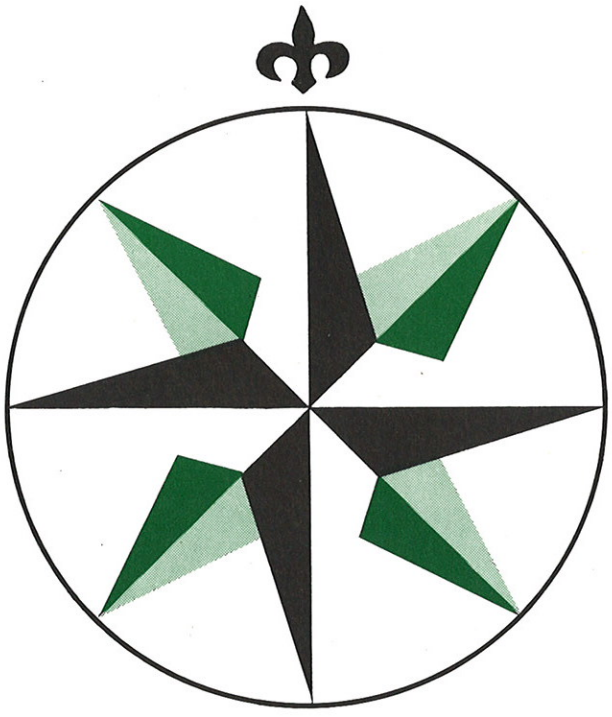


Sailor

Sailor

INSTRUKTIONSBOG FOR
SAILOR N2160

INSTRUCTION BOOK FOR
SAILOR N2160

INSTRUKTIONSBUCH FÜR
SAILOR N2160

INSTRUCTIONS POUR
SAILOR N2160

INSTRUCCIONES PARA
SAILOR N2160

A/S S. P. RADIO · AALBORG · DENMARK

CONTENTS

CONTENTS

1. INTRODUCTION

1.1. GENERAL DESCRIPTION

The power supply SAILOR N2160 is a general purpose 12V DC to 24V DC converter, designed for supplying the HF SSB Transmitter SAILOR T2130 from a 12V battery.

The SAILOR N2160 is a switch mode, step-up converter, working at 50 kHz, and constructed with MOSFET transistors. It has undervoltage shut-down with hysteresis, current limiter, reverse polarity protection, and input transient protection.

If any of the internal control wires is broken or shortened to ground, the N2160 automatically turns off, or continues without frequency synchronization. There is no adjustment at all.

1.2. TECHNICAL DATA

Input Voltage:	10.8 - 15.6V DC
Input Current:	Up to 60A
Output Voltage:	27.5V DC ±10% at 0.5A load
Output Current:	0.5 - 18 ADC
Output Current Limiter:	For output voltages higher than the input voltage, the current is limited to 18 Amp. by the electronic current limiter. For output voltages lower than the input voltage, the current is limited by fuse to 60 Amp.
Transient Protection:	The N2160 can withstand 300 cycles with a duty cycle of 50%, a repetition time of 50 mS, and a peak voltage of 100V DC.
Operating Temperature Range:	-15°C to +55°C
Fuse:	M 20 Amp. 6.3 x 32 mm

1.3. PRINCIPLE OF OPERATION

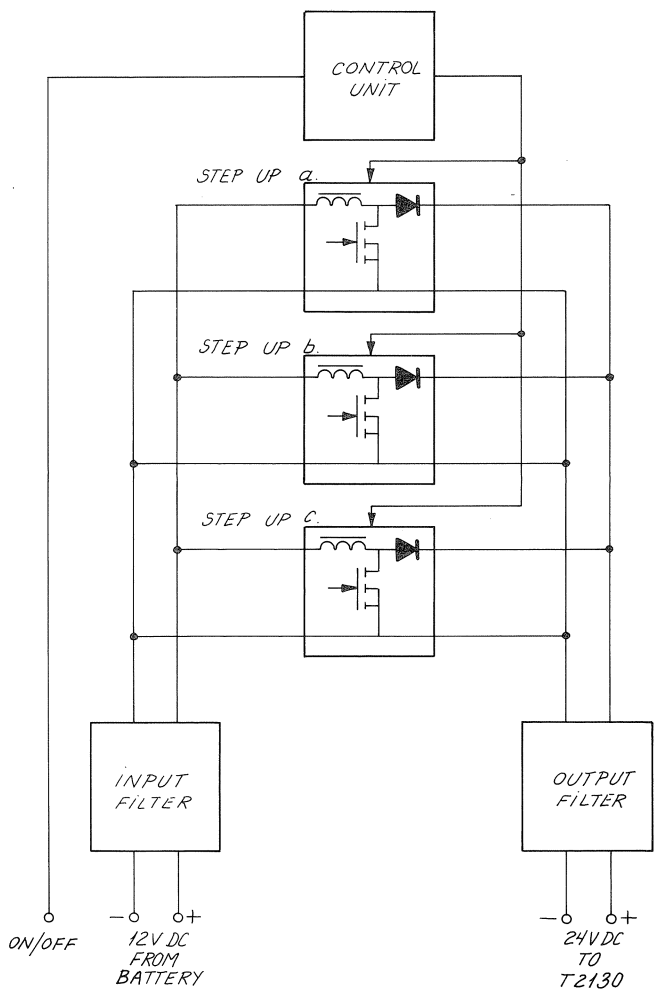
The converter is divided into three separate step-up converters and one control unit. The three step-up converters are working at the same frequency but with a 120 degrees phase shift in order to reduce the ripple current in the output capacitors and to reduce the input and output ripple and the current loss. The ripple frequency is 150 kHz instead of 50 kHz.

Each of the three step-up converters compares their output current with a control voltage from the control unit, so they all deliver the same output current, current sharing. When this control voltage is changed, the output currents are changed, and thereby the output voltage. They are working in current mode.

All fuses are monitored by the control unit and if one blows then the power supply is shut down.

If the input voltage is lower than 10V DC, the power supply is prevented from starting, and if the input voltages become less than 9V DC when the power supply is operating, it is stopped too.

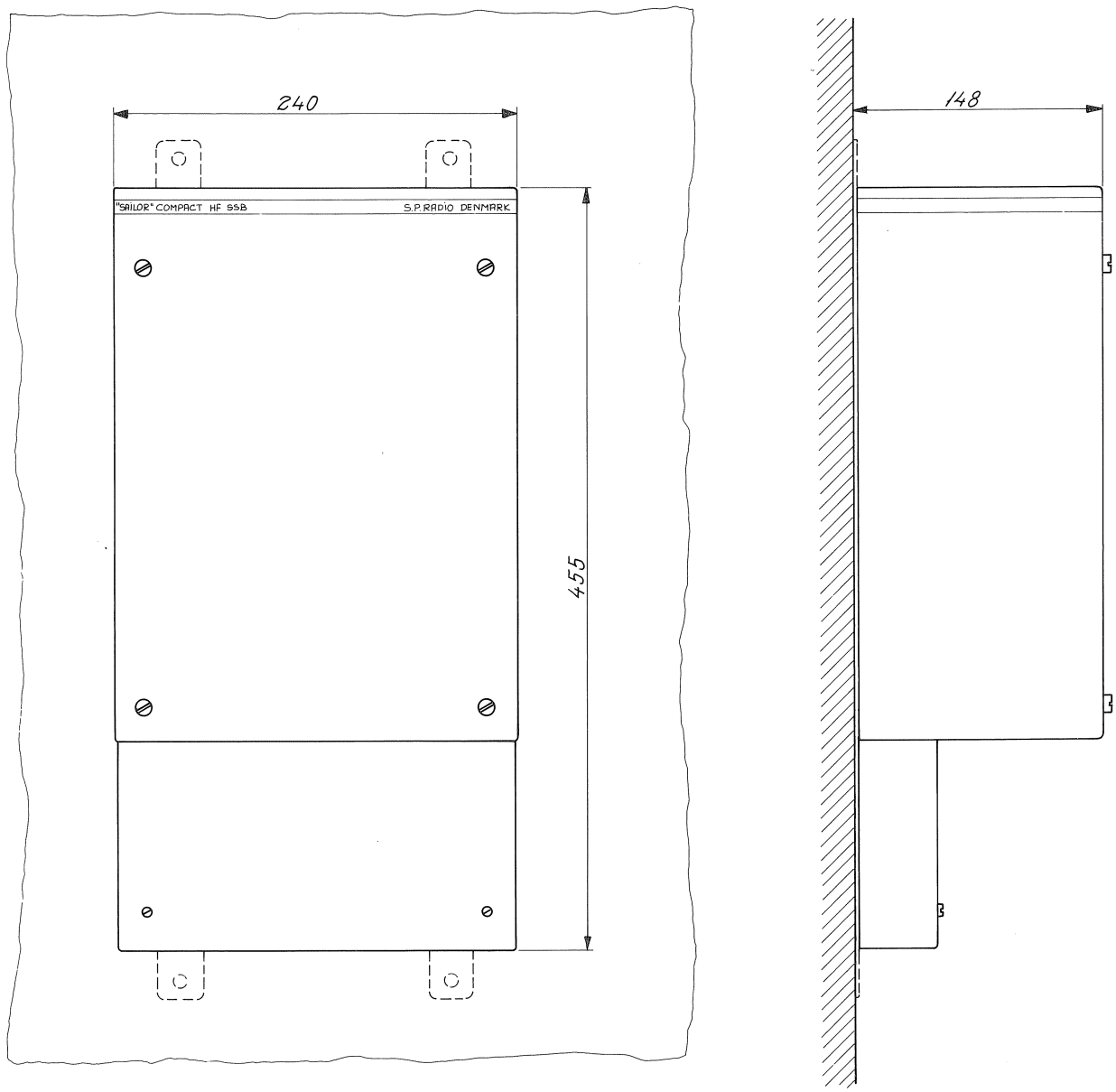
When the N2160 is switched on or restarts the output voltage will rise slowly in soft start mode.



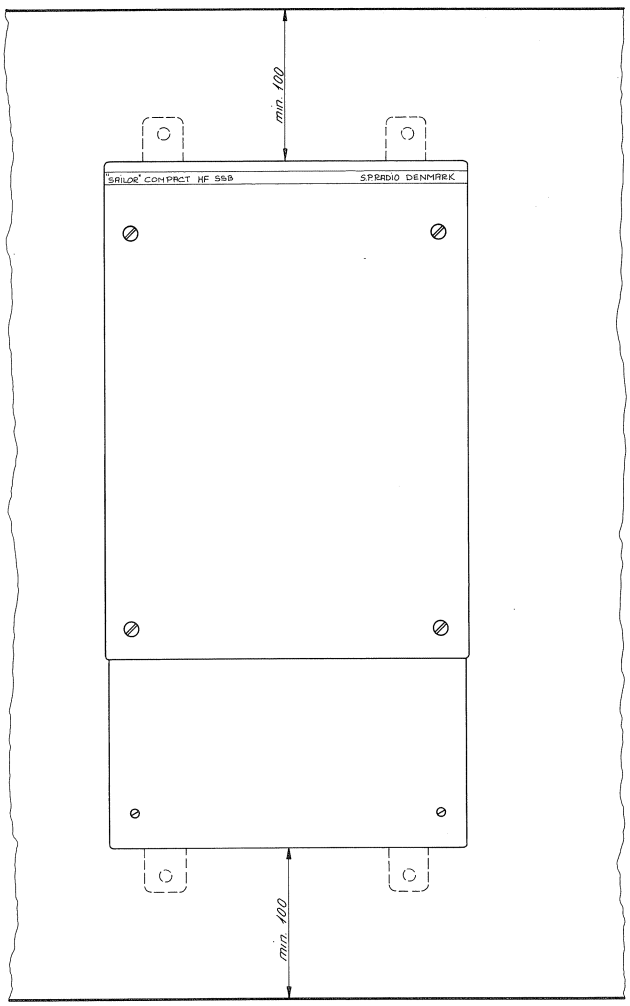
CONTENTS

2. INSTALLATION MECHANICAL HF SSB POWER SUPPLY N2160

2.1. MOUNTING POSSIBILITIES/DIMENSIONS AND DRILLING PLAN

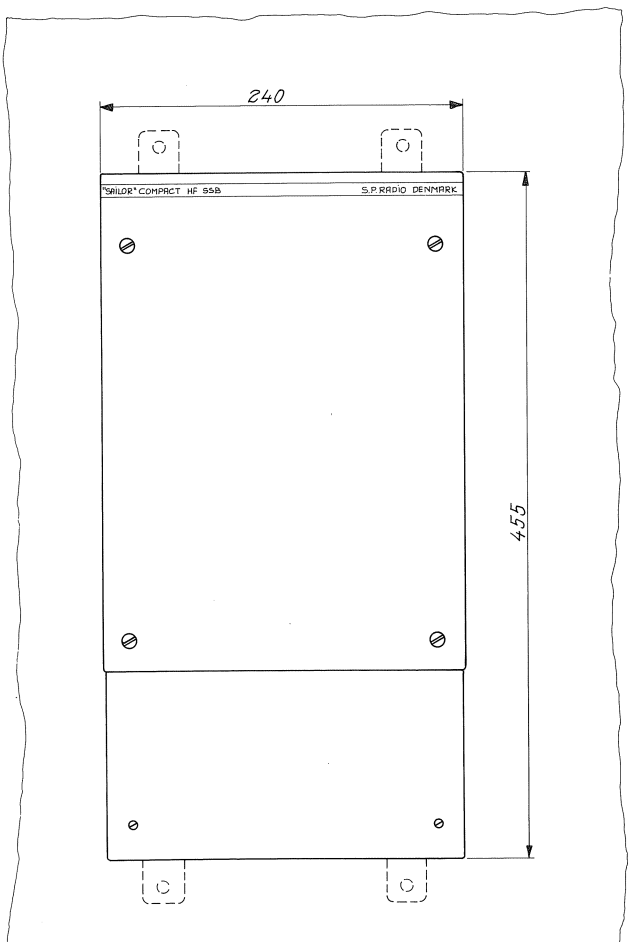


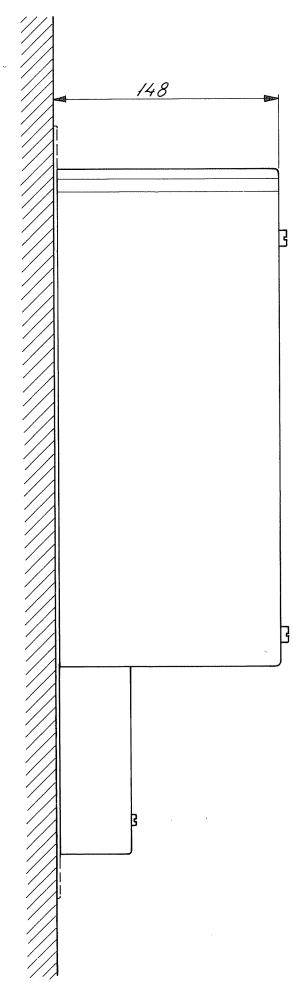
2.1. **MOUNTING POSSIBILITIES/DIMENSIONS AND DRILLING PLAN** cont.:



Free space for air circulation. Ambient temperature: Max. 40°C.
Weight N2160: 8.5 kg

Free space for air circulation and cable entry.





N2160 4-0-25891A 4-0-25980

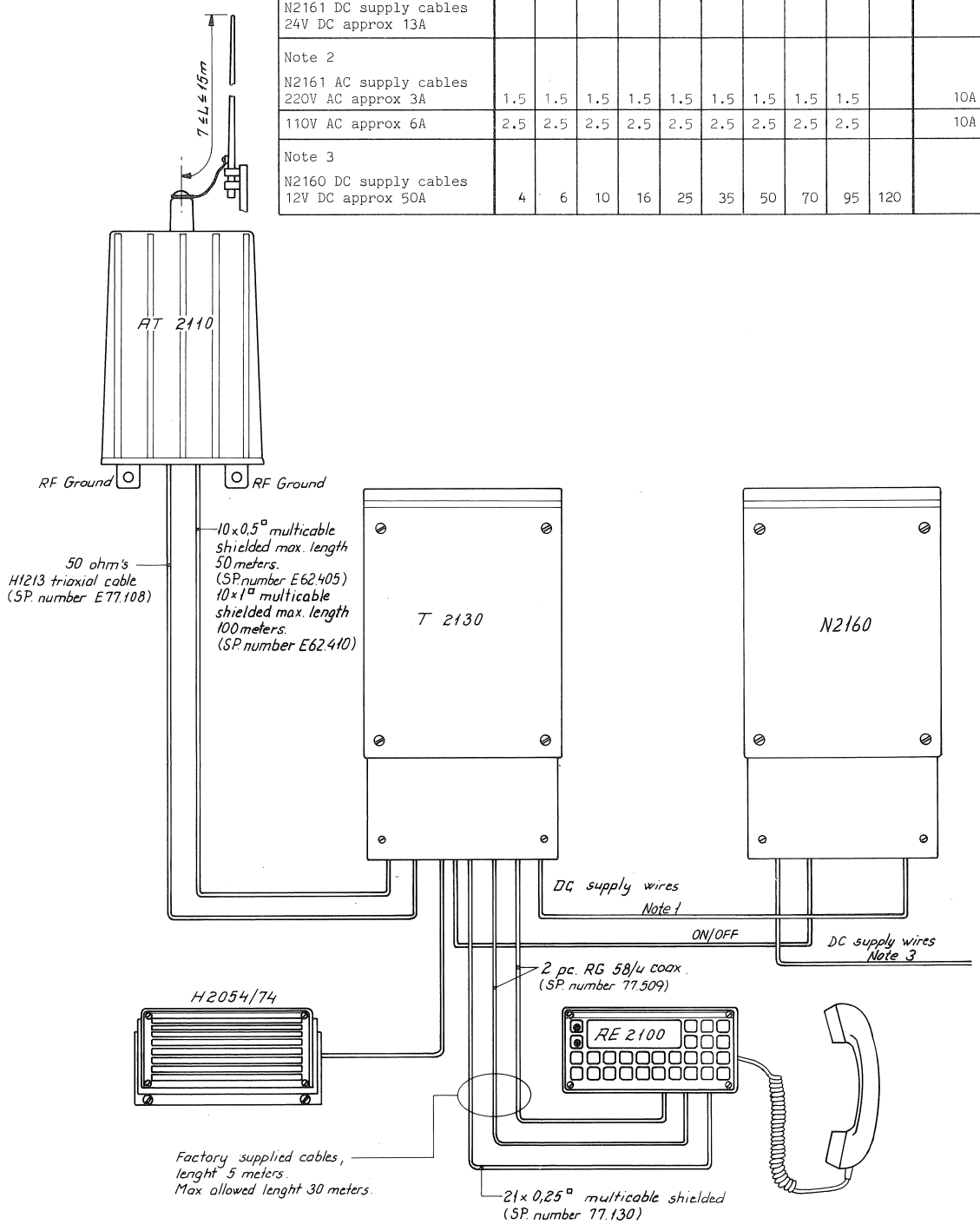
2.2. ELECTRICAL CONNECTION

2.2.1. MAIN CABLE PLAN WHEN CONNECTED TO TRANSMITTER T2130

Note 1, 2 and 3

Distance/cable dimensions table

Distance in meters	1.3	2	3.2	5	8	10	13	16	24	34	Mains fuse
Copper cable dimensions in mm^2											
Note 1 T2130 DC supply cables 24V DC approx 13A and N2161 DC supply cables 24V DC approx 13A	1.5	2.5	4	6	10	10	16	16	25	35	
Note 2 N2161 AC supply cables 220V AC approx 3A	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5		10A
110V AC approx 6A	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5		10A
Note 3 N2160 DC supply cables 12V DC approx 50A	4	6	10	16	25	35	50	70	95	120	

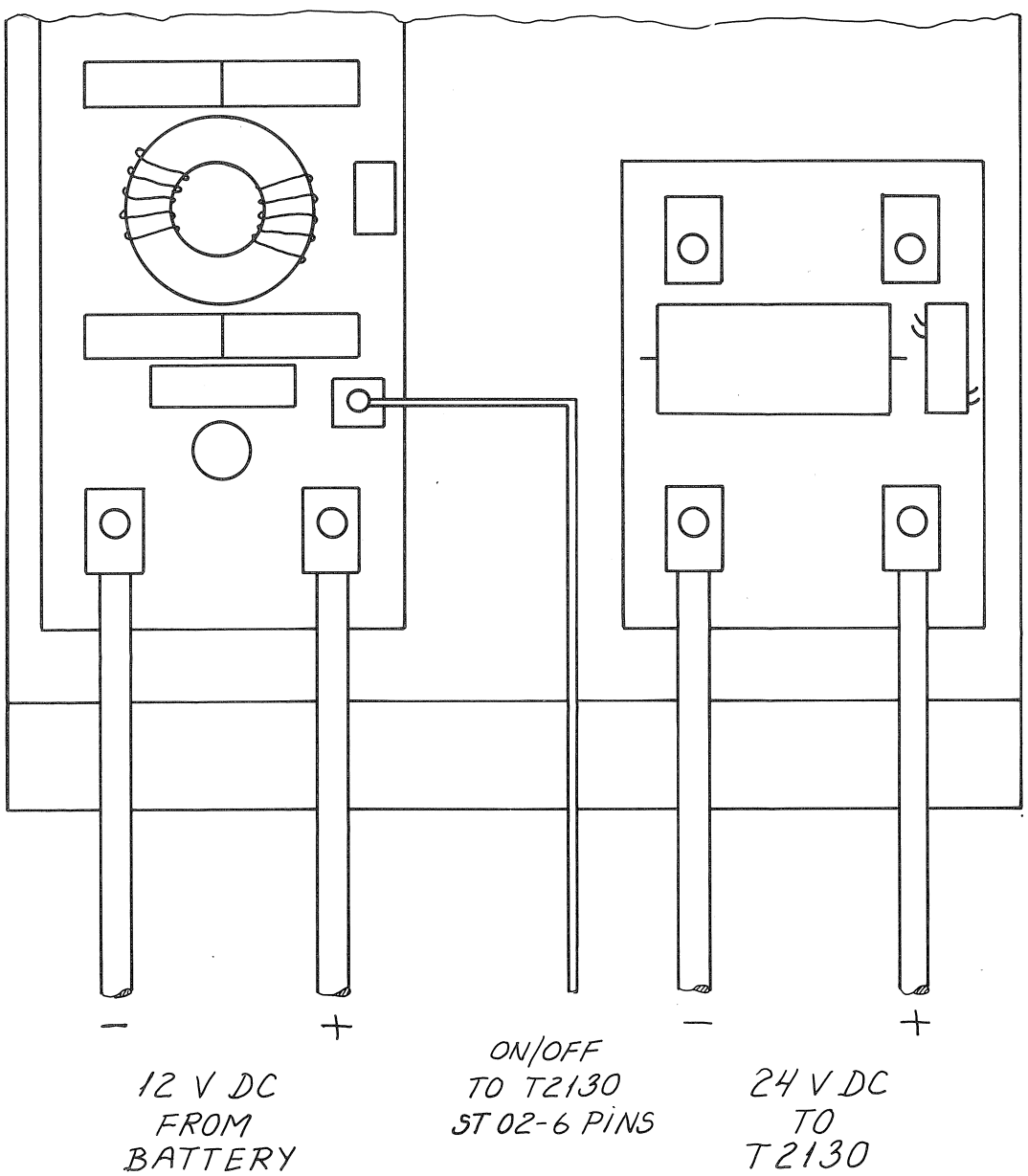


2.2.2. CONNECTIONS TO N2160

Note 1, 2 and 3

Distance/cable dimensions table

Distance in meters	1.3	2	3.2	5	8	10	13	16	24	34	Mains fuse
Copper cable dimensions in mm^2											
Note 1 T2130 DC supply cables 24V DC approx 13A and N2161 DC supply cables 24V DC approx 13A	1.5	2.5	4	6	10	10	16	16	25	35	
Note 2 N2161 AC supply cables 220V AC approx 3A	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5		10A
110V AC approx 6A	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5		10A
Note 3 N2160 DC supply cables 12V DC approx 50A	4	6	10	16	25	35	50	70	95	120	



CONTENTS

3. SERVICE

3.1. MAINTENANCE

When the SAILOR N2160 has been correctly installed, the maintenance of the power supply can, dependent on the environments 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 section 3.4. PERFORMANCE CHECK.

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 3.5 NECESSARY CHECK AFTER REPAIR.

3.2. RECOMMENDED TEST EQUIPMENT

Multimeter ..... Philips PM2505
Oscilloscope ..... Philips PM3214

3.3. TROUBLE SHOOTING

Trouble shooting, repair, and check of N2160 should only be performed by persons, who have sufficient technical knowledge and the necessary test equipment at their disposal.

1. The output voltage is too high:
   a. The control voltage wire between the step-up converter and the control unit is broken.
   b. The +24V wire between the control unit and the output filter unit is broken.

2. The output voltage is too low:
   a. The N2160 is overloaded. Max. output current is 18 Amp.
   b. A step-up converter is out of order.

3. The output voltage is approx. equal to the input voltage, which means that the step-up converters are not working:
   a. The input voltage is too low. It has to be above 10.8V.
   b. The on/off circuit is out of order.
   c. Fault in the relay RE1-2.
   d. Fault in the Control Unit (module 2).
   e. A fuse in a step-up converter is blown out. Check that the power MOSFET Q5-3, Q6-3, and the diode D15-3 are not short-circuited.

Some faults require that each module can be checked separately. To check the Control Unit (module 2) only, all three fuses on the step-up converter are removed. The on/off terminal PO3-1 is connected to -24V DC output terminal PO4-4 to switch on the control unit. Some measurements can now be done, but notice, that the voltages on the diagramme do not correspond to this case.
To check one step-up converter only, the fuses can be removed from the two other step-up converters. To switch on the step-up converter in question and the control unit, it is necessary to cancel the fuse supervising circuit in the control unit. This can be done by connecting a wire from -24V DC (e.g. the anode of D4-2) to the base of Q2-2 (connected to R14-2). Some measurements can now be done on the step-up converter. One step-up converter can handle a load up to 7A.

3.4. PERFORMANCE CHECK

Any value, which differs too much from the values given in this chapter, should lead to a repair of the circuit or module in question.
Hints to locate some faults are given in the chapter 3.3. TROUBLE SHOOTING.

1. Connect a power supply, which can be adjusted from 8 - 10.8V DC, to the input terminals of N2160.

2. Connect a small dummy load of approx. 330 ohm/4W to 24V DC output terminals of N2160 to get a proper regulation.

3. Connect the on/off terminal PO3-1 to the -24V DC output terminal PO4-4 to switch on the N2160.

4. Connect a voltmeter across the output terminals of N2160.

5. Adjust the input voltage to 8.0V DC and check that the N2160 is shut down and cannot be switched on. That is, the output voltage is 7.5V DC.

6. Adjust the input voltage to 10.8V DC and check that the N2160 can be switched on. Read the output voltage to 27.5V DC $\pm$3.5V.

7. Connect the N2160 to a 12V DC power supply, which is able to deliver approx. 60 Amp. E.g. a 12V battery can be used.

8. Connect the output of N2160 to a dummy load of 1.55 ohm. The dummy load can be made by parallelling several power resistors so it can handle up to 600 W.

9. Connect a voltmeter across the 24V DC output terminals of N2160 and read the voltage to be approx. 1V less than under point 6, while the N2160 is switched on. If the N2160 is switched off, the output voltage is approx. 1V less than the input voltage because of the diode D15-3 on the step-up converters.

10. Connect a scope across the 24V DC output terminals of N2160. Check that the output ripple voltage is less than 0.3Vpp (without the voltage spikes), while the N2160 is switched on with full load.

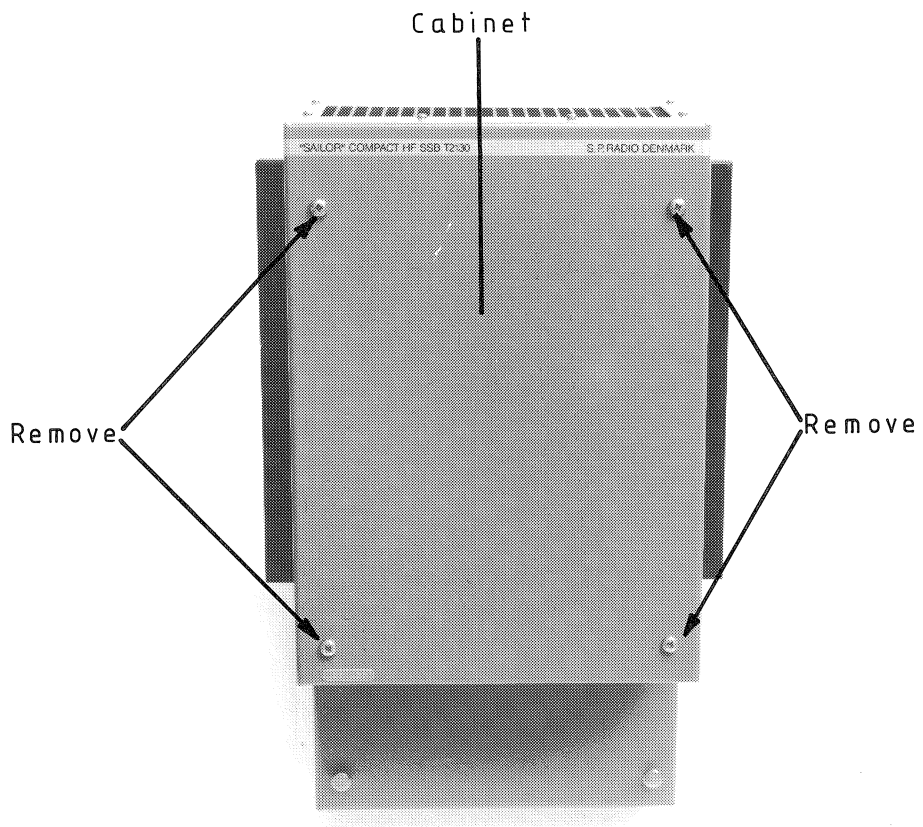
3.5. NECESSARY CHECK AFTER REPAIR

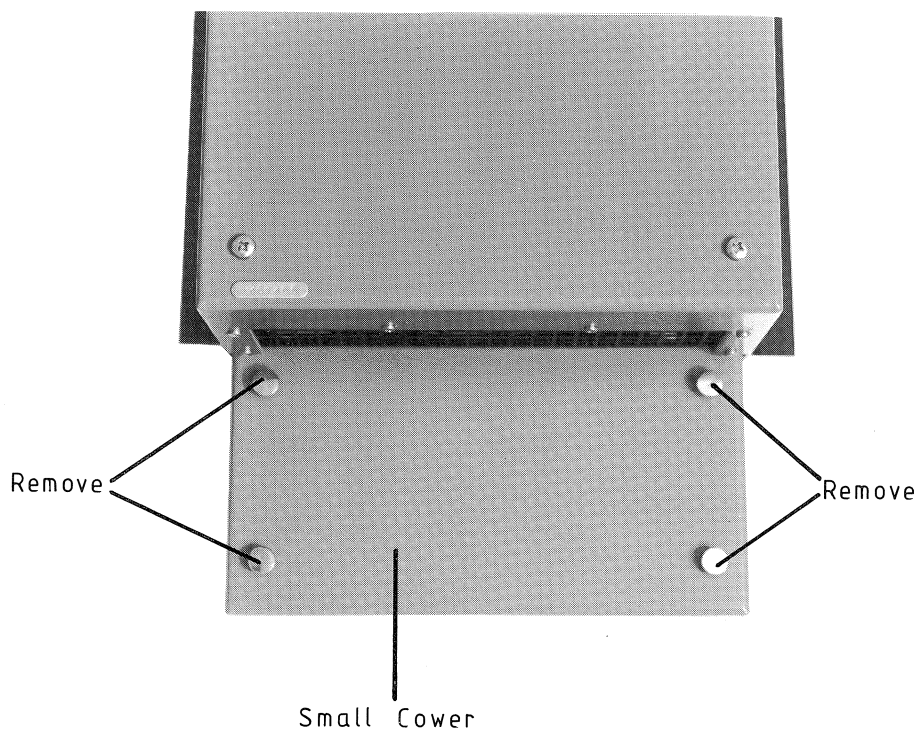
There is no adjustments at all, but any repair or change of modules should be followed by a performance check. See the chapter 3.4. PERFORMANCE CHECK.

To check that all three step-up converters are working, connect a scope across the power FETs Q5-3 and Q6-3. Check that all three step-up converters produce approximately the same drain-source switching voltage (see the diagramme for the step-up converter).

At full load of 18A at the output, the output ripple voltage is less than 0.3Vpp (without voltage spikes) if all step-up converters are correct working.

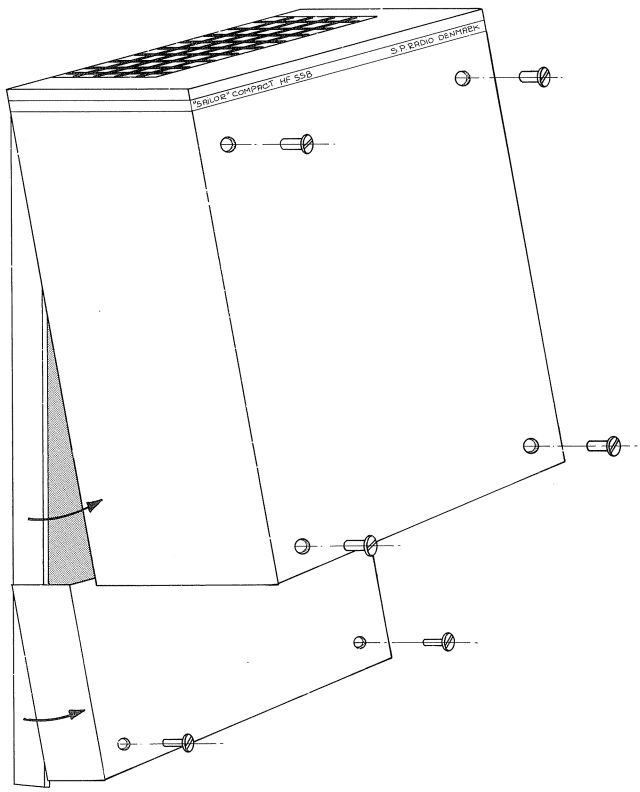
CONTENTS

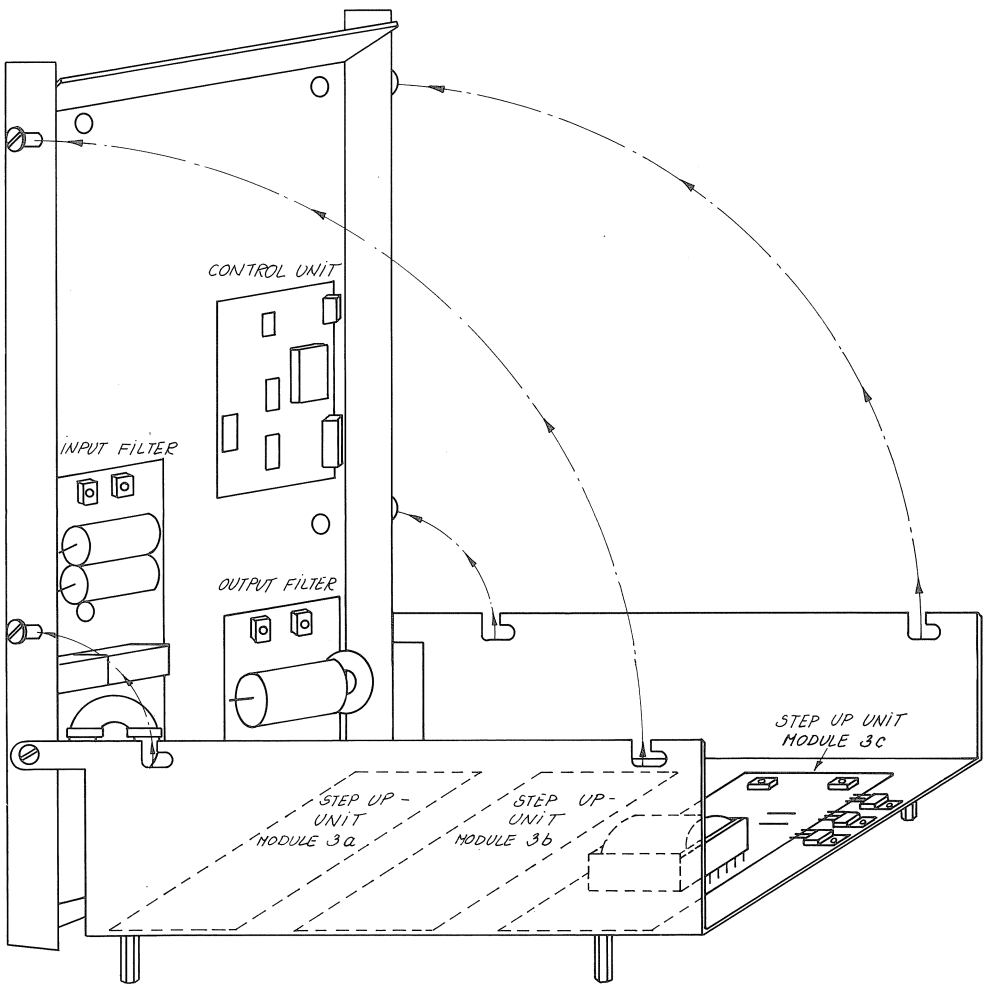




N2160 FOTO NR. 50 995, 50 996
4-6-26047

4. MECHANICAL DISASSEMBLING AND MODULE LOCATION N2160





MECHANICAL DISASSEMBLING AND MODULE LOCATION N2160

N2160 4-0-26155 4-0-25892

CONTENTS

5. CIRCUIT DESCRIPTION

5.1. INPUT FILTER (MODULE 1)

The capacitors and the transformer TR1-1 are a noise reducing lowpass filter. The capacitors C9-1 and C10-1 are the low frequency energy reservoir.

5.2. CONTROL UNIT (MODULE 2)

CLOCK PULSE CIRCUIT
The U1-2 is an astable multivibrator circuit where the oscillating frequency is determined by resistor R10-2 and capacitor C5-2 to approx. 150 kHz. This signal is led to the gate of U2-2. This is a 5-stage divide-by10 Johnson counter with 10 decoded outputs. This integrated circuit produces the three 50 kHz pulses with 120 degrees phase shift.
The three clock signals are buffered by U3-2 and sent to the step-up converters.
Resistor R5-2, capacitor C2-2, and diode D5-2 are the power supply for U1-2 and U2-2.

CONTROL VOLTAGE
The output voltage is sensed by the Op-Amp. U4-2 via resistor R7-2 and resistor R8-2 and compared with the 6.2V reference voltage made by resistor R9-2, capacitor C3-2, and diode D5-2. The error signal is amplified by Op-Amp. U4A-2 and transferred to the control voltage output via the resistors R17-2 and R19-2.
Resistor R19-2 together with the capacitor C8-2 is a lowpass filter to reduce the noise sensitivity of the control voltage wires, and to prevent signals from one step-up converter to another.
The capacitor C5-2, resistor R16-2, and resistor R15-2 are the feed-back circuit for the Op-Amp. U4A-2.
The resistor R4-2, together with capacitor C1-2 and D4-2, are the 13V power supply for the U4-2.

UNDERVOLTAGE SENSE
The Op-Amp. U4B-2 is connected as a Schmitt trigger with a 0.8V hysteresis. Op-Amp U4B-2 senses the input voltage via resistor R3-2 and resistor R13-2. If the input voltage is lower than approx. 9.8V, and the N2160 is not operated, the output of Op-Amp. U4B-2 is high. If the input voltage comes below 9.0V and the N2160 is operated, the output goes high too. Otherwise the output is low.
The high output voltage from Op-Amp. U4B-2 turns on the transistor Q2-2 via resistor R14-2. When transistor Q2-2 is turned on, the control voltage output is forced low and all the step-up converters stop.
The diode D3-2 protects the input of Op-Amp. U4B-2 against input voltage transients.

FUSE SUPERVISION

If any of the three fuse inputs are high, the diodes D9-2, D10-2, and D11-2 will turn on transistor Q2-2 and stop the N2160. The resistors R20-2, R22-2, and R24-1 are pull-up resistors in case of broken fuse signal wires. The capacitor C7-2 is used to remove noise.

SOFT START

When transistor Q2-2 turns off, the diode D8-2 and capacitor C6-2 work as a slow rise or soft start of the control voltage. The resistor R5-2 protects transistor Q2-2 against high current when transistor Q2-2 goes ON and discharges the soft start capacitor C6-2.
N2160 can be switched on/off by means of the relay RE1-2 and transistor Q1-2. The on/off wire is via the Input Filter (module 1) connected to T2130 and RE2100. Thus the N2160 is switched on/off by means of the RE2100 on/off button. However, even if the N2160 is switched off, there is still 12V battery voltage at the output of the N2160.

5.3. STEP-UP CONVERTER (MODULE 3)

Transistor Q5-3 and transistor Q6-3 are the output transistors. When they are conducting, energy is taken from the input supply voltage and stored in the inductor L1. When the output transistors stop conducting, the energy is transferred through diode D15-3 to the output capacitor C10-3. The output voltage depends on the on/off ratio of the output transistors. This ratio is controlled by the PWM regulator U2-3. This integrated circuit contains all the necessary features to make a PWM (Pulse Width Modulated) switch mode regulator.

The switch frequency is controlled by an external clock of approx. 50 kHz. This 5V clock signal comes from the Control Unit (module 2). The clock signal is shaped by the Schmitt trigger NAND gate U1B-3 and a well defined pulse is produced by the one-shut connection NAND gates U1A-3, U1D-3, U1C-3, and capacitor C1-3, diode D2-3, and resistor R1-3. This pulse with a duration of approx. 5 uS is then connected to the oscillator output of the PWM regulator U2-3 via resistor R3-3 and transistor Q1-3. This external clock overrides the clock produced by the PWM regulator U2-3, and furthermore it limits the maximum ON time of the output transistors to approx. 15 uS.

If the clock input is floating or is shorted to GND the internal clock of the PWM regulator U2-3 takes over with a frequency of approx. 45 kHz.
Diode D1-3 is a clock input protection diode.

Pin 16 on the PWM regulator U2-3 is a 5V voltage reference with a bypass capacitor C3-3.

The capacitor C2-3 and the resistor R4-3 are used by the PWM regulator U2-3 to produce a ramp voltage. This ramp voltage is internally compared with an error voltage by a comparator. This comparator controls the output on/off ratio via some flip-flops.

The output is on U2-3 pin 12/13. The error voltage comes from two internal Op-Amps. One is used as a current error amplifier, input pin 4 and 5. The other is used as a voltage error amplifier input, pin 1 and 2.

The voltage error amplifier in the PWM regulator U2-3 senses the current running in the output transistors by the resistors R19-3 to R22-3 via the resistor R18-3 and compares it with a control voltage from the control unit via resistor R2-3. If the current is too high compared to the control voltage, then the ON time for the output transistors is reduced. If the current is too small, the ON time is increased. Because of this current regulation it is easy to achieve current sharing between the three step-up converters.

The R5-3/R7-3 and R6-3/R18-3 resistor-connection are a DC offset of the voltage error amp.

The capacitor C5-3 and the resistor R12-3 are the feedback circuit for the voltage error amplifier.

If the control voltage input is left floating or shorted to GND, the converter stops automatically. The output current is told to be less than zero.

The current error amplifier has a built-in 200 mV offset. It senses the current via the lowpass filter of resistor R13-3 and capacitor C7-3. If the mean output current is higher than approx. 20 Amp., the converter starts current limiting.

Diodes D8-3, D9-3 and capacitor C6-3 are the soft start circuit.
The on board power supply is a standard series regulator connection consisting of transistor Q3-3, capacitors C8-3, C9-3, diodes D10-3, D11-3, and resistor R15-3. It delivers the supply voltage for the PWM regulator U2. This on board supply protects the PWM regulator U2-3 against input voltage transients.

The reference voltage from the PWM regulator U2 is used as supply for IC U1-3.

In the PWM regulator U2-3 there is an undervoltage lock-out with a threshold level of typ. 5.2V. This level is raised by the diodes D4-3 and D5-3 to approx. 6.6V to ensure that there is sufficient supply voltage to get a proper drive voltage to the output transistors. This function is only in action in case of failure in the control unit.

The output of the PWM regulator U2-3 are two NPN transistors. The resistor R11-3 is the common emitter resistor. It limits the base current to transistor Q2-3. The common collector drives a Baker clamped transistor Q2-3 via the diodes D6-3 and D7-3. Resistor R10-3 ensures a fast turn off of transistor Q2-3.

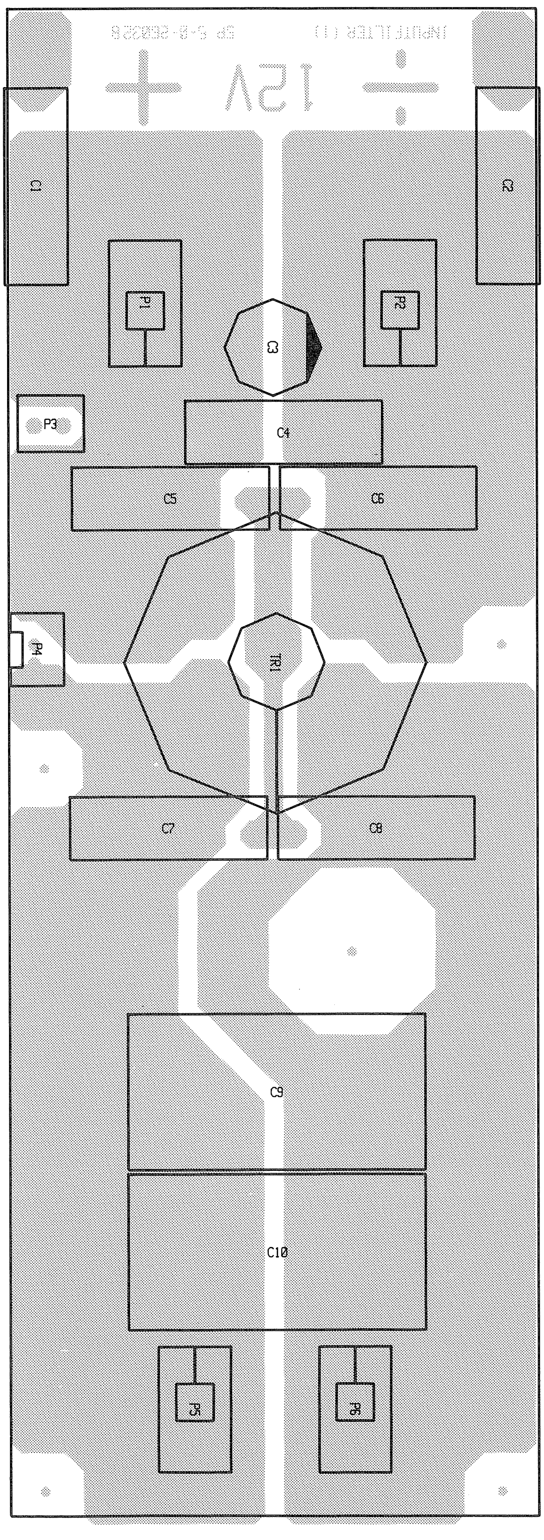
The output signal is then led to the output transistors Q5-3 and Q6-3 by diode D12-3 and resistor R16-3 or resistor R17-3. Resistor R16-3 or R17-3 together with the input capacitance of the MOSFETs slows down the rise times to reduce noise. The transistor Q4-3 together with the resistor R14-3 are used to get a proper turn off of the transistors Q5-3 and Q6-3. The zener diodes D13-3 and D14-3 protect the gates against voltage transients.
R23-3 and C11-3 are a noise reducing snupper circuit.

Diode D3-3 protects against reverse polarity of the supply voltage. In such case the fuse F1-3 is blown.

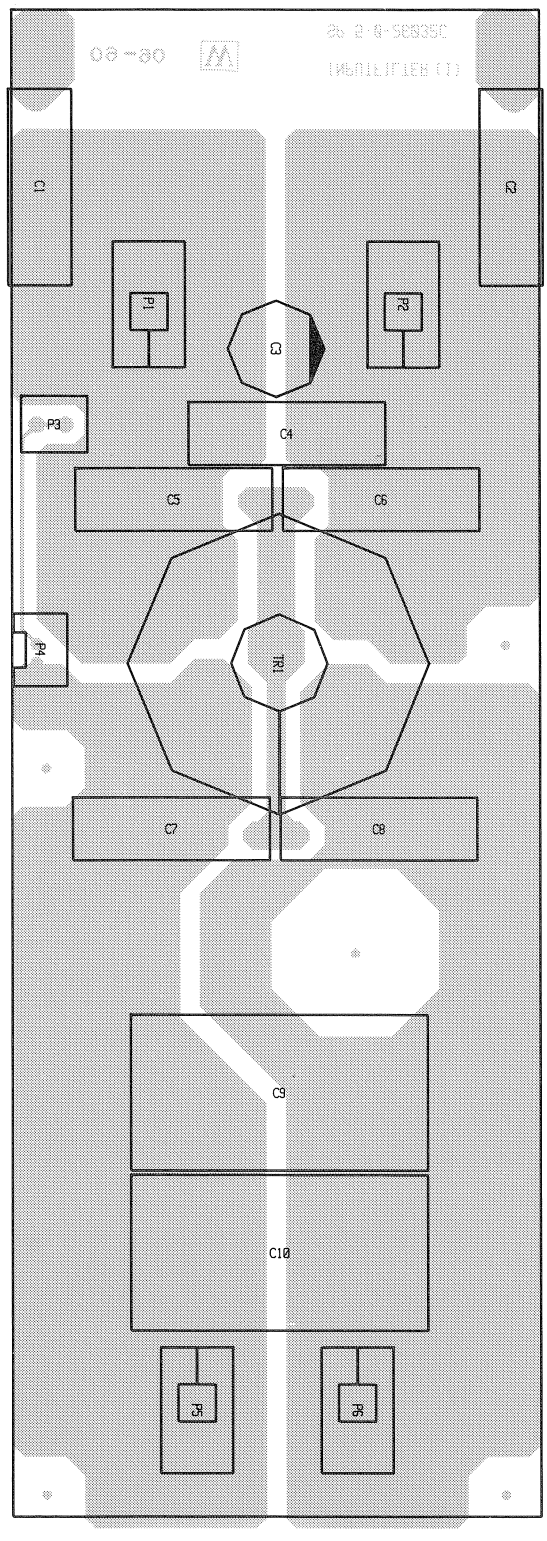
5.4. OUTPUT FILTER (MODULE 4)

The common output from the three step-up converters is filtered by inductor L1-4 and capacitor C1-4. The inductor L1-4 is used for limiting the high frequency ripple current in the output capacitor C1-4.

COMPONENT LOCATION INPUT FILTER (MODULE 1)

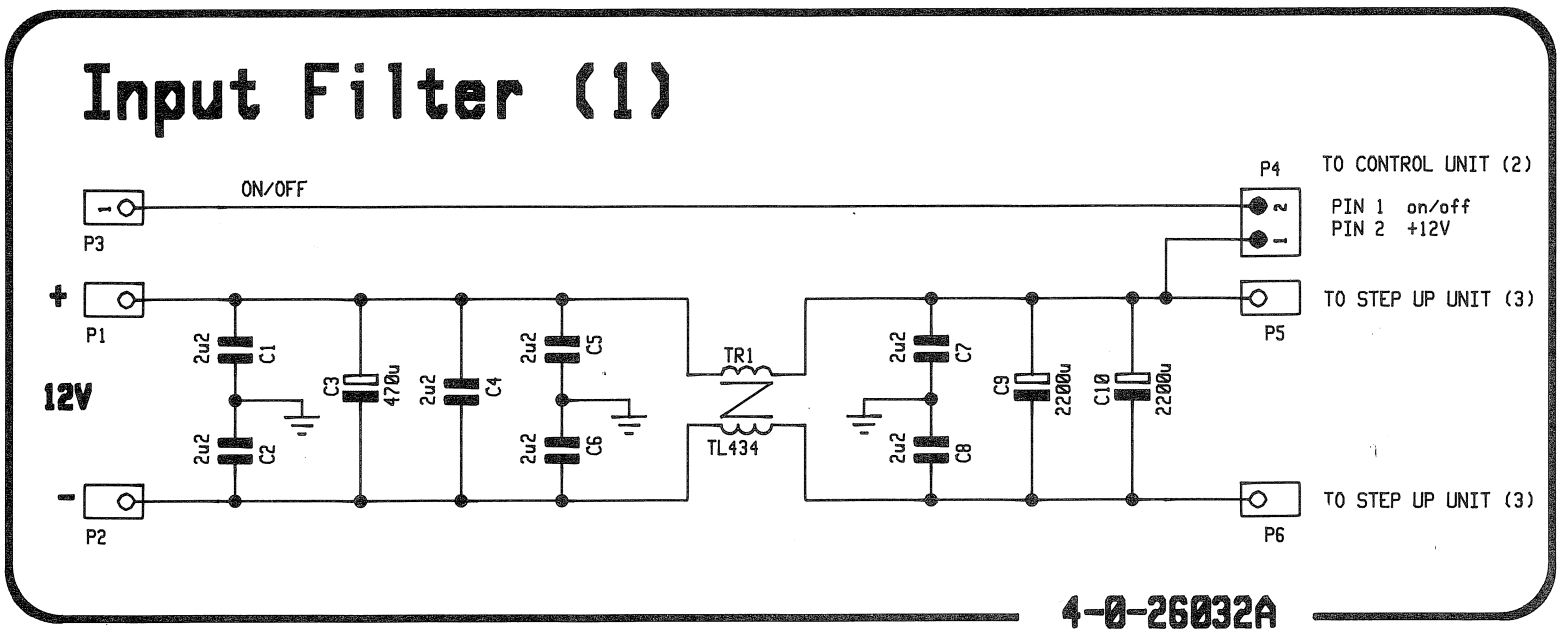


Seen from component side with upper side tracks



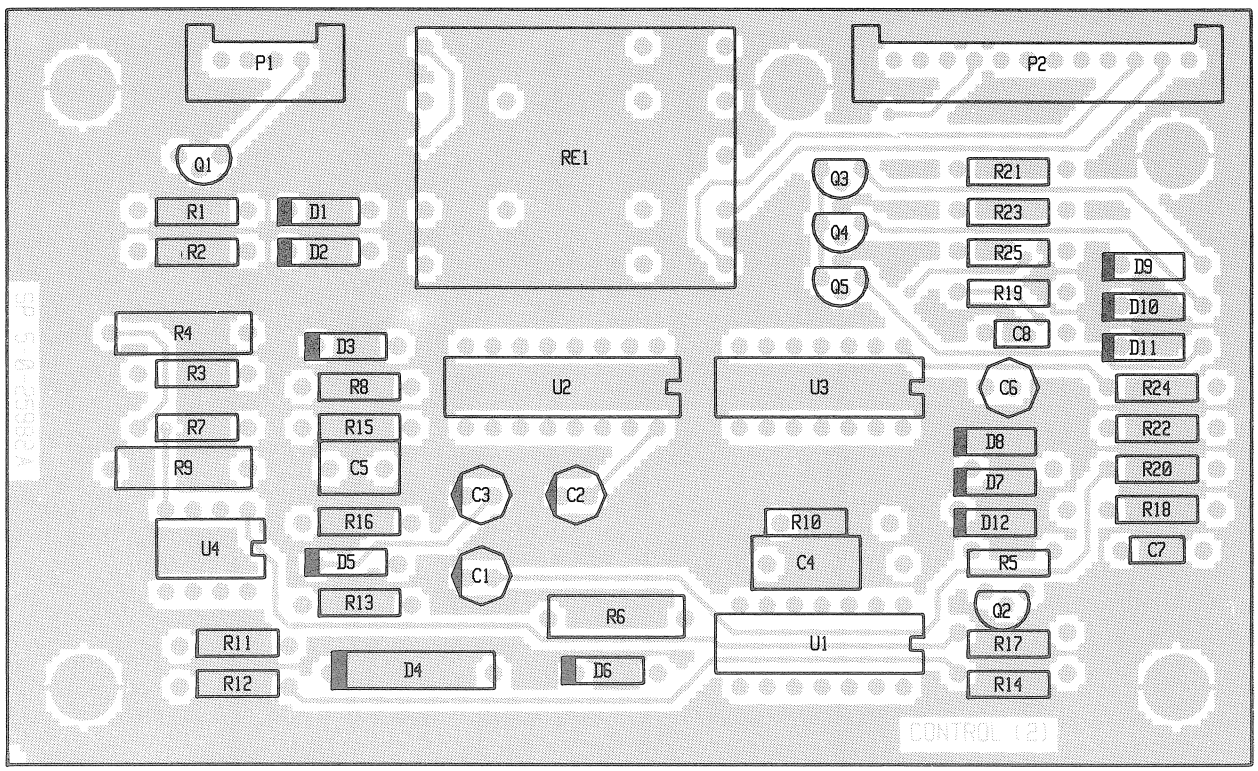
Seen from component side with lower side tracks

N2160 4-6-26032



INPUT FILTER 1

COMPONENT LOCATION CONTROL UNIT (MODULE 2)



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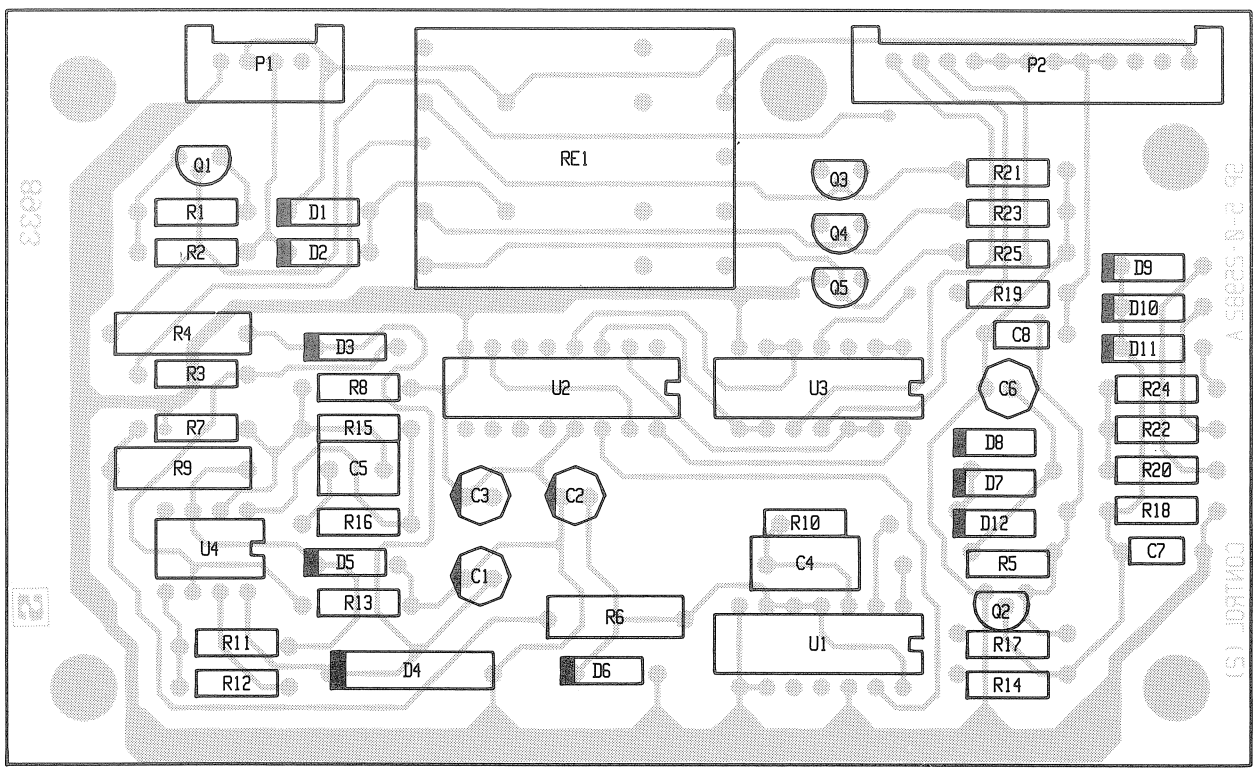
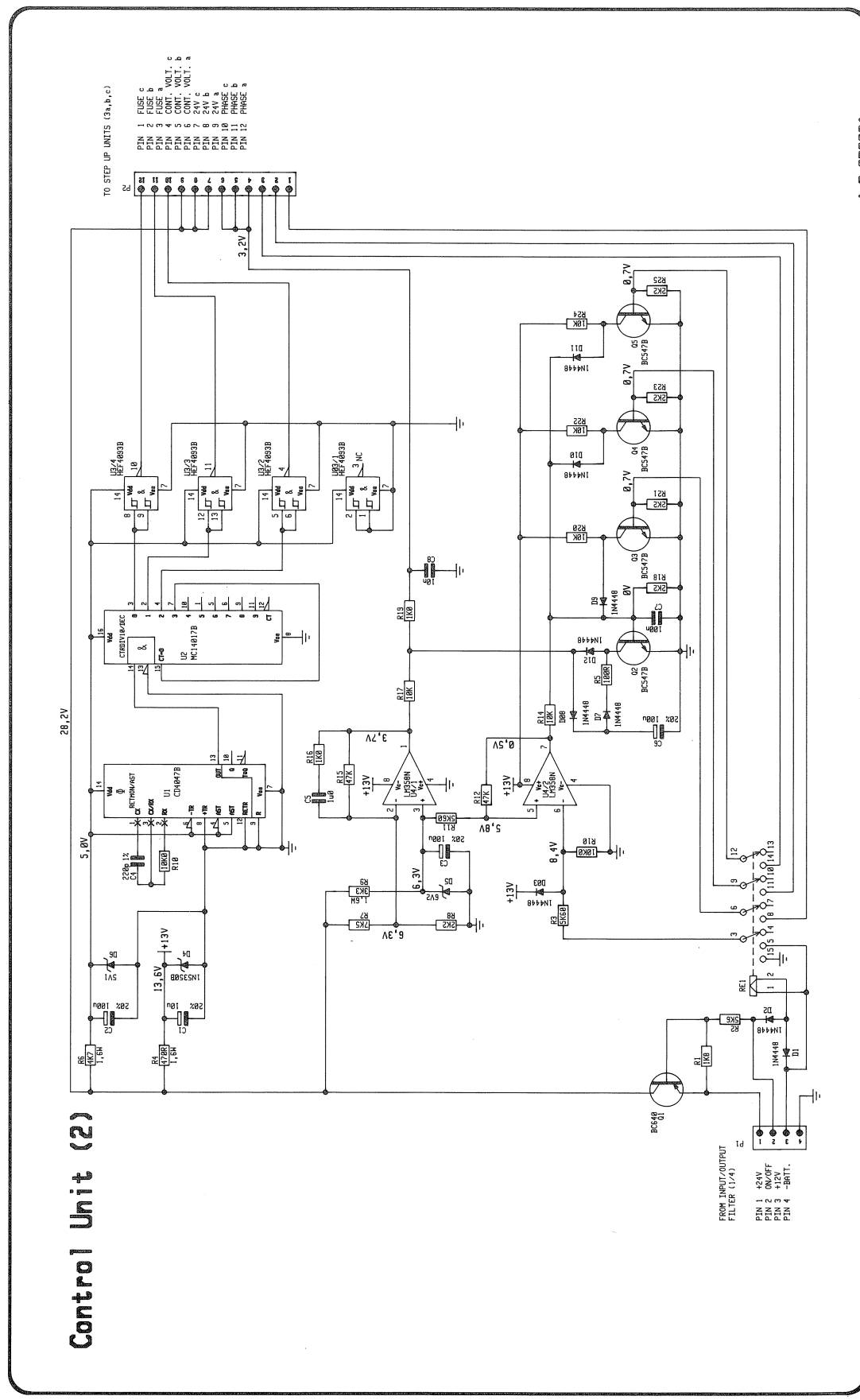
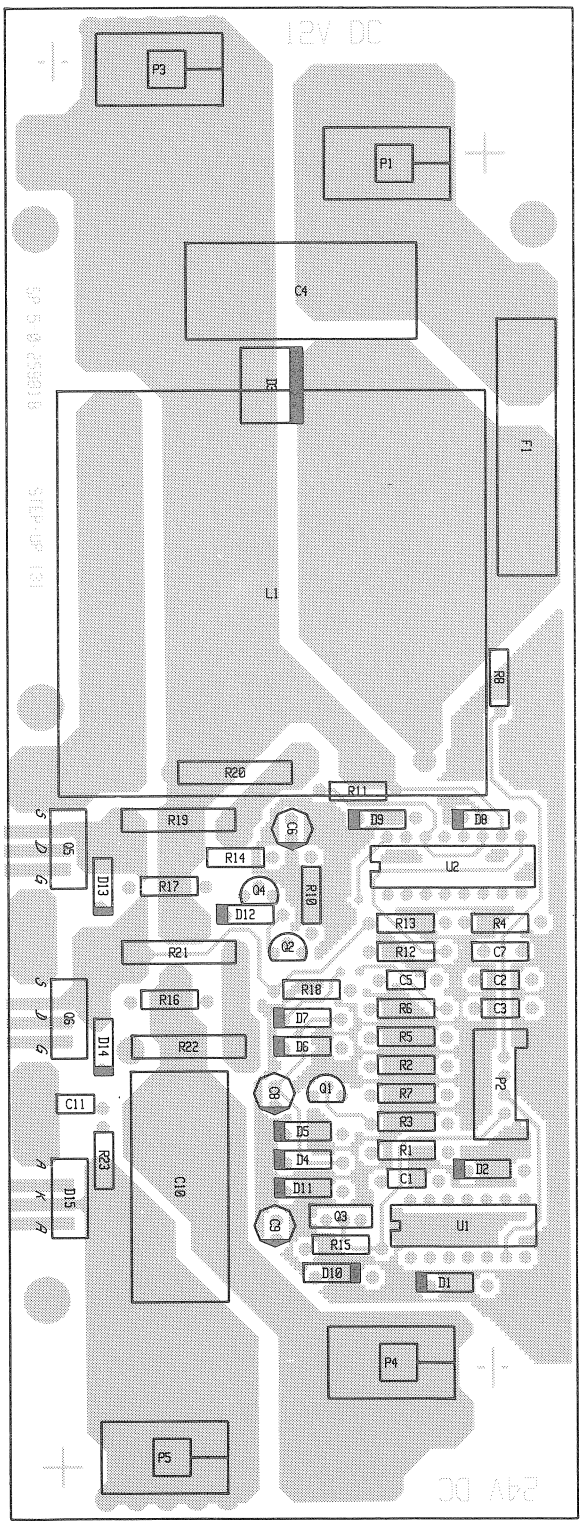


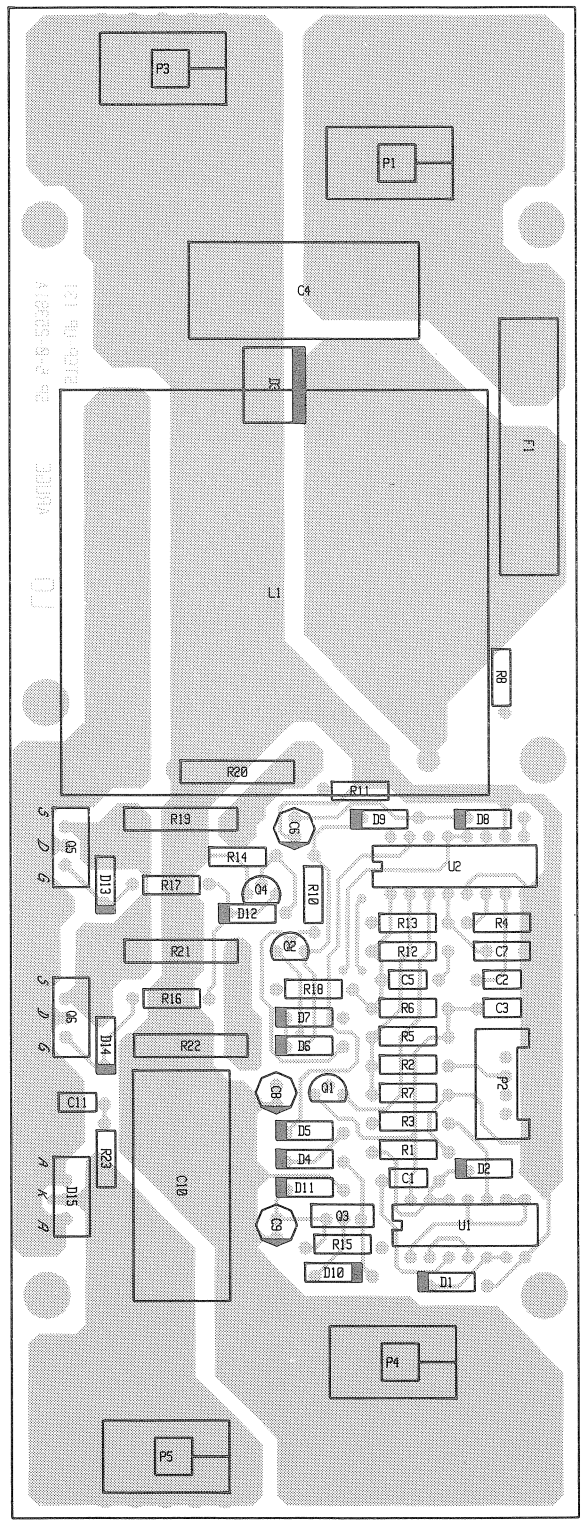
Seen from component side with lower side tracks


Control Unit (2)
4-0-25982A
TO STEP UP UNITS (3a,b,c)
PIN 1 FUSE c
PIN 2 FUSE b
PIN 3 FUSE a
PIN 4 CONT. VOLT. c
PIN 5 CONT. VOLT. b
PIN 6 CONT. VOLT. a
PIN 7 24V c
PIN 8 24V b
PIN 9 24V a
PIN 10 PHASE c
PIN 11 PHASE b
PIN 12 PHASE a
3,2V
28,2V
5,0V
13,6V
6,3V
6,3V
3,7V
5,8V
0,5V
0,4V
0V
0,7V
FROM INPUT/OUTPUT FILTER (1/4)
PIN 1 +24V
PIN 2 ON/OFF
PIN 3 +12V
PIN 4 -BATT.

COMPONENT LOCATION STEP UP UNIT (MODULE 3)

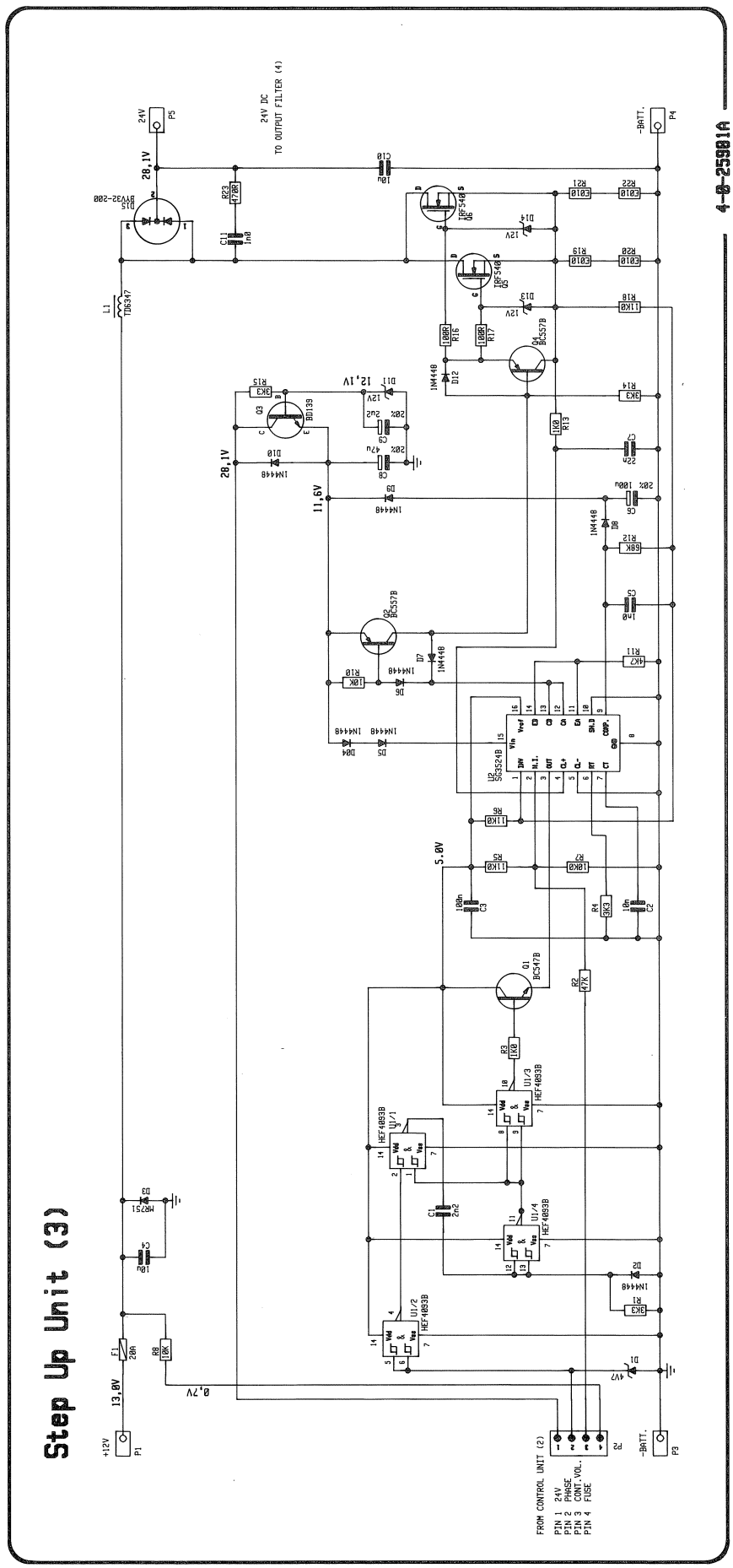


Seen from component side with upper side tracks

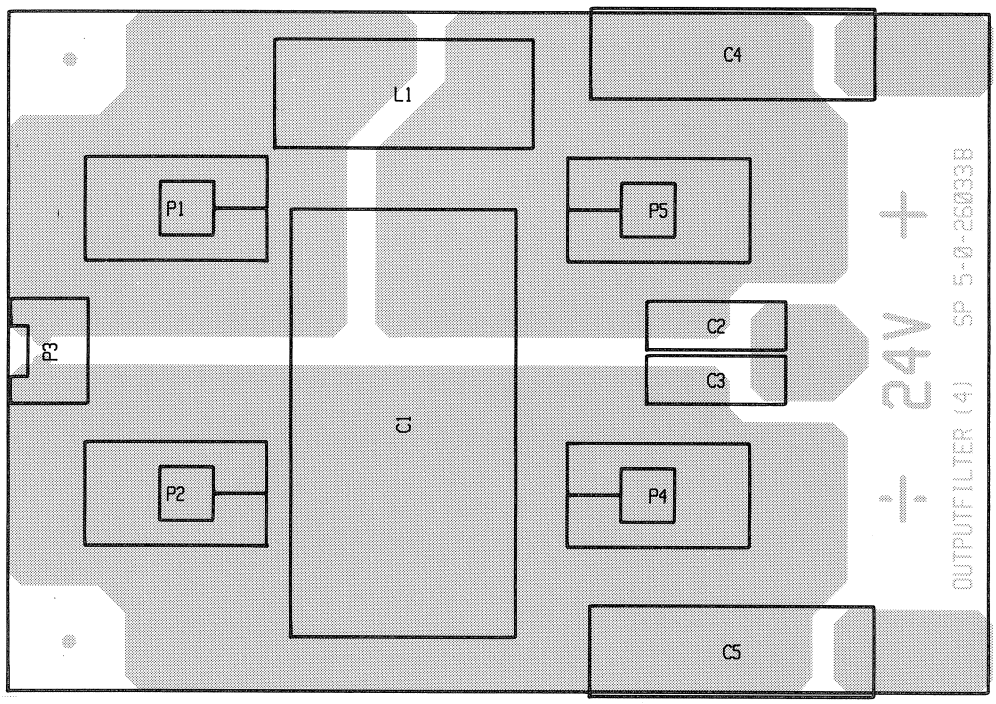


Seen from component side with lower side tracks

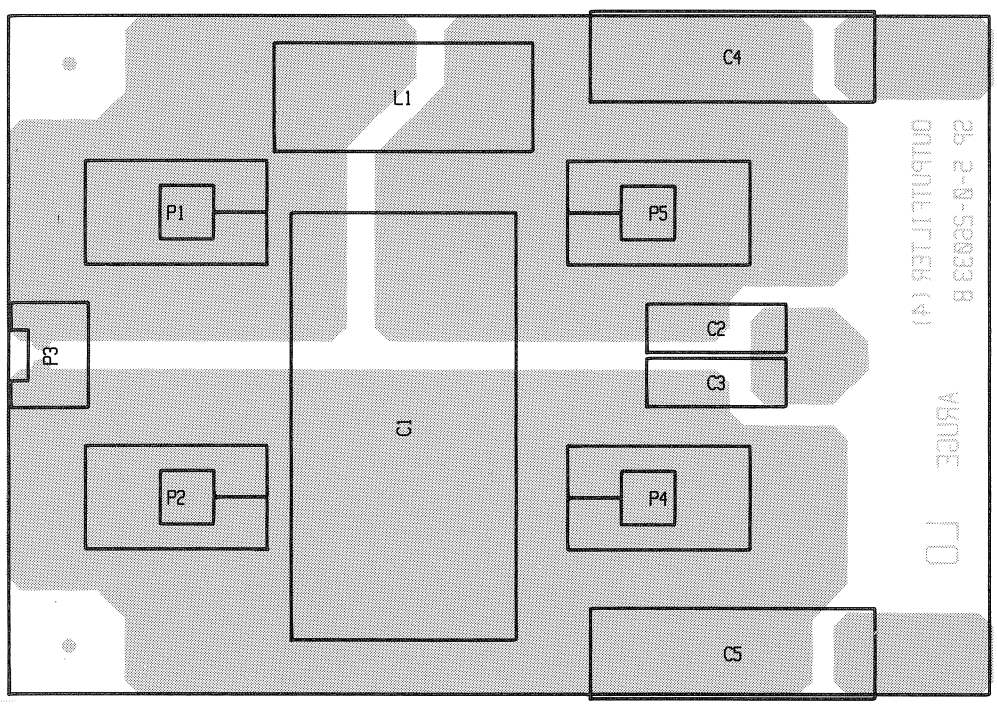
N2160 4-6-25981


Step Up Unit (3)
4-0-25981A
24V DC
TO OUTPUT FILTER (4)
FROM CONTROL UNIT (2)
PIN 1 24V
PIN 2 PHASE
PIN 3 CONT.VOL.
PIN 4 FUSE
+12V
-BATT.
28,1V
12,1V
11,6V
5,0V
0,7V
13,8V
4V7
SG3524B
HEF4093B
BC547B
BC557B
BD139
IRF540
1N4448
MR751
BYV32-200

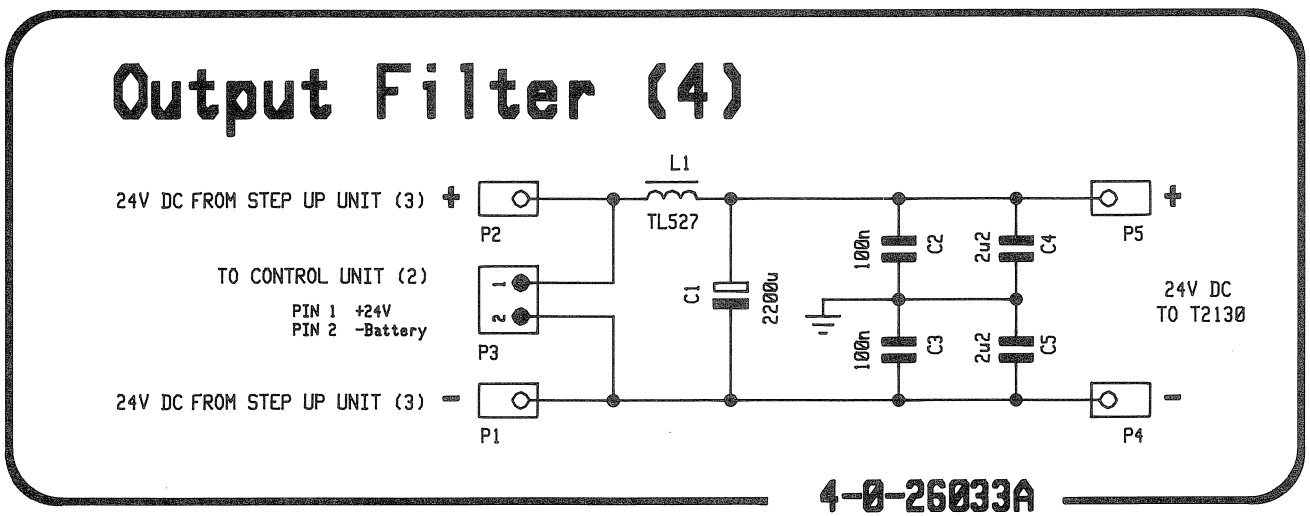
COMPONENT LOCATION OUTPUT FILTER (MODULE 4)



Seen from component side with upper side tracks



Seen from component side with lower side tracks



OUTPUT FILTER 4

CONTENTS

N2160 GRØN

POSITION	DESCRIPTION		MANUFACTOR	TYPE	S.P.NUMBER
	HF SSB N2160	POWER SUPPLY 12 to 24VDC	ESPERA	HF SSB N2160	802160
	MAIN HAIRNESS FOR N2160		ESPERA	3-0-26150	526150
-1	INPUT FILTER MODULE 1	N2160	ESPERA	5-0-26032C	626032
-2	CONTROL UNIT	FOR DC/DC KONVERTER N2160	ESPERA	5-0-25982B	625982
-3a	STEP-UP UNIT	DC/DC KONVERTER N2160	ESPERA	5-0-25981C	625981
-3b	STEP-UP UNIT	DC/DC KONVERTER N2160	ESPERA	5-0-25981C	625981
-3c	STEP-UP UNIT	DC/DC KONVERTER N2160	ESPERA	5-0-25981C	625981
-4	OUTPUT FILTER MODULE 4	N2160	ESPERA	5-0-26033C	626033

POSITION	DESCRIPTION		MANUFACTOR	TYPE	S.P.NUMBER
	INPUT FILTER MODULE 1	N2160	ESPERA	5-0-26032C	626032
VARIOUS	SCREW	M5x12 STEEL	HFC	HFC 473 FORZ.	87.413
C1-1	CAPACITOR POLYESTER	2.2uF 10% 100V	PHILIPS*	2222 344 25225	11.142
C2-1	CAPACITOR POLYESTER	2.2uF 10% 100V	PHILIPS*	2222 344 25225	11.142
C3-1	CAPACITOR ELECTROLYTIC	470uF -10/+50% 40VDC	PHILIPS*	2222 035 57471	14.650
C4-1	CAPACITOR POLYESTER	2.2uF 10% 100V	PHILIPS*	2222 344 25225	11.142
C5-1	CAPACITOR POLYESTER	2.2uF 10% 100V	PHILIPS*	2222 344 25225	11.142
C6-1	CAPACITOR POLYESTER	2.2uF 10% 100V	PHILIPS*	2222 344 25225	11.142
C7-1	CAPACITOR POLYESTER	2.2uF 10% 100V	PHILIPS*	2222 344 25225	11.142
C8-1	CAPACITOR POLYESTER	2.2uF 10% 100V	PHILIPS*	2222 344 25225	11.142
C9-1	CAPACITOR ELECTROLYTIC	2200uF-10/+50% 40V	ERO*	EG 00 MG 422 G	14.720
C10-1	CAPACITOR ELECTROLYTIC	2200uF-10/+50% 40V	ERO*	EG 00 MG 422 G	14.720
P1-1	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
P2-1	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
P3-1	SUPPLY TERMINAL BLOCK	1 POLE	RIACON	00247	81.028
P4-1	PLUG	2 POLES	AMP	0-826375-2	78.102
P5-1	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
P6-1	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
TR1-1	CHOKE	TL434	B.B.ELEKTRONIK	6-0-24569D	400434

POSITION	DESCRIPTION		MANUFACTOR	TYPE	S.P.NUMBER
	CONTROL UNIT	FOR DC/DC KONVERTER N2160	ESPERA	5-0-25982B	625982
C1-2	CAPACITOR ELECTROLYTIC	10uF 20% 35VDC	ELNA	RJ2-35-V-100-M-F12	14.512
C2-2	CAPACITOR ELECTROLYTIC	100uF 20% 10VDC	ELNA	RJ3-10-V-101-M-F12	14.607
C3-2	CAPACITOR ELECTROLYTIC	100uF 20% 10VDC	ELNA	RJ3-10-V-101-M-F12	14.607
C4-2	CAPACITOR POLYSTYRENE	220pF 1% 630VDC	PHILIPS	2222 431 82201	10.409
C5-2	CAPACITOR MKT	1uF 5% 63VDC	PHILIPS	2222 370 79105	11.190
C6-2	CAPACITOR ELECTROLYTIC	100uF 20% 10VDC	ELNA	RJ3-10-V-101-M-F12	14.607
C7-2	CAPACITOR MKT	100nF 10% 100VDC	PHILIPS	2222 371 28104	11.180
C8-2	CAPACITOR MKT	10nF 10% 250VDC	ERO	MKT 1818-310/25 5-G	11.148
D1-2	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D2-2	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D3-2	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D4-2	DIODE ZENER	1N5350B 13V 5W	MOTOROLA	1N5350B	26.966
D5-2	DIODE ZENER	6.2V 5% 0.4W BZX79C6V2	PHILIPS*	BZX79C6V2	26.533
D6-2	DIODE ZENER	5.1V 2% 0.4W	* PHILIPS	BZX79B5V1	26.497
D7-2	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D8-2	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D9-2	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D10-2	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D11-2	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D12-2	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
P1-2	PLUG (MALE)	4 POLE	AMP	0-826375-4	78.104
P2-2	PLUG (MALE)	12 POLE	AMP	1-826375-2	78.112
Q1-2	TRANSISTOR	BC640	PHILIPS	BC640	28.124
Q2-2	TRANSISTOR AF	BC547B NPN TO-92	PHILIPS	BC547B	28.067
Q3-2	TRANSISTOR AF	BC547B NPN TO-92	PHILIPS	BC547B	28.067
Q4-2	TRANSISTOR AF	BC547B NPN TO-92	PHILIPS	BC547B	28.067
Q5-2	TRANSISTOR AF	BC547B NPN TO-92	PHILIPS	BC547B	28.067
R1-2	RESISTOR MF	1k8 OHM 5% 0.4W	PHILIPS	2322 181 53182	01.206
R2-2	RESISTOR MF	5k6 OHM 5% 0.4W	PHILIPS	2322 181 53562	01.218
R3-2	RESISTOR	5k6 OHMS 1% 0.6W	* PHILIPS	2322 156 15602	03.397
R4-2	RESISTOR PMF	470 OHM 5% 2W	PHILIPS	2322 191 34701	04.191
R5-2	RESISTOR MF	100 OHM 5% 0.4W	PHILIPS	2322 181 53101	01.175
R6-2	RESISTOR PMF	4k7 OHM 5% 2W	PHILIPS	2322 191 34702	04.211
R7-2	RESISTOR MF	7k5 OHM 5% 0.4W	PHILIPS	2322 181 53752	01.221
R8-2	RESISTOR MF	2k2 OHM 5% 0.4W	PHILIPS	2322 181 53222	01.208
R9-2	RESISTOR PMF	3k3 OHM 5% 2W	PHILIPS	2322 191 33302	04.209
R10-2	RESISTOR MF	10k0 OHM 1% 0.6W	* PHILIPS	2322 156 11003	03.427
R11-2	RESISTOR	5k6 OHMS 1% 0.6W	* PHILIPS	2322 156 15602	03.397
R12-2	RESISTOR MF	47k OHM 5% 0.4W	PHILIPS	2322 181 53473	01.241
R13-2	RESISTOR MF	10k0 OHM 1% 0.6W	* PHILIPS	2322 156 11003	03.427
R14-2	RESISTOR MF	10k OHM 5% 0.4W	PHILIPS	2322 181 53103	01.225

POSITION	DESCRIPTION		MANUFACTOR	TYPE	S.P.NUMBER
R15-2	RESISTOR MF	47k OHM 5% 0.4W	PHILIPS	2322 181 53473	01.241
R16-2	RESISTOR MF	1k0 OHM 5% 0.4W	PHILIPS	2322 181 53102	01.200
R17-2	RESISTOR MF	10k OHM 5% 0.4W	PHILIPS	2322 181 53103	01.225
R18-2	RESISTOR MF	2k2 OHM 5% 0.4W	PHILIPS	2322 181 53222	01.208
R19-2	RESISTOR MF	1k0 OHM 5% 0.4W	PHILIPS	2322 181 53102	01.200
R20-2	RESISTOR MF	10k OHM 5% 0.4W	PHILIPS	2322 181 53103	01.225
R21-2	RESISTOR MF	2k2 OHM 5% 0.4W	PHILIPS	2322 181 53222	01.208
R22-2	RESISTOR MF	10k OHM 5% 0.4W	PHILIPS	2322 181 53103	01.225
R23-2	RESISTOR MF	2k2 OHM 5% 0.4W	PHILIPS	2322 181 53222	01.208
R24-2	RESISTOR MF	10k OHM 5% 0.4W	PHILIPS	2322 181 53103	01.225
R25-2	RESISTOR MF	2k2 OHM 5% 0.4W	PHILIPS	2322 181 53222	01.208
RE1-2	RELAY	12VDC 4SH.2A.	ERNI	REL35-B0-4W1.0P-12VDC	21.194
U1-2	CD4047B		??????	CD4047B	33.165
U2-2	INTEGRATED CIRCUIT	MC14017BCP	PHILIPS*	HEF4017BP	33.085
U3-2	QUAD 2-INP.NAND SCHM.TRI	MC14093BCP	SIGNETICS*	HEF 4093 BP	33.300
U4-2	DUAL OP AMP	LM358N	TEXAS	LM358P	31.100

POSITION	DESCRIPTION		MANUFACTOR	TYPE	S.P.NUMBER
	STEP-UP UNIT	DC/DC KONVERTER N2160	ESPERA	5-0-25981C	625981
VARIOUS	FUSE CLIP	1/4" PCB TYPE	LITTELFUSE	102 071	78.389
VARIOUS	SCREW	M5x12 STEEL	HFC	HFC 473 FORZ.	87.413
C1-3	CAPACITOR MKT	2n2F 10% 400VDC	ERO	MKT 1818-222/63 5-G	11.143
C2-3	CAPACITOR MKT	10nF 10% 250VDC	ERO	MKT 1818-310/25 5-G	11.148
C3-3	CAPACITOR MKT	100nF 10% 100VDC	PHILIPS	2222 371 28104	11.180
C4-3	CAPACITOR	10uF 63V	PHILIPS	2222 371 28104	11.086
C5-3	CAPACITOR MKT	1000pF 10% 400VDC	SIEMENS	B32520-A6102-K-289	11.139
C6-3	CAPACITOR ELECTROLYTIC	100uF 20% 10VDC	ELNA	RJ3-10-V-101-M-F12	14.607
C7-3	CAPACITOR MKT	22nF 5% 100VDC	PHILIPS	2222 370 89223	11.169
C8-3	CAPACITOR ELECTROLYTIC	47uF 20% 25VDC	ELNA	RJ2-25-V-470-M-F1	14.524
C9-3	CAPACITOR ELECTROLYTIC	2u2F 20% 50VDC	ELNA	RJ2-25-V-2R2-M-F12	14.503
C10-3	CAPACITOR	10uF 63V	PHILIPS	2222 371 28104	11.086
C11-3	CAPACITOR MKT	1000pF 10% 400VDC	SIEMENS	B32520-A6102-K-289	11.139
D1-3	DIODE ZENER	4.7V 5% 0.4W	PHILIPS	BZX79C4V7	26.524
D2-3	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D3-3	DIODE	MR751	MOTOROLA	MR751	25.220
D4-3	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D5-3	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D6-3	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D7-3	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D8-3	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D9-3	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D10-3	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D11-3	DIODE ZENER	12V 5% 0.4W BZX79C12	PHILIPS*	BZX79C12	26.554
D12-3	DIODE HIGH SPEED	1N4448	PHILIPS	1N4448	25.147
D13-3	DIODE ZENER	12V 5% 0.4W BZX79C12	PHILIPS*	BZX79C12	26.554
D14-3	DIODE ZENER	12V 5% 0.4W BZX79C12	PHILIPS*	BZX79C12	26.554
D15-3	DIODE DUAL	2x10A/200VDC TO-220	PHILIPS	BYV32-200	27.159
F1-3	FUSE	20AM 6.3x32mm	WICKMANN	19 341-20	45.631
L1-3	CHOKE 50uH IDC 20A		TRADANIA	TD6347.1	22.186
P1-3	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
P2-3	PLUG (MALE)	4 POLE	AMP	0-826375-4	78.104
P3-3	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
P4-3	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
P5-3	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
Q1-3	TRANSISTOR AF	BC547B NPN TO-92	PHILIPS	BC547B	28.067
Q2-3	TRANSISTOR AF	BC557B NPN TO-92	PHILIPS	BC557B	28.091
Q3-3	TRANSISTOR EFF.	BD139-10	MOTOROLA	BD139-10	29.062
Q4-3	TRANSISTOR AF	BC557B NPN TO-92	PHILIPS	BC557B	28.091
Q5-3	TRANSISTOR POWER MOSFET	N-CHANNEL 100V/27A/85mOHM	SILICONIX	IRF540	29.402
Q6-3	TRANSISTOR POWER MOSFET	N-CHANNEL 100V/27A/85mOHM	SILICONIX	IRF540	29.402

POSITION	DESCRIPTION		MANUFACTOR	TYPE	S.P.NUMBER
R1-3	RESISTOR MF	3k3 OHM 5% 0.4W	PHILIPS	2322 181 53332	01.212
R2-3	RESISTOR MF	47k OHM 5% 0.4W	PHILIPS	2322 181 53473	01.241
R3-3	RESISTOR MF	1k0 OHM 5% 0.4W	PHILIPS	2322 181 53102	01.200
R4-3	RESISTOR MF	3k3 OHM 5% 0.4W	PHILIPS	2322 181 53332	01.212
R5-3	RESISTOR	11 KOHM 1% 0.4W	*PHILIPS	2322 156 11103	03.458
R6-3	RESISTOR	11 KOHM 1% 0.4W	*PHILIPS	2322 156 11103	03.458
R7-3	RESISTOR MF	10k0 OHM 1% 0.6W	* PHILIPS	2322 156 11003	03.427
R8-3	RESISTOR MF	10k OHM 5% 0.4W	PHILIPS	2322 181 53103	01.225
R10-3	RESISTOR MF	10k OHM 5% 0.4W	PHILIPS	2322 181 53103	01.225
R11-3	RESISTOR MF	4k7 OHM 5% 0.4W	PHILIPS	2322 181 53472	01.216
R12-3	RESISTOR MF	68k OHM 5% 0.4W	PHILIPS	2322 181 53683	01.245
R13-3	RESISTOR MF	1k0 OHM 5% 0.4W	PHILIPS	2322 181 53102	01.200
R14-3	RESISTOR MF	3k3 OHM 5% 0.4W	PHILIPS	2322 181 53332	01.212
R15-3	RESISTOR MF	3k3 OHM 5% 0.4W	PHILIPS	2322 181 53332	01.212
R16-3	RESISTOR MF	100 OHM 5% 0.4W	PHILIPS	2322 181 53101	01.175
R17-3	RESISTOR MF	100 OHM 5% 0.4W	PHILIPS	2322 181 53101	01.175
R18-3	RESISTOR	11 KOHM 1% 0.4W	*PHILIPS	2322 156 11103	03.458
R19-3	RESISTOR	10 MILLI OHM 2W	MODULOHM	10U-J-MI-A-1	06.210
R20-3	RESISTOR	10 MILLI OHM 2W	MODULOHM	10U-J-MI-A-1	06.210
R21-3	RESISTOR	10 MILLI OHM 2W	MODULOHM	10U-J-MI-A-1	06.210
R22-3	RESISTOR	10 MILLI OHM 2W	MODULOHM	10U-J-MI-A-1	06.210
R23-3	RESISTOR MF	470 OHM 5% 0.4W	PHILIPS	2322 181 53471	01.191
U1-3	QUAD 2-INP.NAND SCHM.TRI	MC14093BCP	SIGNETICS*	HEF 4093 BP	33.300
U2-3	INTEGRATED CIRCUIT	IP3524BN	INOTEC	IP3524BN	31.494

POSITION	DESCRIPTION		MANUFACTOR	TYPE	S.P.NUMBER
	OUTPUT FILTER MODULE 4	N2160	ESPERA	5-0-26033C	626033
VARIOUS	SCREW	M5x12 STEEL	HFC	HFC 473 FORZ.	87.413
C1-4	CAPACITOR ELECTROLYTIC	2200uF-10/+50% 40V	ERO*	EG 00 MG 422 G	14.720
C2-4	CAPACITOR POLYESTER	0.1uF 10% 100V	PHILIPS*	2222 344 25104	11.073
C3-4	CAPACITOR POLYESTER	0.1uF 10% 100V	PHILIPS*	2222 344 25104	11.073
C4-4	CAPACITOR POLYESTER	2.2uF 10% 100V	PHILIPS*	2222 344 25225	11.142
C5-4	CAPACITOR POLYESTER	2.2uF 10% 100V	PHILIPS*	2222 344 25225	11.142
L1-4	COIL	TL527	ESPERA	6-0-26122	400527
P1-4	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
P2-4	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
P3-4	PLUG	2 POLES	AMP	0-826375-2	78.102
P4-4	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860
P5-4	CONNECTION ELEMENT	FOR M5 SCREW	ESPERA	1-0-25860	225860