Technical Manual Ionometer 2

This Technical Manual has been updated to

1/01.00 = 1st edition January 2000

To save costs, only pages which have been corrected will be replaced.
Refer to the table below to verify that the Operating Instructions are up-to-date.

Page(s)	**Current version**
0-1 – 0-8	1/04.97
1-1 – 1-17	1/04.97
1-18	1/01.00
2-1 – 2-7	1/04.97
2-8 – 2-9	1/01.00
2-10 – 2-14	1/04.97
2-15 – 2-16	1/01.00
2-17 – 2-19	1/04.97
2-20 – 2-22	1/01.00
2-23 – 2-31	1/04.97
2-32 – 2-38	1/01.00
2-37 – 2-46	1/04.97
3-1 – 3-6	1/04.97
3-7	1/01.00
3-8 – 3-26	1/04.97
3-27	1/09.99
3-28 – 3-30	1/04.97
3-31	1/01.00
3-32	1/04.97

Technical Manual Ionometer™ 2

The Technical Manual provides basic information required for maintenance and repair.

Assembly, extenstions, modifications and repair may only be performed by the manufacturer or persons authorized by him.

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Local Service:

HOW TO USE THE TECHNICAL MANUAL

What?	Where?
Abbreviations	Page 0-5
Table of Contents	Page 0-7

Purpose

This manual is intended for:

– first studies(to acquire a basic knowledge)
– use as the basis in company training courses
– for reference purposes (setup, maintenance and repair)

Organization

This manual is divided into 4 chapters:

0 General Notes
1 Maintenance, Calibration
2 Functional Descriptions and Circuit Diagrams
3 Spare Parts Catalog

Numbering system

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

Qualification

This manual is intended for maintenance engineers

– who have the necessary background experience in mechanics, electronics and medical engineering,
– who have been trained by the manufacturer to service and repair the equipment
– who have access to the required technical and measuring equipment.

Limitations

This manual does not replace the training courses offered by the manufacturer.

Manual changes

Manual changes will be released as new editions, supplements or technical product information.

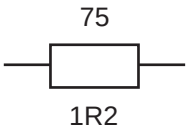
In general, this manual is subject to modification.

Representation

Circuit diagrams will include graphic symbols that reflect the latest state of DIN standards and VDE requirements.

Component identification in circuit diagrams:

Example:



This refers to a resistor with position no. 75 and a resistance of 1.2 ohms

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

Example:

Resistors		Capacitors	
0R1	= 0.1 Ohm	0µ1	= 0.1 µF
1R2	= 1.2 Ohm	1µ2	= 1.2 µF
1K2	= 1.2 KOhm	1000µ	= 1000 µF

Technical Data

For technical data of the Ionometer™ 2 refer to the Operating Instructions, chapter 15.

ABBREVIATIONS

Part no.	=	Fresenius part number
ADC	=	analog-to-digital converter
DAC	=	digital-to-analog converter
CPU	=	microprocessor (central processing unit)
PIO	=	programmable input/output chip
IC	=	integrated circuit
IP	=	pumping current
PCB	=	printed circuit board
MP	=	measurement point
OPA	=	operational amplifier
TP	=	test point
Pin	=	terminal
ST, X	=	plug connector
SO	=	(plug-in) socket
BR, J	=	bridge, jumper
UI-control	=	voltage/current-regulated pump motor control
mmol/l	=	millimol per liter (unit of measure representing the concentration of substance or ions per liter solution)
mS/cm	=	millisiemens per centimeter (unit of measure for the conductance per centimeter length of line)
g/dl	=	gramms per deciliter (concentration of hemoglobin per deciliter whole blood)
Hk %	=	percent hematocrit (packed cell volume of red cells expressed as a percentage of the total blood volume)
Na	=	sodium
K	=	potassium
GLU	=	glucose
Ca	=	calcium
CD	=	conductivity
pH	=	pH value
Hk	=	hematocrit
Hb	=	hemoglobin
T	=	temperature
G	=	optical sensor
V	=	valve (line clamping valve)
P	=	potentiometer

Table of Contents

Table of Contents
1 Maintenance and Calibration

1.1 Service and Maintenance Schedule

It is of utmost importance that service and maintenance procedures be performed at regular intervals to maintain the proper function of the Ionometer™ 2 . The maintenance procedures are simple and do not require much time.
The following schedule is an overview and a guideline regarding the intervals at which certain procedures should be performed. In the following the individual procedures are described in detail.

1.1.1 Every Morning

1. Check the filling level of the fluid bottles. Discard small volumes of residual solutions.
2. Perform test measurements using Ionosafe. Should the rated values repeatedly exceed the specified tolerances, check the electrodes.
   EG-HK ONLY: If the activity of the glucose electrode is repeatedly below 50%[1], replace the electrode.

1.1.2 Every Evening

1. Empty, clean and fill the waste bottle with a small amount of disinfectant solution ➜ Operating Instructions.
2. Has the Ionometer™ 2 been properly connected to the external power supply? If not, the integrated batteries will discharge.

1.1.3 Every Week

1. Visually check the line set for leaks or contamination.
2. Check the electrode unit for traces of salt or moisture.

1.1.4 Every 6 Months

1. Regenerate or replace the reference electrode ➜ Chapter 1.3.2, page 1-6.
2. If the slope of the potassium or the calcium electrode is below 80%[1], replace the electrode ➜ Chapter 1.3.1, page 1-5.
3. **Check, and if necessary, replace all lines** ➜ Chapter 1.3.3.
4. **Replace the pump lines** ➜ Chapter 1.3.4.
5. Replace the waste bottle.
6. ***EH-F AND EH-HK ONLY:*** Replace the air filter.

1.1.5 Every 12 Months

1. Perform the same maintenance procedures as described for every 6 months.
2. Replace all lines.
3. Replace the sodium or the pH electrode, if the slope is constantly below 80%[1] even after conditioning ➜ Chapter 1.3.1.

[1] shown in protocol printout, switch position 1

1.2 Test Measurements

1.2.1 Control Serums

The majority of all test serums contains preserving additives (e.g. acids), which irritate the electrodes of the Ionometer™ 2 as well as those of other ion-sensitive and enzymatic analyzers. In certain cases, these additives may not only produce incorrect measurement results, but may even damage the electrodes.

The use of liquid control serums containing acids, glycol or substances similar to glycol for stabilization (such as MultiCal by Corning, Decision by Beckmann[1]) will destroy the electrodes.

For accurate measurement results we recommend to use only the solutions[1] recommended by us.

The glucose results of the Ionometer™2 must be compared with the manufacturers' specifications using the hexokinase method.

[1] Registered trademark of the company mentioned.

1.3 Maintenance Procedures

1.3.1 Replacing Electrodes

- **Removal** (see fig. 2)

  – Turn the Ionometer off.
  – Pull the front panel downward to remove it and place it on the Ionometer housing.
  – Remove the line to the left of the electrode unit (**A**); do not pull on the lines going to the rear.
  – Remove the black knurled-head screw (**B**) located under the electrode unit.
  – Carefully remove the electrode unit by pulling it downward.
  – Use a screw driver to fully unscrew the tightening screw (**C**) to the right of the electrode unit.
  – Remove the plexiglass section including the swivel adapter (**D**) by pullling it to the right.
  – Carefully remove the optical sensor chamber (**E**).
  Be careful not to lose any of the optical sensor inserts or O-rings.
  – Remove the electrodes from the holder from right to left.

Note
The glucose electrode will easily dry out and will then be unfit for use; do not leave the sample channel dry for more than 15 minutes ! Observe the instructions on the package insert of the glucose electrode.
The electrode surface must be free from salts and moisture; if necessary, clean and dry with a paper towel. Clean the O-rings and check for damages

  – Replace the electrode(s)

- **Installation** (see fig. 2)

  – Insert the reference electrode in the holder and check the optical sensor insert and the O-ring.
  – Place the measuring electrodes onto the reference electrode from left to right.
  Make sure the electrodes are installed in the correct order (refer to the labeling above the electrode window on the front panel). Check to be sure that no O-rings are missing or are improperly fitted.
  – Insert the optical sensor chamber into the holder (check optical sensor insert and O-ring) and push it to the left.
  – Reinstall the plexiglass section including the swivel adapter. Turn the tightening screw (**C**) **fully clockwise**. While tightening the screw, check repeatedly if the sides of the electrodes are flush with each other and with the optical sensor chambers.
  – Knock the underside of the assembled electrode unit against a soft surface.
  – Secure the electrode unit with the knurled-head screw (**B**) to the Ionometer™ 2 and connect the line to the left of the unit.
  – Turn the Ionometer™ 2 on.
  – An automatic 2-point calibration will be performed. On completion of the calibraction check the electrode unit for leakage. The underside of the electrode block must be dry.

1.3.2 Replacing the Reference Electrode's Internal Electrolyte

Note
Replacement is required at least **every 6 months,** with high sample throughput even earlier.
Refilling the electrode must be completed within a few minutes to prevent the membrane of the reference electrode from drying out.

– Disassemble the electrode block into its component parts ➜Chapter 1.3.1, Removal

– Remove the two locking plugs on the upper and lower rear of the reference electrode and remove line 1 and 2 (fig. 1)

– Use a 20-ml syringe with a 0.6 to 1.0 mm Ø cannula to suck out both internal electrolytes as completely as possible.

– Completely empty the syringe and rinse it with distilled water; or take a new syringe and new cannula.

– Draw up a new internal electrolyte (part no. 501 333 1) and first fill the small chamber (at the top), if possible without any air bubbles. Repeatedly tilt the electrode and slightly knock it on a surface.

Note
Use new locking plugs and lines.

– Push in the locking plug (part no. 650 629 1) including line no. 2 (part no. 545 310 1).

– Fill the large chamber with the same internal electrolyte - while occasionally removing air bubbles - hold the reference electrode tilted and slightly knock it on a surface.

– Push in the locking plug (part no. 650 629 1) including line no. 1 (part no. 642 450 1).

– Use a paper towel to thoroughly wipe down the electrode and in particular the electrode contact.

– Wipe down the measuring electrodes and install them in the order indicated on the front panel.

– Reassemble the electrode unit ➜ Chapter. 1.3.1, Installation

Fig. 1

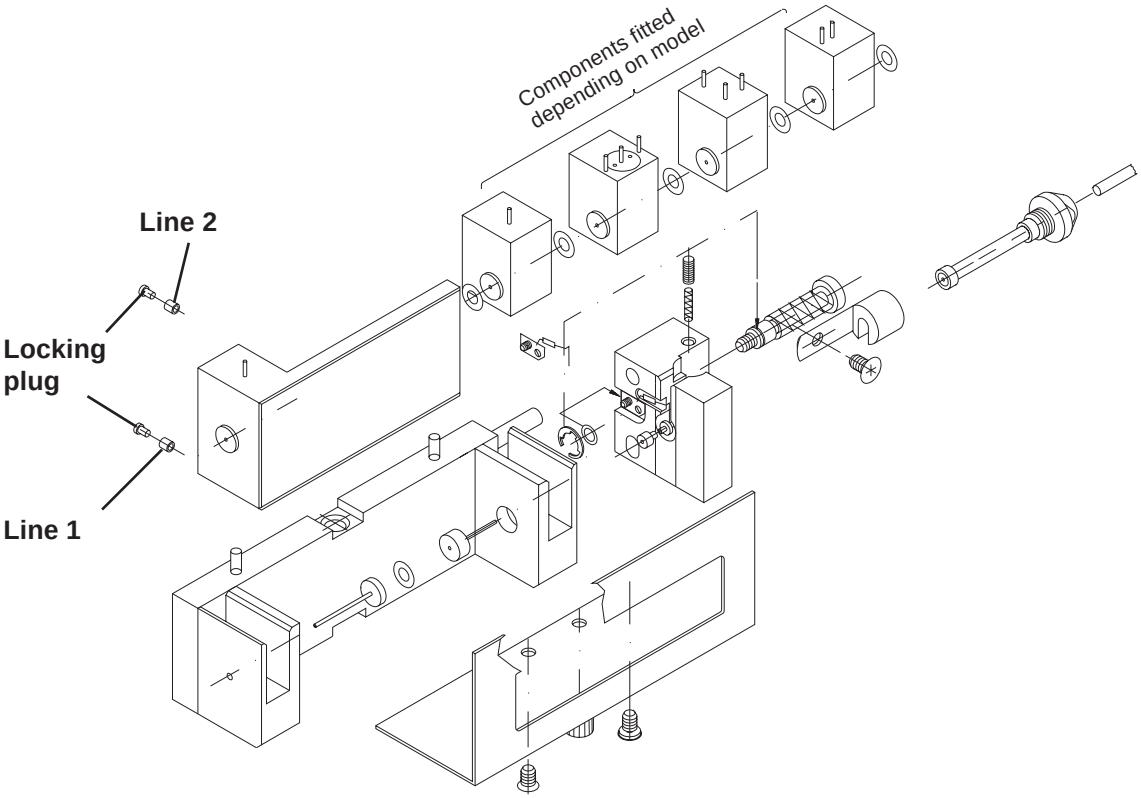
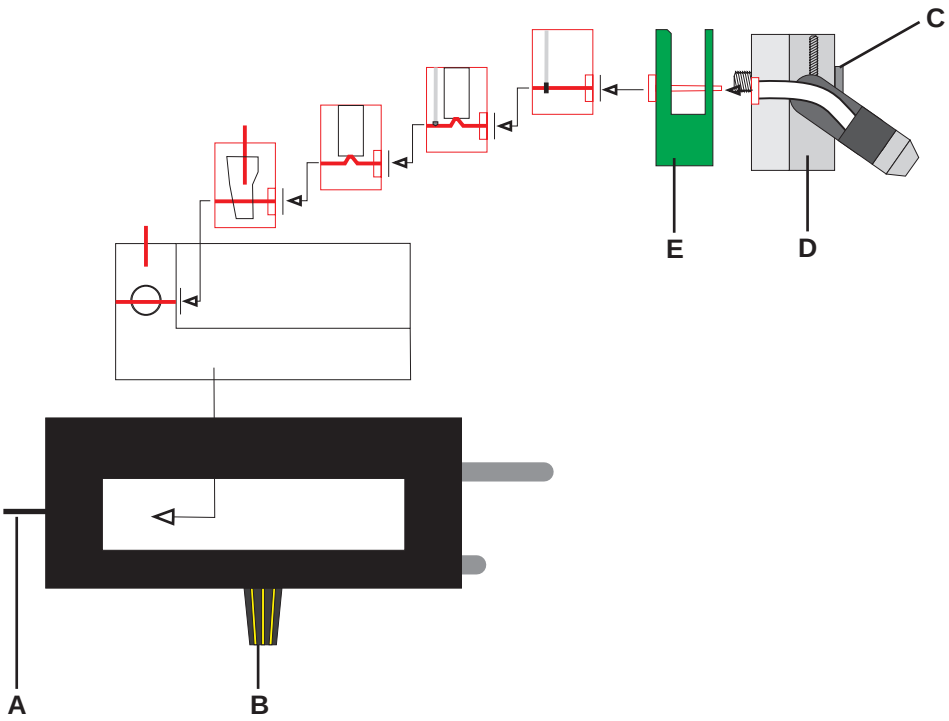

Components fitted
depending on model
Line 2
Locking
plug
Line 1

Fig. 2


C
E
D
A
B

1.3.3 Line Set

The line set must be checked once a week. Remove the cover above the fluid bottles, and remove the bottles from the unit. The fluid transportation system is located behind the bottles. The transparent plate including the printed line guide provided above the system can be removed by loosening the two fix-lock connectors.
Check that no lines are leaking (damp spots or salt crusts?), obstructed or clogged (particles or salt crystals in the line?), and look for mechanical damage. If the valve lines are clogged, carefully move them back and forth in line direction.
The complete line set should be replaced once a year (➜ plexiglass plate with line guide).

1.3.4 Pump Lines

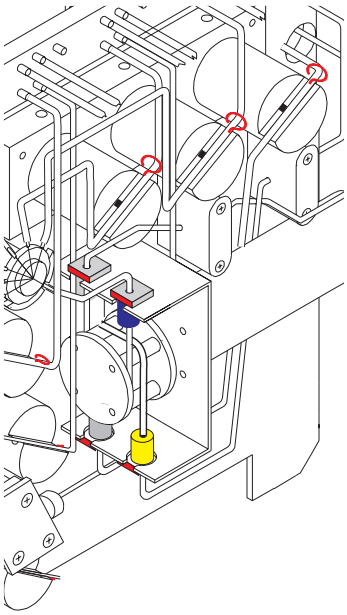
Check the pump lines for leaks, obstructions and obvious wear.
Saline solution leaking from pump lines may cause corrosion of the pump rotor bearings, the pump rotor will become sluggish, which will adversely affect motor and gear. This may become appearent even a long time after defective lines have been replaced. Therefore, it is recommended to preventively replace the line set at the prescribed intervals.
Replace the two pump lines at least every 6 months or earlier if measurement rates are exceptionally high.
Install the pump lines according to the color codings on the pump line and bracket. Do not twist the lines.

To install the pump lines, proceed as follows:
– First connect the colorless connector of the thicker line (“yellow pump line”) to the rear and the yellow connector to the front of the lower end of the bracket.
– Then connect the colorless connector of the thin line (“blue pump line”) to the rear and the blue connector to the front of the upper end of the bracket.

Make sure the lines will not rub against the edges of the rotor.

Note
After replacing the pump lines, always determine the delivery volume (➜ Chapter 1.3.5).

Fig. 3



1.3.5 Verifying the Pump Function and the Delivery Volume

Measuring equipment:
- Measuring cylinder, 10 ml and 25 ml
- Line clamps
- Distilled water

The following measurement conditions must be fulfilled to determine the delivery volume:
- The pump lines are less than 6 months old.
- The pump lines are running parallel.
- The Ionometer™ 2 is connected to the external power source.
- The rotor rolls are running smoothly. Lubricate, if necessary.
- The terminal voltage of the motor must be 4.7 ±0.1 V and the current may not exceed 220 mA (➜ Chapter 1.4.5).
- The line set has no leaks, is not clogged or trapped and reflects the latest state of manufacture

Verifying the delivery volume of the yellow pump line
- Disconnect line 16 (waste line) from the waste bottle and place it in a container filled with distilled water.
- Clamp line 10 (dosage line) with a line clamp.
- Set the coding switch to switch position **E** and press **Reset**.
- Select Service Program step 11b (page 1-16) (pump runs backwards: pumping off)
- Collect the volume delivered in a capillary tube and measure the amount of fluid collected.
- The delivery volume should be 18 ± 3 ml/min
- Reconnect line 16 to the waste bottle and remove the clamp from line 10.

Verifying the delivery volume of the blue pump line
- Remove line 5 from valve V_L (air) and place it in a container filled with distilled water.
- Clamp line 4 (waste line) with a line clamp.
- Set the coding switch to switch position **E** and press **Reset**.
- In the Service Program select item 11a (page 1-16) (pump runs forwards: dosing)
- Collect the volume delivered in a capillary tube and measure the amount of fluid collected.
- The volume delivered should be 5.6 ± 1.4 ml/min
- Reconnect line 5 to V_L and remove the clamp from line 4.

Note
If the volume delivered is not within the specified tolerance, check the length of the pump lines.

Part no. 650 282 1 yellow pump line: length 57 – 59 mm
Part no. 650 283 1 blue pump line: length 64 – 65 mm
(measured from the inner end of the two colored sleeves)

1.3.6 **Air filter** (H devices only)

Caution
The filtering media is a caustic powder. Do not open the filter!

The H1, H2, H3 bottles are aerated via a filter. This filter prevents a shift in the set pH calibration values in the solutions, caused by the carbonic acid present in the ambient air.
The lines of the aeration system are numbered consecutively. They must be connected to the blue-marked tube on the supply bottles. The line set must be completely closed (insure the line is connected, no leaks), as otherwise the filter would be ineffective. Replace the filter every 6 months.

1.3.7 **Battery**

The Ionometer™ 2 is equipped with a lead-acid battery protected against deep discharging.
After temporary operation of the Ionometer™ 2 without external power supply (battery operation), the battery should be recharged immediately to restore the battery capacity and to insure the device is ready for use at any time. Verify that the power indicator is illuminated.
Prior to each use, the Ionometer™ 2 automatically checks the charging level of the battery. As soon as the battery capacity has dropped markedly, the **CHARGE BATTERY** message is displayed. This message indicates that only a few more measurements can be performed.
In the event of a prolonged power failure, a special protective circuit prevents the battery from becoming completely discharged. In this case, the message **BATTERY DISCHARGED** will be displayed and operation of the Ionometer ™2 is no longer possible.
After reconnection to the external power supply, operation of the Ionometer™ 2 can immediately be resumed. It will, however, take approx. 10 hours until the battery is fully recharged.

1.4 Calibration / Verification

In addition to the maintenance procedures, the following calibration and/or verification procedures must be performed by personnel trained by the manufacturer.

Cause	Affects	Action
Malfunction	Optical sensors G1, G2, G3, G4	Check values ➜ 1.4.1, calibrate, if necessary ➜ 1.4.2
	Speed	Check, calibrate, if necessary ➜ 1.4.5
	Power suply	Check ➜ 1.4.3

Note
Always deproteinize the unit prior to calibrating or checking the optical sensor values.
To deproteinize, set the coding switch to positon 0 and select "Deproteinization" in the main menu.

1.4.1 Verification of Optical Sensors

– Set the coding switch to position E and press Reset.

Air value G1, G2, G3 and G4:
– Select service program steps 13a and 13b (dosing and pumping out) until the values displayed have stabilized.
– Select step 13 (pump stopped).
– Verify the optical sensor values.
– The air value G1-G2-G3-G4 shoul be: 900 – 1100 mV

Water value G1 and G2:
– Immerse the suction capillary in a vessel filled with destilled water.
– Select service program step 13a (dosing). Wait for the displayed values to stabilize.
– Verify the values.
– The water value G1-G2 should be: <150 mV
– Select step 13 (pump stopped).

Water value G3 and G4:
– Remove the air line from V_L .
– Clamp the line between the electrode unit and the T-connector.
– Place the air line into distilled water.
– Select service program step 13a (dosing), wawait for the displayed values to stabilize.
– Verify the values.
– The water value G3-G4 should be: <250 mV
– Select step 13 (pump stopped).
– Reinstall the line in V_L and remove the clamp.

If the values are outside the specified tolerances, perform a calibration in the service program. Do not calibrate before having properly cleaned the line system and the electrode block!

1.4.2 Optical Sensor Calibration

The Ionometer™ 2 automatically calibrates the optical sensors G1, G2, G3 and G4 after selection in the service menu. To calibrate, set the coding switch to position **D** and press Reset. The calibration procedures is started by pressing the Start key. (➜ 1.5 Service program).
On completion of the calibration procedure, select step 13a and 13b and wait for the optical sensor values to stabilize.
Select step 13 and record the optical sensor values.
The optical sensor calibration may have to be repeated a few times before the values are within the specified tolerances (900 – 1100 mV).

1.4.3 Verification of Supply Voltage

– Set the coding switch to position E and press Reset.
– Select service program step 11.
– Verify the value.
– U_{Batt} with AC adapter should be: 6.7 – 6.9 V
– without AC adapter after one minute with the battery fully charge: U_{Batt} > 6.1 V

1.4.4 Verification of Valve Function

– Set the coding switch to position E and press Reset.
– Select service program step 12a.
– The valves are controlled consecutively.

1.4.5 Speed Calibration (LP 766)

Measuring equipment: Voltmeter

The speed can be verified over the motor terminal voltage and the motor current.

Motor terminal voltage:
– Connect a voltmeter to the terminals of the motor.
– The pump lines must be connected.
– Set the coding switch to position E and press Reset.
– Select service program step 12.
– Record the terminal voltage measured by the voltmeter.
– The terminal voltage should be: 4.6 – 4.8 V
– If the terminal voltage is outside the tolerance range, it must be set to 4.7 V with the multi-turn trimmer P1 on the power supply board 766. This corresponds to the rated speed of 250 rpm of the motor.

Motor current:
– Set the coding switch to position E and press Reset.
– Select service program step 12.
– The motor current I_{Pump} is shown on the display.
– The motor current should not exceed 220 mA.

1.5 Service Program

Switch positions:

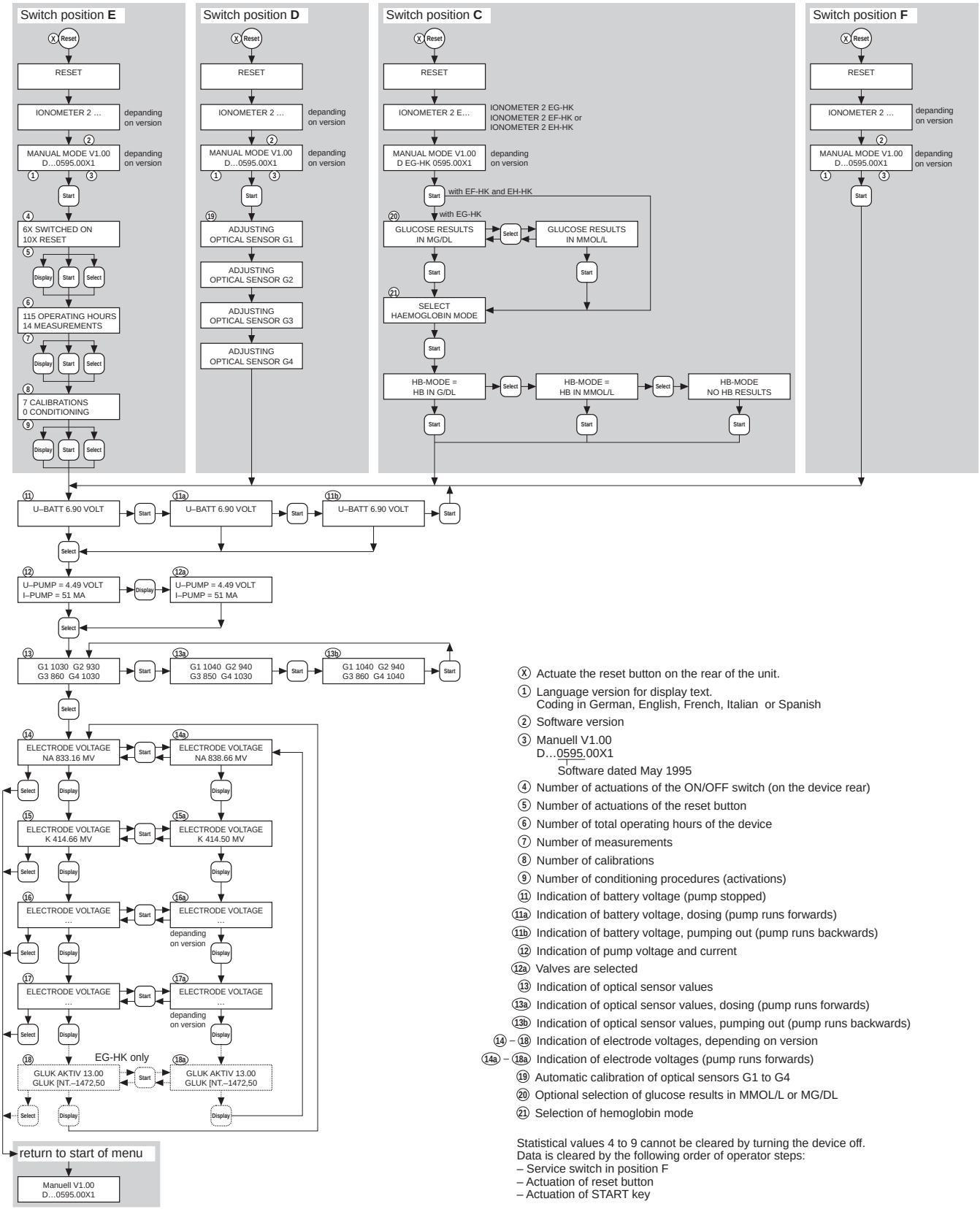
Switch position **E**:
– Indication of statistical values:
  Number of actuations of the On/Off switch
  Number of actuations of the Reset button
  Number of total operating hours
  Number of calibrations
  Number of conditioning procedures
– Verification of
  voltage supply
  motor voltage and current
  valve functions
  optical sensor values
  electrode voltages

Switch psition **D**:
– Optical sensor calibration

Switch position **C**:
– Selection of units for glucose measuring results (EG-HK only)
– Selection of units for hemoglobin values (xx-HK only)

Switch position **F**:
– Resetting statistical values

Note
Switching to the measurement mode is generally done by setting the coding switch to position 0, 1 or 2 (different printer report layouts) and pressing the Reset button.



- (X) Actuate the reset button on the rear of the unit.
- (1) Language version for display text.
  Coding in German, English, French, Italian or Spanish
- (2) Software version
- (3) Manuell V1.00
  D…0595.00X1
  Software dated May 1995
- (4) Number of actuations of the ON/OFF switch (on the device rear)
- (5) Number of actuations of the reset button
- (6) Number of total operating hours of the device
- (7) Number of measurements
- (8) Number of calibrations
- (9) Number of conditioning procedures (activations)
- (11) Indication of battery voltage (pump stopped)
- (11a) Indication of battery voltage, dosing (pump runs forwards)
- (11b) Indication of battery voltage, pumping out (pump runs backwards)
- (12) Indication of pump voltage and current
- (12a) Valves are selected
- (13) Indication of optical sensor values
- (13a) Indication of optical sensor values, dosing (pump runs forwards)
- (13b) Indication of optical sensor values, pumping out (pump runs backwards)
- (14) – (18) Indication of electrode voltages, depending on version
- (14a) – (18a) Indication of electrode voltages (pump runs forwards)
- (19) Automatic calibration of optical sensors G1 to G4
- (20) Optional selection of glucose results in MMOL/L or MG/DL
- (21) Selection of hemoglobin mode

Statistical values 4 to 9 cannot be cleared by turning the device off.
Data is cleared by the following order of operator steps:
– Service switch in position F
– Actuation of reset button
– Actuation of START key

Note
The mode can be changed by turning the coding switch and subsequently pressing the Reset button.

1.6 Ionometer™ 2 Maintenance Schedule

Note
Maintenance, extentions, adjustment, modification or repair may only be performed by the manufacturer or persons authorized by him.
The maintenance intervals are listed in the maintenance report form.

Maintenance Report

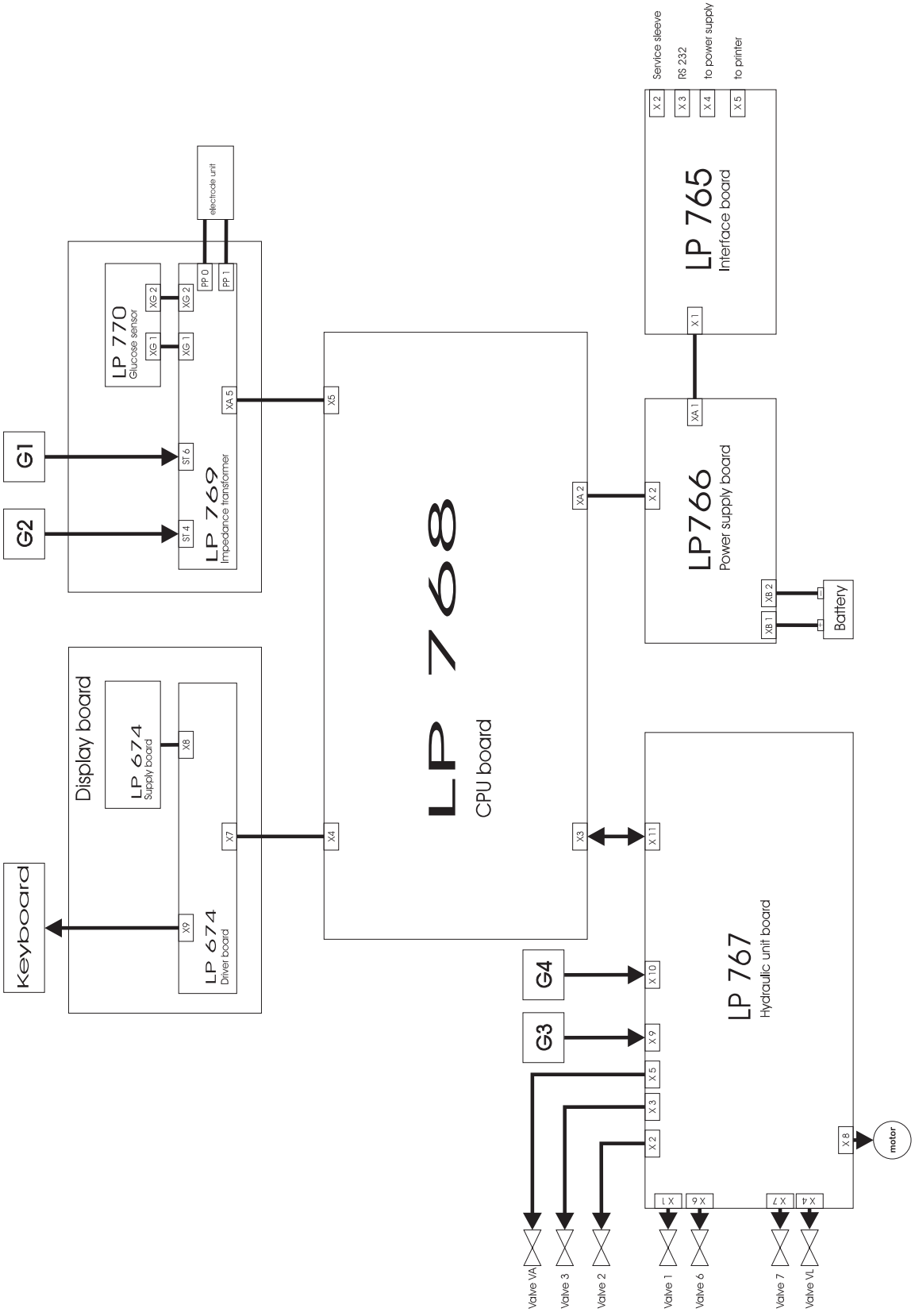
Device: _____ **Date:** _____

Operating hours: _____ **Technician:** _____

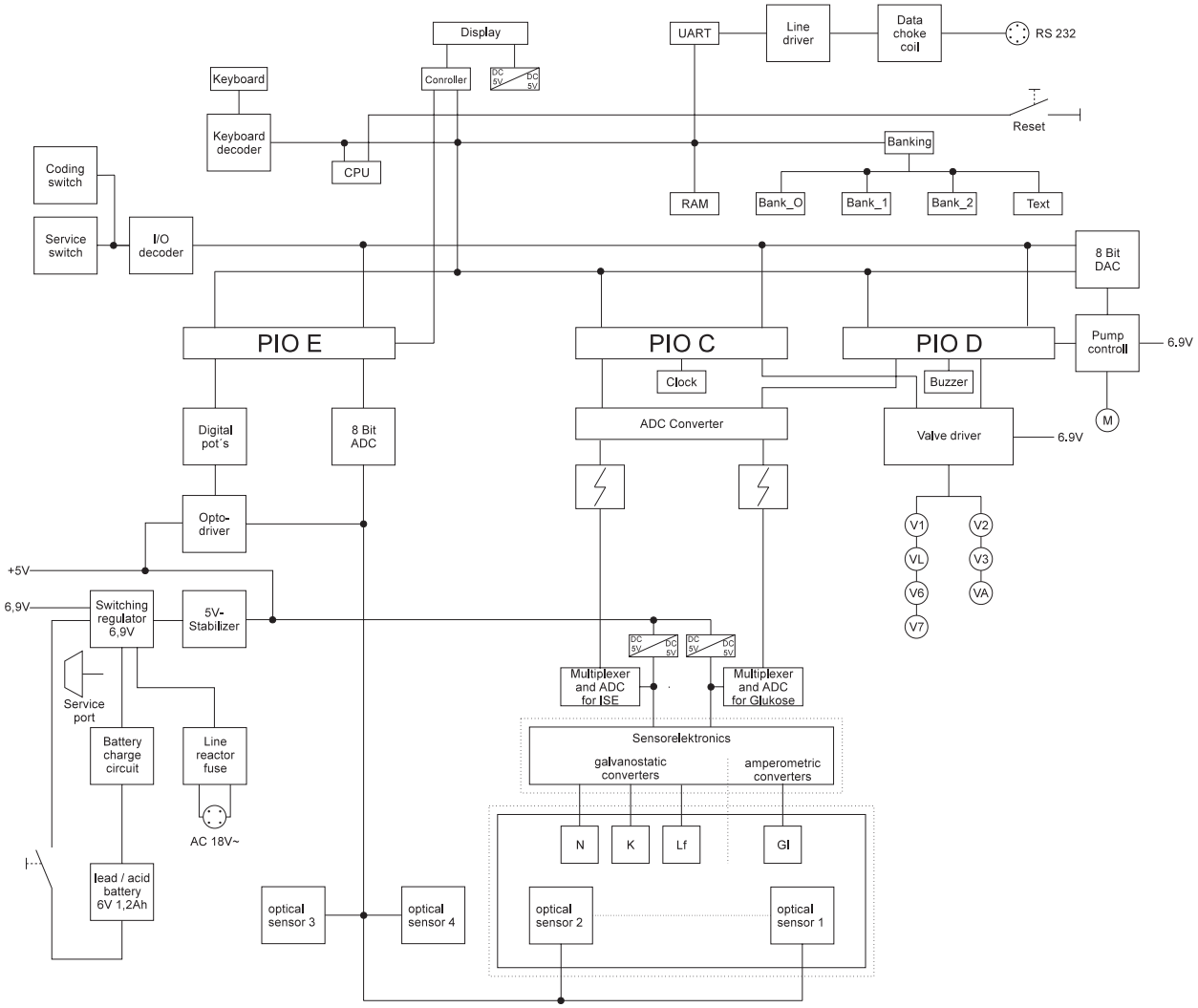
No.	Description	Rated value/action	checked	OK
1. Maintenance intervall: every 6 months				
1.1	Reference electrode	Regenerate or replace (➜ Chapter 1.3)	❑	❑
1.2	Calcium electrode Potassium electrode	Replace if slope less than 80 % (➜ Chapter 1.1.4, 1.3.2)	❑	❑
1.3	Pump lines	Replace. Verify delivery volume: (➜ Chapter 1.3.4, 1.3.5) Delivery volume yellow line: 18 ± 3 ml Delivery volume blue line: 5.6 ± 1.4 ml	❑ _____ ml _____ ml	❑
1.4	Waste bottle	Replace	❑	❑
1.5	Air filter (H devices only)	Replace (➜ Chapter 1.3.6)	❑	❑
2. Maintenance intervall: every 12 months				
2.1	Line set	Replace all lines (➜ Chapter 1.3.3)	❑	❑
2.2	Sodium electrode Ph electrode	Replace if slope less than 80 % (➜ Chapter 1.1.4, 1.3.2)	❑	❑
2.3	Optical sensors	Verify optical sensor values: (➜ Chapter 1.4.1) Air value: G1 – G4: 900 – 1100 mV G1: G2: G3: Water value: G1 – G2: <150 ml G1: G2: G3 – G4 <250 ml G3: G4:	❑ _____ mV _____ mV _____ mV _____ ml _____ ml _____ ml _____ ml	❑
2.4	Voltage supply	Verify voltage: (➜ Chapter 1.4.3) $U_{Batt, soll}$: 6.7 – 6.9 V $U_{Batt, (1min)}$: > 6.1 V	❑ _____ V _____ V	❑
2.5	Valves	Check valve function (➜ Chapter 1.4.4)	❑	❑
2.6	Speed calibration	Check motor terminal voltage: (➜ Chapter 1.4.5) U_{Pump}: 4.5 – 4.9 V Check motor current: I_{Pump}: max. 120 mA	❑ _____ V ____ mA	❑

Table of Contents
2 Functional Descriptions and Circuit Diagrams

2.1 Ionometer™ 2 Block Diagram



2.2 Ionometer™ 2 Functional Overview



2.3 Display Board LP 673/674

2.3.1 Circuit Description

To save space the display assy. is accommodated on two printed circuit boards using sandwich technology, i.e. the supply board LP 674 and the driver board LP 673.
The two boards are interconnected by a rigid 16-pin connector (X8); in addition, its structure is stabilized by means of two spacers.

The VF display comprises 2 x 20 digits, with 14 display segments plus decimal point and comma each and is connected via socket connectors X1 to X6. Display positions, which are lying on top of each other, have a common grid connection and are therefore always switched in pairs.

With all segments on and at full brightness the entire display assy. requires approx. 250 mA of the +5-V voltage supply.

- **Supply-Board LP 674**

On this P.C.B. the voltages required to engergize the VF display are derived from the +5-V voltage of the Ionometer by means of a DC-to-DC/AC converter (TR1). These are the heating voltage (AC voltage) for the VF tube, the –20-V voltage V_{DD} for operating the display controller and the –36-V voltage V_{GG} provided as cutoff grid voltage of the individual digits of the display. The reference potential V_{SS} for the entire display assembly is represented by the +5-V supply voltage, which results in V_{DD} amounting to –15 V and V_{GG} amounting to –31 V as compared with the ground of the Ionometer. C1, C2 and C3 smooth the voltage applied,C4 suppresses oscillations of the linear regulator IC2.

In addition, the supply board comprises the slave-grid controller (R10939/IC1), which is running synchronously to its master controller (R10939/IC1/LP 673) and is responsible for activating the segment driver (R10941/IC3/LP 673) of the lower display line. Since the grids of two display positions lying on top of each other are inter-connected and can therefore only be switched on simultaneously, the grid drivers of the slave controller are not connected.

- **Driver Board LP 673**

  This board represents the essential part of the circuit provided for activating the VF display. Via line D0 (X7.9), the characters to be represented are transmitted serially to the grid controllers in ASCII format, with line D1 (X7.10) serves as clock line (SCLK).
  Pins D2 to D7 of the two grid controllers must be fixedly applied to V_{DD}, so that the serial transmission mode will be set upon initialization of the modules.
  After the eight data bits have been transmitted, a strobe pulse at the respective load pin (LD) of the grid controller is used to transfer the character into the RAM of the chip. A pulse on line LDU (X7.5) selects the upper display line; a pulse on line LDL (X7.7) selects the lower line.

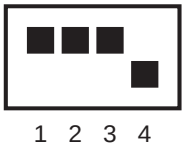
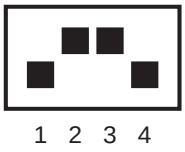
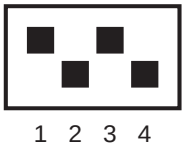
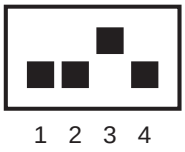
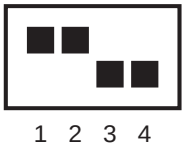
  The master grid controller (IC1) is provided for timing the display representation. One after the other, the individual characters are read out in the display buffers in cycles and transmitted to the segment drivers (IC2/IC3); then the digits (STR00 to STR19) are switched on. One complete refresh procedure over all 20 digit pairs takes approx. 7 ms, which is to be interpreted as a repetition rate of 140 Hz. The pulse for the line synchronization (SOP) is not only fed back from the master controller to its own synchronization input (SIP), but also transmitted to the slave controller, so that both grid controllers always access the same position of their buffers.

  With the power plug connected, X7.1 is used to transmit approx. 8 volts from the hydraulics board to the power indicator D1 via the CPU board.

  Via X9, the front panel including the integrated key pads START (X9.1), DISPLAY (X9.4) and SELECT (X9.3) are connected to P.C.B. LP 673. Together with the common connector (X9.2), all keyboard lines are connected to the CPU board via X7.12/14/15/16.

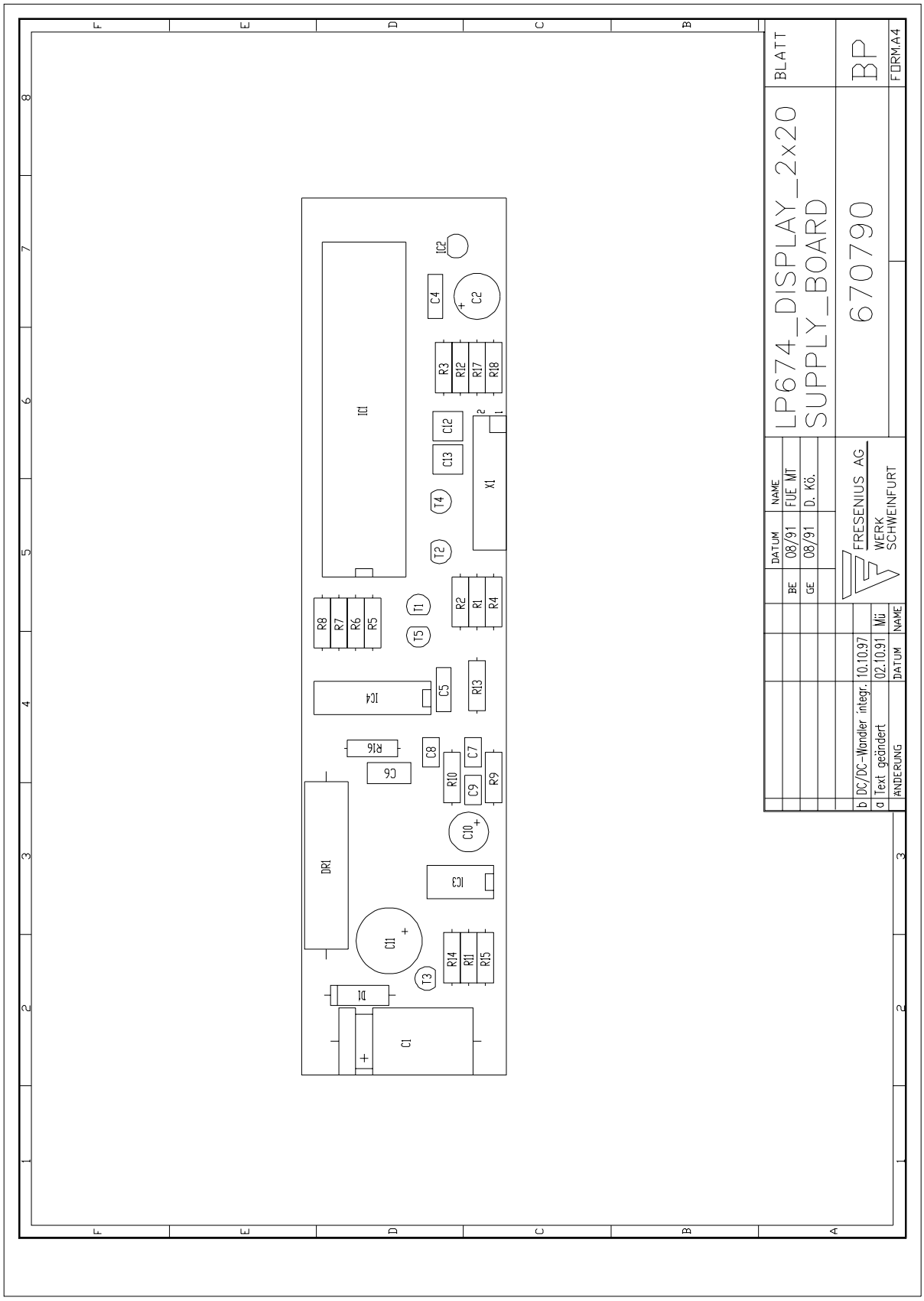
  The language is selected via coding switch S1.

2.3.2 DIP Switch Settings S1 for Language Options on PCB LP 673-1

Switch position	Language
	German
	English
	French
	Italian
	Spanish

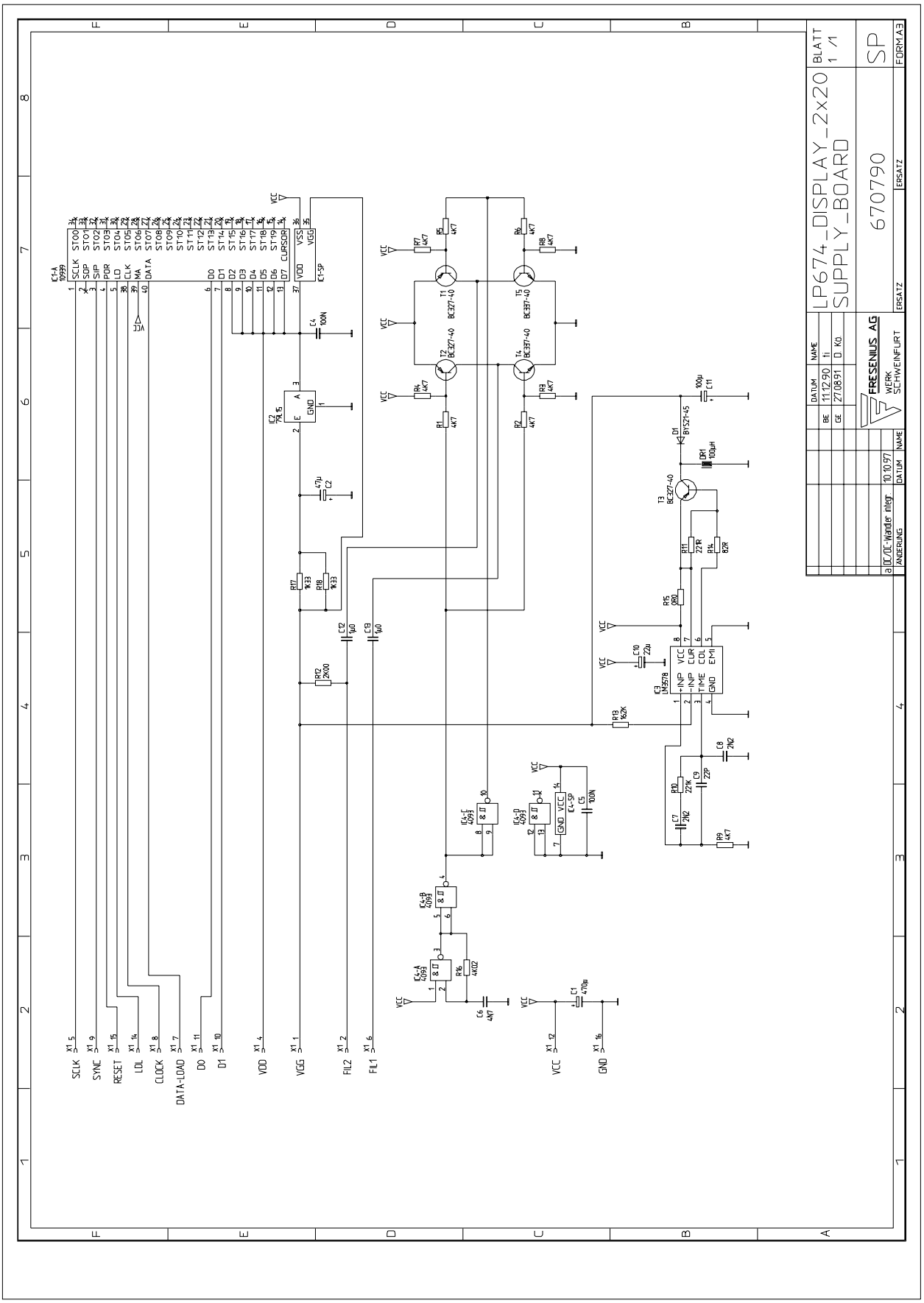
Display Board LP 674

Component Layout



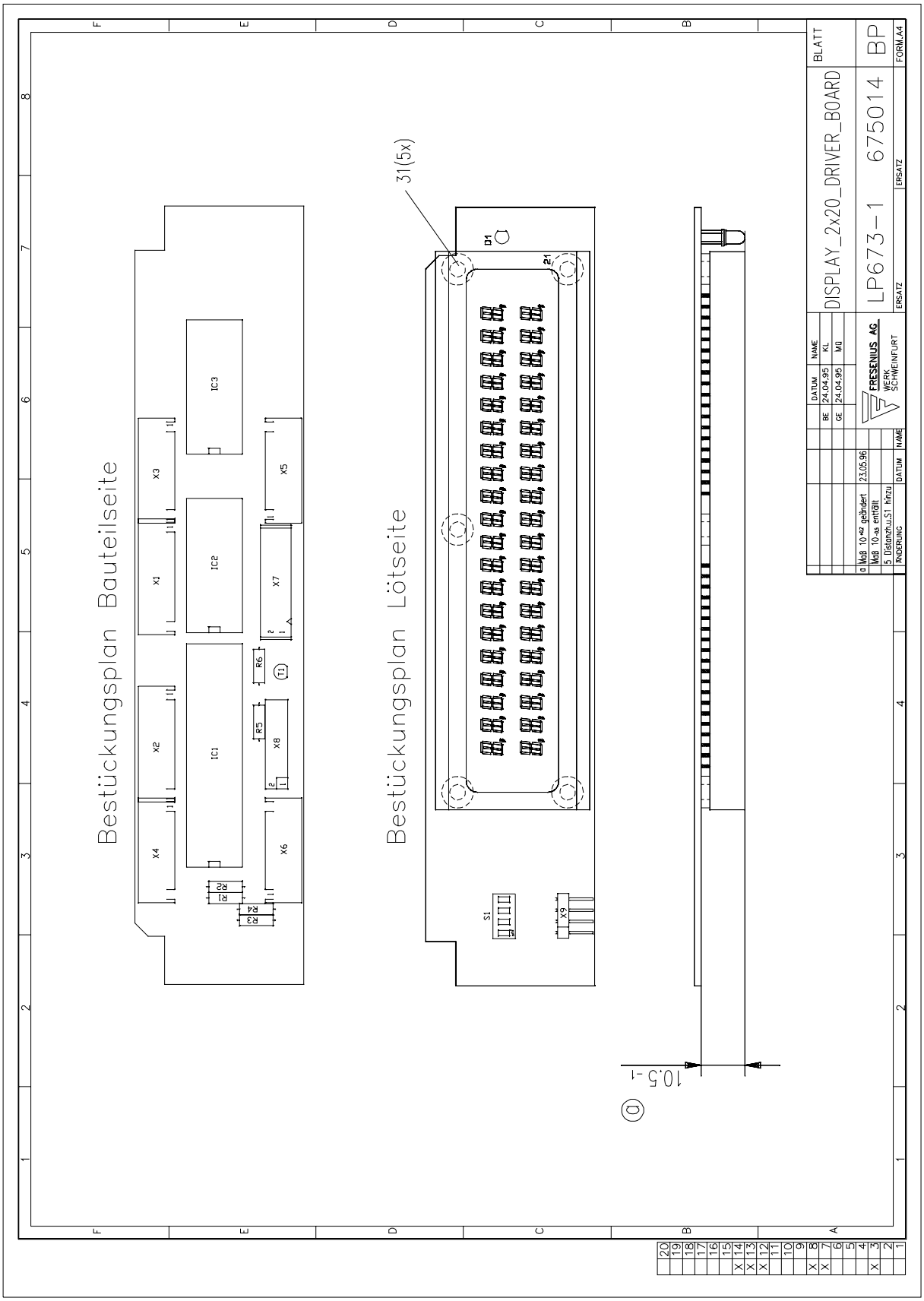
Display Board
LP 674

Circuit Diagram



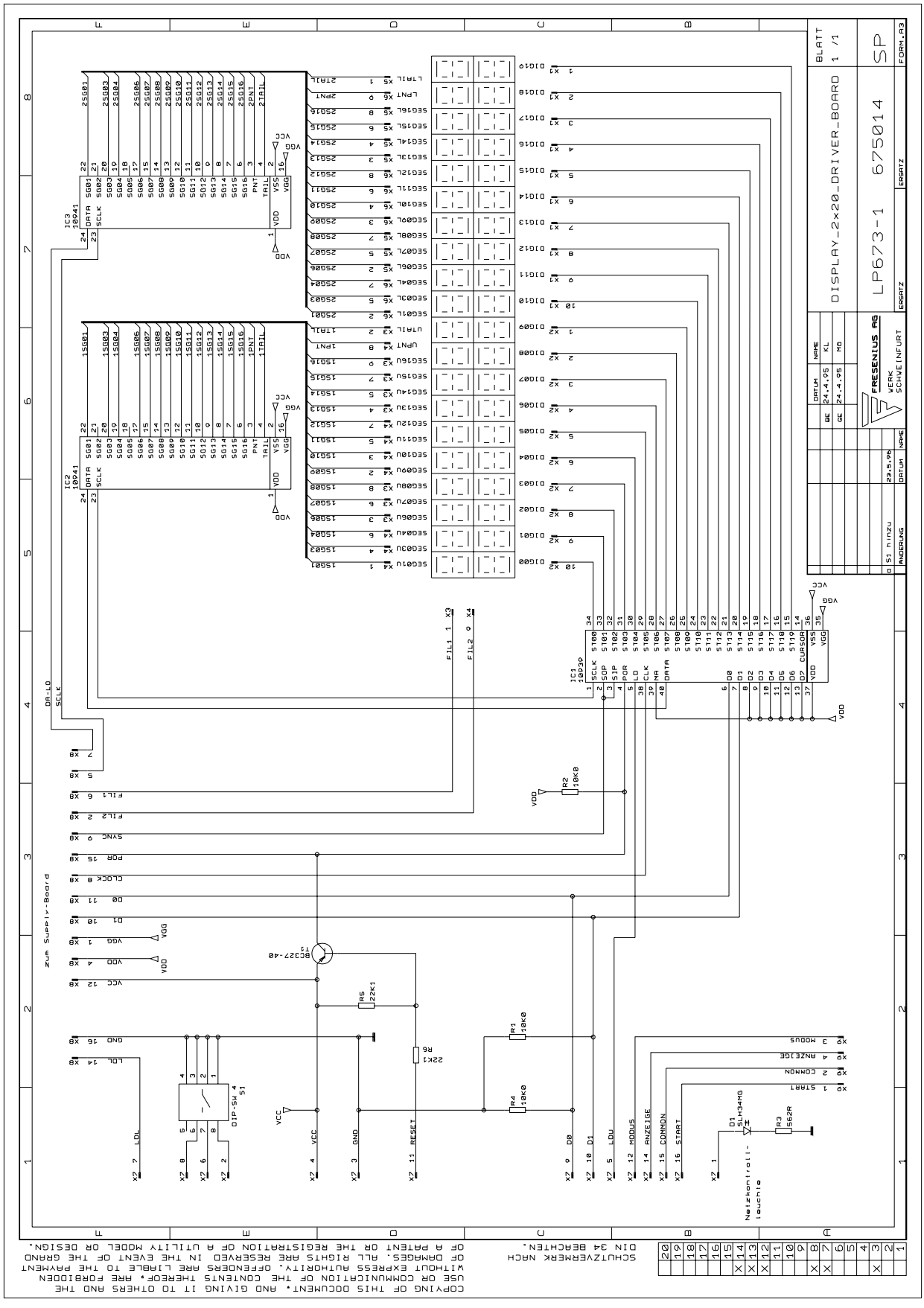
Display Board LP 673

Component Layout



Display Board
LP 673

Circuit Diagram



2.4 Interface Board LP 765

2.4.1 Circuit Description

The only function of the Interface Board LP765 is to provide a connection to the peripherals.

This P.C.B. comprises:
- a 25-pin service port (X2) where parameters relevant for the device are present
- a service switch (S3) for the selection of different service routines
- a 7-pin optically decoupled RS 232 port (X3) (the supply voltage for the active components is derived from the respective signals)
- a 2-pin connector (X5) providing 6.8 V and max. 0.5 A (e.g. for the printer)
- a 4-pin connector (X4) for connection of an external AC adapter or power module
- a slide switch (S1) to turn the device ON/OFF
- a reset key (S2) to restart the processor at a defined address

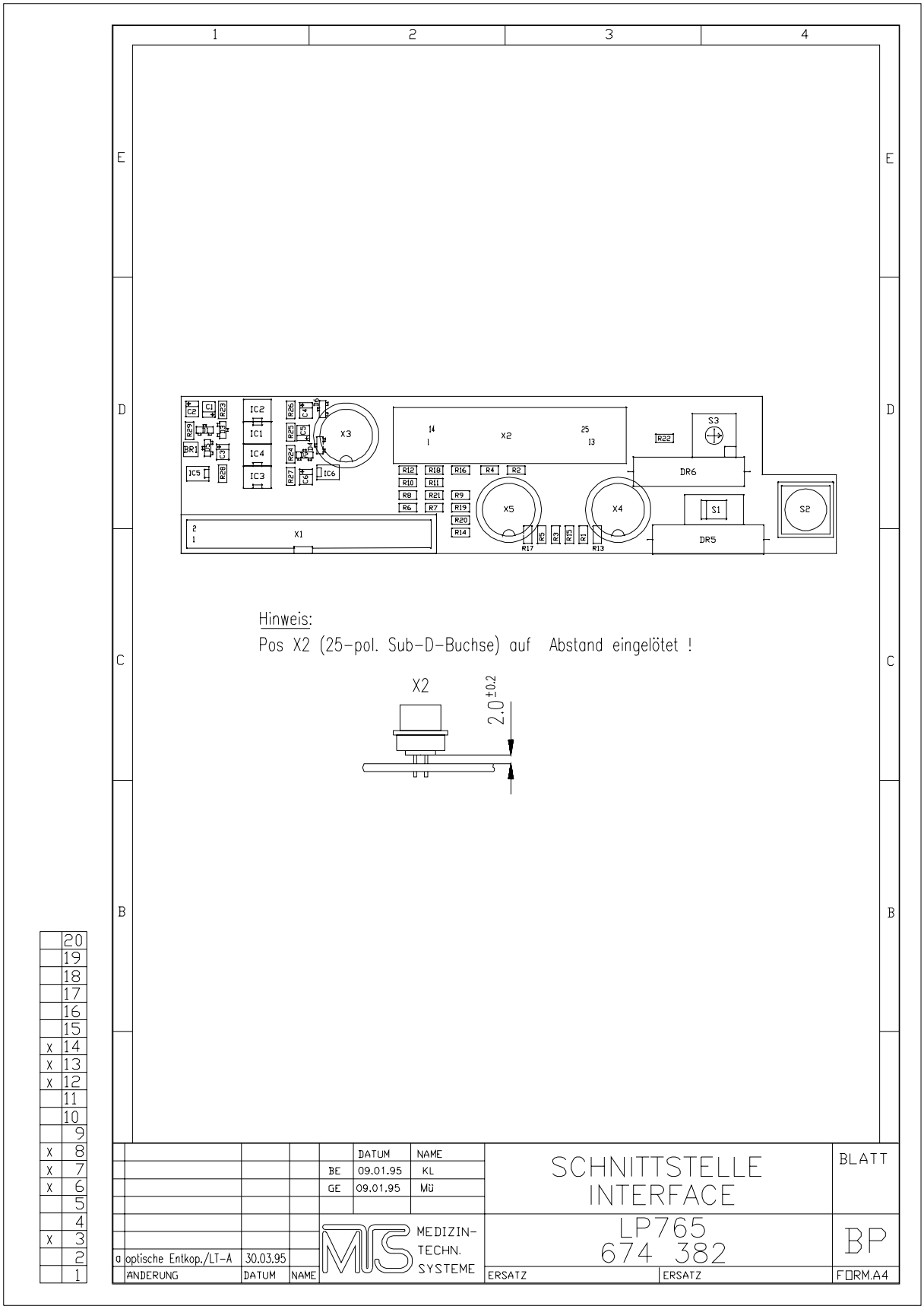
2.4.2 Pinout of the 25-pin Service Port (X2)

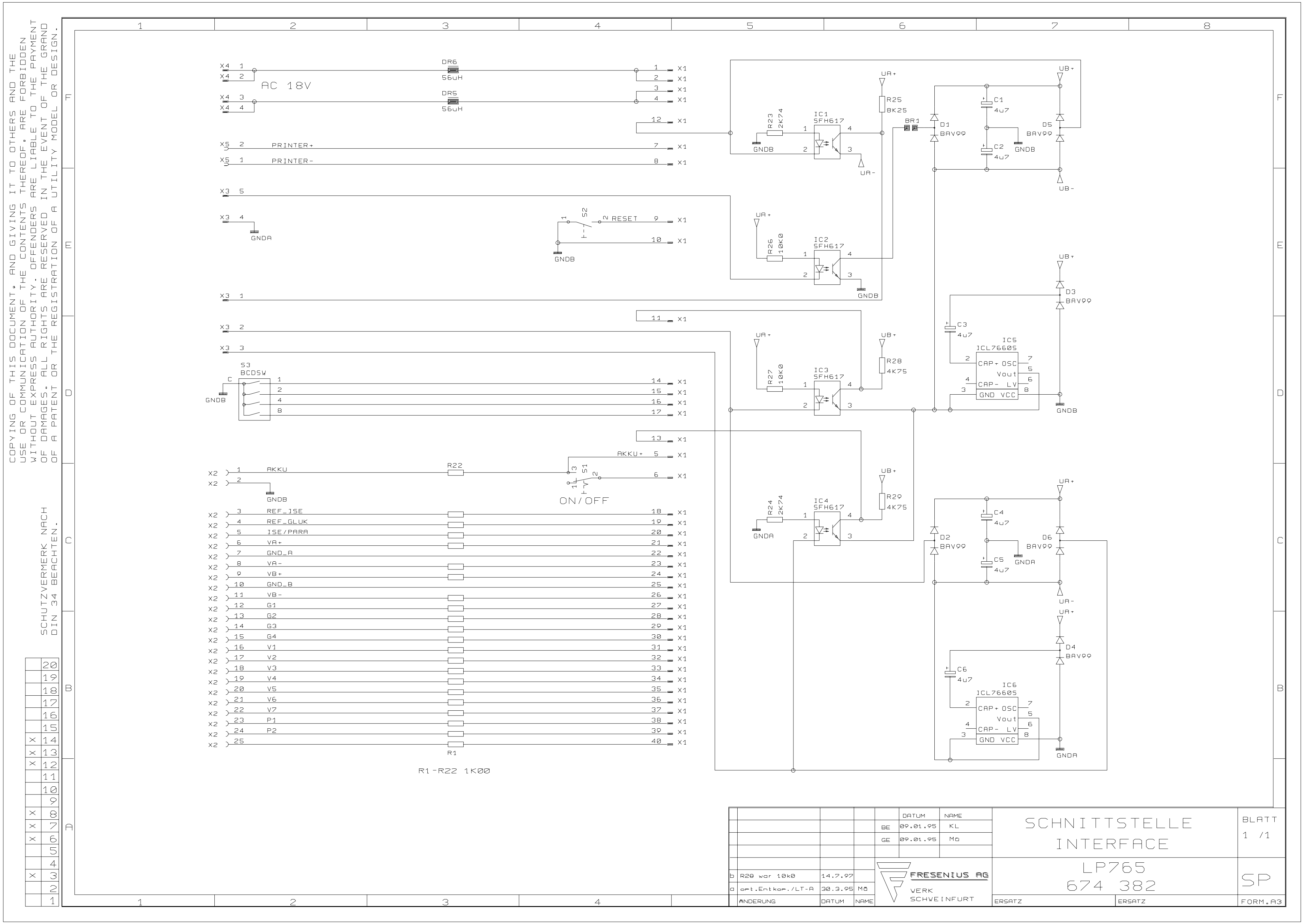
1 Battery voltage / AC adaptor voltage
2 Battery voltage /AC adaptor voltage GND
3 Reference voltage for Na, K, Ca, pH, CD electrode
4 Reference voltage for the glucose sensor
5 Parameter voltage of the Na, K, Ca, pH, CD electrode
6 VA+, isolated supply voltage for sensors
7 GND A
8 VA–,isolated supply voltage for sensors
9 VB+, isolated supply voltage for the glucose unit
10 GND B
11 VB–, isolated supply voltage for the glucose unit
12 Voltage optical sensor G1
13 Voltage optical sensor G2
14 Voltage optical sensor G3
15 Voltage optical sensorG4
16 Pull-in and holding voltage V1
17 Pull-in and holding voltage V2
18 Pull-in and holding voltage V3
19 Pull-in and holding voltage V air
20 Pull-in and holding voltage V waste
21 Pull-in and holding voltage V6
22 Pull-in and holding voltage V7
23 Roller pump +
24 Roller pump –
25 not used

All signal voltages are decoupled above1 kΩ.

Interface Board LP 765

Component Layout





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SCHUTZVERMERK NACH DIN 34 BEACHTEN.
AC 18V
DR6 56uH
DR5 56uH
PRINTER+
PRINTER-
RESET
GNDA
GNDB
S3 BCDSW
AKKU
AKKU+
R22
ON/OFF
REF_ISE
REF_GLUK
ISE/PARA
VA+
GND_A
VA-
VB+
GND_B
VB-
G1
G2
G3
G4
V1
V2
V3
V4
V5
V6
V7
P1
P2
R1
R1-R22 1K00
IC1 SFH617
IC2 SFH617
IC3 SFH617
IC4 SFH617
R23 2K74
R24 2K74
R25 8K25
R26 10K0
R27 10K0
R28 4K75
R29 4K75
BR1
D1 BAV99
D2 BAV99
D3 BAV99
D4 BAV99
D5 BAV99
D6 BAV99
C1 4u7
C2 4u7
C3 4u7
C4 4u7
C5 4u7
C6 4u7
IC5 ICL7660S
IC6 ICL7660S
CAP+ OSC
Vout
CAP- LV
GND VCC
UA+
UA-
UB+
UB-
DATUM
NAME
BE 09.01.95 KL
GE 09.01.95 Mö
b R28 war 10k0 14.7.97
a ant.Entkor./LT-A 30.3.95 Mö
ÄNDERUNG DATUM NAME
FRESENIUS AG
VERK SCHWEINFURT
SCHNITTSTELLE
INTERFACE
LP765
674 382
ERSATZ
ERSATZ
BLATT
1 /1
SP
FORM.A3

Interface Board
P.C.B. LP 765
Circuit Diagram

2.5 Power Supply / Actuators LP 766

2.5.1 Circuit Description

P.C.B. LP 766 comprises 4 functional blocks:
– Valve driver with current saver circuitry
– Switching power supply to supply the device with power and to charge the battery
– „On/Off“ logic with battery monitoring function
– U/I regulation for the roller pump

- **Valve driver with current saver circuitry**

In the following only the valve driver with current saver circuitry will be described (V1),as the structure of the other output stages is identical.

With H level across X2 pin 40 the two transistors T1 and 2 turn on and valve V1 is energized. Caused by the differential turn-on pulse, T2 temporarily takes over the valve pull-in current and then switches off. After T2 has switched off, only the valve holding curent will flow across T1 and R4 until V1 is turned off. For V1 D1 has the function of clamping any back EMF voltages when inductive loads are switched off.

- **Switching power supply to supply the device with power and to charge the battery**

The AC input voltage is connected across XA1 Pin 1/2, XA1 Pin 3/4, fuse F1 and rectifier GL1 to the charging capacitor C11. This voltage is fed to the switching regulator C2 with output stage T19, which uses the voltage to generate a constant output voltage of 6.8 V ±250 mV. This voltage is made available to the device via D13 (cathode) and the printer via D16 (cathode) as supply voltage, and to the battery as charging voltage. The current sensing resistors R62 in parellel with R51 limit the current to approx. 1.8 A ±0,5 A.

Operation from external power supply is indicated via X2 Pin. Buffering of the battery is insured with the AC adapter connected and the device turned of.

The Ionometers™ 2 can be operated with AC adapter without battery.

- **„ON/OFF logic with battery monitoring function**

The device is switched on via XA1 Pin 6, comparator IC3A, T20 and T21/T22. T21/T22 applies the battery and/or AC adaptor voltage to the actuators and IC4, which generates a stable 5 V ±200 mV supply. The device can, however, not be turned on when the battery voltage is below 6 V .

IC3A also monitors the battery to prevent deep discharge. Comparator IC3A switches off T21 if the battery voltage drops below 5.4 V ±100 mV.

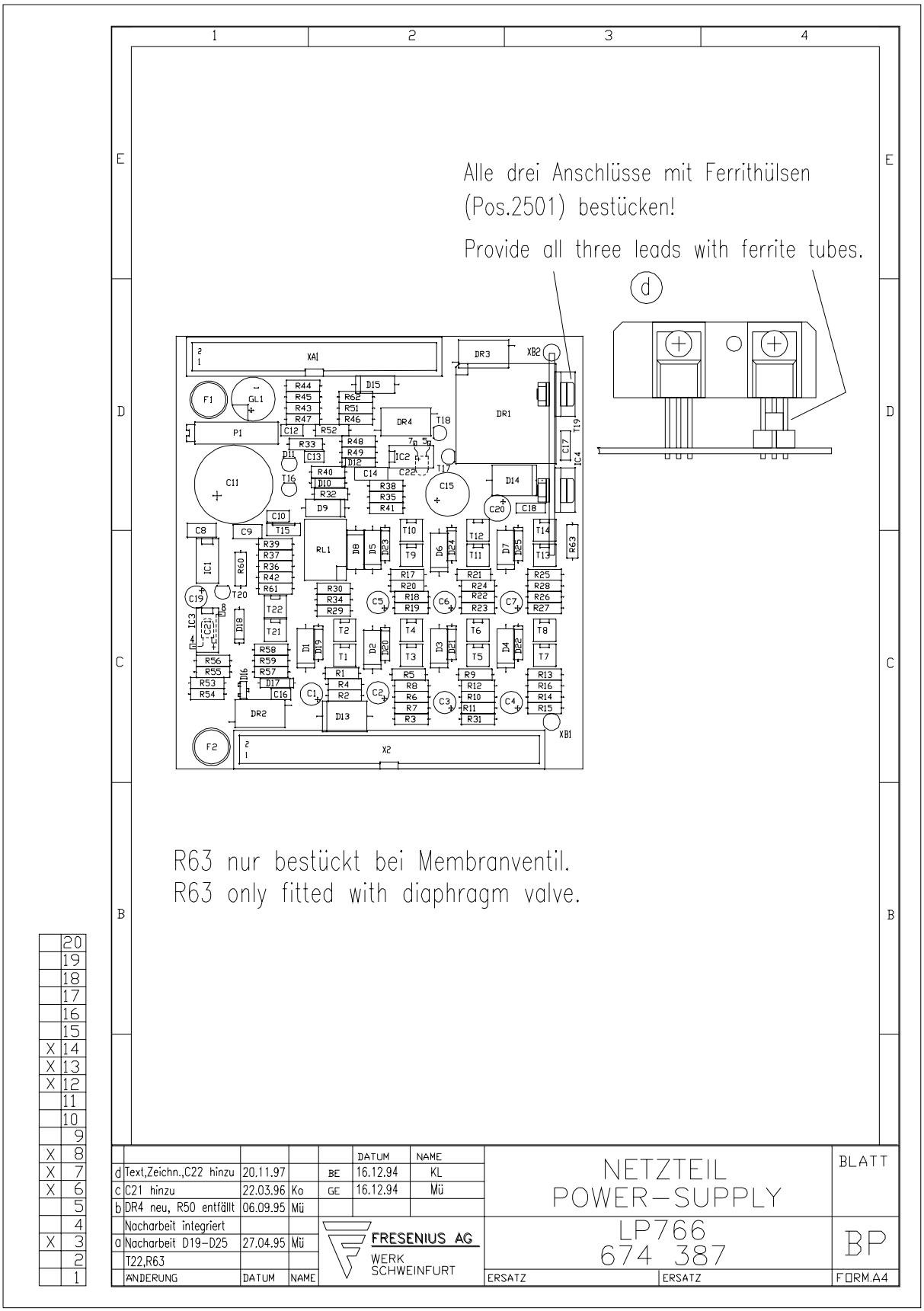
IC3B monitors the 5V voltage. If this voltage drops below 4.6 V ±150 mV, the CPU will be reset via X2 Pin 9.

- **U/I regulation for roller pump**

  The control signals for the motor control are received via X2 Pin 48, 49, 50. A processor-controlled D/A applies a variable voltage to Pin 48 to set the desired motor speed. This signal passes across IC1A and transistor T15, which controls the motor. A voltage which is proportional to the motor current is fed via the shunt R42 of 0.33 Ω across the two operational amplifiers to transistor T15 which causes to motor voltage to rise when the current increases. This prevents dropping of the motor speed. X2 Pin 49 controls clockwise - counter-clockwise rotation of the motor. X2 Pin 50 provides the motor On/Off signal.

Power Supply/ Actuators LP 766

Component Layout



	20
	19
	18
	17
	16
	15
X	14
X	13
X	12
	11
	10
	9
X	8
X	7
X	6
	5
	4
X	3
	2
	1

					DATUM	NAME
d	Text,Zeichn.,C22 hinzu	20.11.97		BE	16.12.94	KL
c	C21 hinzu	22.03.96	Ko	GE	16.12.94	Mü
b	DR4 neu, R50 entfällt	06.09.95	Mü			
	Nacharbeit integriert					
a	Nacharbeit D19-D25	27.04.95	Mü			
	T22,R63					
	ÄNDERUNG	DATUM	NAME			

FRESENIUS AG
WERK SCHWEINFURT

NETZTEIL
POWER-SUPPLY

LP766
674 387

BLATT
BP

ERSATZ | ERSATZ | FORM.A4

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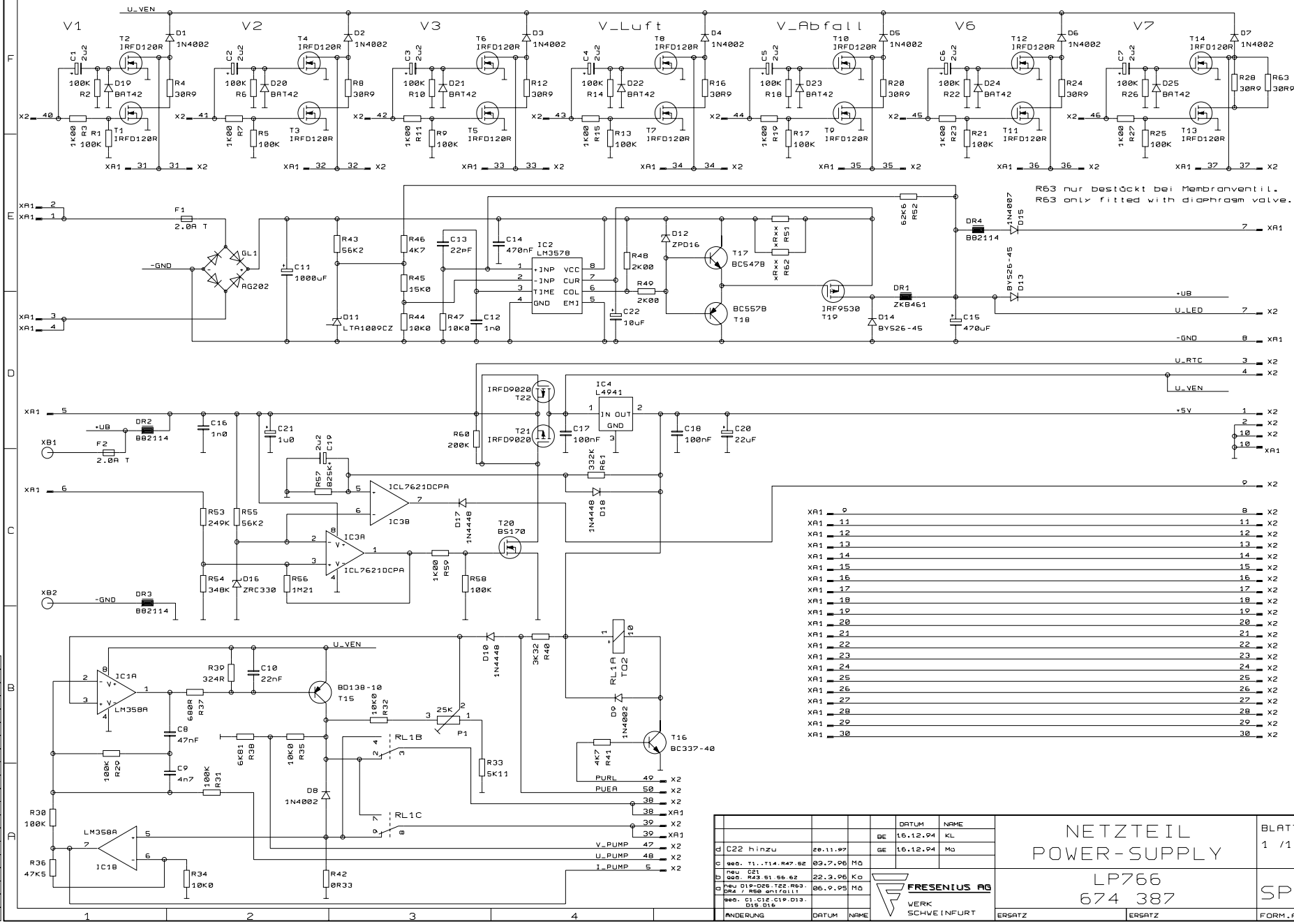
SCHUTZVERMERK NACH DIN 34 BEACHTEN.



					DATUM	NAME
d	C22 hinzu	20.11.97		BE	16.12.94	KL
c	geä. T1..T14.R47.62	03.7.96	MÖ	GE	16.12.94	Mö
b	neu C21 geä. R43.51.56.62	22.3.96	Ko			
a	neu D19-D25.T22.R63. DR4 / R60 entfällt	06.9.95	MÖ			
	geä. C1.C12.C19.D13. D19.D16					
	ÄNDERUNG	DATUM	NAME			

FRESENIUS AG
WERK SCHWEINFURT

NETZTEIL
POWER-SUPPLY

LP766
674 387

BLATT 1 /1

SP

ERSATZ | ERSATZ | FORM.A3

Power Supply / Actuators
P.C.B. LP 766
Circuit Diagram

2.6 Hydraulics Board LP 767

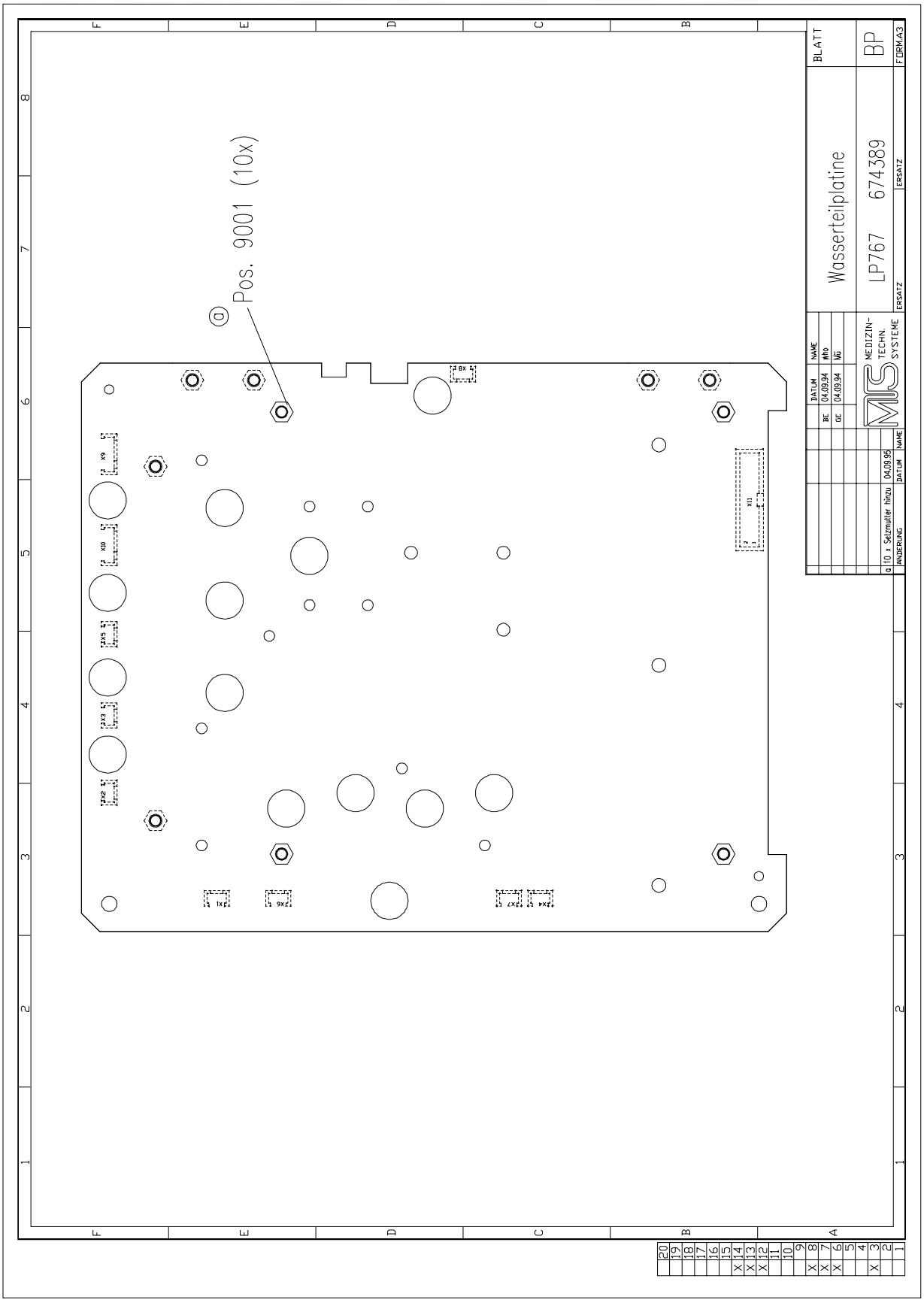
2.6.1 Circuit Description

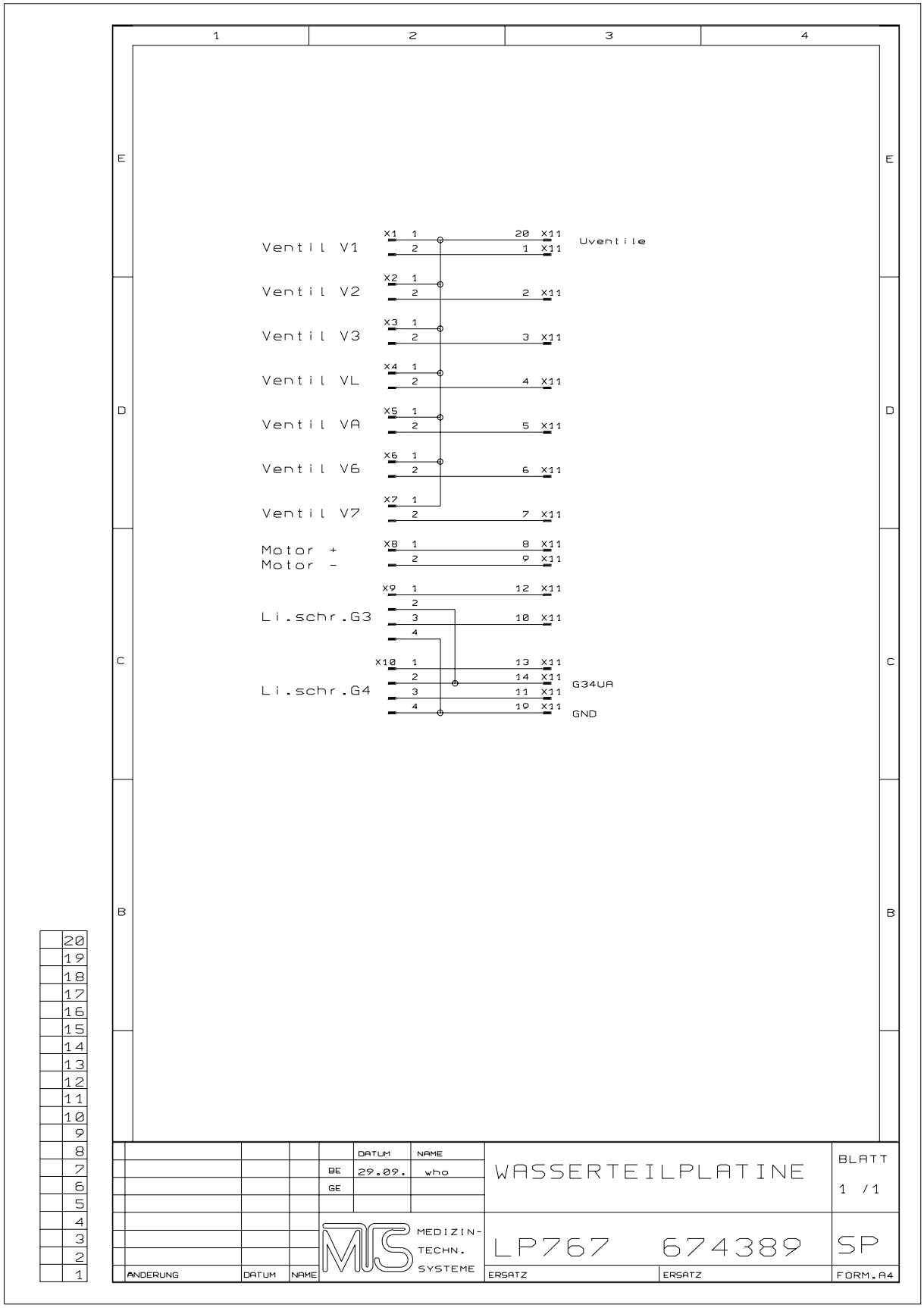
The hydraulics board LP 767 comprises several actuators and provides their supply voltages via connector X11.

Plug-connections for valves, optical sensors and roller pump:
V1 – X1
V2 – X2
V3 – X3
VL – X4
VA – X5
V6 – X6
V7 – X7
Motor – X8
G3 – X9
G4 – X10

Hydraulics Board LP 767

Component Layout




1
2
3
4
E
D
C
B
Ventil V1
Ventil V2
Ventil V3
Ventil VL
Ventil VA
Ventil V6
Ventil V7
Motor +
Motor -
Li.schr.G3
Li.schr.G4
X1 1
2
20 X11
1 X11
Uventile
X2 1
2
2 X11
X3 1
2
3 X11
X4 1
2
4 X11
X5 1
2
5 X11
X6 1
2
6 X11
X7 1
2
7 X11
X8 1
2
8 X11
9 X11
X9 1
2
3
4
12 X11
10 X11
X10 1
2
3
4
13 X11
14 X11
11 X11
19 X11
G34UA
GND
DATUM
NAME
BE
29.09.
who
GE
WASSERTEILPLATINE
BLATT
1 /1
MEDIZIN-
TECHN.
SYSTEME
LP767 674389
SP
ANDERUNG
DATUM
NAME
ERSATZ
ERSATZ
FORM.A4
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1

2.7 CPU Board LP 768

2.7.1 General Notes

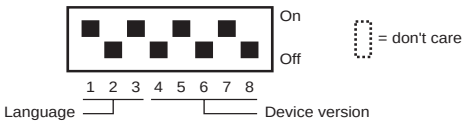
The operating software covers all Ionometer™ 2 models and language options available. The respective model is defined by the setting of switches 4 to 8 of the coding switch S1.

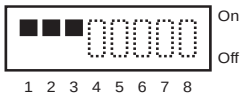
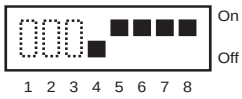
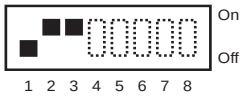
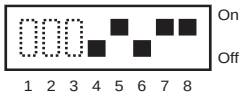
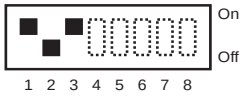
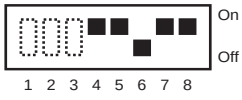
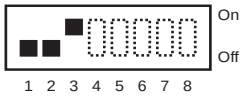
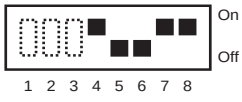
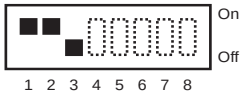
To relieve the processor, some of the basic functions (generation of constant delays, sequence control of an A-D conversion cycle, sequence control of a measuring phase) are relocated into intelligent peripheral modules, which are communicating with the processor via interrupts. This method has the advantage that individual functions and events can be masked and priorized by software.

The utilization of a complex interrupt structure requires a hardware which permits selective manipulation of certain interrupts (enable, disable, set priority) and is able to process interrupt requests occurring simultaneously.

Software features:
- Management of a main memory expanded by bank switching
- Integration of a certain address range for all existing texts, determined by mapping.
- Adjustment of all operating parameters with the exception of the device version.
- Programs for all device versions, defined by DIP switch settings
- Support of the interrupt structure.

2.7.2 DIP Switch Positions S1 for Language and Device Options



Switch position	Language	Switch position	Version
	German		EF
	English		EF-HK
	French		EH-F
	Italian		EH-HK
	Spanish		EG-HK
	If the language is selected on LP 673-1B.		

2.7.3 Plug Connections from and to PCB LP 768

X2 LP 768 to X2 LP 768
X3 LP 768 to X11 LP 767
X5 LP 768 to XA5 LP 769
X4 LP 768 to X7 LP 673

2.7.4 Circuit Description PCB LP 768

- **Processor and memory**

The 8-bit microprocessor NSC800 (IC2), which is operated at a clock frequency of 8 MHz, is the core of the P.C.B.. When the supply voltage is switched on, the processor receives a reset pulse via an RC combination. The reset pulse causes the program sequence to start at a defined point (address 0).
In addition to the power-up “interrupt”, there is a second non-maskable interrupt condition: Upon actuation of the reset button, an NMI pulse is transmitted to the CPU via monoflop IC4B (CD4098). This causes the program sequence to be rerouted to the fixed and preset address 66h. The only pin of the maskable interrupt inputs used is the INTR pin. This pin permits the connection of a programmable interrupt controller (PIC). The interrupt inputs RSTA, RSTB and RSTC are connected to VCC, i.e. they are inactive. The pertinent interrupt vectors are pointing to the cold starting address (address 0000h).

The high byte of the address bus is directly transmitted to the connected memory chips (EPROM, RAM PAL); the data bus divides the low byte by time-division multiplexing. Timing is done via the ALE signal, which is used to load the address latch IC3 (74HC573), which then transfers the address bits A0 to A7 to the EPROMs and the RAM. The data byte, which then follows in the time sequence, is transferred to or from the processor respectively via the bidirectional bus driver IC12 (74HC245), depending upon the read or the write signal being active.The root EPROM IC5 (27C256) is superimposed depending upon the current address. The address of the memory chips is decoded in the GAL IC10. The two memory locations IC6 and IC7 are activated by the common address range from 8000h to FFFFh. On the basis of the state of the page select flipflop IC11A (74HC74), it is then decided, which of the two chips can transmit data to the bus.

The language EPROM IC8 (27C256) is divided into eight equal segments of 3F00h bytes each, which are used to file the texts of the selected language. A section is selected by means of the position of the three lower bits of the DIP switch S1 on P.C.B. LP 673 and is superimposed into the adress area from 5100h to 5FFFh.

The text range is superimposed only upon temporary access to the individual text sections, when individual strings are being copied into the RAM. The default setting of the text code latch is “code”.

The entire range from 5100h to 5FFFh is masked out, when the text/code select flipflop is set to “code”. At this moment, the root EPROM is superimposed, which comprises the floating-point computation routines within the addressing range from 5100h to 5FFFh. Within this code range, any access to texts is denied.

The nonvolatile RAM chip (NovRAM) IC9 comprises an 8 KB read-write memory and is superimposed into the range from 6000h to 7FFFh via address decoding. Here, all variables are filed; stacks, printer spooler and string buffer are also set up.

- **Interrupt controller**

  The programmable interrupt controller (PIC) 82C59A-2 (IC21) is the only peripheral directly connected to the data bus. With an interrupt request being processed by the interrupt controller, the bidirectional bus driver 74HC245 (IC20) is switched to high-impedance condition during the communication of the PIC with the CPU. As a consequence, the data bus is decoupled from all other I/O modules.

  All working parameters of the PIC are set by software and can be altered at any time (if permitted), this also applies to the starting address of the INT vector table.

  PIC 82C59A-2 has eight interrupt inputs which can be individually masked and for which variable priorities can be defined. Depending on the input of the PIC which has triggered the interrupt request, the address of the associated INT routine will be communicated to the CPU which will then execute a call command at this address. The interrupt routine table starts with address 40h (INT 0) and consists of eight vectors with 4-byte spacing each of the type
  CALL <Adr.Lo-Byte> <Adr.Hi-Byte> (cf.page 2-28).

  Six of the eight interrupt sources are connected to the PIC via latches to prevent that one of the interrupt request is “neglected” during an interrupt routine if one or more interrupt requests occur (by edge or pulse on the respective INT line). This measure is taken for the following interrupts: 10 ms, one-second, ISE, glucose, lactate, and keyboard interrupt.
  As soon as the respective interrupt routine is completed, the individual flipflops are again reset . The interrupt request of the serial interface (UART NSC858/NS16C450) is not stored, since it is automatically saved by the chip until it has been processed.

  Generally the 8 interrupt inputs of the PIC used always have different priorities. A special software control insures, however, that all interrupt requests are treated as having the same priority. When an interrupt request occurs other interrupts in the associated routine will temporarily be disabled. The interrupt currently being processed will then be given the least priority before all other interrupts are enabled. After completion of an INT routine all other interrrupts will therefore be given priority over the interrupt that has just been processed
  Interrupts actually never really occur simultaneously and priorities are based on the time they occur.

- **Input-output range**

The major part of the I/O operations are performed via the programmable port chips IC15, IC16 (NSC831) and IC22 (NSC810). The individual chips are enabled by the signals from the address decoder in IC10 (GAL 20V8 /TICPAL22V10Z).

PIO C/IC15/NSC810:	Interface to real-time clock
	Control of the ISE glucose and lactate conversion sequence
PIO D/IC16/NSC810:	Reset of the RS232 controller
	Activation of the buzzer
	Activation of the valves
PIO E /IC22/NSC810:	Activation of G1 and G2
	Display control
	Calibration of the digital potentiometer
	Timer 0 generates the 10-ms interrupt
	Timer 1 supplies the ADC counter with clock pulses

Direct I/O operations are performed via the decoder IC27 (74HC154), which selects eight individual chips:

Chip	Operation
IC18A/19A	Reading in of the DIP switch (device version)
IC18B(19B	Reading in of the coding switch
IC11A	Page select flipflop
IC11B	Text/code select flipflop
IC28	DAC
IC29	Keyboard decoder
IC54	Reset of the interrupt latches for ISE, glucose, lactate and 10-ms interrupts
IC20B	Reset of the interrupt latches for keyboard and 1-second interrupts

- **Serial interface**

The serial interface is formed by IC24 (NSC858). All working parameters, such as baud rate, transmission format and status control of the modem page are set by software. External setting elements are, thus, not present. Conversion to the V24 level is made in IC25 (MAX232).

- **Triple timer**

IC26 (µPD71054) comprises three independent 16-bit timers/counters, which represent a part of the three ADC channels provided for measurement of the electrode voltages. All of the three timers/counters are supplied with the same clock pulse of 200 kHz. They work as binary decrementers, i.e. each of them is loaded with an initial value, decremented to one and then restarted. Gate signals and output lines of the three timers are generated and/or processed on the interface board.

- **Digital-to-analog converter**

The pump voltage is set via the digital-to-analog converter IC28 and then fed to IC30B/pin5.
The pump voltage applied to IC30B/pin7 can be set within a range from 0 to +2.5 volts in increments of approx. 10 mV.

- **Keyboard decoder**

  When either of the three keys “SELECT”, “START” or “DISPLAY” is pressed, the keyboard decoder IC29 (74C922) issues an interrupt request to the CPU which is temporarily stored in a flipflop (IC20B).

- **Real-time clock**

  The supply for the real-time clock formed by IC14 (MSM5832) is derived from the battery of the Ionometer, so that the time is preserved even after the device has been turned off.
  The RTC is controlled via the port lines of IC15 (NSC810). Via the PIC, an interrupt request to the CPU is generated by line D1 at one-second intervals (1-second interrupt).

- **Voltage supply**

  The DC-DC converter (IC38) provides the supply voltages for the sensors, which are isolated from the power supply unit of the Ionometer. The negative supply voltages are derived from voltage inverter IC36/37. The maximum current of the DC-DC converter is 100 mA. The voltage inverter has a maximum output of 40 mA.

- **Serial ADC**

  The circuitry for data collection of the optical sensor values is implemented via the serial ADU IC39. With an additional multiplexer IC40, the number of the analog inputs has been increased to 8, since pump voltage, pump current and battery voltage are also measured, in addition to the voltages of the optical sensors.

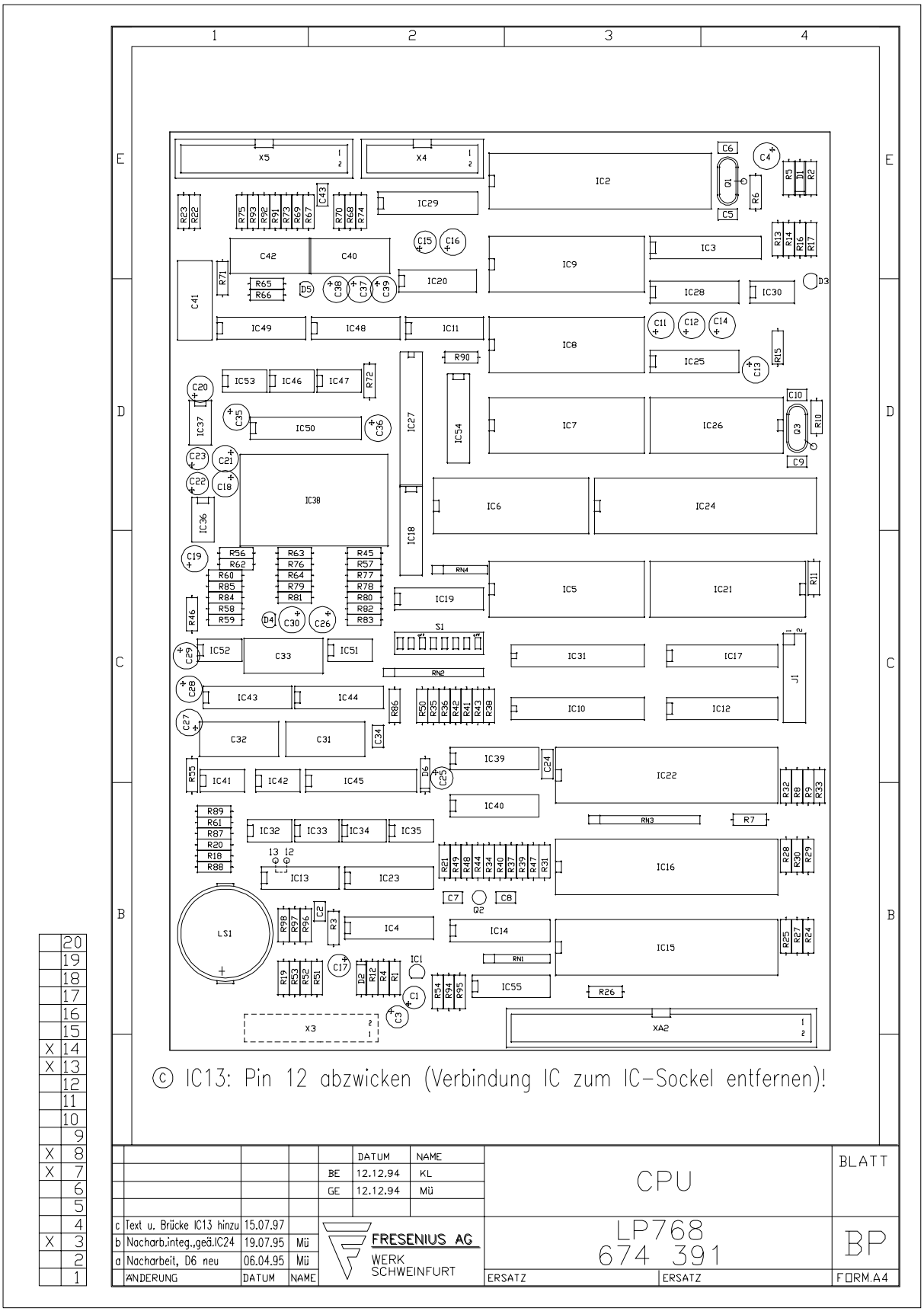
- **Galvanically decoupled A-D converters**

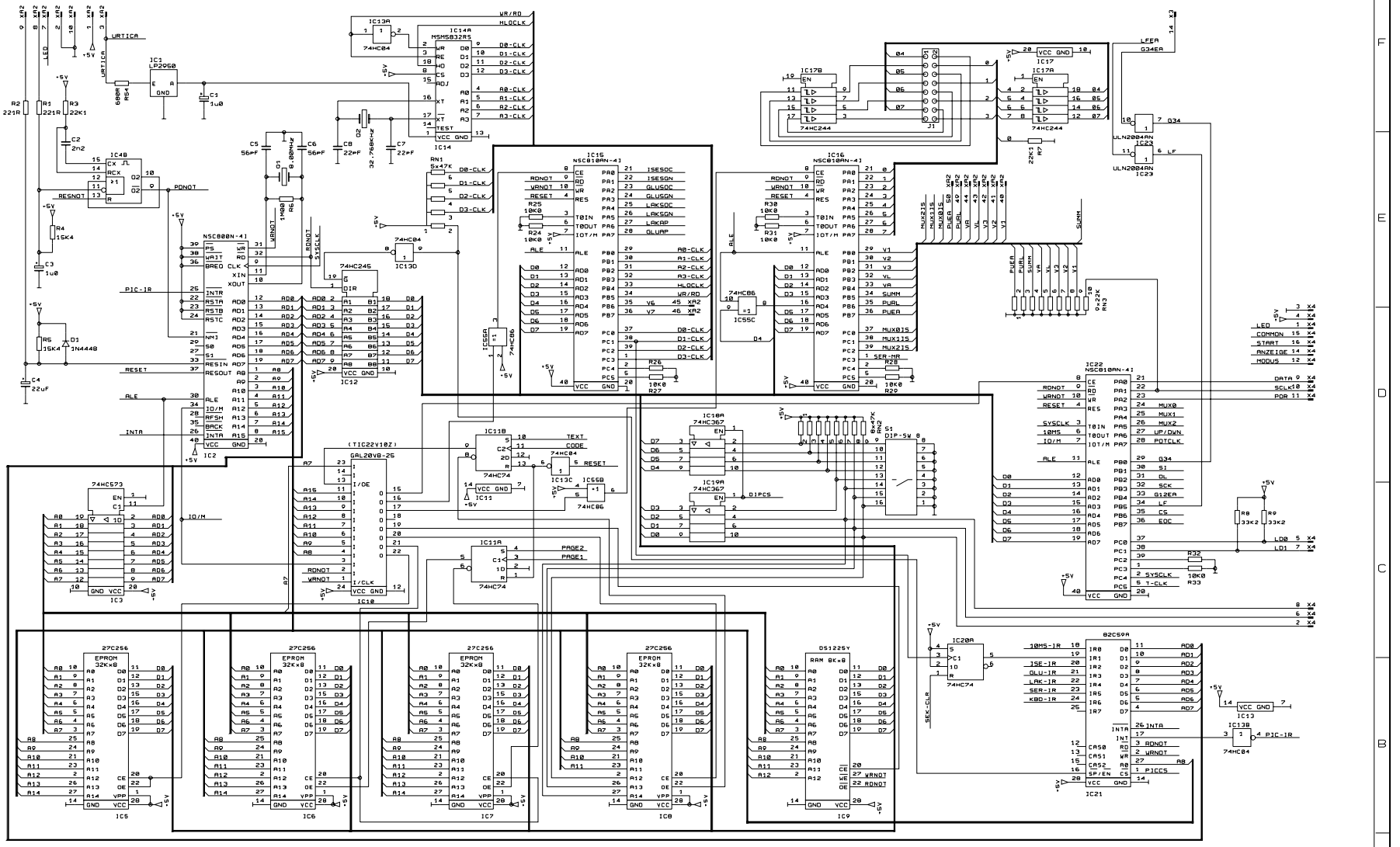
  To reduce the number of components, the sequence control has been realized by means of a PAL. The reference voltage for each serial converter (IC43, IC48) is 2 V ±1%. The resolution for ISE was defined by software to 12.000 counts and for glucose to 8,000 counts. This corresponds to an effective resolution of 2,000 mV/12,000 = ±0.166 mV for ISE and 2,000 mV/8,000 = ±0.25 mV for glucose. The individual channels and the individual ADC phases are selected by means of optocouplers. The circuit was originally designed for HCPL 2630 optocouplers. The disadvantage of these devices is the relatively high power consumption of approx. 45 mA per optocoupler. It was therefore decided to change to the pin-compatible HCPL 2232 which has a power consumption of approx. 15 mA . The HCPL 2232 also differs from the HCPL 2630 in that its output polarity is reversed and that, as a consequence, the sequence control had to be changed. With the appropriate PAL, use of both types is, however, possible.

- **Optical sensors**

  The optical sensors are calibrated in the service program, switch position D, by means of digitally adjustable potentiometers (IC32 - IC35). The adjustment is performed automatically.

CPU Board
LP 768
Component Layout





		DATUM	NAME
	BE	12.12.94	KL
	GE	12.12.94	MO

d	geo.Bl.2	15.7.97	
c	geo.Bl.3	4.11.96	MO
b	geo.Bl.2 u.3	26.1.96	MO
a	geo.Bl.2 u.3	06.4.95	MO
	ANDERUNG	DATUM	NAME

FRESENIUS AG
WERK SCHWEINFURT

CPU

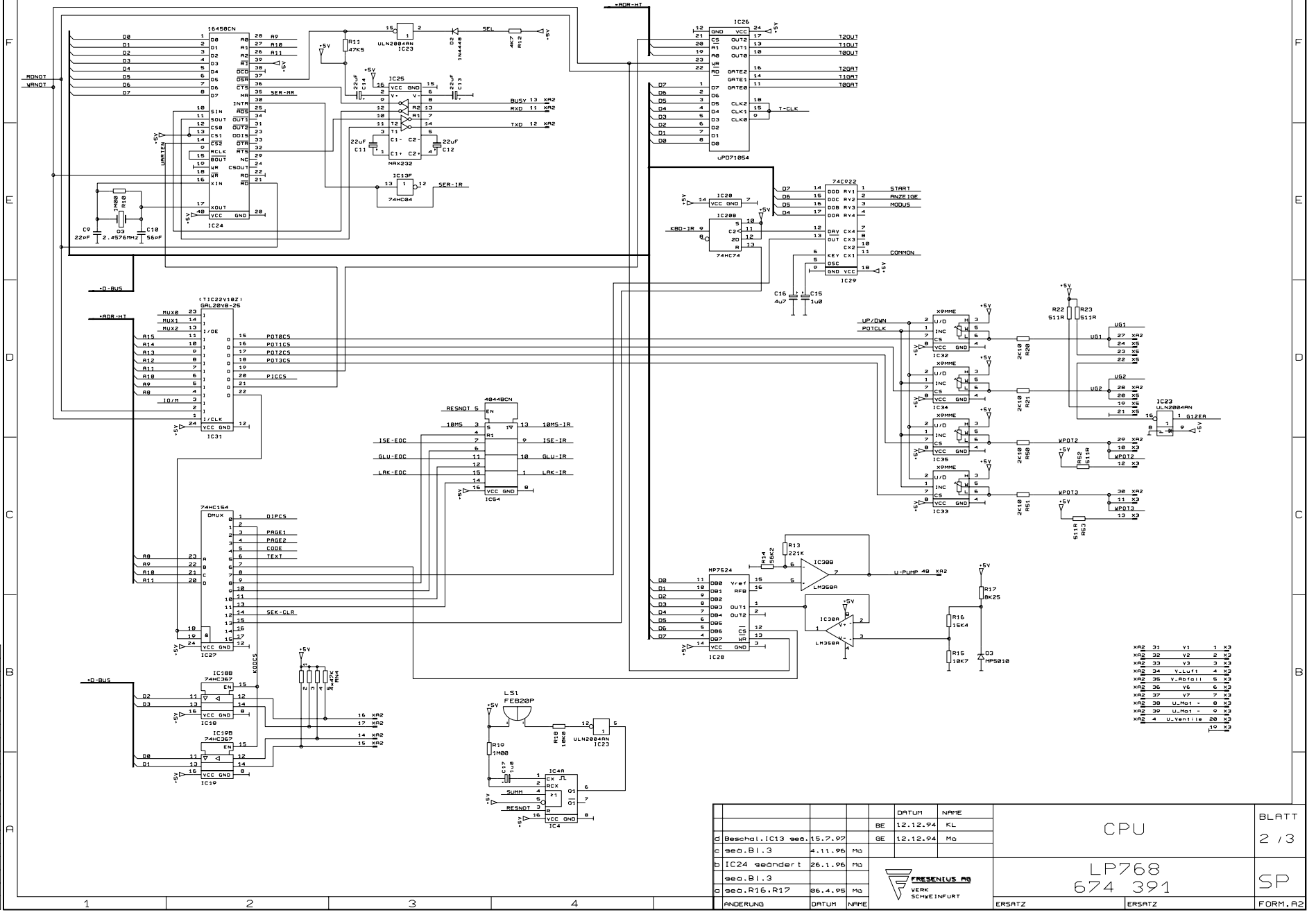
LP768
674 391

BLATT 1 / 3

SP

ERSATZ | ERSATZ | FORM.A2

CPU Board
P.C.B. LP 768
Circuit Diagram 1/3



					DATUM	NAME
				BE	12.12.94	KL
d	Beschal.IC13 gee.	15.7.97		GE	12.12.94	Ma
c	gee.Bl.3	4.11.96	Ma			
b	IC24 geandert	26.1.96	Ma			
	gee.Bl.3					
a	gee.R16,R17	06.4.95	Ma			
	ANDERUNG	DATUM	NAME			

FRESENIUS AG
WERK SCHWEINFURT

CPU

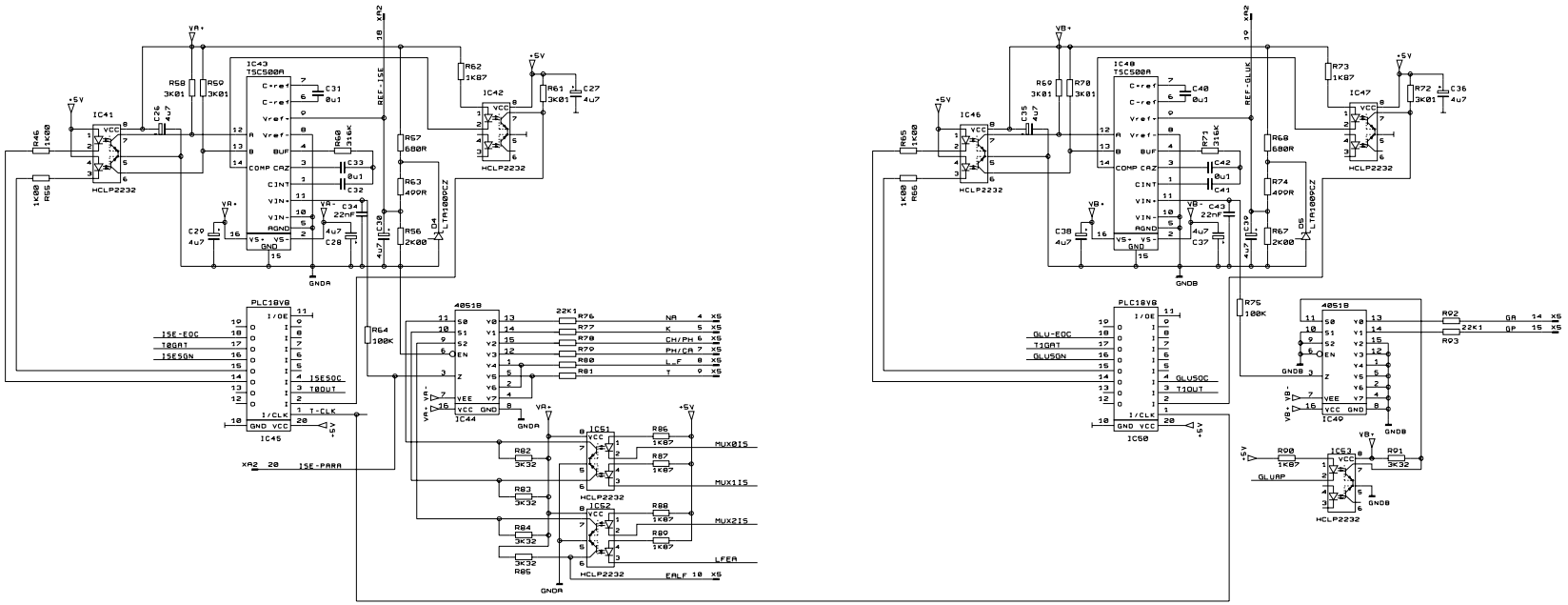
LP768
674 391

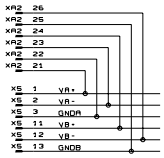
BLATT 2 / 3

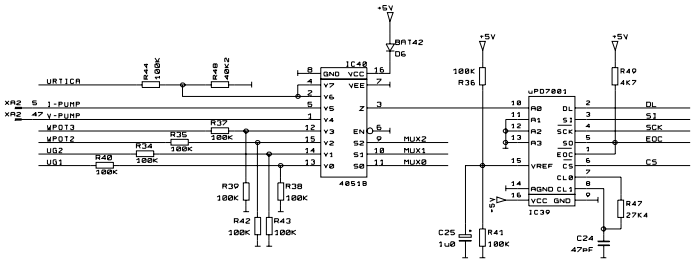
SP

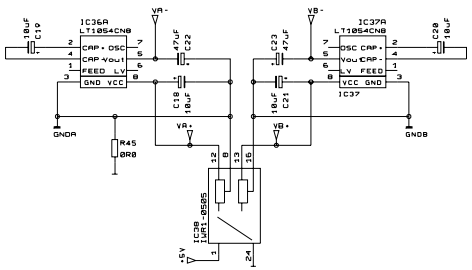
ERSATZ | ERSATZ | FORM.A2

CPU Board
P.C.B. LP 768
Circuit Diagram 2/3









					DATUM	NAME	
				BE	12.12.94	KL	
d	seä.Bl.2	15.7.97		GE	12.12.94	Ma	
c	R62.R73.R86-R90seä.	4.11.96	Ma				
b	R44var10k.R48var4k02	26.1.96	Ma				
	seä.Bl.2						
a	neu D6	06.4.95	Ma				
	ÄNDERUNG	DATUM	NAME				

FRESENIUS AG
VERK
SCHWEINFURT

CPU

BLATT 3 / 3

LP768
674 391

SP

ERSATZ | ERSATZ | FORM.A2

CPU Board
P.C.B. LP 768
Circuit Diagram 3/3

2.8 Sensor Board LP 769

2.8.1 Circuit Description

- **Impedance transformer and filter**

  With an amplification of 1, the maximum offset voltage is specified to be ±0,5 mV for the operational amplifier OPA 129. With an amplification of 21, an offset voltage of 10,5 mV, thus, results at the Na electrode. The following lowpass filter with an amplification of 1, provides a maximum offset of another 5 mV. With both voltages taken into consideration, an offset of <15.5 mV is achieved. Since, with an ISE measurement, this offset voltage is applied both to the sample and to the standard solutions, there are neither measuring errors nor significant limitations to the measuring range of 0 V to 2 V. Potentiometers for setting the zero are therefore not required. The voltage is supplied by an isolated DC-DC converter on the CPU board.

- **CD generator**

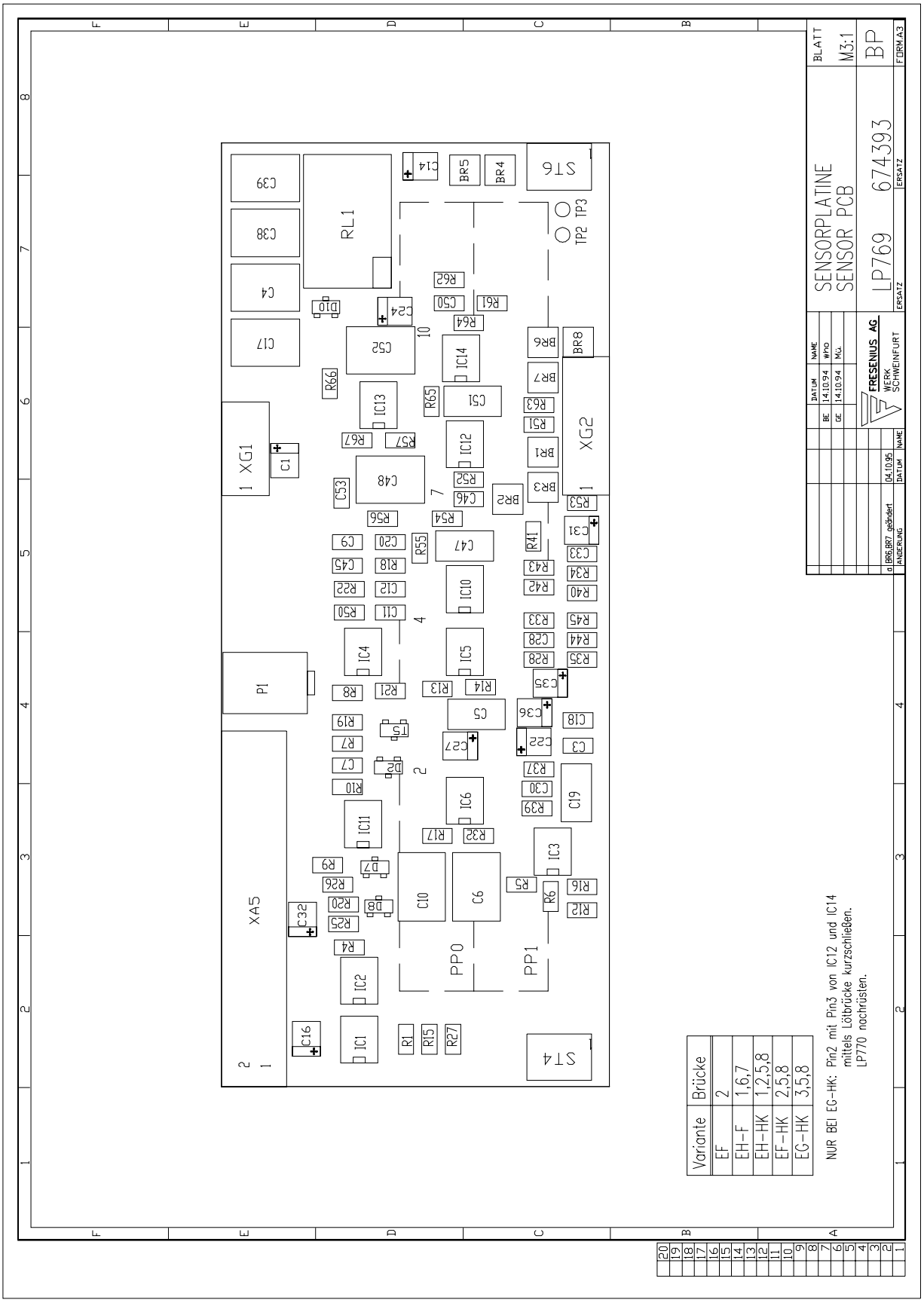
  This P.C.B. also comprises the CD generator. The CD cell can be "turned off" for calibration. Due to manufacturing tolerances of the regulating transistor, conductivity must be calibrated as before.

- **Temperature measurement circuit**

  The temperature measurement circuit was completely redesigned. Computation of the components with all tolerances taken into account revealed that a calibration of the circuit is not necessarily required. Simulation of 1,000 circuits on a PC showed a max. tolerance of ±0.2 °C, related to the circuit without NTC tolerances. With the previous calibration a tolerance of ±0.2 °C was acceptable. This circuit, which cannot be calibrated, requires the use of components with tight tolerances: resistors ±0.1%; reference voltage source ±0.4%; operational amplifier offset ±60 µV.
  Another change is the use of SMD resistors with a tolerance of ±0.1%.

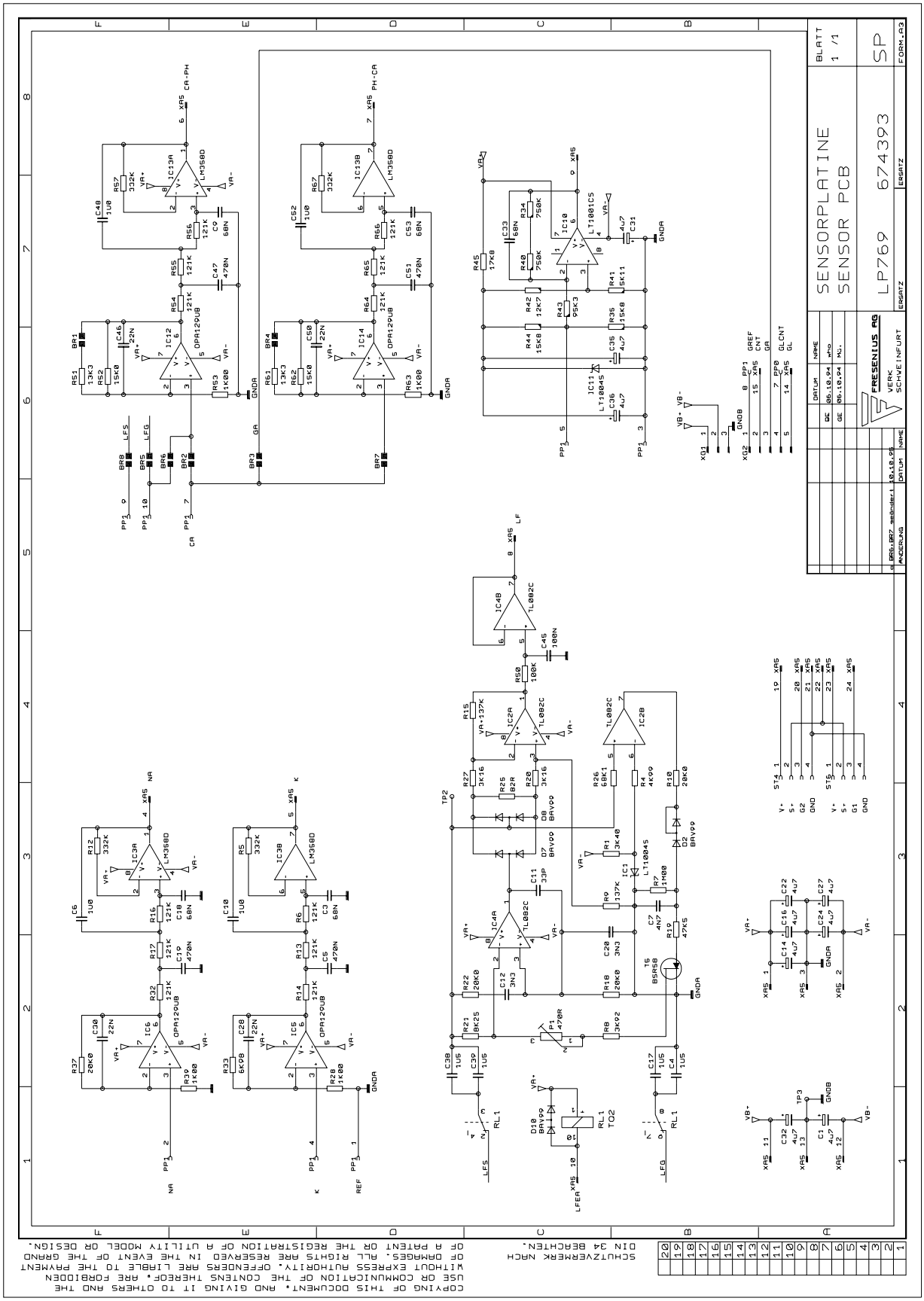
Sensor Board LP 769

Component Layout



Sensor Board
LP 769

Circuit Diagram 1/1



2.9 Glucose Sensor

2.9.1 Amperometric Circuit

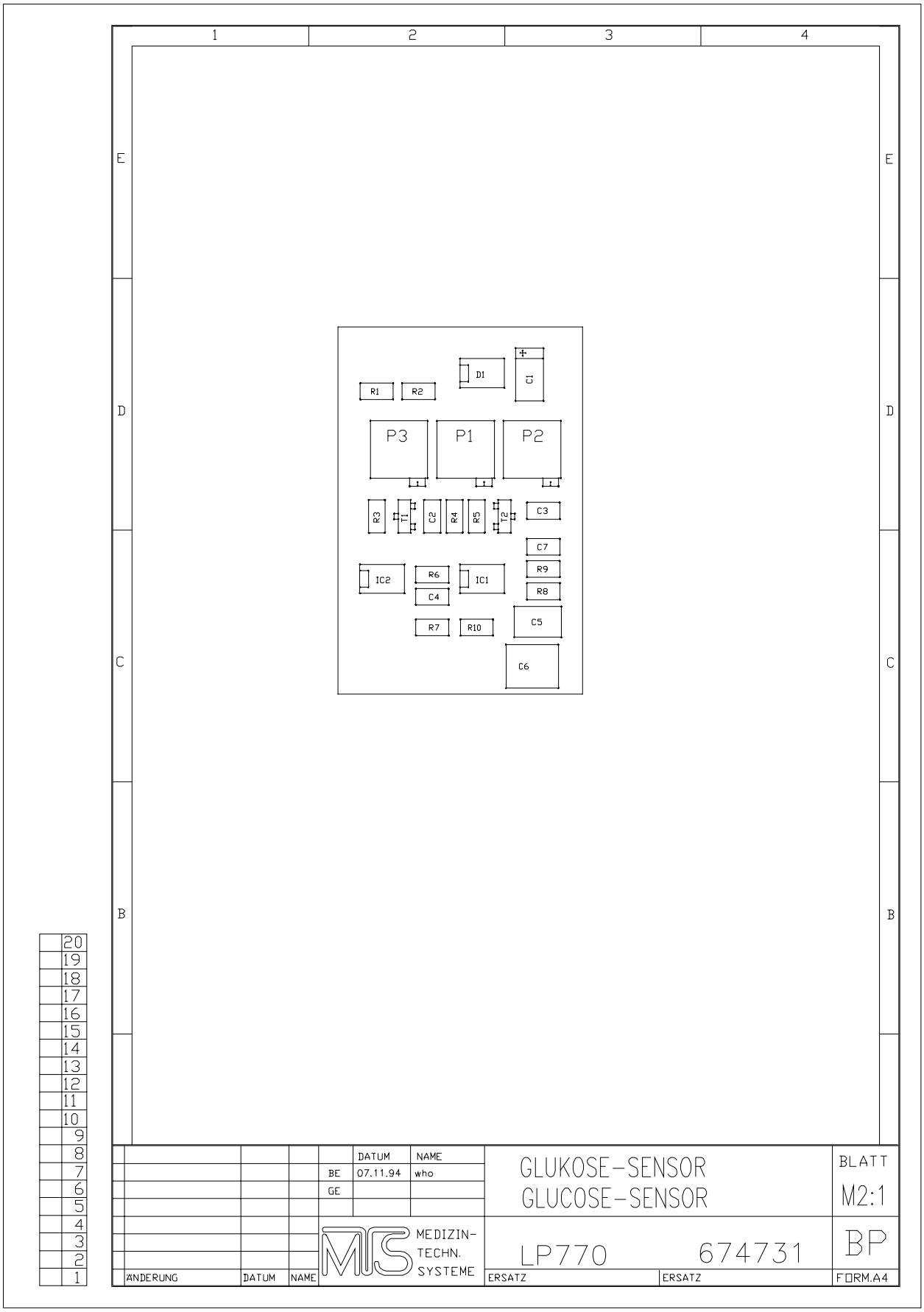
This circuit requires a reference voltage of approx. –0.3 V. This voltage is set via an accurate reference diode and a resistance voltage divider (trimmer) (330 mV ±10 mV). Current-voltage conversion is made by means of an operational amplifier.
The reference voltage (working voltage) is fed into the sensor via the counter electrode (GLCNT). Via the reference electrode (GREF), the voltage is countercoupled and, thus, stabilized. The actual voltage applied to the counter electrode is lower/higher than the reference voltage, which depends on the glucose concentration and the materials used in the glucose sensor. Operational amplifiers convert the current flowing from the counter electrode to the measuring electrode (depending upon the glucose concentration) to voltage.
The maximum permissible voltage applied to the counter electrode should not exceed ±2 V (±50 mV). It is set by means of trimming potentiometers.

2.9.2 Optical Sensors

The optical sensors are calibrated in the service program, switch position D, by means of digitally adjustable potentiometers.

Glucose Sensor Board LP 770

Component Layout



Glucose Sensor
LP 770

Circuit Diagram

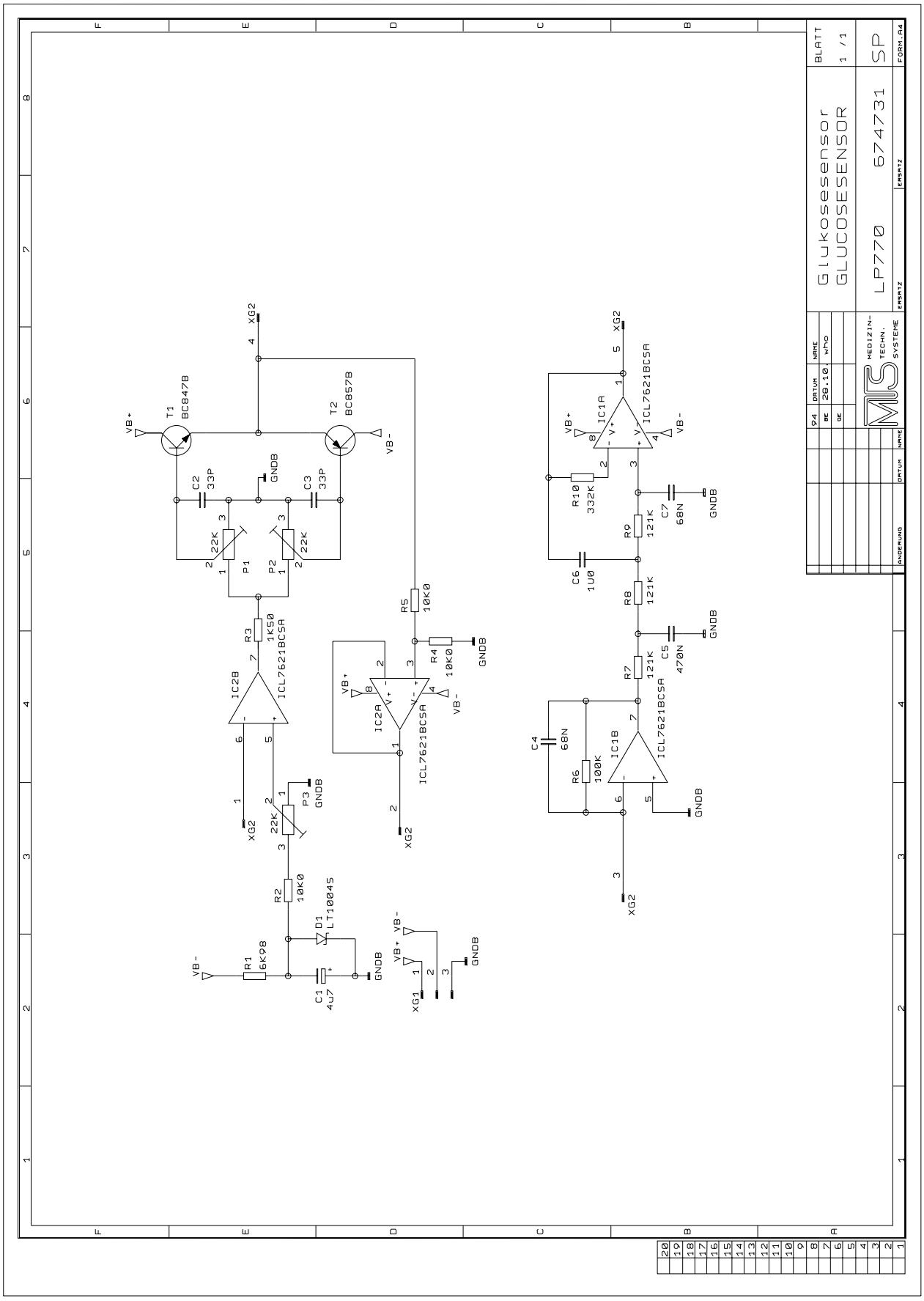


Table of Contents
3. Spare Parts Catalog

How to Use the Spare Parts Catalog

Purpose

To define and order the spare parts required.

Any inqiries should be addressed to:

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

Local Service:

For correct spare parts orders the following information is required:

– Indication of the part number

– Indication of the serial number

– Indication of the equipment code

Record all modifications performed and change the E- code, if appropriate.
It is recommended to maintain a machine record or machine card for entering these changes.

Organization

The Spare Parts Catalog comprises 14 assemblies.
Each assembly has been allocated a specific assembly number. Incompatible changes (modifications) are identified by an increasing decimal of the assembly number.

E-code

The equipment code (E-code) is shown on the label attached on the device. The E-code always indicates the status of the device upon delivery.

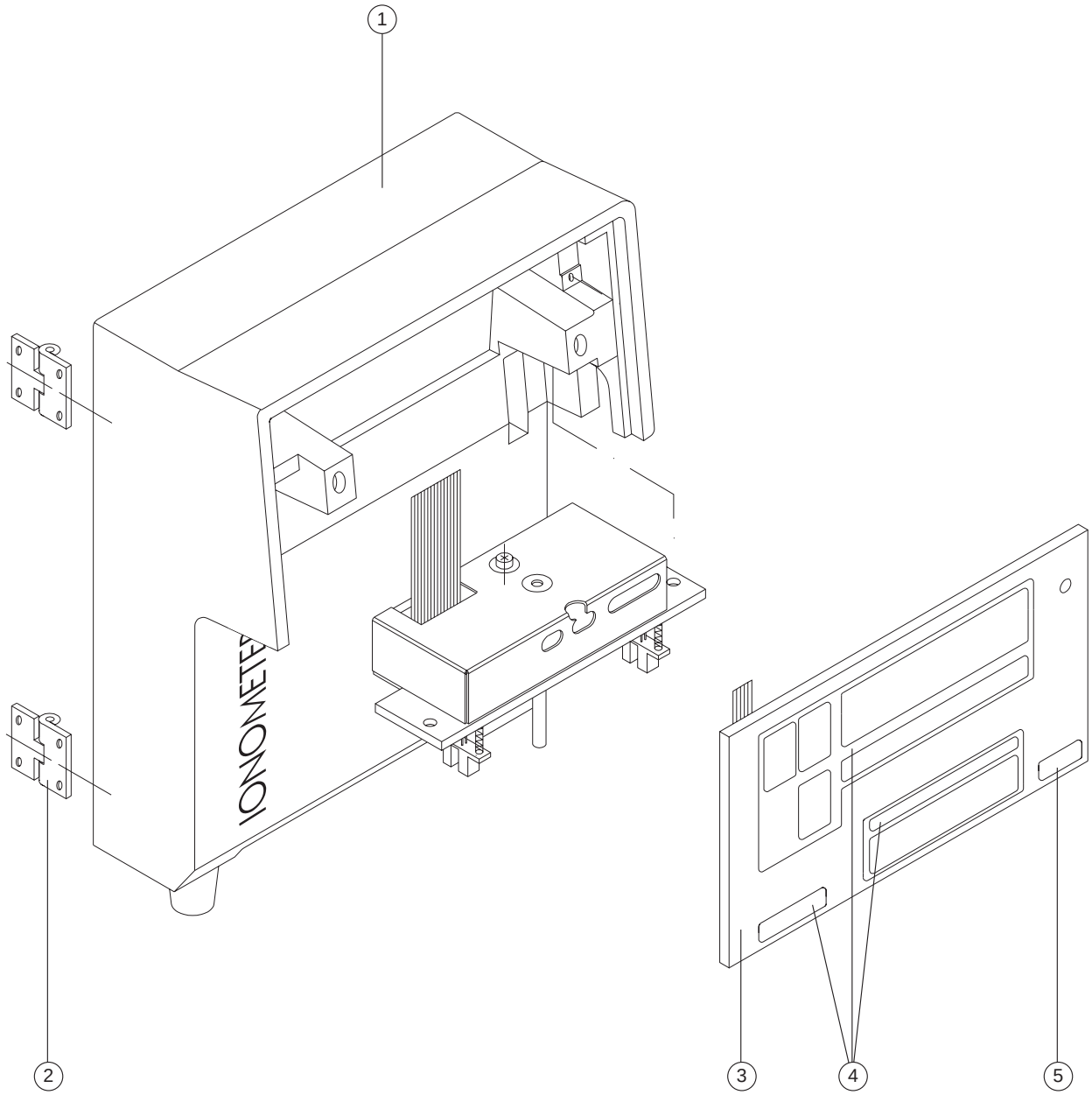
The present Spare Parts Catalog is applicable for devices from equipment code:
E-Code 200

Update service

Updates to the Spare Parts Catalog will be released as:
– Replacement page
– Supplementary pages
– Technical information sheets

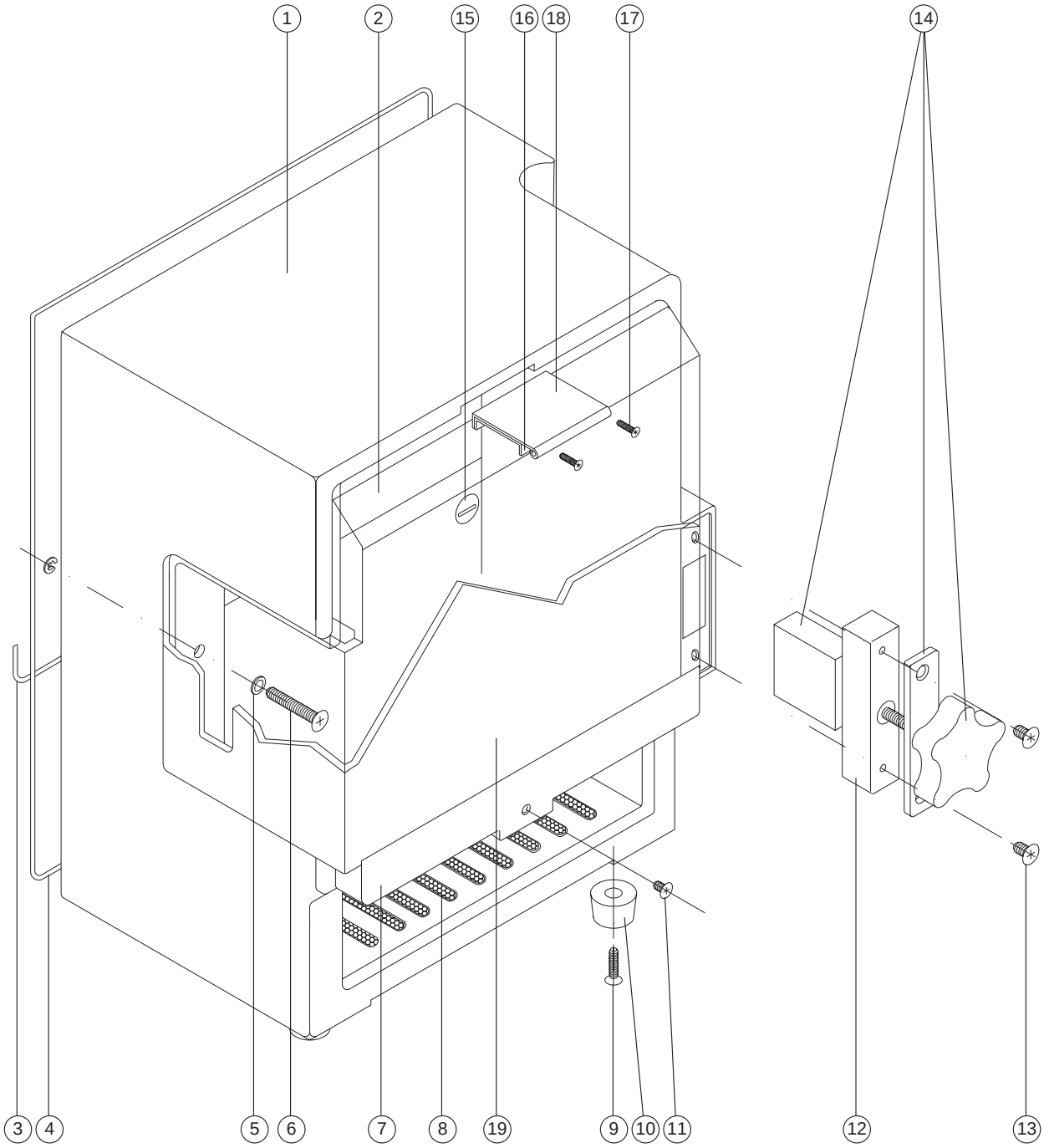
Subject to alteration.

Group 1.0 Housing Front



Pos.	Part no.	Description
1	675 028 1	Housing shell, front
	675 114 1	Housing front complete
2	675 136 1	Hinge
3	674 626 1	Front panel
4	678 635 1	Label set (3 labels) EG-HK
	678 633 1	Label set (3 labels) EF-HK
	678 634 1	Label set (3 labels) EH-HK
	678 636 1	Label set (3 labels) EH-F
	678 632 1	Label set (3 labels) EF
5	678 627 1	Label FMC-Symbol

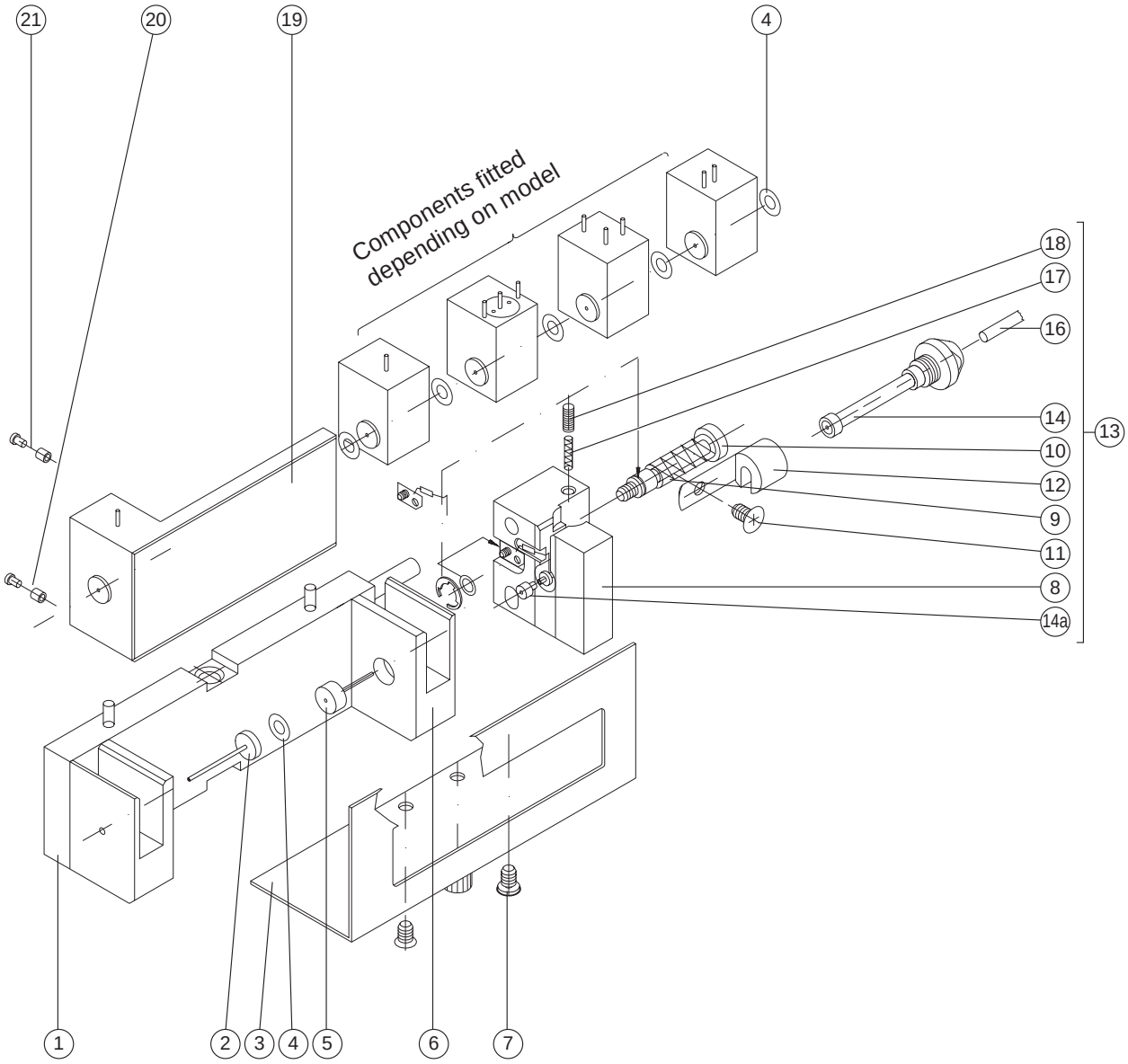
Group 2.0 Housing Rear



Group 2.0 Housing Rear

Pos.	Part no.	Description
1	675 030 1	Housing shell, rear
2	675 491 1	Center cover plate EG-HK, EF-HK, EF
	675 490 1	Center cover plate EH-HK, EH-F
3	641 280 1	Seal
4	579 211 1	Sealing cord
5		Washer A 4.3
6	650 078 1	Screw
7	674 812 1	Support rail
8	652 241 1	Perforated plate
9		Screw B 3.5 x 13
10	640 965 1	Housing foot
11		Screw M 3 x 2.5
12	674 813 1	IV-pole clamp block
13		Screw M 4 x 30
14	650 300 1	IV-pole clamp complete
15	644 028 1	Screw cap (black)
16	650 834 1	Spring stop
17		Screw B 2.2 x 6.5
18	642 078 1	Locating spring
19	674 816 1	Rear panel

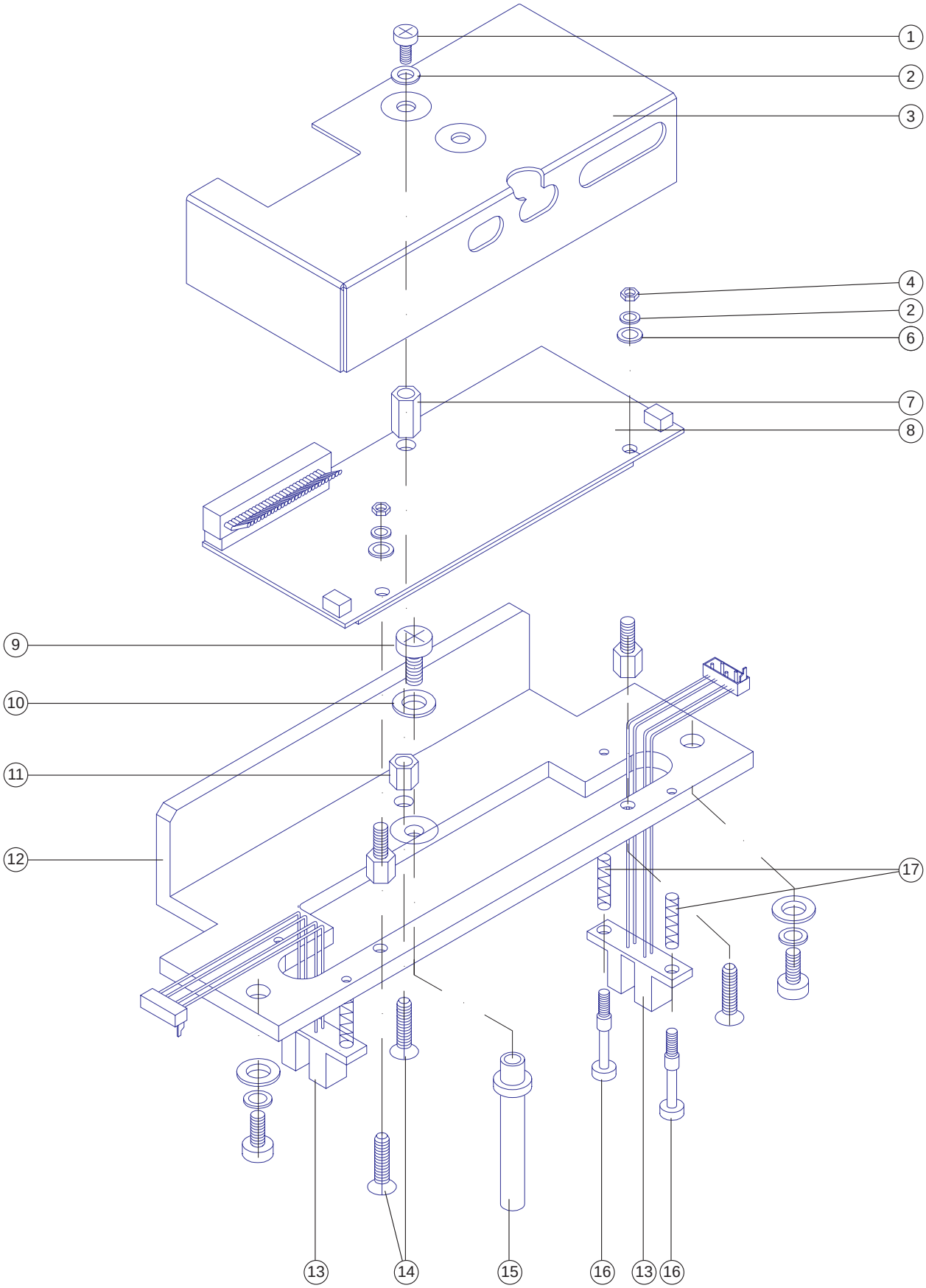
Group 3.0 Electrode Unit



Group 3.0 Electrode Unit

Pos.	Part no.	Description
1	650 075 1	Guide plate cpl. (incl. items 2, 3, 4, 5, 6, 7)
2	650 013 1	Optical sensor insertion capillary (left)
3	641 736 1	Screening bracket
4	579 062 1	O-ring
5	650 012 1	Optical sensor insertion capillary (right)
6	650 073 1	End piece right
7		Screw M 3 x 6
8	652 124 1	Support block C
	651 709 1	Support block
9	643 874 1	Compression spring
10	651 714 1	Screw
11		Screw M 3 x 8
12	650 228 1	Joint
13	501 335 1	Swivel adapter without C (EG-HK, EH-HK, EF-HK)
	501 336 1	Swivel adapter C complete with grounding capacitor
	501 335 1	Swivel adapter complete
14	674 084 1	Tubing for swivel adapter cpl.
14a		Part of item 14 only to be cut off with swivel adapter C
	501 381 1	Temperature sensor complete (incl. item 4)
16	501 321 1	Suction capillary, 1.3 mm, 100 units
	501 322 1	Suction capillary, 1.6 mm, 100 units
17	643 873 1	Compression spring
18	640 946 1	Threaded pin
19	501 330 1	Reference electrode complete (incl. item 4, 20, 21)
20	643 252 1	Reference electrode plug 1
21	643 634 1	Reference electrode plug 2
	501 327 1	NA electrode complete (incl. item 4)
	501 329 1	K-/T-electrode complete (incl. item4)
	651 753 1	CD measuring cell, 16 mm (incl. item 4)
	501 326 1	Glucose electrode complete (incl. item 4)
	650 653 1	Ca electrode complete (incl. item 4)
	501 380 1	pH electrode complete(incl. item 4)
	650 612 1	Electrode spacer (incl. item 4)

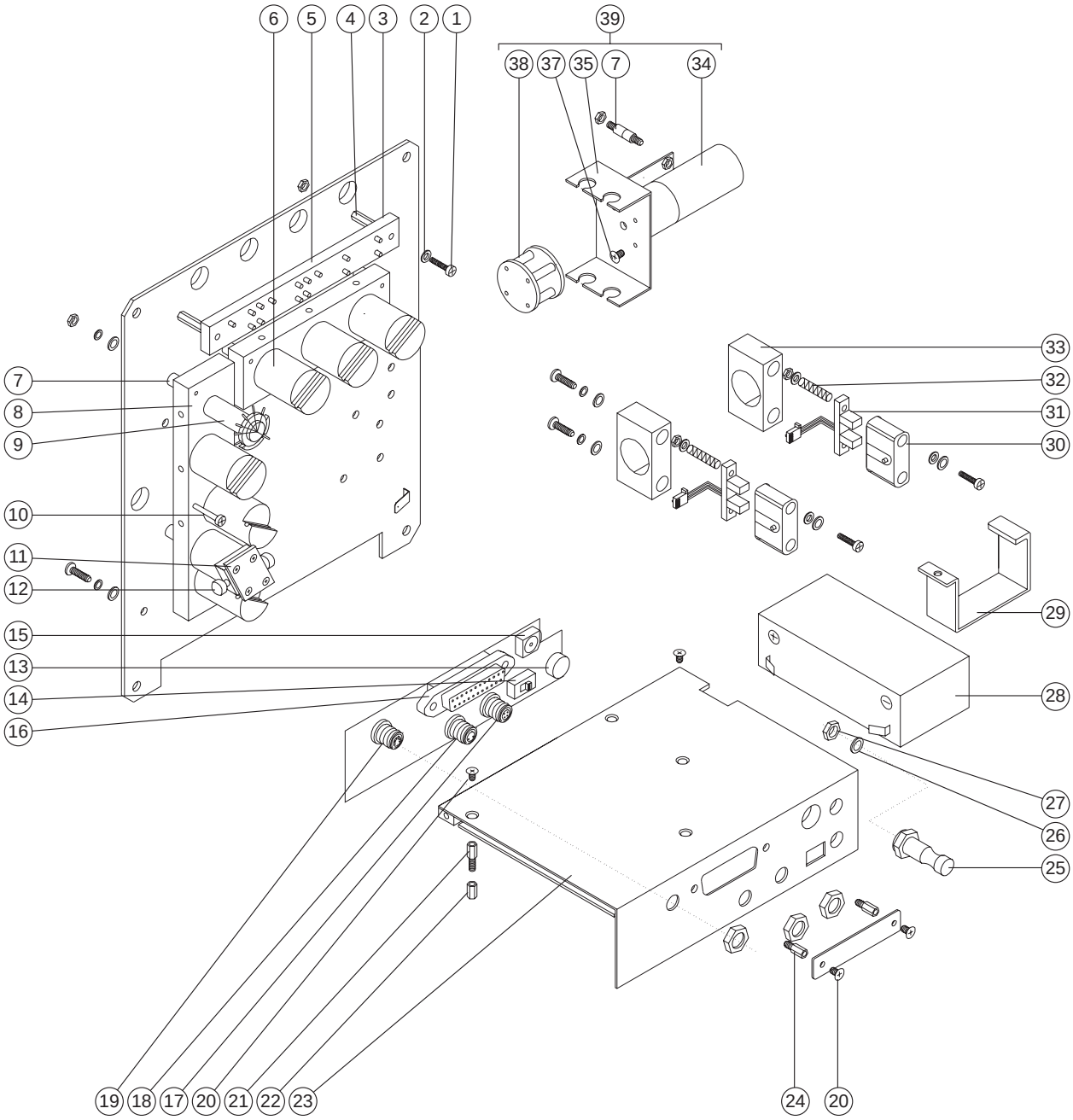
Group 4.0 P.C.B. Housing with Mounting Hardware



Group 4.0 P.C.B. Housing with Mounting Hardware

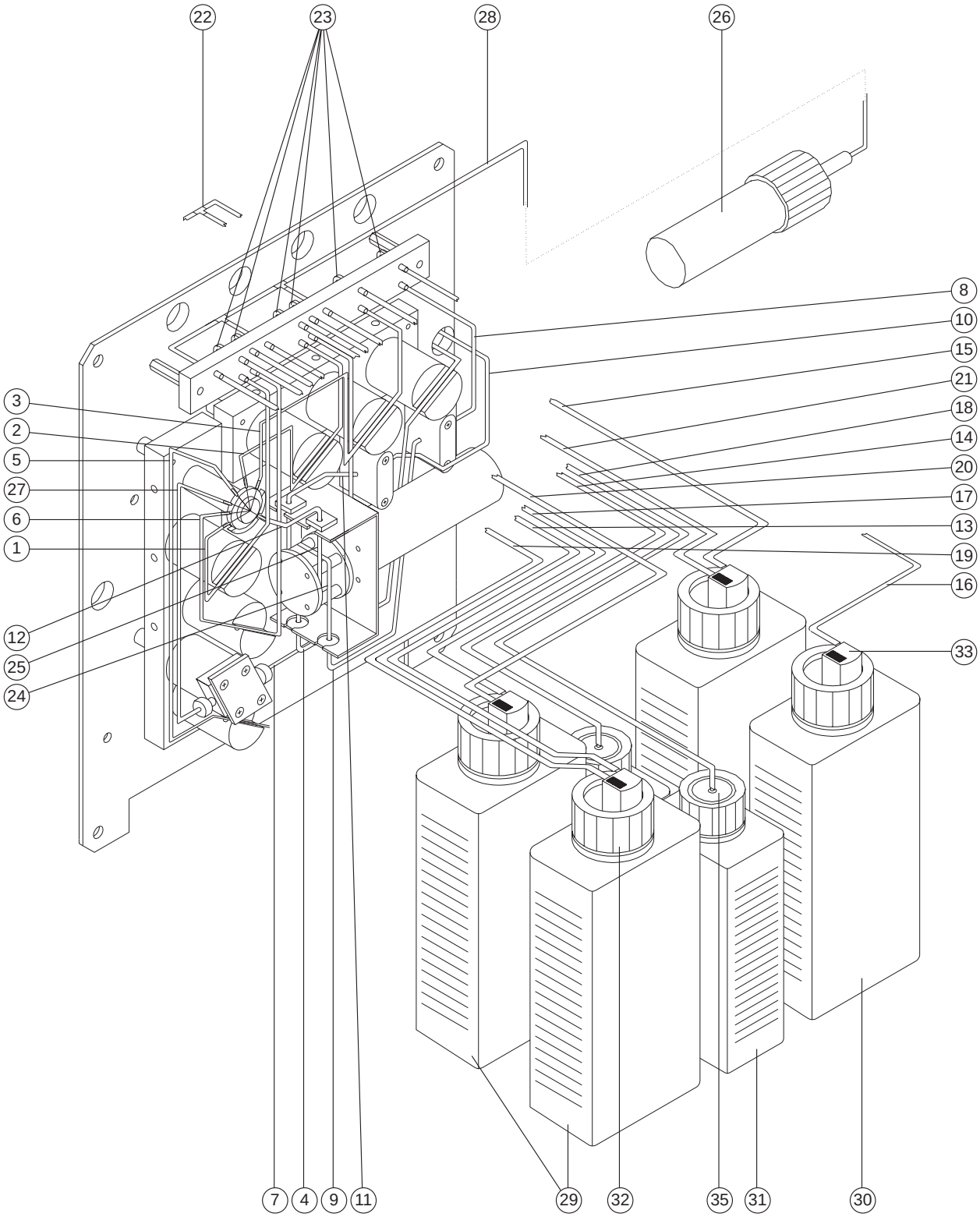
Pos.	Part no.	Description
1		Screw M 3 x 6
2		Spring washer B 3
3	650 015 1	Housing cover
4	553 692 1	Washer A 3,2
6	553 620 1	Hexagon nut M 3
7	650 439 1	Spacer M 3 x 12,5
8	674 393 1	P.C.B. LP 769 complete
	674 731 1	P.C.B. LP 770 (for EG-HK only)
–	640 399 1	Jumper
9		Screw M 4 x 6
10		Tooth washer A 4.3
11	580 731 1	Spacer M 3 x 5
12	652 355 1	Bracket
13	647 458 1	Optical sensor complete
14		Screw M 3 x 6
15	650 039 1	Guide bolt
16	650 080 1	Screw
17	643 902 1	Compression spring

Group 5.0 Hydraulics Board LP 767 with Add-On Units



Pos.	Part no.	Description
	674 382 1	LP 765 Interface board
	674 387 1	LP 766 Power supply board
1		Screw M3x30
2		Spring washer
3	650 325 1	Distribution bar
4	640 990 1	Spacer 3 x 18
5	650 063 1	Valve clamping strip (3 valves)
6	650 392 1	Pinch valve
	644 046 1	Pinch valve locking pin
7	640 988 1	Rubber pad
8	674 810 1	Valve clamping strip (4 valves)
9	674 993 1	Distributor complete, 7 terminals
10		Pin (without heat-shrink) M 3 x 30
11	675 292 1	Membrane valve
12	675 291 1	Adapter
13	670 890 1	Reset button
14	674 823 1	Slide switch
15	645 801 1	Coding switch
16	674 824 1	25-pin D-SUB connector
17	645 030 1	4-pin socket
18	641 329 1	2-pin socket
19	641 331 1	7-pin socket
20		Screw M3x4
21	675 134 1	Spacer 3x6
22	644 040 1	Spacer 3x13
23	674 814 1	Mounting bracket
24	641 676 1	Bolt 3x5 mm
25	647 035 1	Ground stud
26		Tooth washer A 5.3
27		Hex nut M 5
28	673 499 1	Battery 6 V 1,2 Ah
29	674 811 1	Battery clip
30	650 832 1	Optical sensor hood
31	675 013 1	Optical sensor with plug
	651 795 1	Optical sensor without plug (for service only)
32	643 902 1	Compression spring
33	674 815 1	Optical sensor mount
34	645 265 1	Motor / gear combination
35	650 059 1	Mounting bracket for motor/gear combination for UI-controlled units
37		Screw M 2 x 5
38	650 061 1	Rotor complete
39	647 697 1	Double tube pump (incl. items 7, 34, 35, 37, 38)
not ill.	652 552 1	AC adapter with grounding plug (D)

Group 6.0 Line Set with Bottles



Group 6.0 Line Set with Bottles

Pos.	Part no.	Description
1	675 116 1	Line no. 1
2	675 117 1	Line no. 2
3	675 118 1	Line no. 3
4	675 119 1	Line no. 4
5	675 120 1	Line no. 5
6	675 121 1	Line no. 6
7	675 122 1	Line no. 7
8	675 123 1	Line no. 8
9	675 124 1	Line no. 9
10	675 125 1	Line no. 10
11	675 126 1	Line no. 11
12	675 127 1	Line no. 12
13	675 458 1	Line no. 13
14	675 459 1	Line no. 14
15	675 460 1	Line no. 15
16	675 461 1	Line no. 16
17	675 466 1	Line no. 17
18	675 467 1	Line no. 18
19	675 462 1	Line no. 19 (for H models only)
20	675 463 1	Line no. 20 (for H models only)
21	675 464 1	Line no. 21 (for H models only)
22	650 318 1	T-piece complete
23	501 391 1	Line set distribution bar
24	650 282 1	Yellow pump line
25	650 283 1	Blue pump line
26	650 883 1	Air filter (for H models only)
27	675 879 1	Line no. 27
28	650 882 1	Line set for air filter (for H models only)
29	642 208 1	Line for 250 ml bottle (inside, long)
30	642 207 1	Line for 250 ml bottle (inside, short)
31	640 950 1	Line for 100 ml bottle
32	650 097 1	White screw cap (waste bottle)
	650 058 1	Black screw cap (E1, H1 or D1)
	650 096 1	Red screw cap (E2, H2 or D2)
	651 529 1	Orange screw cap (E3, D3)
	650 854 1	Yellow screw cap (H3)
	675 398 1	Violet screw cap (conditioning solution)
	675 396 1	Green screw cap (deproteinizer)
33	650 133 1	Waste bottle insert complete incl. item 30
34	650 048 1	Standard solution bottle insert incl. item 29
35	675 369 1	100 ml bottle insert complete
	501 320 1	Empty 250 ml bottle without label
	058 834 1	"Waste" label
	678 320 1	Replacement line set complete - E models
	678 321 1	Replacement line set complete - H models

Group 7.0 Solutions

Batch number identification on solution bottles:

The respective batch number is indicated on each label attached on the bottle or box and is shown after the abbreviation CH.-B/Batch No./Lot. No.

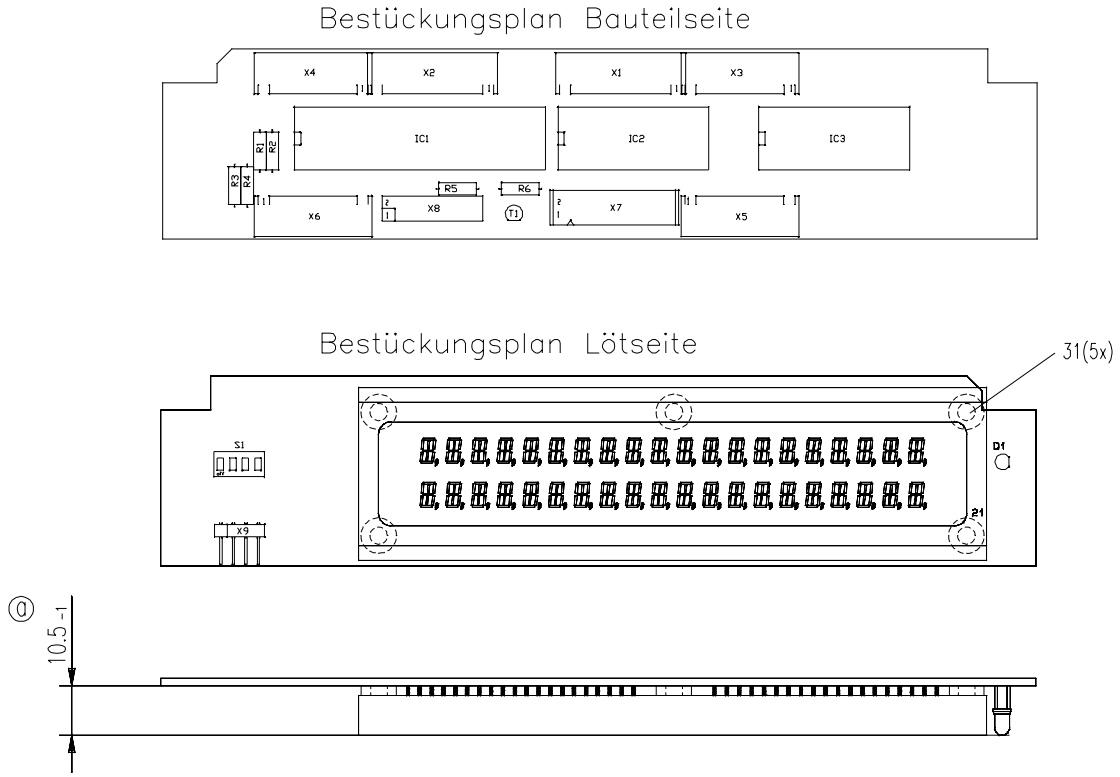
e.g.: **6M1806**

- 6 — year of production (6 stands for 1996)
- M — site of production
- 18 — week of production
- 06 — consecutive production number, starting each year with 00

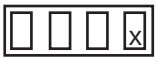
Pos.	Part no.	Description
		EF, EF-HK:
	501 395 1	Standard solution E1, 250 ml from Ch.B. (batch) 6F1006
	501 396 1	Standard solution E2, 250 ml from Ch.B. (batch) 6F1007
	501 397 1	Standard solution E3, 250 ml
	501 323 1	Conditioning solution, 100 ml
	501 359 1	Deproteinizer, 100 ml
	805 951 1	Ionosafe control serum, 3 x 6 ml
	501 333 1	Internal electrolyte for reference electrode, 100 ml
	501 352 1	Ionotest, 100 ml
		EH-F, EH-HK:
	501 307 1	Standard solution H1, 250 ml
	501 308 1	Standard solution H2, 250 ml
	501 309 1	Rinse solution H3, 250 ml from Ch.B. (batch) 6F1005
	501 323 1	Conditioning solution, 100 ml
	501 359 1	Deproteinizer, 100 ml
	805 951 1	Ionosafe control serum, 3 x 6 ml
	501 333 1	Internal electrolyte for reference electrode, 100 ml
	501 310 1	Ionotest-H, 100 ml
		EG-HK:
	501 355 1	Standard solution D1, 250 ml
	501 356 1	Standard solution D2, 250 ml
	501 357 1	Standard solution D3, 250 ml
	805 950 1	GL solution for glucose adjustment, 100 ml
	501 323 1	Conditioning solution 100 ml
	501 359 1	Deproteinizer, 100 ml
	805 951 1	Ionosafe control serum, 3 x 6 ml
	501 333 1	Internal electrolyte for reference electrode, 100 ml
	501 358 1	Ionotest-D5, 100 ml
	501 339 1	Ionotest-D15, 100 ml

Group 8.0 Display Board LP 673-1

LP 673-1



Switch position S1:



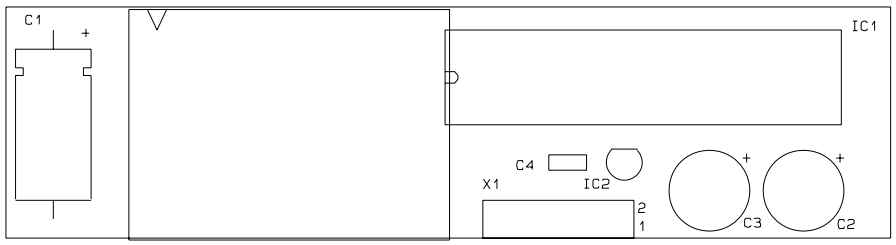
1: ON
0: OFF

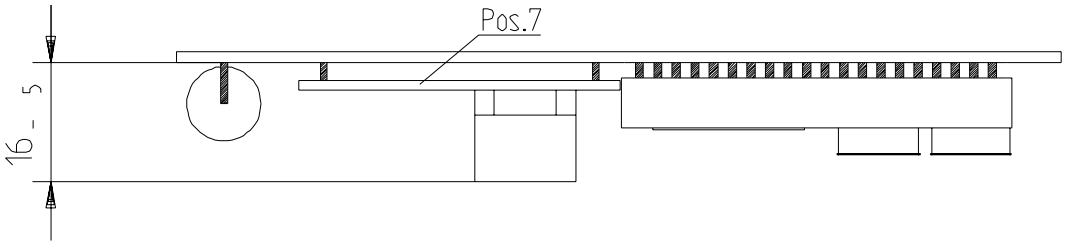
	1	2	3	4	
German	1	1	1		
English	0	1	1		
French	1	0	1		If the language is selected
Italian	0	0	1		on PCB LP 768,
Spanish	1	1	0		S1 must be set to 000.

Pos.	Part no.	Description
	675 014 1	LP 673-1 Display Driver Board complete
	670 292 1	VF display

Group 8.1 Display Board LP 674

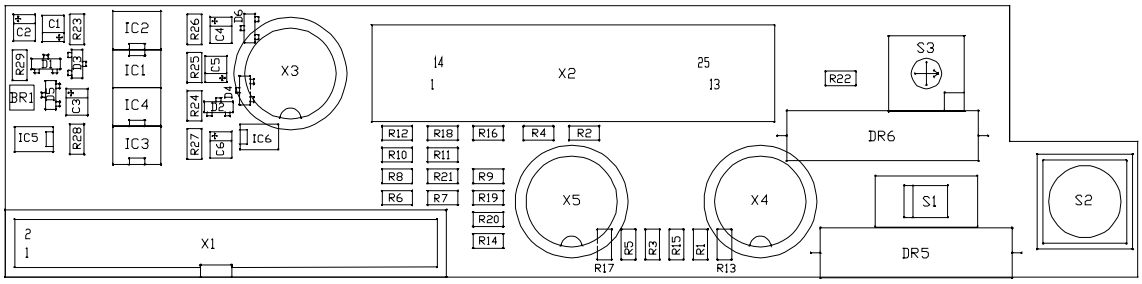
LP 674



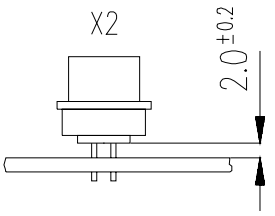


Pos.	Part no.	Description
	670 790 1	LP 674 Display Supply Board complete

Group 9.0 Interface Board LP 765



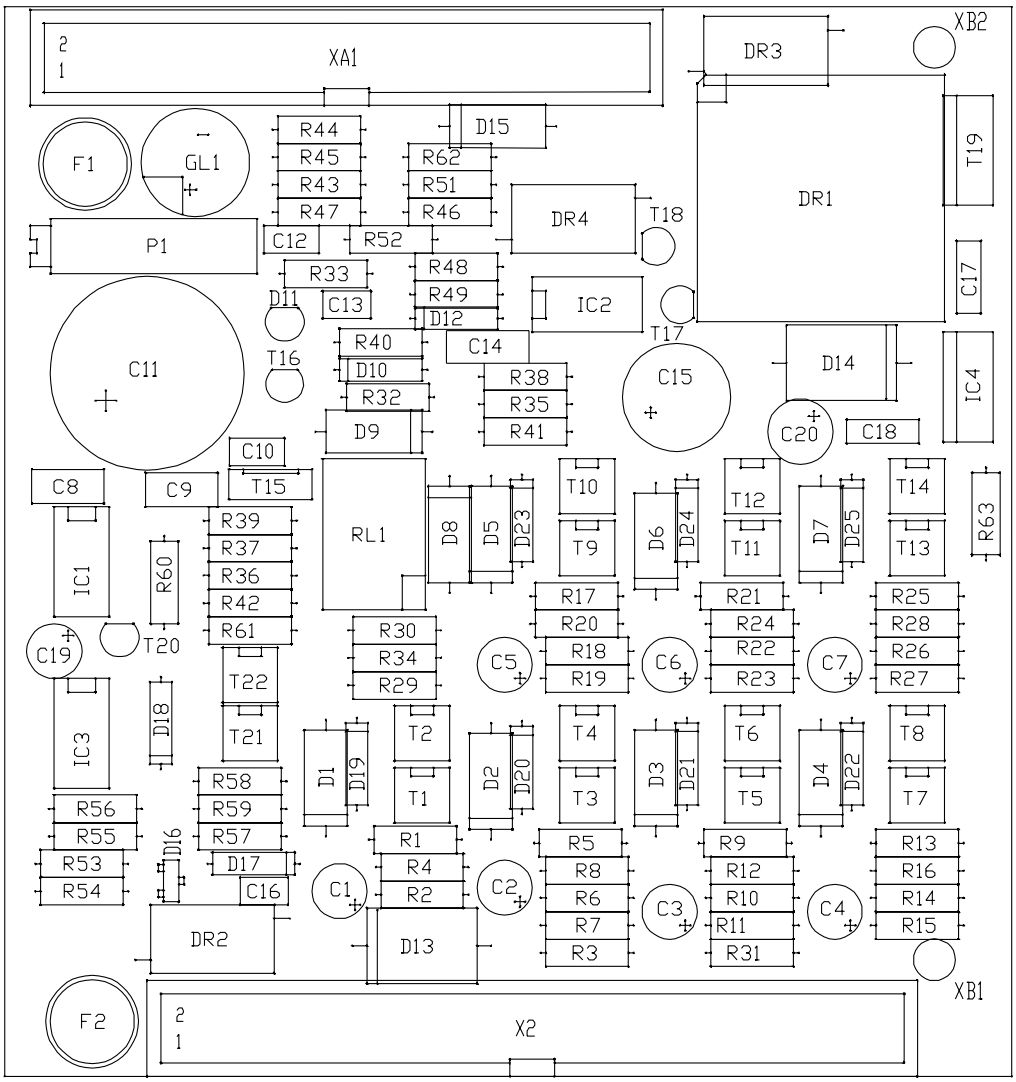
Note:
Pos. X2 (25 pin-Sub-D-Connector) soldered with spacing



Group 9.0 Interface Board LP 765

Pos.	Part no.	Description
	674 382 1	LP 765 Interface Board complete
X2	674 824 1	25-pin D-SUB connector
X3	641 331 1	7-pin socket
X4	645 030 1	4-pin socket
X5	641 329 1	2-pin socket
S1	674 823 1	Slide switch
S2	670 890 1	Push-button
S3	645 801 1	Coding switch

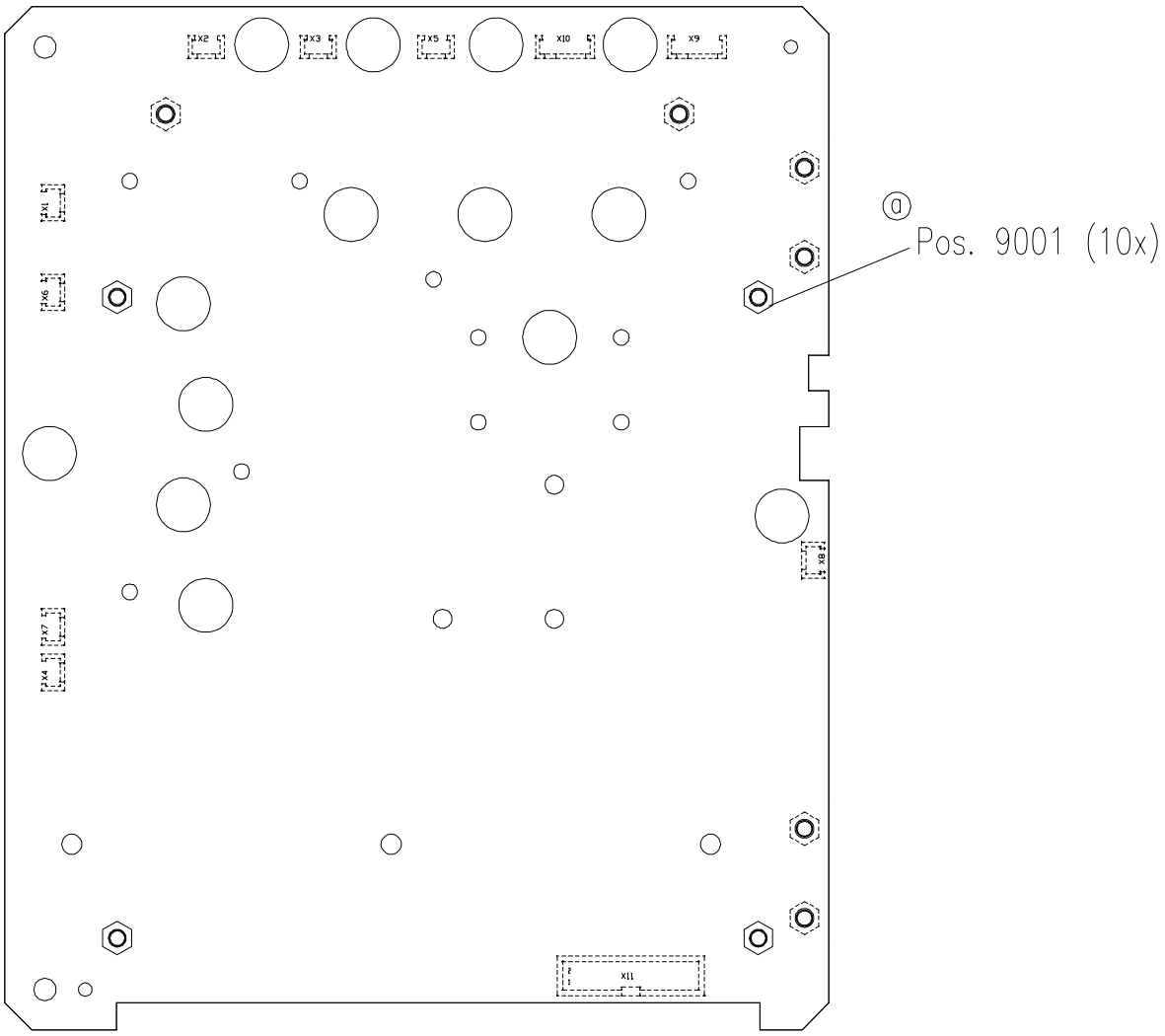
Group 10.0 Power Supply Board LP 766



Group 10.0 Power Supply Board LP 766

Pos.	Part no.	Description
	674 387 1	LP 766 Power Supply Board complete
F1	645 024 1	Fuse 2 AT
F2	645 024 1	Fuse 2 AT
	675 008 1	Red battery connecting cable
	675 009 1	Black battery connecting cable

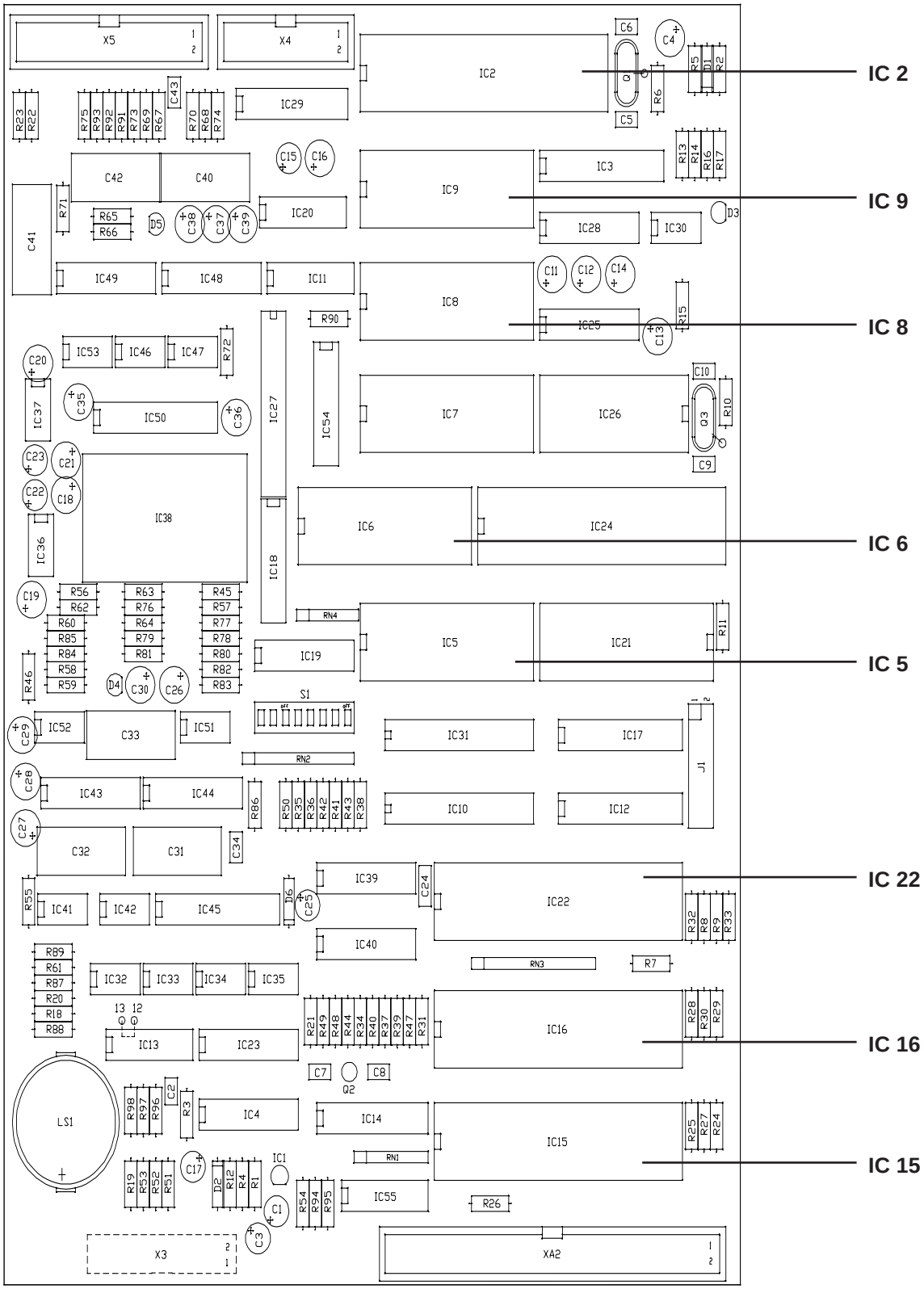
Group 11.0 Hydraulics Board LP 767



Group 11.0 Hydraulics Board LP 767

Pos.	Part no.	Description
	674 389 1	LP 767 Hydraulics Board complete

Group 12.0 CPU Board LP 768

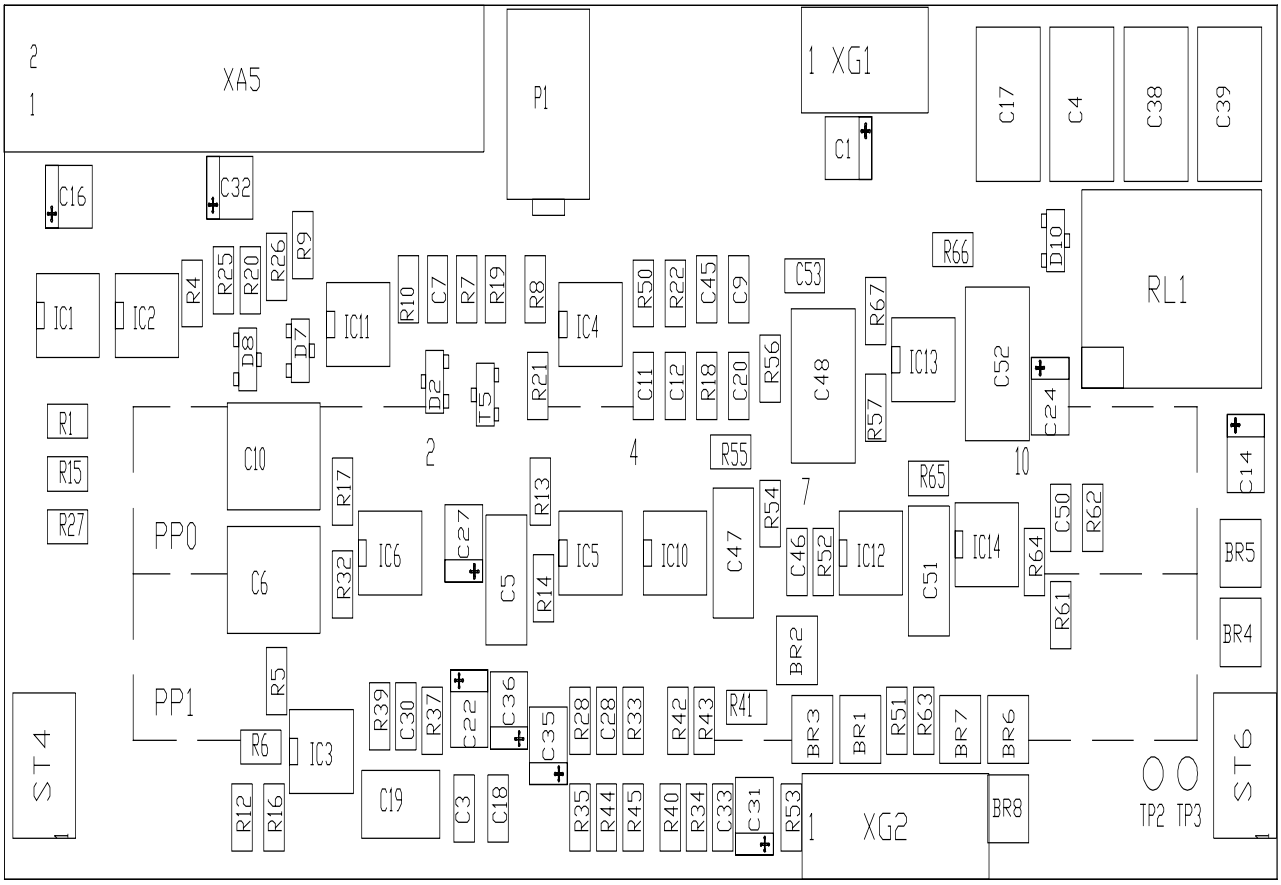


Group 12.0 CPU Board LP 768

Pos.	Part no.	Description
	674 391 1	LP 768 CPU Board complete
IC 2	647 371 1	Microprocessor NSC 800
IC 15	647 373 1	I/O-Timer NSC 810 A N-41
IC 16	647 373 1	I/O-Timer NSC 810 A N-41
IC 22	647 373 1	I/O-Timer NSC 810 A N-41
IC 5	679 606 1	Ionometer EPROM bank 0, 32 Kx8
IC 6	679 607 1	Ionometer EPROM bank 1, 32 Kx8
IC 8	679 608 1	Ionometer EPROM text bank, 32 Kx8
IC 9	642 769 1	NOVRAM 8Kx8 DS 1225 Y
–	678 836 1	EPROM set comprising IC 5, IC 6 and IC 8

Group 13.0 Impedance Converter Board LP 769A

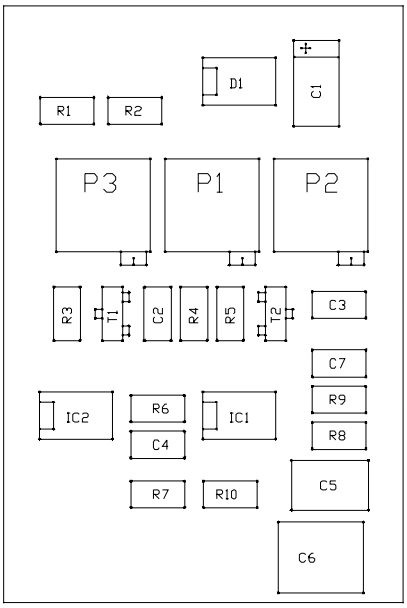
LP 769A



Pos.	Part no.	Description
	674 393 1	LP 769A Sensor board complete

Group 13.1 Impedance Converter Board LP 770

LP 770



Pos.	Part no.	Description
	674 731 1	LP 770 Glucose sensor board complete (for EG-HK only)

Group 14.0 Printer and Accessories

Pos.	Part no.	Description
	679 186 1	Thermal printer Seico complete
	679 190 1	Printer cable
	641 469 1	Paper for thermal printer