4008 HDF

Technical Manual

Fresenius Medical Care

4008 HDF

Technical Manual

4008 HDF Technical Manual

The Technical Manual contains all information necessary for performing maintenance and repair work.

The 4008 HDF option reflects the latest state of technology and complies with the requirements of EN 60601-1

Assembly, extension, adjustment, modification or repair may only be carried out by the manufacturer or persons authorized by him.

Any inquiries should be addressed to:

Head office:
Fresenius Medical Care
Deutschland GmbH
Borkenberg 14
D-61440 Oberursel/Ts., Germany
Tel.: 06171-60-0
Telex: 410805 fres d
Fax: 06171-251-58

Manufacturer:
Fresenius Medical Care
Deutschland GmbH
Plant Schweinfurt
Hafenstraße 9
D-97424 Schweinfurt, Germany
Tel.: 09721-678-0
Fax: 09721-678-200

Local Service:

How to use the Technical Manual

Search and find	*What?*	*Where?*
	Tables Contents	Pages 0-5 and at the beginning of each chapter

Purpose

This manual is intended for:
- first studies (to acquire basic knowledge)
- reference purposes (for start-up, maintenance and repair)

Organization

The manual is divided into 6 chapters:

0 General Notes
1 Description of machine functions
2 Technical safety checks
3 Calibration instructions
4 Circuit descriptions and circuit diagrams
5 Spare parts

Numbering system

Page number 1-3 is to be interpreted as: Chapter 1, Page 3

Qualification

This manual is intended for service technicians
- who are familiar with the current Operating Instructions (Operating Instructionseratining to this Technical Manual are available under part no. 674 406 1)
- who have the necessary background experience in mechanics, electrical and medical engineering
- who have been authorized by the manufacturer to perform maintenance and repair work
- who have access to the necessary auxiliary and measuring equipment

Restrictions

The study of this manual does not represent an alternative to the training courses offered by the manufacturer.

Manual changes

Manual changes will be released as new editions, supplement sheets or product information.

Note:
Modifications relating to circuit diagrams and component layouts (SP/BP) do not necessarily involve a change of the footer (edition).
Refer to the index field of the respective circuit diagram or component layout for the respective state of these diagrams. The identification on the P.C.B. permits the user/technician to verify if the circuit diagram / component layout matches the P.C.B. actually installed.

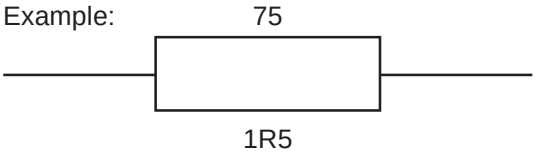
In general, this manual is subject to modification.

Representation

New circuit symbols are used in the circuit diagrams. Potential data given in the circuit diagrams and setting instructions refer to the respective earth.
For example: ⊥ 24 means ground for 24 V voltage.

Component marking in circuit diagrams

Example:



This refers to a resistor with a position number 75 with a resistance of 1.5 Ohm.

The decimal point is replaced by a unit symbol (to reduce the possibility of errors).

Resistors:		Capacitors:	
R1:	0.1 Ω	µ 1:	0.1 µF
1R5:	1.5 Ω	1µ5:	1.5 µF
1K5:	1.5 kΩ	1000µ:	1000 µF

Note:

When repairing or exchanging replacement parts make sure to take the applicable ESD precautions (e.g. EN 100 015-1).
During repair/troubleshooting in the hydraulic unit, protect the components from dialysate.

Technical data:

The technical data for the 4008 HDF option is to be found in Chapter 1 of the Operating Instructions.

Table of contents

Section		Page
1	**Description of machine functions**	1-
1.1	Description	1-3
1.2	Description of extended T1 test	1-8
1.3	Error messages	1-10
2	**Technical safety checks**	2-
3	**Calibration instructions**	3-
3.0	General information on the calibration instructions	3-3
3.1	Calibrating the UF2 pump	3-5
3.2	VDE inspections	3-7
3.3	Calibrating the 4008 HDF scale	3-8
3.4	Calibrating the substituate sensor	3-13
3.5	Calibrating the HDF blood pump	3-15
3.6	Repair instructions	3-17
4	**Circuit descriptions and circuit diagrams**	4-
4.1	LP 625 display board	4-3
4.2	LP 754 control board HDF	4-9
4.3	LP 760 HDF motor control	4-19
4.4	LP 761 HDF drive keyboard	4-27
4.5	LP 762 scale comm	4-33
4.6	LP 763 SSE serial interface extender	4-39
5	**Spare parts**	5-
5.0	How to use the spare parts catalog	5-3
5.1	P.C.B.s	5-4
5.2	Scales	5-6
5.3	Substituate lift	5-8
5.4	UF2 pump / blood pump (HDF) / valve V 126	5-10

Table of contents
1 Description of machine functions

Section		Page
1.1	**Description**	1-3
1.1.1	Components	1-3
1.1.2	Description	1-3
1.1.3	Component tests	1-3
	Fig.: Block diagram	1-4
	Fig.: Flow diagram	1-5
	Fig.: Flow diagram	1-6
1.2	**Description of extended T1 test / error messages in T1 test**	1-8
1.2.1	Test UF-Function	1-8
1.3	**Error messages during treatment and the HDF test**	1-10
1.4	**Error messages, substituate pump**	1-13

1.1 Description

1.1.1 Components

The components of the 4008 HDF option are permanently connected to the hemodialysis machine. The 4008 HDF option comprises the following components:
– Substituate lift
– Scales (weighing range < 20 kg) with data interface and taring facility
– Substituate pump with bidirectional data interface
– UF2 pump

1.1.2 Description

The scales determine the actual weight of the substituate reserve and signals this to the hemodialysis machine. This calculates the substituate rate depending on the set treatment time.

A substituate sensor mounted on the substituate lift recognises whether:
– Line set is fitted without substituate or
– Line set is fitted with substituate.

The substituate pump delivers the substituate solution to the venous bubble catcher. The filtrate from the dialysis fluid circuit is removed by the UF2 pump.

1.1.3 Component tests

The scales are checked by the operator by means of a plausibility test before treatment. The substituate sensor is tested while the 4008 HDF is filling.
The 4008 HDF test tests:
– The substituate pump
– The UF2 pump (electrically and hydraulically)
(If the 4008 HDF test is not carried out then the connections are to be tested but once).
The UF2 pump is tested cyclically during treatment.
The electric control system of the UF2 pump is checked continuously.

Fig.: Block diagram

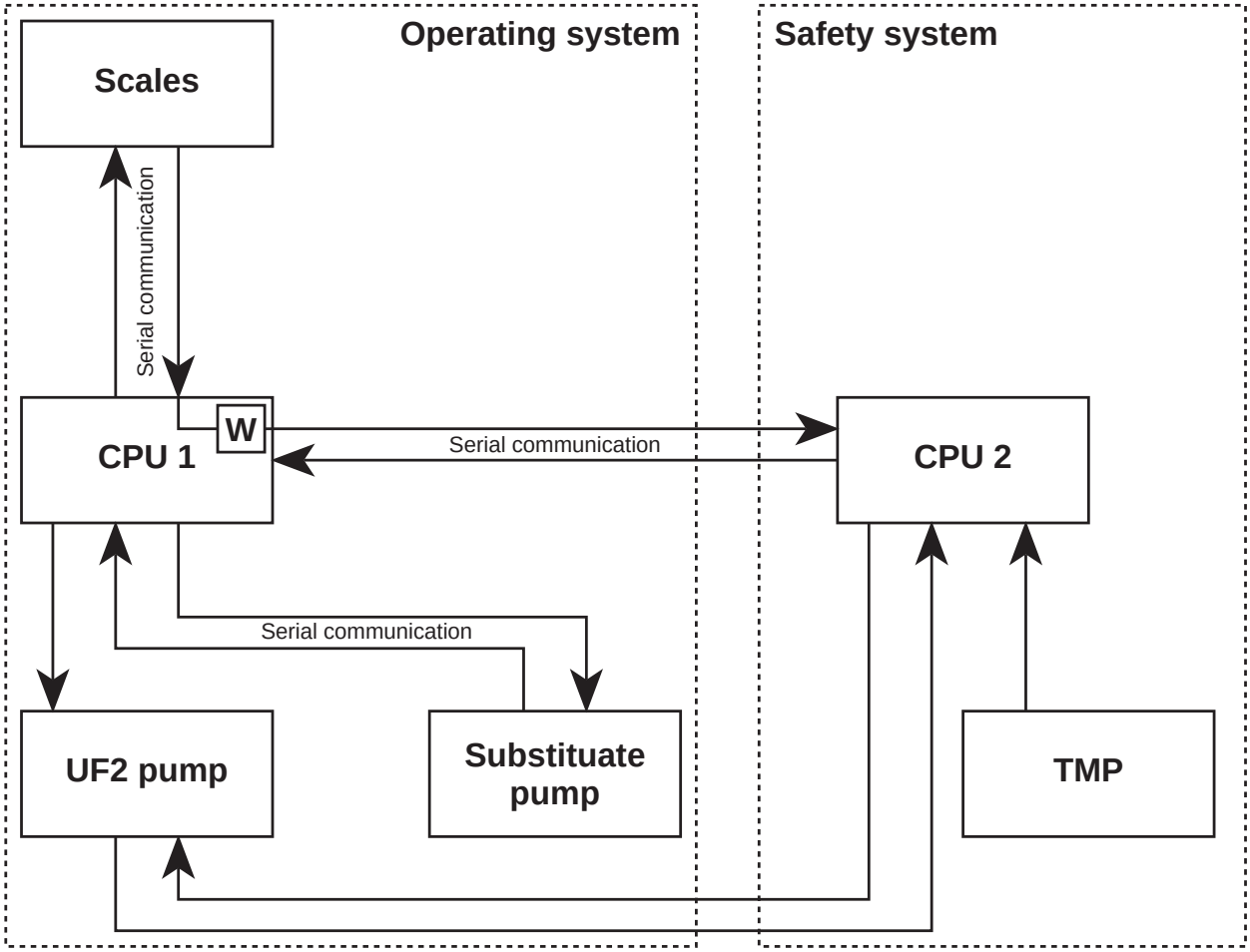


Fig.: Flow diagram

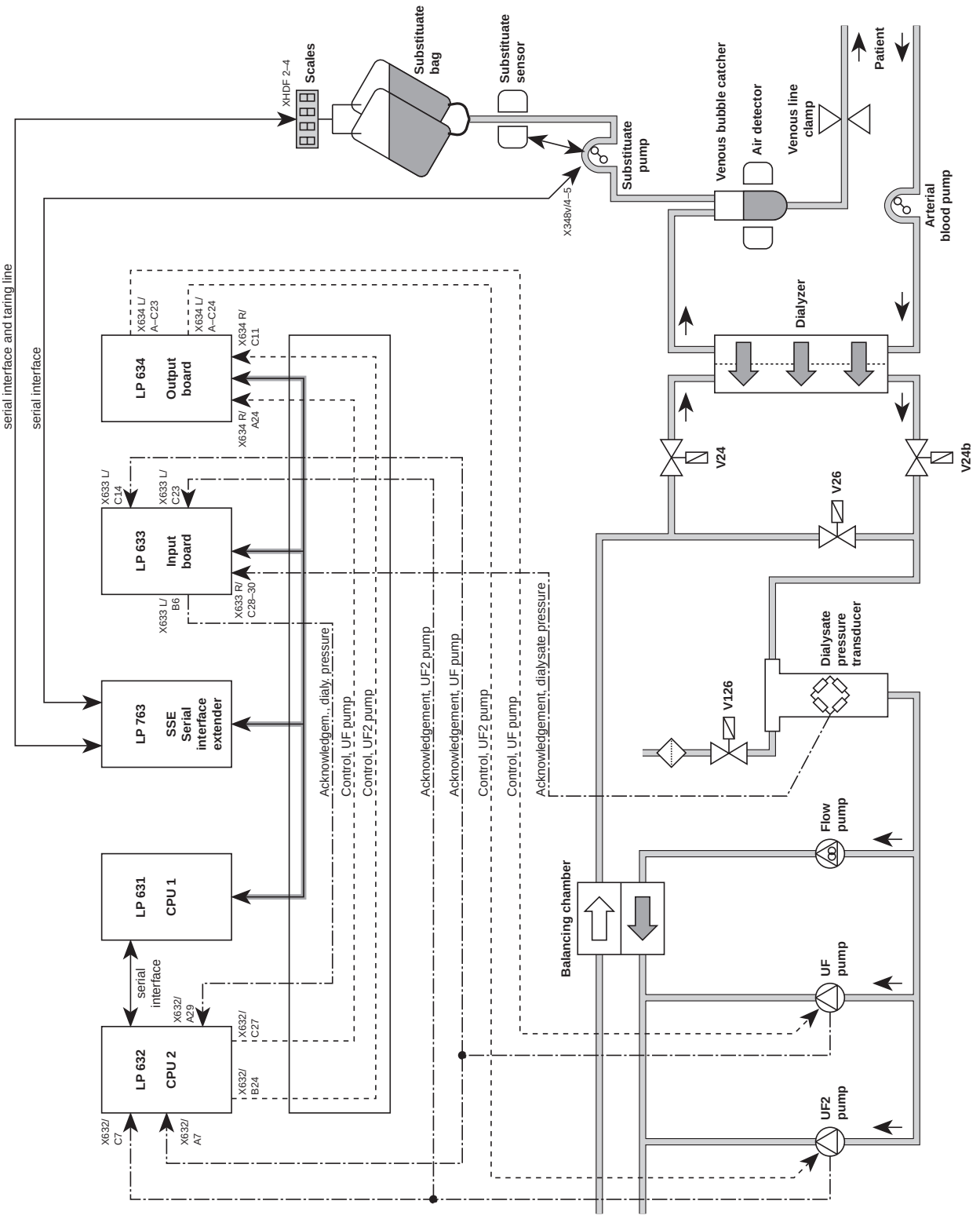
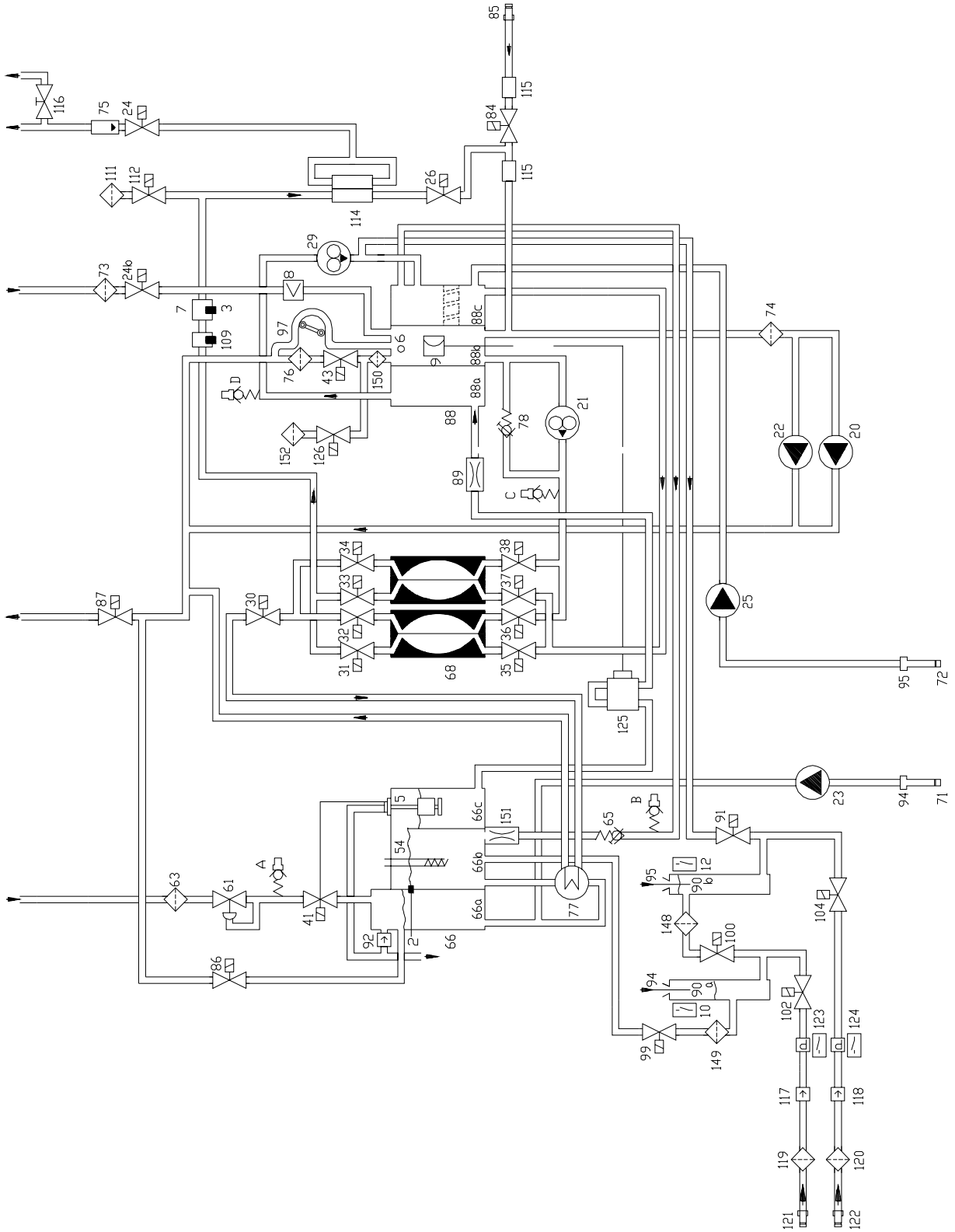


Fig.: Flow diagram



Legend

2 Temperature sensor
3 Temperature sensor
5 Float switch
6 Level sensor
7 Conductivity measuring cell
8 Blood leak detector
9 Pressure transducer
10 Reed contact for concentrate
12 Reed contact for bicarbonate
20 UF2 pump
21 Flow pump
22 UF pump
23 Concentrate pump
24 Dialyzer valve 1
24b Dialyzer valve 2
25 Bicarbonate pump
26 Bypass valve
29 Degassing pump
30 Drain valve
31 Balancing chamber valve 1
32 Balancing chamber valve 2
33 Balancing chamber valve 3
34 Balancing chamber valve 4
35 Balancing chamber valve 5
36 Balancing chamber valve 6
37 Balancing chamber valve 7
38 Balancing chamber valve 8
41 Water inlet valve
43 Fill valve
54 Heater rod
61 Pressure reducing valve
63 Filter/water inlet
65 Loading pressure valve
66 Heater block
66a Water inflow chamber
66b Heater rod chamber
66c Float chamber
68 Balancing chamber
71 Filter/concentrate
72 Filter/bicarbonate
73 Filter/external dialysate
74 Filter/UF
75 External flow indicator
76 Filter/fill valve
77 Heat exchanger
78 Relief valve
84 Disinfection valve
85 Disinfectant conncector
86 Recirculation valve
87 Discharge valve
88 Multifunction block
88a Degassing chamber
88b Secondary air separator
88c Primary air separator
89 Degassing orifice
90a Rinse chamber concentrate
90b Rinse chamber bicarbonate
91 Rinse valve
92 Vent valve
94 Concentrate suction tube
95 Bicarbonate suction tube
97 Ventilation pump
99 Rinse valve
100 Rinse valve
102 Concentrate valve in central delivery system
104 Bicarbonate valve in central delivery system
109 Temperature sensor
111 Hydrophobic filter
112 Vent valve
114 Dialysate filter
115 Disinfection valve sensor
116 Sampleing valve
117 Check valve (concentrate)
118 Check valve (bicarbonate)
119 Filter (concentrate)
120 Filter (bicarbonate)
121 Concentrate connector in central delivery system
122 Bicarbonate connector in central delivery system
123 Pressure switch for V 102
124 Pressure switch for V 104
125 Adapter plate
126 4008 HDF vent valve
148 Filter/rinse valve
149 Filter/rinse valve
150 Filter
151 Orifice
152 4008 HDF hydrophobic filter

Hydraulic measurement points

A Reduced water inlet pressure
B Balancing chamber loading pressure
C Flow pump pressure
D Degassing pump pressure

1.2 Description of extended T1 test / error messages in the T1 test

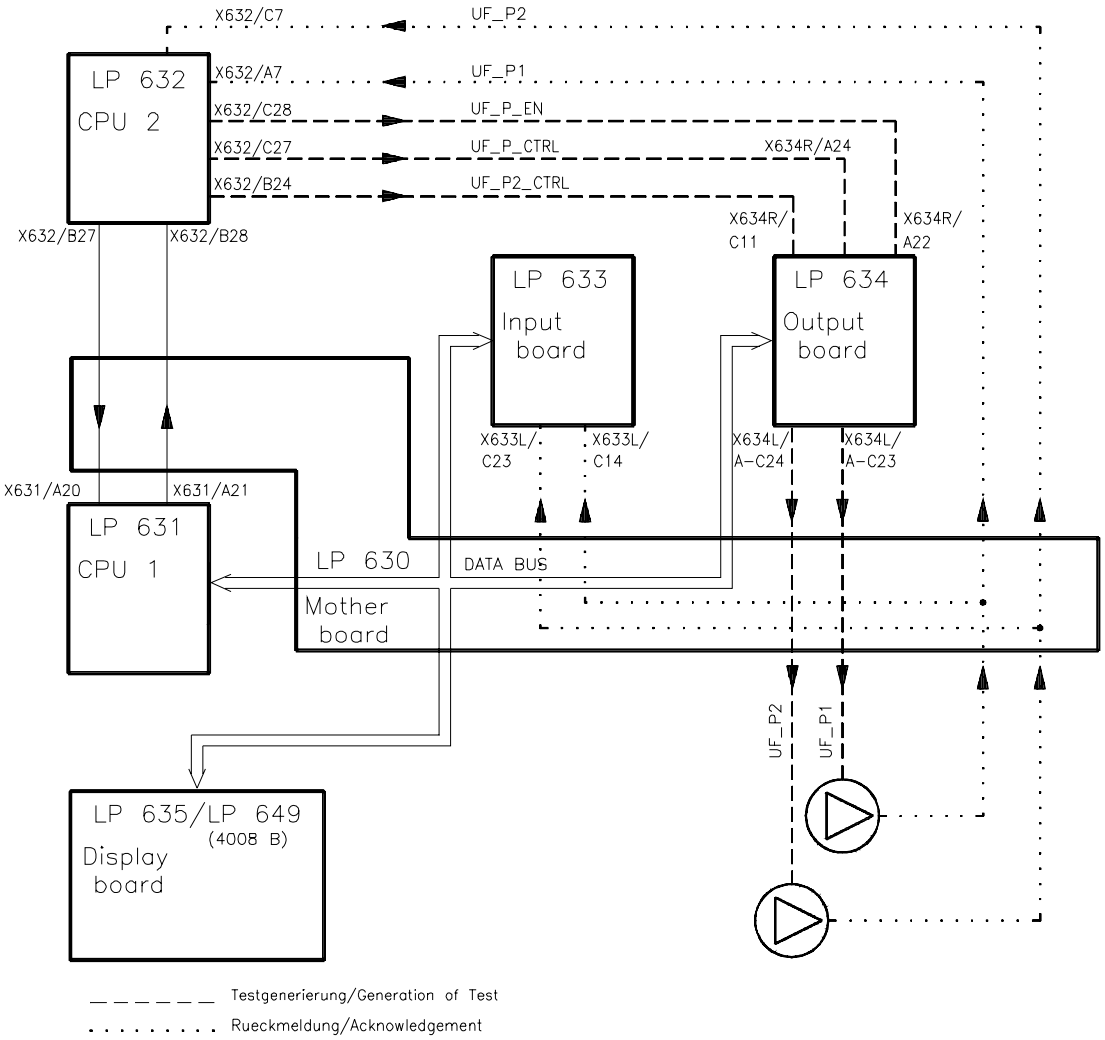
Possible error messages displayed in the T1 test are listed in the Technical Manual for the hemodialysis machine. If the HDF option is installed and activated the following error codes can also appear:

1.2.1 Test UF-Function

Test description:

CPU 1 starts up the UF2 pump at a defined rate.
CPU 2 controls the hydraulic and electrical function of the UF2 pump.
CPU 2 blocks the control line of the UF2 pump and checks for standstill.
UF2 counter check.

Figure:



Error description:

Error message	*Description*
F11 UF-Function	The interval between the strokes of the UF2 pump was less than 220 ms. Correct delivery of the required volume is not safeguarded because the stroke return travel is too short. – A pump rate which was too high was signalled by the CPU 1.
F12 UF-Function	The pulse time for the UF2 pump is less than 180 ms. Correct delivery of the required volume is not safeguarded because the discharge time is too short. – Monoflop on LP 634 defect (IC 42/R65/C45).
F 13 UF-Function	The pulse for the UF2 pump is longer than 500 ms. A maximum rate of 5000 ml/h is not possible. – Monoflop on LP 634 defect (IC 42/R65/C45).
F14 UF-Function	UF2 pump not active during the test (4 s). – Acknowledgement (UF_P2, X637/B26) → X632/C7 no LOW pulse – Control line (UF_P2, X634L/A–C24) → X637/B26 no LOW pulse
F15 UF-Function	The UF2 pump cannot be stopped by the CPU2. – Control line (UF_P_EN, X632/C28) → X634R/A22 no 5 V. – Reset input to IC 42/pin 13 on LP 634 defect.
F16 UF-Function	The UF pump acknowledgement from CPU1 is faulty. – Acknowledgement (UF_P2, X637/B26) → X633/C23 no LOW pulse
F17 UF-Function	The change in pressure after a UF2 pump stroke less than 20 mmHg. – UF2 pump mechanically defect. – Control line (UF_P2_CRTL, X632/B24) → X634R/C11 no HIGH pulse.
F20 UF-Function	Difference in pressure between UF pump stroke and UF2 pump stroke more than 20 %. – Stroke rate for UF pump or UF2 pump not set correctly.

1.3 Error messages during treatment and the HDF test

Message on the display	Cause	Possible error elimination
F321 HDF-failure	The UF pump or UF2 pump test will not be started as long as the level sensor (6) detects air. The level sensor (6) will detect air one minute after the 4008 HDF test has been selected	Check level sensor (6) (defect).
F322 HDF-failure	The UF pump or UF2 pump has carried out more than 50 strokes and still no air has been detected.	Check V126 (does not open, venous bubble catcher collapses), check V43 (whether leaking or open). Check UF pump or UF2 pump, respectively (mech. defect).
F323 HDF-failure	The substituate pump runs at a rate of 10 ml/min. to raise the fluid level by a defined amount in the secondary air separator (the fluid will just be detected). Air will still be detected after 2 minutes.	Check substituate tubing (clamped off, not connected to the venous bubble catcher).
F324 HDF-failure	Since fluid has been recognized in the secondary air separator the substituate pump starts at a rate of 10 ml/min. until a change in weight follows on the scales (i.e. a jump in grammes). There was no difference in weight established after one minute.	Check substituate tubing (clamped off).
F325 HDF-failure	If the expected change in weight (i.e. a jump in grammes) is higher or lower than –1 g, the respective UF pump test will be repeated. The UF pump test was repeated more than 5 times.	Check bag (fluctuations in air draft) Check scales (for drifting).

Message on the display	Cause	Possible error elimination
F326 UF-failure	The fluid level in the secondary air separator is raised again by the substituate pump after 100 strokes of the UF pump or UF2 pump, respectively, until fluid is detected. Plus run-on time at a rate of 10 ml/min. for the gramme jump. Air will still be detected after a specific period of time (depending on the delivery rate of the substituate pump).	Check substituate hose (clamped off, not connected with the venous bubble catcher).
UF1 volume-Error or **UF2 volume-Error**	One UF pump did not pass the test. The filling volume for the secondary air separator is not within the given tolerance of 100 ml; ± 5 ml. Should the test give a reading of over 105 ml the cause could also be air taken in the flow from a badly vented dialysator.	Check UF pump or UF2 pump, respectively (not calibrated, mechanical defect).
F327 UF-failure	Interval between two strokes of the UF pump less than 220 ms.	Check CPU 1 (defect).
F328 UF-failure	Pulse time of a stroke of UF pump less than 180 ml.	Check LP 634 (regulating monoflop defect).
F329 UF-failure	Pulse time of a stroke of UF pump more than 500 ms.	Check LP 634 (regulating monoflop defect).
F330 UF-failure	Starting time for the UF pump more than 10 seconds.	Check LP 634 (regulating end stage defect).
F331 UF-failure	Difference between desired or actual delivery rate of the UF pump greater than ± 10%.	Check CPU 1 / CPU 2 (communication problems).
F332 UF-failure	UF pump stops longer than the maximum period time.	Check LP 634 (regulating end stage defect). Check UF pump (interruption, control). Check CPU 1 / CPU 2 (communication problems)
F333 UF-failure	Despite switched off ultrafiltration the change in delivery rate of the UF pump is greater than 10 ml.	Check CPU 1 / CPU 2 (communication problems)
F334 UF-failure	Interval between two strokes of the UF2 pump less than 220ms.	Check CPU 1 (defect).

Message on the display	Cause	Possible error elimination
F335 UF-failure	Pulse time of a stroke of the UF2 pump less than 180 ms.	Check LP 634 (regulating monoflop defect).
F336 UF-failure	Pulse time of a stroke of the UF2 pump more than 500 ms.	Check LP 634 (regulating monoflop defect).
F337 UF-failure	Reaction time of the UF2 pump more than 10 seconds.	Check LP 634 (regulating end stage defect).
F338 UF-failure	Difference in desired or actual delivery rate of UF2 pump greater than ± 10 %.	Check CPU 1 / CPU 2 (communication problems).
F339 UF-failure	UF2 pump stops longer than the maximum period time.	Check LP 634 (regulating end stage defect). Check UF pump (interruption, control). Check CPU 1 / CPU 2 (communication problems).
F340 UF-failure	Despite switched off 4008HDF change in delivery rate of the UF2 pump greater than 10 ml.	Check CPU 1 / CPU 2 (communication problems).
F341 UF-failure	Failure of UF pump.	Check UF pump (spring, screen)
F342 UF-failure	Failure of UF2 pump.	Check UF2 pump (spring, screen)
F343 UF-failure	Volume difference between UF pump and UF2 pump.	Check UF pump and UF2 pump (delivery volume)
F344 HDF-failure	Balance failure recognized by CPU2 greater than ± 500 ml.	Check monitor / scales (communication problems).
F345 HDF-failure	Bolus exceeded by more than + 20 ml, detected by CPU2.	Check monitor / scales (communication problems).
F346 HDF-failure	CPU2 failed to perform the cyclic UF pump test within 5 minutes.	Check V24B and V43 feedback lines. Check sense of rotation of aspiration pump. Check hydraulics unit for leaks.
F348 HDF-failure	Weight change on the scales during the weighing test greater than 2g.	Check scales Check substituate bag
F349 HDF-failure	The delivery rate correction factor could still not be determined after 20 minutes treatment time.	Check substituate bag (weight fluctuations) Check HDF control system (greater fluctuations)

1.4 Error messages, substituate pump

Code	Description of failure
E.01	Line diameter outside the permitted range
E.02	Non-defined hexaswitch position
E.03	Venous pressure transducer not balanced
E.04	Failure, running time monitoring system, SN operation
E.05	SN stroke volume outside the permitted range
E.06	The SN pressure thresholds outside the value range of the AD converter
E.07	Not defined
E.08	Failure in the AD conversion
E.09	Not defined
E.10	Not defined
E.11	Not defined
E.12	Failure, speed monitoring (hall sensor)
E.13	Failure, monitoring system, current sensing resistors
E.14	Failure, monitoring system, current sensing resistors
E.15	Failure, speed monitoring system

2 Technical safety checks

General Notes

This chapter includes all necessary technical safety checks (TSC).

These inspections must be carried out every 12 months.

The technical safety inspections stipulated for the hemodialysis machine must be carried out in addition to these technical saftey checks.

The technical safety checks are to be recorded in the equipment log.

A technical safety checks report is to be found at the page 2-3.

Technical safety checks report

Manufacturer:	.....	**Date:**	.....
Machine:	.....	**Technician:**	.....
Operating hours:	.....		

Extent of checks and time limits for technical safety checks.

TIME LIMIT: every 12 months

The following checks and inspections have to be carried out on the machine at least every 12 months by persons who are capable of carrying out such technical safety checks efficiently as a result of their training, knowledge and experience gained in practice and are not subject to instructions as to their checking activity.
(See also BMA Bulletin dated 02.04.1987)

TSC	WA	No.	Description	Desired value/function	OK
		1	**UF2 pump**		
TSC		1.1	Delivery volume (1 ml/stroke)	60 strokes = 60 ml ± 1 %	❑
		2	**VDE inspections** (values according to EN 60601-1)		
TSC		2.1	Protective ground resistance	max. 0.3 Ω	❑
TSC		2.2	Summarized leakage current	Must fulfill both conditions: 1. No more than 1.5 times the “summarized value first measured” (“Summarized value first measured”: Refer to the machine card enclosed with the machine.) 2. No more than 1 mA	❑

The technical safety checks are to be recorded in the equipment log and the results of the checks documented.

If the machines are not safe in function and/or operation they are to be repaired or the operator is to be informed as to the dangers involved when using the machine in its given state.

The correct completion of the listed work and the correctness of statements made are hereby certified.

Signature, technician:	**Signature, customer:**
..... , date	**..... , date .....**
.....	.....

Table of contents
3 Calibration instructions

Section		Page
3.0	**General information on the calibration instructions**	3-3
3.1	**Calibrating the UF2 pump**	3-5
3.2	**VDE inspections**	3-7
3.3	**Calibrating the 4008 HDF scales**	3-8
3.4	**Calibrating the substituate sensor**	3-13
3.5	**Calibrating the HDF blood pump**	3-15
3.5.1	Pressure transducer	3-15
3.5.2	Checking SN switchover points	3-16
3.6	**Repair instructions**	3-17

3.0 General information on the calibration instructions

Measuring instruments:
The same measuring instruments as used for the hemodialysis machines are to be employed.
Required in addition is a calibration weight PT6 – 5000 g.

Fig.: P.C.B. overview 4008 HDF

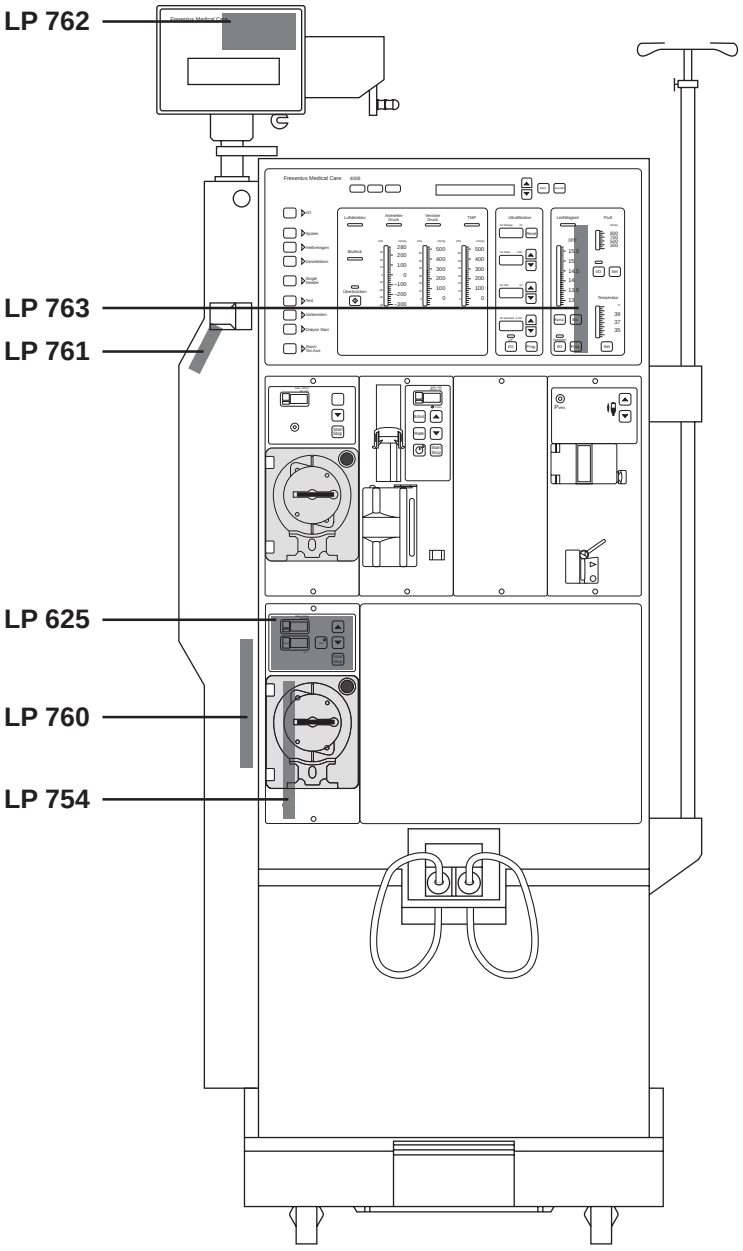
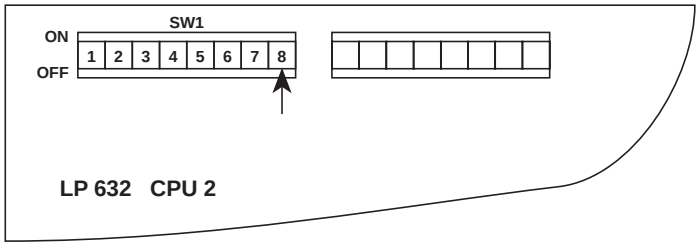


Fig.: DIP switch 4008 HDF



SW 1, DIP switch 8:
ON: 4008 HDF test selectable (required/not required)
OFF: 4008 HDF test carried out automatically

3.1 Calibrating the UF2 pump

Switch off hemodialysis machine.

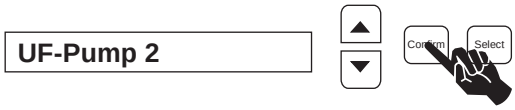
Set service switch to ON (top).

Switch on hemodialysis machine.

Press the **Confirm** key.

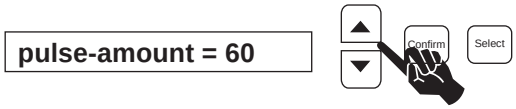
Select **ADJ. UF-PUMP VOLUME** by pressing the ▲ and ▼ keys.

Press the **Confirm** key.

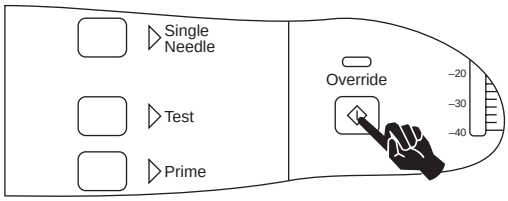


Select **UF-PUMP 2** by pressing the ▲ and ▼ keys.

Press the **Confirm** key.



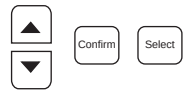
Enter the number of strokes by pressing the ▲ and ▼ keys.



Press the **Override** key.

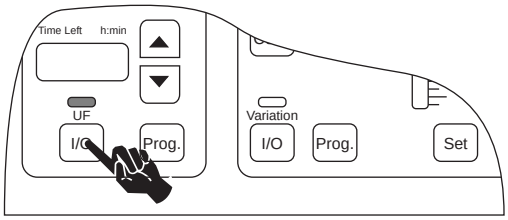
Text display for approx 3 sec.

press uf key



Text display

Draw off UF 2 pump line, close T-piece, hang line in a measuring cylinder.

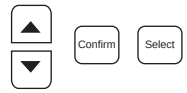


Press the key **UF I/O.**

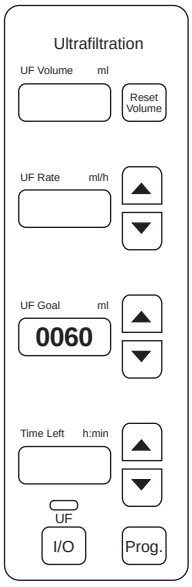
The **UF** LED emits light.

The UF2 pump delivers.

uf pulses left = 59

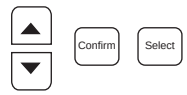


The remaining UF Pulses are shown in the display.



The number of preselected pulses is shown in the UF Goal display.

UF-Pump 2



Text display after completion.

Check delivered quantity.
If necessary adjust UF 2 pump and repeat process.

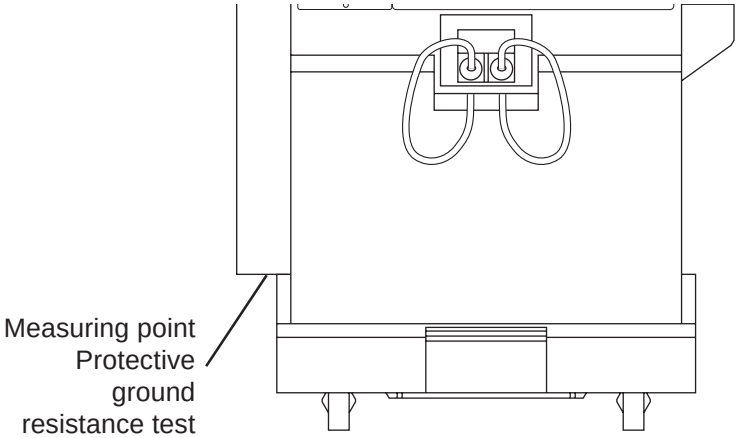
Delivery rate: 1 ml/stroke
(60 strokes = 60 ml)
Tolerance: ± 1 %.

3.2 VDE inspections

(Values in accordance with EN 60601-1)

.1 Protective ground resistance:

– max. 0.3 Ω.



.2 Summarized leakage current

Must fulfill both conditions:
1. No more than 1.5 times the “summarized value first measured”
   (“Summarized value first measured”: Refer to the machine card supplied with the machine.)
2. No more than 1 mA

The measurements must be taken in the dialysis mode of operation in the “ON phase” of the heating control system.
The scales must be travelled out to such an extent that neither of the two end switches are actuated (middle position).
The two leakage currents are to be measured each time with different mains connection poling.
The two leakage currents are added together and give the summarized leakage current.

3.3 Calibrating the 4008 HDF scales

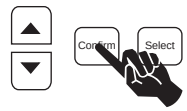
Note:
The prompts shown in the text display have to be run through correctly by the technician since no *direct* return signal is given by the scales.

Switch off hemodialysis machine.

Set service switch to ON (top).

Switch on hemodialysis machine.

CALIBRATION



Press the **Confirm** key.

CALIB. HDF-SCALE

Select **CALIB. HDF-SCALE** by pressing the ▲ and ▼ keys.

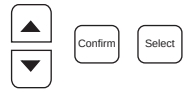
Press the **Confirm** key.

CHECKING HDF-SCALE!

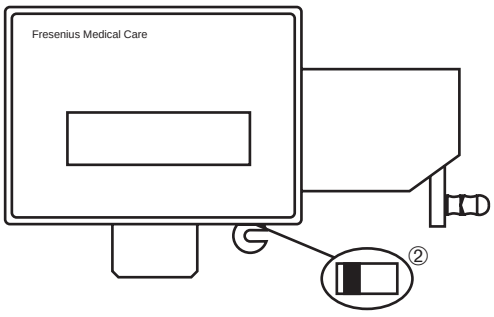
Brief text display.

Display on scales is not illuminated.

calib. Switch ON?

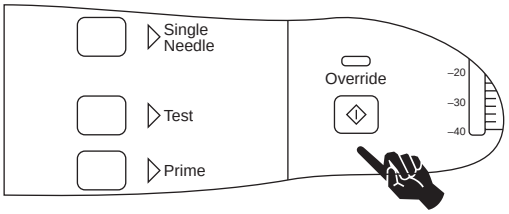


Text display.



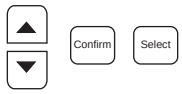
① Open housing of scales at the back.

② Set calibration switch for the scales in ON position.

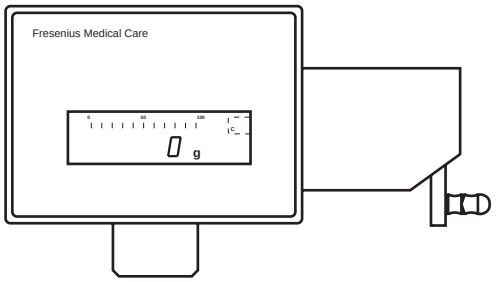


Press the **Override** key.

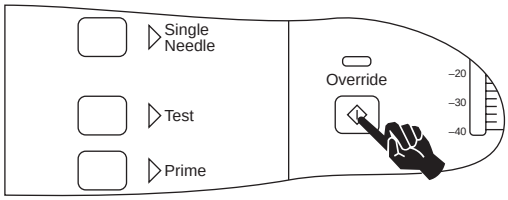
HDF-DISPL shows C?



Text display.

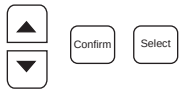


The display on the scales is active.
A **"C**" appears at the top right.

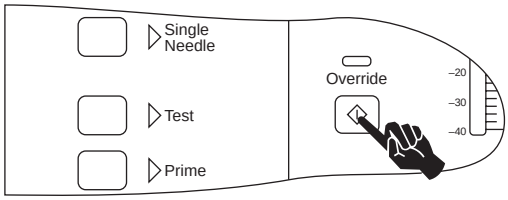


Press the **Override** key.

HDF-SCALE unloaded ?

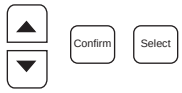


Text display.
No weight is to be on the scales.

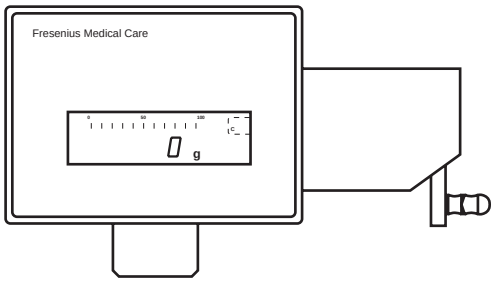


Press the **Override** key.

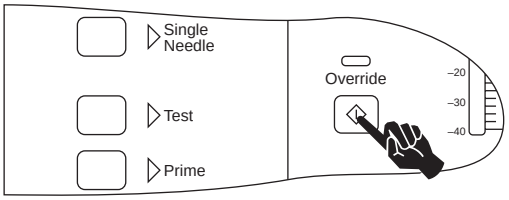
HDF-DISPL shows 0 ?



Text display.



Scales display.



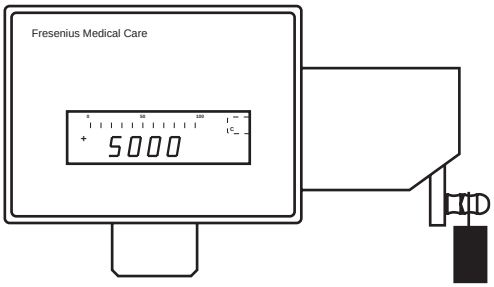
Press the **Override** key.

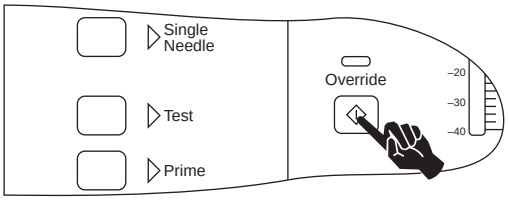
load 5 kg CAL. WEIGHT

Text display.

Scales display: 5000 g

Hang calibration weight PT6 – 5000 g on scales.

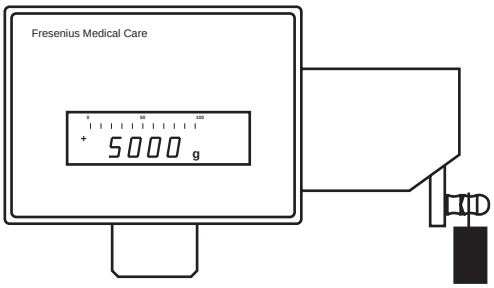




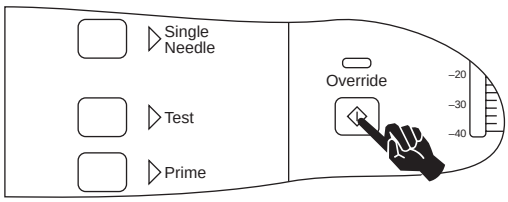
Press the **Override** key.

DISPL shows UNIT “g”?

Text display.

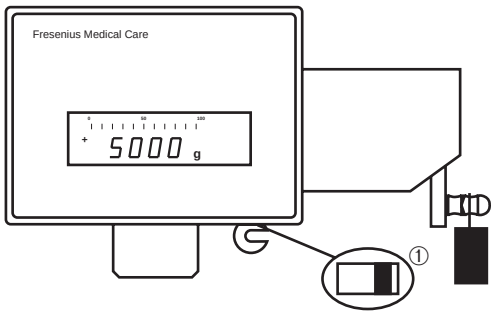


Scales display: 5000 g.



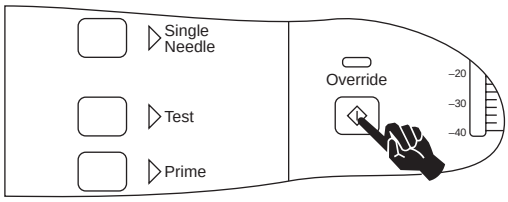
Press the **Override** key.

Text display.

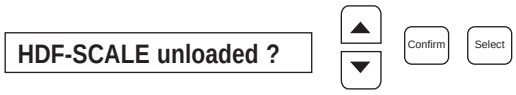


① Set calibration switch for the scales to OFF position.

② Close housing.

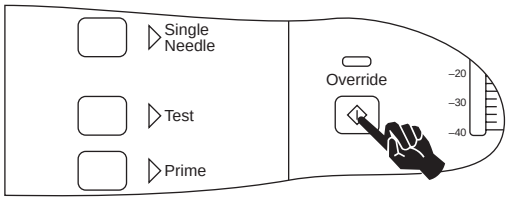


Press the **Override** key.

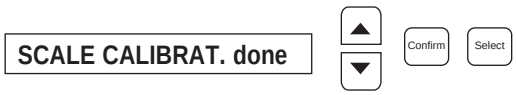


Text display.

Remove calibration weight.



Press the **Override** key.



Brief text display.

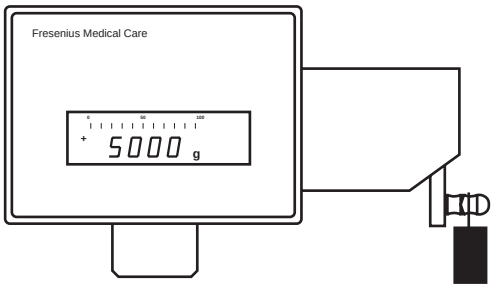
Text display.

Switch off hemodialysis machine.

Set service switch to OFF (bottom).

Switch on hemodialysis machine.

Hang calibration weight PT6 – 5000 g on scales.

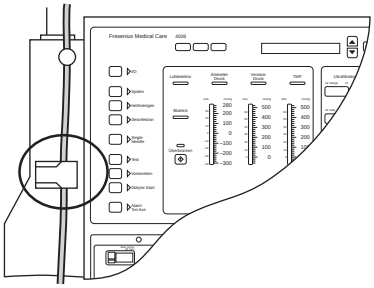


Scales display: 5000 g

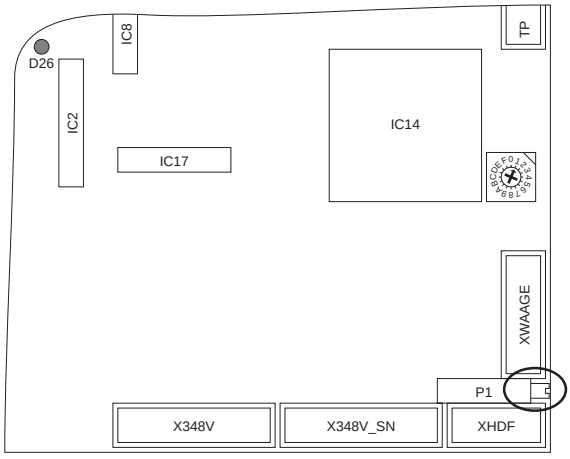
Remove calibration weight.

Calibration of 4008 HDF scales completed.

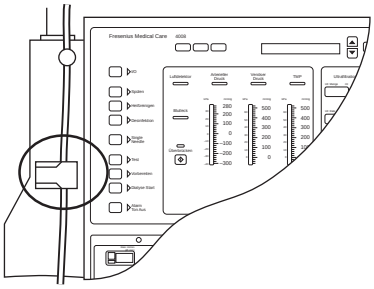
3.4 Calibrating the substituate sensor



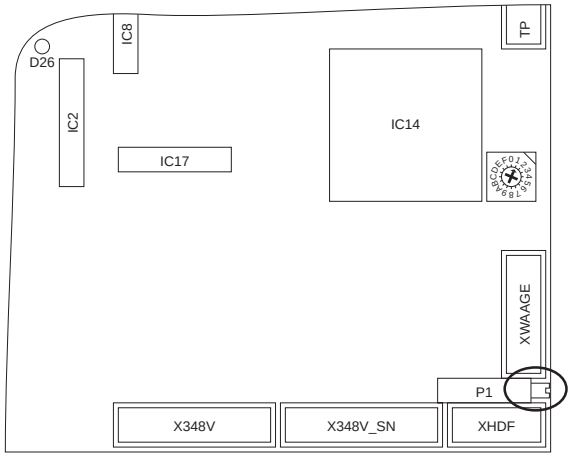
Place filled substituate line in substituate sensor.



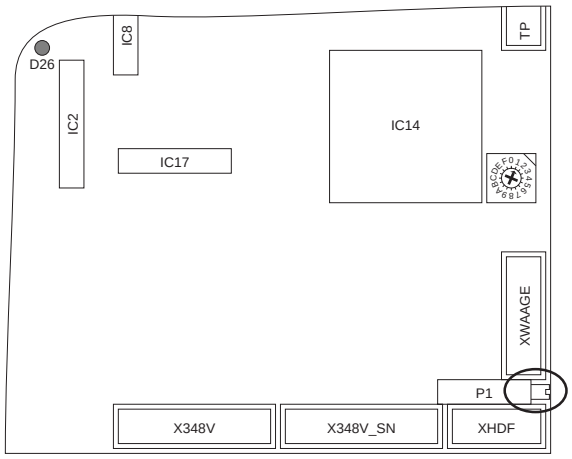
Set potentiometer P1 on the LP 754 so that the LED D26 just illuminates.



Place empty substituate line in substituate sensor.



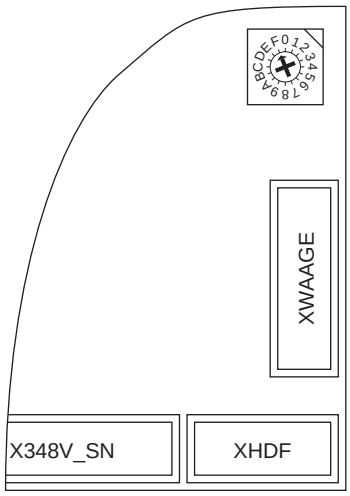
Adjust potentiometer P1 on LP 754 until LED D26 just turns off.
Count the number of revolutions the potentiometer is turned. Keep this number in your mind.



Turn back the potentiometer P1 on the LP 754 by half this number.
The LED D26 will illuminate again.

3.5 Calibrating the HDF blood pump

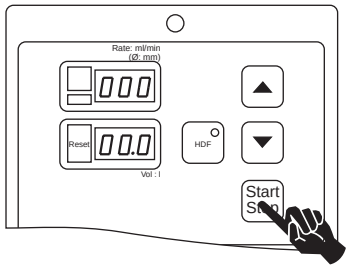
3.5.1 Pressure transducer



Switch the hemodialysis machine off.

Set HEX switch on the LP 754 to position **“F”.**

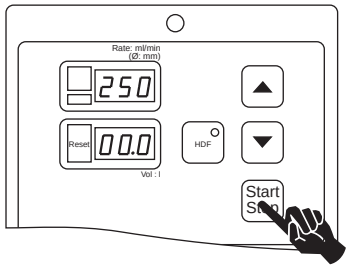
Switch the hemodialysis machine on.



Display **000**

Open SN pressure transducer to atmosphere.

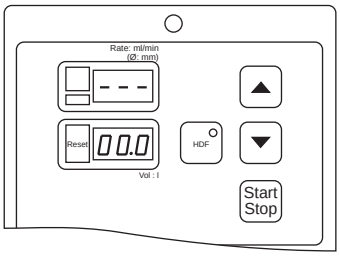
Press the **Start/Stop** key.



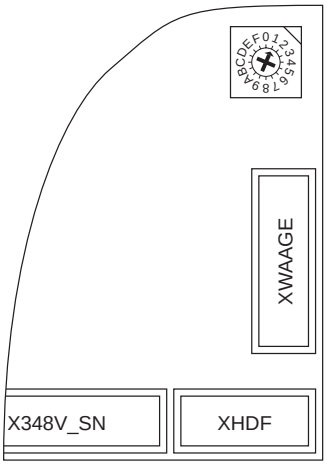
Display **250**

Apply a pressure of 250 mmHg to the SN pressure transducer.

Press the **Start/Stop** key.



Display – – –



Switch off hemodialysis machine.

Set HEX switch on the LP 754 to position **1.**

Balancing out has been completed.

3.5.2 Checking SN switchover points

Bottom switchover point: fixed at 75 mmHg (± 6 mmHg)

Top switchover points (± 6 mmHg):

Stroke volumes (ml)	10	15	20	25	30	35	40	45	50
Top switchover point	110	130	150	172	195	219	244	270	299

3.6 Repair instructions

Important:
If the substituate lift has to be dismounted for repair the seal is to be checked and if necessary renewed before fitting the lift again.
Drip water protection!

Table of contents
4 Circuit descriptions and circuit diagrams

Section		Page
	Fig.: Connection diagram 4008 HDF	4-3
	Fig.: Wiring diagram 4008 HDF	4-5
	Fig.: Block circuit diagram, mains voltage 4008 HDF	4-7
	Fig.: Block circuit diagram, low voltage 4008 HDF	4-7
4.1	**LP 625 display board**	4-9
4.1.1	Description	4-9
4.1.2	Circuit and component layout diagram	4-11
4.2	**LP 754 control board HDF**	4-15
4.2.1	Description	4-15
4.2.2	Circuit and component layout diagram	4-17
4.3	**LP 760 HDF motor control**	4-23
4.3.1	Description	4-23
4.3.2	Circuit and component layout diagram	4-25
4.4	**LP 761 HDF drive keyboard**	4-29
4.4.1	Description	4-29
4.4.2	Circuit and component layout diagram	4-31
4.5	**LP 762 scales comm**	4-35
4.5.1	Description	4-35
4.5.2	Circuit and component layout diagram	4-37
4.6	**LP 763 serial interface extender**	4-41
4.6.1	Description	4-41
4.6.2	Circuit and component layout diagram	4-43

Fig.: Connection diagram 4008 HDF

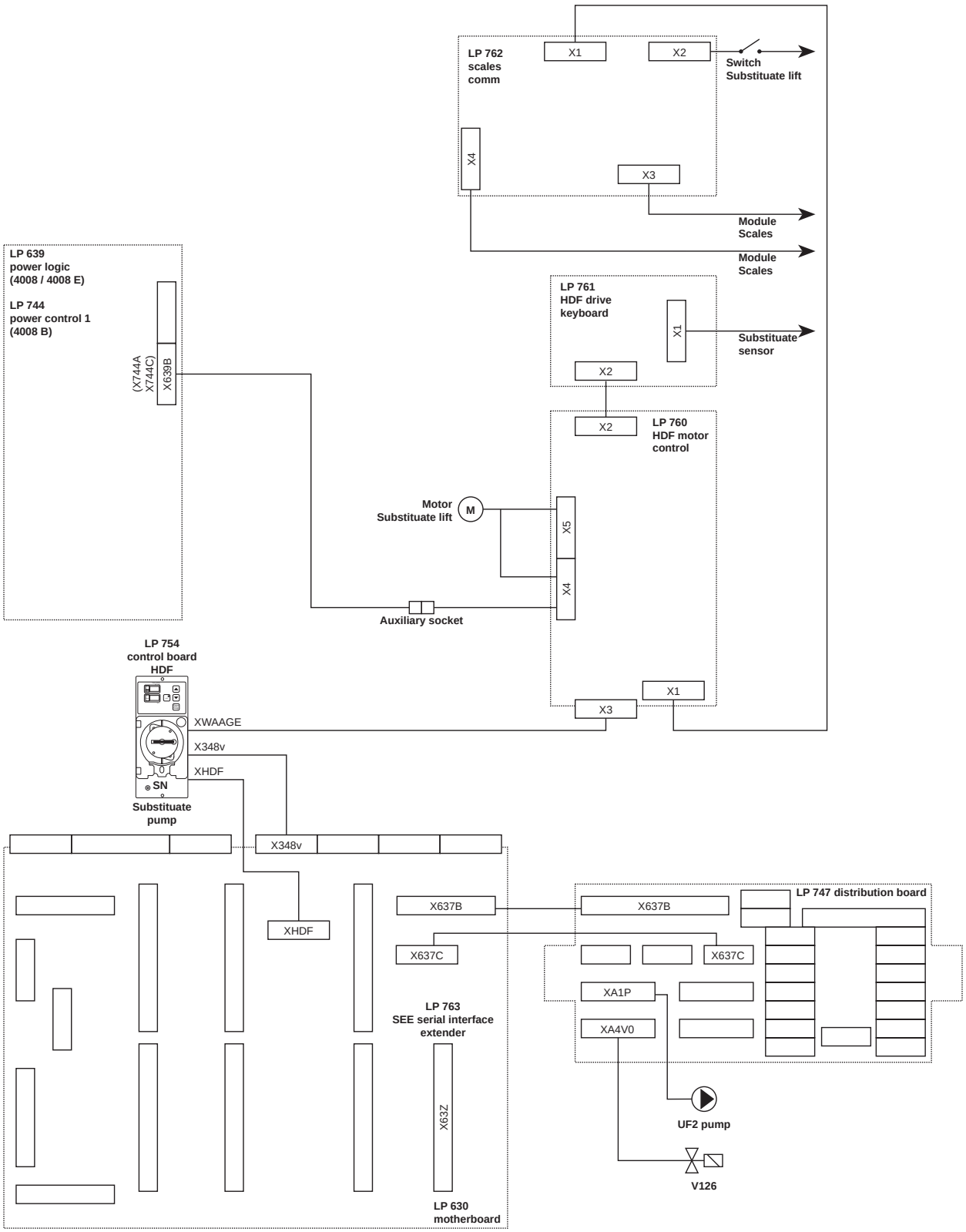


Fig.: Wiring diagram 4008 HDF

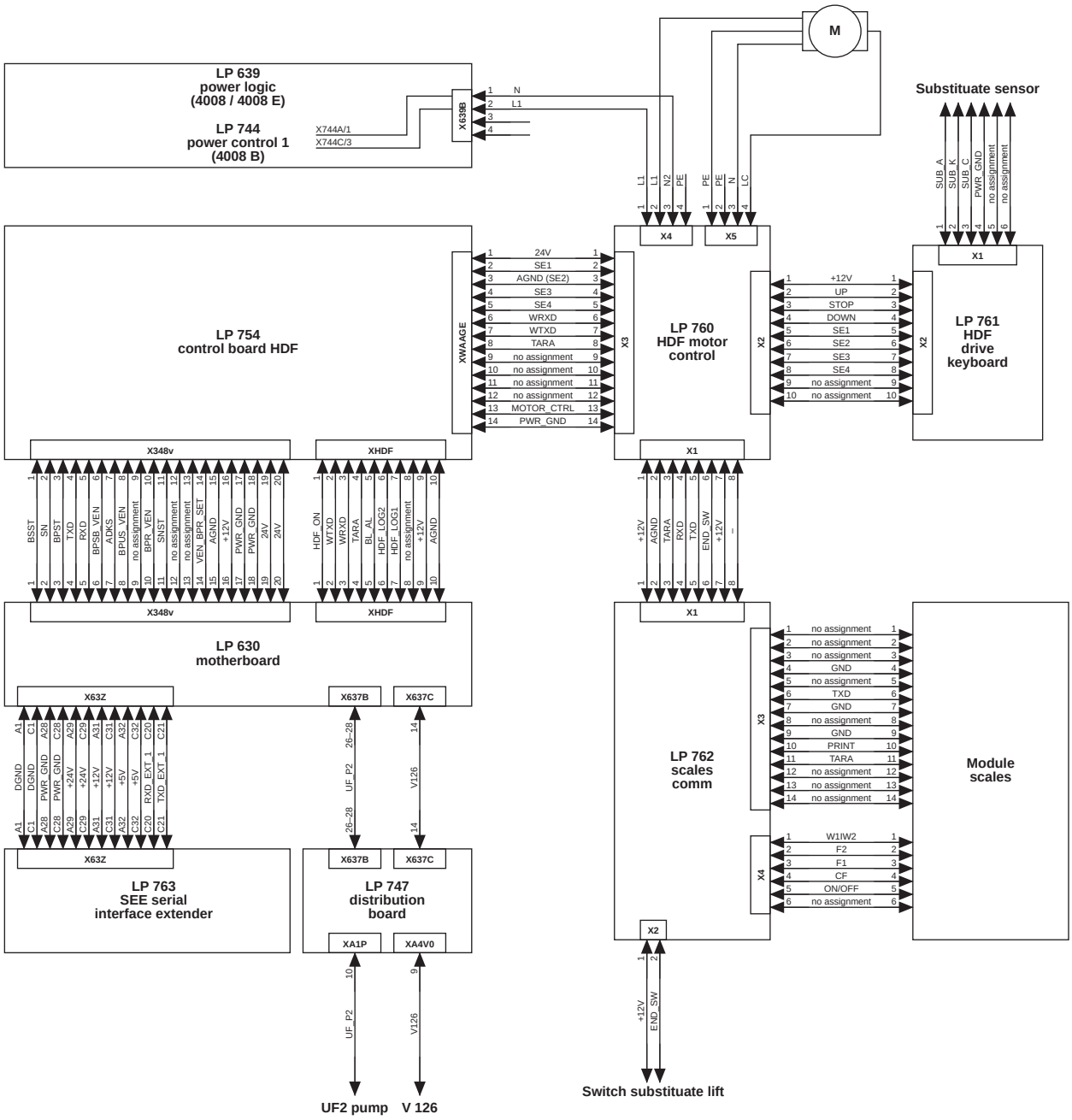


Fig.: Block circuit diagram, mains voltage 4008 HDF

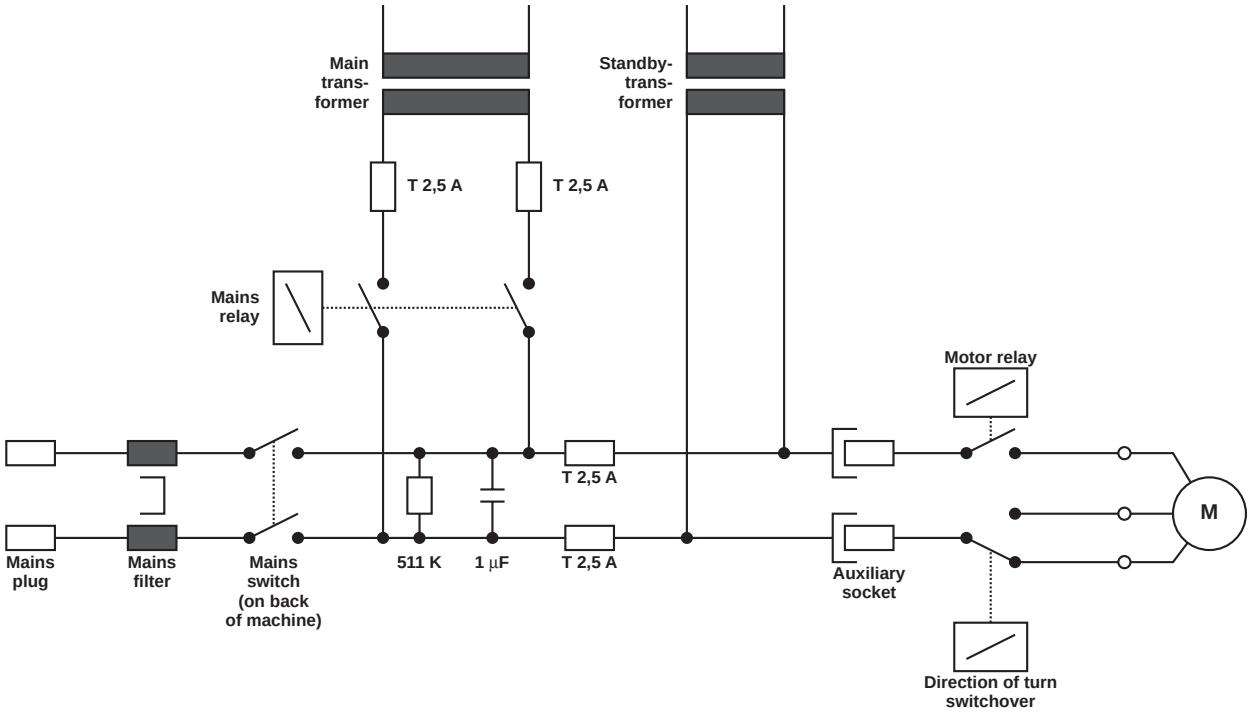
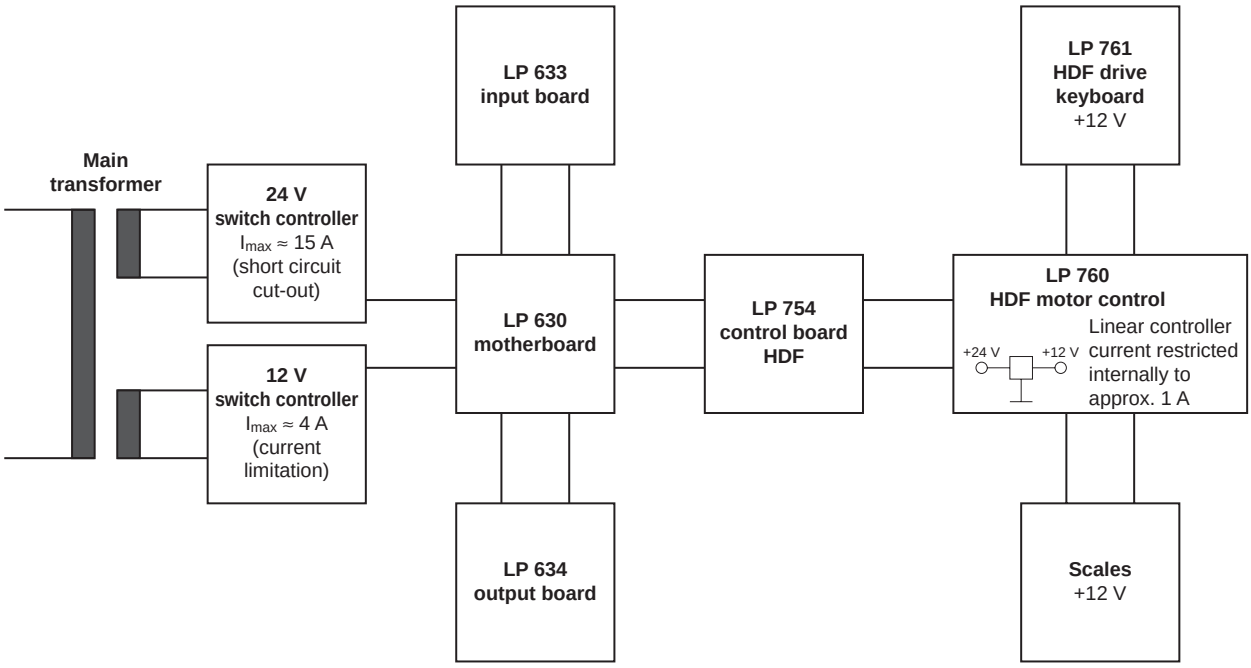


Fig.: Block circuit diagram, low voltage 4008 HDF



4.1 LP 625 display board

4.1.1 Description

- **General**

  The displays and the keyboard are on this P.C.B..

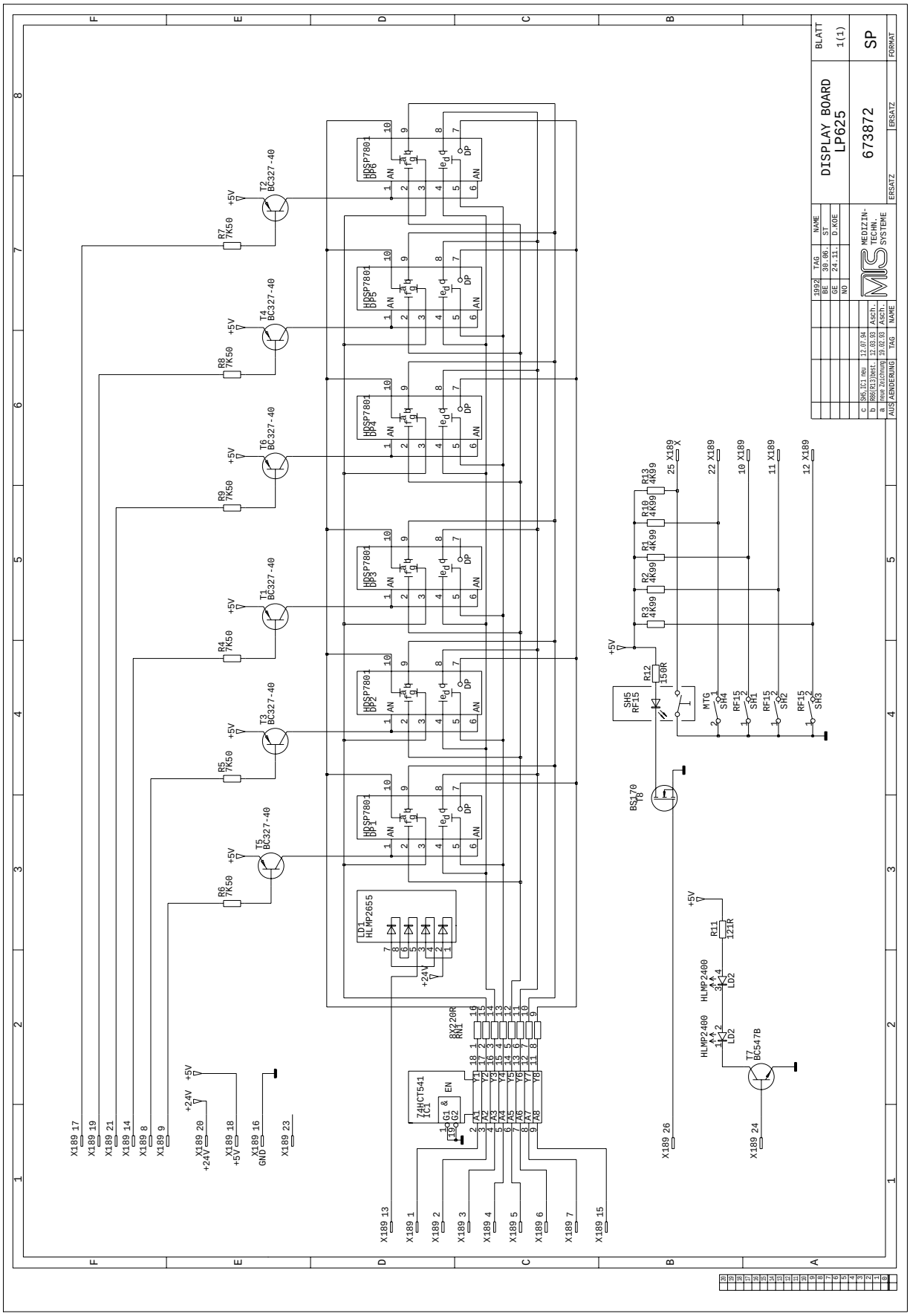
  Plug connections to LP 625:
  – X189, connection to LP 760

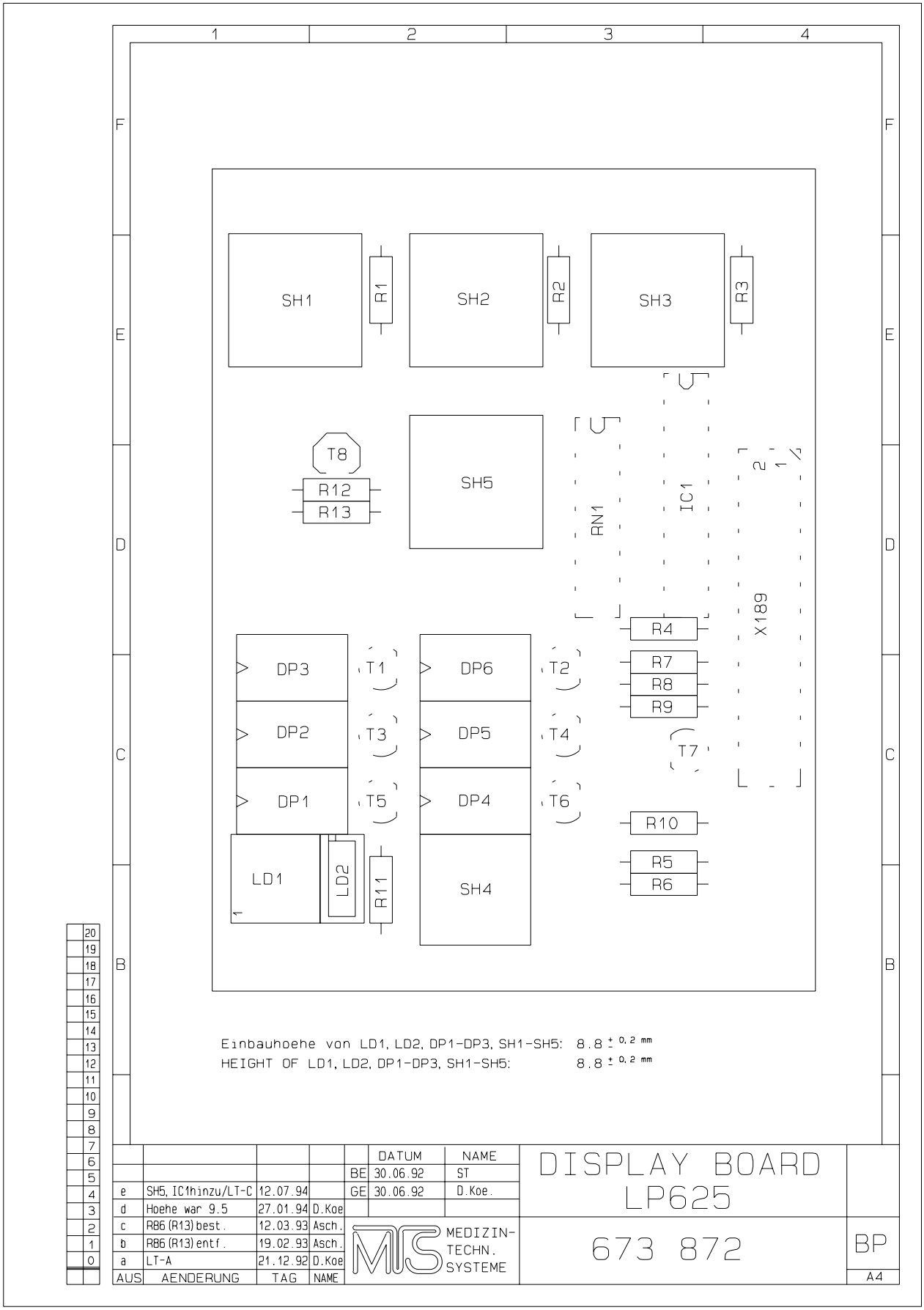
- **Display**

  All necessary information is given to the user through 6 multiplex 7-segment displays and 2 LEDs which are mounted on the socket.

- **Keyboard**

  The keyboard comprises 3 single non-illuminated keys and 1 key with integrated LED (HDF). The keys are soldered directly to the P.C.B..
  The user receives a acknowledgement through a spring contact when the keys are pressed.


DISPLAY BOARD
LP625
673872
SP
BLATT
1(1)
FORMAT
ERSATZ
MEDIZIN-
TECHN.
SYSTEME
NAME
TAG
ST
D.KOE
AUSG AENDERUNG
Asch.
Neue Zeichnung
R66(R13)best.
SW6.2C1 neu
+5V
+24V
GND
HDSP7801
BC327-40
HLMP2655
HLMP2400
74HCT541
BS170
BC547B
MTG
SH1
SH2
SH3
SH4
SH5
RF15
X189



AUS	AENDERUNG	TAG	NAME
e	SH5, IC1hinzu/LT-C	12.07.94	
d	Hoehe war 9.5	27.01.94	D.Koe
c	R86 (R13) best.	12.03.93	Asch.
b	R86 (R13) entf.	19.02.93	Asch.
a	LT-A	21.12.92	D.Koe

	DATUM	NAME
BE	30.06.92	ST
GE	30.06.92	D.Koe.

MEDIZIN-TECHN. SYSTEME

DISPLAY BOARD LP625

673 872

BP

A4

4.2 LP 754 control board HDF

4.2.1 Description

- **General**

  The control, section and power pack are on the this P.C.B..

  Plug connections to LP 754:
  – X186, connection to position sensor
  – X188, connection to stepper motor
  – X189, connection to LP 748
  – X190, connection to cover switch
  – X192, connection to pressure transducer
  – X348, connection to dialysis monitor

  Hexswitches on the LP 754:
  0 No function
  1 Single needle blood pump / 4008 HDF / ON LINE HDF
  2 – A No function
  B Blood pump stop alarm (15, 30 secs.)
  C No function
  D Call-up operating time meter (display x 100 = number of hours)
  E Test operation (only manufacturer)
  F Pressure transducer calibration

- **Voltage generation**

  The +24 V and +12 V voltage supply is made available to the blood pump by the monitor. The +5 V supply voltage is generated on the module by the switch controller IC 20 from the +24 V voltage to minimize loss of power.

- **Stepper motor control**

  The stepper motor is run in microstep operation to reduce noise. The resolution is 60 microsteps per step. The RISC processor transmits a 8-bit dataword alternately on the pins 3 and 5 of the DA converter from IC 7. Two sine form voltages are available on the output of the converter, phase offset by 90°. They are conducted to the stepper motor controller IC 2 together with the current direction signals. Together with the two SM drivers IC 1/IC 22 and the current sensor resistors R58/R59 as feedback these form a closed control circuit which determine two sine-shaped currents, phase offset by 90°, in the two coils.

- **Microprocessor**

  The cycle frequency of the microprocessor is determined by the quartz Q2 between the processor connections 39 and 40. Quartz oscillation is made possible by the capacitors C5 and C6.
  The keyboard signals and the signals BSST, BPST are read-in through the port P4.
  The IC 9 serves as intermediate memory for the addresses AO/A7.
  The ALE signal on pin 50 of the microprocessor is the control line of the data address latch.
  The signal from the revolution and direction of turn sensor (position sensor) in the pump bed is read-in through port T1.
  The operation data of the pump is saved in the NOVRAM IC 21 through ports 5.1 to 5.3 when the dialysis machine is switched off or there is a voltage failure. Undervoltage detection (power down) is through the comparitor IC 23.
  With the WR line the data takeover for the display is controlled in the external data latch IC 14.

- **PLL intermediate circuit**

  PLL component IC 4 together with the counter IC 19 causes the frequency coming from the processor to control the stepper motor to be multiplied otherwise the processor would be too slow to generate this frequency.

- **RISC processor**

  The RISC processor IC 5 is supplied with a cycle signal from the processor. With each cycle an 8-bit data word is read from a look up table by the processor alternately for each phase of the stepper motor, respectively. Included in this data word is both the current direction as well as the current desired value.
  A watchdog for the CPU is also incorporated in the RISC processor. When a cycle is missing on pin 8/IC 5 the RISC processor triggers a reset by the CPU through pin 7.

- **Display control**

  The data word for controlling the display is stored in IC 14. The multiplex operation of the individual digits is made possible through the decoder IC 18.

- **Speed and flow**

  The speed is transmitted by the processor through port P 1.1 and the flow through port P 1.2 to the dialysis monitor.

- **Pressure measurement**

  The differential measurement amplifier for the pressure transducer is formed by the IC 6 (1/2/3) and IC 6 (5/6/7). The measuring signal is read-in by the processor through the AD converter input AN 7 and calibrated for zero and steepness by the software. Afterwards the measuring signal is modulated to pulse width through port P1.3 and transmitted through a subsequent DA converter IC 11 (5/6/7) to the monitor.

LP 754

Circuit diagram 1/2

LP 754

Circuit diagram 2/2

LP 754

Component layout diagram

4.3 LP 760 HDF motor control

4.3.1 Description

- **General**

The LP 760 serves to control the lift drive.
Lift operation presupposes that the scales are swung away. This is recognized by a limit switch. The scales can be moved upwards or downwards by pressing the ▲ or ▼ keys. The drive is switched off automatically, likewise by limit switches, when reaching the uppermost or bottom-most position. When the scales are being travelled upwards or downwards they can be stopped at any time with the **Stop** key.
The motor for the lift drive is safeguarded against overloading by means of an integrated thermoswitch. If this protection facility responds the lift will come to a standstill. The lift can be used again after the motor has cooled down.

- **Circuit structure**

Supply voltage
The control circuit is supplied with +12 V. This voltage is generated from the +24 V voltage of the hemodialysis machine by the linear controller T1 in conjunction with the capacitors C4, C5 and C6.

Motor control
Two types of circuit are implemented to control the motor:
a) continuous operation (R21 with components, R22 without components
b) inching operation for downwards movement (R21 without components, R22 with components).

To Point a):
One D flip-flop is available for each direction of movement (IC 3). The flip-flops are set by a high level on X2/2 (key ▲) or X2/4 (key ▼). The flip-flop for the respective other direction of movement is reset at the same time by pressing the appropriate key. The two flip-flops are reset through high level on X2/3 (**Stop** key). This also takes place should the head of the scales be swung over the machine (high level on X1/6).

To Point b):
There is only one flip-flop available for the upwards movement (IC 3/pin 1/2). The flip-flop for the downward movement is set through IC 5. The control logic for the downward operation is not influenced by this (see Point a). However, the drive is only active as long as the key ▼ is pressed.

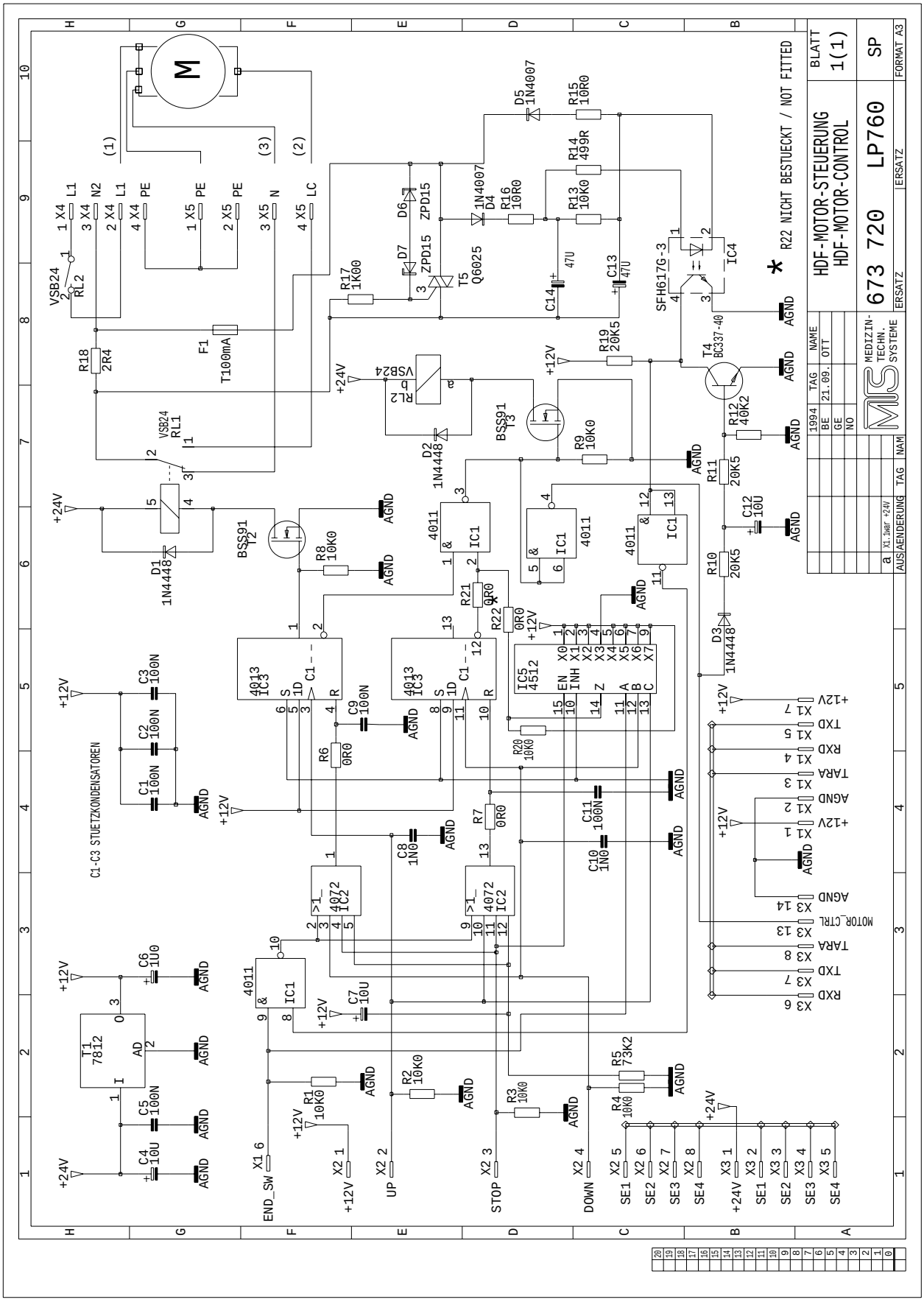
The IC 5 works as an 8 to 1 multiplexer. The address (0 to 7) of the input to be interconnected is provided through the pins 11 to 13. Only the address 3 leads to a low level on output IC 5/14 and, as a result, to the motor starting. R 20 serves as a pull-up resistor. A defined output level is obtained with the IC 5/14 in high ohmic state, caused by pressing the **Stop** key (high level on IC 5/15).

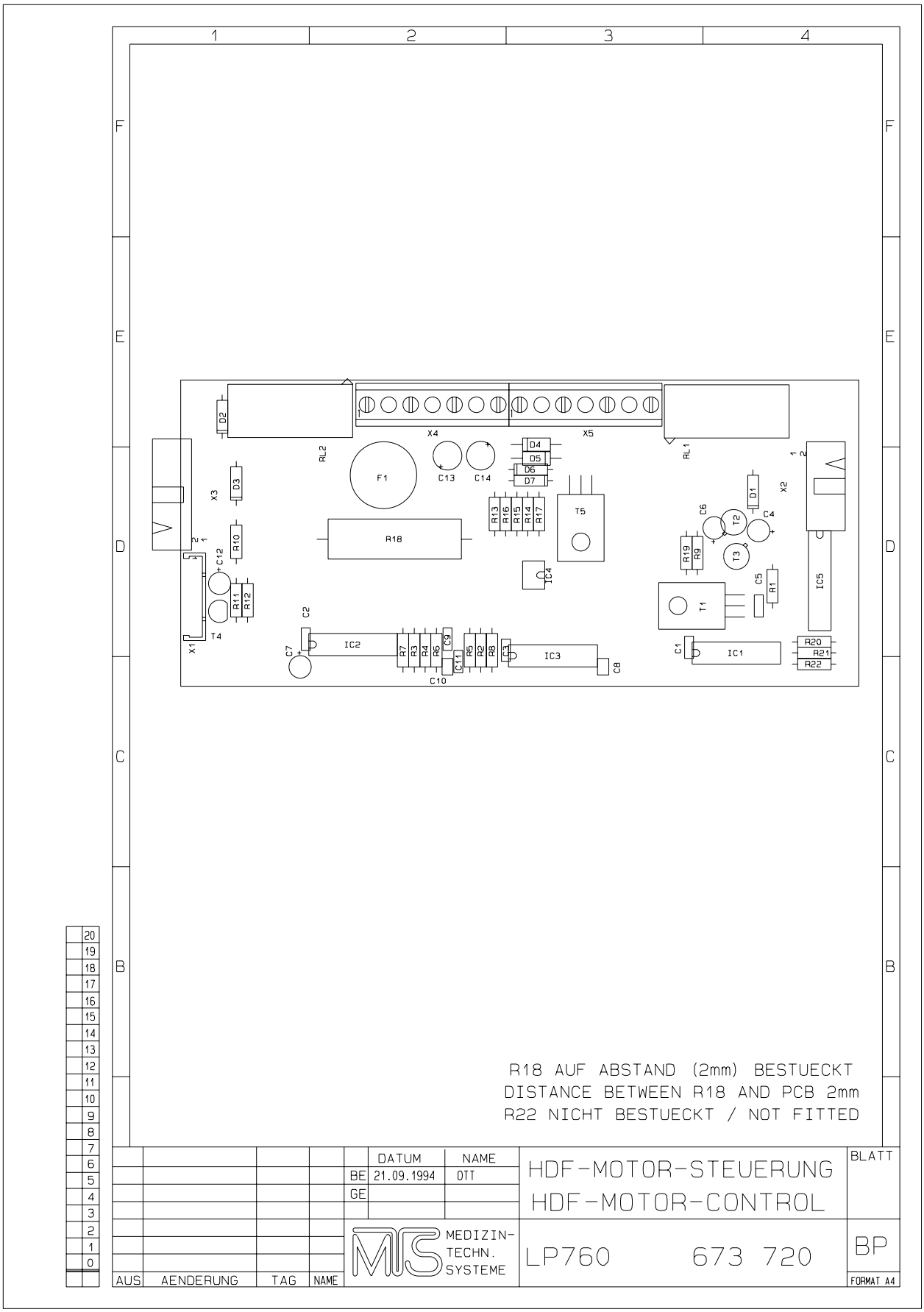
- **Other circuit sections**

  The motor feed lines are circuited through the relay RL 1 and RL 2. The position of RL 1 determines the travel direction of the lift. The motor is switched on and off through RL 2. Both relays are controlled by the transistors T 2 (RL 1) and T 3 (RL 2). T 2 is controlled directly from the non-inverted output IC 3/1. The output signals of both flip-flops, IC 3/2 and IC 3/12 (inverted) are used to control T 3 and are linked with each other through IC 1/1 and IC 1/2. In the case of low level on one of the two flip-flop outputs IC 3/2 or IC 3/13 (i.e. the respective flip-flop has been set) the IC 1/pin 3 links up high level and T 3 switches RL 2.

- **Motor current recognition**

  The motor current is monitored while the lift is operating. The internal thermal-protective switch responds in the case of the motor becoming overheated. Both flip-flops (IC 3) are reset by motor current recognition so that the motor does not start up again automatically after the drive has cooled down. The voltage drop is evaluated through the high load resistor R 18 for motor current recognition. The generated alternate voltage caused by the current flow through R 18 is connected to the capacitor C 14 and C 13 through the diodes D 4 and D 5. The resulting direct voltage through R 13 is approx. double so high as the peak value of a half wave of the alternate voltage on R 18 less the on state voltages of D 4 and D 5. The direct voltage controls the optocoupler IC 4 through R 14. R 13 serves to completely discharge C 13 and C 14 when the motor is switched off.
  IC 4 ensures protective isolation of the control circuit from the mains voltage conducting components of the current recognition system.
  The output of the optocoupler is circuited with the pull-up resistor R 19 against 12 V. High level on the collector of IC 4 resets both flip-flops through IC 1/pin 12 and 13 and IC 1/8. This would lead to continuous blocking of the control circuit unless further measures were taken. This is why the output of IC 4 is connected up parallel to a further transistor T 4. In switched off state the capacitor C 12 is charged through high level on IC 1/4 through D 3 and R 10. This makes the transistor T 4 conductive. After setting one of the flip-flops (IC 3) the IC 1/4 goes to low. C 12 discharges itself through R 11, R 12 and the B-E path from T 4. T 4 blocks after approx. 500 ms. The output transistor must be linked by IC 4 before this time has elapsed otherwise both flip-flops will be reset again.


HDF-MOTOR-STEUERUNG
HDF-MOTOR-CONTROL
673 720 LP760
BLATT 1(1)
FORMAT A3
ERSATZ
MEDIZIN-TECHN. SYSTEME
R22 NICHT BESTUECKT / NOT FITTED
C1-C3 STUETZKONDENSATOREN
+12V
+24V
AGND
END_Sw
UP
STOP
DOWN
SE1
SE2
SE3
SE4
TXD
RXD
TARA
MOTOR_CTRL

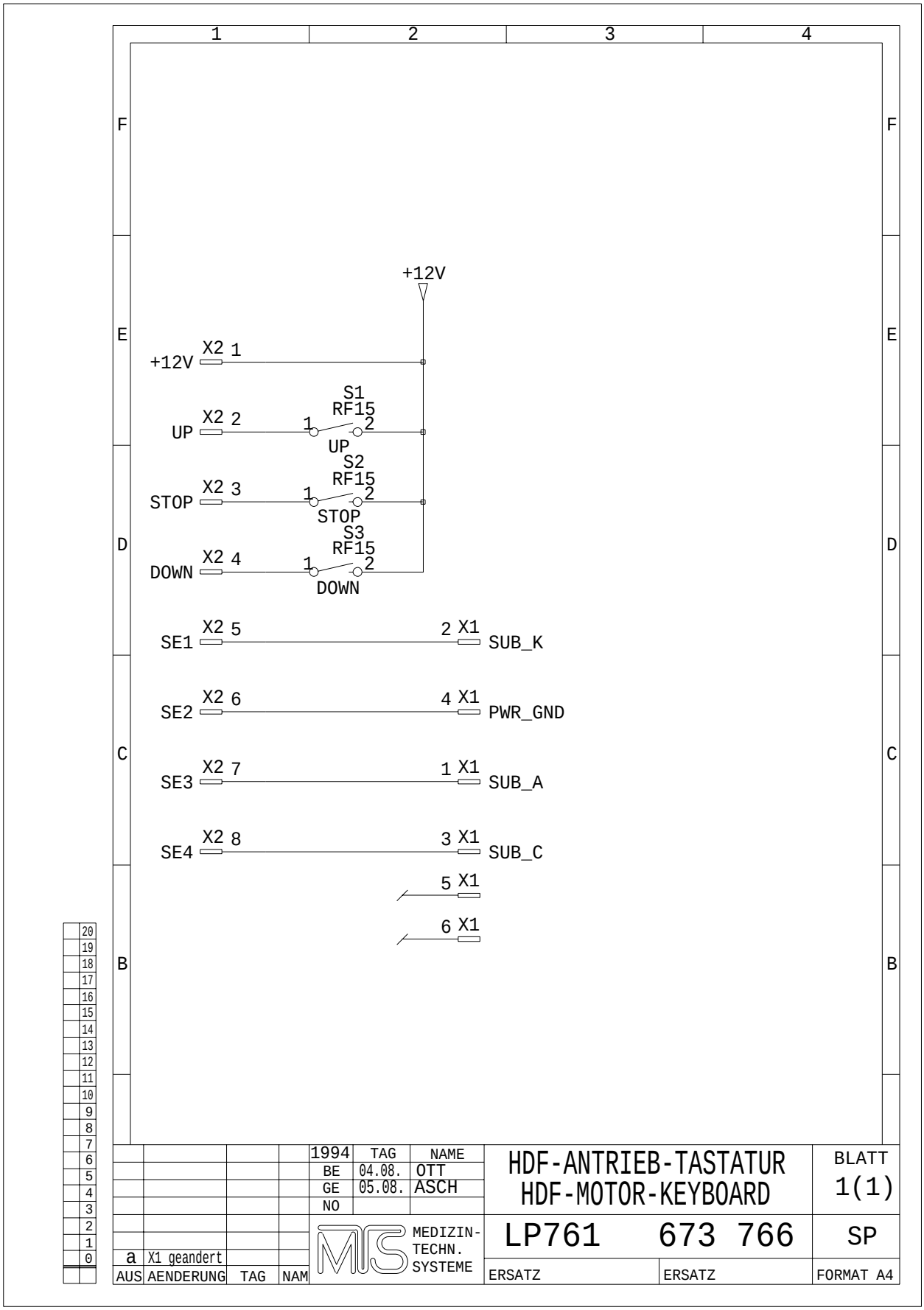

1
2
3
4
F
E
D
C
B
X4
X5
RL2
RL1
F1
C13
C14
D2
D3
D4
D5
D6
D7
X3
X2
R10
R18
R13
R16
R15
R14
R17
T5
T2
T3
C6
C4
D1
R19
R9
C12
R11
R12
T4
X1
C2
C7
IC2
R7
R3
R4
R6
C9
C11
C10
R5
R2
R8
IC3
C8
C1
IC1
T1
C5
R1
IC5
R20
R21
R22
R18 AUF ABSTAND (2mm) BESTUECKT
DISTANCE BETWEEN R18 AND PCB 2mm
R22 NICHT BESTUECKT / NOT FITTED
DATUM
NAME
BE 21.09.1994 OTT
GE
HDF-MOTOR-STEUERUNG
HDF-MOTOR-CONTROL
BLATT
MEDIZIN-
TECHN.
SYSTEME
LP760 673 720
BP
AUS
AENDERUNG
TAG
NAME
FORMAT A4

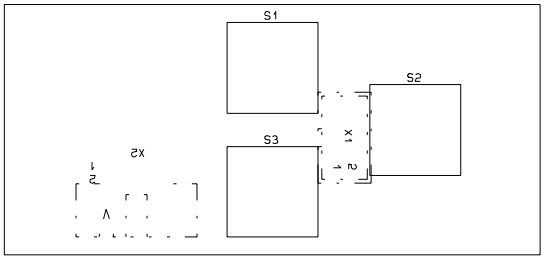
4.4 LP 761 HDF drive keyboard

4.4.1 Description

- **General**

  The keys for controlling the substituate lift are found on this P.C.B..


1
2
3
4
F
E
D
C
B
+12V
X2 1
+12V
S1
RF15
X2 2
UP
1
2
UP
S2
RF15
X2 3
STOP
1
2
STOP
S3
RF15
X2 4
DOWN
1
2
DOWN
X2 5
SE1
2 X1
SUB_K
X2 6
SE2
4 X1
PWR_GND
X2 7
SE3
1 X1
SUB_A
X2 8
SE4
3 X1
SUB_C
5 X1
6 X1
1994 TAG NAME
BE 04.08. OTT
GE 05.08. ASCH
NO
HDF-ANTRIEB-TASTATUR
HDF-MOTOR-KEYBOARD
BLATT
1(1)
MEDIZIN-
TECHN.
SYSTEME
LP761 673 766
SP
a X1 geandert
AUS AENDERUNG TAG NAM
ERSATZ
ERSATZ
FORMAT A4



AUS	AENDERUNG	TAG	NAME
a	X1 geandert		

	DATUM	NAME
BE	04.08.1994	OTT
GE	05.08.1994	ASCH

MEDIZIN-TECHN. SYSTEME

HDF-ANTRIEB-TASTATUR
HDF-MOTOR-KEYBOARD

LP761 673 766

BLATT BP

FORMAT A4

4.5 LP 762 scales comm

4.5.1 Description

The LP 762 serves as interface between the dialysis machine and the scales.

The serial transmission from the dialysis machine arrives on the plug X1 pin 4 (RXD) and is converted at the interface IC 1 (max. 232) to 5 V level. IC 2 makes a serial parallel conversion and passes the signal on to the scales. The scales are switched on or off, respectively, by the transistor T1.

The serial carry forward (weight) comes from the scales to the plug X3 pin 6 (TXD) and is converted by IC 1 from 5 V to RS 232 level. The signal arrives at the dialysis machine through plug X1 pin 5 (TXD).

SP1 (ML78L05) converts the 12 V into 5 V which serves as the supply voltage for LP 762.

LP 762

Component layout diagram

4.6 LP 763 SSE serial interface extender

4.6.1 Description

- **General**

The LP 763 is necessary for serial communication of the monitor with the scales and the HDF pump module.

- **Circuit structure**

The circuit of the LP 763 comprises two circuit units independent of each other.

Serial interfaces
Heart of the LP 763 P.C.B. is an 8-fold UART (universal asynchronous receiver/transmitter), i.e. an interface IC (IC 1) with eight independent serial channels. Also to be found on the P.C.B. are two TTL/RS232 level converters (IC 2 and IC 3) and an interrupt logic IC (IC 4), as well as diverse resistors, capacitors and an oscillation quartz Q1 for generating the working cycle for IC 1.

COMMCO connection
The slot 63Z used by the LP 763 P.C.B. is also provided for the installation of P.C.B. LP 752. The LP 752 takes over the connection of the 4008 monitor signals to the COMMCO P.C.B. LP 729. In order to be able to also continue the linking to COMMCO/FINESSE in 4008 HDF machines the circuit section of the LP 752 P.C.B. is taken over in the LP 763 P.C.B..

- **Function**

After switching on the machine the UART is initialled with the transmission parameters.

Transmission parameter channel A:
1200 Baud, 8 databits, 1 stopbit, no paritibit

Transmission parameter channel B:
9600 Baud, 8 databits, 1 stopbit, no paritibit

Channel A is responsible for communication with the scales, channel B for communication with the HDF pump module.

After going through the watchdog test the scales are switched on through the transmission line from channel A and the weight requirements of the 4008 monitor are communicated to the scales. The weight value of the scales is read by the 4008 monitor on the reception line.

Commands and data from the 4008 monitor are sent through the transmission line from channel B to the HDF pump modules. Data which comes from the HDF pump module is received by the 4008 monitor through the receiving line.

The remaining six communication channels are not used in 4008 operation.

If UART data is ready for collecting or if the transmission buffer is ready to accept new digits during a transmission the component causes an interrupt at CPU 1. CPU 1 processes this interrupt demand (in so far as nothing more important is to be done) and reads a digit from the reception buffer or writes a digit on the transmission buffer.

LP 763

Circuit diagram 1/2

LP 763

Circuit diagram 2/2

LP 763

Component layout diagram

Table of contents
5 Spare parts

Section		Page
5.0	**How to use the spare parts catalog**	5-3
5.1	**P.C.B.s**	5-4
5.2	**Scales**	5-6
5.3	**Substituate lift**	5-8
5.4	**UF2 pump / blood pump (HDF) / valve V126**	5-10

5.0 How to use the spare parts catalog

Objective:

Spare parts can be defined and ordered.

Organization:

This spare parts catalogue contains 4 assemblies.
5.1 P.C.B.
5.2 Scales
5.3 Substituate Lift
5.4 UF2 pump / blood pump (HDF) / valve V126

Each assembly has its assembly number. 5.X.0 refers to the basic version.
Major changes (modifications) within an assembly can be identified by an increasing decimal (e.g. 5.X.1, 5.X.2, …)

In the spare part lists it is refered to:
Built-in
From Equipment Code
To Equipment Code

Update service:

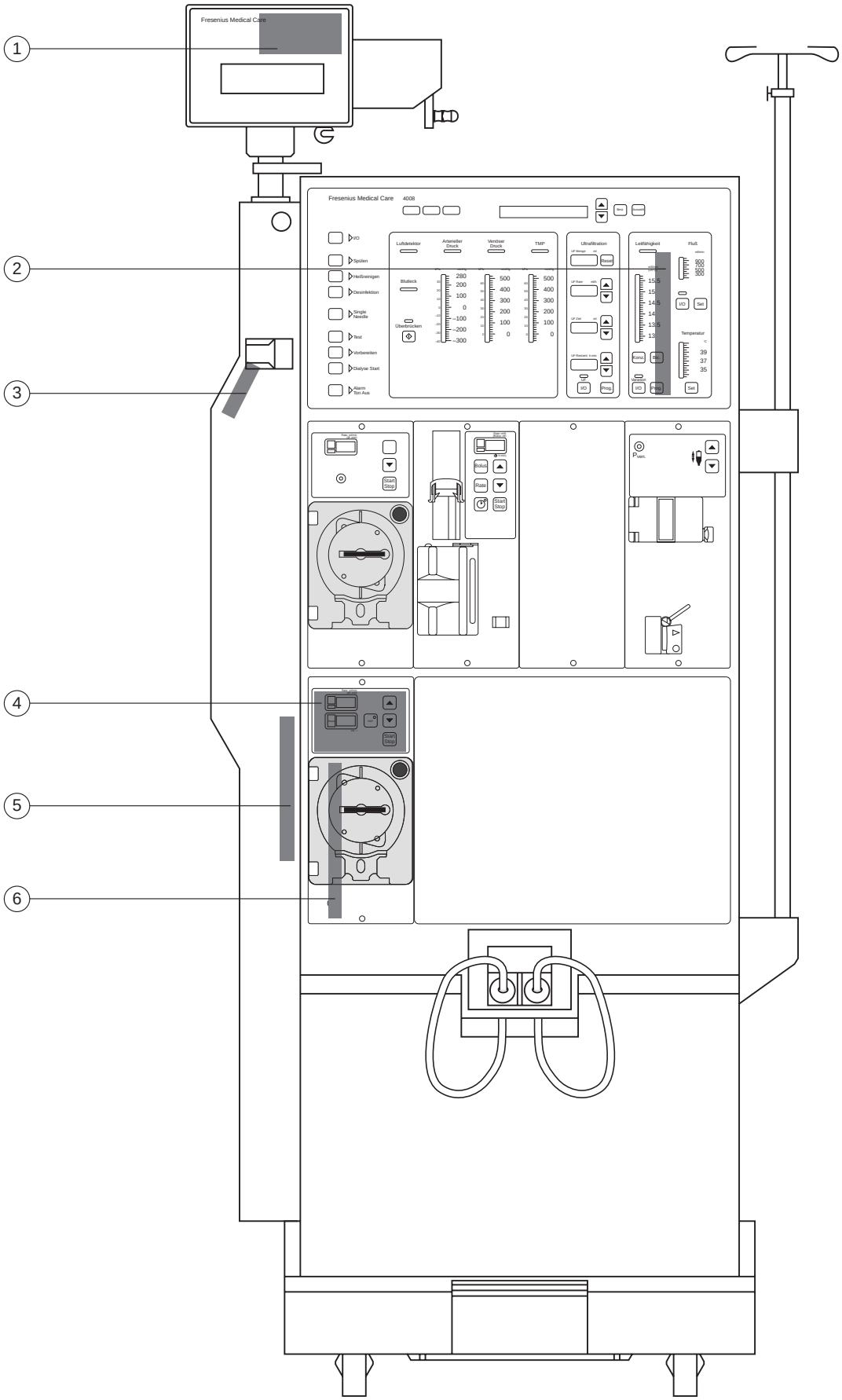
Updates to this spare parts catalog will be released as:
– Replacement pages
– Supplementary pages
– Technical information

Generally we reserve the right to make changes.

Requirements for correct spare part orders:

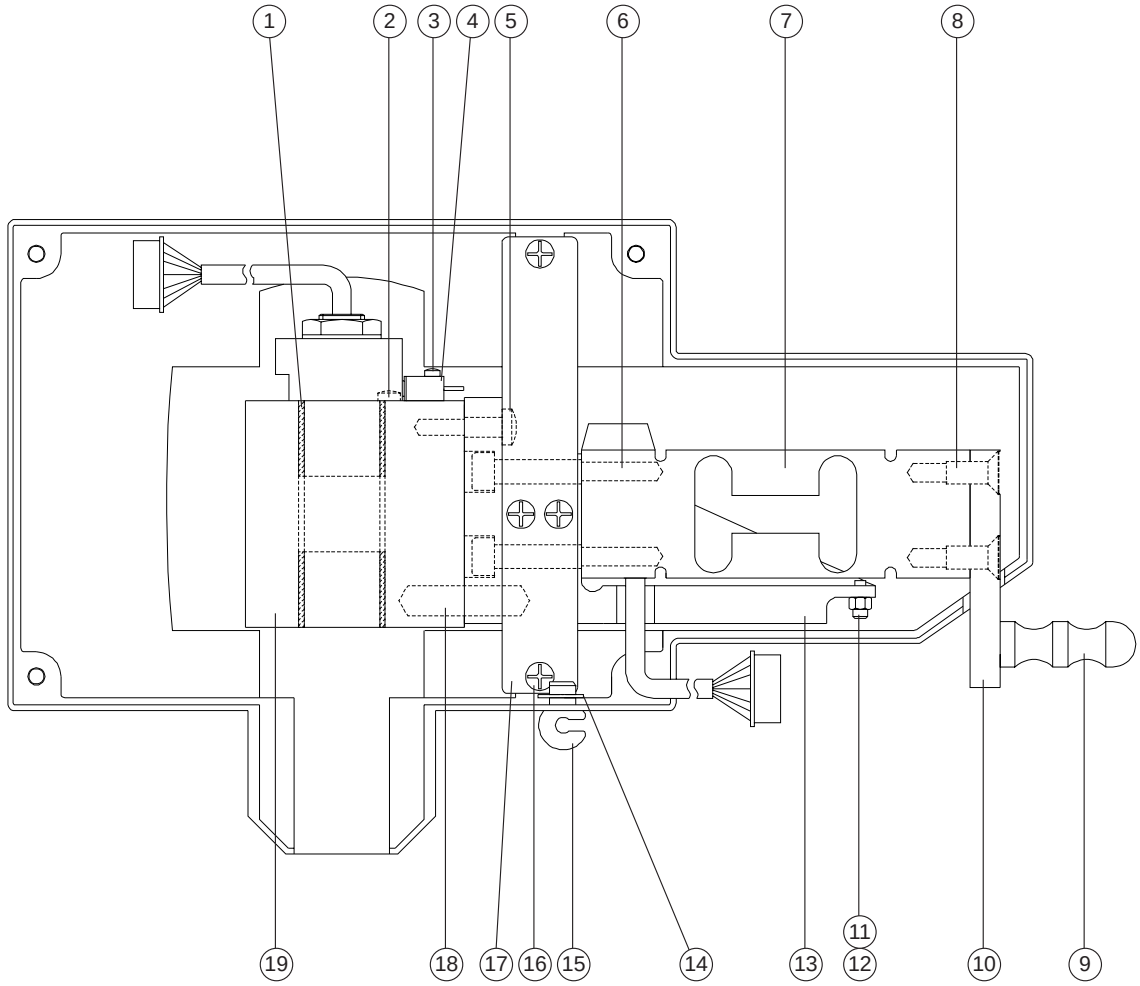
The equipment code must be entered in the machine record.
All modifications must be entered in the machine record. Update the equipment code, if necessary, to ensure that the correct spare parts will be ordered.

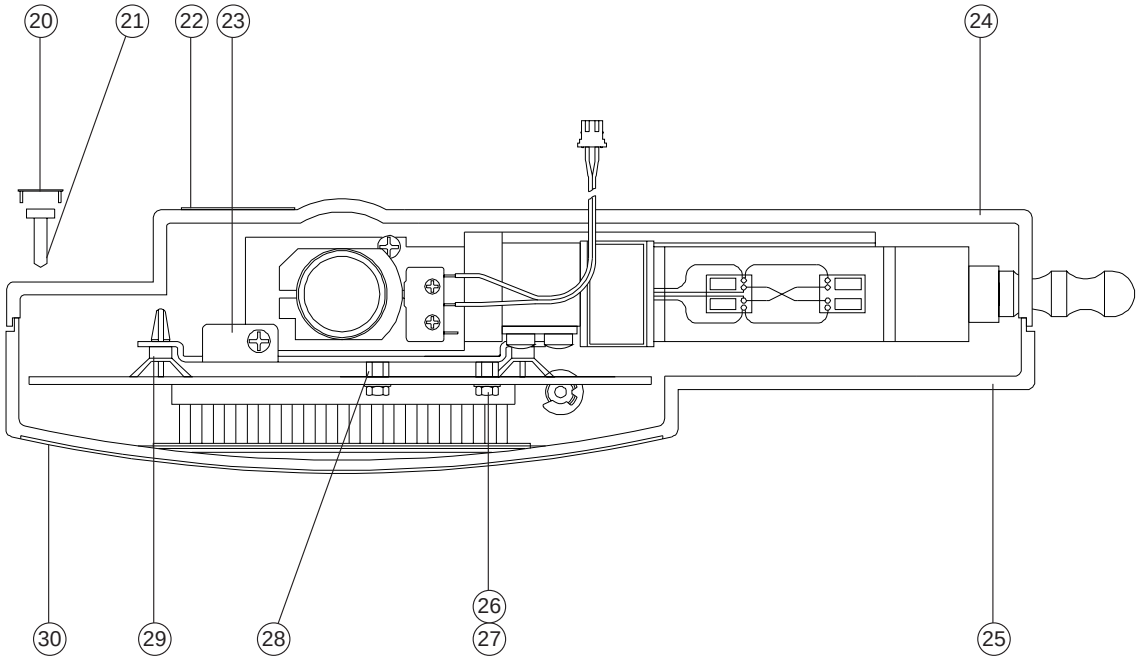
5.1 P.C.B.s


1
2
3
4
5
6
Fresenius Medical Care
Fresenius Medical Care 4008

		Built-in From/until Equipment Code	**000 – 000**
Item	**Part number**	**Description**	
1	673 790 1	P.C.B. LP 762 scales comm	
2	674 182 1	P.C.B. LP 763 SEE serial interface extender	
3	673 766 1	P.C.B. LP 761 HDF drive keyboard	
4	673 872 1	P.C.B. LP 625 display board	
5	673 720 1	P.C.B. LP 760 HDF motor control	
6	673 041 1	P.C.B. LP 754 control board HDF	

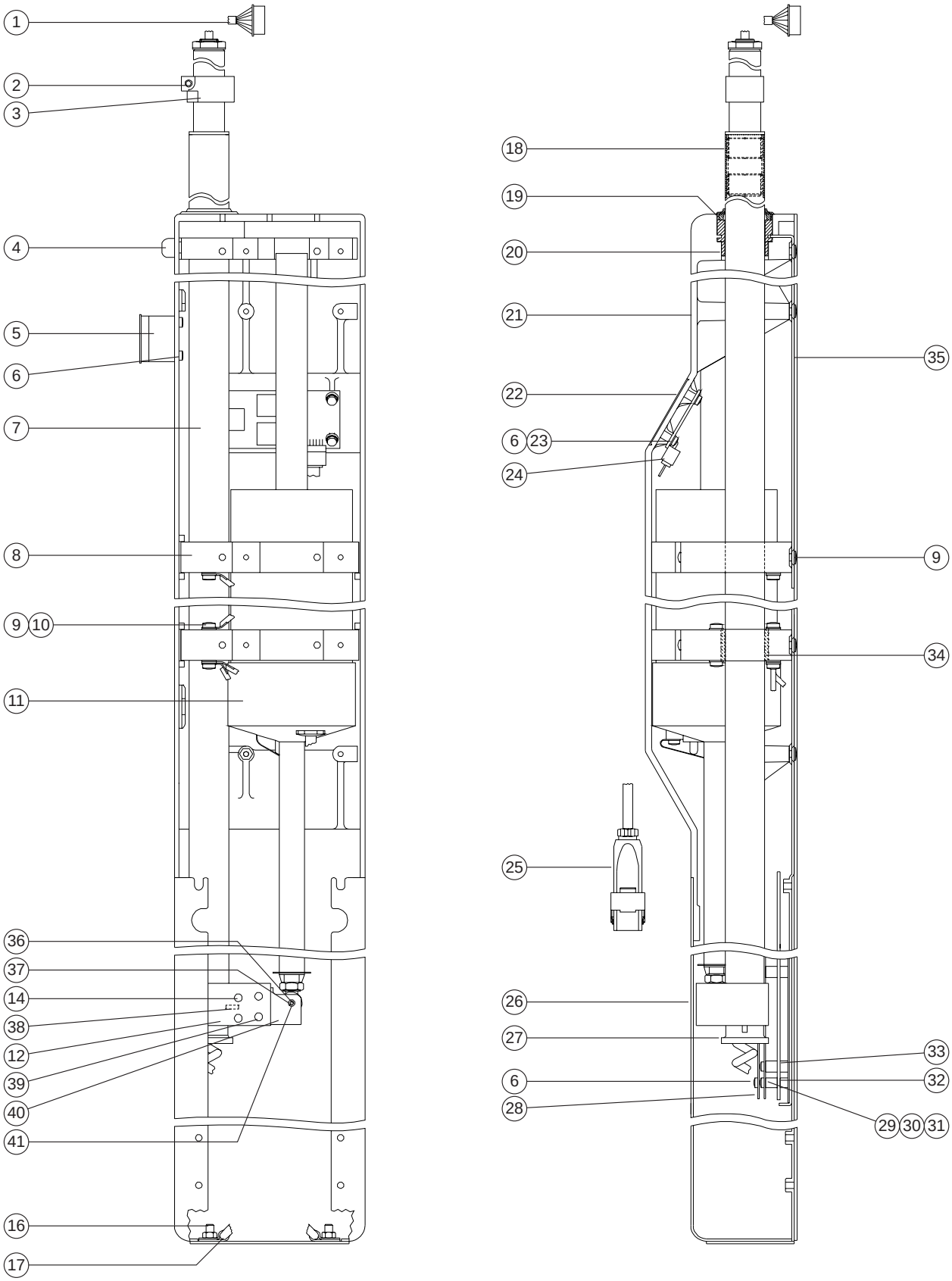
5.2 Scales


1
2
3
4
5
6
7
8
19
18
17
16
15
14
13
11
12
10
9


20
21
22
23
24
30
29
28
26
27
25

		Built-in From/until Equipment Code	000 – 000
Item	**Part number**	**Description**	
1	673 983 1	Sliding bush	
2	552 244 1	Screw	
3	646 352 1	Screw	
4	674 409 1	Microswitch	
5	552 312 1	Screw	
6	553 330 1	Screw	
7	673 635 1	System unit, scales	
8	643 161 1	Screw	
9	673 988 1	Hook	
10	673 987 1	Latch	
11	642 861 1	Screw	
12	553 621 1	Nut	
13	673 986 1	Adapter	
14	563 151 1	Retaining washer	
15	674 106 1	Line holder	
16	552 275 1	Screw	
17	673 971 1	Fastening plate	
18	642 693 1	Screw	
19	673 985 1	Bearing	
20	672 530 1	Cover	
21	552 276 1	Screw	
22	674 551 1	Caution label: Stability limit	
23	673 977 1	Display plate	
24	673 922 1	Back shell	
25	673 921 1	Front shell	
26	553 620 1	Nut	
27	559 690 1	Washer	
28	642 648 1	Spacer sleeve	
29	640 143 1	Spacer	
30	673 923 1	Front foil display	
	674 068 1	Scales, complete	

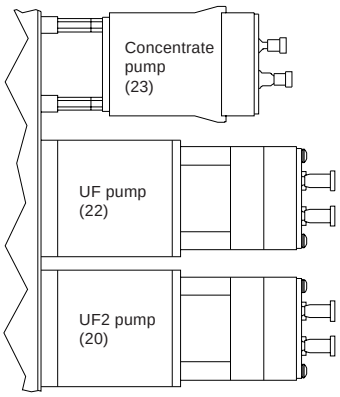
5.3 Substituate lift



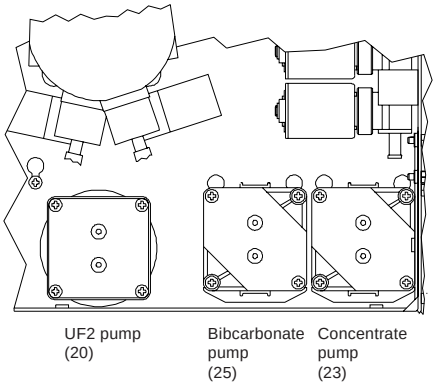
		Built-in From/until Equipment Code	**000 – 000**
Item	**Part number**	**Description**	
1	674 399 1	Connection cable	
2	644 205 1	Screw	
3	673 990 1	Locking ring	
4	674 106 1	Line holder	
5	653 099 1	Sensor	
6	552 244 1	Screw	
7	674 334 1	Pipe	
8	673 975 1	Clamping plate	
9	552 275 1	Screw	
10	553 733 1	Toothed washer	
11	674 395 1	Drive	
12	673 973 1	Dog	
14	673 755 1	Screw	
16	553 621 1	Nut	
17	537 203 1	Fastening clip	
18	646 274 1	Tolerance sleeve	
19	674 078 1	Stripper	
20	673 974 1	Collar bush	
21	673 920 1	Housing, lift	
22	673 639 1	Front foil, lift	
23	559 690 1	Washer	
24	674 400 1	Connection cable	
25	674 358 1	Connection cable	
26	673 918 1	Base plate	
27	673 972 1	Funnel	
28	674 255 1	P.C.B. cover	
29	646 606 1	Spacer bolt (M 3 x 8.5)	
30	650 439 1	Spacer bolt (M 3 x 12.5)	
31	559 690 1	Washer	
32	574 617 1	Spacer sleeve	
33	644 040 1	Spacer bolt (M 3 x 13)	
34	673 982 1	Bush	
35	674 487 1	Sealing tape	
36	675 052 1	Split pin	
37	553 694 1	Washer	
38	674 333 1	Locating pin	
39	552 312 1	Screw M5x16	
40	675 222 1	Fork	
41	675 051 1	Bolt with head	
	673 915 1	Substituate lift, complete	

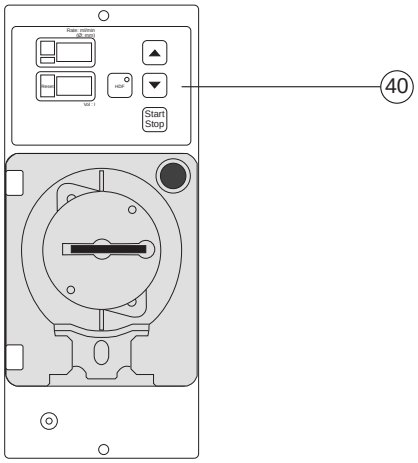
5.4 UF2 pump / blood pump (HDF) / valve V126

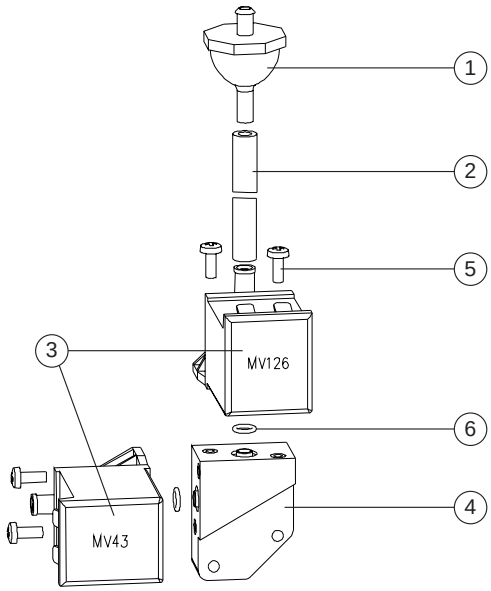
Hydraulic section 4008 / 4008 E



Hydraulic section 4008 B







		Built-in From/until Equipment Code	000 – 000
Item	**Part number**	**Description**	
		UF2 pump	
		The UF2 pump is identical with the ultrafiltration pump (see appropriate Spare Parts Catalogue 4008)	
	670 706 1	Ultrafiltration pump, complete	
		Blood pump (HDF)	
		The blood pump (HDF) is similar to the blood pump (single needle) (see appropriate Spare Parts Catalogue 4008)	
40	671 726 1	Front foil	
	673 924 1	Blood pump module HDF, complete	
		Valve V126	
1	645 881 1	Filter	
2	545 361 1	Silicon tube (0.12 m)	
3	674 349 1	Solenoid valve MV 126 / solenoid valve MV43	
4	674 347 1	Valve block	
5	552 275 1	Screw	
6	579 072 1	O-ring	
	674 941 1	Valve block, complete	