DUAL TRACE OSCILLOSCOPE OS3000

Instruction Manual

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Introduction

OS3000 40MHz DUAL TRACE OSCILLOSCOPE

The Advance OS3000 is a 40MHz Lightweight dual-trace oscilloscope. Its facilities make it particularly suitable for General Purpose and High Quality laboratory work, and its size and light weight suit it for portable servicing applications of an exacting nature such as computers and data processors.

The high sensitivity and fast timebase speeds make the instrument ideal for the display of fast transients, and the comprehensive dual timebases allow detailed examination of complex waveforms and pulse trains. The mixed sweep facility gives continuous identification of the location of the section of waveform being examined.

Triggering facilities are independent for each channel, an essential feature for TV and pulse operation to eliminate waveform jitter.

Display
8 x 10cm Rectangular faced CRT
EHT 10kV overall
Illuminated graticule 8 x 10cm divisions with centre lines marked in 2mm divisions.
Phosphor P31 standard, P7 optional.

Vertical Deflection
Two identical input channels which may be operated in chopped or alternate modes, separately or summed.
Bandwidth DC – 40MHz (–3dB) DC coupled
5Hz – 40MHz (–3dB) AC coupled
Rise time <9ns
Input coupling DC – Ground – AC
Sensitivity 5mV/cm to 20V/cm in 1–2–5 sequence with uncalibrated fine gain control giving >2.5:1 reduction in sensitivity.

A x5 facility on each channel gives maximum sensitivity of 1mV/cm with a bandwidth of DC to 10MHz.
Accuracy ±3% (±5% on x5)
Input impedance – 1MΩ/28pf
Signal Delay – at least 1 cm visible delay on fastest time base speed.
Maximum input volts (DC plus pk AC) 400V

Operating Modes
Y1 only
Y2 only
Channel Y1 and Y2 chopped (500kHz approx.)
Y1 and Y2 alternate
Y1 + Y2 (Algebraic addition)
NOTE: Y2 may be inverted

Horizontal Deflection

	'A' Timebase	'B' Timebase
Sweep Speeds	22 ranges covering 200ns/cm to 2s/cm in 1–2–5 sequence.	21 ranges covering 200ns/cm to 1s/cm in 1–2–5 sequence
Fine speed control	Reduces speed by 2.5 times (slowest speed approx. 1 min)/x10 X expansion gives fastest timebase speed of 20ns/cm.	Reduces speed by 2.5 times/x10 X expansion gives fastest timebase speed of 20ns/cm.
Accuracy	±3% (±5% on x10)	±3% (±5% on x10)
Trigger Selection	Internal Y1, + or – slope Internal Y2, + or – slope External , + or – slope Line , + or – slope Free Run	Internal Y1, + or – slope Internal Y2, + or – slope External , + or – slope Line , + or – slope
Trigger Input coupling	AC, DC, AC Fast, TV Frame	AC, DC, AC Fast
Trigger level control	a) Manual b) Bright line auto (40Hz to 5MHz)	a) Manual (gated) after delay b) Direct sweep after delay.
Trigger sensitivity Internal:–	Manual – 2mm to 5MHz 1cm at 40MHz Auto – 3mm trace height.	Manual – 2mm to 5MHz 1cm at 40MHz
External:–	Manual – 300mV to 5MHz 1.5V at 40MHz Auto – 500mV	Manual – 300mV to 5MHz 1.5V at 40MHz

Delay
10 turn delay control gives selection of 'B' timebase starting position.
Accuracy ±1% scale ±3% reading
Jitter <1 in 10,000 of scale
Linearity ±1.5%

Time Base Modes
'A' Sweep
'A' Intensified by 'B'
'B' Delayed by 'A'
'A' and 'B' mixed.

Horizontal Amplifier

x10 Expansion

Operates on all timebase modes giving fastest sweep speed of 20ns/cm. Accuracy ±5%.

External X

Sensitivity 1V per cm
0.1V per cm on x10 expansion
Bandwidth dc – 5MHz
Input Impedance 100kΩ

XY

Y2 output (rear panel) coupled to Ext. X input with x10 X expand. Bandwidth dc – 1MHz
Phase shift <3° at 500kHz. Sensitivity as Y2 input attenuator (Y2 x5 inoperative)

Ext. Z mod. (rear panel)

Input Impedance – 47kΩ
Frequency Response – dc to 40MHz
Sensitivity: 1 volt for visible modulation at low brilliance
+20 volts for blanking from normal brilliance.

Outputs

Calibrator – front panel test point 1V pk-pk sq. wave ±2% 1 kHz approx.
'A' Ramp rear panel 4mm socket 0 to +10V from <10kΩ
'A' Gate " " " " 0 to +10V from <10kΩ
'B' Gate " " " " 0 to +10V from <10kΩ
Y2 out. Rear Panel BNC socket 0.1V per cm of deflection.

Supplies

95-111, 103-121, 111-130V) 45 to 440Hz
190-222, 206-242, 222-260V)
Consumption 70VA approx.

Operating temperature Range

0-50°C
Full specification is met over range 15°C–30°C

Size and Weight

7" (18cm) x 11⅜" (29cm) x 16½" (42cm)
27 lbs. (12kg)

Accessories supplied

Handbook P.No.32262

2 off BNC-BNC lead	PL43
2 off BNC-Clips lead	PL44
2 off 4mm plug	PN1244

Optional accessories

Viewing Hood	PN32264
Passive Probe Kit	PN31846
Protective cover	PN32479
Trolley	TR4
Timebase Extension Lead	PL91

3.1. SWITCHING ON

CAUTION The OS3000 is convection cooled and must always be operated in a position such that air circulation through the bottom and side vents is not restricted.

1. Set the support/carrying handle to the required operating position. The handle is released by pulling outward both fixing bushes when it can then be turned to lock in any one of 5 positions.
2. ENSURE THAT THE SUPPLY VOLTAGE SELECTOR ON THE REAR PANEL IS SET TO SUIT THE VOLTAGE OF THE SUPPLY TO BE USED. The selector must not be operated while the instrument is switched on. Connect the supply.
3. Turn the BRILL control clockwise beyond the POWER OFF setting and ensure that the indicator lamp lights.

3.2 OBTAINING A TRACE

1. To obtain a trace
   - (a) Set the Y1 shift control to approximately mid setting.
   - (b) Set MODE switch to Y1.
   - (c) Set the X shift control to approximately mid setting.
   - (d) Set the A TRIG SELECT switch to FREE RUN.
   - (e) Set the A TIME/CM switch to 5μs.
   - (f) Set the timebase SWEEP switch to Normal.
   - (g) Set the DISPLAY switch to A.
   - (h) Adjust the BRILL control to obtain a display of the required brightness.
   - (i) Centralise the display by adjusting the Y1 and X shift controls.
   - (j) Adjust the FOCUS control and ASTIG preset control to obtain a sharply defined trace.

3.3 SETTING UP Y CHANNELS

1. Using one of the coaxial input signal leads (PL43 or PL44), connect a signal to the Y1 or Y2 input socket.
2. For
   - (a) Direct connection of the input signal, set the associated AC, GND, DC input lever switch to DC.
   - (b) Capacitive coupling of the input signal through an internal 0.1μF 400V capacitor, set the lever switch to AC.

NOTE When examining low amplitude ac signals superimposed on a high dc level, the lever switch should be set to AC and the sensitivity of the Y amplifier increased as in 4.

3. To locate the baseline, set the lever switch to the GND setting. At this setting, the input signal is open circuit and the input of the amplifier is switched to ground.
4. To adjust the sensitivity
   - (a) Set the VOLTS/CM switch to a suitable setting. To minimise pick up at sensitive settings, it is essential to ensure that the ground lead connection is near to the signal point.
   - (b) If necessary, adjust the concentric VARIABLE control.

NOTE The range of the VARIABLE control is approximately 3:1 so that its full adjustment overlaps the adjacent lower sensitivity range. Except at the CAL setting, the VARIABLE control is uncalibrated. At the CAL setting, the calibration corresponds to the setting of the VOLTS/CM switch.

5. For vertical movement of the trace, adjust the Y shift controls (identified with vertical arrows).
6. If, under no signal conditions, trace movement is detected when the VARIABLE is altered, reset the BAL preset control.

NOTE This control will only need adjustment at infrequent intervals. Before adjusting the BAL preset control however, ensure that the input lever switch is set to the GND setting.

3.4 SINGLE TRACE OPERATION

1. For single trace operation on the Y1 channel, set
   - (a) The MODE switch to Y1.
   - (b) The Y1 shift control (indicated by double ended vertical arrow) to mid setting.
2. For single trace operation on the Y2 channel set
   - (a) The MODE switch to Y2.
   - (b) The Y2 shift control (indicated by double ended vertical arrow) to mid setting.
3. High sensitivity operation with a bandwidth of dc to 10MHz can be obtained on either channel by pulling the SHIFT control which increases the sensitivity 5 times,

i.e. 1mV/cm with the sensitivity set to 5mV/cm
2mV/cm " " " " 10mV/cm
4mV/cm " " " " 20mV/cm

Beyond this it is better to revert to normal operation.

4. It is possible to obtain useful higher sensitivities with unspecified overall performance by cascading the two channels. The input signal should be coupled into Y2 and the Y2 OUTPUT socket on the rear panel coupled to the Y1 input using a coaxial connector PL43.

The MODE switch should be set to Y1. The Y2 output provides 0.1V/cm of normal Y2 display, i.e. an additional gain of x20. DC offsets and drift will necessitate the use of ac coupling in this mode and amplifier noise will negate the use of the full sensitivity of 50μV/cm.

3.5 DUAL TRACE OPERATION

In the dual trace condition, the beam switching function is in operation and results in the independent display of two signals simultaneously. Two modes of beam switching – chopped or alternate – are used, selected by the setting of the MODE switch. At any fast setting from 0.2μs/cm to 0.5ms/cm inclusive, the alternate switching mode is recommended. At slow settings from 1ms/cm to 2s/cm, inclusive and EXT X, the chopped switching mode is preferable.

1. For dual trace operation, set
   - (a) The Y1 shift control to mid position.
   - (b) The Y2 shift control to mid position.
   - (c) Select ALT or CHOP on MODE switch.

3.6 A TIMEBASE OPERATION

The speed of the A timebase is determined by the setting of the A TIME/CM switch. In addition to selection of the speed of the internal timebase, the switch has a functional setting, EXT X in which the internal timebase is inoperative.

The gain of the internal X amplifier may be increased x10 by pulling out the PULL x10 control on the VARIABLE TIME/CM switch. This facility is available at all settings including EXT X. The facility effectively increases the sweep length from 10cm to 100cm and thus allows close examination of any portion of the trace. Any portion of the increased sweep length may be selected for viewing on the display by adjusting the X shift control.

A particular advantage of this facility is to increase the maximum sweep speed to 20ns/cm.

1. To adjust the time scale of the horizontal axis
   (a) Set the A TIME/CM switch to the required setting.
   (b) If necessary, adjust the concentric VARIABLE control to reduce the speed.

NOTE The range of the VARIABLE control is approximately 3:1. The VARIABLE control is uncalibrated. At the CAL setting only, the calibration corresponds to the setting of the TIME/CM switch.

Selection of the 2 sec/cm range and full use of the variable control, provides a total sweep time of approximately 1 min.

2. If close examination of any portion of the trace or the fastest sweep rates are required, operate the PULL x10 control.
3. For horizontal shift of the trace, adjust the X shift control (identified by horizontal arrow). The control has a dual speed function. Initial operation provides coarse shift control, the return adjustment provides fine shift control.

3.7 A TRIGGER

The A timebase may be operated in a FREE RUN condition or, more normally, triggered from the positive or negative slope of a signal as determined by the setting of the TRIG SELECT switch. The triggering sources selected by the TRIG SELECT switch are as follows.

(a) The supply line input frequency derived internally from the supply transformer.
(b) Y1 or Y2 amplifiers (irrespective of which beam is displayed).
(c) An external triggering source connected to the A EXT TRIG socket.

The A LEVEL control concentric with the A TRIG SELECT switch, allows selection of the triggering point on the trigger waveform and hence determination of the start of the horizontal trace. When the LEVEL control is set to AUTO, the trigger circuit automatically biases itself to a sensitive trigger level condition. In the absence of a trigger signal in this mode, the timebase will free run and maintain a displayed sweep at the selected speed.

The TRIG SELECT switch is used in conjunction with the A TRIGGER COUPLING lever switch. This switch connects different networks into the trigger amplifier circuit and is effective at all settings of the TRIG SELECT switch.

The operating facilities available at the four settings of the lever switch are as follows.

1. AC Wideband trigger mode used for most common triggering signals.
2. ACF (AC Fast) A filter is switched into circuit to reject low frequencies. High frequency triggering may be effected from complex waveforms such as those with high ripple content or line triggering from a television video signal waveform.
3. TVF (TV Frame) A television sync separator is switched into circuit so that the timebase can be triggered from a television video waveform.
4. DC A wideband trigger mode but it is most useful at very low frequencies. The Y input coupling must also be dc for this mode to be effective on internal trigger.

Triggering control is effected as follows.

1. Set the A TRIG SELECT switch to select the required trigger signal.
2. Set the A TRIGGER COUPLING switch to the required setting.
3. On most waveforms it is convenient to select Auto. If not, adjust the LEVEL control so that the trace starts at the required point on the waveform.

If the timebase is not required to be triggered, set the A TRIG SELECT switch to FREE RUN.

NOTE If, in the Auto mode, the frequency of the trigger is less than approx. 40Hz or the amplitude is too low for reliable triggering, the timebase automatically changes to a free run condition. This condition produces a trace at the selected sweep speed.

3.8 SINGLE SWEEP FACILITY

To set the timebase to give a single sweep

1. Apply a repetitive waveform and obtain a trace with the SWEEP switch in NORMAL by adjusting the A LEVEL control.
2. Move SWEEP switch to SINGLE SHOT.
3. Disconnect input waveform.
4. Move SWEEP switch against the return spring arm and release.

The neon indicator will now light to show that the circuit is primed ready for the next trigger pulse to occur.

5. Apply repetitive waveform. The next trigger pulse will initiate a sweep and the neon will be extinguished. The timebase will not again operate until the SWEEP switch is moved to the ARM position again.

3.9 B TIMEBASE AND TRIGGER

The speed of the B timebase is determined by the B TIME/CM switch, which has all the ranges of the A TIME/CM switch except 2s/cm. The B VARIABLE sweep speed potentiometer is concentric with the TIME/CM switch.

The B TRIG SELECT switch is identical to the A except that there is no FREE RUN position. The B LEVEL is identical to the A except that the AUTO function is taken by the B STARTS AFTER DELAY function. The B TRIG COUPLING switch has AC, ACF, DC positions.

3.10 DUAL TIMEBASE OPERATION – NORMAL DELAYED SWEEP

To examine a small period of a stable 'A' sweep

1. Set the B TIME/CM switch about two ranges faster in speed than the A TIME/CM switch.
2. Rotate B LEVEL control anticlockwise to the switched position, B STARTS AFTER DELAY.
3. Move DISPLAY switch to A INTEN BY B.
4. Adjust preset CONTRAST if necessary to give good visibility of the intensified portion of the trace.
5. Adjust B TIME/CM and the delay multiplier potentiometer so that the intensified portion covers the period of interest.
6. Move DISPLAY switch to B and make final adjustments of delay multiplier potentiometer and B TIME/CM switch.

3.11 DUAL TIMEBASE OPERATION – GATED SWEEP

If the display exhibits annoying jitter

1. Return display switch to A INTEN BY B.
2. Select appropriate trigger source, slope and coupling on the B TRIG SELECT and TRIG COUPLING switches.
3. With the B LEVEL still in the B STARTS AFTER DELAY position, adjust the delay multiplier so that the bright-up starts just before the edge of the waveform selected as a trigger point.
4. Rotate B LEVEL clockwise and adjust for a stable triggering by observing bright-up.
5. Move DISPLAY switch to B.

3.12 DUAL TIMEBASE OPERATION – MIXED SWEEP

This allows expansion of a part of the 'A' sweep while still displaying the 'A' sweep up to the point set by the delay multiplier.

1. Set DISPLAY switch to 'A' and obtain a display using the 'A' timebase controls only.
2. Set B TIME/CM switch two ranges faster in speed than the A TIME/CM switch.
3. Set B LEVEL to B STARTS AFTER DELAY.
4. Move DISPLAY switch to MIXED and adjust the DELAY multiplier potentiometer and the B TIME/CM switch for the best display. The CONTRAST can also be adjusted if necessary to allow for widely differing sweep speeds in the two sections of the trace.

3.13 EXTERNAL X

In this condition, the external signal is applied directly to the internal X amplifier to produce a calibrated (1V/cm) horizontal deflection. Dual trace Y operation may be used if chop is selected. Bandwidth is 5MHz.

1. Set the A TIME/CM switch to EXT X.
2. Connect the external signal to the EXT X socket.

3.14 X-Y MODE

It is possible to use the flexibility of the two Y inputs for XY displays.

1. Set the A TIME/CM switch to EXT X.
2. Set the Y2 input switch to DC or AC.
3. Connect the external signal which is to be used for X deflection to the Y2 socket.
4. Select x10 X amplifier gain.
5. Couple Y2 OUT (rear panel) to EXT X input with a co-axial lead PL43.
6. Operate the Y1 channel as for single trace operation and use the Y2 VOLTS/CM switch to control the X deflection. The Y2 shift is inoperative.

3.15 ADDITIONAL FACILITIES

3.15.1 USE OF OPTIONAL PASSIVE PROBE

An x10 passive probe may be used to extend the voltage range and increase the input impedance of the Y amplifiers. The input resistance of a Y channel is 1MΩ shunted by approximately 28pF. The effective capacity of the input lead must be added to this and the resultant impedance will sometimes load the signal source. Therefore it is advisable to use a 10MΩ x10 probe. This reduces the input capacity and increases the input resistance, at the expense of the sensitivity. The probe contains a shunt RC network in series with the input, and forms an attenuator with the input RC of the Y channel. To obtain a flat frequency response it is necessary to adjust the capacitance of the probe to match the input capacity of the Y channel as follows.

1. Set the Y channel VOLTS/CM switch to 20mV/cm, and the A TIME/CM switch to .2ms/cm.
2. Connect the probe to the CAL 1V pin.
3. Set the adjustable capacitor in the probe tip or termination with a small screwdriver for a level response with no overshoot or undershoot visible on the display.

3.15.2 CAL 1V

This pin provides a dc coupled positive-going square wave of 1V ±2% amplitude at approximately 1kHz frequency for calibration checks. The square wave has a source impedance of 200Ω and a rise time of less than 100ns. Shorting the CAL pin to ground will produce a square current waveform of 5mA in the shorting link. This can be used for current probe calibration.

3.15.3 'A' AND 'B' GATE OUTPUTS

These sockets on the rear panel provide a dc coupled positive going square pulse of 10V amplitude from <10kΩ source impedance. The duration of the pulse is coincident with the appropriate time base sweep. Improved rise time may be obtained at the expense of amplitude by resistively loading the outputs.

3.15.4 'A' RAMP

This socket on the rear panel provides a dc coupled positive-going timing ramp of approximately 10V amplitude generated by the 'A' timebase. Source impedance is 4.7kΩ and the ramp may be used as a drive for external frequency swept oscillators to allow display of voltage against frequency.

3.15.5 Z MOD

This socket on the rear panel allows dc coupled blanking to be applied to the tube.

The CRT trace is intensified by a negative input, and blanked by a positive input. The required amplitudes are

(a) 2 volts for visible brilliance modulation.
(b) +20 volts for blanking at normal brilliance.

This facility is available in any operating mode of the instrument.

For convenience, the circuit reference of any component can be used to determine its location in the instrument.

1 – 99	Frame or interconnection.
100 – 199	Y1 and Y2 Preamplifiers and attenuators.
200 – 299	Beam switch and delay line drive amplifier.
300 – 399	Delay equaliser and Y O/P amplifier.
400 – 499)	'A' Timebase
500 – 599)	
600 – 699)	'B' Timebase
700 – 799)	
800 – 899	Power supply and EHT supply.
900 – 999	Bright up amplifier and X output amplifier.

e.g. R370 is part of the Y output amplifier
D801 is part of the EHT oscillator.

The circuit diagrams are generally arranged for each printed board assembly or group of boards. These diagrams include some of the switches, potentiometers etc., closely associated with the circuit although these components may be mounted on the frame. Consequently not all such components appear on the interconnection diagram fig. 11 and where it makes the circuits easier to follow, some componei appear on more than one circuit.

In addition to the relevant circuit diagrams, useful referencє can be made to the waveform diagrams, figs. 12 and 13, when following the description of the timebase section.

4.1 THE BLOCK DIAGRAM

The block diagram for the complete instrument is shown in Fig. 1. It is not intended to be a full logic diagram but details the functional points of the circuit and their interrelation. The circuit can readily be divided into two main sections which are the Y and the X deflection circuits. The latter includes the two time bases with their associated trigger systems. The bright-up or Z modulation function is described as part of the time base function.

The main X and Y signal paths for a dual trace display using the main A sweep only, are indicated by the heavy lines.

Y CHANNELS

The switched attenuator, preamplifier and trigger amplifiers are identical for the two Y channels. Y2 differs in having invert and output facilities. The state of the decade steps of attenuation and 1, 2, 5 sequence of preamp gain switching are determined by the sensitivity selected.

The use of the x5 GAIN on each channel increases their basic sensitivity to 1mV per centimetre but reduces the overall bandwidth to 10MHz.

The channel switch is a fast electronic switch with the equivalent of a changeover action as shown. It selects either the Y1 or the Y2 signal to be passed to the subsequent stages and is controlled from a bistable. In the chop mode the bistable is driven by continuous pulses from the free running multivibrator, switching the beam between the Y1 and Y2 signals as the X sweep progresses. In the alternate mode, the multivibrator acts as a monostable generating a single pulse to reverse the beam switch at the end of each time base sweep, giving alternate Y1 and Y2 sweeps. In the ADD mode, both the Y1 and Y2 switches are closed and the two signals are summed algebraically. On Y1 or Y2 only the appropriate switch is closed allowing that signal to pass.

The signal from the selected channel is passed via a delay line and amplifiers to the Y deflection plates of the CRT. This delay allows examination of that point in the waveform which initiated the sweep because the deflecting signal reaches the Y plates after the time base sweep has been initiated and the trace brightened.

THE TIMEBASES

The purpose of the timebase system is to generate a linear ramp or ramps to deflect the spot in the X direction. The trigger system initiates each sweep from the incoming or other signals, normally to obtain a stationary display of a repeated waveform.

TIMEBASE 'A' OPERATION ONLY

The internal or external signal as selected is amplified by the trigger amplifier to drive a trigger circuit. If the timebase is ready to commence a sweep, a transition of the trigger circuit will set the 'A' timebase bistable which in turn initiates the 'A' ramp. This signal is passed through the X gate and X output amplifier to the X deflection plates of the CRT. At the end of the sweep, when the ramp reaches the required level the bistable is reset, returning the ramp to its original level. During the period of sweep the trigger gate is prevented from passing trigger pulses to the bistable and this inhibition is maintained by the hold off circuit until the ramp generator is fully recovered, ready for the next sweep to commence on the next trigger pulse, when the cycle repeats.

The bright-up amplifier normally holds the CRT beam in the cut off state. The output of the 'A' bistable which allows the 'A' ramp to operate, also feeds the bright-up amplifier to raise the brilliance of the CRT spot to the level determined by the brilliance control.

At the end of sweep, this output of the bistable is reset and blanks the trace during the flyback period.

If the Y channels are being switched in the chopped mode, the differentiated output of this multivibrator is also fed to the bright-up amplifier to blank the trace while the Y switching transition takes place. This leaves the appearance of two separate traces for Y1 and Y2 on the screen unless the sweep speed is higher than that normally recommended for chop operation.

'A' INTENSIFIED BY 'B' ('B' starts after delay)

In this mode operation of the 'A' ramp is the same as foı 'A' only. The 'B' timebase bistable is switched on at the required point in the 'A' sweep when the 'A' ramp reaches the potential set by the delay control detected by the comparator. The 'B' ramp generator then runs either for its full period or until the end of the 'A' ramp, whichever occurs first, when the 'B' bistable is reset. The 'B' single shot bistable ensures that there is only one 'B' sweep during any 'A' sweep. The output of the 'B' bistable drives the bright-up amplifier to brighten the 'B' portion of the 'A' trace above the normal level, the relative level of the normal to brightened portion being determined by the contrast control setting.

'A' INTENSIFIED BY 'B' – GATED

In this mode the operation is as outlined for the normal intensified mode except that the output from the comparator only opens the 'B' timebase bistable trigger gate, allowing the next 'B' trigger pulse to trigger the bistable and hence initiate the 'B' ramp.

'B' ONLY

In this mode, the 'A' and 'B' sweeps are triggered and run as in the intensified mode. However, the X gate allows only the 'B' sweep signal to the X amplifier as the deflecting signal. The resultant display is then that section brightened up in the previous mode, now expanded to the full screen width. In this mode, the trace is only brightened during the 'B' sweep.

MIXED 'A' AND 'B'

This mode is a combination of the 'A' and 'B' modes. The 'A' sweep is triggered and runs as normal until the 'B' sweep starts as in the intensified or 'B' modes. During this time the 'A' ramp is fed via the 'B' ramp generator to the X gate to deflect the trace. This 'A' ramp connection also ensures that the 'B' ramp generator starts from the correct point. When the 'B' bistable is energised, the 'B' ramp runs, starting from the 'A' level at that instant and this ramp is passed by the X gate to increase the sweep speed to the 'B' rate. When the 'B' ramp reaches the normal end of sweep level, the 'B' timebase bistable is reset, in turn resetting the 'A' timebase bistable allowing the cycle to repeat after the 'A' hold off period.

The bright-up circuit operates as in the 'A' intensified by 'B' mode, allowing the contrast control to be used to equalise the brightness of the 'A' and 'B' portions of the trace despite the differing sweep speeds.

TRIGGER MODES

The trigger signal for either time base, selected from internal, external or line frequency sources, is ac or dc coupled before being fed into the trigger amplifier which is biased by the required trigger level and the resultant output passed to the trigger circuit to be squared up.

In the FREE RUN mode, the 'A' trigger gate is permanently energised and the 'A' timebase bistable is set again at the end of each hold-off period.

When AUTO coupling is selected, the 'A' trigger amplifier is automatically biased to the optimum working point for sensitive operation of the trigger. If the signal level out of the trigger amplifier is insufficient to operate the trigger circuit, a further output from the auto circuit causes the 'A' timebase to free run, displaying the necessary bright line trace.

When TV Frame coupling is selected for the 'A' timebase, a synch. separator circuit is introduced into the signal path and the A timebase is triggered by each frame pulse.

In Single Sweep, the relevant bistable normally inhibits trigger pulses from reaching the 'A' timebase bistable. When the single shot bistable is set manually, the trigger gate is opened and the next trigger pulse initiates a sweep. When the sweep starts the single sweep bistable is reset, preventing the timebase from sweeping more than once.

THE EXTERNAL X I/P

When external X is selected, the trace is brightened and the timebases are inhibited. The amplified X input signal passes through the X gate to the main amplifier.

4.2 INPUT ATTENUATORS AND PREAMPLIFIERS

NOTE The Attenuator and Preamplifiers in the Y1 channel are identical to those in the Y2 channel. Accordingly, only the Y1 channel is described. Where a corresponding component carries a different number in Y2, this number is shown in brackets after the Y1 number.

The input signal is applied from the front panel socket SKY to the 3 position lever switch, S10. When the INPUT COUPLING SWITCH is in the DC position, the input signal is coupled directly to the Input Attenuator stage. In the AC position, the input signal passes through C155. This capacitor prevents the dc component of the input signal from passing to the amplifier. The GND position opens the signal path and connects the input circuit of the amplifier to ground. This provides a ground reference without having to disconnect the applied signal from the input connector.

The input attenuators are frequency compensated, voltage dividers. For dc and low frequency signals they are primarily resistance dividers and the attenuation is determined by the resistance ratio, the effect of the capacitors being negligible. However, at high frequencies, the reactance of the capacitors decreases and the attenuator becomes primarily a capacitive divider. Each attenuator contains an adjustable series capacitor to provide optimum response for the high frequency components and an adjustable shunt capacitor to set up the input capacity of each section. The component values in each section are arranged to provide the required attenuation and present the same RC characteristic for all settings of the VOLT/cm switch.

Two attenuator sections are employed giving an attenuation of 10 or 100 respectively. These are used singly or cascaded. The basic amplifier provides a maximum sensitivity (for full bandwidth) of 5mV/cm; gain switching in the amplifier reduces this to provide the 10mV/cm and 20mV/cm settings. The x10 attenuator is introduced to provide the 50, 100 and 200mV/cm ranges; the x100 to provide the 500mV, 1V, 2V/cm ranges and the x100 and x10 cascaded to provide the 5, 10 and 20V ranges.

The x10 attenuator consists of R176 and R177. Capacitor, C165 adjusts the input capacitance on the 50, 100, 200mV/cm ranges, while C167 corrects the frequency response of the attenuator.

The x100 attenuator consists of R163 and R169. Capacitor C159 adjusts the input capacitance on 500mV, 1V, 2V/cm ranges, while C161 corrects the frequency response of the attenuator.

Capacitor, C171 provides adjustment for the input capacity when the attenuators are not in circuit. R187 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 output from the attenuator is taken via the input current limiting resistor, R189, to the input stage consisting of a pair of matched field effect transistors, TR101 and TR102, operating as source followers.

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

The field effect transistor gives a high input impedance which does not shunt the attenuator. 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.

The input stage drives a pair of emitter followers, TR103 and TR104, to provide a low impedance drive to the following stage.

The output from the emitter followers is applied to the long tail pair amplifier, TR121 and TR122. TR120 being a constant current source of this stage. The stage provides a nominal gain of about 5, the emitter circuit however contains the FINE GAIN CONTROL, R10 (R20), which allows a reduction in gain of at least 2:5:1. The two transistors in this stage are matched and thermally coupled together in order to reduce drift to a minimum. In addition, they are mounted on the rear screen of the attenuator assembly in close proximity to the FINE GAIN CONTROL. This ensures that the length of the emitter leads to the gain control and consequently their inductance is kept to a minimum.

A potentiometer, R123, is provided in the emitter circuit giving some variation of the collector currents. This allows the emitter potentials of the following stage to be equalised to prevent trace movement when gain switching.

The collector supply is stabilised by the 5.6V zener diode, D121, giving a collector potential of +4V. This provides sufficient margin to allow for variations of input dc level due to the possible range of FET source to gate voltage.

The following stage is also a long-tailed pair with gain switching incorporated into the emitter circuit.

In the minimum gain condition the gain is determined by the emitter resistors, R132 and R134.

The gain is raised by x2 and x4 by connecting between the emitters network, R137 and R138, or network, R135 and R136, respectively.

The two trimmers, C122 and C123, provide a high frequency compensation to equalise frequency response between ranges.

Decoupled resistors, R154 and R155, are added to reduce collector dissipation and keep drift due to thermal effects to a minimum.

The collector supply is stabilised by the 5.6V zener, D122.

The final stage on this board and on the attenuator assembly is a pair of emitter followers, TR125 and TR126.

The trigger signal is taken directly from the emitters but the signal for the remainder of the Y amplifier is tapped down the emitter loads by the addition of a small series resistor. This allows a dc shift of the output to be provided for, balancing in the following stage by the addition of the potentiometer, R146, in the bottom end of the emitter loads.

The signal outputs from this stage represent approximately 25mV/cm of screen deflection, the dc level being nominally +7.5 volts.

The signals are then passed to the Beam Switch printed circuit board, in the case of Y1 direct but in the case of Y2 via the INVERT SWITCH, S201.

4.3 BEAM SWITCH

The Y1 and Y2 signals feed to the beam switch printed circuit board into two identical long-tail pair amplifiers, TR203/4 and TR205/6. Each amplifier provides a number of additional functions, namely:

1. SHIFT CONTROL is obtained by means of potentiometers, R26 and R27, in series with the emitter resistors of each stage.
2. Overall gain adjustment of each channel is provided for by means of the two networks, R226/R227 and R231/R232.
3. The maximum sensitivity of both Y1 and Y2 channels can be increased to 1mV/cm, this requires that the gain of these stages is increased by five times and is achieved by shunting across the emitter circuit the network, R228/R229 for Y1 and R233/234 for Y2. The switch for this function is mounted on the rear of the respective shift controls.
4. Networks, R230/C202 and R235/C206, are included to allow the h.f. response of the two channels to be matched.

The signals from this pair of amplifiers are fed to the beam switch circuit consisting of eight diodes, D201 to D208 inclusive. The switch is operated by signals applied in antiphase to points 26 and 29 from the Beam Switch Bistable. The signal level at these points switches from approximately +7V to approximately +0.3V. Thus when point 26 rises to +7V diodes, D201 and D202, are cut-off and diodes, D203 and D204, are turned on allowing Y1 signals to pass to the following stage. At the same time, point 29 will be at approximately +0.3V allowing D205 and D206 to conduct and prevent Y2 signals reaching the following stage. When the potentials on points 26 and 29 reverse, Y2 signals will pass to the following stage and Y1 signals will be blocked.

The output from the beam switch network is taken to transistors, TR210 and TR211, connected as shunt feedback amplifiers with R249 and R250 providing feedback from the collector to base of the respective transistor. Provision is also made in this stage by means of A.O.T. resistors, R294/R295, to take out small unbalances which cause excessive trace movement when switched to the ADD mode. Also in the ADD mode it is necessary, since two stages are now connected to a common load, to remove half the resultant current in the load, this is achieved by returning R245 and R246 to the −15V line when switching to ADD.

Signals from this stage pass to the delay line driver, a further long tail pair, TR212/TR213, fed from a constant current source, TR214. A current of 10mA per side is common to this stage and, via the delay line, to the delay line terminating stage.

The Beam Switch Bistable consists of transistors, TR215 and TR216, the conducting state of these determining which channel is displayed. For single trace operation, either of the emitters is grounded via points 35 and 36. For dual trace operation, both emitters are grounded and the transistors are turned on or off by pulses from TR217 routed via capacitors, C213 and C218, and diodes, D212 and D211. In the ADD mode both emitters are open circuited raising both collector voltages and hence opening both diode gates.

The chop multivibrator contains transistors, TR217 and TR218, which operate as an emitter-coupled astable multivibrator whose frequency of approx. 500kHz is determined by R280, R285, and C221.

In addition to operation for the chop function, the circuit acts as a monostable when the alternate mode of beam switching is selected. In the alternate mode, the circuit produces 1 pulse per timebase sweep and is fed with an end of sweep pulse from the time base bistable. The −15V volts supply is connected to point 32 via the FUNCTION SWITCH, this increases the current through TR218 and causes a drop in the level of the collector voltage.

This drop cuts off TR217. The negative going end of sweep pulse thus finds the circuit in a monostable condition which it triggers producing a high amplitude positive-going pulse at the collector of TR218 and a negative-going pulse at TR217. The output from TR218 is taken to the Bright-up Amplifier to blank the trace during the chop transistion period and that from TR217 to the Beam Switch Bistable.

4.4 DELAY LINE AND DELAY LINE EQUALISER

The Delay Line is of the printed circuit type and introduces a signal delay of approximately 95ns. This time allows for delay in the time base and bright-up circuits and ensures that the first part of a signal is visible.

The output of the delay line is terminated by the resistors, R301 and R302, and feeds into the common base stage, TR300 and TR301.

The pulse response for the uncompensated delay line can be represented by a fast rise for about 50% of the amplitude followed by a considerably longer rise to full amplitude. Correction for this response is provided in the following stage, TR302/TR303, by means of resistance/capacitor networks, R308/C302, R309/C303, R310/C305, R311 and C306, connected between the emitters.

A further stage, TR304/TR305, provides additional frequency compensation (C310, C311, R324/C312) and raises the signal to the required level to drive the output stage.

4.5 OUTPUT STAGE

The output stage consists of four transistors, TR351, TR352, TR353 and TR354, operating as a differential cascode amplifier. The collector loads are made up of four resistors in series/parallel in order to give the required dissipation with minimum stray inductance and capacitance. High frequency compensation is provided by the inductances, L351 and L352.

A constant current transistor, TR355, gives a current in each side of the output stage of approximately 35mA and holds this stable against small variations of the dc input level of +7.25V. At this current the nominal mean Y plate potential is +55V.

4.6 Y TRIGGER AMPLIFIERS AND Y2 OUTPUT AMPLIFIER

Incorporated on the Beam Switch printed circuit board are the Y1 and Y2 trigger amplifiers and the Y2 output amplifier stage.

The trigger amplifiers consist of long-tail pairs, TR201/TR202 and TR207/TR208, receiving differential signals from the Y1 and Y2 pre-amplifiers and providing a single ended output for the Time Base.

R213 and R223 provide a means of setting the d.c. level for the trigger circuits (nominally 0V).

In addition a further output is taken from the Y2 trigger amplifier and fed to an amplifying and inverting stage, TR209. This provides an output level of 100mV/cm and when used in conjunction with the X amplifier, gives an X-Y operation facility.

The gain of this stage can be set by R238 and phase shift correction is provided by C228 connected across the feedback resistor, R242.

4.7 "A" TRIGGER SELECTION AND AMPLIFICATION

Trigger sources (Y1, Y2, Line, Ext) are taken to S40AF. The internal trigger signals are brought via 50Ω coax, and are terminated by R400 and R406. The line trigger signal is provided from a single turn secondary winding on the mains transformer and the correct trigger voltage is obtained by the simple attenuator, R405 (mounted on S70) and R746. External trigger signals are attenuated approximately fifty times by the network, R401, C400, R402 and C401. The signal selected by S40AF is passed via the trigger coupling switch, S42, to two cascaded emitter-follower stages, TR409 and TR410. D406 and D407 provide the necessary protection against excessively large external trigger signals. The signal from the emitter of TR410 is switched by S40BF and S40BB, according to the selected trigger slope, to the base of TR413 or TR414 which form a long-tailed pair amplifier. S40BF, S40BB also connect the undriven base of this amplifier to the network, C451, R437, and R420, which provides a low impedance path to ground for high frequency signals and the correct bias to balance the amplifier. The trigger level control (R440) also acts on this network via R441, introducing a positive or negative offset, which is thus mixed with the amplified trigger signal.

The network, R422 and C415, between the emitter of

TR413 and TR414, provides high frequency compensation. The output from TR414 is applied to the base of TR415 which together with TR416, forms another long-tailed amplifier; R488, R490 and C424 provide high frequency compensation. The base of TR416 is normally held at a fixed bias by zener diode, D423, except when S41b (the auto level switch) is open (see Auto operation). When the level control (R440) is adjusted so that the base potentials of TR413 and TR414 are equal, R453 adjusts the dc potential on the base of TR415 so that the Schmitt trigger circuit is brought near its switching point, maintaining the same trigger level for positive and negative slope selection.

The output from the collector of TR415 is taken via D402 (See trigger signal routing) to grounded-base amplifier, TR404, and from the collector of this transistor via D415 to the Schmitt trigger circuit. The output from TR416 collector is connected to the auto level circuit, and the TV sync separator circuit.

4.8 AUTO

When auto is selected by turning the 'A' trigger level control to its extreme anticlockwise position, S41a and S41b open. R491 and the base of TR416 are disconnected from the zener diode, D423, so that the dc potential set by R453 has little effect on the amplifier, TR415 and TR416. The opening of S41 causes the potential at the extreme anticlockwise end of the level control to change from −15V approx. to 0V approx. (R440 and R552 form a potential divider across the ±15V lines). Thus the amplifier, TR413/TR414, is still approximately balanced. S41a also operates on TR403 (see Trigger signal routing) to energise the bright-line circuit. (See Free run and bright-line circuit). Trigger signals from the collector of TR416, are coupled via C411 and C412 to the bases of the complementary amplifier stage, TR406 and TR407. Emitter resistors, R426 and R427, define the gain, and C442 and C443 provide high frequency compensation. Both transistors are normally biased off but are sensitive to small input signals with one or the other being turned on. The output resultant from the commoned collectors is an amplified form of the input which is not paralysed by inputs of widely differing mark/space ratio. It is applied via D416 to grounded base stage, TR404, and thence to the Schmitt trigger.

4.9 T.V.

Trigger signals from the collector of TR416, are taken via R447 and C445 to the base of TR408. When the trigger coupling switch, S42, is set to select TV operation, current is allowed to flow into the base of TR408, and the collector load, R449 and R448, is connected to the +15V line. A TV video waveform, with positive-going sync. pulses, applied to the base of TR408 will cause base current to flow and charge up C445, biasing off TR408 on all but the most positive (sync. pulse) part of the signal. The collector voltage waveform is thus composed only of the line sync. signal. The low pass filter, R449 and C416, extracts the frame pulse information from this waveform, to be applied via D413 direct to the Schmitt trigger input.

4.10 "A" TRIGGER SIGNAL ROUTING

The three different trigger circuit connections, manual trigger, auto and TV frame,are controlled by the state of TR403/TR405, and the position of the trigger coupling switch, S42. In manual operation, S41a is closed and with no voltage across its base resistor, R552, TR405 is cut off. Current through R439 and R421 turns on TR403 causing its collector potential to become approximately −15V. Current through R424 and D410, pulls the collector potentials of TR406 and TR407 negative, cutting off D416, and disconnecting the auto circuit output from the grounded base amplifier, TR604. Current through R418 acts on the bright-line circuit (see Free run and bright-line circuit), to prevent it operating. Trigger signals from TR415 are passed to the Schmitt trigger as current from TR415 flows through D402 into TR404, and from the collector of TR404 via D415 to the Schmitt trigger.

When Auto is selected, S41a is open, base current through R552 bottoms TR405, and this in turn cuts off TR403. Current through R408 and D435 causes the collector of TR415 to go negative, cutting off D402. At the same time, the current through R424 and D410 is removed allowing the collector potentials of TR406 and TR407 to rise, turning on D416. Trigger signals now pass from the collector of TR416 to the auto circuit, TR406 and TR407, and then via TR404 to the Schmitt trigger. Also, when TR403 is cut off, current through R418 is removed, energising the bright-line circuit, TR411 and TR412, and diode D404, is turned on by current flowing through R422 enabling the Schmitt trigger output waveform to drive C407. (See Free run and bright-line circuit).

With the trigger coupling switch in the AC, ACF or DC positions, the junction, R446/R492, is connected to −15 volts, and the junction, R492/R448, is held negative with respect to ground, cutting off D413. The Schmitt trigger circuit takes its input through D401 from TR404.

When TVF is selected, the junction, R446/R492, is disconnected from −15V allowing current to flow into the base of TR408 through R446. R419 is connected to −15V pulling the collector of TR404 negative and cutting off D401. The normal trigger signal path is therefore interrupted and a TV frame waveform on C416 will bias on D413 and be connected to the Schmitt trigger input.

4.11 "A" SCHMITT TRIGGER

This consists of TR401, TR402 and associated components. When the base of TR401 is negative with respect to ground, TR401 is off and TR402 is on.
R471 and R416 bias the base of TR402 about 0.5 volt positive. When the base voltage of TR401 is driven positive it will start to conduct. R416 provides positive feedback causing a rapid transition to the opposite state with TR401 conducting and TR402 cut off. When the base of TR401 returns negative, the switchover will occur at a lower level because of the change in potential across R416. This backlash prevents the trigger from responding to low level noise when biased to its operating point.

C404, R414 and C405 provide high frequency compensation of the feedback network. The output from the collector of TR402 is differentiated by C420 to operate the timebase bistable, and also via D404 and C407 to the bright-line circuit as follows.

(a) **FREE-RUN AND BRIGHT-LINE CIRCUIT**

When Free run is selected by S40, −15V is connected to pin 9, and TR403 and TR405 are cut off by diodes, D403 and D405.

In turn, TR411 is cut off and the negative movement of its collector is passed by emitter-follower, TR412, to R462.

Current in R465 is switched from D419 into D420 and D421 to the base of TR419, turning on the timebase bistable. At the end of the sweep the hold off current from R458 will exceed that from R465, turning off the bistable for the hold-off period.

At the end of the hold-off period, the base of TR419 goes negative and the timebase bistable is again turned on. The cycle repeats as long as Free Run is selected.

When Auto is selected, TR405 is turned on, turning off TR403 and causing the time base to free run as above. When trigger signals are received and operate the Schmitt trigger, trigger pulses are routed from the Schmitt to the base of TR411. The negative transition of the collector of TR402 is transferred by D404, C407 and D415 to the base of TR411. As this transistor turns on, the rise of its collector potential is transferred via TR412, D418 and C418 in a regenerative loop to its emitter, so that TR411 bottoms, and the emitter of TR412 follows. This action inhibits the free run bias from R465 to the time base bistable and is maintained for approx 40ms, determined by C418 and R430. If no further trigger pulse is received in this period, the system will return to its free run condition. However, the regenerative action caused by any trigger pulse can be initiated at any point in the discharge of C418, and when the time base is being triggered at medium and high frequencies, the system is permanently biased in the condition which allows normal triggered operation.

4.12 "A" TIMEBASE BISTABLE

TR419 and TR420 form the emitter-coupled trigger bistable. R470 normally biases on TR419 and the low potential across R479 holds off TR420.

A negative transition from the Schmitt trigger is coupled via C420 and D421 to turn on TR419. The positive movement of the collector of TR419 is transferred by R479 to hold on TR420 and the bistable is reversed.

The collectors of TR421 and TR422 provide the two buffered outputs from the bistable. TR421 provides the "A" bright-up current pulse to the bright-up amplifier. The alternate beam switching pulse is provided from TR422 via C432 and emitter-follower, TR430. When TR420 is turned on, its collector potential falls and the diode, D422, conducts to initiate generation of the "A" ramp as described in section 4.13. The effect is that the emitter of TR432 goes negative until D431 is brought into conduction when TR420 is turned off and the bistable reverts to its initial condition, ready for the next trigger pulse via D421.

4.13 "A" RAMP GENERATOR

The basic ramp generator is the bootstrap feedback circuit formed by F.E.T., TR426, as a source-follower with two subsequent emitter-followers, TR427 and TR428. The base-to-emitter voltages of these two transistors are approximately equal and opposite so that the emitter of TR428 follows any change of gate voltage on TR426 with an offset which is the gate to source voltage of TR426, plus the potential across R514. The current in TR426 and hence the voltage between its gate and the base of TR427, is held constant, independent of actual potential as this current is the collector current of the grounded-base transistor, TR435.

Consequently there is a constant voltage across the selected timing resistor, Rt which in the absence of other influences, flows to ground through the selected timing capacitor Ct causing the voltage across this capacitor to drop linearly. This linear ramp, appears similarly on the emitter of TR428, is transferred to the emitter of TR432 and goes via the diode gate, D432 and D433, to the X gate. It is also tapped off via R547 to the 'A' ramp output amplifier, as described in section 4.21.

The sweep speed, that is the ramp slope, is determined by the values of Ct and Rt which are selected for a particular range. Details of this range switching is shown in fig. 5.

The third factor to control the sweep speed is the gate-to-source voltage of TR426. This F.E.T. is matched in characteristics with TR425. As both devices carry the same current, being coupled via the grounded base transistor TR435, and as R512 is equal to R514, the voltage between the gate of TR426 and the base of TR427 is equal to the voltage between gate and source of TR425, plus the voltage across R512. The latter voltage sum is set by resistor network, R511, R508 and R509, together with the preset calibration control, R510, and the variable sweep speed control, R507.

During the flyback period when the time base bistable is reset, D422 is biased off and current flows through R540 into the emitter of TR431 and so to D429. This current is much greater than the current through Rt, so that the timing capacitor Ct is charged rapidly positive, and the emitter of TR428 follows until it approaches zero potential. At this point, TR429 conducts, diverting current from TR431. This subsequent reduction of the current in D429, limits when it balances the current through Rt. This is the quiescent point of the ramp generator with the emitter of TR428 and the collector of TR435 approximately at zero, and the voltage on the gate of TR426 at +4V. When the timebase bistable is switched by a trigger pulse, D422 is turned on, removing completely emitter current from TR431 and reducing the current in D429 to zero. The normal ramp action then takes place with the constant current through the timing resistor, Rt negatively charging the capacitor, Ct. The capacitor charges linearly until the emitter of TR432 is at about –4V, when D431 conducts to reset the timebase bistable and complete the cycle.

4.14 HOLD-OFF

Triggering of the timebase bistable must be prevented or held off during the flyback period until the ramp generator has fully returned to its quiescent state. When a trigger pulse switches the timebase bistable, TR419/TR420, the collector potential of TR422 goes positive and, acting through R560, D440 pulls the base of TR417 positive. This causes current to flow from TR417 through D443, presenting a low impedance path to ground to inhibit trigger pulses through C420. The capacitor, C_{HO} (representing the next smallest timing capacitor in the timing series Ct) is charged negatively by the negative-going ramp on the emitter of TR432, via gate, TR423/D425/D426. TR423 is only turned on by the timebase bistable during the sweep, via R481, and ensures that C_{HO} starts to charge immediately the ramp is initiated.

As C_{HO} charges negative, TR418 is cut off and the current in R466 flows through D442 as a second source to cause TR417 to conduct. At the end of sweep when the timebase bistable is reset, the collector of TR422 returns to ground, cutting off D440, and TR423 is cut off removing the charging current from C_{HO}. Current through R468 slowly discharges C_{HO}.

While the sweep generator is in its flyback period, C_{HO} holds TR418 cut off, leaving TR417 in conduction to inhibit trigger pulses into the timebase bistable. After the ramp generator has reached its quiescent condition, C_{HO} discharges sufficiently to allow TR418 to conduct and cut off TR417, allowing D421 to conduct on the next trigger pulse to initiate another sweep.

4.15 SINGLE SWEEP

This part of the circuit is based in IC400, a quad gate TTL integrated circuit connected to form two bistables. Gates, a and b, form a bistable to store the arm signal from the single sweep switch, and gates, c and d, form a bistable which acts on the hold-off circuit of the 'A' timebase to prevent trigger. When the single sweep switch is moved from NORMAL to SINGLE SWEEP, S44a grounds input 5 of IC400b. As R517 holds input 10 high, the bistable settles with 8 low and 6 high. The switch, S44b, removes the positive potential from R533 allowing R530 to turn off TR418 via D424, simulating the hold-off signal (see section 4.14) to inhibit trigger pulses. When the switch is moved to ARM position, S44a grounds input 10 and the state of bistable, IC400a/IC400b, is reversed. As output 6 goes low, this negative transition is coupled through C437 and D427 to input 2 of the second bistable. This switches over and input 3 goes high, cutting off D424 and removing the hold-off condition. Then a trigger pulse is able to trigger the bistable and a normal sweep is executed. At the end of sweep, the timebase bistable resets, generating a negative-going pulse on the emitter of TR430 which is coupled to input 12 by C436 and resets the second bistable. Output 3 goes low again, turning on D424, to reinstate the hold-off and prevent further sweeps. When the single sweep switch is returned to the SINGLE SWEEP position, before, during or after the sweep, the first bistable is reset, ready for the cycle to be initiated again after the sweep is complete. The action of this bistable avoids possible multiple triggering due to contact bounce of S44A since this switch must re-make to the SINGLE SWEEP position before the ARM condition of the bistable is removed. TR443 controls the neon indicator lamp, N400, to indicate the state of the second bistable.

4.16 COMPARATOR AND "B" SINGLE TRACE BISTABLE

TR615, TR616, TR614 and TR617 form the comparator which operates on the "A" ramp to define the delay period. Assuming D608 is cut off, (TR620 on) the comparator functions as follows:– The bases of the long-tailed pair, TR614 and TR617, are driven from the "A" ramp and the delay potentiometer, respectively. R745 ensures that the starting potential of the "A" ramp is more positive than that on the wiper of the delay multiplier potentiometer. Thus current initially flows more in TR614 rather than in TR617, biasing the second long-tailed pair, TR615/TR616, with TR615 on and TR616 off. The collector current of TR615 biases D633 into conduction to present a low impedance to "B" trigger pulses applied through C620, and prevents the triggering of the "B" timebase bistable, TR612/TR613.

At the point in the "A" sweep determined by the setting of the delay control potentiometer, R744, the base of TR614 becomes more negative than that of TR617, and so the bias on the input of the pair, TR615/TR616, is reversed, and TR615 is turned off. This removes the current through D633, and allows the reset trigger pulse through C620 to trigger the "B" timebase bistable. Alternatively, if S71 is closed for 'B starts after delay', the bias of R663 acts as a trigger pulse to start the "B" sweep immediately. TR620 and TR621 form the "B" timebase single trace bistable. In the 'A only' position, R699 is pulled negative so that D612 is cut off. The collector potential of TR621 is near zero, TR620 is turned off, and current flows through R691 (the comparator) such that TR615 remains on, independent of the state of TR614 and TR617. This stops the "B" timebase bistable triggering in the 'A only' condition.

In all but the 'A only' position of the display switch the collector resistor of TR621, R699, is connected to approx. +15V and the bistable can function.

At the start of the "A" sweep, a negative pulse from the "A" timebase bistable (B enable) is applied through C630, turning off TR621 and turning on TR620, to reverse bias D608 and allow the comparator to operate. When the "B" timebase bistable is triggered, the collector of TR613 goes negative and this transition is coupled via R676 and diode D611, to turn off TR620, resetting the "B" single trace bistable. D608 again conducts to override the comparator action and so inhibit further triggering of the "B" timebase.

4.17 "B" TRIGGER AND RAMP GENERATION

The "B" trigger amplifier, Schmitt trigger, timebase bistable and ramp generator are very similar to their "A" timebase counterparts. The following description is brief and reference to the equivalent component in the "A" circuit is shown in brackets.

The "B" trigger source is selected by S70 from Y1, Y2 or LINE which are each common to the "A" and "B" timebases. The "B" ext. trigger is separate and is derived from the attenuator of approximately 50:1 consisting of R614, R615, C601 and C602. The selected signal is taken to emitter-followers, TR605 and TR606 (TR409 and TR410), and then to the long-tailed pair, TR607/TR608 (TR413/TR414) via the polarity switch, S70d and S70c. The level potentiometer, R631 (R440), determines the potential on the undriven side of this amplifier. The amplified signal is taken to the second long-tailed pair, TR609/TR610 (TR415/TR416). The output of this amplifier drives direct to the Schmitt trigger, TR601 and TR602 (TR401 and TR402).

The trigger pulses generated by the Schmitt trigger are coupled via C620 and D604 to the base of TR612 (TR419) which together with TR613 (TR420), forms the "B" timebase bistable. The action of the comparator in gating trigger signals into the bistable is already described in section 4.14.

A trigger pulse allowed through the gate turns off TR612 and TR613 on. The 'B' ramp generator will now run until the negative-going ramp on the emitter of TR629, pulls the base of TR613 negative through D610, when the bistable will be reset. TR618 and TR619 (TR421 and TR422) generate the "B" bright-up current, and the "B" gate output signal respectively. TR611 will reset the "B" bistable at the end of the "A" sweep if this occurs before the "B" ramp has reached its normal amplitude.

The "B" gate output transistor, TR422, also provides the "B ends A" pulse which is used in the mixed mode, and is taken via C632 to a gate, D630/D632/R659/R739, and from there to the A timebase (see Mixed mode). In the "A intensified by B" and the "B" modes the "B" ramp generator operates in a manner similar to the "A" ramp generator current through R719, turns on gate, D620/D618, and effectively connects the emitter of TR631 (TR429) to ground.

The source-follower, TR622 (TR426), is not half of a matched pair of F.E.T's in this case, but has a simple current source, TR623 (TR425), as a very high impedance load. The emitter-followers, TR627 and TR629 (TR427, TR428), are connected directly to TR631 (TR429). TR628 (TR431) provides the flyback current. The "B" ramp is taken from the emitter of TR629 via the gate, D625 and D626.

In normal operation the "B" ramp will be reset at the end of a sweep so that in the quiescent state, TR631 is operating as an amplifier transistor, part of the negative feedback loop, TR631, TR628, TR622, TR627 and TR629. In the mixed mode, the gate (D620 and D621) connecting the emitter of TR631 to ground, is turned off, and the gate, D619 and D624, is closed to connect its emitter to the "A" ramp output voltage. In the reset state of the "B" ramp generator, as the "A" ramp voltage goes negative, the feedback loop will make the "B" ramp follow. When the "B" sweep starts, the feedback loop is broken as TR628 is turned off, and the "B" ramp runs normally but starting from the "A" ramp level.

4.18 THE BRIGHT-UP AMPLIFIER

The Bright-up amplifier which controls the Z modulation of the C.R.T. consists of an inverting amplifier, TR902, TR904 and TR903, with shunt feedback applied through R919; the base of TR902 being a virtual earth point. The inputs include current pulses from the "A" and "B" timebase bistables, (TR421, TR618 respectively), chop blanking current pulses from TR218, and external Z modulation current waveforms (from emitter-follower, TR901, and R913), a d.c. current derived from the BRILLIANCE control, R60, through R912, and a bias current through R909, obtained from the timebase DISPLAY switch circuit and the CONTRAST control. The instantaneous sum of these input currents is balanced by the feedback current from the output through R919, so that the output voltage waveform follows the sum of the input currents.

The operating levels in the various display modes are tabulated overleaf.

The mixed mode follows the "A intensified by B" bright-up condition. The Brilliance control current and the Ext. Z modulation current are added through D904, the maximum brilliance condition being when the current in D904 is zero, and the blanked condition being when the current in D904 is +2mA.

During the chop blanking period, a further +2mA current pulse is added which makes total applied input current $\geqslant$+2mA, and blanks the trace for all settings of the brilliance control.

The maximum output from the amplifier is approximately 25 volts, corresponding to this 2mA change in input current. The diode, D905, ensures that when the amplifier is overloaded by a negative input, the "A" and "B" bright-up inputs do not move far from their normal working voltage.

Diodes, D908 and D909, ensure that TR904 does not bottom. TR903 provides essentially a high impedance constant current load for TR904 but C904 causes it to act as a complementary amplifier with TR904, to provide a low output impedance at high frequencies to drive the mainly capacitive load.

The output of the amplifier is connected via C911 directly to the grid of the C.R.T, and through R923 to the low voltage side of the floating grid supply. The dc voltage with respect to ground applied to the grid is then determined by the potentiometer, R928, (to allow for variations in grid cutoff between C.R.T's), resistor chain, R930/933, across the grid supply and the voltage on the output of the amplifier.

Display Mode	Condition	Input Current				Total Current in D204	Brilliance Control Range
		Bright-up		Bias			
		'A'	'B'	Contrast MAX.	Contrast MIN.		
EXT X		+2mA	+2mA	−4mA	−4mA	0	Full Brill to Blanked
'A'	Waiting	+2	+2	−2	−2	+2	Blanked
	running	0	+2	−2	−2	0	Full Brill to Blanked
'A' intens by 'B'	'A'&'B' Waiting	+2	+2	0	−2	+4/+2	Blanked
	'A' running	0	+2	0	−2	+2/0	From Brill set by CONTRAST to Blanked
	'B' running	0	0	0	−2	0/0*	Full Brill to Blanked
'B'	'A'&'B' Waiting	+2	+2	0	0	+4	Blanked
	'A' running	0	+2	0	0	+2	Blanked
	'B' running	0	0	0	0	0	Full Brill to Blanked

*D904 prevents reversal to −2mA.

The time constant, C911/R929, is much longer than the time constant, C912/R923, so that a voltage step of say +25V at the output of the amplifier is coupled to the grid and held by C911 and R929, while C912 rapidly charges through R923, causing the floating grid supply to rise by +25V. This causes the voltage across R928 to be reduced to zero before C911 can discharge significantly, preventing any further change in grid potential. Any voltage change on the output of the amplifier is faithfully reproduced on the grid by this means. The neons, N901 and N902, protect the C.R.T. from excessive grid-to-cathode voltage on switch-on or switch-off.

EXT. Z MODULATION

R903, R905, R906 and R907 form an attenuator and dc shift circuit for Ext. Z modulation signals. D907 and D901 are protection diodes. R913 defines an input current to the bright-up amplifier from emitter-follower, TR901.
The voltage gain from the Z mod input socket to the output of the bright-up amplifier is approximately unity and high frequency signals are connected via C901, R904 and C906 to the C.R.T. cathode, so that the bandwidth of the Ext.Z modulation is not limited by the bandwidth of the bright-up amplifier.

4.19 X GATE AND X OUTPUT STAGE

The input of the X output amplifier can be connected to either "A" or "B" ramp outputs, or the output of the External X amplifier as determined by the Display switch, S50, and the "A" timebase range switch, S43. This switching is performed by diode gates, D432/D433 and D625/D626 for the "A" and "B" ramps respectively and by D603 for the External X amplifier.

When External X is selected on the "A" timebase range switch, −15V is applied via R549 and R742 to the "A" and "B" gates respectively, cutting off both, irrespective of the position of S50. Simultaneously +15V is applied to the External X amplifier supply rail, bringing its output (emitter TR604) to approximately +2V. With the "A" and "B" gates off, current flows from R651 through D603 to the emitter of TR604, thus connecting this point to the input of the X amplifier, PLB12.

With the "A" timebase range switch in any position other than Ext. X, S50 determines which ramp gate functions by applying either a negative voltage (off) or +15V (on) to R549 or R742. The Ext. X amplifier and gate are disabled by the removal of +15V from its supply line. In the positions "A" and "A intensified by B" the "A" gate is turned on and "B" gate turned off. In the "B" position and "A and B Mixed" position, the "A" gate is turned off and "B" gate turned on.

The ramp selected by S50 is passed to the base of TR953, one half of a long-tailed amplifier, TR953/TR954, for which TR955 is a constant current source to provide good common mode rejection. The emitter resistors of this stage can be switched to give a x10 increase in gain. The shift voltage derived from the shift control, R602 and R603, is passed by emitter follower, TR952, to the other input of the long-tailed pair. The differential output of this stage is then the sum of the ramp and shift signals. This signal is connected directly to the bases of TR958 and TR959, a long-tailed pair which is the lower part of a balanced cascode amplifier whose upper stage is TR956 and TR957. The gain of this stage is determined by the emitter feedback resistor, R982, and the load resistors, R976, R979. R983 and C953 provide high frequency compensation. The diodes, D953, D952, D955 and D954 prevent TR956 and TR957 from saturating. The output from the collectors of TR956 and TR957 is taken directly to the X plates of the C.R.T.

4.20 EXTERNAL X AMPLIFIER

The circuit for the external X amplifier is included on the 'B' timebase circuit Fig. 6. The external input signal is applied to the base of the amplifier transistor, TR603, through the capacitor/resistor network, C606/R619. The trimmer, C645, is used to set the H.F. response. The diode, D600, protects the base-emitter junction of the transistor against excessive reverse voltage. Resistors, R618 and R620, together with R619 set the quiescent base voltage of the input transistor. Capacitor, C607, provides some HF peaking. The collector voltage swing is passed via emitter-follower, TR604, through diode, D603, (if enabled) to the X amplifier. Only when External X is selected, is the +15 volt line connected via the 'A' timebase range switch to enable the amplifier.

4.21 RAMP AND GATE OUTPUTS

THE 'A' RAMP OUTPUT

Mounted on the interconnect printed circuit board is the inverting buffer amplifier connected to the 'A' ramp via PLA1 of SKA. The 'A' ramp, running from near zero to approximately −4V, is connected directly to the base of TR951. This transistor is biased on by emitter resistors, R953 and R952. A positive-going ramp (0V to +10V) is generated across the collector load, R951, and is taken, via R954, to the output socket, (SKJ).

THE 'A' GATE OUTPUT

This signal is taken from the collector of TR422 in the 'A' timebase. The transistor is driven from the timebase bistable and gives a positive output pulse while the 'A' ramp is running. The pulse is taken through R503 and PLA4 of SKA to the rear panel, SKK.

THE 'B' GATE OUTPUT

This output is taken from the collector of TR619 in the 'B' timebase. The transistor is driven from the timebase bistable and gives a positive output pulse while the 'B' ramp is running. The pulse is taken through R684 and PLB3 of SKB to the rear panel, SKL.

4.22 CALIBRATOR

The circuit diagram for the calibrator is included on the 'B' timebase circuit, Fig. 6.

The components forming this circuit are mounted on the 'B' timebase P.C. assy. The circuit consists of an emitter-coupled oscillator, TR624 and TR625, with C634 as the timing capacitor.

The collector current through TR625 is used to turn TR626 on and off to give a square wave output across R732. This is set to be 1 Volt peak to peak by R730.

The values of the resistors in the dividing chain are selected such that the output resistance is 200Ω, giving a 5mA calibrator current if the output is shorted.

4.23 THE POWER SUPPLIES

The OS3000 basically operates from positive and negative 15V lines and a +150V line, each stabilised and independently protected against overload. The E.H.T. lines are all obtained from a high frequency oscillator with overload protection but with direct stabilisation only on the −1.5kV CRT cathode supply. This oscillator is supplied from the +20V unstabilised line used for the +15V line.

All supplies are obtained from transformer, T83, via the range selector switch, S81, the supply fuse, FS83, and supply on/off switch, S80.

One secondary from T83 is the 6.3V supply to the CRT heater and another the low voltage (approx. .25 Volt) for the line trigger signal. This latter voltage passes via SKB – PLB19 and PLB20 to the trigger selector switches. The three remaining secondaries are rectified and smoothed as follows.

4.23.1 +15V, −15V and +150V LINES

One secondary from T83 feeds the bridge rectifier, MR83, and develops approximately 20V across capacitor, C85. This is used to obtain a stable, overload protected, −15 Volt line using an integrated circuit regulator, IC801, which contains a reference, comparator input amplifier and output current amplifier. In addition it includes the overload protection circuitry to operate from the voltage developed across the current sensing resistor, R836. The output from this IC regulator drives the external series regulator, TR838.

The output of the line is set to be −15V by the preset potentiometer, R838. Components, R855 and C831, reduce the noise present on the internal reference and C832 gives feedback compensation to prevent oscillation.

A similar secondary from T83 is rectified by MR82 and develops approximately +20V across C84. Protected by FS832 this +20V supply feeds the EHT oscillator. The voltage across C84 is also used to obtain the stablisied +15 volt line.

TR833, TR834, TR835 and TR837 form the +15V stabiliser circuit, which is referenced to the −15V line. If the +15V line is not at the correct potential, the junction of the two equal resistors, R847 and R848, will not be at 0V. The resultant differential voltage between the bases of TR833 and TR834 will modify the collector current of TR833 to drive through TR835 to the series regulator element, TR837, and so correct the line potential.

Excessive current drawn from the +15V line will develop a potential across R835 causing D833 to conduct in turn limiting the base current to TR835 and so also that in TR837.

Protection diodes, D835 and D836, are normally reverse biased and only conduct in the accidental condition of a short circuit between the +15V and −15V lines.

Diode, D834, protects the base-emitter junctions of TR833 and TR834 against excessive reverse voltages. Capacitors, C836 and C833, give h.f. roll-off to prevent oscillation; C835 reduces output ripple.

The secondary from T83 is rectified by MR81 and develops approximately 180V across C83.

R84 and C86 reduce the output line ripple. The +150 Volt line is referenced from the −15 Volt line by resistors, R842 and R843. Any error potential at the junction of these resistors drives the error amplifier, TR831, which in turn controls the series transistor, TR839. Transistor, TR832, protects TR839 from over voltage at switch on, or in the event of failure of the −15V line. If the junction of the potential divider, R840 and R841, goes too far negative, TR832 conducts allowing TR839 to conduct.

Short circuit protection on the 150V line is by means of the fuse, FS831.

4.23.2 E.H.T. SUPPLIES

The EHT supply circuitry as shown in Fig.10 is contained within the EHT box assembly. It comprises an oscillator driving a transformer with three secondaries, each rectified to provide the three lines of approximately −1580 volts, −1500 volts and +9kV.

The oscillator is formed by the centre tapped primary winding, of the transformer in the collectors of transistors, TR814 and TR815, with feedback windings taken to the bases via protection diodes, D813 and D814. The centre tap of the primary is taken through the choke, L801, to the supply and that of the secondary being returned to the supply through R818.

The waveform at the collectors is approximately alternate half waves of 55 volts amplitude at 30kHz.

The independent grid supply from one high voltage secondary winding is rectified and smoothed by D805 and C807. The cathode supply from a further secondary is rectified and smoothed by D804 and C804, and is stabilised by a feedback circuit which controls the supply switched to the primary of the transformer.

The current through R803, (the focus control potentiometer) and R821 is compared with the reference current taken from the +15 volt line through the 'set EHT' preset (R854) potentiometer on the power supply P.C. assembly and R816.

The difference signal is amplified by TR811 which controls TR812 and in turn the series regulator, TR813, which controls the supply line for the oscillator at approximately 14 volts.

Overload protection is provided when the voltage across R814 causes D811 to conduct, thereby reducing the drive into TR812. The output from TR813 is limited to approximately 600mA and if this current is maintained, the fuse FS832 on the power supply P.C. assembly will blow.

The third high voltage secondary winding is connected in series with the cathode winding to give approximately 3kV p-p a.c. input into the tripler circuit, D801, D802 and D803, with capacitors, C801, C802 and C803. The ripple present on this output is removed by the additional filter circuit, R801 and C806, and the resultant +9kV used as the P.D.A. potential for the CRT.

4.24 CATHODE RAY TUBE AND ITS INPUTS

The OS3000 employs a conventional mesh PDA tube with a high efficiency aluminised screen.

The interconnection diagram fig. 11 shows the necessary connections to the various electrodes.

THE GUN

An independent winding on the mains transformer drives the heater for the cathode. The beam current and hence the spot intensity is controlled by the differential potential between the grid and cathode. The −1.5kV cathode potential is the direct stabilised output from the EHT oscillator. The grid potential is the sum of the floating grid supply from the EHT oscillator and the output potential of the bright-up amplifier to which the grid supply is referred.

The CRT beam is brought to a clear, well focussed spot by varying the potentials applied to the focus and astigmatism electrodes. These signals are derived from R82 (focus) and R81 (astigmatism) mounted on the front panel, the latter being a screwdriver adjustment. The focus electrode is normally variable over the range −1100V to −1350V and the astigmatism from +150V to 0V.

THE DEFLECTION SYSTEM

The Y plates are connected to the output of the Y amplifier and the differential signal applied, deflects the beam in the vertical direction. The mean plate potential is normally +55V and the sensitivity is approx. 4.5V/cm.

Similarly, the X plates are connected to the X output amplifier and the differential signal deflects the beam in the horizontal direction. The mean X plate potential is normally +60V and the sensitivity is approx. 16V/cm.

The deflection plate shield, S1, screens the deflection plates from the other electrodes and is held at a potential of +50V obtained from the junction of R936 and R937 on the bright-up p.c. board.

The interplate shield, S2, screens the X plates from the Y plates and is held at a potential 15V more negative than the X mean plate potential, derived from the wiper of R381 on the 'Y' output p.c. board.

Shield, S3, the geometry electrode, is set for optimum linear deflection in both the X and Y axes. Its potential can be varied over the range +150V to −15V and is derived from the wiper of R851 on the power supply.

Having passed through the deflection plate system the beam accelerates to the screen which is held at +9kV by an output from the EHT oscillator, striking the phosphor at high velocity to produce the necessary bright trace.

THE TRACE ROTATION COIL

A coil, L83, fitted round the neck of crt, inside the magnetic shield is used to align the trace with the horizontal graticule lines.

The current for this coil is taken from the preset potentiometer, R850, through R849, on the power supply board. The direction of rotation can be reversed by reversing the connection of the leads to the coil.

4.25 GRATICULE ILLUMINATION

The external graticule is illuminated by two lamps, ILP83 and ILP84.

The supply for these lamps is derived from the emitter-follower, TR836, on the power supply board; being set by the graticule illumination potentiometer, R80, on the front panel.

Both the emitter-follower and the control potentiometer are supplied from the full-wave rectified signal taken from the transformer at the junction of diodes, D83 and D84.

5.1 GENERAL

The instrument is electrically protected by three fuses as follows:–

1. 1A 'Slo-blo' Size 0 (FS80 Pt.No.21619) in the supply input and mounted on the rear panel.
2. 250mA Size 00 (FS831 Pt.No.19815) in +150V supply line and mounted on the Power Supply board.
3. 500mA Size 00 (FS832 Pt.No.5119) in the +20V line supplying the E.H.T. Oscillator also mounted on the Power Supply board.

Access to the two latter fuses is by removal of the bottom cover.

The following sections give information allowing access to and removal of the various printed circuit boards and assemblies as may be found necessary, during fault finding procedures.

If, during fault finding a component needs replacing, it should be cut from the printed circuit board as close as possible to the component, 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.

If a fault on a printed circuit board cannot be cleared, it is recommended that the instrument is returned to the manufacturer for repair. When faults have been cleared it is recommended that the test procedure is implemented to ensure that the instrument conforms to the specification.

5.2 ACCESS

Figures 14, 15, 16 and 17 illustrate various views of the instrument showing access to the majority of preset components when the top and bottom covers have been removed. Each cover is retained in position by four latch fasteners. Each fastener is released by turning it one quarter of a turn clockwise or counter-clockwise.

The construction of the instrument has been arranged so that individual boards and assemblies can be checked and components changed without actually removing the assemblies from the main frame or disconnection of cable forms. In the case of the Time Base unit this has been achieved by making it a plug-in assembly which can be removed and operated on an extension lead, PL91. This assembly is then still fully functional and access is provided to both sides of both printed circuit boards.

The following description details the method for removing the individual assemblies:–

5.2.1 ATTENUATOR AND PRE-AMPLIFIER ASSEMBLY

1. Each assembly is fitted with its own screening cover and it is only necessary to remove the cover from the unit requiring attention. The procedure is identical for both attenuator assemblies.
2. Having removed the screen, take out the shift control spindle by loosening the grub screws on the universal coupling, also remove the coupling.
3. Unsolder the three supply leads and four signal leads from the rear of the horizontal printed circuit board.
4. Remove the knob from the VOLTS/cm selector switch and its fixing nut, the lever switch knob and the coaxial socket. Later models do not require the removal of this socket but have a fixing stud behind the front panel mounted between the BNC socket and the lever switch.
5. The unit can now be removed by lifting first from the rear to clear the shift control support bracket and pulling towards the rear of the instrument.
6. Care should be taken when removing the left hand unit not to disturb the graticule illumination lamp, also ensure that this lamp is correctly positioned when the unit is replaced.
7. For fault finding, the unit may be operated out of the frame by extending the supply and signal leads. Providing that the signal leads are kept reasonably short, the complete channel may be checked at frequencies approaching the full bandwidth.

5.2.2 BEAM SWITCH & DELAY LINE EQUALISER BOARD

1. Disconnect the signal leads from the rear of the board and remove the seven fixing screws.
2. The board may now be brought carefully to the upright position without unsoldering any further connections. This operation then gives access to both sides of the board.
3. If it is required to operate the board in this position, it is recommended that the output should be reconnected via extended leads.
4. Raising this board also gives access to the SHIFT control potentiometers, the x5 GAIN pull switches and the Y2 INVERT switch.

5.2.3 DELAY LINE

1. The Delay Line is mounted in a tray above the shield, by means of four screws, two through the top of the front extrusion and two on the rear tube support assembly.

5.2.4 OUTPUT BOARD

1. Remove the two Y Plate leads and the S2 connection from the tube side pins.
2. Remove the board fixing screws and also the screws attaching the output transistor heat sink to the tube support assembly.
3. The board, together with the output transistors, may now be swung out of the frame on the connecting leads giving access to both sides of the board.
4. The output transistors can be changed without removing the board by taking out the three fixing screws and lifting of the paxolin clamp.

5.2.5 TIME BASE UNIT

1. Remove the fixing screws from the Time Base section of the front panel and also slacken the two fixing screws attaching the rear of the unit to the cross bar (see fig.2).
2. Carefully draw Time Base Unit through the front of the instrument, taking care not to catch any components on the front extrusion.
3. Check that both polarising keys are still correctly positioned in the multiway connectors.
4. Both Time Base Boards are now accessible and the unit may be operated on the extension lead, PL91.

5.2.6 BRIGHT-UP AMPLIFIER BOARD

1. Remove the perspex protection cover and unsolder the two leads marked:– BU BIAS and A + B.
2. Removal of the four hexagon threaded spacers allows this board to be lifted into the vertical position from the edge closest to the centre of the instrument, thus giving access to both sides.

5.2.7 POWER SUPPLY ASSEMBLY

The low voltage power supply unit is on a removable sub-chassis mounted in the rear of the instrument.

1. Remove the screws securing the moulded rear cover, and remove the cover.
2. Remove remaining screws holding the unit on to the rear extrusion and the screw supporting the Bright-Up Amplifier support bar.
3. Remove the four screws, XX and YY, in the rear cross bar (See fig. 2).
4. The unit may now be removed from the frame as shown in fig. 1, to the distance provided by the loop in the cable form.
5. Access is now provided to the mains transformer and VOLTAGE SELECTOR switch, smoothing capacitors and series stabiliser transistors.

5.2.8 POWER SUPPLY PRINTED CIRCUIT BOARD

1. Remove the four fixing screws.
2. The board will now lift into the vertical position on its cable form giving access to both sides.
   i) **X Amplifier and Interconnect Board**
   Access to this board may be obtained by removing a number of units as previously described, namely:– Time Base Unit, Bright-Up Amplifier and Power Supply Assembly.

5.2.9 E.H.T. UNIT

1. Remove the two screws at the top of the box, which pass through the box and into the centre bar of the instrument.
2. Lift the box out of the instrument on its cable form.
3. Remove the six screws which hold the lid and remove. Insert one of the long fixing screws through its original hole in the rear of the box and screw into the threaded insert provided in the centre bar of the instrument. This secures the unit for servicing purposes.
4. The oscillator printed circuit board and transformer are now accessible. The printed circuit board may be slid out on its runners to provide access to both sides.

5.2.10 CATHODE RAY TUBE

1. Access to the base of the tube is possible by removing the moulded cover which is attached to the rear of the instrument.
2. The tube may be removed by withdrawing from the front after taking off the escutcheon and graticule assembly.
3. Before attempting to extract the tube, remove the side pin connectors and the base. It will also be necessary to unsolder the twist coil leads from the interconnection printed circuit board (pins TWIST & 0V). The twist coil is attached to the tube and therefore its leads should be fed through the hole in the shield as the tube is pulled forward.
4. Care should be taken when removing the tube not to bend the side pins as this may crack the glass around the seal.

5.3 FAULT FINDING TABLES

Faults may be localised by reference to the Fault Localisation information presented in fig. 18 and the Circuit Voltages listed in Section 5.4.

Table 4 should be used as a general guide of voltage obtainable at certain locations within the instrument and can be used as an aid to servicing.

The power supply input voltage should be approximately at the mid range of the Supply Voltage setting. The power supply voltages in the tables are those appearing under these conditions. Other voltages assume that the Y inputs are grounded and the amplifiers are set to 5mV/cm sensitivity. The Time Base is set to FREE RUN, Y1 Mode with Y1 trace brought to the centre of the screen.

5.4 OPERATING POTENTIALS

(a) INPUT ATTENUATOR AND PRE-AMPLIFIER

Location		Voltage
TR101 and TR102	Drains	7.2V
TR101 and TR102	Sources	0 to +2V
TR103 and TR104	Collectors	7.8V
TR103 and TR104	Emitters	+0.7 to +2.7V
TR121 and TR122	Collectors	+4V
TR120	Collector	–5.5V
TR123 and TR124	Collectors	+6.6V
TR125 and TR126	Bases	+8.6V
"Trig" output		+7.9V
"Sig" output		+7.6V

(b) BEAM SWITCH AND DELAY LINE EQUALISATION

Location		Voltage
TR201,202,207 and 208	Emitters	+8.6V
TR202 and TR208	Collectors	Nominally 0V
TR207	Collector	+0.8V
TR203,204,205 and 206	Collectors	+5.4V
TR209	Collector	+2.5V
TR209	Base	+0.8V
Y2 O/P		Nominally 0V
TR210 and TR211	Collectors	+6.3V
TR214	Collector	+7.4V
Pin 31 and 33		+5V
TR215	Collector (Y1 Selected)	+2V
TR215	Collector (Y2 Selected)	+7V
TR217	Collector	+13.7V
TR218	Collector	+2.8V
TR300 and TR301	Emitters	+4.1V
TR300 and TR301	Collectors	–1.4V
TR302 and TR303	Collectors	–2.3V
TR304 and TR305	Collectors	+3.8V
Pins 43 and 44		+7.5V

(c) Y OUTPUT AMPLIFIER

Location		Voltage
TR351 and TR352	Collectors	+11.5V
TR355	Collector	+5V
TR353 and TR354	Collectors	+55V
Pin S2		Approx 40V

(d) X OUTPUT AMPLIFIER AND INTERCONNECT

Location		Voltage
TR953 and TR954	Collectors	–8.0V
TR968 and TR969	Collectors	–5.7V
TR956 and TR957	Collectors	+60V

(e) BRIGHT-UP AMPLIFIER

Location		Voltage
TR901	Emitter	+1.2V
TR904	Collector (Ext X Mode,Max Brill)	+25V
Vg. Hi		–1580V
Vk		–1500V

(f) E.H.T. SUPPLY

Location		Voltage
TR813	Collector	+20V
TR813	Emitter	+15V
TR811	Collector	+17.3V
PDA	Connector	+9kV

(g) LOW VOLTAGE POWER SUPPLY

Location		Voltage
TR837	Collector	+20V
TR835	Collector	+15.5V
TR833	Collector	–0.65V
TR839	Emitter	–18V
TR836	Collector	+15V
TR838	Collector	+8.5V

(h) TIMEBASES

Operating potentials and waveforms within the timebase unit are shown in figs. 12 and 13.

SINGLE SWEEP I.C.

	I.C. Pin No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Lever position	Arm	0	2.5V	3.6	4.4	4.8	0	0	4.4	0	0	0	2.5	0	5
	Single Sweep(Armed)	0	2.5V	3.6	0	0	4.4	0	0	4.4	4.8	0	2.5	0	5
	Single Sweep (Fined)	3.8V	2.6	0	0	0	4.4	0	0	4.4	4.8	3.8	2.5	0	5

5.5 CALIBRATION PROCEDURE

5.5.1 TEST EQUIPMENT

1. Variable autotransformer. Output voltage 95 to 260V at 1A with ac rms voltmeter. (Variac).
2. Multimeter. 0-2.5kV with at least 20,000 ohms/volt sensitivity. Accuracy within 2%
3. Voltage Calibrator. 1kHz squarewave generator with amplitude 5mV to 100V. Accuracy within 1%.
4. Time Mark Generator. Marker generator of 0.5μs to 1 sec. Accuracy within 1%.
5. Squarewave Generator. 1MHz flat top square wave generator with adjustable amplitude 0.1V to 1V into 50 ohms having a rise time of less than 2ns.
6. R.F. Sinewave generator. 500kHz to 50MHz with 50kHz reference frequency. Output amplitude 25mV to 5V p-p into 50 ohms. Amplitude accuracy at 50kHz and 500kHz to 50MHz within 3%.
7. LF SineWave Generator.
8. Capacitance Standardiser. 1MΩ/28pF, BNC 50Ω terminational, BNC-BNC connector lead (PL43), Time Base Extension Lead PL91.
9. E.H.T. Meter 0-10kV.

NOTE Calibration should be carried out at normal ambient temperature and should not be commenced until the instrument has been operating for at least 15 mins.

5.5.2 SET SUPPLY RAIL VOLTAGE

1. Set the BRILL. control to minimum.
2. Set the SUPPLY VOLTAGE switch on the rear panel to suit the supply. Apply the supply voltage via the Variac set to mid range of the Supply Voltage setting.
3. Check that the GRATICULE control varies the graticule intensity and that the neon, N80, is energised.
4. Connect the multirange meter between chassis and pin '–15V' on the Power Supply printed circuit board. Adjust the voltage to –15V ±2% by means of R838.
5. Check that the voltage to chassis on the following pins on the Power Supply printed circuit board, are within the following limits,
   '+15V' +15 ±4%
   +150V +150V ±4%
6. Set the multirange meter to read 2500V and meter between chassis and pin 'VK' on Bright-Up Amplifier printed circuit board. Adjust R854 on Power Supply printed circuit board for a reading of –1500V.
7. Check that e.h.t. supply at tube cavity cap connector is +9kV ±0.5kV.

5.5.3 SET TUBE CUT-OFF AND VISIBLE DELAY

Due to small changes in the c.r.t. control grid characteristics during warming up, the first part of the adjustment should be made as soon as a trace appears after switch-on.

1. Advance BRIGHTNESS Control to the '9 o'clock' position. Adjust R928 on Bright-Up Amplifier printed circuit board so that the trace is just not visible.
2. Set the TIME BASE controls to give a sweep rate of 20ns/cm. Inject the 1MHz fast rise pulse and adjust trigger so that the leading edge is visible.
3. Adjust trimmer, C905, on Bright-Up Amplifier printed circuit board for maximum visible delay with no brightened up spots appearing at the start of the trace.

5.5.4 Z MODULATION

1. Apply a 1KHz square wave of 5V amplitude to the Z MOD socket on the rear panel and to Y1 INPUT socket with Y1 VOLTS/cm switch set to 2V.
2. Obtain a stable trace and check that the modulation is just visible.
3. Increase input to 20V p-p, check that the trace can be fully blanked and that positive signals cut off and negative signals brighten up the trace.

5.5.5 X AMPLIFIER ADJUSTMENTS

These adjustments should be carried out with the TB unit on an extension lead, PL91, to give access to controls.

1. Set "A" TIME/cm to EXT X and VARI TIME/cm control to CAL.
2. Inject a 10V p-p 1kHz square wave into the EXT X socket.
3. Adjust R972 on X Amplifier and Interconnect printed circuit board, to give 10cm of X deflection.
4. Pull 'A' Time Base x10 control.
5. Inject a 1V p-p 1kHz square wave into the EXT X socket.
6. Adjust R969 on X Amplifier and Interconnect printed circuit board to give 10cm of X deflection.
7. Inject an 8V p-p 10kHz square wave into the EXT X socket. Pull X Amp x10 'In'. Adjust C645 (Time Base 'B' printed circuit board) to remove any 'tail' which extends beyond the bright spots at the extremes of the deflection.

5.5.6 TIME BASE ACCURACY ADJUSTMENT

These adjustments should be carried out with the Time Base operating on an extension lead, PL91, to give access to the appropriate controls.

A Time Base:–

1. Set "A" TIME/cm to 1mS/cm, VARIABLE TIME/cm Control fully clockwise.
2. Inject 1kHz marker pulses into Y1 channel and trigger for a stable trace.
3. Adjust R510 on 'A' Time Base printed circuit board for 1 marker pulse per cm.
4. Set Time Base Range Switch to 0.5μs/cm, VARIABLE TIME/cm Control fully clockwise.
5. Inject 2MHz marker pulses into Y1 channel and trigger for a stable trace.
6. Adjust C535 on 'A' Time Base printed circuit board for 1 marker pulse per cm.
7. Check that 'A' TIME/cm VARIABLE gives greater than 3:1 reduction in speed.

B Time Base:–

The procedure should be repeated for the 'B' Time Base, adjusting R708 at 1kHz and C631 at 2MHz. These controls are situated on the 'B' Time Base printed circuit board.

5.5.7 TRIGGER LEVEL SLOPE BALANCE ADJUSTMENT

Adjustment to be carried out with Time Base on Extension lead, PL91.

A Time Base

1. Inject a 1KHz sine wave into Y1 and set TRIGGER LEVEL control to mid-position, TRIGGER COUPLING in AC position.
2. Adjust R453 ("Slope Bal") so that there is no significant movement of the trigger point when the TRIGGER SELECT Switch is moved from "+ve to –ve".
3. Move TRIGGER COUPLING to DC position and adjust R213 to obtain the same trigger point. Repeat using Y2 channel and R223.

B Time Base

The above procedure should be repeated for the 'B' Time Base adjusting R643 to give the desired effect.

5.5.8 INTERNAL 1v CAL. ADJUSTMENT

Adjustment to be carried out with Time Base on Extension lead PL91.

1. Inject 1V p-p 1kHz square wave into Y1 channel from external calibrator. Set Y1 VOLTS/cm to 0.1V and adjust VARIABLE GAIN Control to give exactly 8cm deflection.
2. Substitute internal cal. waveform for signal from external calibrator and adjust R730 to give exactly 8cm deflection.

5.5.9 CHANNEL 1 & 2 FINE GAIN CONTROL BALANCE

1. Set Y1 VOLTS/cm switch to 5mV, INPUT COUPLING Switch to GND, Mode switch to Y1, Time Base to Free Run.
2. Set trace on centre line by means of Y1 shift control. Adjust front panel BAL control to give no trace movement when the Y1 FINE GAIN Control is operated.
3. Repeat procedure for Channel 2.

5.5.10 CHANNEL 1 & 2 STEP ATTENUATOR BALANCE

1. Set Y1 VOLTS/cm switch to 20mV, INPUT COUPLING Switch to GND, Mode switch to Y1, Time Base to Free Run.
2. Set trace on centre line by means of Y1 SHIFT CONTROL. Adjust R123 (Y1) to give no trace movement when the VOLT/cm switch is moved to 5mV/cm.
3. Repeat procedure for Channel 2, adjusting R123(Y2).

5.5.11 ADJUST TRACE ALIGNMENT

Set Time Base to 1ms/cm and TRIGGER SELECT to FREE RUN.
Adjust R850 to bring the trace parallel to the horizontal centre line. If there is insufficient range, reverse pink lead connections to pins marked "Twist" and '0V' on X Amplifier and Interconnection printed circuit board.

5.5.12 GEOMETRY

Apply to Y1 INPUT a 1kHz sinewave to give an amplitude of 8cm, adjust ASTIG and FOCUS controls for a sharp display and set Time Base to display approximately 10 cycles. Adjust R851 for a compromise between horizontal and vertical deflection to eliminate pincushion and barrel distortion. Reset ASTIG and FOCUS controls if necessary.

5.5.13 BACKGROUND ILLUMINATION

Adjust R381 to set voltage on S2 (Y O/P Board) to 15 volts negative with respect to the X mean plate potential.

5.5.14 DELAY LINE MATCHING

1. Set Y1 VOLTS/cm switch to 20mV, inject 1MHz squarewave to give 6 cm deflection, adjust trigger to give stable trace.

2. Inspect top of waveform for any step occurring approximately 200μs after the start of the pulse.
3. If any step is present replace A.O.T. resistor, R265, with a small 220Ω carbon potentiometer on short leads, adjust for no step, measure required value and substitute fixed resistors of nearest preferred value.

5.5.15 'ADD MODE' AMPLIFIER BALANCE

1. Set FUNCTION SWITCH to CHOP and bring both traces to the centre horizontal line, by means of Y1 and Y2 SHIFT controls.
2. Set the MODE SWITCH to ADD and note the direction and amount of movement of the trace. Return to CHOP Mode.
3. Add 100kΩ potentiometer across a.o.t. position, R294 or R295, to give a direction of movement the same as that given when moving from CHOP to ADD.
4. Adjust potentiometer to bring both traces to position found in '2'.
5. Re-centre traces, switch to ADD, movement should now be less than 0.5 cm.
6. Replace potentiometer with fixed resistor of the nearest preferred value.

5.5.16 CHANNEL 1 and 2 GAIN ADJUSTMENT

1. Set Y1 VOLTS/cm switch to 20mV, INPUT COUPLING Switch to DC, FINE GAIN CONTROL to Cal.
2. Inject a 1kHz squarewave having an amplitude of 120mV into Y1, adjust R227 to a deflection of 6 cms.
3. Switch to 10mV range, inject 60mV and adjust R138 (Y1) to give 6 cm deflection.
4. Switch to 5mV range, inject 30 mV and adjust R136 (Y1) to give 6 cm deflection.
5. While still on 5mV range, inject 6mV, pull for X5 gain and adjust R229 to give 6 cm deflection.
6. Switch to all other ranges and inject the appropriate signal to give 6 cm deflection. Check that all ranges are accurate to within ±3%.
7. Repeat the above procedure for Channel 2 the adjustments for the 20mV, 10mV, 5mV and 1mV ranges being respectively, R231, R138 (Y2), R136 (Y2) and R233.

5.5.17 CHANNEL 1 and ATTENUATOR COMPENSATION

1. Ensure that the attenuator covers are correctly fitted and that the link across the universal coupling on the SHIFT control is continuous.
2. Set Y1 VOLTS/cm switch to 20mV, INPUT COUPLING switch to DC, Inject 200mV 1kHz squarewave via the 28pF/1MΩ standardiser. Trigger for stable trace.
3. Adjust input trimmer, C171 (Y1) for square corner.
4. Remove standardiser, switch VOLTS/cm to 0.2V, inject 1V squarewave and adjust x10 compensating trimmer, C167 (Y1), for square corner.
5. Inject 2V squarewave via standardiser and adjust x10 input trimmer, C165 (Y1), for square corner.
6. Remove standardiser, switch VOLTS/cm to 2V, inject 10V squarewave and adjust x100 compensating trimmer, C161 (Y1), for square corner.
7. Inject 20V squarewave via standardiser and adjust x100 input trimmer, C159 (Y1), for square corner.
8. Remove standardiser and check all attenuator ranges, applying the appropriate amplitude, to ensure all ranges give a square corner to the applied waveform and are accurate to within ±3%.
9. Repeat above for Channel 2 the component numbering is the same except for a suffix 'Y2'.

5.5.18 Y2 OUTPUT AMPLITUDE AND PHASE ADJUSTMENT

1. Set Y1 and Y2 INPUT VOLTS/cm switches to 0.1V. INPUT COUPLING Switches to DC. Link Y2 OUTPUT to Y1 INPUT. FUNCTION SWITCH to ALT. FINE GAIN CONTROL to CAL.
2. Inject 0.5V 1kHz squarewave into Y2 input, trigger for a stable trace.
3. Adjust R238 to give equal deflections on Y1 and Y2 (i.e. Y2 Output of 100mV/cm).
4. Remove Y2 OUTPUT link from Y1 INPUT and take to EXT X and PULL x10.
5. Apply a sine wave source to Y1 and Y2. Adjust input level to give a convenient size display which should be a 45° line at low frequencies.
6. With input frequency of 500kHz, adjust capacity (approx 15pF) C228 (a.o.t.) until ellipse just closes. (Max. phase shift 3°, dc – 500kHz).

5.5.19 Y AMPLIFIER OVERALL PULSE RESPONSE

1. Set Y1 and Y2 VOLTS/cm switch to 20mV, INPUT COUPLING Switch to DC. Ensure that the AOT R230 and R235 are initially not in circuit. FINE GAIN CONTROLS to CAL.
2. Select Y1 Mode and inject 100mV squarewave at 50kHz. Adjust R324 to give optimum flat top response.
3. Change input frequency to 500kHz. Adjust R357 and C357 for optimum flat top response.
4. Change input frequency to 1MHz. Adjust R309 and R311 to give a response having approximately 20% undershoot over the first 35-40ns.
5. Adjust C311 to improve the edge response without affecting adjustment 4.
6. Connect a small carbon 1kΩ potentiometer on short leads across a.o.t. pins R230. Adjust potentiometer and C202 to remove undershoot left in adjustment 4. Replace potentiometer with fixed resistor.
7. Inject 1MHz signal into Y2 and repeat adjustment 6 to establish correct value of R235.
8. Adjust C211 to give improvement in, without increasing, overshoot over first 15μs.

5.5.20 5mV and 10mV HF COMPENSATION

1. Set Y1 and Y2 VOLTS/cm switch to 10mV, INPUT COUPLING SWITCH to DC, FINE GAIN CONTROL to CAL.
2. Select Y1 Mode and inject 50mV squarewave at 1MHz. Adjust C123 (Y1) to give a square corner.
3. Switch to 5mV/cm, inject 25mV and adjust C122 (Y1) to give a square corner.
4. Repeat 2 and 3 for Y2 input, adjusting C123 (Y2) and C122 (Y2) respectively.

5.5.21 BANDWIDTH

1. Set Y1 and Y2 VOLTS/cm switches to 20mV, INPUT COUPLING SWITCH to DC, FINE GAIN CONTROL to CAL.

2. Select Y1 Mode and inject 50KHz from Constant Amplitude Generator to give 5cm deflection. Increase the frequency of the generator until the display amplitude falls to 3.5cms. This frequency should be greater than 40MHz.
3. Repeat '2' for 10mV and 5mV positions on Y1 and for 20, 10, and 5mV positions on Y2.
4. Repeat to 1mV/cm on both channels, the bandwidth should be greater than 10MHz.

5.5.22 CHOP WAVEFORM COMPENSATION

1. If any of the transistors or diodes associated with the beam switch are changed it may be necessary to readjust the capacitive balance of the circuit.
2. Set INPUT COUPLING SWITCH to GND, Couple A EXT TRIG via probe to the collector of TR218 (R283). Turn A TRIG SELECT to EXT.
3. Switch to CHOP Mode and set the two traces 0.5cm either side of the centre line by means of the SHIFT controls and adjust the Time Base (1μs/cm) so that individual chop transitions are visible.
4. Small amounts of capacity should be added between points 26 and 25 or 26 and 27 for Y1, and between 29 and 28 or 28 and 30 for Y2, to ensure that the chop transitions are flat and parallel to the centre line. The capacity required is usually small and is most easily achieved by using short lengths of enamelled copper wire twisted together.

TIMEBASE WAVEFORMS

These were drawn under the following conditions. The 'A' timebase was switched to 0.1ms/cm and the 'B' timebase to 10μs/cm. A 5cm 10kHz square wave was applied to the Y1 channel, and the 'A' trigger set to Y1 +ve slope. The 'B' trigger was set to "B starts after delay", or to Y1 +ve slope. The delay multiplier potentiometer was set to about 5.

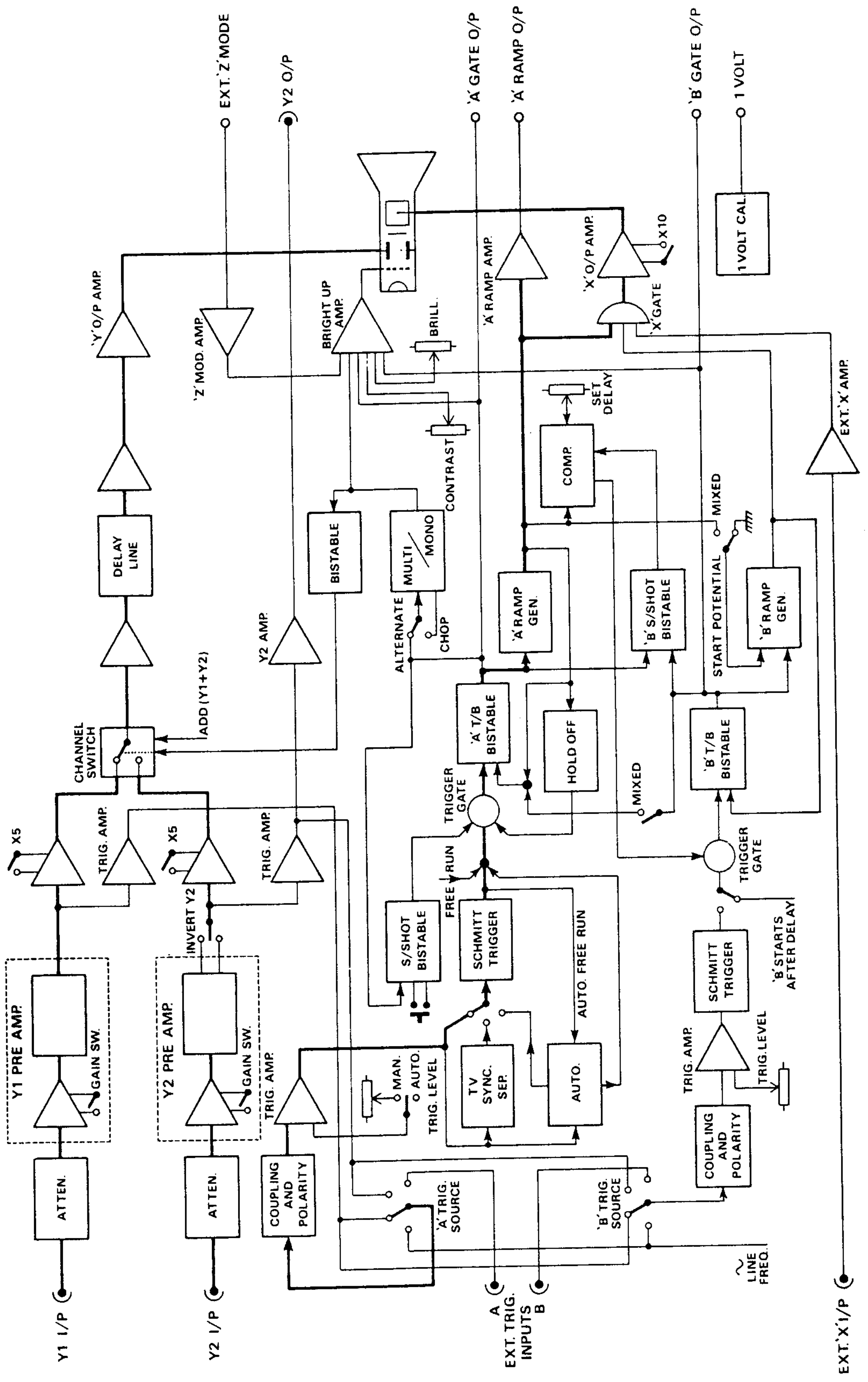


Fig. 1 Block Diagram.

PRE-AMP 1 & 2 AND GAIN SWITCHING OS3000

RESISTORS (Min.Carb.Film ±5% $^1/_8$W unless otherwise stated)

Ref	*Value*	*Description*	*Tol%±*	*Part No*
R10	470Ω	Control Pot.		31277
R11	500Ω	Control Pot.		A4/31250
R20	470Ω	Control Pot.		31277
R21	500Ω	Control Pot.		A4/31250
R101	270Ω			28720
R102	270Ω			28720
R103	3k3			21803
R104	3k3			21803
R105	1k2			21800
R106	1k2			21800
R107	1k			21799
R108	4k7			21805
R109	4k7			21805
R110	47Ω			28714
R111	47Ω			28714
R112	680Ω			28723
R113	3k3			21803
R114	3k3			21803
R115	100Ω			21794
R116	10Ω			21793
R117	10Ω			21793
R118	56Ω	Carbon Film	5 $^1/_8$W	2411
R119	56Ω	Carbon Film	5 $^1/_8$W	2411
R120	3k9	Carbon Film	5 $^1/_8$W	312
R121	680Ω	Carbon Film	5 $^1/_8$W	309
R122	1k	Carbon Film	5 $^1/_8$W	384
R123	100Ω	Plessey MPD/PC Carbon		28520
R124	1k	Carbon Film	5 $^1/_8$W	384
R125	56Ω	Carbon Film	5 $^1/_8$W	2411
R126	56Ω	Carbon Film	5 $^1/_8$W	2411
R127	330Ω	High Stab.Met.Ox.	2	26741
R128	330Ω	High Stab.Met.Ox.	2	26741
R129	560Ω	Carbon Film	5 $^1/_8$W	308
R130	10Ω	Carbon Film	5 $^1/_8$W	2259
R131	10Ω	Carbon Film	5 $^1/_8$W	2259
R132	390Ω	High Stab.Met.Ox.	2	26740
R133	1k5	Carbon Film	5 $^1/_8$W	385
R134	390Ω	High Stab.Met.Ox.	2	26740
R135	180Ω	Carbon Film	5 $^1/_8$W	21795
R136	100Ω	Plessey MPD/PC		28520
R137	680Ω	Carbon Film	5 $^1/_8$W	309
R138	220Ω	Plessey MPD/PC Carbon		28522
R139	100Ω	High Stab.Met.Ox.	2	26747
R140	100Ω	High Stab.Met.Ox.	2	26747
R141	10Ω			21793
R142	10Ω			21793
R143	100Ω			21794
R144	100Ω			21794
R145	2k2			21802
R146	1k	Plessey MPD/PC Carbon		26870
R147	2k2			21802
R148	100Ω			21794
R149	100Ω			21794
R150	270Ω			28720
R151	270Ω			28720

Ref	*Value*	*Description*	*Tol±*	*Part No.*
R153	10Ω			21793
R154	390Ω	High Stab.Met.Ox.	2	26740
R155	390Ω	High Stab.Met.Ox.	2	26740
R156	10Ω	Carbon Film	5 $^1/_8$W	2259
R157	10Ω	Carbon Film	5 $^1/_8$W	2259
R158	820Ω	Carbon Film	5 $^1/_8$W	1637
R159	10Ω	Carbon Film	5 $^1/_8$W	2259
R160	27Ω	Carbon Film	5 $^1/_8$W	724
R161	10Ω	Carbon Film	5 $^1/_8$W	2259
R163	990k	Met.Film Welwyn 4034 150PPM/°C	.5	31927
R165	18Ω	Carbon Film	5 $^1/_8$W	722
R167	10Ω	Carbon Film	5 $^1/_8$W	2259
R168	18Ω	Carbon Film	5 $^1/_8$W	722
R169	10k1	Met.Film Welwyn 4034 150 PPM/°C	.5	31928
R173	33Ω	Carbon Film	10 $^1/_8$W	28712
R175	10Ω	Carbon Film	5 $^1/_8$W	2259
R176	900k	Met.Film Welwyn 4034 150 PPM/°C	.5	31929
R177	111k	Met.Film Welwyn 4034 150 PPM/°C	.5	31930
R183	10Ω	Carbon Film	5 $^1/_8$W	2259
R184	10Ω	Carbon Film	5 $^1/_8$W	2259
R187	1M	Met.Film Welwyn 4014 150 PPM/°C	1	26346
R189	330k	Carbon	10	4408

CAPACITORS

Ref	*Value*	*Description*	*Tol±*	*Part No.*
C101	.01μf	Erie Disc Style 801	25 250V	22395
C102	.01μf	Erie Disc Style 801	25 250V	22395
C103	.01μf	Erie Disc Style 801	25 250V	22395
C104	.01μf	Erie Disc Style 801	25 250V	22395
C120	3.3pF	Silver Mica	½pF	817
C121	3.3pF	Silver Mica	½pF	817
C122	3/16pF	Trimmer		32059
C123	.7/6pF	Trimmer		29421
C124	220pF	Erie Disc Style 801	10 500V	22379
C125	220pF	Erie Disc Style 801	10 500V	22379
C126	.01μF	Erie Disc Style 801	25 250V	22395
C127	.01μF	Erie Disc Style 801	25 250V	22395
C128	.01μF	Erie Disc Style 801	25 250V	22395
C129	.01μF	Erie Disc Style 801	25 250V	22395
C130	2.7pF	Silver Mica	½pF	816
C131	.01μF	Erie Disc Style 801	25 250V	22395
C132	.01μF	Erie Disc Style 801	25 250V	22395
C155	.01μF		10 400V	29495
C156	47pF	Erie Disc Style 801	10 500V	22372
C157	6.8pF	Silver Mica	½pF	4617
C159	.7/6pF	Trimmer		25750
C161	.7/6pF	Trimmer		25750
C163	330pF	Feed Thru'		31293
C165	.7/6pF	Trimmer		25750
C167	.7/6pF	Trimmer		25750
C168	47pF	Feed Thru'		29918
C171	.7/6pF	Trimmer		25750
C173	5.6kpF	Ceramic Disc	400V	22394

PRE-AMP 1 & 2 AND GAIN SWITCHING OS3000 (cont.)

Ref	Value	Description	Tol%±	Part No
DIODES				
D101		1N3595		29330
D102		1N3595		29330
D103	6V2	Zener	5	4032
D104	6V2	Zener	5	4032
D120	7V5	Zener	5	22173
D121	5V6	Zener	5	4109
D122	5V1	Zener	5	20218
TRANSISTORS				
TR101 TR102		AE12 Matched Pair		A31253
TR103 TR104		AE13 Matched Pair		A31254

Ref	Value	Description	Tol±	Part No.
TR120		2N2369		23307
TR121 TR122		AE13 Matched Pair		A31254
TR123		2N2369/BSX20		23307
TR124		2N2369/BSX20		23307
TR125		2N2369/BSX20		23307
TR126		2N2369/BSX20		23307
MISCELLANEOUS				
S10		Switch – lever		A3/31292
S11		Switch – rotary		31276
S20		Switch – lever		A3/31292
S21		Switch – rotary		31276
SKY	50Ω	BNC		1222

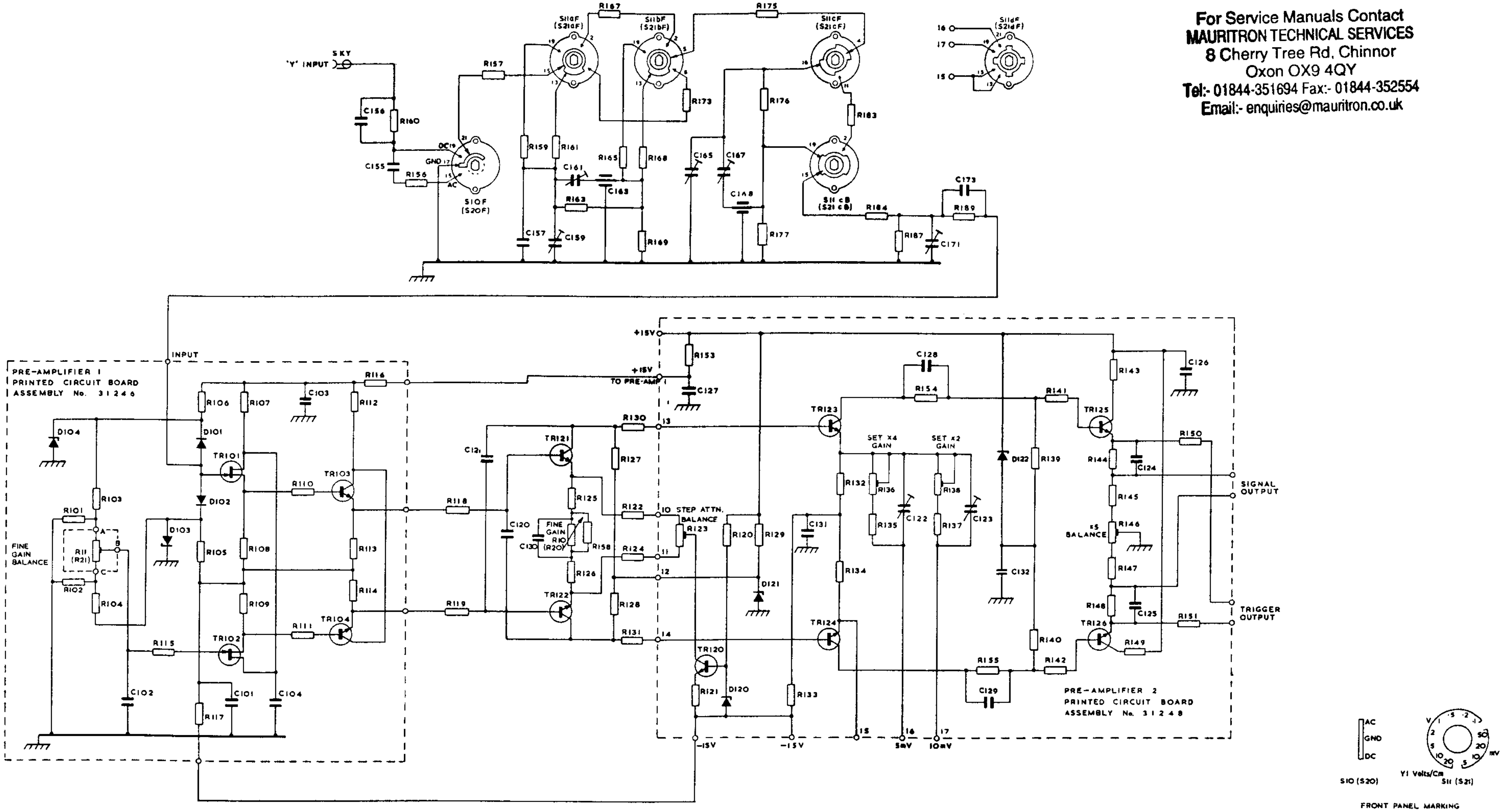


Fig. 2 Circuit Diagram, Pre-amp 1 and 2 and Gain Switching, AO/SK 2315

DELAY LINE DRIVER AND BEAM SWITCH OS3000

RESISTORS (Min.Carb.Film ±5% $^1/_8$W unless otherwise stated)

Ref	*Value*	*Description*	*Tol%±*	*Part No*
R26	250Ω	Control Pot.	20	A4/31257
R27	250Ω	Control Pot.	20	A4/31257
R200	10Ω			21793
R201	10Ω			21793
R202	10Ω			21793
R203	270Ω	High Stab.Met.Ox.	2	26742
R204	10Ω			21793
R205	10Ω			21793
R206	270Ω	High Stab.Met.Ox.	2	26742
R207	10Ω			21793
R208	10Ω			21793
R209	10Ω			21793
R210	10Ω			21793
R211	10Ω			21793
R212	56Ω			28715
R213	100Ω	Plessey MPD/PC Carbon		28520
R214	220Ω	High Stab.Met.Ox.	2	26743
R215	2k2			21802
R216	330Ω	High Stab.Met.Ox.	2	26741
R217	180Ω			21795
R218	330Ω	High Stab.Met.Ox.	2	26741
R219	330Ω	High Stab.Met.Ox.	2	26741
R220	180Ω			21795
R221	330Ω		2	26741
R222	56Ω			28715
R223	100Ω	Plessey MPD/PC		28520
R224	220Ω		2	26743
R225	1k5			21801
R226	680Ω			28723
R227	2k2	Plessey MPD/PC		24561
R228	68Ω			28716
R229	100Ω	Plessey MPD/PC		28520
R230		A.O.T.		
R231	2k2	Plessey MPD/PC		24561
R232	680Ω			28723
R233	100Ω			28520
R234	68Ω			28716
R235		A.O.T.		
R236	68Ω			28716
R237	470Ω			21797
R238	1k	Plessey MPD/PC		26870
R239	33k			21814
R240	1k8			28725
R242	2k2			21802
R243	15k			28727
R245	3k9		2	26724
R246	3k9		2	26724
R247	470Ω		2	26739
R248	470Ω		2	26739
R249	330Ω		2	26741
R250	330Ω		2	26741
R251				
R252	820Ω		2	26736
R253	220Ω		2	26743
R254	22Ω			28710
R255	1k8			28725
R256	22Ω			28710
R257	2k2			21802
R258	10Ω			21793
R259	10Ω			21793
R260	47Ω			28714
R261	120Ω			28718
R262	390Ω			28722
R263	39Ω			28713
R264	39Ω			28713
R265	180Ω			21795
R266	56Ω			28715
R267	150Ω			28719
R268	1k			384
R269	4k7			21805
R270	820Ω			1637
R271	6k8			21807
R272	6k8			21807
R273	820Ω			1637
R274	10Ω			21793
R275	10Ω			2259
R276	4k7			21805
R277	1k			384
R278	150Ω			28719
R279	390Ω			2410
R280	10k			11503
R281	2k2			21802
R282	3k3			21803
R283	3k9			21804
R284	1k8			310
R285	2k4	High Stab.Met.Ox.	2	26729
R286	470Ω			21797
R287	2k2			425
R288	10Ω			2259
R289	10Ω			21793
R290	10Ω			21793
R291	47Ω			28714
R292	47Ω			28714
R294		A.O.T.		
R295		A.O.T.		
R296	100Ω			21794

CAPACITORS

Ref	*Value*	*Description*	*Tol%±*	*Part No*
C200	100pF	Ceramic		22376
C201	.01μF	Erie Disc Style 801	25 500V	22395
C202	3.5/12pF	Trimmer		18803
C203	.1μF	Silver Ceramic	$^{+80}_{-25}$ 30V	19647
C204	100pF	Ceramic		22376
C205	.1μF	Silver Ceramic	$^{+80}_{-25}$ 30V	19647
C206	3.5/12pF	Trimmer		18803
C209	15pF	Erie Disc Style 831	1pF 500V	22366

DELAY LINE DRIVER AND BEAM SWITCH OS3000 (Cont.)

Ref	Value	Description	Tol%±		Part No
C210	15pF	Erie Disc Style 831	1pF	500V	22366
C211	10/40pF	Trimmer			29483
C212	330pF	Erie Disc Style 831	10	500V	22381
C213	33pF	Erie Disc Style 801	10	500V	22370
C214	.01μF	Erie Disc Style 801	25	250V	22395
C215	39pF	Erie Disc Style 801	10	500V	22371
C216	39pF	Erie Disc Style 801	10	500V	22371
C217	.01μF	Erie Disc Style 801	25	250V	22395
C218	33pF	Erie Disc Style 801	10	500V	22370
C219	330pF	Erie Disc Style 831	10	500V	22381
C220	.01μF	Erie Disc Style 801	25	250V	22395
C221	900pF		1	125V	24885
C222	.01μF	Erie Disc Style 801	25	250V	22395
C223	47pF	Erie Disc Style 801	10	500V	22372
C224	.01μF	Erie Disc Style 801	25	250V	22395
C225	.1μF	Silver Ceramic	+80 −25	30V	19647
C226	22μF	Electrolytic	+50 −10	25V	32181
C227	3300pF	Erie Disc Style 801	20	250V	22391
C228		A.O.T.			
C229	3300pF	Erie Disc Style 801	20	250V	22391

TRANSISTORS

Ref	Value	Description	Tol±	Part No.
TR201		MPS 3640		24128
TR202		MPS 3640		24128
TR203		AE 16		A31781
TR204		AE 16		A31781
TR205		AE 17 Matched Pair		A4/32063
TR206		AE 17 Matched Pair		A4/32063
TR207		MPS 3640		24128
TR208		MPS 3640		24128
TR209		2N2369/BSX20		33701
TR210		2N2369/BSX20		33701
TR211		2N2369/BSX20		33701
TR212		AE 16		A31781
TR213		AE 16		A31781
TR214		MPS 3640		24128
TR215		2N2369/BSX20		33701
TR216		2N2369/BSX20		33701
TR217		2N2369/BSX20		33701
TR218		2N2369/BSX20		33701

DIODES

Ref	Value	Description	Tol±	Part No.
D201		IN916		1949
D202		IN916		1949
D203		IN916		1949
D204		IN916		1949
D205		IN916		1949
D206		IN916		1949
D207		IN916		1949
D208		IN916		1949
D209	5V6	Zener	5	4109
D210	3V3	Zener	5	4034
D211		IN4148		23802
D212		IN4148		23802

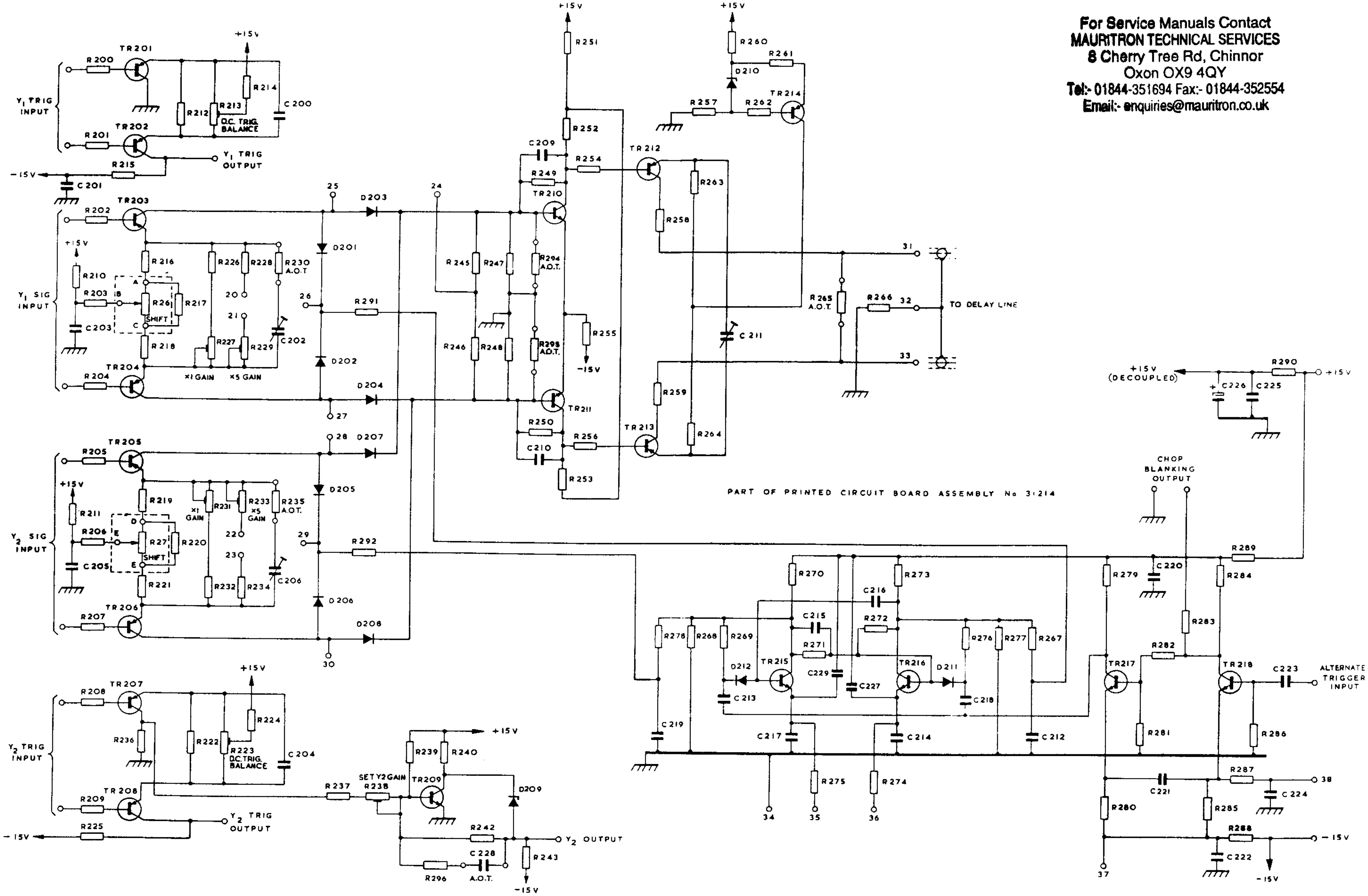


Fig. 3 *Circuit Diagram, Delay Line Driver and Beam Switch, AO/SK 2316*

Component List and Illustrations

DELAY EQUALISER & OUTPUT DRIVER OS3000

Ref	Value	Description	Tol%±		Part No
RESISTORS					
R300	1.5k	Carbon Film A.O.T.	5	⅛W	21801
R301	100Ω	High Stab.Met.Ox.	2		26747
R302	100Ω	High Stab.Met.Ox.	2		26747
R303	3k3	Carbon Film	5	⅛W	1638
R304	22Ω	Carbon Film	5	⅛W	723
R305	22Ω	Carbon Film	5	⅛W	723
R306	390Ω	High Stab.Met.Ox.	2		26740
R307	390Ω	High Stab.Met.Ox.	2		26740
R308	8k2	Carbon Film	5	⅛W	314
R309	22k	Plessey MPD/PC			25885
R310	22k	Carbon Film	5	⅛W	21812
R311	10k	Plessey MPD/PC			28525
R312	390Ω	High Stab.Met.Ox.	2		26740
R313	39Ω	Carbon Film	5	⅛W	28713
R314	39Ω	Carbon Film	5	⅛W	28713
R315	100Ω	High Stab.Met.Ox.	2		21794
R316	100Ω	High Stab.Met.Ox.	2		21794
R317	510Ω	High Stab.Met.Ox.	2		26738
R318	100Ω	High Stab.Met.Ox.	2		26747
R319	100Ω	High Stab.Met.Ox.	2		26747
R320	47Ω	Carbon Film	5	⅛W	727
R321	22Ω	Carbon Film	5	⅛W	723
R322	22Ω	Carbon Film	5	⅛W	723
R323	22Ω	Carbon Film	5	⅛W	21710
R324	470k	Plessey MPD/PC			28524
R325	3k3	Carbon Film	5	⅛W	1638
R326	3k3	Carbon Film	5	⅛W	1638
R327	56Ω	Carbon Film	5	⅛W	28777
R328	56Ω	Carbon Film	5	⅛W	28777
R329	560Ω	High Stab.Met.Ox.	2		26737
R330	390Ω	High Stab.Met.Ox.	2		26740
R331	390Ω	High Stab.Met.Ox.	2		26740
R332	220Ω	Carbon Film	5	⅛W	304
R333	270Ω	High Stab.Met.Ox.	2		28720
R334	270Ω	High Stab.Met.Ox.	2		28720
R335	10Ω	Carbon Film	5	⅛W	2259
R336	10Ω	Carbon Film	5	⅛W	2259
R337	10Ω	Carbon Film	5	⅛W	2259
R338	100k	Carbon Film	5	⅛W	319
R339	3k3	Carbon Film	5	⅛W	21803
R351	2k2	Carbon Film	5	⅛W	425
R352	47Ω	Carbon Film	5	⅛W	727
R353	39Ω	Carbon Film	5	⅛W	3010
R354	56Ω	Carbon Film	5	⅛W	28777
R355	56Ω	Carbon Film	5	⅛W	28777
R356	10Ω	Carbon Film	5	⅛W	2259
R357	2k2	Plessey MPD/PC			24561
R358	22k	Carbon Film	5	⅛W	21812
R359	10Ω	Carbon Film	5	⅛W	2259
R360	82Ω	High Stab.Met.Ox.	2		28781
R361	82Ω	High Stab.Met.Ox.	2		28781
R362	56Ω	Carbon Film	5	⅛W	2411
R363	56Ω	Carbon Film	5	⅛W	2411
R364	56Ω	Carbon Film	5	⅛W	2411
R365	1k	Carbon Film	5	1W	17758
R366	1k	Carbon Film	5	1W	17758
R367	1k	Carbon Film	5	1W	17758
R368	1k	Carbon Film	5	1W	17758
R369	1k	Carbon Film	5	1W	17758
R370	1k	Carbon Film	5	1W	17758
R371	1k	Carbon Film	5	1W	17758
R372	1k	Carbon Film	5	1W	17758
R373	2k2	Wirewound	5	6W	599
R374	10Ω	Carbon Film	5	⅛W	2259
R380	56k	Carbon Film	5	⅛W	756
R381	100k	Plessey MPD/PC			26582
R382	129k	Carbon Film	5	⅛W	5332
R383	2k2	Wirewound	5	6W	599
CAPACITORS					
C301	.001μF	Ceramic Disc	25	250V	22387
C302	.22μF	Metal Polyester	10	160V	31379
C303	82pF	Ceramic Disc	10	500V	22375
C304	.001μ	Ceramic Disc	25	250V	22387
C305	680pF	Ceramic Disc	10	500V	22385
C306	47pF	Ceramic Disc	10	500V	22372
C307	.01μF	Ceramic Disc	25	250V	22395
C308	.01μF	Ceramic Disc	25	250V	22395
C309	.01μF	Ceramic Disc	25	250V	22395
C310	39pF	Ceramic Disc	10	500V	22371
C311	10/40pF	Trimmer			29483
C312	33pF	Ceramic Disc	10	500V	22370
C313	33μF	Electrolytic	+50 −10	16V	32173
C314	33μF	Electrolytic	+50 −10	16V	32173
C315	.001μF	Ceramic Disc	25	250V	22387
C316	.001μF	Ceramic Disc	25	250V	22387
C317	.01μF	Ceramic Disc	25	250V	22395
C318	.01μF	Ceramic Disc	25	250V	22395
C319	.01μF	Ceramic Disc	25	250V	22395
C320	27pF	Ceramic Disc	10	500V	22369
C351	5600pF	Ceramic Disc	25	500V	22394
C352	100pF	Ceramic Disc	25	500V	22376
C353	100pF	Ceramic Disc	10	500V	22376
C354	0.1μF	Metal Polyester	10	160V	2740
C355	0.1μF	Metal Polyester	10	160V	2740
C356	.01μF	Ceramic Disc	25	250V	22395
C357	10/40pF	Trimmer			29483
C358					
TRANSISTORS					
TR300	AE 16				A31781
TR301	AE 16				A31781
TR302	2N2369				33701
TR303	2N2369				33701
TR304	2N2369				33701
TR305	2N2369				33701

DELAY EQUALISER & OUTPUT DRIVER OS3000 (Cont.)

Ref	*Value*	*Description*	*Tol±*	*Part No.*
TR351		2N2369		33701
TR352		2N2369		33701
TR353		2N3119		31255
TR354		2N3119		31255
TR355		2N2369		33701
DIODES				
D300	3V9	Zener	5	3817
D351	3V3	Zener	5	4034
L351	3.3μH			31256
L352	3.3μH			31256

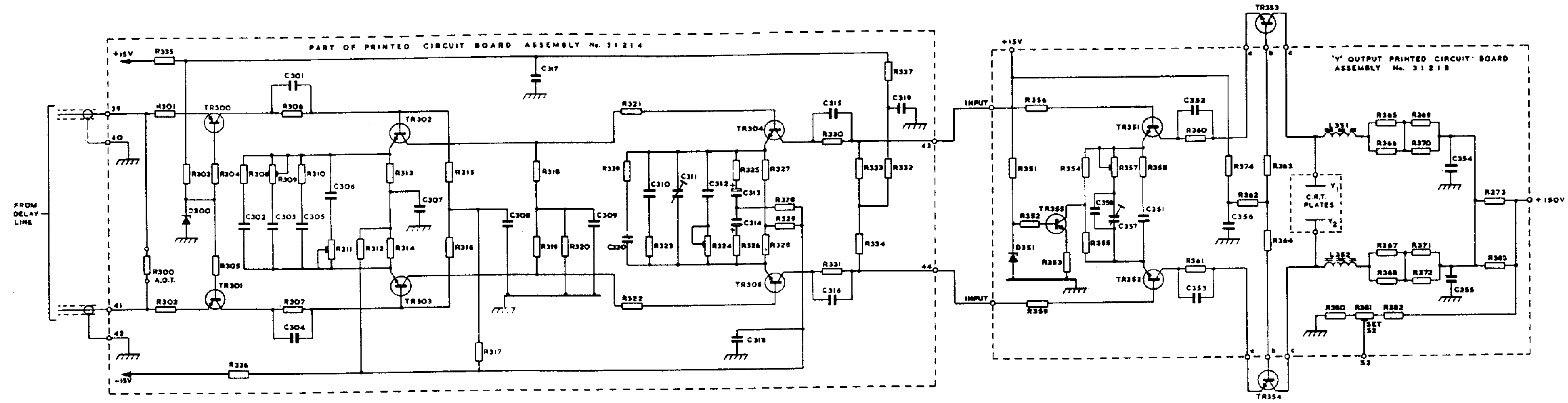


Fig. 4 Circuit Diagram, Delay Equaliser and Output Driver, AO/SK 2317

'A' TIMEBASE OS3000

RESISTORS (Carbon Film ±5% $^1/_8$W unless otherwise stated)

Ref	Value	Description	Tol%±	Part No
R400	47Ω			727
R401	100k	Carbon Film	5 1W	19061
R402	2k2			425
R403	10Ω		10	2259
R404	47Ω			727
R405	47Ω			727
R406	47Ω			727
R407	47Ω			727
R408	1k5			385
R409	10k			11503
R410	1k			384
R411	3k9			312
R412	100Ω			11504
R413	2.7k			311
R414	220Ω			304
R415	1k5	Carbon Film	½W	18552
R416	560Ω			308
R417	8k2			314
R418	470k			1518
R419	2k2			425
R420	10k			11503
R421	220k			4023
R422	33k			317
R423	22k			1544
R424	1k8			310
R425	33k			317
R426	1k			384
R427	1k			384
R428	100k			319
R429	470Ω			1373
E430	560k			17966
R431	100Ω			11504
R432	4k7			386
R433	150k			4018
R434	3k9			312
R435	39Ω			3010
R436	47Ω			727
R437	15k			315
R438	100Ω			11504
R439	10Ω			2259
R440	100k	Potentiometer (with S41)		31283
R441	4.7k			386
R442	22Ω			723
R443	3k3			1638
R444	4k7			386
R445	1k5			385
R446	22k			1544
R447	33k			317
R448	470k	High Stab.Met.Ox.		1518
R449	12k			1685
R450	4k7			386
R451	47Ω			727
R452	680Ω			309
R453	1k	Plessey MPD/PC		26870
R454	1k3	High Stab.Met.Ox.		28792
R455	3k3			1638
R456	1k5			385
R457	100Ω			11504
R458	470Ω			1373
R459	10Ω			2259
R460	10Ω			2259
R461	330Ω			1894
R462	33k			317
R463	10Ω			2259
R464	10Ω			2259
R465	820Ω			1637
R466	22k			1544
R467	470Ω			1373
R468	220k			4023
R469	470Ω			1373
R470	390Ω			2410
R471	4k7			386
R472	2.7k			311
R473	10Ω			2259
R474	220Ω			304
R475	1k			384
R476	1k5	Carbon Film	½W	18552
R477	82Ω			730
R478	1k2			2087
R479	8k2			314
R480				
R481	180k			4135
R482	1k2			2087
R483	22k			1544
R484	4k7			386
R485	820Ω			1637
R486	22k			1544
R487	2k7			311
R488	10Ω			2259
R489	750Ω	High Stab.Met.Ox.	2	28790
R490	10Ω			2259
R491	470Ω			1373
R492	2k2			425
R493	820Ω			28724
R494	100k			319
R495	1k5			385
R496	10Ω			2259
R497	10Ω			2259
R498	120k			5332
R499	8k2			314
R500	6k8			313
R501	1k2			2087
R502	100k			319
R503	8k2			314
R504	3k3			1638
R505	1k2			2087
R506	4k7			386
R507	10k	Potentiometer (with S74)		31281
R508	4k7			386
R509	1k2			2087
R510	470Ω	Plessey MPD/PC		28524
R511	10k			11503
R512	3k3	High Stab.Met.Ox.	2	26726
R513	100Ω			11504

'A' TIMEBASE OS3000 (Cont.)

RESISTORS (Carbon Film ±5% ⅛ W unless otherwise stated) (cont.)

Ref	*Value*	*Description*	*Tol%±*	*Part No*
R514	3k3	High Stab.Met.Ox.	2	26726
R515	100Ω			11504
R516	10k			11503
R517	10k			11503
R518	8k2			314
R519	10k			11503
R520	10k			11503
R521	10k			11503
R522	10k			11503
R523	100Ω			11504
R524	47k			318
R525	6k8			313
R526	470Ω			1373
R527	100Ω			11504
R528	15k			315
R529	1k5			385
R530	10k			11503
R531	47k	Carbon Film	½W	18570
R532	390Ω	Carbon Film	½W	18545
R533	6k8			313
R534	1k			384
R535	4k7			386
R536	1k			384
R537	10Ω			2259
R538	10M	Carbon Film	10 ½W	1179
R539	47Ω			727
R540	4k7			386
R541	10k			11503
R542	6k8			313
R543	4k7			386
R544	1k3			33338
R545	100Ω			11504
R546	47Ω			727
R547	47Ω			727
R548	100k			319
R549	3k9			312
R550	10Ω			2259
R551	390Ω			28722
R552	100k			319
R553	2k	High Stab.Met.Ox.	2	26731
R554	680Ω			309
R555	1k			384
R556	1k8			28725
R557	33			28712
R558	47Ω			727
R559	100Ω			11504
R560	10k			11503
R561	3k9	High Stab. Met. Ox.		312
R562				
R571	22Ω			723
R572	470Ω			21797
R573	4k3	High Stab. Met. Ox.		26723
R574	3k9			312

CAPACITORS

Ref	*Value*	*Description*	*Tol%±*	*Part No*
C400	4.7pF	Silver Mica		4502
C401	220pF	Erie Disc 801	10 500V	22379
C402	.47μF	Erie Disc 801	10 160V	31381
C403	470Ω	Erie Disc 801	10 500V	22383
C404	33pF	Erie Disc 801	10 500V	22370
C405	100pF	Erie Disc 801	10 500V	22376
C406	10pF	Erie Disc 801	10 500V	22364
C407	33pF	Erie Disc 801	10 500V	22370
C408	47pF	Erie Disc 801	10 500V	22372
C409	.01μF	Erie Disc 801	25 250V	22395
C410	1000pF	Erie Disc 801	10 500V	22387
C411	.1μF	Erie Disc 801	10 160V	31377
C412	.1μF	Erie Disc 801	10 160V	31377
C413	100pF	Erie Disc 801	10 500V	22376
C414	1000pF	Erie Disc 801	10 500V	22387
C415	220pF	Erie Disc 801	10 500V	22379
C416	.033μF	Erie Disc 801	10 160V	31374
C417	.1μF	Silver Ceramic	+80 −25 30V	19647
C418	.1μF	Metal Polyester	10 160V	31377
C419	.01μF	Erie Disc 801	25 250V	22395
C420	22pF	Erie Disc 801	10 500V	22368
C421	.1μF	Silver Ceramic	+80 −25 30V	19647
C422	.1μF	Silver Ceramic	+80 −25 30V	19647
C423	1000pF	Erie Disc 801	10 500V	22387
C424	390pF	Erie Disc 801	10 500V	22382
C425	22μF	Erie Disc 801	25V	32181
C427	.01μF	Erie Disc 801	25 250V	22395
C428	.01μF	Erie Disc 801	25 250V	22395
C429	1.5pF	Silver Mica		813
C430	10pF	Erie Disc 801	10 500V	22364
C431	18pF	Erie Disc 801	10 500V	22367
C432	6.8pF	Erie Disc 801	1pF 500V	22362
C433	.01μF	Erie Disc 801	25 250V	22395
C434	.01μF	Erie Disc 801	25 250V	22395
C435	6/25pF	Trimmer		23593
C436	100pF	Erie Disc 801	10 500V	22376
C437	100pF	Erie Disc 801	10 500V	22376
C438	100pF	Erie Disc 801	10 500V	22376
C439	.01μF	Erie Disc 801	25 250V	22395
C440	33pF	Erie Disc 801	10 500V	22370
C441	.1μF	Silver Ceramic	+80 −25 30V	19647
C444	.01μF	Erie Disc 801	25 250V	22395
C445	.1μF	Erie Disc 801	10 160V	31377
C446	.1μF	Silver Ceramic	+80 −25 30V	19647
C447	220pF	Erie Disc 801	10 500V	22379
C448	.01μF	Erie Disc 801	25 250V	22395
C449	.01μF	Erie Disc 801	25 250V	22395
C450	.01μF	Erie Disc 801	25 250V	22395
C451	.01μF		25 250V	22395
C452	33μF	Erie Disc 801	16V	32173
C453	.01μF	Erie Disc 801	25 250V	22395
C454	1000pF		10 500V	22387
C455	22pF	Erie Disc 801	10 500V	22368
C462	.01			22395
C463	4.7pF			29649
C464				
C465	27pF			22369

'A' TIMEBASE OS3000 (Cont.)

Ref	Value	Description	Tol%±	Part No
TRANSISTORS				
TR401		BSX20/2N2369		23307
TR402		BSX20/2N2369		23307
TR403		BC107		26790
TR404		2N3906		21533
TR405		BC107		26790
TR406		2N3906		21533
TR407		BC108		26110
TR408		2N3906		21533
TR409		2N930		21548
TR410		2N3906		21533
TR411		2N3906		21533
TR412		BC107		26790
TR413		AE13 Matched		A31254
TR414		Pair		
TR415		MPS 3640		24128
TR416		MPS 3640		24128
TR417		BSX20/2N2369		23307
TR418		BC108		26110
TR419		BSX20/2N2369		23307
TR420		BSX20/2N2369		23307
TR421		2N3906		21533
TR422		2N3906		21533
TR423		2N930		21548
TR424		BC108		26110
TR425		AE12 Matched		A31253
TR426		Pair		
TR427		BC107		26790
TR428		2N3906		21533
TR429		AE13 (Matched pair with TR436)		A31254
TR430		2N3906		21533
TR431		MPS3640		24128
TR432		2N3906		21533
TR433		C407		20388
TR434		MPS3640		24128
TR435		BSX20/2N2369		23307
TR436		AE13 (See TR429)		
TR437/8		BSX20/2N2369		23307
IC400		SN74OON		52038
DIODES				
D401		1N 4148		23802
D402		1N 4148		23802
D403		1N 4148		23802
D404		1N 4148		23802
D405		1N 4148		23802
D406		1N 4148		23802
D407		1N 4148		23802
D408		1N 4148		23802

Ref	Value	Description	Tol±	Part No.
D409		1N 4148		23802
D410		1N 4148		23802
D411		1N 4148		23802
D412		1N 4148		23802
D413		1N 916		1949
D414		OA47		4468
D415		OA47		4468
D416		1N 4148		23802
D417		1N 4148		23802
D418		1N 4148		23802
D419		AAZ13		4472
D420		1N 4148		23802
D421		1N 4148		23802
D422		1N 4148		23802
D423	6V8	Zener	5	
D424		1N 4148		23802
D425		OA47		4468
D426		1N 4148		23802
D427		1N 4148		23802
D428		1N 4148		23802
D429		1N 3595		29330
D430		NOT USED		
D431		1N 4148		23802
D432		1N 4148		23802
D433		1N 4148		23802
D434	4V7	Zener	5	4073
D435		1N 4148		23802
D436		1N 4148		23802
D437		1N 916		1949
D438		1N 4148		23802
D439		1N 4148		23802
D440		1N 4148		23802
D441				
D442				
D443				
D444				
D445				
MISCELLANEOUS				
L400	15μH			29496
L402				26986
N400				26586
S40				31282
S41		Part of R440		
S42				A3/31266
S44				A3/31267
SKE		50Ω B.N.C.		1222

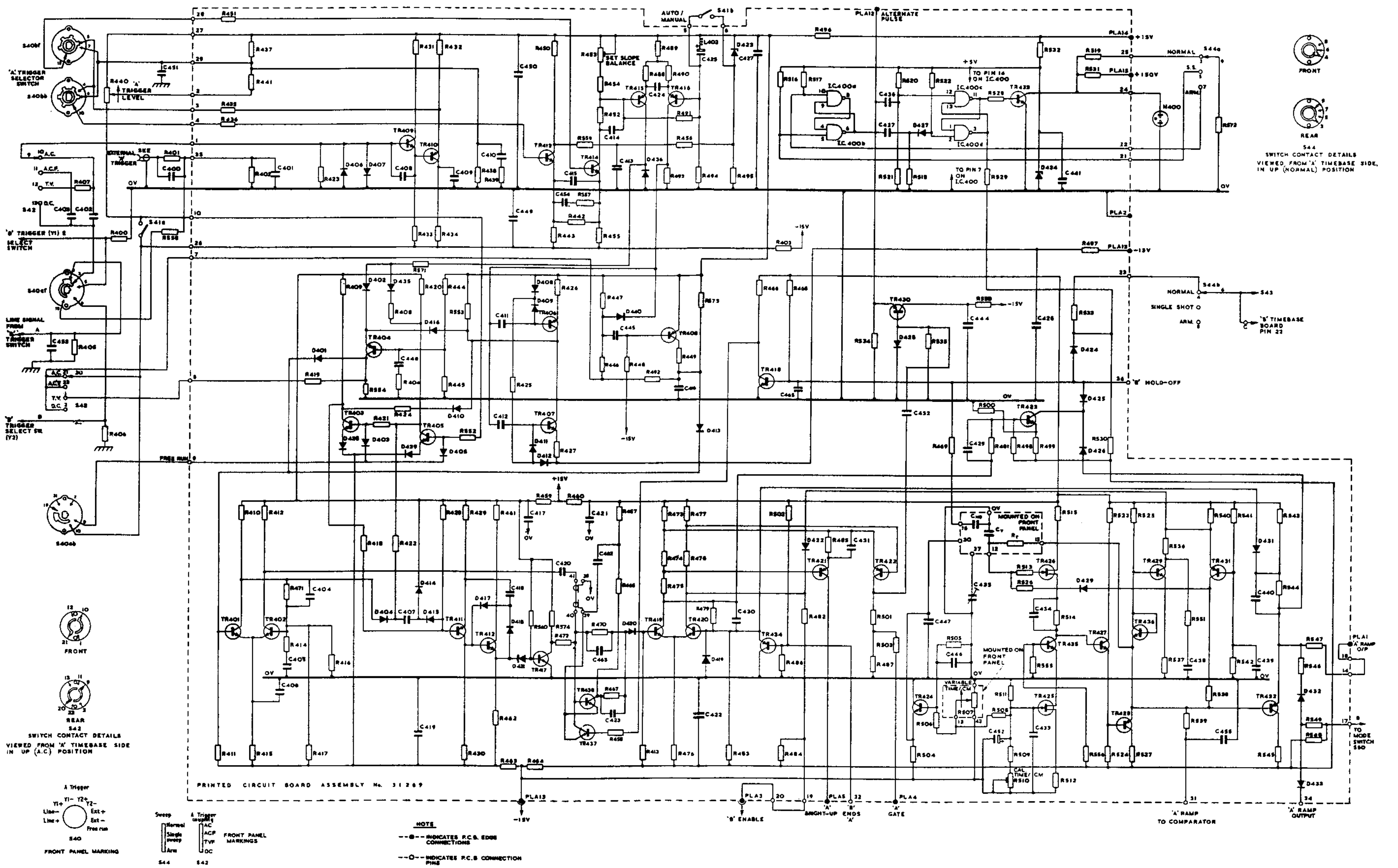


Fig. 5 Circuit Diagram, A Timebase, AO/SK 2313

"B" TIMEBASE OS3000

Ref	Value	Description	Tol%±	Part No
RESISTORS (Carbon Film ±5% ⅛W unless otherwise stated)				
R600	3k9			312
R601	1k5			385
R602	1k	Control Pot.) DUAL		A29553
R603	1k	Control Pot.)		
R604	1k8			310
R605	3k9			312
R606	3k9			312
R607	1k			384
R608	1k5	Carbon Film	5 ½W	18552
R609	1k			384
R610	8k2			314
R611	100Ω			11504
R612	4k7			386
R613	470Ω			1373
R614	100k	Carbon Film	5 1W	19061
R615	2k2			425
R616	47Ω			727
R617	22k			1544
R618	200k	High Stab.Met.Ox.	2	28829
R619	150k	High Stab.Met.Ox.	2	28826
R620	47k	High Stab.Met.Ox.	2	28814
R621	1M			766
R622	13k	High Stab.Met.Ox.	2	28803
R623	2k	High Stab.Met.Ox.	2	26731
R624	5k6	High Stab.Met.Ox.	2	22483
R625	3k9			312
R626	100Ω			11504
R627	150k			4018
R628	4k7			386
R629	3k9			312
R630	39Ω			3010
R631	100k	Control Pot. Part of S71		31486
R633	47Ω			727
R634	15k			315
R635	10Ω			2259
R636	100Ω			11504
R637	4k7			386
R638	4k7			386
R639	47Ω			727
R640	3k3			1638
R641	22Ω			723
R642	3k3			1638
R643	1k	Plessey MPD/PC		26870
R644	1k3	High Stab Met.Ox.	2	28792
R645	680Ω			309
R646	1k5			385
R647	10Ω			2259
R648	10Ω			2259
R649	10Ω			2259
R650	10Ω			2259
R651	6k8			313
R652	820Ω			1637
R653	10Ω			2259
R654	10Ω			2259
R655	680Ω			309
R656	470Ω			1373
R657	470Ω			1373
R658	10Ω			2259
R659	27k			316
R660	47Ω			727
R661	1k5			385
R662	10Ω			2259
R663	6k8			313
R664	470Ω			1373
R665	6k8			313
R666	1k			384
R667	47Ω			727
R668	1k5			385
R669	2k7			311
R670	4k7			386
R671	2k7			311
R672	15k			315
R673	10Ω			2259
R674	220Ω			304
R675	1k			384
R676	1k5	Carbon Film	5 ½W	18552
R677	82Ω			730
R678	1k2			2087
R679	8k2			314
R680	2k2			425
R681	680Ω			309
R682	1k2			2087
R683	2k7			311
R684	8k2			314
R685	1k5	High Stab.Met.Ox.	2	26733
R686	2k4	High Stab.Met.Ox.	2	26729
R687	8k2	High Stab.Met.Ox.	2	28798
R688	22k			1544
R689	47Ω			727
R690	4k7			386
R691	2k7			311
R692	22k			1544
R693	22k			1544
R694	2k2	High Stab.Met.Ox.	2	26730
R695	1k	Plessey MPD/PC		26870
R696	1k2			2087
R697	4k7			386
R698	680Ω			309
R699	2k7			311
R700	4k7			386
R702	680Ω			309
R702	100Ω			11504
R703	4k7			386
R704	3k3			1638
R705	100Ω			11504
R706	2k2			425
R707	1k5			385
R708	2k2	Plessey MPD/PC		24561
R709	100Ω			11504
R710	6k8			313
R711	10M	Carbon	10 ½W	1179
R713	13k	High Stab.Met.Ox.	2	28803

"B" TIMEBASE OS3000 (Cont.)

RESISTORS (Carbon Film ±5% $\frac{1}{8}$W unless otherwise stated (cont.)

Ref	Value	Description	Tol%±	Part No
R714	100Ω			11504
R715	22k	Control Pot.		A4/31510
R716	8k2			314
R717	3k9			312
R718	4k3	High Stab.Met.Ox.	2	26723
R719	3k9			312
R720	10k			11503
R721	6k8			313
R722	47k			318
R723	100Ω			11504
R724	4k7			386
R725	1k			384
R726	220Ω			304
R727	470Ω			1373
R728	10k	High Stab.Met.Ox.	2	28800
R729	10Ω			2259
R730	470Ω	Plessey MPD/PC		28524
R731	2k7	High Stab.Met.Ox.	2	26728
R732	214Ω	Met.Film Welwyn 4034G	1	32248
R733	47Ω			727
R734	4k7			386
R735	1k			384
R736	680Ω			309
R737	47Ω			727
R738	3k9			312
R739	5k6			787
R740	470Ω			1373
R741	100k			319
R742	3k9			312
R743	5k6			787
R744	1k	Control Pot.10 Turn		A4/31264
R745	4.7Ω			29433
R746	470Ω			1373
R756	470Ω			1373
R757	33Ω			1685

CAPACITORS

Ref	Value	Description	Tol%±		Part No
C601	4.7pF	Silver Mica	½pF		4502
C602	220pF	Ceramic Disc	10	500V	22379
C603	10pF	Ceramic Disc	10	500V	22364
C604	10pF	Ceramic Disc	10	500V	22364
C605	100pF	Ceramic Disc	10	500V	22376
C606	8.2pF	Ceramic Disc	10	500V	22363
C607	10pF	Ceramic Disc	10	500V	22364
C608	.01µF	Ceramic Disc	25	250V	22395
C609	47pF	Ceramic Disc	10	500V	22372
C610	470pF	Ceramic Disc	10	500V	22383
C611	.47µF	Ceramic Disc	10	160V	31381
C612	.01µF	Ceramic Disc	25	250V	22395
C613	.1µF	Silver Ceramic	+80 −25	30V	19647
C614	.1µF	Silver Ceramic	+80 −25	30V	19647
C615	.1µF	Silver Ceramic	+80 −25	30V	19647
C616	1000pF	Ceramic Disc	10	500V	22387
C617	1000pF	Ceramic Disc	10	500V	22387
C618	1000pF	Ceramic Disc	10	500V	22387
C619	390pF	Ceramic Disc	10	500V	22382
C620	22pF	Ceramic Disc	10	500V	22368
C621	.01µF	Ceramic Disc	25	250V	22395
C622		Not used			
C623	.01µF	Ceramic Disc	25	250V	22395
C624	.01µF	Ceramic Disc	25	250V	22395
C625	.01µF	Ceramic Disc	25	250V	22395
C626	22pF	Ceramic Disc	10	500V	22368
C627	10pF	Ceramic Disc	10	500V	22364
C628	18pF	Ceramic Disc	10	500V	22367
C629	18pF	Ceramic Disc	10	500V	22367
C630	33pF	Ceramic Disc	10	500V	22370
C631	6/25pF	Trimmer			23593
C632	4.7pF	Ceramic Disc			29649
C633	.01µF	Ceramic Disc	25	250V	22395
C634	.33µF	High Stab.Met.Ox.		160V	4539
C635	22µF	Electrolytic		25V	32181
C636	.01µF	Ceramic Disc	25	250V	22395
C637	.01µF	Ceramic Disc	25	250V	22395
C638	.01µF	Ceramic Disc	25	250V	22395
C639	.01µF	Ceramic Disc	25	250V	22395
C640	33pF	Ceramic Disc	10	500V	22370
C641	100pF	Ceramic Disc	10	500V	22376
C642	330pF	Ceramic Disc	10	500V	22381
C643	.01µ	Ceramic Disc	25	250V	22395
C644	.1µF	Silver Mica	+80 −25	30V	19647
C645	6/25pF				23593
C646	33µF	Electrolytic	+50 −10	16V	32173
C647	.1µF	Silver Mica	+80 −25	30V	19647
C648	.01µF	Ceramic Disc	25	250V	22395
C649	1000pF	Ceramic Disc			22387
C654	5.6pF	Ceramic			22361
C656	0.01µF	Ceramic Disc			22395

TRANSISTORS

Ref	Description	Part No
TR601	2N2369/BSX20	23307
TR602	2N2369/BSX20	23307
TR603	2N930	21548
TR604	2N3906	21533
TR605	2N930	21548
TR606	2N3906	21533
TR607 / TR608	AE13 Matched Pair	A31254
TR609	MPS3640	24128
TR610	MPS3640	24128
TR611	2N2369/BSX20	23307
TR612	2N2369/BSX20	23307
TR613	2N2369/BSX20	23307
TR614	AE13 Matched pair with TR617	31254
TR616	2N3906	21533
TR617	AE13 See TR614	21533
TR619	2N3906	21533
TR620	2N2369/BSX20	23307

"B" TIMEBASE OS3000 (Cont.)

Ref	Value	Description	Tol%±	Part No
TR622		AE15		A32067
TR623		BC108		26110
TR624		BC108		26110
TR625		BC108		26110
TR626		2N3906		21533
TR627		BC107		26790
TR628		MPS3640		24128
TR629		2N3906		21533
TR630		2N2369/BSX20		23307
TR631		2N2369/BSX20		23307
TR632		BC108		26110
DIODES				
D600		1N3595		29330
D601		1N4148		23802
D602		1N4148		23802
D603		1N4148		23802
D604		1N4148		23802
D605		1N4148		23802
D606	6V8	Zener	5	4666
D607	8V2	Zener	5	3798
D608		1N4148		23802
D609		1N4148		23802
D610		1N4148		23802
D611		1N4148		23802
D612		1N4148		23802
D613		1N3595		29330
D614		1N4148		23802
D615		1N4148		23802
D616		1N4148		23802
D617		1N4148		23802
D618		1N4148		23802
D619		1N4148		23802
D620		1N4148		23802
D621		1N4148		23802
D622		1N4148		23802
D623		1N4148		23802
D624		1N4148		23802
D625		1N4148		23802
D626		1N4148		23802
D627		1N4148		23802
D628		1N4148		23802
D629		1N4148		23802
D630		1N4148		23802
D631		1N4148		23802
D632		1N916		1949
D633		1N916		1949
MISCELLANEOUS				
L601		FX1242 Ferrite		26986
S50		Switch Lever		A3/32309
S70		Switch Rotary		31487
S71		With R631		31486
S72		Switch Lever		A3/31265

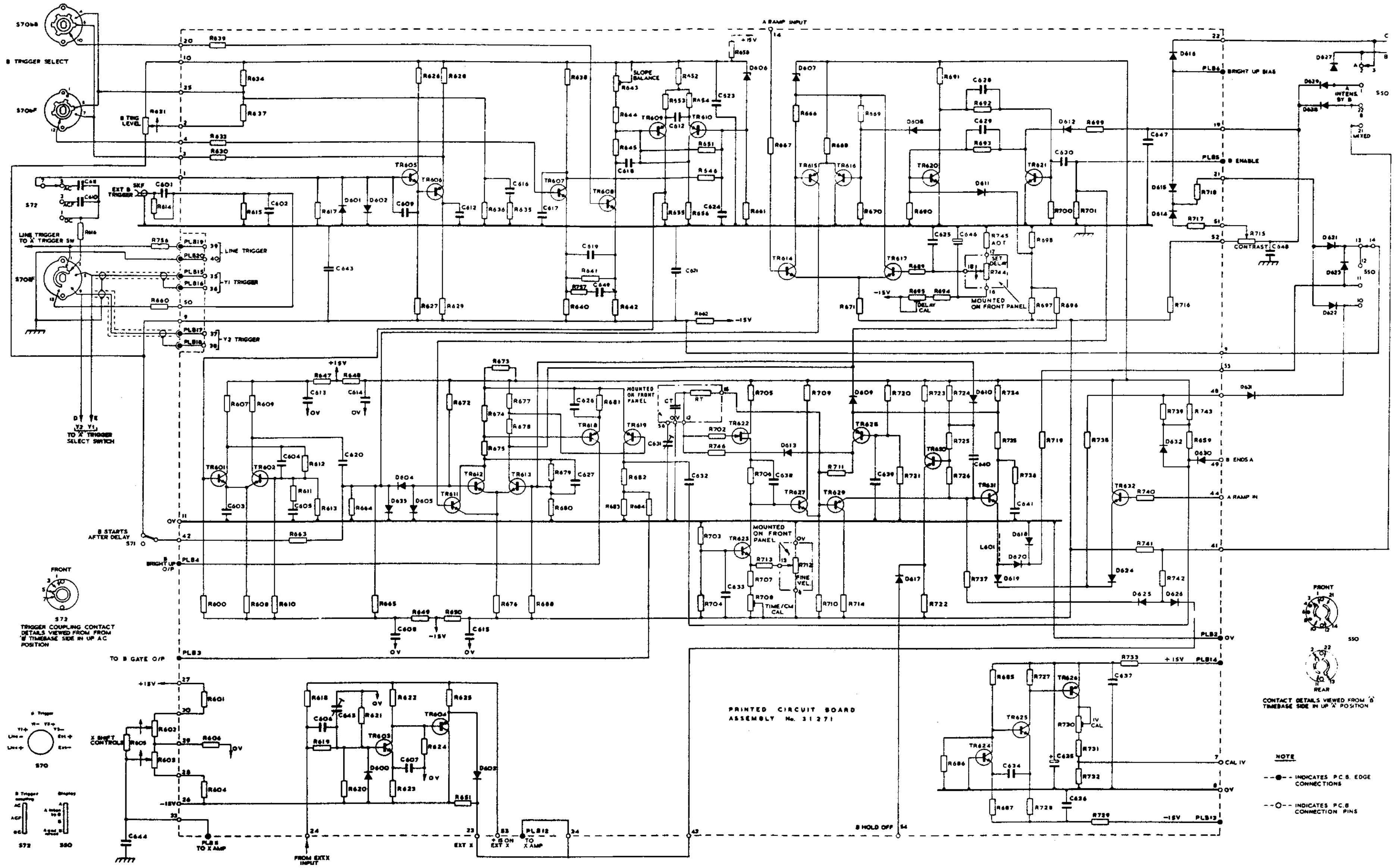


Fig. 6 Circuit Diagram, B Timebase, AO/SK 2314

BRIGHT-UP + Z MOD. OS3000

Ref	Value	Description	Tol%±		Part No
RESISTORS (Carbon Film ±5% ⅛W unless otherwise stated)					
R903	22k	Carbon Film	5	½W	18566
R904	470Ω				1373
R905	47k				318
R906	10k				11503
R907	39k				1639
R908	2k2	Carbon Film	5	½W	18554
R909	4k3	High Stab.Met.Ox.	2		26723
R910	10Ω				2259
R911	680Ω				309
R912	4k7				386
R913	5k6				787
R914	47Ω				727
R915	9k1	High Stab.Met.Ox.	2		28799
R916	100Ω				11504
R917	1k8	Carbon Film	5	½W	18553
R918	10k				11503
R919	15k	High Stab. Met. Ox.	2		28804
R920	82k	Carbon Film	5	½W	18573
R921	27k	Carbon Film	5	1W	19054
R922	10Ω				2259
R923	47k				318
R924	10Ω				2259
R925	10Ω				2259
R926	10k				11503
R927	100Ω				11504
R928	1M	Plessey MPD/PC			26867
R929	1M				766
R930	3M3	Carbon Film	5	½W	30278
R031	3M3	Carbon Film	5	½W	30278
R932	3M3	Carbon Film	5	½W	30278
R933	3M3	Carbon Film	5	½W	30278
R934	10k				11503
R935	100k				319
R936	47k				318
R937	100k				319

Ref	Value	Description	Tol%±		Part No
CAPACITORS					
C901	220pF	Disc Ceramic	10	500V	22379
C902	.01μF	Disc Ceramic	25	250V	22395
C903	.01μF	Disc Ceramic	25	250V	22395
C904	820pF	Disc Ceramic	10	500V	22386
C905	.7/3pF	Trimmer			31221
C906	.01μF	Polyester Film		2kV	32066
C907	0.1μF	Met. Polyester		160V	2740
C908	.01μF	Disc Ceramic	25	250V	22395
C909	.01μF	Disc Ceramic	25	250V	22395
C910	.01μF	Disc Ceramic	25	250V	22395
C911	.01μF	Polyester Film		2kV	32066
C912	2200pF	Disc Ceramic	20	500V	22389
C913	.01μF	Polyester Film		2kV	32066
C914	2.7pF	Silver Mica	½pF		816
TRANSISTORS					
TR901		BC108			26110
TR902		2N2369/BSX20			23307
TR903		BCY70			23354
TR904		BC107			26790
DIODES					
D901		IN4148			23802
D902		IN4148			23802
D903		IN4148			23802
D904		IN4148			23802
D905		IN4148			23802
D906		IN4148			23802
D907		IN4148			23802
D908		IN916			1949
D909		IN916			1949
D910		IN4148			23802
MISCELLANEOUS					
L901		Ferrite FX1242			26986
N901		Hivac 34H			26845
N902		Hivac 34H			26845

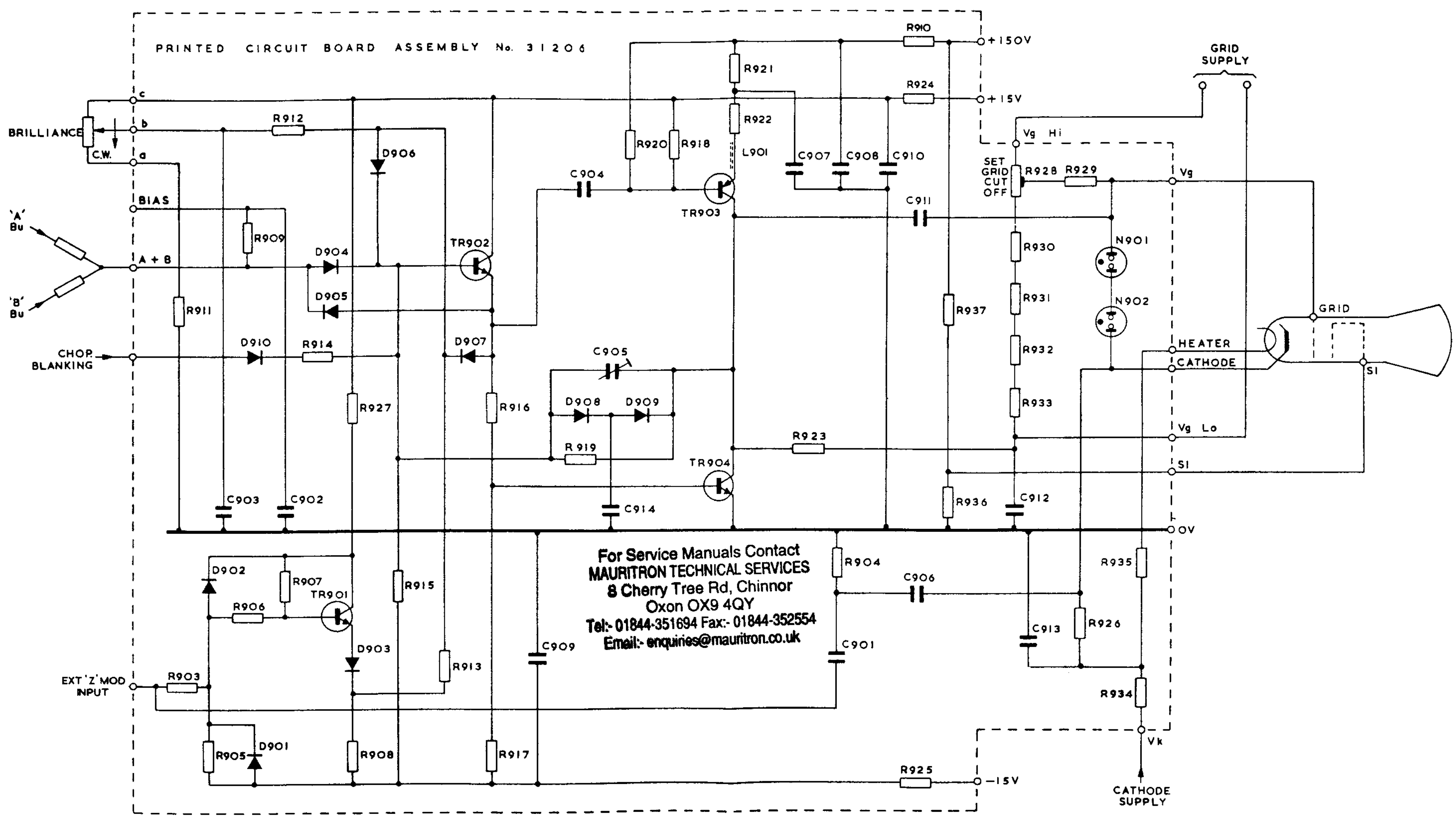


Fig. 7 Circuit Diagram, Bright-up and Z mod, AO/SK 2319

'X' O/P AMP OS3000

Ref	Value	Description	Tol%±	Part No
RESISTORS (Carbon Film ±5% ⅛W unless otherwise stated)				
R951	4k7	High Stab.Met.Ox.	2	26722
R952	4k7	High Stab.Met.Ox.	2	26722
R953	3k9			312
R954	330Ω			1894
R955	33Ω			2931
R956	33Ω			2931
R957	100Ω			11504
R958	47Ω			727
R959	47k			318
R962	3k3			1638
R963	4k7			386
R964	100Ω			11504
R965	680Ω			309
R966	1k5			385
R967	68Ω			1640
R968	1k5			385
R969	100Ω	Erie Type BI/IS		33700
R971	1.5k			385
R972	1k	Erie Type BI/IS		33699
R973	470Ω			1373
R974	750Ω	High Stab.Met.Ox.	2	28790
R975	470Ω			1373
R976	3k9	Welwyn F77 Oxide	5 8W	31244
R979	3k9	Welwyn F77 Oxide	5 8W	31244
R981	1k			384
R982	180Ω			1517
R983	33Ω			2931
R984	300Ω	Carbon Film	5 ½W	28788
R985	2k2			425
R986	300Ω	Carbon Film	5 ½W	28788
R987	100Ω			11504
R988	100Ω			11504
R989	10Ω			2259
R990	100Ω			11504
R992	100Ω			11504
R993	6k8			313

Ref	Value	Description	Tol%±		Part No
CAPACITORS					
C951	.01μF	Disc Ceramic	25	250V	22395
C952	.01μF	Disc Ceramic	25	250V	22395
C953	560pF	Polystyrene		125V	33248
C954	.01μF	Disc Ceramic	25	250V	22395
C955	.01μF	Disc Ceramic	25	250V	22395
C956	.1μF	Silver Ceramic	+80 −25	30V	19647
C957	.01μF	Disc Ceramic	25	250V	22395
C958	.01μF	Disc Ceramic	25	250V	22395
C959	.01μF	Disc Ceramic	25	250V	22395
C961	.1μF	Met.Polyester	10	160V	31377
C962	220pF	Disc Ceramic	10	500V	22379
C963	47μF	Electrolytic	+50 −10	25V	32182
C964	47μF	Electrolytic	+50 −10	25V	32182
C965	10μF	Disc Ceramic			22364
C966	150pF	G.P. Ceramic			22378
TRANSISTORS					
TR951		BC107			26790
TR952		2N3906			21533
TR953		2N3906			21533
TR954		2N3906			21533
TR955		2N3906			21533
TR956		BF258			31490
TR957		BF258			31490
TR958		2N2369/BSX20			23307
TR959		2N2369/BSX20			23307
TR960		BSX20			23307
TR961		BSX20			23307
DIODES					
D952		IN4148			23802
D953		IN4148			23802
D954		IN4148			23802
D955		IN4148			23802
MISCELLANEOUS					
SKA		15 Way			A3/31240
SKB		20 Way			A3/31241

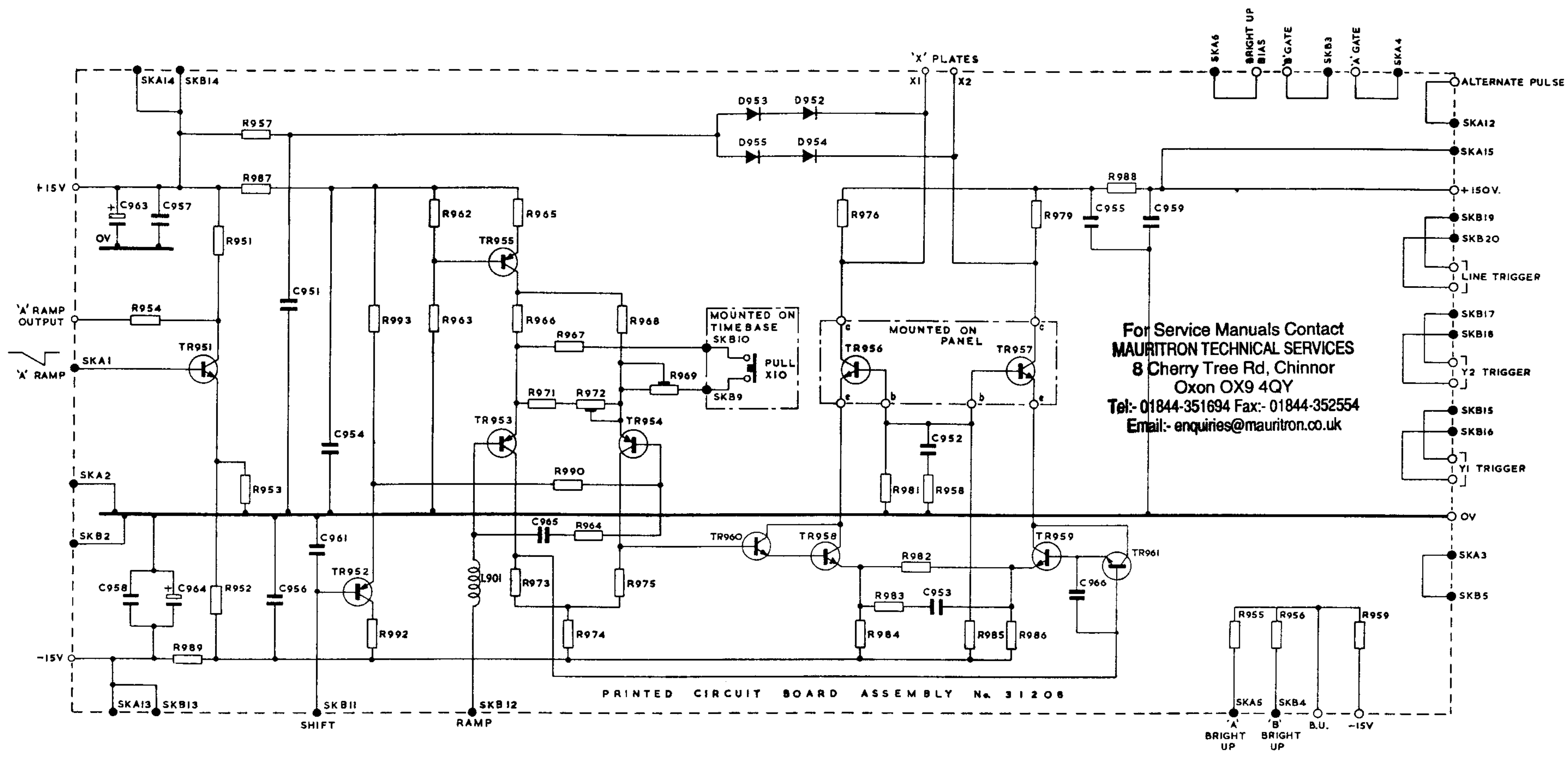


Fig. 8 Circuit Diagram, X Output Amplifier, AO/SK 2321

Component List and Illustrations

Section 6

POWER SUPPLY OS3000

Ref	*Value*	*Description*	*Tol%±*	*Part No*
RESISTORS				
R83	68k	Carbon Film	5 ⅛W	1636
R84	47Ω	Wirewound	5 6W	18739
R831	22Ω	Carbon Film	5 1W	19028
R832	470Ω	Carbon Film	5 ⅛W	1373
R833	180Ω	Carbon Film	5 ⅛W	1517
R834	3k3	Carbon Film	5 ⅛W	1638
R835	1Ω	Wirewound	5 6W	239
R836	0.82Ω	Wirewound	5 6W	18006
R837	7k5	High Stab.Ox.	2	28797
R838	1k	Plessey MPD/PC		26870
R839	6k8	High Stab.Met.Ox.	2	28796
R840	820Ω	Carbon Film	5 ⅛W	1637
R841	2k7	Carbon Film	5 1W	19043
R842	39k	High Stab. Met. Ox.	2 1W	33286
R843	3k6	High Stab.Met.Ox.	2	26725
R844	4k7	Carbon Film	5 ⅛W	386
R845	1k	Carbon Film	5 ⅛W	384
R846	4k7	Carbon Film	5 ⅛W	386
R847	7k5	High Stab.Met.Ox.	2	28797
R848	7k5	High Stab.Met.Ox.	2	28797
R849	100Ω	Carbon Film	5 ⅛W	11504
R850	1k	Plessey WMP/PC		27156
R851	100k	Plessey MPD/PC		26582
R852	120Ω	Carbon Film	5 ⅛W	735
R854	10k	Plessey MPD/PC		28525
R855	3k3	Carbon Film	5 ⅛W	1638
R856	100Ω	Carbon Film	5 ⅛W	11504
R857	100Ω	Carbon Film	5 ⅛W	11504
R858	1M	Min.Carb.Film	5 ⅛W	766
CAPACITORS				
C83	100 + 200μF	CCL.EN61/S	275V	24740
C84	4000μF	Mullard C431	40V	4851
C85	4000μ	Mullard C431	40V	4851
C86	100 + 200μF	CCL EN61/S	275V	24740

Ref	*Value*	*Description*	*Tol%±*	*Part No*
C831	5μF	Mullard C426	+50 −10 64V	20773
C832	100pF	Disc Ceramic	10 500V	22376
C833	.01μF	Disc Ceramic	25 250V	22395
C834	3300pF	Disc Ceramic	20 500V	22391
C835	5μF	Mullard C426	+50 −10 64V	20773
C836	.01μF	Disc Ceramic	25 250V	22395
C837	.01μF	Disc Ceramic	25 250V	22395
DIODES				
D83		IN4003		23462
D84		IN4003		23462
D831		IN4148		23802
D832		IN4148		23802
D833		IN4148		23802
D834		IN4148		23802
D835		IN4003		23462
D836		IN4003		23462
TRANSISTORS				
TR831		2N3905		20818
TR832		2N2369/BSX20		23307
TR833		BC108		26110
TR834		BC108		26110
TR835		MM1614		19320
TR836		MM1613		19323
TR837		MJE520		24739
TR838		MJE520		24739
TR839		2N5296		28639
MISCELLANEOUS				
MR81		W04		29367
MR82		IN4003		23462
MR83		W02		19725
IC831		μA 723C		31228
T83		Transformer, Supply		31924
S81		Switch, Voltage Select.		29547
FS81 } FS82 }		Fuse 1½ Amp Size '0'		141
FS83		Fuse 1 Amp 'Slow-Glo' Size '0'		21619
FS831		Fuse 250mA Size '00'		19815
FS832		Fuse 500mA Size '00'		5119

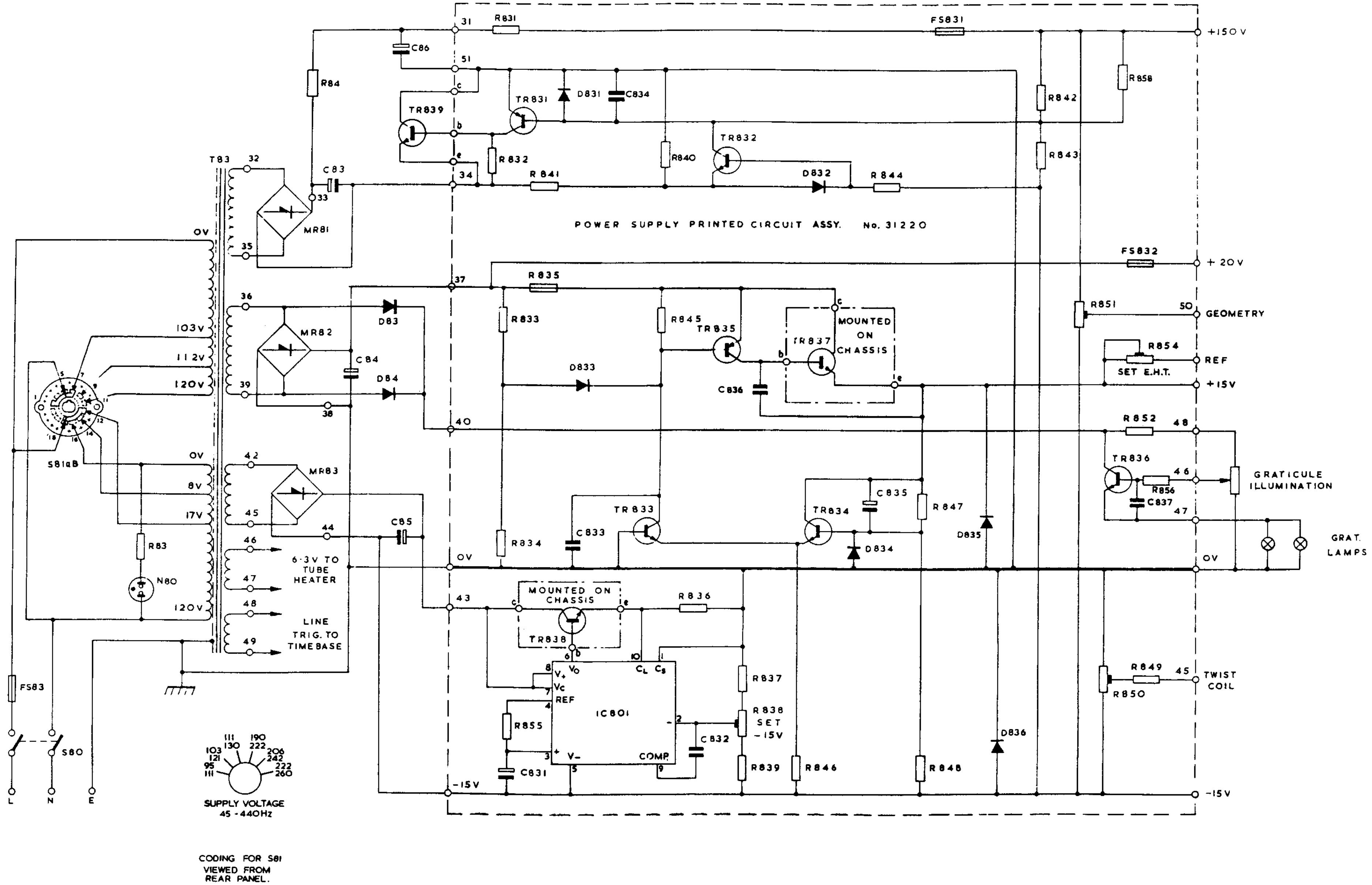


Fig. 9 Circuit Diagram, Power Supply, AO/SK 2318

Component List and Illustrations

Section 6

EHT SUPPLY OS3000

Ref	*Value*	*Description*	*Tol%±*	*Part No*
RESISTORS				
R801	1M	Carbon Film	5 ⅛W	766
R802	2M2	Welwyn C25 Carbon Film	5 2W	31237
R803	390k	Carbon Film	5 ½W	18581
R811	120Ω	Carbon Film	5 ⅛W	735
R812	2k2	Carbon Film	5 ½W	18554
R813	1k	Carbon Film	5 ⅛W	384
R814	1Ω	Wirewound	5 3W	31890
R815	2k7	Carbon Film	5 ⅛W	311
R816	27k	Carbon Film	5 ⅛W	316
R817	47k	Carbon Film	5 ⅛W	318
R818	390Ω	Wirewound	5 3W	26766
R819	470Ω	Carbon Film	5 ⅛W	1373
R820	470Ω	Carbon Film	5 ⅛W	1373
R822	10Ω	Carbon Film	5 ⅛W	2259
R823	1k	Carbon Film	5 ⅛W	384
CAPACITORS				
C801	500pf	Erie CHV 417	8KV	26862
C802	500pF	Erie CHV 417	8KV	26862
C803	500pF	Erie CHV 417	8KV	26862
C804	4700pF	Erie K600041 CDB	4KV	26863
C805	.02μF	Erie CP3E	1.5KV	25223
C806	470pF	Thompson CSF 015	12.5KV	31239
C807	4700pF	Erie K600041	4KV	26863
C808	.02μF	Erie CP3E	1.5KV	25223
C809	1000pF	Ceramic Disc	10 500V	22387
C812	12μF	Mullard 121-16129	25V	31238

Ref	*Value*	*Description*	*Tol%±*	*Part No*
C813	.01μF	Ceramic Disc	25 250V	22395
C814	.01μF	Ceramic Disc	25 250V	22395
C815	10μF	Electrolytic	25V	32180
C816	.01μF	Ceramic Disc	25 250V	22395
C817	33μF	Electrolytic	16V	32173
C818	0.1μF	Met-Polyester		31394
TRANSISTORS				
TR811		BC107		26790
TR812		BCY70		23354
TR813		MJE520		24739
TR814		BFY50		26112
TR815		BFY50		26112
TR816		2N3905		20818
DIODES				
D801		BY187		31817
D802		BY187		31817
D803		BY187		31817
D804		BY187		31817
D805		BY187		31817
D811		IN4148		23802
D812		IN4148		23802
D813		IN4148		23802
D814		IN4148		23802
MISCELLANEOUS				
T801		Transformer E.H.T.		A3/31334
L801	150μH	Cambion 551-7109-39		34216

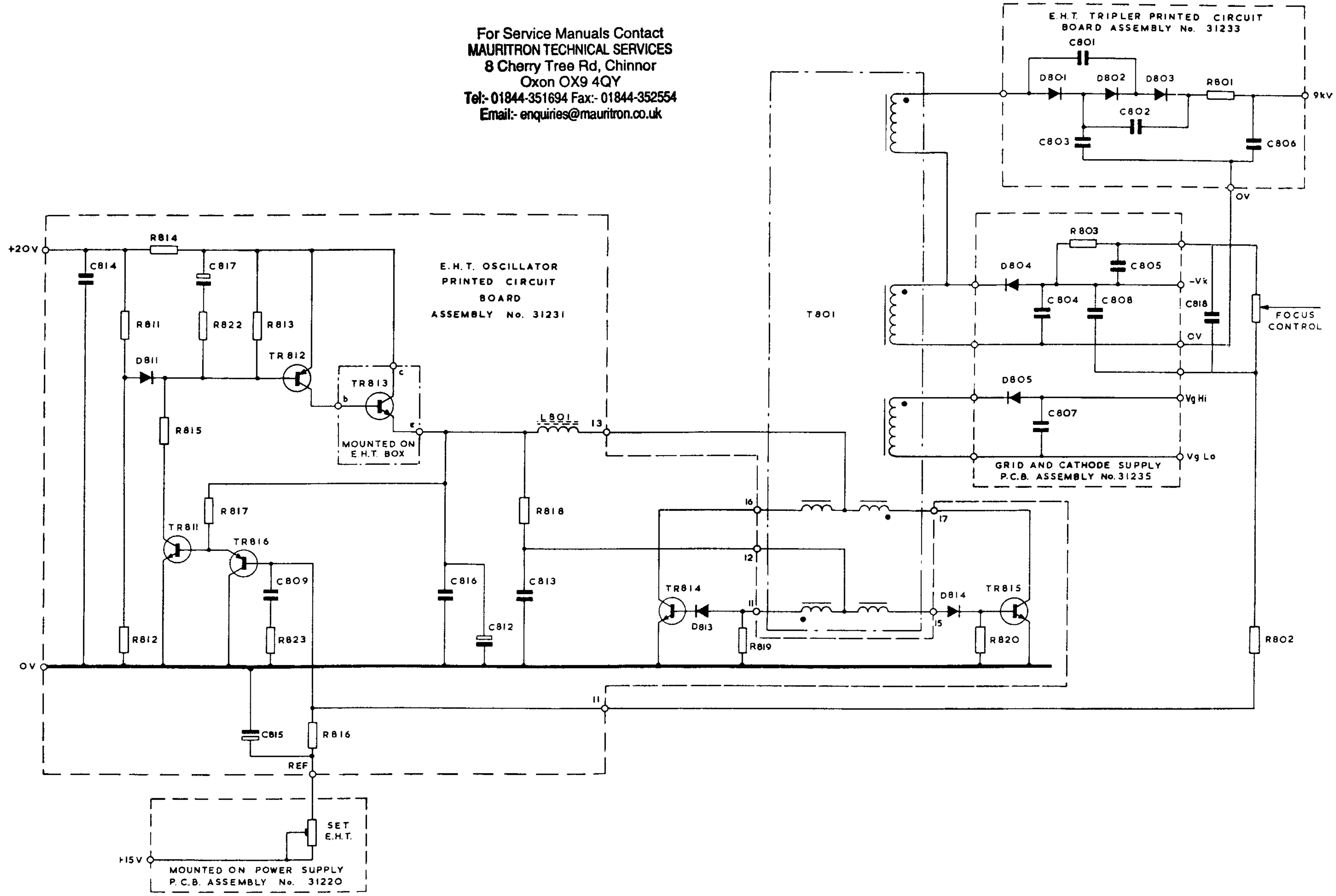


Fig. 10 Circuit Diagram, EHT Supply, A1/SK 2320

INTERCONNECTION OS3000

Ref	*Value*	*Description*	*Tol%±*		*Part No*
RESISTORS					
R28	100Ω	Carbon Film	5	1/8W	11504
R29	100Ω	Carbon Film	5	1/8W	11504
R30	100Ω	Carbon Film	5	1/8W	11504
R31	100Ω	Carbon Film	5	1/8W	11504
R60	4k7	Control Pot. with S80			A4/31224
R80	470k	Control Pot.			A4/31222
R81	100k	Control Pot.			A4/31225
R82	4k7	Control Pot.			A4/31223
R507	10k	Control Pot. with S74			31281
R561	10M	Welwyn 4016Z	1		27305
R562	4M99	Welwyn 4035G	1		29470
R563	3M01	Welwyn 4034G	1		29478
R564	1M	Welwyn 4014G	1		26346
R565	499k	Welwyn 4014G	1		26342
R566	301k	Welwyn 4034G	1		29477
R567	100k	Welwyn 4034G	1		29476
R568	49k9	Welwyn 4034G	1		29475
R569	30k1	Welwyn 4034G	1		31261
R570	20k	Welwyn 4014C	1		27917
R712	10k	Control Pot.			31279
R747	4M99	Welwyn 4035G	1		29470
R748	3M01	Welwyn 4034G	1		29478
R749	1M	Welwyn 4014G	1		26346
R750	499k	Welwyn 4014G	1		26342
R751	301k	Welwyn 4034G	1		29477
R752	100k	Welwyn 4034G	1		29476
R753	49k9	Welwyn 4034G	1		29475
R754	30k1	Welwyn 4034G	1		31261
R755	20k	Welwyn 4014C	1		27917
CAPACITORS					
C456	68pF	Silver Mica			4513
C457	1µF	Metallised Polyester	1	160V	24888
C458	.1µF	Metallised Polyester	1	160V	24887

Ref	*Value*	*Description*	*Tol%±*		*Part No*
C459	.01µF	Metallised Polyester	1	160V	24886
C460	900pF	Metallised Polyester	1	125V	24885
C461	100pf		10	500V	22376
C649	1µF	Metallised Polyester	1	160V	24888
C650	.1µF	Metallised Polyester	1	160V	24887
C651	.01µF	Metallised Polyester	1	160V	24886
C652	900pF	Metallised Polyester	1	125V	24885
C653	56pF	Silver Mica			30544
MISCELLANEOUS					
L83		Coil CRT Twist			A3/31329
ILP83		L.E.S. 14V 0.56W			24910
ILP84		L.E.S. 14V 0.56W			24910
V83		CRT D14-121GH			31210
	or	CRT D14-121GM (Long Persistence)			32259
TP600		Terminal Lead Thru'			24159
S12		Part of R26			
S22		Part of R27			
S31		Switch Rotary			31226
S43		Switch Rotary			31280
S73		Switch Rotary			31278
S74		Part of R507			
S201		Switch slider			4069
SKD		BNC 50Ω			1222
SKG		4mm. Hirschman Bil.20			29492
SKH		4mm. Hirshman Bil.20			29492
SKJ		4mm. Hirschman Bil.20			29492
SKL		4mm. Hirschman Bil.20			29492
SKP		BNC 50Ω			1222
SKY		BNC 50Ω			1222

Welwyn 40 – series one metal film.

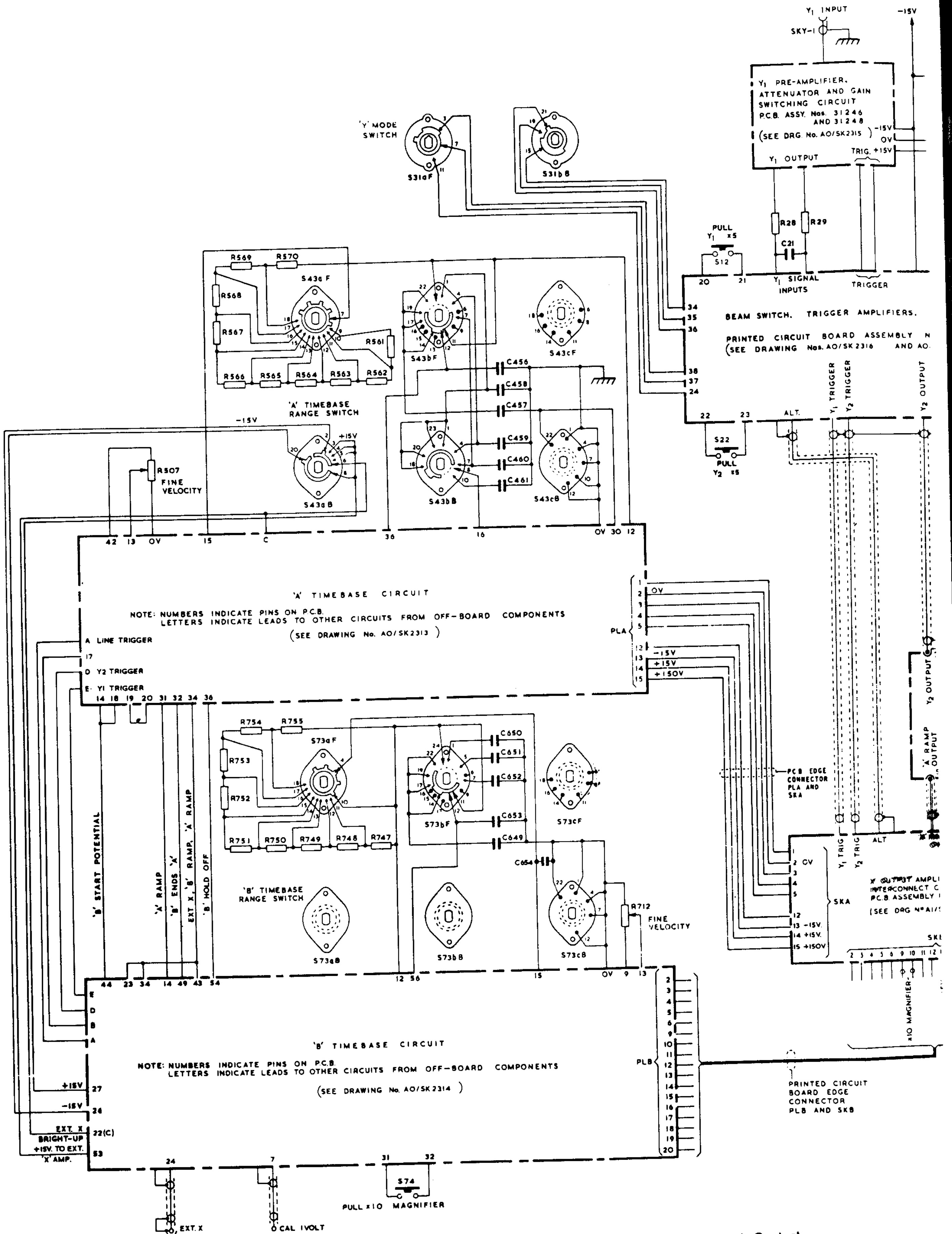
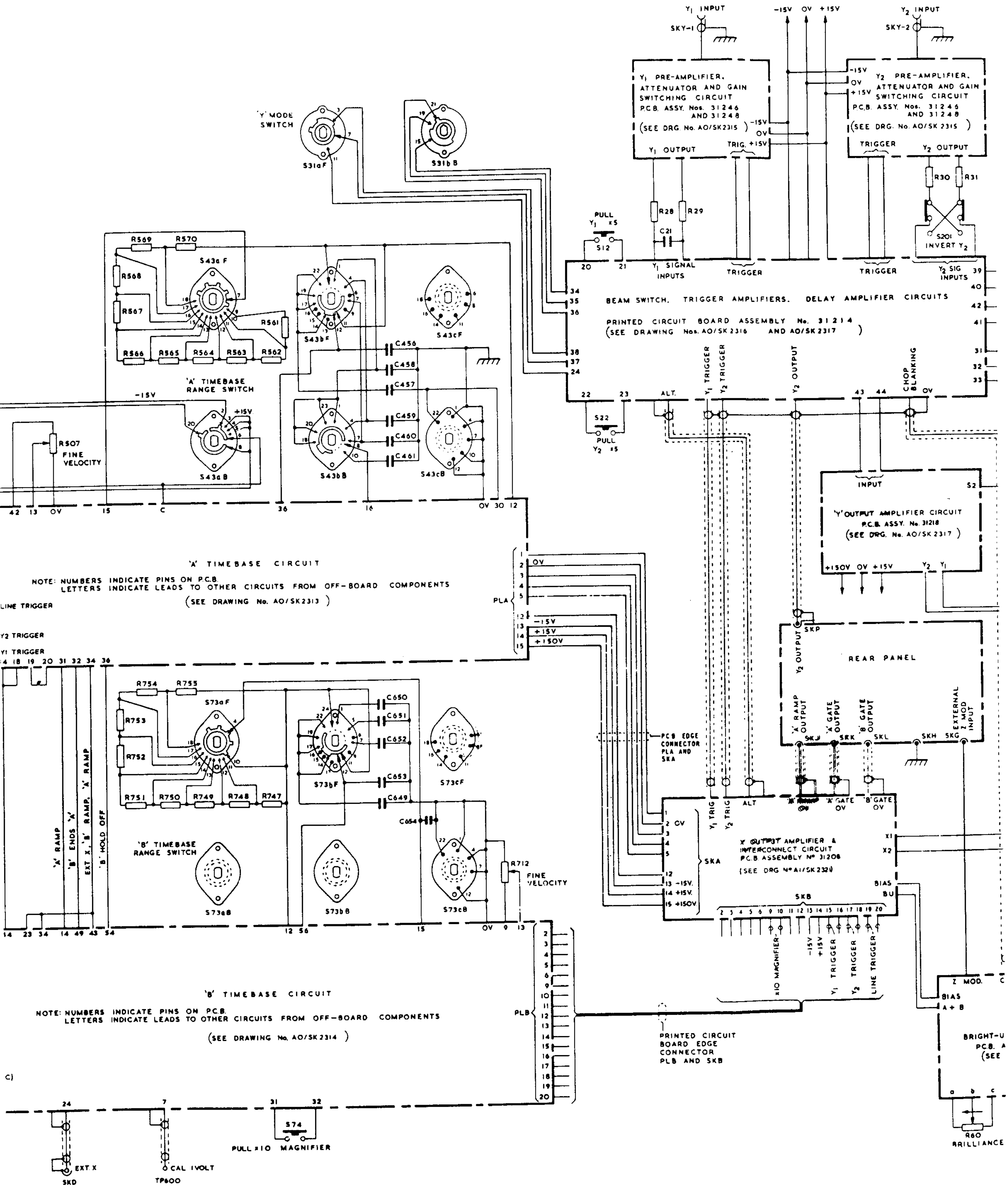
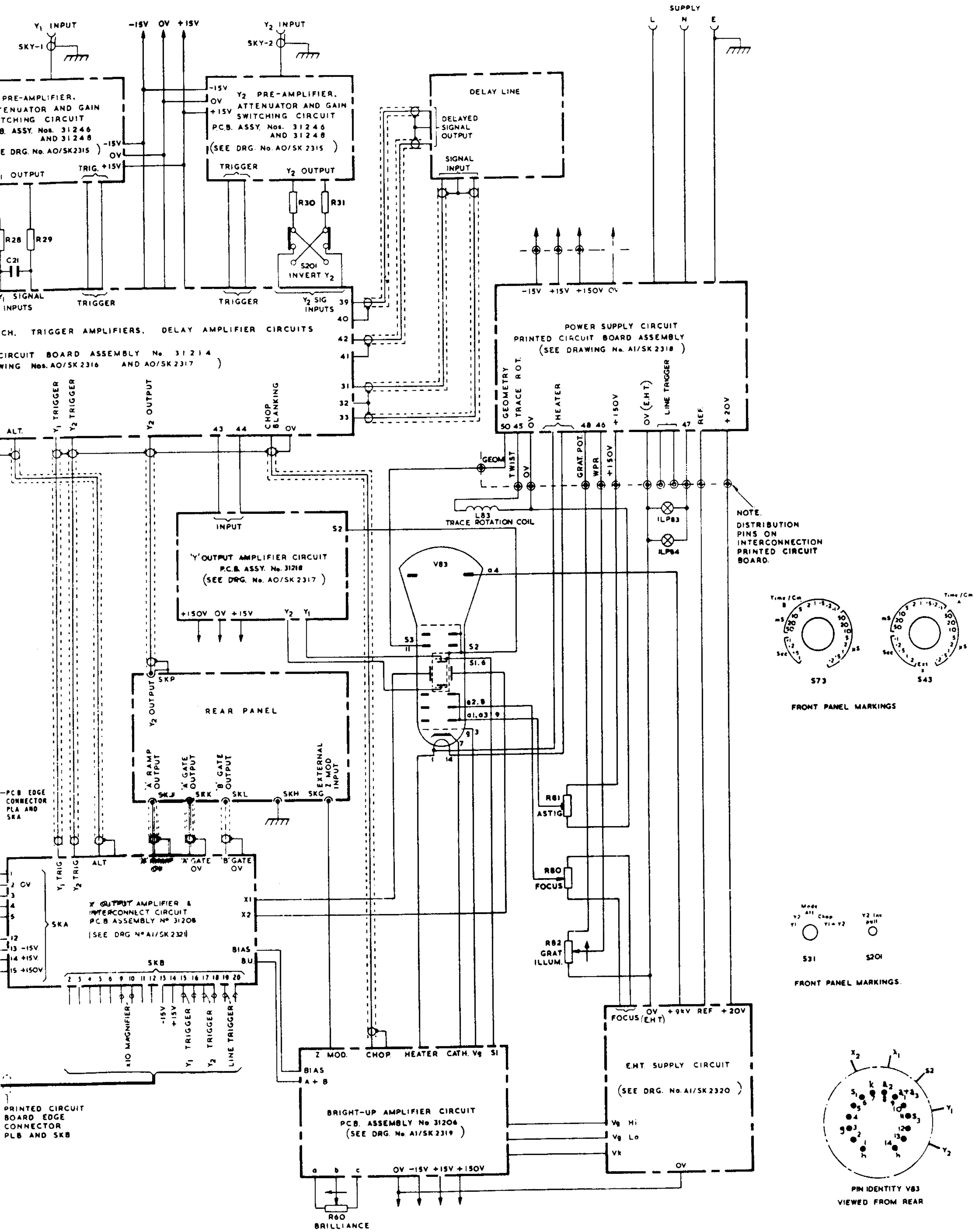


Fig. 11 Circuit Diagram, Interconnection, AO/SK 2312



Diagram, Interconnection, AO/SK 2312



Y1 INPUT
-15V OV +15V
Y2 INPUT
SKY-1
SKY-2
SUPPLY
L N E
Y2 PRE-AMPLIFIER, ATTENUATOR AND GAIN SWITCHING CIRCUIT
P.C.B. ASSY. Nos. 31246 AND 31248
(SEE DRG. No. AO/SK 2315)
DELAY LINE
DELAYED SIGNAL OUTPUT
SIGNAL INPUT
TRIGGER
Y2 OUTPUT
R30 R31
R28 R29
C21
S201 INVERT Y2
TRIGGER
Y2 SIG INPUTS
TRIGGER AMPLIFIERS, DELAY AMPLIFIER CIRCUITS
-15V +15V +150V OV
POWER SUPPLY CIRCUIT PRINTED CIRCUIT BOARD ASSEMBLY
(SEE DRAWING No. AI/SK 2318)
GEOMETRY
TRACE ROT.
HEATER
LINE TRIGGER
REF.
+20V
+150V
OV (E.H.T)
ALT.
Y1 TRIGGER
Y2 TRIGGER
Y2 OUTPUT
CHOP BLANKING
IGEOM
TWIST
GRAT POT.
WPR
L83 TRACE ROTATION COIL
ILP83
ILP84
NOTE. DISTRIBUTION PINS ON INTERCONNECTION PRINTED CIRCUIT BOARD.
INPUT
'Y' OUTPUT AMPLIFIER CIRCUIT
P.C.B. ASSY. No. 31218
(SEE DRG. No. AO/SK 2317)
+150V OV +15V
V83
S73
S43
FRONT PANEL MARKINGS
SKP
Y2 OUTPUT
REAR PANEL
'A' RAMP OUTPUT
'A' GATE OUTPUT
'B' GATE OUTPUT
EXTERNAL Z MOD INPUT
SKJ SKK SKL SKH SKG
R81 ASTIG
R80 FOCUS
R82 GRAT ILLUM.
Y1 TRIG
Y2 TRIG
ALT
'A' GATE OV
'B' GATE OV
X OUTPUT AMPLIFIER & INTERCONNECT CIRCUIT
P.C.B ASSEMBLY No 31208
(SEE DRG No AI/SK 2321)
SKA
BIAS
B.U.
SKB
X10 MAGNIFIER
-15V
+15V
Y1 TRIGGER
Y2 TRIGGER
LINE TRIGGER
S31
S201
FRONT PANEL MARKINGS.
FOCUS (E.H.T)
OV +9kV REF +20V
E.H.T. SUPPLY CIRCUIT
(SEE DRG. No. AI/SK 2320)
Vg Hi
Vg Lo
Vk
Z MOD. CHOP. HEATER CATH. Vg S1
BIAS
A + B
BRIGHT-UP AMPLIFIER CIRCUIT
PCB. ASSEMBLY No 31206
(SEE DRG. No. AI/SK 2319)
OV -15V +15V +150V
R60 BRILLIANCE
PRINTED CIRCUIT BOARD EDGE CONNECTOR PLB AND SKB
PIN IDENTITY V83 VIEWED FROM REAR

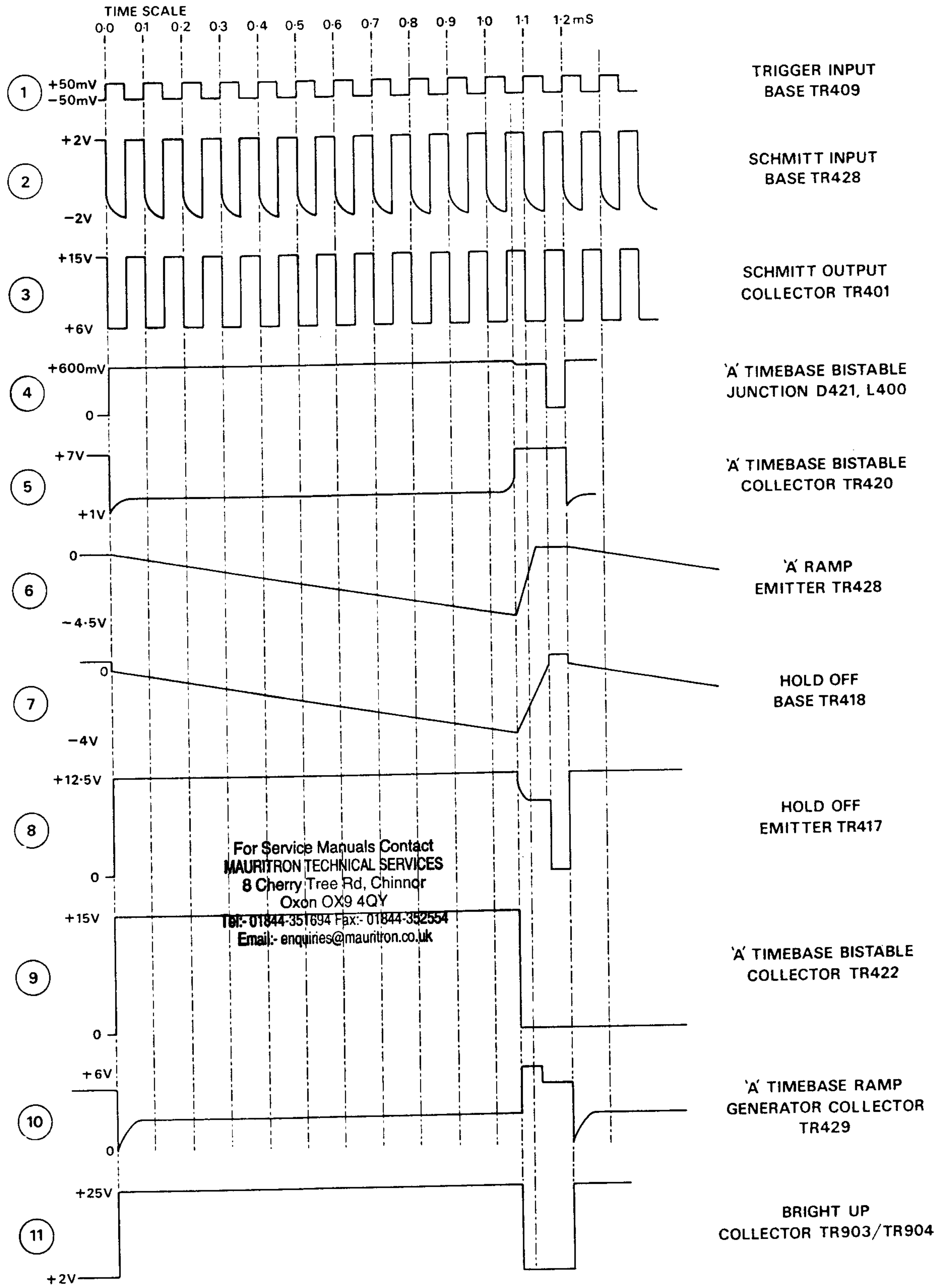


Fig. 12 Waveform Diagram Normal A Sweep

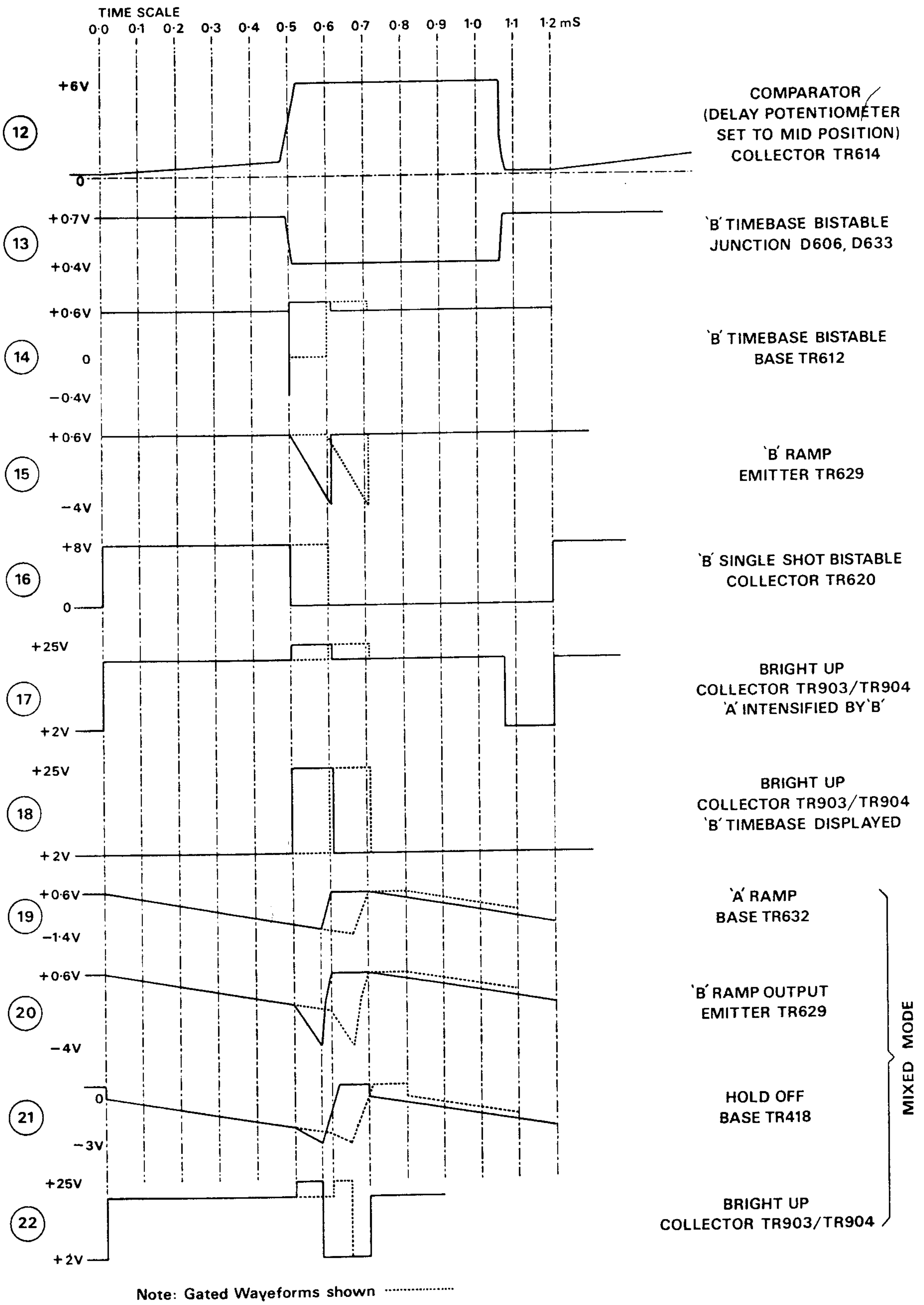


Fig. 13 Waveform Diagram Dual Timebase Operation

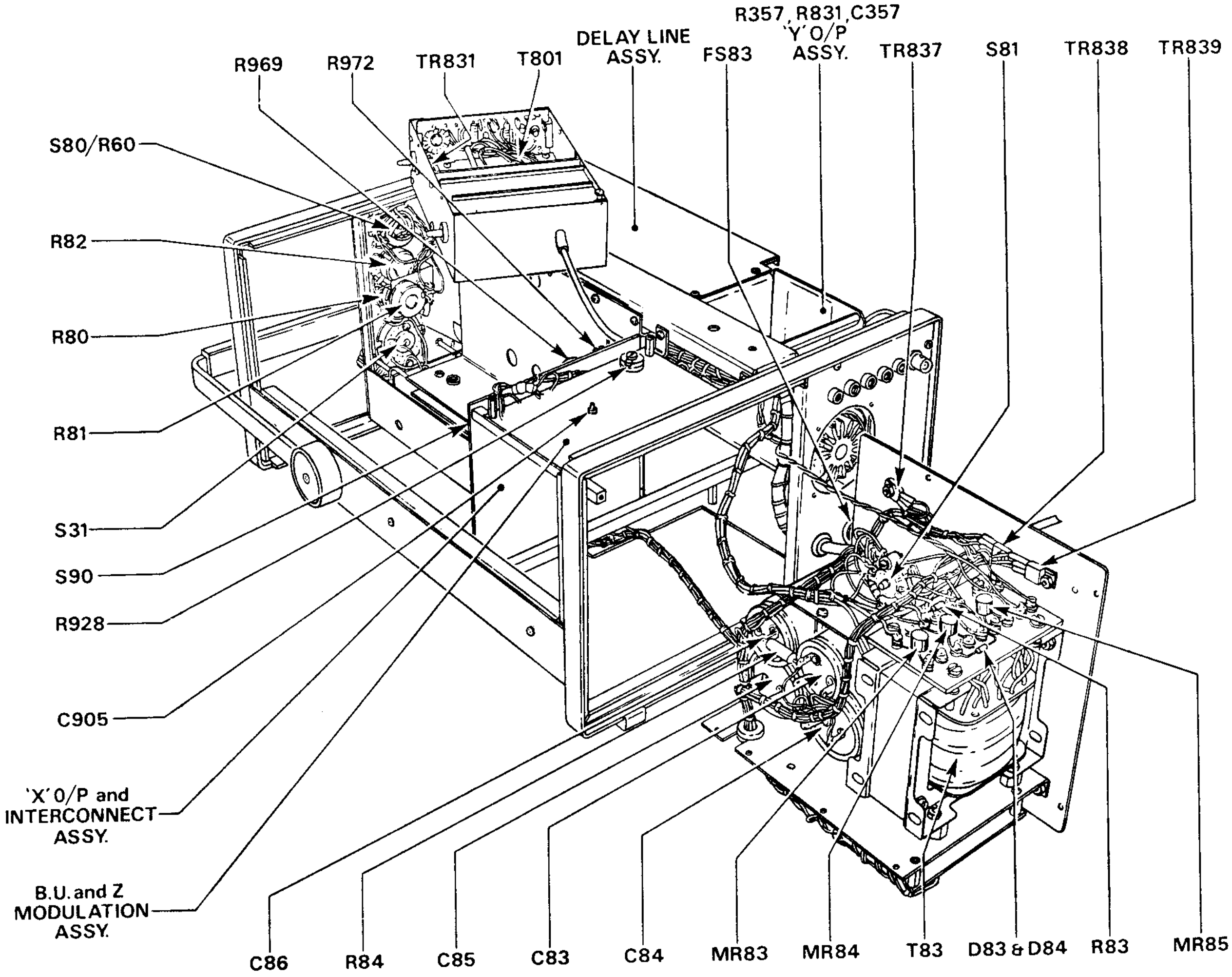
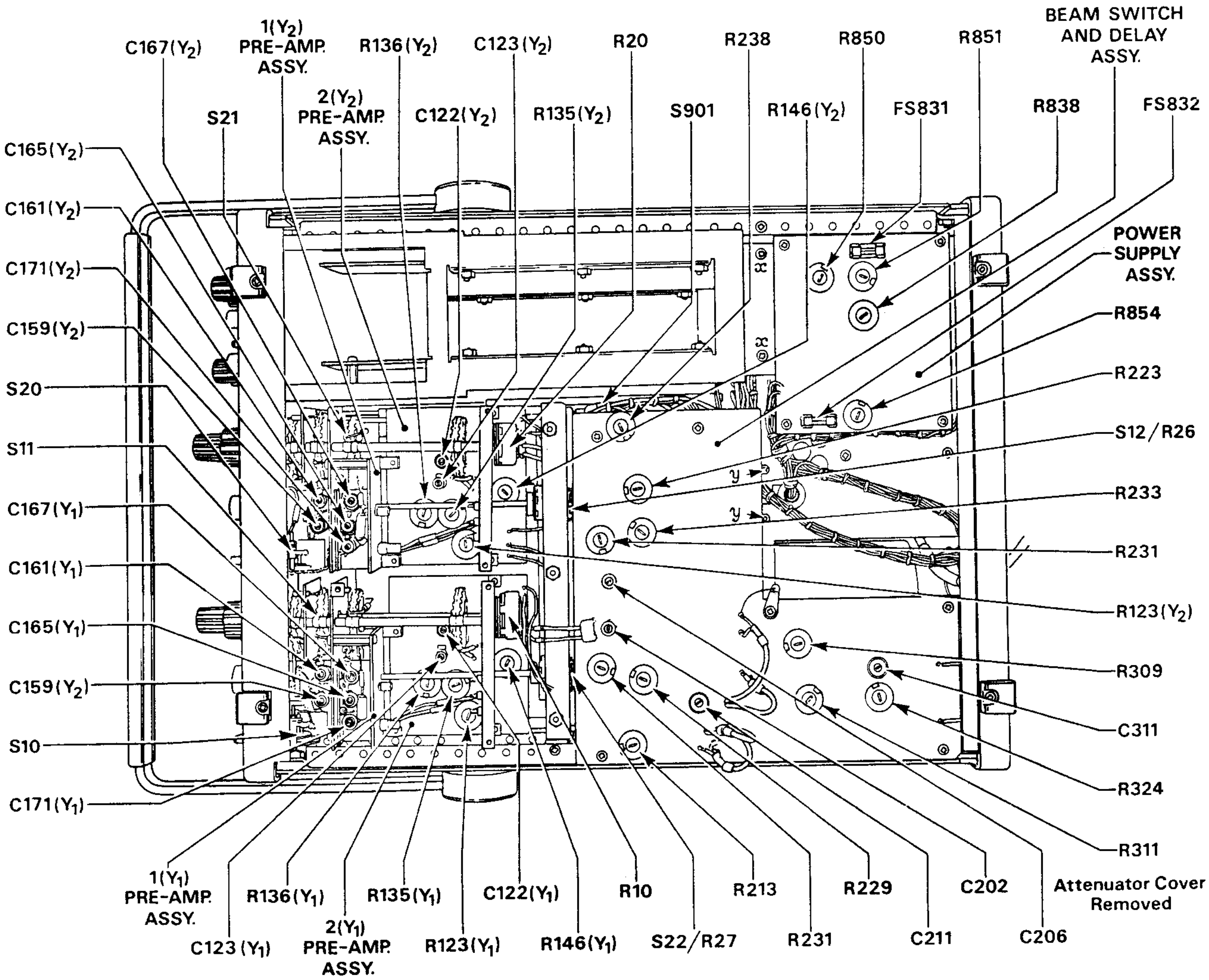


Fig. 14 Main Frame showing access to Power supply and EHT unit



Note: To remove Power Supply Assy. Remove Screws x,x and y,y. To remove Timebase Assy. Slacken Screws x,x

Fig. 15 Underside View

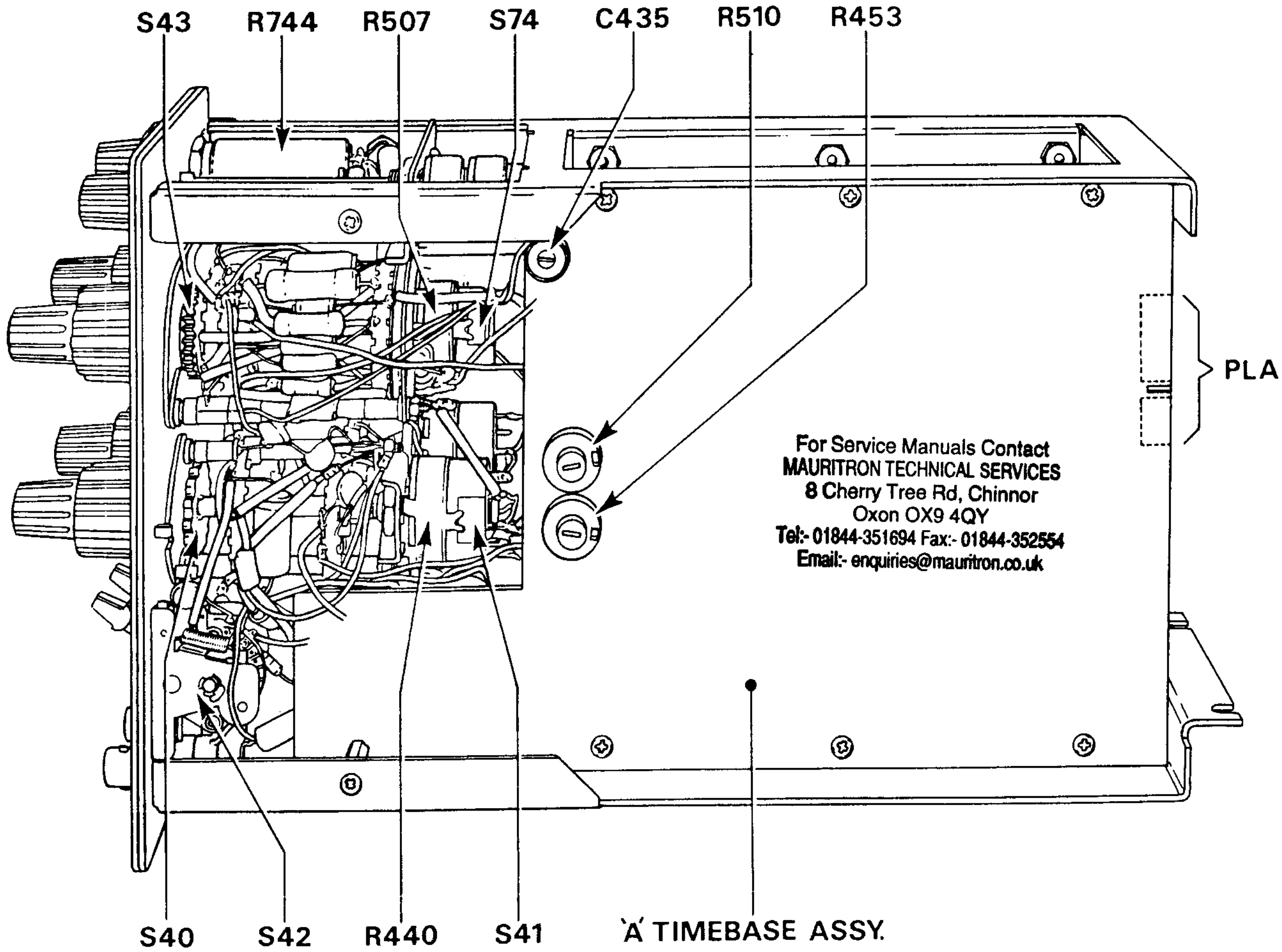


Fig. 16 Timebase Unit A side

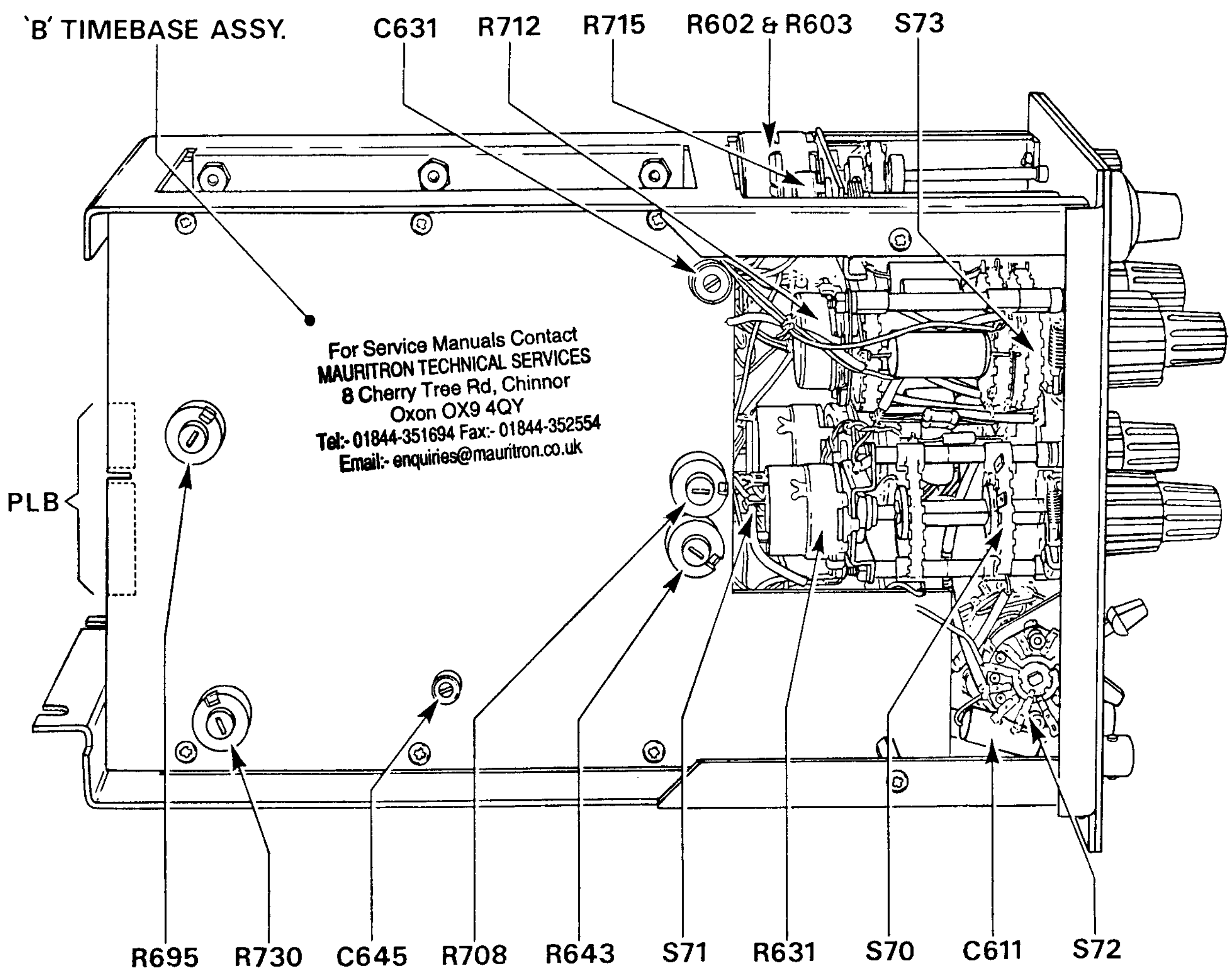


Fig. 17 Timebase Unit B side

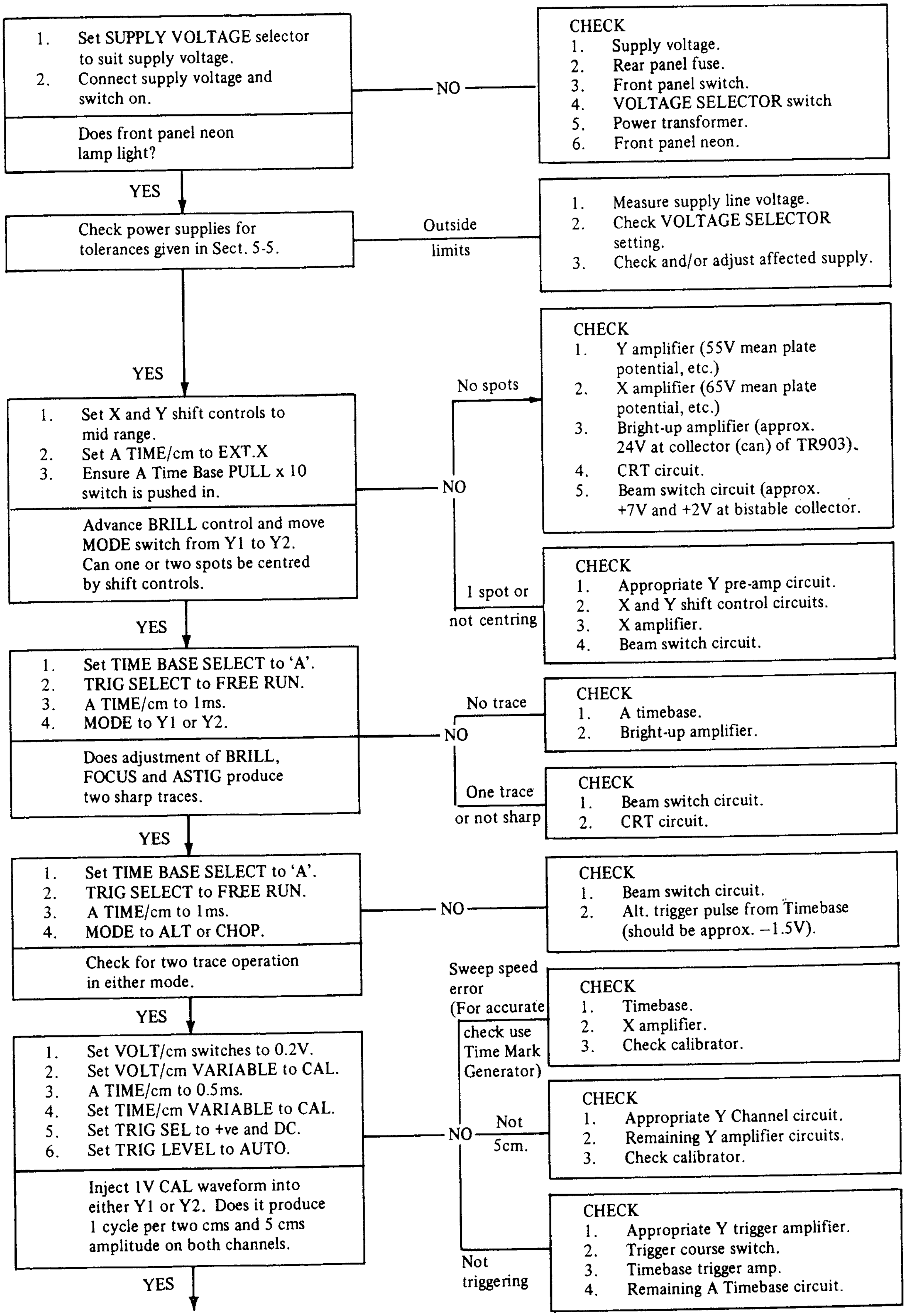


Fig. 18 Fault Localisation Chart

continued overleaf

Fig. 18 Fault Localisation Chart (cont.)

YES ↓

Set as for previous check, except:–
1. Set A TIME/cm to 5ms.
2. Set X Amp PULL x 10.

Check for 1 cycle/two cms.

— NO — CHECK
1. PULL x 10 switch and wiring.
2. X amplifier.

YES ↓

1. Push in X Amp x 10 switch.
2. Set B TIME BASE LEVEL control to 'B'. Starts after delay.
3. Set DISPLAY switch to A Inter by B.
4. Set B TRIGGER TO Y1+
5. Set B TIME/cm to 0.5ms.

Check for brightened up portion on display.

— NO — CHECK
1. B Timebase.
2. Bright-up output from bistable.
3. Combining gate on Bright-up amplifier.
4. Check Bright up o/p shows +ve step during B sweep time.
5. Check setting and operation of Contrast control.

YES ↓

1. Rotate Set Delay Potentiometer.

Check that brightened up portion moves.

— NO — CHECK
1. Delay Pickoff Comparitor.
2. Delay Bistable.

YES ↓

1. Set DISPLAY switch to B.

Check for 1 cycle/two cms.

— NO — CHECK
1. B Timebase calibration.

YES ↓

1. Set DISPLAY switch to A Inter by B.
2. Set B TRIGGER to Y1+
3. Move TRIGGER LEVEL control from B. Starts after delay. Adjust for stable display.

Check that rotation of the DELAY control causes trigger point to jump from one edge to the next.

— NO — CHECK
1. B Trigger generator circuits.

YES ↓

1. Set DISPLAY switch to A Inter by B.
2. Set B TRIG to B. Starts after delay.
3. Set A TIME/cm to 2ms.
4. Set B TIME/cm to 0.5ms.
5. B TRIGGER to Y1+

Move DISPLAY switch to A and B mixed. Check that brightened up portion expands and runs at B sweep rate.

— NO — CHECK
1. Display SELECT switch.
2. Single shot bistable.

YES ↓

1. Set DISPLAY to A only.
2. A TIME BASE LEVEL to AUTO.
3. A TIME BASE MODE to SINGLE SWEEP.

Switch to Arm. Check single trace produced.

— NO — CHECK
1. B Trigger generator circuits.
2. Delay Pickoff Comparitor.

Guarantee and Service Facilities

This instrument is guaranteed for a period of one year from its delivery to the purchaser, covering the replacement of defective parts other than tubes, semiconductors and fuses. Tubes 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 the special box supplied, and shipped with transportation charges prepaid. We can accept no responsibility for instruments 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 instructions are received.

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

Manual Part No. 32262

WL.1000 rev. 8.73