Oscilloscope
OS 15
Instruction Manual

Advance

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Introduction

Section 1

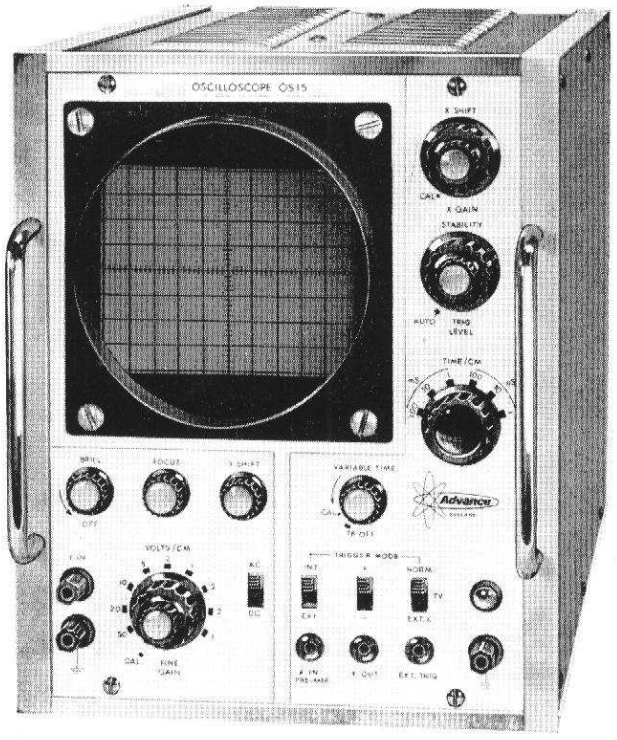
Advance Oscilloscope OS15 is a general purpose instrument designed for the measurement and display of signals in the range 0 to 3MHz on a five inch PDA tube. The oscilloscope uses one type of valve throughout and is of rugged construction. A further feature of the instrument is its simplified operation.

The vertical (Y) deflection amplifier has an associated input attenuator providing nine input sensitivities from 100mV/cm to 50V/cm, and a continuously variable control provides overlapping control between the steps. The timebase has six speeds selected from a control on the front panel, and may be triggered internally or from an external source; a continuously variable control provides fine adjustment. In addition to trigger source selection, positive or negative triggering can be selected. The timebase can also be switched off and signals fed to the X amplifier via a socket at the rear of the instrument.

A control on the front panel incorporated in the horizontal (X) amplifier enables the trace to be expanded two diameters. Sufficient control is provided for any part of the expanded trace to be displayed.

A pre-amplifier is also provided for use with the X amplifier and its operation is controlled by the NORM/TV/EXT.X switch on the front panel. The input to the pre-amplifier is applied via the X IN PRE AMP socket also located on the front panel. The sensitivity of this pre-amplifier is 100mV/cm and it has a bandwidth of approximately 10kHz.

Other facilities provided are: BRILLIANCE, FOCUS, Y SHIFT, X SHIFT and ON/OFF controls, a time base output (X OUT), and beam modulation (Z mod) via a socket at the rear of the instrument.



Specification

Section 2

Vertical Amplifier

Bandwidth: D.C. to 3MHz (−3dB)

Sensitivity: 100 mV/cm

Input Impedance: Nominally 1MΩ/50pF

Measuring Accuracy: Typically ±5%

Input Attenuator

A nine-position frequency compensated attenuator provides the following input sensitivities for the vertical (Y) amplifier:

100, 200, 500 mV/cm and 1, 2, 5, 10, 20, 50 volts/cm.

The above fixed steps are augmented by a FINE GAIN control to give continuous coverage with over-lap between steps.

Time Base

The following calibrated speeds are provided:

100, 10, 1 ms/cm and 100, 10, 1 μs/cm

Measuring Accuracy: Typically ±5%.

By employing the X GAIN and VARIABLE TIME controls a continuous time base coverage from 1 sec/cm to 0.5 μs/cm can be obtained.

Time Base Triggering

The time base may be triggered internally or externally in the following modes:

Auto: 50Hz to 1MHz +ve or −ve.

Trigger Level Selection: Up to 3MHz +ve or −ve

Trigger Sensitivity:
Internal, 5mm of vertical deflection. External, 1 volt.

Time Base Output

A negative-going saw-tooth waveform is available at a front panel terminal (X OUT). The amplitude of this waveform is approximately 4.5 volts.

Horizontal (X) Amplifier

Two input channels are provided for the horizontal amplifier: X IN and X IN PRE-AMP.

X IN socket is a.c. coupled to the horizontal amplifier.

X IN PRE-AMP socket is connected direct to the pre-amplifier input.

Horizontal Amplifier

Bandwidth: 5 Hz to 100 kHz approx.

Sensitivity: 0.25V/cm to 0.5V/cm approx.

Pre-amplifier

Bandwidth: D.C. to 10kHz (approx.).

Sensitivity: 100mV/cm to 200mV/cm.

X Expansion

The X GAIN control enables the X axis to be expanded to 20cm.

Sufficient X shift is provided to permit any portion of an expanded trace to be viewed at the centre of the screen.

TV Sync

A built-in TV sync. integrator enables the time base to be triggered from the frame pulses of a composite TV waveform.

Z Modulation

An input terminal at the rear of the instrument is a.c. coupled to the grid of the CRT. Positive going-pules applied to this terminal brighten the trace.

Cathode Ray Tube

A 5 inch (12.7cm) helical PDA cathode ray tube is fitted and operates at an e.h.t. supply of 3kV over-all. 10cm of horizontal deflection and 8cm of vertical deflection are provided.

Power Supply Requirements

100-125V, 200-250V, 50-60Hz, 80W. Voltage taps at 110V, 200V, 220V and 240V.

Dimensions

$10\frac{7}{8}$″ high x $8\frac{3}{4}$″ wide x $16\frac{1}{4}$″ deep.

(27.8cm) (41.3cm) (22.2cm)

Weight

$18\frac{3}{4}$ lb (8.5 kg).

Finish

Light blue case and side panels with otter grain finish, medium grey side frames and light grey front panel.

Operation

Section 3

3.1 FRONT PANEL CONTROLS

Fig. 1 shows the front panel controls of the OS15 oscilloscope, the functions of these controls are detailed in Table 1

TABLE 1, Front Panel Controls

CONTROL	*FUNCTION*	*REMARKS*
ON/OFF	Controls the input supply	Incorporated in the BRILLIANCE control.
BRILL	Controls the brightness of the trace.	
FOCUS	Controls the definition of the trace.	
Y SHIFT	Controls the vertical position of the trace.	
VOLTS/CM	Controls the sensitivity of the vertical (Y) amplifier.	VOLTS/CM figures apply only when FINE GAIN in CAL position (maximum sensitivity).
FINE GAIN	Used to make display occupy definite graticule area.	Affects the accuracy of the VOLTS/CM control.
AC/DC	Determines whether input to Y axis is AC or DC coupled.	
X SHIFT	Controls the horizontal position of the trace.	
X GAIN	Controls the sensitivity of the X amplifier.	Affects the accuracy of the TIME/CM control.
STABILITY	Affects the operation of the time base circuit.	
TRIG. LEVEL	Controls the point at which the Schmitt trigger fires when operating in the manual mode.	In the extreme counter-clockwise position a switch operates to provide triggering in the AUTO mode.
TIME/CM	Controls the duration of the time base sweep.	Only accurate when X GAIN and VAR TIME controls are at CAL.
VARIABLE TIME	Provides fine adjustment for the time base.	Affects the accuracy of the TIME/CM switch.
TRIGGER MODE		
INT/EXT	Determines whether internal or external trigger is used.	
+/−	Provides negative trigger-to-trigger circuit from a positive or negative trigger source.	
NORM/TV/EXT.X	Determines the nature of the input to the Schmitt Trigger.	In the EXT.X position the X IN PRE-AMP socket is brought into circuit and the X pre-amplifier coupled to the X amplifier.

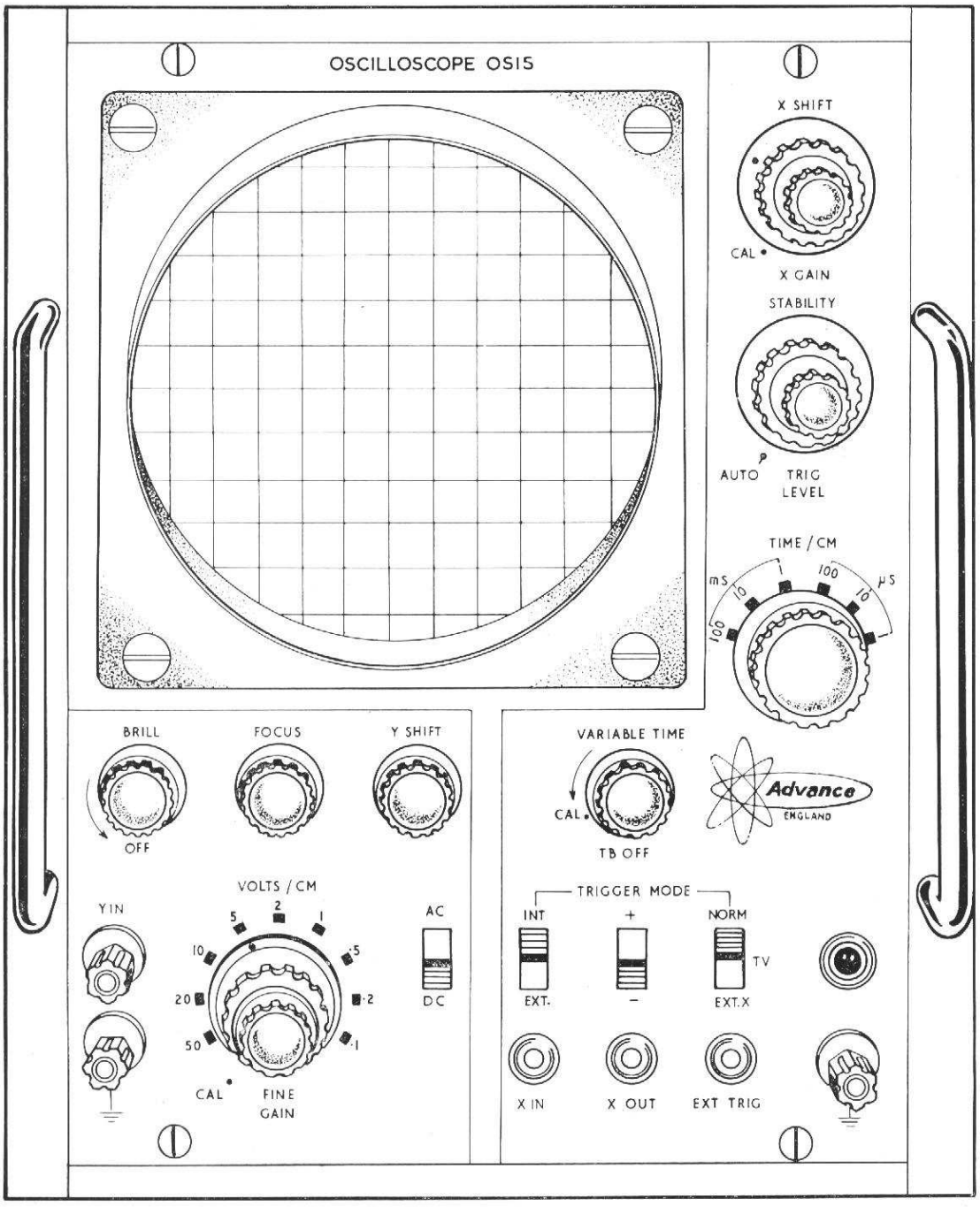


Fig. 1 Front Panel Layout

Operation

Section 3

3.2 USE OF CONTROLS

The following guidance on the correct operation of the instrument and its various controls is given to ensure that the best results are obtained, and is applicable to all modes of operation.

(1) Always keep the display in the centre of the screen.

(2) When making time or frequency measurements, compute from the centre six centimetres of horizontal deflection whenever possible. This ensures maximum accuracy.

(3) Avoid using vertical displays which exceed the eight centimetres height of the screen.

NOTE The VOLTS/CM control enables a maximum Y input voltage of 400V peak-to-peak to be displayed on the screen. This is the maximum safe Y input voltage.

CAUTION It is possible with the full attenuation of the FINE GAIN control to display an input of 1200V peak-to-peak on the screen. This should not be attempted, otherwise damage to the Y amplifier may result.

(4) Avoid using the Y SHIFT control to examine positive and negative peaks, otherwise non-linearity may be introduced.

(5) Do not display stationary traces which are too bright. Doing so will impair the focus of the trace and may also burn the screen of the CRT.

(6) When a waveform is being displayed, always adjust the FOCUS control to obtain optimum sharpness over the whole trace.

(7) When making measurements set all controls which affect the accuracy of the VOLTS/CM and TIME/CM controls (see Table 1) to their CAL position. Also, rotate the graticule so that it is accurately aligned with a horizontal line on the centre of the screen.

3.3 SUPPLY VOLTAGE CHECK

Before the instrument is switched on, the input to the supply transformer should be set to the correct tapping as indicated in Table 2.

TABLE 2 Transformer Tappings

Input Supply	Transformer Tapping
105 – 115V	110V
190 – 210V	200V
210 – 230V	220V
230 – 250V	240V

From the table it can be seen that there is a choice in transformer taps. In general it is preferable to use the higher supply tappings (e.g. if the supply is 230V set the tapping to 240V rather than 220V).

Access to the supply transformer is obtained by removing the four securing screws at the rear of the instrument and removing the wrap-round case.

NOTE When despatched from the factory the supply tapping is set to 240V. The instrument should be fitted with a three-pin plug and the supply leads connected as follows:

Red — Line
Black — Neutral
Green — Earth

3.4 FUNCTIONAL CHECK

(1) Turn the ON/OFF switch, which is incorporated in the BRILL(IANCE) control, clockwise until it operates. (This is indicated by the glowing of the neon indicator on the front panel).

(2) Set the BRILL(IANCE) control to its mid-position and set the TRIGGER MODE switches to INT, + and NORM.

(3) Allow five minutes for the instrument to warm up.

(4) Set the TIME/CM switch to 1ms/cm.

(5) Set the VARIABLE TIME control to the CAL position.

(6) Set the STABILITY control fully clockwise.

(7) Rotate the TRIG LEVEL control to the AUTO position and then turn it clockwise until the AUTO switch just operates.

(8) Adjust the X SHIFT and Y SHIFT controls to produce a line across the centre of the screen.

(9) Adjust the BRILL control to obtain a trace of reasonable brightness.

(10) Adjust the FOCUS control to produce a sharp edged line across the centre of the screen.

NOTE At this stage the time base is free running.

(11) Adjust the STABILITY control anti-clockwise until the trace just disappears. When this control is set correctly, the trace will reappear when the TRIG LEVEL control is rotated counter-clockwise to the AUTO position.

NOTE At this point the time base is being triggered at approximately 50 Hz which is the output produced by the time base trigger circuit.

(12) Rotate the TIME/CM switch through all positions. The trace should remain on the screen at all positions but will become dimmer at the higher switch positions (μs positions), and it may be necessary to reset the position of the STABILITY control to produce a trace on the highest switch position (1μs).

NOTE The reason for the dimming of the trace is that the trigger source repetition rate is much lower than the time base sweep time. This is not important when operating under normal con-

ditions as the time base is triggered by an internal or external trigger source appropriate to the waveform being displayed, which will restore the brightness.

The sequence detailed above checks that the instrument is operating correctly.

3.5 AUTO OPERATION

3.5 (a) Normal Mode

AUTO operation provides automatic triggering or synchronisation of the time base from the input signal applied to the vertical amplifier or to the EXT. TRIG socket. The deflection required for this mode of triggering is less than 5 mm. and the trigger may be positive or negative-going. This mode is normally used when it is required to display a repetitive waveform.

To set the instrument to this mode of operation, using internal triggering proceed as follows:

(1) Adjust the STABILITY and TRIG LEVEL controls as detailed in Section 3.4 (6), (7) and (11).

(2) Set the input selector switch to A.C.

(3) Apply the input signal across the Y IN and earth terminals.

(4) Set the TRIGGER MODE switches to INT, NORM and + or — respectively.

(5) Adjust the VOLTS/CM control to produce three centimetres of vertical deflection.

NOTE If the trace appears as a fairly solid rectangle the time base is too slow and the TIME/CM switch should be set to a higher speed.

If horizontal sloping lines appear the trace is too fast and the TIME/CM switch should be set to a lower position.

3.5 (b) Displaying TV Waveform

If a composite television signal is to be displayed the foregoing procedure should be adopted but the TRIGGER MODE switches should be set to INT, + and TV. When the TV position is in use line pulses are attenuated and frame pulses are integrated, so that the time base is triggered by the frame synchronisation pulses. The TV position is also useful when it is required to trigger the time base from a low frequency source superimposed with a large level of h.f. noise.

3.5 (c) External Triggering

If it is required an external trigger source can be used to trigger the time base circuit. In this instance the trigger source (1V minimum) is applied to the EXT. TRIG input on the front panel and the INT/EXT trigger selector switch in the TRIGGER MODE group of switches is set to EXT.

3.6 MANUAL OPERATION

When the instrument is used in the manual mode the time base is no longer triggered by a fixed level of trigger input but by a level determined by the TRIG LEVEL control. This trigger voltage may again be positive or negative going

To set the instrument to the manual mode of operation, proceed as follows:

(1) Set-up the STABILITY and TRIG LEVEL controls as detailed in Section 3.4 (6), (7) and (11).

(2) Apply a signal across the Y IN and earth terminals and obtain a suitable display by adjustment of the TIME/CM and VARIABLE TIME controls.

(3) Rotate the TRIG LEVEL control clockwise until the trace disappears then reappears.

NOTE Further clockwise rotation will cause the trace to commence at a higher or lower level on the leading edge depending on the setting of the +/— switch. If the +/— switch is set to +, the trace will disappear again if the trigger point voltage equals or exceeds the most positive point of the input signal. If the +/— switch is set to —, then the trace will disappear when the trigger point voltage equals or exceeds the most negative point of the input signal.

3.7 USE OF X INPUT FACILITIES

3.7 (a) X IN Facility

When the timebase is switched off (VARIABLE TIME set to T.B. OFF), and the NORM/TV/EXT.X switch set to NORM or TV any a.c. signal applied to the X IN and earth sockets at the rear of the oscilloscope will produce a horizontal deflection of the trace on the screen. The length of this deflection can be varied by the X GAIN control. If the trace cannot be reduced to 10 cm or less by use of this control, the input signal is too large. If an a.c. signal is also applied to the vertical (Y) amplifier, a Lissajous figure will be displayed on the screen.

3.7 (b) X IN PRE-AMP Facility

A horizontal pre-amplifier is provided on the OS15, and the input socket for this pre-amplifier is located on the front panel (X IN PRE-AMP). The circuit will respond to d.c. or d.c. superimposed with a.c. and its sensitivity is 100mV/cm with the X GAIN control fully clockwise and 200mV/cm with the control fully anti-clockwise.

CAUTION The input to the X IN PRE-AMP socket should not exceed 1V peak to peak.

To use the X IN PRE-AMP facility proceed as follows:

(1) Set up the vertical (Y) amplifier as usual.

(2) Set the VARIABLE TIME control to TB. OFF.

(3) Set the NORM/TV/EXT.X switch to EXT. X.

(4) Rotate the TRIG LEVEL control fully clockwise.

(5) Set the INT TRIG/EXT TRIG. switch to EXT. TRIG.

Steps (4) and (5) ensure that there is no break-through from the time base trigger circuit.

NOTE When displaying Lissajous figures, it is better to use the X IN socket due to the wider bandwidth of the main horizontal (X) amplifier.

3.8 Z MODULATION

Bright-up of a particular part (or parts) of the displayed signal can be obtained by applying a positive going signal to the grid of the CRT via the Z MOD socket at the rear of the instrument.

Circuit Description

Section 4

4.1 GENERAL

A functional diagram of the oscilloscope is shown in Fig. 2, the full circuit diagram of the instrument is shown in Fig. 7 (Section 6). The oscilloscope comprises seven sections: input attenuator, vertical deflection (Y) amplifier, timebase trigger circuit, time base generator, horizontal (X) amplifier, horizontal (X) pre-amplifier, and the CRT.

4.3 VERTICAL DEFLECTION (Y) AMPLIFIER

Signals applied to the Y IN terminal on the front panel are applied to the grid of V1a via the input attenuator. These signals are amplified and applied to the grid of V2a via the cathode follower V1b which acts as a buffer stage to the amplifier stage V1a. The h.t. for V1a is derived from the cathode circuits of V2b and V3b.

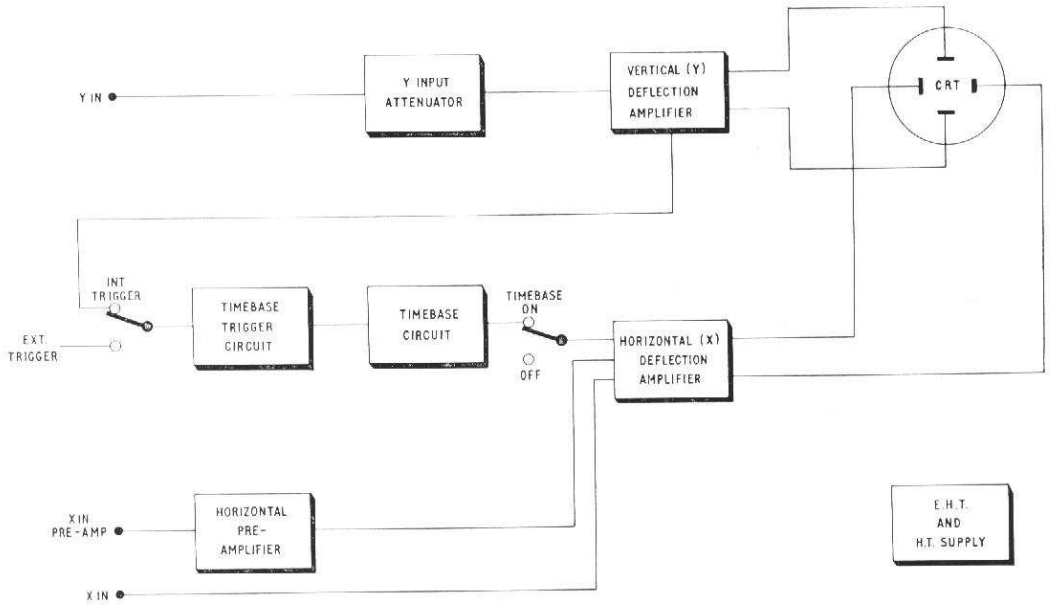


Fig. 2 Functional Diagram

4.2 INPUT ATTENUATOR

A nine position switch (S2—VOLTS/CM) selects frequency compensated networks which provide the nine possible input sensitivities for the vertical (Y) amplifier. The accuracy of this attenuator is set by adjustment of RV1 (SET GAIN) in the vertical amplifier. Continuous variation of the sensitivity between each of the nine settings of the attenuator is provided by RV2, and this control is useful when it is required to fit the trace to a given height.

NOTE The setting of the attenuator is only accurate when the FINE GAIN control is set to its CAL position.

V2a and V3a form a long tailed pair providing anti-phase, amplified outputs which are applied to the Y deflection plates of the CRT via cathode follower V2b and V3b. The cathode circuits of V2a and V3b are coupled by two potentiometers RV1 (SET GAIN) and RV2 (FINE GAIN). RV1 is preset and is used to set the gain of the stage to produce an input sensitivity of 100mV/cm. RV2 is used to provide the continuous variation between the settings of the input attenuator. RV3 (Y SHIFT), in the cathode circuits of V2b and V3b, is the vertical shift control.

Frequency compensation for the vertical amplifier is provided by C1, L1, L2 and L3.

4.4 TIMEBASE TRIGGER

The time base trigger circuit comprises a phase splitter (V4b) and a cathode coupled multivibrator circuit (V5.) The time base can be triggered either internally from a signal derived from the cathode of V2b, or externally from a trigger source applied to the EXT. TRIG socket. Internal or external triggering is selected by the INT/EXT switch (S3) but in each instance the input is applied to the grid of V4b. This valve is used as a phase splitter producing in phase and anti-phase outputs at its cathode and anode respectively. These triggers which are selected by S4 (+/—) drive the time base trigger circuit. The trigger circuit action is initiated by a negative-going signal applied to the grid of V5a. S4a is therefore used to select the anode output of V4b when a positive trigger input is used, and the cathode output when a negative trigger input is used.

The selected signal is applied via S5a (NORM/TV/EXT.X) to the grid of V5a, part of the cathode coupled multivibrator. This circuit is controlled by S6 (AUTO) and acts as a bistable device locking to positive or negative pulses at a point determined by the setting of RV12 (TRIG LEVEL) when the switch is in the manual position, or as a free running multivibrator when S6 is in the AUTO position. In this position the repetition frequency of the circuit is determined by C36, R67 and R68 and is approximately 50Hz.

When operating in this mode the circuit locks readily to positive or negative inputs up to 2MHz applied to V5a grid. The output at V5b anode is differentiated by R44 and C42 and the positive excursions are removed by MR5. The negative pips are applied to the grid of V6b in the time base circuit via MR6. The first negative-going pip drives V6b to cut-off and triggers the time base valve V6a. Subsequent negative-going signals are ineffective until the time base circuit has completed its action.

When S5 is set to TV, the input signals to V5a are integrated and the time base trigger is generated by the frame pulse of the composite TV waveform.

NOTE This position is also useful when it is required to trigger the time base from a low frequency source superimposed with a large level of h.f. noise.

4.5 TIME BASE

The time base circuit consists of V6, V7 and associated components. The negative signal from MR6 is applied to V6a and drives the grid to cut-off. The anode voltage rises and is applied to V7b grid via S7 (TIME/CM) causing the voltage at V7b anode to fall. This fall is fed back to V6b grid and the action becomes cumulative so that V6b anode rises to h.t. and V7b anode (and hence V6b grid) falls to a relatively low voltage. When V6b cuts-off its cathode potential falls and so does V6a anode. This is also applied to V6a grid via the appropriate timing capacitor between S7a and S7b. This set of circumstances creates a situation where both anode and grid have fallen in potential simultaneously, the valve is almost cut off therefore, and current is drawn via R25. The Miller run-down action now starts and V6a grid rises due to the current flowing through the timing resistor (R73 or R74) and capacitor. As the grid voltage rises, so the current flow through the valve increases and the anode voltage falls thus causing the cathode voltage of V6B to fall also. At some point V6b cathode goes negative with respect to its grid and the valve starts to conduct once more. Cumulative action between V6b and V7b causes V6b to quickly reach its fully conducting state again. The circuit will repeat the foregoing action when the next negative-going pip is received.

The action described takes place when RV11 (STABILITY) is adjusted so that the time base just fails to free run. If RV11 is too far advanced the time base will free run at a rate determined by the hold-off capacitors on S7c and S7d. These capacitors act as speed-up elements for the trigger action of V6b and V7b and also provide recovery time for the time base.

The required potential for the timing capacitors is derived via RV16 (VARIABLE TIME) which is in series with RV15 (SET SPEED). RV15 is a preset potentiometer which is adjusted during manufacture.

The time base operation is controlled by S8a (TB ON/OFF). When the switch is set to OFF the cathode circuit of V7b is made open circuit and prevents the valve operating, thus stopping the time base circuit. Also, S8b open circuits the anode of V6b and inhibits the automatic bright-up signal from this valve.

The output of the time base is applied to the horizontal (X) amplifier via the frequency compensating network C37, C60, R63 and RV14, C39.

4.6 HORIZONTAL (X) AMPLIFIER AND PRE-AMPLIFIER

V7a and V8a form a long tail pair which makes up the horizontal (X) amplifier. The anode outputs of these valves are applied to the X deflection plates of the CRT. RV8 (SET GAIN) is a preset control which is adjusted during manufacture so that full clockwise rotation of the X GAIN control (RV9), on the front panel, causes the trace to be expanded by a factor of two. The signal at V7a cathode (a sawtooth waveform) is made available at an outlet on the front panel (X OUT) via C43. This output is only linear however, when the trace is not expanded, i.e., X GAIN control is fully anti-clockwise. In any other position the output will flatten out top and bottom and will contain a linear

portion proportional to the part of the trace occupying the centre 10cm of horizontal deflection.

The grid of V7a is also connected to the X IN socket at the rear of the instrument and the applied input is fed to V7a via C59/R83. When the time base circuit is switched off, any input applied to the X IN socket is amplified by the X amplifier and applied to the X deflection plates as before.

V8a has the X shift voltage applied to its grid. This voltage is applied via S5c when S5 is in the NORM position, via S5B when this switch is in the TV position and via S5B and V4a when in the EXT X position (V4a anode is connected to V8a grid via S5c).

A pre-amplifier (V8b, V4a) is provided for use with the X amplifier if required. The pre-amplifier comprises a cathode follower feeding a single stage amplifier. The gain of the circuit is preset during manufacture by RV17 (SET GAIN) to be 100mV/cm. The output of the pre-amp is fed to the X amp via S5C.

4.7 Cathode Ray Tube (CRT)

A helical PDA type CRT is used in the instrument and provides a vertical deflection of 8cm and a horizontal deflection of 10cm. Astigmatism correction is provided by RV4 (ASTG) and is preset during manufacture together with RV5 and RV6 which affect the geometry of the display. Direct coupled bright-up is provided from the time base circuit (V6b) to G2 of the CRT. When the time base is switched off, G2 assumes the same potential as A1. Signals applied to the Z MOD socket at the rear of the instrument are fed to the grid of the CRT providing brightness modulation.

The BRILLIANCE and FOCUS controls are conventional circuits controlling G1 and A2 of the CRT respectively.

4.8 POWER SUPPLIES

MR1, MR2, C7 and C8 form a voltage doubling circuit providing the h.t. for the X and Y deflection circuits. MR3 provides the positive +1750V d.c. for the PDA terminal (A4) and MR4 provides the −1200V d.c. supply for the cathode. The input supply to the supply transformer (T1) is fed via FS1, and the supply switch (S9). The centre tap of the 6.3V heater winding is connected to the positive h.t. line to avoid voltage stresses between the heaters and cathodes of the valves.

Maintenance

Section 5

5.1 GENERAL

Maintenance is expected normally to be restricted to replacement of valves, and this action will not incur any re-calibration of the instrument. However, in order to help servicing personnel to maintain the instrument in first class condition the following data and guidance is provided. Reference should be made to Figs. 3 to 6 for component location details, including preset controls.

The voltages and waveforms shown on the circuit diagram (Fig. 7) are a useful aid to maintenance and fault finding. They are, however, only typical results and and some deviations can be expected. The voltages indicated are measured with a moving coil meter (20,000 ohms/volt). The waveforms can be displayed using another OS15 oscilloscope or an instrument having similar characteristics.

CAUTION With the exception of V4B, all valves are directly coupled and the instrument must not be operated unless all the valves are fitted.

5.2 TEST EQUIPMENT

The following items of test equipment are recommended for use when servicing the oscilloscope:

(1) Square wave signal generator

Frequency range	300kHz
Voltage range	0-500mV
Rise time	Less than 100ns

(Advance Double Pulse Generators PG54 and PG5002D meets these requirements.)

5.3 INPUT ATTENTUATOR (VOLTS/CM)

To align the attenuator the following procedure should be adopted:

(1) Apply a 3 kHz square wave to the Y IN socket of the instrument.

(2) Set the VOLTS/CM switch to 0.1.

(3) Set the FINE GAIN control to CAL.

(4) Adjust the TIME/CM control (and VARIABLE TIME control if necessary) to display three or four cycles of the input waveform on the screen.

NOTE This action checks the quality of the pulse output from the generator since in the 0.1 position the attenuator path is a short circuit.

(5) Set the VOLTS/CM switch to 0.2 and adjust the output of the square wave generator to produce a vertical display two to three centimetres high.

(6) Adjust C4 to produce sharp corners on the displayed square wave.

(7) Repeat steps (6) and (7) with the VOLTS/CM switch set as detailed in Table 3 and adjust the corresponding trimmer.

TABLE 3 Attenuator Adjustments

VOLTS/CM SETTING	*ADJUSTING TRIMMER*
0.5	C17
1.0	C10
2.0	C61
5	See Note 1
10	C18
20	C63
50	See Note 2

NOTES (1) 5 VOLTS/CM setting is correct if adjustment to C61 has been correctly made

(2) 50 VOLTS/CM setting is correct if adjustment to C63 has been correctly made.

C3 and C15 are adjusted during manufacture so that the input capacitance on all settings of the VOLTS/CM switch are equal to the input capacitance of the 0.1 position. If it is found necessary to readjust these trimmers the following procedure should be followed.

(1) Connect a 1M Ω resistor in parallel with a 6 to 30pF trimming capacitor.

(2) Connect one end of this network to the Y IN socket.

(3) Apply the square wave signal between the other end of the network and earth.

(4) Set the VOLTS/CM control to 0.1.

(5) Adjust the output of the signal generator to produce a vertical display of two to three centimetres.

(6) Adjust the trimmer capacitor of the test network to produce the best possible square wave on the oscilloscope.

(7) Set the VOLTS/CM control to 0.2.

(8) Repeat step (5).

(9) Adjust C3 to produce the best possible square wave on the oscilloscope.

(10) Set the VOLTS/CM switch to 0.5.

(11) Repeat step (6).

(12) Adjust C15 to produce the best possible square wave on the oscilloscope.

5.4 VERTICAL (Y) AMPLIFIER

5.4 (a) Sensitivity

RV1 is adjusted during manufacture so that the sensitivity of the vertical amplifier is 100mV/cm. To reset this sensitivity proceed as follows:

(1) Apply a signal of 3.55V r.m.s. (10V pk-pk) to the 5 volts/cm input of the attenuator.

(2) Set the FINE GAIN to its CAL position.

(3) Adjust RV1 to produce a vertical deflection of 2cm.

If this cannot be achieved V1, V2 or V3 should be replaced with a new valve.

5.4 (b) Frequency Compensation

L1 is the only variable component in the frequency compensation network of the vertical amplifier. This is a high stability component and is unlikely to need re-adjustment. Its accuracy may be checked as follows:

(1) Apply a square wave of 300 kHz at a level of 200 to 300mV to the Y IN socket.

(2) Set the VOLTS/CM to 0.1.

(3) Adjust the core of L1 to produce the best flat top possible on the displayed waveform.

5.5 TRIGGER CIRCUIT

The only component liable to need adjustment is RV13 (TRIG SENS). The adjustment should be done as follows:

(1) Apply a square wave of 1 to 3 kHz

(2) Adjust the VOLTS/CM switch to give a vertical display height of 2mm.

(3) Rotate the TRIG LEVEL control until the display is stationary. If this cannot be done, adjust RV13 until it is possible to lock the display using the TRIG LEVEL control.

(4) Reduce the input signal so that the vertical display height is less than 2mm and check that the TRIG LEVEL control can no longer lock the display.

NOTE The setting of RV13 must be set finally so that a minimum of 2mm vertical deflection allows the TRIG LEVEL control to lock the display. If less than 2mm of vertical display can be locked, the Schmitt trigger will be too sensitive and will produce instability and erratic triggering.

If the above limit cannot be obtained V4 and V5 should be checked.

5.6 TIME BASE

5.6 (a) Time Base Calibration

To check the calibration of the time base proceed as follows:

(1) Apply a square wave of exactly 1000 Hz to the Y IN socket of the oscilloscope.

(2) Set the TIME/CM control to the 1ms position.

(3) Set the X GAIN and VARIABLE TIME controls to their CAL positions.

(4) Adjust RV15 (SET SPEED) until the trace has a spread over the centre 8cm of X deflection of 1 pulse/cm.

(5) Set the TIME/CM control to the 1μs position.

(6) Apply a square wave of exactly 1 MHz to the Y IN socket.

(7) Adjust C41 until the trace has a spread over the centre 8cm of X deflection of 1 pulse/cm.

At the completion of this procedure the time base is correctly aligned at all speeds. This can be checked by setting the TIME/CM to each position in turn, and applying a square wave signal of equivalent period to the Y IN socket. In each position the trace should lock. If this does not occur, check the following components: R73, R74, C40, C41, C46, C48, C50, C52.

5.6 (b) Frequency Compensation and Linearity

C37 provides frequency compensation, and affects the linearity of the time base sweep. To make adjustments to these parameters, proceed as follows:

(1) Remove the connection to G2 of the CRT.

(2) Disconnect any input signals to the instrument.

(3) Increase the brilliance until a trace of a straight line preceded by a dot is displayed on the screen.

(4) Set the TIME/CM control to the 100μs/cm position.

(5) Advance the STABILITY control until the sweep free runs.

(6) Adjust C37 until any elongation of the spot is removed.

(7) Reconnect the connection to G2 of the CRT.

(8) If the trace shrinks below 10cm, adjust RV14 (TRACE LENGTH) to restore the trace to 10cm.

NOTE If excessive adjustment to RV14 is required suspect V7 or V8. Whenever RV14 is adjusted, C37 must be re-adjusted and the time base calibration checked using the procedures detailed above.

If any other time base faults become apparent, check V6, V7 and V8.

5.7 HORIZONTAL AMPLIFIER

RV8 is the only preset control and this is set during manufacture so that full clockwise rotation of RV9 (X GAIN) expands the trace two diameters. This control should not need resetting.

5.8 HORIZONTAL PRE-AMPLIFIER

5.8 (a) Sensitivity Adjustment

To check and adjust the sensitivity of the X pre-amplifier the following procedure should be adopted:

(1) Set the oscilloscope to the appropriate mode of operation.

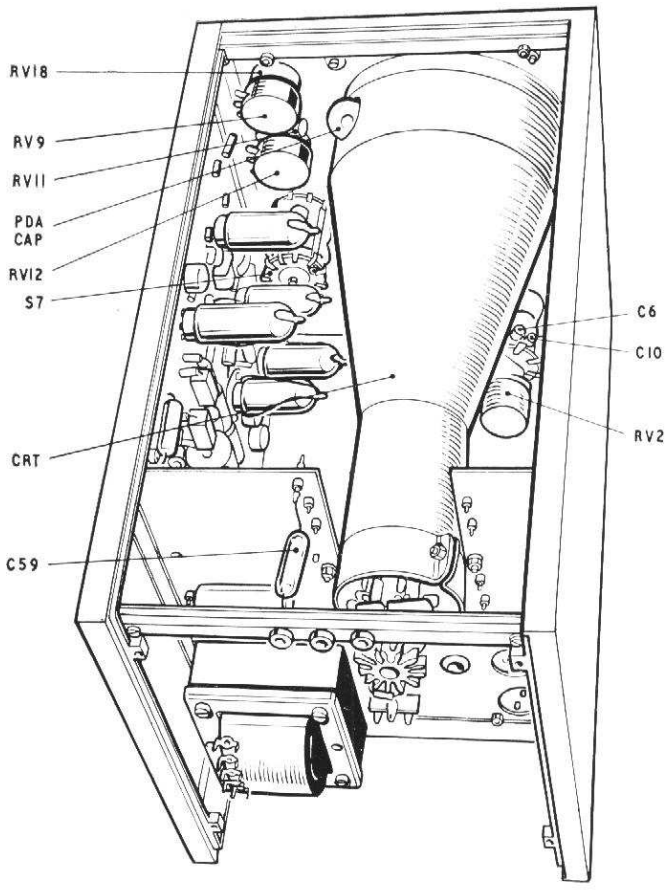


Fig. 3
Component Location—Top View

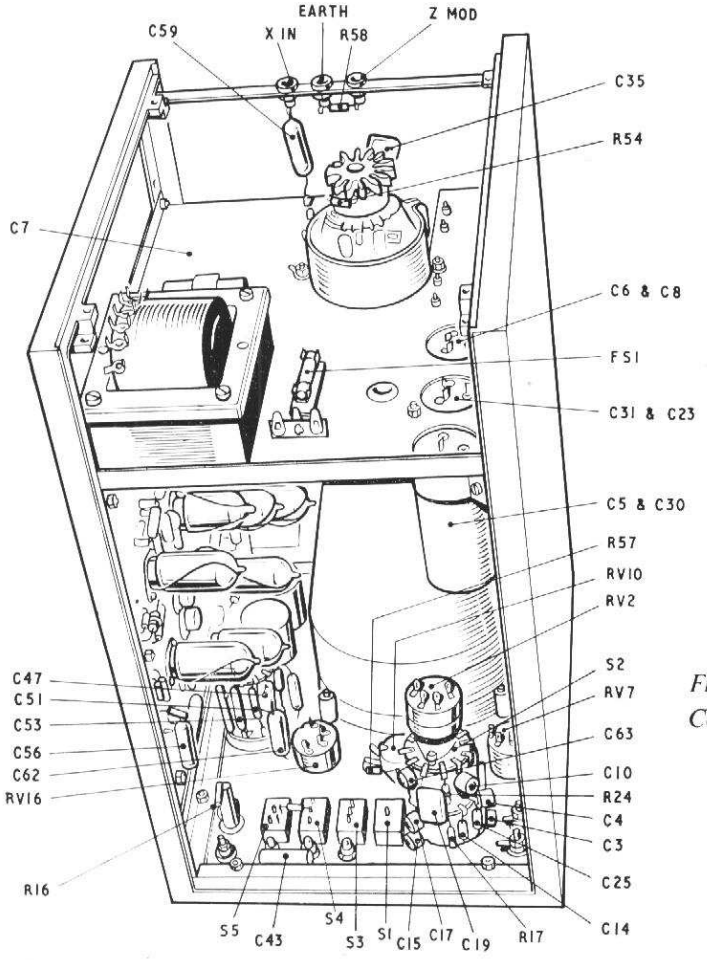


Fig. 4
Component Location—Underside View

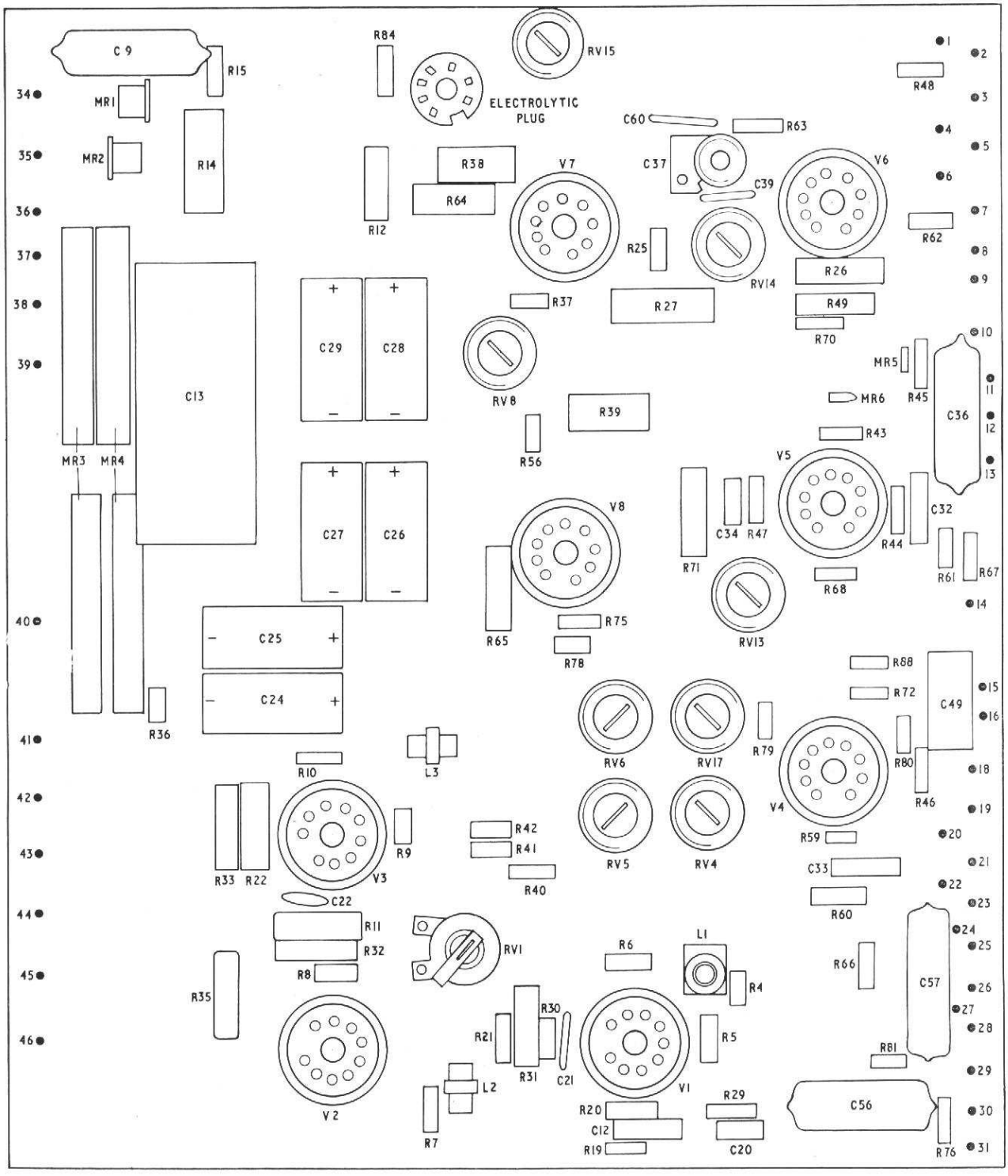


Fig 5 Printed Circiut Board Layout

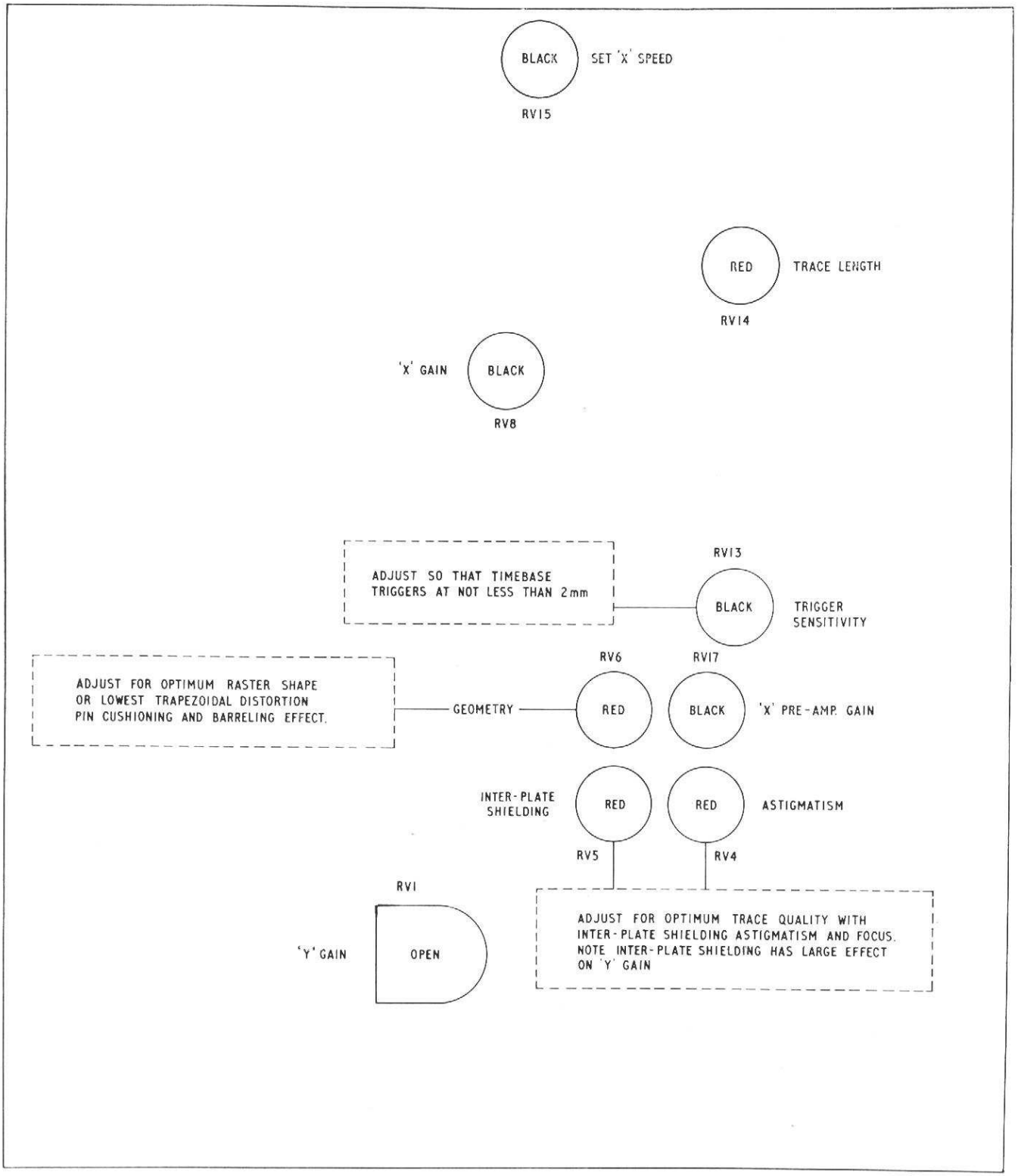


Fig. 6 Functions of Preset Controls on Printed Circuit Board

Components List and Circuit Diagram

Section 6

6.1 GENERAL

The following abbreviations are used in the Components List:

CER — CERAMIC
DP — DUAL CONCENTRIC POTENTIOMETER
EL — ELECTROLYTIC
P — PAPER
POLY — POLYSTYRENE
PS — POTENTIOMETER WITH SWITCH
SM — SILVERED MICA
TR — TRIMMER

RESISTORS (Carbon 10% ½ Watt, unless specified)

Ref	*Value*	*Description*	*Part No.*
R1	500K	1% ¼W	
R2	1M	1% ¼W	
R3	900K	1% ¼W	
R4	2.2K		
R5	4.7K		
R6	100		
R7	6.8K	10% 1W	
R8	100		
R9	6.8K	10% 1W	
R10	100		
R11	4.7K	10% 1W	
R12	3.3K	10% 2W	
R13	330K		
R14	560	10% 5Wire Wound	
R15	47K		
R16	100K		
R17	800K	1% ¼W	
R18	111K	1% ¼W	
R19	100K		
R20	47		
R21	100		
R22	4.7K	10% 1W	
R23	250K	1% ¼W	
R24	990K	1% ¼W	
R25	560K		
R26	10K	10% 1W	
R27	100K	10% 2W	
R28	10.1K	1% ¼W	
R29	1M	1% ¼W	
R30	270		
R31	6.8K	10% 1W	
R32	6.8K	10% 1W	
R33	6.8K	10% 1W	
R34	12K		
R35	4.7K	10% 2W	
R36	27K		
R37	2.7K		
R38	47K	10% 2W	
R39	47K	10% 2W	
R40	330K		
R41	330K		
R42	330K		
R43	3.3K		
R44	2.7K		
R45	4.7K		
R46	1K		
R47	56K		
R48	1M		
R49	10K	10% 2W	
R50	1M	10% 1W	
R51	1M		
R52	22K		
R53	22K		
R54	100K		
R55	27K		
R56	100		
R57	1M	10% 1W	
R58	1M		
R59	1M		
R60	470		
R61	100		
R62	470		
R63	1.8M		
R64	4.7K		
R65	4.7K		
R66	1K		
R67	56K		
R68	560K		
R69	820K		
R70	220K		
R71	10K	10% 1W	
R72	56K		
R73	400K	1% ¼W	
R74	8M	1% ¼W	
R75	1M		
R76	220K		
R77	4.7K		
R78	3.3K		
R79	1.8K		
R80	6.8K		
R81	150K		
R82	75K	5% ¼W	
R83	18K	5% ¼W	
R84	56K		
R85	4.7K		
R86	5.1M		
R87	6.8K		
R88	6.8K		
RV1	470	¼W	
RV2	3.3K	½W PS	
RV3	100K	½W	
RV4,5,6	1M	½W	
RV7	250K (S9)	½W PS	
RV8	10K	½W	
RV9	10K	½W DP	
RV10	1M	½W	
RV11	1M	½W	
RV12	100K (S6)	½W PS	
RV13	100K	½W	
RV14	1M	½W	
RV15	100K	½W	
RV16	100K	½W	
RV17	10K	½W	
RV18	100K	½W DP	

NOTES: RV9 and RV18 are ganged dual concentric pots. RV16 is assembled on S7 a,b,c,d.

CAPACITORS (Electrolytic +50%–25% 500V, unless specified)

Ref	*Value*	*Description*	*Part No.*
C1	0.22	10% 400V P	
C2	56p	10% 350V CER	
C3,4	6–25p	400V TR	
C5,6,8	50	500V	
C7	64	275V	
C9	0.1	10% 400V P	
C10	6–25p	400V TR	
C11	100p	2% 350V SM	
C12	0.01	+50%–25% 400V CER	
C13	0.05	10% 2kV POLY	
C14,16	18p	2½% 350V CER	
C15,17	6–25p	400V TR	
C18	6–25p	400V TR	
C19	2000p	2% 400V SM	
C20	18p	2½% 350V CER	
C21	100p	10% 150V	
C22	0.01	+50%–25% 400V CER	
C23	50	500V	
C24	4	500V	
C25	4	500V	
C26	4	500V	
C27	4	500V	
C28	4	500V	
C29	4	500V	
C30	50	500V	
C31	50	500V	
C32	100p	10% 400V	
C33	0.01	+50%–25% 400V CER	
C34	39p	10% 400V CER	
C35	0.01	10% 1.5kV CER	
C36	0.1	10% 400V P	
C37	3–30p	400V TR	
C38	0.01	+50%–25% 400V CER	
C39	330p	2% 400V SM	
C40	18p	10% 250V CER	
C41	6–25p	400V TR	
C42	39p	10% 400V CER	
C43	0.1	10% 400V P	
C44	not used		
C45	8	+50%–25% 275V EL	
C46	330p	2% 250V SM	
C47	100p	2% 400V SM	
C48	200p	2% 400V SM	
C49	0.22	10% 125V P	
C50	2000p	1% 350V POLY	
C51	1000p	10% 400V CER	
C52	20,000p	10% 350V POLY	
C53	0.01	10% 400V CER	
C54	0.2	2% 250V POLY	
C55	0.1	10% 400V P	
C56	0.1	10% 400V P	
C57	0.1	10% 400V P	
C58	not used		
C59	1	10% 125V P	
C60	18p	10% 400V CER	
C61	6–25p	400V TR	
C62	0.1	10% 400V P	
C63	6-25p	10% 400V TR	
C64	39p	10% 400V	

MISCELLANEOUS

FS1	2A for 200-250V supply 5A for 110V supply	
MR1,2	BY105 or equivalent	
MR3,4	Z39EJ68	
MR5,7,8	OA90 Mullard or Huges H1067	
MR6	1S131	
NV1	Neon 80V	
V1 to V8	ECF82 or 6U8	
T1	Supply transformer	MT482
CRT	Mullard D1327GH	20287

Guarantee and Service Facilities — Section 7

This instrument is guaranteed for a period of one year from its delivery to the purchaser, covering the replacement of defective parts other than valves, semiconductors and fuses. Valves and semiconductors are subject to the manufacturers' guarantee.

We maintain comprehensive after sales facilities and the instrument can, if necessary, be returned to our factory for servicing. The Type and Serial Number of the instrument should always be quoted, together with full details of any fault and the service required. The Service Department can also provide maintenance and repair information by telephone or letter.

Equipment returned to us for servicing must be adequately packed, preferably in he special box supplied, and shipped with ransportation charges prepaid. We can accept no responsibility for insruments arriving damaged. Should the cause of failure during the guarantee period be due to misuse or abuse of the instrument, or if the guarantee has expired, the repair will be put in hand without delay and charged unless other insructions are received.

OUR SALES, SERVICE AND ENGINEERING DEPARTMENTS ARE READY TO ASSIST YOU AT ALL TIMES.

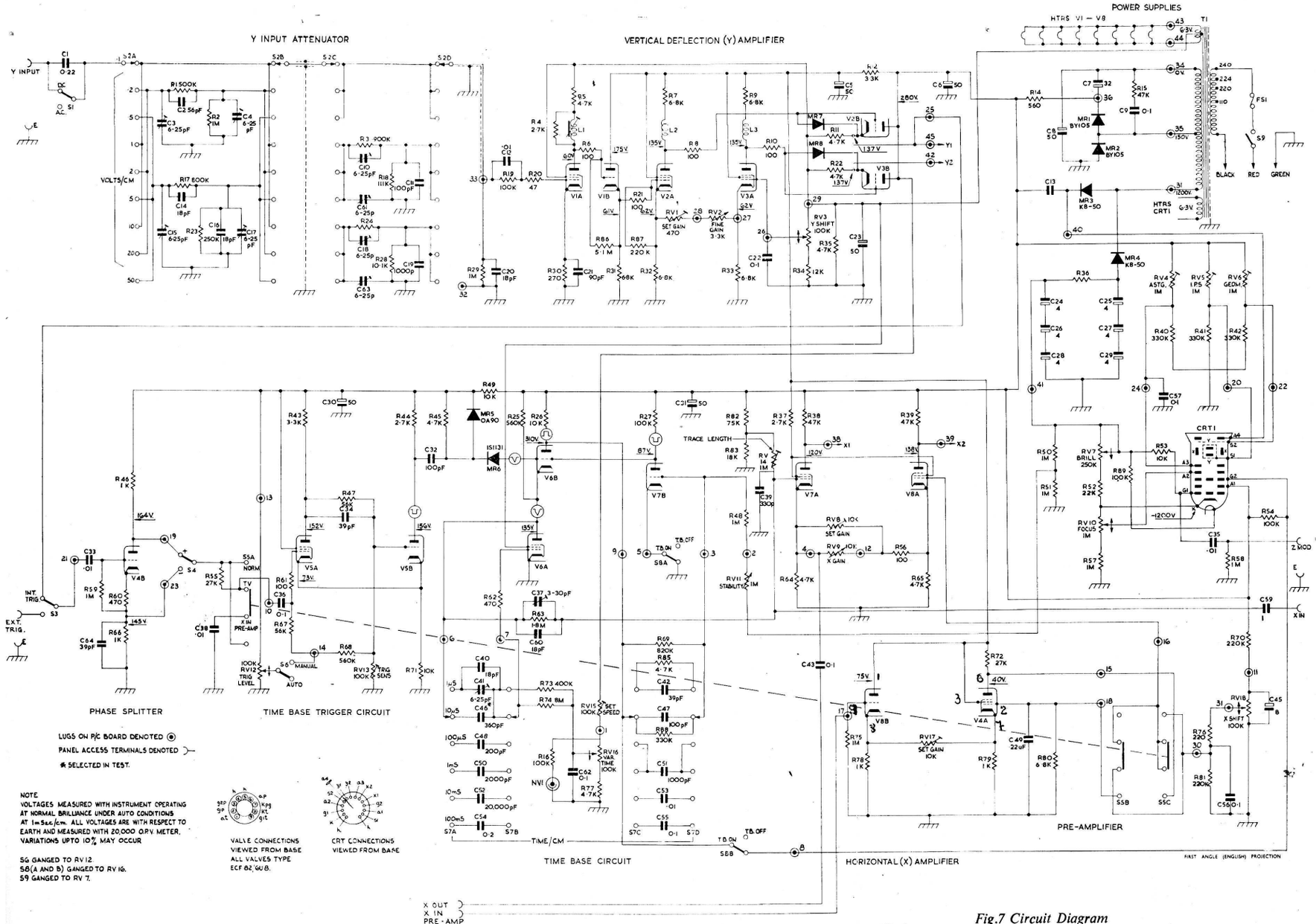


Fig.7 Circuit Diagram