TABLE OF CONTENTS

1 INTRODUCTION

1.1 Intended use of the ventilator

The PV 401 is a pressure-controlled, pressure-monitored ventilator, especially developed for treatment in the home of patients with chronic breathing difficulties.

The PV 401 is designed to give many years of trouble-free breathing assistance to the user provided that preventive maintenance is done at the specified intervals described in this manual.

Well-performed maintenance will increase the service life of the ventilator considerably. It is also important that any peripheral equipment and accessories are checked at the time the service is carried out.

1.2 Design and function of the ventilator

The PV 401 is constructed around a bellows and a drive screw assembly driven by an electronically-controlled servo-motor. A microprocessor controls the correct speed of the motor and its power supply by means of calculations based on the settings for pressure, rate, inspiration time etc. The set pressure and the trigger level are monitored at the same time.

In the event of a mains power supply fail, the ventilator will automatically switch to the external battery supply. This is indicated by the LED in the On/Off button flashing. If the external battery voltage drops too low, an audible alarm is given.

1.3 The scope of this manual

The manual contains all the points to be checked during the maintenance service and other service instructions for the PV 401. Also included are reference copies of the Operating Manual and the Patient Data Analysis Manual.

1.4 Intended audience

This Service Manual is intended for technicians who have medical/technical training and knowledge of 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 the simple construction of the PV 401, 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 as described in this manual.

Operating Manual

PV 401

CONTENTS

1 INTRODUCTION

The PV 401 is a pressure controlled and pressure support ventilator.

It has two modes of operation; PSV and PCV. Both modes have an adjustable trigger sensitivity setting which allows the patient to initiate ventilator-assisted breaths.

In PSV mode (Pressure Support Ventilation), the ventilator's expiratory sense can also be adjusted allowing the ventilator to more easily match each patient's needs.

In PCV mode (Pressure Controlled Ventilation) the ventilator provides assisted/controlled breathing.

Explanation of label symbols under the ventilator:

Read the Operating Manual thoroughly before connection to the patient.

Body floating.

Class II equipment; dual isolation.

CE marking applies according to the directive MDD 93/42/EEC.

TÜV approved according to IEC 601-1, EN 794-2.

2 IMPORTANT SAFETY NOTICES

- The PV 401 should not be used for total life support. Use BREAS PV 501 instead.
- Clinic personnel and patients must read this operating manual and understand how the PV 401 works before setting up and using the ventilator.
- Adjustments to settings may only be carried out by authorised clinic personnel.
- Before use, a function check must be performed.
- To ensure maximum operational reliability, the PV 401 must be serviced at the specified intervals by authorised service personnel.
- Oxygen may only be supplied through the patient hose, use BREAS oxygen adapter.
- Do not use the PV 401 in environments where there are explosive gases or other inflammable anaesthetic agents present.
- Do not use patient hoses or tubes made of static or electrically conducting material.
- Electromagnetic fields greater than 10 V/m can affect operation. Examples of equipment that produce electromagnetic fields are defibrillators, diathermia equipment, cellular telephones, etc.
- Do not use a steam autoclave to sterilise the ventilator.
- The ventilator's performance may deteriorate at temperatures below 5°C and above 50°C.
- Do not place the PV 401 on soft surfaces so that the air inlet on the underside can be blocked.
- Always clean all parts that come in contact with the exhalation air before use on a new patient.
- If an air humidifier is used, always place it **lower** than the PV401 to prevent water from running into the ventilator if the humidifier tips over.

3 INSTALLATION

3.1 Unpacking

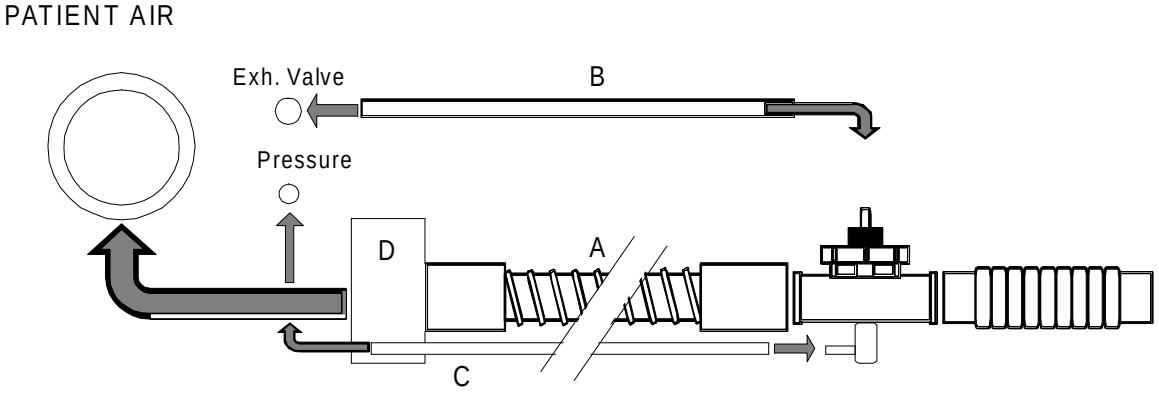
- Check the ventilator for any damage and that all ordered accessories are included.

3.2 Placement

- Place the PV 401 on its feet, on a hard, flat surface. Make sure that nothing can block the patient air inlet under the ventilator.

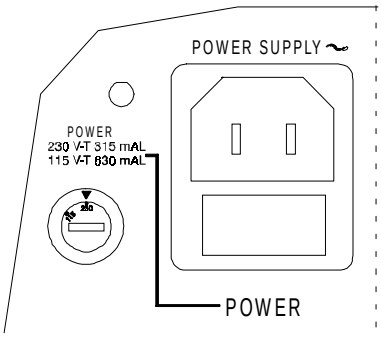
3.3 Connecting the tubes

- Connect the patient circuit (A) to the “PATIENT AIR” outlet on the front panel.
- Connect the thin tube (B) for the exhalation valve to the “EXH. VALVE” nipple.
- Connect the pressure measuring tube (green) (C) to the “PRESSURE” connector.
- If a bacteria filter/oxygen adapter (D) is used, connect it between hose (A) and the patient air outlet.



3.4 Mains power supply

- IMPORTANT! Make sure that the power cord is undamaged before it is connected to the ventilator.

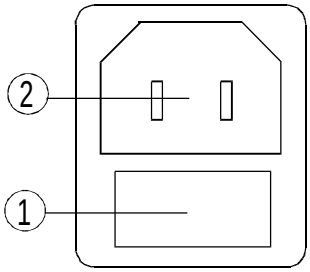


- Check that the voltage selector is set for the voltage the ventilator is to be connected to. Different countries have different power supplies, the USA has, for example 115 V. All European countries have 230 V.
  Voltage range 115 V covers 110 – 120 V
  Voltage range 230 V covers 220 – 240 V

To change the voltage setting

- Make sure the power cord is **not** connected.
- Change by turning with a screwdriver.
- Change to the correct fuse rating.

3.5 Replacing the fuse



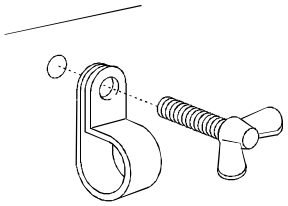
- Check that the power supply fuse ① has the correct rating for the set voltage.

  For 230 V, use a glass fuse F 315 mAL
  For 115 V, use a glass fuse F 630 mAL

- Change the fuse by pulling the fuse holder straight out.

  There is a spare fuse in the holder.

3.6 Power cord



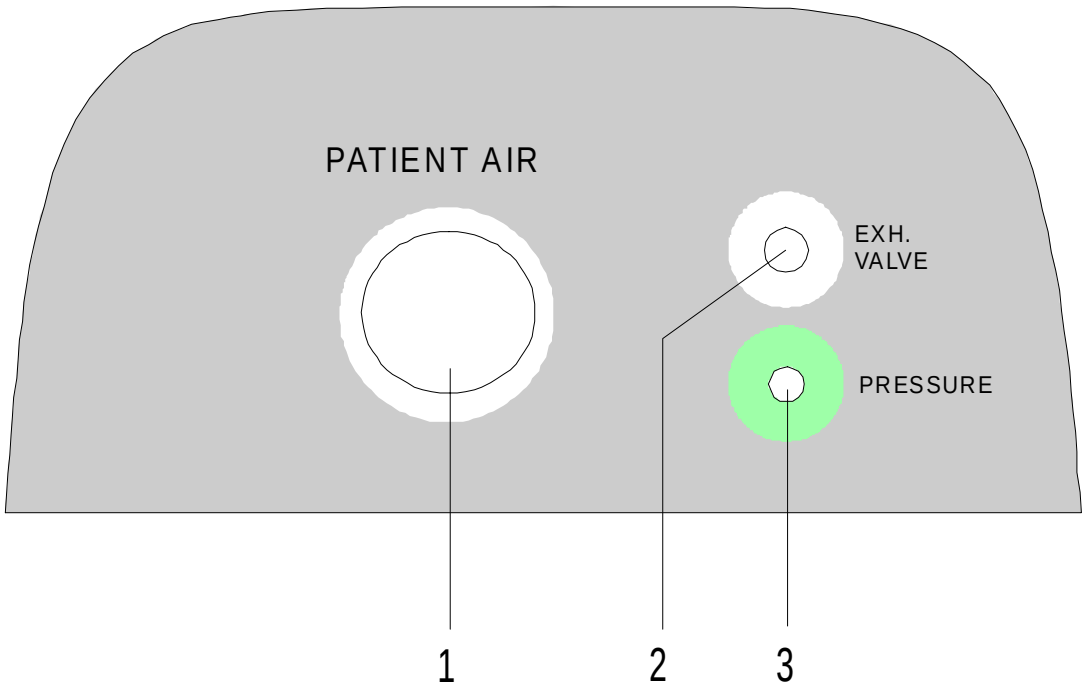
- Connect the power cord to the power socket ②. Only use a BREAS power cord.
- Secure the power cord in the clip to prevent accidental disconnection.

3.7 External battery power

See Chapter 8 for complete information.

4 PANEL DESCRIPTIONS

4.1 Front panel

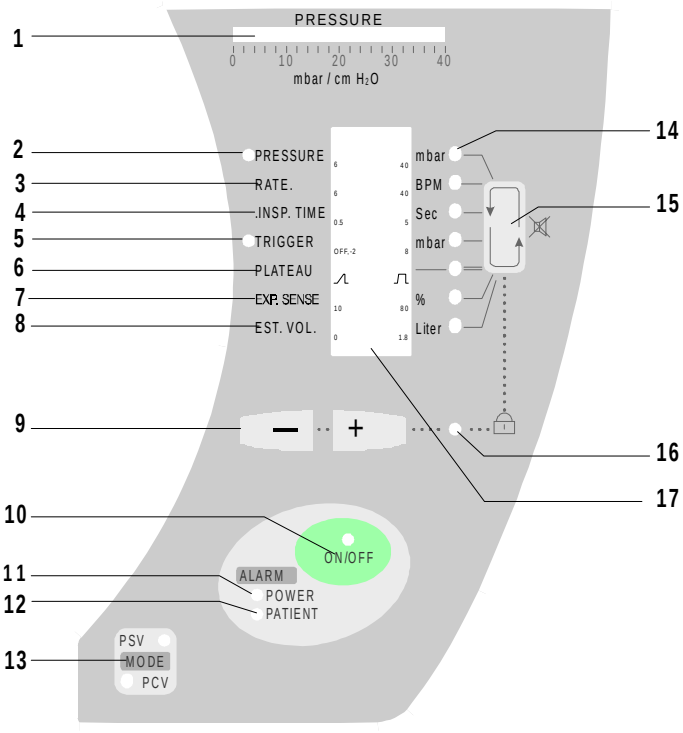


(1) Patient air outlet, ∅ 22 mm ISO cone, male.

(2) Exhalation valve connector, ∅ 4 mm tube.

(3) Connector for pressure measuring at the exhalation valve, ∅ 3 mm tube (green).

4.2 Setting panel description



(1) Patient pressure meter;
0 to 40 mbar/cm H_2O.

(2) Patient pressure setting;
Green LED is lit during inspiration.

(3) Rate setting;
Breaths per minute (BPM).

(4) Inspiration time setting; in seconds
(only active in PCV mode.)

(5) Trigger setting; green LED is lit during a patient triggered inspiration.

(6) Plateau setting; the time to reach the set pressure.

(7) Expiratory sense setting; percentage of maximum flow. (Only active in PSV mode.)

(8) Est. Vol. The tidal volume delivered is displayed here after each breath.
The alarm level setting function for Pressure and low Tidal Volume is also accessed here.

(9) - and + buttons to increase or decrease the selected parameter. The buttons are also used to set the date and time and to make selections in different displays.

(10) ON / OFF switch; Keep pressed for 2 seconds to start or stop the ventilator.

(11) Alarm for power failure; red LED lights if the mains or external battery supply fails. An audible alarm is also given.

(12) Patient alarm. The red LED flashes if the set percentage of the set pressure is not reached within 15 seconds, e.g. due to leakage from the mask and/or the tidal volume is low. An audible alarm is also given together with a flashing arrow indication against the function in question (Pressure and/or Est. Vol) in the display.

(13) Button for changing between PSV (Pressure Support Ventilation) and PCV (Pressure Control Ventilation) mode. Keep pressed for 1 second to change mode.

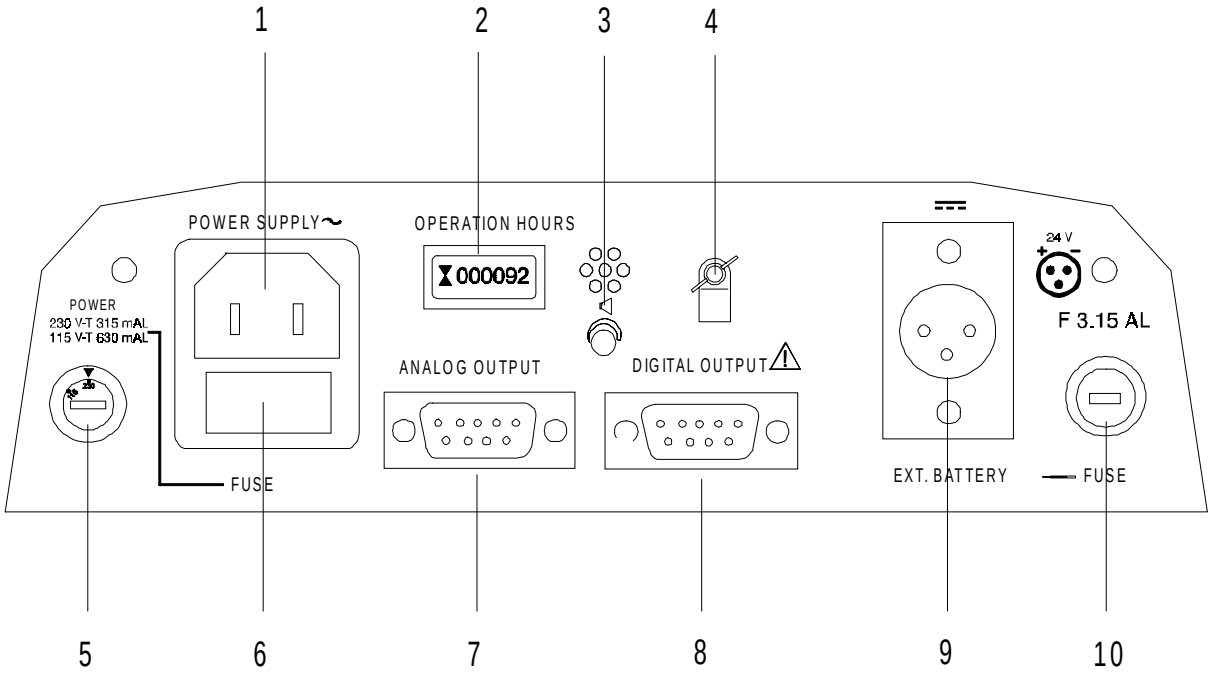
(14) Seven LED indicators showing which function is selected. The selection function's parameter can be adjusted using the **–/+** buttons (9).

(15) Function button. Used to select required parameter or to mute audible alarms for 2 minutes.

(16) Green LED, when lit, indicates that the setting panel is locked.

(17) LCD Display. Shows the current settings. It is also used when setting the Date & Time. The background lights when button (15) is pressed and stays on for 2 minutes after the last press on a setting button.

4.3 Rear panel description



(1) Connection for power cord.

(2) Hour meter, shows the ventilator's total operation time.

(3) Buzzer for alarm. Adjust the sound level using a small screwdriver.

(4) Fastening clamp for power cord.

(5) Voltage selector switch; 115 V or 230 V AC.

(6) Fuse holder with fuse, T 630 mA for 115 V, T 315 mA for 230 V.

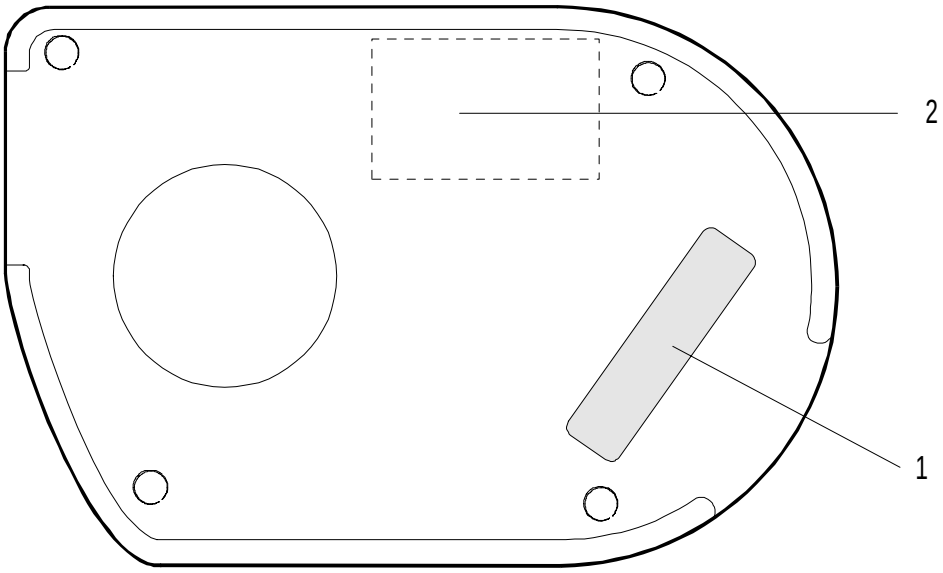
(7) Analog signal output for registering patient pressure and tidal volume, male.

(8) Digital communication connector, female.

(9) Socket for external battery, 24V DC.

(10) Fuse holder with fuse for external battery supply. F 3.15 A.

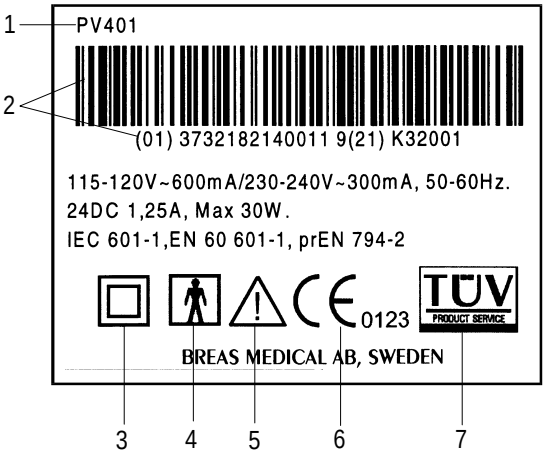
4.4 Underside description



(1) Air inlet and filter for patient air. See Chapter 10 for replacing/cleaning the filter.

(2) Model and serial number label.

Explanation of symbols on label:



(1) Model number.

(2) Serial number.

(3) Class II equipment; dual isolation.

(4) Body floating.

(5) Read the Operating Manual thoroughly before using with the patient.

(6) CE marking applies according to the directive MDD 93/42/EEC.

(7) TÜV approved according to IEC 601-1, EN 794-2.

5 DETAILED FUNCTION DESCRIPTION

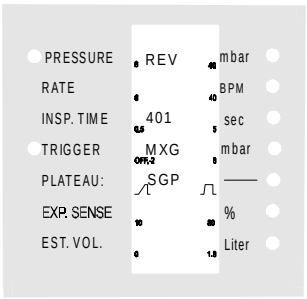
5.1 On/Off button and External battery operation

The green LED shows a steady light when the ventilator is operating from the mains supply. The LED flashes when operating from an external battery.

Press and hold the button for 2 seconds to switch on or off.

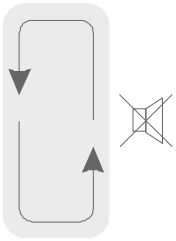
The ventilator should be kept connected to the mains supply, even when not in use, to maintain charging of the alarm batteries.

5.2 Checking the software version



When switching on the ventilator, the software version installed is shown for approx. 1 second before the ventilator starts working.
The illustration shows an example of how the software version designation can appear.

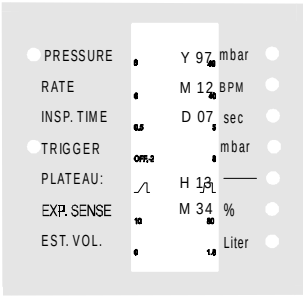
5.3 Function button



This button is used to:

Select the parameter to be adjusted
This button is used to select the required parameter to be set. A lit green LED indicates which parameter is active. If no setting is done within 5 seconds, the selected parameter LED will go off.

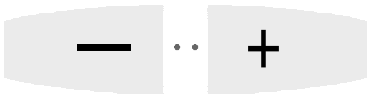
Mute the acoustic alarm
This button is also used to mute acoustic alarms for two minutes.



Select Date & Time
If this button is held while switching on the ventilator, the current date & time is shown in the display. See section 5.6, Setting Date and Time, for more information

Pressing the function button will light the background illumination of the display.

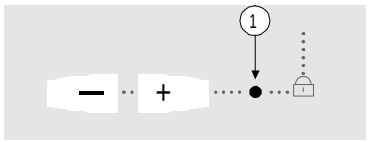
5.4 Decrease/Increase and Selection buttons



These buttons have two functions.
They are used to adjust a parameter setting, press **–** to decrease or **+** to increase the value of the selected parameter. The new setting is saved in the ventilator's memory at the first breath after the value has been set.

The buttons are also used to set the date and time and as Yes/No selection buttons when setting the alarm levels for pressure and tidal volume, where
+ = Yes and - = No.

5.5 Lock function



The lock function is used to lock the setting panel to prevent accidental changes to the settings.

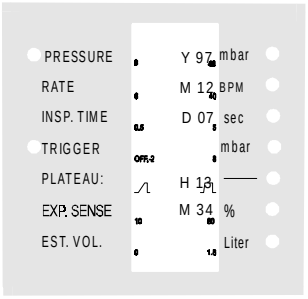
When the LED ① is on, the lock is active. It is now only possible to switch the ventilator On or Off.
Press and hold both the **–** and **+** buttons for 5 seconds to lock or unlock.

5.6 Setting Date and Time

As part of the data storage function, the date and time is recorded to allow analysis of the patient data in the different printouts available.

Note! The clock function uses the 24-hour clock standard.

To check or set the date and time:

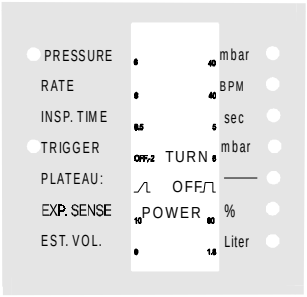


- Press and hold the Function button while pressing the On/Off button.

The display will now show the current settings for date and time.

To change a setting:
- Press the Function button until the LED for the required setting is lit.
- Press + to increase the setting or - to decrease it.
- Continue by moving down through the menu to the M setting.
- To exit this display, press the Function key after the M setting has been selected.

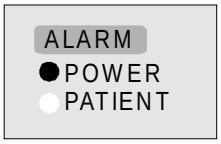
The display will now show the following text.



- Switch off the ventilator.
  The new date and/or time will be saved.

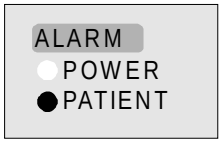
5.7 Alarms

Power (red LED)



Should the power supply fail during operation, the ventilator will alarm by the red LED for “POWER” being lit and an audible alarm. Attempts to start the ventilator without any power source connected will also cause this alarm.

Patient (red LED)



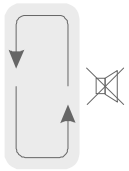
The patient alarm (red LED) flashes if the set percentage of the set pressure is not reached within 15 seconds, e.g. due to leakage from the mask and/or the tidal volume is low. An audible alarm is also given together with a flashing arrow indication against the function (Pressure and/or Est. Vol) in the display.

The alarm is reset once the pressure and/or the tidal volume reaches the set value.

Alarm for low Pressure
The alarm for low pressure can be set as required. Refer to section 5.9.3, Alarm for low Pressure, for information.

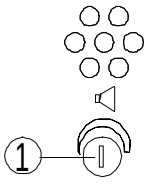
Alarm for low Tidal Volume
The alarm for low Tidal Volume can be set as required. Refer to section 5.9.10, Alarm for low Tidal Volume, for information.

Alarm mute



The alarm can be muted for 2 minutes by pressing the Function (alarm mute) button.
The alarm for low tidal volume can also be adjusted, see 5.7.7.

Alarm sound level



Adjust the sound level of the alarm to a suitable level. Adjust the screw (① in figure) on the ventilator’s rear panel using a small screwdriver.

5.8 PCV & PSV Modes

This section describes the PCV and PSV modes. The ventilator always starts in the mode which was active when it was switched off.

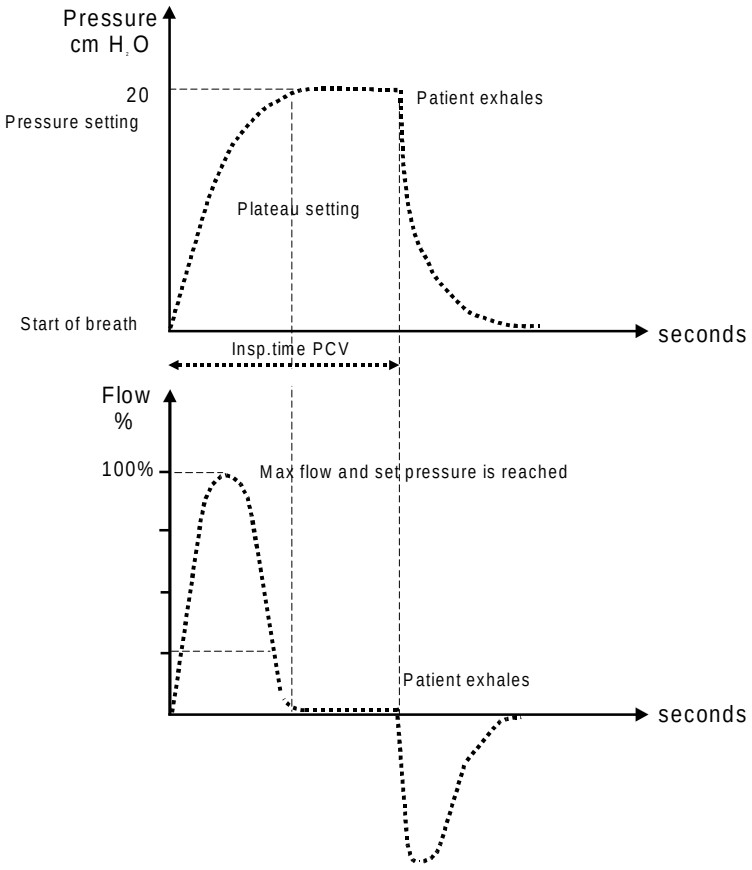
- To change between PSV and PCV mode, press the MODE button for one second.

5.8.1 PCV (Pressure Control Ventilation) Mode

In **PCV** mode, the ventilation is controlled by the ventilator. The RATE setting corresponds to the patient's breathing rate expressed as the number of breaths per minute (BPM). The length of each inspiration is controlled by the INSPIRATION TIME setting. The PLATEAU parameter sets the speed at which the pressure increases to the set value. The lower the setting, the slower the pressure increase will be, a higher setting will give a faster pressure increase and therefore a longer plateau.The setting has 9 steps where 1 is the lowest and 9 is the highest.

The figure below shows how the Pressure and Flow settings control the ventilator's function in PCV mode, where the Pressure setting is 20 cm H_2O, the Inspiration Time is 1.8 seconds and the Plateau setting is 5.

A breath is started when either the set rate starts a breath or the patient triggers a breath (if trigger is activated). The ventilator tries to reach and maintain the set pressure until either the inspiration time setting expires or the bellows reaches its end position.



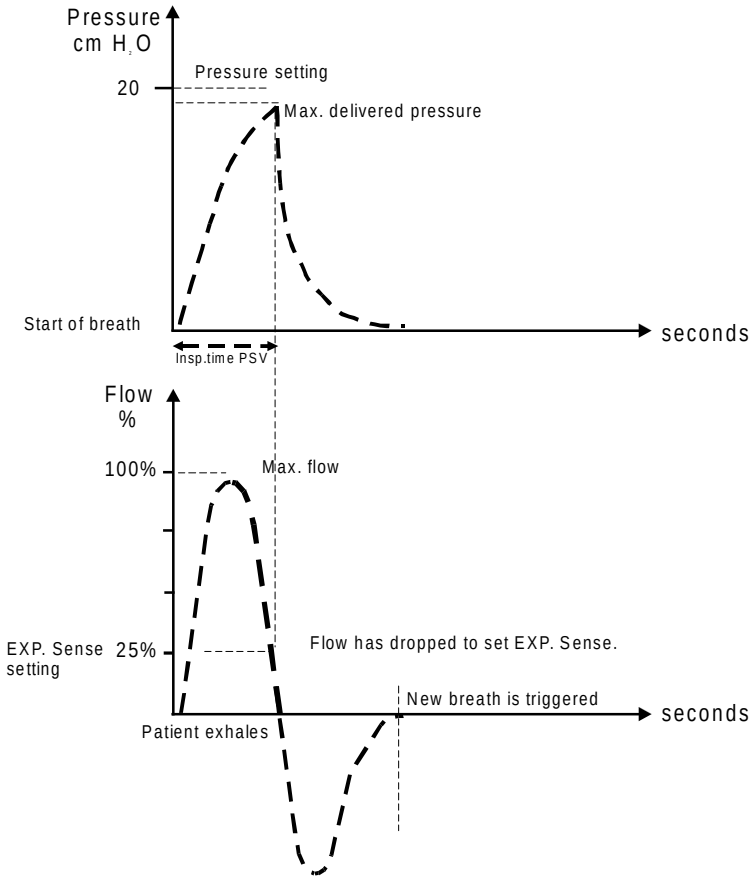
5.8.2 PSV (Pressure Support Ventilation) Mode

In **PSV mode**, the *patient* normally controls both inspiration through the *trigger function*, and exhalation by the *expiratory sense.* If the patient's own "triggering" ceases, the ventilator's *rate* setting will take over where the RATE setting corresponds to the patient's breathing rate expressed as the number of breaths per minute (BPM).

The PLATEAU parameter sets the speed at which the pressure increases to the set value. The lower the setting, the slower the pressure increase will be, a higher setting will give a faster pressure increase. The setting has 9 steps where 1 is the lowest and 9 is the highest.

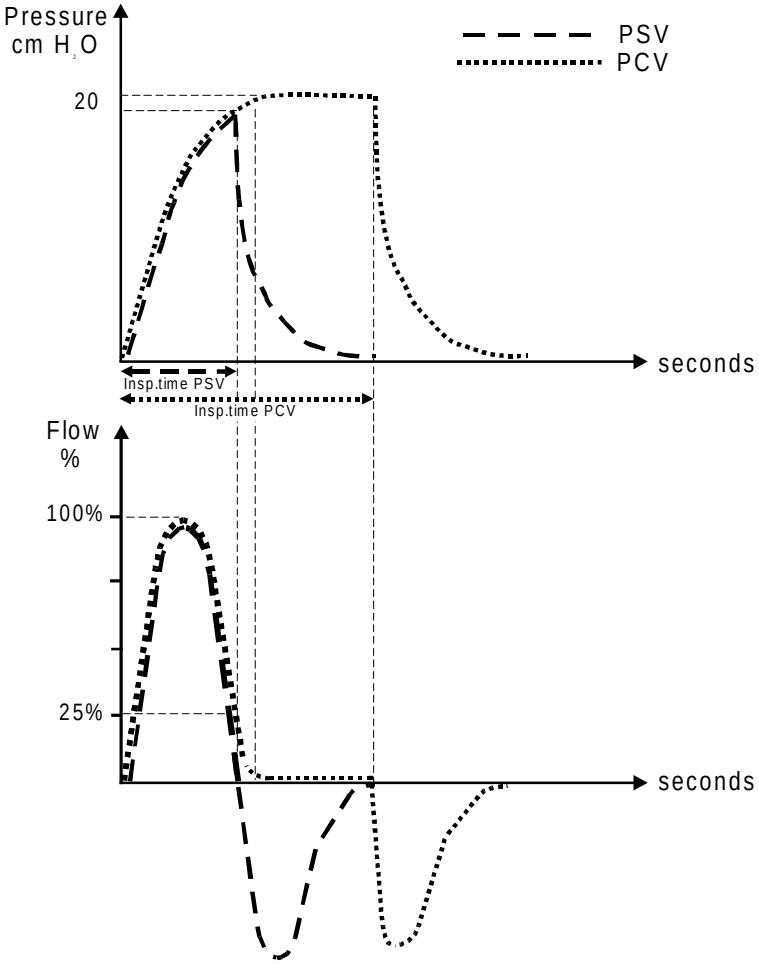
The figure below shows how the Pressure and Plateau (Flow) settings control the ventilator's function in PSV mode, where the Pressure setting is 20 cm H_2O, the Expiration Sense is 25% and the Plateau setting is 5.

A breath is started when either the patient triggers a breath (if trigger is activated) or the set back-up Rate takes over. The ventilator tries to reach and maintain the set pressure until either the flow drops to the "EXP.SENSE" setting (percentage of maximum insp. flow), the bellows reaches its end position or Inspiration is longer than 3 seconds.



5.8.3 Comparing PCV and PSV

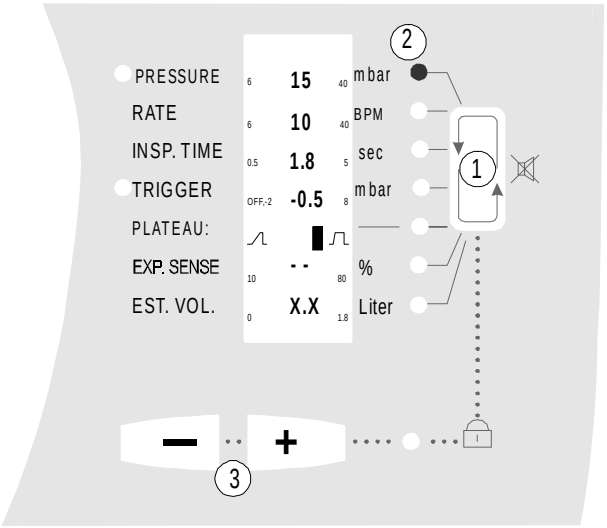
The figure below shows the previous two examples superimposed to illustrate how the PCV and PSV modes differ.



5.9 Settings

This section describes the different parameters and how they are set, both in PSV and PCV modes. Note! Certain parameters are not accessible in the PSV or PCV modes repectively.

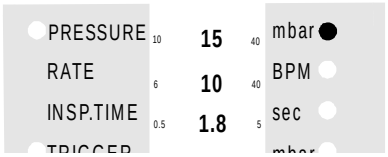
5.9.1 Setting a parameter value



1. Press the Function button until the required parameter is active.
   The parameter is active for 5 seconds after the last button has been pressed, thereafter the parameter must be re-selected in order to be adjusted.
2. Lit LED shows which parameter is active.
3. Adjust to the required setting with the **–** or **+** button.

The settings are saved at the next breath.

5.9.2 Pressure

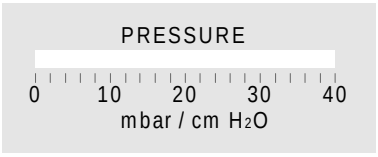


Lit LED indicates the selected parameter.

Setting range: 6 to 40 mbar

Press **–** to decrease or **+** to increase the value of the selected setting.

Pressure meter

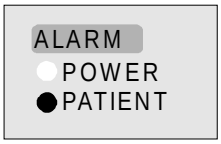


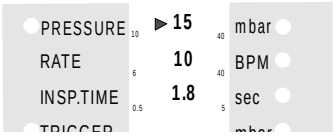
Displays the pressure measured at the exhalation valve.

Range 0 to 40 mbar (cm H_2O).

5.9.3 Alarm for low Pressure

The ventilator has a Pressure alarm function which is activated if the set percentage of the pressure setting is not reached within 15 seconds, e.g. due to leakage from the mask.



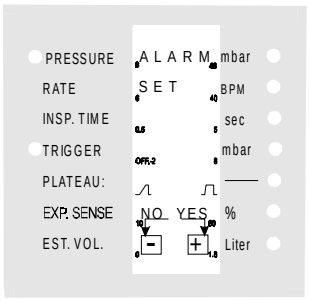


The alarm is given as:

- the red Patient LED flashing
- an audible alarm
- a flashing arrow indication shown against the Pressure field in the display.

The alarm is reset once the pressure reaches its set value again.

5.9.3.1 Setting the alarm level for Pressure

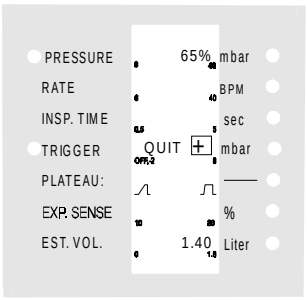


- Make sure the setting panel is not locked.
- Press the Function button until Est. Vol. is selected. The display will change as shown in the figure.

Note! The alarm setting display will only be active for 5 seconds. If no other button is pressed during this time the display will return to standard display. Press the Function button once more to return to the Alarm Setting function.

- Select Yes by pressing the + button.

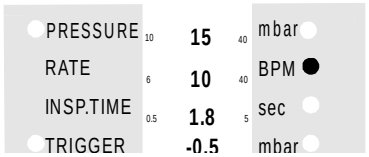
The display will now change as shown below.



- Press the Function button to select the Pressure parameter.
- Adjust the setting using the - or + button as required (within 5 seconds).
- To exit the alarm settings display, select the Trigger function by pressing the Function button and then press the + button (Quit). (Note! If required, the Tidal Volume alarm can also be set before quitting).
  The value is automatically saved when Quit is selected or the display switches back to the standard setting display.

Note! If no other button is pressed within 5 seconds the display will return to standard display. In this case, the entire alarm setting procedure must be repeated.

5.9.4 Rate



Lit LED indicates the selected parameter.

Setting range: 6 to 40 breaths per minute (BPM).

Press **–** to decrease, or **+** to increase the value of the selected setting. The ventilator always gives the set number of breaths, plus any triggered breaths.

5.9.5 Inspiration time

Can only be selected in PCV mode.

Lit LED shows parameter selected.

Setting range: 0.5 – 5 seconds

Press **–** to decrease or **+** to increase the value of the selected setting.

I/E Table

I/E Table
Table for calculating the I/E ratio based on inspirations time and rate

Inspiration time (seconds)	Breaths per minute (BPM)																							
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	22	24	26	28	30	32	34	36	38
0.5	1:19	1:16	1:14	1:12	1:11	1:10	1:9	1:8	1:8	1:7	1:7	1:6	1:6	1:5	1:5	1:4	1:4	1:4	1:3	1:3	1:3	1:3	1:2	1:2
0.6	1:16	1:13	1:12	1:10	1:9	1:8	1:7	1:7	1:6	1:6	1:5	1:5	1:5	1:4	1:4	1:4	1:3	1:3	1:3	1:2	1:2	1:1.9	1:1.8	1:1.6
0.7	1:13	1:11	1:10	1:9	1:8	1:7	1:6	1:6	1:5	1:5	1:4	1:4	1:4	1:4	1:3	1:3	1:3	1:2	1:2	1:1.9	1:1.7	1:1.5	1:1.4	1:1.3
0.8	1:12	1:10	1:8	1:7	1:7	1:6	1:5	1:5	1:4	1:4	1:4	1:3	1:3	1:3	1:3	1:2	1:2	1:1.9	1:1.7	1:1.5	1:1.3	1:1.2	1:1.1	
0.9	1:10	1:9	1:7	1:6	1:6	1:5	1:5	1:4	1:4	1:3	1:3	1:3	1:3	1:3	1:2	1:2	1:1.8	1:1.6	1:1.4	1:1.2	1:1.1			
1.0	1:9	1:8	1:7	1:6	1:5	1:4	1:4	1:4	1:3	1:3	1:3	1:3	1:2	1:2.2	1:2	1:1.7	1:1.5	1:1.3	1:1.1	1:1.0				
1.2	1:7	1:6	1:5	1:5	1:4	1:4	1:3	1:3	1:3	1:2	1:2	1:1.9	1:1.8	1:1.6	1:1.5	1:1.3	1:1.1							
1.5	1:6	1:5	1:4	1:3	1:3	1:3	1:2	1:2	1:1.9	1:1.7	1:1.5	1:1.4	1:1.2	1:1.1	1:1.0									
2.0	1:4	1:3	1:3	1:2	1:2	1:1.7	1:1.5	1:1.3	1:1.1	1:1.0														
2.5	1:3	1:2	1:2	1:1.7	1:1.4	1:1.2	1:1.0																	
3.0	1:2	1:1.9	1:1.5	1:1.2	1:1.0																			
4.0	1:1.5	1:1.4	1:1.1																					
4.5	1:1.2	1:1.1																						
5.0	1:1.0																							

Example: Inspiration time is set to 1.5 seconds and rate to 12 breaths/minute.
This gives an I/E ratio of 1:2 (See markings in the table).

5.9.6 Trigger

Lit LED shows parameter selected.

Setting range: Off / -2 to +8 mbar.

Press **–** to decrease or **+** to increase the value of the selected setting.

When the patient starts a breath, a negative pressure is created in the patient circuit which the ventilator registers and immediately starts an inspiration.

- Choose a setting comfortable for the patient; normally between -0.2 to -0.5 mbar.

If the patient cannot trigger a breath, the ventilator automatically takes over and delivers breaths according to the set rate. For each breath the patient triggers, the green LED “TRIGGER” in the setting panel lights.

When the trigger is set to **OFF,** the patient cannot trigger any extra breaths.

The trigger can be set to positive values if an external PEEP valve is used.

Note! In the range 0 to +8 mbar there is a risk of the ventilator “self triggering”

5.9.7 Plateau

Lit LED shows parameter selected.

PLATEAU sets the speed at which the set pressure increase is reached.

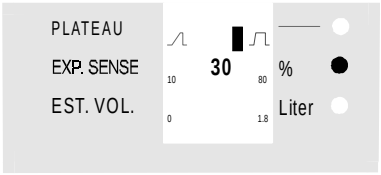
A lower setting will give a slower pressure increase and therefore a shorter plateau.

A higher setting will give a faster pressure increase and therefore a longer plateau.

Press **–** to decrease or **+** to increase the value of the setting. The setting has 9 steps between the end positions where 1 is the lowest and 9 is the highest.

As the pressure increase is experienced differently by each patient, it should be adjusted to give each patient the best possible breathing comfort.

5.9.8 Expiratory sense (EXP. SENSE)



Can only be selected in PSV mode.

Lit LED shows parameter selected.

Setting range: 10 to 80 % of max. flow.

10 % gives the largest tidal volume.
80 % gives the lowest tidal volume.

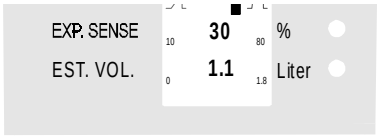
Normal setting is 25 to 30%

Press **–** to decrease or **+** to increase the value of the setting.

The ventilator measures the internal maximum flow during inspiration. When the flow drops below the set percentage of the maximum flow, the inspiration phase stops and an exhalation phase starts.

This setting allows the tidal volume to be matched to different types of diagnosis/compliance.

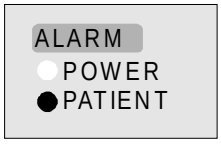
5.9.9 Tidal volume (Est. Vol.)



Shows the estimated tidal volume the ventilator delivered at the latest breath.

5.9.10 Alarm for low Tidal Volume

The ventilator has a low tidal volume alarm function which is activated if the delivered tidal volume does not reach the set value.

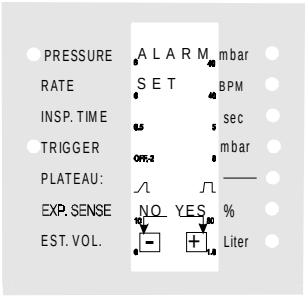


The alarm is given as:

- the red Patient LED flashing
- an audible alarm
- a flashing arrow indication is shown against the Est. Vol. field in the display.

The alarm is reset once the tidal volume reaches its set value.

5.9.10.1 Setting the alarm level for low Tidal Volume



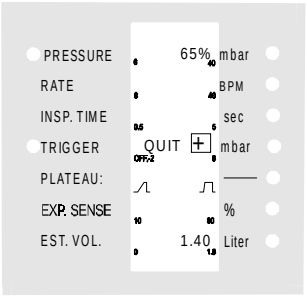
Alarm setting range 0.05 – 1.4 litre.

- Make sure the setting panel is not locked.
- Press the Function button until Est. Vol. is selected. The display will change as shown in the figure.

Note! The alarm setting display will only be active for 5 seconds. If no other button is pressed during this time the display will return to standard display. Press the Function button once more to return to the Alarm Setting function.

- Select Yes by pressing the + button.

The display will now change as shown below.



- Use the Function button to select the Est. Vol. parameter.
- Adjust the setting as required (within 5 seconds).
- To exit the alarm settings display, select the Trigger function by pressing the Function button and then press the + button (Quit). (Note! If required, the Pressure alarm can also be set before quitting).

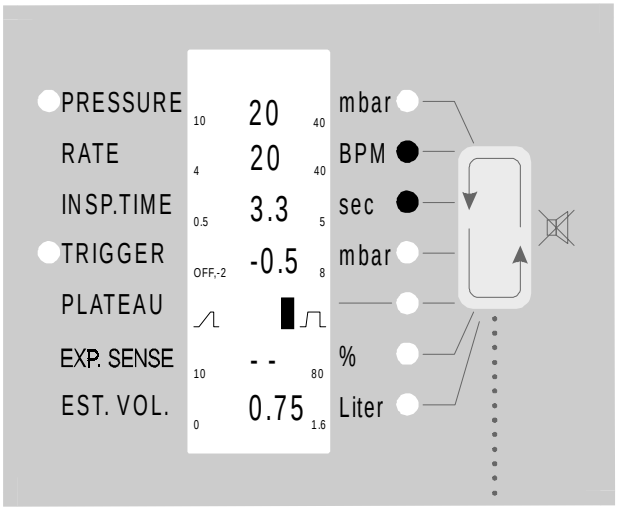
The value is automatically saved when Quit is selected or the display switches back to the standard setting display.

Note! If no other button is pressed within 5 seconds the display will return to standard display. In this case, the entire alarm setting procedure must be repeated.

5.10 Incorrect settings

If the set values for Rate and Insp. time are outside the ventilator's working range and cannot be achieved, the LEDs for Rate and Insp. time will flash.
In PSV mode, only the Rate LED flashes.
Note! In PSV mode this depends on how the patient controls the ventilator.

Adjust the settings so that the alarm indication ceases.



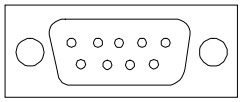
5.11 Digital Output (D-sub, female)

Connection for digital communication.

Only use BREAS cables.

Only connect equipment approved according to the relevant IEC standard.

Digital connector

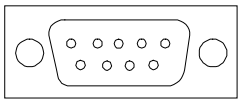


Pin 2 = RX
Pin 3 = TX
Pin 5 = Ground

5.12 Analog Output (D-sub, male)

Analog connection to record patient pressure and tidal volume.

Analog connector



Used to register the patient pressure and estimated tidal volume curve during, for example, operation during the night.
Normally connected to an analog printer or sleep registering equipment.

Only use BREAS cables.

Only connect approved equipment according to the relevant IEC standard.

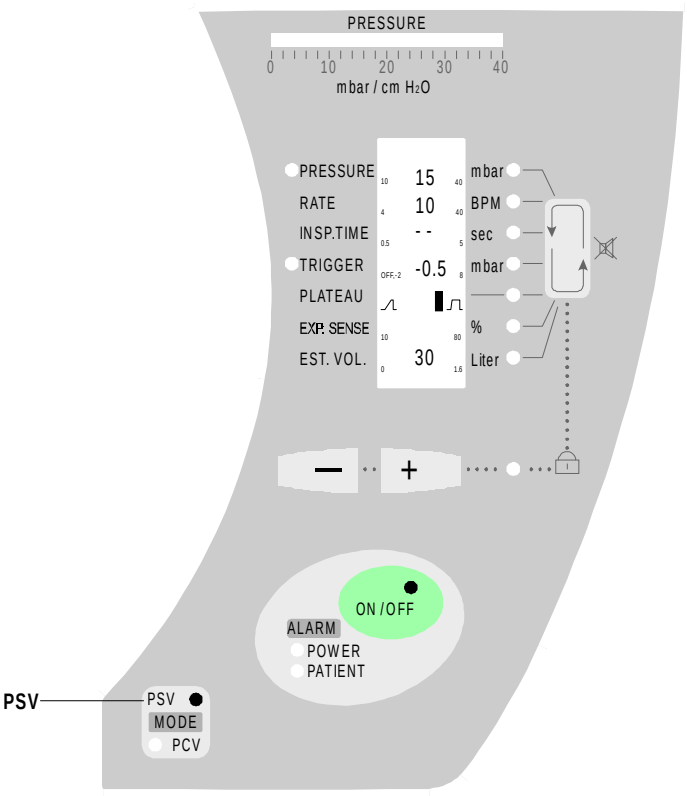
Pin 1 = Pressure	0 mbar = 1 V; 10 mbar = 2 V etc.
Pin 2 = Ground	
Pin 3 = Volume	0.5 litre = 0.5 V; 1 litre = 1 V etc.
Pin 4 = Reference	

6 FUNCTION CHECKS

6.1 Function check in PSV (Pressure Support Ventilation) mode

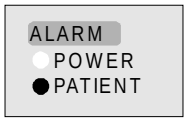
In the **PSV mode,** the ventilator is normally controlled by the patient; inspiration by the *trigger function* and exhalation by the *expiratory sense.*
If the patient's own "triggering" ceases, the set *rate* takes over the ventilation.

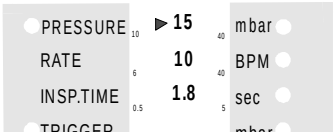
- Connect the ventilator to the mains supply.
- Make sure the patient circuit is correctly connected (see section 3.3).
- Start the ventilator by pressing the On/Off button for 2 seconds. The green LED comes on and the ventilator starts.
- If the Lock LED is lit, the setting panel is locked. Press and hold both the **–** and **+** buttons for 5 seconds to unlock.
- If necessary, change to PSV mode by pressing the MODE button for 1 second.
- Adjust the ventilator settings as follows:



PRESSURE	15 mbar
RATE	10 breaths/min
INSP. TIME	--(only PCV mode)
TRIGGER	-0.5 mbar
PLATEAU	
EXP. SENSE	30 %

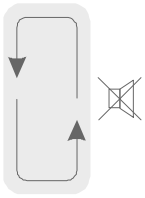
6.1.1 Alarm check "PATIENT" – low Pressure



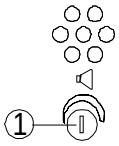


- Make sure that the red LED "PATIENT" starts to flash after 15 seconds, the flashing arrow alarm indicator is shown against the Pressure field in the display and an audible alarm is heard.
- Hold your hand over the exhalation valve to create a pressure. Check that a pressure is indicated on the pressure gauge.

The alarm should stop when the pressure exceeds the set percentage of the pressure setting.



- The alarm can be muted for 2 minutes by pressing the alarm mute button.



- Adjust the setting screw, on the ventilator's rear panel (① in figure) to a suitable sound level using a small screwdriver.

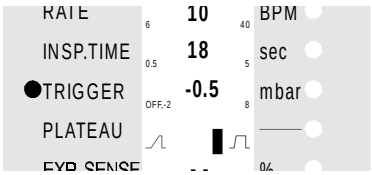
6.1.2 Inspiration

- Connect a 0.5 litre test lung. Check that the test lung inflates. The pressure gauge should show a pressure of approx. 15 mbar before inspiration stops. Depending on the compliance of the test lung, breaths can be stopped more quickly for different test lungs. Check that the membrane in the exhalation valve seals properly.

6.1.3 Exhalation

- The air in the test lung should easily flow out through the exhalation valve.

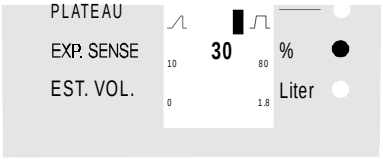
6.1.4 Trigger



- Create a negative pressure in the patient circuit and make sure the green LED "TRIGGER" comes on and a breath is started.

6.1.5 Expiratory sense (EXP. SENSE)

There are three parameters that can stop an inspiration and start an exhalation.

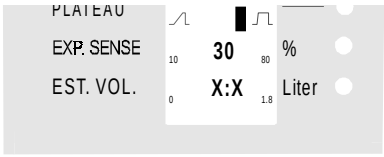


(1) The inspiration flow has dropped to the value set for EXP.SENSE .

(2) The inspiration is longer than 3 seconds.

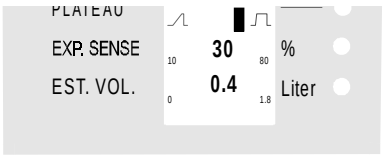
(3) The bellows in the ventilator reaches its end position.

6.1.6 Tidal volume (EST. VOL.)

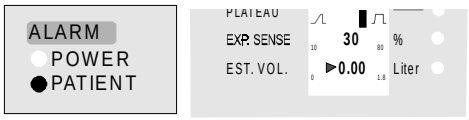


EST. VOL. shows the estimated tidal volume delivered from the ventilator at the latest breath.

6.1.7 Alarm check for low Tidal Volume

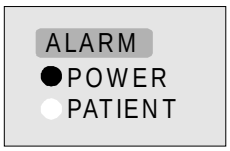


- Select the EST. VOL. parameter.
- Adjust the alarm setting as described under 5.9.10, Alarm for low Tidal Volume.
- Exit the alarm set function.
- Block the patient circuit.



- If the tidal volume now drops below the set alarm limit for more than 15 seconds, an audible alarm is given, the red Patient LED comes on and an arrow will flash against the Est. Vol. field, see figure.
- Readjust the alarm setting to its original setting.

6.1.8 Alarm check for Power failure



- Disconnect the power supply while the ventilator is running. The red LED for “POWER” should come on and an audible alarm be heard.
- Reconnect the power supply. The ventilator will start automatically.

6.1.9 Completing the function check

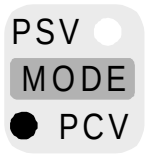
- Switch off the ventilator by pressing the On/Off button for 2 seconds.

The function check of PSV mode is now completed.

Note! Adjust the ventilator settings to the values prescribed by the doctor.

If anything is unclear or there are doubts, perform a new function check, reading the detailed description for each function.

6.2 Function check in PCV (Pressure Control Ventilation) mode



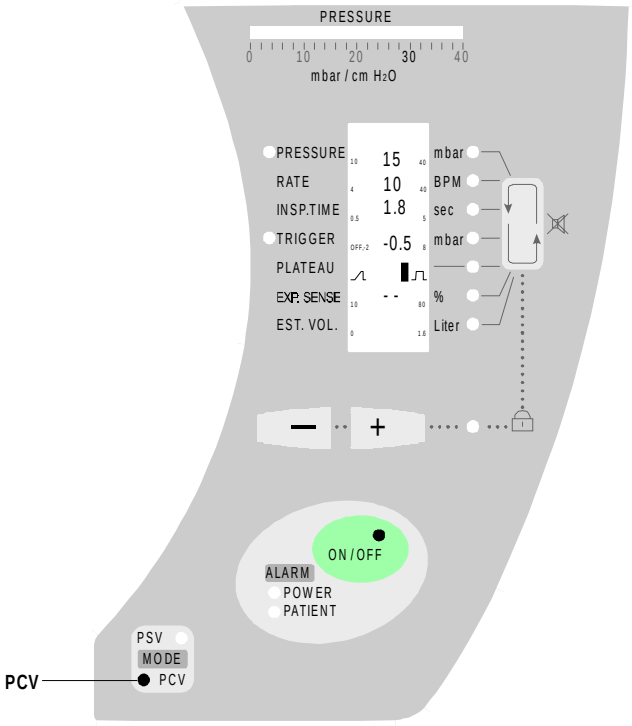
In the PCV mode, ventilation is controlled by the ventilator. The *rate* setting controls the patient’s breathing rate. The length of each breath is controlled by the *inspiration time* setting. If the *trigger function* is used, the patient can start an “extra” breath.

- Connect the ventilator to the mains supply.
- Make sure the patient circuit is correctly connected (see section 3.3).
- Start the ventilator by pressing the On/Off button for 2 seconds. The green LED lights and the ventilator starts.

- If the Lock LED is lit, the setting panel is locked. Press both the **–** and **+** buttons for 5 seconds to unlock.
- If necessary, change to PCV mode by pressing the MODE button for 1 second.

Adjust the ventilator settings as follows:

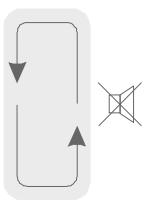
PRESSURE:	15 mbar
RATE:	10 breaths/min
INSP.TIME:	1.8 seconds
TRIGGER	-0.5 mbar
PLATEAU:	
EXP. SENSE:	--% (only PSV mode)



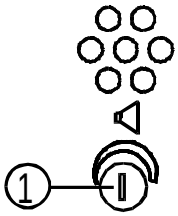
6.2.1 Alarm check PATIENT – low pressure

- Make sure that the red LED “PATIENT” starts to flash after 15 seconds, the flashing arrow alarm indicator is shown against the Pressure field in the display and an audible alarm is heard.
- Hold your hand over the exhalation valve to create a pressure. Check that a pressure is indicated on the pressure gauge.

The alarm should stop once the pressure exceeds the set percentage of the pressure setting.



- The alarm can be muted for 2 minutes by pressing the alarm mute button.



- Adjust to a suitable sound level (① in figure) by using a small screwdriver on the ventilator's rear panel.

6.2.2 Inspiration

- Connect a 0.5 litre test lung. Check that the test lung inflates. The pressure gauge should show a pressure of 15 mbar. Make sure that the membrane in the exhalation valve seals properly.

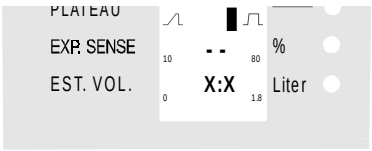
6.2.3 Exhalation

- Check that the air in the test lung easily flows out through the exhalation valve.

6.2.4 Trigger

- Create a negative pressure in the patient circuit and make sure the green LED "TRIGGER" comes on and a breath is started.

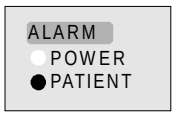
6.2.5 Tidal volume (EST. VOL.)

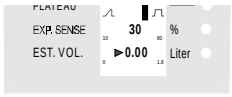


Shows the estimated tidal volume delivered from the ventilator at the latest breath.

6.2.6 Alarm check for low Tidal volume

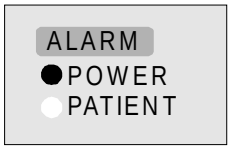
- Select the EST. VOL. parameter.
- Adjust the alarm setting as described under 5.9.10, Alarm for low Tidal Volume.
- Exit the alarm set function.
- Block the patient circuit.





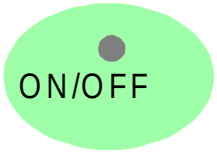
- If the tidal volume now drops below the set alarm limit for more than 15 seconds, an audible alarm is given, the red Patient LED comes on and an arrow will flash against the Est. Vol. field, see figure.
- Readjust the alarm setting to its original value.

6.2.7 Alarm check POWER



- Disconnect the power supply while the ventilator is running. The red LED for “POWER” should light and an audible alarm be heard.
- Reconnect the power supply. The ventilator will start automatically.

6.2.8 Completing the function check



- Switch off the ventilator by pressing the On/Off button for 2 seconds.

The function check of PCV mode is now completed.

Note! Adjust the ventilator settings to the values prescribed by the doctor.

If anything is unclear or there are doubts, perform a new function check, reading the detailed description for each function.

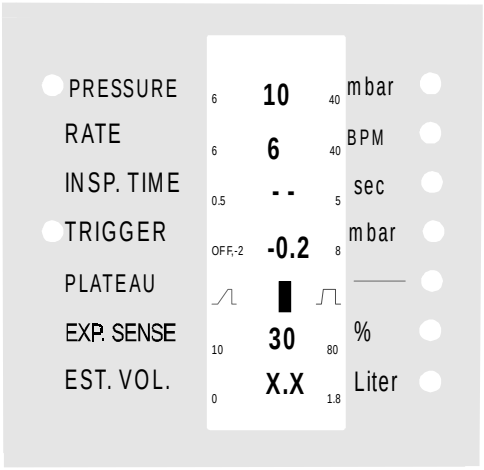
7 USAGE

7.1 Adjustment of the mask and patient circuit

- Adjust the mask straps so that it feels comfortable for the patient.
  IMPORTANT! Don't strap the mask too tight. Start with loose straps and tighten as necessary to prevent leakage from the mask.
- Route the patient circuit in a way convenient for the patient. Try different ways to find the best one.
- Place the PV 401 on a hard flat surface. Make sure that the air inlet on the underside cannot be blocked.

7.2 Settings in PSV mode

NOTE! All adjustments must be carried out by trained clinic personnel.



In **PSV mode**, the ventilator has basic settings (see illustration) which are usually suitable to start with when setting-up. The *pressure* and "back-up" *rate* are settings that ***must*** be adjusted to suit each patient.

Adjust the *plateau* setting to find the most comfortable pressure curve for each patient.

Blood gases must **always** be measured during the "setting-up" period.

Always document the set values before the patient returns home.

The setting panel should normally be "locked" when the ventilator is used away from the clinic.

7.3 Settings in PCV mode

NOTE! All adjustments must be carried out by trained clinic personnel.

In **PCV mode**, a more accurate setting of the rate and inspiration time is required for maximum patient comfort and the most effective result.

Blood gases must **always** be measured during the "setting-up" period.

Always document the set values before the patient returns home.

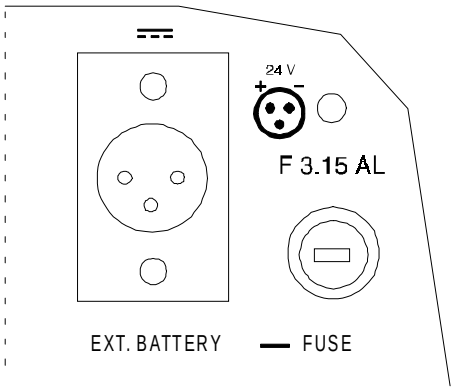
The setting panel should normally be "locked" when the ventilator is used away from the clinic.

8 BATTERY OPERATION

The mains supply is always selected first if both mains power and battery power are available. Should the mains power supply fail during operation, the ventilator will automatically switch over to the external battery supply, if connected, and give a short audible alarm. The ventilator automatically returns to mains power once the supply is restored.

8.1 External Battery

The PV 401 has low power consumption and is therefore suitable for battery operation, for example, while travelling.



Note! The battery supply is 24 VDC
(Min 22 V, Max. 27 V)

A 24 V battery is connected to the “Ext. battery” connector in the rear panel.

Use BREAS battery cable: BK 524 or
BREAS external 24 V Battery Pack.

When battery power is being used, the green LED in the ON/OFF switch will flash to indicate that battery power is being used.

CAUTION! The battery voltage must not drop below 22 V.

If a 12 V car battery is used, use a BREAS 12 to 24 Voltage converter.

External batteries connected are not charged by the PV 401 ventilator.

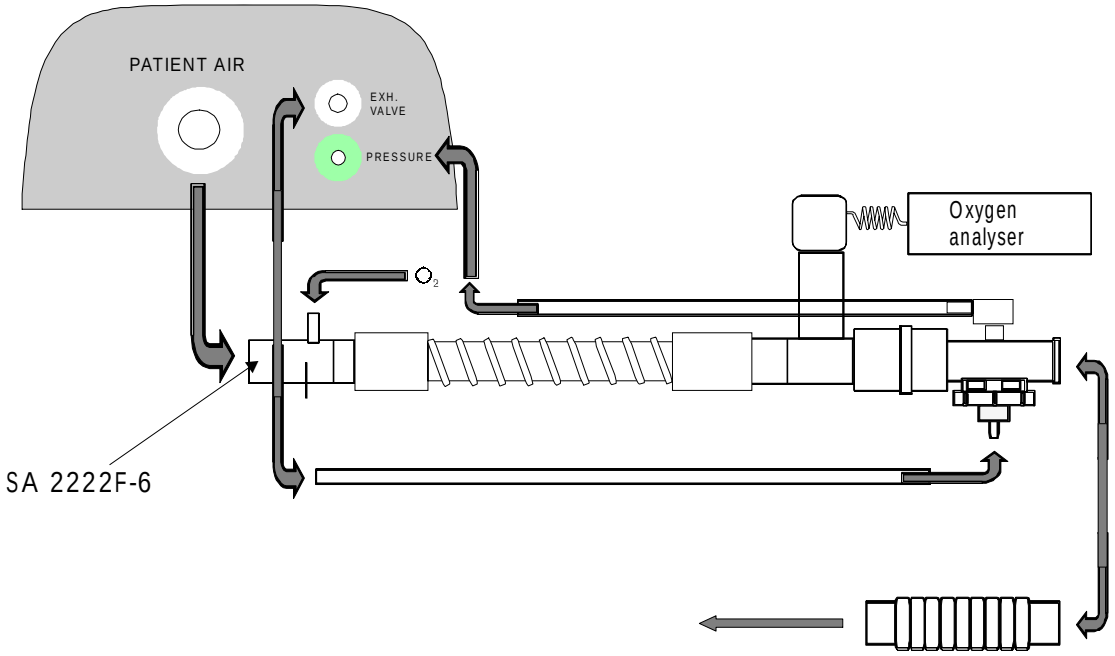
8.2 Low battery voltage alarm

If, during operation, the battery voltage drops below 22.5 V, an audible alarm (short signals) is given.

If the voltage drops below 22 V, the ventilator will switch off.

9 OXYGEN CONNECTOR

Oxygen can be added via the patient circuit using oxygen adapter SA 2222F-6.
Always use an oxygen analyser to make sure that the correct oxygen level is obtained.
Measure it as close as possible to the exhalation valve (see illustration).



10 CLEANING, FILTER REPLACEMENT AND SERVICE

Do not sterilise the ventilator using a steam autoclave. General sterilisation fluid can be used. Clean the ventilator using a lint-free cloth and a mild detergent, such as washing-up liquid.

Fluid must not be allowed to enter into the ventilator.

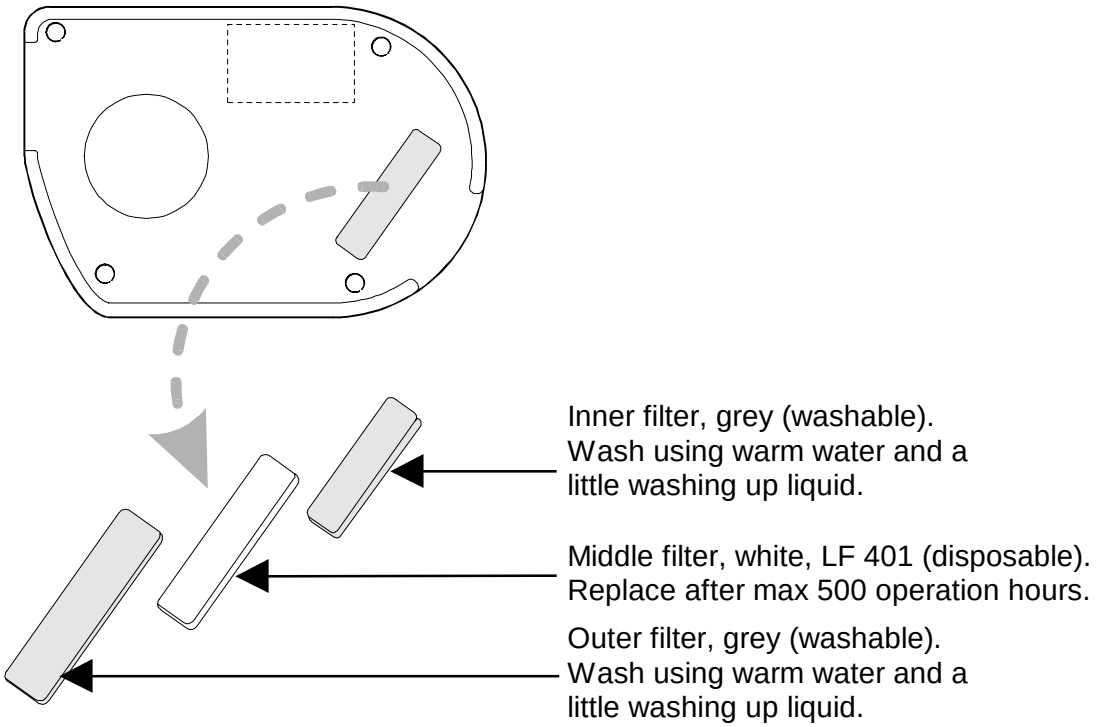
The patient/staff should be observant if the ventilator shows signs of abnormal operation. If in the least doubt, contact service personnel.

10.1 Cleaning/replacing the air filter

The patient air filter consists of three filters; a grey foam rubber inner and outer filter which can be washed and re-used, and the middle, white filter that must **not** be washed and re-used. The white filter must be replaced. The filters are located underneath the ventilator.

All filters must be replaced after every 500th hour of operation.

Wash the two grey foam rubber filters in warm water and, if necessary, use a little washing-up liquid. Let them dry before refitting them.



Switch on the ventilator and make sure it runs sounding normal.

10.2 Yearly service

The yearly service should be carried out by authorised personnel according to the separate maintenance scheme.

11 FAULT TRACING

11.1 Fault tracing chart

SYMPTOM	POSSIBLE CAUSE	REMEDIAL ACTION	SEE CHAPTER
LED for “POWER” is on and the ventilator alarms at start-up.	The power cord is not properly connected.	Connect the power cord. Check the connection at the back of the ventilator and at the power socket.	3.4
	Mains fuse blown.	Replace the fuse.	3.5
If the faults persists.		Contact service personnel.	
Does not work running from external battery.	External battery cable is not connected properly or is faulty.	Connect the cable / measure and replace if faulty.	8
	Ext. batt. fuse blown.	Replace the fuse.	8
	If the fuse blows immediately after connecting the ext. battery cable.	Check the polarity of the connector.	8
If the fault persists.		Contact service personnel.	
The ventilator does not give adequate pressure/volume.	Leakage from patient circuit/mask.	Check the tubes, mask and exhalation valve for leakage.	
	Filter dirty.	Replace filter.	10
If the fault persists.		Contact service personnel.	
Fault code “FAIL 39” is shown in the display.	Green pressure tube in the patient circuit is correctly connected.	Connect the patient circuit correctly.	3.3
If the fault persists.		Contact service personnel.	
Fault code “POWER FAIL” is shown in the display.	Power voltage, mains or battery, is too low.	Check the power source.	
A fault code “FAIL XX” where XX can be 00 to 45, except 39, is shown in the display.	The ventilator does not function.	Send the ventilator for service.	

12 ACCESSORIES

Part Number	Description
204 020	Patient circuit PV 401, with exhalation valve SC 301
204 030	Patient circuit PV 401, with exhalation valve and flextube
200 050	Flextube 22/22 mm, 9 cm length
200 278	Flextube 22/15 mm, 9 cm length
204 190	Exhalation valve 401, P/B
200 530	Oxygen adapter SA 2222F-6
202 500	Adapter 22/22/15F
202 870	Peep-adapter exp. valve P/B
200 040	Arm for patient circuit, incl. mount (table mounting)
200 320	Mount, for patient circuit arm
200 210	Nylon carry bag
200 120	Ventilator trolley, VB 301
204 050	Filter LF 401, 5 pcs/package (disposable)
200 250	Battery cable, BK 524
200 261	External battery 24 V, incl. cable, charger and bag
201 290	Converter 12–24V, BC 501
204 210	Filter, grey foam rubber

13 TECHNICAL SPECIFICATIONS PV 401

Setting ranges/performance

Modes ..... PSV (pressure supported ventilation)
PCV (pressure controlled ventilation)
Patient pressure..... 6 to 40 mbar
Rate ..... 6 to 40 breaths per minute (BPM)
Inspiration time..... 0.5 to 5 seconds
Trigger ..... -2 to +8 mbar
Pressure plateau..... Adjustable
Exp. sense ..... 10 – 80% of max. flow
Minute volume..... 2 to 50 l/min
Maximum flow ..... 120 l/min

Display/Outputs
Patient pressure..... 0 to 40 mbar
Delivered tidal volume..... 0.1 to 1.6 litres
Analog output..... 0 to 6V
Digital output..... PC connector

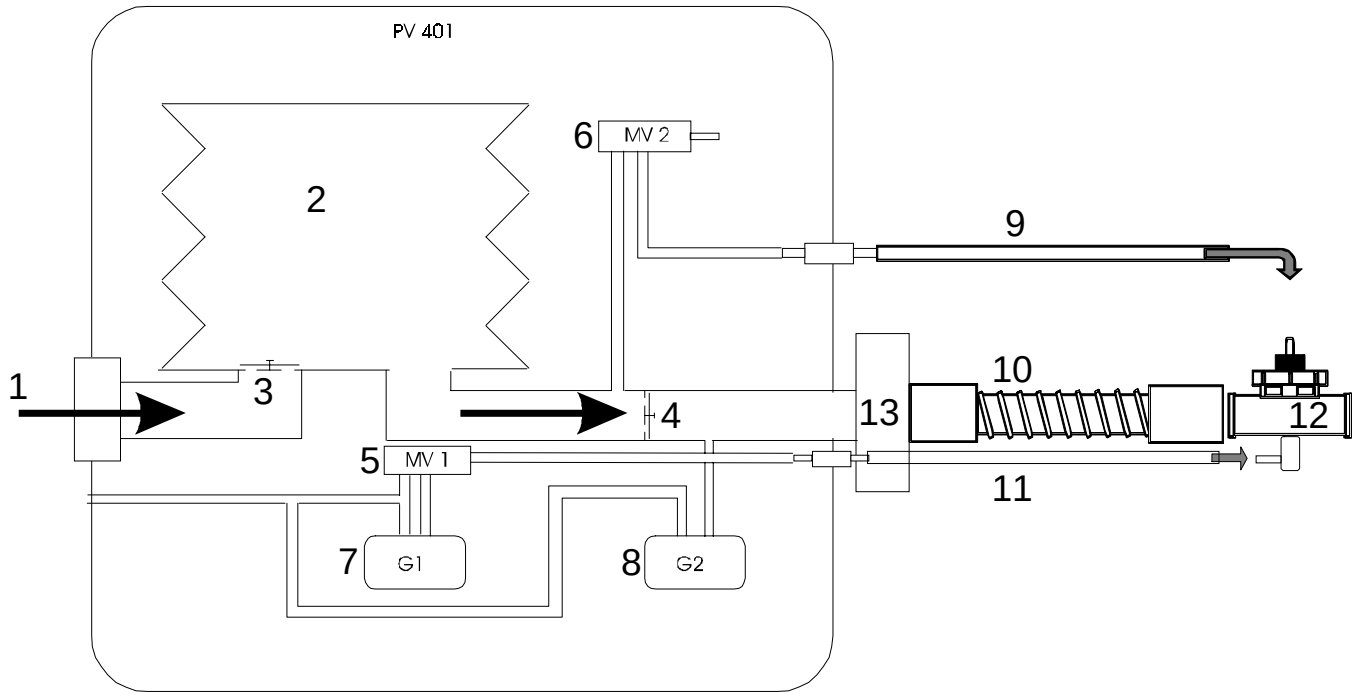
Indications/Alarms
Mains ..... Green LED
Ext. battery..... Green LED, flashing
Inspiration ..... Green LED
Trigger ..... Green LED
Low Pressure/Leakage alarm ..... Red LED, flashing arrow indicator, audible alarm
50 - 80 % of set pressure
Power failure alarm..... Red LED/audible alarm
Low Tidal volume ..... Red LED, flashing arrow indicator, audible alarm

Power supplies
Mains supply..... 115–120/230–240 VAC, 50–60 Hz, 50VA
External battery operation..... 24 VDC, max. 30W

Dimensions/Weight
Dimensions (W x H x D)..... 350 x 175 x 260 mm
Weight ..... 5.5 kg

Meets requirements according to IEC, ISO and EMC.
Designed and manufactured in Sweden.
Tested and approved by TÜV, Germany.

14 PNEUMATIC DIAGRAM



1. Patient air inlet (through air filter)
2. Bellows
3. Check valve (closed during inspiration)
4. Check valve (closed during exhalation)
5. Magnetic valve MV 1 (Normally set as per fig. 1. Switches at autocalibration of G1 according to fig. 2.)
6. Magnetic valve MV 2 (Normally set as per fig. 2. Safety valve that switches at too high pressure.)
7. Pressure sensor G1
8. Pressure sensor G2
9. Control pressure tube for the exhalation valve
10. Patient air tube
11. Tube for measuring the pressure
12. Exhalation valve
13. Bacteria filter (if used)

Fig 1

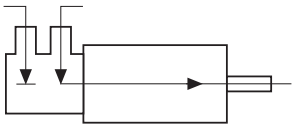
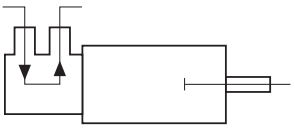
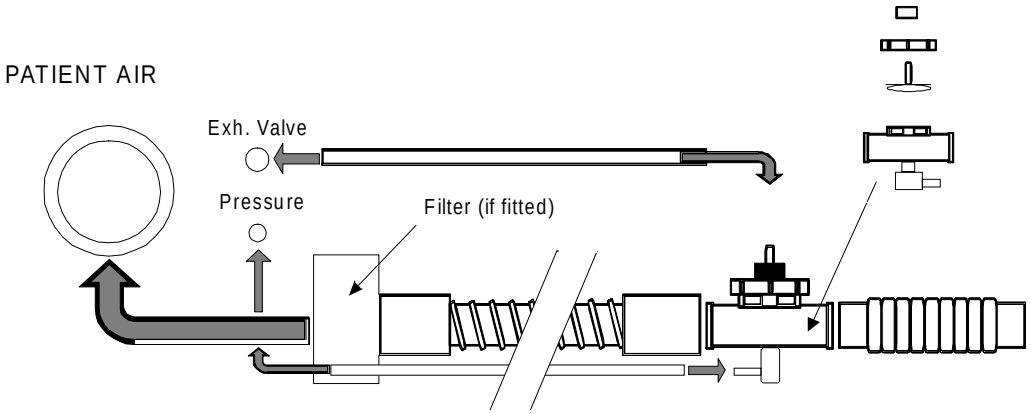


Fig. 2



15 PATIENT INSTRUCTIONS FOR BREAS PERSONAL VENTILATOR PV 401

Note! These instructions must be thoroughly explained to the patient together with the doctor before the patient/care giver takes over the operation at home.



Always check before connecting to patient:

- Start the ventilator.
- During normal use, only the LED in the ON/OFF button should show a steady light. A flashing LED indicates the ventilator is running from the external battery and the mains supply should be checked.
- Alarm “PATIENT”. Do not connect anything to the patient circuit and check that both a light (LED) and an audible alarm are given after 15 seconds. Block the patient circuit and check that the alarm resets when the pressure exceeds the percentage setting for the low pressure alarm.
- If alarm indication “FAIL” is seen in the display and an audible alarm is heard, switch off the ventilator and then on again. If the fault persists, the ventilator must not be used and service personnel must be called immediately.
- Check that the air inlet underneath the ventilator is not blocked. Change the air filter after every 500 hours of operation or when needed. For further instructions, see Chapter 10.

Leakage test

- Check that there is no leakage from the patient circuit. This is easiest done by blocking the tube when the ventilator delivers an inspiration. Listen for any leakage. Make sure that all hoses are connected properly.
  If a mask is used, perform a leakage test after the mask has been fitted. Instructions on how this is done should be given by the doctor depending on what type of mask is used.

Cleaning

- Wipe the outside of the ventilator using a damp cloth with a little mild washing-up liquid or window cleaning fluid.
- The fluid must not be allowed to enter into the ventilator.
- The responsible clinic must always instruct on the usage and how the patient circuit and mask are best cleaned.
- Patient hose, exhalation valve, flex tube and mask are cleaned, when required, in warm water with a mild fragrance-free soap. The thin tube to the exhalation valve does not need to be washed. Remove these tubes before cleaning – it is important that no water enters into the tubes. Always be careful when cleaning so as not to damage anything.
- Let all parts dry before reassembling them. (See illustration above).

Always perform a leakage test after cleaning.

The ventilator casing may only be opened by authorised personnel.

- The ventilator, complete with patient circuit, power cord and Operating Manual, must be handed in each year to authorised personnel for a function check and service. If in the slightest doubt, always contact the medical staff.

Note! Adjustment of set values may only be carried out by clinic personnel.

SETTINGS

VENTILATOR BREAS PV 401

Patient: _____

_____

_____

Date: _____

Clinic: _____

_____

Set by: _____

MODE: ☐ PSV ☐ PCV

PRESSURE: _____mbar

RATE: _____BPM

INSPIRATION TIME: _____seconds

TRIGGER: _____mbar

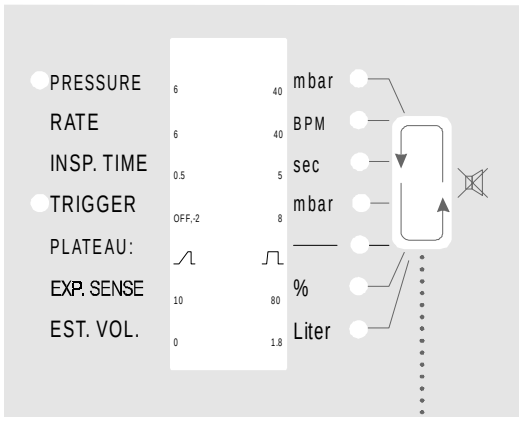
PLATEAU: _____

EXPIRATORY SENSE: _____%

TIDAL VOLUME: _____litres

PRESSURE ALARM SETTING _____ %

LOW TIDAL VOL. ALARM SETTING: _____litres



3 MAINTENANCE SERVICE INSTRUCTIONS

All routine maintenance checks and additional service instructions for the PV 401 are described in this chapter. For information about fault-tracing, detailed drawings, board schematics, spare parts etc, please refer to the respective chapter in this Service Manual.

The patient and/or care providers should follow the checks described in the Patient Instructions supplied with the ventilator.

Before starting the maintenance service, read the Special Safety Precautions section and have a new Service Record (copy the example in the Appendices chapter) and all the necessary equipment, tools and replacement parts at hand.

3.1 Verifying the components and software installed

Check the Engineering Change History in the Appendices for a history of changes made, and from which serial number they were implemented.

If in any doubt, read the component designation on circuit boards and PROMs, as upgrades may have been made which have not been recorded.

3.2 Special safety precautions

- Do not work on the ventilator with the casing removed and the power supply connected.
- Explosive gases and fluids must not be used near the ventilator.
- Take all necessary ESD precautions.

3.3 Equipment and tools required

A test lung or test reservoir bag.

A measuring instrument for tidal volume and minute volume/rate. (Biotek Ventilator tester, Timeter, Spirometer or equivalent).

A universal instrument.

A new Service Record (photocopy the Service Record in the Appendices section of this binder).

A standard toolkit containing screwdrivers, Allen keys, Torx keys and sockets.

3.4 Replacement parts required

The following parts should be available when servicing.

Part No.	Description
204020	Patient circuit
204200	Service kit incl. membranes for check valves and drive belts
205180	Membrane assembly for exhalation valve
205570	Grease (BREAS 240 AZ)
285911	Power cord
204210	Air filter, patient air, washable
204050	Air filter, patient air, disposable
	Cable tie
If required:	
285403	Battery for alarm (Ni-Cd)
204010	Motor Unit Kit for replacement at 10,000 operating hours

3.5 Servicing instructions

The maintenance service comprises the checks listed in this section and the service checks described in the table below.

3.6 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.

Every 12th month or every 6th month if the ventilator is used for continuous operation (24 hours per day)	See Ch./ Section No.
Motor Unit	
Replace drive belts	7.2
Lubricate felt sleeve for drive screw	7.3
Replace check valve membrane in patient air outlet	7.4.1
Test of motor unit and tube for leakage	7.5
Electronics	
Calibrate the pressure sensor	8.6
Check operation using external battery	8.7
Check electrical safety levels	8.9
Accessories (where applicable)	
Inspect patient circuit	3.9.9
Replace membrane in exhalation valve	3.9.9
Clean PEEP adapter, change O-ring	3.9.9
Every 5th year	
Replace the alarm batteries	8.8
Every 10,000 operating hours	
Replace the complete motor unit	6.5

3.6.1 Open a new Service Record, identify and register the ventilator

- Make a copy of the Service Record in the Appendices chapter.
- Fill out the model, serial number and any inventory number on the Service Record.
- Check any comments recorded on previous Service Records.
- Document the current patient settings.

3.6.2 Additional Services Required

- Check the number of operating hours and enter it on the service record.
- Check the service schedule to see whether the alarm batteries or the complete motor unit are due to be replaced.

3.6.3 Markings

Make sure that all markings on labels can be read:

- Make, model description, serial number.
- Warning texts.
- Any inventory markings.
- All other texts etc.

3.6.4 Information from the user

Check the following with the patient:

- Has the function of the ventilator been trouble-free? If not, what problems have there been?
- How does the patient check the function of the ventilator. How often?
- How often has the filter been changed?
- How many filters will the patient need of until the next service?
- Other observations?

3.6.5 Validity of the technical documentation

- Check the validity of the patient instructions.
- Check if any modification or upgrading of the ventilator needs to be done at the same time as the service.

3.7 External checks

3.7.1 Visual inspection for external damage and wear

- Clean the outside using window-cleaning fluid.
- Check for any visible damage to the casings and other components.
- Check that nothing has worked loose (incl. the handle).

3.7.2 Power connection

- Check the plugs on the power cable, the cable itself and the ventilator's power socket.
- Make sure that the strain relief for the power cord is not damaged.
- Inspect the external battery cable, if used.
- Check the external battery socket in the ventilator.

3.7.3 Minimum function check

- Connect the power cord.
- Connect the patient circuit.
- Switch on the ventilator and make sure it operates normally.

3.8 Internal checks

3.8.1 Cleaning

- Remove the casing. See Chapter 6 Dismantling and Assembling the PV 401 for instructions.
- Remove any dirt or dust that has collected in the ventilator.

3.8.2 Cabling

- Inspect all cables and their connectors. Check the front and rear panels to make sure that cables and wires are not pinched.
- Change any cable strap anchor that has become loose.

3.8.3 Fastening of components

- Make sure that all components, such as the motor, printed circuit boards, connectors, etc are fastened securely.

3.8.4 Change drive belts

- Refer to section 7.2 for information.

3.8.5 Lubricate the felt sleeve

- Refer to section 7.3 for information.

3.8.6 Change check valve membranes

- Refer to section 7.4 for information.

3.8.7 Power supply

- Make sure that the power socket is undamaged and is securely in place.
- Make sure that the touch-protection is undamaged and properly tensioned over the socket.
- Make sure the transformer is securely fastened.
- Check the wiring to and from the transformer.

3.8.8 Calibrate the pressure sensors

- Refer to Chapter 8.5 for information.

3.8.9 Reassemble the casing

- Refer to Chapter 6 for instructions.

3.8.10 Electrical Safety

- Refer to Chapter 8.8 for information.

3.8.11 Leakage test of tubes and bellows

- Refer to Chapter 7.5 for information.

3.9 Final checks before handing over

3.9.1 Function check

- Connect the patient circuit, start the ventilator and check that everything works normally.

3.9.2 Check low pressure/leakage alarm

- Set the pressure to 20 mbar.
- Check the accuracy (±10%). Check that the LED for PATIENT lights and an audible alarm is given.

3.9.3 Check low volume alarm

- Set the low volume limit to 1.0 litre.
- Check the accuracy (±10%). Check that the LED for PATIENT lights, that the text LOW is shown in the display and that an audible alarm is given.

3.9.4 Alarm mute

- Switch on the ventilator. Do not connect anything to the patient air connection. Wait 15 seconds for the "PATIENT" alarm to be activated. Press the mute button and make sure the signal is muted. Make sure the signal is heard again after approximately 2 minutes.

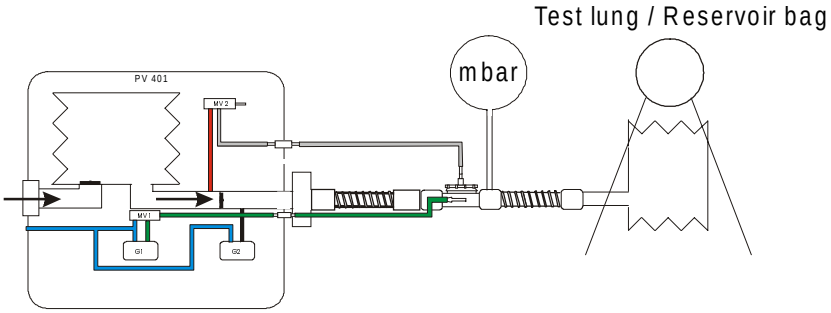
3.9.5 Trigger

- Set the trigger to -0.5 mbar.
- Create a negative pressure and make sure a triggered breath is given. The green LED should light.

3.9.6 Check of pressure/rate

- Adjust the settings to:

  Pressure: 20 mbar
  Rate: 10 BPM
  Insp: 3.0 sec
  Mode: PCV



- Measure the pressure, rate and insp. time and check that they are correct, (accuracy ± 10%). The measuring should be done with a test lung or a test bladder connected. (If these are not available, block the exhalation valve in the patient circuit).

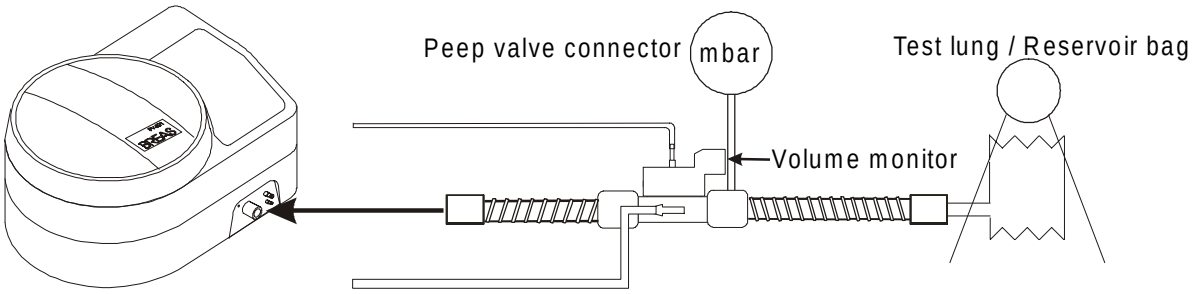
3.9.7 Checking the tidal volume indication

If a ventilator tester Biotek VT-1 or 2 is used, the estimated tidal volume can be tested as follows:

- Set the compliance of the test lung to 0.02 L/cm H_2O
- Select volume measuring
- Set the PV 401 as follows:

  Pressure: 30 mbar
  Rate: 8 BPM
  Insp: 5.0 sec
  Mode: PCV

When using a volume monitor, an exhalation valve with a PEEP valve connector is required. The volume monitor is then connected to the PEEP valve outlet of the exhalation valve.



- Check the accuracy (± 20%).

3.9.8 Battery operation

- Connect an external battery.
- Disconnect the power cord while the ventilator is running.
- Check that the ventilator automatically switches over to external battery operation, that an audible alarm is given and the LED in the ON/OFF button starts to flash.
- Reconnect the power cord and make sure that the LED in the ON/OFF button shows a steady light and the audible alarm stops.

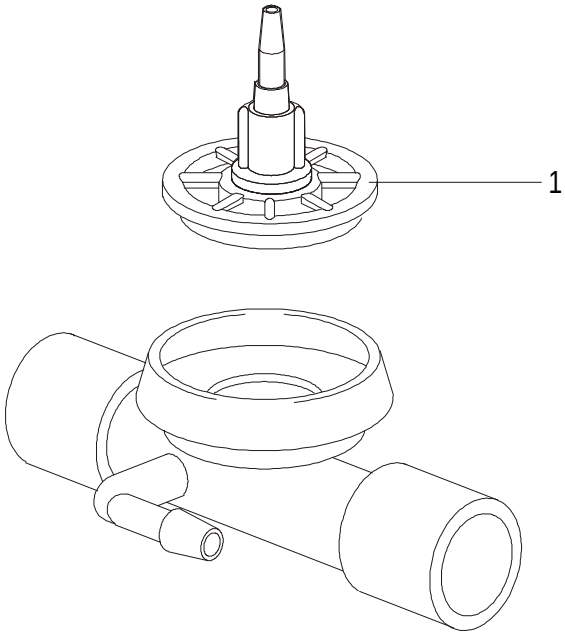
3.9.9 Check of accessories

Patient circuit

- Inspect the patient circuit and replace it if necessary.

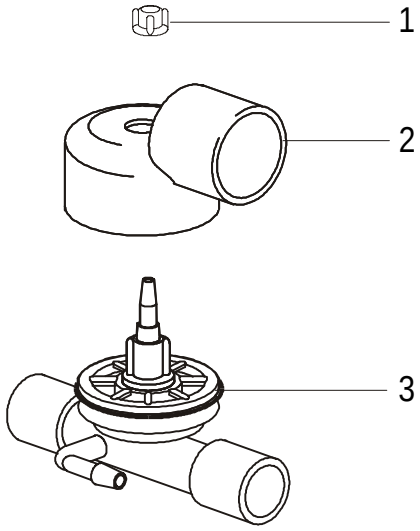
Replacing the membrane assembly in the exhalation valve

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



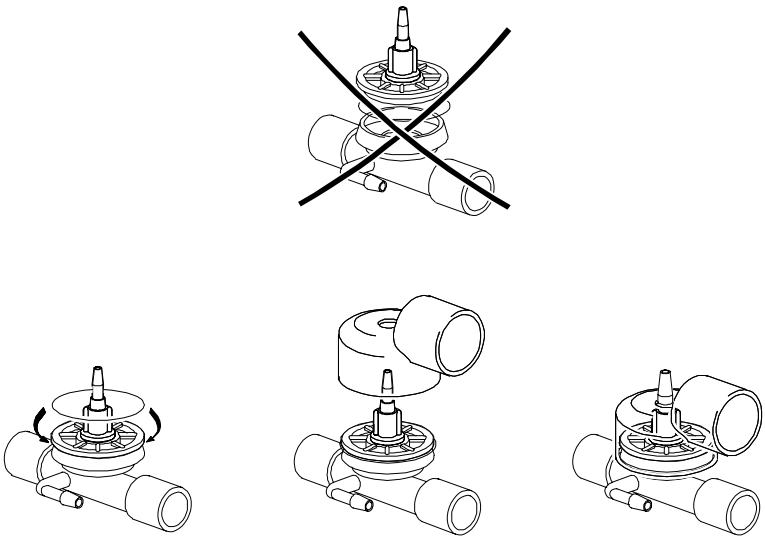
- Unscrew and remove the complete membrane assembly (1).
- Clean the inside of the exhalation valve using a moist rag or wash in hot water using a washing-up liquid. Let it air dry.
- Screw on the new membrane assembly, part No. 205180.
- Connect the exhalation valve to a test lung. Check that no leakage occurs during the exhalation phase.

Cleaning the 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.
- Before fitting the PEEP cover, remove the old O-ring (3), see figure, and fit a new one as shown in the figures below.

Note! Do not fit the O-ring to the exhalation valve cover before screwing it on.



Fit the PEEP adapter to the exhalation valve and screw on the plastic nut

Check any other accessories.

3.9.10 Change/wash patient filters

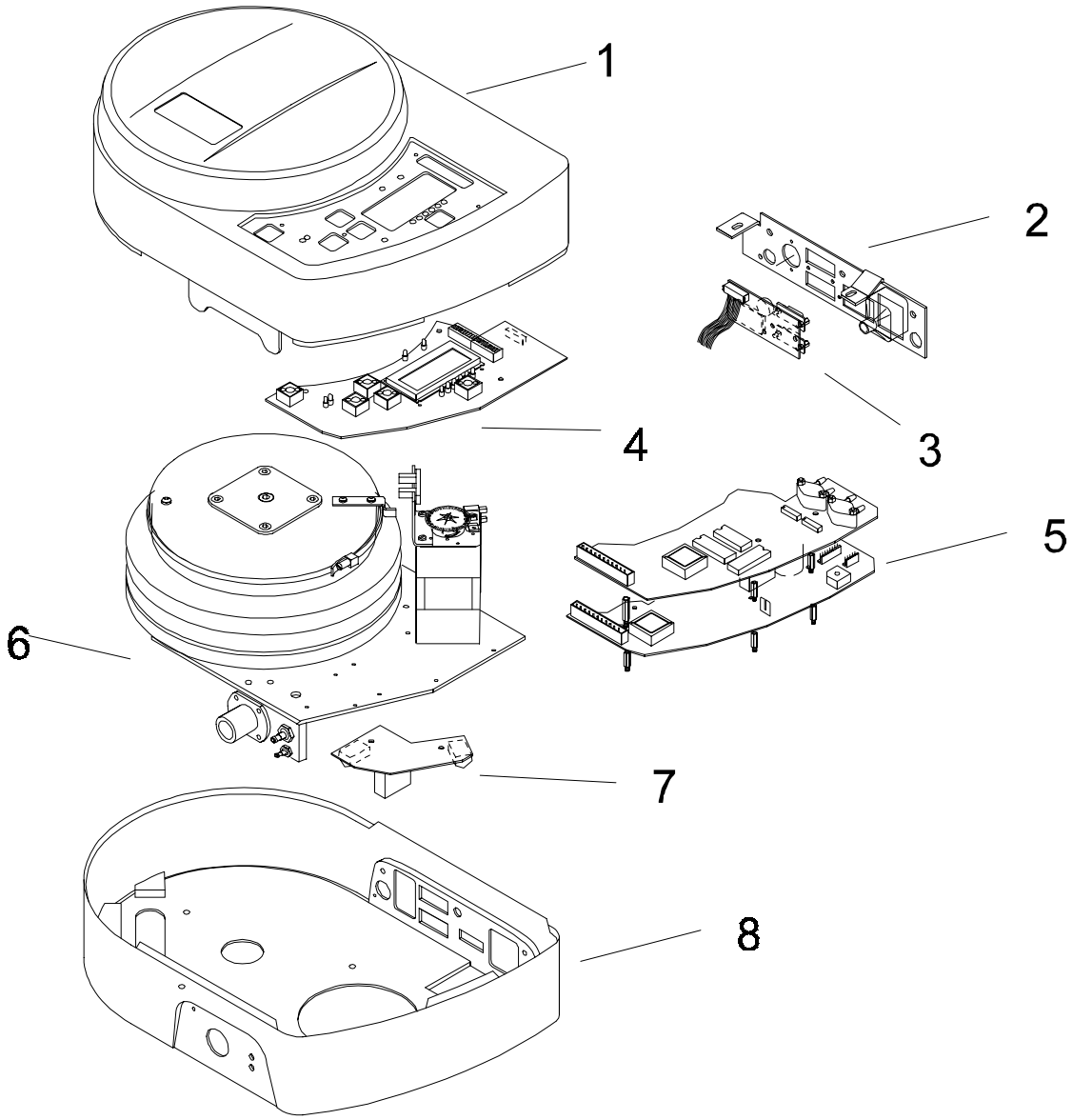
- Change the white air filter. Make sure that the patient has a supply of filters to last to the next service interval.
- Wash or change the grey filters if necessary.

3.9.11 Adjust the settings for the patient

Adjust the settings as prescribed for the patient.

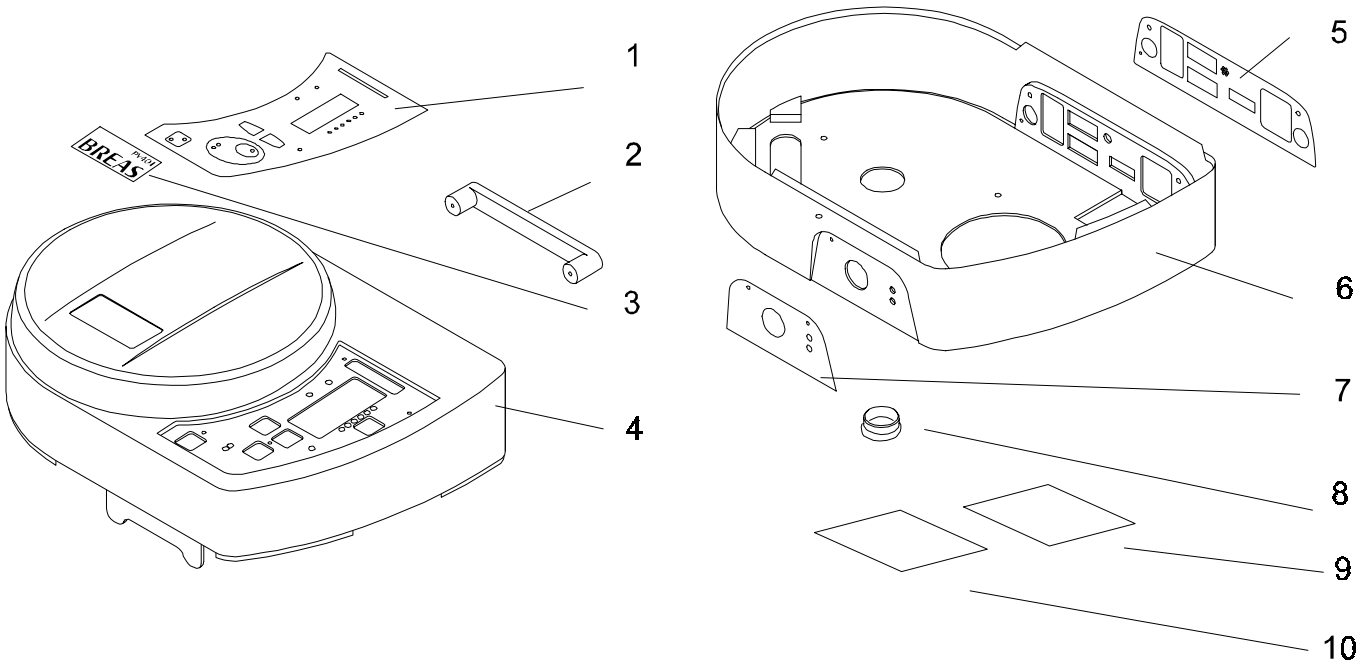
4 REPLACEMENT PARTS

4.1 General view



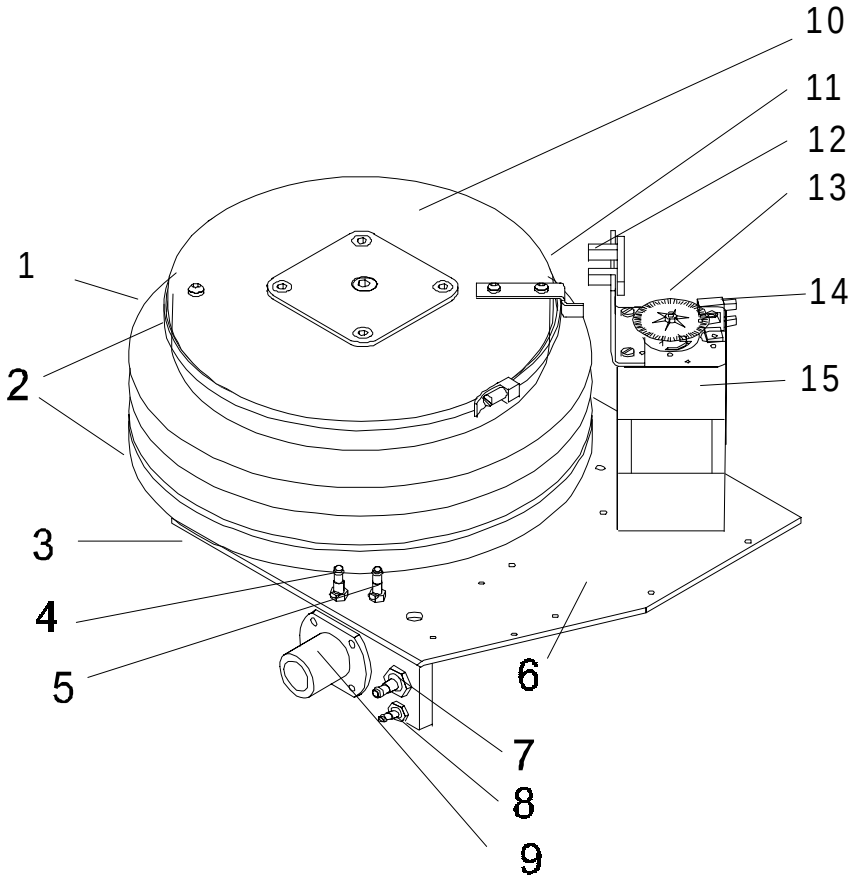
Pos. No.	Description
1	Upper casing
2	Fastening plate, rear panel
3	Printed circuit board - Hour meter
4	LCD-board
5	CPU-MDA printed circuit board package
6	Motor unit (also available as exchange unit, part No. 204740
7	Printed circuit board - Filter
8	Lower casing

4.2 Casings and decals



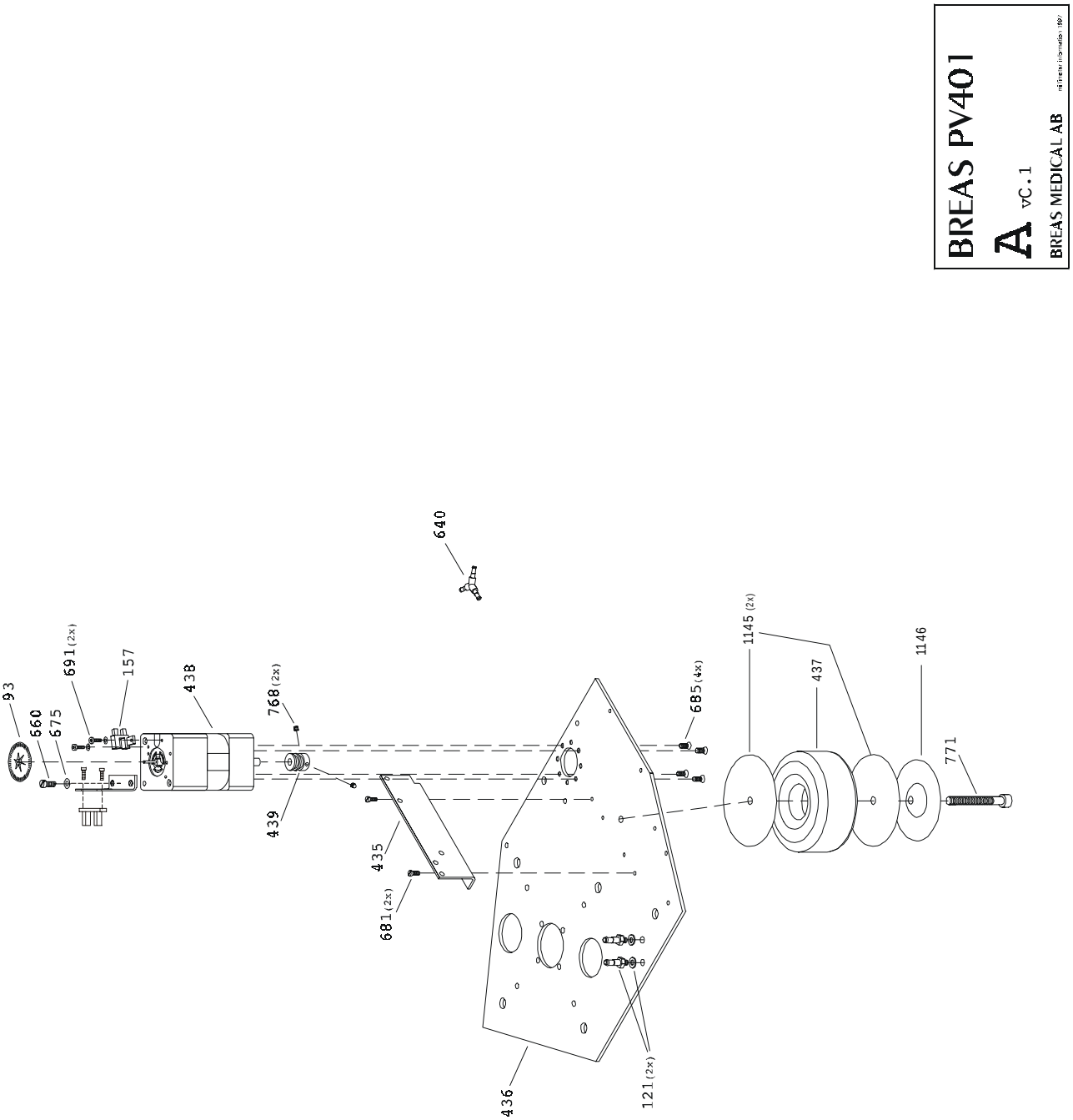
Pos. No.	Description
1	Label, display panel
2	Carrying handle
3	Label, logo
4	Upper casing
5	Text plate, rear panel
6	Lower casing
7	Label front panel
8	Plastic plug
9	Label, serial/model Nos.
10	Label, warning texts

4.3 Motor unit

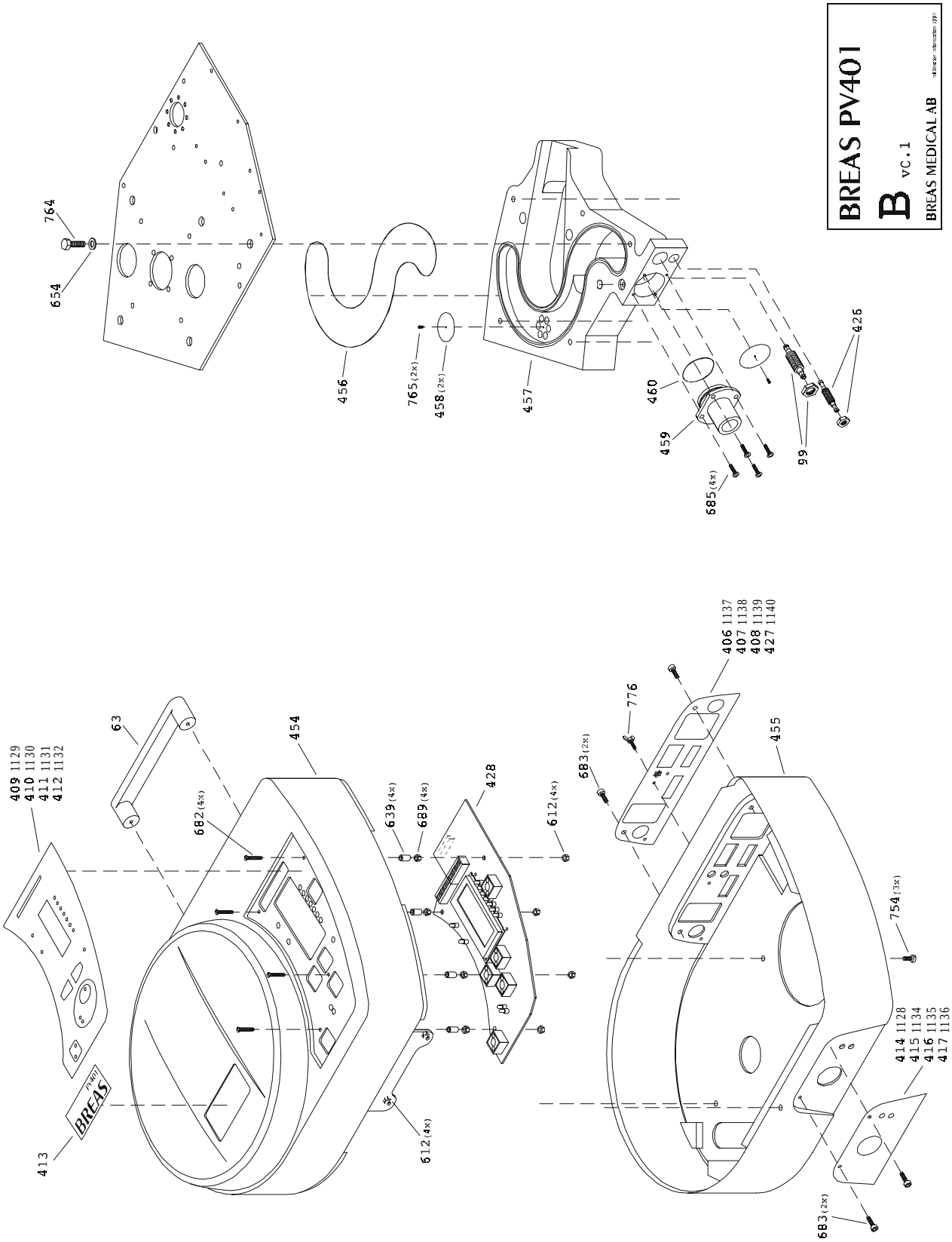


Pos. No.	Description
1	Bellows
2	Clamp
3	Base plate
4	Air pressure nipple for regulator sensor G2
5	Air pressure nipple for exhalation valve, internal
6	Cover plate
7	Air pressure nipple for exhalation valve, patient circuit
8	Nipple for measuring pressure in patient circuit
9	Patient air outlet
10	Bellows top cover
11	Breaker for light beam in home position
12	Opto-switch
13	Slotted disc
14	Encoder
15	Motor

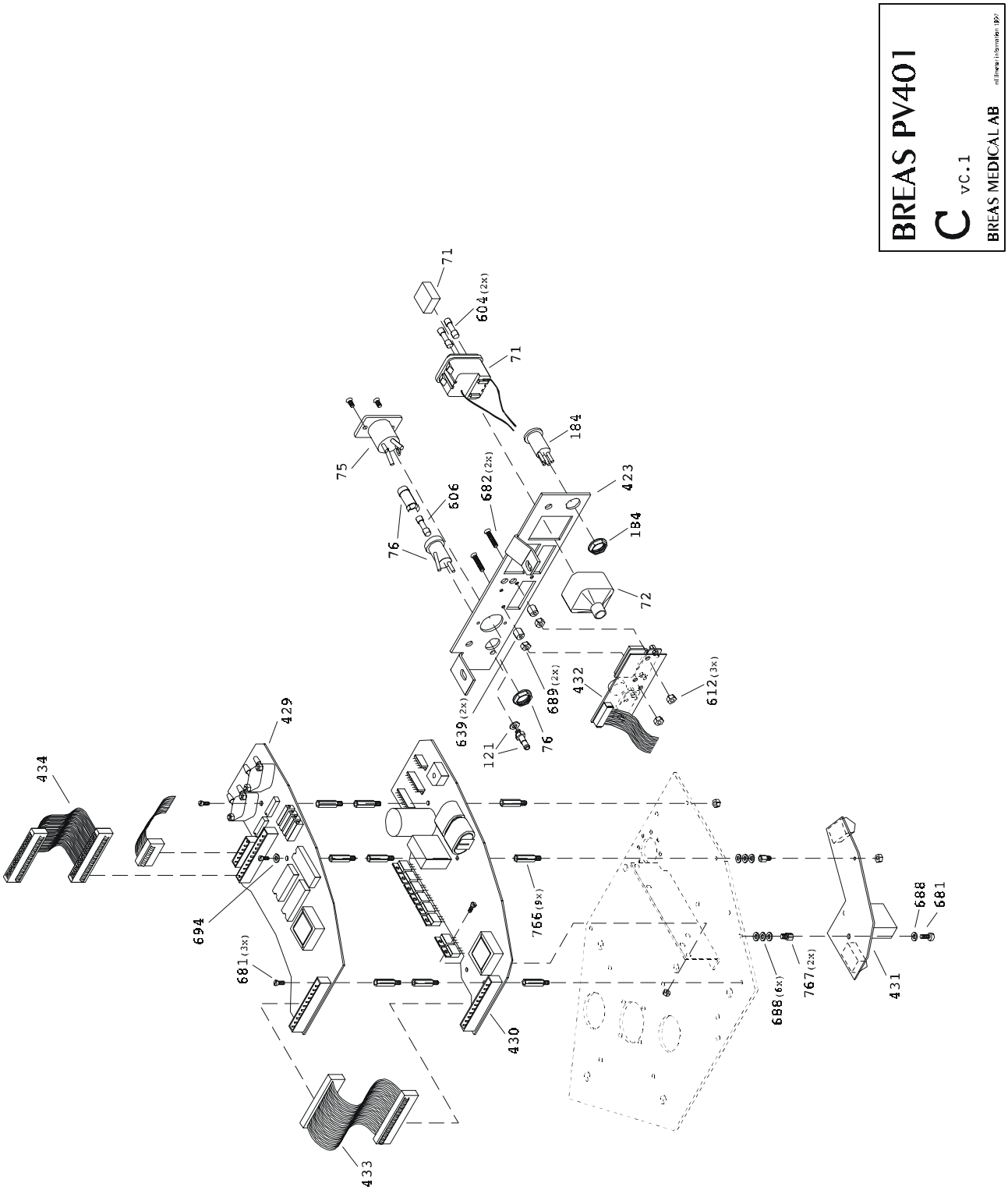
4.4 Exploded view, Motor and Transformer



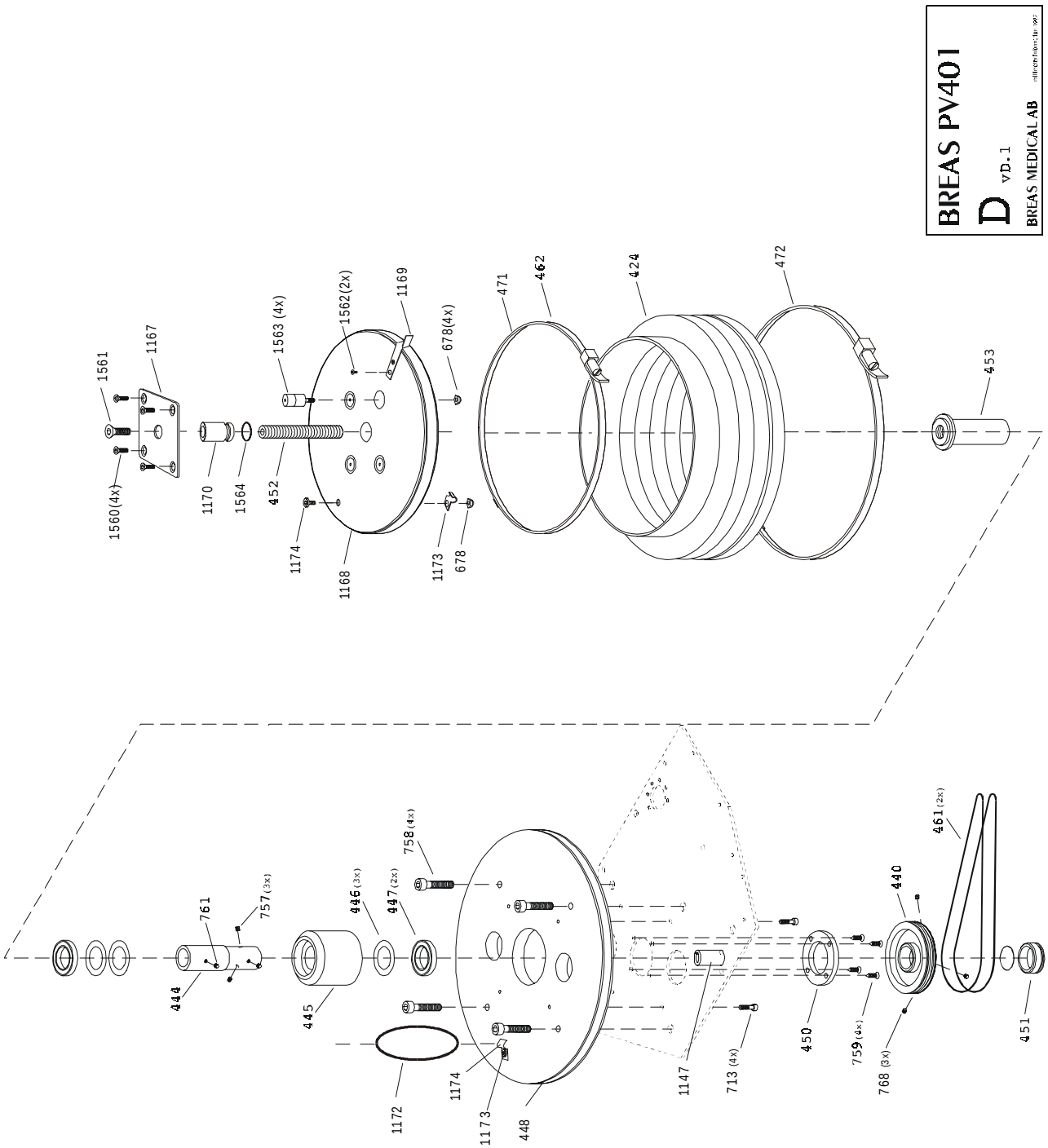
4.5 Exploded view, Casing and Base Plate



4.6 Exploded view, Circuit Boards and Connectors



4.7 Exploded view, Bellows and Drive Screw



4.8 Part No. list

Part No.	Description
31	Rubber mount - shock absorbing. (photocell)
36	Alarm batteries - NiMH (501)
42	Decal - serial number
63	Carrying handle, red
71	Fuse, power socket
72	Touch protection
75	XLR sleeve
76	Fuse holder
93	Slotted disc
99	Nipple
109	Solenoid
121	Nipple
157	Opto-switch
184	Voltage selector
401	Motor package - complete
402	Patient circuit, PV 401
403	Patient circuit, PV 401 - incl. flextube
405	Filter, PV 401
406	Text plate, PV 401 - SWE
407	Text plate, PV 401 - ENG
408	Text plate, PV 401 - GER
409	Label, PV 401 - ITA
410	Label, PV 401 - SWE
411	Label, PV 401 - ENG
412	Label, PV 401 - GER
413	Label, PV 401 - logo
414	Label, PV 401 - pat.air SWE
415	Label, PV 401 - pat.air ENG
416	Label, PV 401 - pat.air GER
417	Label, PV 401 - pat.air ITA
418	Label, PV 401 - serial number
420	Service kit, PV 401
421	Filter, inner
422	Filter, outer
423	Rear panel, PV 401
424	Bellows
426	Nipple - SCN-M6-PK3
427	Text plate, PV 401 - ITA
428	Printed circuit board, PV 401 - LCD
429	Printed circuit board, PV 401 - CPU
430	Printed circuit board, PV 401 - MDA
431	Printed circuit board, PV 401 - Filter board
432	Printed circuit board, PV 401 - Hour meter board
433	Ribbon cable, PV 401 - 40 pole
434	Ribbon cable, PV 401 - 34 pole
435	Angled heat sink, PV 401
436	Cover plate - Motor package
437	Transformer, PV 401
438	Motor, PV 401

439	Pulley, motor, PV 401
440	Pulley, motor screw, PV 401
441	Reflection sensor, PV 401
442	Securing bracket reflection sensor
443	Insulation washer, PV 401
444	Sleeve
445	Bearing case
446	Spring washer
447	Bearing
448	Bellows bottom end cover PV 401
449	Bellows top end cover PV 401
450	Flange
451	Cover for hollow shaft
452	Drive screw, PV 401
453	Nut, PV 401
454	Upper casing, PV 401
455	Lower casing, PV 401
456	O-ring - seal cover plate
457	Bottom plate
458	Membrane - check valve
459	Tube connector - air out, PV 401
460	O-ring - Tube connector air out
461	Drive belt
462	Reflection plate
463	Software
466	Bottom plug
467	Cover, motor wiring
468	Circuit board set, complete
469	Dust protection D-sub (male)
470	Dust protection D-sub (female)
471	Bellows clamp, lower, steel
472	Bellows clamp, upper, steel
473	O-ring small for sealing cover plate
474	Motor unit complete, exchange unit
475	Bolt+nut+bearing+shaft, kit
476	O-ring 473 + 456 kit
481	Opto-switch, end position, complete
482	Software PROM
483	Software, Processor
534	Software Master (U6) PV401 MXG
535	Software Slave (U28) PV401 SGP
536	Internal memory (U41 Dallas 1644-150) PV 401
601	Cellulose rubber strip
602	Suction tube 4 x 6 - frosted
604	Fuse - T 315mA
605	Fuse - T 160mA
606	Fuse - F 3,15A
607	Silicon cable
608	Ring cable terminal - 6mm
609	Ring cable terminal - 5mm
610	Ring cable terminal - 4mm
611	M3 x 8 with washer
612	M3 - washer-nut
613	Cooling paste - HTC10S

614	Shrink tubing- 6,4mm
615	Shrink tubing- 3,2mm
616	Shrink tubing- 2,4mm
617	Shrink tubing- 12,7mm
618	Shrink tubing- 1,6mm
619	Cable terminal- insulated
620	Wire - 0,75mm black
621	Wire - 0,75mm red
622	Wire - 0,75mm twin conductor
623	Wire - 0,75mm brown
624	Wire - 0,75mm blue
625	Wire - 0,50mm black
626	Wire - 0,50mm red
627	Wire - 0,50mm brown
628	Wire - 0,22mm white
629	Wire - 0,22mm black
630	Wire - 0,22mm red
631	Wire - 0,22mm brown
632	Ribbon cable clip
633	Cable strain relief - 4mm
634	Cable strain relief - 3,5mm
635	Cable strap anchor
636	Cable strap - 8"
637	Cable strap - 4"
638	Cable strap - 14½"
639	5mm metal spacer
640	Y-connector
641	Blue Festo tube
642	Power cord strap
643	Black screw 201 - RXS 3,5 x 19
644	Transparent tube 9 x 12
645	Transparent tube 4 x 7
646	Transparent tube 3 x 6
647	Transparent tube 3 x 5
648	SPAX 4 x 20
649	SPAX 3 x 12
650	SGA 22
651	Seeger fuse - AK-26
652	M6 x 25 - bolt
653	M6 x 22 - washer
654	M6 - flat washer
655	M6 - lock nut
656	M5 x 80 F
657	M5 x 50 F
658	M5 x 20 cap socket
659	M5 x 16 F
660	M5 x 16
661	M5 - serrated washer
662	M5 - flat washer
663	M5 - nut
664	M5 - lock nut
665	M4 x 8 F
666	M4 x 8
667	M4 x 45

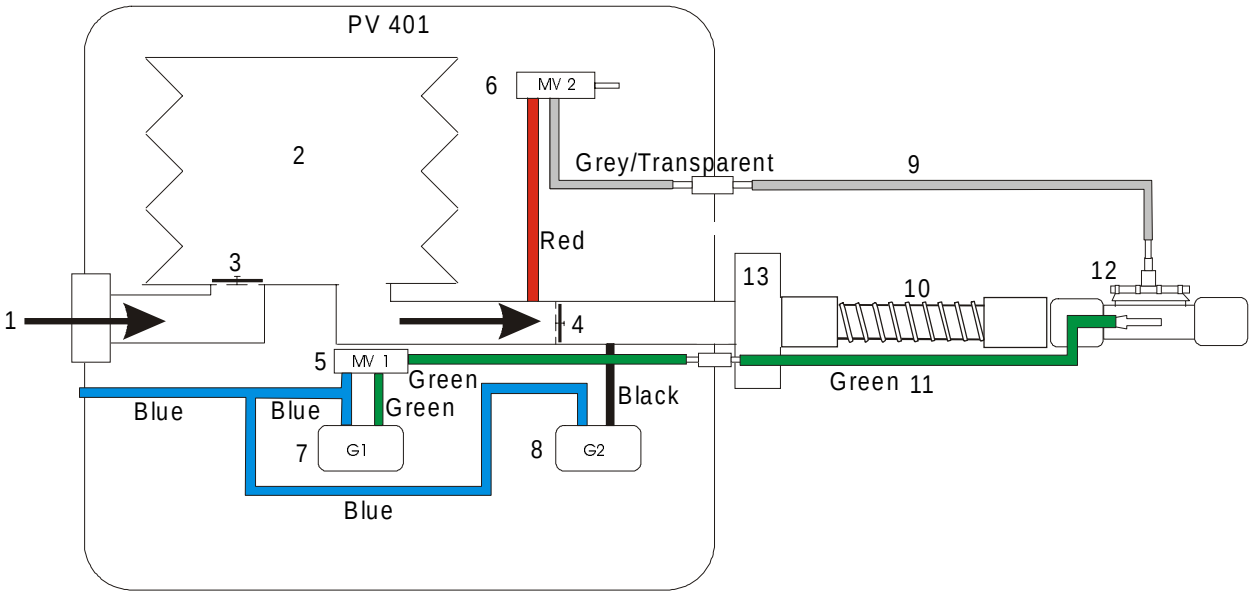
668	M4 x 30
669	M4 x 20
670	M4 x 16 F
671	M4 x 16
672	M4 x 12
673	M4 x 10 F
674	M4 - wing nut
675	M4 - serrated washer
676	M4 - flat washer
677	M4 - nut
678	M4 - lock nut
679	M3 x 8
680	M3 x 6 F
681	M3 x 6
682	M3 x 16 F
683	M3 x 12 black cap socket
684	M3 x 12
685	M3 x 10 F
686	M3 x 10
687	M3 - serrated washer
688	M3 - flat washer
689	M3 - nut
690	M3 - threaded stud
691	M2 x 10
692	M10 - serrated washer
693	KFXS 2,9 x 9,5 F
694	Fibre washer
695	WAGO - marking 301
696	WAGO - marking 1-8
697	WAGO - marking 1-6
698	WAGO - marking 1-4
699	Wire - 0,22mm blue
701	Plastic spacer- 4 x 15
702	Plastic spacer- 4 x 10
703	Plastic spacer- 3 x 10
704	Blind plug - securing bracket hole
705	Double-sided adhesive tape
706	Power cord strain relief
707	Nuts - 201
709	Fuse - T 1,25 A
711	Cable tie - mini
713	M4 x 6 cap socket
714	IC - MDA
715	IC - 33035
716	M8 x 45 stop screw
717	Cone - counterpressure when test running
718	M5 x 12 F
719	Fuse - T 6,3A
720	Shrink tube 4,8mm
721	Velcro fastening
722	BREAS - label (small transparent)
723	Magnetic strip
724	Cable tie - alarm
725	Shrink tube - 19,1mm (transp.)

726	Plastic spacer
728	O-ring - check valve (inner)
729	M3 x 8 - bolt
730	Flat washer - 5 x 16 x 1
731	Silicon tube - 3 x 5
732	Silicon tube - 3 x 6
734	Bolt - M5 or M6 collar
736	M5x16 torx for end cover
737	Thermoplastic bolt - fixed bg
738	Spacer - motor plate M4
739	Silicon hose - 4 x 7
740	M4 x 8 F - black
741	M3 x 6 F - black
742	M4 x 30 F
743	M8 - lock nut
744	Spacer bolt - 40mm
745	Pop rivet for fixing bracket - cover
746	Rivet screw for vib.damper M4
747	Rivet nut - bottom plate M3
748	Rivet nut - rear panel M3
749	Rivet nut - rear panel M4
750	M3 x 16 Torx
751	Rivet nut for MDA M3
752	Silicon tube 2,5 x 6 - white
753	O-ring - check valve 501
754	M6 x 16 - black cap socket
755	Spacer tube 15x10x3
756	Spacer tube 10x6x3
757	Stop screw - M4 x 5
758	M6 x 30 - cap socket
759	Thermoplastic bolt - 10mm
760	Thermoplastic screw - 12mm
761	Stop screw
762	M4
763	Washer
764	M6 x 30 - bolt
765	M2 x 6
766	Spacer screw - 10mm
767	Spacer screw - 5mm
768	Stop screw - M3 x 4
769	M2 - flat washer
770	M3 x 20
771	M5 x 40 cap socket black
772	Spacer bolt - 20mm
773	M4 x 6 cap socket
774	M3 x 20 F
775	M3 x 5 Phillips
776	Wing bolt
777	M5 x 8 Phillips
778	M5 x 6
779	Spacer tube 2,5 x 10
780	Silicon tube - red
781	Silicon tube - black
782	Silicon tube - green

783	Silicon tube - blue
784	Krytox - AZ
792	Fuse, 630 mA
794	Screw - MRX steel M3*4 FZB POZ
1120	Hour meter LCD 24V
1128	Decal - pat.air FR
1129	Decal - FR
1130	Decal - ESP
1131	Decal - NL
1132	Decal - DK
1134	Decal - pat.air ESP
1135	Decal - pat.air NL
1136	Decal - pat.air DK
1137	Text panel - ESP
1138	Text panel - NL
1139	Text panel - DK
1140	Text panel - FR
1145	Rubber washer for transformer
1146	Metal washer for transformer
1147	Felt sleeve for drive screw PV 401
1167	Fastening plate (401DP top of moving end cover)
1168	End cover for bellows, moving
1169	Stop plate for photocell PV401
1170	Bushing
1171	Fastening bracket (for photocell)
1172	O-ring 44,2 x 3 EPDM
1173	Cable tie
1174	Screw ETP 4x12 (thermo-plastic)
1478	Cover kit lower casing 401
1479	Cover kit upper casing401

5 FUNCTIONAL DIAGRAMS

5.1 Pneumatic Diagram



(1) Patient air inlet (through air filter)

(2) Bellows

(3) Check valve (closed during inspiration)

(4) Check valve (closed during expiration)

(5) Magnetic valve MV 1 (Normally set as per fig. 1. Switches at auto-calibration of G1 according to fig. 2.)

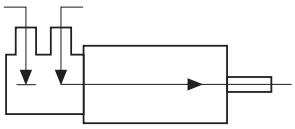


Fig 1

(6) Magnetic valve MV 2 (Normally set as per fig. 2. Safety valve that switches at too high pressure.)

(7) Pressure sensor G1

(8) Pressure sensor G2

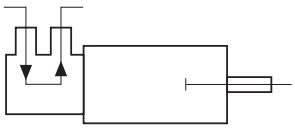


Fig 2

(9) Control pressure tube for the exhalation valve

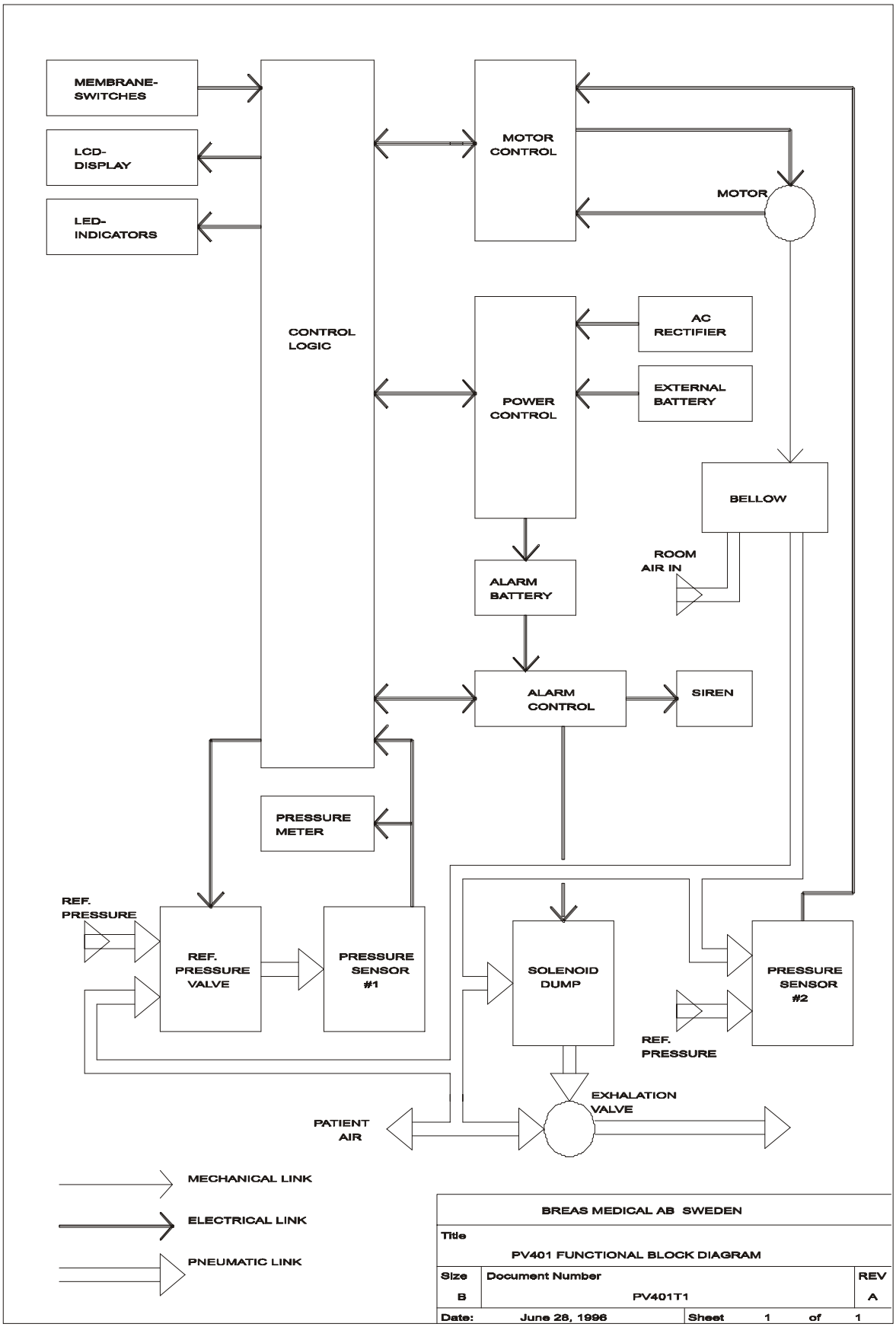
(10) Patient air tube

(11) Tube for measuring the pressure

(12) Exhalation valve

(13) Bacteria filter (if used)

5.2 Functional block diagram



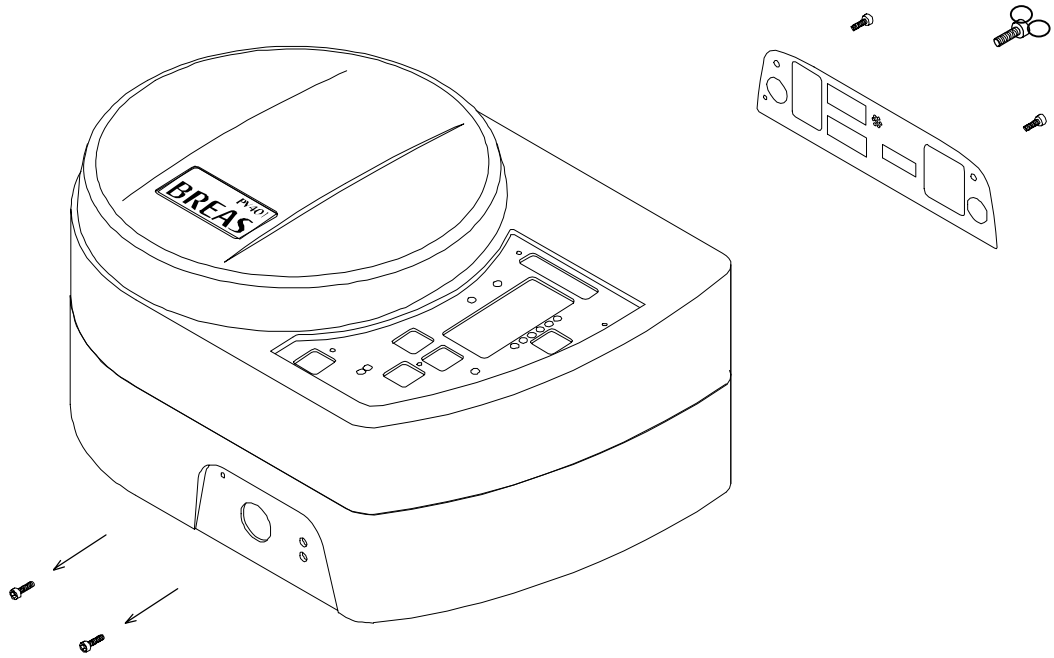
6 DISMANTLING AND ASSEMBLING THE PV 401

6.1 Tools required

The following tools are required to dismantle and assemble the different units in the PV 401.

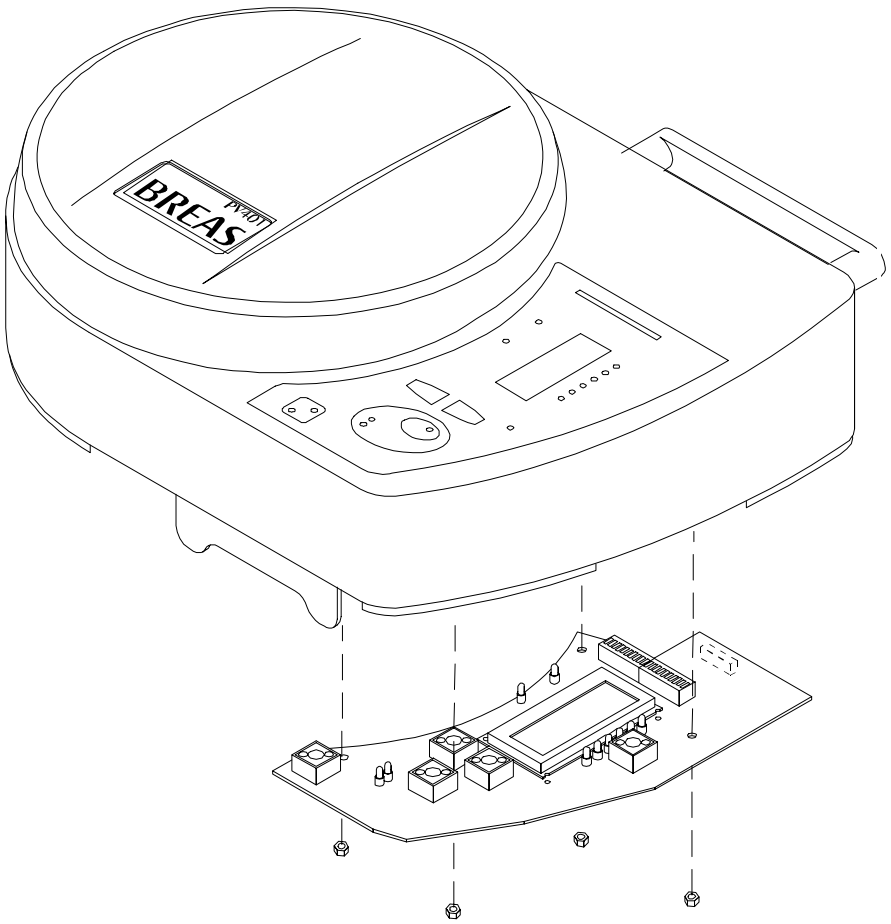
Allen keys: 2, 4, and 5 mm (magnetic)
Socket 5.5 mm
Standard flat screwdriver (magnetic)
Philips screwdriver (magnetic)
Cable tie pliers

6.2 Removing the upper casing



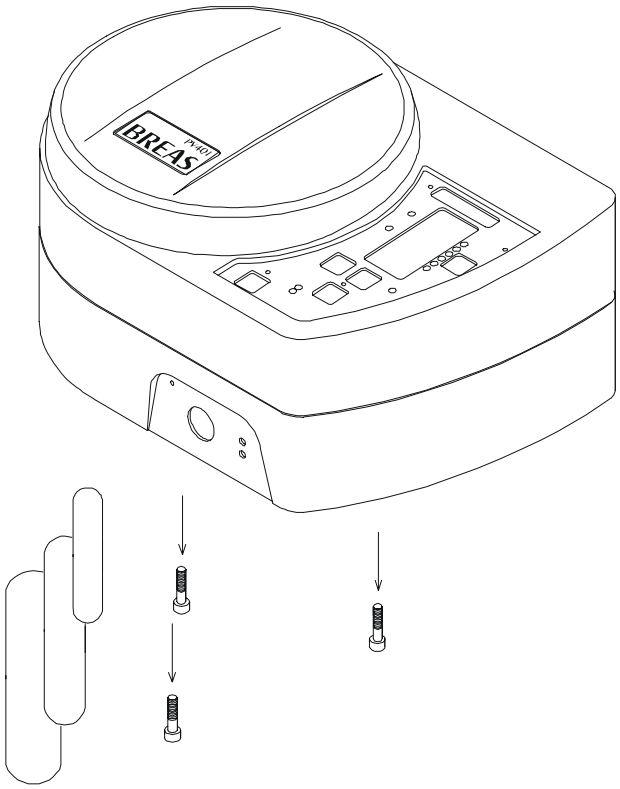
- Remove the power cord.
- Remove the four cap head socket screws (2 mm Allen key) from the front and rear panels (2 pcs in each panel) and the wing bolt for the power cord strain relief.
- Carefully lift the upper casing upwards and disconnect the ribbon cable and the black ground wire from the CPU board. Put the casing and panel plates to one side.

6.3 Replacing the LCD board

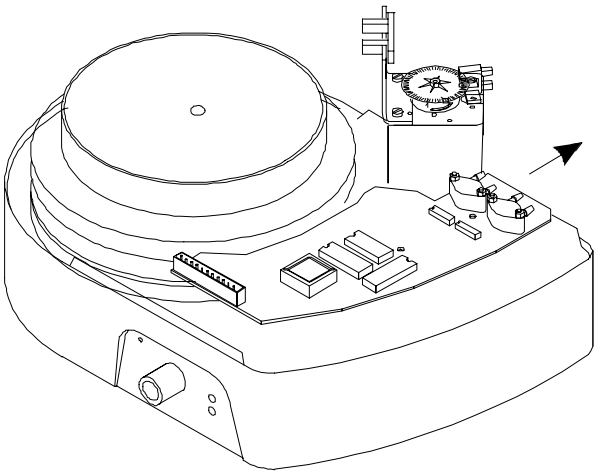


- Remove the upper casing.
- Remove the four M3 nuts holding the LCD board.
- Disconnect the ribbon cable and the black ground wire from the LCD board.
- Reassemble with the new board in the reverse order.

6.4 Removing the motor unit from the lower casing



- Remove the upper casing.
- Remove the filters from the filter holder and remove the three screws underneath the lower casing that hold the motor unit.



- Carefully bend the rear edge of the lower casing in the direction of the arrow (see figure above) so that the motor unit can be lifted out. Holding the motor, lift the complete unit upwards and backwards from the lower casing.

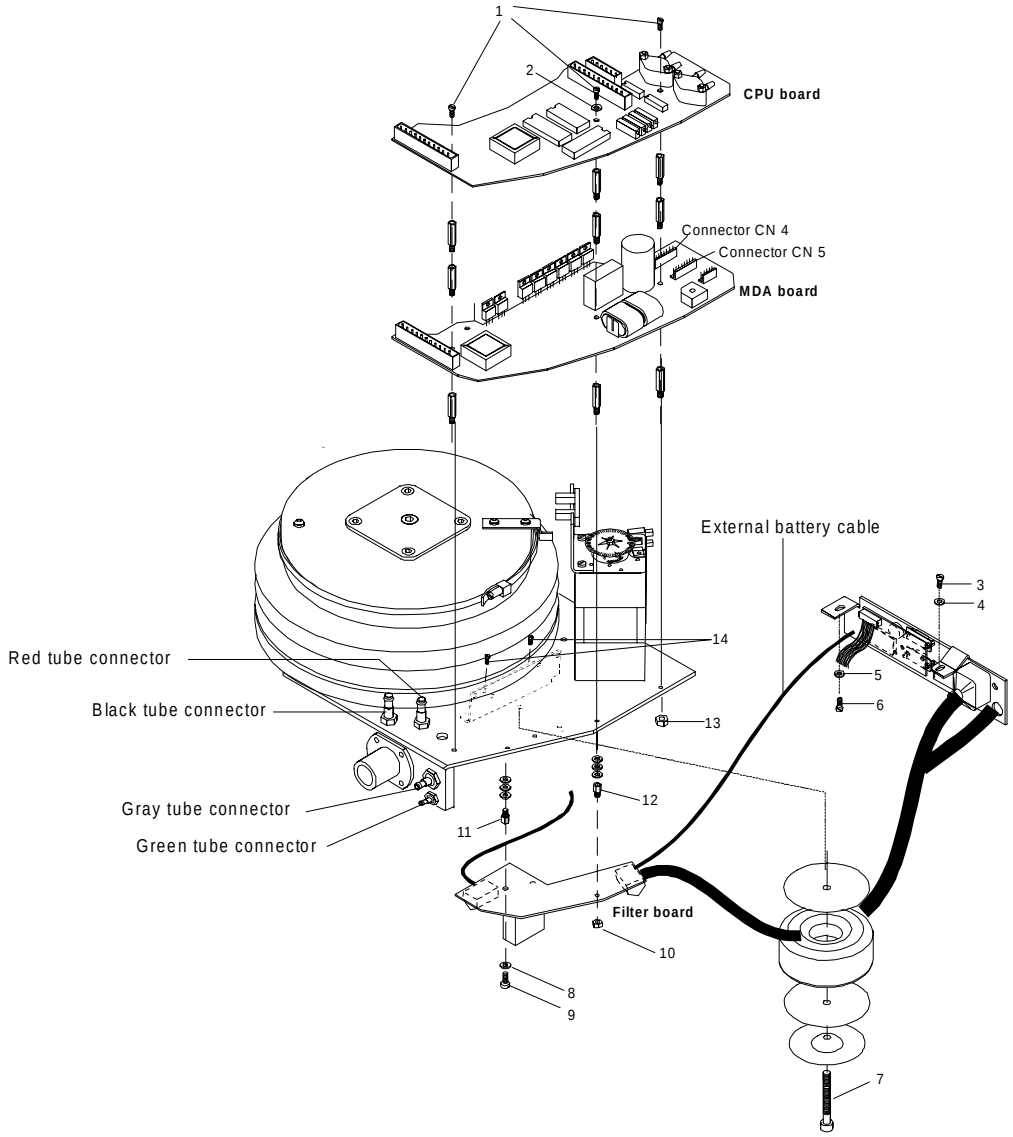
6.5 Replacing the complete motor unit

The complete motor unit must be replaced after 10,000 operating hours. To replace the motor unit, the motor unit must first be removed from the casing.

6.5.1 Removing the Circuit Board Package from the Motor Unit

Important! When performing this operation be careful to note how the different coloured tubes are fitted to ensure their correct location when reassembling.

- Remove the motor unit, see operation Nos. 6.2 and 6.4.
- Move the bellows upwards by turning the shaft from underneath.
- Without disconnecting any of the air tubes, proceed to loosen the CPU board by removing the three screws (1 in figure). Take care of the fiber washer (2) under the centre screw.



- Lift the CPU board at the rear edge enough to disconnect the two connectors CN4 and CN 5, see figure.

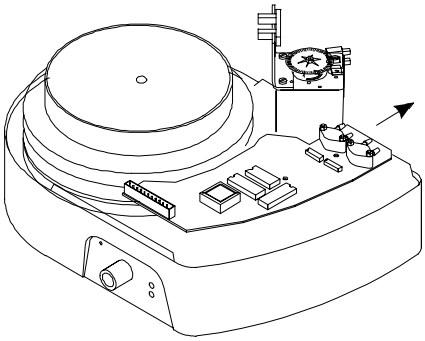
- Remount the CPU board using only the two outer screws but with the connectors disconnected.
- Remove the screw (3) and washer (4) for the rear panel.
- Turn the motor unit over taking care not to damage the boards, etc.
- Remove the screw (5) and washer (6) that hold the rear panel.
- Cut and remove the plastic cable tie for the external battery input cable.
- Loosen the transformer by removing the centre bolt (7).
- Disconnect the green and gray tubes from their connectors at the rear of the patient air outlet.
- Proceed to loosen the Filter board. Start by removing the screw and washer (8 and 9). Loosen nut (10).
- Using a 5.5 mm socket remove the three nuts and washers holding the circuit board package to the base plate (11, 12 and 13). Swing the Filter board out a little to access the nut behind the patient air outlet.
- Turn the Motor Unit over taking care not to damage any of the components.
- Remove the two screws (14) that hold the cooling bracket for the MDA board. The bracket can remain attached to the board.
- Finally, disconnect the red and black tubes from their connectors above the patient air outlet, see figure.
- The circuit board package can now be separated from the Motor Unit.

6.5.2 Assembling the Circuit Board Package to the Motor Unit

- Fasten the bracket for the MDA board in place with the two screws (14).
- Connect the red and black tubes to their respective connectors above the patient air outlet.
- Take a good firm grip around the Motor Unit and Circuit Board Package and turn it upside down.
- Mount the Filter board and screw on the three nuts and washers (11, 12 and 13) that hold the Circuit Board Package. Tighten the two outer nuts using appropriate hand pressure. Do not tighten the nut holding the Filter board at this stage.
- Connect the green and tubes to their respective connectors.
- Swing the Filter board in place. Fasten it with screw (9) and washer (8) and tighten the third nut.
- Mount the transformer and fasten it with the centre bolt (7) and washer. Tighten using appropriate hand pressure.

- Mount the rear panel. Start by only fitting the screw (5). The Motor Unit must be turned over before screw (3) can be fitted.
- Turn the motor unit and circuit board package the right way up.
- Remove the outer screws (1) holding the CPU board.
- Lift the board a little so that the two connectors, CN4 and CN5 can be connected. CN4 is connected to the Sensor connector and CN5 to the Motor connector. Make sure that all the pins locate in their respective holes.
- Mount the CPU board and fasten it with the three screws (1). Make sure that the tubes are NOT kinked or pinched. Do not forget the fibre washer (2) under the centre screw.
- Check, by looking from the side between the CPU and MDA boards, that the black and red tubes run at a 45° angle down behind the large capacitor.
- Fit a new plastic cable tie to the external battery input cable.

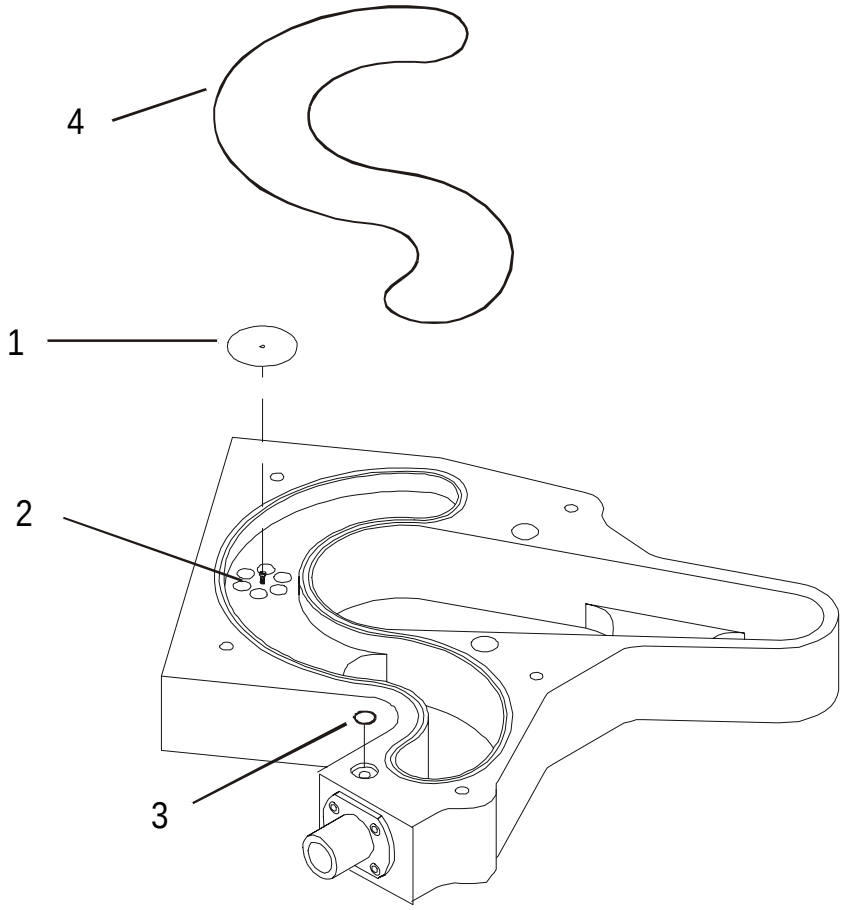
6.6 Assembling the motor unit in the casing



- Carefully bend out the rear edge of the lower casing in the direction of the arrow (see figure) fit the motor unit into the lower casing. Secure in place with the three screws inserted from underneath the lower casing.
- Connect the ribbon cable and the black ground wire to the CPU board. Fit the upper casing. Fit the front and rear panels and secure with the four cap head socket screws (2 mm key) (2 pcs in each panel) and the wing bolt for the power cord strain relief.

7 MOTOR UNIT

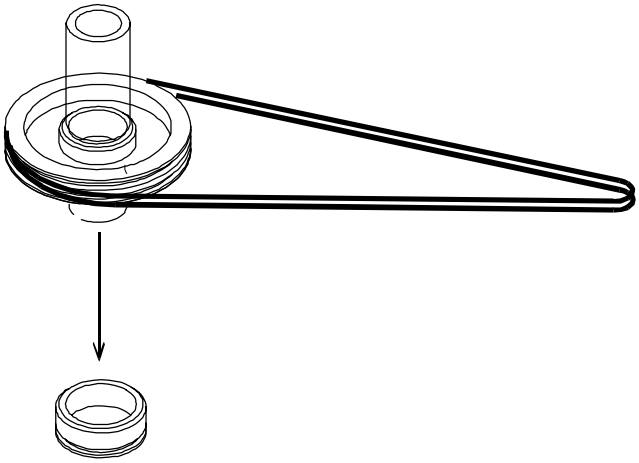
7.1 Construction



Pos.	Description
1	Bellows
2	Bellows clamps
3	Air channel block assembly
4	Air pressure nipple for regulator sensor G2
5	Air pressure nipple for exhalation valve, internal
6	Base plate
7	Air pressure nipple for exhalation valve, patient circuit
8	Nipple for measuring pressure in patient circuit
9	Patient air outlet
10	Bellows end cover
13	Slotted disc
14	Opto-switch
15	Motor

7.2 Inspecting/Replacing the drive belts

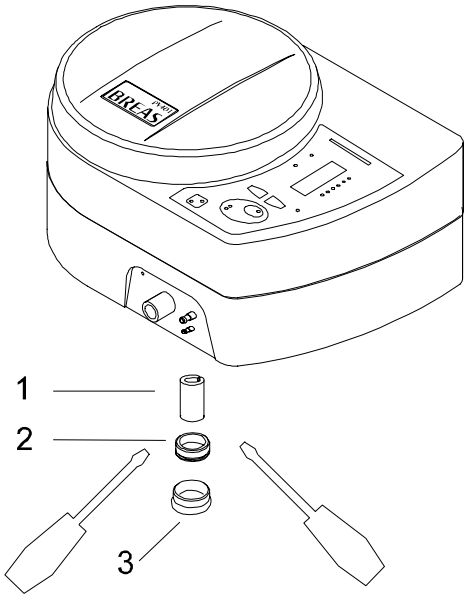
This operation is carried out with the main unit removed from the casing.
See Chapter 6 for instructions on removing the main unit.



- Check that the drive belts are undamaged and have not become slack. Replace the belts at each service.
- Reassemble the main unit and casing. See Chapter 6.

7.3 Lubricating the drive screw

The drive screw can be lubricated without removing the casing.



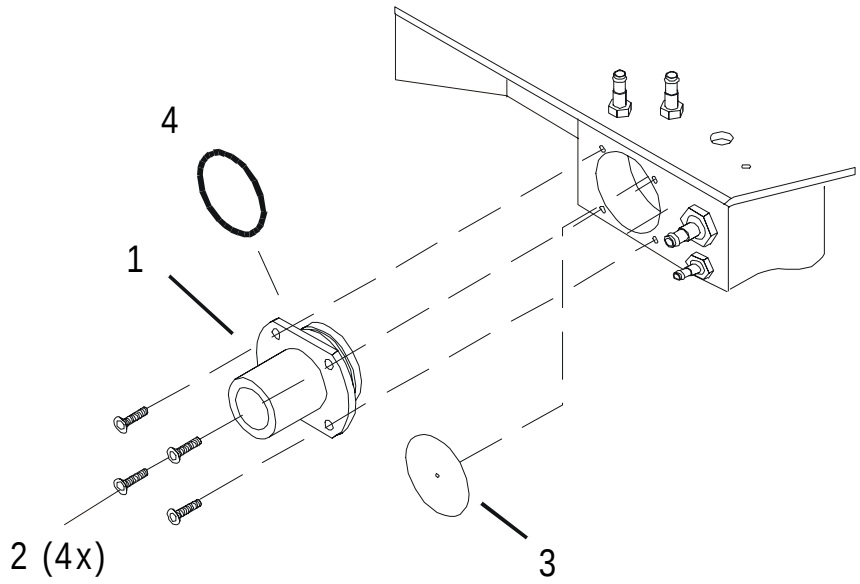
- Remove the protection plug (3) from underneath the lower casing.
- Remove the aluminium plug (2) using two screwdrivers.
- Apply grease of type BREAS 240 AZ to the inside of the felt sleeve (1).
- Fit the felt sleeve and press the protection plug back into place.

7.4 Replacing the membranes in the check valves

This operation is carried out with the motor unit removed from the casing. See Chapter 6 for instructions.

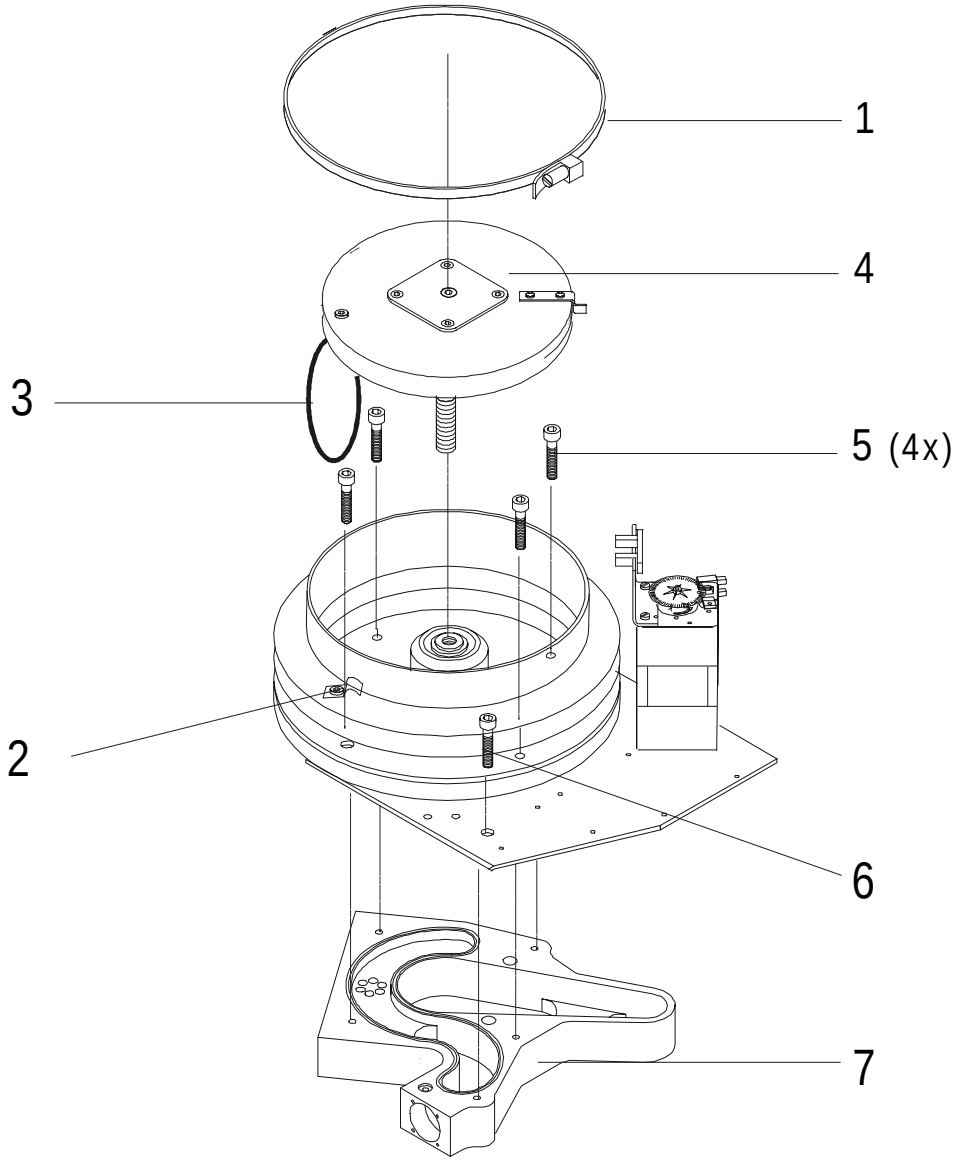
Before starting work make sure you have at hand a Service kit for check valves which contains, 1 pce membrane and 1 pce O-ring for 22 mm hose connector and 2 drive belts.

7.4.1 Replacing the membrane in the patient air outlet

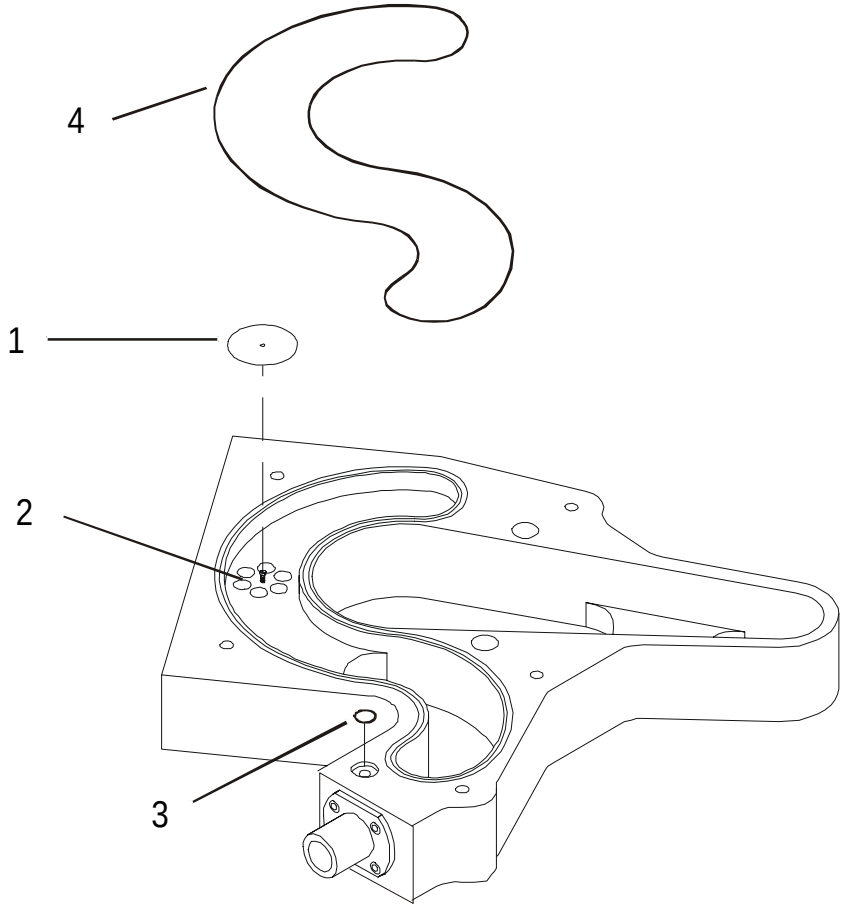


- Remove the patient air outlet (1) by removing the four screws (2).
- Remove the membrane (3) by carefully pulling it over the screw head.
- Wipe the membrane seat clean using a moist rag.
- Carefully fit the new membrane over the screw head.
- Make sure that the new membrane lies flat against its surface.
- Fit a new O-ring (4) to the patient air outlet (1).
- Reassemble in the reverse order.

7.4.2 Replacing the membrane in the air channel block assembly



- Remove the circuit board package comprising the filter, MDA and CPU boards. See Chapter 6 for instructions.
- Leave all tubes and cables in place.
- Remove the hose clamp (1) from the top cover.
- Loosen the screw (2) for the lower clamp that holds the rubber damper band (3). Unhook the damper band and let it hang from the top clamp.
- Unscrew and remove the top cover (4) complete with the drive screw.
- Remove the four Allen bolts (5) and bolt (6).
- The air channel block assembly (7) can now be removed.

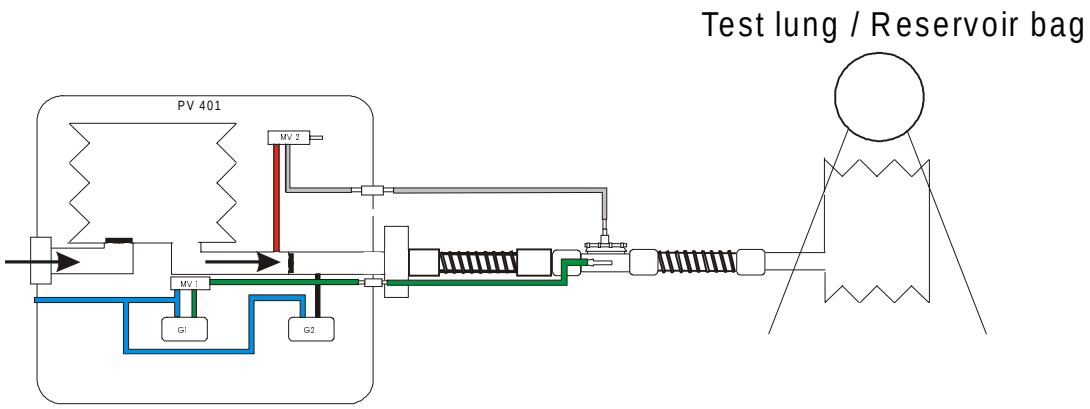


- Remove the membrane (1) by carefully pulling it over the screw head.
- Wipe the membrane seat (2) clean using a moist rag.
- Carefully fit the new membrane over the screw head.
- Make sure that the new membrane lies flat against its surface.
- Reassemble in reverse order. Do not forget to fit the O-ring (3) and rubber seal (4).
- Perform a leakage test to check the function of the check valve.

7.5 Leakage check of tubes and bellows,

This operation is carried out with the main unit removed from the casing. See Chapter 6 for instructions.

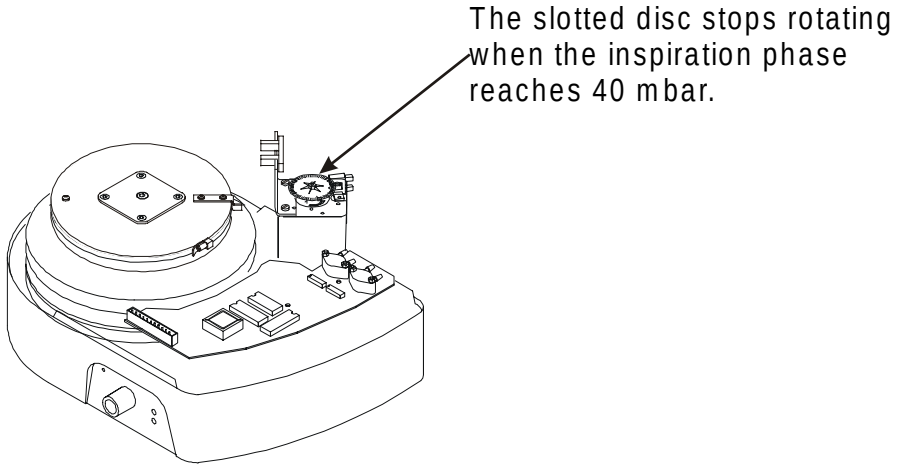
- Connect the main unit with the patient circuit to a test lung/reservoir bag.



- Connect the LCD board to the CPU on the main unit.
- Check that the bellows has not worked loose from its end covers.
- Check that the hose clamps are properly tightened.
- Connect the mains power supply or an external 24 V battery and switch on.
- Set the following parameters:

Pressure	40 mbar
Rate	6 BPM
Insp.time	5.0 seconds
Mode	PCV

- Check that the motor stops when the pressure has reached 40 mbar. If there is any leakage, the motor will continue to work to compensate for the air leakage. The tidal volume should be less than 0.05 litre.



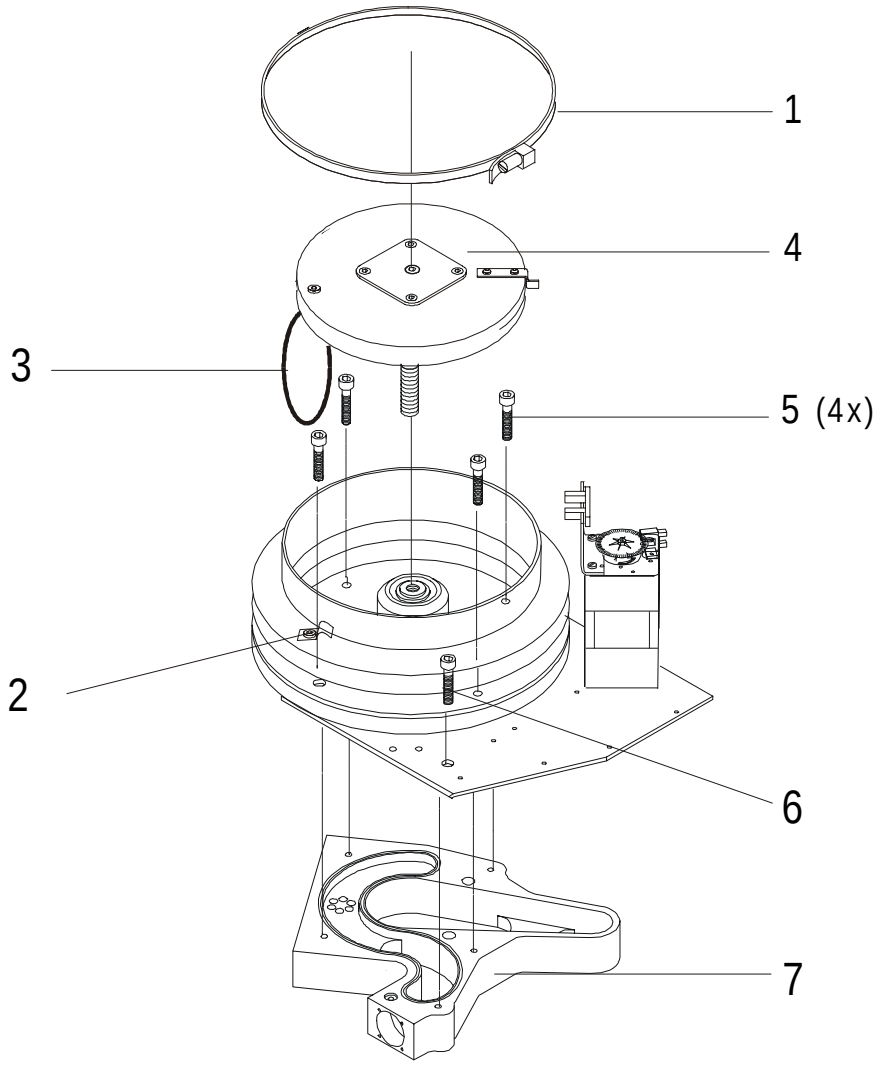
7.6 Replacing the drive screw assembly

This operation should only be performed by personnel who have attended an appropriate Breas training course and have access to the special tools required. BREAS MEDICAL recommends the use of exchange units rather than attempting to replace the drive screw assembly.

The circuit board package should be removed from the Motor Unit before starting this operation, see Chapter 6 for instructions.

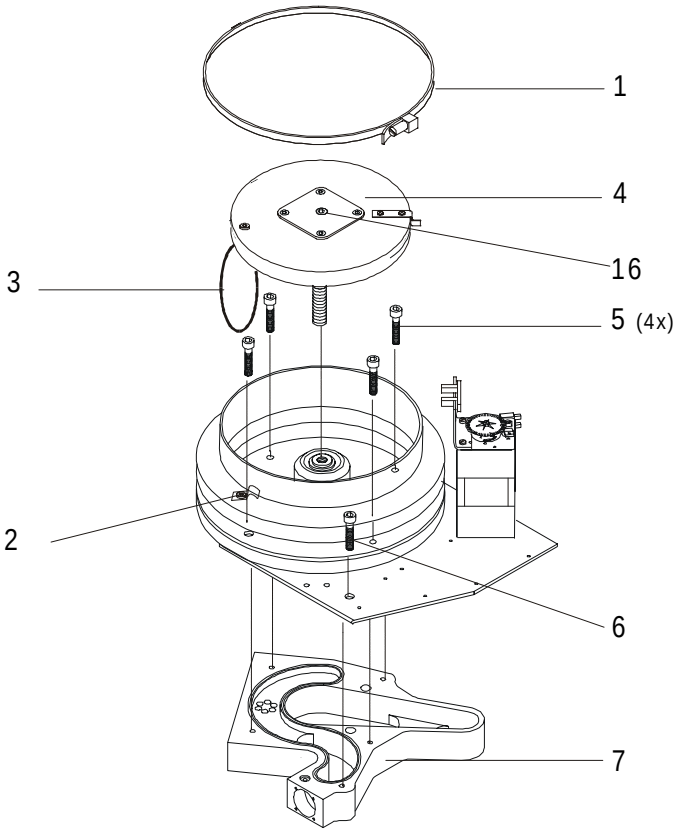
7.6.1 Removing the drive screw assembly

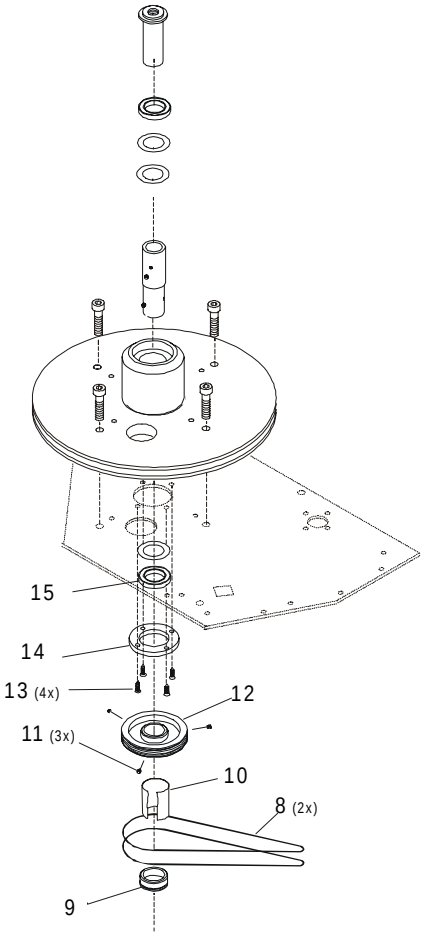
- Separate the Motor unit from the circuit board package, see Chapter 6.



- Remove the circuit board package comprising the filter, MDA and CPU boards. See Chapter 6 for instructions.
- Leave all tubes and cables in place.
- Remove the hose clamp (1) from the top cover.

- Loosen the screw (2) for the lower clamp that holds the rubber damper band (3). Unhook the damper band and let it hang from the top clamp.
- Unscrew and remove the top cover (4) complete with the drive screw.
- Remove the four Allen bolts (5) and bolt (6).
- Turn the unit over and cut the plastic cable tie for the external battery input cable.
- The air channel block assembly (7) can now be removed.





- Remove the two drive belts (8).
- Remove the aluminium cap (9) using two screwdrivers.
- Remove the felt sleeve (10).
- Unscrew the three stop screws (11) (Allen key 2 mm) so that approx. 2 mm of thread is showing.
- Using a suitable puller and a counterhold for the drive sleeve, approx. 18 mm diameter, pull off the pulley wheel (12) taking care that none of the components are damaged.
- The drive sleeve assembly can now be knocked out from underneath using a plastic hammer.

- To remove the lower bearing, unscrew the four screws (13) holding the black plastic ring (14). Work the bearing (15) up with a flat screwdriver.
- To remove the drive screw from the top cover, grip the screw firmly in a vice (with protective jaw covers) and unscrew the centre screw (16). Note! Lock fluid is used at assembly which can make loosening difficult.

7.6.2 Installing the drive screw assembly

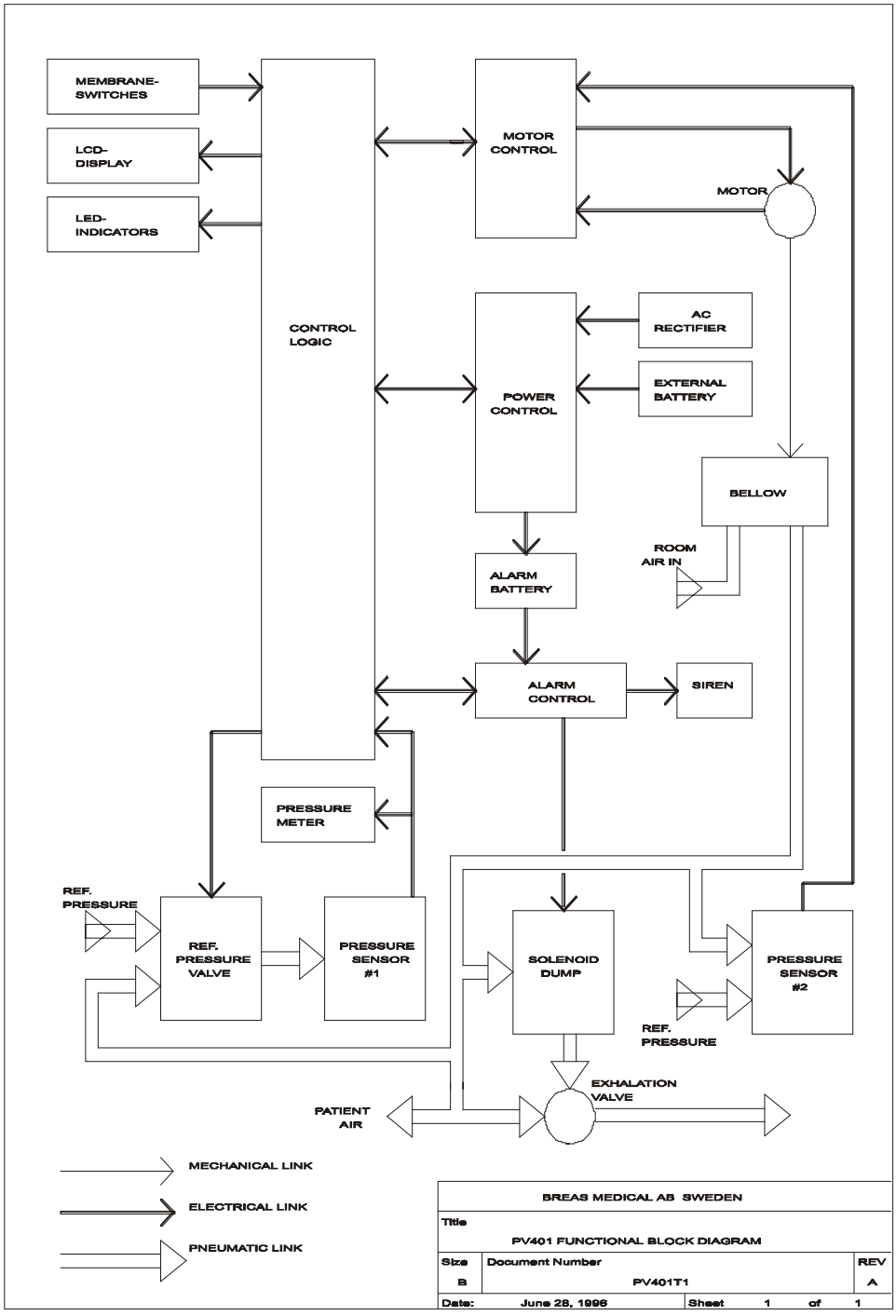
- Fit the lower bearing (15) in the recess under the bottom cover. Fit the black plastic ring (14) and fasten with the four screws (13).
- Arrange good support for the base plate. Apply a little grease to the sleeve assembly and from above, press it down through the lower bearing making sure the upper bearing seats properly in the recess provided. Note! If the sleeve is being reused, remove any rough edges caused by the locking screws for the pulley wheel.
- To fit the pulley wheel (12), turn the Motor unit upside down. Note! Inspect the pulley wheel grooves for damage before fitting. Remove one of the stop screws. Arrange for a suitable counterhold for the drive sleeve so that the red plastic insert does not get damaged. Press on the pulley wheel. Align the screw hole with one of the recesses in the drive sleeve. With the hole aligned, tighten the other two stop screws. Screw in the third screw and tighten.
- Before installing the air channel block assembly, replace the membranes for the check valve and O-rings. See Section 7.4.
- Install the air channel block assembly and fasten with the four Allen bolts (5) from above the bottom cover and bolt (6).
- Grip the new screw firmly in a vice (with protective jaw covers). Apply a little lock fluid to the centre screw threads. Align the top cover centre screw hole and fit the centre screw. Tighten using normal hand pressure.
- Apply a little grease to the drive screw. Screw in the top cover assembly all the way down. This is to ensure that grease gets applied to the threads in the drive sleeve.
- Unscrew the top cover assembly and remove any excess grease from the top of the drive sleeve. Make sure the drive sleeve threads are greased.
- Screw in the top cover assembly again.
- Hook the rubber damper band under the lower clamp and tighten the clamp screw.
- Pull the bellows up around the top cover and fit the hose clamp.
- Before fitting, apply grease type BREAS 240 AZ to the inside of the felt sleeve (10).
- Fit the aluminium cap (9). Fit a new O-ring if necessary.
- Finally, fit two new drive belts (8).
- The Motor unit should be tested for 24 hours before it is installed in a machine.

8 ELECTRONICS

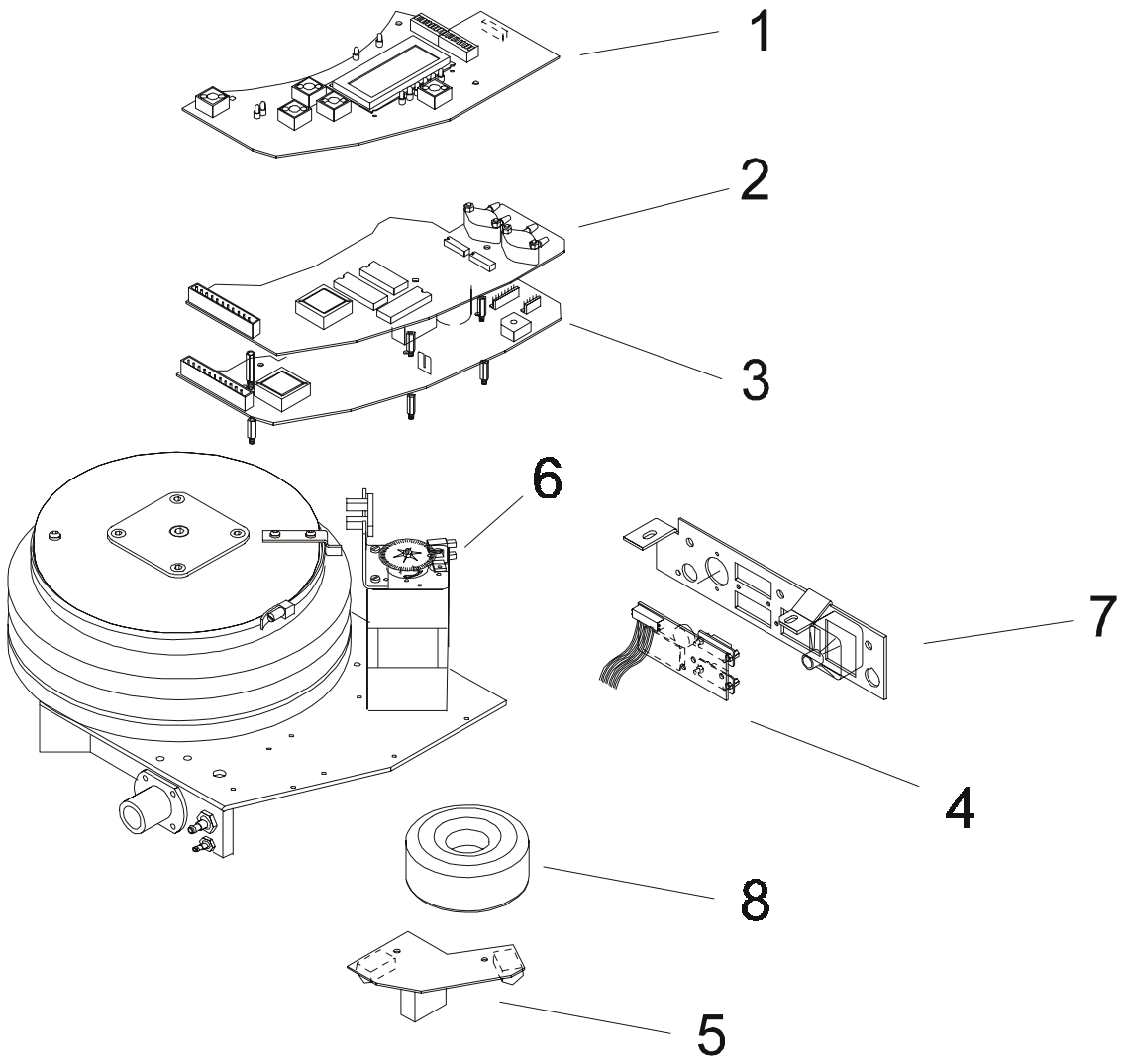
8.1 Function, construction

The electronics, optics, mechanics and pneumatics in the PV 401 are integrated. To fully understand the electronics used in the Breas PV 401, you must know how to use the ventilator, have studied the air flow diagram and acquainted yourself with the mechanical construction.

The block diagram (PV401T1) below shows how the electronics are arranged and how they are connected to other components.



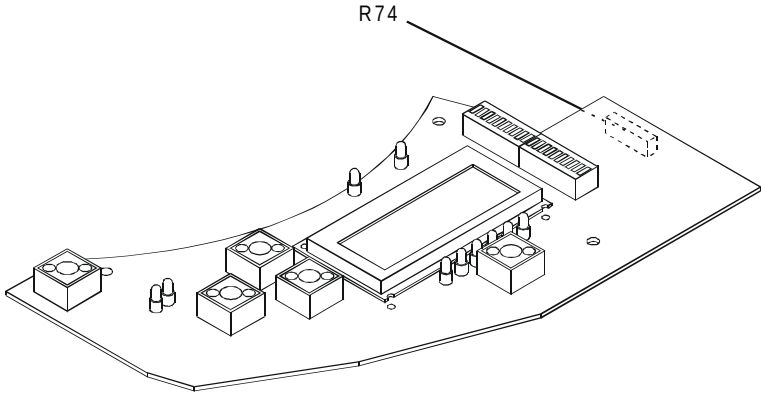
The electronics of the PV 401 comprises 5 printed circuit boards, the motor with sensor, rear panel with connectors, and the transformer**.**



Pos. No	Component	Location
1	LCD board	Inside the upper casing
2	CPU board	On the Motor unit
3	MDA board	On the Motor unit
4	Hour meter board	Rear panel
5	Filter board	Underneath the Motor unit
6	Motor with sensor	On the Motor unit
7	Power socket, voltage selector, etc	Rear panel
8	Transformer	Underneath the Motor unit

8.2 Description of circuit boards

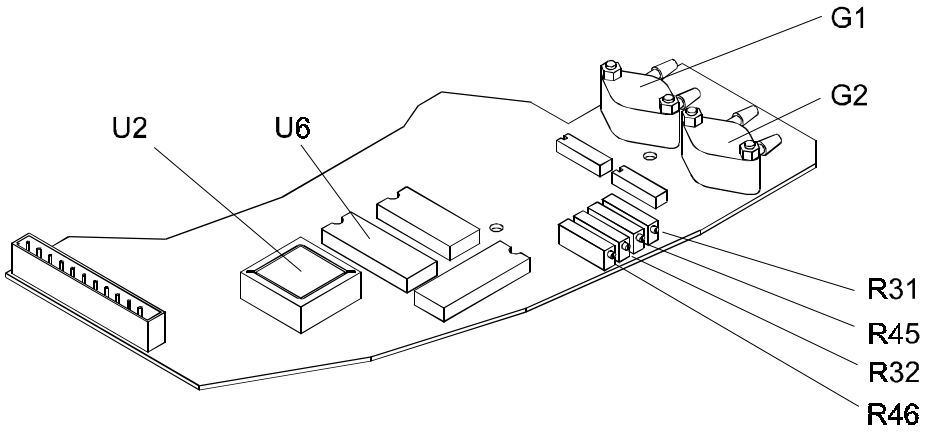
8.2.1 LCD board



All pushbuttons, the LCD display, LEDs and bar indicator for the pressure gauge are mounted on this board.

The LCD display contrast can be adjusted by R74 (underneath the board) without removing the board.

8.2.2 CPU board



The master processor U2 has its program stored in EPROM U6. U2 reads all button presses, stores all settings in its integrated eeprom memory, presents the settings on the display and controls the LEDs.

The values are saved just prior to the next breath and the display flashes once. U2 manages all alarm functions, such as low and high pressure, low volume, low power, etc.
The pressure sensors, G1, which monitors and presents the patient air pressure, and G2, which is used for regulating the pressure, are located here.

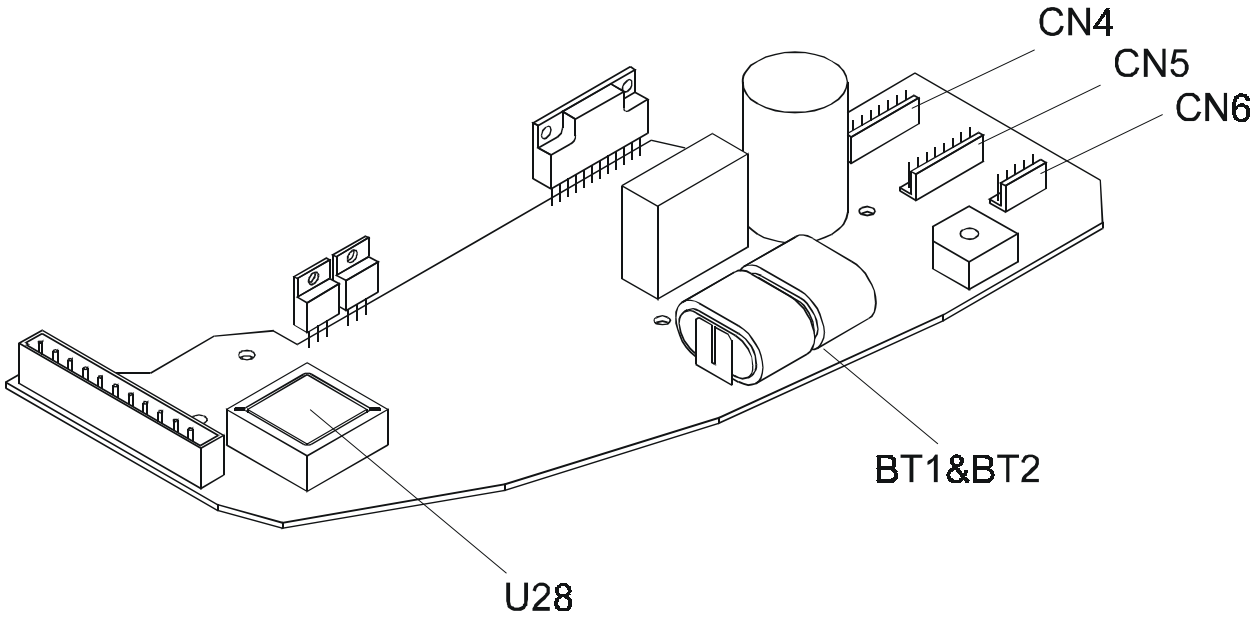
The magnetic valves MV1 and MV2 are located underneath the board.

MV1 is used for calibration of the zero pressure level for the pressure sensor G1.

When the trigger function is activated, G1 is auto-calibrated between each breath.

MV2 is used as a safety valve at high pressure alarm.

8.2.3 MDA board



Motor control, charging of alarm batteries and part of the power supply is done from the MDA board.

The transformer supplies CN6 on the MDA board, via the filter board, with 18 VAC rectified. If an external 24 VDC supply is connected, the supply is fed via the filter board to CN6.

At switch-on, relay K1 supplies the rest of the MDA board and other boards with power.

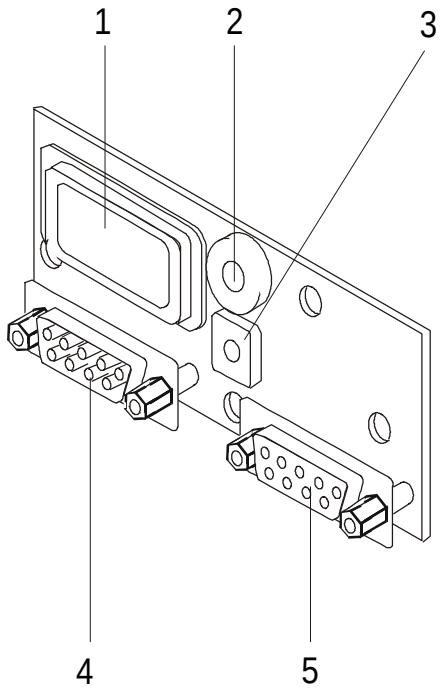
Motor control is managed by the slave processor U28, control circuit U30 and the transistors MF1-MF6.

U 28 calculates the moment the motor started based on the settings and regulates towards the set patient pressure with the help of G2.

The reflection sensor for the motor registers the home position. The opto switch counts the number of pulses given through the rotating slotted disc on the shaft of the motor to register many revolutions the motor has made and from this, calculate how far the bellows has travelled. The estimated tidal volume, which is shown in the display, is calculated using the number of pulses counted after each breath

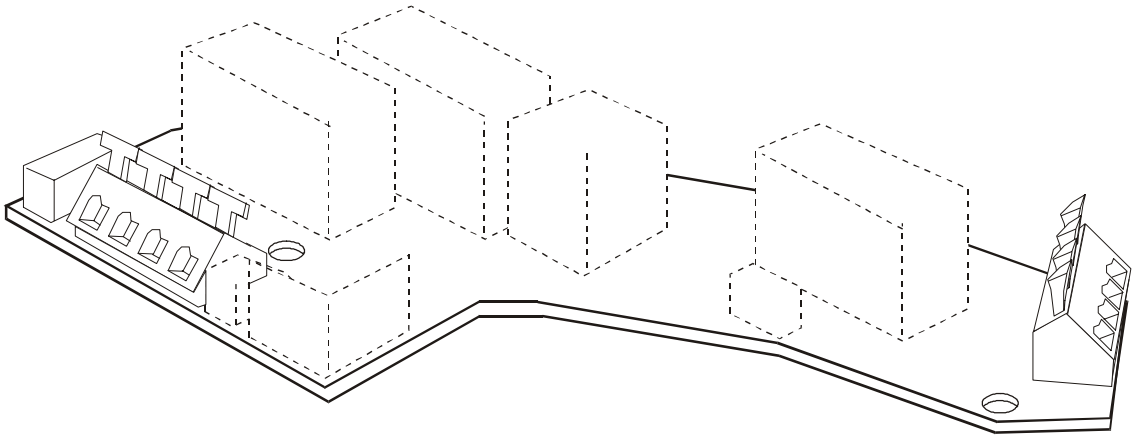
8.2.4 Hour meter board

This board comprises the hour meter LCD display (1), the alarm buzzer (2), the trim potentiometer (3) to adjust the sound level with, and the analog (4) and digital (5) connectors.

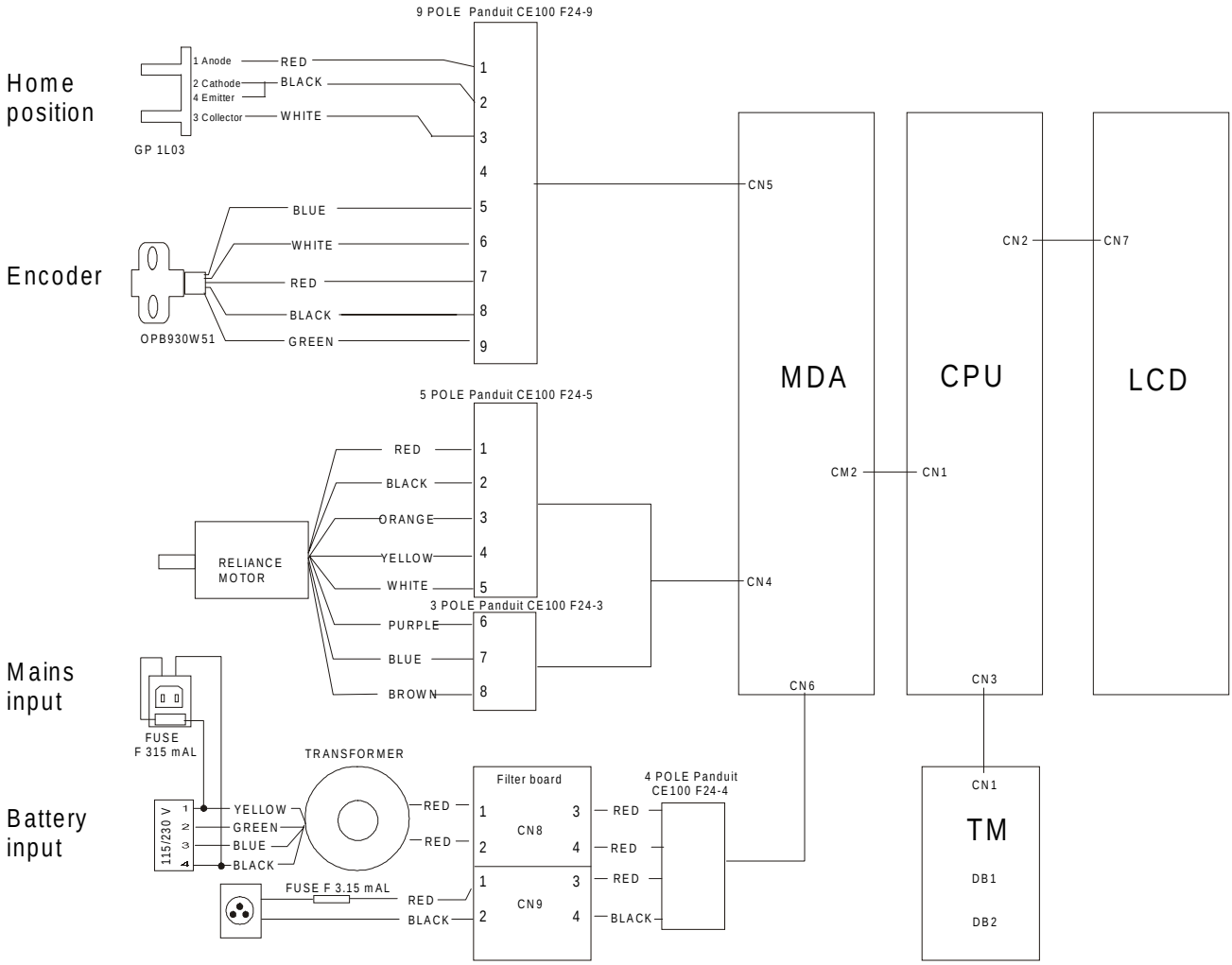


8.2.5 Filter board

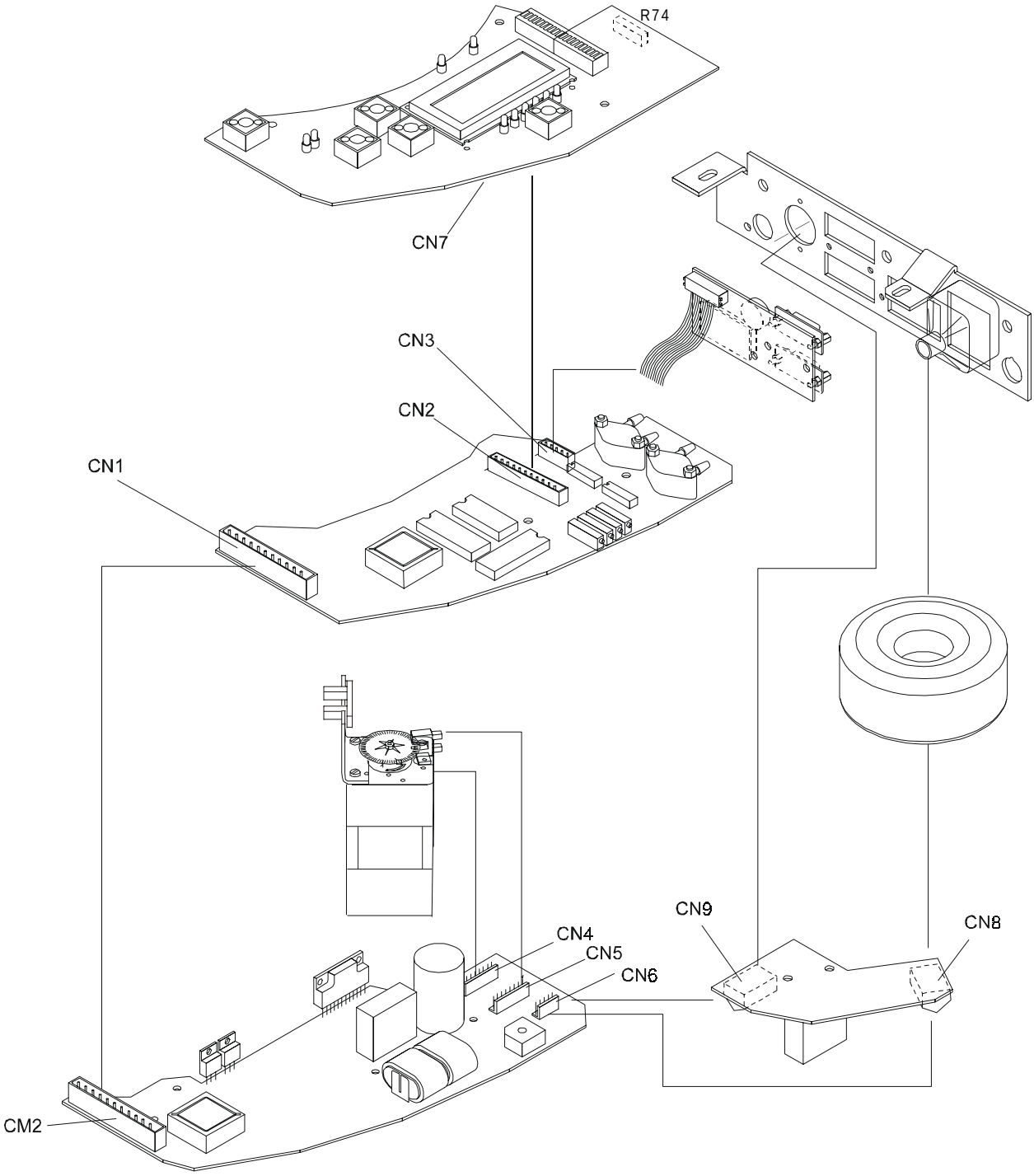
This board comprises the filter used to prevent electro-magnetic interference both to and from the ventilator. Also located here is the relay which disconnects the external battery when mains power is available.



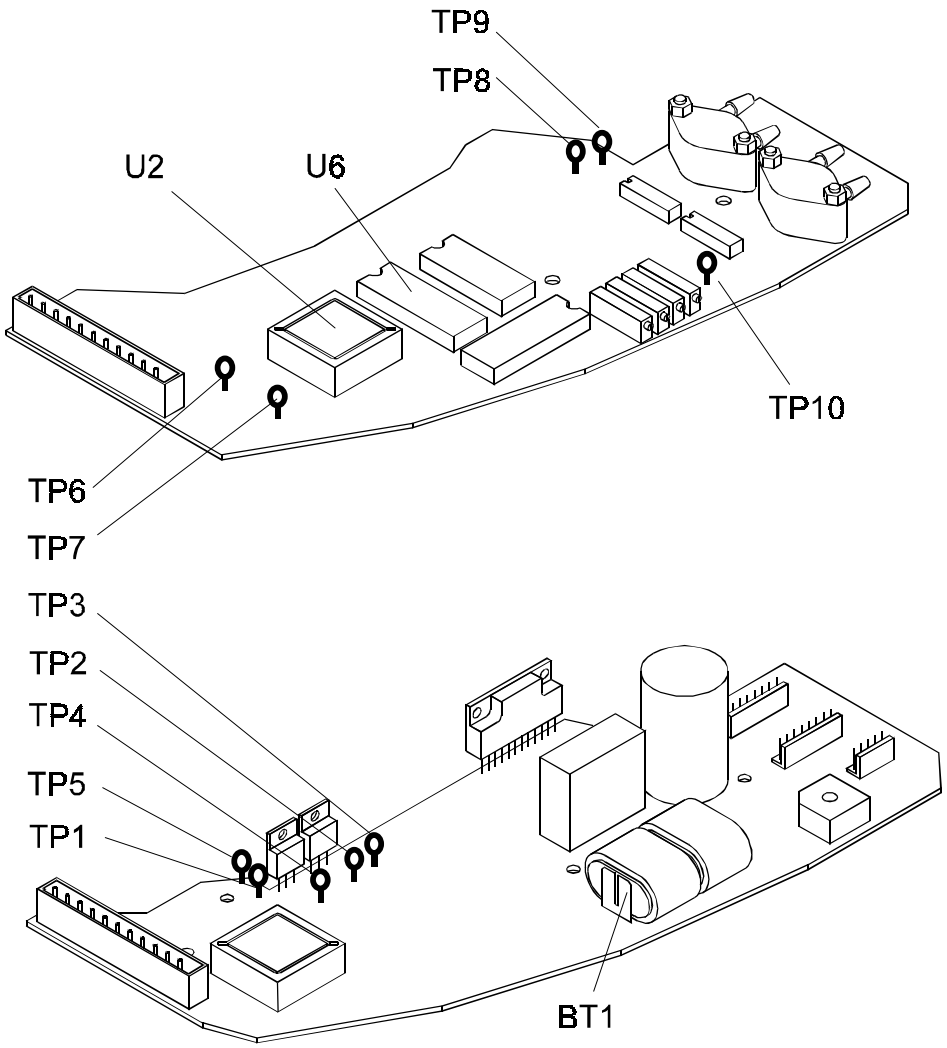
8.3 Wiring diagram, test points



8.4 Main cabling diagram



8.5 Test points

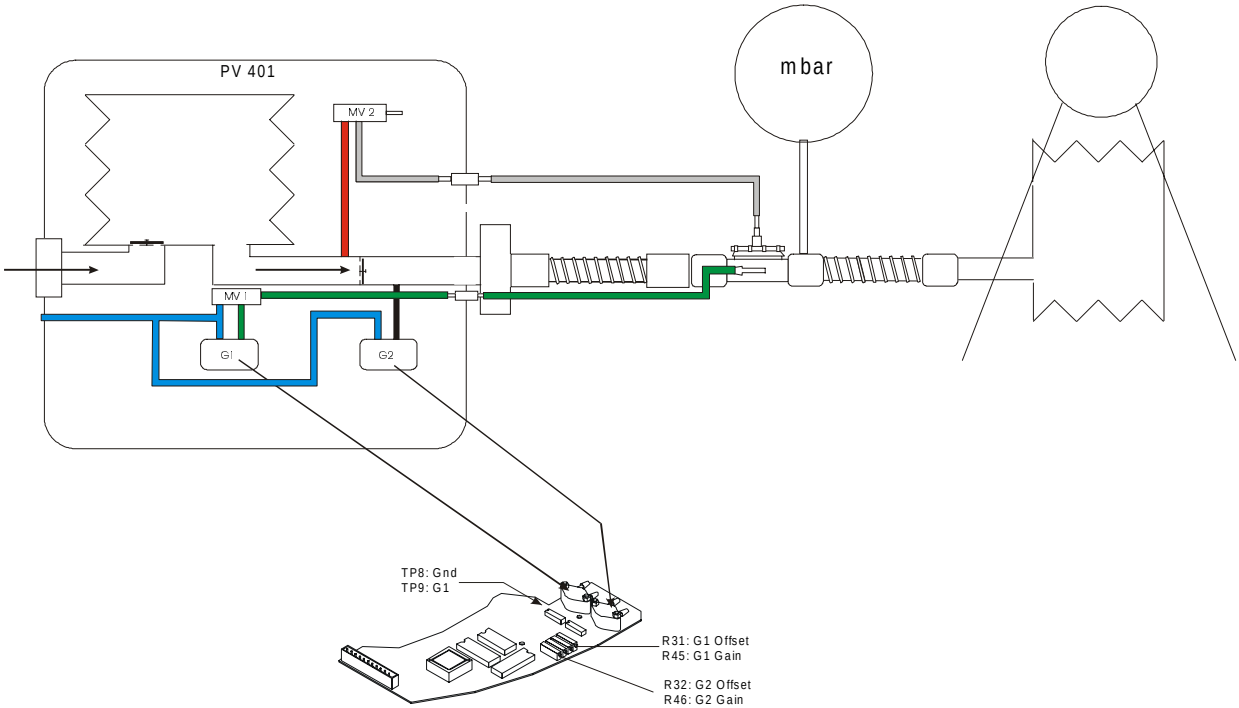


Test point		Voltage name	Status	Measured value	Adj. pot.
MDA board:					
TP 1	(TC2, 9&10)	GND			
TP 2	(TC2, 2&6)	Unregulated	on	20-32 VDC	-
TP 3	(TC2, 3)	24 V	on	24 VDC	-
TP 4	(TC2, 4)	12 V	on	12 VDC	-
TP 5	(TC2, 5)	5 V	on	5 VDC	-
	(TC2, 7)	+NET	mains	20 - 32VDC	-
BT1	(TC2, 1)	Alarm battery	off, mains	7.8 ± 0.5 VDC	-
	(TC2, 8)	+EXT	ext.batt connected	24VDC	
CPU board:					
TP 6	(TC1, 2)	5 V	on	5 VDC	-
TP 7	(TC1, 1)	9 V	on	9 VDC	-
TP 8	(TC1, 5-10)	GND			
TP 9	(TC1, 3)	Pressure amplifier G1	on P=0 mbar	1.0 VDC	R31,(R45)
			P=30 mbar	4.0 VDC	
TP 10	(TC1, 4)	Pressure amplifier G2	on P=10 mbar	1.0 VDC	R32,(R46)
			P=30 mbar	3.0 VDC	

8.6 Calibration of pressure sensors

PV 401 has two pressure sensors, G1 and G2. G1 monitors the pressure at the exhalation valve and displays the value on the pressure gauge. G2 is the pressure regulator sensor.

Let the ventilator run with a test lung connected (with the compliance high enough so that at a pressure of 40 mbar, the volume is no larger than 1.2 litre) for 30 minutes so that it is well warmed-up.



Adjusting the pressure regulator sensor G2

- Set the following parameters:

Pressure	40 mbar
Rate	6 BPM
Insp.time	5.0 seconds
Plateau	max pos. to the right
Mode	PCV

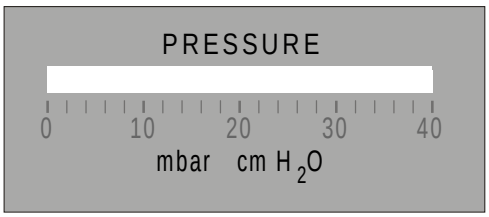
- Make sure that the pressure, at each breath, stabilises at 40 - 41 mbar.
  If not, adjust R46.
- Set the PV 401 pressure to 6 mbar.
- Check that the pressure, at each breath, stabilises at 6 - 6.5 mbar.
  If not, adjust R32.
- Repeat steps 1-4 until both pressures are maintained without any adjustment.

Adjusting the pressure-measuring sensor G1

- Connect the ventilator as for adjustment of G2
- Set the following parameters:

Pressure	30 mbar
Rate	6 BPM
Insp.time	5.0 seconds
Plateau	max position to the right
Mode	PCV

- Make sure that the pressure, at each breath, stabilises at approx. 30 mbar.
  If not, adjust R45.



- Disconnect the patient circuit for the ventilator.
- Check that the voltage at tp9 (see fig.) is 0.97 V (± 0.02 V). If not, adjust R31.
- Repeat steps 1-4 until both pressures are maintained without any further adjustment.

8.7 Check of battery operation

This procedure checks battery operation and low external battery voltage alarm.

- Set the following parameters:

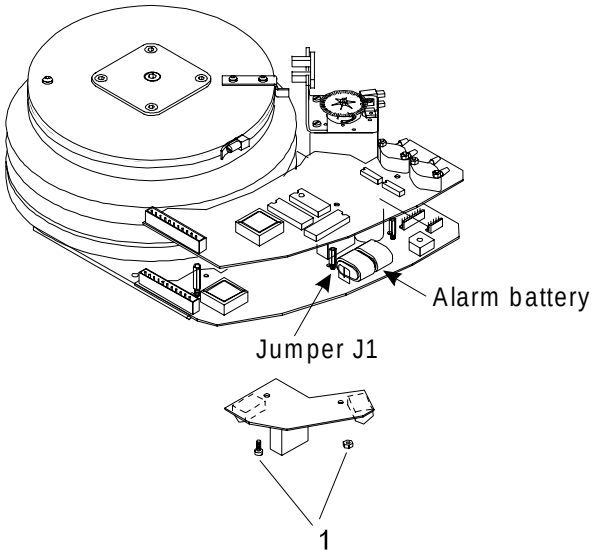
  Pressure: 6 mbar
  Rate: 8
  Insp.time: 3 seconds
  Mode PCV

- Connect a 1 litre test bladder with an exhalation valve.
- Connect an adjustable DC power supply unit to the external 24V socket of the ventilator.
- Set the voltage to 24V.
- Switch on the ventilator, and make sure the LED in the ON/OFF button flashes.
- When the external battery voltage drops to 22.5V (± 0.2V) the low battery voltage alarm will start.
- Run the ventilator and slowly reduce the voltage to 22.5V.
- Check that a “power alarm” is given as an audible signal every 5th second at 22.5 V (± 0.2 V).
- Again, slowly reduce the voltage down to 22.0 V. Check that the ventilator switches off at 22.0 V(± 0.2 V) and that the red LED for “POWER” is lit.

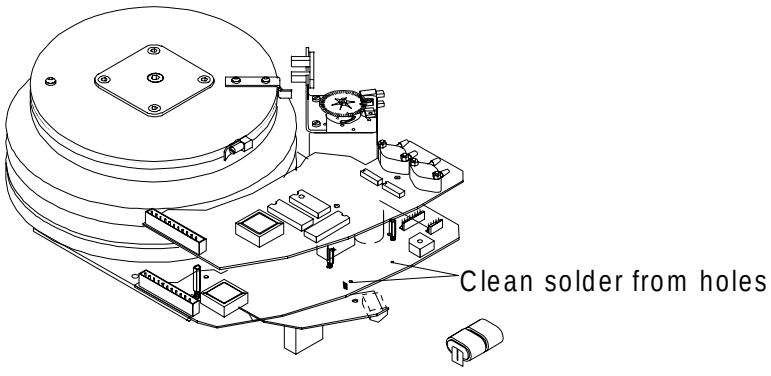
8.8 Replacing the alarm battery

The alarm battery should be replaced after 5 years from the delivery date and then every 5th year.

The alarm batteries are located on the MDA board and provide power for the Mains power failure and Low voltage alarms.



- Disconnect the mains power supply and any external battery. Remove jumper J1 from the MDA board.
- Remove the filter board (2 screws) (1).
- Leave all the wires in place. This makes it easier to get access with a soldering iron.
- Clip the two plus pins of the outer battery (Y). Unsolder the battery from the minus pole.
- Unclip the other battery.



- Unsolder the clipped-off pins and suck away any remaining solder from the holes.
- Fit the new batteries and solder them in place.
- Fit the printed circuit board.
- Fit the jumper J1

- Make a test start.
- The PV 401 checks, at each start cycle, the condition of the alarm batteries.
- If a fault occurs with the alarm batteries, the ventilator will not start and the LED for “POWER” will light and error message FAIL 08 is displayed. If this should happen after replacing the batteries, let the ventilator remain switched on for a few hours, running from the mains supply, so that the batteries are charged.
- Restart the ventilator.
- With the ventilator running from the mains supply, pull out the power cord. The red LED “POWER” should light and an audible alarm be given. When the power supply is reconnected, the ventilator should re-start normally.

8.9 Electrical safety precautions

Electrical safety measuring must be taken according to IEC 601. However, the insulation resistance can be measured instead of the voltage test specified by the standard.

The measurements can be done using an automatic electrical safety tester. All tests must be done according to class II type BF.

Supply voltage
Note the power voltage reading. As the currents measured are directly in relation to the supply voltage, the voltage must be noted for each service check. This allows all measurements made on the same ventilator to be compared with measurements made on different occasions.

Insulation
The insulation resistance is measured using a 500 VDC power supply. The most suitable method is to connect the plus lead to both the ventilator power socket pins and the minus lead to the casing or patient air connector. The measurements taken during the delivery inspection provide the reference values with which measurements taker during later services are compared. If no reference values are available, then the value for the insulation resistance should be > 20MΩ.

Leakage currents
Leakage currents are measured at different parts of the ventilator using an RC circuit to ground.

The measurements are taken partly at normal case (NC) and at the single fault condition (SFC). Reverse the polarity of the power supply and note the lowest value.

Leakage currents to ground must not exceed the stated limit values.

Leakage currents from the casings
Measured at an unpainted point, e.g. the head of a screw.

Limit values: NC….< 0.1mA
SFC...< 0.5mA

Break neutral for SFC.

Patient leakage currents
Measured between the patient connector and ground.

Limit: values NC....< 0.1mA
SFC...< 0.5mA

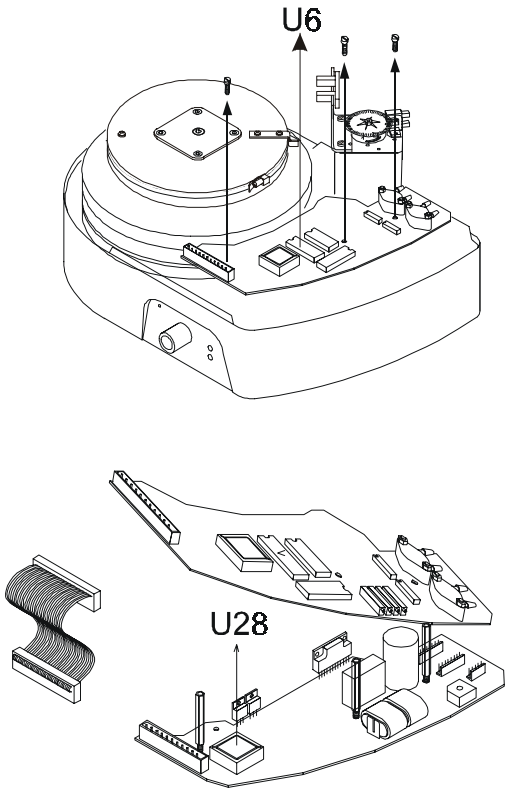
Break neutral for SFC.

Leakage currents with mains power supply at the patient connected part
This test must be done using an automatic electrical safety tester that has this function. See the safety instruction for the tester.

Limit value: SFC...< 5mA

8.10 Upgrading the software

The software is contained in EPROM U6 and processor U28.



- Remove the casing, see chapter 6.
- Make sure you have the correct tool to pull the PLCC capsule from its socket.
- Disconnect the mains supply, and if connected, the external battery supply.
- Remove the jumper J1 for the alarm battery.
- Remove U6 and fit the new software
- Remove the three screws holding the CPU board .
- Remove the ribbon cable.
- Carefully lift up the front edge of the CPU board.
- Pull out U28 using a PLCC puller and replace with the new version software.
- Reassemble in the reverse order.
- Check that the magnetic valves underneath the CPU board are not pinched.

Note! Do not forget to fit jumper J1!

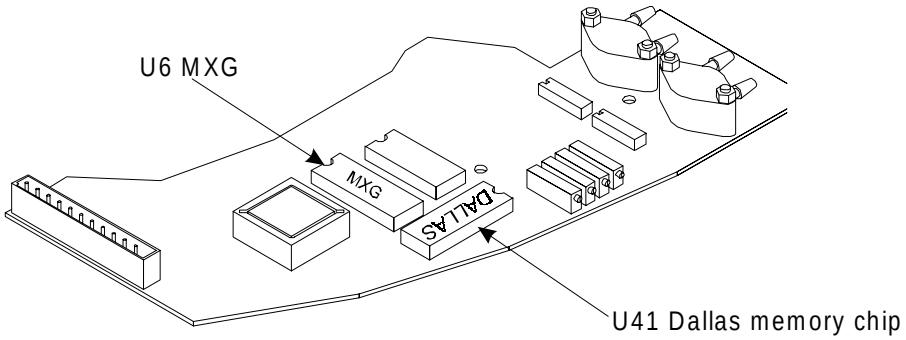
8.11 Upgrading the software to revision MXG

The software revision MXG contains an internal memory and an adjustable low pressure alarm level.

To upgrade, proceed as follows:

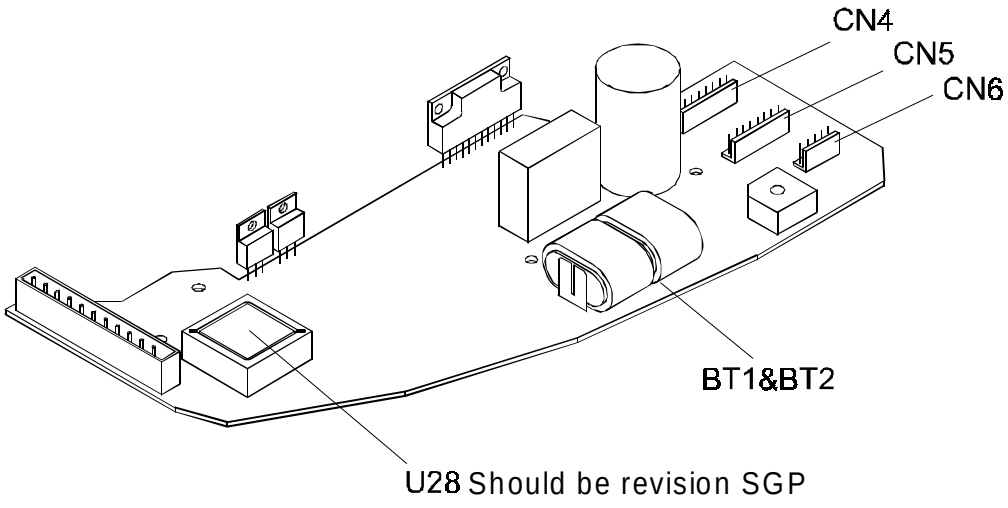
CPU board

Besides replacing memory chip U6, memory chip U41 must also be installed. Make sure the chips are installed in the right directions, see figure.



MDA board

Check that the slave processor has software revision SGP. This can be checked on the display at start up. If not, replace the chip with version SGP.

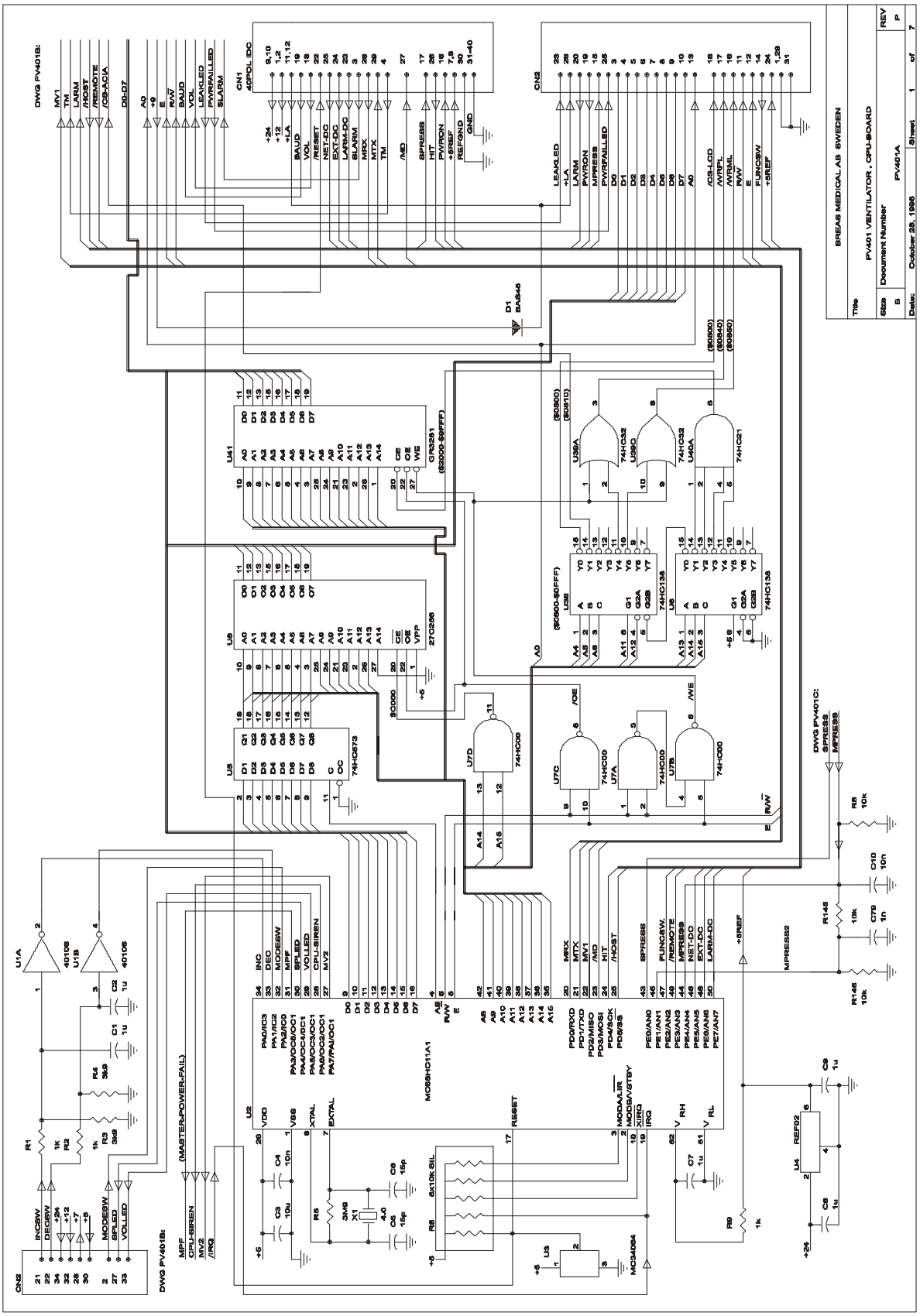


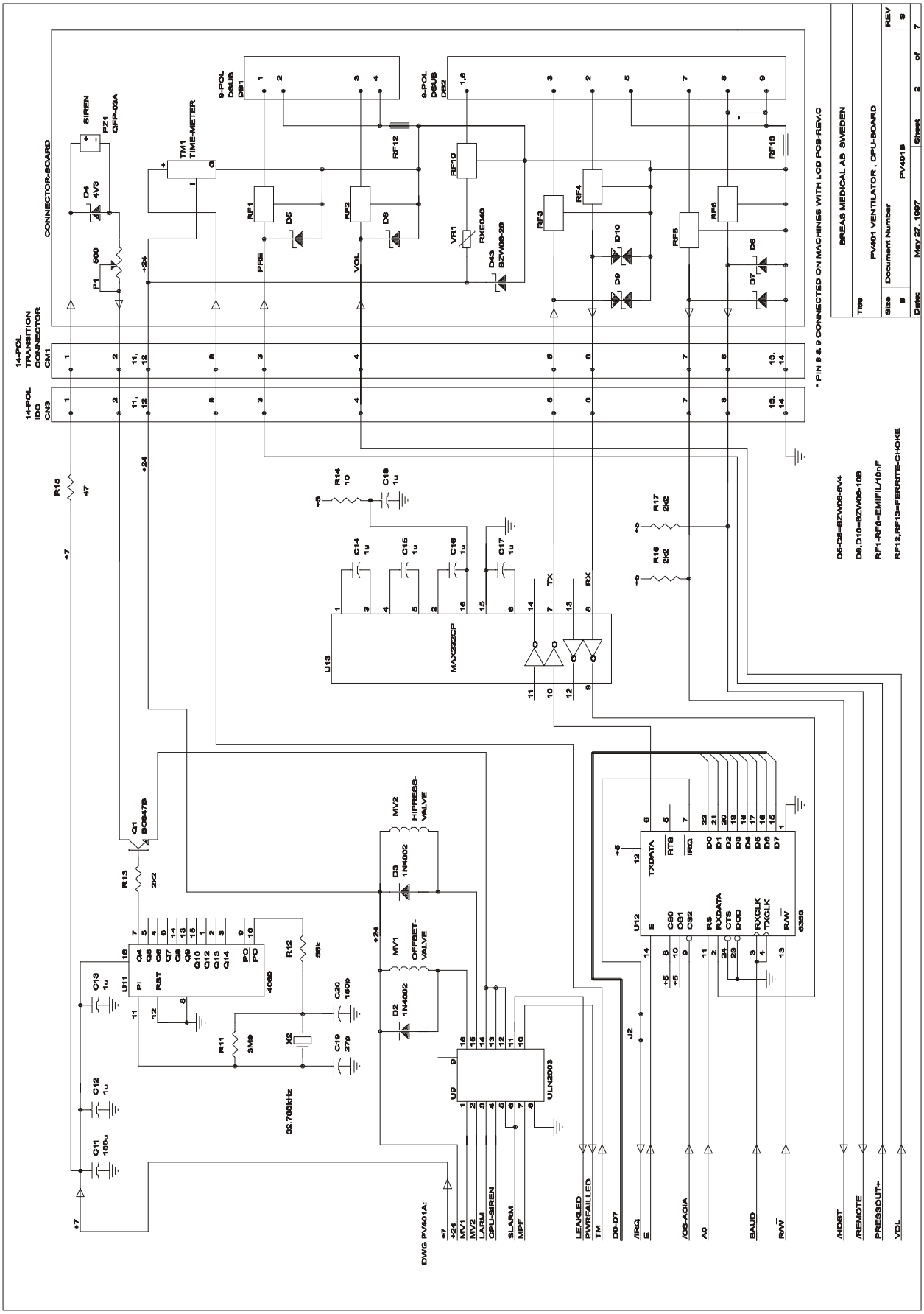
After installation:

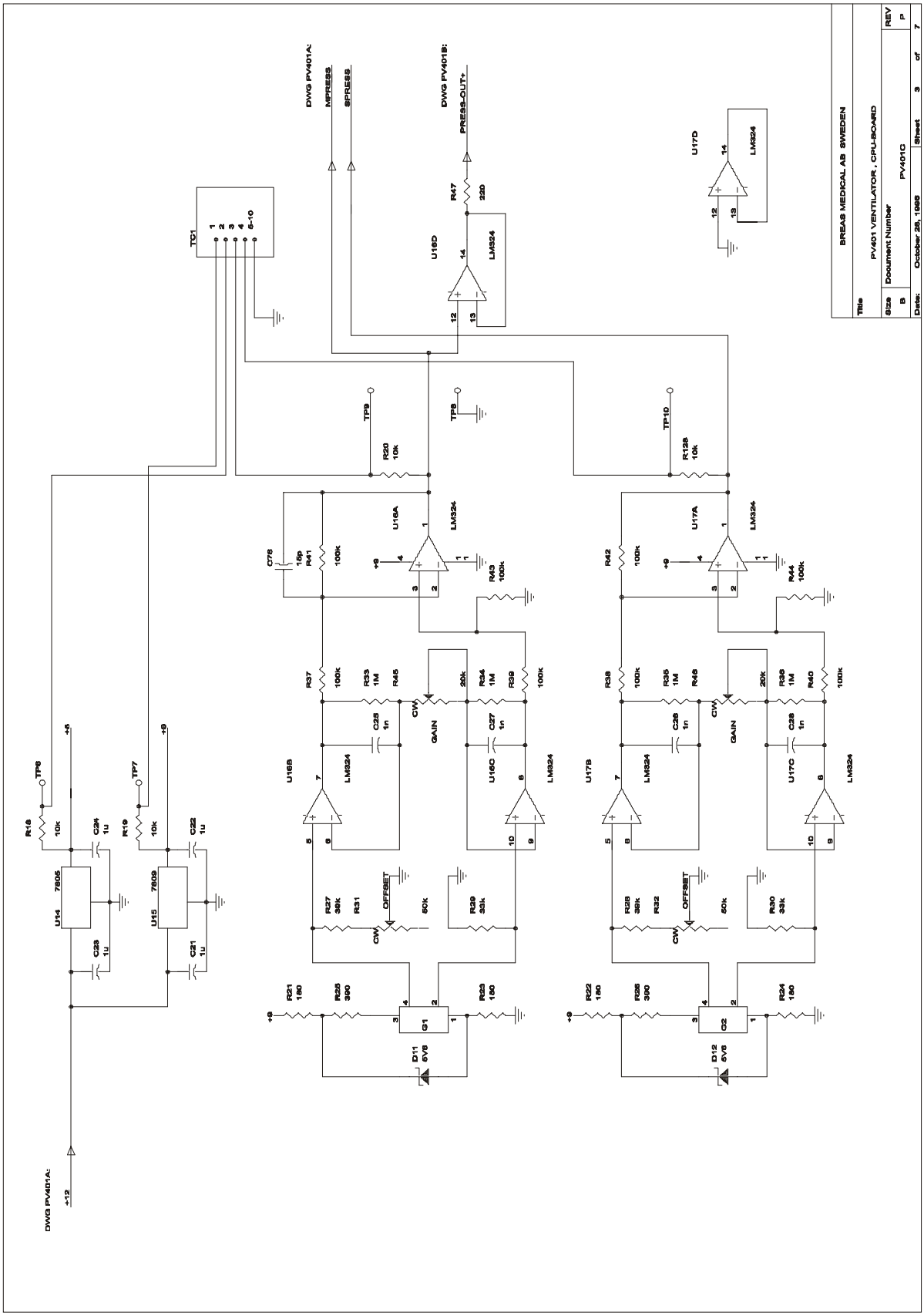
- Start the ventilator.
- Switch off again.
- Press and hold the Function button and start the ventilator in order to access "Set date and time" mode.

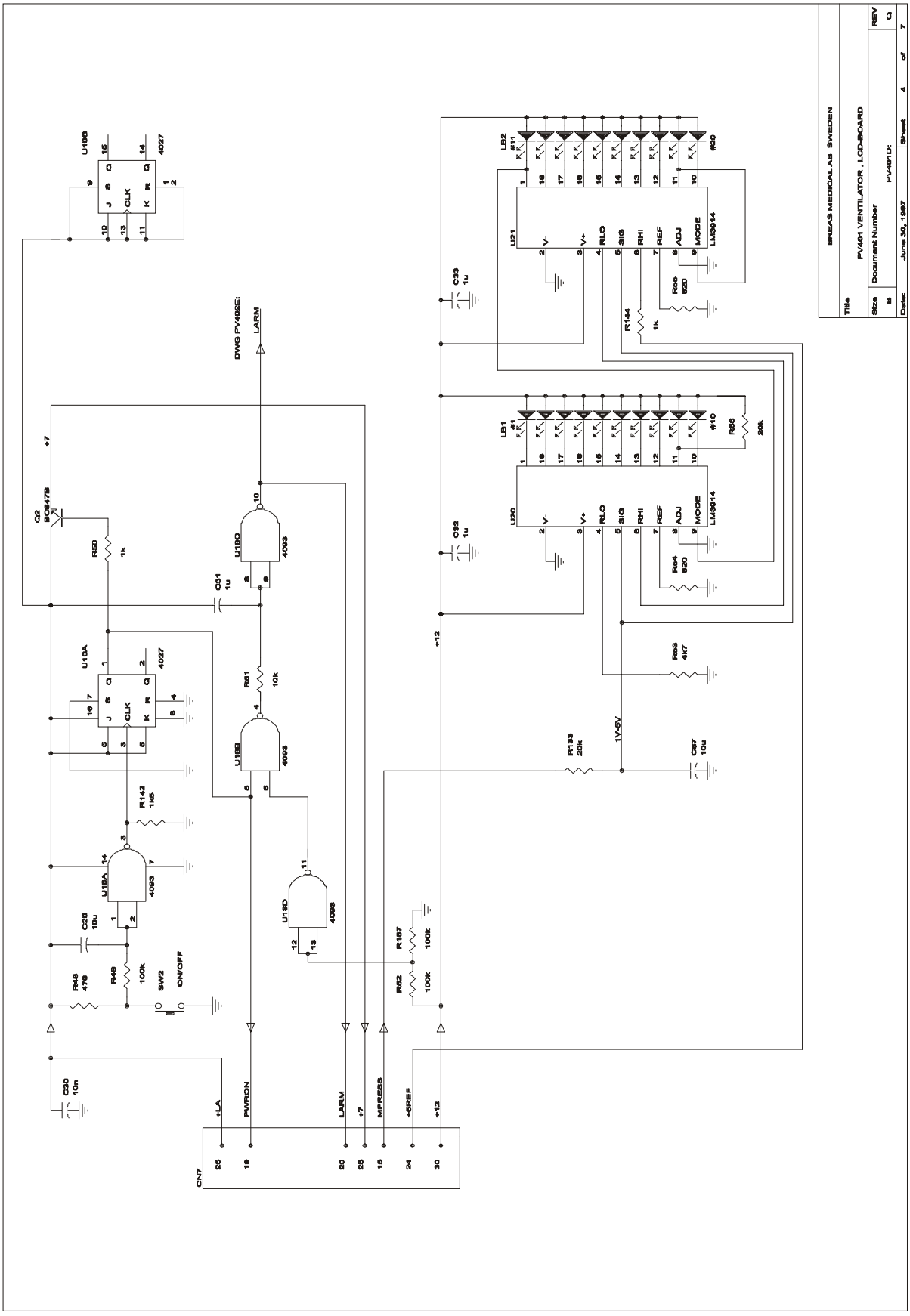
- Set the date and time using the Function key and the **-** and **+** buttons.
- Switch off the ventilator when the display shows "TURN OFF PWR"
- To erase the memory, press and hold the + button and start the ventilator. The display shows the text "DUMP MEM PUSH FUNC TO DUMP". Press the Function button. The display will now show the text "WAIT DUMP IS ON". When the display shows "DUMP RDY TURN OFF PWR", press the PSV/PCV Mode button for 10 seconds until the display shows "MEM CLR RDY TURN OFF PWR". Switch off the ventilator.
- The PV 401 is now ready for use.
- Check that the correct version of the Operating Manual accompanies the ventilator. This covers the additional functions available with the MXG software.
- For full information about the internal memory, please refer to the PV 401 Calendar Data Analysis Program manual (Doc. No. 1399).

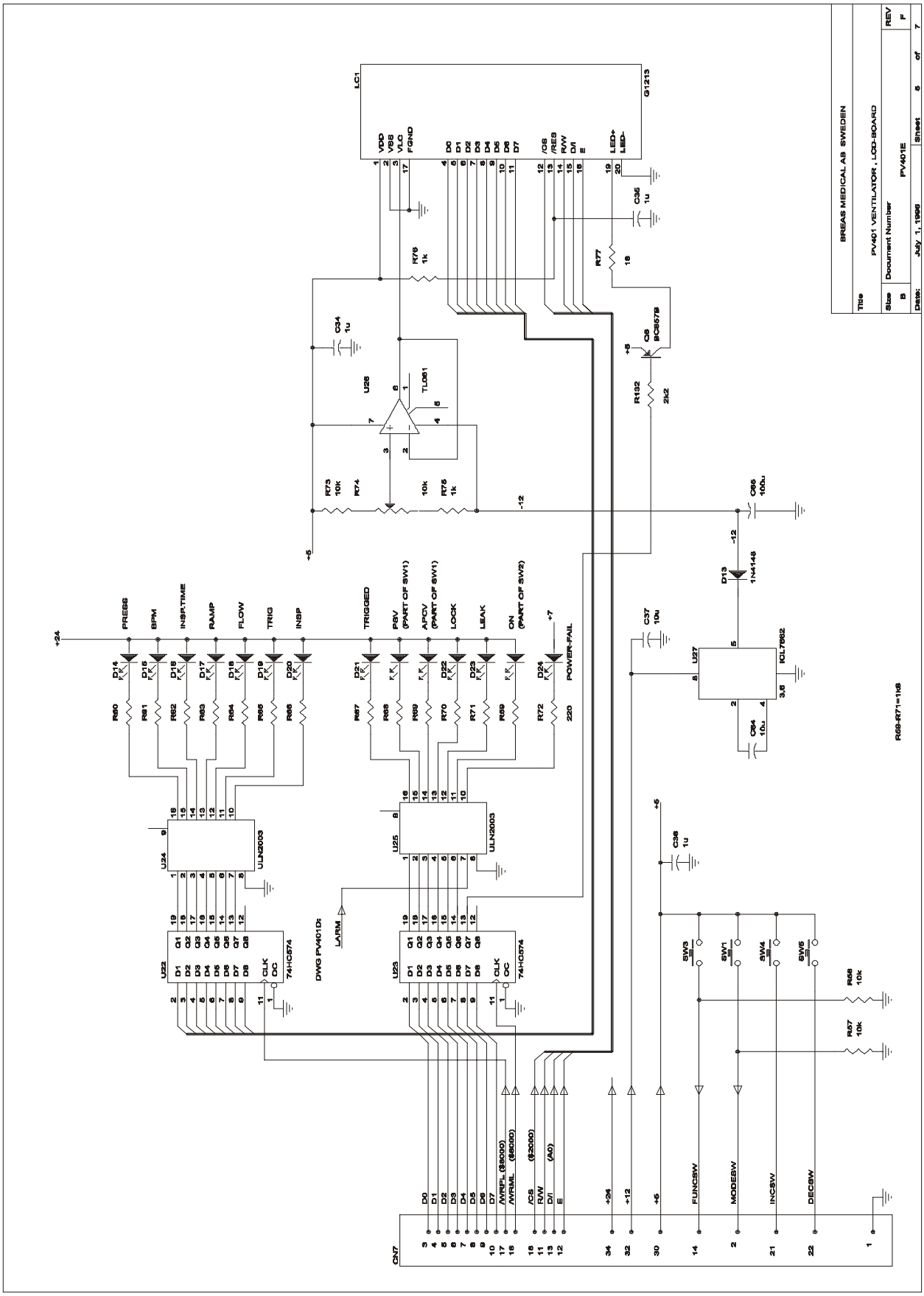
8.12 Circuit diagrams

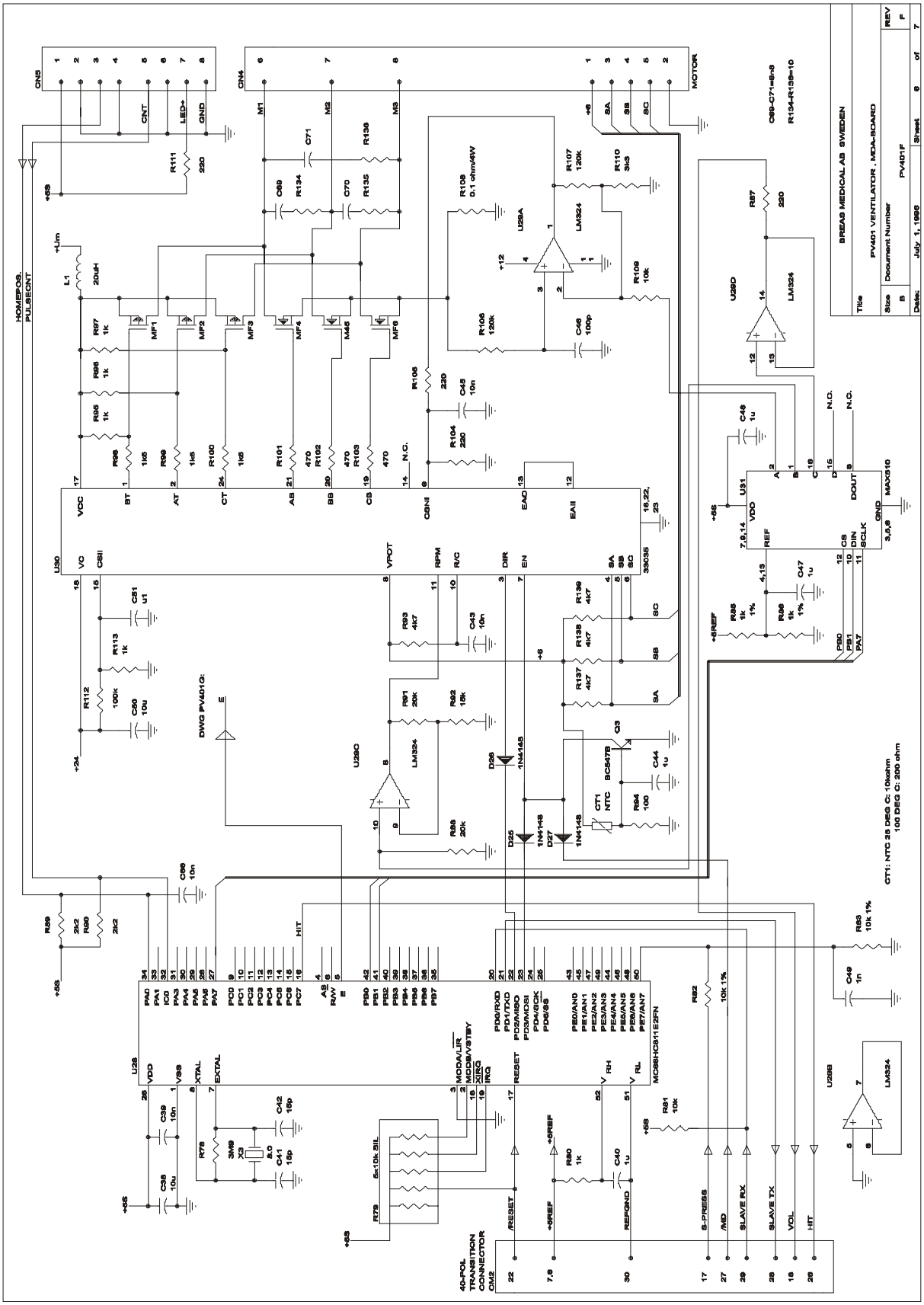


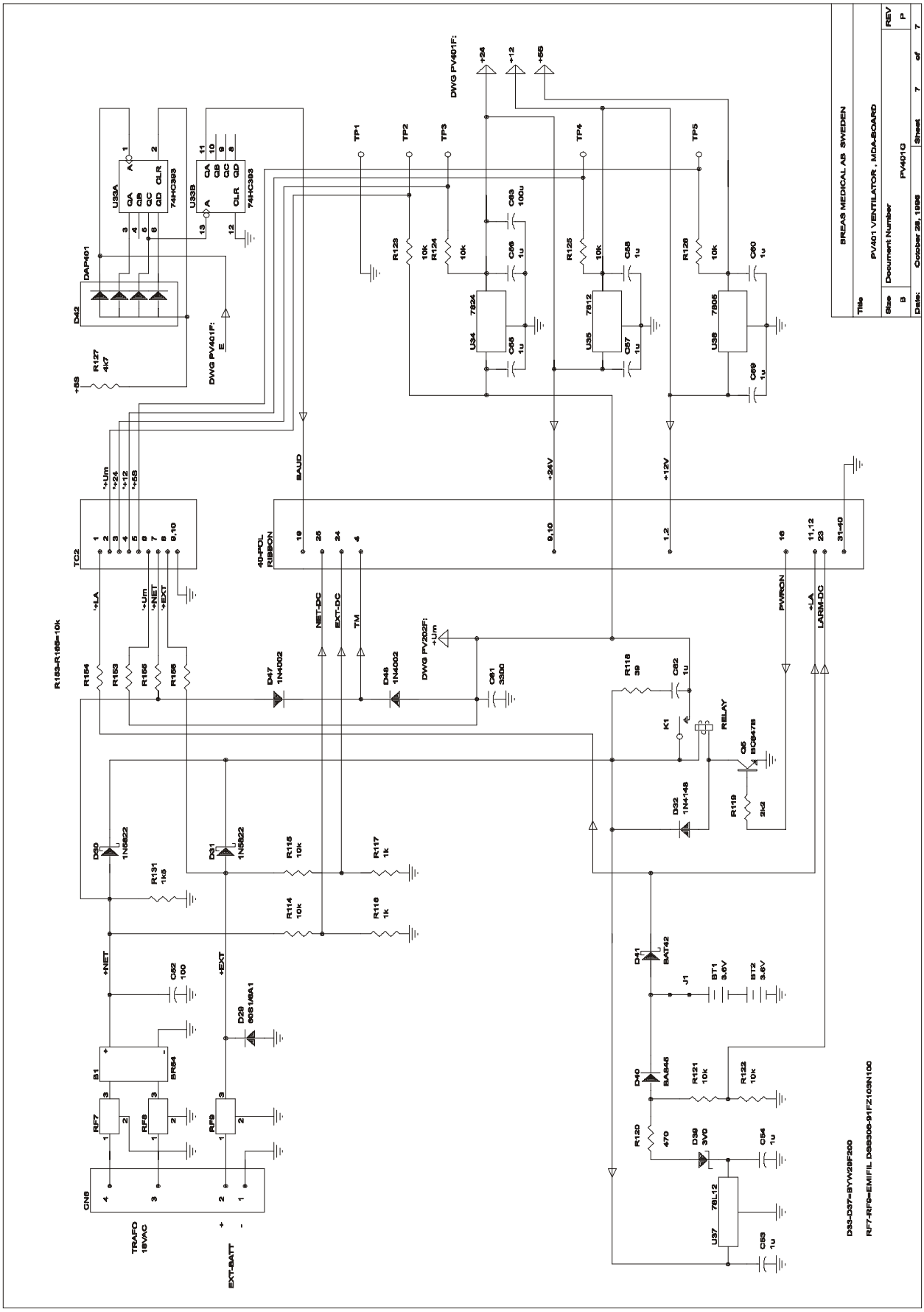

BREAS MEDICAL AB SWEDEN
PV401 VENTILATOR , CPU-BOARD
PV401B
May 27, 1997
* PIN 8 & 9 CONNECTED ON MACHINES WITH LCD PCB-REV.C
D5-D8=BZW06-5V4
D9,D10=BZW06-10B
RF1-RF9=EMIFIL/10nF
RF12,RF13=FERRITE-CHOKE
CONNECTOR-BOARD
14-POL TRANSITION CONNECTOR CM1
14-POL IDC CN3
9-POL DSUB DB1
9-POL DSUB DB2
SIREN PZ1 QFP-03A
TM1 TIME-METER
P1 500
PRE
VOL
VR1 RXE040
D43 BZW06-28
MAX232CP
U13
TXDATA
RXDATA
6350
ULN2003
U9
4060
U11
BC847B
Q1
HIPRESS-VALVE
OFFSET-VALVE
1N4002
32.768kHz
DWG PV401A:
LEAKLED
PWRFAILLED
TM
D0-D7
/IRQ
E
/CS-ACIA
A0
BAUD
R/W
/HOST
/REMOTE
PRESSOUT+
VOL
+7
+24
MV1
MV2
LARM
CPU-SIREN
SLARM
MPF

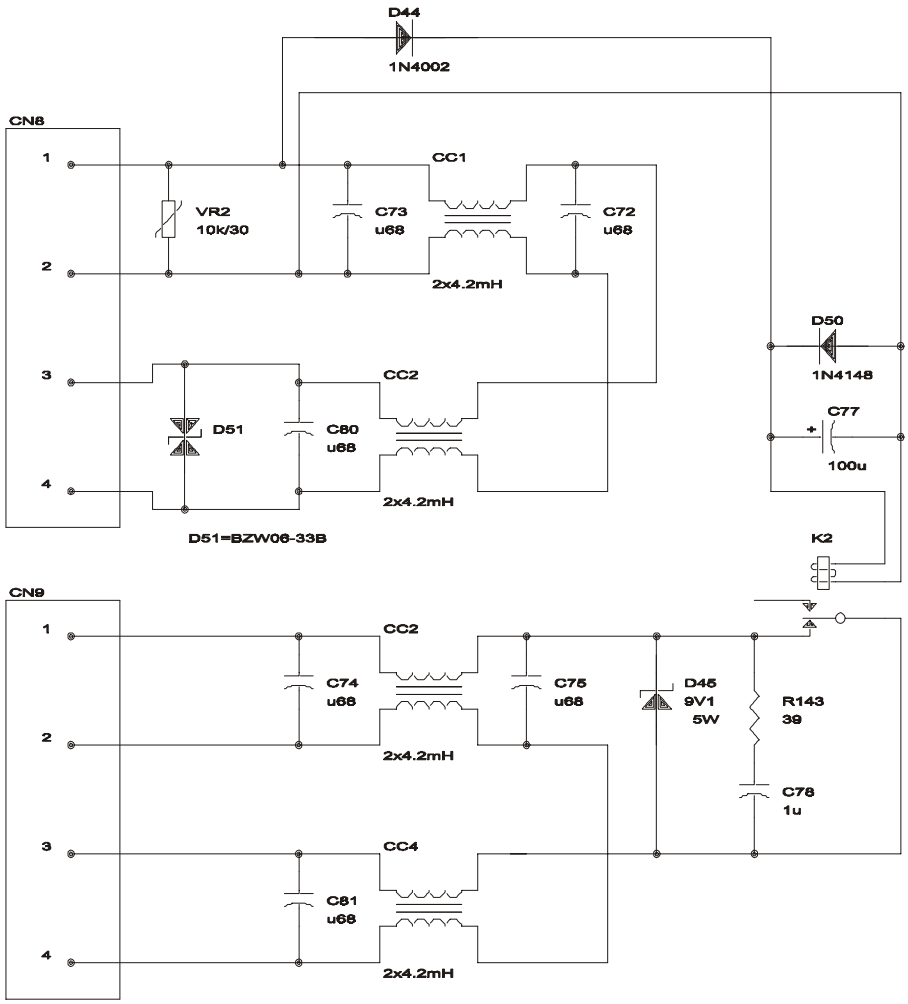

BREAS MEDICAL AB SWEDEN
PV401 VENTILATOR, CPU-BOARD
PV401C
October 28, 1998
DWG PV401A:
MPRESS
SPRESS
DWG PV401B:
PRESS-OUT+
TC1
U16D
U17D
LM324
R47
220
TP9
TP8
TP10
R20
10k
R138
10k
U16A
U17A
C76
16p
R41
100k
R42
100k
R43
100k
R44
100k
R37
100k
R33
1M
R45
20k
R34
1M
R39
100k
R38
100k
R35
1M
R46
20k
R36
1M
R40
100k
C25
1n
C27
1n
C26
1n
C28
1n
GAIN
U16B
U16C
U17B
U17C
R27
39k
R31
OFFSET
50k
R29
33k
R28
39k
R32
OFFSET
50k
R30
33k
R21
180
R25
390
R23
180
R22
180
R26
390
R24
180
G1
G2
D11
6V8
D12
6V8
TP6
TP7
R18
10k
R19
10k
C24
1u
C22
1u
U14
7805
U15
7809
C23
1u
C21
1u
+5
+9
+12
DWG PV401A:


BREAS MEDICAL AB SWEDEN
Title
PV401 VENTILATOR, LCD-BOARD
Size B
Document Number PV4910:
REV C
Date: June 30, 1997
Sheet 4 of 7
DWG PV4022E:
LARM
+7
Q2 BC547B
R50 1k
U18C 4093
C31 1u
U18A 4027
R61 10k
U18B 4093
R142 1M5
U18A 4093
C28 10u
R48 470
R49 100k
SW2 ON/OFF
U18D 4093
R157 100k
R62 100k
C30 10n
+LA
PWRON
LARM
+7
MPRESS
+5REF
+12
CN7
25
19
20
28
15
24
30
U19B 4027
LS2 #11 #20
U21 LM3914
R144 1k
R65 820
C33 1u
LS1 #1 #10
R58 20k
U20 LM3914
R64 820
C32 1u
R63 4k7
R133 20k
1V-5V
C27 10u

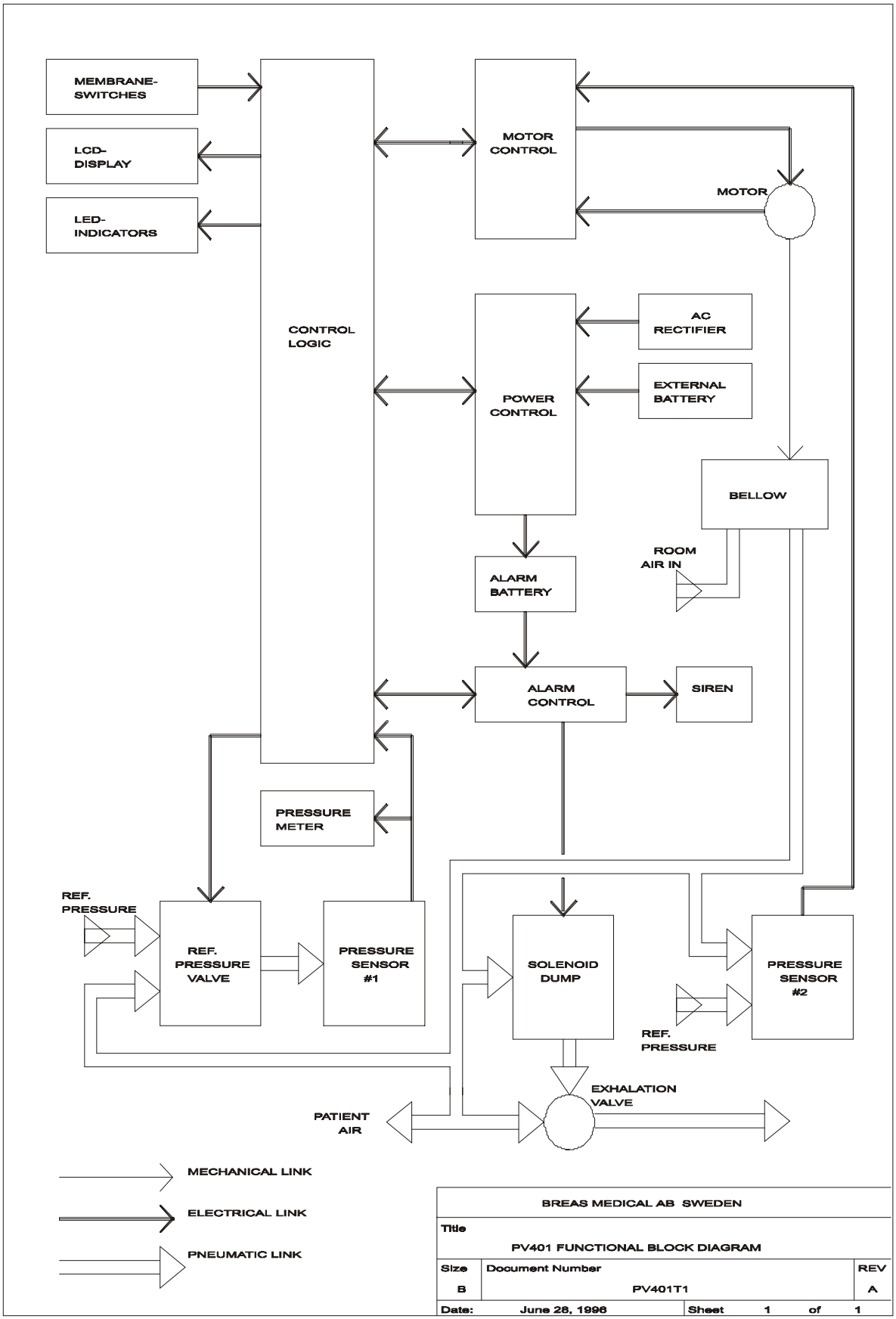

BREAS MEDICAL AB SWEDEN
PV401 VENTILATOR , LCD-BOARD
PV401E
July 1, 1996
LC1
G1213
U26
TL061
Q9
BC857B
R132
2k2
C35
1u
C34
1u
C36
1u
C37
10u
C84
10u
C85
100u
D13
1N4148
U27
IGL7662
U24
ULN2003
U25
ULN2003
U22
74HC574
U23
74HC574
SW3
SW1
SW4
SW5
R68
10k
R67
10k
CN7
FUNCSW
MODESW
INCSW
DECSW
PRESS
BPM
INSP.TIME
RAMP
FLOW
TRIG
INSP
TRIGGED
PSV (PART OF SW1)
APCV (PART OF SW1)
LOCK
LEAK
ON (PART OF SW2)
POWER-FAIL
LARM
DWG PV401Dc
R69-R71=1k8

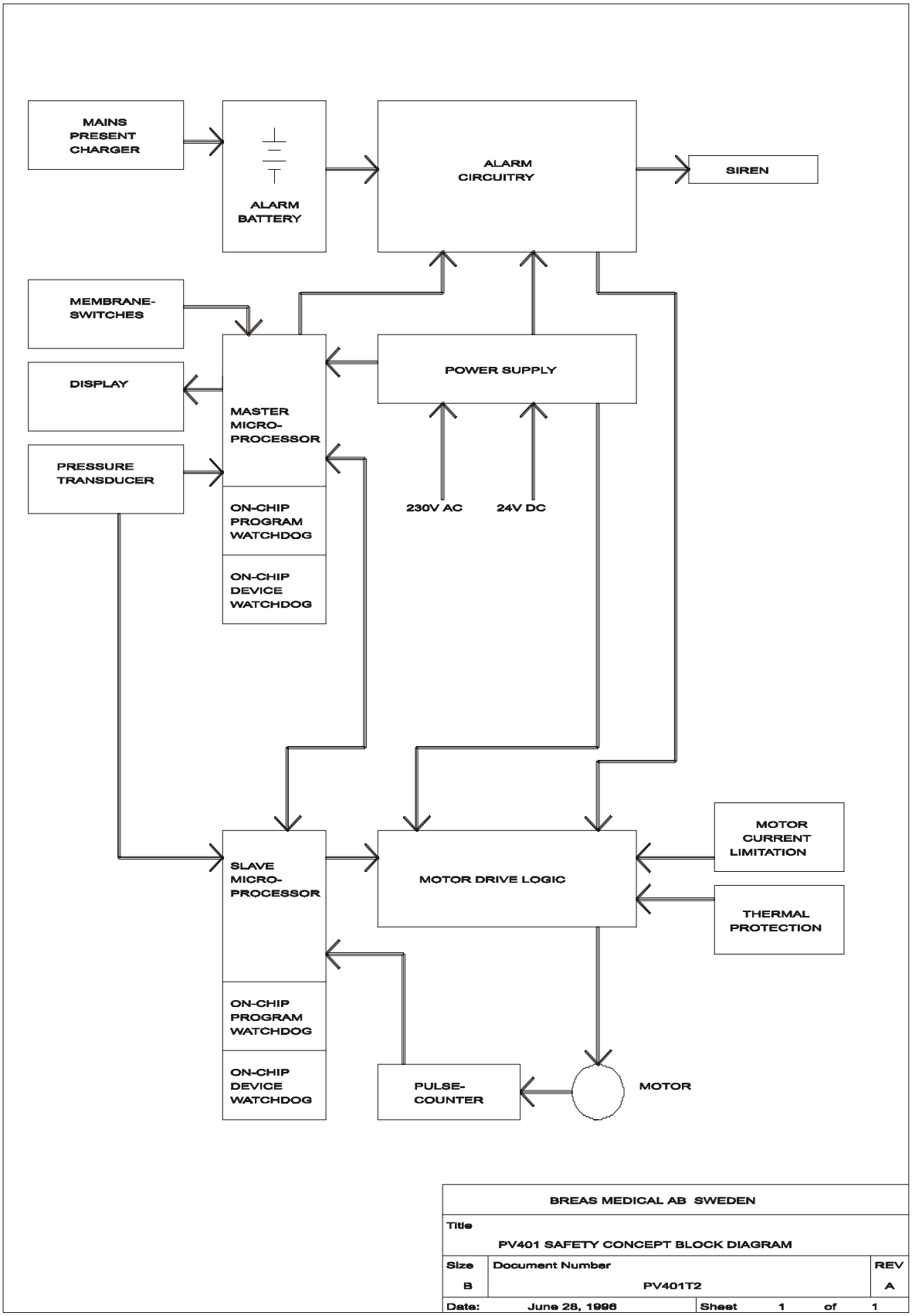



BREAS MEDICAL AB SWEDEN
PV401 VENTILATOR , MDA-BOARD
Document Number PV401G
October 28, 1998
DWG PV401F:
DWG PV401F: E
DWG PV202F:
TRAFO 18VAC
EXT-BATT
40-POL RIBBON
BAUD
+24V
+12V
PWRON
LARM-DC
NET-DC
EXT-DC
TM
RELAY
D33-D37=BYW29F200
RF7-RF9=EMIFIL DSS309-91FZ103N100
R153-R165=10k



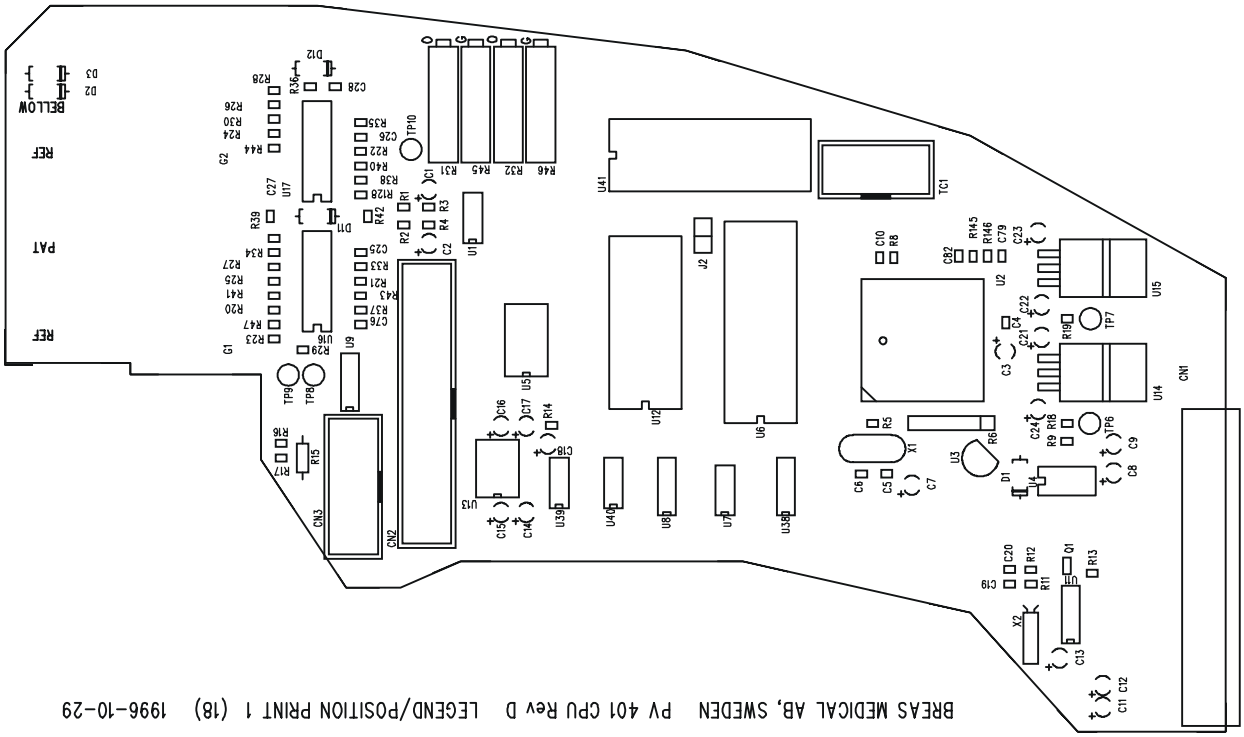
BREAS MEDICAL AB SWEDEN		
Title: PV401 VENTILATOR , FILTER-BOARD		
Size: B	Document Number: PV401H2	REV: Q
Date: October 26, 1998	Sheet 8 of	

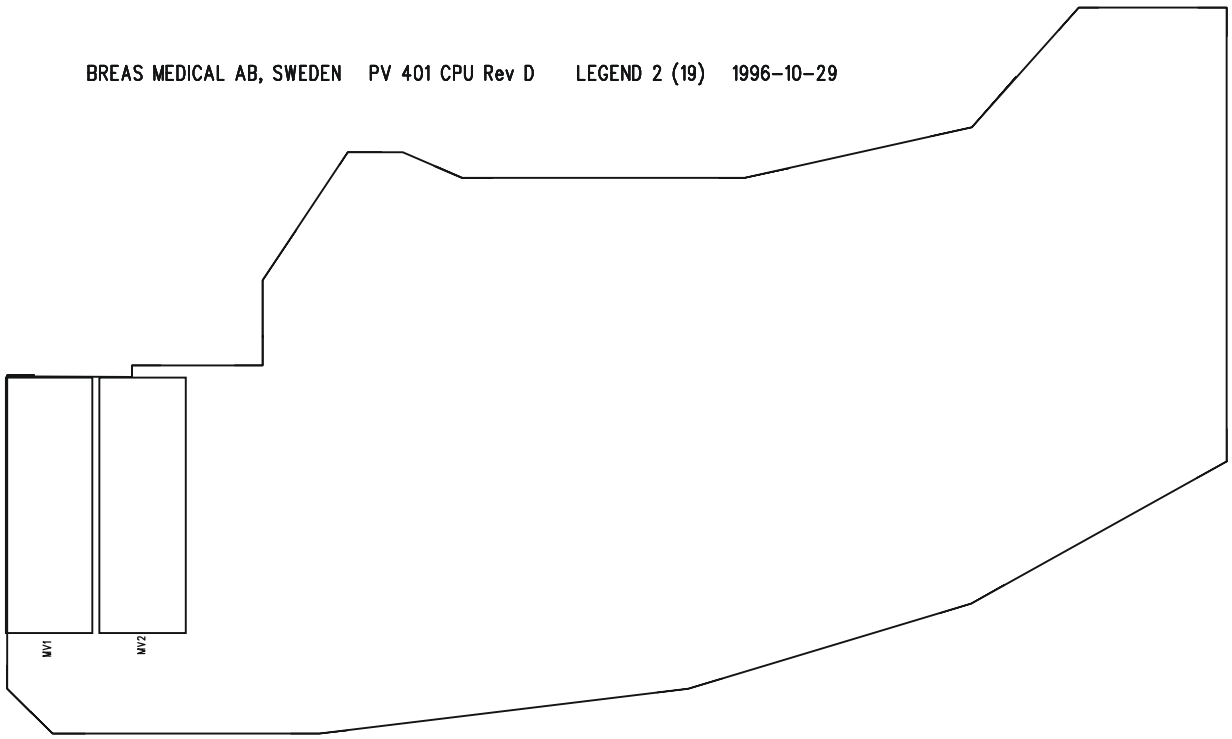

MEMBRANE-
SWITCHES
LCD-
DISPLAY
LED-
INDICATORS
CONTROL
LOGIC
MOTOR
CONTROL
MOTOR
AC
RECTIFIER
EXTERNAL
BATTERY
POWER
CONTROL
BELLOW
ROOM
AIR IN
ALARM
BATTERY
ALARM
CONTROL
SIREN
PRESSURE
METER
REF.
PRESSURE
REF.
PRESSURE
VALVE
PRESSURE
SENSOR
#1
SOLENOID
DUMP
PRESSURE
SENSOR
#2
REF.
PRESSURE
EXHALATION
VALVE
PATIENT
AIR
MECHANICAL LINK
ELECTRICAL LINK
PNEUMATIC LINK
BREAS MEDICAL AB SWEDEN
Title
PV401 FUNCTIONAL BLOCK DIAGRAM
Size
B
Document Number
PV401T1
REV
A
Date: June 28, 1996
Sheet 1 of 1


MAINS PRESENT CHARGER
ALARM BATTERY
ALARM CIRCUITRY
SIREN
MEMBRANE-SWITCHES
DISPLAY
PRESSURE TRANSDUCER
MASTER MICRO-PROCESSOR
ON-CHIP PROGRAM WATCHDOG
ON-CHIP DEVICE WATCHDOG
POWER SUPPLY
230V AC
24V DC
SLAVE MICRO-PROCESSOR
ON-CHIP PROGRAM WATCHDOG
ON-CHIP DEVICE WATCHDOG
MOTOR DRIVE LOGIC
MOTOR CURRENT LIMITATION
THERMAL PROTECTION
PULSE-COUNTER
MOTOR
BREAS MEDICAL AB SWEDEN
Title
PV401 SAFETY CONCEPT BLOCK DIAGRAM
Size B
Document Number PV401T2
REV A
Date: June 28, 1996
Sheet 1 of 1

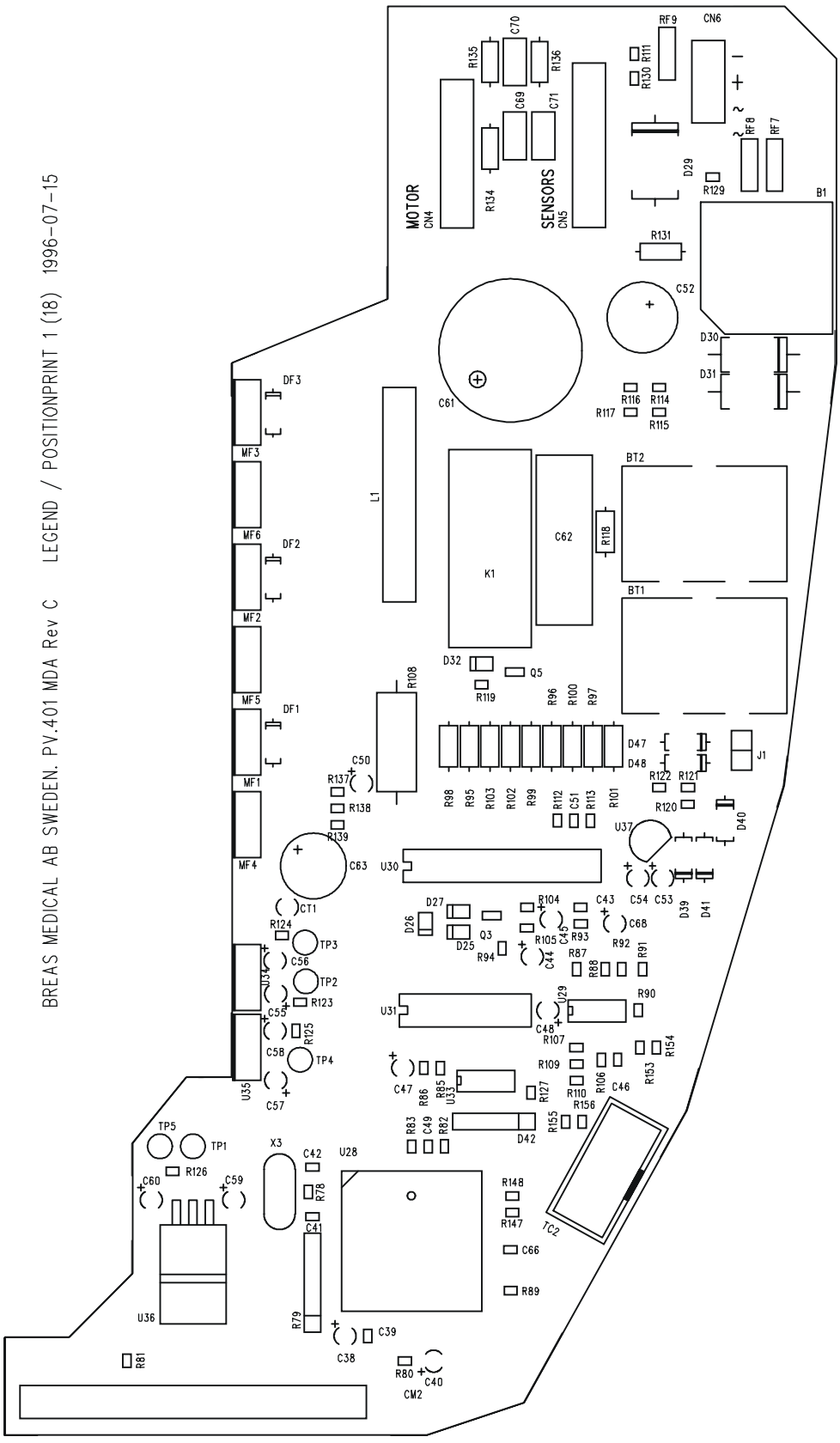
8.13 Component positions

8.13.1 CPU board

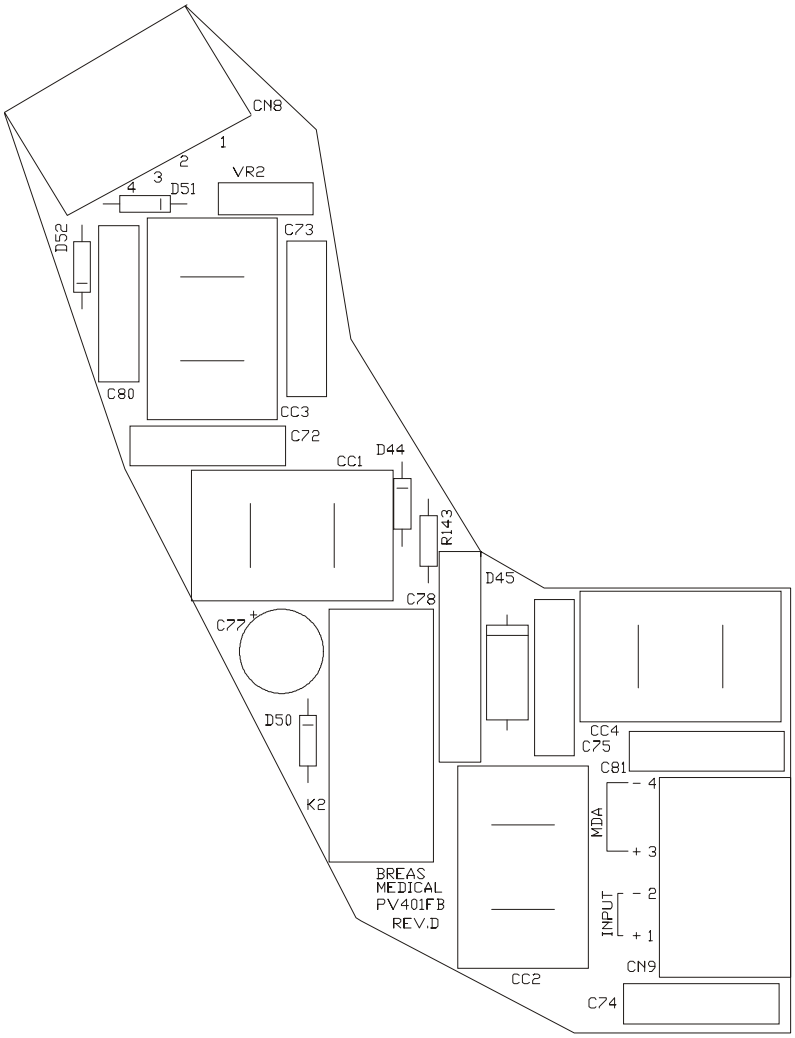




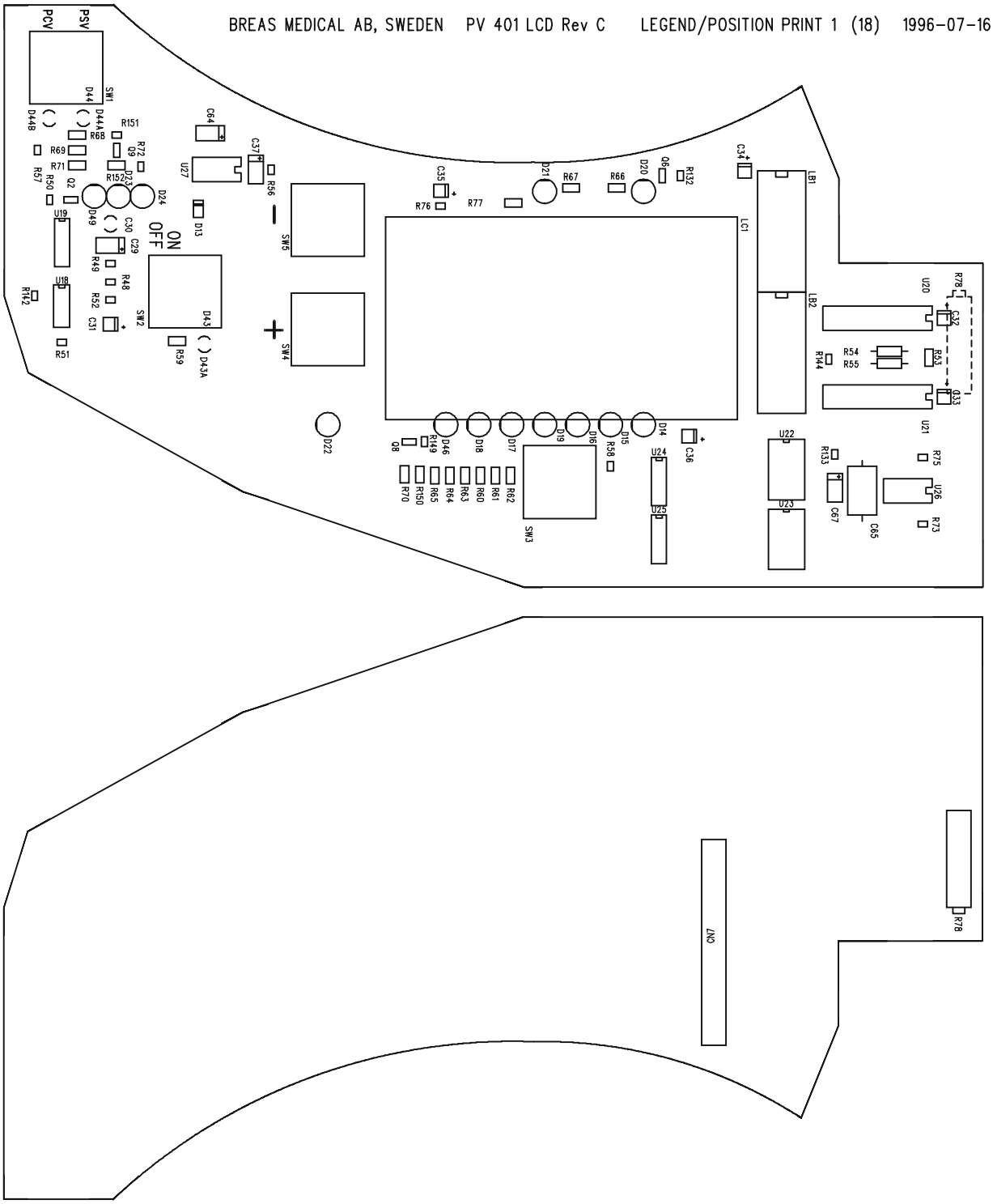
8.13.2 MDA board



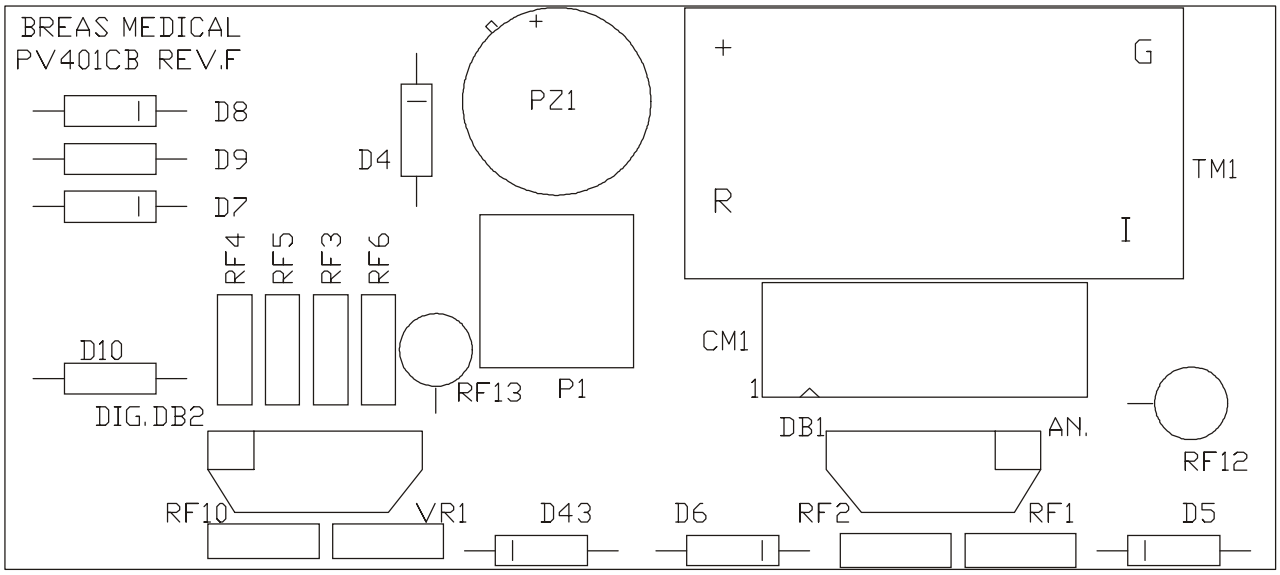
8.13.3 Filter board



8.13.4 LCD board



8.13.5 Hour counter board



8.14 List of components

R1	1k	0805
R2	1k	0805
R3	3k9	0805
R4	3k9	0805
R5	3M9	0805
R6	5x10k	6-PIN SIL
R7	*	
R8	10k	0805
R9	1k	0805
R10	*	
R11	3M9	0805
R12	56k	0805
R13	2k2	0805
R14	10	0805
R15	47	0.25W 4MOD
R16	2k2	0805
R17	2k2	0805
R18	10k	0805
R19	10k	0805
R20	10k	0805
R21	180	0805
R22	180	0805
R23	180	0805
R24	180	0805
R25	390	0805
R26	390	0805
R27	39k	0805
R28	39k	0805
R29	33k	0805
R30	33k	0805
R31	50k TRIM	BI 89P
R32	50k TRIM	BI 89P
R33	1M	0805
R34	1M	0805
R35	1M	0805
R36	1M	0805
R37	100k	0805
R38	100k	0805
R39	100k	0805
R40	100k	0805
R41	100k	0805
R42	100k	0805
R43	100k	0805
R44	100k	0805
R45	20k TRIM	BI 89P
R46	20k TRIM	BI 89P
R47	220	0805
R48	470	0805
R49	100k	0805
R50	1k	0805
R51	10k	0805
R52	100k	0805
R53	4k7 1%	1206
R54	820	0.25W 4MOD
R55	820	0.25W 4MOD
R56	20k	0805
R57	10k	0805
R58	10k	0805
R59	2k4	1206
R60	2k4	1206
R61	2k4	1206
R62	2k4	1206
R63	2k4	1206
R64	2k4	1206
R65	2k4	1206
R66	2k4	1206
R67	2k4	1206
R68	2k4	1206
R69	2k4	1206
R70	2k4	1206
R71	2k4	1206
R72	220	0805
R73	10k	0805
R74	10k TRIM	BI 89P
R75	1k	0805
R76	1k	0805
R77	18	1206
R78	3M9	0805
R79	5x10k	6-PIN SIL
R80	1k	0805
R81	10k	0805
R82	10k 1%	0805
R83	10k 1%	0805
R84	*	
R85	1k 1%	0805
R86	1k 1%	0805
R87	220	0805
R88	20k	0805
R89	2k2	0805
R90	2k2	0805
R91	20k	0805
R92	6k8	0805
R93	4k7	0805
R94	100	0805
R95	1k	0.5W 4MOD
R96	1k	0.5W 4MOD
R97	1k	0.5W 4MOD
R98	1k5	0.5W 4MOD
R99	1k5	0.5W 4MOD
R100	1k5	0.5W 4MOD
R101	470	0.5W 4MOD
R102	470	0.5W 4MOD
R103	470	0.5W 4MOD
R104	220	0805
R105	220	0805
R106	120k	0805
R107	120k	0805
R108	0.1	4W 9MOD
R109	10k	0805
R110	3k3	0805
R111	220	0805
R112	100k	0805
R113	1k	0805
R114	10k	0805
R115	10k	0805
R116	1k	0805
R117	1k	0805
R118	39	0.5W 4MOD
R119	2k2	0805
R120	470	0805
R121	10k	0805
R122	10k	0805
R123	10k	0805
R124	10k	0805
R125	10k	0805
R126	10k	0805
R127	4k7	0805
R128	10k	0805
R129	470	0805
R130	100	0805
R131	1k5	1W 4MOD
R132	2k2	0805
R133	20k	0805
R134	10	0.6W 4MOD

R135	10	0.6W 4MOD
R136	10	0.6W 4MOD
R137	4k7	0805
R138	4k7	0805
R139	4k7	0805
R140	*	
R141	*	
R142	1k5	0805
R143	39	0.6W 4MOD
R144	1k 1%	0805
R145	10k 1%	0805
R146	10k 1%	0805
R147	10k 1%	0805
R148	10k 1%	0805
R149	2k2	0805
R150	2k4	1206
R151	2k2	0805
R152	2k4	1206
R153	10k	0805
R154	10k	0805
R155	10k	0805
R156	10k	0805
C1	1u/35	RAD 1MOD
C2	1u/35	RAD 1MOD
C3	10u/16	RAD 1MOD
C4	10n/50	0805
C5	15p/50	0805
C6	15p/50	0805
C7	1u/35	RAD 1MOD
C8	1u/35	RAD 1MOD
C9	1u/35	RAD 1MOD
C10	10n/50	0805
C11	100u/16	RAD 1MOD
C12	1u/35	RAD 1MOD
C13	1u/35	RAD 1MOD
C14	1u/35	RAD 1MOD
C15	1u/35	RAD 1MOD
C16	1u/35	RAD 1MOD
C17	1u/35	RAD 1MOD
C18	1u/35	RAD 1MOD
C19	27p/50	0805
C20	150p/50	0805
C21	1u/35	RAD 1MOD
C22	1u/35	RAD 1MOD
C23	1u/35	RAD 1MOD
C24	1u/35	RAD 1MOD
C25	1n/50	0805
C26	1n/50	0805
C27	1n/50	0805
C28	1n/50	0805
C29	10u/16	6032
C30	10n/50	RAD 1MOD PHILLIPS 62908
C31	1u/35	3528
C32	1u/35	3528
C33	1u/35	3528
C34	1u/35	3528
C35	1u/35	3528
C36	1u/35	3528
C37	10u/16	6032
C38	10u/16	RAD 1MOD
C39	10n/50	0805
C40	1u/35	RAD 1MOD
C41	15p/50	0805
C42	15p/50	0805
C43	10n/50	0805
C44	1u/35	RAD 1MOD
C45	10n/50	RAD 1MOD PHILIPS 62908
C46	100p/50	0805
C47	1u/35	RAD 1MOD
C48	1u/35	RAD 1MOD
C49	1n/50	0805
C50	10u/50	RAD 1MOD
C51	u1/50	0805
C52	100u/50	RAD 2MOD ELLYT
C53	1u/35	RAD 1MOD
C54	1u/35	RAD 1MOD
C55	1u/50	RAD 1MOD (OBS ELLYT)
C56	1u/35	RAD 1MOD
C57	1u/35	RAD 1MOD
C58	1u/35	RAD 1MOD
C59	1u/35	RAD 1MOD
C60	1u/35	RAD 1MOD
C61	3300/50	RAD 4MOD
C62	1u/250	RAD 11MOD
C63	100u/50	RAD 2MOD
C64	10u/16	6032
C65	100u/16	AXIAL 6MOD
C66	10n/50	0805
C67	10u/16	6032
C68	10n/63	RAD 1MOD PHILIPS 62908
C69	10n/200	POLY 2MOD
C70	10n/200	POLY 2MOD
C71	10n/200	POLY 2MOD
C72	u68/63	POLY 6MOD
C73	u68/63	POLY 6MOD
C74	u68/63	POLY 6MOD
C75	u68/63	POLY 6MOD
C76	15p/63	0805
C77	100u/50	RAD 2MOD ELLYT
C78	1u/250	RAD 11MOD
C79	1n/63	0805
C80	680n/100	RAD 6MOD
C81	680n/100	RAD 6MOD
C82	10n/63	0805
C83 -	0.033u/250V	RIFA X2-PME271
CT1	NTC	PHILIPS 640/3977-10k
D1	BAS45	DIODE 4MOD
D2	1N4002	DIODE 4MOD
D3	1N4002	DIODE 4MOD
D4	4V3/0.5W	ZENER 4MOD
D5	BZW06-6V4	ZENER 4MOD
D6	BZW06-6V4	ZENER 4MOD
D7	BZW06-6V4	ZENER 4MOD
D8	BZW06-6V4	ZENER 4MOD
D9	BZW06-10B	ZENER 4MOD
D10	BZW06-10B	ZENER 4MOD
D11	5V6/0.5W	ZENER 4MOD
D12	5V6/0.5W	ZENER 4MOD
D13	1N4148	DIODE SOD87
D14	SLH34MG	LED
D15	SLH34MG	LED
D16	SLH34MG	LED
D17	SLH34MG	LED
D18	SLH34MG	LED
D19	SLH34MG	LED
D20	SLH34MG	LED
D21	SLH34MG	LED
D22	SLH34MG	LED
D23	SLH34VR	LED
D24	SLH34VR	LED
D25	1N4148	DIODE SOD87
D26	1N4148	DIODE SOD87
D27	1N4148	DIODE SOD87
D28	*	
D29	60S1/6A1	DIODE 7MOD
D30	1N5822	DIODE 7MOD
D31	1N5822	DIODE 7MOD
D32	1N4148	DIODE SOD87
D33-D37	*	
D38	*	
D39	3V0/0.5W	ZENER 4MOD
D40	BAS45	DIODE 4MOD

D41	BAT42	DIODE 4MOD
D42	DAP401	5-PIN DIODENET
D43	BZW06-26	ZENER 4MOD
D44	1N4002	DIODE 4MOD
D45	9V1/5W	ZENER 7MOD
D46	SLH34MG	LED
D47	1N4002	DIODE 4MOD
D48	1N4002	DIODE 4MOD
D49	SLH34VR	LED (Note, Not yet fitted)
D50	1N4148	DIODE 4MOD
D51	BZW06-33B	ZENER 4MOD
D52	*	
Q1	BC847B	SOT23
Q2	BC847B	SOT23
Q3	BC847B	SOT23
Q4	*	
Q5	BC847B	SOT23
Q6	BC857B	SOT23 (Note! PNP)
Q7	*	
Q8	BC847B	SOT23
Q9	BC847B	SOT23
U1	CD40106	SO16
U2	68HC11A1FN	52PLCC IN SOCKET
U3	MC34064P-5	SOT23
U4	REF02	DIP8
U5	74HC573	SO20
U6	27C256	DIP28 IN SOCKET
U7	74HC00	SO14
U8	74HC138	SO16
U9	ULN2003AD	SO16
U10	*	
U11	CD4060	SO16
U12	HD6350	DIP24
U13	MAX232CWE	SO16L
U14	7805UC	TO220
U15	7809UC	TO220
U16	LM224J	DIP14
U17	LM224J	DIP14
U18	CD4093	SO14
U19	CD4027	SO16
U20	LM3914N	DIP18
U21	LM3914N	DIP18
U22	74HC574	SO20
U23	74HC574	SO20
U24	ULN2003AD	SO16
U25	ULN2003AD	SO16
U26	TL061CP	DIP8
U27	ICL7662CPA	DIP8
U28	MC68HC811E2FN	52PLCC IN SOCKET
U29	LM324D	SO14
U30	MC33035P	DIP24 3MOD
U31	MAX510BCPE	DIP16
U32	*	
U33	74HC393	SO14
U34	7824UC	TO220
U35	7812UC	TO220
U36	7805UC	TO220
U37	78L12	TO92
U38	74HC138	SO16
U39	74HC32	SO14
U40	74HC21	SO14
U41	GR3281 NVRAM	DIP28

L1	20uH/2A	SIEMENS B82134-A5202M
X1	4.0MHz	HC49/4H
X2	32.768kHz	RAD 1MOD, SOLDERED TO PCB
X3	8.0MHz	HC49
B1	BR64	RECTIFIER
MV1,MV2	MAGNETVALVE	PNEUTRONICS 1094 ohm
LC1	32x128-LCD	SEIKO G1213
M1	24V-TIMEMETER	CURTIS 701P
L1-L3	*	
CC1-CC4	2x4.2mH	SCHAFFNER RN214-2/02-4.2mH
PZ1	QFP-03A	BUZZER STAR MICRONICS
SW1	RF15-AG	RAFI-SWITCH WITH 2 GREEN LEDS
SW2	RF15-AG	RAFI-SWITCH WITH 1 GREEN LED
SW3	RF15-OBEL-AG	RAFI-SWITCH WITHOUT LED
SW4	RF15-OBEL-AG	RAFI-SWITCH WITHOUT LED
SW5	RF15-OBEL-AG	RAFI-SWITCH WITHOUT LED
K1	SGR282-24VDC	RELAY ELESTA
K2	SGR282-24VDC	RELAY ELESTA
DB1	9-POL DSUB MALE	
DB2	9-POL DSUB FEM.	
CN1	40-POL HEADER	
CN2	34-POL STRIP	
CN3	14-POL HEADER	
CN4	8-POL STRIP	2.54 PANDUIT
CN5	9-POL STRIP	2.54 PANDUIT
CN6	4-POL STRIP	3.96 PANDUIT
CN7	34-POL STRIP	
CN8,CN9	4-POL TERMINAL	WAGO 256-404
CM1	14-POL	TRANSITION CONNECTOR
CM1B	14-POL IDC FEM.	14-STRAINRELIEF
CM2	40-POL	TRANSITION CONNECTOR
CM2B	40-POL IDC FEM.	40-STRAINRELIEF
TC1,TC2	10-POL HEADER	
JP1,JP2	8-POL PLUG	WEIDMULLER 15-00159742-1
JP3	4-POL PLUG	WEIDMULLER 15-00159738-1
VR1	RXE040	POLYSWITCH RAYCHEM
VR2	30/38V VARISTOR	SIEMENS S10K30
RF1-RF10	-10nF EMIFIL	MURATA DSS306-91FZ103N100
RF11	RIBBON-FERRITE	FERRITE 0443166651
RF12-RF13	- FERRITE	MURATA BL02RN1-R62
BT1,BT2	3.6V/110mAh	NiCd VARTA 3/V100R-LP1+2
G1,G2	MPX10DP	PRESSURESENSOR MOTOROLA
TP1-TP11	TESTPOINT	VERO 20-2136
J1,J2	JUMPER (1/18)	
LB1,LB2	10-LEDBAR GREEN	
MF1-MF3	BDX34C	TO220
MF4-MF6	MTP5N20	TO220
DF1-DF3	UF4004	DIODE 4MOD
P1	500 1T TRIM	BECKMAN 72P

SOCKET FOR G1,G2 (8/20)
SOCKET FOR U2,U28 52-POL PLCC
RIBBON CABLE 14-POL FOR CM1
RIBBON CABLE 40-POL FOR CM2
RIBBON CABLE 34-POL FOR CN2-CN7
ALL 1u/35 RAD 1MOD ARE TANTALUM
ALL 10u/16 RAD 1MOD ARE TANTALUM

Note:

All 1mod-tantal-capacitors shall be “kemet type t350”.
All LEDs shall be specified type.
Components other than specified are not allowed,
All capacitors shall have specified module raster.
Maximum length of all resistors, except r108 is 8mm; mounted on 4mm-raster.
Ni-Cd batteries bt1, bt2 cannot be wave soldered (short circuit).

9 FAULT TRACING

9.1 Fault tracing

SYMPTOM	POSSIBLE CAUSE	REMEDIAL ACTION	SEE CH.
LED for "POWER" is on and the ventilator alarms at start-up.	The power cord is not properly connected.	Connect the power cord.	2
	Measure the voltage at contact CN6 (MDA board) across pins 3 and 4. Voltage should be 18 VAC	If there is voltage, replace the MDA board, or If there no voltage, check the filter board and transformer.	8
	Mains fuse blown.	Replace the fuse.	2
Will not run from external battery supply.	External batteries are discharged.	Charge the batteries	2
	External battery cable is not connected properly or is faulty.	Connect the cable / measure and replace if faulty.	2
	Ext. batt. fuse in rear panel has blown.	Replace the fuse.	2
	If the fuse blows immediately after connecting the ext. battery cable.	Check the polarity.	2
	With the battery connected, measure the voltage between TP1 and pin 2 on CN6. It should be approx. 24 VDC.	If the voltage is OK, replace the MDA board. If there is no voltage, check the wiring and filter board. Replace if faulty.	8
The ventilator does not give adequate pressure/volume.	Leakage from patient circuit/mask.	Check the tubes, mask and exhalation valve for leakage.	2
	Internal leakage from tubes, bellows or check valves.	Perform a leakage test.	3
	Filters dirty.	Replace white filter, wash grey filters.	2
Pressure indicator shows no pressure reading.	Internal supply tube blocked.	Check the tubes and connectors.	5
	MDA board faulty.	Check by connecting a voltmeter to the pressure outlet on the rear panel if a change in pressure causes a change in the voltage. P = 0 cm H_2O gives 1V P = 30 cm H_2O gives 4V If OK, replace the LCD board If not, replace the CPU board.	8

9.2 Error codes

If the PV 401 has the MXG software installed (see section 8.10) an Error Code memory is provided which can store the last 20 error codes generated. (Earlier software will only show the current error code and this information is lost once the machine is switched off.) The error codes provide useful information when fault-finding or carrying out service work. To read the error codes, proceed as follows:

- Press and hold the minus button.
- Start the ventilator, keeping the minus button pressed.
- The display will now show the message FAIL MEM. PUSH FUNC TO SHOW
- Press the Function button.
- The latest error code stored is shown first. The information given is YEAR, MONTH, DAY, HOUR, MINUTE, the text FAIL and the error code itself, see below for explanations.
- Press the function button to page back through the error codes to the earliest code stored.
- After the last code has been displayed, the message; SHOW FAIL RDY, is shown. Switch the ventilator off.

9.2.1 Table of Error Codes

The table below shows each error code, its meaning and the action required to remedy the situation. Where the Action Required column contains more than one action they are listed in the order they should be carried out e.g. if recommended action No. 1 does not solve the problem proceed with action No. 2 and so on.

Refer to Chapter 6 for information about removing the different boards etc.

Error code	Explanation	Action required
00	Slave processor does not answer.	1 Replace ribbon cable between CPU - MDA board. 2 Replace MDA board. 3 Replace CPU board.
01	Movement of bellows failed to start.	1 If ventilator is cold, let it warm up. 2 Replace motor. 3 Replace MDA board.
02	Slave processor answer fail.	1 Replace ribbon cable between CPU - MDA board. 2 Replace MDA board. 3 Replace CPU board.
03	Movement of bellows failed.	1 If ventilator is cold, let it warm up. 2 Replace motor. 3 Replace MDA board.

Continued on next page

04	Master processor EEPROM failure.	Replace CPU board.
05	Master processor RAM failure.	Replace CPU board.
06	Master processor program failure.	Replace CPU board.
07	Master processor failure.	Replace CPU board.
08	Alarm battery low.	1 Connect to mains for charging. 2 Replace MDA board.
09	Motor pulse counter failure.	3 Replace motor. 4 Replace MDA board.
10	Master processor program IC failure.	Replace CPU board.
11	Mains power low.	If mains power is OK, replace MDA board.
21	Cannot find home position.	Check home position sensor/ replace motor unit.
22	Communication error	1 Replace CPU board. 2 Replace MDA board.
31	Pressure transducer/amplifier #1 failure.	Replace CPU board.
32	Pressure transducer/amplifier #2 failure.	Replace CPU board.
33	Motor stop signal path diode D25 failure.	Replace MDA board.
34	Motor stop signal path diode D27 failure.	Replace MDA board.
35	Slave processor RAM failure.	1 Replace slave processor. 2 Replace MDA board.
36	Slave processor failure.	1 Replace slave processor. 2 Replace MDA board.
37	Master processor measurement failure.	Replace CPU board.
38	D/A converter failure.	Replace MDA board.
39	Pressure transducer/amplifier failure.	1 Check internal/external tubes. 2 Replace CPU board.
40	External battery voltage low.	Charge/Replace external battery.
41	Pressure measurement failure.	1 Check internal/external tubes. 2 Replace CPU board.
42	PC communication IC (U12) failure.	1 Replace CPU board. 2 Replace MDA board.
43	Communication error at serial port.	Check the serial cable's connection.
44	PC communication IC failure.	1 Try again. 2 Check PC cable. 3 Replace CPU board.

Continued on next page

51	NV time does not match.	Replace CPU board
52	NV store pointer does not match.	Replace CPU board
53	NV store pointer points below NVRAM..	Replace CPU board
54	NV store 10-bit converter counter does not match.	Replace CPU board
55	NV read 10-bit converter counter does not match.	Replace CPU board
56	Calender pointer does not match.	Replace CPU board
57	No NVRAM mounted.	Replace CPU board

10-1 ENGINEERING CHANGE HISTORY PV 401

From serial No.	Change made
October 1996	Software upgrade Master MT6, Slave SGI 15 second delay for low volume alarm. More power to motor on return if bellows go to max.
November 1996	Software upgrade Master MT8, Slave SGJ More power to motor on return if it does not move.
40416 (July 1997)	Software upgrade Master MUE, Slave SGN 50 ml low volume alarm.
40445 (July 1997)	Software upgrade Master MUF, Slave SGP PC connection.
41003 (April 1998)	Software upgrade Master MXG, Slave SGP Internal memory (Dallas). Adjustable low pressure alarm. Requires new operating manual.

Service record for Breas PV 401

Service Record No:_____

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, Identify the ventilator	3.6.1	____
Note number of operating hours	3.6.2	____
Check all markings	3.6.3	____
Information from user	3.6.4	____
Check validity of technical documentation	3.6.5	____
External checks		
Inspect for external damage and wear	3.7.1	____
Check power connection	3.7.2	____
Run minimum function check	3.7.3	____
Internal checks		
Clean inside ventilator	3.8.1	____
Check cabling	3.8.2	____
Check fastening of components	3.8.3	____
Motor Unit		
Check if complete motor unit is to be replaced	6.5	____
Replace the drive belts	7.2	____
Lubricate the felt sleeve for drive screw	7.3	____
Replace the check valve membrane in patient air outlet	7.4.1	____
Electronics		
Power supply	3.8.7	____
Calibrate the pressure sensor	8.5	____
Check operation using external battery	8.6	____
Check if alarm batteries need to be replaced	8.7	____
After reassembly		
Check electrical safety levels	8.8	____
Leakage test of motor unit and tubes	7.5	____
Final checks before handing over		
Function check	3.9.1	____
Check low pressure/leakage alarm	3.9.2	____
Check low volume alarm	3.9.3	____
Check alarm mute	3.9.4	____
Check trigger function	3.9.5	____
Check pressure/rate	3.9.6	____
Check tidal volume indication	3.9.7	____
Check external battery operation	3.9.8	____
Check accessories (where applicable)	3.9.9	____
Replace/Wash patient filters	3.9.10	____
Set correct setting for patient	3.9.11	____

Turn for comments and notes

Comments and notes:

10-3 RETURNING PRODUCTS TO BREAS

If a product needs to be returned to Breas for any reason, e.g. for service, warranty, repair or upgrade, the following routine must be followed to ensure that the correct action is taken and to avoid unnecessary delays.

Pack the product in its original packaging. If this is not available, pack the product in packaging suitable for the transportation to Breas.

Fill out the Customer part of a Service Report and pack it together with the product. The Service Report, completed by Breas, will be returned with the product.

A copy of the Service Report is provided on the next page. This can be photocopied and used as required.

Service Report

Breas Ref. No:

Customer Name & Address:.....

.....

Reference: ..... Ref. No. .....

Model: ..... Serial No:..... Running time .....h

Error /Complaint / Accessories

.....

.....

.....

Date received by BREAS:..... Signature.....

Repair ☐ **Warranty** ☐ **Update** ☐ **Charge** ☐ **Other** ☐

Action taken:

_____

_____

_____

_____

_____

_____

_____

Parts used	**Pcs**	**Price**

Running hours from BREAS:_____h

Date returned to customer: _____ Signature:_____

Use reverse side for notes etc.