TELEQUIPMENT

LABORATORY OSCILLOSCOPE

TYPE D53A

All TelequipmenT instruments are subject to continuous development and improvement, consequently this instrument may incorporate minor changes in detail from the information contained herein.

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GENERAL DESCRIPTION

The D53A is a dual-trace split-beam oscilloscope with independent plug-in vertical amplifiers and a plug-in timebase. The cathode ray tube and power supply circuitry is incorporated in the main frame.

Owing to the high gain of some amplifiers, hum caused by earth currents is a considerable problem, particularly when two amplifiers are in use simultaneously. To avoid multiple earth paths, these amplifiers have all earth connections in the high-gain parts of the circuit brought to a common point to which are connected the outer of the UHF INPUT socket and the LOW terminal. These are not connected directly to the chassis but via a 100 ohm resistor.

To avoid hum loops around the oscilloscope, when one amplifier is being used, its LOW terminal should be linked to the chassis earth. However, when two amplifiers are in use at high sensitivity and connected to a common signal source, the LOW terminals of both amplifiers should be linked and one connection made to chassis earth.

To avoid hum loops between the source and the oscilloscope, the link between LOW and chassis earth should be broken and one earth connection made at the source, alternatively LOW and chassis earth should be linked and no earth connection made at the source.

NOTE As extensive use is made of semi-conductors and since high voltages are present at some parts of the circuit, adjustment tools with insulated shafts and handles should always be used.

As there is only a high-resistance discharge path for the 7.5kV EHT+ supply, a high voltage will persist for some time after switching-off. Care should be taken that this supply is discharged before attempting work in its neighbourhood.

TECHNICAL DATA

VERTICAL DEFLECTION AMPLIFIERS

Summary of characteristics:

Type	Approx. 3dB bandwidth hertz	Risetime 10-90%	Calibrated sensitivity per cm	Internal trigger output coupling
A	d.c. - 800k d.c. - 15M	440ns 23ns	10mV - 5V 100mV - 50V	a.c.
B	d.c. - 75k	4.7µs	1mV - 5V	a.c.
C-2	5Hz - 100k 5Hz - 100k d.c. - 800k d.c. - 15M	3.5µs 3.5µs 440ns 23ns	100µV - 50mV 1mV - 500mV 10mV - 5V 100mV - 50V	a.c.
G	d.c. - 500k d.c. - 10M	700ns 35ns	2mV - 1V 20mV - 10V	a.c.
J	5Hz - 100k 5Hz - 100k d.c. - 5M d.c. - 25M	3.5µs 3.5µs 70ns 14ns	100µV - 50mV 1mV - 500mV 10mV - 5V 100mV - 50V	a.c.
JD	5Hz - 100k 5Hz - 100k d.c. - 10M d.c. - 25M	3.5µs 3.5µs 35ns 14ns	100µV - 50mV 1mV - 500mV 10mV - 5V 100mV - 50V	d.c.

Calibration accuracy is ± 5%.
Further information may be found in the individual manuals.

TD51 TIMEBASE

Trigger

Internal - minimum deflection	2mm
External minimum input	0.5Vp-p
input impedance approx.	1 megohm
Useful bandwidth	
Automatic	50Hz - 1MHz
Trigger level	d.c. - 5MHz
HF	1 - 25MHz
Time constant a.c. coupled approx.	
AC SLOW	100ms
AC FAST	50µs

Sweep generator

Sweep speeds in 1-2-5 sequence	22
Calibration accuracy	± 5%
Calibrated speed range	5s - 500ns/cm
Maximum speed range approx.	12.5s - 50ns/cm
Sweep delay ranges	
0-5ms	500µs approx. - 5ms
0-50ms	5ms approx. - 50ms

Horizontal amplifier

3dB bandwidth approx.	d.c. - 1MHz
Deflection sensitivity approx.	500mV - 5V/cm
Maximum input	50V
Input impedance approx.	1 megohm & 30pF

CATHODE RAY TUBE

Standard phosphor	P31
Display area per beam	6 x 10 cm
Overall tube voltage	9kV
External intensity modulation (Z MOD)	
Signal for perceptible modulation at average brightness approx.	20V
Input time constant approx.	10ms

FRONT PANEL OUTPUTS

Calibrator (via plug-in amplifier)	1Vp-p ± 2%
Sweep output, positive-going	0-50V approx.
Minimum load	100 kilohms
Probe test (a.c. coupled)	6Vp-p approx.

POWER REQUIREMENTS

Voltage	100-125 & 200-250V
Frequency	50-400Hz
Consumption	200VA approx.

PHYSICAL CHARACTERISTICS

Approximate overall dimensions and weight

High	Wide	Deep	Weight
11	11½	20¼ in	52 lb
28	29.2	51.5 cm	24 kg

Cooling - convection

Maximum ambient operating temperature 40°C, 104°F

OPERATING INSTRUCTIONS

The following instructions refer in details to a D53A fitted with A amplifiers and a TD51 timebase.

External controls and connectors are shown in underlined CAPITALS, internal presets are shown in CAPITALS only.

FIRST-TIME OPERATION

Before connection to the mains supply, check that the voltage selector link at the rear of the instrument indicates the local supply voltage and confirm that the fuse is of the correct rating: 3A for 100-125V and 1.5A for 200-250V.

The following recommendations are intended merely to enable the operator to familiarise himself with the effect of the majority of the controls. A fuller description of some controls is contained in the Additional Information and Facilities section.

Set the controls as follows:

CRT controls

SCALE ILLUMINATION	Fully anti-clockwise, power OFF
ASTIGMATISM	Both to mid position
BRIGHTNESS	Mid position
FOCUS	Mid position

Timebase controls

DISPLAY	NORMAL, all buttons out
TIME/CM	5mS
VARIABLE	Fully clockwise
DELAY COARSE & FINE	Any position
X GAIN	Fully anti-clockwise

Timebase controls contd.

X SHIFT	Mid position
TRIGGER SELECTORS	AC SLOW, Y UPPER +
STABILITY	Fully clockwise
TRIG LEVEL	Switched to AUTO

Amplifier controls

DC - AC	AC
VOLTS/CM	0.5
Y SHIFT & VERNIER	Mid position
Y GAIN	x1

Link INPUTS and CAL 1Vp-p.

Plug-in to the supply and switch on with SCALE ILLUM/POWER control.

Allow a minute or so warm-up time, then rotate BRIGHTNESS clockwise for traces of convenient intensity.

Centre traces by X SHIFT and adjust Y SHIFTS for convenient display.

Rotate STABILITY anti-clockwise until a stable display is obtained.

Adjust FOCUS and ASTIGMATISM controls for best definition.

On removal of the CAL to INPUT links the oscilloscope is in a condition to display most simple waveforms with appropriate adjustment of the switched and variable VOLTS/CM and TIME/CM controls.

ADDITIONAL INFORMATION and FACILITIES

TRIGGER SOURCE This selector enables the timebase to be triggered externally, internally from the upper or lower vertical amplifiers or from a signal derived from the mains supply line. + or - determines whether triggering occurs on the positive or negative going slope of the triggering waveform.

EXT TRIG This is a convenient setting when examining signals from several points on the same piece of equipment, the same trigger source being suitable for each. If delay plug-in Y amplifiers are not available, this setting may be used to simulate signal delay by feeding EXT TRIG with a prepulse suitably in advance of the desired signal; this enables the leading edge of the desired pulse to be viewed using a non-delay amplifier, despite the delay inherent in the trigger and sweep circuits.

Y UPPER or Y LOWER These settings are most suitable for the majority of applications. A fraction of the output of the upper or lower Y amplifiers is fed to the trigger circuit. A display of at least 2mm is required. The trigger output of some amplifiers is a.c.-coupled, see page 2.

SUPPLY FREQ This is a convenient setting for examining signals at mains supply frequency or its harmonics.

TRIGGER MODE This control in effect enables the frequency response of the trigger circuit to be varied so as to best suit the characteristics of the trigger signal whether internally or externally derived.

DC By direct coupling of the trigger source to the trigger circuit, all frequencies from d.c. to the upper limit of the trigger circuit may be handled in this position. If d.c. blocking is required at a lower frequency than is acceptable in the AC SLOW position, a capacitor of larger capacity than 0.1μF should be inserted between the signal source and the EXT TRIG terminal with the TRIGGER SOURCE switch set to EXT TRIG. Internal d.c. triggering can only be obtained from amplifiers with d.c. trigger output coupling, see page 2. With other amplifiers the trigger coupling time constant in this mode is about 100ms, the same as AC SLOW.

AC SLOW A 0.1μF capacitor is inserted in series with the trigger signal, providing d.c. blocking with a time constant of about 100ms. For general use, AC SLOW will be found the most convenient setting.

AC FAST A 470pF capacitor is placed in series with the input providing a high-pass filter and reducing the input time constant to about 50μs; low frequencies are thus attenuated. This setting is particularly useful to avoid triggering from unwanted low-frequency trigger signal components such as supply frequency ripple.

HF This mode is suitable for recurrent waveforms from about 1MHz up to 25MHz or better. The TRIG LEVEL control is used to synchronise the display with the input signal.

TV LINE and TV FRAME These positions enable the trigger circuit to best respond to the line or frame (field) pulses in a composite TV waveform. The TRIG LEVEL control determines which sync pulse triggers the sweep. The sweep delay facility, used as described later, can progressively retard the starting point of the sweep with reference to the trigger signal to allow the examination of individual line or frame periods. The FRAME setting is also useful when triggering from low frequency signals when unwanted higher frequency signals are present.

TRIG LEVEL In the AUTO position the sweep is automatically triggered at the mean level of the input waveform. When switched from AUTO, the TRIG LEVEL control enables the starting point of the sweep to be selected from any point on the displayed waveform. With control settings as for first-time operation and with the calibration signal applied, rotation of TRIG LEVEL will cause the sweep to start at various points on the positive-going slope of the waveform. If the TRIGGER SOURCE switch is set to −, the same will be seen to apply to the negative-going slope. The TRIG LEVEL control thus acts as an amplitude discriminator, enabling small signals to be ignored and the sweep to be triggered only when the input voltage reaches a predetermined value.

Since increase of sweep speed and X GAIN does not affect the starting point of the sweep but merely expands the trace from this point, it is possible to examine a section of the trace in detail by setting TRIG LEVEL so that the sweep is triggered just in advance of the part to be examined and expanding the trace with TIME/CM and X GAIN.

TRIG LEVEL is also employed in the HF trigger mode to lock the display to the input signal.

STABILITY This control provides three modes of operation for the timebase: free-running, triggerable and off. When fully clockwise the sweep will run recurrently with or without a trigger input. If backed-off anti-clockwise to the triggerable zone, the sweep will run in synchronism with trigger pulses. When more fully anti-clockwise, the amplitude of pulses from the trigger circuit is insufficient to initiate the sweep. The usual setting is in the central triggerable zone.

TIME/CM, VARIABLE and X GAIN The indicated sweep rates are only attained when VARIABLE is fully clockwise and X GAIN fully anti-clockwise. Turning VARIABLE anti-clockwise progressively reduces sweep speed by a factor of up to about 2.5, whereas clockwise rotation of X GAIN expands the sweep and increases speed by up to about 10 times.

SET SPEED This control is used to calibrate the sweep speed. This may be readily done as follows using the CAL 1Vpp waveform; accuracy of calibration will depend on supply line frequency:

With TIME/CM at 10mS and VARIABLE and X GAIN at CAL, apply the calibrator waveform to a vertical amplifier input. Adjust other controls for a convenient display.

On 50Hz supply, adjust SET SPEED for 1 cycle in 2cm.
" 60Hz " " " " " 3 cycles " 5cm.
" 400Hz " switch to 1mS and adjust SET SPEED for 2 cycles in 5cm.

SINGLE SHOT The single-shot condition assists in viewing or photographing a non-repetitive signal or a random event. The use of delay plug-in amplifiers prevents the loss of pulse leading edges. Either internal or external triggering may be used.

To illustrate single-shot operation, apply the CAL 1Vp-p waveform to one amplifier and, in the NORMAL condition, adjust timebase controls for a locked display. Select SINGLE SHOT button and depress RESET; the sweep will run once each time RESET is pressed. To simulate a random signal, remove the CAL input and then press RESET; the neon will light to indicate that the timebase is armed. Reapply CAL and the sweep will run once, the neon being extinguished at the end of the sweep.

In practice, for preliminary adjustments with buttons at NORMAL, TRIG LEVEL should be set to determine the signal amplitude to fire the sweep and TIME/CM set to an appropriate sweep speed.

A second application of the single-shot facility is to trigger external apparatus at will with the 0-50V sawtooth from the SWEEP OUTPUT terminal. With SINGLE SHOT depressed, turn STABILITY fully clockwise and press RESET; on release of the button, the timebase will run once producing the output sawtooth.

LOCATE Depression of the LOCATE button causes a spot to appear a few millimetres to the left of the start of the trace. This facility is of particular use in the single-shot mode to determine the location of the display.

SWEEP DELAY The start of the sweep may be delayed, by between about 500µs and 50ms after the triggering signal, by selection of the appropriate DELAY button and by use of the COARSE & FINE DELAY controls. The 0-5mS button will produce a delay range between about 500µs and 5ms; while the 0-50mS button will give a range between about 5ms and 50ms.

The sweep should first be triggered normally using STABILITY and TRIG LEVEL, the latter set either to AUTO or to select the triggering level. The required delay range button should then be depressed and STABILITY advanced fully clockwise; adjustment of the COARSE & FINE controls will then continuously vary the point of commencement of the sweep. The switched and variable TIME/CM controls and X GAIN may then be used to expand the portion of the sweep required to be studied in detail.

PROBE TEST A fast-rise positive-going pulse of about 6Vp-p is provided to enable the input capacitance of a high-impedance probe to be matched to that of the vertical amplifier. Assuming a 10:1 probe, set amplifier VOLTS/CM switch to 0.2V/cm and TIME/CM to 1mS. Apply the probe tip to PROBE TEST and adjust the probe trimmer for a square corner on the displayed pulse.

X INPUT With the TIME/CM switch set at EXT X the timebase is switched off and external horizontal deflection signals may be fed to the X amplifier via the X INPUT terminal. Amplifier sensitivity is variable between about 0.5 and 5V/cm by use of X GAIN, the 3dB bandwidth being d.c. to 1MHz approximately; input impedance is in the order of 1 megohm & 30pF.

SWEEP OUTPUT A d.c.-coupled positive-going sawtooth about 50V in amplitude is available from this terminal when the timebase is running. STABILITY should be set fully clockwise in the free-running condition when using the oscilloscope to drive an external circuit. The input resistance of an applied load should exceed 100 kilohms to avoid overloading the sweep generator.

Z MOD This rear socket is a.c.-coupled, with a time constant of about 10ms, to the first grid of the CRT. A positive-going pulse will intensify the trace facilitating rise-time measurement.

CIRCUIT DESCRIPTIONS

TD51 TIMEBASE

TRIGGER - Figure 2.1

GENERAL The trigger selects the source of signals, upper or lower vertical amplifier, external or line, at differing amplitudes, rise times and polarity, and produces a pulse of fixed amplitude, rise time and polarity to trigger the sweep generator.

CIRCUIT DETAILS Switch S101 selects the source of the trigger signals. In some vertical amplifiers the trigger signals are applied in push-pull, while in other amplifiers, external and line sources, they are single-ended.

These signals are applied to the appropriate grids of V101, depending on the setting of S102 (+ or -), and if the signals are single sided, then one grid of V101 is earthed.

V101 is a long-tailed pair, with TR101 acting as the tail, and the amplified output is taken from V101B anode. The input signals to V101 grids are coupled via C103 and C104 in the AC SLOW position, while in the AC FAST position, C105 and C106 are added in series to increase the low frequency cut-off. In the AC SLOW position the input time constant is about 100ms, while in the AC FAST position the time constant is 50µs approximately.

RV111, the TRIG LEVEL control varies the bias of the two halves of V101, and hence varies the output d.c. level, allowing the triggering point to be set to any point on the waveform. On the AUTO position R113 is added to provide the two valves with similar biasses and hence currents.

The output from V101 anode is coupled via the emitter follower TR102 to the Schmitt trigger circuit TR103, TR104.

In the AUTO position the signal is a.c.-coupled through C113 and in the absence of a triggering signal the circuit free runs at about 40Hz due to the time constant C113, R122. As soon as a trigger signal is applied, the circuit is synchronised and the Schmitt will trigger from a point near the mean level of the trigger waveform. This setting may be used for almost all applications involving

repetitive waveforms with approximately equal excursions about the mean level, and repetition frequencies between 50Hz and 1MHz.

RV124 adjusts the mark to space ratio of the free-running waveform, and RV127 the sensitivity of the circuit. When the TRIG LEVEL control is operated, then C113 is shorted out and signals are d.c.-coupled from TR102 emitter to TR103 base.

On the HF position R128 is added between the emitters and the circuit oscillates at a frequency of about 1MHz. The circuit then synchronises to high frequencies in the range from about 1MHz to 25MHz.

In the TV positions of S102, TR102 is converted into a sync separator which strips the picture information from the sync, the emitter of TR102 is switched from R121 to the junction of C109, R118 & 119. The signal at the collector of TR102 is clipped at approximately 0.7V by MR100, differentiated by C107 & R213 to give positive-going frame pulses of larger amplitude than the line pulses and applied to the base of TR113. In the TV LINE setting a short time-constant is provided in the emitter of TR113 by C110 & 111 in series in parallel with R218. This gives negative-going line and frame pulses of approximately equal amplitude at the collector. In the TV FRAME setting, C111 is short-circuited and R218 open-circuited; the remaining components provide the necessary longer time-constant and a single negative-going frame pulse is obtained at the collector. The output from the collector is fed through C112 to the base of TR103.

The output of the trigger circuit at the collector of TR104 is taken to C121 & 122 in the timebase.

SWEEP GENERATOR and HORIZONTAL AMPLIFIER - Figures 2.2 & 2.3

SWEEP GENERATOR In the NORMAL position of the push buttons, the output from the trigger circuit is differentiated by C122, R145 and the negative going spike is coupled through MR105 to the base of TR107. This causes the bistable circuit TR107, TR108 to switch, hence TR108 collector goes negative and the resulting negative voltage cuts off MR105 and prevents any further trigger pulses from entering the circuit.

The negative excursion of TR108 collector also causes MR107 to conduct. This lowers the potential of the junction of MR107, MR108. Hence MR108 open

circuits and releases the grid of V103. The positive excursion at TR107 collector is amplified by V102a and coupled via V102b to the blanking grid of the CRT to unblank the trace.

V103, V104 form a grid-triggered Miller run-up circuit, the timing components comprising C277 to C284 and R282 to R287. The capacitor is connected between pin 2 of V103 and pin 3 of V104 and the resistor between pin 2 of V103 and the -98 volt line.

The positive going sawtooth at V103 anode is coupled to the cathode follower grid (V104) via the divider R178, C131 and R181, and a portion of the cathode waveform, at the junction of R182, R183 is applied through the diode MR111 to the base of TR112. At a potential determined by RV172, the bistable circuit formed by TR111, TR112 will switch. Hence TR112 collector goes negative taking the base of TR108 with it. This causes the bistable TR107, TR108 to switch over. Hence TR108 collector goes positive and open circuits diode MR107. Diode MR108 then conducts and the current through R173 flows into the timing capacitor to start the flyback. The flyback continues until the falling potential at V104a cathode causes diode MR112 to conduct, so reducing the current through the timing capacitor to zero.

Incoming trigger pulses will not however affect TR107, TR108 bistable due to the large negative potential at TR108 base which prevents further switching action.

The base of TR112 meanwhile moves negative, as the hold-off capacitor between tag 34 and earth discharges through R174, R180 until eventually the bistable TR111, TR112 resets. TR112 collector goes positive taking the base of TR108 with it.

This is then the original starting condition, and the next input trigger pulse will switch the bistable TR107, TR108 and initiate the same sequence of operations.

SWEEP DELAY When the delay is switched in, diode MR109 is connected to earth. This prevents the hold-off time constant discharging sufficiently to reset the bistable TR111, TR112 in the normal way. Hence after a forward sweep and flyback, the bistable TR111, TR112 is permanently switched to prevent any further action.

The input trigger pulse is also connected via C121 MR104 to the flip-flop TR105, TR106.

In the absence of a signal TR105 is conducting, its base potential being determined by MR101.

A negative trigger pulse causes regenerative action to start. TR106 collector goes negative and biasses off MR104, so preventing further trigger pulses entering the circuit. The diode MR102 is in series with the base emitter diode and protects it from excessive reverse bias due to the large negative signal coupled from TR106 collector.

The time constant C120 or C119 and R137 then charges until eventually the circuit will switch back. When the circuit resets, the negative edge at TR105 collector is differentiated by C127, R159 and causes MR106 to conduct, so resetting the bistable TR111, TR112. This allows the next incoming trigger pulse to trigger TR107, TR108 in the normal way.

When TR111 conducts, TR109 is held conducting, thus cutting off MR104 and preventing trigger pulses from reaching the delay circuit until after the normal timebase action has taken place.

SINGLE-SHOT In the single-shot position of the push buttons the diode MR109 is connected to earth, so preventing the bistable TR111, TR112 from resetting, hence the sweep generator will not recycle. At the same time TR105 is biased off by taking R137 to the -100 volt line, through R176.

When the reset button is pushed, C119 charges through R137 until TR105, TR106 multivibrator fires. The negative-going edge at the collector of TR105 resets TR111, TR112, as in the delayed sweep condition. This then arms the sweep generator to be ready for the next incoming trigger pulse; neon N101 lights to indicate the timebase is armed.

LOCATE When the LOCATE button is operated, S105 opens and RV219 is inserted in series with the emitter of TR107. With STABILITY set in the triggerable condition, the current through TR107 is reduced and its collector, the cathode and anode of V102A and the grid of V102B rise to unblank the CRT. At the same time the grid of V106, normally held at about -0.25V via R220 and S105, rises due to the potential difference developed across RV219 by the emitter current of TR107; this causes the anode of V106 to fall and that of V105 to rise and so deflect the electron beam to a position to the left of the normal starting point of the sweep.

HORIZONTAL AMPLIFIER The X amplifier consists of V104B, a d.c. shift and sawtooth mixing stage, followed by V105 and V106 connected as a long-tailed pair.

The timebase sweep voltage at V104A cathode is coupled to the grid of V104B via the attenuator network C132, R185, R189. The bottom end of R189 is taken to the variable d.c. shift voltage.

The output from V104B cathode is coupled to the grid of V105 via the X GAIN control RV193. The longtailed pair V105 & 106 drives the deflector plates directly, and high frequency compensation is effected by C135, 136 & R202, between the cathodes.

External X signals are fed in via the front panel terminal marked X INPUT to the grid of V104A, when the TIME/CM switch is in the EXT X position. The input sensitivity is about 500mV/cm and the 3dB bandwidth d.c.-1MHz at maximum X gain.

CATHODE RAY TUBE - Figure 4.1

GENERAL The CRT is a M-O Valve Company single-gun tube with a beam-splitting plate to produce two beams which are independently deflected by two pairs of Y-plates. Mesh and helical PDA are employed and provision is made for differential brightness adjustment and individual astigmatism correction. P31 is the standard phosphor for the aluminised screen.

CIRCUIT DETAILS The 1.6kV EHT-supply is applied to the cathode via MR301 which provides a low-impedance path for the beam current. Beam current and thus brightness is varied by RV307 which controls the potential of g1; external intensity modulation is also applied to this grid via the rear Z MOD socket, a positive signal brightening both traces. RV321 adjusts the potential on g2 to enable the splitter electrode a3 to divide the beam equally and produce traces of equal brightness.

In the absence of a sweep, g3 is held negative to a1 by the cathode potential of V102b in the timebase. This causes the electron beam to be deflected and prevented from reaching the tube phosphor; the traces are thus blanked. During a sweep and when EXT X is selected by the TIME/CM switch, the cathode of V102b and with it g3 rise to the potential of a1; the unblanked beam can now pass through the gun to strike the phospor.

Focussing of the beam is accomplished by use of RV304 to vary the potential of a2.

After division of the beam by the splitter plate a3, the two resulting beams are independently deflected by the Y-plates and corrected for astigmatism by RV301 & 308; the beams are then both deflected by the single pair of X-plates.

Apart from acting as the PDA mesh electrode, s2 serves to optimise trace geometry; its potential is adjusted by RV311. s3 is maintained slightly negative to s2 so as to suppress background illumination of the phosphor.

The 7.5 kV EHT+ supply is applied to the final anode a4 with an internal connection to the PDA helix. The lower potential end of the helix is returned to s2.

Trace rotation is effected by varying the magnitude and direction of current through L401 with RV405. (Figure 5.1).

POWER SUPPLIES - Figure 5.1

The double-wound electrostatically-screened power transformer T401 provides all LT, HT and EHT supplies from eight secondary windings. 110V a.c. is provided from one primary winding for the Type B amplifier. The transformer is protected against overload by F401. The primaries are interconnected by a plug in the voltage selector panel to accommodate supply voltages in the ranges 100-125V and 200-250V, 50-400Hz.

LT Five secondary windings provide the various LT supplies.

Two 12.6V windings tapped at 6.3V provide a.c. supplies for the plug-in amplifiers. A 6.3V winding, floated at EHT- potential, feeds the heater of the CRT. A further 6.3V winding, one side of which is grounded, feeds the pilot lamp, scale illumination lamps via RV401 and all timebase valve heaters. A full-wave rectifying circuit, formed by MR418, 409 and reservoir capacitor C417, provides negative d.c. supplies for the trace rotation coil L401, delay amplifiers and the timebase.

HT Two windings provide all HT supplies for the oscilloscope.

MR403 & 404 with C404 & 405 form a voltage-doubler circuit which provides individually decoupled HT positive supplies to both Y amplifiers, the timebase and the CRT circuit.

A second winding, centre-tapped to chassis, provides positive and negative 100 volt lines via MR405, 406 and MR407, 408 respectively. The calibrator circuit is fed from one end of this winding.

EHT A single 1,600V winding, tapped at 1,200V, provides positive and negative EHT voltages for the CRT.

The 7.5kV positive supply to the CRT PDA electrode is derived from a voltage-quadrupler circuit consisting of MR401, 402, 410 & 411 in association with C410, 411, 403 & 402.

MR412 to 416 with C423 to 426 provide a 1.6kV negative potential for the CRT grid and cathode.

CALIBRATOR The calibrator zener diode MR417 is fed with a.c. via R404 from one side of the 84-0-84V transformer secondary.

The diode clips both half-cycles of the a.c.; the resulting constant amplitude squarewave is attenuated by R414, 415 & RV416. The output is set at precisely 1Vp-p by RV416 and is fed to both Y amplifiers. C420 & 416 provide decoupling at the amplifier connecting plugs.

MAINTENANCE and RECALIBRATION

GENERAL

Occasional recalibration is desirable, mainly to compensate for changes in valve characteristics through ageing; procedures are detailed in the Amplifier Appendices and the Recalibration section.

The two factors which chiefly influence accuracy of measurement, namely vertical amplifier gain and timebase sweep speed, may be readily corrected by external adjustment using only the oscilloscope's own calibrator waveform.

Sweep speed is adjusted with the SET SPEED preset as outlined in the Additional Information section of Operating Instructions.

Amplifier gain may be checked as follows:

Set VOLTS/CM to 0.2 (200mV - Type B), input switch to DC and Y GAIN, if fitted, to x1. Link one input to CAL 1Vpp terminal and adjust SET GAIN x1 to give a display precisely 5cm in amplitude. Then, on the amplifiers with a Y GAIN switch, switch VOLTS/CM to 2, select x10 gain and adjust SET GAIN x10 for a 5cm display.

Before it is assumed that a fault condition exists, control settings should be verified with reference to the information on first-time operation. For the most part, servicing will be limited to the replacement of defective valves. Less common faults may be traced with the aid of the circuit diagrams. Approximate voltages obtaining in normal operation are indicated.

Valves may, in general, be replaced without readjustment of preset controls except in the case of vertical amplifiers where it is desirable to select pairs of valves with approximately similar characteristics and to readjust the d.c. balancing and gain controls.

MECHANICAL

To remove the plug-in vertical amplifiers and timebase, unscrew the knurled nut at each side of the amplifier front panel and at the top of the timebase; the units may then be withdrawn forwards. On replacement of a unit the locating

pin(s) at the rear should be directed into the corresponding hole(s) in the main frame and the unit pushed fully home. The knurled securing nut(s) should then be tightly replaced.

The side and rear covers are removable to permit access to the interior of the instrument for servicing and recalibration.

To remove the side covers, first remove the carrying handle by unscrewing the screw at each end, then lever up and remove the top centre panel; the tops of the side covers may then be slid outwards and the bottoms released from the locating screws.

The rear cover is removed by undoing the two securing screws, one at each side of the voltage selector panel.

RECALIBRATION

Adoption of the following procedures will enable the performance of the instrument to be optimised. Procedures for vertical amplifiers are described in the appendices.

The instrument should be switched on for at least a 15 minute warm-up period before adjustments are carried out.

Trimming tools with insulated handles and shafts should always be used, to reduce the risk of personal injury and component damage.

TD51 TIMEBASE

Waveforms and equipment required

Test oscilloscope	Steps 2 & 3
10kHz squarewave 25Vp-p	Step 5
100kHz squarewave 1Vp-p	Step 5
1ms & 1µs time markers or crystal controlled 1kHz & 1MHz waveform	Step 6

1 Preliminary

Remove top and right-hand side covers.
Switch on.
Set front-panel controls as follows and leave for at least 15 minutes to warm-up.

DISPLAY	NORMAL, all buttons out	X SHIFT	Mid-position
TIME/CM	1mS	STABILITY	Fully clockwise
VARIABLE	Fully clockwise	TRIG LEVEL	Switched to AUTO
SET SPEED	Mid-position	TRIG MODE	AC SLOW
X GAIN	Fully anti-clockwise	TRIG SOURCE	EXT TRIG +

Set internal presets as follows:

C277	As found	C135	Fully open
C132	As found	RV164	Mid-position
RV167	Fully clockwise	RV127	Fully clockwise
RV172	Mid-position	RV124	Mid-position

2 Sweep length and hold-off

Apply signal from SWEEP OUTPUT to test oscilloscope set to 10V/cm.

Adjust RV167 to give about 50Vp-p of sawtooth.

Depress SINGLE SHOT button.

Adjust RV172 until timebase just stops.

Switch back to NORMAL by partially depressing either DELAY button.

Note the lengths of the flyback and waiting periods. If the waiting period is longer than half the flyback period, adjust RV172 to double the waiting period. If the waiting period is shorter than half the flyback period, adjust RV172 to make the waiting period equal to the flyback period. The waiting period is the length of the horizontal portion of the waveform between flyback and sweep.

Reset sweep amplitude to 50Vp-p with RV167.

Remove connection to test oscilloscope.

3 Trigger

Apply signal from the left-hand end of R122 (the junction of R122 & 123) to the test oscilloscope set to 0.5V/cm a.c. coupled.

Adjust RV124 to give a symmetrical triangular waveform. The HT line ripple present on the display may be removed by use of a differential amplifier in the test oscilloscope, the other input being connected to the timebase +100V line.

Adjust RV127 to make amplitude of triangular waveform 100mVp-p.

Reset RV124 if necessary to restore symmetry.

Remove connection to test oscilloscope.

4 CRT unblanking

Set BRIGHTNESS for low trace intensity.

Adjust RV164 for maximum intensity.

5 X amplifier compensation

Set TIME/CM to EXT X and check X GAIN is fully anti-clockwise.

Apply a 25Vp-p 10kHz squarewave between X INPUT and chassis.

Adjust C132 for no undershoot or overshoot.

Change squarewave to 1Vp-p at 100kHz.

Turn X GAIN fully clockwise, centreing trace with X SHIFT.

Screw-in C135 to position just before overshoot appears.

Return X GAIN fully anti-clockwise.

6 Sweep speed

Set TIME/CM to 1mS, checking that VARIABLE is fully clockwise and X GAIN fully anti-clockwise.

Feed 1mS markers or accurate 1kHz squarewave into a Y amplifier.

Set trigger selector switches, TRIG LEVEL and STABILITY for a locked display.
Adjust SET SPEED for one marker or cycle per centimetre over the middle 8cm of trace.
Adjust RV167 to give about 10.5cm length of trace.
Switch TIME/CM to 0.5μS.
Adjust C277 for one marker or cycle in two centimetres over the centre 8cm.
Switch TIME/CM to 1μS and if necessary readjust C277 to halve any speed error.

7 Beam locate

Switch TIME/CM to 5mS, set STABILITY and TRIG LEVEL fully clockwise and adjust controls for free-running traces starting on the second graticule division; no trigger signals should be applied. Back-off STABILITY until traces just disappear, depress LOCATE and adjust RV219 for spots of convenient brightness just to the left of the second graticule division.

CATHODE RAY TUBE

1 Preliminary

Remove top and then left-hand side covers, switch-on and leave for 15 minutes to warm-up.

2 Differential brightness

With no signal input, adjust controls for two traces at low brightness near the centre of the CRT. Adjust DIFFERENTIAL BRIGHTNESS for traces of equal intensity.

3 Trace rotation

Adjust TRACE ROTATION for traces parallel with centre graticule line.

4. Trace alignment or geometry

Switch TIME/CM to EXT X. With amplifier VOLTS/CM switches at 0.2, apply CAL 1Vp-p to each amplifier input. Set the resulting 5 cm high traces to the first, left-hand, vertical graticule line with X SHIFT. Adjust RV311 TRACE ALIGNMENT on PC 32 for straight traces with best coincidence in the horizontal sense. Shift traces to final, right-hand, graticule line and check straightness and coincidence. If necessary readjust RV311 to obtain the best compromise between the first and final graticule line positions.

5 Vertical amplifier gain

If the setting of RV311 has been altered in step 4, vertical amplifier gain calibration should be checked in case the CRT deflection sensitivity has varied.

6 Replace side and then top covers.

POWER SUPPLY

Waveform required

Accurate 1Vp-p squarewave, at supply frequency or within Y amplifier bandwidth.

Set calibrator

1 Disconnect from supply and remove rear cover by undoing two screws towards sides of instrument, level with voltage selector panel.

2 Reconnect to supply, switch-on and feed accurate 1Vp-p squarewave into one Y amplifier set to 0.2V/cm with VARIABLE, if fitted, to CAL.

3 Adjust amplifier SET GAIN for exactly 5cm of display.

4 Remove external squarewave and feed signal from CAL 1Vp-p terminal into Y input without variation of amplifier gain controls.

5 Adjust RV416 SET CAL for exactly 5cm of display.

6 Switch-off, disconnect from supply and replace rear cover.

COMPONENT LISTS

All resistor and capacitor values are stated in ohms and microfarads respectively unless otherwise shown; ratings are similarly stated in watts and volts at 70°C.

Carbon composition resistors are 10% ¼W unless stated otherwise.

Whenever possible, exact replacements for components should be used. These should be ordered from the company or its agents stating:

(1) Instrument type
(2) Instrument serial number
(3) Component circuit reference
(4) Component part number
(5) Component value

For standard components, locally available alternatives may be satisfactory.

ABBREVIATIONS

C	Carbon composition	P	Paper
CER	Ceramic	PC	Polycarbonate
CP	Carbon preset	PE	Polyester
CT	Ceramic trimmer	PS	Polystyrene
CV	Carbon variable	RE	Reversible electrolytic
E	Electrolytic	Se	Selenium
Ge	Germanium	Si	Silicon
HS	High-stability carbon	SM	Silver mica
MF	Metal film	WW	Wire-wound
MO	Metal oxide	WWP	Wire-wound preset
		WWV	Wire-wound variable

TELEQUIPMENT LTD
313 Chase Road
Southgate
LONDON, N.14.

TELEPHONE: 01-882 1166
CABLES: TELEQUIPT LONDON N 14

TD51 TIMEBASE

Cct. ref.	Part number	Value	Description	Tol. %	Rating
R103	316-0105-01	1M	C		
R104	316-0105-01	1M	C		
R105	316-0104-01	100k	C		
R106	316-0104-01	100k	C		
R107	316-0101-01	100	C		
R108	316-0104-01	100k	C		
R109	316-0562-01	5.6k	C		
R110	316-0822-01	8.2k	C		
RV111	311-0724-00	500	CV (with RV148 & S103)	20	2
R112	316-0561-01	560	C		
R113	316-0471-01	470	C		
R114	316-0122-01	1.2k	C		
R115	316-0103-01	10k	C		
R116	316-0101-01	100	C		
R117	316-0471-01	470	C		
R118	316-0223-01	22k	C		
R119	316-0104-01	100k	C		
R120	316-0102-01	1k	C		
R121	303-0223-01	22k	C	5	1
R122	316-0472-01	4.7k	C		
R123	315-0104-01	100k	C	5	¼
RV124	311-0756-00	47k	CP	20	¼
R125	316-0221-01	220	C		
R126	303-0153-01	15k	C	5	1
RV127	311-0717-00	220	CP	20	¼
R128	316-0122-01	1.2k	C		
R129	316-0221-01	220	C		
R130	316-0180-01	18	C		
R131	303-0333-01	33k	C	5	1
R132	316-0392-01	3.9k	C		
R133	316-0124-01	120k	C		
R134	316-0393-01	39k	C		
R135	316-0101-01	100	C		
R136	316-0563-01	56k	C		
R137	319-0112-00	500k	HS	1	¼
R138	316-0273-01	27k	C		
R139	316-0472-01	4.7k	C		
R140	316-0102-01	1k	C		
RV141)	311-0729-00	(1k	CV	20	2
RV142)		(25k	CV	20	2
R143	316-0224-01	220k	C		
R144	316-0684-01	680k	C		
R145	316-0102-01	1k	C		
R146	319-0110-00	4.7k	HS	1	¼

Carbon resistors are 10% ¼W unless otherwise shown

Cct. ref.	Part number	Value	Description	Tol. %	Rating
R147	319-0102-00	2.7k	HS	1	¼
RV148	311-0724-00	10k	CV (with RV111 & S103)	20	2
R149	303-0103-01	10k	C	5	1
R150	316-0101-01	100	C		
R151	319-0042-01	1k	HS	1	¼
R152	303-0183-01	18k	C	5	1
R153	316-0222-01	2.2k	C		
R154	316-0821-01	820	C		
R155	316-0101-01	100	C		
R156	316-0224-01	220k	C		
R157	316-0155-01	1.5M	C		
R158	316-0473-01	47k	C		
R159	316-0103-01	10k	C		
R160	316-0153-01	15k	C		
R161	319-0102-00	2.7k	HS	1	¼
R162	319-0104-00	3.3k	HS	1	¼
R163	316-0124-01	120k	C		
RV164	311-0765-00	100k	CP	20	¼
R165	303-0683-01	68k	C	5	1
R166	316-0331-01	330	C		
RV167	311-0735-00	10k	CP	20	¼
R168	316-0272-01	2.7k	C		
R169	319-0106-00	3.9k	HS	1	¼
R170	316-0154-01	150k	C		
R171	316-0393-01	39k	C		
RV172	311-0756-00	47k	CP	20	¼
R173	316-0473-01	47k	C		
R174	319-0031-01	1M	HS	1	¼
R175	316-0101-01	100	C		
R176	316-0105-01	1M	C		
R177	303-0683-01	68k	C	5	1
R178	316-0394-01	390k	C		
R179	316-0101-01	100	C		
R180	316-0395-01	3.9M	C		
R181	316-0105-01	1M	C		
R182	316-0472-01	4.7k	C		
R183	303-0183-01	18k	C	5	1
R184	316-0180-01	18	C		
R185	316-0474-01	470k	C		
R186	316-0180-01	18	C		
R187	303-0183-01	18k	C	5	1
R188	316-0101-01	100	C		
R189	316-0824-01	820k	C		
R190	316-0270-01	27	C		
R191	316-0222-01	2.2k	C		
RV192)	311-0742-00	(100k	CV	20	2
RV193)		(10k	CV	20	2
R194	303-0184-01	180k	C	5	1

Cct. ref.	Part number	Value	Description	Tol. %	Rating
R195	316-0681-01	680	C		
RV196	311-0786-00	1.5k	CP	20	¼
R197	316-0101-01	100	C		
R198	307-0161-00	12k	MO	5	3¼
R199	305-0103-01	10k	C	5	2
R200	316-0101-01	100	C		
R201	303-0183-01	18k	C	5	1
R202	316-0271-01	270	C		
R203	307-0161-00	12k	MO	5	3¼
R204	316-0101-01	100	C		
R205	316-0102-01	1k	C		
R206	305-0103-01	10k	C	5	2
R207	316-0223-01	22k	C		
R208	316-0102-01	1k	C		
R209	316-0180-01	18	C		
R210	316-0180-01	18	C		
R211	316-0180-01	18	C		
R212	319-0135-00	5.6k	HS	1	¼
R213	316-0473-01	47k	C		
R214	316-0562-01	5.6k	C		
R215	316-0105-01	1M	C		
R216	316-0101-01	100	C		
R217	316-0224-01	220k	C		
R218	316-0105-01	1M	C		
RV219	311-0802-00	4.7k	CP	20	¼
R220	316-0393-01	39k	C		
R281	316-0105-01	1M	C		
R282	319-0112-00	500k	HS	1	¼
R283	319-0112-00	500k	HS	1	¼
R284	319-0092-00	1.5M	HS	1	¼
R285	319-0101-00	2.5M	HS	1	¼
R286	319-0035-01	5M	HS	1	¼
R287	309-0457-00	15M	HS	2	½
R288	315-0514-01	510k	C	5	¼
R289	316-0153-01	15k	C		
R291	315-0303-01	30k	C	5	¼
R292	316-0683-01	68k	C		
R293	316-0394-01	390k	C		
RV294	260-0964-00	1M	CV (with S276)	20	¼
C100	281-0712-00	5p	CER	¼p	750
C103	285-0772-00	0.1	PE	10	400
C104	285-0772-00	0.1	PE	10	400
C105	285-0874-00	470p	PS	5	125
C106	285-0874-00	470p	PS	5	125
C107	285-0874-00	470p	PS	5	125
C108	290-0354-00	100	E		12
C109	290-0353-00	16	E		32

Cct. ref.	Part number	Value	Description	Tol. %	Rating
C110	285-0800-00	0.01	PE	20	250
C111	285-0783-00	2,200p	PE	20	400
C112	290-0353-00	16	E		32
C113	290-0356-00	16	E		25
C114	285-0858-00	1,000p	PS	1	350
C115	285-0843-00	30p	PS	2p	350
C116	285-0796-00	0.1	PE	20	250
C117	285-0796-00	0.1	PE	20	250
C118	290-0360-00	2	E		150
C119	285-0798-00	0.022	PE	20	250
C120	285-0795-00	0.22	PE	20	250
C121	285-0854-00	100p	PS	2p	350
C122	285-0854-00	100p	PS	2p	350
C123	285-0844-00	39p	PS	2p	350
C124	285-0796-00	0.1	PE	20	250
C125	285-0769-00	0.01	PE	20	400
C126	285-0869-00	47p	PS	2p	350
C127	285-0854-00	100p	PS	2p	350
C128	281-0712-00	5p	CER	¼p	750
C129	285-0796-00	0.1	PE	20	250
C130	285-0773-00	0.1	PE	20	400
C131	285-0869-00	47p	PS	2p	350
C132	281-0130-00	4-20p	CT		250
C133	290-0360-00	2	E		150
C134	290-0374-00	50	E		150
C135	281-0683-00	50-450p	CT		
C136	285-0858-00	1,000p	PS	1	350
C276	285-0842-00	15p	PS	1p	350
C277	281-0137-00	6-30p	CT		350
C278	285-0794-00	4	PE	2	250
C279	285-0846-00	380p	PS	1	125
C281	285-0789-00	0.4	PE	2	125
C282	285-0848-00	0.04	PS	1	125
C283	285-0852-00	4,000p	PS	1	125
C284	285-0867-00	20p	PS	1p	350

MR100	152-0062-01)		
MR101	152-0062-01)		
MR102	152-0062-01)		
MR103	152-0062-01)		
MR104	152-0062-01)	1N914	Si
MR105	152-0062-01)		
MR106	152-0062-01)		
MR107	152-0062-01)		
MR108	152-0343-00	1N914T	Si
MR109	152-0062-01)		
MR111	152-0062-01)	1N914	Si
MR112	152-0062-01)		

Cct. ref.	Part number	Value	Description
N101	150-0069-00	60V	Neon 3L
S101	260-0962-00		Rotary (8-position)
S102	260-1073-00		Rotary (6-position)
S103	311-0724-00		Rotary (with RV111 & 148)
S104	260-0942-00		Push (4-button)
S105	260-0949-00		Push (1-button)
S276	260-0964-00		Rotary (23-position with RV294)
TR101	151-0242-00)		
TR102	151-0242-00)		
TR103	151-0242-00)		
TR104	151-0242-00)		SPS2506 Motorola Si
TR105	151-0242-00)		
TR106	151-0242-00)		
TR107	151-0242-00)		
TR108	151-0242-00)		
TR109	151-0243-00		ACY22 Mullard Ge
TR111	151-0242-00)		
TR112	151-0242-00)		SPS2506 Motorola Si
TR113	151-0242-00)		
V101	154-0187-01)		ECC88/6DJ8
V102	154-0187-00)		
V103	154-0535-00		EF184/6EJ7
V104	154-0187-01		ECC88/6DJ8
V105	154-0535-00)		EF184/6EJ7
V106	154-0535-00)		

D53A MAINFRAME

Cct. ref.	Part number	Value	Description	Tol. %	Rating
*R101	316-0685-01	6.8M	C		
*R102	316-0685-01	6.8M	C		
RV301	311-0782-00	100k	CV (with RV308)	20	2
R302	316-0683-01	68k	C		
R303	316-0395-01	3.9M	C		
RV304	311-0821-00	1M	CV (with RV307)	20	¼
R305	316-0224-01	220k	C		
R306	316-0683-01	68k	C		
RV307	311-0821-00	1M	CV (with RV304)	20	¼
RV308	311-0782-00	100k	CV (with RV301)	20	2
R309	316-0823-01	82k	C		
R310	316-0184-01	180k	C		
RV311	311-0801-00	470k	CP	20	¼
R312	316-0334-01	330k	C		
R313	316-0473-01	47k	C		
R314	316-0394-01	390k	C		
R315	316-0105-01	1M	C		
R316	316-0104-01	100k	C		
R317	316-0823-01	82k	C		
R318	316-0124-01	120k	C		
R319	316-0393-01	39k	C		
R320	316-0683-01	68k	C		
RV321	311-0805-00	500k	CP	20	2
R322	316-0104-01	100k	C		
RV401	311-0709-00	25	WW (with S401)	10	1
R402	316-0680-01	68	C		
R403	316-0121-01	120	C		
R404	316-0154-01	150k	C		
RV405	311-0706-00	100+100	CP (ganged)	20	2
R406	303-0102-01	1k	C 5	5	1
R407	303-0102-01	1k	C	5	1
R408)	308-0471-00	(820	WW	5	10
R412)		(820	WW	5	10
R409	308-0493-00	1k	WW	5	6
R411	303-0560-01	56	C	5	1
R413	308-0493-00	1k	WW	5	6
R414	322-0670-00	1k	MF	1	¼
R415	319-0068-01	7.5k	HS	1	¼
RV416	311-0802-00	4.7k	CP	20	¼
R417	316-0680-01	68	C		
R418	316-0560-01	56	C		

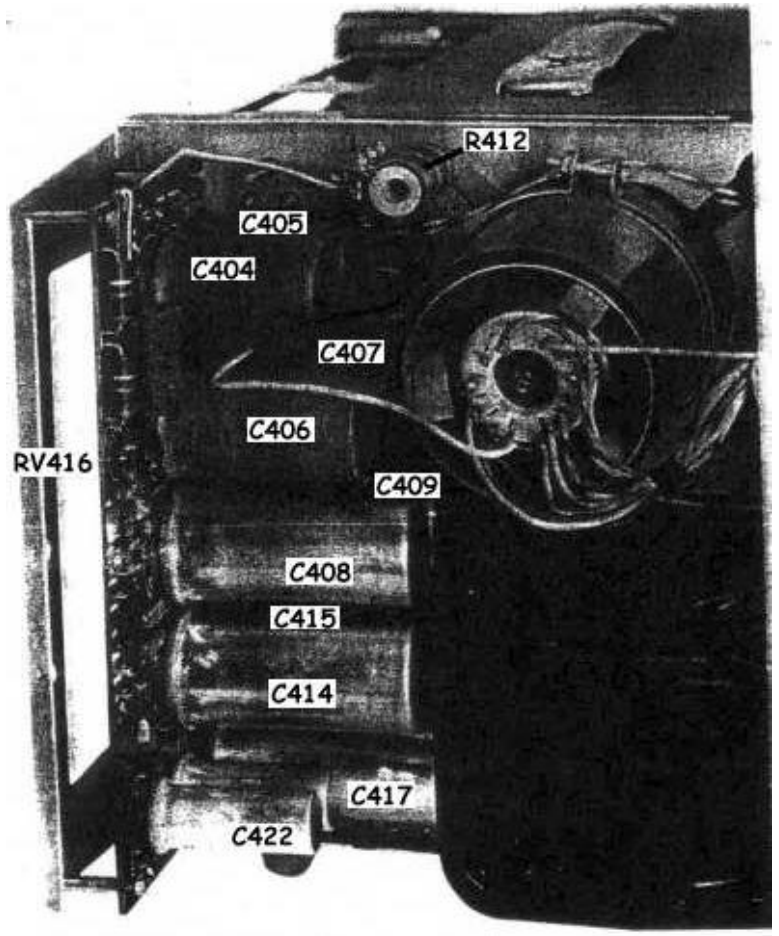
*Shown in Figure 2.1

Carbon resistors are 10% ¼W unless otherwise shown

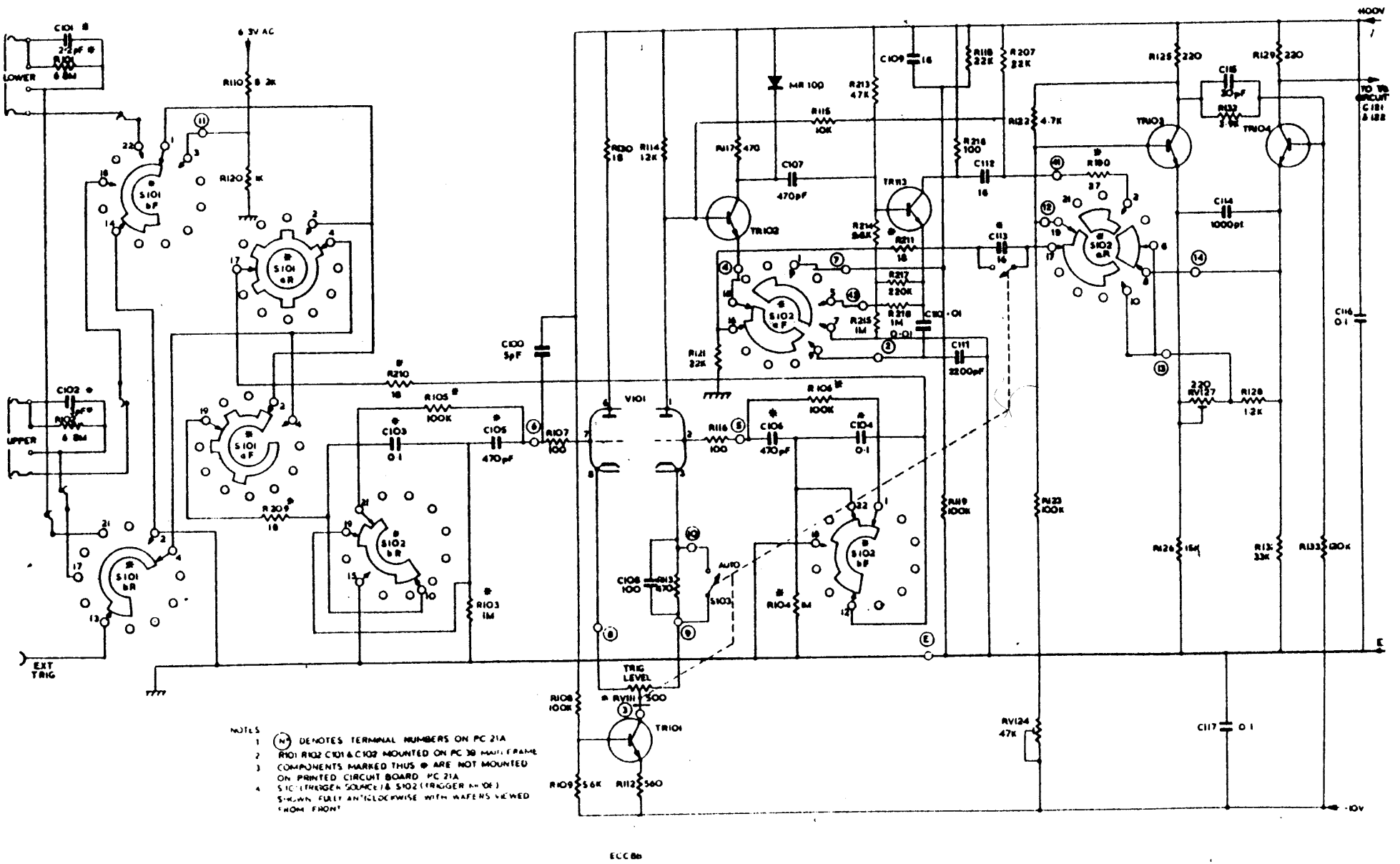
Cct. ref.	Part number	Value	Description	Tol. %	Rating
C101	281-0676-00	2.2p	CER	0.1p	500
C102	281-0678-00	3p	CER	0.1p	500
C301	281-0677-00	0.01	CER		1.5k
C302	285-0772-00	0.1	PE	10	400
C401	285-0796-00	0.1	PE	20	250
C402	281-0682-00	0.02	CER		2k
C403	285-0837-00	0.02	PE		5k
C404	290-0351-00	120	E		200
C405	290-0351-00	120	E		200
C406a)		(32	E		450
b)	290-0359-00	(32	E		450
c)		(32	E		450
C407a)		(32	E		450
b)	290-0359-00	(32	E		450
c)		(32	E		450
C408	290-0375-00	400	E		150
C409	290-0375-00	400	E		150
C410	285-0837-00	0.02	PE		5k
C411a	285-0837-00	0.02	PE		5k
b	285-0837-00	0.02	PE		5k
C412	285-0796-00	0.1	PE	20	250
C413	285-0796-00	0.1	PE	20	250
C414	290-0375-00	400	E		150
C415	290-0375-00	400	E		150
C416	285-0792-00	4,700p	PE	20	125
C417	290-0389-00	7,500	E		18
C418	290-0387-00	500	E		18
C419	290-0388-00	500	E		18
C420	285-0792-00	4,700p	PE	20	125
C422	290-0388-00	500	E		18
C423	290-0364-00	16	E		450
C424	290-0364-00	16	E		450
C425	290-0364-00	16	E		450
C426	290-0364-00	16	E		450
F401	159-0075-00	1.5A	1¼ in delay 200-250V		
	159-0076-00	3A	1¼ in delay 100-125V		
L401	108-0477-00		Trace rotation coil (480 turns)		
LP401	150-0074-00	6.5V	Lamp LES		0.15A
LP402	150-0074-00	6.5V	Lamp LES		0.15A
LP403	150-0074-00	6.5V	Lamp LES		0.15A
MR301	152-0344-00	100V	Si zener	10	0.33W
MR401	152-0350-00	5.6kV	Se rectifier		0.48mA

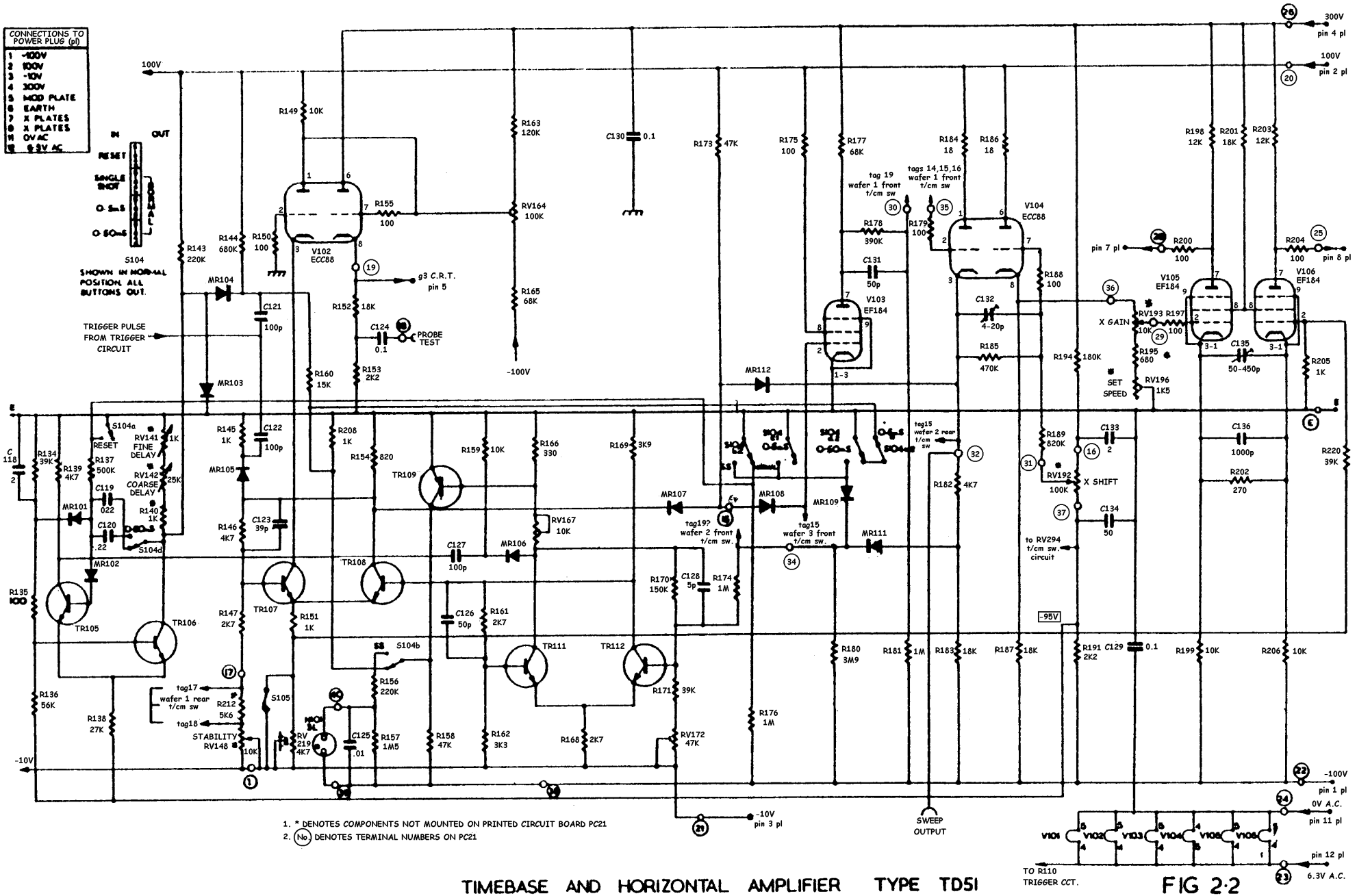
*Shown in Figure 2.1

Cct. ref.	Part number	Value	Description	Tol. %	Rating
MR402	152-0350-00	5.6kV	Se rectifier		0.48mA
MR403	152-0341-00	450V	Si rectifier		0.5A
MR404	152-0341-00	450V	Si rectifier		0.5A
MR405	152-0341-00	450V	Si rectifier		0.5A
MR406	152-0341-00	450V	Si rectifier		0.5A
MR407	152-0341-00	450V	Si rectifier		0.5A
MR408	152-0341-00	450V	Si rectifier		0.5A
MR409	152-0339-00	50V	Si rectifier		0.5A
MR410	152-0350-00	5.6kV	Se rectifier		0.48mA
MR411	152-0350-00	5.6kV	Se rectifier		0.48mA
MR412	152-0352-00	800V	Si rectifier		0.2A
MR413	152-0352-00	800V	Si rectifier		0.2A
MR414	152-0352-00	800V	Si rectifier		0.2A
MR415	152-0352-00	800V	Si rectifier		0.2A
MR416	152-0352-00	800V	Si rectifier		0.2A
MR417	152-0346-00	11V	Si zener	5	0.33W
MR418	152-0339-00	50V	Si rectifier		0.5A
S401	311-0709-00		Rotary (with RV401)		
T401	120-0532-00		Power transformer		
CRT	154-0526-00		1374P P31 (standard)		
	154-0555-00		1396P P7		
	154-0582-00		1358P P11		



H.T. Supply

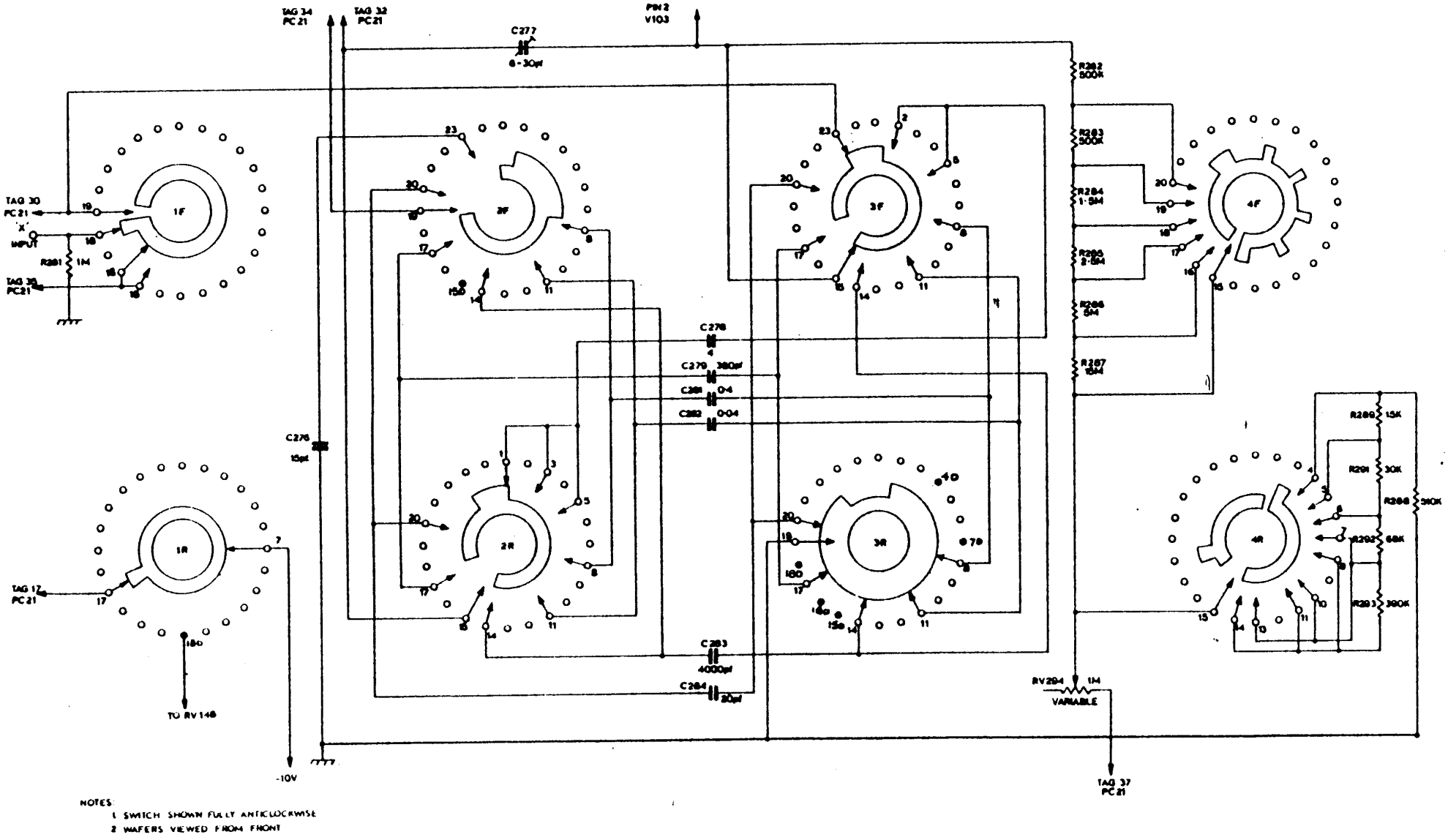

LOWER
UPPER
EXT TRIG
6·3V AC
400V
-10V
TRIG LEVEL
AUTO
TRIGGER CIRCUIT TYPE TD51
FIG 2·1



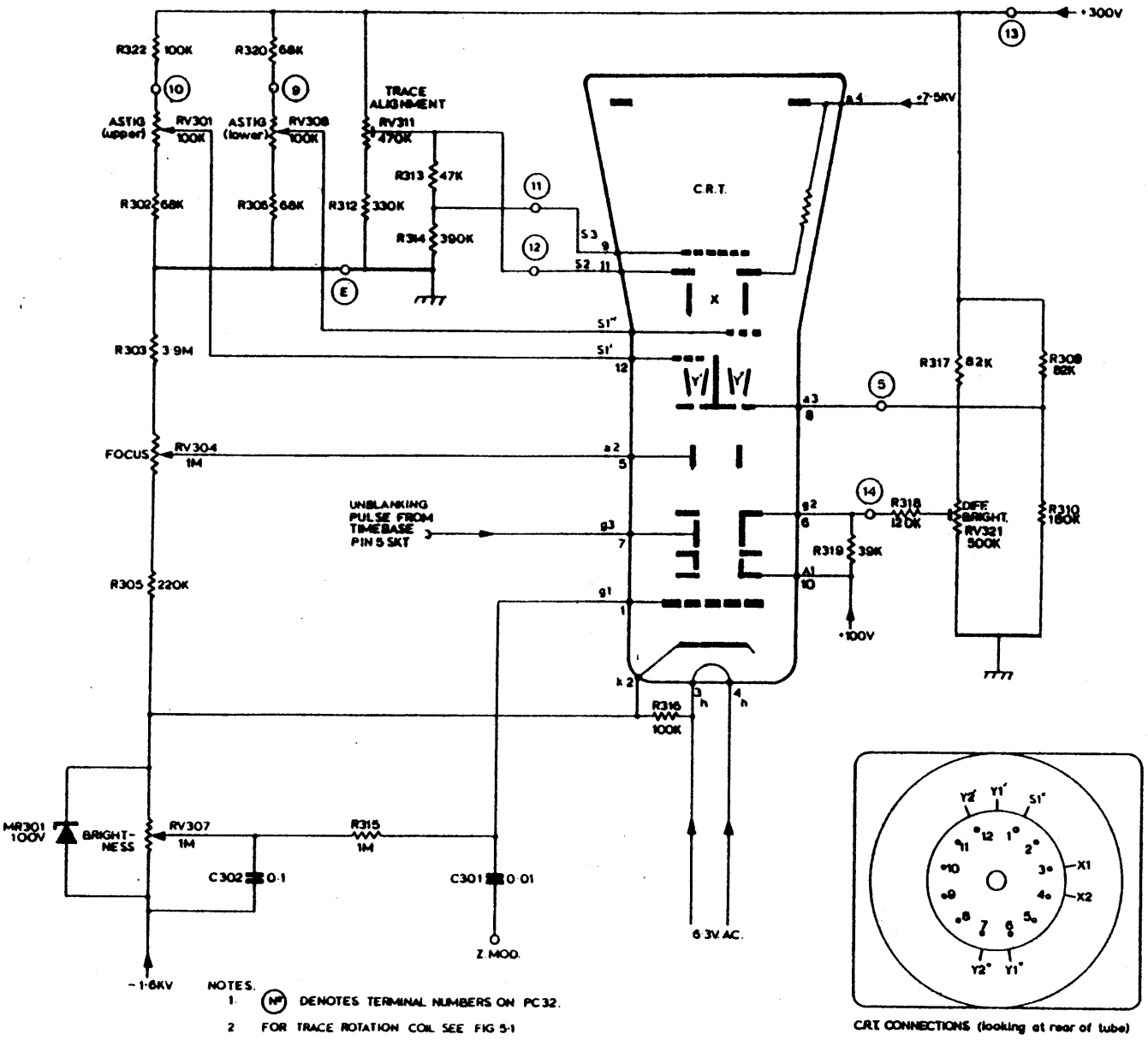
1. * DENOTES COMPONENTS NOT MOUNTED ON PRINTED CIRCUIT BOARD PC21
2. (No.) DENOTES TERMINAL NUMBERS ON PC21

TIMEBASE AND HORIZONTAL AMPLIFIER TYPE TD51

FIG 2·2



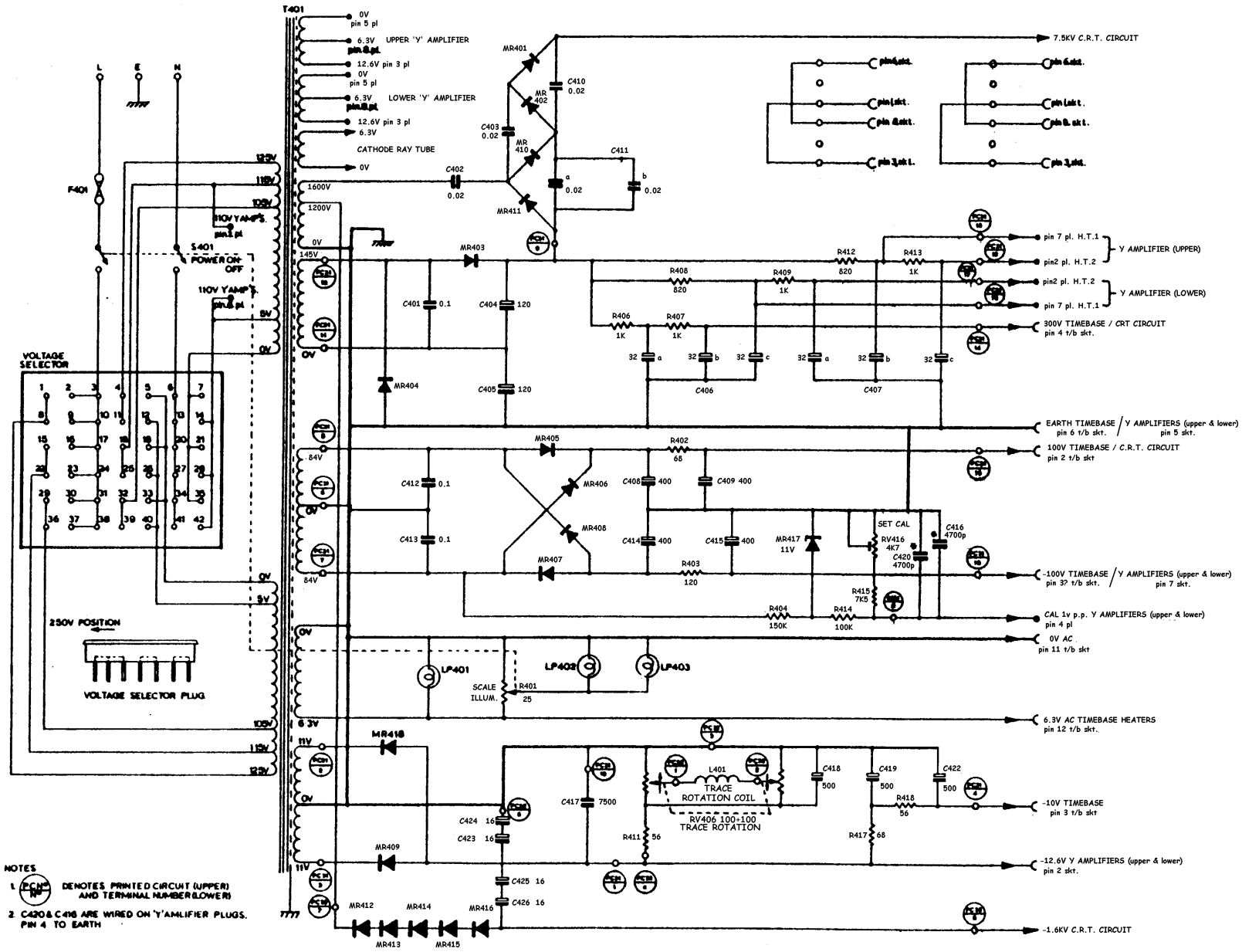
TIME / CM SWITCH TYPE TD51 FIG 2·3



C.R.T. CIRCUIT

C.R.T CONNECTIONS (looking at rear of tube)

FIG 4·1



POWER SUPPLY TYPE D53A FIG 5·1