BIEGLER
MEDIZINELEKTRONIK

Emergency Warmer
ESH 04

Service Manual

Table of Contents

1.	Technical Information	3
2.	Safety Information / Warranty	4
3.	Alarms / Safety Shut Off	5,6
4.	Circuit Schematics and Layouts	7-12
5.	Block Diagram	13
6.	Parts Lists	14-18
7.	Test Sheet and Test Log Procedure	19-24
8.	Safety Checks	25
9.	Spare Parts	26

1. Technical Information

Technical Information ESH 04:

Type designation	ESH 04
Rated voltage	12 VDC; 100V-240VAC (power supply)
Line frequency	50 / 60 Hz (power supply)
Power consumption	max. 20W
Operating temperature	37 °C
Emergency shut off	double
Moisture protection	IPX 4 (splash protection)
Protection against electrical shock	built-in rechargeable battery pack
Degree of protection against electrical shock	B
Dimensions	W x D x H 190 x 120 x 320 mm
Weight	1.3 kg
Class	IIa as defined in Rule 9
Operating mode	continuous

2. Safety Information / Warranty

- The Emergency Warmer may only be used or connected in vehicles if the on-board equipment meets applicable standards and regulations.
- The Emergency Warmer must always be hanging when it is in use. It may not be used for pressure infusion while it is lying on its side or while it is in an inverted upright position. Otherwise there is a risk that air bubbles may form.
- The doctor who is performing treatment must check the patient's condition at regular intervals. Failure to do so could pose a serious risk to the patient's health.
- If the device is attached to an infusion pole or stand, the pole or stand must have sufficient stability and load bearing capacity to support the device.
- Force must not be applied to the device or its accessories.
- The only way to ensure that the device is disconnected from the line voltage is to unplug the power adapter.
- The system may only be used in conjunction with electrical systems which comply with applicable standards and regulations.
- The device must not be used in potentially explosive atmospheres.
- Only persons or service centers that have been authorized by Biegler may carry out repairs or modifications to the Emergency Warmer.
- Fluid, steam or thermochemical methods must not be used to sterilize the device.
- The effects of external fields such as electromagnetic radiation and high temperature must be minimized.
- Periodic safety checks must be conducted as defined in the "Periodic Checks" section of the Operating Manual.
- If the device falls, is damaged or does not function as described in the Operating Manual, it must be shut off immediately and sent for service.

WARRANTY:

Biegler Medizinelektronik provides a device warranty for a period of **one year** following the date of sale. The warranty covers defects in materials or workmanship and includes both parts and labor. The guarantee is valid only if an invoice or receipt is supplied and if the warranty claim is made within the warranty period. The warranty is void if the device is damaged or is not used or maintained properly as described in the Operating Manual or if unauthorized work has been carried out.

3. Alarms / Safety Shut Off

The Emergency Warmer has separate “Self Test” and “Over Temperature Alarm” functions.

SELF TEST:

The software performs periodic self tests. If a fault is detected during one of these tests, the unit shuts off automatically.

OVER TEMPERATURE ALARM:

As the first level of over temperature protection, the software generates an alarm when the temperature rises above 41°C, and all functions are shut off. The red Alarm LED is illuminated and an alarm buzzer sounds to alert the user.

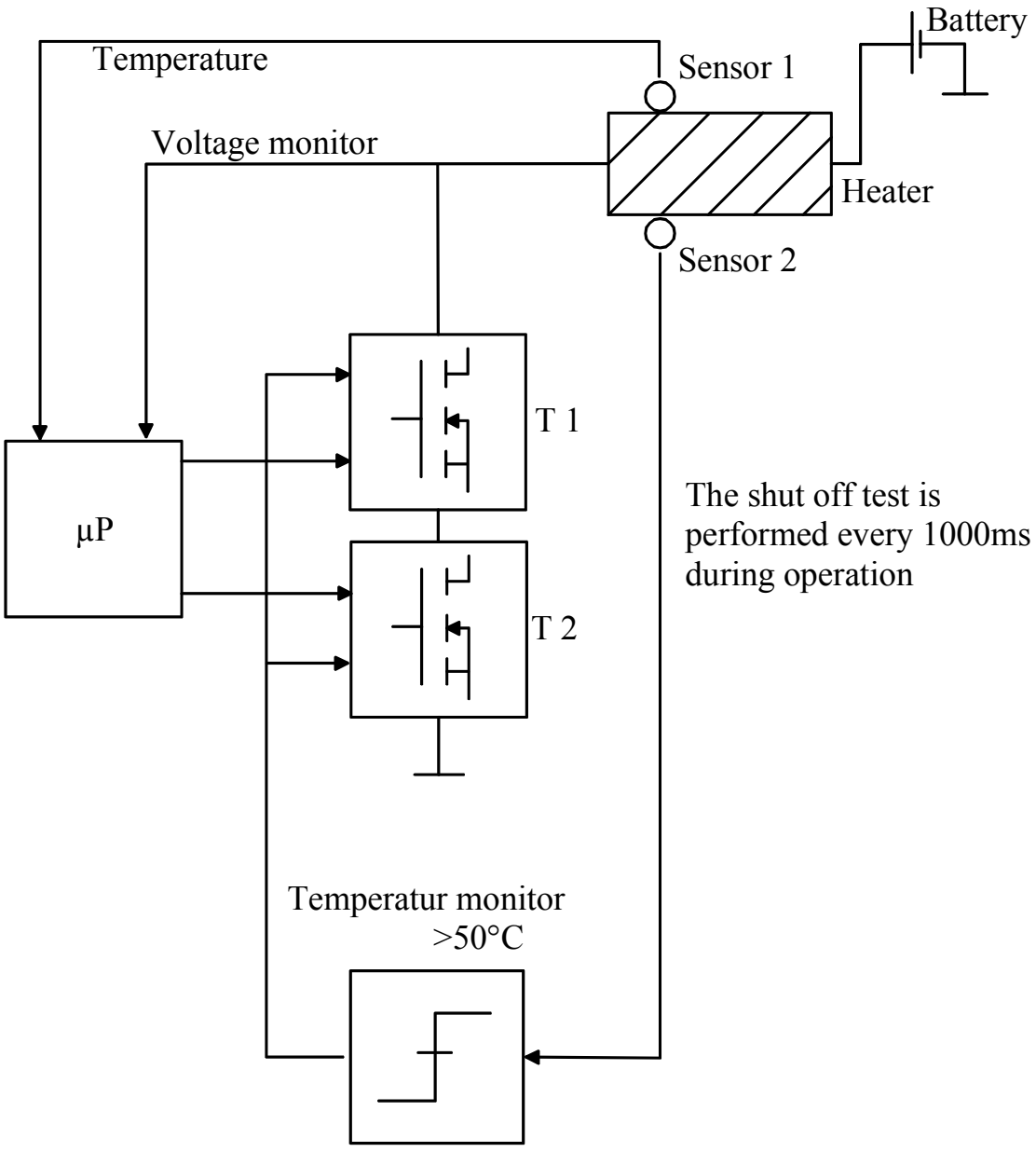
The second-level safety shut off is triggered by the hardware when the temperature exceeds 45°C.

SAFETY SHUT OFF:

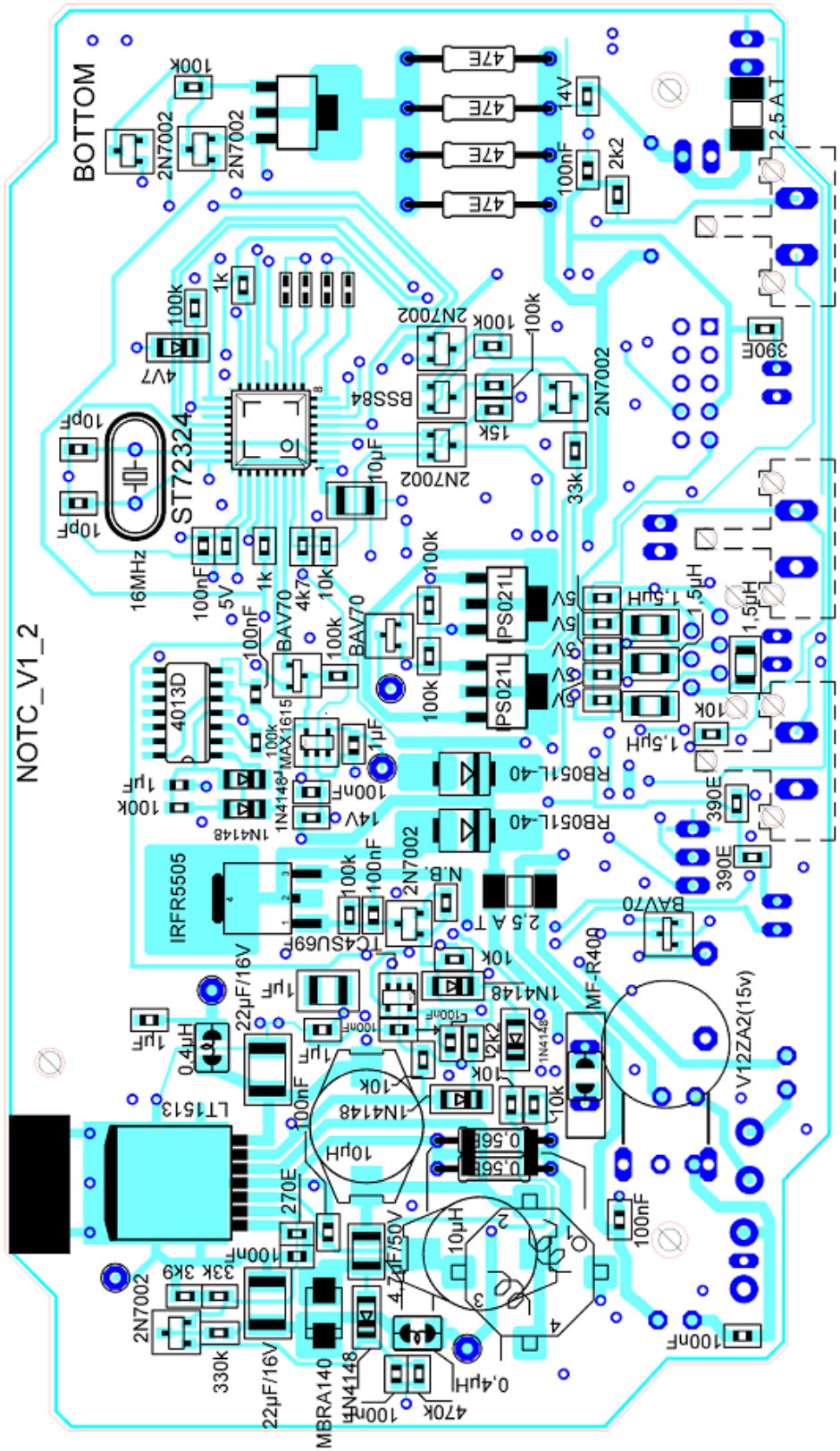
The temperature on the ESH 04 is factory set to 37°C. A digital sensor is used to monitor the temperature. This sensor together with the second-level safety shut off mechanism is mounted on a small PCB which is attached to the heating mat.

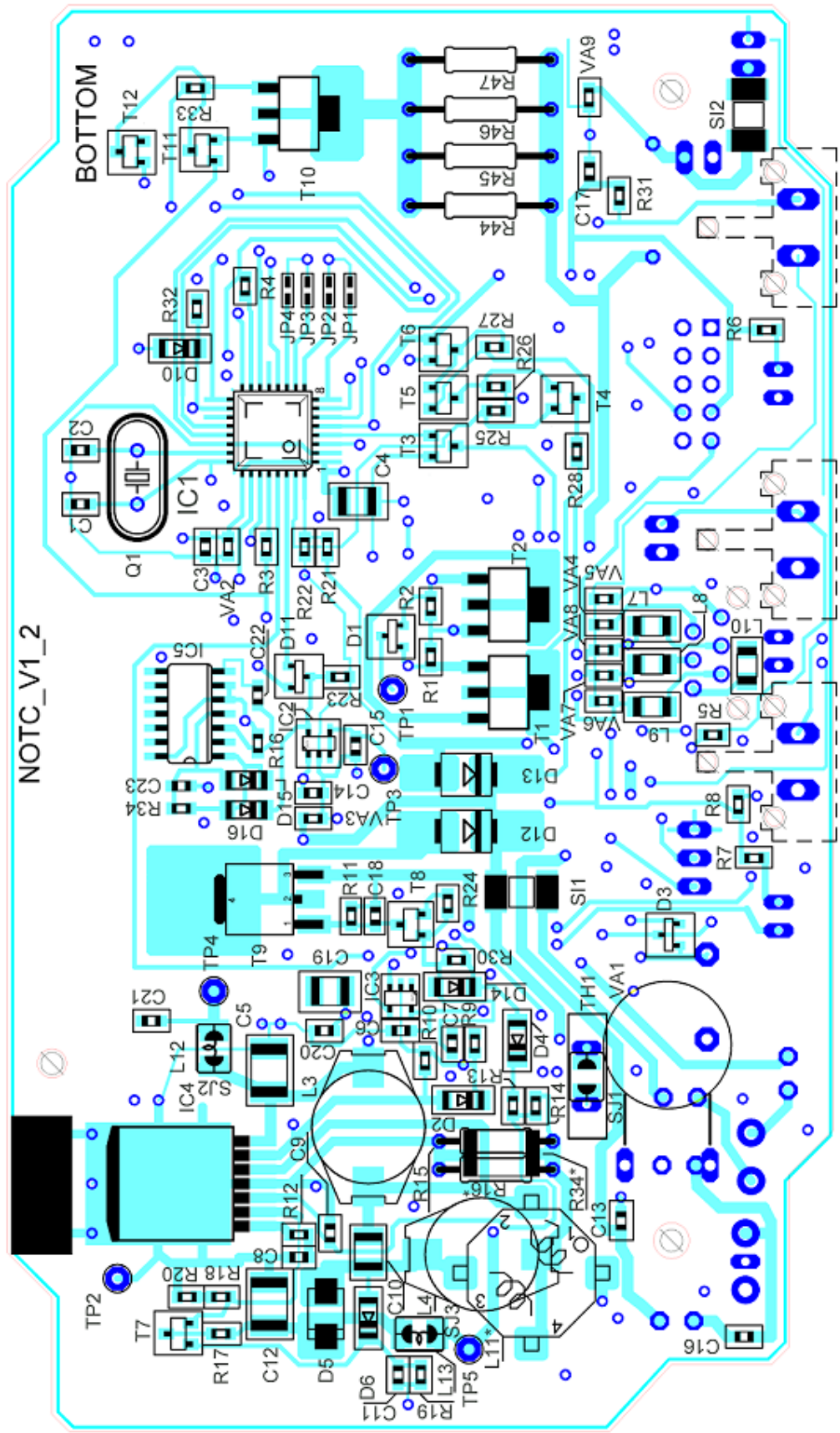
A microcontroller on the ESH 04 provides temperature control, scans the keys, acts as the service interface and runs the output stage self test. Two power MOSFETs connected in series control the heating. The controller tests the function of the output transistors every 1,000 milliseconds. If a fault is detected during this test, the ESH 04 shuts off and generates a visual and acoustic alarm.

If the controller develops a fault, a hardware-based safety shut off overrides the first-level safety shut off. The second-level over temperature shut off is activated at a fixed temperature of 45°C.



4. Circuit Schematics and Layouts




BOTTOM
NOTC_V1_2
IC1
Q1
TP1
TP2
TP3
TP4
TP5
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
D1
D2
D3
D4
D5
D6
D10
D11
D12
D13
D14
D15
D16
L3
L4
L7
L8
L9
L10
L11*
L12
L13
SJ1
SJ2
SJ3
SI1
SI2
TH1
VA1
VA2
VA3
VA4
VA5
VA6
VA7
VA8
VA9
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16*
R17
R18
R19
R20
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R22
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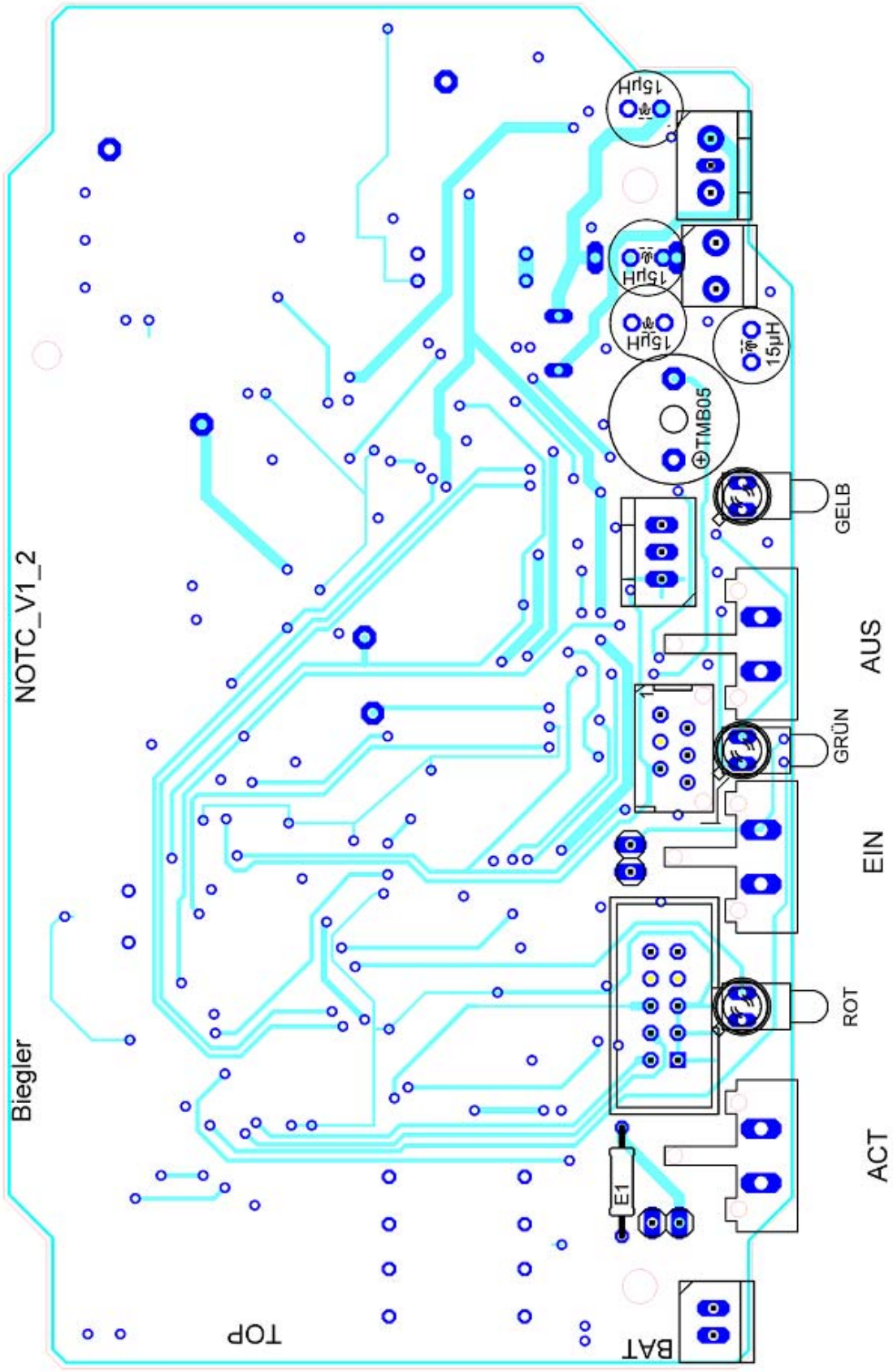
R25
R26
R27
R28
R30
R31
R32
R33
R34*
R44
R45
R46
R47
C1
C2
C3
C4
C5
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19
C20
C21
C22
C23
IC2
IC3
IC4
IC5
JP1
JP2
JP3
JP4

ACT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Biegler
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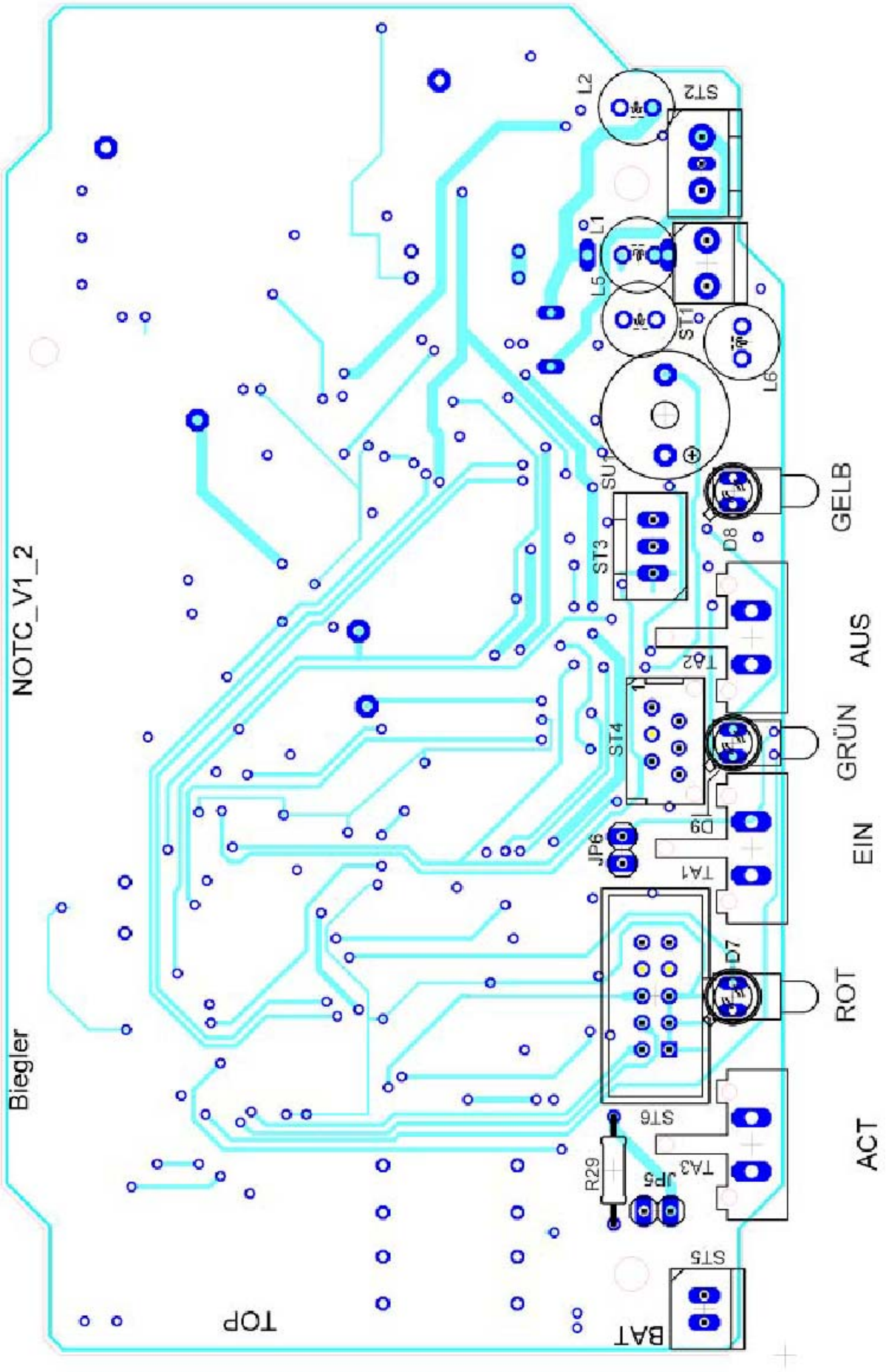
15µH
15µH
15µH
TMB05
GELB
GRÜN
ROT
E1
AUS
EIN
ACT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BAT
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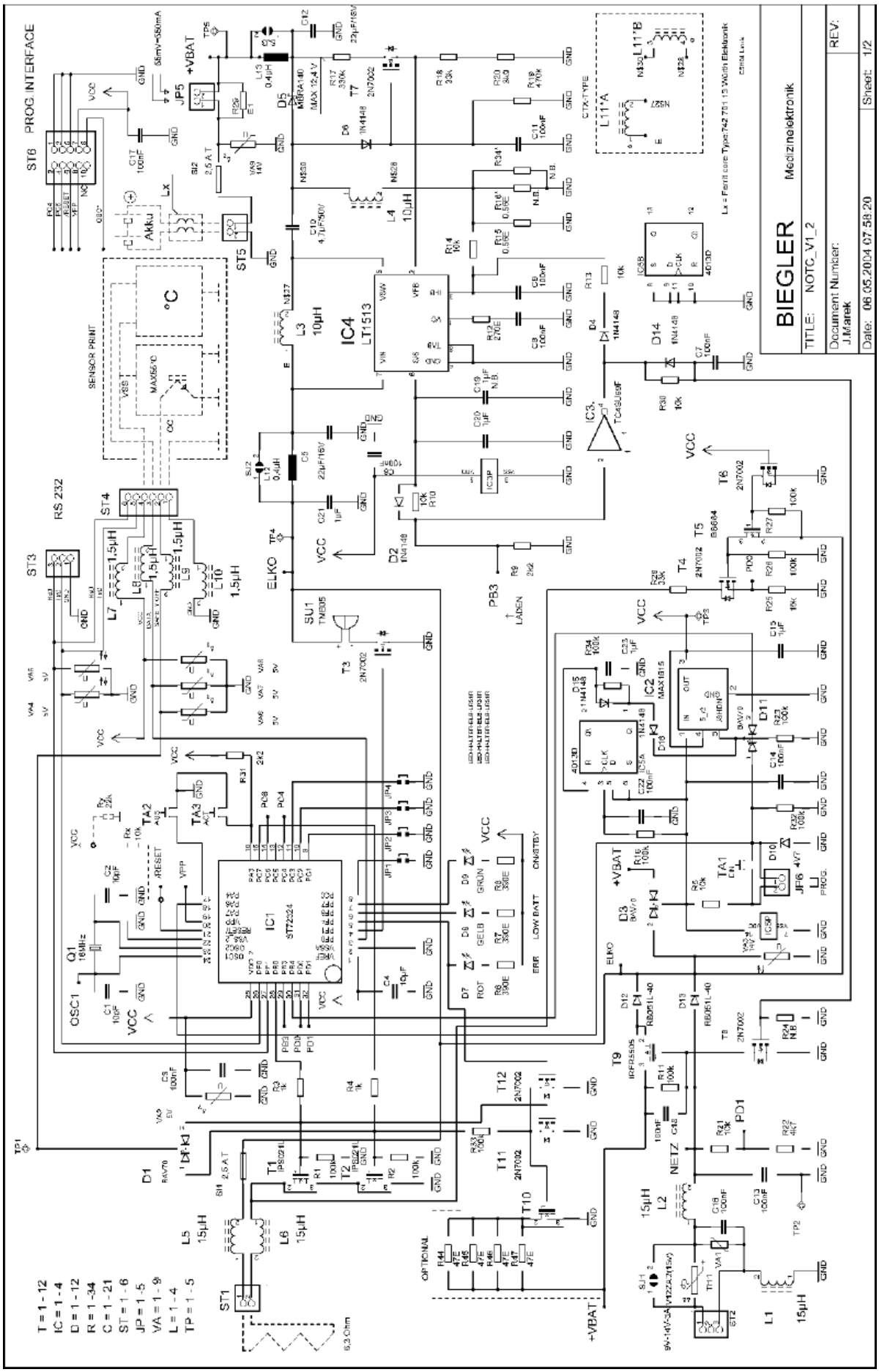
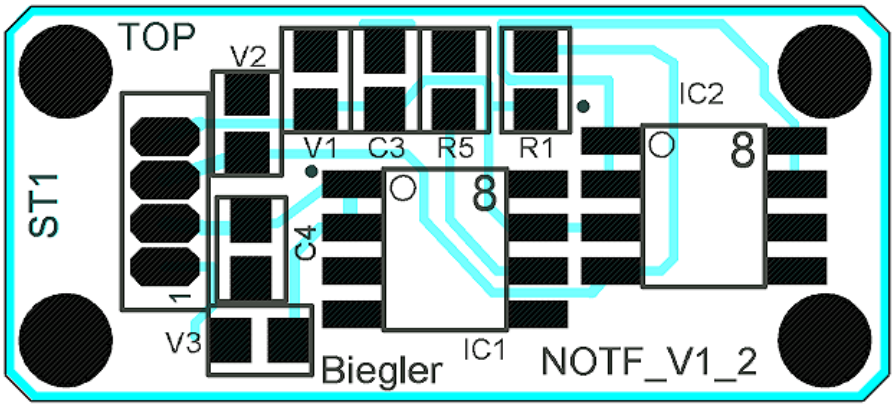
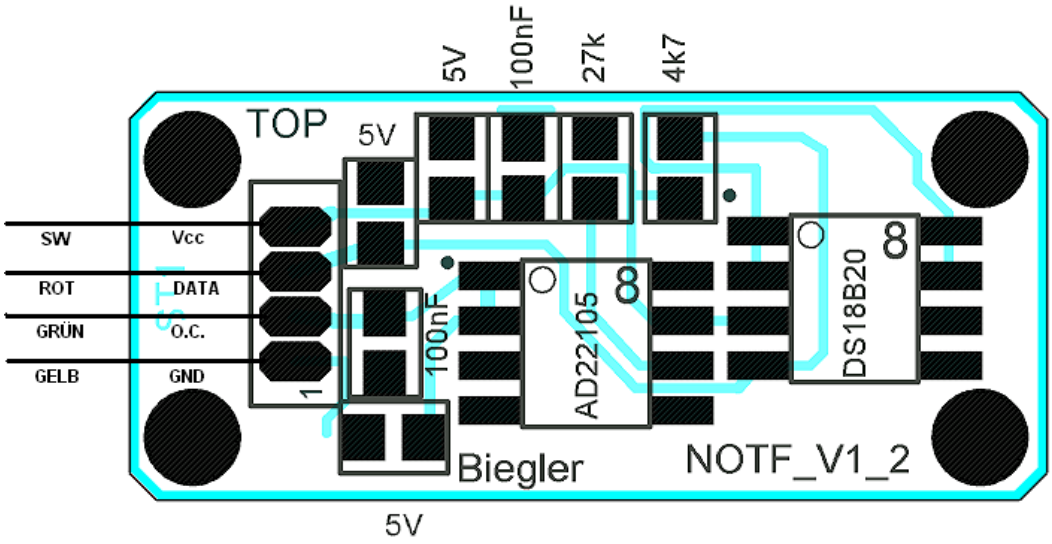
L2
L1
L5
ST1
L6
SU1
ST3
D8
GELB
TA2
ST4
AUS
GRÜN
D9
JP6
EIN
TA1
D7
ROT
ST6
R29
TA3
JP5
ACT
ST5

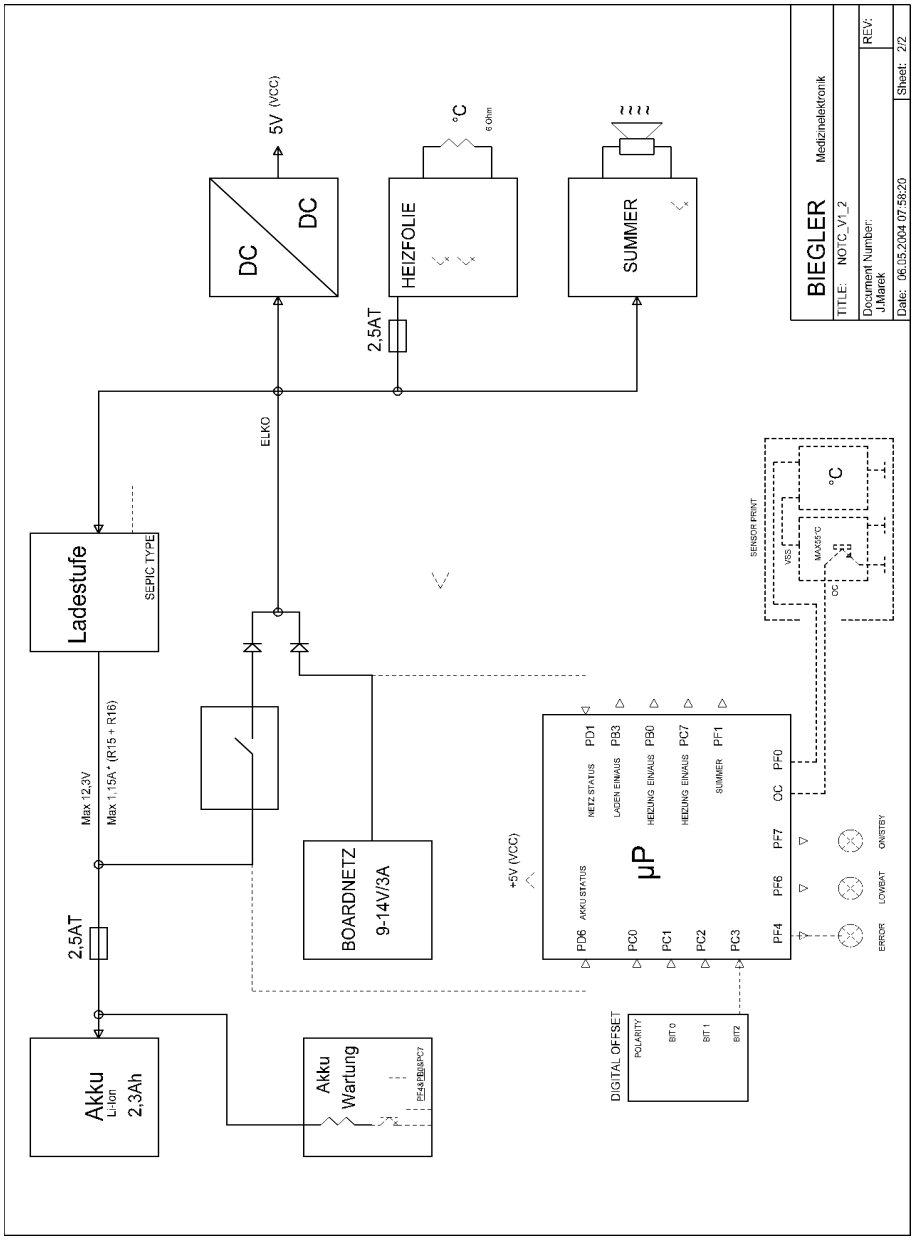

BIEGLER
Medizinelektronik
TITLE: NOTC_V1_2
Document Number:
J.Marek
Date: 06.05.2004 07:58:20
Sheet: 1/2
REV:
ST6 PROG. INTERFACE
IC4 LT1513
IC1 ST72324
SENSOR PRINT
RS 232
ELKO
+VBAT
VCC
T = 1 - 12
IC = 1 - 4
D = 1 - 12
R = 1 - 34
C = 1 - 21
ST = 1 - 6
JP = 1 - 5
VA = 1 - 9
L = 1 - 4
TP = 1 - 5

Sensor PCB : Component Layout





5. Block Diagram



6. Parts Lists

NAME	DESCRIPTION	PART NUMBER	ITEM
R1	Res. 100k , SMD 0603		
R2	Res. 100k , SMD 0603		
R3	Res. 1k , SMD 0603		
R4	Res. 1k , SMD 0603		
R5	Res. 10k , SMD 0603		
R6	Res. 390E , SMD 0603		
R7	Res. 390E , SMD 0603		
R8	Res. 390E , SMD 0603		
R9	Res. 2k2 , SMD 0603		
R10	Res. 10k , SMD 0603		
R11	Res. 100k , SMD 0603		
R12	Res. 270E , SMD 0603		
R13	Res. 10k , SMD 0603		
R14	Res. 10k , SMD 0603		
R15	Res. 0.56E , thru-hole, 0.33W		
R16	Res. 0.56E (not populated)		
R17	Res. 330k , SMD 0603		
R18	Res. 33k , SMD 0603		
R19	Res. 470k , SMD 0603		
R20	Res. 3k9 , SMD 0603		
R21	Res. 10k , SMD 0603		
R22	Res. 4k7 , SMD 0603		
R23	Res. 100k , SMD 0603		
R24	Res. 1M , SMD 0603		
R25	Res. 15k , SMD 0603		
R26	Res. 100k , SMD 0603		
R27	Res. 100k , SMD 0603		
R28	Res. 33k , SMD 0603		
R29	Res. 1E , thru-hole, 0.33W		
R30	Res. 10k , SMD 0603		
R31	Res. 2k2k , SMD 0603		
R32	Res. 100k , SMD 0603		
R33	Res. 100k , SMD 0603 (not populated)		
R34	Res. 0.56 , RL73-3A (not populated)		
R44-47	Res. 47E, SMD 0207/12 (not populated)		

NAME	DESCRIPTION	PART NUMBER	ITEM
C1	Cap. 10pF , SMD 0603		
C2	Cap. 10pF , SMD 0603		
C3	Cap. 100nF , SMD 0603		
C4	Cap. 10µF , SMD 1210		
C5	Cap. 22µF / 16V , SMD 1812		
C6	Cap. 100nF , SMD 0603		
C7	Cap. 100nF , SMD 0603		
C8	Cap. 100nF , SMD 0603		
C9	Cap. 100nF , SMD 0603		
C10	Cap. 4.7µF / 50V , SMD 1210		
C11	Cap. 100nF , SMD 0603		
C12	Cap. 22µF / 16V , SMD 1812		
C13	Cap. 100nF , SMD 0603		
C14	Cap. 100nF , SMD 0603		
C15	Cap. 1µF , SMD 0603		
C16	Cap. 100nF , SMD 0603		
C17	Cap. 100nF , SMD 0603		
C18	Cap. 100nF , SMD 0603		
C19	Cap. 1µF , SMD 1210		
C20	Cap. 1µF , SMD 0603		
C21	Cap. 1µF , SMD 0603		
JP5	PINHD-1X2		
JP6	PINHD-1X2		
Q1	Quartz, 16MHz, RM5, Crystal HC49U70		
A1	LION rechargeable battery, 10.8V, 2.3Ah		
SU1	Buzzer, thru-hole TMB 05		
ST1	Connector, 1x2 PANCON		
ST2	Connector. 1x3 PANCON		
ST3	Connector. 1x3 PANCON		
ST4	Connector. PF-50x6		
ST5	Connector. 1x2 PANCON		
ST6	Connector. Pinhead 2x5 N		

NAME	DESCRIPTION	PART NUMBER	ITEM
D1	Duodiode BAV 70 , SMD-SOT23		
D2	Diode 1N4148 , SMD SOD80		
D3	Duodiode BAV 70 , SMD-SOT23		
D4	Diode 1N4148 , SMD SOD80		
D5	Diode MBRA 140 T3		
D6	Diode 1N4148 , SMD SOD80		
D7	LED Diode red, 3mm		
D8	LED Diode yellow, 3mm		
D9	LED Diode green, 3mm		
D10	Zener diode, 4V7, SMD		
D11	Duodiode BAV 70 , SMD-SOT23		
D12	Schottky diode, 3A / 0.45V , RB 051L-40, SMD-SMB		
D13	Schottky-Diode, 3A / 0.45V , RB 051L-40, SMD-SMB		
D14	Diode 1N4148 , SMD SOD80		
IC1	ST 72324		
IC2	MAX 1615		
IC3	TC 4SU69F (C-MOS inverter)		
IC4	LT1513 (D Pack) charging IC		
VA1	Varistor 18V DC, thru-hole RM5		
VA2	Varistor 5V, SMD 0603		
VA3	Varistor 14V, SMD 0603		
VA4	Varistor 5V, SMD 0603		
VA5	Varistor 5V, SMD 0603		
VA6	Varistor 5V, SMD 0603		
VA7	Varistor 5V, SMD 0603		
VA8	Varistor 5V, SMD 0603		
VA9	Varistor 14V, SMD 0603		
SI1, SI2	Fuse 2.5AT, SMD		
TA1-TA3	Pushbutton RAFI 3, AC402		
	plunger l=7mm, D=8mm		
	90° base		
JP1-JP4	Jumper		
JP5	PINHD-1x2		
HA1-HA3	Led holder ELB-LR31R		

NAME	DESCRIPTION	PART NUMBER	ITEM
T1	IPS 021L , BSP75 , SMD SOT223		
T2	IPS 021L , BSP75 , SMD SOT223		
T3	FET-N-2N7002 , SMD SOT23		
T4	FET-N-2N7002 , SMD SOT23		
T5	BSS 84 , SMD SOT23		
T6	FET-N-2N7002 , SMD SOT23		
T7	FET-N-2N7002 , SMD SOT23		
T8	FET-N-2N7002 , SMD SOT23		
T9	2SJ182 (P-channel FET)		
T10	IPS 021L, BSP75, SOT223, (not populated)		
T11	FET-N-2N7002 , SMD SOT23		
T12	FET-N-2N7002 , SMD SOT23		
TH1	Bridge PTC 995, (not populated)		
L1	15µH , choke RM3D7		
L2	15µH , choke RM3D7		
L3	10µH , choke RM5 , WE-PD4		
L4	10µH , choke RM5 , WE-PD4		
L5	15µH , choke RM3D7		
L6	15µH , choke RM3D7		
L7	1.5µH , choke, 1206		
L8	1.5µH , choke, 1206		
L9	1.5µH , choke, 1206		
L10	1.5µH , choke, 1206		
L11	choke CTX (not populated)		
L12	inductor 0.4µH, SM-NE45 (not populated)		
L13	inductor 0.4µH, SM-NE45 (not populated)		
Rx	res. 1k , 0.33W, thru-hole		
Lx	1µH ferrite core,D12, d5, L9 mm		
Cx	Cap. 1µF , SMD 0603		
Dx	Diode 1N4148 , SMD SOD80		
Dy	Diode 1N4148 , SMD SOD80		
Dz	Diode 1N4148 , SMD SOD80		

Sensor PCB

NAME	DESCRIPTION	PART NUMBER	ITEM
ST1	4-pole connector, STE4x1-27		
R1	Res. 4k7 , SMD-0603		
R5	Res. 27k , SMD-0603		
V1	Varistor 5V , SMD-0603		
V2	Varistor 5V , SMD-0603		
V3	Varistor 5V , SMD-0603		
C3	Cap. 100nF / 25V , SMD-0603		
C4	Cap. 100nF / 25V , SMD-0603		
IC1	Thermostat AD22105 , SO 08		
IC2	Temperature sensor DS18B20 SO 08		
	PCB NOTF_1_2		

Test Sheet Procedure

ESH 04

Emergency Warmer

ESH 04 Test

Persons performing this procedure must have a very good understanding of the various test steps.

The procedure should be used as a reference in conjunction with the ESH 04 test sheet. If applicable, BIEGLER will provide updates as supplemental sheets, which must be immediately inserted into the procedure.

Test sequence :

Start the communications program at the computer.

Connect the communications cable to the ESH04.

Connect the ESH04 to the power adapter.

Use a stop watch to check the whether the time counts down from 255 at one minute intervals. (Observe for at least two minutes.)

Monitor display: S (Standby), N (power), 0 (no heating).

Check the charge function on the ESH04 – the Charge LED must be illuminated.

Check charge shut off: press the “L” key on the computer
(simulates one minute charging time).
The Charge LED on the ESH04 must turn off after one minute.

Turn on theESH04.
Check whether the “On” LED is illuminated and the ESH04 is heating.
Monitor display: B (operating), N (power), 1 (heating).

Unplug the power adapter and plug it in again (check the Charge LED).
Shut off the ESH04, disconnect the power adapter and connect it again.
(Timer set).
Charging starts; it should be finished after 4:15 hrs.
(Charge LED must not be illuminated).

Temperature test:

Place 2 infusion flasks (500 ml) into the ESH04. Attach a temperature probe half way up the left flask along side of the right flask. The temperature meter should have an accuracy of 0.1°C.

Take the measurement at room temperature (flasks and device) with the communications cable attached and without the power adapter.

Pump the pressure bag up to 300mmHg.

Turn on the ESH04. The unit should still be heating after about 90 minutes (the rechargeable battery is then OK).
Connect the device to the power adapter and after another 30 minutes check the regulated temperature (37 +/- 1.5°C). Watch the temperature control (0 and 1 on the monitor).

Check to ensure that the pressure cuffs for leaks.

When the temperature test has run for more than 120 minutes, a minimum pressure of 200mmHg should still be present.

Continuous test :

- Startup at room temperature with two 500ml flasks.
- After about 2 hours, measure the temperature at the flask.
- After 24h, measure the temperature again at the flask.

The initial and final values must remain within the tolerances. Be sure that ambient conditions are always the same when you take the measurements.

The final value may deviate by ± 0.5°C from the initial value.

DETAIL VIEWS:

Complete
pressure cuff
+ heating foil:

ESH04 populated PCB with
battery and lower housing:

Complete housing with cable connection
(serial communications connector)

Emergency Warmer ESH04 Test Log

INITIAL TEST / MAINTENANCE TEST

Device No.: ..... Date: ...../...../.....

A detailed knowledge of the applicable procedure is required to perform these tests.

TEST	NOMINAL / FUNCTION	RESULT	
		OK	not OK
1.Data communications	PC communications		
2.Check charge cycle shut off (“L”)	simulated charging time 1 min. - Charge LED turns off		
3.Operating temp. **Battery operation - power adapter**	37°C +/- 1.5°C (after about 2 hrs.)		
4.Pressure sleeve leakage	initial : min. 300 mmHg final : min. 200 mmHg		
5. Battery charging	about 4.5 hr. Charge LED turns off		
6.Elect. safety	see printout		
7.Mech. condition			
8.Contamination			
9.Markings			
10. Visual inspection	device / power adapter		

Signature of test engineer:	

8. Safety Checks

Periodic checks must be carried out on the ESH 04 Emergency Warmer at least every 12 months. Persons performing the checks must have sufficient training, knowledge and practical experience to conduct safety checks.

- The safety information on the unit and its accessories must be clearly legible.
- The mechanical condition of all components must be suitable for continued safe use (housing, zipper, cord, window, stitching, cable, tubing, manometer and hand pump).
- There must be no contamination on the Emergency Warmer which could impair safety.
- Electrical testing of the power adapter (equivalent device leakage current, power consumption)

Item Description

GERB023 Calibrate test lead
Measure resistance to the protective conductor

Units: Ohms	spec. value: 0.00	limit: 0.00	abs.tol.: 0.00	rel.tol.: 0.00
Units: Ohms	spec. value: 0.00	limit: 0.00	abs.tol. :0.00	rel.tol.: 0.00

GERB001 Line voltage test
Measure the line voltage (RMS)

Units: VOLTS	spec. value: 230	limit: 0.00	abs. tol.: 0.00	rel. tol. 0.00
Units: VOLT	spec. value: 230	limit: 0.00	abs. tol.: 0.00	rel. tol. 0.00

GERB024 Power consumption test
Measure the RMS power consumption of the device under test.
The test has a time limit. A message is issued if the time is exceeded.
Maximum power 3.5 kVA.
Be sure that the blood heater is in the heating phase when you take this measurement.
.

Units: Watts	spec. value: 0.00	limit: 0.00	abs. tol.: 0.00	rel. tol. 0.00
Units: Watts	spec. value: 0.00	limit: 0.00	abs. tol.: 0.00	rel. tol. 0.00

GERB019 Derived leakage current as show in Fig.9 and defined in VDE 0751
The line voltage is the test voltage which is applied to the device under test.
Measure the current which flows from the housing to ground.
The derived leakage current must not be more that 1.5 times the initial value and it also must not exceed the limit value of 750 µA.
Line power switch: ON.

Units: µA	spec. value: 0.00	limit: < 750	abs. tol.: 0.00	rel. tol.: 0.00
Units: µA	spec. value: 0.00	limit: < 750	abs. tol.: 0.00	rel. tol.: 0.00

9. Spare Parts

DESCRIPTION	PART NO.
Charger complete	FL 1000001
Vehicle charger cable	FL 1000002
ESH04 cable	FL 1000003
Pressure cuffs + heating foil complete	LE 1000001
Populated ESH04 PCB	IP 9004026
Rechargeable battery pack (lithium ion)	IE 2001006
Rubber bellows with discharge screw	DA 1006004
Manometer with side connection (0 – 300 mmHg)	DC 1040003
Pressure bag	DS 4230221
Case	JR 1005001