Sailor

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INSTRUKTIONSBOG FOR
SAILOR N1409

INSTRUCTION BOOK FOR
SAILOR N1409

A/S S. P. RADIO · AALBORG · DENMARK

CONTENTS:

1. GENERAL DESCRIPTION

SAILOR N1409 is an AC power supply intended to supply a SAILOR SSB short wave set, when the set has to be supplied from AC-mains.

SAILOR N1409 is a switch mode power supply which reduces power consumption.

SAILOR N1409 has a built-in delay unit which ensures the proper sequence for applying voltages to the transmitter, regardless of how the MAIN SWITCH is operated.

SAILOR N1409 with MAIN SWITCH in position RECEIVER ONLY. Only the receiver is supplied and low power consumption is achieved.

SAILOR N1409 is provided with thermal breakers which switch off the set if the temperature inside the power supply gets too high.

SAILOR N1409 fits into SAILOR 19" rack system.The power supply is incorporated in the transmitter module T1130.

1.1. TECHNICAL DATA

The power supply N1409 delivers all necessary voltages to a SAILOR SSB short wave set 1000/B with an output power of 400 W PEP in the frequency range 1.6 - 27.5 MHz.

INPUT VOLTAGE: 220/237V AC, frequency 50 - 60 Hz.

INPUT CURRENT: by 220V AC INPUT

2-tone	approx. 6.5A
A3J	approx. 4.5A
A3H	approx. 6.0A
R.O.	approx. 0.38A

OUTPUT VOLTAGES:

POWER UNIT I

8V	I_{max} 2.0A
-45V	I_{max} 0.15A
22V	I_{max} 3.2A

POWER UNIT II

28V	I_{max} 3.4A
38V	I_{max} 14A

AC VOLTAGE

24V AC for blowers I_{max} 2A

OPERATION TEMPERATURE RANGE: -15°C to +55°C

COOLING: With MAIN SWITCH in position RX-ONLY and the temperature inside the power supply exceeding +55°C the internal blower will start automatically. When the temperature falls below +45°C the blower stops.

With MAIN SWITCH in position ON the internal blower is running when transmitter is keyed.

If temperature in transmitter is too high the power supply is reduced from 38V to 30V. If temperature is further increasing the Power Unit II is blocked and blowers start. When temperature is decreased blowers stop and Power Unit II is unblocked again.

1.2. PRINCIPLE OF OPERATION

The power supply N1409 consists of three power supplies.

Power Unit I is a forward converter producing low power voltage for receiver, exciter and transmitter.

Power Unit II is a symmetrical half bridge push-pull converter producing high power to the transmitter.

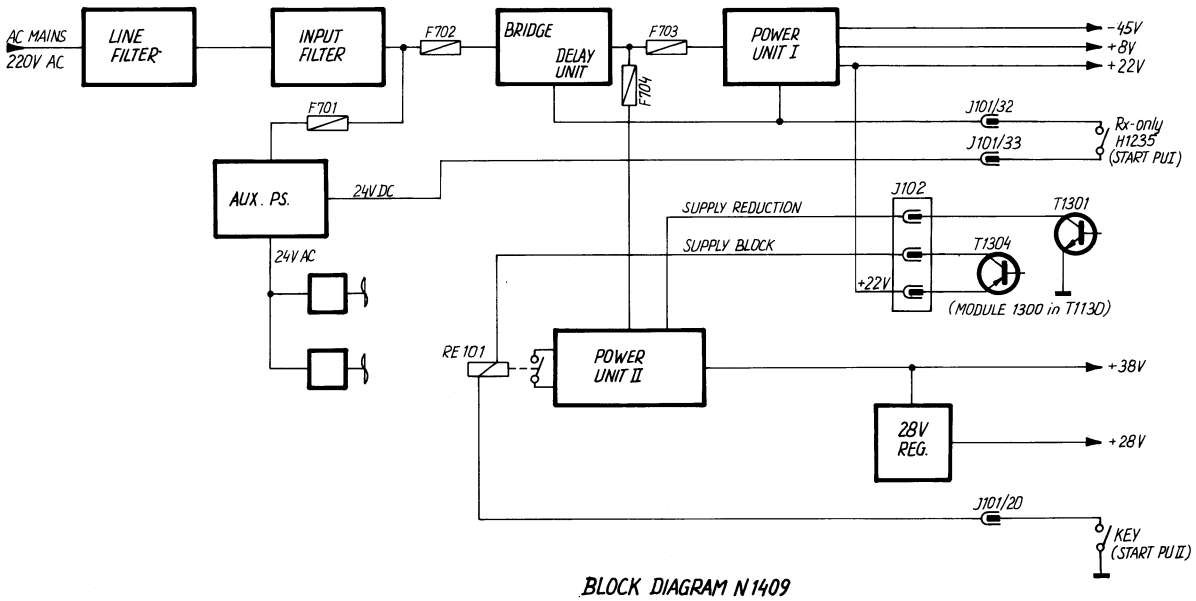
An auxiliary power supply produces an internal 24V DC and a 24V AC for the blowers.

Aux. P.S. is always switched on when N1409 is connected to AC-mains.

PU I is working when the set is switched on.

PU II is only working when PU I is switched on and the transmitter is keyed.

N1409 is switched on/off by the switches in H1235 rack system.



BLOCK DIAGRAM N1409

CONTENTS:

2. SERVICE

2.1. MAINTENANCE

When the SAILOR Short Wave Set type 1000/B has been correctly installed. the maintenance of the power supply can, dependent on the environment and working hours, be reduced to a performance check at the service workshop at intervals not exceeding 5 years.

A performance check list is enclosed in the PERFORMANCE CHECK section.

Also inspect cables and plugs for mechanical defects and corrosion.

Any repair of the set should be followed by a check described in the section NECESSARY ADJUSTMENT AFTER REPAIR.

2.2. RECOMMENDED MEASUREMENT INSTRUMENTS

MULTIMETER ..... PHILIPS PM2505

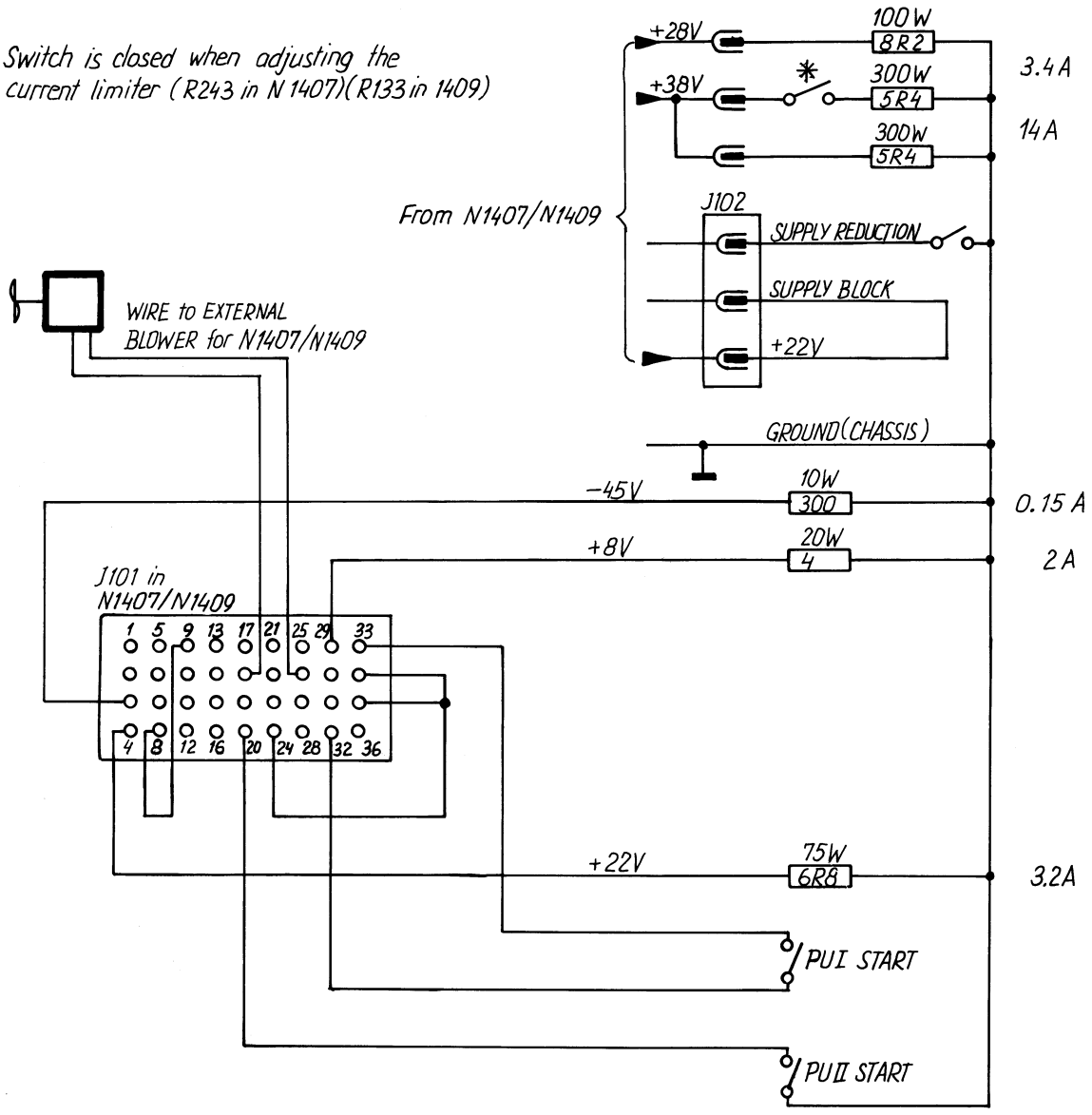
OSCILLOSCOPE ..... PHILIPS PM3214

Because of high voltage in the power supply it is recommended to use an oscilloscope probe which can withstand at least 1000V DC, e.g. PHILIPS PM8932.

2.3. PERFORMANCE CHECK

1. N1409 is mounted in T1130 (1000/B rack).
2. Connect AC-mains. Normally 220V AC; if over approx. 235V AC then strap TR701 to 240V AC.
3. Check Aux. P.S. 24V DC can be measured at R101 for regulator IC701 and at C136 for regulator IC106.
4. Push "RX-ONLY" (switches on PU I).
5. Check 22V, 8V and -45V output voltages. If necessary then adjust to 22.0V with R154.
6. Push "ON" button and press key.
7. Check 28V and 38V output voltage. If necessary then adjust to 28V with R165 and to 38V with R169.
8. Current limiters cannot be adjusted.
9. While pressing the key check that both blowers are running.

2.4 SELF MADE TEST LOAD



SELFMADE TEST LOAD FOR N1407/N1409

2.5. NECESSARY ADJUSTMENT AFTER REPAIR (USING SELFMADE TEST LOAD)

POWER UNIT I

CAUTION!

When AC-mains is connected to P103 there is always mains in the power supply.

1. Connect selfmade test load to N1409 outputs.
2. Remove the fuses F702, F703 and F704. Not F701.
3. Connect AC-mains. If this is over 235V AC, then connect transformer TR701 to the terminal marked "240V".
4. Check 24V DC from IC701 (R101) and IC106 (C136).
5. Connect scope probe to collector of T102 and scope ground to chassis. Let the scope be trigged on positive going edge of delay pulse.

   Switch on PU I and observe the delay pulse at 45 - 50 ms.

   Switch off PU I with PU I start switch.
6. Connect scope to base and emitter of T703. Can be done by connecting the scope probe to D114 and scope ground to R131.
7. Switch on PU I (RX-ONLY).
8. Check with scope:

   Soft start: Square wave builds up slowly (approx. 100 ms).

   Frequency: Approx. 25 kHz (40 usecs).

   Duty cycle: Approx. 15 %.

   Reverse bias: See fig. on diagram.
9. Switch off PU I with PU I start switch.
10. Turn R144 in middle position.
    Turn R154 counter clockwise to stop.
    Replace F702 and F703.
11. Switch on PU I and switch also PU II on because of the current to RE101 while adjusting the current limiter.
12. Adjust 22V with R154 to 22.0V.
13. Adjust current limiter with R144.
    Turn R144 until PU I just goes out of current limiting.
    Check 8V output to approx. 8.6V and -45V to approx. -45V.
14. Switch off PU I and PU II.

POWER UNIT II

When PU II is switched on, it is always necessary to cool the switch transistors T701 and T702 and the output rectifier D704. It is recommended to mount N1409 in a T1130 chassis with a blower to cool the power supply.

Necessary adjustment after repair continued:

1. Fuse F704 is removed.
2. Check PU I and switch off PU I
3. Check base driver of T701.
   Connect scope probe to cathode of D109 and scope ground to R126 (in connection to emitter of T701).
4. Switch on PU I and PU II and check on scope:

   Soft start: Drive signal builds up slowly (approx. 1.5 secs).

   Frequency: Approx. 20 kHz (50 usecs).

   Duty cycle: Approx. 45%

   Reverse bias: See fig. on diagram.
5. Switch off PU I and PU II and connect scope probe to cathode of D111 and scope grouns to R128 (in connection to emitter of T702).
6. Switch on PU I and PU II and check on scope:

   Soft start: Drive signal builds up slowly (1.5 secs).

   Frequency: Approx. 20 kHz (50 usecs).

   Duty cycle: Approx. 45%

   Reverse bias: See fig. on diagram.
7. Switch off PU I and PU II.
   Turn R133 clockwise to stop.
   Turn R169 counter clockwise to stop.
   Turn R165 in middle position.
8. Replace fuse F704.
9. Switch on PU I and PU II.
10. Turn R133 out of current limiting.
    Adjust 38V output with R169 to 38.0V.
    Adjust 28V output with R165 to 28.0V.
    Adjust current limiter with R133 so the 38V output is 35.5V with full load at 38V output and at 28V output.

While PUII is working with full loads some noise and "jitter" occurs.

2.6. TROUBLE SHOOTING

FAILURE IN POWER UNIT I

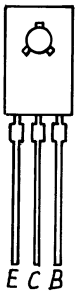
1. Bad connections in plug to P103 or J101.
2. Auxiliary power supply is out of function.
   a) Check fuse F701.
   b) Check 24V DC from IC701 and IC106.
3. Relay RE501 is not activating.
   a) There is no 24V DC on RE501 when PU I is started.
   b) RE501 is defective.
4. Fuse F702 is blown out.
   a) Diode D701 or capacitor C701 is defective.
5. Fuse F703 is blown out and T703 is short-circuited.
   a) Remove T703 and F703 and check if T110 and T111 also are damaged. If damaged then repair.
   b) Start PU I and check if base drive to T703 is correct.
6. PU I starts up but goes into "hiccup mode".
   a) Wrong adjustment of current limiter R144 or of voltage adjuster R154.
   b) Output voltage is short-circuited or overloaded.
   c) One of the output diodes is damaged.
   d) Failure in the control loop.

FAILURE IN POWER UNIT II

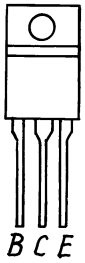
1. Relay RE101 is not activated when handset key is pressed.
   a) PU I is out of function.
   b) Handset key is out of function.
2. Supply is blocked.
   a) Temperature protection unit in T1130 blocks the power supply because of overheating of the transistors in the power amplifier in T1130. Check also the blowers and air filter.
   b) Bad connection of J102.
   c) Over- and undervoltage shut-down at IC101.
3. Supply starts up but goes into "hiccup mode".
   a) Wrong adjustment of current limiter R133.
   b) Output voltage is short-circuited or overloaded.

2.7. PIN CONFIGURATION

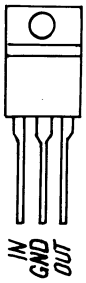
FRONT VIEW



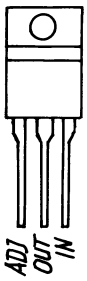
BD131
BD138
BD680
BDX43
BDX47



BD649
BD650
BD808
BDX 34B

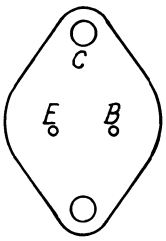


MC 7824 CT



LM317T

BOTTOM VIEW



MJ802
BUV 19
BUS 12
BUX 98

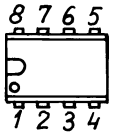
BC338
BC547
BC548
BC557
BC558

BC639
BC640

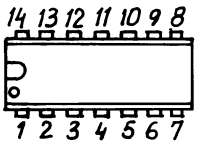
MPS-A06

MC 78L08 ACP

TOP VIEW

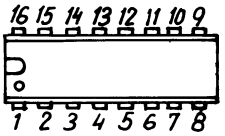


MC 1455 P1
LM 358 N

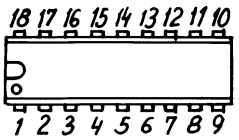


MC 1723 CP
MC 14013 BCP

TOP VIEW



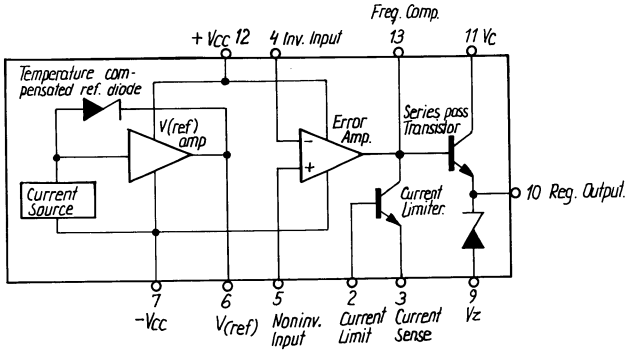
TDA 1060A



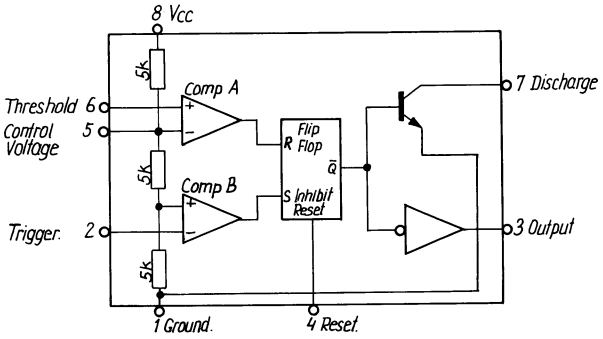
TDA 4718 A

N1407/N1409

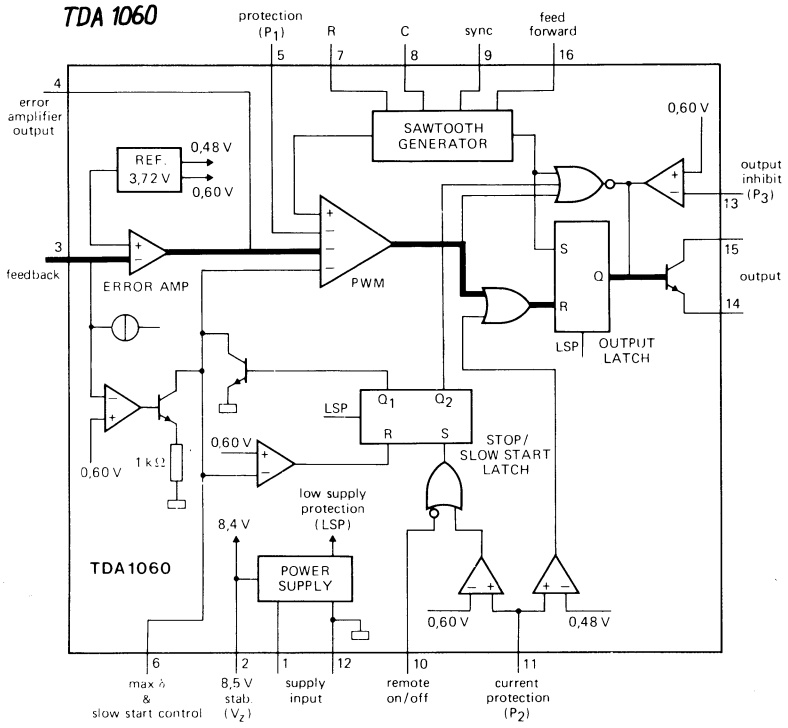
MC 1723



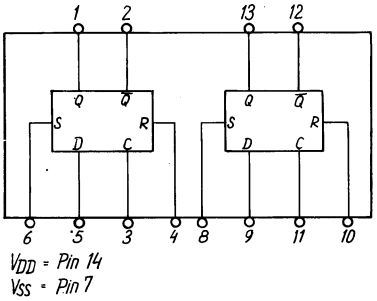
MC 1455



TDA 1060

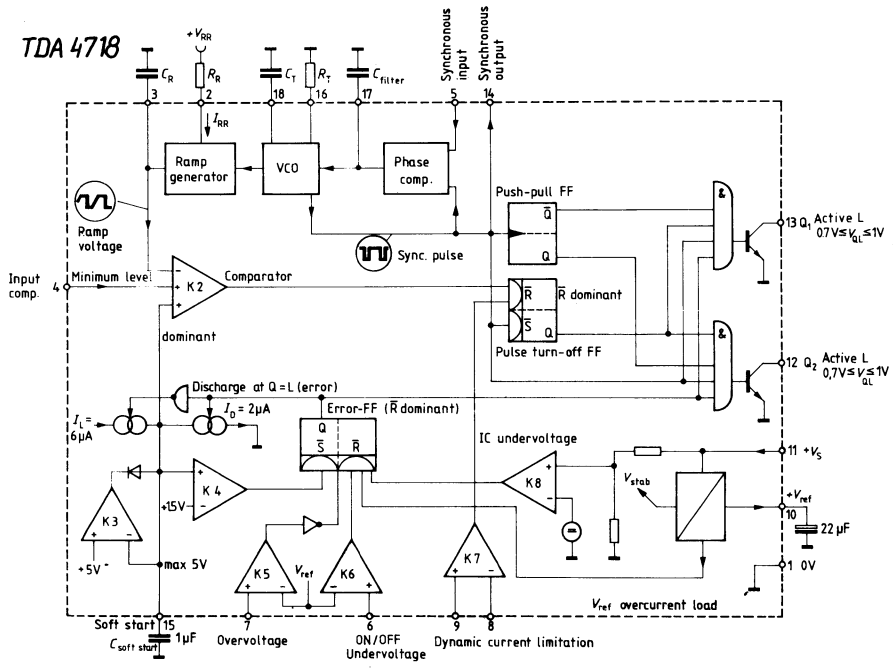


MC 14013B

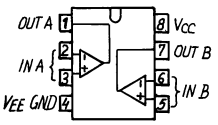


Block diagram of the TDA1060

TDA 4718



LM358



CONTENTS:

3. CIRCUIT DESCRIPTIONS AND DIAGRAMS WITH MEASUREMENTS

3.1. INPUT FILTER (MODULE 600)

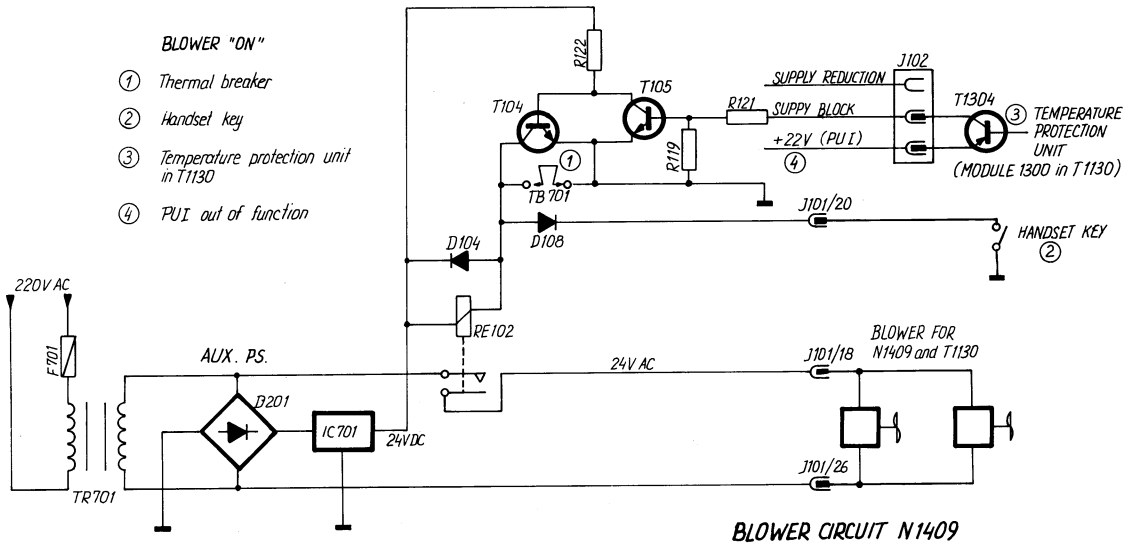
To suppress switch noise, the power supply has a mains input filter (module 600) and an AC Line Filter mounted outside the rack.

CAUTION! Because of AC-mains, N1409 must be grounded (earth connection to chassis).

3.2. AUXILIARY POWER SUPPLY (MODULE 100, 200)

AC-mains is led through fuse F701 to transformer TR701. If AC-mains is over approx. 235V RMS, the transformer TR701 has to be connected to the terminal marked 240V. The secondary of TR701 produces 24V AC for the blowers mounted in the rack. The bridge D201 rectifies the 24V AC and the DC voltage is then regulated to 24V DC in IC701 and IC106.

Even when all fuses are removed, mains is still present in the set. Always remove mains plug from P103 when working with the power supply. For about 15 minutes there is still high voltage on switch transistors and transformer because of capacitor C701.



BLOWER CIRCUIT N1409

3.3. DELAY UNIT AND BLOWER CIRCUIT (MODULE 100, 500)

Mains current is led through fuse F702 and to relay RE501, which turns on when starting PU I. After 45 - 50 ms, determined by the delay unit, relay RE502 turns on and short-circuits R401, which limits the inrush current through D701. The delay is produced by a timer circuit IC102 and determined by R118 and C113. Switch on PU I makes 24V DC at R120 and is regulated to 9.1V by means of D107.

By means of RE102 the blowers can be switched on in four ways. RE102 is always biased with 24V DC from aux. P.S.

If temperature in the whole power supply exceeds 55°C, the thermal breaker TB701 is switched on and starts the blowers until temperature is approx. 40°C.

When transmitter is keyed, diode D108 is grounded via handset key and the blowers are running.

The temperature protection unit in the transmitter unit will break the connection between +22V and supply block terminal at J102.

If PU I is out of function, the transistor T105 is then off and T104 is on, which turns on the blowers and blocks the PU II.

3.4. POWER UNIT I

PU I is constructed as a multiple output forward switch mode converter and is regulated after the pulse width modulation principle. The switch transistor T703 is controlled by IC103 which creates a square wave signal. The "ON"-time (duty-cycle) mainly depends on the input voltage.

Transformer TR703 has a demagnetizing winding from pin 1 to pin 3, which prevents the transformer from saturating.

During the "ON"-time of T703 a current is established in the primary of TR703. A voltage is transfered to the secondary, say pin 8 to pin 9 and creates a current through D702. The choke L701 is charged and acts as an energy reservoir. Finally the current is smoothed by the capacitors C215 - C216 before it goes out to the load.

During the "OFF"-time of T703, the voltage is reversed at the secondary winding and D702 is reversed-biased. But the choke L701 discharges and sends a current through the load and back through D703.

Resistor R205 ensures a minimum load for good regulation. Resistor R303 and capacitor C303 prevent unwanted oscillations. The two other outputs are acting in the same way.

The switch current is led through TR401, which creates a voltage by means of C119 and D116. Voltage over R144 is proportional to the current and is led to IC103 pin 11, where it regulates the duty-cycle and then the output voltage. It performs a dynamic current limiter for PU I and is adjusted with R144.

An increase in the load current and then in the primary switch current will create a higher voltage at pin 11 and the PU I will go in continuous soft start ("hiccup mode") until the extra load is removed.

The controlled square wave from IC103 pin 14 turns on T110 and by means of TR103 a current goes through D114 and turns on the switch transistor T703. The base current of T703 flows through capacitor C118 and D115, back to TR103. The charging of C118 is turning on T703 very fast. In the rest of the on-period, the base current goes through resistor R131, back to TR103. The diodes D403 and D114 form a "baker clamp" configuration which prevents hard saturation of T703 to make it switch faster.

At the beginning of the "off-period" the polarity of TR103 is reversed. The voltage over C118 has now connection to the base of T703 via T111 and gives negative bias to T703 which turns off T703 very fast. The discharge time of C118 is so long that T703 is always reversed biased when it is off.

The pulse width modulator IC103 has many features. The duty-cycle is limited to approx. 40 % by means of R149 and R156. The capacitor C126 determines the soft start time which reduces the peak current in T703 and the output diodes when starting up the PU I. The switch frequency of 25 kHz is determined by resistor R159 and capacitor C128. Resistor R145 limits the supply current for IC103. The voltage supply for the output of IC103 is determined by means of R137 and R142, while D117 limits the voltage at pin 15.

IC103 provides protection in the event of a fault in the regulation loop. In open-circuit case pin 3 is going positive by means of an internal current source and the duty-cycle is reduced to near zero.

In short-circuit case pin 3 is pulled down to 0V. If the voltage is below 0.6V at pin 3 the duty-cycle is reduced to approx. 15%. If fuse F703 is removed the regulation loop will react as it was short-circuited and the duty-cycle is at the reduced value and not at the maximum attainable.

Output voltage of PU I is adjusted with R154 and is led to pin 3 to regulate the duty-cycle. C127, R155 and R157 stabilize the regulation loop. If output voltage should come over 24V, the zener diode D118 will conduct and the voltage over R148 will try to shot down the PU I. Only the 22V output is regulated. The other two outputs follow the regulation of the 22V.

The transistors T113 and T114 work as switch for -45V output and is controlled by the 8V to the receiver. The relays RE103, RE104 and RE105 which switch on the output voltages to the rack are controlled by the switches in the rack H1235.

3.5. POWER UNIT II

When transmitter is keyed the relay RE101 switches on. The antenna tuner AT1500 gets 22V supply via J101 pin 7. The voltage at IC101 pin 6 and pin 7 is determined by R106, R105 and R104. These inputs form an over- and undervoltage protection. If TR701 is connected for 240V AC, "overvoltage" shot down occurs at approx. 265V AC mains input. If TR701 is connected for 220V AC, "undervoltage" shot down occurs at approx. 180V AC mains input.

Switching on PU II means that transistor T101 is turned off and C107 can be charged by IC101 and create a soft start function at pin 15 to limit the peak current in the switch transistors and the output diodes.

The IC101 has two outputs, pin 12 and pin 13, working as push-pull and are active low. The switch frequency is 20 kHz, but the frequency of the internal sawtooth oscillator is 40 kHz, determined by R110 and C108. The ramp of the sawtooth oscillator is determined by R103 and C106. The duty-cycle is limited to approx. 45 % by means of R107 and R108. Regulation of the duty-cycle is also on pin 4. The regulation signal to control the output current and voltage is created in IC105.

Voltage supply for IC101 and IC105 is regulated by R101 and D101.

Explanation of one of the switch circuits: The pulse from IC101 pin 12 turns on T107, which by means of TR102, D111, C116, and D112 turns on the switch transistor T702. When C116 is charged the current flows through R128 back to TR102. To turn off T702, TR102 reverses polarity. The voltage over C116 will through R128 turn on T109 and the negative voltage of C116 is then through T109 connected to the base of T702 which is turned off. During the off-period, T702 is always reverse biased. The "baker clamp" diodes D111 and D402 prevent T702 from saturating and this makes it switch faster. The resistor R139 and the capacitors C134, R405 and C402 prevent unwanted oscillations and voltage transients. The other switch circuit around T701 works in the same way.

The transformer TR702 is connected in a symmetrical half bridge configuration and is hanged up in the middle of the rectified mains. If T701 is off and T702 is on, the current flows through C403 - C407 and in the primary of TR702 and through T702. Next period T702 is off and T701 is on. The current now flows in the opposite direction, through T701, TR702 and C408 - C412.

The output voltage is rectified in D704. The choke L702 is an energy reservoir. Together with C206 - C211 it is smoothing the output current.

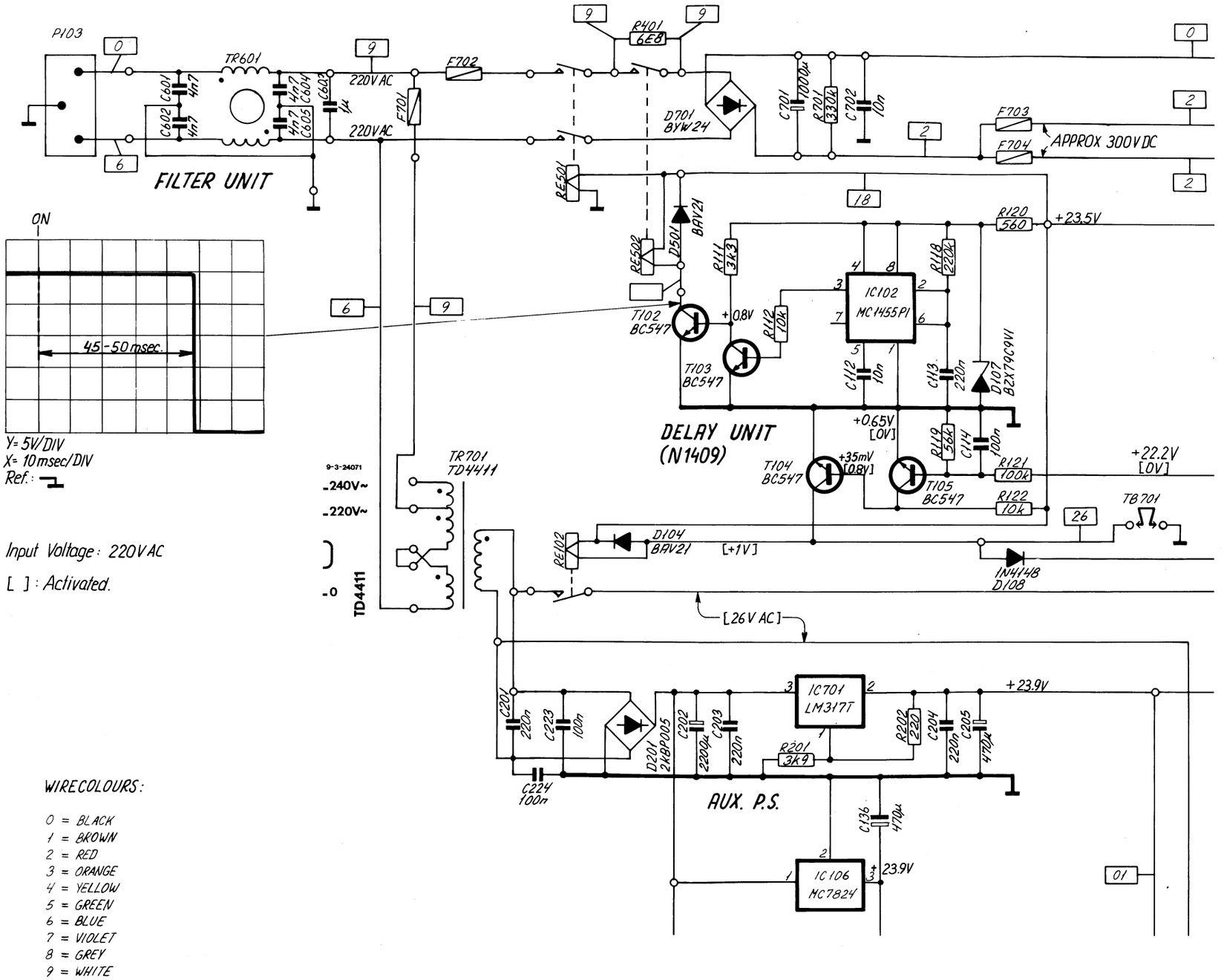
The output voltage of 38V is regulated by IC105b. The reference voltage is taken from D121. Adjustment is done with R169. If the output voltage increases, pin 7 will go low and pull down IC101 pin 4, which reduces the duty-cycle and with it the output voltage. R172 has to be connected to ground to get 38V. For supply reduction to the transmitter, R172 is released from ground and the output voltage is approx. 30V.

A current limiter is performed by IC105a. R206 is the current sense and is made of a konstantan wire. If current comes over the level determined by R133, the output pin 1 goes low and turns on T112, which again pulls down the reference voltage for IC105b. This means that the output voltage to the transmitter will be reduced. D120 protects T112 while its base voltage is high.

POWER UNIT 2 cont.:

The current limiter is made slow with C125 to prevent variation from the modulation of the transmitter. It cannot protect the output transistors or diodes against short circuit of the output.

The 28V output is regulated by IC104 and is adjusted with R165. Transistor T704 turns on and the current flows through L202 to C217 and load. The voltage increases at pin 4 and IC104 turns off T704. The current flows continuously into L202 and back through D206. The voltage will decrease at pin 4 and IC104 turns on T704 again. The regulator is then self oscillating. R208 forms a current limiter.



WIRECOLOURS:

0 = BLACK
1 = BROWN
2 = RED
3 = ORANGE
4 = YELLOW
5 = GREEN
6 = BLUE
7 = VIOLET
8 = GREY
9 = WHITE

POWER UNIT I (N1409)

Input voltage : 220 V AC

Outputs are max. loaded.

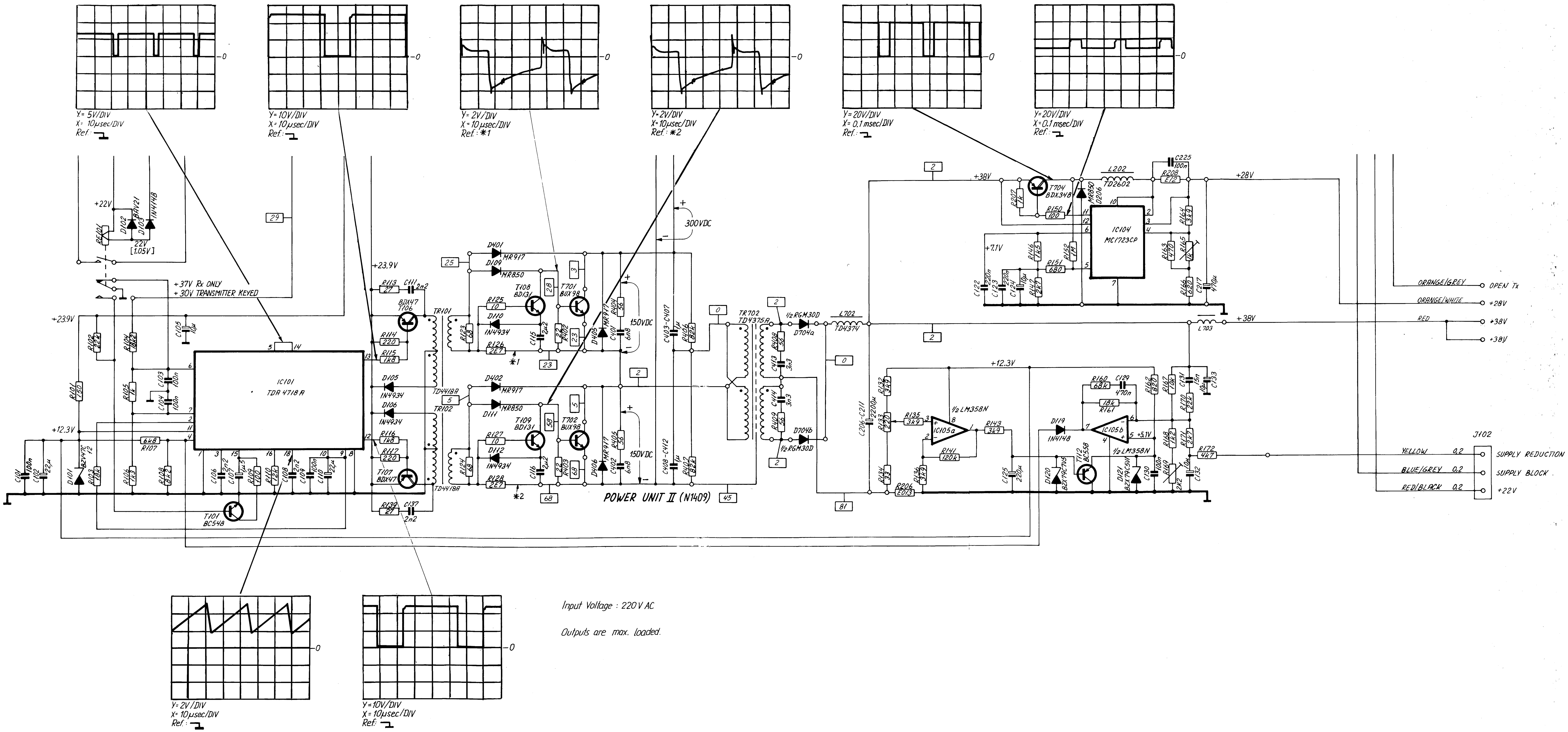
Y= 100V/DIV
X= 10µsec/DIV
Ref.: ✱1

Y= 2V/DIV
X= 10µsec/DIV
Ref.: ✱2

Y= 1V/DIV
X= 10µsec/DIV
Ref.: ⊓

Y= 2V/DIV
X= 10µsec/DIV
Ref.: ⊓

WHITE/GREY
GREEN/BLACK 0.5°
BROWN 0.5°
BROWN/GREEN
WHITE/BLUE 0.5°
ORANGE/WHITE
WHITE
WHITE
BROWN
BLACK/YELLOW
GREEN/WHITE 0.5°
GREEN/WHITE
YELLOW/GREY
BLACK/RED
BROWN/GREY

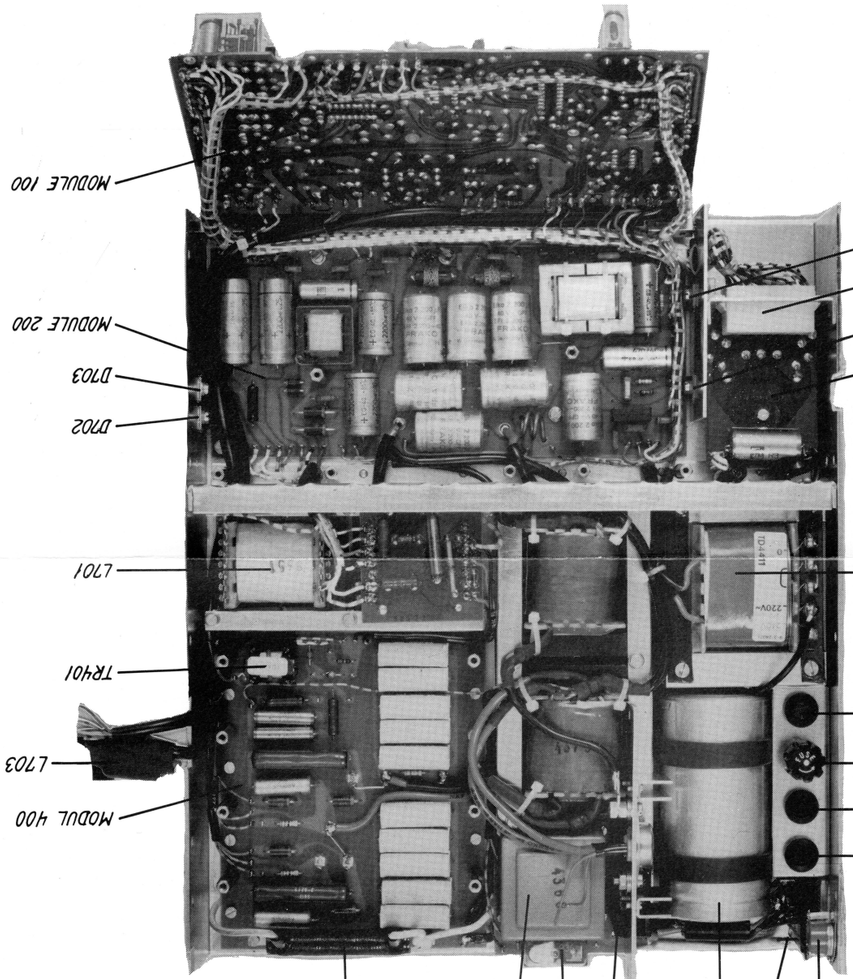


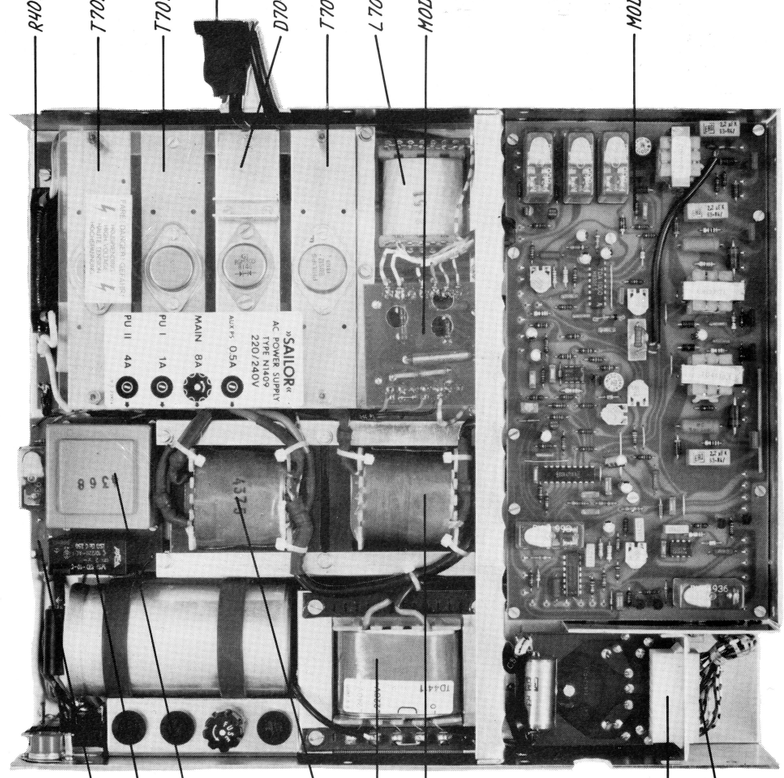
Input Voltage : 220 V AC

Outputs are max. loaded.

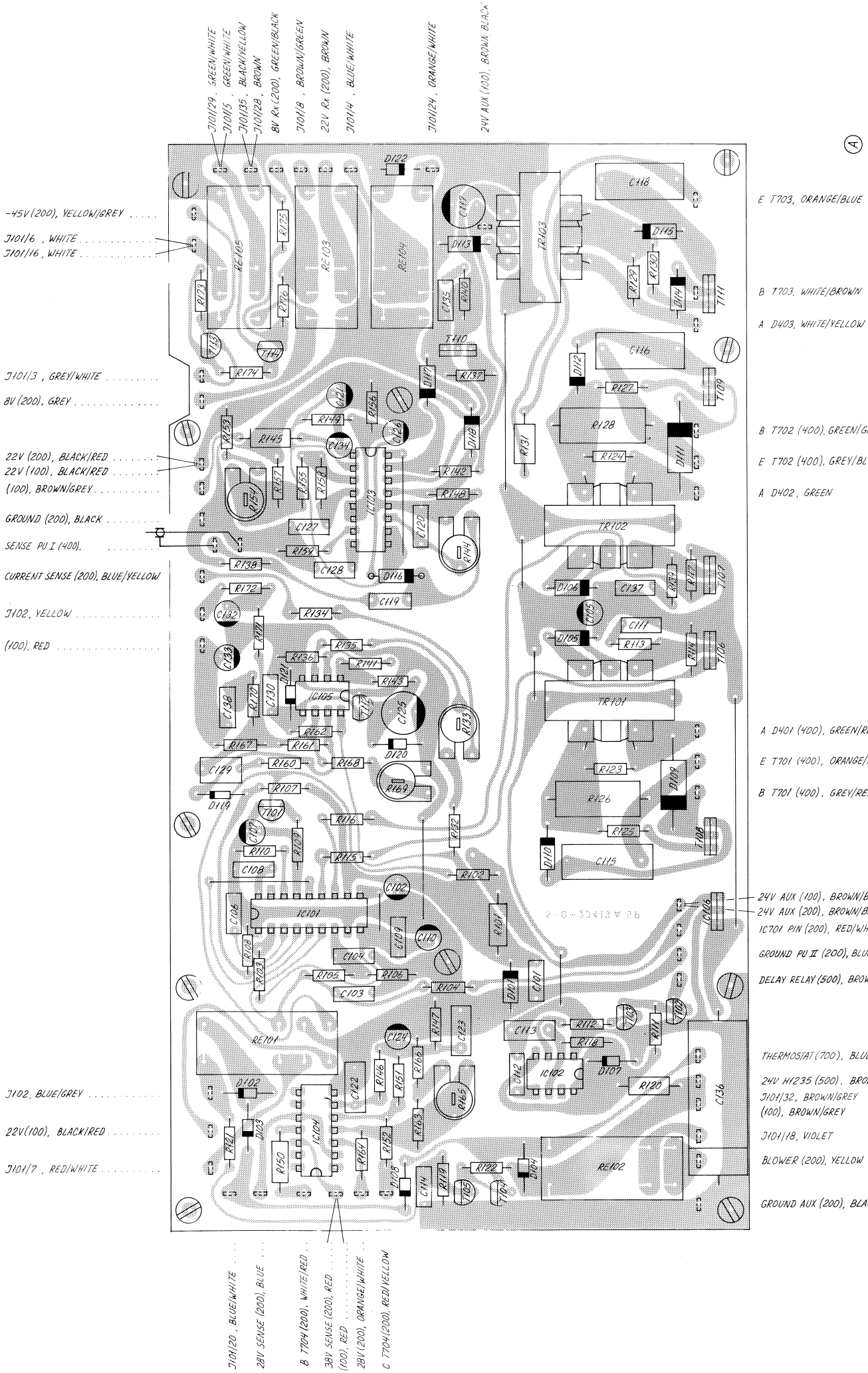
CONTENTS:

TOP VIEW


MODULE 100
MODULE 200
D703
D702
L701
TR401
L703
MODUL 400
R401
L501
RE502
RE501
C701
D701
TB701
F704, 4A FOR PU II
F703, 1A FOR PU I
F702, 8A MAIN
F701, 0.5A FOR AUX. P.S.
TR701
MODULE 600
IC701
J101
T704

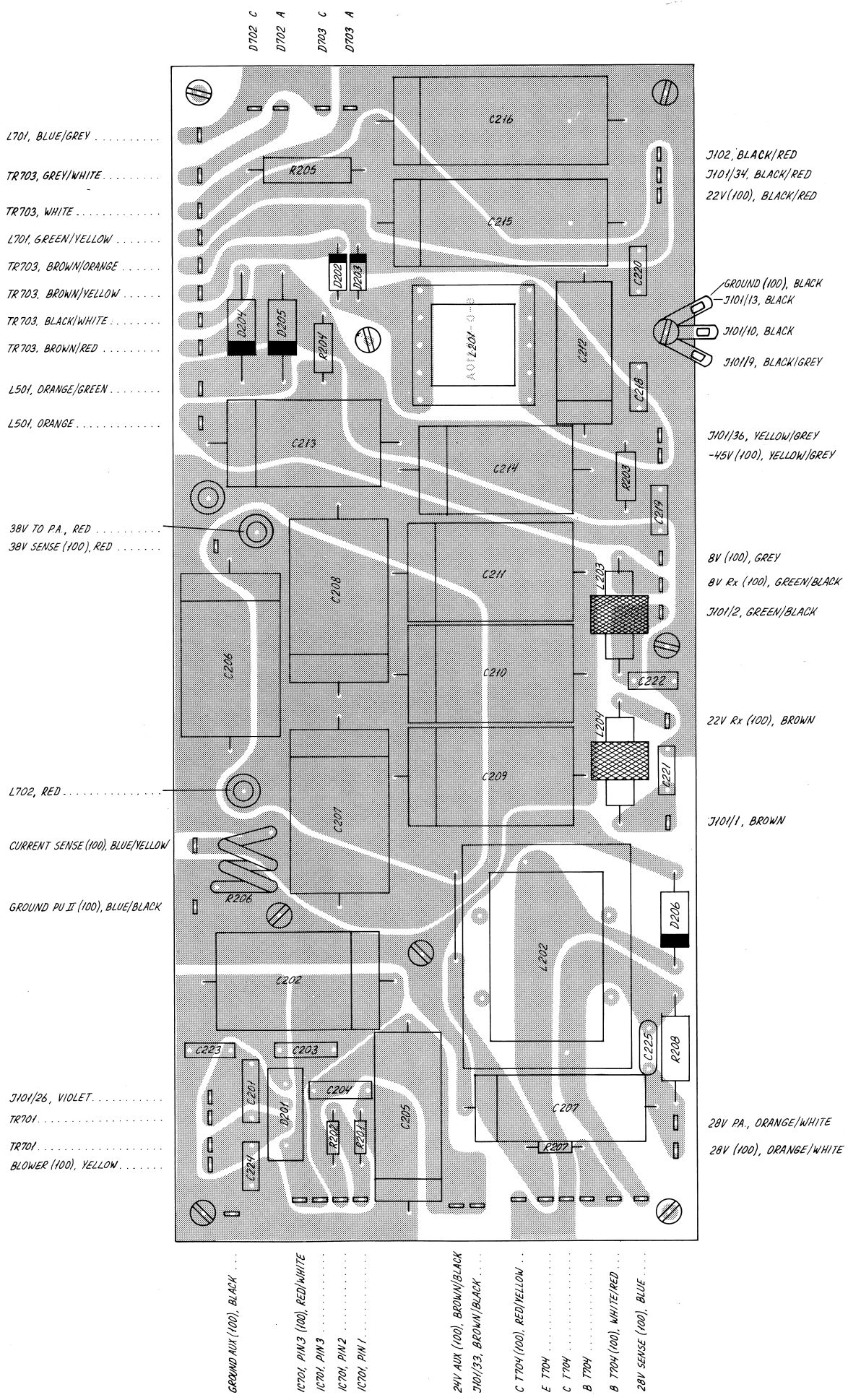

R401
T702
T701
L703
D704
T703
L701
MODULE 300,
MODULE 100
MODULE 500
RE501
L501
TR702
TR701
L702
J101
P103

4.1. POWER SUPPLY CONTROL UNIT MODULE 100

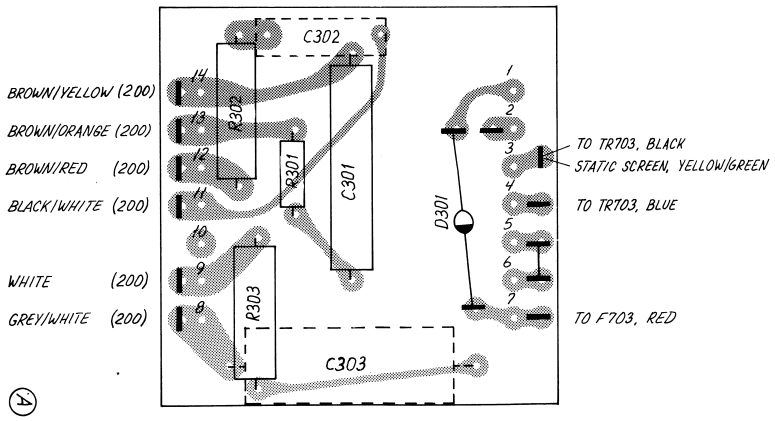


N1409 4-6-23413A

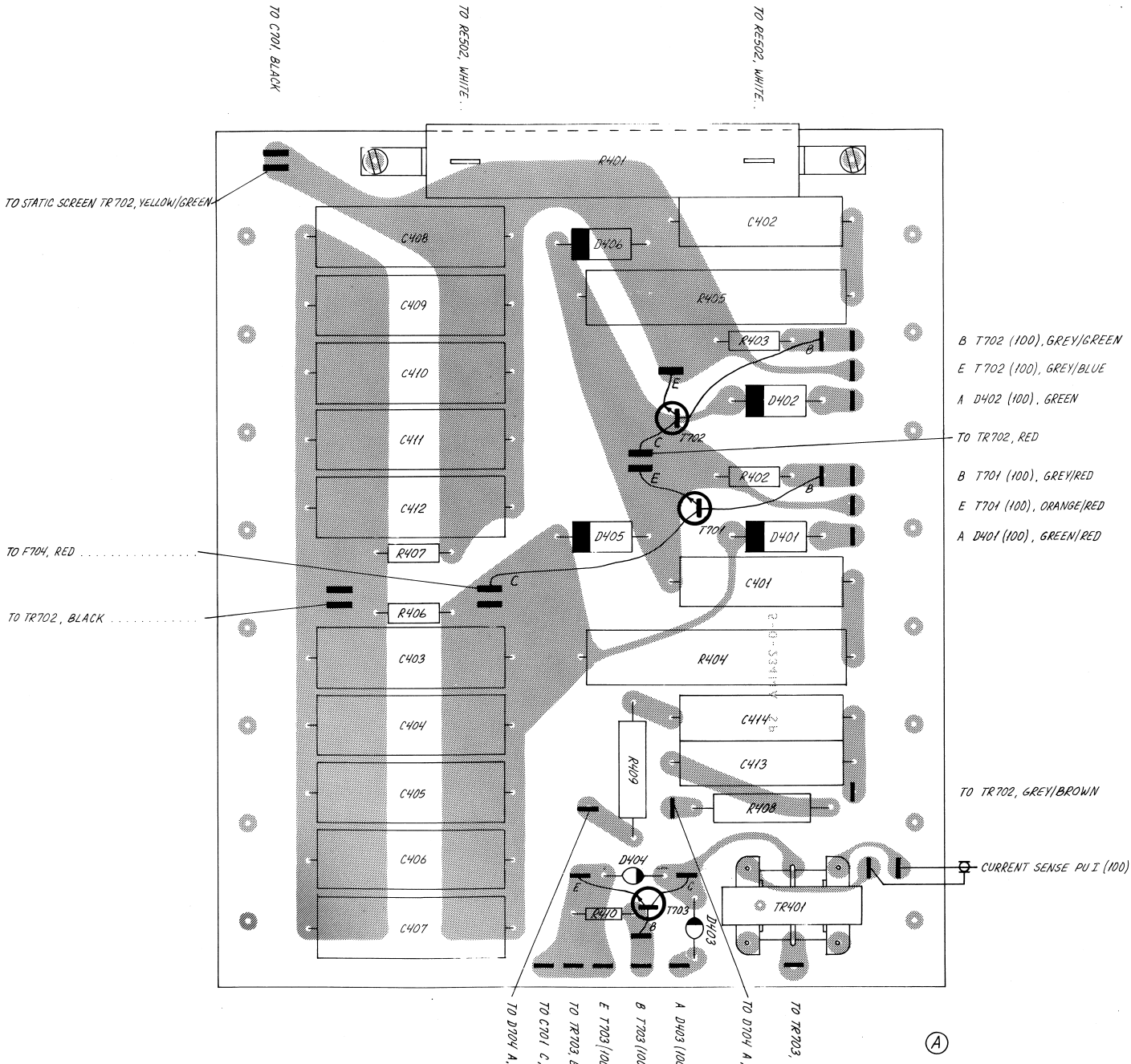
4.2. FILTER BOARD AND AUX. P.S. MODULE 200



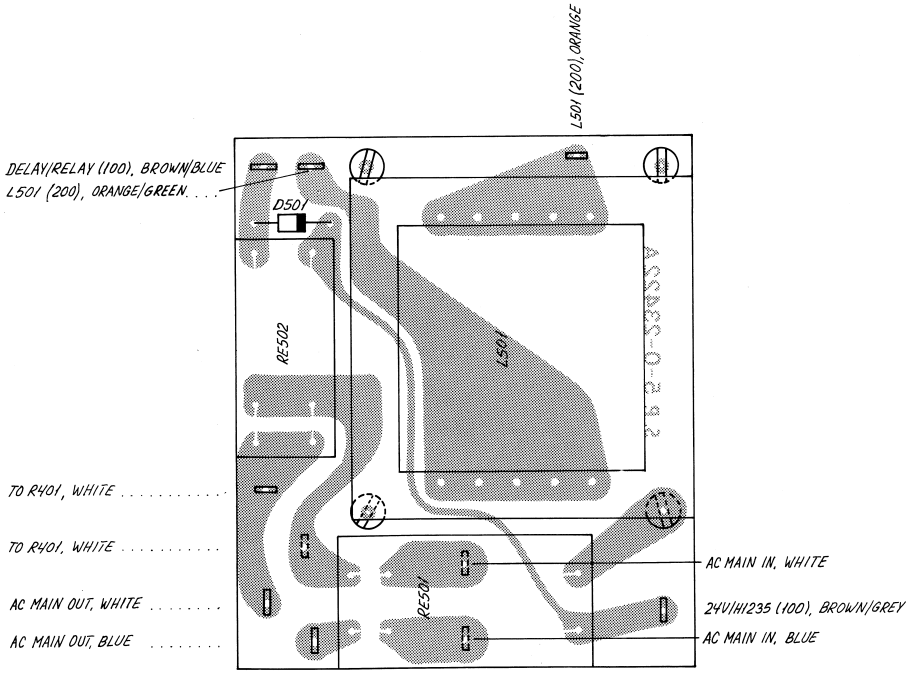
4.3. CONNECTION BOARD I MODULE 300



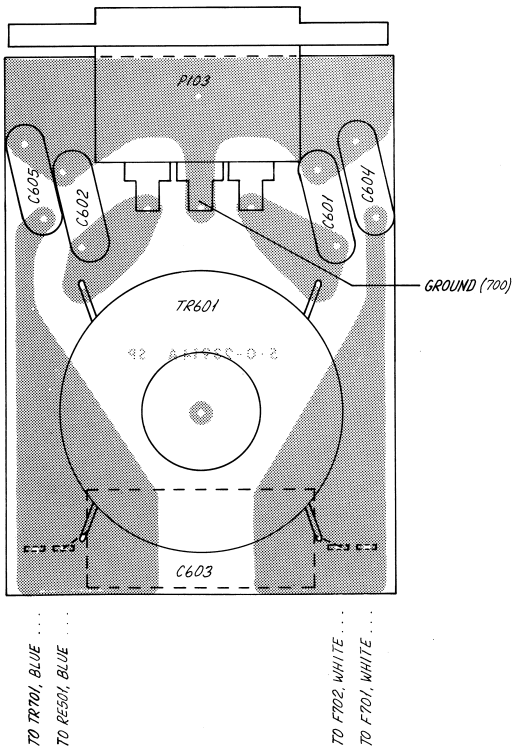
4.4. CONNECTION BOARD II MODULE 400

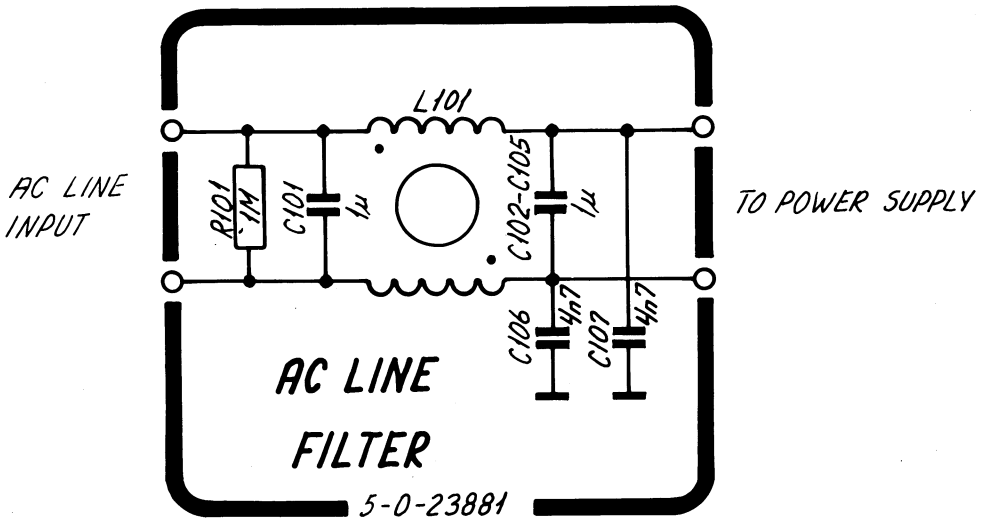


4.5. INPUT RELAYS MODULE 500



4.6. MAINS FILTER MODULE 600



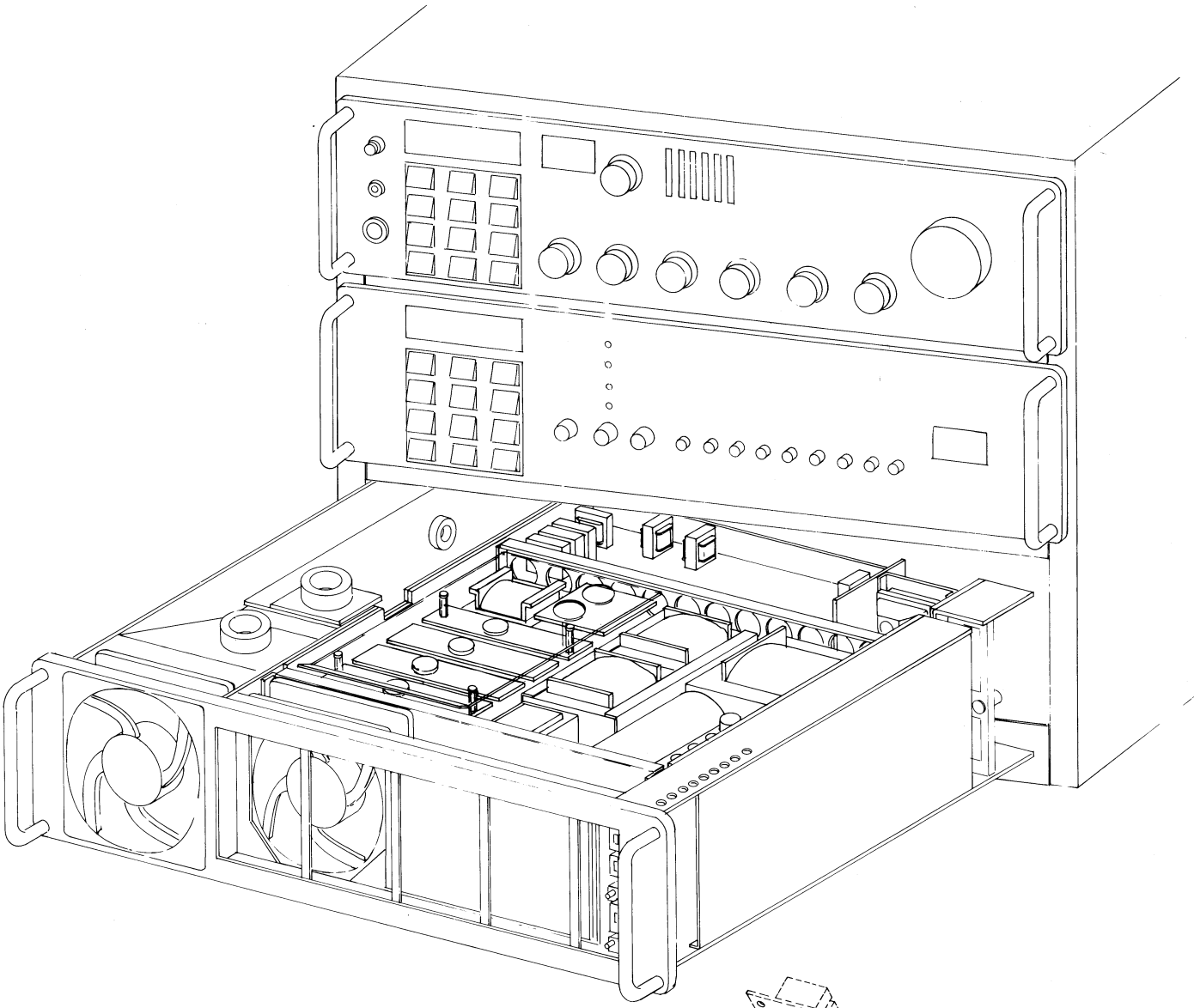


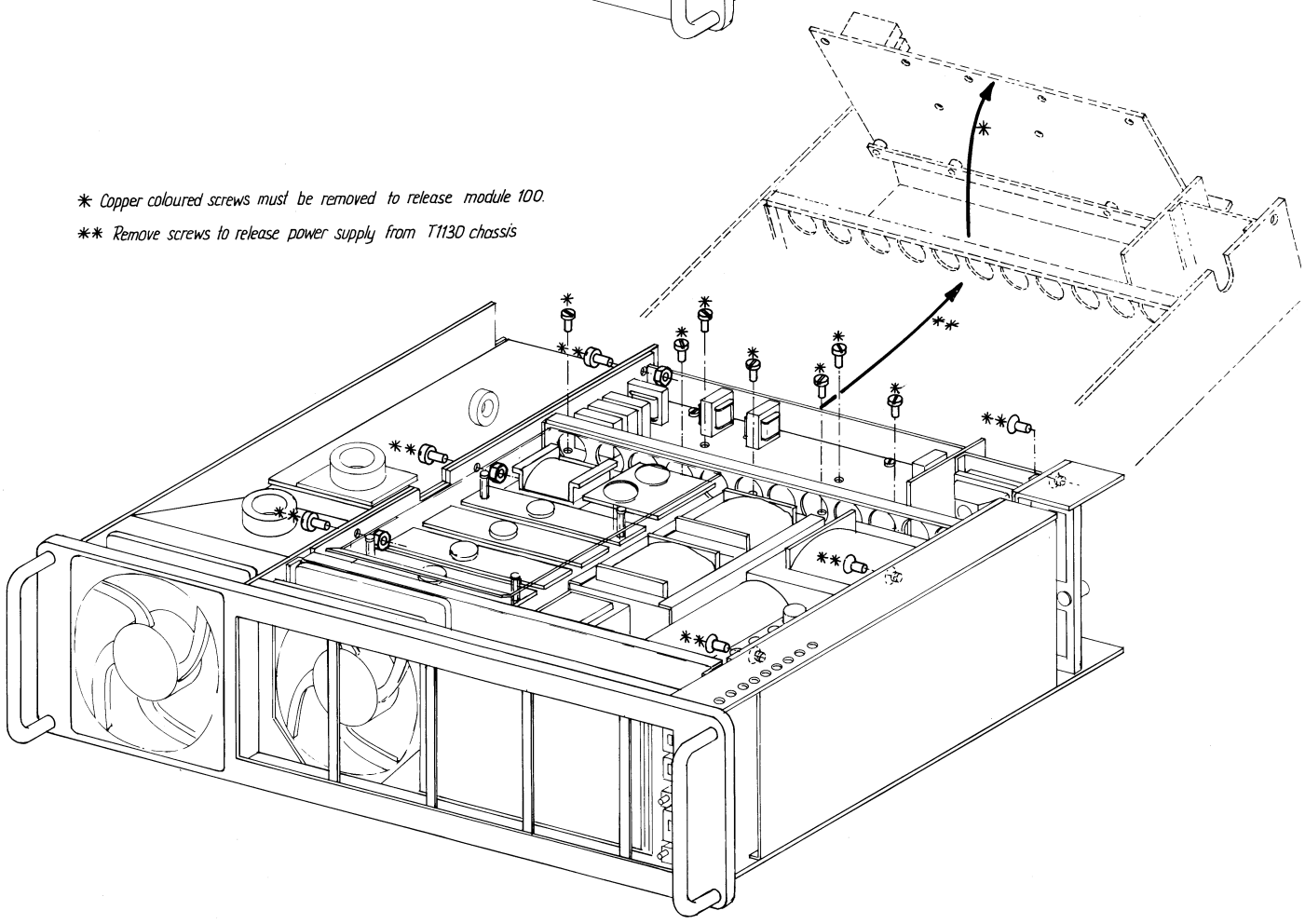
N1409

AC LINE FILTER N1409 (100) 1/1

Symbol	*Description*			*Manufact.*	
C101	Capacitor, polyester	1uF ±10%	400V	ERO	F 1772-510-2000
C102	Capacitor, polyester	1uF ±10%	400V	ERO	F 1772-510-2000
C103	Capacitor, polyester	1uF ±10%	400V	ERO	F 1772-510-2000
C104	Capacitor, polyester	1uF ±10%	400V	ERO	F 1772-510-2000
C105	Capacitor, polyester	1uF ±10%	400V	ERO	F 1772-510-2000
C106	Capacitor, ceramic	4.7nF ±20%	5KV	Ferroperm	9/0138.9
C107	Capacitor, ceramic	4.7nF ±20%	5KV	Ferroperm	9/0138.9
L101	Filter choke TL382			S.P.	6-0-23900
R101	Resistor	1Mohm ±5%	0.33W	Philips	2322 211 13105

4.9. DISASSEMBLING FROM T1130





* Copper coloured screws must be removed to release module 100.

** Remove screws to release power supply from T1130 chassis

N1409 4-0-24977 4-0-24978

N 1409
4-0-23850 C

WIRECOLOURS:

0 = BLACK
1 = BROWN
2 = RED
3 = ORANGE
4 = YELLOW
5 = GREEN
6 = BLUE
7 = VIOLET
8 = GREY
9 = WHITE

FILTER UNIT

DELAY UNIT

AUX. P.S.

POWER UNIT I

POWER UNIT II

J101

1	22V TO Rx
2	8V TO Rx
3	-45V TO Rx
4	22V TO Ex
5	8V Ex
6	-45V TO Ex
7	22V RT1500
8	Rx ON
9	GROUND Rx
10	GROUND Ex
11	
12	POWER DOWN
13	GROUND H1235
14	
15	
16	-45V TO T1130
17	
18	BLOWER
19	
20	TRANSMITTER START
21	OPEN Tx
22	
23	
24	H1 ON
25	
26	BLOWER
27	
28	22V T1130
29	8V T1130
30	
31	
32	START PU I
33	+BATTERY
34	22V TO H1235
35	ON
36	-45V

J102

YELLOW	0.2	SUPPLY REDUCTION
BLUE/GREY	0.2	SUPPLY BLOCK
RED/BLACK	0.2	+22V

220V AC P.S. N1409 ©

4.10. MAIN SCHEMATIC DIAGRAM N1409

CONTENTS:

N1409

Symbol	Description		Manufact.	
R101	Resistor	150 ohm ±5% 1,6 W	Philips	2322 191 31501
R102	Resistor	22 Kohm ±5% 0,33W	Philips	2322 181 53223
R103	Resistor	18 Kohm ±5% 0,33W	Philips	2322 181 53183
R104	Resistor	18,2 Kohm ±1% 0,4 W	Philips	2322 151 51823
R105	Resistor	1 Kohm ±1% 0,4 W	Philips	2322 151 51002
R106	Resistor	1,3 Kohm ±1% 0,4 W	Philips	2322 151 51302
R107	Resistor	6,8 Kohm ±5% 0,33W	Philips	2322 181 53682
R108	Resistor	8,2 Kohm ±5% 0,33W	Philips	2322 181 53822
R109	Resistor	100 ohm ±5% 0,33W	Philips	2322 181 53101
R110	Resistor	12 Kohm ±5% 0,33W	Philips	2322 181 53123
R111	Resistor	3,3 Kohm ±5% 0,33W	Philips	2322 181 53332
R112	Resistor	10 Kohm ±5% 0,33W	Philips	2322 181 53103
R113	Resistor	27 ohm ±5% 0,33W	Philips	2322 181 53279
R114	Resistor	220 ohm ±5% 0,33W	Philips	2322 181 53221
R115	Resistor	1,8 Kohm ±5% 0,33W	Philips	2322 181 53182
R116	Resistor	1,8 Kohm ±5% 0,33W	Philips	2322 181 53182
R117	Resistor	220 ohm ±5% 0,33W	Philips	2322 181 53221
R118	Resistor	220 Kohm ±5% 0,33W	Philips	2322 181 53224
R119	Resistor	56 Kohm ±5% 0,33W	Philips	2322 181 53563
R120	Resistor	560 ohm ±5% 1,6 W	Philips	2322 191 35601
R121	Resistor	100 Kohm ±5% 0,33W	Philips	2322 181 53104
R122	Resistor	10 Kohm ±5% 0,33W	Philips	2322 181 53103
R123	Resistor	68 ohm ±5% 0,33W	Philips	2322 181 53689
R124	Resistor	68 ohm ±5% 0,33W	Philips	2322 181 53689
R125	Resistor	10 ohm ±5% 0,33W	Philips	2322 181 53109
R126	Resistor	2,7 ohm ±5% 5 W	Philips	2322 329 35278
R127	Resistor	10 ohm ±5% 0,33W	Philips	2322 181 53109
R128	Resistor	2,7 ohm ±5% 5 W	Philips	2322 329 35278
R129	Resistor	68 ohm ±5% 0,33W	Philips	2322 181 53689
R130	Resistor	12 ohm ±5% 0,33W	Philips	2322 181 53129
R131	Resistor	12 ohm ±5% 1,6 W	Philips	2322 191 31209
R132	Resistor	3,9 Kohm ±5% 0,33W	Philips	2322 181 53392
R133	Resistor	Potentiometer 220 ohm ±20%	Noble	TM8KV2-1S/220
R134	Resistor	33 ohm ±5% 0,33W	Philips	2322 181 53331
R135	Resistor	3,9 Kohm ±5% 0,33W	Philips	2322 181 53392
R136	Resistor	3,9 Kohm ±5% 0,33W	Philips	2322 181 53392
R137	Resistor	220 ohm ±5% 0,33W	Philips	2322 181 53221
R138	Resistor	27 ohm ±5% 0,33W	Philips	2322 181 53279
R139	Resistor	27 ohm ±5% 0,33W	Philips	2322 181 53279
R140	Resistor	27 ohm ±5% 0,33W	Philips	2322 181 53279

Symbol	Description		Manufact.	
R141	Resistor	120 Kohm ±5% 0,33W	Philips	2322 181 53124
R142	Resistor	1,8 Kohm ±5% 0,33W	Philips	2322 181 53182
R143	Resistor	3,9 Kohm ±5% 0,33W	Philips	2322 181 53392
R144	Resistor	Potentiometer 1 Kohm ±20%	Noble	TM8KV2-1S/1K
R145	Resistor	390 ohm ±5% 1,6 W	Philips	2322 191 33901
R146	Resistor	1,5 Kohm ±5% 0,33W	Philips	2322 181 53152
R147	Resistor	2,7 Kohm ±5% 0,33W	Philips	2322 181 53272
R148	Resistor	10 Kohm ±5% 0,33W	Philips	2322 181 53103
R149	Resistor	8,06 Kohm ±1% 0,4 W	Philips	2322 151 58062
R150	Resistor	100 ohm ±5% 1,6 W	Philips	2322 191 31001
R151	Resistor	680 ohm ±5% 0,33W	Philips	2322 181 53681
R152	Resistor	1 Mohm ±5% 0,33W	Philips	2322 181 53105
R153	Resistor	2,2 Kohm ±5% 0,33W	Philips	2322 181 53222
R154	Resistor	Potentiometer 2,2 Kohm ±20%	Noble	TM8KV2-1S/2K2
R155	Resistor	1 Kohm ±5% 0,33W	Philips	2322 181 53102
R156	Resistor	4,53 Kohm ±1% 0,4 W	Philips	2322 151 54532
R157	Resistor	560 ohm ±5% 0,33W	Philips	2322 181 53561
R158	Resistor	100 Kohm ±5% 0,33W	Philips	2322 181 53104
R159	Resistor	22 Kohm ±5% 0,33W	Philips	2322 181 53223
R160	Resistor	68 Kohm ±5% 0,33W	Philips	2322 181 53683
R161	Resistor	18 Kohm ±5% 0,33W	Philips	2322 181 53183
R162	Resistor	820 ohm ±5% 0,33W	Philips	2322 181 53821
R163	Resistor	470 ohm ±5% 0,33W	Philips	2322 181 53471
R164	Resistor	3,9 Kohm ±5% 0,33W	Philips	2322 181 53392
R165	Resistor	Potentiometer 1 Kohm ±10%	Noble	TM8KV2-1S/1K - 10%
R166	Resistor	620 ohm ±5% 0,33W	Philips	2322 181 53621
R167	Resistor	10 Kohm ±5% 0,33W	Philips	2322 181 53103
R168	Resistor	1,2 Kohm ±5% 0,33W	Philips	2322 181 53122
R169	Resistor	Potentiometer 2,2 Kohm ±20%	Noble	TM8KV2-1S/2K2
R170	Resistor	22 Kohm ±5% 0,33W	Philips	2322 181 53223
R171	Resistor	2,7 Kohm ±5% 0,33W	Philips	2322 181 53272
R172	Resistor	4,7 Kohm ±5% 0,33W	Philips	2322 181 53472
R173	Resistor	18 Kohm ±5% 0,33W	Philips	2322 181 53183
R174	Resistor	15 Kohm ±5% 0,33W	Philips	2322 181 53153
R175	Resistor	18 Kohm ±5% 0,33W	Philips	2322 181 53183
R176	Resistor	2,2 Kohm ±5% 0,33W	Philips	2322 181 53222

Symbol	*Description*				*Manufact.*	
C101	Capacitor	MKT	100nF ±20%	100V	ERO	MKT 1818 410 016
C102	Capacitor	Electrolytic	22uF ±20%	25V	ROE	EKI 00 AA 222 E
C103	Capacitor	MKT	100nF ±20%	100V	ERO	MKT 1818 410 016
C104	Capacitor	MKT	100nF ±20%	100V	ERO	MKT 1818 410 016
C105	Capacitor	Electrolytic	10uF ±20%	35V	ROE	EKI 00 AA 210 F
C106	Capacitor	MKT	2,2nF ±10%	400V	Siemens	B32510-D6222-K
C107	Capacitor	Electrolytic	1,5uF ±20%	50V	ROE	EKI 00 AA 115 H
C108	Capacitor	MKT	2,2nF ±10%	400V	Siemens	B32510-D6222-K
C109	Capacitor	MKT	100nF ±20%	100V	ERO	MKT 1818 410 016
C110	Capacitor	Electrolytic	22uF ±20%	25V	ROE	EKI 00 AA 222 E
C111	Capacitor	MKT	2,2nF ±10%	400V	Siemens	B32510-D6222-K
C112	Capacitor	MKT	10nF ±20%	250V	ERO	MKT 1818 310 256
C113	Capacitor	MKT	220nF ±20%	63V	ERO	MKT 1818 422 066
C114	Capacitor	MKT	100nF ±20%	100V	ERO	MKT 1818 410 016
C115	Capacitor	MKT	2,2uF ±10%	63V	ERO	MKT 1822 522 065
C116	Capacitor	MKT	2,2uF ±10%	63V	ERO	MKT 1822 522 065
C117	Capacitor	Electrolytic	100uF	25V	ROE	EKM 00 CC 310 E
C118	Capacitor	MKT	2,2uF ±10%	63V	ERO	MKT 1822 522 065
C119	Capacitor	MKT	100nF ±20%	100V	ERO	MKT 1818 410 016
C120	Capacitor	MKT	4,7nF ±10%	400V	Siemens	B32510-D6472-K
C121	Capacitor	Electrolytic	47uF ±20%	10V	ROE	EKI 00 AA 247 E
C122	Capacitor	MKT	220nF ±20%	63V	ERO	MKT 1818 422 066
C123	Capacitor	MKT	220nF ±20%	63V	ERO	MKT 1818 422 066
C124	Capacitor	Electrolytic	10uF ±20%	35V	ROE	EKI 00 AA 210 F
C125	Capacitor	Electrolytic	220uF	10V	ROE	EKM 00 CC 322 C
C126	Capacitor	Electrolytic	33uF ±20%	35V	ROE	EKI 00 AA 233 D
C127	Capacitor	MKT	22nF ±10%	250V	ERO	MKT 1818 322 255
C128	Capacitor	MKT	2,2nF ±10%	400V	Siemens	B32510-D6222-K
C129	Capacitor	MKT	470nF ±10%	63V	ERO	MKT 1818 447 065
C130	Capacitor	MKT	100nF ±20%	100V	ERO	MKT 1818 410 016
C131	Capacitor	MKT	15nF ±10%	250V	ERO	MKT 1818 315 255
C132	Capacitor	Electrolytic	10uF ±20%	35V	ROE	EKI 00 AA 210 F
C133	Capacitor	Electrolytic	10uF ±20%	35V	ROE	EKI 00 AA 210 F
C134	Capacitor	Electrolytic	10uF ±20%	35V	ROE	EKI 00 AA 210F
C135	Capacitor	MKT	2,2nF ±10%	400V	Siemens	B32510-D6222-K
C136	Capacitor	Electrolytic	470uF	40V	ROE	EB 00 HE 347G
C137	Capacitor	MKT	2,2nF ±10%	400V	Siemens	B32510-D6222-K

Symbol	*Description*			*Manufact.*	
D101	Diode, Zener	12V	2W	Thomson CSF	BZV47C12
D102	Diode, Silicon			Philips	BAV21
D103	Diode, Silicon			Philips	1N4148
D104	Diode, Silicon			Philips	BAV21
D105	Diode, Silicon			Motorola	1N4934
D106	Diode, Silicon			Motorola	1N4934
D107	Diode, Zener	9,1V	0,5W	Philips	BZX79C9V1
D108	Diode, Silicon			Philips	1N4148
D109	Diode, Silicon			Motorola	MR850
D110	Diode, Silicon			Motorola	1N4934
D111	Diode, Silicon			Motorola	MR850
D112	Diode, Silicon			Motorola	1N4934
D113	Diode, Silicon			Motorola	1N4934
D114	Diode, Silicon			Motorola	1N4934
D115	Diode, Silicon			Motorola	1N4934
D116	Diode, Germanium			ITT	AA143
D117	Diode, Zener	13V	2W	Thomson CSF	BZV47C13
D118	Diode, Zener	24V	0,5W	Philips	BZX79C24
D119	Diode, Silicon			Philips	1N4148
D120	Diode, Zener	7,5V	0,5W	Philips	BZV79C7V5
D121	Diode, Zener	5,1V	0,5W	Philips	BZX79C5V1
D122	Diode, Silicon			Philips	BAV21
T101	Transistor			Philips	BC548
T102	Transistor			Philips	BC547
T103	Transistor			Philips	BC547
T104	Transistor			Philips	BC547
T105	Transistor			Philips	BC547
T106	Transistor			Philips	BDX47
T107	Transistor			Philips	BDX47
T108	Transistor			Philips	BD131
T109	Transistor			Philips	BD131
T110	Transistor			Philips	BDX43
T111	Transistor			Philips	BD131
T112	Transistor			Philips	BC558
T113	Transistor			Philips	BC639
T114	Transistor			Philips	BC640

Symbol	*Description*	*Manufact.*	
IC101	Integrated circuit	Siemens	TDA4718A
IC102	Integrated circuit	Motorola	MC1455P1
IC103	Integrated circuit	Philips	TDA1060A
IC104	Integrated circuit	Motorola	MC1723CP
IC105	Integrated circuit	National	LM358N
IC106	Integrated circuit	Motorola	MC7824CT
RE101	Relay	Pasi	KS/U BV998
RE102	Relay	Pasi	KH/A BV936
RE103	Relay	Pasi	KS/U BV998
RE104	Relay	Pasi	KH/A BV936
RE105	Relay	Pasi	KS/U BV998
TR101	Transformer	Tradania	TD 4418a
TR102	Transformer	Tradania	TD 4418a
TR103	Transformer	Tradania	TD 4418a

Symbol	*Description*	*Manufact.*	
R201	Resistor 3,9 Kohm ±5% 0,33W	Philips	2322 181 53392
R202	Resistor 220 ohm ±5% 0,33W	Philips	2322 181 53221
R203	Resistor 3,3 Kohm ±5% 1,6W	Philips	2322 191 33302
R204	Resistor 56 ohm ±5% 1,6W	Philips	2322 191 35609
R205	Resistor 150 ohm ±5% 4W	Philips	2322 330 22151
R206	Resistor 13,3 mohm	S.P.	TL 380
R207	Resistor 1 Kohm ±5% 0,33W	Philips	2322 181 53102
R208	Resistor 0,12 ohm ±5% 3W	Danotherm	VC3 - 0,12 ohm
C201	Capacitor MKT 220nF 100V	Siemens	B32511-D1224-K
C202	Capacitor electrolytic 2200uF 40V	FRAKO	EFI 2200uF 40V
C203	Capacitor MKT 220nF 100V	Siemens	B32511-D1224-K
C204	Capacitor MKT 220nF 100V	Siemens	B32511-D1224-K
C205	Capacitor electrolytic 470uF 40V	ROE	EB 00 HE 347 G
C206	Capacitor electrolytic 2200uF 40V	FRAKO	EFI 2200uF 40V
C207	Capacitor electrolytic 2200uF 40V	FRAKO	EFI 2200uF 40V
C208	Capacitor electrolytic 2200uF 40V	FRAKO	EFI 2200uF 40V
C209	Capacitor electrolytic 2200uF 40V	FRAKO	EFI 2200uF 40V
C210	Capacitor electrolytic 2200uF 40V	FRAKO	EFI 2200uF 40V
C211	Capacitor electrolytic 2200uF 40V	FRAKO	EFI 2200uF 40V
C212	Capacitor electrolytic 100uF 63V	ROE	EB 00 GD 310 J
C213	Capacitor electrolytic 2200uF 16V	ROE	EG 00 KE 422 G
C214	Capacitor electrolytic 2200uF 16V	ROE	EG 00 KE 422 G
C215	Capacitor electrolytic 2200uF 25V	ROE	EG 00 KG 422 F
C216	Capacitor electrolytic 2200uF 25V	ROE	EG 00 KG 422 F
C217	Capacitor electrolytic 470uF 40V	ROE	EB 00 HE 347 G
C218	Capacitor MKT 100nF ±20% 100V	ERO	MKT 1818 410 016
C219	Capacitor MKT 100nF ±20% 100V	ERO	MKT 1818 410 016
C220	Capacitor MKT 100nF ±20% 100V	ERO	MKT 1818 410 016
C221	Capacitor MKT 100nF ±20% 100V	ERO	MKT 1818 410 016
C222	Capacitor MKT 100nF ±20% 100V	ERO	MKT 1818 410 016
C223	Capacitor MKT 100nF ±20% 100V	ERO	MKT 1818 410 016
C224	Capacitor MKT 100nF ±20% 100V	ERO	MKT 1818 410 016
C225	Capacitor MKT 100nF ±20% 100V	ERO	MKT 1818 410 016
L201	Choke	Tradania	TD 4367
L202	Choke	Tradania	TD 2602
L203	Choke	S.P.	TL 079
L204	Choke	S.P.	TL 079
D201	Diode, bridge	General Instruments	2KBP005

Symbol	*Description*	*Manufact.*	
D202	Diode, silicon	Motorola	BA 157
D203	Diode, silicon	Motorola	BA 157
D204	Diode, silicon	Motorola	MR 850
D205	Diode, silicon	Motorola	MR 850
D206	Diode, silicon	Motorola	MR 850

Symbol	*Description*	*Manufact.*	
R301	Resistor 330 ohm ±5% 1,6W	Philips	2322 191 33301
R302	Resistor 15 ohm ±5% 2,5W	Philips	2322 192 31509
R303	Resistor 56 ohm ±5% 2,5W	Philips	2322 192 35609
C301	Capacitor Polypropylen 1nF ±10% 2KV	ERO	KP1832 210 205
C302	Capacitor Polyester 47nF ±20% 400V	Philips	2222 344 54 473
C303	Capacitor Polypropylen 10nF ±10% 1,5KV	ERO	KP1832 310 155
D301	Diode, Silicon	Philips	BYV96D

Symbol	*Description*		*Manufact.*	
R401	Resistor 6,8 ohm	25V	Danotherm	GRF25L-6,8 ohm
R402	Resistor 22 ohm ±5%	0,5W	Philips	2322 182 53229
R403	Resistor 22 ohm ±5%	0,5W	Philips	2322 182 53229
R404	Resistor 56 ohm ±5%	10W	Danotherm	VC10-56 ohm
R405	Resistor 56 ohm ±5%	10W	Danotherm	VC10-56 ohm
R406	Resistor 82 Kohm ±5%	0,5W	Philips	2322 182 53823
R407	Resistor 82 Kohm ±5%	0,5W	Philips	2322 182 53823
R408	Resistor 56 ohm ±5%	4W	Philips	2322 330 22561
R409	Resistor 56 ohm ±5%	4W	Philips	2322 330 22561
R410	Resistor 47 ohm ±5%	0,33W	Philips	2322 181 53471
C401	Capacitor Polypropylen 6,8nF ±10%	1,5KV	ERO	KP1832 268 155
C402	Capacitor Polypropylen 6,8nF ±10%	1,5KV	ERO	KP1832 268 155
C403	Capacitor Polyester 1uF ±10%	250V	Philips	2222 341 89105
C404	Capacitor Polyester 1uF ±10%	250V	Philips	2222 341 89105
C405	Capacitor Polyester 1uF ±10%	250V	Philips	2222 341 89105
C406	Capacitor Polyester 1uF ±10%	250V	Philips	2222 341 89105
C407	Capacitor Polyester 1uF ±10%	250V	Philips	2222 341 89105
C408	Capacitor Polyester 1uF ±10%	250V	Philips	2222 341 89105
C409	Capacitor Polyester 1uF ±10%	250V	Philips	2222 341 89105
C410	Capacitor Polyester 1uF ±10%	250V	Philips	2222 341 89105
C411	Capacitor Polyester 1uF ±10%	250V	Philips	2222 341 89105
C412	Capacitor Polyester 1uF ±10%	250V	Philips	2222 341 89105
C413	Capacitor Polypropylen 3,3nF ±10%	1,5KV	ERO	KP1832 233 155
C414	Capacitor Polypropylen 3,3nF ±10%	1,5KV	ERO	KP1832 233 155
D401	Diode, Silicon		Motorola	MR917
D402	Diode, Silicon		Motorola	MR917
D403	Diode, Silicon		Philips	BYV96D
D404	Diode, Silicon		Philips	BYV96D
D405	Diode, Silicon		Motorola	MR917
D406	Diode, Silicon		Motorola	MR917
TR401	Transformer		Tradania	TD4366

Symbol	*Description*	*Manufact.*	
D501	Diode, Silicon	Philips	BAV21
L501	Choke	Tradania	TD4368
RE501	Relay	Pasi	WSA/GD-10-C
RE502	Relay	Pasi	KH/A BV936

Symbol	*Description*		*Manufact.*	
C601	Capacitor ceramic 4,7nF	5KV	Ferroperm	9/0138,9
C602	Capacitor ceramic 4,7nF	5KV	Ferroperm	9/0138,9
C603	Capacitor 1uF	250V AC	ERO	F1773-510-2000
C604	Capacitor ceramic 4,7nF	5KV	Ferroperm	9/0138,9
C605	Capacitor ceramic 4,7nF	5KV	Ferroperm	9/0138,9
TR601	Choke			TL 384

Symbol	*Description*	*Manufact.*	
R701	Resistor 330 Kohm ±5% 0,5W	Philips	2322 182 53334
C702	Capacitor polypropylen 10nF 1,5V	ERO	KP1832 310 155
L701	Choke	Tradania	TD 4369
L702	Choke	Tradania	TD 4374
L703	Choke	S.P.	TL 383
D701	Diode, bridge	Motorola	BYW 24
D702	Diode, silicon	Philips	BYW 29-150
D703	Diode, silicon	Philips	BYW 29-150
D704	Diode, double	General Instrument	RGM 30D
T701	Transistor	Thomson CSF	BUX 98
T702	Transistor	Thomson CSF	BUX 98
T703	Transistor	Philips	BUS 12
T704	Transistor	Motorola	BDX 34B
IC701	Integrated circuit	National	LM 317T
TR701	Transformer	Tradania	TD 4441
TR702	Transformer	Tradania	TD 4375A
TR703	Transformer	Tradania	TD 4364

Symbol	*Description*			*Manufact.*	
TB701	Thermal breaker			Elmwood	2455R-21-923
	At 220V:				
C701	Capacitor electrolytic	1000uF	350V	FRAKO	EKBC 1000-350
F701	Fuse	0,5A time lag	250V	ELU	5x20 mm 0,5A
F702	Fuse	8,0A time lag	250V	Little Fuse	3AB 314 008
F703	Fuse	1,0A time lag	250V	ELU	5x20 mm 1,0A
F704	Fuse	4,0A time lag	250V	ELU	5x20 mm 4,0A