Fresenius HemoCare

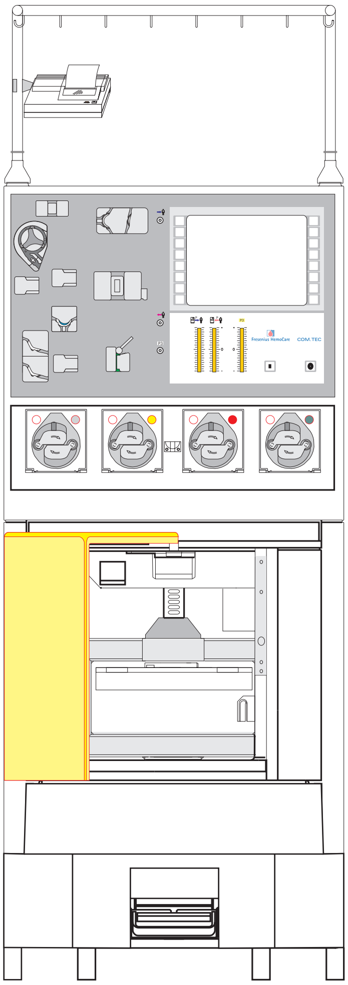
Technical Manual for COM.TEC

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

The blood cell separator reflects the latest technology and complies with the requirements of IEC 601, Part 1.

It belongs to safety class I and should be only used in rooms reserved for medical use in accordance with VDE 0107.

Assembly, update, readjustment, modification and repair work should be performed only by the manufacturer or by persons authorized by him.



Part No. 679 469 1

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How to Use the Technical Manual

Search and Find

What?	*Where?*
Table of contents	Page 0-5 and at the beginning of each chapter

Intended Use

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

Organization

The manual is divided into 6 chapters:
0 General Information
1 Config.Sys, Service.Sys, CCS Program
2 Repair / Adjustment / Maintenance
3 Circuit Descriptions and Circuit Diagrams
4 Spare Parts Catalog
5 Start-up and TSC

Page Identification

Page identification 1-3 is to be interpreted as: Chapter 1, page 3.

Qualification

This manual is intended to assist service technicians and assumes the following:
– that the user is familiar with the current operating instructions
– that he has the necessary background experience in mechanics, electrical engineering and medical engineering;
– that he has been authorized by the manufacturer to perform maintenance and repair work;
– that he has access to the necessary auxiliary and measuring equipment.

Limitations

This manual is not intended to provide an alternative to instruction courses offered by the manufacturer.

Manual changes

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

Note:
Any modifications to circuit and component layout diagrams (SP/BP) do not always affect footers (edition).
The current state of these diagrams is indicated in the index field of each respective SP/BP.
The user/technician can use the respective marking on the printed circuit board to verify whether the SP/BP comply with the actually existing printed circuit board in the machine.

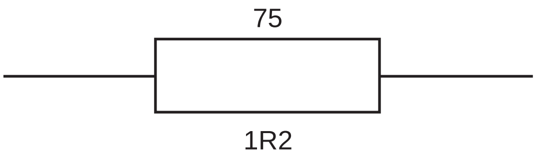
In general, this manual will be subject to modification.

Specification

Unless otherwise specified, potentials indicated in circuit diagrams and calibration instructions are related to the perinent ground.
For example, $\perp$ 24 means ground for the 24 V voltage.

Component identification in circuit diagrams

Example:



This refers to a resistor with position number 75 and a resistance of 1.2 ohm.

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

Resistors		Capacitors:	
R1:	0.1 Ω	µ 1:	0.1 µF
1R2:	1.2 Ω	1µ2:	1.2 µF
1K2:	1.2 kΩ	1000µ:	1000µF

Note

When repairing blood cell separators and replacing spare parts, observe the protective ESD measures to be taken to prevent electrostatic discharge (e.g. EN 100 015-1).

Technical Data

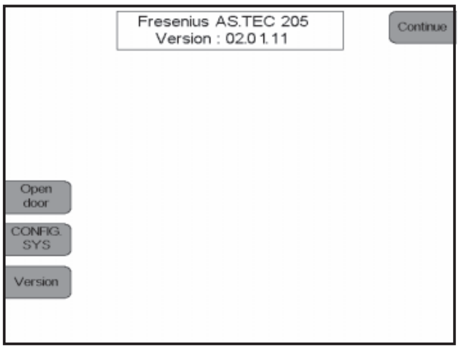
The technical data of the COM.TEC Blood Cell Separator are listed in the Operating Instructions.

Table of Contents

Table of Contents
1 Config.Sys, Service.Sys, CCS Program

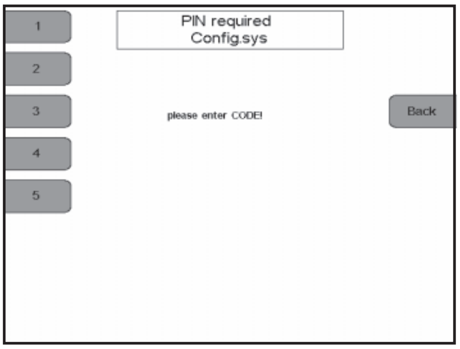
1.1 Config. Sys

The basic configuration of the COM.TEC can be changed in the **Config.sys**.



Display

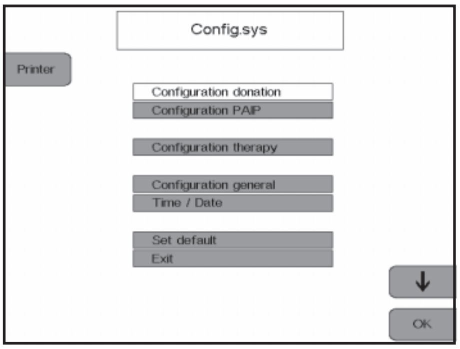
Press the **CONFIG.SYS** key.



Display

Enter the code **1 3 5 2 4**
with the numeric keys.

The Config.Sys codes can be entered as often as desired.



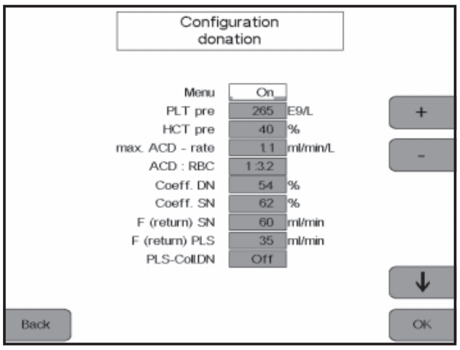
The Config.Sys screen displays.

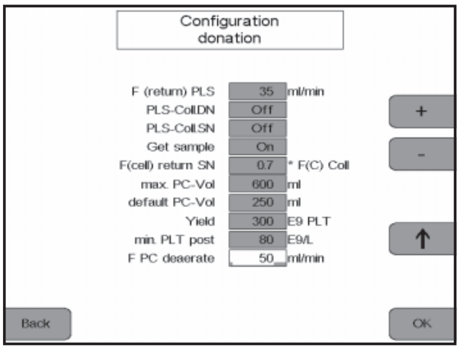
Select the desired configuration with the ↑ and ↓ keys.

Press the **OK** key.

The selected menu option displays.

1.1.1 Configuration Donation





Display

Select the values to be altered by pressing the ↑ and ↓ keys.

Alter the values by pressing the + and – keys.

Press the **OK** key to save all changes.

To exit the configuration menu and to return to the previous screen, press the **Back** key.

– **Menu**
Donor menu and donor data display can be activated and deactivated.

– **PLT pre**
Presetting of the donor's mean platelet pre-value.

– **HCT pre**
Presetting of the donor's mean HCT pre-value.

– **Max. ACD-rate**
Setting of the ACD rate per liter of whole blood volume tolerated by the donor.

– **ACD:RBC**
The ACD:RBC ratio influences the ACD: WB ratio based on the hematocrit. The pH value is optimized in the storage bag.

– **Coeff. DN**
Operand for adapting the yield to the predicted value.

– **Coeff. SN**
Operand for adapting the yield to the predicted value.

– **F(return)SN**
Adjustment of the return flow rate to the donor.

- **F(return)PLS**
  Adjustment of the blood pump flow during the SN return phase with active plasma collection.

- **PLS-Coll.DN**
  Preselection of automatic plasma collection and selection of the volume to be separated (Off = 0). Dual needle.

- **PLS-Coll.SN**
  Preselection of automatic plasma collection and selection of the volume to be separated (Off = 0). Single needle.

- **Get sample**
  Selection and deselection of help texts for sample collection. Single needle.

- **F(cell) return SN**
  Factor for the cell flow in the return phase. Single needle.

- **max. PC-Vol**
  Determination of the maximum collection volume for the platelet concentrate.

- **default PC-Vol**
  Selection of the standard PC volume.

- **Yield**
  Preadjustment of the platelet yield.

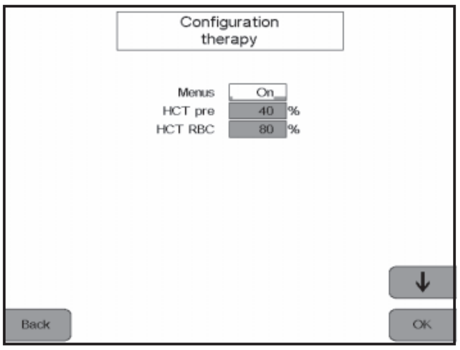
- **min. PLT post**
  Threshold for the donor’s PLT-post value which causes a warning when reached.

- **F PC deaerate**
  Selection of the plasma pump flow during deaeration of the platelate concentrate (Off = 0)

- **Increments and limits for donation parameter configuration**

	Default	Increment	Max.	Min.
Menus	On	–	On	Off
PLTpre	265 x E9/L	1 x E9/L	400 x E9/L	100 x E9/L
HCT pre	40%	1%	60%	20%
max. ACD-rate	1.1ml/min/L	0.1 ml/min/L	2.2 ml/min/L	0.1 ml/min/L
ACD:RBC	1:3.2	0.1	1:5.0	1:2.0
Coeff. DN	49%	1%	70%	30%
Coeff. SN	59%	1%	70%	30%
F(return) SN	75 ml/min	1 ml/min	200 ml/min	50 ml/min
F(return) PLS	35 ml/min	1 ml/min	70 ml/min	35 ml/min
PLS-Coll. DN	Off	10 ml	500 ml	Off, 50 ml
PLS-Coll. SN	Off	10 ml	500 ml	Off, 50 ml
Get sample	On	–	On	Off
F(cell) return SN	0.7*F(c) coll	0.1*F(c)coll	2.0*F(c)coll	0.1*F(c)coll
max. PC-Vol	600 ml	10 ml	1500 ml	600 ml
default PC-Vol	250 ml	10 ml	600 ml	100 ml
Yield	300 x E9	10 x E9	1500 x E9	50 x E9
min. PLT post	80 E9/L	1 E9/L	150 E9/L	50 E9/L
F PC deaerate	50 ml/min	1 ml/min	120 ml/min	Off, 10 ml

1.1.2 Configuration Therapy



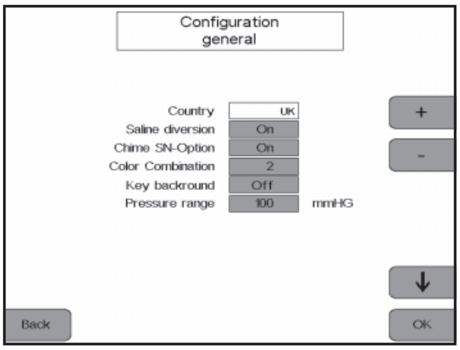
Display

- **Menus**
  Selection and deselection of the TPE and RBC menus.

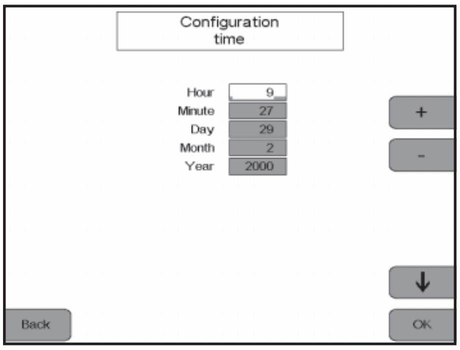
- **HCT pre**
  Preadjustment of the patient's hematocrit value for calculation of the menus.

- **HCT RBC**
  Preadjustment of the hematocrit value, which is adjusted by the Hct controller (see controller options) in the RBC line. During the RBC procedure, this value is computed and changed correspondingly by the menu.

1.1.3 Configuration General



– **Configuration time**



Setting of year, day, hour, minute.

– **Country**
The country version changes language, units and clock to national conventions.

– **Saline diversion**
Activates and deactivates saline diversion.

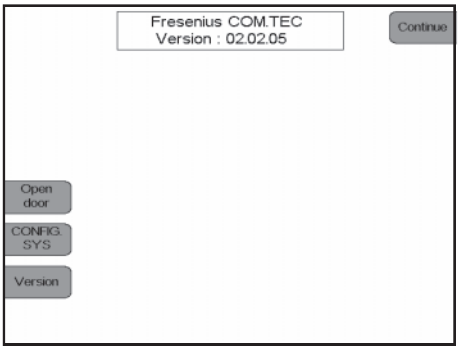
– **Chime SN-Option**
Activates the chime if no automatic cuff is used.

– **Colour combination**
Setting the colour combination of the display.

– **Key background**
Switching the key background on and off.

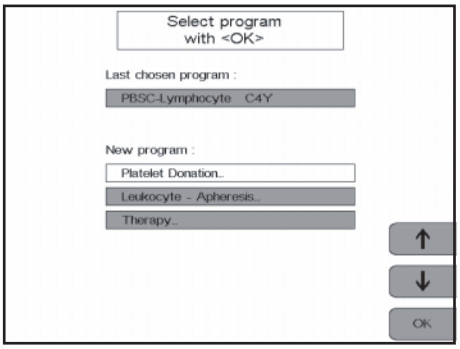
– **Pressure range**
Selects the pressure range for the inlet pressure monitor which initiates a pre-alarm if the inlet pressure drops.
Default: 100 mmHg

1.2 Service.sys



Display.

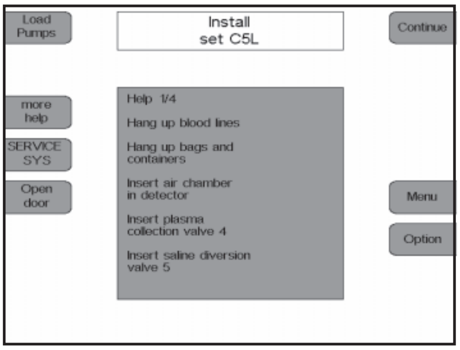
Press the **Continue** key.



Display.

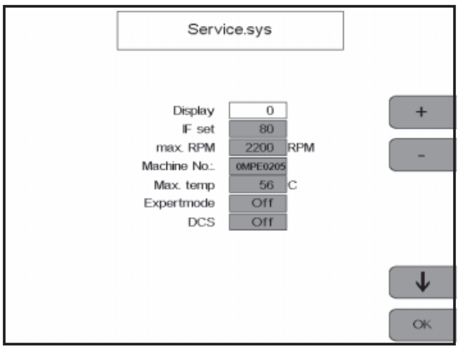
Press the 2nd, the 4th and the 1st key to the left of the display one after the other.

Press the **OK** key.



Display.

Press the **SERVICE.SYS** key.



The Service.Sys screen is displayed.

Select the desired program item by pressing the ↑ and ↓ keys.

1.2.1 Display

Selection of the program phase window

1.2.2 IF set

Adjustment of the interface sensitivity

1.2.3 max. RPM

Maximum centrifuge speed set to 2200 rpm

1.2.4 Machine No.

Possibility to enter the machine no. shown on the type label

1.2.5 Max. temp

Indication of the maximum temperature that prevailed inside the centrifuge

1.2.6 Expertmode

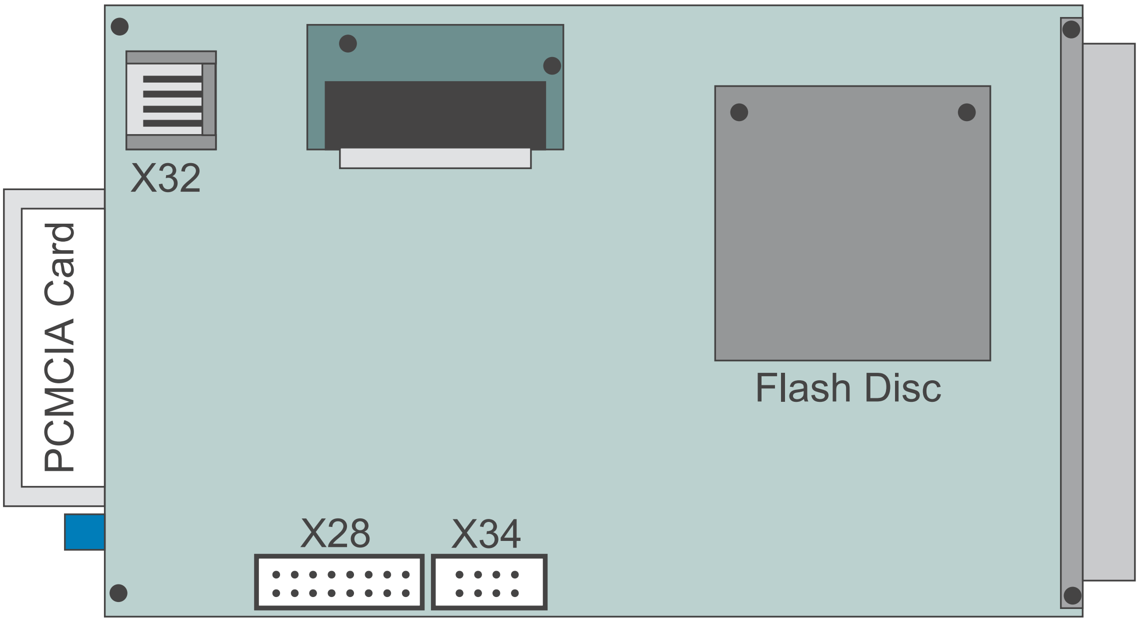
Possibility to create RAM programs

1.2.7 DCS

Activation/deactivation of the optional radio communication interface

1.3 PC E53

Fig.: PC E53



1.3.1 Flash Disc

The Flash Disc is incorporated as system drive C:\ and contains the DOS system, the program control and display software.

1.3.2 PCMCIA Card

The PCMCIA Card is incorporated in the system as drive C:\. In this case, the Flash Disc automatically becomes drive D:\.
The PCMCIA Card contains the current program control and display software (in case of a software update) and the diagnosis/service program.

1.3.3 Signals

LCD/X33	
PIN	**Signal**
1	VS
2	HS
3	VCKL
4	nc
5	nc
6	_Blank
7	nc
8	VID
9	nc
–	nc

X32	
PIN	**Signal**
1	GND
2	DATA
3	VCC
4	CLK

1.3.4 BIOS Setup

The BIOS setup is accessed by pressing the **Ctrl + Alt + F6** keys, when turning power on to the COM.TEC.

E 53 SETUP PROGRAM	
DISK DRIVE 0 TYP 0: NOT INSTALLED DISK DRIVE 1 TYP 0: NOT INSTALLED	
PCMCIA - ATA / IDE BOOT DRIVE SELECT BOOT FROM 1: ATA-CARD	ATA-BIOS EXT : YES
SHOW BOOT MESSAGES: NO	KEYBOARD TEST: NO
SELECT DISPLAY TYPE: AUTO	
POST WAIT TIME IN SECONDS: 00	
BOOT FROM: HARD DISC	
CTL ALT DEL RESET: ACTIVATE HW	
COM3 / COM4 IRQ: 4 / 3	
ALL INPUTS ARE CORRECT? (1) KEYS: <↑> CHANGE VALUE, <RET> NEXT ITEM	

1.4 SERVICE TOOL for COM.TEC

1.4.1 How to access the SERVICE TOOL for COM.TEC

- Turn the COM.TEC power off.
- Insert the PCMCIA card in the PC.
- Connect the external keyboard to X32 / PC.
- Turn the COM.TEC power on.
- Press the ↵ key.
- The **Service Tool for COM.TEC** screen displays.
- The following options are available:

Menu	key	Menu	key	Menu	key
Service Tool	**S**				
Update	**U**	Software Update to	**A**	Select BIOS Version BIOS E53 00.01.06 BIOS E53 00.01.07	 **A** **B**
		System Config	**C**	Install DCS Driver Deinstall DCS Driver Exit Update	**I** **D** **E**
		EXIT UPDATE	**E**		

- The desired option is selected by pressing the associated key.

1.4.2 Working with the CCS program

```
CCS FRESENIUS TT WND                                                   1.0021

                                   menu
 use arrows to select, <enter> to execute

 CAN register       DPRAM              CCD                CAN-I/O

 Exec               pumps              power supply       clamps

 astecio1           astecio2           hbhk               CE_1

 colors             record             quit
```

– Use the cursor to select the desired menu.

– Display the menu selected by pressing the ↵ key.

– Press the **Esc** key to exit the respective menu.

– To exit the CCS program, select **quit** using the cursor and confirm this selection by pressing the ↵ key.

– Within the CCS program, menu-specific help is available, which can be displayed by pressing the **F1** key.

1.4.3 Power Supply

```
CCS FRESENIUS TT WND                                                1.0021
                         power supply logic
 accu (test)   :    0  ................................  0.00  V
 accu (start)  :  181  ██████████████████.......... 24.93  V
 temperature   :   25  ██..............................    24 °C
 ext. analog 1 :    0  ................................  0.00  V
 ext. analog 2 :    0  ................................  0.00  V
 supply     24V:  177  ██████████████████.......... 24.38  V
 supply      5V:  209  █████████████████████......  5.25  V
 centrifuge S  :  ◄  ► ................................     0/min
 centrifuge I  :       ................................     0/min

 door-switch   :  closed   device        :ASII       door-lock     :   ►█◄
                           skew strobo   :◄14►
 ext. input  1 :  ■        skew ccd      :◄ 1►       fan           :    ■
                           holes (abs)   :◄41►
 ext. input  2 :  ■        holes (mean)  :◄41►       operating hrs.:    ■

 power outage  :  ■        stroboscope   : OFF       unused        :

 thumbwheel    :  $E       chamber lock  :  OK       test accu     :    ■
power supply logic ON    centrifuge ON

F1=HLP ESC=END F8=STATUS CTRLF8=AUTOSEND SHFTF8=CFG-STATUS
```

accu (test):	battery voltage during the battery test
accu (start):	battery voltage
temperature:	temperature of power supply unit
supply 24 V:	current value of the 24-V supply voltage
supply 5 V:	current value of the 5-V supply voltage
centrifuge S:	target centrifuge speed; see help menu for adjustment
centrifuge I:	actual centrifuge speed
door-switch:	door switch display: close - alarm - open
device:	must be set to AS II
door-lock:	door opener
fan:	activation/deactivation of the fan
operating hrs.:	activation/deactivation of the time meter
test accu:	activation of the battery test

1.4.4 Pumps

```
CCS FRESENIUS TT WND                                                  1.0021
                                  pumps
pump 0 ON  ACD 205                        pump 4 ON  blood
 set :   0 .....................  ◄  ►    set :   0 .....................  ◄  ►
         0.00 ml/min                              0.00 ml/min
 inst:   0 .....................           inst:   0 .....................
         0.00 ml/min                              0.00 ml/min
 turnover       :      0                   turnover       :      0
pump 5 ON  plasma                         pump 6 ON  cells
 set :   0 .....................  ◄  ►    set :   0 .....................  ◄  ►
         0.00 ml/min                              0.00 ml/min
 inst:   0 .....................           inst:   0 .....................
         0.00 ml/min                              0.00 ml/min
 turnover       :      0                   turnover       :      0
pump 7 ON  ACD 204
 set :   0 .....................  ◄  ►
         0.00 ml/min
 inst:   0 .....................
         0.00 ml/min
 turnover       :      0
F1=HLP ESC=END F2=ALL F3=T->0 F4=SET IN F5=NOON F6=ALM F7=RES F8=INF F9=RST
```

Pins 9 and 10 of relay RL 300 / P.C.B. LP 823-1 must be bridged to activate the pumps.

set:	target speed in digits; see help menu for adjustment
inst:	actual speed in digits
turnover:	number of rotor revolutions
cover closed:	pump cover display: close - alarm

1.4.5 Clamps

```
CCS FRESENIUS TT WND                                                     1.0021

                                    clamps
  clamp-control-unit ON
  plasmaclamp        : ►   collect     ◄      bypass          install

  wastebagclamp      :     reserve            separate         prime

  NaCl 1             :    separate            install         not used

  NaCl 2             :    separate            install         not used

  spilloverclamp     :     collect            bypass          install
  ---------------------------------------------------------------------------
  clamp-PIC ON         modified    tested       actual

  NaCl 2  <separate> :   dark        dark        dark
  plasma    <bypass> :   dark        dark        dark
  wastebag <separate>:   dark        dark        dark
  spillover <bypass> :   dark        dark        dark
  endclamp           : closed                   closed


F1=HLP ESC=END F2 F8 SHFTF8 F9=RST
```

clamp-control-unit:	clamp-control-unit display: on - off
plasmaclamp:	position of the plasma collection clamp
wastebagclamp:	position of the saline diversion clamp
NaCl 1:	position of the saline clamp in the inlet line
NaCl 2:	position of the saline clamp in the return line
spilloverclamp:	position of the collection / return clamp

1.4.6 ASTEC IO1

```
CCS FRESENIUS TT WND                                                          1.0021

                                    ASTEC IO1
  outputs & identifiers      analog and digital inputs
  test alarm 1          ►  ◄ temperature      21 °C       alarm air control
  test alarm 2               pressure1      -520 mmHg     optical control
  dong                       pressure2         0 mmHg     alarm HB/HCT
  ding                       pressure3         0 mmHg     alarm press. in L
  endclamp signal            pressure4       640 mmHg     alarm press. out H
  alarm µP                   IL inst.          0 red      alarm press.3 H
  IL set               00    setting PLS       0 /min     alarm blood leak
  IL automatic               IL sensivity      0 mV       alarm SR-MC1
  ID rotorpulse        00    imbalance                    alarm SR-MC2
  ID bloodpump         F4    alarm press.4 L              all alarms
  ID controled pump    F5    alarm press.4 H              override (s)
  max. pumpspeed       FE    alarm ACD high               prime override
  IL sensivity         0F    alarm substit.               alarm free
  IL scale factor      00    mute                         alarm air actual
                             alarm press.3 L              alarm air memory
                             alarm press. in H            alarm ACD L
                             alarm press. out L
                                 ASTEC IO1 ON

F1=HLP ESC=END F2=res err. F3=V24 out F8=status F9=RST
```

Digital outputs and identifier:

test alarm 1: initiates the alarm test
test alarm 2: cancels stored alarms
dong: deep signal tone
ding: high signal tone
endclamp signal: opens the return clamp of the air detector if no alarm is pending and if **alarm µP** is set
alarm µP: alarm-free if the output is set
IL set: target value of the interface position
IL automatic: interface controller
ID rotorpulse: CAN identifier; do not change
ID bloodpump: CAN identifier; do not change
ID controlled pump: CAN identifier; do not change
max pumpspeed: max. speed of the pump; do not change
IL sensitivity: sensitivity of the interface
IL scale factor: activation of the interface control by the PLS pump

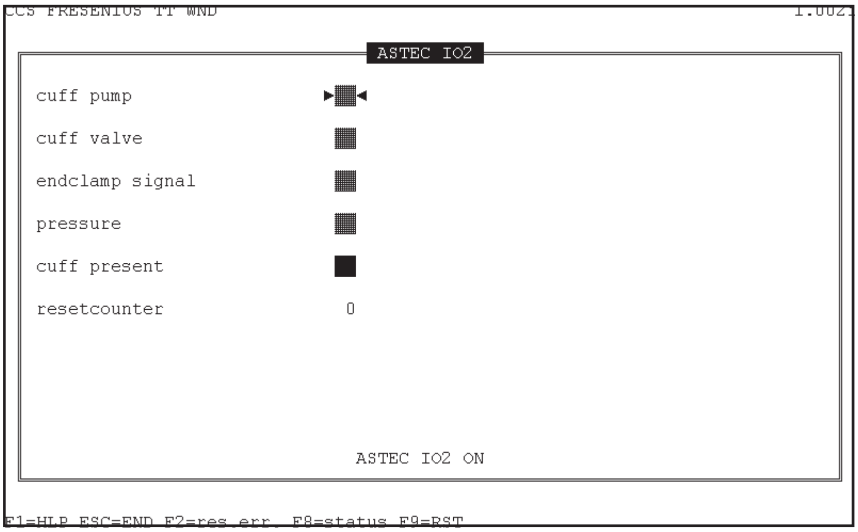
Analog inputs:

temperature: temperature inside the centrifuge
pressure 1: P3 pressure value
pressure 2: inlet pressure value
pressure 3: return pressure value
pressure 4: reserve pressure channel value
IL inst.: number of red holes of the interface detection
setting PLS: target value of the PLS pump
IL sensitivity: value of the control voltage

Digital inputs:

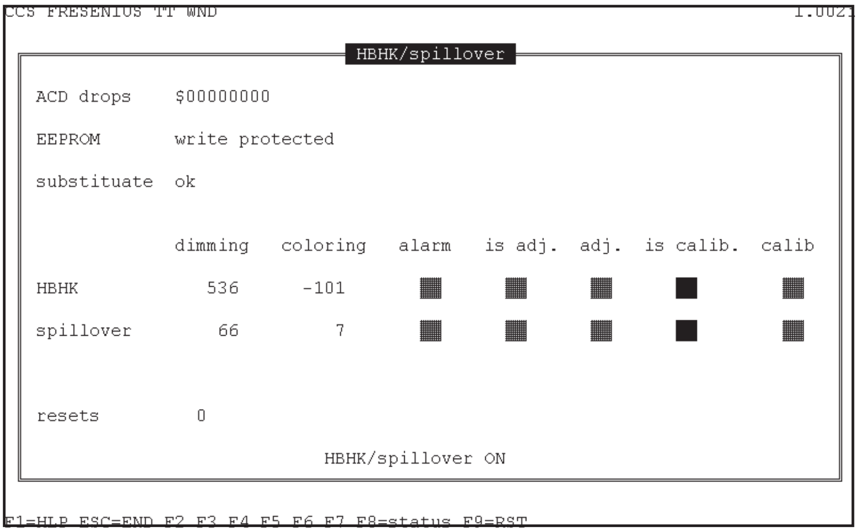
imbalance:	imbalance alarm
alarm press. 4 L:	alarm pressure 4 too low
alarm press 4 H:	alarm pressure 4 too high
alarm ACD high:	alarm ACD ratio too high
alarm substit.:	alarm no replacement fluid
mute:	mute alarm tone generator
alarm press. 3 L:	alarm pressure P3 too low
alarm press in H:	alarm inlet pressure too high
alarm press. out L:	alarm return pressure too low
air control:	alarm air detector
optical control:	optical detector of the return clamp of the air detector
alarm HB/HK:	alarm hemolysis
alarm press. in L:	alarm inlet pressure too low
alarm press. out H:	alarm return pressure too high
alarm press. 3 H:	alarm pressure P3 too high
alarm blood leak:	alarm blood leak
alarm SR-MC 1:	alarm safety system, channel 1
alarm SR-MC 2:	alarm safety system, channel 2
all alarms:	all alarms are active (scanned during the alarm test)
override(s):	brief overriding of alarms (to fill the drip chamber)
prime override:	overriding of alarms during priming
alarm alarm free:	no alarm is pending
alarm air actual:	current air detector alarm
alarm air memory:	stored air detector alarm
alarm ACD L:	alarm - ACD ratio too low

1.4.7 ASTEC IO2



cuff pump:	activates the single-needle pump
cuff valve:	activates the single-needle valve (the end clamp must also be activated)
endclamp signal:	end clamp signal for single-needle control
pressure:	indicates whether the pressure has been achieved
cuff present:	single-needle assembly P.C.B. LP-Z 175 present

1.4.8 HBHK / spillover



ACD drops:	number of ACD drops
EEPROM:	indicates position of switch S1 / LP 867
substituade:	status of substituate-empty detector
HBHK:	Hb/Hk detector
spillover:	spillover detector
dimming:	dimness of detector in digits
coloring:	coloring of detector in digits
alarm:	Alarm Hb/Hk or Spillover
is adj.:	lights after adjustment of the reference value
adj.:	lights during adjustment of the reference value
is calib.:	lights after calibration
calib:	lights during calibration

1.4.9 CCD camera

```
CCS FRESENIUS TT WND                                                   1.0021
                               CCD camera
CCD camera ON
   histogram bright                           is   set       spxl fine(i)    0
  0 ................   C4 detected  :   OFF  OFF       spxl (init)     0
  0 ................   chamberlight :   OFF  OFF
  0 ................   C5 detected  :   OFF  OFF       IL C4           0
  0 ................   initsearch   :   ON
  0 ................   locked by rpm:   YES
  0 ................   automatic    :   ON             spixel fine     0
  0 ................   holeskew     : ◄  1►            IL C5           0
  0 ................   startpixel   : ◄ 80►            ◄...............
  0 ................   resetcounter :     1
  0 ................   edgepixelval.:    80            centrifuge      0
  0 ................   ADC ref.low  :   0.7V  217      ................
  0 ................   ADC ref. high:   2.3V  140
  0 ................   lighttime ml.: ◄  0►
  0 ................   lighttime cl.: ◄  0►
  0 ................   errorbyte    :   $00
255                    mode         :   histo
          dark         IL valid     :   yes

F1=HLP ESC=END F2 F3 F4 F5 F6 F7 F8 F9
```

loop control: –
chamberlight: chamber light on - off
mirrorlight: mirror light on - off
initsearch: initialisation phase on - off
automatic: automatic position test on - locked
holeskew: hole skew, camera trigger
startpixel: start pixel, interface window
resetcounter: number of camera resets
edgepixelval.: –
ADC ref. low: reference voltage low
ADC ref. high: reference voltage high
lighttime ml.: mirror light exposure time
lighttime cl.: chamber light exposure time
errorbyte: internal display error counter
set. line: target interface value
interfaceline: actual interface value
pmp max.: –
set. pmp: –

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2 Repair / Adjustment / Maintenance

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2.1 Verification of the Interface Detection

Measuring equipment: 2-channel storage oscilloscope,
CCD test adapter – camera (part no. 678 617 1),
BNC test cable (part no. 678 482 1),
Reference chamber (part no. M60 383 1),
Test cable (part no. 679 763 1)

Mode of operation: CCS program

> **Caution**
> Clean the optical axis prior to the verification of the interface detection.

– Access the CCS program.

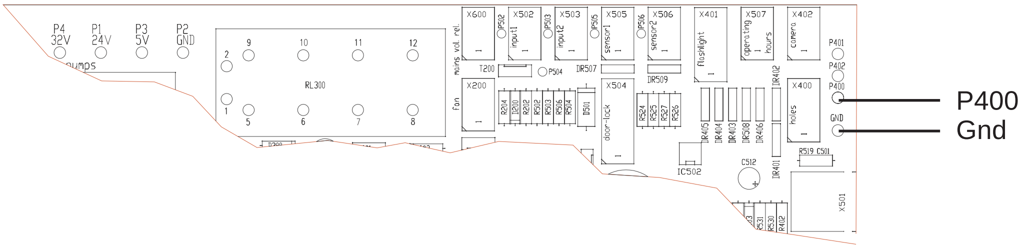
– Select the **power supply** menu.

– The following screen displays:

```
CCS FRESENIUS TT WND                                                  1.0021
                           power supply logic
  accu (test)   :    0  ................................  0.00  V
  accu (start)  :  181                      .......... 24.93  V
  temperature   :   25     ............................    24 °C
  ext. analog 1 :    0  ................................  0.00  V
  ext. analog 2 :    0  ................................  0.00  V
  supply     24V:  177                      .......... 24.38  V
  supply      5V:  209                          ......  5.25  V
  centrifuge S  :  ◄  ► ................................     0/min
  centrifuge I  :       ................................     0/min


  door-switch   :  closed   device        :ASII       door-lock     :  ►■◄
                            skew strobo   :◄14►
  ext. input  1 :  ■        skew ccd      :◄ 1►       fan           :   ■
                            holes (abs)   :◄41►
  ext. input  2 :  ■        holes (mean)  :◄41►       operating hrs.:   ■

  power outage  :  ■        stroboscope   : OFF       unused        :

  thumbwheel    :  $E       chamber lock  :  OK       test accu     :   ■
 power supply logic ON    centrifuge ON

F1=HLP ESC=END F8=STATUS CTRLF8=AUTOSEND SHFTF8=CFG-STATUS
```

2.1.1 Verification of the Optical Sensor

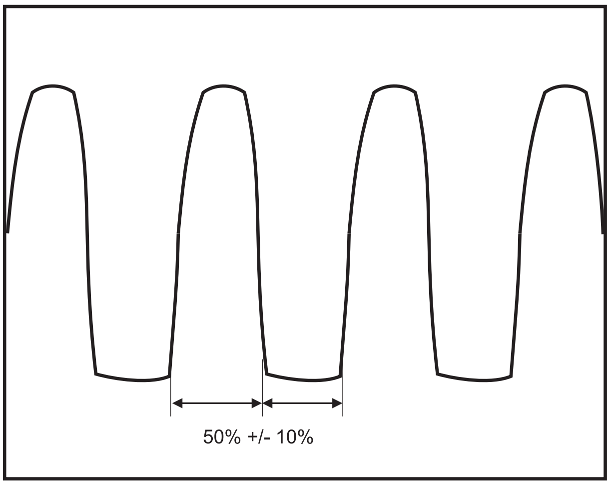
Fig.: P.C.B. LP 823-1



– Stop the centrifuge (**pos. 1**), open the door (**door lock**).

– Connect the oscilloscope to P400 /LP 823-1 and GND / LP 823-1.

– Set the centrifuge speed to 1000 rpm.

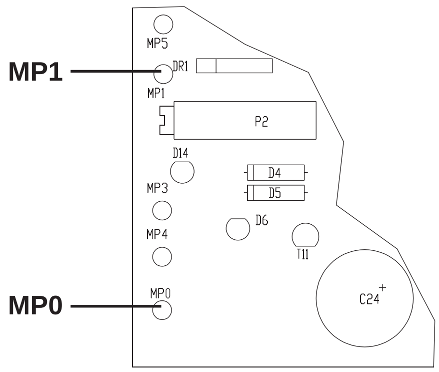


Oscilloscope setting:
P400 / LP 823-1: 1 V/Div.
Time base: 0.5 ms/Div

– Check the optical sensor signal at 300 rpm and 2000 rpm.
  Optical sensor signal:
  Amplitude: >4.7 V
  Pulse duty factor: 50 % ± 10 %
– Signal not flickering

– If the optical sensor signal deviates from the target values the interface detection must be completely adjusted. (➜ Chapter 2.2).

2.1.2 Verification of the 8 Hole Pulses



– Install the reference chamber with segment 1.

– Connect the test cable to connector X3 / LP 863.

– Connect the oscilloscope to the test adapter X3.2 / LP 863 (ground) and to X3.1 / LP 863 (hole pulses).

– Connect the oscilloscope to MP 0 / LP 866 (ground) and to MP 1 / LP 866 (current of the transmitting diode).

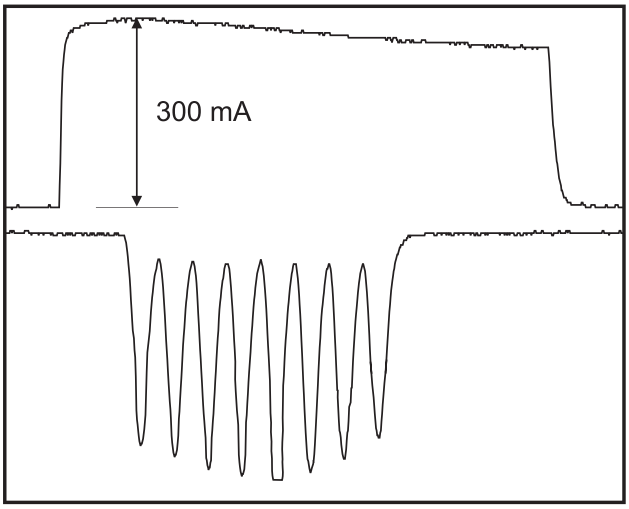
– Close the centrifuge door and set the centrifuge speed to 1000 rpm in the **power supply** menu.

– Activate automatic sending of the target values (**AUTOSEND**) by pressing the **Ctrl** and the **F8** key. Press the ↵ key.

– Exit the **power supply** menu and select the **CAN-I/O** menu.

– Activate the trigger unit **output 2 / no. 0**.

Note
The current of the transmitting diode depends on the temperature. Before the verification the centrifuge must therefore have been in operation for at least 10 minutes, with the trigger unit **output 2 / no. 0** activated, and the current of the transmitting diode must be 300 mA.



Oscilloscope setting:

X3.1 / LP 863 (hole pulses):	2 V / Div
MP 1 / LP 866 (current of the transmitting diode):	0.1 V / Div
Time base:	0.5 ms / Div
Triggering:	current of the transmitting diode, ascending edge

– The 8 hole pulses must appear within the signal of the current of the transmitting diode (see figure).

– Reduce the centrifuge speed to 300 rpm and then increase the speed to 2200 rpm. While altering the speed, the 8 hole pulses must always be within the signal of the current of the transmitting diode (see figure).

– If the 8 hole pulses are not within the signal of the current of the transmitting diode or if they leave this signal when the speed is altered, the interface detection must be completely adjusted (➜ Chapter 2.2).

2.1.3 Verification of the Interface Sensitivity of the 8 Hole Pulses

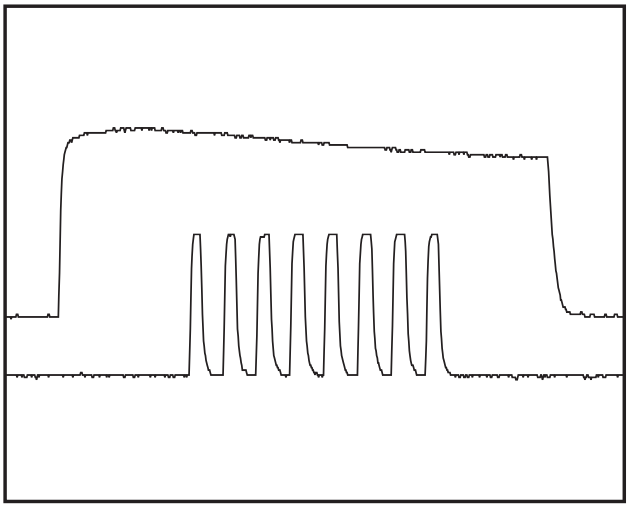
– Stop the centrifuge (**pos. 1**), open the door (**door lock**).

– Insert the reference chamber with the C4 hole area covered with adhesive foil (segment 2).

– Connect the oscilloscope to the test adapter X3.2 / LP 863 (ground) and to X3.4 / LP 863 (digital hole pulses).

– Connect the oscilloscope to MP 0 / LP 866 (ground) and MP 1 / LP 866 (current of the transmitting diode).

– Close the door, set the centrifuge speed to 1000 rpm.



Oscilloscope setting:

MP 1 / LP 866 (current of the transmitting diode):	0.1 V / Div
X3.4 / LP 863 (digital hole pulses):	2 V / Div
Time base:	0.5 ms / Div
Triggering:	current of the transmitting diode, ascending edge

Note
The current of the transmitting diode depends on the temperature. Before the verification the centrifuge must therefore have been in operation for at least 10 minutes, with the trigger unit **output 2 / no. 0** activated. The current of the transmitting diode must be 300 mA.

– All of the 8 hole pulses (digital) must just be visible and may not flicker (see figure).

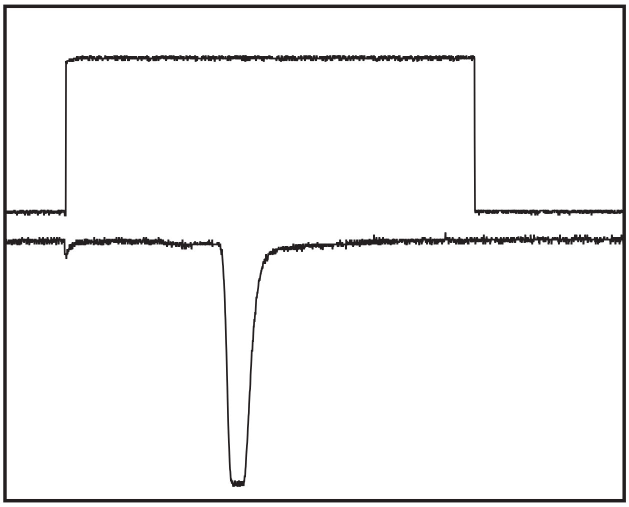
– If the 8 hole pulses (digital) are not visible or flicker, the interface detection must be completely adjusted (➜ Chapter 2.2).

2.1.4 Verification of the C5 Interface Detection

- Stop the centrifuge (**pos. 1**), open the door (**door lock**).
- Insert the reference chamber segment 5.
- Connect the CCD test adapter to the plug connector that exits the camera housing.
- Connect the oscilloscope with the two BNC test cables to the CCD test adapter.
- Close the door, set the centrifuge speed to 2200 rpm.
- Exit the power **supply menu** and select the **CCD** menu.
- Press the **F9** and the ↵ key to reset the camera and wait until the initialization phase of the camera is completed (**initsearch: OFF**) and segment 5 of the reference chamber has been detected (**C5 detected: ON**).
- Use the **F3** key to set **chamberlight: ON** (lighting).
- Use the **F6** key to set **automatic: locked**.

> **Caution**
> If the camera does not receive a new CAN command within one minute (**holeskew**, **lighttime cl**, **startpixel**), it automatically exits the locked mode and the display changes from **automatic: locked** to **automatic: ON**.

- Use the ↑ and ↓ keys to select **holeskew** and use the ← and → key to set the value to 8 (reference signal).
- The C5 reference signal must appear within the gate pulse (see figure).



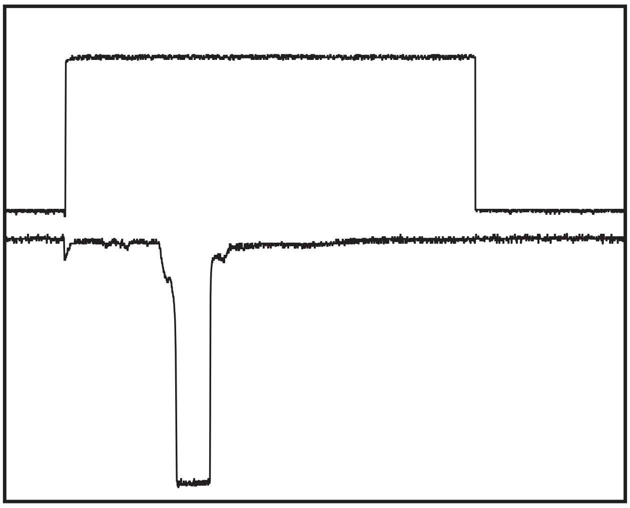
Oscilloscope setting:

Video signal:	0.5 V / Div
Gate pulse:	2 V / Div
Time base:	5 ms / Div
Triggering:	gate pulse, ascending edge

- If the C5 reference signal is not within the gate pulse, the interface detection must be completely adjusted (➜ Chapter 2.2).

– Use the ↑ and ↓ keys to select **holeskew** and use the ← and → keay to set the value to 11 (C5 interface signal).

– The C5 interface signal must appear within the gate pulse (see figure).



Oscilloscope setting:

Video signal:	0.5 V / Div
Gate pulse:	2 V / Div
Time base:	5 ms / Div
Triggering:	gate pulse, ascending edge

– If the C5 interface signal is not within the gate pulse, the interface detection must be completely adjusted (➔ Chapter 2.2).

– If the C5 interface signal is flickering, the interface detection need not be adjusted.

2.2 Adjustment of the Interface Detection

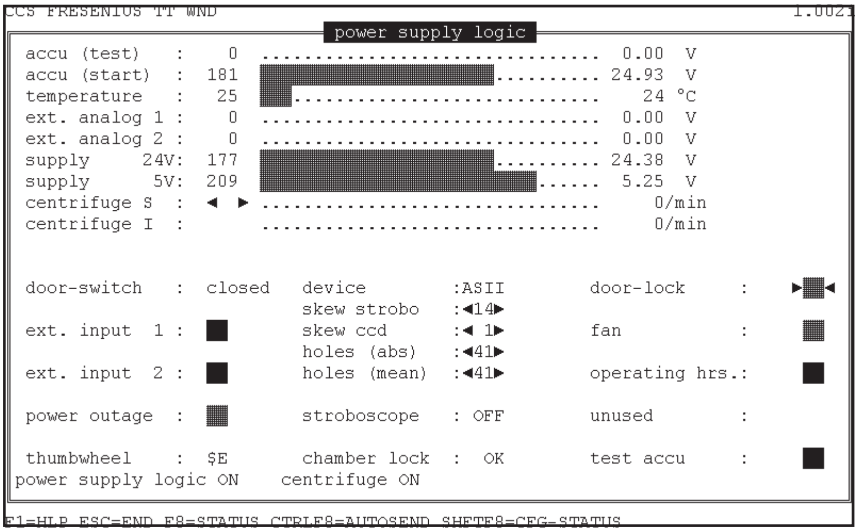
Measuring equipment:	2-channel storage oscilloscope, CCD test adapter – camera (part no. 678 617 1), BNC test cable (part no. 678 482 1), Reference chamber (part no. M60 383 1), Test cable (part no. 679 763 1)
Mode of operation:	CCS program

> **Caution**
> Before adjusting the interface detection:
> – Check the belt tension and adjust, if necessary.
> – Clean the optical axis.

– Access the CCS program.

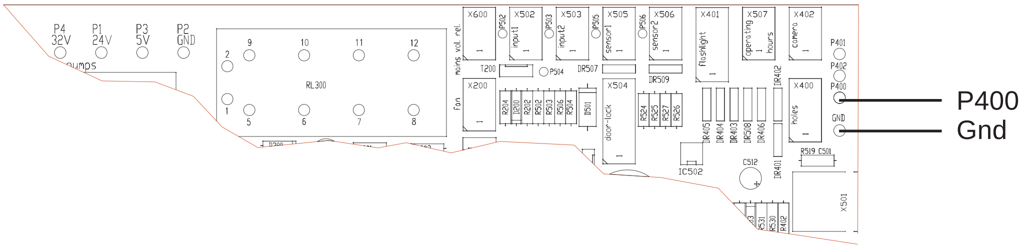
– Select the **power supply** menu.

– The following screen displays:



2.2.1 Adjustment of the Optical Sensor

Fig.: P.C.B. LP 823-1

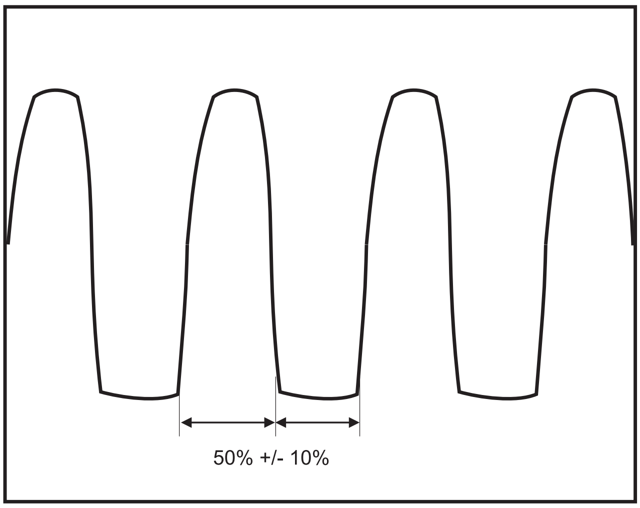


– Stop the centrifuge (**pos. 1**), open the door (**door lock**).

– Unscrew the 2 Allen screws that secure the optical sensor bracket.

– Connect the oscilloscope to P 400 / LP 823-1 and to GND / LP 823-1.

– Set the centrifuge speed to 1000 rpm.



Oscilloscope setting:
P400 / LP 823-1: 1 V/Div.
Time base: 0.5 ms/Div

– Radially adjust the optical sensor bracket until the pulse duty factor is 50 % ± 10 % (see figure).

Caution
Do not adjust the optical sensor bracket unless the centrifuge is completely stopped (0 rpm).

– Tighten the fixing screw of the optical sensor bracket.

– Check the optical sensor signal at 300 rpm and 2000 rpm:
Amplitude: > 4.7 V
Pulse-duty factor: 50 % ± 10 %
Signal not flickering

2.2.2 Basic Adjustement of the Camera and the Lighting Unit

– Stop the centrifuge (**pos. 1**), open the door (**door lock**).

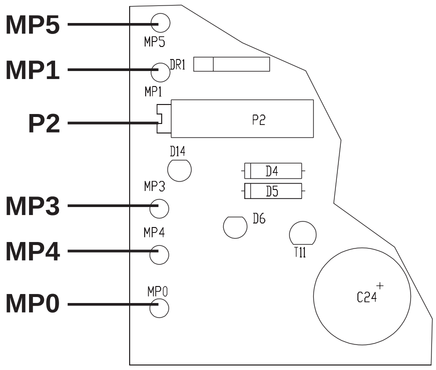
– Loosen the four size 3 Allen screws of the camera and the size 2.5 Allen screw of the support bracket to permit positioning of the camera.

– Position the camera with 3 mm distance to the front stop and parallel to the telescopic rail of the power supply unit.

– Lightly loosen the size 4 Allen screw of the lighting unit to permit positioning of the lighting unit.

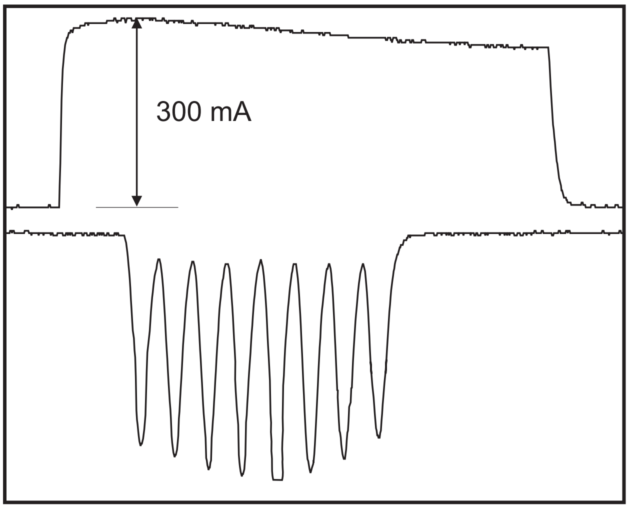
– Position the lighting unit centrally to the drilled hole and perpendicular to the front panel.

2.2.3 Precision Adjustment of the Camera and the Lighting Unit



- Insert the reference chamber with segment 1.
- Place the interface window into the optical axis. The missing hole on the perforated disc should now be located within the optical sensor.
  Adjustment:
  Loosen the size 2.5 Allen screw of the perforated disc carrier and position the missing hole to be within the optical sensor while maintaining the position of the reference chamber. Re-tighten the size 2.5 Allen screw when the adjustment is completed.
- Connect the test cable to connector X3 / LP 863 (ground).
- Connect the oscilloscope to the test adapter X3.2 / LP 863 (ground) and to X3.1 / LP 863 (hole pulses).
- Connect the oscilloscope to MP 0 / LP 866 (ground) and to MP 1 / LP 866 (current of the transmitting diode).
- Close the centrifuge door and set the centrifuge speed to 1000 rpm in the **power supply** menu.
- Activate automatic sending of target values (**AUTOSEND**) by pressing the **Ctrl** and the **F8** keys. Press the ↵ key.
- Exit the **power supply** menu and select the **CAN-I/O** menu.
- Activate the trigger unit **output 2 / no. 0**.
- Use P2 / LP 866 to set the current of the transmitting diode to 300 mA (equals a 300 mV amplitude on the oscilloscope).

> **Note**
> The current of the transmitting diode depends on the temperature. Before the verification the centrifuge must therefore have been in operation for at least 10 minutes, with the trigger unit **output 2 / no. 0** activated, and the current of the transmitting diode must be 300 mA.



Oscilloscope setting:

X3.1 / LP 863 (hole pulses):	2 V / Div
MP 1 / LP 866 (current of the transmitting diode):	0.1 V / Div
Time base:	0.5 ms / Div
Triggering:	Current of the transmitting diode, ascending edge

– Move the camera and the lighting unit to set the optimum amplitude height. The difference between the maximum and the minimum amplitude may not exceed 50 %. Use P1 / LP 863 to adjust the amplitude height so that clipping of one amplitude occurs.

– On completion of the adjustment the camera should be positioned parallel to the telescopic rail of the power supply unit and the lighting unit should be parallel to the front panel.

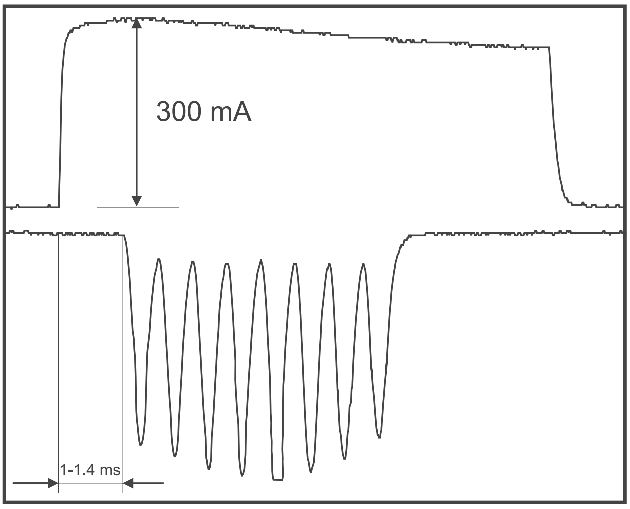
– Stop the centrifuge (**pos. 1**), open the door (**door lock**).

– Tighten the four size 3 Allen screws of the camera.

– Tighten the size 4 Allen screw of the lighting unit.

– Verify the adjustment and repeat, if necessary.

2.2.4 Adjustment of the 8 Hole Pulses (Basic Adjustment C5 Detection)



Oscilloscope setting:

X3.1 / LP 863 (hole pulses):	2 V / Div
MP 1 / LP 866 (current of the transmitting diode):	0.1 V / Div
Time base:	0.5 ms / Div
Triggering:	current of the transmitting diode, ascending edge

- The descending edge of the 1st hole pulse should appear 1 – 1.4 ms after the ascending edge of the current of the transmitting diode (see figure).
- Ascertain whether the 8 hole pulses are to the left or the right of the desired position.
- Exit the **CAN I/O** menu and select the **power supply** menu.
- Stop the centrifuge (**pos. 1**), open the door (**door lock**).
- Loosen the size 2.5 Allen screw of the perforated disc carrier.
- Rotate the perforated disc while holding the rotor shaft.
  If the 8 holes are to the right of the desired position, the perforated disc must be turned anti-clockwise (rotor viewed from below).
  If the 8 holes are to the left of the desired position, the perforated disc must be turned slightly clockwise (rotor viewed from below).
- Tighten the size 2.5 Allen screw of the perforated disc carrier.
- Verify the adjustment and repeat, if necessary.

2.2.5 Adjustment of the Interface Sensitivity of the 8 Hole Pulses

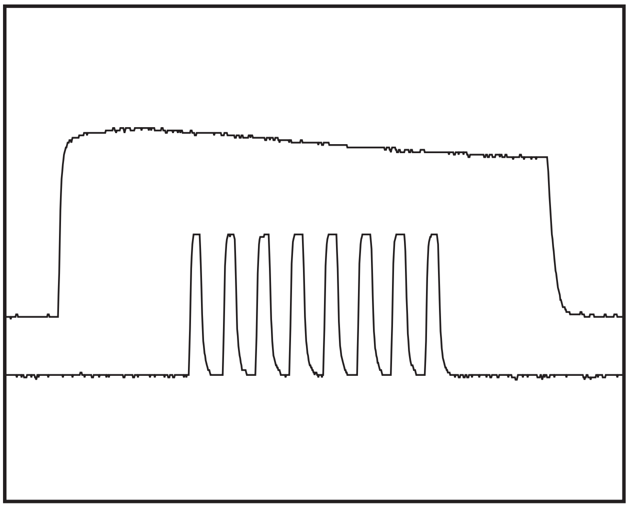
– Stop the centrifuge (**pos. 1**), open the door (**door lock**).

– Insert the reference chamber with the C4 hole area (segment 2) covered with foil.

– Connect the oscilloscope to the test adapter X3.2 / LP 863 (ground) and to X3.4 / LP 863 (digital hole pulses).

– Connect the oscilloscope to MP 0 / LP 866 (ground) and to MP 1 / LP 866 (current of the transmitting diode).

– Close the door, set the centrifuge speed to 1000 rpm.



Oscilloscope setting:

MP 1 / LP 866 (current of the transmitting diode):	0.1 V / Div
X3.4 / LP 863 (digital hole pulses):	2 V / Div
Time base:	0.5 ms / Div
Triggering:	current of the transmitting diode, ascending edge

Note
The current of the transmitting diode depends on the temperature. Before the verification the centrifuge must therefore have been in operation for at least 10 minutes, with the trigger unit **output 2 / no. 0** activated. The current of the transmitting diode must be 300 mA.

– Use P1 / LP 863 to adjust the 8 hole pulses (digital) so that they are all just visible and do not flicker (see figure).

2.2.6 Adjustment of the C5 Interface Detection

– Stop the centrifuge (**pos. 1**), open the door (**door lock**).

– Insert the reference chamber, segment 5.

– Connect the CCD test adapter to the plug connection that exits the camera housing.

– Connect the oscilloscope with the two BNC test cables to the CCD test adapter.

– Close the door, set the centrifuge speed to 2200 rpm.

– Exit the **power supply** menu and select the **CCD** menu.

– Reset the camera with the **F9** key and the ↵ key and wait until the intialisation phase of the camera is completed (**initsearch: OFF**) and segment 5 of the reference chamber has been detected (**C5 detected: ON**).

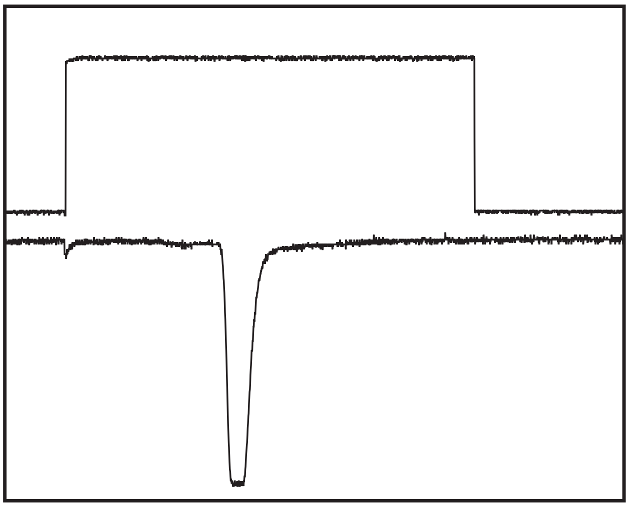
– Use the **F3** key to set **chamberlight: ON** (lighting).

– Use the **F6** key to set **automatic: locked**.

> **Caution**
> If the camera does not receive a new CAN command (**holeskew**, **lighttime cl**, **startpixel**) within one minute, it automatically exits the locked mode and the display changes from **automatic: locked** to **automatic: ON**.

– Use the ↑ and ↓ keys to select **holeskew** and set the value to 8 (reference signal) by pressing the ← and → keys.

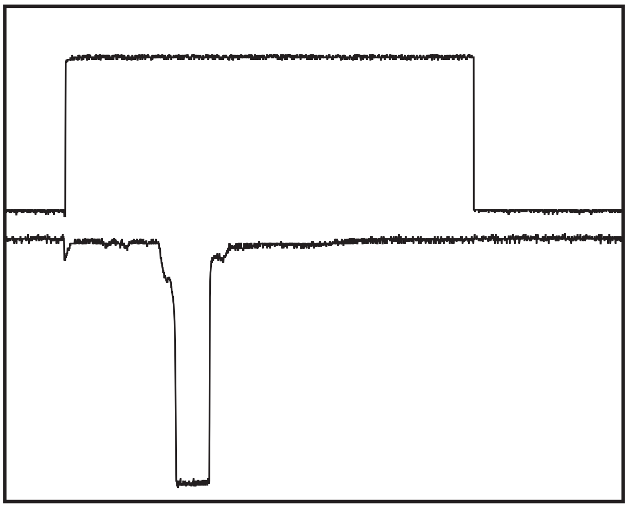
– The C5 reference signal must now be within the gate pulse (see figure).



Oscilloscope setting:

Video signal:	0.5 V / Div
Gate pulse:	2 V / Div
Time base:	5 ms / Div
Triggering:	gate pulse, ascending edge

– Use the ↑ and ↓ keys to select **holeskew** and use the ← and → keys to set the value to 11 (C5 interface signal).



Oscilloscope setting:

Video signal:	0.5 V / Div
Gate pulse:	2 V / Div
Time base:	5 ms / Div
Triggering:	gate pulse, ascending edge

– If no C5 interface signal appears, use the ↑ and ↓ keys to select **lighttime cl** (exposure time) and use the → key to increment the value to 15 while observing the oscilloscope for the C5 interface signal to appear.

– Exit the **CCD** menu and select the **power supply** menu.

– Stop the centrifuge (**pos. 1**), open the door (**door lock**).

– Loosen the size 2.5 Allen screw of the perforated disc carrier.

– Rotate the perforated disc in the following direction while holding the rotor shaft.
  – C5 interface signal visible when increasing the exposure time:
    Turn the perforated disc slightly anticlockwise (rotor viewed from below).
  – C5 interface signal not visible when increasing the exposure time:
    Turn the perforated disc slightly clockwise (rotor viewed from below).

– Tighten the size 2.5 Allen screw of the perforated disc carrier.

– Close the door, set the centrifuge speed to 2200 rpm.

– Exit the **power supply** menu and select the **CCD** menu.

> **Caution**
> If the camera does not receive a new CAN command within one minute (**holeskew**, **lighttime cl**, **startpixel**), it automatically exits the locked mode and the display changes from **automatic: locked** to **automatic: ON**.

– Use the ↑ and ↓ keys to select **holeskew** and use the ← and → keys to set the value to 11.

– Use the ↑ and ↓ keys to select **lighttime cl** (exposure time) and then use the ← and → keys to set the value to 0.

– The C5 interface signal should now appear within the gate pulse.
If the C5 interface signal fails to appear within the gate pulse, the adjustment must be repeated.

– Exit the **CCD** menu and select the **power supply** menu.

– Stop the centrifuge (**pos. 1**), open the door (**door lock**).

– Tighten the size 2.5 Allen screw of the fixing bracket of the camera.

– Set the centrifuge speed to 2200 rpm.

– Exit the **power supply** menu and select **CCD** menu.

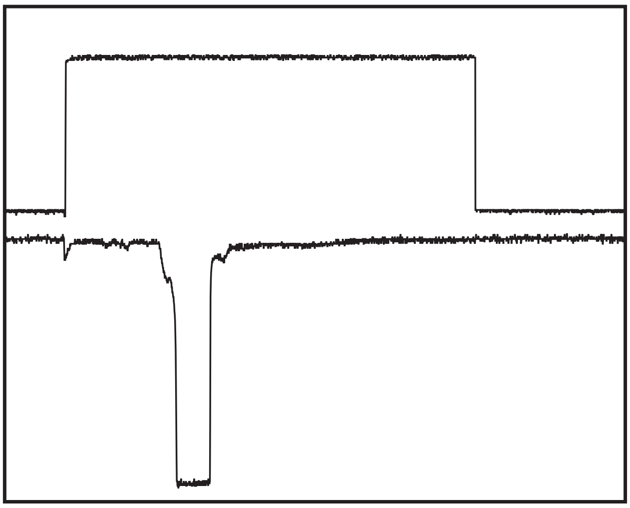
– Use the **F6** key to set **automatic: locked**.

Caution
If the camera does not receive a new CAN command within one minute (**holeskew**, **lighttime cl**, **startpixel**), it automatically exits the locked mode and the display changes from **automatic: locked** to **automatic: ON**.

– Use the ↑ and ↓ keys to select **holeskew** and use the ← and → key to set the value to 11.

– Use the ↑ and ↓ keys to select **lighttime cl** (exposure time) and then use the ← and → keys to set the value to 0.

– The C5 interface signal should now appear within the gate pulse.



Oscilloscope setting:

Video signal:	0.5 V / Div
Gate pulse:	2 V / Div
Time base:	5 ms / Div
Triggering:	gate pulse, ascending edge

– On completion of the adjustment the 8 hole pulses in the gate pulse must be verified using the C4 reference chamber, segment 1. At 1000 rpm and 2200 rpm the 8 hole pulses must appear within the gate pulse.

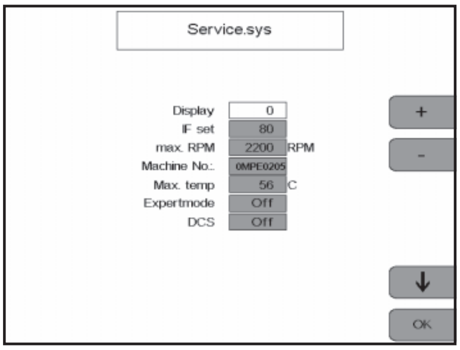
2.3 C5 Interface Sensitivity

Measuring equipment: Reference chamber (part no. M60 383 1)

Mode of operation: PLT-5d program

2.3.1 Verification of the Interface Sensitivity

- Turn the COM.TEC power on.
- Enter the **Service.sys** code (Chapter 1.2).
- Access the **PLT-5d** program.
- Insert the reference chamber with segment 6.
- Access the **Service.sys** (Chapter 1.2).



Use the ↑ and ↓ keys to select **Expert Mode**.

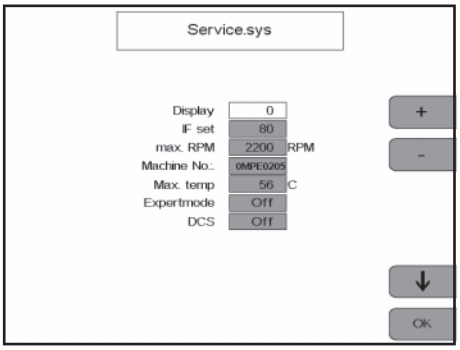
Use the **+** and **–** keys to set **Expert Mode** to **On**.

Press the **OK** key.

- Start the **PLT-5d** separation program.
- Read the actual interface value IF_{act} displayed.
- Stop the separation program.
- Determine the difference between the actual interface value displayed IF_{act} and the interface value $IF_{chamber}$ printed on the chamber. The value determined for $IF_{difference}$ must range between +5 and –5.
  $IF_{act} - IF_{chamber} = IF_{difference}$ (tolerance: ±5).

2.3.2 Adjustment of the Interface Sensitivity

– Access the **Service.sys** (Chapter 1.2).



Use the ↑ and ↓ keys to select **IF set**.

Use the **+** and **–** keys to change **IF set** by the value determined for $IF_{difference}$:
IF set ± $IF_{difference}$ = IF set_{new}

Press the **OK** key.

– Start the **PLT-5d** separation program.

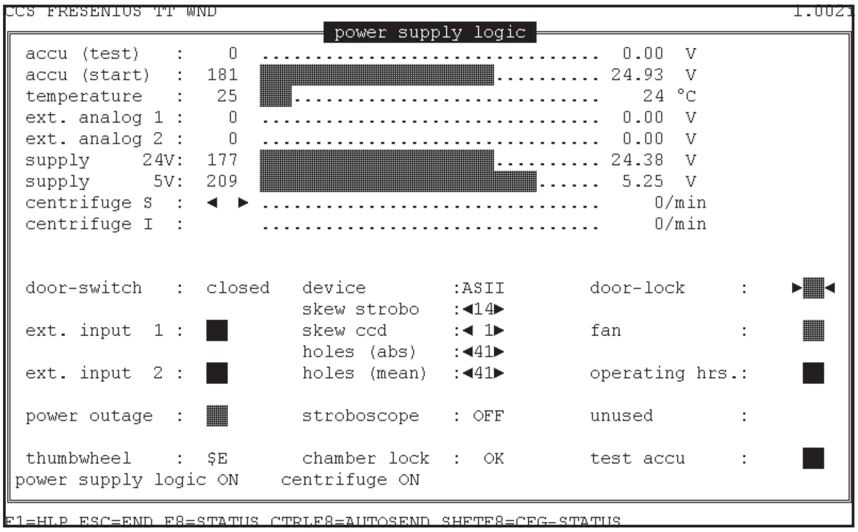
– On completion of the adjustment the actual interface value displayed, IF_{act}, must correspond to the value $IF_{chamber}$ printed on the chamber.

2.4 Verification of the C5 Illuminance

Measuring equipment: Reference chamber (part no. M60 383 1)

Mode of operation: CCS program

- Access the CCS program.
- Select the **power supply** menu.
- The following screen displays:



- Stop the centrifuge (**pos. 1**), open the door (**door lock**).
- Insert the reference chamber with segment 6.
- Set the centrifuge speed to 2000 rpm.
- Activate automatic sending of the target values (**AUTOSEND**) by pressing the **Ctrl** and the **F8** key. Press the ↵ key.
- Exit the **power supply** menu and select the **CCD** menu.
- Reset the camera with the **F9** key and the ↵ key and wait until the intialisation phase of the camera is completed (**initsearch: OFF**) and segment 5 of the reference chamber has been detected (**C5 detected: ON**).
- Use the **F3** key to set **chamberlight: ON** (lighting).

– Use the **F6** key to set **automatic: locked**.

> **Caution**
> If the camera does not receive a new CAN command (**holeskew**, **lighttime cl**, **startpixel**) within one minute, it automatically exits the locked mode and the display changes from **automatic: locked** to **automatic: ON**.

– Use the ↑ and ↓ keys to select **holeskew** and set the value to 11 (reference signal) by pressing the ← and → keys.

– Use the ↑ and ↓ keys to select **lighttime cl** (exposure time) and then use the ← and → keys to set the value to 8.

– Press the **F7** key to access the CCD camera display module.

– Use the **F8** (right) key and the **shift F8** (left) key to move the red column to determine the illuminance.

– Shift the column until the right edge intersects the center of the descending edge of the signal, note down the pixels ($pixel_1$).
Typical pixel value: 40 – 65

– Shift the column until the right edge intersects the center of the ascending edge of the signal, note down the pixels ($pixel_2$).
Typical pixel value: 60 – 85

– Determine the difference between $pixel_2$ and $pixel_1$. The value determined for the illuminance should range between 18 and 45 pixels.
Illuminance = $pixel_2 – pixel_1$ (typcal values: 18 – 45 pixels).

2.5 Inlet Pressure Monitor

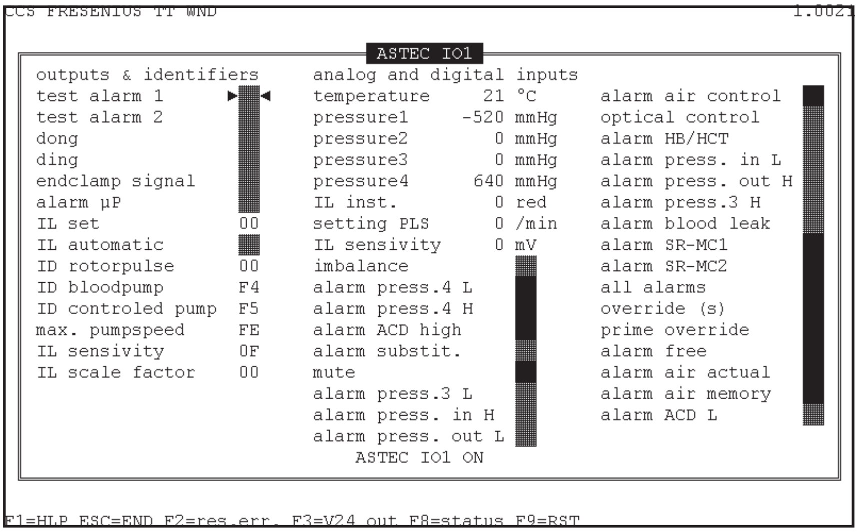
Measuring equipment: Pressure gauge in mmHg

Measurement point: Pressure port – inlet pressure

Measuring signal: Pressure display, LED D201, LED D202

Mode of operation: CCS program

- Access the CCS program.
- Select the **astecio1** menu.
- The following screen displays:



2.5.1 Verification of the Gain

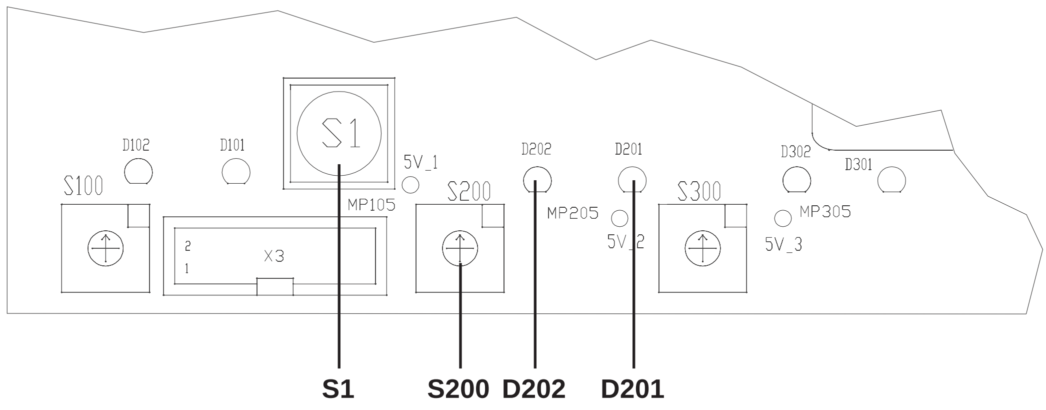
- Zero:
  With the pressure port open, verify that the inlet pressure display **pressure2** indicates 0 mmHg.
- Gain:
  Apply a pressure of 240 mmHg to the inlet pressure port; verify that the **pressure2** display indicates 240 mmHg.
  If one of the values displayed deviates from the target value, adjust the pressure.

2.5.2 Verification of the Alarm Limits

- Lower alarm limit: –310 mmHg ±10 mmHg
- Upper alarm limit: +310 mmHg ±10 mmHg

2.5.3 Adjustment of the Gain

Fig.: P.C.B LP 870



- **Reset of the Pressure Monitor**

> **Note**
> After a reset of the inlet pressure monitor, zero, gain and alarm limits of the inlet pressure monitor must be readjusted.

– Set the mode switch S200 to position C.

– Press the S1 button twice.
All values of the inlet pressure monitor that were stored will be erased.

- **Calibration of the Zero**

– Set the mode switch S200 to position D, the LED D201/P.C.B. LP 870 lights.

– With the inlet pressure port open (0 mmHg/0 Pa), press the S1 button.
After successful calibration, the LED D201/P.C.B. LP 870 will stop lighting and the LED D202/P.C.B. LP 870 will start lighting.

– Press the S1 button again, the LED D202/P.C.B. LP 870 stops lighting.

> **Note**
> If the LED D201/P.C.B. LP 870 is flashing after the S1 button has been pressed for the first time, this may be due to one of the following errors:
> 1. The pressure being applied to the inlet pressure port exceeds +16.6 mmHg or is lower than –20.8 mmHg.
> 2. The IC 201/P.C.B. LP 870 or its external wiring is defective.

- **Calibration of the Gain**

  – Set the mode switch S200 to position E, the LED D202/P.C.B. LP 870 lights.

  – Apply +500 mmHg (66661 Pa) to the inlet pressure port and press the S1 button.
  After successful calibration, the LED D202/P.C.B. LP 870 will stop lighting and the LED D201/P.C.B. LP 870 will start lighting.

  – Press the S1 button again, the LED D201/P.C.B. LP 870 stops lighting.

> **Note**
> If the LED D202/P.C.B. LP 870 is flashing after the S1 button has been pressed for the first time, the pressure being applied to the inlet pressure port is lower than +16.6 mmHg (2213 Pa).

  – Set the mode switch S200 to position 0.

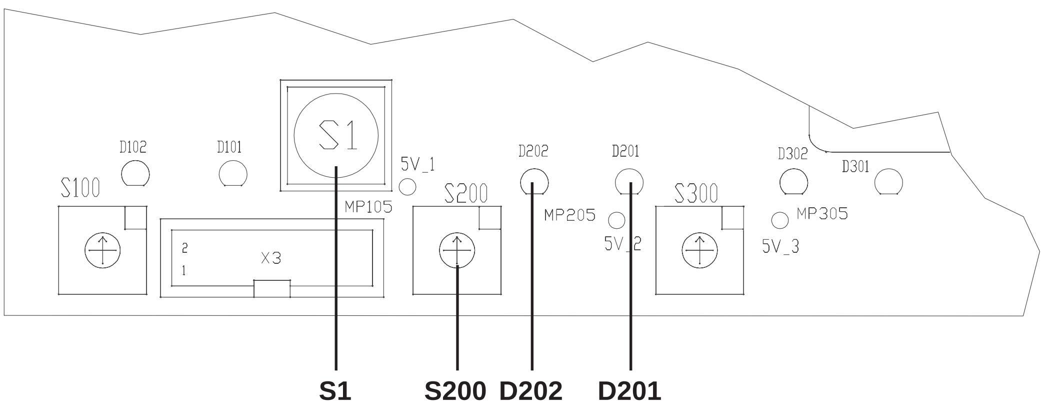
- **Final Check**

  – Check the pressure transducer for tightness at 500 mmHg.

> **Note**
> Verify after completion of the adjustment and readjust, if necessary.

2.5.4 Adjustment of the Alarm Limits

Fig.: P.C.B. LP 870



- **Reset of the Pressure Monitor**

> **Note**
> After a reset of the inlet pressure monitor, zero, gain and alarm limits of the inlet pressure monitor must be readjusted.

– Set the mode switch S200 to position C.

– Press the S1 button twice.
All values of the inlet pressure monitor that were stored will be erased.

- **Adjustment**

– Set the mode switch S200 to position F, the LEDs D201/P.C.B. 870 and D202/P.C.B. 870 light.

– Apply +310 mmHg (upper alarm limit) to the inlet pressure port and press the S1 button.

– After successful calibration, the LED D202/P.C.B. LP 870 stops lighting and the LED D201/P.C.B. LP 870 will start lighting.

> **Note**
> If the LEDs D201/P.C.B. 870 and D202/P.C.B. 870 are flashing after the S1 button has been pressed for the first time, the pressure being applied to the inlet pressure port is lower than +16.6 mmHg (2213 Pa).

– Apply –310 mmHg (lower alarm limit) to the inlet pressure port and press the S1 button.

– After successful calibration, the LED D201/P.C.B. LP 870 stops lighting.

> **Note**
> If the LEDs D201/P.C.B. LP 870 and D202/P.C.B. LP 870 are flashing after the S1 button has been pressed for the first time, the pressure being applied to the inlet pressure port exceeds –20 mmHg (2666 Pa). A recalibration of the upper and lower alarm limits must be performed.

– Set the mode switch S200 to position 0.

- **Final Check**

– Start the **test alarm 1** test. The actual value on the bargraph display must be one LED above the upper limit and one LED below the lower limit.

– Start the **test alarm 2** test. All alarms are reset.

2.6 Outlet Pressure Monitor

Measuring equipment:	Pressure gauge in mmHg
Measurement point:	Pressure port – outlet pressure
Measuring signal:	Pressure display, LED D301, LED D302
Mode of operation:	CCS program

– Access the CCS program.

– Select the **astecio1** menu.

– The following screen displays:

```
CCS FRESENIUS TT WND                                                        1.0021
                                      ASTEC IO1
   outputs & identifiers     analog and digital inputs
   test alarm 1              temperature     21 °C     alarm air control
   test alarm 2              pressure1     -520 mmHg   optical control
   dong                      pressure2        0 mmHg   alarm HB/HCT
   ding                      pressure3        0 mmHg   alarm press. in L
   endclamp signal           pressure4      640 mmHg   alarm press. out H
   alarm µP                  IL inst.         0 red    alarm press.3 H
   IL set             00     setting PLS      0 /min   alarm blood leak
   IL automatic              IL sensivity     0 mV     alarm SR-MC1
   ID rotorpulse      00     imbalance                 alarm SR-MC2
   ID bloodpump       F4     alarm press.4 L           all alarms
   ID controled pump  F5     alarm press.4 H           override (s)
   max. pumpspeed     FE     alarm ACD high            prime override
   IL sensivity       0F     alarm substit.            alarm free
   IL scale factor    00     mute                      alarm air actual
                             alarm press.3 L           alarm air memory
                             alarm press. in H         alarm ACD L
                             alarm press. out L
                                 ASTEC IO1 ON

F1=HLP ESC=END F2=res.err. F3=V24 out F8=status F9=RST
```

2.6.1 Verification of the Gain

– Zero:
With the pressure port open, verify that the outlet pressure display **pressuer3** indicates 0 mmHg.

– Gain:
Apply 240 mmHg to the outlet pressure port and verify that the **pressure3** display indicates 240 mmHg.
If one of the values displayed deviates from the target value, adjust the pressure.

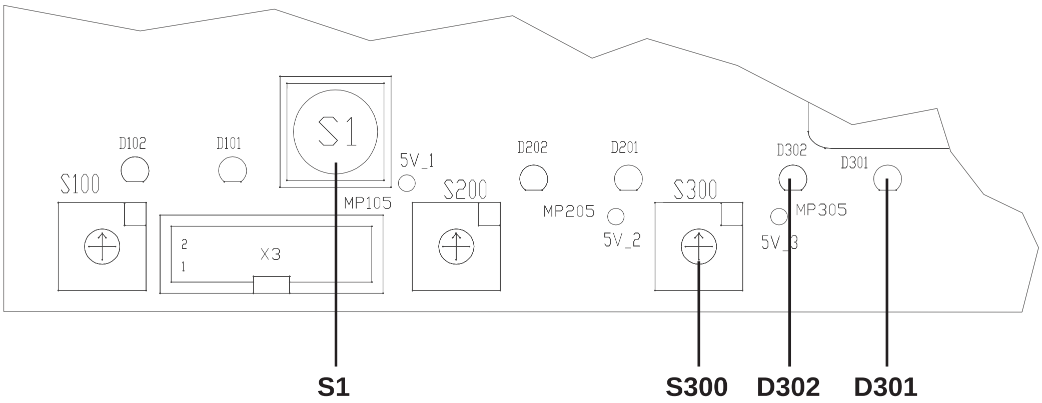
2.6.2 Verification of the Alarm Limits

– Lower alarm limit: –110 mmHg ± 10 mmHg

– Upper alarm limit: +310 mmHg ± 10 mmHg

2.6.3 Adjustment of the Gain

Fig.: P.C.B. LP 870



- **Reset of the Outlet Pressure Monitor**

> **Note**
> After a reset of the outlet pressure monitor, zero, gain and alarm limits of the outlet pressure monitor must be readjusted.

– Set the mode switch S300 to position C.

– Press the S1 button twice.
All values of the outlet pressure monitor that were stored will be erased.

- **Calibration of the Zero**

– Set the mode switch S300 to position D, the LED D301/P.C.B. LP 870 lights.

– With the outlet pressure port open (0 mmHg/0 Pa), press the S1 button.
After successful calibration, the LED D301/P.C.B. LP 870 will stop lighting and the LED D302/P.C.B. LP 870 will start lighting.

– Press the S1 button again, the LED D302/P.C.B. LP 870 stops lighting.

> **Note**
> If the LED D301/P.C.B. LP 870 is flashing after the S1 button has been pressed for the first time, this may be due to one of the following errors:
> 1. The pressure being applied to the outlet pressure port exceeds +16.6 mmHg or is lower than –20.8 mmHg.
> 2. The IC 301/P.C.B. LP 870 or the external wiring of IC 301/P.C.B. LP 870 is defective.

- **Calibration of the Gain**

  – Set the mode switch S300 to position E, the LED D302/P.C.B. LP 870 lights.

  – Apply +500 mmHg (66661 Pa) to the outlet pressure port and press the S1 button.
  After successful calibration, the LED D302/P.C.B. LP 870 will stop lighting and the LED D301/P.C.B. LP 870 will start lighting.

  – Press the S1 button again, the LED D301/P.C.B. LP 870 stops lighting.

> **Note**
> If the LED D302/P.C.B. LP 870 is flashing after the S1 button has been pressed for the first time, the pressure being applied to the outlet pressure port is lower than +16.6 mmHg (2213 Pa).

  – Set the mode switch S300 to position 0.

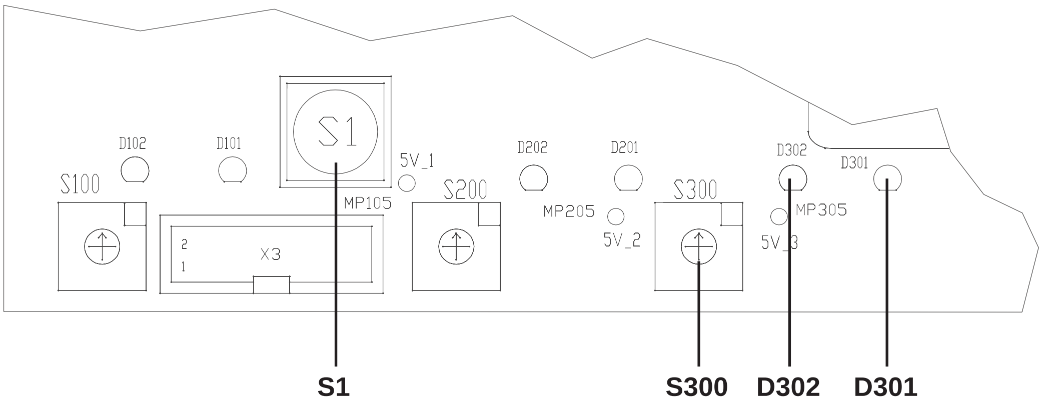
- **Final Check**

  – Check the pressure transducer for tightness at 500 mmHg.

> **Note**
> Verify after completion of the adjustment and readjust, if necessary.

2.6.4 Adjustment of the Alarm Limits

Fig.: P.C.B. LP 870



- **Reset of the Outlet Pressure Monitor**

> **Note**
> After a reset of the outlet pressure monitor, zero, gain and alarm limits of the outlet pressure monitor must be readjusted.

– Set the mode switch S300 to position C.

– Press the S1 button twice.
All values of the outlet pressure monitor that were stored will be erased.

- **Adjustment**

– Set the mode switch S300 to position F, the LEDs D301/P.C.B. 870 and D302/P.C.B. 870 light.

– Apply +310 mmHg (upper alarm limit) to the outlet pressure port and press the S1 button.

– After successful calibration, the LED D302/P.C.B. LP 870 will stop lighting and the LED D301/P.C.B. LP 870 will start lighting.

> **Note**
> If the LEDs D301/P.C.B. LP 870 and D302/P.C.B. LP 870 are flashing after the S1 button has been pressed for the first time, the pressure applied to the outlet pressure port is lower than +16.6 mmHg (2213 Pa).

– Apply –110 mmHg (lower alarm limit) to the outlet pressure port and press the S1 button.

– After successful calibration, the LED D301/P.C.B. LP 870 will stop lighting.

Note
If the LEDs D301/P.C.B. LP 870 and D302/P.C.B. LP 870 are flashing after the S1 button has been pressed for the first time, the pressure applied to the outlet pressure port exceeds –20 mmHg (2666 Pa). The upper and lower alarm limits must be readjusted.

– Set the mode switch S300 to position 0.

- **Final Check**

– Start the **test alarm 1** test. The actual value on the bargraph display must be one LED above the upper limit and one LED below the lower limit.

– Start the **test alarm 2** test. All alarms are reset.

2.7 P3-Monitor

Measuring equipment:	Pressure gauge in mmHg
Measurement point:	Pressure port – P3-pressure
Measuring signal:	Pressure display, LED D101, LED D102
Mode of operation:	CCS program

– Access the CCS program.

– Select the **astecio1** menu.

– The following screen displays:

```
CCS FRESENIUS TT WND                                                     1.0021

                                    ASTEC IO1
 outputs & identifiers     analog and digital inputs
 test alarm 1              temperature      21 °C     alarm air control
 test alarm 2              pressure1      -520 mmHg   optical control
 dong                      pressure2         0 mmHg   alarm HB/HCT
 ding                      pressure3         0 mmHg   alarm press. in L
 endclamp signal           pressure4       640 mmHg   alarm press. out H
 alarm µP                  IL inst.          0 red    alarm press.3 H
 IL set              00    setting PLS       0 /min   alarm blood leak
 IL automatic              IL sensivity      0 mV     alarm SR-MC1
 ID rotorpulse       00    imbalance                  alarm SR-MC2
 ID bloodpump        F4    alarm press.4 L            all alarms
 ID controled pump   F5    alarm press.4 H            override (s)
 max. pumpspeed      FE    alarm ACD high             prime override
 IL sensivity        0F    alarm substit.             alarm free
 IL scale factor     00    mute                       alarm air actual
                           alarm press.3 L            alarm air memory
                           alarm press. in H          alarm ACD L
                           alarm press. out L
                               ASTEC IO1 ON

F1=HLP ESC=END F2=res.err. F3=V24 out F8=status F9=RST
```

2.7.1 Verification of the Gain

– Zero:
With the pressure port open, verify that the P3 pressure display **pressure 1** indicates 0 mmHg.

– Gain:
Apply 240 mmHg to the P3 pressure port and verify that the **pressure1** display indicates 240 mmHg.
If one of the values displayed deviates from the target value, adjust the pressure.

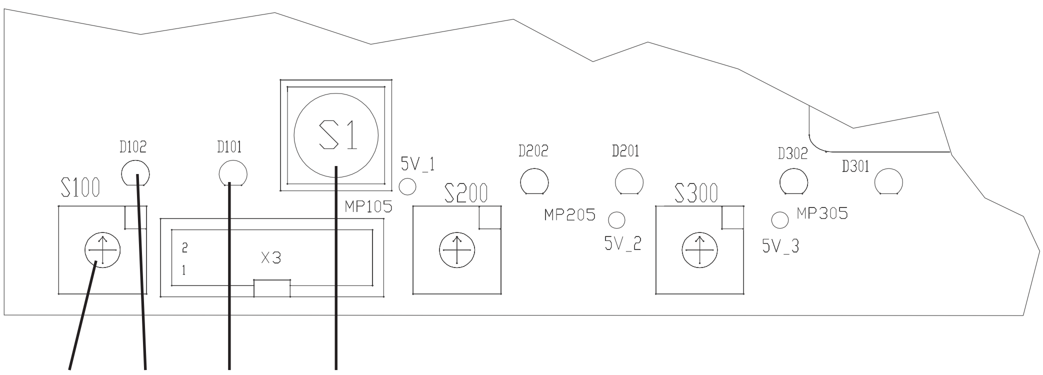
2.7.2 Verification of the Alarm Limits

– lower alarm limit: –310 mmHg ± 10 mmHg

– upper alarm limit: +310 mmHg ± 10 mmHg

2.7.3 Adjustment of the Gain

Fig.: P.C.B. LP 870



- **Reset of the P3 Pressure Monitor**

> **Note**
> After a reset of the P3 pressure monitor, zero, gain and alarm limits of the P3 pressure monitor must be readjusted.

– Set the mode switch S100 to position C.

– Press the S1 button twice.
All values of the P3 pressure monitor that were stored will be erased.

- **Calibration of the Zero**

– Set the mode switch S100 to position D, the LED D101/P.C.B. LP 870 lights.

– With the P3 pressure port open (0 mmHg/0 Pa), press the S1 button.
After successful calibration, the LED D101/P.C.B. LP 870 will stop lighting and the LED D102/P.C.B. LP 870 will start lighting.

– Press the S1 button again, the LED D102/P.C.B. LP 870 stops lighting.

> **Note**
> If the LED D101/P.C.B. LP 870 is flashing after the S1 button has been pressed for the first time, may be due to one of the following errors:
> 1. The pressure being applied to the P3 pressure port exceeds +16.6 mmHg or is lower than –20.8 mmHg.
> 2. The IC 101/P.C.B. 870 or the external wiring of IC 101/P.C.B. 870 is defective.

- **Calibration of the Gain**

  – Set the mode switch S100 to position E, the LED D102/P.C.B. LP 870 lights.

  – Apply +500 mmHg (66661 Pa) to the P3 pressure port and press the S1 button.
  After successful calibration, the LED D102/P.C.B. LP 870 will stop lighting and the LED D301/P.C.B. LP 870 will start lighting.

  – Press the S1 button again, the LED D101/P.C.B. LP 870 stops lighting.

> **Note**
> If the LED D102/P.C.B. LP 870 is flashing after the S1 button has been pressed for the first time, the pressure being applied to the P3 pressure port is lower than +16.6 mmHg (2213 Pa).

  – Set the mode switch S100 to position 0.

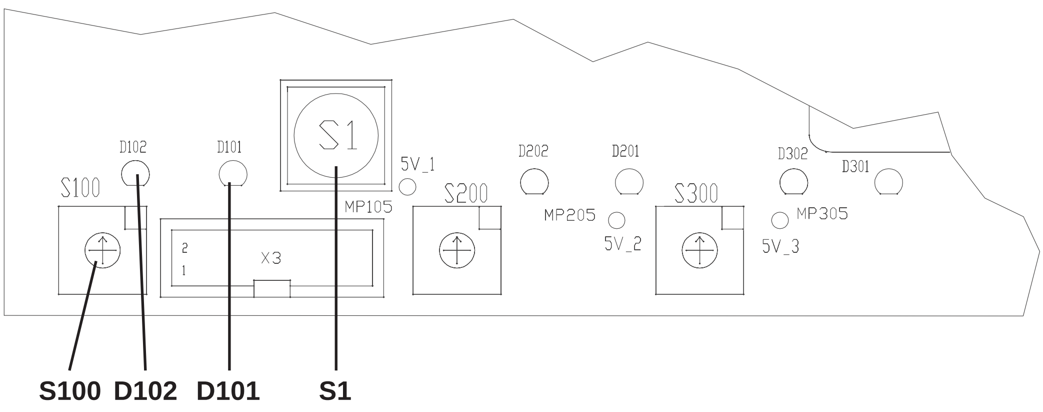
- **Final Check**

  Check the pressure transducer for tightness at 500 mmHg.

> **Note**
> Verify after completion of the adjustment and readjust, if necessary.

2.7.4 Adjustment of the Alarm Limits

Fig.: P.C.B. LP 870



- **Reset of the P3 Pressure Monitor**

Note After a reset of the P3 pressure monitor, zero, gain and alarm limits of the P3 pressure monitor must be readjusted.

– Set the mode switch S100 to position C.

– Press the S1 button twice.
All values of the P3 pressure monitor that were stored will be erased.

- **Adjustment**

– Set the mode switch S100 to position F, the LEDs D101/P.C.B. 870 and D102/P.C.B. LP 870 light.

– Apply +310 mmHg (upper alarm limit) to the P3 pressure port and press the S1 button.

– After successful calibration, the LED D102/P.C.B. LP 870 will stop lighting and the LED D101/P.C.B. LP 870 will start lighting.

Note If the LEDs D101/P.C.B. LP 870 and D102/P.C.B. LP 870 are flashing after the S1 button has been pressed for the first time, the pressure applied to the P3 pressure port is lower than +16.6 mmHg (2213 Pa).

– Apply –310 mmHg (lower alarm limit) to the P3 pressure port and press the S1 button.

– After successful calibration the LED D101/P.C.B. LP 870 will stop lighting.

> **Note**
> If the LEDs D101/P.C.B. LP 870 and D102/P.C.B. LP 870 are flashing after the S1 button has been pressed for the first time, the pressure being applied to the P3 pressure port exceeds –20 mmHg (2666 Pa). The upper and lower alarm limits must be recalibrated.

– Set the mode switch S100 to position 0.

- **Final Check**

  – Start the **test alarm 1** test. The actual value on the bargraph display must be one LED above the upper limit and one LED below the lower limit.

  – Start the **test alarm 2** test. All alarms are reset.

2.8 Operating Voltages / Battery Voltage

Measuring equipment: CCS program

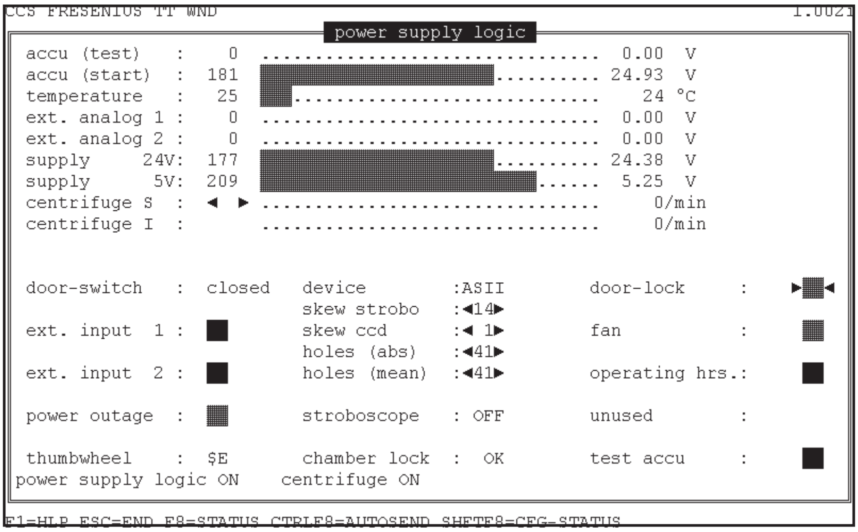
Mode of operation: Power On

2.8.1 Verification

– Access the CCS program.

– Select the **power supply** menu.

– The following screen displays:



– To display the **accu-test** voltage, use the keyboard to select **test accu**.

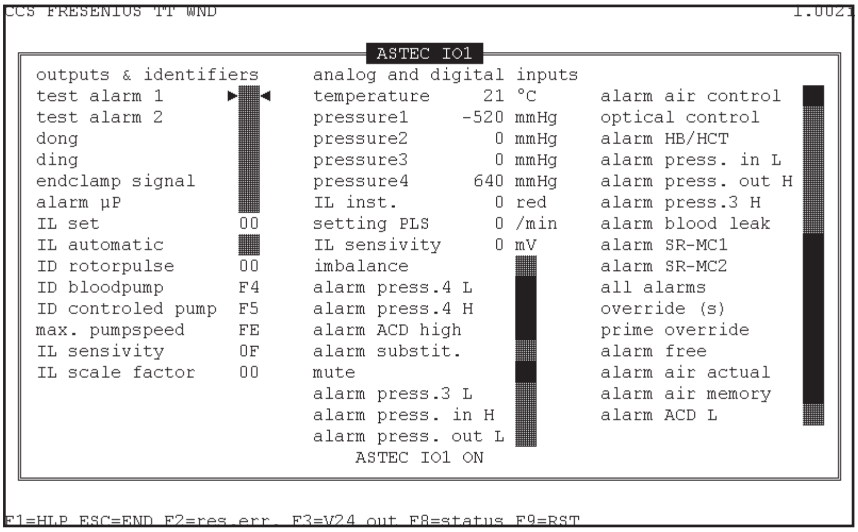
	Target value	Actual value
24 V supply (**supply 24 V**)	24 V ± 1 V	
5 V supply (**supply 5 V**)	5.1 V ± 0.1 V	
Battery off-load voltage (**accu start**)	24 V – 26 V	
Battery loaded (**accu test**)	>23 V	

2.9 Air Detector

Measuring equipment:	Drip chamber filled with water, setting standard (part no. 645 670 1), air detector test adapter (part no. 678 497 1)
Measurement point:	Air detector test adapter between X23 / P.C.B. LP 865 and air detector connecting cable
Measuring signal:	LED D39 and D40 / LP 840 (5th and 6th LED from top)
Mode of operation:	Installed drip chamber filled with water, CCS program

2.9.1 Verification

- Turn the machine Off.
- Connect the air detector test adapter between X23 / LP 845 (**air control**) and the air detector connecting cable with adapter switch in position “Off”.
- Turn the machine On.
- Access the PC2 program.
- Select the **astecio1** menu.
- The following screen displays:



- Install the drip chamber filled with water.

- Reset the alarms with **test alarm 2**.
  Alarm air control = bright
  Alarm air actual = bright
  Alarm air memory = bright

- The two LED's D39 and D40 / LP 840 are lit.

- Operate the switch on the test adapter, the two LED's D39 and D40 must stop lighting.

- Display in CCS program:
  Alarm air control = dimmed
  Alarm air actual = dimmed
  Alarm air memory = dimmed

- If the above conditions are not attained, calibrate the air detector.

- Turn the machine Off.

- Remove the test adapter.

2.9.2 Adjustment

- Turn the machine On.

- Place the setting standard, to which grease has been applied, into the drip chamber holder.

- Set jumper J164 / LP-Z 241 to the “calibration“ position.

- Rotate potentiometer P144 / LP-Z 241 clockwise until LED D34 / LP-Z 241 stops lighting. Then rotate potentiometer P144 / LP-Z 241 anticlockwise until D34 / LP-Z 241 just starts lighting.

- Rotate potentiometer P145 / LP-Z 241 clockwise until LED D39 / LP-Z 241 stops lighting. Then rotate potentiometer P145 / LP-Z 241 anticlockwise until LED D39 / LP-Z 241 just starts lighting.

- Set jumper J164 / LP-Z 241 to the „Operation“ position.

- Verify the setting.

2.10 Optical Detector in Air Detector

Measuring equipment:	Neutral wedge (13-shade) (part no. 679 514 1), neutral filter (part no. 640 560 1), 2 layers – 1.2 ND
Measurement point:	LED D24 / P.C.B. LP 840 (yellow, 3rd LED from bottom)
Mode of operation:	Machine power on

2.10.1 Verification

- Place the neutral wedge into the optical detector, close the cover.
- Dim the light beam by moving the neutral wedge slowly from grey-scale value 1 through the optical detector.
- At a grey scale value of 5 or earlier, the optical detector must sense dark, diode D24 (yellow) on P.C.B. LP 840 stops lighting.
- If not, calibrate the optical detector.

2.10.2 Calibration of the Optical Detector

- Install the neutral filter with 2 layers.
- Close the cover.
- Rotate potentiometer P148 / LP-Z 241 clockwise, until LED D24 / LP 840 lights.
- Rotate potentiometer P148 / LP-Z 241 anticlockwise until LED D24 / LP 840 just stops lighting (rotate slowly, time constant = 1 second).
- Rotate potentiometer P148 / LP-Z 241 another 1.5 turns anticlockwise.
- Verify the setting.

2.11 Hb/Hct Detector

Measuring equipment: Neutral wedge (13-step) (part no. 679 514 1), red filter (part no. 646 920 1), line filled with water, drip chamber filled with water

Measuring signal: see calibration

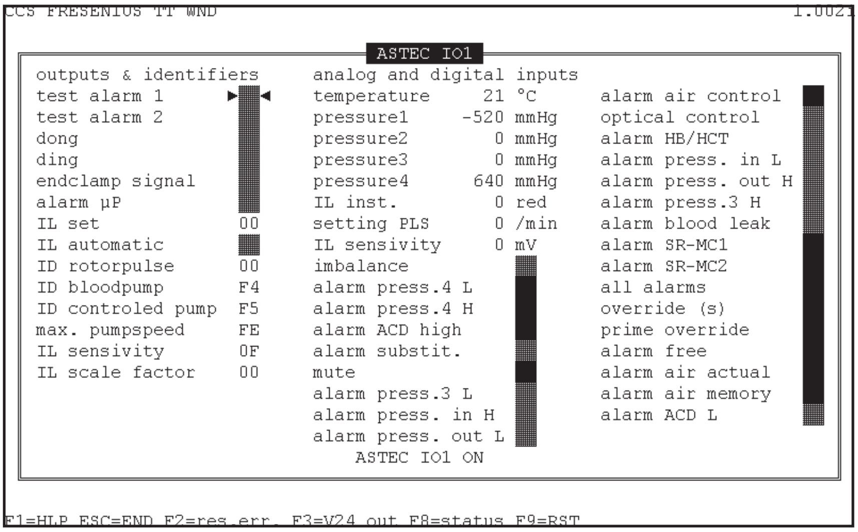
Mode of operation: CCS program

2.11.1 Verification

– Access the CCS program.

– Select the **astecio1** menu.

– The following screen displays:



– Reset the alarms with **test alarm 2**.

– Insert the neutral wedge into the Hb/Hct detector.

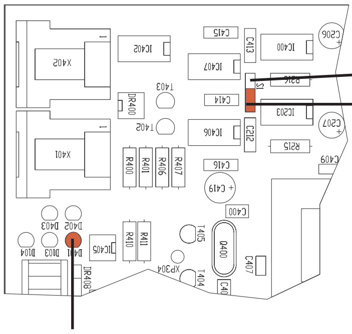
– Dim the light beam by moving the neutral wegde in the Hb/Hct detector slowly from grey-scale value 1 through the Hb/Hct detector. At a grey-scale value of 3 or earlier, the **alarm HB/HCT** display must light.

– Reset the alarms with **test alarm 2**.

– Insert the red filter into the Hb/Hct detector. The **alarm HB/HCT** display must be lit.

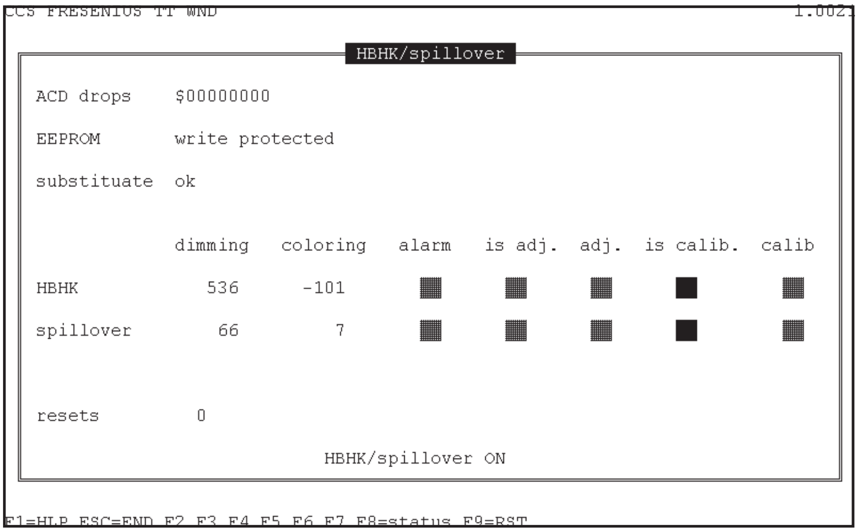
– Reset the alarms with **test alarm 2**.

2.11.2 Adjustment



– Insert a length of original tubing (3.1 x 0.6) filled with water into the Hb/Hct detector.

– Select the **hbhk** menu.



– Set S1/P.C.B. LP 867 to the *Calibration* position; the display changes from **EEPROM write protected** to **EEPROM write enabled**.

– Press the **F4** key and the submenu **calibrate hbhk** will display.

– Press any key and wait until the **HB/HK is calib.** display lights again.

– Set S1/P.C.B. LP 867 to the *Operation* position; the display in the **hbhk** menu changes from **EEPROM write enabled** to **EEPROM write protected**.

– Verify the setting.

2.12 Spillover Detector

Measuring equipment: Neutral wedge (13-shade) (part no. 679 514 1), red filter (part no. 646 920 1),
line filled with water, drip chamber filled with water

Measuring signal: see calibration

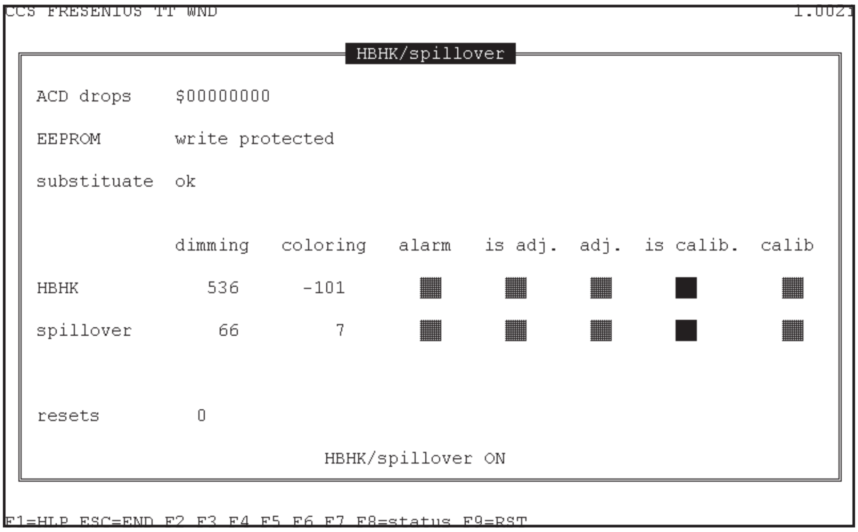
Mode of operation: CCS program

2.12.1 Verification

– Access the CCS program.

– Select the **hbhk** menu.

– The following screen displays:

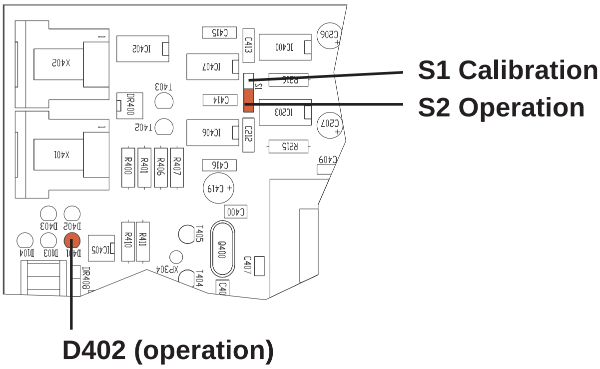


– Insert the neutral wedge into the Spillover detector.

– Dim the light beam by moving the neutral wegde in the Spillover detector slowly from grey-scale value 1 through the Spillover detector. At a grey scale value of 3 or earlier, the **alarm spillover** display must light.

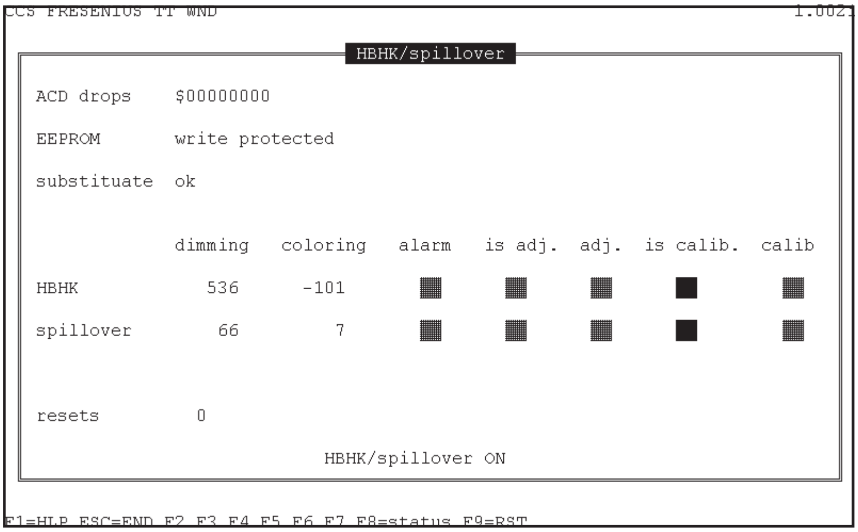
– Insert the red filter into the Spillover detector. The **alarm spillover** display must be lit.

2.12.2 Adjustment



– Insert a length of original tubing (3.1 x 0.6) filled with water into the Spillover detector.

– Select the **hbhk** menu.



– Set S1/P.C.B. LP 867 to the *Calibration* position; the display changes from **EEPROM write protected** to **EEPROM write enabled**.

– Press the **F6** key and the submenu **calibrate hbhk** will display.

– Press any key and wait until the **spillover is calib.** display lights again.

– Set S1/P.C.B. LP 867 to the *Operation* position; the display in the **hbhk** menu changes from **EEPROM write enabled** to **EEPROM write protected**.

– Verify the setting.

2.13 Substituate-Empty Detector

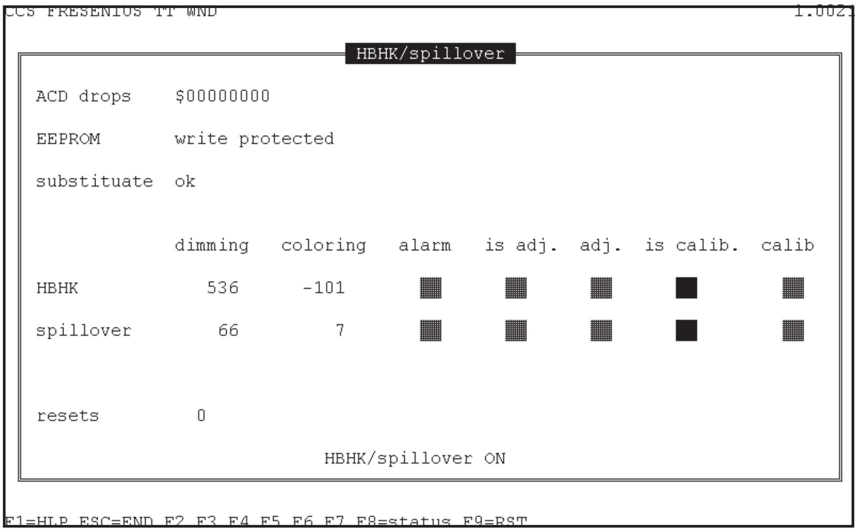
Measuring equipment:	Line filled with water (3.1 mm x 0.6 mm)
Measurement point:	LED D402 / P.C.B. LP 867
Measuring signal:	LED D402 / P.C.B. LP 867 (ON/OFF)
Mode of operation:	CCS program

2.18.1 Verification

– Access the CCS program.

– Select the **hbhk** menu.

– The following screen displays:



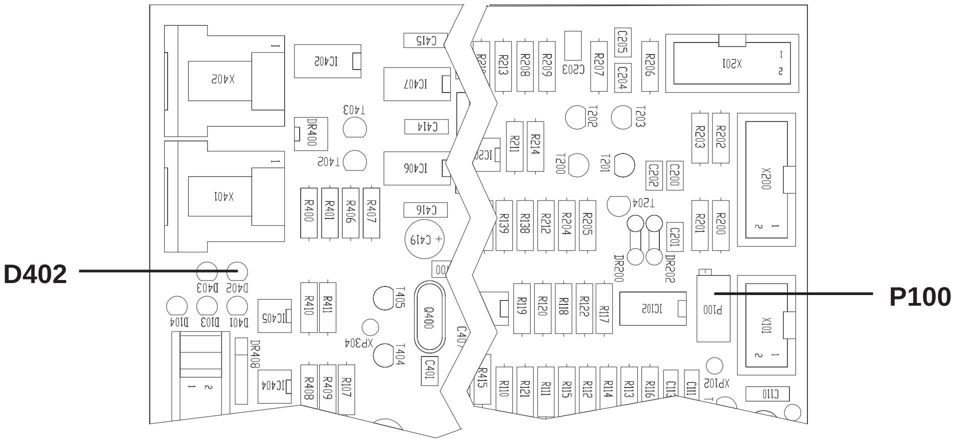
– Insert the line filled with water into the substituate detector: **substituate ok** is displayed.

– Drain the water from the line: **substituate end** is displayed.

– Detector without line: **substituate ok** is displayed.

– If the above conditions are not fulfilled, readjust the substituate detector.

2.13.2 Adjustment



– Place an empty line in the substituate detector.

– Slowly rotate potentiometer P100 / P.C.B. LP 867 until LED D402 / P.C.B. LP 867 stops lighting.

– Fill the line installed with water (avoid air bubbles). The LED D402 lights.

– Slowly rotate potentiometer P100 / P.C.B. LP 867 anticlockwise until LED D402 stops lighting again. Remember the number of rotations and then rotate half this number of rotations clockwise.

– Verify the setting.

2.14 Gap Width of Outlet Clamp

Measuring equipment:	Feeler gauge (0.1 – 2.0 mm), pressure gauge in mmHg
Measurement point:	Outlet clamp
Desired value:	0.7 – 1.0 mm

2.14.1 Verification of Gap Width

– Use the feeler gauge to verify the gap width of the outlet clamp. It should be possible to slightly move the feeler gauge.

2.14.2 Verification of Line Occlusion

– Install the original line (4.5 x 10 mm).

– Place the outlet side in a container with water.

– Use a syringe to apply a pressure of 750 mmHg (1 bar) to the closed outlet clamp (verify the pressure with the gauge fitted to the Y-connector).

– The outlet clamp must fully occlude.

2.14.3 Adjustment

– Remove the rear panel from the COM.TEC.

– Pull the front panel toward the front to remove.

– Use a size 2.5 Allen ball wrench to remove the two fixing screws that secure the clamping pad on the rear of the clamping pad.

– Change the position of the clamping pad on the front panel until the gap has the appropriate width.

– Tighten the fixing screws.

– Verify gap width and occlusion.

2.15 Line Pumps

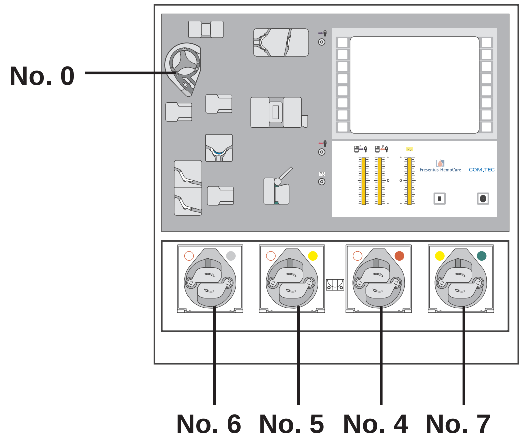
Mode of operation: CCS program

2.15.1 Verification

- Turn the machine Off.
- Short contacts 9 and 10 RL300 / LP 823-1 by using a link wire.
- Turn the machine On.
- Access the CCS program.
- Select the **pumps** menu.
- The following screen displays:

```
CCS FRESENIUS TT WND                                                      1.0021

                                     pumps
pump 0 ON  ACD 205                       pump 4 ON  blood
 set :   0 .....................  ◄  ►    set :   0 .....................  ◄  ►
         0.00 ml/min                              0.00 ml/min
 inst:   0 .....................          inst:   0 .....................
         0.00 ml/min                              0.00 ml/min
 turnover       :      0                  turnover       :      0

pump 5 ON  plasma                        pump 6 ON  cells
 set :   0 .....................  ◄  ►    set :   0 .....................  ◄  ►
         0.00 ml/min                              0.00 ml/min
 inst:   0 .....................          inst:   0 .....................
         0.00 ml/min                              0.00 ml/min
 turnover       :      0                  turnover       :      0

pump 7 ON  ACD 204
 set :   0 .....................  ◄  ►
         0.00 ml/min
 inst:   0 .....................
         0.00 ml/min
 turnover       :      0

F1=HLP ESC=END F2=ALL F3=T->0 F4=SET IN F5=NOON F6=ALM F7=RES F8=INF F9=RST
```

2.15.2 Verification of the 5 Line Pumps



– Insert dummy pump no. 0.

– Verify the target (**set**) and actual speed (**inst**) of the pumps at various delivery rates.
The maximum speed of pump no. 0 (ACD pump) is limited to 47 digits.

– Verification of the rotor pulses: For each complete revolution the **turnover** display must increase by one digit.

– Open the pump doors while the pumps (no. 4, 5, 6, 7) are running; the screen for each respective pump should display **cover open** and **alarm!!**.

– While the pump no. 0 is running, remove the dummy; the screen of pump no. 0 (ACD pump) should display **cover open** and **alarm!**.

– If the display fails to appear it may be necessary to replace the respective pump.

2.15.3 Cleaning of the Pump Rotors and the Pump Beds

– Cleaning of the pump beds no. 4, 5, 6, 7
Pull off the rotors from the drive shaft. If this is not possible manually, it is necessary to re-adjust the spring loaded ball pin which fixes the rotor to the drive shaft.

– Cleaning of the pump bed no. 0 (ACD pump)
Loosen the size 2 Allen screws and pull the rotor off the drive shaft.

– Cleaning of the pump rotors
To clean, turn and rinse the rotor rollers and pump rotors under running warm water.

2.15.4 Adjustment of the Pump Rotors No. 4, 5, 6, 7

- Turn the pump rotor until the threading pin points straight down and the adjusting hole points straight up.

- Use a screw driver to adjust the pin. Remove and reinstall the rotor several times to find the correct setting point. The rotor must engage and may be neither too tight nor too loose.

2.15.5 Final Check

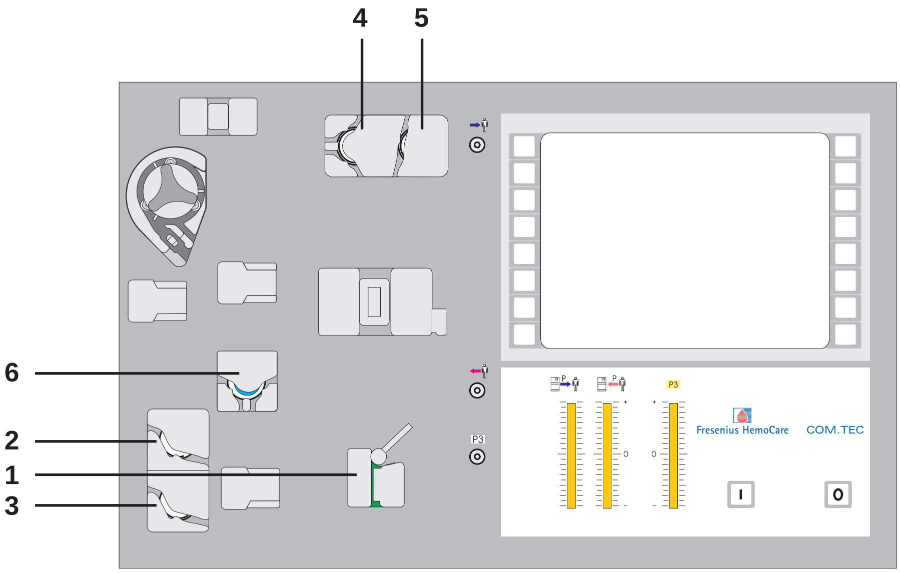
- Turn the machine Off.

- Remove the link wire used to short contacts 9 and 10.

2.16 Clamps

Measuring equipment: Pressure gauge, syringe

Mode of operation: CCS program



1 Clamp 1 (outlet clamp)
2 Clamp 2 (red)
3 Clamp 3 (blue)
4 Clamp 4 (plasma collection clamp)
5 Clamp 5 (diversion clamp)
6 Clamp 6 (spillover clamp)

– Access the CCS program.

– Select the **clamps** menu.

– The following screen displays:

```
CCS FRESENIUS TT WND                                                        1.0021
                                          clamps
 clamp-control-unit ON
 plasmaclamp          : ►   collect     ◄         bypass            install

 wastebagclamp        :     reserve               separate           prime

 NaCl 1               :    separate               install           not used

 NaCl 2               :    separate               install           not used

 spilloverclamp       :     collect               bypass            install
 
 clamp-PIC ON          modified     tested        actual

 NaCl 2   <separate> :   dark         dark          dark
 plasma     <bypass> :   dark         dark          dark
 wastebag <separate>:    dark         dark          dark
 spillover <bypass> :    dark         dark          dark
 endclamp            : closed                     closed

F1=HLP ESC=END F2 F8 SHFTF8 F9=RST
```

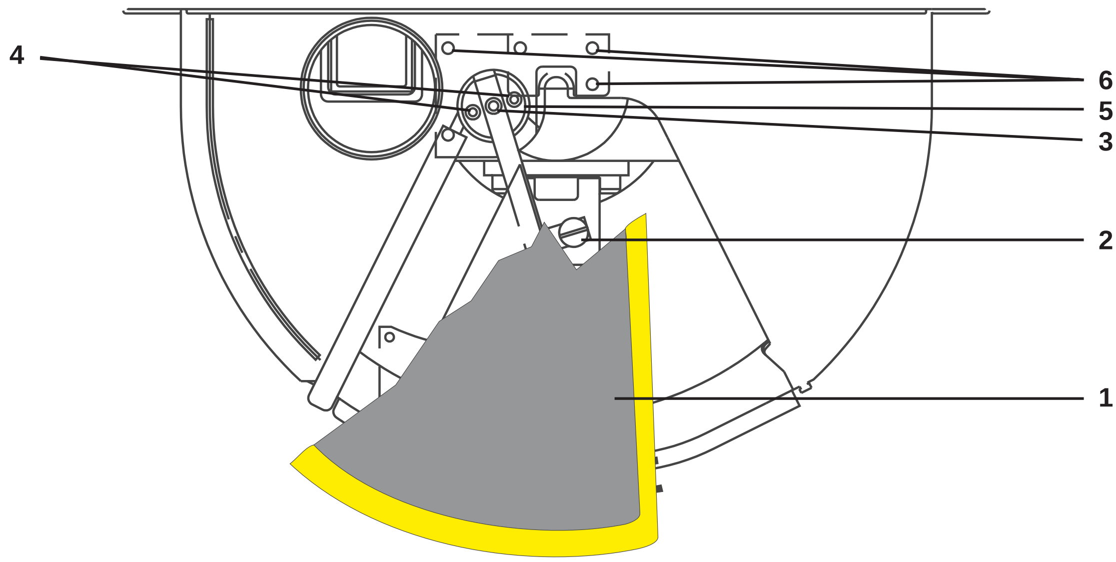
2.16.1 Verification of the Occlusion Pressure of the Clamps

	Line size	Position	Target value in bar
Clamp 4 (plasmaclamp)	3.1 x 0.6	collect bypass	> 2.0 > 2.0
Clamp 5 (wastebagclamp)	3.1 x 0.6	separate	> 2.0
Clamp 3 (blue) (NaCl 1)	3.1 x 0.6	separate	> 2.0
Clamp 2 (red) (NaCl 2)	3.1 x 0.6	separate	> 2.0
Clamp 6 (spilloverclamp)	3.1 x 0.6	collect bypass	> 2.0 > 2.0

– If the occlusion pressure is not attained, replace the clamp or the clamping pad.

2.17 Centrifuge Door

The centrifuge door can be removed to facilitate mounting of components or for cleaning of the machine.



2.17.1 Removing the Door

– Turn the COM.TEC on and press the **Open door** key to unlock the door.

– Lift the rubber mat (**1**) on the plane surface and remove the brass screw (**2**) underneath.

– Lift the door shell to remove it.

2.17.2 Removing the Door Frame (Chassis) and the Pivot Bearing

– Unscrew the size 5 Allen screw (**3**) and remove the door frame.

– Unscrew both size 4 Allen screws (**4**) and remove the upper flange.

– Unscrew the four Philipps screws (**6**) inside the centrifuge compartment and remove the metal plate.

– Then remove the pivot bearing (**5**) consisting of the metal flange and a plastic ring.

– For installation, perform the above steps in reverse order.

2.17.3 Adjustment

– The door shell and the door frame must be removed for the adjustment.

– The bearing (**5**) is adjusted with the spring washers between the upper and the lower metal flange. Slightly tighten the two size 4 Allen screws (**4**) until the bearing (**5**) can be moved easily and without play.

– Check the setting with the door frame reassembled. If it does not move easily, readjust with the door frame installed.

– After completetion of the adjustment, seal the two size 4 Allen screws (**4**) with lacquer.

2.18 Door Switch

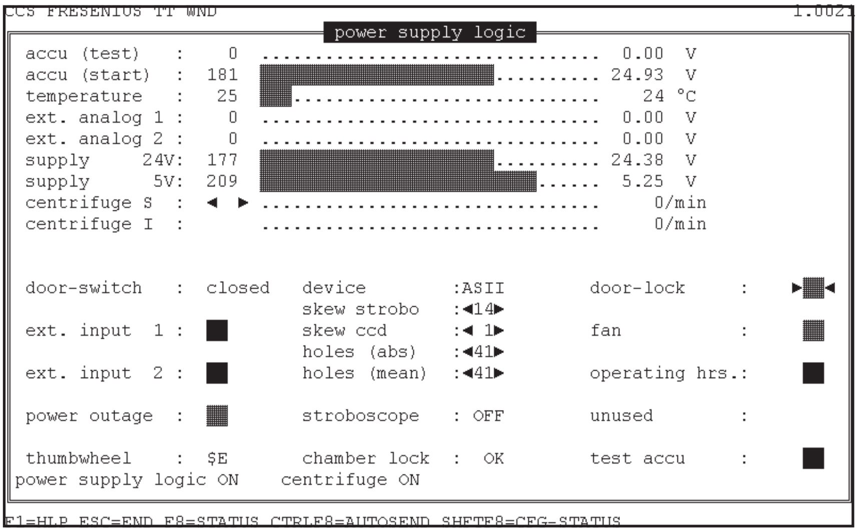
If the COM.TEC indicates the alarm **alarm door switch**, the door switch needs to be replaced or adjusted.

2.22.1 Verification

– Access the CCS program.

– Select the **power supply** menu.

– The following screen displays:



– Open the centrifuge door, the display reads: **door switch: open**

– Close the centrifuge door, the display reads: **door switch: closed**

– If the display reads: **door switch: alarm**, verify the setting of the latch bolt or replace the door switch.

2.18.2 Removal / Installation

- Turn the COM.TEC On and press the **Open door** key.
- If the door cannot be opened over the keyboard, unscrew and remove the service cover and pull on the cord provided for emergency unlocking.
- Unscrew the two Philipps screws (M 4) that secure the door lock and remove the door lock.
- Unscrew the two Philipps screws with nuts (M 3) to remove the metal cover
- Then uninstall the door lock (2 Phillips screws) and the door switch (2 nuts SW 7)
- For installation perform the above steps in reverse order.

2.18.3 Adjustment

- The door lock is adjusted with the latch bolt on the centrifuge door.
- Unscrew the size 10 nut and change the position (length) of the latch bolt.
- Lock the size 10 nut and close the door.
- This procedure must be repeated until the bolt is in the correct position.

2.19 Centrifuge Motor Carbon Brushes

Wear of the carbon brushes should be checked at each maintenance interval. Carbon brushes having reached a length of 5mm must be replaced.
The motor has four carbon brushes that are secured with screw caps.

2.19.1 Verification

- Unscrew the service cover.
- All four carbon brushes are now accessible from the left and right side of the housing.
- Disconnect the two cable connectors.
- Unscrew the plastic screw cap.
- Remove the carbon brush and check the length.
- For installation or replacement perform the above steps in reverse order.

2.20 Single Needle / Cuff Control

Measuring equipment: Pressure gauge, pressure cuff with inflating bulb, link wire.

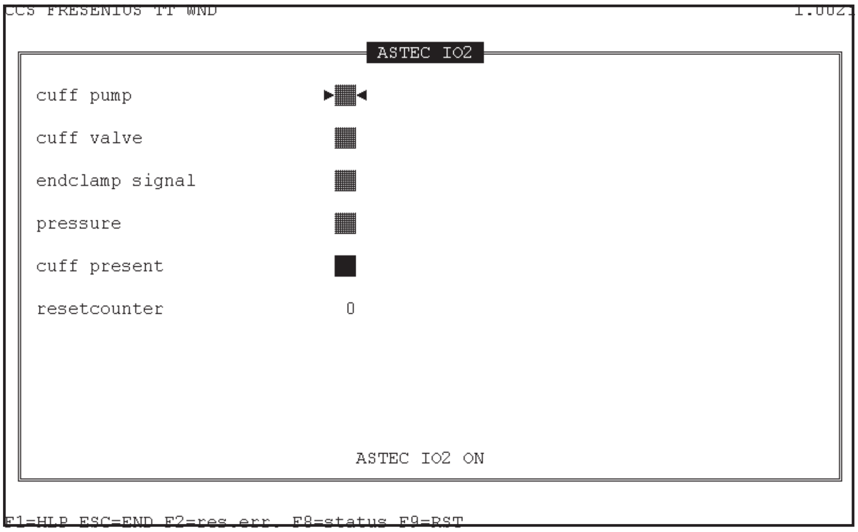
Mode of operation: CCS program

2.20.1 Verifications

– Access the CCS program.

– Select the **astecio2 menu**.

– The following screen displays:



- **Verification of leakage in the line system**

– Check the line system and the pressure cuff incl. the connecting line for tightness.

– Fold the pressure cuff and generate a pressure of approx. 100 mmHg.

– Verify that the pressure reading on the pressure gauge of the cuff does not fall by more than 10 % below the initial value within one minute.

– In the event of leakage, replace the defective section.

- **Verification of the upper switching point of the pressure switch**

– Use the inflating bulb to slowly increase the pressure and verify the upper switching point.

– The upper switching point has been reached when the **pressure** field changes from bright to dimmed.

– Target value: 55 mmHg ±5mmHg (7.3 kPa ±0.6 kPa)

- **Verification of the lower switching point of the pressure switch**
  - Perform this check immediately after the verification of the upper switching point.
  - Slowly release the pressure via the pressure release valve on the inflating bulb.
  - The lower switching point has been reached when the **pressure** field changes from dimmed to bright.
  - Target value: 20 – 30 mmHg (2.6 – 4.0 kPa)

- **Verification of the pump's maximum over-pressure**
  - Short the SN pressure switch on LP-Z 175 by using a link wire.
  - Turn **cuff pump** on.
  - Verify that the maximum pressure in the pressure cuff does not exceed 120 mmHg (16 kPa).
  - Remove the link wire from the pressure switch.

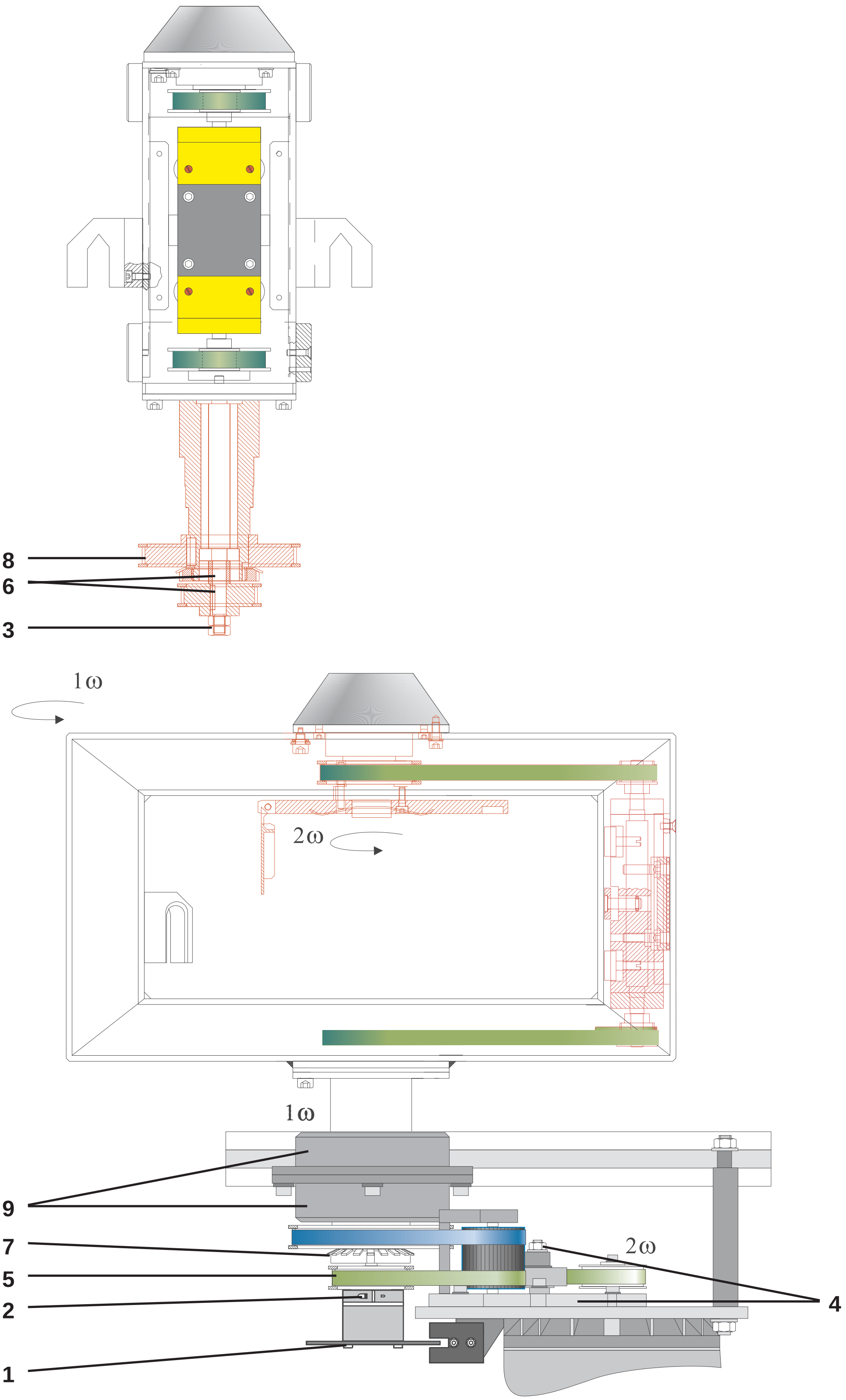
- **Verification of the inflation time**
  - Apply the pressure cuff to the arm.
  - Turn **cuff pump** on.
  - The cut-off pressure must have been reached after a maximum of 20 seconds.

2.20.2 Adjustment

- The adjustment is restricted to the upper switching point of the pressure switch.
- Connect the reference gauge to the luer lock connector (rear panel).
- Clamp the line on the outlet side of the air valve.
- Use a syringe to apply just as much pressure for the contact of the switch to change.
- The switching point can be adjusted with the stud screw (Allen screw 1.27 mm or. 1/20 inch) on top of the pressure switch. Adjust the pressure switch to 55 mmHg ±3 mmHg (7.3 kPa ±0.4 kPa).
- Seal the stud screw with lacquer.

2.21 Removal and Installation of the Centrifuge Rotor

Fig.: Operational principle of rotor and chamber drive



2.21.1 Removal of the Centrifuge Rotor

- Remove the rear panel and the service cover.
- Unscrew the three Phillips screws (**1**) to remove the perforated disc from the disc carrier.
- After loosening the clamping screw (**2**), pull the carrier off the rotor.
- Use the rotor installation aid to protect the rotor against inadvertant turning.
- Remove both size 13 lock nuts (**3**) from the drive shaft.
- Loosen the belt tensioners (**4**), release the tension on the toothed belts.
- Remove the belts.
- Remove the small lower belt pulley (**5**).
- Remove the distance bush and the locating pin (**6**).
- Check the rotor for bearing clearance and noise.
- Bend open the tab of the securing washer for the shaft nut.
- Use the hook spanner SW 52/55 to loosen the shaft nut (**7**).
- Remove the large belt pulley (**8**) and the key.
- Lift the rotor from the bearings (**9**) (do not tilt). If necessary use a puller.
- Check the bearings for lubrication.

2.21.2 Installation of the Centrifuge Rotor

– After checking the two angular contact ball bearings (**9**), install the rotor.

– Insert the large key in the key slot.

– Put the large belt pulley (**8**) with the stepped side up onto the shaft.

– Use the rotor installation aid to protect the rotor against inadvertant turning.

– Screw on the shaft nut (**7**) and use a torque wrench (with adapter for the hook spanner) to tighten to a torque of 25 Nm.

> **Note**
> When positioning the torque wrench (using the adapter, part no. 660 355 1) ensure that the hook spanner and torque wrench are perpendicular (90°).

– Push the closest tab of the securing washer into one of the grooves in the shaft nut.

– If none of the tabs fits, tighten the shaft nut to a maximum torque of 35 Nm and then push in the tab.

– Slide the bush (**6**) onto the shaft.

– Place the key (**6**) into the key slot.

– Attach the small belt pulley (**5**) with the stepped side down, screw on and slightly tighten the size 13 nut.

– Remove the rotor installation aid.

– Insert the reference chamber with segment 1 and orientate the rotor to be parallel with the housing front.

– Turn the reference disc, until the chamber guide rail is vertical to the rotor (Check: open the chamber lock).

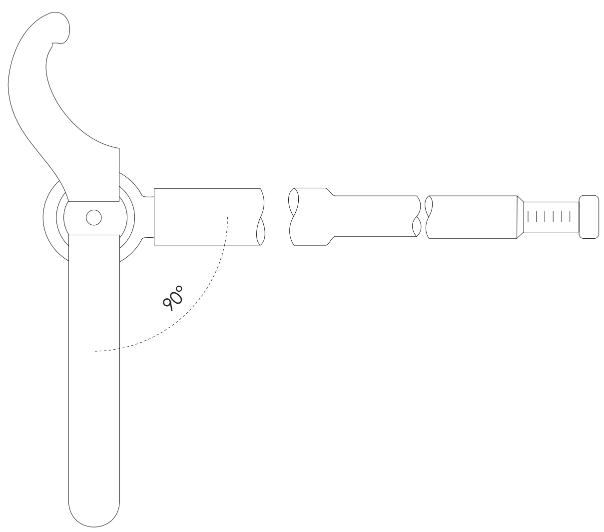
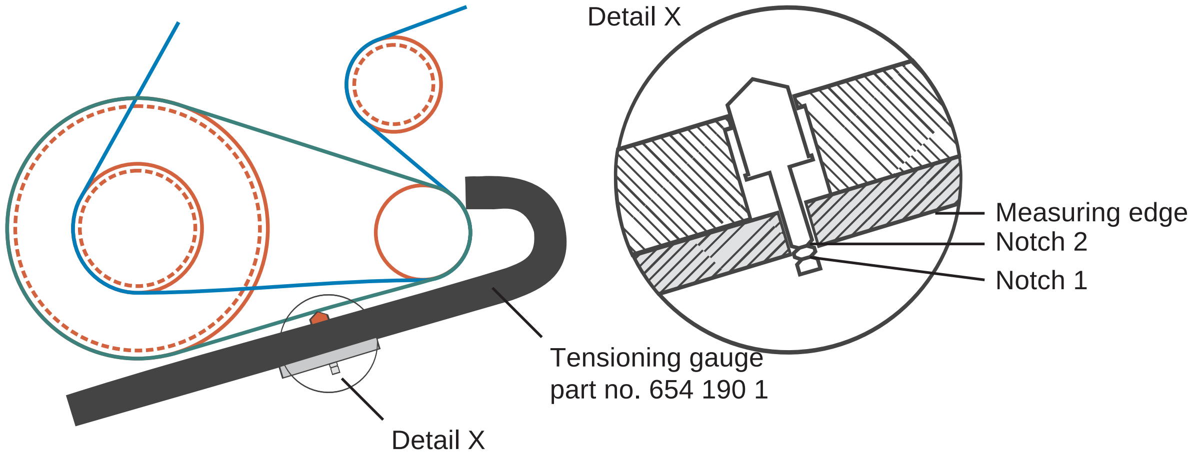


Fig.: Checking the belt tension on the rotor drive



– Install both toothed belts.

> **Caution**
> Do not change the position of the rotor to the reference chamber during installation and adjustment.

– Use the tensioning gauge (part no. 643 190 1) to adjust the belt tension of the upper toothed belt on the belt tensioner (**4**) until the belt tension is between the second and the third notch (see figure) of the gauge.

– Use the two size 4 Allen screws to secure the belt tensioner (**4**).

– Use the eccentric pulley (**4**) to adjust the belt tension of the lower belt until the belt tension is between the second and the third notch (see figure) of the gauge.

– Tighten the size 10 nut.

– Use a size 13 wrench to tighten nut M 8 of the drive shaft (**3**). Back up with the reference chamber to prevent the shaft from turning with the nut.

> **Caution**
> If the tightening torque is too high, the belts will skip over.

– Screw on and tighten the lock nut (**3**).

– Place the perforated disc carrier (**2**) onto the small belt pulley and mount the perforated disc (**1**) with the drill-marked hole on top.

– Adjust the interface detection (➜ Chap. 2.2)

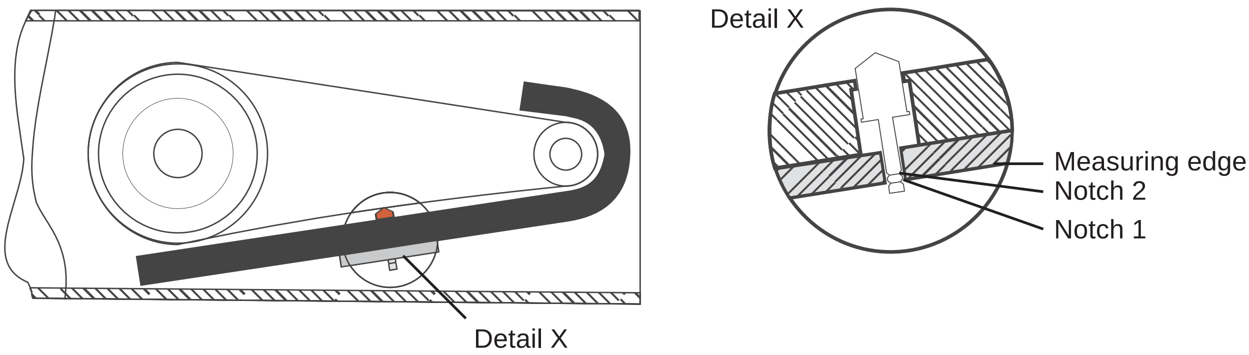
2.22 Tightening the Belts in the Rotor

2.21.1 Verification

– Open the centrifuge door.

– Unscrew the four Philips screws on the lateral rotor blanking plate. Remove the blanking plate including the plastic plate (spacer) from the rotor.

Fig.: Checking the belt tension in the rotor



– Use the tensioning gauge on the upper belt first. The plastic pads on the gauge must face down.

– When correctly adjusted, the first notch of the gauge must be visible.

– Verify the tension of the lower belt, apply the tensioning gauge.

– When correctly adjusted, the first notch of the gauge must be visible.

– Install the plastic plate, ensuring that it is parallel. Verify that it is installed such that when securing the blanking plate with the screws, there is a uniform pressure on the intermediate shaft.

– Tighten the four Philips screws that secure the lateral blanking plate.

– Close the centrifuge door

– Perform a test run.

2.22.2 Adjustment

– Evenly turn the two upper slotted screws in the intermediate shaft until the belt tension is inside the first notch of the tensioning gauge.

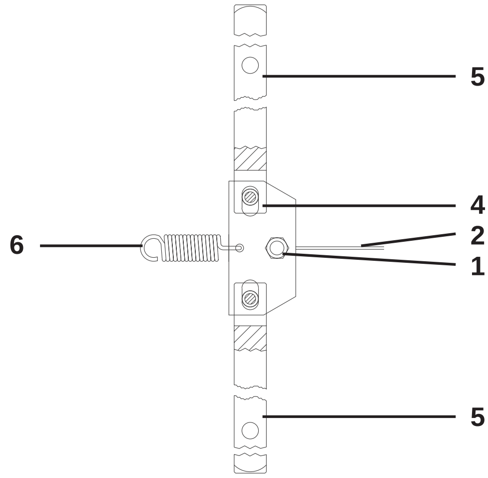
– Evenly turn the two lower slotted screws in the intermediate shaft until the belt tension is inside the first notch of the tensioning gauge.

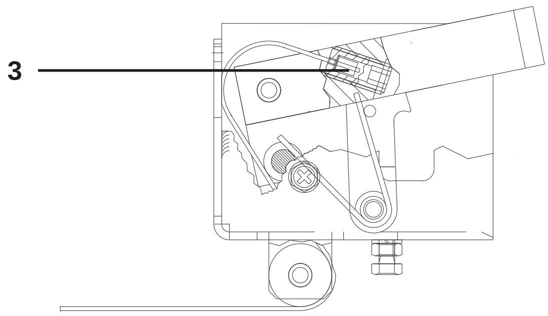
– Reinstall the plastic plate.

– Use the 4 size 4 Allen screws to align the plastic plate for the surface of this plate to be flush with the surface of the metal plate (no play).

2.23 Brake

The COM.TEC must be brought in a position, where the bottom side including the brake unit is easily accessible. The rear castors must have free movement.





2.23.1 Removal / Installation

– Loosen the clamping screw (**1**) on the lead plate.

– Remove the brake rope (**2**).

– Pass the new brake rope through the adjustment screw (size 4 Allen screw) (**3**).

2.23.2 Adjustment

– Screw the size 4 adjustment screw (**3**) into the pedal.

– Remove the spring from the bolt on the bottom plate.

– Shift the lead plate and the lever bolts (**5**) until both lever bolts are just in touch with the castors.

– Secure the brake rope with the size 8 clamping screw.

– Install the tension spring (**6**) to the bolt on the bottom plate.

– Adjust the brake by using the adjustment screw (size 4 Allen screw) (**3**). The lever bolts (**5**) must be just in touch with the castors, when the brake is open.

2.24 Flutter Detector

Measuring equipment: Voltmeter

Measuring point: MP 4 / P.C.B. LP 866

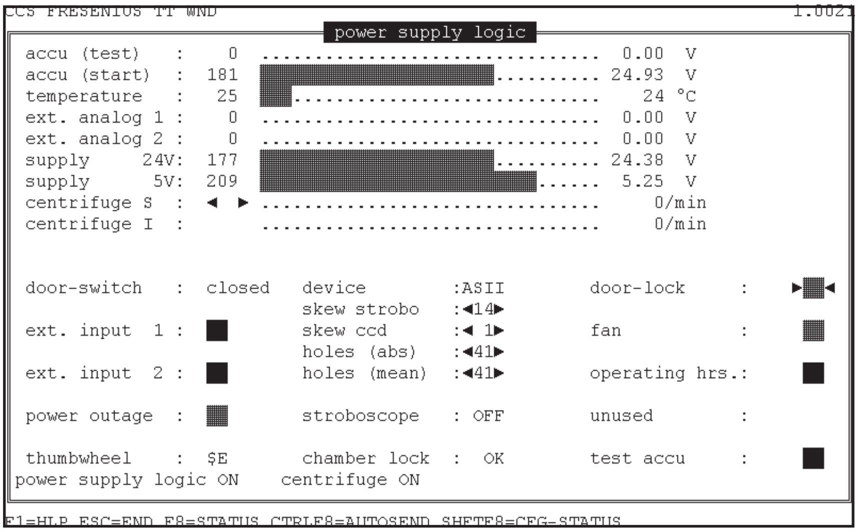
Measuring signal: DC voltage

Mode of operation: CCS program

– Access the CCS program.

– Select the **power supply** menu.

– The following screen displays:



2.24.1 Verification

– Connect the voltmeter between MP 4 / P.C.B. LP 866 and MP 0 / P.C.B. LP 866 (ground).

– The voltage measured at MP 4 / P.C.B. LP 866 may never exceed 200 mV. Higher values with rotating centrifuge are indicative of increased bearing clearance or an imbalance of the rotor.

– Measure the DC voltage with the centrifuge off.

– Set the speed to 1000 rpm and measure the DC voltage.

– Set the speed to 2000 rpm and measure the DC voltage.

2.25 General Mechanical Checks

2.25.1 Housing

Visually inspect the housing for cracks and flaking, paying special attention to those areas where components are mounted with screws.

2.25.2 Rubber Pads

Visually inspect the rubber pads that carry the rotor base plate for cracks. Check the metal pieces of the pads that may have come loose and check the tight fit of the pads.

2.25.3 Mounting Screws

Check all accessible screws of the drive unit and the rotor for tight fit.

Size	Torque in Nm
M3	0.9
M4	2.2
M5	4.2
M6	7.3
M8	17.7

2.25.4 Optical Sensors

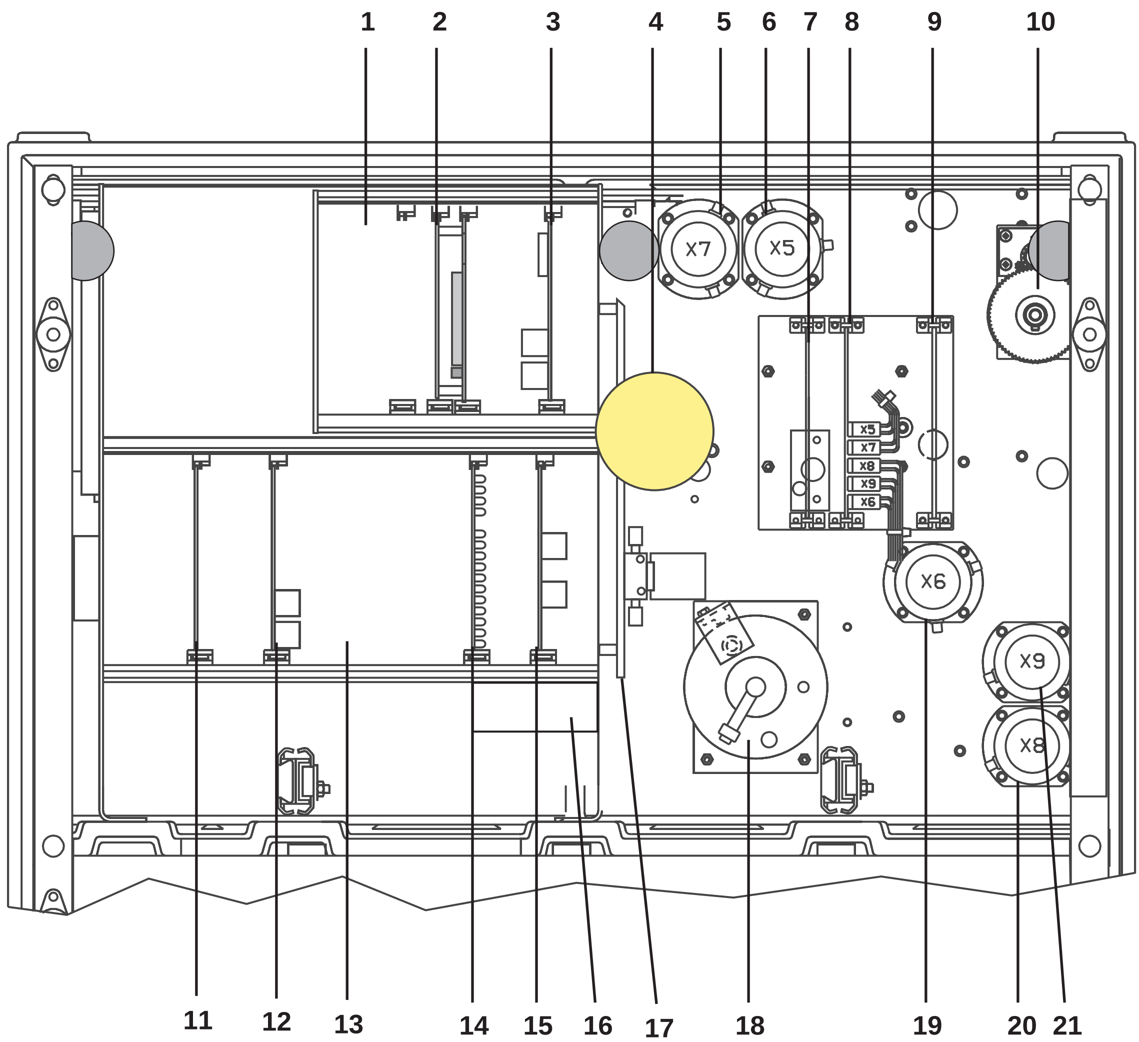
Check all optical sensors for contamination and clean, if necessary.

2.25.5 Fan

Check all fans for dust and clean, if necessary.

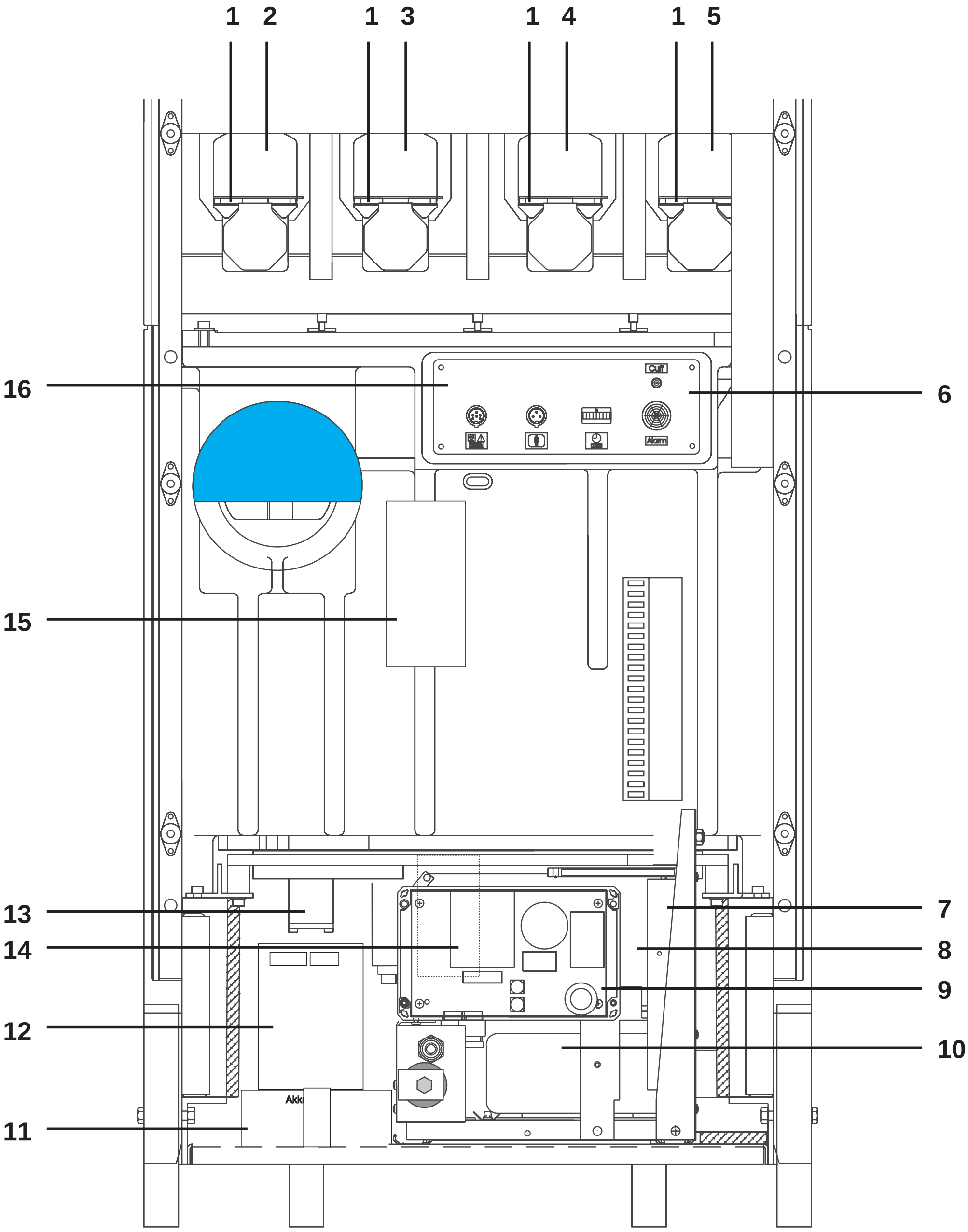
Table of Contents
3 Circuit Descriptions and Circuit Diagrams

3.1 Rear View of the COM.TEC Housing Top Part

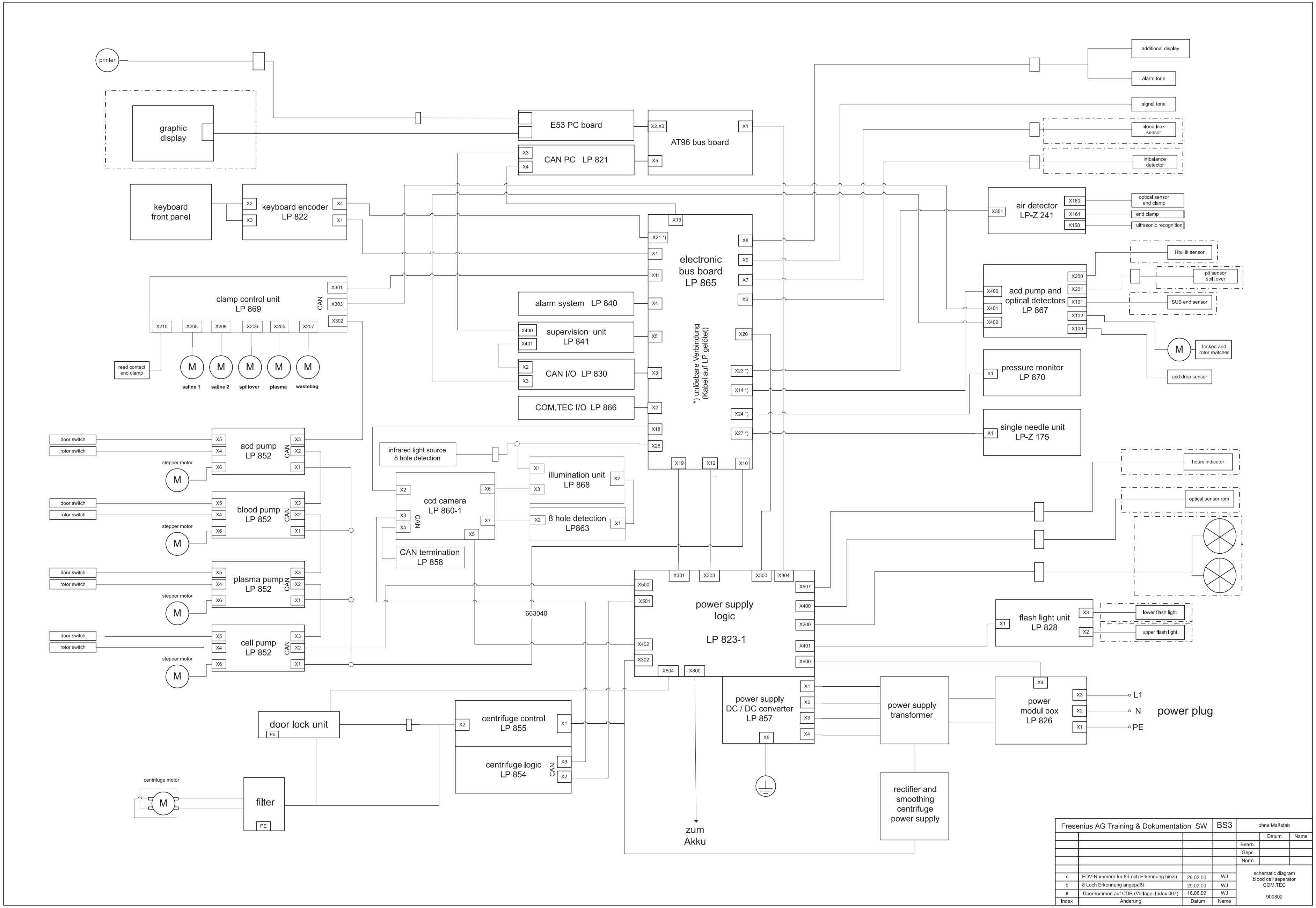


1	P.C.B. LP 864
2	PC E53
3	P.C.B. LP 821
4	Loudspeaker
5	Clamp 5 (diversion clamp)
6	Clamp 4 (plasma collection clamp)
7	P.C.B. LP-Z 241
8	P.C.B. LP 869
9	P.C.B. LP 867
10	ACD pump
11	P.C.B. LP 866
12	P.C.B. LP 830
13	P.C.B. LP 865
14	P.C.B. LP 840
15	P.C.B. LP 841
16	P.C.B. LP 870
17	P.C.B. LP-Z 175
18	Clamp 1 (outlet clamp)
19	Clamp 6 (spillover clamp)
20	Clamp 3 (blue) (saline clamp)
21	Clamp 2 (red) (saline clamp)

3.2 Rear View of the COM.TEC Housing Bottom Part



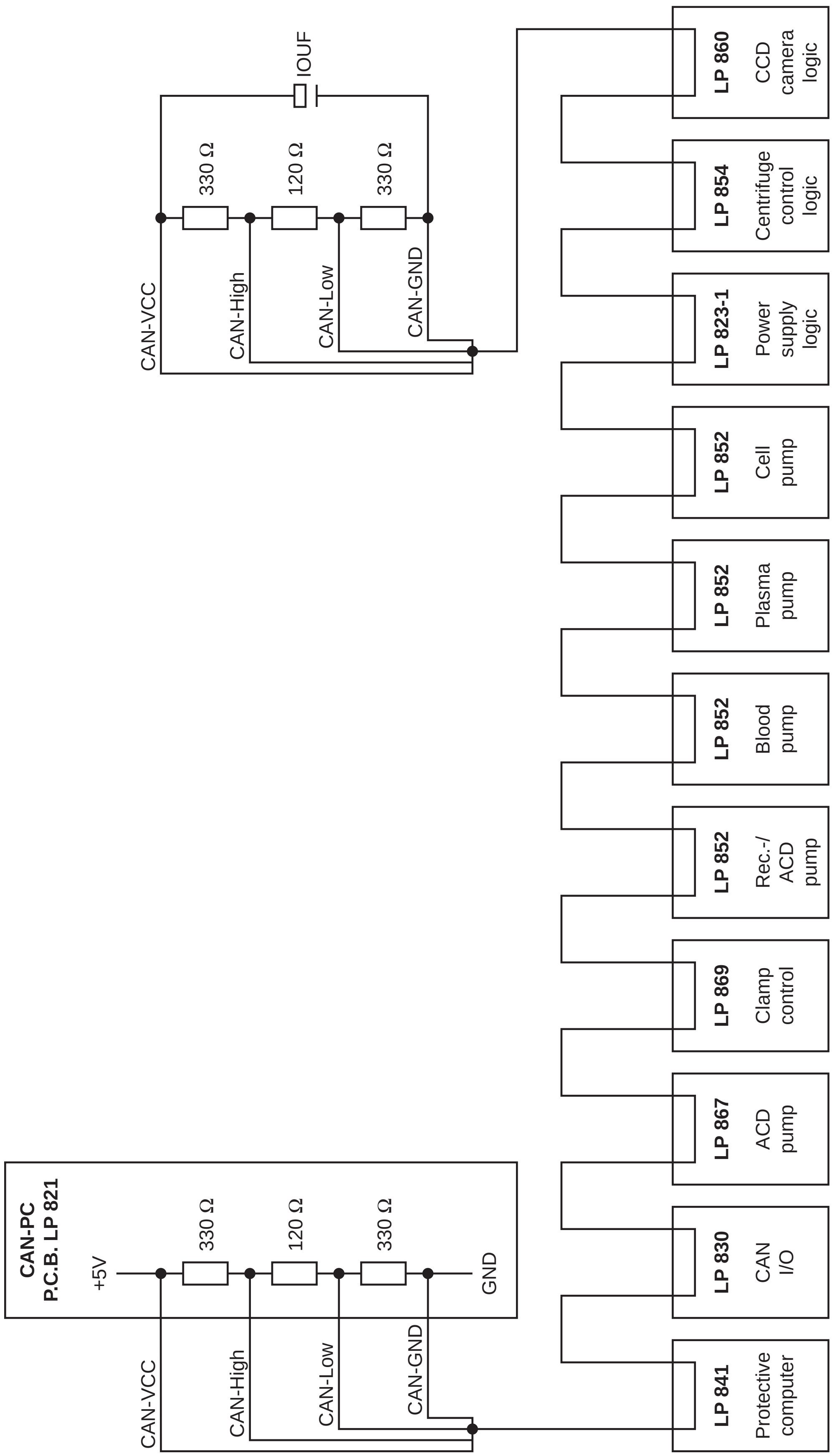
1 P.C.B. LP 852
2 ACD pump
3 Whole blood pump
4 Plasmapumpe
5 Cell pump
6 Plug section
7 P.C.B. LP 857
8 P.C.B. LP 823-1
9 P.C.B. LP 826
10 Toroidal transformer
11 Batteries
12 Centrifuge control
13 Flutter detector
14 Camera
15 P.C.B. LP 863
16 P.C.B. LP 868



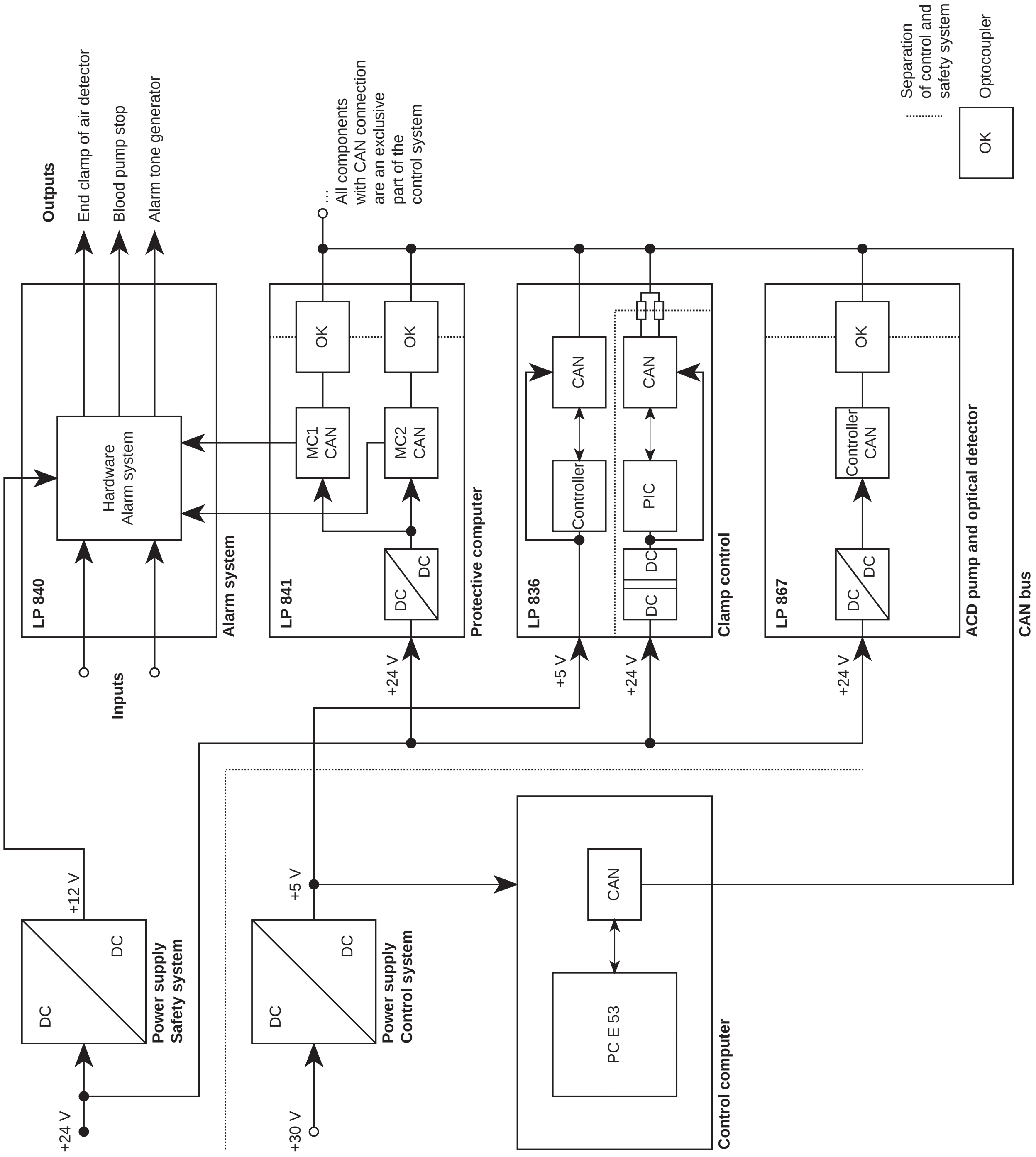
printer
graphic display
E53 PC board
AT96 bus board
CAN PC LP 821
keyboard front panel
keyboard encoder LP 822
clamp control unit LP 869
CAN
reed contact end clamp
saline 1
saline 2
spillover
plasma
wastebag
electronic bus board LP 865
*) unlösbare Verbindung (Kabel auf LP gelötet)
alarm system LP 840
supervision unit LP 841
CAN I/O LP 830
COM.TEC I/O LP 866
additional display
alarm tone
signal tone
blood leak sensor
imbalance detector
air detector LP-Z 241
optical sensor end clamp
end clamp
ultrasonic recognition
acd pump and optical detectors LP 867
Hb/Hk sensor
plt sensor spill over
SUB end sensor
locked and rotor switches
acd drop sensor
pressure monitor LP 870
single needle unit LP-Z 175
door switch
rotor switch
stepper motor
acd pump LP 852
blood pump LP 852
plasma pump LP 852
cell pump LP 852
infrared light source 8 hole detection
illumination unit LP 868
ccd camera LP 860-1
8 hole detection LP863
CAN termination LP 858
hours indicator
optical sensor rpm
power supply logic LP 823-1
663040
flash light unit LP 828
lower flash light
upper flash light
door lock unit
centrifuge control LP 855
centrifuge logic LP 854
power supply DC / DC converter LP 857
power supply transformer
power modul box LP 826
L1
N
PE
power plug
centrifuge motor
filter
zum Akku
rectifier and smoothing centrifuge power supply
Fresenius AG Training & Dokumentation SW
BS3
ohne Maßstab
Datum
Name
Bearb.
Gepr.
Norm
c EDV-Nummern für 8-Loch Erkennung hinzu 29.02.00 WJ
b 8 Loch Erkennung angepaßt 29.02.00 WJ
a Übernommen auf CDR (Vorlage: Index 007) 16.08.99 WJ
Index Änderung Datum Name
schematic diagram blood cell separator COM.TEC
900802

3.3 COM.TEC Block Diagram

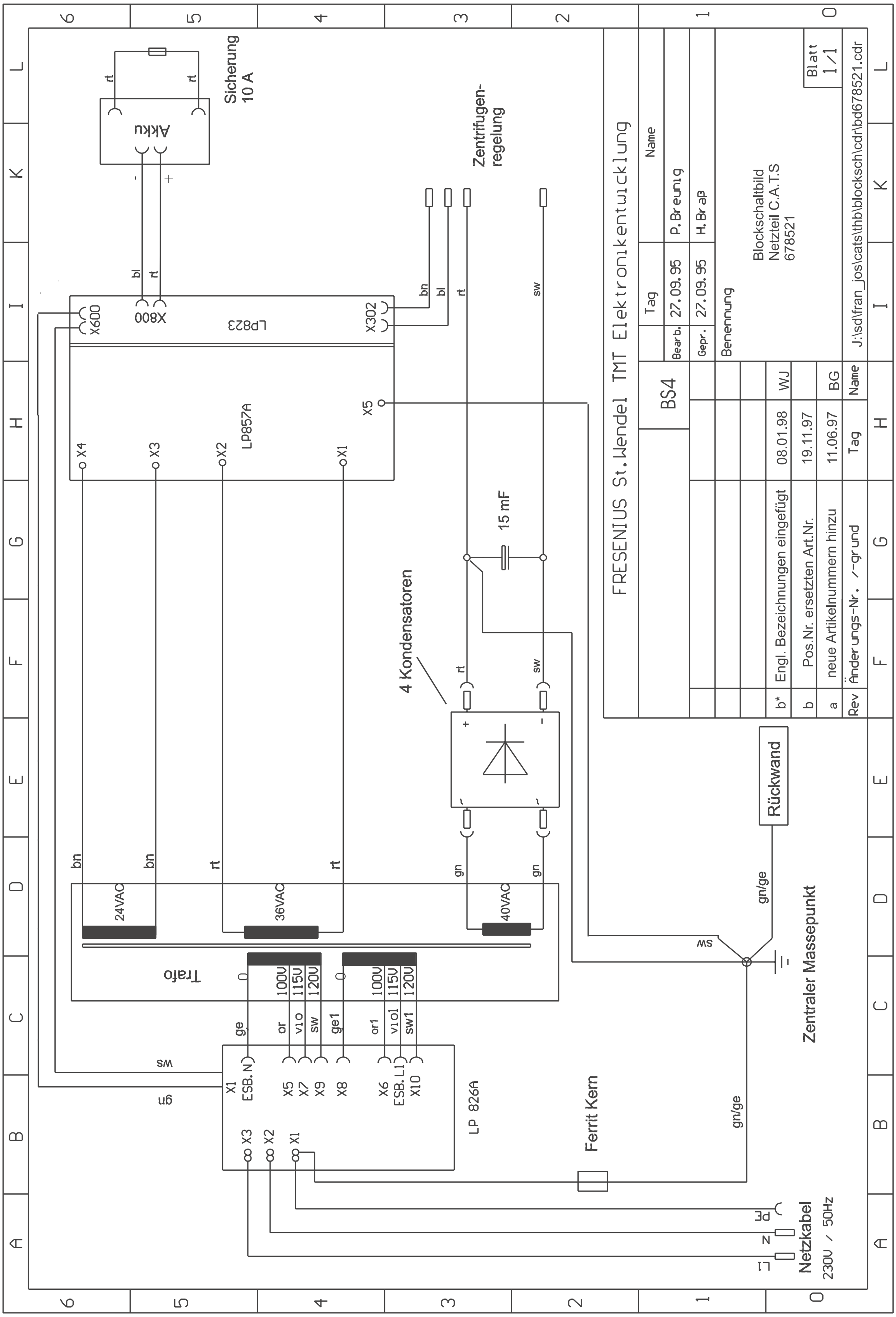
3.4 CAN Chain Block Diagram



3.5 Block Diagram of the Power Supply Separation COM.TEC Control and Safety System



3.6 Block Diagram of Voltage Supply



3.7 P.C.B. LP-Z 175 Single Needle

3.7.1 Circuit Description

P.C.B. LP-Z 175 comprises a circuit for activation of the air pump and the air relief valve mounted on this board. In addition, it comprises a pressure switch and a line set connecting the mechanical components to each other.

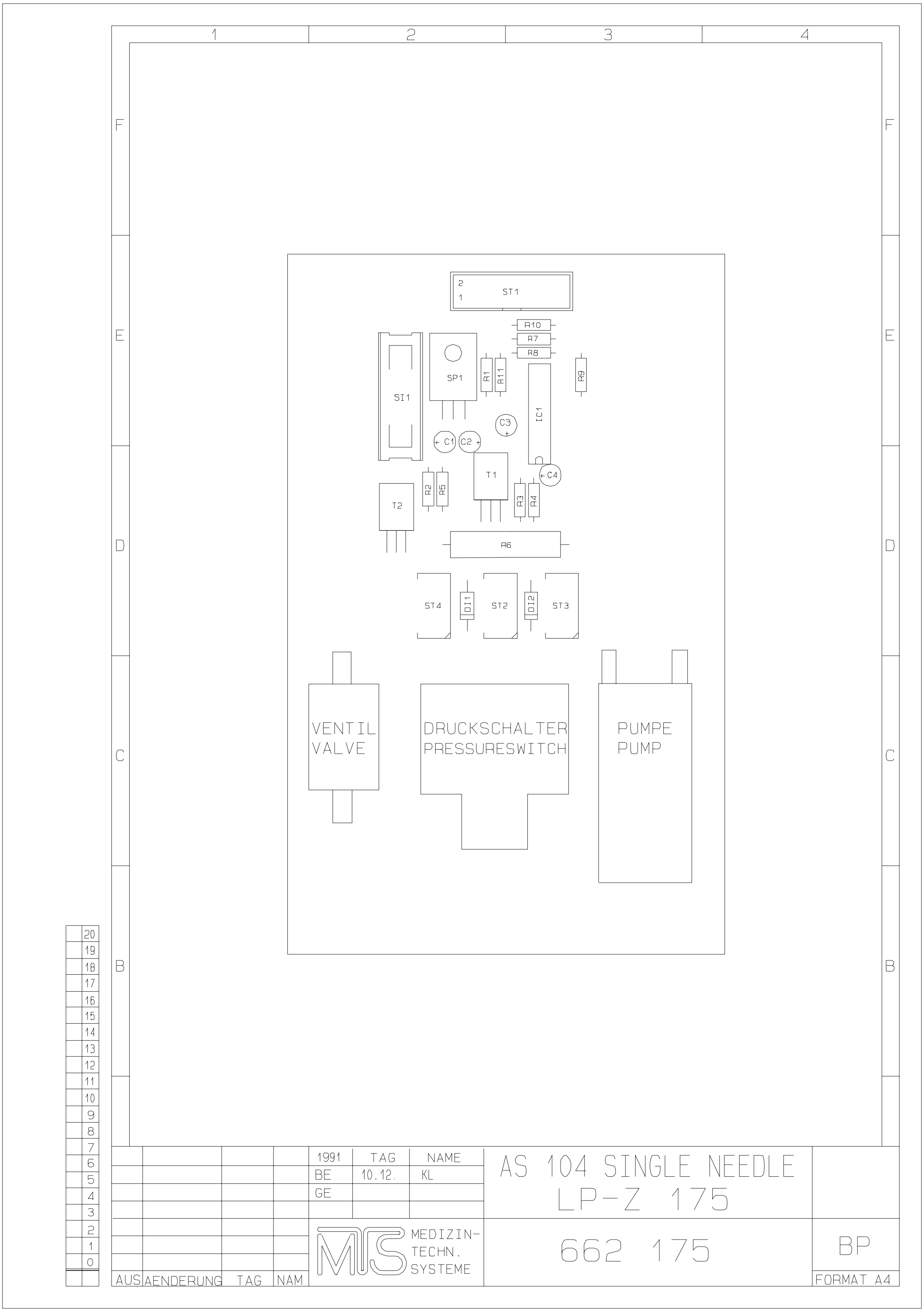
The control pulses are transmitted to a monoflop consisting of IC 1 and the components C3, C4 and R10, R11. The time constant of the monoflop is approx. 1 second.

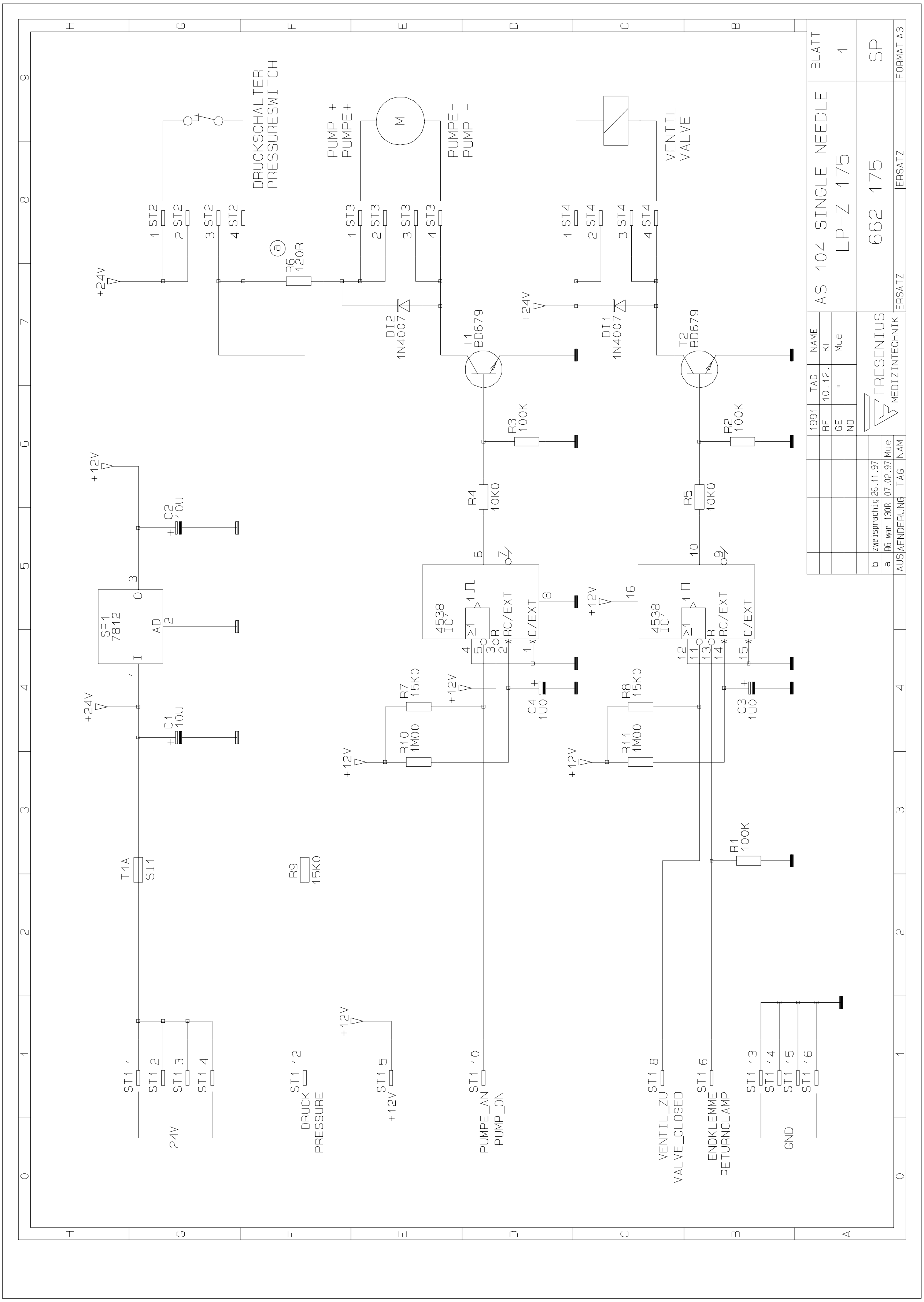
With control pulses applied to the “pump on” connection, the air pump is switched on via the driver transistor T1, as long as the pressure switch has not yet reached its turn-off pressure.

The resistor R6 limits the operating voltage of the pump and, thus, the maximum overpressure which can be built up by the pump. A wire resistor is used for resistor R6, to ensure that the resistor can fail only at higher resistance values.

As soon as the pressure switch reaches its switching point, the supply voltage of the pump is switched off, with the fact that the switching point has been reached being indicated to the microprocessor system via the resistor R9.

Pulses at the “valve closed” connection cause the air relief valve to close. In currentless condition, the valve is open, i.e. the air is deflated from the cuff. The return line clamp signal at the reset input of the monoflop ensures that the valve can be closed with closed return line clamp only.


ST1
SI1
SP1
R1
R11
R10
R7
R8
R9
IC1
C1
C2
C3
C4
T1
T2
R2
R5
R3
R4
R6
ST4
DI1
ST2
DI2
ST3
VENTIL
VALVE
DRUCKSCHALTER
PRESSURESWITCH
PUMPE
PUMP
1991
TAG
NAME
BE
10.12.
KL
GE
AS 104 SINGLE NEEDLE
LP-Z 175
MEDIZIN-
TECHN.
SYSTEME
662 175
BP
AUS
AENDERUNG
TAG
NAM
FORMAT A4



DRUCKSCHALTER
PRESSURESWITCH
PUMP +
PUMPE+
M
PUMPE-
PUMP -
VENTIL
VALVE
R6
120R
DI2
1N4007
DI1
1N4007
T1
BD679
T2
BD679
R3
100K
R2
100K
R4
10K0
R5
10K0
4538
IC1
C/EXT
RC/EXT
SP1
7812
C2
10U
C1
10U
T1A
SI1
R9
15K0
R7
15K0
R8
15K0
R10
1M00
R11
1M00
C4
1U0
C3
1U0
R1
100K
+24V
+12V
24V
DRUCK
PRESSURE
PUMPE_AN
PUMP_ON
VENTIL_ZU
VALVE_CLOSED
ENDKLEMME
RETURNCLAMP
GND
AS 104 SINGLE NEEDLE
LP-Z 175
662 175
BLATT
1
SP
FORMAT A3
ERSATZ
FRESENIUS
MEDIZINTECHNIK

3.8 P.C.B. LP-Z 241 Air Monitoring System

3.8.1 Circuit Description

The system provided as protection against air infusion uses the method of ultrasonic transmission. Ultrasonic converters are provided on either side of the air chamber in the return line. At periodical intervals of approx. 80 ms, a transmitting resonator generates dampened ultrasonic vibrations with a natural frequency of approx. 90 kHz. The dampened ultrasonic vibrations are absorbed by the receiving resonator and converted into electrical signals. The amplitude of the signal received is dependent upon the medium between the converters: with the air chamber being filled with air, it is at its minimum; with bubble-free fluid, it is at its maximum. With the air contents increasing (froth), the receiver amplitude decreases. Up to and including the receiving resonator, the signal path is failsafe, i.e. any component failure or other defects always result in smaller receiver amplitudes, thus releasing an alarm.

After the receiving converter, the signal voltage is divided onto two independent transmission paths. One of these paths directly switches the return clamp and delivers its information to the microprocessor as well as to the independent alarm system; the second path acts upon the microprocessor system as well as upon the alarm system.

- **Optical Detector in Return Clamp**

In addition to the air detector, the electronic circuit of the optical detector is provided on P.C.B. LP-Z 241. The measuring section, which is realized by an infrared optical sensor, is incorporated in the return clamp and is used to recognize any presence of blood in the return line. As soon as this optical sensor indicates that there is blood in the line installed, the COM.TEC has entered the treatment condition.

- **Audible Section**

Transmitter:
The self-capacitance of the transmitting converter is charged up to +12 V via R 114 and periodically discharged via T 20. The discharge current excites the resonator to a dampened ultrasonic vibration. With the jumper J 164 being plugged in position, the charge of the converter achieves only +6 V due to the voltage division via R 114 and R 113. This causes the transmitter amplitude to be reduced to half its value (calibration). With the transistor T 21 being activated, the transmitter amplitude is reduced to a third of its value due to the voltage division via R 114 and R 111 (test).

Receiver:
Up to the outputs of the alarm monoflops U3 and U6 respectively, the two receiver channels are identical with one another. For this reason, the receiver description will be restricted to the upper channel.
The voltage released by the receiving converter is amplified in the amplifier stage by means of T 15 and delivered to OP U 1, which is connected as precision rectifier. The amplified positive half-waves, which are delivered to pin 5 of comparator U 2 via the RC element R 80 and C 50, are appearing at the cathode of D 32. As soon as the peaks of the signal envelope waiting to be served there exceed the reference voltage at pin 6, the output 7 releases H pulses at intervals of 80 ms. Inverted via T 16, these H pulses are applied to the trigger input pin 5 of the first monoflop of U 3. The two monoflops of U 3 can be retriggered; in relation to the wiring, the first one has a time constant of 60 ms and the second one a time constant of 500 ms. The first 60-ms time constant has been selected such that, subsequent to each trigger pulse arriving at the input side, the output can return to its initial position until the next trigger pulse arrives. Should this be the case, the second monoflop is triggered at intervals of 80 ms, with its output pin 10 remaining at H level (alarm-free).
Should the comparator U 2 fail to release trigger pulses due to too small an input signal, the second monoflop returns to its initial position after 500 ms and causes pin 10 of plug X 351 to turn to L level. This L level will then set an alarm storage on the alarm board, and the alarm storage will stop the pumps and close the return clamp.
With the exception of the longer time constant of the second monoflop of U 6 amounting to 700 ms, the second receiver channel works as has been described for the first one. However, output pin 9 sets the storage flip-flop U 7 by means of H level in case of an alarm. Using L level, output pin 12 of U 7 then inhibits the FET Q 27 causing the return clamp in the drain branch to be disconnected from current as well as to be closed.
Simultaneously with the inhibition of T 27, D 43 is inhibited as well and, via R 124, delivers H level to pin 2 of plug X 351, with this H level also causing an alarm storage of the alarm system to be set.
Should the alarm situation have been eliminated in the meantime, flip-flop U 7 can be reset by means of the positive edge of the start pulse of pin 8 of plug X 351. In this case, FET T 27 is switched on again by the H level at pin 12 of U 7, and the return clamp is opened.

Clamp Control:
Transistor T 28 is also used to control the clamp magnet. This method is used for turn-off in case of miscellaneous alarms and for the single-needle control. Should an H level be applied to the control input pin 4 of plug X 351, the clamp magnet is applied single-sided to the positive supply voltage via T 28, thus opening the clamp unless there is an air detector alarm. As soon as the control input pin 4 of X 351 turns to L level, the clamp closes.

Pulse Generation:
The timer IC U 10 is connected as astable multivibrator. It generates a symmetrical rectangular frequency of approx. 2.8kHz, which is divided down by the binary divider U9. At pin 3, 90 Hz are available for activating the infrared emitter of the optical detector. The unbalanced rectangular voltage for activating the ultrasonic transmitter is generated via the flip-flop U8 (90 ms L level, 0.2 ms H level).

- **Optical Section**

Via transistors T 23 and T 24, pin 3 of U 9 activates the infrared emitter of the optical detector with a frequency of 90 Hz. The phototransistor on the opposite side of the optical sensor absorbs the modulated light and, at pin 2, activates U 14, which is connected as current-voltage converter. A rectangular voltage, the amplitude of which is proportional to the transparency of the medium in the optical sensor, is applied to pin 1 of U 14. Via the voltage divider R 140 and R 141, this voltage is transmitted to pin 5 of comparator U 14. Should the positive half-waves exceed the reference level at pin 6 of U 14, the output pin 7 delivers a rectangular voltage; otherwise, the output is at L level. Via pin 1 of plug X 351, the rectangular voltage is delivered into the alarm system, where it is used to generate a logic level.

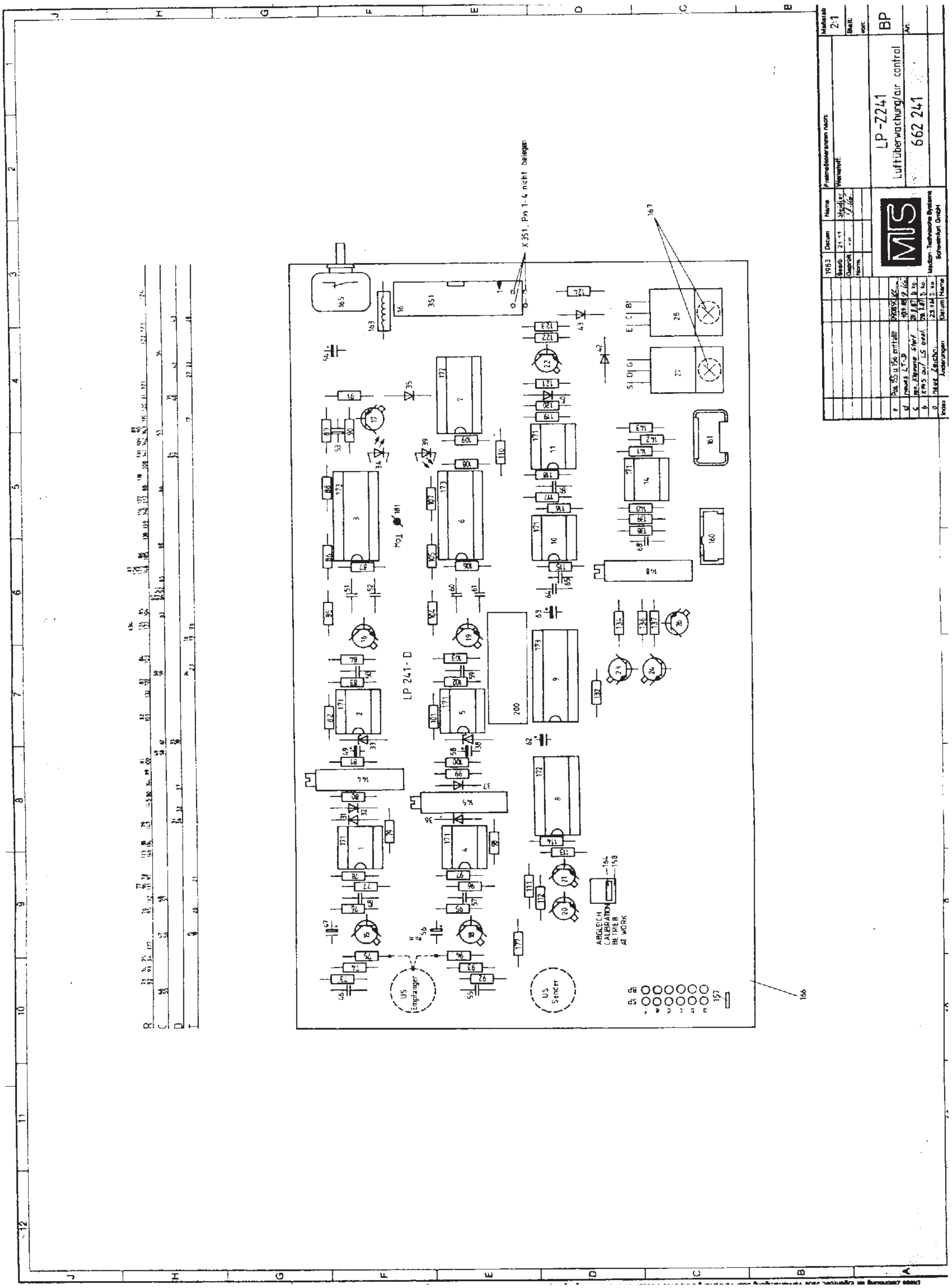
- **+12 V Monitoring System**

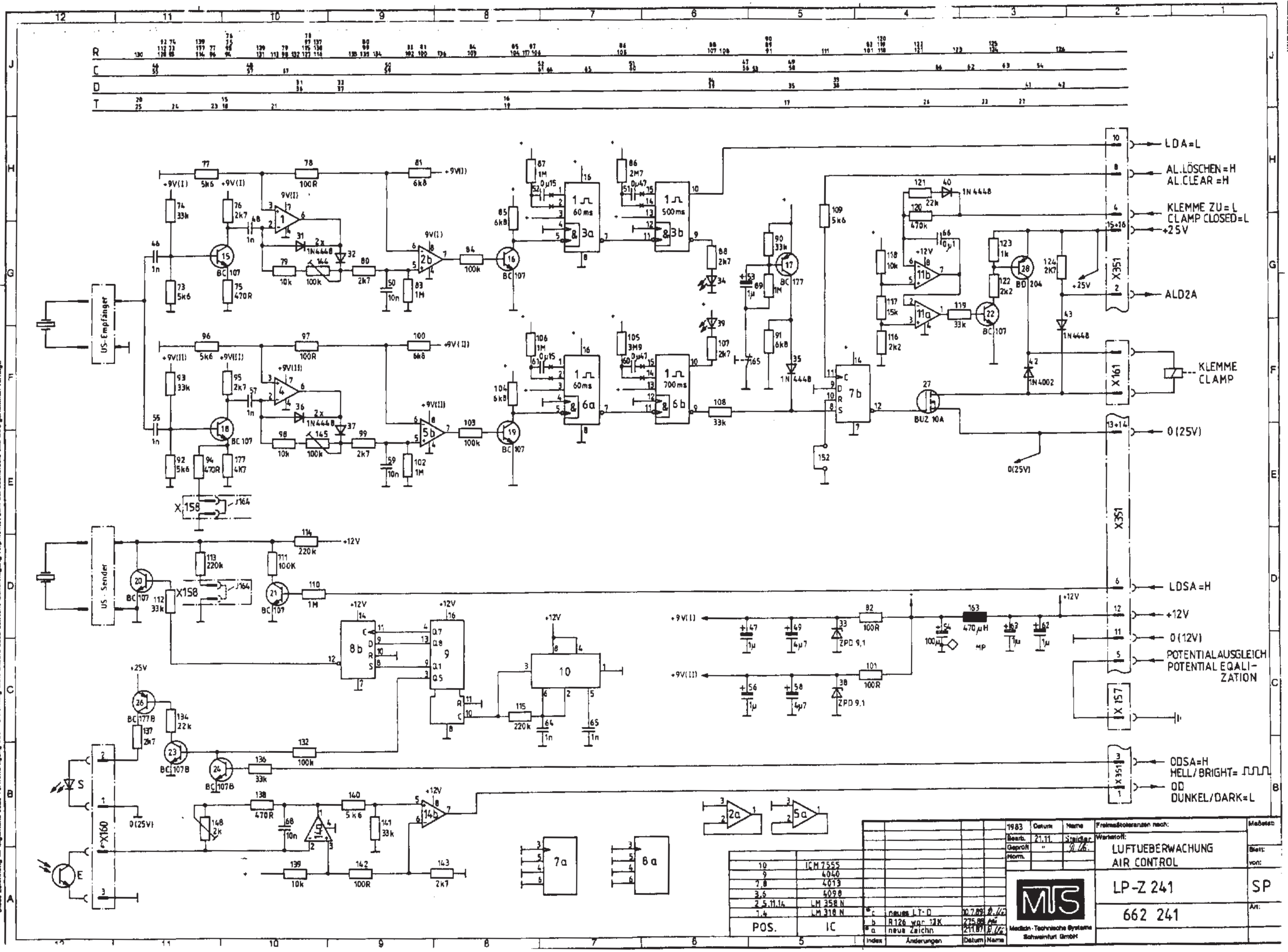
Should the +12 V voltage supply be modulated by an error in the power supply network, this might disturb the function of the air detector as well as of other circuits. In order to recognize such a failure, the transistor T 17 is used to monitor the +12 V voltage. Via C 53, any possible AC voltage superposition of the 12-V voltage is coupled onto the base-emitter section which is biased via R 89 and R 90. Should the share exceed approx. 0.5 V_{ss}, T 17 becomes conductive by means of the AC voltage, and positive 12-V pulses, which set the alarm flip-flop U 7 via D 35, are applied to the collector. This causes the return clamp to close.

- **Test of the Air Monitoring System**

The two independent cut-off routes of the air monitoring system are tested by means of transmitter attenuation. Prior to each start of the treatment, both the microprocessor and the alarm system are testing whether the two alarm channels release an alarm. During this test, an empty air chamber is provided in the air detector. During the technical safety checks, however, the air detector is tested by means of a filled air chamber and the activation of transistor T 21.
The optical part is likewise tested by transmitter attenuation, simulating a line filled with blood. The clock pulse at pin 1 of plug X 351 is suppressed.

3.8.2 Circuit and Component Layout Diagram P.C.B. LP-Z 241 Air Monitoring System





Diese Zeichnung ist Eigentum. Jede Vervielfältigung oder Verwertung ohne unsere ausdrückliche Genehmigung verpflichtet zum Schadenersatz und wird gerichtlich verfolgt.

P.C.B. LP-Z 241

Circuit Diagram

3.9 P.C.B. LP 821 CAN/PC Card

3.9.1 Circuit Description

- **General Functional Description**

This circuit represents the interface between an IBM-PC/XT BUS and a CAN BUS system.

Essentially, the circuit consists of the following units:
– dual port RAM (IDT 7132)
– microcontroller (80C32)
– basic CAN interface module (82C200)
– serial interface (MAX 232)

- **Data Transfer in the Interface**

Data is filed in the dual port RAM from the PC side. The microcontroller (μC) retrieves the data from the dual port RAM (DPRAM) and causes the CAN interface module to transmit the data via the CAN BUS. Data, which is received via the CAN BUS, is read from the CAN interface module by the μC, processed and entered in the DPRAM. The μC is also able to receive and transmit data via a serial interface.
Via an 8-fold DIL switch, a combination can be set which can be evaluated either by the ECB side or by the participants in the CAN BUS.

- **Dual Port RAM**

A DPRAM module, 2 k x 8 bit in size, is used as dual port RAM. The module is addressed from the PC side via the following addresses:

DIL switch S1 1	2	3	Basic address	Final address
OFF	OFF	OFF	$C0000	$C07FF
OFF	OFF	ON	$C8000	$C87FF
OFF	ON	OFF	$D0000	$D07FF
OFF	ON	ON	$D8000	$D87FF
ON	OFF	OFF	$E0000	$C07FF
ON	OFF	ON	$E8000	$C87FF
ON	ON	OFF	$F0000	$D07FF
ON	ON	ON	unused	

In addition, the ECB BUS lines /WAIT, /RD, /WR, and /MREQ are used for access control. /MREQ serves to select the modules. /RD and /WR decide whether access to the DPRAM is done in reading or writing mode, and /WAIT indicates to the ECB BUS that there has been an access collision in the DPRAM.
The description of data exchange in the DPRAM can be found in the circuit description of the P.C.B. LP 820, CAN/ECB card.

- **Microcontroller and CAN Interface Module**

  With its address and data BUS, the microcontroller is connected to the CAN interface module and the DPRAM. Since the registers of the CAN module are addressed as is a usual RAM, the area of the external RAM is divided among the DPRAM and the CAN module.

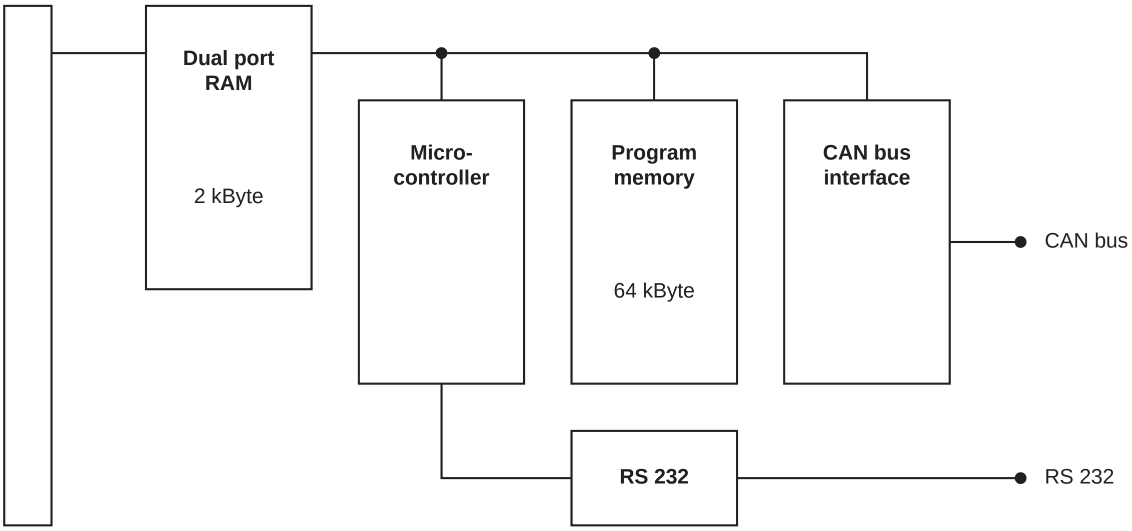
  A monitoring module (watchdog, MAX 690), which can reset the µC, is used to increase the availability of the µC. The clock pulse frequency for the µC is generated in the CAN module. Via the driver module 75176 and a current-compensated inductance coil as well as a resistor network, the CAN module is coupled to the CAN BUS. The resistor network should be fitted only if the card represents the beginning or the end of the CAN BUS.

  With its interrupt request line, the CAN module is connected to the interrupt input /INT0 of the µC. This line is used to request the µC to process the data received.

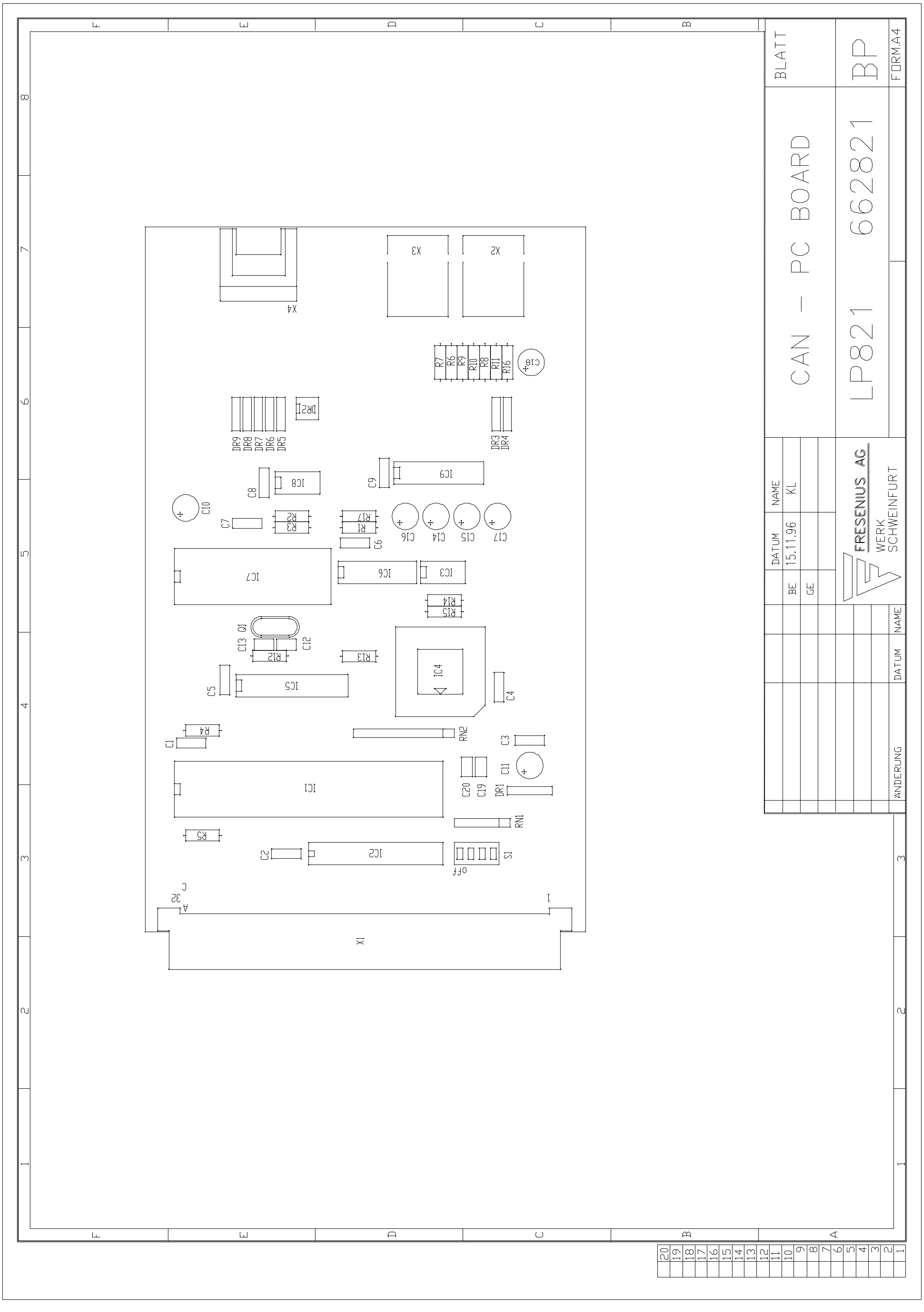
- **Serial Interface**

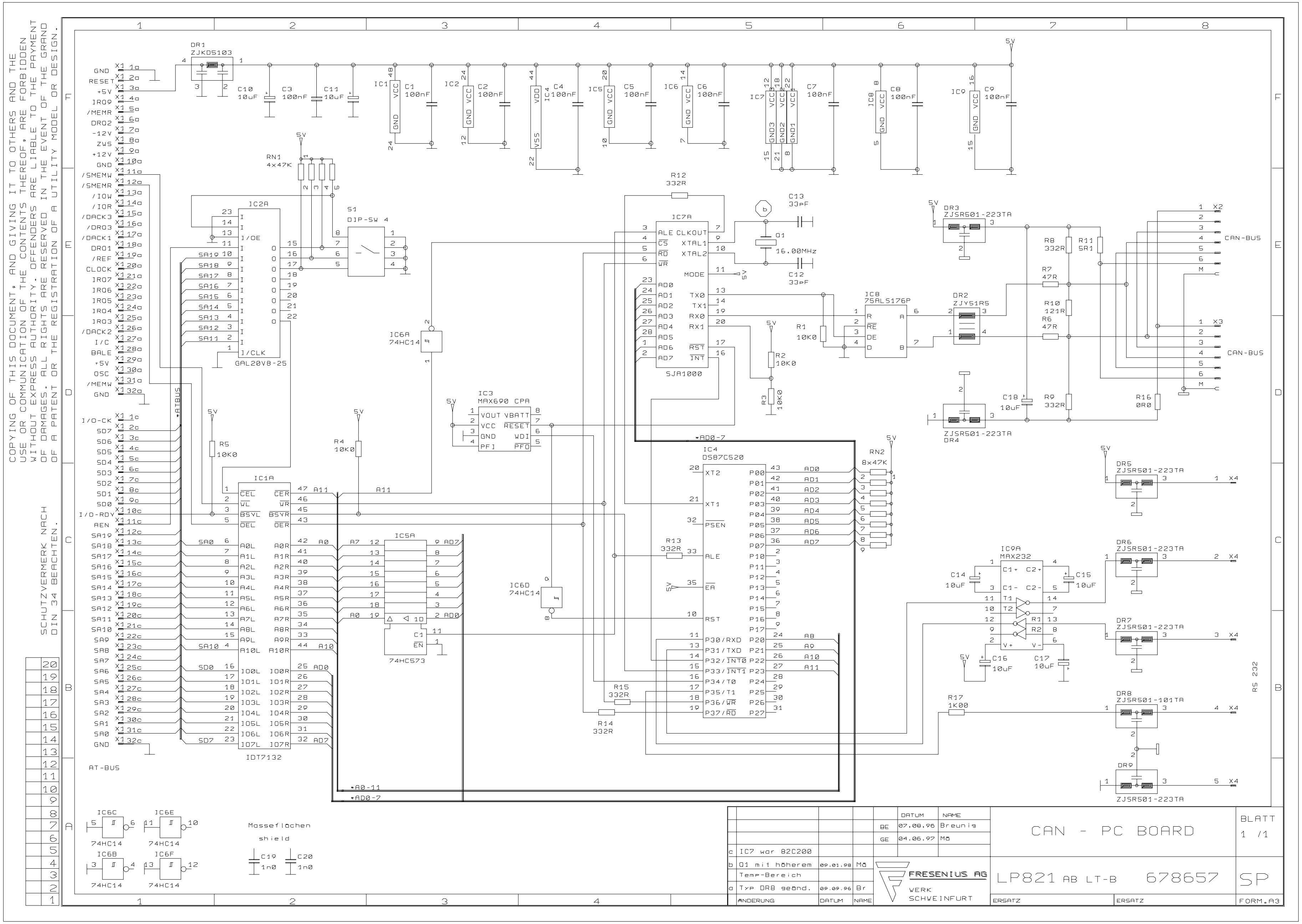
  The µC is provided with a serial interface. The levels of the interface lines are adjusted to the levels of an RS232 interface via the module MAX 232.

Fig.: Block Diagram of P.C.B. LP 821 CAN/PC Card



3.9.2 Circuit and Component Layout Diagram P.C.B. LP 821 CAN/PC Card





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SCHUTZVERMERK NACH DIN 34 BEACHTEN.
AT-BUS
CAN-BUS
RS 232
SJA1000
DS87C520
IDT7132
GAL20V8-25
MAX690 CPA
MAX232
75ALS176P
74HC573
74HC14
DIP-SW 4
16.00MHz
Masseflächen shield
CAN - PC BOARD
BLATT 1 /1
LP821 AB LT-B 678657
SP
FRESENIUS AG
VERK SCHWEINFURT
BE 07.08.96 Breunig
GE 04.06.97 Mö
c IC7 war 82C200
b Q1 mit höherem Temp-Bereich 09.01.98 Mö
a Typ DR8 geänd. 09.09.96 Br
ÄNDERUNG DATUM NAME
ERSATZ
ERSATZ
FORM.A3

P.C.B. LP 821

Circuit Diagram

3.10 P.C.B. LP 822 Keyboard Board

3.10.1 Circuit Description

- **General Functional Description**

Essentially, the keyboard encoder (KE) consists of three functional units:
– microcontroller PIC16C55
– RS232 interface with MAX 232
– DC-decoupled evaluation of the hardware keys for the alarm system

Interfaces are represented by the contact strips leading to the alarm system (X1), the keys on the front panel (X2, X3), and the serial interface (X4). The KE is supposed to recognize those keys on the front panels of the devices which have been pressed and to transmit this information.

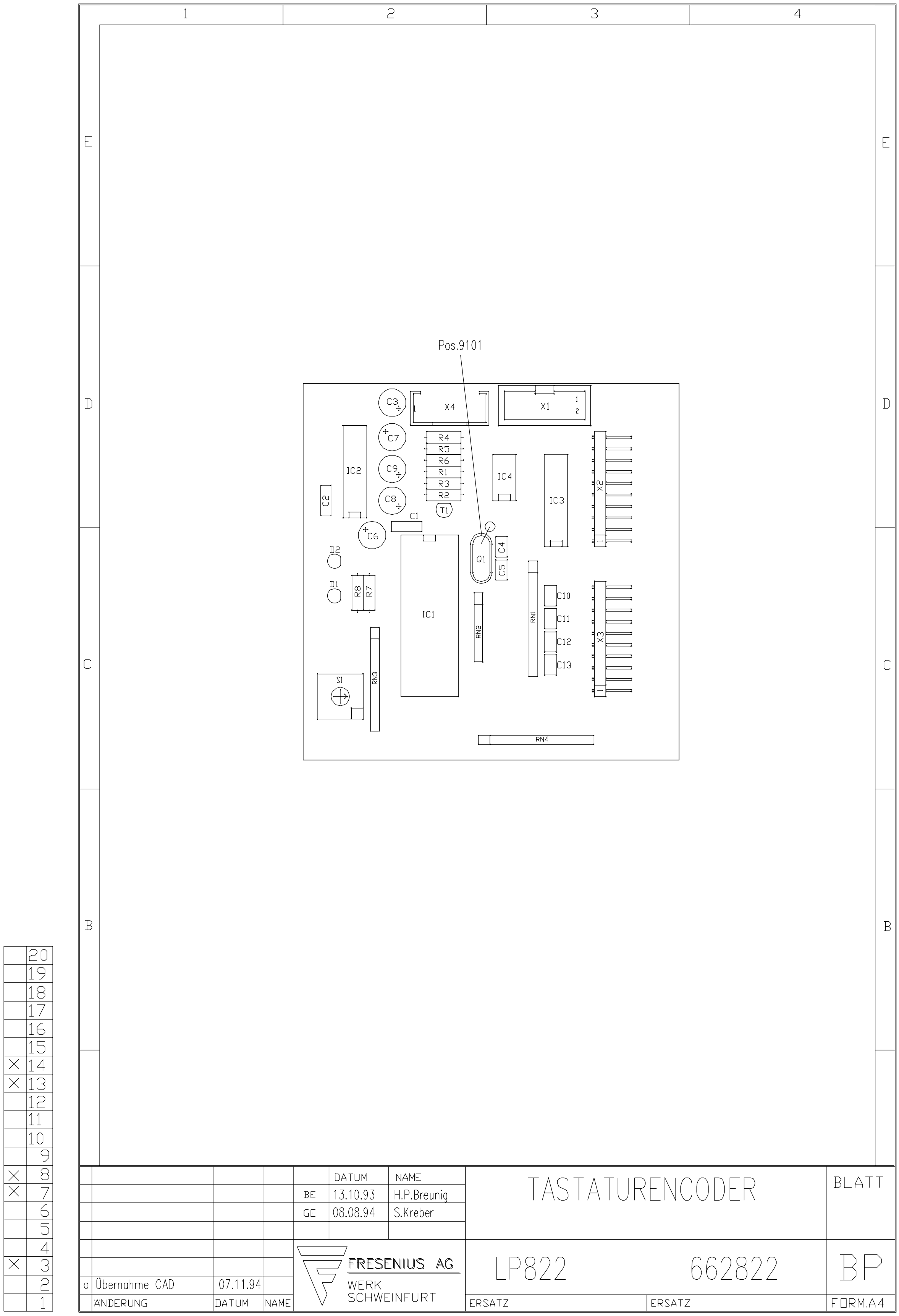
- **Function**

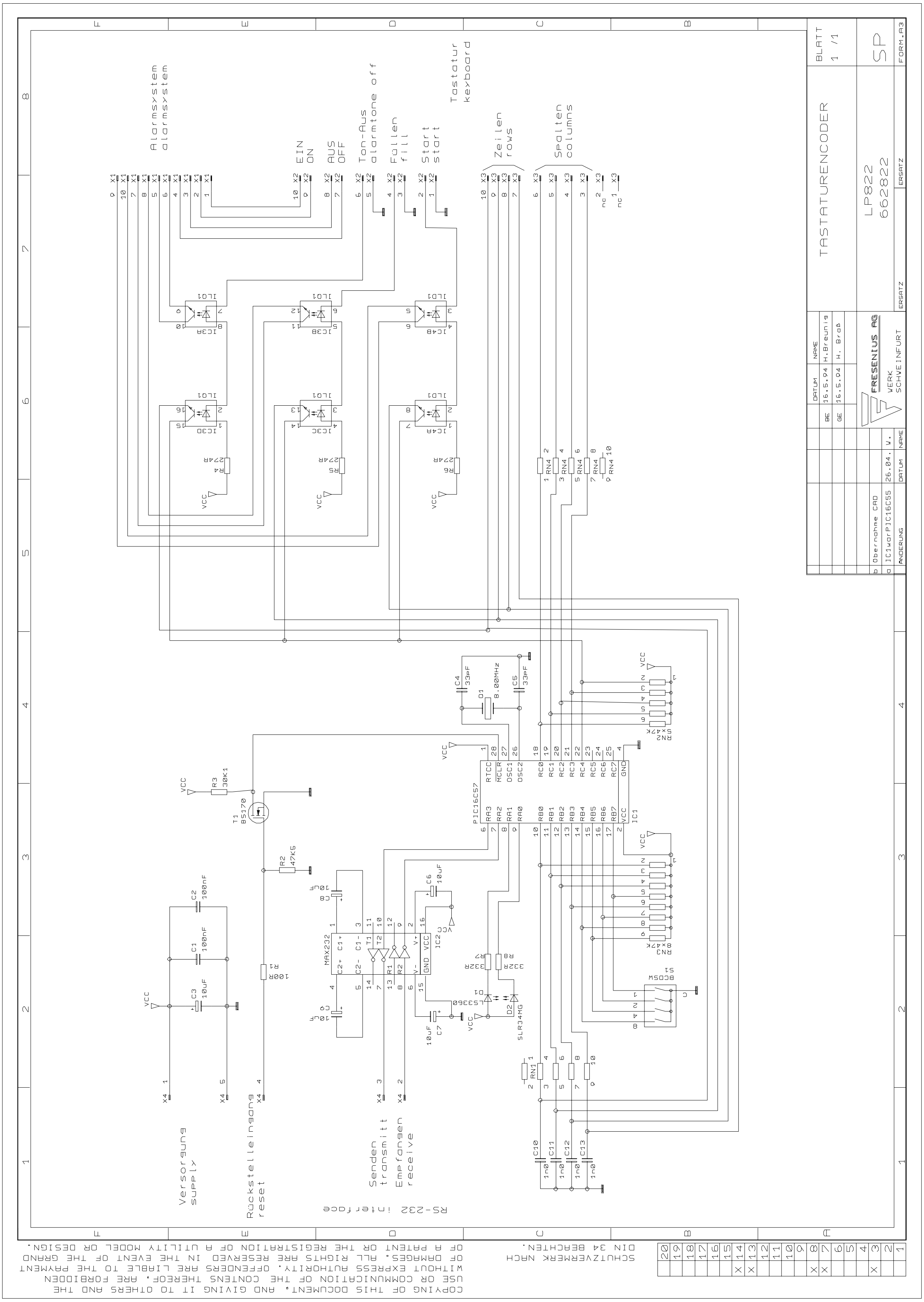
The microcontroller receives its clock pulse frequency from the internal oscillator and an external crystal (Q1). Via input X1.4, the µC can be reset by applying a high level. A key matrix is connected to the µC. The lines of the matrix are applied to port RB0 to RB3; the columns are applied to port RC0 to RC1. Hence, a maximum of 4 x 5 keys can be connected. The RB port is connected to the lines of the key matrix via RC elements, in order to reduce the slope of the edges, thus preventing the scan signals (to be described later) from radiating to the front panel via the lines. The lines of the “Prime” (X2.7, X2.8), “Start” (X2.9, X2.10) and “Mute” (X2.5, X2.6) keys are not directly connected to the port pin RC4. This is necessary since these keys must still be evaluated with DC-decoupling for the alarm system in the COM.TEC. The µC can transmit information on a pressed key to a superior unit via the serial interface (RA0 = TXD, RTA1 = RXD). The level converter MAX 232 sets the signals of the µC to the RS232 level. Various baud rates can be adjusted via the switch S1.

The “on” (X2.1, X2.2) and “off” (X2.3, X2.4) keys on the front panel are transmitted without evaluation. These keys are evaluated in the power supply logic.

- **Scanning Procedure**

A key in the key matrix is considered to be pressed if it is the only one that has been pressed for a specific time interval. In order to detect this, the key matrix is scanned for pressed keys. One after the other, the output lines RB0 to RB3 are put to low level. This low level appears on an input line (RC0 to RC4), if one and only one key is pressed. After this condition has been recognized, it is tested whether it is maintained for a specific time interval. If the test result is positive, the key is considered to be pressed and the key code is issued via the serial interface.


Pos.9101
C3
X4
X1
C7
R4
R5
R6
R1
R3
R2
IC2
C9
C8
IC4
IC3
X2
C2
T1
C1
C6
Q1
C4
C5
D2
D1
R8
R7
IC1
RN2
RN1
C10
C11
C12
C13
X3
S1
RN3
RN4
TASTATURENCODER
BLATT
DATUM
NAME
BE 13.10.93 H.P.Breunig
GE 08.08.94 S.Kreber
FRESENIUS AG
WERK SCHWEINFURT
LP822
662822
BP
a Übernahme CAD 07.11.94
ÄNDERUNG
DATUM
NAME
ERSATZ
ERSATZ
FORM.A4



TASTATURENCODER
LP822
662822
FRESENIUS AG
PIC16C57
MAX232
RS-232 interface

3.11 P.C.B. LP 823-1 Power Control Logic and Door Switch

3.11.1 Circuit Description

- **General Functional Description**

The circuit of P.C.B. LP 823-1 (power control logic and door lock) has been developed for use with the COM.TEC and the C.A.T.S® autotransfusion system. Some of its functions are used in only one of these two devices. The corresponding differences will not be described here.
The overall circuit of the power control logic (PCL) consists of the following functional units:
- voltage distribution
- low voltage recognition with changeover to battery operation
- battery charging and test circuit
- on/off switching logic
- 87C592 microcontroller with integrated basic CAN interface
- long-hole recognition and stroboscope activation
- switch-off for pump voltage supply
- control of fan, lighting and door lock

The PCL (P.C.B. LP 823-1) distributes the voltages made available by the power unit (P.C.B. LP 638-1) via the contact strip X1 among subassemblies. Detection of low voltage will cause a changeover to battery operation. The PCL evaluates the “on” or “off” keys of the device.

- **Voltage Distribution**

The power unit P.C.B. LP 638-1 delivers the following voltages and currents:

–	U1	+40 V / 10 mA,	non-stabilized	(reference: 0 V)
–	U2	+24 V / 5.5 A,	stabilized	(reference: 0 V)
–	U3	+30 V / 2.5 A,	non-stabilized	(reference: GND)
–	U4	+5 V / 5.0 A,	stabilized	(reference: GND)

Voltages relate to GND and 0 V. The ground potential is separated immediately after the infeed of the power unit. It must be guaranteed that the separation of the ground potentials of power supply voltage (24 V) and logic voltage (5 V) is maintained. Any connection should only be established via high-impedance resistors (≥ 10 kΩ), in order to maintain the reason of this separation (absence of interference voltages in the logic unit).

The voltages are distributed via the power supply plugs:
- X301 supply of pumps with +24 V 0 V, +5 V GND
  The +24-V voltage is switched via a safety relay which is energized via a fail-safe circuit.
- X302 Supply of centrifuge logic with +5 V GND
- X303 Sub-distribution +24 V 0 V, +5 V GND
- X304 Computer and display +30 V 2.5 A
- X305 Sub-distribution +24 V 0 V

- **Low Voltage Recognition and Changeover to Battery Operation**

  In the event of voltage failure, a 24-V battery (X800) is connected via T 701. This battery delivers the voltage U2 (24 V) and, via D1, the reduced voltage U3, which is used to generate the voltage U4 in the power unit. Usually, D1 is not conductive.

  A drop of the non-stabilized 50 V (U1) voltage below a value of approx. 28 V is interpreted as voltage failure. Should the voltage fall below 28 V, the 24-V regulator is no longer able to make a clean 24-V voltage available on the power unit. The value of U1 is compared with a reference value (D704). In the event of voltage failure, IC 700B switches the battery to U2 via T701. The regulator of U2 is switched off via R711. The microcontroller (interrupt input) is informed of the changeover via IC 702.

- **Battery Charging and Test Circuit**

  A charging voltage of approx. 28 V is required to charge the battery. This voltage is made available by the switching regulator IC 800, and is gained from the voltage U3. The maximum charging current is limited by R802.

  After switch-on, the battery is tested, i.e. the battery voltage is measured under load. The microcontroller switches the relay RL800 via IC 801A. The battery is connected to the load R803 and R804. For this time interval, the battery charging circuit is deactivated via IC 801B. The resistor R803 (PTC) is provided to prevent the resistor R804 from overheating in case of errors.

- **On/Off Switching Logic**

  The battery voltage is switched to the I/O logic via the diode D600 and the relay contacts RL300B. In the event that the safety relay is defective (the restricted contact RL300B is sticky), the I/O logic is currentless. As a result, the machine cannot be switched on. Usually, the transistor T600 becomes conductive via the on-button (X300.1 and X300.2), and the transistor T602 of the bistable circuit (T601, T602) switches the power supply relay on. From this moment, U2 is present and supplies the I/O logic via D601. The optocoupler IC 701, which releases the low voltage recognition, is provided in parallel to the power supply relay. When the off-button is pressed (X300.3 and X300.4), the capacitor C601 is discharged via R603, and the potential applied to the gate of T602 drops, until the capacitor inhibits and the power supply relay drops. T601 then becomes conductive and securely inhibits T602. The off-button must be pressed for approx. 0.5 sec to cause the bistable circuit to change its state. During battery operation, the machine is switched off by the microcontroller via the optocoupler IC 508D, as soon as the battery voltage falls below 19 V (protection against deep discharge).

- **87C592 Microcontroller with integrated basic CAN interface**

The microcontroller IC 500 controls and monitors the circuit of P.C.B. LP 823. The temperature sensor IC 506 delivers a voltage proportional to the temperature to the analog input P6.1. The microprocessor is provided with several external interfaces:

– X500, X501 CAN bus
– X505, X506 External temperature generator
– X502, X503 DC-coupled digital inputs, X502 interruptable
– X504 Door switch control and door switch position
– X401 Release of stroboscope
– X402 Camera trigger
– X200 Fan
– X507 Time meter
– X400 Perforated disc read-in

The microcontroller controls the battery charging and test circuit. The changeover to battery operation generates an interrupt in the microcontroller.

The microcontroller constantly observes the operating voltage and, during battery operation, switches the machine off, if the battery voltage falls below approx. 19 V.

- **Long-Hole Recognition and Stroboscope Activation**

The perforated disc provided for measuring the speed of the centrifuge is detected by the optical sensor X400 and is fed to a RISC µC PIC16C56 (IC 400). By means of the missing hole in the perforated disc, this µC determines the synchronization pulse and passes this pulse on to the microcontroller 87C592. The RISC microcontroller also generates the stroboscope pulse. This pulse is passed on to the interface control (X300.7 and X300.9) via IC 508.

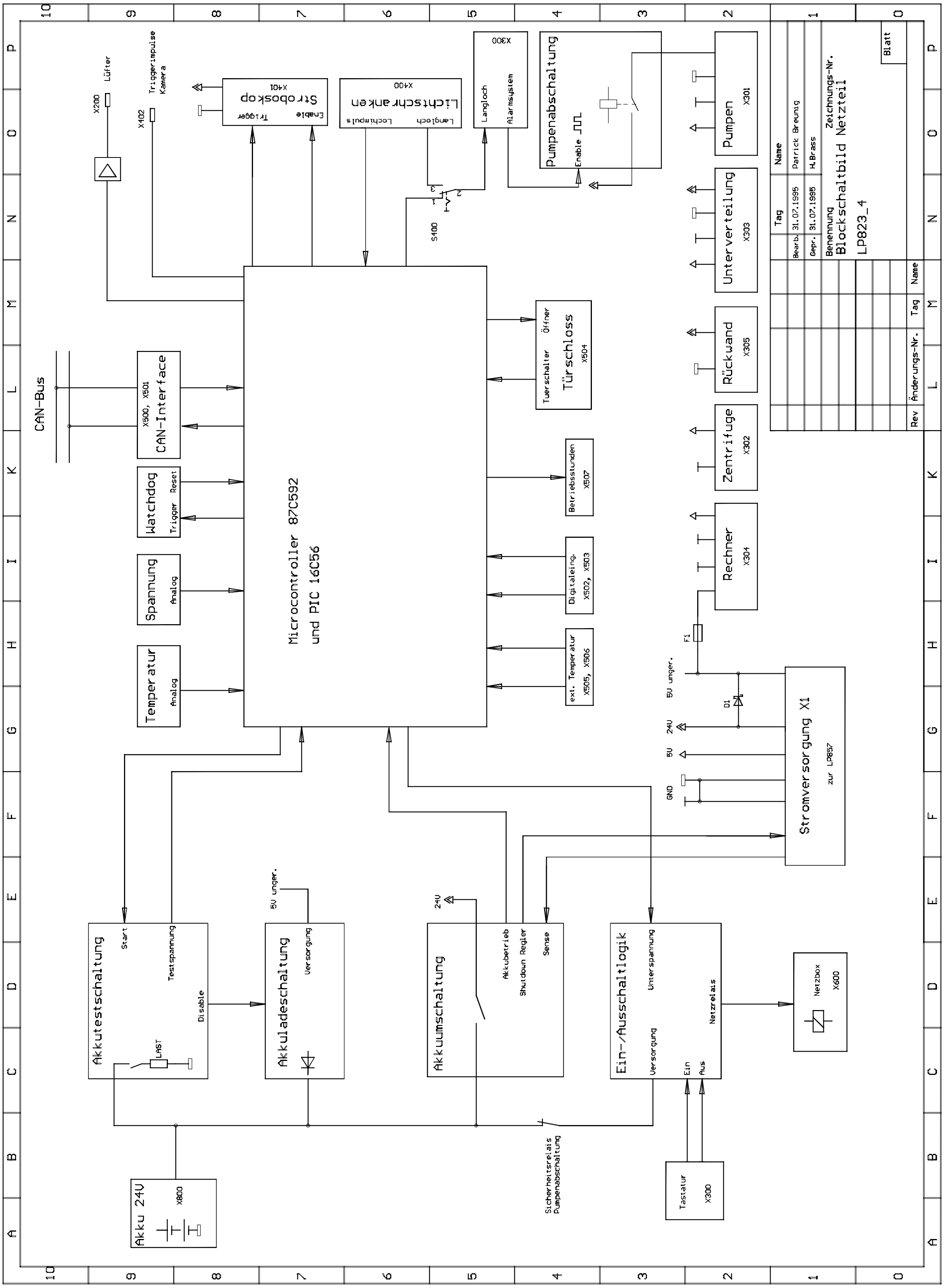
- **Switch-Off for Pump Voltage Supply**

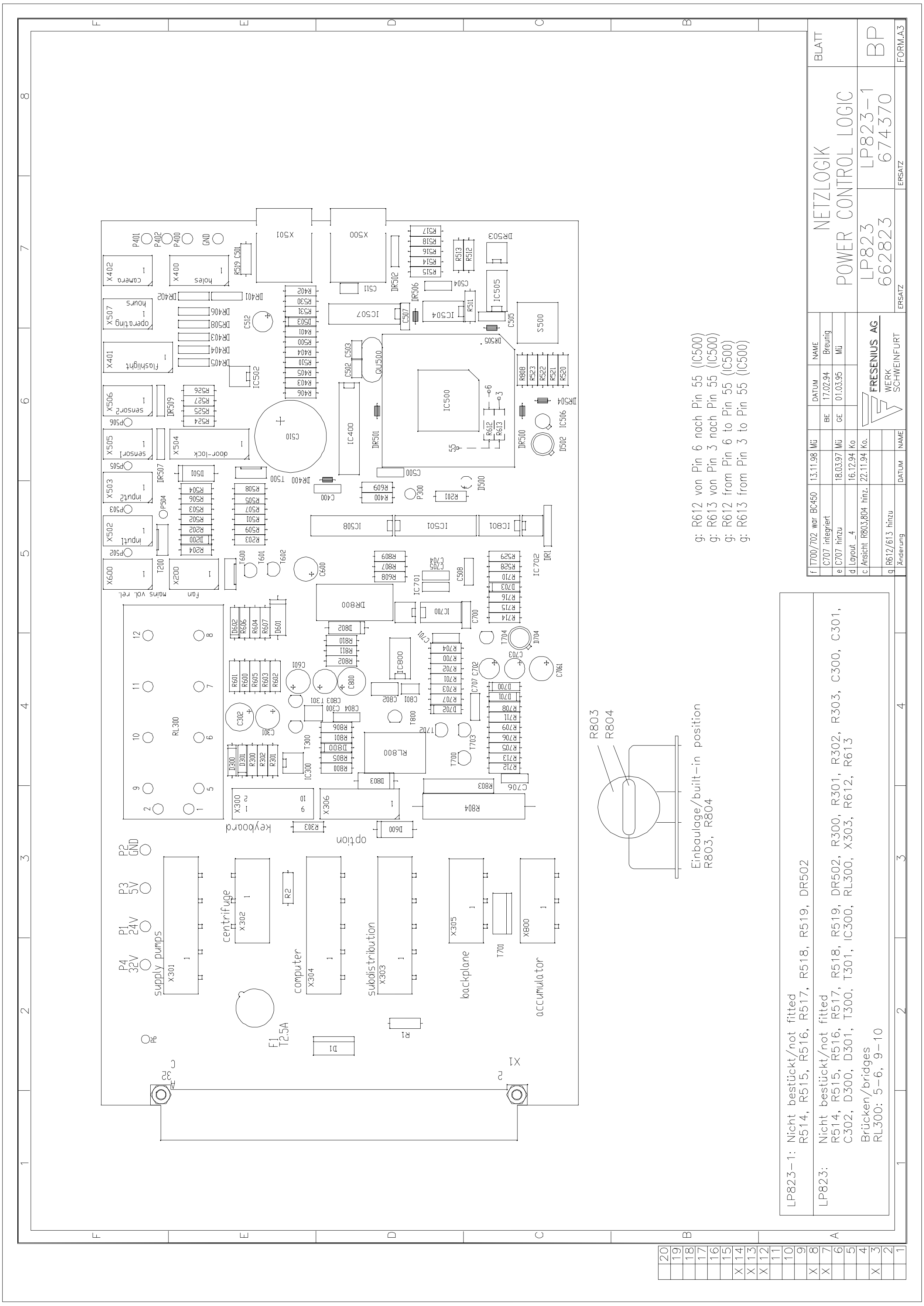
  In the event of an error, it must be ensured that the blood pumps are disconnected from the supply voltage. This is achieved by the relay RL 300, which requires a negative supply voltage. This voltage is made available by the transistors T300 and T301 via C301 and the diodes D30, D301 only when a rectangular signal of a sufficiently high frequency is applied to X300.8 and X300.10. This signal is supplied by the fail-safe alarm system, as long as there is no alarm.

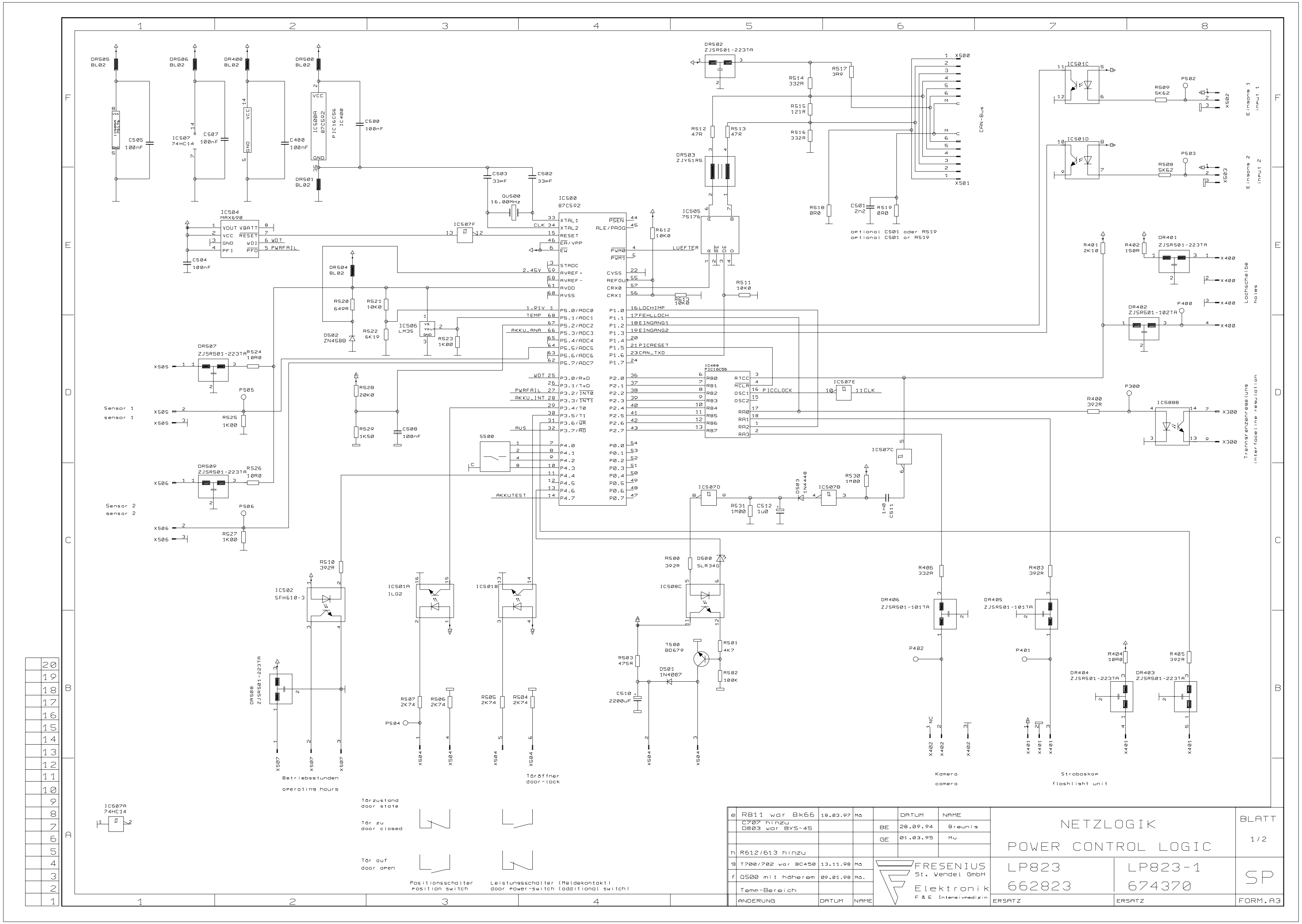
- **Control of Fan, Lighting and Door Lock**

  These units are controlled by the microprocessor IC 500 (see above).

Fig.: Block Diagram of P.C.B. LP 823-1

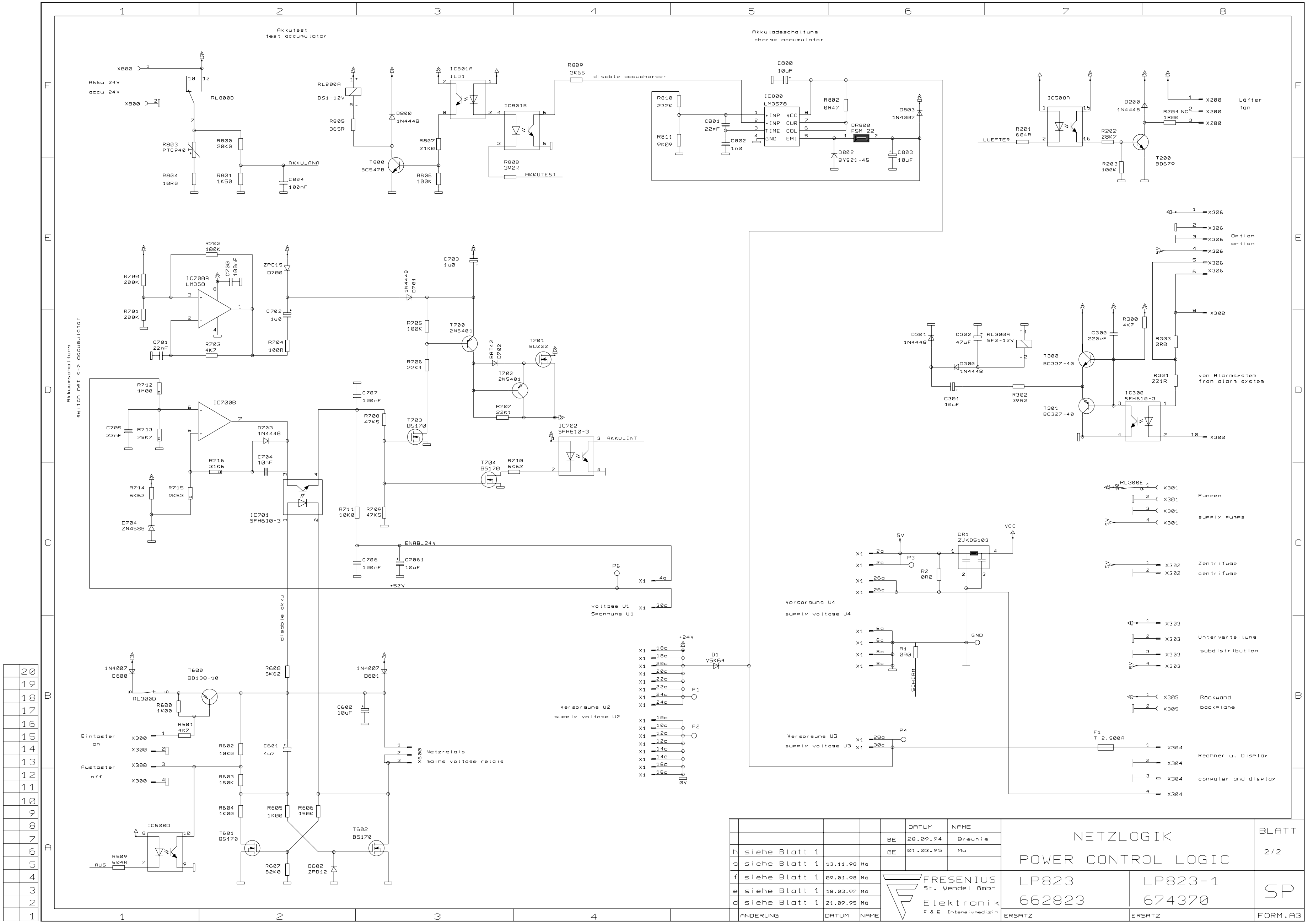



NETZLOGIK
POWER CONTROL LOGIC
LP823 662823
LP823-1 674370
BLATT
BP
FRESENIUS AG WERK SCHWEINFURT
g: R612 von Pin 6 nach Pin 55 (IC500)
g: R613 von Pin 3 nach Pin 55 (IC500)
g: R612 from Pin 6 to Pin 55 (IC500)
g: R613 from Pin 3 to Pin 55 (IC500)
Einbaulage/built-in position
R803, R804
LP823-1: Nicht bestückt/not fitted
R514, R515, R516, R517, R518, R519, DR502
LP823: Nicht bestückt/not fitted
R514, R515, R516, R517, R518, R519, DR502, R300, R301, R302, R303, C300, C301,
C302, D300, D301, T300, T301, IC300, RL300, X303, R612, R613
Brücken/bridges
RL300: 5-6, 9-10
supply pumps
centrifuge
computer
subdistribution
backplane
accumulator
keyboard
option


NETZLOGIK
POWER CONTROL LOGIC
BLATT
1/2
LP823
662823
LP823-1
674370
SP
FORM.A3
ERSATZ
ERSATZ
FRESENIUS
St. Wendel GmbH
Elektronik
F & E Intensivmedizin
DATUM
NAME
BE
28.09.94
Breunig
GE
01.03.95
Mu
e R811 war 8k66 18.03.97 Mü
C707 hinzu
D803 war BYS-45
h R612/613 hinzu
g T700/702 war BC450 13.11.98 Mü
f Q500 mit höherem 09.01.98 Mü.
Temp-Bereich
ÄNDERUNG
DATUM
NAME
IC500
87C592
IC400
PIC16C56
IC504
MAX690
IC505
75176
CAN-Bus
Eingang 1
input 1
Eingang 2
input 2
Lochscheibe
holes
Trenngrenzenregelung
interface regulation
Sensor 1
sensor 1
Sensor 2
sensor 2
Betriebsstunden
operating hours
Türöffner
door-lock
Kamera
camera
Stroboskop
flashlight unit
Türzustand
door state
Tür zu
door closed
Tür auf
door open
Positionsschalter
position switch
Leistungsschalter (Meldekontakt)
door power-switch (additional switch)
optional C501 oder R519
optional C501 or R519

P.C.B. LP 823-1

Circuit Diagram 1/2


Akkutest
test accumulator
Akkuladeschaltung
charge accumulator
Akku 24V
accu 24V
RL800B
R803
PTC940
R800
20K0
R801
1K50
R804
10R0
AKKU_ANA
C804
100nF
RL800A
DS1-12V
R805
365R
D800
1N4448
T800
BC547B
R807
21K0
R806
100K
IC801A
ILD1
IC801B
R808
392R
AKKUTEST
R809
3K65
disable accucharger
C800
10uF
IC800
LM3578
R802
0R47
DR800
FSM 22
D803
1N4007
R810
237K
R811
9K09
C801
22nF
C802
1n0
D802
BYS21-45
C803
10uF
IC500A
R201
604R
LUEFTER
R202
20K7
D200
1N4448
R204
1R00
T200
BD679
R203
100K
X200
Lüfter
fan
R702
100K
R700
200K
R701
200K
IC700A
LM358
C700
100nF
C701
22nF
R703
4K7
ZPD15
D700
C702
1u0
R704
100R
D701
1N4448
C703
1u0
R705
100K
T700
2N5401
R706
22K1
BAT42
D702
T701
BUZ22
T702
2N5401
R707
22K1
Akkuumschaltung
switch net <-> accumulator
R712
1M00
IC700B
C705
22nF
R713
78K7
D703
1N4448
C704
10nF
R716
31K6
R714
5K62
R715
9K53
D704
ZN4588
IC701
SFH610-3
C707
100nF
R708
47K5
T703
BS170
T704
BS170
R710
5K62
IC702
SFH610-3
AKKU_INT
R711
10K0
R709
47K5
ENAB_24V
C706
100nF
C7061
10uF
P6
voltage U1
Spannung U1
disable akku
X306
Option
option
D301
1N4448
C302
47uF
RL300A
SF2-12V
D300
1N4448
T300
BC337-40
C300
220nF
R300
4K7
R303
0R0
R301
221R
vom Alarmsystem
from alarm system
C301
10uF
R302
39R2
T301
BC327-40
IC300
SFH610-3
X300
RL300E
X301
Pumpen
supply pumps
X302
Zentrifuge
centrifuge
X303
Unterverteilung
subdistribution
X305
Rückwand
backplane
X304
F1
T 2,500A
Rechner u. Display
computer and display
5V
VCC
DR1
ZJKD5103
P3
R2
0R0
Versorgung U4
supply voltage U4
GND
R1
0R0
SCHIRM
+24V
D1
V5K64
P1
P2
Versorgung U2
supply voltage U2
Versorgung U3
supply voltage U3
P4
0V
1N4007
D600
T600
BD138-10
RL300B
R600
1K00
R601
4K7
Eintaster
on
Austaster
off
X300
R608
5K62
D601
C600
10uF
C601
4u7
R602
10K0
R603
150K
R604
1K00
R605
1K00
R606
150K
T601
BS170
T602
BS170
R607
82K0
D602
ZPD12
X600
Netzrelais
mains voltage relais
IC500D
R609
604R
AUS
DATUM
NAME
BE
28.09.94
Breunig
GE
01.03.95
Mu
h siehe Blatt 1
g siehe Blatt 1 13.11.98 Mö
f siehe Blatt 1 09.01.98 Mö
e siehe Blatt 1 18.03.97 Mö
d siehe Blatt 1 21.09.95 Mö
ÄNDERUNG
DATUM
NAME
FRESENIUS
St. Wendel GmbH
Elektronik
F & E Intensivmedizin
NETZLOGIK
POWER CONTROL LOGIC
BLATT
2/2
LP823
662823
LP823-1
674370
SP
ERSATZ
ERSATZ
FORM.A3

P.C.B. LP 823-1

Circuit Diagram 2/2

3.12 P.C.B. LP 826 Power Module Box

3.12.1 Circuit Description

Essentially, the circuit on P.C.B. LP 826 comprises the following functional units:
– power connection terminals,
– fusible cutouts,
– power relay with override
– power filter
– making current limiting device

The power cord is connected to terminals X1 to X3. It is not necessary to provide the conductors with wire end ferrules. The two live conductors are connected to the power relay via the fuses F1 and F2. The relay coil is energized via the contact strip X4. The power relay can be overridden by means of the bushbutton S1, should the auxiliary energy required for switch-on not be available.

The power filter, comprising the capacitor C1 and the current-compensating inductance coil DR1, serves to suppress interference voltages in and from the housing.

The making current limiting device (MCL) RL2 is connected via the solder pads XX7 and XX8. The MCL prevents the overcurrent safety elements from being released by the power supply network when the transformer is connected.

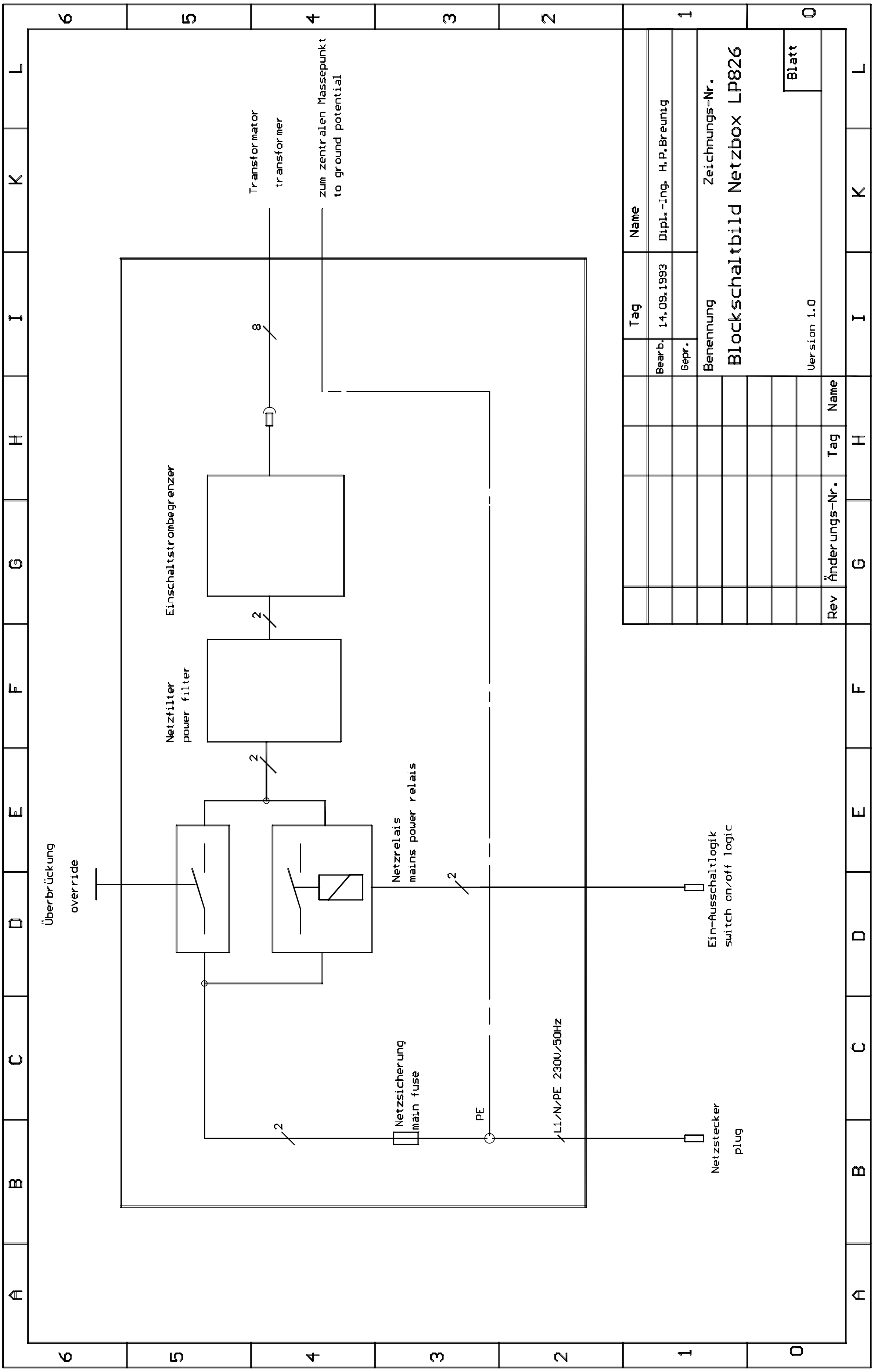
The transformer is connected to the printed circuit board via fast-on plug connectors (6.3 mm) connected to plugs X5 to X10 as well as directly to the MCL. It is possible to connect a transformer with 2 separate primary windings, each with 2 additional taps per winding. The plugs X5, X6, X8, and X10 serve to fix the unused taps of the transformer mechanically.

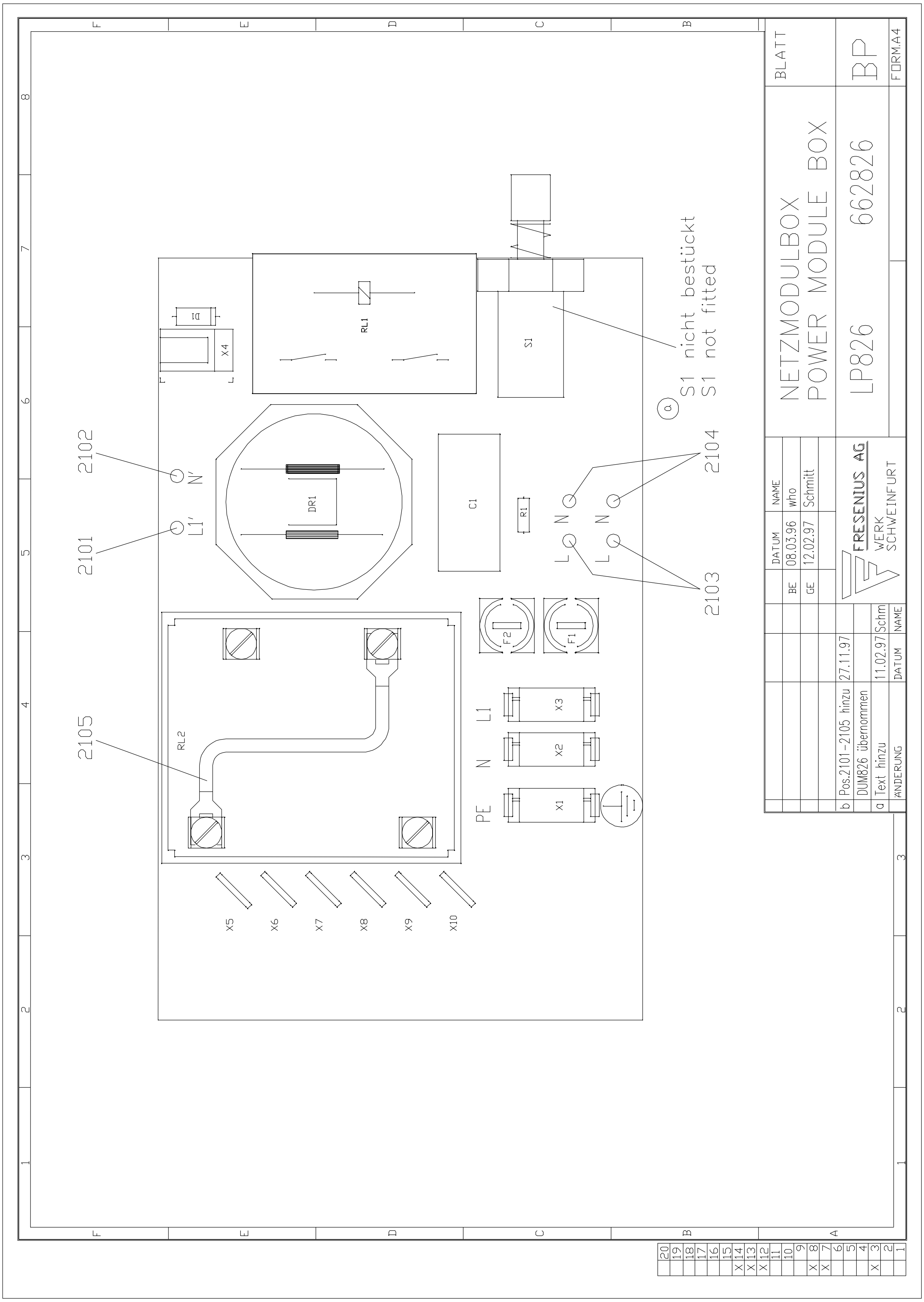
- **Transformer Connection Tables**

U_{Nom}/V	Winding 1				Winding 2			
	0 **yellow**	**100** **orange**	**115** **violet**	**120** **black**	**0** **yellow 1**	**100** **orange 1**	**115** **violet 1**	**120** **black 1**
240	N	X5	X9	X7	X8	X6	X10	L1*
230	N	X5	X7	X9	X8	X6	L1*	X10
200	N	X7	X5	X9	X8	L1*	X6	X10
120	N	X5	X9	L1*	N	X6	X10	L1*
115	N	X5	L1*	X9	N	X6	L1*	X10
100	N	L1*	X5	X9	N	L1*	X6	X10

N Plug connector N of the inrush current limiter
L1* Output of the inrush current limiter

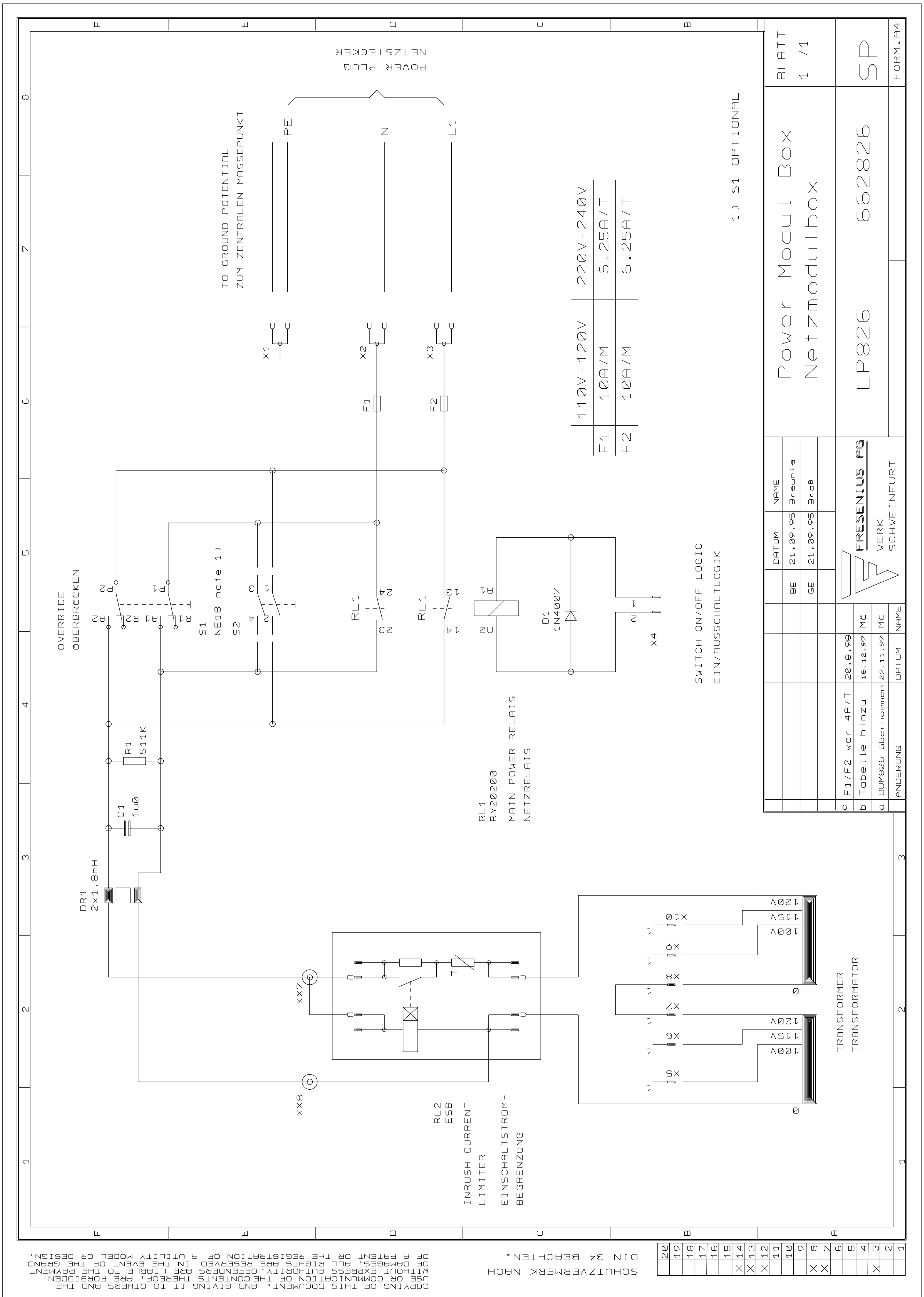
Fig.: Block Diagram of P.C.B. LP 826




NETZMODULBOX
POWER MODULE BOX
LP826
662826
BLATT
BP
FORM A4
FRESENIUS AG
WERK SCHWEINFURT
DATUM
NAME
BE 08.03.96 who
GE 12.02.97 Schmitt
b Pos.2101-2105 hinzu 27.11.97
DUM826 übernommen
a Text hinzu 11.02.97 Schm
ÄNDERUNG
DATUM
NAME
a S1 nicht bestückt
S1 not fitted
2101
2102
2103
2104
2105
L1'
N'
L
N
L1
PE
RL1
RL2
S1
DR1
C1
R1
D1
X4
F1
F2
X1
X2
X3
X5
X6
X7
X8
X9
X10

P.C.B. LP 826

Circuit Diagram



3.13 P.C.B. LP 828 Dual Stroboscope

3.13.1 Circuit Description

The circuit serves to activate and supply two flash tubes. Essentially, it consists of a DC-DC converter, which delivers the necessary flash voltage, and the trigger circuit for releasing the flashes. Both flash tubes are ignited simultaneously and illuminate an object from different sides. The two flashes are of a different brightness, which is determined by the respective flash capacitors.

- **DC-DC Converter**

In order to charge the flash capacitors C13 and C14 to the voltage required, a DC voltage flow converter increases the supply voltage from 24 V to approx. 300 V. The main item of the converter is the IC TL598. At a fixed frequency, this module energizes the two power transistors T1 and T2 such that current is alternately flowing through the two primary windings of the transmitter TR1. The respective winding current also flows through the parallel circuit of the resistors R3 and R4. The resultant voltage is returned to the non-inverting input (PIN 1) of a comparator in the IC via the low-pass filter C2 and R5. This comparator deactivates the power transistors as soon as the voltage exceeds the value at the inverting input (PIN 2). This measure ensures protection of the circuit from excess currents.

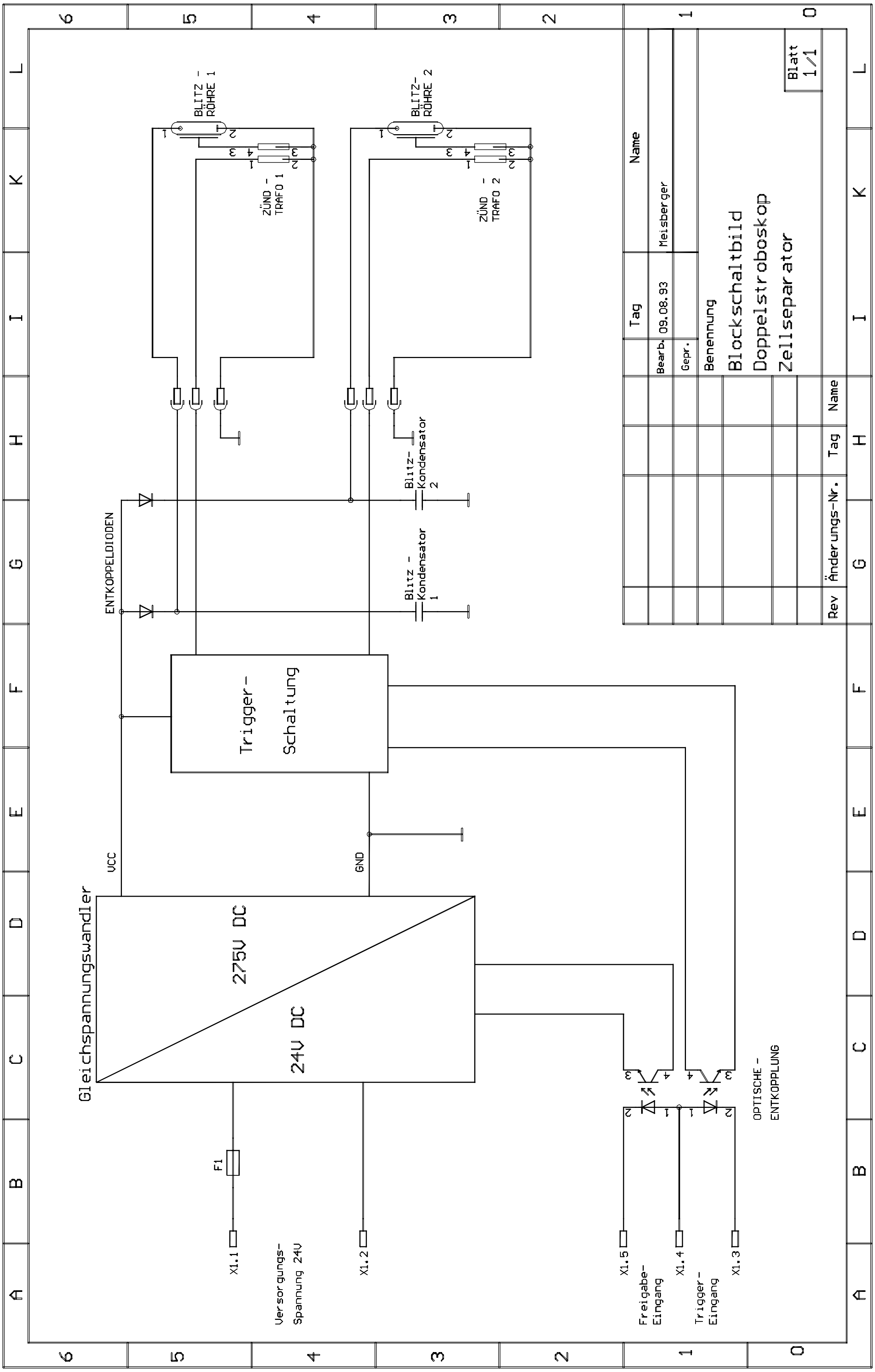
An additional internal comparator in the IC (PINs 15 and 16) is used to switch the converter on and off. If current flows through the light-emitting diode of the optocoupler IC 3, the DC-DC converter is switched on. The working frequency of the circuit is determined by the capacitor C3 and the resistor R10. The voltage at PIN 4 of the IC adjusts an idle time, during which both of the power transistors are switched off to prevent current peaks. The supply voltages of the IC applied to PINs 11 and 12 are filtered or filtered and stabilized.

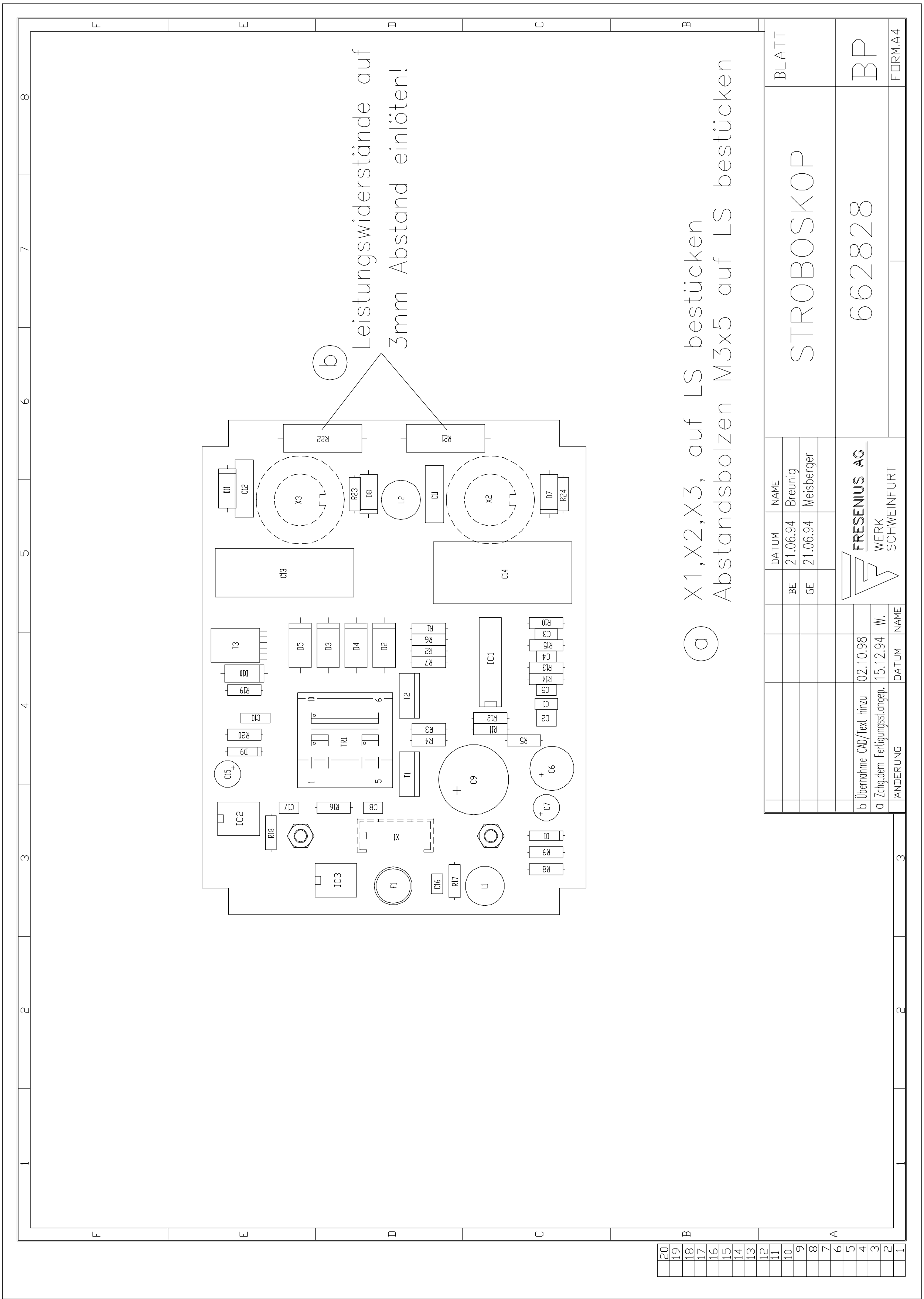
The secondary voltage of the transmitter TR1 is rectified by means of the diodes D2 to D5, and charges the flash capacitors C13 and C14 via the decoupling diodes D7 and D8. D7 and D8 ensure that the flash tubes receive energy from the respectively pertinent capacitor only.

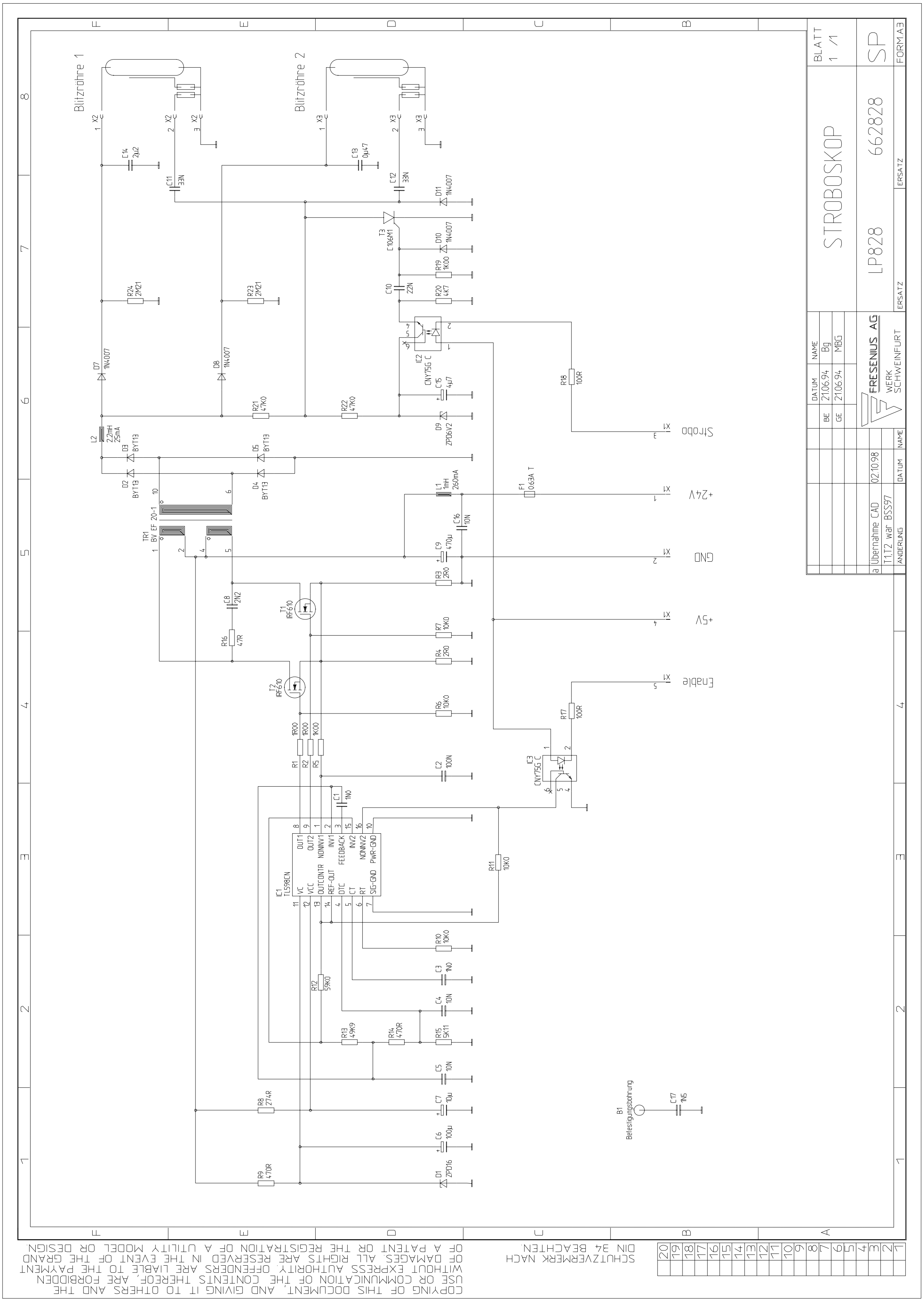
- **Trigger Circuit**

Essentially, the trigger circuit consists of the ignition transformers, which are placed immediately next to the flash tubes, and a circuit section for the latter's energization. The output DC voltage of the DC-DC converter slowly charges the capacitors C11 and C12 via R21. A current flows through the primary windings of the ignition transformers. Since, however, it is only slightly changed over time, this current does not generate any output voltage. C15 is also charged via R21 and R22. The zener diode D9 limits the voltage at C15 to approx. 6 V. As soon as a current pulse (trigger) is emitted to the optocoupler IC 2, the thyristor T3 ignites due to the energization via the capacitor C10. This causes the capacitors C11 and C12 to discharge abruptly, so that the current flowing through the ignition transformers of the flash tubes generates a high ignition voltage at the electrodes of the tubes. The flashes are ignited, i.e. the capacitors C13 and C14 discharge abruptly via the flash tubes. If the voltage of the capacitors C13 and C14 falls below the tube voltage drop of the tubes, then the resistance of the tubes becomes high, and the capacities can again charge.

Fig.: Block Diagram of P.C.B. LP 828




Leistungswiderstände auf
3mm Abstand einlöten!
X1,X2,X3, auf LS bestücken
Abstandsbolzen M3x5 auf LS bestücken
STROBOSKOP
662828
BLATT
BP
FORM.A4
DATUM
NAME
BE 21.06.94 Breunig
GE 21.06.94 Meisberger
FRESENIUS AG
WERK SCHWEINFURT
b Übernahme CAD/Text hinzu 02.10.98
a Zchg.dem Fertigungsst.angep. 15.12.94 W.
ÄNDERUNG
DATUM
NAME



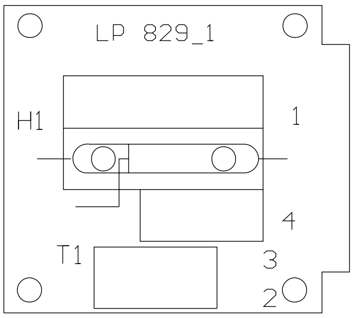
STROBOSKOP
LP828
662828
FRESENIUS AG
WERK SCHWEINFURT
Blitzröhre 1
Blitzröhre 2
Strobo
+24V
GND
+5V
Enable

3.14 P.C.B. LP 829 Flash Tube Board

3.14.1 Circuit Description

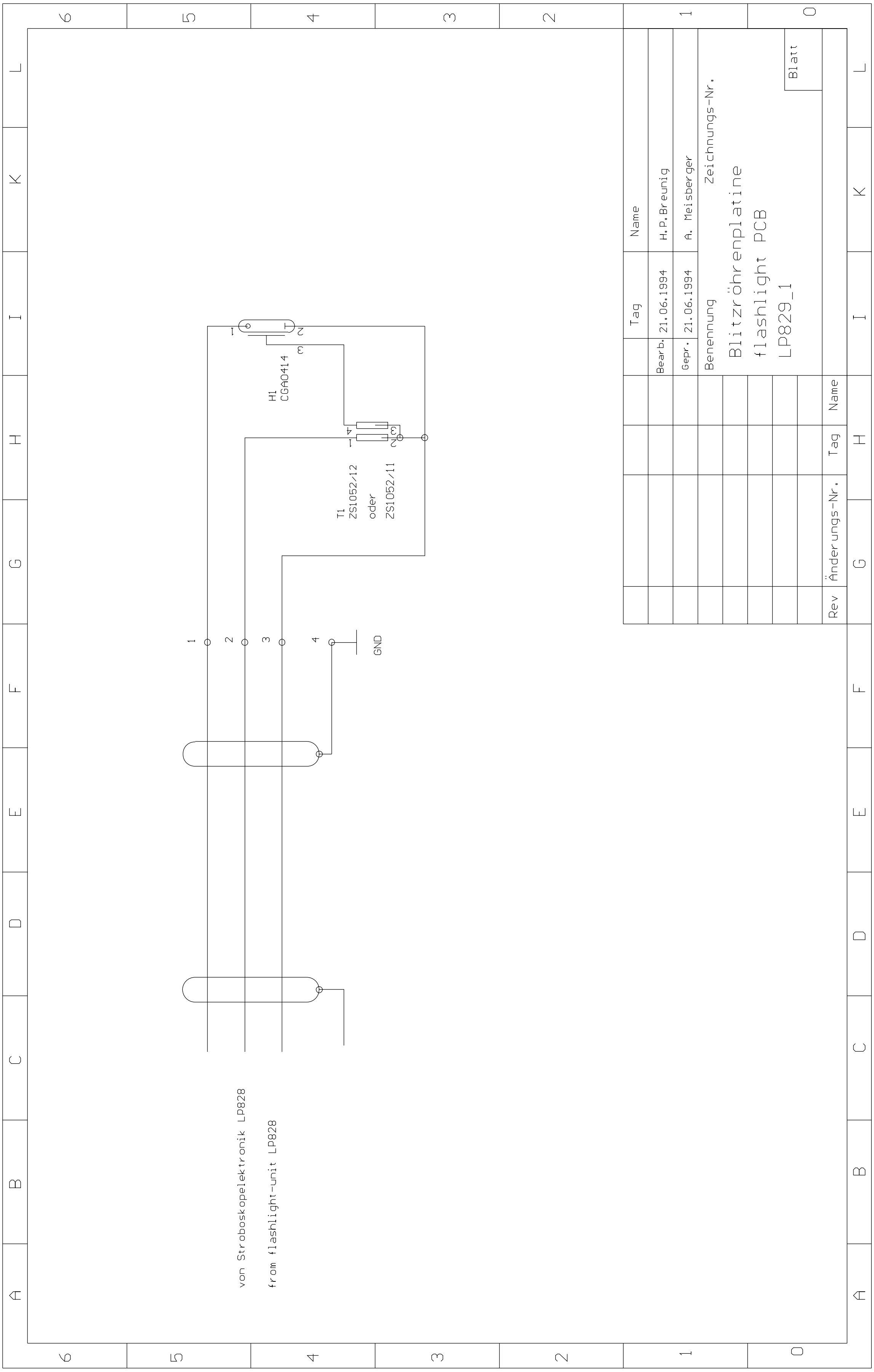
The flush tube board LP 829 serves to mount the flash tube, the reflector and the ignition coil. The supply line (with 3 pins, screened) is soldered onto the solder points 1 to 4. Strain relief is achieved by means of a cable tie.

The supply line is used to transmit the supply voltage of approx. 275 V DC to the anode (pin 1, H1) and the cathode (pin 2, H1) of the flash tube. A rapid change of the current in the ignition coil T1 causes an induction voltage on the secondary side of T1, thus causing the flash tube to discharge. In order that the flash can be extinguished, the supply voltage must collapse upon this discharge.


LP 829_1
H1
1
4
T1
3
2

P.C.B. LP 829

Circuit Diagram



3.15 P.C.B. LP 830 CAN-I/O Card

3.15.1 Circuit Description

- **General Functional Description**

This circuit represents the interface of a CAN bus system to external equipment. The CAN-I/O card consists of the following functional units:
- 80C535 microcontroller with 64-kbyte program memory and CAN interface with PCA82C200
- 8 analog inputs
- 8 digital inputs
- 18 digital outputs
- RS 232 interface

Inputs and outputs are directed to a 96-pin contact strip. The CAN-I/O card requires 2 supply voltages: 5 V–GND for the logic unit and 24 V–0 V for the sensor-actuator unit.

- **Sensor-Actuator Unit**

Input and output lines are divided such that a total of 8 “sensors” can be connected to the card. One sensor receives the following signals:
- 24 V
- 0 V
- 1 analog input
- 2 digital outputs
- 2 joint digital outputs (signals directed to all of the sensors)
- 1 digital input

For example, sensor 0 receives the following signals:
- 24 V, 0 V
- analog input Port AN0
- digital outputs Port 1.0, Port 5.0
- joint digital outputs Port 3.4, Port 3.5
- digital input Port 1.0

Physical coupling to the port pins will be described later.

- **Microcontroller with CAN Interface**

  With its address and data lines, the microcontroller (µC) IC1 (80C535) is connected to a program memory (IC7) and the CAN controller (IC4). The µC is monitored by the watchdog IC2 and, if necessary, reset. It receives its output values (level of digital outputs) via the CAN bus and, upon request, transmits the input values (analog inputs and digital inputs) to the outside via the CAN bus. The digital inputs are read in via port 4, the analog inputs via port AN. The digital outputs are controlled via the ports P1 and P5. The two joint digital outputs are activated by the port pins P3.4 and P3.5. Physical connection to the CAN bus is made via the driver IC5 and the current-compensated inductance coil DR3.

- **Analog Inputs**

  Eight analog inputs are available for measurement of analog signals. An analog input consists of a subtracter circuit with OP (IC9, IC10), an output resistor (R8, R9) and a protective diode (D0 to D7). The subtracter computes the difference between the voltage applied to the positive and that to the negative input (AN_POS 0 – 7 and AN_NEG 0 – 7). The subtracter circuit allows the measurement of analog voltages without reference. The output resistor and the protective diode serve to limit the current of the OP and to limit the voltage applied to the µC in the event of an error. An error is incurred whenever negative voltage is applied to the output of the OP. This would destroy the analog input of the µC. The negative supply voltage for the OPs is delivered by IC3.

- **Digital Inputs**

  Digital signals are read in by the µC via port 4. The µC is DC-decoupled from the sensor via the optocouplers IC18 and IC 19. If an input signal of a sensor E0 – E7 is connected to 0 V, the corresponding diode in the optocoupler emits light and the port pin is pulled to ground (0-signal). If the input is not loaded, the µC detects a 1-signal.

- **Digital Outputs**

  Digital outputs are set by ports 1 and 5. A port signal is amplified via the drivers (IC11 to IC13) and, DC-decoupled via optocouplers (IC14 to IC17), directed to the sensor. A series resistor (R36, R37, R46, R47) is provided for current limitation, so that the output is short-circuit-proof. One signal from port 1 and port 5 is available for each sensor. With a 1-signal at the port pin, a voltage of approx. 24 V is applied to the idle output on the sensor. With a 0-signal at the port pin, the level of the output is not defined (if the output is evaluated, a pull-down resistor is required).

- **Common Digital Outputs**

  Via IC20, the output lines of port 3.4 and port 3.5 are DC-decoupled from the 24-V supply and are amplified by means of T1 and T2. The signal level is fed to each sensor via the resistor networks R22 and R23. If 0 level is applied to P3.4, 0 level is also applied to the sensors.

- **Serial Interface**

  The µC 80C535 is equipped with a serial interface (port 3.0 and port 3.1). By means of the level converter IC6, an RS232 interface is, thus, available (TXD to AX1.29; RXD to X1.A30).

- **IC 6**

  On the CAN-I/O board, IC 6 will not be fitted, but a 560 Ω resistor is soldered between pins 11 and 14.

Fig.: Block Diagram of P.C.B. LP 830

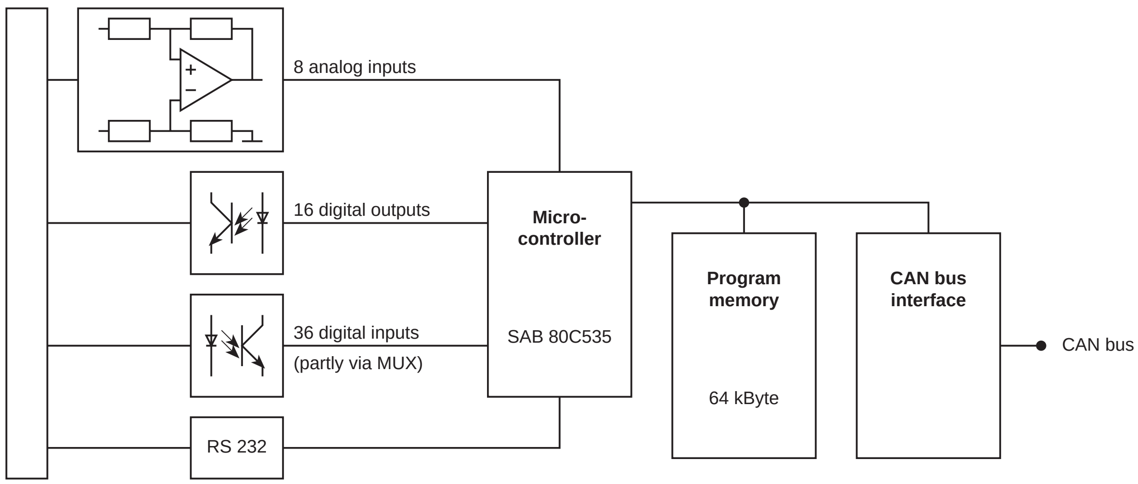


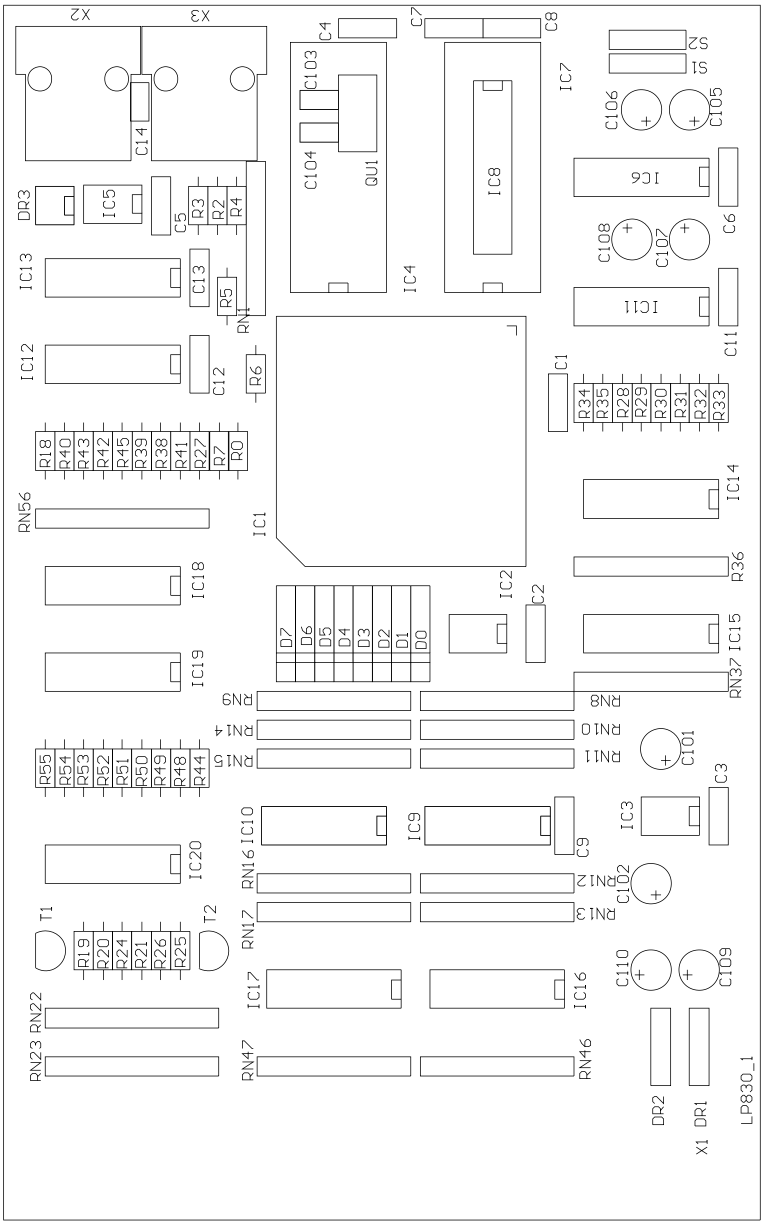
Table: Configuration of Inputs and Outputs of the CAN-I/O 1 P.C.B. LP 830

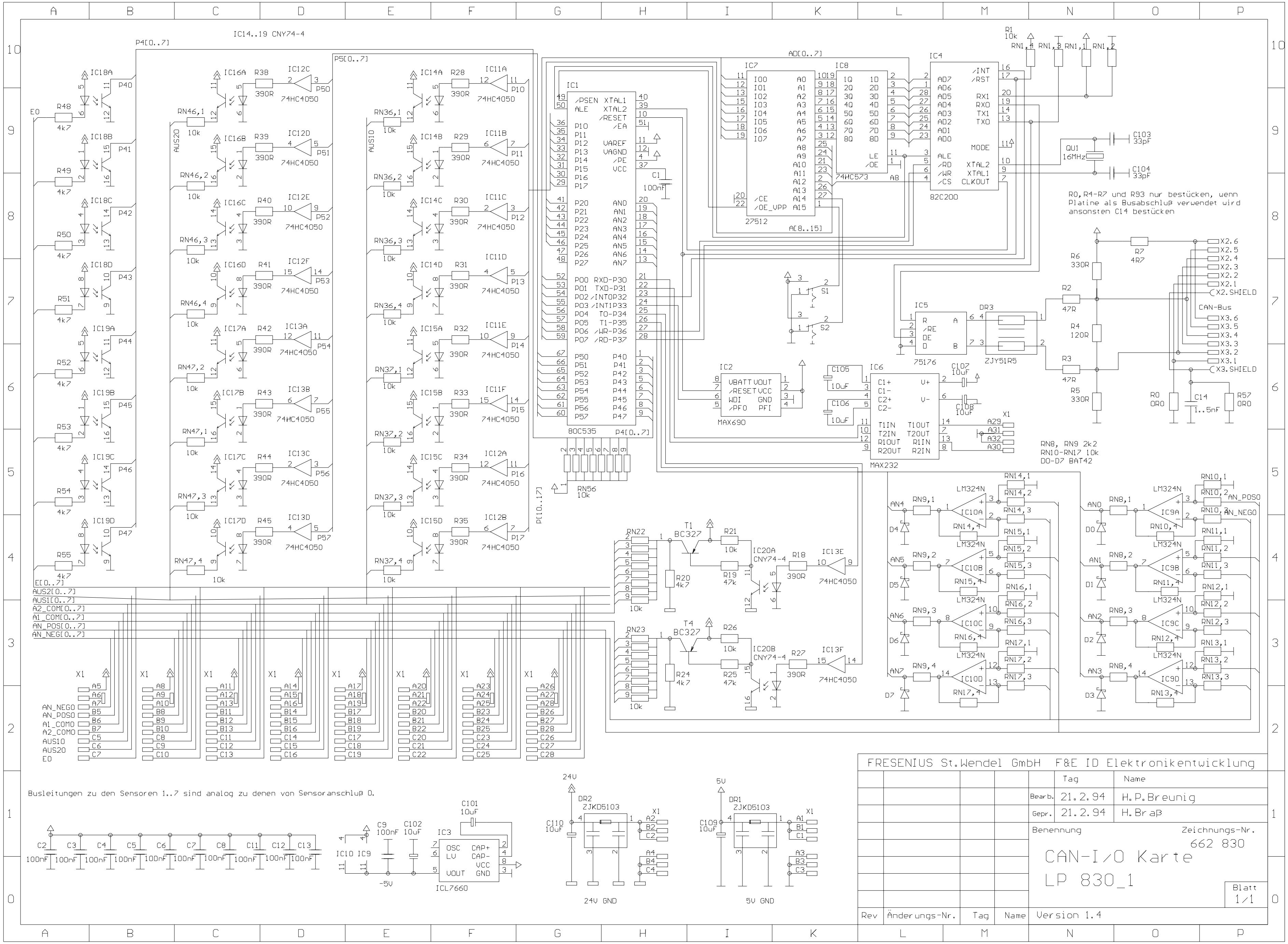
	Analog Inputs	**Digital Inputs**	**Digital Outputs 1**	**Digital Outputs 2**
0	Temperature Centrifuge	n.c.	Return clamp Single Needle	C4 Interface detection
1	Pressure monitor 1 (TMP)	n.c.	n.c.	Chime 1
2	Pressure monitor 2 (On)	Imbalance alarm	Pump Single Needle	Chime 2
3	Pressure monitor 3 (Off)	n.c.	Valve Single Needle	Return clamp open/closed
4	Pressure Single Needle	Multiplex input 1	Multiplex activation C	n.c.
5	n.c.	n.c.	Multiplex activation B	n.c.
6	n.c.	Multiplex input 3	Multiplex activation A	n.c.
7	n.c.	Multiplex input 4	Alarm of microprocessor	n.c.
Joint	n.c.	n.c.	Test alarm TA1 (release of alarm test)	Test alarm TA2 (Clearing of stored alarms)

Overview: Multiplexer Inputs on the CAN-/O 1 P.C.B. LP 830

	0 **Dig. Input**	**1** **Dig. Input**	**2** **Dig. Input**	**3** **Dig. Input**	**4** **Multiplexer**	**5**	**6**	**7**
Channel 0	n.c.	n.c	Alarm Imbalance (on = alarm)	n.c.	n.c.	Alarm LD current (on = alarm)	Optical detector (on = dark)	All Alarms (off = all present)
Channel 1	n.c.	n.c	Alarm Imbalance (on = alarm)	n.c.	n.c.	n.c.	Alarm Hb/Hct (on = alarm)	Brief override (off = override)
Channel 2	n.c.	n.c	Alarm Imbalance (on = alarm)	n.c.	n.c.	n.c.	Alarm Pressure On l (on = alarm)	Prime override (off = override)
Channel 3	n.c.	n.c	Alarm Imbalance (on = alarm)	n.c.	Alarm Replacement fluid (on = alarm)	n.c.	Alarm Pressure Off h (on = alarm)	No alarm (off = alarm-free)
Channel 4	n.c.	n.c	Alarm Imbalance (on = alarm)	n.c.	Mute TO (off = active)	n.c.	Alarm Pressure P3 h (on = alarm)	Alarm LD current (on = alarm)
Channel 5	n.c.	n.c	Alarm Imbalance (on = alarm)	n.c.	Alarm Pressure P3 l (on = alarm)	n.c.	Alarm Blood leak (on = alarm)	Alarm LD stored (on = alarm)
Channel 6	n.c.	n.c	Alarm Imbalance (on = alarm)	n.c.	Alarm Pressure On h (on = alarm)	n.c.	Alarm SR-MC 1 (on = alarm)	Alarm Lower ACD (on = alarm)
Channel 7	n.c.	n.c	Alarm Imbalance (on = alarm)	n.c.	Alarm Pressure Off l (on = alarm)	n.c.	Alarm SR-MC 2 (on = alarm)	n.c.

3.15.2 Circuit and Component Layout Diagram P.C.B. LP 830 CAN-I/O Card




IC14..19 CNY74-4
R0,R4-R7 und R93 nur bestücken, wenn Platine als Busabschluß verwendet wird ansonsten C14 bestücken
RN8, RN9 2k2
RN10-RN17 10k
D0-D7 BAT42
Busleitungen zu den Sensoren 1..7 sind analog zu denen von Sensoranschluß 0.
80C535
27512
74HC573
82C200
75176
MAX690
MAX232
ICL7660
LM324N
74HC4050
CAN-Bus
FRESENIUS St.Wendel GmbH F&E ID Elektronikentwicklung
Tag
Name
Bearb. 21.2.94 H.P.Breunig
Gepr. 21.2.94 H.Braß
Benennung
Zeichnungs-Nr.
662 830
CAN-I/O Karte
LP 830_1
Blatt
1/1
Rev
Änderungs-Nr.
Tag
Name
Version 1.4

P.C.B. LP 830

Circuit Diagram

3.16 P.C.B. LP 840 Alarm System

3.16.1 Circuit Description

- **General Functional Description**

Redundantly to the control processor of the machine, the alarm system processes the alarms relevant for the patients' safety. It allows or inhibits activation of the pumps and the return clamp. The connection of the alarm system to the processor is separated via safety impedances (resistors of 1 mOhm), so that any feedback in case of an error is prevented.

The alarm system is provided with the following alarm inputs:
AD1UA: current lower pressure alarm of pressure channel 1 (cannot be overridden)
AD2OA: current upper pressure alarm of pressure channel 2 (cannot be overridden)
AD3OA: current upper pressure alarm of pressure channel 3 (cannot be overridden)
AMC1A: current alarm of microcontroller 1 of the safety system
AMC2A: current alarm of microcontroller 2 of the safety system
ADEA: current hemolysis alarm (cannot be overridden)
ALD1A: current air alarm from channel 1 of the air detector (can be overridden)
ALD2A: current air alarm from channel 2 of the air detector (can be overridden)

An alarm occurs if low level is applied to the corresponding alarm line. In order that the machine can be started, some of the alarms can be overridden in the system, since upon switchon of the machine alarms are pending, e.g. the air detector alarm. Without the possibility of overriding individual channels, the pending alarms would prevent priming of the line set of the machine with fluid, because the alarm system does not permit the pumps to rotate. This, in turn, would for example cause the air alarm to remain active. Alarms can be overridden only briefly or only during priming of the line set. The decisive outputs of the alarm systems are “pump alarm” and “return clamp closed”. Both lines are inactive as soon as alarms are occurring. This ensures that the pumps of the machine are stopped and the return clamp is closed.

The optical detector, prime and start inputs are used to control the alarm system. A clock pulse signal is applied to the optical detector input, if the optical detector of the return clamp does not recognize any blood in the line set. The prime input is triggered if the machine has the task of priming the line set; and the start input receives a pulse if the treatment is supposed to start or to be continued.

- **Input Circuitry of Alarm Channels and Alarm Memories**

All of the alarm inputs are connected to ground via resistors. Hence, an open input is defined as an evaluated alarm. ICs 5 to 13 operate as alarm memories which are used to store any occurring alarms. The ALD2A alarm does not require any memory since it is already stored in a different place. The protective resistors R36 to R45 protect the inputs of the ICs from overvoltages. The output of each alarm memory is buffered by IC 39 to IC 48. These modules make the driver line required for the following electronics available. All alarm memories can be reset via the corresponding “reset alarm memories” line. This is, however, possible only if the pertinent alarm input is likewise alarm-free.

While the machine is switched on, the gate IC 13D generates an automatic reset; thereafter, it is inactive for the entire operating time.

By means of diode circuits, the alarm inputs listed as being overridable can be overridden by signals generated internally in the alarm system. Should one of these diodes D3 to D12 be short-circuited, the input resistors R41 to R45 prevent the alarm-free inputs from pulling the alarm-carrying inputs to high potential.

- **Alarm Displays**

The light-emitting diodes D31 to D40 indicate absence of an alarm at the corresponding channel. In this case, they emit green light. If an alarm occurs, the LEDs are dark.

- **Fail-Safe Circuit Sections**

Fail-Safe NOR Circuit

Together with the output stage consisting of T1 and T4 as well as the transmitter TR1 and the jumper GL1, the optocoupler chain IC 23 to IC 32 represents a fail-safe logic NOR circuit. At its beginning, the optocoupler chain is supplied with a clock pulse signal by IC4. This clock pulse reaches the transmitter TR1 only if alarm potential (low) is applied to all of the alarm inputs and if the optical detector also carries a low signal (detector dark). In this case, an active signal, which initiates the override condition of the individual alarm channels, appears at the output of the jumper GL1.

Fail-Safe AND Circuit

Together with the output stage consisting of T2 and T3 as well as the transmitter TR2 and the jumper GL2, the optocoupler chain IC 14 to IC 22 represents a fail-safe logic AND circuit. At its beginning, the optocoupler chain is supplied with a clock pulse signal by IC4. This clock pulse reaches the transmitter TR2 only if high potential is applied to all of the alarm inputs. In this case, the output of jumper GL2 becomes active and, via the conductive optocouplers IC 36 and IC 37, allows operation of the pumps and opening of the return clamp. Further safety-relevant components can be looped into the fail-safe AND function via the alarm loop a and alarm loop b lines. In this case, the jumper R56 must be removed.

- **Control Logic**

The “opt. detector” input signal is a pulse-supplied signal which reaches IC 3A via the gate IC 1D. IC 3A represents a retriggerable monostable circuit whose time constant is large, as compared with the duration of the period of the clock pulse signal.

If the pulse is applied – this means that the corresponding detector in the return clamp of the machine recognizes light (no blood) –, low level is permanently applied to connector 7 of IC 3A. This potential is inverted by IC 49A so that the latter’s output 7 is active (high). This potential allows the overriding function so that the machine can be started. Should blood be recognized in the system, the signal permanently turns to low level.

The “start” signal is emitted by the start key of the machine and triggers the monoflop IC 2A via the gate IC 1C. At the output of IC 2A, a short reset pulse appears which resets the alarm memories, unless an alarm is pending. The inverted output of the monoflop acts upon the Reset LD line and clears the external alarm memory of the channel ALD2A. Via the gates IC 1A and IC 1B, the “prime” signal from the prime key of the machine acts upon IC 1C as if the start key had been pressed. i.e. the alarm memories are cleared. In addition however, the monoflop IC 2B is triggered, which becomes active at the output for approx. 5 seconds and suppresses the alarms connected there. The monoflop IC 3B generates a trigger pulse whenever the optical detector changes from dark to light. This pulse acts as if the start key had been pressed.

- **Override logic**

Essentially, the override logic comprises the circuitry around the relay K1. An active signal must be applied to the central contact of the relay alternating switch, in order that the optocouplers IC 36 and IC 37 can be switched on; only then is it possible for the outputs of the alarm system to become alarm-free. During normal, alarm-free operation, the alternating contact is applied to the alarm channel ALD1 which, since being alarm-free, carries high potential. In this condition, the relay K1 is not excited. However, before the machine can enter this operating condition, in which the air detector channel ALD1 becomes alarm-free, the line set of the machine must first be primed with fluid.

To this end, various alarms in the machine must be overridden.

The optical detector can be light only if there is no blood present in the line set of the machine. If this is the case, the central contact of the relay alternating switch carries active potential via the diode D28. It is, thus, possible that the optocouplers IC 36 and IC 37 are switched on.

However, the fail-safe AND circuit must also be active in order that the alarm outputs leading to the pumps and the return clamp can become active (alarm-free). To achieve this, individual alarm channels are overridden via the input circuit described above. High potential is applied to the prime-alarm-override line by means of the optocoupler IC 35; at the alarm memory, this is equal to an alarm-free input signal.

This override condition is possible whenever the optical detector recognizes light, i.e. no blood is present in the line set and the relay K1 has picked up. However, the relay K1 picks up only if the output of the fail-safe NOR circuit becomes active. This is the case only if all alarms are activated at the same time. After the machine has been switched on, all alarms are provoked during a self-test, so that the fail-safe NOR circuit causes the relay K1 to pick up. Thereafter, the relay keeps its state via its alternating contact, until the “opt. detector” light signal is applied. As soon as the optical detector becomes dark, the relay drops, thus terminating the override condition.

- **Multiplexers**

The integrated circuits IC 33 and IC 34 represent 8-to-1 multiplexers, whose outputs are connected to the control computer of the machine via transistors T9 and T10. This allows the alarms and various operating conditions of the alarm card to be read out by the processor. All inputs of the multiplexers are connected to the alarm circuit via protective impedances (1mOhm resistors). In case of an error, this prevents any feedback from the multiplexers to the alarm circuit.

- **Safety Considerations**

The function of the circuit is checked before each treatment. Those parts which are not covered by this test are designed as fail-safe circuits. This concerns the alarm combinations with the fail-safe AND and NOR circuits.

A test ensures that all alarm lines can enter the alarm state and that the optical detector recognizes dark. Only then is it possible to override alarms and is the machine ready for operation.

If it is not possible to initiate the override condition due to a defective alarm line, the line set cannot be primed, since there is at least an air detector alarm which prevents the pumps from starting to run.

The return clamp of the air detector remains closed as long as there is too much air present in the detector chamber. During the priming phase, this air can escape, so that the fluid level in the air detector can be set with the return clamp closed. Thereafter, the redundant alarm channel ALD2A, which acts directly upon the return clamp, releases the clamp for activation. After the priming phase is completed, however not later than when the line set is filled with blood, the microprocessor causes the optical detector to become dark, thus terminating the override condition. The relay RL1 drops, and its changeover contact leaves the override position. If, at this moment, the line set has been correctly primed, there will be no air detector alarm. This allows the inputs of the optocouplers IC 36 and IC 37 to be pulled to high level via D28. If no other alarm is present, the output of the fail-safe AND circuit is active (alarm-free) and the machine is ready for performance of the treatment procedure.

If the relay RL1 did not drop due to a defect, ICs 36 and 37 could not become active since, with the optical detector being dark (blood present in the system), the output of the optical detector is inactive. Any intermediate condition which might, for example, occur due to a contact with all of the three contacts of the changeover switch is excluded by the corresponding design of the relay (restricted contacts).

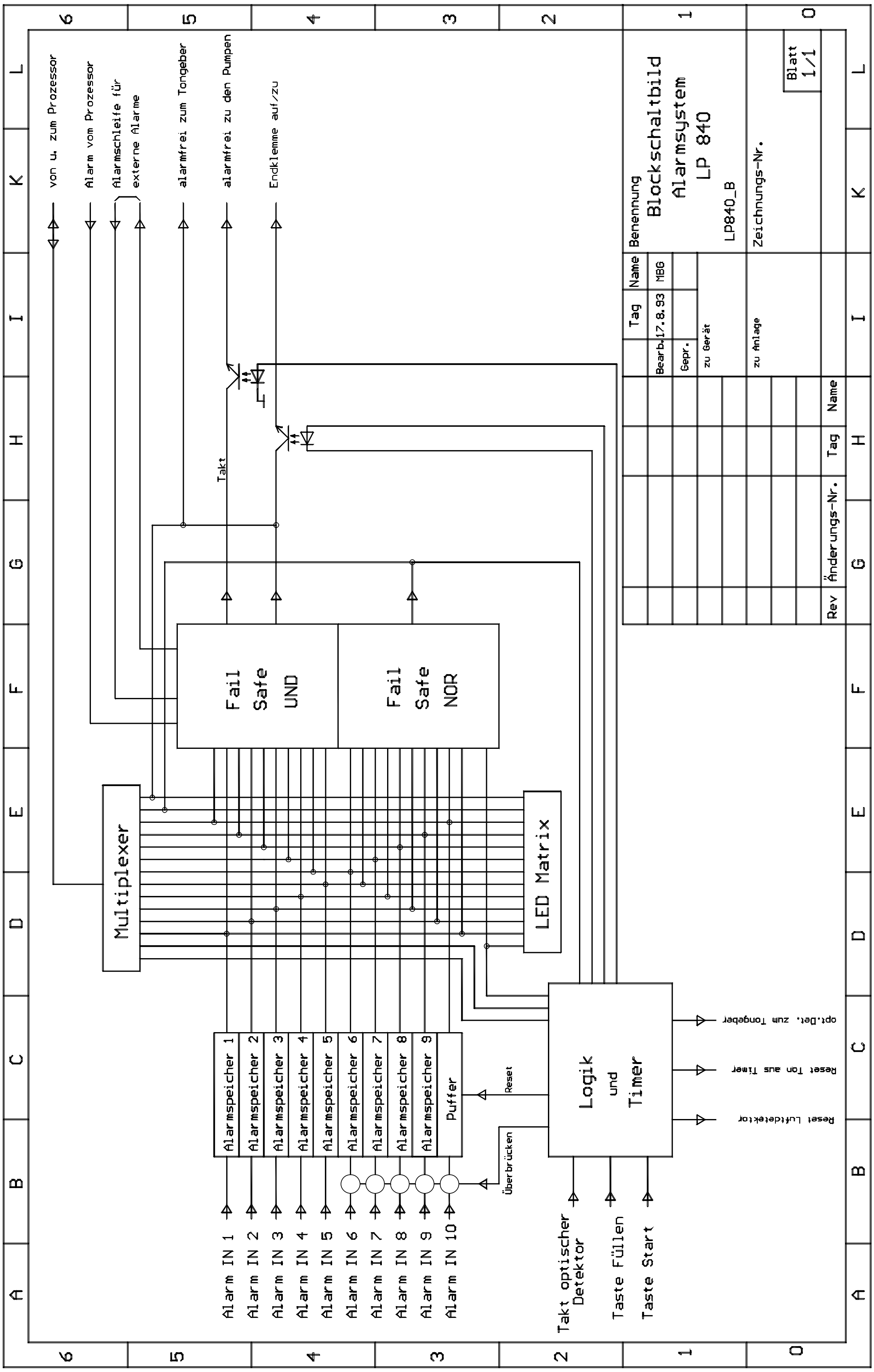
Other disturbances, such as defects of the monoflops IC 2 and IC 3, are detected during the alarm test. This also applies to the alarm tone. In this case, however, the user must make sure that the alarm tone can be heard during the test.

Table: COM.TEC Blood Cell Separator – Course of the Alarm Test Over Time – LEDs on P.C.B. LP 840

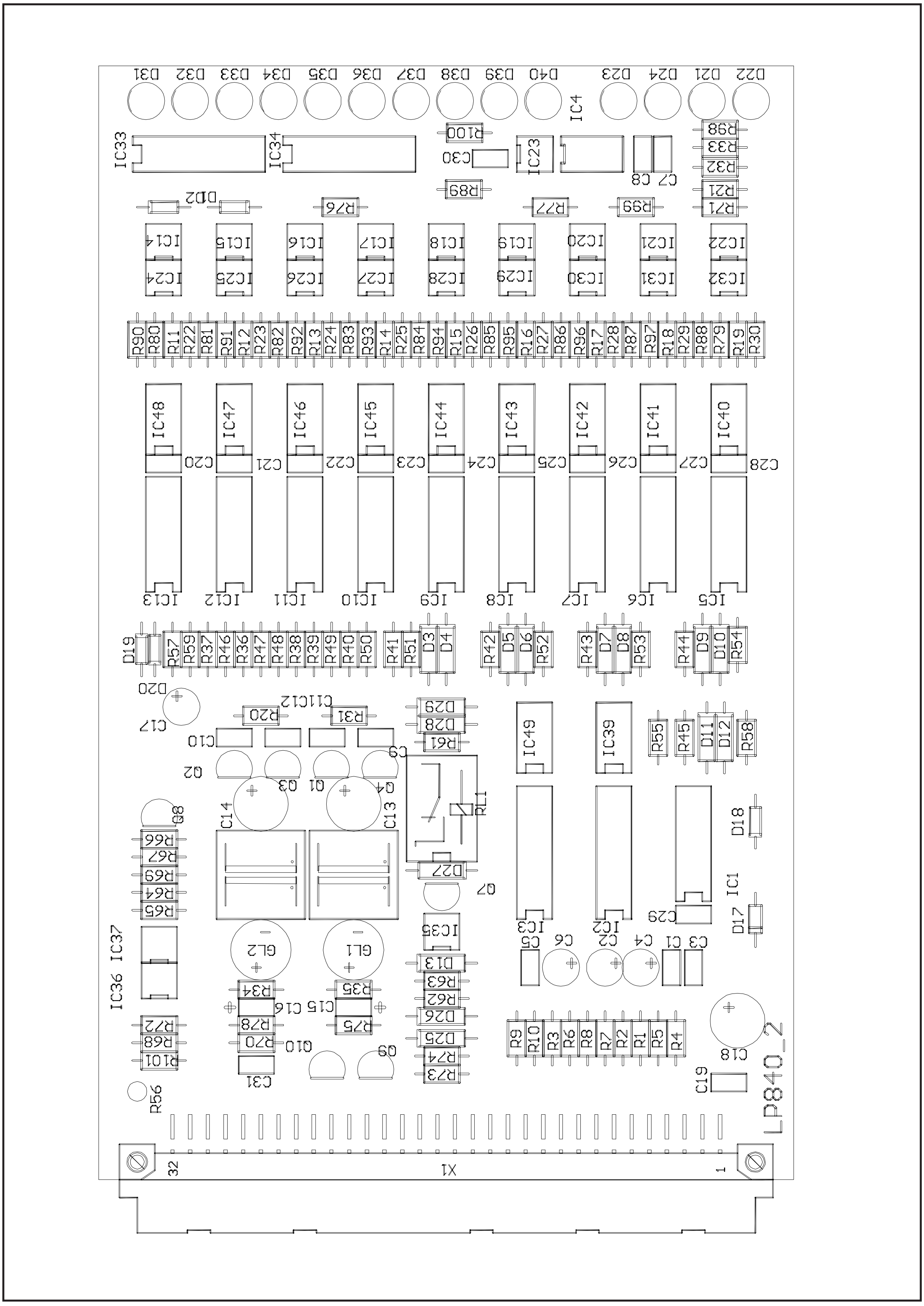
Diode	Interpretation	Condition of Light-Emitting Diodes						
D22	All alarms present	off	off	off	off	off	red	off
D21	Override	off	off	off	off	off	off	red
D24	Optical detector	yellow	off	yellow	yellow	yellow	off	yellow
D25	Alarm-free	off	off	off	off	off	off	green
D40	Air detector alarm, channel 2	off	off	off	off	off	off	green
D39	Air detector alarm, channel 1	off	off	off	off	off	off	green
D38	Alarm Pressure P3 too low	green	green	green	off	off	off	green
D37	Safety system alarm, channel 2	green	green	green	green	off	off	green
D36	Safety system alarm, channel 1	green	green	green	off	off	off	green
D35	Blood leak alarm	green	green	green	off	off	off	green
D34	Alarm Pressure P3 too high	green	green	green	off	off	off	green
D33	Alarm Outlet pressure too high	green	green	green	off	off	off	green
D32	Alarm Inlet pressure too low	green	green	green	off	off	off	green
D31	Hemolysis alarm	green	green	green	off	off	off	green
Time (approx. in seconds)		0	10	13	35	36	37	40

Legend:
○ LED off
◍ yellow LED is lit
◉ green LED is lit
● red LED is lit

Fig.: Block Diagram of P.C.B. LP 840



3.16.2 Circuit and Component Layout Diagram P.C.B. LP 840 Alarm System



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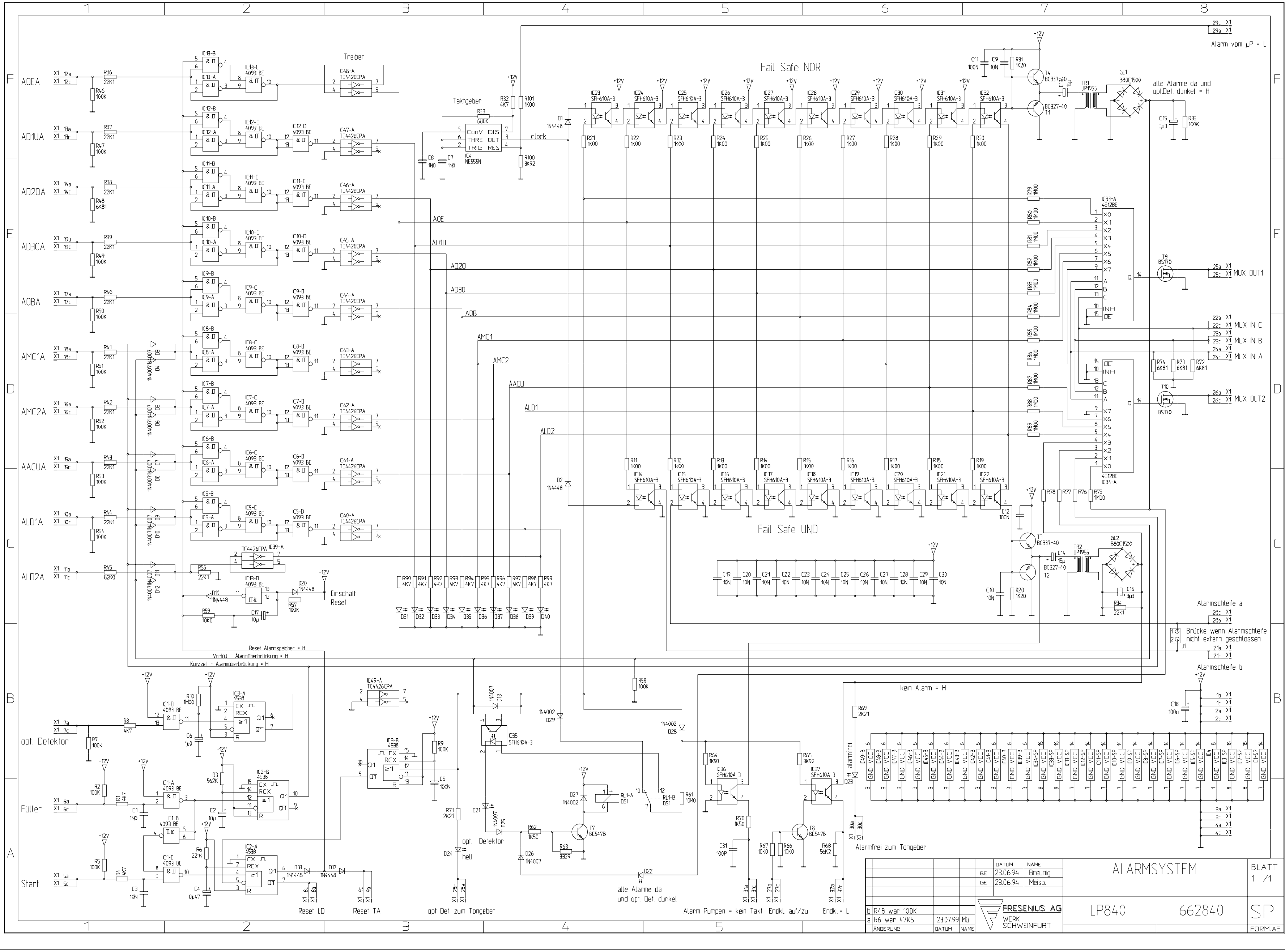
SCHUTZVERMERK NACH DIN 34 BEACHTEN



P.C.B. LP 840

Circuit Diagram

3.17 P.C.B. LP 841 Safety System

3.17.1 Circuit Description

The safety system assembly comprises the printed circuit board LP 841. The two microcontrollers and the remaining electronics of the card are supplied with a 5-V voltage which is generated from the 24-V voltage. As a result, the safety system and the procedure-controlling computer are supplied from two independent voltage sources.

The assembly contains two identical microcontroller units with memory, watchdog and CAN controller. The two microcontrollers are DC-decoupled with the CAN bus via two separate CAN controllers.

The input signals of the hardware alarm system (optical detector and start key) are read without feedback via optocouplers.

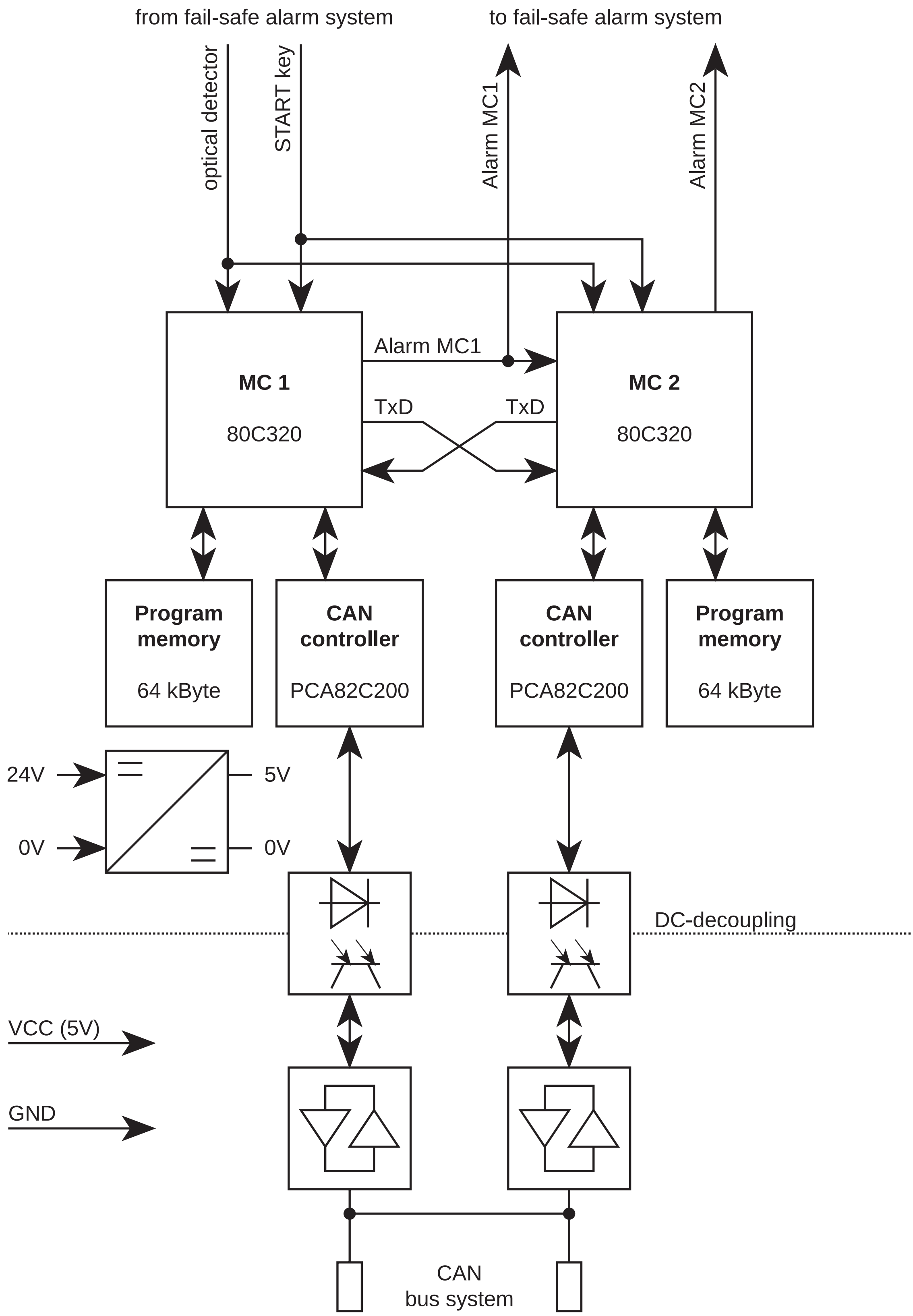
The AMC1 and AMC2 alarm outputs reach the alarm inputs of the hardware alarm system via driver transistors; each alarm output of a microcontroller is checked by the other microcontroller without feedback.

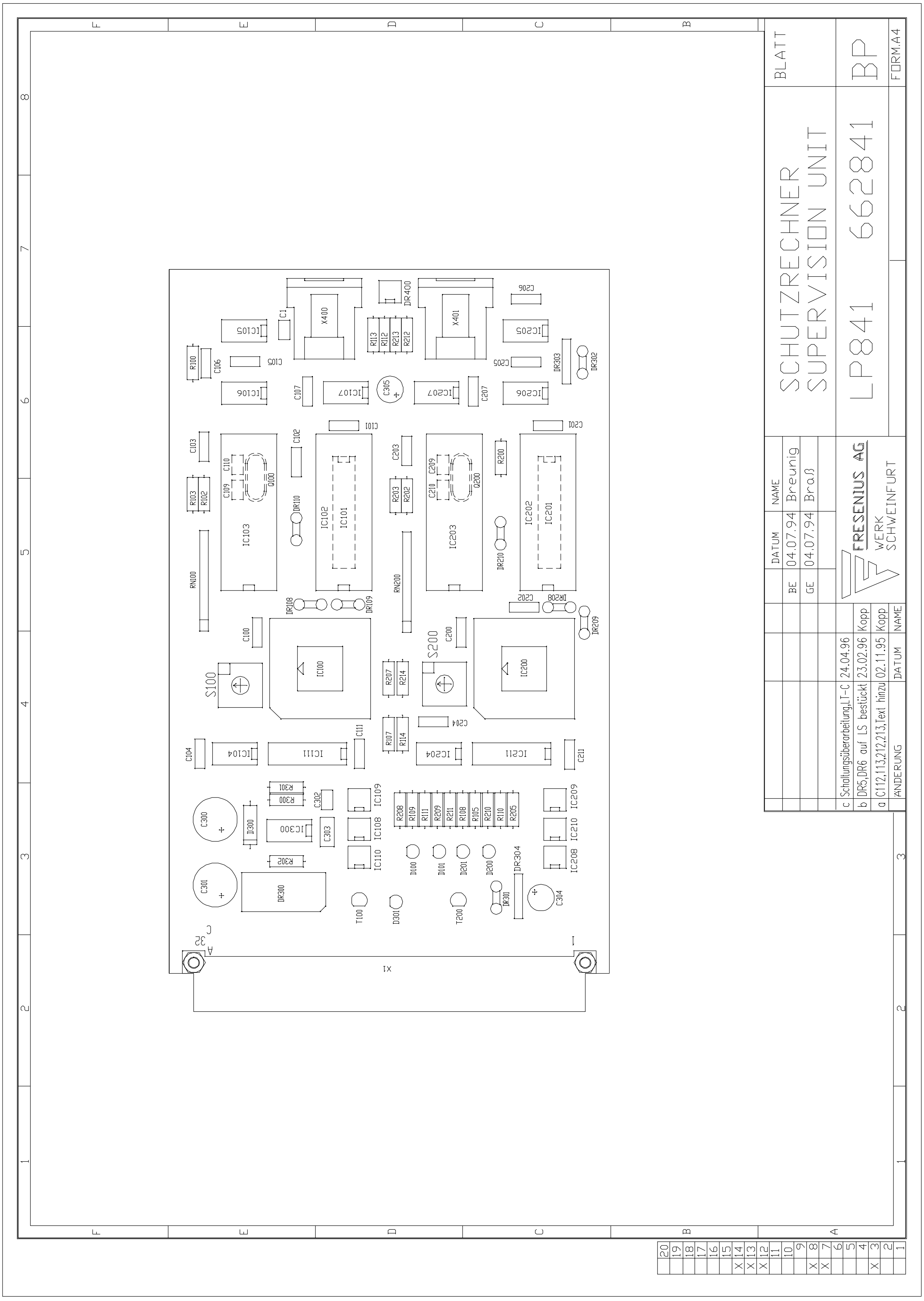
The two controllers communicate with each other via two port lines and the serial interfaces of the microcontrollers.

Table: Alarm Codes of the Safety System

Alarm Codes		Interpretation
First Digit	**Second Digit**	
1 2 4 8 16 32 64 128		Reserve code 0 (unused at the moment) Error of coding switch of safety system ACD flow exceeds 12.5 ml/min Extracorporeal volume exceeds 750 ml Deviation in speed of the PLT pump Deviation in speed of the ACD pump Deviation in speed of the WB pump Deviation in speed of the PLS pump
	1 2 4 8 16 32 64 128	Reserve code 1 (unused at the moment) Clamp pic does not respond No response of microcontroller clamps Incorrect position of spillover clamp Incorrect position of blue saline clamp Incorrect position of red saline clamp Incorrect position of saline diversion clamp Incorrect position of PL clamp

Fig.: Block Diagram of Safety System P.C.B. LP 841




BLATT
SCHUTZRECHNER
SUPERVISION UNIT
LP841 662841
BP
FORM.A4
DATUM
NAME
BE 04.07.94 Breunig
GE 04.07.94 Braß
FRESENIUS AG
WERK SCHWEINFURT
c Schaltungsüberarbeitung,LT-C 24.04.96
b DR5,DR6 auf LS bestückt 23.02.96 Kopp
a C112,113,212,213,Text hinzu 02.11.95 Kopp
ÄNDERUNG DATUM NAME
S100
S200
X1

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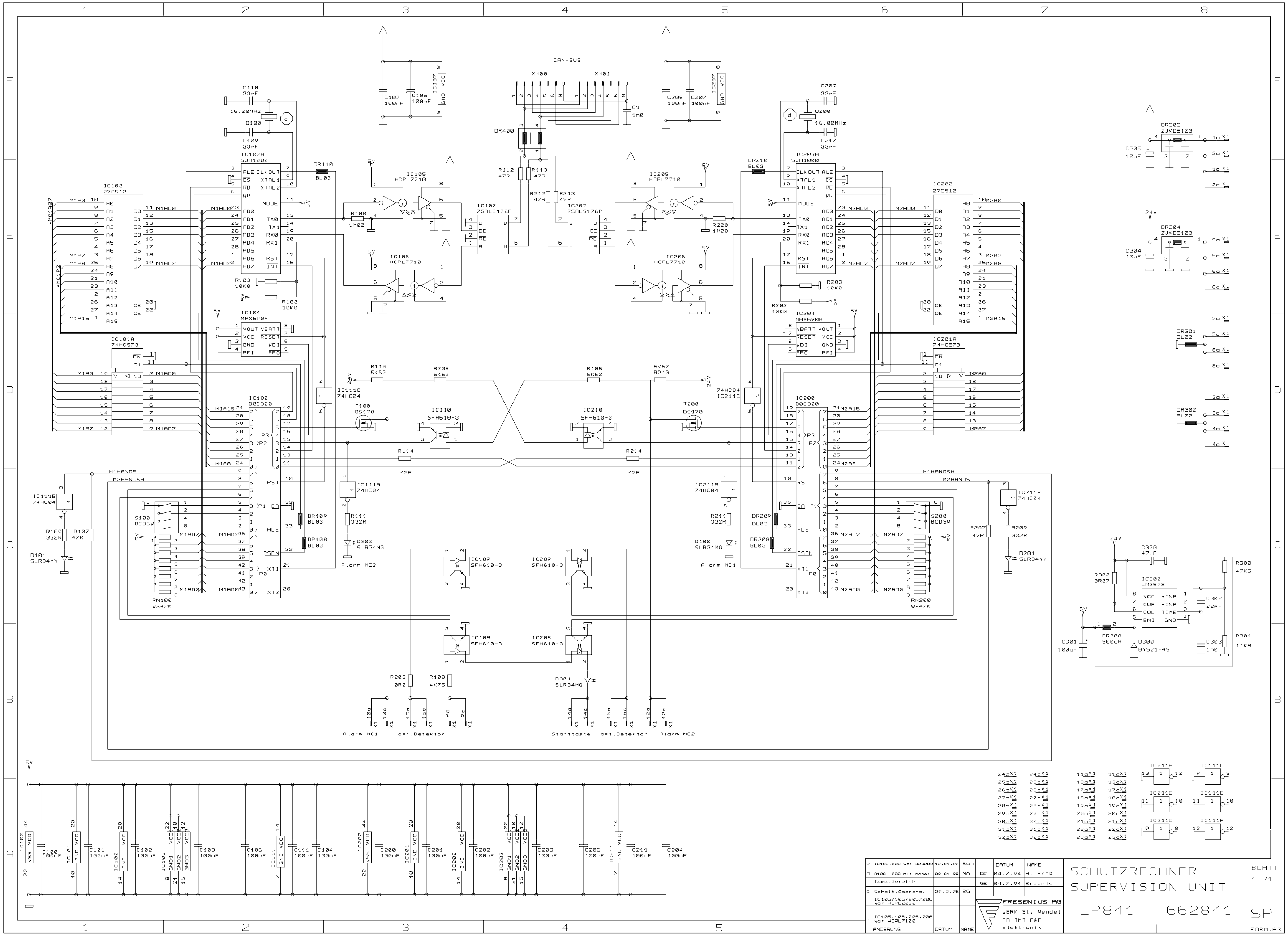


P.C.B. LP 841

Circuit Diagram

3.18 P.C.B LP 852 Pump Control

3.18.1 Circuit Description

- **General Functional Description**

The main task of the logic unit P.C.B. LP 852 is that of generating PWM and other control signals for the microstep operation of a two-phase stepper motor. The rated speed value is specified optionally via the CAN bus or an analog signal.

The P.C.B. LP 852 assembly comprises the 87C592 microcontroller with integrated CAN interface and a few logic circuits. The following interfaces are available:

– Voltage supply (X1)
– CAN bus (X2, X3)
– Generator for rotor pulses (X4)
– Switch for pump cover (X5)
– Motor windings (X6)
– Specification of rated analog value (XX4 – XX6)

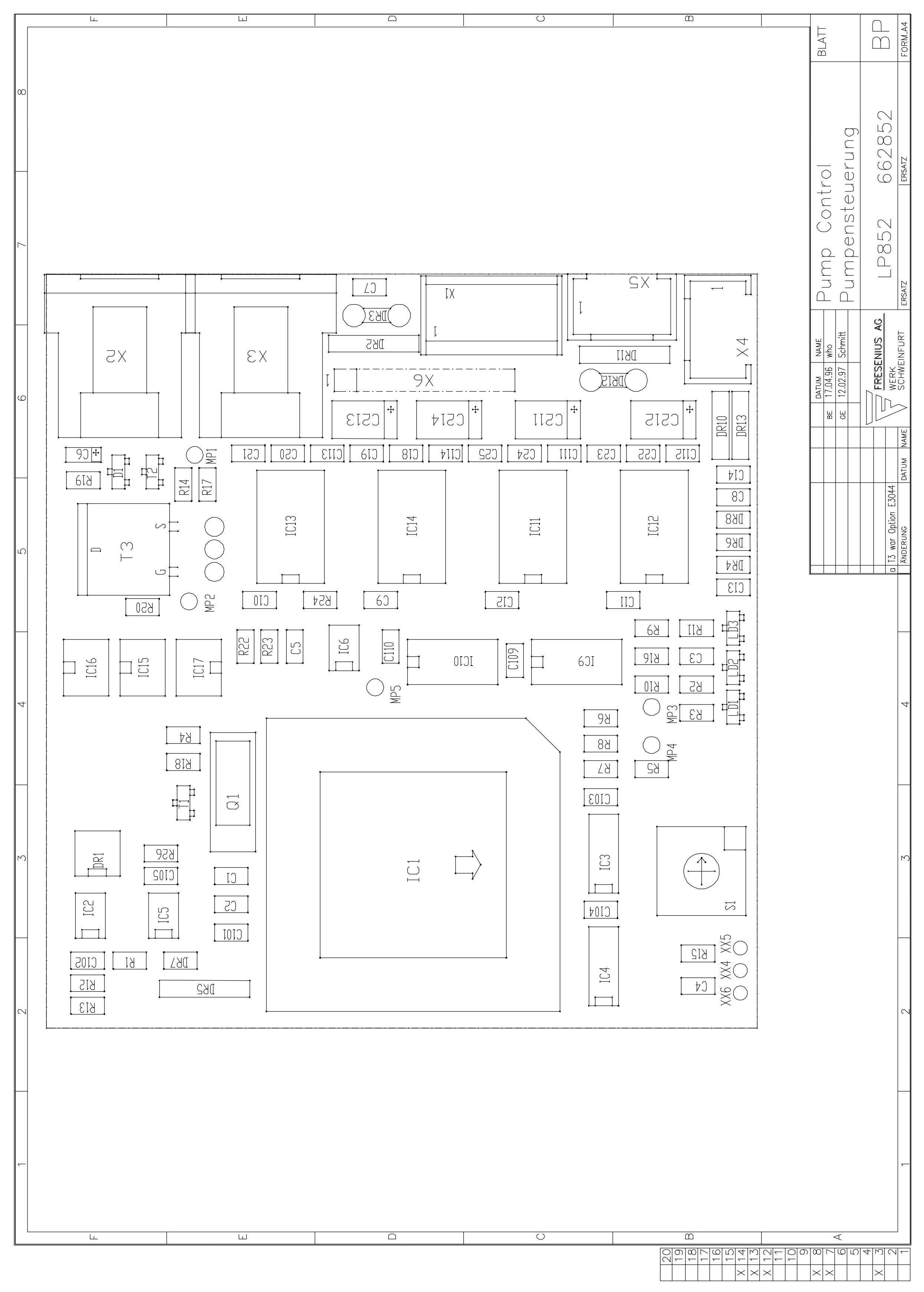
- **Function**

With the rotary switch in position 0...E, the microcontroller (IC1) receives the rated speed value via the CAN bus; with the switch in position F, the analog input 0 is inquired. The microcontroller generates two PWM signals, with the instantaneous values of the pulse duty factor corresponding to two sine-wave functions shifted by 90 degrees. The frequency of these sine-wave functions is specified by the rated speed value and their amplitude is a linear function of the frequency, so that a constant current flow can be achieved, independent of the inductivity of the motor windings. Simultaneously, the controller generates four control signals for the full bridges (IC11..IC14) provided on the power unit, with the direction of current flow being specified by the motor. The logic circuits link the bridge control signals with the PWM signals, in order to assign the latter to the current branch of the bridge. The PWM signals are decoupled by the controller and fed to the full bridge. The linear controller IC6 generates the auxiliary supply for the optocouplers.

In addition, the microcontroller fulfills several monitoring and controlling functions. Except during loading operation (i.e. increased current and limitation to no more than one revolution), the pump motor is stopped with open pump cover as well as in case of an error. In case of operation via the CAN bus, the rated speed values must be transmitted at regular intervals, in order to monitor the operability of the bus; otherwise, the watchdog module (IC5) is no longer triggered and the hardware would be reset. In addition, the controller monitors the number of the steps having occurred between two rotor pulses, so that any blocking of the drive can be detected. The accumulated revolutions of the rotor can be requested via the CAN bus.

A current limiter implemented directly after the supply plug, limits the motor current. During normal operation TEMPFET T3 is switched on a via IC5 and R20. Above the max-level, a proprtional voltage drop occurs at R14 and R17, T2 conducts and the output current is reduced. In this event the temperature of T3 rises until its cutoff temperature is attained.

3.18.2 Circuit and Component Layout Diagram P.C.B. LP 852 Pump Control



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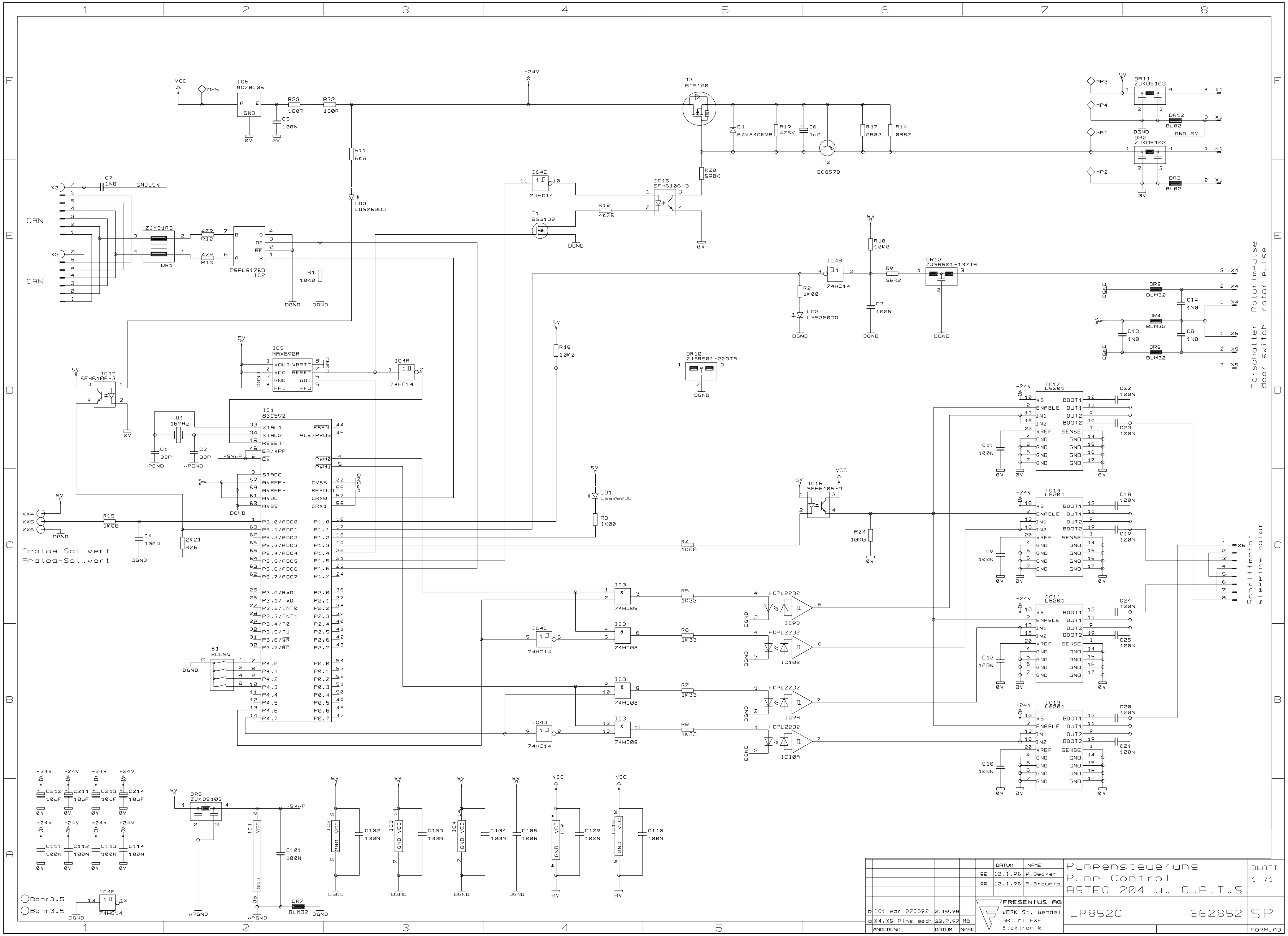


P.C.B. LP 852

Circuit Diagram

3.19 P.C.B. LP 854 Centrifuge Control Logic

3.19.1 Circuit Description

- **Design and Purpose**

The function of the Centrifuge Control Logic LP854 is to generate a PWM and other control signal for the centrifuge control LP 855.
The setpoint value for the speed is optionally preset via the CAN bus or an analog signal.

The LP854 board assembly is comprised of the microcontroller 87C592 with integrated CAN interface. The following interfaces are available:
Voltage supply and control signals for PCB LP855 (X1)
CAN bus (X2, X3)
Serial interface (X5)
Analog setpoint value (X4)

- **Function**

With the rotary switch in position 0-D, setpoint and actual values are sent via the CAN bus (CAN operation) to the microcontroller (IC1). If the rotary switch is set to position F, the setpoint value will be derived from the level of the input voltage at the analog input 0 (control operation)

- **CAN Operation**

The microcontroller comprises a software controller and generates a PWM signal (X1.4) to provide a manipulated variable for the power unit, where it is converted into a variable DC voltage. Apart from this signal it generates a control signal to actuate the electromechanical brake (X1.10) and reads the temperature of the power transistors at the analog input 1. During CAN bus operation setpoint and actual speed values to monitor the bus must be sent regularly to prevent the watchdog chip (IC3) from initiating a reset.

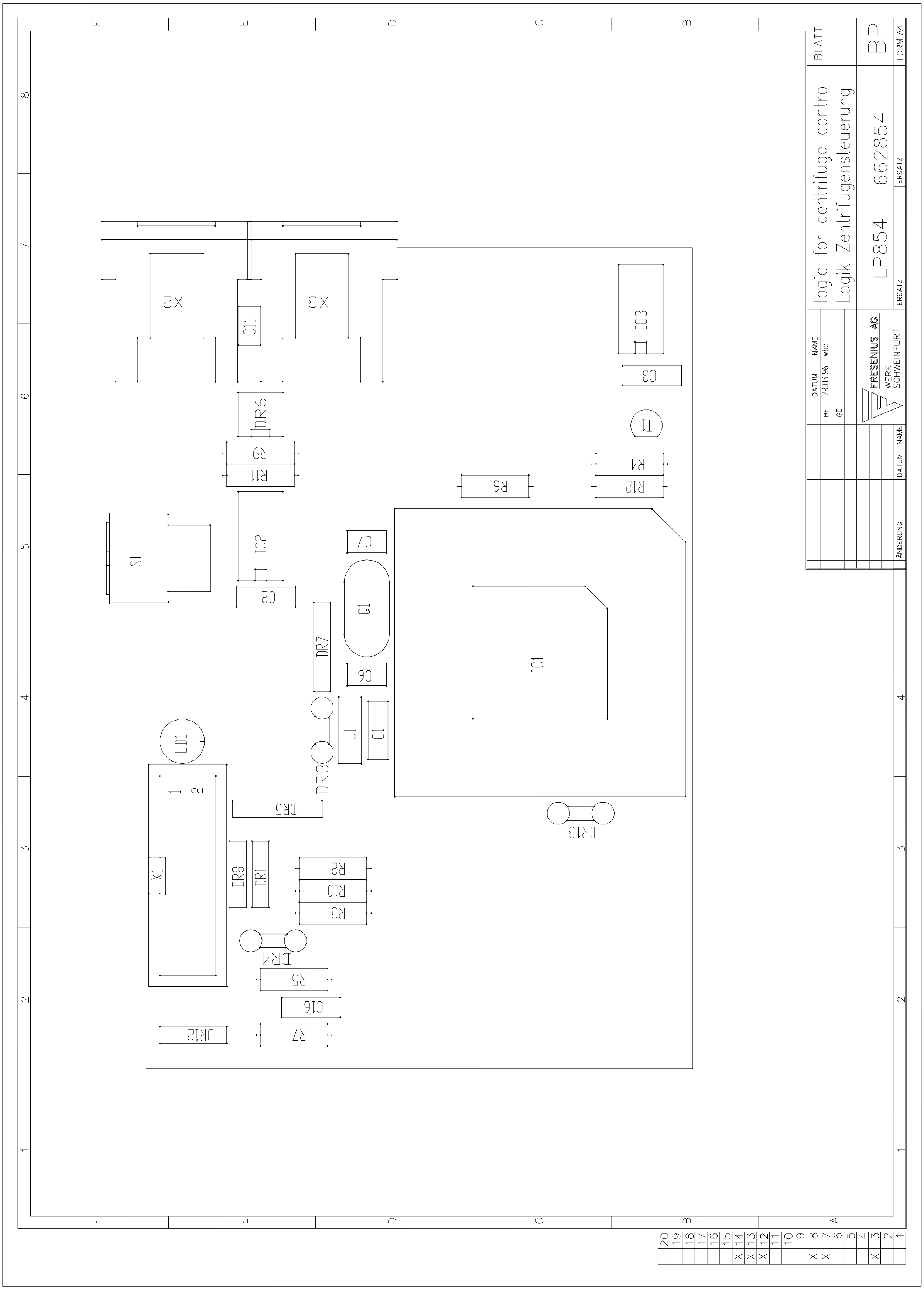
- **Control operation**

A proportional signal is generated from the value of the voltage present at the analog input (X4). 0V corresponds to a pulse duty factor of 0% and 2.5V to 100 %. If the voltage is above 2.5V, the signal is generated for electromagnetic braking.

The serial interface (IC5) and the EEPROM (IC4) are optional and are not used for the centrifuge control function.

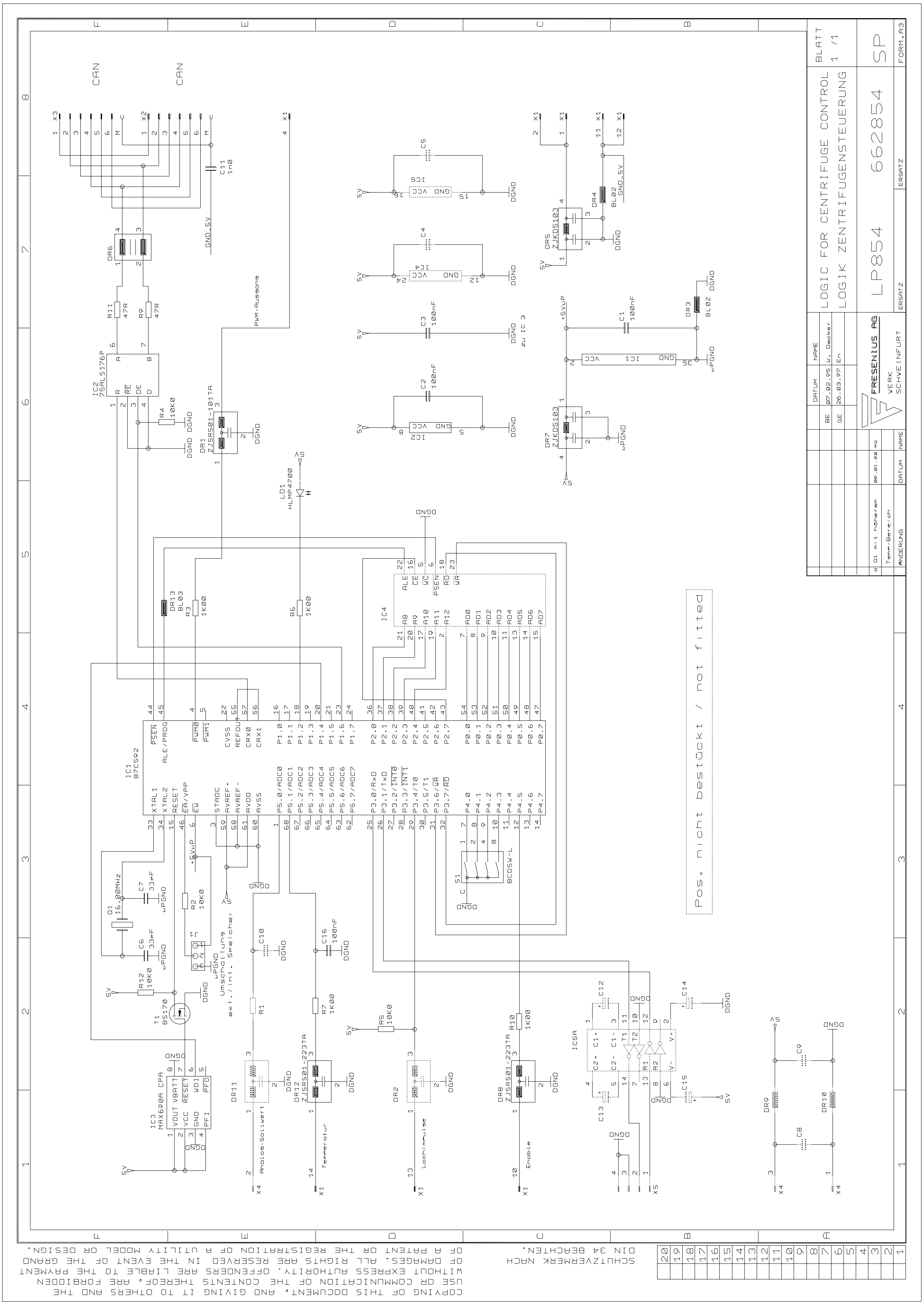
P.C.B. LP 854

Component Layout Diagram



P.C.B. LP 854

Circuit Diagram



3.20 P.C.B. LP 855 Centrifuge Control

3.20.1 Circuit Description

- **General Functional Description**

The P.C.B. LP 855 comprises the power unit for driving and stopping the centrifuge motor, a trigger circuit for detecting the actual speed by means of an optical sensor, and a temperature monitoring unit for the output stages. In addition, the requisite operating voltages, which are lower than the fed supply voltage, are generated.

- **Operating Voltage Generation**

A voltage of approx. 13.5 V and 5 V is required from the fed supply voltage. The circuit comprising the zener diode D1 and the transistor T1 generates the 13.5-V voltage, which supplies the corresponding circuit parts and the voltage regulator IC 1. At its output, IC 1 delivers the +5-V voltage.

- **Trigger Circuit and Temperature Monitoring Unit**

The comparator IC 5B is connected as Schmitt trigger. It converts the signals coming from the optical sensor via X4 to rectangular voltages, which are fed to the controller via X3. The comparator IC 5A is also designed as trigger circuit, which compares a preset reference voltage applied to pin 3 with the temperature-proportional voltage applied to pin 2, and switches off the power units if these are overheating. Switch-off is effected by IC 4 and IC 2. IC 6, whose output voltage reaches the controller via X3, is provided as temperature sensor. These circuit parts are supplied with a +5-V voltage, which is not generated on the board itself. It also supplies the controller with voltage and is conducted via X3.

- **Drive**

The motor voltage of the centrifuge motor is generated by means of a switching regulator, which receives a pulse-width-modulated activation signal from the controller via the optocoupler CI 3 G2. The driver capacity required for switching the MOS-FET T2 is made available by IC 2 for the PWM signal. With T2 being switched on, the motor current flows across the resistors R4 and R5 and generates a voltage drop, which is conducted to IC 2 by the divider and lowpass filter R6, R7 and C10. As soon as a current limit determined by the resistors R4 to R7 and by a reference voltage present in IC 2 is exceeded, the transistor T2 is switched off by IC 2. After T2 has been switched off, the motor current, which has also flown through the inductance coil L1, continues to flow across D9 and the motor. Due to the serial inductance coil L1, the ripple content of the motor current remains low and is, in addition, smoothed by the capacitors C8 and C9. The motor voltage is directly proportional to the supply voltage and the pulse duty factor of the PWM signal. The capacitors C11, C12, C13, and C18 are provided for interference suppression.

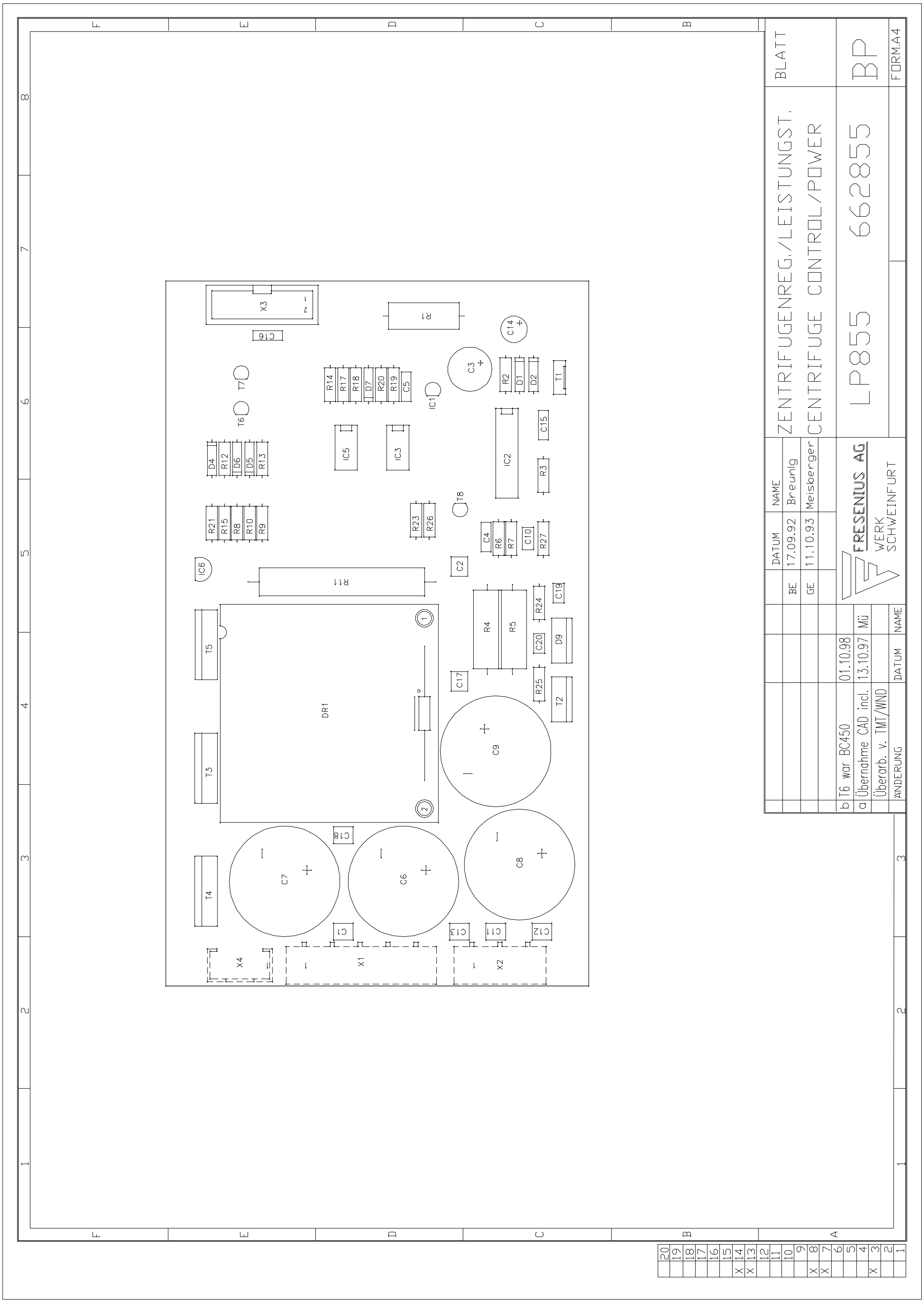
- **Decelerating Electronics**

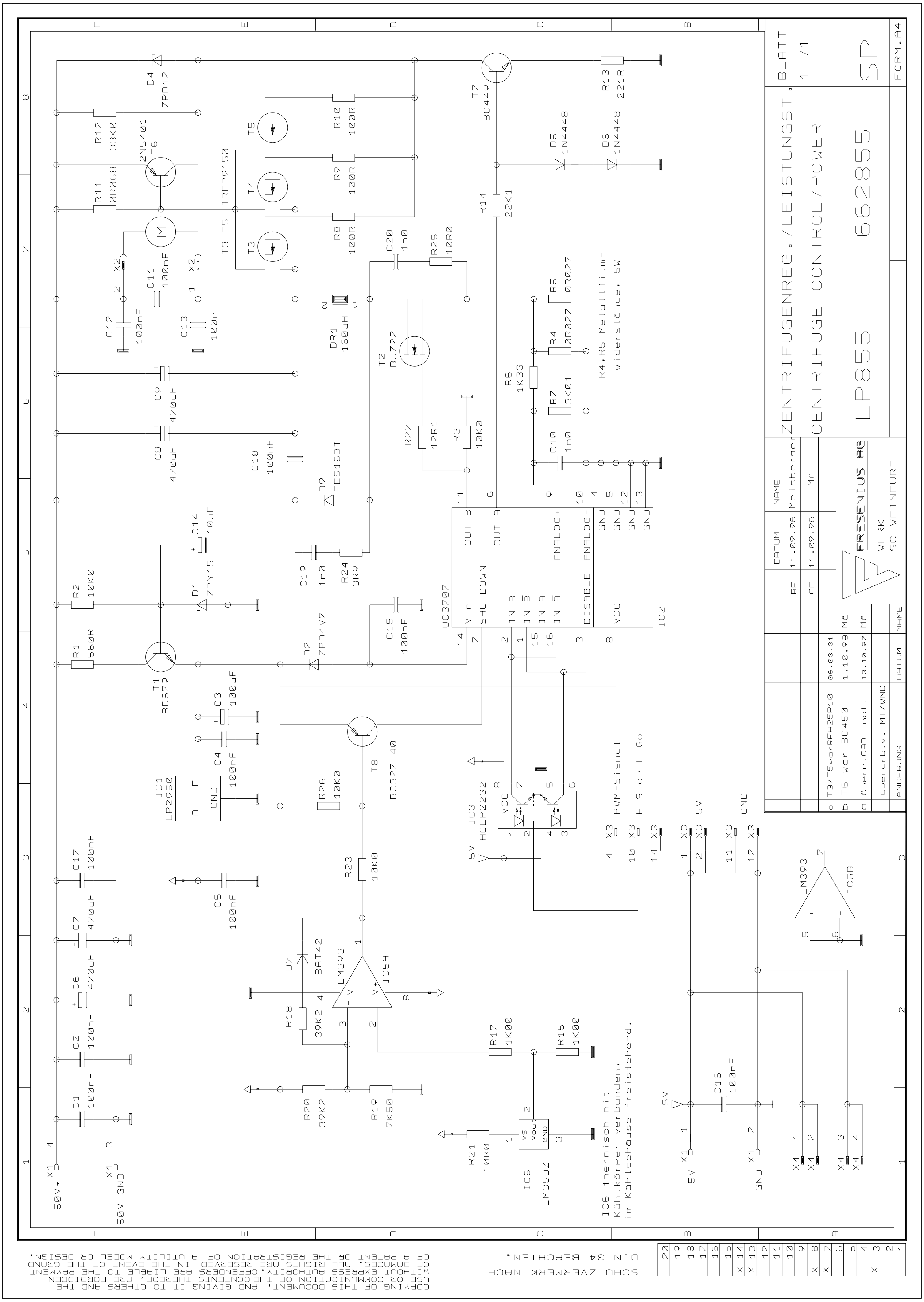
The centrifuge motor is decelerated via a deceleration electronics circuit, in order to be quickly stopped. If IC 2 is switched to the deceleration operating mode by the optocoupler CI 3 G1, the transistor T2 inhibits on the drive side, and the transistor T7 is switched on. T7 operates as current source, which impresses a fixed current in the collector of T7. This current, in turn, generates a voltage drop at R12, thus switching on the FETs T3, T4 and T5. D4 limits the voltage value to permissible gate voltages of the FETs. Driven by the e.m.f. of the centrifuge motor, a current flows through the motor, R11 and the FETs, thus decelerating the motor. Should this current become so high that the voltage drop at R11 exceeds the threshold voltage of T6, T6 becomes conductive and assumes activation from the FETs. Thus, the circuit operates as constant current brake.

3.20.2 Circuit and Component Layout Diagram P.C.B. LP 855 Centrifuge Control

P.C.B. LP 855

Component Layout Diagram





ZENTRIFUGENREG./LEISTUNGST.
CENTRIFUGE CONTROL/POWER
LP855
662855
FRESENIUS AG
WERK SCHWEINFURT

3.21 P.C.B. LP 857 Supply Voltage

3.21.1 Circuit Description

- **Design and Purpose**

The circuit comprises the following functional units:
– Switching regulator 24V/3A, max. 4.5 A
– Switching regulator 5V/4A max. 5A
– Power failure detector

- **24V Switching Regulator**

The AC voltage for the generation of the stabilized 24V is connected across X1.1 and X1.2 to LP857. It is rectified (GL1), filtered (C1 -C4, DR3) and smoothed (C7, C8). The switching regulator IC1 generates a PWM signal which is smoothed by D1, DR4 and C11. The output voltage is 24.3 V (+/- 4 %) and is determined by R6 and R7. R4 limits the maximum switched current of the regulator to 5.5A.
R5 limits the maximum output current to 4.5A.
A voltage monitoring chip (IC2) is connected to the output of the regulator. In the event of overvoltage (U>29.5V) IC1 activates thyristor T1, which shorts the input voltage of the regulator and trips the fuse F1.
Diode D3 prevents the input voltage of the reguator from dropping in excess of the permissible tolerance as opposed to the output voltage during battery operation (battery at regulator output).

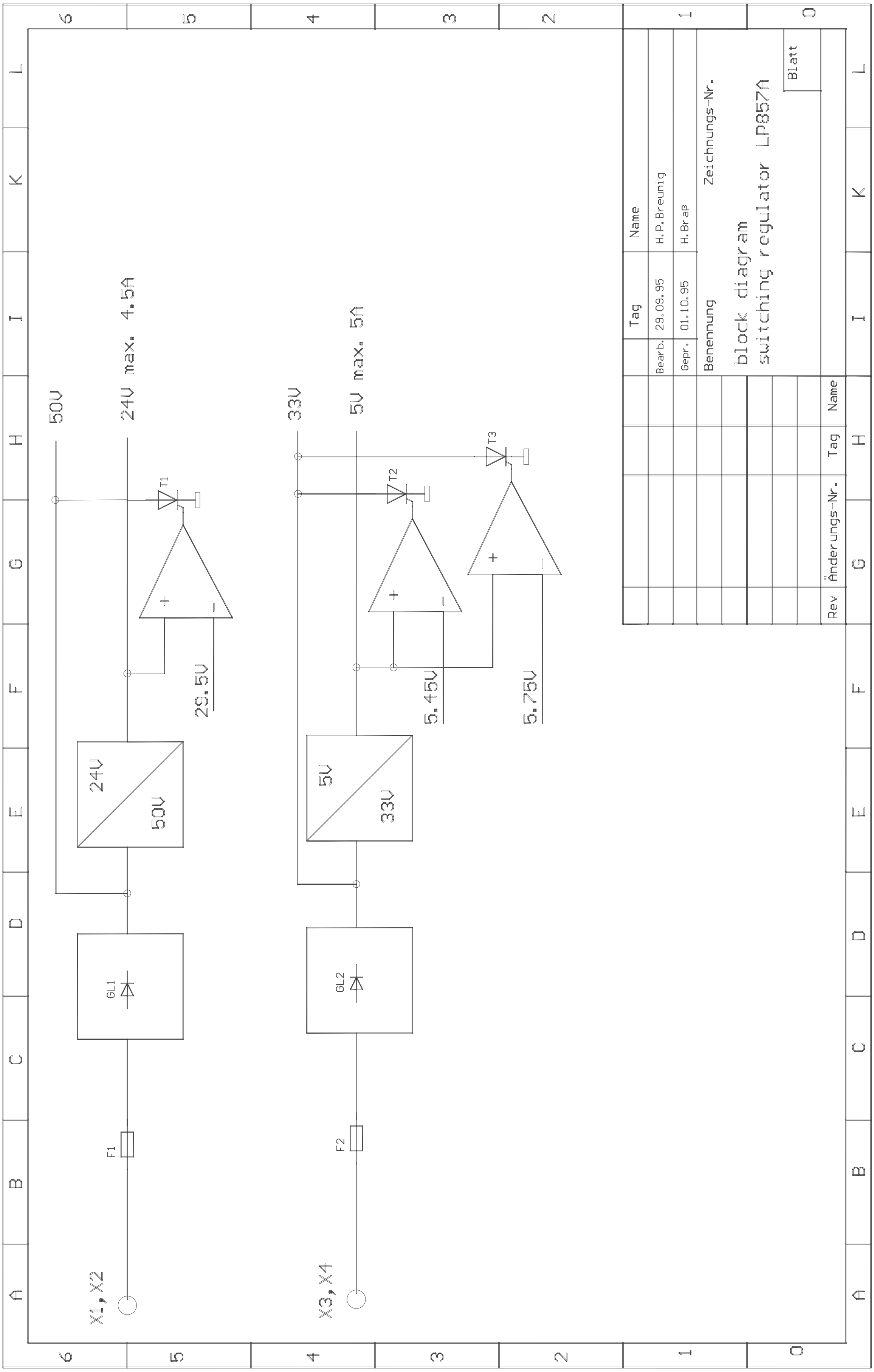
- **5V Switching Regulator**

  The AC voltage for the generation of the stabilized 5V is connected across X1.3 and X14 to LP857. It is rectified (GL2), filtered (C15..C18,Dr8) and smoothed (C21..C22). The switching regulator IC3 generates A PWM signal which is smoothed by D4, DR9 and DC25. The output voltage is 5.22V (+/- 2%)and is determined by R15 and R16. R13 limits the maximum switched current ot the regulator to 5.5A.
  R14 limits the maximum output current to 5A.
  Two voltage monitoring chips (IC4,IC5) are connected to the output of the regulator. In the event of overvoltage (U>5.45 for 1.25 ms and U>5.75 for 125 s, IC4 and IC5 activate the thyristors T2 and T3, which short the input voltage of the regulator and trip the fuse F2.
  This circuitry is provided twice to satisfy the requirements.

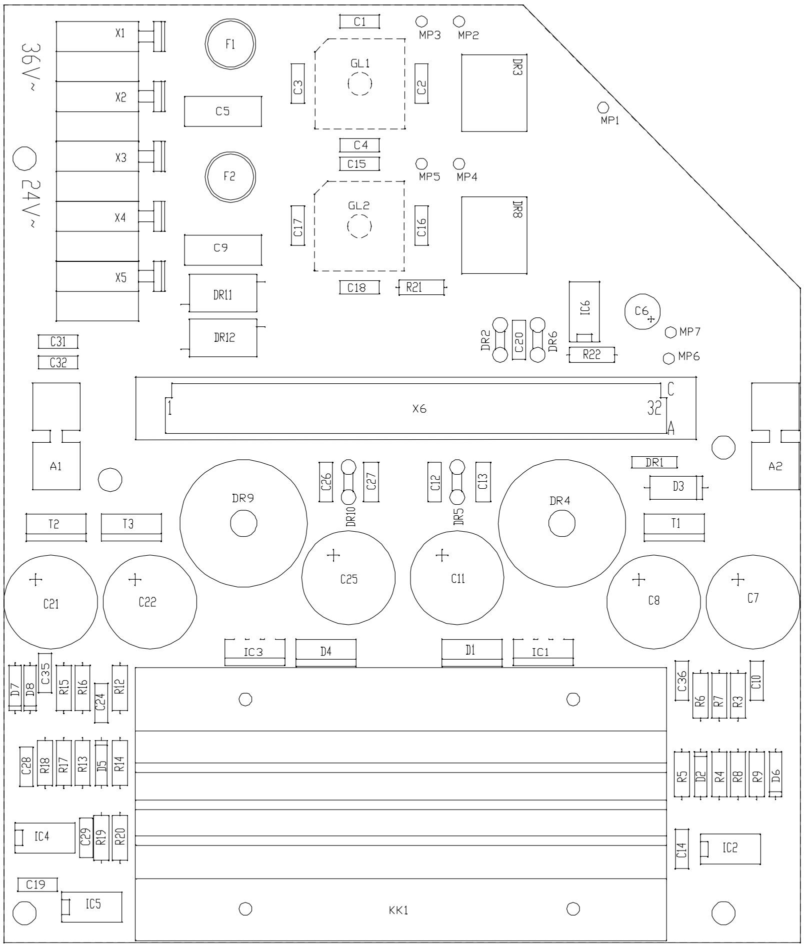
- **Power Failure Detector**

  IC6 detects missing half-waves in the AC supply. A signal is generated at IC6.6 after each missing half-wave (10 ms) which indicates a power failure.

Fig.: Block Diagram of P.C.B. LP 857 Supply Voltage



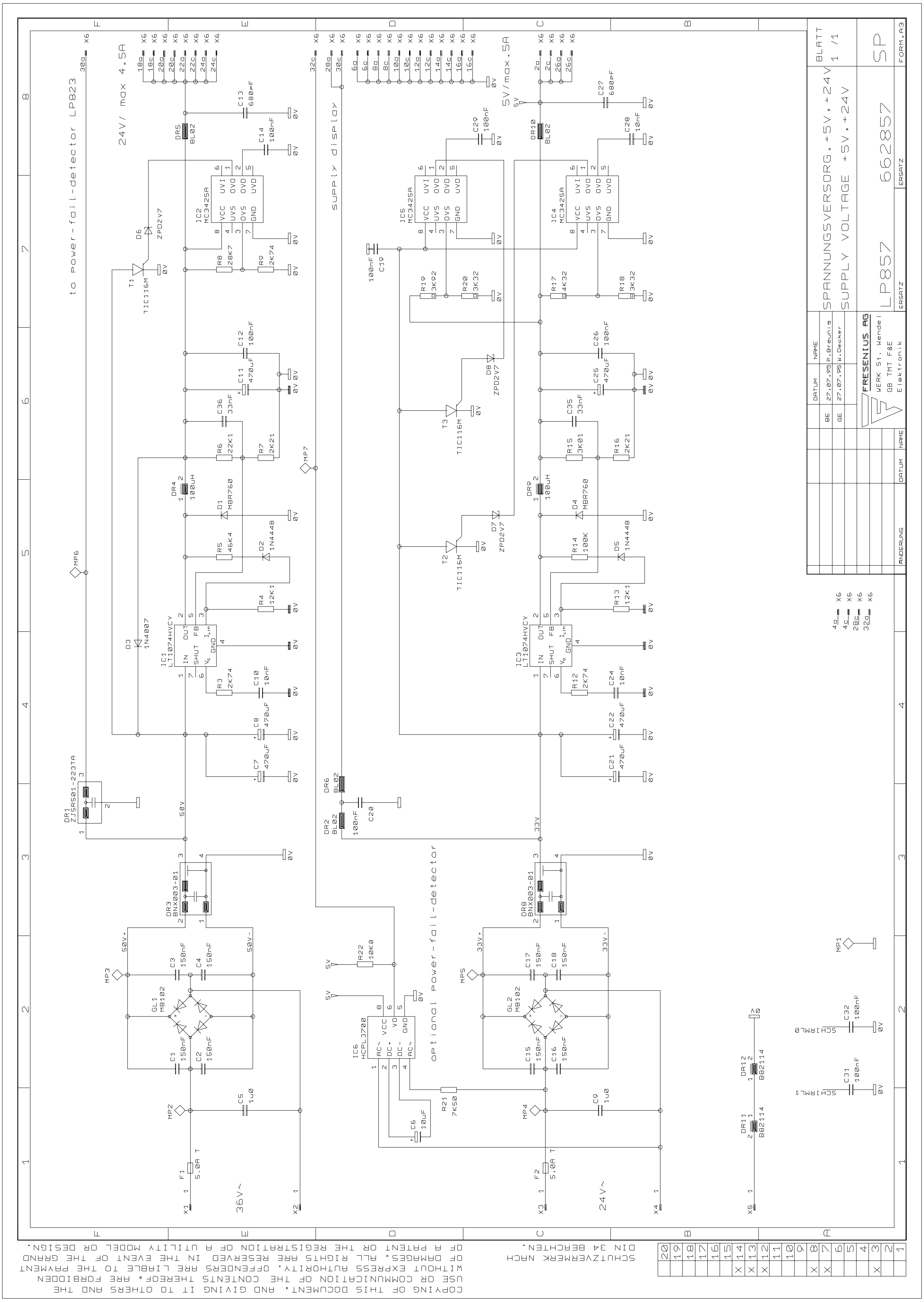
3.21.2 Circuit and Component Layout Diagram P.C.B. LP 857 Supply Voltage



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

				DATUM	NAME		
			BE	10.04.96	who	Spannungsversorgung SUPPLY VOLTAGE	BLATT
			GE				
			FRESENIUS AG WERK SCHWEINFURT			LP857 662857	BP
ÄNDERUNG	DATUM	NAME				ERSATZ / ERSATZ	FORM.A4

P.C.B. LP 857
Circuit Diagram



3.22 P.C.B. LP 860 Camera Logic

3.22.1 Circuit Description

- **General Functional Description**

The P.C.B. LP 860 assembly serves to detect and control the position of the media in the separation chamber.

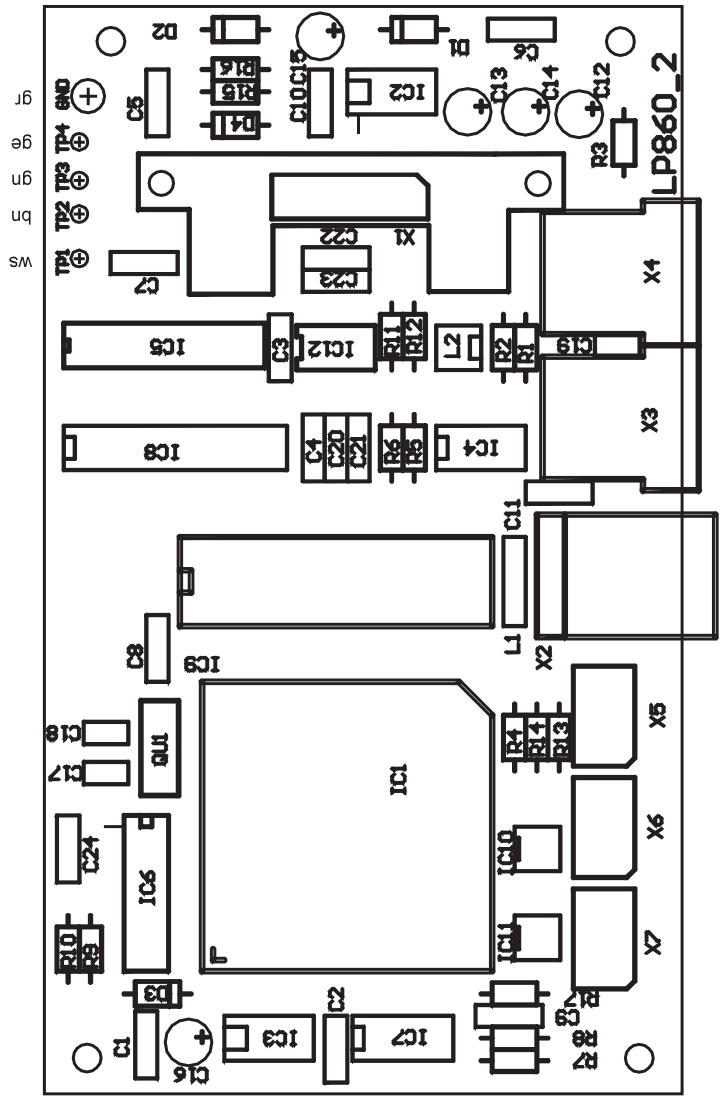
The P.C.B. LP 860 comprises the following circuit parts:
– microcontroller (87C592) with CAN interface and watchdog module
– RISC controller (16C56) for energizing the CCD sensor
– A-D converter (MAX 150) and RISC controller (16C57) for signal processing of the CCD sensor signal
– lighting control
– 9-V voltage converter

Control of the CCD camera and communication via the CAN bus is realized by the microcontroller IC1 (87C592). The CCD camera is connected to the two RISC controllers IC5 and IC9 via the ports 2, 4 and 1. It is coupled to the CAN bus via the driver IC1. The oscillator frequency (16 MHz) reaches the RISC controllers IC5 and IC9 via the gates IC6E and IC6F.

The RISC controller IC5 processes the camera trigger signals from the power supply unit and generates the CLK, ROG and SHUT activation signals of the CCD sensor. The lighting is controlled via the gates IC6B, IC6C and the optocouplers IC10 and IC11; the top light source and the lower light source can be separately connected via the port lines P40 and P41 of IC1. The connection of R9, R10 and C25 prevents the lighting unit P.C.B. LP 862 from being damaged by excessive lighting times.

The signal processing unit consists of the A-D converter IC8 and the RISC controller IC9. The reference voltages for the A-D converter can be optionally set via the trimmers P1 and P2 or via the pulse-width outputs of the microcontroller IC1. Buffered and lowpass-filtered, they reach the reference inputs of the converter via the amplifier IC2A and IC2B. The 2048 analog brightness signals coming from the CCD sensor are converted into 2048 8-bit data words by IC8 and read in by IC9. The RISC controller uses the data to perform a transformation and then makes the transformed data available to the microcontroller IC1 for further processing.

From the 5-V voltage, the D-C/D-C converter, consisting of IC2 with connected units, generates a 9-V voltage which is required to supply the CCD sensor on P.C.B. LP 861.


LP860_2
gr
ge
gn
bn
ws
GND
TP4
TP3
TP2
TP1
D2
D1
C6
C5
R14
R15
D4
C10
C15
IC2
C13
C14
C12
R3
X1
C22
C23
C7
X4
IC5
C3
IC12
R11
R12
L2
R2
R1
C19
X3
IC8
C4
C20
C21
R6
R5
IC4
C11
IC9
L1
X2
C8
C18
QU1
C17
IC1
R4
R14
R13
X5
X6
C24
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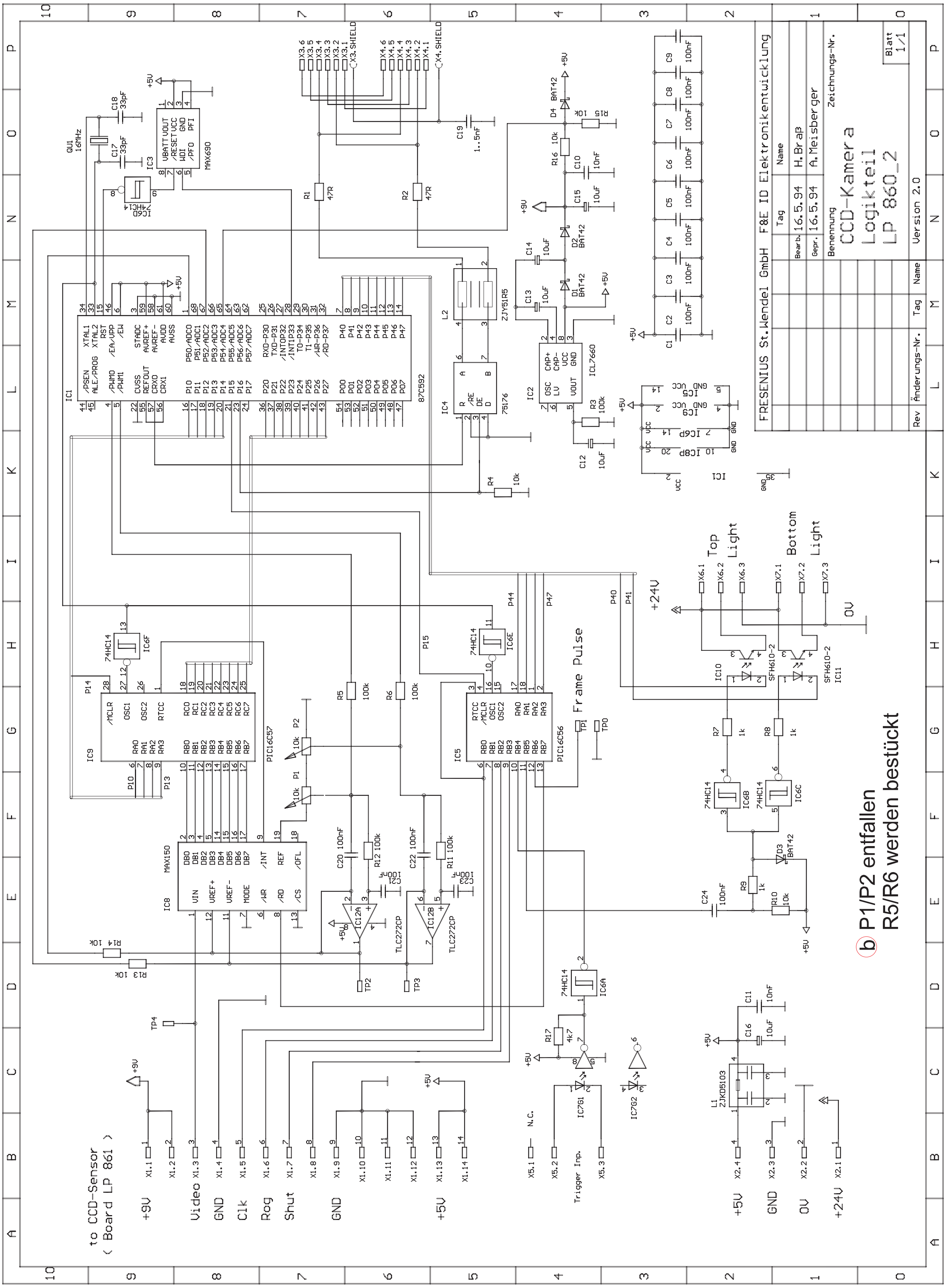
C16
IC3
IC7
C9
R8
R7



FRESENIUS St.Wendel GmbH F&E ID Elektronikentwicklung
CCD-Kamera
Logikteil
LP 860_2
Version 2.0
16.5.94 H.Braß
16.5.94 A.Meisberger
to CCD-Sensor (Board LP 861)
b P1/P2 entfallen
R5/R6 werden bestückt
Frame Pulse
Top Light
Bottom Light

3.23 P.C.B. LP 861 Camera Sensor

3.23.1 Circuit Description

- **General Functional Description**

The CCD sensor with voltage supply is provided on P.C.B. LP 861.

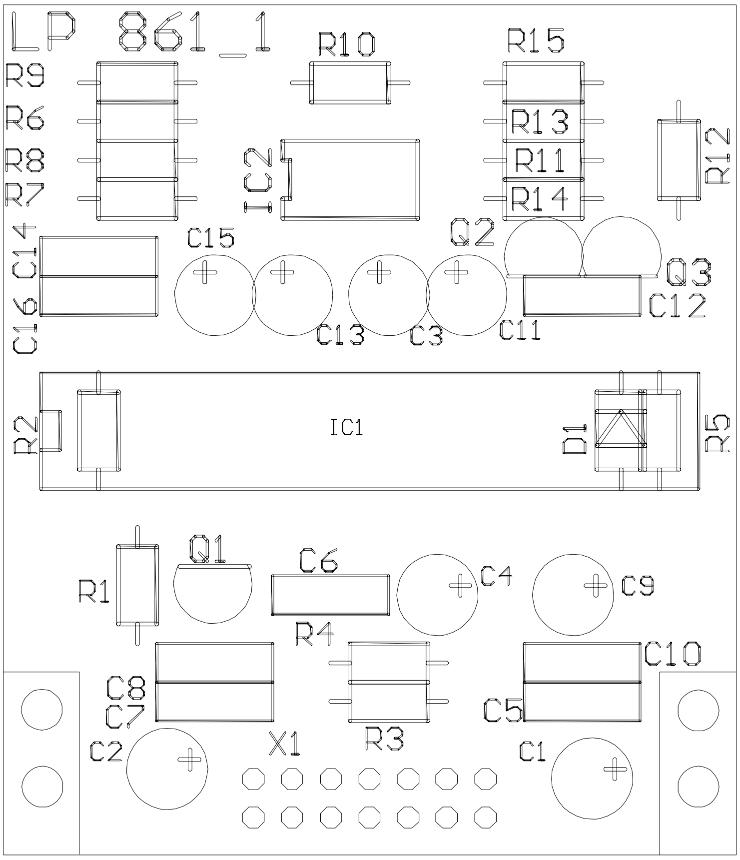
The P.C.B. LP 861 is mounted on P.C.B. LP 860.

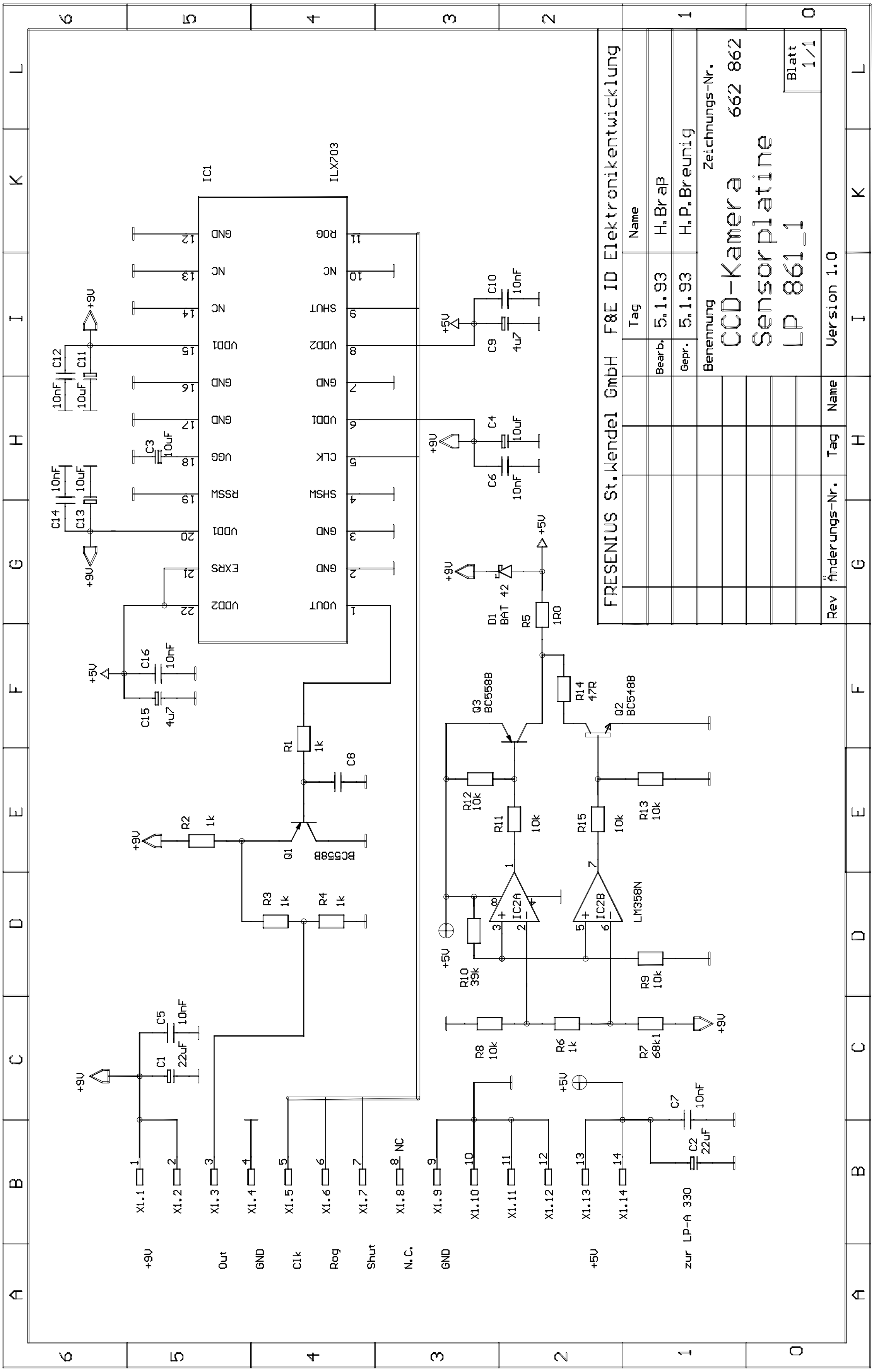
The control signals, the output signal and the current supply of the sensor are conducted via plug X1. The correct order of the +5-V and the +9-V supply voltages upon switch-on and switch-off is ensured by the circuit part around IC2.

The output signal of the CCD sensor is made available with low impedance by the driver transistor Q1 for further processing.

P.C.B. LP 861

Component Layout Diagram





FRESENIUS St.Wendel GmbH F&E ID Elektronikentwicklung
Tag
Name
Bearb.
5.1.93
H.Braß
Gepr.
5.1.93
H.P.Breunig
Zeichnungs-Nr.
662 862
Blatt
1/1
Benennung
CCD-Kamera
Sensorplatine
LP 861_1
Version 1.0
Rev
Änderungs-Nr.
Tag
Name
IC1
ILX703
LM358N
zur LP-A 330
+9V
Out
GND
Clk
Rog
Shut
N.C.
GND
+5V

3.24 P.C.B. LP 863 Interface Detection

3.24.1 Circuit Description

P.C.B. LP 863 comprises circuits for detecting the interface in the separation chamber and for temperature detection inside the centrifuge.

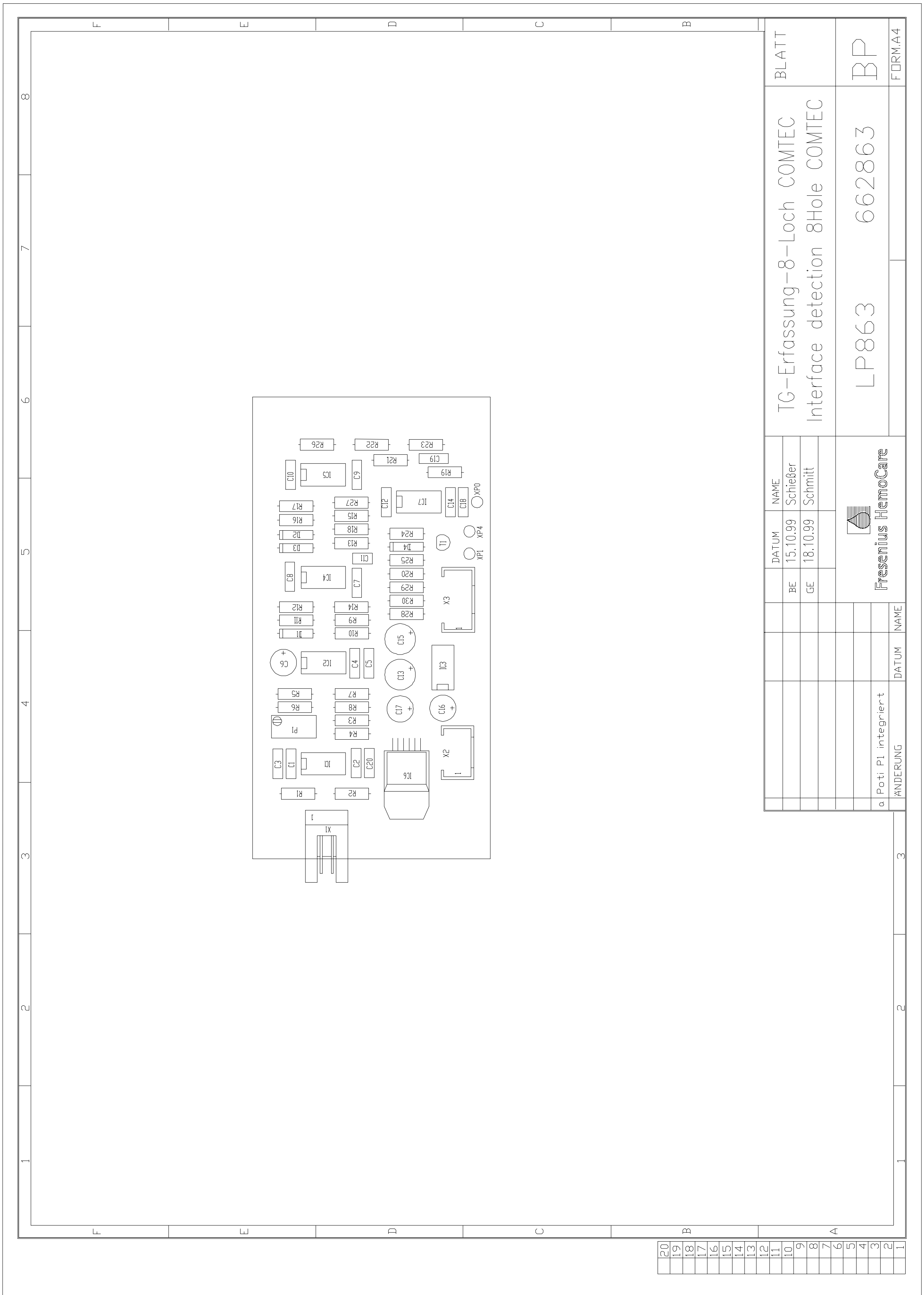
- **Interface**

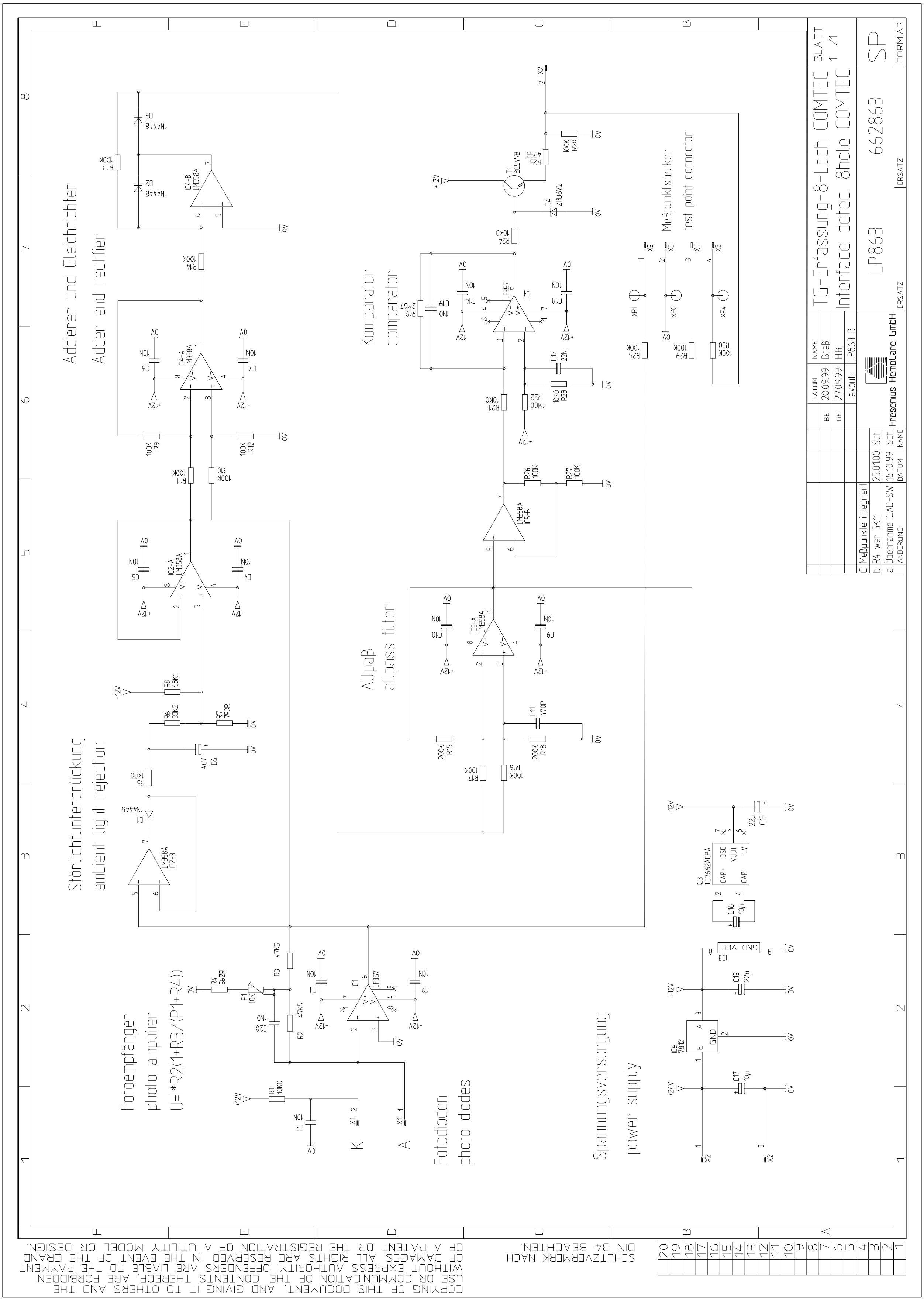
The interface detection comprises the following circuit sections: photoelectric receiver, rectifier, lowpass filter, interference suppression, and pulse generation.

A photoelectric current proportional to the incident infrared radiation is transmitted from the anode of the photodiode to the inverting input of the operational amplifier IC1. After the current has been converted into voltage and the bandpass has been filtered, a carrier frequency signal modulated by the holes of the separation chamber is available at the output of IC1. By means of the following rectifier circuit, the signal is recovered. This non-stabilized signal is available at pin 1 of plug 3 for calibration purposes.

This is followed by a circuit section for interference suppression. The operational amplifier B of IC2, the resistor R5, the diode D1, and the capacitor C6 are used to detect the peak value of the non-stabilized signal, a part of which is deducted from the original non-stabilized signal by the subtracter S 2-IC 5. Then this signal is rectified, i.e. all positive shares of the signal are suppressed. The inference suppression is used to avoid disturb signals caused by poor chamber printing and/or scratches on the printing.

The stabilized signal is then delivered to the all-pass network by means of IC5A. A mass-symmetrical signal, which is amplified by a factor of two, is applied to the output of the operational amplifier IC5B. Depending on the amplitude of the signal, the hole pulses are generated at measuring point MP3 by means of the comparator circuit around IC7. The sensitivity of the evaluation circuit is adjusted via the ratio of resistor R22 to resistor R23. After having been floated by transistor T1, the hole pulses are available at pin 2 of plug 2 for further processing. Each descending edge of the signal corresponds to a hole which has been recognized (cf. diagrams 2a and 2b).


BLATT
TG-Erfassung-8-Loch COMTEC
Interface detection 8Hole COMTEC
BP
FORM.A4
LP863
662863
NAME
DATUM
BE 15.10.99 Schießer
GE 18.10.99 Schmitt
Fresenius HemoCare
a Poti P1 integriert
ÄNDERUNG
DATUM
NAME



TG-Erfassung-8-Loch COMTEC
Interface detec. 8hole COMTEC
LP863
662863
Fresenius HemoCare GmbH
Addierer und Gleichrichter
Adder and rectifier
Komparator
comparator
Allpaß
allpass filter
Störlichtunterdrückung
ambient light rejection
Fotoempfänger
photo amplifier
U=I*R2(1+R3/(P1+R4))
Fotodioden
photo diodes
Spannungsversorgung
power supply
Meßpunktstecker
test point connector
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SCHUTZVERMERK NACH DIN 34 BEACHTEN

3.25 P.C.B. LP 864 Computer Bus Board

3.25.1 Circuit Description

- **Design and Purpose**

The circuit on P.C.B. LP 864 has the following functions:
– Providing an AT96/ISA96 bus including the necessary supply voltages
– Generating the necessary supply voltages

- **Function**

Via X1, 2 supply voltages are supplied. Between X1.1 and X1.2 the voltages 27 – 35 V (U1) and between X1.4 and X1.3 the voltages 4.9 – 5.3 V (U2) must be applied.

An input filter consisting of DR1 – DR4 and C2, C3 is intended to prevent primarily cycle irregularities on the supply positions at exit, via the supply lines.
From U1 a controlled voltage of 12 V (U3) is generated through the step down control switch around IC1. As an alternative to this switch control solution it is also possible to use an integrated switch controller IC3 to generate U3. In that case the circuit around ICI remains unassigned.

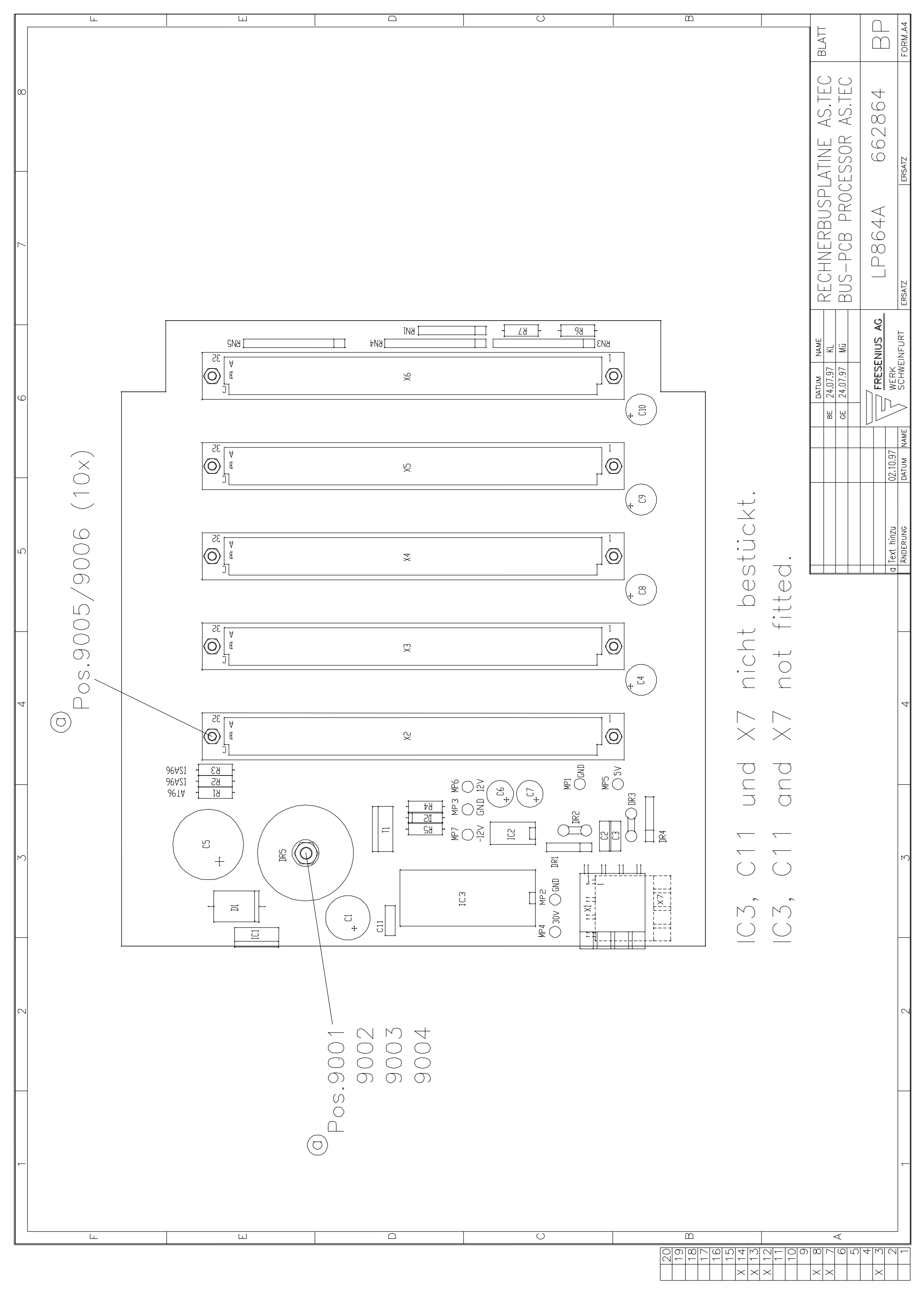
With the voltage inverter IC2, U3 is converted into –12 V (U4).
This means availability of all voltages for a AT96/ISA96 bus. It is possible to measure all voltages at test points on the back of the printed circuit board.
If U3 increases through a fault to a value of about 14 V, the thyristor T1 is switched on via D2 and U3 is short circuited.

The AT96/ISA96 slots are provided via the panel connector X2 – X6.
The adjustment for an AT96 or ISA96 bus is made via R1 – R3

	AT96	ISA96
R1	fitted	not fitted
R2	not fitted	fitted
R3	not fitted	fitted

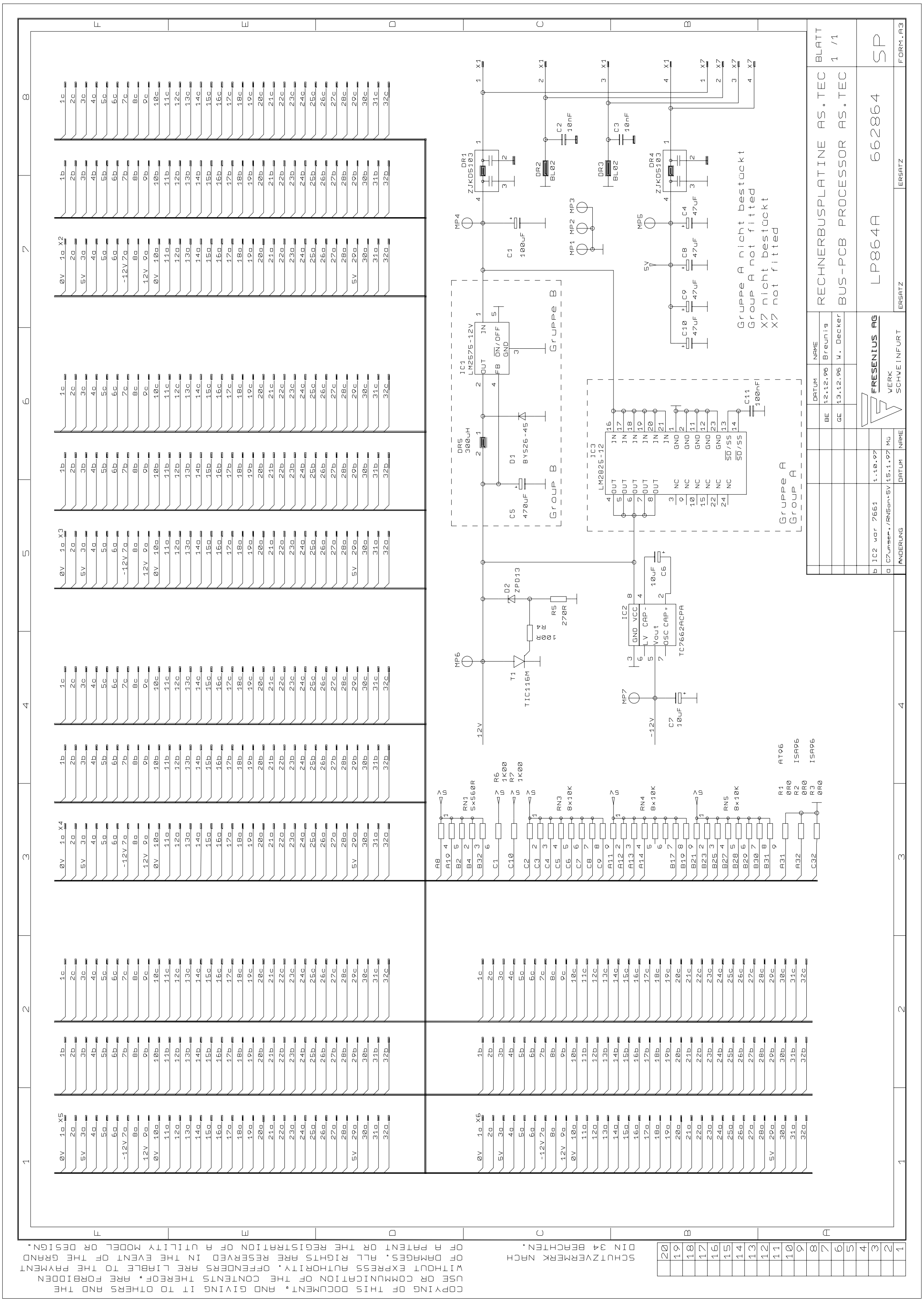
Certain signals of the bus are completed with the required impedance’s via resistors RN1 – RN5.

3.25.2 Circuit and Component Layout Diagram P.C.B. LP 864 Computer Bus Board



P.C.B. LP 864

Circuit Diagram



3.26 P.C.B. LP 865 Elektronics Bus Board

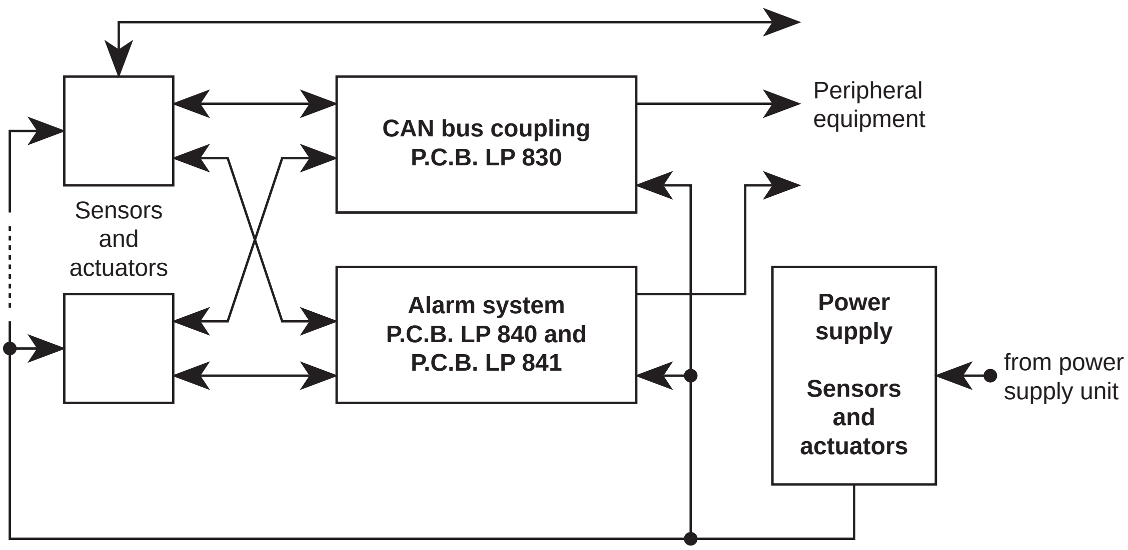
3.26.1 Circuit Description

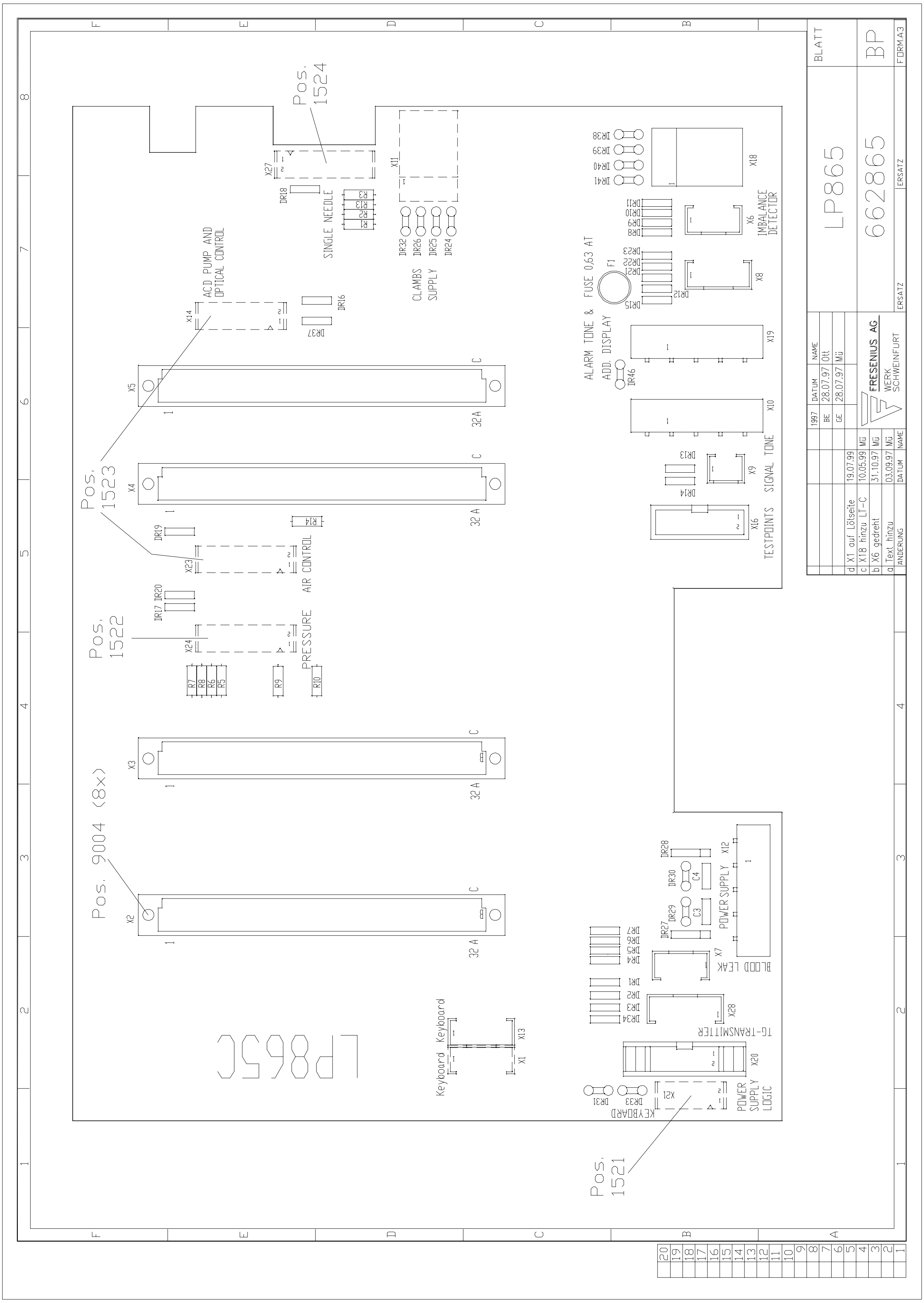
The printed circuit board is used to connect those components required for the controls which do not contain their own CAN bus coupling. Also, the alarm system is plugged into the circuit board P.C.B. LP 865.

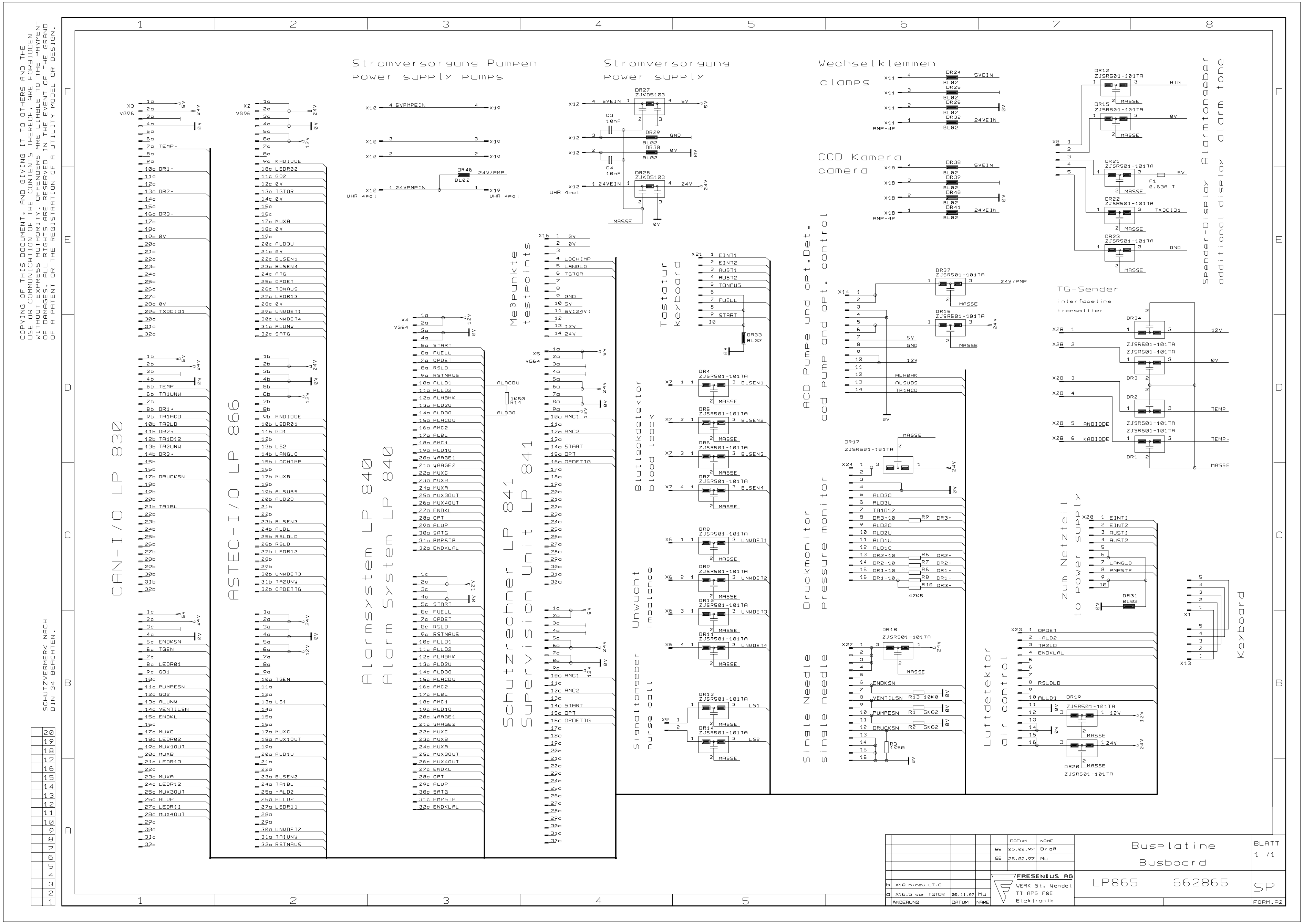
The plug positions X4 and X5 are used for the components alarm system P.C.B. LP 840 and safety system P.C.B. LP 841of the alarm system.

The CAN I/O card P.C.B. LP 830 on plug position X3 forms the link to the CAN bus system.

Fig.: Block Diagram of P.C.B. LP 865







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SCHUTZVERMERK NACH DIN 34 BEACHTEN.
Stromversorgung Pumpen
power supply pumps
Stromversorgung
power supply
Wechselklemmen
clamps
CCD Kamera
camera
Alarmtongeber
alarm tone
Sender-Display
additional display
TG-Sender
interfaceline transmitter
CAN-I/O LP 830
ASTEC-I/O LP 866
Alarmsystem LP 840
Alarm System LP 840
Schutzrechner LP 841
Supervision Unit LP 841
Meßpunkte
testpoints
Tastatur
Keyboard
Blutleckdetektor
blood leack
Unwucht
imbalance
Signaltongeber
nurse call
ACD Pumpe und opt.Det.
acd pump and opt. control
Druckmonitor
pressure monitor
Single Needle
single needle
Luftdetektor
air control
zum Netzteil
to power supply
Keyboard
Busplatine
Busboard
LP865
662865
BLATT 1 /1
SP
FORM.A2
FRESENIUS AG
WERK St. Wendel
TT APS F&E
Elektronik
BE 25.02.97 Broß
GE 25.02.97 Mu
b X10 hinzu LT-C
a X16.5 war TGTOR 06.11.97 Mu
ÄNDERUNG DATUM NAME

P.C.B. LP 865

Circuit Diagram

3.27 P.C.B. LP 866 COM.TEC-I/O Card

3.27.1 Circuit Description

- **Design and Purpose**

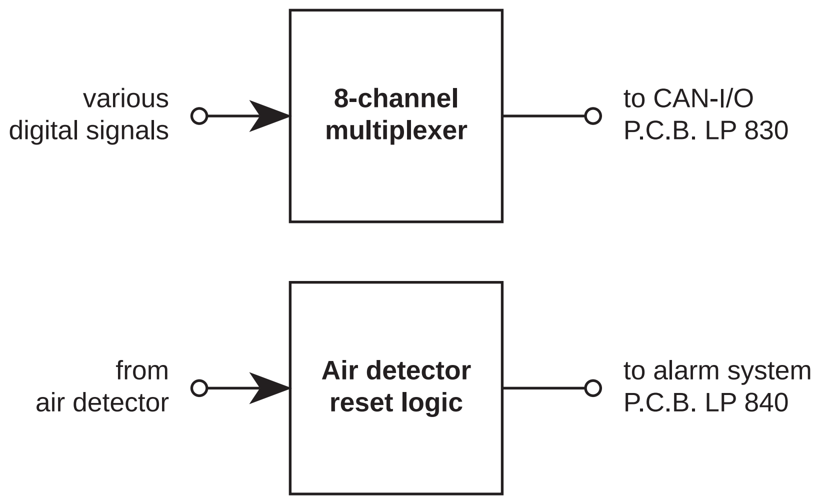
The COM.TEC I/O card P.C.B. LP 866 contains the electronics for various sensors and actuators, the generation of a supply voltage and the interface control.

The circuit consists primarily of the following functional units
- Sensors/actuators: flutter detector, blood leak detector, signal tone generator and alarm tone generator
- Interface detection – transmitter control
- Air detector reset logic
- Inputting digital signals via multiplexer
- Switch control +12 volt for supply of components connected on printed circuit board P.C.B. LP 865

- **General Functional Description**

From the signals /ALD2 of the air detector and the signals RSLD and OPDET of the alarm system, the circuit part "air detector reset logic" generates the signals ALD2A and RSRSLD.

The multiplexer formed from IC101 with switching is used to input digital signals into the control system via the CAN-I/O card P.C.B. LP830. For this purpose, an input position (X0 to X7) is selected via the control inputs A, B and C of the multiplexer and the output signal Q is input via the transistor T100.



- **Transmitter Control Interface Detection**

  Triggering and Enable

  The circuit part transmitter control interface detection generates the selection signal of the five transmitter LEDs of the P.C.B. LP 868 from the long hole signal of the optical sensor perforated disk.
  This part of the circuit is used for those processes using the separation chambers with the 8 hole printing, i.e. when using C4 or PL1 separation chambers.
  The trigger signal “TG-Trigger” is conducted via IC6A to the circuit part, consisting of IC6B – IC6D and switching. The actual trigger signal is generated at the collector at transistor T2 together with the Monoflop IC7A, which prevents a continuous triggering of the transmitter LED during standstill of the centrifuge.
  The Monoflop IC7B generates the “Gate” signal which can be used for triggering oszilloscopes during adjustment.
  The signal “TG-Enable” can be used to switch off the triggering of the transmitter LEDs; this is necessary in all processes in which the interface is detected with the help of the CCD camera.

  Changing the current for transmitter LEDs

  It is possible to change the setting of the interface detection transmitter current in the range from approximately 50% to 100% with the help of the circuit part “TG – current setting”.
  This is necessary for the interface detection in all processes with separation chambers with 8 hole printing.
  The triggering of the transmitter LEDs is carried out with the help of a switched current source, consisting of transistor T4, resistor R29 and the diodes D4 and D5. The amount of current of the current source depends on the voltage at the base of transistor T4.
  This voltage can be varied through the potentiometer P2. It is possible to observe the current pulse at MP1 on the oscilloscope (100 ml corresponds to 100 mA).

- **Blood Leak Detector**

  This circuit is used for the detection of blood leaks inside the centrifuge space. For this purpose a surface censor with wiring is installed in the appliance, which are linked up electrically while blood or other conductive liquids run over them.

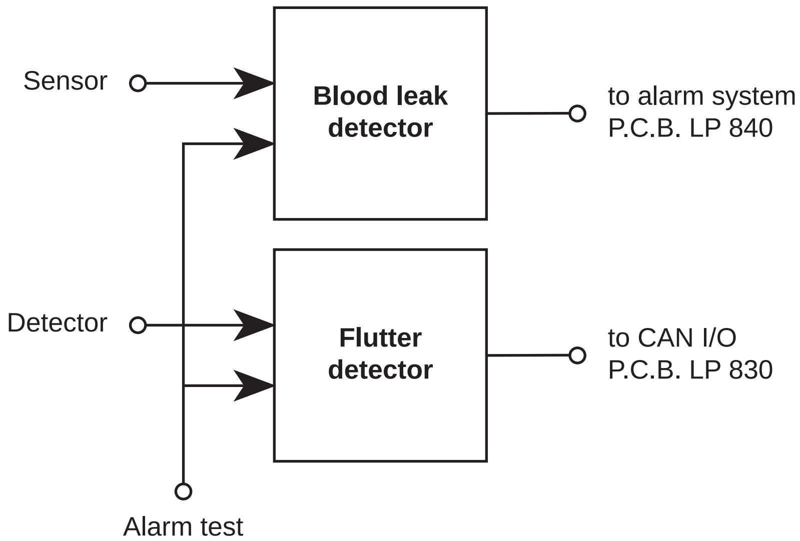
  The timer IC1 generates the pulse signal which is conducted to the Flip-Flop IC2A. Two counter-phase rectangular signals with exactly 50 % feeler ratio are available at outputs pin 1 and pin 2. These voltages are connected to the voltage divider, consisting of R2, R4 and R6. The sensor is situated in parallel to the central resistor R4. Through wetting of the sensor, its electrical resistance is reduced so that the voltage reduction at R4 is also decreased.

The voltage at R4 is conducted to two comparitors IC4A and IC4B. The reference voltages on these comparators are generated by the resistance splitter R2, R5 and R14 and are 1/3 and 2/3 of the operating voltage. When the sensor is not wetted by liquid, the voltage reduction at R4 is larger than at R5. Through the constant reversal of the sensor voltage at the Flip-Flop IC2A, the comparators IC4A and IC4B switch over in the same rhythm so that the retriggerable Monoflop IC5A is constantly in a triggered mode. When the sensor is wetted by liquid, its resistance decreases and the voltage drop at R4 is reduced so that the comparators can no longer switch over. The Monoflop IC5A flops back and gives off alarm at its output.

It is possible to check the circuit with the circuit test, consisting of resistor R13 and the analogue switch IC3A. When the test input is activated, the analog switch closes and switches the resistor R13 parallel to R4. This simulates the sensor being wetted by conductive liquid and leads to alarm.

- **Flutter Detector**

The circuit evaluates the signals from the optical sensor which is located in the detector. The light beam of this optical sensor is reduced more and longer the more the unit is out of balance. Once a default limit value has been reached the circuit causes an alarm, which is stored.
It is possible to test the circuit for proper function via test input TA1.
Normally (i.e. when unit not out of balance) the phototransistor in the optical sensor is switched through, i.e. it draws the potential to UNWDET1 against ground potential.
If the light beam is reduced or completely interrupted, the potential there rises and the capacitor C13 is charged via R48 and D7. If the voltage at C13 exceeds the trigger threshold of IC 15 A (typically 2/3 of operating voltage), an alarm is generated. The resistor R49 discharges the capacitor C13 when the potential at UNWDET1 falls below the voltage of C13. The components R50 and C13 form an average value which determines the trigger response of the circuit.
The gates IC 15 B to IC 15 D form a storage which stores any occurring alarm at the output of gate IC 15 A, putting it on the output of the circuit.
With the help of test input TA1 it is possible to switch off transistor T3. This interrupts current through the light-emitting diode of the optical sensor, simulating out of balance conditions, which causes the circuit to generate an alarm.
If one of the two inputs TA2 or RSTNAUS is activated the alarm storage is reset and the capacitor C13 is charged via the transistor T12.

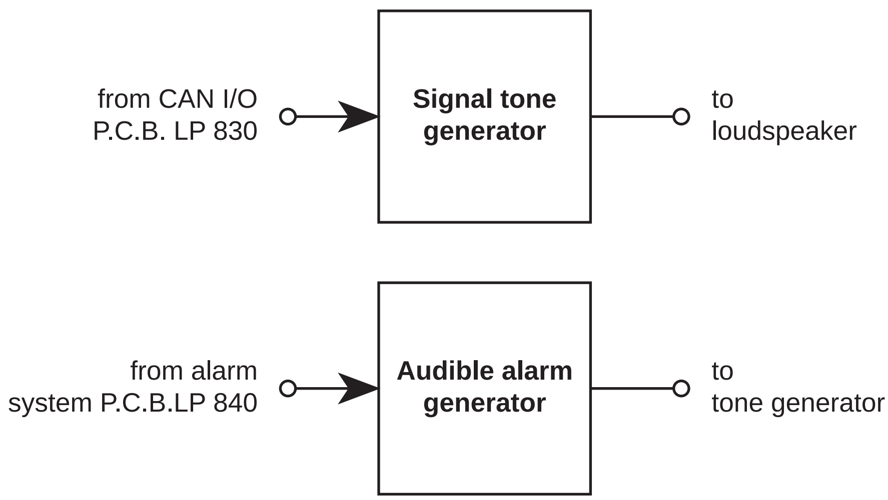


- **Signal Tone Generator**

With this circuit, two different signal tones are generated.
The core of the circuit is the chime component IC 17. This generates a sequence of tones when the input GO1 is activated. The tone frequency is determined by components C16 and R61.
Via signal GO2 the tone frequency is affected. As soon as the optocoupling IC 18 is activated, the sound frequency is not only influenced by R61 but also by R60. The potentiometer P1 is used for adjusting the sound volume.

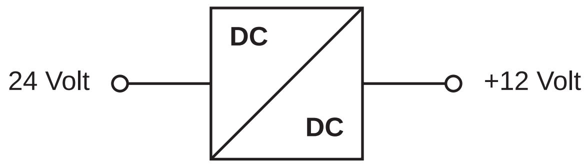
- **Audible Alarm Generator**

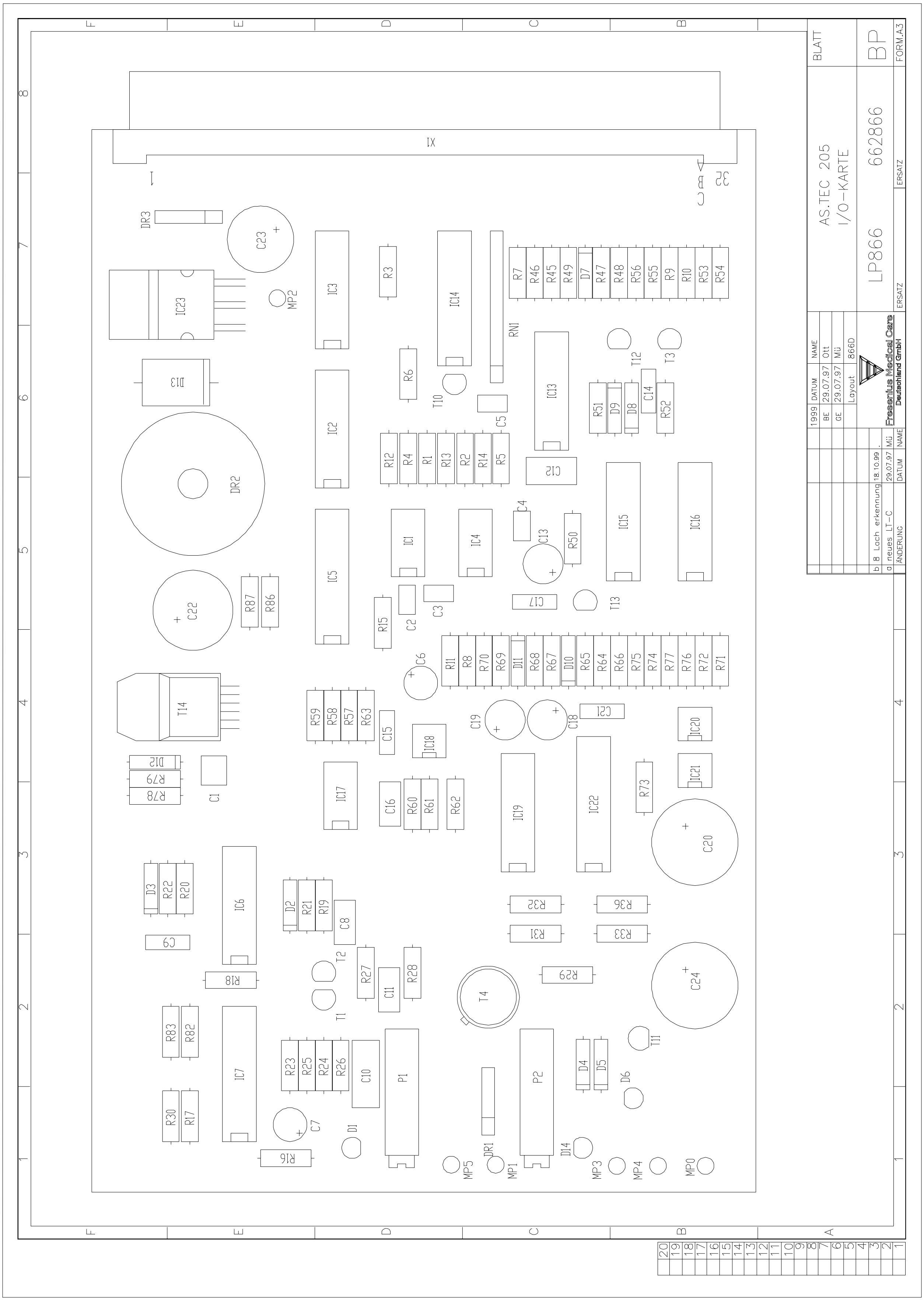
The audible alarm generator is designed to generate an alarm signal as soon as an alarm has been caused in the machine. The circuit consists of a tone generator, an interval switching and a logic processor, processing the input signals.
The audible alarm generator ATG is self vibrating and when connected to operating voltage generates a constant tone.
The tone generator is switched on and off with the transistor T13 in order to generate an intermittent sound. The transistor T13 is selected by gate IC 19A, which is switched as multi-vibrator (active: IC 19A, pin 2 high).
When in operation (Mute OFF) the output of IC 19B is on high potential. The resistor R68 would switch on the alarm sound when one of the optocouplers IC 20, IC 21 is not activated. If no alarm has occurred in the system, the line SATG is high so that IC 21 draws the potential at pin 2 IC19A to low. That means the alarm tone is switched off. The same effect is achieved when the input OPDETTG is high. If both inputs are inactive (low), an alarm condition is present and the alarm is sounded.
It is possible to switch off the alarm tone for a defined period. A signal at the input TONAUS triggers the Monoflop IC22, on which the output pin 7 changes from high to low. In turn, the interval generator IC19A is switched off via gates IC19B and IC19C. This condition is maintained at the Monoflop throughout the pre-set period and is transmitted via output TO to the control logic.
It is possible to activate the alarm tone via input ´RSTNAUS´ before the mute period has expired at the Monoflop.
The circuit consisting of R69, C19 and D11 suppresses undefined conditions when switching on the operating voltage; the alarm sound remains switched off during this period.



- **Voltage Supply**

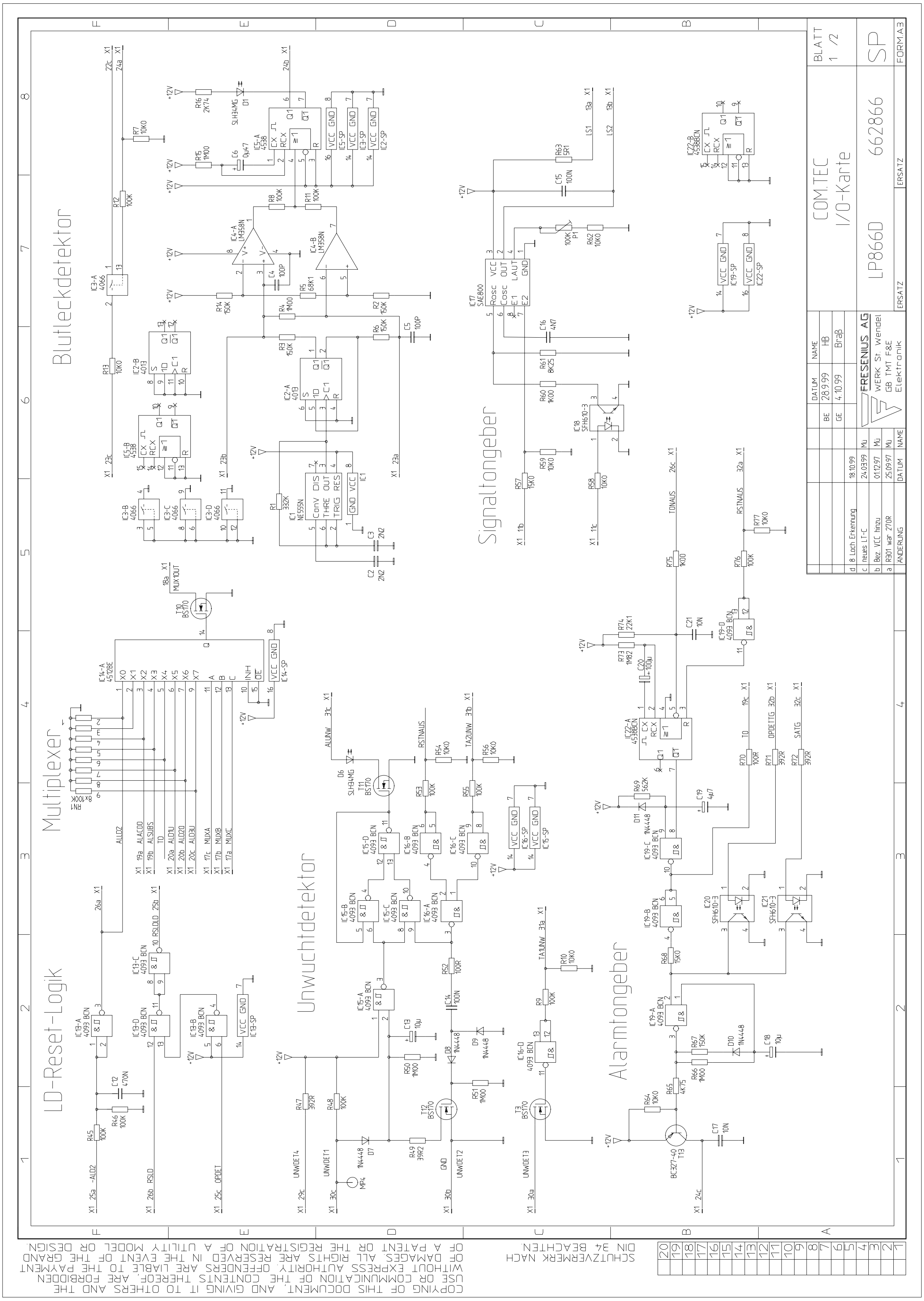
The switch control consisting of IC23 and switching is used for the 12 volt supply of the components which are connected on the bus printed circuit board P.C.B. LP 865 (air detector, alarm system, etc.). The thyristor T14 is triggered when excess voltage occurs at output of switch controller and therefore triggers the fuse F1 on the P.C.B. LP 857. This prevents the connected components to be damaged by excess voltage.

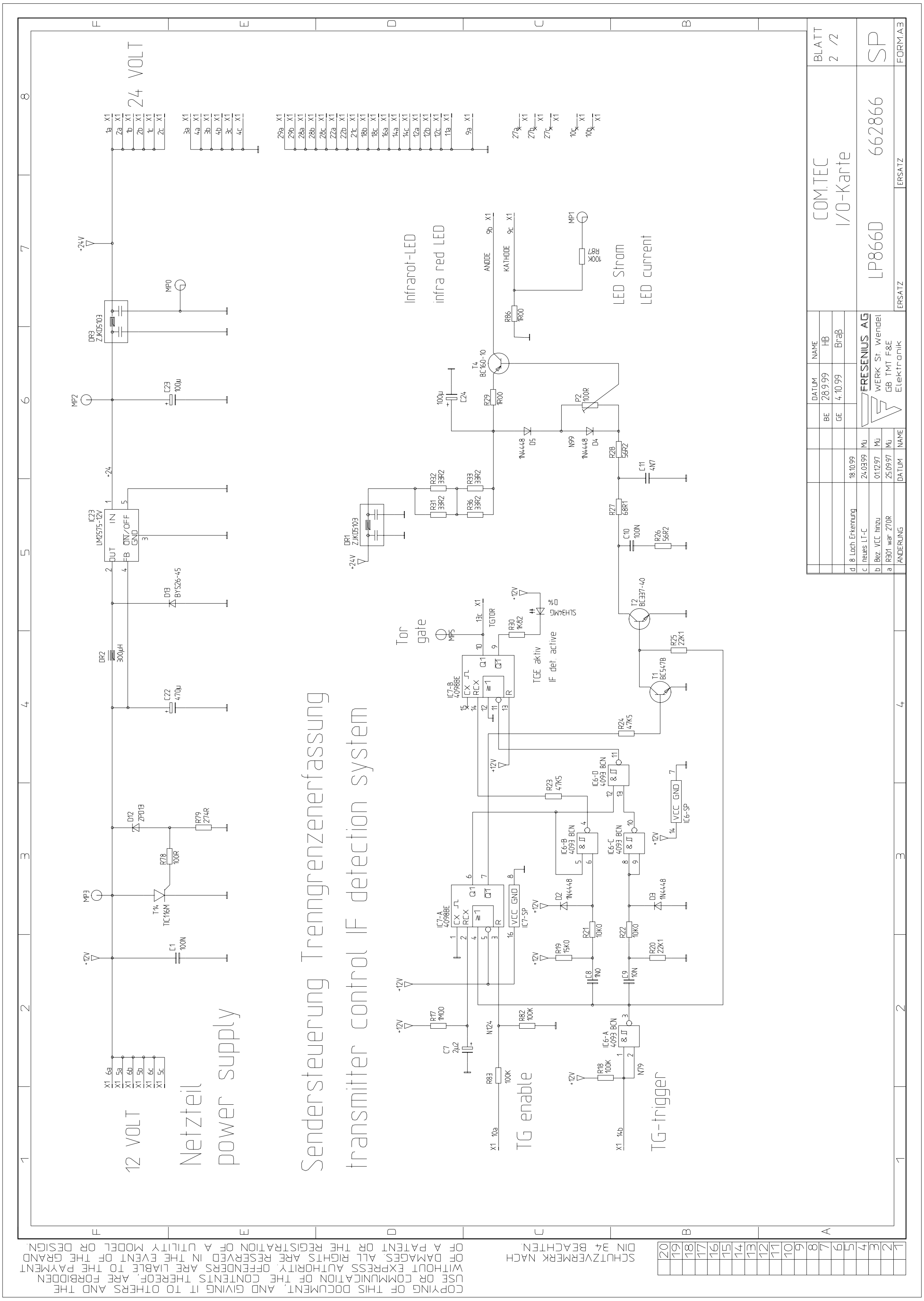




P.C.B. LP 866

Circuit Diagram 1/2





24 VOLT
12 VOLT
Netzteil
power supply
Sendersteuerung Trenngrenzenerfassung
transmitter control IF detection system
Infrarot-LED
infra red LED
LED Strom
LED current
Tor
gate
TGE aktiv
IF det. active
TG enable
TG-trigger
COM.TEC
I/O-Karte
LP866D
662866
FRESENIUS AG
WERK St. Wendel
GB TMT F&E
Elektronik
BLATT 2/2
SP
FORMAT A3
SCHUTZVERMERK NACH DIN 34 BEACHTEN

3.28 P.C.B. LP 867 ACD Pump Unit

3.28.1 Circuit Description

The printed circuit board of the ACD pump at the optical detectors of the TP.C.B. LP 867 contains the following functions:

– ACD drip detection
– Substituate end detection
– Motor control of ACD pump
– Hb/Hk detector and PLT detector
– Micro controller and CAN interface

- **ACD Drip Detection**

The circuit path “ACD drip detection” is used for detecting falling ACD drops in the ACD drip chamber. The circuit consists of an optical sensor which is operated with infrared light.
The circuit part consists of the transistor T100 and T101 with switching and is used for selecting the transmitter LED of the optical sensor and suppresses effects from ambient light.
The receiving signal of the photo transistor of the optical sensor is conducted to the comparator IC100 A. After the pulse formation IC101 C and IC101D, the ACD drop pulses are available for further processing by the micro controller.

- **Detection of Substituate Empty**

The circuit part “Substituate empty detection” is used for the detection of substituate in the substituate line. The circuit consists of an infrared optical sensor in cyclical operation.
The circuit part consist IC102A and the transistor T102 with switching and a fuse for selecting the transmitter LED of the optical sensor; it suppresses the effects of ambient light.
The receiving signal of the phototransistor of the optical sensor is conducted to the comparator IC102B.
With the help of the P100 potentiometer it is possible to adjust the response sensitivity of the optical sensor.
The Monoflop IC103B converts the cyclical receiving signal into a voltage level (high = alarm free)

- **ACD Pump Control**

The circuit part “ACD pump control” is used for selecting the ACD pump. The circuit consists of the following functional units:

– Specification of rated value
– Switching regulator
– IxR compensation
– Switch checking

Specification of Rated Value

The specification of the rated value is carried out by micro controller and a pulse amplitude modulated (PWM) signal. This PWM is converted into direct voltage (“set value”) with the help of the active filter IC105A (low pass 2. order).

Switching Regulator

The actual selection of the direct current motor of the ACD pump is carried out by the switch regulator component IC104. This component generates a variable direct current from 24 volts in the range of 1 volt to approximately 15 volts, depending on the rated value.
The output current from IC104 is amplified with the transistor unit, consisting of the transistor T103 and T105 with switching. Following the recovery diode D102 and the smoothing choke DR100 of the switching regulator, the desired direct voltage is available at capacitor C120.
The actual voltage at the motor is conducted via the voltage splitter R135 and R128 to the switching regulator component. To achieve current restriction for the motor current, the voltage at R127 is utilised.

IxR Compensation

The IxR compensation is used to balance sharp resolution drops when the motor is subjected to changes in load.
With increasing load (moment) of the motor the current through the motor increases and the revolutions decrease.
To balance out this decrease in revolutions, when the current through the motor is increased, a voltage proportional to the default revolutions is added to the nominal value, thus compensating for the drop in revolutions. This is carried out with the help of the operation increaser IC105B.

Switch Checking

At the stator mechanics of the ACD pump a switch is situated which indicates the presence of the pump adapter in the pump.
In order to detect the rotor pulse (one pulse per pumped revolution) of the ACD pump a ‘Hall’ switch is fitted in the pump bed of the stator which is operated by a magnet on the pump motor. Both signals are available for further processing by the micro controller.

- **Hb/Hk Detector and PLT Detector**

The circuit parts “Hb/Hk Detector” and “PLT-Detector” of P.C.B. LP 867 are used for detecting turbidity and colouring of the medium in the plasma or cell line of the blood cell separator COM.TEC.

Both detectors consist of an optical sensor with a two colour transmitter LED on which the red and green light are switched on in turns. For the Hb/Hk detector this is carried out with the transistors T200 (red) and T201 (green) and for the PLT sensor with the transistor T202 (red) and T203 (green).
The light penetrating through the medium (plasma line or cell line) is received by a photo-transistor (measuring branch).
The light emitted to the back by the two colour transmitter LEDs is used to compensate for ageing effects or temperature drifts of the LEDs or photo-transistors (reference branch).
The signals of the photo-transistors from the measuring and reference branches are received by the A/D converter inputs of the components IC 201A and IC202A, are processed there and sent to the micro controller via the serial SPI bus.

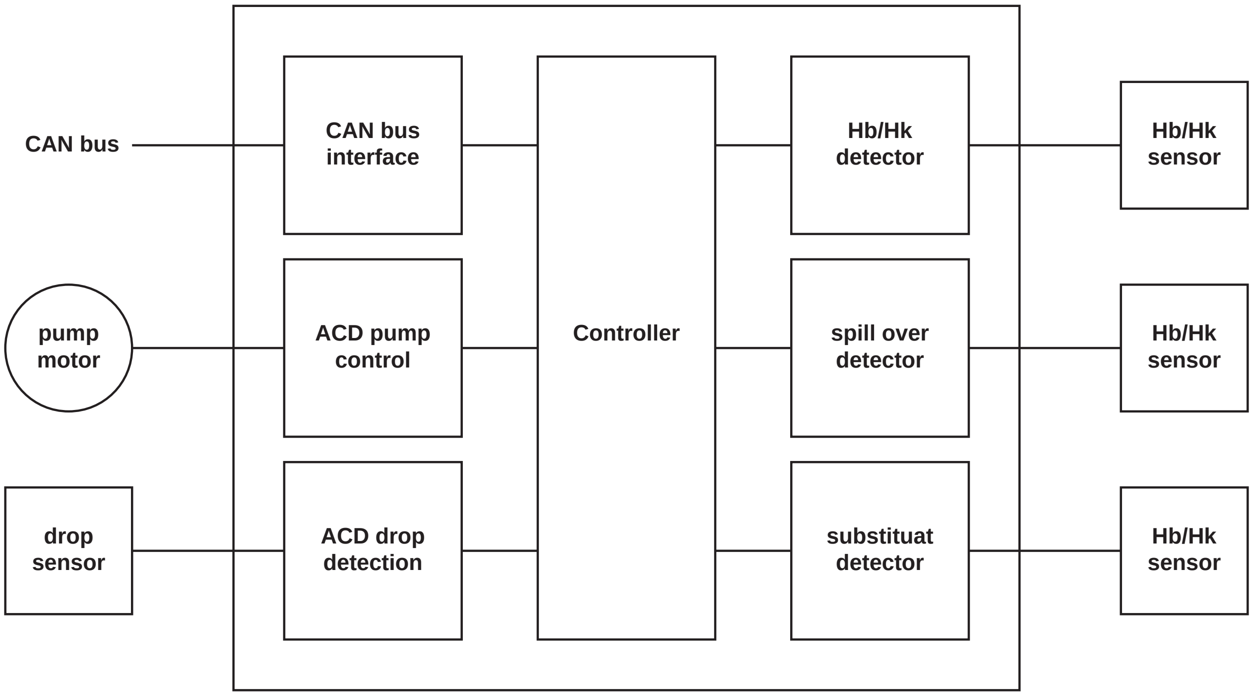
Due to the tolerances of the respective sensors (line holder and optical sensor) a balancing with respect to the sensor response is necessary.
The balancing data obtained in this process are stored in the EEPROM IC203; for this purpose the switch S1 must be moved to the position ‘write enable’. This prevents wrong balancing data to be written into the EEPROM due to a software error during operation.

With the help of the optocoupler IC200 it is possible during the alarm test to test the function of the Hb/Hk detector. In the green phase of the optical sensor the voltage at the measuring branch is reduced through transistor T204 and R212, which thereby simulates the colour in the plasma line turning red.
This is only required for the Hb/Hk detector, since only the hemolysis alarm is relevant to safety.

- **Micro Controller and CAN Interface**

The control of the functions of the P.C.B. LP867 is carried out with the micro controller IC401A; it is connected to the CAN bus through the optocouplers IC 407 and IC407, with galvanic separation.
The switching regulator component IC403 with switching generates 5 volts from the 24 volt supply.

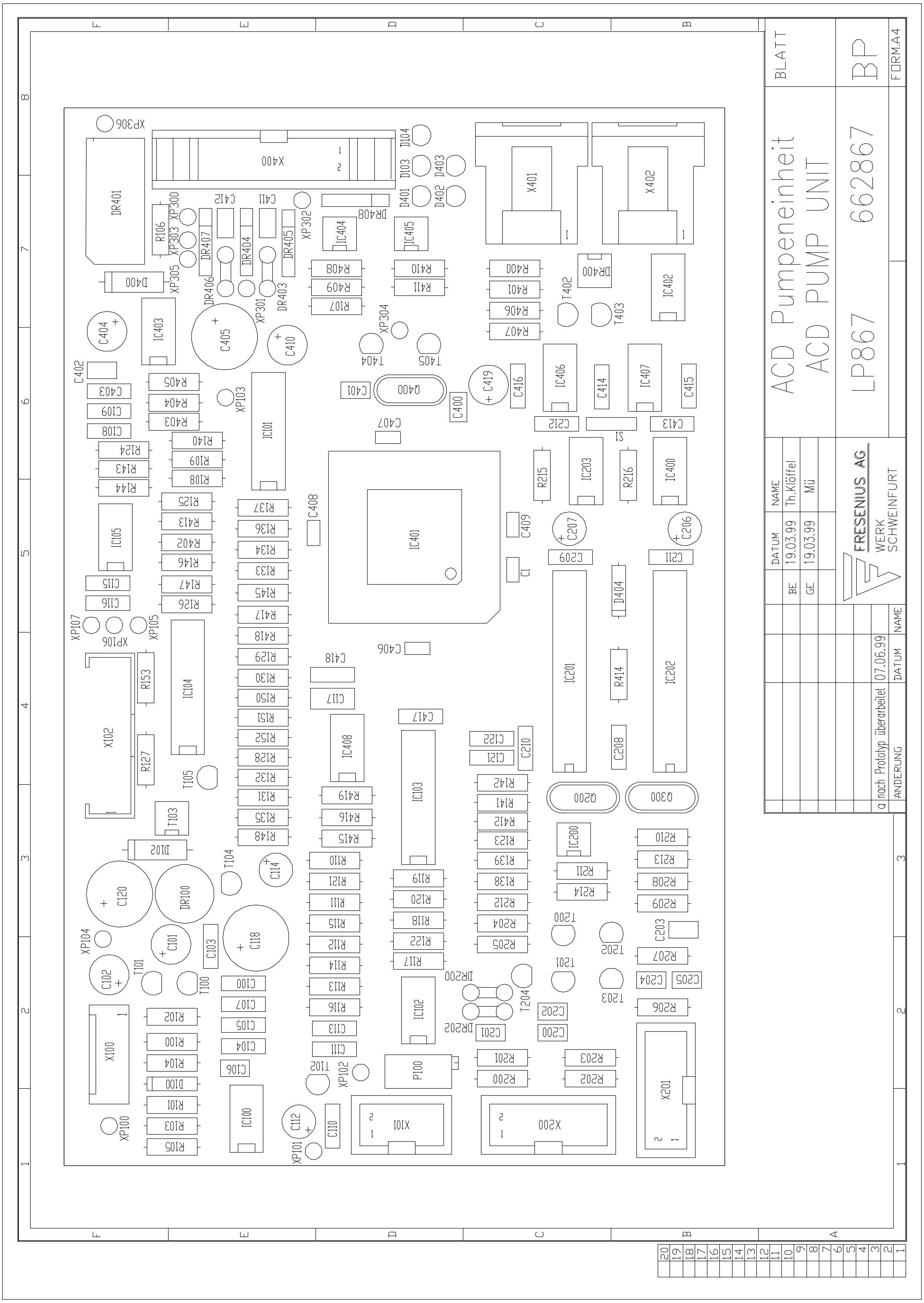
Block Diagram of P.C.B. LP 867



3.28.2 Circuit and Component Layout Diagram P.C.B. LP 867 ACD Pump Unit

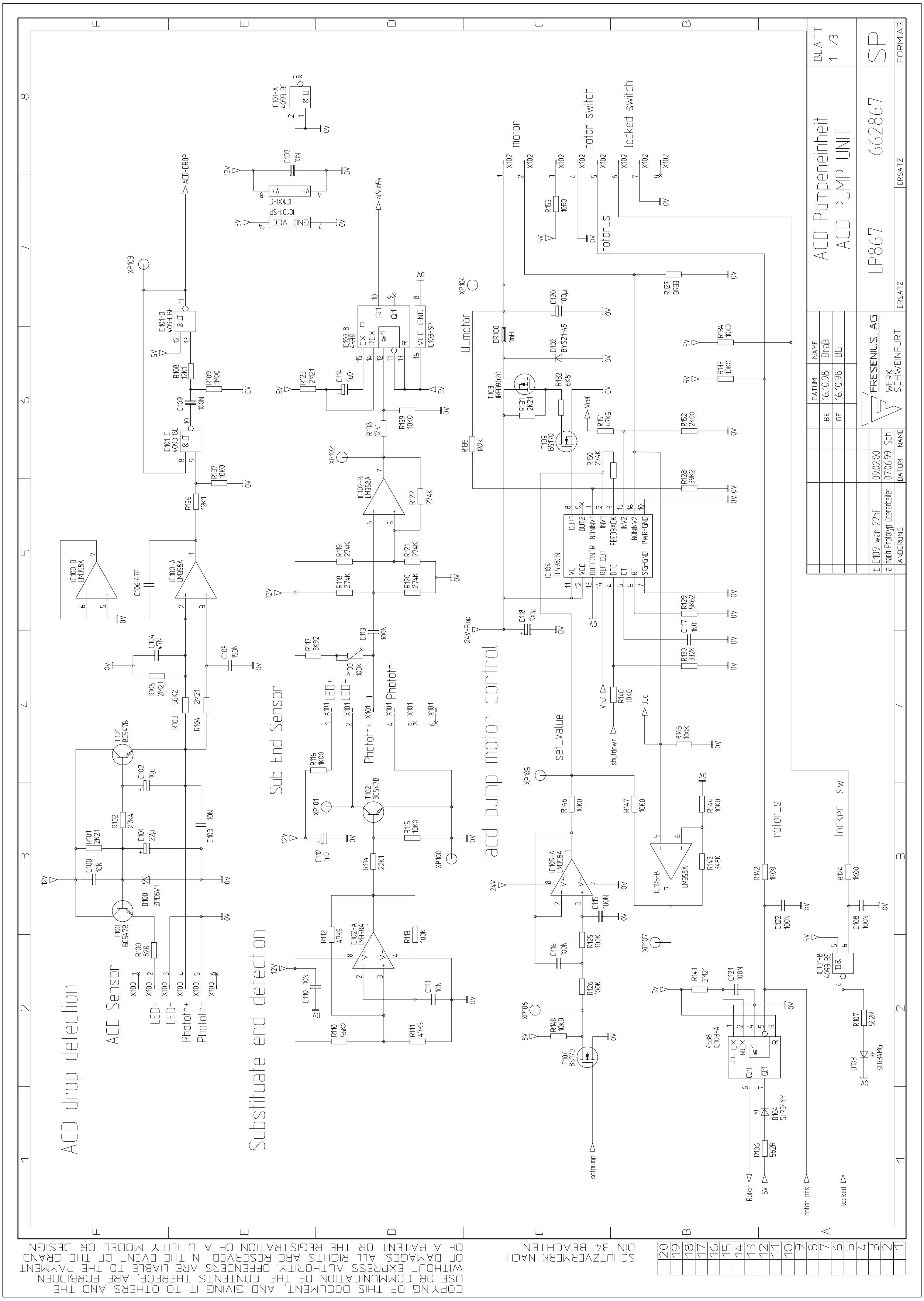
P.C.B. LP 867

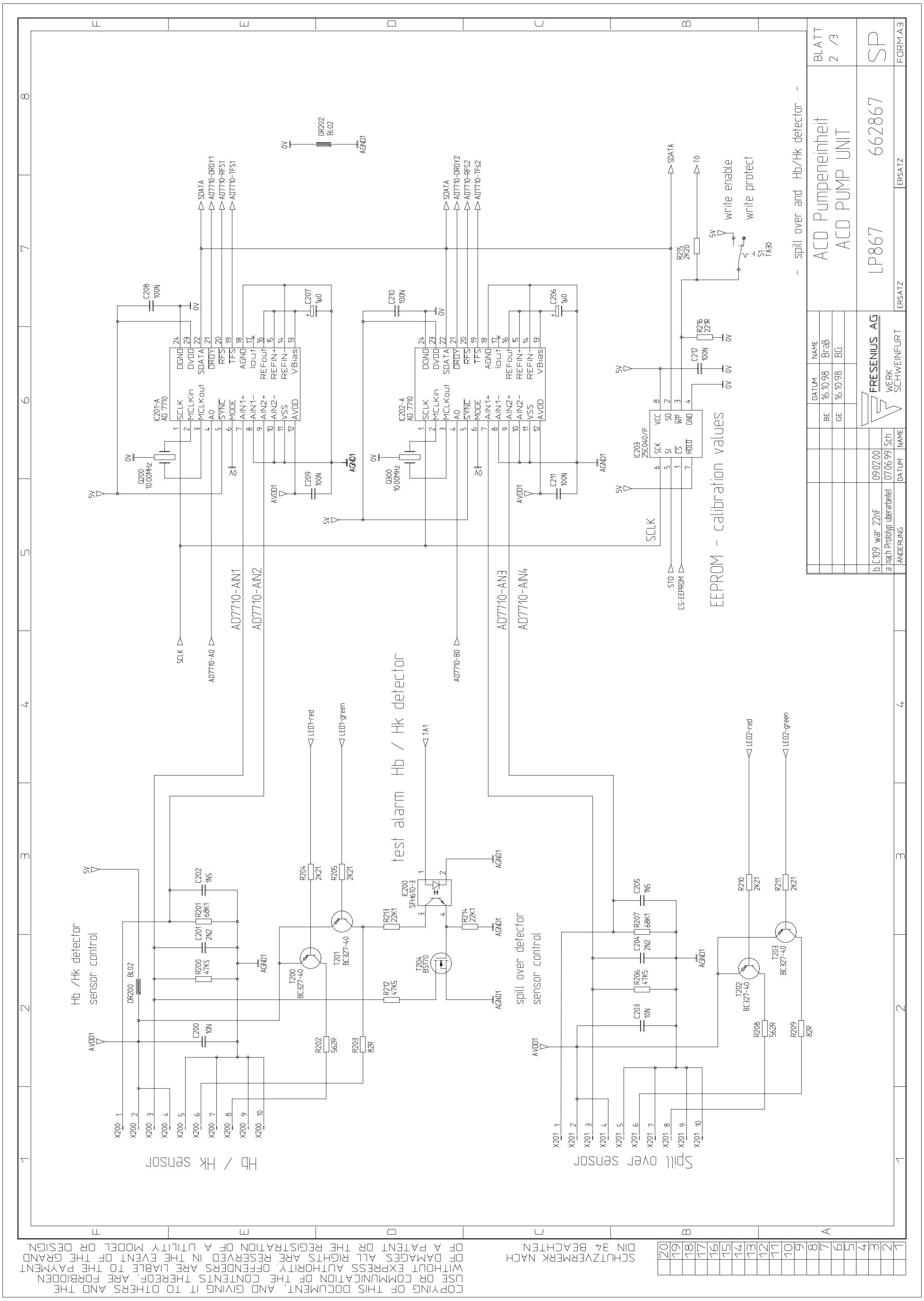
Component Layout Diagram



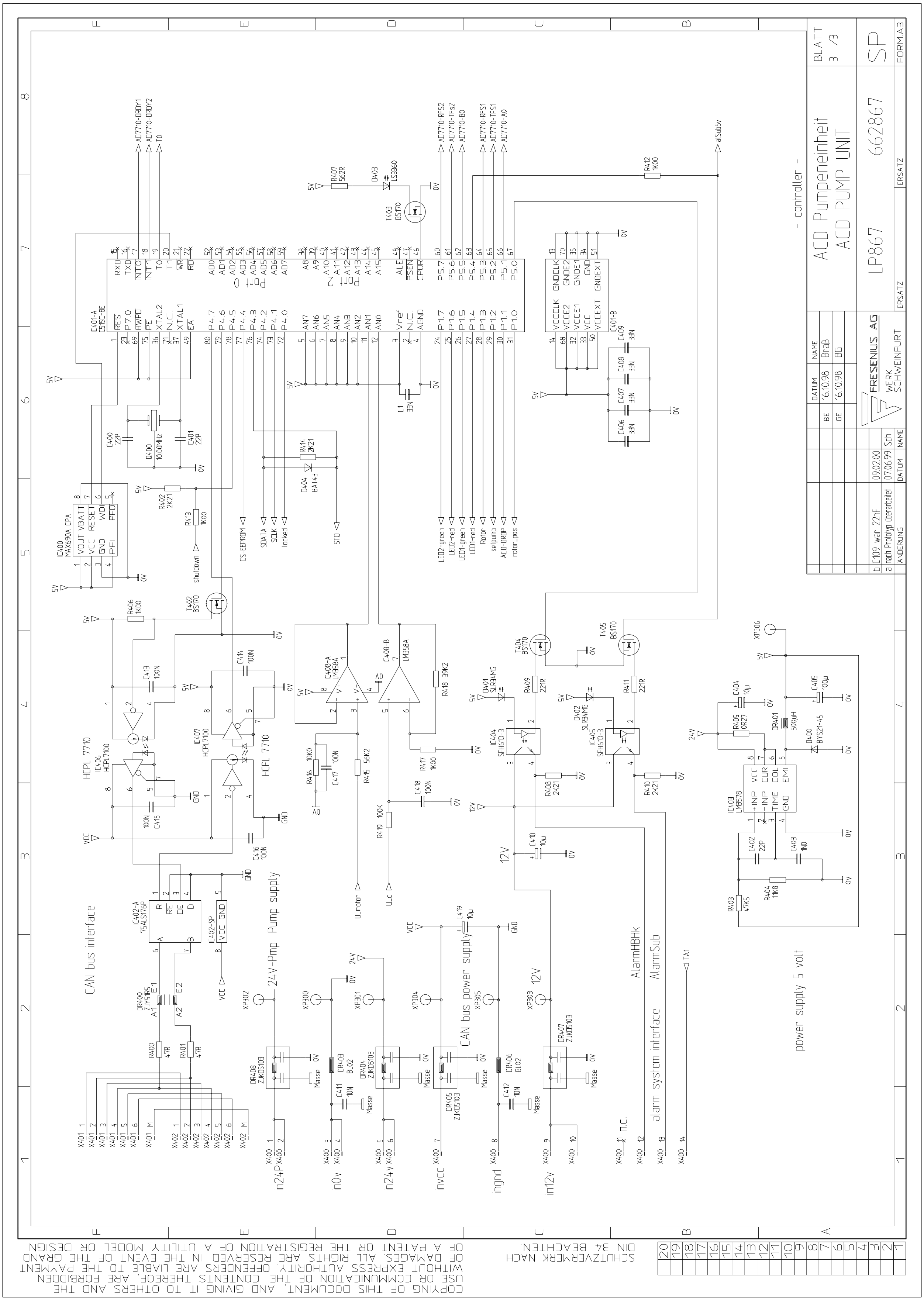
P.C.B. LP 867

Circuit Diagram 1/3





- spill over and Hb/Hk detector -
ACD Pumpeneinheit
ACD PUMP UNIT
LP867
662867
FRESENIUS AG
WERK SCHWEINFURT
EEPROM - calibration values
write enable
write protect
test alarm Hb / Hk detector
Hb /Hk detector sensor control
spill over detector sensor control
Hb / HK sensor
Spill over sensor



CAN bus interface
24V-Pmp Pump supply
CAN bus power supply
alarm system interface
power supply 5 volt
- controller -
ACD Pumpeneinheit
ACD PUMP UNIT
LP867
662867
FRESENIUS AG
WERK SCHWEINFURT

3.29 P.C.B. LP 868 Camera Lighting

3.29.1 Circuit Description

- **General Functional Description**

The lighting is not an independent unit but a component belonging to the CCD camera (P.C.B. LP 860). It consists of 8 Darlington transistors (T300 – T307), switched as power sources, each of which power 5 infrared LEDs (D300 – D339) switched in series. The plug X1 affords the connection to the camera.

- **Function**

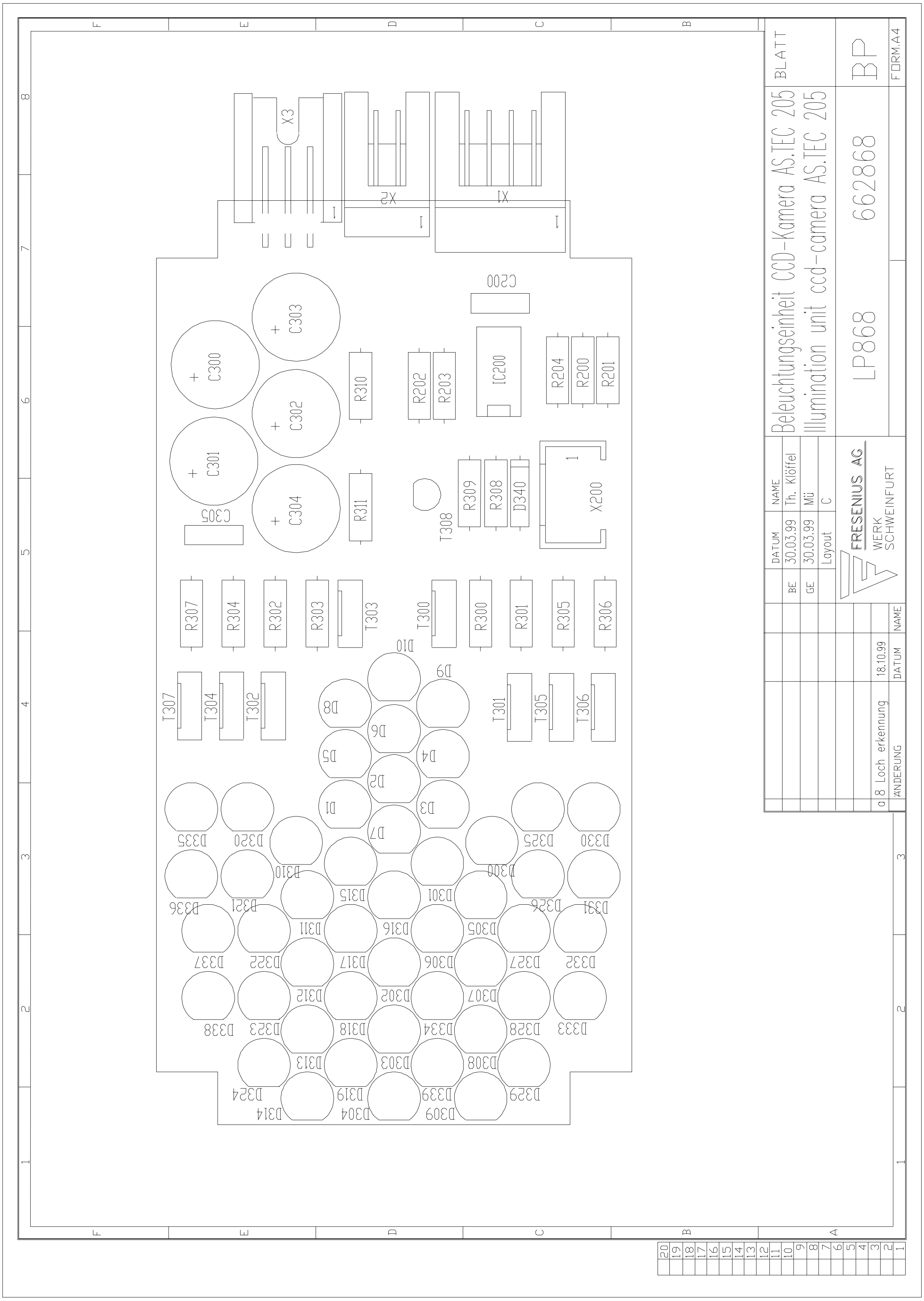
The circuit is supplied from the camera with 24 V direct voltage. When the pulse at the plug X300, pin 2 is high, the drive transistor T308 switches on the parallel alignment of the power sources for the duration of the pulse (max pulse duration: 400 µs).

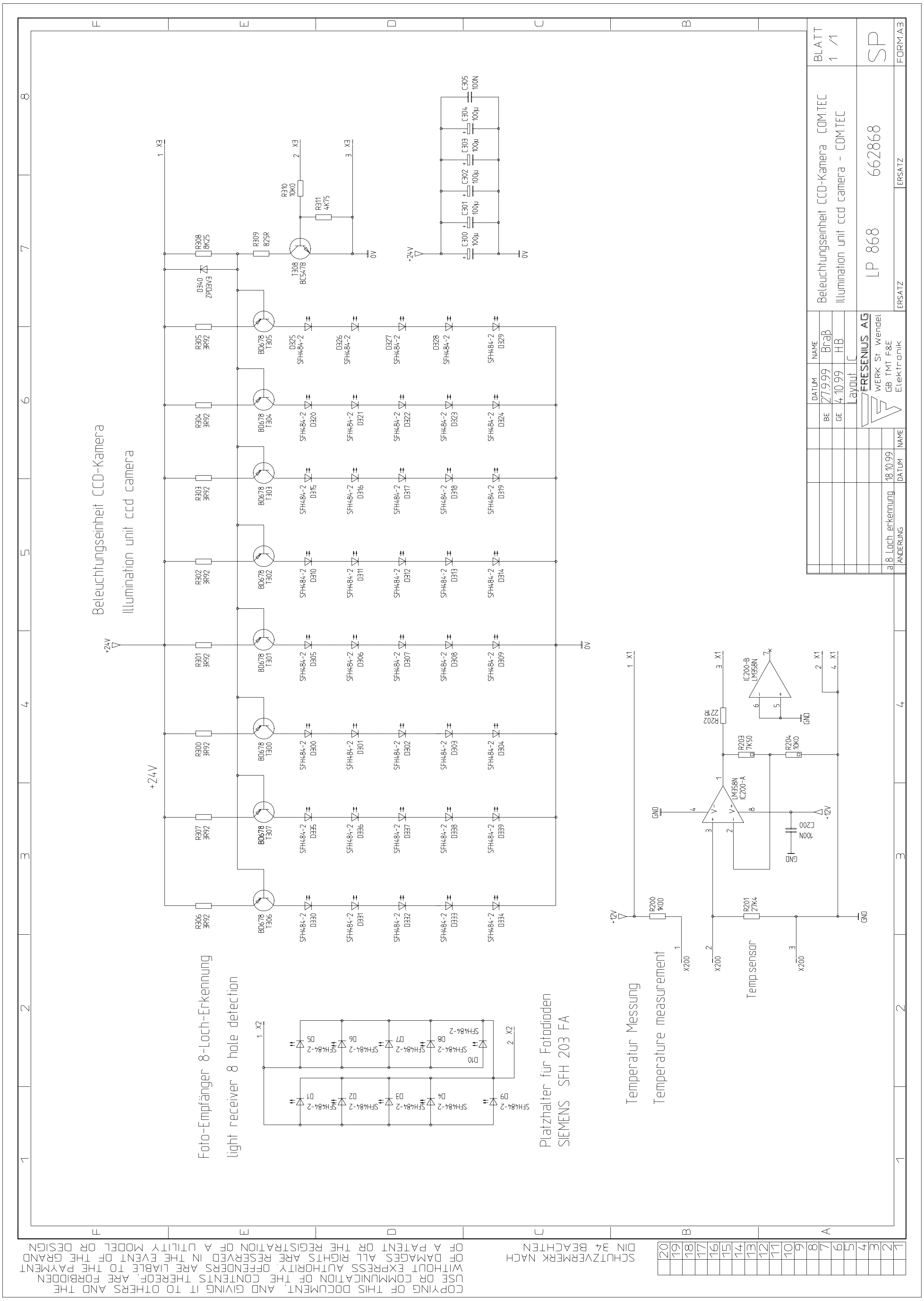
- **Temperature Detection**

The circuit part “temperature measurement” is used for detecting the temperature in the centrifuge space. The signal coming from the temperature sensor is amplified by IC200 and conducted via plug X1 to the CAN-I/O card P.C.B. LP 830.

- **Interface Detection**

The photo-diodes D1 to D8 are needed for the interface detection with 8 hole series (C4 and PL1 chamber). The photo-current of the diodes is conducted via plug X2 to the interface receiver P.C.B. LP 863.


X3
X2
X1
C200
C303
C300
C302
C301
C304
C305
R310
R202
R203
IC200
R204
R200
R201
R311
T308
R309
R308
D340
X200
R307
R304
R302
R303
T303
T300
R300
R301
R305
R306
T307
T304
T302
T301
T305
T306
Beleuchtungseinheit CCD-Kamera AS.TEC 205
Illumination unit ccd-camera AS.TEC 205
LP868
662868
BLATT
BP
FORM.A4
FRESENIUS AG
WERK SCHWEINFURT
DATUM
NAME
BE
30.03.99
Th. Klöffel
GE
30.03.99
Mü
Layout
C
a 8 Loch erkennung
18.10.99
ÄNDERUNG



Beleuchtungseinheit CCD-Kamera
Illumination unit ccd camera
Foto-Empfänger 8-Loch-Erkennung
light receiver 8 hole detection
Platzhalter fur Fotodioden
SIEMENS SFH 203 FA
Temperatur Messung
Temperature measurement
Temp.sensor
Beleuchtungseinheit CCD-Kamera COM.TEC
Illumination unit ccd camera - COM.TEC
LP 868
662868
FRESENIUS AG
WERK St. Wendel
GB TMT F&E
Elektronik
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SCHUTZVERMERK NACH DIN 34 BEACHTEN

3.30 P.C.B. LP 869 Clamp Control

3.30.1 Circuit Description

- **General Functional Description**

P.C.B. LP 869 serves to activate five motor-driven line clamps which can be set to different positions. They are activated via the CAN BUS. Safety-relevant positions of the clamps are monitored redundantly. To fulfill these tasks, the printed circuit board is provided with the following items:
– a power unit with motor drivers,
– a microcontroller for all control tasks,
– a microcontroller for monitoring tasks.

For reduction of problems arising in conjunction with EMC, the power supply of the power unit is DC-decoupled from the control and monitoring units by means of an optocoupler.

- **Power Unit with Motor Drivers**

ICs 109 to 113 represent full bridge drivers, each of which drive the motor of a motor clamp. All drivers are provided with a current measuring resistor at their pin 1. The voltage drop of the current measuring resistor is directed to the ICs 101 to 103. Each of these circuits is equipped with two current regulators which limit the output current of the motor drivers. The clock pulse signal for all current regulators is generated in IC103 and transmitted to pin 3 of ICs 101 to 103. Via pin 4 of the Ics, a PWM signal to control the motor voltage can be fed in. If it is carrying high level, the output of the optocoupler IC227 releases or activates the power drivers IC109 to IC113. High levels at the outputs of the optocouplers IC222 to IC226 each determine the direction of rotation of the motors at the respectively connected driver. For example, a high level at the optocoupler IC223 causes the motor of the saline diversion clamp to rotate in backward direction, while the same motor rotates in forward direction if IC223 is active. If both control lines are low or high at the same time, the motors are decelerated by a generator, if the power drivers are released. The maximum possible motor current is computed from the voltage applied to the reference inputs of IC101 to IC103 (pin 16 and pin 17 of each), divided by the value of the current measuring resistor R104 to R108.

- **Microcontroller for Control Tasks**

The microcontroller IC201 comprises a usual controller function and, in addition, a CAN BUS connection, which is used to exchange the necessary control and status information with the control system of the machine. The clamp motors are separately activated by optocouplers via ports 0 and 5 of the controller. In addition to the status indicator, the 4 light-emitting diodes D1 to D4 can be turned on and off, depending on the program. The positions of all clamps, which are scanned by means of optical sensors, are read in via ports P2 and AN. A HEX switch, whose position is read in for controlling the program, is connected to the four lower inputs of port 4. The reset circuit IC221 ensures that the controller starts running correctly as soon as the operating voltage is switched on.

- **Monitoring Circuit**

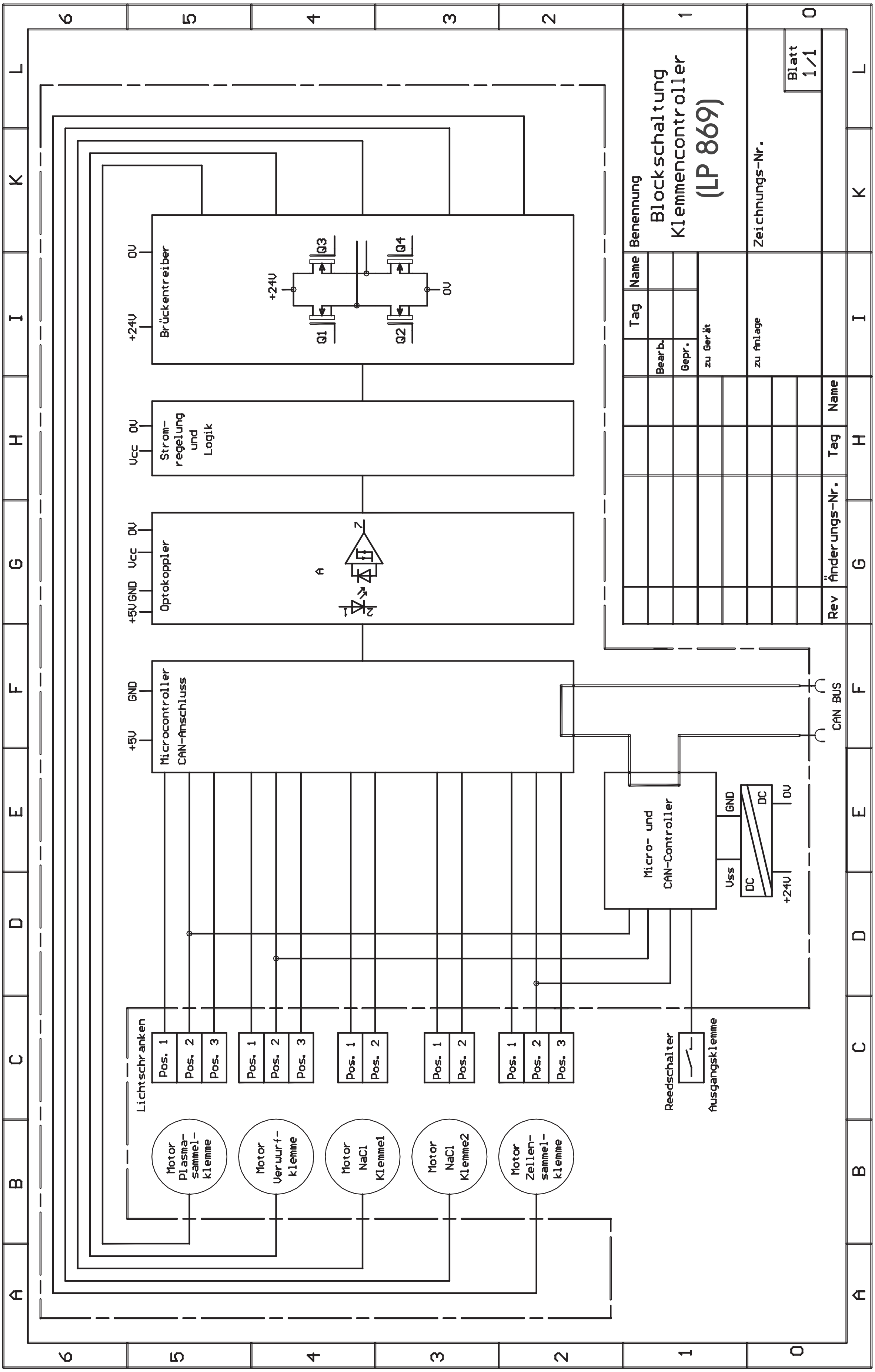
For safe monitoring of the four clamp positions, the printed circuit board comprises a second controller IC 314 with additional CAN interface IC 315. The controller uses the inputs RC3 to RC5 to recognize whether the pertinent optical sensors are in that position which is to be safely monitored. If this is the case, the controller can, by briefly activating the transistor T302, check whether the signals of the optical sensors are changing correspondingly. All signal lines are decoupled via resistors, so that any faulty feedback from the control and monitoring controller is prevented. Input RC6 is used to monitor the position of the reed switch at the output clamp. All of the information thus obtained is compared with the data reaching the controllers via the CAN BUS. Any detection of a dangerous difference causes the corresponding alarm messages to be emitted. The CAN BUS is energized by means of the driver modules IC 319 and IC 320 for one controller each.

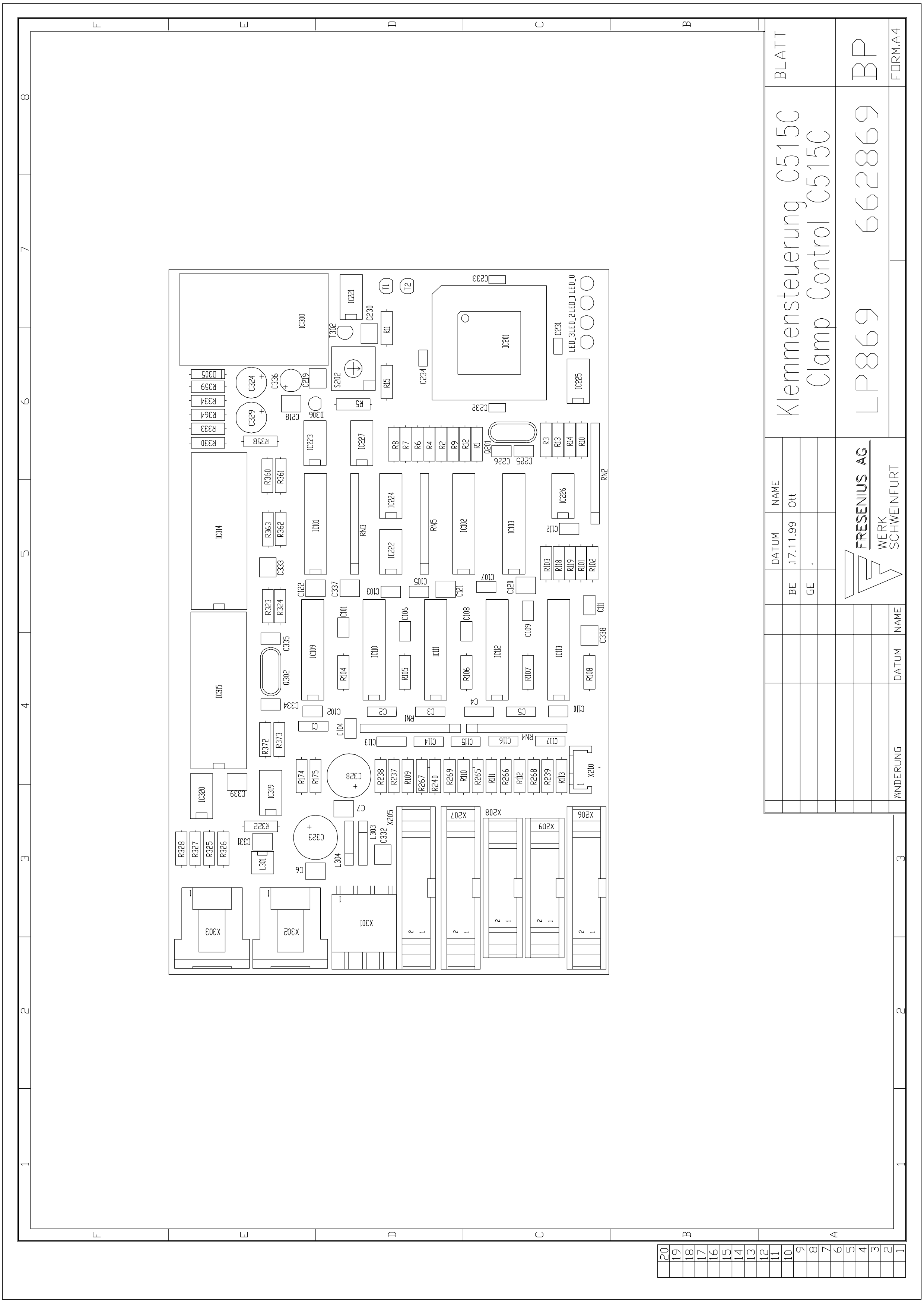
- **Diagnose LEDs**

The LEDs listed below indicate the following faults and transitional modes:

LED	Description	On	Off
LED0	Processor status CPUR: CPU RUNNING	CPU operational mode is not correct. Serious fault: operation not possible. Processor not in operation.	CPU ready for operation. CPU is in operation and works properly.
LED1	Clamp alarm	At least one clamp has triggered an alarm. A clamp alarm can be triggered through time-out or fault of the optical sensor. *Time-out:* When the target position is not found, e.g. the cable is pulled off. *Fault of the optical sensor:* When more than one position of the optical sensor is active, e.g. the optical sensor is defective or cable, plug or circuit board are short circuited. Serious fault: Clamp positioning not possible.	Alarm
LED2	CAN fault occurred	At least one CAN fault has occurred. The faults are counted in the fault counters and then stored. If there are a great number of faults, the transmission is faulty. This may result in the operation being obstructed.	No fault
LED3	Clamp drive	While selecting a clamp drive the LED 3 is switched on. No fault: normal operational indication; the drive selection for clamp is just moved to new position.	No drive in operation

Fig.: Block Diagram of Clamp Control P.C.B. LP 869




Klemmensteuerung C515C
Clamp Control C515C
LP869 662869
BLATT
BP
FORM.A4
FRESENIUS AG
WERK SCHWEINFURT
DATUM
NAME
BE
17.11.99
Ott
GE
ÄNDERUNG

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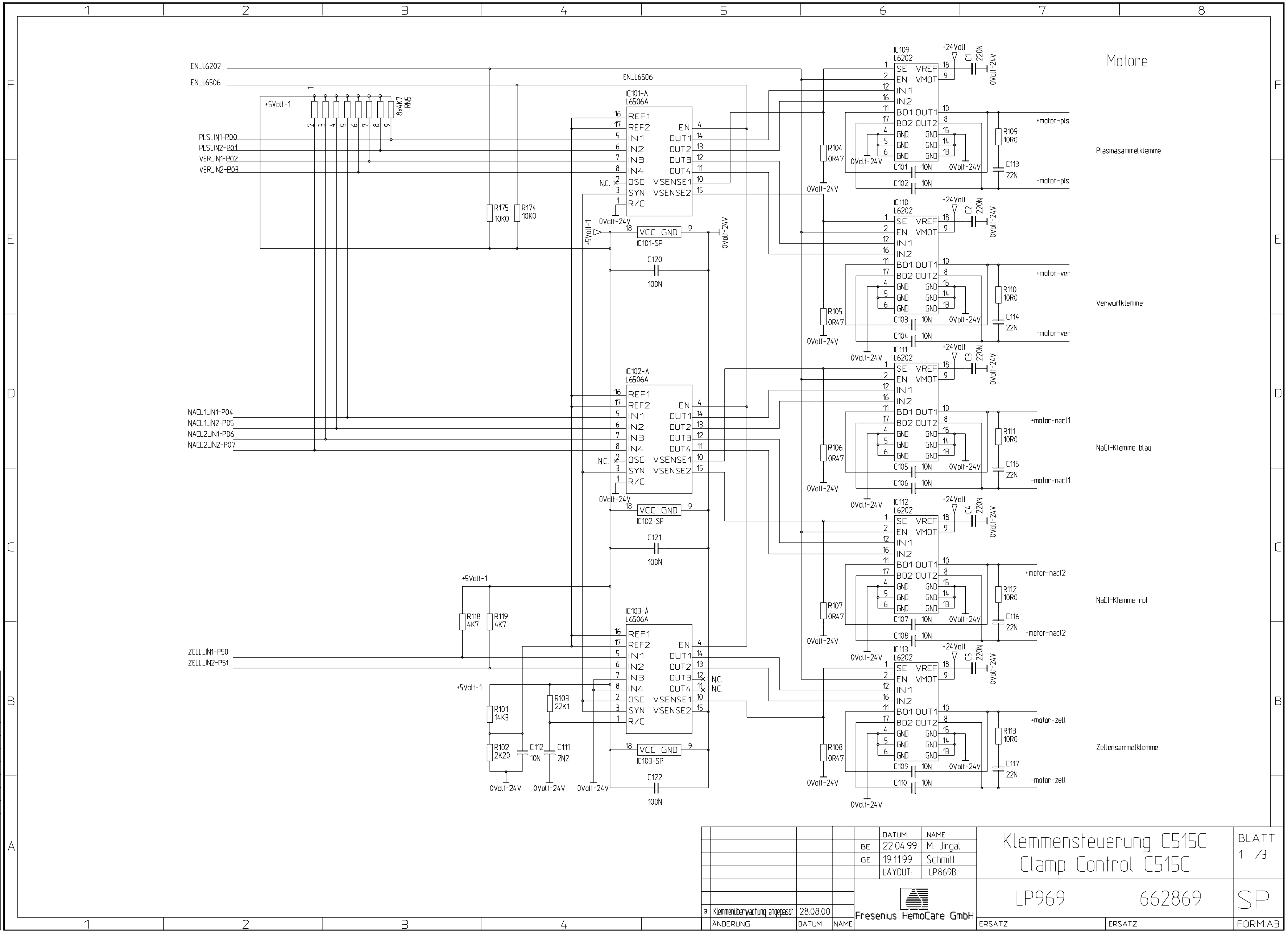

P.C.B. LP 869

Circuit Diagram 1/3

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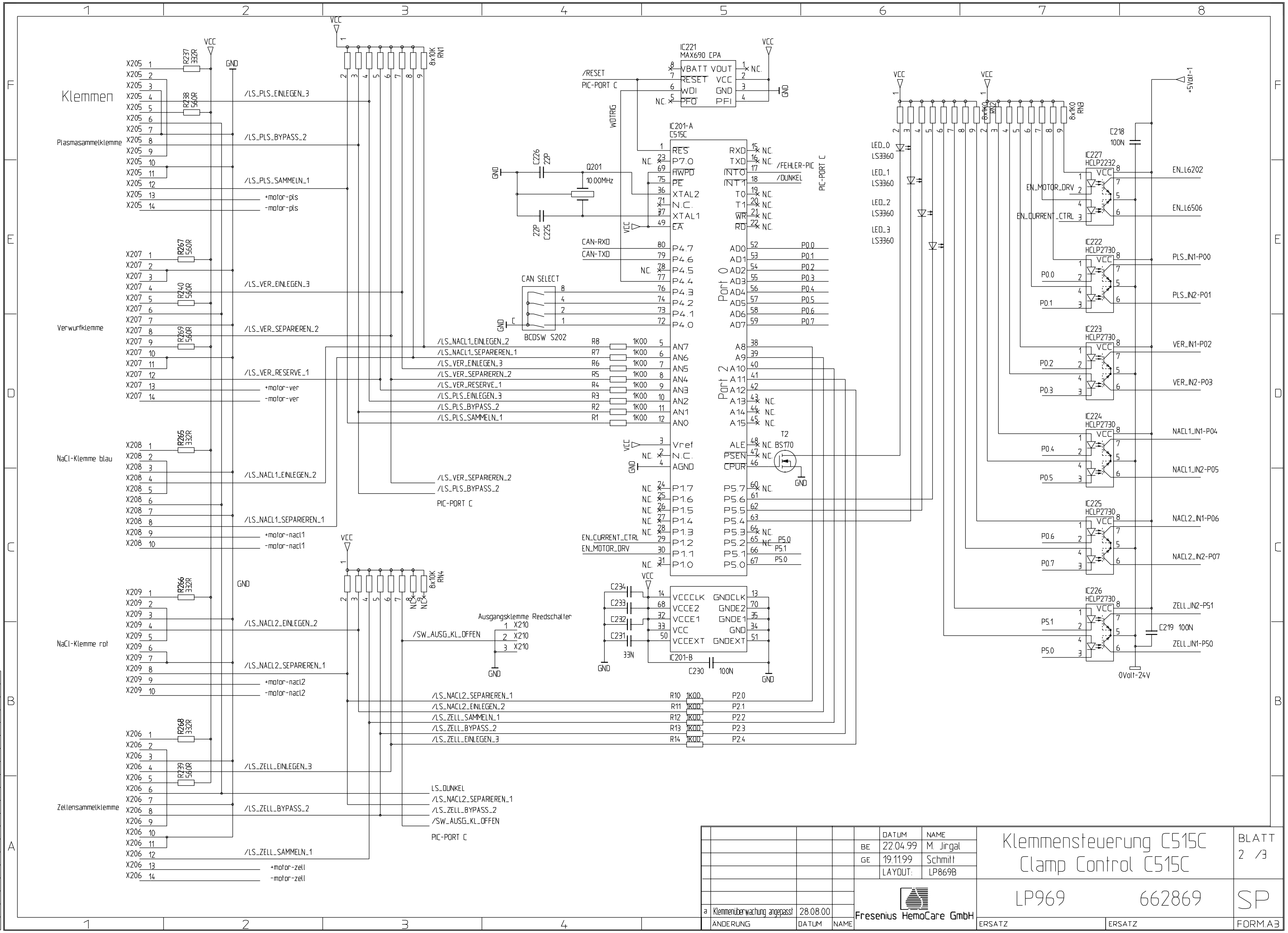
SCHUTZVERMERK NACH DIN 34 BEACHTEN.



P.C.B. LP 869

Circuit Diagram 2/3

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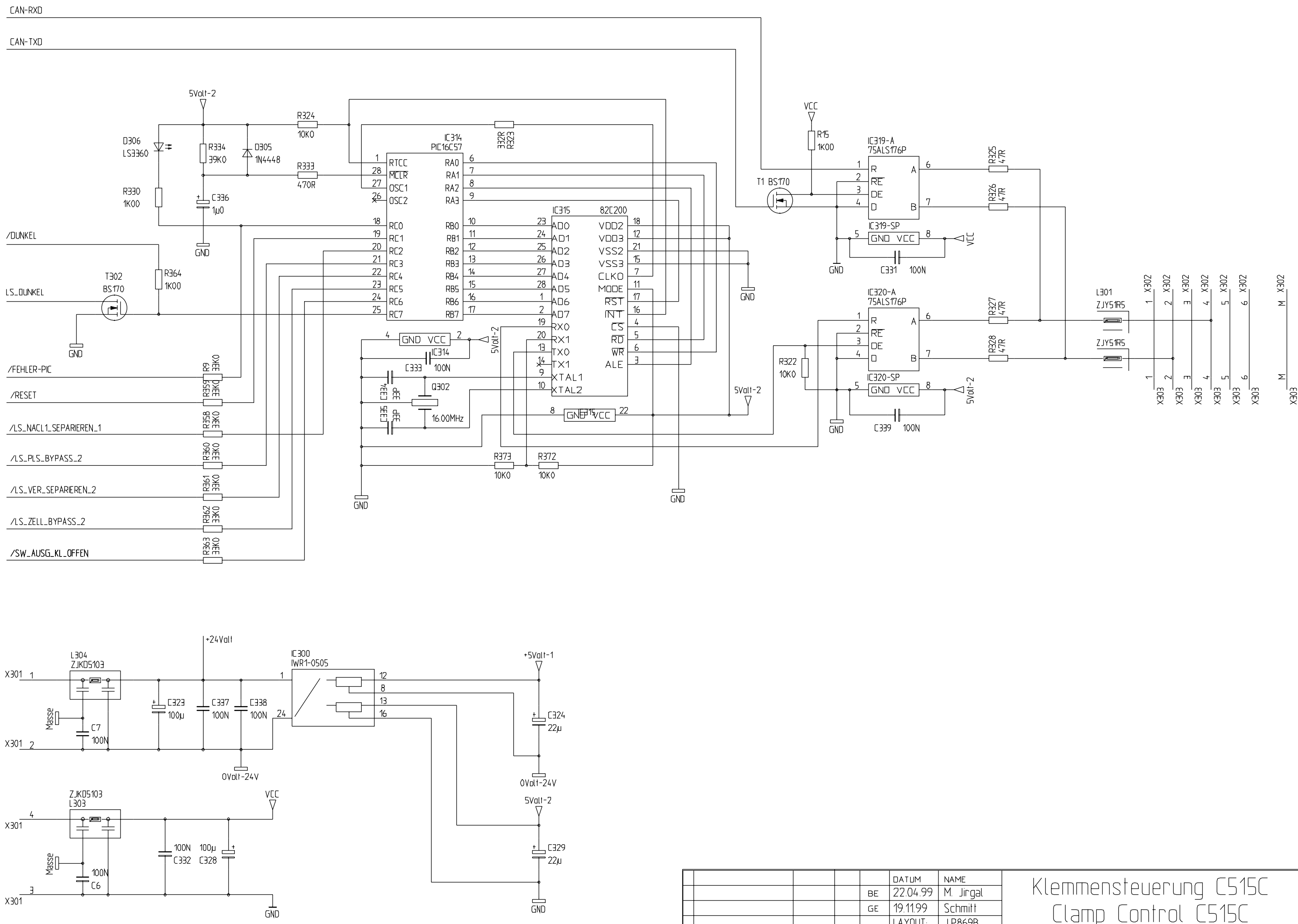
SCHUTZVERMERK NACH DIN 34 BEACHTEN.



	DATUM	NAME	Klemmensteuerung C515C	BLATT
BE	22.04.99	M. Jirgal	Clamp Control C515C	3 /3
GE	19.11.99	Schmitt		
	LAYOUT:	LP869B		
Fresenius HemoCare GmbH			LP969 662869	SP
			ERSATZ / ERSATZ	FORM.A3

a	Klemmenüberwachung angepasst	28.08.00	
	ÄNDERUNG	DATUM	NAME

P.C.B. LP 869

Circuit Diagram 3/3

3.31 P.C.B. LP 870 Pressure Monitor

3.31.1 Circuit Description

- **Design and Purpose**

The component P.C.B. LP 870 is used to measure three different system pressures in the blood cell separator and to monitor the alarm limit values for being exceeded or not reached. At the same time, the current pressure and the pre-set alarm limits are indicated on a bar graph display with 30 LEDs.

Each component P.C.B. LP 870 consists of the following circuit parts:

For one pressure measuring channel each (three channels per component P.C.B. LP 870):
– piezo resisting pressure sensor
– intermediate circuit
– PIC-RISC controller:
for selecting the bar graph display
for generating alarm signals
for generating voltage proportional to pressure
for carrying out and storing the calibration

For each component P.C.B. LP 870:
– circuit part for carrying out the alarm test
– power supply unit

- **General Functional Description**

Pressure Sensor and Amplifier

The output signals of the piezo resisting measuring bridge from the pressure sensor are conducted to a measure amplifier. The degree of amplification and the offset of the amplifier unit are pre-set fixed.
In order to detect the value for pressure two analog voltages of the amplifier are read in through the PIC controller and calculated together with the values for offset and amplification deposited in a serial EEPROM.

PIC Controller

The PIC controller 16C73 is used in the component P.C.B. LP 870 for selecting the bar graph display, for generating the alarm signals, for generating the voltage proportional to pressure and for carrying out and storing the calibration.

The PIC controller selects the bar graph display with 30 LEDs via six of its outputs. The value for pressure is calculated from one of the analog voltages of the amplifier and the values for offset and amplification deposited in an EEPROM and are compared with the pre-set alarm limit values.

The alarm limit values can be selected with an encoding switch; three pairs of limit values (upper and lower alarm) can be selected and in one position values specific to the user can be set.
0 Normal operation, alarm limits are those limits set during balancing
1 Normal operation, alarm limits ± 300 mmHg
2 Normal operation, alarm limits ± 300 mmHg
3 Normal operation, alarm limits + 300 mmHg, –100 mmHg.

When the limit values are exceeded, a cycle which exists in the alarm free state at the controller exit, is switched off; this causes the output of the hardware alarm system of the blood cell separator COM.TEC to change from 12 V to 0 V.
The PIC controller generates a pressure proportional voltage through a pulse amplitude modulation (PWM). For this purpose, the PWM is converted by an active filter into direct voltage and amplified; the output voltage is fed back by the PIC controller via an A/D converter input and controlled. This voltage is utilised in the blood cell separator COM.TEC for generating e.g. software preliminary alarms, or in the case of detecting small changes of pressure in the system.

In addition, the calibration of the component is carried out with the help of the PIC controller. For this purpose a button is connected to the component, the encoding switch turned to position “zero point” and at 0 mmHg pressure the button is pressed; the same is carried out in the position “pressure” of the encoding switch during a determined existing pressure (see calibration instruction).
From the above the PIC controller calculates the values for amplification and offset and stores these in the serial EEPROM; the process of storing is only possible when the hardware write protection of the EEPROM is not activated (certain positions of the turn switch); this is intended to prevent unintentional overwriting of the stored values in the EEPROM through a program error or external spurious signals (ESD).
The values are deposited in the EEPROM redundant so that flipping over of individual bits is detected in the EEPROM.

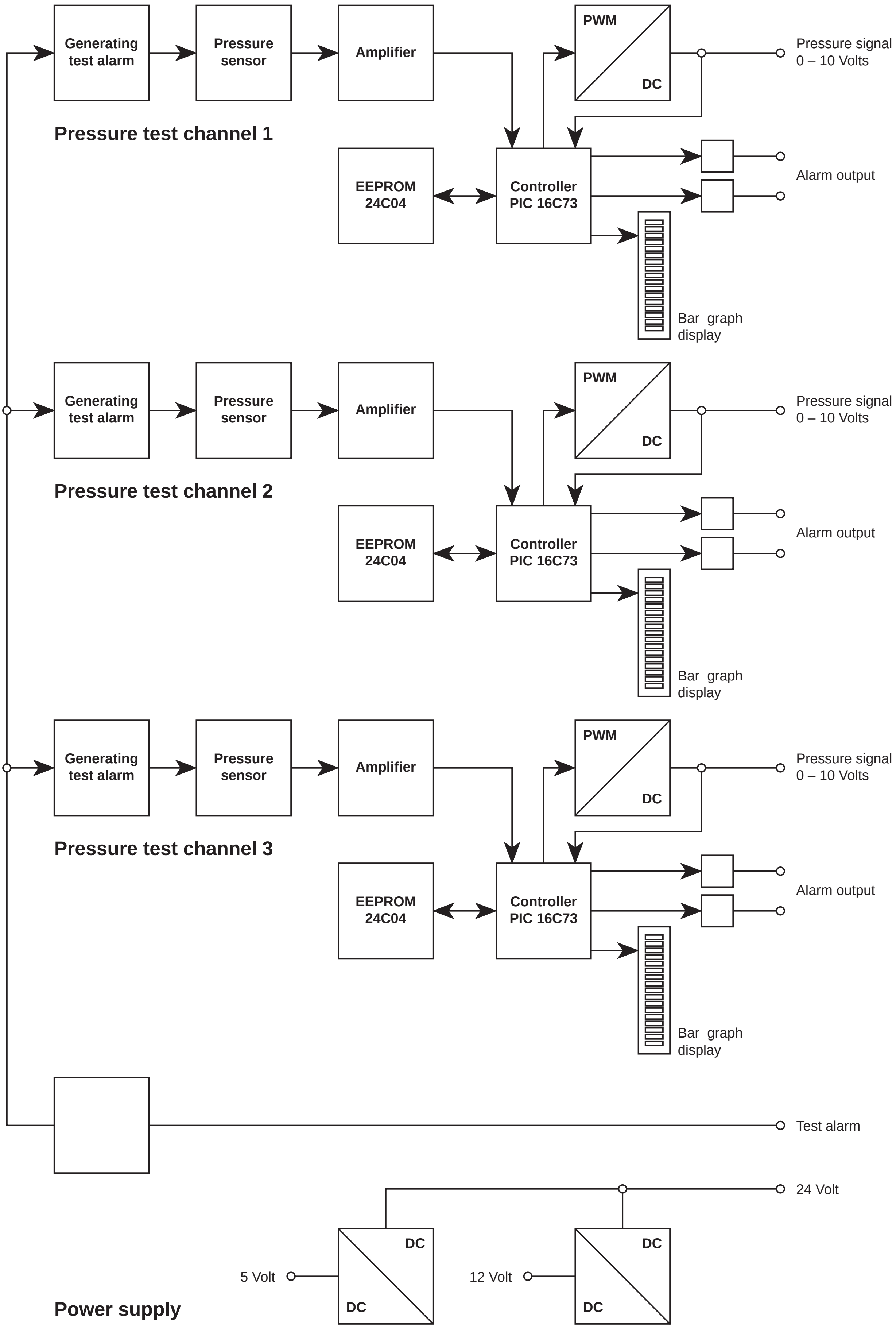
Alarm Test

The joint circuit part for carrying out the alarm test is independent of the PIC controllers of the individual pressure measuring channels.
The test alarm signal arrives externally at a level-controlled Monoflop which detunes the measuring bridge of the pressure sensor with respect to alarm limits via analog switch and resistors.
In an alarm test the measuring bridge is just enough detuned so that the next LED after the alarm limit lights up.

Power Supply Unit

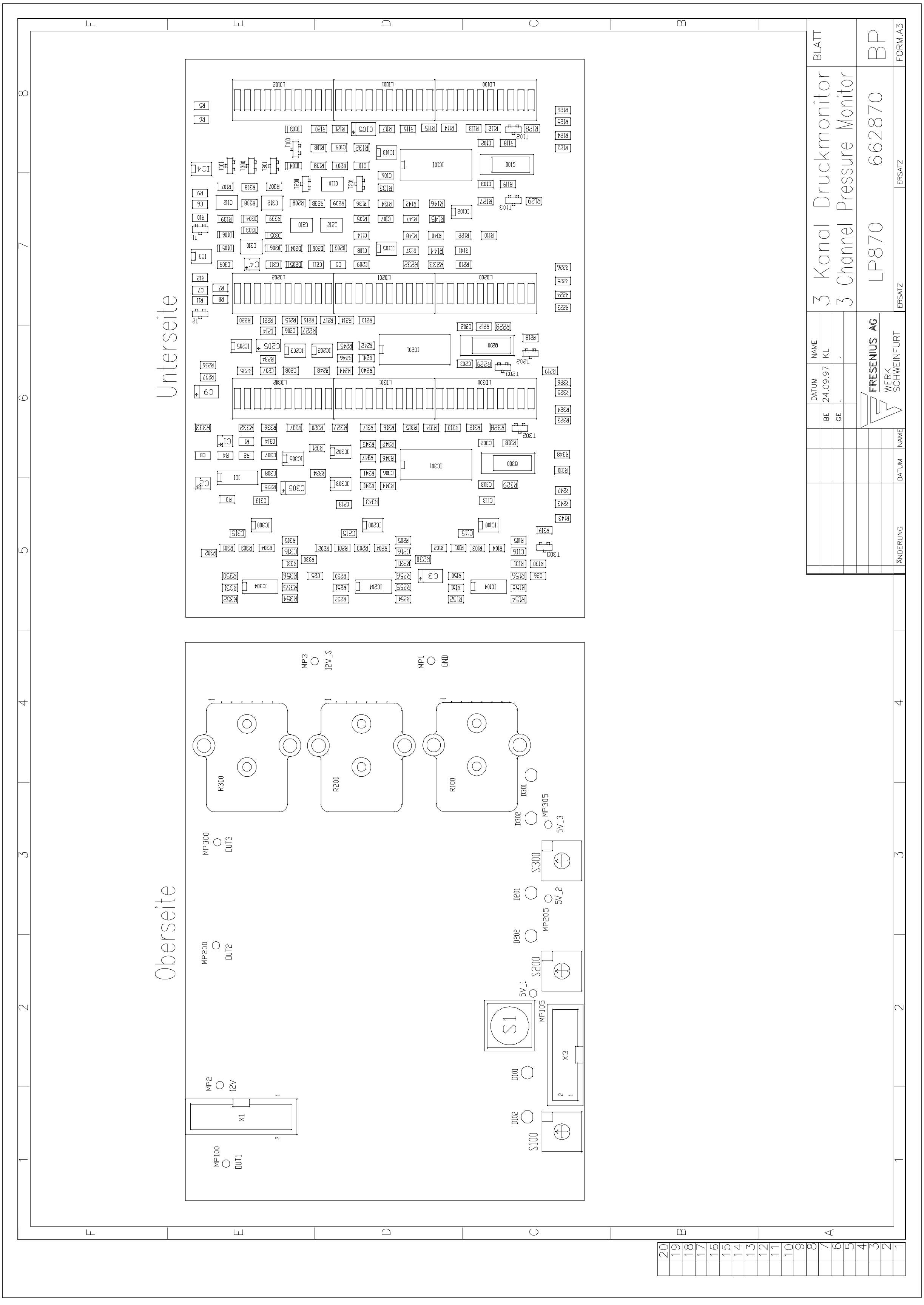
A power supply unit generates the supply voltage for the analog part (12 V) and controller part (5 V) of the component. Both supply voltages are converted from 24 volt.
The voltage control is realised through a linear controller, using for each voltage (5 V, 12 V) several voltage controller in order to keep the loss of the individual components to a minimum.

Fig.: Block Diagram of P.C.B. LP 870



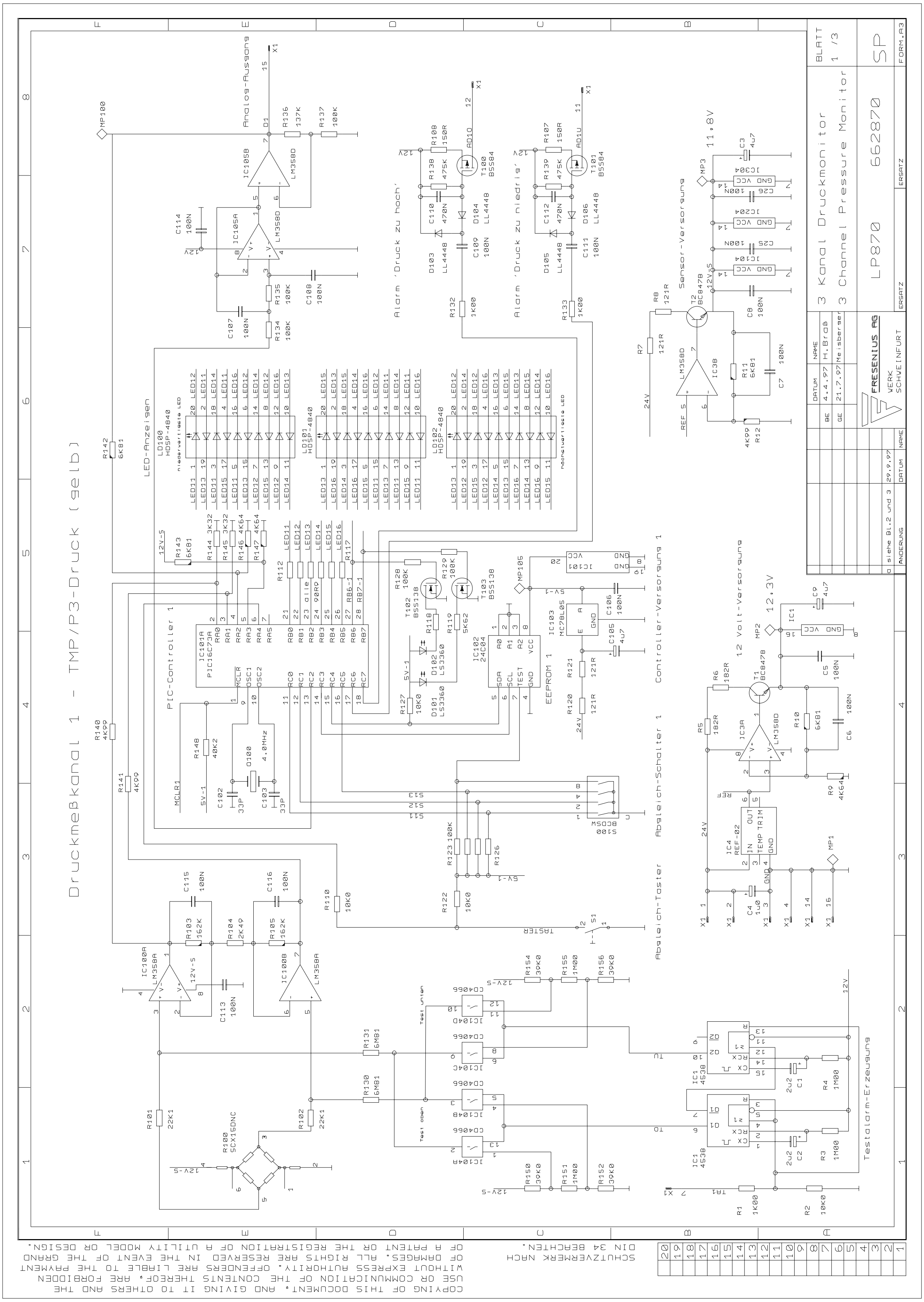
P.C.B. LP 870

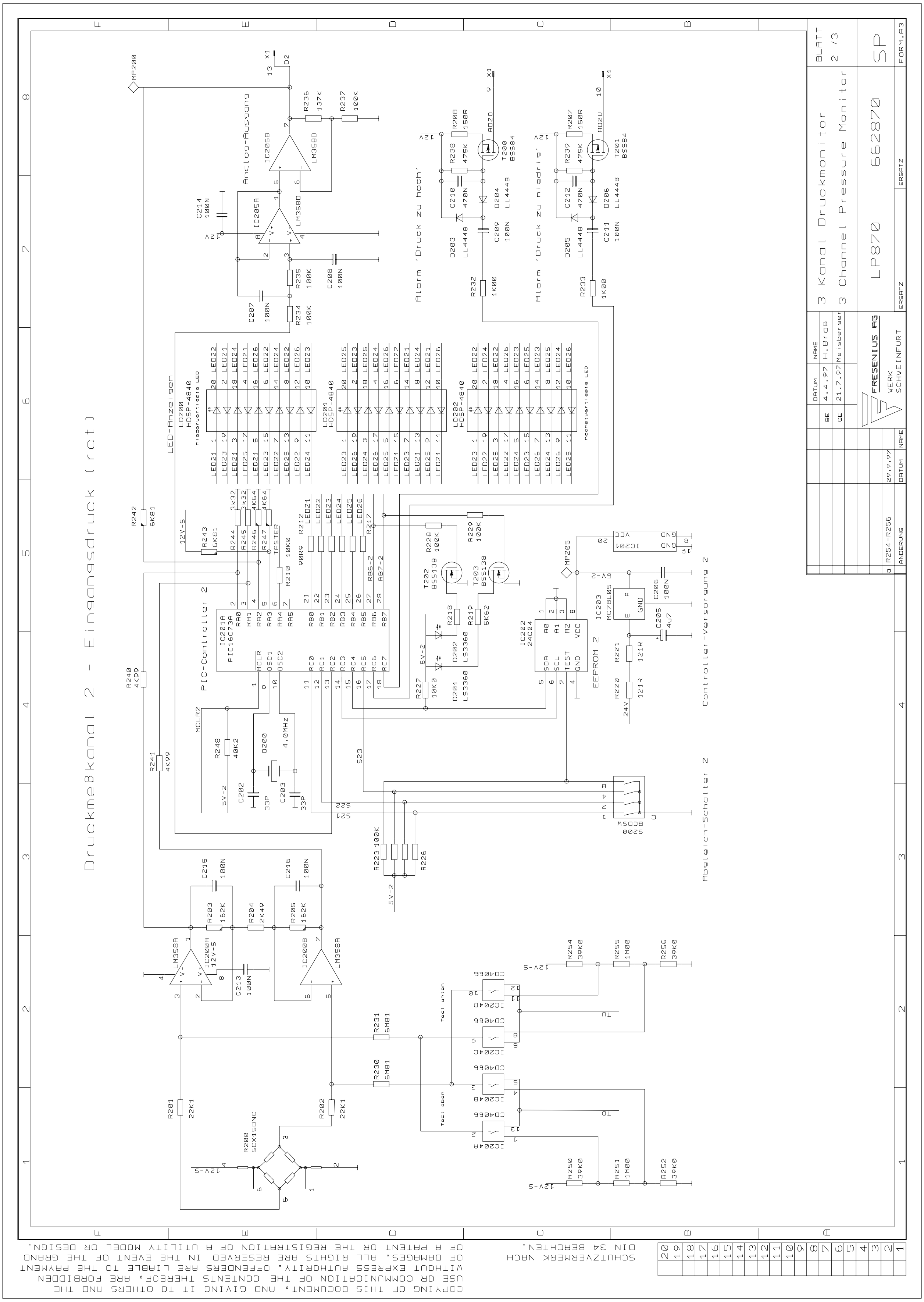
Component Layout Diagram



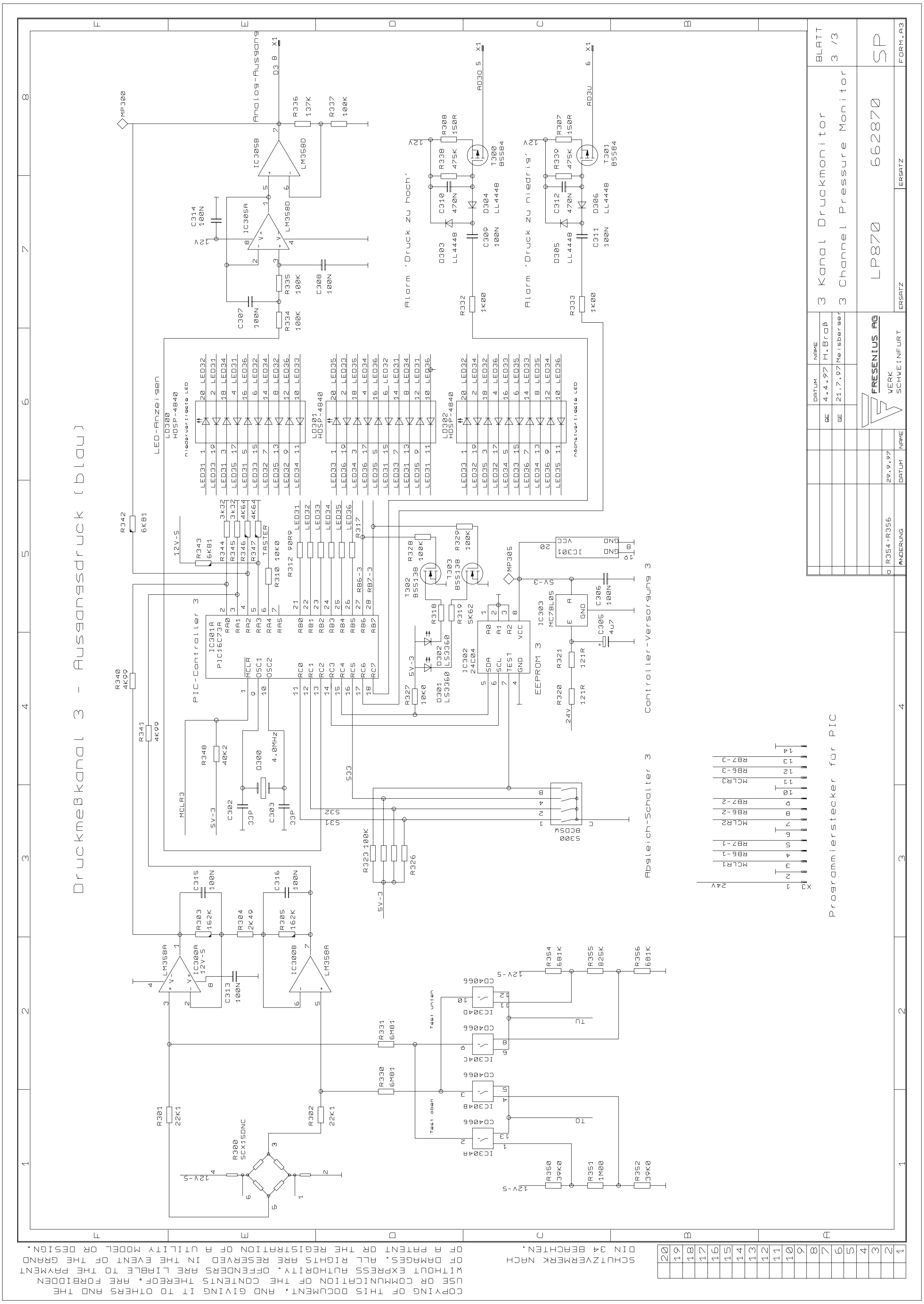
P.C.B. LP 870

Circuit Diagram 1/3





3 Kanal Druckmonitor
3 Channel Pressure Monitor
LP870
662870
FRESENIUS AG
Druckmeßkanal 2 - Eingangsdruck (rot)



Druckmeßkanal 3 - Ausgangsdruck (blau)
PIC-Controller 3
EEPROM 3
Controller-Versorgung 3
Abgleich-Schalter 3
Programmierstecker für PIC
LED-Anzeigen
3 Kanal Druckmonitor
3 Channel Pressure Monitor
LP870
662870
FRESENIUS AG

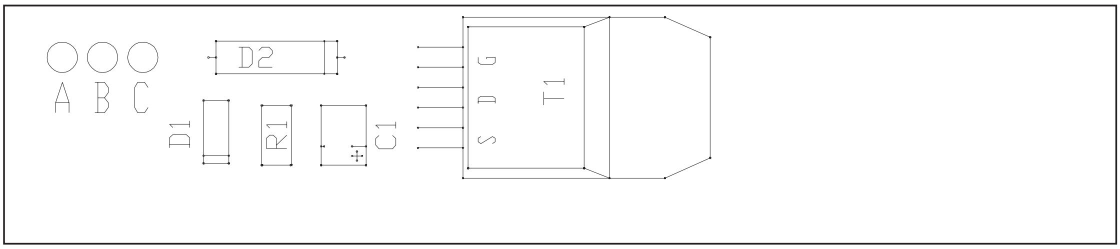
3.32 P.C.B. LP 945 Printer Adapter (Seiko)

- **Function**

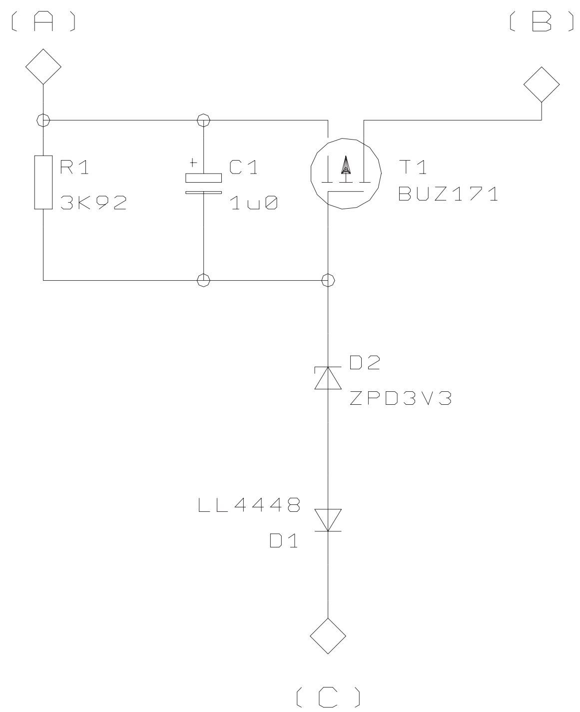
P.C.B. LP 945 is used to simultaneously switch the Seiko printer and the COM.TEC on and off.

Charging the internal printer batteries:
– COM.TEC off: the internal printer batteries are not being charged.
– COM.TEC on: printer off: the internal printer batteries are being charged.

- **Component Layout**



- **Circuit Diagram**



Fresenius HemoCare

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Fresenius Transfusions GmbH Landsteinerstraße 5 D-63303 Dreieich	Fresenius HemoCare Deutschland GmbH Produktionsbereich Geräte Hafenstraße 9 D-97424 Schweinfurt
Tel.: 06103/801814 Fax: 06103/801672	Tel.: (+49) 9721/678-803 Fax: (+49) 9721/678-806

Name:	Kundennummer / Customer Account No.:
Position:	Firma / Company:
Adresse / Adress:	
Telefon / Telephone:	Fax:

Pos.	Teile-Nummer Part number	Beschreibung Description	Anzahl Quantity

Bitte fotokopieren Sie dieses Formular so oft Sie es für Ihre Bestellungen benötigen.
Please photocopy this form and use as often as required to order your parts.

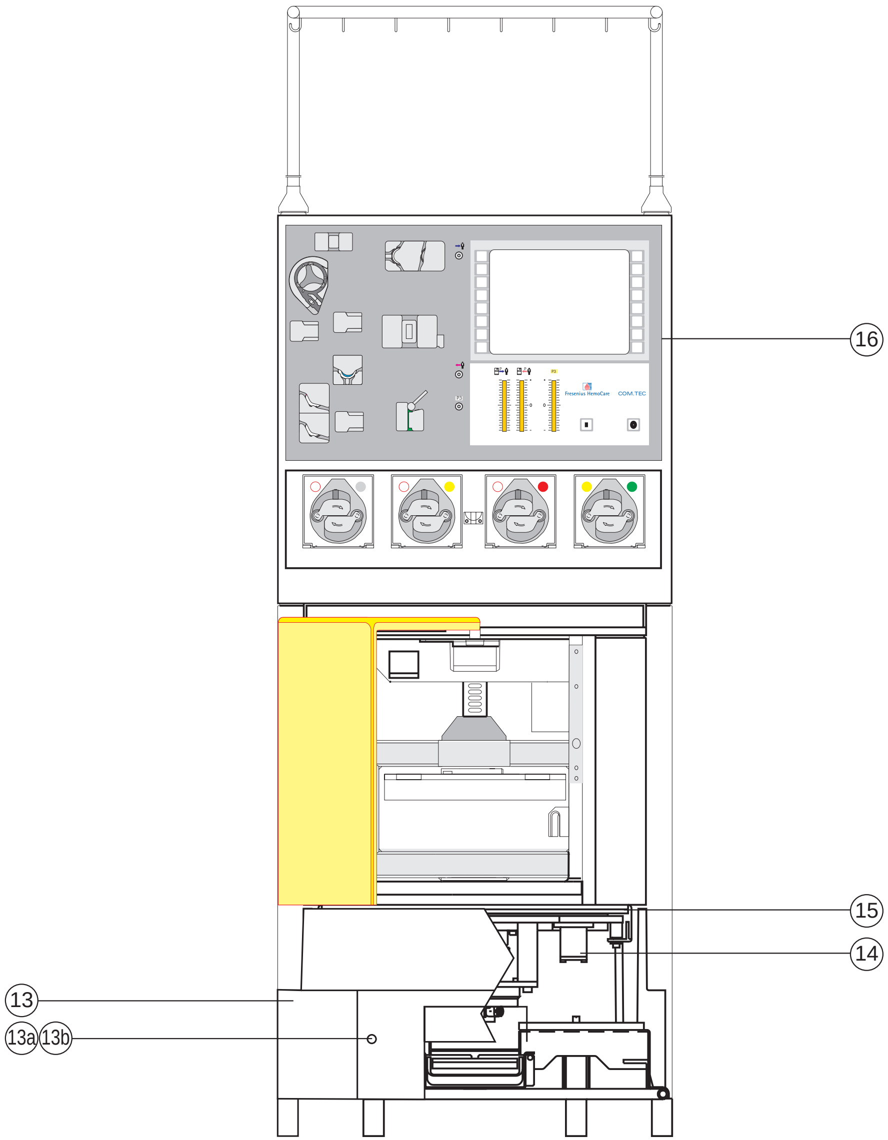
Pos.	Teile-Nummer Part number	Beschreibung Description	Anzahl Quantity

4 Ersatzteilkatalog Baugruppenübersicht

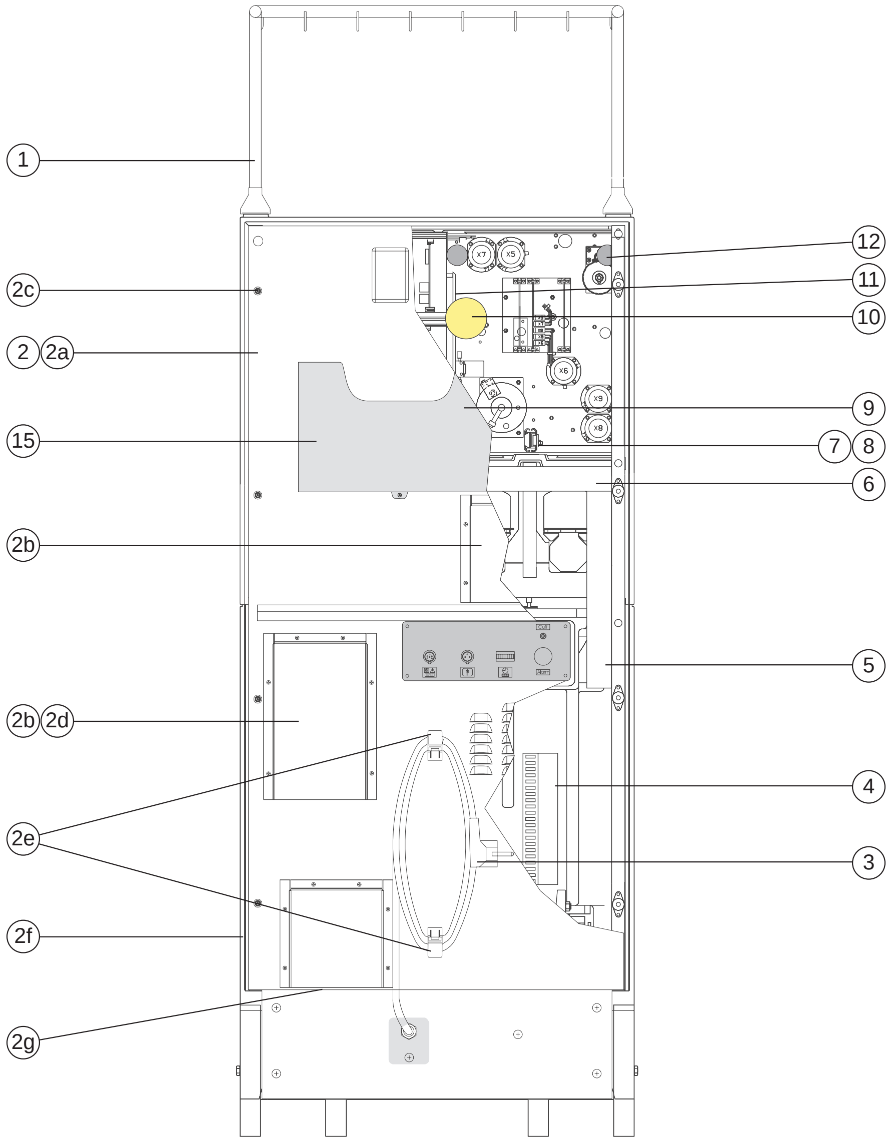
Spare Parts Catalog Table of Contents

1.0 Gehäuse
Housing

1.0 Gehäuse



1.0 Housing



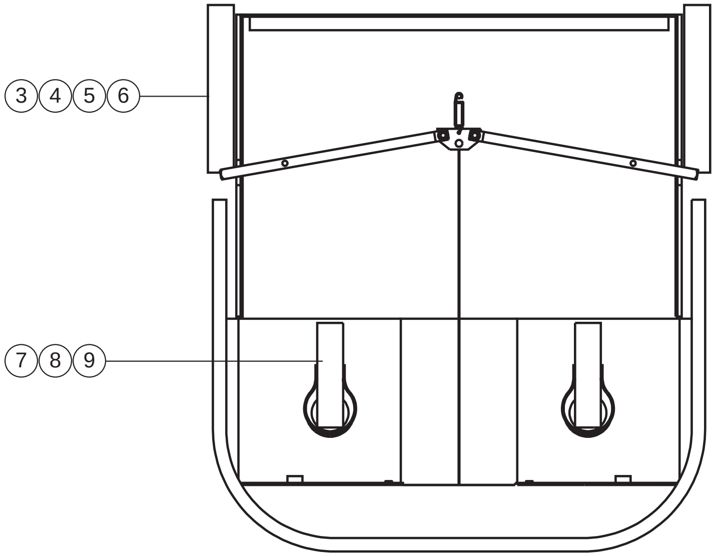
1.0 Gehäuse

1.0 Housing

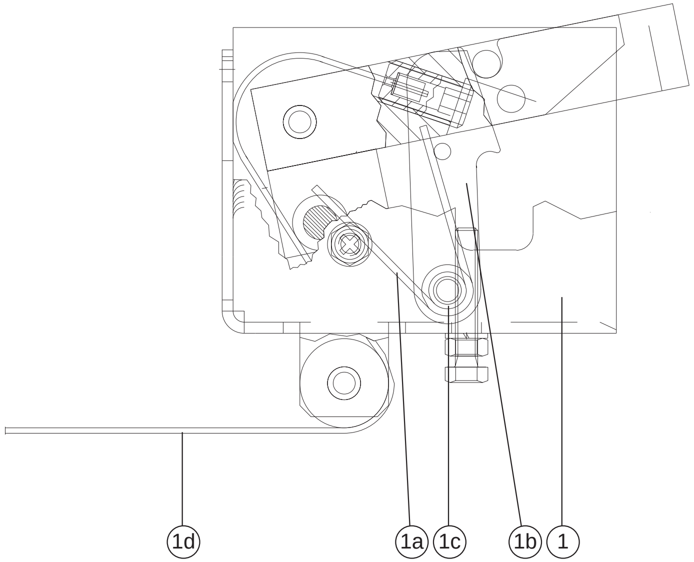
Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	673 079 1	Galgen	IV frame	1
2	679 687 1	RŸckwand komplett	Rear panel cpl.	1
2a	679 688 1	RŸckwand ohne Anbauteile	Rear panel without mounting parts	1
2b	670 419 1	LŸfter	Fan	2
2c	678 720 1	Verschlu§zapfen	Locking bolt	8
2d	670 422 1	Schutzgitter	Guard	1
2e	674 577 1	Kabelhalter	Cable reel	2
2f	675 101 1	Dichtung RŸckwand (Seite / oben)	Rear panel gasket (side / top)	
2g	674 127 1	Dichtung RŸckwand (unten)	Rear panel gasket (bottom)	
3	640 084 1	Netzkabel mit Eurostecker	Power cable with European plug	1
4	675 835 1	Verdrahtungskanal L=200	Wiring duct, length=200	1
5	675 834 1	Verdrahtungskanal L=300	Wiring duct, length=300	1
6	675 833 1	Verdrahtungskanal L=530	Wiring duct, length=530	1
7	660 812 1	Teleskopschiene	Telescopic rail	2
8	661 063 1	Feder	Spring	2
9	675 402 1	Unterlagenbox	File box	1
10	533 203 1	Lautsprecher	Loudspeaker	1
11	661 107 1	Prozessoreinschub	Processor slot	1
12	661 058 1	SpindelfŸhrung komplett	Spindle guide	3
13	674 942 1	Service-Blende	Service cover	1
13a	674 964 1	Inbusschraube mit Schaft	Allen screw with shank	2
13b	643 383 1	Abdeckkappe schwarz	Cap, black	2
14	661 029 1	Unwuchtdetektor	Flutter detector	1
15	674 854 1	Dichtung Service-Blende	Service cover gasket	
16	660 699 1	Dichtung Frontplatte	Front panel gasket	

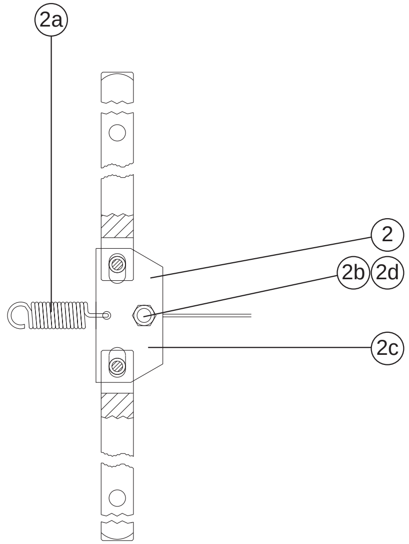
2.0 Bremse und Rollen
Brake and Castors

2.0 Bremse und Rollen



2.0 Brake and Castors





2.0 Bremse und Rollen

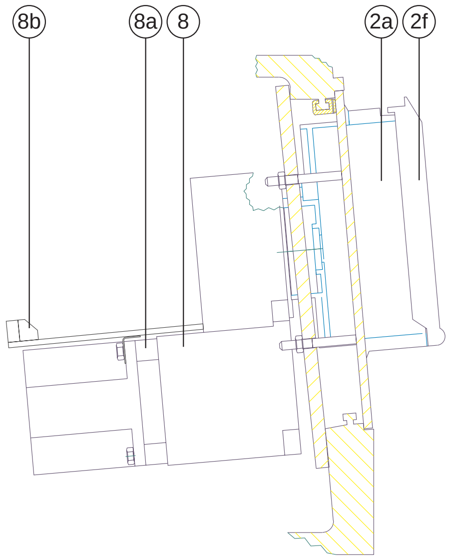
2.0 Brake and Castors

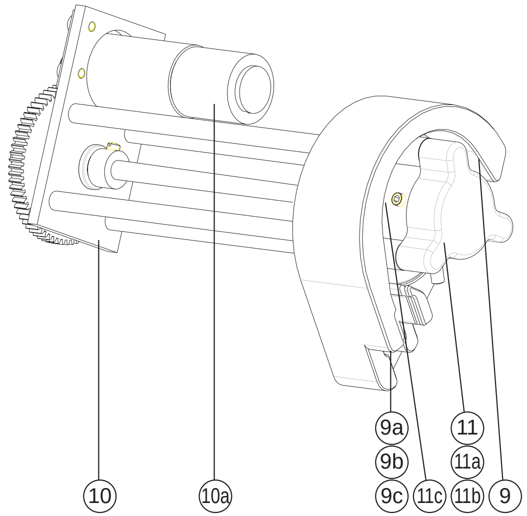
Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	653 249 1	Pedale komplett	Pedals cpl.	1
1a	653 172 1	Schenkelfeder	Leg spring	1
1b	653 159 1	Rasthebel	Notch lever	1
1c	563 150 1	Sicherungsscheibe fŸr Rasthebel	Retaining washer for notch lever	1
1d	653 261 1	Bremsseil	Brake cable	1
2	653 250 1	Bremshebel komplett	Brake lever cpl.	1
2a	673 470 1	Zugfeder	Tension spring	1
2b	678 112 1	Kabelklemmscheibe	Cable clamp plate	1
2c	661 012 1	Lenkerblech	Guide plate	1
2d	563 150 1	Sicherungsscheibe	Retaining washer	1
3	673 054 1	Rad	Wheel	2
4	643 083 1	Sechskantschraube/Rad	Screw/wheel	2
5	553 624 1	Sechskantschraube/Rad	Screw/wheel	2
6	553 696 1	Unterlegscheibe/Rad	Washer/wheel	2
7	673 053 1	Rolle drehbar	Swivelling castor	2
8	674 809 1	Unterlegscheibe/Rolle	Washer/castor	2
9	553 626 1	Sechskantmutter/Rolle	Nut/castor	2

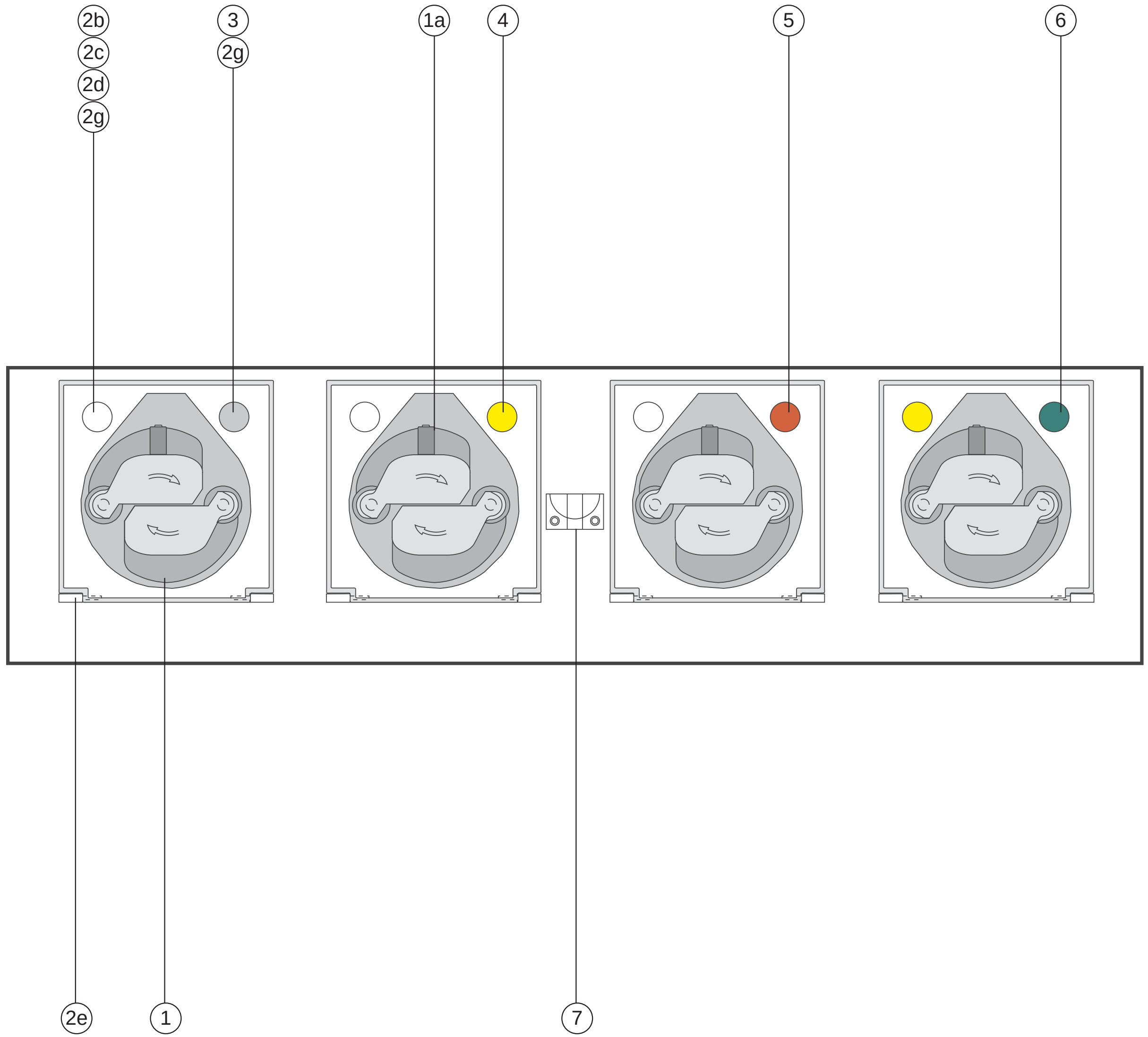
3.0 Schlauchpumpen und Pumpenbett
Line Pumps and Pump Housing

3.0 Schlauchpumpen und Pumpenbett

3.0 Line Pumps and Pump Housing







3.0 Schlauchpumpen und Pumpenbett 3.0 Line Pumps and Pump Housing

Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	660 922 1	Pumpen-Rotor komplett	Pump rotor cpl.	4
1a	661 102 1	EinfŠdelrolle ¿14 mm	Threading pin ¿14 mm	4
2	660 923 1	Pumpenbett komplett	Pump housing cpl.	4
2a	660 720 1	Pumpenbett (mit Magnetbleche u. Hallschalter)	Pump housing (including magnetic discs and hall switch)	1
2b	660 960 1	Klebefolie wei§	Adhesive film, white	1
2c	660 939 1	Klebefolie doppelseitig	Foil, adhesive on both sides	3
2d	671 867 1	Magnetblech	Magnetic disc	1
2e	567 172 1	Scharnierschraube	Hinge screw	2
2f	660 721 1	Deckel (ohne farbiges Magnetblech)	Cover (without colored magnetic disc)	1
2g	672 167 1	Dauermagnet (Deckel)	Permanent magnet (cover)	2
2h*	673 256 1	Hallschalter	Hall switch	1
2i*	673 255 1	Reedschalter	Reed switch	1
3	661 008 1	Magnetblech wei§	Magnetic disc, white	2
4	661 009 1	Magnetblech gelb	Magnetic disc, yellow	2
5	661 010 1	Magnetblech rot	Magnetic disc, red	2
6	661 011 1	Magnetblech grŸn	Magnetic disc, green	2
7	660 826 1	Halter	Holder	1
8	661 007 1	Pumpenantrieb kpl.	Pump drive cpl.	4
8a	673 067 1	Motor / Getriebe	Motor / Gear unit	1
8b	662 852 1	LP 852 Pumpensteuerung	LP 852 Pump control	1
9	679 375 1	Stator ACD-Pumpe komplett	ACD pump stator	1
9a	679 377 1	Schalteraufnahme	Switch casing	1
9b	679 379 1	Schaltelement	Switching element	1
9c	679 603 1	Mikroschalter	Microswitch	1
9d*	679 602 1	Hall-Schalter	Hall switch	1
9e*	679 659 1	Rillenkugellager	Deep groove ball bearing	2
10	679 592 1	Pumpenantrieb ACD-Pumpe komplett	ACD pump drive assy.	1
10a	M00 404 1	Motor und Getriebe 43:1	Motor and gear 43:1	1

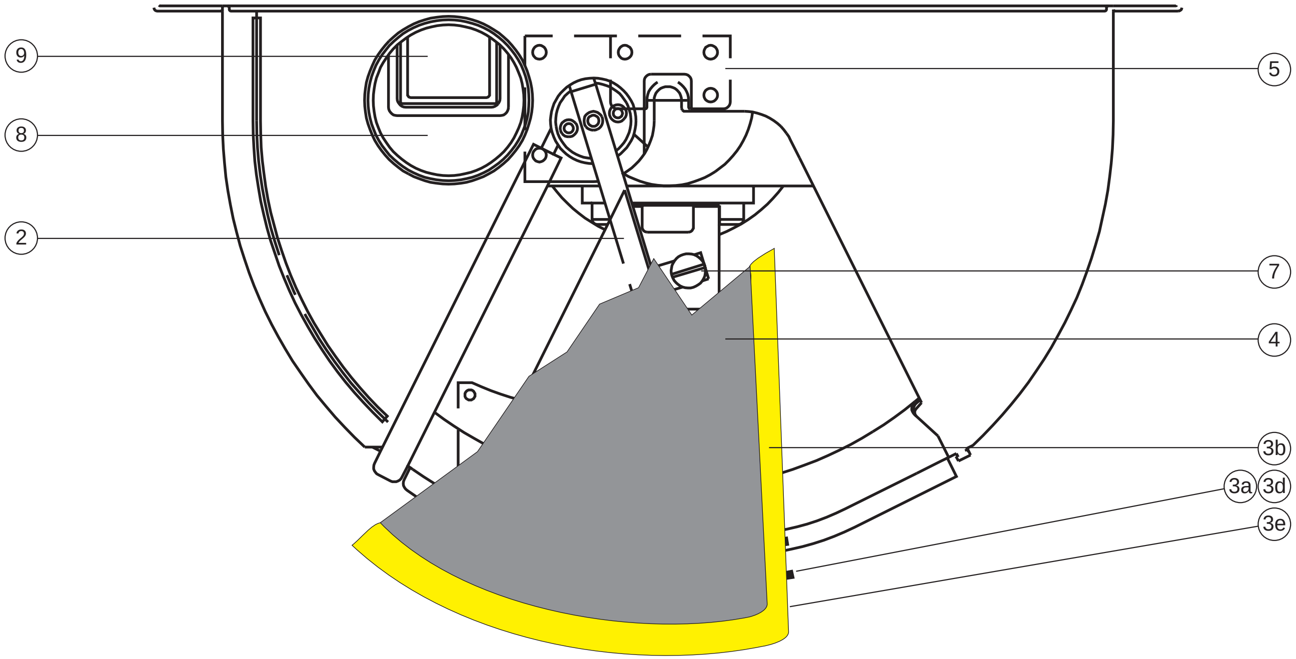
Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
11	679 677 1	Rotor ACD-Pumpe komplett	ACD pump rotor cpl.	1
11a	651 226 1	Dauermagnet	Permanent magnet	1
11b	674 196 1	Magnetabdeckung	Magnet cover	1
11c	562 014 1	Madenschraube	Stud screw	1
12*	679 380 1	Abstandshalter	Spacer	1

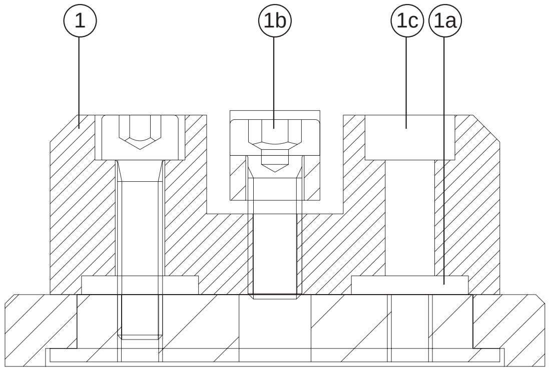
* nicht abgebildet / not illustrated

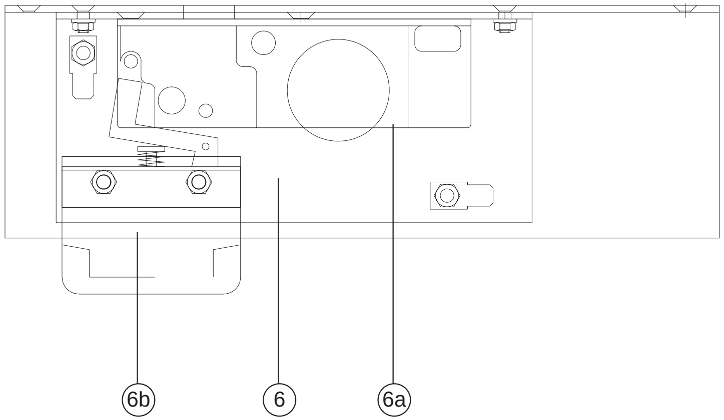
4.0 Zentrifuge und Tür
Centrifuge and Door

4.0 Zentrifuge und Tür

4.0 Centrifuge and Door







4.0 Zentrifuge und Tür

4.0 Centrifuge and Door

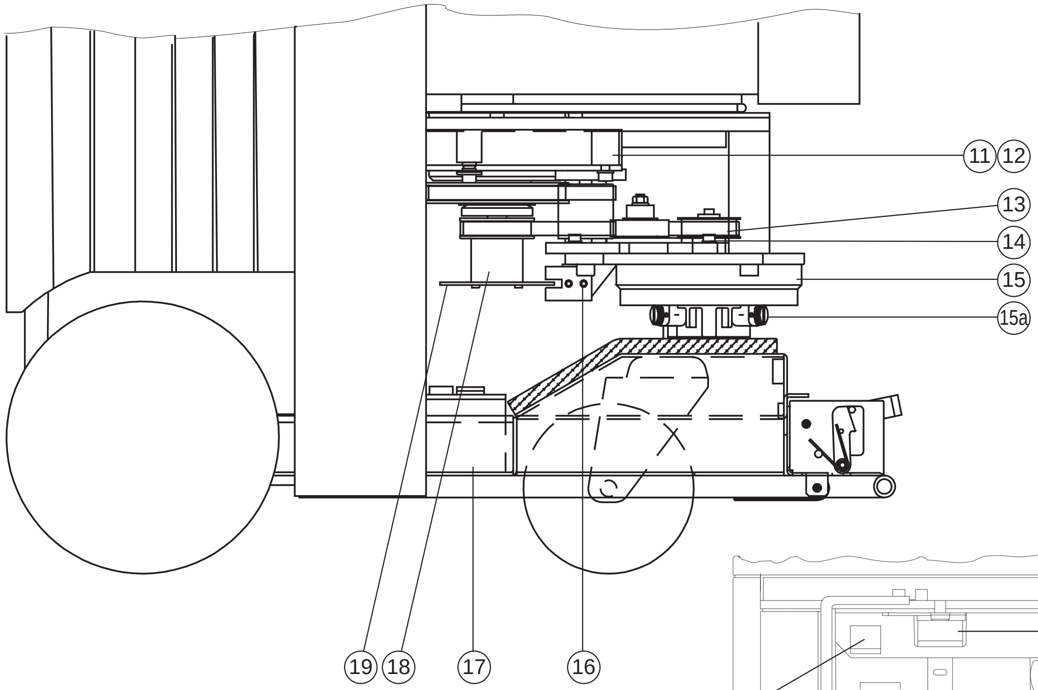
Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	660 715 1	TŸrlager komplett	Door bearing cpl.	1
1a	673 057 1	Tellerfeder	Cup spring	8
1b	553 315 1	Innensechskantschraube M6	Allen screw M6	1
1c	673 755 1	Innensechskantschraube M5	Allen screw M5	2
2	660 701 1	TŸrchassis komplett	Door frame cpl.	1
3	678 107 1	TŸr komplett	Door cpl.	1
3a	675 707 1	Faltenbalg	Bellows	1
3b	675 056 1	Dichtung TŸr (Seite)	Door seal (side)	
3c*	674 821 1	Gleitklotz	Slide block	1
3d	674 965 1	Kloben TŸrschlo§	Locking bolt (door lock)	1
3e	672 626 1	Dichtung TŸr (oben)	Door seal (top)	
4	673 074 1	Ablagematte	Rubber mat	1
5	661 111 1	Lagerplatte kpl.	Bearing plate cpl.	1
5a*	661 096 1	Adapterhalterung	Adapter holder	1
6	679 597 1	TŸrverriegelung komplett	Door latch cpl.	1
6a	673 065 1	TŸrschloss	Door lock	1
6b	642 462 1	Schnappschalter	Snap-action switch	1
7	660 733 1	MŸnzschraube	Screw	1
8	673 073 1	Schauglas rund	Window, round	1
9	673 072 1	Schauglas rechteckig	Window, rectangular	1

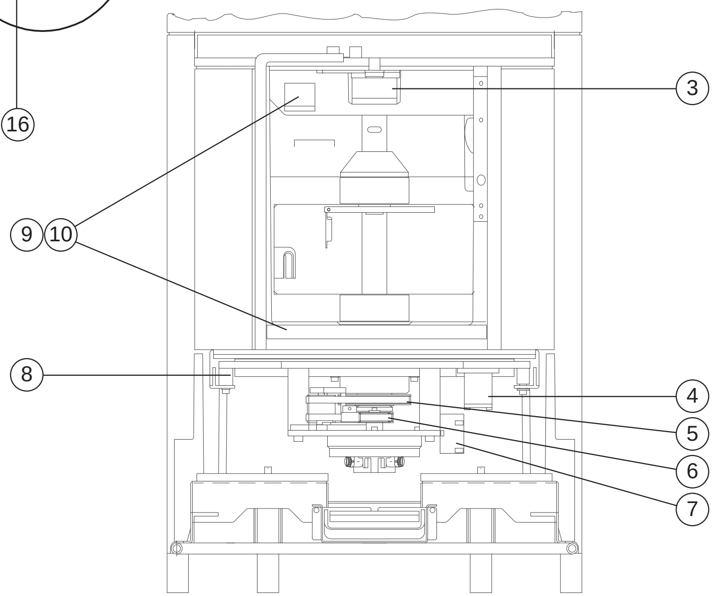
* nicht abgebildet / not illustrated

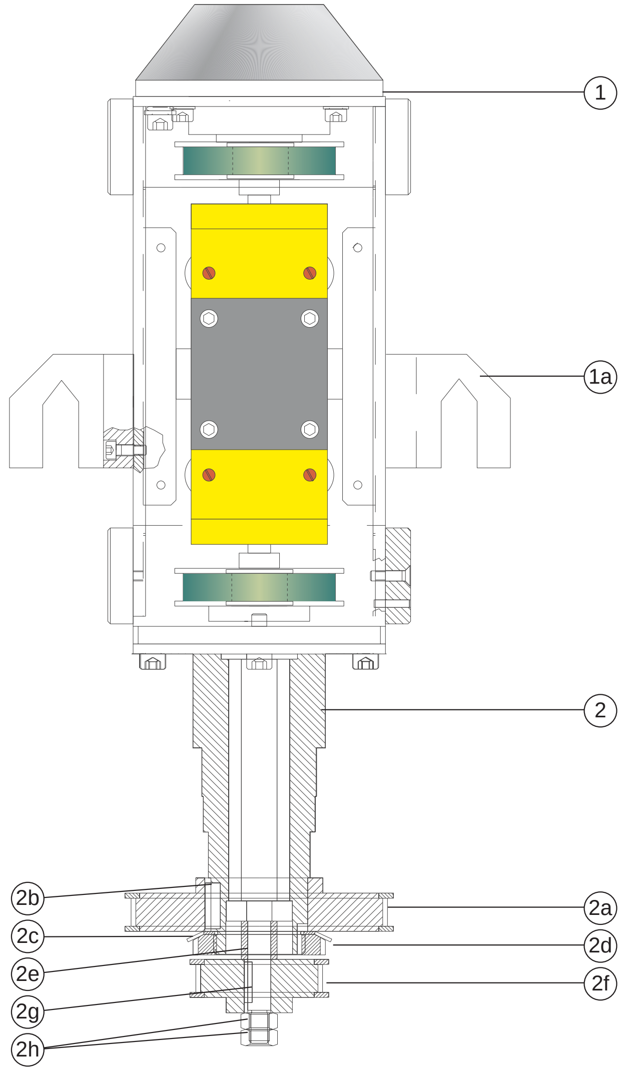
5.0 Antrieb
Drive

5.0 Antrieb

5.0 Drive







5.0 Antrieb

5.0 Drive

Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	679 686 1	Rotor komplett	Rotor cpl.	1
1a	679 683 1	Schlauchhalter	Line holder	2
1b*	679 684 1	Scheibe	Washer	
1c*	661 091 1	HŸlse	Sleeve	
1d*	661 086 1	Silikonring	Silicone washer	
1e*	679 685	Entkopplungsblech	Decoupling plate	
2	660 068 1	Antriebswelle komplett	Drive shaft cpl.	1
2a	660 339 1	Zahnriemenscheibe (Z=64)	Belt pulley (64 teeth)	1
2b	642 815 1	Pa§feder (fŸr 660 339 1)	Key (for 660 339 1)	1
2c	642 805 1	Sicherungsblech	Securing washer	1
2d	642 806 1	Wellenmutter	Shaft nut	1
2e	660 107 1	DistanzhŸlse	Brass bush	1
2f	660 340 1	Zahnriemenscheibe (Z=32)	Belt pulley (32 teeth)	1
2g	642 803 1	Passfeder (fŸr 660 340 1)	Key (for 660 340 1)	1
2h	553 624 1	Kontermutter	Lock nut	2
3	679 512 1	Kamerabeleuchtung	Camera lighting	1
4	661 029 1	Unwuchtdetektor komplett	Flutter detector cpl.	1
5	644 254 1	Zahnriemen oben (455 RPP5-10)	Toothed belt, top (455 RPP5-10)	1
6	644 253 1	Zahnriemen unten (565 RPP5-10)	Toothed belt, bottom (565 RPP5-10)	1
7	673 838 1	Netzleitungsfilter	Line filter	1
8	673 909 1	Gummipuffer	Rubber pad	4
9	678 097 1	Stroboskop oben	Upper stroboscope	1
10	660 840 1	Stroboskop unten	Lower stroboscope	1
11	642 811 1	SchrŠgkugellager oben	Upper angular contact ball bearing	1
12	642 812 1	SchrŠgkugellager unten	Lower angular contact ball bearing	1
13	660 338 1	Zahnriemenscheibe (Z=26)	Belt pulley (26 teeth)	1
14	660 303 1	Lagerbock komplett	Support cpl.	1
15	673 085 1	ScheibenlŠufermotor	Disc-type motor	1
15a	674 970 1	Kohlen	Carbon brushes	4
16	663 094 1	Lichtschranke	Optical sensor	1
17	670 637 1	Akku 12 V / 3,0 Ah	Battery 12 V / 3.0 Ah	2

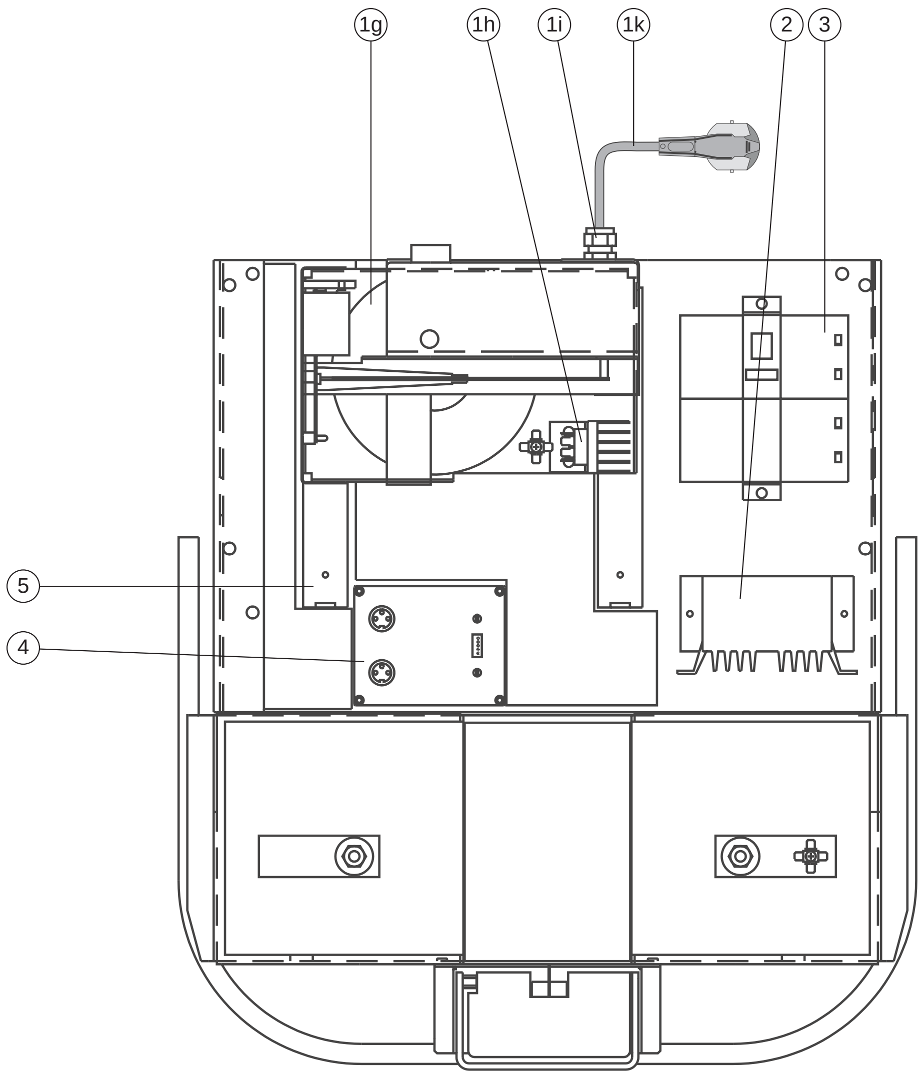
Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
18	660 377 1	LochscheibentrŠger	Perforated disc carrier	1
19	660 376 1	Lochscheibe	Perforated disc	1
20*	679 509 1	Kamera	Camera	1
21*	678 150 1	Aufkleber Warnschild deutsch	German warning label	1
	678 545 1	Aufkleber Warnschild englisch	English warning label	1

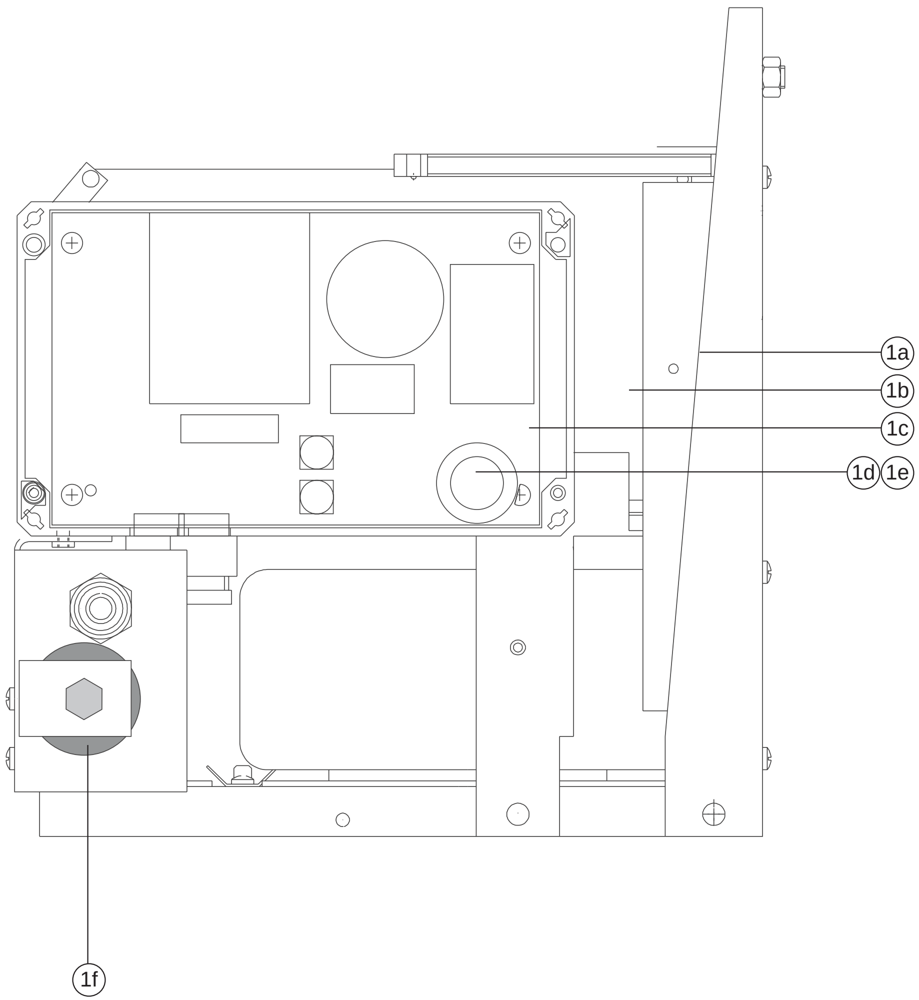
* nicht abgebildet / not illustrated

6.0 Netzteil und Gehäuseboden
Power Supply Unit and Housing Base

6.0 Netzteil und Gehäuseboden

6.0 Power Supply Unit and Housing Base





6.0 Netzteil und Gehäuseboden

6.0 Power Supply Unit and Housing Base

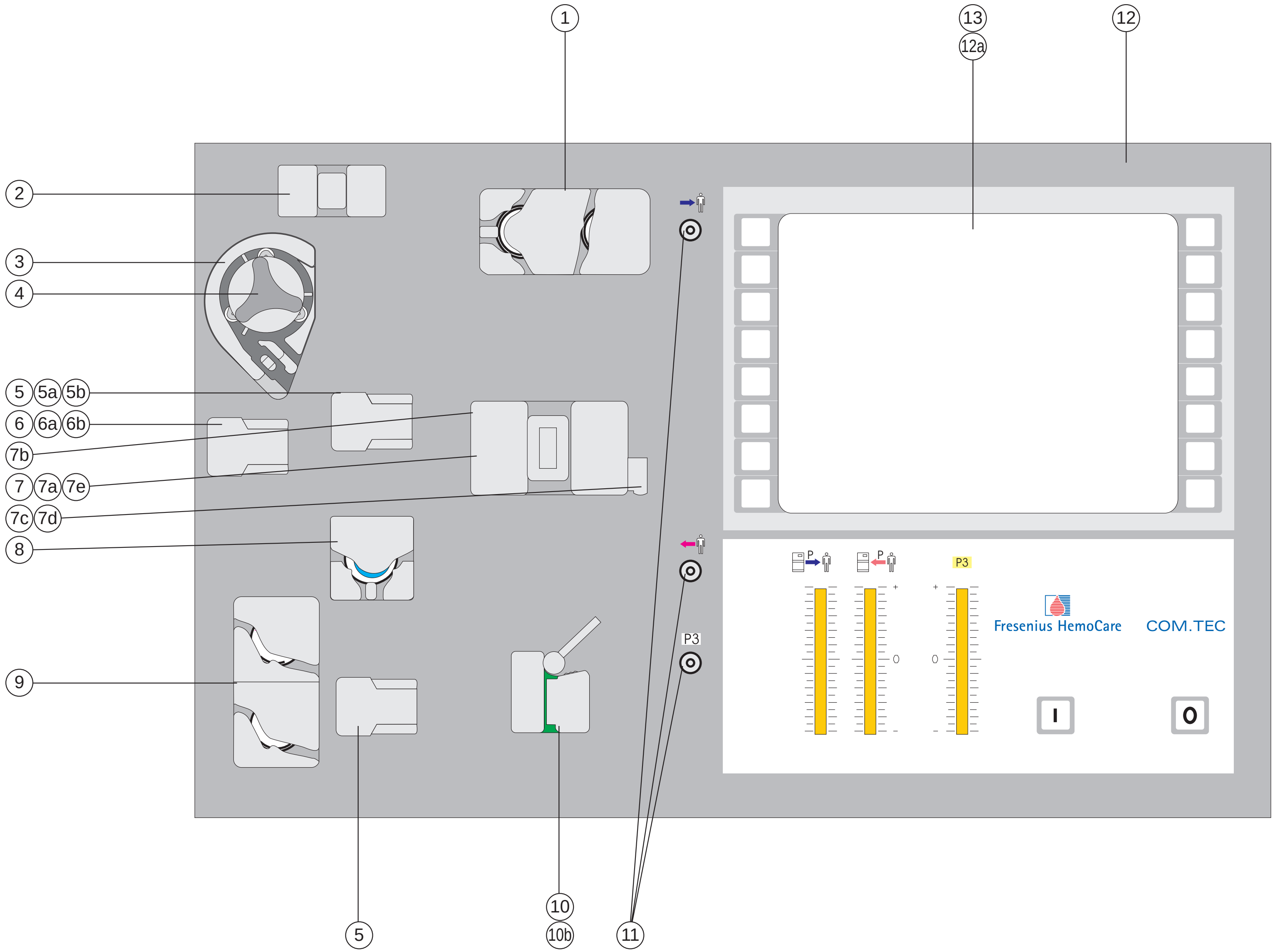
Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	660 828 1	Netzteil komplett	Power supply unit cpl.	1
1a	662 857 1	LP 857	P.C.B. LP 857	1
1b	674 370 1	LP 823-1	P.C.B. LP 823-1	1
1c	662 826 1	LP 826	P.C.B. LP 826	1
1d	674 603 1	Schutzkappe	Cap	1
1e	673 736 1	Drucktaster	Push-button	1
1f	673 732 1	Kondensator-Elko UF 15000	Electrolytic capacitor UF 15000	1
1g	673 707 1	Ringkerntransformator	Toroidal transformer	1
1h	678 155 1	Gleichrichter (mit Kondensatoren) 80V/25A	Rectifier (with capacitors) 80V/25A	2
1i	537 132 1	Kabelverschraubung	Cable gland	1
1k	640 084 1	Netzkabel mit Eurostecker	Power cable with European plug	1
1l	646 130 1	Kondensator NF 150	Capacitor NF 150	8
2	679 111 1	Zentrifugenregelung	Centrifuge control	1
2a*	662 854 1	LP 854	P.C.B. LP 854	1
2b*	662 855 1	LP 855	P.C.B. LP 855	1
3	678 248 1	Akku 12 V / 3,0 Ah	Battery 12 V / 3.0 Ah	2
4	660 924 1	HF-GehŠuse	HF housing	1
5	660 812 1	Teleskopschiene	Telescopic rail	2

* nicht abgebildet / not illustrated

7.0 Frontplatte Vorderansicht
Front Panel Front View

7.0 Frontplatte Vorderansicht

7.0 Front Panel Front View



7.0 Frontplatte Vorderansicht

7.0 Front Panel Front View

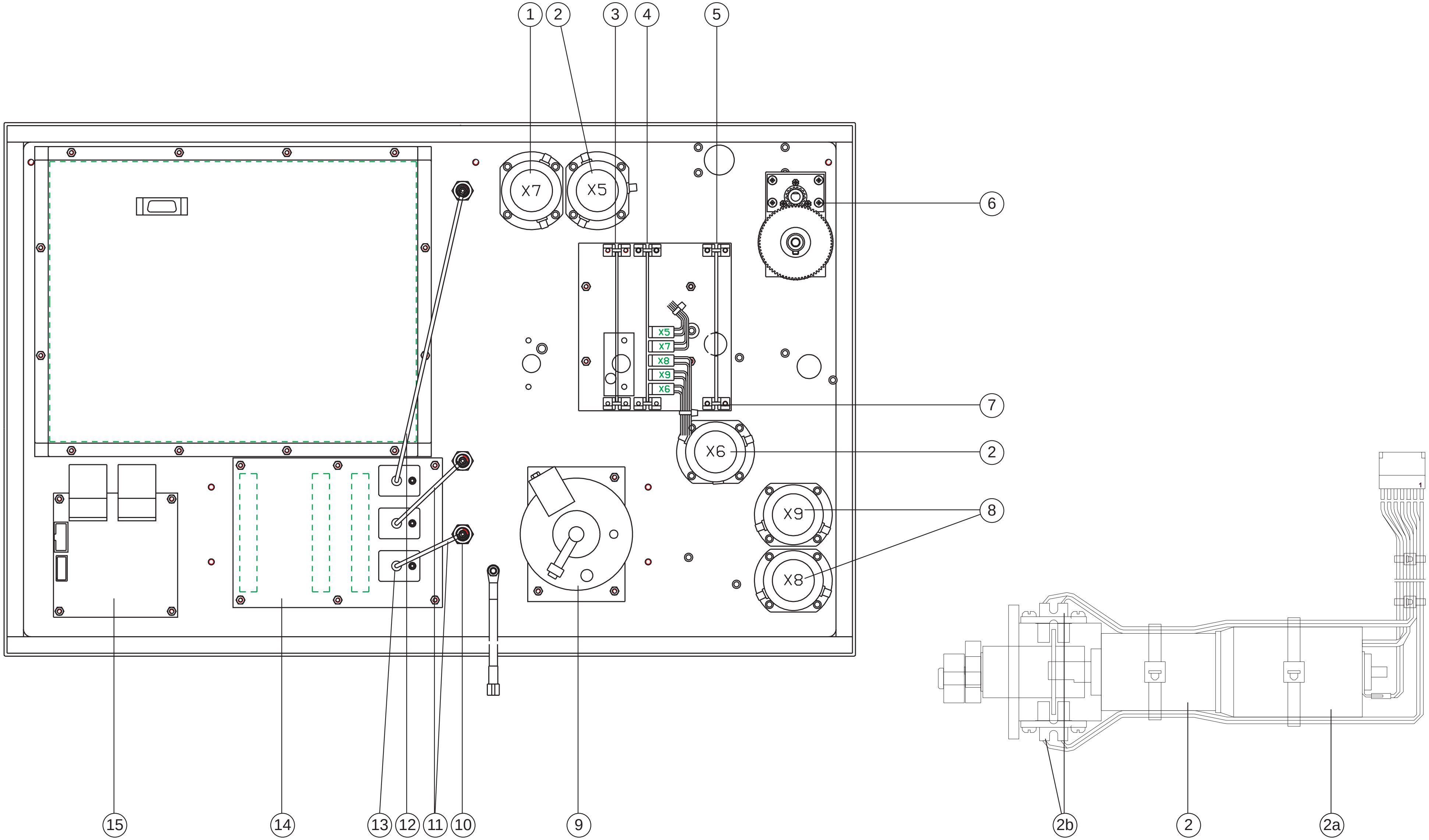
Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	678 023 1	GehŠuse Klemme 4/5 (Plasmasammel-/Verwurfklemme)	Clamp 4/5 (Plasma collection/diversion clamp) housing	1
2	660 675 1	ACD-Detektor	ACD detector	1
3	679 375 1	Stator ACD-Pumpe komplett	ACD pump stator cpl.	1
4	679 677 1	Rotor ACD-Pumpe komplett	ACD pump rotor cpl.	1
5	653 100 1	Plasma HB/HK-Detektor / Spillover-Detektor	Plasma Hb/Hct detector / Spillover detector	2
5a	653 095 1	Klappe	Hinged cover	1
5b	562 012 1	Zylinderstift	Pin	1
5c	653 093 1	GehŠuse	Housing	1
6	653 099 1	Detektor Substituatende	No-replacement-fluid detector	1
6a	653 095 1	Klappe	Hinged cover	1
6b	562 012 1	Zylinderstift	Pin	1
6c	653 093 1	GehŠuse	Housing	1
7	679 116 1	Tropfkammerhalter	Drip chamber holder	1
7a	642 288 1	Klappe	Hinged cover	1
7b	640 851 1	Zylinderstift	Pin	1
7c	650 752 1	Riegel	Latch	1
7d	642 275 1	Feder	Spring	1
7e	679 075 1	GehŠuse Tropfkammerhalter	Drip holder housing	1
8	678 024 1	GehŠuse Klemme 6 (Spilloverklemme)	Clamp 6 (Spillover clamp) housing	1
9	678 025 1	GehŠuse Klemme 2/3 (NaCl-Klemmen)	Clamp 2/3 (Saline clamps) housing	1
10	679 549 1	Optischer Detektor	Optical detector	1
10a	679 078 1	Klappe	Hinged cover	1
10b	679 548 1	GehŠuse Optischer Detektor	Optical detector housing	1
11	566 252 1	Anschlu§kegel	Luer connector	3
12	661 087 1	Frontplatte (Frontplatte, Frontfolie, Frontscheibe)	Front panel (front panel, front foil, front glass)	1
12a	661 075 1	Frontscheibe	Front glass	1
13	661 085 1	Display	Display	1
14*	552 243 1	Linsenschraube M3X6 (fŸr alle Abdeckungen)	Screw M3x6 (suitable for all covers)	1

* nicht abgebildet / not illustrated

8.0 Frontplatte Rückansicht
Front Panel Rear View

8.0 Frontplatte Rückansicht

8.0 Front Panel Rear View



8.0 Frontplatte Rückansicht

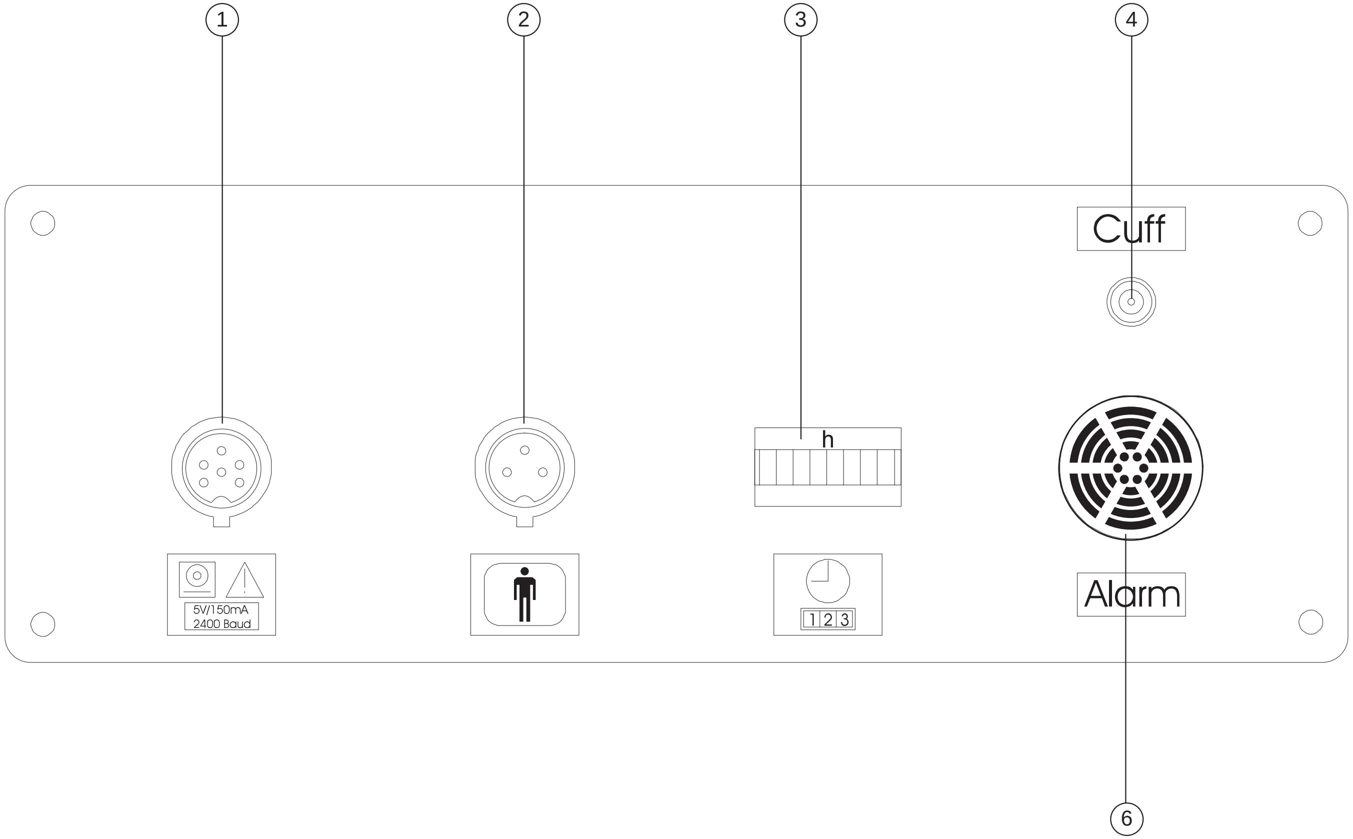
8.0 Front Panel Rear View

Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
	661 105 1	Frontplatte komplett	Front panel cpl.	1
1	660 982 1	Antrieb Klemme 5 kpl. (Verwurfklemme)	Drive, clamp 5 cpl. (diversion clamp)	1
2	660 981 1	Antrieb Klemme 4 kpl. (Plasmasammelklemme) Antrieb Klemme 6 kpl. (Spilloverklemme)	Drive, clamp 4 cpl. (plasma collection clamp) Drive, clamp 6 cpl. (spillover clamp)	2
2a	660 734 1	Klemmenantrieb (fŸr alle Klemmen)	Clamp drive (for all clamps)	1
2b	645 849 1	Gabellichtschranke (fŸr alle Klemmen)	Optical sensor (for all clamps)	1
3	662 241 1	LP-Z 241	P.C.B. LP-Z 241	1
4	662 869 1	LP 869	P.C.B. LP 869	1
5	662 867 1	LP 867	P.C.B. LP 867	1
6	679 592 1	Pumpenantrieb ACD-Pumpe komplett	ACD pump drive assy.	1
7	640 268 1	KartenfŸhrung	P.C.B. guide	6
8	660 983 1	Antrieb Klemme 2/3 kpl. (NaCl Klemmen)	Drive, clamp 2/3 cpl. (saline clamps)	2
9	678 035 1	Drehmagnet	Solenoid	1
10	641 640 1	1-Ohr-Klemme	Line clamp	3
11	660 543 1	Schlauchsystem fŸr Druckmonitor	Pressure monitor line set	2
12	661 101 1	Schlauchsystem fŸr Druckmonitor	Pressure monitor line set	1
13	647 791 1	1-Ohr-Klemme	Line clamp	3
14	662 870 1	LP 870	P.C.B. LP 870	1
15	662 822 1	LP 822	P.C.B. LP 822	1

9.0 Steckerrückwand
Connector Panel

9.0 Steckerrückwand

9.0 Connector Panel



9.0 Steckerrückwand / 9.0 Connector Panel

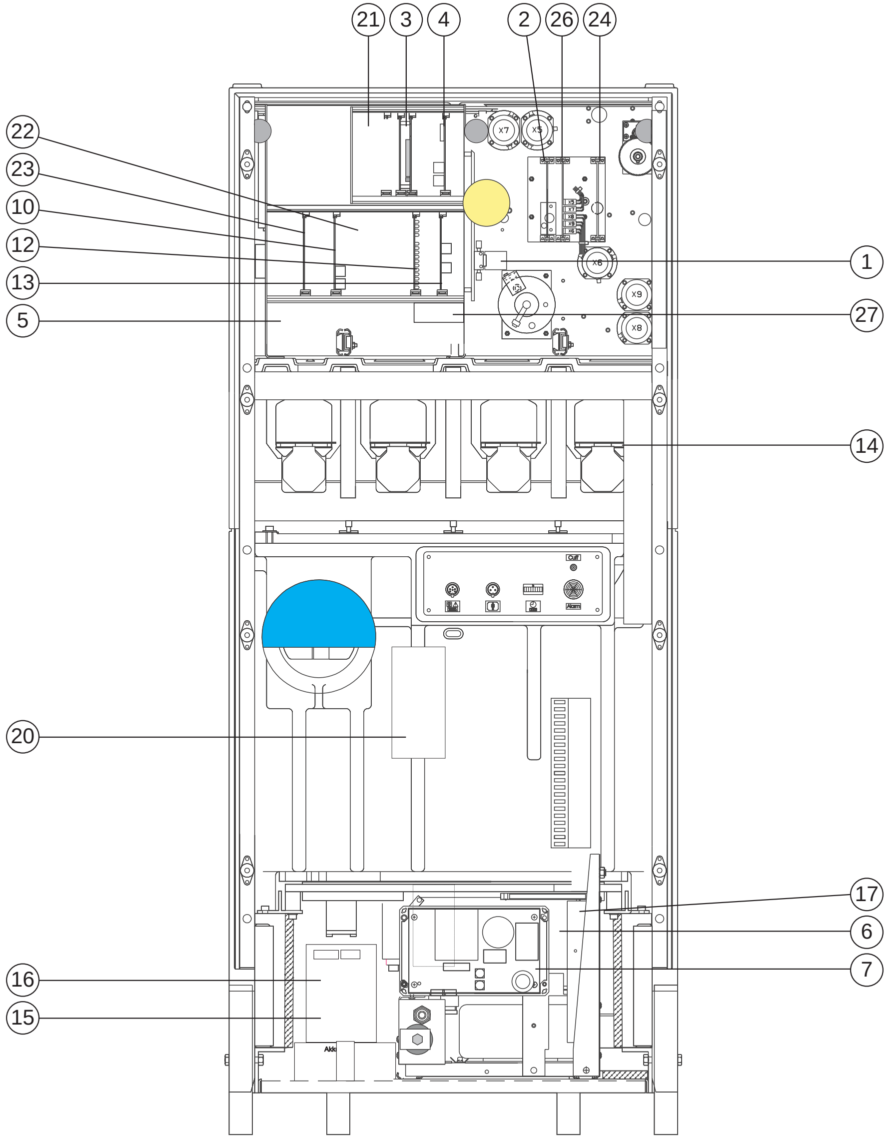
Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
	661 089 1	SteckerrŸckwand komplett	Connector panel cpl.	1
1	678 911 1	Anschlu§kabel mit Steckdose, 6polig	Connecting cable with 6-pin female connector	1
2	678 932 1	Anschlu§kabel mit Steckdose 3-polig/Spenderdisplay incl. Tongeber	Connection cable with 3-pin female connector/donor display incl. beeper	1
3	663 105 1	BetriebsstundenzŠhler	Time meter	1
4	566 252 1	Anschlu§kegel	Connecting head	1
5*	672 410 1	Schlauch fŸr Cuff-Steuerung	Line for cuff control	1
6	641 471 1	Tongeber	Audible alarm generator	1

* nicht abgebildet / not illustrated

10.0 Platinen
Printed Circuit Boards

10.0 Platinen

10.0 Printed Circuit Boards



10.0 Platinen

10.0 Printed Circuit Boards

Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	662 175 1	LP-Z 175	PCB LP-Z 175	1
1a	644 068 1	Schmelzeinsatz 1 A/T	Fuse link 1 A/T	1
1b	671 101 1	Druckschalter	Pressure switch	1
2	662 241 1	LP-Z 241	PCB LP-Z 241	1
3	678 857 1	PCAT E53-K1	PCAT E53-K1	1
4	678 657 1	LP 821	PCB LP 821	1
5	662 822 1	LP 822	PCB LP 822	1
6	674 370 1	LP 823-1	PCB LP 823-1	1
6a	641 566 1	Sicherung (Kleinst) 2,5 A/T	Fuse (subminiature) 2.5 A/T	1
7	662 826 1	LP 826	PCB LP 826	1
7a	679 117 1	Schmelzeinsatz 230 V: 6,25 A/T	Fuse link 230 V: 6,25 A/T	2
	678 459 1	Schmelzeinsatz 100 Đ 120 V: 10 A/T	Fuse link 100 Đ 120 V: 10 A/T	2
7b	673 735 1	Drossel	Choke	1
7c	675 128 1	Einschaltstrombegrenzung (110 Đ 230V)	Inrush current limiter (110 - 230V)	1
7d	640 245 1	Relais	Relay	1
8*	662 828 1	LP 828	PCB LP 828	1
9*	662 829 1	LP 829	PCB LP 829	1
10	678 285 1	LP 830-1 CAN I/O	PCB LP 830-1 CAN I/O	1
11*	662 838 1	LP 838	PCB LP 838	1
12	662 840 1	LP 840	PCB LP 840	1
13	662 841 1	LP 841	PCB LP 841	1
14	662 852 1	LP 852	PCB LP 852	1
15	662 854 1	LP 854	PCB LP 854	1
16	662 855 1	LP 855	PCB LP 855	1
17	662 857 1	LP 857	PCB LP 857	1
18*	679 676 1	LP 860-1	PCB LP 860-1	1
19*	662 861 1	LP 861	PCB LP 861	1
20	662 863 1	LP 863	PCB LP 863	1
21	662 864 1	LP 864	PCB LP 864	1
22	662 865 1	LP 865	PCB LP 865	1
23	662 866 1	LP 866	PCB LP 866	1
24	662 867 1	LP 867	PCB LP 867	1

Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
25*	662 868 1	LP 868	PCB LP 868	1
26	662 869 1	LP 869	PCB LP 869	1
27	662 870 1	LP 870	PCB LP 870	1
28*	679 119 1	LP 945	PCB LP 945	1
29*	662 858 1	CAN Termination	CAN Termination	1

* nicht abgebildet / not illustrated

11.0 Sicherungen, Kabel, Verbrauchsmaterial
Fuses, Cables, Consumables

11.0 Sicherungen, Kabel, Verbrauchsmaterial

11.0 Fuses, Cables, Consumables

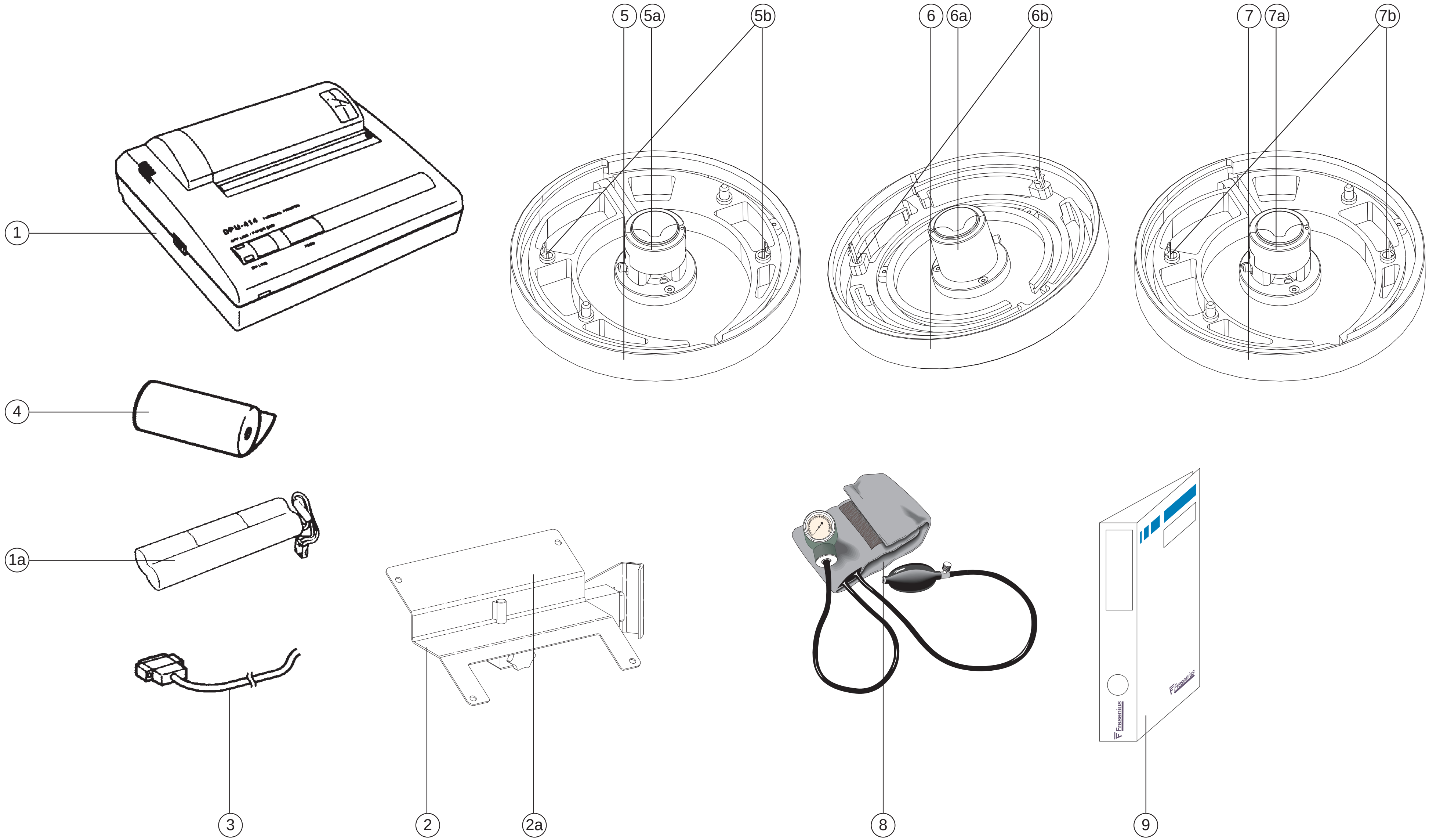
11.0 Sicherungen, Kabel, Verbrauchsmaterial 11.0 Fuses, Cables, Consumables

Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	646 120 1	Sicherung (kleinst) T 0,63 A	Fuse (subminiature) T 0.63 A	1
2	644 336 1	Sicherung (kleinst) T 1,0 A	Fuse (subminiature) T 1.0 A	1
3	640 707 1	Schmelzeinsatz 2 A/T	Fuse link 2 A/T	1
4	641 566 1	Sicherung (kleinst) 2,5 A/T	Fuse (subminiature) 2.5 A/T	1
5	670 579 1	Sicherung (kleinst) 3,15 A/T	Fuse (subminiature) 3.15 A/T	1
6	679 117 1	Schmelzeinsatz M4 A/T	Fuse M4 A/T	1
7	673 864 1	Schmelzeinsatz 6,25 A/T	Fuse link 6.25 A/T	1
8	678 459 1	Schmelzeinsatz 10 A/T (6,3x32 mm)	Fuse link 10 A/T (6,3x32 mm)	1
9	644 066 1	Schmelzeinsatz 10 A/T (5x20 mm)	Fuse link 10 A/T (5x20 mm)	1
10	663 043 1	Can Leitung 0,25 m	Can line 0.25 m	1
11	678 682 1	Can Leitung 0,67 m	Can line 0.67 m	1
12	663 042 1	Can Leitung 0,1 m	Can line 0.1 m	1
13	663 040 1	Can Leitung 1,2 m	Can line 1.2 m	1
14	662 858 1	Can-Abschlu§ (LP 858)	Can bus termination (PCB LP 858)	1
15	567 915 1	Selbstklebeplatte (Kabelbinder)	Self-adhesive plate (cable tie)	1
16	537 206 1	Kabelbinder (2,5x10 mm)	Cable tie (2.5 x 100 m)	1
17	593 003 1	Kleber Uhu-plus	Adhesive Uhu-plus	1
18	640 905 1	Kleber Elastosil	Adhesive Elastosil	1
19	640 141 1	Kleber Cyanolit	Adhesive Cyanolit	1
20	641 950 1	Kleber Loctite (Sicherungs-Lack)	Loctite (screwlock)	1
21	678 446 1	Farbstift gelb	Pencil, yellow	1
22	644 410 1	Farbstift wei§	Pencil, white	1

12.0 Zubehör
Accessories

12.0 Zubehör

12.0 Accessories



12.0 Zubehör / 12.0 Accessories

Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	679 182 1	Drucker (Seiko)	Printer (Seiko)	1
1a	679 110 1	Akku-Pack (Seiko)	Battery pack (Seiko)	1
2	679 201 1	Druckerhalterung (Seiko)	Printer holder (Seiko)	1
2a	679 158 1	Befestigungsplatte (Seiko)	Mounting plate (Seiko)	1
3	679 181 1	Druckeranschlu§leitung (Seiko)	Printer connecting cable (Seiko)	1
4	641 469 1	Thermodruckerpapier	Paper for thermal printer	1
5	661 052 1	Kammeraufnahme, kpl. (C4, C4Y)	Chamber holder, cpl. (C4, C4Y)	1
5a	660 433 1	SchlauchfŸhrung	Line guide	1
5b	660 469 1	Haltefeder	Retaining spring	1
6	661 038 1	Kammeraufnahme, kpl. (PL1, P1Y)	Chamber holder, cpl. (PL1, P1Y)	1
6a	660 433 1	SchlauchfŸhrung	Line guide	1
6b	660 469 1	Haltefeder	Retaining spring	1
7	661 114 1	Kammeraufnahme, kpl. (C5)	Chamber holder, cpl. (C5)	1
7a	660 433 1	SchlauchfŸhrung	Line guide	1
7b	660 469 1	Haltefeder	Retaining spring	1
8	671 140 1	Druckmanschette, kpl.	Pressure cuff, cpl.	1
9	679 465 1	Gebrauchsanweisung, CE, deutsch	Operating Instructions, CE, German	1
9	679 466 1	Gebrauchsanweisung, CE, englisch	Operating Instructions, CE, English	1
9	679 907 1	Gebrauchsanweisung, CE, italienisch	Operating Instructions, CE, Italian	1

* nicht abgebildet / not illustrated

13.0 Werkzeuge und Hilfsmittel
Tools and Service Equipment

13.0 Werkzeuge und Hilfsmittel

13.0 Tools and Service Equipment

13.0 Werkzeuge und Hilfsmittel

13.0 Tools and Service Equipment

Pos. Item	Teile-Nummer Part number	Benennung	Description	Anzahl Quantity
1	M60 383 1	Referenzkammer	Reference chamber	1
2	670 010 1	Druckme§gerŠt in mmHg	Pressure gauge in mmHg	1
3	675 250 1	Tastaturadapter 4-polig	4-pin keyboard adapter	1
4	645 670 1	Einstellnormal	Setting standard	1
5	646 325 1	Fett fŸr Einstellnormal	Grease for setting standard	1
6	679 514 1	Graukeil (13 Stufen)	Neutral wedge (13-step)	1
7	640 560 1	Graufilter	Gray filter	1
8	646 920 1	Rotfilter	Red filter	1
9	678 497 1	Testadapter Luftdetektor	Test adapter air detector	1
10	671 140 1	BG Druckmanschette mit Handpumpe	Pressure cuff with inflating bulb	1
11	671 199 1	FŸhlerlehre (0,1 Ð 20 mm)	Feeler gauge (0.1 Ð 20 mm)	1
12	671 189 1	HackenschlŸssel (SW 52/55)	Hook spanner (SW52/55)	1
13	671 188 1	DrehmomentschlŸssel	Torque wrench	1
14	660 355 1	Adapter fŸr DrehmomentschlŸssel	Adapter for torque wrench	1
15	643 190 1	Riemenspannlehre	Tensioning gauge	1
16	643 835 1	Rotorabziehglocke	Rotor puller	1
17	671 198 1	Zweiarmiger Abzieher	Two-jaw puller	1
18	678 486 1	InnensechskantschlŸssel 1,27mm	Allen wrench 1.27 mm	1
19	678 487 1	Installationshilfe Rotor	Rotor securing aid	1
20	672 069 1	VerlŠngerungskarte	Extension board	1
21	678 482 1	PrŸfkabel BNC	BNC test cable	2
22	675 260 1	Tastatur Ð klappbar	Collapsible keyboard	1
23	679 468 1	Technisches Handbuch D	Technical Manual D	1
24	679 469 1	Technisches Handbuch GB	Technical Manual GB	1
25	679 763 1	Testkabel CCD	CCD test adapter	1
26	679 762 1	Dummy ACD-Pumpe (5. Pumpe)	ACD pump dummy (5th pump)	1
27	M61 773 1	Dummy ACD-Pumpe (ACD/Rezirk.)	ACD pump dummy (ACD/Recirc.)	1
28	678 617 1	Testadapter CCD-Kamera	Test adapter CCD Camera	1
29	679 776 1	PCMCIA Card	PCMCIA card	

Table of Contents 5 Start-Up and TSC

5.1 Instructions for First Start-Up

A site suitable for the installation of the blood cell separator must be determined. It must be ensured that the COM.TEC is installed at a distance of no less than 5 cm to walls, cabinets, curtains or other items apt to impair air cooling through the ventilation grating on the rear of the machine. The COM.TEC should not be exposed to direct solar radiation. The main circuit connection should be free from electric interferences.

Prior to starting the functional test it should be made sure that all parts have been accounted for.

Functional tests should not be performed by persons other than those authorized to do so.

5.1.1 General Checks Outside

Check the COM.TEC on the outside for possible damage in transit or other damages.

5.1.2 Machine Checks Inside

Remove rear and front covers and check the machine inside for loose or damaged parts.

5.1.3 Connection of the Machine

Connect COM.TEC to the external power supply and turn it on.

5.1.4 Removal of Rotor Protection

After turning the machine on, open the centrifuge door by pressing the **Open Door** key and remove the rotor protections.

5.1.5 Printer Installation

Screw the printer onto the printer holder which can be attached to the IV pole in any position and use the printer cable supplied to connect the printer to the COM.TEC. Perform a printer self-test (press and hold the **Feed** key while turning the printer on) as described in the printer Operator Instructions.
Then turn the printer on. The COM.TEC should already be turned on . Enter a program in which the printer must print out the program header including date, program version and clock time.
If the printer has discharged, it must be charged for approximately 15 minutes on the powered-on COM.TEC. See your printer Operator Manual for complete instructions.

5.1.6 Alarm Function Test

The alarm test must be performed in a platelet or a plasma program. The platelet alarm test must be passed after the **Prime** key has been pressed with the machine not being equipped with a line set (the machine automatically enters the priming program); the plasma alarm test must generate the display message **Failure no replacement fluid**.

5.1.7 Door Switch Function

Enter a program with the centrifuge door open. Skip priming with an installed drip chamber dummy and press the **Start** key. This must cause the **ALARM Door**, and the centrifuge must start running when the **Start** key is again pressed after the centrifuge door has been closed. When closed, moving the centrifuge door should not cause a door switch alarm.

5.1.8 Check and, if Necessary, Adjustment of the Gap Width of Clamp 1

The gap width of clamp 1 must be 0.7-1.0 mm.

5.1.9 Electrical Tests

- Measure the resistance of the protective conductor according to VDE 0751*, Part 1:
  limit: 0.2 ohms
- Measure the current leakage to ground according to VDE 0751*, Part 1: limit: 0.5 mA
  First measured value: . . . mA

Current leakage to ground must amount to no more than 1.5 times the first measured value while simultaneously not exceeding the limit mentioned above.

Caution
When measuring the resistance of the protective conductor, resistances of more than 0.2 Ω may be measured on the IV rack. Since the IV rack is connected to the protective ground for reasons of ground potential only (discharge of static charges when the protective hood is pulled off, etc.), this does not reduce the safety of the machine. In order to measure the insulation resistance and the current leakage to ground in accordance with DIN VDE 0751*, both the power supply switch and the pushbutton on the power supply unit must be actuated, unless the measurement can be performed on the machine in the operating mode. Test equipment according to VDE 0751 measure at a voltage which does not suffice for starting the power relay so the latter must be overriden by means of the pushbutton. In addition, when measuring the current leakage to ground, the value measured must be compared with the value first measured.
Should the visual inspection in accordance with the above instructions give rise to the suspicion that the insulation might be impaired by dirt or moisture, the insulation resistance should also be checked.first measured value.
Set value according to DIN VDE 0751*, Part 1: ⩾2 Mohms.

Start-Up Report	Page 1 of 1

Manufacturer:	....	**Date:**	....
Machine:	....	**Technician:**	....
Operating hours:	....	**Serial number:**	....
Place:	....	**Service report no.:**	....

No.		checked OK	repaired
–	Scope of delivery	❑	❑
1	General checks outside	❑	❑
2	Machine checks inside	❑	❑
3	Connection of the machine	❑	❑
4	Removal of rotor protection	❑	❑
5	Printer installation	❑	❑
6	Alarm function test	❑	❑
7	Door switch function	❑	❑
8	Check and, if necessary, adjustment of the gap width of clamp 1	❑	❑
9	Electircal tests	❑	❑

It is herewith confirmed that the checks listed have been performed correctly and that all statements concerning the checks are correct.

Technician's signature:	**Customers's signature:**
.........................., date	..............................., date ....
....	....

5.2 Technical Safety Checks

This chapter describes the Technical Safety Checks (TSC) to be performed.

Every 500 operating hours, however no less than once a year, the Technical Safety Checks listed below must be performed on the machine, by persons who are in a position to correctly perform such Technical Safety Checks on the basis of their training, their knowledge or their experience acquired through practical activities, and who are not subject to any directives with regard to this type of checking activity (also see: the BMA's publication dated April 2, 1987).

Performance of the Technical Safety Checks must be recorded in the Medical Device Register.

On completion of the routine checks the following steps must be taken to perform the individual checks, if necessary:

- Install a filled drip chamber in the air detector.
- Simulate a blood-filled line segment in the optical detector of clamp1 by means of a cardboard strip.
- Turn the machine on and enter the main program.
- Each time the **Start** key is pressed a slightly excessive pressure must be briefly generated at the return pressure connector.
- Prior to every individual test the machine must be free of all alarms.

The COM.TEC must enter the alarm mode as soon as one or several alarms occur. Should this be the case, all pumps must stop, the clamp 1 must be closed, and an audible alarm must be sounded. The alarm is shown on the display in plain text. The audible alarm is not activated in the alarm mode if, in the priming program, the optical detector at the clamp 1 detects light (a single operator call will be audible instead) or the **Mute** key has been pressed.

TSC report	Page 1/6

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

Scope and terms of Technical Safety Checks

TERMS: once a year (every 12 months)

The checks listed in the tables below must be performed on this machine at least every 12 months, by persons who are in a position to correctly perform such Technical Safety Checks on the basis of their training, their knowledge and their experiences acquired through practical activities, and who are not subject to any directives with regard to this type of checking activity (also see: the BMA's publication dated April 2, 1987).

No.	Description	Set value/Function	O.K.
1	**Visual checks**		
1.1	Labels and symbols	Must be attached and legible.	❑
1.2	Mechanical condition	Must permit safe operation.	❑
1.3	Contaminations affecting safety	Not acceptable.	❑
2	**Extracorporeal blood loss into the environment**		
2.1	Zero position of pressure displays	With pressure measurement ports open. Pressure measurement ports must be equal to a scale reading of 0 mmHg (0 bar).	❑
2.2	Lower limit of inlet pressure –300 mmHg (–0.4 bar)	Apply an inlet pressure of –320 mmHg (–0.42 bar). The machine must enter the alarm mode.	❑
2.3	Upper limit of inlet pressure +300 mmHg (0.4 bar)	Apply an inlet pressure of +320 mmHg (0.42 bar). The machine must enter the alarm mode.	❑
2.4	Lower limit of return pressure –100 mmHg (–0.13 bar)	Apply a return pressure of –120 mmHg (–0.16 bar). The machine must enter the alarm mode.	❑
2.5	Upper limit of return pressure +300 mmHg (0.4 bar)	Apply a return pressure of +320 mmHg (0.42 bar). The machine must enter the alarm mode.	❑
2.6	Lower limit of P3 pressure –300 mmHg (–0.4 bar)	Apply a P3 pressure of –320 mmHg (–0.42 bar). The machine must enter the alarm mode.	❑
2.7	Upper limit of P3 pressure +300 mmHg (0.4 bar)	Apply a P3 pressure of +320 mmHg (0.42 bar). The machine must enter the alarm mode.	❑

No.	Description	Set value/function	O.K.
3	**Extracorporeal blood loss due to separation error in the plasma outlet or due to lacking replacement**		
3.1	No-replacement-fluid detection	Select the **TPE** program. Install a water-filled line segment (3.1 x 0.6 line) in the replacement fluid end detector. Withdraw the water from the line using a syringe. The machine must enter the alarm mode.	❑
3.2	Blood-in-plasma recognition (hematocrit increase)	Install the gray wedge filter, 13 shades, (part no. 679 514 1) in the Plasma Hb/Hc detector. At a gray scale value of 3 or earlier, the machine must enter the alarm mode. Alarm display: **Alarm Hemolysis**.	❑
3.3	Hemolysis recognition	Install the red filter (part no. 646 920 1) in the Plasma Hb/Hct-detector. The machine must enter the alarm mode. Alarm display: **Alarm Hemolysis**.	❑
4	**Air embolism via return line**		
4.1	Air detector	Install a filled drip chamber (part no. 645 670 1). Connect the air detector test adaptor (part no. 678 497 1) between X23/LP 865 and the air detector cable. Turn the switch on the test adaptor on. The machine must enter the alarm mode and the two LEDs D39 and D40 on P.C.B. LP 840 must turn dark (5th and 6th LEDs from above).	❑
4.2	Time-limited deaeration of the drip chamber	Take the drip chamber out of the air detector. Press the **Deaerate** key. The whole blood pump and the ACD-A pump start. The clamp 1 is closed. The machine must return to the stop mode after 5 s ± 2 s.	❑
4.3	Redundant pump and clamp disconnection	Initiate an alarm of the hardware alarm system (e.g. air detector alarm), with the pumps running and clamp 1 open. The pumps must stop and clamp 1 must close. With darkened optical detector, the audible alarm must be sounded. Test the independent disconnection via the RL300 safety relay on P.C.B. LP 823-1 by measuring the 24V voltage (LP 823-1 / X301 / Pin 1, Ground/Pin 2): 24 V: alarm-free; 0 V: alarm.	❑

No.	Description	Set value/function	O.K.
5	**Risk due to excessive or insufficient administration of anticoagulants (ACD-A)**		
5.1	Drip control of ACD-A flow, lower limit	Simulate drops. With drop numbers of less than 4 drops per revolution of the whole blood pump, the machine must enter the alarm mode not later than after the fourth revolution of the pump.	❑
5.2	Drip control of ACD-A flow, upper limit	Simulate drops. With drop numbers of 36 and more per revolution of the whole blood pump, the machine must enter the alarm mode.	❑
6	**General function of alarm and safety system**		
6.1	Optical detector Clamp 1	Reduce the lightbeam of the optical detector by means of the gray wedge. With gray scale values higher than 5, the yellow LED D24 (3rd LED from above) on LP 840 must stop lighting with a delay of approx. 1 s.	❑
6.2	Reset Audible alarm suppression	Activate a continuous alarm (e.g. remove the drip chamber). Silence the audible alarm by pressing the **Mute** key. Press the **Start** key. After pressing the **Start** key the audible alarm must be sounded again.	❑
6.3	Alarm test with audible alarm	Select the program. Initiate the alarm test. All alarms must be activated during the test and the alarm tone must be audible. Programs without replacement fluid monitoring: All green LEDs on LP 840 must stop lighting. Programs with replacement fluid monitoring: The green LED D402 on LP 867 must stop lighting when an empty line segment (3.1 x 0.6) is installed.	❑

No.	Description	Set value/function	O.K.
7	**Mechanical danger to operator or patient**		
7.1	Door switch of centrifuge (Power switch)	Check correct opening of the door switch by means of a continuity test device.	❑
7.2	Door switch of centrifuge (Microswitch)	After the door lock connector X504 on LP 823-1 has been pulled off, the alarm message **ALARM door** must be displayed.	❑
7.3	Line occlusion of roller pumps	Pressure test 1: with one locking roller; put the rotor into a vertical position. Pressure test 2: with two locking rollers; put the rotor into a horizontal position.	
7.3.1	Line occlusion of whole blood pump	Install the blood pump line segment (6.4 x 1.8 mm). Connect its inlet (above the Y-piece) to the pressure measuring device (e.g. 50-ml syringe). Place its outlet into a vessel filled with water. Apply a pressure of 600 mmHg (0.8 bar) to the inlet. There should be no pressure loss. Perform pressure tests 1 and 2.	❑ ❑
7.3.2	Line occlusion of plasma pump	Install the plasma pump line segment (4.0 x 1.2 mm). Proceed as described for the whole blood pump.	❑
7.3.3	Line occlusion of cell pump	Install the cell pump line segment (2.25 x 0.95 mm). Proceed as described for the whole blood pump, however with a pressure of 225 mmHg (0.3 bar).	❑
7.3.4	Line occlusion of recirculation/ACD-A pump	Proceed as described for the cell pump.	❑
7.3.5	Line occlusion of ACD-A pump	Proceed as described for the cell pump.	
7.4	Locking effect of clamp 1	Install the 4.5 x 1.0 mm line segment. Place its outlet into a vessel filled with water. Using a syringe, apply a pressure of 750 mmHg (1 bar) against the closed clamp 1 (check on the pressure measuring device connected via the Y-piece). Clamp 1 must close tightly.	❑
7.5	Locking effect of eccentric clamps	Install the 3.1 x 0.6 mm line segment in the clamps. Connect the upper ends to the pressure measuring device and a syringe. Place the lower ends into a vessel filled with water. Move each of the clamps to its closed position, using the **CCS** program. Apply a pressure of 750 mmHg (1 bar) to the lines. All clamps must close tightly.	❑

No.	Description	Set value/function	O.K.
7.6	Functional check of the pump return stops	Thread in the line pertinent to the pump concerned: blood pump line (6.4 x 1.8 mm) in the whole blood pump; plasma pump line (4.0 x 1.2 mm) in the plasma pump; ACD-A/cell pump line (2.25 x 0.95 mm) in the ACD-A or cell pump respectively. Then rotate each pump counterclockwise. The return stop must block up after a rotation of no more than 10° and prevent any further counterclockwise rotation. The ACD-A pump does not need to be checked (d.c. drive).	❑
7.7	Cuff	Check the function of the cuff. Cut-off-point: 55 mmHg ±5 mmHg	❑
8	**Extracorporeal blood loss in the centrifugee space**		
8.1	Centrifuge blood leak detector	Moisten the blood leak sensor with water (let the water drip through the opening for the line adaptor). The machine must enter the alarm mode. The centrifuge must stop.	❑

No.	Description	Set value/function	O.K.
9	**Electrical tests** (values according to VDE 0751)		
9.1	Protective conductor resistance	max. 0.2 Ω	__ Ω
9.2	Total current leakage to ground	Must fulfill the following conditions: 1. value should not exceed 1.5 times the “total value first measured”, (“total value first measured”: see equipment log), 2. value should not exceed 0.5 mA.	__ mA

Caution
When measuring the resistance of the protective conductor, resistances of more than 0.2 Ω may be measured on the IV rack.
In order to measure the insulation resistance and the current leakage to ground in accordance with DIN VDE 0751, both the power supply switch and the pushbutton on the power supply unit must be actuated, unless the measurement can be performed on the machine in the operating mode. Test equipment according to VDE 0751 measure at a voltage which does not suffice for starting the power relay so the latter must be overriden by means of the pushbutton.
In addition, when measuring the current leakage to ground, the value measured must be compared with the value first measured.
Should the visual inspection in accordance with the above instructions give rise to the suspicion that the insulation might be impaired by dirt or moisture, the insulation resistance should also be checked.
Set value according to DIN VDE 0751, Part 1: ⩾2 Mohms.

Enter the Technical Safety Check in the Medical Device Register and document the results of the check.

Should the machine fail to be safe with regard to function and/or operation, it must be repaired, or the operator must be informed of the risk caused by the machine.

It is herewith confirmed that the checks listed have been performed correctly and that all statements concerning the checks are correct.

Technician’s signature: **Customer’s signature:**

.........................., date .... **..............................., date ....**

.. **...**

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

Scope and intervals of Technical Safety Checks

INTERVAL: once a year (every 12 months)

No.	Description	O.K.
1.1	Labels and symbols	❑
1.2	Mechanical condition	❑
1.3	Contaminations affecting safety	❑
2.1	Zero position of pressure displays	❑
2.2	Lower limit of inlet pressure –300 mmHg (–0.4 bar)	❑
2.3	Upper limit of inlet pressure +300 mmHg (0.4 bar)	❑
2.4	Lower limit of outlet pressure –100 mmHg (–0.13 bar)	❑
2.5	Upper limit of outlet pressure +300 mmHg (0.4 bar)	❑
2.6	Lower limit of P3 pressure –300 mmHg (–0.4 bar)	❑
2.7	Upper limit of P3 pressure +300 mmHg (0.4 bar)	❑
3.1	No-replacement-fluid detection	❑
3.2	Blood-in-plasma detection (hematocrit increase)	❑
3.3	Hemolysis detection	❑
4.1	Air detector	❑
4.2	Time-limited deaeration of the drip chamber	❑
4.3	Redundant pump and clamp disconnection	❑
5.1	Drip control of ACD-A flow, lower limit	❑
5.2	Drip control of ACD-A flow, upper limit	❑
6.1	Optical detector clamp 1	❑
6.2	Reset alarm tone suppression	❑
6.3	Alarm function test with alarm tone	❑
7.1	Door switch of centrifuge (power switch)	❑
7.2	Door switch of centrifuge (microswitch)	❑
7.3	Line occlusion of roller pumps	❑
7.4	Locking effect of outlet line clamp	❑

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No.	Description	O.K.
7.5	Locking effect of eccentric clamps	❑
7.6	Functional check of the pump return stops	❑
8.1	Centrifuge blood leak detector	❑
9.1	Protective conductor resistance _________ Ω	❑
9.2	Total current leakage to ground _________ mA	❑

The technical safety checks must be entered in the equipment log with documentation of the check results.

Should the machine not be safe with regard to function and/or operation, it must be repaired or the operator must be informed of the risk caused by the machine.

It is herewith confirmed that the checks listed have been performed correctly and that all statements concerning the checks are correct.

Technician's signature:	**Customers's signature:**
.........................., date	**..............................., date ....**
..	**...**