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Dewald Electronic

Bedienungsanleitung

10 MHz Zweikanal-Oszillograf OS 245 A

1) Allgemeines

Der GOULD ADVANCE OS 245 A ist ein 10 MHz Zweikanal-Oszillograf mit einer vergleichsweisen hellen 10 cm Kathodenstrahlröhre. Das Schirmbild-Raster hat 8 x 10 Teile à 0,8 cm.

Die Bandbreite beider Kanäle beträgt DC bis 10 MHz bei Eingangsempfindlichkeiten von 5 mV/Teil . . . 20 V/Teil. Eine automatische Chopp-/Altumschaltung wählt für langsame Ablenkgeschwindigkeiten bis 1 msec choppenden und für schnelle Ablenkgeschwindigkeiten ab 0,5 msec alternierenden Betrieb.

Besonderes Augenmerk wurde auf zuverlässige Triggerung gelegt. Es ist möglich, Signale bis über 20 MHz zu erfassen. Die bereits weithin bekannte, abschaltbare Freilaufautomatik (Bright-Line) läßt die Zeitbasis in Abwesenheit eines geeigneten Triggersignals frei laufen.

Eine gesonderte Stellung der Zeitbasis ermöglicht XY-Darstellung über die beiden identischen Eingangskanäle.

Beim OS 245 A kommen nur zuverlässige Bauteile hoher Qualität zum Einsatz. Da auch die Dimensionierung der Gesamtschaltung großzügig vorgenommen wurde sind wir in der Lage, unseren Kunden eine Garantie von 2 Jahren anzubieten. Diese umfaßt im Ernstfall die Kosten für Bauteile, Arbeitszeit und den Transport in eine Richtung. Die Kathodenstrahlröhre als Verschleißteil kann im Falle eines Defekts nur anteilig ersetzt werden, nach einem Jahr beispielsweise zu 50%.

Der OS 245 A wird ab Werk auf 220 V, 50 Hz eingestellt. Er sollte so aufgestellt werden, daß die während des Betriebes entstehende Wärme durch Luftzirkulation abgeleitet werden kann.

Der praktische Tragegriff kann auch zum Aufstellen des Gerätes verwendet werden, indem er durch axiales Ziehen der Scharniere entrastet und in die gewünschte Stellung gebracht wird.

2) Einschalten des Gerätes

a) Das Potentiometer INTENSITY wird im Uhrzeigersinn in Mittelstellung gedreht. Dabei wird das Gerät eingeschaltet, die Netzkontrollampe leuchtet.

b) Die Potentiometer, die mit vertikalen und horizontalen Pfeilen gezeichnet sind, werden in Mittelstellung gebracht.

c) Der Schiebeschalter BRIGHT-LINE sollte in Stellung ON stehen, damit die Freilaufautomatik in Betrieb ist. Durch Korrigieren der Potentiometer INTENSITY und FOCUS kann Helligkeit und Schärfe optimal eingestellt werden.

3) Vertikalablenkung

a) Die Meßsignale sollten den Oszillografeneingängen immer über Coaxial-Kabel zugeführt werden. Diese Forderung ist unabdingbar bei Signalen ab einigen 100 kHz.

b) Im Normalfall steht der Eingangswahlschalter auf DC und das Signal ist dann mit dem Verstärkereingang direkt gekoppelt.

c) In Stellung AC wird der Gleichspannungsanteil durch einen Kondensator abgetrennt. Dies ist nur dann sinnvoll, wenn z. B. eine kleine Wechselspannung gemessen werden soll, die einer hohen Gleichspannung überlagert ist.

d) In der Mittelstellung GROUND wird die Eingangsbuchse vom Verstärker getrennt, der Verstärkereingang geerdet. Sie dient lediglich zur Lokalisierung der O-Lage.

e) Der Drehschalter VOLTS PRO DIV wählt die gewünschte Eingangsempfindlichkeit zwischen 5 mV und 20 V. Besonders bei hohen Empfindlichkeiten muß darauf geachtet werden, daß das Meßkabel bzw. der Tastkopf in der Nähe des Meßpunktes geerdet wird.

f) Zur Einhaltung der Bandbreite in allen Empfindlichkeitsbereichen realisiert GOULD ADVANCE ein kombiniertes Umschaltverfahren von Teilungs- und Verstärkungsfaktor. Dadurch kann beim Umschalten von 0,2 V auf 0,5 V ein Sprung in vertikaler Richtung auftreten. Dieser kann durch vorsichtiges Abgleichen am Potentiometer BALANCE weitgehend vermieden werden. Diese Einstellung darf erst vorgenommen werden, wenn das Gerät seine Betriebstemperatur erreicht hat. (Nach 15 – 30 min.)

g) Für den Fall, daß Einkanalbetrieb gewünscht wird, lassen sich die Kanäle durch Einrasten des Potentiometers zur vertikalen Strahlverschiebung im linken Anschlag abschalten.

h) Zweikanalbetrieb ist in den Zeitablenkbereichen 1 μs/Teil – 0,5 msec/Teil alternierend, in den Bereichen 1 ms/Teil – 0,5 s/Teil choppend möglich. Die Umschaltung erfolgt automatisch. Charakteristisch ist für choppenden Betrieb, daß beide Kanäle durch punktweise Umschaltung in einem Durchlauf gleichzeitig aufgezeichnet werden. Im alternierenden Betrieb wird für je einen Durchlauf abwechselnd Kanal 1 und Kanal 2 geschrieben.

4) Horizontalteil

a) Am Drehschalter TIME/DIV. können 18 geeichte Ablenkgeschwindigkeiten eingestellt werden. Darüber hinaus ist es möglich, die X-Ablenkung 5- bzw. 10-fach zu dehnen. Am Potentiometer VARIABEL kann die Ablenkgeschwindigkeit kontinuierlich im Verhältnis 1:2,5 verringert werden. Nur wenn das Potentiometer am rechten Anschlag in Stellung CAL steht gilt die Eichung des TIME/DIV.-Schalters.

b) Bis zu einer Bandbreite von 500 kHz ist die 2-Koordinaten-Darstellung von Signalen über die beiden identischen Eingangskanäle möglich. Dabei muß der Drehschalter TIME/DIV. am linken Anschlag in Stellung XY stehen.

5) Triggerteil

a) Im Normalfall soll der Schiebeschalter BRIGHT LINE in Position ON stehen. Dabei ist der Strahl immer sichtbar, bei falsch eingestelltem Triggerpegel läuft das Bild frei (ungetriggert) durch. Steht das Potentiometer LEVEL in Mittelstellung wird jeweils im Bereich des O-Durchgangs getriggert.

b) Es ist frei wählbar (trig. sel.), ob extern oder nach einem der beiden Kanäle CH1 und CH2 getriggert wird.

c) Am Schiebeschalter SLOPE kann die Polarität der Triggerflanke gewählt werden.

d) Der Schiebeschalter FUNCTION dient zur Einstellung der Triggerkopplung. AC ist die Normalstellung, das Signal läuft über einen Kondensator zur Abtrennung der Gleichspannungsteile. ACF unterdrückt niedrige Frequenzen, sodaß z. B. bei Fernsehsignalen nach den Zeilenimpulsen getriggert werden kann. TV unterdrückt höhere Frequenzen; trotz Anwesenheit von Zeilenimpulsen könnte nach dem Fernsehbild getriggert werden.

6) Eingänge – Ausgänge

a) Der GATE-Ausgang liefert eine Spannung aus ca. 20 V auf 15 kOhm. Die Frequenz ist abhängig von der Einstellung des Zeitbasiswahlschalters. Das Rechteck ist sehr sauber und kann zum Kompensieren des 10:1 Tastkopfes verwendet werden. Die Ablenkgeschwindigkeit sollte dabei etwa 1 ms/Teil betragen, der Tastkopf wird an der entsprechenden Einstellschraube mit einem Kunststoffschraubenzieher auf optimales Rechteck-Übertragungsverhalten abgeglichen.

b) Der Extern-Triggereingang besitzt keinen Koaxialanschluß. Es empfiehlt sich, trotzdem eine abgeschirmte Zuleitung zu verwenden und den Schirm an der dafür vorgesehenen Erdbuchse anzuschließen.

c) Über den Z-Mod.-Eingang auf der Rückseite des Gerätes kann der Strahl hell bzw. dunkel getastet werden. Bei mittlerer Helligkeit ergibt eine Spannung von 10 V ss eine gut sichtbare Modulation. Die Bandbreite beträgt 2 Hz bis 10 MHz, die Eingangsimpedanz 100 kOhm.

Wir hoffen, daß Sie in Zukunft viel Freude an Ihrem Zweikanal-Oszillografen haben werden.

Wir können Ihnen versichern, daß der OS 245 A in Relation zu seinem Preis ein Maximum an Leistung bietet. Sollten Sie im einen oder anderen Punkt höhere Anforderungen an Ihren Oszillografen stellen bitten wir zu bedenken, daß dieses Gerät unser kleinstes in einer umfangreichen Serie von 7 Modellen ist.

OS245A 10MHz DUAL TRACE OSCILLOSCOPE

Instruction Manual

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Contents

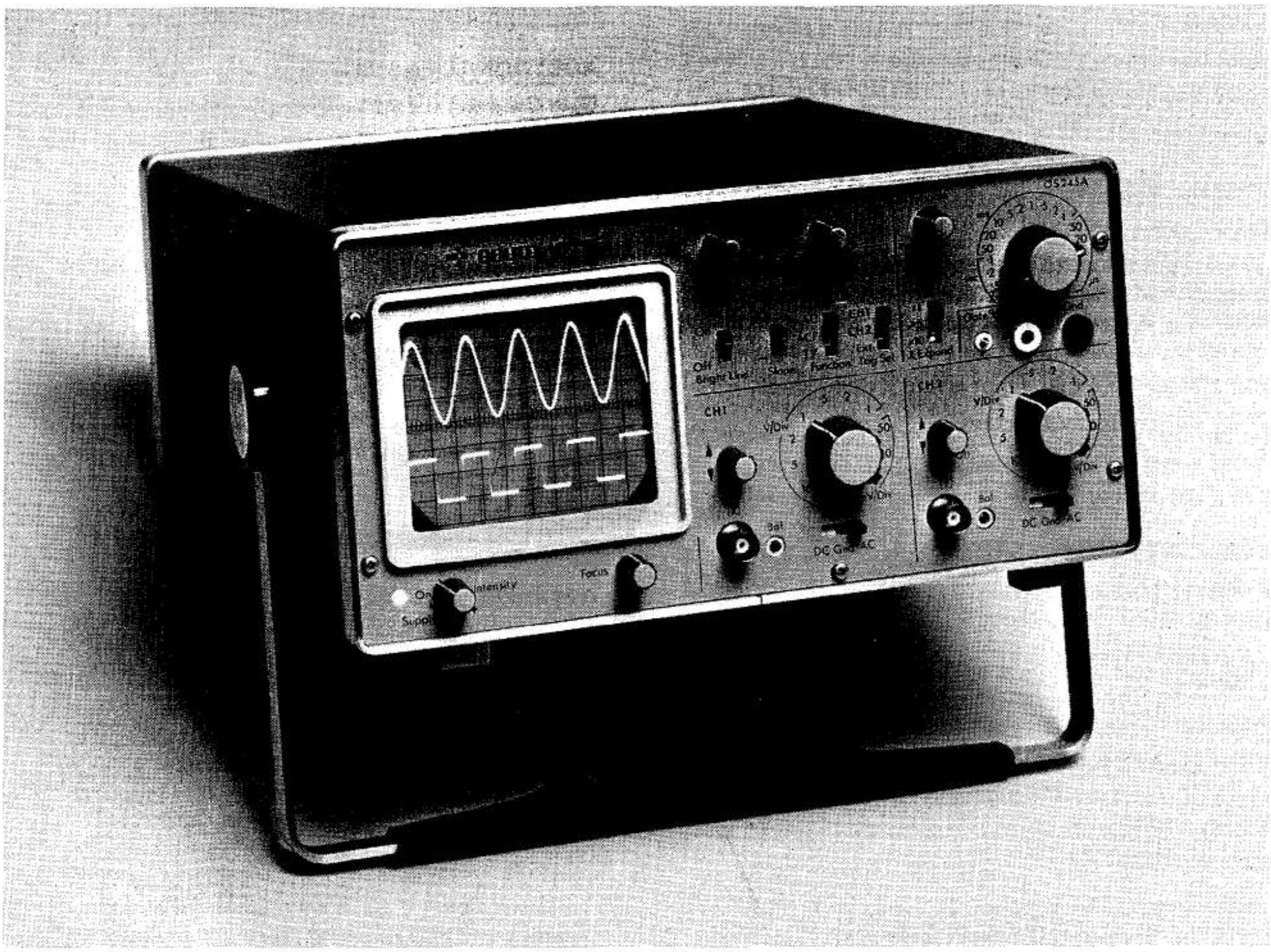
Introduction

The Gould Advance OS245A Oscilloscope is a 10MHz dual trace instrument with a 8 x 10div display, each division being 0.8cm. It is designed for use in general purpose laboratory work, educational uses, TV and servicing applications, etc.

It features two identical channels with maximum sensitivities of 5mV/div and band-widths of d.c. to 10MHz. The two channels may be viewed separately, alternately at fast timebase speeds, or chopped at a 250kHz rate at low timebase speeds.

Particular attention has been paid to trigger performance, and the system used includes a variable trigger level control with bright line operation in the absence of a signal, or when the control is set outside the range of the input signal.

The instrument can also be used to provide a single trace X-Y display via the CH1(X) and the CH2(Y) input channels with full sensitivity adjustment on each channel.



Specification

DISPLAY

4 in flat faced CRT with 8 x 10 division graticule, each division 0.8cm EHT 1.5kV.

Phosphor – P31, Long Persistence (P7) available as an option.

VERTICAL DEFLECTION

Two identical input channels, CH1 and CH2.

Bandwidth (–3dB) d.c. – 10MHz.

Sensitivity 5mV/cm to 20V/cm in 1-2-5 sequence.

Accuracy ± 5%

Input Impedence 1MΩ/approx. 28pF.

Input coupling DC-GND-AC.

Protection 400V DC or pk AC.

DISPLAY MODES

Single trace – CH1

Dual trace – Chopped or alternate modes automatically selected on timebase switch. 1ms/div and slower – chopped at approx. 250kHz 0.1ms/div and faster – alternate

X – Y Mode with CH1 input giving X deflection

CH2 input giving Y deflection

Bandwidth d.c. to 500kHz.

<3° phase shift at 20kHz.

HORIZONTAL DEFLECTION

Timebase Ranges 1μs per division to 0.5s per division in 18 ranges (1, 2, 5 sequence).

Uncalibrated variable control give >2.5:1 reduction in sweep speed.

Accuracy ±5%.

X Expansion x 5 and x10 expansion gives fastest sweep speed of 100ns per division.

Accuracy ± 5% except x10 expansion on fastest range when accuracy ± 20%.

TRIGGER

Variable level control with option of bright line in absence of input.

Source CH1, CH2 or External

Slope + or –

Coupling AC, AC fast, TV frame

Sensitivity	Internal <0.3 division	40Hz-1MHz
	approx 1 division	8Hz-10MHz
	External <1.5 volt	40Hz-1MHz
	approx 5 volts	8Hz-10MHz
	External Input impedence	100kΩ <10 pF.

ADDITIONAL FACILITIES

Gate Output 1.0V ± 5% from approx. 750Ω

Z mod Input a.c. coupled. Bandwidth 2Hz – 10MHz. 10V gives visible modulation

SUPPLY

115V, 220V, 240V ± 10% a.c. 45-440Hz

OPERATING TEMPERATURE RANGE

0-50°C (15°C to 35°C for full accuracy)

DIMENSIONS

132 x 270 x 317mm (5¼" x 10¾" x 12½")

WEIGHT

5kg (11 lbs) approx.

OPTIONAL ACCESSORIES

Probe Kit PB12. A passive probe kit with switched X1 and X10 attenuations. With X10 attenuation the input impedance is 10MΩ/13.5pF.

3.1 SWITCHING ON

CAUTION The OS245A employs convection cooling and must always be operated in a position such that external air circulation is not restricted.

1. Set the support/carrying handle to the required operating position. The handle is released by pulling both fixing bushes outward. It can then be turned to lock in one of 2 positions.
2. Check that the supply input selector switch is correctly set for the supply voltage. The switch is mounted within the instrument. Check that the fuse fitted is correct for the selected range (see rear panel detail). To change the setting and/or the fuse see section 5.1 b.
3. Turn INTENSITY control clockwise away from the OFF setting and ensure that the indicator lights up.

3.2 OBTAINING A TRACE

1. To obtain a trace
   (a) Set the CH1 shift control to approximately mid setting.
   (b) Set the CH2 shift control to CH2 OFF.
   (c) Set the X shift control to approximately mid setting.
   (d) Set BRIGHT LINE slide switch to ON.
   (e) Set the TIME/DIV switch to 10μs.
   (f) Adjust the INTENSITY control to obtain a display of the required brightness.
   (g) Centralise the display by adjusting the CH1 and X shift controls.
   (h) Adjust the FOCUS control to obtain a sharply defined trace.

3.3 SETTING UP THE Y CHANNELS

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

NOTE When examining low amplitude a.c. signals superimposed on a high d.c. level, the slide switch should be set to AC and the sensitivity of the Y amplifier increased as in (4).

3. To locate the base line, set the slide switch to the GND setting. At this setting, the input signal is open circuit and the input to the amplifier is connected to ground.
4. To select the sensitivity, set the VOLTS/DIV switch to the required range. To minimise pick up at sensitive settings it is essential to ensure that the ground lead connection is near to the signal point.
5. For vertical shift of the trace, adjust the Y shift controls (identified by the vertical arrows).
6. Any trace movement under no signal conditions, when the setting of the VOLTS/DIV switch is altered, can be minimised by adjustment of the preset front panel balance control.

   This control will only need adjustment at infrequent intervals. Before adjusting the BAL control however, ensure that the input coupling switch is set to GND. In any case no adjustment should be made until a minimum of 15 min. warm-up time has elapsed after switch on, or immediately after any large change of ambient temperature.

3.4 SINGLE TRACE

For single trace operation on CH1, set
   (a) The CH1 shift control to the mid position.
   (b) The CH2 shift control to OFF.

3.5 DUAL TRACE OPERATION

For dual trace operation set both shift controls to the mid positions approximately.

In the dual trace condition, the beam switching function is in operation and results in display of the two signals simultaneously. Two modes of beam switching – chopped and alternate – are used, and selected automatically by the setting of the TIME/DIV switch. On any fast setting from 1μs/div to 0.5μs/div inclusive, the alternate switching mode is in operation. At slow settings from 1ms/div to 0.5s/div inclusive, the chopped mode is in operation.

3.6 TIMEBASE AND X EXPANSION

The sweep speed of the internal timebase (i.e. the time scale of the horizontal axis) is determined by the setting of the TIME/DIV switch. The setting of the switch automatically determines which mode of beam switching is used during dual trace operation. In addition to selection of the speed of the internal timebase, the switch has one further setting, X-Y, at which the internal timebase is inoperative.

1. To adjust the time scale of the horizontal axis:
   (a) Set the TIME/DIV switch to a suitable setting.
   (b) If necessary, the sweep may be slowed by the uncalibrated VARIABLE control.

NOTE The range of the variable control is approximately 2.5:1. Except at the CAL setting, the VARIABLE control is uncalibrated. At the CAL setting, the calibration corresponds to the setting of the TIME/DIV switch.

2. For horizontal shift of the trace, adjust the X shift control (identified by the horizontal arrow).
3. If close examination of any portion of the trace is required, two degrees of expansion are provided on the X EXPAND slide switch, namely x5 and x10, these provide respectively effective trace

Operation

lengths of 50div and 100div. Any portion of increased sweep length may be selected for viewing on the screen, by use of the X shift control.

3.7 X-Y MODE

When the TIME/DIV switch is set to X-Y, the CH1 is switched to the X amplifier. Under this condition, an external signal applied to the CH1(X) socket is routed through the input attenuators in CH1, and the full range of sensitivity may be utilised to obtain a calibrated horizontal deflection. Only single trace operation is possible. In this mode, the CH1 shift control is inoperative and X shift is effected by the X shift control. The X bandwidth is 500kHz and the relative phase shift between X and Y is significant only above 20kHz.

3.8 TRIGGER

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

(a) CH1 or CH2 signal (irrespective of which beam is being displayed).

(b) An external triggering source connected to the EXT TRIG socket.

When the BRIGHT-LINE slide switch is set to OFF, the timebase will only trigger when the trigger signal reaches the selected level. When the level control is set outside the range of signal or when there is insufficient signal amplitude the timebase will not run and the screen will remain blank.

The normal mode of operation is with the BRIGHT-LINE ON, when the timebase will free-run in the absence of the correct trigger signal to display a bright line or unsynchronised display until the level control is adjusted and/or the amplitude of the trigger signal is increased. This free-run action in the absence of correct trigger helps in finding the trace and leads to ease of operation. If the timebase is required to free-run continuously, the LEVEL control should be set to either end of its rotation.

It is expected that the BRIGHT-LINE OFF mode will be selected only when the instrument is to be used to display signals at repetition rates below 45Hz to prevent additional sweeps between correctly triggered sweeps.

The TRIGGER SELECT switch is used in conjunction with the AC-ACF-TVF slide switch. This latter switch connects different networks into the trigger amplifier circuit and is effective at all settings of the TRIGGER SELECT switch. The operating facilities available at the three settings of the slide switch are as follows:

AC – Wide band trigger mode used for most signals.

ACF – A filter is switched into circuit to reject low frequencies. High frequency triggering may be effected from complex waveforms such as those with high ripple content or line triggering from a television video signal waveform. The filter cut-off frequency is approximately 20kHz.

TVF – A filter is switched into circuit to reject high frequencies. Its cut-off is chosen to accept the frame synch of a TV video waveform and reject the line frequency component. The filter cut-off frequency is approx 200Hz.

Summarising, trigger control is effected as follows:

1. Set the TRIGGER SELECT switch to select the required trigger signal and slope.
2. Set the AC-ACF-TVF switch to the required setting.
3. Adjust the LEVEL control so that the trace starts at the required point on the waveform.

3.9 ADDITIONAL FEATURES

(a) Gate Output

This output pin provides a positive-going square wave of approximately 1V ± 3% amplitude from a source impedance of 750Ω. Its frequency is dependant on the setting of the TIME/DIV and is suitable for probe compensation. (See section 3.9.c.)

(b) Z Mod

The socket on the rear panel allows an a.c. coupled signal to modulate the brightness. The input impedance at this socket is 100kΩ; the frequency response, 2Hz – 10MHz; and the sensitivity, approximately 10V p.t.p. for visible modulation at normal brightness, and approximately 60V for full blanking, a positive going signal increasing brightness.

(c) Use of Optional Passive Probe

Passive probes may be used to extend the voltage range and increase the input impedance of the Y amplifiers. The input resistance of a Y channel is 1MΩ shunted by approximately 28pF. The effective capacity of the input lead must be added to this and the resultant impedance can often load the signal source. Therefore it is advisable to use a 10MΩ X10 probe e.g. the Advance PB12. This reduces the input capacity and increases the input resistance, at the expense of a 10:1 reduction in sensitivity. The probe contains a shunt RC network in series with the input and forms an attenuator with the input RC of the Y channel. To obtain a flat frequency response it is necessary to adjust the capacitance of the probe to match the input capacity of the Y channel as follows:

1. Set the channel VOLTS/DIV switch to 20mV/div, the TIME/DIV switch to 1ms and TRIG INT POS from the appropriate channel. Set probe to X10.
2. Connect the probe to the GATE O/P pin.
3. Adjust the probe compensation to obtain a level trace, i.e. flat top without overshoot or undershoot over the first few milliseconds of the trace.

The OS245A block diagram is shown in Fig.1. Interconnection of the printed circuit boards, controls,tube and associated components is shown in Fig.5.
Circuit diagrams are as follows:

Fig.2 CH1 and CH2 attenuators, pre-amplifiers, the main Y amplifier, beam switch and drive circuits.
Fig.3 Timebase, X amplifier and trigger circuits.
Fig.4 The power supply, bright-up and tube network.

4.1 GENERAL

Referring to the block diagram (Fig.1) signals applied to the CH1 and CH2 input sockets pass into their respective attenuators and amplifiers. The VOLTS/DIV switch controls the gain of the amplifier in a 1.2.5 sequence to cover the ranges from 5mV/div to 0.2V/div. Above this a ÷ 100 attenuator is introduced before the amplifier.

The fast electronic beam switch selects either the CH1 or the CH2 signal to be amplified further and passed to the Y deflection plates of the c.r.t.

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

At fast sweep rates, for a dual trace display, the TIME/DIV switch automatically selects the alternate sweep mode of control for the beam switch. At the end of each sweep the signal from the timebase bistable reverses the

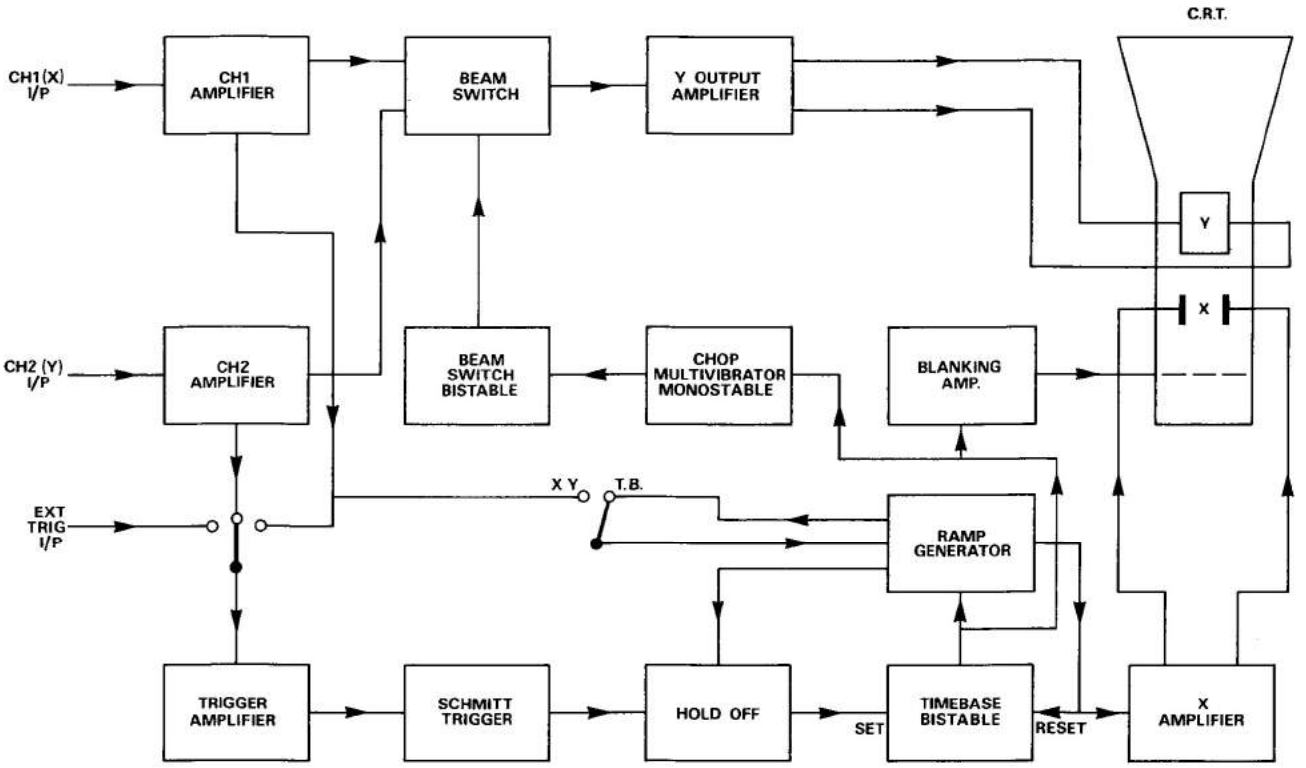


Fig. 1 Block diagram

state of the beam switch bistable, causing alternate displays of the CH1 and CH2 signal on successive sweeps of the timebase. At low sweep rates, the chop mode is selected, when the chop oscillator free runs independently, causing the beam to switch CH1 and CH2 levels during the sweep. A signal from the oscillator also blanks the trace during each switching transition. With the CH2 switched to the OFF position, the beam switch is locked to switch on CH1.

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

4.2 THE Y AMPLIFIERS

The attenuator and the pre-amplifier in the CH1 are identical to those in the CH2. Accordingly, only the CH1 is described.

The input is applied to the front panel socket, SKC, and then to the 3 position slide switch, S20, via R20. The switch selects a.c. or d.c. input coupling by including or by-passing C21 in the signal path. In the middle position of the switch, the input socket is disconnected and the input of the attenuator is connected to ground through the network, C240 and R294. The attenuator feeds into an impedance of 1MΩ, R202. The ÷100 attenuation is determined by the potential divider action of R26 in series with the parallel combination of R201 and R202. High frequency compensation of the attenuator is achieved by the a.c. potential divider, C202 and C204; C202 is set for the correct ratio. C201 is adjusted to maintain constant input capacitance between attenuated and unattenuated ranges. This attenuator is used on the six higher voltage ranges, i.e. 0.5V/div to 20V/div, dividing them down to 5-200mV/div. Further selection of input sensitivity is carried out by gain switching within the amplifier and is described later.

Diodes, D203 and D204, in conjunction with R203 protect the input up to 400 volts peak.

The input stage of the amplifier consists of a matched pair of field effect transistors TR201 and TR202. The input signal is applied to the gate of TR201 and the d.c. balance signal to TR202 via the potential divider R217/R213.

The following stage incorporates the gain switching arrangements and is formed by the emitter follower TR203 and the common base stage TR204. Gain switching is achieved by variation of the resistance between their emitters. Signal current from the collector of the common base stage TR204 passes to the shunt feedback amplifier TR205.

Minimum change of balance during warm-up and with ambient temperature changes is achieved by the use of the dual matched F.E.T. operating at low current in the first stage and by thermally coupling transistors TR203 and TR204. Adjust on test resistors R401 and R402 in conjunction with R264 provide for centering of the shift control range.

The signal from the collector of TR204 is passed via R220 to the base of TR205 which, in conjunction with TR206, forms a long tail pair amplifier, the gain of which is set by R223 and R229.

The collector current of TR205 feeds into the trigger section of the timebase and X amplifier circuit (Fig.3). Potentiometer, R30' provides a variable current via R225 into the collector circuit of TR206, to produce a Y shift. The bases of TR206 (CH1) and TR216 (CH2) are driven from the collector circuit of TR217 which being connected in a manner similar to TR204 and TR215, provides the correct bias and compensation for supply and temperature variations.

The beam switch consists of diodes, D207, D208, D209, and D211, with their associated drive circuitry and is described in detail in section 4.3. It selects the collector current of TR206 or of TR217 to pass through D210 and R229. The voltage developed across R229 consists of a fixed d.c. component, a variable d.c. component (Y shift) and the signal, and is applied to the base of TR207, a common emitter amplifier. The emitter circuit includes potentiometer, R233, to set the gain of the stage and hence the overall gain of the amplifier. The signal from the collector of TR207 is passed to the base of TR208, which with TR209, TR210 and TR211, forms the output cascode stage. TR208 and TR209, is a long-tail pair, which converts the input signal voltage to differential output current; its gain is determined by the emitter resistor, R234, with high frequency gain set by networks, R241/C217 and R240/C216. The collector currents of TR208 and TR209 flow into the emitters of the grounded base transistors, TR210 and TR211, to develop the differential output voltage across the load resistors, R236/R244, to drive the c.r.t. deflection plates. Inductors, L201 and L202, are included to improve the high frequency response.

4.3 THE BEAM SWITCH

The beam switching waveforms are generated by IC201, a dual J-K flip flop within a single 16 lead package, one section operating as the chop oscillator the other as the beam switch bistable. The flip-flop is made to oscillate by taking signals from the Q2 and $\overline{Q2}$ outputs and feeding them back to the clock input via the amplifier transistor, TR219. The oscillator section is not, in fact, self starting and must be triggered into operation, this is achieved by feeding the alternate pulse to the clock input via TR220. This is not a disadvantage since the alternate pulse is always present under normal conditions when the timebase is running.

The frequency of operation and the mark-space ratio of the output is determined by the time constants, C234/R284 and C233/R283. An output is taken from Q2 to drive the second flip-flop.

The cathode of D207 is supplied with a 5 volt positive-going square wave from Q1. When the waveform is 'high', D207 is biased off and the collector current of TR206 passes through D208 and D210 into the output amplifier. During the 'low' state of the waveform, D207 conducts, passing this current to ground through the output of the flip-flop Q1. As diodes, D207 and D211, are fed with complementary waveforms when the current from TR206 passes to the output amplifier, that from TR217 is shunted to ground and vice-versa.

The chop oscillator section runs at approximately 500kHz on TIME/DIV settings from 0.1 sec to 1 ms causing the beam switch to operate at 250kHz. A further output is taken from $\overline{Q}2$ and fed to the bright-up amplifier circuits, this in turn is fed to the c.r.t. to blank the traces during the beam switching transitions.

In the chop mode of operation alternate pulses from the timebase bistable are fed to a "J" input of IC201. This has the effect of inhibiting the beam switching operation during the flyback and hold-off periods, thus preventing switching spikes interfering with the trigger circuits.

At faster TIME/DIV settings of 0.1 ms to 1 μs, the positive end of D216 is returned to the +20V line via R287 and a contact on the timebase switch. This potential turns off D216, preventing the feedback action and stopping the chop oscillator. This flip-flop is now clocked via TR220 at the end of each sweep by pulse from the timebase bistable, each pulse reversing the beam switch bistable for alternate display of CH1 and CH2.

For single trace operation, the CH2 shift control is rotated fully anti-clockwise to operate the OFF switch. In this position the switch, S27, is closed grounding Preset (Q1). This causes $\overline{Q}1$ to go 'low' shunting the collector current of TR217 to ground. Q1 goes 'high' turning off D207 and directing collector current from TR206 to the output stage. Thus only CH1 trace is visible on the screen. Switch, S27, also grounds Preset (Q2) which stops the chop oscillator when operating in the single trace mode.

In the X-Y mode, CH2 shift control is set in the ON position. Clear (Q1) is grounded via D12 on the timebase switch. This causes Q1 to go 'low' shunting the collector current of TR206 to ground and allowing CH2 signals only to reach the Y output stage.

4.4 THE TRIGGER CIRCUITS

The collector currents from TR205 and TR216 in the Y amplifier, pass to the timebase printed circuit board into R108 and R109, respectively. In series with R108 is R110 shunted by C101, a collector load netowrk used when X-Y mode is selected. External trigger signals appear across R107 and these, together with those across R108 and R109, pass to the trigger selector switch. The selected trigger signal is amplified by TR107 and passed to the coupling switch. Here, direct, high pass and low pass filter networks provide the required AC-ACF-TVF response. Trigger level and slope selection operations are performed by the long-tail amplifier, TR101/TR102. The signal is applied to either input as determined by the slope selector switch, the other input being grounded via C121. The trigger level control, R187, provides a variable d.c. bias at both inputs, which the amplifier sums with the signal. The output at the collector of TR102, consisting of an alternating signal voltage superimposed on a d.c. level, passes to the Schmitt Trigger, TR103/TR104, where fast negative edges are generated as the input signal crosses the circuit threshold.

4.5 BRIGHT LINE CIRCUIT

When sufficient trigger signal is available, the square wave from the collector of TR104 passes through R127/C104, where restoration by D101 produces a negative going signal with respect to the negative rail. This negative signal on the base of TR105 is integrated by R124/C107 to produce a d.c. bias sufficient to hold off TR106. In this condition the circuit has no effect on timebase operation. However, when the triggering signal falls below the required level, the Schmitt trigger ceases to operate, removing the signal from D101. The voltage on the emitter of TR105 rises to approximately one volt above the negative line, turning on TR106. R177 is now effectively connected between the negative rail and the cathode of D102. It rapidly discharges the hold off capacitor below the normal quiescent level to a point where D102 conducts, turning TR108 off and initiating a sweep. At the end of the ramp, the charge on the hold off capacitor is again removed by R177/R143 and another ramp begins. These consecutive sweeps produce the bright line display. When the "BRIGHT LINE OFF" control is operated, switch S12 closes, effectively shorting the base and emitter of TR106, holding it off; in this condition a ramp is only generated after the arrival of a trigger pulse.

4.6 THE TIMEBASE BISTABLE AND RAMP GENERATOR

The ramp generator comprises TR111, TR112 and TR113 as cascaded emitter follower stages, with bootstrap feedback action provided from the cathode of zener diode, D104. This feedback maintains constant voltage across the VARIABLE TIME control, R185, R148, R147 and the variable timing resistor selected by the TIME/DIV switch. This constant voltage drop, independent of actual voltage level, produces a constant current to linearly charge the timing capacitor, also selected by the TIME/DIV switch. The VARIABLE TIME control provides fine adjustment of the timing current, and hence sweep time, by varying the feedback voltage applied to the timing resistor.

In the quiescent condition of the timebase bistable, TR108 is on, TR109 is off and clamp transistor, TR110, which shunt the timing capacitor, is saturated. A negative-going pulse from the Schmitt Trigger is coupled via C111 and D102 to turn off TR108. TR109 turns on, thus turning off TR110. The clamp is removed, allowing the timing capacitor to charge, producing the linear ramp. As the emitter of TR113 rises, a feedback voltage, via D105, R143 and R133, biases off D102 to prevent any

Circuit Description

further pulses reaching the bistable. Connected to the junction of R133/R143 is the HOLD-OFF capacitor which now charges positive. When the ramp reaches its final amplitude, a rise of approximately 10V, feedback from the junction of R151/R149 is applied to the base of TR108 turning it on. The bistable now reverts to its initial state allowing TR110 to turn on, rapidly discharging the timing capacitor and returning the ramp to its quiescent level. The hold-off capacitor, which was charged to a positive voltage during the ramp, now slowly discharges through R143 and R153, until it is caught by D105. Only then is D102 biased for the next trigger pulse to initiate the next sweep.

The output is taken from the ramp generator via R155 to the input of the X output amplifier.

4.7 THE BRIGHT-UP CIRCUIT and TUBE SUPPLIES

The bright-up circuit consists of TR311, TR312 and TR313 arranged in the form of a bistable. The bistable is clocked on or off by the AC coupled signal via C310 and C311 to follow the collector signal of transistor TR309. The output from the bistable at the junction of the collectors of TR311 and TR312 is taken to the cathode of the CRT.

When operating in the chop mode, pulses from the chop oscillator are fed to the base of TR309 via TR308. Short positive-going pulses at the base of TR309 during the sweep cause the tube beam current to be cut off for the period of the chop transition.

The focus chain is supplied from the −1500V line via two zener diode networks; D315 and D316 provide a 60V supply across which is connected the intensity control, R342 and D317, which provides a 30V supply for the bright-up amplifier.

The low potential end of the focus chain is returned to the e.h.t. stabiliser circuit described in a leter section.

Geometry and Astigmatism adjustment are provided by R315 and R345 in series with R359 and R360 connected across the 280V line.

Z Modulation signals may be applied via the socket on the rear panel and C314 to the grid of the c.r.t. where they produce intensity modulation.

4.8 THE X OUTPUT AMPLIFIER

The ramp or X-Y signal at the emitter of TR113, passes through R156 to the base of TR114 which with TR117 forms a long tail pair. Gain switching is carried out in the emitter circuit by selection of one of three resistance paths, with gains set by R169/R189(X1), R162/R188(X5) and R158(X10). In the timebase mode, the X EXP.switch, S15, can be operated in order to expand the trace length 5 or 10 times. In the X-Y mode contacts on the TIME/DIV switch, is parallel with S15 close to select a X10 gain setting automatically. An X shift voltage is produced at the base of TR117 by R186. The signals on the collectors of TR111 and TR117 are applied to the differential output amplifiers, TR115 and TR116. Signals from the collectors of these two transistors drive the horizontal deflection plates of the c.r.t.

4.9 X-Y MODE

In this mode, signals are applied to both CH1 and CH2 input sockets; CH2 is routed through the beam switch to the Y deflection plates in the normal manner. CH1 is routed through the ramp generator, now acting as a high impedance unity gain buffer, and into the X output stage.

Signals entering the CH1 channel pass through the attenuator and gain switching stage, as previously described. Current from TR205 passes to the X board, while that in TR206 is shunted to ground through D207. The current from TR205 develops a voltage across the series connections of R110, R108. This voltage is level shifted by R144/R146 to the base of TR111. In the X-Y mode, both timing resistors and capacitors are switched out of circuit, consequently TR111, TR112 and TR113 merely act as emitter followers which provide buffering between the level-shift resistors and the X amplifier.

When this mode is selected, a contact on the TIME/DIV switch, S14(a), connects a 'clear' input in the beam switch J-K flip-flop, to ground; this has the effect of taking Q1 'low' shunting CH1 signals to ground via D207. Q1 goes 'high' thus turning off D211 and allowing CH2 signals to pass to the Y output amplifier via D209.

Also when this mode is selected, S14 connects the cathodes of D106 and D107 to the negative line. The current drawn through D106 and R138 turns of TR108 and consequently TR110, and removes the blanking. It also connects +20V to D216 via R287 turning off this diode and stopping the chop oscillator.

4.10 POWER SUPPLIES

All power supplies are derived from transformer, T31. The primary windings are connected to a slider switch arranged to accept three supply voltage ranges.

The transformer secondary has four windings developing the following r.m.s. voltages: 6.3V, 44V (centre tapped), 115V and 1250V.

The 6.3V winding supplies the c.r.t. heater.

The 44V a.c. is rectified by MR301 and smoothed by C301/303 to form the unstabilised +26V and −26V d.c. lines. These voltages are fed to series regulators to provide the stabilised +20V and −20V lines. As both regulators operate in an identical manner, only one will be described.

The base of the series pass transistor, TR313, is fed from the output of the high gain error amplifier formed by TR301 and TR302. This amplifier compares the zener reference voltage from D307 with the voltage at the junction of R306 and R309, a potential divider connected between the emitter of TR313 and ground. As this emitter supplies the +20V line, any fluctuations in the line voltage appear at the base of TR302, where they are amplified inverted. This signal is then fed to the base of TR313 to correct the error, thus maintaining a constant output voltage. Resistor, R305, in series with the collector of TR313 drops a voltage which is proportional to the output current. Under normal conditions, this voltage drop is less than that across R303, biasing off D309. As the output current rises above the safe manimum, D309 turns on, taking the current in R303 away from the emitter of TR301. This causes a drop in the voltage at the collector of TR302 and hence on the base and emitter of TR313, limiting the current to a safe value.

The voltage from the 115V is rectified by D302 and D301 in half wave and voltage double circuits to provide outputs of 140V d.c. and 280V d.c., both unstabilised.

The –1500V line is derived from the 1250V winding via the diode, D311, and smoothing circuit, C307/C308 and R313. Stabilisation of this line is achieved as follows. The positive end of the supply is returned to ground via the collector of TR306 which under nominal input voltage conditions is adjusted to approximately +200V. A current from the –1500V line is fed via the focus chain to the base of TR307, this current is balanced by a reference current from the +20V line via R351 and the e.h.t. potentiometer, R316. The voltage at the summing point of the two currents appears at the emitter of TR307 and controls the current in TR306. If the –1500V line drops in voltage for any reason, the voltage at the base of TR307 rises, consequently, so does the emitter voltage thus increasing the current in TR306 and causing a drop in its collector voltage. Since this collector potential is effectively in series with the –1500V supply the drop will compensate for the fall in the –1500V line. A rise in the –1500V will be similarly compensated for by a rise in the collector potential of TR306. An additional degree of compensation is achieved by adding a further current at the summing point from the –27V line via R312.

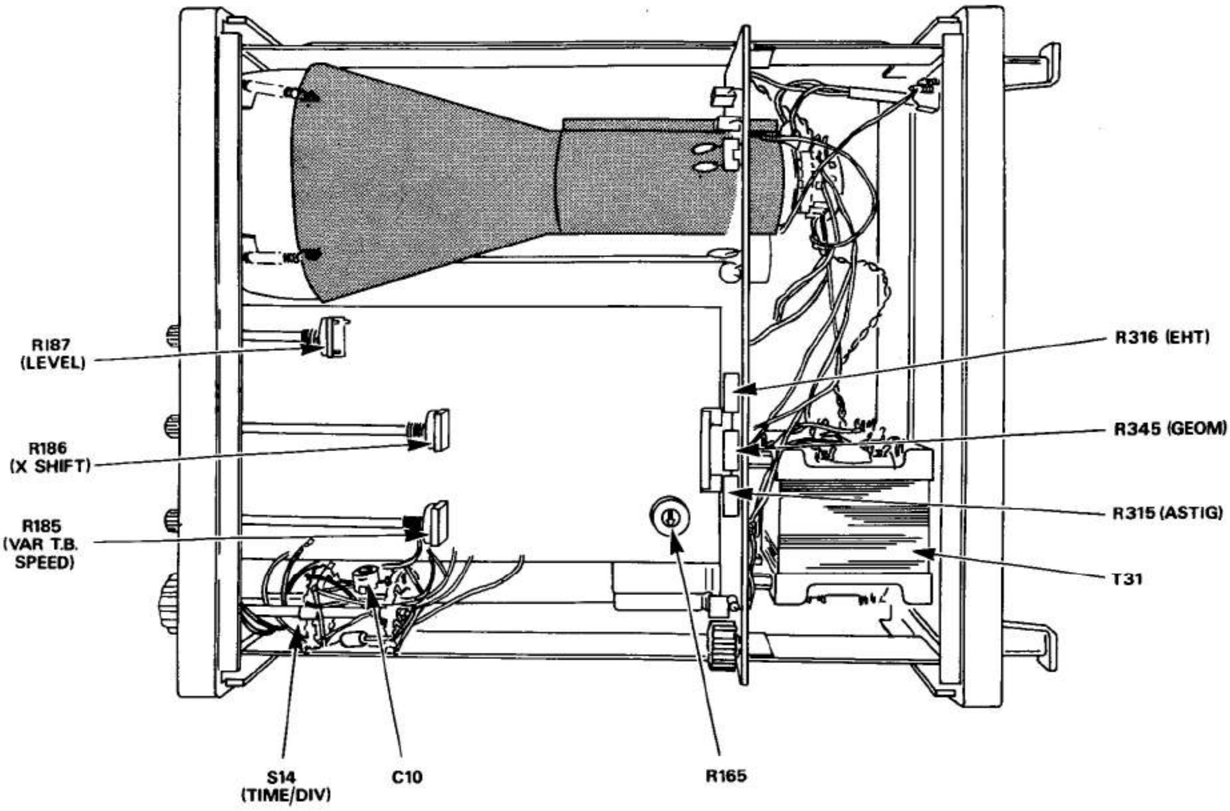


Fig. 6 Top view

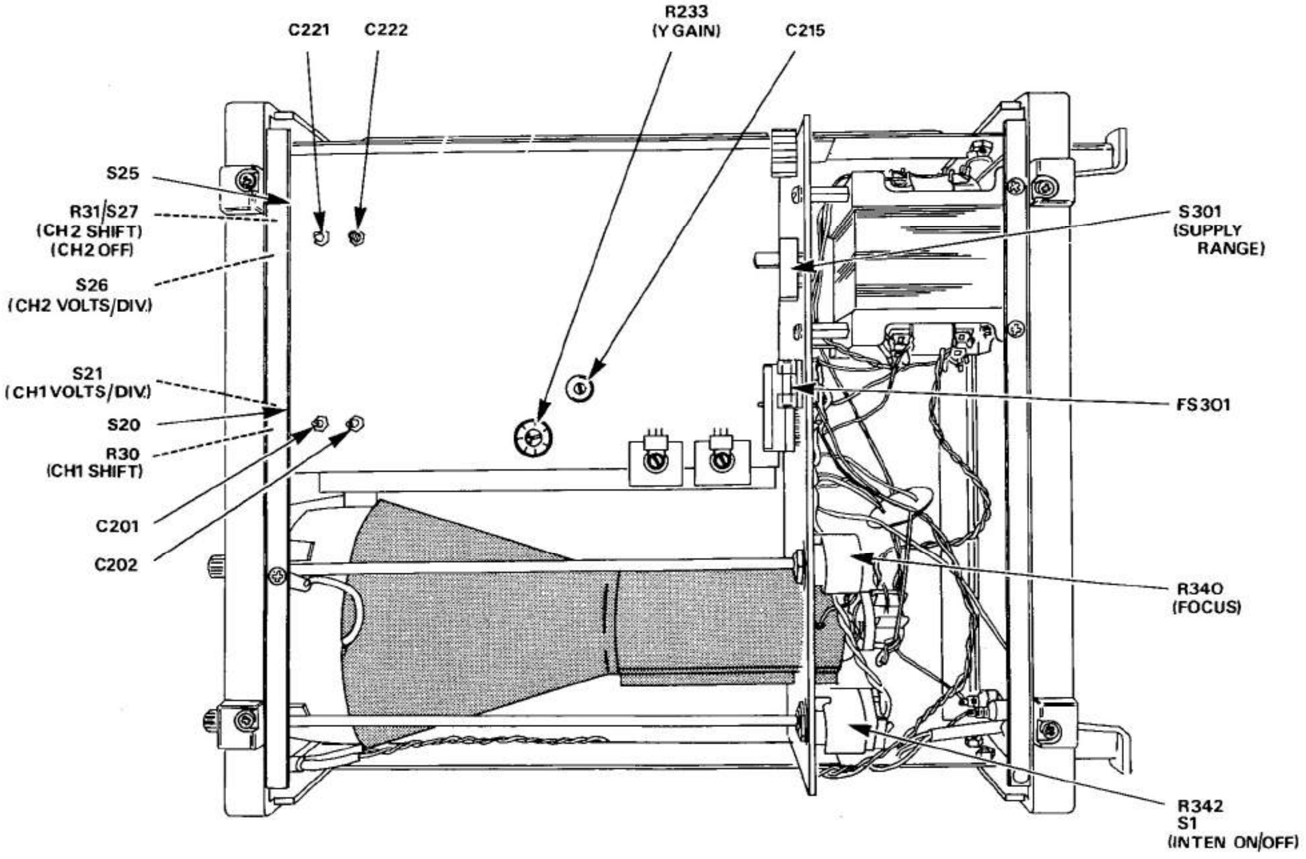


Fig. 7 Bottom view