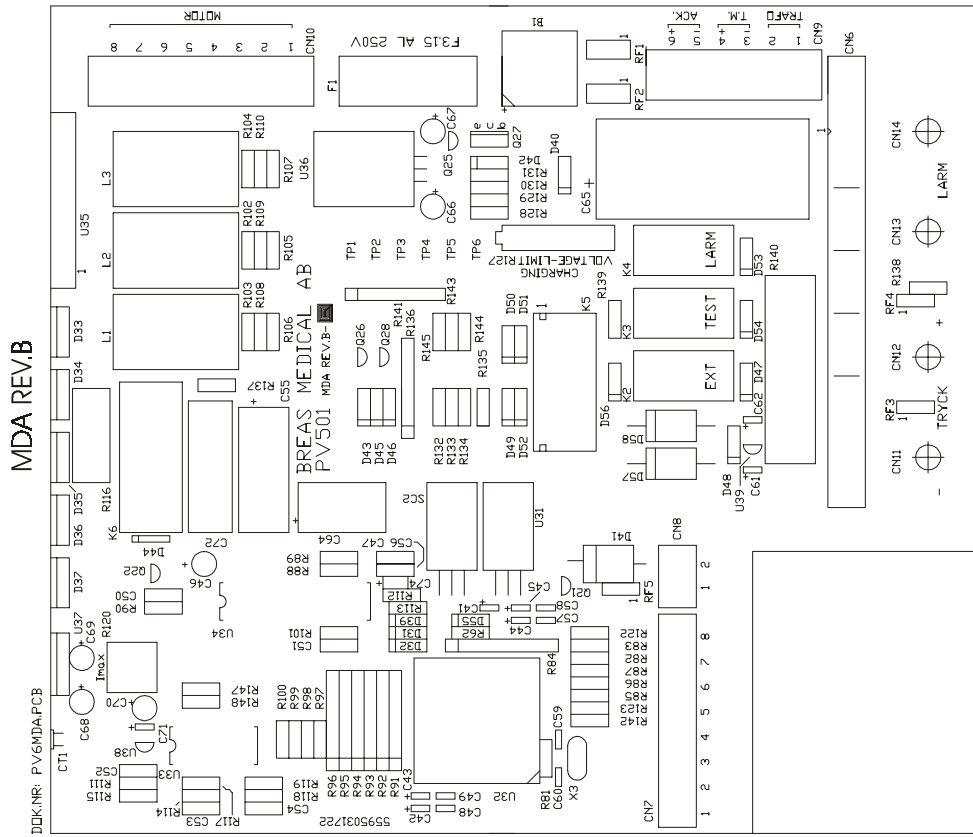
CPU rev. B



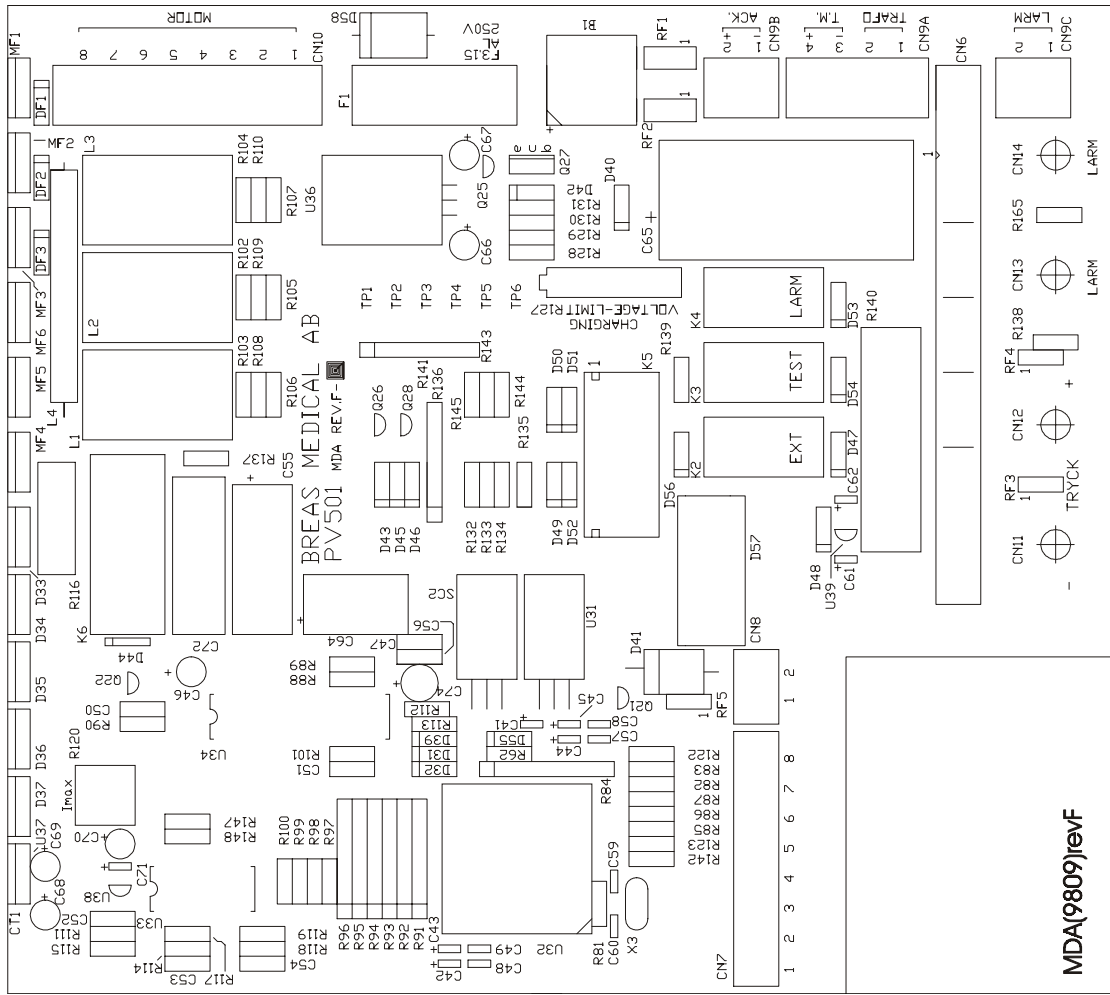
CPU rev. E



8.15.4 MDA Boards PV 501



MDA re. F

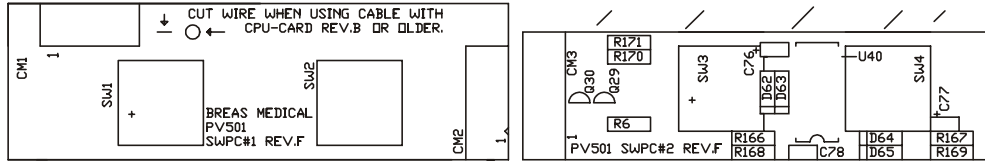


MDA(9809)revF

8.16 COMPONENT LOCATION DRAWINGS PV 501-2

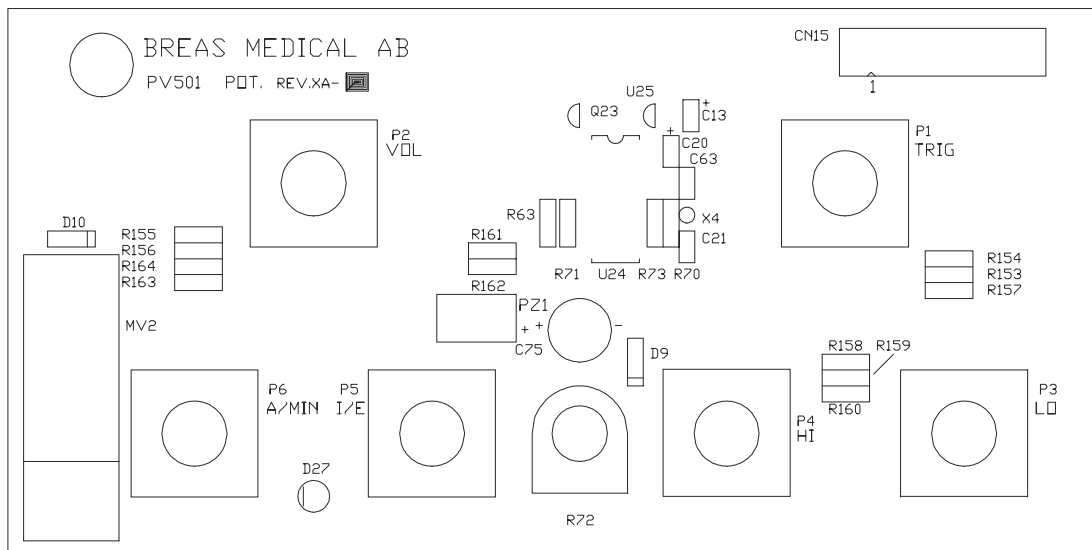
8.16.1 Pushbutton Boards PV 501-2

SW Rev. F

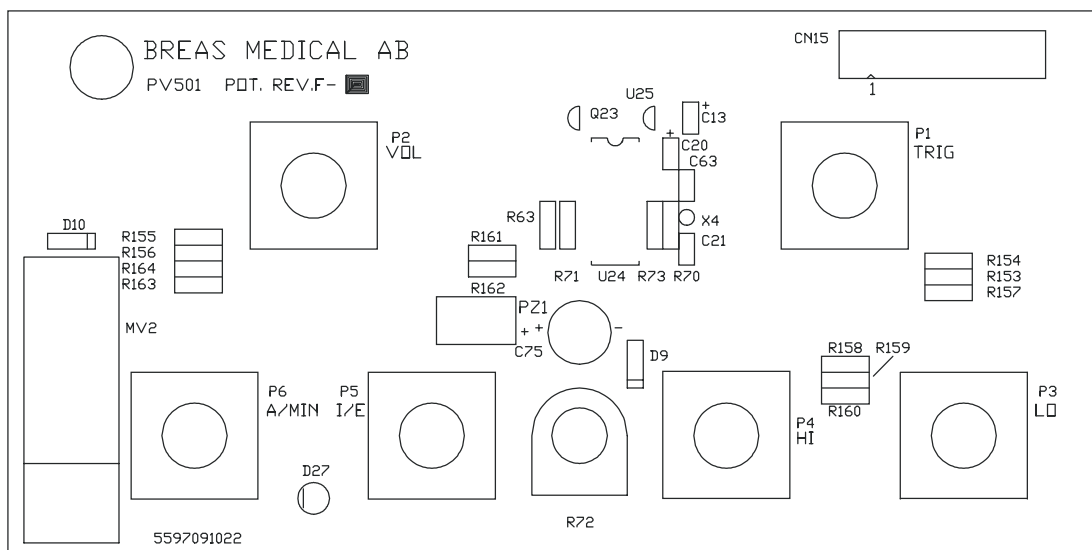


8.16.2 Potentiometer Board PV 501-2

Rev. XA

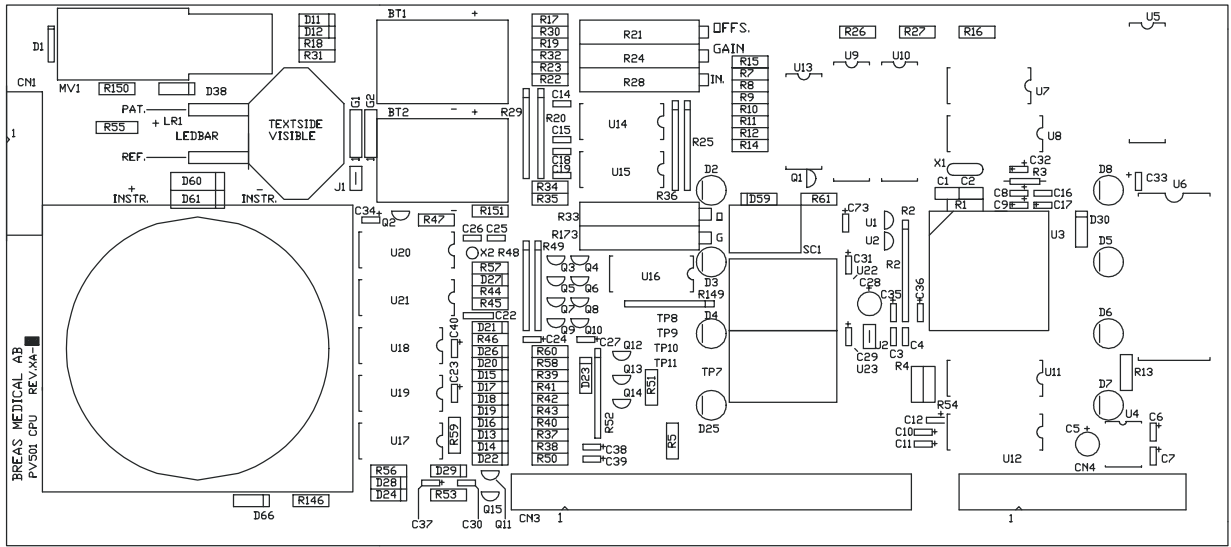


Rev F

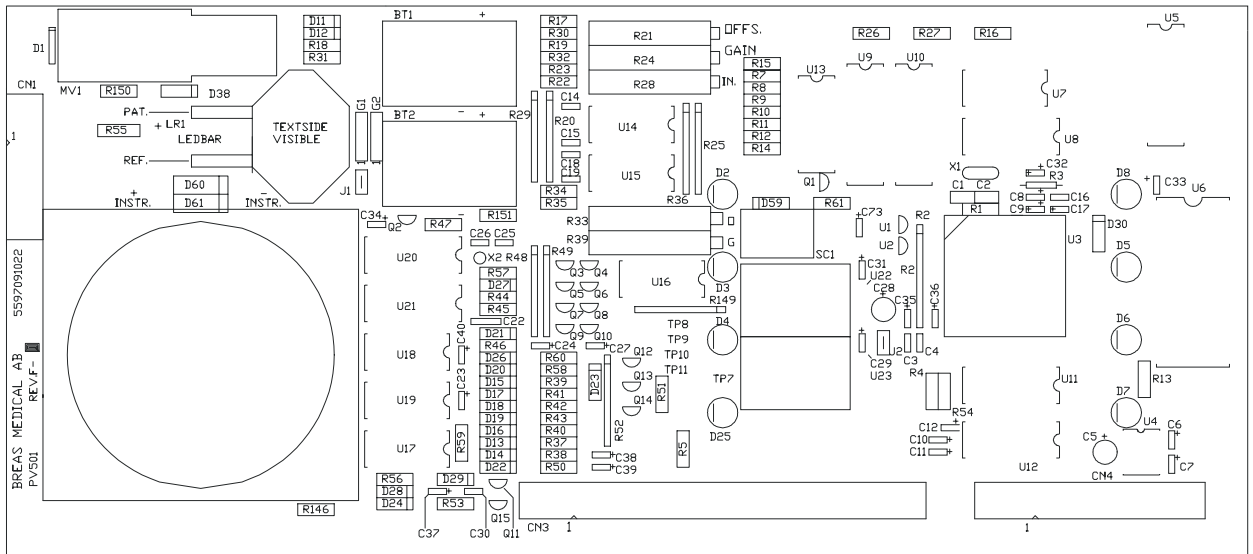


8.16.3 CPU Boards PV 501-2

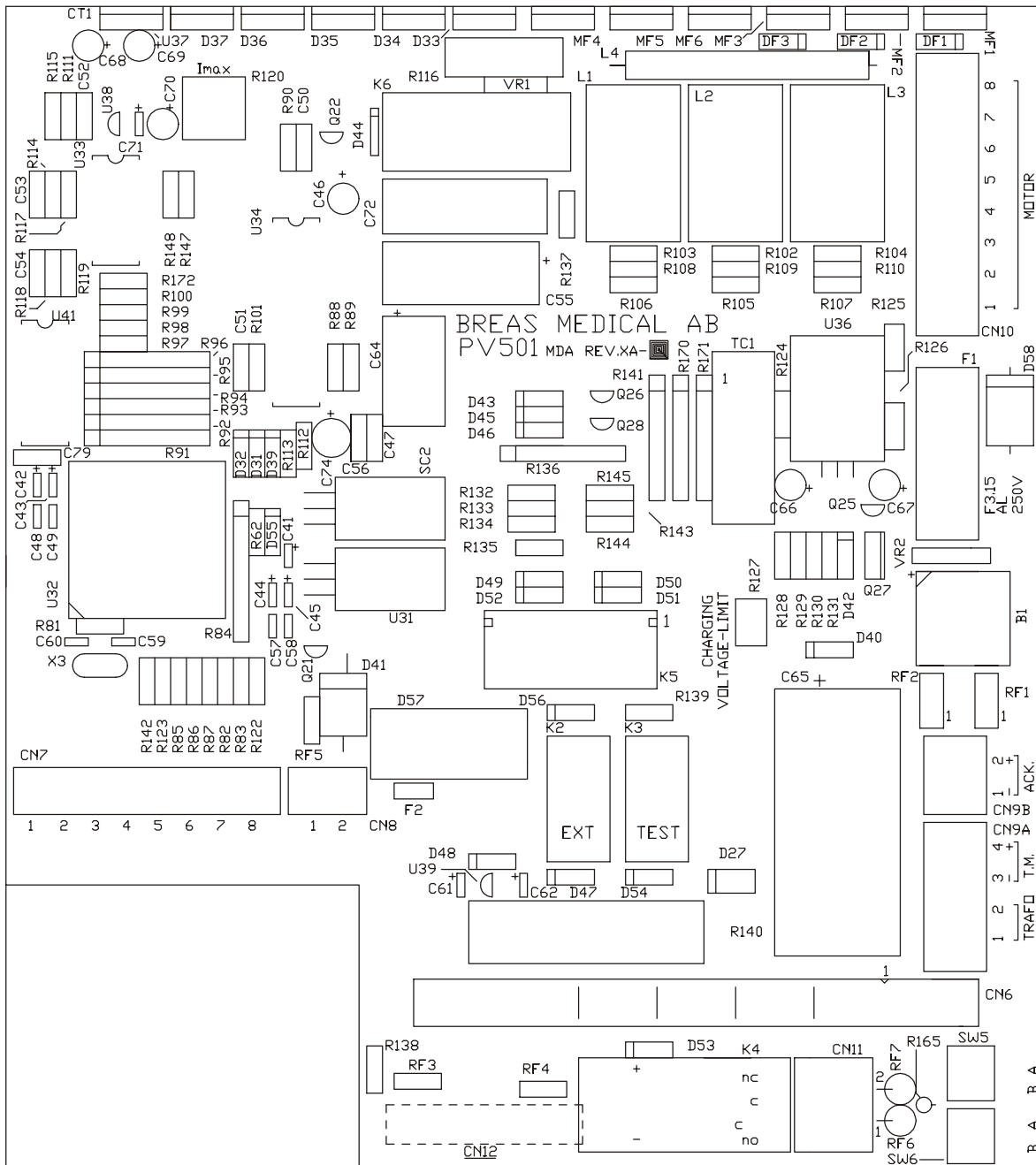
Rev. XA



Rev. F



8.16.4 MDA Boards PV 501-2 XA



8.17 List of components PV 501

R1,R70	3M9	0.25W
R2	8x10k	SIL 9PIN/BRESISTOR
R3	1k	0.25W
R4	100	0.25W
R5	27k	0.25W
R6	2k2	0.25W
R7-R13,R15	1k8	0.25W
R14	2k2	0.25W
R16	4k7	0.4W
R17,R19	180	0.25W
R18	390	0.25W
R20	4x33k	SIL 8PIN/4RESISTOR
R21,R28,R33	100k	15T TRIMBOURNS 3006P
R22,R23	1M	0.25W
R24	20k	15T TRIMBOURNS 3006P
R25,R36	4x100k	SIL 8PIN/4RESISTOR
R26,R27	10k 1%	0.25W
R29	4x10k	SIL 8PIN/4RESISTOR
R30,R32	180	0.25W
R31	390	0.25W
R34,R35	1M	0.25W
R37-R43	10k	0.25W
R44	100	0.25W
R45,R53	100k	0.25W
R46,R59	1M	0.25W
R47	1k	0.25W
R48,R49,R52	4x10k	SIL 8PIN/4RESISTOR
R50,R60	10k	0.25W
R51	220	0.25W
R54	27k	0.25W
R55	1k8	0.25W
R56,R150	470	0.25W
R57	3M9	0.25W
R58	47k	0.25W
R61,R62	100	0.5W
R63	47	0.5W
R64-R68	*	
R69,R97-R100	20k 1%	0.25W
R71,R82,R83	2k2	0.25W
R72	500 1T	TRIMPIHER PN18EZA
R73-R80	*	
R81	3M9	0.25W
R84	8x10k	SIL 9PIN/BRESISTOR
R85	1k	0.25W
R86,R87	10k 1%	0.25W
R88	100k	0.25W
R89	10k	0.25W
R90	100	0.25W
R91-R96	4x10k 2%	SIL8PIN/4RESISTOR
R101	4k7	0.25W
R102-R104	1k	0.5W
R105-R107	1k5	0.5W

R108-R110	470	0.5W
R111	220	0.25W
R112,R113,R115	100k	0.25W
R114	1M	0.25W
R116	0.1 OHM	4W
R117	47k	0.25W
R118	3k3	0.25W
R119	27k	0.25W
R120	10k 1T	TRIMBOURNS 3386P
R121	0 OHM	(JUMPER)
R122,R128,R129	220	0.25W
R123	2k2	0.25W
R124-R126	*	
R127	5k 15T	TRIMBOURNS 3006P
R130	3.3 OHM	0.5W
R131,R135,R148	10k	0.25W
R132-R134	82k 1%	0.25W
R136,R141,R149	4x10k	SIL 8PIN/4RESISTOR
R137	39	1W
R138,R142	220	0.25W
R139	51k 1%	0.25W
R140	100	9W
R143-R145	10k 1%	0.25W
R146	125mAF	4MODPICO FUSE
R147	15k	0.25W
R151	180k	0.25W
R153-R164	150	0.25W

(RESISTORS 5% TOLERANCE UNLESS OTHERWISE STATED)

CT1	NTC	PHILIPS 640/3977	-10k
C1,C2	15p/63	1MOD	CERAMIC
C3,C4	10n/63	1MOD	CERAMIC
C5-C11,C20	1u/35	1MOD	TANTAL
C12	10u/16	1MOD	TANTAL
C13	1u/35	1MOD	TANTAL
C14-C19	1n/63	1MOD	CERAMIC
C21	150p/63	1MOD	CERAMIC
C22	10n/63	2MOD	POLYESTER
C23	4u7/16	1MOD	TANTAL
C24,C73,C74	1u/35	1MOD	TANTAL
C25	150p/63	1MOD	CERAMIC
C26	27p/63	1MOD	CERAMIC
C27	10u/16	1MOD	TANTAL
C28,C29	1u/35	1MOD	TANTAL
C30	10n/63	1MOD	CERAMIC PHILIPS TYPE 62908
C31-C34	1u/35	1MOD	TANTAL
C35,C36	10u/16	1MOD	TANTAL
C37-C43,C61,C62	1u/35	1MOD	TANTAL
C44-C45	10u/16	1MOD	TANTAL
C46	10u/35	1MOD	TANTAL
C47	u1/63	2MOD	POLYESTER
C48,C49	1n/63	1MOD	CERAMIC
C50,C52,C53	u1/63	2MOD	POLYESTER

C51	10n/63 2MOD	POLYESTER
C54	u22/63 2MOD	POLYESTER
C55	220u/6310MOD	AXIAL ELLYT
C56	22n/63 2MOD	POLYESTER
C57,C58	10n/63 1MOD	CERAMIC
C59,C60	15p/63 1MOD	CERAMIC
C63	27p/63 1MOD	CERAMIC
C64	100u/408MOD	AXIAL ELLLYT PHILIPS TYPE 031
C65	2200/63AXIELL	ELLYT PHILIPS TYPE 021
C66,C68	1u/50 1MOD	ELLYT
C67,C69-C71	1u/35 1MOD	TANTAL
C72	1u/250 11MOD	POLYESTER
D1,D10	IN4002	DIODE
D2,D25,D27	SLH56VRLED RED	
D3,D4	SLH56YYLED YELLOW	
D5-D8	SLH56MGLED GREEN	
D9	4V3/0.5WZENERDIODE	
D11,D12,D59	5V6/0.5WZENERDIODE	
D13-D23	IN4148 DIODE	
D24,D28	BAS45 DIODE	
D26,D27	IN4148 DIODE	
D29	BAT42 DIODE	
D30	IN4148 DIODE	
D31,D32	IN4148 DIODE	
D33-D37	BYW29F200DIODE INSULATED	
D38	BAS 45DIODE	
D39,D40	IN4148 DIODE	
D41	60S1/6A1DIODE	
D42	IN4002 DIODE	
D43-D47	IN4148 DIODE	
D48	3.0V/0.5WZENERDIODE	
D49-D54	IN4148 DIODE	
D55	30V/0.5WZENERDIODE	
D56	18V/0.5WZENERDIODE	
D57,D58	IN5822 DIODE	
D60,D61	12V/5WZENERDIODE	
B1	BR64 RECTIFIER	
SC1,SC2	S4010LS2THYRISTOR	
Q1-Q15,Q21-Q23	BC547BTRANSISTOR	
Q16-Q20	*	
Q24	*	
Q25,Q26	BC557BTRANSISTOR	
Q27	BD136"	
Q28	BC547B"	
U1,U2	MC34064P-5IC	
U3	MC68HC11A1FN	
U4	REF02"	
U5	74HC573"	
U6	27C256"	
U7	74HC00"	
U8	74HC138"	
U9,U10	74HC574"	
U11	CD4053"	
U12,U13	ULN2003A	

U14-U16	LM324N"
U17,U18	CD4093"
U19	CD40106"
U20	CD4060"
U21	C4040 "
U22	7805UC"
U23	7809UC"
U24	CD4060"
U25	78L05 "
U26-U30	* "
U32	MC68HC811E2FN"
U33	LM324N"
U34	MC33035P"
U35	MPM3003DRIVERMODULE MOTOROLA
U36	LM317TIC
U37	7824UC"
U38,U39	78L12 "
X1,X3	8.0 MHz PARCRYSTAL
X2,X4	32.768 kHz"
L1-L3	100uH/3AFILTER CHOKE
P1-P6	10k LIN POTBOURNS TYPE 91
LR1	HLMP-2550/HPLEDBAR GREEN
PZ1	QFP-03ABUZZER STAR MICRONICS
SW1	RF15-AG YELRAFI-SWITCH WITH LED
SW3	RF15-AG GREEN"
K1	*
K2-K4	M4-24HRELAY
K5	ST1-L2-24VRELAY
K6	SGR282-24VDCRELAY ELESTA
CN1	10-POL IDC
CN2	*
CN3,CN6	50-POL IDC
CN4	20-POL IDC
CN5	*
CN7,CN10	8-POL TERMINAL(WAGO 231-368/001-000)
CN8	2-POL TERMINAL(WAGO 231-362/001-000)
CN9	6-POL TERMINAL(WAGO 231-366/001-000)
CN11-CN14	4MM-FEMALEINSULATED TERMINAL
CM1-CM3	10-POLTRANSITION CONNECTOR
CM4	20-POLTRANSITION CONNECTOR
FC1	10-POL IDC W STRAIN RELIEF
FC2-FC3	*
FC4	20-POL IDC W STRAIN RELIEF
RF1-RF5	10nF EMI-FILTERMURATA DSS306-91FZ103N100
BT1,BT2	3.6V/110mAhNiCd VARTA 3/V100R-LP1+2
G1,G2	MPX10DPPRESSURESENSOR MOTOROLA
TP1-TP11	TESTPOINTMOLEX
J1,J2	JUMPER (1/18)
F1	3.15A FAST FUSE 5x20mm
SOCKET FOR LR1(8/20)	
SOCKET FOR G1,G2(8/20)	
SOCKET FOR U3,U32 52-POL PLCC	

SOCKET FOR F1 WITH CAP
RIBBON CABLE 10-POL FOR CM1-CM3
RIBBON CABLE 20-POL FOR CM4

M1KM66/100 μ A INSTRUMENT

HEATSINK FOR U22,U23,U36AAVID 576802B03100

SCREWS, WASHERS, NUTS FOR G1,U31,U35,U37,D33-D37

8.18 List of components PV 501-2, Rev. XD

R1,R70	3M9	0.25W
R2	8x10k	SIL 9PIN/8RESISTOR
R3	1k	0.25W
R4	100	0.25W
R5	27k	0.25W
R6	2k2	0.25W
R7-R13,R15	1k8	0.25W
R14	2k2	0.25W
R16	4k7	0.4W
R17,R19	180	0.25W
R18	390	0.25W
R20	4x33k	SIL 8PIN/4RESISTOR
R21	50k	15T TRIM BOURNS 3006P
R28	100k	15T TRIM BOURNS 3006P
R22,R23	1M	0.25W
R24	20	15T TRIM BOURNS 3006P
R25,R36	4x100k	SIL 8PIN/4RESISTOR
R26,R27	10k 1%	0.25W
R29	4x10k	SIL 8PIN/4RESISTOR
R30-R35	*	
R37-R43	10	0.25W
R44	100	0.25W
R45,R53	100k	0.25W
R46,R59	1M	0.25W
R47	1k	0.25W
R48,R49,R52	4x10k	SIL 8PIN/4RESISTOR
R50	10k	0.25W
R51	220	0.25W
R54	27k	0.25W
R55	1k8	0.25W
R56,R150	470	0.25W
R57,R81	3M9	0.25W
R58	47k	0.25W
R60	*	
R61,R62	1k	0.5W
R63	47	0.5W
R64-R69	*	
R97-R99	20k 1%	0.25W
R71,R82,R83	2k2	0.25W
R72	500 1T TRIMPIHER	PN18EZA
R73	56k	0.25W
R74-R80	*	
R84	8x10k	SIL 9PIN/8RESISTOR
R85	1k	0.25W
R86,R87	10k 1%	0.25W
R88	100k	0.25W
R89	10k	0.25W
R90	100	0.25W
R91-R96	4x10k 2%	SIL 8PIN/4RESISTOR
R100	20k	0.25W
R101	4k7	0.25W
R102-R104	1k	0.5W

R105-R107	1k5	0.5W
R108-R110	470	0.5W
R111	220	0.25W
R112,R113,R114	1500k	0.25W
R114	1M	0.25W
R116	0.1 OHM	4W
R117	47k	0.25W
R118	3k3	0.25W
R119	15k	0.25W
R120	10k 1T	TRIMBOURNS 3386P
R121	*	
R122,R128,R129	2200	0.25W
R123	2k2	0.25W
R124	10k	0.25W
R125	0 ohm	
R126	10k	0.25W
R127	5k 15T TRIM	BECKMAN 67Y
R130	3.3 OHM	0.5W
R131,R135,R136	10k	0.25W
R132-R134	82k 1%	0.25W
R136,R141,R149	4x10k	SIL 8PIN/4RESISTOR
R137	39	1W
R138,R142	220	0.25W
R139	51k 1%	0.25W
R140	100	9W
R143-R145	10k 1%	0.25W
R146	125mAF 4MOD	PICOFUSE (ELFANR 33-034-19)
R147	15k	0.25W
R151	180k	0.25W
R153-R162	150	0.25W
R163	270 1%	0.25W
R164	150 1%	0.25W
R165	10k	0.6W
R166-R167	10k	0.6W
R168-R169	220k	0.6W
R170,R171	4x10k	SIL 8PIN/4RESISTOR
R172	100	0.6W
R173	*	
R174	2k2	0.5W
R175	2k2	0.5W
CT	NTC	PHILIPS 640/3977-10k (ELFANR 60-260-41)
C1,C2	15p/63	1MODCERAMIC
C3,C4	10n/63	1MODCERAMIC
C5,C28	1u/50	1MOD ELLYT
C6-C11,C20	1u/35	1MODTANTAL
C12	10u/16	1MODTANTAL
C13	1u/35	1MODTANTAL
C14-C17	1n/63	1MODCERAMIC
C18-C19	*	
C21	150p/63	1MODCERAMIC
C22	10n/63	2MOD POLYESTER
C23	4u7/16	1MODTANTAL
C24,C73	1u/35	1MODTANTAL
C25	150p/63	1MODCERAMIC

C26	27p/63	1MOD CERAMIC
C27	10u/16	1MOD TANTAL
C29	1u/35	1MOD TANTAL
C30	10n/63	1MOD CERAMIC PHILIPS TYPE 62908
C31-C34	1u/35	1MOD TANTAL
C35,C36	10u/16	1MOD TANTAL
C37-C40,C42,C43	1u/35	1MOD TANTAL
C41	1u/50	1MOD ELLYT
C44-C45	10u/16	1MOD TANTAL
C46	10u/50	1MOD ELLYT
C47	u1/63	2MOD POLYESTER
C48,C49	1n/63	1MOD CERAMIC
C50,C52,C53	u1/63	2MOD POLYESTER
C51	10n/63	2MOD POLYESTER
C54	u22/63	2MOD POLYESTER
C55	220u/63	10MOD AXIAL ELLYT
C56	22n/63	2MOD POLYESTER
C57,C58	10n/63	1MOD CERAMIC
C59,C60	15p/63	1MOD CERAMIC
C61,C62,C66-C70	1u/50	1MOD ELLYT
C63	27p/63	1MOD CERAMIC
C64	100u/40	8MOD AXIAL ELLYT PHILIPS TYPE 031
C65	2200/63	AXIELL ELLYT PHILIPS TYPE 021
C71	1u/35	1MOD TANTAL
C72	1u/250	11MOD POLYESTER (ELFANR 65-236-66)
C74	100u/16	1MOD ELLYT
C75	100u/25	6MOD AXIAL ELLYT
C76-C77	10u/16	1MOD TANTAL
C78	10n/63	1MOD CERAMIC PHILIPS TYPE 62908
C79	u1/63	2MOD POLYESTER
D1,D10	1N4002	DIODE
D2,D25,D27	SLH56VR	LED RED
D3,D4	SLH56YY	LED YELLOW
D5-D8	SLH56MG	LED GREEN
D9	4V3/0.5W	ZENERDIODE
D11,D59	5V6/0.5W	ZENERDIODE
D12,D26	*	
D13-D23	1N4148	DIODE
D24,D28	BAS45	DIODE (ELFANR 70-100-10)
D27	12V/1.3W	ZENERDIODE
D29	BAT42	DIODE
D30	1N4148	DIODE
D31,D32	1N4148	DIODE
D33-D37	BYW29F200	DIODE INSULATED
D38	BAS45	DIODE
D39,D40	1N4148	DIODE
D41	60S1/6A1	DIODE
D42	1N4002	DIODE
D43-D47	1N4148	DIODE
D48	3.0V/0.5W	ZENERDIODE
D49-D54	1N4148	DIODE
D55	30V/0.5W	ZENERDIODE
D56	18V/0.5W	ZENERDIODE
D57	BYV143F-45	DUAL SCHOTTKY

D58	60S1/6A1	DIODE
D60,D61	12V/5W	ZENERDIODE
D62-D65	1N4148	DIODE AXIAL 4MOD
D66	3V0/1.3W	ZENERDIODE
DF1-DF3	UF4004	DIODE SCHOTTKY
B1	BR64	RECTIFIER
SC1,SC2	BT151	THYRISTOR
Q1-Q15,Q21-Q23	BC547B	TRANSISTOR
Q16-Q20	*	
Q24	*	
Q25,Q26	BC557B	TRANSISTOR
Q27	BD136	TRANSISTOR
Q28	BC547B	TRANSISTOR
Q29,Q30	BC547B	TRANSISTOR TO92
U1,U2	MC34064P-5	TO92
U3	MC68HC11A1FN	PLCC52
U4	REF02	DIP8
U5	74HC573	DIP20
U6	27C256	DIP28
U7	74HC00	DIP14
U8	74HC138	DIP16
U9,U10	74HC574	DIP20
U11	CD4053	DIP16
U12,U13	ULN2003A	DIP16
U14	LM224	DIP14 CERAMIC
U15	*	
U16	LM324N	DIP14
U17,U18	CD4093	DIP14
U19	CD40106	DIP14
U20	CD4060	DIP16
U21	CD4040	DIP16
U22	7805UC	TO220
U23	7812UC	TO220
U24	CD4060	DIP16
U25	78L05	TO92
U26-U30	*	
U31	7805UC	TO220
U32	MC68HC811E2FN	PLCC52
U33	LM324N	DIP14
U34	MC33035P	TO92
U35	*	
U36	LM317T	TO220
U37	7824UC	TO220
U38,U39	78L12	TO92
U40	CD4093	DIP14
U41	4040	DIP16
MF1-MF3	BDX34C	TRANSISTOR TO220
MF4-MF6	MTP5N20	MOSFET TO220
DF1-DF3	UF4004	DIODE SCHOTTKY
X1,X3	8.0 MHz PAR	CHRYSTAL HC49
X2,X4	32.768 kHz	CHRYSTAL RADIAL 1MOD
L1-L3	100uH/3A	FILTER CHOKE (ELFANR 58-690-29)
L4	20uH/2A	SIEMENS B82134-A5202M
P1-P6	10k LIN POT	BOURNS TYPE 91

LR1	HLMP-2550/HP	LEDBAR GREEN (ELFANR 75-523-67)
PZ1	QFP-03A	BUZZER STAR MICRONICS(ELMETRIC AB)
SW1	RF15-AG YEL	RAFI-SWITCH WITH LED
SW3	RF15-AG GREEN	"
SW2,SW4	RF15-OBEL-AG	RAFI-SWITCH W/O LED
SW5	2-POL SWITCH	FUJISOKU ATE2D-6M3-10
SW6	2-POL SWITCH	FUJISOKU ATE2D-6M3-10
K	*	
K2-K3	RELAY	M4-24H (ELFANR 37-043-76)
K4	RELAY	CLARE CUPV 10302
K5	RELAY	ST1-L2-24V (ELFANR 37-064-62)
K6	RELAY	ELESTA SGR282-24VDC
CN1	10-POL IDC	(ELFANR 43-650-03)
CN2	*	
CN3,CN6	50-POL IDC	(ELFANR 43-650-78)
CN4	20-POL IDC	(ELFANR 43-650-37)
CN5	*	
CN7,CN10	8-POL TERMINAL	(WAGO 231-368/001-000)
CN8	2-POL TERMINAL	(WAGO 231-362/001-000)
CN9A	4-POL TERMINAL	(WAGO 231-364/001-000)
CN9B	2-POL TERMINAL	(WAGO 231-362/001-000)
CN11	-POL CAGECLAMP	(WAGO 233-202)
CN12	9-POL DSUB FEM.	(ELFANR 44-056-01)
CM1-CM3	10-POL	TRANSITION CONNECTOR(ELFANR 43-654-09)
CM4	20-POL	TRANSITION CONNECTOR (ELFANR 43-654-33)
FC1	10-POL IDC	(ELFANR 43-646-00)WITH STRAIN RELIEF (ELFANR 43-647-09)
FC2-FC3	*	
FC4	20-POL IDC	(ELFANR 43-646-34)WITH STRAIN RELIEF (ELFANR 43-647-33)
RF1-RF5	10nF EMI-FILTER	MURATA DSS306-91FZ103N100 (ELFANR 65-640-74)
RF6-RF7	FERRITE	MURATA BL01RN1-A62
VR1	60V VARISTOR	SIEMENS S10K60
VR2	60V VARISTOR	SIEMENS S10K60
BT1,BT2	3.6V/110mAh	NiCd VARTA 3/V100R-LP1+2 (ELFANR 69-379-24)
G1	MPX10DP	PRESSURESENSOR MOTOROLA
TP1-TP6	*	
TP7-TP11	TESTPOINT	MOLEX (ELFANR 48-415-65)
TC1	IDC16 MALE	(ELFANR 43-666-47)
J1,J2	JUMPER (1/18)	(ELFANR 43-709-04)
J3	*	
F1	3.15A FAST	FUSE 5x20mm
F2	3.5A SLOW	PICOFUSE
SOCKET FOR LR1	(8/20)	(ELFANR 48-155-36)
SOCKET FOR G1	(8/20)	(ELFANR 48-157-91)
SOCKET FOR U3,U32	52-POL PLCC	(ELFANR 48-109-41)
SOCKET FOR U14	DIP14 CLOSED FRAME	
SOCKET FOR F1	WITH CAP	(ELFANR 33-150-17, 33-150-25)
RIBBONCABLE	10-POL FOR CM1-CM3	
RIBBONCABLE	20-POL FOR CM4	
M1	KM66/100uA	(ELFANR 76-210-30)
SCALE FOR M1		
MV1,MV2	MAGNETVALVE	PNEUTRONICS TYPE 11-18-3-BV-24P

HEATSINK FOR U22,U23,U36

AAVID TYPE 576802B03100

SCREWS, WASHERS, NUTS FOR:
U37,D33-D37,MF1-MF6

G1,M1,SC1,SC2,D57,U31,U37,

LOCKNUTS FOR CN12 4-40UNC

RESISTORS 5% TOLERANCE UNLESS OTHERWISE STATED.
ELFANR REFERENCES TO PARTNUMBER ELFA AB, SWEDEN.
* INDICATES COMPONENT DOES NOT EXIST.

9 FAULT TRACING

9.1 Fault tracing guide

SYMPTOM	PROBABLE CAUSE	ACTION	SEE CH.
The "internal battery" LED flashes when running from mains power.	Mains cable incorrectly connected.	Connect mains cable.	2
	Mains fuse blown.	Replace fuse.	2
	Measure the voltage for contact CN5 (MDA board) between pins 1 and 2. Should be approx. 25 VAC.	If no voltage is present replace the transformer. If voltage is present replace MDA circuit board.	8
Does not operate from internal battery.	Batteries dead.	Connect PV 501 to mains supply to charge the batteries.	2
	Fuse F1 on MDA circuit board blown.	Replace fuse.	8
	Measure voltage between TP1 and TP3 (charging voltage) Should be approx. 28.2 VDC.	If charging voltage is present, replace battery. If charging voltage is not present replace MDA circuit board.	8 8
Does not operate from external battery.	External battery cable incorrectly connected/open circuit.	Reconnect cable / measure and repair the cable breakage.	2
	Ext.bat. fuse blown.	Replace fuse.	2
	If the fuse blows immediately when external battery cable is connected.	Check the polarity of the connection contact battery cable.	2

Continued on next page.

Fault tracing guide (cont.)

SYMPTOM	PROBABLE ERROR	ACTION	SEE CH.
Ventilator not providing sufficient air pressure/ air volume.	Leakage in patient air-hose/ mask.	Check the air-hose, mask and exhalation valve for leakage.	2
	Internal leakage, air-hoses, bellows, non-return valves.	Run a leakage check.	3
	Filter blocked.	Replace filter.	3
Motor only runs the bellows towards the side unit with opto-switches.	The opto-switch is not registering home position.	Check the function of the opto-switch. If the voltage levels are correct replace MDA board. If voltage for pins 1 & 2 in CN7 is > 1.1 V replace the motor unit.	8
Pressure gauge does not register any pressure.	Internal air-hose blocked.	Check the air-hose and nipples.	5
	Gauge broken.	Using a voltmeter connected to pressure output in the rear panel, check to see if a change in pressure results in a change in voltage. P=0 cm H ₂ O gives 1V, 30cm H ₂ O gives 4V. If OK, replace the gauge. If not OK, replace CPU board.	8

9.2 Error codes

Should there be a fault in the function of the PV 501 an error code is created and stored in the PV 501's memory. At the same time, the LED for "Function failure" flashes and the cause of the error is indicated by a combination of LEDs lighting as shown in the table below. Note! The LED for Charging is not used in any combination.

The PV 501's memory allows a maximum of 5 error codes to be stored. Should a sixth error occur, the earliest error code stored will be deleted.

9.3 Recalling error codes

With the ventilator switched off, press and hold the Alarm mute button and start the PV 501. This procedure will provide electrical power to the PV 501, but the motor unit is disabled. All the LED indicators (except Mains/Charging) will briefly flash.

Press the Alarm mute button again to see the first (latest) error code (an audible signal will be heard consisting of one beep). Press again to see the second error code (an audible signal consisting of two beeps is given to indicate the second error code). As the contents of the memory is read the audible alarm will beep the number of times corresponding to the error code number (1 through 5). When the last error code is reached all the LED indicators (except Mains/Charging) will light and the LED in the Alarm mute button will light.

To see the error codes again, the PV 501 must be switched off and then restarted as described above.

9.4 Erasing the error code memory

Step through all the error codes stored, as described above, until the last code is displayed. If there less than five errors stored, continue to press the alarm mute button until five beeps are heard. The memory can then be erased by pressing and holding the Alarm mute button.

All the LEDs will light to indicate the memory has been deleted.

9.5 ERROR CODE TABLE

ERROR	LED COMBINATION				
	FUNCTION FAILURE	LOW PRESSURE	HIGH PRESSURE	LOW BATTERY	TRIGGER
SLAVE-PROCESSOR-ERROR	●	0	0	0	0
REFERENCE MOVEMENT-ERROR	●	●	0	0	0
PRESSURE TRANSDUCER ERROR	●	0	●	0	0
TIME-OUT ERROR	●	●	●	0	0
LOW BATTERY CUT OFF	●	0	0	●	0
MEMORY ERROR	●	●	0	●	0
SOFTWARE ERROR	●	0	●	●	0
MASTER PROCESSOR ERROR	●	●	●	●	0
ALARM BATTERY UNCHARGED	●	0	0	0	●
MOTOR ENCODER ERROR	●	●	0	0	●
PROGRAM MEMORY ERROR	●	0	●	0	●
POTENTIOMETER ERROR	●	●	●	0	●

● = ON, 0 = OFF

If the Function Failure LED shows a steady light this indicates a problem with the processor memory which means that the error codes cannot be retrieved.

9.6 Fault tracing using the error codes

SYMPTOM	PROBABLE ERROR	ACTION	SEE CHP.
Slave Processor Error	Communication error between the processors.	Replace MDA board.	8
Reference Movement Error	Bellows end cover has not reached limit position within 10 seconds of start-up.	Replace the motor unit. If problem persists, replace MDA board	6 8
Pressure Amplifier/ Transducer Error	Voltage from pressure amplifier lies outside 1.0 V +/- 20 % at 0 cm H ₂ O at start-up.	Adjust the pressure amplifier.	8
Time-Out Error	An inhalation has taken longer than 15 seconds.	Replace MDA board.	6
Low Battery Cut Off	Internal battery voltage has dropped below 22 V.	Charge the batteries by connecting the ventilator to the mains supply. If the problem persists, replace the batteries.	8 8
Memory Error	Error in memory for master processor.	Replace CPU board.	6
Software Error	Interference, error in databus	Replace CPU board.	6
Master Processor Error	Watchdog, internal error in master processor U3.	Replace CPU board.	6
Alarm Accumulators Discharged	Voltage in the alarm battery < 5 V.	Charge the batteries by connecting the ventilator to the mains supply. If the problem persists, replace the batteries.	8 8
Motor Encoder Error	Error in motor unit.	Replace the motor unit.	6
Program Memory Error	PROM error.	Replace EPROM U6 on CPU board	8
Potentiometer Error	One of the setting potentiometers P1 - P6 has broken or short-circuited.	Replace the potentiometer board.	8

10-1 ENGINEERING CHANGE HISTORY PV 501 and PV 501-2

<u>From serial No.</u>	<u>Change made</u>
5127	Firmware upgrade Master MQ, Slave SK Adjustment of low pressure alarm level
5180	Transformer moved to rear panel.
5329	Firmware upgrade Master MS, Slave SL Faster trigger.
5512	Firmware upgrade Master MT4, Slave SL Error code memory.
5740 (May 1997)	Firmware upgrade Master MT4, Slave SM Firmware upgraded to handle new power transistors and later on, the new motor BEI.
5896 (October 1997)	Firmware upgrade Master MT5, Slave SM Erasable error code memory.
6070 (March 1998)	Firmware upgrade Master MT6, Slave SM SEI/CLI before/after check in GOROK1 & BIG2B) (Both SL & SM are compatible with MT6)
M38000	Firmware upgrade Master MT7 (Slave SM is compatible with MT7) CPU board, diod D27 omitted.
October 1998	MDA rev. F. new Schottky diods D57 and D58 now one dual 10A BYV143(=D57). D58 now for protection from wrong polarization of internal battery.
F11177	Release of PV 501-2
F36077	Motor unit rev. 11, new checkvalve seats and new motor coupling

Registration

Model: _____ Serial No. _____ Inventory No. _____

Accessories: _____

Delivery date: _____ No of operating hours: _____

Service started: _____ Signature: _____

Service completed: _____ Signature: _____

Handed over, date: _____ Signature: _____

General checks

Read instruction No.

OK

- Open new service record, register the ventilator 3.5.1 _____
- Information from user 3.5.2 _____
- Check validity of documentation 3.5.3 _____

External checks

- Inspect for external damage and wear 3.6.1 _____
- Check power cables and plugs 3.6.2 _____
- Run minimum function check 3.6.3 _____

Internal checks

- Open ventilator casing 3.7.1 _____
- Clean inside ventilator 3.7.2 _____
- Check cabling and connectors 3.7.3 _____
- Check fastening of components 3.7.4 _____
- Check mains supply 3.7.5 _____

Motor Unit

- Replace motor unit (at 20000 hrs)? 3.7.6 _____
or
- Remove motor unit for inspection 3.7.7 _____
- Lubricate the ball screw 3.7.8 _____
- Replace the check valve membranes 3.7.9 _____
- Leakage test of motor unit and tubes 3.7.10 _____

Other checks

- Check offset adjustment of pressure transducer 3.7.11 _____
- Check instrument accuracy 3.7.15 _____

Batteries

- Replace batteries 3.7.13 / 3.7.14 _____
- Check alarm and internal batteries 3.7.12 _____

Electrical Safety

- Check mains supply value _____ 3.8.1 _____
- Check isolation, Class II type BF. See delivery inspection _____ 3.8.2 _____
- Leakage current Do not forget to reverse the polarity. 3.8.3 _____
- Leakage from exterior NC <0,1 mA (Nominal) 3.8.4 _____
SFC <0,5 mA (Nominal) _____

Patient leakage current NC <0,1 mA (Nominal)	3.8.5	___
SFC <0,5 mA (Nominal)		___
Leakage current with mains on the patient connected parts	3.8.6	___
Only auto test. SFC <5 mA (Nominal)		___

Final inspection before handing over

Function test/Leakage	3.9.1	___
Tidal volume 1 litre, amount measured _____	3.9.2	___
Frequency 12, measured frequency _____	3.9.3	___
Check Pressures:	3.9.4	___
Low pressure 10 cm H ₂ O, registered limit		_____
High pressure 40 cm H ₂ O, measured limit		_____
Check low volume alarm/Alarm mute	3.9.4	___
Check trigger	3.9.5	___
Check battery operation	3.9.6	___
Check any accessories	3.9.7	___
Adjust correct settings for patient	3.9.8	___

Comments and notes:
