OS260
DUAL TRACE
OSCILLOSCOPE

Contents

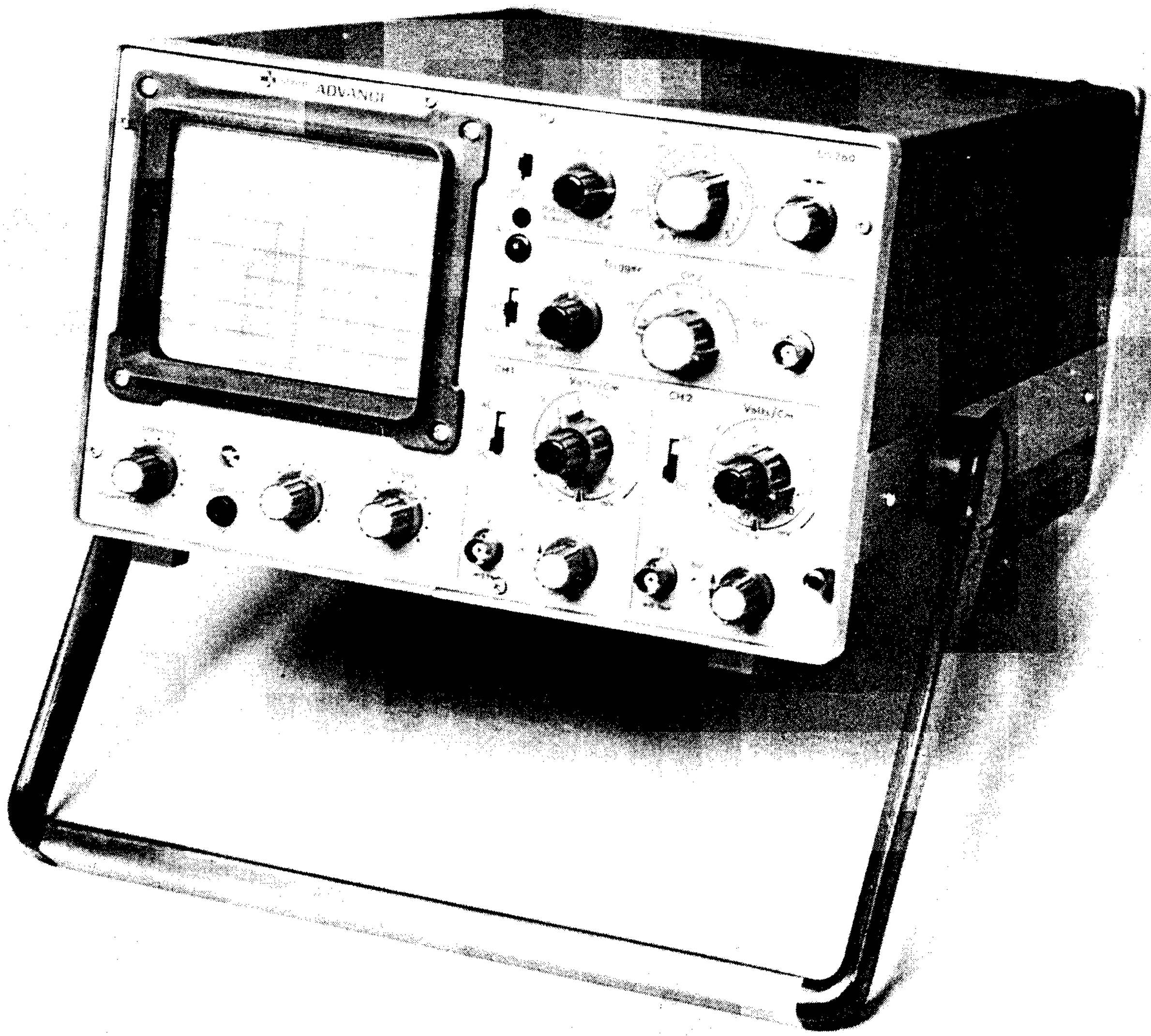
Introduction

The Gould Advance OS260 Oscilloscope is a 15MHz true dual trace instrument incorporating a split beam cathode ray tube with a 10cm x 8cm display.

It features two identical Y input channels with maximum sensitivities of 2mV/cm and bandwidths of d.c. – 15MHz. The display modes are:- "CH1 or CH2" single trace; "dual trace" with completely separate amplifiers, giving an unambiguous bright display of fast waveforms; "X-Y" operation in which one input channel is utilised to give X deflection, and "external X" operation in which both Y channels can be used while X deflection is by an external signal.

Sweep speeds from 0.2sec/cm to 0.5μs/cm are covered in 18 switched ranges with a variable control effective on all ranges. A X10 facility is incorporated, increasing the maximum effective sweep speed to 50ns/cm.

Switch selected trigger sources, a.c. or d.c. coupled, are internal from either channel or external via a front panel socket. A switched bright line trigger gives a trace on the screen in the absence of a trigger signal, or when the trigger level is outside the range of the input signal. A single shot circuit allows one sweep of the timebase after only an arm button is operated.



CRT

Rectangular dual beam tube with 8 x 10cm display
Total Accelerating Voltage – 10kV
Phosphor type – P31 (P7 to special order)
Overlap of beams – 100%
Graticule – External illuminated.

VERTICAL DEFLECTION

Two identical channels CH1 and CH2.

Bandwidth D.C. D.C. – 15MHz (3dB down)
A.C. 2Hz – 15MHz (3dB down)

Rise Time 23ns

Sensitivity (switched) 5mV/cm to 20V/cm in 12 ranges

Accuracy ±5%

Variable Gain Continuously variable gain control increases sensitivity up to 2.5 times. Gives maximum sensitivity of 2mV/cm

Input Impedance 1MΩ/28pF

Input Coupling A.C. – Gnd – D.C.

Input Protection 400V d.c. + pk a.c.

Display Modes Single trace, CH1 or CH2
True Dual trace, CH1 and CH2

HORIZONTAL DEFLECTION

Timebase 0.5μs/cm to 0.2s/cm in 18 ranges

Accuracy ±5%

Variable Speed Uncalibrated variable control gives continuous adjustment between ranges

X Expansion X10 pull switch gives fastest speed of 50ns/cm. Expansion accuracy ±5%

TRIGGER

Variable trigger level control with option of bright line in the absence of a signal

Source Internal CH1 + or –
Internal CH2 + or –
External + or –
External trigger input impedance 100kΩ/10pF

Trigger Coupling D.C. A.C. A.C. Fast

Sensitivity Internal: 3mm approx. 40Hz – 2MHz
1.5cm approx. at 8Hz and 15MHz
(Bright line off)
External: 1.5V approx. 40Hz – 2MHz
7.5V approx. at 8Hz and 15MHz
(Bright line off)

Single Sweep A single sweep for photographic use is armed by a push button and initiated by the next trigger pulse.

X-Y

Two modes of X-Y operation are provided

i) X-Y Channel 1 provides X deflection and Channel 2 provides Y deflection
X bandwidth d.c. – 500kHz
Phase Shift <3° at 20kHz

ii) X-Y-Y An External X input (rear panel) is displayed against the two Y inputs giving two X-Y traces
X bandwidth d.c. – 1.5MHz
Phase Shift <3° at 200kHz

External X Sensitivity approx. 0.9V/cm (0.09V/cm with X expansion)
Input Impedance approx. 100kΩ

ADDITIONAL FACILITIES

Calibrator 1 Volt ±2½% square wave at supply frequency

Ramp Output 0 to +10V from 4kΩ approx.

Z mod Input 10V gives visible modulation
70V gives full blanking
Input coupling – a.c.
Input impedance – 22kΩ approx.

SUPPLY

100V, 115V, 220V, 240V ± 10% 45 – 440Hz
Consumption approx. 40VA.

OPERATING TEMPERATURE

0 – 50°C. Full specification is met over the range 15–35°C

DIMENSIONS and WEIGHT

HEIGHT	180mm
WIDTH	290mm
DEPTH	445mm
WEIGHT	8kg approx.

ACCESSORIES SUPPLIED

Handbook
Two X10 probes type PB13
One BNC-BNC lead PL43
One BNC-Clips lead PL44
Supply lead PL98

OPTIONAL ACCESSORIES

Probe PB12 A passive probe kit with switched X1 and X10 attenuators
Viewing Hood PN33425
Rack Mount Kit PN37714
Carrying Case PN32479
Front Panel Cover PN34402
Trolleys TR4 and TR6

3.1 SUPPLIES

The instrument is normally despatched from the factory with the supply range switch on the rear panel set to the 240V (± 10%) range. Check that this is set correctly before connecting to the supply. Note that the correct fuse for the two high voltage ranges, 220V and 240V, is 500mA Slo-Blo (20mm) Advance Part No. 33685. If the 115V range is selected the fuse should be changed to a 1A Slo-Blo Advance Part No. 34790.

NOTE: Do not change the supply range switch with the instrument connected to the supply.

While the instrument does not rely on forced air circulation, it should not be operated with the natural convection cooling restricted, particularly at the rear of the instrument.

The instrument is switched on by turning the INTENSITY control clockwise, the associated neon indicator should light.

3.2 OBTAINING A TRACE

1. To obtain a trace
   (a) Set the CH1 shift control to approximately mid setting.
   (b) Set the CH2 shift control to OFF.
   (c) Set the X shift control to approximately mid setting.
   (d) Set the TRIG level control to normal position, i.e. not pulled out for BRIGHT LINE OFF.
   (e) Set the TIME/CM switch to 5μs.
   (f) Adjust the INTENSITY control to obtain a display of the required brightness.
   (g) Centralise the display by adjusting the CH1 and X shift control.
   (h) Adjust the FOCUS control to obtain a sharply defined trace.

3.3 Y CHANNEL CONTROLS

1. Using one of the coaxial input signal leads (PL43 or PL44) connect a signal to the CH1 and CH2 input socket.
2. For
   (a) Direct connection of the input signal, set the associated input slide switch to DC.
   (b) Capacitive coupling of the input signal through an internal 0.1μF 400V capacitor, set the slide switch to AC.

NOTE:
When examining low amplitude a.c. signals superimposed on a high d.c. level, the slide switch should be set to a.c. and the sensitivity of the Y amplifier increased as in (5). To minimise pick up at sensitive settings, it is essential to ensure that the ground lead connection is near to the signal point.

3. To locate the baseline, set the slide switch to GND. At this setting, the input signal is open circuit and the input of the amplifier is switched to ground.
4. To adjust the sensitivity, set the VOLTS/CM switch to a suitable setting.
   If necessary, adjust the concentric VARIABLE control.

NOTE:
The range of the VARIABLE control give a 2.5:1 increase in gain, ±5% when in the fully clockwise position. 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 shift of the trace, adjust the Y shift controls (identified with vertical arrows). To switch off either channel, turn the relevant shift control fully anticlockwise until the switch operates.
6. If, under no signal conditions, trace movement is detected when the setting of the VOLTS/CM switch is altered, reset the BAL preset control. Adjust this control to minimise vertical movement of the CH1 or CH2 traces at the CAL position of the fine gain, when the inputs are grounded and the attenuator switch is moved between the 0.5V/cm position and the 0.2V/cm position. This should be done after a warm up time of, say, 15 minutes or longer and should require only infrequent adjustment thereafter.

3.4 SINGLE TRACE OPERATION

1. For single trace operation on CH1, set
   (a) The CH1 shift control away from the OFF setting.
   (b) The CH2 shift control to Y2 OFF.
2. For single trace operation on the CH2 channel, set
   (a) The CH2 shift control away from the OFF setting.
   (b) The CH1 shift control to OFF.

3.5 DUAL TRACE OPERATION

In the dual trace condition each channel has its own complete amplifier chain ensuring a correct dual display even under single shot conditions.

For dual trace operation, set both shift controls away from the OFF positions so that two traces appear on the screen.

3.6 TIMEBASE AND X AMPLIFIER

The sweep speed of the internal timebase (i.e. the time scale of the horizontal axis) is determined by the setting of the TIME/CM switch. In addition to selection of the speed of the internal timebase, the switch has two functional settings. These are EXT X and X-Y, on both of these positions the internal timebase is inoperative. The gain of the internal X amplifier may be increased ten times by pulling out the PULL X10 control on the VARIABLE TIME/CM switch. This facility is available at all settings except X-Y of the TIME/CM switch. 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.

1. To adjust the time scale of the horizontal axis:-
   (a) Set the TIME/CM switch to a suitable setting.
   (b) If necessary, the sweep can be slowed by adjustment of the concentric VARIABLE control.

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

2. If close examination of any portion of the trace is 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 over a limited arc provides fine shift control.

3.7 X-Y MODE

The single trace X-Y display can be obtained via the two main input sockets.

1. Set the TIME/CM switch to X-Y.
2. Set the CH1 input slide switch to DC or AC.
3. Connect the external signal which is to be used for X deflection, to the X (CH1) socket.
4. Operate the CH2 channel as for single trace operation and use the CH1 VOLTS/CM switch to control the X deflection.
   The CH1 shift control is inoperative.

3.8 EXTERNAL X MODE

For a dual trace X-Y display, the external signal can be applied directly to the X amplifier. Sensitivity is approximately 900mV/cm or 90mV/cm with X10 pulled. Band width is 1.5MHz.

1. Set the TIME/CM switch to EXT X.
2. Connect the external signal to the EXT X socket at the rear of the instrument.
3. Adjust the horizontal position with the X shift control.

3.9 TRIGGER

The timebase may be triggered from the positive or negative slope of the signal selected by the TRIG SELECT switch as follows:-

(a) CH1 or CH2 signal (irrespective of which beam is displayed).
(b) An external triggering source connected to the EXT TRIG socket.

The LEVEL control 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 pulled out to select BRIGHT LINE OFF, the timebase will only trigger when the input signal passes through the selected level. When the LEVEL control is set outside the range of signal or when there is insufficient signal amplitude, the timebase will not run and the screen will remain blank.

The more convenient mode of operation for normal use is with the LEVEL control pushed in, when the timebase will free run in the absence of the correct trigger, and display a bright line or unsynchronised display until the level control is adjusted and/or the amplitude of the input signal is increased. This free run action in the absence of correct trigger, helps in locating the trace. If the timebase is required to free run continuously, the LEVEL control should be set to either end of its rotation. It is expected that the BRIGHT LINE OFF mode will be selected only when the instrument is to be used to display signals at low or high repetition rates.

The TRIG SELECT switch is used in conjunction with the AC/ACF/DC switch. This switch is effective at all settings of the TRIG SELECT switch. The operating facilities available at the three settings are as follows:-

AC — The a.c. coupled wideband mode used for most common trigger signals.
ACF — A filter is switched into circuit to reject low frequencies. High frequency triggering may be effected from complex waveforms such as a high frequency signal with a low frequency ripple content. The 3dB point is approx. 15kHz.
DC — The trigger signal is d.c. coupled enabling the timebase to be triggered from very low frequency waveforms or consistently triggered from variable mark/space waveforms.

The SINGLE SHOT facility is useful for photographic recording of displayed waveforms, or visual study of non-recurring traces.

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

Summarising, normal triggering control is effected as follows:-

1. Set NORMAL/SINGLE SHOT switch to NORMAL.
2. Set the TRIG SELECT switch to the required trigger signal and slope.
3. Set the ACF/AC/DC switch to the required setting.
4. Adjust the LEVEL control so that the trace starts at the required point on the waveform.

3.10 ADDITIONAL FACILITIES

(a) Scale
Illumination of the graticule is provided. Adjustment of the intensity is by the front panel control.

(b) Cal.
This socket provides a d.c. coupled positive-going square wave of 1V ±2% amplitude at line frequency for calibration checks. The square wave has a source

impedance of 1kΩ and a risetime of approximately 20μs suitable for probe adjustment.

(c) **Ramp**

This socket at the rear of the instrument provides a d.c. coupled positive-going timing ramp of approximately 10V amplitude generated by the timebase. Source impedance is 18kΩ.

(d) **Z Mod.**

The socket at the rear of the instrument allows an a.c. coupled signal to modulate the brightness. Coupling is by an internal 0.08μF capacitor into approximately 22kΩ. Bandwidth is 100Hz-1MHz.

1. Sensitivity is approximately 10V pk-pk for visible modulation at normal brightness.
2. Full blanking requires a 70V negative-going pulse.

(e) **Passive Probe**

A 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 10M X10 probe. This reduces the input capacity and increases the input resistance, whilst reducing 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. In the Normal Mode, set the Y channel VOLTS/CM switch to 20mV/cm, and the TIME/CM switch to .2ms/cm.
2. Connect the probe to the CAL 1V socket.
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.

(f) **Camera**

A camera may be fitted to the oscilloscope to record waveforms. This facility is particularly useful for the display of transient signals at slow or fast speed timebase setting. Suitable cameras utilising Polaroid or 35mm film may be obtained from D. Shackman & Sons, or Telford Products Ltd. Adaptors are available for attaching the camera to the oscilloscope. Almost any other oscilloscope camera may be used with the OS260 but a suitable adaptor must be obtained and should be discussed with the camera manufacturer.

4.1 GENERAL

Referring to the block diagram (Fig. 1) signals applied to the CH1 and CH2 input sockets pass into their respective attenuators, preamplifiers and output amplifiers, to the two sets of cathode ray tube Y plates. The VOLTS/CM switch controls the gain of the preamplifier in the necessary 1 - 2 - 5 sequence to cover the ranges from the 5mV/cm to 0.2V/cm. Above this a ÷ 100 attenuator is introduced before the amplifier.

Each signal is passed also to the trigger switch where selection of CH1 and CH2 or EXT. TRIG. source is made. The selected signal is AC, ACF or DC coupled to the trigger amplifier and then passed to the Schmitt trigger, where it is converted into fast negative-going pulses. The hold-off circuit acts as a gate which is normally open to allow a trigger pulse to set the timebase bistable. The bootstrap ramp generator then begins to generate its linear ramp, which after passing through the X amplifier is applied to the X plates of the cathode ray tube and drives the electron beam linearly across the tube face. A small portion of the signal from the ramp generator is fed back to the hold-off circuit, shutting the gate to prevent any further pulses from the Schmitt trigger from reaching the timebase bistable during the ramp period. When the ramp has reached the necessary maximum level, the timebase bistable is reset, and the ramp is quickly returned to its quiescent state. A time constant in the hold-off circuit now holds the gate closed to inhibit another ramp from being initiated for a short period, until the ramp timing capacitor is discharged fully. Thus a ramp is generated at a rate set by the TIME/CM switch when the trigger signal reaches a predetermined level. This ramp sweeps the beam across the c.r.t. face, returns and waits for the next trigger point to be reached. The hold-off circuit is also controlled by the single shot circuit when this facility is used. The timebase bistable is connected to a blanking amplifier which drives the grid of the c.r.t. and whose function is to turn on the electron beam during the sweep and blank it off during the fly back and subsequent waiting period.

In the X-Y mode, the signal from the CH1 amplifier, normally used for trigger, is passed via the ramp generator, which acts as a voltage follower, to drive the X plates while the beam switch selects CH2 to drive the Y plates. The beam blanking signal is not used.

External X signal is applied to the ramp generator in that mode in a similar way to X-Y operation.

External Z modulation signal is a.c. coupled to the cathode ray tube cathode.

4.2 Y PREAMPLIFIERS

The attenuator and preamplifier in CH1 are identical to those in CH2. Accordingly only CH1 will be described. Referring to Fig. 4 the input signal is applied to the front panel socket, SKA, and then to the 3 position slide switch, S20, via R2. This switch selects a.c. or d.c. input coupling by including or by-passing C3 in the signal path. On the centre position of the switch, the input socket is disconnected and the input to the amplifier is connected to ground. Input sensitivity selection is performed in two

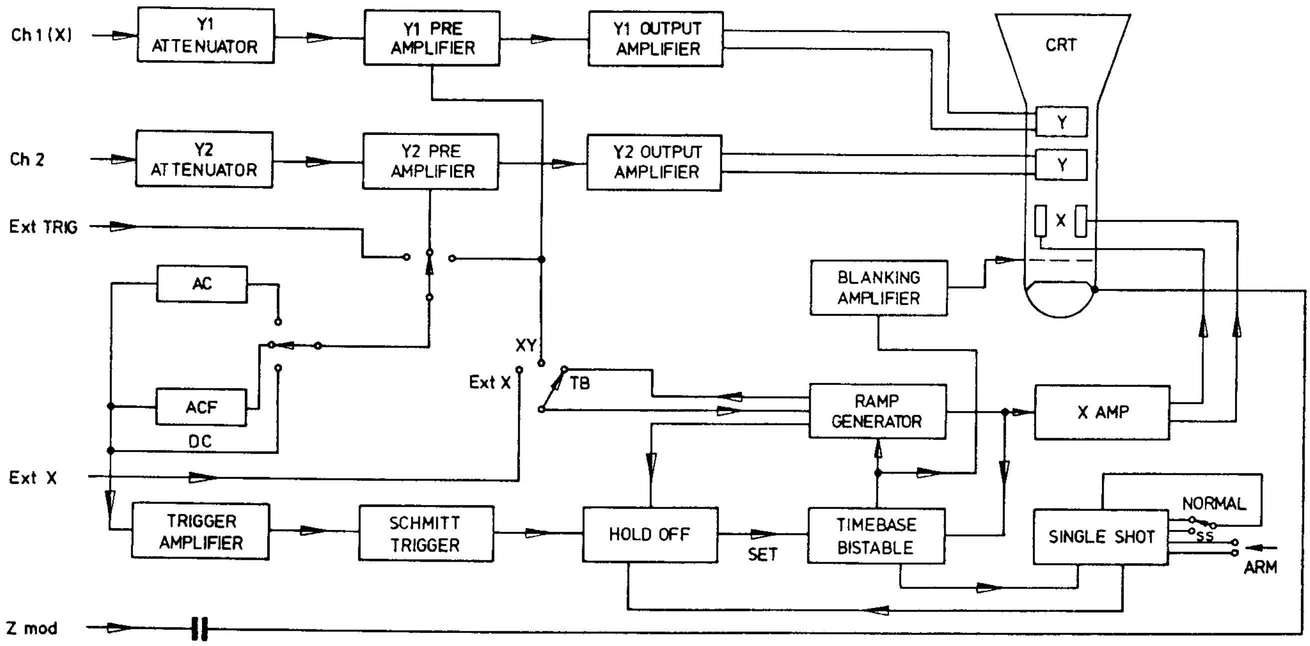


Fig. 1 Block diagram

stages; the six lowest ranges, 5-200mV/cm, are obtained by switching the gain of the amplifier as described later. The 0.5-20V/cm ranges are provided by switching in a ÷ 100 attenuator section before the amplifier and repeating the gain switching. This attenuator is formed by R4 and R201 with C202 to set the h.f. response. C201 is adjusted to maintain the total input capacitance of the highest ranges equal to that of the lower ranges. Diodes, D201 and D202, limit the peak signal voltage at the amplifier input to approximately 8 volts and in conjunction with R7 protect the instrument against damage from inputs of up to 400 volts peak.

The input stage consists of half of a dual field effect transistor, TR201, connected as a source follower, driving the emitter follower, TR203. The collector emitter voltage of TR203 is maintained constant independent of input voltage at one base emitter voltage plus the voltage across R236 by the bootstrap transistor, TR205.

The signal at the emitter of TR203 is applied via the switched resistor network, R40/45, and the common base stage, TR204, to shunt feedback amplifier formed by TR206, R212 and R211. This can be regarded as a "virtual earth" amplifier with R211 as the feedback resistor and the R28 to R34 network as the input resistor. Thus, the overall gain of the stage is selected by S21b to provide the six basic input sensitivities of the instrument. The common base transistor, TR204, is interposed to balance the d.c. offset voltage introduced into the signal path by TR205. The base of TR204 is connected to the source of TR202, which is half of a dual field effect transistor with TR201. TR202 is biased by R209, R210 and the balance potentiometer R203. This is set so that with the input grounded the d.c. potentials of TR204 and TR203 emitters are identical and there is no resultant change of signal level as R40 etc. is switched in. Diode, D206, is fitted to protect TR204 from reverse base-emitter voltages. The output from the collector of TR206 is taken via R215 to the base of TR208, which, together with TR209, forms a long-tailed pair. Transistors, TR212 and TR207, are connected in a similar fashion to TR202 and TR206 and provide a balancing d.c. voltage at the base of TR209.

Movement of the displayed trace will occur when the variable sensitivity control R58, is operated unless the voltages at the emitters of TR208 and TR209 are equal (when the input is grounded) and this balance is set up using potentiometer, R218.

The mutual conductance of the long-tailed pair, TR208 and TR209, is determined in the variable range, by the series of R235, R233 and R58 and in the CAL position by R220. Fixed high frequency compensation is provided by C206, C205 and R234. The collector current of TR208 feeds into a load resistor on the timebase board to provide an internal trigger signal.

The signal voltage developed across R224 is added to the Y shift voltage derived from the potentiometer R52, and is buffered by the emitter follower, TR210, to drive the coaxial cable connection to the CH1 output amplifier. R228 and D209 provide a collector supply for TR210.

R223 is returned to the −20 volt supply through TR211 and provides the correct d.c. potential at the collector of TR209. When the shift control, R52, is turned anticlockwise, S27 closes, cutting off TR211 and effectively shifting the trace completely off the screen. When in the X-Y mode, TR211 is also turned off by −20 volts applied to pin 3 from the timebase assembly.

4.3 Y OUTPUT AMPLIFIERS (Fig. 6)

The two output amplifiers are identical, therefore only CH1 will be described.

The Y signal from the preamplifier is applied at pin 16 to the base of TR311, a common emitter amplifier. The emitter circuit includes potentiometer, R342, (to set the gain of the stage and hence the overall gain of the channel) and high frequency compensating network R345, C322 and C323. The signal from the collector of TR311 is passed through the emitter follower to the base of TR313, which with TR316, TR314 and TR315 forms the output cascode stage. TR313 and TR316, is a long tail pair, which converts the input signal voltage to differential output current; its gain is determined by emitter resistor, R352, with high frequency gain set by networks R351/C324/C325, R393/C326 and R350/C327. The collector currents of TR313 and TR316 flow into the emitter of the grounded base transistors, TR314 and TR315, to develop the differential output voltage across the load resistors, R347/R357, to drive the c.r.t. deflection plates. Inductors, L1 and L2, and damping resistors, R383 and R384, are included to improve the high frequency response. The base of TR316 is biased by the zener diode, D302, and resistor network, R358 and R359.

4.4 TRIGGER CIRCUITS (Fig. 5)

The trigger signal via pins 25 and 23 from the preamplifier channels is developed across R104 and R105 which are the collector loads of TR228 and TR208 respectively. 1cm of Y deflection gives approximately 25mV across these loads.

R28 and R106 form an approximately 200:1 attenuator to external trigger signals. R107, R108 and R109, R110 are adjusted to offset the standing collector currents which flow in the CH1, CH2 trigger leads, thus maintaining the voltage across R104 and R105 near zero in the absence of Y signals. One of these signals, selected by S13aF, the trigger source and slope switch, is passed to S12, the trigger coupling switch, and from there to the base of TR101. There are three possible signal paths, AC coupled via C18, LF. rej. via C17 with R112 bypassing l.f. signals to ground (fco ≏ 15kHz) or DC coupling.

TR101, acting as an emitter follower, passes the trigger signal to the amplifier pair, TR102 and TR103, the potential derived from the level control, R10, being passed via emitter follower, TR104, to the base of TR103. Thus the amplified trigger signal appearing between the collectors of TR102 and TR103 contains a d.c. component determined by the setting of R10. The gain of this amplifier is determined by R113 and R114, and is approximately 4X. The output signals are passed via the reversing switch,

S13aB, to the input of amplifier TR105/TR106. The collectors of TR102 and TR103 are connected to the bases of TR105 and TR106 respectively for positive slope, and reversed for negative slope. TR105/106 form a differential amplifier whose output on the collector of TR106, drives the Schmitt trigger circuit, TR107/TR108. The gain of amplifier TR104/106 is approximately 20 and the output d.c. voltage is adjusted with the common emitter resistor, R132.
The function of the trigger circuit, TR107/108, is to generate a fast negative edge at the collector of TR108, independent of the rate of change of the applied signal. The signal appearing on the collector load of TR107/R140, is coupled via the network, R143, C110 and R146, to the base of TR108, whose emitter is connected to the emitter of TR107 and the common emitter resistor, R145. The emitter coupling introduces positive feedback which results in a latching action.

4.5 TIMEBASE BISTABLE AND RAMP GENERATOR (Fig. 5)

The ramp generator comprises TR119, TR120 and TR121 as cascaded emitter follower stages, with bootstrap feedback action provided from the cathode of zener diode, D108. This feedback maintains constant voltage across the VARIABLE TIME control, R11, R172, R183 and the timing resistor selected by the TIME/CM switch. This constant voltage drop, independent of actual voltage level produces a constant current to charge linearly the timing capacitor, also selected by the TIME/CM switch. The VARIABLE TIME control provides fine adjustment of the timing current, and hence sweep time, by varying the feedback voltage applied to the timing resistor.

In the quiescent condition of the timebase bistable, TR114 is on, TR115 is off and clamp transistor, TR116, which shunts the timing capacitor, is saturated.
A negative-going pulse from the Schmitt trigger is coupled via C112 and D105 to turn off TR114. TR115 turns on, thus turning off TR116. The clamp is removed, allowing the timing capacitor to charge, producing the linear ramp. As the emitter of TR121 rises, a feedback voltage (via D111, the emitter follower - TR126, D109, R169 and R148) biases off D105 to prevent any further pulses reaching the bistable. Connected to the junction of R148/R169 is the HOLD OFF capacitor which now charges positive. When the ramp reaches its final amplitude (a rise of approximately 10V) feedback from the junction of R184/R185 is applied to the base of TR114, turning it on. The bistable reverts to its initial state allowing TR116 to turn on, rapidly discharging the timing capacitor and returning the ramp to its quiescent level. The hold-off capacitor, which was charged to a positive voltage during the ramp, now discharges through R169 and R186 more slowly than the timing capacitor, until it is caught by D109. Only then is D105 biased for the next trigger pulse to initiate the next sweep.

An output is taken from the ramp generator via R176 to SKE the RAMP OUT socket on the rear panel.

4.6 BRIGHT LINE CIRCUIT (Fig. 5)

When sufficient trigger signal is available, the square wave from the collector of TR108 passes through R144/C113, where restoration by D102 produces a negative going signal with respect to the negative rail. This negative signal on the base of TR111 is integrated by R149/C116 to produce a d.c. bias sufficient to hold off TR112. In this condition the circuit has no effect on timebase operation. However, when the triggering signal falls below the required level, the Schmitt trigger ceases to operate, removing the signal from D102. The voltage on the emitter of TR111 rises to approximately one volt above the negative line, turning on TR112. R147 is now effectively connected between the negative rail and the cathode of D105. It further discharges the hold-off capacitor below the normal quiescent level to a point where D105 conducts, turning TR114 off and initiating a sweep. At the end of the ramp, the charge on the hold-off capacitor is again removed by R147/R169 and another ramp begins. These consecutive sweeps produce the bright line display. When the PULL BRIGHT LINE OFF control is operated, switch S10 closes, effectively shorting the base and emitter of TR112, holding it off; in this condition a ramp is only generated after the arrival of a trigger pulse.

4.7 SINGLE SHOT (Fig. 5)

The CMOS integrated circuit, IC101, provides the gating and set/reset bistable of the single shot circuit and is powered by a +15 volt supply derived from the +20 volt line by R137 and D104.

When S16 is in the NORMAL position, R150 is high forcing pin 11 low, therefore operation of the timebase bistable through R142 is not affected. When S16 is switched from NORMAL to SINGLE SHOT, the base of TR112 is connected to its emitter thus preventing operation of the bright line circuit. Also R150 is connected to 0V, allowing the bistable formed by the gates on pins 8-13 to be reset (with pin 11 high) after each sweep of the timebase through the differentiator, C121 and R156. At the end of the current sweep, R142 is at +15V, back biasing D105 and preventing trigger pulses from the Schmitt trigger from triggering the timebase bistable.

C123, (pins 1, 2 of IC101) is charged to +15V through R93, R94 and R157. When the ARM button is pressed, C123 is discharged through R93, causing the output of the gate (pin 3 of IC101) to go high. The bistable is set by this positive transition, through the differentiating circuit, C124 and R150 to pin 13. R142 is now at 0V allowing the timebase bistable to be triggered once by the first trigger pulse through diode, D105.

The l.e.d. indicator, D11, is driven by TR117 through R158. The base of TR117 is switched by the NOR gate either from the bistable, through the input on pin 5, or in the NORMAL mode by S16 through pin 6.

4.8 X OUTPUT AMPLIFIER (Fig. 5)

The ramp or X signal at the emitter of TR121 passes through R187 to the base of TR122, which with TR125 forms a long tail pair. D101 protects TR122 from reverse base emitter voltages possible when Ext. X is overloaded. Gain switching is carried out in the emitter circuit by selection of one of two resistance paths. In normal operation only R189 is in circuit, with the preset, R191, to set the X1 gain. In timebase mode, the PULL X10 switch, S11, can be operated in order to expand the trace length ten times introducing R188 with preset R191 to set the X10 gain. In the X-Y mode, contacts on the TIME/CM switch in parallel with S11, close to automatically select this higher gain setting. The dual X shift potentiometer, R17, gives coarse and fine control. The two sections are mechanically linked so that one section is directly driven and the other (fine) driven only when the backlash has been taken up. The signals on the collectors of TR122 and TR125 are applied to the differential output amplifier, TR123 and TR124. Signals from the collectors of these two transistors drive the horizontal deflection plates of the c.r.t. High frequency compensation is provided by C122.

4.9 X-Y MODE (Fig. 5)

In this mode signals are applied to both CH1 and CH2 input sockets. CH2 is routed to the Y deflection plates in the normal manner. CH1 is routed through the ramp generator which is now acting as a high impedance unity gain buffer, and into the X output stage. Signals entering CH1 pass through the attenuator and gain switching stage, as described previously. Signal current from TR208 on the Y preamplifier board (otherwise used for trigger), develops a voltage across R101 and R105 in series. This voltage is level shifted by R170/R163 and applied through the diode gate, D107, and S14bF to the base of TR119. In the X-Y mode, the timing resistors and capacitors are switched out of circuit, consequently TR119, TR120 and TR121 merely act as emitter followers which provide buffering between the level shift resistors and the X output amplifier.

When this mode is selected, a contact on the TIME/CM switch, S14aF, connects the cathode of D106 to the negative line. The current drawn through D106 and R153 turns of TR114 and consequently TR116 and removes blanking. (See section 4.13).

4.10 EXTERNAL X MODE (Fig. 5)

The Ext. X signal applied to Sk.G passes through the h f. stopper, R97, and is level shifted by the network, R85/R86/R87, and switched by S14aF to the base of TR119. The signal is thus amplified and applied to the X plates in the same way as in the X-Y mode. Protection from excessive inputs is provided by R87, D112 and D113. In the Ext. X mode TR109 is held non-conducting by R92 which is switched to −20V by S14aF, in all other modes TR109 is held conducting by a positive base bias through R89 and effectively short circuits the Ext. X signal so that it cannot cause interference to the trace.

4.11 CALIBRATOR (Fig. 6)

The 1V ±2% square wave at the CAL 1V socket, SKD, is produced by TR309, on the power supply board. Current for the base of this transistor is supplied via R334 and D318. The anode of D317 is connected to the junction of these components, its cathode being taken to one of the 22V windings. On positive excursions of the winding, D317 is biased off and the current through R334/D318 saturates TR309. During negative excursions D317 conducts, and the current in R334 passes through the transformer winding. In this condition D318 and TR309 are turned off. The result is a square wave at line frequency on the collector of TR309, with amplitude set by adjustment of R328. The CAL signal is attenuated to 1V by R330 and R331.

4.12 POWER SUPPLIES (Fig. 6)

All the power supplies for the instrument are derived from the transformer, T31. Two tapped primary windings are switched by S31 to allow for three supply voltage ranges and fuse, FS31, provides fault protection. The supply indicator neon, V32, is supplied via limiting resistor, R32, from the 115 volt tap on the transformer.

For the low voltage supplies two separate secondary windings supply bridge rectifiers, BR31 and BR32, mounted on the transformer and provide unregulated supplies of +200V, +26V and −26V across the reservoir capacitors, C33B, C31 and C32 respectively. The +200V supply is further smoothed by R31 and C33A. The +26V and −26V supplies are fed to high performance integrated circuit regulators, IC301 and IC302 respectively, to provide stabilised lines of +20V and −20V. These devices contain all the circuitry necessary for a conventional series regulator, together with current limiting and thermal shutdown facilities to protect the device against overloads arising from short circuits or component failures. Note that the −20V line is in fact provided by a 15V regulator, IC302, in conjunction with a zener diode, D203.

The two remaining secondary windings are associated with the cathode ray tube supplies. The 6.3V winding feeds the c.r.t. heater. The 1400V winding provides the −1500V and the +8.5kV supplies.

The 1500V supply is derived by the diode, D301, feeding the reservoir capacitors, C301, C302, C303 and C304. The voltage is smoothed by R305, C305, C306, C307 and C308, and applied to the c.r.t. network.

The +8.5kV c.r.t. anode supply is provided by quadrupling the 1800V a.c. supply in a separate encapsulated multiplier module.

Stabilisation of both e.h.t. lines against supply voltage variations is achieved as follows:-
One end of the 1800V winding feeds the rectifier diodes in the normal manner, the other end is connected to ground via a bridge rectifier, BR301. The alternating

current in the winding passes through BR301, TR307, R324, TR308 and R349 as direct current which develops a d.c. voltage across C318 and C319. Overvoltage protection of these components is afforded by the chain of zener diodes, D314, D315 and D316. This d.c. voltage, controlled by the conduction of the cascode connected pair of transistors, TR307 and TR308, is effectively subtracted from the peak voltage available at the 'hot' end of the winding; thus by varying the conduction of TR308, the rectified high voltage supplies can be controlled.

The stabilising circuit operates at the negative peak of the waveform from the e.h.t. winding, when current flows from the low side of the winding through pin 42 and the bridge rectifier, BR301, to 0V. Conduction in the bridge holds the negative side of C316, C317 etc. near 0V. The voltage drops across R349 and R320 are small. Consequently for balanced working conditions potentials at the base of TR308, the emitter of TR306 and hence the base of TR306 must also be near to 0V. In fact the diode junction drops cancel in TR306, D313, TR308 and BR301. If the feedback current from the −1500V supply through R318 is not exactly cancelled by that defined by R315 and the preset control R314 from the +20V supply, the base potential of TR306 will differ from 0V. The conduction of TR308 and hence TR307 will vary the voltage across C318 and C319 to correct the −1500V supply level.

At this same peak of the supply cycle, current from the e.h.t. multiplier, via R903, flows in D312 defining the base potential of TR307 just above +20V so that TR307 operates in cascode from TR308. At other points of the cycle D313 and D312 are reverse biased and capacitors, C316, C317 and C318, retain the relative operating potentials of TR307 and TR308. When the positive peak output from the e.h.t. winding is reached, the same correction voltage across C318 and C319 is subtracted and first order stabilisation is applied to the +8.5kV p.d.a. supply. A small correction current from the unstabilised −26V supply is applied to the base of TR306 to null any remaining variation of e.h.t. supplies with supply variations.

Graticule illumination is provided by two bulbs which are supplied through R301 from the emitter follower, TR301. The lamp voltage is controlled by the front panel control, R39. Collector supply for TR301 is full wave rectified by separate diodes, D305 and D306.

4.13 BLANKING (Fig. 6)

The blanking circuit is powered by the voltage drop across the zener diode, D307, which is in series with the negative 1500V c.r.t. gun supply. The grid of the c.r.t. is returned to the junction of the collectors of two complementary transistors, TR303 and TR305. When the timebase is triggered, TR114 conducts turning off TR110 (timebase bistable, see Section 4.5) and a negative edge is applied via pin 30 to the two capacitors, C314 and C315. This turns off TR303 and turns on TR305 thus reducing the negative bias on the c.r.t. grid and increasing the intensity. Feedback through R313 turns off TR304 causing its collector to go negative which turns on TR305 harder, through D309. This speeds up the pulse on the c.r.t. grid and maintains the circuit in this condition until the blanking pulse from the timebase goes positive at the end of the sweep, when the circuit reverts to its blanked condition with TR303 on and TR305 off. The time constant of R303/C346 ensures that when the instrument is switched on it is in the bright trace condition. Blanking is not effective in the Ext. X or X-Y modes. External Z modulation is a.c. coupled through C320 and applied directly to the cathode of the c.r.t.

4.14 TUBE NETWORKS (Fig. 6)

Intensity is controlled by R38 and the range of this control by R319. As the cathode supply is stabilised by feedback through R318, adjusting the intensity changes the negative supply at the cathode of D301.

Focus and focus range is controlled by R34 and R325. With a split beam tube it is necessary when changing focus, to correct a small Y shift which occurs due to the construction of the c.r.t. The focus control is a twin gang potentiometer, the first section directly control the potential on the focus electrode and the second section changes the base and emitter voltages of the emitter follower, TR310. The required Y shift compensation is applied. R337 to CH1 and, in antiphase, through R381 to CH2. R323 causes the focus voltage to change slightly with changes in the intensity control, R38.

R307 adjusts the potential on the GEOM electrode and R311, buffered by the emitter follower, TR302, provides adjustment of the ASTIG electrode.

Trace rotation is adjustable by varying the current through coil, L31, by R306.

5.1 GENERAL

Top and bottom views of the OS260 are shown in Figs. 2 and 3 respectively. Access to all preset components is possible when the upper and lower covers and the rear blow moulding have been removed. The top and bottom covers are removed by releasing the four latch fasteners by turning these one half turn, and the rear blow moulding by removing six screws.

If during fault finding a component needs replacing, it may be cut from the printed circuit board as close as possible to the component, leaving the wires protruding through to the component side of the board. The new component can 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 be implemented to ensure that the instrument confirms to the specification.

5.1.1 Supply Voltage Selection

Selection of 115, 220 or 240V operation is by the three position slide switch, S31, located on the rear panel of the instrument. Note that the POWER ON switch should be turned off before S31 is operated. 100 volt operation is available as an alternative to 115V by changing connections to the transformer primary. BEFORE CHANGES ARE MADE DISCONNECT THE INSTRUMENT FROM THE SUPPLY. Remove the instrument top cover, locate the supply transformer, T31, Fig. 2, and unsolder the two pink wires (on the 115V tap) and resolder onto the adjacent 100V tap. Unsolder the orange wire (on the other 115V tap) and resolder onto the other 100V tap, located between the yellow and black wires. The voltage selection switch, S31, now has its voltages changed as follows:-

the 115V position becomes 100V
the 220V position becomes 205V
the 240V position becomes 225V.

5.1.2 Fuse Replacement

SWITCH OFF INSTRUMENT POWER SWITCH BEFORE CHANGING FUSE.

The supply line fuse, FS31, is mounted on the rear panel beneath the supply plug. The rating is 500mA Slo Blo (Pt. No. 33685) for 190-260 volt operation, and 1A Slo Blo (Pt. No. 34790) for 95-130 volt operation.

5.2 REMOVAL OF PRINTED CIRCUIT ASSEMBLIES

Removal procedures for each of the printed circuit board assemblies are outlined below. However, almost all the components in the instrument, with the exception of those in the early stages of the Y amplifiers, are accessible without recourse to board removal.

5.2.1 Y Preamplifier Sub-Assembly

(a) Remove the three sockets from the rear of the assembly. Remove socket from pin 3 (green wire).
(b) Remove two sockets, on coaxial cables, from the power supply board.
(c) Remove the screw securing the rear of the assembly to the centre screen. Remove screw through side frame, at rear of assembly.
(d) Remove all knobs from the front panel controls. (Prise off top covers of the knobs and loosen the collet securing nuts revealed.)
(e) Remove fixing nuts from the attenuator switches.
(f) The assembly can now be removed from the instrument.

5.2.2 Timebase and X Amplifier Sub-Assembly

(a) Remove power socket, twin feeder socket, socket on pin 46, 47, single sockets on pin 11 (brown wire), and pin 8 (green wire).
(b) Remove two sockets on coaxial cables, from Y preamplifier assembly.
(c) Remove socket from pin 14 (yellow wire).
(d) Remove four screws fixing the p.c.b. to instrument.
(e) Remove all knobs from front panel controls. (Prise off top covers of the knobs and loosen the collet securing nuts revealed.)
(f) Remove fixing nuts from the TIME/CM switch and trigger switch.
(g) The assembly can now be removed from the instrument.

5.2.3 Power Supply and Y Output Printed Circuit Board

(a) Remove socket from pin 14 on timebase p.c.b. (yellow wire).
(b) Remove single wires from pin 29 (white wire), pin 50 (orange wire), pin 31 (brown wire), pin 32 (red wire), pin 33 (orange wire), pin 34 (yellow wire).
(c) Remove the eight remaining socket assemblies.
(d) Remove rear blow moulding from instrument.
(e) Remove four screws fixing the p.c.b. to the side frame.
(f) Remove three screws fixing heat sink to rear panel of the instrument.
(g) The assembly can now be removed from the instrument.

5.2.4 C.R.T. Replacement

(a) Remove rear moulding from the instrument.
(b) Remove the tube base connector.
(c) Remove the p.d.a. cap.
(d) Remove the socket from pins 1 and 2 on the power supply p.c.b. (pink wires).
(e) Remove the screw through the rear tube shield support bracket.
(f) Remove two screws to separate the rear support bracket.
(g) Slide the c.r.t. assembly rearwards and lift the front clear of the framework and remove forwards.

5.3 FAULT FINDING

Before any fault location is attempted, it is suggested that all supply line voltages are checked with respect to 0V. These are given in Table 1, refer to Fig. 3.

Table 1

LINE	MEASURED VOLTAGE	MEASURE-MENT POINT
+20V	+19 to +21V	Plug A
−20V	−19 to −21V	on power board
+190V	+180 to +200V	
−1450V	−1390 to −1550V	End of C320 adjacent to D317
PDA	+8000V	PDA cap

NOTE: The power supply input voltage should be approximately at the centre of the range for which the transformer taps are connected.

Table 2, indicating voltages at various circuit locations, may be used as a general guide and servicing aid. The front panel controls should be set as follows:

NORMAL/SINGLE SHOT switch to NORMAL
INTENSITY, X SHIFT, CH2 SHIFT all at mid position
CH1 SHIFT to OFF position
CH1 and CH2 INPUT switches to ground position
TRIG SELECT to CH1 +ve
ACF, AC, DC to A.C.
LEVEL to mid position, BRIGHT LINE on
TIME/CM to X-Y

Adjust X and CH2 shift controls to bring spot to centre of screen.

Table 2 Circuit Voltages

Y – Preamplifier Sub-Assembly

LOCATION	TYPICAL VOLTAGES
TR203, 204, 223, 224 Base	+1.3V
TR203, 223 Collector	+1.8V
TR206, 207, 226, 227 Collector	+7.5V
TR208, 228 Collector	+3.0V

Timebase Sub-Assembly

LOCATION	TYPICAL VOLTAGES
TR101 Base	0V
TR102, 103 Collector	+8.2V
TR102, 103 Emitter	+7.5V
TR106 Collector	+14V
TR107 Collector	+17V
TR108 Base	+13V
TR108 Collector	+20V
TR112 Collector	−20V
IC101 Pin 11	0V
TR115 Collector	+0.2V
TR121 Emitter	+4.2V
TR123, 124 Emitter	−6.8V
TR123, 124 Collector	+130V

Power Supply and Y Output

LOCATION	TYPICAL VOLTAGES
TR306 Emitter	+1.8V
TR311 Collector	+1.3V
TR317 Collector	+4V
TR316, 322 Base	+8.5V
TR320, 321 Collector	+130V
TR314 Collector	+175V
TR315 Collector	+90V

5.4 CALIBRATION PROCEDURE

Calibration adjustments should be made only after a 15 minute warm up period following switch on.
Refer to Figs. 2 and 3 for component locations.

5.4.1 Test Equipment

(a) Multirange Test Meter, 0-2.5kV with sensitivity >20kΩ/V.
(b) Variable Autotransformer output voltage 95-260V at 1A.
(c) Sine/Square wave signal generator covering the range 10Hz-100kHz amplitude 20mV-5V.
(d) Source of Time and Voltage Calibration signals, to cover the range 0.1μs-0.5s and 25mV-100V.
(e) Squarewave Generator to provide 500kHz flat top square wave with amplitude adjustable between 25mV and 1 volt. Risetime to be less than 5ns.
(f) Constant amplitude r.f. sinewave generator to cover the range 500kHz to 15MHz with a 50kHz reference frequency. Output amplitude 25mV to 5 volts pk-pk when terminated with 50Ω load. Amplitude accuracy over the frequency range to be within ±3%.
(g) 50Ω BNC through-termination.

5.4.2 Power Supply Voltages (Fig. 3)

(a) Set the INTENSITY control to minimum.
(b) Set the SUPPLY VOLTAGE switch on the rear panel to suit the available supply. Using the auto-transformer, set the supply to the instrument to within ±1% of the selected nominal voltage.
(c) Check that the POWER neon, V32, is lit and that the SCALE control varies the graticule illumination.
(d) With the voltage selector switch set for 240V operation, connect the instrument to the a.c. supply via a variable autotransformer and set the voltage to 240V ±1%. If the voltage selector switch is not set for 240V operation the tests should be carried out with the supply within 1% of the nominal voltage selected.
(e) Adjust R314 (SET EHT) to give 240V d.c. between the +ve end of C318 and the −ve end of C319. Check the voltages listed in Table 1 are within the limits specified while the supply voltage is varied from 222-260 volts.

5.4.3 C.R.T. Controls (Fig. 3)

(a) Set the front panel controls as follows:-
NORMAL/SINGLE SHOT switch to NORMAL

TIME/CM switch to X-Y
INTENSITY to mid position
FOCUS to mid position
X SHIFT to mid position
CH1 and CH2 VOLTS/CM switch to 20V/cm

Adjust X and CH2 shift to centre a spot on the screen. Adjust R311 (ASTIG) together with the INTENSITY and R325 (FOCUS RANGE) controls to obtain a sharp round spot.

(b) Switch TIME/CM switch to 1ms/cm. Remove rear instrument cover (six screws), loosen bolt in magnet clamp round neck of the c.r.t. Rotate the ceramic magnet with a screwdriver, inserted into the square centre hole, until the intensity of the two traces is equal; reduce INTENSITY control and ensure that the equality holds down to low intensity. Repeat adjustment of FOCUS RANGE and ASTIG controls as described above.

(c) Switch TIME/CM switch to 1ms/cm, turn X shift clockwise until the start of the trace is visible on the screen. Switch NORMAL/SINGLE SHOT switch to SINGLE SHOT. Turn front panel INTENSITY control fully clockwise. Turn R319 (INTENSITY RANGE) clockwise until the spot is visible and then turn anticlockwise until the spot is just extinguished.

(d) Set the TIME/CM to 1ms/cm, and BRIGHT LINE on. Adjust R308 (TRACE ROTATE) to bring the trace exactly parallel with the horizontal axis of the graticule.

(e) Set the CH2 shift to off, CH1 input switch to a.c., trigger selector to CH1 and apply to CH1 input socket a 20kHz sine wave, set to give approximately 8cm of Y deflection. Set the TIME/CM switch to 1ms/cm and adjust TRIGGER LEVEL control so that a raster is displayed. Adjust R307 (GEOM) for a compromise between horizontal and vertical pin cushion and barrel distortion. Reset R325 (FOCUS RANGE) and if necessary re-adjust R311 (ASTIG).

5.4.4 Y Calibration (Fig. 2)

(a) With the input coupling switch in the GND position, and CH2 off, obtain a trace on CH1 by operating the CH1 shift control. Adjust the front panel BALance control, R203, so that there is no trace shift when changing from the 0.2V/cm range to the 0.5V/cm range. Adjust R218 (VAR. GAIN BAL) on the Y preamplifier board so that there is no shift when the CH1 variable sensitivity control is operated.

(b) Repeat the preceding step for CH2 using R253 (BAL) and R268 (VAR. GAIN BAL).

(c) Turn CH2 off and set CH1 shift control to the centre of its range. If the trace is more than ±3cm from the centre of the screen change the value of R392 to rectify this.

(d) Repeat the preceding step for CH2, changing the value of R393 if necessary.

(e) Apply a sinewave signal to each channel in turn and set the amplitude for 8cm pk-pk display. Check that the traces can be shifted completely off the screen in each direction.

(f) Set both CH1 and CH2 attenuators to 0.2V/cm, both input switches to d.c., and the TIME/CM switch to 5ms/cm. Apply 1V from a calibrator to CH1, trigger on CH1, and adjust R342 (CH1 GAIN) for a 5cm display. Apply the same signal to CH2 input, trigger on CH2, and adjust R364 (CH2 GAIN) for a 5cm display.

5.4.5 Attenuator Compensation (Fig. 3)

Capacitors, C2 and C22, are selected such that the input capacitance is approximately 28pF.

To set the attenuator compensation, set the CH1 VOLTS/CM switch to 0.5, the input coupling to d.c. and the TIME/CM to 0.5ms/cm. Connect a low impedance 3V, 1kHz square wave signal to the input and adjust C202 for a square top to the display. Repeat for CH2, adjusting C222.

To equalise the input capacitance on all ranges connect a 1kHz square wave signal either via a 10:1 probe or a 1MΩ series resistor connected in parallel with a 10 to 40pF trimmer capacitor, mounted close to the input socket. Set the input amplitude for approximately 6cm of display and adjust the probe compensation or the trimmer for a square top to the display. Set the CH1 VOLTS/CM switch to 0.5 and adjust C201 to regain the flat top to the display. Repeat for CH2 adjusting C221.

5.4.6 Pulse Response and Bandwidth (Fig. 3)

Switch the CH1 attenuator to 5mV/cm and set TIME/CM to 1μs/cm. Apply a 500kHz fast risetime square wave signal to CH1 input using a 50Ω termination at the input socket to prevent cable reflections. Adjust output from the generator to give a 6cm display. Adjust C324 to obtain a flat level top towards the leading edge of the square wave, and adjust C323 and R345 to obtain a square corner. Repeat for CH2 using C335, C334 and R367 respectively. Check that the pulse response is square on all ranges between 5mV/cm and 0.2V/cm, adjusting the generator for approximately 6cm amplitude on each range. Allow a maximum of 4% over or under shoot.

Check bandwidth by applying a 50kHz sine wave to CH1 input and adjust the generator to give a 6cm display. Increase the frequency until the amplitude drops to 4.2cm, this frequency should be greater than 15MHz. If bandwidth is lower than 15MHz the capacitor, C328, may be increased and the pulse response re-optimised as above. Repeat bandwidth check on CH2 adjusting the value of C340 if necessary.

5.4.7 Timebase Calibration (Fig. 2)

(a) Set TIME/CM control to 1ms/cm and pull the PULL X10 XAMP control. Apply 1ms time markers to CH1, adjusting Y sensitivity to give approximately 3cm amplitude, triggering with bright line off (TRIGGER LEVEL control pulled out). Adjust R190 (X10 GAIN) on the timebase board for exactly 10cm between markers.

(b) Set PULL X10 XAMP (pushed in) and adjust R191 (X1 GAIN) on timebase board for 1cm between markers.

(c) With 1ms markers still applied, vary the supply voltage to the instrument by ±10% from the nominal value and check that there is less than ±1% change in timebase calibration.

(d) Set TIME/CM to 10μs/cm and apply 10μs markers. Adjust the trimmer, C10, (SET 1μs/cm) on the timebase range switch for 1cm between markers.

(e) With the PULL X10 XAMP control at X1, check all the timebase ranges from 1μs/cm to 0.5s/cm with the appropriate markers, to within ±5%.

(f) Check that the trace length is greater than 11cm on all timebase ranges.

(g) Check that the variable time control reduces the speed by greater than 2.5:1.

5.4.8 Trigger Balance (Fig. 2)

(a) With the NORMAL/SINGLE SHOT switch in the NORMAL position and no trigger signals applied, check that the timebase free runs with the BRIGHT LINE on and does not free run with the BRIGHT LINE off.

(b) Apply a 1kHz sine wave to CH1 and adjust amplitude to give approximately 6cm display. Adjust R132 (TRIG BAL) on the timebase board so that there is no vertical shift in the trigger point when moving the trigger source control between CH1 + and –. Check that the TRIGGER LEVEL is midway through its range when the timebase is triggering at the zero crossing point in the displayed waveform.

(c) With the signal applied to CH1 input, adjust R108 (CH1 DC BAL) on the timebase board so that there is no change in trigger point when the trigger coupling switch is moved from AC to DC. Repeat this adjustment with R116 (CH2 DC BAL) for CH2.

(d) Check that the ACF position of the trigger coupling switch is functional.

(e) Apply a 1kHz square wave input signal and reduce the amplitude to 3mm. Check that stable triggering can be obtained on both + and – slope positions for both input channels.

(f) Set the trigger source selector to EXT and apply a 1.5 volt, 1kHz square wave to the EXT TRIG input. Check that stable triggering can be obtained on both + and – slope settings with the BRIGHT LINE either on or off.

(g) Apply a 15MHz sine wave to CH1 and adjust amplitude for 1.5cm of display on the 20mV/cm attenuator range. Check that steady triggering can be obtained with the BRIGHT LINE switched off. Switch the attenuator to 0.1V/cm to give 2.5mm display and reduce the input frequency to 2MHz. Check for stable triggering and repeat both tests on CH2.

(h) Switch NORMAL/SINGLE SHOT to SINGLE SHOT and check for correct operation of the single shot facility. Press the ARM button and check that the l.e.d. lamp lights. Apply a trigger signal and check that a single trace occurs after which the lamp extinguishes.

5.4.9 Internal Calibrator (Fig. 3)

Set CH1 attenuator to .2V/cm. Apply a 1V ± 1% square wave calibration signal (approximately 50Hz) to CH1 input and note the exact deflection. Remove the 1V square wave and apply the internal calibrator to CH1 input. Adjust R328 (SET CAL) to give the deflection previously noted.

5.4.10 X-Y Operation

(a) Apply a 1kHz sine wave signal to the CH2 input socket and set TIME/CM to 1ms. Adjust the generator to give 5cm amplitude and apply this signal also to the CH1 input. Set the TIME/CM switch to X-Y and position the trace with the X shift control so that the X deflection is equal about the vertical centre line. Increase the frequency gradually to 20kHz and ensure that, if the 45° line gradually changes to an ellipse, the spacing of the lines on the vertical axis does not exceed 2.5mm over the frequency range.

(b) Set the CH2 input switch to GROUND and apply a 50kHz sine wave to the X(CH1) input socket. Adjust the amplitude to give a horizontal line 10cm long. Increase frequency until trace reduces to 7cm and ensure that this frequency is greater than 500kHz.

5.4.11 External X Operation

Apply a 50kHz sine wave to the EXT X socket with the TIME/CM switch set to EXT X and the PULL X10 XAMP control pulled. Adjust the amplitude to give 10cm deflection. Increase frequency until the trace reduces to 7cm and ensure that this frequency is greater than 1.5MHz.

5.4.12 Z Modulation

Set the CH1 attenuator to 1V/cm and apply both to the CH1 input and to the Z MOD socket at 10V 1kHz square wave. Check that blanking occurs at normal brilliance levels.

Component List and Illustrations — Section 6

ABBREVIATIONS USED FOR COMPONENT DESCRIPTIONS

RESISTORS

CC	Carbon Composition	$\frac{1}{2}$W	10%	unless otherwise stated
CF	Carbon Film	$\frac{1}{8}$W	5%	unless otherwise stated
MO	Metal Oxide	$\frac{1}{2}$W	2%	unless otherwise stated
MF	Metal Film	$\frac{1}{4}$W	1%	unless otherwise stated
WW	Wire Wound	6W	5%	unless otherwise stated
CP	Control Potentiometer			
PCP	Preset Potentiometer Type	MPD, PC	20%	unless otherwise stated
MG	Metal Glaze	$\frac{1}{2}$W	0.5%	unless otherwise stated

CAPACITORS

CE(1)	Ceramic		+ 80% − 25%	
CE(2)	Ceramic	500V	± 10%	unless otherwise stated
SM	Silver Mica	350V		
PF	Plastic Film and Foil		± 10%	unless otherwise stated
PS	Polystyrene			
PE	Polyester		± 10%	unless otherwise stated
PC	Polycarbonate			
E	Electrolytic (aluminium)		+ 50% − 10%	
T	Tantalum		+ 50% − 10%	

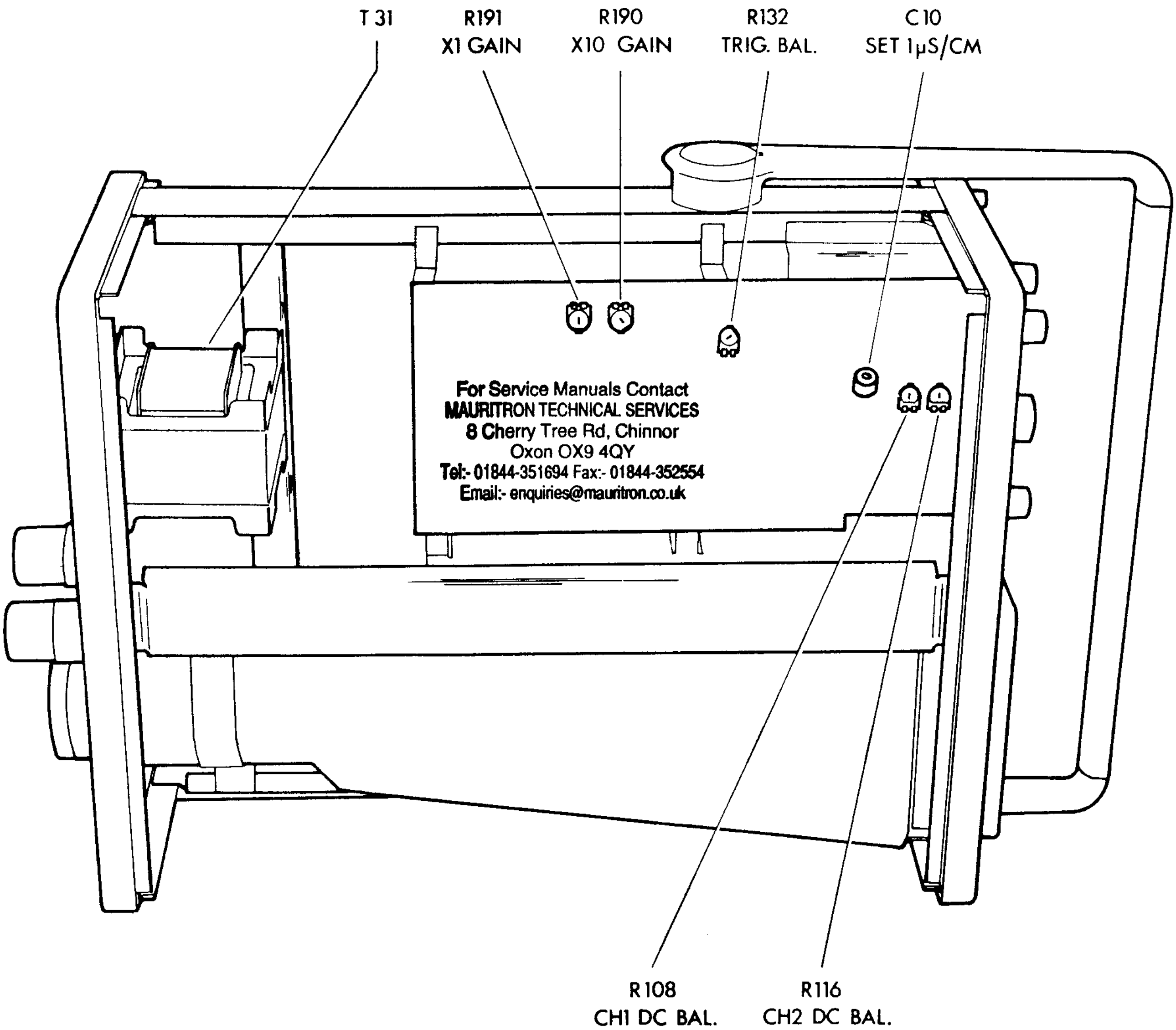


Fig. 2 Top view

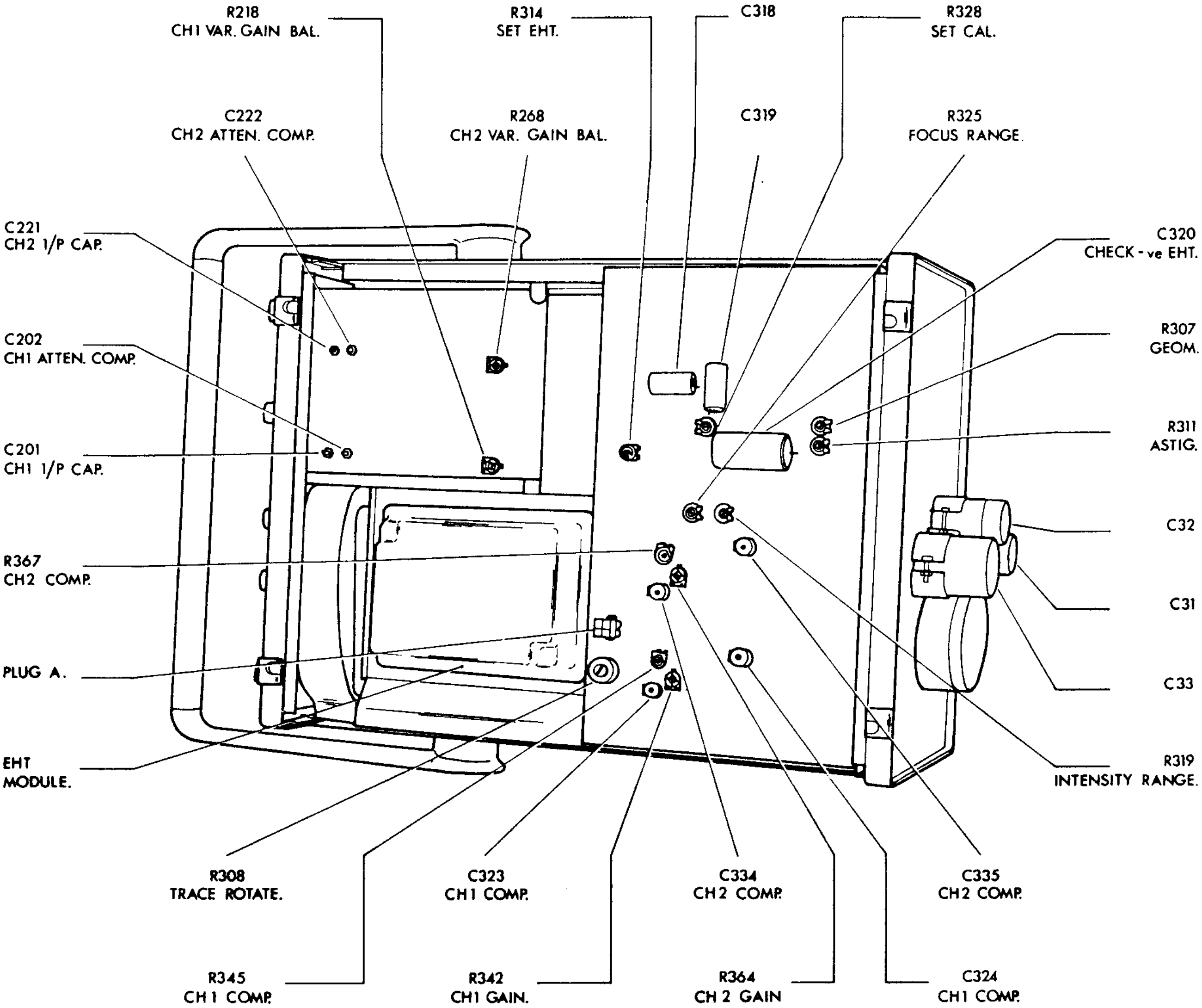


Fig. 3 Bottom view

Component List and Illustrations

Section 6

'Y' PRE-AMP

Ref	*Value*	*Description*	*Tol %±*	*Part No*
RESISTORS				
R201	10k1	MF		26338
R202	470	CF		21797
R203	22k	CP		A4/32894
R204	6k8	CF		21807
R205	10k	CF		21809
R206	3k3	CF		21803
R207	10k	MO		28800
R208	6k8	CF		21807
R209	100	CF		21794
R210	47k	CF		21815
R211	1k8	MO		26732
R212	2k7	CF		28726
R213	2k7	CF		28726
R214	1k8	MO		26732
R215	47	CF		28714
R216	47	CF		28714
R217	10k	MO		28800
R218	470	PCP		37419
R219	2k7	CF		28726
R220	180	MO		26744
R221	2k7	CF		28726
R222	100	CF		21794
R223	5k6	CF		21806
R224	470	CF		21797
R225	12k	CF		21810
R226	1k5	CF		18552
R227	47	CF		28714
R228	1k2	CF	½W	18551
R229	10	CF		21793
R230	10	CF		21793
R231	150	CF		28719
R232	180k	CF	A.O.T.	21822
R233	270	CF		28720
R234	470	CF		21797
R235	62	MO		28778
R236	180	CF		21795
R237	150	CF		28719
R238	1k5	CF		21801
R239	1k5	CF		21801
R240	4k7	CF		21805
R241	4k7	CF		21805
R242	27k	CF		21813
R243	56k	CF		28729
R244	5k6	CF		21806
R251	10k1	MF		26338
R252	470	CF		21797
R253	22k	CP		A4/32894
R254	6k8	CF		21807
R255	10k	CF		21809
R256	3k3	CF		21803
R257	10k	MO		28800
R258	6k8	CF		21807
R259	100	CF		21794
R260	47k	CF		21815
R261	1k8	MO		26732
R262	2k7	CF		28726
R263	2k7	CF		28726
R264	1k8	MO		26732
R265	47	CF		28714
R266	47	CF		28714
R267	10k	MO		28800
R268	470	PCP		37419
R269	2k7	CF		28726
R270	180	MO		26744
R271	2k7	CF		28726
R272	100	CF		21794
R273	5k6	CF		21806
R274	470	CF		21797
R275	12k	CF		21810
R276	1k5	CF	½W	18552
R277	47	CF		28714
R278	1k2	CF	½W	18551
R279	10	CF		21793
R280	10	CF		21793
R281	150	CF		28719
R282	180k	CF	A.O.T.	21822
R283	270	CF		28720
R284	470	CF		21797
R285	62	MO		28778
R286	180	CF		21795
R287	150	CF		28719
CAPACITORS				
C201	6pF	TRIMMER		25750
C202	6pF	TRIMMER		25750
C203	.01μF	CE(2)	250V	22395
C204	.01μF	CE(2)	250V	22395
C205	15pF	CE(2)		22366
C206		FITTED IF REQUIRED		
C207	0.1μF	CE(2)		36709
C208	.01μF	CE(2)	250V	22395
C209	3.0pF	S/M		34225
C221	6pF	TRIMMER		25750
C222	6pF	TRIMMER		25750
C223	.01μF	CE(2)	250V	22395
C224	.01μF	CE(2)	250V	22395
C225	15pF	CE(2)		22366
C226		FITTED IF REQUIRED		
C227	0.1μF	CE(2)		19647
C228	.01μF	CE(2)	250V	22395
C229	3.9pF	S/M		34225
C240	.01μF	CE(2)	250V	22395
C241	.01μF	CE(2)	250V	22395
TRANSISTORS				
TR201 TR202		AE31	Dual F.E.T.	A36243
TR203 TR204		ZTX313 ZTX313	Matched Pair	A31254
TR205		2N3906		21533

Component List and Illustrations

Section 6

Ref	*Description*	*Part No*
1	Frame Front	30575
2	Frame Rear	37502
3	Bracket Support Side	34460
4	Bracket Support Top	34462
5	Trim Side	29297
6	Insert Threaded 4–40	29905
7	Panel Front (Gould)	38762
8	Panel Front Inner (Timebase)	36660
9	Panel Front Inner (Y Amp)	36661
10	Terminal Earth	32310
11	Escutcheon	36351
12	Graticule	36048
13	Filter (Blue)	33749
14	Moulding Tube Support Assy.	36238
15	Foot Moulded	36329
16	Plate, P.C.B. Support	37071
17	Screen	37073
18	Bracket Support, Transformer	37051
19	E.H.T. Assy.	37176
20	Panel Rear	37070
21	Cover Rear	37076
22	Handle Assy.	36656
23	Title Strip	37122
24	Spindle	36358
25	Spring	29206
26	Block Indexing	30578
27	Circlip	10016
28	Screw 6–32 x $\frac{3}{8}$ Pan Head	22816
29	Screw M3 x 8 C'sk Head	33069
30	Button Handle	36681
31	Plate Support E.H.T.	37075
32	Holder Fuse	32210
33	Fuse 1A (115V Supply)	34790
34	Cover Top	37088
35	Cover Bottom	37089
36	Latch	37864
37	'O' Ring	37915
38	Screw 4–40 x $\frac{5}{16}$ Pan Head T.T.	22695
39	Screw 4–40 x $\frac{3}{8}$ Pan Head T.T.	22696
40	Screw 4–40 x $\frac{1}{4}$ C'sk Head	22780
41	Screw 4–40 x $\frac{3}{8}$ Pan Head	22844
42	Screw 6–32 x $\frac{3}{8}$ C'sk Head	22772
43	Washer 4–40	1200
44	Washer 4–40 Wavey	4591
45	Washer 6–32 Wavey	4590

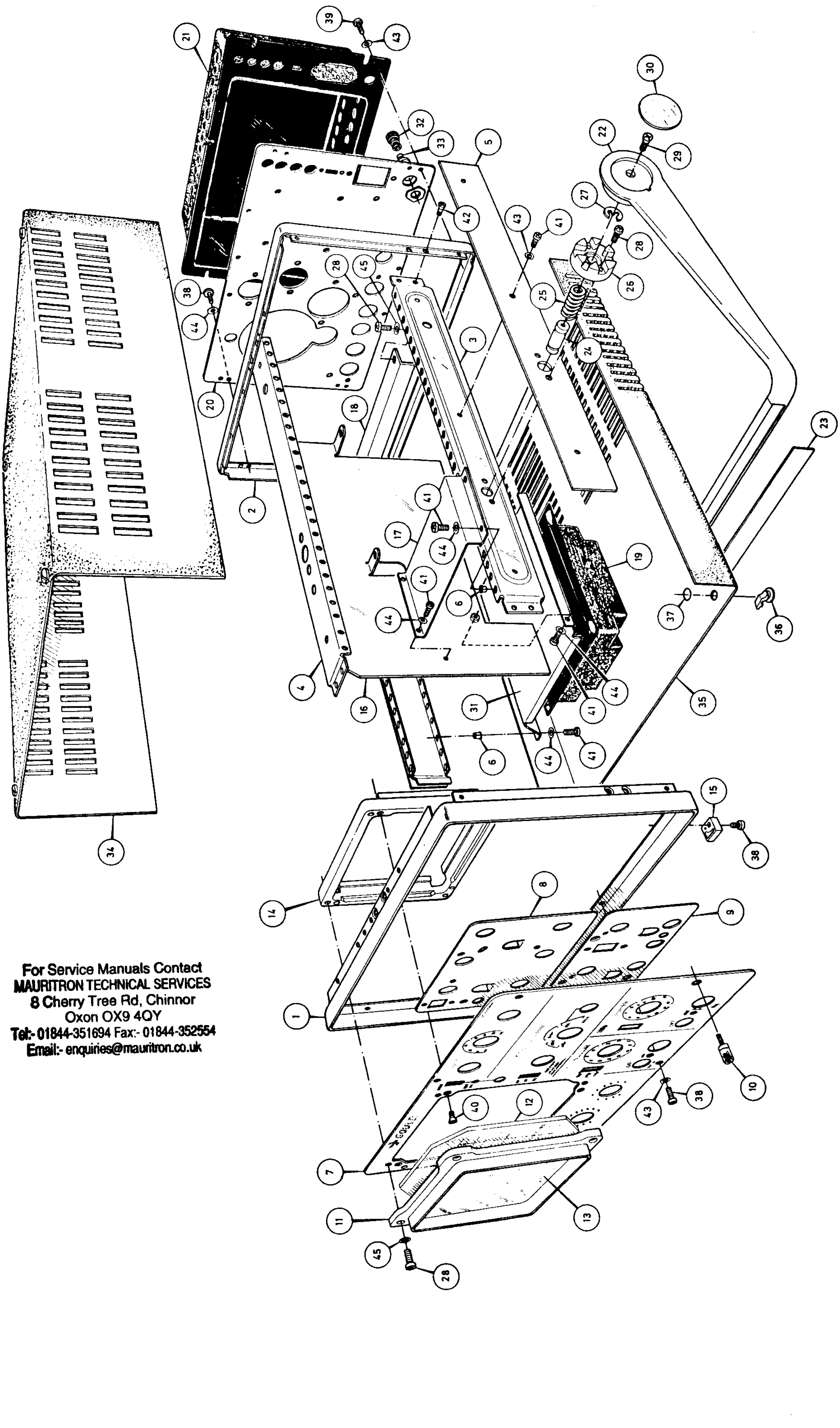


Fig.8 Mechanical Views

'Y' PRE-AMP (Cont.)

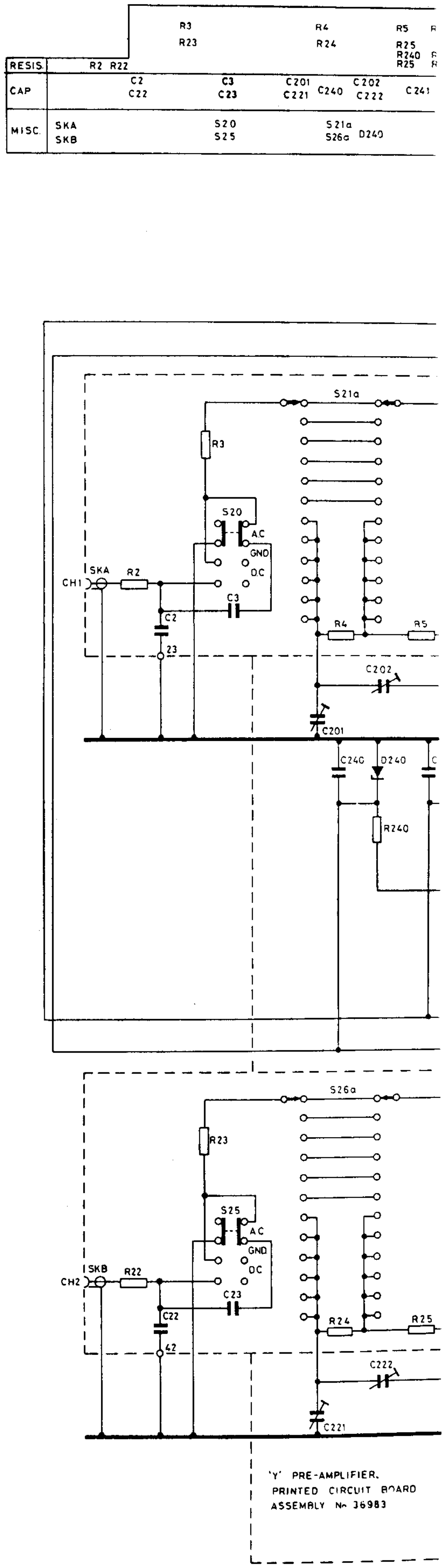
Ref	Value	Description	Tol %±	Part No
TR206		ZTX313 Matched Pair		A31254
TR207		ZTX313		
TR208		2N3906		21533
TR209		2N3906		21533
TR210		2N3906		21533
TR212		BC182B		33205
TR212		ZTX313 Matched Pair with TR232		A31254
TR221		AE31 Dual F.E.T.		A36243
TR222				
TR223		ZTX313 Matched Pair		A31254
TR224		ZTX313		
TR225		2N3906		21533
TR226		ZTX313 Matched Pair		A31254
TR227		ZTX313		
TR228		2N3906		21533
TR229		2N3906		21553
TR230		2N3906		21533
TR231				
TR232		ZTX313 Matched Pair with TR212		A31254

Ref	Value	Description	Tol %±	Part No
DIODES				
D201		IN3595		29330
D202		IN3595		29330
D203		IN4148		23802
D206		IN4148		23802
D207				
D208	3V3	ZENER		33923
D209		IN4148		23802
D221		IN3595		29330
D222		IN3595		29330
D223		IN4148		23802
D224				
D225				
D226		IN4148		23802
D227				
D228	3V3	ZENER		33923
D229		IN4148		23802
D240	8V2	ZENER		33933
D241	8V2	ZENER		33933

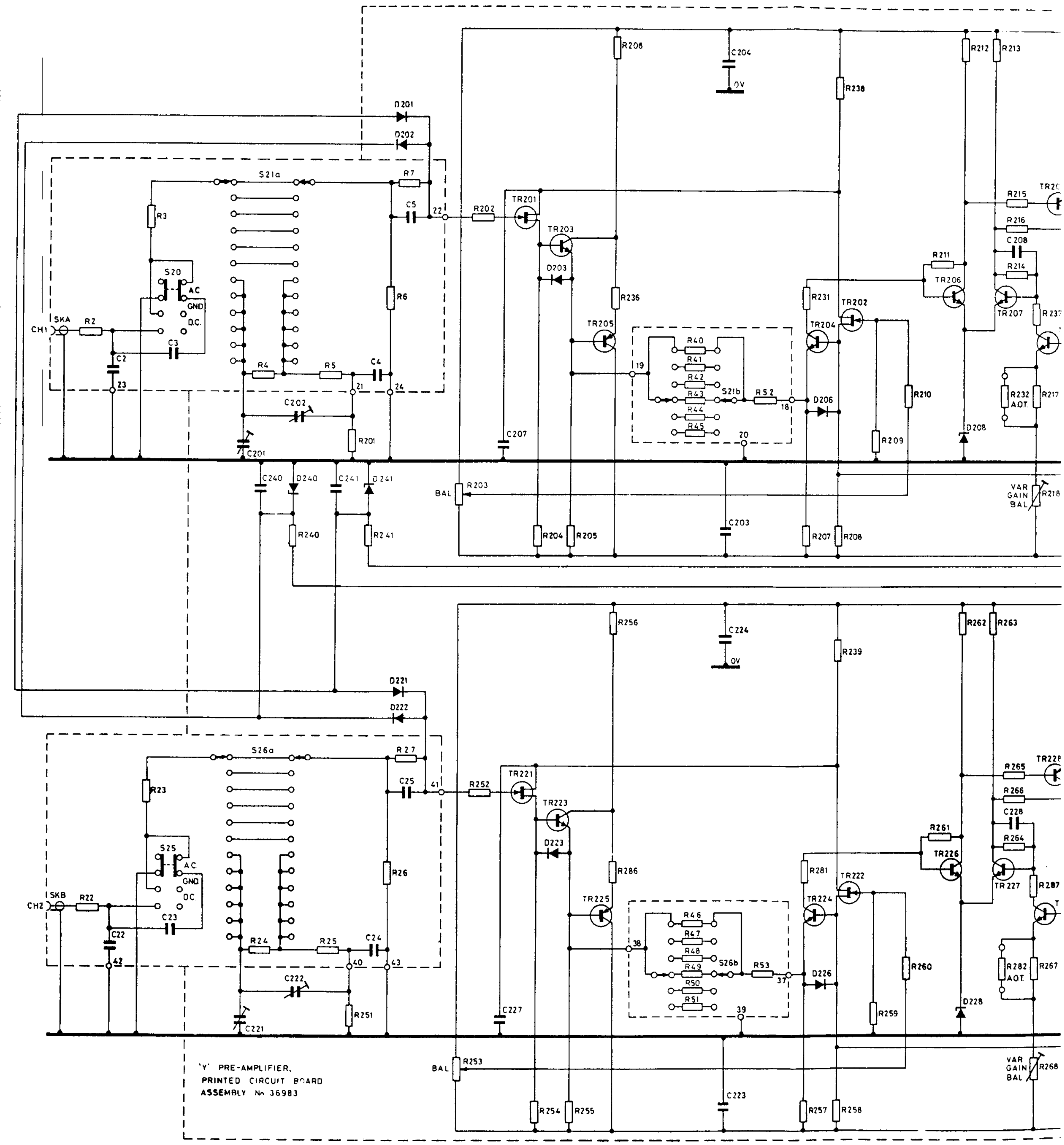
ns

Section 6

Ref	Value	Description	Tol %±	Part No
DIODES				
D201		IN3595		29330
D202		IN3595		29330
D203		IN4148		23802
D206		IN4148		23802
D207				
D208	3V3	ZENER		33923
D209		IN4148		23802
D221		IN3595		29330
D222		IN3595		29330
D223		IN4148		23802
D224				
D225				
D226		IN4148		23802
D227				
D228	3V3	ZENER		33923
D229		IN4148		23802
D240	8V2	ZENER		33933
D241	8V2	ZENER		33933



			R3 R23			R4 R24		R5 R25 R240 R25	R201 R241 R251	R6 R26	R7 R27	R203 R202 R203 R253 R252		R204 R254	R205 R255		R206 R236 R256 R286	R40–45 R46–51	R52 R53	R231 R207 R281 R257	R238 R208 R258 R239	R209 R259	R210 R260	R211 R261	R212 R262	R232 R213 R263 R282	R215 R217 R216 R214 R237 R255 R266 R267 R264 R287
ESIS	R2 R22																										
AP		C2 C22		C3 C23	C201 C221	C240	C202 C222	C241	C4 C24		C5 C25		C207 C227						C204 C203 C224 C223								C208 C228
ISC.	SKA SKB			S20 S25		S21a S26a	D240		D241		D201 D202 D221 D222		TR201 TR221		TR203 D203 TR223 D223	TR205 TR225			S21b S26b	TR204 D206 TR224 D225		TR202 TR222		TR206 D208 TR226 D228		TR207 TR227	TR20 TR21 TR22 TR23



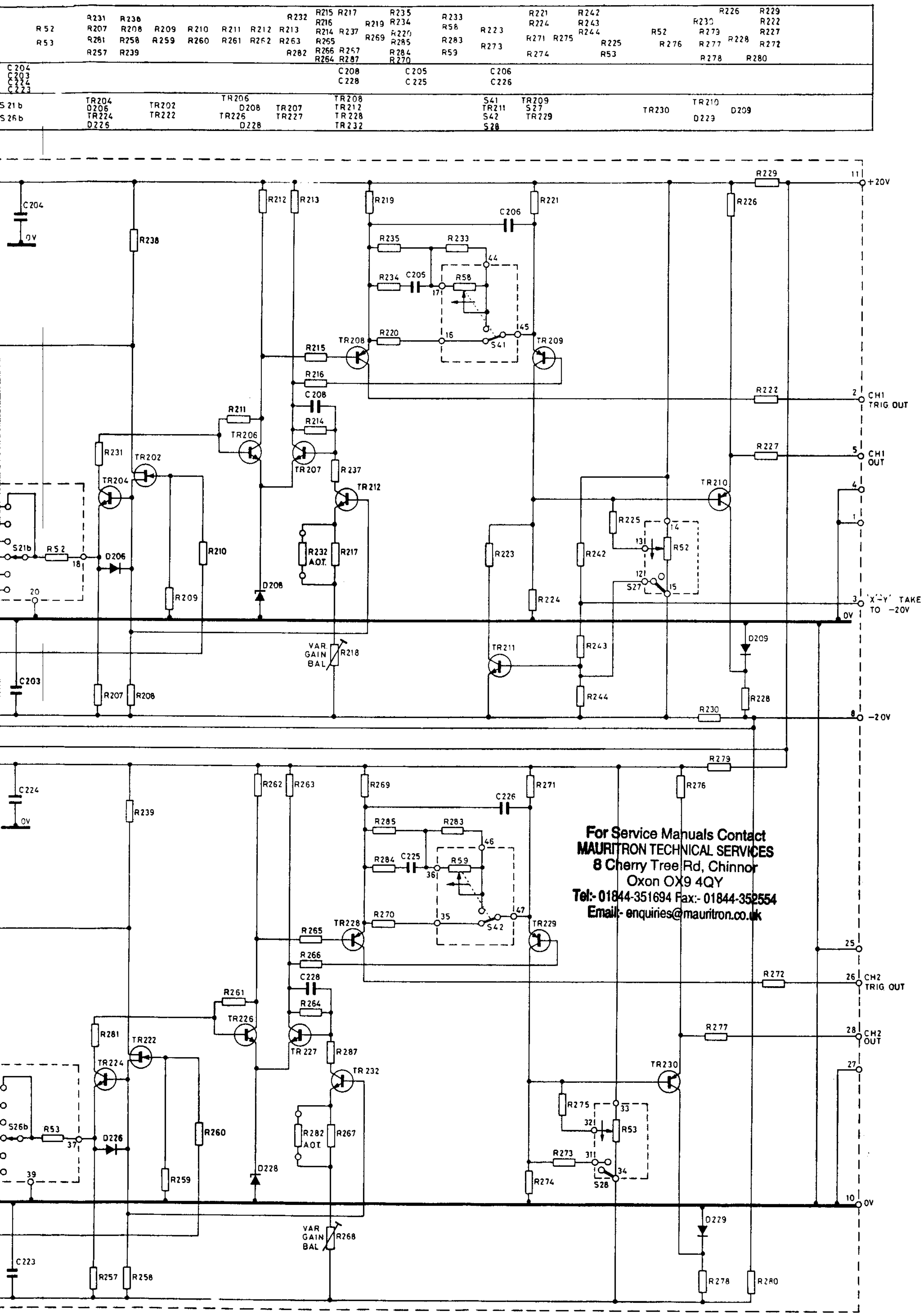


Fig. 4 Y Preamplifiers Circuit Diagram

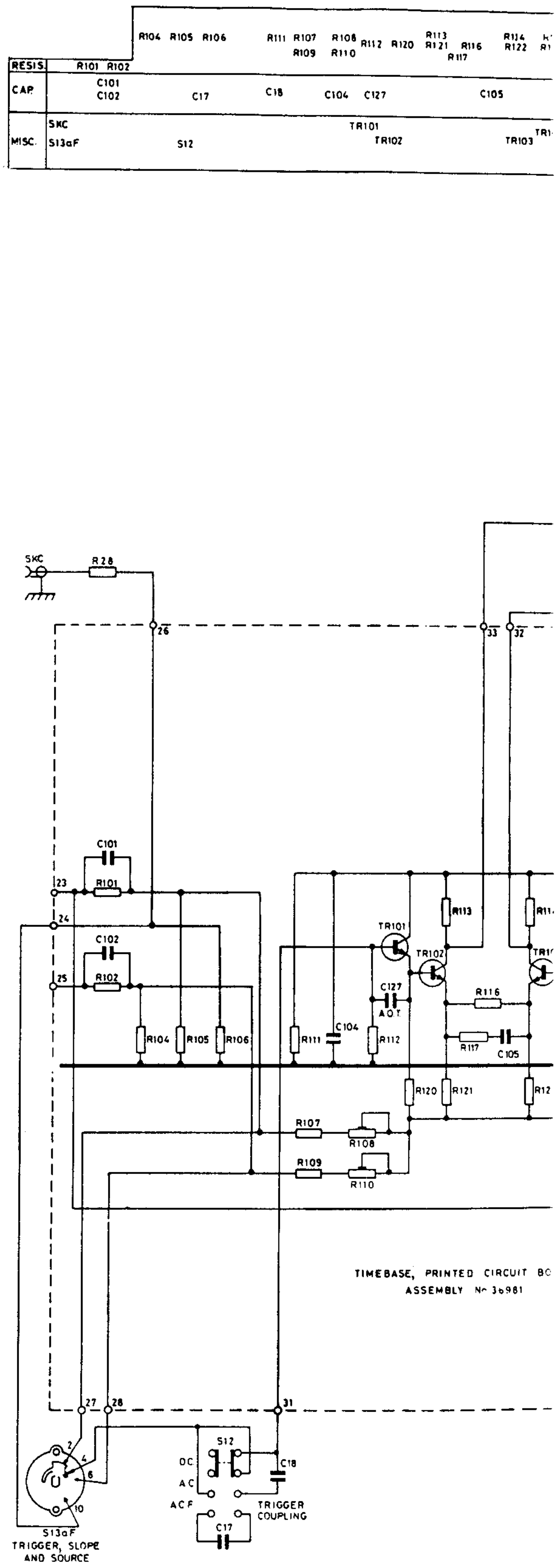
TIMEBASE

Ref	Value	Description	Tol %±	Part No
RESISTORS				
R85	2M2	CF		24838
R86	150k	CF		21821
R87	680k	CF		31839
R88	1M	CF		31840
R89	10k	CF		21809
R90				
R91	4k7	CF		21805
R92	4k7	CF		21805
R93	100	CF		21794
R94	10k	CF		21809
R95	3k3	CF		21803
R96	1k8	CF	½W	18553
R97	100	CF		21794
R98				
R99				
R100				
R101	620	MO		22485
R102	620	MO		22485
R103				
R104	390	MO		26740
R105	390	MO		26740
R106	820	CF		28724
R107	3k3	CF		21803
R108	2k5	CP		36265
R109	3k3	CF		21803
R110	2k5	CP		36265
R111	3k9	CF		21804
R112	22k	CF		21812
R113	330	CF		28721
R114	330	CF		28721
R115	2k7	CF		28726
R116	56	CF		35352
R117	47	CF		28714
R118	220k	CF		21823
R119	3k9	CF		21804
R120	820k	CF		32360
R121	22k	CF		21812
R122	22k	CF		21812
R123	820k	CF		32630
R124	10	CF		21793
R125	390	CF		28722
R126	47	CF		28714
R127				
R128	1k2	CF		21800
R129	47	CF		28714
R130	15	CF		28708
R131	15	CF		28708
R132	2k5	CP		36265
R133	3k3	CF		21803
R134	10	CF		21793
R135	10	CF		21793
R136	10	CF		21793
R137	1k	CF		21799
R138				
R139	10	CF		21793
R140	330	CF		28721
R141	390	CF		28722
R142	8k2	CF		21808
R143	1k5	CF		21801
R144	10k	CF		21809
R145	3k3	CF		21803
R146	4k7	CF		21805
R147	27k	CF		21813
R148	1k	CF		21799
R149	1M	CF		31840
R150	100k	CF		21819
R151	1k	CF		21799
R152	3k9	CF		21804
R153	10k	CF		21809
R154				
R155				
R156	100k	CF		21819
R157	10M	CF		32661
R158	680	CF		28723
R159	2k2	CF		21802
R160	15k	CF		28727
R161	3k9	CF		21804
R162	3k9	CF		21804
R163	15k	CF		28727
R164	12k	CF		21810
R165	47k	CF		21815
R166	100k	CF		21819
R167	100k	CF		21819
R168	10k	CF		21809
R169	1k	CF		21799
R170	1k5	CF		21801
R171	270k	CF		32356
R172	680k	CF		31839
R173	100	CF		21794
R174	56k	CF	1W	19058
R175	3k9	CF		21804
R176	3k9	CF		21804
R177	56k	CF	1W	19058
R178	10k	CF	4W	29481
R179	100	CF		21794
R180	100	CF		21794
R181	10k	CF	4W	29481
R182	56k	CF	1W	19058
R183	68k	CF		21816
R184	910	CF		52991
R185	2k2	CF		21802
R186	27k	CF		21803
R187	100	CF		21794
R188	270	CF		28720
R189	2k7	CF		28726
R190	100	CP		36261
R191	1k	CP		36264
R192	1k2	CF		21800
R193	1k5	CF		21801
R194	180	CF		21795
R195	100	CF		21794
R196	1k2	CF		21800
R197	1k6	MO		29793
R198	1k6	CF		29793
R199	1k6	MO		29793

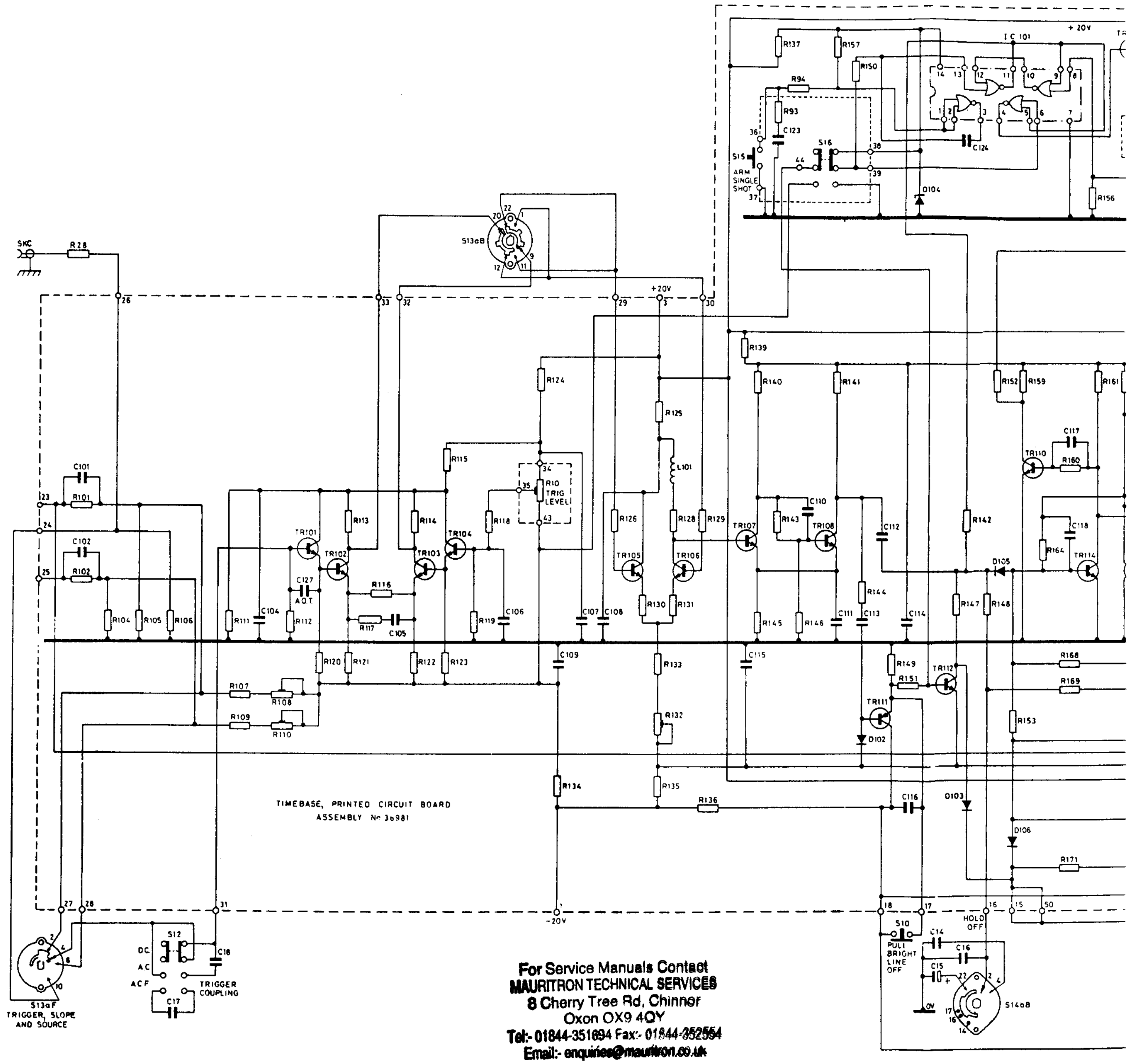
TIMEBASE (Cont.)

Ref	Value	Description	Tol % ±	Part No
CAPACITORS				
C101	100pF	CE(2)		22376
C102	100pF	CE(2)		22376
C103				
C104	.01μF	CE(2)		24902
C105	1500pF	CE(2)		22388
C106	.01μF	CE(2)		24902
C107	.01μF	CE(2)		24902
C108	.01μF	CE(2)		24902
C109	.1μF	CE(2)	25V	36709
C110	33pF	CE(2)		22370
C111	33pF	CE(2)		22370
C112	27pF	CE(2)		22369
C113	.01μF	CE(2)		24902
C114	.1μF	CE(2)	25V	36709
C115	.01μF	CE(2)		24902
C116	.47μF	CE(2)		35352
C117	22pF	CE(2)		22368
C118	27pF	CE(2)		22369
C119	27pF	CE(2)		22369
C120	10pF	CE(2)		22364
C121	100pF	CE(2)		22376
C122	330pF	CE(2)		29498
C123	.01μF	CE(2)		24902
C124	100pF	CE(2)		22376
C125				
C126	.01μF	CE(2)		24902
C127			A.O.T.	
TRANSISTORS				
TR101		BC182B		33205
TR102		2N2369		23307
TR103		2N2369		23307
TR104		BC182B		33205
TR105		2N2369		23307
TR106		2N2369		23307
TR107		2N2369		23307
TR108		2N2369		23307
TR109		BC182B		33205
TR110		2N2369		23307
TR111		BC212		29327
TR112		BCB2B		33205
TR113				
TR114		2N2369 (I.T.T. Only)		33701
TR115		2N2369 (I.T.T. Only)		33701
TR116		2N2369		23307
TR117		2N2369		23307
TR118				
TR119		BC212		29327
TR120		BC212		29327
TR121		BC182B		33205
TR122		BC212		29327
TR123		BF258		31490
TR124		BF258		31490
TR125		BC212		29327
TR126		BC212		29327
DIODES				
D101		IN4148		23802
D102		IN3595		29330
D103		IN4148		23802
D104	15V	ZENER		33939
D105		IN4148		23802
D106		IN4148		23802
D107		IN4148		23802
D108	8V2	ZENER		33933
D109		IN4148		23802
D110		IN4148		23802
D111		IN4148		23802
D112		IN4148		23802
D113		IN4148		23802
D114	3V9	ZENER		33925
D115		IN4148		23802
D116		IN4148		23802
INTEGRATED CIRCUITS				
IC101		MC14001		36195
MISCELLANEOUS				
L101	15μH			29496

Ref	Value	Description	Tol % ±	Part No
TR112		BCB2B		33205
TR113				
TR114		2N2369 (I.T.T. Only)		33701
TR115		2N2369 (I.T.T. Only)		33701
TR116		2N2369		23307
TR117		2N2369		23307
TR118				
TR119		BC212		29327
TR120		BC212		29327
TR121		BC182B		33205
TR122		BC212		29327
TR123		BF258		31490
TR124		BF258		31490
TR125		BC212		29327
TR126		BC212		29327
DIODES				
D101		IN4148		23802
D102		IN3595		29330
D103		IN4148		23802
D104	15V	ZENER		33939
D105		IN4148		23802
D106		IN4148		23802
D107		IN4148		23802
D108	8V2	ZENER		33933
D109		IN4148		23802
D110		IN4148		23802
D111		IN4148		23802
D112		IN4148		23802
D113		IN4148		23802
D114	3V9	ZENER		33925
D115		IN4148		23802
D116		IN4148		23802
INTEGRATED CIRCUITS				
IC101		MC14001		36195
MISCELLANEOUS				
L101	15μH			29496



RESIS.	R101 R102 R104 R105 R106 R111 R107 R109 R108 R110 R112 R120 R113 R121 R117 R116 R114 R122 R115 R123 R119 R118 R124 R10 R134 R126 R130 R125 R133 R132 R135 R128 R131 R129 R136 R139 R140 R145 R137 R94 R93 R143 R146 R157 R141 R144 R150 R149 R151 R142 R147 R148 R152 R153 R159 R164 R160 R168 R169 R171 R156 R161 R157
CAP.	C101 C102 C17 C18 C104 C127 C105 C106 C109 C107 C108 C115 C123 C110 C111 C113 C112 C114 C116 C14 C15 C16 C124 C117 C118
MISC.	SKC S13aF S12 TR101 TR102 TR103 TR104 S13aB TR105 TR106 L101 S15 TR107 S16 TR108 TR111 D102 S10 D104 TR112 D103 D105 D106 S14bB IC101 TR110 TR114 TR



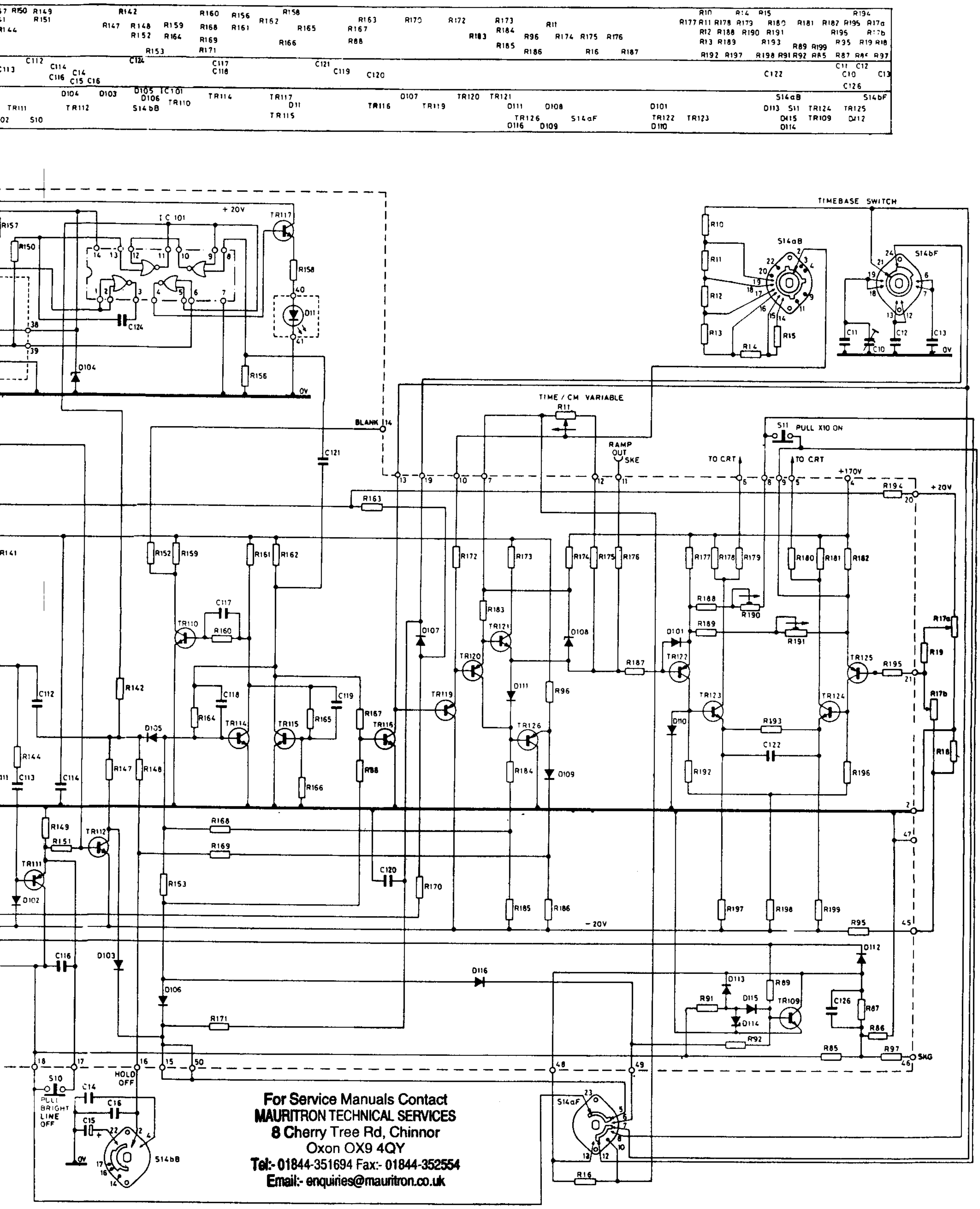


Fig. 5 Timebase Circuit Diagram

POWER SUPPLY & 'Y' O/P

Ref	*Value*	*Description*	*Tol %±*	*Part No*
RESISTORS				
R301	120	CF	½W	18539
R302				
R303	390k	CF		32358
R304	3k3	CF		21803
R305	100k	CF		21819
R306	4k7	PCP		28279
R307	500k	CP		36271
R308	390k	CF		32358
R309	270k	CF		32356
R310	100	CF		21794
R311	500k	CP		36271
R312	100k	CF		21819
R313	1M	CF		31840
R314	25k	CP		36268
R315	82k	CF		21818
R316	33k	CF		21814
R317	5k6	CF		21806
R318	6M8	MG		37201
R319	25k	CP		36268
R320	100	CF		21794
R321	680k	CF		31839
R322	1k	CF		21799
R323	22k	CF		21812
R324	3k3	CF		21803
R325	500k	CP		36271
R326	6M8	MG		37201
R327	470k	CF		32330
R328	10k	PCP		29574
R329	8k2	CF		21808
R330	5k6	CF		21806
R331	1k	CF		21799
R332	680k	CC		5024
R333	680k	CC		5024
R334	100k	CF		21819
R335	22k	CF		21812
R336	100	CF		21794
R337	220k	CF		21823
R338	10	CF		21793
R339	330	CF		28721
R340	820	CF		28724
R341	82	CF		28717
R342	100	CP		36958
R343	10	CF		21793
R344	2k7	CF		28726
R345	250	PCP		29371
R346	2k2	CF		21802
R347	2k4	MF		37208
R348	39	CF		28713
R349	680	CF		28723
R350	5k6	CF		21806
R351	470	CF		21797
R352	120	CF		28718
R353	620	MF		37207
R354	10	CF		21793
R355	47	CF		28714
R356	150	CF		28719

Ref	*Value*	*Description*	*Tol %±*	*Part No*
R357	2k4	MF		37208
R358	100	CF		21794
R359	2k2	CF		21802
R360	10	CF		21793
R361	820	CF		28724
R362	330	CF		28721
R363	82	CF		28717
R364	100	CP		36958
R365	10	CF		21793
R366	2k7	CF		28726
R367	250	PCP		29371
R368	2k2	CF	⅛W	21802
R369	2k4	MF		37208
R370	39	CF		28713
R371	1M5	CF	½W	18588
R372	5k6	CF		21806
R373	470	CF		21797
R374	120	CF		28718
R375	10	CF		21793
R376	47	CF		28714
R377	620	MF		37207
R378	2k4	MF		37208
R379	100	CF		21794
R380	2k2	CF		21802
R381	33k	CF		21814
R382	150	CF		28719
R383	4k7	CF		21805
R384	4k7	CF		21805
R385	4k7	CF		21805
R386	4k7	CF		21805
R387	100k	CF		21819
R388	4k7	CF		21805
R389	270k	CF		32356
R390	220k	CF		21823
R391	100	CF	½W	18538
R392			A.O.T.	
R393			A.O.T.	
R394			A.O.T.	
R395			A.O.T.	
R901	4M7	MG	1W	37171
R902	68M	MG	1W	37173
R903	27M	MG	1W	37172
CAPACITORS				
C301	4.7μF	E	450V	34841
C302	4.7μF	E	450V	34841
C303	4.7μF	E	450V	34841
C304	4.7μF	E	450V	34841
C305	4.7μF	E	450V	34841
C306	4.7μF	E	450V	34841
C307	4.7μF	E	450V	34841
C308	4.7μF	E	450V	34841
C309	10μF	E	25V	32180
C310	10μF	E	25V	32180
C311	1000pF	CE(2)	500V	22387

POWER SUPPLY & 'Y' O/P (Cont.)

Ref	Value	Description	Tol %±	Part No
C312	1000pF	CE(2)	500V	22387
C313	4.7μF	E	63V	32195
C314	56pF	CE(2)	2kV	37202
C315	56pF	CE(2)	2kV	37202
C316	4.7μF	E	63V	32195
C317	1μF	E	63V	32193
C318	2.2μF	E	350V	37214
C319	2.2μF	E	350V	37214
C320	.08μF	PE	5kV	36277
C321	1000pF	CE(2)	500V	22387
C322	68pF	PS		35911
C323	10/70pF	TRIMMER		37219
C324	10/70pF	TRIMMER		37219
C325	27pF	CE(2)	500V	22369
C326		A.O.T.		
C327	15pF	PS		35907
C328	68pF	PS A.O.T.		35911
C329	.1μF	CE(2)	25V	36709
C330	.1μF	CE(2)	25V	36709
C331	.1μF	CE(2)	25V	36709
C332	1000pF	CE(2)	500V	22387
C333	68pF	PS		35911
C334	10/70pF	TRIMMER		37219
C335	10/70pF	TRIMMER		37219
C336	27pF	CE(2)	500V	22369
C337		A.O.T.		
C338	15pF	PS		35907
C339	.1μF	CE(2)	25V	36709
C340	68pF	PS A.O.T.		35911
C341	.1μF	CE(2)	25V	36709
C342	.1μF	CE(2)	25V	36709
C343	.1μF	CE(2)	25V	36709
C344	4700pF	CE	4kV	26863
C345	.01μF	CE(2)	250V	22395
C346	0.47μF	PE	63V	31362
C347	4.7μF	E Fitted if req.	450V	34841
C348	4.7μF	E Fitted if req.	63V	32195
C901	.08μF	PE	5kV	36277
C902	.08μF	PE	5kV	36277
C903	.08μF	PE	5kV	36277
C904	.08μF	PE	5kV	36277

TRANSISTORS

Ref	Value	Description	Tol %±	Part No
TR301		BFY50		26112
TR302		BF380		32902
TR303		BC182B		33205
TR304		BC212		29327
TR305		BC212		29327
TR306		BC212		29327
TR307		BUX86		37562
TR308		BC182B		33205
TR309		BC182B		33205
TR310		BC182B		33205
TR311		2N3904		24146
TR312		2N2369		23307
TR313		2N2369		23307
TR314		BF380		32902
TR315		BF380		32902
TR316		2N2369		23307
TR317		2N3904		24146
TR318		2N2369		23307
TR319		2N2369		23307
TR320		BF380		32902
TR321		BF380		32902
TR322		2N2369		23307

DIODES

Ref	Value	Description	Tol %±	Part No
D301		REMO HS 2-6 or H691 8kV		37809 or 37174
D302	10V	ZENER		33935
D303	4V7	ZENER		33927
D304		IN4003		23462
D305		IN4003		23462
D306		IN4003		23462
D307		ZENER		27957
D308		IN4148		23802
D309		IN4148		23802
D310		IN4148		23802
D311		IN4148		23802
D312		IN4007		52337
D313		IN4007		52337
D314	160V	ZENER		37212
D315	160V	ZENER		37212
D316	150V	ZENER		29485
D317		IN4148		23802
D318		IN4148		23802
D319	8V2	ZENER		33933
D320	8V2	ZENER		33933
D321	10V	ZENER		33935
D322		IN4148 Fitted if req.		23802
D323		IN4148 Fitted if Req.		23802
D901		REMO HS 2-6 or H691 8kV		37809 or 37174
D902		REMO HS 2-6 or H691 8kV		37809 or 37174
D903		REMO HS 2-6 or H691 8kV		37809 or 37174
D904		REMO HS 2-6 or H691 8kV		37809 or 37174

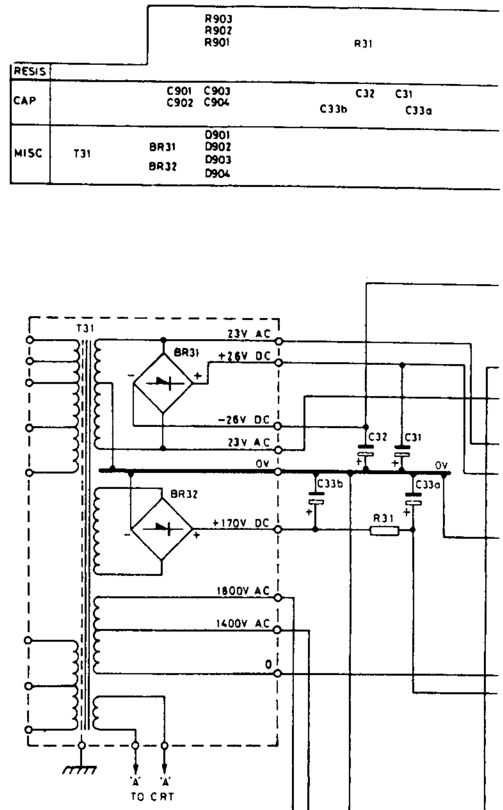
INTEGRATED CIRCUITS

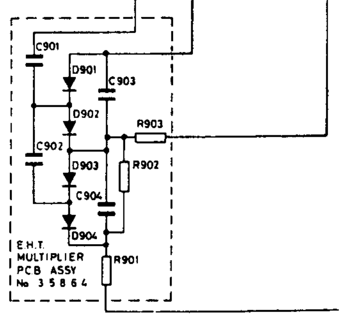
Ref	Value	Description	Tol %±	Part No
IC301		78M20CP		37213
IC302		7915		36185

MISCELLANEOUS

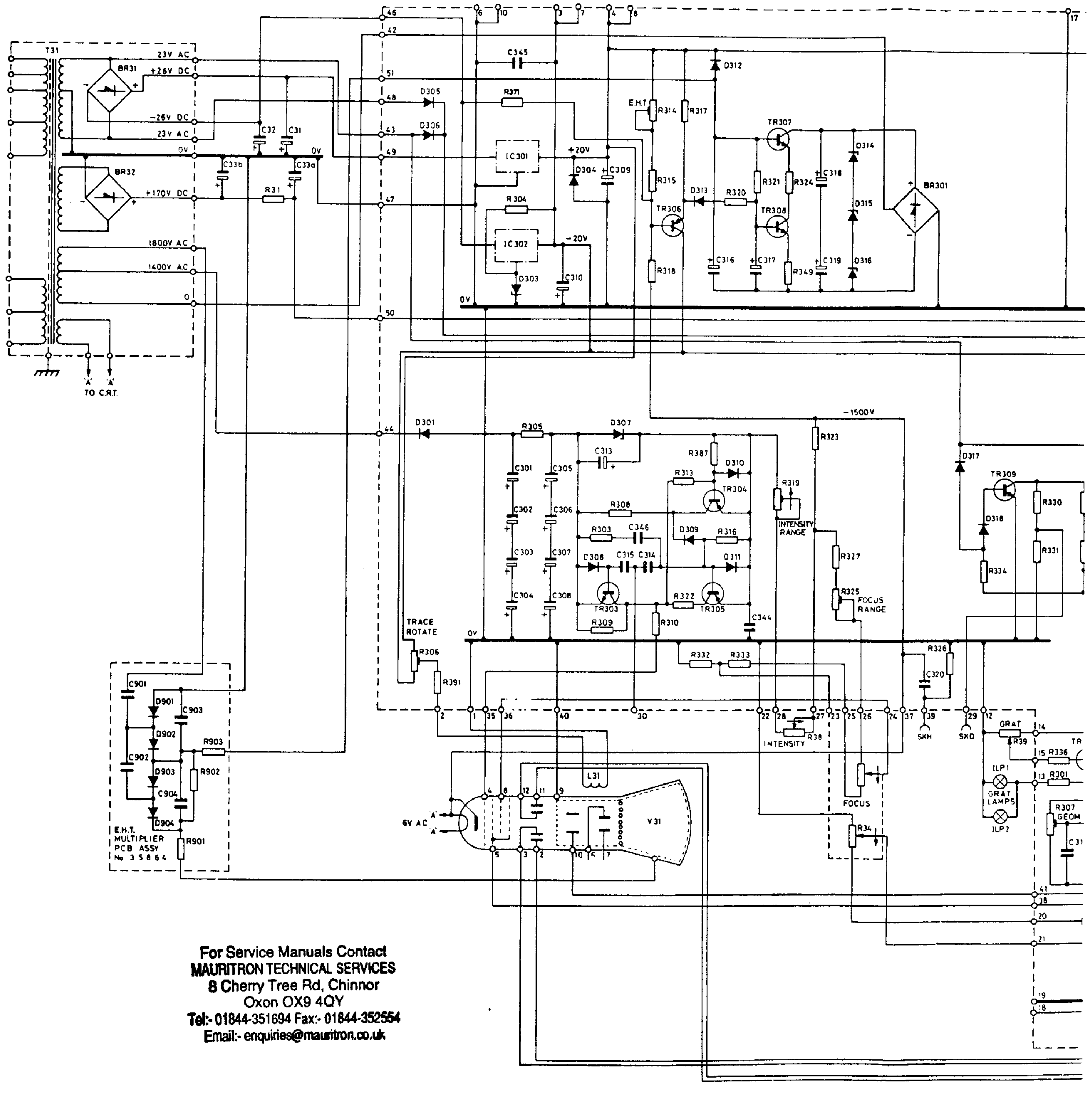
Ref	Value	Description	Tol %±	Part No
BR301		WO6		21150
L301	15μH			29496
L302	15μH			29496
L303	15μH			29496
L304	15μH			29496

t No	Ref	Value	Description	Tol % ±	Part No
387	TR313		2N2369		23307
195	TR314		BF380		32902
202	TR315		BF380		32902
202	TR316		2N2369		23307
195	TR317		2N3904		24146
193	TR318		2N2369		23307
214	TR319		2N2369		23307
214	TR320		BF380		32902
277	TR321		BF380		32902
387	TR322		2N2369		23307
911					
219	**DIODES**				
219	D301		REMO HS 2-6		37809
369			or H691 8kV		or 37174
	D302	10V	ZENER		33935
907	D303	4V7	ZENER		33927
911	D304		IN4003		23462
709	D305		IN4003		23462
709	D306		IN4003		23462
709	D307		ZENER		27957
387	D308		IN4148		23802
911	D309		IN4148		23802
219	D310		IN4148		23802
219	D311		IN4148		23802
369	D312		IN4007		52337
	D313		IN4007		52337
907	D314	160V	ZENER		37212
709	D315	160V	ZENER		37212
911	D316	150V	ZENER		29485
709	D317		IN4148		23802
709	D318		IN4148		23802
709	D319	8V2	ZENER		33933
363	D320	8V2	ZENER		33933
95	D321	10V	ZENER		33935
62	D322		IN4148	Fitted if req.	23802
41	D323		IN4148	Fitted if Req.	23802
95					
	D901		REMO HS 2-6		37809
77			or H691 8kV		or 37174
77	D902		REMO HS 2-6		37809
77			or H691 8kV		or 37174
77	D903		REMO HS 2-6		37809
			or H691 8kV		or 37174
	D904		REMO HS 2-6		37809
			or H691 8kV		or 37174
12					
02	**INTEGRATED CIRCUITS**				
05	IC301		78M20CP		37213
27	IC302		7915		36185
27					
27	**MISCELLANEOUS**				
62	BR301		WO6		21150
05					
05	L301	15μH			29496
05	L302	15μH			29496
46	L303	15μH			29496
07	L304	15μH			29496





RESIS	R903 R902 R901	R31	R306 R391	R371 R304 R305	R303 R309 R308	R314 R315 R318 R310 R317 R313 R322 R332 R387 R316 R333 R320 R321	R324 R349 R319 R38 R373 R327 R325 R34	R326 R39 R334 R330 R331 R336 R307 R301 R329 R328 R388
CAP	C901 C902 C903 C904	C33b C32 C31 C33a		C345 C301-304 C305-308 C310	C309 C313 C346 C315 C314	C316 C317 C344	C318 C319	C320 C312
MISC	T31 BR31 BR32	D901 D902 D903 D904	D305 D306 D301	IC 301 IC 302 D303	D304 D307 D308 TR303 L31	TR306 D313 D312 D309 TR304 D310 TR305 D311 V31	TR307 TR308 D314 D315 D316	BR301 D317 TR309 ILP1 ILP2 D318 TR301



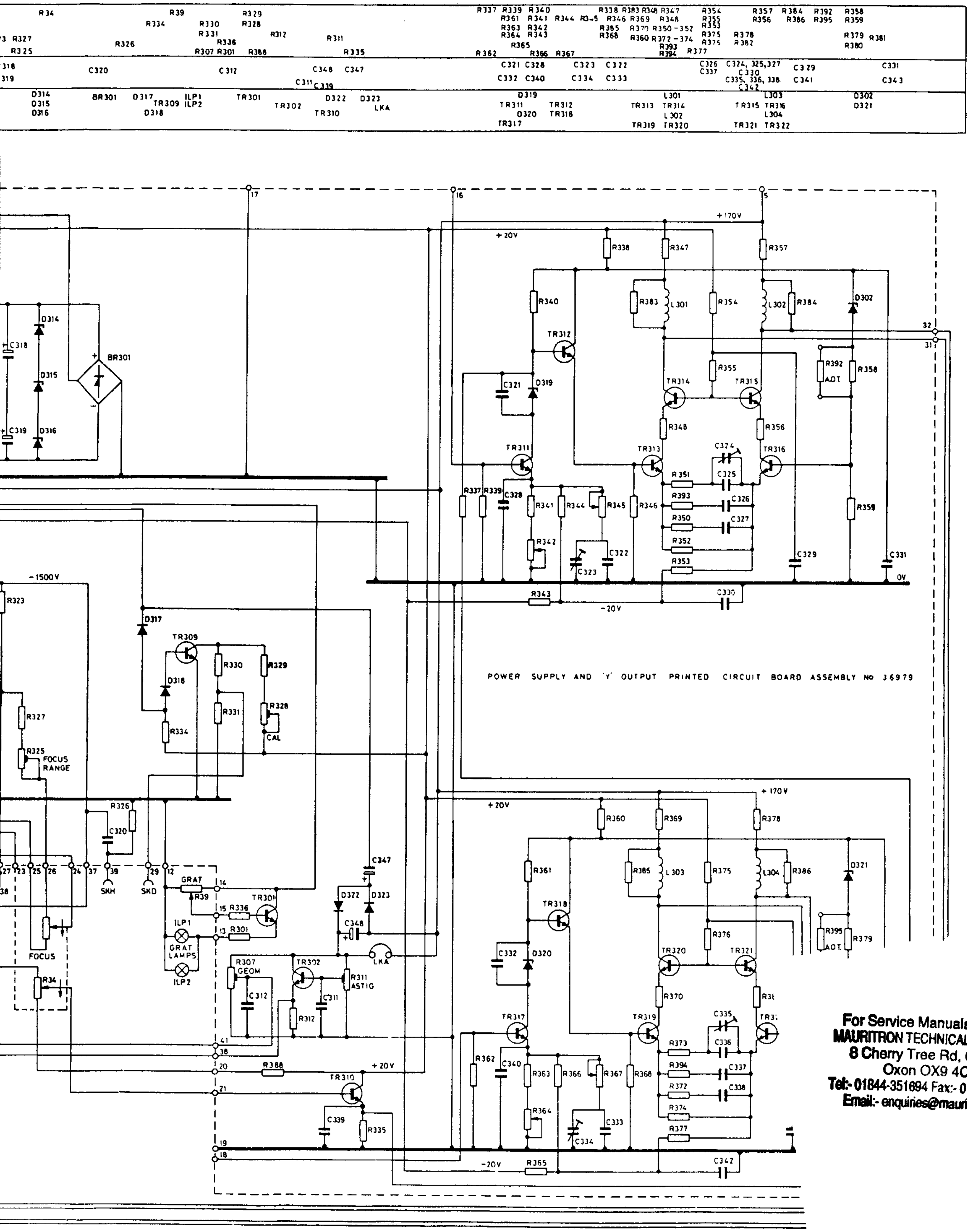


Fig. 6 Power Supplies and Y Output Am

Component List and Illustrations — Section 6

INTERCONNECTIONS

Ref	Value	Description	Tol %±	Part No
RESISTORS				
R2	22	CF		28710
R3	22	CF		28710
R4	990k	MF		26345
R5	22	CF		28710
R6	1M	MF		26346
R7	470k	CC		4906
R10/R15	RESISTOR NETWORK			A3/36455
R16	1M	CF		31840
R17	1k + 1k	CP R17a + R17b		A4/36069
R18	4k7	CF		21805
R19	470	CF		21797
R20		CP With S10		A4/32897
R21		CP With S11		A4/32898
R22	22	CF		28710
R23	22	CF		28710
R24	990k	MF		26345
R25	22	CF		28710
R26	1M	MF		26346
R27	470k	CC		4906
R28	100k	CF	1W	19061
R31	47	WW		18739
R32	68k	CF		21816
R33				
R34		CP		A4/37180
R38		CP With S30		A4/37179
R39		CP		A4/37181
R40	16k	MF		29361
R41	15k8	MF		33291
R42	5k23	MF		33290
R43	1k72	MF	5	33289
R44	787	MF		33288
R45	360	MF		33287
R46	16k	MF		29361
R47	15k8	MF		33291
R48	5k23	MF		33290
R49	1k72	MF		33289
R50	787	MF		33288
R51	360	MF		33287
R52	22k	CP With S27		A4/32895
R53	22k	CP With S28		A4/32895
R54				
R55	18	CF		28709
R56	18	CF		28709
R57				
R58	500	CP With S21/S41		37216
R59	500	CP With S26/S42		37216

Ref	Value	Description	Tol %±	Part No
CAPACITORS				
C2	3.3pF	CE(2)		817
C3	.1μF	CE(2)		29495
C4	470pF	PS		11492
C5	.01μF	CE(2)		24902
C10	6/25pF	TRIMMER		23593
C11	68pF	SM		4513
C12	.01μF	PS		24886
C13	1μF	PC		33206
C14	.047μF	CE(2)	30V	2793
C15	4.7μF	E	63V	32195
C16	680pF	CE(2)		22385
C17	470pF	CE(2)	10V	22383
C18	.47μF	CE(2)	63V	31362
C22	8.2pF	CE(2)		22363
C23	.1μF	PE		29495
C24	470pF	PS		11492
C25	.01μF	CE(1)		24902
C31	2200μF	E	40V	36022
C32	2200μF	E	40V	36022
C33	100μF + 100μF	E C33a + C33b		A4/36023
DIODES				
D11				35202
ILP1				37178
ILP2				37178
SOCKETS				
S10		With R20		A4/32897
S11		With R21		A4/32898
S12				34991
S13				32636
S14				37199
S15				4881
S16				36662
S20				34991
S21		With R58/S41		37216
S25				34991
S26		With R59/S42		37216
S27		With R52		A4/32895
S28		With R53		A4/32895
S29				

INTERCONNECTIONS (Cont.)

Ref	Value	Description	Tol % ±	Part No
S30			With R38	A4/37179
S31				36815
S41			With S21/R58	37216
S42			With S26/R59	37216
SKA				26587
SKB				26587
SKC				26587
SKE				29492
SKF				29492
SKG				29492

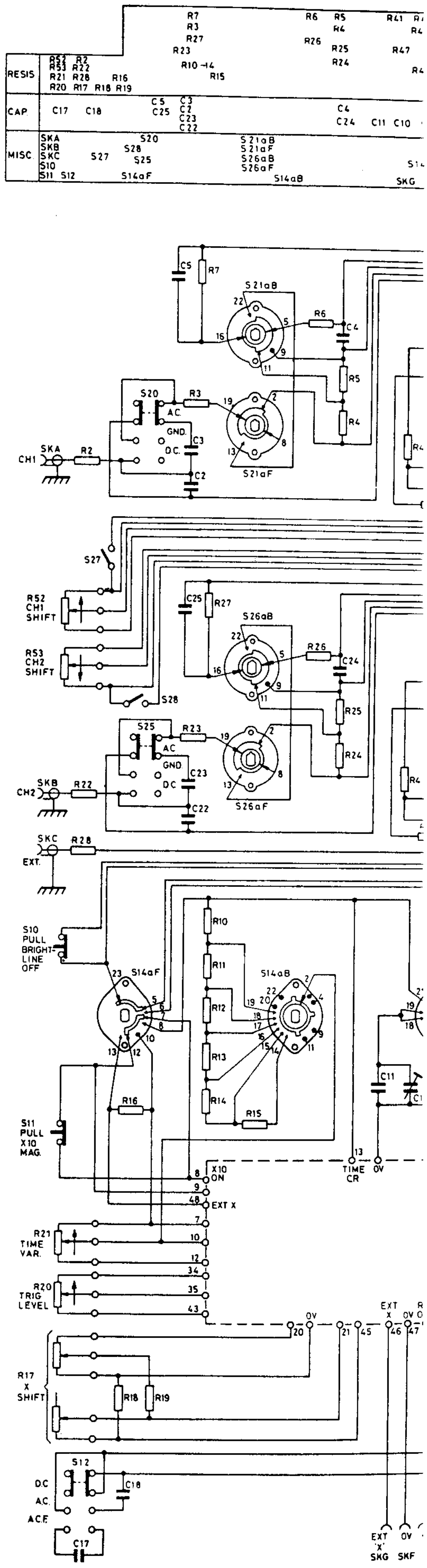
MISCELLANEOUS

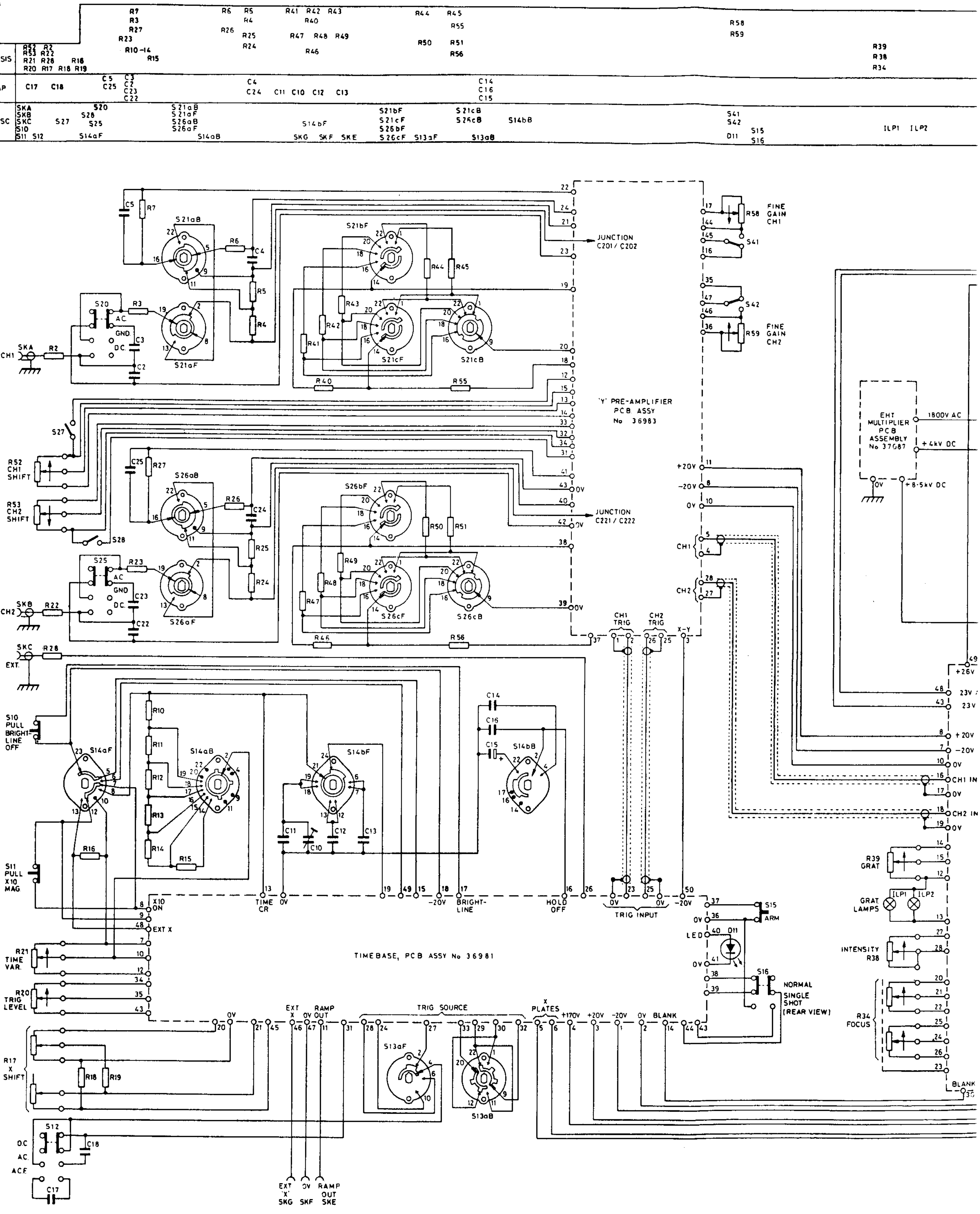
Ref	Value	Description	Tol % ±	Part No
BR31		WO2		19725
BR32		WO4		29367
L31				A3/31329
T31				A1/37168
FS31		500mA	230V Supply	33685
		1A	115V Supply	34790
PLA				33787
V31		C.R.T. E14-101GH		37194
V32				26586

s

Section 6

Value	Description	Tol % ±	Part No
CELLANEOUS			
1	WO2		19725
2	WO4		29367
			A3/31329
			A1/37168
1	500mA	230V Supply	33685
	1A	115V Supply	34790
			33787
	C.R.T. E14-101GH		37194
			26586





'Y' PRE-AMPLIFIER PCB ASSY No 36983
TIMEBASE, PCB ASSY No 36981
EHT MULTIPLIER PCB ASSEMBLY No 37087
1800V AC
+4kV DC
+8·5kV DC
JUNCTION C201 / C202
JUNCTION C221 / C222
FINE GAIN CH1
FINE GAIN CH2
R52 CH1 SHIFT
R53 CH2 SHIFT
S10 PULL BRIGHT-LINE OFF
S11 PULL X10 MAG
R21 TIME VAR.
R20 TRIG LEVEL
R17 X SHIFT
TIME CR
BRIGHT-LINE
HOLD OFF
TRIG INPUT
CH1 TRIG
CH2 TRIG
X-Y
X10 ON
EXT X
EXT X
RAMP OUT
TRIG SOURCE
X PLATES
BLANK
S15 ARM
LED D11
S16 NORMAL SINGLE SHOT (REAR VIEW)
R39 GRAT
GRAT LAMPS
INTENSITY R38
R34 FOCUS
CH1 IN
CH2 IN
EXT 'X' SKG
0V SKF
RAMP OUT SKE
DC AC ACF

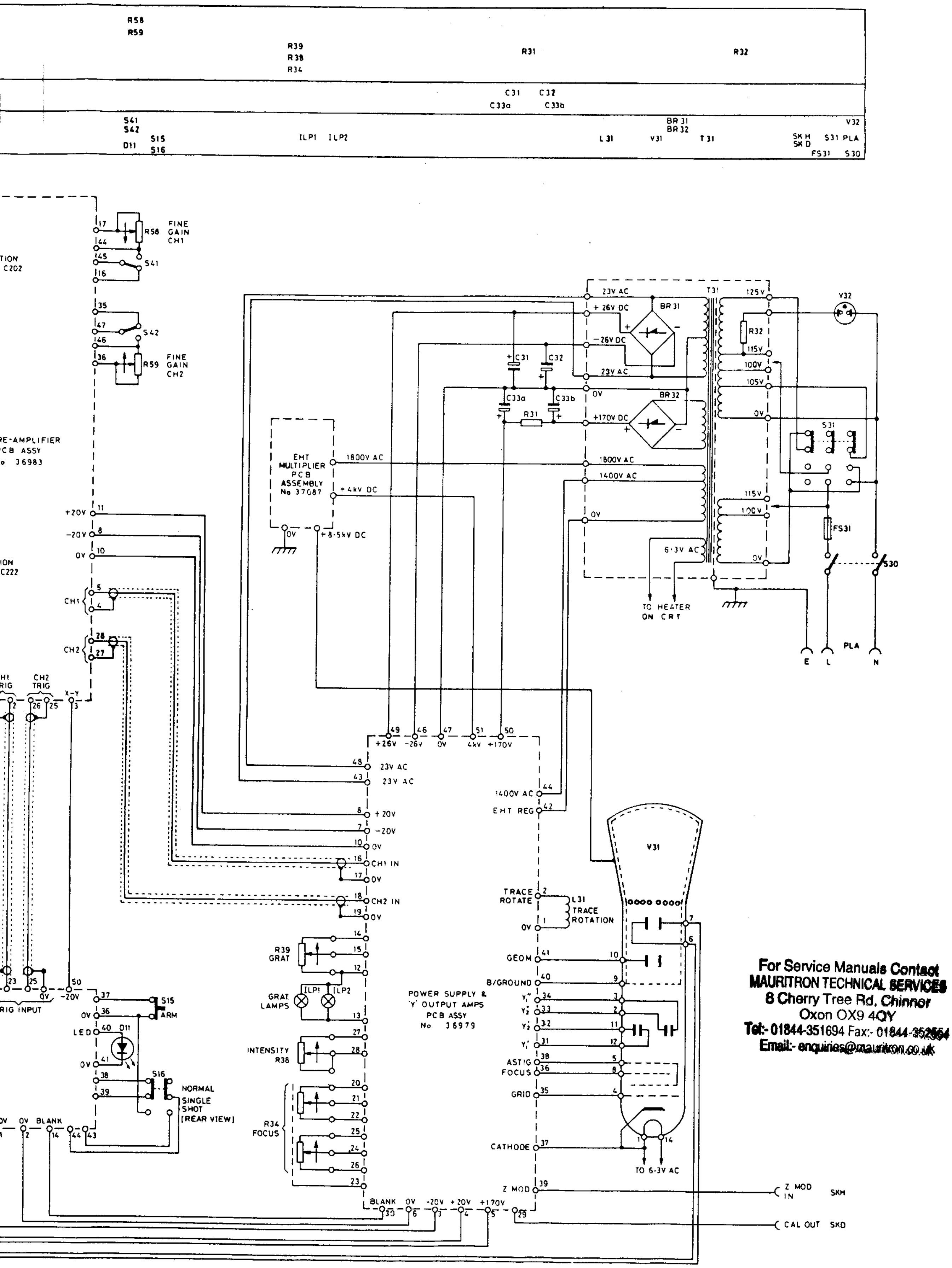


Fig. 7 Interconnection diagram

Guarantee and Service Facilities

Section 7

This instrument is guaranteed for a period of two years from its delivery to the purchaser, covering faulty workmanship and replacement of defective parts other than cathode ray tubes and batteries (where fitted). Cathode ray tubes are subject to the manufacturers guarantee. This assumes fair wear and tear and usage in the specified environment and does not cover routine recalibrations and mechanical adjustments.

We maintain comprehensive after sales facilities and the instrument should be returned to our factory for servicing if this is necessary. The type and serial number of the instrument should always be quoted, together with full details of any fault and service required.

Equipment returned for servicing must be adequately packed, preferably in the box in which the instrument was supplied and shipped with transportation charges prepaid. We 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.

The Service Department can provide maintenance and repair information by telephone or letter, if required.

Note: Please check fuses before returning instruments for service.