SECTION 1

STABILISED POWER SUPPLIERS PS2/1, PS2/2, PS2/1A AND PS2/2A

1.1 Introduction

The PS2/1, PS2/2, PS2/1A and PS2/2A units are series-valve stabilisers designed to provide voltage-regulated h.t. supplies when used with the Unstabilised Power Suppliers PS3/4 and PS3/4A described in Part 3, Section 4. The stabilisers are for use with equipment having built-in l.t. power supplies.

All four stabilisers are basically similar, with differences only in their output voltages and maximum load current ratings, as summarised below.

(*a*) *PS2/1 and PS2/2* These are used with the PS3/4 supplier to provide a regulated supply at 200 volts. The maximum load current of the PS2/1 is 600 milliamperes; that of the PS2/2 is 300 milliamperes. One PS2/1 and one PS2/2, or up to three PS2/2 stabilisers, may be connected to each PS3/4 unit.

(*b*) *PS2/1A and PS2/2A* These have been designed for use with the PS3/4A supplier if a regulated supply at 250 volts is required. The maximum load current of the PS2/1A is 600 milliamperes; that of the PS2/2A is 300 milliamperes. One PS2/1A or two PS2/2A stabilisers may be connected to each PS3/4A unit.

The output of each stabiliser is isolated from earth. Provision is made for connecting the outputs of two units so that a stabilised supply of $\pm$ 200 volts or $\pm$ 250 volts can be obtained.

Each unit is constructed on a CH1/3 plug-in chassis and all input and output connections are made in a 24-way plug at the rear.

A cold-cathode trigger tube circuit is incorporated, to protect subsequent equipment from the effects of an excessive rise in h.t. voltage caused, for instance, by a fault in the stabiliser.

1.2 Circuit Description (Fig. 1.1)

Circuit diagrams of the PS2/1, PS2/2, PS2/1A and PS2/2A are in Figs. 1.1, 1.2, 1.3 and 1.4 respectively. The PS2/1 is described in detail in the following paragraphs; short notes at the end detail the differences which distinguish the other three units.

The unstabilised input, from a PS3/4 supplier, is applied to the anodes of four double-triode valves V1 to V4, connected in parallel as the series control valves. The shunt amplifier is a cascode stage V5A and V5B and the cathode of V5B is held at a stable potential by the reference tube V6. This tube generates a small noise-voltage and also has appreciable impedance, particularly at high frequencies, and for these reasons the cathode of V5B is decoupled by R25 and C1.

The principle of this type of stabiliser is described in Section A of Instruction V.4. It is shown there that the output impedance of the stabiliser is approximately

$$1/(1 + A\beta)\, g_m,$$

where A is the gain of the shunt amplifying stage, β is the fraction of the output voltage fed to the grid of the shunt amplifying valve, g_m is the mutual conductance of the series control valve, or the effective mutual conductance if valves are connected in parallel. The stage gain A must be as large as possible to give the lowest possible value of output impedance, which is the condition for least variation of output voltage with load current. The cascode stage, V5A and V5B, has a gain of 1500 to 2000, and the output impedance of the stabiliser is less than 0·5 ohm.

Alteration of the output voltage over a small range can be effected by variation of RV1, which changes the grid voltage of V5B.

The unstabilised input to the series control valves is connected through break contact A1 of relay A, which is energised by the cold-cathode trigger tube V7. The type of tube used, Z803U,

has a very stable trigger ignition voltage. This voltage varies from tube to tube over the range 128 to 137 volts, but for a given tube does not vary by more than 1 per cent over the operating range of anode voltage. To ensure that triggering is instantaneous and that the ignition voltage is not dependent upon external conditions which could affect the state of ionisation in the tube, such as the intensity of the ambient light, a continuous priming discharge is necessary. This priming discharge is obtained by connection of the priming anode through R37 to the junction of R38 and R39.

The trigger electrode of V7 is fed from the junction of R26 and R27 through break contact A2 of relay A, the operating coil of which is in the anode circuit of V7, with a limiting resistor R36. If a fault, for instance an inter-electrode short-circuit in a series control valve, causes the output voltage to rise by an amount sufficient to fire the trigger tube, relay A operates and disconnects the input to the series control valves. Simultaneously, break contact A2 opens and disconnects the trigger electrode of V7; this is necessary for the protection of the tube. The anode of V7 is fed from the potential divider R38, R39, R40, R41, connected to the input side of contact A1, so the trigger tube remains conductive and the relay energised until the unit is disconnected from its supplies. A rise in output voltage of about 20 volts is sufficient to fire the trigger tube. R35 and C4 delay the operation of the trigger tube so that the device does not operate on surges of short duration, such as are encountered when the stabiliser is switched on. The time of operation of the circuit is about 3 seconds. R44 limits to a safe value the current that flows in the trigger-electrode circuit from the discharge of C4.

The protection circuit is automatically reset by extinction of the trigger tube discharge-current and release of relay A when the unit is withdrawn from the rack for investigation of the fault. This method of resetting avoids damage to the series control valves which would occur if the h.t. was suddenly applied, by a reset switch for example, with the valve heaters at operating temperature.

For a normal h.t. supply, with negative earthed, pins 9 and 19 of plug A are connected together and earthed at the socket on the rack into which the unit is plugged. When a power supply of $\pm$ 200 volts is required, two units are connected together in the following manner. Pin 21 of plug A on the positive supplier is connected to pins 9 and 19 of the negative supplier. Pins 9 and 12 on the positive supplier are connected to pins 7 and 10 on the negative unit to give the common terminal. In this way a common reference voltage is used for the two stabilisers and the units are self-compensating for voltage changes caused by changes in load current and mains voltage, or internal drift.

Socket A and shunt resistor R33 enable the total current through the series control valves to be checked with a Portable Test Meter ME15/3P.

1.3 Circuit Variations (Figs. 1.2 to 1.4)

(*a*) *PS2/2* (*Fig.* 1.2) This has only two series control valves, V1 and V2, and is otherwise identical with the PS2/1.

(*b*) *PS2/1A* (*Fig.* 1.3) The only circuit differences between this unit and the PS2/1 are in the feeds to the trigger electrode and to the anode of V7 and in the value of R42.

(*c*) *PS2/2A* (*Fig.* 1.4) Apart from having only two series control valves V1 and V2, this unit is identical with the PS2/1A.

All four types of stabiliser are designed to use an external reference voltage of -200 volts. If therefore a stabilised supply of $\pm$ 250 volts is required, an additional resistor must be inserted in series with pin 21 of the positive supplier (PS2/1A or PS2/2A). This resistor is connected to the negative rail of the negative supplier and must be of such value that there is no potential difference between pins 9 and 19 of the positive supplier. Apart from the additional resistor the connections for a $\pm$ 250 volts supply are the same as for the $\pm$ 200 volts supply described above.

1.4 Fuses

Fuses are incorporated in the mains input to the heater transformer; the ratings are as follows:

PS2/1 and PS2/1A	1 A
PS2/2 and PS2/2A	500 mA

The fuses are Beswick anti-surge type and are located at the rear of the chassis. Access to them is obtained by withdrawing the chassis from the rack.

1.5 Valve Data

The double-triode series control valves each carry a total current of up to 150 milliamperes, 75 through each section. The voltage drop across the valves varies from about 70 volts at maximum current to about 150 volts at minimum current. Grid-cathode voltage varies, over the same current range, from about 20 volts to about 120 volts.

Cascode Stage	*PS2/1 and PS2/2*	*PS2/1A and PS2/2A*
V5A (or V3A)		
Anode volts	170*	210*
Grid volts	108	136
Anode current	16 μA	16 μA
V5B (or V3B)		
Anode volts	109	138
Grid volts	83	83
Anode current	0·4 mA	0·5 mA
Reference tube		
V6 (or V4)		
Anode current	3 mA	4 mA

* At full load current. Measured with Avometer Model 8 on 1,000 volts range.

1.6 Adjustment of Output Voltage

The unit must be withdrawn from the rack to obtain access to the Output Voltage control RV1. Connect the stabiliser to its appropriate unstabilised supplier, and to a load to take a convenient current, preferably near full load. Measure the output voltage with a valve voltmeter or an Avometer Model 8. Adjust RV1 to obtain the correct output voltage, 200 volts for PS2/1 and PS2/2, 250 volts for PS2/1A and PS2/2A.

1.7 Output Impedance and Regulation

For all units the output impedance is less than 0·5 ohm; this may be checked by measuring the regulation.

(*a*) *PS2/1 and PS2/1A* The output voltage should not change by more than 0 3 volt when the load current varies from zero to 600 mA.

(*b*) *PS2/2 and PS2/2A* The output voltage should not change by more than 0·15 volt when the load current varies from zero to 300 mA.

1.8 Mains Voltage Variation (All four types)

For a 15-volt change in the voltage of the mains supply to the unstabilised supplier and to the heater transformer of the stabiliser, the output voltage of the stabiliser should not change by more than 0·5 volts at any load current within the capacity of the stabiliser.

A sudden change in mains voltage can be introduced by switching a voltage-dropping resistor into the mains supply to the unstabilised supplier. The change in output voltage of the stabiliser can be monitored using an oscilloscope with a slow scanning speed, and should not exceed 100 mV d.a.p. for a 6 per cent change in mains voltage.

1.9 Hum (All four types)

Hum should be measured on full load by connecting the output terminals to a high-impedance oscilloscope, keeping the leads as short as possible, and with one output terminal earthed. If an amplifier is needed between the stabiliser and the oscilloscope, a battery-operated one should be used.

Hum should not exceed 1 mV d.a.p.

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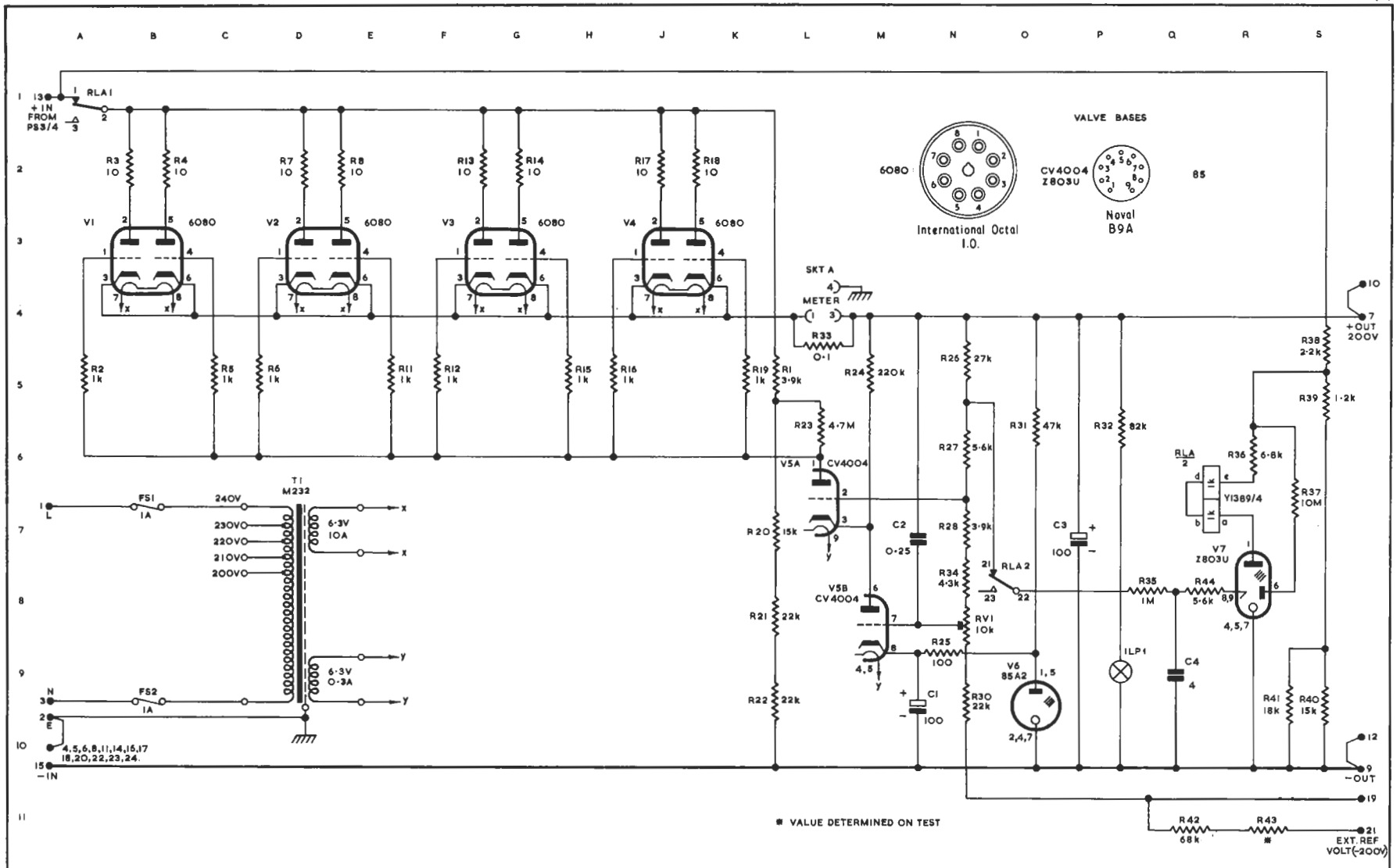
COMPONENT TABLE: FIG. 1.1

Comp.	Loc.	Type	Tolerance Per cent
C1	N9	Plessey CE874/1	
C2	N7	Hunts B501K	
C3	P7	Plessey CE874/1	
C4	Q9	Hunts B553	
R1	L5	Erie 9	10
R2	A5	Erie 9	10
R3	A2	Morganite R	10
R4	B2	Morganite R	10
R5	C5	Erie 9	10
R6	D5	Erie 9	10
R7	D2	Morganite R	10
R8	E2	Morganite R	10
R11	E5	Erie 9	10
R12	F5	Erie 9	10
R13	F2	Morganite R	10
R14	G2	Morganite R	10
R15	H5	Erie 9	10
R16	H5	Erie 9	10
R17	J2	Morganite R	10
R18	K2	Morganite R	10
R19	K5	Erie 9	10
R20	L7	Erie 8	10
R21	L8	Erie 8	10
R22	L8	Erie 8	10
R23	L6	Erie 9	10
R24	M5	Erie 9	10
R25	N9	Erie 9	10
R26	N5	Erie 109	2
R27	N6	Erie 109	2
R28	N7	Erie 109	2
R30	N9	Erie 109	2
R31	O5	Erie 9	10
R32	P5	Erie 9	10
R33	L4	Erie 8 2·2 megohm ±10 per cent, carrying winding of 22 S.W.G. Eureka cotton-covered wire to make resistance of 0·1 ohm	2
R34	N7	Erie 109	2
R35	Q8	Erie 9	10
R36	R6	Erie 9	10
R37	S7	Erie 9	10
R38	S5	Painton P301A	5
R39	S5	Painton P301A	5
R40	S9	Painton P302A	5
R41	S9	Painton P302A	5
R42	Q11	Erie 109	2
R43	R11	Erie 109	2
R44	Q8	Erie 9	10
RV1	N8	Morganite LH/WN	20
T1	D8	M232	
iLP1	P9	Neoflex ZGL/110 Clear	



STABILISED POWER SUPPLIER PS2/1: CIRCUIT

G2 PART 2

FIG. 1.1 (ALSO IN V4)

COMPONENT TABLE: FIG. 1.2

Comp.	Loc.	Type	Tolerance Per cent
C1	K10	Plessey CE874/1	
C2	K8	Hunts B501K	
C3	N8	Plessey CE874/1	
C4	O10	Hunts B553	
R1	G10	Erie 8	10
R2	G9	Erie 8	10
R3	G8	Erie 8	10
R4	G5	Erie 9	10
R5	A5	Erie 9	10
R6	B2	Morganite R	10
R7	B2	Morganite R	10
R8	C5	Erie 9	10
R9	H5	Erie 8 2·2 megohm ±10 per cent, carrying winding of 22 S.W.G. Eureka cotton-covered wire to make resistance of 0·1 ohm	2
R10	D5	Erie 9	10
R11	G6	Erie 9	10
R12	E2	Morganite R	10
R13	E2	Morganite R	10
R14	J6	Erie 9	10
R15	K10	Erie 9	10
R16	F5	Erie 9	10
R17	L10	Erie 109	2
R19	L9	Erie 109	2
R20	L8	Erie 109	2
R21	L7	Erie 109	2
R22	M6	Erie 9	10
R23	N6	Erie 9	10
R24	L5	Erie 109	2
R25	O9	Erie 9	10
R26	Q7	Erie 9	10
R27	Q8	Erie 9	10
R28	P12	Erie 109	2
R29	Q12	Erie 109	2
R30	R6	Painton P301A	5
R31	R5	Painton P301A	5
R32	R10	Painton P302A	5
R33	Q10	Painton P302A	5
R34	P9	Erie 9	10
RV1	L9	Morganite LH/WN	20
T1	C9	M233	
ILP1	O10	Neoflex ZGL/110 Clear	

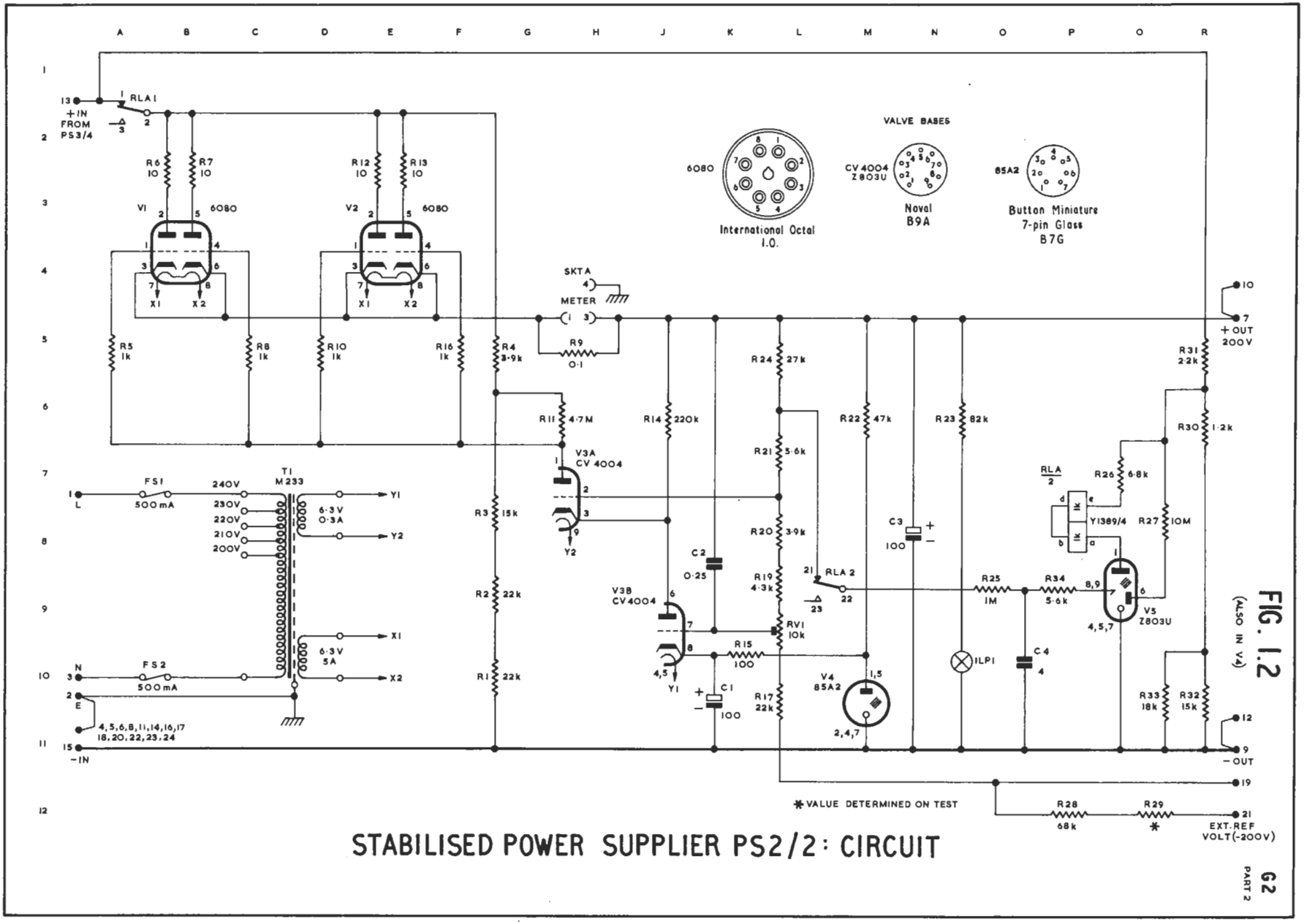


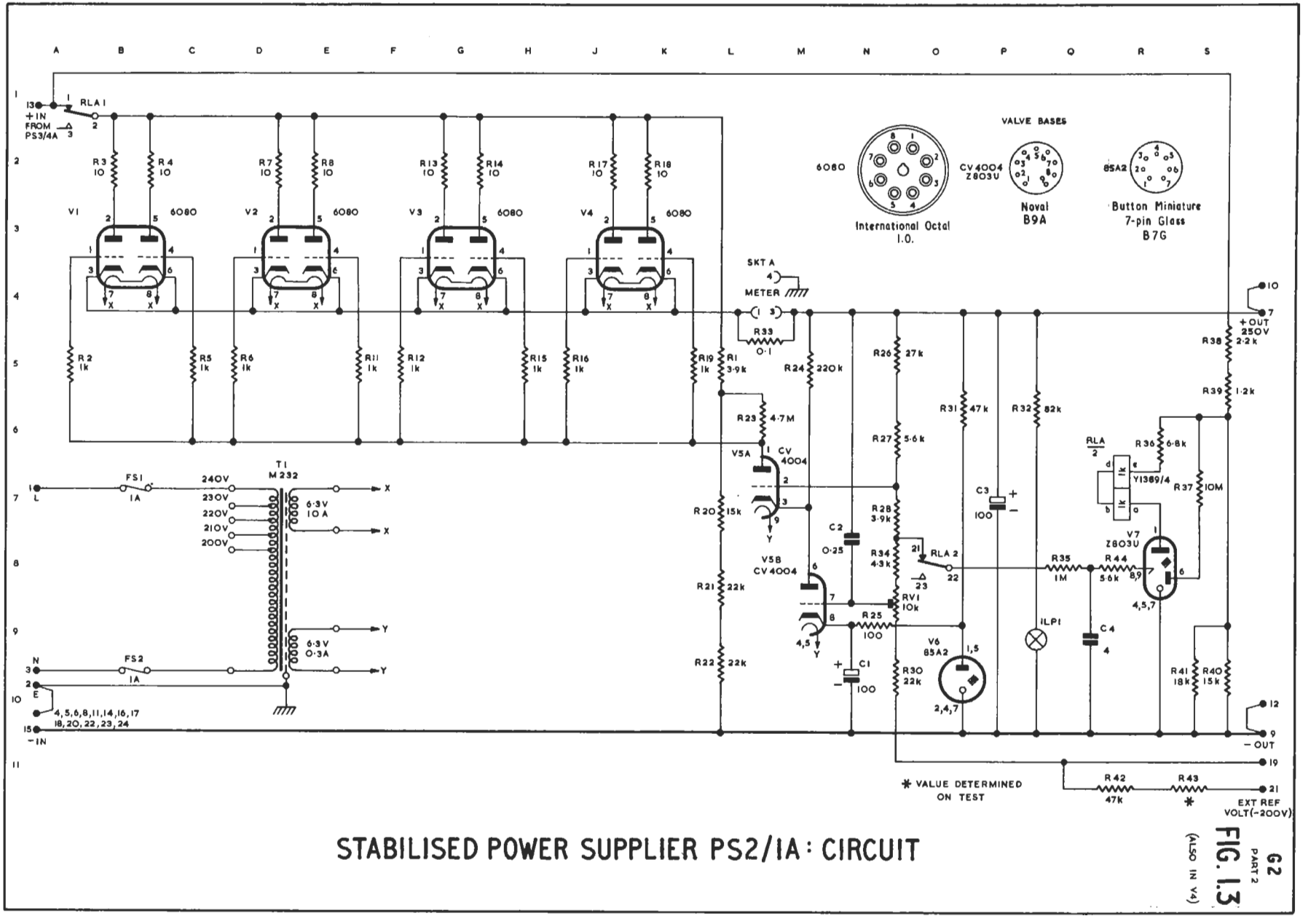
FIG. 1.2 (ALSO IN V4)

STABILISED POWER SUPPLIER PS2/2: CIRCUIT

G2 PART 2

COMPONENT TABLE: FIG. 1.3

Comp.	Loc.	Type	Tolerance Per cent
C1	M10	Plessey CE874/1	
C2	M8	Hunts B501K	
C3	P7	Plessey CE874/1	
C4	Q9	Hunts B553	
R1	L5	Erie 9	10
R2	A5	Erie 9	10
R3	B2	Morganite R	10
R4	C2	Morganite R	10
R5	C5	Erie 9	10
R6	D5	Erie 9	10
R7	D2	Morganite R	10
R8	E2	Morganite R	10
R11	F5	Erie 9	10
R12	F5	Erie 9	10
R13	G2	Morganite R	10
R14	G2	Morganite R	10
R15	H5	Erie 9	10
R16	J5	Erie 9	10
R17	J2	Morganite R	10
R18	K2	Morganite R	10
R19	L5	Erie 9	10
R20	L7	Erie 8	10
R21	L8	Erie 8	10
R22	L9	Erie 8	10
R23	L6	Erie 9	10
R24	M5	Erie 9	10
R25	N9	Erie 9	10
R26	N5	Erie 109	2
R27	N6	Erie 109	2
R28	N7	Erie 109	2
R30	N10	Erie 109	2
R31	O6	Erie 9	10
R32	P6	Erie 9	10
R33	L5	Erie 8 2·2 megohm ± 10 per cent, carrying winding of 22 S.W.G. Eureka cotton-covered wire to make resistance of 0·1 ohm	2
R34	N8	Erie 109	2
R35	Q8	Erie 9	10
R36	R6	Erie 9	10
R37	S7	Erie 9	10
R38	S5	Painton P301A	5
R39	S6	Painton P301A	5
R40	S10	Painton P302A	5
R41	S10	Painton P302A	5
R42	R11	Erie 109	2
R43	S11	Erie 109	2
R44	R8	Erie 9	10
RV1	N9	Morganite LH/WN	20
T1	D8	M232	
ILP1	P9	Neoflex ZGL/110 Clear	

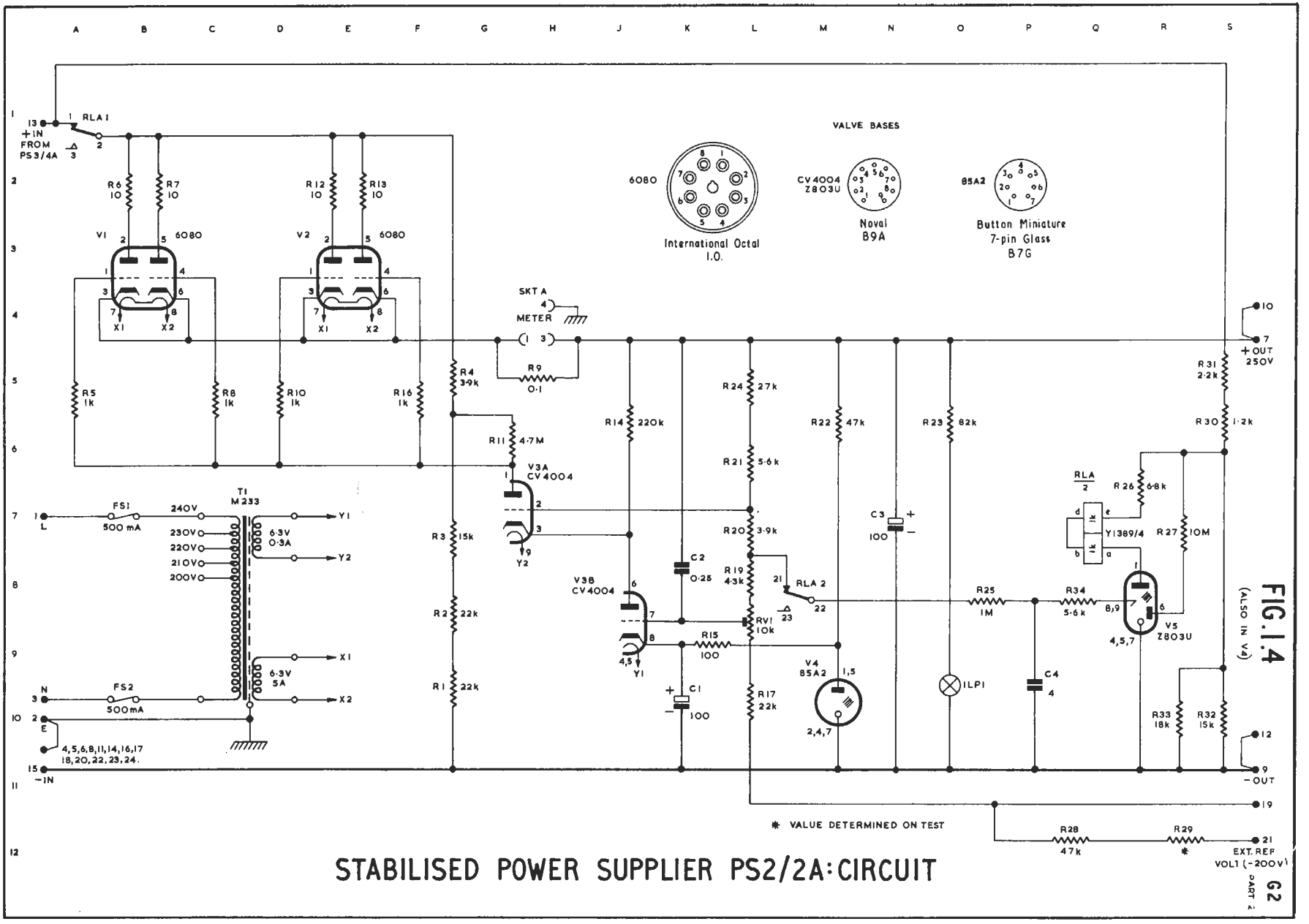


STABILISED POWER SUPPLIER PS2/1A: CIRCUIT

G2 PART 2
FIG. 1.3
(ALSO IN V4)

COMPONENT TABLE: FIG. 1.4

Comp.	Loc.	Type	Tolerance Per cent
C1	K10	Plessey CE874/1	
C2	K8	Hunts B501K	
C3	N7	Plessey CE874/1	
C4	P10	Hunts B553	
R1	F10	Erie 8	10
R2	F9	Erie 8	10
R3	F8	Erie 8	10
R4	G5	Erie 9	10
R5	A5	Erie 9	10
R6	B2	Morganite R	10
R7	B2	Morganite R	10
R8	C5	Erie 9	10
R9	H5	Erie 8 2·2 megohm ± 10 per cent, carrying winding of 22 S.W.G. Eureka cotton-covered wire to make resistance of 0·1 ohm	2
R10	D5	Erie 9	10
R11	G6	Erie 9	10
R12	E2	Morganite R	10
R13	E2	Morganite R	10
R14	J6	Erie 9	10
R15	K9	Erie 9	10
R16	F5	Erie 9	10
R17	L10	Erie 109	2
R19	L8	Erie 109	2
R20	L7	Erie 109	2
R21	L6	Erie 109	2
R22	M5	Erie 9	10
R23	O6	Erie 9	10
R24	L5	Erie 109	2
R25	P8	Erie 9	10
R26	R7	Erie 9	10
R27	R7	Erie 9	10
R28	Q11	Erie 109	2
R29	R11	Erie 109	2
R30	S6	Painton P301A	5
R31	S5	Painton P301A	5
R32	S10	Painton P302A	5
R33	R10	Painton P302A	5
R34	Q8	Erie 9	10
RV1	L9	Morganite LH/WN	20
T1	C8	M233	
ILP1	O10	Neoflex ZGL/110 Clear	



STABILISED POWER SUPPLIER PS2/2A: CIRCUIT