



®

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 after switching off and before touching any internal parts, the EHT should be discharged by temporarily shorting the appropriate points to chassis, (for instance the CRT cathode pin and PDA connector where applicable).

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

TELEQUIPMENT is a registered trade mark of TEKTRONIX U.K. LTD.

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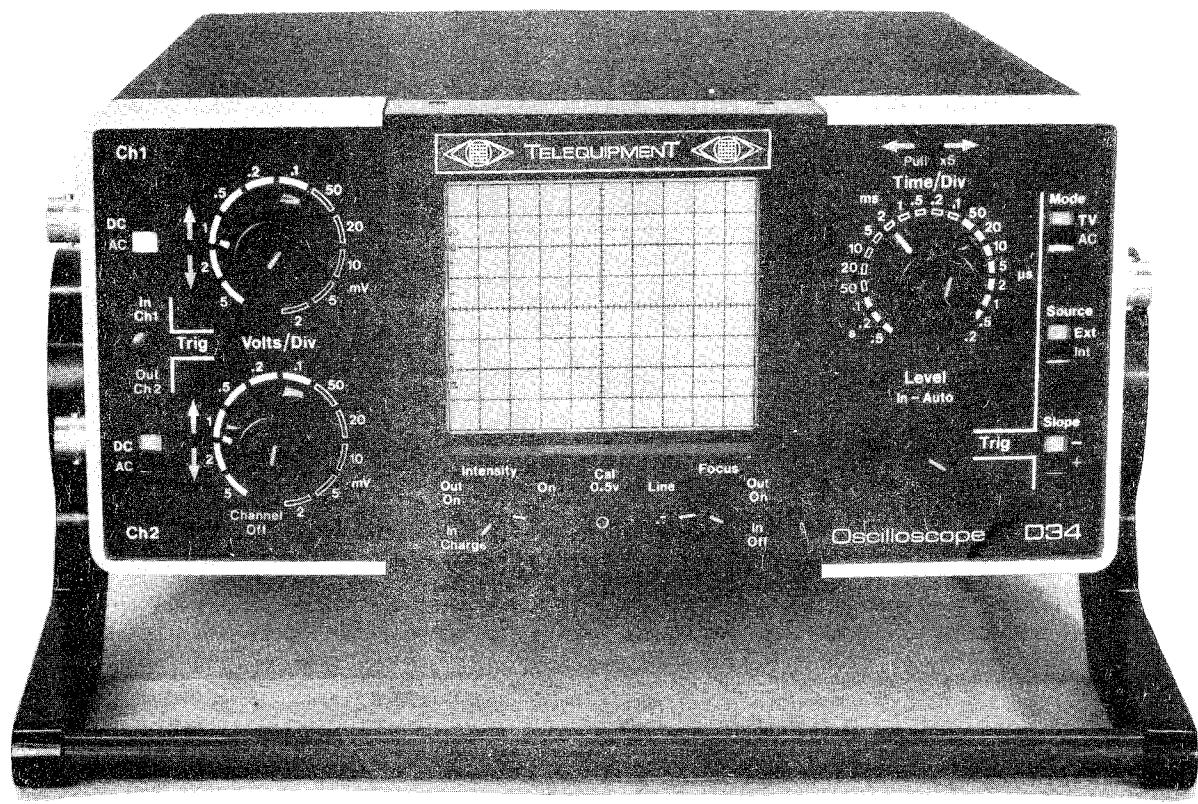
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OSCILLOSCOPE TYPE D34

INSTRUCTION MANUAL



INTRODUCTION

The D34 is a portable, mains or battery operated, 15 MHz solid state dual trace oscilloscope. FET input circuitry is used for minimum drift and fast stabilisation time, and the high-brightness CRT with a 5cm x 6.3cm face has an inbuilt graticule to avoid parallax on display. The two vertical amplifiers have a common signal delay circuit, and both channels can be displayed in either the alternate or the chop mode. Channel 1 can be displayed separately.

The design of this instrument is subject to continuous development and improvement, consequently minor changes from the information contained herein may be incorporated.

These changes which usually affect the Components Lists and Circuit Diagrams are described on Amendment Lists issued at regular intervals between manual reprints. Any Amendment List appertaining to this Manual is located in the pocket provided inside the back cover of this manual.

In addition to the standard instrument, variations known as Options are available and are listed in Section 7 of this Manual.

NOTICE TO OWNER

To lessen the risk of damage during transit and to facilitate packaging, the owner is requested NOT to send the following items unless they are suspect, if this instrument is returned for servicing.

Probe

Plug Assemblies



D34 – Betjeningsanvisning

For å hjelpe Dem med førstegangsbruk av dette oscilloskopet, anbefaler vi følgende fremgangsmåte:

1. Still alle glidevendere (slide switches) i nederste stilling – (↓).
(Trig selector, CH1)
2. Trykk inn (Level control, til Auto)
(Horizontal position)
3. Slå på oscilloskopet ved å dra ut Intensity control.
(Hvis oscilloskopet er koblet til lysnettet, trekker De ut Focus kontrollknappen).
4. Skru Intensity til maksimum (til høyre).



TELEQUIPMENT TYPE D34 OPERATING INSTRUCTIONS

To obtain a trace quickly and easily we suggest you try the following procedure.

1. Put all slide switches down (↓).
(TRIG selector (CH1)).
2. Push in (LEVEL control to AUTO).
(↔ Horizontal position).
3. Switch on by pulling the INTENSITY control. (If connected to an AC line pull FOCUS control out).
4. Turn INTENSITY to maximum (fully clockwise). →

TELEQUIPMENT TYPE D34 BEDIENINGSVOORSCHRIFT

Om snel en eenvoudig een tijd-as te verkrijgen s.v.p. de volgende procedure volgen.

1. Plaats alle schuifschakelaars in de onderste stand.
2. Druk de volgende schakelaars in:
(TRIGGER SELECTOR (CH1)
(NIVEAU regeling (LEVEL control)
(naar automatisch
(HORIZONTAAL (position)
3. Instrument inschakelen door INTENSITEITS controle schakelaar uit te trekken.
(Als het instrument met het net verbonden is, de FOCUS potmeter uittrekken).
4. Zet INTENSITEIT op maximum (rechtsom). →

D34 BEDIENUNGSKARTE

Diese Bedienungskarte soll bei der Inbetriebnahme des Gerätes eine kleine Hilfestellung geben. Beachten Sie bitte folgende Punkte:

1. Setzen Sie alle Kippschalter nach unten (↓).
2. Drücken Sie:
(TRIG (auf CH1)
(LEVEL (auf AUTO)
(↔ Horizontaler Einsteller
3. Schalten Sie das Gerät ein, indem Sie das Bedienelement INTENSITY ziehen. (bei Netzbetrieb muß der Knopf FOCUS gezogen werden).
4. Wählen Sie die höchste Helligkeit (INTENSITY auf Rechtsanschlag). →

D34 HANDLEDNING

För att hjälpa Er när Ni första gången ska använda Ert oscilloskop föreslår vi att Ni följer nedanstående punkter.

1. Ställ samtliga switchar i läge ner.
2. Tryck in knapperna TRIG, LEVEL och PULL x 5.
3. Slå på oscilloskopet genom att dra ut ratten märkt INTENSITY. (Om oscilloskopet är anslutet till nätet drag även ut ratten märkt FOCUS).
4. Vrid ratten INTENSITY max medurs.



TELEQUIPMENT MODELO D34 INSTUCCIONES DE MANEJO DEL OSCILOSCOPIO

Para obtener fácil y rápidamente el trazo, sugerimos el siguiente procedimiento:

1. Poner todos los comutadores hacia abajo.
2. Pulsar (El selector de TRIG a (CH1) hacia dentro (El desplazamiento horizontal (horizontal position ↔))
3. Tirar hacia fuera del control INTENSITY para poner en marcha el osciloscopio. (Si está conectado a una línea de A.C. tirar hacia fuera el control de enfoque FOCUS).
4. Girar totalmente en sentido de las agujas del reloj el control INTENSITY (máximo brillo). →

TELEQUIPMENT Modello D34 Istruzioni per l'uso

Per ottenere una traccia rapidamente e facilmente-Vi consigliamo di seguire la seguente procedura:

1. Posizionare verso il basso tutti gli interruttori a slitta (↓).
2. Premere (il pulsante TRIG
(il comando LEVEL in AUTO)
(il comando posizione orizzontale (↔))
3. Accendere lo strumento tirando il comando INTENSITY (Se collegato alla rete c.a. tirare anche il comando FOCUS).
4. Ruotare completamente l'INTENSITY (in senso orario). →



D34

START INSTRUKTION

For at lette forståelsen og første start af instrumentet, anbefaler vi nedenstående procedure:

1. Skub alle skydeomskiftere i deres nederste position.
2. Indtryk TRIG-knappen (til stillingen CH1) og LEVEL-knappen (til stillingen AUTO) og HORIZONTAL-knappen.
3. Tænd instrumentet ved at trække ud i INTENSITY-kontrolen. Hvis instrumentet er tilsluttet lysnettet, træk også FOCUS-kontrolle ud.
4. Drej INTENSITY helt op (med uret). →



O

TELEQUIPMENT TIPO D34 INSTRUÇÕES DE OPERAÇÃO

Para obter com facilidade e rapidez o traço no osciloscópio sugerimos o seguinte procedimento:

- 1.. Coloque todos os comutadores na posição mais baixa (↓).
2. Carregue (Selector "TRIG" (CH1) nos (Controle "LEVEL" para AUTO) Comandos (Posição horizontal (↔))
3. Ligue a alimentação puxando o controle INTENSITY (se estiver ligado à alimentação AC puxe também o controle de focagem "FOCUS").
4. Rode o controle INTENSITY para o máximo (no sentido dos ponteiros do relógio). →



5. Skru Vertical (\downarrow) og Horizontal (\leftrightarrow) posisjonskontrollene slik at orange-merkene blir vertikale.
6. Juster Intensity og Focus-kontrollene slik at De får en fokusert stråle med passende intensitet.
7. Juster Trace Rotate (på instrumentets baksiden) slik at strålen blir horisontal.
8. Koble til et signal til CH1-inngangen og velg en passende følsomhet Volts/div. og tidsbase Time/div., slik at De får en kurve som står stille og som har passende høyde og bredde.

5. Turn \downarrow (Vertical) and \leftrightarrow (Horizontal) position controls so that the orange marks are vertical.
6. Adjust INTENSITY and FOCUS controls for a focussed line(s) of suitable intensity.
7. Adjust TRACE ROTATE (situated on the rear panel) for horizontal line(s).
8. Connect an input signal to CH1 INPUT and select the appropriate VOLTS/DIV and TIME/DIV positions to give a locked trace of convenient signal amplitude and width.

5. Placer les réglages de position (\downarrow) à mi-course (repères oranges verticaux).
6. Réglér les commandes d'intensité 'INTENSITY' et de focalisation 'FOCUS' pour obtenir une représentation satisfaisante.
7. Régler l'alignement horizontal de la trace à l'aide de la commande 'TRACE ROTATE' (à l'arrière de l'appareil).
8. Connecter un signal à l'entrée Voie 1 (CH1) et choisir le facteur de déflexion (Volts/Div) et la vitesse de balayage (Time/Div) permettant d'obtenir une représentation stable, d'amplitude et de largeur satisfaisantes.

5. Zet de (Horizontale) en (Verticale) positie-knoppen zo dat de oranje merktekens verticaal staan.
6. Zet INTENSITEIT en FOCUS instelling voor een heldere goed gefocuseerde lijn.
7. Zet TRACE ROTATE (op achterzijde) zo dat de lijn parallel is aan het raster.
8. Verbind het te meten signaal met de KANAAL 1 (CH1) INGANG en zet de VOLT/DIV en TIME/DIV posities voor een gemakkelijk afleesbaar signaal in hoogte en breedte.

5. Ruotare i comandi per la posizione verticale (\downarrow) ed orizzontale (\leftrightarrow) in modo che i riferimenti arancioni siano verticali.
6. Regolare i controlli INTENSITY e FOCUS per avere una traccia focalizzata della voluta intensità.
7. Regolare il TRACE ROTATE (posto sul pannello posteriore) per allineare la traccia con le linee del reticolato.
8. Collegare un segnale di ingresso al CH1 INPUT e scegliere le appropriate posizioni dei comandi VOLTS/DIV e TIME/DIV per ottenere una traccia della voluta ampiezza e durata.

5. Stellen Sie die \downarrow vertikalen und \leftrightarrow horizontalen Lageeinsteller so ein, daß die orangefarbigen Markierungsstriche senkrecht stehen.
6. Stellen Sie mit Hilfe der Bedienungselemente INTENSITY und FOCUS einen gut fokussierten Abienstrahl mit ausreichender Helligkeit ein.
7. Benutzen Sie, falls notwendig, das Justierelement TRACE ROTATE (Rückwand) dazu, die Strahlspur parallel zu den horizontalen Rasterlinien auszurichten.
8. Schließen Sie ein Signal an den Eingang CH1 INPUT und wählen Sie mit Hilfe der Stufenschalter VOLTS/DIV und TIME/DIV den entsprechenden Spannungs- und Zeitbereich.

5. Drei VERTIKAL og HORIZONTAL positionskontrollerne, så de orange mærker står lodret.
6. Juster INTENSITY OG FOCUS kontrollerne til et skarpt spor med rimeligt lys.
7. Juster TRACE ROTATE (på bagpanelet), så sporene er vandrette.
8. Tilslut et indgangssignal til CH1 input. Stil VOLT/DIV. til passende signalstørrelse og TIME/DIV. til passende bredde på signalet.

5. Vrid rattarna för vertikala \downarrow och horisontala \leftrightarrow positionerna så att den orangefärgade markeringen är lodrät (från centrum och uppåt).
6. Justera ljusstyrkan och skärpan i strålarna med rattarna INTENSITY och FOCUS till lämpligt värde.
7. Justera ratten TRACE TILT som finns på baksidan av oscilloskopet så att strålarna blir parallella med rutnätet.
8. Anslut signalen som ska mäts till ingången CH1 och ställ in storleken på signalet med omkopplaren VOLTS/DIV samt sveptiden med omkopplaren TIME/DIV.

5. Rode os controlos de posição vertical (\downarrow) e horizontal (\leftrightarrow) de forma a que as marcas laranja fiquem verticais.
6. Ajuste os controlos INTENSITY e FOCUS de forma a obter uma linha bem focada e com intensidade desejada.
7. Ajuste o controle TRACE ROTATE (situado no painel traseiro) de forma a obter uma linha horizontal.
8. Ligue um sinal à entrada CH1 INPUT e selecione os comutadores VOLTS/DIV e TIME/DIV de forma a representar o sinal com as amplitudes e largura convenientes.

5. Mover los controles de desplazamiento vertical y horizontal de forma que las marcas de color maranja queden verticales.
6. Ajustar los controles INTENSITY y FOCUS para obtener una buena definición del trazo con una intensidad moderada.
7. Ajustar la alineación horizontal del trazo 'TRACE ROTATE', situado en el panel posterior de forma que éste coincida con las líneas horizontales de la graticula.
8. Conectar una señal de entrada al 'CH1 INPUT' y seleccionar apropiadamente las posiciones de los mandos VOLTS/DIV. y TIME/DIV. hasta obtener un trazo fijo con la conveniente amplitud y anchura.

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Amendment Lists containing change information if any, are located in the pocket at the rear of the manual

SECTION 1

SPECIFICATION

1.1 CATHODE RAY TUBE (CRT)

Display area
Phosphor
Overall accelerating potential

Rectangular flat faced CRT with mesh screen.
10 x 8 divisions (each division = 0.65 cm)
P31
9.5 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
AC
Signal Delay

DC — 15 MHz
3 Hz — 15 MHz
Enables the leading edges of waveforms to be inspected.

1.2.3 VERTICAL DEFLECTION

Calibrated (11 ranges 1.2.5 sequence)
Input impedance
Max. input voltage

2 mV/div — 5 V \pm 5% except 1st and 8th vertical div = \pm 7½%
 $1 M\Omega$ in parallel with 25 pF.
 \pm 250 V peak

1.3 HORIZONTAL DEFLECTION

1.3.1 SWEEP RATES (20 ranges in 1, 2, 5 sequence)

X1
X5

500 ms/div — 0.2 μ s div \pm 5%
100 ms/div — 100 ns/div \pm 7% 40 ns/div \pm 10%

1.3.2 TRIGGER

Level

Fully variable over 8 divisions on all waveforms.

Auto

Bright light in absence of trigger signal, automatic trigger on symmetrical 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 μ s/div.

Source

CH1, CH2 or external. All positive or negative.

Sensitivity

Internal
40 Hz — 2 MHz
2 MHz — 15 MHz

0.3 div Level and Auto Trigger. Generally 0.3 div rising to 0.4 at 40Hz.
1 div. Level Trigger.

External

40 Hz — 5 MHz
5 MHz — 15 MHz

100 mV approx.
300 mV

1.4 CAL OUTPUT SOCKET

Output Voltage
Output Impedance
Wave Shape

+ 500 mV \pm 1%
 600Ω
Vertical edge at screen centre — positive with respect to earth.

1.5 GENERAL

1.5.1 POWER REQUIREMENTS

Internal rechargeable battery	6 x 1.25 V ('D' CELLS)
Voltage	4 hours approximately continuous use.
Battery life	Built-in charger fully charges the batteries in 14 hours with the instrument switched off, or trickle charges the batteries if the instrument is switched on.
Mains	
Voltage	100 -- 112 V External Battery Adaptor 112 -- 125 V Input Voltage 12 - 30V DC @ 1 200 -- 224 V Out put Voltage 11v DC 225 -- 250 V
Frequency	50 -- 400 Hz
Consumption	14 VA

1.5.2 SIZE

Height (stand retracted)	106 mm
Width	240 mm
Depth	337 mm

1.5.3 WEIGHT

5.5 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
Cover front protection	1	437-0171-00
Manual	1	070-2089-00

1.7 ACCESSORIES AVAILABLE AS EXTRAS

ACCESSORY	PART NUMBER (for ordering)
Allen key 1.5 mm A/F	131-0649-00
BNC connector plug	016-0499-00
Carrying case	016-0619-00
Carrying case (attache style)	012-0571-00
Calibration lead	110-0766-00
External Battery adaptor	
Probe type TP2 (X10 attenuator)	
cable length 1.5 metres (approx)	010-0270-00
cable length 2 metres (approx)	010-0270-02

IMPORTANT NOTICE

It is recommended that the specification limits of this instrument be checked periodically according to the Calibration Procedure, as temperature, humidity, and long-term ageing could affect the measurement accuracy. This is particularly important before making critical measurements.

with a VOLTS/DIV setting of 200 mV and the probe attenuation factor is X1

$$\therefore \text{Instantaneous voltage} = \text{Vertical distance} \times \text{Polarity} \times \text{VOLTS/DIV (Setting)} \times \text{Probe Attenuator factor}$$

For the values given

$$\text{Instantaneous voltage} = 2.7 \times 1 \times 0.2 \times 1$$

$$\therefore \text{Instantaneous voltage} = 0.54 \text{ Volts}$$

2.8.5 INSTANTANEOUS VOLTAGE MEASUREMENT WITH REFERENCE TO A DC VOLTAGE

Proceed as in 2.8.4 but in step (6) set the switch to DC and feed in the reference voltage to the input. Step 8 will be to remove the reference voltage.

2.8.6 TIME DURATION MEASUREMENT

1. Connect the waveform to be measured, to CH1 or CH2 INPUT.
2. Set the VOLTS/DIV switch to display a suitable vertical amplitude of the waveform.
3. Set the TIME/DIV and LEVEL controls to display the appropriate portion of the waveform to be measured over the maximum number of horizontal graticule divisions possible, keeping well inside the graticule limits.
4. Use the Y POSITION control to move the trace so that the measurement points are on the horizontal centre line.
5. The X POSITION control is used to move the start of the measurement period to a convenient reference point.
6. Measure the distance (divs) between the measurement points.
7. Multiply the measurement in 6 above by the setting of the TIME/DIV switch and if the X5 control is used to divide by 5. This gives the time duration.

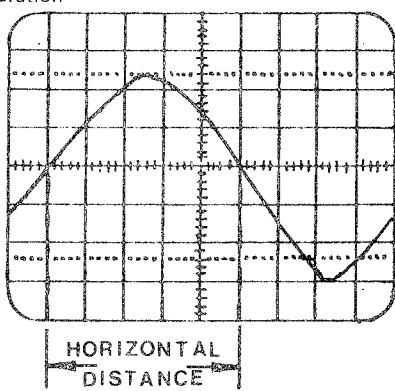
EXAMPLE

If the distance between the points is 2.5 divisions with the TIME/DIV control on 0.2ms/div and the magnifier is not used,

$$\text{Time duration} = \frac{\text{horizontal distance (divisions)}}{\text{TIME/DIV setting}}$$

$$\therefore \text{Time duration} = 2.5 \times 0.2 \text{ ms}$$

$$\therefore \text{Time duration} = 0.5 \text{ ms}$$



Measuring the Time Duration between points on a Waveform

2.8.7 FREQUENCY MEASUREMENT

The time duration technique shown in 2.8.6 can be used to establish the frequency of a periodically recurrent waveform. The start of two adjacent cycles is taken as the measurement points and the time duration between these points established. The frequency is the reciprocal of the time duration.

EXAMPLE

If one cycle occupies 5 divisions with the time division control on 0.2 ms/div and the X5 magnifier is used

$$\begin{array}{lcl} \text{Time duration} & = & \frac{\text{Horizontal Distance}}{\text{TIME/DIV (setting)}} \\ & & \times \text{Magnification} \end{array}$$

for the example

$$\begin{aligned} \text{Time duration} &= \frac{5 \times 0.2 \text{ ms}}{5} \\ &= 0.2 \text{ ms} \end{aligned}$$

$$\begin{aligned} \text{Frequency} &= \frac{1}{\text{Time duration}} \\ &= \frac{1}{0.2 \times 10^{-3}} \\ &= 5 \text{ kHz} \end{aligned}$$

2.8.8 RISE TIME MEASUREMENTS

Rise time measurements employ the same basic techniques as time duration measurements. Rise time t_r is the time required by the leading edge of a waveform to rise from 10% to 90% of the waveform amplitude. The procedure is as follows:

1. Connect the waveform to either input.
2. Set the AC/DC switch of the channel being used to the appropriate position.
3. Set the appropriate VOLTS/DIV switch to display 4 to 8 divisions amplitude.
4. Centre the display about the centre horizontal line.
5. Set the trigger controls to obtain a stable display.
6. Set the TIME/DIV switch so that the 10% and 90% points of the waveform lie within the centre 8 divisions horizontally.
7. Determine the 10% point of the waveform and use the X and Y position controls to set this point to a convenient graticule point.
8. Determine the 90% point and estimate the horizontal distance in graticule divisions between the 10% and 90% points of the waveform.
9. Multiply the distance obtained in (8) by the setting of the time divisions switch. If the sweep magnifier is used divide the result by 5. If the result is close to the rise time of the instrument it is necessary to apply a correction factor (see below).

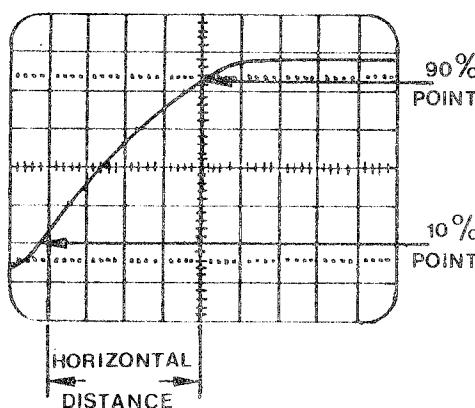
EXAMPLE

Assume that the horizontal distance between the 10% and 90% points is 5 divisions and the TIME/DIV switch is set to 100 μ s and the sweep magnifier is used,

$$\begin{array}{lcl} \text{Rise time} & = & \frac{\text{horizontal distance (divs)}}{\text{TIME/DIV setting}} \\ & & \times \text{sweep magnification} \end{array}$$

for the example

$$\begin{aligned} \text{Rise time} &= \frac{5 \times 100 \mu\text{s}}{5} \\ &= 100 \mu\text{s} \end{aligned}$$



Measuring Rise Time

SECTION 2

OPERATING INSTRUCTIONS

2.1 PRE-OPERATIONAL CHECK

Although this instrument is robust and is subjected to stringent checks before leaving the 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.

Remove the front protection cover by uncoupling the retainers from the BNC sockets and gently pulling the cover off.

as per paragraph 4.2.1. The fuse is vertically mounted towards the rear of the instrument.

A.C.LINE VOLTS	LINE SWITCH	RANGE SWITCH	INSTRUMENT FUSE
110-112	112	LO	500 mA
113-125	112	HI	500 mA
200-224	225	LO	250 mA
225-250	225	HI	250 mA

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 despatch 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 7.5 volts to 8 volts should be obtained. If no voltage reading at all is obtained the DC fuse should be checked. If the voltage is below 7.5V the batteries should be charged. If no improvement in voltage level is obtained check the cells.

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. FOCUS control should then be pulled out and the LINE indicator lamp on the front panel should glow. The instrument should be OFF. This can be checked by seeing that the INTENSITY control is pushed in so that the ON indicator lamp does not glow. After 14 hours the batteries should be fully charged.

2.3 MAINS OPERATION

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 Line
Blue. Neutral
Green/Yellow Earth

FOR SAFETY REASONS THE GND WIRE MUST BE CONNECTED, AND IF AN EXTENSION LEAD IS USED - APPROPRIATE RATED INSULATION MUST BE PROVIDED.

Two voltage selector switches are provided, on the rear panel, which 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 alternate 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 rear cover

Two voltage selector switches are provided on the rear. Having carefully checked the fuse rating and voltage selector switch positions, refit the rear cover. The instrument can be plugged into the mains supply. Pull out FOCUS control; LINE indicator lamp should glow. 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 mains 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 11 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 20 calibrated steps in the range 500 ms/division to 0.2 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 40ns/division.
X POSITION	The X POSITION control uses the same knob as the speed magnifier. When it is rotated it moves the trace on the 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 μ s/division to 0.2 μ s/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 } 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 0.5 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 0.1 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	This 5 pin DIN socket has a dual function. Two connections are used to enable the state of charge of the internal batteries to be determined. Two other connections are used to enable the instrument to be operated from an external DC supply via an external battery adaptor (part number 119-0766-00).

2.6 FIRST TIME OPERATION

2.6.1 SETTING THE CONTROLS

Set the front panel controls as follows:-

INTENSITY Fully anti-clockwise and click OFF

FOCUS	Central
CH1 }	VOLTS/DIV 0.05 V
CH2 }	AC/DC DC
CH1 POSITION	Central
CH2 POSITION	Fully anti-clockwise and click off.
TRIG. BUTTON	In
TIME/DIV	50 μ s
X POSITION	In and central
LEVEL	In and central
MODE	AC
SOURCE	EXT.
SLOPE	+

Connect the CAL 0.5 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.

2.6.2 SWITCH ON

1. Switch on by 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 5 vertical divisions 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 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. Disconnect the CAL signal and connect a sinewave to the INPUT. 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

This control has been used 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 μ s/div to 0.2 μ s/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 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 D34. Only outline procedures are given to allow the user to adapt the method to individual requirements. Familiarity with the controls of the instrument as outlined in 2.4, 2.5 and 2.6 should allow these basic techniques to be applied to a wide variety of uses.

2.8.1 USE AS A MONITOR OR DISPLAY

One of the most frequent uses of an oscilloscope is as a monitor or display. By correct adjustment of the X and Y controls it is possible to display many cycles or a fraction of one cycle of a repetitive waveform. Generally it is desirable to limit the display to the centre 6 divisions vertically and in the case of a repetitive waveform to display 1 to 8 cycles within the centre 8 divisions horizontally. It is possible to use the D34 instrument in this way to inspect a waveform for slope, over or undershoot and ringing. Where it is required to compare two waveforms, such as the waveforms entering and leaving a device, it is possible to feed the two waveforms to the two channels and display them either vertically one above the other, or superimposed.

2.8.2 PEAK TO PEAK VOLTAGE MEASUREMENT

AC - Symmetrical 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. Measure the vertical deflection (v) of the signal on the screen.
7. Multiply the deflection 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.

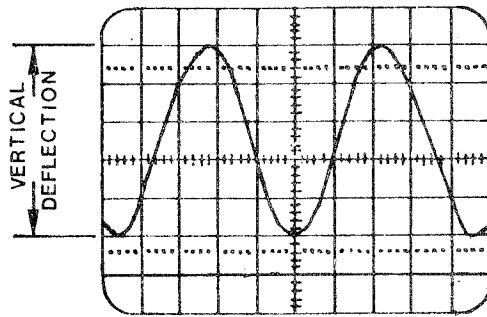
$$\therefore \text{Peak to Peak Voltage} =$$

$$\text{Vertical deflection} \times \text{VOLTS/DIV} \times \text{Attenuator factor (probe)}$$

for our example

$$\text{Peak to Peak voltage} = 5.3 \times 0.05 \times 10$$

$$\therefore \text{Peak to Peak voltage} = 2.65 \text{ Volts.}$$



Measuring Peak to Peak Voltage
of a Waveform

2.8.3 VOLTAGE MEASUREMENT BETWEEN TWO POINTS ON A WAVEFORM

Proceed as in 2.8.2 above substituting the two measurement points for the peaks and setting the lower point on one of the lower graticule lines.

2.8.4 INSTANTANEOUS VOLTAGE MEASUREMENT WITH REFERENCE TO GROUND

To make a measurement of the DC level at a specified point on a waveform use the following procedure:

1. Set the AC/DC switch of the selected channel to DC.
2. Set the TRIG switch to the channel selected.
3. Push the TRIG LEVEL control in to the AUTO position.
4. Connect the waveform to be measured to the INPUT of the selected channel.
5. If the waveform is repetitive use the TIME/DIV and X POSITION (\leftrightarrow) controls to display at least one cycle.
6. Remove the INPUT signal and short circuit the INPUT to ground.
7. Set the trace to the lowest graticule line or other suitable reference line, using the Y POSITION control, if the point to be measured is positive. Set to highest or other suitable graticule line if the point to be measured is negative. AFTER THIS DO NOT ADJUST THE Y POSITION CONTROL.
8. Remove the INPUT short circuit and reconnect the signal.
9. Measure the distance in divisions from the reference line to the point to be measured.
10. Establish the polarity of the measured voltage. If the measurement point is above the reference line the voltage is positive. If the measurement point is under the reference line it is negative.
11. Multiply the measurement in (9) above by the VOLTS/DIV switch setting and any probe attenuation factor.

EXAMPLE

Assume that the vertical distance measured is +2.7 divisions

with a VOLTS/DIV setting of 200 mV and the probe attenuation factor is X1

$$\therefore \text{Instantaneous voltage} = \frac{\text{Vertical distance}}{\text{Polarity}} \times \frac{\text{VOLTS/DIV}}{\text{(Setting)}} \times \text{Probe Attenuator factor}$$

For the values given

$$\text{Instantaneous voltage} = 2.7 \times 1 \times 0.2 \times 1$$

$$\therefore \text{Instantaneous voltage} = 0.54 \text{ Volts}$$

2.8.5 INSTANTANEOUS VOLTAGE MEASUREMENT WITH REFERENCE TO A DC VOLTAGE

Proceed as in 2.8.4 but in step (6) set the switch to DC and feed in the reference voltage to the input. Step 8 will be to remove the reference voltage.

2.8.6 TIME DURATION MEASUREMENT

1. Connect the waveform to be measured, to CH1 or CH2 INPUT.
2. Set the VOLTS/DIV switch to display a suitable vertical amplitude of the waveform.
3. Set the TIME/DIV and LEVEL controls to display the appropriate portion of the waveform to be measured over the maximum number of horizontal graticule divisions possible, keeping well inside the graticule limits.
4. Use the Y POSITION control to move the trace so that the measurement points are on the horizontal centre line.
5. The X POSITION control is used to move the start of the measurement period to a convenient reference point.
6. Measure the distance (divs) between the measurement points.
7. Multiply the measurement in 6 above by the setting of the TIME/DIV switch and if the X5 control is used to divide by 5. This gives the time duration.

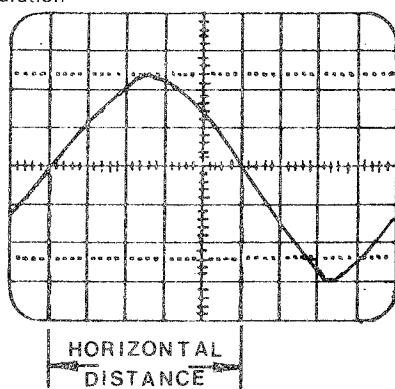
EXAMPLE

If the distance between the points is 2.5 divisions with the TIME/DIV control on 0.2ms/div and the magnifier is not used,

$$\text{Time duration} = \frac{\text{horizontal distance}}{\text{(divisions)}} \times \frac{\text{TIME/DIV}}{\text{setting}}$$

$$\therefore \text{Time duration} = 2.5 \times 0.2 \text{ ms}$$

$$\therefore \text{Time duration} = 0.5 \text{ ms}$$



Measuring the Time Duration between points on a Waveform

2.8.7 FREQUENCY MEASUREMENT

The time duration technique shown in 2.8.6 can be used to establish the frequency of a periodically recurrent waveform. The start of two adjacent cycles is taken as the measurement points and the time duration between these points established. The frequency is the reciprocal of the time duration.

EXAMPLE

If one cycle occupies 5 divisions with the time division control on 0.2 ms/div and the X5 magnifier is used

Time duration	\times	Horizontal Distance	\times	TIME/DIV (setting)
				Magnification
for the example				
Time duration	$=$	$\frac{5 \times 0.2 \text{ ms}}{5}$		
	$=$	0.2 ms		
Frequency	$=$	$\frac{1}{\text{Time duration}}$		
	$=$	$\frac{1}{0.2 \times 10^{-3}}$		
	$=$	5 kHz		

2.8.8 RISE TIME MEASUREMENTS

Rise time measurements employ the same basic techniques as time duration measurements. Rise time t_r is the time required by the leading edge of a waveform to rise from 10% to 90% of the waveform amplitude. The procedure is as follows:

1. Connect the waveform to either input.
2. Set the AC/DC switch of the channel being used to the appropriate position.
3. Set the appropriate VOLTS/DIV switch to display 4 to 8 divisions amplitude.
4. Centre the display about the centre horizontal line.
5. Set the trigger controls to obtain a stable display.
6. Set the TIME/DIV switch so that the 10% and 90% points of the waveform lie within the centre 8 divisions horizontally.
7. Determine the 10% point of the waveform and use the X and Y position controls to set this point to a convenient graticule point.
8. Determine the 90% point and estimate the horizontal distance in graticule divisions between the 10% and 90% points of the waveform.
9. Multiply the distance obtained in (8) by the setting of the time divisions switch. If the sweep magnifier is used divide the result by 5. If the result is close to the rise time of the instrument it is necessary to apply a correction factor (see below).

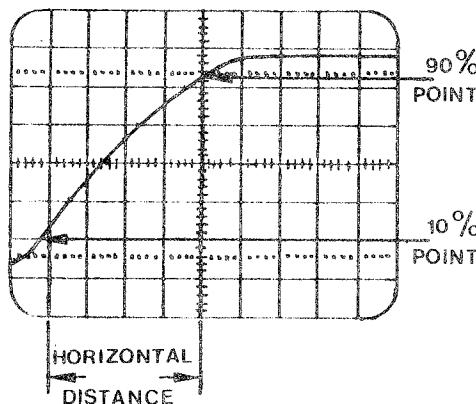
EXAMPLE

Assume that the horizontal distance between the 10% and 90% points is 5 divisions and the TIME/DIV switch is set to 100 μ s and the sweep magnifier is used,

Rise time	\times	horizontal distance (divs)	\times	TIME/DIV setting
				sweep magnification
for the example				

$$\text{Rise time} = \frac{5 \times 100 \mu\text{s}}{5}$$

$$\therefore \text{Rise time} = 100 \mu\text{s}$$



Measuring Rise Time

2.8.9 CORRECTION FORMULA FOR FAST RISE TIME WAVEFORMS

When the rise time of the oscilloscope is of the same order as the rise time of the waveform being measured it is necessary to apply a correction formula as follows :-

$$\text{Actual Rise time} = \sqrt{\left(\frac{\text{Measured Rise time (trm)}}{\text{Rise time (tro)}}\right)^2 - \left(\frac{\text{Oscilloscope}}{\text{Rise time (tro)}}\right)^2}$$

EXAMPLE

Assume the rise time found by the method given in 2.8.8 is 40 ns. The oscilloscope rise time is approximately 23 ns. Applying the formula

$$\begin{aligned}\text{Actual rise time} &= \sqrt{(40)^2 - (23)^2} \\ &= \sqrt{1600 - 529} \\ &= \sqrt{1071} \\ &\approx 33\end{aligned}$$

NOTE It should not be necessary to apply the correction to waveforms having a rise time greater than 80 ns. Also the quoted rise time for the oscilloscope is the maximum figure and the actual rise time could be considerably better than this. This would mean that a calculated rise time would be in error. If it is necessary to work to great accuracy it would be necessary to measure the bandwidth of the instrument and calculate the rise time as follows:-

$$\text{Rise time} = \frac{350}{\text{Bandwidth (MHz)}} \text{ ns}$$

SECTION 3

CIRCUIT DESCRIPTION

3.1

GENERAL

The D34 uses solid state circuitry to drive a single beam cathode ray tube (CRT). Six internal nickel cadmium cells supply power to a switched mode regulator circuit which then supplies the CR timed inverter power unit. The cells are charged from either AC line or external DC supply via an internal AC line transformer and battery charger in the case of AC input or via the battery charger only where external DC supplies are used.

UNDER NO CIRCUMSTANCES MUST BOTH AC LINE AND EXTERNAL DC SUPPLIES BE APPLIED AT THE SAME TIME

Field effect transistors (FETs) in the first stage of each vertical or Y amplifier ensures a constant high input impedance and a further FET is used in the range generator for good sweep linearity.

Dual Y channel operation at high sweep speeds is achieved by alternating the traces on a time sharing basis whilst at slow sweep speeds, and rapidly chopping the position of each channel input on a time division multiplex basis. Selection of 'Alternate' or 'Chop' is done automatically according to the setting of the sweep speed control (TIME/DIV Switch). Triggering is AC coupled with selection of trigger point and polarity from normal symmetrical signals; the Alternate mode allows triggering from TV line or field synchronising pulses only. In both modes an 'AUTO' facility is provided whereby a trace reference is displayed in the absence of a suitable trigger signal. An external trigger input socket is provided to trigger from signals not applied to the Y amplifiers.

3.2

CHANNELS 1 & 2 Y AMPLIFIER AND ATTENUATOR figure 6.

Reference to component numbers is 600 upwards for Channel 1 and 700 upwards for Channel 2. References 800 upwards and 900 upwards are used for circuitry common to both channels. Both channels being almost identical, only Channel 1 operation will be described.

Input signals applied to Channel 1 BNC socket SK601 are passed to the attenuator switch S602 either directly or via C601 according to the position of switch S601.

The first (high impedance) part of S602 provides (a) No attenuation to input signals (b) 10 : 1 reduction and (c) 100 : 1 reduction; (b) and (c) being frequency compensated, attenuation is provided in (b) by R601, C602 and C603, and in (c) by R603, C605 and C606; C604 and C607 are adjusted to maintain constant input capacitance in each case with the non-attenuated position. Basic input impedance and capacitance is set by precision resistor R605 shunted by stray capacitance and fixed capacitor C608.

D601, R609 and C609 form input protection network for N Channel FET TR601A whilst C611 and R611 are decoupling and antiparasitic components respectively. TR601A and B are dual N Channel FETs, in the same can, and comprise a long tailed source follower pair with gain switching resistors R615, R616 and R617 between the sources selecting the 1, 2, 5 subdivisions via a wafer on S602. TR601B provides thermal balance to prevent temperature drift and offset balancing by R605, R607 and R608; C612 and R612 are decoupling and antiparasitic components respectively. Source currents to TR601A/B are supplied from the -10V DC line via R613 and R614.

Signals from TR601A and B sources are applied to the base electrode of Q3 and Q4 which form part of a 5 element NPN transistor array (IC601), and comprise a long tailed pair with gain switching resistors between their emitters; transistor Q5 forms a constant current source biased by R628, R629 and R631 decoupled to line noise by C613. Final gain switching for the 5 mV and 2 mV/div ranges is via S602 (4th set of contacts) and precision resistors R624, R625, R626 and R627. R619, R621 and R622 are base current equalising resistors; any remaining unbalance is provided by adjustment of preset potentiometer R618 via R623.

Amplified signals from Q3 and Q4 are DC coupled to the base electrodes of Q1 and Q2 forming a balanced, common emitter shunt feedback pair, converting current signals to voltage signals and possessing a low output impedance. Shunt feedback resistors R632 and R636 determine the stage gain at this point; base bias incorporating vertical position DC signals are provided by the resistor chain R633, R634 and R635 from the +10 volts rail. Common emitter resistor R637 determines emitter voltage and neutralises AC signals appearing via Q1 and Q2 emitters whilst collector load resistors R638 and R639 are supplied from the +10 volt rail. Voltage output signals from Q1 and Q2 are coupled to PNP transistors TR607 and TR608 bases at a DC level of approximately 5.5 volts. Trigger signals via R641 and R643 are applied to NPN emitter follower pair TR907 and TR908 via trig select switch S901 and thence to trigger amplifier (fig.1) via a pair of coaxial cables. R901 and R902 form emitter load resistors for TR907 and TR908, their collectors being connected directly to +10 volt rail.

Gain adjustment to compensate for CRT Y plate sensitivity spread is provided between the emitters of TR607 and TR608 by R647 together with fixed resistor R646. R644 and R645 enables long tailing with vertical position preset potentiometer R642 connected to +10 volt rail.

R6483 and R649 form thermalising resistors, by-passed to h.f. by C614 and C615, to prevent trace drift to screen extremes. Signals are then diverted either to the delay line driver stage TR901 and TR902 (fig.7), or 'lost' in the chop/alternate bistable circuit (fig.7), depending on the amplitude of the switching potential. They are applied to the common point of channel switching diodes D602, D603 with respect to the common point potential of diodes D604, D605.

3.3

CHOP/ALTERNATE BISTABLE figure 7

TR801 and TR802 and associated components form either a free running astable (CHOP mode) or a bistable which changes state upon the application of an input pulse (ALTERNATE mode) controlled by applying a -10 volt bias to the junctions of R805 and R817.

Either of these modes may be suppressed by switching off Channel 2 which opens switch S802 and causes TR802 to switch permanently on, diverting all signals from Channel 1 to the Y plates. The -10 volt bias signals are controlled by the setting of the Time/Div Switch S1 (fig.9).

In the Chop mode the emitters of TR801 and TR802 are long tailed through D802, D805, R805 and R814, and connected together via a time constant network C805, R809 with an additional chop transient signal output via C802 and C807. TR801 and TR802 form a cross-coupled bistable with a loop gain considerably greater than 1. Cross-coupling resistors R807 and R808 are by-passed by speed-up capacitors C803 and C804.

Chop operation is as follows:-

When TR801 switches on, collector potential fall is transmitted to TR802 base causing it to switch off; TR802 emitter potential then commences to fall at a rate determined by the discharge of C805 through R809. After a period of time, TR802 emitter potential arrives at the point where the emitter base potential is sufficient to switch on TR802 and switch off TR801; the half cycle is then repeated. Chop switching speed is approximately 100 kHz.

Alternate operation is as follows:-

With TR801 on and TR802 off, a 1 volt negative going transient is applied to the junction of C801 and C806 from the sweep generator (fig.2), TR801 collector potential is therefore lower than that of TR802.

Diode D801 is effectively biased by the collector potentials via R808 and R802 into a forward conducting state, and conversely, D806 into a reverse biased state. The negative transient is applied to D801 and D806 cathodes via C801 and C806 respectively. D801 only conducts and causes TR801 base to go negative, switching off TR801 and hence switching on TR802. The next negative going pulse will restore the initial conditions.

3.6

collector load resistors. C912 provides h.f. bypass for any unbalanced h.f. voltages present at the junction of R925 and R926.

TRACE ROTATE figure 7

The trace rotate circuit, comprising zener D901 for stabilisation, screw-driver control R915, trace rotate coil L301 fitted to CRT neck, and resistors R920, R923 and R924, utilise surplus current available from the delay line drive circuit. L301 is connected into a resistance bridge, and can accept bi-directional currents depending upon the setting of potentiometer R915.

The highest coil current will flow from connection 221/7 to 221/6 when R915 wiper is nearest to connection 221/9. A small reverse coil current will flow from connection 221/6 to 221/7 when R915 wiper is nearest to connection 221/5; this enables the trace to be adjusted to align with the horizontal graticule and compensate for CRT electrode misalignment and tilt due to stray fields etc. DC supply line decoupling is provided for both +10 V and -10 V lines by means of C908, C911, L902 and C909 and L903 respectively.

3.4

CHANNEL SWITCHING figures 6 & 7

Diode gate matrix D602, D603, D604 and D605 for Channel 1, and D702, D703, D704 and D705 for Channel 2, form a "steering" circuit permitting signals from either Channels 1 or 2 to be diverted to the delay line and final Y amplifier (fig.7). Matrix switching is controlled by the respective states of TR801 and TR802. Assuming that TR802 is on with its collector potential at approximately -2.7 volts, this potential is applied to the cathodes of D702 and D703 via R819. When the cathode potential of diodes D704, D705 remain constant at about -0.7 volt, these diodes are reverse biased and therefore switched off. Any signal currents from Channel 2 are therefore conducted through D702 and D703, which are forward biased, and absorbed by TR802. During the forgoing period, the collector potential of TR801 in the switched off condition is approximately +0.6 V and is applied to the cathodes of D602 and D603 via R818. Diodes D604 and D605 with cathode potential of -0.7 V are therefore forward conducting and signal currents from Channel 1 pass through these two diodes and hence to the final Y amplifier. Diodes D602 and D603 being reverse biased are effectively switched off. Reversal of the states of TR801 and TR802 will therefore switch Channel 2 to the final Y amplifier and suppress CH1.

3.7

TRIGGER AMPLIFIER figure 1

The trigger amplifier will accept either balanced signals via the coaxial cable from the Y amplifier, or single ended signals via the BNC socket, SK21 from internal source; front panel switch S21 selects the facility required. R21 is bypassed to h.f. by C21, and C22 blocks any DC to 250 V peak.

C23 and C24 provide AC only coupling to the trigger amplifier input, and S22 selects the trigger signal polarity.

TR21 and TR22 form a simple long tailed window amplifier with R23 as the long tail resistor. Bias current for TR21 is via R22 and R44, and for TR22 via R29, from divider chain R31, D20 and R32.

A DC bias offset signal to select start point on a displayed waveform is obtained from panel LEVEL control R43 and applied via either S24 for full screen selection, or via R42 in the AUTO mode for restricted control; R41 determines the overall LEVEL range. The DC LEVEL signal is first applied to emitter follower transistor TR24 then to the input of window amplifier TR21 via R22. A small proportion of DC signal is fed to TR22 in the same phase via R38 and D20 to reduce thermal drift. TR22 collector load resistors R26 and R28 are shunted by the input impedance of TR23, R37, R35, R36 and C26. H.F. peaking in the ALTERNATE mode is provided by shunt bypass capacitor C26 and h.f. cut in the CHOP mode is automatically carried out by the application of a -10 V bias to R34 and R27. This causes D21 to conduct and effectively connect C27 between TR23 collector and base; the bandwidth is then reduced to about 50 kHz. C30 prevents base line noise being applied to TR23 input. R28 permits adjustment of TR22 DC level input and to set TR23 output symmetrically about the switching level of NPN Schmitt trigger transistors TR26 and TR27; R58 adjusts for backlash. R25 restricted by R24, permits adjustment of the AUTO DC bias to align to TR21 and TR22 window.

Amplified AC mode signals developed across R27 are applied directly to TR26 via panel switch S23 and to amplifier/sync separator TR24 and TR25 in the TV mode. L21 at high frequencies, by generating a high degree of overshoot on the switching transient, enables the Schmitt to divide down and generate a train of output pulses which are an exact subdivision of higher frequency input signals. Dividing down commences at about 3.5 MHz for low level input signals and at about 12 MHz for high level signals.

Two outputs are available from the Schmitt, a positive going pulse from the junction of R66 and R67, and a positive going pulse from the junction of TR26 and TR27 emitters; but isolation is necessary to prevent feedback interaction.

Television video waveforms are diverted via S23, in the TV mode, to TR24 which acts as a high gain limiter amplifier to TV signals. Picture information is suppressed leaving positive going sync pulses at the collector of TR24. Line

3.5

VERTICAL OUTPUT AMPLIFIER figure 7

Amplified Channel 1 or 2 input signals are applied to the bases of TR901, TR902 which comprise a push-pull shunt feedback pair with feedback peaking. TR901 and TR902 effectively drive the delay line and provide delay line equalisation by means of a triple CR network comprising C901, R903, C902, R906, C903 and R908. These components, when adjusted, provide the correct time constants to equalise for h.f. attenuation in the delay line. Resistors R904 and R907 form the shunt feedback circuit for TR901; similarly R905 and R909 are for TR902.

Collector load resistors and delay line terminating resistors are R911, R912, R913 and R914. The delay line comprises a twin helix insulated wire wound on a polythene rod fitted into a compact moulding.

Delay line impedance is 200 ohms giving approximately 200 ns delay. Signals from the delay line are applied to the bases of TR903 and TR904 which comprise a long tailed h.f. and temperature compensated amplifier. Long tail resistors R921 and R922 are connected to the -10 volt rail. C905, C907 and R919 comprise h.f. peaking network between the emitters. Temperature compensation is provided by thermalising and bypass components, R917, C904 respectively for TR903; likewise R918 and C906 for TR904. The final amplifier stage which drives the Y plates of the CRT comprises TR905 and TR906 forming a grounded base stage cascaded on TR903 and TR904. R927 and R928 are anti-parasitic stopper resistors; R925 and R926 are the

sync pulses are picked off at the junction of R46 and R47 and applied via C31 and D23 to TR26 which is in a conducting state through bias current via R51. D22 acts as a clamp to prevent TR24 saturating; meanwhile D24 is back biased by means of -10 V DC being applied to R56 from the Time/Div Switch S1.

Broad field synchronising pulses are applied to the base of TR25 an NPN emitter follower. Short duration line and equalising pulses are attenuated in R48, C32 network leaving broader field pulses predominant. Further pulse separation occurs between base and emitter leaving only fast rise positive going field pulses developed across R52, to be applied to TR26 base via C34 and D24 biased to forward conducting state. Under field trigger conditions D23 is back biased by -10 V DC applied to R49 from the Time/Div Switch S1 over the 12 slowest sweep speed positions, and -10 V to R56 during the 8 remaining fast sweep positions, thus automatically displaying field and line waveforms at the appropriate sweep speeds.

3.8 SWEEP GENERATION UNBLANKING AND BRIGHT LINE AUTO figure 2

3.8.1 SWEEP GENERATOR

The positive trigger pulse from R66 and R67 (fig.1) junction is further differentiated by network C103, R103 and R104, D101 clips the negative overshoot leaving a reduced but shorter duration positive pulse to be applied to the base of TR102 which together with TR105 form a fast gating bistable. Initially in the 'wait' condition TR105 is conducting and TR102 is switched 'off' by base bias potentials set by R119 (stability potentiometer) adjustment. Upon receiving a positive going trigger pulse from D101, TR102 instantly switches on and by emitter coupling and collector coupling through C107, TR105 switches OFF. TR102 collector potential falls rapidly to be clamped by D104 at -0.65 Volts. TR101 emitter current from the +10 V rail via R106 then ceases and TR101 switches OFF.

TR104 gate potential starts to fall toward C102 and R103 junction potential via a train of precision resistors R1 to R6 on S1 (fig.9). At the instant the gate potential falls, the drain potential rises out of clamp level carrying with it TR106 base and emitter. TR106 emitter and TR104 gate are connected by one or more of the precision timing capacitors C1 to C5 on S1 (fig.9) to form a linear Miller ramp generator, where the speed of the ramp is determined by C1 to C5 and R1 to R6, all selected by means of Time/Div Switch S1. TR106 emitter potential developed across load resistor R125 rises linearly with time and provides four outputs:- a) Positive feedback to TR104 source via R117 for enhanced ramp linearity. b) Termination of ramp sensing voltage to TR105 via R121, D105, R122 and C110, and via hold-off capacitors C111 and C6 to C8 on S1. c) Ramp to X amplifier TR114, TR115, TR116 and TR117 via R149 and C119 in parallel and d) Ramp to calibrator (fig.8) via R521 and C512 in parallel.

TR105 is switched off during the ramp period, a proportion of rising ramp voltage being fed to the base causes TR105 to switch on and TR102 to switch off and hence TR101 to switch on. TR106 emitter then falls rapidly towards the clamp potential of R106 caught by D102. Timing capacitor discharge takes place during the fall period via TR101 and R106.

To prevent further triggering during the flyback period TR105 base is held at a higher potential than during the wait period by the slow discharge of C111 and C6 to C8. Triggering is then only possible when TR105 base potential has fallen to or almost to the potentials existing in the wait condition.

3.8.2 UNBLANKING GENERATOR

TR103, TR107 and TR108 form the unblanking generator which provides a fast edged 26 volt positive going pulse during the sweep period, and is time related to the sweep output as follows:

The unblanking pulse is derived from the collector signal of TR105 which is clamped between the limits of +0.6 V and -0.6 V by diodes D106 and D107 during the off and on periods of TR105. D108 transfers this signal to a level

0.6 volt lower. During the sweep period (TR105 off) TR108 base and emitter are at approximately the same potential and TR108 is switched off with its collector potential set by R132 and R129 junction potential. R131 voltage drop under these conditions is insufficient to cause TR107 to conduct; TR107 collector and therefore the unblanking signal approaches that of the 18 volt line. The fast rise characteristic of the unblanking pulse is provided by TR103 which is biased just below the conducting state such that upon receipt of a negative going pulse from TR102 via C105, TR103 instantly switches on, discharging stray capacitance associated with the output line and produces a fast positive going edge.

At the end of the sweep period TR105 conducts causing TR108 to conduct hard, saturation being avoided by clamp diodes D109 and D111. TR107 switches on and the unblanking signal then moves rapidly down to almost the -10 V rail, blanking the CRT trace.

Chop blanking during the slower sweep speeds, is achieved by processing a triangular waveform signal from the chop bistable (fig.7). TR109 and TR111 form a simple Schmitt trigger circuit the output of which is a squarewave applied to the base of TR107.

The signal is amplified and fed eventually to the CRT grid blanking the CRT trace during the transition period from CH1 to CH2 and vice versa.

3.8.3 BRIGHT LINE AUTO

TR112 and TR113 comprise a long-tailed pair bistable with TR112 normally conducting and TR113 switched off. Under these conditions TR112 collector is at low potential drawing current through R143 and D114, TR105 base bias is thereby lowered via D112 and R122 causing the gating bistable to adopt a "free run" condition; the trace is displayed in the absence of signal to give the user a reference level. On receipt of an input signal the Schmitt trigger transistors TR26 and TR17 provide a train of positive going pulses from their common emitter point. These pulses are applied to the base of TR113 (normally off) which then conducts; TR112 base is driven negative via C118 as TR113 collector potential falls then rises towards the +18 volt rail, back biasing D114 and restoring normal bias conditions for sweep triggering to TR105.

C118 discharges relatively slowly (approximately 50 msec) towards the point of conduction of TR112 causing TR113 to switch off; if however further trigger pulses are applied to TR113 then the cycle commences almost immediately; the C117 slugging action on TR112 collector potential ensures that TR105 base is not allowed to become sufficiently negative to free run the trace during the short period when TR113 is off.

AUTO free run action is removed in the LEVEL mode by S102.

3.9 HORIZONTAL OR X AMPLIFIER figure 2

The X amplifier drives the X or horizontal deflection plates of the CRT with a push pull amplified ramp signal.

The sweep generator provides a ramp signal of approximately 10 volts amplitude on a DC pedestal of 2 volts. The ramp signal is applied to TR114 base via R149 and C119. TR114 is a normal shunt feedback stage with the output taken from the junction of feedback resistors R162 and R161; R159 is the collector load resistor. Horizontal position DC bias is fed to TR114 base from R153 via R157. C124 by-passes R162 to high frequencies to preserve h.f. response at fast sweep speeds.

TR115 and TR116 form a long tailed amplifier pair driving the X plates, with X1 and X5 gain determining networks between the emitters. TR117 acts as a horizontal position preset and prevents the signal from TR115 emitter being shunted to -10 V rail via the tail resistor R172, providing almost perfect balance of push pull output. C125 in the X5 gain position provides h.f. peaking to preserve sweep linearity without incurring extra current demand from the supply.

3.10 C.R.T. CIRCUIT figure 3

V301 is a flat face mesh cathode ray tube with grid

unblanking applied via two routes. Fast unblanking signals from TR107 collector (fig.2) are applied to the junction of C304, R325 and R323 via a short coaxial cable and the CRT grid therefore responds immediately to fast transients via C304, but would tend to restore to some other potential shortly afterwards. A DC component of the unblanking waveform is applied to the base of TR303 via a resistor chain R373, R317, R318 and R319, which with R321 and R322 form a potential divider down to cathode potential (approximately 1500 V). The unblanking waveform is considerably attenuated by this chain therefore TR303, TR304 and TR306 amplify the DC component.

A rectified positive bias is applied to the base of TR303 via D306 and C307 so that the output signal of TR304 is in the unblanked state. Blanking is obtained by the fast short term pulse via C304.

R322 sets the threshold of switching to take up resistor chain tolerances; D307 prevents the negative excursion on the grid from affecting the intensity control R336 and clamps the positive excursion to the grid/cathode potential set up by R336 wiper. R338 presets the minimum intensity with R336 in the fully anticlockwise position. TR302 and V301 cathode behave as a long tailed pair to prevent CRT current pulses varying the cathode potential; thus the net current drawn from the -1630 volt supply is substantially constant at all times. TR302 gate potential is set by resistor chain R303, R304, R306, R307 and R308, and drain current drawn for TR303 is obtained via a chain of resistors which include the astigmatism preset control R301 feeding TR301 emitter follower to the CRT astigmatism electrode.

R302 presets CRT geometry and the current from this and R301 in parallel and R309, R311, R312, R313 and the Focus control R314 supply all current required for the blanking amplifier. Zener diode D303 prevents current fluctuations in TR302 affecting the setting potentials of the above controls.

R300, R305, C300 and C305 comprise decoupling components to provide a high degree of smoothing for the -1630 volt line.

R332 refers the centre potential of the CRT filament to TR302 source; filament power is obtained from an isolated low voltage winding on the inverter transformer T21.

D501 and R504 form a temperature compensated voltage divider and a proportion of the battery voltage is applied to the base of TR501.

Collector current for TR501 is drawn from the positive rail via R506. If however the battery PD is high then TR501 base voltage will be proportionally high, causing extra collector current to flow via TR502 base emitter junction. TR502 then conducts via R509, D502 the indicator lamp and R508. The indicator lamp giving a continuous light. During discharge, the battery PD falls causing TR501 collector current to fall. A point is reached when the voltage drop across R506 is insufficient to maintain TR502 in the bottomed state and the collector voltage then commences to fall towards the negative rail. C502 transmits this change to TR501 base which then rapidly reduces TR501 collector current to zero. TR502 collector voltage switches rapidly to battery negative carrying TR501 base with it so that transistors and the indicator lamp are momentarily switched off. C502 then charges via R502 and R503 to the point where TR501 begins to conduct, causing TR502 to conduct. The rising collector voltage causes TR501 to switch on rapidly at which point the indicator lamp comes on. C502 then discharges through TR501, D501 and R504 to the point previously reached. This critical point of battery PD therefore causes the lamp to switch on and off warning the user that battery PD is low. Threshold level is set by R502 so that D502 flashes at a battery PD of 6.8 to 6.9 Volts. Approximately ten minutes use of the instrument remains after the lamp starts flashing.

3.12

BATTERY CHARGER figure 4

Mains transformer T401 supplies current via fullwave 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 of 100 - 125 V AC or 200 - 250 V AC is set by S402 (located under the instrument via a small access hole) and is connected to T401 primary. Range selection of the lower or upper 10% of each line voltage is set by S403 (located at the rear of the instrument) and is connected to T401 secondary. C402 smooths the rectified output; D406 and D407 stabilise TR401 base emitter voltage and bias current is provided by R402. TR401 with R403 in its emitter provides a constant current to the negative rail via the ON panel LED and part of R408.

Forward bias voltage developed between R408 wiper and the negative rail causes TR402 to conduct and draw current from the positive rail via D409 forming the charge current for the battery pack; R408 therefore controls the charge current rate.

C401 and R401 are spike suppression components and C403 prevents parasitic oscillation caused by the long leads to D408 and S404a. Current demand in the ON condition is over twice that in the OFF condition and the increased current is obtained from TR402 by switching in an additional parallel resistor R404. 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. D409 prevents battery discharge when the instrument is stored.

3.13

REGULATOR AND P.S.U. figure 5

3.13.1

REGULATOR

The function of the regulator is to deliver a constant voltage to the inverter drive from a battery source, the PD of which may vary some $\pm 15\%$ about nominal, thus enabling improved stability of instrument functions.

Referring to fig.5, when the instrument is switched ON, the battery positive and negative are connected to terminations 233/1 and 233/2 respectively. A 5.6 volt potential is developed across zener diode D421 via dropping resistor R421. Current also flows through base emitter junction of series switching transistor TR424 via R429, thus TR424 conducts and draws current from the positive rail via L421, T421 and inverter transistors TR427 and TR428 which then commence to oscillate at approximately 14 kHz.

3.11 CALIBRATOR AND LOW BATTERY INDICATOR figure 8

3.11.1 CALIBRATOR

The calibrator provides an accurate reference squarewave voltage of +0.5 volts peak with respect to chassis or zero volts, and is gated on and off by the timebase sweep waveform.

PNP transistors TR512 and TR513 form an emitter coupled bistable pair with a closely defined threshold switch-over potential. Stable supply voltage is derived from the +18 Volt rail via R519 and the circuit is fed from the voltage developed across zener diode D516.

At the commencement of sweep, the voltage applied to TR512 base via R521 and C512 causes TR512 to conduct and TR513 to switch off. The CAL out socket is then grounded through R528 to provide a reference zero voltage. At approximately half the sweep amplitude, TR512 base potential set by divider chain R527, D512, D513, D514, R526 and R524, equals that of TR513 base. TR512 and TR513 then change state as the ramp voltage increases. TR512 switches off and TR513 switches on with collector current then flowing through R528 and developing the cal output voltage. TR513 current is set by emitter resistances R522 and R518. Stabilization diodes D512, D513 and D514 compensate for any thermal drift occurring in D516 and TR513.

3.11.2 LOW BATTERY INDICATOR

TR501 and TR502 and associated components form a high gain amplifier with a CR positive feedback network. The circuit is connected directly to the battery when the instrument is switched on. R501 and C502 attenuate inverter ripple to provide smooth DC to the circuit. R502, R503,

Immediately after switch on, and before the voltage across the sensing chain, comprising R433, R434, TH421, R436 and L422, has risen to that of the battery, TR426 is conducting and the forward bias developed across R431 is applied to TR421 base via R428.

TR421 and TR422 form a Schmitt trigger circuit with a well defined threshold, hence during the initial period TR422 and TR423 are switched off. When the inverter input voltage reaches 6.5 volts set by R434, it initiates the following sequence:

TR426 off, TR421 off, TR422 on, TR423 on, thus bypassing TR424 base current from R429 to the battery negative line, whereby TR424 abruptly switches off. Back EMF developed across L421 causes TR424 collector voltage to rise rapidly towards the battery positive rail. D422, a slow heavy current diode and D423 a fast diode catch the back EMF at battery positive rail and enable the magnetic energy in the core of L421 to be combined with the current which continues to flow for a short period of time. The voltage across the sensing chain commences to fall to the point where TR426 begins to conduct and TR424 switches on via TR421, TR422 and TR423, thus the cycle of events is repeated. Circuit time constants have been adjusted to lock the regulator switching frequency to that of the inverter to avoid audible beat frequencies and switching transient beats which could cause problems in the smoothing circuits.

3.13.2

REGULATOR AND P.S.U. figure 5

All supply rails, with the exception of the battery charger, are derived from a push-pull, C.R. timed, DC to DC converter. TR427 and TR428 with protection diodes D424 and D426 drive ferrite cored transformer T421 at approximately 14 kHz, feedback being obtained from a single winding in series with C426, the timing capacitance. R437 and R438 are forward bias resistors decoupled by L423 and C424. C427 decouples supply lines from voltage spikes generated by switching action. +10 and -10 volt supplies are obtained from the two 10.7 volt windings on T421 rectified by D427, D428, D429 and D431. Smoothing is provided by C428, L427 and C436 for +10 V, and C429, L428 and C437 for -10 V.

The 70.7 Volts winding added serially to a 10.7 V winding, rectified by D433 and smoothed by C431, L426 and C434 supplies +70 V.

Additionally, +10 V is obtained and smoothed by D432, C432, L429 and C433. M401 is a 10 + 2 Cockcroft Walton Multiplier which provides an EHT of approximately +8 kV DC from the 829 V winding of T421 for the CRT PDA electrode and 1630 volts for the CRT cathode supplies. M401 is a moulded hermetically sealed block with flying leads and cannot be repaired, in the event of failure the whole block must be replaced.

SECTION 4

MAINTENANCE AND RE-CALIBRATION

Care should be taken not to touch high voltage areas. The instrument should be disconnected from AC supply before carrying out rear, and whereabouts procedure during servicing. In addition, the battery connection should be disconnected.

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, Section 3, will assist in deciding which part of the circuit requires adjustment.
- 4.1.2 The internal 500 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:—
- Standard servicing tool kit.
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 $\pm 0.25\%$.
Time calibrator, providing markers of amplitude between 50 mV and 10 V, 1 μ sec. to 1 msec., timing accuracy $\pm 0.1\%$.
Squarewave generator, providing a terminated 1 MHz signal, of approximately 500 mV, rise time less than 10 ns.
Sinewave generator, providing 50 kHz, to 10 MHz signal of amplitude up to 25 volts.
Monitor oscilloscope with X 10 passive probe.
Digital voltmeter DC, with input impedance of not less than 1 megohm, or greater.
Composite TV video signal source.
Meter for voltage measurement with resistance of not less than 20 k Ω per volt.
Ammeter 0-500 mA DC accuracy $\pm 3\%$.
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
- Switch off LINE and instrument and remove all external leads and cables.
 - Follow the advice given in the Danger Warning.
 - Remove six screws securing rear cover.
 - Remove rear cover.
 - Hold case firmly, and push on rear chassis to withdraw the instrument through front of case.
- 4.2.2 OPENING OUT SIDE AND LOWER PANELS
(See exploded view)
- Remove case as in 4.2.1 above.
 - To open the right hand panel loosen the screws at the top and bottom of the instrument just behind the Time/Div switch.
 - To open the left hand panel loosen the screws at the top and bottom of the instrument just behind the attenuators.
 - To open the bottom flap loosen the screw under the attenuator and the screw under the level potentiometer.
- 4.2.3 CRT REMOVAL
- Remove instrument from case as in 4.2.1.
 - Through elongated hole in top rear chassis, slide back
- shield extension and carefully prise off tube base.
- Stand instrument on rear chassis and open out side and bottom assemblies as 4.2.2.
 - Break P.D.A. connector and earth each termination through $2M\Omega$ resistor.
 - Unsolder trace rotate leads from eyelet numbers 6 & 7 on PC221.
 - Remove CRT shield securing screws located forward of battery packs.
 - Push CRT back to clear foam strips, and to unhook shield at top.
 - Lower face end of CRT and shield; withdraw both through lower opening.
 - Carefully separate the CRT and its shield.
- 4.2.4 CRT REFITTING
- Follow the procedure 4.2.3 in reverse order, and make sure that CRT is pressed into the shield to locate against bezel rear before securing shield with its screws.
If trace rotation is in the opposite sense, reverse wires to eyelets 6 & 7, on PC221.
- 4.3 CALIBRATION PROCEDURE
- 4.3.1 BATTERY CHARGE RATE AND INITIAL SETTING
- Check the a.c. supply voltage available, and set the AC line switch S402, and range switch S403 (both located at rear of instrument) as follows:-
- | AC LINE VOLTS | LINE SWITCH SETTING | RANGE SWITCH SETTING |
|---------------|---------------------|----------------------|
| 100-112 | 112 | LO |
| 113-125 | 112 | HI |
| 200-225 | 225 | LO |
| 226-250 | 225 | HI |
1. Remove instrument chassis from case as in 4.2.
2. Disconnect battery connector on r/h set of batteries.
3. Connect a DC ammeter (0 - 1A range) across the connector contacts.
4. Set instrument on/off switch to OFF.
5. Connect instrument to AC supply and set LINE switch to ON.
6. Adjust R408 on PC222 for a charge current of 380 mA.
7. Allow 5 minutes to warm up, then adjust R408, if necessary, for 400 mA current.
8. Set AC line switch to OFF, remove ammeter, and couple up connector.
 - With the exception of R408, set all preset trimmer resistors and capacitors on all boards to mid-range.
 - Set front panel controls as follows:—
 - DC/AC switches (CH1 & 2) to AC.
 - VOLTS/DIV switches (CH1 & 2) to 5 V.
 - CH1 Y POSITION to mid-range.
 - CH2 Y POSITION to OFF.
 - TRIG to CH1.
 - Instrument switch to IN.
 - INTENSITY to mid-range.
 - LINE switch to OFF.
 - FOCUS to mid-range.
 - TIME/DIV to 1 ms.
 - HORIZONTAL POSITION to mid-range, and X1 (IN).
 - AUTO (IN) and LEVEL to mid-range.
 - Mode to AC, Source to INT and Slope to +.

4.3.2 REGULATOR SETTING

- Set AC LINE and instrument switches to ON. Check that both red indicator lamps glow. The LINE lamp should be the brighter lamp.
- Connect 0 - 10 V DC voltmeter to stub leads on PC223.
- Adjust R434 on PC223 for 6.4 V. Allow 3 minutes to warm-up then check that voltage is 6.5 V. Re-adjust R434 if necessary.

4.3.3 POWER SUPPLY VOLTAGES

All power supply rails are available on PC223 and the voltage test points are as follows:—

NOMINAL VOLTAGE	TEST POINTS	LIMITS
+ 10 V	8 & 9	+9.7 V to 10.3 V
+ 18 V	6 & 7	+17.5 V to 18.5 V
+ 70 V	17 & 18	+68 V to 72 V
- 1630 V	19	+1548.5 V to 1711.5 V
- 10 V	11 & 12	-10.3 V to - 9.7V

4.3.4 TRACE AND CRT SETTINGS

- Set front panel control as in 4.3.1 (d) but with TIME/DIV switch set to 0.5 sec.
- Switch on CH2 to display both spots on the screen near to the horizontal centre.
- Switch on LINE and instrument.
- Adjust INTENSITY to eliminate halation.
- Adjust FOCUS together with R301 (Astigmatism) on PC223 to obtain best spot definition.
- Visible trace between the spots indicates lack of chop blanking.
- Set TIME/DIV to 1 ms.
- Align trace with graticule horizontals by adjusting Trace Rotate on r/h side of rear panel. If alignment is unobtainable, reverse the black coil leads to terminals 6 and 7 on PC221. Re-adjust Trace Rotate.
- Adjust R302 on PC223 for minimum pin cushion and barrel distortion, with trace at top or bottom of screen.

4.3.5 UNBLANKING AMPLIFIER SETTING

- Set front panel controls as in 4.3.1 (d) but with TIME/DIV set to 5 ms.
- Switch on LINE and instrument.
- Set start of CH1 trace 1.5 divisions from l/h edge.
- Pull LEVEL and turn fully clockwise to stop free run. If free run continues adjust R119 on PC224 anti-clockwise until it ceases.
- Display a stationary visible spot at the start of the trace by adjusting R322 on PC223. Adjust R322 further until spot just disappears; note the position of the rotor.
- Set AUTO so that full trace is visible, and then adjust R322 until r/h section of trace just starts to shorten; note position of rotor. Finally set R322 midway between the two noted positions.
- Turn INTENSITY anticlockwise to minimum and adjust R338 on PC224 for zero intensity.
- Check that the clockwise rotation of the INTENSITY control allows linear increase of trace intensity. No fly-black should be visible at any speed on maximum intensity.

4.3.6 CH1 and CH2 BALANCE

- Set front panel controls as in 4.3.1 (d) but with CH1 VOLTS/DIV set to 50 mV and Y POSITION to mid-range.
- Short circuit CH input socket with 50Ω coaxial load. Switch on LINE and instrument.
- Switch alternately between 10 mV, 20 mV and 50 mV on VOLTS/DIV switch and adjust R605 for minimum trace movement at each operation.
- Switch alternately between 2 mV, 5 mV and 10 mV on VOLTS/DIV switch and adjust R618 for minimum trace movement at each operation (limit = 0.2 div).
- Check that mid-range position of Y POSITION control sets the display equally disposed above and below the horizontal centre — line of the graticule. Adjust (if necessary) R642. A 10 div sinewave display assists in this adjustment.
- For CH2 balance repeat the foregoing procedure but substitute R705, R718 and R742.

4.3.7 TRIGGER AMPLIFIER AND SWEEP INITIAL SETTINGS

- Set front panel controls as in 4.3.1 (d) but with TIME/DIV set to 10 μ s/div. Apply a 50 kHz sinewave input to CH1 to display 8 div amplitude. Switch on LINE and instrument.
 - Pull LEVEL and turn fully anticlockwise.
 - Adjust R119 anticlockwise until trace ceases to free run.
 - Set LEVEL to mid-range and ensure that the trace triggers correctly according to slope switch setting.
 - Connect the probe of the monitor oscilloscope to the rear end of R37 or top lead of R39. Adjust LEVEL for symmetrical waveform (i.e. equal clipping on + and - peaks).
 - Observe the display of 8 div amplitude on the 'scope under test and then adjust R28 until triggering occurs midway between + and - peaks.
 - Without disturbing LEVEL setting, select AUTO. Reduce input signal amplitude to 1 div p.p. and adjust R25, via access hole above trig input socket, so that triggering occurs midway between + and - peaks.
 - Set monitor 'scope to 100 mV/div and adjust R58 (backlash) to separate transients displayed on monitor by 80 mV. Disconnect probe and monitor.
 - Adjust R25 so that on AUTO the display is an equally set 1 div waveform.
- Note that R115 (trace length) and R119 (stability) are not yet finally set.

4.3.8 ATTENUATOR COMPENSATION SETTING AND INPUT CAPACITY

- Set front panel controls as in 4.3.1 (d) but with CH1 set to 10 mV/div and DC. TIME/DIV set to 0.2 ms. Switch on LINE and instrument.
- Connect squarewave calibrator to CH1 input and set to 50 mV at 1 kHz. Adjust R647 (gain) for a 5 division amplitude display.
- Set CH1 to 0.1 V/div; TIME/DIV to 20 μ s; calibrator to 500 mV at 10 kHz. Adjust C602 for squarest leading edge corner.
- Set CH1 to 1 V/div; calibrator to 5 V. Adjust C605 for squarest leading edge corner.
- For CH2 repeat the foregoing procedure, using R747, C702 and C705 respectively.
- Switch off CH2; Set CH1 only to 50 mV/div and DC; TIME/DIV to 0.2 ms.
- Connect calibrator to CH1 input and set to 2.5 V at 1 kHz. Adjust trimmer on probe for squarest leading edge corner.
- Set CH1 to 0.1 V/div and calibrator to 5 V. Adjust C604 for squarest leading edge corner.
- Set CH1 to 1 V/div and calibrator to 50 V. Adjust C607 for squarest leading edge corner.
- For CH2 repeat the foregoing procedure, substituting C704 and C707 respectively.

4.3.9 TIME/DIV CALIBRATION SETTING (SIDE MEMBER MUST BE CLOSED).

- Set front panel controls as in 4.3.1 (d) but with TIME/DIV set to 1 ms.
- Switch on LINE and instrument.
- Apply 1 ms marker pulses to CH1 input.
- Adjust R169 (X1 gain) on PC224 for best marker to graticule alignment.
- Adjust R115 (Trace length) for 10.5 to 11 divs.
- Select X5 horizontal gain and apply 0.2 ms marker pulses.
- Adjust R166 (X5 gain) for best marker to graticule alignment.
- Set TIME/DIV to 0.2 μ s and X1 horizontal gain. Apply 0.2 μ s markers. Adjust C2 on TIME/DIV switch for best marker to graticule alignment.
- Adjust C119 on PC224 for equal pulse spacing at start of trace.
- Select X5 gain and re-adjust C119 for best compromise between X1 and X5.
- Check all TIME/DIV calibrations and, if necessary, equalise errors around zero.
- Set LEVEL to mid-range position and adjust R119 for a point midway between free run and zero.

4.3.10 HORIZONTAL POSITION

Set the Horizontal Position control fully clockwise and using R160 set the start of the sweep at the screen centre

for both X1 and X5 setting.

4.3.11 Y AMPLIFIER H.F. RESPONSE

- a) Set front panel controls as in 4.3.1 (d) but with CH1 set to 10 mV and TIME/DIV 0.2 μ s.
- b) Apply a fast rise 1 MHz squarewave signal to CH1 input via a 50 Ω terminator.
- c) Switch on LINE and instrument.
- d) Adjust display for 4 div p.p.
- e) Adjust C902 and C903 on PC220 for squarest response with no undershoot, overshoot, rise or sag.
- f) Adjust R919 and C907 on PC221 to finalise the setting of the HF response.
- g) Check that the bandwidths at 10 mV/div, 0.1 V/div and 1 V/div referenced to 5 div at 50 kHz meet the specification.
- h) Check the bandwidths for signal input to CH2.

4.3.11 SETTINGS FOR EXT, INT, TRIG AND TV ON L.F.RANGE

- a) Set front panel controls as in 4.3.1 (d) but with Source set to EXT.
- b) Switch on LINE and instrument.
- c) Apply a 40 Hz input signal to CH1 and EXT sockets simultaneously.
- d) Measure the minimum amplitude of signal display which will lock on AUTO and LEVEL. Limit should be <100 mV. Set Slope to — and repeat.
- e) Switch on CH2 and repeat measurements in d).
- f) Switch Source to INT and Slope to +.
- g) Measure the minimum amplitude of signal display which will lock on AUTO and LEVEL. Limit should be <0.3div. Set Slope to — and repeat.
- h) Switch on CH2 and repeat measurements in g).
- i) Switch to TV and + Slope, and Source to INT.
- k) Apply a composite + TV video signal to CH1 and EXT simultaneously.
- l) Measure the minimum sync pulse amplitude which locks on TV Line and TV Frame at 10 μ s/div and 5 ms/div respectively. Limit to be <0.3 div.
- m) Switch to — Slope and repeat l).
- n) Switch to EXT and + Slope and check triggering on TV signal containing 0.5 V sync amplitude.
- p) Switch to — Slope and repeat n).

4.3.12 SETTING FOR EXT AND INT H.F. RANGES

- a) Set front panel controls as in 4.3.1 (d).
- b) Apply a 2 MHz sinewave to CH1. Switch on LINE and instrument.
- c) Measure the minimum signal amplitude which locks the display. Limit to be <0.3 div.

- d) Switch to EXT and apply a 5 MHz sinewave simultaneously to EXT and CH1. Measure minimum signal amplitude which locks the display. Limit to be <100 mV.
- e) Switch to INT and apply a 15 MHz sinewave to CH1.
- f) Measure the minimum signal amplitude which locks the display. Limit to be <1 div.
- g) Switch to EXT and apply a 15 MHz sinewave to EXT and CH1 simultaneously.
- h) Measure the minimum signal amplitude which locks the display. Limit to be <300 mV.

4.3.13 CALIBRATOR

- a) Set front panel controls as in 4.3.1 (d) but with TIME/DIV set to 0.5 s and Source to EXT.
- b) Connect digital voltmeter to CAL and chassis. Switch on LINE and instrument.
- c) Adjust R519 on PC224 so that calibrator switches from 0 V \pm 1 mV to 500 mV \pm 1% during display.
- d) Switch CH1 to DC and connect CAL. Check that switch-over from 0 V to 5 mV occurs at approximately mid-screen. Limits to be 3.5 to 6.5 divs of sweep.

4.3.14 LOW BATTERY INDICATOR

- a) Switch off LINE and instrument.
- b) Remove bottom tray assembly.
- f) Disconnect blue lead from PC225 terminal 2.
- d) Using a variable 0.10 V DC supply, connect the positive lead to S404 at the junction of the red and orange leads, and the negative lead to PC225 terminal 2.
- e) Adjust R502 on PC225 so that the instrument ON indicator lamp flashes at approximately 2 Hz with 6.8 V or less applied. The lamp should flow steadily when 6.9 V is applied.
- f) Remove d.c. supply and reconnect blue lead to PC225 terminal 2.
- g) Re-fit bottom tray.

4.3.15 ADJUSTMENT OF Z MOD

- a) Set front panel controls as in 4.3.1 (d) but with TIME/DIV set to 0.1 ms.
- b) Set the rotor of R332 on PC223 to one end of its track. Switch on LINE and instrument.
- c) Apply a sinewave signal of approximately 4 kHz to CH1 and vary the input frequency until spots appear to travel through the display.
- d) Adjust R332 for an even intensity display without spots.
- e) Switch off LINE and instrument.
- f) Remove input signal.
- g) Fit instrument chassis back into case as in 4.2.

SECTION 5

COMPONENT LIST

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. In the UK enquiries should be made to Harpenden.

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

Whenever possible, exact replacements for components should be used, although locally available alternatives 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 and printed circuit boards in Section 6.

Circuit Reference		Circuit	Figure
From	To		
1	100	(Trigger Amplifier (Time/Div Switch	1 9
101	200	Sweep Generator & Horizontal Amplifier	2
301	400	CRT	3
401	500	(Battery Charger (Regulator & PSU	4 5
501	600	Low Battery Indicator & Calibrator	8
601	1000	(Volts/Div Switch & Vertical Amplifier (Vertical Output Amplifier & Switching	6 7

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

Telephone. Harpenden 63141

Telex: 25559

CIR REF	PART NUMBER	VALUE	DESCRIPTION				CIR REF	PART NUMBER	VALUE	DESCRIPTION			
			TYPE	TOL %	RATING VOLTS	Eff. Ser.No.				TYPE	TOL %	RATING VOLTS	Eff. Ser.No.
C703	285-0776-00	27 p	PS	1 p	350		C804	285-0920-00	56 p	PS	2	350	
C704	281-0155-00	2-22 p	PP		500		C805	285-1053-00	3.3 n	PS	5	160	
C705	281-0156-00	1.4-6.4 p	PP		500		C806	285-0873-00	200 p	PS	5	350	
C706	285-0874-00	470 p	PS	5	125		C807	285-1063-00	390 p	PS	5	160	
C707	281-0155-00	2-22 p	PP		500								
C708	281-0802-00	6.8 p	CER	0.5 p	400								
C709	281-0710-00	10 n	CER		250								
C710	285-0850-01	1.0 n	PS	5	160	731901							
C711	281-0710-00	10 n	CER		250								
C712	281-0710-00	10 n	CER		250		C901	285-1018-00	22 p	PS	1 p	350	
C713	281-0710-00	10 n	CER		250		C902	281-0155-00	2-22 p	PP		500	
C714	285-0810-00	820 p	PS	5	125		C903	281-0155-00	2-22 p	PP		500	
C715	285-0810-00	820 p	PS	5	125		C904	281-0710-00	10 n	CER		250	
							C905	285-0838-00	75 p	PS	2 p	350	689051
C801	285-0873-00	200 p	PS	5	350		C906	281-0710-00	10 n	CER		250	
C802	285-1063-00	390 p	PS	5	160		C907	281-0191-00	10-60 p	CER		250	
C803	285-0920-00	56 p	PS	2	350		C908	290-0707-00	22 μ	ELEC		25	
							C909	290-0661-00	100 μ	ELEC		16	
							C911	281-0710-00	10 n	CER		250	
							C912	281-0710-00	10 n	CER		250	

CIR REF	PART NUMBER	VALUE	DESCRIPTION	TYPE	TOL. %	RATING	Eff. Ser.No.
D20	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D21	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D22	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D23	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D24	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D25	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D26	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D101	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D102	152-0541-00	12 V	BAY82	Si		50 mA	
D103	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D104	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D105	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D106	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D107	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D108	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D109	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D110	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D111	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D112	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D113	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D114	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D115	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D116	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D301	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D302	152-0658-00	24 V	Zener BZY88 C24	Si		400 mW	
D303	152-0510-00	150 V	Zener 1N4190B/1N4768A			1 W	
D304	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D306	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D307	152-0658-00	24 V	Zener BZY88 C24	Si		400 mW	
D308	152-0658-00	24 V	Zener BZY88 C24	Si		400 mW	
D401	152-0339-00	500 mA	1N4001	Si		50 V	
D402	152-0339-00	500 mA	1N4001	Si		50 V	
D403	152-0339-00	500 mA	1N4001	Si		50 V	
D404	152-0339-00	500 mA	1N4001	Si		50 V	

CIR REF	PART NUMBER	VALUE	DESCRIPTION	TYPE	TOL %	RATING	Eff. Ser.No.
D406	152-0421-00	3.3 V	Zener BZY88 C3V3	Si		400 mW	
D407	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D408	152-0625-00	3 V	L.E.D. Red	GrASP		120 mW	
D409	152-0467-00	3 A	1N5400	Si		50 V	
D421	152-0472-00	5.6 V	Zener BZY 88 C7V5	Si		330 mW	
D422	152-0339-00	500 mA	1N4001	Si		50 V	
D423	152-0062-01	75 V	1N4148	Si		50 mA	
D424	152-0062-01	75 V	1N4148	Si		50 mA	
D426	152-0062-01	75 V	1N4148	Si		50 mA	
D427	152-0468-00	200 mA	BAX16	Si		150 V	
D428	152-0468-00	200 mA	BAX16	Si		150 V	
D429	152-0468-00	200 mA	BAX16	Si		150 V	
D431	152-0468-00	200 mA	BAX16	Si		150 V	
D432	152-0468-00	200 mA	BAX16	Si		150 V	
D433	152-0468-00	200 mA	BAX16	Si		150 V	
D501	152-0370-00	50 V	AAY42	GE			
D502	152-0625-00	3 V	L.E.D. Red	GaASP		120 mW	
D512	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D513	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D514	152-0062-01	75 V	1N914/1N4148	Si		50 mA	
D516	152-0347-00	7.5 V	Zener BZY88 C7V5	Si		330 mW	
D601	152-0483-00	10 V	CE1104	Si			
D602	152-0614-00	75 V	1N4448/1N4152	Si		50 mA	
D603	152-0614-00	75 V	1N4448/1N4152	Si		50 mA	
D604	152-0614-00	75 V	1N4448/1N4152	Si		50 mA	
D605	152-0614-00	75 V	1N4448/1N4152	Si		50 mA	
D701	152-0483-00	10 V	CE1104	Si			
D702	152-0614-00	75 V	1N4448/1N4152	Si		50 mA	
D703	152-0614-00	75 V	1N4448/1N4152	Si		50 mA	
D704	152-0614-00	75 V	1N4448/1N4152	Si		50 mA	
D705	152-0614-00	75 V	1N4448/1N4152	Si		50 mA	
D801	152-0062-01	75 V	1N914	Si		50 mA	
D802	152-0062-01	75 V	1N914	Si		50 mA	
D803	152-0062-01	75 V	1N914	Si		50 mA	
D804	152-0062-01	75 V	1N914	Si		50 mA	
D805	152-0062-01	75 V	1N914	Si		50 mA	
D806	152-0062-01	75 V	1N914	Si		50 mA	
D901	152-0472-00	5v6	Zener BZY88 C6V8	Si		400 mW	609651
D902	152-0062-01	75V	1N914/1N4148	Si		50 mA	609501
DL901	636-0006-00		Delay Line				

CIR REF	PART NUMBER	VALUE ohms	DESCRIPTION TYPE	TOL %	RATING W	Eff. Ser.No.
R901	317-0472-01	4.7 k	C	5	125 m	
R902	317-0472-01	4.7 k	C	5	125 m	
R903	317-0123-01	12 k	C	5	125 m	
R904	317-0391-01	390	C	5	125 m	
R905	317-0391-01	390	C	5	125 m	
R906	317-0392-01	3.9 k	C	5	125 m	
R907	317-0431-01	430	C	5	125 m	
R908	317-0182-01	1.8 k	C	5	125 m	
R909	317-0431-01	430	C	5	125 m	
R910	317-0180-01	18	C	5	125 m	
R911	317-0910-01	91	C	5	125 m	
R912	317-0910-01	91	C	5	125 m	
R913	321-0099-48	105	MF	1	125 m	
R914	321-0099-48	105	MF	1	125 m	
R915	311-1873-00	2.2 k	CP	20	250 m	
R916	317-0390-01	39	C	5	125 m	
R917	317-0101-01	100	C	5	125 m	
R918	317-0101-01	100	C	5	125 m	
R919	311-1870-00	100	CP	20	50 m	
R920						609501
R921	317-0911-01	910	C	5	125 m	
R922	317-0911-01	910	C	5	125 m	
R923						609501
R924						609501
R925	315-0122-02	1.2 k	C	5	250 m	
R926	315-0122-02	1.2 k	C	5	250 m	
R927	317-0101-01	100	C	5	125 m	
R928	317-0101-01	100	C	5	125 m	

CIR REF	PART NUMBER	DESCRIPTION	TYPE	Eff. Ser.No.
TR21	151-0317-01	BC109C/BC239C	Si NPN	
TR22	151-0317-01	BC109C/BC239C	Si NPN	
TR23	151-0320-01	Motorola MPS 6518	Si PNP	
TR24	151-0320-01	Motorola MPS 6518	Si PNP	
TR25	151-0317-01	BC109C/BC239C	Si NPN	
TR26	151-0127-02	2N2369	Si NPN	
TR27	151-0127-02	2N2369	Si NPN	
TR101	151-0320-00	MPS6518	Si PNP	
TR102	151-0242-00	2N3904	Si NPN	
TR103	151-0320-00	MPS6518	Si PNP	
TR104	151-1062-00	FET N CHAN WN340	Si	
TR105	151-0242-00	2N3904	Si NPN	
TR106	151-0240-00	3904	Si NPN	
TR107	151-0240-00	3904	Si NPN	
TR108	151-0320-00	MPS6518	Si PNP	
TR109	151-0320-00	MPS6518	Si PNP	
TR111	151-0320-00	MPS6518	Si PNP	
TR112	151-0317-00	BC109C/BC239C	Si NPN	
TR113	151-0326-00	BC107	Si NPN	
TR114	151-0326-00	BC107	Si NPN	
TR115	151-0525-00	FRB749	Si NPN	
TR116	151-0525-00	FRB749	Si NPN	
TR117	151-0326-00	BC107	Si NPN	
TR301	151-0525-00	MPS5286/FRB749	Si NPN	
TR302	151-1076-00	FET N CHAN WN537B	Si NPN	
TR303	151-0372-00	2N5401	Si PNP	
TR304	151-0525-00	MPS5286	Si NPN	
TR306	151-0525-00	MPS5286	Si NPN	
TR401	151-0320-00	MPS6518	Si PNP	
TR402	151-0480-00	25C1173	Si NPN	
TR421	151-0320-00	MPS6518	Si PNP	
TR422	151-0320-00	MPS6518	Si PNP	
TR423	151-0242-00	2N3904	Si NPN	
TR424	151-0479-00	BDX36	Si NPN	
TR426	151-0317-00	BC239C	Si NPN	609351
TR427	151-0479-01	Mullard BDX36	Si NPN	
TR428	151-0479-01	Mullard BDX36	Si NPN	
TR501	151-0317-00	BC109C/BC239C	Si NPN	
TR502	151-0320-00	MPS6518	Si PNP	
TR512	151-0320-00	MPS6518	Si PNP	
TR513	151-0320-00	MPS6518	Si PNP	
TR601a)	151-1036-00	FET Dual N-CHAN	Si	
TR601b)	151-1036-00	FET Dual N-CHAN	Si	
TR607	151-0320-01	Motorola MPS6518	Si PNP	
TR608	151-0320-01	Motorola MPS6518	Si PNP	
TR701a)	151-1036-00	FET Dual N-CHAN	Si	
TR701b)	151-1036-00	FET Dual N-CHAN	Si	
TR707	151-0320-01	Motorola MPS6518	Si PNP	
TR708	151-0320-01	Motorola MPS6518	Si PNP	
TR801	151-0242-00	2N3904	Si NPN	
TR802	151-0242-00	2N3904	Si NPN	
TR901	151-0320-00	MPS6518	Si PNP	
TR902	151-0320-00	MPS6518	Si PNP	
TR903	151-0127-02	2N2369	Si NPN	
TR904	151-0127-02	2N2369	Si NPN	
TR905	151-0242-00	2N3904	Si NPN	
TR906	151-0242-00	2N3904	Si NPN	
TR907	151-0242-00	2N3904	Si NPN	
TR908	151-0242-00	sN3904	Si NPN	
TH421	307-0258-00	Thermistor 130 Ω 20% 500 mW		
TH901	307-0175-00	Thermistor 50 Ω 20% 500 mW		
V301	154-0726-05	CRT TEK Type T3350		

SK21 131-1654-00 Socket - Ext Trig BNC
SK401 131-1733-00 Socket 5 pin Din
SK402 136-0389-00 Socket - Battery Disconnection
SK521 131-1268-00 Socket - Cal 500 mV 2 mm
SK601 131-1654-00 Socket CH1 input BNC Bulk Hd.
SK701 131-1654-00 Socket CH2 Input BNC Bulk Hd.

T401 120-1047-00 Transformer - AC Line
T421 120-1044-00 Inverter

MECHANICAL PARTS

For positions of the mechanical parts see the exploded drawings which follow

Item No.	Part Number	Description	Eff. Ser. No.	Item No.	Part Number	Description	Eff. Ser. No.
1	101-0026-01	Front Trim LH		71	407-0746-03	Bracket - Pot Moulding	609351
2	101-0025-01	Front Trim RH		73	381-0377-00	Bar	
3	333-2175-00	Front Panel (Time/div)		74	334-2824-00	Label (DIN Socket)	
4	333-2176-00	Front Panel (Volts/Div)		76	348-0160-00	Grommet Ring	
5	333-2177-00	Front Panel (Control)		77	348-0161-00	Grommet Ring	
6	333-2207-00	Side Panel		78	391-0143-01	Block (Voltage Indicator)	
8	200-1657-01	Front Bezel (Side)		79	391-0143-03	Block (Line Indicator)	
9	101-0028-00	Front Bezel (Upper)		81	334-2752-00	Label (MOD Record)	
10	200-1828-01	Front Bezel (Lower)		82	334-2821-00	Name Plate (Serial Number)	
12	407-1503-00	Bracket		83	334-2968-00	Marker (Warning)	
13	407-1502-00	Bracket		85	343-0635-00	Clamp (for Voltage Multiplier)	
14	381-0376-00	Bar		86	437-0171-00	Front Cover Protection Assembly	
15	441-1335-00	Centre Chassis		88	346-0138-00	Cable Tie	
16	407-1820-00	Bracket - Bar Mounting		89	343-0234-00	Cable Cleat	
17	441-1334-00	Rear Chassis		90	343-0207-00	Cable Cleat	
18	333-2170-02	Rear Panel		92	437-0206-01	Cover Cabinet	609451
19	441-1333-01	Bottom Tray	609451	93	367-0208-02	Handle (LH)	
20	343-0637-00	Transformer Clamp		94	367-0208-03	Handle (RH)	
21	376-0148-01	Flexible Coupling		95	214-2286-00	Index Ring (LH)	
22	384-1381-00	Shaft Extension		96	214-2286-01	Index Ring (RH)	
24	361-0670-00	Spacer Pivot		97	101-0027-02	Handle Trim (LH)	
26	378-0861-04	Filter Assembly - (Green)	689001	98	101-0027-03	Handle Trim (RH)	
or	378-0851-04	Filter Assembly - (Blue)	689001	99	200-1830-01	Handle Cover	
or	378-0852-04	Filter Assembly - (Amber for P7 Tube)	689001	100	105-0680-00	Handle Catch	
27	366-1654-00	Knob Assembly		101	214-2287-00	Handle Spring	
28	366-1657-01	Knob Assembly		102	210-1235-00	Handle Washer	
29	366-1656-01	Knob Assembly		103	377-0447-00	Handle Insert	
31	366-1414-15	Knob - Push Button - Assembly		104	367-0207-01	Handle Grip	
32	376-0132-00	Switch Extension Coupling		105	348-0167-01	Foot	
33	384-1141-01	Extension Rod		106	200-0882-01	Cap	
35	220-0527-00	Nut - Ring		107	385-0215-00	Spacer 6 BA HEX	
36	210-1247-00	Felt Washer		108	361-0576-00	Spacer 6 BA STUDDED	
37	358-0460-00	Bush		109	361-0283-00	Spacer 6 BA STUDDED	
38	200-1885-00	Push Button Bezel		110	213-0460-00	Screw 8 BA CH HD x 1/4"	
40	337-2375-00	Shield - Electrical		111	213-0460-00	Screw 8 BA CH HD x 1/4"	
41	337-2054-00	Screen, Cover		112	213-0397-00	Screw 8 BA CSK HD x 3/16"	
42	378-0836-00	Screen, Attenuator		113	213-0454-00	Screw 8 BA CSK HD 1/4"	
43	334-2749-00	Label (Identification)		114	213-0720-00	Screw 8 BA R/CSK HD x 3/16"	
45	636-0006-00	Delay Line Assembly		115	213-0699-00	Screw 8 BA R/CSK HD x 3/8"	
46	131-1259-00	Earthing Contact		116	213-0392-00	Screw 6 BA PAN HD x 3/16"	
47	376-0137-01	Extension Coupling		117	213-0393-00	Screw 6 BA PAN HD x 1/4"	
48	384-0941-00	Extension Rod		118	213-0394-00	Screw 6 BA PAN HD x 5/16"	
49	124-0331-00	Potentiometer - Insulator Strip		119	213-0406-00	Screw 6 BA PAN HD x 3/8"	
51	337-2324-00	Shield - CRT		120	213-0668-00	Screw 6 BA PAN HD x 5/8"	
52	337-2376-00	Extension Shield - CRT		121	213-0399-00	Screw 6 BA PAN HD x 1 1/4"	
53	136-0266-01	Socket - CRT Base		122	213-0748-00	Screw 6 BA CH HD x 3/16"	
55	204-0563-01	PDA Connector - Body		123	213-0638-01	Screw 6 BA CSK HD x 3/16"	
56	136-0522-00	Socket		124	213-0391-00	Screw 6 BA CSK HD x 1/4"	
	210-1206-00	Washer 4 BA - Small		125	213-0404-00	Screw 6 BA CSK HD x 5/16"	
	358-0531-00	PDA Connector Bush		126	213-0475-00	Screw 4 BA CSK HD x 3/8"	
56	214-2153-00	Pin		127	213-0403-00	Screw 4 BA CSK HD 1/2"	
	210-1206-00	Washer 4 BA - Small		128	213-0583-01	Screw 4 BA MUSH HD x 3/8"	
57	200-2126-00	Cover Fuse insul.	609451	129	213-0515-00	Screw 2 BA PAN HD x 1/2"	
58	352-0265-00	Fuse Holder		130	213-0350-00	Screw S/T No. 2 CSK HD x 3/16" 609351	
59	352-0447-00	Battery Holder		131	213-0354-00	Screw S/T No.2 PAN HD x 1/4"	
	352-0448-00	Insulator		132	213-0280-00	Screw 6 BA Nylon CH HD x 1/4"	
60	344-0258-00	KWIK Clip Plastic	707201	133	213-0248-00	Screw Set M3 x 3 mm	
61	343-0500-01	Capacitor Clamp		134	210-1079-00	Washer Lock 3/8" x 1/2"	609320
62	407-1821-00	Bracket		135	210-1213-00	Washer 8 BA Small	
63	166-0511-00	Insulating sleeve		136	210-1214-00	Washer 8 BA Shakeproof	
64	391-0100-01	Block - Mounting		137	210-1209-00	Washer 6 BA Small	
65	358-0460-01	Bush		138	210-1207-00	Washer 6 BA Large	
66	134-0154-00	Power Connector		139	210-1210-00	Washer 6 BA Shakeproof	
67	334-2822-00	Label (Fuse Identification)		140	210-1209-00	Washer 6 BA Small	
68	210-0297-00	Solder Tag 6 BA		141	210-1207-00	Washer 6 BA Large	
70	407-1819-00	Bracket -DIN Socket Mounting		142	210-1210-00	Washer 6 BA Shakeproof	

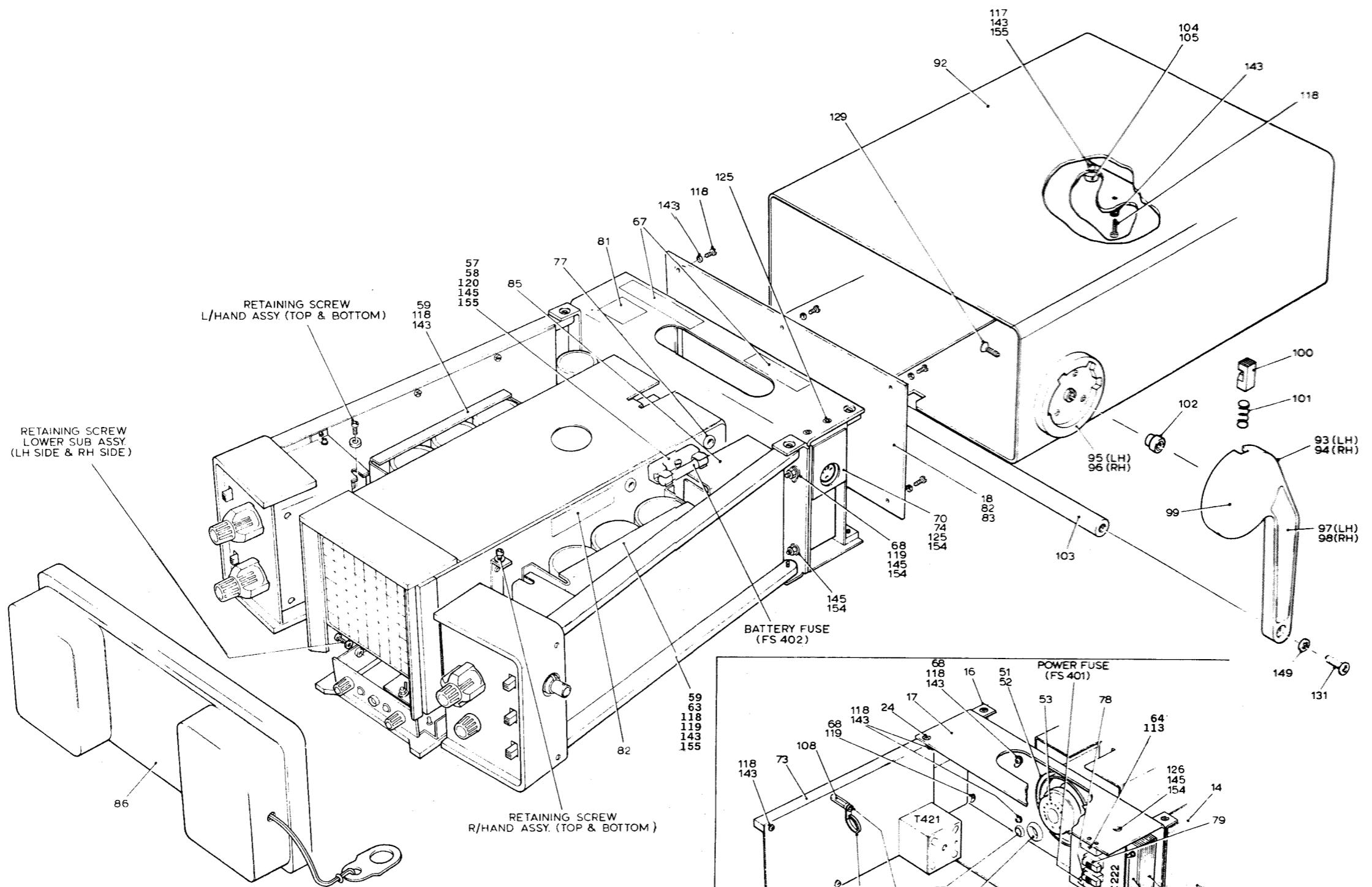
MECHANICAL PARTS

continued

Item No.	Part Number	Description	Item No.	Part Number	Description
147	210-1215-00	Washer 4 BA Shakeproof	154	220-0716-00	Nut 6 BA Full
149	210-1203-00	Washer 2 BA Shakeproof	155	220-0717-00	Nut 6 BA Half
151	210-1165-00	Washer Lock	157	220-0720-00	Nut 6 BA Nylon
153	220-0718-00	Nut 8 BA Full	159	220-0750-00	Nut 3/8" x 32 TPI

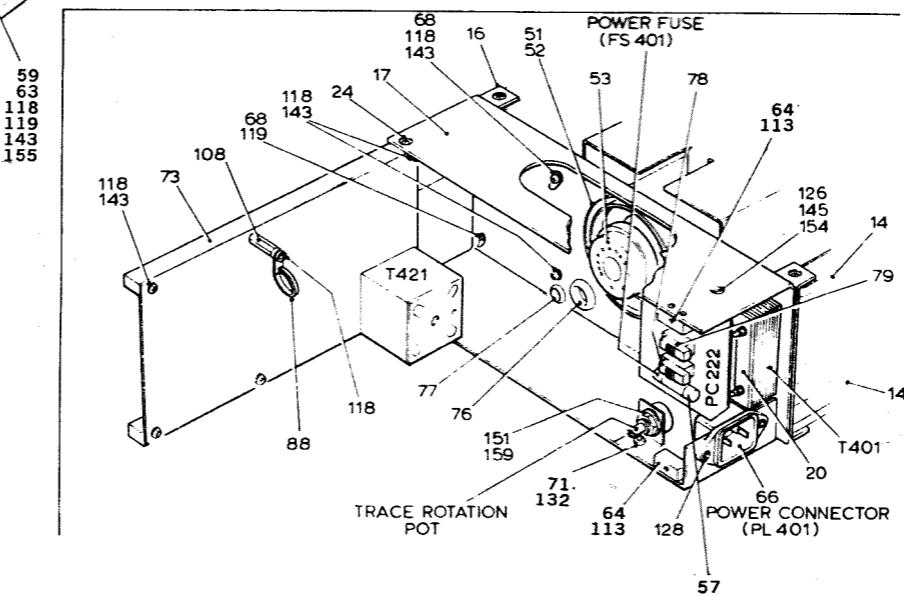
PRINTED CIRCUIT BOARD ASSEMBLIES

Circuit	PC Board	Part Number
Vertical Amplifiers	220 wired	670-4630-00
Volts/Div Switching	221 wired	670-4631-00
Battery Charger	222 wired	670-4632-00
CRT, Regulator & P.S.U.	223 wired	670-4633-00
Trigger Amplifier, Sweep Generator & X Amp and Calibrator	224 wired	670-4634-00
Low Battery Indicator	225 wired	670-4629-00

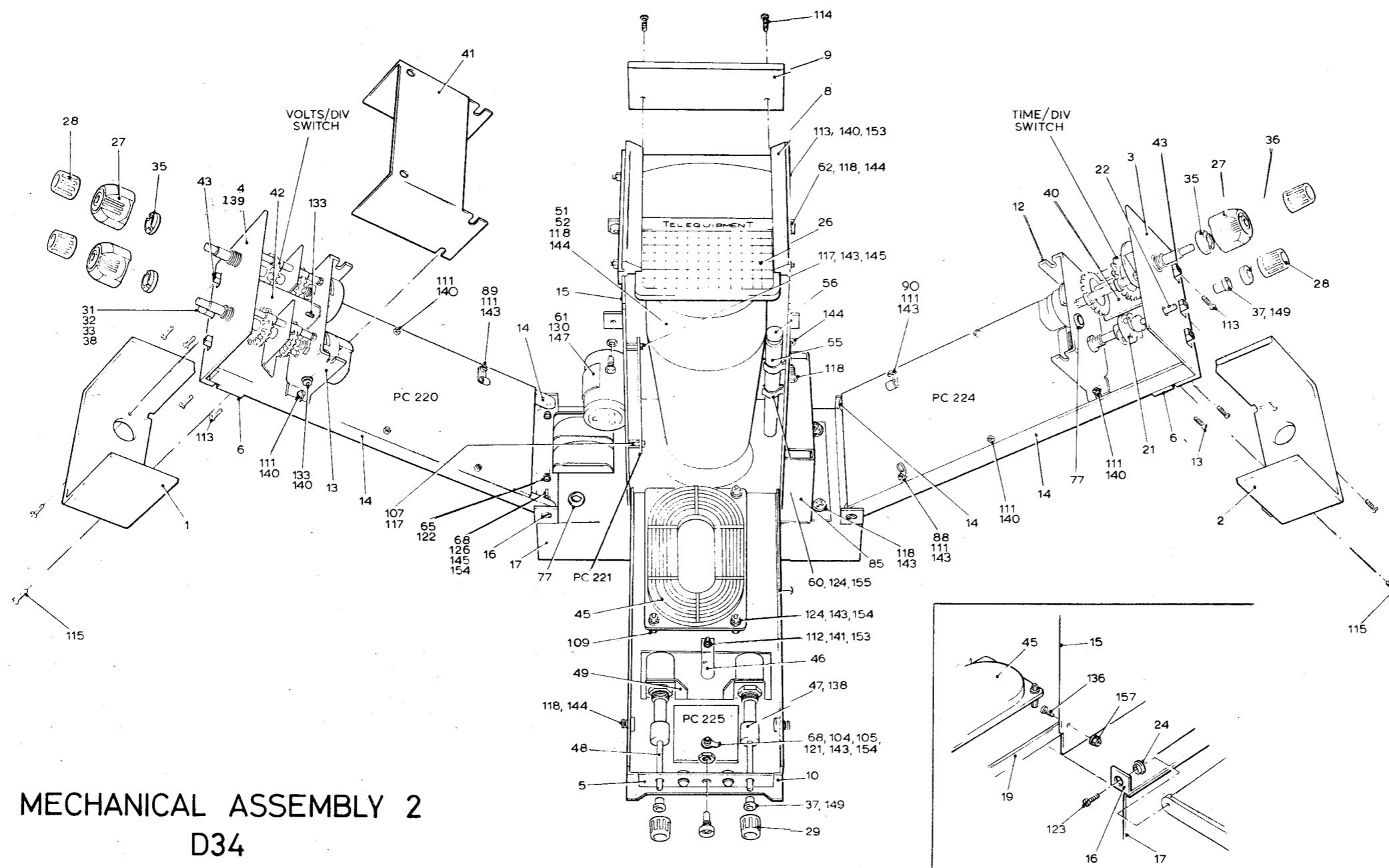


MECHANICAL ASSEMBLY 1

D34



B



B

SECTION 6

CIRCUIT DIAGRAMS

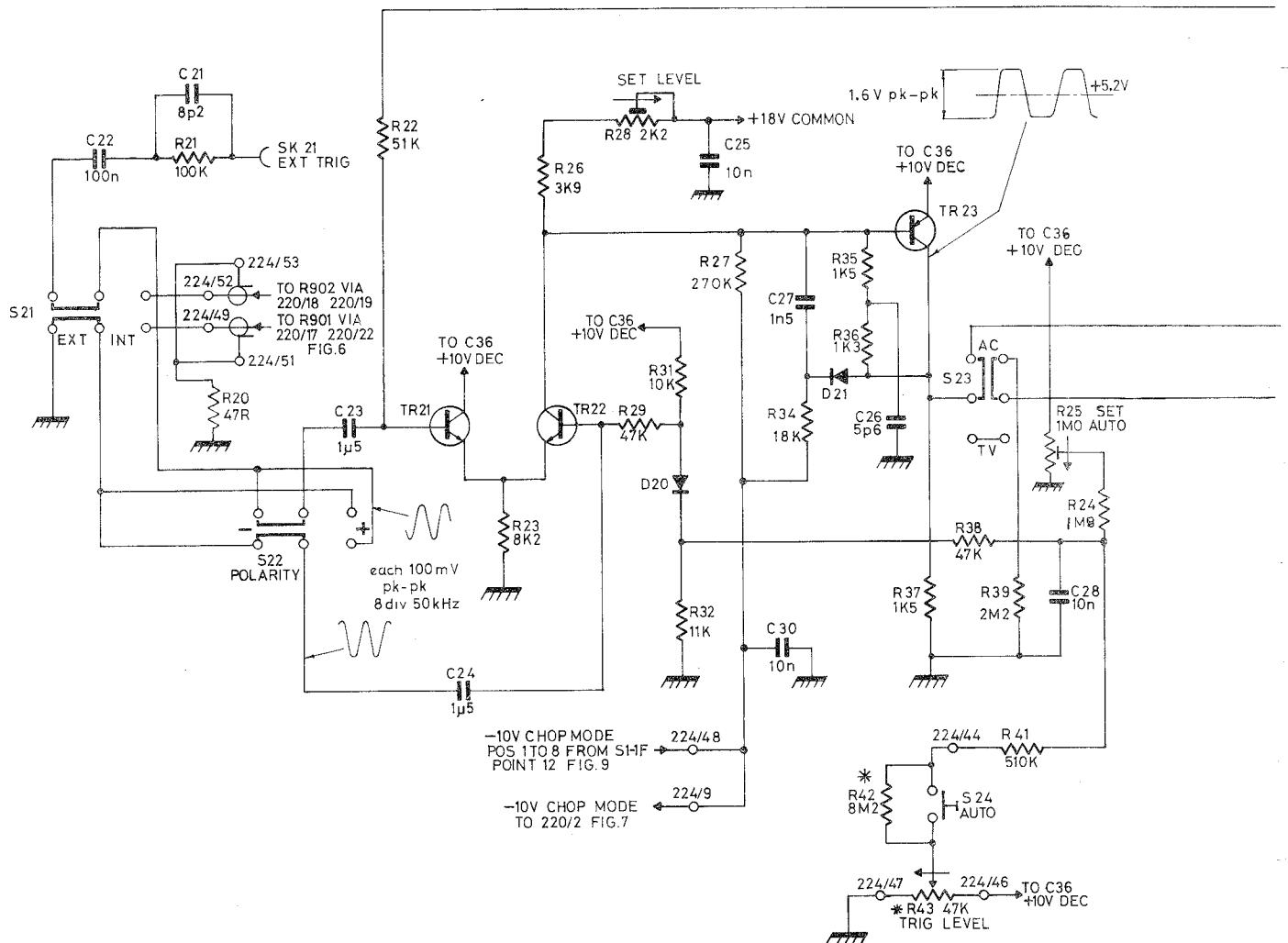
To minimize the risk of misinterpretation of component values on circuit diagrams, the decimal point has been replaced by the multiplier or sub-multiplier of the basic unit. For instance, 2.2 megohms is shown as 2M2 and 1.8 picofarads is shown as 1p8.

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	P.C. Board
1	Trigger Amplifier	224
2	Sweep Generator & Horizontal Amplifier	224
3	CRT	223
4	Battery Charger	222
5	Regulator & PSU	223
6	Volts/Div Switch & Vertical Amplifier	220
7	Vertical Output Amplifier & Switching	220 & 221
8	Low Battery Indicator & Calibrator	225 & 224
9	Time/Div Switch	

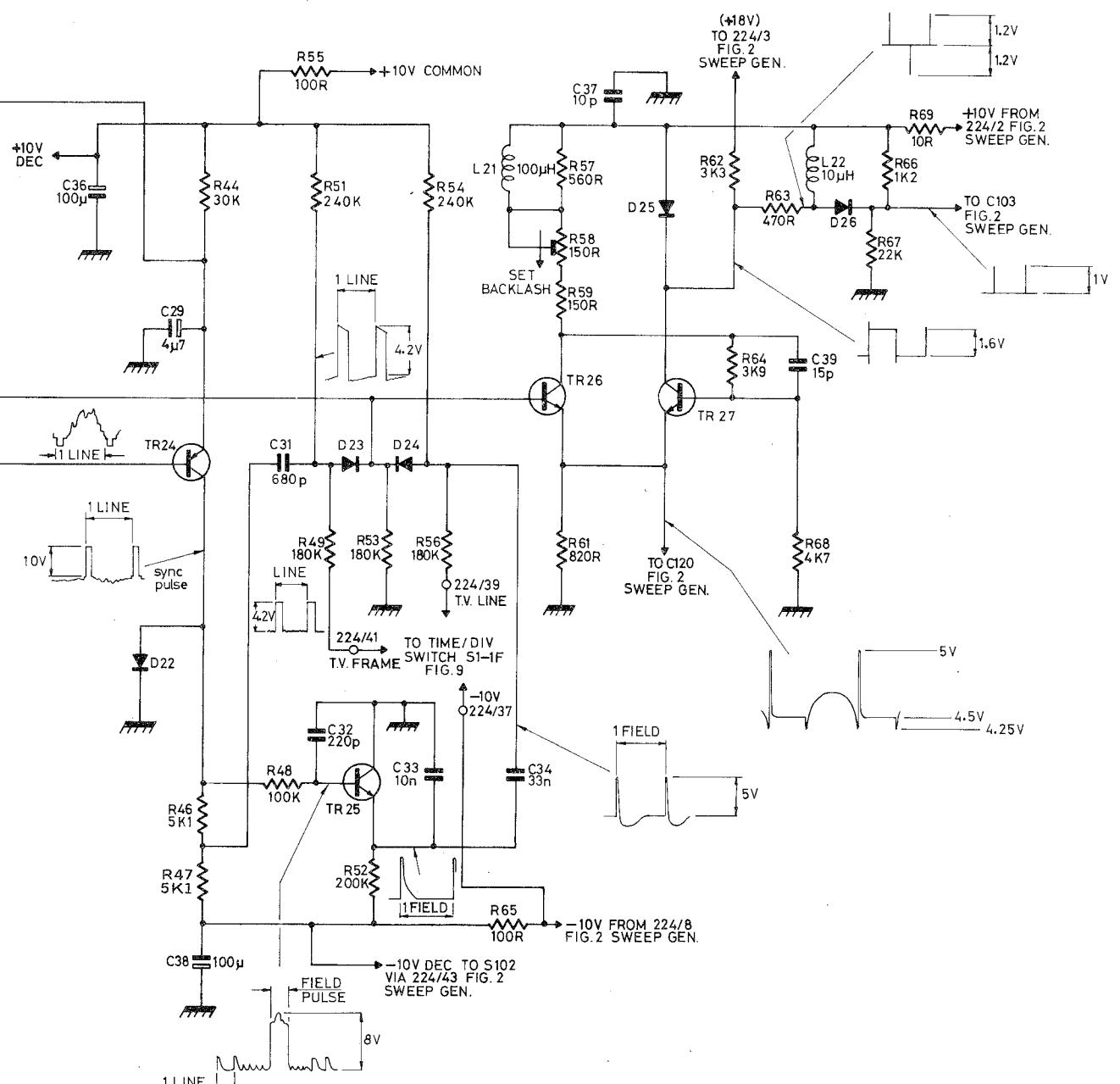
RESISTORS	21	22	26	28 29	27 31	34	35 36	38	25
CAPACITORS	22	21	23	24	25	30	27	26	28
MISC	S21	SK21	TR21	TR22	D20	D21	S24	S23	
	S22								



NOTES.

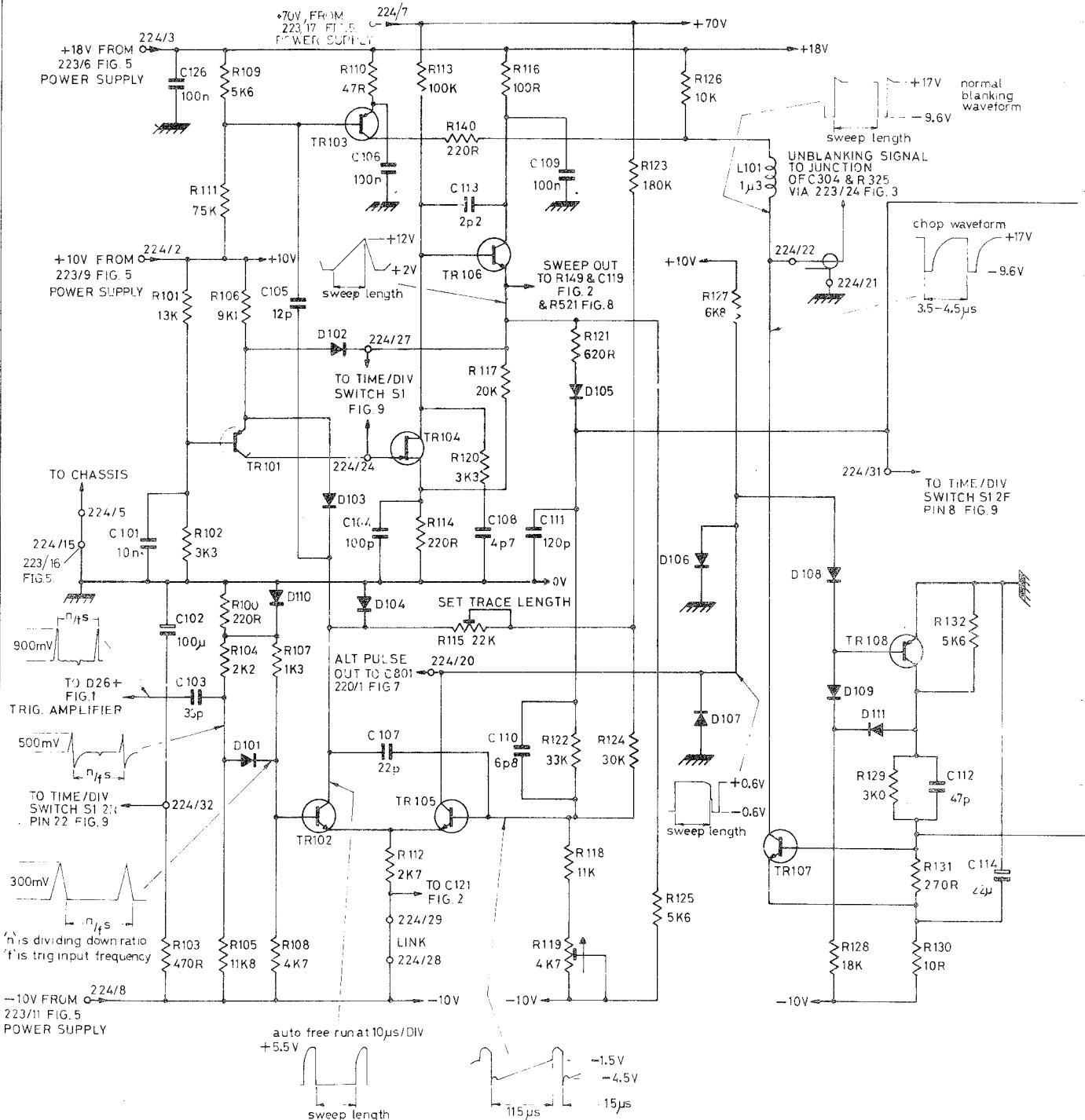
- 1.* DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD.
2. 224/9 DENOTES P.C. BOARD / TAKE OFF POINT OR TERMINAL NO.

44	55 51 49	53 52	54 56	57 58 59 61	62	63 68	66	69
46 47	48			65				
36	29	31	32	33	34	37	39	
				L21	TR 26	D25 TR 27	L22 D26	
D22	TR 24	TR 25						



TRIGGER AMPLIFIER
P.C. 224 FIG.1 D.34

RESISTORS	109 101 111 105 102 104 107 103 105 108 100	110 114 112	113 120 117 115	140 116 108	121 118 119	123 124 125	126 127		129 131 130	132
CAPACITORS	126 101 102 103	105	106 104 107	113 108 111	109 110				112	114
MISC.		TR101 D101 D110	TR103 D103 TR102	TR104 D104	TR106 TR105	D105	D106 D107	TR107	D108 D109 D111	TR108



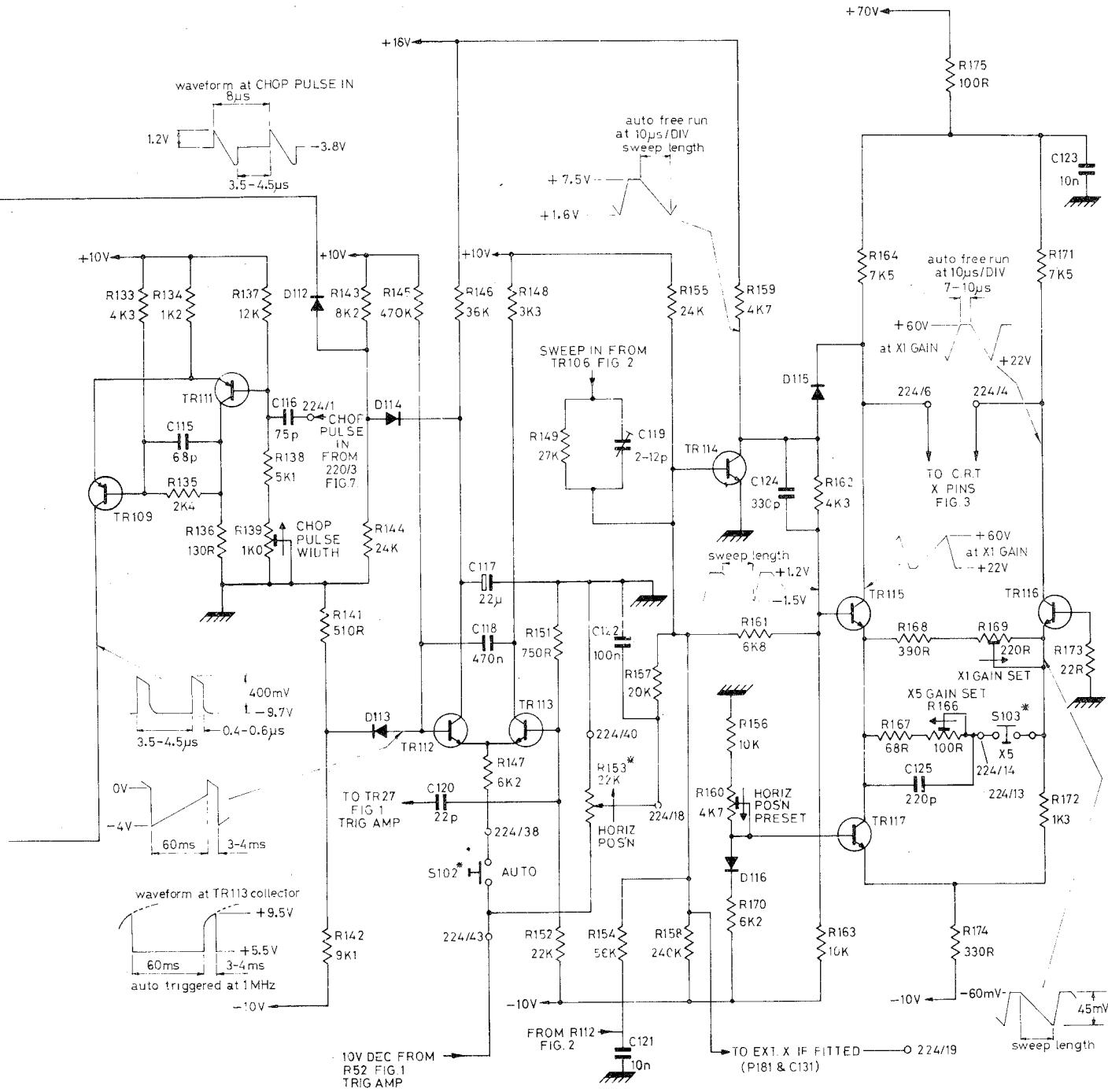
NOTES

1. 224/5 DENOTES P.C. BOARD/TAKE OFF POINT OR TERMINAL N°
2. * DENOTES COMPONENTS NOT MOUNTED ON THE P.C. BOARD

133	134	137	143	145	146	148	149	151	152	153	155	159	160	162	164	168	167	166	171	172
135	136	138	144		147		150	151	152	153		157	158		163		167	166	172	
		139	141																	

115	116		117	118		119	122	121			124			125						
			120																	

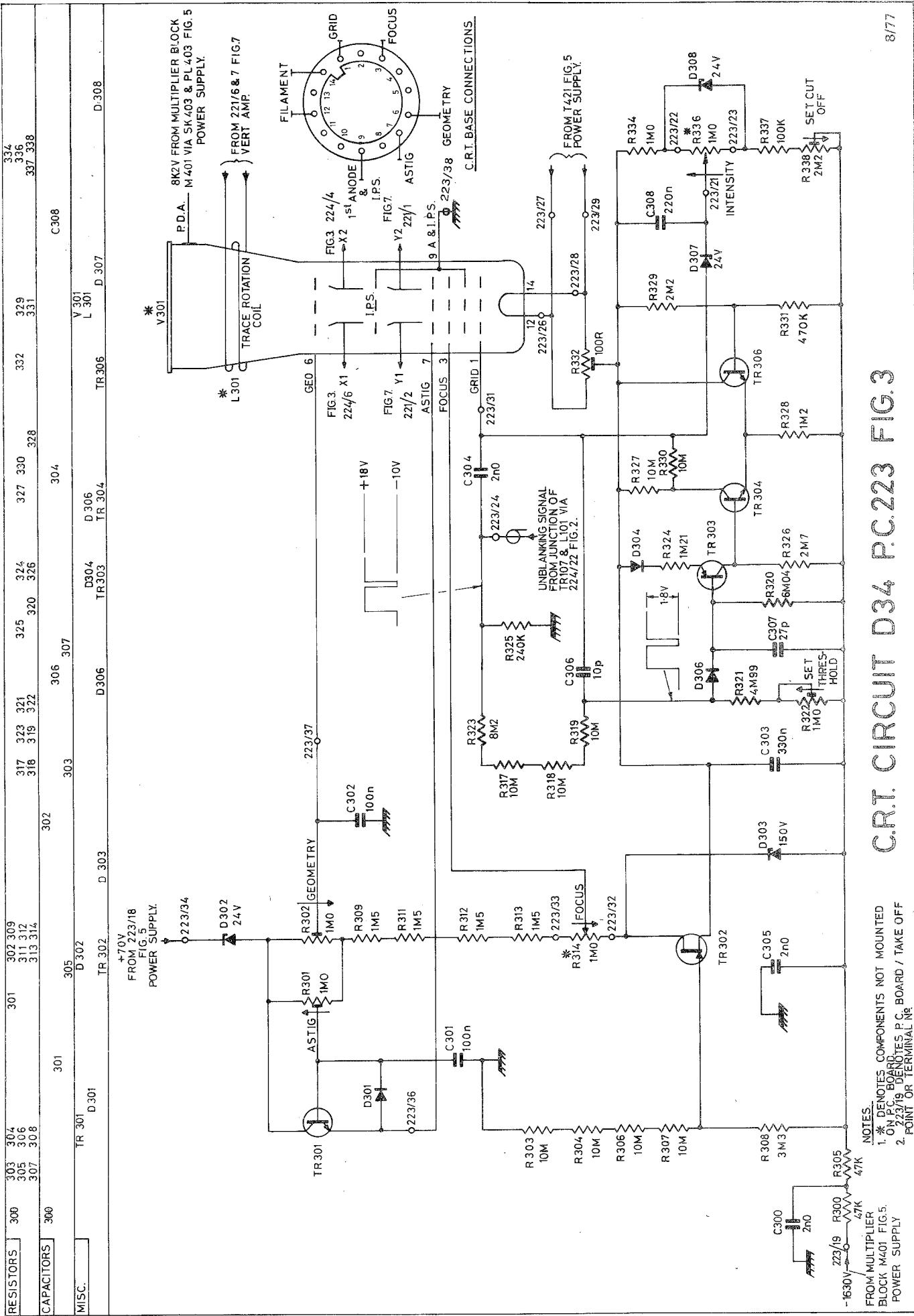
TR109	TR111	D112	D114 D113	TR112	S102	TR113					TR114 D116	D115	TR115 TR117		S103	TR116				
-------	-------	------	--------------	-------	------	-------	--	--	--	--	---------------	------	----------------	--	------	-------	--	--	--	--



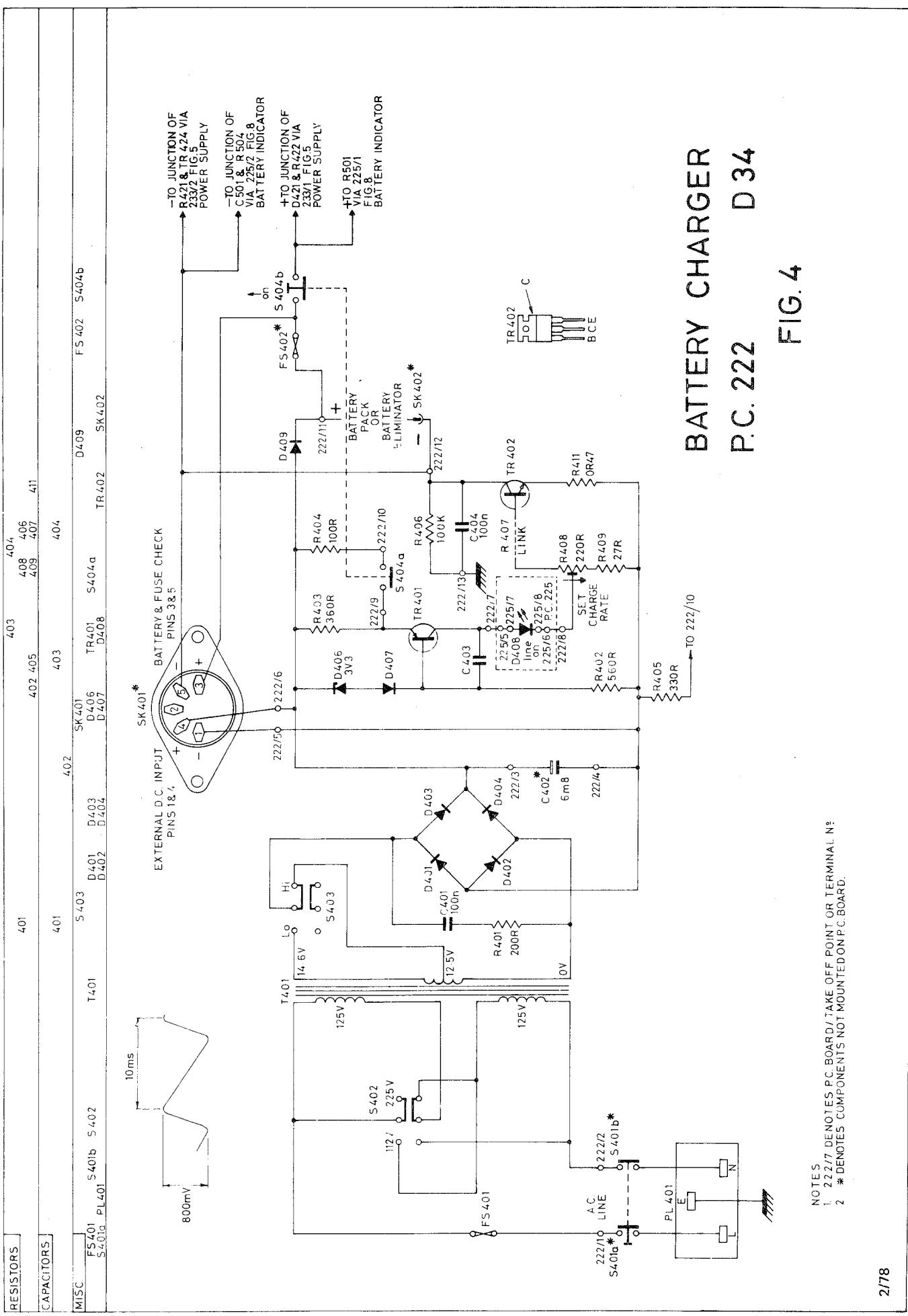
D 34 SWEEP GENERATOR & X AMP.

P.C.224

FIG. 2



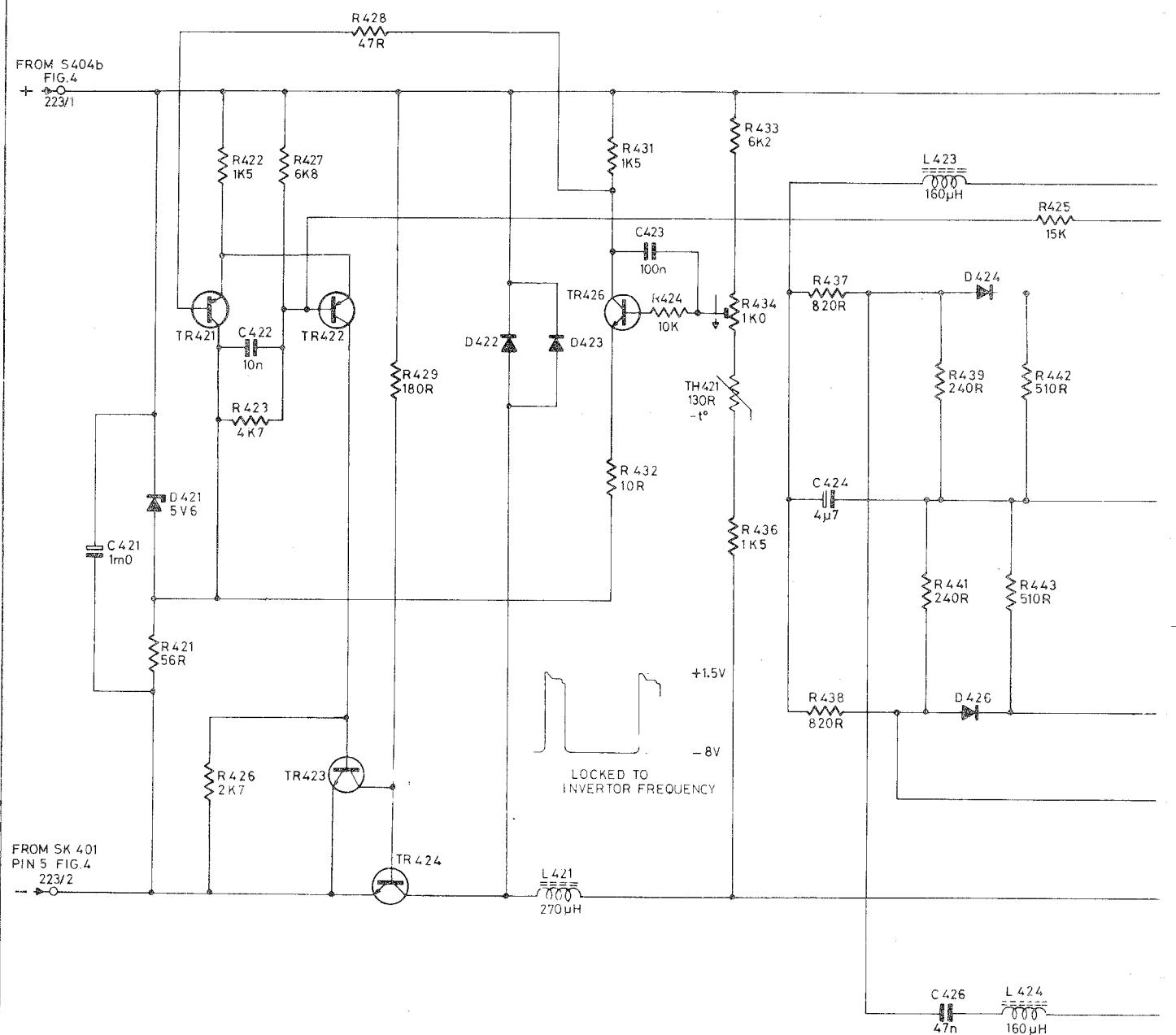
C.R.T. CIRCUIT D 34 P.C. 223 FIG. 3



BATTERY CHARGER
P.C. 222 D 34

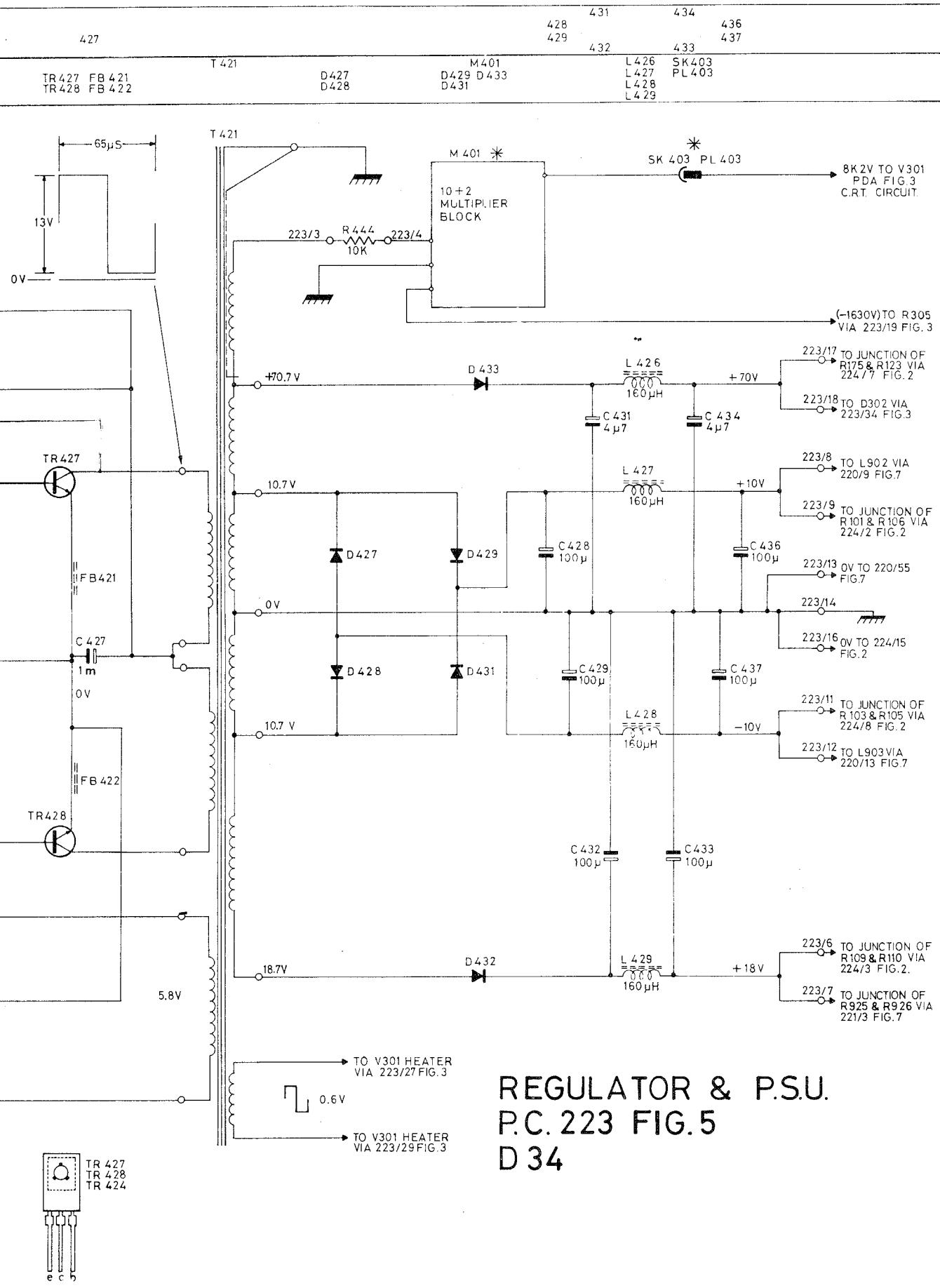
NOTES
 1. 222/7 DENOTES PC BOARD/TAKE OFF POINT OR TERMINAL N°
 2. * DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD.

RESISTORS	422 423 427	428		431	433 434 436	437	439	442
	421 426	429		432 424		438	441 443	425
CAPACITORS			423			424		
	421	422					426	
MISC				D 422	D 423	TR 426	TH 421	L 423 D 424 D 426 L 424
	D 421	TR 421	TR 422 TR 423			L 421		
			TR 424					



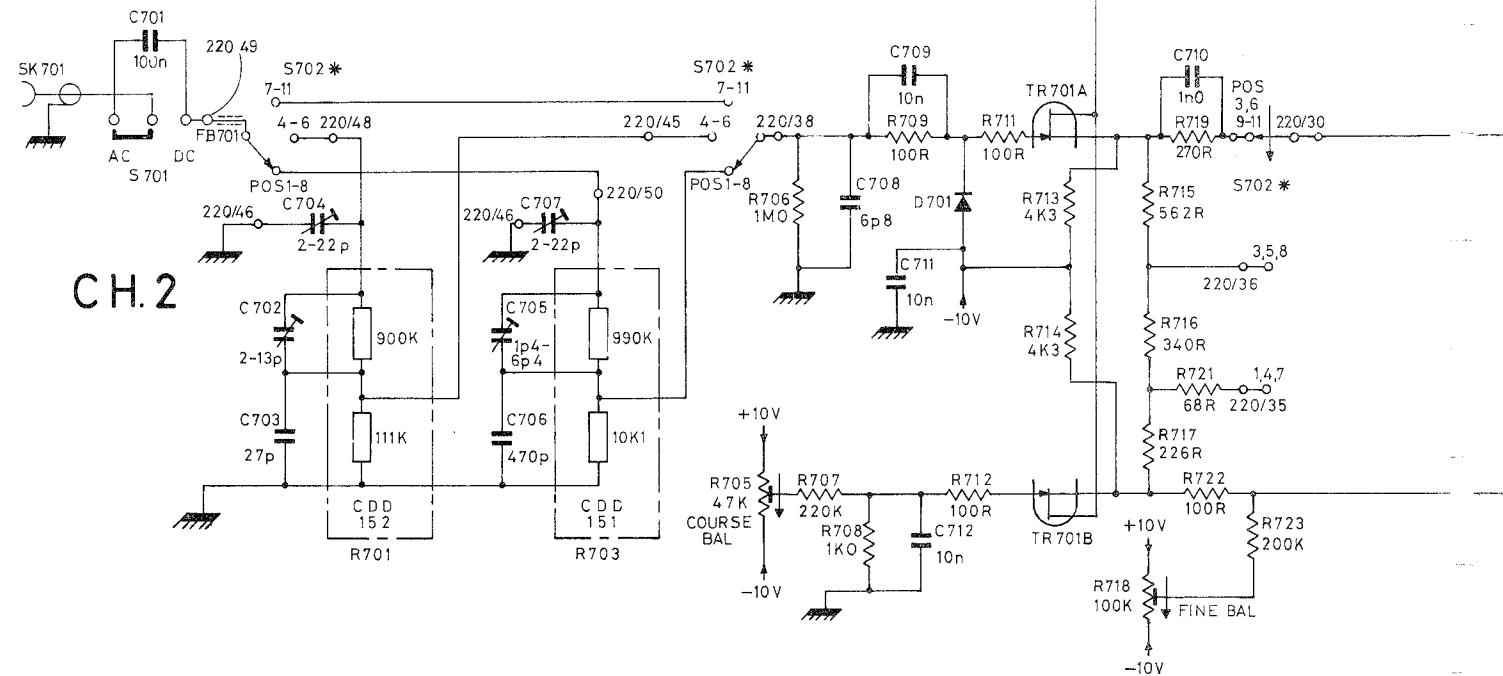
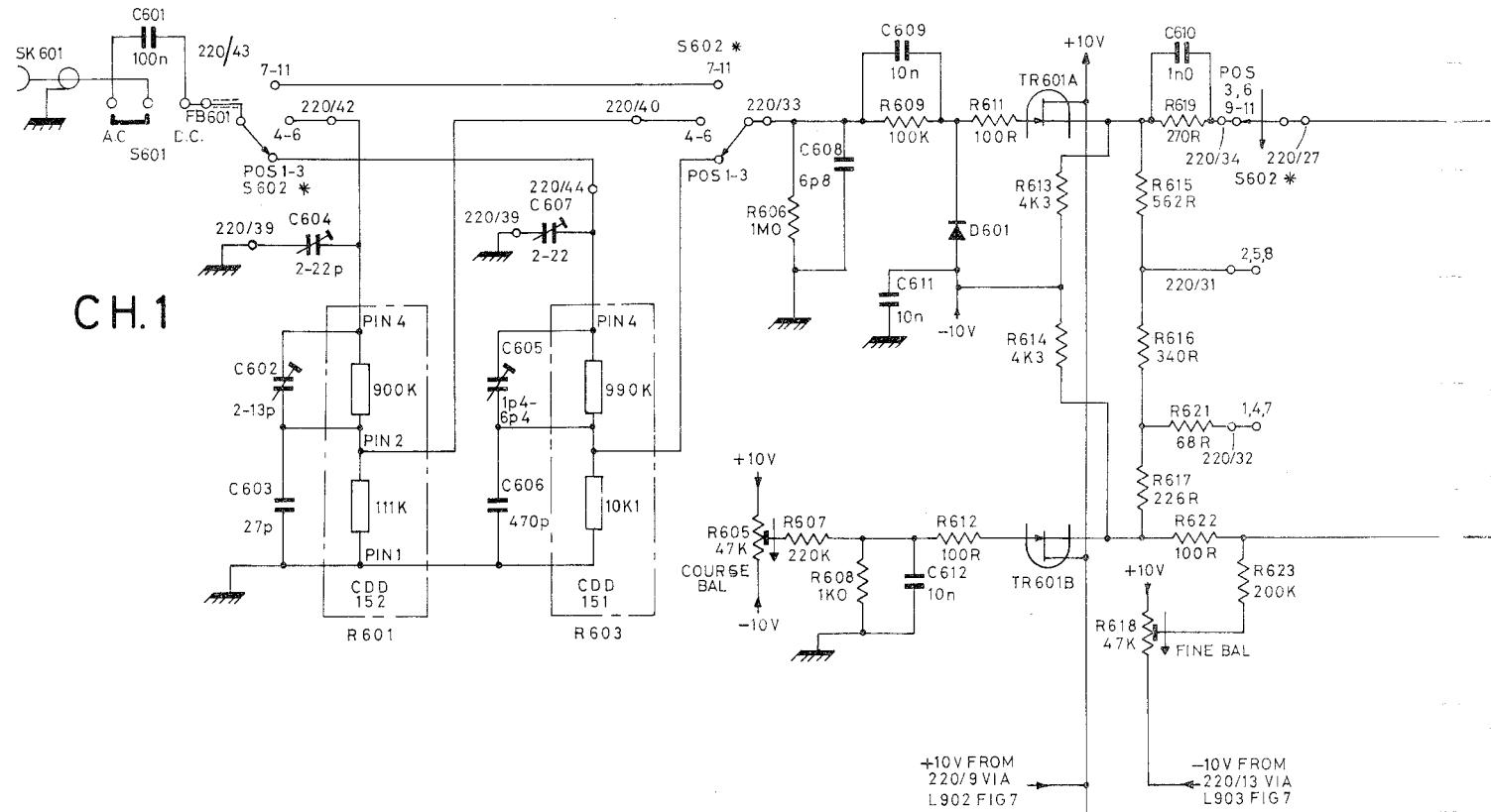
NOTES.

1. * DENOTES COMPONENTS NOT MOUNTED ON PC. BOARD.
2. 223/2 DENOTES P.C. BOARD / TAKEOFF POINT OR TERMINAL N°.

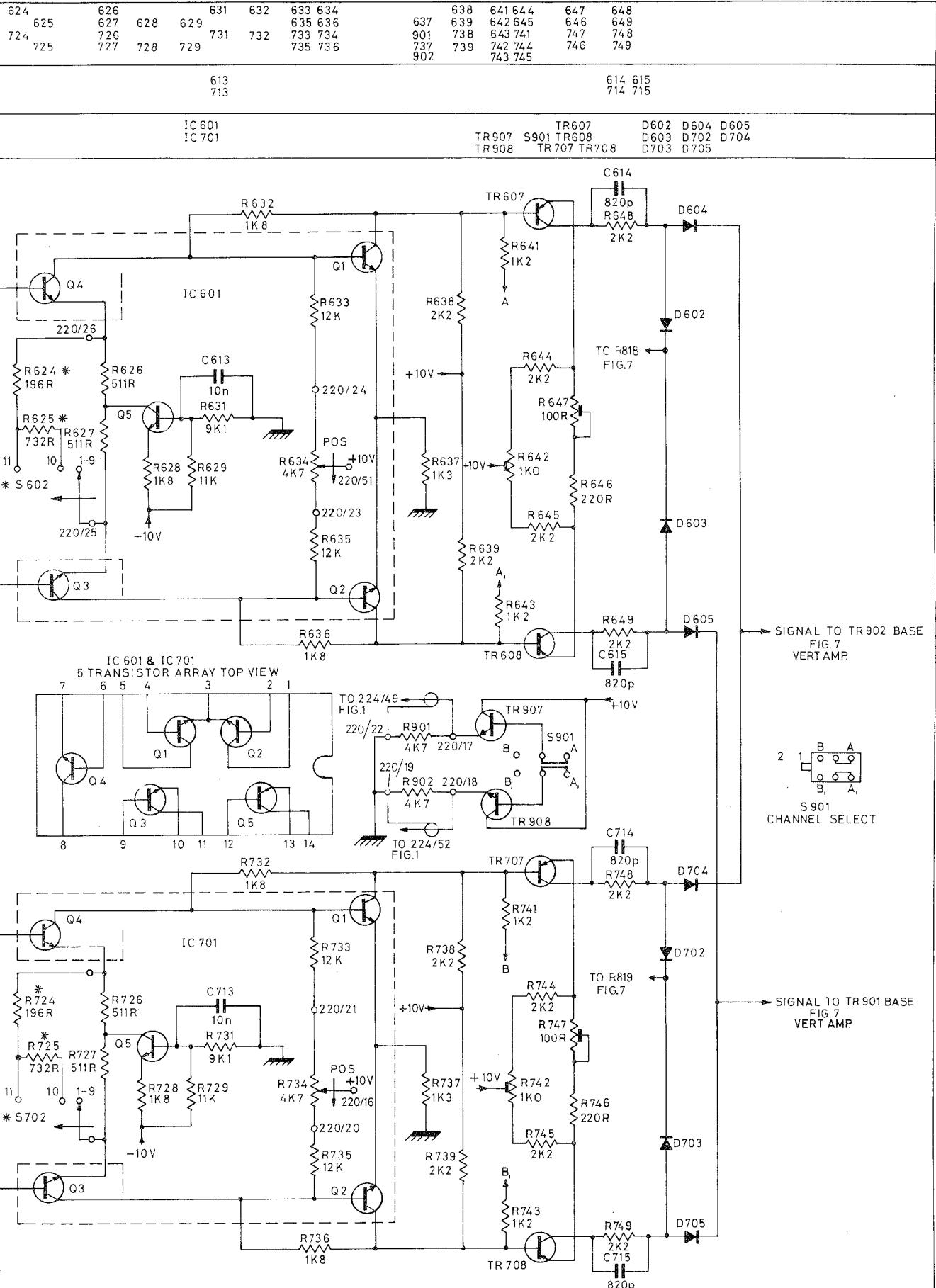


REGULATOR & P.S.U.
P.C. 223 FIG. 5
D 34

RESISTORS	601	603	605 705	606 706	608 708	609 709	611 711	613 713	615 717	616 716	619 719	621 721
	701	703		705	707		712	714				
CAPACITORS	601	602 604 603 704	605 607 606 707		608 609 611 612 709 708 711 712				610			
	701	702 703	705 706						710			
MISC	S601 FB601 S701	S602	S603		S602	D601 D701	TR 601 TR 701		S602			
	SK601 SK701	FB701 S702			S702				S702			

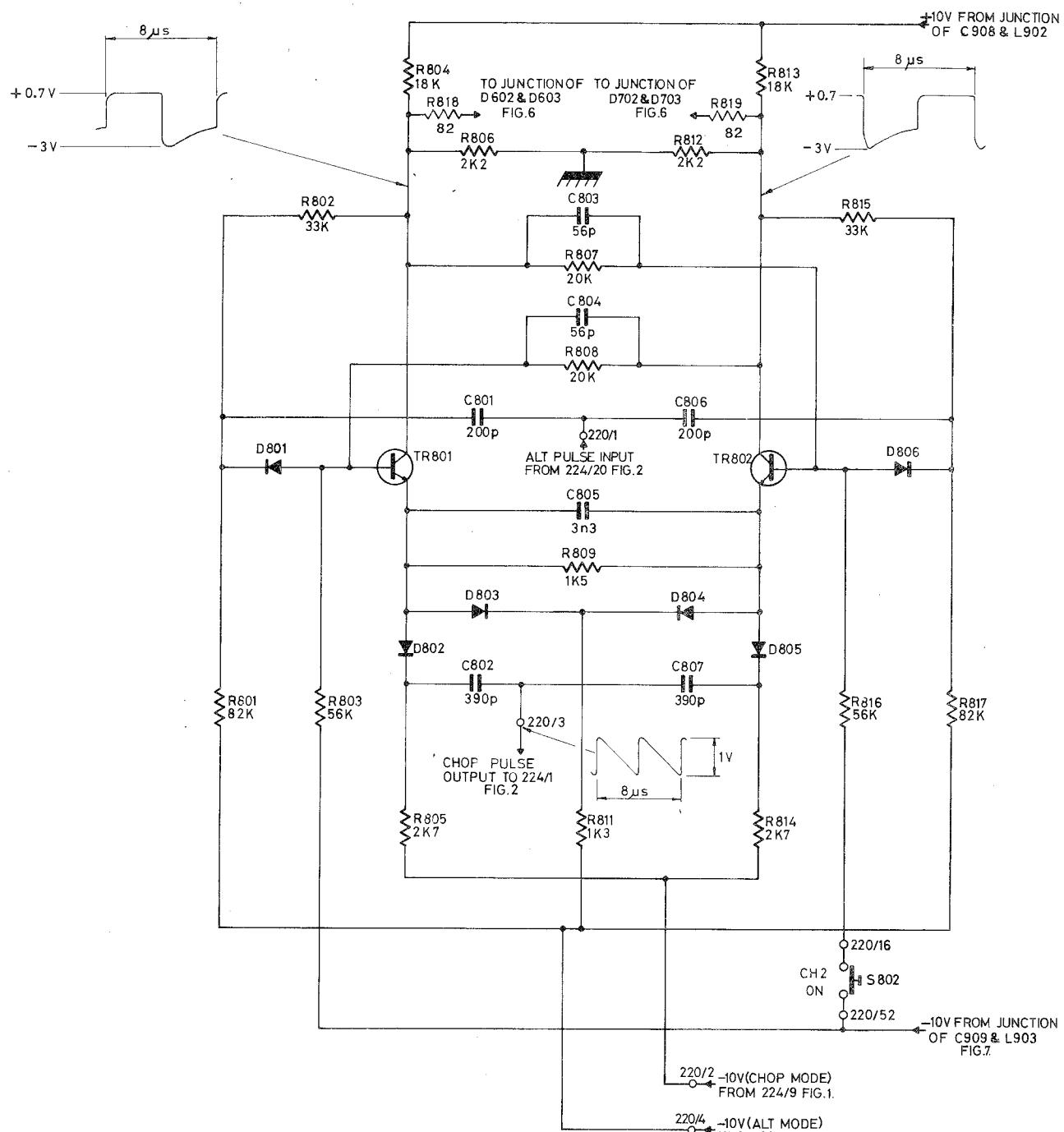


1. * DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD.
2. 220/12 DENOTES P.C. BOARD / TAKE OFF POINT OR TERMINAL NO.

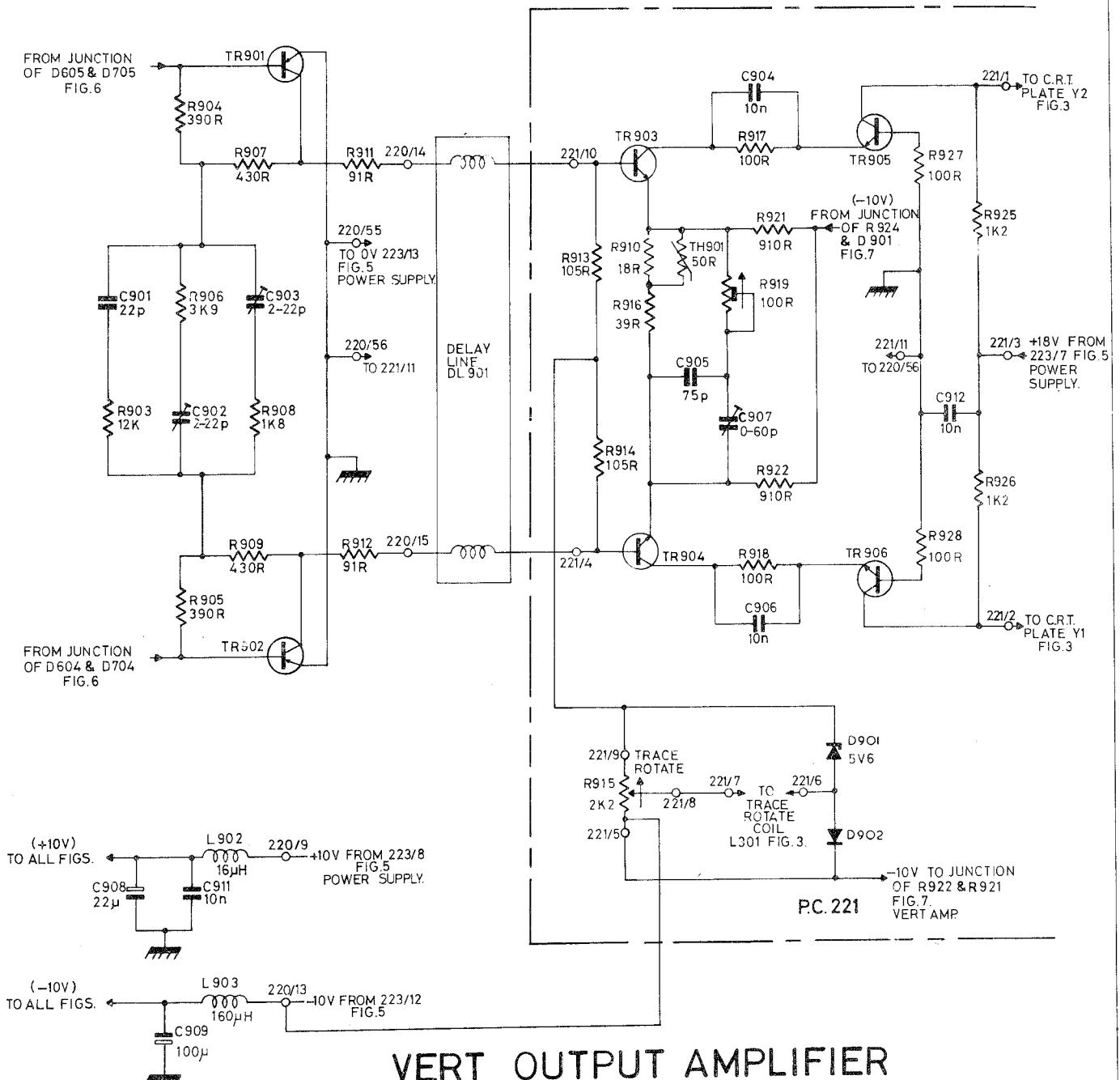


VOLTS/DIV. SWITCH & VERTICAL AMPLIFIERS.
P.C. 220 D 34 FIG.6.

RESISTORS		804	806	807 808 809 811	812	813		
		801	802 803	805 818	819 814	815 816	817	
CAPACITORS				803 804 805 807	806			
MISC		D 801	TR 801 D 802	D 803	D 804	TR 802 D 805	D 806	S 802



	904	907	911			913	916	919	917	921	922	927	925
903	906	908		912		914	910	918	915	920	922	928	926
	905	909					915					927	925
901		903				905	907		904			912	
	902								906				
	908	909	911										
L902		TR 901		DL 901		TR903	TR904	TH901	L901	D901	TR906		
L903		TR 902								D902			

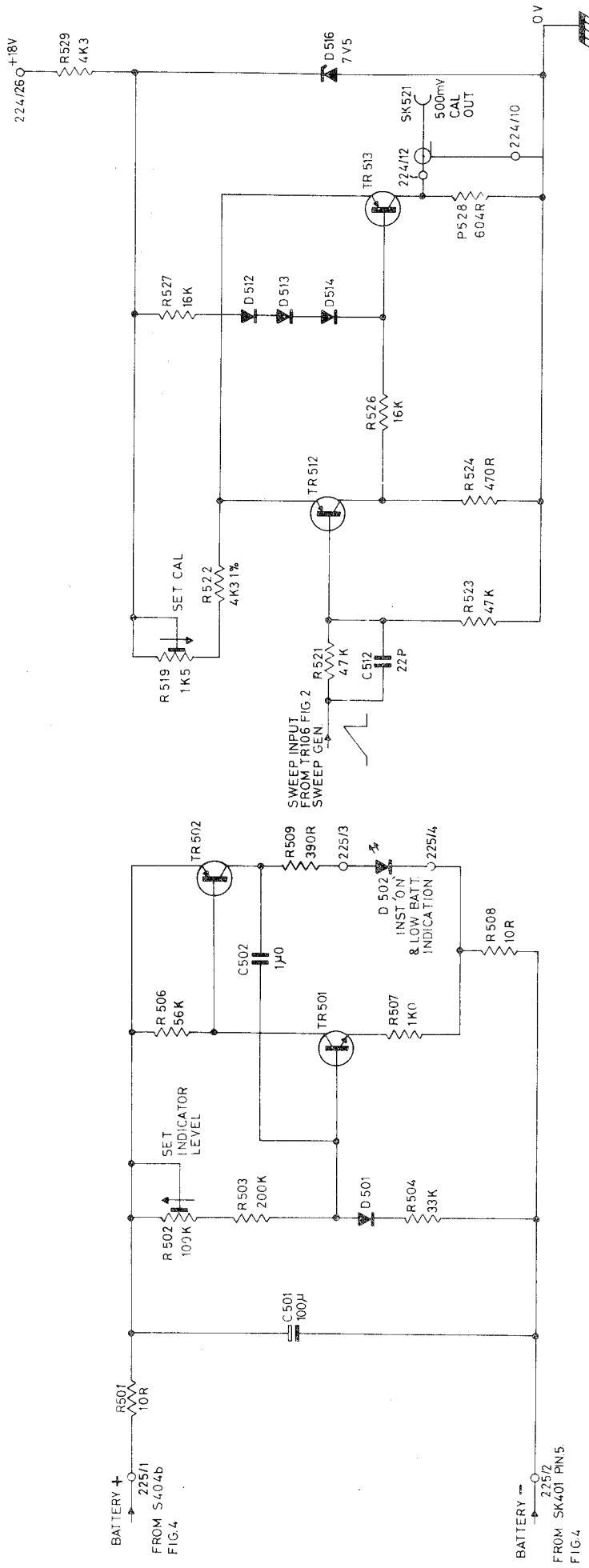


VERT OUTPUT AMPLIFIER & SWITCHING PC 221 & PC 220

D.34 FIG. 7

FOR [R 901, R 902, TR 907, TR 908] SEE FIG. 6.
S 901.

RESISTORS	501	502 503 504	506	509	519	521	522	526	527	529
CAPACITORS	510	D501	507	508	523	524			528	
MISC.			502	TR501	TR502 D502	512	TR512	D512	D513 D514	D516



LOW BATTERY INDICATOR

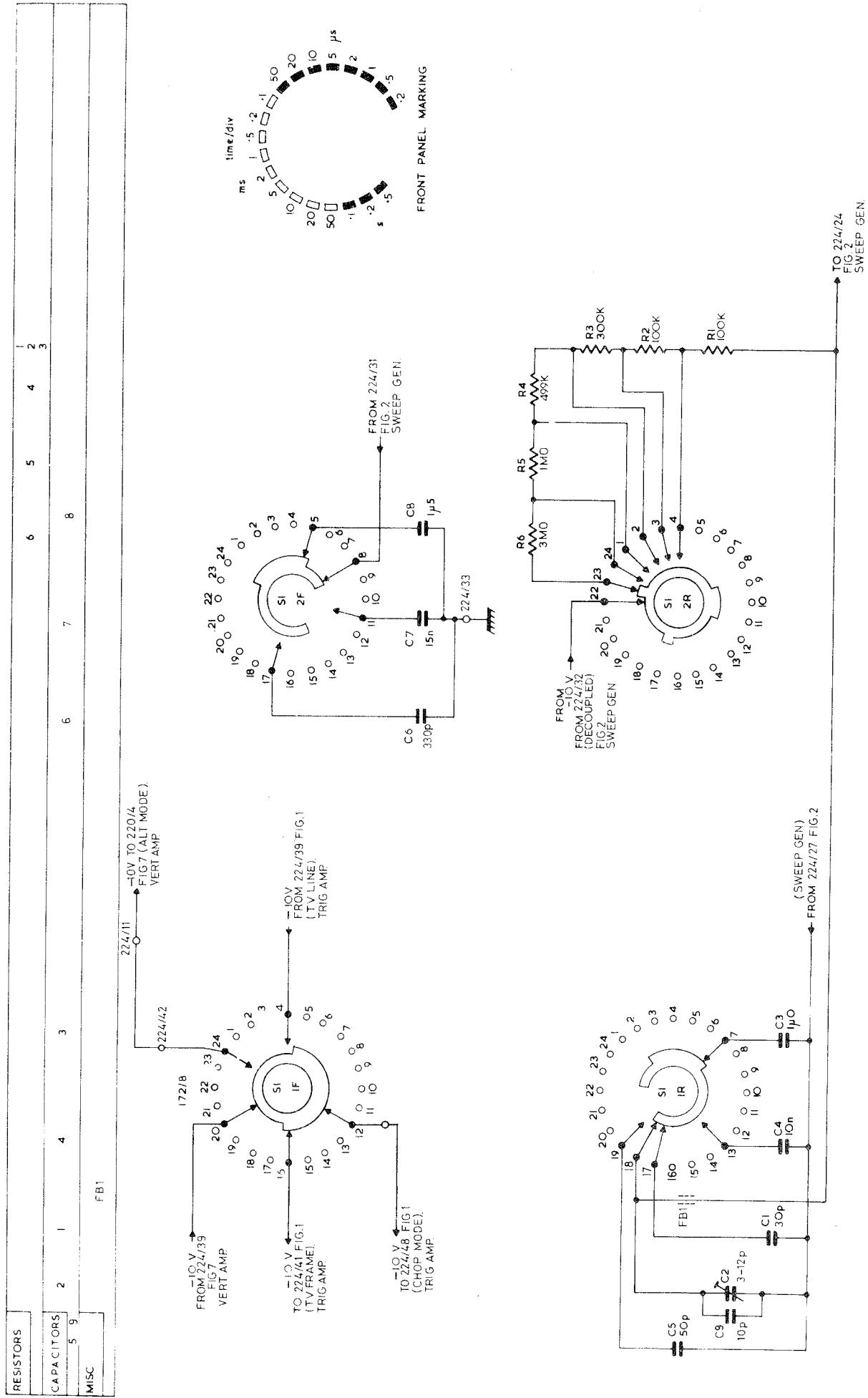
P.C. 225

NOTES:
 1. * DENOTES COMPONENTS NOT MOUNTED ON P.C. BOARD.
 2. 225/2 DENOTES P.C. BOARD / TAKE OFF POINT OR TERMINAL N°

CALIBRATOR

FIG. 8 D 34
P.C. 224

FIG. 8 D 34



D34 TIME/DIV. SWITCH FIG.9

SECTION 7

STANDARD OPTIONS

If the standard D34 instrument to which this manual applies has been supplied with one or more of the Standard Options listed below, the appropriate technical data must be used in conjunction with the standard manual information.

- Option 4 P7 CRT (Part Number 037-4136-07) fitted in place of standard P31 tube.
- Option 6 For operation on 115V line voltage and fitted with USA power cord (Part Number 161-0104-02)
- Option 8 Addition of Variable sweep speed facility. See separate supplement, Part Number 070-2593-00
- Option 10 Addition of External X input facility. See separate supplement 070-2594-00



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**OSCILLOSCOPE
TYPE D34
OPTION 8 SUPPLEMENT
INSTRUCTION MANUAL**

070-2593-00

Issue 1
July 1978
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INTRODUCTION

This is a supplement to the standard D34 Instruction Manual and describes the addition of the Variable Time/Div control to the standard instrument. The facility provides intermediate sweep speeds of at least 2.5 : 1 between adjacent fixed calibrated positions of the Time/Div switch. A mechanical detent at the extreme end of the track of the variable control in the clockwise position gives positive location for the CAL function.

The information is arranged in the order in which the corresponding sections in the standard manual appear.

SECTION 2

OPERATING INSTRUCTIONS

The following instructions are in addition to those quoted in Section 2 of the Instruction Manual for a standard D34 instrument

First Time Operation

Variable Time/Div - pull out and turn clockwise to CAL position.

Switch On

After setting the Time/Div Switch, turn the Variable Time/Div anticlockwise and observe the changes in sweep speed.

Use of Additional Facilities

Variable Time/Div, push in to obtain the Level control in the Auto position only. 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 obtained.

SECTION 3

CIRCUIT DESCRIPTION

(Refer to Figure 2A)

The negative end of the sweep timing resistor chain R1 to R6 is connected to the wiper of R140 (Variable Time/Div control) which together with R120 forms a potential divider network between ground and the junction of C102 and R103; the potential being nearly -10V. Rotation of R140 provides a variable negative DC supply to the resistor chain and the resulting changes in the voltage and current cause the sweep speed to vary.

SECTION 4

CALIBRATION

The following procedure should be used in addition to para 4.3.8 in the standard Manual

The instrument is now ready for calibration according to the following procedure; Extreme care must be taken not to touch high voltage tags which may be exposed when the instrument is switched on.

- a) Select CH1 DC, AC mode, INT source, +ve slope.
- b) Connect the instrument to the a.c. line.
- c) Set Time/Div to 0.1ms and Trig to AUTO.
- d) Switch on instrument and display a free running trace.
- e) Apply a 1kHz squarewave from calibrator to CH1, adjust attenuator to display one complete cycle of squarewave.
- f) Adjust if necessary, R169 on PC244 to align the positive going edge of the squarewave with the extreme vertical graticule lines.
- g) Set the Variable Time/Div control to fully anticlockwise and note that sweep speed reduction is at least 2.5 : 1.
- h) Return the Variable Time/Div to the CAL position.
- j) Check the calibration using the pulse from a marker generator for every third sweep speed.

SECTION 5

COMPONENT LISTS

Electrical Parts

R120 Pt. No. 317-0562-01 5K6 ohms Type C 5% tol 125mW

R140 Pt. No. 311-1891-00 10k ohms Type CV 20% tol 250mW

Wire, blue PVC insulated 7/0.2 Pt. No. 175-0800-00 x 95mm

Mechanical Parts

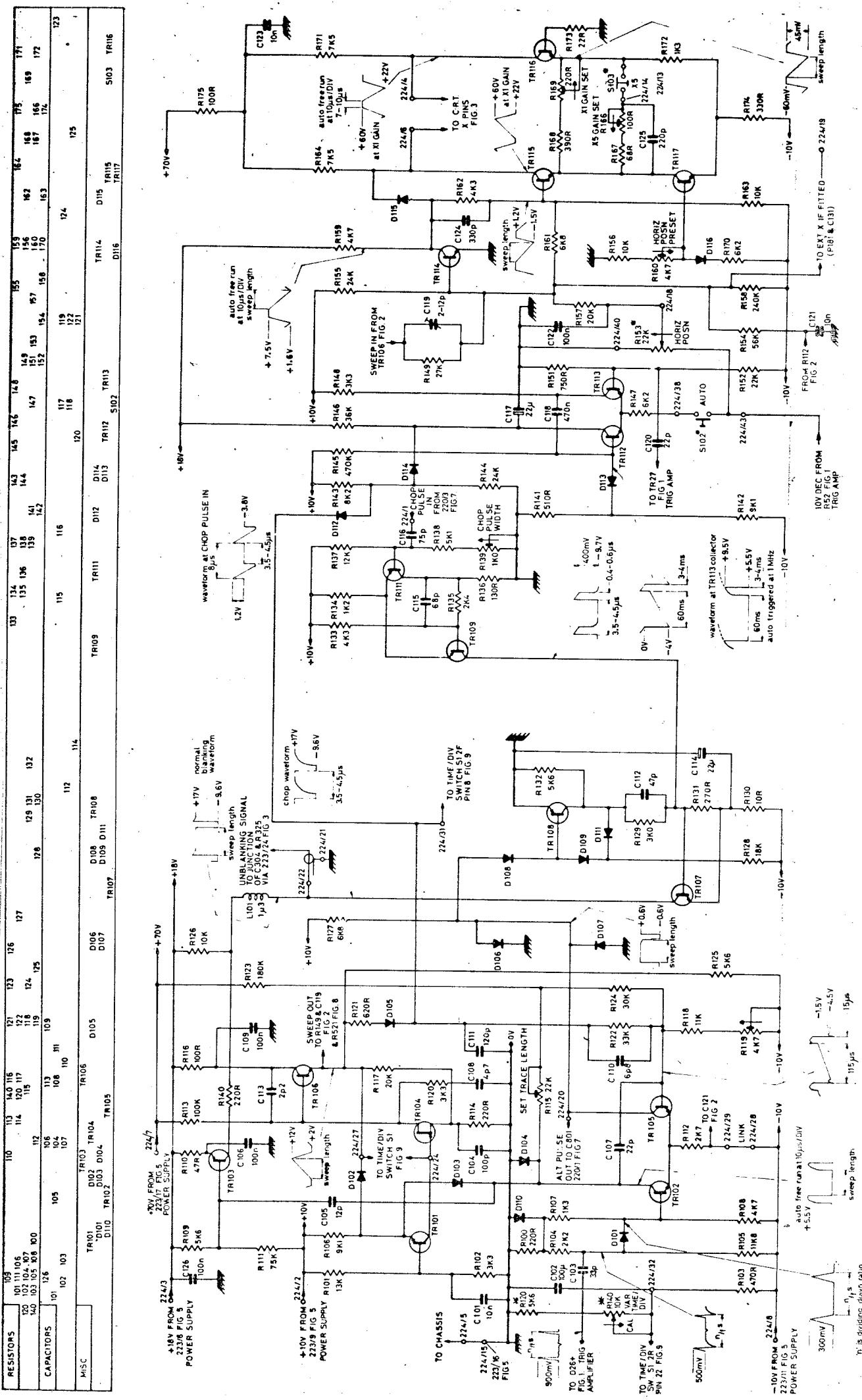
Chrome slotted ring nut R140 Pt. No. 200-0527-00.

Knob Assembly (Variable Time/Div) Pt. No. 366-1254-02.

Knob Assembly (Level) Pt. No. 366-1656-01.

Shaft Extension Pt. No. 384-1444-00.

Front Panel Pt. NO. 333-2197-02.



**D 34 SWEEP GENERATOR & X AMP – P.C. 224
OPTION 8 VARIABLE TIME/DIV.**

1. 224/5 DEICTES P.C. BOARD / TAKE OFF POINT OR TERMINAL NO.
2. * INDICATES COMPONENTS NOT MOUNTED ON P.C. BOARD

NOTES

1. 224/5 DEICTES P.C. BOARD / TAKE OFF POINT OR TERMINAL NO.

2. * INDICATES COMPONENTS NOT MOUNTED ON P.C. BOARD

FIG. 2A



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OSCILLOSCOPE
TYPE D34
OPTION 10 SUPPLEMENT
INSTRUCTION MANUAL

070-2594-01

Issue 2
December 1978
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INTRODUCTION

This is a supplement to the standard D34 Instruction Manual and describes the addition of the External X switch to the standard instrument. The facility allows an external signal to be applied directly to the horizontal amplifier.

The information is arranged in the order in which the corresponding sections in the standard manual appear.

SECTION 1

SPECIFICATION

- a) Bandwidth (x1 and x5 horizontal gain) 6Hz to 600kHz
- b) Horizontal gain x1 3.75V/div ±15%
- x5 750mV/div ±15%

with horizontal sensitivity at 50kHz and internal battery P.D. 8V (nominal).

Note. Horizontal sensitivity is inversely proportional to internal battery P.D.

- c) Input impedance (Trig Source set to INT) 100kΩ.

SECTION 2

OPERATING INSTRUCTIONS

- 2.1 The EXT X Mode switch is of the slider type fitted with an indicator block visible through an aperture underneath the instrument. It can be set to either 'NORM' OR 'EXT X' by using a screwdriver.
If the EXT X Mode is required proceed as follows:-

- a) Set switch to EXT X.
- b) Switch off CH2.
- c) Apply signal to EXT Trig connector (BNC).
- d) Return switch to NORM after use.

SECTION 3

CIRCUIT DESCRIPTION

(Refer to Figures 1A & 2B)

- 3.1 In the EXT X Mode, switch S1001 disables the sweep generator, open circuits the tail resistor R112 of the gating bistable, and applies a negative bias to the X amplifier driver TR116 via resistor R1001. The resulting effect is to display a stationary spot at the horizontal centre of the screen. A signal applied to Ext Trig SKT21 is fed to the horizontal amplifier driver TR114 via DC isolating capacitor C1001 and resistor R181. A positive going signal causes the spot to move to the right, and a negative signal to the left.

SECTION 4

CALIBRATION PROCEDURE

4.1 Initial Setting

- a) Select CH1 AC & trig, AC Mode, EXT Source, +ve slope, instrument off, CH2 off, and EXT X (new switch).
- b) Connect instrument to a.c. line and switch on.

4.2 Check Bandwidth as follows:-

- a) Select xl Sweep rate.
- b) Apply a 50kHz sinewave signal to the EXT socket and adjust the signal generator for 3 divs p-p display on the horizontal axis.
- c) Change the input signal to 600kHz and check that display is greater than 2.1 divs p-p.
- d) Change the input signal to 6Hz and check that display is greater than 2.1 divs p-p.
- e) Select x5 Sweep rate.
- f) Apply a 50kHz sinewave signal to the EXT socket and adjust the signal generator for 5 divs p-p display on the horizontal axis.
- g) Change input signal to 600kHz and check that the display is greater than 3.5 divs.
- h) Change input signal to 6Hz and check that the display is greater than 3.5 divs.

4.3 / Check Horizontal Sensitivity as follows:-

- a) Select x1 Sweep rate.
- b) Apply 1kHz 10V squarewave signal to EXT socket from a calibrated source, and check that the distance between the two bright spots on the display is greater than 3.3 divs p-p.
- c) Select x5 Sweep rate.
- d) Apply 1kHz 2.5V squarewave signal to EXT socket from a calibrated source, and check that the distance between the two bright spots on the display is greater than 4 divs p-p.
- e) Switch off instrument and remove all external leads.
- f) Close the RH Panel and secure in position with the screws.
- g) Fit new Cabinet Cover so that the aperture on the underside coincides with the new switch block and secure with the two screws.

SECTION 5

COMPONENT LISTS

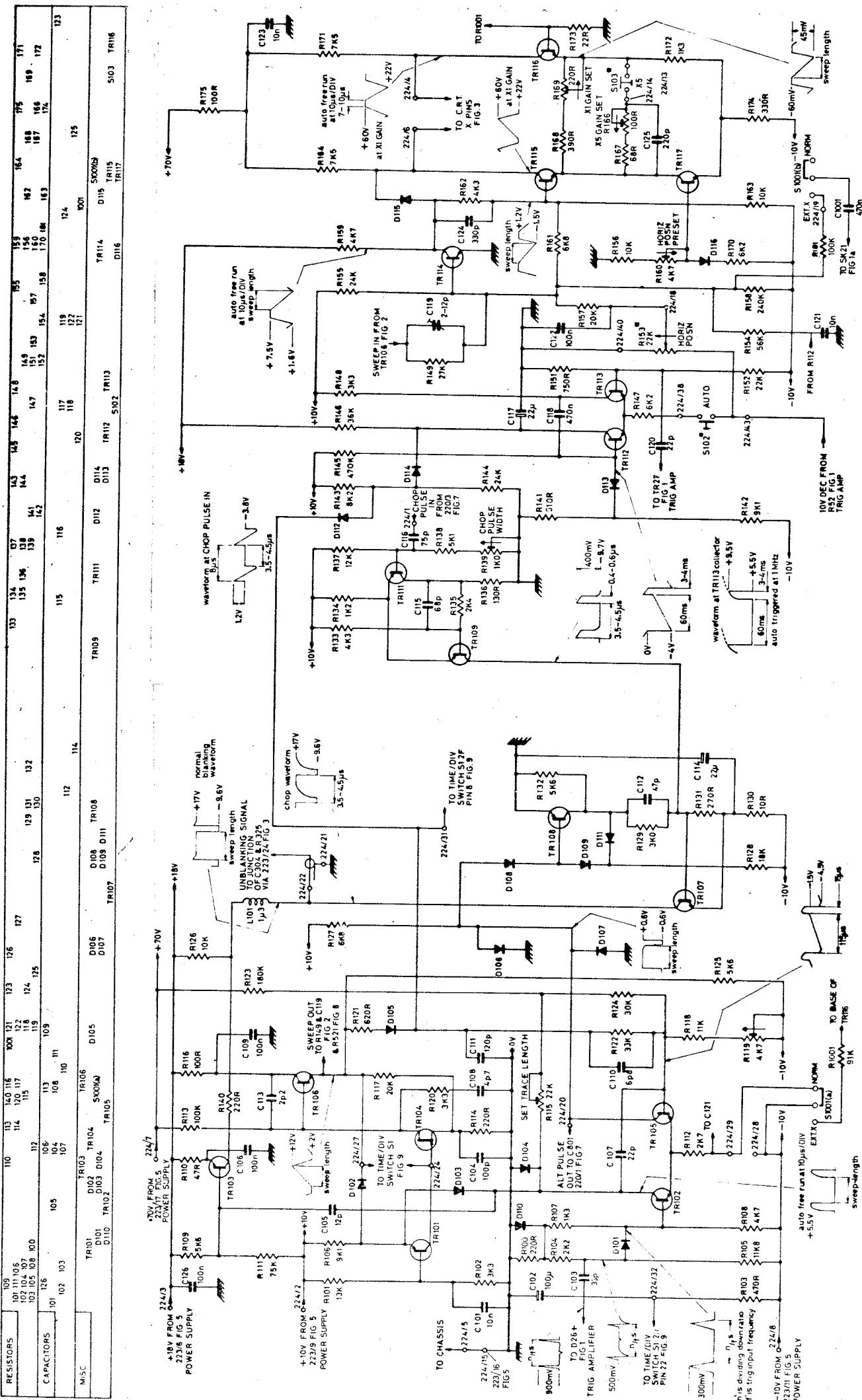
Electrical Parts

C1001Pt. No. 285-1135-00 470nF PE 10% tol 250V DC	*
R181 Pt. No. 317-0104-01 100k ohms Type C 5% tol 125mW	
R1001Pt. No. 317-0913-01 91k ohms Type C 5% tol 125mW	
S1001Pt. No. 260-1429-00 DPDT Type 51MP slider	*
Wire, blue, PVC insulated, 7/0.2 Pt. No. 175-0800-00 x 38mm	*
Wire, brown, PVC insulated, 7/0.2 Pt. No. 175-0798-00 x 100mm	*
Wire, green, PVC insulated, 7/0.2 Pt. No. 175-0799-00 x 76mm	*
Wire, pink, PVC insulated, 7/0.2 Pt. No. 175-0794-00 x 89mm	*
Wire, white, PVC insulated, 7/0.2 Pt. No. 175-0801-00 x 178mm	*
Sleeving, white H12 Pt. No. 166-0500-00	
Sleeving, grey H12 Pt. No. 166-0499-00	

Mechanical Parts

Switch mounting bracket Pt. No. 407-1771-00	*
Marking block Pt. No. 391-0143-02	*
Insulator (Oxley barb) Pt. No. 342-0177-00	*
Cabinet Cover Pt. No. 437-0206-02	

* denotes part of Switch Assembly Pt. No. 262-0994-00



D34 SWEEP GENERATOR & X AMP WITH EXT. X
P.C. 24

NOTES
 1. 224/5 DENOTES PC BOARD/TAKE OFF POINT OR TERMINAL N^o
 2. * DENOTES COMPONENTS NOT MOUNTED ON THE PC BOARD

FIG. 2b