DELTA ELEKTRONIKA BV

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4300 AA ZIERIKZEE
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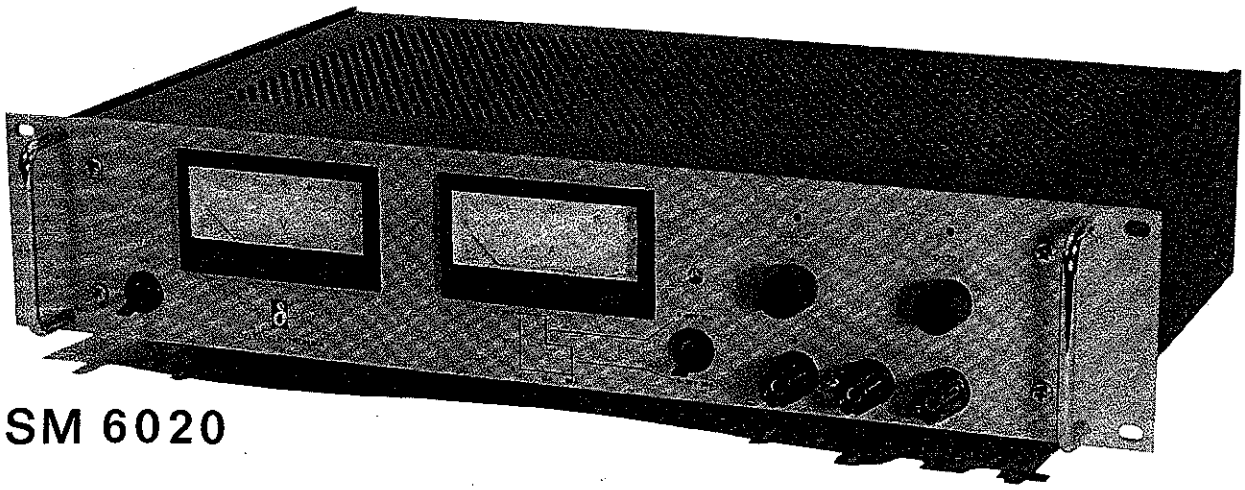


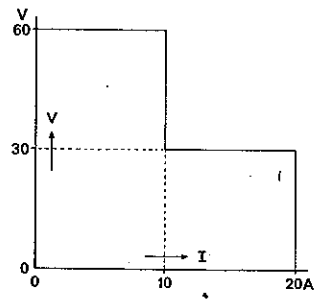
SM 6020

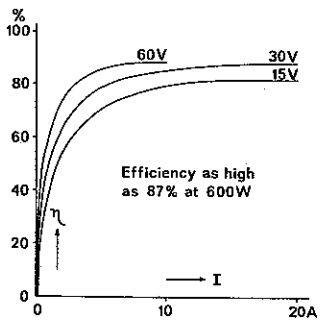
SWITCHED MODE LABORATORY POWER SUPPLY

* 600 Watts DC output
  in 2 ranges, front panel switch selectable

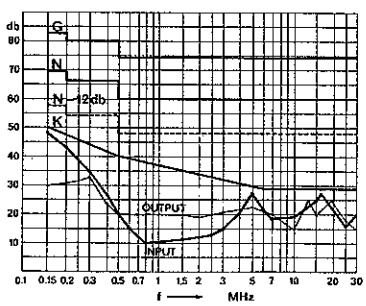
0 - 30 V	0 - 20 A	CV/CC
0 - 60 V	0 - 10 A	CV/CC

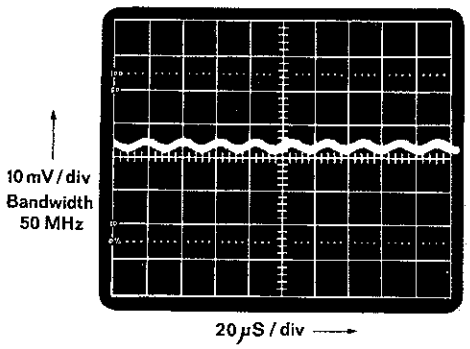
* New 40 kHz switching technique
* Weight only 9 kgs
* Input 95-132 V AC / 185-265 V AC, 50-60 Hz
  220-350 V DC
* Insulation 2.5 kV RMS
* Soft start + choke input
* Protected against all overload and short circuit conditions
* Natural convection cooling, no blower
* Built-in over voltage protector, range 6-65 V
* V and I programmable by voltage (0-6 V)





* RFI suppression according to grade K of VDE 0875 on both input and output.





Output ripple + noise as low as 10 mV p-p

	CV	CC
Line regulation:		
Input 185-265 V	5 mV	70 mA
Load regulation:		
Load 0-100%	5 mV	70 mA
Ripple: p-p	10 mV	50 mA
Temp. coeff. per °C:	5.10^{-5}	5.10^{-4}
Stability:		
During 8 hours after 30 min. warm up, under constant load and ambient conditions	1.10^{-4}	1.10^{-3}
Recovery time:		
For recovery to within 0.1 V after a load step from 10 to 100%, measured at 30V 20A	0.5 mS	-

Ambient temperature:

-20°C to +50°C at full load
At -20°C recovery time is 1 mS and CV ripple 30 mV p-p

Parallel, and series operation:

Up to 500 V combined output

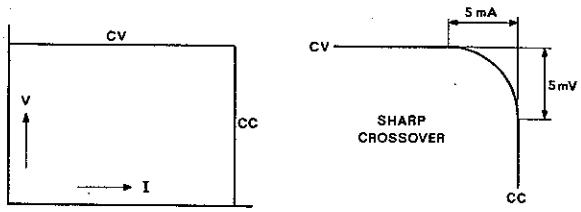
RFI suppression:

According to grade K of VDE 0875, both on input and output

Voltage and current controls:

By two 10-turn potentiometers

CV/CC regulation:



The SM 6020 can be used as a constant voltage source or as a constant current source. The change of mode occurs sharply at the crossing of the voltage and current settings

Remote sensing:

Separate amplifier terminals (S+ and S- on the rear panel) enable the output voltage to be regulated at a remote load point. Voltage drop maximum 2 V per lead

Input voltage:

185-265 V, 50-60 Hz or 220-350 V DC. After changing an internal link also 95-132 V 50-60 Hz

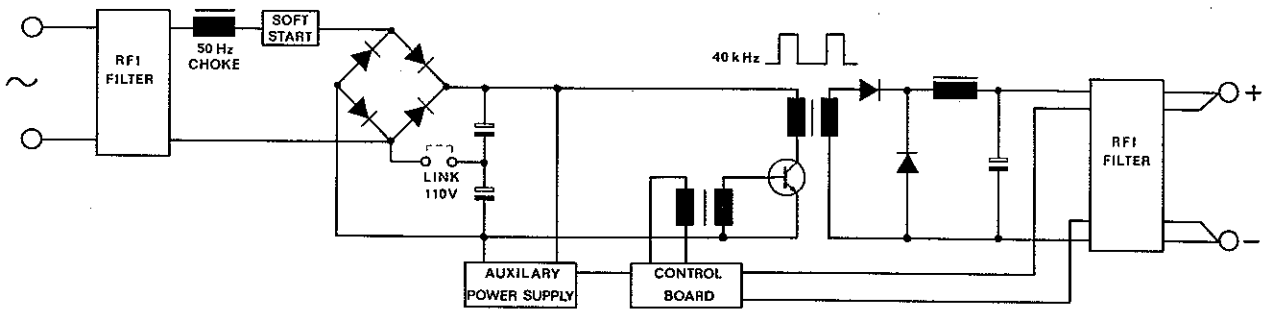
Insulation:

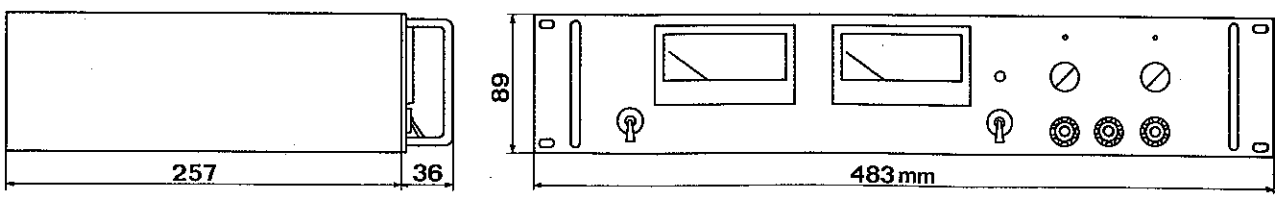
2.5 kV RMS for 1 minute between input and output and between input and case. 500 V DC between output and case.

Insulation resistance better than 50 MOhm (measured at 500 V DC)

Soft start: To limit input peak current

Choke input: For low mains distortion





SM 6020

1. INPUT

1.1 185-265 VAC 50-60Hz

The SM 6020 is normally delivered for input 185-265 VAC 50-60Hz to operate on European line voltages.
In this case the black wire with faston receptacle from the centre tap of the 50Hz choke (L3) is connected to the faston tab at the bottom side of P.C.board P247.

1.2 220-350 VDC

In the same configuration as above the SM 6020 can also work on 220-350 VDC. The polarity does not matter because the input circuit has a bridge rectifier.

1.3 95-132 VAC 50-60Hz

For use on 95-132 VAC 50-60Hz the black wire with faston receptacle from the centre tap of the 50Hz choke (L3) has to be connected with the faston tab on the upper side of P 247. In this case the input circuit acts as a voltage doubler.

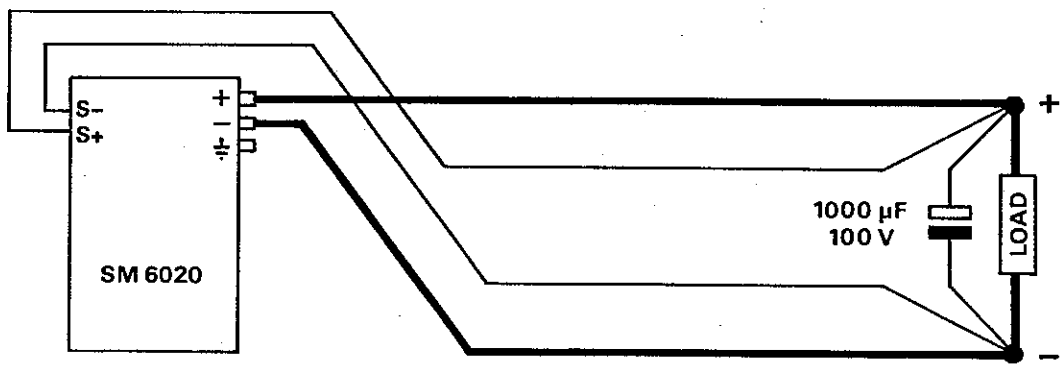
2. VOLTAGE AND CURRENT CONTROL

Voltage control and current control are by 10 turn potentiometers for high resolution.
10 turns corresponds with 60V respectively 20A.
If the output range selection switch is at 0-30V 20A only the first 5 turns of the voltage control knob react. The same happens with the current control knob at 0-60V 10A.

3. INTERNAL OR EXTERNAL SENSING

In most applications the power supply is used with internal sensing, which means that the output voltage is kept constant at the output terminals on the front panel. In this case the sense-switch, accessible through a hole of the rear panel, has to be in the position "Internal".

If it is desirable to compensate the voltage drop over the leads to the load, the point of stabilisation can be displaced from the output terminals to the load terminals by using sense wires from S+ and S- (rear terminal block) to the load and putting the sense switch in the position "External".



To prevent for undisirable interference or oscillations it is advisable to twist the sense leads and to connect an electrolytic capacitor to the loads terminals.

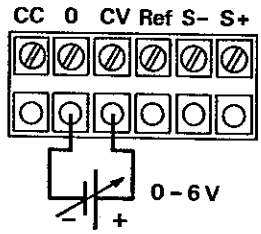
4. OVER VOLTAGE PROTECTOR

The built-in over voltage protector can be adjusted between 6V and 65V with a screwdriver through the front panel.
When the output voltage reaches the setted trip level of the OVP the power supply shuts down.
To reset the output voltage it is necessary to switch off the power supply and switch on again.
The OVP is not of the crowbar type and therefore cannot absorb power from external sources.

5. REMOTE PROGRAMMING

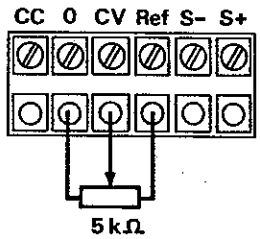
5.1 Voltage by voltage

To program the output voltage by an external voltage, connect the driving voltage between CV and 0 at rear terminal block.
A driving voltage of 0 to about 6V programs the output from 0-60V.
Terminal 0 is internally connected with S- of the output and an internal fuse in series is protecting the S-wire for burn out in case of a wrong connection.



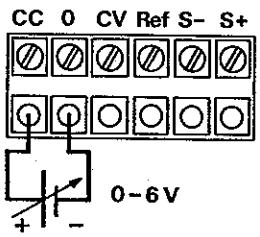
5.2 Voltage by external potentiometer

To set the output voltage with an external potentiometer connect a potentiometer of 5 kOhm to the terminals Ref, CV and 0 and turn the potentiometer on the front panel on maximum.



5.3 Current by voltage

To make this possible the internal switch S4 on P250 has to be put in the position "current prog".
With about 0-6V between terminals CC and 0 the output current varies between 0 and 20A if working in the current mode.



5.4 Programming Speed

The programming speed is very much limited by the electrolytic capacitors on the output which will heat up at combined high repetition rate, high amplitude and high programming speed. The maximum programming speed is about 600V/sec, however the product of $\frac{dv}{dt}$ (in V/s) x amplitude (in V) x repetition frequency (in Hz) may not exceed 2.10^4.

R = Ohm

1 =	Z 21 L 471			
2 =	2,2	M		VR 25
3 =	8,2		10 W	WW
4 =	120			PR 37
5 =	100		7 W	WW
6 =	47		7 W	WW
7 =	390	k		MR 30
8 =	390	k		MR 30
9 =	1		7 W	WW
10 =	10		1 W	
11 =	100		25 W	RCL
12 =	470			
13 =	68	k		
14 =	CR			
15 =	68	k		
16 =	1,2	k		
17 =	330	k		
18 =	CR			
19 =	390	k		
20 =	100	k		MR 30
21 =	100	k		MR 30
22 =	100	k		MR 30
23 =	100	k		MR 30
24 =	270			
25 =	100			
26 =	330			
27 =	3,3	k		
28 =	22	k		
29 =	CR			
30 =	1	k		
31 =	CR			
32 =	5,6			
33 =	1	k		
34 =	330			
35 =	15			
36 =	3,3	k		
37 =	6,8	k		
38 =	10	k		
39 =	27	k		
40 =	CR			
41 =	CR			
42 =	NTC			
43 =	33	k		
44 =	390			
45 =	1	k		
46 =	1	k		
47 =	2,2	k		
48 =	1,8	k		
49 =	2,2	k		
50 =	68	k		MR 30
51 =	2,2	k		
52 =	2,7	k		
53 =	2,7	k		
54 =	2,2	k		
55 =	2,7	k		
56 =	2,7	k		
57 =	150	k		
58 =	820	k		
59 =	5	k		10 trns
60 =	33	k		
61 =	CR			
62 =	1	k		
63 =	1	k		
64 =	68	k		
65 =	4,7	k		
66 =	3,9	k		
67 =	2,2	M		VR 25
68 =	47	k		
69 =	22	k		
70 =	22	k		
71 =	3,3	k		
72 =	CR			
73 =	12	k		
74 =	2,7	k		
75 =	39	k		
76 =	56	k		MR 30
77 =	56	k		MR 30
78 =	4,7	k		
79 =	680			
80 =	2,7	k		
81 =	5	k		10 trns
82 =	1			
83 =	560			
84 =	4,7	k		
85 =	1	k		
86 =	10	k		10 trns
87 =	100			
88 =	CR			
89 =	330			
90 =	470			PR 37
91 =	27			PR 37
92 =	27			PR 37
93 =	2,2		7 W	
94 =	1,2	k	10 W	
95 =	180			
96 =	5,6	k		
97 =	0,01			1%
98 =	22			
99 =	22			
100 =	22			
101 =	22			
102 =	22			
103 =	22			
104 =	1			
105 =	1	k		trim
106 =	180			
107 =	56	k		
108 =	10	k		trim
109 =	2,2	M		VR 25

CR = calibration resistor
WW = wire wound
MR 25 = metal film 0,4 W 1%
MR 30 = metal film 0,5 W 1%
PR 37 = metal film 1,6 W 5%
VR 25 = metal film 0,25W 5% 1600 V-

All non specified resistors are of type MR 25.

			Title: Part list SM6020
			Date: 1-'79
Modifications	Date	App.	delta elektronika bv

C

1 =	0,22	µF	250	V~
2 =	2,2	nF	4	kV
3 =	0,22	µF	250	V~
4 =	0,22	µF	250	V~
5 =	2,2	nF	4	kV
6 =	1,5	µF	160	V
7 =	0,15	µF	250	V~
8 =	800	µF	200	V
9 =	800	µF	200	V
10 =	800	µF	200	V
11 =	800	µF	200	V
12 =	800	µF	200	V
13 =	800	µF	200	V
14 =	1	µF	400	V
15 =	3,3	µF	100	V
16 =	10	µF	63	V
17 =	1	nF	630	V
18 =	1,8	nF	2	kV
19 =	1,8	nF	2	kV
20 =	1,8	nF	2	kV
21 =	33	pF	4	kV
22 =	100	µF	10	V
23 =	15	pF	500	V
24 =	150	pF	400	V
25 =	470	pF	160	V
26 =	47	pF	500	V
27 =	100	pF	500	V
28 =	0,1	µF	400	V
29 =	150	pF	1600	V
30 =	0,22	µF	63	V
31 =	15	µF	16	V
32 =	15	µF	16	V
33 =	1	nF	1000	V
34 =	22	µF	40	V
35 =	15	µF	16	V
36 =	1	nF	630	V
37 =	1	nF	630	V
38 =	10	nF	250	V
39 =	22	nF	250	V
40 =	0,22	µF	63	V
41 =	470	pF	160	V
42 =	100	pF	500	V
43 =	15	µF	16	V
44 =	1	nF	630	V
45 =	470	pF	500	V
46 =	47	µF	40	V
47 =	2,2	µF	16	V
48 =	1	nF	630	V
49 =	1	nF	630	V
50 =	15	µF	16	V
51 =	15	µF	16	V
52 =	470	pF	500	V
53 =	470	pF	500	V
54 =	10	nF	1000	V
55 =	1	nF	630	V
56 =	100	pF	500	V
57 =	470	pF	500	V
58 =	10	nF	250	V
59 =	470	pF	500	V
60 =	15	µF	16	V
61 =	15	µF	16	V
62 =	470	pF	500	V
63 =	22	nF	250	V
64 =	47	nF	250	V
65 =	470	pF	500	V
66 =	15	µF	16	V
67 =	15	µF	16	V
68 =	2,5	nF	250	V~
69 =	2,5	nF	250	V~
70 =	10	µF	100	V
71 =	10	µF	100	V
72 =	470	µF	100	V
73 =	47	nF	250	V
74 =	470	µF	100	V
75 =	470	µF	100	V
76 =	470	µF	100	V
77 =	470	µF	100	V
78 =	470	µF	100	V
79 =	470	µF	100	V
80 =	47	µF	63	V
81 =	0,22	µF	250	V~
82 =	15	µF	16	V
83 =	0,22	µF	63	V
84 =	0,22	µF	63	V
85 =	0,22	µF	63	V
86 =	0,22	µF	63	V
87 =	0,22	µF	63	V
88 =	0,22	µF	250	V~
89 =	47	µF	63	V
90 =	15	µF	16	V
91 =	470	µF	100	V
92 =	10	nF	1000	V
93 =	470	µF	100	V
94 =	1	µF	250	V
95 =	0,47	µF	250	V
96 =	10	nF	1000	V
97 =	0,15	µF	250	V~

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Modifications	Date	App.	delta elektronika bv

D

1 =	BTW 41-G500	Philips
2 =	26 MB 60A	IR
3 =	BY 218-800	Sescosem
4 =	BY 218-800	Sescosem
5 =	BY 218-800	Sescosem
6 =	BY 218-800	Sescosem
7 =	BY 218-800	Sescosem
8 =	BZV 15C 12	Philips
9 =	BY 218-800	Sescosem
10 =	BY 218-800	Sescosem
11 =	BY 218-800	Sescosem
12 =	ZPD 8,2	ITT
13 =	1N4148	
14 =	ZPD 3,3	ITT
15 =	1N4148	
16 =	BYX 55/600	Motorola
17 =	BYX 55/600	Motorola
18 =	BZV 15C 12	Philips
19 =	BYX 55/600	Motorola
20 =	ZPD 8,2	ITT
21 =	ZPY 13	ITT
22 =	1N4148	
23 =	1N4148	
24 =	1N4148	
25 =	1N4148	
26 =	ZPY 51	ITT
27 =	1N4148	
28 =	TIC 46	TI
29 =	TIL 209 B	TI
30 =	TIL 209 B	TI
31 =	1N4148	
32 =	1N4148	
33 =	1N4148	
34 =	1N4148	
35 =	———	
36 =	1N4148	
37 =	1N4148	
38 =	1N4148	
39 =	1N4148	
40 =	1N4148	
41 =	1N825	IR
42 =	1N4148	
43 =	1N4148	
44 =	1N4148	
45 =	1N4148	
46 =	1N4148	
47 =	1N4148	
48 =	ZPD 5,1	ITT
49 =	ZPD 8.2	ITT
50 =	1N825	IR
51 =	BYW 77/200	Sescosem
52 =	BYW 77/200	Sescosem
53 =	BYW 77/200	Sescosem
54 =	BYW 77/200	Sescosem
55 =	40 HF10/1N249C	IR/RCA
56 =	———	
57 =	40 HF10/1N249C	IR/RCA
58 =	1N4148	
59 =	ZPD 3,3	ITT
60 =	TL 431	TI
61 =	40 HF10/1N249C	IR/RCA

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Q

1 =	BUX 48	Sescocem
2 =	BUX 48	Sescosem
3 =	BUX 48	Sescosem
4 =	BUX 48	Sescosem
5 =	BUX 84	Philips
6 =	2 N 2907 A	Sescosem
7 =	2 N 2222 A	Sescosem
8 =	2 N 2907 A	Sescosem
9 =	VN 66 AF	Siliconix
10 =	VN 66 AF	Siliconix
11 =	VN 66 AF	Siliconix
12 =	VN 66 AF	Siliconix
13 =	VN 66 AF	Siliconix
14 =	2 N 2907 A	Sescosem
15 =	2 N 2222 A	Sescosem
16 =	2 N 2222 A	Sescosem
17 =	2 N 2222 A	Sescosem
18 =	2 N 2907 A	Sescosem
19 =	2 N 2907 A	Sescosem
20 =	BF 398	TI

IC

1 =	HEF 4049 B	Philips
2 =	HEF 4049 B	Philips
3 =	HEF 4049 B	Philips
4 =	SFC 2747 M	Sescosem
5 =	SFC 2747 M	Sescosem

F

1 =	10	A (220V), 15A (110V) slow blow
2 =	10	A (220V), 15A (110V) slow blow
3 =	6,3	A silverwire
4 =	250	mA
5 =	250	mA

L

1 =	S 144	Delta
2 =	S 145	Delta
3 =	S 133	Delta
4 =	S 146	Delta
5 =	4,7 µH	Secre
6 =	S 147	Delta
7 =	S 148	Delta

T

1 =	T 149	Delta
2 =	T 150	Delta
3 =	T 153	Delta
4 =	T 154	Delta
5 =	T 156	Delta

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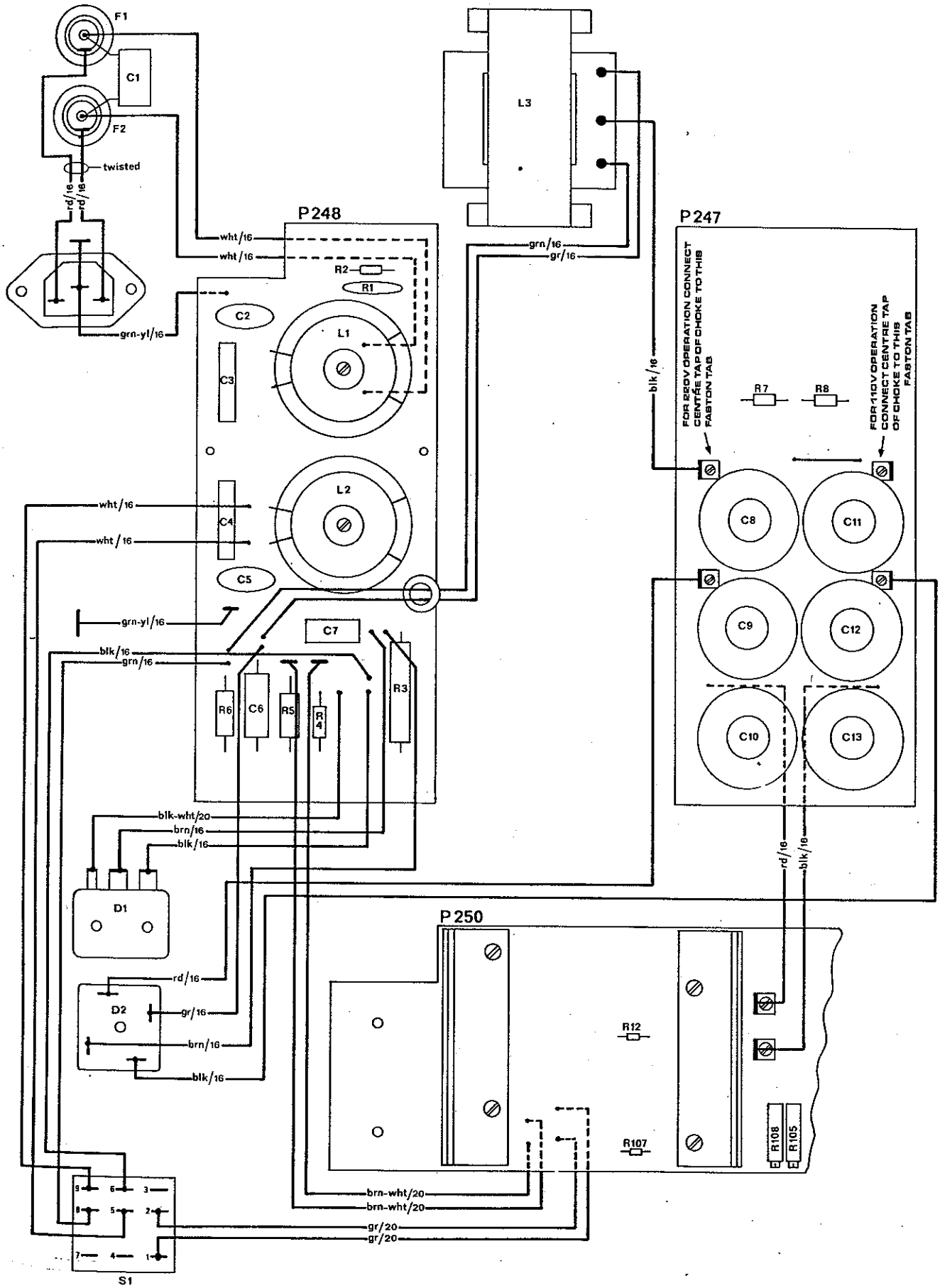
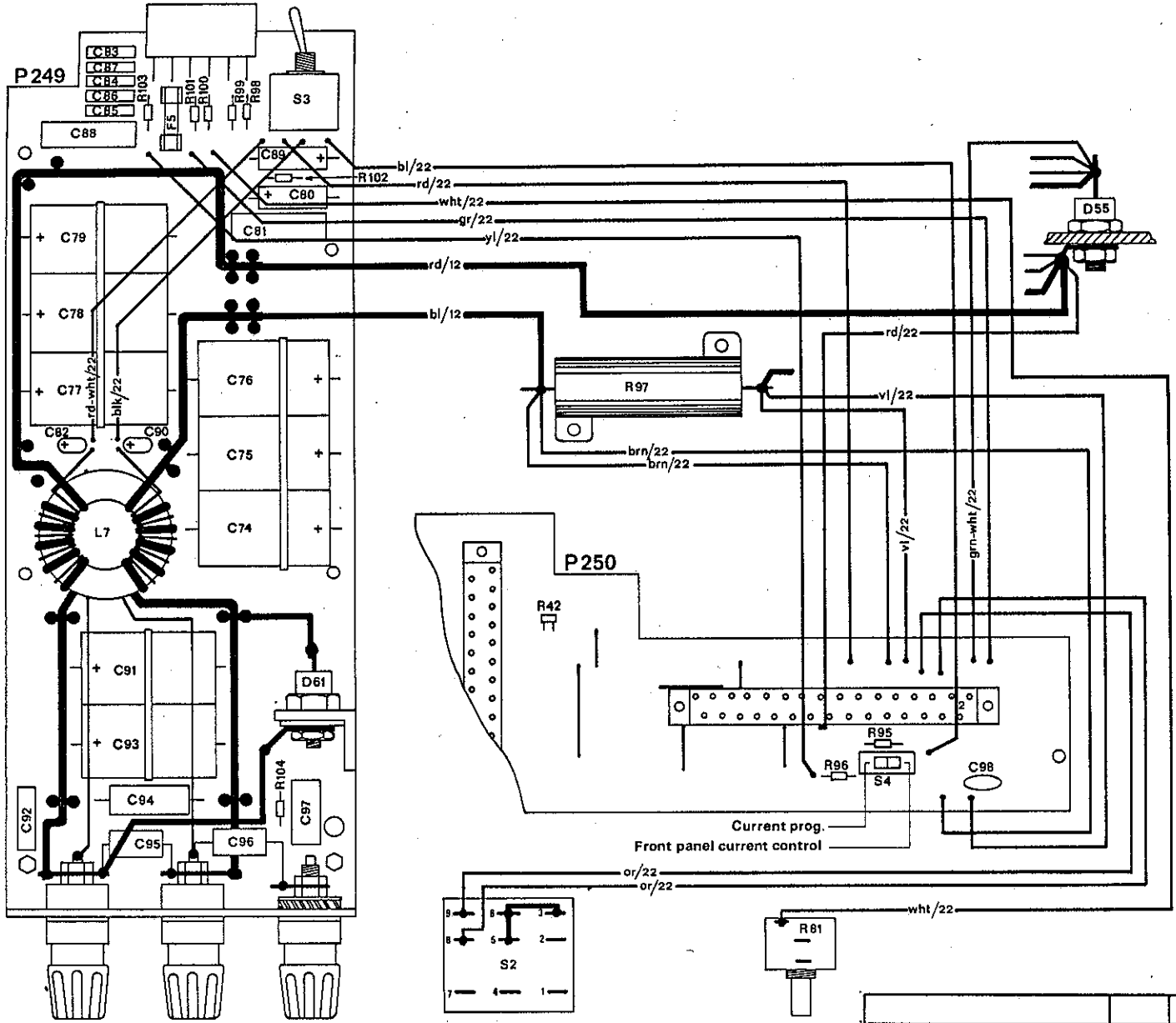


			Title: Wiring diagram SM6020
			Date: 1-'79
Modifications	Date	App.	delta elektronika bv



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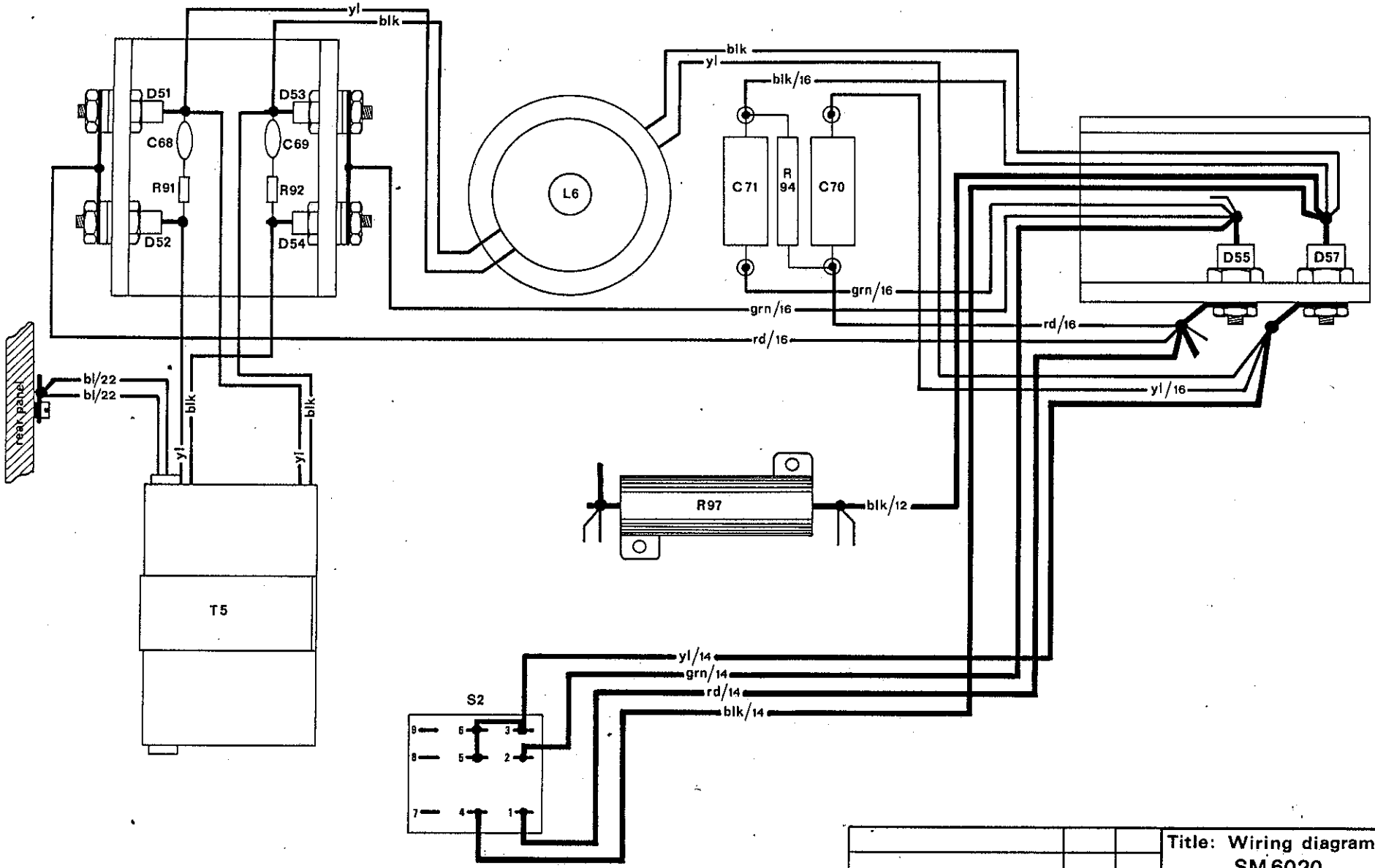

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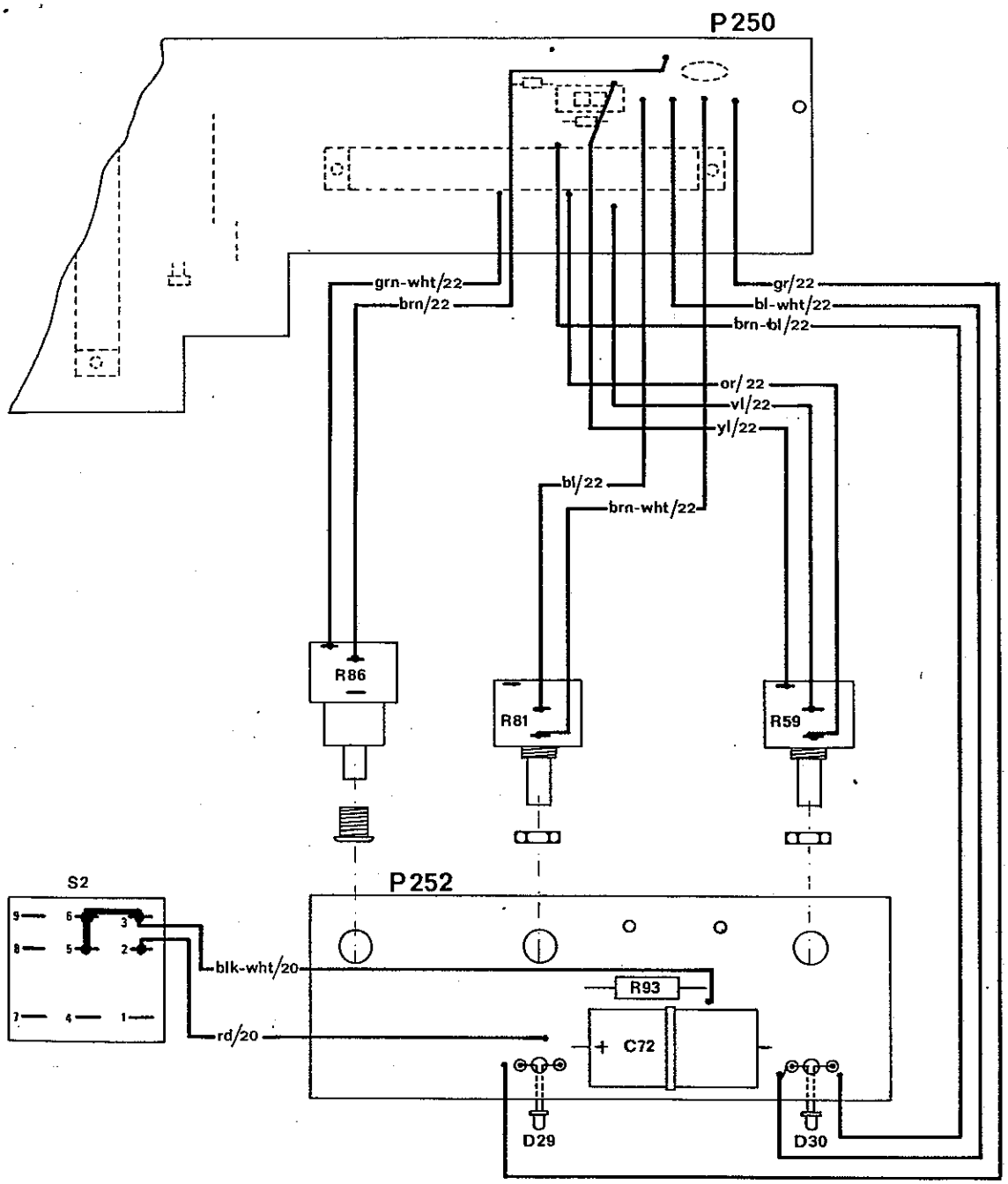

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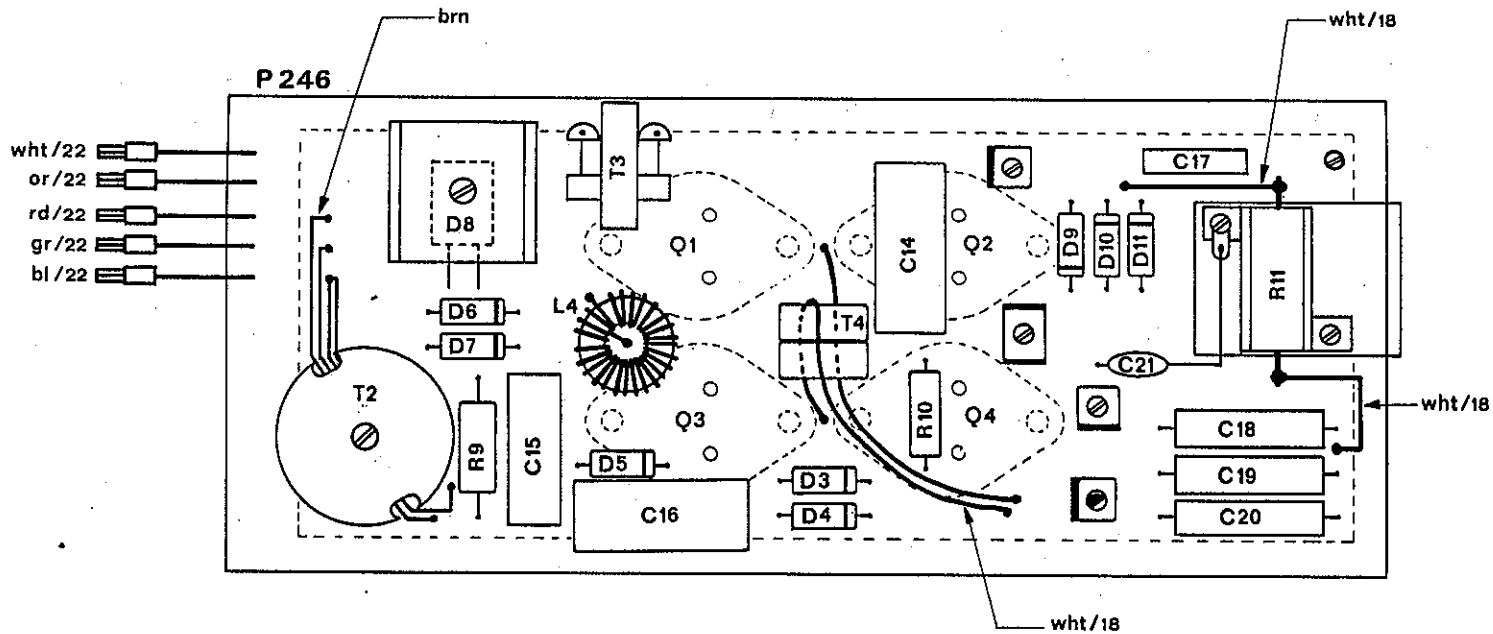
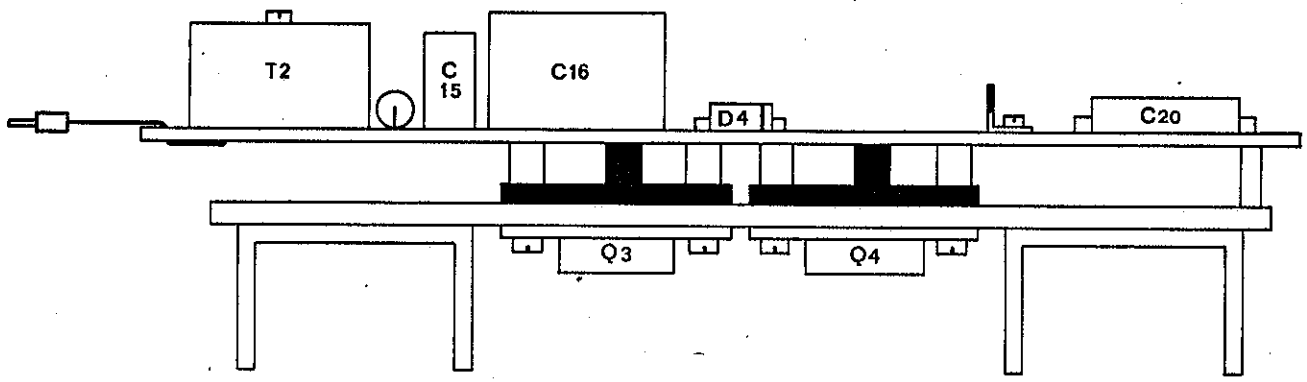
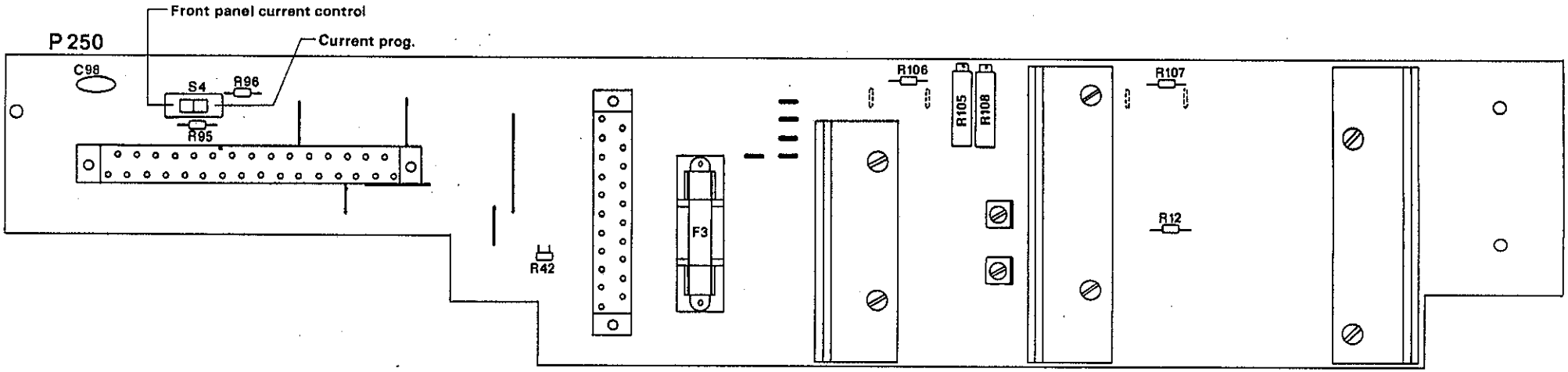




			Title: PC board SM6020
			Date: 1-'79
Modifications	Date	App	delta elektronika bv



			Title: PC board SM 6020
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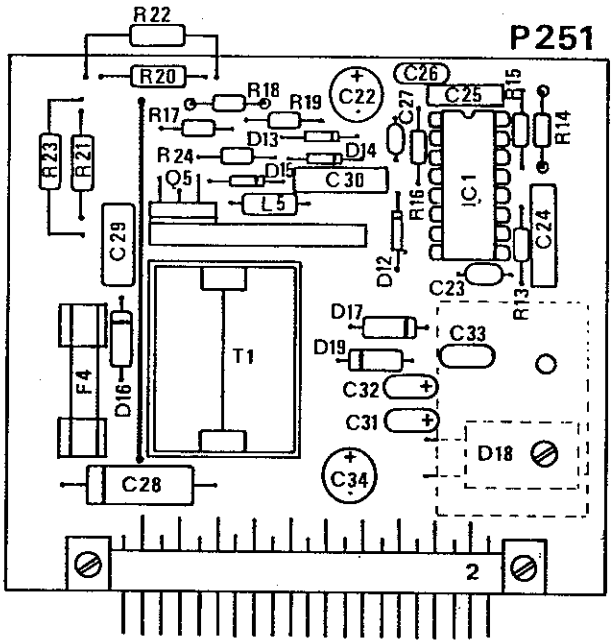
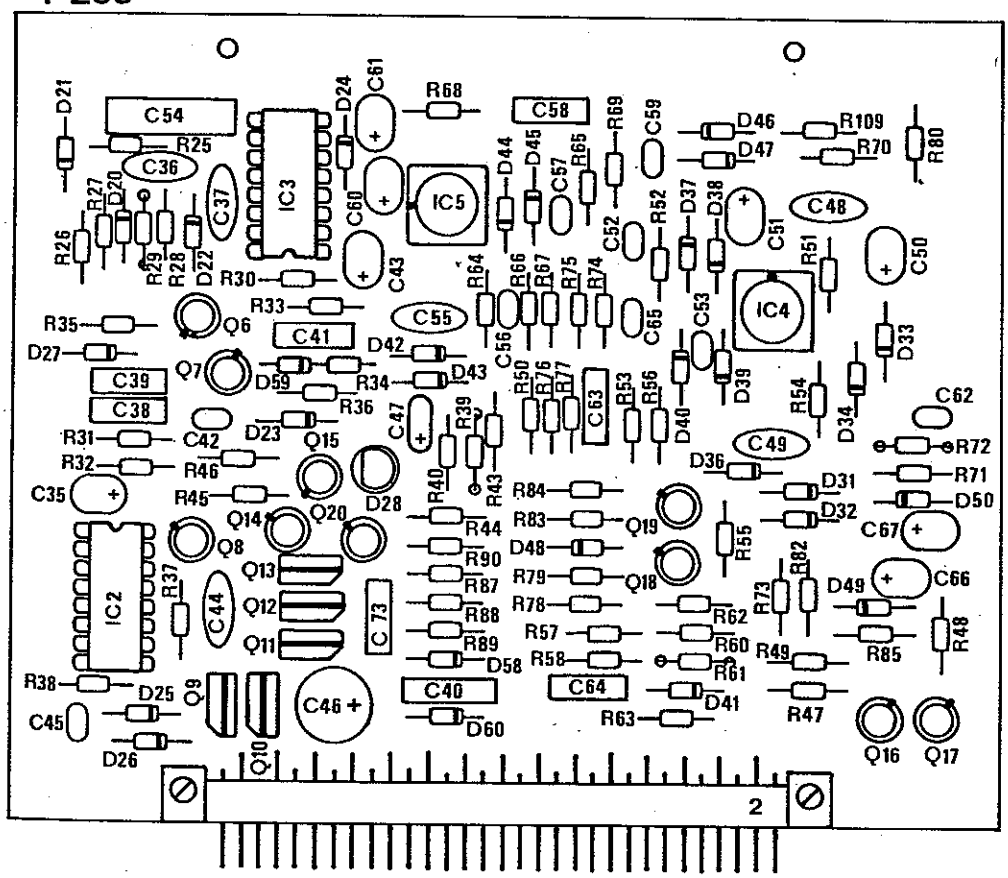
Modifications	Date	App	delta elektronika bv

P251

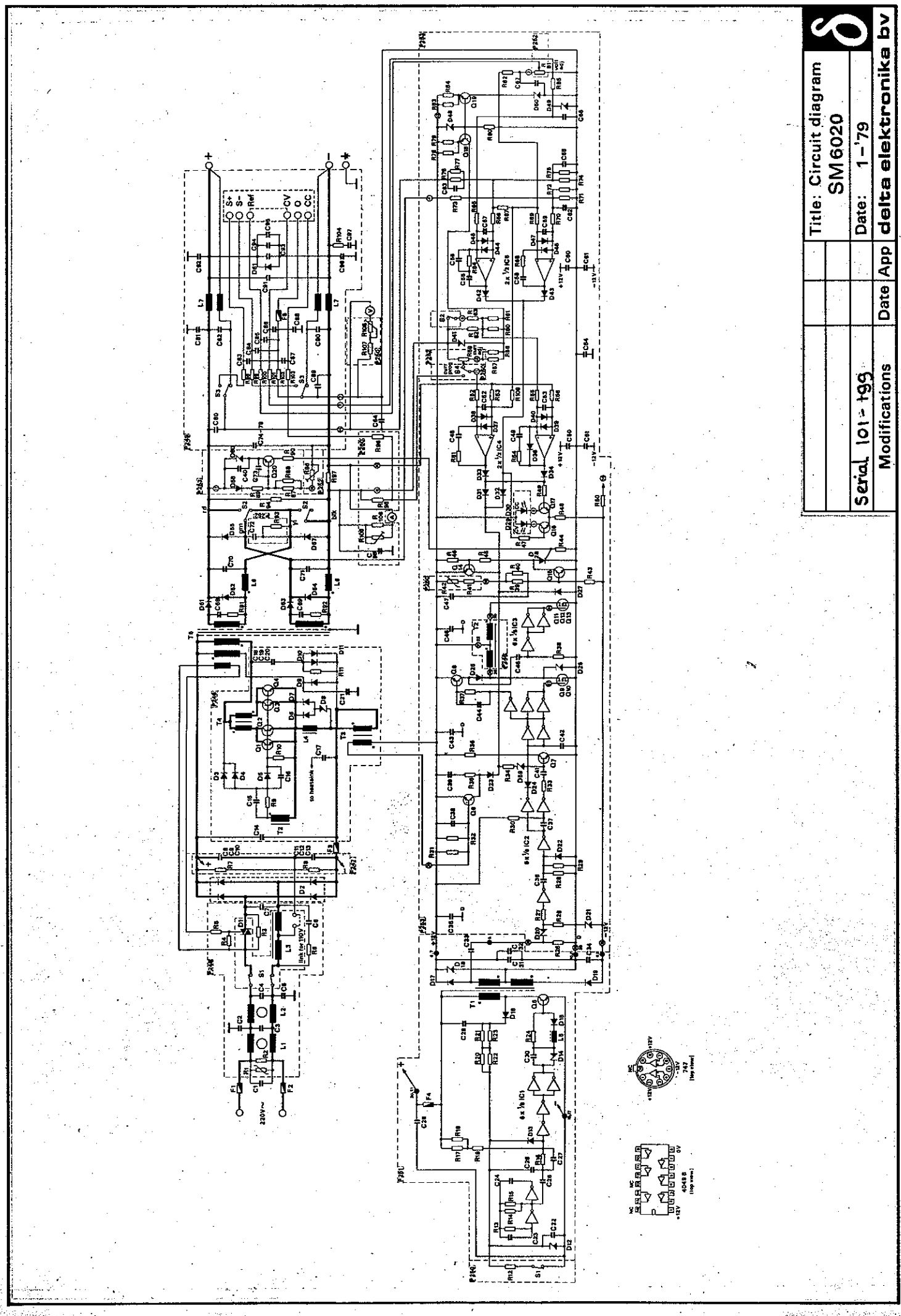


P253



			Title: PC boards SM6020
			Date: 1-'79
Modifications	Date	App.	delta elektronika bv

Serialnr. 199

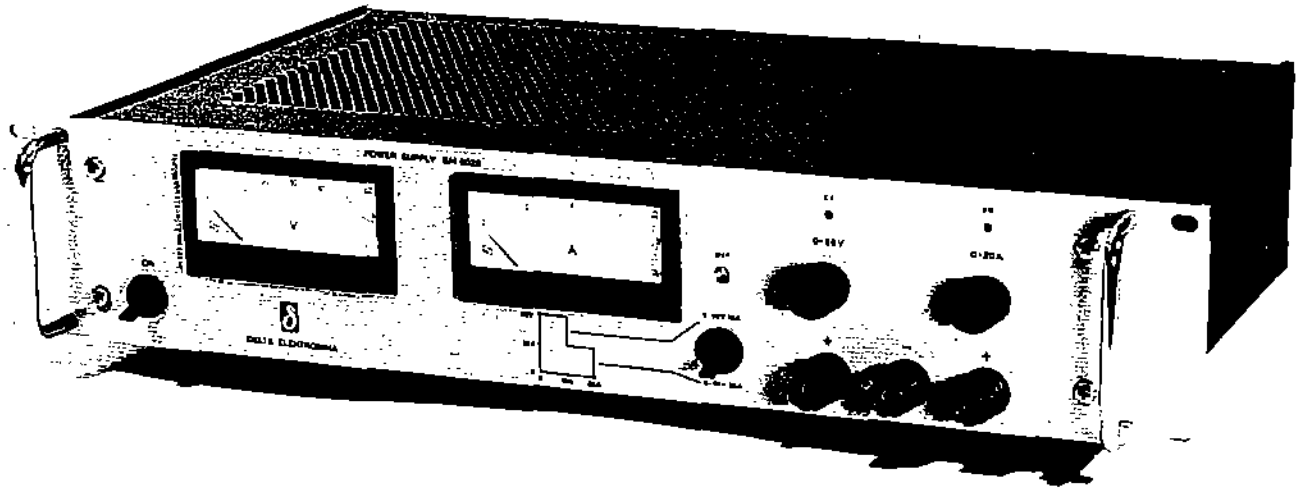


SM 6020

serial no. 200 and up

DELTA ELEKTRONIKA BV

P.O. BOX 27
4300 AA ZIERIKZEE
NETHERLANDS
TEL. (01110) 3656 TLX 55349



SM 6020

SWITCHED MODE LABORATORY POWER SUPPLY

* **600 Watts DC output**

  in 2 ranges, front panel switch selectable

0 - 30 V	0 - 20 A	CV/CC
0 - 60 V	0 - 10 A	CV/CC

  0 - 37.5 V / 0 - 75 V optional

* **Weight only 9 kgs**

* **87% efficiency** (40 kHz switching technique)

* World wide input voltage range

* Low inrush current

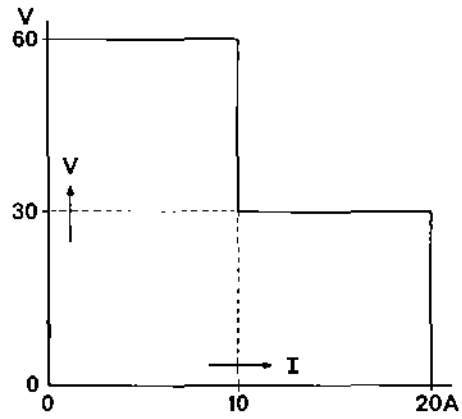
* Very low output ripple (10mVp-p)

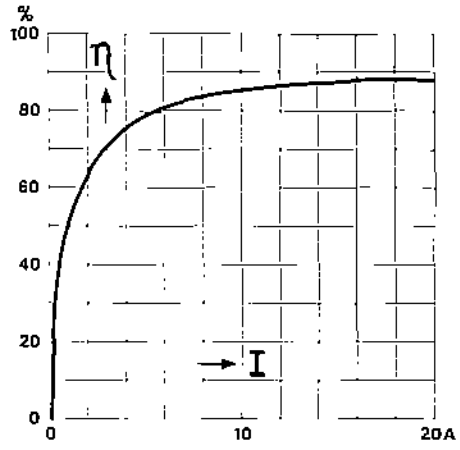
* Protected against all overload and short circuit conditions

* Natural convection cooling, no blower, no noise

* Built-in overvoltage protector, range 6-65 V

* V and I programmable by voltage (0-5 V)

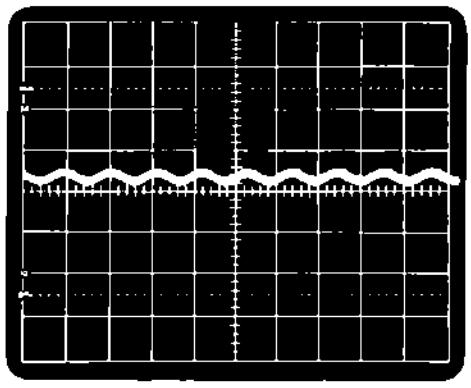




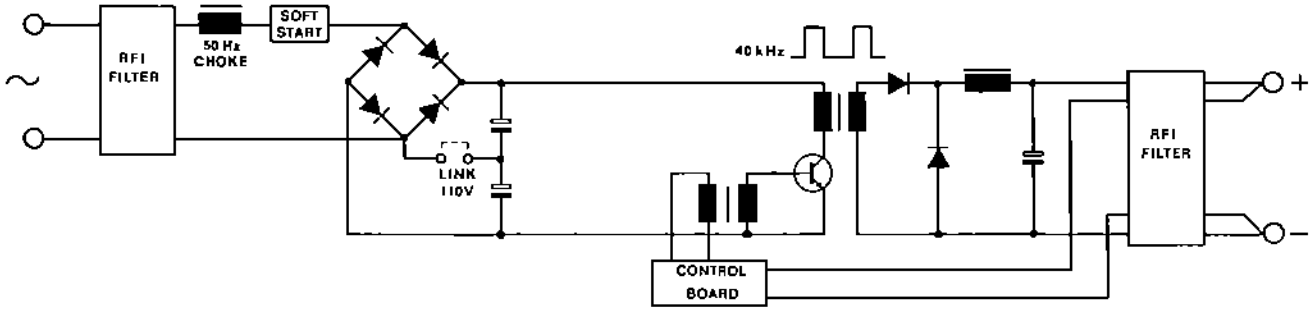
Efficiency versus load current at 30 V output

Ripple voltage

The ripple voltage at the output is less than 10mV peak to peak and there are no high frequency spikes on it due to a carefully designed RFI filter in the output circuit. The photo shows the 40kHz ripple at the output seen on a scope with a bandwidth of 50MHz. Horizontal scale is 20uS/div.



Ripple voltage 10mV/div.

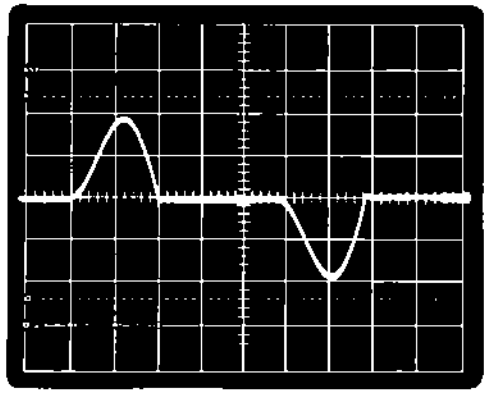


Input voltage

185-265 VAC 50-60Hz or 220-350 VDC or after changing the internal link 95-132 VAC

Input current

At 600 Watts output and 220 VAC input the input current is about 4A rms.



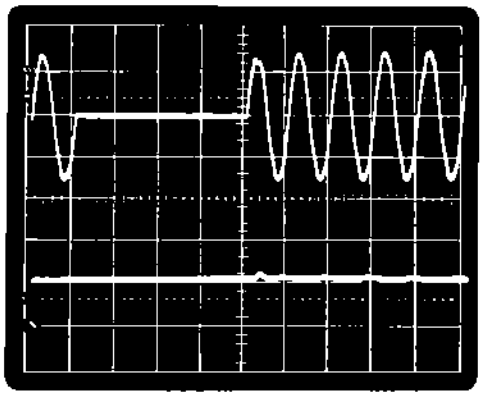
AC input current 4A/div.

Input choke

A 50Hz choke in the input circuit limits sharp current peaks in order to keep the distortion at the line voltage as low as possible.

Inrush current

During switch on the inrush current is limited by a resistor of 7,5 Ohm which is bridged by a triac during operation. The output voltage comes up about 300mS after switch on.



AC input voltage 200V/div.

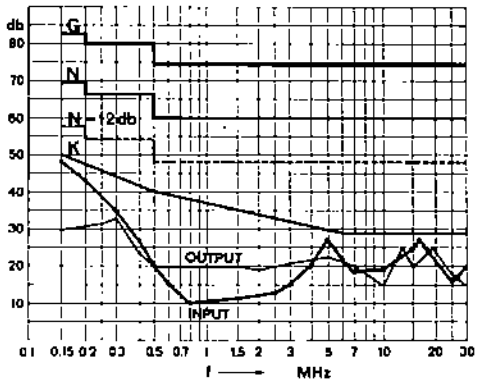
DC output voltage 50mV/div.

Line voltage interruption

Photo shows that a line voltage interruption of 80mS (4 cycles) does not affect the output voltage. Load is 60V 5A. At 60V 10A the maximum allowed line voltage interruption is about 30mS.

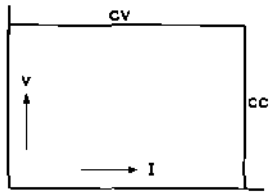
RFI suppression

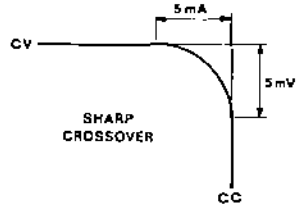
Practically no radio frequency interference on input and output due to carefully designed filters.
RFI suppression is in accordance with VDE 0875 grade K, both on input and output.



CV/CC regulation

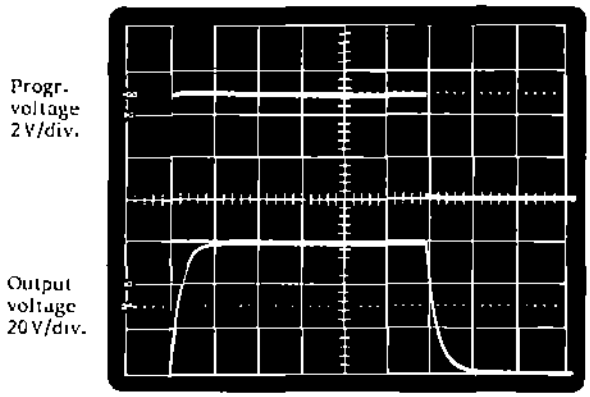
The SM6020 can be used as a constant voltage source with current limiting or as a constant current source with voltage limiting. The change of mode occurs sharply at the crossing of the voltage and current settings.





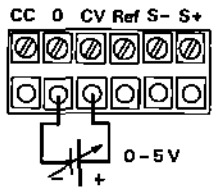
Remote programming

Output voltage and current can be programmed. A programming voltage of 0-5V corresponds with zero to full range of output voltage or current. The maximum programming speed is 600V/sec. However the output electrolytic capacitors might be overheated if a high amplitude is combined with a high repetition frequency. Voltage and current can also be setted by external 5kOhm potentiometers.



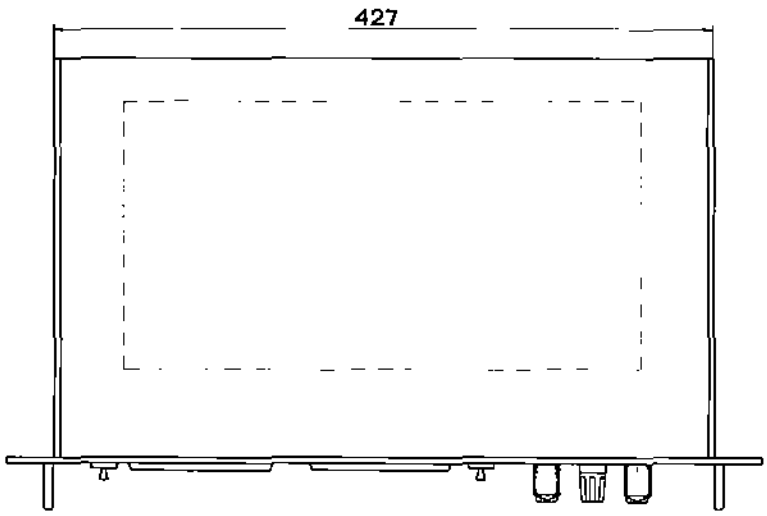
Remote sensing

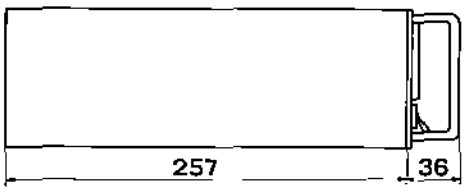
Normally the sense switch at the rear is at "internal". To keep the voltage constant at the load terminals instead at the output terminals the sense switch has to be put at "external" and sense wires have to be connected from S+ and S- to the load. A maximum of 2V per lead can be compensated.

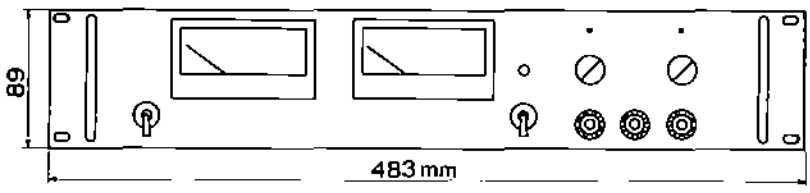


Voltage and current controls

Voltage and current controls are by 10-turn potentiometers for reliable high resolution.







		CV	CC
Line regulation	Input 185-265 VAC	5 mV	70 mA
Load regulation	Load 0-100%	5 mV	70 mA
Ripple + noise p-p		10 mV	50 mA
Temperature coefficient per °C		5.10^{-5}	5.10^{-4}
Stability			
During 8 hours, after one hour warm up, under constant load and ambient conditions		$3\text{-}10^{-4}$	1.10^{-3}
Output impedance			
Up to 100 kHz, less than		0,1 Ohm	-

Recovery time

0,5 mS for recovery to within 0,1 V after a load step of 10-100%, measured at 30 V 20 A.

Efficiency

87%. Total losses are only 90 Watts at 600 Watts output.

Ambient temperature

-20 to +50°C at full load. At -20°C the recovery time increases to about 1 mS and the ripple to 30mVp-p.

Thermal protection

In case of insufficient cooling a thermoswitch shuts down the output voltage.

Overvoltage protection

Built-in overvoltage protection is adjustable from 6 to 65V with a screwdriver through a hole in the front panel. When the output reaches the setted trip level of the OVP the power supply shuts down. To reset the output it is necessary to switch off the power supply and switch it on again. The OVP is not of the crowbar type and therefore cannot absorb power from external sources. An external voltage exceeding 75V can damage the OVP circuit and the output capacitors.

Parallel and series operation Up to 500 V combined output.

Insulation

2,5kVACrms (1 min.) between input and case and between input and output. 500VDC between output and case. Insulation resistance is better than 50MOhm (measured at 500VDC). Safety is in accordance with with IEC 348.

Option 75 V

The SM6020 is also available with extended output voltage ranges 0-37,5V/0-75V instead 0-30V/0-60V. At 75V this unit can still supply the full 10A (750W) but at a derated maximum ambient temperature of 35°C instead 50°C. Another limitation is the minimum required AC input voltage which is:

210VAC at 75V 10A (37,5V 20A)
198VAC at 75V 8A (37,5V 16A)
185VAC at 65V 10A (32,5V 20A)

SM 6020

1. INPUT

1.1 185-265VAC 50-60Hz

The SM6020 is normally delivered for input 185-265VAC 50-60Hz to operate on European line voltages 220V and 240VAC.
In this mode the black wire with faston receptacle from the centre tap of the 50Hz choke (L3) is connected to the faston tab at the bottom side of the PC-board P247.
Input fuse: 10A slow blow 6 x 32 mm.

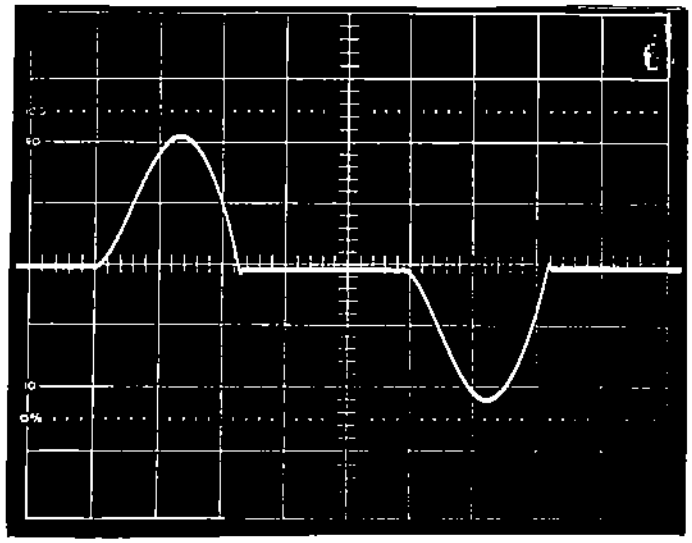
1.2 220-350VDC

In the same configuration as above the SM6020 can also work on 220-350VDC. The polarity does not matter, because the input circuit has a bridge rectifier.

1.3 95-132VAC 50-60Hz

For use on 95-132VAC 50-60Hz, the black wire with faston receptacle from the centre tap of the 50Hz choke (L3) has to be connected to the faston tab on the upper side of P247. In this mode the input circuit acts as a voltage doubler.
Input fuse: 15A slow blow 6 x 32 mm.

1.4 Input current



AC input current wave-form
(at 600W load)

Horizontal: 2 mS/div.
Vertical : 4 A/div.

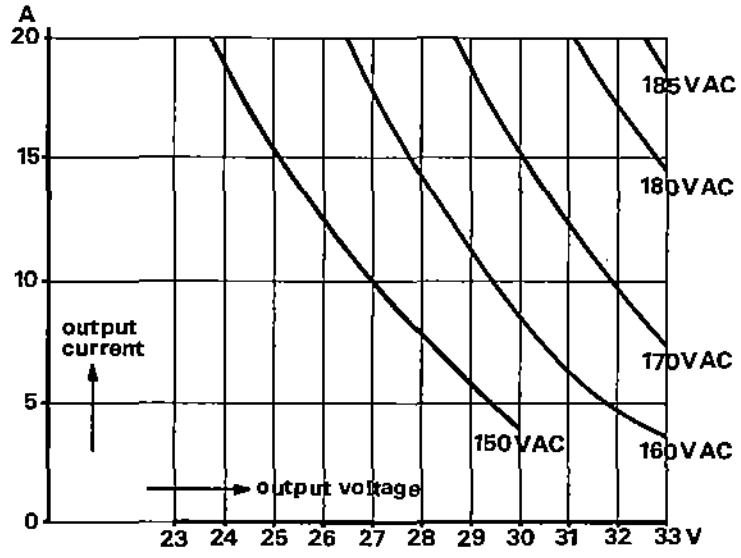
The AC-input current waveform is greatly improved by the low frequency choke in series with the input (This improvement usually lacks in designs of other manufacturers).

Additionally a soft start circuit keeps the peak input current low during switch-on. This circuit consists of a power resistor which is shunted by a triac as soon as the input capacitors are charged.

At 220VAC and full load the input current is about 4A RMS.

1.5 DERATING OF OUTPUT AT INPUT LOWER THAN 185VAC

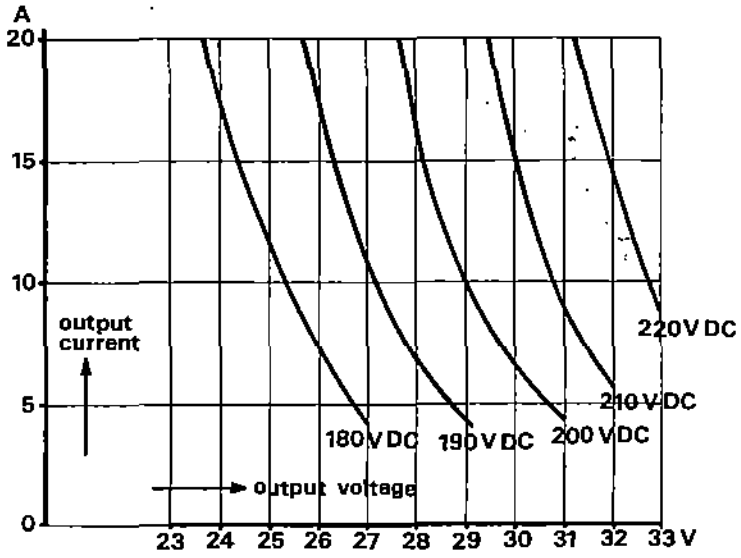
The SM6020 still functions normal at very low AC input voltages, but with reduced output voltage and current.



Maximum output current as function of output voltage with AC-line input as a parameter.

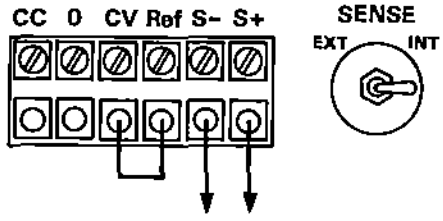
1.6 SM6020 USED AS A DC-DC CONVERTER

The SM6020 can also be used as a DC-DC converter at 220VDC input.



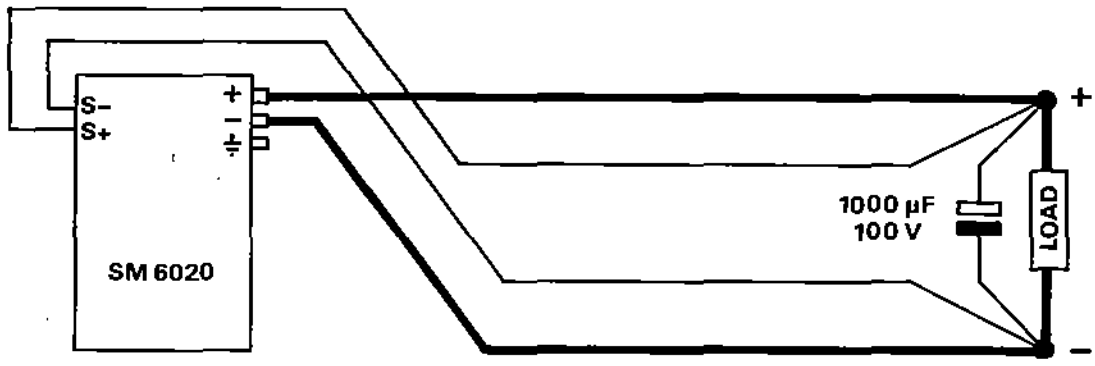
Maximum output current as a function of output voltage with DC-line input as a parameter.

2. INTERNAL OR EXTERNAL SENSING



In most applications the power supply is used with internal sensing, which means that the output voltage is kept constant at the output terminals on the front panel. In this case the sense switch, accessible through a hole of the rear panel, has to be in the position "Internal".

If it is desirable to compensate the voltage drop over the leads to the load, the points of stabilisation can be displaced from the output terminals to the load terminals by using sense wires from S+ and S- (rear terminal block) to the load and putting the sense switch in the position "External".

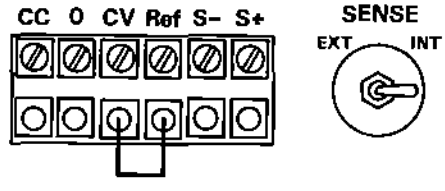


To prevent for undesirable interference or oscillation it is advisable to twist the sense leads and to connect an electrolytic capacitor to the load terminals.

3. OVER VOLTAGE PROTECTOR

The built-in over voltage protector can be adjusted between 6V and 65V with a screwdriver through the front panel.
When the output reaches the setted trip level of the OVP the power supply shuts down. To reset the output voltage it is necessary to switch off the power supply and switch on again.
The OVP is not of the crowbar type and therefore cannot absorb power from external sources. An external voltage exceeding 100V can damage the internal OVP circuit and the output capacitors.

4. VOLTAGE AND CURRENT CONTROL BY FRONT PANEL POTENTIOMETERS



Connect a link between CV and Ref at the rear terminal block. Take care that the sense-switch is on INTERNAL.
The internal current prog switch S4 on P266 has to be in the position "Front panel current control"(As on delivery of the SM6020).

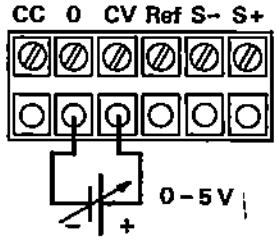
Voltage and current controls are by 10-turn potentiometers for reliable high resolution.
10 turns of the voltage contol corresponds with 0 to 60V.
10 turns of the current control corresponds with 0-20A.

When the output range selector switch is at 0-30V 20A, only the first 5 turns of the voltage control knob react. This means that the output voltage will not rise to the double value when the selector switch is switched to 60V by error. The same happens with the current control knob when the selector switch is at 60V 10A.

5. REMOTE PROGRAMMING

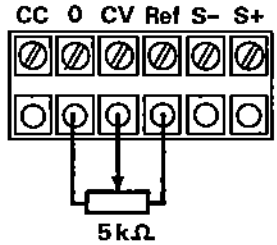
5.1 VOLTAGE BY VOLTAGE

To program the output voltage by an external voltage, connect the driving voltage between CV and 0 at the rear terminal block.
A driving voltage of 0 to about 5V programs the output from 0 to 60V.
Terminal 0 is internally connected to S- of the output and an internal fuse in series is protecting the sense wire for burn out in case of a wrong connection.



5.2 VOLTAGE BY EXTERNAL POTENTIOMETER

To set the output voltage with an external potentiometer, connect a potentiometer of 5 kOhm to the terminals Ref, CV and 0 and turn the potentiometer at the front panel on maximum.

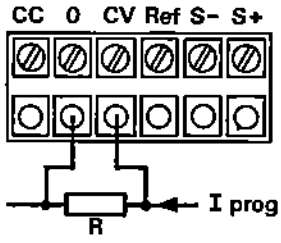


5.3 VOLTAGE BY CURRENT

For max. output voltage applies:

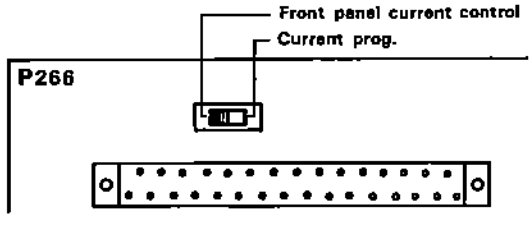
$$R = \frac{5}{I\,prog}$$

For example: With R = 500 Ohm a current of 0-10mA will program the output 0-60V

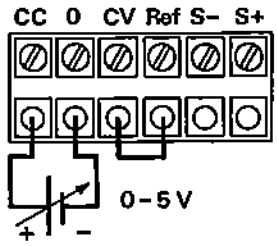


5.4 CURRENT BY VOLTAGE

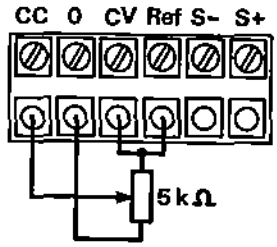
To make this possible the internal switch S4 on P266 has to be put in the position "current prog".



With about 0-5V between the terminals CC and 0 the output current varies between 0 and 20A if working in the current mode.

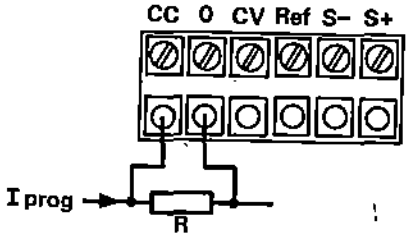


5.5 CURRENT BY EXTERNAL POTENTIOMETER



Internal switch S4 on P266 at "current prog". If no external 5V source is available the CV reference has to be used to power the external current control potentiometer. This is possible if the voltage control potentiometer at the front panel is turned on maximum.

5.6 CURRENT BY CURRENT



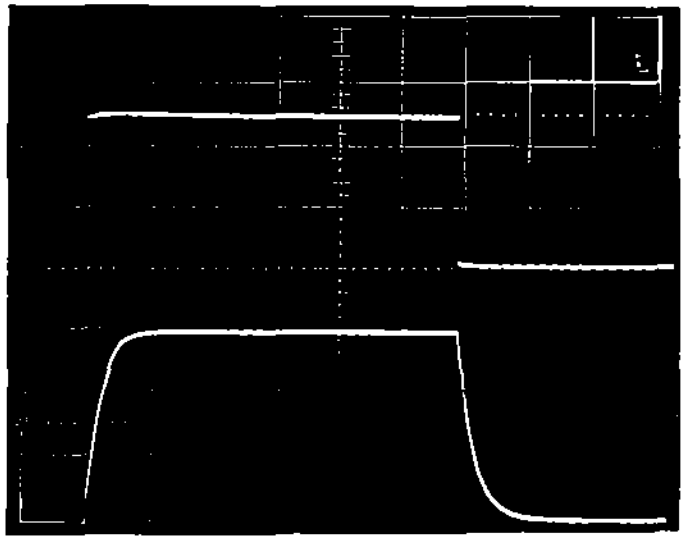
Internal switch S4 on P266 at "current prog". For maximum output current applies:

$$R = \frac{5}{I\,prog}$$

For example with R = 500 Ohm a current of 0-10 mA can program the output 0-20A.

6. PROGRAMMING SPEED

The programming speed is very much limited by the electrolytic capacitors on the output, which will heat up at a combined high repetition rate, high amplitude and high programming speed. The maximum programming speed is about 600V/sec., however the product of dv/dt (in V/s) x amplitude (in V) x repetition frequency (in Hz) may not exceed 2.10^4.

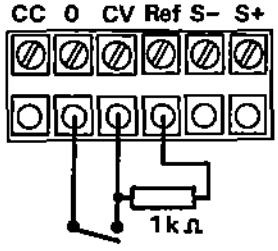


Upper diagram:
Programming voltage.
Vertical scale 2V/div.

Lower diagram:
Output voltage.
Vertical scale 20V/div.

Horizontal scale 100mS/div.

7. OUTPUT ON/OFF BY AN EXTERNAL CONTACT



The output can be switched on and off by shorting terminal CV to terminal 0 by a switch or a reed relais contact.
Instead of a link a resistor of 1kOhm has to be connected between Ref and CV.

8. PARALLEL OPERATION

8.1 PARALLEL OPERATION IN CV MODE

Several units SM6020 can be connected in parallel to obtain a higher current. Before putting in parallel first adjust all outputs to the same voltage. Use leads of equal lenght from each output to the summing point. When the outputs are unequal the power supply with the highest output starts to supply all the current till it goes in constant current. Then the output drops to the next highest setted voltage etc.
No provision is made for master and slave parallel operation.

8.2 PARALLEL OPERATION IN CC MODE

In the CC mode the total current is the sum of the setted individual currents.

9. SERIES OPERATION

9.1 SERIES OPERATION IN CV MODE

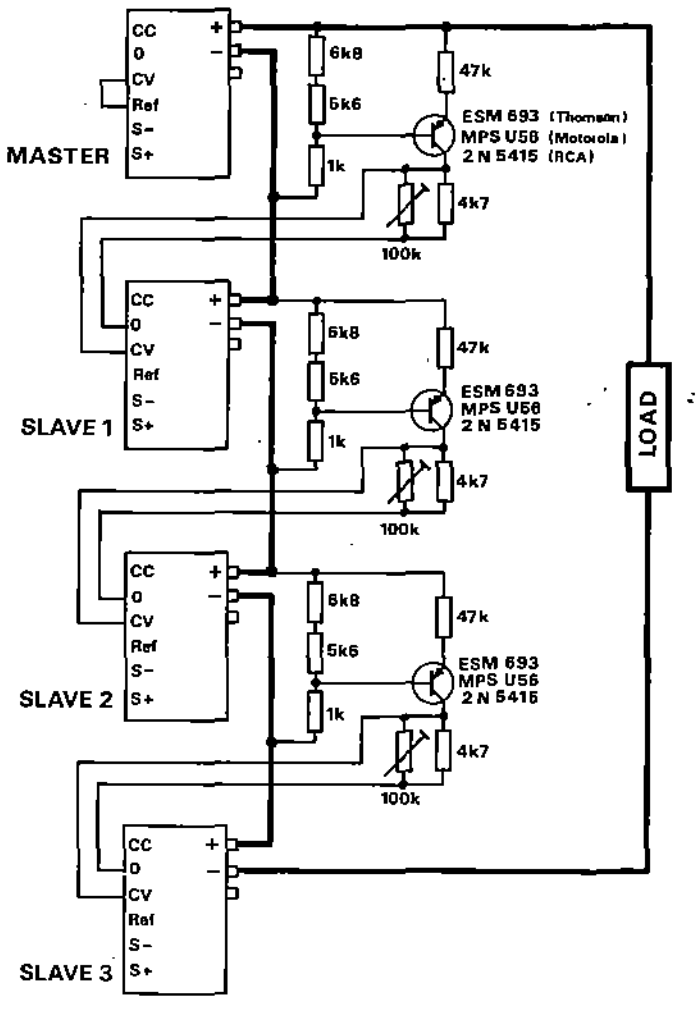
Power supplies SM6020 may be connected in series to a maximum total voltage of 500V (max. 8 units), by simply connecting the plus of the one with the minus of the next. The voltage control potentiometers can be set individually at different values, but the CC potentiometers have to be set at an about equal maximum current which is safe for the load.

9.2 MASTER AND SLAVE SERIES OPERATION IN CV AND CC MODE

If it is required to control the voltage or current of the series connection by controlling one unit (the master), some extra circuitry is necessary.

With this circuit the total voltage can continuously be varied from zero to full by the voltage control potentiometer of the master, or by programming the master as described under 6.1 to 6.3.

Also the current of the series connection is only determined by the current setting or programming of the master.
The current control knobs of the slaves have to be put on maximum in this case.
A disadvantage of this circuit is that the programming speed is much lower than with one unit.



MASTER AND SLAVE SERIES CONNECTION

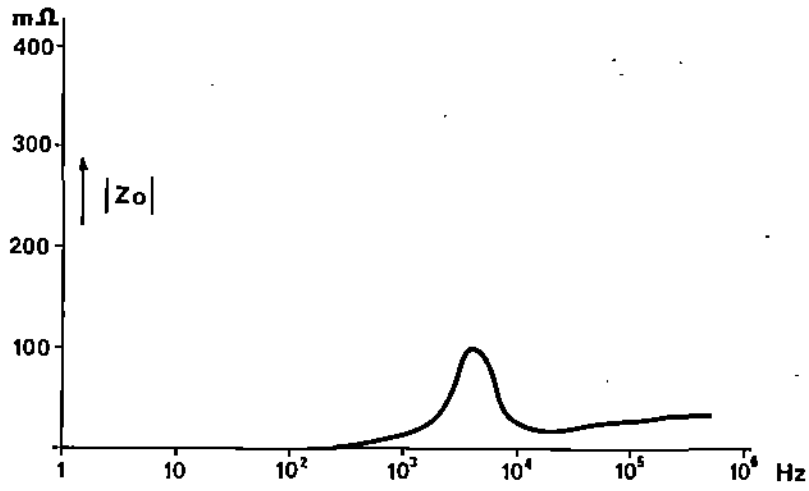
9.3 SERIES OPERATION IN CC MODE

If in the CC mode the output voltage of one unit is not sufficient a second unit (in CV mode) can be put in series. The current setting of the first unit will then still determine the constant current as long as the voltage variation caused by the load is less than the max. voltage of one unit (60 V).
When the voltage variation exceeds the max. voltage of the first unit, the constant current will in one step change to the setted current of the second one. To keep this step change small the CC setting of both units can be put at the same value before connecting in series.
The additional circuit of 9.2 overcomes these difficulties.

10. LOAD RIPPLE AND PEAK CURRENTS

Ripple currents caused by the load at frequencies below 1 kHz are compensated by the voltage regulation.
However high load ripple currents which exceed the current limit or which have strong components above 1 kHz can overheat the output electrolytic capacitors. Also repetitive high peak currents, like taken by thyristor DC-AC inverters can have this effect. In such a case an electrolytic capacitor of 10.000 uF parallel to the load is recommended.

11. OUTPUT IMPEDANCE



Output impedance as function of load frequency

12. THERMAL PROTECTION

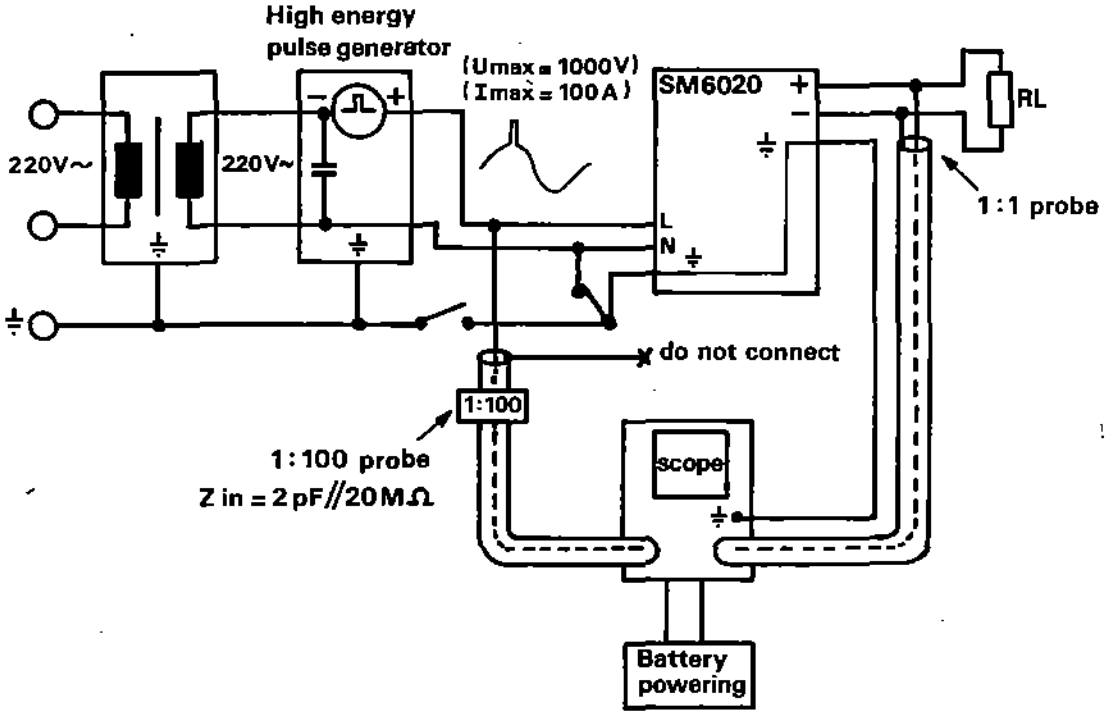
A thermal shut down circuit protects the power supply against overheating in case of insufficient cooling.

13. SM6020 USED AS A BATTERY CHARGER

CV/CC regulated power supplies are ideal battery chargers. However sometimes the internal wiring is burned out by connecting the polarity of the battery wrong by error.
The SM6020 has a heavy diode in reverse polarity parallel to the output terminals, directly behind the front panel. However this diode cannot withstand the hundreds of amperes supplied by a wrong connected battery. So it is recommended to use always a fuse in series with the battery.

14. SUPPRESSION OF HIGH ENERGY, HIGH VOLTAGE INTERFERENCE

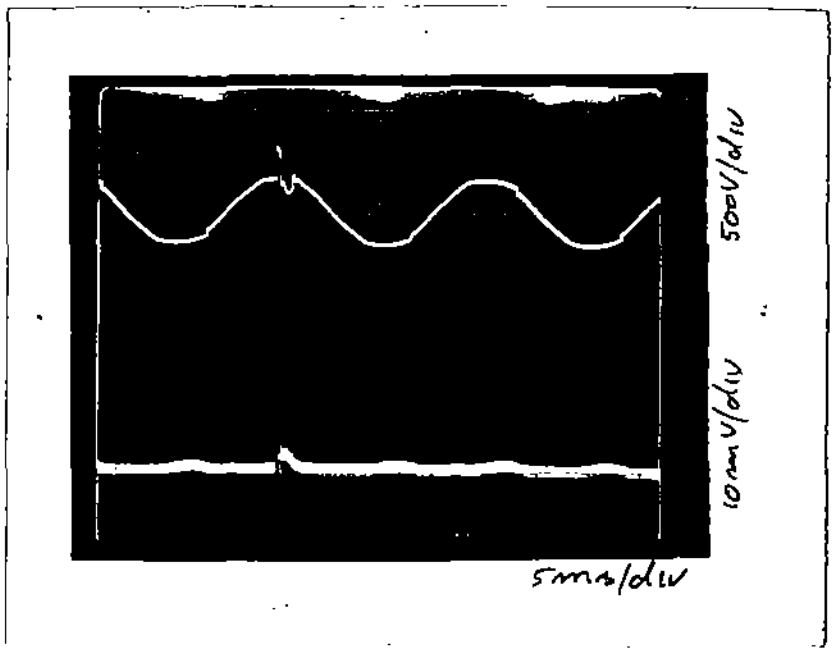
14.1 SYMMETRICAL HV INTERFERENCE (LINE TO LINE)



Input voltage (line to line)
500V/division
Probe 1:100 with
Z_{input} = 2pF // 20MOhm

DC output voltage
10mV/division
Probe 1:1

Horizontal scale 5mS/div.

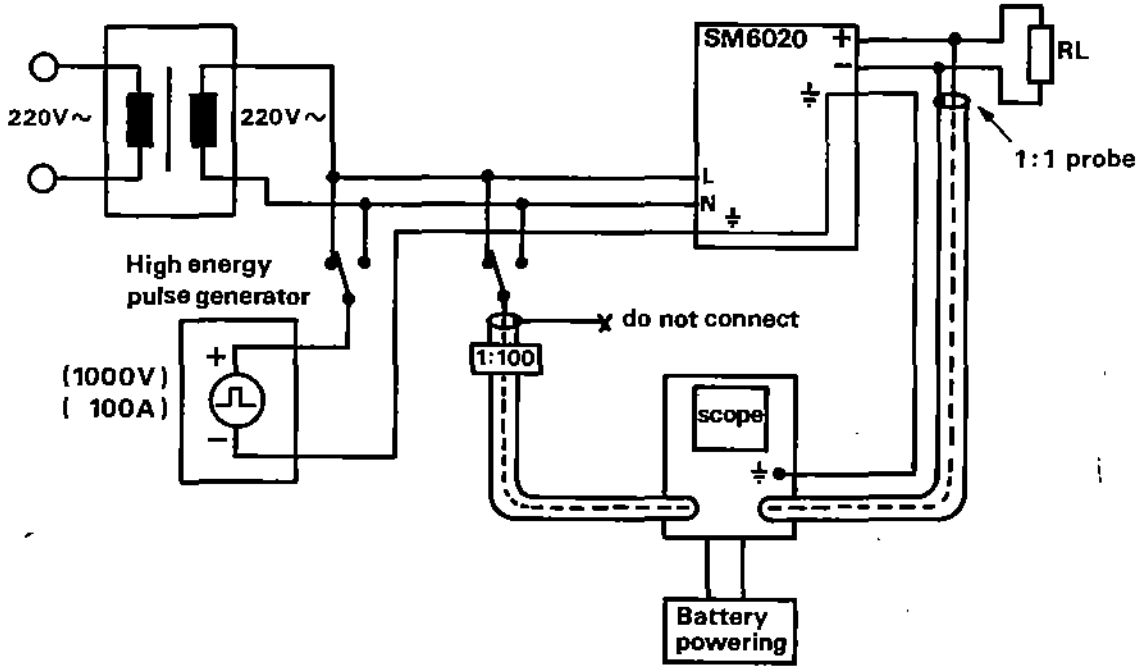


The input of the SM6020 is protected against short duration, high voltage pulses by means of a varistor, which clips these pulses at about 700V peak.

At above scope photo is shown how a 1000V, 300uS pulse on the AC input is clipped at about 700V above zero level by the varistor.

The lower diagram shows that this high energy pulse causes only a very small spike of about 20mV peak to peak at the regulated DC output voltage, which is almost negligible.

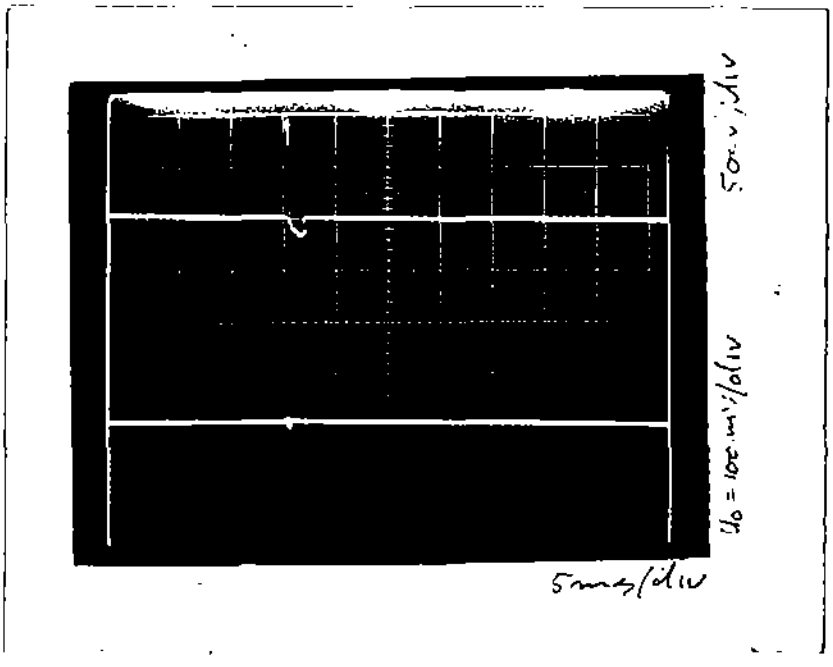
14.2 ASYMMETRICAL HV INTERFERENCE (LINE TO EARTH)



Voltage between input and case, 500 V/division
Probe: 1 : 100 with
Z_{input} = 2pF // 20 MOhm

DC output voltage
100mV/division
Probe 1 : 1

Horizontal scale 5mS/div.



Above scope photo shows that a 1000 V, 200 uS pulse between line and earth causes only a 20 mV peak to peak disturbance on the regulated DC output voltage.

15. OPTION "0-75V"

The SM6020 is also available with option "0-75V", which means extended output voltage ranges 0-37,5V/0-75V instead of 0-30V/0-60V.

At 75V this unit can still supply the full 10A (750W) but at a derated maximum ambient temperature of 35°C instead of 50°C.

Another limitation is the lowest AC input voltage, which is:

210VAC (250VDC) at 75V 10A (37,5V 20A)
198VAC (235VDC) at 75V 8A (37,5V 16A)
185VAC (220VDC) at 65V 10A (32,5V 20A)

When connected for 110VAC these values are 108V, 102V and 95V respectively.

All other specifications are unchanged.

16. TROUBLE SHOOTING

No output: In case of no output after switch on first check:

* If link between CV and Ref (on rear panel) is made.
* If sense switch is on "internal".
* If CV and CC control potentiometers are not on zero.
* If perhabs the OVP has tripped (Turn up OVP potmeter and switch unit off and on again).
* If perhabs the internal switch S4 on P266 is at "Front panel current control" (see 5.4, page 6).

Warning:

Before opening the cover first disconnect the line cord and wait a few minutes till all capacitors are discharged.

Internal fuse:

When the internal fuse F3 is found blown, do not replace it, because it means that the power switching transistor Q1 on P262 is defective. Replacing fuse F3 in such a case will cause wire wound resistor R3 on P268 to burn out.

Fault finding

Check diodes D51,52,53,54 of output circuit with an Ohmmeter. If defective Q1 at P262 will also be defective. Replace defective diodes and exchange P262

Modular construction:

The SM6020 is built up modular and all modules are fully exchangeable.
It is recommended not to try to repair modules but to send them to Delta for repair and inspection.

Repair of P262

Disconnect all terminals of P262. Disconnect Q1 (BUV98). Check diodes D3,4,9 with Ohmmeter. D5 has to be disconnected to check. Replace defective parts.

When repairing old models leave D3 out and replace D4 (BY218-800) by BYT12P800 (Sescosem) and D5 (BY218-800) by BYV96D (Philips).

Check R3 on P268 and replace defective fuse F3 (8A type F).

R = Ohm

1 =	Z 21 L 471		63 =	1	k		100 =	22		
2 =	2,2	M	VR 25	64 =	56	k		101 =	22		
3 =	15		10 W WW	65 =	4,7	k		102 =	22		
4 =	120		PR 37	66 =	3,9	k		103 =	22		
5 =	47		7 W WW	67 =	2,2	M	VR 25	104 =	1		
6 =	47		7 W WW	68 =	10	k		105 =	1	k	trim
7 =	100	k	MK 3	69 =	22	k		106 =	180		
8 =	100	k	MK 3	70 =	22	k		107 =	56	k	
9 =	1		7 W WW	71 =	3,3	k		108 =	10	k	trim
10 =	10		PR 37	72 =	CR			109 =	2,2	M	VR 25
11 =	100		25 W RCL	73 =	12	k		110 =	10	k	
12 =	470			74 =	2,7	k		111 =	10	k	
13 =	68	k		75 =	39	k		112 =	10	k	
14 =	CR			76 =	56	k	MK 3	113 =	10	k	
15 =	68	k		77 =	56	k	MK 3	114 =	2,2	k	
16 =	1,2	k		78 =	4,7	k		115 =	3,3	k	
17 =	390	k		79 =	680			116 =	Z 7 L 821		
18 =	CR			80 =	2,7	k		117 =	22	k	
19 =	390	k		81 =	5	k	10 trns	118 =	15		10W WW
20 =	100	k	MK 3	82 =	-						
21 =	100	k	MK 3	83 =	560						
22 =	100	k	MK 3	84 =	4,7	k					
23 =	100	k	MK 3	85 =	1	k					
24 =	270			86 =	10	k	10 trns				
25 =	330			87 =	680						
26 =	100			88 =	470						
27 =	1	k		89 =	270						
28 =	10	k		90 =	330		PR 37				
29 =	33	k		91 =	27		PR 37				
30 =	CR			92 =	27		PR 37				
31 =	CR			93 =	2,2		7 W				
32 =	6,8			94 =	1,2	k	10 W				
33 =	CR			95 =	120						
34 =	-			96 =	3,3	k					
35 =	15			97 =	0,01		1% 50 W				
36 =	1	k		98 =	22						
37 =	330			99 =	22						
38 =	6,8	k									
39 =	100										
40 =	2,2	k									
41 =	1	k									
42 =	470										
43 =	470										
44 =	1	k									
45 =	150										
46 =	-										
47 =	2,2	k									
48 =	1,8	k									
49 =	2,2	k									
50 =	68	k	MK 3								
51 =	2,2	k									
52 =	2,7	k									
53 =	2,7	k									
54 =	2,2	k									
55 =	2,7	k									
56 =	2,7	k									
57 =	150	k									
58 =	820	k									
59 =	5	k	10 trns								
60 =	33	k									
61 =	CR										
62 =	1	k									

CR = calibration resistor
WW = wire wound
MRS 25 = metal film 0,4 W 1%
MK 3 = metal film 0,5 W 1%
PR 37 = metal film 1,6 W 5%
VR 25 = metal film 0,25W 5% 1600 V-

All non specified resistors are of type MRS 25

			Title: Part list SM6020
R42 = 470Ω	7-'86	Vr.	Date: 1-'79
Modifications	Date	App.	delta elektronika bv

C

1 =	0,22	µF	250	V~
2 =	2,2	nF	4	kV
3 =	0,22	µF	250	V~
4 =	0,22	µF	250	V~
5 =	2,2	nF	4	kV
6 =	1,5	µF	160	V
7 =	0,15	µF	250	V~
8 =	800	µF	200	V
9 =	800	µF	200	V
10 =	800	µF	200	V
11 =	800	µF	200	V
12 =	800	µF	200	V
13 =	800	µF	200	V
14 =	1	µF	400	V
15 =	3,3	µF	100	V
16 =	10	µF	63	V
17 =	10	nF	1000	V
18 =	1,8	nF	2	kV
19 =	1,8	nF	2	kV
20 =	1,8	nF	2	kV
21 =	10	pF	4	kV
22 =	100	µF	10	V
23 =	15	pF	500	V
24 =	150	pF	400	V
25 =	470	pF	160	V
26 =	47	pF	500	V
27 =	100	pF	500	V
28 =	0,1	µF	400	V
29 =	150	pF	1600	V
30 =	0,22	µF	63	V
31 =	15	µF	16	V
32 =	15	µF	16	V
33 =	1	nF	630	V
34 =	22	µF	40	V
35 =	15	µF	16	V
36 =	470	pF	160	V
37 =	–			
38 =	10	nF	250	V
39 =	220	nF	63	V
40 =	47	nF	250	V
41 =	470	pF	160	V
42 =	100	pF	500	V
43 =	15	µF	16	V
44 =	470	pF	160	V
45 =	470	pF	160	V
46 =	47	µF	40	V
47 =	15	µF	16	V
48 =	1	nF	630	V
49 =	1	nF	630	V
50 =	15	µF	16	V
51 =	15	µF	16	V
52 =	470	pF	500	V
53 =	470	pF	500	V
54 =	10	nF	1000	V
55 =	1	nF	630	V
56 =	100	pF	500	V
57 =	470	pF	500	V
58 =	10	nF	250	V
59 =	470	pF	500	V
60 =	15	µF	16	V
61 =	15	µF	16	V
62 =	470	pF	500	V
63 =	22	nF	250	V
64 =	47	nF	250	V
65 =	470	pF	500	V
66 =	15	µF	16	V
67 =	15	µF	16	V
68 =	2,5	nF	250	V~
69 =	2,5	nF	250	V~
70 =	10	µF	100	V
71 =	10	µF	100	V
72 =	470	µF	100	V
73 =	220	nF	63	V
74 =	470	µF	100	V
75 =	470	µF	100	V
76 =	470	µF	100	V
77 =	470	µF	100	V
78 =	470	µF	100	V
79 =	470	µF	100	V
80 =	47	µF	63	V
81 =	0,22	µF	250	V~
82 =	15	µF	16	V
83 =	0,22	µF	63	V
84 =	0,22	µF	63	V
85 =	0,22	µF	63	V
86 =	0,22	µF	63	V
87 =	0,22	µF	63	V
88 =	0,22	µF	250	V~
89 =	47	µF	63	V
90 =	15	µF	16	V
91 =	470	µF	100	V
92 =	10	nF	1000	V
93 =	470	µF	100	V
94 =	1	µF	250	V
95 =	470	nF	250	V
96 =	10	nF	1000	V
97 =	0,15	µF	250	V~
98 =	5	nF	250	V~

			Title: Part list SM6020
Serial 0200 and up	11-'81	VR	Date: 1 – '79
Modifications	Date	App	delta elektronika bv

D

1 =	T 2513 NK	TAG
2 =	SKB 25/06	Semicron
3 =	-	
4 =	BYT 12 P 800	Sescosem
5 =	BYV 26 D	Philips
6 =	BY 218-800	Sescosem
7 =	-	
8 =	BZV 15C 12	Philips
9 =	BY 218-800	Sescosem
10 =	BY 218-800	Sescosem
11 =	BY 218-800	Sescosem
12 =	ZPD 8,2	ITT
13 =	1N4148	
14 =	ZPD 3,3	ITT
15 =	1N4148	
16 =	BYV 26 D	Philips
17 =	BYV 26 D	Philips
18 =	BZV 15C 12	Philips
19 =	BYV 26 D	Philips
20 =	ZPD 8,2	ITT
21 =	ZPY 13	ITT
22 =	1N4148	
23 =	1N4148	
24 =	1N4148	
25 =	1N4148	
26 =	ZPY 51	ITT
27 =	ZPD 3,3	ITT
28 =	PO 102 BA	TI
29 =	CQY 54-3	Philips
30 =	CQY 54-3	Philips
31 =	1N4148	
32 =	1N4148	
33 =	1N4148	
34 =	1N4148	
35 =	ZPD 8,2	ITT
36 =	1N4148	
37 =	1N4148	
38 =	1N4148	
39 =	1N4148	
40 =	1N4148	
41 =	1N825	IR
42 =	1N4148	
43 =	1N4148	
44 =	1N4148	
45 =	1N4148	
46 =	1N4148	
47 =	1N4148	
48 =	ZPD 5,1	ITT
49 =	ZPD 8,2	ITT
50 =	1N825	TI
51 =	BYW 77/200	Sescosem
52 =	BYW 77/200	Sescosem
53 =	BYW 77/200	Sescosem
54 =	BYW 77/200	Sescosem
55 =	40 HF10/1N249C	IR/RCA
56 =	1N4148	
57 =	40 HF10/1N249C	IR/RCA
58 =	1N4148	
59 =	1N4148	
60 =	TL 431	TI
61 =	40 HF10/1N249C	IR/RCA
62 =	ZPD 8,2	ITT
63 =	ZPD 10	ITT
64 =	1N4148	

Modifications	Date	App.	Title: Part list SM6020
Ds, 16, 17, 19, 28	10-'86	Vr.	
D3, 4, 5, 16, 17, 19	12-'84	Vr.	
Serial 0200 and up	11-'81	Vr	Date: 1-'79

delta elektronika bv

Q

1 =	BUV 98 A	Sescosem
2 =	-	
3 =	-	
4 =	-	
5 =	BUX 84	Philips
6 =	2 N 2907 A	Sescosem
7 =	2 N 2222 A	Sescosem
8 =	BS 250	ITT
9 =	BD 522	ITT
10 =	BD 522	ITT
11 =	BD 522	ITT
12 =	BD 522	ITT
13 =	BD 522	ITT
14 =	2 N 2907 A	Sescosem
15 =	2 N 2907 A	Sescosem
16 =	2 N 2222 A	Sescosem
17 =	2 N 2222 A	Sescosem
18 =	2 N 2907 A	Sescosem
19 =	2 N 2907 A	Sescosem
20 =	2 N 2907 A	Sescosem
21 =	2 N 2222 A	Sescosem

IC

1 =	HEF 4049 B	Philips
2 =	HEF 4069 UB	Philips
3 =	HEF 4069 UB	Philips
4 =	SFC 2747 M	Sescosem
5 =	SFC 2747 M	Sescosem

F

1 =	10 A (220V), 15A (110V)	slow blow
2 =	10 A (220V), 15A (110V)	slow blow
3 =	8 A	FAST
4 =	315 mA	FAST
5 =	315 mA	FAST

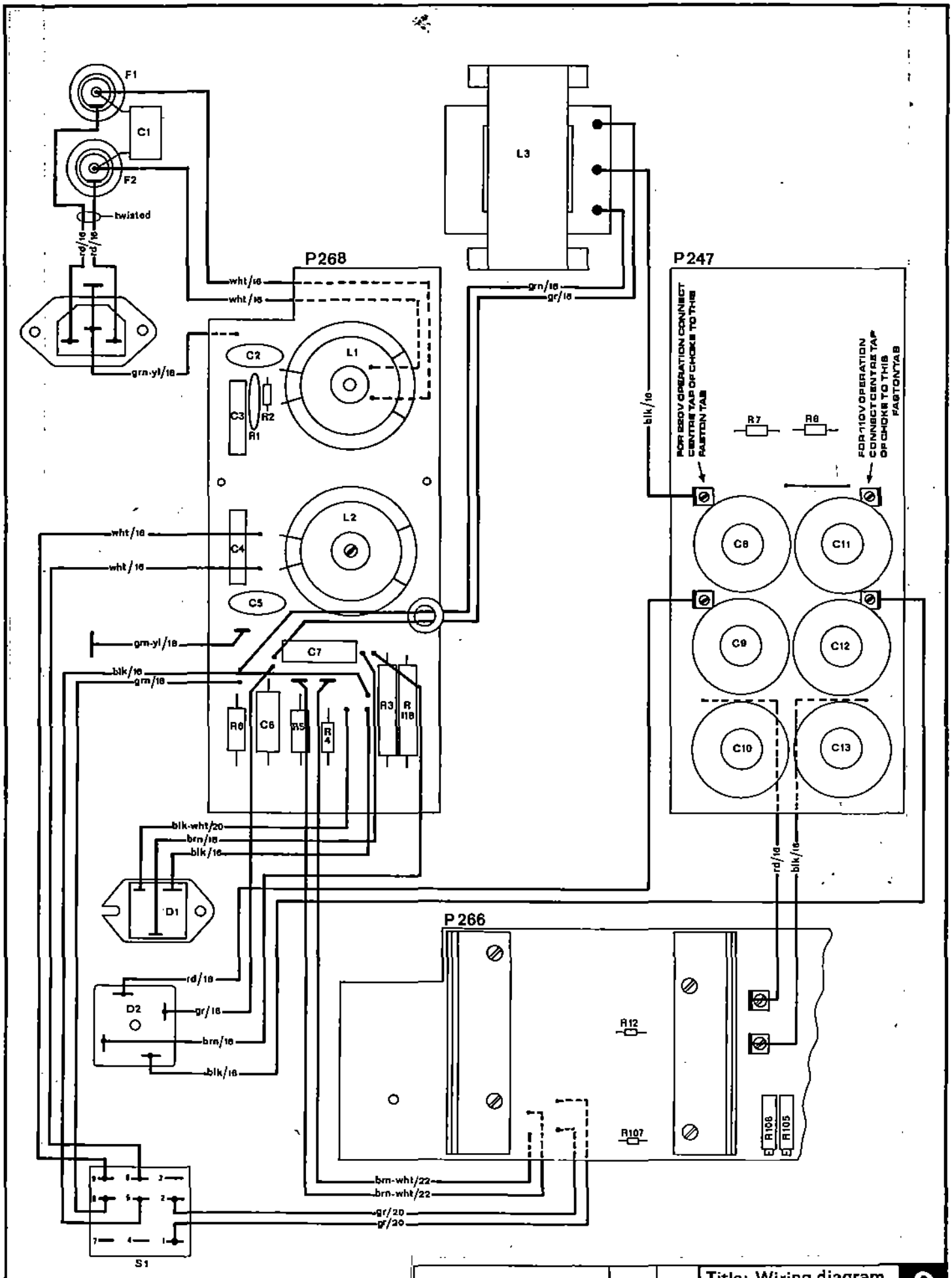
L

1 =	S 144	Delta
2 =	S 144	Delta
3 =	S 133	Delta
4 =	S 146	Delta
5 =	4,7 µH	Secre
6 =	S 147	Delta
7 =	S 148	Delta
8 =	2,2 µH	Secre

T

1 =	T 149	Delta
2 =	T 150	Delta
3 =	AT 4043/47	Philips
4 =	-	
5 =	T 156	Delta

				Title: Part list SM6020
Serial 0200 and up	11-'81	Vr		Date: 1-'79
Modifications	Date	App.		delta elektronika bv

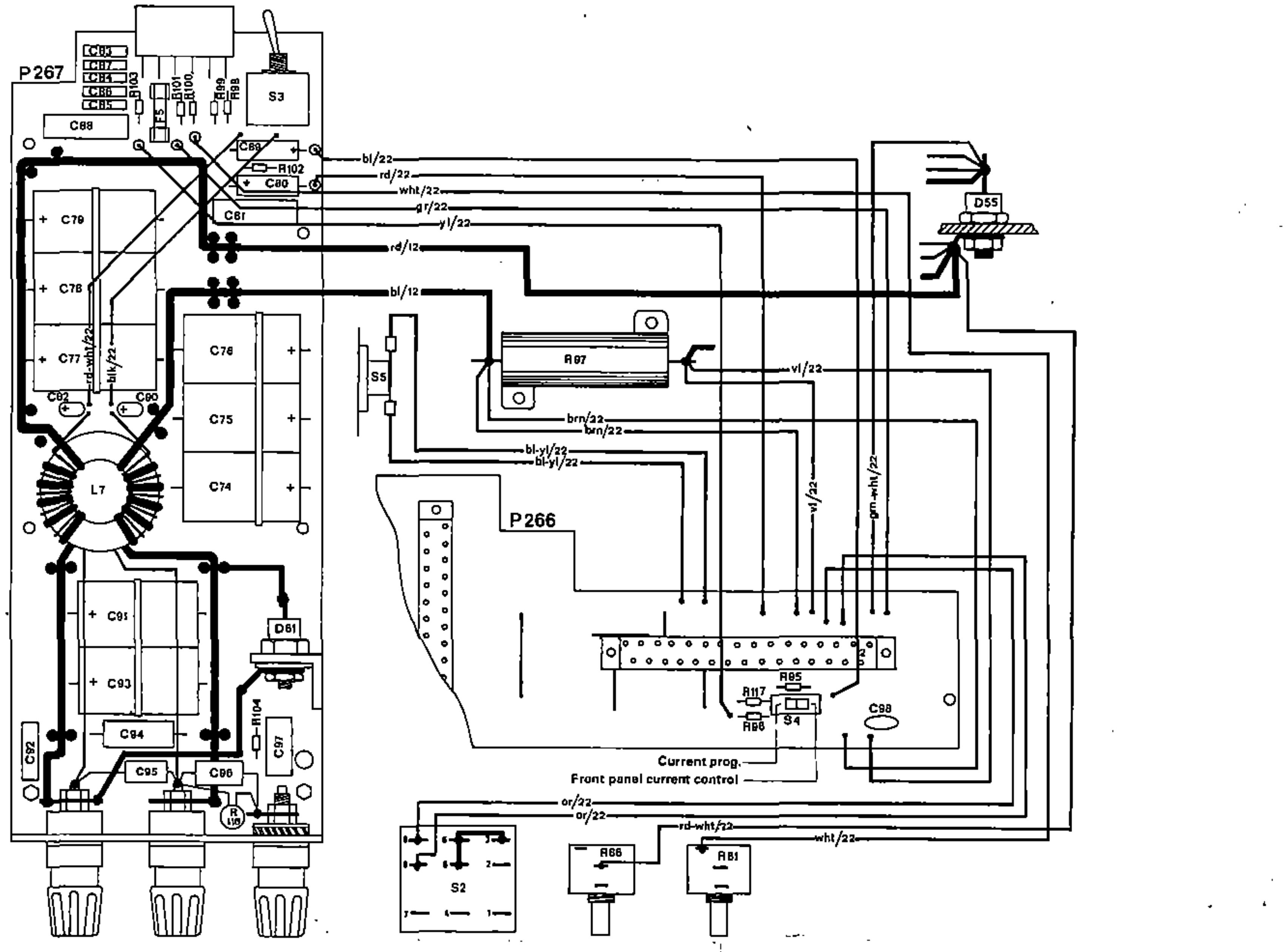


Modifications	Date	App.
R118 (P268)	12-'84	Vr
Serial 0200 and up	11-'81	Vr

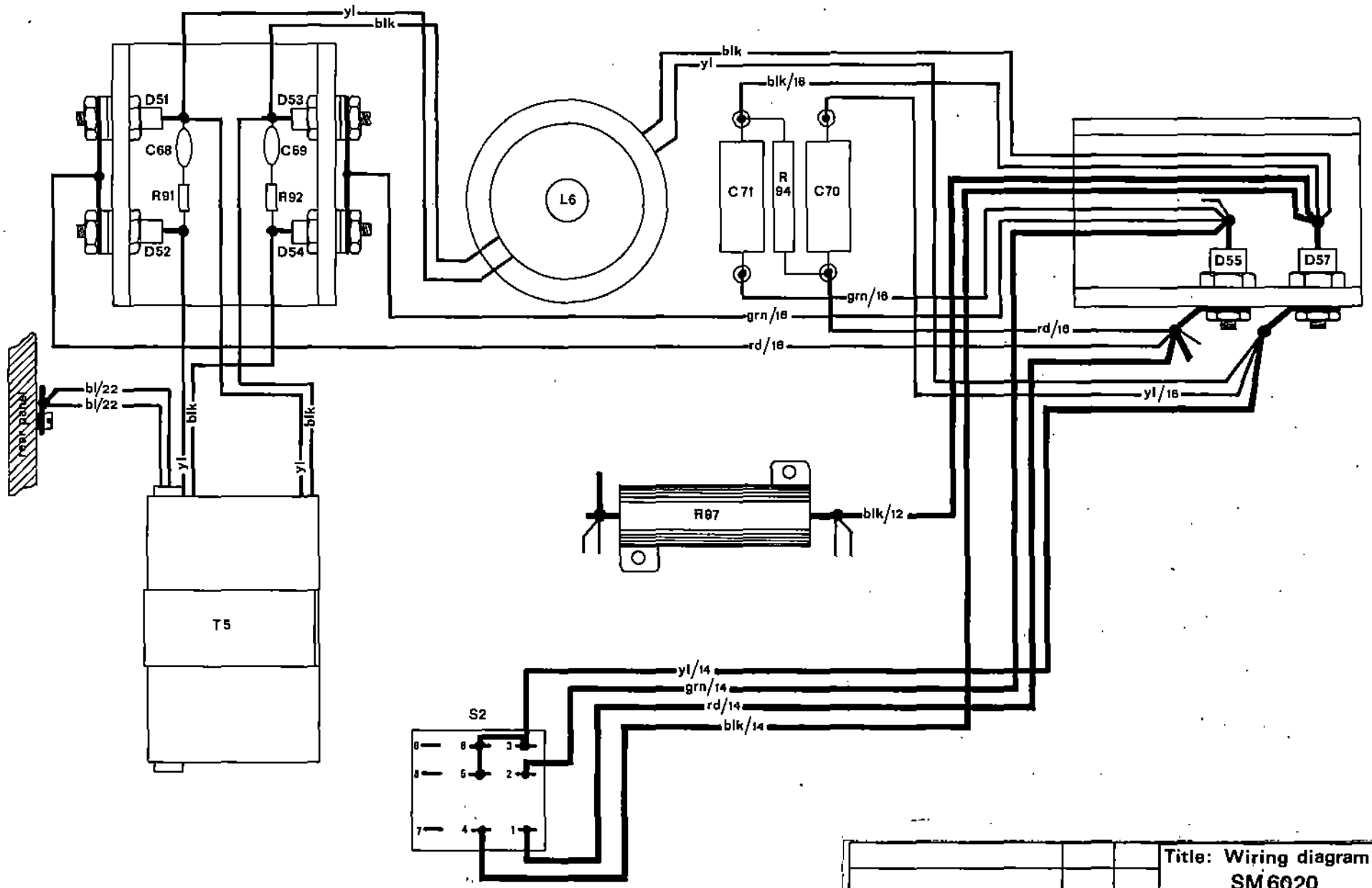
Title: Wiring diagram SM6020

Date: 1-'79

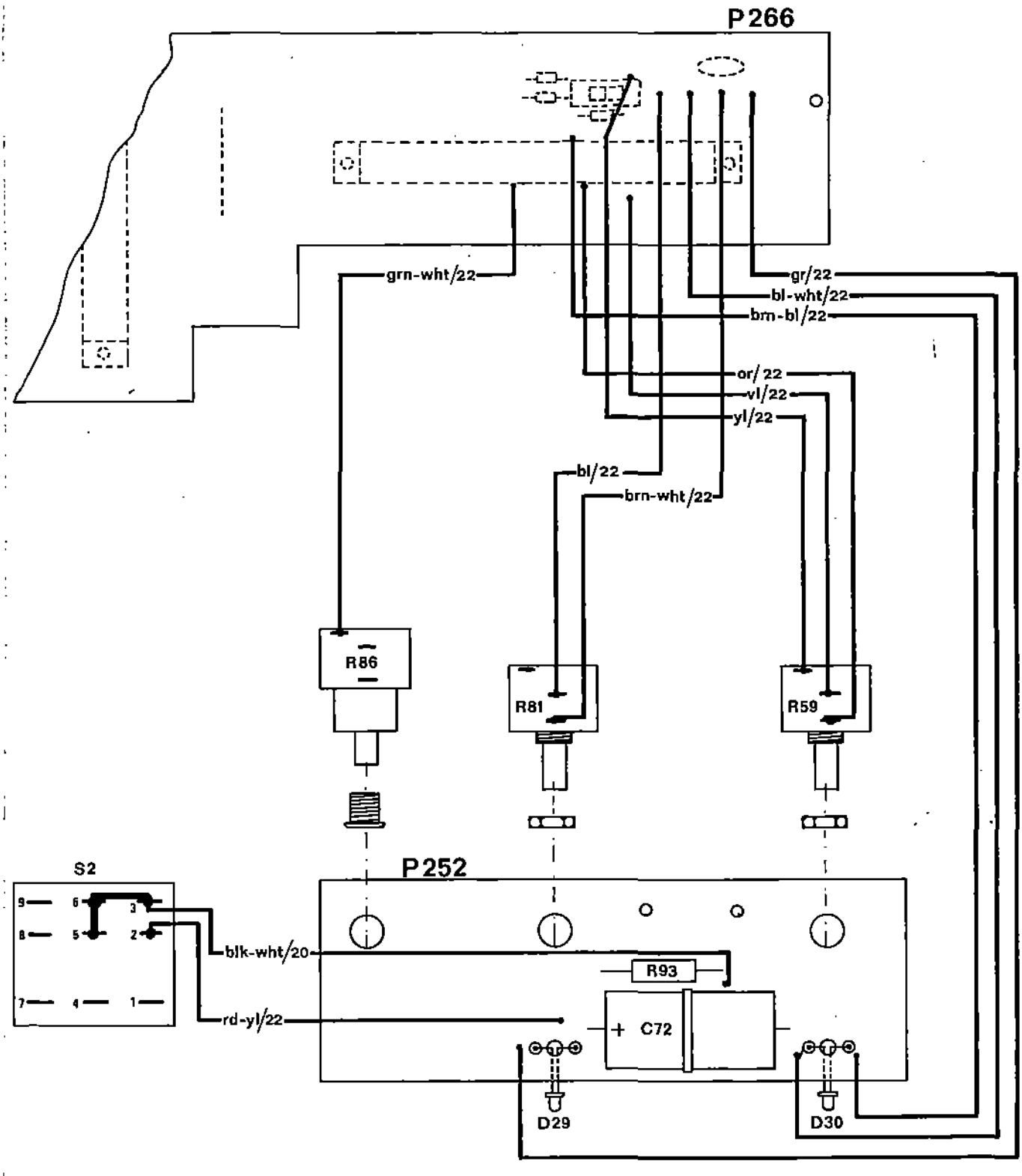
delta elektronika bv



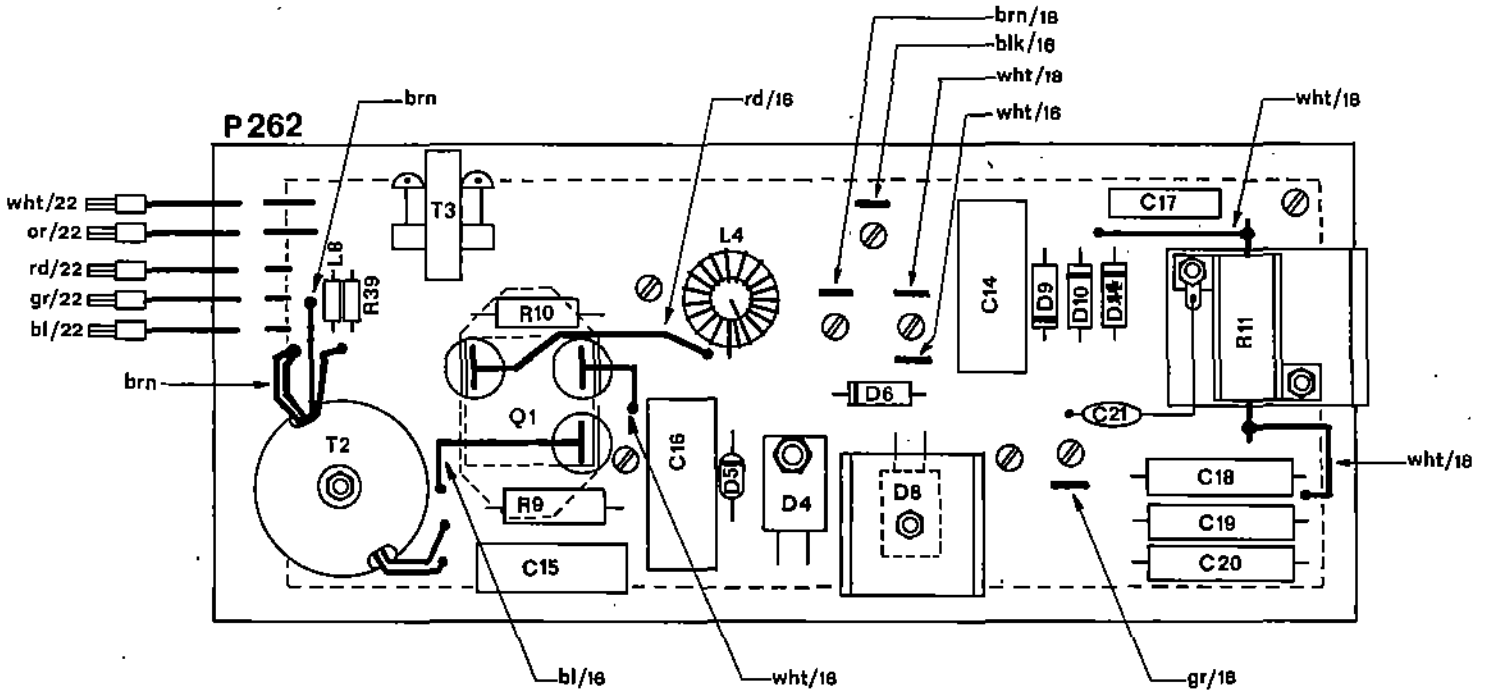
R117	6-83	Vr.	Title: Wiring diagram SM6020
Serial 0200 and up	11-'81	Vr.	Date: 1-'79
Modifications	Date	App	delta elektronika bv

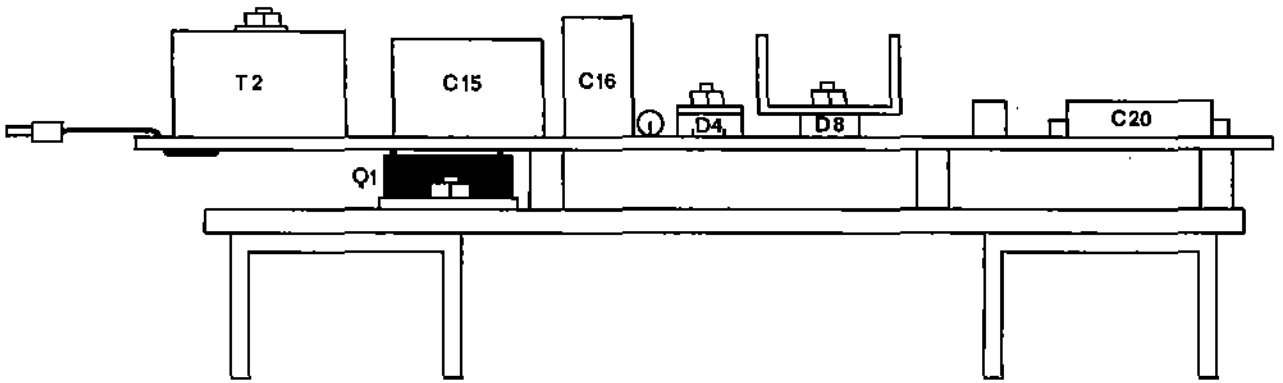


			Title: Wiring diagram SM 6020
			Date: 1-'79
Modifications	Date	App	delta elektronika bv

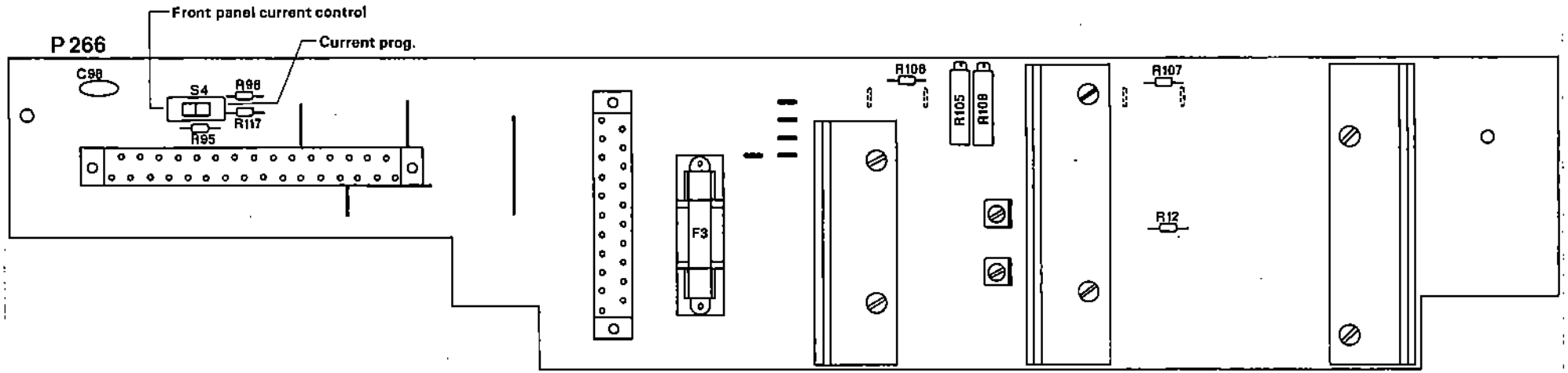


			Title: Wiring diagram SM 6020
Serial 0200 and up	11.'81	Ur	Date: 1–'79
Modifications	Date	App.	delta elektronika bv



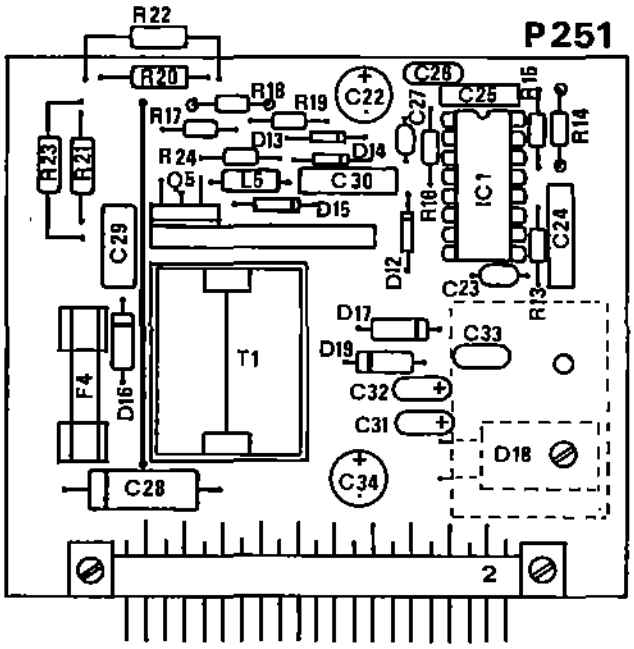


			Title: PC board SM6020
D3,4,5	12-'84	Vr	
Serial 0200 and up	11-'81	Vr	Date: 1-'79
Modifications	Date	App	delta elektronika bv

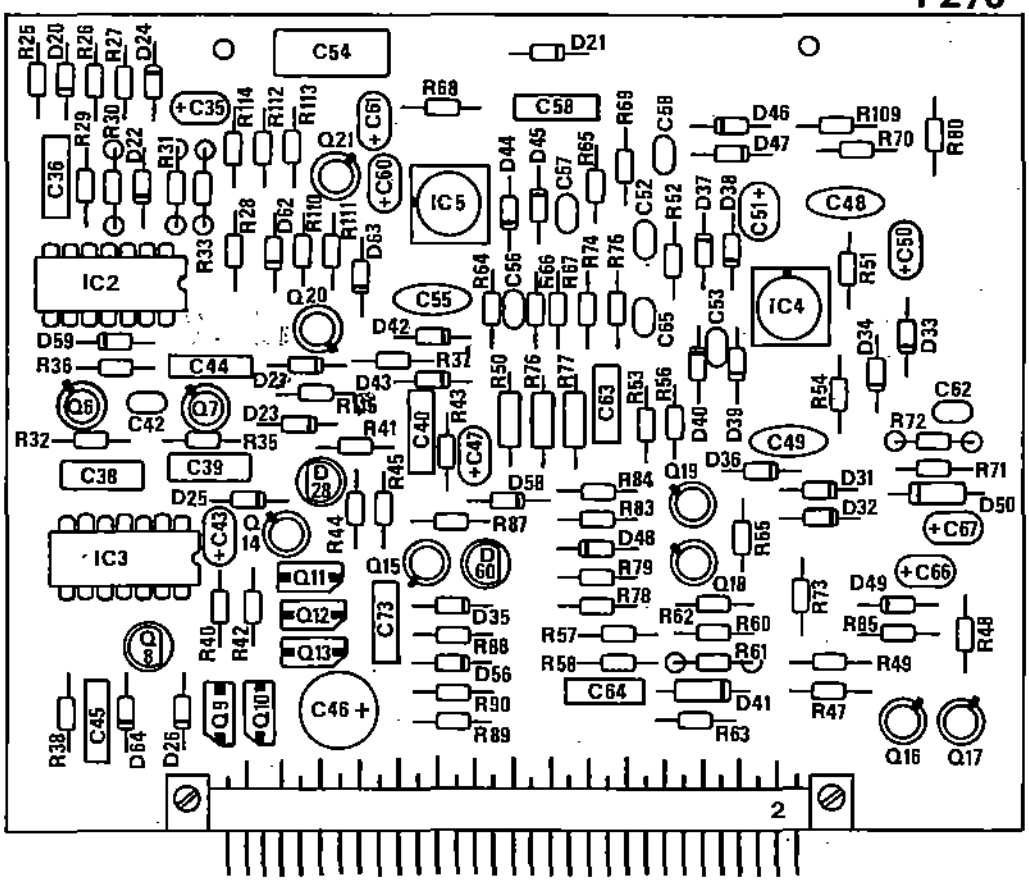


			Title: PC board SM 6020
R117	6-83	Vr	
Serial 0200 and up	11-81	Vr	Date: 1-'79
Modifications	Date	App	delta elektronika bv

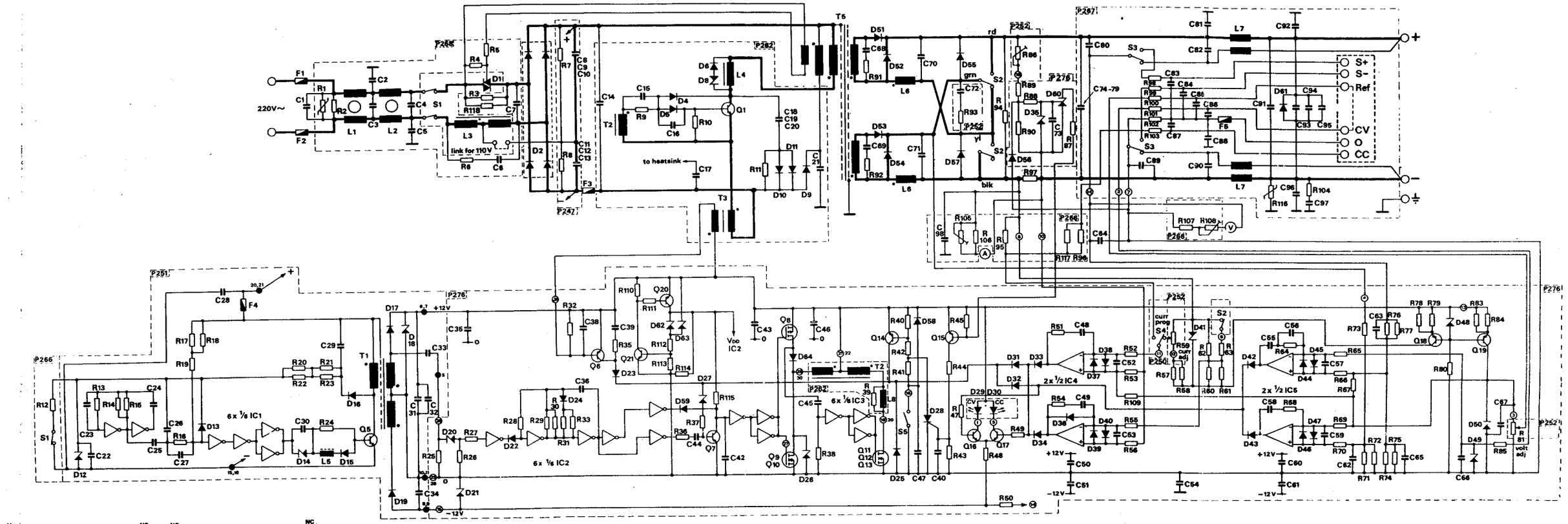
P251



P276



			Title: PC boards SM 6020
Serial 0200 and up	II-81	Vr.	Date: 1-'79
Modifications	Date	App.	delta elektronika bv



D3, R118	12-'84	Vr	Title: Circuit diagram SM6020
R117	5-'83	Vr	
Serial 0200 and up	11-'81	Vr	Date: 1-'79
Modifications	Date	App	delta elektronika bv