TELEQUIPMENT ®

OSCILLOSCOPE

TYPE D32

FOR SERVICING AND SPARES ENQUIRIES
SEE THE INFORMATION AT START OF SECTION 5.

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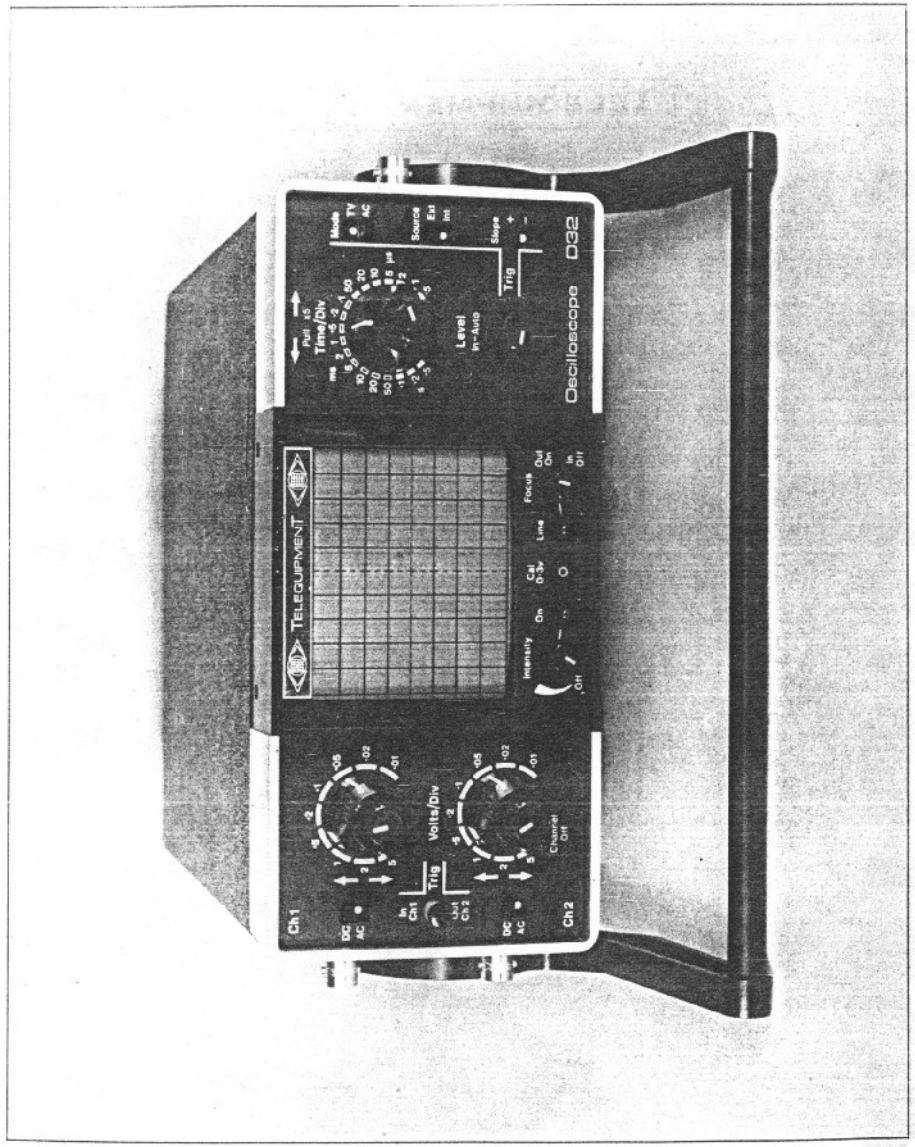
CONTENTS



INTRODUCTION

The D32 is a dual trace portable 'scope' operating from internal batteries or an external AC supply. It incorporates a built-in battery charger and is intended for general servicing and field use.

WARNING

THE ATTENTION OF A USER IS DRAWN TO THE FOLLOWING IMPORTANT POINTS.

1. (a) The instrument should be switched off by turning the intensity control fully anti-clockwise until it clicks off.

   (b) The battery charger should be switched off by pushing in the FOCUS control.

2. The instrument should have the batteries fitted at all times because as well as a supply source the batteries act as high value capacitors when operating from an AC supply.

3. Before fault finding or servicing is carried out on this instrument, careful attention should be paid to the notes at the start of Chapter 4.

NOTICE TO OWNER

To obviate the risk of damage during transit and facilitate packaging, the owner is requested to remove the power supply plug and NOT send the following items unless they are suspect, should this instrument be returned to TELEQUIPMENT for servicing:–

Manual
Probes
Power Supply Lead
Plug Assemblies

CHAPTER 1
SPECIFICATIONS

1.1 CATHODE RAY TUBE (CRT)

Rectangular flat faced CRT with mesh screen.

Display area	10 x 8 divisions (each division = 0.7 cm.)
Phosphor	P31
Overall accelerating Potential	3 kV

1.2 VERTICAL AMPLIFIERS

1.2.1 DISPLAY MODE

CH1
CH1 and CH2 alternate
CH1 and CH2 chopped (at 100 kHz)
Chop or alternate selected automatically on TIME/DIV switch

1.2.2 BANDWIDTH (3db)

DC	DC – 10 MHz
AC	3 Hz – 10 MHz

1.2.3 VERTICAL DEFLECTION

Calibrated (9 ranges 1.2.3 Sequence)	10 mV/div – 5 V div ± 5%
Input impedance	1 MΩ in parallel with 32 pF.
Max. Input voltage	± 250 V peak

1.3 HORIZONTAL DEFLECTION

1.3.1 SWEEP RATES (19 ranges in 1, 2, 5 sequence)

X1	500 ms/div – 0.5 µs div ± 5%
X5	100 ms/div – 200 ns/div ± 7%
	200 ns/div – 100 ns/div ± 10%

1.3.2 TRIGGER

Level	Fully variable over 8 divisions on all waveforms.
Auto	Bright line in absence of trigger signal automatic trigger on symetrical waveforms over 1 div. with restricted level control.
Mode	AC or TV field for sweep ranges 0.5 sec/div to 0.1 ms/div. and TV line from 50 µs/div. to 0.5 µs/div.
Source	CH1, CH2 or external. All positive or negative.
Sensitivity	
Internal	
40 Hz – 2 MHz	0.3 div. Level and Auto Trigger
2 MHz – 10 MHz	1 div. Level Trigger
External	
40 Hz – 5 MHz	500 mV approx.
5 MHz – 10 MHz	1 V approx.

1.4 CAL OUTPUT SOCKET

Output Voltage	300 mV ± 1%
Output Impedance	600Ω
Wave Shape	Vertical edge at screen centre – positive with respect to earth.

1.5 GENERAL

1.5.1 POWER REQUIREMENTS

Internal rechargable battery

Voltage	6 x 1.25 V ('D' CELLS)
Battery life	4 hours approximately continuous use. Built in charger allows the batteries to be charged in 14 hours with the instrument switched off or trickle charges the batteries if the instrument is switched on.

Mains

Voltage	100–112 V 112–125 V 200–224 V 225–250 V
Frequency	50–400 Hz
Consumption	14 VA

1.5.2 SIZE

Height (stand retracted)	105 mm
Width	230 mm
Depth	288 mm

1.5.3 WEIGHT

4.5 kg

1.5.4 COOLING

Convection

1.5.5 TEMPERATURE RANGE (AMBIENT)

Operational	0° to 35°C
Storage	–10°C to 40°C

1.6 STANDARD ACCESSORIES SUPPLIED WITH THE INSTRUMENT

ACCESSORY	QUANTITY	PART NUMBER
BNC connector plugs	2	131-0649-00
Cover front protection	1	437-0171-01
Manual	1	070-1797-00
Allen key 1.5 mm A/F	1	

1.7 ACCESSORIES AVAILABLE AS EXTRAS

ACCESSORY	PART NUMBER (for ordering)
Carrying case	016-0601-00
Carrying case (attaché style)	
Calibration lead	012-0571-00
Probe type TP2 (X10 attenuator)	
4.5 foot cable	010-0270-00
6.0 foot cable	010-0270-02

CHAPTER 2

OPERATING INSTRUCTIONS

2.1 PRE-OPERATIONAL CHECK

Although this instrument is robust and is subjected to stringent checks before leaving our factory, it should be checked externally for possible damage. In the case of damage contact the carriers and your local Tektronix field office immediately.

Before switching the instrument on it is recommended that this chapter is read right through and that some time be spent in becoming familiar with the controls. Experienced oscilloscope users will find the instructions in paragraph 2.6 rather laborious and it is left to the individual user to decide what to omit reading.

Remove the front protection cover by gently pulling off.

2.2 BATTERY OPERATION

2.2.1 BATTERIES

The batteries fitted in this instrument have been charged before despatch. If a considerable time has elapsed between dispatch and putting the batteries into use, a self discharge process, may result in the batteries either being discharged or in a low state of charge. A battery test socket is provided on the rear panel to allow a check to be made. Using a voltmeter of 20 kΩ/Volt connected between the + and − of the rear battery check socket a reading of 6.8 volts to 9 volts should be obtained. If no voltage reading at all is obtained the DC fuse should be checked. If the voltage is low the batteries should be charged as follows.

2.2.2 BATTERY CHARGING

Before carrying out the charge procedure the mains cable should be fitted and the voltage selector switches set to the available mains voltage. For this procedure see the paragraph headed Mains Operation. Having carried out this procedure the unit should be plugged into the mains supply. The Line indicator on the front panel should light. The instrument should be Off. This can be checked by seeing that the switch on the intensity control is fully anti-clockwise and that the ON indicator is not illuminated. After 14 hours the batteries should be fully charged.

2.3 MAINS OPERATION

The mains cable should be plugged into the back of the instrument and secured using the screws and nuts supplied. Where a standard mains lead is supplied it will be necessary to fit a plug to suit the available supply. The mains cable connections are as follows.

Brown ..... Live
Blue ..... Neutral
Green/Yellow..... Earth

Two voltage selector switches are provided. The range switch is located on the under side of the instrument and a tapping switch is on the rear panel. These switches should be set to the available mains supply according to the table below. If the selector switches have to be moved it may be necessary to change the instrument fuse using the alternative one provided. The correct fuse to be fitted is shown in the table. The fuse is located inside the instrument so it is necessary to remove the case as per paragraph 4.2.1. The fuse is the vertically mounted one towards the rear of the instrument.

A.C. LINE VOLTS	RANGE VOLTS	TAPPING	INSTRUMENT FUSE
100–112	112	LO	500 mA
113–125	112	HI	500 mA
200–224	225	LO	250 mA
225–250	225	HI	250 mA

Having carefully checked the fuse rating and voltage selector switch positions the instrument can be plugged into the mains supply. On plugging in, the line indicator should light immediately the FOCUS control is pulled out. With the instrument switched off, the battery charger provides a full charge to the batteries but when the instrument is switched on the charge becomes a trickle charge, to keep the battery voltage topped up.

2.4 OPERATION OF CONTROLS

2.4.1 CRT

INTENSITY — varies the display intensity. An instrument ON/OFF switch is fitted to this control.

FOCUS — controls the display definition a power ON/OFF switch is fitted to this control.

TRACE ROTATION — This control is fitted on the back of the instrument. It allows the trace to be aligned with the horizontal graticule lines.

2.4.2 VERTICAL

VOLTS/DIVISION — provides attenuation of the input signal in 9 calibrated steps.

Y POSITION — marked with a double headed vertical arrow. Moves the respective trace in the Y or vertical axis. CH2 POSITION control also has fitted a channel off control which operates when the control is turned fully anti-clockwise position (clicks off).

AC/DC — This selects the input coupling. In the AC position a capacitor is in series with the input, whilst in the DC position the signal is coupled directly to the attenuator.

2.4.3 TRIG (Pick off)

The push button selects the channel required to give a triggering pulse.

2.4.4 HORIZONTAL

TIME/DIV — selects the sweep speed having 19 calibrated steps in the range 500 ms/division to 0.5 µs/division.

X5 — When the X5 switch is pulled out the sweep speeds are magnified by a factor of 5 and therefore the sweep range becomes 100 ms/division to 100 ns/division.

X POSITION ←→ — The X POSITION control uses the same knob as the speed magnifier. When it is rotated it moves the trace in an X or horizontal axis.

TRIG. MODE — Triggering is normally AC coupled (AC position) but when TV is selected, triggering is from a TV frame at sweep speeds of 0.5 s/division to 0.1 ms/division and from a TV line at sweep speeds of 50 µs/division to 0.5 µs/division.

TRIG. SOURCE — In the INT position triggering is from the input signal whilst the EXT position allows triggering from an external source connected to the EXT TRIG. socket.

TRIG. SLOPE — This switch allows triggering on a positive or negative slope of an input waveform.

TRIG. LEVEL — The level control selects the voltage level of the input waveform at which the sweep starts. With the knob pushed in, the AUTO position is selected. In the absence of an adequate trigger signal the sweep generator free runs providing a stable reference trace.

2.5 INPUT AND OUTPUT SOCKETS

CH1 / CH2 INPUT — These sockets connect the input signal to the respective vertical amplifiers.

EXT TRIG. — This socket connects an external signal to the trigger circuit and is used in connection with the trig SOURCE switch.

CAL. — A waveform of 0.3 V amplitude is provided at this socket to allow for the checking of the calibration of the vertical channels.

The CAL. waveform can be used to set up a probe, connected to CH1 or CH2 INPUT. With the appropriate VOLTS/DIV switch set to 0.01 V and TIME/DIV switch set to 1 ms/DIV the probe tip should be connected to the CAL. socket. The probe trimmer should be adjusted for the best obtainable square corner. TRIG SOURCE should be set to EXT.

BATT CHECK AND EXTERNAL SUPPLY FACILITY (5 Pin DIN) — This socket is provided to enable the state of charge of the internal batteries to be determined, and to provide a facility for operation from an external supply via a DC to DC converter available as an accessory.

2.6 FIRST TIME OPERATION

2.6.1 SETTING THE CONTROLS

Set the front panel controls as follows:-

INTENSITY	Fully anti clockwise – OFF	
FOCUS	Central – In	
CH1 / CH2	VOLTS/DIV	0.05 V
	AC/DC	DC
CH1 Y POSITION	Central	
CH2 Y POSITION	Fully anti clockwise (should click off)	
TRIG. BUTTON	In	
TIME/DIV	50 µs	
X POSITION	In and central	
LEVEL	In and central	
MODE	AC	
SOURCE	EXT.	
SLOPE	+	

Connect the CAL 0.3 V socket (2mm) to Input socket. For this operation a lead of 75Ω CO-AXIAL cable is required with a BNC plug at one end and a 2 mm plug at the other. It should be possible to construct such a lead using one of the BNC plugs provided and using locally obtained, coax and a 2 mm plug but in case of difficulty contact your local Tektronix field office.

2.6.2 SWITCH ON

1. Switch on by pulling out the FOCUS control and turning the INTENSITY control clockwise.
2. Allow a short while for a trace to appear.
3. Centralize the trace using the X and Y (CH1) POSITION controls.
4. Adjust the INTENSITY control so that the trace is at a suitable viewing intensity.
5. Adjust the FOCUS control for the sharpest obtainable trace.
6. Adjust the CH1 Y POSITION control so that the lower edge of the trace is level with one of the two lower graticule lines.
7. Observe that the overall waveform occupies 6 full vertical divisions of the graticule.
8. Switch CH1 VOLTS/DIV switch to 0.1 V.
9. Observe now that the trace will only occupy 3 vertical division of the graticule.
10. Disconnect the input from CH1 INPUT leaving only a reference trace, which can be aligned with the graticule lines by using the TRACE ROTATION control.
11. Turn this trace off of the screen using the CH1 Y POSITION control.
12. Connect the input plug to CH2 INPUT.
13. Push the TRIG switch so that it releases to the outer position.
14. Switch on CH2 by rotating CH2 Y POSITION control clockwise until a click is heard. Further rotation will move the trace up the screen.
15. Set the lower edge of the trace to a suitable reference line and observe that the trace occupies 6 full vertical divisions.
16. By now the user will be conversant with the operation of the Y or vertical controls so now they should turn to the sweep controls. By turning the TIME/DIV control anti-clockwise in steps as far as it will go, it should be noticed that the sweep speed decreases.
17. Set the TIME/DIV knob to 1 ms and observe the sweep speed.
18. Set the TIME/DIV knob to 5 ms and note that the sweep should be slower.
19. Pull out the X5 control and observe that the sweep speeds should be the same as 17 above.

2.7 USE OF ADDITIONAL FACILITIES

2.7.1 TRIGGER SOURCE

We have been using the control in the INT position but it is possible to trigger from an external signal by plugging the signal into the EXT TRIG. socket (BNC) at the side of the instrument. The SOURCE switch should be set to EXT.

2.7.2 SLOPE

The SLOPE switch allows triggering from a positive (+) going or negative (−) going portion of the trigger signal. This is important when it is only required to observe a portion of a waveform but where several cycles of a waveform are displayed the setting is often unimportant.

2.7.3 MODE

For the inspection or measurement of most waveforms the MODE control is used in the AC position. For the inspection of TV frame or TV line waveforms the switch should be set to TV. For TV field waveforms sweep ranges of 0.5 sec/div to 0.1 ms/div should be used. For TV line waveforms sweep ranges of 50 µs/div to 0.5 µs/div are required.

2.7.4 LEVEL

There are two modes of level control operation. In the normal (control out) position the triggering point can be varied over the whole of the waveform to a maximum of 8 divisions and with a minimum sensitivity of 0.3 divisions.

In the AUTO position (control in) level control is restricted to approximately 1/8 of the normal variation. In the absence of a triggering waveform or if the waveform does not meet the required minimum sensitivity an automatic bright line reference trace is displayed.

2.8 BASIC APPLICATIONS

The following are typical applications of Oscilloscope type D32.

2.8.1 PEAK TO PEAK VOLTAGE MEASUREMENT – AC-Symetrical waveform

1 Connect the waveform to be measured to CH1 or CH2 INPUT.

2 Set the appropriate VOLTS/DIV switch to display about 5 or 6 divisions of the waveform.

3 Set the AC/DC switch to AC.

4 Set the TIME/DIV switch to display several cycles of the waveform.

5 Use the Y POSITION control to set the lower edge of the waveform on one of the lower graticule lines and so that the top edge of the waveform is in the graticule area.

6 Estimate the vertical amplitude (div) of the signal on the screen.

7 Multiply the amplitude in 6 above by the VOLTS/DIV setting and by the attenuation factor of any probe used.

EXAMPLE

Assume a vertical deflection of 5.3 division using a X10 attenuation probe and a VOLTS/DIV setting of 0.05 Volts per division.

$$\therefore \text{Peak to Peak Voltage} =$$

$$\text{Vertical deflection} \times \text{VOLTS/DIV (Setting)} \times \text{Attenuation factor (Probe)}$$

for our example

Peak to Peak voltage = 5.3 x 0.05 x 10

∴ Peak to Peak voltage = 2.65 Volts.

2.8.2 FREQUENCY MEASUREMENT

1 Connect the waveform to be measured, to CH1 or CH2 INPUT.

2 Set the VOLTS/DIV switch to display approximately 5 or 6 vertical divisions of the waveform.

3 Set the TIME/DIV control to display about 3 or 4 cycles of the waveform, keeping well inside the graticule limits.

4 Use the Y POSITION control to move the trace so that the start of each cycle is on the centre line.

5 The X POSITION control is used to move the start of 1 cycle to a convenient reference point.

6 Measure the distance (divs) between the start of the cycle and the end.

7 Multiply the measurement in 6 above by the setting of the TIME/DIV switch and if the X5 control is used divide by 5. This gives the time duration of 1 cycle.

8 In order to obtain the frequency it is necessary to take the reciprocal of the time duration found in 7.

EXAMPLE

If one cycle occupies 2.5 divisions with the TIME/DIV control on 0.2 ms/div and the magnifier is not used.

$$\text{Frequency} = \frac{1}{\text{horizontal distance} \times \text{TIME/DIV setting}}$$

$$\therefore \text{Frequency} = \frac{1}{2.5 \times 0.2 \text{ ms}}$$

∴ Frequency = 2 kHz.

CHAPTER 3

CIRCUIT DESCRIPTION

3.1 GENERAL

The D32 uses entirely solid state circuitry to drive a single beam cathode ray tube (CRT). Internal nickel cadmium cells supply a non-regulated invertor power unit. The cells are charged from a.c. lines via an internal line transformer and constant current charger. Field effect transistors (FETs) in the first stage of each vertical (Y) amplifier enable constant, high impedance inputs to be applied, whilst a further F.E.T. in the sawtooth generator ensures a high degree of ramp linearity.

Dual Y channel operation is achieved by alternate displays on a time sharing basis. At slow sweep speeds this is achieved by 'chopping' the waveforms and displaying portions of each waveform in turn during each sweep period. At higher sweep speeds the complete information on each channel is displayed on 'alternate' sweeps. The selection of 'Chop' or 'Alternate' is done automatically according to the setting of the TIME/DIV switch.

Normal triggering is a.c. coupled with selection of trigger point and polarity but an alternative mode allows triggering from a TV waveform. In both modes an 'AUTO' facility is provided whereby a bright line reference is displayed in the absence of a suitable triggering signal.

3.2 CHANNEL 1 & 2, Y AMPLIFIER AND ATTENUATOR

Reference to component numbers is 600 onwards for channel 1 and 700 onwards for channel 2, circuit operation for both channels being identical. Channel 1 operations will be described.

An input signal is fed into the BNC socket SK601 and fed to S601. In the A.C. position of the switch the signal is passed via C601 and in the D.C. position it is connected directly, to S602, the attenuator switch. The attenuator in addition to the straight through 1 : 1 range has four frequency – compensated resistive dividers, with ratios of 100 : 1, 10 : 1, 5 : 1 and 2 : 1.

These are switched singly or in tandem with C604, C605, C612 and C613 serving to standardise the input time constants. C602, C603, C606, C607, C608, C609, C611 and R610 provide compensation for the respective dividers. Basic input impedance is set by precision 1 MΩ resistor R609, shunted by capacity C616 which in addition to stray capacitance sets the basic channel input capacitance at high frequencies.

R611, C617 and low leakage diode D601 form an input protection circuit for the Field Effect Transistor TR601 connected as a source follower stage. Two signal outputs are provided from the FET, source, (1) a trigger signal to trigger select switch S623 and (2) vertical amplifier signal to TR603 at a DC level on or about ground, via R613. Main source load is R614. TR603 forms part of a long tailed pair amplifier with TR604. Emitter coupling diodes D602 and D603 provide the signal carrying capacity to provide close vertical amplifier gain tracking, with DC rail variation necessary to compensate for tube sensitivity variations. TR603 and TR604 tail resistors include trimmer R617 to initially set up amplifier gain and thermistor TH601 shunted by R625, to provide gain compensation with temperature. Thermal balance of TR603 and TR604 is provided by collector resistors R615 and R618, and H/F component of collector currents being shunted through capacitors C619 and C621.

Common base transistor TR602 buffers the collector of TR603 from post, chop/alternate switching waveforms thus isolating the trigger pick-off from these signals, which would lead to undesirable triggering effects.

3.3 VERTICAL OUTPUT AMPLIFIER figure 3

The collector currents of the selected channel pass through diodes D651 and D652 for Channel 1, or D657 and D658 for Channel 2, to the bases of shunt feedback stages TR651 and TR654. The outputs of TR651 and TR654 are fed to the bases of TR652 and TR653, a longta iled pair whose collectors feed the Y plates of the CRT. C655 and R657 in the emitter circuit are adjusted for the best fast pulse response. Channel 2 vertical amplifier can be switched on or off using S631 which is ganged to the CH2 Y POSITION control. With CH2 off the instrument is effectively a single channel instrument but when it is on the channels are selected for display by the CHOP/ALTERNATE circuit, TR631 and TR632. On TIME/DIV speeds of 2 ms/div and slower, TR631 and TR632 operate as a free running multivibrator at a frequency of approximately 100 kHz. When TR632 conducts, D653 and D654 conduct and turn off D651 and D652 thus disconnecting Channel 1. Conversely when TR631 conducts D655 and D656 conduct and turn off D657 and D658 thus disconnecting Channel 2. C632 and C637 feed pulses to the unblanking amplifier to blank out the trace during the transition. On Time/Div speeds above 2 ms/div, TR631 and TR632 operate as a bistable whose state is changed at the end of each timebase sweep by a negative going pulse from the collector of TR104. The network L631, C652, R648 in CH1 and L632, C650, R649 in CH2 delay the transitions until the trace is blanked.

3.4 TRIGGER CIRCUITS figure 4

The ac coupled trigger amplifier accepts either internal or external signals. Internal selection from either channel 1 or channel 2 being made by selector switch S632 to emitter follower TR633 and then by coaxial cable to C22. External trigger signals are applied via sockets SK21 and SK22 on the right hand side of the instrument and to the trigger amplifier via C21 and R21. Switch S21 selects EXT or INT, and S22 selects polarity before applying signals to the bases of amplifier pair TR21 and TR22. As all signals are derived from unbalanced sources the free transistor base is grounded with respect to ac via C23. The collector of TR22 is ac coupled via D23 to the base of TR23, a shunt feedback stage, whose input voltage excursion is limited by diodes D21, D22 and D23. C27, D24 and D25 attenuate high amplitude signals at H/F. The output of TR23 is fed to the Schmitt trigger circuit, TR25 and TR24, which provides a constant amplitude trigger signal to the timebase and bright line auto circuit on the AC position of S23. On the TV position of S23 TR25 is converted to a sync separator, and TR24 on TIME/DIV speeds slower than 100 µs has a long time constant in the emitter circuit, which provides positive differentiated field pulses of much greater amplitude than the line pulses and therefore the timebase triggers on the field pulses. On TIME/DIV speeds faster than 100 µs, the emitter time constant is reduced by TR26 which short circuits R42, so that differentiated field and line pulses are of equal amplitude and the timebase therefore triggers at line frequency. In the AUTO position S24 switches in R40 to reduce effect of level potentiometer, permitting CRT displays greater than 1 div to be automatically triggered.

3.5 TIMEBASE, UNBLANKING AND BRIGHT LINE AUTO CIRCUIT figure 5

The differentiated positive pulse from the trigger circuit is fed via D101 to the base of TR102 which together with TR104 forms a bistable. The positive pulse turns on TR102 which in turn cuts off the clamping transistor TR101. The timebase a

F.E.T. Miller circuit, then runs up linearly charging up the hold-off capacitor via R110 and D106 and resetting the bistable via R112. When TR102 switches off, TR101 conducts and discharges the timing capacitor until D103 conducts and reduces the current in TR101 to the value required by the timing resistor. At this point the flyback stops. During the flyback the hold-off capacitor discharges through R112 until D108 conducts, the circuit then "clamps" in a quiescent state and remains so until the arrival of the next triggering pulse.

If the Trig level control is in the Auto position and no trigger pulses are present, TR105 and D109 conduct and reduce the potential at the anode of D108. This allows the hold-off capacitor to discharge further and re-trigger the bistable. The timebase then free-runs. If trigger pulses are applied at the anode of C113 to TR106 base, TR106 then conducts during the period of the pulse, switching off TR105 via C108. TR105 collector potential then rises, back biasing D109 thus inhibiting the free run timebase sweep which is then dependant upon the trigger pulses.

The collector current of TR104 which is cut off during the sweep, is fed to the input of TR107. The collector of TR107 goes negative at the beginning of the sweep driving TR108 on, bringing the unblanking plate positive, and unblanking the trace. If the vertical channels are in the chopped mode the chop transitions are blanked via TR109 which pulls the unblanking plate negative in response to the chop blanking pulses fed to its base via C111. At the end of sweep, TR104 turns on, turning off TR107, TR108, and turning on TR109, returning the trace to the blanked condition.

Negative pulses from TR104 collector are fed to CHOP/ALT bistable to switch channels in the ALT mode at the end of each trace.

3.6 HORIZONTAL AMPLIFIER figure 5

TR111, TR112, TR113 and TR114 form a balanced symmetrical amplifier system to drive the CRT X plates.

Shunt feedback amplifier TR111 accepts sweep generator currents via R138 and a current from the horizontal position potentiometer R137 via R139. An output voltage proportional to the input currents is then applied to TR112 base. TR113 is longtailed with TR112 to form the output stage with X1 and X5 gain adjustment located between the emitters. Balance for TR113 is obtained from TR114, a similar stage to TR111, but with an effectively grounded input.

3.7 CATHODE RAY TUBE figure 6

V301 is a flat face, mesh cathode ray tube. The astigmatism electrode is fed from a low impedance supply, TR302, avoiding the necessity for readjustment of the astigmatism with change of brilliance.

Cathode-grid potential is stabilised by zener diode D313 and pre-set intensity control R309 takes up spread in tube characteristics. The geometry, mesh and focus electrodes are fed from a resistive divider which, with R313, provide bias currents for D303. A coil L301 is provided to take up variations in trace alignment with the graticule. It is fitted to the CRT neck, and supplied with a stabilised current, from TR301. The rear panel rotation control is in the base circuit of TR301. C303 and C304 provide inter plate decoupling to avoid unwanted Z modulation effects.

3.8 CALIBRATOR figure 6

Transistors TR315 and TR316 form a bistable switch, compensated against ambient temperature variations by D316 and D317, and supply stabilised by zener diode D315. Switch over is controlled by the sweep voltage applied via R316, to TR315. In the absence of sweep voltage, TR315 conducts and TR316 is switched off and DC voltage at SK315 is therefore zero. An increasing voltage applied to TR315 base reaches a level equal to TR316 base voltage, switch over then occurs, TR315 switches off and TR316 switches on. Collector current of TR316 determined by R316 and R318 then flows through precision resistor R323, providing a 300 mV DC output level to SK315. Switch over of TR315 and TR316 is arranged to occur at approximately half sweep, so that the CAL signal when applied to the Y amplifier, provides a zero volt datum level and a calibrated +300 mV level during the period of the sweep. R316 enables accurate setting of CAL voltage.

3.9 BATTERY CHARGER figure 7

Mains transformer T401 supplies current via full-wave rectifier D401 – D404, to TR401 and TR402 which provide a constant current charge to the batteries with the instrument switched off, or a trickle charge with the instrument on. Line voltage switching 100–125 V AC or 200–250 V AC is set by S401 located under the instrument via a small access hole, and connected to T401 primary. Range switching selecting the lower or upper 10% of each line voltage is set by S402 located at the rear of the instrument and is connected to T401 secondary. D402 smooths the rectified output. D405 and D406 stabilise TR401 base emitter voltage, bias current being provided by R401. TR401 with R402 in its emitter provides a constant current to the negative rail via D407 the "ON" panel LED, and part of R404. Forward part voltage developed between R404 wiper and the negative rail causes TR402 to conduct and draw current from the positive rail via D408 and hence form the charge current for the battery pack. R404 therefore controls the charge current rate.

S403 and S404 form the 'ON' switch and are ganged together. Current demand in the 'ON' condition is over twice that in the 'OFF' condition, increased current is obtained from TR402 by switching in an additional parallel resistor R403. TR401 current is therefore increased, thereby increasing TR402 current. Battery charge rate in the 'OFF' condition is 400 mA and varies between zero and 100 mA in the 'ON' condition dependent upon actual line input voltage. D408 prevents battery discharge when instrument is stored.

3.10 CONVERTOR POWER SUPPLY UNIT figure 7

All supply rails, with the exception of the battery charger, are derived from a push-pull, C.R. timed, DC to DC convertor TR411 and TR412 with protection diodes D411 and D412 drive ferrite cored transformer T411 at approximately 14 kHz, feedback being obtained from a single winding in series with C412 the timing capacitance. R411 and R412 are forward bias resistors decoupled by L411 and C411. C413 decouples supply lines from voltage spikes generated by switching action. +13 and −13 volt supplies are obtained from the two 14.6 volt windings on T411, rectified by D412, D414, D415 and D416 and smoothing is provided by R418, C418, L412 and C423 for +13 V and C471, L413 and C424 for −13 V.

An additional 23 volts winding acted serially to a 14.5 V winding, rectified by D421 and smoothed by C422, L414 and C425 supplies +36 V. Additionally +80 V is obtained from the same windings by a voltage doubler D417, D418, D419 and C419.

CRT negative supplies for the gun are half wave rectified, from 523 volt winding, by D417 and smoothed by C415 and C416 in series.

PDA potential of 2.4 kV is obtained from the gun supply via a conventional quadrupler, comprising C431, C432, C433, C434, D431, D432, D433 and D434.

CHAPTER 4
MAINTENANCE AND CALIBRATION

DANGER

It is not possible to screen all high voltages, so care should be taken not to touch high voltage tags. Also where possible the instrument should be unplugged AND switched off during servicing. A BLEEDER PATH FOR THE EHT IS NOT PROVIDED, so before touching any internal parts the EHT should be discharged by temporarily shorting pin 13 on PC173 to chassis. It is advisable when replacing any component, or carrying out internal work, to disconnect the plug (PL402) and socket (SK402) at the top of the batteries.

4.1 INTRODUCTION

4.1.1 The solid state design of the instrument makes frequent adjustment of the internal preset components unnecessary. The appropriate part of the Calibration Procedure should be performed whenever the instrument fails to meet its specification, or whenever a defective component is replaced. The Circuit Description, Chapter 3, will assist in deciding which part of the circuit requires adjustment.

4.1.2 The internal 300 mV calibrator allows the accuracy of the vertical amplifiers to be checked. Timing accuracy should be checked against an external sinewave or marker pulse source.

4.1.3 To carry out the whole calibration procedure, the following tools and equipment are required –

Small screwdriver (for access).

Trimming tool, low capacitance (for preset capacitors and potentiometers).

Amplitude calibrator, approximately 1 kHz squarewave providing outputs of 50 mV to 50 V. To an accuracy of ±0.25%.

Time calibrator, providing markers of amplitude between 50 mV and 10 V. 1 μsec. to 1 msec., timing accuracy ±0.1%.

Squarewave generator, providing a terminated 1 MHz signal, of approximately 500 mV, rise time less than 10 nsec.

Sinewave generator, providing 50 kHz, to 10 MHz signal of amplitude up to 25 volts.

Monitor oscilloscope with X 10 passive probe.

Digital voltmeter D.C. with input impedance of 1 meg ohm, or greater.

Meter for voltage measurement with resistance of 20 kΩ per volt or better.

Ammeter 0-500 mA DC Accuracy ±3%.

Co-Axial connecting leads and terminating load suitable for matching to co-ax impedance.

X10 probe, available as equipment accessory.

4.2 MECHANICAL

4.2.1 ACCESS TO INTERIOR

a) Remove all external leads and cables, switch unit off.
b) Remove 3 screws visible on underside of instrument case.
c) Holding case firmly, push rear panel, withdraw chassis through front of case.

4.2.2 OPENING OUT SIDE AND LOWER FLAPS
(see photograph of open instrument)

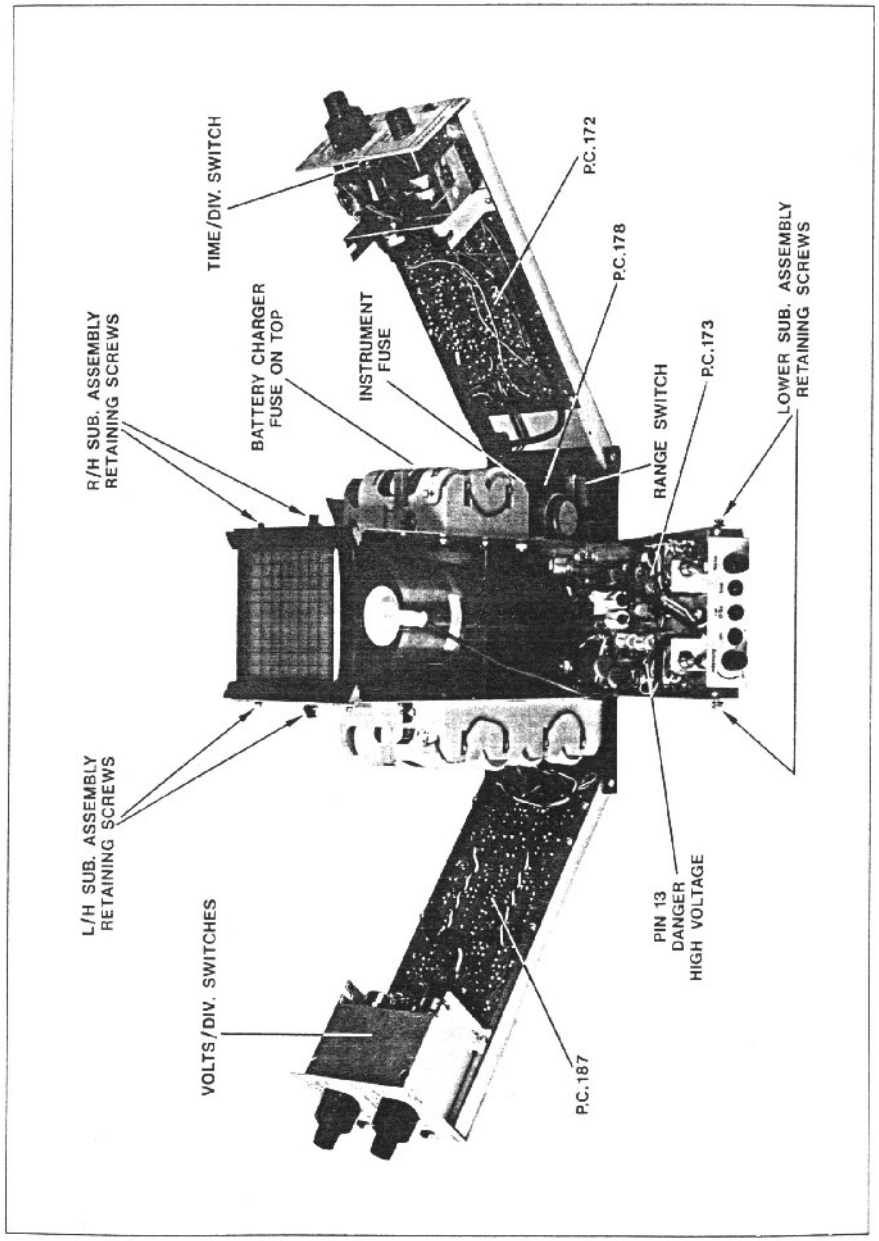
a) Remove case as in 4.2.1 above.
b) To open the right hand panel undo the screws at the top and bottom of the instrument just behind the TIME/DIV switch.
c) To open the left hand panel undo the screws at the top and bottom of the instrument just behind the attenuators.
d) To open the bottom flap undo the screw under the attenuator and the screw under the level potentiometer.

4.2.4 CRT REMOVAL

a) Remove instrument from case as in 4.2.1 above.
b) Through access hole in top rear carefully prise off tube base.
c) Stand chassis on rear panel, slacken both, side sub-assembly and under sub-assembly screws, as in 4.2.2.
d) Open all three sub-assemblies.
e) Earth lower end of P.D.A. lead by shorting out pin 13 on PC173, then disconnect the lead from tube.
f) Unsolder trace rotate leads from eyelets numbers 49 and 50 at rear of PC187.
g) Remove CRT shield securing screws located forward of battery packs.
h) Press tube clear of rubber strips by gently pushing towards the rear of the instrument and withdraw through the lower sub-assembly opening.
j) Slide Mu-metal screen off tube neck.

4.2.5 CRT FITTING

To be able to get to the tube base it is necessary to remove the rear voltage warning label. Reverse the order detailed in para. 4.2.4 above. Make sure tube is pressed forward in housing to locate against bezel rear, before tightening CRT shield securing screws. If trace rotate operation is in opposite sense, reverse wires on eyelets numbers 49 and 50 PC187.



A

4.3 CALIBRATION PROCEDURE

4.3.1 BATTERY CHARGE RATE AND INITIAL SETTING

a) Ascertain actual A.C. line voltage available, and set ac range switch S401, located underneath and tapping switch, S402 on rear panel, as follows:—

AC LINE VOLTS	RANGE VOLTS (S401)	TAPPING (S402)
100-112 V	112 V	LO
113-125 V	112 V	HI
200-225 V	225 V	LO
226-250 V	225 V	HI

b) 1. Remove instrument chassis from case as in 4.2.1 above.
2. Open R.H. side assembly and remove one cell from battery pack.
3. Connect D.C. ammeter across cell holder contacts with ON/OFF switch set to off.
4. Connect instrument to A.C. line.
5. Adjust R404 on PC173 (underneath) for a current indication of 370 mA.
6. Disconnect a.c. line, remove ammeter, replace cell and secure side assembly.

c) Set front panel controls as follows:—
1. CH1 and CH2 AC/DC switches to AC.
2. CH1 and CH2 VOLT/DIV switches to 5 V/DIV.
3. Select CH1 trig.
4. CH1 position centralised, using Y POSITION knob.
5. CH2 position fully anti-clockwise to channel OFF position.
6. INTENSITY/Off to Off, focus centralised.
7. TIME/DIV to 1 ms horizontal position centralised and pushed to 'IN' position.
8. LEVEL, centralised, push in for 'AUTO'.
9. MODE, SOURCE and SLOPE switches set to A.C., INT. and — respectively.

4.3.2 SUPPLY LINE VOLTAGES

Set controls as in para. 4.3.1, switch unit ON using intensity control. No adjustments exist for supply lines. The voltages shown in the table below are those which should be obtained for a nominal 7.8 volts battery pack voltage. (Measured between chassis and battery fuse using volt meter having resistance of 20 kΩ per volt). Allowance should be made for pack voltages differing from above. The under sub-assembly may be lowered to facilitate these measurements.

4.3.3 ASTIGMATISM AND GEOMETRY

a) Switch unit 'ON' and connect to a.c. line if batteries are in a low state of charge.
b) Set TIME/DIV to 20 μsec.
c) Apply 50 kHz sinewave signal to CH1 and set VOLTS/DIV for a 2 div p-p display.
d) Adjust LEVEL for stable trace.
e) Set trace equally about 2 horizontal lines from top of graticule.
f) Adjust FOCUS and R312 (Astigmatism) on PC173 for best trace definition.
g) Disconnect 50 kHz signal.
h) Set LEVEL to 'AUTO', trace should free run.
j) Set trace under centre graticule line, adjust trace rotate if necessary for best alignment.
k) Set trace under top horizontal line, adjust R302 (GEOMETRY) on PC173 for least curvature of trace.
l) After carrying out this adjustment the sweep accuracy should be checked, see para 4.3.8.

4.3.4 CH1 AND CH2 BALANCE

a) Set controls as para 4.3.1 (c).
b) Switch unit ON and display a free running trace.
c) Set CH1 POSITION control to half rotation.
d) Adjust R621 (CH1 BALANCE) PC187 to set trace to screen centre.
e) Set CH1 VOLTS/DIV switch to 10 mV.
f) Select DC and short circuit CH1 input socket, there should be no trace movement.
g) Apply 50 kHz sinewave to CH1 input and adjust amplitude for 8 vertical divisions display.
h) Adjust POSITION control from end to end note display overlaps.
j) Adjust R621 for equal peak overlap.
k) Repeat for CH2 using R721 (CH2 BALANCE).

4.3.5 CH1 AND CH2 GAIN AND ATTENUATOR

a) Select CH1, A.C. and 10 mV/DIV.
b) Switch unit ON and display a free-running trace (AUTO/LEVEL control IN).
c) Connect CH1 directly to 50 mV, 1 kHz squarewave calibrator.
d) Adjust R617 (CH1 GAIN) on PC187 for a 5 division amplitude display, neglecting any over, or under shoot.
e) Apply 500 mV 1 kHz squarewave to CH1 via 10 : 1 probe and adjust probe compensation for squarest corner and flat top on display then remove probe.
f) Set CH1 to 20 mV, apply 100 mV 10 kHz squarewave, adjust C611 for squarest corner and flat top.
g) Apply 1 volt 10 kHz via 10 : 1 probe, adjust C612 only for squarest corner and flat top on display, then remove probe.
h) Set CH1 to 50 mV/div, apply a 250 mV 10 kHz signal and adjust C615 for squarest corner and flat top.
j) Apply 2.5 V 10 kHz signal via 10 : 1 probe and adjust C613 for squarest corner and flat top then remove probe.
k) Set CH1 to 0.1 V/div, apply 0.5 V 10 kHz signal and adjust C603 for squarest corner and flat top.
l) Apply 5 V 10 kHz signal via 10 : 1 probe, adjust C604 for squarest corner and flat top then remove probe.
m) Set CH1 to 1.0 V, apply 5 V 10 kHz signal adjust C608 for squarest corner and flat top.
n) Apply 50 V 10 kHz via 10 : 1 probe, adjust C605 for squarest corner and flat top then remove probe.
p) Apply squarewave from calibrator to each of the nine V/div settings in turn and check for square response and amplitude error, which should not exceed 5%.
q) Repeat above for CH2 using appropriate trimmers which are prefixed with a 7, e.g. R617 for CH1 becomes R717 for CH2 etc.

TABLE OF EXPECTED VOLTAGES

SUPPLY LINE	TEST POINT	P.C. BOARD	LIMITS
+7.5 V	Lower end of D301	PC187	+7.1 V to +7.9 V
+13 V	Eyelet No. 46	PC187	+12.65 V to +14 V
+36 V	Positive lead of C425	PC187	+35 V to +41 V
+80 V	Junction C419, D419	PC173	+78 V to +86 V
+2400 V	Eyelet No. 13	PC173	+2.2 kV to +2.43 kV
−560 V	Neg. lead of C416	PC173	−540 V to −600 V
−13 V	Forward lead of L413	PC187	−12.9 V to −14.5 V
−7.5 V	Lower end of D302	PC187	−7.2 V to −7.95 V

4.3.6 CH1 AND CH2 HF PULSE RESPONSE

a) Set controls as in para 4.3.1 but with both VOLTS/DIV switches set to 0.05 V.
b) Apply 1 MHz square wave signal to both channels simultaneously via cable terminating load.
c) Switch unit on and switch CH2 on.
d) Set TIME/DIV switch to 0.5 µsec.
e) Display 5 div signal of CH1 and adjust R657 and C655 on PC187 for squarest leading/top edge of display. (x5 horizontal gain may be used to facilitate this).
f) Display CH2 and adjust R657 and C655 for best compromise, a 3 per cent overshoot or ring on the leading corner is permissible.
g) The 10 MHz channel response may now be checked, from a 50 kHz, 5 division datum point at all settings of V/DIV switches 3db = >10 MHz.

4.3.7 SWEEP ACCURACY

a) Set controls as in para 4.3.1.
b) Apply 1 m sec time markers to CH1.
c) Switch unit on.
d) Adjust level for most stable display.
e) Adjust R152 (x1 gain) on PC172, in conjunction with horizontal position control for an accurate marker/graticule alignment of 1 : 1.
f) Pull horizontal position control for x5 gain and adjust R151 (x5 gain) on PC172; and horizontal position control for an accurate marker/graticule alignment of 1 : 5.
g) Set TIME/DIV to 0.5 µsec. set horizontal position to x1 gain, apply 1 µsec. markers, adjust C2, trimmer capacitor on TIME/DIV switch, and horizontal position control for an accurate marker/graticule alignment of 1 : 2.

4.3.8 TRIGGER SENSITIVITY

a) Set controls as in para 4.3.1 but with TIME/DIV set to 10 µsec.
b) Apply 50 kHz sinewave signal to CH1 input.
c) Connect x10 probe of monitor oscilloscope to upper end of R32 or R33 on PC172.
d) Switch unit on.
e) Set monitor scope sensitivity to 10mV/div and adjust 50 kHz input to display approximately 6 div. on monitor.
f) Adjust level until switching transients appear on monitor display. See waveform below.
g) Adjust R36 (backlash) on PC172 until transients are separated by 1.5 div vertically for 150 mV at probe tip. Disconnect probe and monitor.

4.3.9 SWEEP STABILITY AND LENGTH

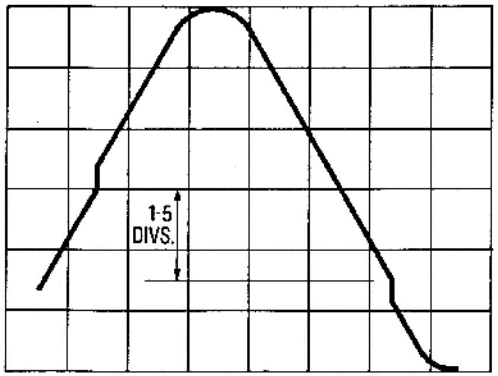
a) Set controls as in para 4.3.1 but with LEVEL control in 'OUT' position and fully clockwise.
b) Switch unit on.
c) Adjust R116 (stability) on PC172 until trace appears then back off R116 until trace just ceases.
d) Note position of R116 rotor.
e) Apply 50 kHz sinewave signal to CH1 input.
f) Set TIME/DIV to 10 µsec.
g) Adjust level for a stable display.
h) Back off R116 until trace disappears and note R116 rotor position.
j) Set R116 mid way between two noted positions.
k) Adjust R107 (sweep length) on PC172 for a trace length of 10.2 divisions.

4.3.10 INTERNAL CALIBRATOR

a) Set controls as in para 4.3.1 but with TIME/DIV set to 0.5 sec.
b) Set CH1 attenuator to 0.1 V and DC.
c) Connect CAL output to CH1 input and to digital voltmeter.
d) Connect ground of digital voltmeter to ground socket on R.H. side.
e) Switch unit on and note that trace steps upwards, approximately half way across screen.
f) Note digital volt meter reading after step has taken place, and adjust R316 (calibrator) on PC172 for a reading of 300 mV ±0.3 mV.

4.3.11 TV TRIGGER

a) Select CH1, DC, TV, INT and +ve polarity.
b) Apply composite T.V. video signal to CH1, and adjust amplitude of CH1 attenuator for a 3 division p-p display.
c) By adjustment of LEVEL control, in the 'OUT' position only, TV line synchronisation should occur on the seven fastest sweep ranges, and TV field on the twelve slowest ranges. There are no internal adjustments for T.V. and failure to lock would indicate a circuit fault.



CHAPTER 5

COMPONENTS LIST

Values of resistors are stated in ohms or multiples of ohms; ratings at 70°C are in watts or sub-multiples of watts. Values of capacitors are stated in sub-multiples of farads; ratings at 70°C are in volts or kilovolts.

Whenever possible, exact replacements for components should be used, although locally available alternative may be satisfactory for standard components.

Any order for replacement parts should include:

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

CIRCUIT REFERENCE BLOCKS

The table below gives the blocks of circuit references, so that the reader can relate the items listed in this chapter and their location in the circuitry in Chapter 6.

Circuit Reference		Circuit	Fig.
From	To		
1	300	Sweep Generator, Unblanking & X Amp. Time/Div Switch Trigger	5 8 4
301	400	Calibrator & CRT	6
401	600	Battery Charger Power Supply	7
601	630	Channel 1 Input	1
631	700	Y Output Chop-Alternate Bistable	3
701	730	Channel 2 Input	2

ABBREVIATIONS

BM	Button mica	CMP	Cermet preset	PS	Polystyrene
C	Carbon	E	Electrolytic	Se	Selenium
CP	Carbon preset	Ge	Germanium	Si	Silicon
CV	Carbon variable	MF	Metal film	SM	Silver mica
CER	Ceramic	MO	Metal oxide	WW	Wire-wound
CT	Ceramic Trimmer	PC	Polycarbonate	WWP	Wire-wound preset
CM	Cermet thick film	PE	Polyester	WWV	Wire-wound variable
		PP	Polypropylene		

TEKTRONIX U.K. LIMITED

36 - 38 Coldharbour Lane, Harpenden, Hertfordshire, England

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All requests for repairs or replacement parts should be directed to the Tektronix Field Office or representative in your area. This procedure will assure you the fastest possible service.

CIR REF	PART NUMBER	VALUE	DESCRIPTION	RATING	Eff. Ser.No.
B401	146-0027-00	1.25 V	Cell Ni Cad. D Size	4AH	
B402	146-0027-00	1.25 V	Cell Ni Cad. D Size	4AH	
B403	146-0027-00	1.25 V	Cell Ni Cad. D Size	4AH	
B404	146-0027-00	1.25 V	Cell Ni Cad. D Size	4AH	
B405	146-0027-00	1.25 V	Cell Ni Cad. D Size	4AH	
B406	146-0027-00	1.25 V	Cell Ni Cad. D Size	4 AH	

CIR REF	PART NUMBER	VALUE F	DESCRIPTION TYPE	TOL %	RATING Volts	Eff. Ser.No.
C1	285-0867-00	20 p	PS	1 p	350	
C2	281-0137-00	6-30 p	CT		500	
C3	285-1110-00	1.0 µ	PC	1	40	
C4	285-0942-00	10 n	PE	1	125	
C5	285-1057-00	50 p	PS	1 p	350	
C6	285-0906-00	15 n	PE	20	250	
C7	285-1078-00	1.5 µ	PE	20	63	
C8	281-0710-00	10 n	CER		250	
C9	281-0710-00	10 n	CER		250	
C21	285-0796-00	100 n	PE	20	250	
C22	290-0493-00	22 µ	ELEC		25	
C23	285-0915-00	100 n	PE	20	100	
C24	281-0710-00	10 n	CER		250	
C25	290-0943-00	22 µ	ELEC		25	
C27	285-0854-00	100 p	PS	2 p	350	
C28	290-0661-00	100 µ	ELEC		16	
C29	290-0661-00	100 µ	ELEC		16	
C31	285-0869-00	47 p	PS	2 p	350	
C32	285-0854-00	100 p	PS	2 p	350	
C33	290-0762-00	22 µ	ELEC		6.3	609351
C34	285-0759-00	2.2 n	PS	5	125	
C35	285-0867-00	1.5 n	PS	5	125	
C36	290-0707-00	22 µ	ELEC		25	
C37	285-0869-00	47 p	PS	2 p	350	
C100	285-0871-00	150 p	PS	5	350	
C101	285-0776-00	27 p	PS	1 p	350	
C102	290-0661-00	100 µ	ELEC		16	
C103	281-0710-00	10 n	CER		250	
C104	285-1054-00	270 p	PS	1	350	609280
C105	285-0867-00	20 p	PS	1 p	350	
C106	285-0779-00	470 n	PE	20	100	
C107	290-0492-00	4.7 µ	ELEC		16	
C108	285-1018-00	22 p	PS	1 p	350	
C109	281-0705-00	1 p	CER	0.1 p	500	
C110	285-0915-00	100 n	PE	20	100	
C111	285-0847-00	560 p	PS	5	125	
C112	285-0915-00	100 n	PE	20	100	
C113	285-0915-00	100 n	PE	20	100	
C114	281-0711-00	3.9 p	CER	0.25 p	750	609151
C115	285-0867-00	20 p	PS	1 p	350	
C116	285-0873-00	200 p	PS	5	350	610002
C301	281-0710-00	10 n	CER		250	
C302	281-0710-00	10 n	CER		250	
C303	281-0710-00	10 n	CER		250	
C304	281-0710-00	10 n	CER		250	
C305	281-0710-00	10 n	CER		250	609249

CIR REF	PART NUMBER	VALUE F	DESCRIPTION TYPE	TOL %	RATING Volts	Eff. Ser.No.
C402	290-0675-01	4.7 m	ELEC		16	
C403	285-0915-00	100 n	PE	20	100	
C411	290-0676-00	1 µ	ELEC		100	
C412	285-0836-00	47 n	PE	20	250	
C413	290-0679-00	1 m	ELEC		10	
C415	290-0677-00	1 µ	ELEC		350	
C416	290-0677-00	1 µ	ELEC		350	
C417	290-0676-00	1 µ	ELEC		100	
C418	290-0678-00	47 µ	ELEC		25	
C419	290-0676-00	1 µ	ELEC		100	
C421	290-0678-00	47 µ	ELEC		25	
C422	290-0688-00	22 µ	ELEC		63	
C423	290-0678-00	47 µ	ELEC		25	
C424	290-0678-00	47 µ	ELEC		25	
C425	290-0688-00	22 µ	ELEC		63	
C431	281-0747-00	1.8 n	CER		1250	
C432	281-0747-00	1.8 n	CER		1250	
C433	281-0748-00	1 n	CER	20	1250	
C434	281-0748-00	1 n	CER	20	1250	
C601	285-0796-00	100 n	PE	20	250	
C602	281-0723-00	1.8 p	CER	0.1 p	500	
C603	281-0155-00	2-22 p	PS		500	
C604	281-0155-00	2-22 p	PS		500	
C605	281-0155-00	2-22 p	PS		500	
C606	Twisted wires mounted on S602					
C607	285-1080-00	220 p	PS	5	350	
C608	281-0157-00	5.5-65.5 p	PS		500	
C609	285-0776-00	27 p	PS	1 p	350	
C611	281-0154-00	2-12 p	PS		500	
C612	281-0156-00	1.4-6.4 p	PS		500	
C613	281-0155-00	2-22 p	PS		500	
C614	281-0731-00	5.6 p	CER	0.5 p	750	
C615	281-0155-00	2-22 p	PS		500	
C616	281-0731-00	5.6 p	CER	0.5 p	750	
C617	281-0710-00	10 n	CER		250	
C618	285-0915-00	100 n	PE	20	100	
C619	285-0887-00	1.5 n	PS		125	
C621	285-0759-00	2.2 n	PS	5	125	
C622	285-0760-00	330 p	PS	5	125	

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CIR REF	PART NUMBER	VALUE F	DESCRIPTION TYPE	TOL %	RATING Volts	Eff. Ser.No.
C631	285-0915-00	100 n	PE	20	100	
C632	285-0850-00	1000 p	PS	5	125	
C633	285-0760-00	330 p	PS	5	125	
C634	285-0869-00	47 p	PS	2 p	350	
C635	285-0800-00	10 n	PE	20	250	
C636	285-0760-00	330 p	PS	5	125	
C637	285-0850-00	1000 p	PS	5	125	
C638	285-0869-00	47 p	PS	2 p	350	
C651	281-0710-00	10 n	CER		250	
C652	285-0854-00	100 p	PS	5	350	
C653	281-0676-00	2.2 p	CER	0.1 p	500	
C654	281-0676-00	2.2 p	CER	0.1 p	500	
C655	281-0157-00	5.5-65.5 p			500	
C656	285-0854-00	100 p	PS	5	350	
C657	281-0710-00	10 n	CER		250	
C658	290-0492-00	4.7 µ	ELEC		16	
C659	290-0707-00	22 µ	ELEC		25	
C660	285-0844-00	39 p	PS	2 p	350	609249
C661	285-0920-00	56 p	PS	2 p	350	609249

CIR REF	PART NUMBER	VALUE F	DESCRIPTION TYPE	TOL %	RATING Volts	Eff. Ser.No.
C701	285-0796-00	100 n	PE	20	250	
C702	281-0723-00	1.8 p	CER	0.1 p	500	
C703	281-0155-00	2-22 p	PS		500	
C704	281-0155-00	2-22 p	PS		500	
C705	281-0155-00	2-22 p	PS		500	
C706	Twisted wires mounted on S702					
C707	285-1080-00	220 p	PS	5	350	
C708	281-0157-00	5.5-65.5 p	PS		500	
C709	285-0776-00	27 p	PS	1 p	350	
C711	281-0154-00	2-12 p	PS		500	
C712	281-0156-00	1.4-6.4 p	PS		500	
C713	281-0155-00	2-22 p	PS		500	
C714	281-0731-00	5.6 p	CER	0.5 p	750	
C715	281-0155-00	2-22 p	PS		500	
C716	281-0731-00	5.6 p	CER	0.5 p	750	
C717	281-0710-00	10 n	CER		250	
C719	285-0887-00	1.5 n	PS		125	
C721	285-0759-00	2.2 n	PS	5	125	
C722	285-0760-00	330 p	PS	5	125	

CIR REF	PART NUMBER	VALUE	DESCRIPTION	TYPE	TOL %	RATING	Eff. Ser.No.
D21	152-0062-01	75 V	1N914	Si		50 mA	
D22	152-0062-01	75 V	1N914	Si		50 mA	
D23	152-0062-01	75 V	1N914	Si		50 mA	
D24	152-0370-00	50 V	AAY30	Ge		25 mA	
D25	152-0370-00	50 V	AAY30	Ge		25 mA	
D101	152-0062-01	75 V	1N914	Si		50 mA	
D102	152-0062-01	75 V	1N914	Si		50 mA	
D103	152-0062-02	75 V	1N4148T	Si		50 mA	609280
D104	152-0062-01	75 V	1N914	Si		50 mA	
D105	152-0062-01	75 V	1N914	Si		50 mA	
D106	152-0062-01	75 V	1N914	Si		50 mA	
D107	152-0062-01	75 V	1N914	Si		50 mA	
D108	152-0062-01	75 V	1N914	Si		50 mA	
D109	152-0062-01	75 V	1N914	Si		50 mA	
D111	152-0062-01	75 V	1N914	Si		50 mA	
D112	152-0062-01	75 V	1N914	Si		50 mA	
D113	152-0062-01	75 V	1N914	Si		50 mA	
D301	152-0347-00	7.5 V	Zener	Si		330 mW	
D302	152-0347-00	7.5 V	Zener	Si		330 mW	
D303	152-0388-00	130 V	Zener	Si		400 mW	
D304	152-0062-01	75 V	1N914	Si		150 mA	
D315	152-0347-00	7.5 V	Zener	Si		330 mW	
D316	152-0062-01	75 V	1N914	Si		50 mA	
D317	152-0062-01	75 V	1N914	Si		50 mA	

CIR REF	PART NUMBER	VALUE	DESCRIPTION	TYPE	TOL %	RATING	Eff. Ser.No.
D401	152-0339-00		1N4001	Si		50 V	
D402	152-0339-00		1N4001	Si		50 V	
D403	152-0339-00		1N4001	Si		50 V	
D404	152-0339-00		1N4001	Si		50 V	
D405	152-0421-00	3.3 V	Zener	Si		330 mW	
D406	152-0062-01	75 V	1N914	Si		50 mA	
D407	152-0575-00		L.E.D.	Ga Asp		50 mA	
D408	152-0467-00		1N5400	Si		50 V	
D411	152-0062-01	75 V	1N914	Si		50 mA	
D412	152-0062-01	75 V	1N914	Si		50 mA	
D413	152-0468-00		BAX16	Si		150 V	
D414	152-0468-00		BAX16	Si		150 V	
D415	152-0468-00		BAX16	Si		150 V	
D416	152-0468-00		BAX16	Si		150 V	
D417	152-0515-00		SCM60	Si		6 kV	
D418	152-0468-00		BAX16	Si		150 V	
D419	152-0468-00		BAX16	Si		150 V	
D421	152-0468-00		BAX16	Si		150 V	
D431	152-0515-00		SCM60	Si		6 kV	
D432	152-0515-00		SCM60	Si		6 kV	
D433	152-0515-00		SCM60	Si		6 kV	
D434	152-0515-00		SCM60	Si		6 kV	
D601	152-0483-00	10 V	CE1104	Si			
D602	152-0541-00	12 V	BAY 82	Si		50 mA	610101
D603	152-0541-00	12 V	BAY 82	Si		50 mA	610101
D631	152-0062-01	75 V	1N914	Si		50 mA	
D632	152-0062-01	75 V	1N914	Si		50 mA	
D633	152-0062-01	75 V	1N914	Si		50 mA	
D634	152-0062-01	75 V	1N914	Si		50 mA	
D635	152-0062-01	75 V	1N914	Si		50 mA	
D651	152-0062-01	75 V	1N914	Si		50 mA	
D652	152-0062-01	75 V	1N914	Si		50 mA	
D653	152-0062-01	75 V	1N914	Si		50 mA	
D654	152-0062-01	75 V	1N914	Si		50 mA	
D655	152-0062-01	75 V	1N914	Si		50 mA	
D656	152-0062-01	75 V	1N914	Si		50 mA	
D657	152-0062-01	75 V	1N914	Si		50 mA	
D658	152-0062-01	75 V	1N914	Si		50 mA	
D659	152-0575-00		L.E.D.	Ga Asp			
D701	152-0483-00	10 V	CE1104	Si			
D702	152-0541-00	12 V	BAY 82	Si		50 mA	610101
D703	152-0541-00	12 V	BAY 82	Si		50 mA	610101

CIR REF	PART NUMBER	VALUE	DESCRIPTION	TYPE	TOL %	RATING	Eff. Ser.No.
FB601	276-0597-00		Ferrox Cube Bead FX1115				609201
FB701	276-0597-00		Ferrox Cube Bead FX1115				609201
FS401	159-0079-00	500 mA	Fuse Link 1.25" lg. slow (for 112V)				
FS401	159-0077-00	250 mA	Fuse Link 1.25" lg. slow (for 225V)				
FS402	159-0076-00	3 A	Fuse Link 1.25" lg. slow(battery)				
L301	(with V301)		Trace Rotation Coil				
L402	108-0837-00	100 µH	Inductor fixed Ferrite cored		5		610101
L411	108-0482-00	160 µH	Inductor fixed Iron dust cored				
L412	108-0482-00	160 µH	Inductor fixed Iron dust cored				
L413	108-0482-00	160 µH	Inductor fixed Iron dust cored				
L414	108-0482-00	160 µH	Inductor fixed Iron dust cored				
L631	108-0780-00	53 µH	Inductor Iron dust cored		10		
L632	108-0780-00	53 µH	Inductor Iron dust cored		10		
L633	108-0482-00	160 µH	Inductor Iron dust cored				
L634	108-0482-00	160 µH	Inductor Iron dust cored				
PL401	134-0135-00		Plug Mains				

CIR REF	PART NUMBER	VALUE Ohms	DESCRIPTION TYPE	TOL %	RATING Watts	Eff. Ser.No.
R1	325-0166-00	143 k	MF	1	250 m	
R2	325-0166-00	143 k	MF	1	250 m	
R3	325-0167-00	422 k	MF	1	250 m	
R4	325-0168-00	715 k	MF	1	500 m	
R5	325-0169-00	1.43 M	MF	1	500 m	
R6	325-0170-00	4.22 M	MF	1	500 m	
R20	317-0180-01	18	C	5	125 m	
R21	317-0104-01	100 k	C	5	125 m	
R22	317-0561-01	560	C	5	125 m	
R23	317-0682-01	6.8 k	C	5	125 m	
R24	317-0622-01	6.2 k	C	5	125 m	
R25	317-0682-01	6.8 k	C	5	125 m	
R26	317-0561-01	560	C	5	125 m	
R27†	311-1708-00	47 k	CP	20	250 m	
R28	317-0393-01	39 k	C	5	125 m	
R29	317-0273-01	27 k	C	5	125 m	
R30	317-0180-01	18	C	5	125 m	

† with switch

CIR REF	PART NUMBER	VALUE Ohms	DESCRIPTION TYPE	TOL %	RATING Watts	Eff. Ser.No.
R31	317-0563-01	56 k	C	5	125 m	
R32	317-0682-01	6.8 k	C	5	125 m	
R33	317-0362-01	3.6 k	C	5	125 m	
R34	317-0101-01	100	C	5	125 m	
R35	317-0622-01	6.2 k	C	5	125 m	609351
R36	311-1655-00	100	CP	20	50 m	
R37	317-0201-01	200	C	5	125 m	
R38	317-0121-01	120	C	5	125 m	
R39	317-0392-01	3.9 k	C	5	125 m	
R40	317-0105-01	1 M	C	5	125 m	
R41	317-0103-01	10 k	C	5	125 m	
R42	317-0334-01	330 k	C	5	125 m	
R43	317-0753-01	75 k	C	5	125 m	
R44	317-0331-01	330	C	5	125 m	
R45	317-0104-01	100 k	C	5	125 m	
R46	317-0105-01	1 M	C	5	125 m	
R47	317-0752-01	7.5 k	C	5	125 m	609351
R48	317-0101-01	100	C	5	125 m	
R49	317-0182-01	1.8 k	C	5	125 m	
R50	311-1892-00	22 k	CP	20	50 m	
R51	317-0821-01	820	C	5	125 m	
R52	317-0470-01	47	C	5	125 m	

CIR REF	PART NUMBER	VALUE Ohms	DESCRIPTION TYPE	TOL %	RATING Watts	Eff. Ser.No.
R101	317-0203-01	20 k	C	5	125 m	
R102	317-0332-01	3.3 k	C	5	125 m	
R103	317-0332-01	3.3 k	C	5	125 m	
R104	317-0104-01	100 k	C	5	125 m	
R105	317-0103-01	10 k	C	5	125 m	
R106	317-0752-01	7.5 k	C	5	125 m	609280
R107	311-1682-00	22 k	CP	20	50 m	
R108	317-0471-01	470	C	5	125 m	
R109	317-0471-01	470	C	5	125 m	
R110	317-0621-01	620	C	5	125 m	
R111	317-0622-02	6.2 k	C	5	125 m	
R112	317-0243-01	24 k	C	5	125 m	
R113	317-0913-01	91 k	C	5	125 m	
R114	317-0123-01	12 k	C	5	125 m	
R115	317-0153-01	15 k	C	5	125 m	
R116	311-1654-00	10 k	C	20	50 m	
R117	317-0103-01	10 k	C	5	125 m	
R118	317-0223-01	22 k	C	5	125 m	
R119	317-0391-01	390	C	5	125 m	
R121	317-0123-01	12 k	C	5	125 m	
R122	317-0564-01	560 k	C	5	125 m	
R123	317-0753-01	75 k	C	5	125 m	
R124	317-0822-01	8.2 k	C	5	125 m	
R125	317-0432-01	4.3 k	C	5	125 m	
R126	317-0123-01	12 k	C	5	125 m	
R127	317-0331-01	330	C	5	125 m	
R128	317-0123-01	12 k	C	5	125 m	
R129	317-0623-01	62 k	C	5	125 m	
R131	317-0222-01	2.2 k	C	5	125 m	
R132	317-0103-01	10 k	C	5	125 m	
R133	317-0334-01	330 k	C	5	125 m	
R134	317-0220-01	22	C	5	125 m	
R135	317-0332-01	3.3 k	C	5	125 m	
R136	317-0822-01	8.2 k	C	5	125 m	
R137†	311-1646-00	22 k	CV	20	250 m	
R138	317-0333-01	33 k	C	5	125 m	
R139	317-0363-01	36 k	C	5	125 m	
R141	317-0223-01	22 k	C	5	125 m	
R142	317-0123-01	12 k	C	5	125 m	
R143	317-0103-01	10 k	C	5	125 m	
R144	317-0822-01	8.2 k	C	5	125 m	
R145	317-0330-01	33	C	5	125 m	
R146	317-0562-01	5.6 k	C	5	125 m	
R147	317-0272-01	2.7 k	C	5	125 m	
R148	317-0680-01	68 k	C	5	125 m	
R149	317-0471-00	470	C	5	125 m	
R151	311-1655-00	100	CP	20	50 m	
R152	311-1706-00	470	CP	20	50 m	
R153	317-0752-01	7.5 k	C	5	125 m	
R154	317-0362-01	3.6 k	C	5	125 m	
R155	317-0330-01	33	C	5	125 m	
R156	317-0622-01	6.2 k	C	5	125 m	
R157	317-0103-01	10 k	C	5	125 m	
R158	317-0103-01	10 k	C	5	125 m	
R301	317-0241-01	240	C	5	125 m	
R302	311-1649-00	470 k	CP	20	50 m	
R303	311-1776-00	47 k	CV	20	100 m	
R304	317-0241-01	240	C	5	125 m	
R305	301-0565-01	5.6 M	C	5	500 m	
R306†	311-1816-00	1 M	CV	20	150 m	609451
R307	316-0185-01	1.8 M	C	10	250 m	609351

† with switch

CIR REF	PART NUMBER	VALUE Ohms	DESCRIPTION TYPE	TOL %	RATING Watts	Eff. Ser.No.
R308*	311-1816-00	1 M	CV	20	150 m	609451
R309	311-1651-00	1 M	CP	20	50 m	
R310	317-0824-01	820 k	C	5	125 m	
R311	317-0105-01	1 M	C	5	125 m	
R312	311-1651-00	1 M	CP	20	50 m	
R313	315-0105-02	1 M	C	5	250 m	
R314	317-0272-01	2.7 k	C	5	125 m	
R315	317-0104-01	100 k	C	5	125 m	
R316	311-1652-00	2.2 k	CP	20	50 m	
R317	317-0104-01	100 k	C	5	125 m	
R318	317-0682-01	6.8 k	C	5	125 m	
R319	317-0222-01	2.2 k	C	5	125 m	
R321	317-0333-01	33 k	C	5	125 m	
R322	317-0433-01	43 k	C	5	125 m	
R323	321-0172-48	604	MF	1	125 m	
R324	317-0222-01	2.2 k	C	5	125 m	
R401	317-0152-01	1.5 k	C	5	125 m	
R402	317-0181-01	180	C	5	125 m	
R403	317-0151-01	150	C	5	125 m	
R404	311-1653-00	220	CP	20	50 m	
R405	308-0727-00	1	WW	10	1	
R406	317-0104-01	100 k	C	5	125 m	
R411	317-0102-01	1 k	C	5	125 m	
R412	317-0102-01	1 k	C	5	125 m	
R413	317-0241-01	240	C	5	125 m	
R414	317-0241-01	240	C	5	125 m	
R415	317-0102-01	1 k	C	5	125 m	
R416	317-0102-01	1 k	C	5	125 m	
R417	317-0102-01	1 k	C	5	125 m	
R418	307-0382-00	7.5	C	5	125 m	
R601*	310-0679-00	900 k		1	250 m	
R602*		111 k		1	250 m	
R603*	310-0678-00	990 k		1	250 m	
R604*		10.1 k		1	250 m	
R605*		500 k		1	250 m	
R606*		1 M		1	250 m	
R607*	310-0683-00	800 k		1	250 m	
R608*		250 k		1	250 m	
R609*		1 M		1	250 m	
R610	317-0100-01	10	C	5	125 m	
R611	315-0104-01	100 k	C	5	250 m	
R612	317-0101-01	100	C	5	125 m	
R613	317-0750-01	75	C	5	125 m	
R614	317-0152-01	1.5 k	C	5	125 m	
R615	317-0332-01	3.3 k	C	5	125 m	
R616	317-0113-01	11 k	C	5	125 m	609351
R617	311-1656-00	4.7 k	C	5	50 m	
R618	317-0912-01	9.1 k	C	5	125 m	
R619	317-0102-01	1 k	C	5	125 m	
R621	311-1764-00	47 k	CMP	20	500 m	
R622	317-0203-01	20 k	C	5	125 m	
R623	311-1658-00	47 k	CV	20	250 m	
R624	317-0124-01	120 k	C	5	125 m	
R625	317-0302-01	3 k	C	5	125 m	

* thick film cermet resistor

CIR REF	PART NUMBER	VALUE Ohms	DESCRIPTION TYPE	TOL %	RATING Watts	Eff. Ser.No.
R631	317-0103-01	10 k	C	5	125 m	
R632	317-0151-01	150	C	5	125 m	
R633	317-0361-01	360	C	5	125 m	
R634	317-0752-01	7.5 k	C	5	125 m	
R635	317-0153-01	15 k	C	5	125 m	
R636	317-0223-01	22 k	C	5	125 m	
R637	317-0103-01	10 k	C	5	125 m	
R638	317-0512-01	5.1 k	C	5	125 m	
R639	317-0223-01	22 k	C	5	125 m	
R640	317-0153-01	15 k	C	5	125 m	
R641	317-0821-01	820	C	5	125 m	
R642	317-0392-01	3.9 k	C	5	125 m	
R643	317-0512-01	5.1 k	C	5	125 m	
R644	317-0153-01	15 k	C	5	125 m	
R645	317-0361-01	360	C	5	125 m	
R646	317-0752-01	7.5 k	C	5	125 m	
R647	317-0103-01	10 k	C	5	125 m	
R648	317-0102-01	1 k	C	5	125 m	
R649	317-0102-01	1 k	C	5	125 m	
R651	317-0152-01	1.5 k	C	5	125 m	
R652	317-0752-01	7.5 k	C	5	125 m	
R654	317-0562-01	5.6 k	C	5	125 m	
R655	315-0152-02	1.5 k	C	5	250 m	
R656	321-0193-48	1 k	MF	1	125 m	
R657	311-1653-00	220	CP	20	50 m	
R658	317-0102-01	1 k	C	5	125 m	
R659	317-0241-01	240	C	5	125 m	
R661	315-0152-02	1.5 k	C	5	250 m	
R662	321-0193-48	1 k	MF	1	125 m	
R663	317-0562-01	5.6 k	C	5	125 m	
R665	317-0752-01	7.5 k	C	5	125 m	
R667	317-0220-01	22	C	5	125 m	
R668	317-0152-01	1.5 k	C	5	125 m	
R701*	310-0679-00	900 k		1	250 m	
R702*		111 k		1	250 m	
R703*	310-0678-00	990 k		1	250 m	
R704*		10.1 k		1	250 m	
R705*		500 k		1	250 mm	
R706*		1 M		1	250 m	
R707*	310-0683-00	800 k		1	250 m	
R708*		250 k		1	250 m	
R709*		1 M		1	250 m	
R710	317-0100-01	10	C	5	125 m	
R711	315-0104-01	100 k	C	5	250 m	
R712	317-0101-01	100	C	5	125 m	
R713	317-0750-01	75	C	5	125 m	
R714	317-0152-01	1.5 k	C	5	125 m	
R715	317-0332-01	3.3 k	C	5	125 m	
R716	317-0113-01	11 k	C	5	125 m	609351
R717	311-1656-00	4.7 k	C	20	50 m	
R718	317-0912-01	9.1 k	C	5	125 m	
R719	317-0102-01	1 k	C	5	125 m	
R721	311-1764-00	47 k	CMP	20	500 m	
R722	317-0203-01	20 k	C	5	125 m	
R723†	311-1672-00	47 k	CV	20	250 m	
R724	317-0124-01	120 k	C	5	125 m	
R725	317-0302-01	3 k	C	5	125 m	

† with switch

CIR REF	PART NUMBER	DESCRIPTION	Eff. Ser.No.
PL401	134-0135-00	Mains	
PL402	134-0125-00	Battery Connection	
S1	260-1638-00	Time/Div	
S21	260-1429-00	Int/Ext Trig	
S22	260-1429-00	Polarity	
S23	260-1429-00	AC-TV	
S24	With R27	Auto	
S101	with R27	Auto	
S102	with R137	x5 gain	
S401	260-1429-00	Slide 125/250 V	
S402	260-1307-00	Slide Hi-Lo Line	
S403	with R308	Instrument On/Off	609451
S404	with R308	Instrument On/Of	
S405	with R306	Power On/Off	
S406	with R306	Power On/Off	
S601	260-1429-00	Slider AC-DC	
S602	260-1690-00	Volts/Div	
S631	with R723	On CH2	
S632	260-1401-00	Trig select	
S701	260-1429-00	AC-DC	
S702	260-1690-00	Volts/Div	
SK21	131-1654-00	BNC Ext. Trig.	
SK315	131-1268-00	2 mm Probe test Cal 0.3 V	
SK401	131-1735-00	External DC/Battery Check	
SK402	136-0889-00	Charging Check	610101
SK601	131-1654-00	B.N.C. 50Ω 73-10-01	
SK701	131-1654-00	B.N.C. 50Ω 73-10-01	

* thick film cermet resistor

CIR REF	PART NUMBER	VALUE	DESCRIPTION	TYPE	TOL %	RATING	Eff. Ser.No.
TH601	307-0288-00	1.3 kΩ	N.T.C. Type VH103a		20	0.5 W	
TH701	307-0288-00	1.3 kΩ	N.T.C. Type VH103B		20	0.5 W	

CIR REF	PART NUMBER	DESCRIPTION		TYPE	Eff. Ser.No.
TR21	151-0127-02	BSX20	Si	NPN	
TR22	151-0127-02	BSX20	Si	NPN	
TR23	151-0317-00	BC109C	Si	NPN	
TR24	151-0320-01	MPS6518	Si	PNP	
TR25	151-0320-01	MPS6518	Si	PNP	
TR26	151-0320-01	MPS6518	Si	PNP	
TR101	151-0320-01	MPS6518	Si	PNP	
TR102	151-0326-00	BC107	Si	NPN	
TR103	151-1076-00	WN537	Si		
TR104	151-0326-00	BC107	Si	NPN	
TR105	151-0326-00	BC107	Si	NPN	
TR106	151-0326-00	BC107	Si	NPN	
TR107	151-0242-00	2N3904	Si	NPN	
TR108	151-0320-01	MPS6518	Si	PNP	
TR109	151-0242-00	2N3904	Si	NPN	
TR111	151-0320-01	MPS6518	Si	PNP	
TR112	151-0242-00	2N3904	Si	NPN	
TR113	151-0242-00	2N3904	Si	NPN	
TR114	151-0320-01	MPS6518	Si	PNP	
TR301	151-0326-00	BC107	Si	NPN	
TR302	151-0525-03	FRB749	Si	NPN	
TR315	151-0320-00	MPS6518	Si	PNP	
TR316	151-0320-00	MPS6518	Si	PNP	
TR401	151-0320-00	MPS6518	Si	PNP	
TR402	151-0480-00	2SC1173 (R)	Si	NPN	

CIR REF	PART NUMBER	DESCRIPTION		TYPE	Eff. Ser.No.
TR411	151-0479-00	BDX36	Si	NPN	
TR412	151-0479-00	BDX36	Si	NPN	
TR601	151-1076-00	WN537A	Si		
TR602	151-0127-02	BSX20	Si	NPN	
TR603	151-0317-00	BC109C	Si	NPN	
TR604	151-0242-00	2N3904	Si	NPN	
TR631	151-0326-00	BC107	Si	NPN	
TR632	151-0326-00	BC107	Si	NPN	
TR633	151-0317-00	BC109C	Si	NPN	
TR651	151-0320-00	MPS6518	Si	PNP	
TR652	151-0242-00	2N3904	Si	NPN	
TR653	151-0242-00	2N3904	Si	NPN	
TR654	151-0320-00	MPS6518	Si	PNP	
TR701	151-1076-00	WN537A	Si		
TR702	151-0127-00	BSX20	Si	NPN	
TR703	151-0317-00	BC109C	Si	NPN	
TR704	151-0242-00	2N3904	Si	NPN	
V301	154-0706-00	CRT Type D10-193			

D32 MECHANICAL DRAWINGS

The exploded views which follow show the mechanical parts used in a D32 instrument.

NOTES

1. The battery mounting system has been changed during production of this instrument. The current manufacturing process is shown in fig. 2 and parts should be ordered as shown.

   The earlier mounting system is shown in fig. 1 and parts should be ordered as shown in the figure.

2. The power socket (PL401) has been changed during the course of manufacture to a "Euro" socket.

   The new socket is shown in fig. 4.

   The old socket and part number is shown in fig. 3.

3. To replace the graticule it is necessary to order a graticule assembly (331-0413-00 blue or 331-0414-00 amber). For earlier instruments which had a lip on the top bezel a new top bezel will also be required. A replacement kit (050-0769-00 blue or 050-0770-00 amber) consisting of graticule assembly and top bezel, should be ordered.

SUB ASSEMBLIES

For positions of the various sub assemblies see the photograph of the open instrumeat in chapter 4. Each main assembly comprises a number of smaller sub-assemblies, miscellaneous components and mechanical parts (see also mechanical parts list).

MAIN ASSEMBLY	SUB ASSEMBLY	PART NUMBER
R/H SIDE ASSEMBLY (Sweep and Calibrator)	PC172 wired	670-3529-00
	TIME/DIV switch	262-0978-00
L/H SIDE ASSEMBLY (Y Amplifier and chop/alternate bistable)	PC187 wired	670-3743-00
	VOLTS/DIV switch (CH1)	262-0977-00
	VOLTS/DIV switch (CH2)	262-0977-00
LOWER ASSEMBLY (Power and tube supplies)	PC173 wired	670-3530-00
CENTRE ASSEMBLY AND REAR PANEL (Tube assembly and line voltage selection	PC187 wired	670-3308-00

D32 MECHANICAL PARTS

FOR POSITIONS OF THE MECHANICAL PARTS SEE THE EXPLODED DRAWINGS WHICH FOLLOW

DRG.	PART NUMBER	DESCRIPTION
1	101-0026-00	Front Trim (LH)
2	101-0025-00	Front Trim (RH)
3	333-2050-00	Front Panel (TIME/DIV)
4	333-2051-00	Front Panel (VOLTS/DIV)
6	333-2052-00	Side Panel
7	337-2120-02	Screen, Elec. (VOLT/DIV)
8	333 1913 03	Front Panel (Control)
9	337-2054-00	Screen, Cover
10	343-0234-00	Cable Cleat
12	200-1657-01	Front Bezel (Side)
13	101-0028-00	Front Bezel (Upper)
14	200-1828-00	Front Bezel (Lower)
16	407-1503-00	Bracket
17	407-1502-00	Bracket
18	381-0351 01	Bar
19	441-1225-02	Centre Chassis
20	343-0108-00	Cable Cleat
21	333-1879-02	Rear Panel
22	390-0416-01	Bottom Tray
23	343-0512-00	Transformer Clamp
24	376-0148-01	Flexible Coupling
25	384-1381-00	Shaft Extension
27	361 0670 00	Spacer Pivot
29	391-0143-01	Block (Voltage Identification)
31	366-1654-00	Knob Assembly
32	366-1657-01	Knob Assembly
33	210-1247-00	Felt Washer
34	358-0460-00	Bush
36	366-1656-01	Knob Assembly
38	334-2227-01	Rear Label
39	366-1414-15	Knob/Push Button-Assembly
41	376-0132-00	Switch Extension Coupling
42	384-1141-07	Extension Rod
44	220-0727-00	Type 'U' Nut
46	200-1863-01	Cover
47	134-0154-00	Power Plug
48	200-1575-01	Transformer Cover
49	334-2552-03	Name Plate (Serial No.)
51	343-0500-01	Clamp (C402)
52	334-2633-00	Label (Fuse Identification)
53	352-0447-00	Battery Holder
54	101 0027-02	Handle Trim (LH)
55	101-0027-03	Handle Trim (RH)
58	437-0186-00	Cover Cabinet
59	367-0208-02	Handle (LH)
60	367 0208 03	Handle (RH)
62	214-2286-01	Index Ring (RH)
63	214-2286-02	Index Ring (LH)
64	105-0680-00	Handle Catch
65	214-2287-00	Handle Spring
66	200-1830-01	Handle Cover
67	367-0207-01	Handle Grip
68	210-1235-00	Handle, Washer Assembly
71	337-2008-00	Gun Shield (CRT)
72	220-0527-00	Nut Ring
73	378-0836-00	Screen
74	348-0167-01	Foot
75	200-0887-01	Cap
77	200-1725-01	Warning Cover
78	384-0941-00	Extension Rod
79	437-0171-01	Front Cover Protection
80	361-0275-00	Spacer Bush
81	407 1500 00	Bracket Heatsink
82	131-1259-00	Earthing Contact
83	210-0297-00	Solder Tag 6BA
84	343-0207-00	Cable Cleat
86	213-0460-00	Screw 8BA CH HD x ¼"
87	213-0694-00	Screw 8BA CH HD x 5/16"
88	213-0454-00	Screw 8 BA CSK HD x ⅜"
89	213-0720-00	Screw 8BA R/CSK HD x ¼"
90	213 0699 00	Screw 8BA R/CSK HD x 3/8"
91	213-0392-00	Screw 6 BA PAN HD x 3/16"
92	213-0393-00	Screw 6BA PAN HD x ¼"
94	213 0406-00	Screw 6BA PAN HD x 3/8"
95	213-0395-00	Screw 6BA PAN HD x 1"
96	213-0321 00	Screw 6BA CH HD x ¼"
97	213-0391-00	Screw 6BA CSK HD x ¼"
98	213-0400-00	Screw 6BA CSK HD x 3/8"
100	213 0403 00	Screw 4BA CSK HD x ⅜"
101	213-0515-00	Screw 2BA PAN HD x ⅜"
103	213-0248-00	Screw Set M3 x 3 mm
105	213-0354-00	Screw S/T No 2 Type B PAN HD x ¼"
106	213-0727-00	Screw S/T No 4 Type B PAN HD x 3/8"
111	210-1213-00	Washer 8BA Small
112	210-1211-00	Washer 8BA Large
113	210-1214-00	Washer 8BA Shakeproof
114	210-1159 00	Washer 6BA SRBP
115	210-1207-00	Washer 6BA Large
116	210-1209-00	Washer 6BA Small
117	210-1210-00	Washer 6BA Shakeproof
120	210-1203-00	Washer 2BA Shakeproof
121	220-0719-00	Nut 8BA (HALF)
122	220 0718 00	Nut 8BA (FULL)
123	220-0717-00	Nut 6BA (HALF)
124	220-0716-00	Nut 6BA (FULL)
128	220-0693-00	Nut (Angle)
129	213-0280-00	Screw 6BA Nylon
131	220-0720-00	Nut 6BA Nylon

VIEW SHOWING BATTERY HOLDER SYSTEMS

BATT HOLDER
PT No 352 0382 00
F/BY SCREW 6 BA
PT No 220 071700
SHAKEPROOF WASHER
PT No 210 121000

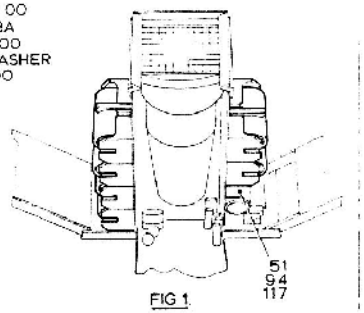


FIG 1.

SHOWING BATT MOUNTING 1

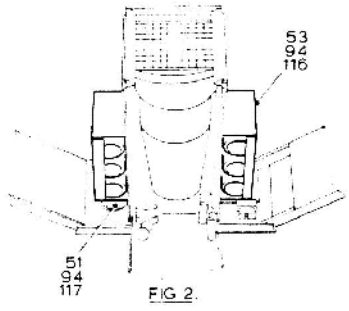
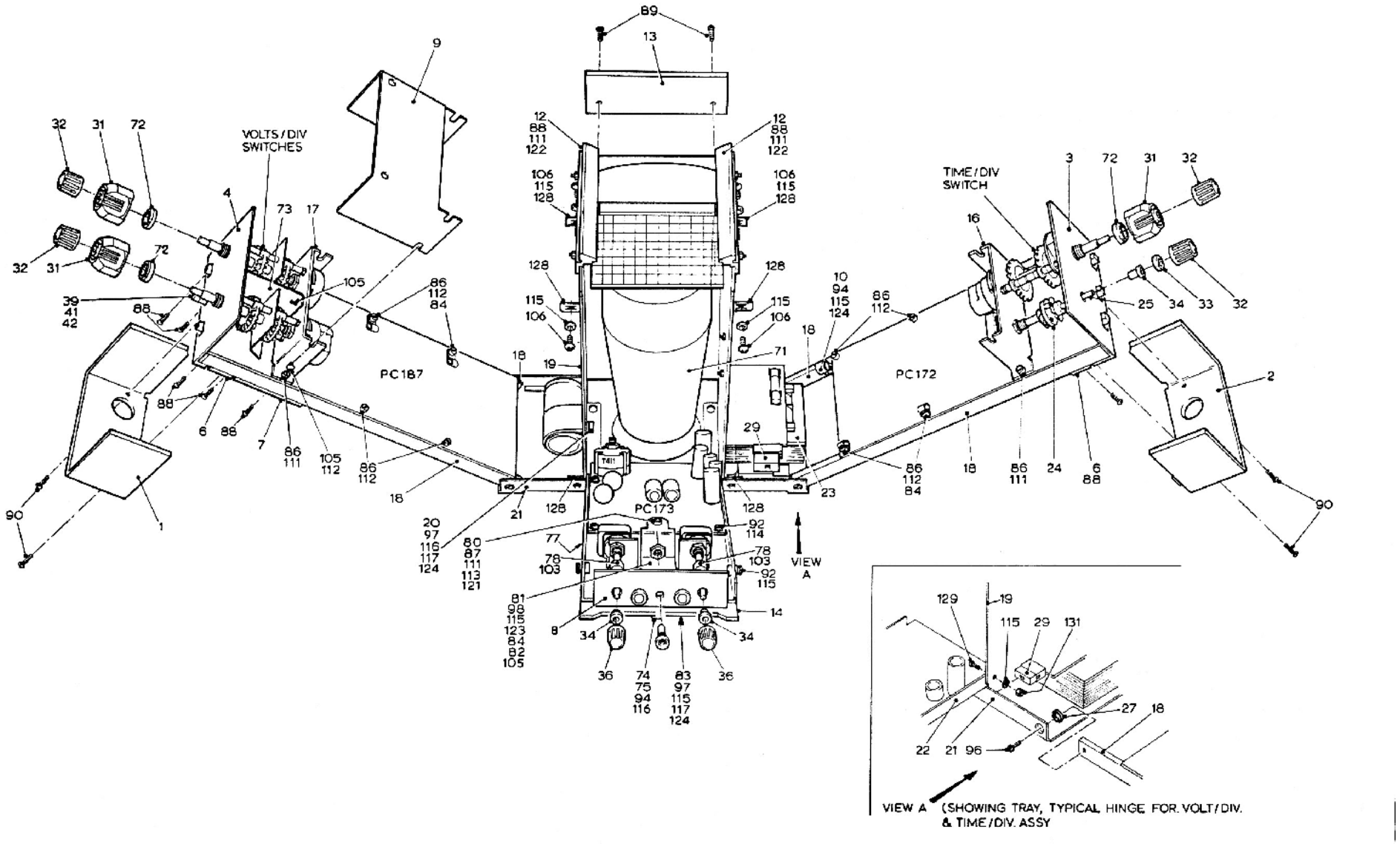


FIG 2.

SHOWING BATT MOUNTING 2

FIG 3 SHOWING
POWER SOCKET
(PL 401)
PT No 134013500

FIG 4 POWER SKT
ITEM 47 (PL 401)


VOLTS/DIV SWITCHES
TIME/DIV SWITCH
PC187
PC172
PC173
VIEW A
VIEW A (SHOWING TRAY, TYPICAL HINGE FOR VOLT/DIV. & TIME/DIV. ASSY

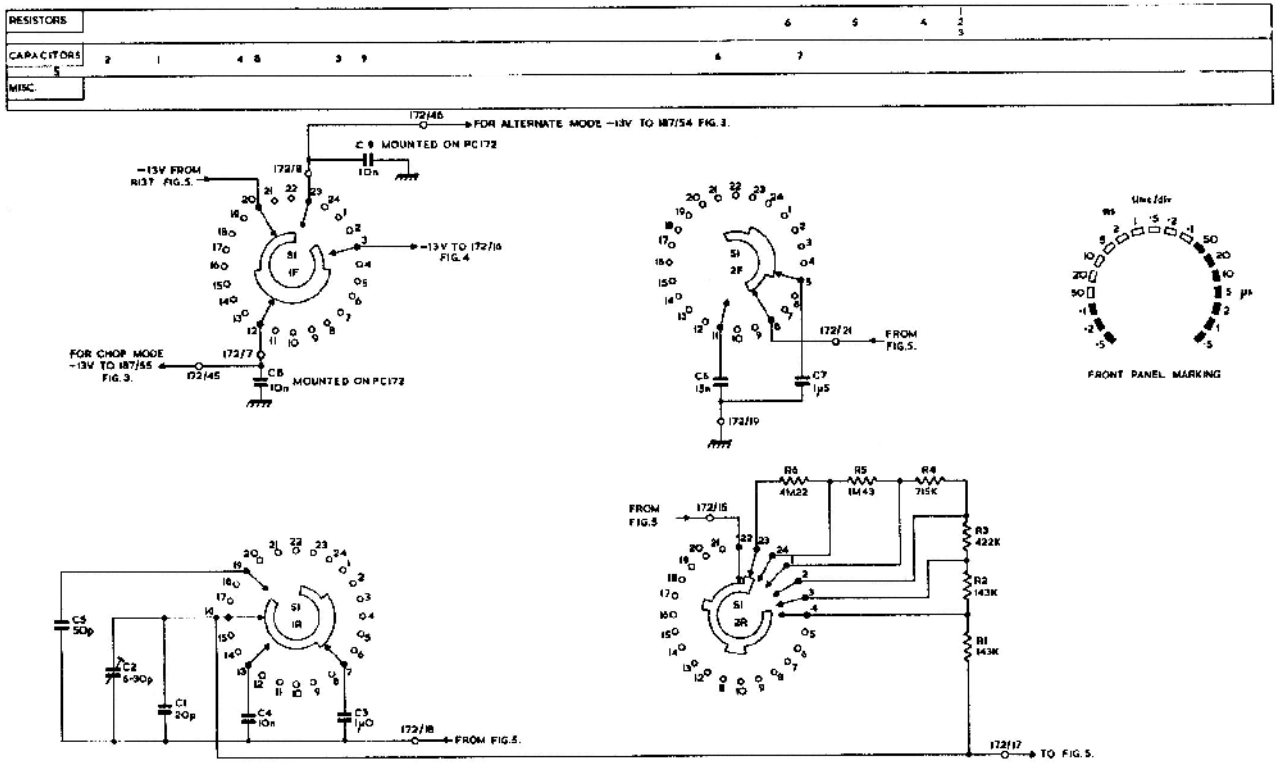
CHAPTER 6
CIRCUIT DIAGRAMS

To minimize the risk of misinterpretation of component values on circuit diagrams, the decimal point has been replaced by the multiplier or sub-multiplier of the basic unit. For instance, 2.2 megohms is shown as 2M2 and 1.8 picofarads is shown as 1p8.

To aid the reader further, in addition to the block Circuit Reference Table in Chapter 5, to locate a component in the circuit diagrams, a table is provided at the top of each circuit diagram, in which the circuit reference will appear, where practicable, directly above the component being sought.

Each figure shows the appropriate Printed Circuit Board for the particular circuitry but the table below gives a complete quick reference guide to that information.

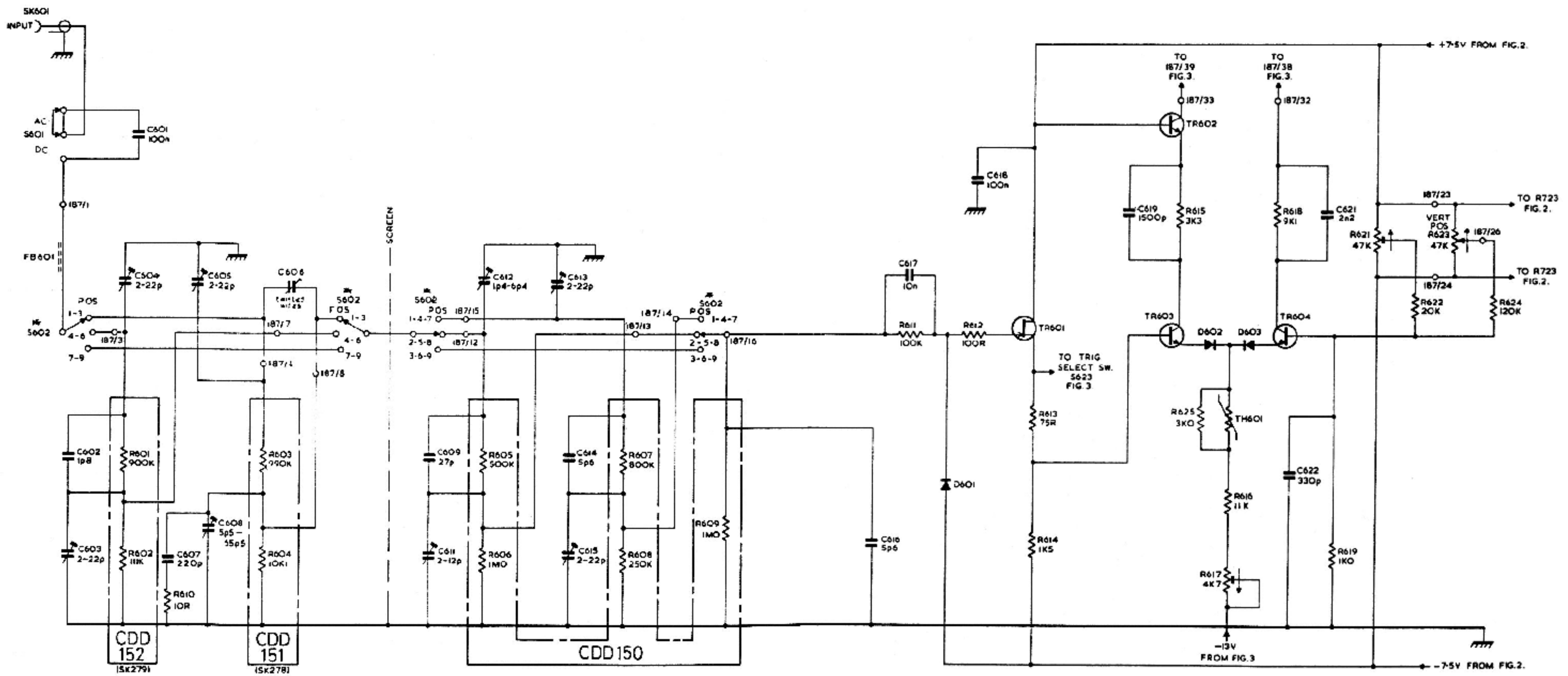
FIGURE	CIRCUIT(s)	P.C. BOARD
1	Channel 1 Input Stage	187
2	Channel 2 Input Stage	187
3	Y Output and Chop — Alternate Bistable	187
4	Trigger	172
5	Sweep Generator, Unblanking and X Amp	172
6	Calibrator and CRT	173
7	Battery Charger and Power Supply	173 178



NOTES.
1. SWITCH IS SHOWN IN FULLY ANTI-CLOCKWISE POSITION.
2. No. OF POSITIONS 12.

D32 TIME / DIV SWITCH FIG. 8

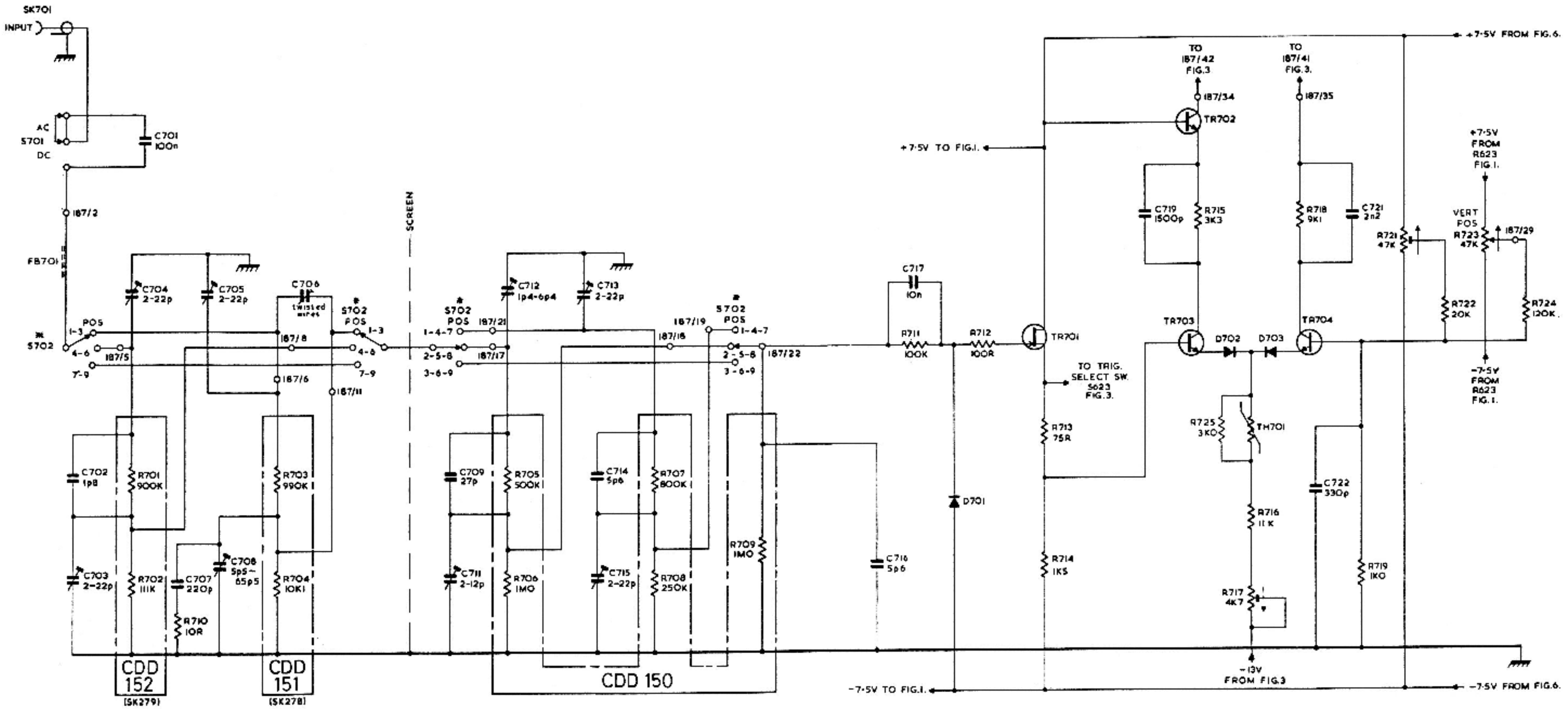
RESISTORS	601 602 610 603 604 605 606 607 608 609 611 612 613 614 615 625 616 617 618 619 621 622 623 624
CAPACITORS	602 603 601 604 607 605 608 606 609 611 612 613 614 615 616 617 618 619 622 621
MISC.	S601 SK601 FB601 S602 D601 TR601 TR602 TR603 D602 TH601 D603 TR604



NOTES
1. 187/1 DENOTES P.C. BOARD/EYELET OR TERMINAL No CONNECTOR.
2. * DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD.

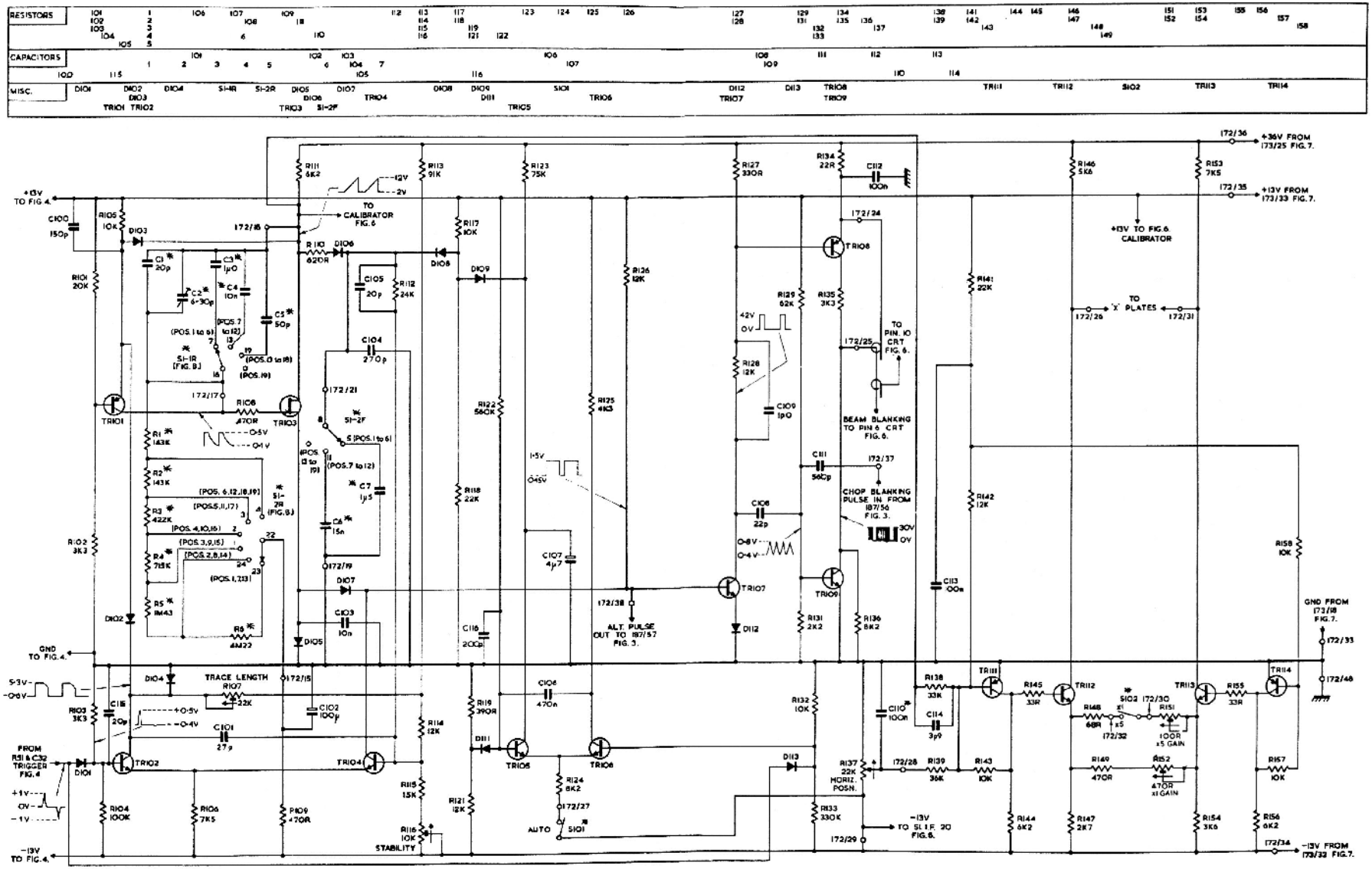
CHANNEL I INPUT STAGE D32
PC 187 FIG.1.

RESISTORS	701 702 710 703 704 705 706 707 708 709 711 712 713 714 715 716 717 718 719 721 722 723 724 725
CAPACITORS	702 703 704 701 705 707 708 706 709 711 712 713 714 715 716 717 719 722 721
MISC.	S701 SK701 FB701 S702 D701 TR701 TR702 TR703 D702 D703 TH701 TR704



NOTES
1. 187/1 DENOTES P.C. BOARD/EYELET OR TERMINAL No. CONNECTOR.
2. ✱ DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD.

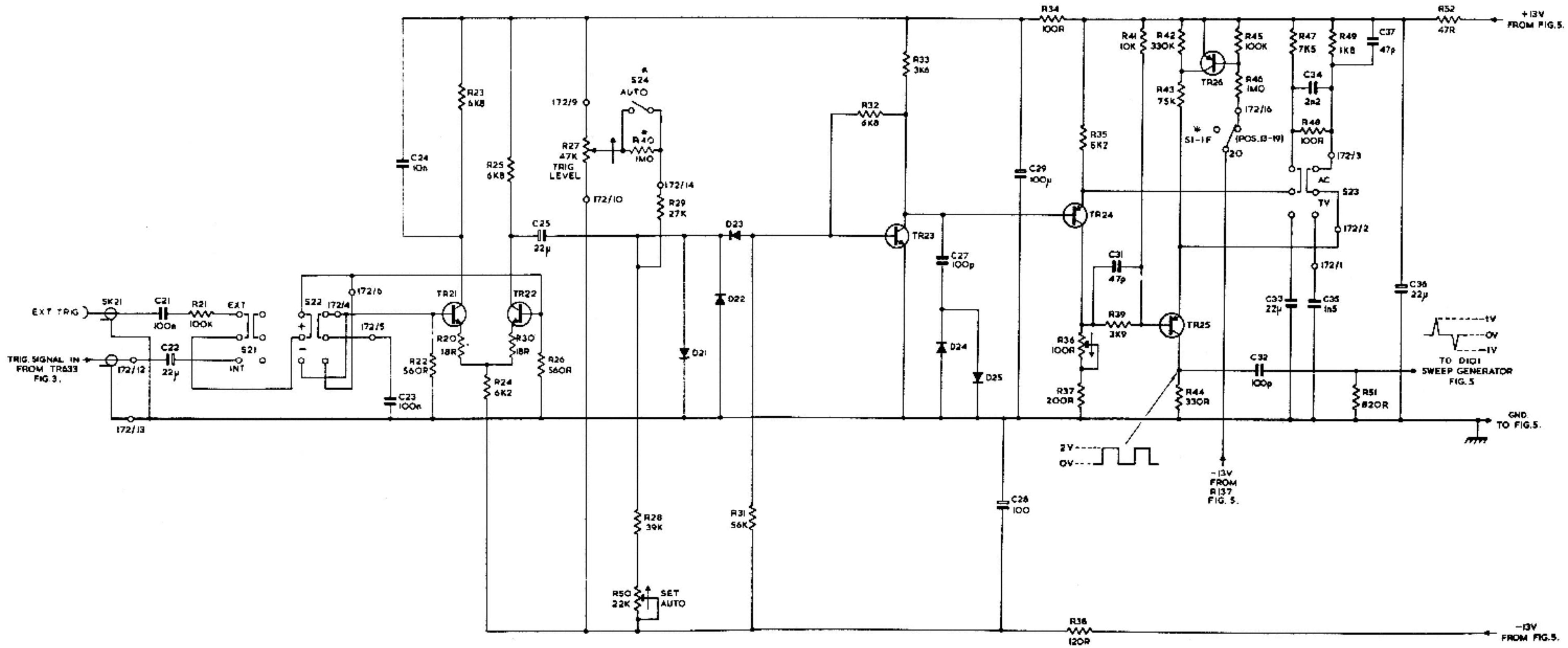
CHANNEL II INPUT STAGE D32
PC187 FIG. 2



NOTES
1. * DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD.
2. 172/ DENOTES P.C. BOARD EYELET OR TERMINAL No. CONNECTION.

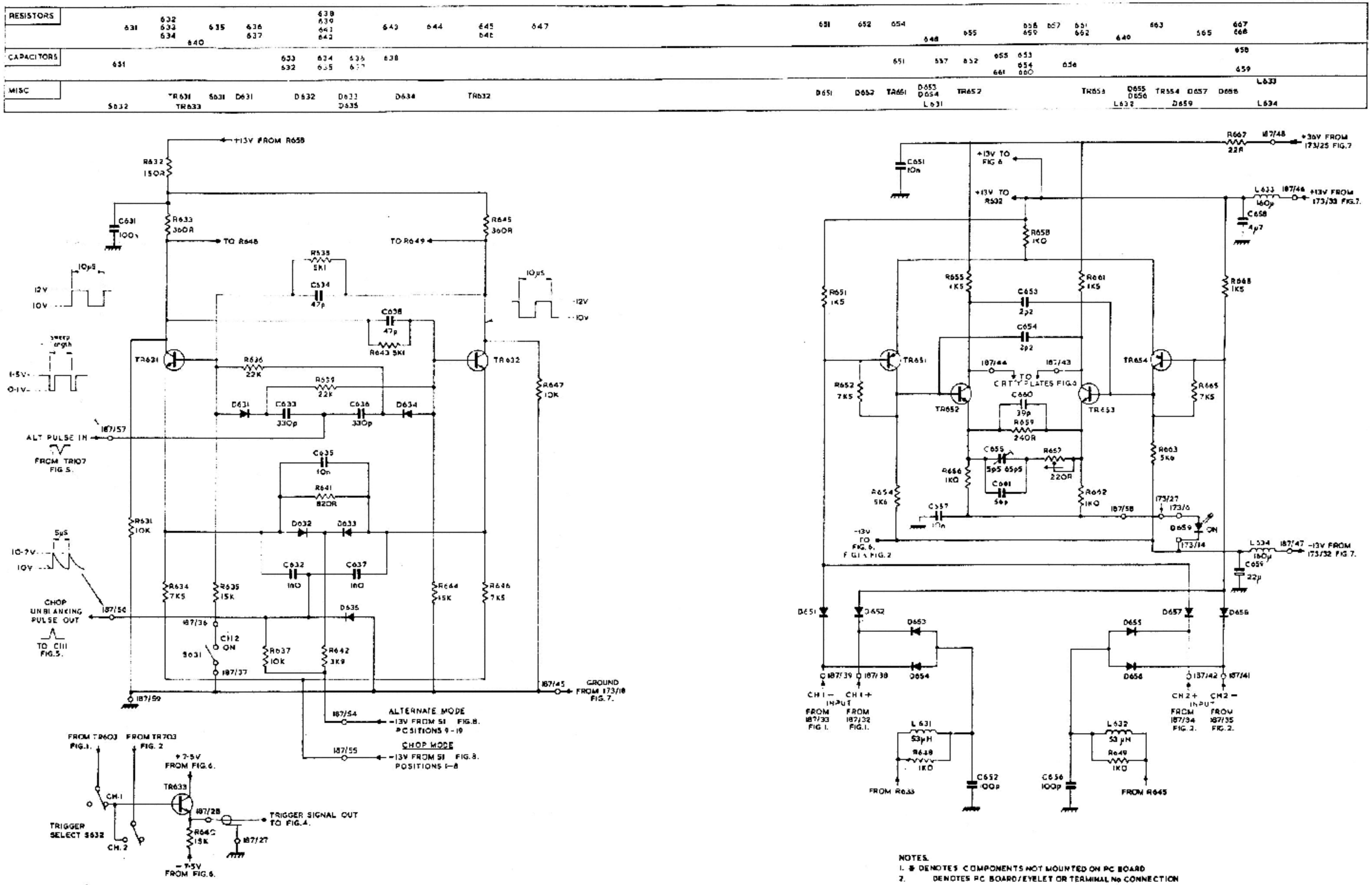
D32 SWEEP GENERATOR. UNBLANKING & 'X' AMP — P.C.172
FIG. 5.

RESISTORS	21 22 23 24 20 26 25 30 27 28 50 40 29 31 32 33 34 35 36 37 38 39 41 42 43 44 45 46 47 48 49 51 52
CAPACITORS	21 22 23 24 25 26 27 28 29 31 32 33 34 35 37 36
MISC.	SK21 SK22 S21 S22 TR21 TR22 S24 D21 D22 D23 TR23 D24 D25 TR24 TR25 TR26 S1-2F S23



NOTES.
1. ✻ DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD.
2. 172/6 DENOTES P.C. BOARD EYELET OR TERMINAL No. CONNECTION.

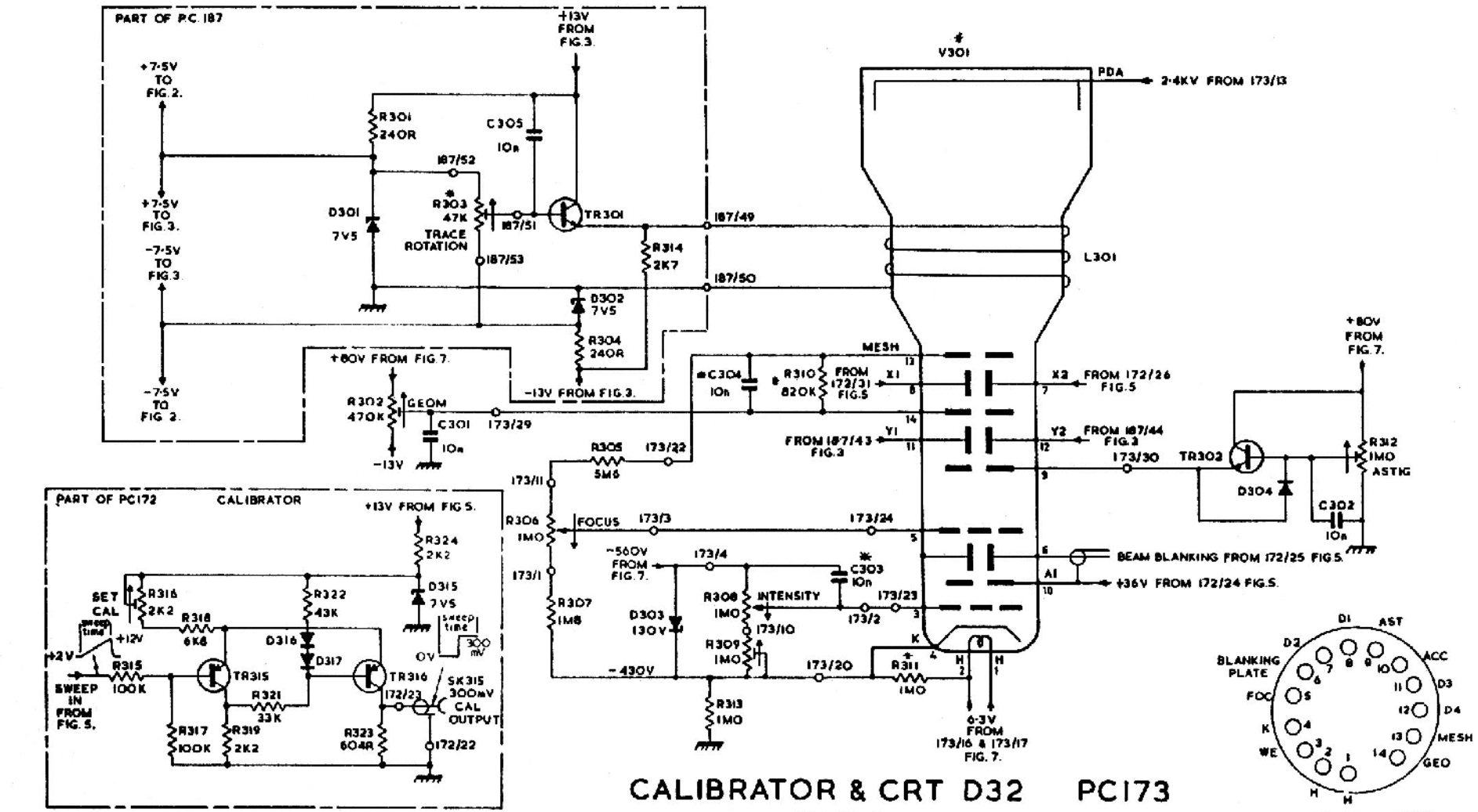
D32 TRIGGER CIRCUIT – P.C.172.
FIG. 4



NOTES.
1. ✱ DENOTES COMPONENTS NOT MOUNTED ON PC BOARD
2. ○ DENOTES PC BOARD/EYELET OR TERMINAL No CONNECTION

Y-OUTPUT & CHOP-ALTERNATE BISTABLE D32
(PC187) FIG. 3

RESISTORS	315 316 317 318 319 321 322 301 302 323 324 303 305 306 304 307 314 313 308 309 310 311 312
CAPACITORS	301 305 304 303 302
MISC	TR315 D316 D317 D301 TR316 TR301 D303 ~~V301~~ TR302 D304



CALIBRATOR & CRT D32 PC173

FIG. 6

NOTES.

1. # DENOTES COMPONENTS NOT MOUNTED ON PC BOARD
2. 173/29 DENOTES PC BOARD/EYELET OR TERMINAL No CONNECTION

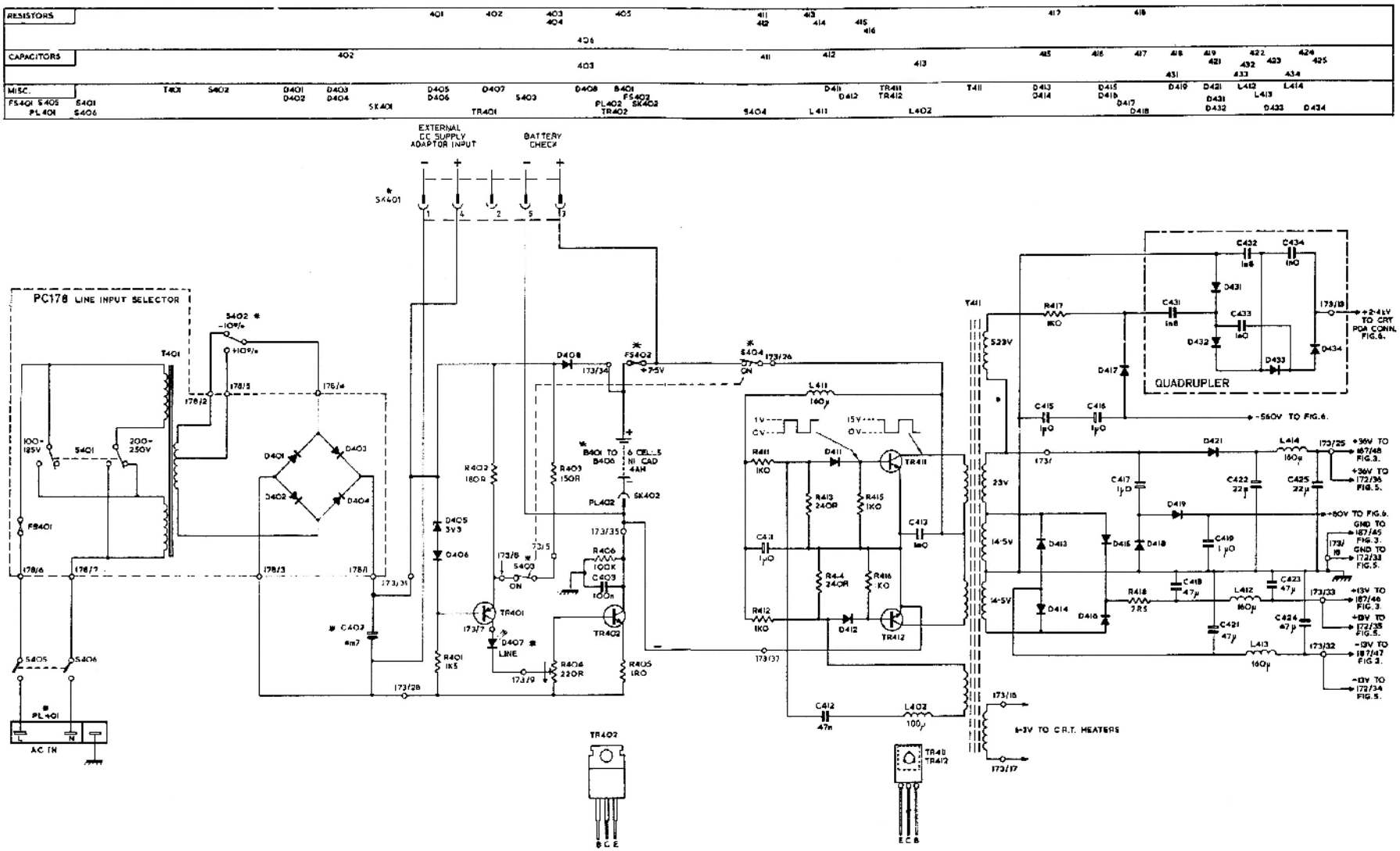


FIG. 7

NOTES.

L * DENOTES COMPONENTS NOT MOUNTED ON PC BOARDS

173/31 DENOTES PC BOARD/EYELET OR TERMINAL No CONNECTION