LAB.GRUPPEN

LAB 2002

SERVICE MANUAL

1999 EMC

LAB 2002
Theory of function

Power supply

AC-power is coming in to terminal K1. The voltage is rectified by D1 and filtered by C10, C11. This gives 310V DC to the transformer TR1. The PWM-controller U1 controls the switch Q1-Q3 to give the correct output voltage at terminal J17, J19. When the switch Q1-Q3 i closed, current flows trough transformer, TR1, storing energy. Because of the voltage polarity, diode D3, D4 are reverse-biased, thus no voltage present at the load. When the switch is open, transformer TR1 reverses polarity because of the collapsing magnetic field, forward-biasing diode D3, D4, and inducing a current flow into the capacitors C12, C14. The reversed voltage is sensed by a winding in TR1 and rectified by diode D8. The PWM-controller adjust the on-time of the switch, by comparing the voltage across C14 with an internal reference, to give a rail voltage of +-155V across the capacitors C12,C14. The voltage can be adjusted by potentiometer TP2. The maximum current in the transformer is sensed over the resistor R6-R8. The voltage across R6-R8 is compared with a reference-voltage, set by TP3, which make it possible to adjust the maximum output power from the power supply. Normally TP3 is in maximum position, but if something has too be repaired in the amplifier, TP3 is used for "slow starting" the amplifier.

Amplifier

The input signal is connected to the balanced amplifier U1. The gain in this amplifier can be reduced by opto resistor LDR1 to prevent clipping in the output amplifier. From amplifier U1 signal is going to limiter U2, Q1, Q2 passing gain control P1. This limiter together with the phase linear lowpassfilter U3, U4 limits the slewrate of the signal going to the output amplifier 4KLF, preventing from intermodulation in this amplifier if signals of too high frequencies are presented on the input terminal.

The output amplifier 4KLF works as an ordinary power amplifier with the difference that the collector voltage to the output transistors is supplied from the switch mode amplifier 4KHF.
The base voltage on the output transistors Q26-Q28, Q31-Q33 is sensed by voltage divider R36-R38 and is then sent to the adjustable limiter U3, U4 on the input board, before it reaches the input on the switch mode amplifier. Limit level is set by the minimum load select-switches (MLS-sv.) to give correct output power in different loads. These switches also change the sensitivity for the led bars on the front panel.

The amplifier U1 (U2) on the HF-board makes sure that the output signal on terminal J4 (J8) is a copy of the input signal on terminal J12, by giving correct control voltage to pulse width modulator U3. U3 compares this voltage with an 614Khz triangular wave giving a pulse wide modulated output signal from Q1 (Q7) which is filtered by L1, C1 (L4, C10). The gain from the base of the output transistors in the LF-amplifier to the output of the HF-amplifier is equal to one. TP1 (TP2) is used to add a DC-offset on the input of U1 (U2) giving +7,5V (J4) -7,5V (J8) relative output of the LF-amplifier (J6), which is the same as collector-emitter voltage for the output transistors Q26-Q28, Q31-Q33.

REPAIRING INSTRUCTIONS

REQUIRED MEASUREMENT EQUIPMENT:
-Audio generator
-AC-voltmeter/THD-meter
-2 digital voltmeters
-Two channel oscilloscope for audio
-Variac 0-280V, 6A
-50Mhz oscilloscope, ex. Tek 2225
with 100x probe ex. Tek P6009

AMPLIFIER

1. Without changing any fuses check the power supply +136V, -136V,+16V, -16V,+30V. If these aren't OK go to section for repairing power supply.

2. If all fuses are OK, follow the signal from input to output, and repair in normal way. The best way is to place the amplifier on the front handles, loosen the rear panel, and mount it back on distances (delivered with this manual) to make it possible to measure.

3. If there is a fault in the power amplifier stage do as follows:

   3:1 Turn TP1, TP2 on the HF-board, TP3 on the power supply board counter clockwise.

   3:2 Short-circuit R38 on LF-board.

   3:3 Disconnect cables from Q28, and Q32 collectors on the LF-board.

   3:4 Replace broken fuses. (only for the channel you repair)

   3:5 Connect DC-voltmeter (200V) to the positive (negative) rail voltage.

   3:6 Connect another DC-voltmeter (20V) to the cable disconnected from Q28 (Q32).

   3:7 Turn TP3 (PSU) slowly clockwise, TP1 and watch the voltmeters. Rail voltage should increase rapidly, "collector voltage" should read 0. After turning TP3 maximum 30°, rail voltage should be 136V.

   a. If the rail voltage is zero or very low, check Q1, D1 (Q7, D5) (shorted) on the HF-board..
      If Q1 (Q7) is broken, also replace R3 (R16) and D2 (D6).

   b. If OK (155V) turn TP1 (TP2) slowly maximum clockwise. Voltage measured on the disconnected collector cable should stop at about 7,5V.

c. If OK turn TP1 (TP2) and TP3 counter clockwise.

3:8 Repeat from 3:5 for the negative side (xx).

3:9 Reconnect cable to Q28 collector.

3:10 Connect dummy load 16Ω to output, and connect an oscilloscope (10V/div) across the load.

3:11 Slowly turn TP3 (PSU) for 136V (-136V) rail voltage.

3:12 Slowly turn TP1 (TP2) clockwise and look at the oscilloscope. There should be no DC on the oscilloscope. If there is DC (⟨1V) repair the positive (negative) output section on the LF-board.

3:13 Turn back TP1 (TP2) and TP3, and disconnect Q28 collector.

3:14 Reconnect Q32 collector and repeat from 3:11 for the negative side.

3:15 Reconnect cables to Q28 and Q32 collector. Turn TP3 for 136V rail voltage. Turn TP1 clockwise, no DC on the oscilloscope. Then slowly turn TP2 clockwise. There can be some oscillation with TP2 in middle position, but it will stop at further turning.

3:16 Connect 1KHz sine wave to the input of the amplifier. Adjust gain until there is signal on the output. It should be a 7V PK sine wave with no distortion.

3:17 Disconnect short circuit from R38, and the amplifier will work.

POWER SUPPLY

Required measurement equipment
-Audio generator
-DVM
-50 MHz oscilloscope, ex. Tek 2225 with 100x probe ex. Tek P6009
-Isolation transformer for the mains, 1:1
-Variac 0-280V, 6A
(-Two channel oscilloscope for audio)
(-AC Voltmeter/ THD-meter)

1) Turn TP2 and TP3 fully counter clockwise.
2) Change F1 on the PSUG.
3) Increase the main voltage slowly by the variac.
4) Measure the voltage across C1 on PSUH.
   a) No voltage: -change R1 PSUG.
   b) The current increases quickly: -check D1- PSUG-check Q1, Q2, Q3 PSUH.
5) It is now possible to increase the voltage across C1 on PSUH to approx. 300 V without current inrush.

6) Connect an oscilloscope to mains voltage via an isolation transformer. Then measure across Q1 collector and emitter.

7) Turn TP3 slowly clockwise until a pulse is visible on the scope. The frequency is approx.27 kHz (see figure1). If the graph is seen, go to item 9).

8) If nothing is seen check:

   a) U1:15 >14V

   b) U1:16 5V

   c) U1:3 < 3V

   d) U1:2 > 3V

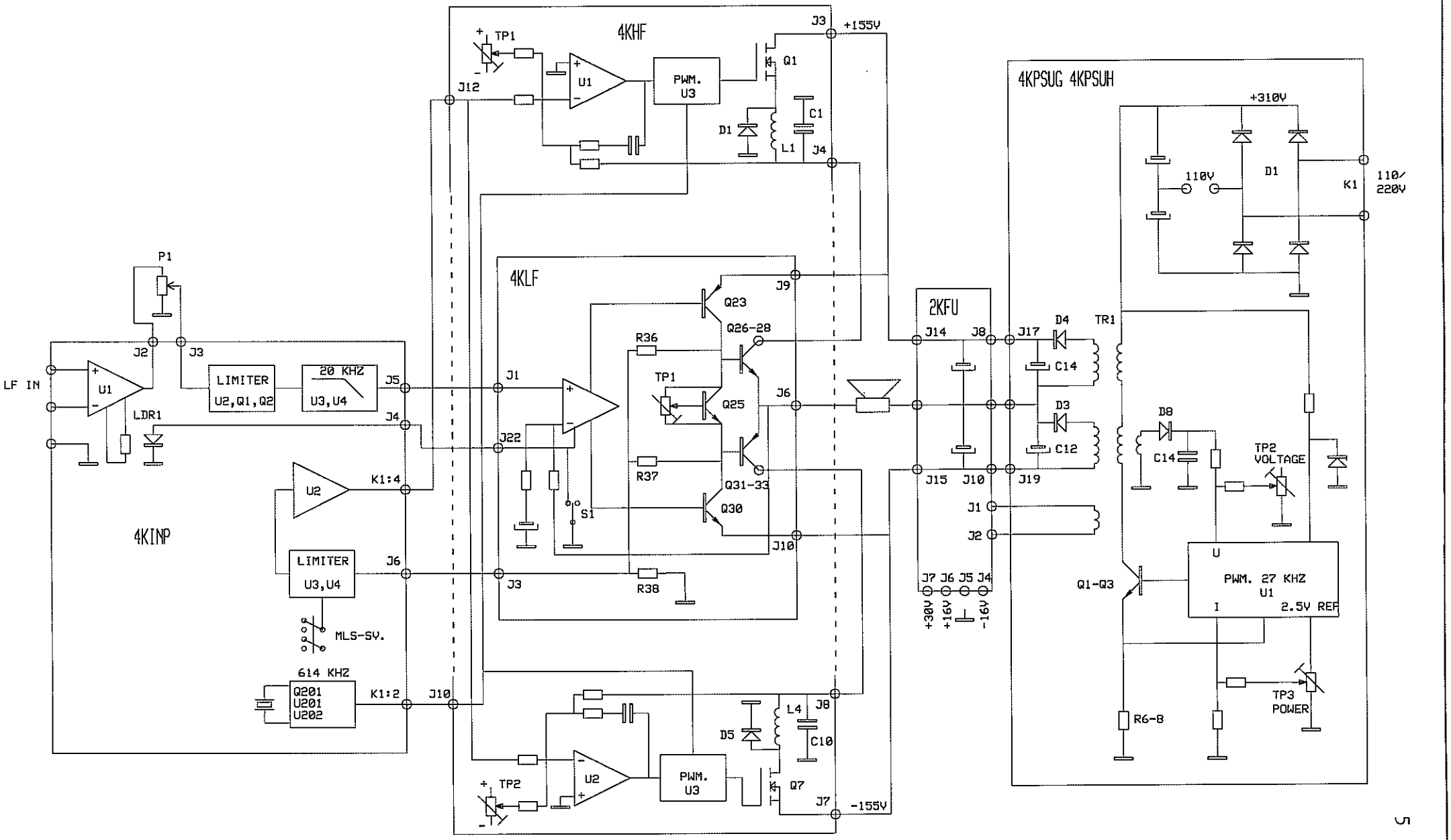
   e) U1:8 > 5V

   f) U1:10 54KHz ramp

8) If only narrow spikes are seen, check the following components.
   a) D3, D4 - PSUH or the output circuits.
   b) D1, D2 -makes U1 goes into over voltage protection.

9) Turn TP3 fully clockwise:
   a) Check the output voltage on C22, C23 – PSUG for correct voltage. Adjust with TP2. Correct voltage is found in the schematics (see below).
   b) Check the soft start circuit by turn on and off the main switch and look at the oscilloscope.
   c) Increase the power by applying an audio signal to the amplifier and turn up the gain controls. -The pulse width will increase.
   d) Check the over/ under voltage protection circuits by turning the variac up to 280 VAC and down to 130 VAC. (No load).

Fig. 1



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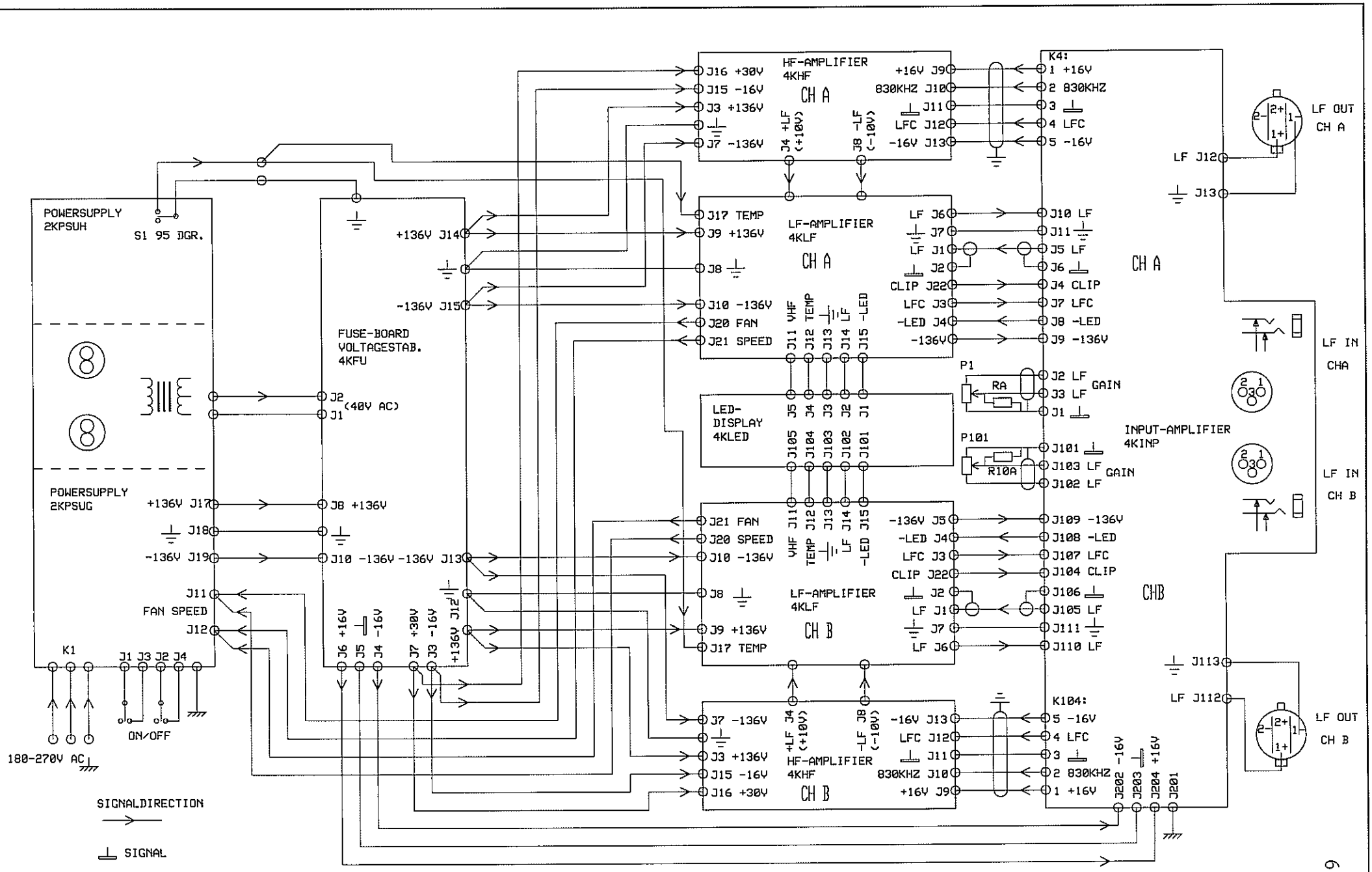

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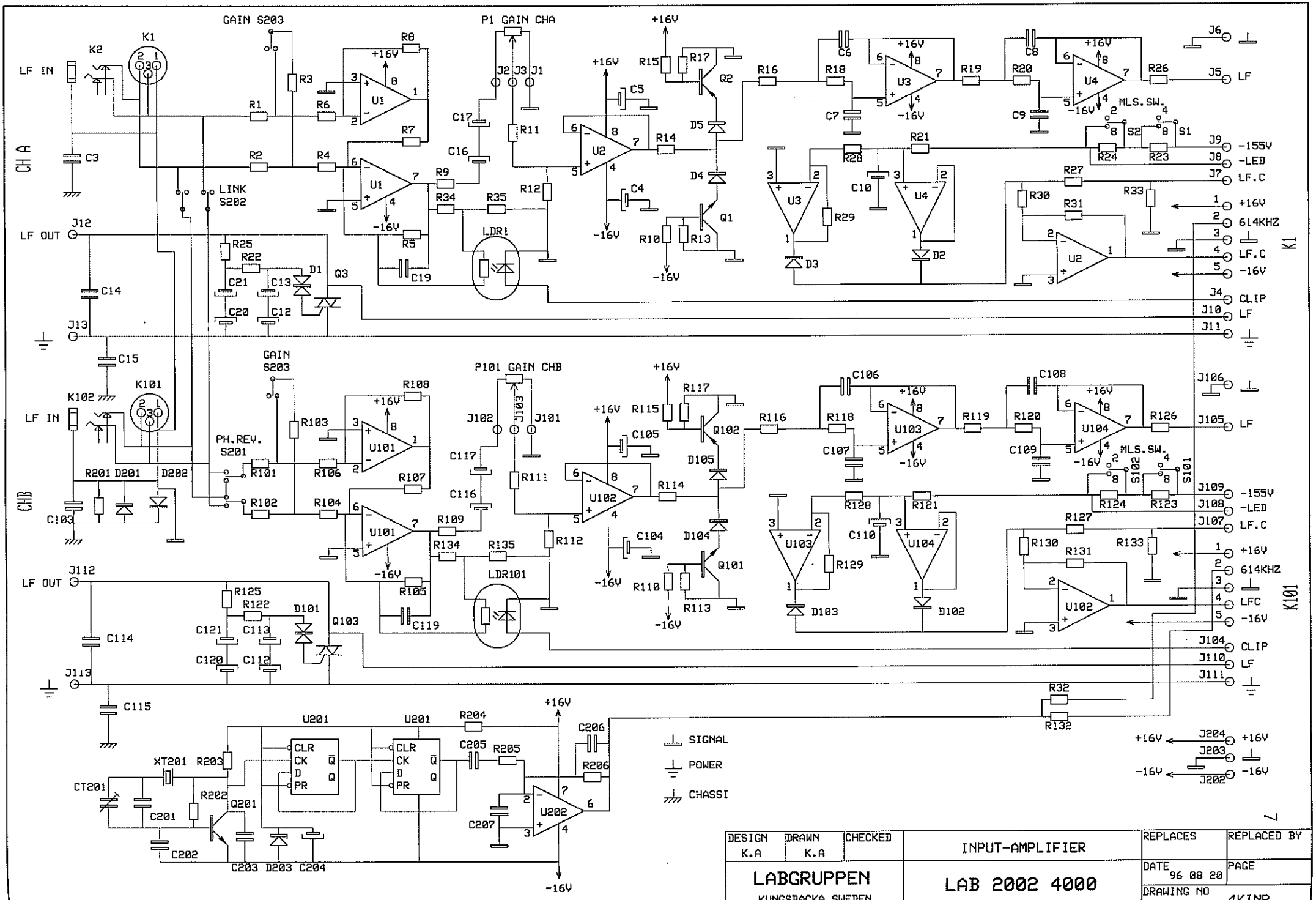
CH A
CHB
LF IN
LF OUT
LINK S202
GAIN S203
P1 GAIN CHA
P101 GAIN CHB
PH.REV. S201
LDR1
LDR101
MLS.SW.
S1
S2
S101
S102
K1
K2
K101
K102
+16V
-16V
-155V
-LED
LF.C
614KHZ
CLIP
LF
SIGNAL
POWER
CHASSI
INPUT-AMPLIFIER
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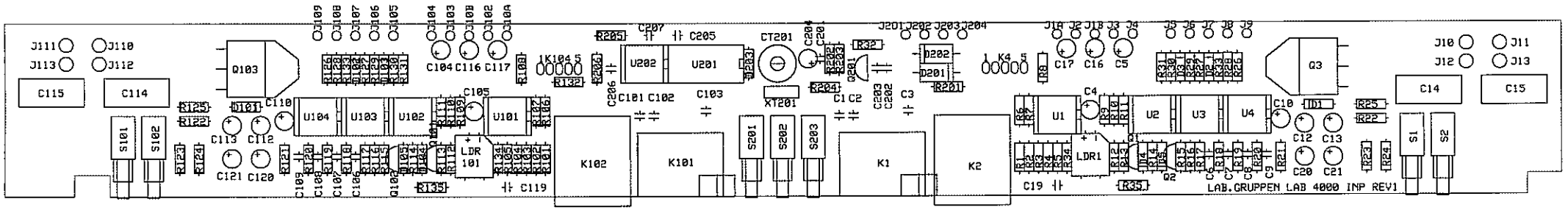

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LAB 2002
INPUT AMPLIFIER AND INTERNAL CONNECTIONS
Component-list

LAB 2002 INPUT AMPLIFIER

Component-list Channel A
(Ch. B; add 100, Ch. A+B add 200)

Resistors

R1	10 kΩ 1%
R2	10 kΩ 1%
R3	5,36 kΩ 1% 29 dB gain
R3	9,76 kΩ 1% 32 dB gain
R4	10 kΩ 1%
R5	66 kΩ 1%
R6	10 kΩ 1%
R7	22 kΩ 1%
R8	22 kΩ 1%
R9	100 Ω
R10	47 kΩ 1%
R11	1 kΩ 1%
R12	47 kΩ 1%
R13	18 kΩ 1%
R14	1 kΩ 1%
R15	47 kΩ 1%
R16	10 kΩ 1%
R17	18 kΩ 1%
R18	10 kΩ 1%
R19	10 kΩ 1%
R20	10 kΩ 1%
R21	715 kΩ 1%
R22	27 kΩ 1%
R23	2,4 kΩ 1% long legs
R24	6,2 kΩ 1W long legs
R25	27 kΩ 1%
R26	100 Ω
R27	10 kΩ 1%
R28	47 kΩ 1%
R29	47 kΩ 1%
R30	10 kΩ 1%
R31	10 kΩ 1%
R32	100 Ω
R33	12,4 kΩ 1%
R34	10 kΩ 1%
R35	1 kΩ 1%
R36	47 kΩ 1%

Optoresistor

LDR1 VTL5C4

Transistors

Q1	BC 547
Q2	BC 557
Q3	Q 4015R6

Capacitors

C1	-
C2	-
C3	330 nF 50V
C4	10 µF 50V
C5	10 µF 50V
C6	220 pF 5%
C7	220 pF 5%
C8	330 pF 5%
C9	100 pF 5%
C10	0.47 µF 50V
C11	-
C12	22 µF 50V
C13	22 µF 50V
C14	0.47 µF 250V
C15	2.2 µF 63V
C16	22 µF 50V
C17	22 µF 50V
C18	-
C19	22 pF
C20	22 uF 50V
C21	22 uF 50V

Diodes

D1	DB 3
D2	1N 4148
D3	1N 4148
D4	1N 4148
D5	1N 4148

Switches

S1	Alps SPPJ3
S2	Alps "

Integrated circuits

U1	NE 5532
U2	NE 5532
U3	LF 353
U4	LF 353

Connectors

K1	3-pole XLR chassie
K2	3-pole Telejack
K4	5-pole pinheader

Resistors

R201	10 Ω
R202	220 kΩ
R203	1 kΩ 1%
R204	2.2 kΩ
R205	2,2 kΩ 1%
R206	22 kΩ 1%

Capacitors

C201	22 pF
C202	220 pF
C203	68 pF
C204	10 µF 25V
C205	1 nF
C206	68 pF 5%
C207	220 pF

Trim capacitors

CT201 2-22pF

Diodes

D201	1N 5404
D202	1N 5404
D203	5.6V Zener 2%

Transistors

Q201 BC 547

Integrated circuits

U201	74HC74
U202	LM 318

Crystals

X201 2,4576 mHz

Switches

S201	Alps SPPJ3
S202	Alps "
S203	Alps "

INTERNAL CONNECTIONS

RA	10 kΩ 1%
P1	10 kΩ lin Tokos
K3	Speak-on NL-4MP

Inductors

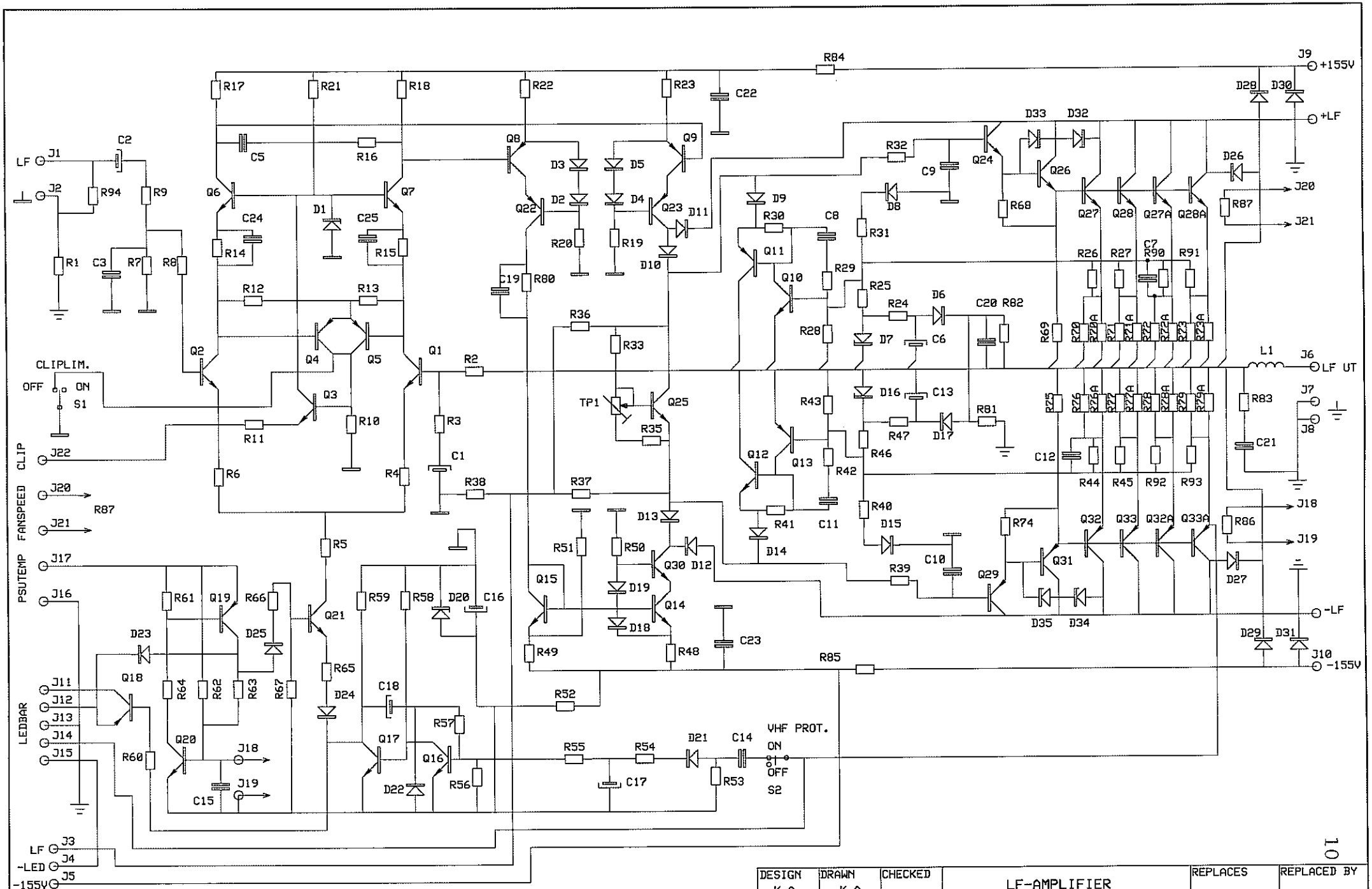
L1	9.5 µH (2 core)
L2	9.5 µH (2 core)

***Until 9902**

C6	470pF 5%
C7	470pF 5%
C8	680pF 5%
C9	220pF 5%

***Until 2001-06**

D1	HS10
R22	47 kΩ 1%
R25	47 kΩ 1%


LF J1
J2
C2
R94
R9
R1
C3
R7
R8
C24
C25
R14
R15
R12
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Q2
Q4
Q5
Q1
Q3
R10
R11
R2
R3
C1
R6
R4
R5
R17
R21
R18
R22
R23
C22
C5
R16
Q8
Q9
Q6
Q7
D1
D3
D5
D2
D4
Q22
Q23
D11
D10
R20
R19
C19
R80
R84
J9
+155V
D28
D30
+LF
D33
D32
Q24
Q26
R32
C9
D8
R68
D26
J20
J21
Q27
Q28
Q27A
Q28A
R87
C7
R90
R91
R26
R27
R69
R70
R70A
R71
R71A
R72
R72A
R73
R73A
D9
R30
C8
R31
Q11
Q10
R29
R25
R24
D6
C20
R82
R28
D7
C6
L1
J6
LF UT
J7
J8
R83
C21
CLIPLIM.
OFF
ON
S1
J22
CLIP
J20
R87
J21
FANSPEED
J17
PSUTEMP
J16
TP1
Q25
R35
R33
R36
R43
D16
C13
R81
R47
D17
R46
R42
Q12
Q13
C12
R44
R45
R92
R93
R75
R75A
R76
R76A
R77
R77A
R78
R78A
R79
R79A
R40
D15
R74
Q32
Q33
Q32A
Q33A
R86
J18
J19
D27
R41
C11
D14
R39
C10
Q29
Q31
D35
D34
-LF
D29
D31
J10
-155V
R38
R37
D13
R51
R50
Q30
D12
Q15
D19
Q14
D18
R49
R48
C23
R85
R52
R61
Q19
R66
D23
D25
Q21
R59
R58
D20
C16
R65
D24
C18
R57
Q18
R64
R62
R63
R67
Q20
Q17
Q16
D22
R56
R60
J18
J19
C15
LEDBAR
J11
J12
J13
J14
J15
R55
R54
D21
C14
C17
R53
VHF PROT.
ON
OFF
S2
LF J3
-LED J4
-155V J5
10
DESIGN K.A
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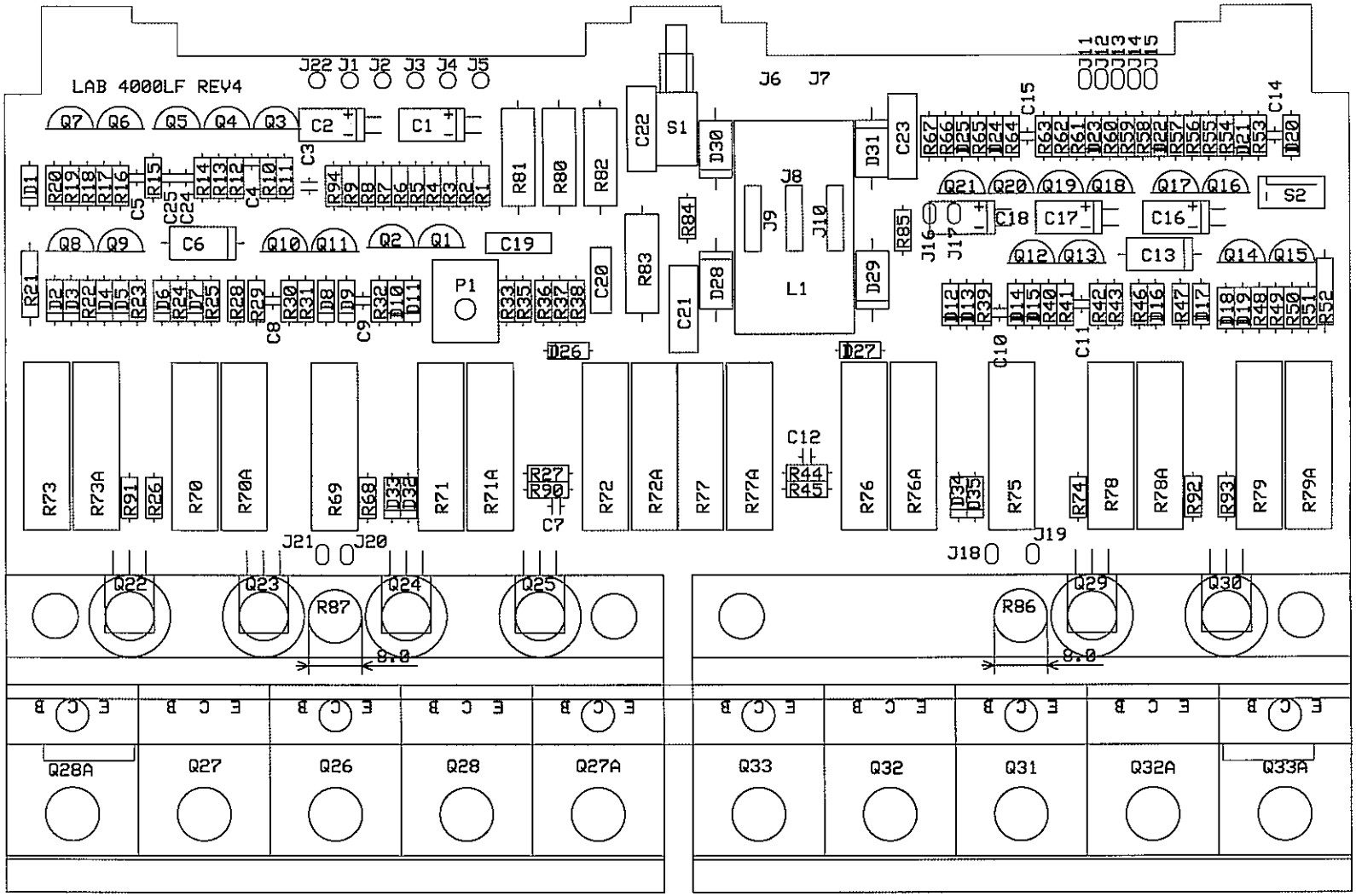

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LAB 2002
LF-AMPLIFIER
Component-list

Resistors

R1	10 Ω
R2	27 kΩ 1%
R3	1 kΩ 1%
R4	180 Ω 1%
R5	1.8 kΩ 1%
R6	180 Ω 1%
R7	27 kΩ 1%
R8	10 Ω
R9	1 kΩ 1%
R10	100 kΩ 1%
R11	1.8 kΩ 1%
R12	27 kΩ 1%
R13	27 kΩ 1%
R14	3.3 kΩ 1%
R15	3.3 kΩ 1%
R16	4.7 kΩ 1%
R17	3.3 kΩ 1%
R18	3.3 kΩ 1%
R19	100 kΩ 1%
R20	100 kΩ 1%
R21	18 kΩ 2W
R22	100 Ω 1%
R23	100 Ω 1%
R24	27 kΩ 1%
R25	68 kΩ 1%
R26	-
R27	12,4 kΩ 1%
R28	3.9 kΩ 1%
R29	10 kΩ 1%
R30	4.7 kΩ 1%
R31	560 kΩ 1%
R32	220 Ω
R33	3.3 kΩ 1%
R34	-
R35	604 Ω 1%
R36	100 kΩ 1% 0.7W
R37	100 kΩ 1% 0.7W
R38	820 kΩ
R39	220 Ω
R40	560 kΩ 1%
R41	4.7 kΩ 1%
R42	10 kΩ 1%
R43	3.9 kΩ 1%
R44	12.7 kΩ 1%
R45	12.7 kΩ 1%
R46	68 kΩ 1%
R47	27 kΩ 1%
R48	100 Ω 1%
R49	100 Ω 1%
R50	100 kΩ 1%
R51	100 kΩ 1%
R52	18 kΩ 2W
R53	10 kΩ 1%
R54	10 kΩ 1%
R55	220 kΩ 1%
R56	100 kΩ 1%
R57	220 kΩ 1%
R58	56 kΩ 1%
R59	56 kΩ 1%
R60	27 kΩ 1%
R61	3.3 kΩ 1%
R62	432 kΩ 1%
R63	2.2 MΩ
R64	27 kΩ 1%
R65	2.7 kΩ 1%
R66	100 kΩ 1%
R67	56 kΩ 1%
R68	47 Ω
R69	4.7 Ω 5W
R70	-
R70a	-
R71	0.27 Ω 5W
R71a	0.27 Ω 5W
R72	0.27 Ω 5W
R72a	0.27 Ω 5W
R73	0.27 Ω 5W
R73a	0.27 Ω 5W
R74	47 Ω
R75	4.7 Ω 5W
R76	0.27 Ω 5W
R76a	0.27 Ω 5W
R77	0.27 Ω 5W
R77a	0.27 Ω 5W
R78	-
R78a	-
R79	0.27 Ω 5W
R79a	0.27 Ω 5W
R80	6.8 kΩ 3W
R81	820 Ω 6W
R82	1.5 kΩ 3W
R83	10 Ω 3W
R84	10 Ω
R85	10 Ω
R86	150 kΩ NTC
R87	150 kΩ NTC
R88	-
R89	-
R90	12.4 kΩ 1%
R91	12.4 kΩ 1%
R92	-
R93	12.4 kΩ 1%
R94	27 kΩ 1%

Trim potentiometers

TP1	250 Ω

Capacitors

C1	220 µF 16V
C2	10 µF 50V
C3	150 pF ker
C4	-
C5	680 pF
C6	1 µF 100V
C7	1 nF 63V
C8	1 nF 63V
C9	680 pF
C10	680 pF
C11	1 nF 63V
C12	1 nF 63V
C13	1 µF 100V
C14	39 pF 500V
C15	0.1 µF 40V
C16	220 µF 16V
C17	4.7 µF 50V
C18	10 µF 50V
C19	22 nF 250V
C20	47 nF 250V
C21	0.1 µF 250V
C22	0.1 µF 250V
C23	0.1 µF 250V
C24	4.7 nF
C25	4.7 nF
C26	-
C27	-

Diods

D1	15 V Zener
D2	1N 4148
D3	1N 4148
D4	1N 4148
D5	1N 4148
D6	1N 4004
D7	27 V Zener
D8	BAV 21
D9	1N 4148
D10	1N 4148
D11	BAV 21
D12	BAV 21
D13	1N 4148
D14	1N 4148
D15	BAV 21
D16	27 V Zener
D17	1N 4004
D18	1N 4148
D19	1N 4148
D20	15 V Zener
D21	1N 4004
D22	1N 4148
D23	1N 4148
D24	1N 4148
D25	1N 4148
D26	1N 4004
D27	1N 4004
D28	BYW 96E
D29	BYW 96E
D30	1N 5404
D31	1N 5404
D32	BZX85C100
D33	BZX85C100
D34	BZX85C100
D35	BZX85C100

Transistors

Q1	BC 549C matched
Q2	BC 549C matched
Q3	BC 547
Q4	BC 557
Q5	BC 557
Q6	MPSA 42
Q7	MPSA 42
Q8	BC 557
Q9	BC 557
Q10	BC 547
Q11	BC 557
Q12	BC 547
Q13	BC 557
Q14	BC 547
Q15	BC 547
Q16	BC 547
Q17	BC 547
Q18	BC 557
Q19	BC 557
Q20	BC 547
Q21	BC 547
Q22	MJE 350
Q23	MJE 350
Q24	MJE 340
Q25*	BD329
Q26	MJL 21194
Q27	-
Q27a	MJL 21194
Q28	MJL 21194
Q28a	MJL 21194
Q29	MJE 350
Q30	MJE 340
Q31	MJL 21193
Q32	MJL 21193
Q32a	MJL 21193
Q33	MJL 21193
Q33a	-

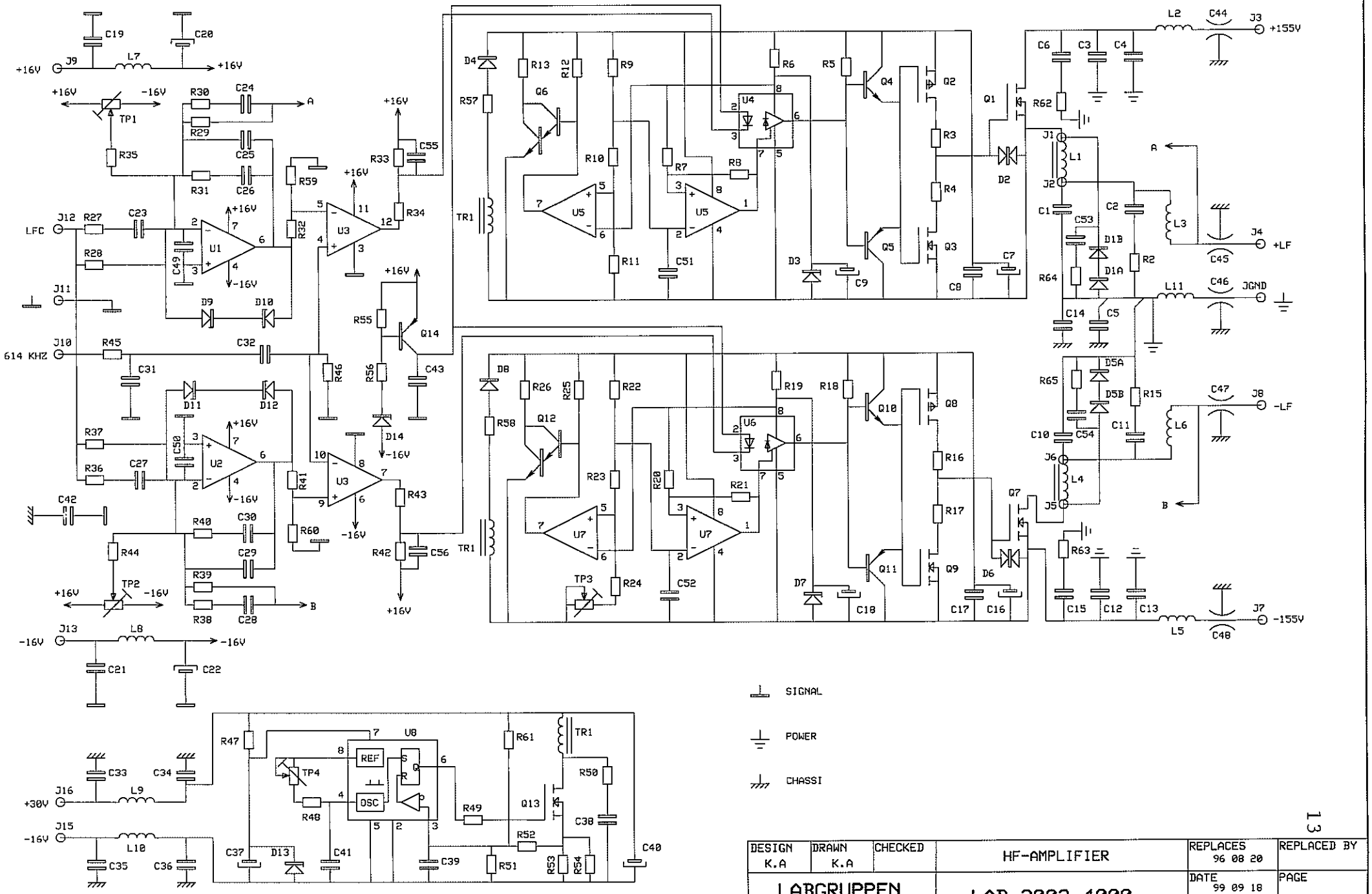
Inductors

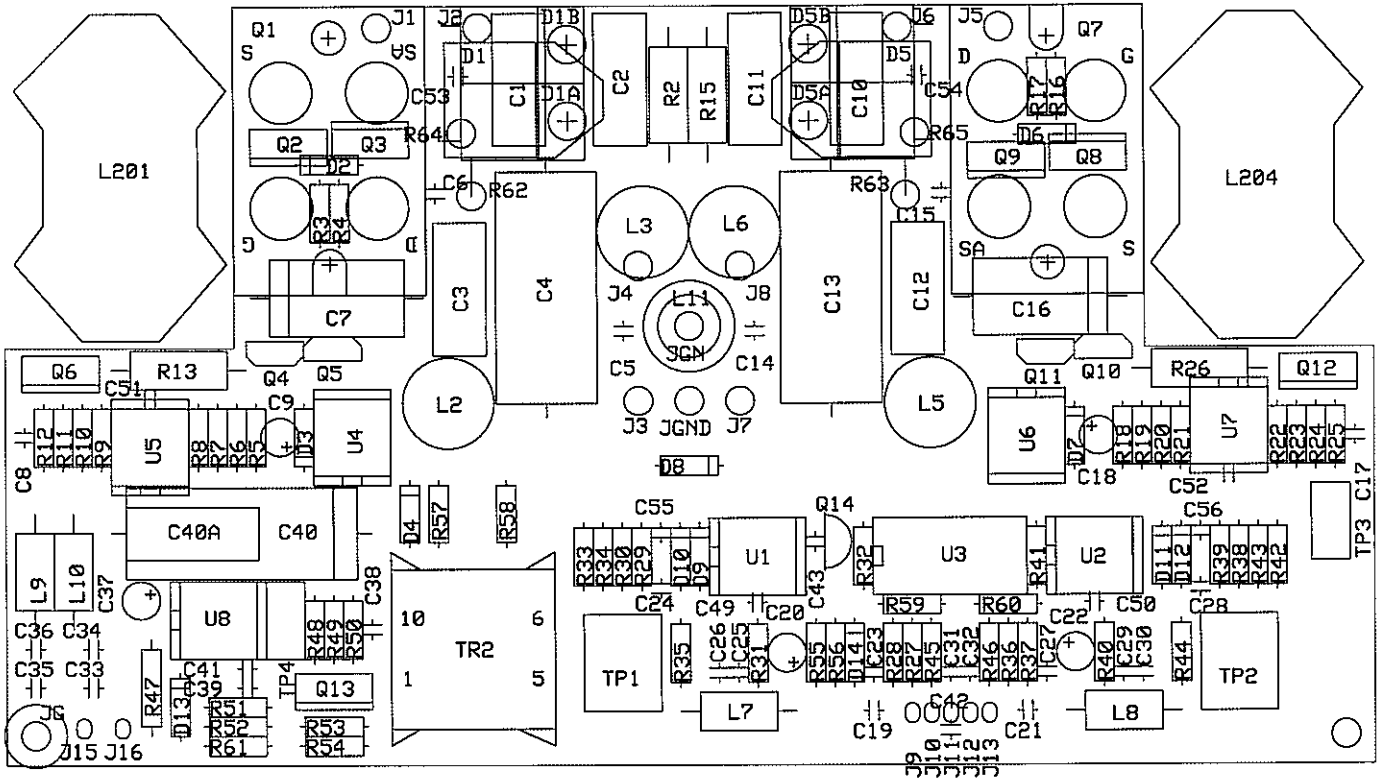
L1	9.5 µH (2 core)

Switches

S1	SPPJ3 Alps
S2	Dipfix Siemens

*	**Until 9801**
R35	750 Ω 1%
Q25	MJE 340


C19
C20
+16V
J9
L7
+16V
+16V
-16V
R30
C24
A
TP1
R29
C25
R35
R31
C26
R59
+16V
R33
C55
J12
R27
C23
LFC
U1
+16V
R32
U3
R34
R28
C49
-16V
J11
D9
D10
+16V
R55
Q14
J10
R45
C32
614 KHZ
C31
R46
R56
C43
D11
D12
D14
R37
C50
U2
+16V
-16V
R36
C27
R41
U3
R43
C42
R40
C30
R60
-16V
R42
C56
R44
C29
TR1
R39
TP2
+16V
-16V
B
R38
C28
+16V
J13
L8
-16V
-16V
C21
C22
D4
R13
R12
R9
R6
R5
Q4
Q2
Q1
R57
Q6
U4
R3
R10
R7
R8
U5
U5
R4
TR1
D2
J1
L1
R11
C51
Q5
Q3
C6
C3
C4
L2
C44
J3
+155V
R62
D3
C9
C8
C7
A
J2
C1
C53
C2
L3
J4
+LF
C45
D1B
D1A
R2
R64
L11
C46
JGND
C14
C5
D8
R26
R25
R22
R19
R18
Q10
Q8
D5A
R65
D5B
R15
C47
J8
-LF
R58
Q12
U6
R16
C10
C54
C11
L6
J6
L4
R23
R20
R21
U7
U7
R17
Q7
J5
B
TP3
R24
C52
Q11
Q9
R63
D7
D6
C18
C17
C16
C15
C12
C13
J7
-155V
L5
C48
SIGNAL
POWER
CHASSI
R47
U8
R61
TR1
C33
C34
REF
TP4
R50
J16
L9
+30V
R48
DSC
R49
Q13
C38
J15
-16V
L10
R52
C40
C37
D13
C41
C39
R51
R53
R54
C35
C36
13
DESIGN K.A
DRAWN K.A
CHECKED
HF-AMPLIFIER
REPLACES 96 08 20
REPLACED BY
LABGRUPPEN
KUNGSBACKA SWEDEN
LAB 2002 4000
DATE 99 09 18
PAGE
DRAWING NO 4KHF



14

DESIGN	DRAWN	CHECKED	HF AMPLIFIER	REPLACES	REPLACED BY
K.A	K.A				
LABGRUPPEN KUNGSBACKA SWEDEN			LAB2002 LAB4000	DATE 99 09 18	PAGE
				DRAWING NO 4KHFR1-P	

LAB 4000
HF-AMPLIFIER
Component-list

Resistors

R1	-
R2	2,2 Ω 2W on legs
R3	4.7 Ω
R4	1 Ω 1W on legs
R5	680 Ω
R6	47 Ω
R7	2.2 kΩ 1%
R8	22 kΩ
R9	820 Ω
R10	47 Ω
R11	2.2 kΩ 1%
R12	4.7 kΩ 1%
R13	15 Ω 6W on legs
R14	-
R15	2,2 Ω 2W on legs
R16	4.7 Ω
R17	1 Ω 1W on legs
R18	680 Ω
R19	47 Ω
R20	2.2 kΩ 1%
R21	22 kΩ
R22	820 Ω
R23	47 Ω
R24	1.8 kΩ 1%
R25	4.7 kΩ 1%
R26	15 Ω 6W on legs
R27	1,5 kΩ 1%
R28	1.8 kΩ 1%
R29	27 kΩ 1%
R30	2,2 kΩ 1%
R31	6,8 kΩ 1%
R32	4.7 kΩ
R33	330 Ω
R34	1.2 kΩ
R35	56 kΩ 1%
R36	1,5 kΩ 1%
R37	1.8 kΩ 1%
R38	2,2 kΩ 1%
R39	27 kΩ 1%
R40	6,8 kΩ 1%
R41	4.7 kΩ 1%
R42	330 Ω
R43	1.2 kΩ
R44	56 kΩ 1%
R45	2.2 kΩ 1%
R46	2.2 kΩ 1%
R47	1,2 kΩ 3W
R48	12 kΩ
R49	47 Ω
R50	27 Ω 1% on legs
R51	1 kΩ 1%
R52	1 kΩ 1%
R53	2.2 Ω
R54	2.2 Ω
R55	2.2 kΩ1%
R56	2.2 kΩ 1%
R57	1 Ω 1W on legs
R58	1 Ω 1W on legs
R59	2.2 kΩ 1%
R60	2.2 kΩ 1%
R61	120 kΩ 1%
R62	2.2 Ω 2W on legs
R63	2.2 Ω 2W on legs
R64	2.2 Ω 2W on legs
R65	2.2 Ω 2W on legs

Trim potentimeters

TP1	25 kΩ
TP2	25 kΩ
TP3	1 kΩ
TP4	10 kΩ

Capacitors

C1	0.33 µF 250V
C2	0.33 µF 250V
C3	0.33 µF 250V
C4	4.7 µF 160V
C5	1 µF 63V
C6	4,7 nF 200V NP0
C7	470 µF 10V
C8	0.1 µF 63V
C9	10 µF 50V
C10	0.33 µF 250V
C11	0.33 µF 250V
C12	0.33 µF 250V
C13	4.7 µF 160V
C14	1 µF 63V
C15	4,7 nF 200V NP0
C16	470 µF 10V
C17	0.1 µF 63V
C18	10 µF 50V
C19	0.1 µF 63V
C20	10 µF 50V
C21	0.1 µF 63V
C22	10 µF 50V
C23	2,2 nF 5%
C24	100 pF 5%
C25	39 pF 5%
C26	270 pF 5%
C27	2,2 nF 5%
C28	100 pF 5%
C29	39 pF 5%
C30	270 pF 5%
C31	68 pF
C32	1 nF
C33	0.1 µF 63V
C34	0.1 µF 63V
C35	0.1 µF 63V
C36	0.1 µF 63V
C37	10 µF 50V
C38	1 nF/100V/5/NP0
C39	220 pF
C40	2,2 uF 100V
C41	1 nF NP0
C42	0.1 µF 63V ker
C43	-
C44	1.5 nF feed through
C45	1.5 nF feed through
C46	1.5 nF feed through
C47	1.5 nF feed through
C48	1.5 nF feed through
C49	220 pF
C50	220 pF
C51	1 nF
C52	1 nF
C53	470 pF 200V NP0
C54	470 pF 200V NP0

Diods

D1a	BYW 81PI200
D1b	BYW 81PI200
D2	BZW 06P15B
D3	5.6V Zener 2%
D4	BYV 100-100
D5a	BYW 81PI200
D5b	BYW 81PI200
D6	BZW 06P15B
D7	5.6V Zener 2%
D8	BYV 100-100
D9	12V Zener
D10	12V Zener
D11	12V Zener
D12	12V Zener
D13	18V Zener 1.3W
D14	27V Zener

Transistors

Q1	IXFN 73N30
Q2	MTP2955V
Q3	BUZ 71
Q4	ZTX 650
Q5	ZTX 750
Q6	Tip 120
Q7	IXFN 73N30
Q8	MTP2955V
Q9	BUZ 71
Q10	ZTX 650
Q11	ZTX 750
Q12	Tip 120
Q13	IRF 730
Q14	BC 557

Integrated circuits

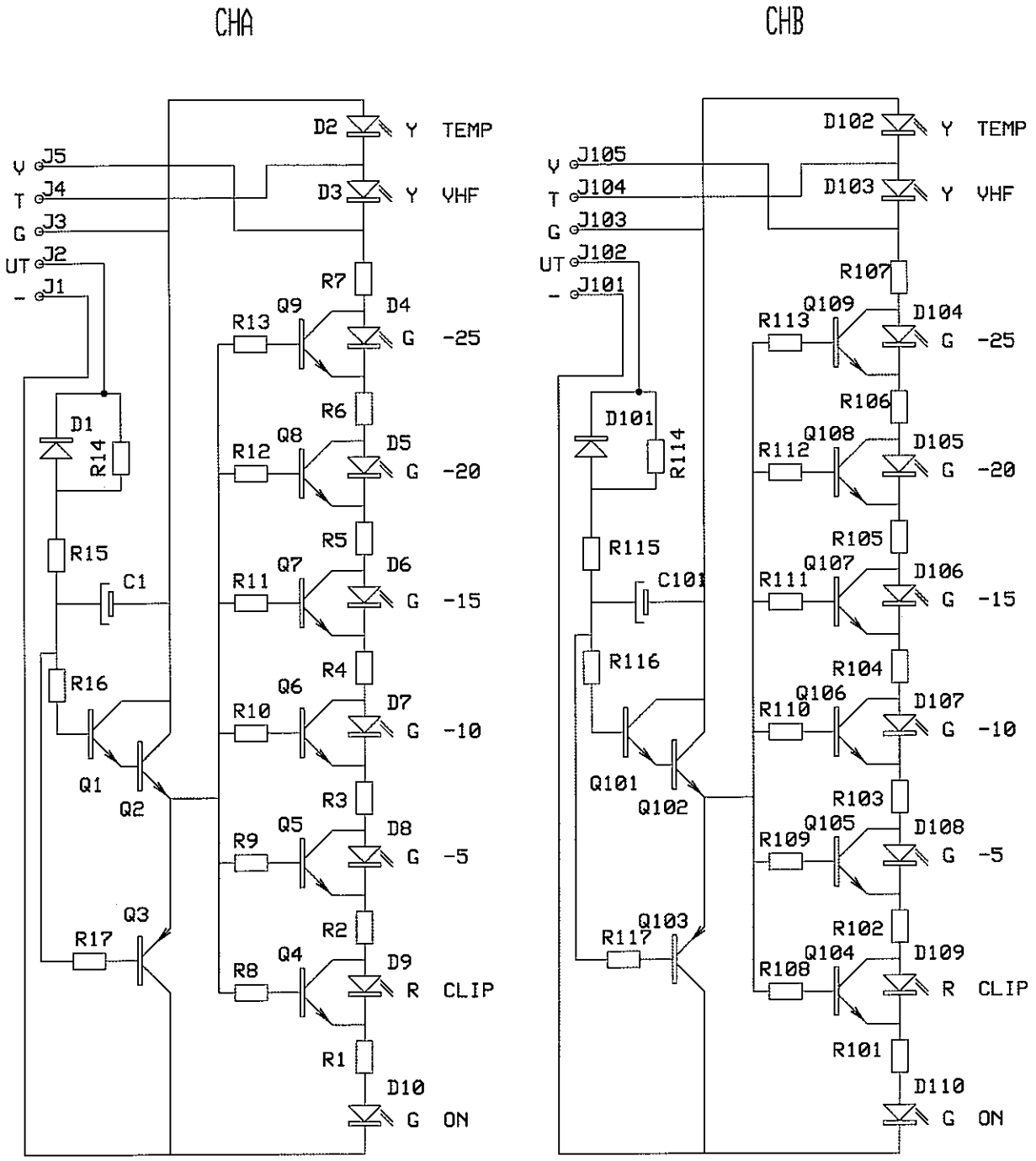
U1	LM 318
U2	LM 318
U3	LM 319
U4	HCPL 2400
U5	LM 393
U6	HCPL 2400
U7	LM 393
U8	UC 3843

Inductors

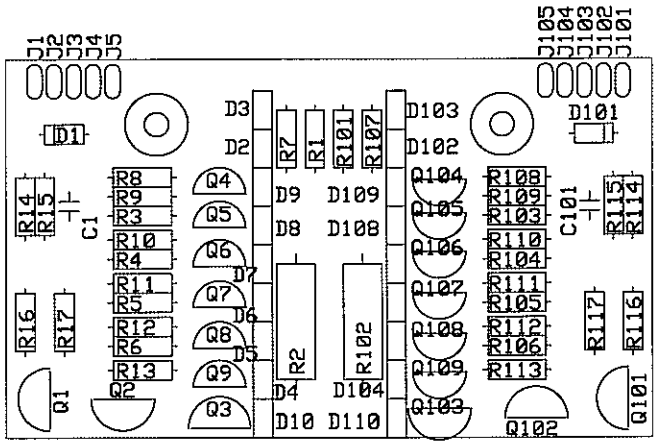
L1	14 µH
L2	1 µH
L3	1 µH
L4	14 µH
L5	1 µH
L6	1 µH
L7	47 µH
L8	47 µH
L9	47 µH
L10	47 µH
L11	1 µH

Transformers

TR1	EF20 N27



DESIGN	DRAWN	CHECKED		REPLACES	REPLACED BY
K.A	K.A		LED.DISPLAY		
LABGRUPPEN			LAB500 1000 1300	DATE 90 12 01	PAGE
KUNGSBACKA SWEDEN			1600 2000 4000	DRAWING NO	2KLED



DESIGN	DRAWN	CHECKED	LED DISPLAY	REPLACES	REPLACED BY
K.A	K.A				
LABGRUPPEN KUNGSBACKA SWEDEN			LAB500 1000 1300 1600 2000 4000	DATE 99 09 18	PAGE
				DRAWING NO	LEDRA-P

LAB 500 – 2002C
LED DISPLAY
Component-list

Channel A
(Ch. B add 100)

Resistors

R1	see below
R2	2.7 kΩ 3W
R3	1.2 kΩ 1W
R4	680 Ω
R5	330 Ω
R6	120 Ω
R7	220 Ω
R8	33 kΩ
R9	33 kΩ
R10	33 kΩ
R11	33 kΩ
R12	33 kΩ
R13	33 kΩ
R14	33 kΩ
R15	100 Ω 1%
R16	2.7 kΩ
R17	2.7 kΩ

Capacitors

C1	4.7 µF 100V

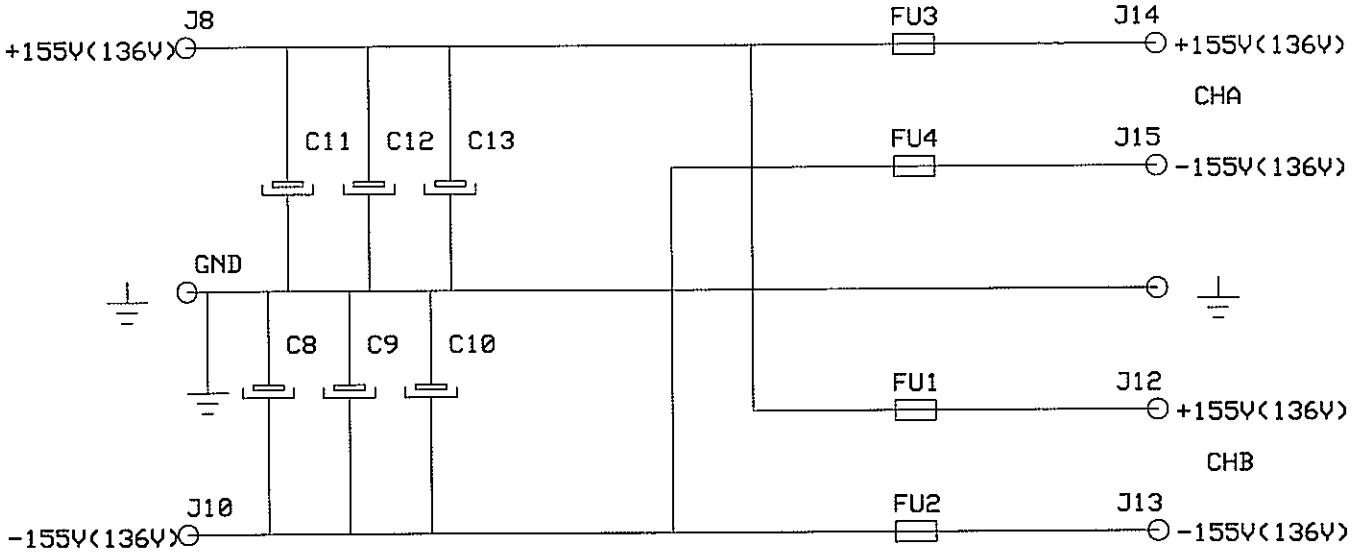
Diods

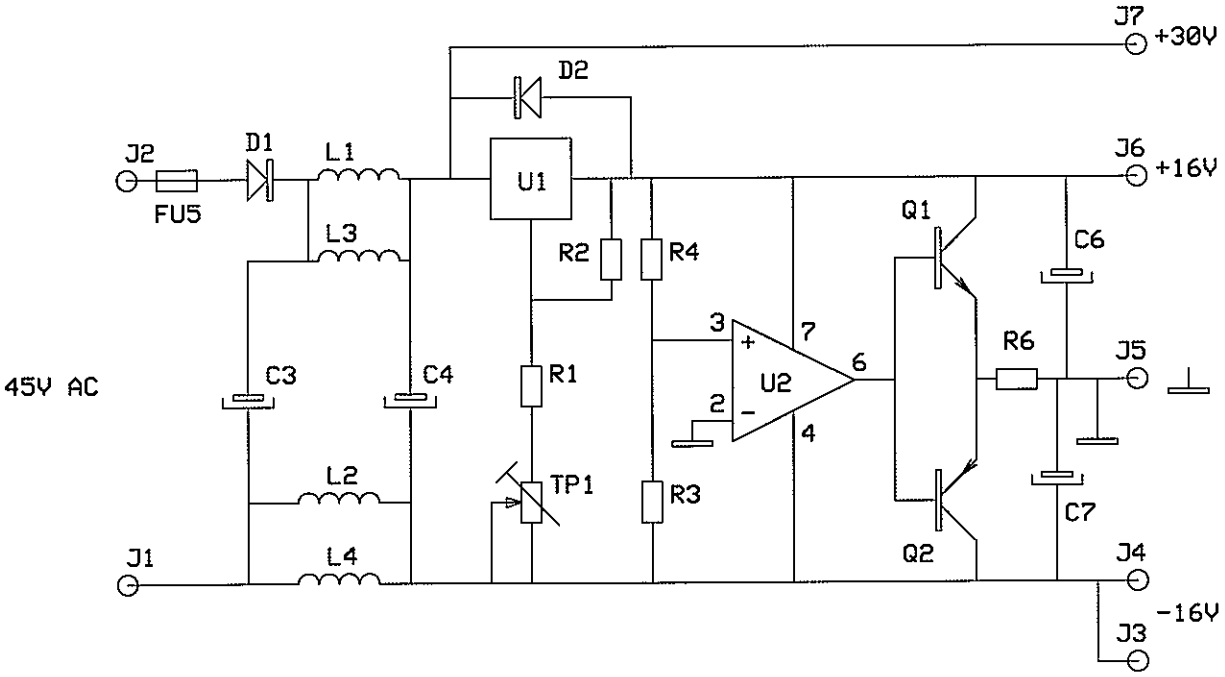
D1	1N 4004
D2	Led Y
D3	Led Y
D4	Led G
D5	Led G
D6	Led G
D7	Led G
D8	Led G
D9	Led R
D10	Led G

Transistors

Q1	MPSA 42
Q2	MPSA 42
Q3	MPSA 92
Q4	BC 547
Q5	BC 547
Q6	BC 547
Q7	BC 547
Q8	BC 547
Q9	BC 547

	500	**1000**	**1300C**	**1600**	**2000**
R1	1,5 kΩ	820 Ω	680Ω	680Ω	680 Ω 1% long legs





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K.A	K.A				
LABGRUPPEN KUNGSBACKA SWEDEN			LAB 2002 4000	DATE 96 08 01	PAGE
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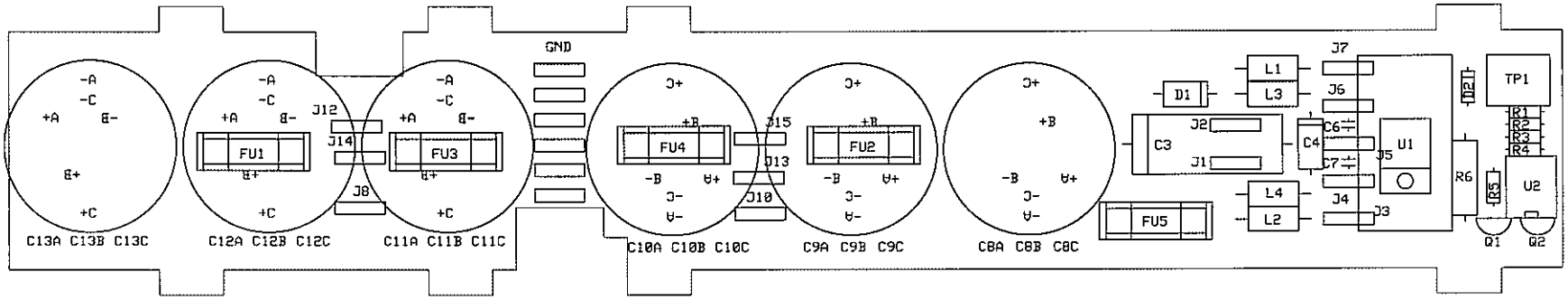

DESIGN	DRAWN	CHECKED		REPLACES	REPLACED BY
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LABGRUPPEN KUNGSBACKA SWEDEN			LAB2000 2002 4000	DATE 99 09 18	PAGE
				DRAWING NO	2KFUC-P

LAB 2002 4000
FUSE, VOLTAGESTABB. BOARD
component-list

Resistors

R1	5.6 kΩ
R2	270 Ω
R3	10 kΩ 1%
R4	10 kΩ 1%
R5	1 kΩ
R6	150 Ω 3W

Trim potentiometers

TP1	2.5 kΩ

Capacitors

C1	-
C2	-
C3	470 µF 100V (ASM021)
C4	22 µF 100V (ASM021)
C5	-
C6	22 µF 50V
C7	22 µF 50V
C8	2200 µF 160V
C9	2200 µF 160V
C10	2200 µF 160V
C11	2200 µF 160V
C12	2200 µF 160V
C13	2200 µF 160V

Diods

D1	BYW 98-200
D2	1N 4004

Transistors

Q1	BC 337
Q2	BC 327

Integrated circuits

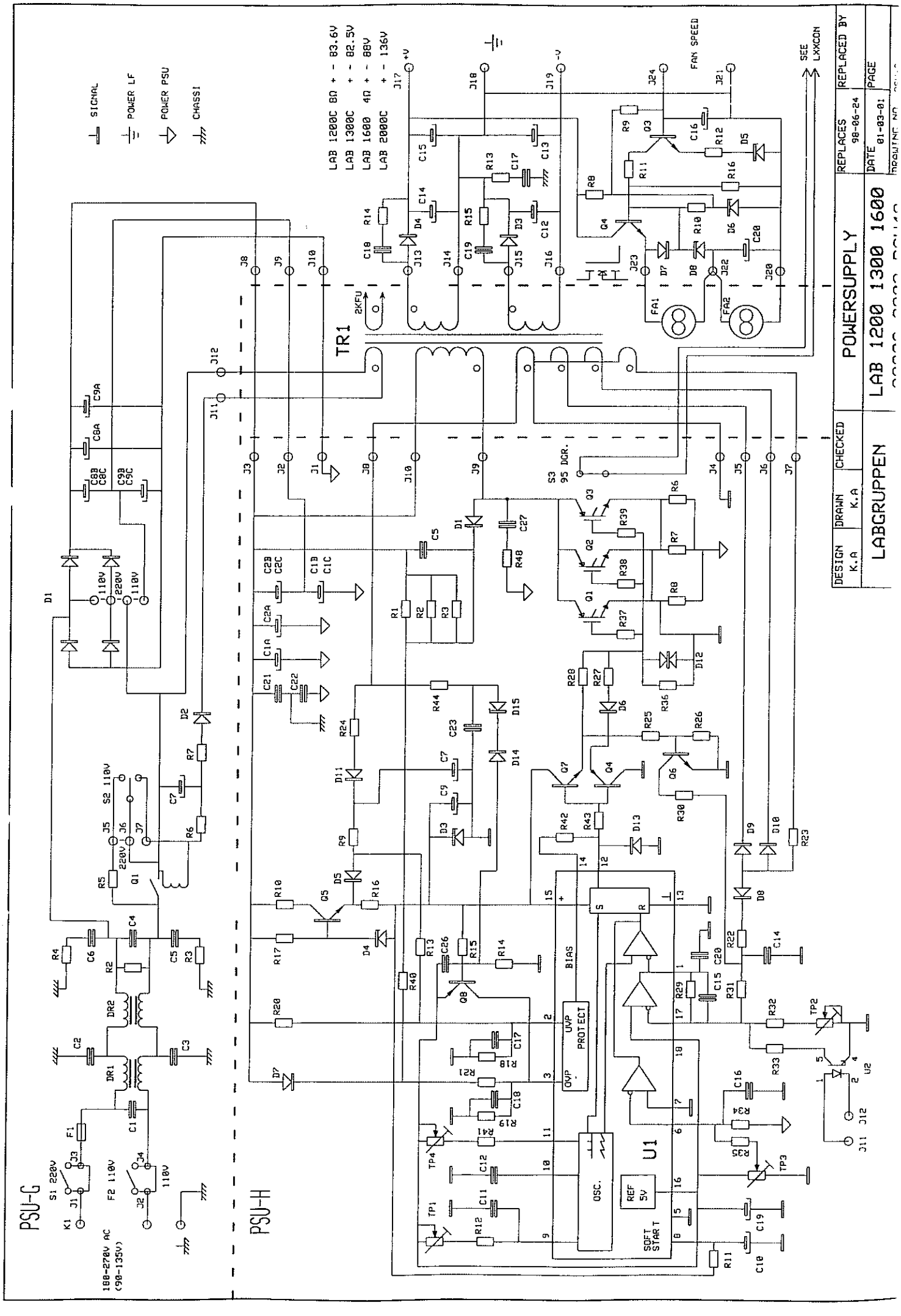
U1	LM 317
U2	UA 741

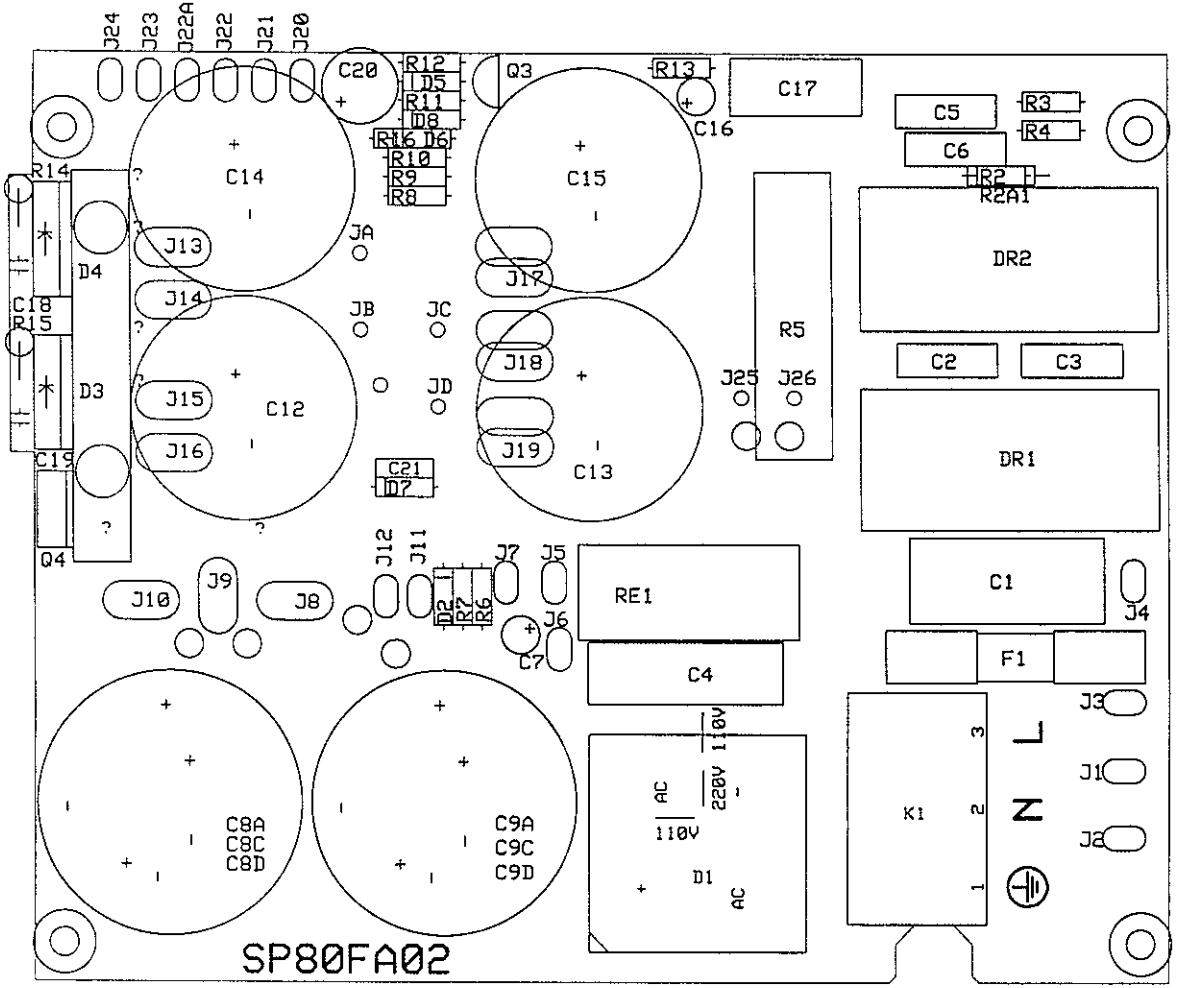
Fuses

FU1	F 15A
FU2	F 15A
FU3	F 15A
FU4	F 15A

Inductors

L1	47 µH
L2	47 µH
L3	47 µH
L4	47 µH


SIGNAL
POWER LF
POWER PSU
CHASSI
LAB 1200C 80 + - 83.6V
LAB 1300C + - 82.5V
LAB 1600 40 + - 88V
LAB 2000C + - 136V
FAN SPEED
SEE LXXCON
TR1
2KFU
S3 95 DGR.
S1 220V
S2 110V
F1
F2 110V
K1
180-270V AC
(90-135V)
PSU-G
PSU-H
U1
OSC.
REF 5V
SOFT START
UVP PROTECT
OVP
BIAS
DESIGN K.A
DRAWN K.A
CHECKED
LABGRUPPEN
POWERSUPPLY
LAB 1200 1300 1600
REPLACES 98-06-24
REPLACED BY
DATE 01-03-01
PAGE



4 rectangles in milling type 1 = hole plated

DESIGN	DRAWN	CHECKED	POWER SUPPLY SP80FA	REPLACES	REPLACED BY
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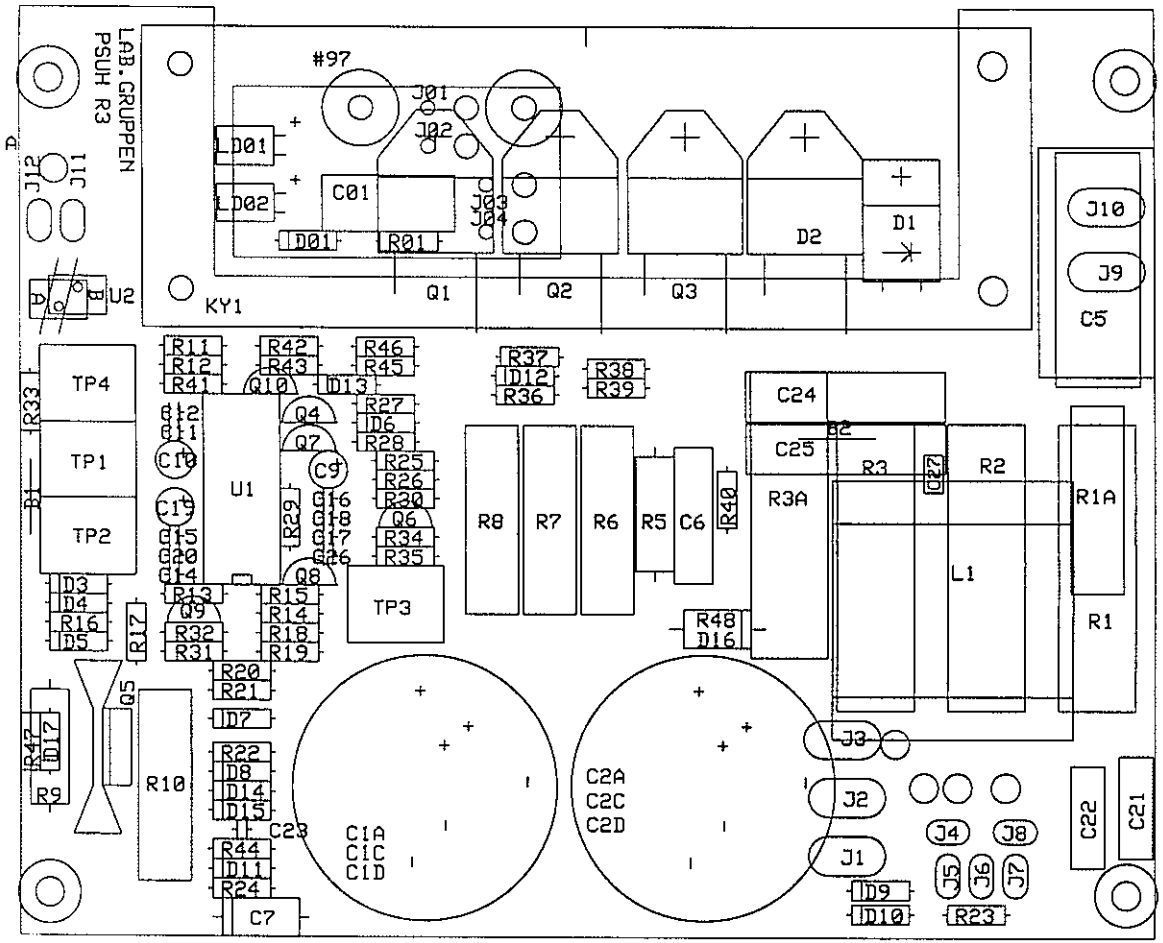
				DRAWING NO	SP80FA02-P



DESIGN	DRAWN	CHECKED	POWER SUPPLY H	REPLACES	REPLACED BY
K.A	K.A			99 09 18	
LABGRUPPEN KUNGSBACKA SWEDEN			LAB 1200 1300 1600 2000C 2002 4000 PSU48	DATE 00 03 02	PAGE
				DRAWING NO PSUHR3-P	

POWER SUPPLY, BOARD PSUG
component-list

Resistors

R1-	
R2	1 MΩ 1%
R3	33 Ω
R4	33 Ω
R5#	47 Ω 9W
R6	33 Ω
R7	2.2 Ω 1W
R8	See below
R9	See below
R10	See below
R11	See below
R12	See below
R13	4.7 Ω
R14	See below
R15	See below
R16	See below

Capacitors

C1	0.47uF
C2#	1.5 nF Y
C3#	1.5 nF Y
C4	0.22uF
C5#	1.5 nF Y
C6#	1.5 nF Y
C7	100uF 50V
C8a#	See below
C9a#	See below
C12	See below
C13	See below
C14	See below
C15	See below
C16	22uF 16V
C17	2.2uF 63V
C18	See below
C19	See below
C20	See below
C21	See below

Diods

D1	600V 35A
D2	BYW26C
D3	STTB3006PI
D4	STTB3006PI
D5	5.6V Zener
D6	See below
D7	See below
D8	See below

Transistors

Q3	BC 546
Q4	See below

Relays

RE1	FEME MZF 0014816

Fuses

FU1	See below

Coils

DR1#	See below
DR2#	See below

Switches

S1#	See below
S2#	See below
S3	Comepa 4JT95 ARIUI 95°C

Relays

RE1	FEME MZF 0014816

Socket

K1	MKDSP10/3-10,16

<u># 110V AC</u>

R5	22 Ω 9W
C2	2,2 nF Y
C3	2,2 nF Y
C5	2,2 nF Y
C6	2,2 nF Y

*	Until 9708
Q4	BDX53F
D7	-
D8	-

POWER SUPPLY, BOARD PSUG

	LAB 1200C	LAB 1300C	LAB 1600	LAB 2000C	LAB 4000	PSU48-8
R8	4.7 kΩ 1%	Jumper	8.2 kΩ 1%	Jumper	27 kΩ 1%long leg	4,7 kΩ 1%
R9	1 MΩ	470 kΩ	150 kΩ	390 kΩ	180 kΩ 1%	470 kΩ
R10	39 kΩ 1%	4.7 kΩ 1%long leg	39 kΩ 1%	47 kΩ 1%	39 kΩ 1%	10 kΩ 1%
R11	18 kΩ 1%	1.8 kΩ	18 kΩ 1%	6.8 kΩ	18 kΩ 1%	4,7 kΩ 1%
R12	4.7 kΩ 1%	Jumper	4.7 kΩ	1.8 kΩ	4.7 kΩ 1%	Jumper
R14	2.2 Ω 2W	-	2.2 Ω 2W	-	-	-
R15	2.2 Ω 2W	-	2.2 Ω 2W	-	-	-
R16	-	18 kΩ 1%	-	39 kΩ 1%	-	-
C8a	220uF 385V	220uF 385V	220uF 385V	220uF 385V		220uF 385V
C9a	220uF 385V	220uF 385V	220uF 385V	220uF 385V		220uF 385V
C8b	-	-	-	-	1500 uF 200V	-
C9b	-	-	-	-	1500 uF 200V	-
C12	3900 uF 100V	3900 uF 100V	3900 uF 100V	1800 uF 160V	1800 uF 160V	3900 uF 100V
C13	3900 uF 100V	3900 uF 100V	3900 uF 100V	1800 uF 160V	1800 uF 160V	3900 uF 100V
C14	3900 uF 100V	3900 uF 100V	3900 uF 100V	1800 uF 160V	1800 uF 160V	3900 uF 100V
C15	3900 uF 100V	3900 uF 100V	3900 uF 100V	1800 uF 160V	1800 uF 160V	3900 uF 100V
C18	4.7 nF 400V	-	4.7 nF 400V	-	-	-
C19	4.7 nF 400V	-	4.7 nF 400V	-	-	-
C20	100 uF 50V	100 uF 50V	100 uF 50V	100 uF 50V	100 uF 50V	-
C21	-	-	-	680 pF/400V	680 pF/400V	-
D6	62 V ±2% Zener	-	62 V ±2% Zener	-	62 V ±2% Zener	27V Zener
D7	-	-	-	15V Zener	15V Zener	-
D8	-	-	-	39V ±2% Zener	39V ±2% Zener	-
Q4	TIP132	TIP41	TIP132	*IRF730	*IRF730	BDX53F
F1	T10AH250V	T8AH250V	T10AH250V	T10AH250V	T15AH250V	T10AH250V
DR1	2.7mH 8A 220V	2.7mH 8A 220V	2.7mH 8A 220V	2.7mH 8A 220V	1.4mH 16A 110V	2.7mH 8A 220V
DR2	2.7mH 8A 220V	2.7mH 8A 220V	2.7mH 8A 220V	2.7mH 8A 220V	1.4mH 16A 110V	2.7mH 8A 220V
S1	8550VB	8550VB	8550VB	8550VB	Jumper	8550VB
S2	-	-	-	-	H8610VBBB	-
B1	JB-JC, D1,2	-	-	-	-	-
B2	-	-	-	-	-	JA-JB, D1,2
B3	-	-	-	-	-	JC-JD, D1,2
B4	J5-J6	J5-J6	J5-J6	J5-J6	-	J5-J6
B5#	Rectifier 220V	Rectifier 220V	Rectifier 220V	Rectifier 220V	Rectifier 220V	Rectifier 220V

 # 110V

C8b#	1500 uF 200V	1500 uF 200V	1500 uF 200V	1500 uF 200V	-	1500 uF 200V
C9b#	1500 uF 200V	1500 uF 200V	1500 uF 200V	1500 uF 200V	-	1500 uF 200V
C8d#	-	-	-	-	2200 uF 200V	-
C9d#	-	-	-	-	2200 uF 200V	-
F1#	T20A	T20A	T20A	T20A	T30A	T20A
DR1#	1.4mH16A110V	1.4mH16A110V	1.4mH16A110V	1.4mH16A110V	1.4mH25A110V	1.4mH16A110V
DR2#	1.4mH25A110V	1.4mH16A110V	1.4mH16A110V	1.4mH16A110V	1.4mH25A110V	1.4mH16A110V
S1	Jumper	Jumper	Jumper	Jumper	Jumper	Jumper
S2#	H8610VBBB	H8610VBBB	H8610VBBB	H8610VBBB	H8610VBBB	H8610VBBB
B5	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V
B6	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V	Rectifier 110V

POWER SUPPLY, BOARD PSUH

component-list

Resistors

R1	See below
R2	See below
R3	See below
R4	-
R5	See below
R6	0.1 Ω 4W
R7	0.1 Ω 4W
R8	0.1 Ω 4W
R9	See below
R10	4.7 kΩ 5W
R11	680 kΩ 5%
R12	33 kΩ 1%
R13	100 kΩ 1%
R14	10 kΩ 1%
R15	18 kΩ 1%
R16	180 Ω 1%
R17	120 kΩ 2W
R18#	8.2 kΩ 1% (110V see below)
R19	See below
R20	432 kΩ 1% highvolt
R21	750 kΩ 1%
R22	4.7 Ω
R23	See below
R24	4.7 Ω
R25	15 kΩ 1%
R26	1 kΩ 1%
R27	See below
R28	82 Ω
R29	4.7 MΩ
R30	See below
R31	220 kΩ 1%
R32	See below
R33	See below
R34	See below
R35	See below
R36	15 kΩ 1%
R37	See below
R38	See below
R39	See below
R40	See below
R41	18 kΩ 1%
R42*	-
R43*	Jumper
R44	See below
R45	See below
R46	See below
R47	See below
R48	See Below

Capacitors

C1a#	See below
C2a#	See below
C5	0.68 uF 250V
C6	-
C7	10 uF 63V
C8	-
C9	10 uF 50V
C10	22 uF 50V
C11*	470 pF NPO
C12	1 nF
C13	-
C14	10 nF
C15	See below
C16	330 pF
C17	-
C18	1 nF
C19	10 uF 50V
C20	-
C21#	1.5 nF Y
C22#	1.5 nF Y
C23	1 nF
C24	See below
C25	See below
C26	1 nF
C27	See Below

Diods

D1	BYT 12PI 1000
D2	See below
D3	15V 1.3W Zener
D4	5.6V 0.4W Zener
D5	1N 4148
D6	BYW 26C
D7	1N 4004
D8	1N 4148
D9	1N 4148
D10	1N 4148
D11	BYW 26C
D12	BZW 06P15B
D13	BAT 85
D14	1N 4148
D15	See below
D16	See below
D17	See below

Trim potentiometers

TP1	10 kΩ
TP2	25 kΩ
TP3	10 kΩ
TP4*	15 kΩ Resistor

Integrated circuits

U1	UC 3851 alt. UC 3841
U2	See below

Transistors

Q1	See below
Q2	See below
Q3	See below
Q4	BC 327
Q5	TIP 50
Q6	BC 547
Q7*	Jumper b-e
Q8	BC 557
Q9	See below
Q10	See below

Switches

S2	Temp switch 95°

Inductors

L1	See below

Jumpers

B1	See below
B2	See below

110V

C1b	See below
C2b	See below
C21	2,2nF Y
C22	2,2nF Y
R18	10kΩ 1%

* UC3841

R42	4.7 kΩ
R43	82 Ω
TP4	10 kΩ
C11	1 nF
Q7	BC 337

POWER SUPPLY, BOARD PSUH

	LAB 1200C	LAB 1300C	LAB 1600	LAB 2000C	LAB 4000	PSU 48-8
R1	18 kΩ 9W	18 kΩ 9W	18 kΩ 9W	18 kΩ 9W	33 kΩ 9W	18 kΩ 9W
R2	18 kΩ 9W	18 kΩ 9W	18 kΩ 9W	18 kΩ 9W	-	18 kΩ 9W
R3	18 kΩ 9W	18 kΩ 9W	18 kΩ 9W	18 kΩ 9W	-	18 kΩ 9W
R5	-	-	-	-	330 Ω 2W	-
R9	1.5 kΩ 2W	1.5 kΩ 2W	1.5 kΩ 2W	1.5 kΩ 2W	1 kΩ 3W	1.5 kΩ 2W
R19	5.62 kΩ 1%	5.62 kΩ 1%	5.62 kΩ 1%	5.62 kΩ 1%	5.9 kΩ 1%	5.62 kΩ 1%
R23	8,2 kΩ 1%	6.8 kΩ 1%	6.8 kΩ 1%	6.8 kΩ 1%	6.8 kΩ 1%	10 kΩ 1%
R27	4.7 Ω	4.7 Ω	4.7 Ω	4.7 Ω	jumper	4.7 Ω
R30	56 kΩ 1%	56 kΩ 1%	56 kΩ 1%	56 kΩ 1%	180 kΩ 1%	56 kΩ 1%
R32	133 kΩ 1%	88.7 kΩ 1%	169 kΩ 1%	88.7 kΩ 1%	88.7 kΩ 1%	
R33	270 kΩ 1%	-	330 kΩ 1%	-	1 kΩ 1%	-
R34	2,2 kΩ 1%	2,0 kΩ 1%	2,2 kΩ 1%	2,2 kΩ 1%	2,4 kΩ 1%	
R35	4.7 kΩ 1%	4.7 kΩ 1%	4.7 kΩ 1%	4.7 kΩ 1%	3,3 kΩ 1%	4.7 kΩ 1%
R37	4.7 Ω	4.7 Ω	4.7 Ω	4.7 Ω	2.2 Ω	
R38	4.7 Ω	4.7 Ω	4.7 Ω	4.7 Ω	2.2 Ω	4.7 Ω
R39	4.7 Ω	4.7 Ω	4.7 Ω	4.7 Ω	2.2 Ω	4.7 Ω
R40	1 MΩ 1%	1 MΩ 1%	1 MΩ 1%	1 MΩ 1%	1,2 MΩ 1%	1 MΩ 1%
R44	470 Ω	470 Ω	470 Ω	470 Ω	560 Ω	470 Ω
R45	-	-	-	-	698 Ω 1%	-
R46	-	-	-	-	196 Ω 1%	-
R47	-	-	-	-	820 Ω	-
R48	2,2Ω 2W	2,2Ω 2W	2,2Ω 2W	2,2Ω 2W	-	2,2Ω 2W
C1a#	220 uF 385V	220 uF 385V	220 uF 385V	220 uF 385V		220 uF 385V
C2a#	220 uF 385V	220 uF 385V	220 uF 385V	220 uF 385V		220 uF 385V
C1b#	-	-	-	-	1500 uF 200V	-
C2b#	-	-	-	-	1500 uF 200V	-
C6	-	-	-	-	1 nF 1.5 kV	-
C15	330 pF	330 pF	330 pF	330 pF	330 pF	1 nF
C24	-	-	-	-	22 nF 1kV	-
C25	-	-	-	-	22 nF 1kV	-
C27	100pF/1600V	100pF/1600V	100pF/1600V	100pF/1600V	-	100pF/1600V
D2	-	-	-	-	STTA 1512PI	-
D15	43V 2% Zener	43V 2% Zener	39V 2% Zener	43V 2% Zener	43V 2% Zener	30V 2% Zener
D16	-	-	-	-	BYM 26E	-
D17	-	-	-	-	1N4148	-
Q1	BUP 307	BUP 307	BUP 307	BUP 307	BUP 314S	BUP 307
Q2	BUP 307	BUP 307	BUP 307	BUP 307	BUP 314S	
Q3	BUP 307	BUP 307	BUP 307	BUP 307	BUP 314S	
Q9	Jumper b-c	-	Jumper b-c	-	BC557	-
Q10	-	-	-	-	BC547	-
U2	PC 113	-	PC 113	-	Jumper 1-5	PC 113
U2	-	-	-	-	Jumper 2-4	-
L1	-	-	-	-	400 uH LAB	-
B1	-	-	-	-	-	jumper
B2	-	-	-	-	-	jumper
# 110V						
C1b#	1500 uF 200V	1500 uF 200V	1500 uF 200V	1500 uF 200V	-	1500 uF 200V
C2b#	1500 uF 200V	1500 uF 200V	1500 uF 200V	1500 uF 200V	-	1500 uF 200V
C1d#	-	-	-	-	2200 uF 200V	-
C2d#	-	-	-	-	2200 uF 200V	-
R18	10 kΩ 1%	10 kΩ 1%	10 kΩ 1%	10 kΩ 1%		
AFS IND.						
R01	-	-	-	-	4,7 kΩ 1%	
C01	-	-	-	-	0,1uF 400V	
D01	-	-	-	-	1N4148	-
LD01	-	-	-	-	green 2,5x5mm	red 2,5x5mm
LD02	-	-	-	-	red 2,5x5mm	green 2,5x5mm