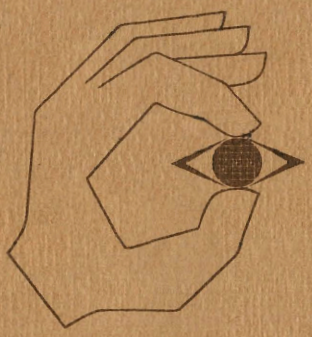

TELEQUIPMENT

STORAGE OSCILLOSCOPE

TYPE DM53A

MANUAL

TELEQUIPMENT

STORAGE OSCILLOSCOPE

TYPE DM53A

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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CONTENTS

GENERAL DESCRIPTION

The DM53A is a direct-view split-beam storage oscilloscope with independent plug-in vertical amplifiers and timebase. Only the cathode ray tube and power supply circuitry is incorporated in the mainframe.

The tube circuitry provides five alternative conditions of operation for the CRT.

(a) Normal: the CRT exhibits P31 phosphor characteristics as in a conventional non-storage oscilloscope.

(b) Variable persistence: the decay time of the image may be controlled.

(c) Store (without enhancement): the image is retained for up to about ten minutes.

(d) Store (with variable enhancement): the writing speed may be increased by up to about ten times; the storage or hold time is, however, reduced.

(e) Hold: the retention time of the image written in the store condition is prolonged to up to about an hour without enhancement and up to five to ten minutes with maximum enhancement.

To avoid multiple earth paths, which could give rise to hum, in the types A, C-2, J and JD amplifiers, the input stage earth connections are brought to a common point; the outer of the UHF INPUT socket and the LOW terminal are connected to this point which is connected to the chassis via a 100 ohm resistor. When one such amplifier is used, the LOW terminal should be linked to chassis. When two amplifiers are used, the LOW terminals should be interconnected and only one link made to chassis.

To avoid a hum loop between the source and the oscilloscope the signal return conductor should be earthed at either the source or the oscilloscope, but not both.

NOTE Adjustment tools with insulated shafts and handles should always be used since high voltages are present at some parts of the circuit.

As there is only a high-resistance discharge path for the 6kV EHT+ supply, a high voltage will persist for some minutes after the instrument is switched off. Care should be taken that this supply is discharged before any work is carried out in its neighbourhood.

TECHNICAL DATA

VERTICAL DEFLECTION AMPLIFIERS - Summary of characteristics:

Type	Approx. 3dB bandwidth hertz	Risetime 10-90%	Calibrated sensitivity per cm	Maximum C.M.R.R.
A	d.c. - 800k d.c. - 15M	440ns 23ns	10mV - 5V 100mV - 50V	-
B	d.c. - 75k	4.7μs	1mV - 5V	10,000:1
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	-
G	d.c. - 500k d.c. - 10M	700ns 35ns	2mV - 1V 20mV - 10V	1,000:1
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	-
* 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	-
* K	d.c. - 150k increasing to d.c. - 5M	2.3μs to 70ns	100μV to 5mV - 20V	10,000:1

Calibration accuracy is ± 5%.

* d.c. trigger output.

TD51 TIMEBASE

Trigger

Internal - minimum deflection	2mm
External - minimum input	0.5Vp-p
input impedance approx.	1 megohm
Useful bandwidth approx.	
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	5 x 9cm
Overall tube voltage	7kV

Writing speed and storage time

	Minimum writing speed	Approximate storage time STORE	HOLD
Enhance off	0.05cm/μs	5-10min	60min
Enhance max.	0.5cm/μs	1min	5min
Normal (non-store)	5cm/μs	-	-

CATHODE RAY TUBE (contd.)

External blanking (Z MOD)	
Signal for blanking at average brilliance	± 45V approx.
Input time constant	600μs approx.

FRONT PANEL OUTPUTS

Sweep output	
Positive going ramp	50V approx.
Minimum load	100 kilohms
Probe test (a.c. coupled)	6Vp-p approx.
Calibrator (via plug-in amplifier)	
A, B, C-2, G, J, & JD	1Vp-p ± 2%
K	5mVp-p ± 2%

POWER REQUIREMENTS

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

PHYSICAL CHARACTERISTICS

Approximate overall dimensions and net weight (DM53A with TD51 only)

Height	Width	Depth	Weight
28cm	29.2cm	51.5cm	20 kg
11in	11½in	20¼in	44¼ lb

Cooling	Convection
Maximum ambient operating temperature	40°C, 104°F

OPERATING INSTRUCTIONS

The following instructions refer in details to a DM53A fitted with type A amplifiers and a TD51 timebase. Operation in the normal mode is first described, followed by illustrations of use in the variable persistence, store, enhance and hold conditions.

FIRST-TIME OPERATION (Normal mode)

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

The supply lead is alternatively colour-coded:

Live	Neutral	Earth (ground)
Brown	Blue	Green & yellow
Red	Black	Green
Black	White	Green

Set controls as below:

CRT controls

VAR PERSIST	Anti-clockwise (before switched to STORE)
ENHANCE	Fully anti-clockwise
MODE	NORMAL
ASTIG	Both central
BRILLIANCE	Fully anti-clockwise, power off
FOCUS	Central

Timebase controls

DISPLAY	NORMAL (all buttons out)
TIME/CM	5ms
VARIABLE	Fully clockwise
DELAY (FINE & COARSE)	Any position

Timebase controls (contd.)

X GAIN	Fully anti-clockwise
X SHIFT	Central
TRIGGER MODE	AC SLOW
STABILITY	Fully clockwise
TRIG LEVEL	Switched to AUTO
TRIGGER SOURCE	Y UPPER +

Amplifier controls

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

Link amplifier inputs to CAL 1Vp-p.
Plug-in to the supply and switch on with BRILLIANCE control.
Allow a minute or so warm-up time, then turn BRILLIANCE clockwise for traces of convenient intensity.
Centre traces with X SHIFT and adjust Y SHIFTS for convenient display.
Turn STABILITY anti-clockwise until the traces just disappear, then turn slightly clockwise to obtain a locked display.
Adjust FOCUS and ASTIG 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 VOLTS/CM and TIME/CM controls.

VARIABLE PERSISTENCE

Set controls and connect CAL signal as described in First-time Operation section.
Reduce sweep speed to 50ms and switch MODE to VAR PERSIST.
Reduce BRILLIANCE and press CLEAR then ERASE buttons.
Adjust BRILLIANCE and VAR PERSIST for best display.

This illustrates the use of the variable persistence mode to provide a continuous display of repetitive signals at a low sweep speed.

STORE (Enhance off)

Set controls and connect CAL signal as described in First-time Operation section.
Depress SINGLE-SHOT button.
Check that one sweep is produced each time RESET is pressed.
Switch MODE to VAR PERSIST and switch VAR PERSIST to STORE.
Press CLEAR then ERASE.
Press RESET; after some minutes the background will gradually flood and impair the legibility of the image.

The limiting sweep speed is in the region of 20μs/cm in the enhance off condition.

STORE (Enhance on)

With settings as in the enhance off condition, switch on ENHANCE.
Press CLEAR then ERASE.
Press RESET; the background will flood more quickly than in the enhance off condition, but the useable sweep speed will be increased to about 2μs/cm.

NOTE

Suitable settings of the BRILLIANCE and ENHANCE controls should be used.

HOLD

Obtain an image as in the preceding STORE conditions, then immediately switch from VAR PERSIST to HOLD.

When ENHANCE is off, the image will be held for up to about an hour at reduced intensity. When ENHANCE is on, the image will be held below visible level for various times down to five to ten minutes with full enhancement. On switching back to VAR PERSIST, the image will be displayed at its original intensity.

ADDITIONAL INFORMATION and FACILITIES

TD51 TIMEBASE

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 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.

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

TRIGGER MODE This control 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.

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.

DM53A MAINFRAME

CLEAR The button should be depressed for about one second before using ERASE. This is particularly important with enhanced writing speed operation. The effect of the control is to raise the potential of the whole storage mesh to a uniform level. The control is inoperative in the NORMAL and HOLD modes.

ERASE This control is used in VAR PERSIST and STORE to delete any stored information; as with CLEAR, the button should be depressed for about one second. To ensure uniformity of erasure, CLEAR should be operated before ERASE; this is particularly necessary in enhanced operation. The control is inoperative in the NORMAL and HOLD modes.

A lead assembly (part number 012-0199-00) is obtainable as an optional accessory to provide button-operated remote control of ERASE and timebase RESET. The lead is plugged into a 5-pin rear socket.

VAR PERSIST When the mode switch is set to its central position, the VAR PERSIST control provides a range of trace decay times. The fully clockwise setting provides minimum persistence or maximum rate of decay. As the control is turned anti-clockwise, the persistence increases until the CRT is switched into the STORE mode.

ENHANCE A lamp indicates that ENHANCE is on. Clockwise rotation progressively brings up the intensity of the background and improves the writing capability of the CRT to better than 0.5cm/μs. The length of time that the image is retained in both STORE and HOLD is however reduced.

MODE (NORMAL - VAR PERSIST - HOLD)

(a) NORMAL This setting disables the CLEAR, ERASE, VAR PERSIST and ENHANCE controls to provide conventional oscilloscope operation. The only CRT controls affecting the display are ASTIG, BRILLIANCE and FOCUS.

(b) VAR PERSIST This setting provides variable persistence or store operation depending upon the setting of VAR PERSIST. All CRT controls on the panel are functional in this setting.

The variable persistence facility is of particular use in providing a continuous display of repetitive waveforms at low sweep speeds and to eliminate the flicker caused by low trigger rates. The VAR PERSIST control should be used in association with BRILLIANCE to provide the best display. When switching from NORMAL it is usually necessary to reduce BRILLIANCE and operate CLEAR and ERASE.

A display obtained in the variable persistence or store conditions may be retained by switching the lever switch across to HOLD. When it is necessary to re-examine the image at normal intensity, VAR PERSIST should be switched to STORE and the lever switch switched to VAR PERSIST.

The use of ENHANCE increases writing speed in the STORE mode at the expense of storage time in STORE and HOLD.

The store condition is especially suited for use with the timebase single-shot facility to display randomly occurring phenomena. A multiple display of non-repetitive events is realisable by adjustment of Y SHIFT while the timebase LOCATE button is depressed during the interval between events. This enables the separation of adjacent traces to be predetermined.

(c) HOLD The storage time in HOLD is about five times that in VAR PERSIST. The trace should first be written in the VAR PERSIST position then the lever switch moved to HOLD. In HOLD, the image is retained at reduced intensity with ENHANCE off or below visible level with ENHANCE on; the original intensity may be recovered by switching back to VAR PERSIST although the rate at which the background floods will be increased.

ASTIG These controls should be used in conjunction with FOCUS to obtain best trace definition over the whole CRT face area.

BRILLIANCE This adjusts the intensity of the display and serves as the power on-off switch.

FOCUS The definition of both traces is adjusted by this control. In the NORMAL mode, spot size is less than in the VAR PERSIST and STORE modes.

SCALE ILLUM (at rear) This controls the intensity of the graticule illuminating lamps.

Z MOD (at rear) The 4mm socket is capacitively coupled to the CRT cathode. The time-constant is about 600μs; if a longer time-constant is required, a larger value capacitor of adequate working voltage may be substituted for C317. Positive-going signals will reduce and negative-going signals increase the intensity of both upper and lower traces.

CIRCUIT DESCRIPTIONS

TD51 TIMEBASE

TRIGGER - Figure 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 with adjustment of TRIG LEVEL.

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 & 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 R369 & C322 on the CRT circuit where a bistable is switched over to unblank the trace except in the HOLD mode.

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 time base is armed.

For remote control of reset from a socket at the rear of the mainframe, a connection is made via pin 10 of the timebase supply plug.

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 long-tailed pair V105 & 106 drives the deflector plates directly; 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

GENERAL The CRT is an English Electric Valve Company direct-view storage tube. Three electron gun systems are incorporated. The writing gun is equivalent to the gun fitted in a conventional non-storage tube; the two flood guns with their collimating electrodes provide beams of uniform electron density over the whole tube face area.

PRINCIPLES OF STORAGE ACTION The operating condition of the tube is primarily determined by the potential of the backing electrode and storage mesh relative to that of the flood gun cathode. The backing electrode consists of a fine metal grid to which is suspended a non-conductive storage mesh.

In the STORE mode, the electron beam from the writing gun causes a charged pattern to form on the storage mesh on the backing electrode. Collimated beams of low-velocity electrons from the flood guns flow towards this mesh and penetrate it in the area where a charge pattern has been built-up by the writing gun; electrons failing to penetrate the mesh are collected by F/Gg5. The high positive potential on the screen electrode then accelerates the electrons passing through the backing electrode onto the phosphor, reproducing a visible image identical with that written on the storage mesh. The continuous flow of flood gun electrons, while the instrument remains switched on, ensures the retention of the image on the viewing screen. Storage time is however limited by gradual overall flooding of the display. This effect arises from stray ions progressively charging the whole storage mesh, thus enabling the flood gun electrons to penetrate the whole mesh area and activate the phosphor.

The ENHANCE condition enables faster writing speeds to be attained but with corresponding decrease in storage time. The backing electrode with attached storage mesh is switched to a variable more positive potential; this brings the mesh closer to the visible level where the flood gun electrons penetrate the mesh and provide a stored display.

Storage time may be increased by switching to HOLD after a trace has been stored. Mean flood gun cathode current is adjusted to about one-seventh of its normal value by feeding negative-going rectangular pulses onto the first grid. The reduction in mean current causes the intensity of the display to fall and reduces the rate at which the background floods to make the trace indistinguishable from the background.

To ERASE the image stored on the mesh, a positive potential is temporarily applied to the backing electrode. By capacitive action the potential of the whole mesh area instantly rises to a level more positive than that charged by the writing gun electron beam. Flood gun electrons now penetrate the whole mesh, producing overall activation of the tube phosphor. The storage mesh potential meanwhile gradually falls towards that of the flood gun cathode, due to the bombardment of flood gun electrons, until the ERASE button is released. The fall in backing electrode potential on release of the ERASE button is communicated to the storage mesh, instantly dropping its potential to below that of the flood gun cathode. The passage of further flood gun electrons is thus prevented and the storage mesh is again ready to be written on.

Prior to erasing and storing the CLEAR button is depressed to ensure that all parts of the storage mesh are equally charged. The backing electrode and mesh potential is temporarily raised to that of F/Gg5, this produces overall flooding of the display.

The VARIABLE PERSISTENCE mode is realised by gradually erasing the stored image by means of a positive-going train of pulses equal in amplitude to the erase voltage. Variation in rate of erasure and thus in persistence is obtained by varying the duty-cycle of the pulse generator by adjustment of pulse width. The degree of persistence is inversely proportional to pulse width.

The flood gun beams are suppressed to provide the NORMAL non-store mode of operation. The backing electrode potential is reduced to below that of the flood gun cathode; flood gun electrons are thus repelled and cannot penetrate the mesh. The higher velocity writing gun electrons however can still penetrate the mesh and produce an image on the phosphor; the intensity of the image decays in the usual way according to the constituents of the phosphor.

CIRCUIT DETAILS

Writing Gun The 1.2kV EHT- supply is applied to the writing gun cathode via MR307 & R346; MR307 provides a low-impedance path for the writing gun beam current. Brilliance control RV345 varies the potential on W/Gg1 via R382 and hence tube current and display intensity. RV344 enables maximum cathode current to be set. External intensity modulation may be applied to W/Gk via C317 and the rear Z MOD socket; positive-going signals will reduce and negative-going signals will increase beam current. The differential brightness preset RV357 adjusts the potential on W/Gg2 to enable the beam to be equally divided by the splitter electrode W/Ga3 and provide two traces of the same intensity.

The potential of the first writing gun grid, controlled by the condition of the bistable TR313 & 314, determines whether the writing beam is blanked or unblanked. A positive-going unblanking signal is produced at the cathode of V102b in the timebase at the start of the sweep and when external X operation is selected. This signal is attenuated and applied to the base of TR312. Phase-inversion occurs and a negative-going signal is fed via C327 to the base of TR313; this is cut off and the collector potential rises along with that of the writing gun grid to turn on the beam.

At the end of the sweep, the base of TR312 goes negative and the collector goes positive to switch over the bistable and turn on TR313. The collector potential of TR313 falls and the writing gun grid is taken sufficiently negative to turn off the beam.

In the NORMAL and VAR PERSIST positions of S301d, R375 is returned to chassis via clamping diodes MR308 & 309. In the HOLD position, this connection is broken and R375 is returned to the -12V line via R373; this ensures that the base of TR312 is biased so that TR312 cannot be turned on by the timebase and switch over TR313 & 314 to unblank the writing gun beam. MR311 clamps the emitter of TR312 just above chassis potential.

Focusing of the beam is effected by variation of the potential on W/Ga2 by the focus control RV338.

W/Ga3, internally connected to F/Gg2 & 3, splits the electron beam into two components, each of which passes through one pair of Y plates; these are directly connected to the outputs of the plug-in Y amplifiers. S1' & S1", fed from RV335 & 355, provide individual astigmatism correction for each beam.

The X plates are common to both beams and are directly connected to the output of the TD51 timebase. R350 is wired across pins 7 & 8 of the interconnecting socket to make the X amplifier output compatible with the deflection sensitivity of the X plates. S2, the X plate shield, provides raster correction via RV329.

The positive beam accelerating potential of 6kV is applied to the screen electrode, formed by the internal aluminising of the CRT face.

Trace rotation is effected by varying the current through L301 by adjustment of RV359.

Flood Guns Biasing voltages for the flood gun electrodes, including the backing electrode in the store or variable persistence and hold modes, are obtained from the 300 & 360V HT+ lines via TR303 & 304 together with Zener diodes MR301 to 306. TR303 & 304 provide low-impedance sources for the bias potentiometer chain RV318, 319, R321, RV322 & 323. By ensuring a constant voltage across R304, RV305 & R306, MR301 enables the base potential of TR303 and the flood gun electrode potentials to vary in step with the potential of W/Ga3 for small changes in supply voltage.

The five alternative operating modes are determined by the settings of S301, 303 & 304; clearing and erasing is carried out by S305 & 302 respectively.

With S301 at NORMAL, the backing electrode is held negative to F/Gk by S301b and the flood gun electrons are caught by F/Gg5. The writing gun electrons are accelerated through the backing electrode by the screen electrode at +6kV to activate the phosphor.

With S301 at VAR PERSIST, either variable persistence or store operation is obtainable depending on the setting of S303; this is ganged to RV326 the VAR PERSIST control. In the variable persistence mode, switches S303 & 301a connect the emitter of TR308 to RV348. The slider of RV348 is connected to the backing electrode via S304, S302, a contact on the remote control socket, S305 and S301b. Pulses from the pulse generator TR301, 302 & 305 to 308 are thus fed onto the backing electrode. The setting of RV326 determines the pulse width and therefore trace decay rate.

In the store mode, S303 is opened and RV348 is disconnected from TR308. The backing electrode is then taken to the level set by RV322. When enhance is switched on, S304 disconnects the backing electrode from RV348 and connects it to

RV391; S402 (Figure 5) makes to switch on LP404. The backing electrode is now connected to a more positive potential which may be varied by adjustment of RV391.

In the hold condition, S301b switches the backing electrode to the potential set by RV322. This operation disables S302, 304 & 305, making the erase, enhance and clear controls inoperative. S301c connects F/Gg1 to the collector of TR311; TR311 with TR309 constitute the hold monostable which is driven by the multivibrator TR301 & 302. RV365 sets the d.c. level of the monostable so that the positive excursions at the collector of TR311 give rise to the same cathode current as when F/Gg1 is returned to RV323; this adjustment is made by temporarily removing TR311. The mark to space ratio of the monostable is set by RV371 to reduce average flood gun cathode current on hold to about one-seventh of its normal value.

POWER SUPPLIES - Figure 5

The double-wound electrostatically-screened power transformer provides LT, HT and EHT supplies from ten secondary windings. 110V a.c. is provided by one primary winding for the Type B amplifier. F401, a delay fuse, protects the transformer against overload. A seven-pin plug in the voltage selector panel interconnects the primary windings so that supply voltages in the ranges 100-125V and 200-250V may be accommodated.

Various rectifier-capacitor combinations provide the d.c. supplies for operation of the CRT in the mainframe and the plug-in timebase and vertical amplifiers:

MR401, 402, 410 & 411 are connected as a four-stage voltage multiplier to provide +6kV for the CRT screen electrode.

MR403 & 404 are connected as a voltage doubler to provide positive supplies in the 300-360V range.

MR405 & 406 provide a full-wave rectified +100V supply for the CRT and timebase.

MR407 & 408 similarly provide a -100V supply for the timebase and delay amplifiers.

MR426-429 form a full-wave bridge supplying 6.3V d.c. for the CRT flood gun heaters.

MR418 & 419 provide a full-wave rectified -12.6V supply for the CRT, delay amplifiers and elapsed time indicator. After decoupling, a -10V supply is provided for the timebase.

MR412-416 are connected in series to provide a half-wave rectified -1.2kV supply for the CRT writing gun grid and cathode.

MR419-422 are bridge-connected to provide a stabilised 27V supply for the CRT variable persistence pulse generator and bias for erase and enhance operation.

MR425 provides a half-wave rectified 93V supply for the CRT unblanking bistable.

The 1Vp-p calibration waveform is derived by applying an 84V alternating potential to MR417 via R404. The diode clips both half-cycles of the a.c.; the resulting constant-amplitude squarewave is attenuated by R414, 415 & RV416 and set to precisely 1Vp-p by RV416.

MAINTENANCE and RECALIBRATION

GENERAL

Occasional recalibration is desirable to allow for changes in valve characteristics through ageing. Complete procedures are detailed in the amplifier manuals and the Recalibration section. The two main factors influencing accuracy of measurement, namely vertical amplifier gain and timebase sweep speed, may be readily checked using only the internally-generated calibration waveform.

Adjustment of sweep speed is effected with the SET SPEED preset as outlined in the Additional Information section of Operating Instructions.

Amplifier gain may be checked as follows:

A, B, C-2, G, J & JD Set VOLTS/CM to 0.2 (200mV-type B), input switch to DC and Y GAIN to x1. Link one input to CAL 1Vpp terminal and adjust SET GAIN or SET GAIN x1 for a display of precisely 5cm. On the A and C-2, the x10 gain range may be calibrated by switching VOLTS/CM to 2 and selecting x10 gain; adjust SET GAIN x10 for a 5cm display. The x10 range on the J & JD and the AC x100 ranges on the C-2, J & JD require internal adjustment; refer to the appropriate manual.

K Set VOLTS/CM to 1mV and input switch to DC. Link one input to CAL 5mVpp terminal and adjust SET GAIN for a display of precisely 5cm.

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 which in general may be replaced without readjustment of preset 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 individual manuals. 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 4
100kHz squarewave 1Vp-p	Step 4
1ms & 1μs time markers or crystal controlled 1kHz & 1MHz waveform	Step 5

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	Central
TIME/CM	1ms	STABILITY	Fully clockwise
VARIABLE	Fully clockwise	TRIG LEVEL	Switched to AUTO

SET SPEED	Central	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	Central
RV167	Fully clockwise	RV127	Fully clockwise
RV172	Central	RV124	Central

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 the negative-going flyback and the positive-going 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 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, centering trace with X SHIFT.

Screw-in C135 to position just before overshoot appears.

Return X GAIN fully anti-clockwise.

5 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.

CATHODE RAY TUBE

Several steps in the following procedure involve the measurement of voltage between TPs (test points). In all cases the more positive test point is stated first.

NOTE Some test points are at a high potential relative to chassis; for maximum safety, the instrument should be switched off before making or breaking any connections. Before making adjustments, sufficient time should be allowed after switch-on for normal voltages and currents to recur.

Waveforms and equipment required

20 kilohms/volt or better multi-range meter
10 kHz or higher frequency sinewave - step 8
100 kHz or higher frequency sinewave - step 35

1 Remove all covers, set front-panel controls as below, then switch on and leave for at least fifteen minutes to warm-up.

CRT controls

VAR PERSIST	Fully anti-clockwise - STORE
ENHANCE	Fully anti-clockwise - OFF
MODE	NORMAL
ASTIG	Both central
BRILLIANCE	Fully anti-clockwise - OFF
FOCUS	Central

Timebase controls

DISPLAY	NORMAL, all buttons out
TIME/CM	0.5μs
VARIABLE	Fully clockwise
DELAY	Any position
X GAIN	Fully anti-clockwise
X SHIFT	Central
TRIGGER SELECTORS	AC SLOW, Y UPPER +
STABILITY	Fully clockwise
TRIG LEVEL	Switched to AUTO

Amplifier controls

As convenient

2 Adjust controls for best display of free-running trace.

3 Switch off and disconnect the lead from pin 2 (cathode) of CRT base socket. Solder a 1 kilohm 5% $\frac{1}{4}$W (or above) resistor to pin 2 and solder the lead to the other end of the resistor. Connect a voltmeter across the resistor with positive to the CRT base end.

4 Switch on, turn BRILLIANCE fully clockwise and adjust RV344 SET Ik for a reading of 500mV.

5 Switch off, disconnect meter and 1 kilohm resistor and resolder lead to pin 2. Switch TIME/CM to 1ms.

6 Switch on, adjust BRILLIANCE for low-intensity traces and adjust RV357 DIFFERENTIAL BRIGHTNESS for traces of equal intensity.

7 Set Y SHIFTS for traces closely adjacent to centre-line of graticule and adjust RV359 TRACE ROTATION for traces parallel to centre-line. If there is insufficient range of adjustment in the direction required, switch off, remove two securing screws at rear of PC61 board and swing board outwards. Reverse trace rotation coil plug, swing back board, replace securing screws, switch on and readjust RV359.

8 Set TIME/CM to 500µs, apply a 10kHz or higher frequency squarewave to one Y input and remove other trace with its Y SHIFT. Adjust BRILLIANCE, FOCUS, ASTIG and STABILITY for best trace and set other controls to give a rectangular raster about 5cm high by 8cm wide.

9 Adjust RV329 SET RASTER CORRECTION for best rectangle. Remove Y input.

10 Apply voltmeter to test points indicated below and adjust appropriate preset for required voltage.

	Operation	Connect Meter +	Connect Meter -	Adjust	Meter Reading
(1)	SET BE d.c.	TP6	TP8	RV322	3V
(2)	SET F/Gg1	TP8	TP7	RV323	6V
(3)	SET F/Gk	TP2	TP8	RV305	50V
(4)	SET ERASE AMP	TP11	TP6	RV349	10V
(5)	SET F/Gg4	TP5	TP8	RV319	50V
(6)	SET F/Gg5	TP4	TP8	RV318	125V

11 Switch TIME/CM to 50μs and VOLTS/CM to 0.2 (1mV on K). Feed CAL 1Vp-p (5mV on K) into one Y amplifier and adjust controls for a locked display. Set BRILLIANCE fully clockwise and adjust FOCUS and ASTIG for best defined trace. Remove CAL waveform, turn STABILITY fully clockwise and depress timebase SINGLE SHOT button. Leave BRILLIANCE fully clockwise.

12 Switch MODE switch to VAR PERSIST.

13 Depress CLEAR for about one second.

14 Depress ERASE for about one second.

15 Reduce erase voltage by turning RV349 SET ERASE AMPLITUDE a few degrees anti-clockwise.

16 Repeat steps 13, 14 & 15 in that order, progressively reducing erase voltage, until on completion of step 14 the tube face is green all over. If this condition cannot be achieved, proceed to step 17. After readjustment of RV305 & 319 return to step 16.

17 Adjust RV305 SET F/Gk and RV319 SET F/Gg4 for the most even colouration and intensity over the whole rectangle of display.

18 Turn RV349 SET ERASE AMPLITUDE a few degrees clockwise then depress ERASE. Continue turning RV349 clockwise in steps, depressing ERASE each step, until on release of ERASE the screen has become completely dark.

19 Increase sweep speed in steps, depressing RESET then ERASE each step, until the trace resulting from the single sweep is only just visible.

It is now required to reduce the backing electrode potential gradually so that the writing speed may be increased whilst retaining uniformity of written trace.

20 Connect voltmeter between TP6 and TP8 and leave connected. Note the meter reading.

21 Turn RV322 SET BE d.c. anti-clockwise to reduce the reading by about 500mV.

22 Repeat steps 15 to 21 (including the repetition of steps 13, 14 & 15 in step 16) until with an optimum setting of RV322 in step 21, the most continuous trace at the fastest realisable sweep speed is achieved.

23 Remove meter from TP6 & 8.

24 Set TIME/CM to 10μs/cm and turn RV349 SET ERASE AMPLITUDE clockwise in steps, each time depressing RESET then ERASE, until RV349 is just anti-clockwise of the setting at which the trace becomes discontinuous when RESET is pressed.

25 Disconnect oscilloscope from supply. Unsolder the lead to the flood gun cathode at pin 9 of the CRT base socket. Connect ammeter negative to lead and positive to pin 9 of socket. Reconnect to supply, switch on and adjust RV323 SET F/Gg1 for a reading of 700μA.

26 Switch off, switch MODE to HOLD and unplug TR311 from its socket on the PC89 board at left rear of instrument.

27 Switch on and adjust RV365 SET HOLD F/G Ik MAX for 700μA.

28 Switch off and replace TR311.

29 Switch on and adjust RV371 SET HOLD F/G Ik MIN for 100μA.

30 Switch off, disconnect from supply and remove meter. Resolder lead to pin 9 of CRT socket.

31 Adjustment of R389 for maximum enhancement.
Switch ENHANCEMENT off, switch to VARIABLE PERSIST and STORE, switch TIMEBASE to SINGLE SHOT, press CLEAR button, press ERASE button for approximately one second. Switch ENHANCE on and turn fully clockwise. The ideal value of R389 will be indicated by the background luminance increasing to a point, where the two areas just merge in the middle of the tube, and the ENHANCE knob at maximum. The 9th division being the permissible minimum.

If the areas do not merge reduce the value of R389 or if the areas merge too soon increase the value. Access to R389 is gained by unscrewing the left edge of PC 61 and swinging the board out on its hinges. R389 is located in the bottom left-hand corner.

32 Switch timebase from SINGLE SHOT to NORMAL, VAR PERSIST from STORE to minimum persistence (fully clockwise) and MODE from HOLD to NORMAL. Connect one Y amplifier input to TP10 and set amplifier controls for 10V/cm with a.c. input coupling. Connect voltmeter between TP11 and TP6.

33 Reconnect instrument to supply, switch on and note meter reading.

34 Switch TIME/CM to 500μs and adjust RV348 SET PULSE AMPLITUDE for the same pulse height displayed on the CRT as the voltage measured in step 32.

35 Switch off, remove meter and connection to Y amplifier.

36 Switch on, set TIME/CM to 0.5μs and display a 100kHz or higher frequency sine-wave. Adjust Y SHIFT so that the display is symmetrically positioned about the centre horizontal graticule line and adjust X SHIFT and TRIG LEVEL so that the right-hand end of the trace is located on or near to the centre graticule lines. Adjust RV164 on TD51 for minimum flyback or tail occurring to the left of the end of the trace. Remove 100kHz signal.

37 Set TIME/CM to 5ms, VOLTS/CM to 0.5V (2mV on K amplifier) and set RV219 on TD51 fully clockwise. Apply CAL 1Vp-p (5mVp-p on K) to Y amplifier and adjust controls for a locked trace beginning at about the second vertical graticule line. Select SINGLE SHOT and switch MODE to VAR PERSIST. Reduce BRILLIANCE until a fine trace is obtained each time RESET is pressed. Operate ERASE, then depress LOCATE button and keep it depressed. Turn RV219 slowly anti-clockwise until two spots appear about 2.5mm to the left of the starting point of the trace. Continue turning RV219 gradually until a fine line joining the spots is obtained. Release LOCATE and switch off instrument.

38 Replace side, top and rear covers.

POWER SUPPLY (Calibrator)

Waveform and equipment required

1Vp-p squarewave, accurate to within ± 1%, at supply frequency or within Y amplifier bandwidth.

For a DM53A with K amplifiers only, a separate test oscilloscope is required.

The procedure to be followed depends on the types of plug-in amplifier available. Since a.c. input coupling is used, a line-frequency squarewave at 50 or 60Hz will introduce tilt in the display. Care should be taken to measure peak-to-peak amplitudes at the same point on the waveform, say at the transition from the positive to negative half-cycle.

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

A, B, C-2, G, J & JD amplifiers

2 Reconnect to supply, switch on and set VOLTS/CM to 0.2V Y GAIN (if fitted) to x1 and DC-AC to AC. Feed in accurate 1Vp-p squarewave and adjust SET GAIN (or SET GAIN x1) for a 5cm peak-to-peak squarewave.

3 Remove external squarewave and connect CAL 1Vp-p to amplifier input. Adjust RV416 (on PC 31 board) for exactly 5cm of squarewave.

K amplifier

4 Feed in 1Vp-p squarewave from accurate squarewave generator to test oscilloscope and note the deflection. Remove 1Vp-p squarewave.

5 Remove left-hand side cover and plug-in amplifiers from DM53A, switch on and apply CAL waveform from pin 4 of the plug-in interconnecting plug. Adjust RV416 for the same deflection as noted in step 2.

6 Switch off, disconnect from supply and replace cover(s).

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% $\frac{1}{4}$W 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
CER	Ceramic
CP	Carbon preset
CT	Ceramic trimmer
CV	Carbon variable
E	Electrolytic
Ge	Germanium
HS	High-stability carbon
MF	Metal film
MO	Metal oxide
P	Paper
PC	Polycarbonate
PE	Polyester
PS	Polystyrene
RE	Reversible electrolytic
Se	Selenium
Si	Silicon
SM	Silver mica
WW	Wire-wound
WWP	Wire-wound preset
WWV	Wire-wound variable

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TD 51 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		
RV135	311-0719-00	470	CP	20	¼
R136	316-0563-01	56k	C		
R137	321-1449-48	470k	MF	1	1/8
R138	321-0850-48	27k	MF	1	1/8
R139	316-0472-01	4.7k	C		
R140	316-0122-01	1.2k	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	316-0122-01	1.2k	C		
R146	321-1257-48	4.7k	MF	1	1/8

672

Carbon resistors are 10% ¼W unless otherwise shown

	Cct. ref.	Part number	Value	Description	Tol. %	Rating
672	R147	321-0845-48	2.7k	MF	1	1/8
	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		
672	R151	321-0193-48	1k	MF	1	1/8
	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		
672	R161	321-0847-48	3.3k	MF	1	1/8
672	R162	321-0845-48	2.7k	MF	1	1/8
	R163	316-0124-01	120k	C		
	RV164	311-0765-00	100k	CP	20	¼
	R165	303-0683-01	68k	C	5	1
	R166	316-0102-01	1k	C		
	RV167	311-1091-00	6.8k	CP	20	¼
	R168	316-0272-01	2.7k	C		
672	R169	321-0866-48	3.9k	MF	1	1/8
	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		
672	R174	321-0481-48	1M	MF	1	1/8
	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	316-0122-01	1.2k	C		
	R209	316-0180-01	18	C		
	R210	316-0180-01	18	C		
	R211	316-0180-01	18	C		
672	R212	321-0869-48	5.6k	MF	1	1/8
	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		
	R221	316-0224-01	220k	C		
	R222	316-0106-03	10M	C		
	R223	316-0103-01	10k	C		
	R224	316-0473-01	47k	C		
	R281	316-0105-01	1M	C		
672	R282	321-0452-48	499k	MF	1	1/8
672	R283	321-0452-48	499k	MF	1	1/8
672	R284	322-0498-40	1.5M	MF	1	¼
672	R285	323-0519-40	2.49M	MF	1	½
672	R286	323-0548-40	4.99M	MF	1	½
672	R287	324-0594-40	15M	MF	1	1
	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	281-0685-00	470p	PS	10	500
	C106	281-0685-00	470p	PS	10	500

Cct. ref.	Part number	Value	Description	Tol. %	Rating
C107	285-0874-00	470p	PS	5	125
C108	290-0354-00	100	E		12
C109	290-0353-00	16	E		32
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	285-0828-00	0.022	PE	5	250
C120	285-0888-00	0.22	PE	5	250
C121	285-0874-00	470p	PS	5	125
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	285-0800-00	0.01	PE	20	250
C136	285-0858-00	1,000p	PS	1	350
C137	285-0873-00	200p	PS	5	350
C138	285-0866-00	10p	PS	1p	350
C139	285-0798-00	0.022	PE	20	250
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		1N914 Si		
MR104	152-0062-01				
MR105	152-0062-01				
MR106	152-0062-01				

Cct. ref.	Part number	Value	Description
MR107	152-0062-01		1N914 Si
MR108	152-0343-00		1N914T Si
MR109	152-0062-01		
MR111	152-0062-01		1N914 Si
MR112	152-0062-01		
N101	150-0069-00	60V	Neon 3L
S101	260-0962-01		Rotary (8-position)
S102	260-1073-01		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	151-0326-00		BC107 Mullard Si
TR102	151-0326-00		
TR103	151-0127-02		BSX20/2N2369 Mullard Si
TR104	151-0127-02		
TR105	151-0326-00		BC107 Mullard Si
TR106	151-0326-00		
TR107	151-0127-02		BSX20/2N2369 Mullard Si
TR108	151-0127-02		
TR109	151-0244-00		2N3702 Texas Si
TR111	151-0127-02		
TR112	151-0127-02		BSX20/2N2369 Mullard Si
TR113	151-0127-02		
V101	154-0187-01		ECC88/6DJ8
V102	154-0187-01		
V103	154-0535-00		EF184/6EJ7
V104	154-0187-01		ECC88/6DJ8
V105	154-0535-00		EF184/6EJ7
V106	154-0535-00		

MAINFRAME

	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	290-0401-00	25	E		30
	C302	285-0779-00	0.47	PE	20	100
	C303	285-0796-00	0.1	PE	20	250
	C304	285-0796-00	0.1	PE	20	250
	C305	285-0779-00	0.47	PE	20	100
	C306	285-0850-00	1,000p	PS	5	125
	C307	285-0800-00	0.01	PE	20	250
	C308	285-0796-00	0.1	PE	20	250
	C309	285-0759-00	2,200p	PS	5	125
	C311	285-0773-00	0.1	PE	20	400
	C312	285-0796-00	0.1	PE	20	250
	C313	290-0364-00	16	E		450
	C314	290-0347-00	8	E		300
	C315	285-0796-00	0.1	PE	20	250
	C316	285-0796-00	0.1	PE	20	250
	C317	281-0682-00	0.02	CER		2k
	C318	285-0796-00	0.1	PE	20	250
	C319	290-0407-00	640	E		16
	C321	285-0906-00	0.015	PE	20	250
	C322	281-0678-00	3p	CER	0.1p	500
	C323	290-0360-00	2	E		150
	C324	285-0800-00	0.01	PE	20	250
	C325	285-0850-00	1,000p	PS	5	125
	C326	285-0850-00	1,000p	PS	5	125
	C327	285-0914-00	100p	PS	10	2k
	C328	285-0788-00	0.1	PE	10	125
735	C332	285-1033-00	0.22	PE	20	160
556	C401	285-0773-00	0.1	PE	20	400
	C402	281-0682-00	0.02	CER		2k
	C403	281-0681-00	0.01	CER		4k
	C404	290-0351-00	120	E		200
	C405	290-0351-00	120	E		200
	C406a	290-0446-00	32	E		450
	b		32	E		450
	c		32	E		450
	C407a	290-0446-00	32	E		450
	b		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

* Shown in Figure 1

Cct. ref.	Part number	Value	Description		Tol. %	Rating
C411	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
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
C429	290-0383-00	100	E			64
C431	290-0343-00	50	E			40
C432	290-0374-00	50	E			150
C433	290-0374-00	50	E			150
C434	290-0344-00	1,600	E			10
CRT	154-0573-00		E714A			
F401	159-0075-00	1.5A	1¼ in delay (200-250V)			
	159-0076-00	3A	1¼ in delay (100-125V)			
L301	108-0502-00		Trace rotation coil (740 turns)			
LP401	150-0074-00	6 5V	LES			0.15A
LP402	150-0074-00	6.5V	LES			0.15A
LP403	150-0074-00	6.5V	LES			0.15A
LP404	150-0074-00	6.5V	LES			0.15A
M401	149-0029-00		Elapsed time indicator			
MR301	152-0388-00	130V	Zener	Si	5	0.33W
MR302	152-0344-00	100V	Zener	Si	10	0.33W
MR303	152-0344-00	100V	Zener	Si	10	0.33W
MR304	152-0388-00	130V	Zener	Si	5	0.33W
MR305	152-0346-00	11V	Zener	Si	5	0.33W
MR306	152-0372-00	13V	Zener	Si	5	0.33W
MR307	152 0388-00	130V	Zener	Si	5	0.33W
MR308	152-0062-01		1N914	Si		
MR309	152-0062-01		1N914	Si		
MR311	152-0370-00		AAY30	Ge		
MR401	152-0374-00	3.4kV	Rectifier	Se		0.6mA
MR402	152-0374-00	3 4kV	Rectifier	Se		0.6mA
MR403	152-0341-00	450V	Rectifier	Si		0.5A

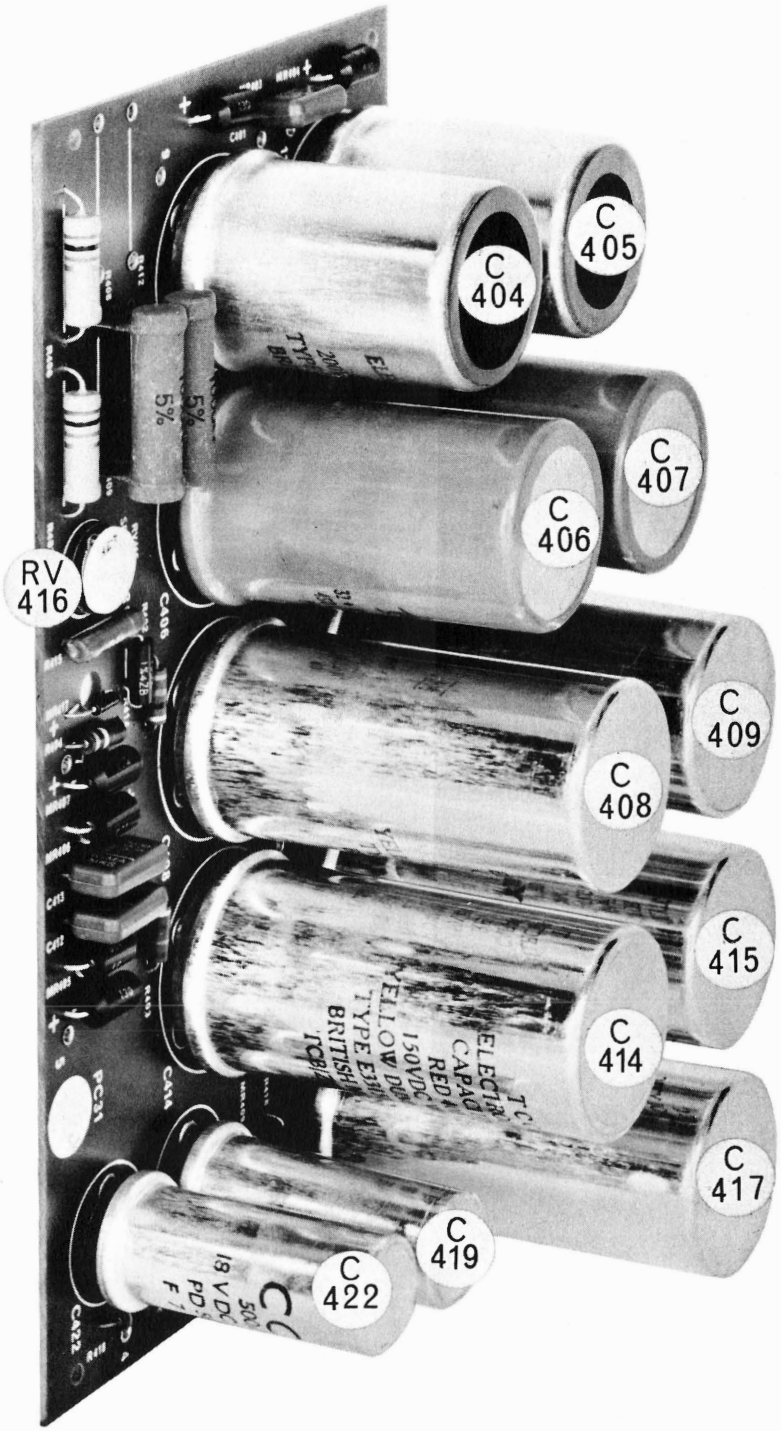
Cct. ref.	Part number	Value	Description	Tol. %	Rating
MR404	152-0341-00	450V	Rectifier Si		0.5A
MR405	152-0341-00	450V	Rectifier Si		0.5A
MR406	152-0341-00	450V	Rectifier Si		0.5A
MR407	152-0341-00	450V	Rectifier Si		0.5A
MR408	152-0341-00	450V	Rectifier Si		0.5A
MR409	152-0339-00	50V	Rectifier Si		0.5A
MR410	152-0374-00	3.4kV	Rectifier Se		0.6mA
MR411	152-0374-00	3.4kV	Rectifier Se		0.6mA
MR412	152-0352-00	800V	Rectifier Si		0.2A
MR413	152-0352-00	800V	Rectifier Si		0.2A
MR414	152-0352-00	800V	Rectifier Si		0.2A
MR415	152-0352-00	800V	Rectifier Si		0.2A
MR416	152-0352-00	800V	Rectifier Si		0.2A
MR417	152-0346-00	11V	Zener Si		0.33W
MR418	152-0339-00	50V	Rectifier Si		0.5A
MR419	152-0341-00	450V	Rectifier Si		0.5A
MR420	152-0341-00	450V	Rectifier Si		0.5A
MR421	152-0341-00	450V	Rectifier Si		0.5A
MR422	152-0341-00	450V	Rectifier Si		0.5A
MR423	152-0389-00	27V	Zener Si	5	1W
MR424	152-0348-00	6.2V	Zener Si	5	0.33W
MR425	152-0341-00	450V	Rectifier Si		0.5A
MR426	152-0339-00	50V	Rectifier Si		0.5A
MR427	152-0339-00	50V	Rectifier Si		0.5A
MR428	152-0339-00	50V	Rectifier Si		0.5A
MR429	152-0339-00	50V	Rectifier Si		0.5A
*R101	316-0685-01	6.8M	C		
*R102	316-0685-01	6.8M	C		
R301	316-0392-01	3.9k	C		
R302	316-0222-01	2.2k	C		
R303	303-0273-01	27k	C	5	1
R304	316-0333-01	33k	C		
RV305	311-0756-00	47k	CP	20	¼
R306	316-0223-01	22k	C		
R307	303-0223-01	22k	C	5	1
R308	316-0153-01	15k	C		
R309	316-0153-01	15k	C		
R311	307-0136-00	18k	MO	5	1½
R312	316-0222-01	2.2k	C		
R313	307-0184-00	15k	MO	5	1½
R314	316-0472-01	4.7k	C		
R315	307-0137-00	33k	MO	5	1½
R316	316-0272-01	2.7k	C		
R317	316-0103-01	10k	C		
RV318	311-0735-00	10k	CP	20	¼

* Shown in Figure 1
Carbon resistors are 10% ¼W unless otherwise shown

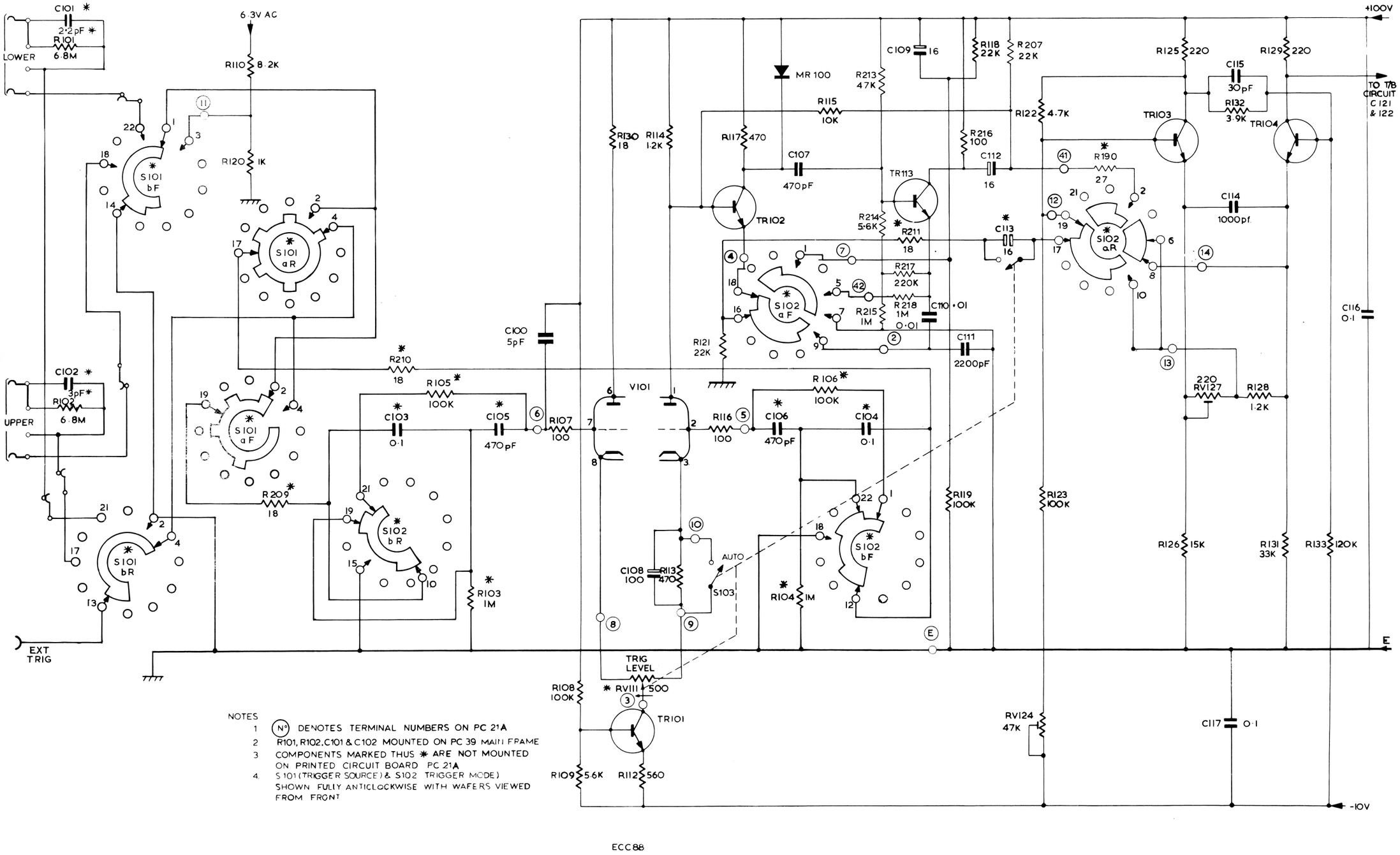
Cct. ref.	Part number	Value	Description	Tol. %	Rating
RV319	311-0750-00	22k	CP	20	¼
R321	316-0103-01	10k	C		
RV322	311-0802-00	4.7k	CP	20	¼
RV323	311-0735-00	10k	CP	20	¼
R324	316-0222-01	2.2k	C		
R325	316-0103-01	10k	C		
RV326	311-1039-00	1M	CV (with S303)	20	0.1
R327	316-0562-01	5.6k	C		
R328	316-0333-01	33k	C		
RV329	311-0765-00	100k	CP	20	¼
R331	316-0124-01	120k	C		
R332	316-0153-01	15k	C		
R333	316-0102-01	1k	C		
R334	316-0473-01	47k	C		
RV335	311-1038-00	100k	CV	20	¼
R336	316-0154-01	150k	C		
R337	316-0275-01	2.7M	C		
RV338	311-1042-00	1M	CV	20	¼
R339	316-0564-01	560k	C		
R341	316-0683-01	68k	C		
R342	316-0222-01	2.2k	C		
R343	316-0224-01	220k	C		
RV344	311-0910-00	2.2M	CP	20	¼
RV345	311-1037-00	1M	CV (with S401)	20	¼
R346	316-0273-00	27k	C		
R347	316-0105-01	1M	C		
RV348	311-0802-00	4.7k	CP	20	¼
RV349	311-0802-00	4.7k	CP	20	¼
R350	316-0104-01	100k	C		
R351	316-0105-00	1M	C		
R352	316-0393-01	39k	C		
R353	316-0124-01	120k	C		
R354	316-0823-01	82k	C		
RV355	311-1038-00	100k	CV	20	¼
R356	316-0124-01	120k	C		
RV357	311-0801-00	470k	CP	20	¼
R358	316-0823-01	82k	C		
RV359	311-0882-00	220	WWP	20	1.2
R360	303-0181-01	180	C	5	1
R361	316-0470-01	47	C		
R362	303-0560-01	56	C	5	1
R363	316-0106-01	10M	C		
R364	316-0823-01	82k	C		
RV365	311-0735-00	10k	CP	20	¼
R366	316-0393-01	39k	C		
R367	316-0103-01	10k	C		
R368	316-0823-01	82k	C		

	Cct. ref.	Part number	Value	Description	Tol. %	Rating
	R369	316-0473-01	47k	C		
	RV371	311-0801-00	470k	CP	20	¼
	R372	316-0154-01	150k	C		
	R373	316-0332-01	3.3k	C		
	R374	316-0184-01	180k	C		
	R375	316-0122-01	1.2k	C		
	R376	316-0393-01	39k	C		
	R377	316-0103-01	10k	C		
	R378	316-0222-01	2.2k	C		
	R379	315-0153-01	15k	C	5	¼
	R381	315-0123-02	12k	C	5	¼
	R382	307-0289-00	3.9k	MO	5	1½
	R383	316-0822-01	8.2k	C		
	R384	316-0823-01	82k	C		
	R385	316-0823-01	82k	C		
	R386	315-0221-02	220	C	5	¼
	R387	316-0822-01	8.2k	C		
	R388	307-0289-00	3.9k	MO	5	1½
	R389	316-0473-01	47k	C		
	RV391	311-1040-00	10k	CV (with S304 & 402)	20	1
	R392	316-0224-01	220k	C		
	RV401	311-1041-00	25	WWV	20	1.6
	R402	316-0680-01	68	C		
	R403	316-0121-01	120	C		
	R404	316-0154-01	150k	C		
676	R405	308-0719-00	0.22	WW	0.05	1
	R406	307-0160-00	1k	MO	5	3¼
	R407	307-0173-00	470	MO	5	1½
	R408) R412)	308-0681-00	820	WW	5	13
	R409	308-0493-00	1k	WW	5	6
	R413	308-0493-00	1k	WW	5	6
	R414	322-0670-00	100k	MF	1	¼
672	R415	321-0277-48	7.5k	MF	1	1/8
	RV416	311-0802-00	4.7k	CP	20	¼
	R417	316-0680-01	68	C		
	R418	316-0560-01	56	C		
	R419	307-0173-00	470	MO	5	1½
	R420	316-0105-01	1M	C		
	R421	316-0222-01	2.2k	C		
	RV422	311-0802-00	4.7k	CP	20	¼
	R423	319-0031-01	1M	HS	1	¼
	R424	316-0681-01	680	C		
	S301	260-1135-00		Lever (3-position)		
	S302	260-1123-00		Push (1-button)		
	S303	311-1039-00		Rotary (with RV326)		
	S304	311-1040-00		Rotary (with RV391 & S402)		

Cct. ref.	Part number	Description		
S305	260-1123-00	Push (1-button)		
S401	311-1037-00	Rotary (with RV345)		
S402	311-1040-00	Rotary (with RV391 & S304)		
T401	120-0652-00	Power transformer		
TR301	151-0242-00	2N3904	Motorola	Si
TR302	151-0242-00	2N3904	Motorola	Si
TR303	151-0257-00	2N1990U	C.S.F.	Si
TR304	151-0257-00	2N1990U	C.S.F.	Si
TR305	151-0242-00	2N3904	Motorola	Si
TR306	151-0242-00	2N3904	Motorola	Si
TR307	151-0242-00	2N3904	Motorola	Si
TR308	151-0242-00	2N3904	Motorola	Si
TR309	151-0242-00	2N3904	Motorola	Si
TR311	151-0242-00	2N3904	Motorola	Si
TR312	151-0242-00	2N3904	Motorola	Si
TR313	151-0257-00	2N1990U	C.S.F.	Si
TR314	151-0257-00	2N1990U	C.S.F.	Si



COMPONENT LOCATIONS POWER SUPPLY BOARD PC31



NOTES

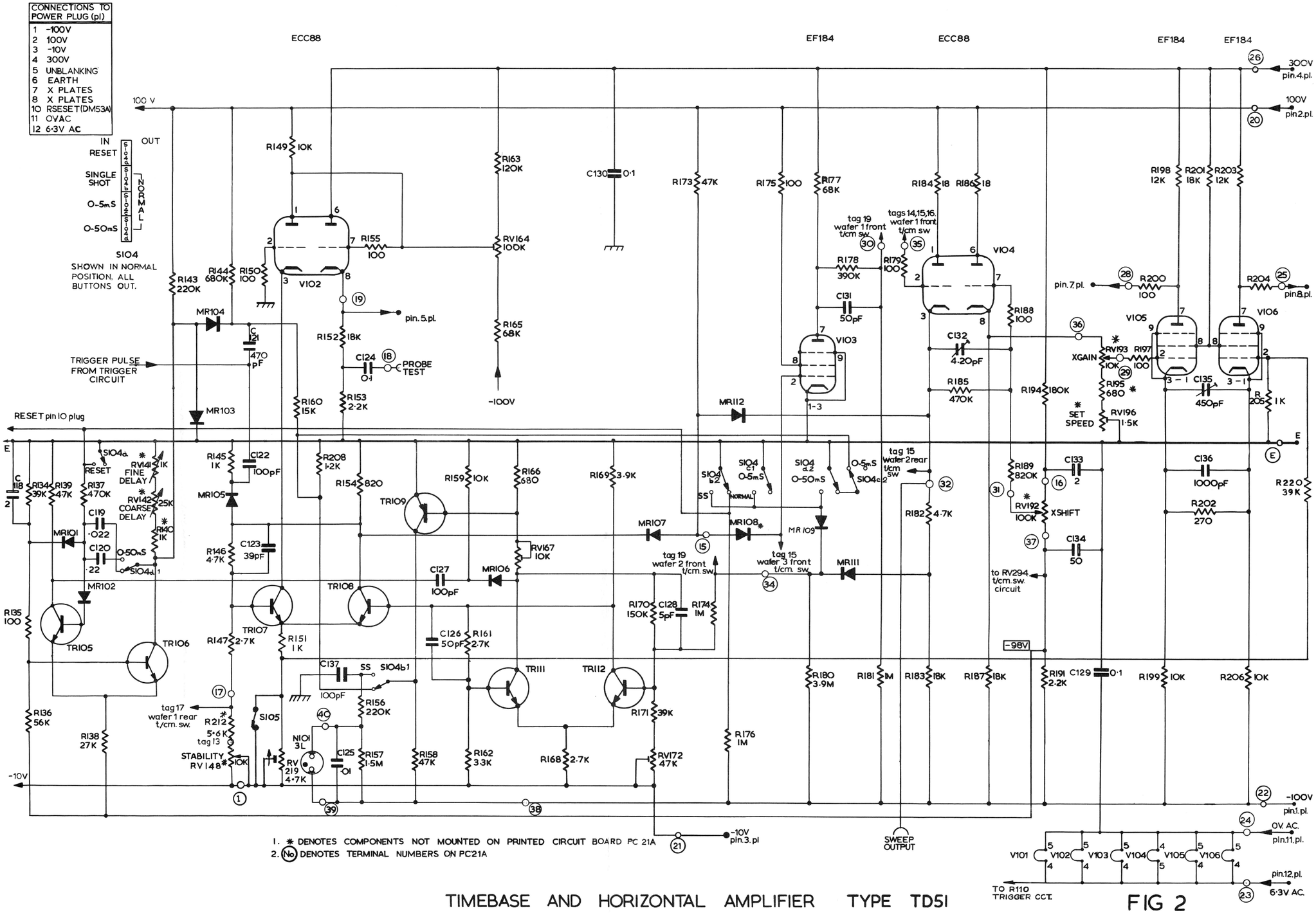
1. (N°) DENOTES TERMINAL NUMBERS ON PC 21A
2. R101, R102, C101 & C102 MOUNTED ON PC 39 MAIN FRAME
3. COMPONENTS MARKED THUS * ARE NOT MOUNTED ON PRINTED CIRCUIT BOARD PC 21A
4. S101 (TRIGGER SOURCE) & S102 TRIGGER MODE) SHOWN FULLY ANTICLOCKWISE WITH WAFERS VIEWED FROM FRONT

ECC88

TRIGGER CIRCUIT TYPE TD51

FIG 1

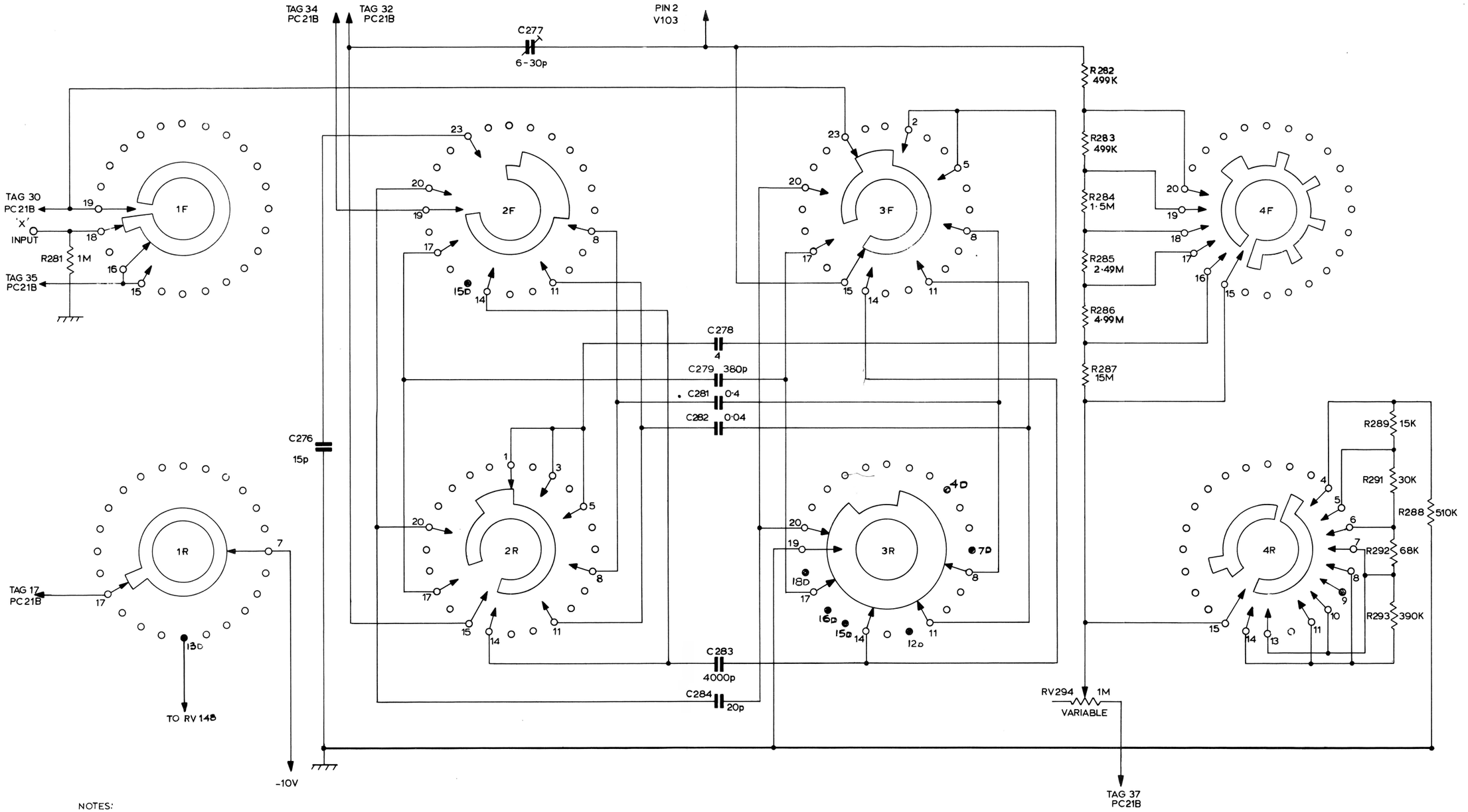
CONNECTIONS TO POWER PLUG (p1)
1 -100V
2 100V
3 -10V
4 300V
5 UNBLANKING
6 EARTH
7 X PLATES
8 X PLATES
10 RSESET (DM53A)
11 OVAC
12 6·3V AC



1. * DENOTES COMPONENTS NOT MOUNTED ON PRINTED CIRCUIT BOARD PC 21A
2. (No) DENOTES TERMINAL NUMBERS ON PC21A

TIMEBASE AND HORIZONTAL AMPLIFIER TYPE TD51

FIG 2

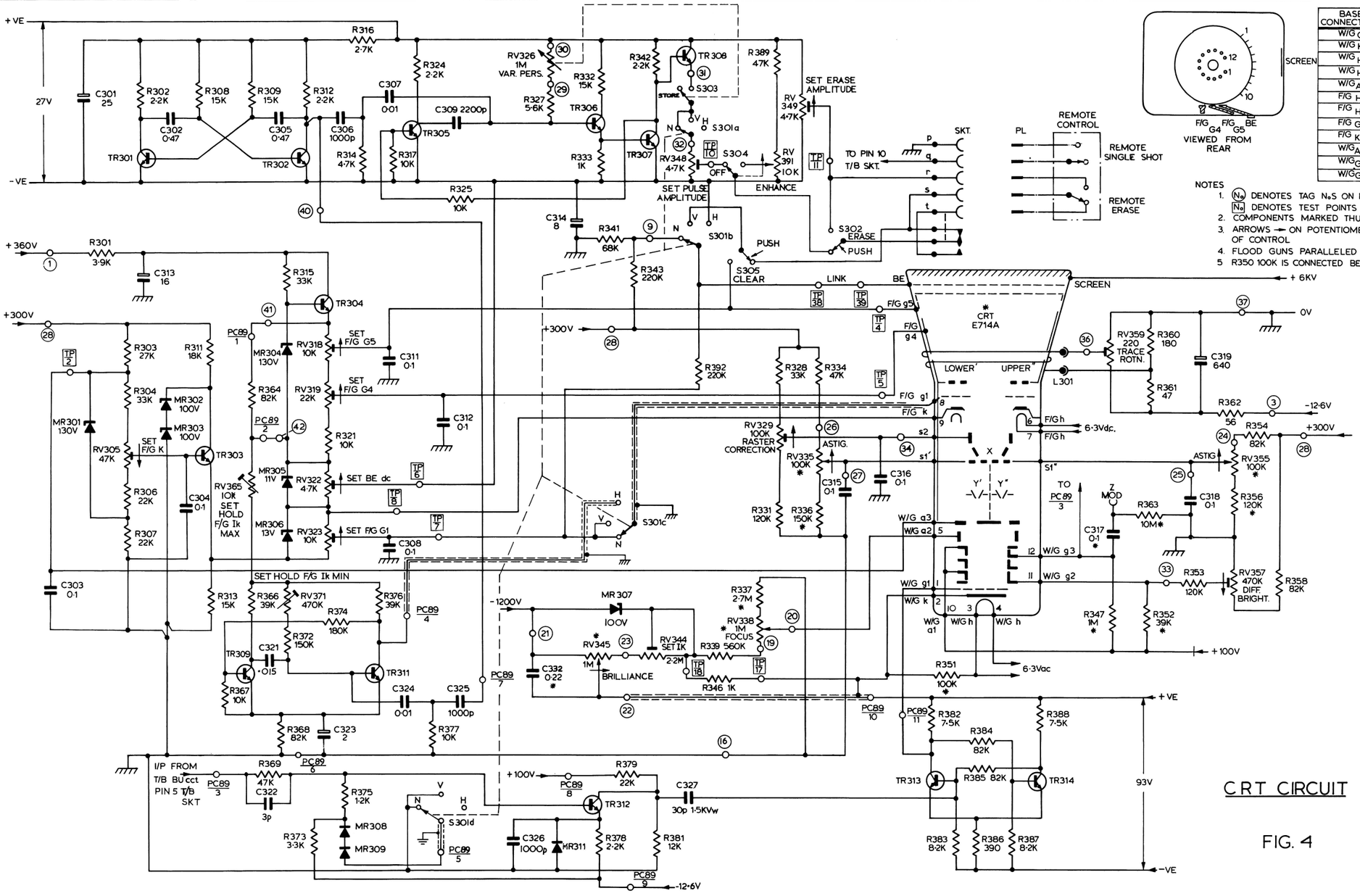


NOTES:

1. SWITCH SHOWN FULLY ANTICLOCKWISE.
2. WAFERS VIEWED FROM FRONT.

TIME / CM SWITCH TYPE TD51 FIG 3

MISC.	MR301 TR301 MR302 MR303 TR303 TR309 MR304 MR305 MR306 TR302 TR304 MR308 MR309 TR311 TR305 S301d MR311 TR306 TR312 MR307 TR307 S301c S303 S301b TR308 S301a S304 S305 S302 CRT E714A TR313 TR314 L301
C CV	C301 C313 C302 C305 C306 C307 C311 C308 C324 C309 C312 C325 C314 C332 C326 C327 C315 C316 C317 C318 C319 C303 C304 C321 C323
R RV	R301 R302 R308 R309 R315 R312 RV318 R316 R314 R317 R324 R325 RV326 R327 R332 R333 R341 R343 R342 RV345 R392 RV348 R389 RV349 R328 RV329 RV391 R334 RV335 R336 R339 R346 R337 RV338 R331 R344 R378 R379 R381 R382 R351 R384 R383 R386 R387 R388 RV359 R360 R361 R363 R353 RV355 R356 R362 R354 RV357 R358 R347 R352 RV303 R304 RV305 R306 R307 R311 R313 R367 R364 RV365 RV366 RV371 R372 R368 RV319 RV321 RV322 R373 R374 R369 R376 R377



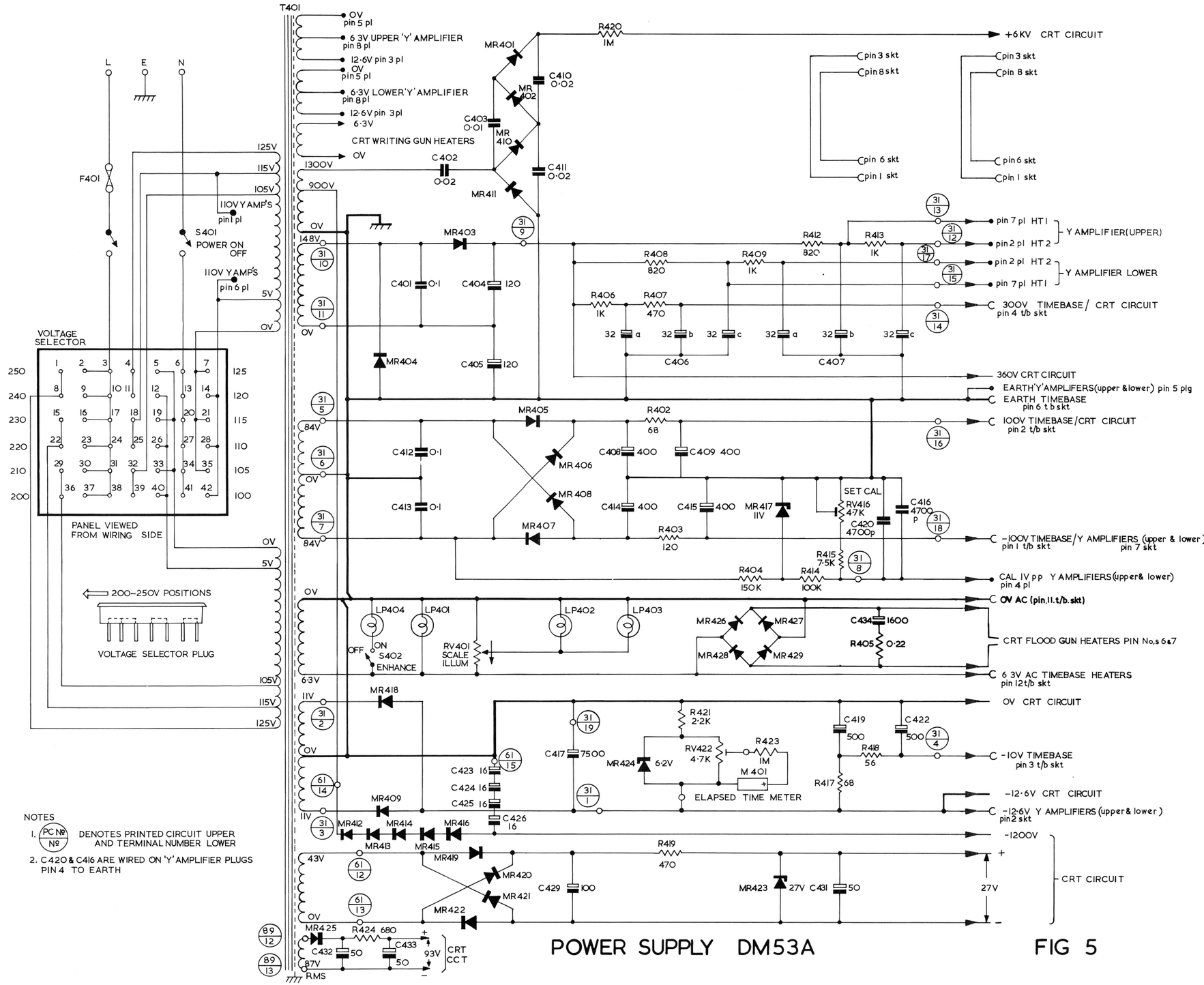
BASE CONNECTIONS		SIDE PIN CONNECTIONS
W/G G1	1	Y1"
W/G K	2	Y2"
W/G H	3	S1"
W/G H	4	S1'
W/G A2	5	W/G A3
F/G H	6	X1
F/G H	7	X2
F/G G1	8	Y2'
F/G K	9	Y1'
W/G A1	10	S2
W/G G2	11	
W/G G3	12	

NOTES

1. (Na) DENOTES TAG NoS ON PC61 PRINTED CIRCUIT.
   [Na] DENOTES TEST POINTS
2. COMPONENTS MARKED THUS * NOT MOUNTED ON PRINTED CIRCUIT
3. ARROWS ← ON POTENTIOMETER INDICATE CLOCKWISE SENSE OF CONTROL
4. FLOOD GUNS PARALLELED INTERNALLY.
5. R350 100K IS CONNECTED BETWEEN PINS 7&8 OF TIMEBASE SOCKET

CRT CIRCUIT

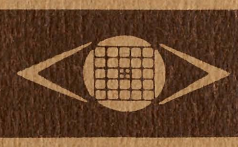
FIG. 4



POWER SUPPLY DM53A

FIG 5

TELEQUIPMENT



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