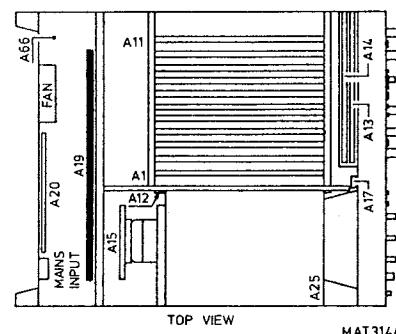


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8.19.1 General Information

WARNING: The complete circuit is at mains potential up to transformer T4401 and opto-coupler H4401. To avoid any electrical shock, it is strongly recommended to read section 10.1 first.

The block diagram below shows the parts of this unit.

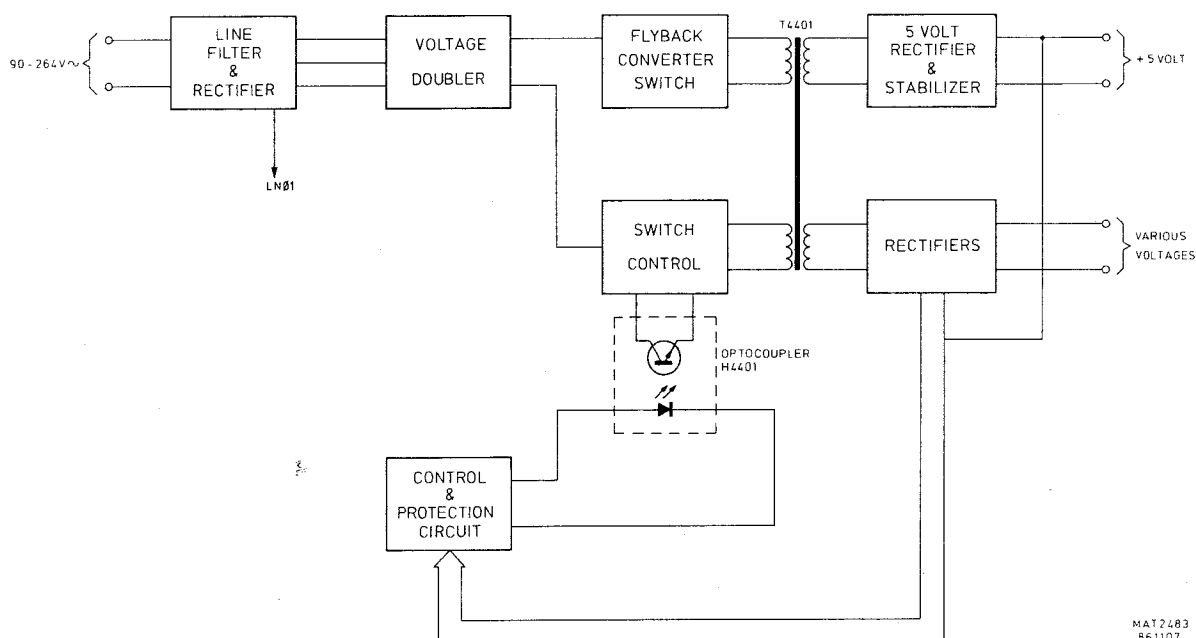
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Figure 8.19.1 Block diagram.

The line voltage is applied via a line filter and a rectifier to a voltage doubler. The voltage is only doubled if the line voltage is below 140 V.

The output voltage of the voltage doubler is applied to transformer T4401 via a flyback converter, which consists of a flyback converter switch and a switch control circuit.

The switch control is influenced by the control and protection circuit via opto-coupler H4401. The latter and transformer T4401 perform a galvanic separation of the instrument from the line voltage.

The various output voltages of transformer T4401 are controlled by the control & protection circuit, which gives protection against over- and undervoltage and a too high temperature.

The +5 V for the digital circuitry has a separate stabilizer.

When the power is on, the POWER ON led on the front panel lights. This led is connected to +7 V on the CRT control unit A16.

8.19.2 The Mains filter and rectifier

The mains input (90 V...264 Vac) is filtered by a mains filter, consisting of C4401 and L4401 and fed into a full bridge rectifier (V4401...4404).

Resistors R4402 and R4403 have a surge current limiting function. A capacitive network C4402...C4407 across the input serves to reduce interference, the centre-point being coupled to earth to provide electromagnetic compatibility. C4403 and R4401 provide a trigger pick-off point LN01 for LINE triggering.

8.19.3 The voltage doubler

To avoid the flyback converter switching high currents a voltage doubler has been provided. This doubler is switched off at high input voltages.

The principle of the voltage doubler is given in figure 8.19.2.

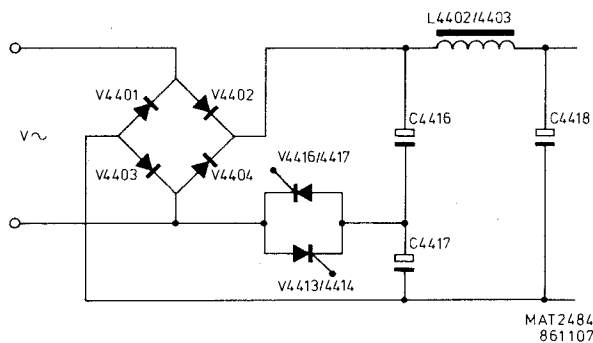


Figure 8.19.2 Simplified diagram of the voltage doubler.

The thyristors are turned on if the output voltage of the doubler is below 200 V approx. (double output voltage).

They are turned off if the output voltage rises above 400 V approx.

If the thyristors are off, the ac-voltage charges the series connection of C4416 and C4417 to the peak value. The voltage on both capacitors is smoothed by L4402/4403 and C4418.

If the thyristors are on, the positive phase of the ac-voltage charges C4416 via V4402 and V4416/17 to the peak value.

The negative phase charges C4417 via V4401 and V4413/4414 to the peak value.

The voltage on the series connection of C4416 and C4417, which is twice the peak voltage of Vac, is smoothed by L4402/4403 and C4418.

The thyristors are switched on and off by a schmitt-trigger circuit consisting of V4406/4408, V4407 and their associated components.

8.19.4 The flyback converter switch (see also figure 8.19.3)

The switch consists of a power transistor V4429, connected in series with diode V4419. The transistor is switched by 2 MOSFETS V4424/V4426, which are controlled by the switch control. By regulating the on and off periods of the switch, the output voltages of T4401 are controlled. The other components of the switch serve as a dV/dt limiter to decrease the switching dissipation, to reduce interference and to protect the switching transistors against overvoltages.

8.19.5 The switch control

The switch control is a rather complicated circuit, which will be explained by the simplified circuit diagram of figure 8.19.3.

After power on, a current via R4434/4436 and the b-c diode of V4433 charges C4423 until the threshold voltage of the FET is reached, after which the converter switch turns on. The current through winding 1-2 of T4401 and R4448...R4452 increases linearly and charges T4401. This causes a linearly increasing voltage on winding 3-4, which turns the converter switch further on.

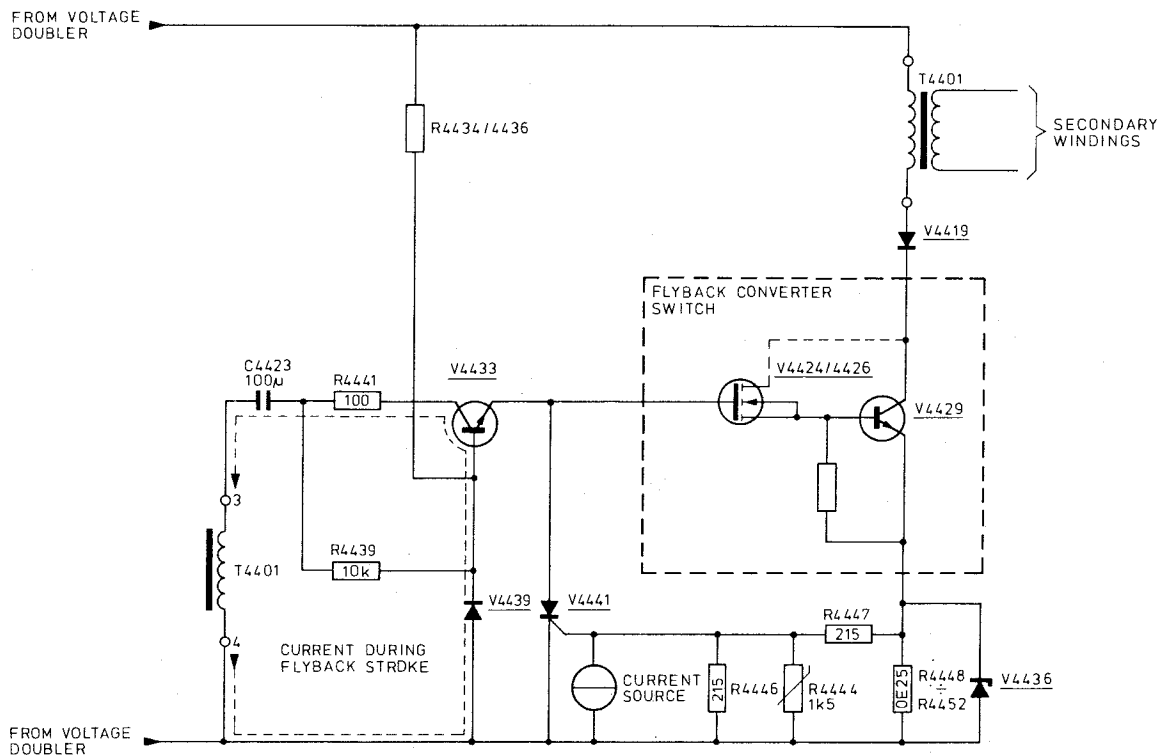
This is the forward stroke.

If the voltage over R4448...R4452 rises above 1,2 V the cathode-gate voltage of thyristor V4441 rises above 0,6 V and it will be fired. The NTC resistor R4444 provides temperature compensation for the firing point of the thyristor.

Now the converter switch is blocked and the flyback stroke starts, during which the secondary windings of T4401 discharge via the rectifiers into the smoothing capacitors.

In this situation winding 3-4 of the transformer gives a negative voltage, which charges C4423 as indicated. The output voltage of V4433 will be zero, so the thyristor extinguishes.

If the transformer is discharged, the output voltage of winding 3-4 drops to zero and C4423 supplies a positive voltage to V4433, which will turn the converter switch on. The forward stroke starts again and so on.



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Figure 8.19.3 Simplified diagram of the flyback converter switch.

V4433, R4439 and V4439 form a voltage stabilizer circuit during the forward stroke, which limits the voltage on the gates of the MOSFETS to 15 V. The switching frequency varies from 20 kHz to 40 kHz, depending on the input voltage.

By inserting a current in R4446 with a current source, the on/off time of the converter switch (duty cycle) can be influenced. This is used to control the output voltages of T4401.

The current source is realised with opto-coupler H4401, which is supplied by C4424. This capacitor is charged during the forward stroke via V4438.

The opto coupler is controlled by the control and protection circuit.

If one or more of the transistors of the converter switch are blown, the zenerdiode V4436 prevents the burning out of R4448...R4452 and the whole switch control circuit, because it blows itself and makes a short circuit over R4448...R4452.

Afterwards, the mains fuse will blow.

If, after having replaced the converter switch transistors and the mains fuse, the power is turned on again, the thyristor V4441 can't be fired due to the short circuit of V4436. In consequence the converter switch won't be turned off and the TRANSISTORS and MAINS FUSE will BLOW AGAIN.

WARNING:

Replace always zenerdiode V4436 after having replaced one or more converter switch transistors (V4424, V4426 and V4429) and the mains fuse.

Figure 8.19.4 shows some wave-forms in the flyback converter.

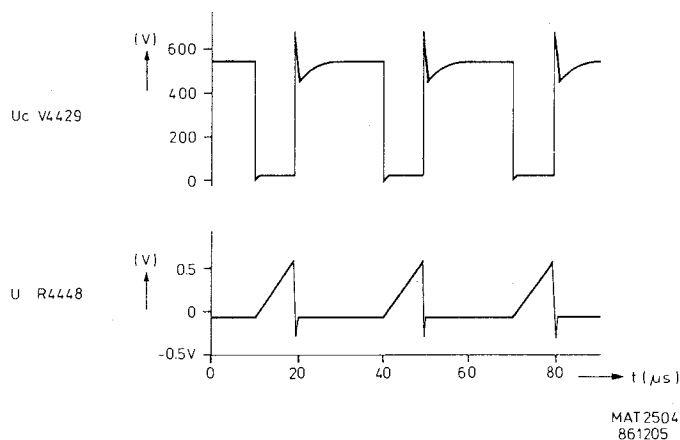


Figure 8.19.4 Voltage waveforms in the flyback converter.

8.19.6 The control circuit

This circuit consists of an operational amplifier (N4401) with some associated components.

The rectified and smoothed +14 V is fed back to the op-amp and compared with the 10 V reference voltage, RV10, which comes from unit A20.

If the +14 V is too high, the op-amp supplies more current into the opto coupler. Next, the opto coupler supplies more current into R4446, which causes the thyristor V4441 to be fired earlier. This shortens the forward stroke, so transformer T4401 is charged less. Next the flyback stroke will be shorter and the smoothing capacitors will be charged less and the output voltages, +14 V inclusive, decrease. So only the +14 V is regulated. All the other voltages are not regulated, except the +5 volt (+5D).

Because the output voltages depend on the length of the flyback stroke, the flyback stroke is regulated by the control circuit. The +5D has a separate stabilizer, which works during the forward stroke (see 8.19.8)

Resumed:

- If the load on +14 V varies, the forward and the flyback stroke vary. The duty cycle remains constant; the frequency varies.
- If the input voltage varies, only the forward stroke varies; the flyback stroke remains constant. A higher input voltage results in a shorter forward stroke.
- The load on the +5D influences only the waveform of primary current through transformer T4401 during the forward stroke. The frequency and the duty cycle remain constant.

8.19.7 The protection circuit

The protection circuit gives the protection against:

- overvoltage on +5D
- overvoltage on +14 V
- too high temperature
- undervoltage on -7 V

The signal C-ON serves as a power supply for this circuit.

Overvoltage on +5D or on +14 V makes V4476 conducting. A too high temperature (e.g. caused by a failure of the fan) also makes V4476 conducting, due to the effect of PTC R4469.

V4476 makes V4474 conducting and via R4459 both transistors keep themselves conducting.

Now V4474 supplies a high current into the opto-coupler, which makes the forward stroke very short and eliminates the overvoltage.

If there is a short circuit in one of the voltage on the secondary side of the transformer all voltages will drop, the -7 V inclusive. This causes V4473 to conduct, due to a voltage rise on the node V4471, R4461, V4472. Next V4471 conducts, which makes the forward stroke very short. No components will be overcharged in this way, in spite of the short circuit.

To prevent the undervoltage protection being active immediate after power on, a delay circuit consisting of R4461 and C4461 is provided. After an over- or undervoltage detection C4461 is discharged fastly by the mains switch, which has a contact connected to connector X4402, when the oscilloscope is switched off.

8.19.8 The +5 volt stabilizer

The output voltage of winding 10-20 of transformer T4401 depends on the load of the +14 V, because this voltage is regulated by the control unit by means of the flyback stroke.

To get a stable +5 V power supply for the digital circuits (+5D) a stabilizer is provided, which works during the forward stroke (forward converter).

During the positive phase of winding 10-20 (the forward stroke), C4429 is charged via L4408, V4449 and L4409. The voltage on C4429 is smoothed by L4411/4412 and C4431.

During the negative phase (the flyback stroke), V4451 acts as a flywheel diode for L4409.

There also flows a current from +5D through V4486, and V4484 in the reverse direction through choke L4408. This demagnetises the core of L4408 or even magnetises it in the reverse direction, depending on the value of the reverse current.

During the forward stroke, the core of L4408 has to be magnetised again. The more the core has to be magnetised, the higher the self inductance will be and the lower the voltage on C4429 and C4431 will be.

A lower voltage on +5D causes the operational amplifier N4401 to give a higher output voltage. The transistor V4486 conducts less, the reverse current through choke L4408 and so the self inductance decrease and so the voltage on C4429 and C4431 rises.

RV10 serves as a reference voltage.

8.19.9 The rectifiers

The rectifiers consist of standard rectifying circuits with smoothing filters.

8.19.10 Signal name list

UNIT A19

Signal name	Description	Signal source	Signal destination(s)
BAVO	Battery voltage	A66	-
C-ON	Converter on	A19	A19,A20
FRUVP	Fast reset under voltage protection	A19	A66
ILØ7--LT	Interrupt level Ø7	A20	-
LNØ1	Line Ø1	A19	A20
M1	Mains 1	A66	-
M2	Mains 2	A66	-
PE	Protective earth	A66	-
RVG	Reference voltage ground	A20	-
RV1Ø	Reference voltage 1Ø V	A20	-
A	Analogue ground	A19	General
D	Digital ground	A19	General
+5D	+5 Volt digital	A19	General
-5D	-5 Volt digital	A19	General
+7V	+7 Volt	A19	General
-7V	-7 Volt	A19	General
+14V	+14 Volt	A19	General
-14V	-14 Volt	A19	General
+19V	+19 Volt	A19	General
-19V	-19 Volt	A19	General
+40V	+40 Volt	A19	General
+100V	+100 Volt	A19	General

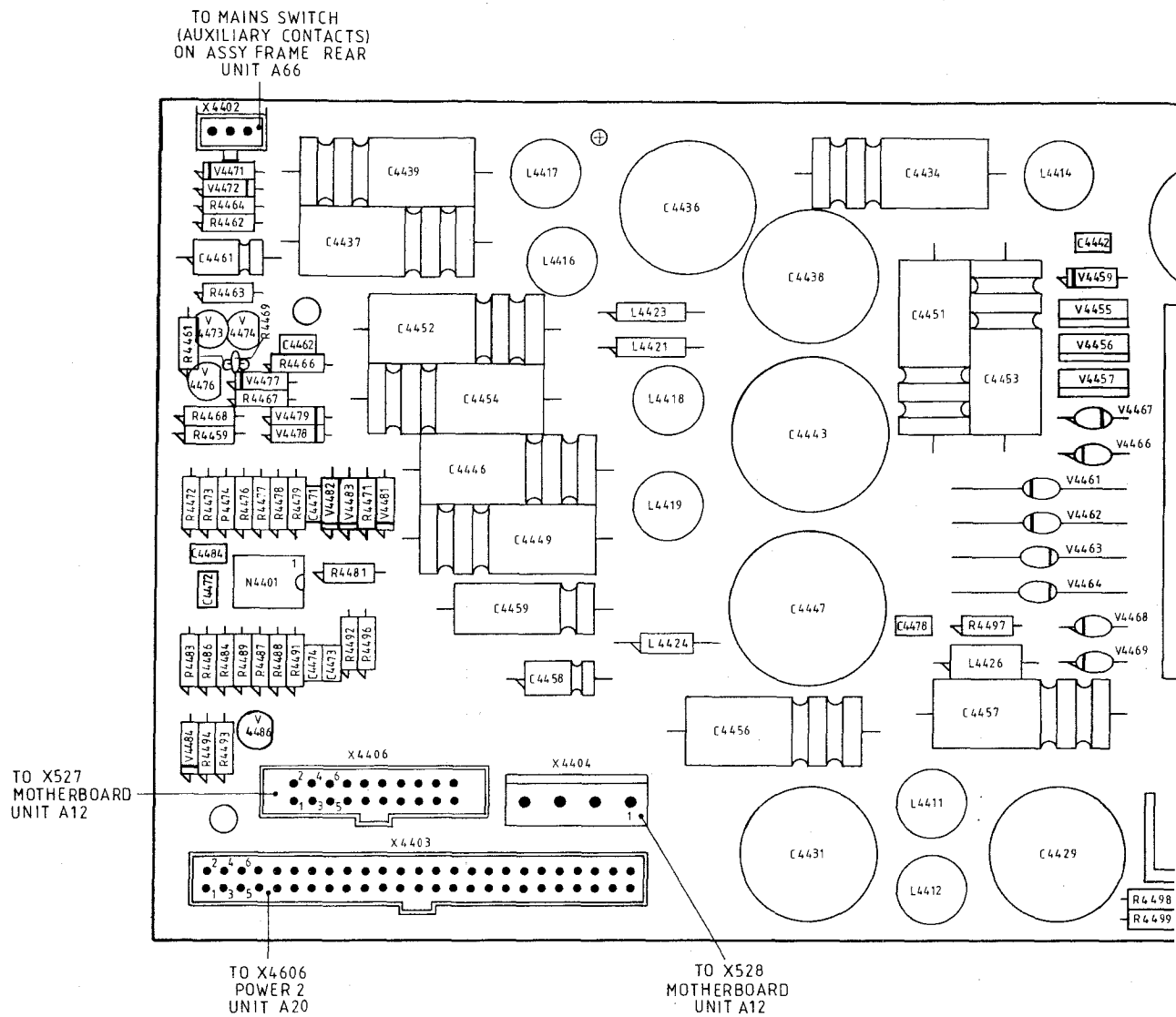
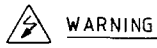


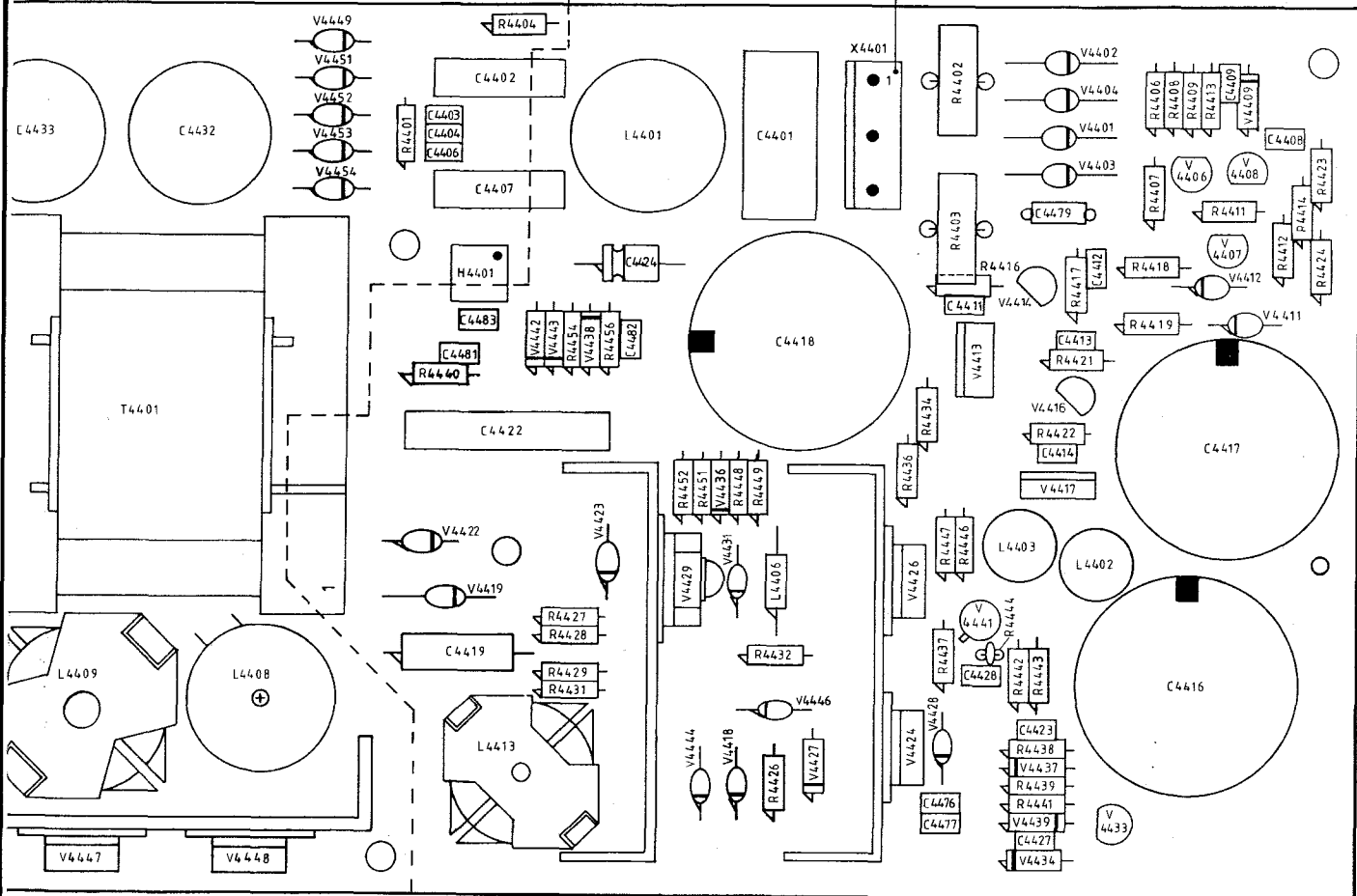
Figure 8.19.5 Unit A19 - POWER 1 - p.c.b. lay-out.



WARNING

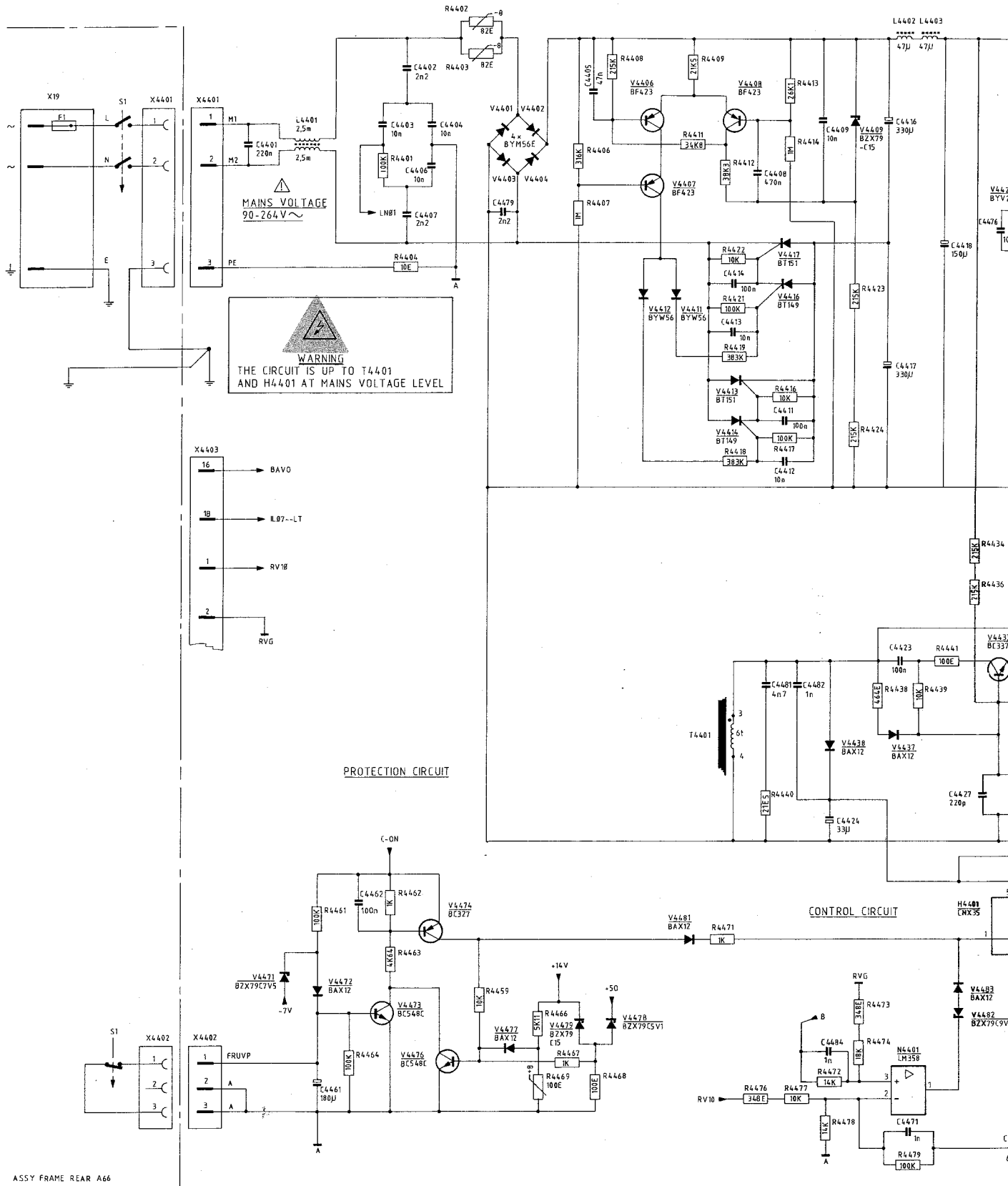
-----CIRCUIT IS UP TO DASHED LINE AT MAINS VOLTAGE LEVEL

TO MAINS SWITCH
ON ASSY FRAME
REAR
UNIT A66



MAT2546A
880205

VOLTAGE DOUBLER



5V STABILIZER



Figure 8.19.6 Unit A19 - POWER 1 - circuit diagram.