Type PM28B

Photomultiplier Power Supply

Designed primarily as a high voltage photomultiplier power supply with a 15-0-15 volt auxiliary low voltage supply, adjustable between 5 V and 15 V, for transistor circuitry. 220 mA capability permits operation of most amplifier/discriminator units.

- provided with high tension plug and lead pre-wired for output polarity specified at time of order and mating connector for the low voltage output facility.
- instant switch-on without 'spikes' or surges
- 100 V to 2800 V at 5 mA max.
- adjustable to within 0.2 V
- digital dial fine voltage control
- very low ripple
- reversible output polarity
- compact and highly stable
- option for programming
- option for 19" rack adaption

Description

The output range provided by this unit is 100 volts to 2800 volts. Any voltage within these limits can be set by means of a 12 position switch with 200 volt steps and a 3 digit indicating dial controlling a 5-turn potentiometer giving 0-500 volts above the switch setting.

Polarity is determined by the specially wired connecting lead provided. This is a convenient and safe method of permanently determining the polarity applied to a photomultiplier and obviates the dangers inherent in other methods of selecting polarity.

The advanced specification and very economical price have been achieved by the use of all solid state linear circuit techniques which develop the high voltage without the 'spikes' and high frequency noise usually associated with inverter or saturated core devices. Excellent line and load regulation has been achieved by careful design. Ripple is less than 2 mV at full output; voltage change with temperature is negligible.

A standard feature of the unit is the provision of a low voltage auxiliary power supply with adjustable outputs for use with a wide range of photomultiplier head amplifier circuits. The positive and negative auxiliary power supply outputs are independently adjustable between 5 V and 15 V via rear panel pre-set controls. All the power supplies necessary to operate a photomultiplier light detecting system have therefore been conveniently contained in a single unit.

Applications

This unit has a wide voltage range sufficient to suit the majority of photomultiplier tubes from side window types to fast linear focused structures. Dependent upon individual dynode chain currents, more than one photomultiplier may be driven from the same supply provided the maximum supply current is not exceeded.

The unit is designed as a laboratory power supply and will find many other applications where a high voltage, precision supply is needed.

Specification

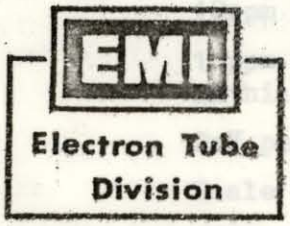
High voltage power supply

Output voltage setting range	100 to 2800 volts.
Polarity	Positive or negative with respect to chassis using alternative output connectors.
Maximum current	5 mA.
Overload protection	Current limit at 6 mA, autoreset. Foldback to approx. 3 mA on short circuit. Lamp indicates limiting.
Load regulation	10 ppm for a no load to full load change.
Line stability	10 ppm for a 10% change of mains voltage, within the permissible mains input limits.
Ripple and noise	2 mV peak to peak.
Meter	Scale length 70 mm (2.75in). Accuracy 3%.
Mains input limits	200 V to 250 V or 100 V to 125 V, 48 to 66 Hz. 50 VA. Mains lead length 2 metres.
Voltage selection	200 volt steps on a twelve position switch plus a 0-500 volt continuous control by a five turn potentiometer with digital dial indication.
Resolution	150 mV.
Calibration accuracy (with fine control at zero)	1%.
Accuracy of fine control	3% of indication.
Temperature coefficient	50 ppm/°C typical.
Drift with time (at constant line, load and temperature)	50 ppm/hr typical. 100 ppm/day typical.
Output voltage float potential with respect to chassis (either terminal)	250 V d.c. maximum.
Ambient temperature	
Working	0 to 45°C.
Storage	−20°C to +70°C.
Output connectors	H.V. connector: Fischer 400 series. H.V. coaxial cable type: UR76; length 2 metres.
Net weight	6 Kg (13.2 lb).
Dimensions	
Case	213 mm ($8\frac{3}{8}$") x 127 mm (5") x 260 mm ($10\frac{1}{4}$").
Overall	213 mm ($8\frac{3}{8}$") x 143 mm ($5\frac{5}{8}$") x 295 mm ($11\frac{5}{8}$").

Auxiliary power supply

Output voltage	Maximum of 15-0-15 volts, each rail independently adjustable between 5 and 15 volts for non-symmetrical operation.
Maximum current	220 mA.
S/C current limit	250 mA.
Ripple	10 mV peak-to-peak.
Load stability	0.15% no load to full load.
Line stability	0.02% for ±10% input change.
Front panel connector	Pye SMC3

Electron Tubes, A division of EMI Industrial Electronics Ltd.,
Bury Street, Ruislip, Middlesex, HA4 7TA, England.
Tel: Ruislip 30771; Telex: 935261 EMIET G;
Cables: Emitube, Ruislip, Middlesex.



PHOTOMULTIPLIER POWER SUPPLY

Type PM28B

Operation Notes

EMI Industrial Electronics Ltd
Electron Tube Division
Ruislip, Middlesex, England

Issue 3

SPECIFICATION FOR PM28B POWER SUPPLY

Output voltage setting range	100 to 2800 Volts
Polarity	Positive or negative with respect to ground depending on output lead provided.
Maximum current	5mA
Overload protection	Current limit at 6mA, auto-reset. Foldback to approx. 3mA on short circuit. Lamp indicates limiting.
Load regulation	10ppm for a no load to full load change.
Line stability	10ppm for a 10% change of mains voltage, within the permissible mains input limits.
Ripple and noise	2mV peak to peak.
Meter	Scale length 70mm (2.75in). Accuracy 3%.
Mains input limits	200V to 250V or 100V to 125V, 48 to 66Hz. 50VA. Mains lead length 2 metres.
Voltage selection	200 volt steps with a twelve position switch plus a 0-500 volt continuous control by a five turn potentiometer with digital dial indication.
Resolution	150mV.
Calibration accuracy (with fine control at zero)	1%
Accuracy at fine control	3% of indication.
Temperature coefficient	50ppm/°C typical.
Drift with time (at constant line, load and temperature)	50ppm/hr typical. 100ppm/day typical.
Output voltage float potential with respect to chassis (either terminal)	250V dc maximum.
Ambient temperature	
Working	0 to 45°C.
Storage	-20°C. to + 70°C.
Auxiliary Supply	±5 to 15Volts independently adjustable 220mA max.
Overload protection	250mA current limit.
Ripple	10mV p-p.
Line stability	0.1% for 10% input charge.
Load stability	0.8% from no load to full load.
Output connectors	3pin Fischer 400 series connector supplied pre-wired for either positive or negative output, with 2 metre length of UR70 coaxial cable. Auxiliary ±5 to 15V supply 3pin Pye SMC 3 connector provided.
Net weight	6Kg. (13 lbs).
Dimensions	
Case	213mm ($8\frac{3}{8}$") x 127mm (5") x 260mm ($10\frac{1}{4}$").
Overall	213mm ($8\frac{3}{8}$") x 143mm ($5\frac{5}{8}$") x 295mm ($11\frac{5}{8}$").

Iss/3

PM28B HIGH VOLTAGE POWER SUPPLY

Description

The Power Supply PM28B provides a stable well regulated output controllable from 100V to 2800V at up to 5mA. Polarity is determined by the specially wired connecting lead provided. This is a convenient and safe method of permanently determining the polarity applied to a photomultiplier and obviates the dangers inherent in other methods of selecting polarity.

An auxiliary adjustable low voltage supply of ± 5 to 15V is provided which is available from a three pin socket mounted on the front panel. This enables the operation of both photomultipliers and semiconductor head amplifiers from a single power unit.

The general design has been carried out to ensure the maximum convenience for users of photomultipliers. In particular the layout and ranges of the voltage controls have been chosen for this application.

Electrical Characteristics

The unit is provided with a 12 position switch controlling the output in 200V steps from 100V to 2300V and a 5 turn potentiometer for fine voltage control giving a range of 0-500V. The power supply circuit employs solid state components which enable the output voltage to be available immediately upon switching on the unit. The output voltage is displayed on a front panel meter and is free from switch-on surges, making the unit particularly suitable for photomultiplier applications.

The auxiliary ± 5 to 15V power supply is adjustable via two preset potentiometer mounted on the rear panel of the unit. These enable independent adjustment of each power rail for non-symmetrical applications. The 0V rail of this auxiliary supply is connected to earth via a 50-Ω resistor to minimise earth loop currents and therefore cannot be floated above earth potential. Should this supply be used with a photomultiplier in the earthed cathode configuration, the signal from the anode must be a.c. coupled to the head amplifier and suitable input protection diodes employed.

Polarity Selection

A coaxial output lead with connectors is provided. In this connector the screen of the coaxial cable is linked to ground. In the connector of a lead marked "positive output" the inner of the coaxial cable is connected to the positive output pin and the screen is connected to the negative output as well as to ground. The "positive output" lead is used for photomultipliers being used with the cathode grounded, for example, in pulse counting applications. In the connector of a lead marked "negative output" the inner of the coaxial cable is connected to the negative output and the screen is connected to the positive output as well as to ground. The "negative output" lead is used for photomultipliers being run with the cathode at EHT−ve, for example in d.c. measurements. This method of polarity selection is particularly convenient for use with photomultipliers since it minimises the chances of the wrong polarity being used.

If earth loops prove to be a problem when the screen of the cable is also grounded at the photomultiplier housing, it may be desirable to remove the link joining the screen and the low potential output to ground in the

output connector. This will be necessary in any case if it is required to float the output voltage with respect to ground.

To avoid the risk of a lead so modified being inadvertently attached to any other photomultiplier circuit or load, it is recommended that each piece of equipment to be fed from the power unit be provided with its own permanently attached lead. Additional leads can be supplied for this purpose.

CAUTION Except when deliberately floating the output, always ensure that one of the two output leads is securely connected to ground at some point. When deliberately floating the output one of the output leads should be connected to a source less than 250V. At the same time care should be taken that no external parts become live.

Mechanical Characteristics

The unit measures 213mm ($8\frac{3}{8}$in) wide by 127mm (5in) high by 260mm ($10\frac{1}{4}$in) deep. It may be used as a free standing unit, or as a half rack mounted unit.

Mounting Position

The unit should be mounted horizontally. Free circulation of air should be maintained above and below the unit. For this reason, the plastic feet fixed to the unit should not be removed.

OPERATING INSTRUCTIONS

MAINS SUPPLY

Unless otherwise requested, the unit will have been wired for use on 200 to 250 volts r.m.s. a.c. mains, 48 to 66Hz.

The factory should be consulted if operation on 110V mains is required.

COLOUR CODE OF MAINS LEAD

Brown = LIVE Blue = Neutral Yellow/Green = EARTH

OPERATING INSTRUCTIONS

Check that the unit is suitable for the mains supply voltage. Connect the appropriate output lead to the photomultiplier housing. Plug the lead into the output socket.
Select the output voltage required.
Switch the unit to 'On'.
The output voltage appears immediately, and is indicated by the panel meter.
Should the maximum output current of 5mA be exceeded, the 'OVERLOAD' indicator will light, and a current limit circuit will operate at approximately 6mA. The output current must be reduced to below 5mA for correct operation. Should the power supply output become inadvertently short-circuit, a current foldback circuit limits the short-circuit current to approximately 3mA. The selected output voltage will re-appear immediately on removal of the short-circuit.

Before using the auxiliary low voltage power supply the output voltage must be measured and set to the required levels using a suitable external voltmeter and the two adjustment potentiometers on the rear panel of the unit.

CAUTION

THE POWER SUPPLY CAN PRODUCE LETHAL VOLTAGES. ALWAYS SWITCH THE SUPPLY OFF AND WAIT UNTIL THE OUTPUT HAS FALLEN TO ZERO BEFORE CONNECTING, DISCONNECTING, OR MAKING ADJUSTMENTS TO THE LOAD.

RECALIBRATION

Equipment required: DVM, Load Resistor, Multimeter.

Full recalibration is carried out as follows:

1. Remove the top cover.
2. Connect the positive output firmly to ground.
3. Connect DVM, set to its 1KV range to the negative output and chassis.
4. Select 900V out, apply mains to the unit, switch on, and allow the unit to warm up for $\frac{1}{2}$ hour.

CAUTION

DANGEROUS VOLTAGES EXIST. PROCEED WITH CARE. USE A FULLY INSULATED TRIMMING TOOL.
ADJUSTMENTS TO BE CARRIED OUT ON PRINTED CIRCUIT BOARD NO. 1.

5. Set switch to 900 volts. Adjust RV1 for a reading on the DVM of 900.0 volts. (See diagram below).

6. Adjust RV2 for 9.0 ± 0.2 volts between TP1 and Pin 2 of Plug B (use 20,000 ohm/volt meter).

7. Rotate RV3 fully anti-clockwise. Draw 6mA load current. Rotate RV3 slowly clockwise until the overload lamp lights.

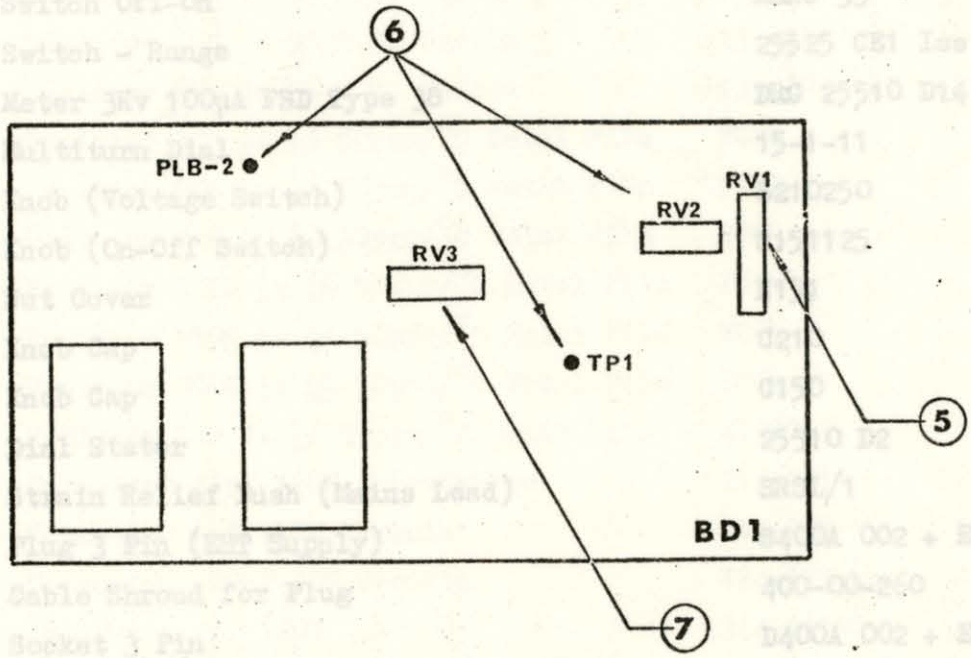
8. Adjust RV1 (on Bd 3 which is on the back of the meter) for correct meter reading at -2300V set by the volts switch with the variable control at zero.

PRE-REGULATOR ADJUSTMENT

For correct circuit operation, the voltage across the series stabilizer transistors TR1 and TR2 on PCB2 is set to 300V ± 10V by adjustment of potentiometer RV1 on PCB2. Re-adjustment of this is not normally necessary in the recalibration procedure.

OUTPUT VOLTAGE CALIBRATION ONLY

If it is not desired to reset the overload characteristic steps 6 and 7 above may be omitted.



MAIN ASSEMBLY PARTS LIST

Component Reference	Description	TYPE	QTY
R1	Resistor 1K ½w 5% Carbon Film	CR 37	1
R7 a & b	Resistor 270K 1w 5% H.S. Carbon Film	134-046	2
R6, R8	Resistor 560K 1w 5% H.S. Carbon Film	134-080	2
R5, R9	Resistor 1M2 1w 5% H.S. Carbon Film	134-125	2
C1	Capacitor 0.047µf	345 CAPAC 660M	1
C2, C3	Capacitor 1800 pf 4Kv Ceramic	K120061 CD8	2
RV1	Potentiometer 5 turn 10K	DRG 25510 D13	1
FS1	20mm Fuse 0.5A Anti-Surge	L2080	1
SK3	Earth Terminal (Black)	L1726/1	1
	Panel Fitting for Earth Terminal	04	1
	Fuseholder	L2006A	1
SK2	3 Pin Socket (5/15V Supply)	SMC 3 Black	1
PL2	3 Pin Plug (5/15V Supply)	SMC 3 Black	1
LP2	Lamp, Amber, 14V	575-813	1
LP1	Lamp, Red, 14V	575-807	1
T1	Transformer	PM 28B T1-2	1
T2	Transformer	PM 28B T2 (EH/G2G)	1
S1	Switch Off-On	MSRC 33	1
S2	Switch - Range	25525 CE1 Iss 2	1
M1	Meter 3Kv 100µA FSD Type 38	DRG 25510 D14	1
	Multiturn Dial	15-1-11	1
	Knob (Voltage Switch)	S210250	1
	Knob (On-Off Switch)	S151125	1
	Nut Cover	N151	1
	Knob Cap	C210	1
	Knob Cap	C150	1
	Dial Stator	25510 D2	1
	Strain Relief Bush (Mains Lead)	SRSL/1	1
PL1	Plug 3 Pin (EHT Supply)	S400A 002 + E	1
	Cable Shroud for Plug	400-00-260	1
SK1	Socket 3 Pin	D400A 002 + E	1
SK D,E,J	Connectors 3 way	4003	3
SK B,C	Connectors 5 way	4005	2
SK A,H	Connectors 7 way	4007	2
SK F,G	Connectors 9 way	4009	2
	Stand-Off Insulator	W 4031 4BA	1

NOTE: For PCB Board 5A connector and rear panel mounted items see Board 5A Parts List Page 12.

P.C. BOARD 1 PARTS LIST

Component Reference	Description	Type	Qty
R16	Resistor 82R ½w 5% Carbon Film	CR 37	1
R2	Resistor 1K ½w 5% Carbon Film	CR 37	1
R7	Resistor 1K2 ½w 5% Carbon Film	CR 37	1
R5	Resistor 1K8 ½w 5% Carbon Film	CR 37	1
R10,R11,R14	Resistor 4K7 ½w 5% Carbon Film	CR 37	3
R12	Resistor 10K ½w 5% Carbon Film	CR 37	1
R17	Resistor 15K ½w 5% Carbon Film	CR 37	1
R18	Resistor 22K ½w 5% Carbon Film	CR 37	1
R19	Resistor 100K ½w 5% Carbon Film	CR 37	1
R15	Resistor 220K ½w 5% Carbon Film	CR 37	1
R22	Resistor 2M2 ½w 5% Carbon Film	CR 37	1
R3	Resistor 47K ½w 5% Carbon Film	CR 37	1
R13	Resistor 750R ½w 5% Carbon Film	132-466	1
R6	Resistor 2K4 ½w 5% Carbon Film	132-589	1
R4	Resistor 24K ½w 5% Carbon Film	132-826	1
R35	Resistor 10R 1w 5% H.S. Carbon	133-510	1
R29	Resistor 5K6 1w 5% H.S. Carbon	133-841	1
R23 - R26	Resistor 5M6 1w 5% H.S. Carbon	134-204	4
R9	Resistor 2K2 ½w ¼% 50ppm/°C Metal Film	FC65	1
R8	Resistor 6K8 ½w ¼% 50ppm/°C Metal Film	FC65	1
R33,R34	Resistor 75K ½w ¼% 50ppm/°C Metal Film	FC65	2
R30	Resistor 120K ½w ¼% 50ppm/°C Metal Film	FC65	1
R32	Resistor 150K ½w ¼% 50ppm/°C Metal Film	FC65	1
R20,R21,R31	Resistor 300K ½w ¼% 50ppm/°C Metal Film	FC65	3
R27,R28	Resistor 1M2 2w ¼% 50ppm/°C Metal Film	4037C	2
C1	Capacitor 47pf 160V Polystyrene	113-241	1
C5	Capacitor 1nf 750V Ceramic	124-279	1
C2,C3	Capacitor 100nf 30V Ceramic	124-178	2
C4	Capacitor 1µf 100V	344-21105	1
C6,C7	Capacitor 100nf 4kV	CAP 4000	2
C8	Capacitor 22nf 100V Ceramic	125-474	1
D1,D14	Zener Diode 15V 400mW	BZY 88-C15	2
D12	Zener Diode 6.8V 400mW	BZY 88-C6V8	1

P.C. BOARD 1 PARTS LIST Continued

Component Reference	Description	Type	Qty
CR1	Current Regulator Diode 2.8mA	E 507	1
D21	Zener Diode	BZX 61C30	1
D2-D7, D9-11, D13,D15,D16	Diode	IN 914	12
D17,D18,D19	Silicon Diode	IN 4003	3
D20	Silicon Diode	IN 4004	1
TR1	Transistor NPN 1W	2N3053	1
TR2	Transistor PNP 250mW -	2N4058	1
TR3,TR4	Transistor NPN 360mW	2N3707	2
IC1,IC2,IC3	Operational Amplifier I.C.	LM741 CN	3
IC4	Voltage Regulator	LM 399H	1
RV1	Potentiometer 1K Lin 0.75W Cermet	Cermet 43P	1
RV3	Potentiometer 100R Lin 0.75W Cermet	VA05V/100R	1
RV2	Potentiometer 10K Lin 0.75W Cermet	VA05V/10K	1
	Dust Covers for RV2 & RV3	99587X	2
	Heatsink for 2N3503	5F2	1
PLA,B,C & E	PCB Pins	4010	22

P.C. BOARD 2 PARTS LIST

Component Reference	Description	Type	Qty
R11	Resistor 22K ½w 5% Carbon Film	CR 37	1
R10,R14,R16	Resistor 1K ½w 5% Carbon Film	CR 37	3
R12	Resistor 6K8 ½w 5% Carbon Film	CR 37	1
R13	Resistor 10K ½w 5% Carbon Film	CR 37	1
R15	Resistor 330R ½w 5% Carbon Film	CR 37	1
R9	Resistor 56K ½w 5% Carbon Film	CR 37	1
R1-R6	Resistor 1M0 1w 5% H.S. Carbon	134-119	6
R8	Resistor 3M3 ½w 5% H.S. Carbon	133-273	1
R7	Resistor 5K6 2w 5% H.S. Carbon	134-844	1
RV1	Potentiometer 2.2K Cermet	VA 05V/2K2	1
	Cover for RV1	99587X	1
C1,C2	Capacitor 500nf 3kV Plastic Film	CAP FACEL X3	2
C9-C13	Capacitor 22nf 630V Plastic Film	PMT2 RO 22M	5
C6	Capacitor 2N2 63V	630-06222	1
C7,C8	Capacitor 100µf 63V Electrolytic	017-18101	2
C3,C4	Capacitor 6n8 5kV Ceramic	K 7900 HV CP6	2
C5	Capacitor .1µf 100V Ceramic	344-21104	1
D7,D8	Zener Diode 4.7V	BZY88-C4V7	2
D5	Zener Diode 18V 1w	BZX61-C18	1
VDR1,VDR2	Zenamic Suppressor	Z10L 391	2
D1,D2	Silicon Diode	FM 75	2
D3	Silicon Diode	IN 4004	1
D6	Rectifier Bridge	1K AB 20	1
D7	Rectifier Bridge	1K AB 80	1
TR1	Transistor TIP50/BUX 86	BUX 86	1
TR2,TR3	Transistor	2N 3904	2
TR4	Transistor	BFR 40	1
RLA	Reed Relay	CD3377	1
	Mounting Pads for 2N/3904	10171	3

P.C. BOARD 3 PARTS LIST

Component Reference	Description	Type	Qty
R1, R2	Resistor 12M 2W 1% Metal Film	4037C	2
RV1	Potentiometer 10K 75W Cermet	43P/10K	1
	P.C.B. Pins	4010	2

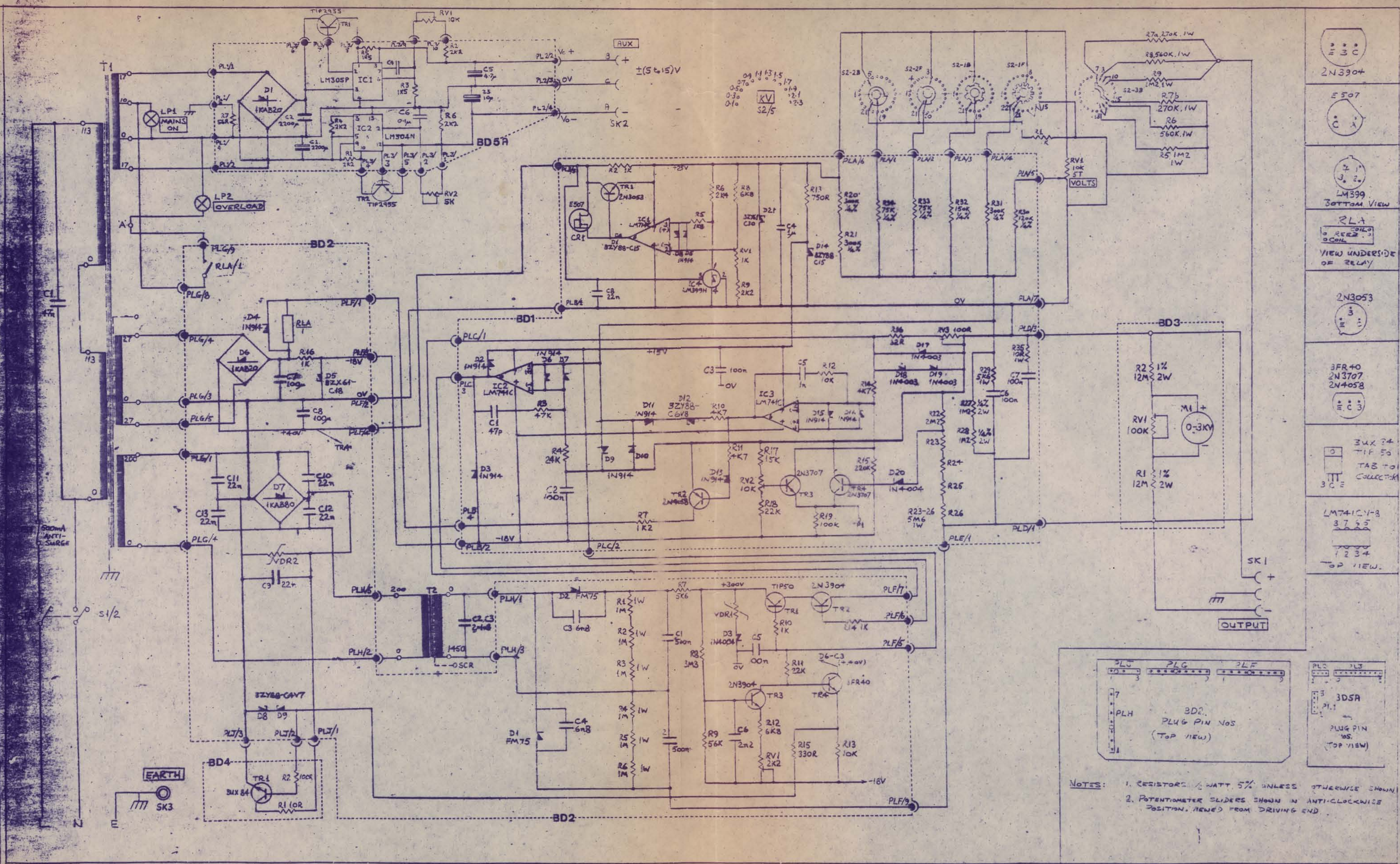
P.C. BOARD 4 PARTS LIST

Component Reference	Description	Type	Qty
T1	Transistor	BUX 84	1
R1	Resistor 10 Ω ½w 5% C.F.	CR 37	1
R2	Resistor 100R ½w 5. C.F.	CR 37	1
	Pin	4010	3
	Thermal Conductive Pad	SK 28 B3	1

P.C. BOARD 5A PARTS LIST

Component Reference			
R5	Resistor 1.5R ½w	CR 37	1
R1	Resistor 2.2R ½w 2%	CR 37	1
R7	Resistor 47R ½w 2%	CR 37	1
R3	Resistor 1k5 ½w 2%	CR 37	1
R2, R4, R6	Resistor 2k2 ½w 2%	CR 37	3
C1, C2	Capacitor 2200µF 40V Al.Elec	EN 12-12 2200/40	2
C4	Capacitor 47pF 100V dc. Sub.Min.Ceramic	632-34479	1
C6	Capacitor 0.1µF 30V dc. Disc Ceramic	124-178	1
C5	Capacitor 2.2µF 35V Solid Tantalum	100-902	1
C3	Capacitor 10µF 35V " "	100-906	1
D1	Rectifier 1.2A Bridge Rectifier	1KAB20	1
PL2	4-Way P.C.B Connector (Male)	467-560	1
PL1	5-Way " " "	467-576	1
PL3	10-Way " " "	467-582	1
IC2	Dil. Positive Voltage Regulator	LM305P	1
IC1	Dil. Negative " "	LM304N	1
	Pot 10k - - 20 Turn Cermet	94PM	1 *
	Pot 5k - - " " "	94PM	1 *
	Transistor PNP	TIP 2955	2 *
	Crimp Terminal (Female)	467-598	19*
	Cable Shell 4-Way "	467-611	1 *
	Cable Shell 5-Way "	467-627	1 *
	Cable Shell 10-Way "	467-633	1 *

* These items are mounted on the rear panel or incorporated in the cable form.



Arthur Missira January 2012

PM 28B Mk II CIRCUIT DIAGRAM

DRWG. NO. 25525 AE 1-A