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OSCILLOSCOPE
MAIN FRAME
OS2000/OS2000R
Instruction | Manual

Division of **ADVANCE ELECTRONICS LIMITED**

Contents

SECTION 1	Introduction	3	SECTION 6	Component List and Illustrations	10
SECTION 2	Specification	4	ILLUSTRATIONS		
SECTION 3	Operation	5	Fig. 1 (a)	Main Frame Circuit Diagram (OS2000)	11
3.1	Preparation for Use	5	(b)	Main Frame Circuit Diagram (OS2000R)	14
3.2	Main Frame Controls	5	Fig. 2	Delay Line Amplifier Circuit Diagram	17
3.3	Photography	5	Fig. 3	Y Output Amplifier Circuit Diagram	20
3.4	CRT Phosphors	5	Fig. 4	X Output Amplifier and Beam Blanking Circuit Diagram	23
SECTION 4	Circuit Description	6	Fig. 5	Low Voltage Power Supply and Calibrator Circuit Diagram OS2000	26
4.1	General Information and Location of Circuits	6	Fig. 6	Low Voltage Power Supply and Calibrator Circuit Diagram OS2000R	29
4.2	Delay Line Amplifier	6	Fig. 7	EHT Supply Circuit Diagram	32
4.3	Y Output Amplifier	6	Fig. 8	Main Frame Component Layout – Top View	35
4.4	X Output Amplifier and Beam Blanking	6	Fig. 9	Y Output Amplifier Component Layout	36
4.5	Low voltage Power Supply and Calibrator	7	Fig. 10	Delay Line Amplifier Component Layout	37
4.6	EHT Supply	7	Fig. 11	Main Frame OS2000R Component Layout (Top View)	38
4.7	Power Supplies and Sensivities	7	Fig. 12	Main Frame OS2000R Component Layout (Bottom View)	39
SECTION 5	Maintenance	8			
5.1	Fuse Replacement	8			
5.2	Access to Instrument	8			
5.3	Replacement of Components	8			
5.4	Lamp Replacement	8			
5.5	Fault Location	8			
5.6	Recalibration	8			

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The general purpose OS2000 and OS2000R series oscilloscope main frames provide a bandwidth of at least 25MHz and readily accept all OS2000 series plug-in modules. The main frame contains the cathode ray tube with appropriate brilliance and focus controls, power supplies, main X and Y amplifier together with a 170 nano sec. delay line, and a 50Hz (60Hz) calibrator. Semiconductors are used throughout and all power rails are fully stabilised against power line voltage fluctuations by means of a constant voltage transformer. Separate plug-in modules are used for the X and Y deflection, thereby ensuring maximum versatility.

The cathode ray tube, operating at 4kV, has a display area of 10 x 6cm. A P31 general purpose phosphor is fitted as standard, with a P7 long persistence phosphor being available as an option. Graticule illumination, focus and brilliance are provided as front panel controls with astigmatism and trace rotation as front panel preset controls.

The nano sec. delay line in the Y deflection system enables the leading edge of the triggering waveform to be

observed. Dual trace display is achieved by chopped/alternate sweep methods; the beam switch circuit being integral with the dual trace Y plug in and the operating mode selected automatically by the position of the time base range switch. The X amplifier is normally driven from the timebase plug-in module and is capable of providing sweep speeds of up to 20nS/cm. Full Z Modulation facilities are provided via a socket on the rear panel.

A notable feature of the main frame is the use of a constant voltage transformer to stabilise the power rails. Apart from providing adjustment-free operation over the line input range, 95 to 130V or 190 to 260V, its transient suppressing capabilities ensure faultless triggering in the presence of substantial power line noise. It should be noted, however, that the line frequency must be specified when ordering.

The construction of the main frame and the availability of blank plug-in modules make the OS2000MF ideally suited for special purpose applications.

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Specification

Section 2

DISPLAY

Single gun 5 in. rectangular cathode ray tube with helical PDA operating at 4kV overall. Display area 10 cm. x 6 cm; P31 phosphor is standard – a general purpose phosphor giving a green trace, medium persistence, and a bright clear display. P7 phosphor is optional – a long persistence phosphor for slow speed displays, with a blue trace and yellow afterglow.

17¼in (44cm) deep
18¼in (47.5cm) deep (including handle)
27lb (12.2Kg)

CALIBRATION ACCURACY

±5% with any OS2000 series plug-in module.

'Y' BANDWIDTH

Greater than 25MHz (-3dB) with wide band 'Y' plug-in OS2001Y or OS20002Y.

CALIBRATOR

250mV, 100mV, 50mV, 5mV and 0.5mV ±2%, 50Hz (60Hz) available at front panel sockets

'Z' MODULATION

30V pk-pk fully modulates the trace via socket on rear panel.

SIGNAL DELAY

Approximately 170nS.

GRATICULE ILLUMINATION

Variable by front panel control.

POWER SUPPLY

95 to 130V, 190V to 260V, 50Hz ±2% or 60Hz ±2%, 60 to 70VA depending on plug-in units. All supply rails are stabilised by a constant voltage transformer.

OPERATING TEMPERATURE RANGE

0 to 40°C.

DIMENSIONS AND WEIGHT

OS2000: 10in (25cm) wide
12½in (32cm) high
17½in (44.5cm) deep
25½lb (11.6Kg)

OS2000R: 17in (43cm) wide
7in (17.5cm) high

ACCESSORIES

	Description	Advance Part Number
Standard:	Instruction Manual Part No.	28084
	Connector BNC/BNC (2')	PL43
	Connector BNC/BNC (8')	PL81
	Connector BNC/Crocodile	PL44
	Plug 2mm Red	26802
	Plug 2mm Black	26803
	Filter Amber	23103
	Filter Blue	23131
	Filter Green	23132
	Filter Grey	27830
	Rack Mount Brackets (OS2000R only)	27852
Optional:	Adaptor BNC - Binding Post	26234
	Viewing Hood	26974
	Passive Probe Kit	25362
	Oscilloscope Trolley	TR2
	Padded Protective Cover	26608

PLUG-IN UNITS

All OS2000 series plug-in modules may be used.

Y units

OS2001Y Single Trace Wide Band
OS2002Y Dual Trace Wide Band
OS2004Y Single Trace Differential
OS2007Y Dual Trace Wide Band

X units

OS20001X X Amplifier
OS2003X Standard Time Base
OS2005X Delay Sweep Time Base
OS2005AX Delay Sweep Time Base
OS2006X Wide Range Time Base

3.1 PREPARATION FOR USE

WARNING The power supply employs a constant voltage transformer for the stabilisation of the supply rails. It is essential that only the specified line frequency be used. **NO OTHER FREQUENCY MUST EVER BE USED.**

When despatched from the factory, the transformer tapplings will be set for 190-260V on 50Hz models, and 95-130V on 60Hz models. Access to the transformer may be obtained by removing the bottom panel. The AC power input is always connected to terminals 1 and 3. For 190-260V working, link terminals 2 and 4; for 95-130V working, link terminals 1 to 2 and 3 to 4, removing the link 1 to 3.

3.2 MAIN FRAME CONTROLS

The main frame requires that both X and Y plug-in modules be fitted before switching on. Both units are automatically held in place after being firmly pressed into the main frame. Withdrawal is by means of a lever fitted to each module.

The instrument is switched on by clockwise rotation of the **BRILLIANCE** control.

NOTE The instrument relies on convection cooling. It is essential that the air flow through and around the instrument should not be impeded. In particular the ventilation holes should not be blocked.

The main frame controls, which are located on the right hand side of the cathode ray tube of the OS2000 and below that on the OS2000R, are associated with the cathode ray tube display.

BRILL Adjusts the brilliance of the display, giving a brighter trace as the control is turned clockwise. An associated switch is opened in the fully counter-clockwise position to switch off the power.

FOCUS Controls the sharpness of the trace and should be set for minimum spot size.

ASTIG This preset control should be adjusted with a screwdriver to equalise focussing at all parts of the screen.

GRAT Controls graticule illumination.

TRACE ROTATION The preset control on the front panel may be adjusted with a screwdriver; it should be set so that the time base runs horizontally, aligned with the graticule.

CALIBRATION OUTPUTS Five 2mm sockets at the bottom right hand corner of the OS2000 front panel and bottom left hand corner of the OS2000R, carry calibration voltages at 50Hz (or 60Hz). These may be connected to the 'Y' amplifier input to check amplitude and time calibration.

Z MODULATION A switch on the back panel selects **EXT**ernal or **INT**ernal modulation. It should normally be left in the **INT** position for control by the relevant plug in unit. When set to **EXT**, the **Z MOD** socket adjacent to the switch, is AC coupled to the CRT grid and a 30V pk-pk signal will fully modulate the beam.

OTHER CONTROLS All other controls, input sockets, etc., are mounted on the plug-in units and reference should be made to the relevant handbook for further information.

3.3 PHOTOGRAPHY

Suitable cameras utilising Polaroid or 35mm film may be obtained from D. Shackman & Sons or Telford Products Ltd. Adaptors are available for attaching the camera to the oscilloscope.

Almost any other oscilloscope camera may be used with the OS2000/OS2000R, but a suitable adaptor must be obtained and reference should be made to the camera manufacturer on this subject.

It is important that in all enquiries concerning cameras, the serial number of the instrument should be quoted.

3.4 CRT PHOSPHORS

The OS2000 Oscilloscope is normally fitted with a P31 cathode ray tube, although a P7 may be fitted.

<i>PHOSPHOR</i>	<i>GH(P31)</i>	<i>GH(P7)</i>
Use	General Purpose High brightness High writing speed photography	DC & Low frequency below 30Hz Long persistence
Light Output Comparison	100%	25%
Persistence	Medium Short 100µS – 1mS	Long 1 – 5S
Colour	Green at low brilliance Blue-green at high brilliance	Blue flash Yellow persistence
Filter	Green or Grey	Blue to reduce persistence, Orange to enhance persistence
Availability	Standard	Optional

4.1 GENERAL INFORMATION AND LOCATION OF CIRCUITS

The cathode ray tube has a 10 x 6cm display area with a P31 phosphor as standard, P7 phosphor (long persistence) is optional. The CRT is operated with -1000V on its cathode and +3kV on the PDA. The face-plate is rectangular and a coil is provided around the tube to enable the display to be rotated. This is necessary to take up the alignment error between the deflection plate structure and the face plate.

The instrument is powered by a constant voltage transformer to stabilise all internal supply rails against wide variations of the power line voltage. All low voltage and EHT supplies are derived from windings on this transformer.

In the OS2000 the X deflection amplifier printed circuit board is mounted horizontally behind the centre panel on the right hand side of the tube. This board also carries the blanking circuits.

The Y output amplifier is mounted vertically behind the centre panel on the right hand side of the tube.

The delay line driver is mounted on and behind the centre panel below the tube. The EHT unit is mounted on the left of the tube and the low voltage power supply together with the constant voltage transformer on a sub-unit at the bottom rear of the instrument.

The OS2000R uses the same sub-units as the OS2000 with the exception of the low voltage power supply board.

The location of the various sub-units is quite evident by reference to Figs. 10 and 11. It should be noted that the low voltage power supply and calibrator board is mounted behind the centre panel. All the associated smoothing capacitors are mounted on the front of the centre panel.

The delay line is mounted above the CRT at the front.

4.2 DELAY LINE AMPLIFIER (Fig.2)

The differential signal from the plug-in 'Y' amplifier is connected to the bases of VT501 and VT502 (an emitter coupled differential amplifier). VT503 provides a constant current source for the differential amplifier and helps to ensure a balanced drive to the delay line when the single trace 'Y' plug-in is in use. The collectors of VT501 and VT502 drive the delay line and matching adjustment is provided by RV501. The collector loads consist of R506/R508 in parallel and R507/R509 in parallel. The output of the delay line drives the bases of VT504 and VT505; the matching adjustment is provided by RV505. VT504 and VT505 are an emitter coupled differential amplifier feeding emitter followers, VT506 and VT507, to provide a low impedance drive to the 'Y' output amplifier. Frequency compensation for the delay line is provided by one fixed (C505/R529) and two variable (C501/RV502 and C507/RV504) time constants in the emitter circuits of the two differential amplifiers.

4.3 'Y' OUTPUT AMPLIFIER (Fig. 3)

The main 'Y' amplifier which drives the 'Y' plates of the CRT, consists of an emitter coupled differential amplifier driving a balanced cascode amplifier. The differential input amplifier consists of VT304 and VT305 with a constant

current source VT307. The current in VT307 may be adjusted by means of RV302 to set the mean potential on the Y plates. RV301 in the emitter circuit of VT305 and VT304 may be adjusted to set the gain of the amplifier to the required level. The networks, C308/C309/R329 and C310/R330, provide compensation for the low frequency characteristics of the high voltage transistors, VT1 and VT2. The outputs from the collectors of VT304 and VT305 drive the lower transistors VT303 and VT306 of the cascode pairs.

The lower transistors are low voltage, high frequency types which drive the emitters of the high voltage output transistors, VT1 and VT2. The collector loads of VT1 and VT2 are each made up of four resistors in series-parallel, in order to give the required dissipation with minimum stray inductance and capacitance. The main high frequency compensation is provided by the tapped inductances, L301 and L302, supplemented by the networks, C301, C302, R310, C311 and R311, and R332 in the emitter circuit of VT303 and VT306. The inductances are made adjustable to allow the optimum response to be obtained.

4.4 X OUTPUT AMPLIFIER AND BEAM BLANKING

The 'X' output amplifier is an emitter coupled cascode differential amplifier. It employs five transistors, VT401, VT402, VT403, VT404 and VT405. The constant current transistor, VT405, forms the common emitter return path for the differential amplifier, VT403 and VT404. The base potential of VT405 and therefore the current through the differential amplifier, may be adjusted by the SET 'X' MEAN POTENTIAL potentiometer, RV403. This is adjusted to obtain the required quiescent potential on the 'X' deflection plates. The emitters of VT404 and VT403 are coupled through RV402 which is set to obtain the required 'X' gain. This variable resistor is shunted by capacitor, C407, to get the highest coupling, and therefore the best possible gain at high frequencies. When the 'x5' gain switch on the 'X' plug-in front panel is operated, RV401 is connected in parallel with RV402, increasing the coupling between the emitters of VT404 and VT403. RV401 is adjusted to give a gain five times as great as the normal 'X' gain. The capacitor, C401, connected across RV401 gives greater coupling at higher frequencies to improve the overall response of the amplifier.

The output currents from the collectors of VT403, VT404 drive the emitters of the high voltage transistors, VT401 and VT402. These two transistors provide the voltage drive required by the 'X' deflection plates. The diodes, MR401, MR402 and MR405, MR406, are connected from the collectors of VT401 and VT402 to the +12V line. These diodes prevent the collector voltage falling below +12V stopping the differential amplifier from bottoming.

Two forms of beam blanking are required, the first operating during the flyback period on all timebases and the second operating during the delay period on the sweep delay plug-in. The normal flyback blanking is connected through R409 and R410 to the base of VT406, which operates as a simple inverter. Negative-going input signals are amplified and transmitted from the

collector of VT406. Positive-going input signals will cause MR403 to conduct, applying heavy feedback round VT406 so that no output signal is available. Negative-going blanking signals on the Blank 2 input will be coupled through MR404 to the blanking output. Positive-going signals on this line will reverse bias MR404 and will not be transmitted.

4.5 LOW VOLTAGE POWER SUPPLY AND CALIBRATOR

OS2000 (Fig. 5)

The constant voltage transformer provides an output approximating to a square wave. In addition to an output of 2kV p-p and a supply for the CRT heater, outputs of 150V and 18-0-18V are provided. A bridge rectifier, MR101/MR102/MR103/MR104, provides 155V DC from the 150V winding and a second bridge, MR105/MR106/MR107/MR108, connected as two full wave rectifiers, provides $\pm 18V$ from the 18-0-18V winding. Two lines, $\pm 12V$, are derived from these by the zener diode and emitter follower systems MR109/MR112/VT3 and MR110/MR111/VT4.

The 18V AC supply is also fed through R106 to the zener diode MR113. This provides a constant amplitude rectangular waveform which is fed through R107 and RV101 to the calibration network on the main frame. RV101 is adjusted to set the calibrator outputs to the correct level.

OS2000R (Fig.6)

The operation of the power supply for the OS2000R is identical to that of the OS2000 although in some instances component coding has been modified.

However, since the distance between the X and Y plug-in modules is greater in the case of the OS2000R, an emitter follower has been added to feed the ALTERNATE trigger pulses to the Y plug-in. This consists of VT101 and R109.

4.6 EHT SUPPLY (Fig.7)

The 1000V winding on the supply transformer is grounded at one end and the other end provides a 2kV AC peak-to-peak waveform into the EHT supply board. The negative-going half-cycle is rectified by MR204, MR205 and MR206 in series, and the rectified output is smoothed by C205, C206, C207, R205 and C202, C203 and C204. The -1kV output voltage is then fed to the cathode ray tube grid through R202, R201, and from E7 through the brilliance control to the cathode via D2.

The focus control is connected between E8 and E3. The interplate shield is connected through D7 to the geometry potentiometer, RV201. This is adjusted to minimise barrel and pincushion distortion. The astigmatism control is connected between E4 and E2, the wiper being connected to E1 and through D9 to A3.

The positive-going half-cycle of the AC input feeds a voltage tripling circuit consisting of MR201, MR202 and MR203 with C208, C209 and C210. These provide a 3kV DC output which is connected to the PDA electrode of the CRT.

4.7 POWER SUPPLIES AND SENSITIVITIES

(a) POWER SUPPLIES

The supplies generated in the main frame and available for the plug-in units are as follows:-

LINE	LIMITS					
	MINIMUM	MAXIMUM	RIPPLE MAX.	CURRENT AVAILABLE	Y SKT A PIN No.	Y SKT B PIN No.
Ground					12,24	1,13
+12V	11.8V	12.7V	10mV P/P	200mA	9	16
-12V	11.8V	12.7V	10mV P/P	200mA total	21	4
-18V	Unstabilised				3	22
+150V	145V	165V	2V P/P	60mA	8	17
36V p-p	34V	37V		100mA	7	18

SENSITIVITIES

The necessary deflection signal for the 'Y' channel is a differential voltage between pins 11 and 23 of Skt. A. The mean DC level of the input should be -3.5V and the sensitivity to differential signals about this level is 70mV/cm. The maximum excursion of voltage of either pin should be limited between -5.5V and -1.5V.

The necessary deflection signal for the 'X' channel is a differential voltage between pins 2 and 14 of Skt. B. The mean DC level of the input should be +2.0V and the normal sensitivity to differential signals about this level is 400mV/cm. This is increased to 80mV/cm if pins 3 and 15 are grounded. The maximum excursion of voltage on either pin should be limited between -1.0V and +5.0V.

5.1 FUSE REPLACEMENT

The fuse holder is mounted at the rear of the instrument and is easily accessible. A 1A fuse (size 0 Part No.4732) is fitted for 230 volt operation. A 2A fuse (Part No. 21180) is fitted for 110 volt operation.

5.2 ACCESS TO INSTRUMENT

(a) OS2000

Removal of side covers:—

Remove the vertical trim bars at the rear of the instrument. Remove the fixing screws at front edge of the covers. The side covers are now free to slide backwards.

Removal of bottom cover:—

Turn the instrument over, and disengage the 'instrument rest' from its clip. Take out the two screws at the rear of the bottom cover. The bottom cover can now be drawn backwards.

Removal of the top cover:—

Remove the screws holding the handle and remove handle assembly. Remove the two screws at the rear of the top cover. The top cover can now be withdrawn.

(b) OS2000R

Remove the vertical trim bars at the rear of the instrument. Remove the fixing screws at the front edge of the top and bottom covers. These covers are now free to slide backwards.

5.3 REPLACEMENT OF COMPONENTS

If during fault finding, a component needs replacement, it should be cut from the printed circuit board as near to the component as possible, leaving the wires connected to the copper track and protruding through to the component side of the board. The new component should then be soldered into position by attaching it to these protruding wires. This protects the copper tracks from damage.

5.4 LAMP REPLACEMENT

The lamps used for graticule illumination are housed behind the CRT bezel. To change them in the event of failure, undo the screws holding the bezel in place, pull the bezel off the front panel and remove the faulty bulbs. Fit suitable replacements and screw the bezel back into place.

5.5 FAULT LOCATION

There are four basic systems in the oscilloscope.

- (1) Power Supplies
- (2) Y Amplifier
- (3) Timebase and X Amplifier
- (4) Blanking Amplifier

The following is a suggested procedure to be adopted in the event of complete loss of trace.

- (a) Remove all covers and switch on.
- (b) Check all supply lines (see recalibration section 5.6 and CRT heater voltage).
- (c) Put timebase in EXT X mode and meter the voltage difference between the second pair of contacts from top (Pin No's 2 and 14) of X

compartment 24 way socket. Adjust shift control to bring this potential to zero. If this cannot be done there is a fault in the timebase plug-in.

- (d) Meter the potential difference between the 'X' plates. Fine adjustment of the X shift should bring this to zero. If this cannot be done, there is a fault in the 'X' output amplifier.
- (e) Meter the potential on pin 8 of 'X' compartment socket. This should be about +10V. If not, there is a fault in the timebase plug-in.
- (f) Meter pin 5 on CRT base (Anode Modulator). With timebase set to EXT X mode, this potential should be 1V or less. Switch time base to 200mS/cm and set LEVEL control so that the time base does not run. The potential should be approximately +80V. If these conditions are not met, there is a fault in the blanking amplifier.
- (g) Meter the voltage difference between the second pair of contacts from the top (Pin No's 11 and 23) of the Y compartment 24 way socket. With single channel operation of the plug-in, adjust the appropriate shift control to bring this potential difference to zero. If this cannot be done, there is a fault in the 'Y' plug-in.
- (h) Meter the voltage difference between signal input pins on the 'Y' output board. This should be adjustable to zero with the 'Y' shift control. If not, there is a fault on the delay driver board.
- (i) Meter the potential difference between 'Y' plates. If this cannot be brought to zero with the 'Y' shift control, there is a fault in the 'Y' output amplifier.

5.6 RECALIBRATION

Equipment required:

20,000Ω/Volt multimeter

AC digital voltmeter with 1mV resolution

5kV electrostatic voltmeter

Audio frequency sine wave oscillator

1kHz ±1% square wave source.

Fast rise time square wave source with good pulse shape.

Rise time <3nS.

- (1) The main frame being tested should be fitted with X and Y plug-in units.
- (2) Switch on the oscilloscope and with the multimeter set to suitable DC ranges, check the line potentials to the tolerances given in the following table:

NOMINAL LINE VOLTAGE	TEST POINT	POWER SUPPLY BOARD	
+12V	C4	1	±0.9V
-12V	C8	1	±0.9V
+150V	C9	1	±7.5V
-1000V	E7	2	±50V
+3000V	+3kV	2	±600V

- (3) Turn the GRAT control clockwise and verify that the graticule illumination increases.
- (4) Set the timebase to FREE RUN and note that the trace appears on the screen. Use a screwdriver to adjust the TRACE ROTATION control until the trace is aligned with the horizontal graticule lines.
- (5) Connect a 1kHz sinewave to the 'Y1' input; select 'Y1' only and adjust the amplitude control to obtain a picture height of 5cm approximately. Switch the timebase to INTERNAL TRIGGER and set the LEVEL control to AUTO. Verify that a stationary display is obtained.
- (6) Switch the timebase velocity control to 0.2mS/cm and adjust the ASTIG and FOCUS front panel controls to obtain a clearly defined picture.
- (7) Change the timebase velocity to 2mS/cm and adjust the geometry control RV201 to obtain a rectangular raster.
- (8) Readjust the ASTIG and FOCUS controls as before.
- (9) Connect a 1MHz square wave with a rise time less than 3nS in place of the 1kHz sinewave. Adjust the peaking coils, L301 and L302, to obtain good pulse response. Note that both these peaking coils have two cores, one each end, and these should be adjusted separately.
- (10) Adjust RV501, the delay line source impedance; and RV505, the delay line terminating impedance to give minimum reflection.
- (11) Adjust RV502 to obtain a square corner on the pulse and, if necessary, select the value of C501. RV503 in the emitter circuits of VT504 and VT505 should not normally require adjustment but, if necessary, set to centre position $\pm 20\%$.
- (12) Change the timebase velocity to 0.5mS/cm and connect a 1kHz square wave to the 'Y1' input, in place of the 1MHz square wave. Connect an AC digital voltmeter across the signal outputs of the 'Y' plug-in unit and adjust the 'Y1' amplitude controls for a voltmeter reading of 400mV peak-to-peak. Adjust RV301 to give a 5cm picture on the cathode ray tube.
- (13) Set the 'Y1' and 'Y2' input coupling switches to GROUND and turn the timebase range switch to EXTERNAL X. Connect a 1kHz square wave to the EXTERNAL X socket and connect an AC digital voltmeter to the X signal output of the plug-in unit. Adjust the input signal amplitude until the voltmeter reads 4V peak-to-peak and adjust RV402 to give a 10cm X deflection.
- (14) Pull the fine velocity control to give x5 X gain and reduce the incoming signal until the voltmeter reads 0.8V peak-to-peak. Adjust RV401 to give a 10cm X deflection.
- (15) Change the timebase velocity to 0.2 μ S/cm and set the X gain to x5. Connect a 30MHz sinewave to the 'Y1' input and adjust the amplitude to give 4cm vertical deflection. Adjust RV403 to obtain best X linearity. Observe the linearity at the start of the trace and adjust C401 if necessary.
- (16) Connect the AC digital voltmeter to the 250mV calibrator socket and adjust RV101 until the digital voltmeter reads 250mV peak-to-peak. Verify that the 100, 50, 5, and 0.5 mV outputs are correct to $\pm 2\%$.

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Component List and Illustrations

Section 6

MAIN FRAME OS2000

Ref	Value	Description	Part No.	Ref	Value	Description	Part No.
RESISTORS				SOCKETS			
R1	900		26592	SKA		24-Way	24610
R2/3	300		26590	SKB		24-Way	24610
R4	8.2k		26593	SKC		Holder Valve B9A	21602
R5	820		26591	SKD		Holder Valve B9A	21602
R6	91		26589	SKE		Holder Valve B9A	21602
R7	10		5% ¼W 2259	SKF		Socket 2mm Black	26588
R8	100		10% ½W 3416	SKG		Socket 2mm Black	26588
R9	47	Erie 16	1818	SKH		Socket 2mm Black	26588
R10	68k		10% ½W 1636	SKJ		Socket 2mm Black	26588
R11	10M		5% ¼W 24921	SKK		Socket 2mm Black	26588
R12	1k		5% ¼W 384	SKL		Socket 2mm Black	26588
R13/14	22		10% ¼W 4419	SKM		Socket 4mm Black	23636
R15	1k		5% ⅛W 384	SKN		Socket 4mm Red	23635
POTENTIOMETERS				MISCELLANEOUS			
RV1	250k	(Including S1)	A4/29234	V1		Thorn CRT D13/47-GH	24911
RV2	1M		A23628	L1		Choke Toroid	A28145
RV3	1M		A22144	T1		Transformer	CV75/173
RV4	500 + 500Ω		A22147	FS1		Fuse	4732
RV5	250		A22145	PLC		Plug B9A Carrs 79/343	23637
CAPACITORS				PLD		Plug B9A Carrs 79/343	23637
C1	.01μF	G.P. Ceramic	1.5kV 22395	PLE		Plug B9A Carrs 79/343	23637
C2		Not used		N1		Neon Indicator	26586
C3	.02μF	Ceramic Disc	10% 1.5kV 25223	LP2		Lamp Pilot	0.56W 14V 24910
C4	.01μF	Ceramic Disc	10% 400V 22395	LP3		Lamp Pilot	0.56W 14V 24910
C5		Not used		S1			Part of RV1
C6/7	1μF		1.5kV 27898	S2		Switch Slider 2 Pole	
TRANSISTORS						Changeover	4069
VT1		SFT187	24916				
VT2		SFT187	24916				

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Component List and Illustrations

Section 6

MAIN FRAME OS2000R

Ref	Value	Description	Part No.	Ref	Value	Description	Part No.
RESISTORS				TRANSISTORS			
R1	900		26592	VT1		SFT 187	24916
R2/3	300		26950	VT2		SFT 187	24916
R4	8.2k		26593	VT201		MJE 520	24739
R5	820		26591	VT202		MJE 370	24738
R6	91		26589	MISCELLANEOUS			
R7	10		2259	T1		Transformer	CV75/173
R8	100		3416	V1		CRT Thorn D.13/47GH	24911
R9	47		1818	FS1		Fuse 1 Amp	4732
R10	220k		6703	N1		Neon Indicator	26586
R11	10M		24921	PLD		Plug B9A	23637
R12	1k		384	PLE		Plug B9A	23637
R13/14	22		4419	S1			Part of RV1
R15	1k		384	S2		Switch Slider	4069
POTENTIOMETERS				LP2		Lamp Pilot	.56W 14V 24910
RV1	250k	(Including S1)	A4/29234	LP3		Lamp Pilot	.56W 14V 24910
RV2	1M		A23628	SKA		Socket Connector 24-Way	24610
RV3	250		A22144	SKB		Socket Connector 24-Way	24610
RV4	500 + 500		A22147	SKC		Not used	
RV5	250		A22145	SKD		Valve Holder B9A	21602
CAPACITORS				SKE		Valve Holder B9A	21602
C1	0.01 μ F		22395	SKF		Socket 2mm Black	26588
C2		Not used		SKG		Socket 2mm Black	26588
C3	0.02 μ F		1.5kV 25223	SKH		Socket 2mm Black	26588
C4	0.01 μ F		22395	SKJ		Socket 2mm Black	26588
C5		Not used		SKK		Socket 2mm Black	26588
C6/7	1 μ F		10% 1.5kV 27898	SKL		Socket 2mm Black	26588
C201	100 μ F + 200 μ F		275V 27470	SKM		Socket 4mm Black	23636
C202/3	1250 μ F		25V 19215	SKN		Socket 4mm Red	23635
C204/5	4000 μ F		25V 4850				

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Section 6

P.C. ASSY. DELAY FOR OS2000/OS2000R

Ref	Value	Description	Part No.	Ref	Value	Description	Part No.
RESISTORS				CONTROL POTS.			
R501/2	10Ω	Cr. Carbon	5% 1/8 W 2259	RV501	470Ω	Davall 80P	25225
R503/4	56Ω	Cr. Carbon	5% 1/8 W 2411	RV502	2.2KΩ	Davall 80P	25227
R505		Not used		RV503	1KΩ	Davall 80P	25226
R506/7	220Ω	Cr. Carbon	5% 1/8 W 304	RV504		Not used	
R508/9	1KΩ	Cr. Carbon	5% 1/8 W 384	RV505	470Ω	Davall 80P	25225
R510	10Ω	Cr. Carbon	5% 1/8 W 2259	CAPACITORS			
R511	1.8KΩ	Cr. Carbon	5% 1/8 W 310	C501	18pF	G.P. Ceramic	(S.O.T.) 22367
R512	820Ω	Cr. Carbon	5% 1/8 W 1637	C501	68pF	G.P. Ceramic	(S.O.T.) 22374
R513	270Ω	Cr. Carbon	5% 1/8 W 2716	C502/4	.01μF	G.P. Ceramic	22395
R514	10Ω	Cr. Carbon	5% 1/8 W 2259	C505	18pF	G.P. Ceramic	22367
R515	820Ω	Cr. Carbon	5% 1/8 W 1637	C506	.01μF	G.P. Ceramic	22395
R516/7	68Ω	Cr. Carbon	5% 1/8 W 1640	C507	18pF	G.P. Ceramic	22367
R518/9	220Ω	Cr. Carbon	5% 1/8 W 304	TRANSISTORS			
R520/1	100Ω	Cr. Carbon	5% 1/8 W 11504	VT501/3		BSX. 20	23307
R522	680Ω	Cr. Carbon	5% 1/8 W 309	VT504/5		2N3905	20818
R523	10Ω	Cr. Carbon	5% 1/8 W 2259	VT506/7		BSX. 20	23307
R524/5	1.8KΩ	Cr. Carbon	5% 1/8 W 310				
R526/7	10Ω	Cr. Carbon	5% 1/8 W 2259				
R528		Not used					
R529	680Ω		1/8 W 309				
R530	10Ω	Cr. Carbon	5% 1/8 W 2259				

Component List and Illustrations

Section 6

Y OUTPUT AMPLIFIER OS2000/OS2000R

Ref	Value	Description	Part No.	Ref	Value	Description	Part No.
RESISTORS				POTENTIOMETERS			
R301	10	5% ¼W	2259	RV301	100		28520
R302	180	5% ¼W	1517	RV302	220		28522
R303	270	5% ¼W	2716	CAPACITORS			
R304	470	5% 1W	19039	C301	100pF	Disc	22376
R305	10	5% ¼W	2259	C302	47pF		22372
R306	47	5% ¼W	727	C303		Not used	
R307	100	5% ¼W	11504	C304/5	.01µF		22395
R308	10	5% ¼W	2259	C306		Not used	
R309	1.5k	6W	598	C307	0.1		400V 2385
R310	4.7k		386	C308/9	50µF	Electrolytic	6V 1746
R311	180		1517	C310	.68µF		250V 4540
R312	100		11504	C311	1000pF	Ceramic Disc	22387
R313	470	5% 1W	19039	C312	0.01µF		22395
R314	180	5% ¼W	1517	TRANSISTORS			
R315	270	5% ¼W	2716	VT303/7		BSX20	23307
R316	10	5% ¼W	2259	INDUCTORS			
R317	180	5% ¼W	1517	L301		Peaking Coil	24627
R318	680	5% ¼W	309	L302		Peaking Coil	A24586
R319	220	5% ¼W	304				
R320	10	5% ¼W	2259				
R321/8	910	5% 1W	24753				
R329	4.7k	5% ¼W	386				
R330	4.7k	5% ¼W	386				
R331	10	5% ¼W	2259				
R332	6.8k	5% ¼W	313				
R333/4	10	5% ¼W	2259				

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Component List and Illustrations

Section 6

X OUTPUT AMPLIFIER OS2000/OS2000R

Ref	Value	Description	Part No.	Ref	Value	Description	Part No.
RESISTORS				CAPACITORS			
R401/2	6.8k	Metox	5% 4W 24744	C401	1500pF	Ceramic	22388
R403/4	220		5% ¼W 304	C402		Not used	
R405	180		5% ¼W 1517	C403/4	.01µF	Ceramic Disc	10% 25V 22395
R406	1K		5% ¼W 384	C405	120pF	Ceramic Disc	10% 400V 22377
R407	2.7k		5% ¼W 311	C406	.1µF	Polyester	400V 2385
R408	560		5% ¼W 308	C407	390pF		22382
R409	2.2k		5% ¼W 425	C408	18pF		22367
R410	2.2k		5% ¼W 425	TRANSISTORS			
R411	22k		5% ¼W 1544	VT401/2		BF179	29055
R412	18k		5% ½W 18565	VT403/5		BSX20	23307
R413	10k		5% 2W 24743	VT406		BF179	29055
R414		Not used		DIODES			
R415	100		5% ½W 11504	MR401/2		OA95	23318
R416/7	820		5% ¼W 1637	MR403/4		BAX17	27046
R418/9	10		5% ¼W 2259	MR405/6		OA95	23318
POTENTIOMETERS							
RV401	100		28520				
RV402	2.2k		24561				
RV403	1k		26870				

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Component List and Illustrations

Section 6

POWER SUPPLY OS2000

<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Part No.</i>	<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Part No.</i>
RESISTORS				TRANSISTORS			
R101	47	5% ½W	1818	VT3		MJE520	24739
R102/5	120	5% ½W	735	VT4		MJE520	24738
R106	6.8K	5% ¼W	313	DIODES			
R107	33K	5% ¼W	317	MR101/4		1N4003	23462
CAPACITORS				MR105/8		PM4206	19725
C101	100 + 200µF		275V 24740	MR109/13	6.2V		400mA 4032
C102/3	1250µF		25V 19215				
C104/5	4000µF		25V 4850				
POTENTIOMETERS							
RV101	22k		25885				

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Section 6

POWER SUPPLY FOR OS2000R

<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Part No.</i>	<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Part No.</i>
RESISTORS				CAPACITORS			
R101	47Ω	Solid Carbon	10% ½W 1818	C101	0.1μF		30V 19647
R102/5	120Ω	Cr. Carbon	5% ¼W 735	TRANSISTORS			
R106	6.8k	Cr. Carbon	5% ¼W 313	VT101	2N3905		20818
R107	33k	Cr. Carbon	5% ¼W 317	DIODES			
R108	22k	Cont.Pot.Davall 80P	25230	MR101	WO.2 Pirelli		19725
R109	3.3k	Cr. Carbon	5% ¼W 1638	MR102/5	MS4H		20422
R110	1k	Cr. Carbon	5% ¼W 384	MR106/10	Zener ZF6.2 STC	5%	4032

Component List and Illustrations

Section 6

EHT SUPPLY OS2000/OS2000R

<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Part No.</i>	<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Part No.</i>
RESISTORS				CAPACITORS			
R201	1M		5% ¼W 766	C201	1µF	Polyester	10% 160V 807
R202	10k		5% ¼W 11503	C202/7		Not used	
R203	270k		5% ¼W 1679	C208/10	.05µF		2.5kV DC 20417
R204	1M		10% ¼W 23023	DIODES			
R205	10k		5% ¼W 11503	MR201/3		K23BEL70	26347
POTENTIOMETERS				MR204/6		BY 237	23605
RV201	1M		26867	MR207		OA95	23318

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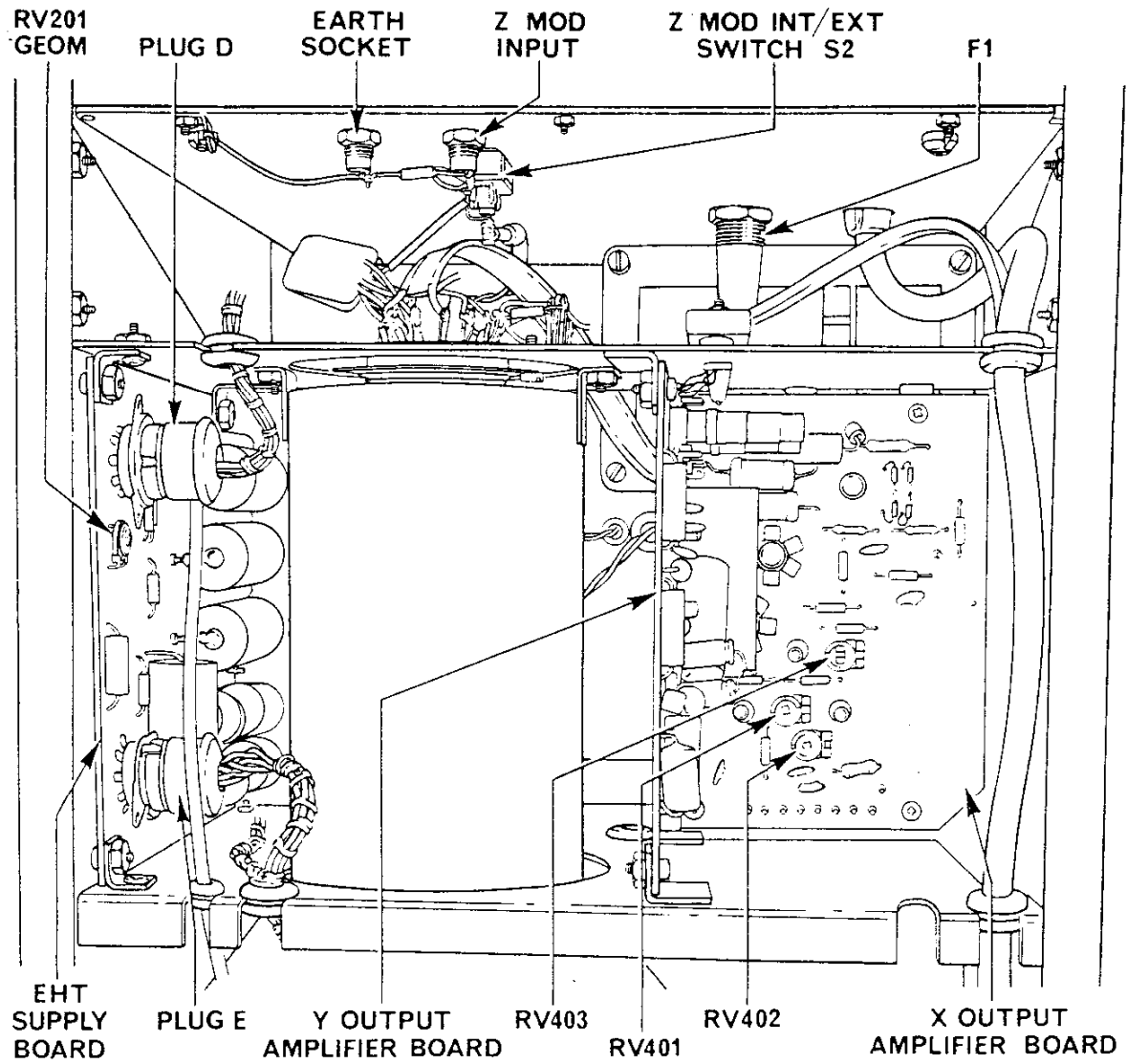


Fig. 8 MAIN FRAME COMPONENT LAYOUT – TOP VIEW

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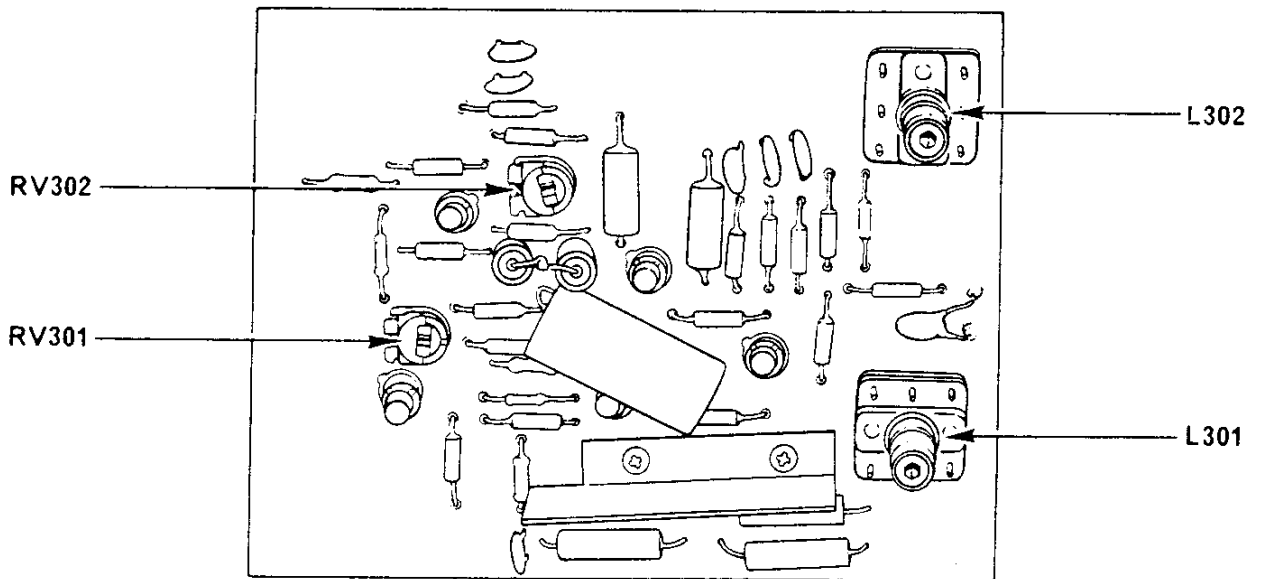


Fig. 9 Y OUTPUT AMPLIFIER COMPONENT LAYOUT

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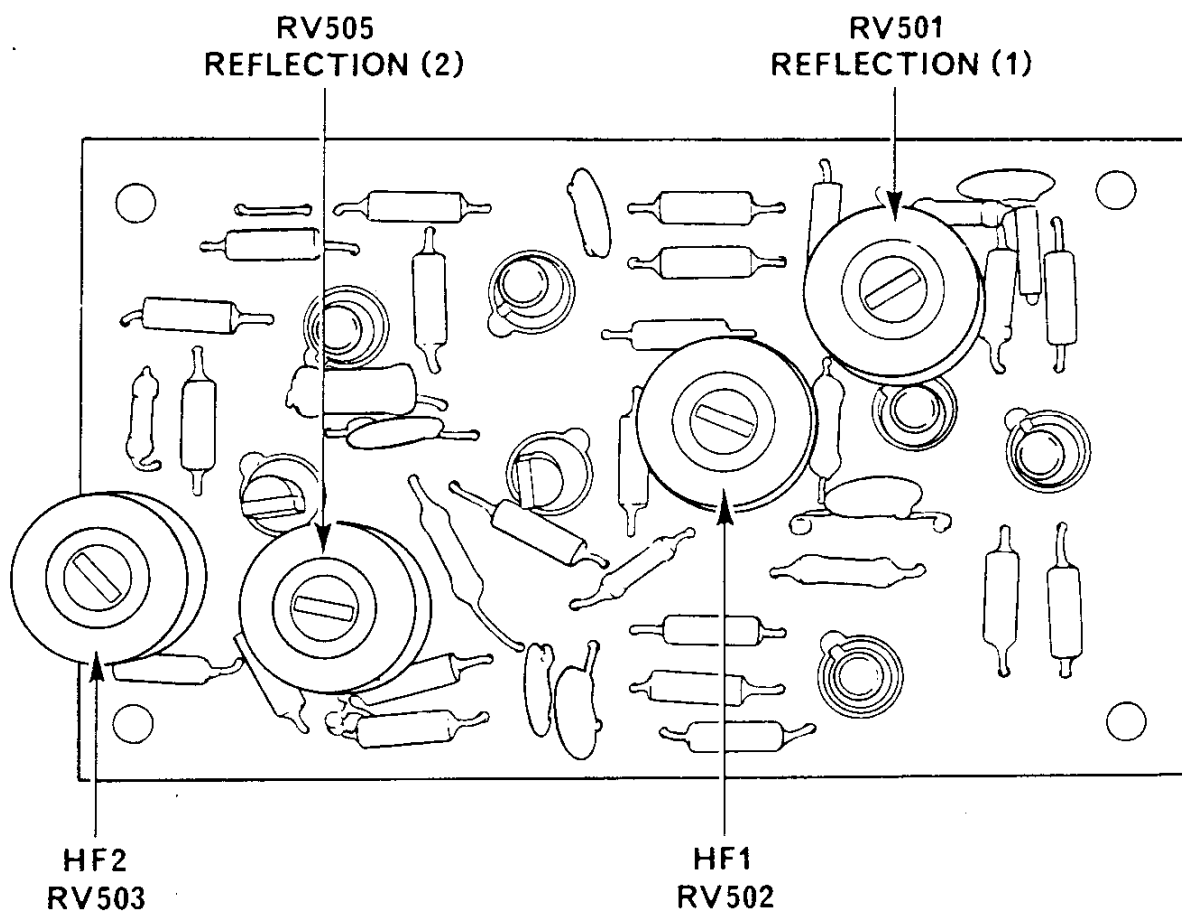


Fig. 10 DELAY LINE AMPLIFIER COMPONENT LAYOUT

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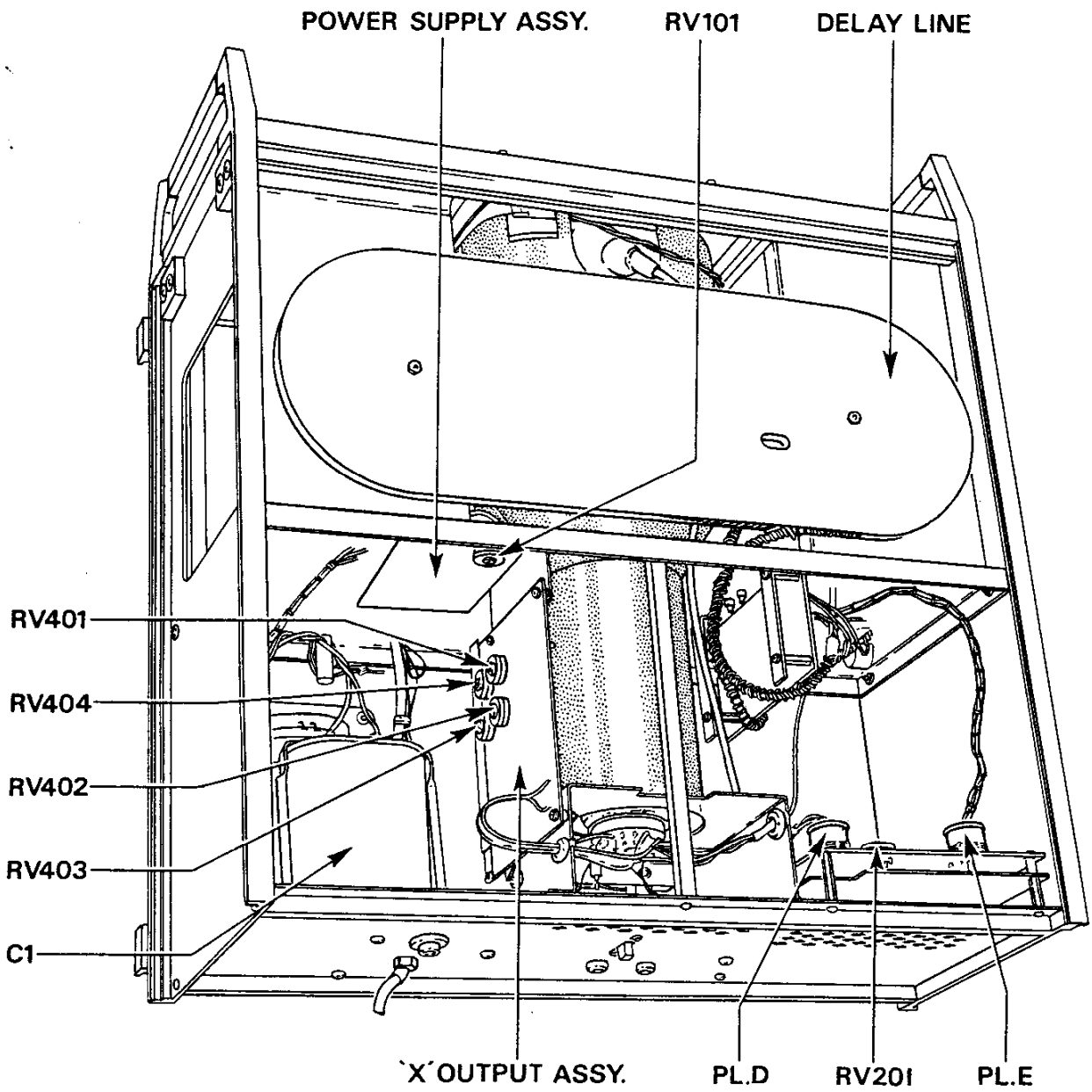


Fig. 11 MAIN FRAME OS2000R COMPONENT LAYOUT (TOP VIEW)

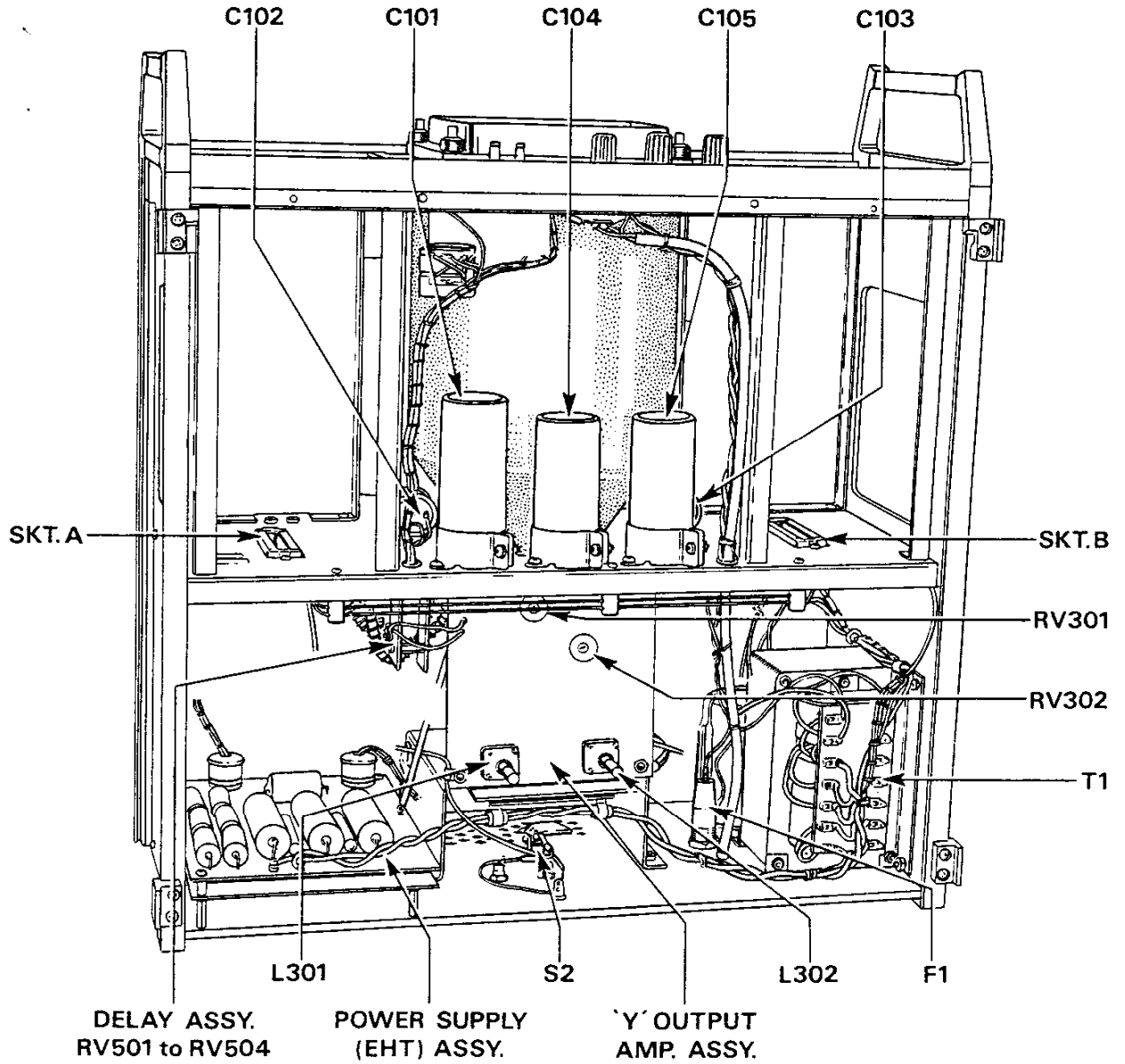


Fig. 12 MAIN FRAME OS2000R COMPONENT LAYOUT (BOTTOM VIEW)

LAB. INSTRUMENTS

**OS2003X & OS2006X
Timebase Plug-in
Units
Instruction Manual**

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Manual Part No. 29873 Printed in England.

Contents

SECTION 1	INTRODUCTION	1	Fig. 5	OS2006X Delay P.C.B. Circuit	22
SECTION 2	SPECIFICATION	2	Fig. 6	OS2006X Interconnection Circuit	24
SECTION 3	OPERATION	4	Fig. 7	Component Layout OS2003X	25
3.1	Controls	4	Fig. 8	Component Layout OS2006X (timebase)	26
3.2	Trace Location	5			
3.3	Triggering	5	Fig. 9	Component Layout OS2006X (delay)	27
3.3.1	Delay (OS2006X only)	5			
3.4	Outputs	5			
3.5	Compatibility of OS2006X	5			
SECTION 4	CIRCUIT DESCRIPTION	6			
4.1	OS2003X	6			
4.1.1	Trigger Amplifier	6			
4.1.2	Timebase Generator	6			
4.2	OS2006X	7			
4.2.1	Trigger Circuit	7			
4.2.1.1	External X/Trig Amplifier	7			
4.2.1.2	Trigger Selector	7			
4.2.1.3	Trigger Amplifier	8			
4.2.1.4	Synch. separator	8			
4.2.1.5	Trigger Bistable	8			
4.2.2	Timebase generator	8			
4.2.2.1	Timebase bistable	8			
4.2.2.2	Ramp Generator	8			
4.2.3	Delay Generator	9			
4.2.4	Single Shot Bistable	9			
SECTION 5	MAINTENANCE	10			
5.1	Power supply currents	10			
5.1.1	Output Signal Levels	10			
5.2	Fault Location	10			
5.3	General	10			
5.4	Equipment required	10			
5.5	OS2003X	10			
5.6	OS2006X	11			
SECTION 6	COMPONENTS LIST & ILLUSTRATIONS				
	OS2003X Circuit Diagram	14			
	OS2006X Timebase P.C.B. Circuit	18			
	OS2006X P.C.B. Circuit	21			
	OS2006X Interconnection Circuit	23			
	Component Layout OS2003X	25			
	Component Layout OS2006X (timebase)	26			
	Component Layout OS2006X (delay)	27			
SECTION 7	GUARANTEE & SERVICE FACILITIES ILLUSTRATIONS	28			
Fig. 1	Block Diagram, OS2003X	13			
Fig. 2	Block Diagram, OS2006X	13			
Fig. 3	OS2003X Circuit Diagram	16			
Fig. 4	OS2006X Timebase P.C.B. Circuit	20			

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Both these timebase units are intended for operation in the OS2000 series of oscilloscope main frames.

The OS2003X has 19 switched sweep rates from .2 Sec/cm to 200nS/cm which with the X5 magnifier gives a maximum rate of 40nS/cm.

The OS2006X offers 23 switched sweep rates of 2 Sec/cm to 100nS/cm; with the X5 magnifier this is equivalent to 20nS/cm. The versatile triggering includes single shot, a calibrated delay between receipt of trigger and commencement of sweep, internal or external source selection and a synch separator for line or frame selection of a TV video waveform.

Both timebases incorporate an overlapping variable rate control and external X input selection.

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THE SPECIFICATION APPLIES IN ALL OS2000, OS2000R, OS2100, AND OS2100R MAIN FRAMES

PARAMETER	OS2003X	OS2006X
SWEEP	19 ranges, 200mS/cm to 200nS/cm Fine control gives >3:1 reduction.	23 ranges, 2S/cm to 100nS/cm Fine control gives >3:1 reduction.
Longest sweep time	>6 secs.	>60 secs.
Accuracy	±5% at CAL end.	±5% at CAL end.
TRIGGER MODE	(1) Internal + or – (2) External + or – (3) Line + or – (4) T.V. frame + or – (5) Free run	(1) Internal + or – (2) External + or – (3) Line + or – (4) T.V. line + or – (5) T.V. Frame + or – (6) Free run
Trigger coupling	AC	AC or DC
Level	MANUAL AUTO (40Hz min)	MANUAL AUTO (40Hz min)
Sensitivity (Internal) (External)	(1) 2mm Y deflection to 1MHz (2) 1cm Y deflection to 15MHz (3) typically 300mV to 5MHz	(1) 2mm Y deflection to 5MHz (2) 1cm Y deflection to 20MHz (3) typically 200mV to 10MHz (4) switch selected to 2V in +10 position
Input impedance	approx. 100kΩ	approx. 1MΩ, 20pF
Max I/P voltage	400V pk. (DC + LF AC)	400V pk. (DC + LF AC)
EXTERNAL X	Selected by time base range switch.	Selected by time base range switch.
Coupling	DC. (AC via EXT. TRIG. socket)	AC or DC
Sensitivity	approximately 3.0V/cm	1V/cm in +1 position 10V/cm in +10 position
Accuracy	Typically ±10%	±5%
Bandwidth	DC to 250kHz	DC to 1MHz (in OS2100)
Input Impedance	approx. 100k	approx. 1MΩ, 20pF
Max. I/P voltage	400V pk. (DC + LF AC)	400V pk. (DC + LF AC)
EXPANSION	X5 magnifier (1) sweep rate increases to 40nS/cm. (2) External X to 0.6V/cm	X5 magnifier (1) sweep rate increases to 20nS/cm (in OS2100). (2) External X to 0.2V/cm.
DELAY	–	Fully variable 10μS to 110mS set by calibrated 10 turn control.
Accuracy	–	±5%

PARAMETER	OS2003X	OS2006X
Jitter	—	<1 in 10,000
SINGLE SHOT	—	By means of a push button. A neon lamp indicating the ARMED state of the trigger.
SIGNAL OUTPUTS	(1) Ramp approx. +4.5V from 4.7k. (2) Probe Test (GATE), approx. +10V from 22k.	(1) Ramp approx. +4.5V from 4.7k. (2) Gate, approx. +10V from 10k. (3) Delay, approx. +5V from 10k.
Weight	2¼lb (1.0 kgm)	2¾lb (1.25 Kgm)

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Either time base will fit into the right-hand aperture of the main frame and is automatically held in place after being firmly pressed in. Withdrawal is by means of the lever at the bottom of the unit. Always ensure that the supply is off before removing or inserting the plug in. Detailed operation of the main frame controls is described in the handbook for the frame.

3.1 CONTROLS

TRIGGER SELECT

The trigger select switch determines the mode of triggering.

FREE RUN This position allows the time base to free run, facilitating trace location or allowing the timebase to be used as a free running ramp generator.

INTERNAL here the trigger signal is derived from the input to the 'Y' amplifier and is AC coupled. (AC or DC coupled on OS2006X). The sensitivity is typically, 2mm vertical deflection up to 1MHz, reducing to 1cm at 15MHz. (2mm to 5MHz, 1cm to 20MHz in the OS2006X).

LINE in this mode the trigger signal is taken from the incoming supply line (50 or 60Hz) so that hum etc. in amplifiers or on power supply lines can be readily identified.

T.V.

OS2003X In this mode a simple integrator network is applied to the internal trigger signal derived from the Y plug in unit. This eliminates the T.V. line pulses from a T.V. video waveform leaving the frame pulses as a trigger source. This mode may also be used as a form of HF reject.

OS2006X. In this mode, intended specifically for the examination of T.V. video waveforms, a trigger signal is taken internally from the 'Y' amplifier and passed through an active sync. separator to distinguish between T.V. line pulses and frame pulses. The polarity indicated is that of the video envelope i.e. positive being when the line pulses are positive. Auto trigger should not be used in this mode; but the optimum level set by the manual control.

EXTERNAL This mode enables an independent signal source to initiate the timebase sweep.

OS2003X. The signal is AC coupled. The sensitivity is typically, 300mV p-p to 5MHz.

OS2006X. The trigger signal is derived from the External X/Trig. input through an AC/DC coupling switch selector and $\div 1$, $\div 10$ attenuator switch. The sensitivity is typically, 200mV peak to peak at 10MHz in the $\div 1$ attenuator setting. (2V p-p in the $\div 10$ position)

TRIGGER LEVEL SELECTION Concentric with the trigger selector switch is the LEVEL control. Fully anti-clockwise is the switched AUTO position which

will give satisfactory AC coupled trigger from repetitive waveforms of greater frequency than 40Hz. For manual selection of LEVEL, this control is used to set the level of input signal needed to trigger the timebase. In the internal mode there is sufficient control to swing over the complete 6cm of vertical screen height. In the external mode the range of swing is approx. $\pm 3V$.

SINGLE SHOT (OS2006X only).

Is of use in this facility photographic or storage recording of displayed waveforms. The trigger level should be set manually. The auto mode should not be selected.

When SINGLE SHOT is selected the time base sweep will be inhibited. Pressing the ARM button will prime the trigger circuit and a neon lamp indicates this state. The next trigger pulse to be received will initiate a single sweep of the timebase and the neon will extinguish at completion of the sweep. Further operation of the push button will arm the trigger in the same way for subsequent sweeps.

SWEEP SPEED The timebase range switch selects the calibrated sweep rate. The ranges are in a 1-2-5 sequence and a variable control concentric with the range switch reduces the sweep rate by approximately 3:1.

EXPANSION A calibrated X5 expansion can be obtained on all sweep speeds by pulling out the Variable time/cm control. This effectively increases the trace length to 50cm and the shift control can be used to bring the required part within the 10cm of the display. This mode allows a maximum calibrated sweep speed of 40nS/cm with the OS2003X and 20nS/cm with the OS2006X. (See section 3.5)

EXTERNAL X The most anticlockwise position of the timebase range switch disables the timebase generator and directly couples the external X socket to the X amplifier.

The OS2006X has provision for AC or DC coupling of the signal and the selection of a 10:1 input attenuator.

The EXT. X input of the OS2003X is DC coupled but AC coupling can be achieved by feeding the input to the EXT. TRIG input socket.

The deflecting sensitivities of the OS2006X (in $\div 1$ mode) is 1V/cm and the OS2003X 3.0V/cm.

The X5 expansion is operative on External X and increases the sensitivity to 200mV/cm and 600mV/cm on the OS2006X and OS2003X respectively.

DELAY The OS2006X has a facility to introduce a controlled delay between the trigger and the beginning of the timebase sweep and is intended to allow detailed examination at a fast sweep speed of part of a wave-

form having a low basic repetition frequency.

The delay is switched in four decade ranges and, adjustment of the multi-turn control with its counting dial allows calibrated fine control of the delay between each decade step of the range switch. The total span of the four ranges is from 10 μ S to 110mS.

3.2 TRACE LOCATION.

Switch off the expansion, the timebase to free run and the Y input coupling switch to Ground.

On the OS2006X, also set the single shot selector to Normal and the Delay to OFF. Select a sweep speed of around 1mS/cm and centralise both X and Y shift controls. With a suitable setting of the brilliance control a trace should be visible on the screen.

3.3 TRIGGERING.

Connect the input signals to the Y plug-in with the coupling, sensitivity, beam selector etc. as required. (see handbook appropriate to Y plug-in unit). Select the required trigger source INT, EXT, or LINE as required with the required triggering slope polarity. If INT is selected, Y1 or Y2 may need to be selected on the Y plug-in. In the auto position, the trigger level is set to be suitable for most applications. If it is required to trigger from a particular level on a waveform or to operate at trigger frequencies below 40Hz, the trigger level control should be switched from AUTO and the required trigger level selected.

On the OS2006X, the trigger signal can be selected as AC or DC coupled by the slider switch. AC coupling is normally used, DC being selected when extremely low frequency triggering is required. The timebase will trigger from internal signals of 2mm or greater up to 5MHz, reducing to 1cm at 20MHz. It requires at least 200mV pk. pk. external input trigger signals up to 10MHz in the $\div 1$ position.

T.V. TRIGGERING

OS2003X. T.V. frame pulses are obtained from the internal trigger signal, by means of an integrator network. When T.V. trigger is selected these pulses are the trigger signals.

OS2006X. If a T.V. video waveform is to be viewed the T.V. line or T.V. frame modes should be selected. This provides internal trigger through a synch separator circuit and should be used in conjunction with the manual trigger level control.

3.3.1 DELAY (OS2006X only)

To view in detail, one particular part of any waveform, the delay function should be switched in and adjusted to shift the desired part to the beginning of the trace. The sweep speed can then be increased as required with fine adjustment of the delay control to maintain the selected part of the trace on the screen. The brilliance may need to be increased since with fast sweep rates and long delay times, the sweep period becomes much smaller than the total cycle

and the display becomes dimmed.

3.4 OUTPUTS

The Ramp and gate outputs are available on the front panels of both timebase plug-ins. The gate pulse being useful as a fast rise time source for setting up the equalisation of the X10 input probe.

The levels and source resistances of the two outputs are approximately 4 volts from 4.7k Ω for the ramp output and approximately 10 volts from 10k Ω for the GATE output. (22k Ω on the OS2003X).

On the OS2006X the delaying pulse is also available at the front panel and is in the form of a pulse of approx. +5V in amplitude. As such its width is variable over the range 10 μ S to 110mS. The source impedance is approximately 10k Ω .

3.5 COMPATIBILITY OF OS2006X

It should be noted that the OS2000 and OS2000R main frames are not capable of responding linearly to sweep speeds above 40nS/cm and the OS2006X cannot be used to its full extent in these.

The full sweep speed facility of the OS2006X can be exploited in the OS2100 and OS2100R main frames, but the mean X plate potential in earlier models of these instruments may need to be adjusted to obtain the optimum linearity at 20nS/cm. This adjustment applies to OS2100's before S. No. 901 and OS2100R before S. No. 201 and should be carried out as follows.

Remove the right-hand side cover of the OS2100 main frame or the top cover of an OS2100R. Apply a 10MHz marker generator to the Y input socket and adjust R431 on the X amp board to give optimum linearity in the X5 mode. This adjustment may have affected the gain settings slightly and these may need adjusting. Apply a 1kHz (approx. frequency) sine wave to the External X socket and select the EXT. X mode. Measure the amplitude at pin marked \surd on the X output board. Adjust signal level to give 283 mV rms. Set R429 to give a 10cm line (in X5 mode). Increase signal level to 1.41 volts rms. return X gain to normal and adjust R430 to give a 10cm line. Re-check the linearity.

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4.1 OS2003X

The circuitry of this timebase plug-in can be broken down into the trigger amplifier with the source selector switch and the ramp generator with the output circuitry. There is a single printed circuit board which has the majority of the components mounted upon it.

A basic block diagram is shown in Fig. 1 and the circuit diagram in Fig. 3. The circuit will be considered in two major sections, the trigger circuitry and the timebase generator.

4.1.1 TRIGGER AMPLIFIER

The external trigger signal is fed to the base of the emitter follower, VT101. Diodes, MR101 and MR102, connected to the base, limit the signal excursion to protect this transistor for large input signals of up to 400V pk. The output from the emitter follower, taken from the junction of R107/109, is connected into the trigger selector switch. The other inputs to this switch are the balanced 'Y1' or 'Y2' signals from the 'Y' amplifier on PA12 and PA24 and a line frequency (50/60Hz) supply waveform on PA18.

The trigger selector switch has nine positions, to select triggering from TV signals + or -, external signals + or -, internal signals + or -, line + or -, and free run. The TV signals are taken from the 'Y1' or 'Y2' amplifier and capacitors, C1 and C2, integrate the frame sync pulses providing a pulse on the composite TV waveform which may be selected by the trigger level control.

A balanced output signal is taken from the trigger selector switches to the bases of VT102 and VT103, which together form an emitter coupled differential amplifier. The emitters are coupled through R113 and R114 and the bases are connected together by the level control potentiometer, RV1. Except when this control is in the AUTO position, the +12V supply is connected through S1A to the wiper of RV1, so that the base potentials of VT102 and VT103 can be varied to select the point on the triggering waveform at which the timebase starts. The preset control, RV101, in the emitter return path of VT102 and VT103 adjusts the static current through the amplifier and determines the central point of the level control. A single ended output is taken from the collector of VT103 through the emitter follower, VT104, to the Schmitt trigger circuit consisting of VT105 and VT106. This connection is made through S1B, except when the level control is in the AUTO position. Thus the Schmitt trigger is switched by the potential at the emitter of VT104. A zener diode, MR103, is used for coupling between the collector of VT105 and the base of VT106 to give maximum signal coupling and the required DC volt drop.

When the level control is set to AUTO, A1B is opened and VT105 and VT106 become astable, the time constant being determined by C108/C109 and R124. The mark/space ratio of the waveform at the collector of VT106 in the AUTO mode may be adjusted by RV102. The amplitude of the waveform at the collector of VT106 may be adjusted by

RV106 to provide the required signal for triggering the timebase bistable. The trigger sensitivity or threshold voltage required to trigger the Schmitt circuit may be adjusted by RV103 which, in series with R122, controls the DC coupling between the emitters of VT105 and VT106. C110 connected in parallel with these resistors provides AC coupling to ensure a fast switching transient.

When VT105 and VT106 are in the astable mode of operation, trigger signals coupled through C108/C109 having a repetition frequency faster than the natural frequency of the astable circuit will automatically lock it to the incoming trigger frequency.

The rectangular waveform out of the collector of VT106 is differentiated by C112 and MR104, to provide positive-going trigger pulses which are coupled through MR105 to the base of VT107.

4.1.2 TIMEBASE GENERATOR

Transistors, VT107, VT108 and VT109, form the timebase bistable circuit. In the quiescent condition, VT107 is cut off and VT108/109 are conducting. Thus the collector of VT109 is held near to ground potential. The positive-going input trigger at the base of VT107 causes it to conduct so that its collector voltage falls, and this falling potential is coupled to the base of VT109, cutting it off, so that its rising collector potential is coupled back through T136 for rapid switching. The positive excursion at the base of VT107 is limited by current through the catching diode, MR106. In the quiescent state with VT107 cut off, VT108 was conducting but with VT107 conducting, VT108 is now cut off. When VT109 is cut off, MR108 conducts, causing the junction MR108/109 to move positively towards +12V. This applies reverse bias to MR109. At the same time, the junction of R137/138 will have moved negatively so that MR110 is reverse biased. Thus, the two diodes holding the gate the F.E.T. of VT111 are cut off, and the timing capacitor selected by S4 commences to charge through the selected timing resistor.

VT111 is a source follower which has a constant current transistor, VT113, in its source circuit. The high impedance to the source by VT113 enables the source to follow the gate signal closely. The signal is transferred via R163 to emitter followers, VT112, VT116, and the zener diodes, MR114, MR115. Therefore any change in potential at the gate of VT111 will be closely followed by the potential at the junction of R172, MR115. The voltage across the charging resistor is thus kept almost constant, ensuring a constant rate of charge, and a linear ramp. The timebase output waveform is taken from the emitter of VT116 through stopper, R180 to the output point PA2. The timebase waveform is also coupled through R171 and R167 from the emitters of VT116 and VT112 respectively, and then through diode, MR112, to the base of VT114. The rising potential charges the hold-off capacitor, C3, C4, C5, C7 or C8 as selected by S4.

VT114 and VT115 together form a compound emitter follower with a high current gain. The rising potential at the emitter of VT115 is coupled through RV104 to the base of VT108. As the potential rises, it will cause VT108 to conduct, causing the timebase bistable to revert to its quiescent state. The timebase amplitude at which the base of VT108 reaches the switching point, may be determined by adjusting RV104 to give the required sweep length.

When the timebase bistable resets, the collector of VT109 moves to zero potential causing MR108 to cut off. MR109 therefore conducts, discharging the timing capacitor through R143 to $-12V$. At the same time, the junction has moved positive permitting a current to flow through R141 and MR110 into the timing capacitor to keep MR109 in conduction during the flyback and quiescent period.

The positive charge on the hold-off capacitor, coupled through emitter followers VT114 and VT115, will hold the base of VT108 positive, long enough for the timing capacitor to completely discharge; any trigger pulse occurring during this period will be ignored. The hold-off capacitor discharges towards $-12V$ through R161.

The rectangular waveform from the collector of VT109 is coupled through R177 to the front panel socket PB to provide a probe test waveform and also through R145 to provide the actuating signal for the beam switch when the ALTERNATE mode is selected in the Y plug-in unit. This same waveform is coupled to the base of the emitter follower, VT110, which provides a brightening up waveform to the cathode ray tube to brighten the trace during the sweep. The shift voltage is obtained from the wiper of RV3 (in the resistive chain of R173 and R174 between the $+12$ and $-12V$ lines).

The timebase switch selects EXT. X in the most anticlockwise position. The timebase bistable is inhibited by applying $+12V$ to R130. The EXT. X signal is coupled through R101 to the base of VT101. This transistor is connected as an emitter follower driving R107/R108 to the gate of VT111 via the timebase range switch, S4.

4.2 OS2006X

In addition to the timebase ramp generator, trigger amplifier and selector this plug-in contains the circuitry associated with the delay and single shot modes and the amplifier for external X or trigger signals.

Two printed circuit boards are employed. One carries all the components associated with the trigger amplifiers, timebase bistable and external input amplifier; whilst the second board has the single shot; delay and ramp output circuitry mounted on it.

A block diagram is shown in Fig. 2 and complete circuits and interconnection schematic in Figs. 4, 5 and 6.

It will be seen from Fig. 2 that an internal or external trigger source operates the trigger bistable via the trigger

amplifier. In normal undelayed operation the output from the trigger bistable initiates a sweep of the ramp generator and at the end of the sweep the trigger bistable is reset. In the delayed mode, the ramp is initiated only after the set delay period.

In the single shot mode, the output from the single shot bistable inhibits trigger pulse inputs to the timebase bistable. When the 'ARM' button is pressed, this inhibition is removed and the timebase bistable operates on the next trigger pulse, initiating a ramp or delay as appropriate.

At the end of the sweep the trigger bistable and the single shot bistable are reset and await the next operation of the ARM button.

4.2.1. THE TRIGGER CIRCUITRY.

This section of the timebase incorporates the External X/TRIG. amplifier and associated attenuator, trigger amplifier and selector switch and the trigger bistable circuits. They will be dealt with in that order.

4.2.1.1. EXTERNAL X/TRIG AMPLIFIER.

This is composed of transistors, TR101 (an F.E.T.) and TR 102. They form a feedback amplifier whose gain is set by R116. The input coupling (AC or DC) is selected by S10, which inserts the DC blocking capacitor, C1, in the AC mode. This signal passes to the attenuator switch, S1, which selects either a $\div 1$ or a $\div 10$ attenuator network. These networks are composed of R111, C104 and R108, C102 (the $\div 1$ arrangement) or R110, C101 and R107, C103 (the $\div 10$ circuit). The frequency response of these attenuators are compensated by capacitive trimmers, C102 and C101, on the $\div 1$, $\div 10$ positions, respectively.

The circuit is protected against excess input voltage by means of diode clamps on the gate of the input F.E.T. (D101 and D102).

As the output of the amplifier is not referred to ground, zero output for zero input has to be set by means of R118. The output of this amplifier feeds the X output amplifier in the main frame via R115, when EXT. X is selected by the timebase range switch, and the trigger amplifier via R117 in the external trigger positions of the trigger selector switch.

4.2.1.2. TRIGGER SELECTOR

The required trigger signal is selected by S2 and fed through the AC/DC coupling switch, S4, which inserts C4 and C5 (the AC mode) or shorts them in the DC mode. The trigger signals as obtained from the internal connection to the Y plug in are balanced and feed the long tailed amplifier, TR103 and TR104. With signals other than these the drive is only single-ended and the unused input connection is grounded via R22.

The line trigger signal is taken from the 18V AC supply transformer secondary in the main frame and is attenuated by resistors, R246 and R247, before passing to the select switch. The external trigger voltage is taken via R117 with

C108 from the external X/TRIG amplifier.

4.2.1.3. THE TRIGGER AMPLIFIER.

This is a long tailed network comprising TR103 and TR104, with the constant current tail, TR105. This current is adjusted by R126 such that the Manual LEVEL control, R1, which is connected between the input bases of TR103 and TR104, is at its mid point when the Schmitt trigger circuit is in its most sensitive condition.

A single ended output is taken from the collector of TR104 via amplifier, TR106. This feeds the Trigger bistable.

4.2.1.4. SYNCH. SEPARATOR.

The active T.V. sync. separating circuit comprises transistors, TR214 and TR215, and associated components. The input to this separator circuit is taken from the internal trigger signal obtained from the Y plug-in via S2 in either T.V. line or frame modes, through R248 to the base of TR214. (This video signal has a positive video voltage, i.e. negative sync. pulses), and hold TR214 in a non conducting state during the positive excursions of the envelope since its base is biased by resistors, R249 and R250, to a point approximately +6V from ground.

The narrow line pulses are AC coupled by C221 from the collector of TR214 and form positive pulses biased about +4V DC above ground by resistors, R258 and R259. The frame pulses are differentiated by C220, R257 and pass through the diode, D212, from a point biased to approximately +1V, by the resistors, R256 and R257. The positive going edge is used to trigger the timebase and these pulses together with the T.V. line pulses are routed back to the selector switch, S2.

4.2.1.5. TRIGGER BISTABLE

This Schmitt trigger is formed by transistors, TR122, TR107 and TR108. The triggering signal is passed by emitter follower, TR122, which is within the feed back loop of the trigger circuit and merely raises the input impedance of the Schmitt circuit. Preset control, R145, between the emitters of TR107 and TR108 sets the sensitivity. The zener diode, D112, gives the necessary DC coupling between the collector of TR107 and the base of TR108 together with a low impedance AC path for fast operation. C109 speeds the regenerative switching action. The amplitude of the output pulses from the collector of TR108 are set by the control, R141. It is adjusted to give a minimum hold-off period of approximately 20% between successive timebase sweeps, in order that the timing capacitor may be fully discharged, before commencing the next sweep. These output pulses are differentiated by C110 and TR119 to give sharp positive spikes to trigger the timebase bistable.

In the AUTO mode, S3A is open, AC coupling the trigger circuit and, with positive feedback provided by R143, forming an astable circuit having a period determined by C107 and R143. When in this astable mode, trigger signals of greater frequency than 40Hz will automatically lock the trigger circuit to the incoming signal.

4.2.2. TIMEBASE GENERATOR.

This comprises a bistable circuit controlling a gate or clamp across the timing capacitor. The capacitor is connected in a bootstrap circuit. When the bistable changes state and turns off the gate transistor, the capacitor charges linearly. The bistable is reset by the ramp voltage when this reaches a preset level and the circuit returns to its quiescent state.

4.2.2.1. THE TIMEBASE BISTABLE

This comprises transistors, TR111 and TR114, in an emitter coupled circuit. In the quiescent state TR111 is off and TR114 is conducting. A positive input pulse will cause TR111 to conduct in the absence of inhibit signals being present on its base, as when the single shot or external X modes are selected. The grounded base amplifier, TR119, and tunnel diode, D122, speed up the switching action and improve the high frequency triggering. Once triggered, TR111 will conduct and its collector voltage will fall. This change is transmitted via the emitter follower, TR112, to the ramp generator.

4.2.2.2. RAMP GENERATOR

The constant current from the collector of TR115 normally passes through D116. When the collector voltage of TR111 falls as the timebase bistable operates, D116 is reverse biased and the current from TR115 passes through D119 turning off the gate of field affect transistor, TR117. (When the DELAY mode of sweep is selected the emitter follower, TR211, inhibits this change until the end of the delay period).

The timing capacitor selected by S5 (C6 to C9 and C116 to C119) will start to charge through the resistors selected by the same switch (R6 to R18). This rising potential is fed to the gate of F.E.T., TR207. The high impedance presented to the source of this transistor by TR208, enables the source to follow the gate signal closely. The signal is transferred via R229 to emitter followers, TR209 and TR210, and the zener diodes, D210 and D211. Therefore any change in potential at the gate of TR207 will be closely followed by potential at the junction R236, D210. The voltage across the charging resistor is thus kept almost constant, ensuring a constant rate of charge and a linear ramp. This ramp voltage is coupled through R240 to the main frame X amplifier. The rising ramp voltage is also fed via the divider, R234 and R235; diodes, D125 and D105; and emitter followers, TR109, TR110 and TR120; to the base of TR114, in the timebase bistable. When the voltage reaches the potential determined by R113, the TRACE LENGTH control, TR114, is turned on and the timebase bistable is reset: the timebase gate transistor, TR117, is turned on, rapidly discharging the timing capacitor and completing the sweep cycle. To prevent a second sweep from being triggered before the timing capacitor is fully discharged, another of the timing capacitors (C7 to C9 and C118 and C119) is connected as the hold-off capacitor by the range switch, S5, to the junction of D105 and D125. D125 is reverse biased as the ramp voltage drops and the hold off capacitors discharge slowly through R155; holding TR114 conducting and preventing any further trigger pulses from turning the bistable on. Also connected as a source of hold off voltage is a capacitor which is dependent upon the delay

time range switch and feeds TR107 through diode, D106. This allows complete recovery of the delay circuit.

The bright-up and alternate pulses into the main frame are also taken from TR112, and amplified by TR116. The alternate pulse is taken directly from TR116 collector through R170 and is used to actuate the beam switching circuit in the dual Y plug in unit. The bright-up signal is taken from the collector of TR116 through emitter follower, TR118.

Transistor, TR121, is driven from the gate controlling voltage at the emitter of TR112 through R162. This amplified and inverted signal, is fed to the timing capacitor via the preset control, R176, and capacitor, C121. It is used to neutralise the effect of capacitance between gate and drain of the gate F.E.T., TR117, which otherwise would produce non-linearity.

4.2.3. DELAY GENERATOR

This is a variable period monostable circuit composed of TR204 and TR205 as an emitter coupled pair. The timing capacitor (C11, 12, 16 or 17) is selected by S8 and is connected between the collector of TR204 (via emitter follower, TR212) and the base of TR205. The charging current is supplied by current source transistor, TR206. To minimise thermal drift within the circuit, emitter followers, TR212 and TR213, are used to reduce the collector current taken by the switching transistors.

When the DELAY mode is selected the diode clamp, D204, on the emitter of TR213 is opened which allows this emitter to rise when a trigger pulse is received from the emitter of TR113 in the timebase bistable. This pulse (positive going) causes TR204 to conduct thereby making the collector of TR205 rise. The negative step on the collector of TR204 is passed by the emitter follower, TR212, through the delay range capacitor to the base of TR205.

The delay period is controlled by the current from the current source transistor, TR206, and will last from the trigger pulse input to the time the base of TR205 has risen sufficiently to enable this transistor to conduct again. The value of this current is set by the chain of resistors in the emitter circuit of the current source and includes the front panel variable delay control.

During this delay period the collector voltage of TR205 is high since the transistor is not conducting and the voltage, via emitter followers, TR213 and then TR211, is used to clamp the ramp gate to prevent the sweep commencing. At the end of the delay period the clamp is released.

4.2.4. SINGLE SHOT BISTABLE

In NORMAL operation, switch S7, applies a clamp to the base of TR202, holding it off. The collector voltage of TR202 is coupled through R202 into the timebase bistable. In this off state this voltage reverse biases D108 thus having no effect on the timebase operation. TR202, forms a bistable with TR201 and when SINGLE SHOT is selected by S7, it normally conducts. This causes D108 to conduct, reverse

biasing the base of TR211 in the timebase bistable and preventing any pulse through C110 from turning it on. When the ARM button is pressed transistor, TR201, will turn on, turning off TR202. The next trigger pulse received by the timebase bistable will initiate the ramp. At the end of the sweep a pulse from TR111 in the timebase bistable causes TR202 to turn on, again clamping the timebase bistable. The bistable output from the collector of TR202 also drives transistor, TR203, which allows the neon indicator, N1, to turn on from the time that the ARM button is pressed until the sweep is complete.

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Both these timebases have been designed to provide trouble free use. The only adjustments that may need to be made from time to time are calibration settings.

5.1 POWER SUPPLY CURRENTS

LINE	PIN No.	Currents Drawn	
		OS2003X	OS2006X
+12V	16	86mA	115mA
-12V	4	75mA	140mA
-18V	22	NIL	13mA
+150V	17	5.5mA	30mA
18V AC	18	0.4mA	0.2mA

5.1.1. OUTPUT SIGNAL LEVELS.

RAMP This is applied to pin 2 of the plug-in connector (PLA2). At the commencement of the sweep the voltage at this pin will rise from near zero to approximately +4.5V. The ramp voltage required for 10cm X deflection, is 4V (400mV/cm). This sensitivity is increased to 80mV/cm when PLA13 and PLA15 are shorted (X5).

SHIFT This is applied to pin 14 of the plug-in connector (PLA14), and has a total range of approximately -1V to +5V.

BRIGHT UP This is applied to pin, PLA8, of the rear plug-in connector. During the period of the sweep the voltage will rise from near zero to approximately +10V.

5.2 FAULT LOCATION

In the event of a failure to operate correctly, determine firstly what is affected by the fault. i.e. all modes of trigger, sweep etc. This will save time in fault finding by enabling the location of the fault to be predicted e.g. no internal trigger, then look for a break in the trigger signal leads from the Y plug-in, through the selector switch into the trigger amplifier. Below are listed some faults and their possible causes.

FAULT	POSSIBLE CAUSE
(a) No trace with delay switched off.	In the event of no trace being visible on the screen possible causes could be a blown fuse or the absence of any of the DC lines in the timebase circuit. Check for faulty bright-up pulse if the timebase is functioning. If the ramp is operating but is not driving the CRT, look for a fault in the output circuitry or open circuit connection in the output or shift leads.
(b) No triggered sweep.	Check for correct mode of the trigger selector switch. Look for correct selection of source with the dual Y input plug-in. Ensure

that there is sufficient Y amplitude. Correct Free run operation points to a fault in the trigger amplifier or selector switch.

- (c) Fixed Spot. If ramp is operating, check X output amplifier in main frame.
- (d) No delay before sweep (OS2006X) Check connection to the delay range switch and the presence of a delay start pulse from the emitter follower, TR113.
- (e) No trace in delay mode. Check delay monostable has reset.
- (f) No single shot (OS2006X) Check connections to ARM button and single shot selector switch. With the timebase non-triggering, i.e. with the level control fully clockwise, check that the single shot circuit acts as a bistable.

5.3 GENERAL

When the instrument leaves the factory, all the preset controls are correctly adjusted and no further adjustment is normally required unless servicing work is carried out. The procedures which follow give the information required for resetting the preset controls, but it presupposes that those parts of the instrument not being reset are in correct functional order.

If during fault finding, a component needs replacing, it should be cut from the printed circuit board as near to the component as possible, leaving the wires connected to the copper track and protruding through to the component side of the board. The new component should then be soldered into position by attaching it to these protruding wires. This protects the copper track from damage.

5.4 EQUIPMENT REQUIRED.

- (a) A Sine/square wave generator 1 kHz 0/10V continuously variable output.
- (b) R.F. oscillator 100 kHz to 30 MHz.
- (c) An oscilloscope, $\pm 5\%$ measuring accuracy, DC-30MHz.
- (d) Multimeter, 20,000 Ω/V .
- (e) Marker generator. 1 p.p. sec. to 10^7 p.p. sec. Accuracy $\pm 0.5\%$.

5.5 OS2003X

- (1) Connect the timebase unit to a calibrated main frame fitted with a 'Y' plug-in amplifier. Select the 'Y1' only mode on the 'Y' amplifier and the 0.5mS/cm range on the timebase.
- (2) Switch on the oscilloscope, select FREE RUN, set RV103 at maximum resistance and observe the trace. Use another oscilloscope to observe the timebase waveform, either using a x 10 attenuator probe connected to R180 or observing the waveform at the timebase output socket. Adjust RV106 to give a reasonable rest period

(10-20%) between the end of the flyback and the commencement of the next trace.

(3) Set the trigger selector to INT+ and connect a 1kHz square wave to the 'Y1' amplifier to give a vertical deflection of 2mm. Set the LEVEL control to AUTO and adjust RV103 until the timebase stops triggering, then turn it slowly back until the timebase is just triggering. Reduce the signal amplitude until the deflection is below 1.5mm and verify that the timebase ceases to trigger at approximately this amplitude.

(4) Select the 0.2mS/cm range and increase the signal amplitude until the timebase just triggers. Adjust RV102 to stop timebase jitter.

(5) Select 'Y1' and 'Y2' triggering from either 'Y1' or 'Y2', and set the timebase to FREE RUN. Check that both traces appear on all timebase ranges and verify that the beam switch mode is working, by observing the simultaneous transission of the 'Y1' and 'Y2' beams at 100mS/cm.

(6) Select the 1mS/cm range and set the LEVEL control to AUTO; verify that the auto repetition rate is less than 30 sweeps per second.

(7) Return to Y1 ONLY mode and inject 1kHz marker pulses to the 'Y1' input socket. Select the 1mS/cm timebase range and adjust RV105 to obtain 1 pulse per centimetre. Adjust RV104 to give a trace length of 11.5cm.

(8) Select the 1 μ S/cm range and connect 1MHz marker pulses to the 'Y1' input. Adjust C135 to obtain 1 pulse per centimetre ignoring first centimetre.

(9) Using suitable input frequencies to the 'Y1' socket, verify that the timebase velocity is accurate to $\pm 5\%$ on all ranges. Turn the variable velocity control counter-clockwise from the CAL position and verify that it reduces the velocity by more than 3:1.

(10) Connect a sinewave of 1kHz frequency to the 'Y1' input and adjust the amplitude to give a 5cm picture. Set the LEVEL control to the middle of its traverse and adjust RV101 so that the timebase triggers from the mean level of the sinewave.

(11) Set the LEVEL control to the AUTO position and the trigger selector to EXT + or EXT -. Connect a 1kHz square wave of 0.25V amplitude to the external trigger socket and verify that the timebase triggers.

(12) EXTERNAL X Select EXT. X. on the timebase range switch with X5 magnifier on. Connect a 1kHz squarewave of 10V peak-to-peak amplitude to the external X socket and verify that the horizontal deflection is approximately 5cm.

5.6 OS2006X

(1) Connect the timebase to a calibrated OS2100 main frame containing a calibrated Y2 unit, via a PL82 plug-in extension lead. (Note - mean X plate potential of MF to be correctly set for fast sweep speed see section 3.5).

(2) Set the timebase to normal sweep, 1mS/cm range, delay off, the trigger selection to INT +ve, Auto level and time/CM variable control in the CAL position. Set the Y2 plug-in selector switch to Y1 only. Set R141 fully anticlockwise. Set R145 fully clockwise. Switch on the supply.

(3) TRIGGER SENSITIVITY

Connect a 1kHz squarewave to the Y1 socket and set its amplitude to give 2mm of deflection. Adjust R145 such that the timebase just triggers. Check that with a 1.5mm deflection the timebase fails to trigger.

Apply a sinewave input to Y1 and check for trigger sensitivities to be better than 2mm at 5MHz.

(4) Hold off. Turn R141 fully clockwise with an input of 1MHz applied to Y channel and level in AUTO, select INT. + trigger and adjust R141 to give a triggered display. Check that operation of variable time/cm does not cause mis-triggering. Re-adjust R141 if necessary.

(5) Check that the repetition rate of the sweep in the auto mode is less than 30per second.

(6) 1kHz CALIBRATION

Apply 1kHz marker pulses into the Y1 socket and adjust R231 to give 1 pulse/cm on the 1mS/cm range.

(7) TRACE LENGTH

Adjust R133 to give a trace length of 11.0cm.

(8) Switch the range switch to 0.1 μ S/cm and with 10MHz pulses applied to the Y1 input, adjust C119 to give 1 pulse/cm.

(9) Set the input to 1MHz and select 1 μ S/cm. Adjust C117 to give 1 pulse/cm. Every range should then be within $\pm 5\%$.

(10) Check that fine control gives $>3:1$ reduction in sweep rate. Return to CAL position.

(11) Centralise level control by applying a 1kHz sine wave, set to give a deflection of 6cm. With the level control in its mid electrical position, (re-position the knob if this is not its mechanical mid position) adjust R126 such that the sweep starts from the centre of the waveform.

(12) With a 20 to 30MHz signal applied to the Y input amplifier observe the trace start with the X5 magnifier on and 0.1 μ S/cm sweep rate selected. Adjust R176 to optimise the start of the ramp.

(13) To prevent back-curling at the end of the trace, C123 may need to be added (nominally 2-5pF.)

(14) EXT. X. CALIBRATION

Switch to EXT. X and apply a 10V 1kHz square wave, DC coupled on $\div 1$ to the external socket. Adjust R116 for a 10cm line. Adjust C102 to give no ingoing or outgoing tails on the two dots displayed.

Select $\div 10$ and increase the input (using X5 magnification/cm if necessary) to give 5 or 10cm deflection. Adjust C101 to give no tail on the two dots displayed.

Connect a sinusoidal input to EXT. X and check bandwidth to be greater than 1MHz in both $\div 1$ and $\div 10$ positions. Remove the external input.

(15) Switch to timebase range of 10mS/cm and use the shift control to set the commencement of sweep to coincide with the left hand end graticule line. Re-select external and use R118 to set the position of the spot to the left hand side of the screen. Re-adjustment of the gain, R116, may be necessary after this as these controls are interdependant.

(16) DELAY MONOSTABLE

Set the timebase to 1mS/cm and the delay to 0.1-1.1mS range. Connect a crystal derived 1kHz signal to the Y input plug in. Using an auxiliary oscilloscope, observe the pulse at the DELAY output socket.

Before proceeding with the calibration, check that the counting dial covers from 1 to 10.99 for the full rotation of the variable delay pot.

Set the control to '10', i.e. a delay of 1mS. Adjust R216 to set up a pulse 1mS wide.

Set the variable control to '1' and adjust R221 to set up a pulse 100 μ S wide. Re-check the maximum value and re-adjust if necessary. Check all four ranges ($\pm 5\%$). Check for jitter greater than 10,000:1, i.e. $< 1\mu$ S jitter for 10mS delay.

(17) SINGLE SHOT

Switch timebase to 0.5mS/cm trigger from INT.+ . Feed 1kHz sinewave into Y input to give 3cm of deflection, triggered manually. Select single shot, turn level control fully clockwise and press ARM button. Neon should light. Rotate level control until neon extinguishes, sweep should trigger. Further pressing of the arm button should trigger the timebase once only per press. Do this repeatedly, checking for phase shift between sweeps.

(18) EXTERNAL TRIG

Apply two time related pulses to the Y input and EXT. trigger input. Check for correct polarity. Reduce amplitude to external trig. socket to 200mV/pk-pk on X $\div 1$ and check for satisfactory trigger, up to a frequency of 10MHz.

(19) T.V. TRIG

With the video waveform from a television receiver applied to the Y input, trigger from the T.V. line or frame pulses can be selected by the trigger selector switch. The positive mode in each case being selected when the picture information is negative (i.e. line pulses are positive). Adjustment of the LEVEL control will give a stable, locked display.

(20) Check that outputs are available from the 3 sockets as below.

(1) RAMP	approx.	+4V	from	4.7k
(2) GATE	approx.	+10V	from	10k
(3) DELAY	approx.	+5V	from	10k

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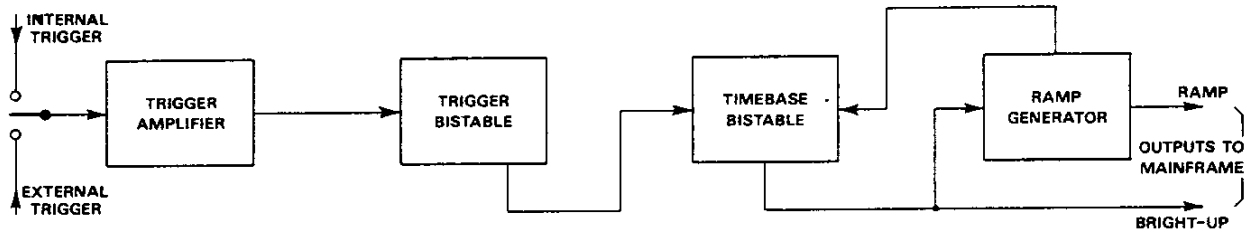


Fig. 1 OS2003X Block Diagram

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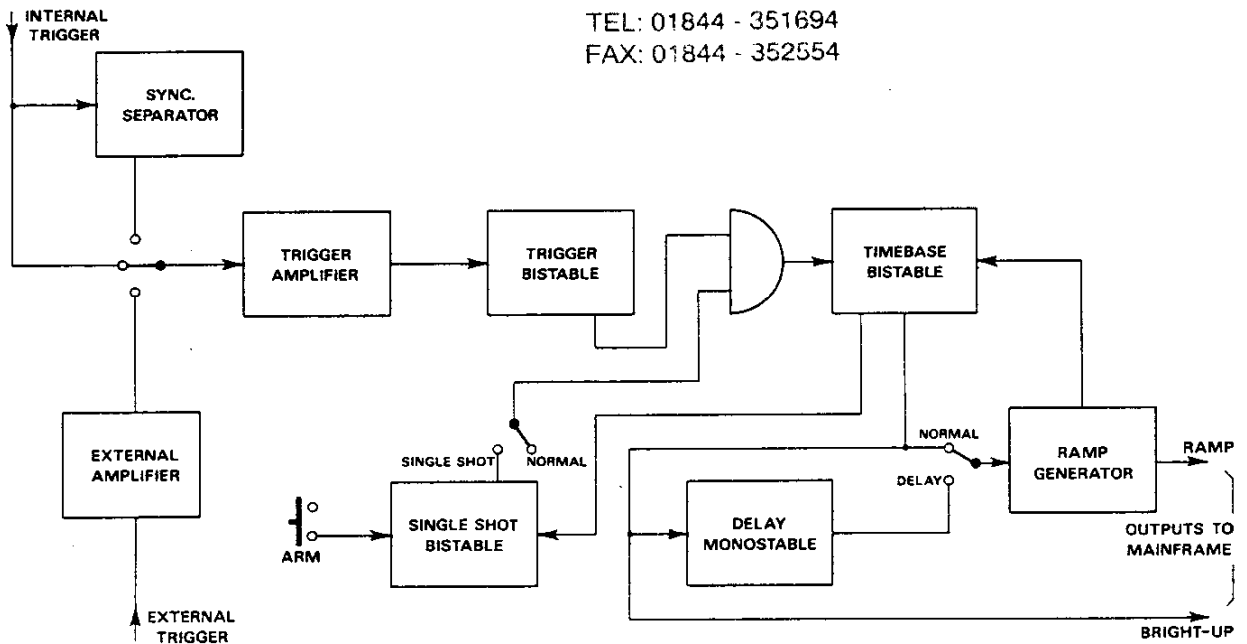


Fig. 2 OS2006X Block Diagram

Component List and Illustrations

STANDARD TIMEBASE P.C. ASSY OS2003X

Ref.	Value	Description	Part No.
RESISTORS			
R101	82kΩ	1W	19060
R102	22kΩ	5% 1/8W	1544
R103	1kΩ	5% 1/8W	384
R104	1kΩ	5% 1/8W	384
R105	1kΩ	5% 1/8W	384
R106	1kΩ	5% 1/8W	384
R107	10kΩ	5% 1/8W	11503
R108	33kΩ	5% 1/8W	317
R109	4.7kΩ	5% 1/8W	386
R110	1kΩ	5% 1/8W	384
R111	47Ω	5% 1/8W	727
R112	1kΩ	5% 1/8W	384
R113	47Ω	5% 1/8W	727
R114	47Ω	5% 1/8W	727
R115	680Ω	5% 1/8W	309
R116	1k	5% 1/8W	384
R117	3.3kΩ	5% 1/8W	1638
R118	470kΩ	5% 1/8W	1518
R119	680kΩ	5% 1/8W	2522
R120	27kΩ	5% 1/8W	316
R121	220Ω	5% 1/8W	304
R122	100Ω	5% 1/8W	11504
R123	1.8kΩ	5% 1/8W	310
R124	10kΩ	5% 1/8W	11503
R125	3.3kΩ	5% 1/8W	1638
R126	470Ω	5% 1/8W	1373
R127	3.9kΩ	5% 1/8W	312
R128	10Ω	5% 1/8W	2259
R129	10Ω	5% 1/8W	2259
R130	1.8kΩ	5% 1/8W	310
R131	47kΩ	5% 1/8W	318
R132	910Ω	5% 1/8W	2182
R133	470Ω	5% 1/8W	1373
R134	1.5kΩ	5% 1/8W	385
R135	10Ω	5% 1/8W	2259
R136	10kΩ	5% 1/8W	11503
R137	560Ω	5% 1/8W	308
R138	1.5kΩ	5% 1/8W	385
R139	4.7kΩ	5% 1/8W	386
R140	10kΩ	5% 1/8W	11503
R141	8.2kΩ	5% 1/8W	314
R142	1.2kΩ	5% 1/8W	2087
R143	12kΩ	5% 1/8W	1685
R144	10Ω	5% 1/8W	2259
R145	470Ω	5% 1/8W	1373
R146	1kΩ	5% 1/8W	384
R147	47Ω	5% 1/8W	727
R148	18kΩ	5% 1/8W	634
R149	10Ω	5% 1/8W	2259
R150	62kΩ	1% 1/4W	24839
R151	93k	1% 1/4W	24840
R152	154kΩ	1% 1/4W	24841
R153	309kΩ	1% 1/4W	24842
R154	931kΩ	1% 1/4W	24845
R155	1.54MΩ	1% 1/4W	24843
R156	3.09MΩ	1% 1/4W	24844
R157	75kΩ	5% 1/8W	24837
R158	100kΩ	5% 1/8W	319
R159	62kΩ	1% 1/4W	24839
R160			
R161	2.2MΩ	5% 1/8W	24838
R162	10Ω	5% 1/8W	2259

Ref.	Value	Description	Part No.
R163	910Ω	5% 1/8W	2182
R164	680Ω	5% 1/8W	309
R165	3.3kΩ	5% 1/8W	1638
R166	100Ω	5% 1/8W	11504
R167	1kΩ	5% 1/8W	384
R168	1.8kΩ	5% 1/8W	310
R169	100Ω	5% 1/8W	11504
R170	10Ω	5% 1/8W	2259
R171	15kΩ	5% 1/8W	315
R172	27kΩ	1W	19054
R173	560Ω	5% 1/8W	308
R174	270Ω	5% 1/8W	2716
R175	47kΩ	5% 1/8W	318
R176	100Ω	5% 1/8W	11504
R177	22kΩ	5% 1/8W	1544
R178	100Ω	5% 1/8W	11504
R179	4.7kΩ	5% 1/8W	386
R180	100Ω	5% 1/8W	11504
R181	100Ω	5% 1/8W	11504
CAPACITORS			
C101			
C102			
C103			
C104	50μF	C426 AR/G50 40V	20778
C105	50μF	C426 AR/G50 40V	20778
C106			
C107			
C108	320μF	C428 AR/B320 4V	23591
C109	320μF	C428 AR/B320 4V	23591
C110	100pF	Disc Ceramic 10% 400V	22376
C111	0.1μF	Wima Tropyfol M10% 400V	2385
C112	18pF		22367
C113	.01μF	Disc Ceramic 10% 400V	22395
C114	1000pF		22387
C115	0.1μF	Wima Tropyfol M10% 400V	2385
C116	47pF		22372
C117	.01μF	Disc Ceramic 10% 400V	22395
C118	39pF		22371
C119	330pF		22381
C120	75pF	Silvered Mica 1%	12187
C121			
C122			
C123			
C124			
C125			
C126			
C127	.01μF	Disc Ceramic 10% 400V	22395
C128	.01μF	Disc Ceramic 10% 400V	22395
C129	.01μF	Disc Ceramic 10% 400V	22395
C130	.01μF	Disc Ceramic 10% 400V	22395
C131	25μF	Mullard 25V	20776
C132	25μF	Mullard 25V	20776
C133	.01μF	Disc Ceramic 10% 400V	22395
C134			
C135	6-25pF	Ceramic Trimmer	23593
C136			
C137	.01μF	Disc Ceramic 10% 400V	22395
RESISTORS			
R1			
R2	5.6kΩ	5%	787
R3	5.6kΩ	5%	787

OS2003X CIRCUIT DIAGRAM

Ref.	Value	Description	Part No.
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RESISTORS

R4			
R5	4.7k Ω	5%	386

PLUGS

PL.A			
PL.B			
PL.C			
PL.D	McMurdo Red Range RP24		24852

SOCKETS

SK.A			
SK.B	B/Lee L1737 2M/M Black		26588
SK.C	B/Lee L1737 2M/M Black		26588
SK.D	B.N.C. (Greenpar)		1222
SK.E	B.N.C. (Greenpar)		1222

CAPACITORS

C1	0.1 μ F	Wima Tropyfol M 10%	400V	2385
C2	0.1 μ F	Wima Tropyfol M 10%	400V	2385
C3				
C4				
C5				
C6				
C7	100pF	Disc Ceramic	10%	400V 22376
C8	18pF			22367

CONTROL POTS

RV1			
RV2			
RV3	500 Ω	Morganite Type 11	A.24587
RV101	1k Ω	Press-Sets Davall Type 80	25226
RV102	100k Ω	Press-Sets Davall Type 80	25231
RV103	100 Ω	Press-Sets Davall Type 80	25228
RV104	4.7k Ω	Press-Sets Davall Type 80	25232
RV105	4.7k Ω	Press-Sets Davall Type 80	25232
RV106	470 Ω	Press-Sets Davall Type 80	25225

TRANSISTORS

VT101	(Mullard) BSX20		23307
VT102	(Mullard) BSX20		23307
VT103	(Mullard) BSX20		23307
VT104	(Mullard) BSX20		23307
VT105	(Mullard) BSX20		23307
VT106	(Mullard) BSX20		23307
VT107	(Mullard) BSX20		23307
VT108	(Mullard) BSX20		23307
VT109	(Mullard) BSX20		23307
VT110	(Mullard) BSX20		23307
VT111	(Union Corp) UC634		24832
VT112	(Motorola) 2N3905		20818
VT113	BSX20		23307
VT114	BSX20		23307
VT115	BSX20		23307
VT116	(Motorola) 2N3905		20818

DIODES

MR101	(Mullard) OA95		23318
MR102	(Mullard) OA95		23318
MR103	(Mullard) Zener	6.2V	4032
MR104	(Mullard) OA95		23318

Ref.	Value	Description	Part No.
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MR105		Texas 1S44	18970
MR106		(Mullard) OA95	23318
MR107		(Mullard) OA95	23318
MR108		Texas 1S44	18970
MR109		Texas 1S44	18970
MR110		Texas 1S44	18970
MR111		(Mullard) OA95	23318
MR112		Texas 1S44	18970
MR113		(Mullard) Zener	6.2V 4032
MR114		(Mullard) Zener	6.2V 4032
MR115		(Mullard) Zener	6.2V 4032

POTENTIOMETER

RV1			
RV2	5k Ω	Pot + Switch	24846

CAPACITORS

C1			
C2			
C3	900pF	Poly	24885
C4	.01 μ F	Poly	24886
C5	.1 μ F	Poly	24887
C6	1 μ F	Poly	24888
C7	100pF	Erie Disc	22376
C8	18pF	Erie Disc	22367

SWITCHES

S2	
S4	

CONTROL POTS

RV1	100k Ω	Pot + Switch	24847
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CAPACITORS

C101	.1 μ F	400V	18260
C134	.1 μ F	400V	18260

RESISTOR

R4	100 Ω	5%	1/4W	11504
R1	3.3k Ω	5%	1/4W	1638

SWITCHES

S1	
S3	

Component List and Illustrations

OS2006X TIMEBASE P.C.B. CIRCUIT

Ref.	Value	Description	Part No.
RESISTORS			
R101	100Ω	5% 1/8W	11504
R102	47Ω	5% 1/8W	727
R103	47Ω	5% 1/8W	727
R104	10Ω	5% 1/8W	2259
R105	1k	5% 1/8W	384
R106	1k	5% 1/8W	384
R107	33k	5% 1/8W	317
R108	330k	2% 1/4W	28834
R109	1k	5% 1/8W	384
R110	1M	2% 1/4W	29849
R111	68k	2% 1/4W	29848
R112	1k	5% 1/8W	384
R113	6.8k	5% 1/8W	313
R114	2.2k	5% 1/8W	425
R115	3.9k	5% 1/8W	312
R116	4.7k	Plessey MPD/PC	24560
R117	3.3k	5% 1/8W	1638
R118	4.7k	Plessey MPD/PC	24560
R119	1k	5% 1/8W	384
R120	22Ω	5% 1/8W	723
R121	22Ω	5% 1/8W	723
R122	1k	5% 1/8W	384
R123	6.8k	5% 1/8W	313
R124	1k	5% 1/8W	384
R125	1k	5% 1/8W	384
R126	220Ω	Plessey MPD/PC	28522
R127	220Ω	5% 1/8W	304
R128	3.3k	5% 1/8W	1638
R129	1.5k	5% 1/8W	385
R130	100Ω	5% 1/8W	11504
R131	1k	5% 1/8W	384
R132	1k	5% 1/8W	384
R133	4.7k	Plessey MPD/PC	24560
R134	18k	5% 1/8W	634
R135	10Ω	5% 1/8W	2259
R136	1.2M	5% 1/8W	29166
R137	10Ω	10% 1/8W	2259
R138	12k	5% 1/8W	1685
R139	270k	5% 1/8W	1679
R140	100Ω	5% 1/8W	11504
R141	470Ω	Plessey MPD/PC	28524
R142	820Ω	5% 1/8W	1637
R143	47k	5% 1/8W	318
R144	10Ω	5% 1/8W	2259
R145	100Ω	Plessey MPD/PC	28520
R146	1.8k	5% 1/8W	310
R147	3.3k	5% 1/8W	1638
R148	3.9k	5% 1/8W	312
R149	120Ω	5% 1/8W	735
R150	10Ω	5% 1/8W	2259
R151	10Ω	5% 1/8W	2259
R152	4.7k	5% 1/8W	386
R153	47k	5% 1/8W	318
R154	1.5k	5% 1/8W	385
R155	2.2M	5% 1/8W	24838
R156	4.7k	5% 1/8W	386
R157	910Ω	2% 1/4W	26735
R158	10k	5% 1/8W	11503
R159	150k	5% 1/8W	4018
R160	1k	5% 1/8W	384
R161	2.2k	5% 1/8W	425
R162	2.2k	5% 1/8W	425

Ref.	Value	Description	Part No.
R163	10k	5% 1/8W	11503
R164	2.7k	5% 1/8W	311
R165	680Ω	5% 1/8W	309
R166	1.8k	5% 1/8W	310
R167	3.3k	5% 1/8W	1638
R168	150k	5% 1/8W	4018
R169	10k	5% 1/8W	11503
R170	470Ω	5% 1/8W	1373
R171			
R172	47Ω	5% 1/8W	727
R173	1.2k	5% 1/8W	2087
R174	2.2k	5% 1/8W	425
R175	82k	5% 1/8W	2088
R176	470Ω	Plessey MPD/PC	28524
R177	1.2k	5% 1/8W	2087
R178	560Ω	5% 1/8W	308
R179	100Ω	5% 1/8W	11504
R180			
R181	100Ω	5% 1/8W	11504
R182	470Ω	5% 1/8W	1373
R183	1k	5% 1/8W	384
R184	330Ω	5% 1/8W	1894
R185	1.8k	5% 1/8W	310
T186	560Ω	5% 1/8W	308
R187	3.3M	10% 1/8W	29167
R188	270Ω	5% 1/8W	2716
R189	100Ω	5% 1/8W	11504
CAPACITORS			
C101	6/25pF	Trimmer	23593
C102	6/25pF	Trimmer	23593
C103	390pF		22382
C104	10pF		22364
C105	.01μF		22395
C106	.01μF		22395
C107	1μF	160V	2364
C108	5.6pF		22361
C109	100pF		22376
C110	18pF		22367
C111	.01μF		22395
C112	.01μF		22395
C113	.01μF		22395
C114	330pF		22381
C115			
C116	56pF		22373
C117	6/25pF	Trimmer	23593
C118	12pF		22365
C119	10pF	Trimmer	28933
C120	39pF		22371
C121	5.6pF		22361
C122	.01μF		22395
C123			
C124	.01μF		22395
C125	25μF	25V	20776
C126	.01μF		22395
C127	25μF	25V	20776
C128	.01μF		22395
C129	47pF		22372
C130	.01μF		22395
C131	.01μF		22395
C132			
C133	47pF		22372
C134	.01μF		22395

OS2006X TIMEBASE P.C.B. CIRCUIT

Ref.	Value	Description	Part No.
CAPACITORS			
C135	560pF		22384
C136			
C137	20µF	16V	21514
C138	20µF	16V	21514
TRANSISTORS			
TR101		U.C. 734	24832
TR102		2N 3905	20818
TR103		BSX20	23307
TR104		BSX20	23307
TR105		BSX20	23307
TR106		BSX20	23307
TR107		BSX20	23307
TR108		BSX20	23307
TR109		BSX20	23307
TR110		BSX20	23307
TR111		BSX20	23307
TR112		BSX20	23307
TR113		BSX20	23307
TR114		BSX20	23307
TR115		BSX20	23307
TR116		BSX20	23307
TR117		U.C. 734	24832
TR118		BSX20	23307
TR119		BSX20	23307
TR120		BSX20	23307
TR121		BSX20	23307
TR122		BC 108	26110
DIODES			
D101		1N 916	1949
D102		1N 916	1949
D103		Zener	2.7V 21002
D104		Zener	4.7V 4073
D105		1N 4148	23802
D106		1N 4148	23802
D107			
D108		1N 916	1949
D109			
D110		1N 916	1949
D111		1N 916	1949
D112		Zener	6.2V 4032
D113		1N 916	1949
D114		1N 4003	23462
D115		1N 4148	23802
D116		1N 4148	23802
D117		Zener	6.2V 4032
D118		1N 916	1949
D119		1N 916	1949
D120		1N 916	1949
D121		OA47	4468
D122		TD716	26841
D123		OA47	4468
D124		1N 916	1949
D125		1N 916	1949

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DELAY BOARD OS2006X					Ref.	Value	Description	Part No.
Ref.	Value	Description	Part No.		CAPACITORS			
RESISTORS								
R201	100Ω	5%	1/8W	11504	C201	.1μF	10% 160V	804
R202	10k	5%	1/8W	11503	C202	18pF		22367
R203	12k	5%	1/8W	1685	C203	.01μF		22395
R204	10Ω	5%	1/8W	2259	C204	39pF		22371
R205	2.2k	5%	1/8W	425	C205	39pF		22371
R206	27k	5%	1/8W	316	C206	22pF		22368
R207	27k	5%	1/8W	316	C207	56pF		22373
R208	6.8k	5%	1/8W	313	C208	.01μF		22395
R209	6.8k	5%	1/8W	313	C209	32μF	64V	20777
R210	2.2k	5%	1/8W	425	C210	.01μF		22395
R211	68k	5%	1/8W	18572	C211	.01μF		22395
R212	6.8k	5%	1/8W	313	C212			
R213	6.8k	5%	1/8W	313	C213	.01μF		22395
R214	68k	5%	1/8W	18572	C214			
R215	47k	5%	1/8W	318	C215	.01μF		22395
R216	1k	Plessey MPD/PC		26870	C216	.01μF		22395
R217	1k	5%	1/8W	384	C217	56pF		22373
R218	1.8k	5%	6W	3394	C218	12.5μF	25V	20775
R219	2.2k	5%	6W	599	C219	220pF		22379
R220	1.8k	5%	6W	3394	C220	2200pF		22389
R221	2.2k	Plessey MPD/PC		24561	C221	.22μF	160V	2601
R222	1.8k	5%	1/8W	310	C222	.01μF		22395
R223	10k	5%	1/8W	11503	TRANSISTORS			
R224	560Ω	5%	1/8W	308	TR201	BSX20		23307
R225	120Ω	5%	1/8W	735	TR202	BSX20		23307
R226	12k	5%	1/8W	1685	TR203	C 407		20388
R227	270Ω	5%	1/8W	2716	TR204	2N 3904		24146
R228	10Ω	5%	1/8W	2259	TR205	2N 3904		24146
R229	910Ω	2%	1/4W	26735	TR206	2N 3905		20818
R230	680Ω	5%	1/8W	309	TR207	UC 734		24832
R231	4.7k	Plessey MPD/PC		24560	TR208	BSX20		23307
R232	10Ω	5%	1/8W	2259	TR209	2N 3905		20818
R233	3.3k	5%	1/8W	1638	TR210	2N 3905		20818
R234	3.3k	5%	1/8W	1638	TR211	BSX20		23307
R235	18k	5%	1/8W	634	TR212	2N 3905		20818
R236	27k	5%	1W	19054	TR213	2N 3905		20818
R237	1.8k	5%	1/8W	310	TR214	2N 3905		20818
R238	100Ω	5%	1/8W	11504	TR215	BSX20		23307
R239	4.7k	5%	1/8W	386	DIODES			
R240	100Ω	5%	1/8W	11504	D201	1N 914		23802
R241	2.2k	5%	1/8W	425	D202	1N 914		23802
R242	1k	5%	1/8W	384	D203	1N 914		23802
R243	10Ω	5%	1/8W	2259	D204	1N 914		23802
R244	10Ω	5%	1/8W	2259	D205	1N 821 (Zener)		23231
R245	15k	5%	1/8W	315	D206	Zener	8.2V	3798
R246	47k	5%	1/8W	318	D207	1N 914		23802
R247	1k	5%	1/8W	384	D208	1N 821 (Zener)		23231
R248	1k	5%	1/8W	384	D209	Zener	6.2V	4032
R249	47k	5%	1/8W	318	D210	Zener	6.2V	4032
R250	47k	5%	1/8W	318	D211	Zener	6.2V	4032
R251	6.8k	5%	1/8W	313	D212	1N 914		23802
R252	22Ω	5%	1/8W	723	D213	1N 914		23802
R253	680Ω	5%	1/8W	309	D214			
R254	680Ω	5%	1/8W	309	D215	1N 914		23802
R255	1k	5%	1/8W	384	D216	1N 914		23802
R256	100k	5%	1/8W	319				
R257	10k	5%	1/8W	11503				
R258	33k	5%	1/8W	317				
R259	15k	5%	1/8W	315				
R260	10Ω	5%	1/8W	2259				
R261	47k	5%	1/8W	318				
R262	33k	5%	1/8W	317				

OS2006X INTERCONNECTION CIRCUIT

Ref.	Value	Description	Part No.
RESISTORS			
R1	100k	Potentiometer (Part of S2/S3)	
R2	12k	5% 1/8W	1685
R3	36k	2%	28811
R4	62k	2%	28817
R5	39k	2%	28812
R6	62k	1%	24839
R7	93k	1%	24840
R8	154k	1%	24841
R9	309k	1%	24842
R10	931k	1%	24845
R11	1.54M	1%	24843
R12	3.09M	1%	24844
R13	9.31M	1%	29655
R14	15M	1%	29656
R15	390k	2%	28836
R16	15M	1%	29656
R17	15M	1%	29656
R18	1M	5% 1/2W	18586
R19	25k	Potentiometer	A4/29657
R20	5k	Potentiometer	
R21	500Ω	Potentiometer	A24587
R22	3.3k	5% 1/8W	1638
R23	12k	5% 1/8W	1685
R24	1k	5% 1/8W	384

CAPACITORS

C1	.1μF		400V	18260
C4	50μF		6V	1746
C5	50μF		6V	1746
C6	1μF	1%	160V	24888
C7	.1μF	1%	160V	24887
C8	.01μF	1%	160V	24886
C9	1000pF	1%	160V	29847
C11	.2μF	2%		23598
C12	.02μF	2%		23597
C13	.022μF		160V	4535
C14	2200pF	10%	400V	773
C15	220pF	10%		22379
C16	2μF	1%	63V	29846
C17	2000pF	2½%		23596
C18	.22μF		160V	2601

DIODES

1N 914				23802
--------	--	--	--	-------

SWITCHES

S1				4069
S2				29332
S3				
S4				4069
S5				27366
S6	P/B Rendar			4881
S7				4069
S8				27500
S9				
S10				4069

SOCKETS

SKA				26588
SKB				26588
SKC				26588
SKD				1222

Ref.	Value	Description	Part No.
SOCKETS			
SKE			A22138
PLUGS			
PLA		McMurdo RP24	24852
N1			
		Hivac 34H	26845
N2			
		Hivac 34H	26845

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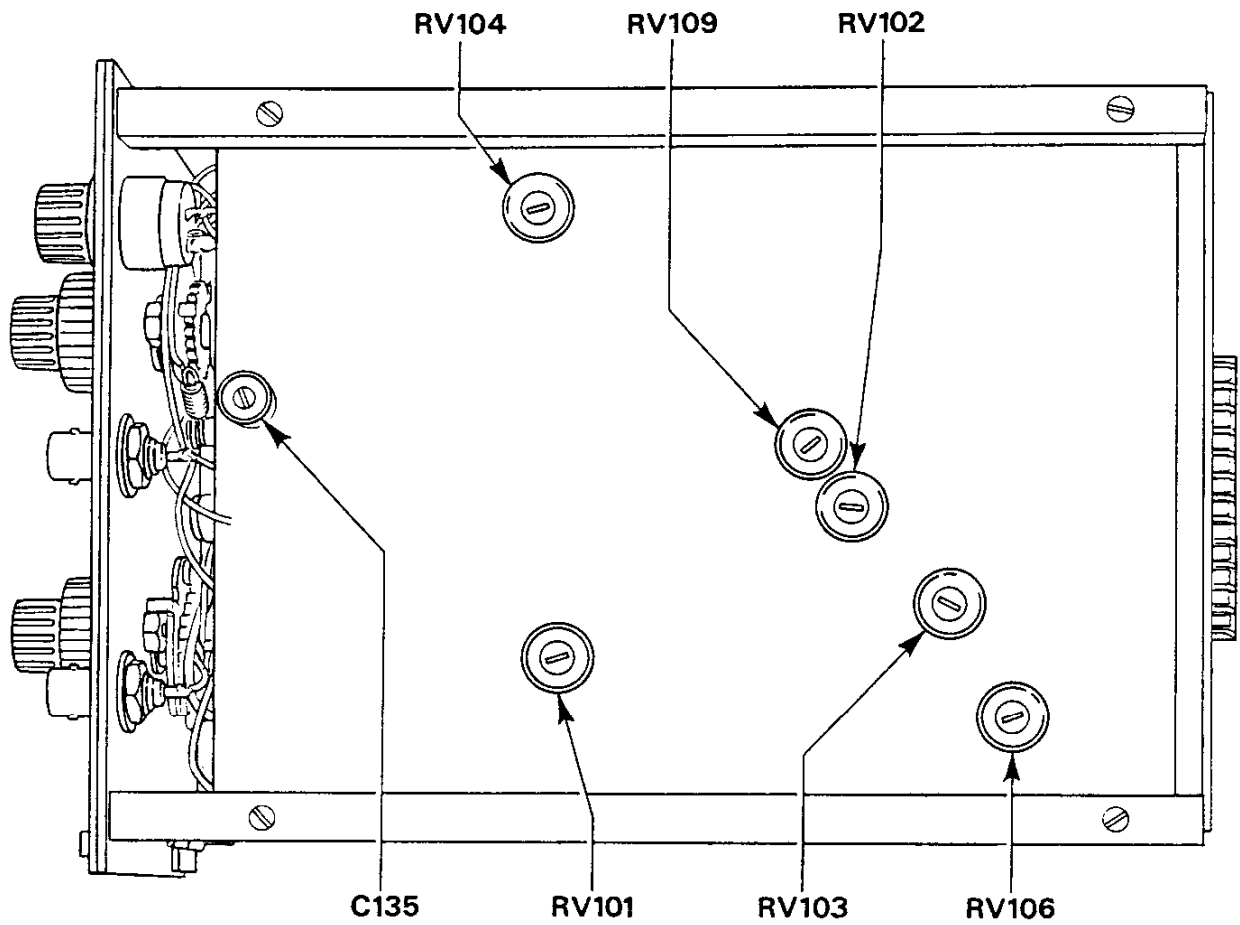


Fig. 7 Component Layout OS2003X

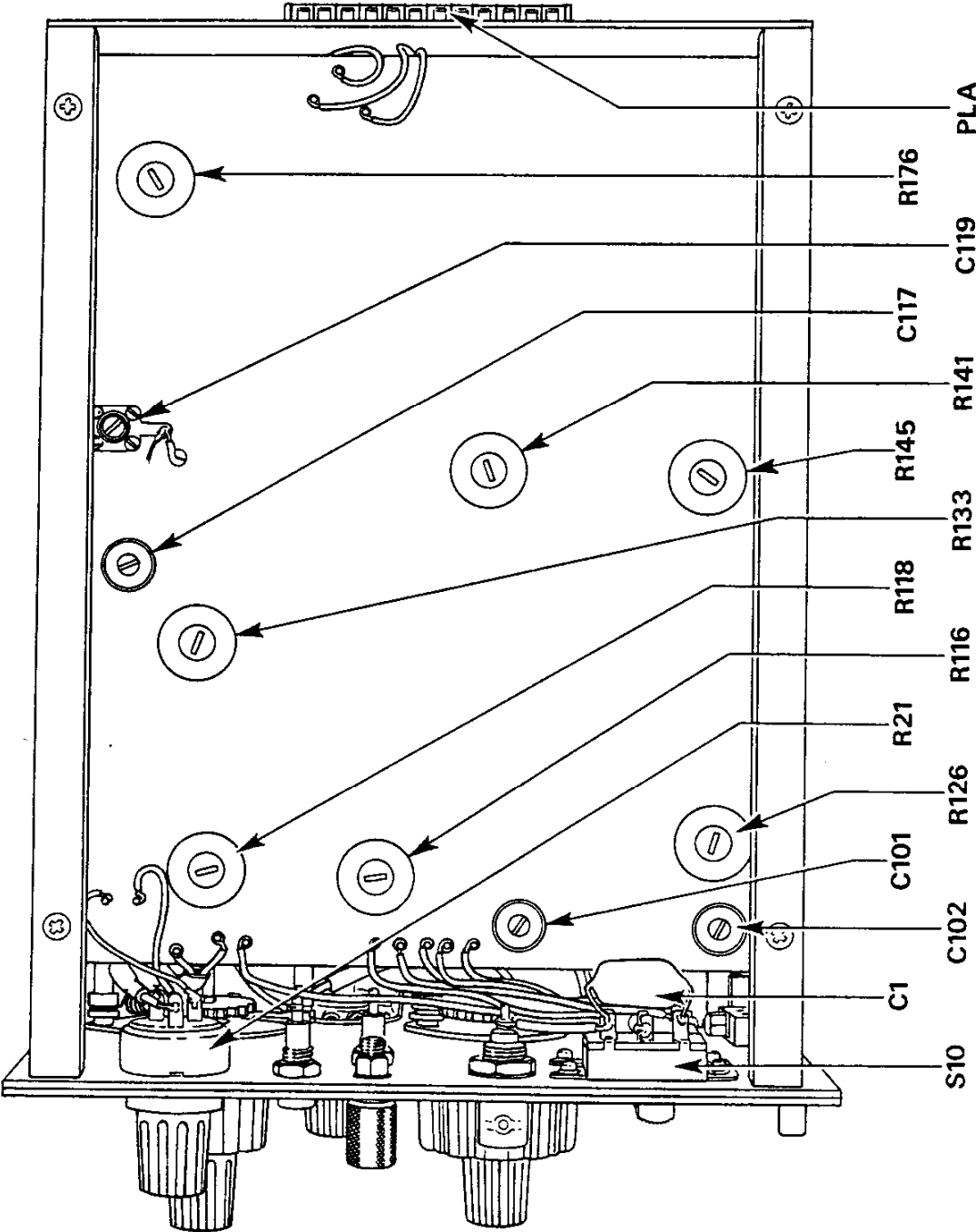


Fig. 8 Component Layout OS2006X (timebase)

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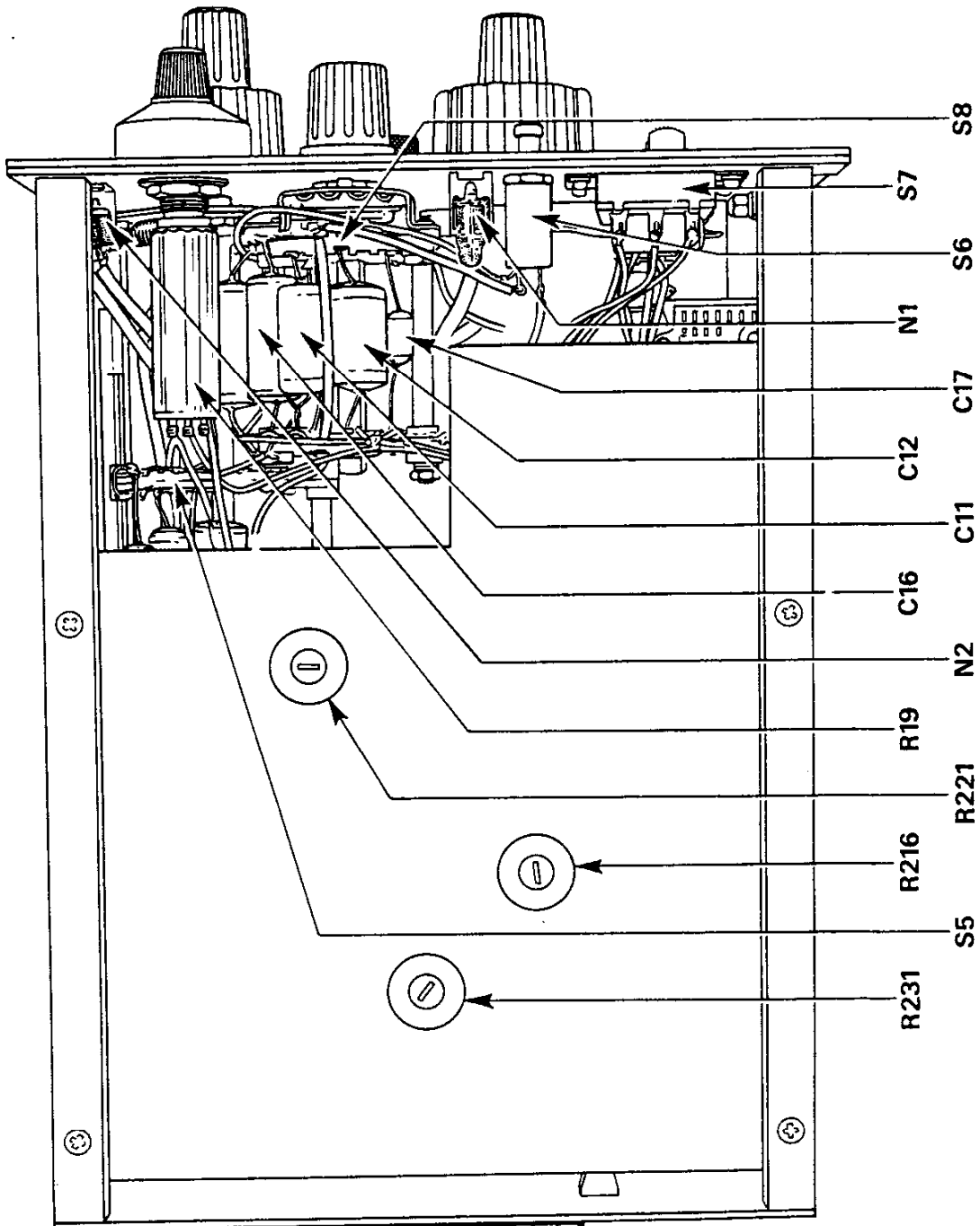


Fig. 9 Component Layout OS2006X (delay)

LAB. INSTRUMENTS

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Supplement for
OS2001Y OS2002Y OS2007Y
and OS2001X
Plug-in Units



**ADVANCE
INSTRUMENTS (Sales Dept.)**

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Contents

SECTION 1 Introduction			
1.1 OS2001Y, OS2002Y, OS2007Y	3		
1.2 OS2001X	3		
SECTION 2 Specification			
2.1 OS2001Y, OS2002Y, OS2007Y	4		
2.2 OS2001X	5		
2.3 Accessories	5		
SECTION 3 Operation			
3.1 OS2001Y, OS2002Y, OS2007Y	6		
3.2 OS2001X	7		
SECTION 4 Circuit Description			
4.1 General	8		
4.2 OS2001Y	8		
4.3 OS2002Y	9		
4.4 OS2007Y	10		
4.5 OS2001X	12		
SECTION 5 Maintenance			
5.1 Power Supplies and Output Levels	14		
5.2 General	14		
5.3 Equipment required	14		
5.4 OS2001Y	14		
5.5 OS2002Y	15		
5.6 OS2007Y	16		
5.7 OS2001X	17		
SECTION 6 Components Lists and Illustrations			
6.1 Components Lists OS2001Y	18		
6.2 Components Lists OS2002Y Y Amplifier Board 1	20		
6.3 Components Lists OS2002Y Y Amplifier Board 2	22		
6.4 Components Lists OS2007Y Y Amplifier Board 1	24		
6.5 Components Lists OS2007Y Y Amplifier Board 2	26		
6.6 Components Lists OS2001X	28		
		ILLUSTRATIONS	
		Fig. 1 Circuit Diagram OS2001Y	19
		Fig. 2 Circuit Diagram OS2002Y Y Amplifier Board 1	21
		Fig. 3 Circuit Diagram OS2002Y Y Amplifier Board 2	23
		Fig. 4 Circuit Diagram OS2007Y Y Amplifier Board 1	25
		Fig. 5 Circuit Diagram OS2007Y Y Amplifier Board 2	27
		Fig. 6 Circuit Diagram OS2001X	29
		Fig. 7 Layout of preset controls OS2001Y	30
		Fig. 8 Layout of preset controls OS2002Y	31
		Fig. 9 Layout of preset controls OS2007Y	32
		Fig. 10 Layout of preset controls OS2001X	33
SECTION 7 Guarantee and Service Facilities			35

1.1 OS2001Y, OS2002Y, OS2007Y

These Y input plug-in units for the OS2000 family of oscilloscopes combine the minimum of front panel controls and hence simplicity of operation, with wide bandwidth and stability.

The single channel OS2001Y offers nine switched ranges from 50mV/cm to 20V/cm. The dual-channel OS2002Y offers eleven switched sensitivity ranges from 10mV/cm to 20V/cm, with a variable control giving overlap on all ranges.

The dual channel OS2007Y offers twelve switched sensitivity ranges from 10mV/cm to 50V/cm, with a variable control giving overlap on all ranges. The OS2002Y and OS2007Y provide display modes of Y1 only; Y2 only; Y1 and Y2 dual beam display; or Y1 + Y2 added alge-

braically on single beam display. The separate facility to invert Y1 allows differential operation in the Y1 + Y2 mode. Also the channels may be cascaded to give a sensitivity of 1 mV/cm.

1.2 OS2001X

This plug-in unit for the OS2000 family of oscilloscopes is intended for applications requiring an X amplifier with a wide range of calibrated sensitivities. The OS2001X offers nine calibrated sensitivity ranges from 50mV/cm to 20V/cm.

It may be used with any OS2000 series of Y amplifier plug-in units to give a simple-to-operate X-Y oscilloscope with low phase shift over a wide range of frequencies.

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Specification

Section 2

Specification applies in OS2000, OS2000R, OS2100 and OS2100R unless otherwise stated.

2.1 Y PLUG-IN UNITS OS2001Y, OS2002Y, OS2007Y.

PARAMETER	OS2001Y	OS2002Y	OS2007Y
BANDWIDTH OS2000/2000R OS2100/2100R	DC – 25MHz DC – 30MHz	DC – 25MHz DC – 30MHz	DC – 25MHz DC – 35MHz *
BW/Cascaded		5Hz – 5MHz	5Hz – 10MHz
Sensitivity	50mV/cm	10mV/cm	10mV/cm
Sensitivity Cascaded		1mV/cm	1mV/cm
Input Attenuator	Switched 9 positions giving sensitivities of 50mV/cm to 20V/cm in 1, 2, 5 sequence.	Switched 11 positions giving sensitivities of 10mV/cm to 20V/cm in 1, 2, 5 sequence. Fine gain control reduces sensitivity to give an uncalibrated control over the full range	Switched 12 positions giving sensitivities of 10mV/cm to 20V/cm in 1, 2, 5 sequence. Fine gain control reduces sensitivity to give an uncalibrated control over the full range.
Input Impedance	1MΩ shunted by 35pF approx.	1MΩ shunted by 35pF approx.	1MΩ shunted by 27pF approx.
Max. Input	±400V (DC & LF only)	±400V (DC & LF only)	±400V (DC & LF only)
Input Coupling	DC. AC & Ground	DC. AC & Ground	DC. AC & Ground
Measuring Accuracy	±5%	±5%	±5%
Operating Modes	Single Beam	1) Channel Y1 only 2) Channel Y2 only 3) Channel Y1 and Y2 chopped at approx. 100kHz on timebase speeds up to 1mS, alternate sweeps on faster rates. 4) Channels Y1 + Y2, the algebraic sum, 5) Channel Y1 inverted 6) Channel Y2 as X10 pre-amplifier Trigger pick-off from channel Y1 or Y2 in modes 3 & 4.	As OS2002Y
Weight	2lb.	3½lb.	3lb.

* If a main frame has previously been set up for use with the OS2002Y Plug-in, it may be necessary to slightly re-trim the main frame to achieve this bandwidth on the 10, 20 and 50V/cm attenuator positions.

2.2 X PLUG-IN UNIT OS2001X

SENSITIVITY

Switched 9 position attenuator giving sensitivities of 50mV/cm to 20V/cm in 1, 2, 5 sequence.

BANDWIDTH (-3dB)

OS2000/OS2000R	DC – 750kHz
OS2100/OS2100R	DC – 1MHz

PHASE SHIFT

OS2000/OS2000R	DC – 100kHz	Typically less
OS2100/OS2100R	DC – 500kHz	than 3 degrees

INPUT IMPEDANCE

1M Ω \pm 1% shunted by 35pF approx.

MEASURING ACCURACY

\pm 5%

MAXIMUM INPUT

\pm 400V (DC + LF only)

INPUT COUPLING

DC, AC and Ground.

WEIGHT

2lb.

2.3 ACCESSORIES

(Normally supplied with the main frame)

Connector BNC – BNC (2")	PL.43
Connector BNC – BNC (8")	PL.81
Connector BNC – Crocodile clips	PL.44
Plug 2mm red	Pt. No. 26802
Plug 2mm black	Pt. No. 26803
Handbook OS2000/OS2000R	Pt. No. 28084
Handbook OS2100/OS2100R	Pt. No. 28136

(Optional)

Adaptor BNC – Binding Post	Pt. No. 26234
Passive Probe Kit	Pt. No. 25362

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3.1 OS2001Y, OS2002Y, and OS2007Y

These units can be used in the OS2000 series of main frames. The Y plug-in is inserted in the left hand aperture of the main frame and is automatically held in place after being firmly pressed in. Withdrawal is by means of the lever at the bottom of the unit.

Insert a suitable time base plug-in into the right hand aperture.

Always ensure that the supply is switched OFF before inserting or withdrawing plug-in units.

3.1(a) TRACE LOCATION

The following instructions should be read in conjunction with the appropriate main frame and timebase handbooks.

To find the trace, set the input coupling switch to ground. On the OS2002Y and the OS2007Y set both input switches to ground and select the required mode of operation with the function switch. Set the timebase trigger switch to FREE RUN. With the X and Y shift controls in their mid-positions, a trace should be visible on the cathode ray tube screen when the brilliance control on the main frame is advanced sufficiently.

3.1(b) INPUT SIGNAL CONNECTION OS2001Y, OS2002Y, and OS2007Y.

DC/AC/GROUND Switch. In the DC mode, the input signal is connected directly to the amplifier input. In the AC mode, a 400V DC working 0.1 μ F capacitor is inserted between the input socket and the amplifier input blocking the DC component of an input signal.

Select a suitable attenuator range and apply the input signal to the input coaxial socket using a screened lead to minimise pickup into the Y amplifier. On sensitive ranges ensure that the ground lead connection is near to the signal point.

When the input coupling switch is in the GROUND position, the input socket is open circuited, the input to the amplifier being shorted to ground. This facilitates balance adjustments and the setting up of DC levels.

3.1(c) PROBE

The input resistance of the Y plug-in is 1M Ω shunted by approx. 35 pF (27pF in the case of the OS2007Y). The effective capacity of the input lead must be added to this and the resultant impedance can often load the signal source. Therefore it may be beneficial to use the 10M Ω x 10 probe Pt.No. 25362. This reduces the input capacity and increases the input resistance at the expense of input sensitivity. The probe contains a shunt CR network in series with the input and which forms an attenuator with the input CR of the Y plug-in. It is necessary to adjust the capacity of the probe to match the input capacity of the plug-in and obtain a flat frequency response. For this, set the Y input sensitivity to 100mV/cm and the timebase speed to 1mS/cm. Connect the probe to the PROBE TEST socket on the OS2003X time base unit or the GATE output socket on the OS2005X or OS2006X timebases.

Adjustment of the capacitance is achieved by unscrewing the small knurled portion of the locking ring near the BNC connector at the Y Plug-in end of the probe lead. The larger portion is the adjustable capacitor and this should be set for a level response with no over-shoot or under-shoot visible on the display. The knurled locking ring should then be tightened against the capacitor ring.

3.1(d) MODES OF OPERATION OS20002Y and OS2007Y

Both plug-in's provide a choice of display modes. The function switch selects the required mode together with the trigger source when displaying multiple input functions.

The functions offered are, Y1 or Y2 only, the algebraic sum of Y1 plus Y2, and Y1 and Y2 simultaneously.

In this mode the beam is switched by chopping at slow timebase sweep rates and by alternating sweeps at higher rates. The most suitable mode for a given timebase sweep speed is automatically selected within the timebase unit.

By inverting Y1 and then selecting the display mode Y1 + Y2, the result is a differential signal Y2 - Y1 being displayed.

To obtain the best common mode rejection in the differential mode, it is necessary to set the gain of the two channels to be exactly equal. To do this, one channel is calibrated as described in the maintenance section and the same signal is then applied to both channels in the Y2 - Y1 mode. The gain of one channel is adjusted with the fine gain control until the residual signal is minimised. The common mode rejection obtained will vary slightly at other settings of the VOLTS/CM controls due to tolerance of the attenuator resistors. The OS2004Y high gain differential plug-in unit should be used if a high common mode rejection performance is necessary.

3.1(e) AC x 10 MODE

An AC coupled sensitivity of 1mV/cm may be obtained by connecting a screened lead, such as the PL81, between the Y2 x 10 output and the Y1 input socket. The incoming signal is connected to the Y2 input and the Y2 VOLT/CM control is set to 0.01V/cm. The Y1 display and trigger mode is selected. The overall sensitivity of the Y1 channel is then increased X10. In this mode, the input signals should not exceed 0.1V peak-peak; the Y1 channel controls should be used for shift and sensitivity adjustment.

3.1(f) BALANCE

If any movement of the trace is detected when the VOLTS/CM control is moved from 0.05 to 0.02 and 0.01, the preset balance control on the front panel should be adjusted to minimise this movement.

Before using the plug-in to determine the amplitude of a signal, ensure that the variable VOLT/CM control, concentric with the attenuator switch, is in the fully clockwise CAL position.

3.2 OS2001X

This unit can be used in the OS2000 series of main frames. This plug-in is intended to provide X-Y operation when used in conjunction with a OS2001Y or OS2002Y plug-in.

Phase shift correction has been adjusted to give optimum performance when used in an OS2100/OS2100R main frame and is typically 3° at 500kHz.

Chopped dual beam operation is provided when the OS2001X is used with a OS2002Y or OS2007Y.

The plug-in is inserted into the right hand aperture of the main frame and automatically held in place after being firmly pressed in. Withdrawal is by means of the lever at the bottom of the unit.

Always ensure that the supply is switched OFF before inserting or withdrawing plug-in units.

3.2(a) TRACE LOCATION

To find the trace, set the input coupling on X and Y units to ground. With the X and Y shift control in their mid positions, a spot should be visible on the cathode ray tube screen when the brilliance control on the main frame is set correctly.

3.2(b) INPUT SIGNAL CONNECTION

DC/AC/GROUND SWITCH. In the DC mode, the input signal is connected directly to the amplifier input. In the AC mode, a 400V DC working, $0.1\mu\text{F}$ capacitor is inserted between the input socket and the amplifier input, blocking the DC component of the input signal.

Select a suitable attenuator range and apply the input

signal to the input coaxial socket using a screened lead to minimise pick-up into the amplifier.

When the input coupling switch is in the ground position the input socket is open circuited, the input to the amplifier only being shorted to ground to facilitate the setting up of DC levels.

3.2(c) PROBE

The input resistance of the plug-in is $1\text{M}\Omega$ shunted by approximately 35pF . The effective capacity of the input lead must be added to this and the resultant impedance can often load the signal source. Therefore it may be beneficial to use the $10\text{M}\Omega \times 10$ probe, Pt. No. 25362. This reduces the input capacity and increases the input resistance at the expense of the sensitivity. The probe contains a shunt C.R. network in series with the input and which forms an attenuator with the input C.R. of the plug-in. It is necessary to adjust the capacitance of the probe to match the input capacity of the plug-in and obtain a flat frequency response. To do this, connect the probe to a 1kHz square wave generator of suitable amplitude to give approx. 5cm of horizontal deflection, adjusting the sensitivity switch as necessary.

Adjustment of the capacitance is achieved by un-screwing the small knurled portion of the locking ring near the BNC connector at the plug-in end of the probe lead. The larger portion is the adjustable capacitor and this should be turned until the horizontal line increases in length beyond the bright spots. Then carefully adjust back the capacitor until the line beyond the spot is just removed. The knurled locking ring should then be tightened against the capacitor ring.

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4.1 GENERAL OS2001Y, OS2002Y, OS2007Y and OS2001X.

The input amplifier consists of a frequency compensated ladder attenuator designed for optimum response; a high impedance amplifier (the input device being an FET) and, in the case of the Y units, trigger and vertical deflection output amplifiers.

In the OS2002Y and OS2007Y, there is also additional circuitry associated with the INVERT Y1 switch, the x10 gain on the Y2 channel and the beam switching facility.

4.2 SINGLE TRACE Y PLUG-IN AMPLIFIER OS2001Y.

The single beam plug-in Y amplifier consists of a constant gain amplifying section mounted on a single printed circuit board, preceded by a two-stage capacity compensated ladder attenuator. The input signal passes through a three-position slide switch, S1, which selects AC or DC input coupling by including or by-passing C2 in the signal path. In the third position of this switch, the input socket is disconnected and the amplifier input is connected to ground through R2.

The input attenuator employs two sections in cascade, the first giving attenuations of 1, 10 or 100 and the second giving attenuations of 1, 2 and 4. Thus by suitable connection of the two attenuating elements in series, sensitivities from 50mV/cm to 20V/cm are obtained. Table 1 shows the attenuators employed in the various ranges.

Range	1st.stage	2nd.stage	Trimming Capacitor
0.05V/cm			No adjustment
0.1V/cm		x2	C108
0.2V/cm		x4	C109
0.5V/cm	x10		C102
1V/cm	x10	x2	C107
2V/cm	x10	x4	C110
5V/cm	x100		C105
10V/cm	x100	x2	No adjustment
20V/cm	x100	x4	No adjustment

TABLE 1

The x2 attenuator consists of R8 and R103. Capacitor, C107, adjusts the input capacitance of the oscilloscope on the 100mV/cm range when this attenuator section is used alone; C108 corrects the frequency response of the attenuator.

The x4 attenuator consists of R9 and R104; C110 adjusts the input capacitance of the oscilloscope of the 200mV/cm range when this attenuator is used alone while C109 corrects the frequency response of the attenuator.

The x10 attenuator consists of R6 and R101; C101 adjusts the input capacitance on the 500mV/cm range when this attenuator is used alone, while C102 adjusts the frequency response of the attenuator.

The x100 attenuator consists of R7 and R102; C104 adjusts the input capacitance on the 5V/cm range when this attenuator is used alone, while C105 adjusts the frequency response of the attenuator. R1 to R5 are stopper resistors incorporated to eliminate the risk of parasitic oscillation. The attenuated signal is fed through R106 to the gate of the Field Effect Transistor, VT101. R105 determines the input resistance of the oscilloscope at 'x1' attenuation and contributes to the attenuating resistors on all other ranges.

The F.E.T., VT101, at the input gives a high input resistance which does not shunt the fixed resistance, R105. The signal excursion at the gate of VT101 is restricted by the limiting diodes, MR101 and MR102, which are returned to +12V and -12V. R106 operates as a gate current limiting resistor.

The source load of VT101 consists of zener diode, MR103, in series with R108. The zener provides 6.2V DC without any loss of signal, so that the potentiometer, RV101, has 6.2V DC across it but no signal volts. This potentiometer is adjusted to obtain the required DC conditions through the amplifier. The signal is tapped from the selected point on RV101 through variable resistor, RV102, to the base of the amplifying transistor, VT102.

The variable resistor, RV102, provides gain adjustment to set the calibration of the amplifier. A phase advance network consisting of C116 in series with R110, provides frequency compensation to give maximum amplifier bandwidth consistent with good pulse response. The output from the collector of VT102 is fed to an emitter follower, VT103, and the negative feedback is taken from the emitter of VT103 to the base of VT102. Thus, the gain of the stage is approximately determined by the ratio of the value of RV102 and R115. An output signal is taken from the emitter of VT103 through R127 to drive one side of the delay input amplifier in the main frame and through R22 to provide the internal trigger signal.

The potentiometer consisting of R118, RV1 and R119 connected between zero volts and -12V, provides the shift voltage. This is decoupled by C120 and C121 and fed through the emitter follower, VT104, to provide the low impedance drive to the second input of the delay input amplifier.

A balanced trigger output is obtained by taking one trigger connection via R122 from the Y signal and the other trigger connection from the output of an inverting amplifier having the Y O/P signal applied to its input (VT105).

The DC offset between these trigger connections is made zero by adjustment of RV103.

4.3 DUAL TRACE Y PLUG-IN AMPLIFIER OS2002Y

The dual trace plug-in 'Y' amplifier employs two printed circuit boards, the first carrying the 'Y1' and 'Y2' preamplifiers and the second carrying the beam-switching circuits. The signal attenuator switches are associated with the first printed circuit board, while the operating mode switch is associated with the second board.

With one exception, the circuits for the 'Y1' and 'Y2' preamplifiers are identical and the 'Y1' channel will be described in detail, after which the additional circuit in the 'Y2' preamplifier will be discussed. The input signal passes to a three-position slide switch, S1, which selects AC or DC input coupling by including or bypassing C1 in the signal path. In the third position of this switch the input socket is disconnected and the amplifier input is connected to ground through R3.

The input attenuator employs two sections in cascade, the first giving attenuations of 1, 10 or 100 and the second giving attenuations of 1, 2 and 4. Thus, by suitable connection of two attenuating elements in series, sensitivities from 50mV/cm to 20V/cm can be obtained. The two most sensitive ranges, 10mV/cm and 20mV/cm, are obtained by increasing the gain of the amplifier. Table 2 below shows the attenuators employed on the various ranges.

Range	1st.stage	2nd.stage	Trimming Capacitor
10mV/cm			No adjustment
20mV/cm			No adjustment
50mV/cm			No adjustment
100mV/cm		x2	C117
200mV/cm		x4	C121
500mV/cm	x10		C107
1V/cm	x10	x2	C119
2V/cm	x10	x4	C125
5V/cm	x100		C109
10V/cm	x100	x2	
20V/cm	x100	x4	

TABLE 2

The x2 attenuator consists of R117 and R119. Capacitor, C119, adjusts the input capacitance of the oscilloscope on the 100mV/cm range when this atten-

uator section is used alone, while C117 corrects the frequency response of the attenuator. The 'x4' attenuator consists of R121 and R123; C125 adjusts the input capacitance of the oscilloscope on the 20mV/cm range when this attenuator is used alone, while C121 corrects the frequency response of the attenuator.

The 'x10' attenuator consists of R113 and R115; C105 adjusts the input capacitance on the 500mV/cm range when this attenuator is in use, while C107 adjusts the frequency response of the attenuator.

The 'x100' attenuator consists of R109 and R111; C111 adjusts the input capacitance on the 5V/cm range when this attenuator is in use, while C109 adjusts the frequency response of the attenuator. R1, R5, R7, R9 and R11 are stopper resistors incorporated to eliminate the risk of parasitic oscillation.

The attenuated signal is fed through R133 to the gate of the F.E.T. VT101. R131 determines the input resistance of the oscilloscope at 'x1' attenuation and contributes to the attenuating resistors on all other ranges. The attenuator resistor values have been selected to maintain a constant input resistance on all ranges.

The F.E.T. at the input gives a high input impedance which does not shunt the fixed resistance, R131. The signal excursion at the gate of VT101 is restricted by the limiting diodes, MR101 and MR103, which are returned to positive and negative potentials of approx. +6V and -6V; determined by zener diodes, MR105 and MR106, respectively. R133 operates as an input current limiting resistor.

VT101, which operates as a source follower, drives the base of VT103, an emitter follower, giving a high current gain to drive the main amplifier and the trigger amplifier.

The 'Y1' signal amplifier consists of VT109 and VT107 connected as an emitter coupled differential amplifier producing a balanced output signal from a single ended input. On all but the two most sensitive ranges, the emitters are coupled through R181 and RV1, a front panel preset control which sets the amplifier calibration at 50mV/cm. On the 20mV/cm range, RV101 is connected in parallel with these components to increase the emitter coupling and RV103 performs a similar function on the 10mV/cm range. These two preset variable resistors are adjusted during test to give the required sensitivities.

To minimise the effect of tolerance of bias voltage on VT101, the quiescent current is maintained constant by VT105 in the emitter return path. The emitter follower, VT111, establishes the base potential of VT107 and VT113 and provides the base current for these transistors from a low impedance source. The potential is set up by adjusting the balance controls, RV105 and RV3, so that the base potential of VT107 is the same as the quiescent base potential of VT109. This will be indicated in operation by no vertical shift of the trace as the sensitivity

is changed from 10mV/cm to 50mV/cm. RV3 is available at the front panel of the instrument, permitting balance to be set during operation; RV105 is set up on test to determine the available range of RV3.

The trigger amplifier consists of VT115 and VT113 connected as an emitter coupled differential amplifier producing a balanced output signal from a single ended input. RV107 in the emitter of VT115 is adjusted to balance the current in the two halves of the amplifier. On the less sensitive ranges, the emitter coupling is through R159, but on the 20mV/cm and 10mV/cm ranges, R159 is shunted by R165 or R163 to give the increased gain in the trigger amplifier required by the low level input signals. The output signal currents from the collectors of the signal amplifier are coupled directly to the beam switching bridge on the second printed circuit board; the outputs from the collectors of the trigger amplifiers are coupled to the trigger source wafer of the mode switch.

On the 'Y2' channel only, the signal from one side of the trigger amplifier is coupled to the base of VT117 to provide the 'Y2 x 10' output. The gain of the amplifier is determined by a negative feedback through RV109, which is adjusted to give an overall gain, from connector PC to connector PD, of x10. To maintain the required DC conditions around the trigger amplifier, the collector load of VT114 is returned to the emitter of VT117 and this point is decoupled against signal voltages through zener diode, MR108, and C146.

Beam switching is achieved by the diode bridge consisting of MR201, 202, 203, 204, 205, 206, 207 and 208. The operation of the two halves of the bridge is similar and only the half referring to the 'Y1' channel will be described.

Input signal currents from the collectors of the signal amplifier flow into R201 and R205 then through Switch 5 to MR201 and MR203. R201 and RV7 connected between the two collectors provide a variable loading on the signal current which is used to vary the amplifier gain. The PULL TO INVERT 'Y1' switch (5) permits the signal current from each collector of the main amplifier to be fed to either side of the switching bridge to give signal inversion. A shift voltage obtained from RV5, connected between -12V and ground, is coupled through R213 to the junction of MR201 and MR205.

Similar reasoning can be applied to the input signals from the 'Y2' channel which are connected through R204 and R206. There is no inversion switch in the 'Y2' channel.

In the 'Y1 + Y2' mode, the junctions of MR201/203 and MR202/204 are both held at ground potential and the junction of R207/208 is held at -12V. This holds MR205, 206, 207 and 208 in conduction so that signals from the 'Y1' and 'Y2' channels are fed simultaneously to the bases of the differential amplifier.

When 'Y1' is selected, the junction of MR201/203 is held at ground and the junction of MR202/204 is held

at -12V. Thus, MR205 and MR207 will conduct signal to the bases of the differential amplifier while MR206 and MR208 will be reverse-biased, blocking the 'Y2' signal.

When 'Y2' is selected, the condition is reversed, the junction of MR201/203 being connected to the -12V and the junction of MR202/204 being at ground potential.

In the 'Y1' and 'Y2' mode, the junctions of MR201/203 and MR202/204 are alternatively switched to ground and -12V, by the signals from the bistable consisting of VT205 and VT206.

The emitter coupled differential amplifier, VT201/202, has R217 as the common emitter load. Negative feedback is provided around the two amplifiers through R209/C218 and R210/C219 respectively. The outputs from the collectors are fed to a pair of emitter followers VT203 and VT204, which provide outputs to the main frame.

When the dual trace mode is selected by the function switch the beam switches by chopping, at timebase sweep rates below 1mS/cm, and by displaying Y1 and Y2 on alternate sweeps, above 1mS/cm. At the slow rates a +12V line is switched, by the timebase range switch, through the plugs and sockets within the main frame and PA 20 on the Y plug-in, to the multivibrator consisting of VT207/VT208.

The multivibrator free-runs at a frequency of approximately 100kHz to provide the required beam switch signal which is taken from the collector of VT208, through C209 to trigger the switching bistable, and also provides an output blanking waveform on PA18 which is fed to the grid on the cathode ray tube.

The beam switch bistable consists of VT205/206. It has two input-trigger steering networks, one of which accepts a trigger from the beam switch multivibrator through C209, MR212 or MR211 and the other receives trigger pulses from the sweep generator through C208 and MR213 or MR214. The bistable changes state with each input trigger pulse to provide the required switching waveforms for the diode bridge. The mode selection switch, S6, has six positions providing selection of display and trigger source. S6A controls the beam switching multivibrator and the beam switching bistable.

S6B connects +12V to the junction of R207/208 in the 'Y1 + Y2' modes. S6C accepts the trigger signal from the 'Y1' and 'Y2' trigger amplifiers and selects the required trigger source for onward transmission to the plug-in X system.

4.4 DUAL TRACE Y PLUG-IN AMPLIFIER OS2007Y

This dual trace plug-in Y amplifier is similar in many respects to the OS2002Y. It however incorporates a modified attenuator arrangement and also some changes to the amplifier circuit. This results in improved bandwidth, attenuator response and drift performance.

The unit employs two printed circuit boards, the first carrying the Y1 and Y2 preamplifiers and the second carrying the beam switching circuits.

With one exception, the circuits for the 'Y1' and 'Y2' preamplifiers are identical and the 'Y1' channel will be described in detail, after which the additional circuit in the 'Y2' preamplifier will be discussed. The input signal passes to a three-position wafer switch, S1, which selects AC or DC input coupling by including or bypassing C1 in the signal path. In the third position of this switch the input socket is disconnected and the amplifier is connected to ground.

The input attenuator employs two sections giving attenuation of 1, 10 or 100. These are used singly or cascaded. The basic amplifier provides a maximum sensitivity of 10mV/cm gain, switching reduces this to provide the 20mV/cm and 50mV/cm. The x10 attenuator is then introduced to provide the 100, 200 and 500mV ranges; the x100 to provide the 1, 2, 5V ranges and the x100 and x10 cascaded to provide the 10, 20 50V/cm ranges.

The x10 attenuator consists of R18 and R19. Capacitor, C9, adjusts the input capacitance of the plug-in on the 100, 200 and 500mV ranges, while C11 corrects the frequency response of the attenuator.

The x100 attenuator consists of R5 and R11; capacitor, C3, adjusts the input capacitance of the plug-in on the 1, 2 and 5V ranges, while C5 corrects the frequency response of the attenuator.

Capacitor, C17, provides adjustment for the input capacity of the unit when the attenuators are not in circuit.

The attenuated signal is fed through R30 to the gate of TR101. R29 determines the input resistance of the oscilloscope when the attenuators are not in circuit and contributes to the attenuating resistors on all other ranges. The attenuator resistor values have been selected to maintain constant input resistance on all ranges.

The input stage consists of a matched pair of F.E.T.'s operating as source followers driving a pair of emitter followers giving a high current gain to drive the main amplifier and the trigger amplifier.

The signal input is fed to the base of TR101 and the balancing potentials to the base of TR102; since these transistors are matched, any drift due to temperature changes will be minimised.

The F.E.T. at the input gives a high input impedance which does not shunt the fixed resistor, R29. The signal excursion at the gate of TR101 is restricted by the limiting diodes, D101 and D102, which are returned to positive and negative potentials of approximately +6V and -6V, determined by the zener diodes, D103 and D104. R30 operates as an input current limiting resistor.

The Y1 signal amplifier consists of TR106 and TR107 connected as an emitter coupled differential amplifier producing a balanced output signal from a single ended input. The emitters are normally coupled through R120, R121 and R122; this provides the 50mV gain

condition. In the ~~20mV~~ ^{10mV} condition, this network is shunted by R126 and R125, with C110 and R132 providing a small degree of frequency compensation.

In the ~~10mV~~ ^{20mV} condition, the basic network is shunted by R123 and R124; C109 giving frequency compensation.

To minimise the effect of tolerance of bias voltage on TR101, the quiescent current is maintained constant by TR105 in the emitter return path.

Transistors, TR108 and TR109, are emitter followers which serve to reduce the loading of the trigger amplifier on the signal amplifier.

The trigger amplifier consists of TR110 and TR111 connected as an emitter coupled differential amplifier producing a balanced output signal from a single ended input. R139 in the emitter of TR111 is adjusted to balance the current in the two halves of the amplifier on the 50mV ranges. The emitter coupling is through R135, but on the 20mV and 10mV ranges, R135 is shunted by R136 or R137 to give the increased gain in the trigger amplifier required by the low level input signals. The output signal currents from the collectors of the signal amplifier are coupled directly to the beam switching bridge on the second printed circuit board; the outputs from the collectors of the trigger amplifiers are coupled to the trigger source wafer of the mode switch.

On the 'Y2' channel only, the signal from one side of the trigger amplifier is coupled to the base of VT123 to provide the 'Y2 x 10' output. The gain of the amplifier is determined by negative feedback through R193 which is adjusted to give an overall gain, from connector PC to connector PD, of x 10. To maintain the required DC conditions around the trigger amplifier, the collector load of VT122 is returned to the emitter of TR123 and this point is decoupled against signal voltages through zener diode, D110, and C117.

Beam switching is achieved by the diode bridge consisting of D201, 202, 203, 204, 205, 206, 207 and 208. The operation of the two halves of the bridge is similar and only the half referring to the 'Y1' channel will be described.

Input signal currents from the collector of the signal amplifier flow into R203 and R205 and then through Switch 5 to D201 and D203. R201 and R41 connected between the two collectors provide a variable loading on the signal current which is used to vary the amplifier gain. The PULL TO INVERT 'Y1' switch (5) permits the signal current from each collector of the main amplifier to be fed to either side of the switching bridge to give signal inversion. A shift voltage obtained from R43 connected between -12V and ground, is coupled through R213 to the junction of MR201 and MR205.

When the junction of D201 and D203 is connected to approximately -12V, the signal currents will flow to the -12V rail and will not be transmitted. When the junction of D201 and D203 is at ground potential, the signal

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currents will flow through D205 and D207 to the input of the balanced amplifier, TR201 and TR202.

Similar reasoning can be applied to the input signals from the 'Y2' channel which are connected through R204 and R206. There is no inversion switch in the 'Y2' channel.

In the 'Y1 + Y2' mode, the junctions of D201/203 and D202/204 are both held at ground potential and the junction of R207/208 is held at -12V. This holds D205, 206, 207 and 208 in conduction so that signals from the 'Y1' and 'Y2' channels are fed simultaneously to the bases of the differential amplifier.

When 'Y1' is selected, the junction of D201/203 is held at ground and the junction of D202/204 is held at -12V. Thus, D205 and D207 will conduct signal to the bases of the differential amplifier while MR206 and D208 will be reverse-biased, blocking the 'Y2' signal.

When 'Y2' is selected, the condition is reversed, the junction of D201/203 being connected to the -12V and the junction of D202/204 being at ground potential.

In the 'Y1' and 'Y2' mode, the junctions of D201/203 and D202/204 are alternatively switched to ground and -12V by the signals from the bistable consisting of TR205 and TR206.

The emitter coupled differential amplifier, TR201/202, has R217 as the common emitter load. Negative feedback is provided around the two amplifiers through R209/C218 and R210/C219 respectively. The outputs from the collectors are fed to a pair of emitter followers, TR213 and TR224, which provide outputs to the main frame.

When the dual trace mode is selected by the function switch the beam switches by chopping, at timebase sweep rates below 1mS/cm and by displaying Y1 and Y2 on alternate sweeps above 1mS/cm. At the slow rates a +12V line is switched by the timebase range switch, through the plugs and sockets within the main frame and PA20 on the Y plug-in plug, to the multivibrator consisting of TR207/208.

The multivibrator free-runs at a frequency of approximately 100kHz to provide the required beam switch signal which is taken from the collector of TR208, through C209 to trigger the switching bistable, and also provides an output blanking waveform on PA 18 which is fed to the grid of the cathode ray tube.

The beam switch bistable consists of TR205/206. It has two input-trigger steering networks, one of which accepts a trigger from the beam switch multivibrator through C209, D212 or D211 and the other receives trigger pulses from the sweep generator through C208 and D213 or D214. The bistable changes state with each input trigger pulse to provide the required switching waveforms for the diode bridge. The mode selection switch, S6, has six positions providing selection of display and trigger source. S6A controls the beam switching multivibrator and the beam switching bistable.

S6B connects +12V to the junction of R207/208 in the 'Y1 + Y2' modes, S6C accepts the trigger signal from the 'Y1' and 'Y2' trigger amplifiers and selects the required trigger source for onward transmission to the plug-in X system.

4.5 SINGLE TRACE X PLUG-IN AMPLIFIER OS2001X

The input signal passes through a three-position slide switch, S1, which selects AC or DC input coupling by including or by-passing C2 in the signal path. In the third position of this switch, the input socket is disconnected and the amplifier input is connected to ground through R2.

The input attenuator employs two sections in cascade, the first giving attenuations of 1, 10 or 100 and the second giving attenuations of 1, 2, and 4. Thus by suitable connection of the two attenuating elements in series, sensitivities from 50mV/cm to 20V/cm are obtained. Table 3 shows the attenuators employed on the various ranges.

Range	1st. stage	2nd. stage	Trimming Capacitor
0.05V/cm	x1	x1	No adjustment
0.1V/cm	x1	x2	C108
0.2V/cm	x1	x4	C109
0.5V/cm	x10		C102
1V/cm	x10	x2	C107
2V/cm	x10	x4	C110
5V/cm	x100		C105
10V/cm	x100	x2	No adjustment
20V/cm	x100	x4	No adjustment

TABLE 3

The x2 attenuator consists of R8 and R103. Capacitor, C107, adjusts the input capacitance of the oscilloscope on the 100mV/cm range when this attenuator section is used alone; C108 corrects the frequency response of the attenuator.

The x4 attenuator consists of R9 and R104; C110 adjusts the input capacitance of the oscilloscope on the 200mV/cm range when this attenuator is used alone, while C109 corrects the frequency response of the attenuator.

The x10 attenuator consists of R6 and R101; C101 adjusts the input capacitance on the 500mV/cm range

when this attenuator is used alone, while C102 adjusts the frequency response of the attenuator.

The x100 attenuator consists of R7 and R102; C104 adjusts the input capacitance on the 5V/cm range when this attenuator is used alone, while C105 adjusts the frequency response of the attenuator. R1 to R5 are stopper resistors incorporated to eliminate the risk of parasitic oscillation. The attenuated signal is fed through R106 to the gate of VT101. R105 determines the input resistance of the oscilloscope at 'x1' attenuation and contributes to the attenuating resistors on all other ranges. The attenuator resistor values have been selected to maintain a constant input resistance on all ranges.

The F.E.T., VT101, at the input gives a high input resistance which does not shunt the fixed resistance, R105. The signal excursion at the gate of VT101 is restricted by the limiting diodes, MR101 and MR102, which are returned to +12V and -12V. R106 operates as a gate current limiting resistor.

The source load of VT101 consists of zener diode, MR103, in series with R108. The zener provides 6.2V DC without any loss of signal so that the potentiometer, RV101, has 6.2V across it but no signal volts. This potentiometer is adjusted to obtain the required DC

conditions through the amplifier. The signal is tapped from the selected point on RV101 through variable resistor, RV102, to the base of the amplifying transistor, VT102.

The variable resistor, RV102, provides gain adjustment to set the calibration of the amplifier. The output from the collector of VT102 is fed to an emitter follower, VT103, and the negative feedback is taken from the emitter of VT103 to the base of VT102. Thus, the gain of the stage is approximately determined by the ratio of the values of RV102 and R115.

The output from VT103 emitter is amplified by the feedback stage, VT105, the gain of which is determined by the ratio of R120 and R130. The output from the connector of VT105 is taken via R121 and R134 to the X amplifier in the main frame. R121 and C123 introduce a phase lag which compensates for the delay line in the Y amplifier.

The potential divider consisting of RV1 and R133 connected between zero volts and +12V provides the shift voltage. This is decoupled by C120 and C121 and fed through the emitter follower, VT104, to provide the low impedance drive to the main frame amplifier. RV103 is adjusted to centre the range of the shift control.

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5.1 POWER SUPPLIES AND OUTPUT SIGNAL LEVELS

LINE	Pin No.		Currents Drawn			
	X	Y	OS2001Y	OS2002Y	OS2007Y	OS2001X
+ 12V	16	9	10 mA	75 mA	95mA	30 mA
- 12V	4	21	18 mA	130 mA	150mA	30 mA
- 18V	22	3	NIL	NIL	NIL	NIL
+ 150	17	8	NIL	NIL	NIL	NIL
18V AC	18	7	NIL	NIL	NIL	NIL

TABLE 4

The currents drawn from the main frame for the various plug-in units are shown in table 4.

The resultant deflecting signal from the 'Y' channel plug-in is a differential signal between pins 11 and 23 on the plug-in connector. The mean DC level should be $-3.5V$ and the output about this level is $70mV/cm$. The maximum excursion on either pin should limit between -5.5 volts and -1.5 volts.

The deflecting signal from the X plug-in is a differential voltage between pins 2 and 14 on the plug-in connector. The mean DC level should be $+2V$ and the normal output about this level is $400mV/cm$.

5.2 GENERAL

When the instrument leaves the factory, all the preset controls are correctly adjusted and no further adjustment is normally required unless servicing work is carried out. The procedures which follow give the information required for resetting the preset control, but it presupposes that those parts of the instrument not being reset are in correct functional order.

If, during fault finding, a component needs replacing, it should be cut from the printed circuit board as near to the component as possible, leaving the wires connected to the copper track and protruding through to the component side of the board. The new component should then be soldered into position by attaching it to these protruding wires. This protects the copper track from damage.

5.3 EQUIPMENT REQUIRED

- A square wave generator and a sine wave generator.
- A multimeter.
- A $\times 10$ high impedance probe.

5.4 SINGLE TRACE Y AMPLIFIER OS2001Y

- Connect the plug-in unit to a calibrated main frame fitted with a timebase unit. Set the timebase to FREE RUN at $1mS/cm$ and switch on the oscilloscope.

- Set the 'Y' input coupling switch to GROUND and centre the shift control. Set RV102 to maximum resistance and adjust RV101 to bring the trace onto the screen. Rotate RV102 and observe the vertical movement of the trace. Readjust RV101 until the vertical trace movement is less than $1cm$ when RV102 is turned over its full range. Adjust the 'Y' shift control as necessary during this test, to keep the trace on the screen.
- Set the input coupling switch to AC and the attenuator to $50mV/cm$. Connect a $200mV$ peak-to-peak $1kHz$ squarewave to the input socket and adjust RV102 so that the vertical trace deflection is $4cm$ peak-to-peak.
- Remove the input signal and move the input coupling switch from AC to GROUND and back to AC. Observe the vertical trace movement, which should be less than $2mm$. Movement in excess of this indicates that the input leakage current is too high and VT101, MR101 or MR102 should be replaced.
- Connect a multimeter (set to $2.5V$ D.C.) between the emitter of VT103 and the collector of VT105. Adjust RV103 until the meter reads zero volts.
- Set the timebase unit to INT TRIG. and connect a $1kHz$ squarewave to the 'Y' amplifier input socket. Set the timebase level control to AUTO and reduce the input signal level unit until the vertical deflection is $1mm$. Verify that the timebase triggers until the deflection amplitude falls to $1.5mm$.
- Connect a $1MHz$ squarewave signal to the input of the 'Y' amplifier. The squarewave should have a $3nS$ rise time and amplitude of $200mV$ peak-to-peak and be fed from and be terminated by 50Ω or 75Ω . Set the timebase to $0.2\mu S/cm$ with $\times 5$ 'X' gain and select INT TRIG. Adjust C116 to obtain a square corner on the waveform, with no overshoot.

- (8) Set the frequency of the incoming squarewave to 1kHz and increase its amplitude to 0.5V. Set the attenuator switch to 100mV/cm and adjust C108 to give a square corner. Continue this procedure by selecting the attenuator ranges tabulated in Table 1 on page 8 increasing the signal amplitude as required and adjusting the corresponding capacitors.
 - (9) Set the attenuator to 50mV/cm. Connect a x10 high impedance probe to the input socket and connect the probe to a 1kHz square wave. Adjust the probe capacitance to give a square corner. Select the 0.5V/cm range and adjust C101 for a square corner; select the 5V/cm range and adjust C104 for a square corner. Increase signal amplitude when required.
- 5.5 DUAL TRACE 'Y' AMPLIFIER OS2002Y**
- (1) The setting-up procedure for the 'Y1' and 'Y2' channels is identical; the sequence for the 'Y1' channel only will be given. To calibrate the 'Y2' channel, repeat the adjustments using the corresponding preset controls and the 'Y2' front panel controls. The 'Y2' component references are shown in brackets.
 - (2) Connect the plug-in unit to an operational main frame fitted with a timebase unit. Set the timebase to FREE RUN at 1mS/cm and select the 'Y1' channel only.
 - (3) Switch on the oscilloscope and measure the potential at the bases of VT109 (VT110) and VT107 (VT108) using a multimeter on the 10V DC range. Set the front panel BALANCE control, RV3 (RV4) to its central position and adjust RV105 (RV106) until the base potentials are approximately equal. The trace should now appear on the screen; move the 'Y1' attenuator control from 50mV/cm and adjust RV3 (RV4) for no trace movement.
 - (4) Move the 'Y1' input coupling switch from GROUND to AC with the attenuator at 10mV/cm and verify that the trace movement is less than 0.5cm. A greater trace movement indicates excessive input leakage current and VT101 (VT102) MR101 (MR102) MR103 (MR104) should be replaced.
 - (5) Connect the multimeter on the 25V DC range between point 67 (68), the junction of R129 R167 (R130 R170) and the point 69 (70), the collector of VT113 (VT114) on the printed circuit board. Set the 'Y1' attenuator to the 10mV/cm position and balance to the 'Y' trigger amplifier by adjusting RV107 (RV108) to obtain a zero reading.
 - (6) Connect a 1kHz squarewave having an amplitude of 250mV peak-to-peak to the 'Y1' input socket; set the 'Y1' attenuator to 50mV/cm with the fine gain control fully clockwise in the CAL position. Adjust RV1 (RV2), the GAIN 50mV/cm control, to give a deflection of 5cm on the screen.
 - (7) Reduce the signal amplitude to 100mV peak-to-peak and switch the attenuator to 20mV/cm. Adjust RV101 (RV102) to give a 5cm deflection.
 - (8) Reduce the signal amplitude to 50mV peak-to-peak and switch the attenuator to 10mV/cm. Adjust RV103 (RV104) to give 5cm deflection.
 - (9) Switch the 'Y1' attenuator to 100mV/cm; increase the amplitude of the incoming signal to 500mV and the frequency to 10kHz. Adjust C117 (C118) to obtain the best possible square wave response.
 - (10) Switch the 'Y1' attenuator to 200mV/cm and adjust C121 (C122) for the best square wave response.
 - (11) Switch to 500mV/cm; increase the signal amplitude, if necessary, and adjust C107 (C108) for optimum square wave.
 - (12) Select the 5V/cm range on the 'Y1' attenuator, increase the signal amplitude as required, and adjust C109 (C110) for best square wave response.
 - (13) Connect a 40pf Max. variable capacitor in parallel with a 1M Ω resistor, in series with the incoming signal. Reduce the signal amplitude and set the 'Y1' attenuator to the 50mV/cm range. Adjust this capacitor for optimum square wave response.
 - (14) Select the 100mV/cm, 200mV/cm, 500mV/cm and 5V/cm ranges in turn, increasing the input signal amplitude as required and adjust C119 (C120), C125 (C126), C105 (C106) and C111 (C112) for best square wave response. This gives a constant input capacitance on all ranges.
 - (15) Repeat the whole test sequence (2) to (14) on the 'Y2' channel referring to the component references in brackets.
 - (16) Select 'Y1' only and connect a screened cable from the x10 Y2 output to the Y1 input. Turn the 'Y1' and 'Y2' attenuators to 10mV/cm and connect a 1kHz square wave of 5mV peak-to-peak amplitude to the 'Y2' input. Adjust RV109 for a 5cm picture.
 - (17) Turn each variable gain control from fully clockwise to fully counter-clockwise and verify that the traces move less than 1.5cm. If the movement is greater than this, check the match of the diodes MR205, 206, 207 and 208 for forward conductivity. This may be carried out using a multimeter on its lowest resistance range. The actual resistance measured will depend on the current drawn by the meter, but will be typically 25 ohms. Diodes should be matched to within ± 5 ohms.
 - (18) Select AC coupling and feed a signal into both channels to give a 6cm deflection. Operate the 'Y1' and 'Y2' SHIFT controls and verify that the traces may be moved off the screen both upwards and downwards.
 - (19) Set the trigger selector of the timebase to INT +, the TIME/CM switch to 1mS/cm and the LEVEL control to AUTO. Switch the input coupling of the 'Y1' channel to GROUND, select 'Y1'

only and switch in turn, the 'Y1' attenuator to 50, 20 and 10mV/cm. Set the input coupling switches to AC and reselect in turn, the three above-mentioned ranges. Verify that the timebase free runs at the AUTO speed less than 30 sweeps per second. Failure to do so indicates that the chop oscillator signal is breaking through into the trigger circuit.

- (20) Connect signals to the 'Y1' input of 10mV, 4mV and 2mV, to give a deflection of 2mm on the 50, 20 and 10mV/cm ranges respectively. Verify that the timebase triggers from the signals.
- (21) Repeat (20) for the 'Y2' channel.
- (22) Set the timebase to FREE RUN and select Y1 + Y2, triggered from 'Y1'. Check that the trace may be shifted by both shift controls and verify that operation of the INVERT 'Y1' switch does not cause more than 0.5cm of shift.

5.6 DUAL TRACE Y AMPLIFIER OS2007Y

- (1) The setting up procedures for the Y1 and Y2 channels are identical; the sequence for the Y1 channel only will be given. To calibrate the Y2 channel, repeat the adjustments using the corresponding preset controls and the Y2 front panel controls. The Y2 component references are shown in brackets.
- (2) Connect the plug-in unit to a calibrated main frame fitted with a timebase unit. Set the timebase to FREE RUN at 1mS/cm and select the Y1 channel only.
- (3) Switch on the oscilloscope, set attenuator switch to 50mV/cm, fine gain control fully clockwise, shift control to mid position and front panel balance control R33 (R34) to mid position. By means of the COARSE BALANCE control, ~~R114 (R164)~~ R114(R164), bring the trace to the centre of the screen. Adjust ~~R114 (R164)~~ R114(R164) to give no trace movement when the attenuator switch is moved from 50mV/cm to 10mV/cm. The final adjustment can be made using the front panel balance control.
- (4) Move the Y1 input coupling switch from GROUND to AC with the attenuator at 10mV/cm and verify that the trace movement is less than 0.5cm. A greater trace movement indicates excessive input leakage current, and the matched F.E.T.'s or their associated protection diodes, D101, D102 (D106, D107) should be changed.
- (5) Set the multimeter to the 2.5V DC range and connect between point 67 (68) and 69 (70) on the printed circuit board. Set the Y1 attenuator to 10mV/cm and balance the trigger amplifier by adjusting R139 (R189) to obtain zero reading.
- (6) Connect a 1kHz squarewave having an amplitude of 250mV p-p to the Y1 input socket; set the Y1 attenuator to 50mV/cm with the fine gain control fully clockwise in the CAL position. Adjust R121 (R171) to give a deflection of 5cms on the screen.
- (7) Reduce the signal amplitude to 100mV p-p and switch the attenuator to 20mV/cm. Adjust ~~R123 (R173)~~ R123(R173) to give 5cm deflection.
- (8) Reduce the signal amplitude to 50mV p-p and switch the attenuator to 10mV/cm. Adjust ~~R125 (R175)~~ R125(R175) to give 5cm deflection.
- (9) Connect a 1MHz square wave of approx. 200mV p-p to the Y1 input socket, set the attenuator to 50mV/cm and the fine gain control to CAL. Verify that under these conditions the main frame/plug-in combination gives a good pulse response. If the main frame has been set up previously using an OS2002Y plug-in, it may be necessary to slightly re-trim the main frame in order to obtain optimum performance from the OS2007Y (see main frame handbook for procedure).
- (10) Reduce the output from the 1MHz generator to approximately 80mV p-p and set the attenuator to 20mV/cm. Adjust ~~C110 (C122)~~ C109 (C123) for best pulse shape.
- (11) Reduce the output from the 1MHz generator to approximately 40mV p-p and set the attenuator to 10mV/cm. Adjust ~~C110 (C122)~~ C110 (C122) for best pulse shape.
- (12) Make up a network consisting of a 27pF capacitor in parallel with a $1M\Omega \pm 1\%$ resistor taking care to keep stray capacitance to a minimum. Set Y1 attenuator to 50mV/cm and inject a 1kHz square wave into Y1 input via the above network. Adjust the level to give approx. 4cm deflection. Adjust C17 (C18) for best square wave response. Verify square wave response on 20mV/cm and 10mV/cm ranges reducing input accordingly. (For more accurate setting of the input capacitance to 27pF a 'Q' meter or Capacitance Meter may be used.)
- (13) Set Y1 attenuator to 500mV/cm, inject 1kHz square wave to give approximately 4cms deflection. Adjust C11 (C12) for best square wave response. Verify square wave response on 200mV/cm and 100mV/cm range.
- (14) Set Y1 attenuator to 5V/cm, inject 1kHz square wave to give approximately 4cms deflection. Adjust C5 (C6) for best square wave response. Verify square wave response on 2V/cm and 1V/cm ranges and also on 10, 20 and 50V/cm ranges.
- (15) Set Y1 attenuator to 500mV/cm, inject 1kHz square wave into Y1 input socket via 27pF/1M Ω network to give approximately 4cm deflection. Adjust C9 (C10) for best square wave response. Verify square wave response on 200mV/cm and 100mV/cm ranges.
- (16) Set Y1 attenuator to 5V/cm, inject 1kHz square wave into Y1 input socket via 27pF/1M Ω network to give approximately 4cm deflection. Adjust C3 (C4) for best square wave response. Verify square wave response on 2V/cm and 1V/cm ranges and also on 10, 20 and 50V/cm ranges.

- (17) Repeat the whole test sequence (3) to (16) on Y2 channel referring to the component references in brackets.
- (18) Select Y1 only, and connect a screened cable from the x10 Y2 output to the Y1 input. Turn Y1 and Y2 attenuator to 10mV/cm and connect a 1kHz square wave of 5mV p-p amplitude to the Y2 input. Adjust R193 for a 5cm deflection.
- (19) Turn each variable gain control from fully clockwise to fully counter-clockwise and verify that the traces move less than 1.5cm. If the movement is greater than this, check the matching of the diodes MR205, 206, 207 and 208 for forward conductivity.
This may be carried out using a multimeter on its lowest resistance range. The actual resistance measured will depend on the current drawn by the meter, but will be typically 25 ohms. Diodes should be matched to within ± 5 ohms.
- (20) Select AC coupling and feed a signal into both channels to give a 6cm deflection. Operate the 'Y1' and 'Y2' SHIFT controls and verify that the traces may be moved off the screen both upwards and downwards;
- (21) Set the trigger selector of the timebase to INT +, the TIME/CM switch to 1mS/cm and the LEVEL control to AUTO. Switch the input coupling of the 'Y1' channel to GROUND, select 'Y1' only and switch the 'Y1' attenuator in turn to 50, 20 and 10mV/cm. Set the input coupling switches to AC and reselect in turn the three above-mentioned ranges. Verify that the timebase free-runs at the AUTO speed of less than 30 sweeps per second. Failure to do so indicates that the chop oscillator signal is breaking through into the trigger circuit.
- (22) Connect signals to the 'Y1' input of 10mV, 4mV and 2mV, to give a deflection of 2mm on the 50, 20 and 10mV/cm ranges respectively. Verify that the timebase triggers from the signals.
- (23) Repeat (21) for the 'Y2' channel.
- (24) Set the timebase to FREE RUN and select Y1 + Y2, triggered from 'Y1'. Check that the trace may be shifted by both shift controls and verify that operation of the INVERT 'Y1' switch does not cause more than 0.5cm of shift.
- 5.7 SINGLE TRACE X AMPLIFIER UNIT OS2001X**
- (1) Connect the plug-in unit via extension lead to a calibrated main frame fitted with a 'Y' unit and switch on the oscilloscope.
- (2) Set the 'Y' and 'X' input coupling switches to GROUND and centralise the shift controls. Set RV102 fully clockwise and adjust RV101 to bring the spot onto the screen. Rotate RV102 and observe the horizontal movement of the spot. Readjust RV101 until the spot movement is less than 1cm when RV102 is turned over its full range. Adjust RV103 as necessary during this test, to keep the spot on the screen, then set RV103 so that spot is centered when X shift control is at mid travel.
- (3) Set the input coupling switch to AC and the attenuator to 50mV/cm. Connect a 200mV peak-to-peak 1kHz squarewave to the input socket and adjust RV102 so that the horizontal spot spacing is 4cm.
- (4) Remove the input signal and move the input coupling switch from AC to GROUND and back to AC. Observe the horizontal trace movement which should be less than 2mm. Movement in excess of this, indicates that the input leakage current is too high and VT101, MR101 or MR102 should be replaced.
- (5) The following procedure for attenuator compensation is a simple yet accurate method involving the minimum of test equipment. As no vertical deflection is used, the square wave is observed as 2 round spots spaced horizontally. It is advisable to adjust focus and astigmatism to obtain sharp round spots and always maintain these spots within the centre 6cm of the graticule to avoid defocussing effects at the edge of the screen.
It should be noticed that incorrect adjustment of the capacitors results in a horizontal line appearing to the left or right of the spots. Either spot may be observed but it may be found that one gives a clearer indication than the other.
- (6) Connect a 500mV peak-to-peak 1kHz squarewave to the input socket. Set the attenuator switch to 100mV/cm and adjust C108 to give well defined spots. Continue this procedure by selecting the attenuator ranges tabulated in Table 1, increasing the signal amplitude as required and adjusting the corresponding capacitors.
- (7) Set the attenuator to 50mV/cm. Connect a x10 high impedance probe to the input socket and connect the probe to a 1kHz square wave. Adjust the probe capacitance to give well defined spots. Select the 0.5V/cm range and adjust C101, select the 5V/cm range and adjust C104, increasing signal amplitude when required.

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Component List and Illustrations

Section

NOTES
 1. VT3 & VT4 ARE SHOWN ON POWER SUPPLY
 CIRCUIT DRG. 95K 2000.

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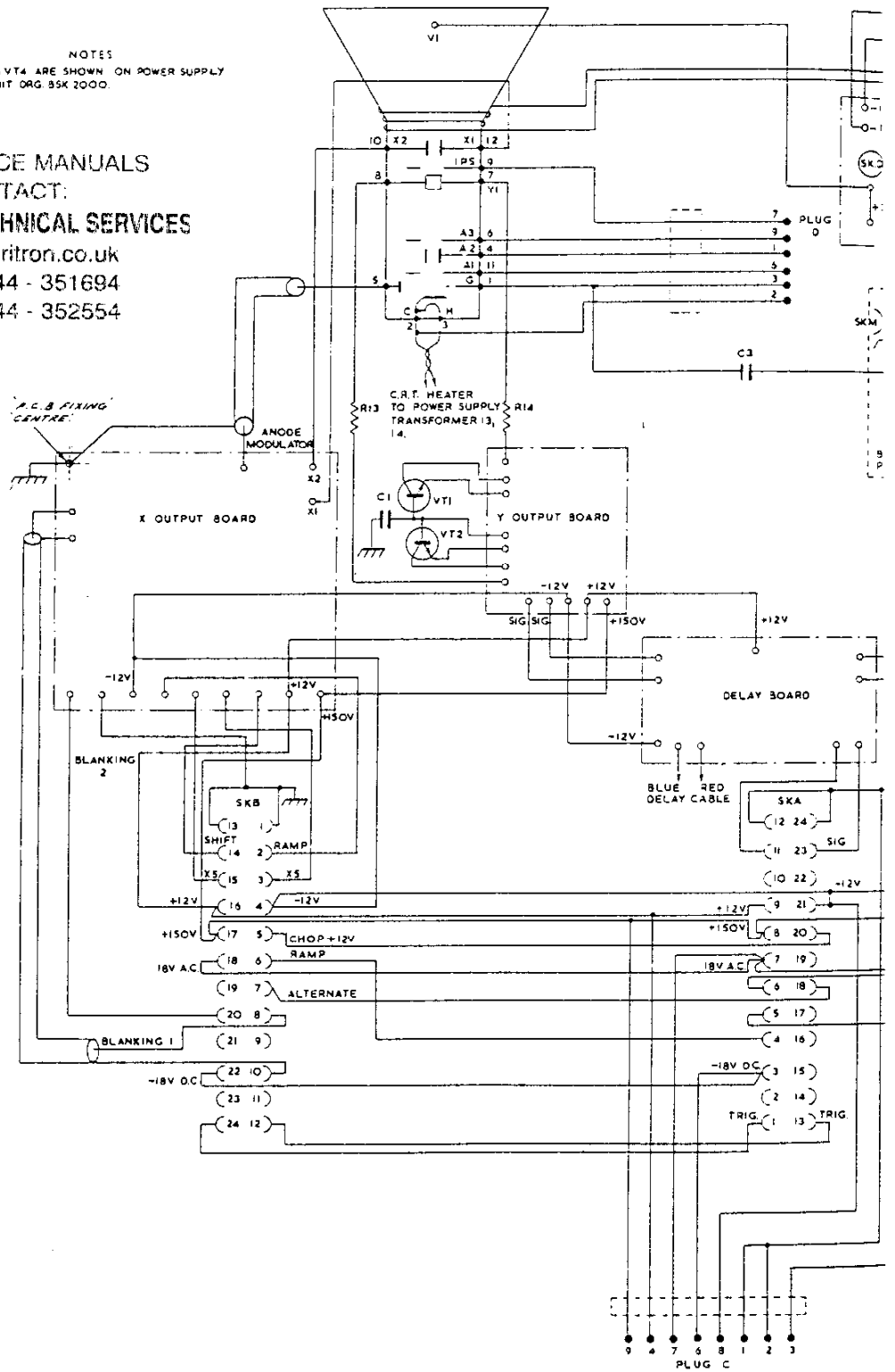
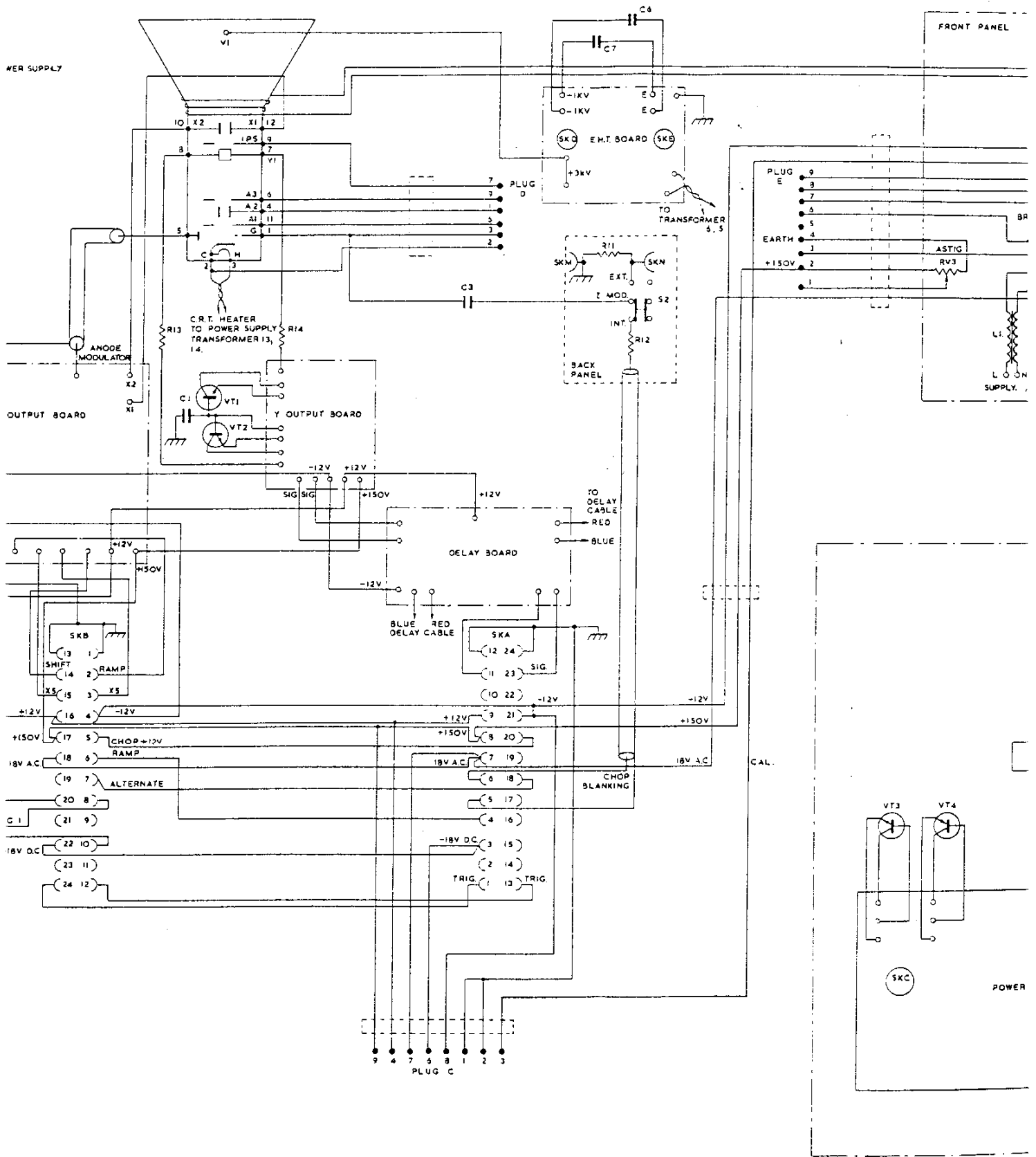
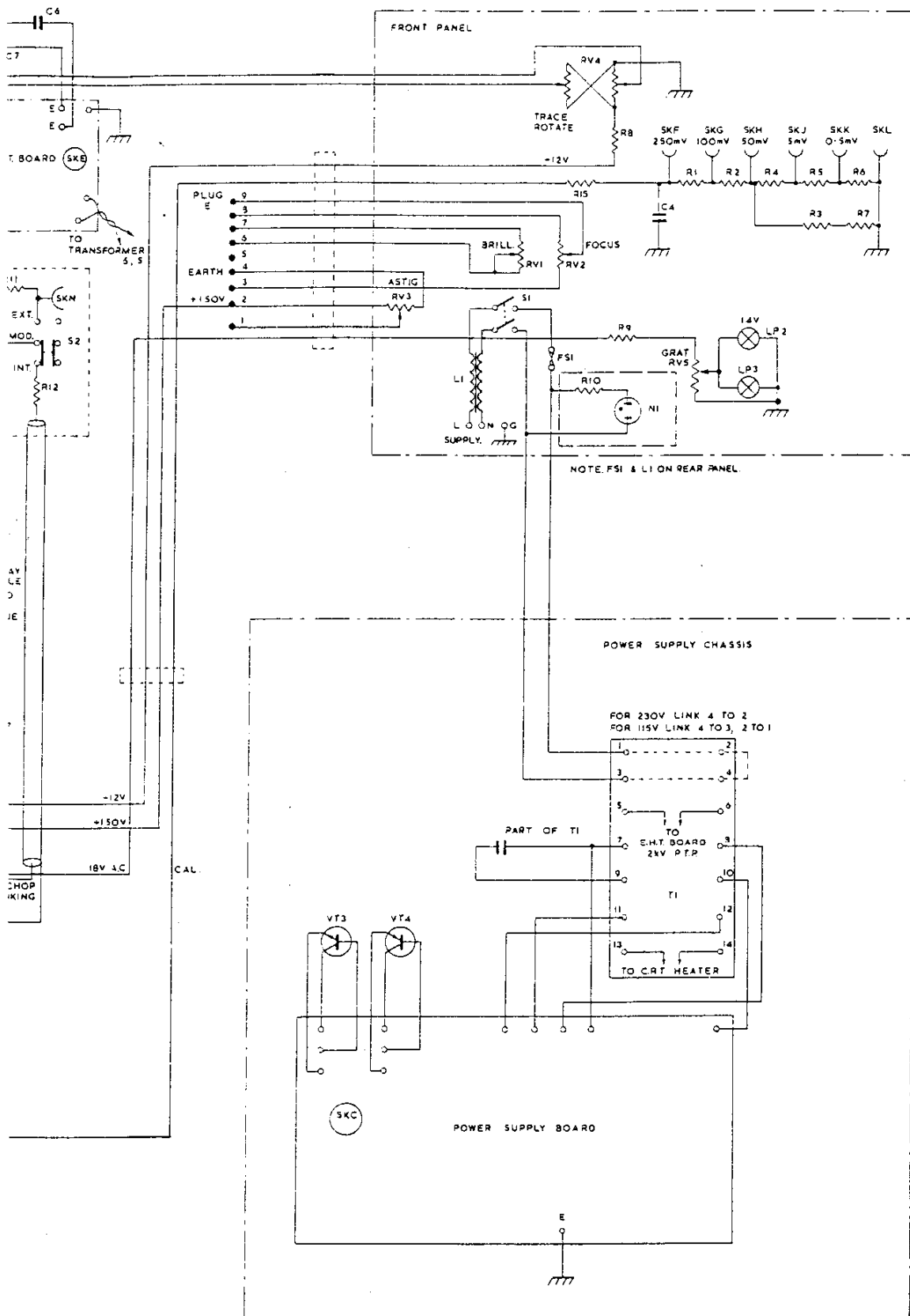


Fig. 1 (a) MAIN FRAME CIRCUIT DIAGRAM OS2000





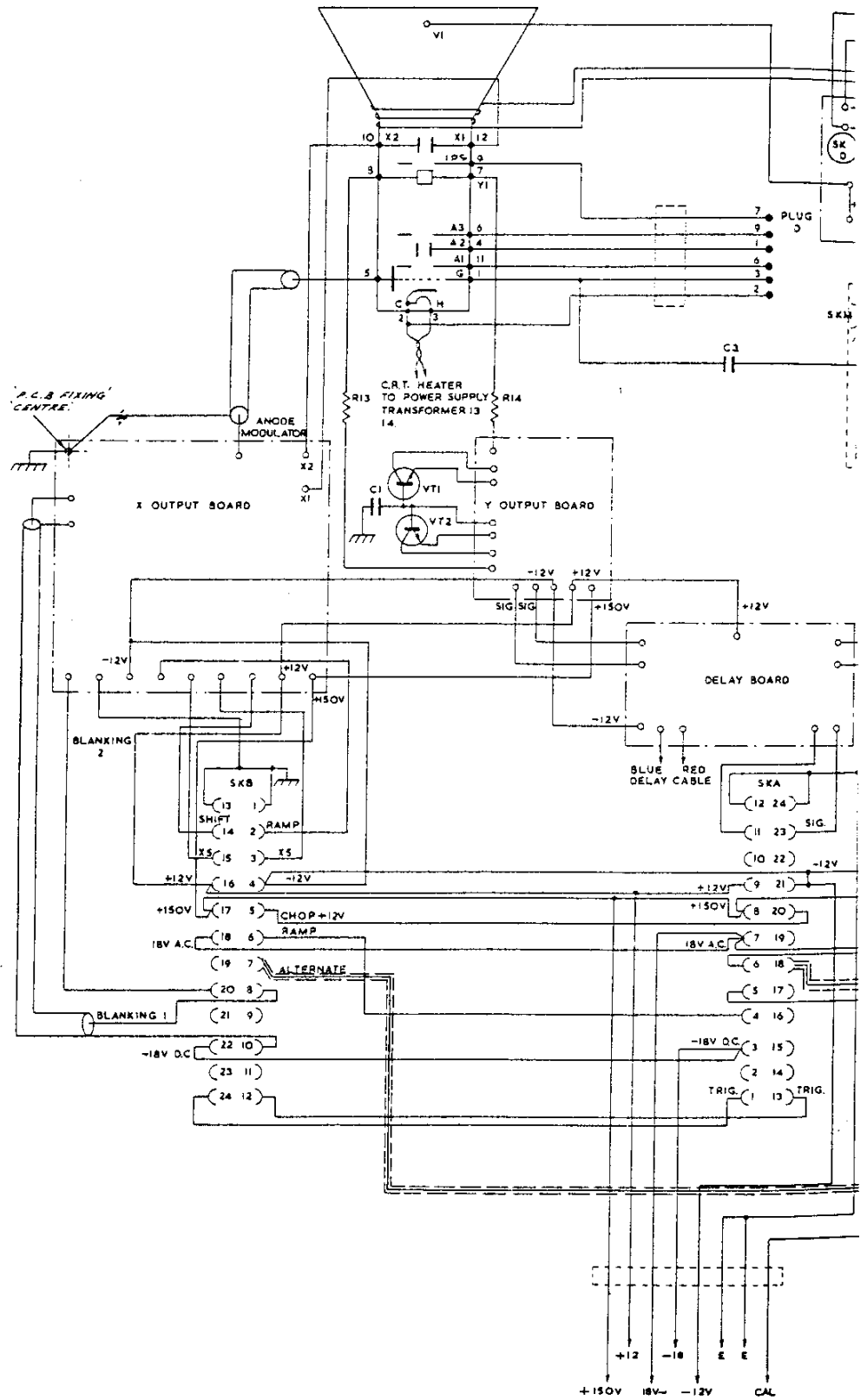
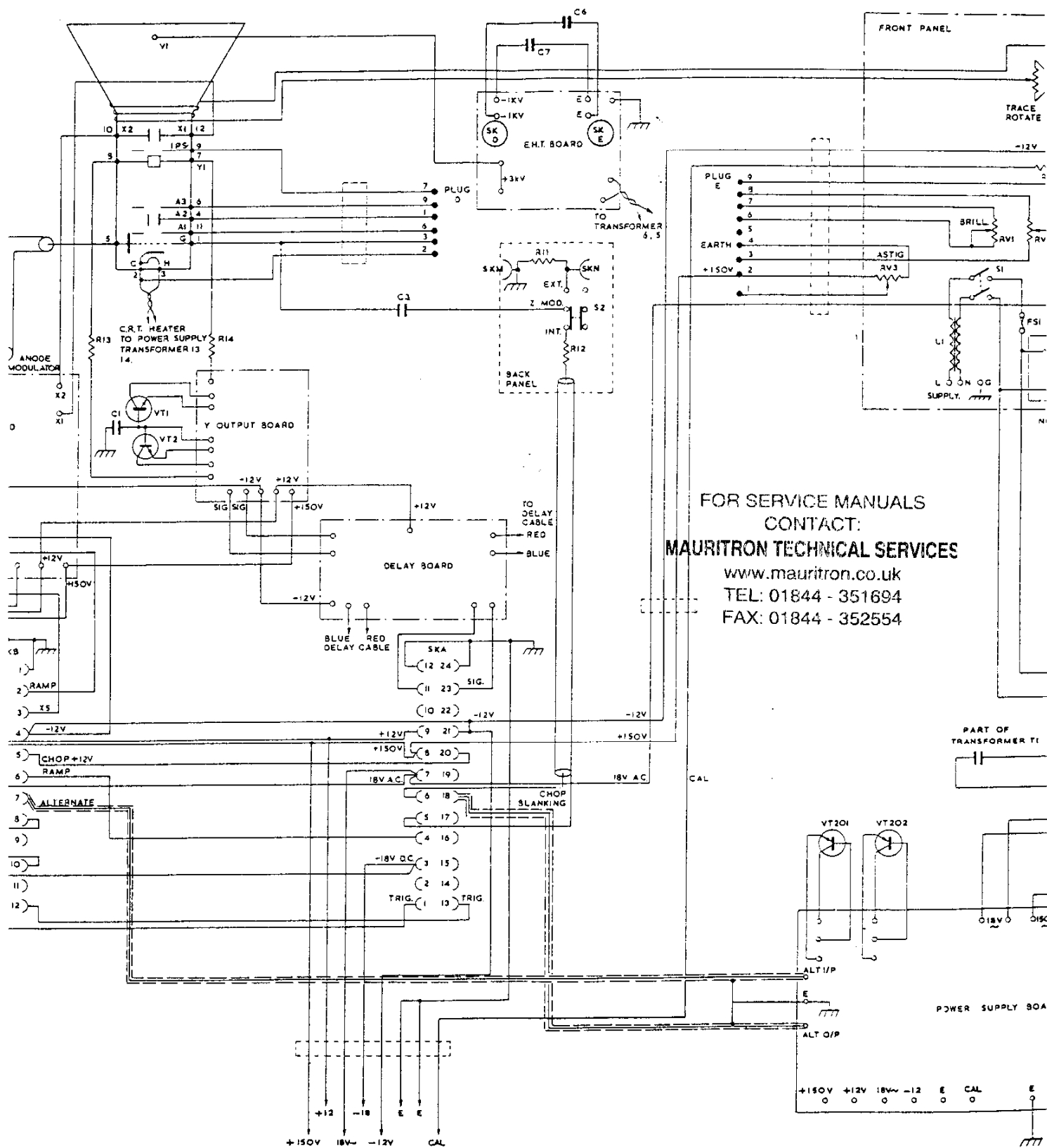
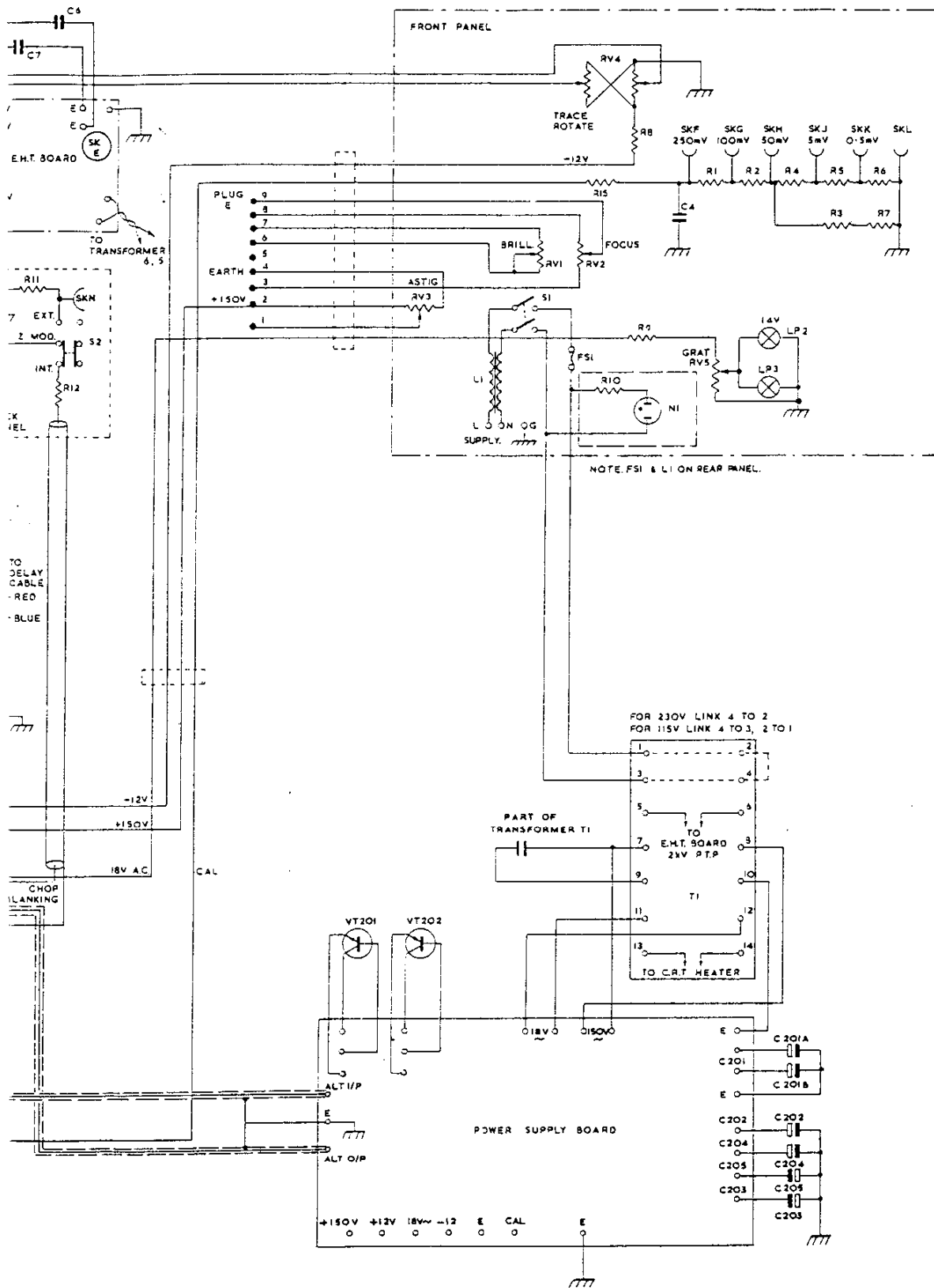


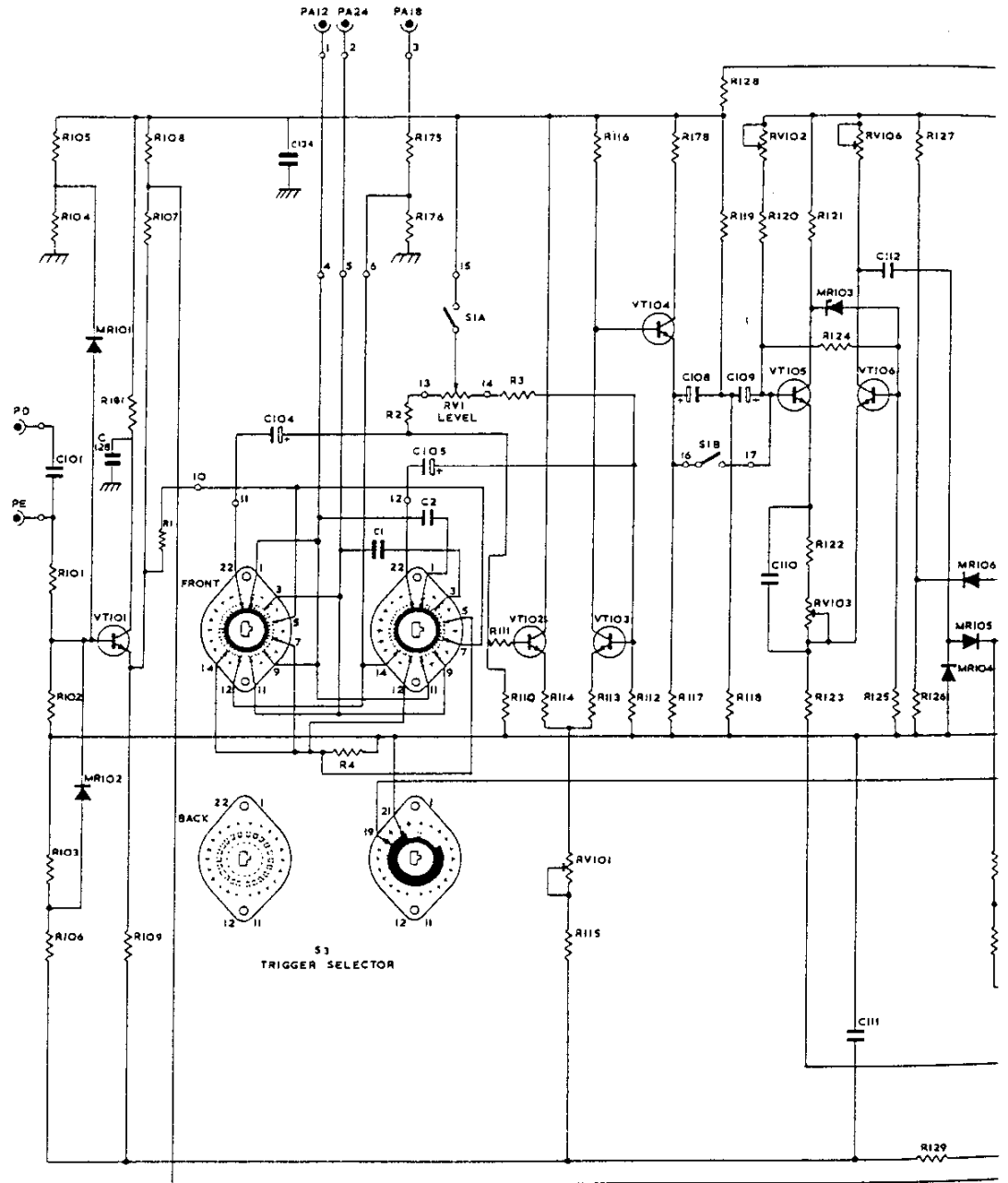
Fig. 1 (b) MAIN FRAME CIRCUIT DIAGRAM OS2000R





Component List and Illustrations

Sectic



NOTE.
 1 SWITCH TAGS OF THE SAME No.
 ON THE FRONT AND REAR OF A
 WAFER ARE CONNECTED BY THE RIVET
 2 S4 SHOWN IN EXT. X POSITION.
 1 S3 SHOWN IN T.V. + POSITION.

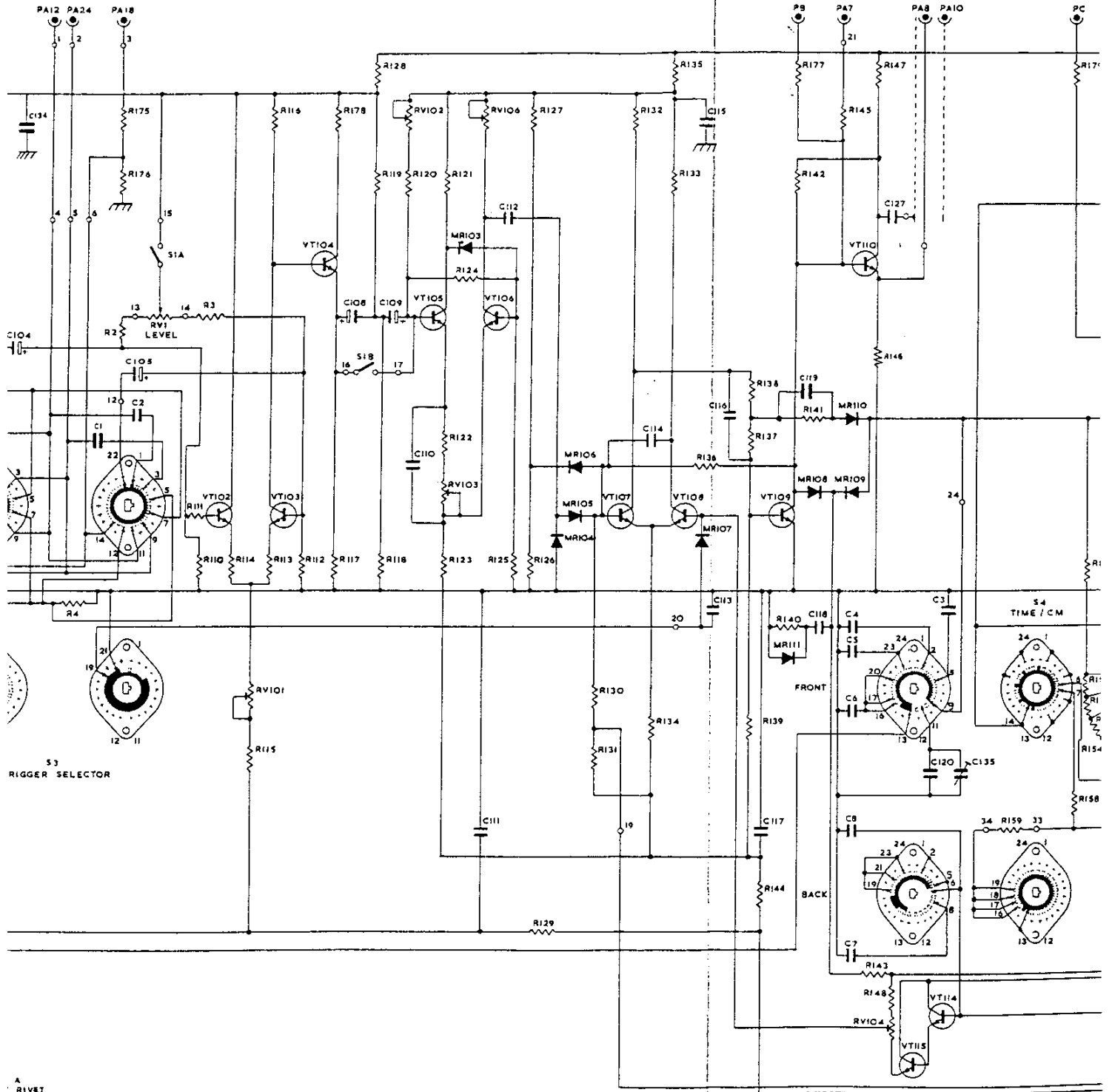
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A RIVET

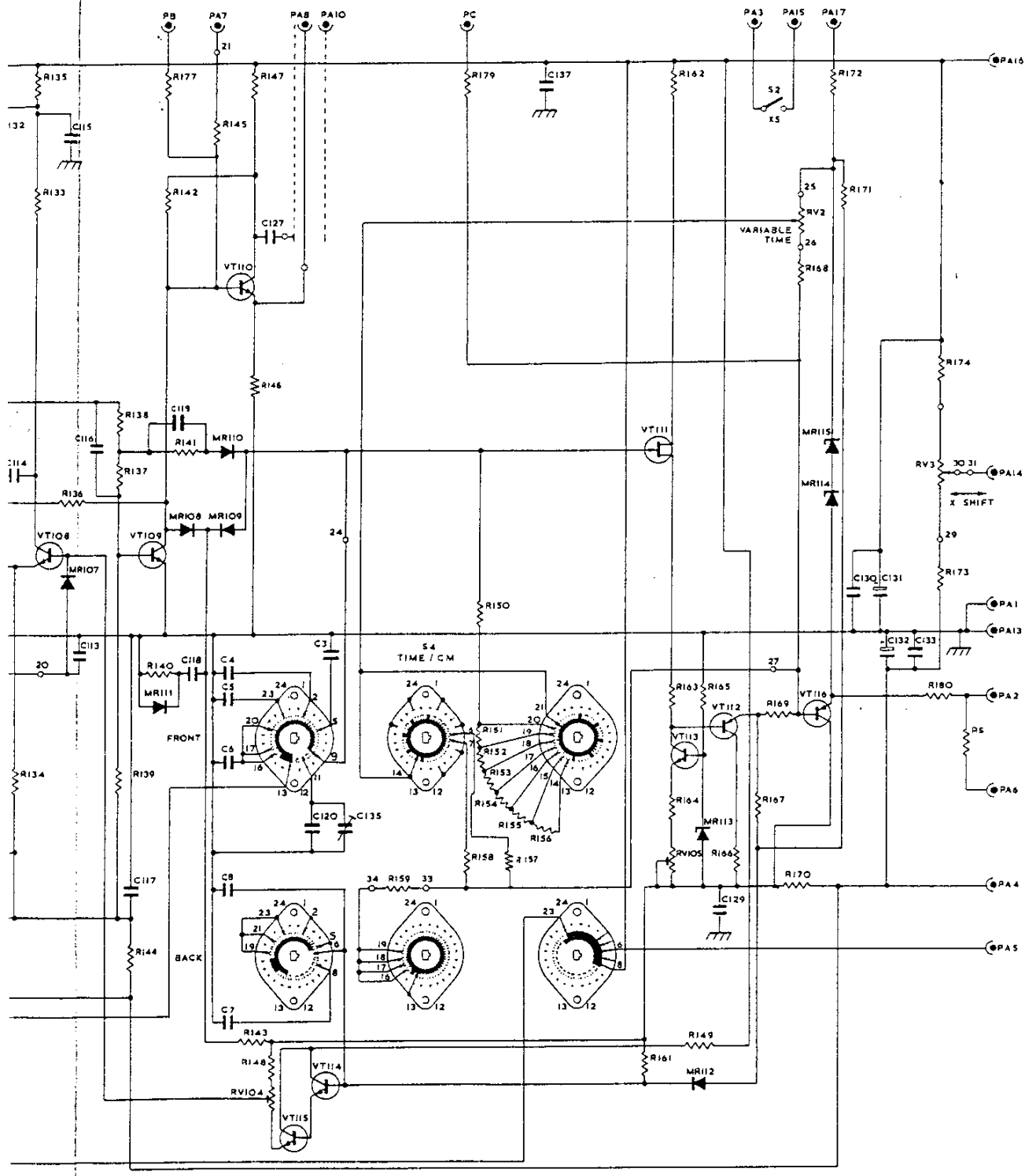


Fig. 3 OS2003X Circuit Diagram

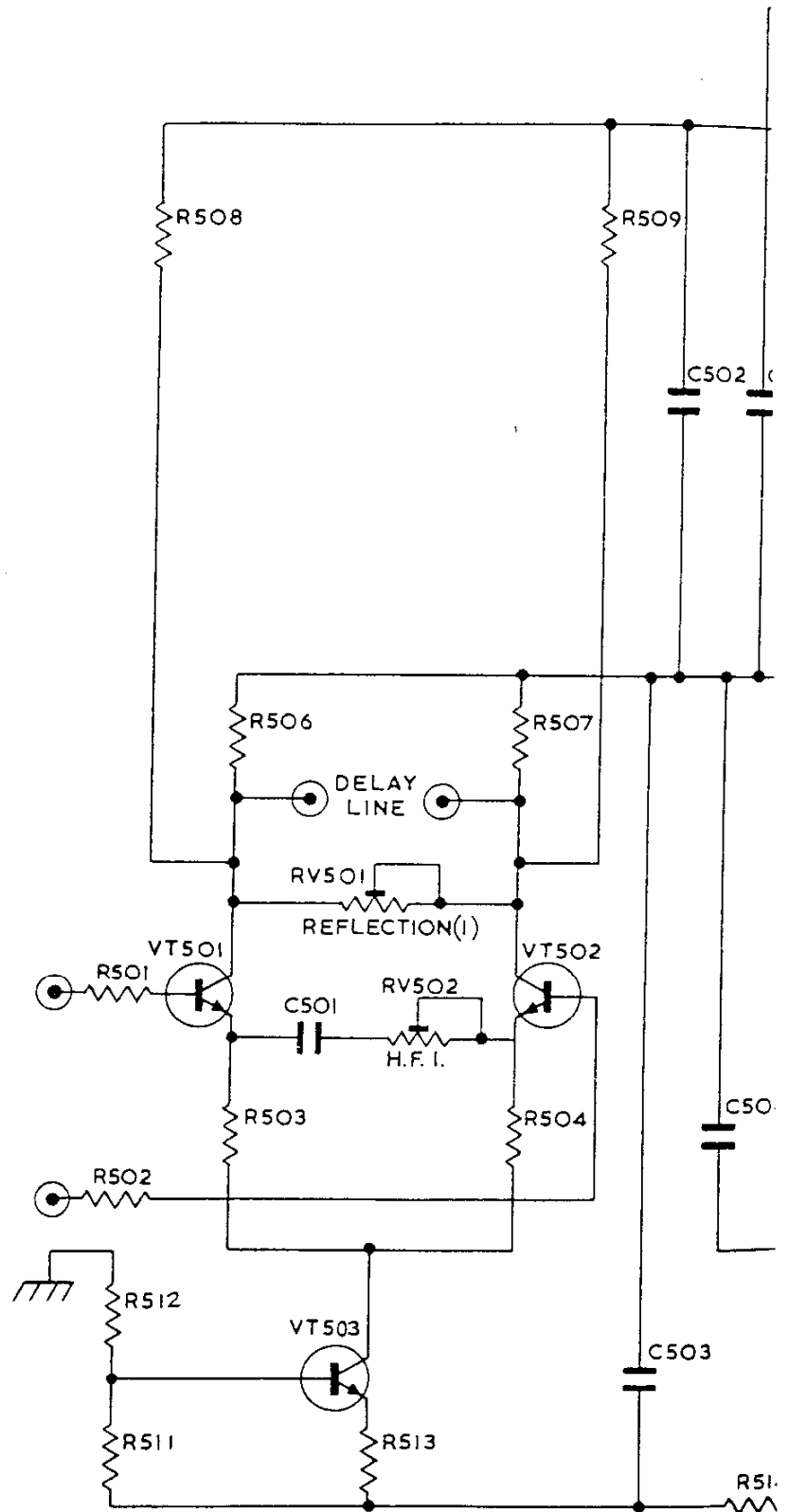
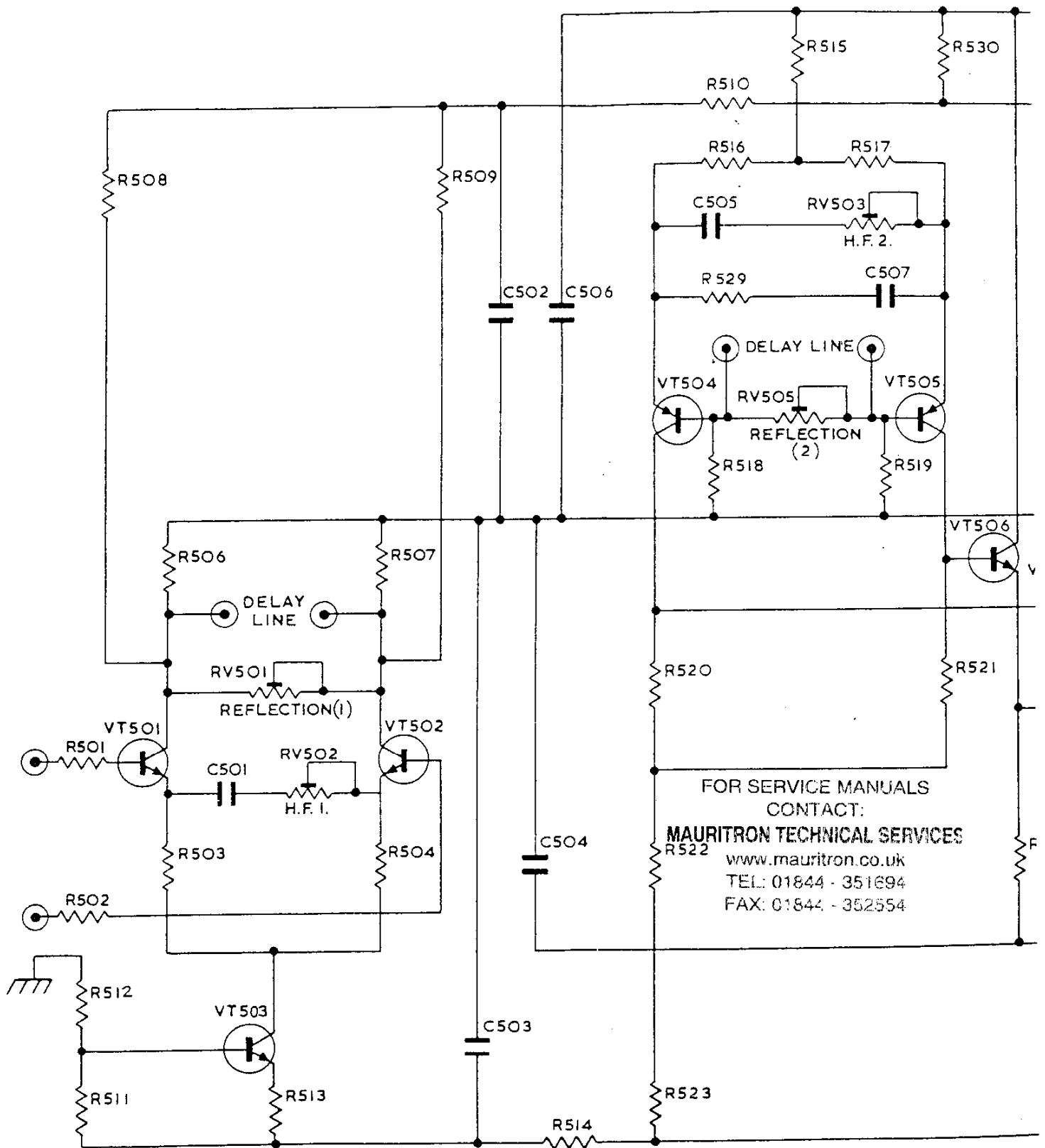
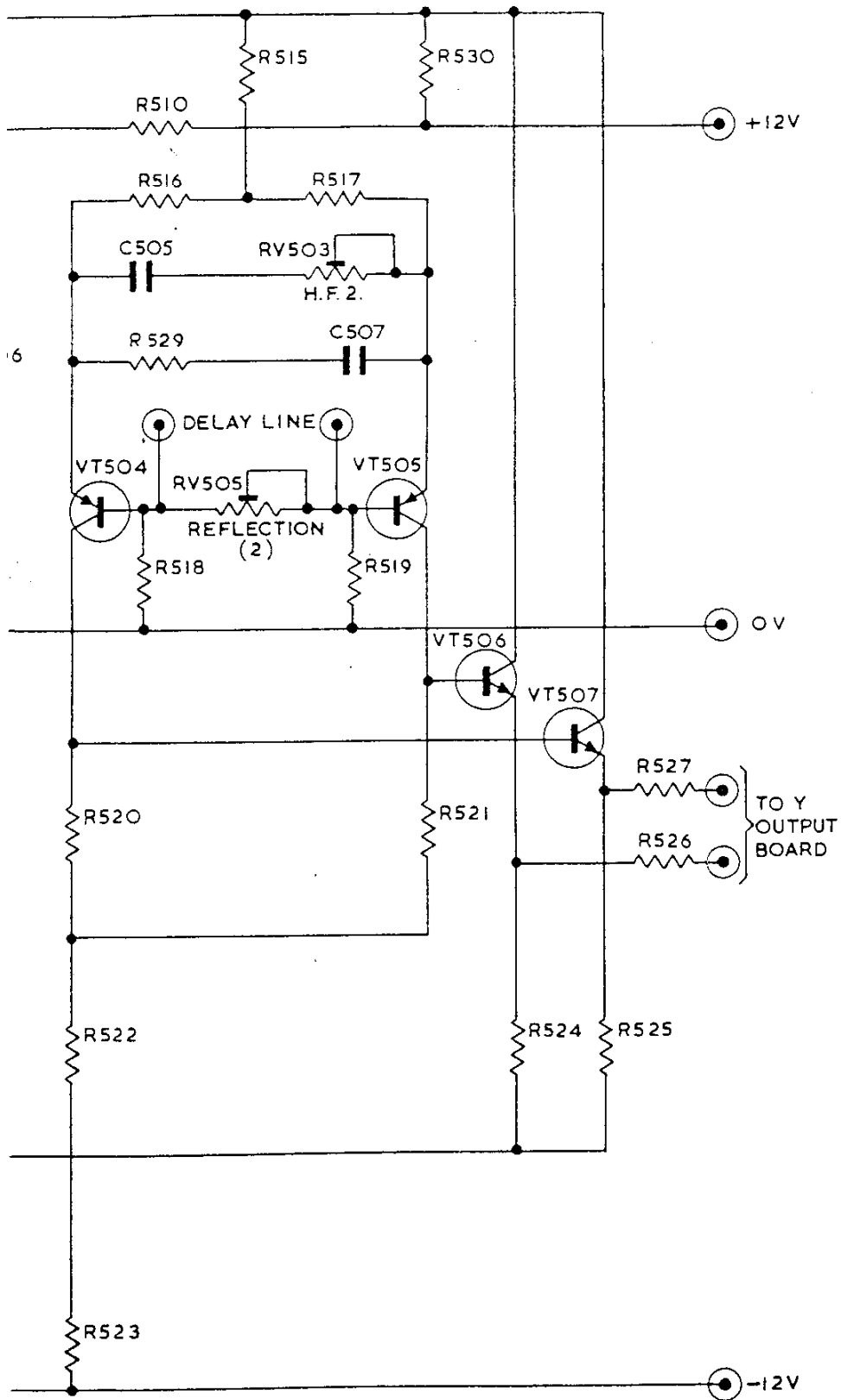


Fig. 2 DELAY LINE AMPLIFIER CIRCUIT DIAGRAM



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CIRCUIT DIAGRAM



Component List and Illustrations

Section 6

6.1 OS2001Y

Ref	Value	Description	Tol%±	Part No.
RESISTORS				
R101	111K	Welwyn 4014	1	26339
R102	10.1K	Welwyn 4014	1	26338
R103	1M	Welwyn 4014	1	26346
R104	333K	Welwyn 4014	1	26539
R105	1M	Welwyn 4014	1	26346
R106	100K	Cr. Carbon	5	1W 19061
R107	10	Cr. Carbon	5	1/8 W 2259
R108	2.7K	Cr. Carbon	5	1/8 W 311
R111/2	10	Cr. Carbon	5	1/8 W 2259
R113	18K	Cr. Carbon	5	1/8 W 634
R114/5	3.3K	Cr. Carbon	5	1/8 W 1638
R117	10	Cr. Carbon	5	1/8 W 2259
R118	470	Cr. Carbon	5	1/8 W 1373
R119	2.7K	Cr. Carbon	5	1/8 W 311
R120/2	1K	Cr. Carbon	5	1/8 W 384
R123	10K	Cr. Carbon	5	1/8 W 11503
R124	100	Cr. Carbon	5	1/8 W 11504
R125/6	10	Cr. Carbon	5	1/8 W 2259
R127	68	Cr. Carbon	5	1/8 W 1640
R128	10	Cr. Carbon	5	1/8 W 2259
R129	3.3K	Cr. Carbon	5	1/8 W 1638
R130	1K	Cr. Carbon	5	1/8 W 384
CAPACITORS				
C101	68pF	Lemco 1106R Ins.	5	4513
C102/5	6/25pF	Trimmer Triko D.90		23593
C106	680pF	Lemco 11068	5	24903
C107/9	6/25pF	Trimmer Triko D.90		23593
C110	6/25pF	Trimmer Triko D.90		23593
C111	10pF	G.P. Ceramic	10	22364
C112/4	.01µF	G.P. Ceramic	25	22395
C116	2/4pF	Waycom Cadsa Trimmer		23781
C117/8	.01µF	G.P. Ceramic	25	22395
C120	50µF	Mullard C.426/ ARG50	40V	20778
C121	.01µF	G.P. Ceramic	25	22395
C122	5.6pF	G.P. Ceramic		22361
DIODES				
MR101		IN 3595		29330
MR102		IN 3595		29330
MR103		Zener ZF6.2 STC.		4032
MR104		Zener ZF6.2 STC.		4032
CONTROL POTS.				
RV101	4.7K	Davall 80		25232
RV102	2.2K	Davall 80		25227
RV103	2.2K	Davall 80		25227
TRANSISTORS				
VT101		2N 3819		26069
VT102		MPS 3640		24128
VT103/5		BSX.20		23307

SWITCH ATTEN. ASSY. FOR OS2001Y

Ref	Value	Description	Tol%±	Part No.
RESISTORS				
R3/5	10	Cr. Carbon	5	1/8 W 2259
R6	900K	Welwyn 4014		26344
R7	990K	Welwyn 4014		26345
R8	500K	Welwyn 4014		26342
R9	750K	Welwyn 4014		26540
R10	39	Cr. Carbon	5	1/8 W 3010
SWITCH				
S2		To SW. Drg.		24580

SINGLE-BEAM PLUG-IN UNIT OS2001Y

Ref	Value	Description	Tol%±	Part No.
RESISTORS				
R1/2	10	Cr. Carbon	5	1/8 W 2259
CAPACITORS				
C1	0.1µF	Wima Tropyfol M.		400V 2385
C2	8.2pF	G.P. Ceramic	±1pF	A.O.T.22363
CONTROL POTS.				
RV1	500	Lin. Morgan 'U'		24587
SWITCH				
S1		Ariel Pressings DP/3T RA2405		25869
SOCKET				
SK.1	50	B.N.C. UG.1094/U		1222

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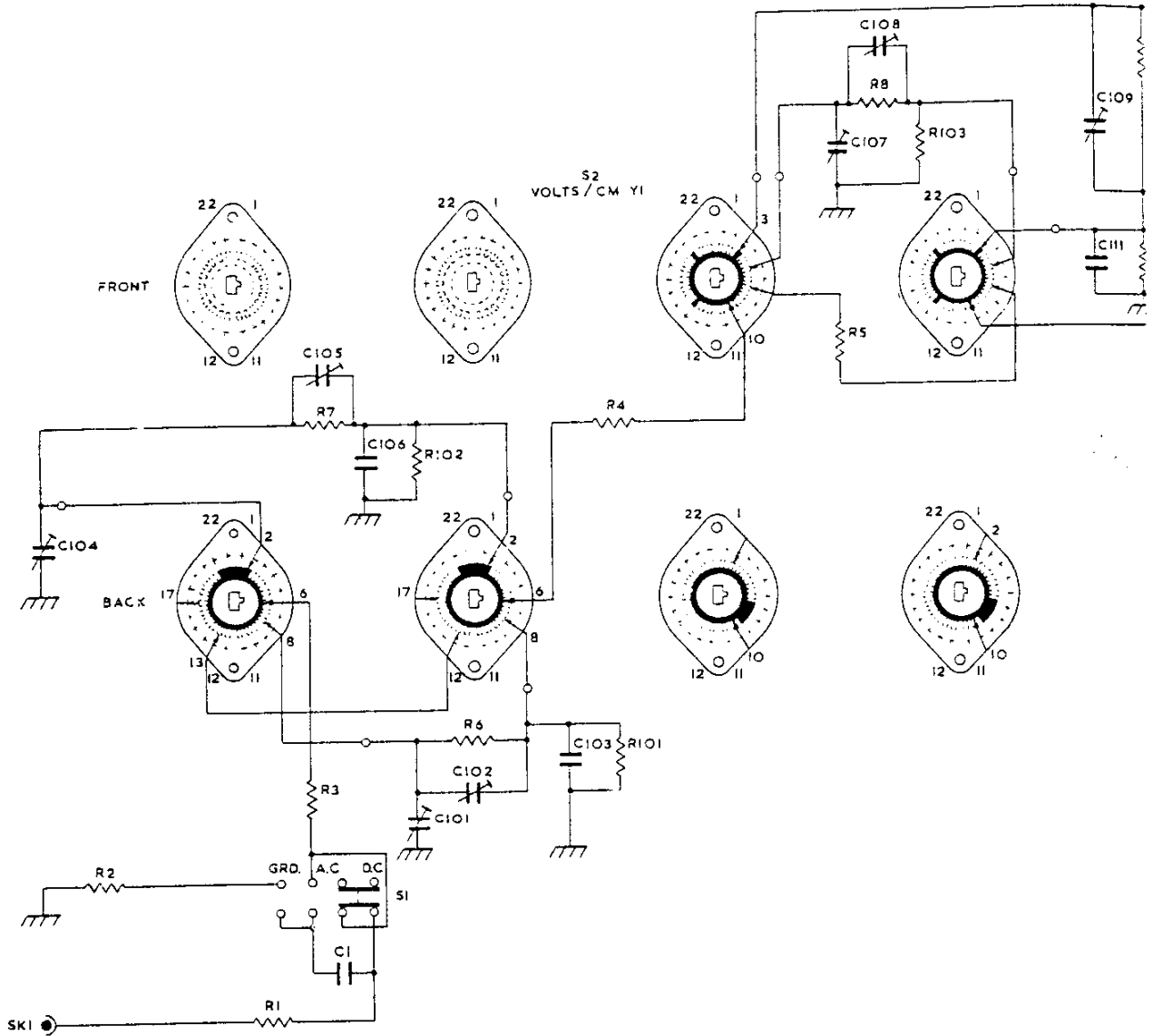
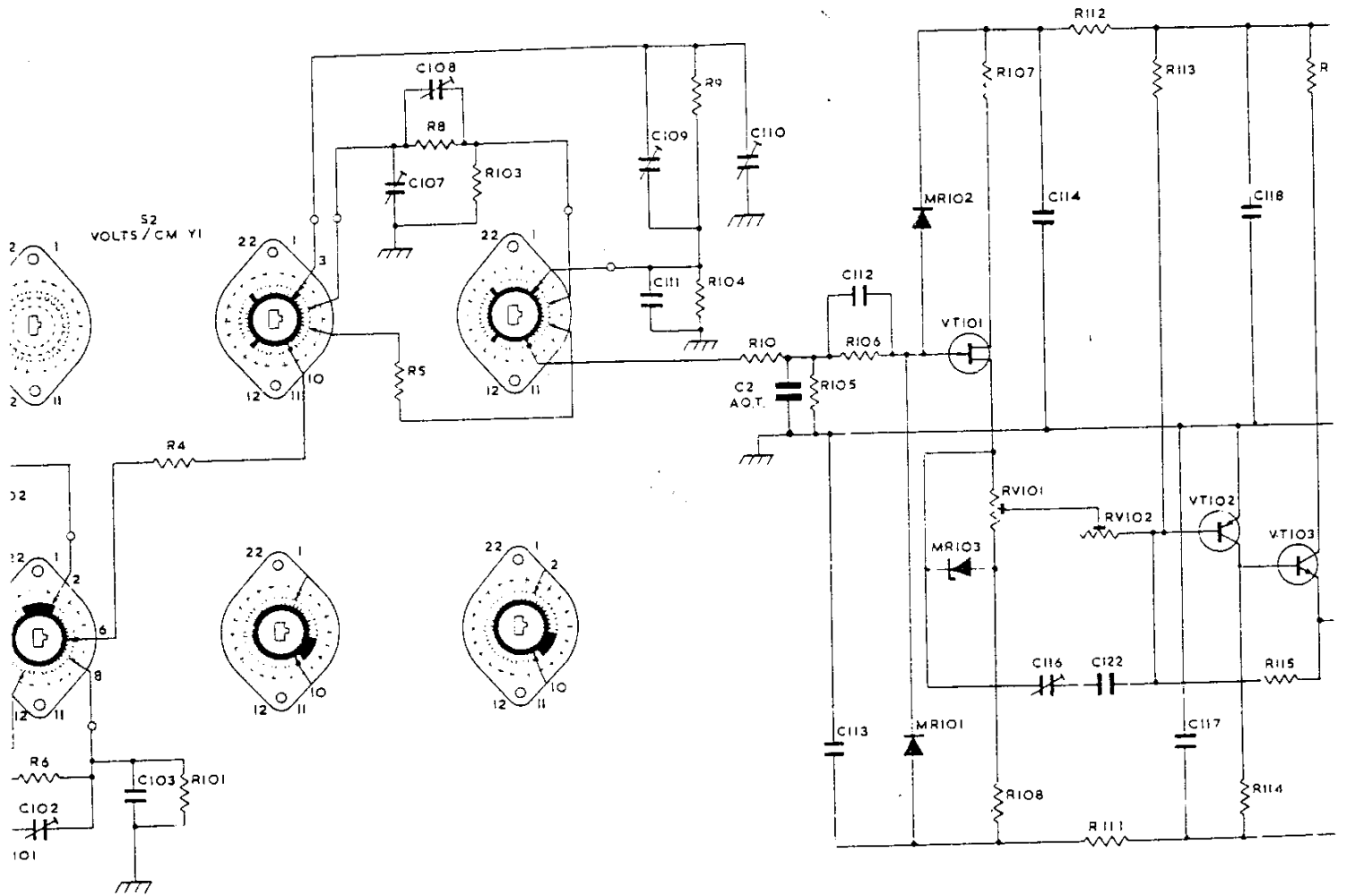
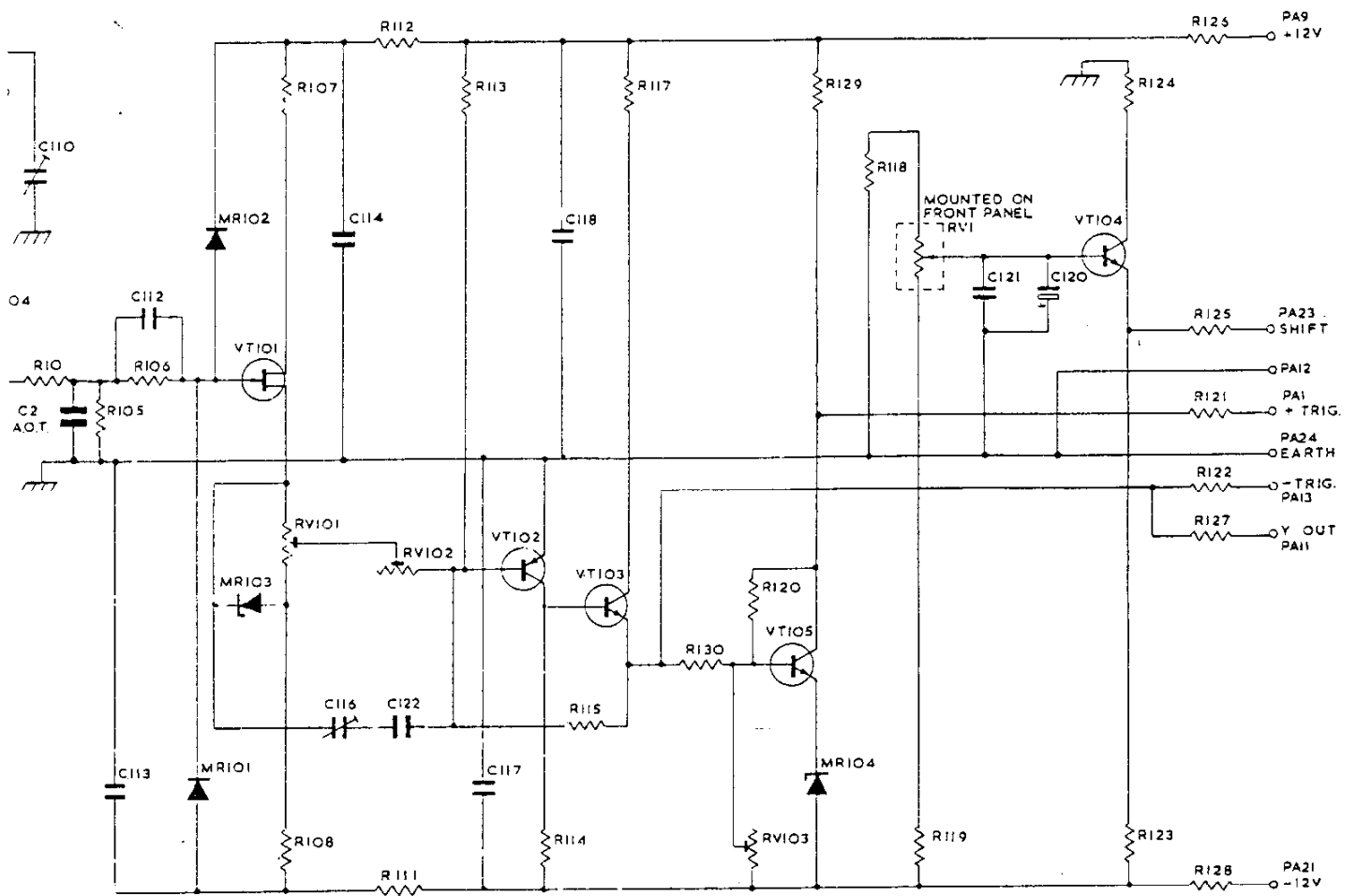


Fig. 1 CIRCUIT DIAGRAM OS2001Y





Component List and Illustrations

Section 6

6.2 OS2002Y Y AMPLIFIER BOARD 1

Ref	Value	Description	Tol%±	Part No.	Ref	Value	Description	Part No.
RESISTORS					C133/8	.01μF	Ceramic	250V 22395
R7/10	10		5	1/8 W 2259	C139	18pF	Erie Disc.	22367
R15/8	33		5	1/8 W 2931	C140	18pF	Erie Disc.	22367
R19/20	47		5	1/8 W 727	C141/4	.01μF	Ceramic	250V 22395
R109	990K	Welwyn 4014 CEC	1	26345	C145	25μF	Mullard Electrolytic	25V 20776
R110	990K	Welwyn 4014 CEC	1	26345	C146	250μF	Mullard Electrolytic	16V 20783
R111/2	10.1K	Welwyn 4014 CEC	1	26338	C147	0.1μF	Polyester	400V 2385
R113/4	900K		1	26344	C148	.01μF	Ceramic	22395
R115/6	111K	Welwyn 4014	1	26339	DIODES			
R117/8	500K		1	26342	MR101/4		Ferranti ZS152	24905
R119	1M	Welwyn 4014 CEC	1	26346	MR105/6		Mullard ODZ243 or BZY88 - 66V2	6.2V 4032
R120	1M	Welwyn 4014 CEC	1	26346	MR107		Texas 1544	19870
R121/2	750K		1	26540	MR108		Mullard ODZ234 or BZY88 - 66V2	6.2V 4032
R123/4	333K	Welwyn 4014	1	26539	PRE-SET POTS			
R129	10		5	1/8 W 2259	RV101	470	Davall Type 80	25225
R130	10		5	1/8 W 2259	RV102	470	Davall Type 80	25225
R131/2	1M	Welwyn 4014 CEC	1	26346	RV103	220	Davall Type 80	25229
R133/4	100K	Erie 8	10	1W 1497	RV104	220	Davall Type 80	25229
R135/8	3.3K		5	1/8 W 1638	RV105	2.2K	Davall Type 80	25227
R139	680		5	1/8 W 309	RV106	2.2K	Davall Type 80	25227
R140	680		5	1/8 W 309	RV107	100	Davall Type 80	25228
R141/2	10		5	1/8 W 2259	RV108	100	Davall Type 80	25228
R143/4	560		5	1/8 W 308	RV109	4.7K	Davall Type 80	25232
R145/6	1.2K		5	1/8 W 2087	TRANSISTORS			
R147/8	3.3K		5	1/8 W 1638	VT101/2		F.E.T. UC 734	24832
R149	1K	Welwyn 4014	1	26541	VT103/4		Mullard BSX. 20	23307
R150/2	1K	Welwyn 4014	1	26541	VT105/10		Motorola 2N 3905	20818
R153/4	6.8K		5	1/8 W 313	VT111/2		Mullard BSX. 20	23307
R155/8	4.7K		5	1/8 W 386	VT113/6		Motorola 2N 3905	20818
R159	1K		5	1/8 W 384	VT117		Mullard BSX. 20	23307
R160	1K		5	1/8 W 384	DUAL TRACE UNIT OS2002Y			
R161/2	39		5	1/8 W 3010	CAPACITORS			
R163/4	470		5	1/8 W 1373	C1/2	0.1μF	Polyester	400V 2385
R165/6	220		5	1/8 W 304	C3/4	.01μF	Ceramic	250V 22395
R167/9	1K	Welwyn 4014	1	26541	CONTROL POTS.			
R170	1K	Welwyn 4014	1	26541	RV1/4	500	Lin. Morgan "U" Spindle 3" x 1/8" . 3/8 Bush	22148
R171	1.5K		5	1/8 W 385	SWITCHES			
R172	100		5	1/8 W 11504	S1/2		3 position Slide Switch Brinmark Type G 128L	25869
R173/6	10		5	1/8 W 2259	S3		Switch Volts/CM Y1	23171
R177/8	2.2K		5	1/8 W 425	S4		Switch Volts/CM Y2	23171
R179	47		5	1/8 W 727	CONNECTORS			
R180	47		5	1/8 W 727	PB/D	50	B.N.C.(Greenpar Pt.No. GE35027)	1222
R181/2	330	SWD18	5	1894	PE		McMurdo Red Range RP24	24852
CAPACITORS								
C100/1	6.25pF			23593				
C105/7	6-25pF	Ceramic		23593				
C109	6-25pF	Ceramic		23593				
C110/2	6-25pF	Ceramic		23593				
C113/4	680pF	S/M Lemco 1106S	5	160V 24903				
C115/6	68pF	S/M Lemco 1106R	5	160V 4513				
C117/9	6-25pF	Ceramic		23593				
C120/2	6-25pF	Ceramic		23593				
C123/4	10pF	Ceramic	10	22364				
C125/6	6-25pF	Ceramic		23593				
C131/2	.01μF	Ceramic		22395				

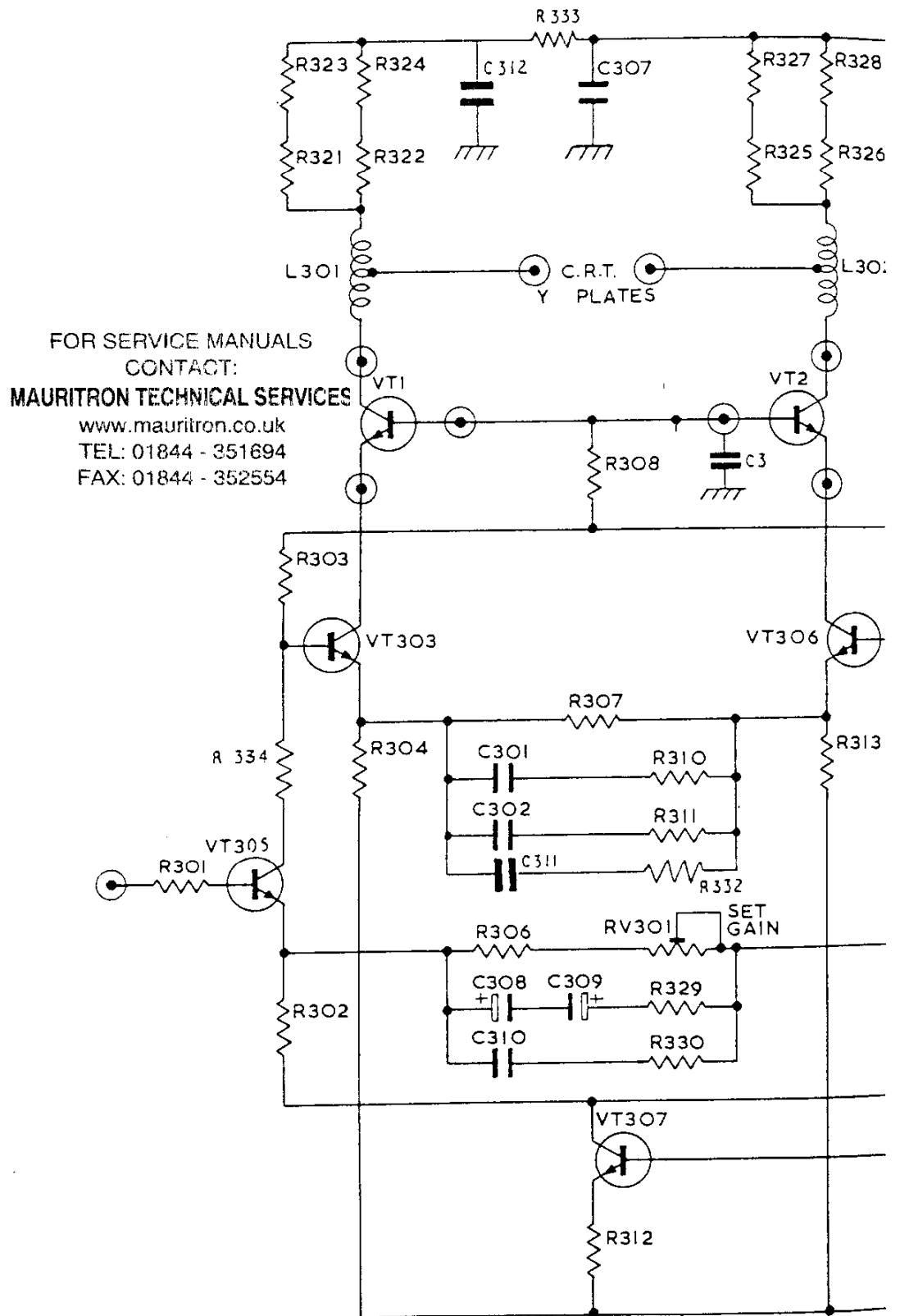
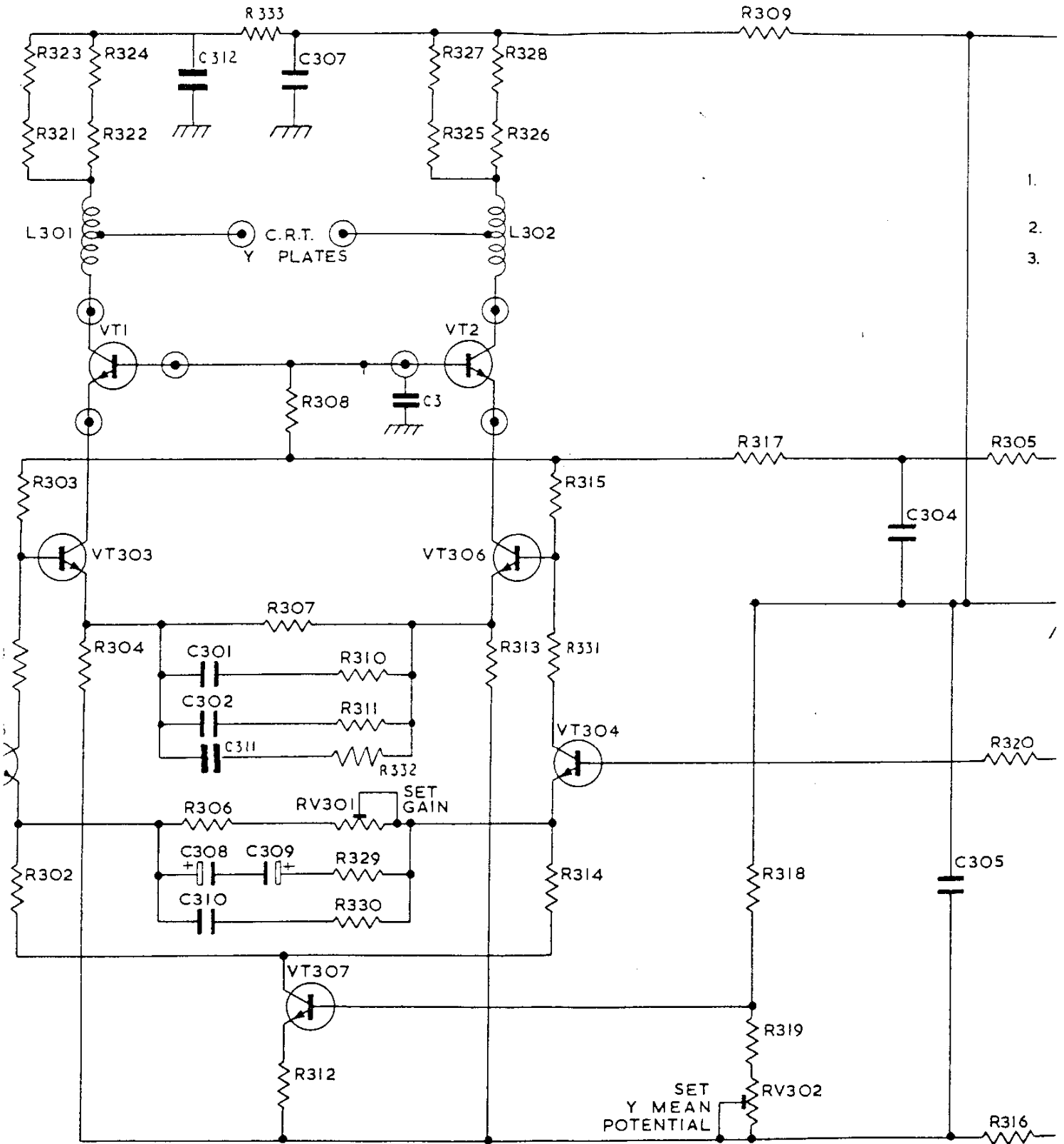
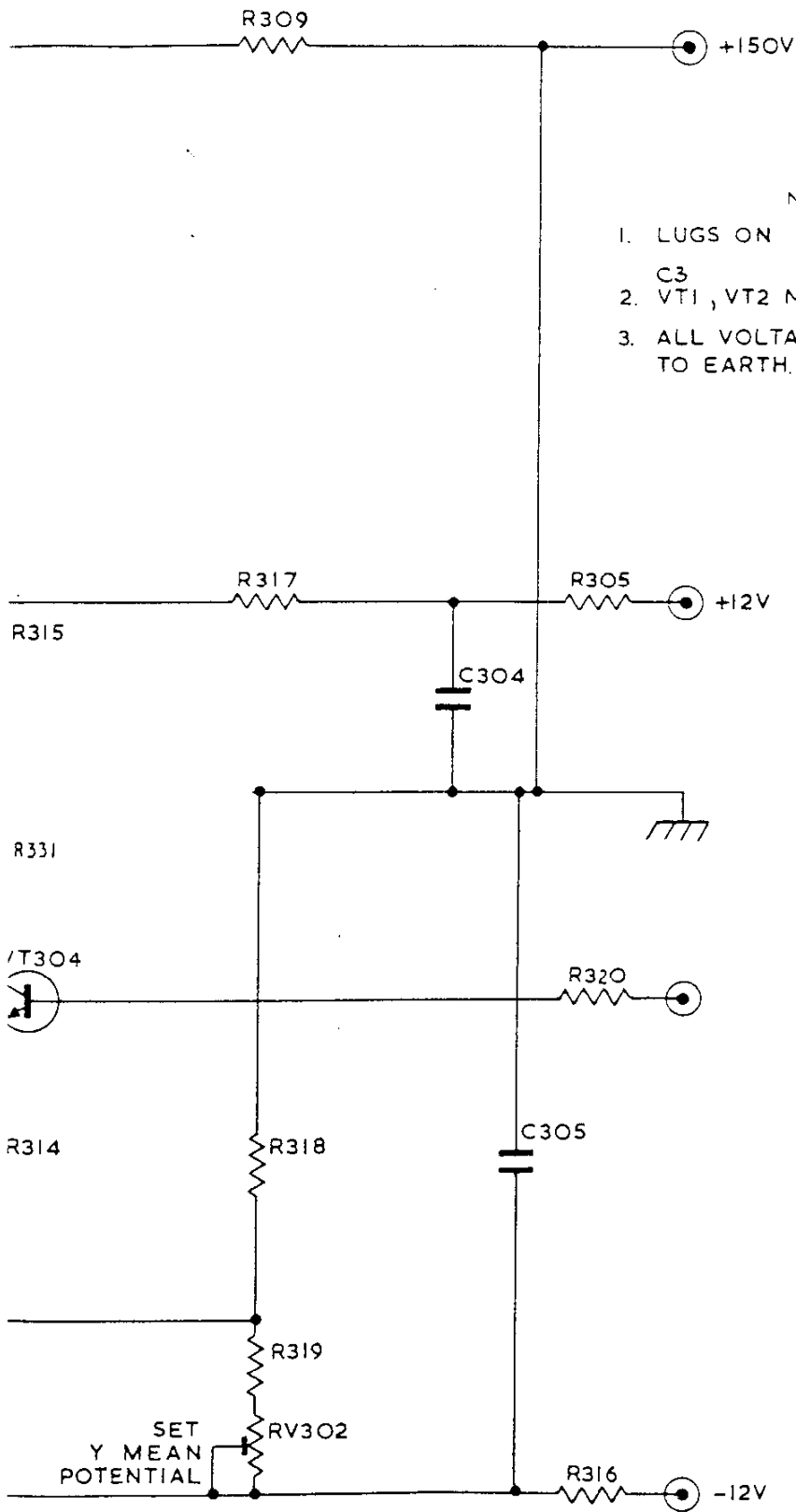



Fig. 3 Y OUTPUT AMPLIFIER CIRCUIT DIAGRAM



- 1.
- 2.
- 3.

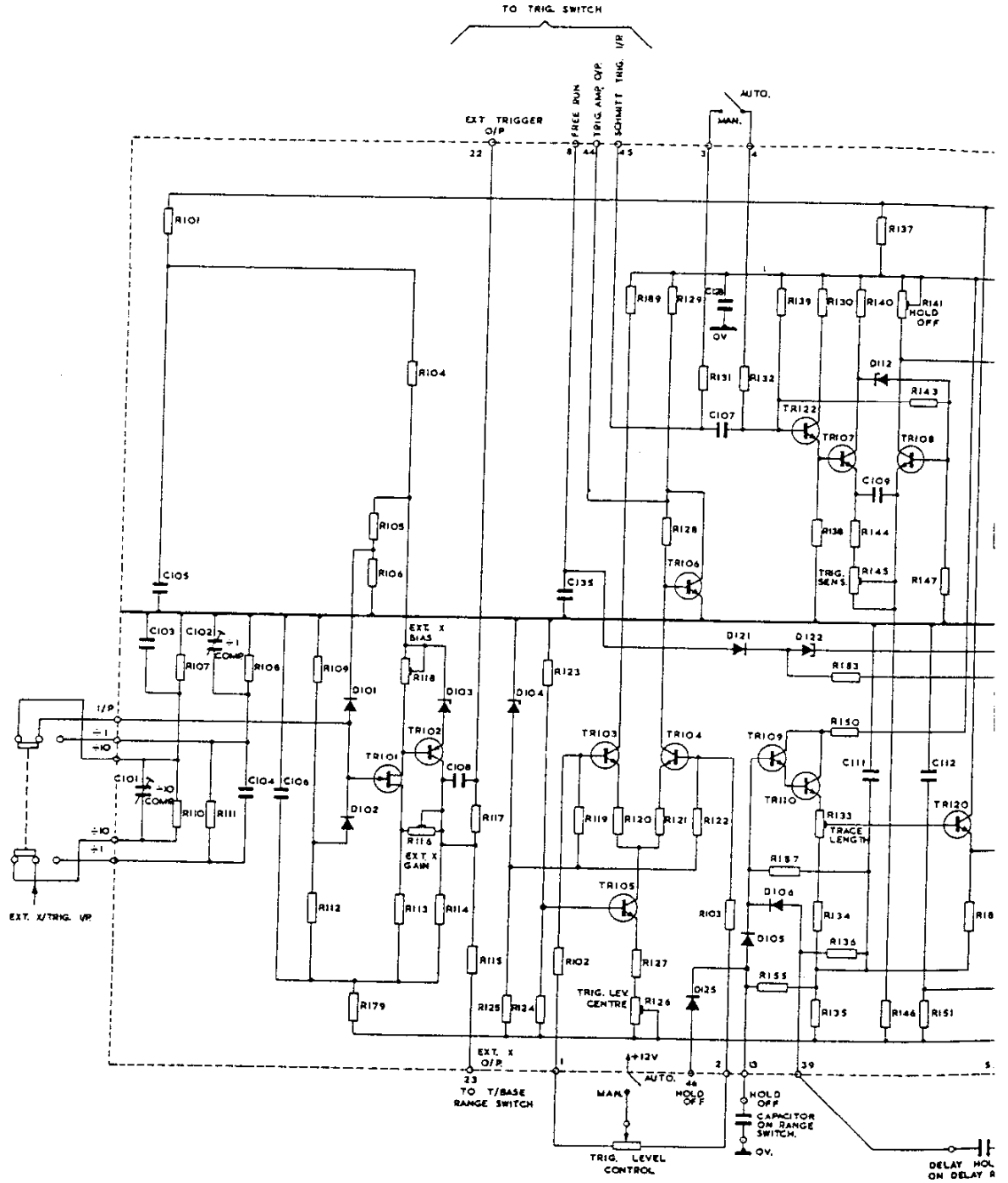


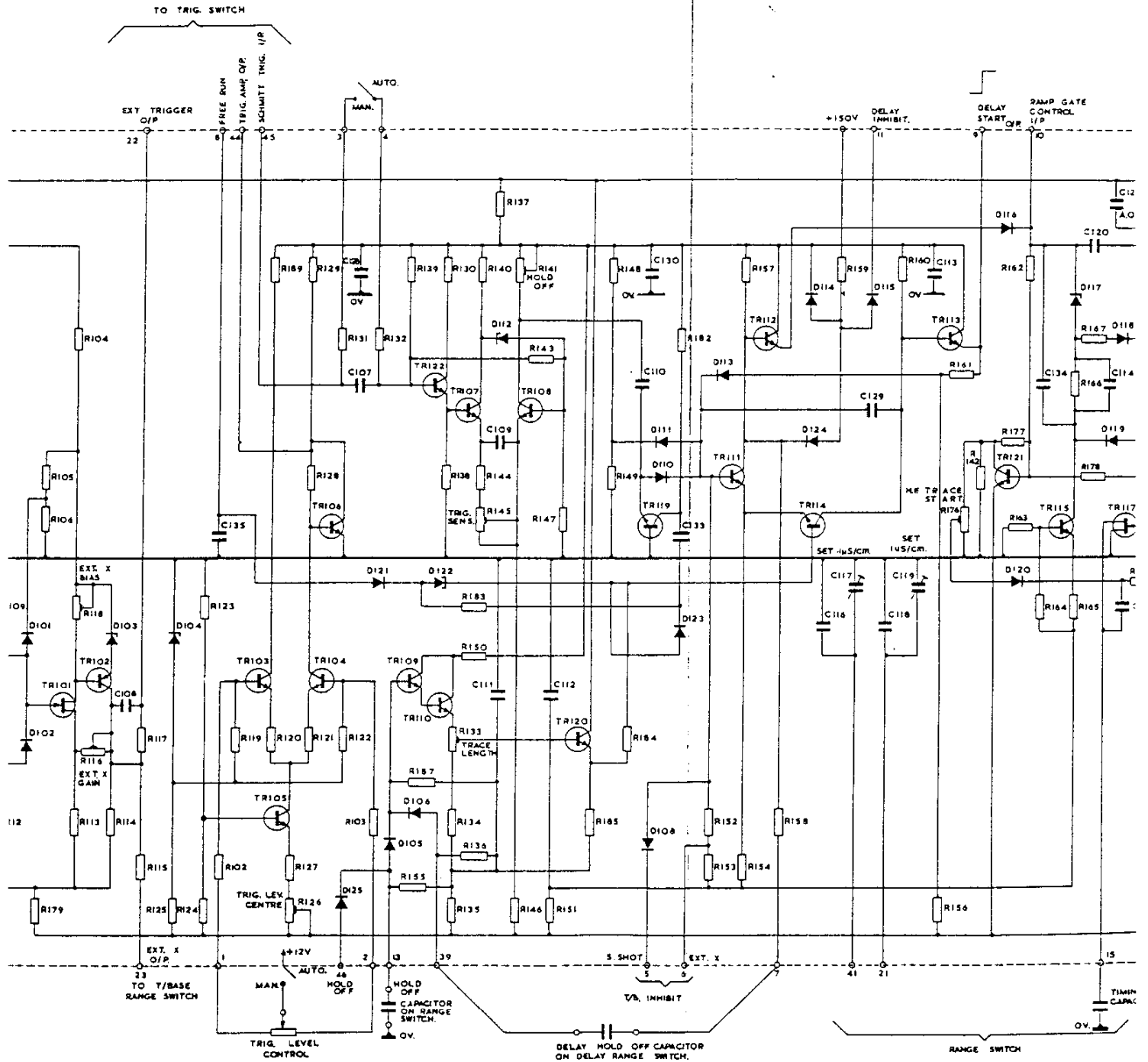
NOTES

1. LUGS ON P.C.B. DENOTED
C3
THUS: 
2. VT1, VT2 NOT MOUNTED ON P.C.B.
3. ALL VOLTAGES MEASURED TO EARTH.

Component List and Illustrations

Section





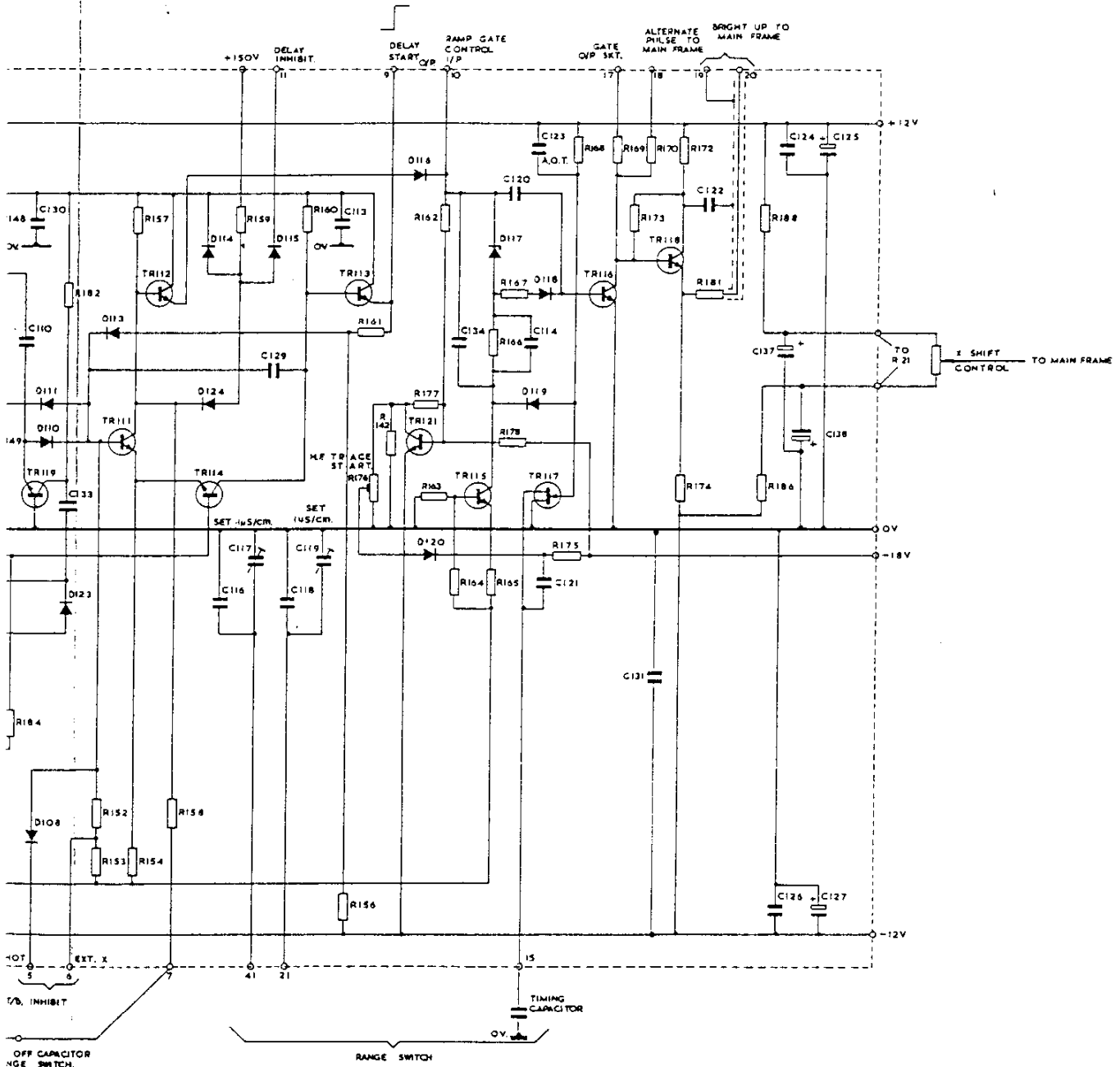


Fig. 4 OS2006X Timebase P.C.B. Circuit

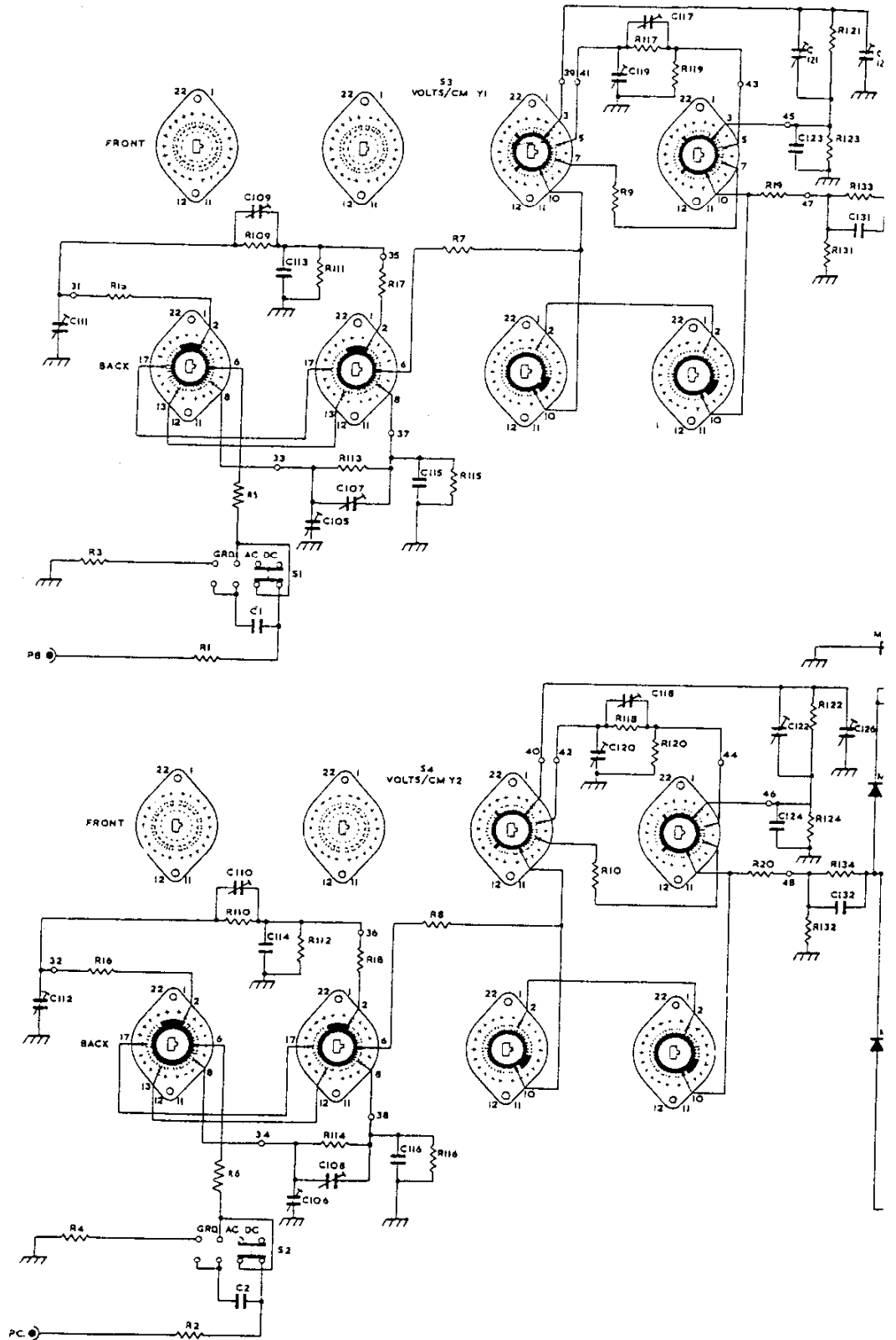
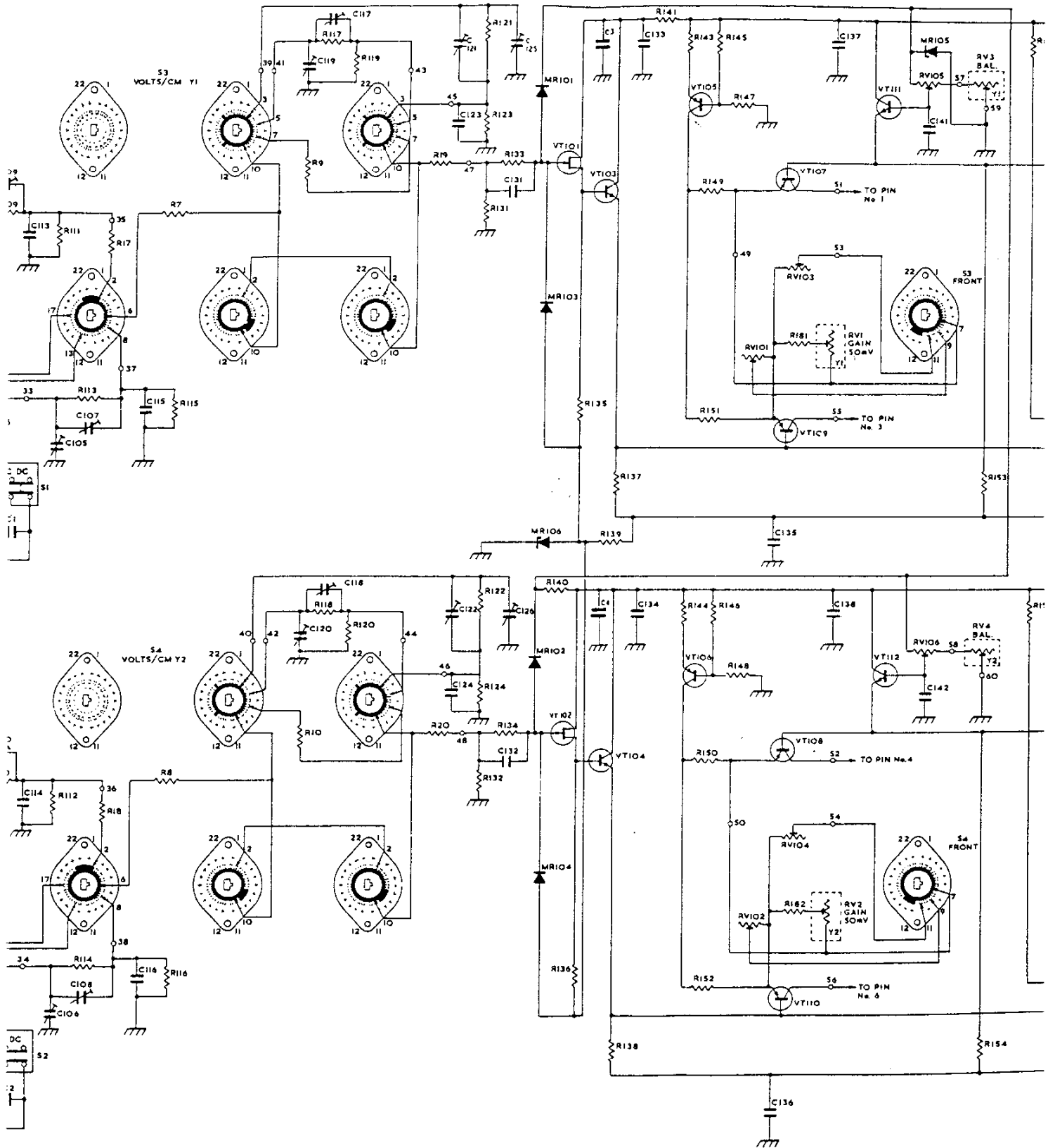
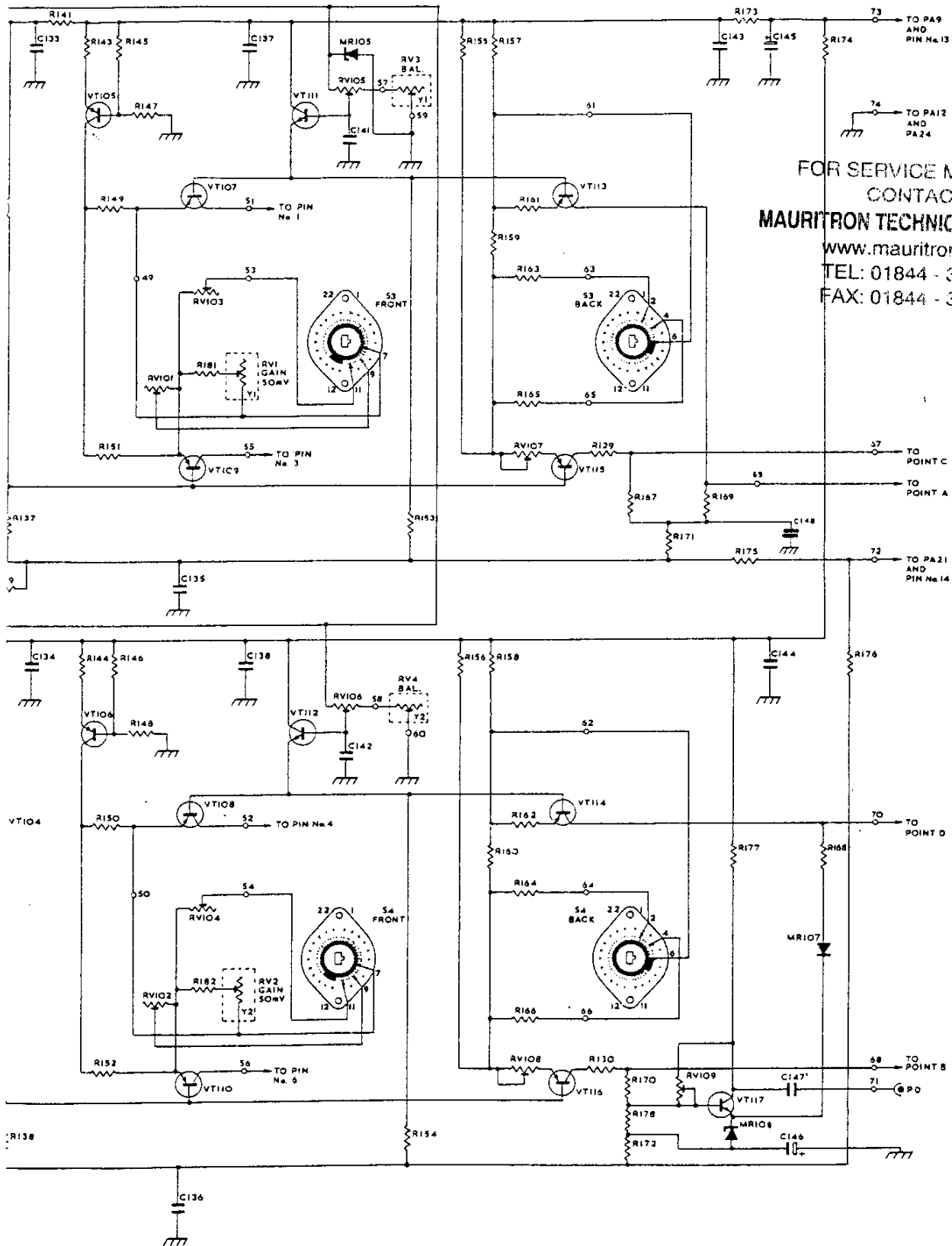


Fig. 2 CIRCUIT DIAGRAM OS2002Y Y AMPLIFIER BOARD 1



LIFIER BOARD 1



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Component List and Illustrations

Section 6

6.3 OS2002Y Y AMPLIFIER BOARD 2

Ref	Value	Description	Tol%±	Part No.	Ref	Value	Description	Part No.	
RESISTORS					CAPACITORS				
R11/4	10		5	1/8 W 2259	C201/3	.01µF	Ceramic Disc	250V 22395	
R201/6	220		5	1/10 W 304	C204/5	470pF	Ceramic Tubular	22383	
R207/8	3.3K		5	1/10 W 1638	C206/8	47pF	Ceramic Tubular	22372	
R209	470		5	1/10 W 1373	C209	18pF	Ceramic Tubular	22367	
R210	470		5	1/10 W 1373	C210	820pF	Ceramic Tubular	22386	
R211/2	1K		5	1/10 W 384	C211	220pF	Ceramic Tubular	22379	
R213/4	2.7K		5	1/10 W 311	C212	.1µF	Polyester	400V 2385	
R215/6	1.5K		5	1/10 W 385	C214/6	.1µF	Polyester	400V 2385	
R217	680		5	1/10 W 309	C218	5.6pF	Ceramic Tubular	22361	
R218/9	2.7K		5	1/10 W 311	C219	5.6pF	Ceramic Tubular	22361	
R220/3	10		5	1/10 W 2259	DIODES				
R224/5	1K		5	1/10 W 384	MR201/10		Texas 1544	18970	
R226/7	2.2K		5	1/10 W 425	MR211/6		Mullard OA95	23318	
R228/9	10K		5	1/10 W 11503	TRANSISTORS				
R230/1	6.8K		5	1/10 W 313	VT201/8		Mullard BSX. 20	23307	
R232	10		5	1/10 W 2259	SWITCHES				
R234	1.2K		5	1/10 W 2087	S5		Pedoka Switch Slider DP/DT	30340	
R235	2.2K		5	1/10 W 425	S6		Function Switch	24585	
R236	12K		5	1/10 W 1685	RV5/6	1K	Lin. Morgan "U" 1/4"	22149	
R237	12K		5	1/10 W 1685			3/8" Spindle		
R238/9	10		5	1/10 W 2259	RV7/8	5K	Control Pot.	A26597	
R240	100		5	1/10 W 11504					
R241	10		5	1/10 W 2259					

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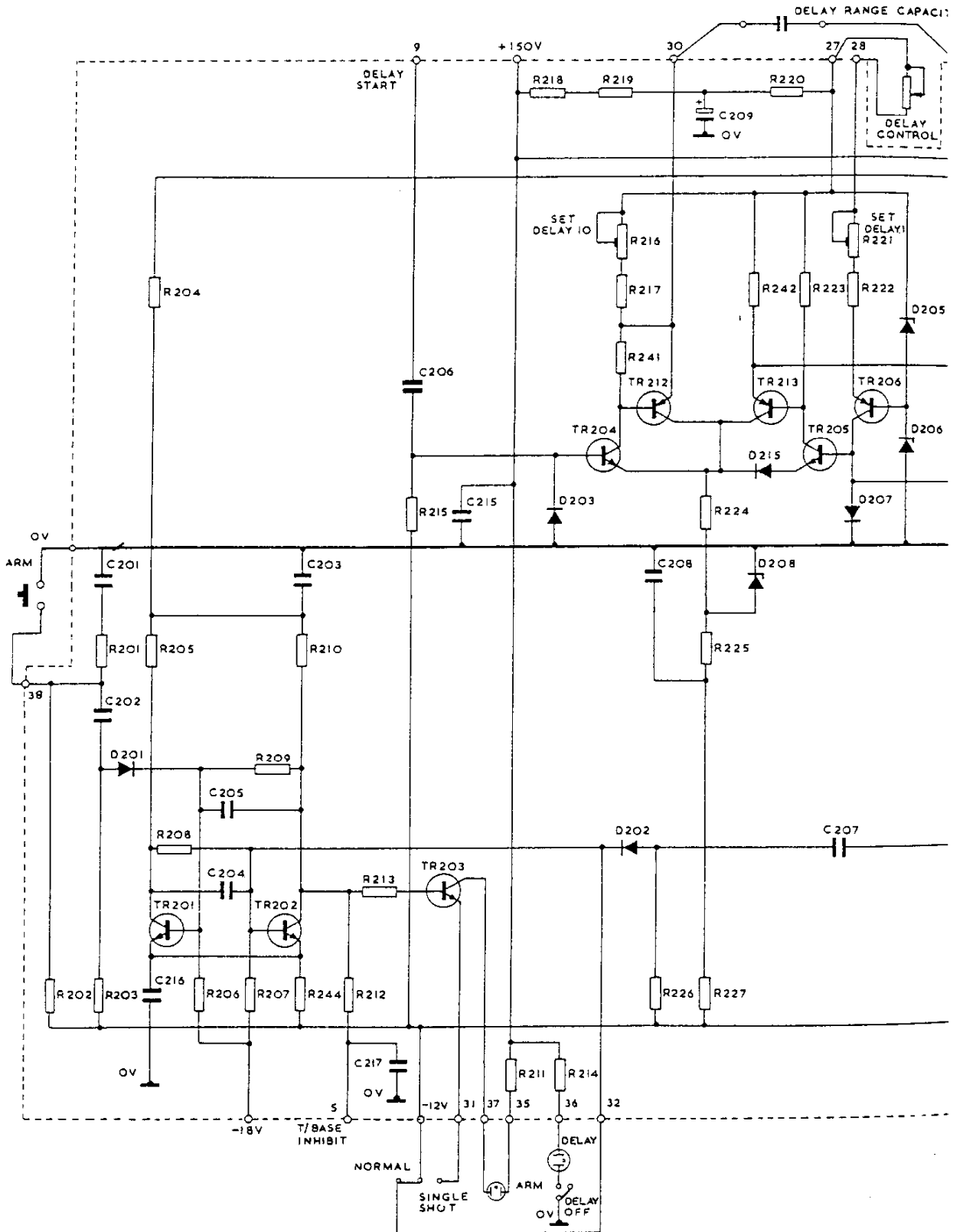
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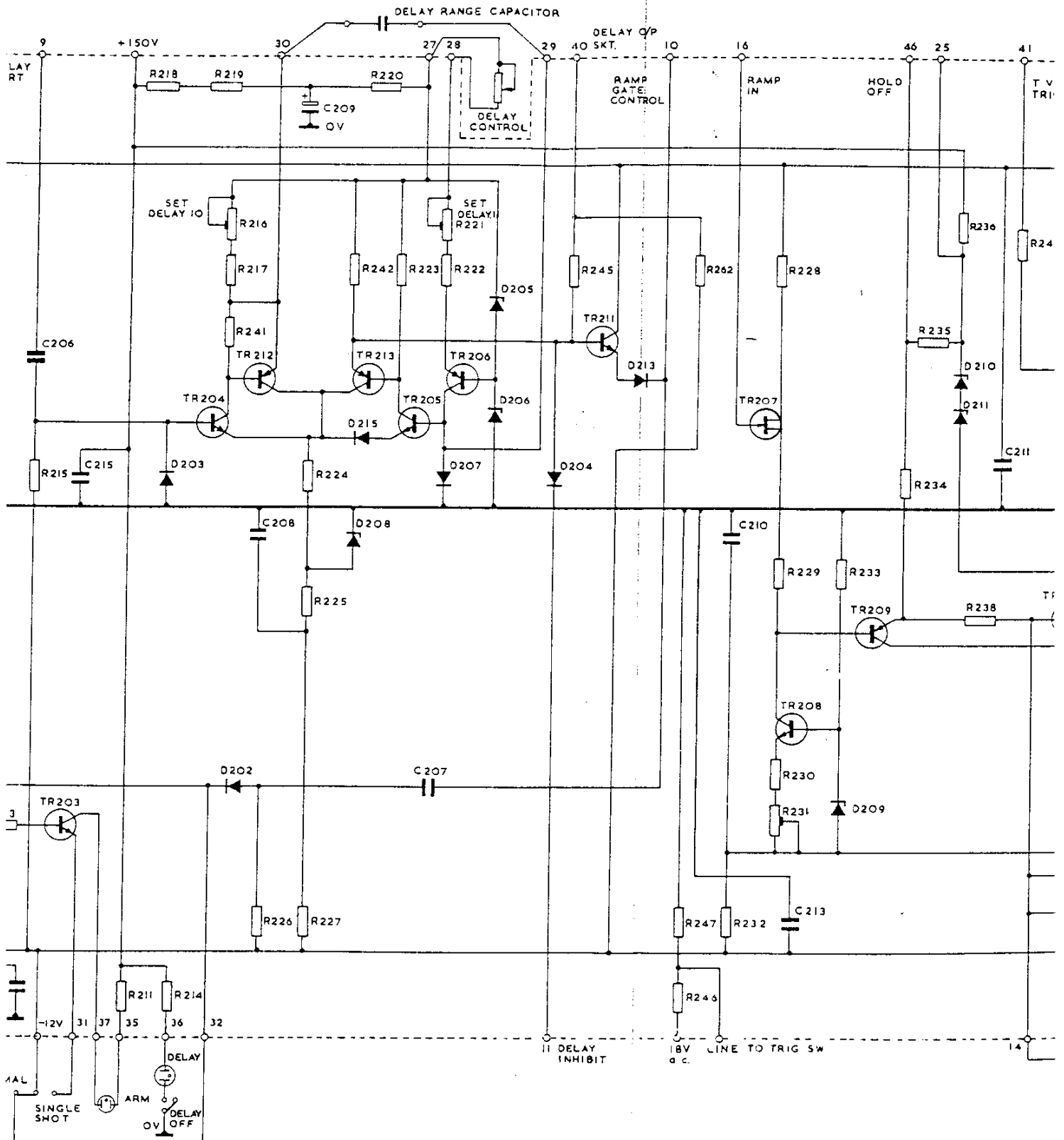
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Component List and Illustrations

Section





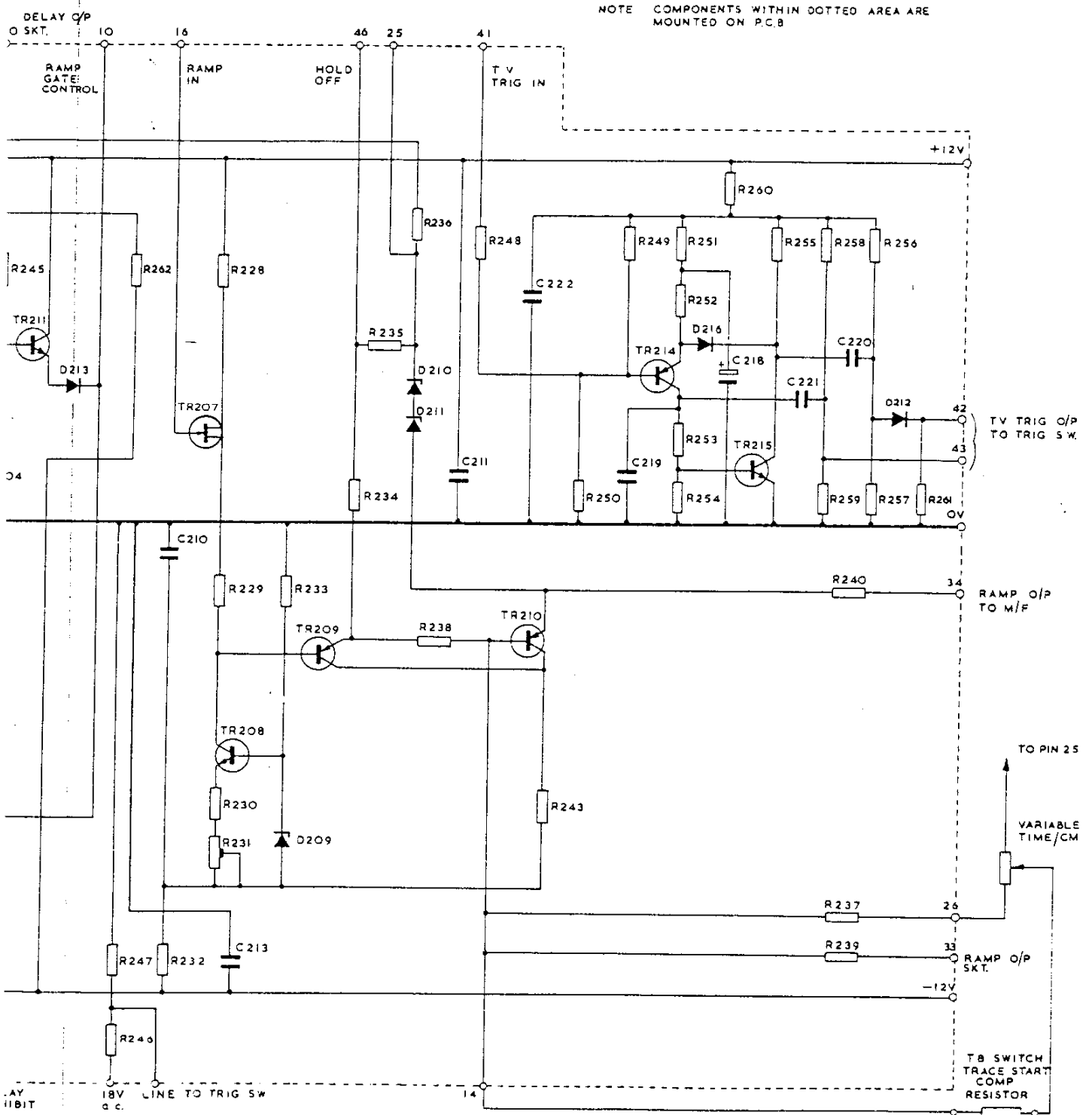
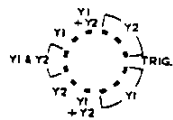
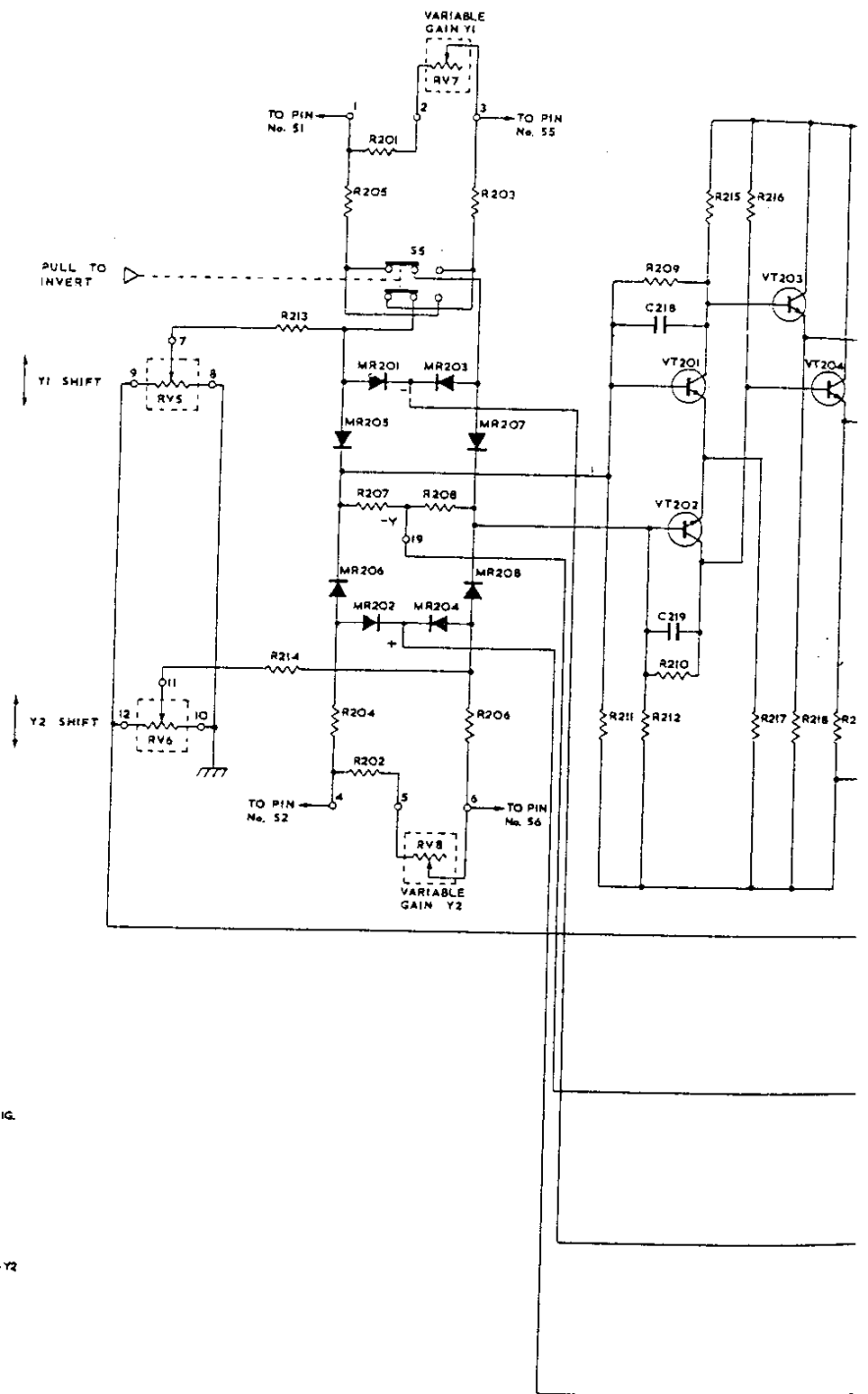
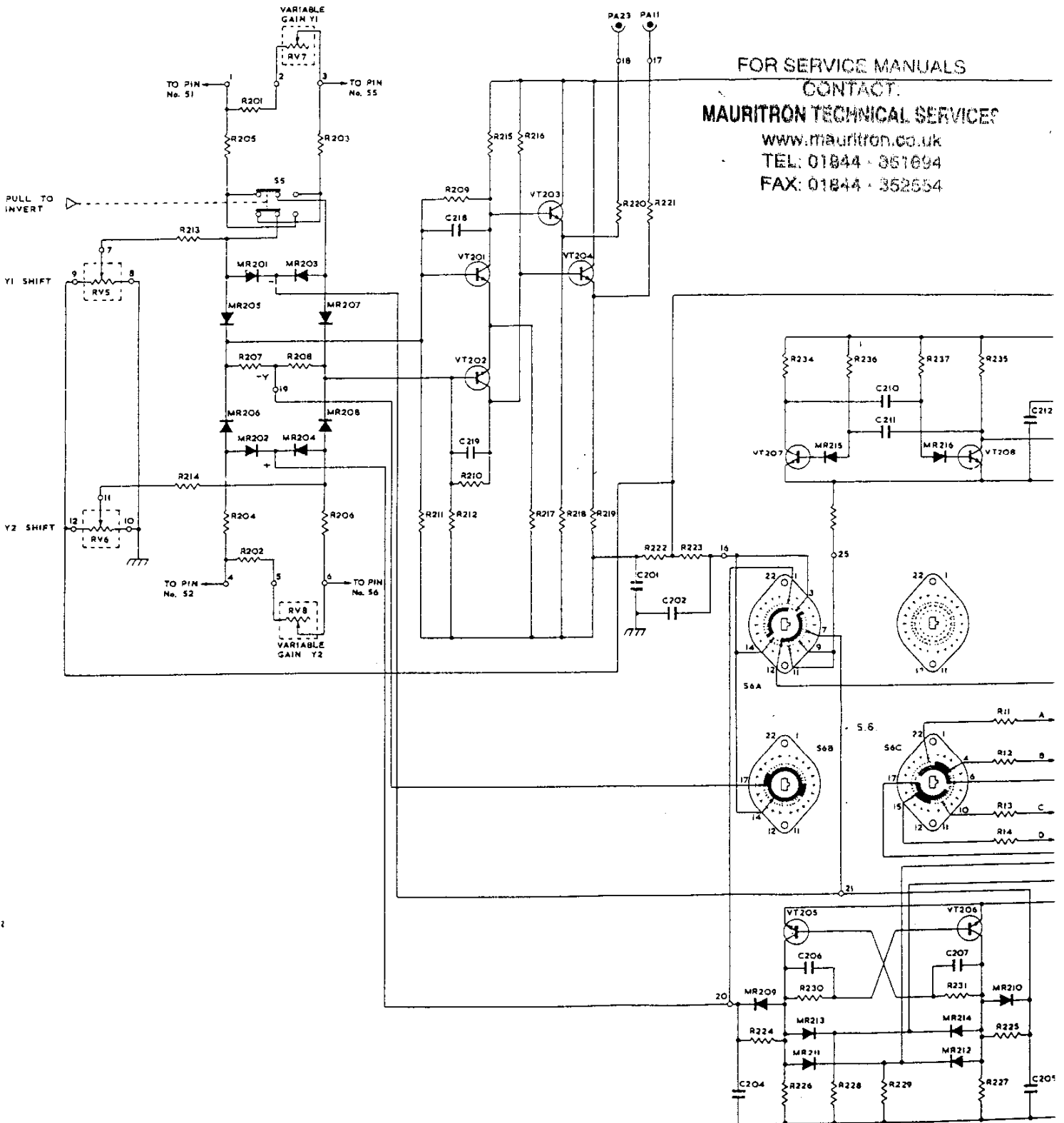


Fig. 5 OS2006X P.C.B. Circuit

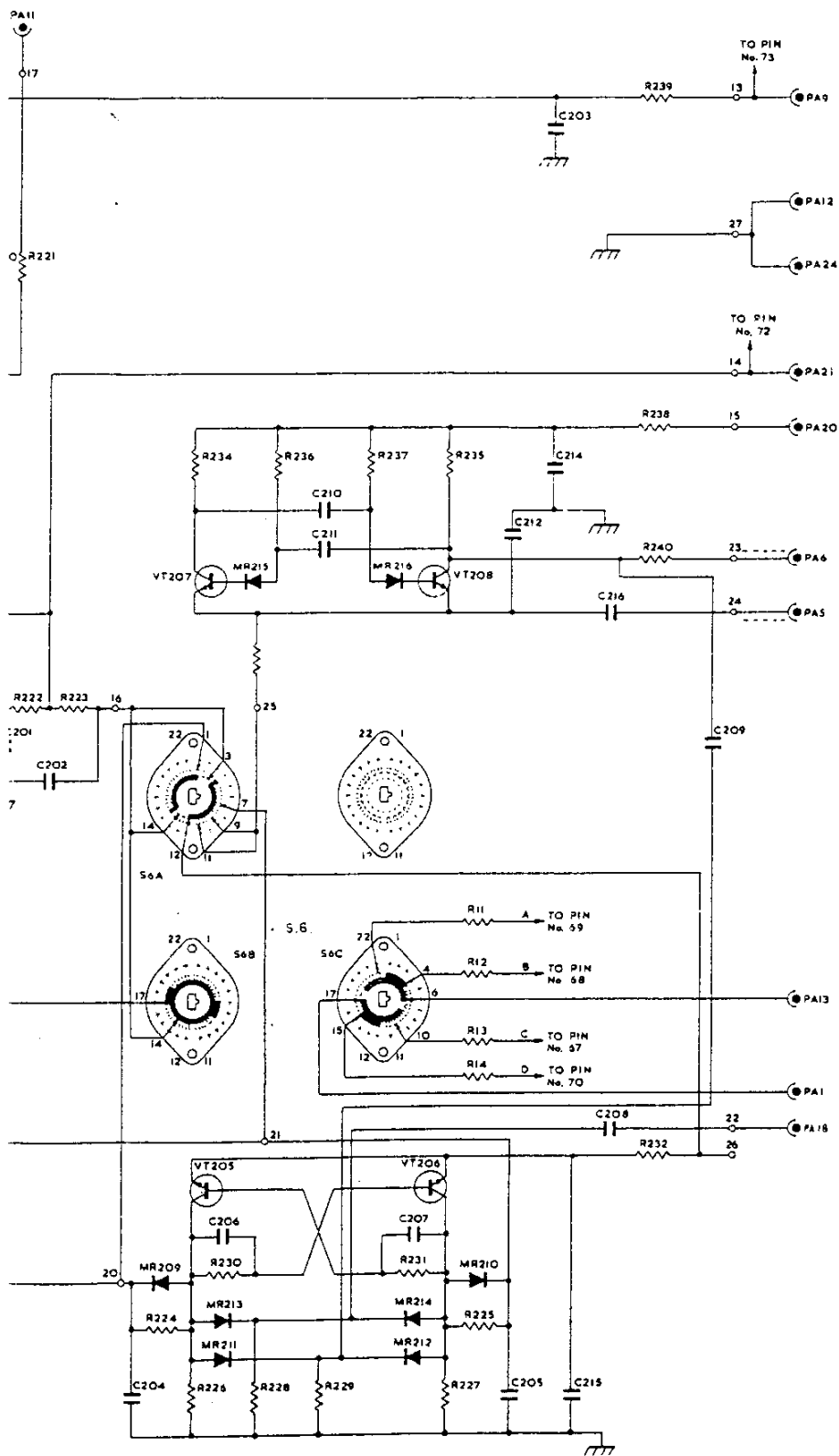


S6
 FUNCTION
 VIEWED FROM
 FRONT PANEL
 S6 IS SHOWN IN Y1-Y2
 MODE TRIGGERED
 FROM Y2

Fig. 3 CIRCUIT DIAGRAM OS2002Y Y AMPLIFIER BOARD 2



AMPLIFIER BOARD 2



Component List and Illustrations

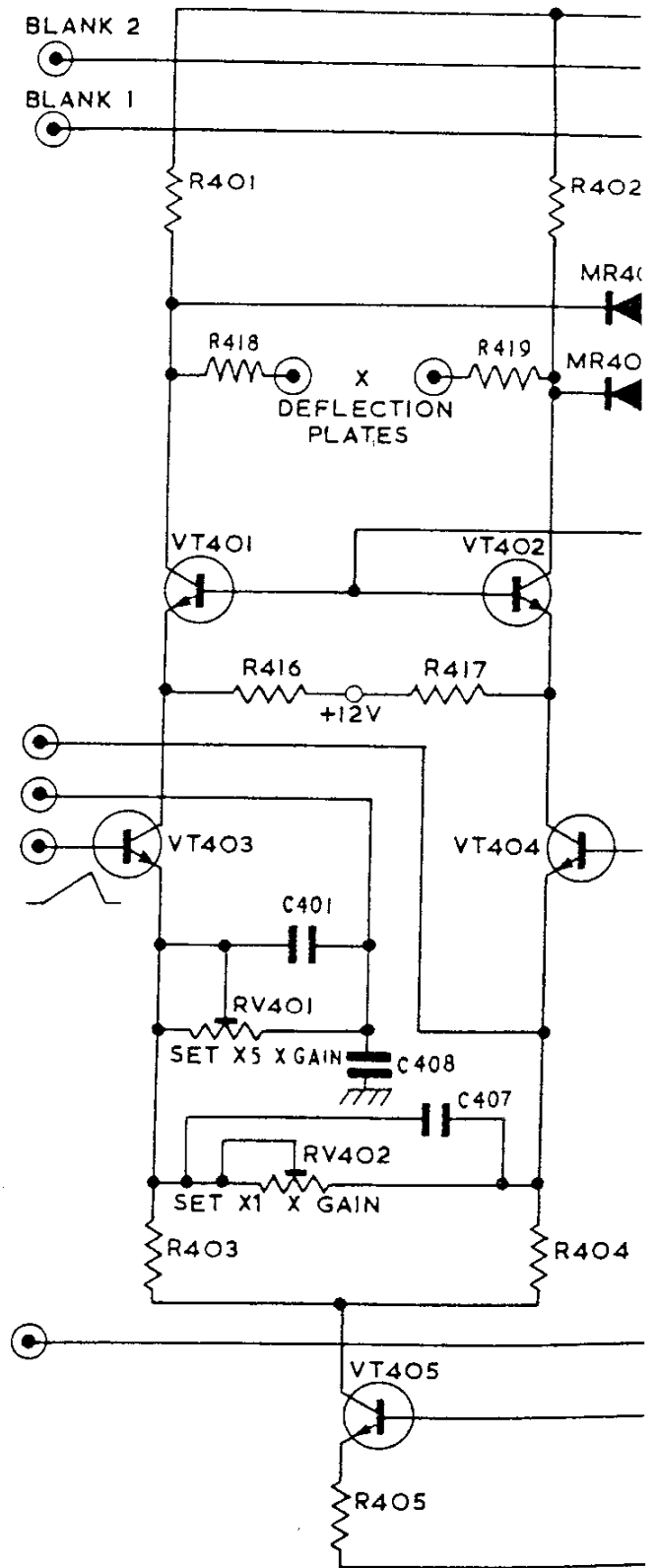
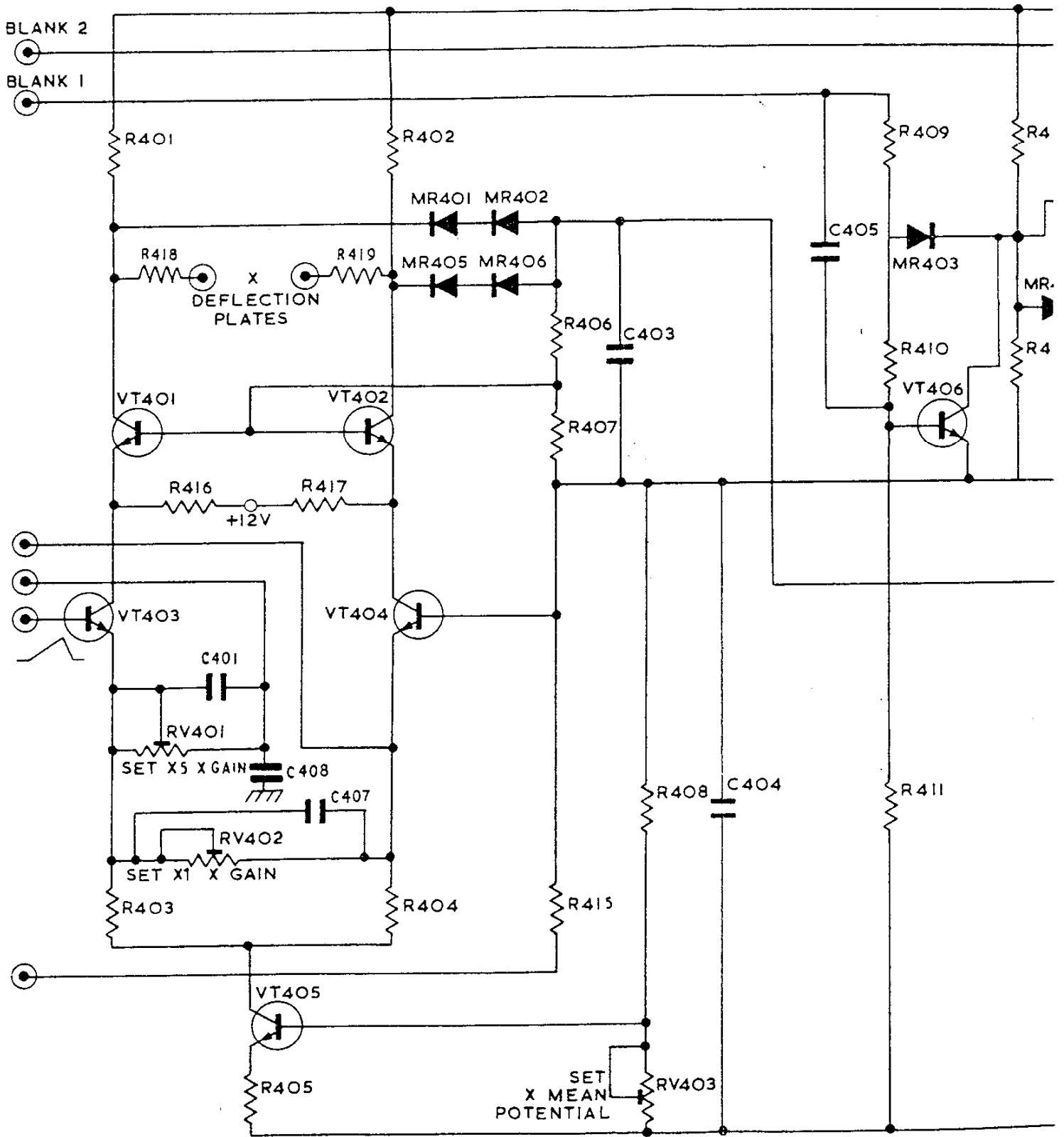
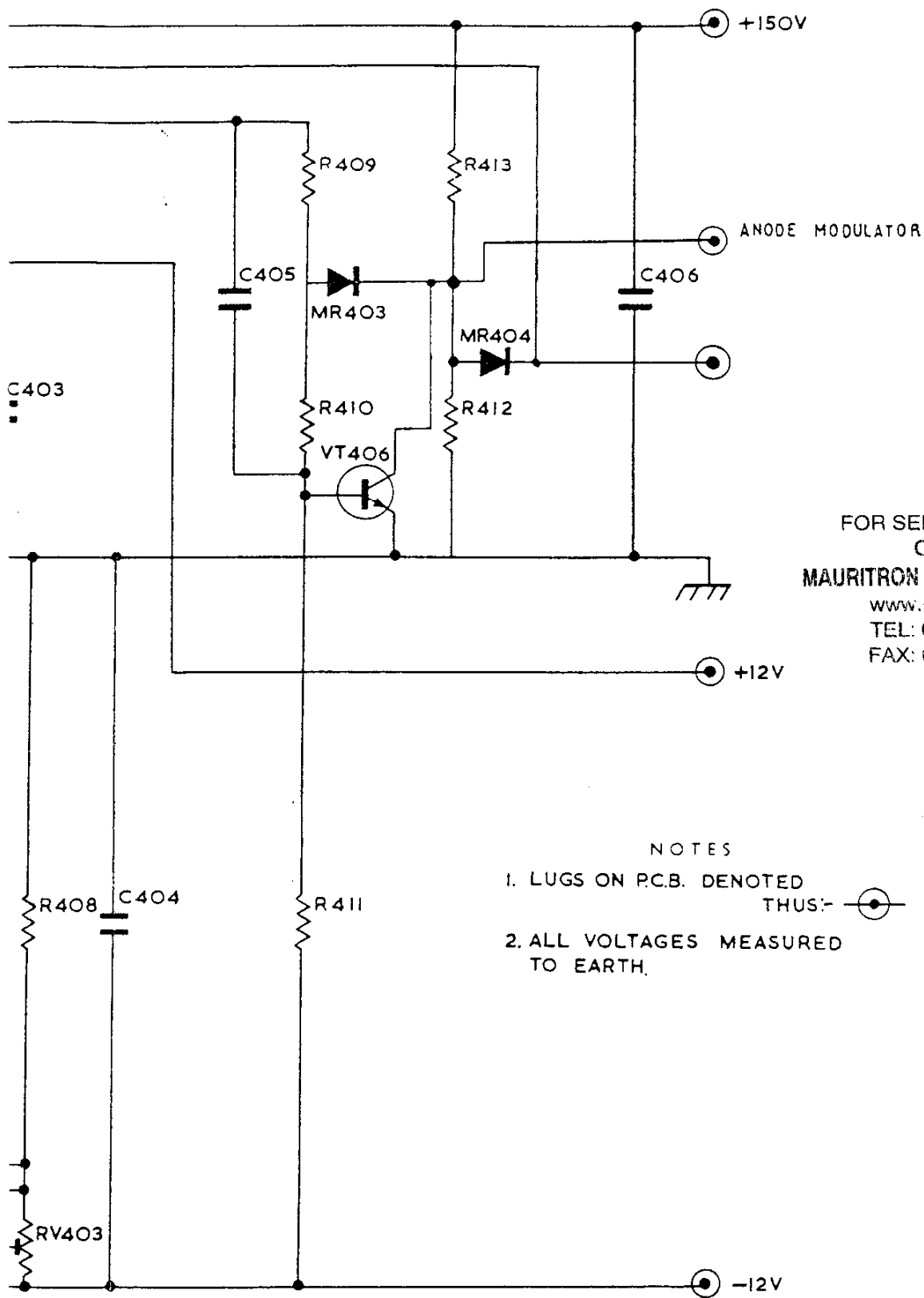


Fig. 4 X OUTPUT AMPLIFIER AND BEAM BLANKING CIRCUIT DIAGRAM




D BEAM BLANKING CIRCUIT DIAGRAM



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NOTES

1. LUGS ON P.C.B. DENOTED
THUS: 
2. ALL VOLTAGES MEASURED
TO EARTH.

Component List and Illustrations

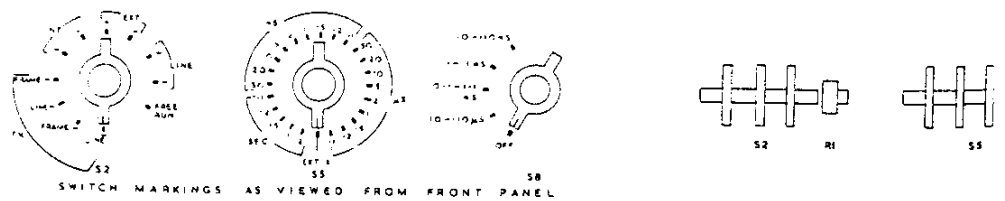
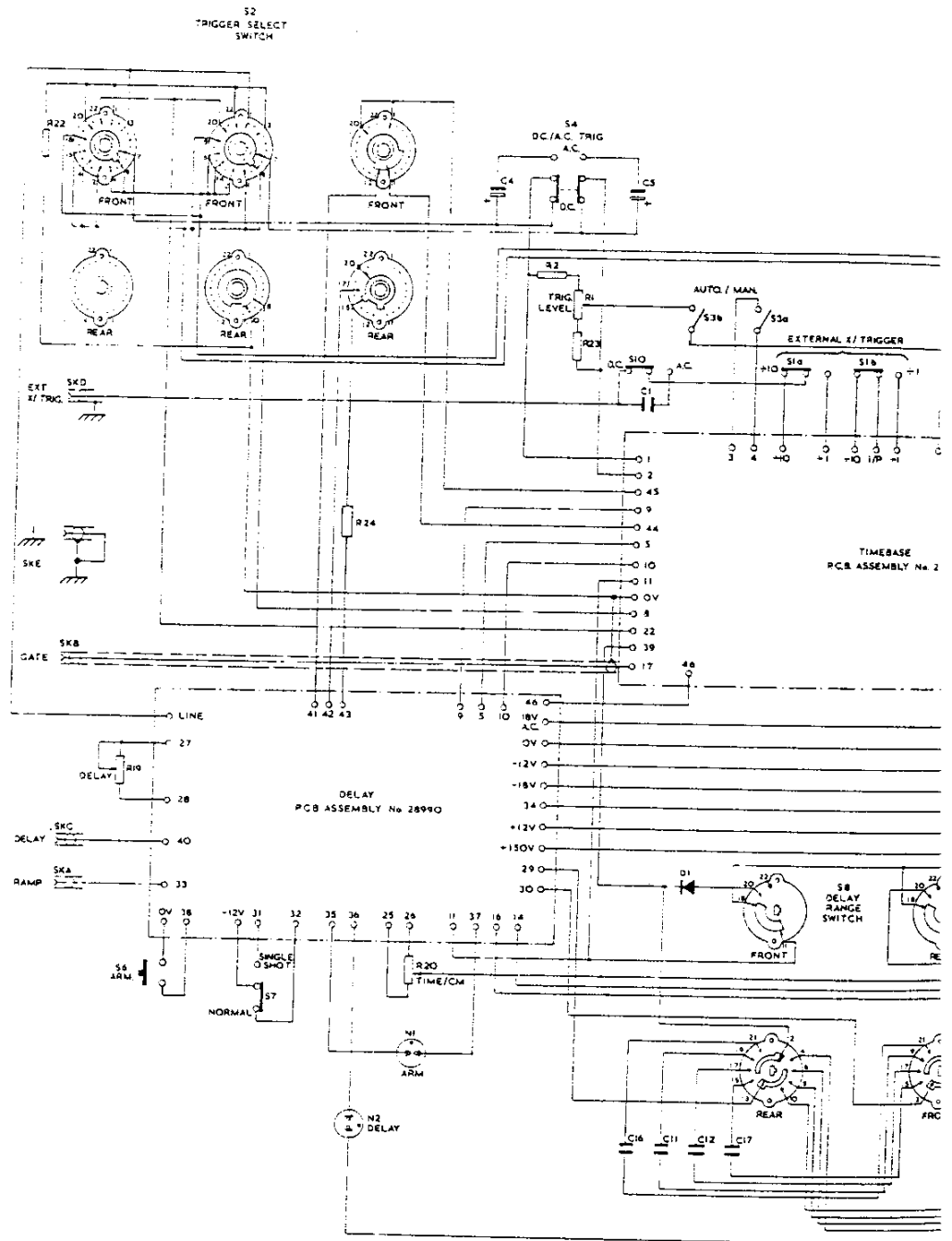
Section 6

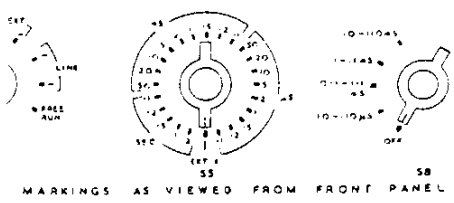
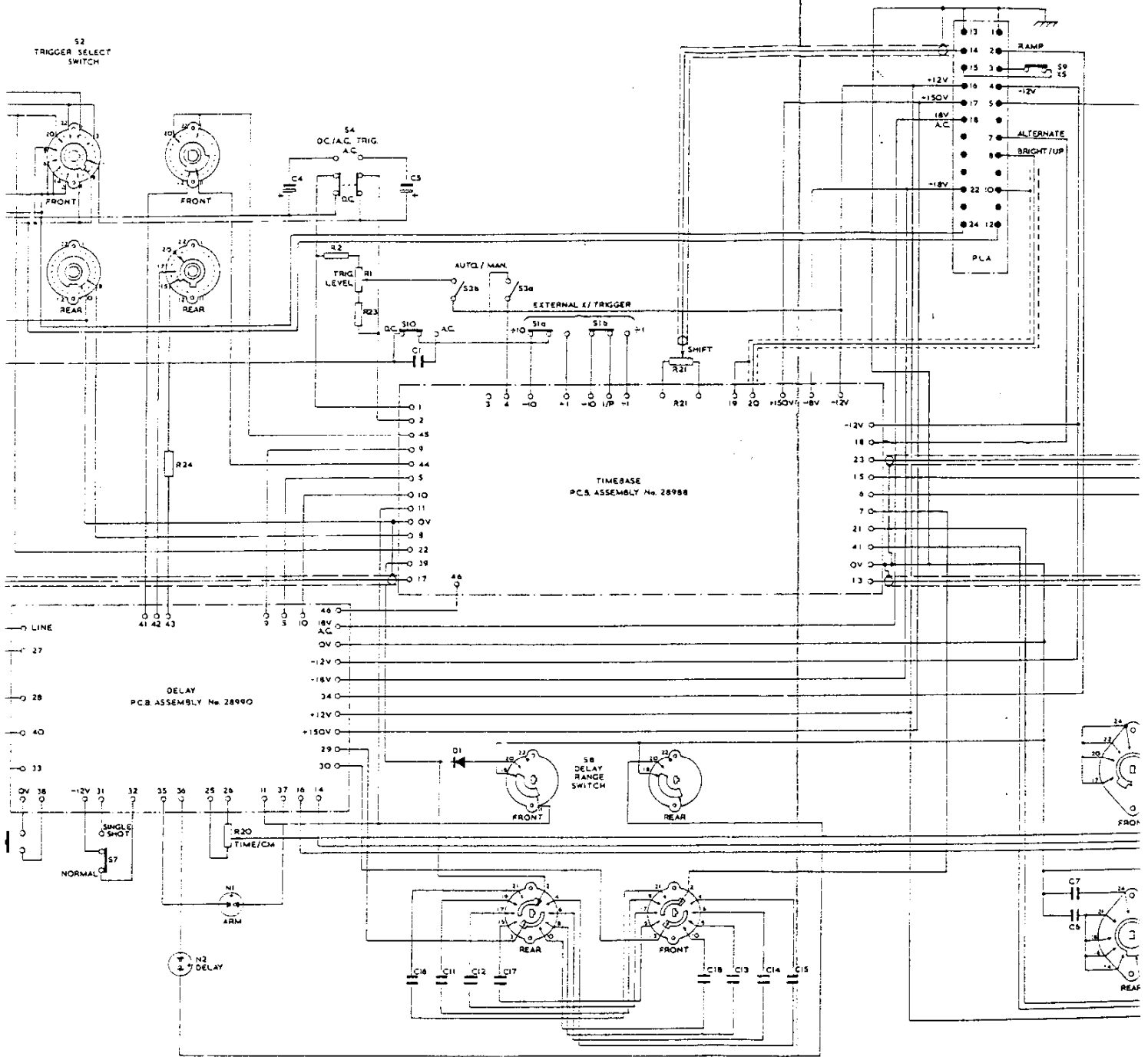
6.4 OS2007Y Y AMPLIFIER BOARD 1

Ref	Value	Description	Tol%±	Part No.	Ref	Value	Description	Tol%±	Part No.
RESISTORS					R138	39		5	1/8 W 28713
R1/2	33		5	1/8 W 2931	R139	100	Plessey MPD/PC	5	1/8 W 28520
R3/4	10		5	1/8 W 2259	R140/1	10		5	1/8 W 2259
R5/6	990k		1	26345	R142	1k5		5	1/8 W 21801
R7/8	47		5	1/8 W 727	R143/4	1k		1	26541
R9	10		5	1/8 W 2259	R146/7	47		5	1/8 W 28714
R10	33		5	1/8 W 2931	R148	10		5	1/8 W 21793
R11	10.1k		1	26338	R153	100		5	1/8 W 21794
R12	10		5	1/8 W 2259	R154/5	3k3		5	1/8 W 1638
R13	33		5	1/8 W 2931	R156	100		5	1/8 W 21794
R14	10.1k		1	26338	R157/8	4k7		5	1/8 W 787
R15/7	10		5	1/8 W 2259	R159	3k3		5	1/8 W 21803
R18	900k		5	26344	R160	3k3		5	1/8 W 21803
R19	111k		1	26339	R161/2	680		5	1/8 W 309
R20	33		5	1/8 W 2931	R163	100		5	1/8 W 21794
R21	10		5	1/8 W 2259	R164	470	Plessey MPD/PC		28524
R22	900k		1	26344	R165	3k3		5	1/8 W 21803
R23	111k		1	26339	R166	1k2		5	1/8 W 21800
R24	33		5	1/8 W 2931	R167	560		5	1/8 W 21798
R25/8	10		5	1/8 W 2259	R168/9	1k		1	26541
R29	1M		1	26346	R170	330		5	1/8 W 28721
R30	330k		5	1/2 W 4408	R171	250	Guest PN10B		29371
R31	1M		1	26346	R172	150		5	1/8 W 28719
R32	330k		5	1/2 W 4408	R173	250	Guest PN10B		29371
R33/4	5k	Control Pot.		A29916	R174	56		5	1/8 W 28715
R35/6	22		5	1/8 W 723	R175	100	Guest PN10B		29915
R101	10		5	1/8 W 2259	R176	47		5	1/8 W 28714
R103	100		5	1/8 W 21794	R177/8	220		5	1/8 W 21796
R104/5	3k3		5	1/8 W 1638	R179	1k		5	1/8 W 21799
R106	100		5	1/8 W 21794	R180/1	4k7		5	1/8 W 787
R107/8	4k7		5	1/8 W 787	R182	47		5	1/8 W 727
R109	3k3		5	1/8 W 21803	R183/4	3k3		5	1/8 W 21803
R110	3k3		5	1/8 W 21803	R185	1k		1	26541
R111/2	680		5	1/8 W 309	R186	120		5	1/8 W 28718
R113	100		5	1/8 W 21794	R187	330		5	1/8 W 28721
R114	470	Plessey MPD/PC		28524	R188	39		5	1/8 W 28713
R115	3k3		5	1/8 W 21803	R189	100	Plessey MPD/PC		28520
R116	1k2		5	1/8 W 21800	R190	220		5	1/8 W 21796
R117	560		5	1/8 W 21798	R191/2	10		5	1/8 W 21793
R118/9	1k		1	26541	R193	4k7	Plessey MPD/PC		24560
R120	330		5	1/8 W 28721	R194	1k		1	26541
R121	250	Guest PN10B		29371	R195	2k2		5	1/8 W 21802
R122	150		5	1/8 W 28719	R196	100		5	1/8 W 21794
R123	250	Guest PN10B		29371	R197	10		5	1/8 W 2259
R124	56		5	1/8 W 28715	R198	2k2		5	1/8 W 425
R125	100	Guest PN10B		29915	R199	1k		1	26541
R126	47		5	1/8 W 28714	DIODES				
R127/8	220		5	1/8 W 21796	D101/2		2S152		24905
R129	1k		5	1/8 W 21799	D103/5	6V2	Zener		4032
R130/1	4k7		5	1/8 W 787	D106/7		2S152		24905
R132	47		5	1/8 W 727	D108	6V2	Zener		4032
R133/4	4k7		5	1/8 W 21805	D109	9V1	Zener		4667
R135	1k		1	26541	D110	6V2	Zener		4032
R136	120		5	1/8 W 28718	D111		1N914		23802
R137	330		5	1/8 W 28721					

Component List and Illustrations

Section





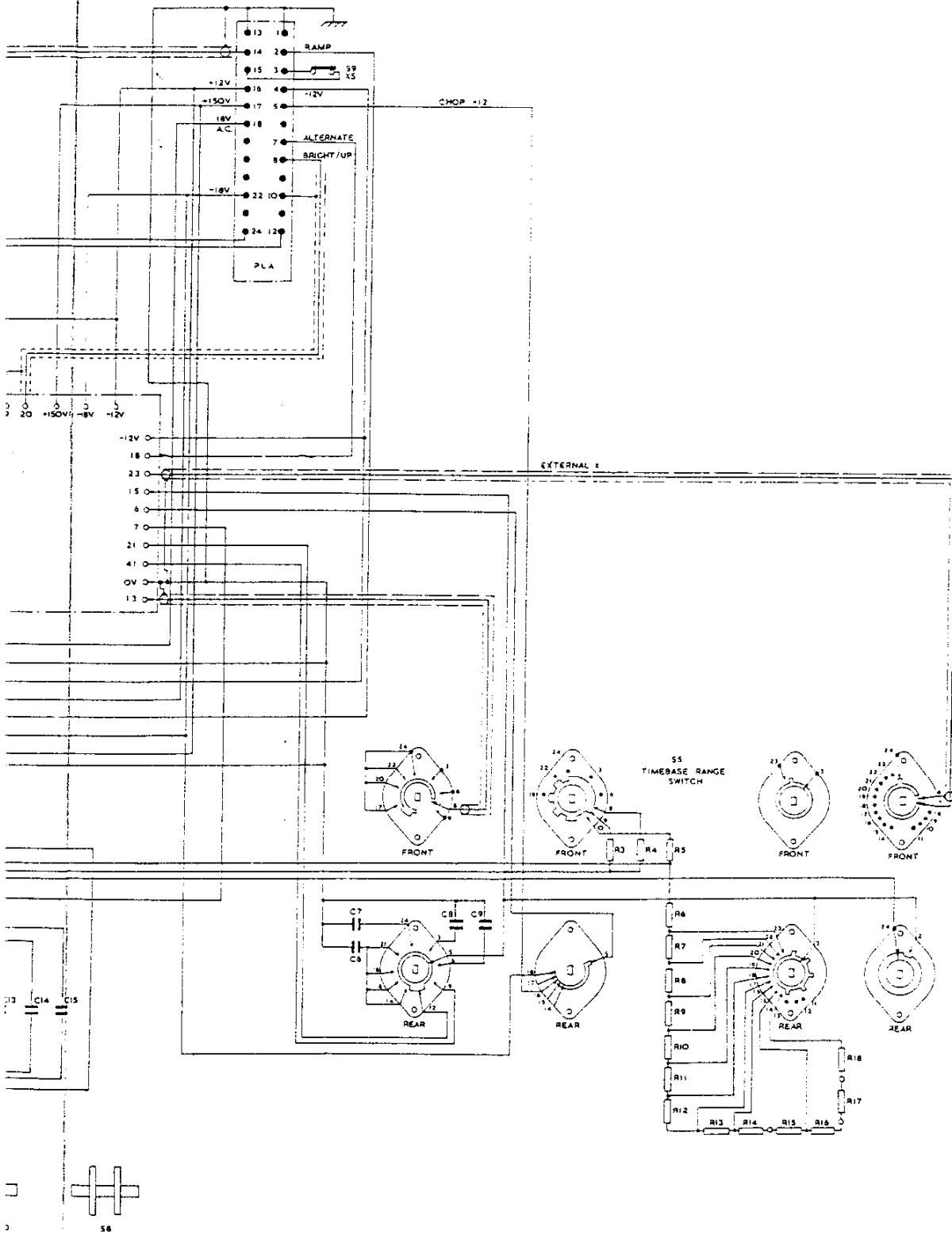


Fig. 6 OS2006X Interconnection Circuit

6.4 OS2007Y Y AMPLIFIER BOARD 1 (Cont.)

Ref	Value	Description	Part No.
CAPACITORS			
C1/2	.1μF		400V 29495
C3/6	.7-6pF		25750
C7/8	500pF		29917
C9/12	.7-6pF		25750
C13/4	47pF		29918
C15/6	6.8pF		4617
C17/8	.7-6pF		25750
C19/20	.01μF		400V 3399
C103/7	.01μF		22395
C108	25μF		25V 20776
C109	6-25pF		23593
C110	6-25pF		23593
C111/3	.01μF		22395
C116	.01μF		22395
C117	250μF		16V 20783
C118	25μF		25V 20776
C119	.1μF		400V 2385
C120/1	.01μF		22395
C122/3	6-25pF		23593
C124/8	.01μF		22395
TRANSISTORS			
TR101	AE11 (FET)	Matched pair	29512
TR102	AE11 (FET)		
TR103/4	2N3662		24123
TR105	2N3905		20818
TR106/7	MPS 3640		24128
TR108/9	2N3662		24123
TR110/1	2N3905		20818
TR112	AE11 (FET)	Matched pair	29512
TR113	AE11 (FET)		
TR114/5	2N3662		24123
TR116	2N3905		20818
TR117/8	MPS 3640		24128
TR119/20	2N3662		24123
TR212/2	2N3905		20818
TR123	BSX20		23307
SWITCHES			
S1/2			28415
S3/4			29238
SOCKETS			
SKA/C	BNC 50		1222
SKD	4mm		23636

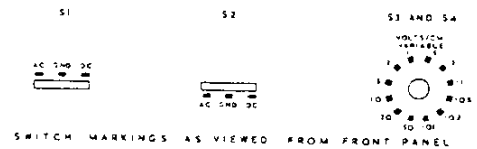
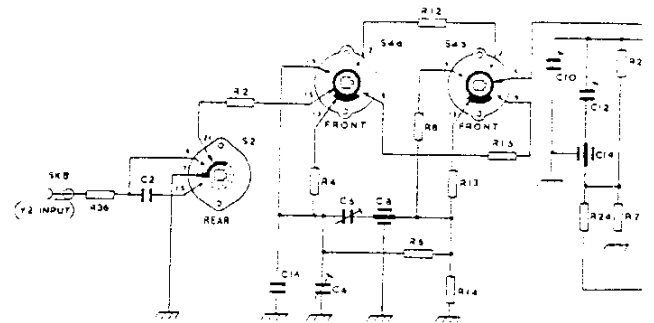
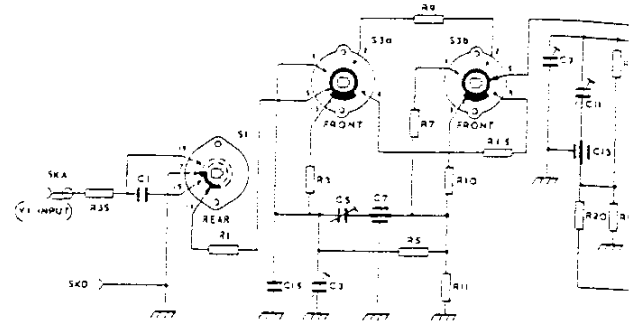
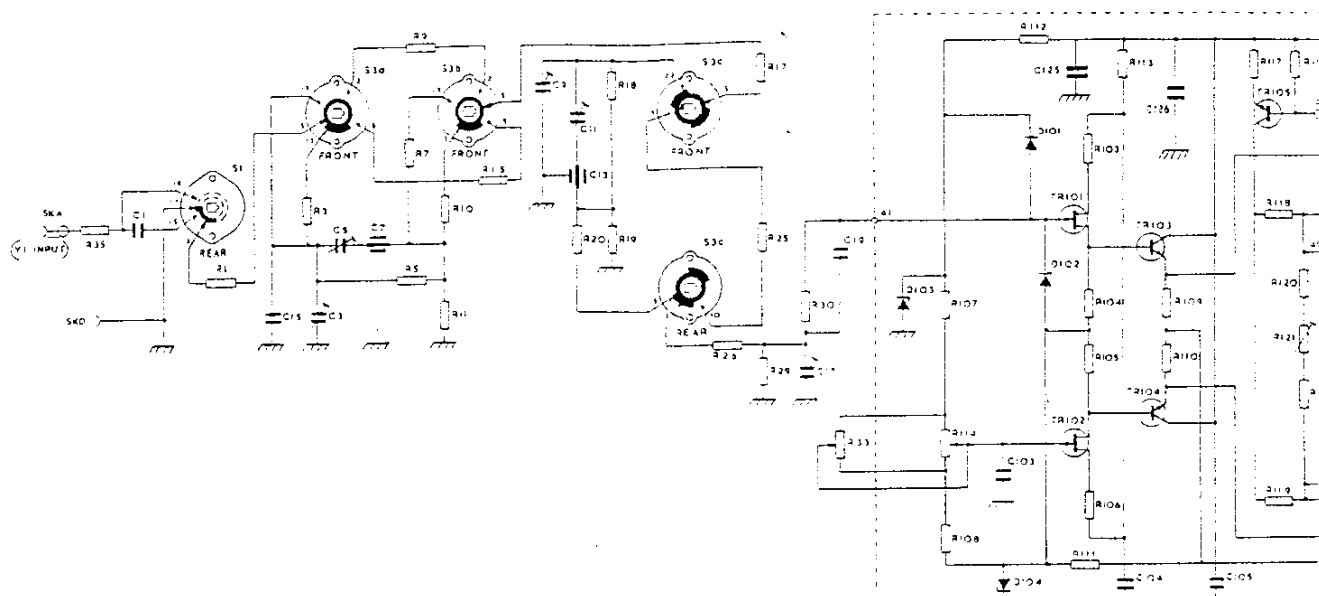


Fig. 4 CIRCUIT DIAGRAM OS2007Y Y AMPLIFIER BOARD 1

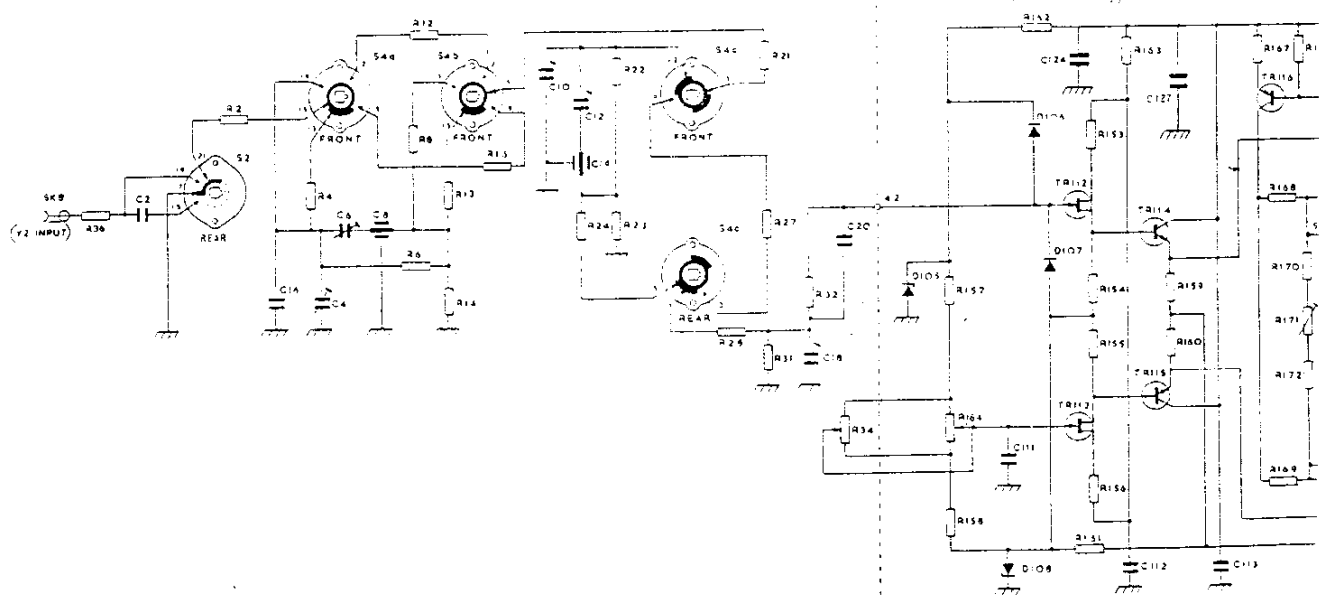
Cont.)

Part No.

- 29495
- 25750
- 29917
- 25750
- 29918
- 4617
- 25750
- 3399
- 22395
- 20776
- 23593
- 23593
- 22395
- 22395
- 20783
- 20776
- 2385
- 22395
- 23593
- 22395



- 29512
- 24123
- 20818
- 24128
- 24123
- 20818
- 29512
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- 20818
- 23307



- 28415
- 29238

- 1222
- 23636

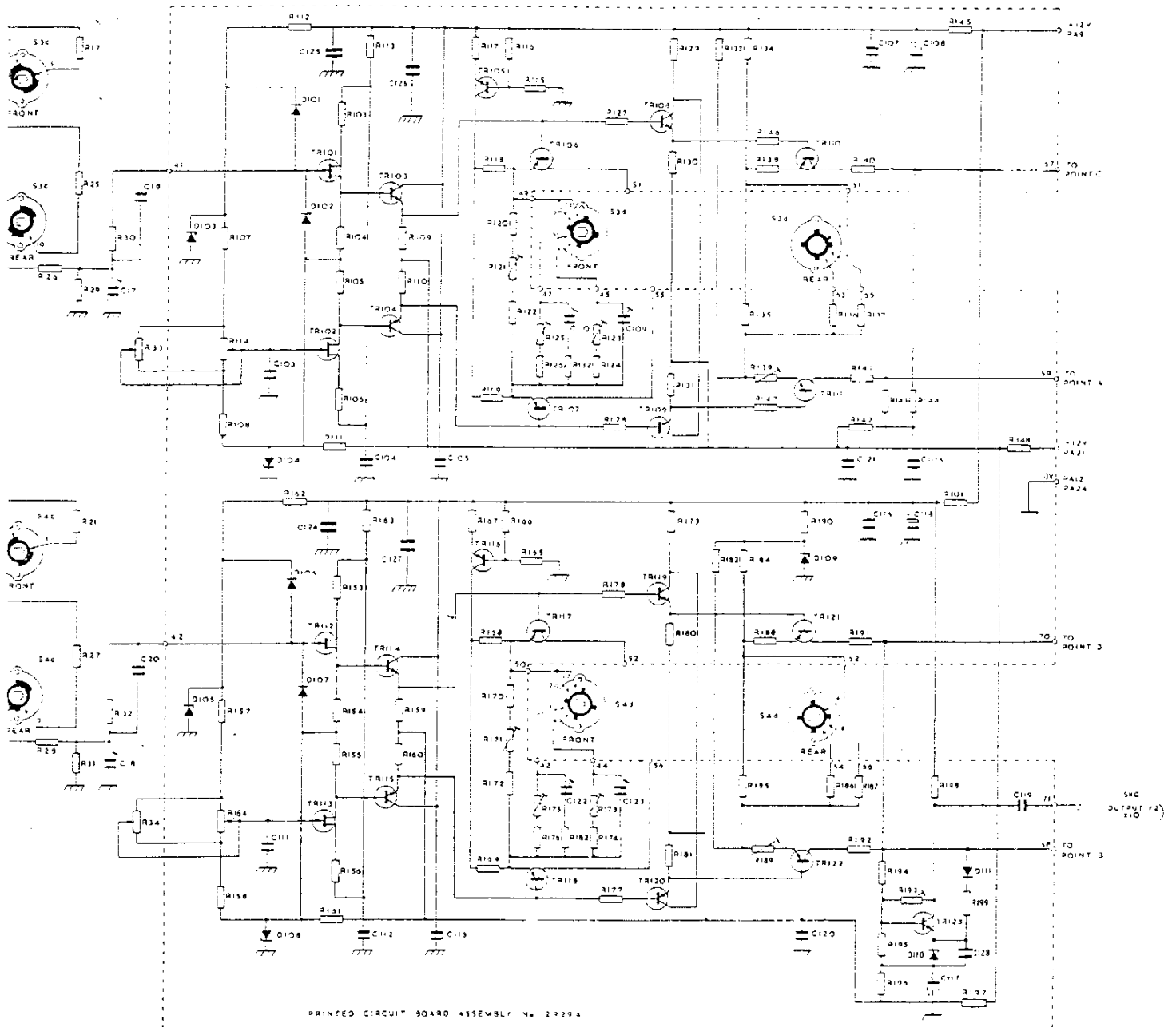


SWITCH MARKINGS AS VIEWED FROM FRONT PANEL

PRINTED CIRCUIT BOARD ASSEMBLY

Fig. 4 CIRCUIT DIAGRAM OS2007Y Y AMPLIFIER BOARD 1

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Component List and Illustrations

Section 6

6.5 OS2007Y Y AMPLIFIER BOARD 2

Ref	Value	Description	Tol%±	Part No.	Ref	Value	Description	Part No.	
RESISTORS					CAPACITORS				
R37/8	2k7		5	1/8 W 311	C201/3	.01µF		22395	
R39/40	100		5	1/8 W 11504	C204/5	470pF		22383	
R41/2	5k	Control Pot.		26597	C206/8	47pF		22372	
R43/4	1k	Control Pot.		A22149	C209	18pF		22367	
R45/8	10		5	1/8 W 2259	C210	820pF		22386	
R201/6	220		5	1/8 W 304	C211	220pF		22379	
R207/8	3k3		5	1/8 W 1638	C212	.1µF	400V	2385	
R209	470		5	1/8 W 1373	C214/6	.1µF	400V	2385	
R210	470		5	1/8 W 1373	C218/9	2.7pF		816	
R211/2	1k		5	1/8 W 384	TRANSISTORS				
R213/4	2k7		5	1/8 W 311	TR1/2	2N 3662		24123	
R215/6	1k5		5	1/8 W 385	TR201/2	2N 3662		24123	
R217	680		5	1/8 W 309	TR205/8	BSX20		23307	
R222/3	10		5	1/8 W 2259	DIODES				
R224/5	1k		5	1/8 W 384	D201/10	1N914		23802	
R226	2k2		5	1/8 W 425	D211/6	OA95		23318	
R227	2k2		5	1/8 W 425	MISCELLANEOUS				
R228/9	10k		5	1/8 W 11503	S5			30340	
R230/1	6k8		5	1/8 W 313	S6			24585	
R232	10		5	1/8 W 2259	PLA			24852	
R234	1k2		5	1/8 W 2087					
R235	2k2		5	1/8 W 425					
R236/7	12k		5	1/8 W 1685					
R238/9	10		5	1/8 W 2259					
R240	100		5	1/8 W 11504					
R241	10		5	1/8 W 2259					

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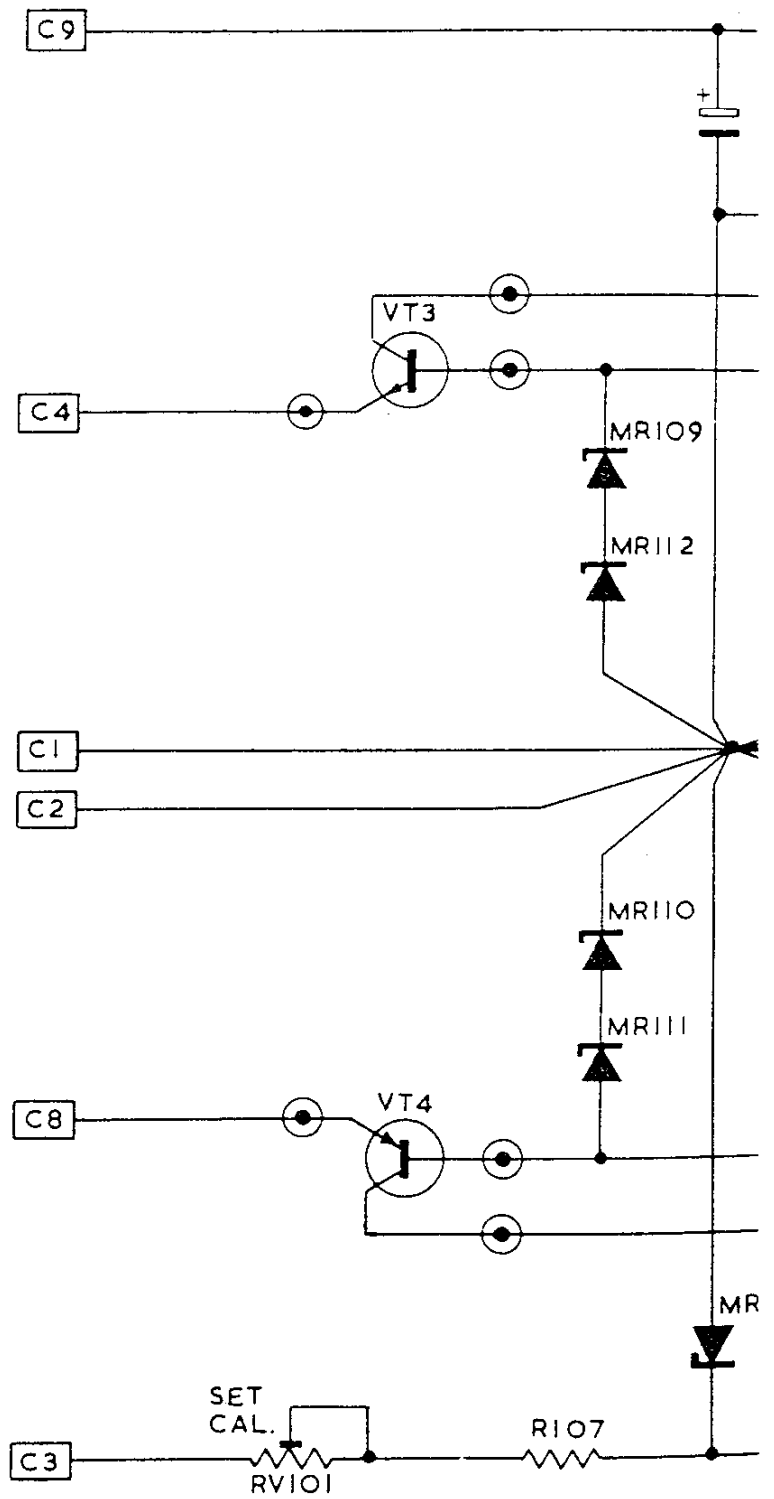
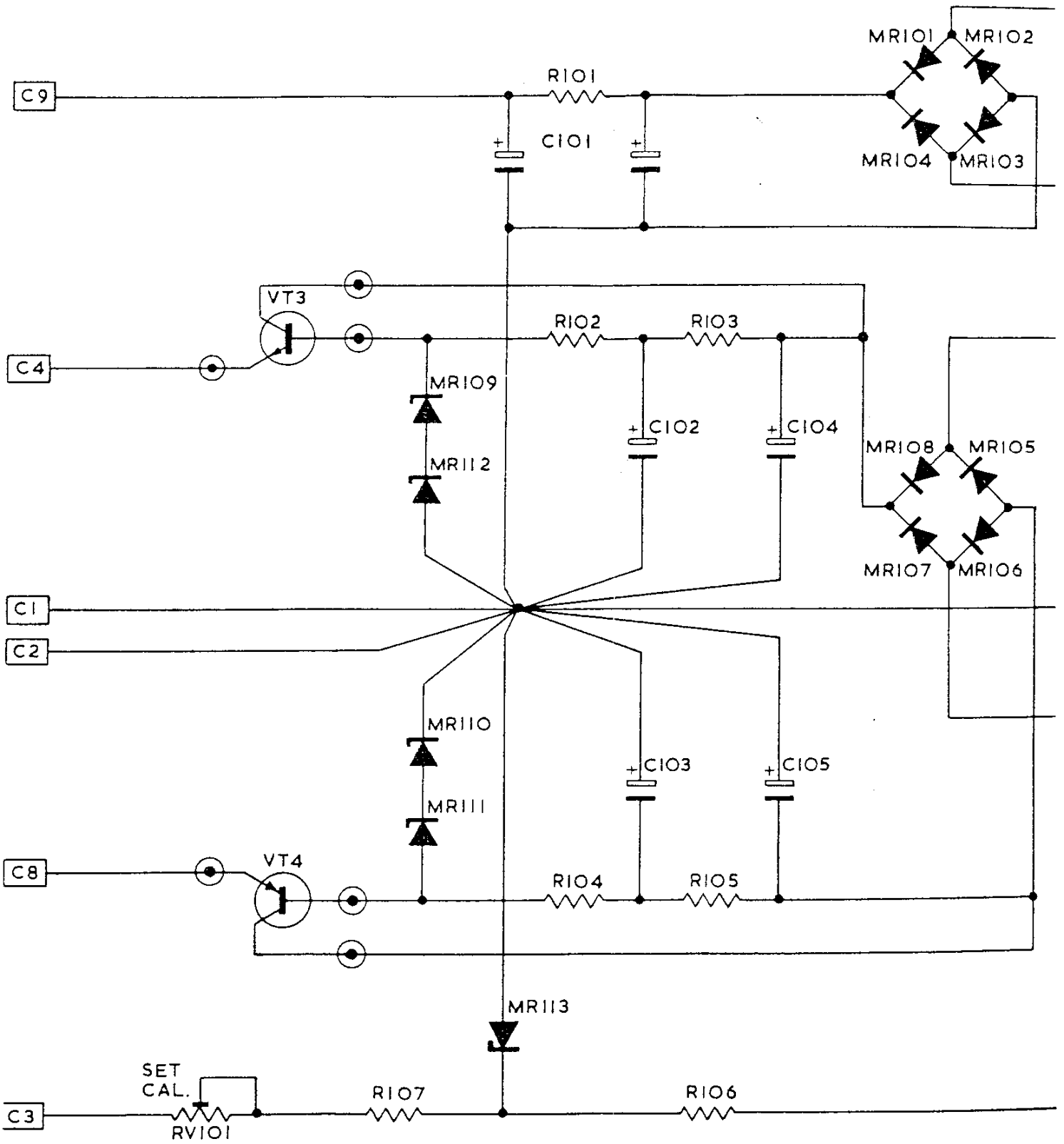
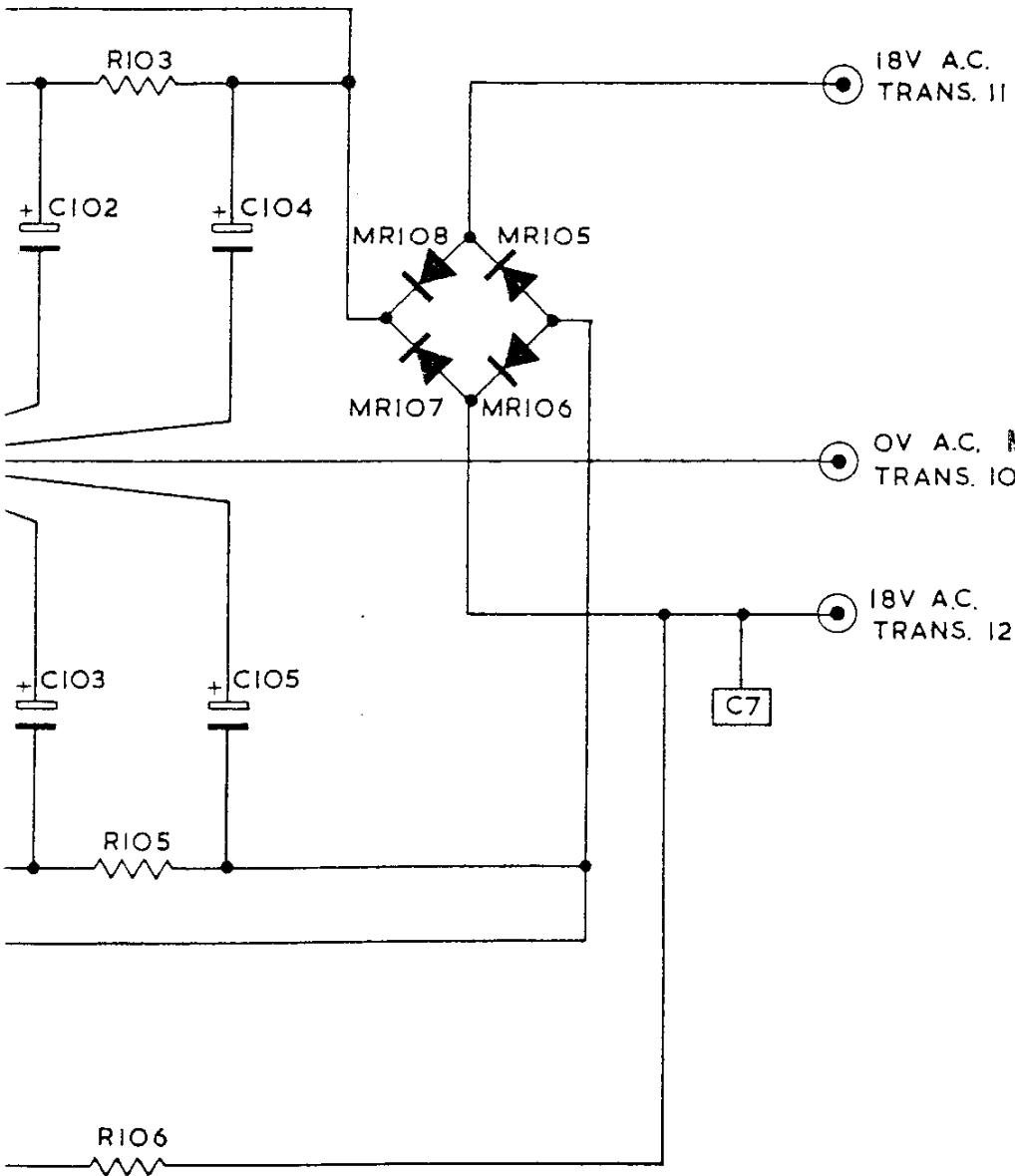
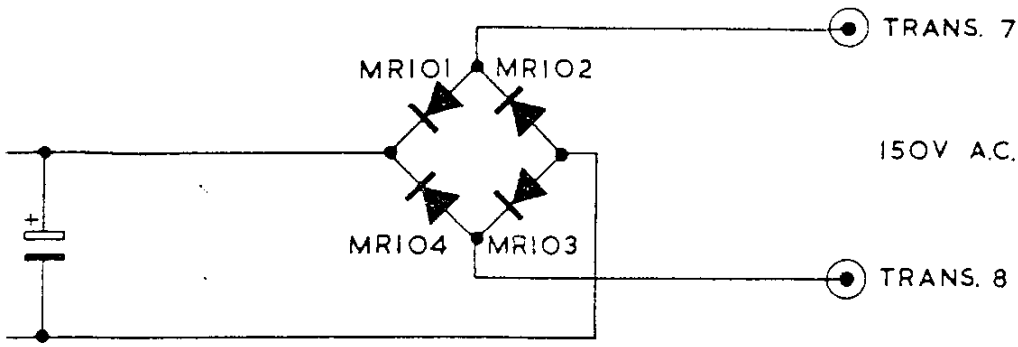


Fig. 5 LOW VOLTAGE POWER SUPPLY AND CALIBRATOR CIRCUIT DIAGRAM OS2000



LY AND CALIBRATOR CIRCUIT DIAGRAM OS2000



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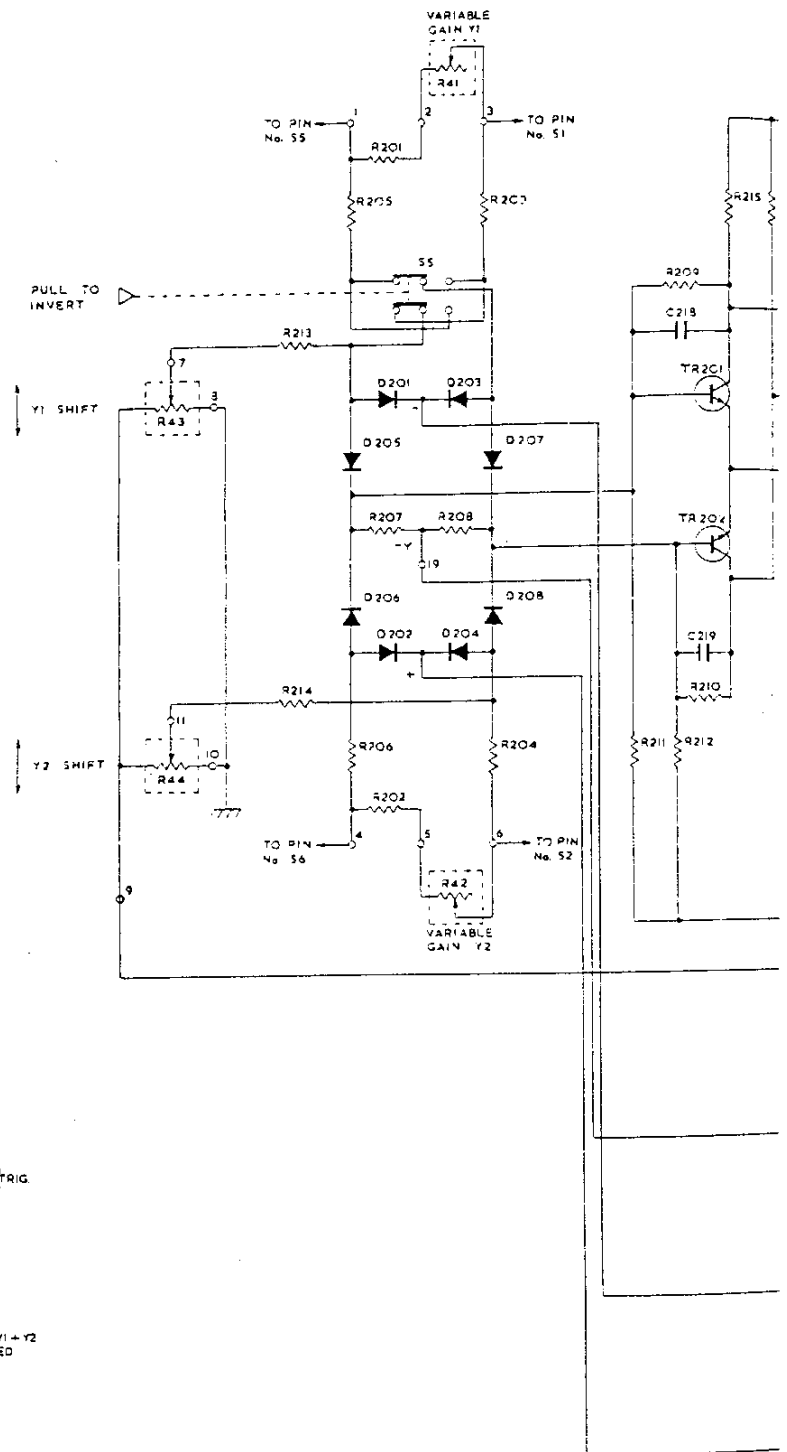
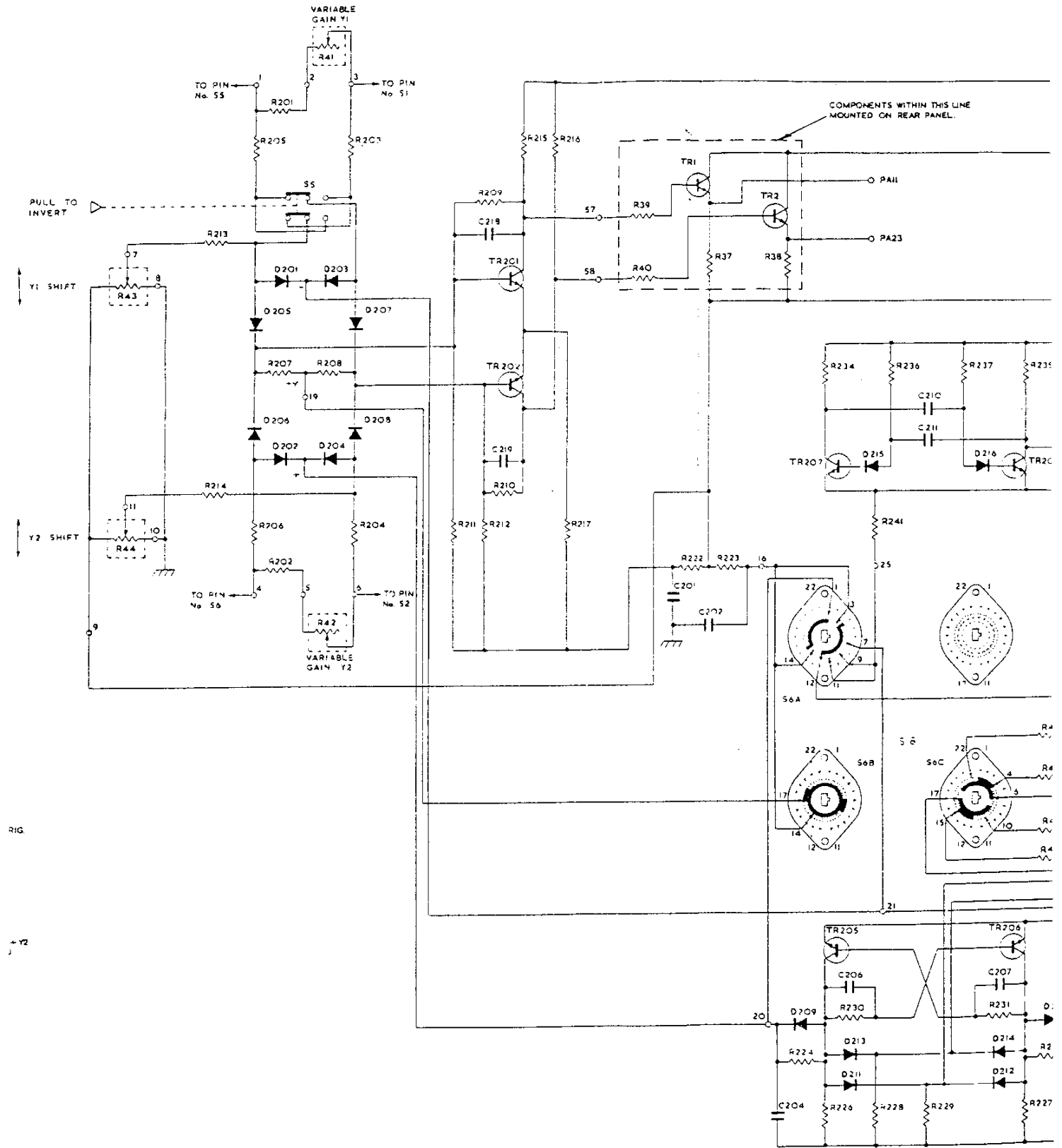
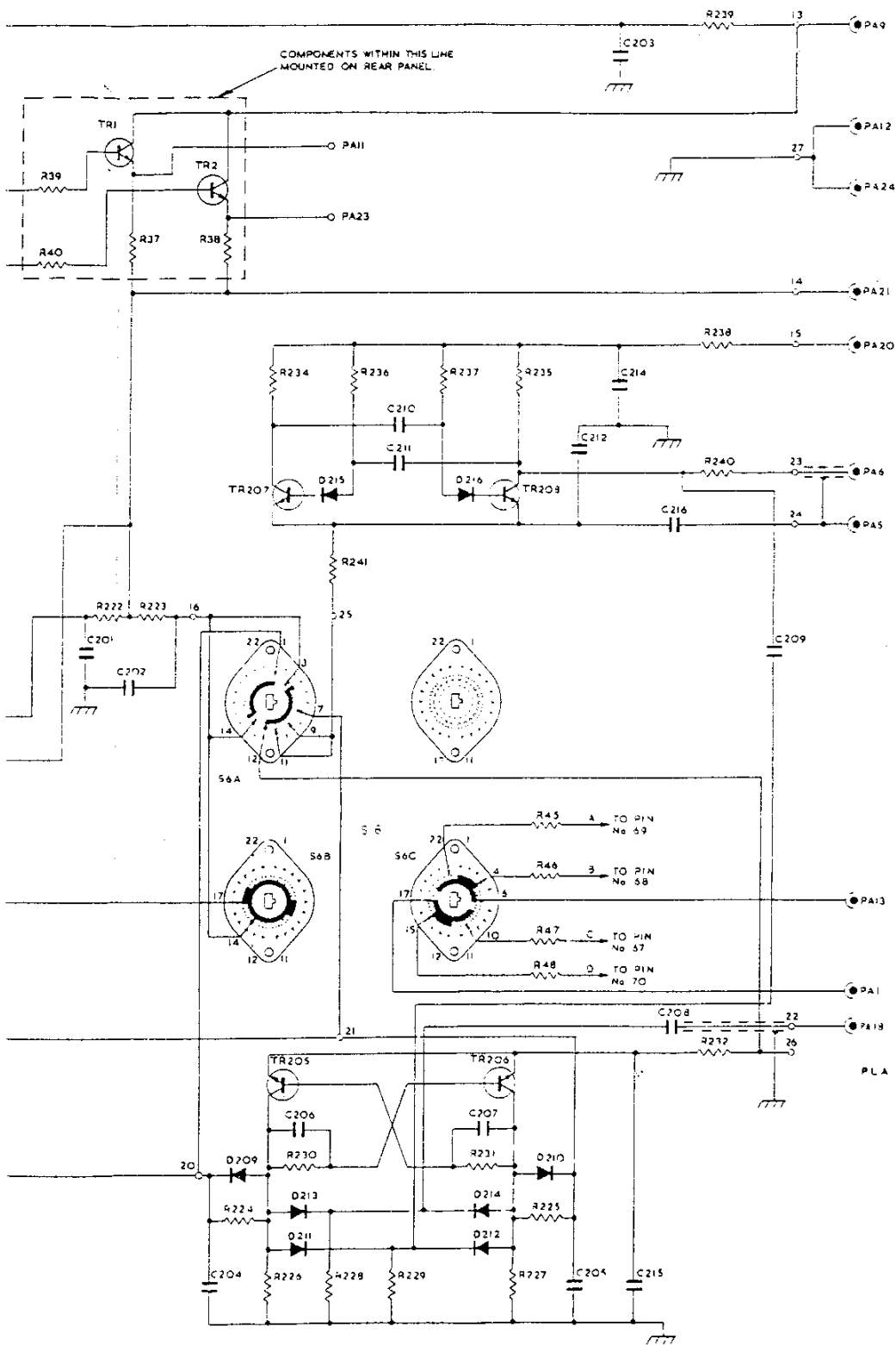


Fig. 5 CIRCUIT DIAGRAM OS2007Y Y AMPLIFIER BOARD 2



MULTIPLIER BOARD 2



Component List and Illustrations

Section 6

6.6 OS2001X

Ref	Value	Description	Tol%±	Part No.	Ref	Value	Description	Tol%±	Part No.
RESISTORS					CAPACITORS				
R1/5	10	Cr. Carbon	5	1/8 W 2259	C1	0.1µF	Wima Tropyfol M	400V	2385
R6	900K	Welwyn 4014		26344	C2	8.2pF	G.P. Ceramic	±1pF	A.O.T. 22363
R7	990K	Welwyn 4014		26345	C101/2	6/25pF	Trimmer Triko D.90		23593
R8	500K	Welwyn 4014		26342	C103	68pF	Lemco 1106R Ins.	5	4513
R9	750K	Welwyn 4014		26540	C104/5	6/25pF	Trimmer Triko D.90		23593
R10	39	Cr. Carbon	5	1/8 W 3010	C106	680pF	Lemco 1106S	5	24903
R101	111K	Welwyn 4014	1	26339	C107/9	6/25pF	Trimmer Triko D.90		23593
R102	10.1K	Welwyn 4014	1	26338	C110	6/25pF	Trimmer Triko D.90		23593
R103	1M	Welwyn 4014	1	26346	C111	10pF	G.P. Ceramic	10	22364
R104	333K	Welwyn 4014	1	26539	C112	.01µF	Polyester	20	3399
R105	1M	Welwyn 4014	1	26346	C113/4	.01µF	G.P. Ceramic	25	22395
R106	100K	Cr. Carbon	5	1W 19061	C117/8	.01µF	G.P. Ceramic	25	22395
R107	10	Cr. Carbon	5	1/8 W 2259	C120	50µF	Mullard C.426/ARG50	40V	20778
R108	2.7K	Cr. Carbon	5	1/8 W 311	C121	.01µF	G.P. Ceramic	25	22395
R11/2	10	Cr. Carbon	5	1/8 W 2259	C123	220pF	Silver Mica	1	11587
R113	18K	Cr. Carbon	5	1/8 W 634	TRANSISTORS				
R114/5	3.3K	Cr. Carbon	5	1/8 W 1638	VT101		UC734		24832
R117	10	Cr. Carbon	5	1/8 W 2259	VT102		MPS 3640		24128
R120	5.6K	Cr. Carbon	5	1/8 W 787	VT103/5		BSX.20		23307
R121	470	Cr. Carbon	5	1/8 W 1373	DIODES				
R123	10K	Cr. Carbon	5	1/8 W 11503	MR101/2		1N 3595		29330
R124	100	Cr. Carbon	5	1/8 W 11504	MR103/5		Zener ZF.6.2 STC.		4032
R125	68	Cr. Carbon	5	1/8 W 1640	SWITCHES				
R126	10	Cr. Carbon	5	1/8 W 2259	S1		Ariel Pressings DP/3T RA2405		25869
R128	10	Cr. Carbon	5	1/8 W 2259	S2		To SW. DRG.		24580
R129	1K	Cr. Carbon	5	1/8 W 384	SOCKET				
R130	1K	Cr. Carbon	5	1/8 W 384	SK.1	50	B.N.C. UG.1094/U		1222
R131	6.8K	Cr. Carbon	5	1/8 W 313	CONTROL POTS.				
R132	330	Cr. Carbon	5	1/8 W 1894	RV1	500	Lin. Morgan 'U'		24587
R133	470	Cr. Carbon	5	1/8 W 1373	RV101	4.7K	Plessey MPD/PC		24560
R134	150	Cr. Carbon	5	1/8 W 301	RV102	2.2K	Plessey MPD/PC		24561
					RV103	4.7K	Plessey MPD/PC		24560

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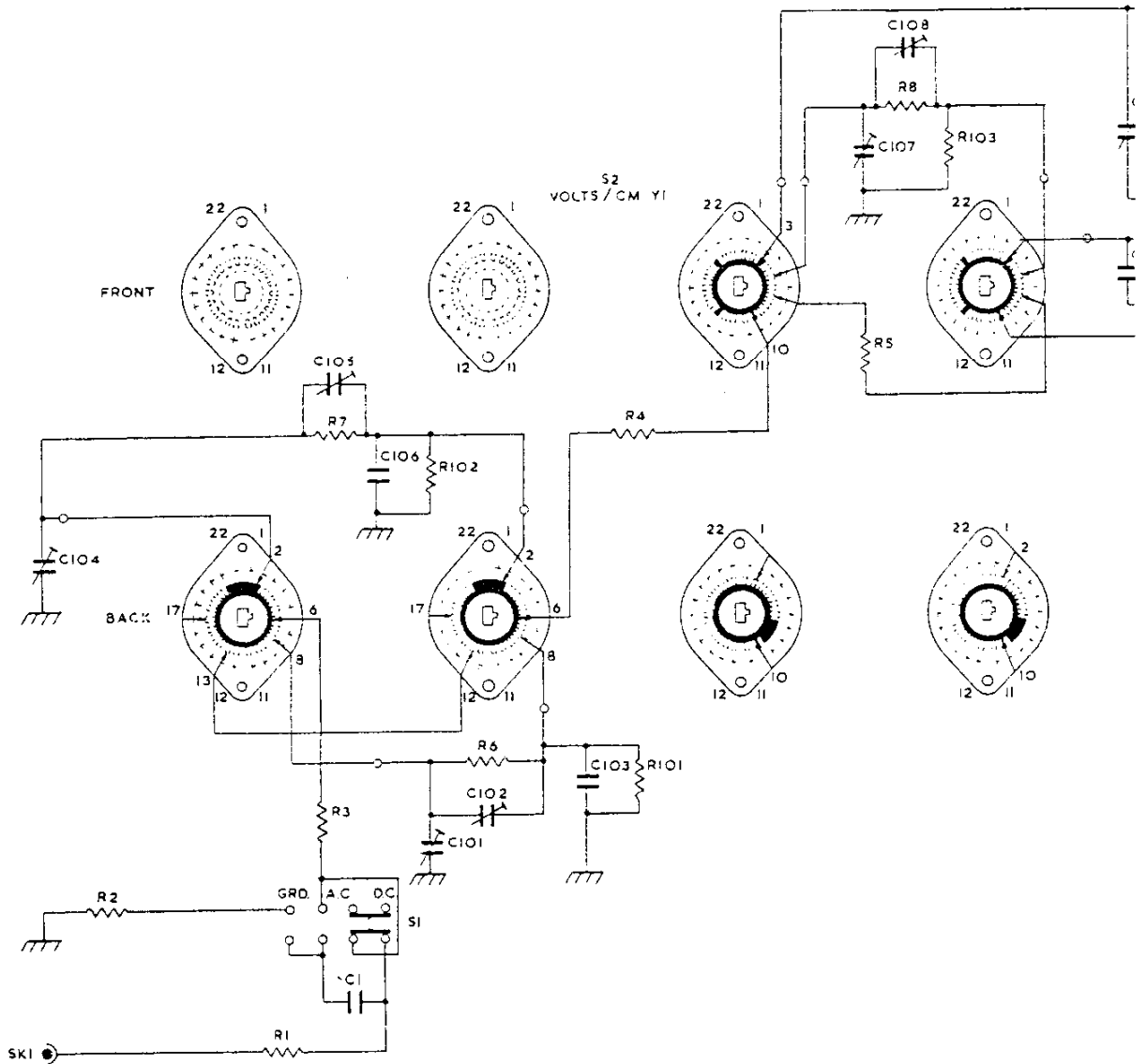
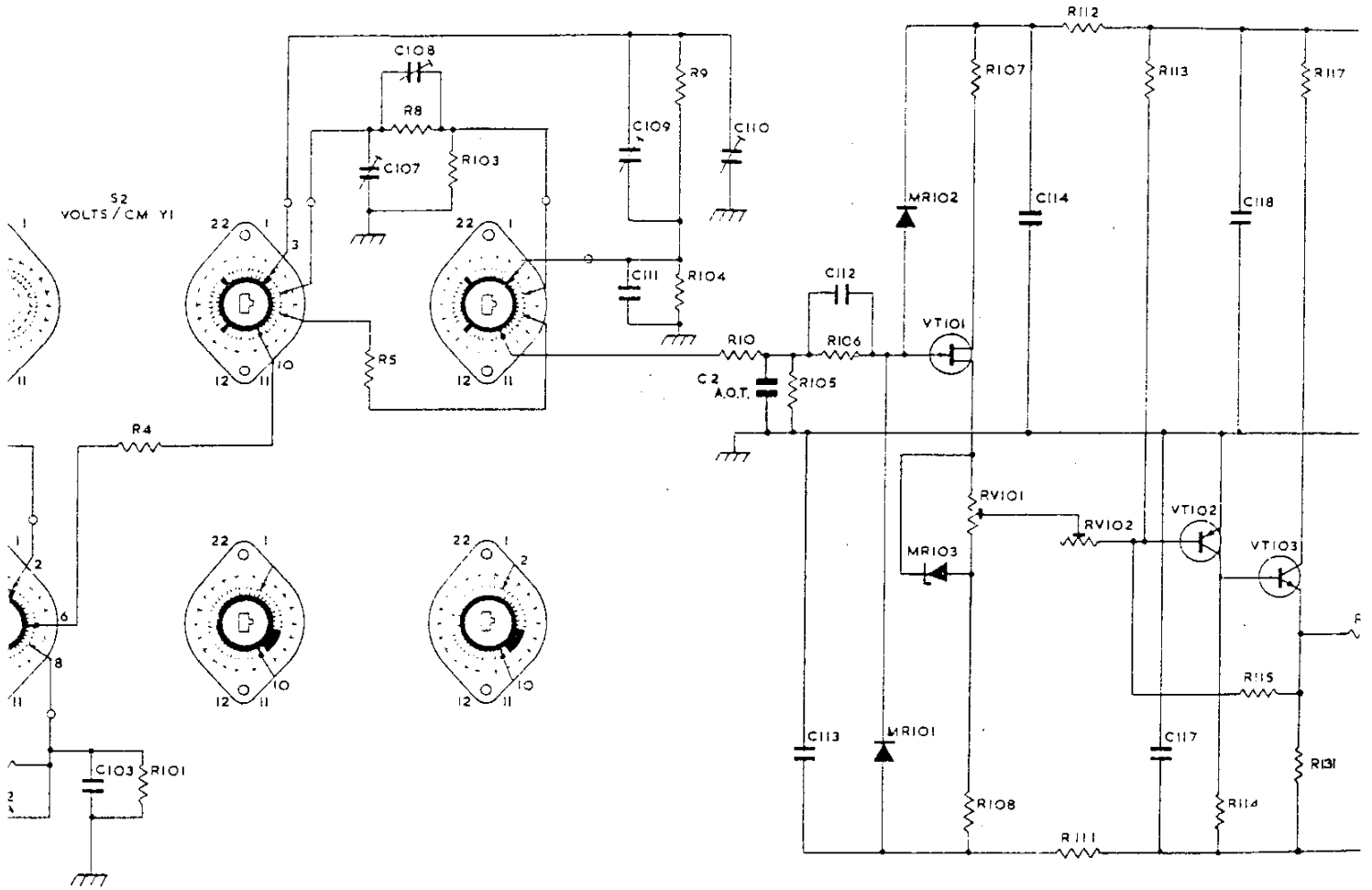
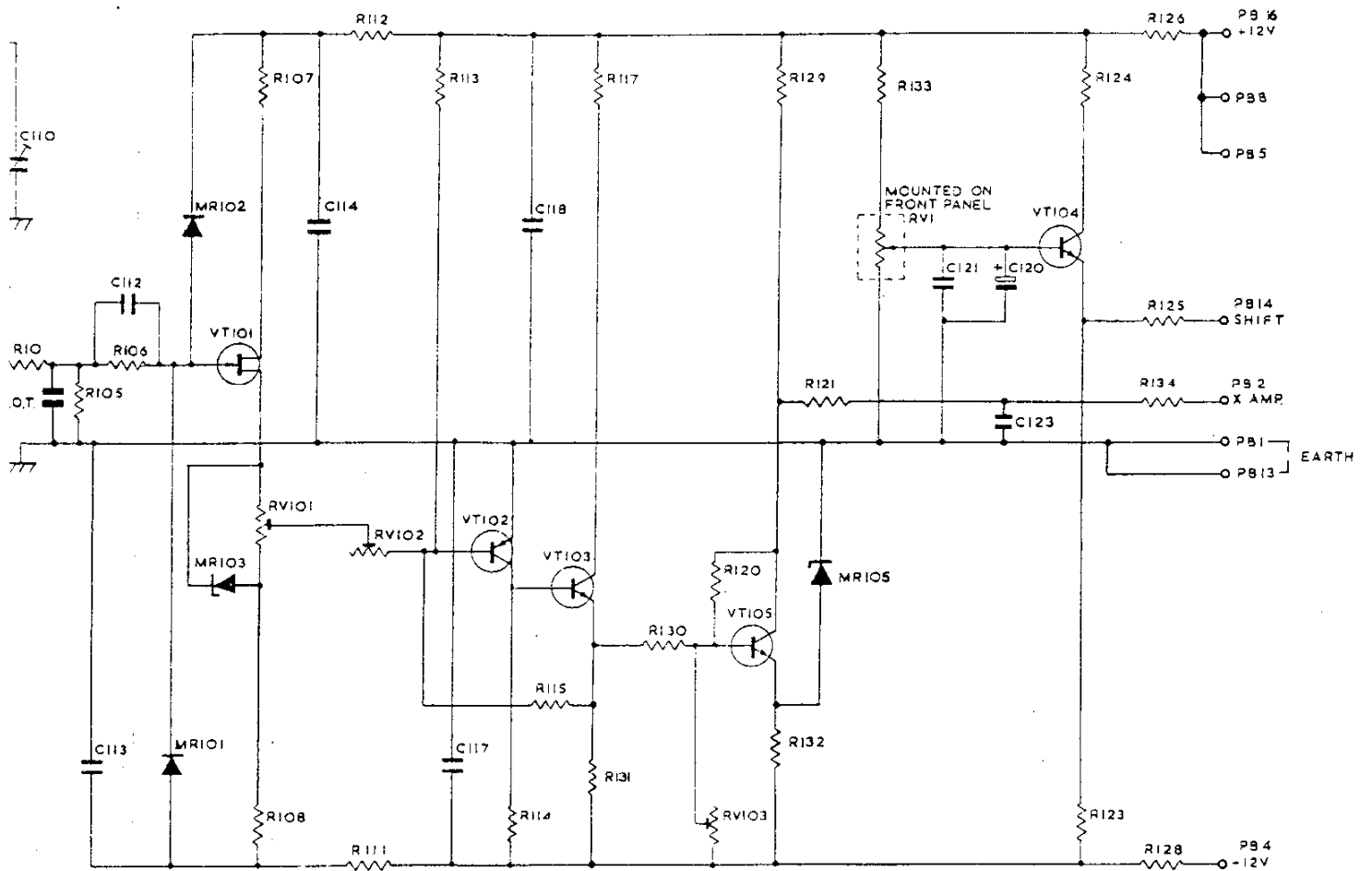


Fig. 6 CIRCUIT DIAGRAM OS2001X

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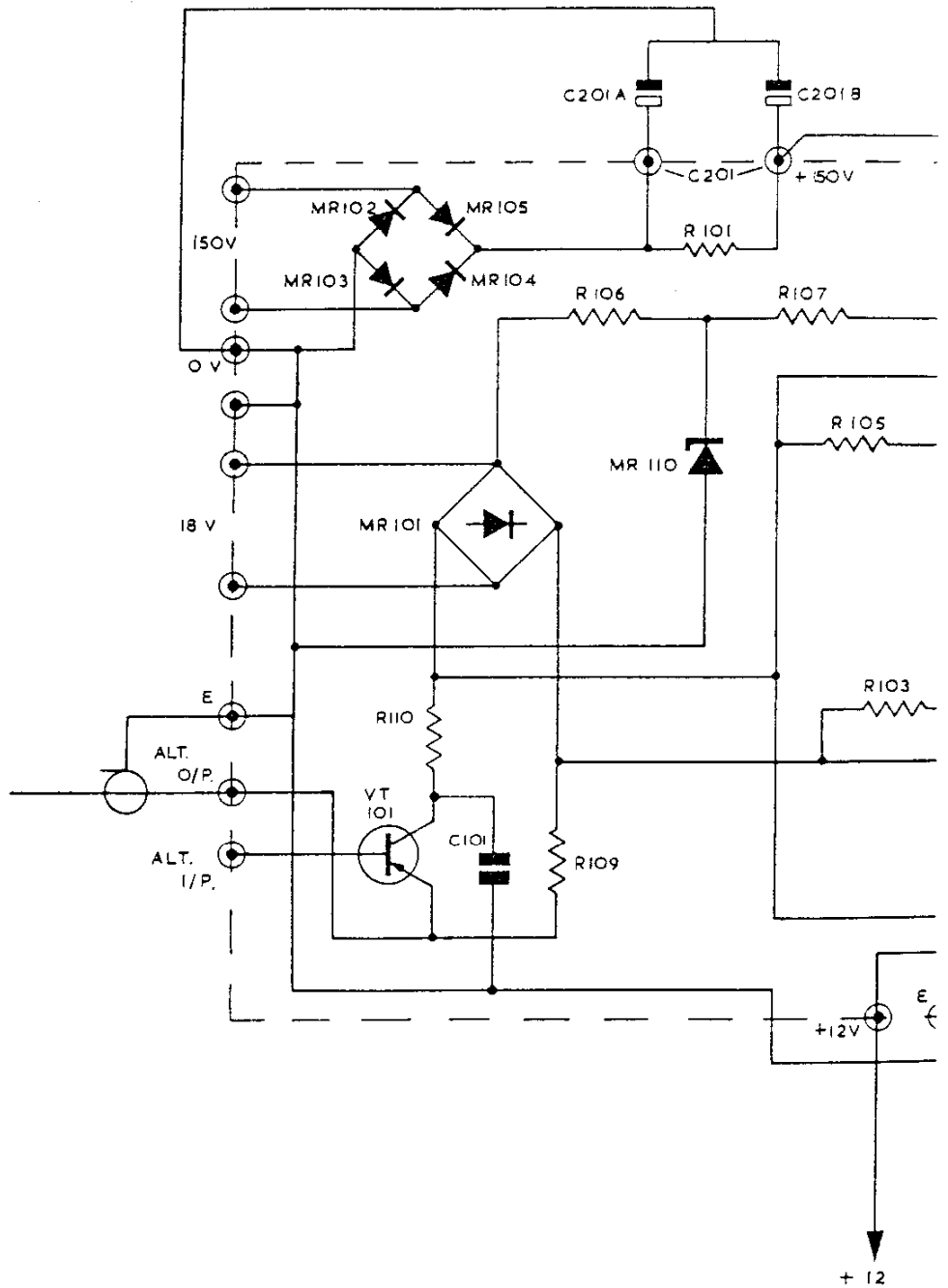
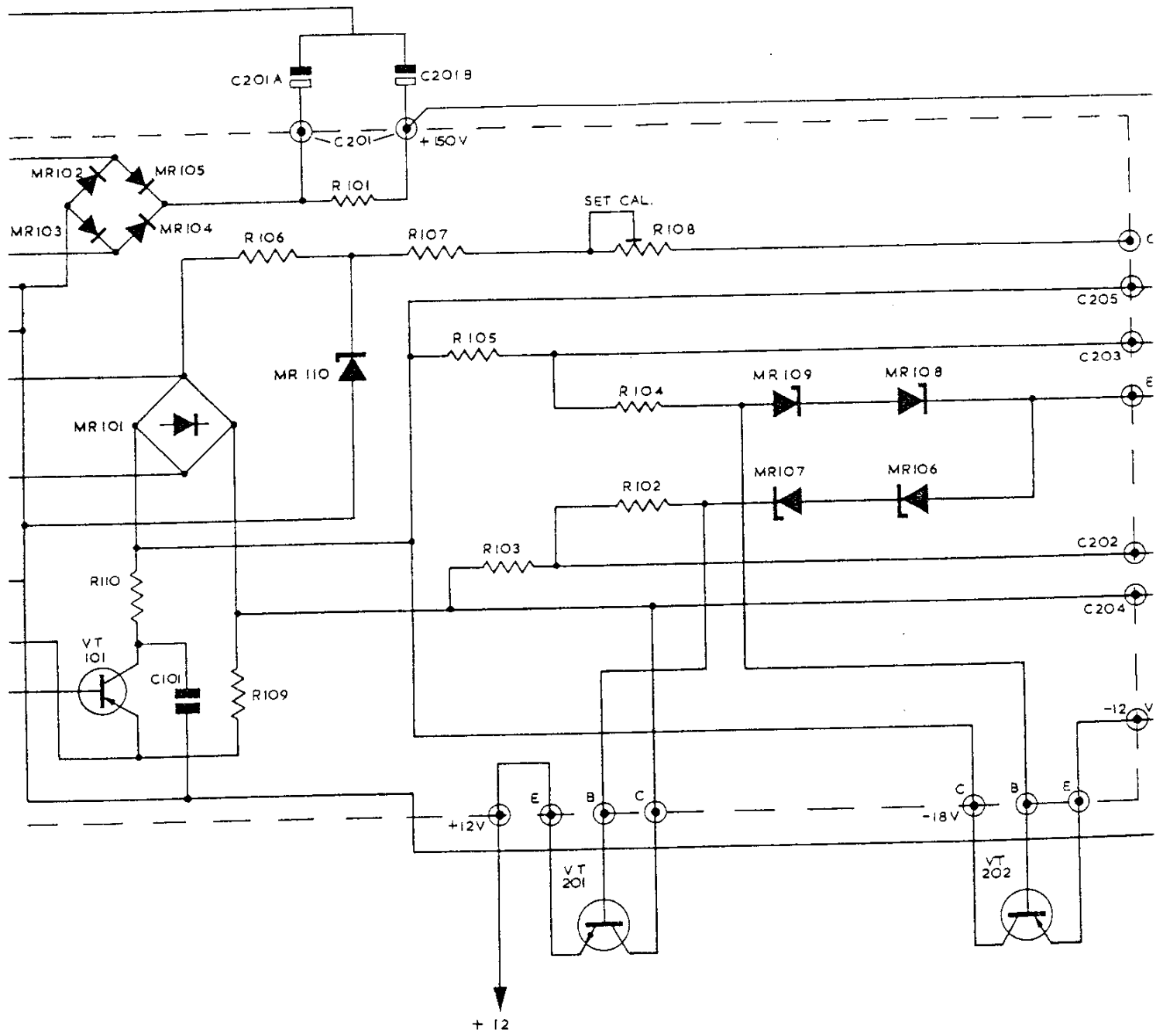
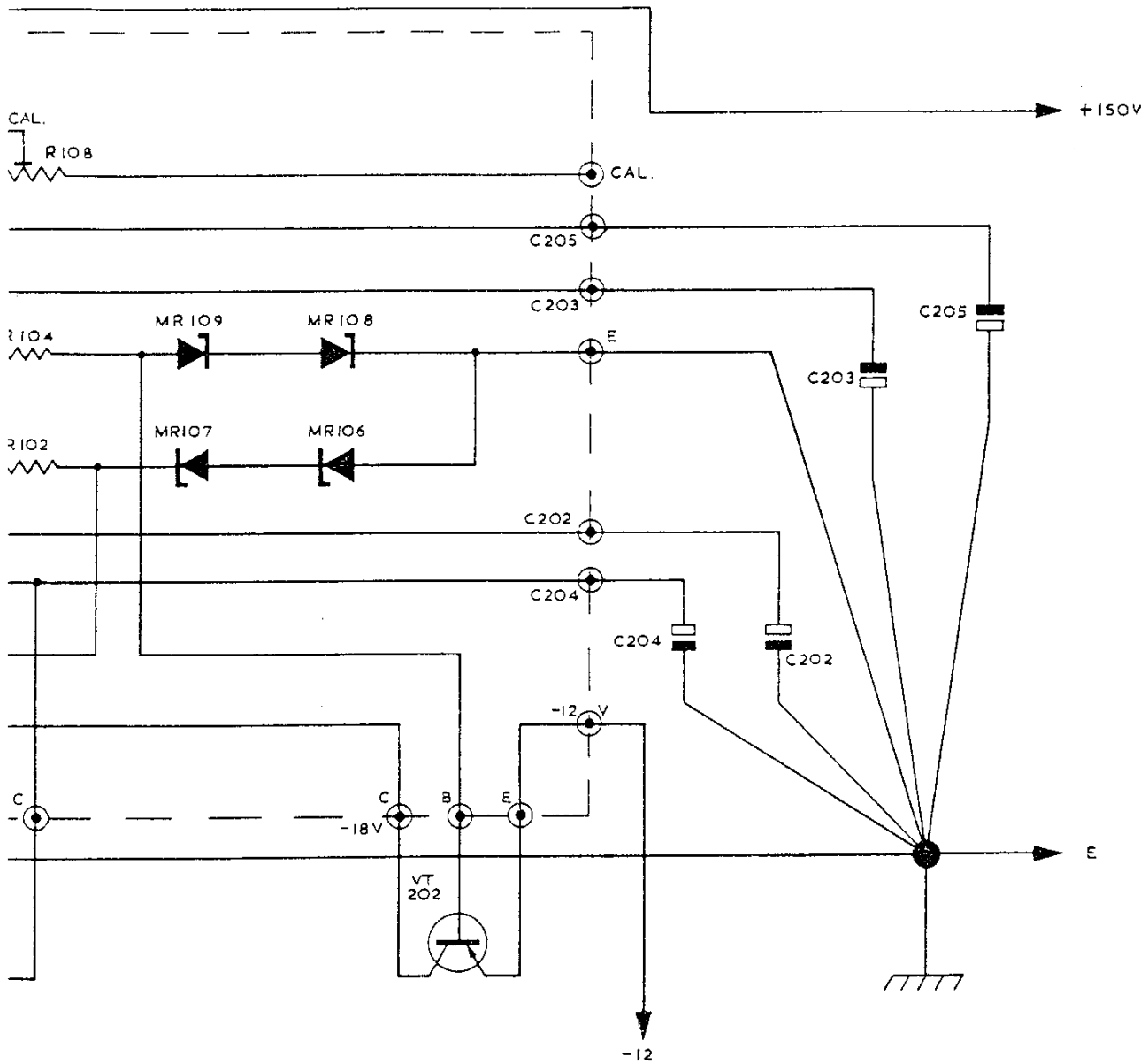


Fig. 6 LOW VOLTAGE POWER SUPPLY AND CALIBRATOR CIRCUIT DIAGRAM OS2000R



X-RAY TUBE CALIBRATOR CIRCUIT DIAGRAM OS2000R

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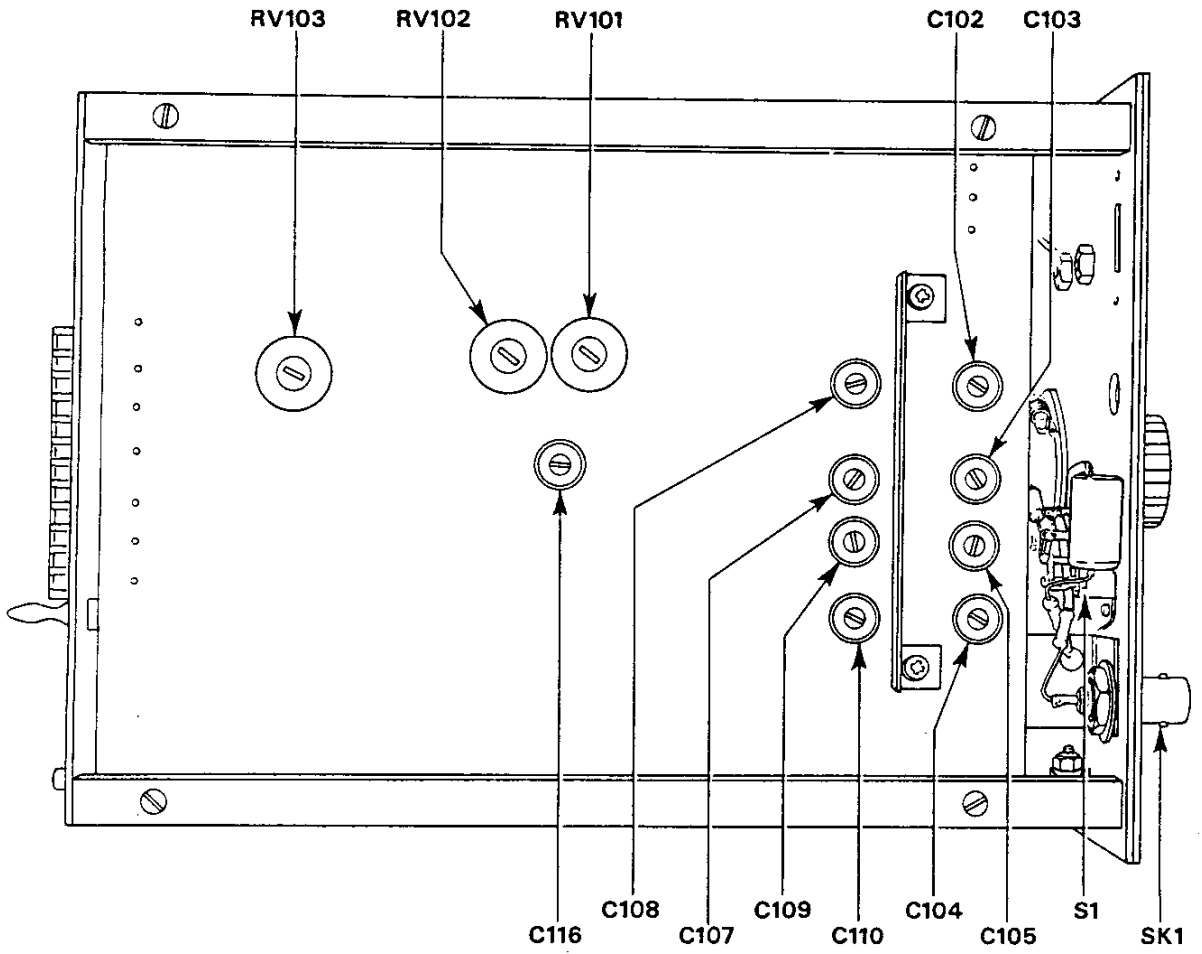
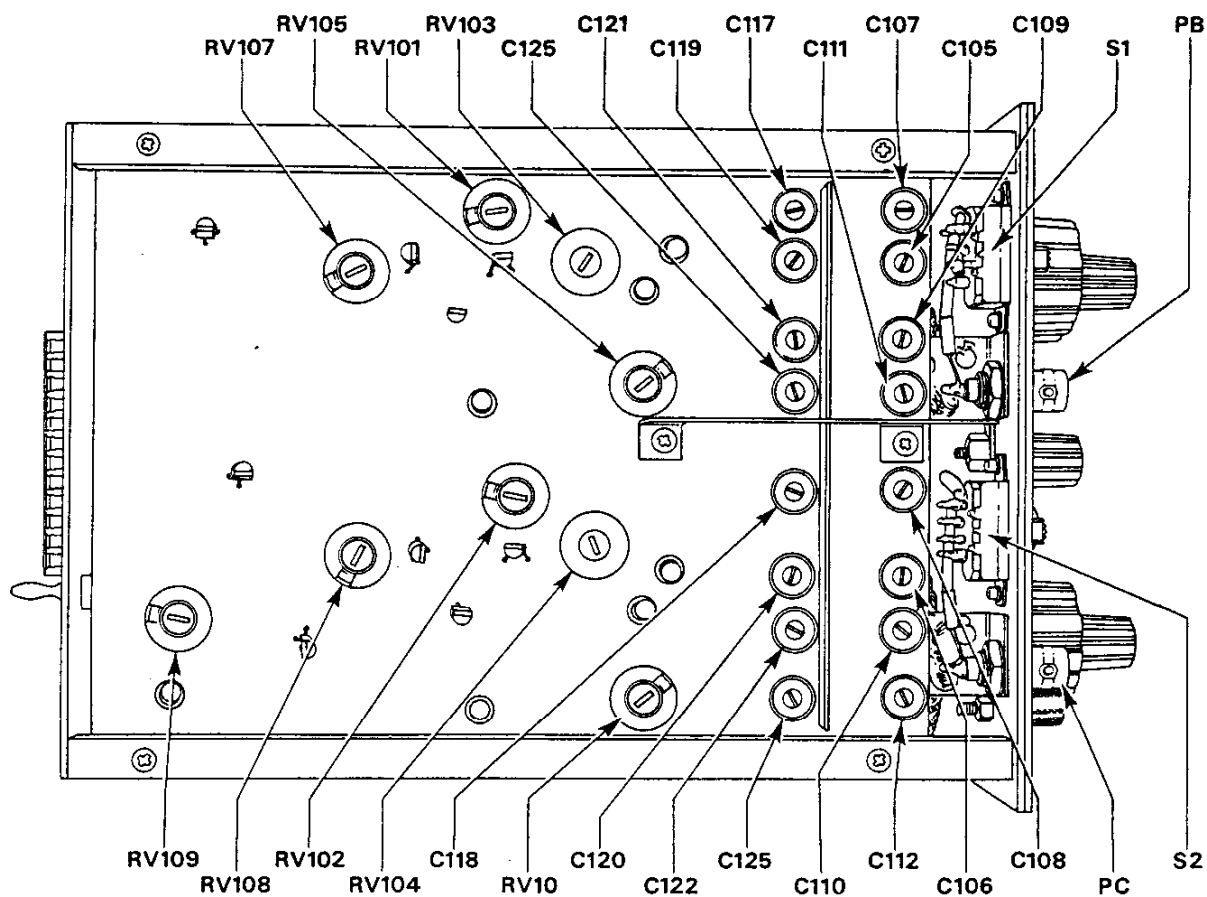


Fig. 7 LAYOUT OF PRESET CONTROLS OS2001Y



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Fig. 8 LAYOUT OF PRESET CONTROLS OS2002Y

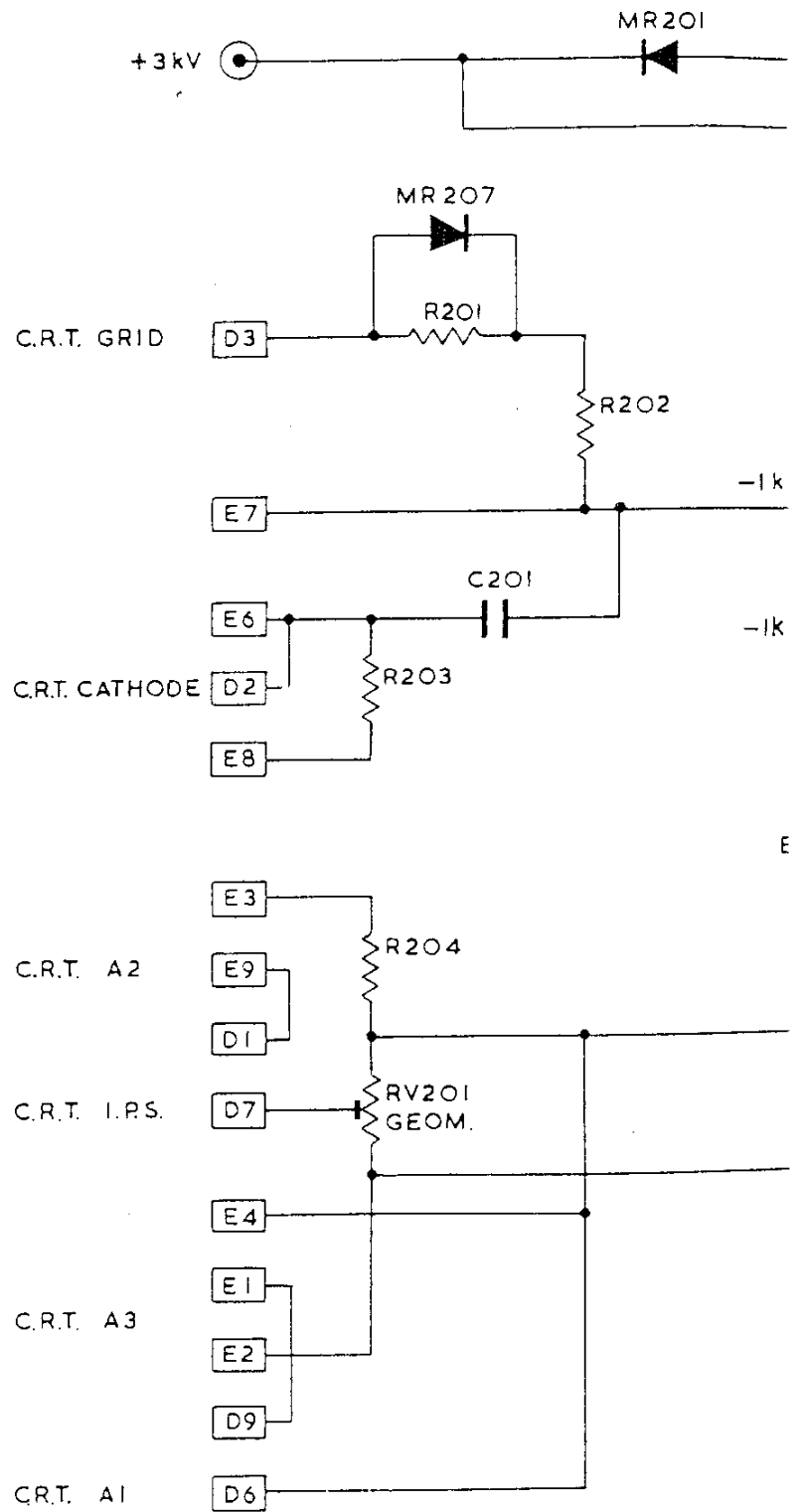
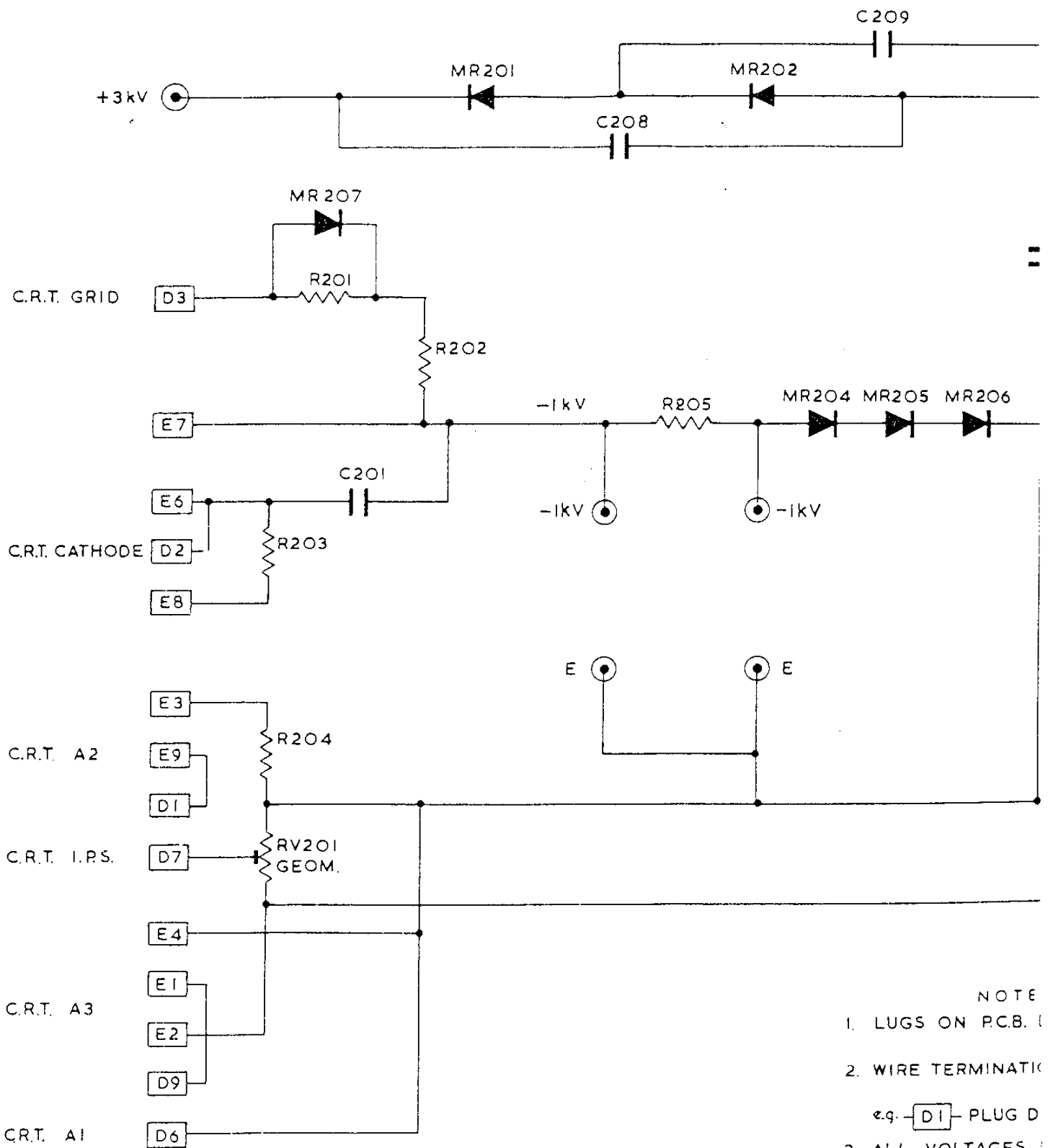
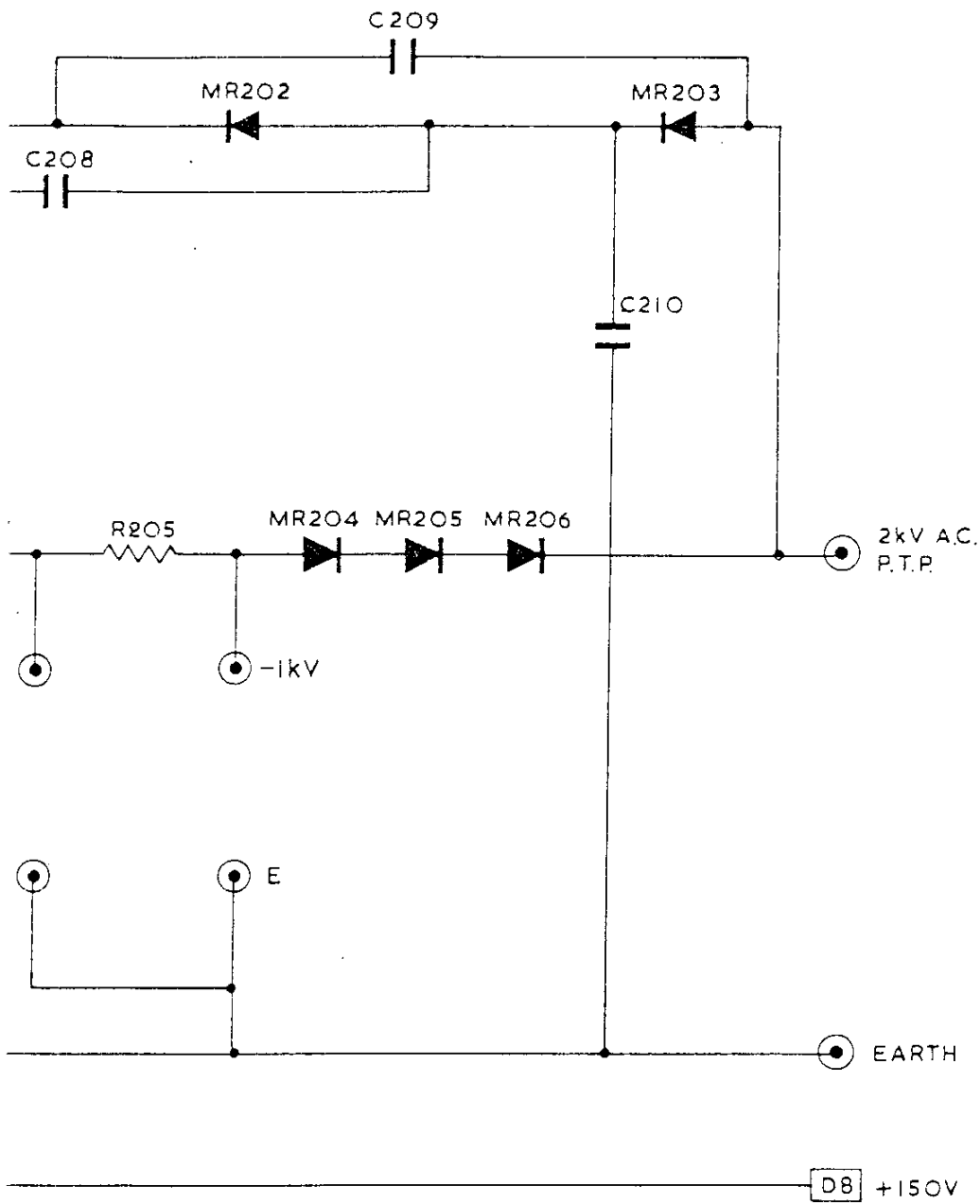





Fig. 7 EHT SUPPLY CIRCUIT DIAGRAM



- NOTE
1. LUGS ON P.C.B. (
 2. WIRE TERMINATI
 - e.g. D1 - PLUG D
 3. ALL VOLTAGES / TO EARTH.



NOTES

1. LUGS ON P.C.B. DENOTED
THUS: 
2. WIRE TERMINATIONS DENOTED
THUS: 
e.g.  PLUG D PIN 1
3. ALL VOLTAGES MEASURED
TO EARTH.

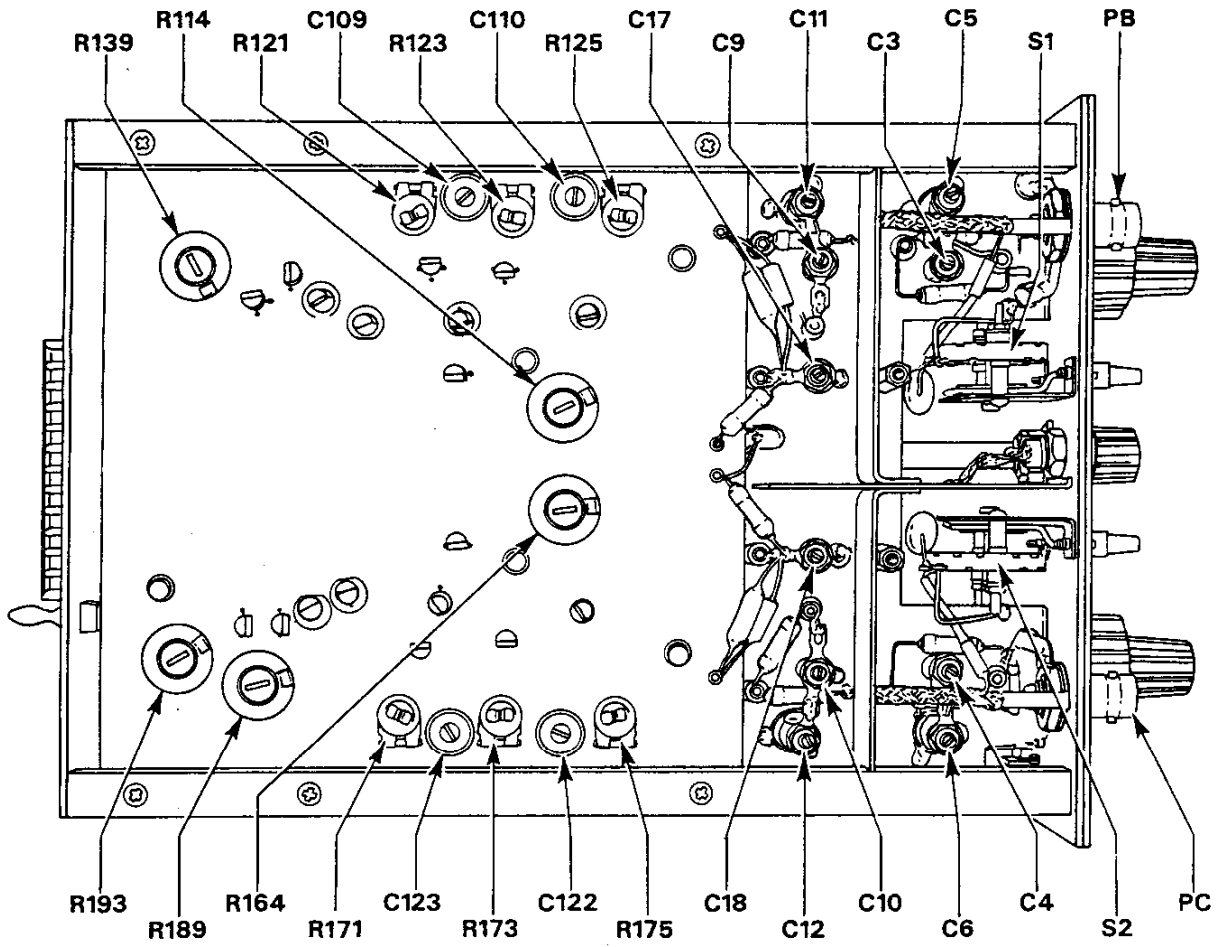
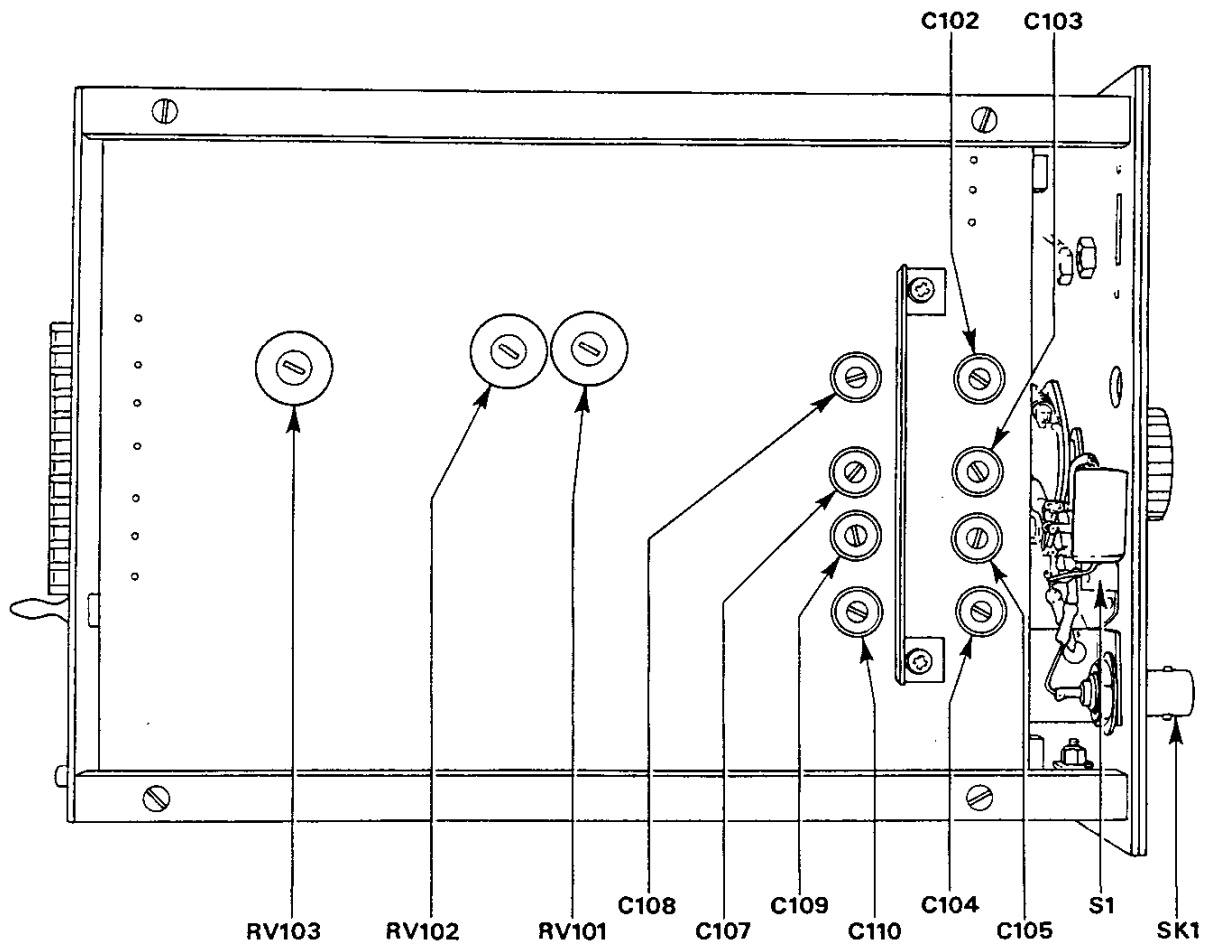


Fig. 9 LAYOUT OF PRESET CONTROLS OS2007Y



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Fig. 10 LAYOUT OF PRESET CONTROLS OS2001X