

Operating and Service Manual

OS300 20MHz
DUAL TRACE
OSCILLOSCOPE
INSTRUCTION MANUAL



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Contents

SECTION 1	Introduction	1.1	SECTION 5	Maintenance	5.2
			5.1	General	5.2
SECTION 2	Specification	2.1	5.2	Access	5.2
			5.3	Fault Finding	5.3
SECTION 3	Operation	3.1	5.4	Setting-up Procedure	5.5
3.1	Connection to the supply	3.1			
3.2	Obtaining a Trace	3.1	SECTION 6	Component Lists and Circuit Diagrams	6.1
3.3	Setting up the Y channels	3.1			
3.4	Display Modes	3.2	SECTION 7	Guarantee and Service Facilities	7.1
3.5	Timebase and X Expansion	3.2			
3.6	Trigger	3.2		ILLUSTRATIONS	
3.7	Additional Facilities	3.3	Fig. 1	Block Diagram	4.1
SECTION 4	Circuit Description	4.2	Fig. 2	Internal Assembly — top view	5.1
4.1	General	4.2	Fig. 3	Internal Assembly — bottom view	5.3
4.2	The Y Amplifier and Beam Switch	4.2	Fig. 4	Circuit Diagram, Y Amplifier	6.8
4.3	The Trigger Circuits	4.3	Fig. 5	Circuit Diagram, Timebase & Trigger	6.9
4.4	The Timebase Generator and X amplifier	4.3	Fig. 6	Circuit Diagram, Power Supply and C.R.T. Circuits	6.10
4.5	The Mode Control Circuits and Calibrator	4.4	Fig. 7	Mechanical Views	6.11
4.6	The Power Supplies and C.R.T. Circuits	4.5			

The OS300 is a versatile general purpose dual trace oscilloscope intended for general laboratory, industrial, servicing and educational applications. The full 8 x 10cm rectangular tube provides a bright display against the calibration graticule.

It features two identical input channels with a maximum sensitivity of 2mV/cm and a bandwidth from D.C. to 20MHz. These channels may be displayed separately or together in dual trace mode. Alternatively they can be added or subtracted for sum or difference display. The timebase ranges from 0.2s/cm to 0.5 μ s/cm and a x 10 expansion facility extends this to 50ns/cm. Independent variable sensitivity and sweep rate controls are provided.

Particular attention has been paid to trigger performance, with D.C. and A.C. coupling available and a bright-line free-run facility to enable trace location in the absence of trigger. An active T.V. synch separator is provided for those working with video waveforms.

The OS300 includes many facilities such as a 1kHz calibrator, a D.C. coupled Z modulation input and a trace rotation control, usually found only on the more expensive instruments.

This compact instrument is readily portable. The internal construction is based largely on a single printed circuit board assembly to provide easy access for maintenance and minimum cost of ownership.

Specification

Section 2

DISPLAY

8 x 10cm rectangular mono-accelerator c.r.t. at 2kV
e.h.t. Trace Rotation by front panel preset.

VERTICAL DEFLECTION

Two identical input channels CH1 and CH2.

Bandwidth (-3dB)

d.c. to 20MHz (2Hz to 20MHz on a.c.)

Sensitivity 2mV/cm to 10V/cm in 1-2-5 sequence.

Accuracy $\pm 3\%$

Variable Sensitivity > 2.5:1 range allows continuous adjustment of sensitivity from 2mV/cm to 25V/cm.

Input Impedance 1M Ω /28pF approx.

Input Coupling DC-GND-AC

Input Protection 400V d.c. or pk a.c.

DISPLAY MODES

Single Trace CH1 or CH2

Dual Trace Chopped or Alternate modes automatically selected by the T.B. switch. Between 0.5 μ s/cm and 0.2ms/cm the ALTERNATE MODE is selected. While on ranges slower than 0.2ms/cm CHOP MODE is selected. The CHOP frequency is 500kHz.

Add CH1 and CH2 added to give the algebraic sum of the two channels.

Invert CH2 CH2 may be inverted. When used in conjunction with Add mode it gives the algebraic difference of the two channels.

X-Y CH2 input gives Y deflection and CH1 input gives X deflection.

Bandwidth (-3dB) DC to 1MHz with less than 3° phase shift at 50kHz.

HORIZONTAL DEFLECTION

Timebase 0.5 μ s/cm to 0.2sec/cm, 18 ranges in 1-2-5 sequence

Accuracy $\pm 3\%$, (to 200ns/cm)

X Expansion x 10 push button gives fastest speed of 50ns/cm. Accuracy $\pm 3\%$ (50ns/cm range $\pm 5\%$)

Variable Sweep > 2.5:1 allows continuous coverage from 0.5 μ s/cm to 0.5sec/cm.

TRIGGER

Variable level control with Bright Line ON/OFF facility. With Bright Line on, the timebase free-runs when insufficient signal (20Hz-20MHz) is present or when the selected level is outside the range of the input signal.

Source Internal CH1 or CH2 or External.

Slope + or -.

Coupling DC, AC or TV (active sync. separator with line/frame selected by T.B. switch between 50 and 100 μ s/cm).

Sensitivity

Internal: DC coupled 2mm to 2MHz, 5mm to 20MHz.

AC coupled 2mm, 10Hz-2MHz.

5mm, 4Hz-20MHz.

External: DC coupled 100mV to 2MHz, 400mV to 20MHz.

AC coupled 100mV, 10Hz to 2MHz,
400mV, 4Hz to 20MHz.

External Input Impedance 100k Ω /10pF approx.

External Input Protection 250V d.c. or pk, a.c.

ADDITIONAL FACILITIES

Calibrator 1V, 2% squarewave at approx. 1kHz.

Ramp Output Approx. +3.5V ramp from 5k Ω .

Z Mod. Input DC coupled, 2V visible mod. sensitivity, +40V cut-off sensitivity, input impedance 10k Ω /10pF approx.

Maximum input 100V d.c. or pk, a.c.

SUPPLY

100V, 120V, 220V and 240V $\pm 10\%$

45 to 440Hz approx. 40VA.

SAFETY

Designed for I.E.C.348 Cat. 1.

OPERATING TEMPERATURE RANGE

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

DIMENSIONS

140 x 305 x 460mm

WEIGHT

6kg approx.

ACCESSORIES SUPPLIED

Manual P.N. 80-OS300

Mains lead P.N. 402001

OPTIONAL ACCESSORIES

Probe Kit PB12

A passive probe kit with switched X1 and X10 attenuations. X10 attenuation input impedance is 10M Ω /11.5pF.

Probe Kit PB13

A X10 passive probe with 1.5m of cable. Input impedance 10M Ω /11.5pF.

Viewing Hood

P.N. 41179.

Trolley

Type TR7. General Purpose.

Protective Carrying Case

P.N. 42610 A strong case which completely encloses the oscilloscope with 3 thicknesses of padding covering the front panel.

Tube Option

Long persistence c.r.t. P7 phosphor.

Rack Mount Kit

P.N. 450070.

Front Cover

P.N. 450240.

INTERNATIONAL SAFETY WARNING

(as required for I.E.C. 348 Class I)

This instruction manual contains information and warnings which must be observed by the user to ensure safe operation and retain the apparatus in a safe condition. The instrument has been designed for indoor use within the specified limits of temperature. It should not be switched on if there are obvious signs of mechanical damage and it should not be used under wet conditions.

GROUNDING

The instrument must be operated with a protective ground connected via the appropriate (yellow/green) conductor of the supply cable. This is connected to the instrument before the line and neutral supply connections when the supply socket is inserted into the plug on the back of the instrument. If the final connection between the instrument and the supply is made elsewhere, the user must ensure that the ground connection is made before line and neutral.

If any supply cable other than that supplied with the instrument is used, it must carry an adequate protective ground conductor.

Any interruption of the protective earth conductor inside or outside the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.

Signal connections into the instrument should be connected after and disconnected before the protective ground connection is made, i.e. the supply lead must be connected at all times that signal leads are connected.

LIVE PARTS

The instrument is safe to operate with the covers fitted and these must not be removed under normal usage. The covers protect the user from live parts and they should be removed only by suitably qualified personnel for maintenance or repair purposes. (see maintenance section).

VENTILATION

The OS300 relies on convection cooling and must not be operated in a position which restricts the external circulation of air.

3.1 CONNECTION TO THE SUPPLY

1. Before connecting the OS300 to the supply, check that the supply range switches are set to suit the supply voltage to be used and that the correct fuse is fitted. Note that the fuse has to be changed when switching between the 100V and 220V ranges. The switches and fuse holder are mounted on the back panel of the instrument. Do not operate the range selection switches while the OS300 is switched on.

3.2 OBTAINING A TRACE

1. After connection to the supply, switch on by turning the INTENSITY control clockwise away from the OFF position. Check that the POWER indicator L.E.D. lights.
2. Set the:
 - MODE switch to CH1
 - CH1 Y shift control (vert. arrows) to approx. mid setting.
 - CH1 VAR SENS control fully clockwise to the CAL position.
 - CH1 input coupling switch to GND.
 - BRIGHT LINE button out (ON).
 - X MAG. button out (X1)
 - X shift control (horiz. arrows) to approx. mid setting.
 - TIME/CM switch to 5 μ s.

A horizontal trace should appear on the screen as the INTENSITY control is advanced.
3. Adjust the INTENSITY control to obtain a display of the required brightness.
4. Adjust the FOCUS control to obtain a sharply defined trace.
5. Adjust the CH1 Y shift control and the X shift control to centralize the trace on the screen.
6. Adjust the TRACE ROTATE preset control if necessary to align the trace with the center graticule line. It may be necessary to re-adjust this control only when the instrument is re-positioned as the beam deflection can be affected by earth's magnetic field or other sources of magnetic radiation.

NOTE: The OS300 should not be operated close to sources of alternating magnetic field such as large transformers as these may interfere with the 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 0.1 μ F 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 sensitivity, set the VOLTS/CM switch to the required range. For calibrated operation, the VARIABLE SENSitivity control should be set fully clockwise to

the CAL position. This control can be used however to reduce the gain of the relevant amplifier and obtain any intermediate sensitivity between the calibrated switched ranges. To set to any particular calibrated sensitivity, the actual variation from the calibrated range can be set by viewing the CAL 1 Volt o/p on the 0.1V/cm or 0.2V/cm ranges. If the VAR SENS control is not moved, the sensitivity will differ from the calibrated value by approximately the same proportion on all settings of the VOLTS/CM switch.

To minimize pick-up at sensitive settings, it is essential to ensure that the ground lead connection is near to the signal point.

5. For vertical movement 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 overcome by adjustment of the relevant 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.

No adjustment should be made until a minimum of 15 min. warm-up time has lapsed after switch-on, or immediately after any large change of ambient temperature.

3.4 DISPLAY MODES

The MODE switch determines the form of the display.

1. For single trace display of one Y input against the timebase this switch should be set to CH1 or CH2 and the input signal applied to the appropriate input connector.
2. For dual trace simultaneous display of both Y inputs against the timebase, this switch should be set to DUAL. Two modes of beam switching are used and selected automatically by the sweep rate selected by the TIME/CM switch. The alternate mode is used at fast sweep rates between 0.2ms/cm and 0.5μs/cm. At the slower rates from 0.2s/cm to 0.5ms/cm the chop mode operates at approx. 500kHz.
3. In the ADD mode, the single trace generated against the timebase is the algebraic sum of the CH1 and CH2 deflections.

If the INV CH2 button is operated the direction of Y deflection for that channel is reversed. If used in the ADD mode, this facility allows the difference between the CH1 and CH2 inputs to be displayed. The INV CH2 button has no effect on the polarity of internal CH2 trigger.

When examining small differences between large signals, the effect of small errors between the sensitivities of the two channels can be overcome by first connecting one input to both channels simultaneously

and adjusting one or other of the VARiable SENSitivity controls to obtain a straight line.

4. In the X-Y mode, the timebase is disabled and the CH2 input is displayed as the vertical Y deflection against the CH1 input displayed as horizontal, X deflection. The CH1 shift control is inoperative and X position is determined only by the X shift control. The X10 MAG facility is also inoperative. X deflection sensitivity being determined by the CH1 controls only. The X bandwidth is limited to 1MHz and relative phase shift between X and Y deflections may exceed 3° above 50kHz.

3.5 TIMEBASE AND X EXPANSION

The sweep speed of the internal timebase is determined by the setting of the TIME/CM switch. The VARiable SWEEP speed control should be set fully clockwise in the CAL position for calibrated operation of the timebase. This control is used to slow the sweep rate to obtain any intermediate sweep rate, between the calibrated ranges.

For horizontal shift of the trace, adjust the X shift control (horizontal arrows). If close examination of any portion of the trace is required, X10 expansion can be introduced by operation of the MAG button. This provides an effective trace length of 100cm and any portion of this may be selected for viewing on the screen by operation of the X shift control.

3.6 TRIGGER

The timebase may be triggered internally from the CH1 or CH2 signals by operation of the corresponding TRIGGER button, irrespective of whether the selected channel is being displayed. Alternatively, the timebase may be triggered from an external signal applied to the EXT TRIG sockets when both CH1 and CH2 buttons are operated simultaneously.

Trigger will occur at a level on the signal which may be set by the TRIG LEVEL control with the slope determined by the ± button. When this button is out, it will occur on a positive-going transition of the signal through the trigger level. When it is pushed in, trigger will occur on the negative-going transition. Normally triggering can be obtained from internal deflection signals greater than 2mm pk/pk up to about 2MHz but the sensitivity reduces to about 1cm pk/pk at 20MHz. Corresponding external sensitivity is 0.25V pk/pk to 2MHz and 1.25V pk/pk at 20MHz.

With A.C. coupling, the low frequency sensitivity reduces to 1cm pk/pk at about 2Hz.

The Ext Trig input impedance is approx. 100k/10pF and care should be taken not to apply more than 250V d.c. or pk, a.c. to this socket.

When the BRIGHT LINE button is out or ON, the timebase will free run in the absence of a correct trigger signal, to display a bright line or unsynchronized 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 less than 40Hz or faster than 2MHz. This will prevent additional free run sweeps from occurring between correctly triggered low frequency sweeps or erratic high frequency operation.

The coupling of the trigger signal may be selected as a.c. or d.c. by operation of the corresponding TRIGGER button. When both are pressed, an active synch. separator circuit is introduced to provide line or frame triggering for video waveforms. Field trigger occurs at low sweep rates up to 100 μ s/cm and line trigger is automatically selected on fast sweep rates from 50 μ s/cm. The trigger polarity should be selected for the polarity of the synch. pulses. At least 2mm pk/pk of synch. pulse amplitude is required with internal triggering or 0.25V with external.

Summarizing the use of the trigger controls for most applications:

- a) With BRIGHT LINE ON (button out), select the trigger source CH1, CH2 or EXT and the coupling required, a.c. or d.c.
- b) Select the trigger slope + or - and adjust the trigger level control to obtain a stable trace, starting at the required point on the waveform.

3.7 ADDITIONAL FACILITIES

1. Calibrator

This output pin on the front panel provides a positive going 1V flat topped square wave at approx. 1kHz. It can be used to check the sensitivity of the instrument or to set to any particular calibrated sensitivity (see section 3.3.4). The rise time is approx. 2 μ s and the output impedance is approx. 470 Ω , providing approx. 2.3mA when shorted to ground.

The CAL output may be used also to set up passive probes (see section 3.7.4).

2. Ramp Output

This 4mm socket on the rear panel provides a d.c. coupled positive-going ramp generated by the

timebase of approx. +3.5V pk from an impedance of approx. 5k ohms. If a lower output level can be tolerated, distortion of fast ramp output signals due to capacitive loading can be avoided by adding resistive loading to attenuate the signal.

3. Z mod

This socket on the rear panel allows modulation of the brightness. The input is d.c. coupled into approx. 10k Ω /10pF. The sensitivity at normal brightness settings requires about 2V to provide visible modulation. Approx. +40V is required to provide full trace blanking.

Care should be taken not to apply more than 100V d.c. or pk, a.c. to this socket.

4. Use of the Passive Probe

A X10 passive probe 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 10M ohms, shunted by approximately 28pF. The effective capacitance 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 1M ohms, X10 probe such as PB12 or PB13. This reduces the input capacitance and increases the input resistance, at the expense of a 10X reduction in sensitivity. The probe inserts a shunt RC network in series to form a 10:1 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 capacitance of the Y channel as follows:

1. Set the Y channel VOLTS/CM switch to 20mV, the TIME/CM switch to 500 μ s and trigger from the appropriate channel.
2. Connect the probe to the CAL socket.
3. Adjust the probe compensation to obtain a level trace, i.e. flat top without overshoot or undershoot.

5. Camera

A camera may be used with the oscilloscope to record waveforms. This facility is particularly useful at slow timebase sweep rates. Suitable cameras utilizing Polaroid film may be obtained from Shackman and hand held against the tube face. Other oscilloscope cameras may be used but suitable adaptors must be obtained and should be discussed with the camera manufacturer.

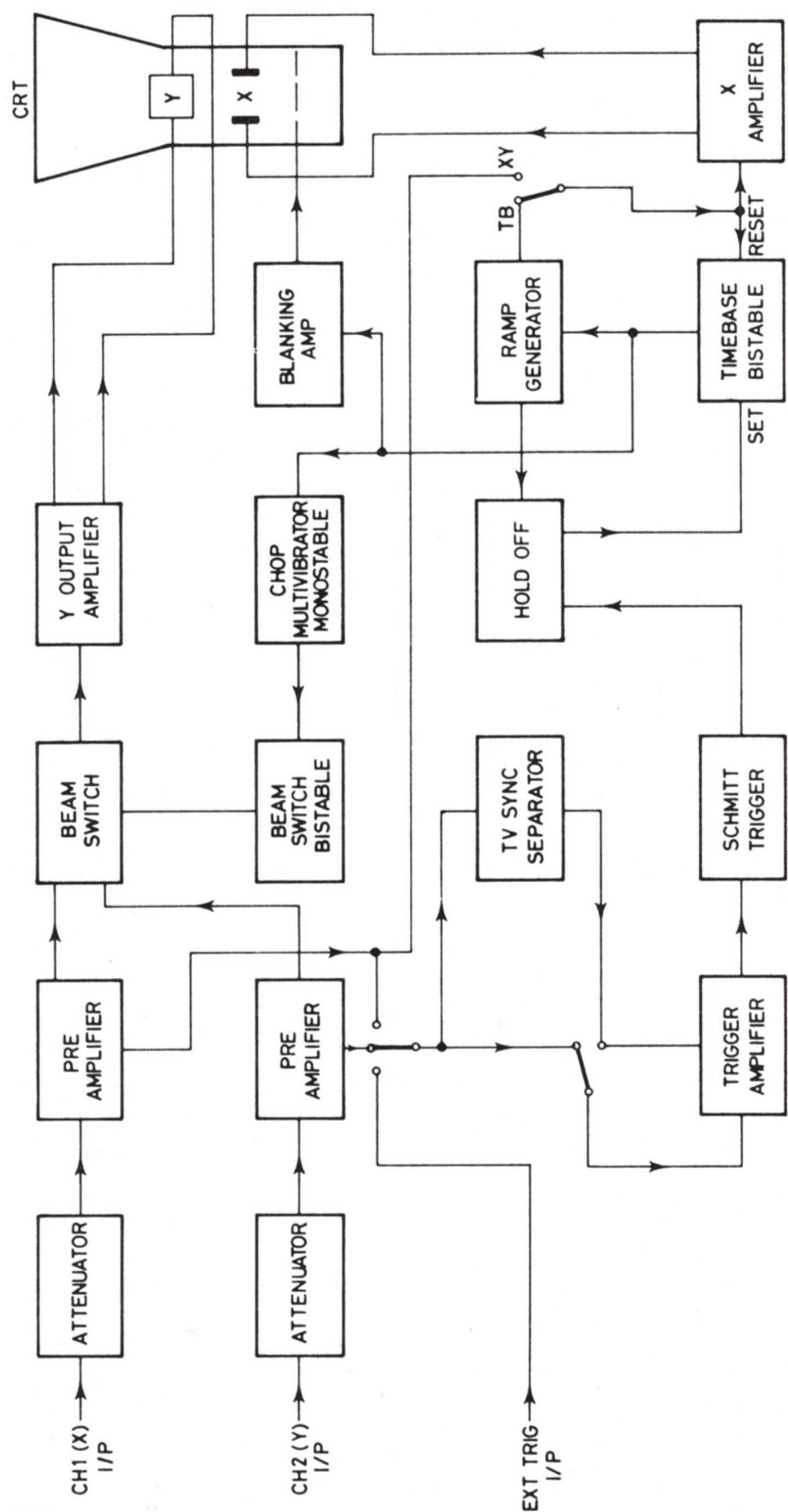


Fig. 1 Block Diagram

To aid component location, circuit references have been allocated in the following general pattern.

- 1 — 99 Components not mounted on printed circuit boards.
- 100 — 199 Components mounted on the attenuator assemblies.
- 200 — 299 Pre-amplifier and Ramp Generator components mounted on the daughter board.
- 300 — 399 Y Pre-amplifier and Beam Switch components mounted on the main board.
- 400 — 499 Y Amplifier and Y Output Amplifier components mounted on the main board.
- 500 — 599 Timebase and X Output Amplifier components mounted on the main board.
- 600 — 699 Trigger circuit components mounted on the main board.
- 700 — 799 Power supply and Modulation Circuit components on the main board.

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/CM switch controls the gain of the pre-amplifier in steps of 1.2.5 sequence to cover the ranges from 2mV/cm to 0.1V/cm and a $\div 100$ attenuator is introduced before the amplifier on the ranges 0.2V/cm to 10V/cm.

The Variable Gain control adjusts the amplifier gain to give 1 to 2.5 times reduction of gain on all settings of the Volts/cm switch. 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 bank where selection of CH1, CH2 or Ext trig source is made.

The selected signal is amplified and passed to the Schmitt trigger, the output of which clocks the timebase bistable "on". The ramp generator then begins to generate its linear ramp, which, after passing through the X amplifier, is applied to the X deflection plates of the c.r.t. and drives the electron beam linearly across the tube face. A 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 retains this signal to inhibit another ramp from being initiated for a short period, until the ramp timing capacitor is discharged fully. Thus a ramp is generated at a rate set by the TIME/CM switch when the trigger signal reaches a pre-determined level. This ramp sweeps the beam across the

c.r.t. face, returns and waits for the next input cycle to reach the set trigger point, so producing subsequent ramps. The timebase bistable is connected to a blanking amplifier whose function is to turn on the electron beam during the sweep and blank it off during the fly-back and subsequent waiting period.

At fast sweep rates for a dual trace display, the TIME/CM switch automatically selects the alternate sweep mode of control for the beam switch. At the end of each sweep, the signal from the timebase reverses the state of the beam switch bistable, causing alternate displays of the CH1 and CH2 signal on successive sweeps of the timebase. At slow sweep rates, the chop mode is selected, when the chop multivibrator free runs independently, causing the beam to switch on chop between CH1 and CH2 levels during the sweep.

A signal from the multivibrator also blanks the trace during each switching transistion. With CH1 or CH2 only selected, the beam switch bistable is held to select that channel only. In the X-Y mode, the bistable is held to select CH2 as the Y deflection signal, while an additional switch diverts the output from the CH1 pre-amplifier, to the X output amplifier as the X deflection signal in place of the normal ramp signal. The blanking amplifier is held in the bright-up state. When TV trigger mode is selected, an additional synch. separator circuit is introduced into the signal path leading into the trigger amplifier.

4.2 THE Y AMPLIFIERS AND BEAM SWITCH

These circuits are shown in Fig. 4.

The attenuators and pre-amplifiers of channel 1 are identical to those of channel 2 and accordingly only channel 1 is described.

The input signal is applied to SKA and then to the attenuator via the 3 position slide switch, S101. This allows the input signal to be directly coupled through in the DC position or coupled via C105 in the AC position. In the central GND position, the input signal from SKA is left open circuited while the input to the attenuator is grounded.

On the most sensitive ranges, 2mV/cm to 100mV/cm, the VOLTS/CM switch, S102, couples the signal through directly to the pre-amplifier and the network resistor, RN101c, provides the input impedance. On the remaining ranges, S102 introduces R101a into the signal path to form a 100:1 attenuator with RN101b in parallel with RN101c.

High frequency compensation of the attenuator is provided by C101 and C104 while C102 with C106 allows the input capacitance of the attenuator to be set to equalise that of the unattenuated ranges.

Diodes, D201 and D202 with R207, provide input protection by limiting the input voltage applied to the amplifier to the voltages of zener diode, D203 and the positive supply line.

The input stage of the pre-amplifier is formed by the f.e.t. source followers, TR201 and TR202, and emitter followers, TR204 and TR203. Unbalance in this stage is corrected by the BAL control potentiometer, R301.

The input stage drives the divider network, RN201. The VOLTS/CM switch second wafer, S201, selects the necessary output, either directly via RN201 on the 2mV or 200mV ranges, or attenuated by 2.5, 5, 10, 25 or 50 times on the subsequent ranges. This network presents a constant output impedance and further attenuation is introduced by the shunt action of the VARIABLE sensitivity control, R217. The resultant signal is amplified by the integrated amplifier, IC301. The amplifier gain is determined by R309 and the preset, R302. The differential output is balanced by the bias through R308 from the preset, R307.

The differential output from IC301 (CH1) or from IC351 (CH2) is selected by the beam switch as the input for the subsequent shunt feedback amplifier stage formed by TR401, TR402. The signal input currents are defined by R316 and R317 and are summed with the Y shift currents defined by R318 and R319 from the CH1 shift control, R315. The corresponding components for channel 2 are R366, R367, R368, R369 and R365. Channel 2 only differs for channel 1 by the addition of the double pole changeover switch, S301, which reverses the output signals from IC351 in the INVERT mode.

The beam switch is formed by the 8 diode gate, D301, D302, D303, D304, D351, D352, D353, D354. The relative control potentials from IC501 allow either the signal current from IC301 and/or IC351 to reach the bases of TR401 and TR402, or divert those currents from the bases.

The outputs from the differential shunt feedback amplifier stage formed by TR401 and TR402, are fed to the grounded emitter amplifier stage, TR403 and TR404. This in turn feeds the differential cascode Y output stage TR405, TR406, TR407 and TR408 to drive the Y deflection plates of the c.r.t.

High frequency compensation of the output amplifier is provided by networks between the emitters of TR403 and TR404 and those of TR405 and TR406. Adjustment of this compensation is by C402 and C405.

4.3 THE TRIGGER CIRCUITS

These circuits are shown in Fig. 5.

The Trigger Source switches, S502 and S503, connect the required trigger signal via the Trigger Coupling switches, S504 and S505, to the trigger buffer amplifier formed by TR601 and TR602. S502 selects the differential CH1 signal via R313 and R314 from IC301 (Fig. 4). S503 selects the equivalent CH2 signal via R363 and R364 from IC351. Where both S502 and S503 are selected, both of the above signals are disconnected and the single-sided input from the EXT TRIG input socket SKC is selected.

When the AC coupling switch, S504, is out, the trigger signals are directly coupled-through, but when this switch is in, AC coupling is introduced via C603 and C604 (C601 on External). TR601 and TR602 form a differential buffer amplifier with the DC balance controlled by the TRIGGER LEVEL control, R602. The differential output from this stage is applied to the comparator, IC602, which has positive feedback applied by R623 to form a Schmitt trigger circuit. The change-over switch, S506, reverses the output from TR601 and TR602 to determine the trigger slope.

When both S504 and S505 are "in" (AC and DC in for TV mode), the junction of R603 and C610 is connected to the -11V supply. D601 and D608 are brought into conduction while D602 and D604 are reverse biased. This diverts the output of the trigger amplifier away from IC602, into TR605, which amplifies the positive tips of the video waveform only. TR605 is prevented from saturation by feeding back the peak detected synch. pulses via TR607 and TR606 to the emitter of TR605. These pulses are amplified by IC601b and applied via R617 and D603 to the Schmitt trigger, IC602. IC601a is used in conjunction with S504 and S505 to disable the synch. separator when AC or DC is selected.

At the fast timebase sweep speeds, S 262a is open and TR603 is cut off. However, at speeds of 100 μ s/cm and slower, R608 is connected to +11V and TR603 is switched on. This effectively grounds C609 to introduce an RC integrating time constant into the synch. pulse signal time path in the TV mode to separate out frame trigger.

4.4 TIMEBASE GENERATOR AND AMPLIFIER

The square wave trigger output from IC602 is applied (with d.c. bias of zener diode, D605) as the clock to the D type TTL flip-flop, IC501a. A positive-going trigger edge will clock the bistable, driving $\bar{Q}$ low. In the waiting state, $\bar{Q}$ was high (+4.5V), turning on TR261 via R507 and R262, holding the input, and hence the output, of the operational amplifier, IC261 at 0V. This timebase amplifier is connected as a direct voltage follower.

When the trigger signal sends $\bar{Q}$ of IC501a low, the timebase clamp transistor, TR261, is turned off. Part of the constant current generated by TR264 flows through the resistor network, RN272, to charge C263 at a constant rate. The resultant positive-going linear ramp voltage generated at the input of IC261 is buffered by that amplifier to generate the low impedance ramp output.

The timebase range switch, S262, selects the tap point on the network, RN272, to vary the ramp slope in the 1.2.5 sequence over a range of three decades. On all fast sweep ranges, TR262 is biased-off but on ramps 0.5ms/cm and slower, S262c connects R263 to +11V. TR262 is turned on and C264 is effectively connected in parallel with C263 to slow the sweep rate 1000 times.

The constant current into the ramp generator is derived from the current mirror circuit formed by TR262 and TR264. The variable gain control, R261, provides an approximate 3:1 range of variation in this current, R506 provides a preset calibration control on the slow sweep rates, only when S262c is closed.

When the ramp reaches its maximum level the negative bias, introduced by R521 and R519, is overcome and TR503 turns on, driving the reset input of the timebase bistable low. As the bistable switches, $\bar{Q}$ returns high and TR261 conducts to discharge the timing capacitor(s) and the sweep is complete. However, a hold-off action takes place to inhibit trigger signals during sweep and this remains for a short period after a sweep to ensure that the ramp potential is fully reset before the next sweep can be triggered. As the ramp goes positive, D506 conducts to charge C502, reverse biasing D503 and turning on TR502. At the end of sweep when the timebase bistable is reset, $\bar{Q}$ goes low and the D input follows via the action of D508 and R511. The ramp output returns rapidly toward 0V but TR502 remains in conduction for a period determined by C502 and R518. Only when TR502 turns off can R516 and D507 take the D input high for the bistable to respond to the next clock input.

TR501 acts in a way similar to TR262 (described above) to introduce additional hold-off time through C501 on the slower half of the timebase ranges.

The bright line facility causes the timebase to free-run in the absence of trigger signals. The square wave output from the Schmitt trigger, IC602, is coupled via C615 into the peak detector diodes, D606 and D607, to generate a positive-going signal into the -ve input of IC601c driving its output negative. In the absence of such trigger signals for a period determined by C618 with R627 and R626, the output of IC601c goes positive. When TR502 turns off at the end of the hold-off period, D509 conducts to turn on TR504, driving the set input low to initiate another sweep.

This free-run condition is removed as soon as IC601c detects an output from the Schmitt trigger. It can be inhibited also with a positive bias via R625 if the BRIGHT LINE OFF switch, S501, is operated.

The X output amplifier is formed by the shunt feedback stage of TR509/TR511 driving single sided into the amplifier stage, TR513 and TR514. The collector output of this stage drives the X deflection plates of the c.r.t. directly from TR514 and via emitter follower TR515 from TR513. The gain introduced by TR509/TR511 is defined in the x10 magnification mode by the input resistance, R539, and the feedback resistance, R552, with the preset, R553. In this mode the transistor switch, TR512, is biased off. However, in the normal x1 magnification mode S507 is open and the current in R548 turns on TR512, introducing R544 with preset, R511, as additional feedback to reduce the gain of the amplifier accordingly.

The X shift control, R271, introduces an additional bias input via R541 and emitter follower TR506, through the potential divider R569/R545.

4.5. MODE CONTROL CIRCUITS

The display mode is controlled by S261 (Fig. 5) which defines the state of three control lines according to the following table.

Mode	L1	L2	L3	Q	Q
				IC501b	
X-Y	+11V	0	+11V	L	H
CH1	0	+11V	0	H	L
Dual	+11V	+11V	0	Switching	
CH2	+11V	0	0	L	H
Add	0	0	0	H	H

These lines in turn control the function of the beam switch and other necessary signal switching.

Section 4.2 described the signal switching action of the beam switch diodes, D301 to D304 and D351 to D354. These are controlled by the Q and $\bar{Q}$ outputs of the beam switch bistable, IC501b. In the CH1 mode L1 is open, allowing R525 to take the set input of the bistable low, Q is high and $\bar{Q}$ is low, selecting the channel 1 signal for Y display. In the CH2 and X-Y modes, L1 is at +11V and R514 takes the set input high but L2 is open and R524 takes the reset input low to reverse the bistable and select the channel 2 signal.

In the Add mode, both L1 and L2 are open so that both set and reset are applied to the bistable, Q and $\bar{Q}$ are high and both channel signals are added into the shunt feedback stage of the Y amplifier (Fig. 4). In this mode only, L1, L2 and L3 are open, removing the bias through D401, D402 or D403 and defined by R401 and R402 via D405 and D406. This offsets the additional bias introduced by the selection of both channel signals.

Only in the X-Y mode, L3 is held at +11V to turn on the diode gate of D515 and D514, so coupling the channel 1 preamplifier signal of IC301, via TR506 and R547 into the X output amplifier. At the same time D504 conducts to turn off the gain switching transistor, TR512, thereby selecting x 10 X magnification irrespective of the position of S507.

D501 conducts allowing current through R509 to turn on TR261, clamping the ramp generator so that no signal is fed into the X amplifier via R539. Finally, current through R512 turns on TR504, holding the timebase bistable set "on" to provide continuous bright-bright-up of the trace.

In the Dual mode, both L1 and L2 are held at +11V so that the beam switch bistable, IC501, is free of set or reset signals. Thus it can respond to clock signals and as its D input is connected to its Q output its state reverses on each clock input.

On the fast sweep ranges (0.2ms/cm and above), the clock input is derived via emitter follower, TR505, directly from the Q output of the timebase bistable. Thus the beam switch operates in the alternate mode. The Y deflection is switched between channels at the

end of each sweep. TR507 and TR508 form a free-running emitter coupled multivibrator but on the above ranges, S262 – is open such that R534 is disconnected and the multivibrator is paralyzed.

On the slow ranges (0.5ms/cm and below), R534 is connected to +11V and the multivibrator runs. During each sweep period, the multivibrator provides continuous clock inputs to the beam switch bistable so that the beam deflection signal is made to chop between the two channel signals. The beam switching is inhibited between sweeps as the emitter follower, TR505, clamps high the clock input to the beam switch bistable. In all modes but Dual, L1 or L2 are low and D512 or D513 conducts to inhibit the action of the multivibrator.

IC601d is used for the 1kHz calibrator. It is connected as an oscillator with positive feedback via R629 and negative feedback via R633. This with C617 defines the frequency as approx. 1kHz. The output is buffered by the transistor switch, TR604, which defines the calibrator output amplitude via the potential divider of R638 and R643 with preset, R641.

4.6 THE POWER SUPPLIES AND C.R.T. CIRCUITS

These circuits are shown in Fig. 6. The following d.c. supplies are generated in the power supply circuit from secondary windings on the supply transformer, T1.

+210V, +11V, +7V, -5V, -11V, -1850V.

The +210V line is used primarily in the X and Y output amplifiers. The -1850V line is the cathode supply for the c.r.t. In addition, a +5V line is generated in the time-base area from the +11V line by IC552 (Fig. 5).

The incoming a.c. supply from the supply connector, PLM, is switched by S1 and fused by FS1 before reaching the two supply range switches, S2 and S3. S2 connects the two primary windings of T1 in series or in parallel for 120V or 240V operation while S3 selects the necessary tap for 100V or 220V operation.

The output from the 210V secondary is bridge rectified by the four bridge connected diodes, D722 to D725, into the reservoir capacitor, C705. The resultant d.c. voltage, protected by FS701 feeds the h.t. regulator for the +210V supply. D730 is the reference for this supply, buffered by emitter follower, TR711, and the Darlington pair, TR713. The return of the rectified 210V supply is via the -11V line to balance load currents in the low voltage supplies.

The four low voltage supplies are derived from a single 25V secondary of transformer, T1. Its output is bridge rectified by bridge connected diodes, D726 to D729, into the reservoir capacitor, C704.

The distribution with respect to the 0V line of the voltage across this capacitor is determined by the -11V shunt regulator and the +11V series regulator. The -11V reference is provided by the zener diode, D711, with temperature compensation diodes, D713 and D714, and

the shunt transistor, TR712, conducts to maintain the -11V line at the correct potential.

The -5V line is derived from this -11V line by the zener diode, D712, with the compensation diode, D720, followed by the emitter follower, TR709.

With the negative side of the unstabilized supply across C704 defined at -11V by that stabilizer, the positive side is applied to the series regulator, IC702, which takes up all variation in the unstabilized supply to define the +11V line. This is a 15V regulator with 'low'. pin 3, returned to a -4V potential defined from the -5V supply by R735 and R734.

The +7V supply is provided from the +11V supply by a further 12V series regulator, IC701, operating with respect to the -5V line.

All the above outputs are connected to the subsequent oscilloscope circuitry via split pads in the copper track pattern. These are normally bridged by solder but can be used to isolate each line to assist fault finding.

The grid and cathode supplies for the c.r.t. are derived via the voltage doubler circuit, D718, D719, C711 and C712, from the 950V secondary of T1. The negative side of the unstabilised supply developed across C711 and C712 is held at approx. -2000V with respect to 0V by the series zener diode, D706, which is returned to the stabilised cathode potential of -1850V. Subsequent variations in the unstabilized supply are developed across the series regulator, TR707, of the e.h.t. regulator. The feedback path of this regulator uses the current from the -1850V line defined by the resistors R715, R714 in parallel with R744 (the FOCUS pot.) and RN720e. The latter being within the e.h.t. network. This current is returned to the +7V line via R731, R725 and R726. If the resultant potential of the tap point defined by the preset, R725, is not at approx. -4.5V, the current in transistor, TR706 will change to correct the stabilizing voltage across TR707. TR706 and TR707 are connected in cascode.

The heater of the c.r.t. is supplied directly from an independent 6.3V secondary winding of T1.

The OS300 employs a novel modulation circuit to control the grid potential with respect to the cathode potential. The transistor pair, TR703 and TR704, generate an essentially constant current from the collector of TR703. This generates a constant voltage across RN720 and preset, R713, and is returned to ground via the output of the bright-up amplifier. Thus signal variations from this amplifier which operates with respect to 0V are transferred with the large negative d.c. offset to the collector of TR703, to be applied to the grid of the c.r.t., via the emitter follower, TR716.

In more detail, the constant current from TR703 is defined by the emitter resistance, RN720c and the base potential, from the divider, RN720a and RN720b.

This constant current source is returned to the -200V line (negative of D706) so that the collector of TR703

(the c.r.t. grid) can move negative from the cathode. The collector potential is protected by D705 against excessive swing during switch-on or switch-off conditions. While RN720d and R713 generate the necessary large d.c. potential to couple the bright-up signals to the grid, the high frequency components are by-passed through C702.

The bright-up signal amplifier is formed by the cascode transistor pair, TR701 and TR702, with shunt feedback via R704. It responds to the sum of three inputs. The first is a d.c. bias via R707 from the INTENSITY control, R745. The second is the external Z Modulation signal from SKG, via R703. The third is the composite signal from the collector of TR507 (Fig. 5 see section 4.5), which provides bright-up during each timebase sweep with blanking of each chop transistion if approp-

riate. Diodes, D701 and D702, provide protection against excessive external inputs and with R702, prevent saturation of TR702.

The focus electrode of the c.r.t. is supplied from the focus control potentiometer, R744, with a portion of the -1850V supply. The astig. electrode is supplied from preset, R708 driven from the +210V supply via the divider network R746, R747.

Minor angular misalignment of the gun assembly of the c.r.t. or the effects of externally applied magnetic fields, axial to the c.r.t. can be corrected by the trace rotation coil. This coil is round the neck of the c.r.t. and the current is determined by the TRACE ROTATION control, R737, connected between the $\pm 11V$ supplies and driving emitter followers, TR714 and TR715.

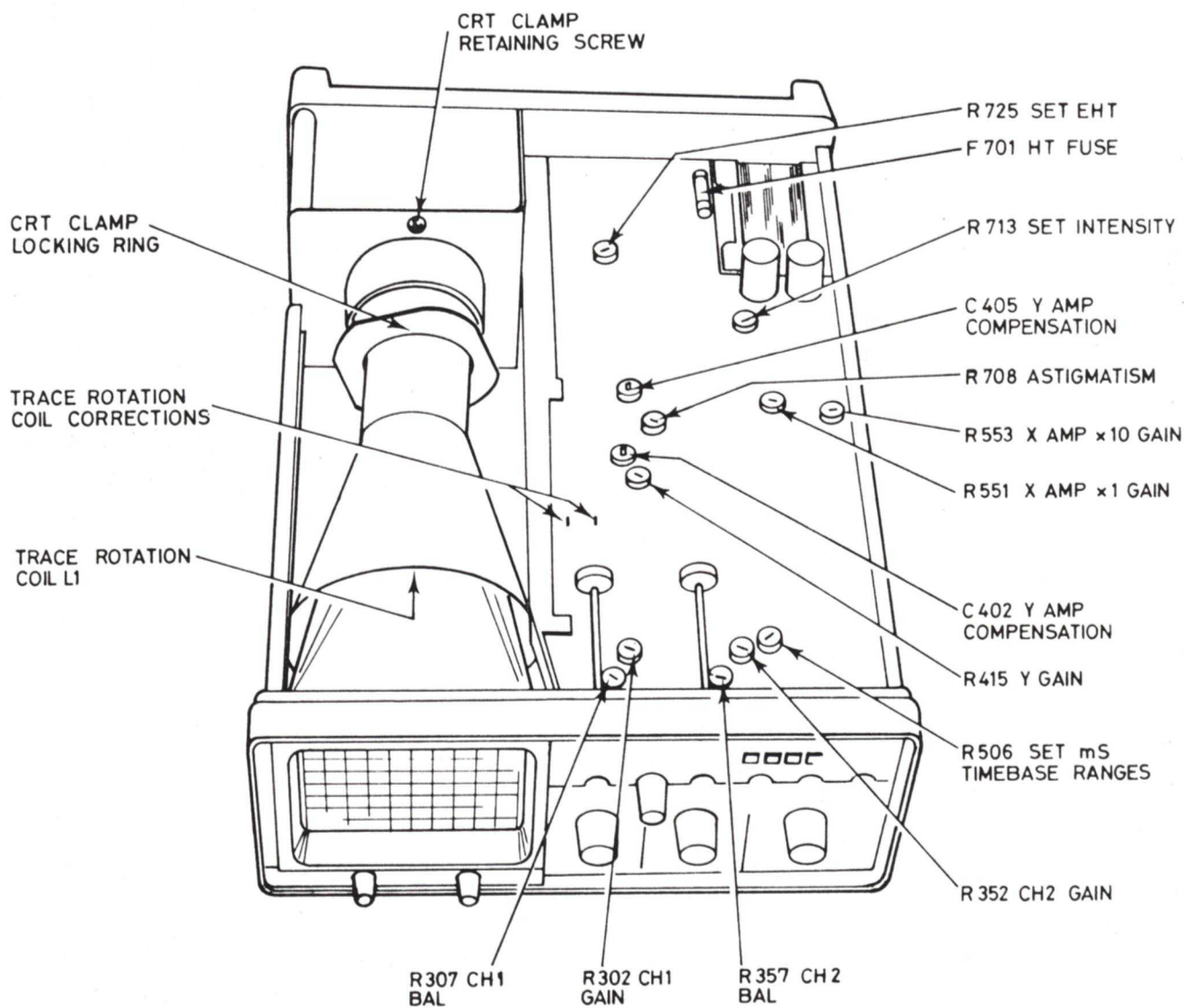


Fig. 2 Internal Assembly – top view

5.1 GENERAL

Figs. 2 and 3 show the internal location of the major components, sub-assemblies and preset controls. No regular maintenance is required apart from routine recalibration. The construction of the instrument is such that full access to all calibration controls and to most components can be obtained once the two halves of the case have been removed. (See section 5.2)

Supply voltage adjustment is made by the two selector switches on the rear panel. The supply fuse is mounted adjacent to these switches and the supply connector. This connector should be removed or the instrument switched off before operating the switches. For 100 or 120V operation a 500mA, 20mm slo-blo fuse is required (Part No. 33685), for 200 or 220V operation a 250mA, 20mm slo-blo fuse is required (Part No. 33684). The internal H.T. fuse is a 100mA, 20mm fuse (Part No. 32958).

5.2 REMOVAL OF THE CASE AND SUB-ASSEMBLIES

WARNING

DANGEROUS VOLTAGES ARE EXPOSED ONCE THE CASE IS REMOVED. MAINTENANCE SHOULD BE CARRIED OUT ONLY BY QUALIFIED PERSONNEL. PARTICULAR CARE SHOULD BE TAKEN ON THE TUBE BASE AND THE E.H.T. AREA OF THE MAIN PRINTED BOARD WHERE VOLTAGES IN EXCESS OF 2000V ARE PRESENT. THESE VOLTAGES MAY BE RETAINED AS STORED CHARGE FOR UP TO ONE MINUTE AFTER THE SUPPLY IS DISCONNECTED.

(a) To remove the Case (Top section)

DISCONNECT FROM THE SUPPLY.

Remove the two fixing screws at the top front sides and lift the top cover up and forward to clear the front moulded frame and the rear plastic moulded cover.

(b) To remove the Case (Lower section) and Handle assembly

DISCONNECT FROM THE SUPPLY.

Remove the two fixing screws at the top front sides and proceed to remove the top cover as detailed in (a) above. Rest the instrument upside down and remove the screw from the centre of the front frame, securing the cover. Lift the lower cover up and forward to clear the front moulded frame and the rear plastic cover. It may assist this operation if the screws holding the rear moulding are slackened but not removed.

(c) Removal of the C.R.T.

Remove the case as described in (a) and (b) above. Disconnect the trace rotation coil leads from pins 734 and 735 on the main printed circuit board. Unplug the tube base assembly. The base itself is carried on a small printed board which has been designed to allow

access on two edges to facilitate withdrawal from the c.r.t. pins. Remove the single clamp fixing screw (see Fig. 2) and rotate the two clamp sections approx 30° to free the clip from the centre panel. Once the tube and clamp assembly are free the clamp itself can be slackened on the tube. Slide the tube backward through the center panel until the c.r.t. face plate is clear of the front mounting clip. The tube can then be lifted up and drawn forward, to clear the top edge of the front panel and frame moulding of the instrument. Withdraw the tube from the shield and the two part clamp.

When fitting a new tube operate in the reverse order to the above instructions, with the exception of the tube clamp and center panel fixing screw. On re-assembly the fixed part (rear) of the c.r.t. clamp is located in the slotted locating holes in the bulkhead and the retaining screw is fitted. The tube is then held forward against the graticule in the front moulding while the clamping ring is rotated to hole and lock the tube in place. Do not over tighten this ring.

Check the polarity of re-connection of trace rotation coil leads. Clockwise rotation of the front panel preset control should cause a corresponding movement of the trace.

(d) Removal of the Attenuator assembly

Should it be necessary during repair to remove the attenuator and screens around the pre-amplifier for access to components on that board or on the front of the main board, proceed as follows.

Remove the collet fitted knob on the timebase switch. Access to the collet securing screw or nut is by prising off the clip in the centre cap on the knob. Remove the small push on knobs on the two Variable Sensitivity controls, the Mode switch, the Trigger Level, the Variable Sweep and X Shift controls. Unsolder and, using a desoldering tool clear the solder from the three screens where they are earthed onto the pre-amplifier board. Unsolder and remove the wires from the CAL 1V pin and the EXT trigger connection on the input printed circuit board. Unsolder also the two signal connections to pins 201 and 231 on the pre-amplifier board.

The sub section front panel, carrying with it the two attenuator volts/cm switches, the two AC/GND/DC switches and the input coupling printed board can now be un-latched by springing the four latch fingers away from the moulded frame and withdrawing the complete unit.

Re-assembly is the reverse of the aforementioned. Since the two attenuator switch wafers are symmetrical the shaft can be inserted in either of the two possible alignment positions.

(e) Removal of the Input Coupling Switch printed circuit assembly

If it is necessary to gain access to the small printed

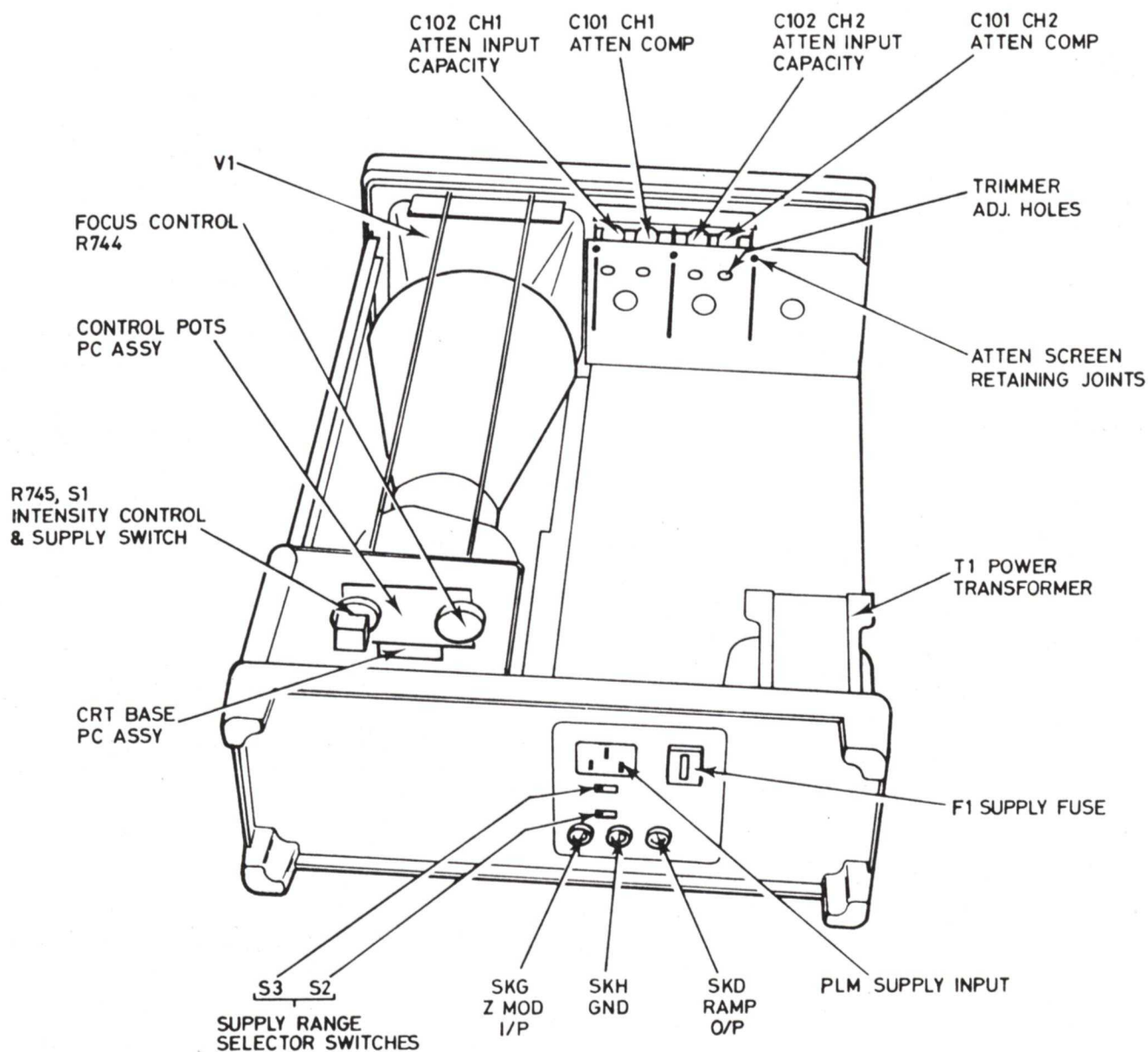


Fig. 3 Internal Assembly – bottom view

board which carried the input selection switches and the A.C. coupling capacitors for each Y channel, together with the input network for the External trigger signal proceed as follows. Using a desoldering tool, unsolder the tags of the input screen, clear the holes of solder and remove the screen. Unsolder and remove the two wires connecting the input printed board with the two attenuator wafer sections of each volts/cm switch. Desolder the three input B.N.C. sockets from this board and the three screen grounding points. The board should then be free for removal by easing upward, off the screen tags, then rotated to enable the switch sliders to clear the front moulding, and so withdrawn.

Re-assembly is the reverse of this sequence.

(f) Removal of the C.R.T. Control Potentiometer board

If it is necessary to gain access to the control pots. proceed as follows. Remove the push on knobs on the Focus and the Intensity controls. Ease the spacer retaining ears out of the printed board, so freeing the board from its retaining plastic spacer. Separate the two control pot shafts from the moulded shaft couplers. Full access to both the component side and the track side of the board is now facilitated and the faulty component can be readily accessed.

5.3 FAULT FINDING

Before any fault location is attempted, it is suggested that all supply voltages are checked. Subsequent signal voltages and waveforms should then be checked according to the following list, which may be used as a general guide and aid to servicing. Note that the typical voltages for un-stabilized supplies are quoted for nominal mid-range supply voltages.

If a fault cannot be cleared it is recommended that the instrument is returned to the manufacturer for repair (see section 7).

When faults have been cleared it is recommended that the setting-up procedure of section 5.4 is followed.

For checking the supply lines there is a double row of test pins, separated by bridged split pads. These pins will give outputs of +11V, -11V, +210V, +7V and -5V and if required the currents drawn by each line can quickly be measured simply by breaking the solder shorting the split pad for normal working operation, and inserting a current measuring meter between the two pins. In all five cases the line feed is nearer to the rear of the instrument, while the line load is connected to the forward pin.

Normal Operating Conditions

Unless otherwise specified the controls are set for single channel operation with the trace centered and timebase running. Potentials are specified with respect to ground and should be measured with a high impedance voltmeter, digital voltmeter or oscilloscope as appropriate.

a) Supplies

Unregulated

30V d.c. across C704 from 25V r.m.s. secondary voltage.

268V d.c. across C705 from 210V r.m.s. secondary voltage

2.5kV d.c. across C711 + C712 from 950V r.m.s. secondary voltage.

Stabilized

+210V	± 21V
+11V	± 0.5V
+7V	+0.4V, -0.6V
-5V	-10.4V, -0.6V
-11V	±0.5V

Note: EHT regulator should be set for collector of TR707 to be at +405V for nominal supply voltage.

b) Y Amplifier

Test Point	D.C. Level	Sensitivity
TR203/204 Collector	+7V	—
IC301, pin 1	+1V ±0.8V	—
IC301, pin 14	+1V ±0.8V	2mV/cm
IC301, pins 7, 8	+3.5V	65mV/cm each side
TR401/402 Collector	+3.7V	40mV/cm each side
TR403/404 Collector	+7.7V	140mV/cm each side
TR405/406 Collector	+12.6V	—
TR4057/408 Base	+15.6V	—
TR407/408 Collector	+115V	6.8V/cm each side

c) Ramp Generator

Test Point	Signal
Across R265 or R266	0.8V d.c. at "cal" 0.3V d.c. at min.
IC261 pin 3 and pin 6	+3.7V ramp from 0.1V level
TR264 Collector	+3.7V ramp from base level between 0 and +4V dependent on sweep rate selected.

d) X Amplifier

Test Point	D.C. level	Signal
TR512 Collector	+0.65V (Centre Screen)	500mV/cm 6.0V ramp
TR511 Emitter	+3.7V (Centre Screen)	500mV/cm 6.0V ramp
TR514 Base	-3.0V	—
TR513/513	+118V	12V/cm each side 140V ramp each side

e) Trigger Amplifier

Test Point	D.C. Level	Signal
TR601/602 Base	0V on Ext. 0V on Int A.C. +3.5V on IntD.C.	65mV/cm each side 65mV/cm each side
TR601/602 Collector	-4.8V	25mV/cm each side

On TV mode:- TR601 and TR602 collector drops to between -8.5V and -10.5V dependent on the setting of the Trig. Level Control.

IC602, pin 9. Trigger output switches between -2V and -5.6V levels.

f) Timebase Control

Test Point	Signal
IC501, pin 14	+5V, $\pm 0.25V$
IC501, pin 1	+5V (+1V at end of ramp)
IC501, pin 2	+4V (0V during hold-off)
IC501, pin 3	Trigger pulses between -0.5V and +2.8V levels
IC501, pin 4	+5V (0V during reset by bright line)
IC501, pin 5	+0.2V between sweeps +4.5V during sweeps
IC501, pin 6	+4.5V between sweeps +0.2V during sweeps
IC501, pins 8,9	Beam switched between +0.2V and +4.3V levels
IC501, pins 10, 13	-0.6V or 4.5V depending on mode switch setting
IC501, pin 11	Chop/alt. pulses between +0.2V and +4.7V levels
IC601, pin 8	+0.5V triggered or bright line off +0V bright line operating
IC601, pin 9	0V triggered or bright line off +9.5V bright line operating

g) Bright-Up Amplifier

Test Point	Signal
TR507 Collector	Switching signal +4.8V (blank) to 0V (Bright up)
TR702 Base	+2V
Collector	Between +6V and +48V dependent on intensity
RN720, pin 4	-2kV
RN720, pin 5	+50V with respect to pin 4
RN720, pin 6	+340V with respect to -1850V

5.4 SETTING UP PROCEDURE

The following procedure details the adjustments necessary to recalibrate the OS300 and set all the preset controls to achieve the specified performance. Inability to make these adjustments or failure to meet the specification after those adjustments have been made should be considered as a fault and the operating conditions should be checked according to section 5.3.

The procedure should be followed in the specified order.

a. Test Equipment

1. Multirange Test Meter including 2.5kV capability at 20k Ω /V
2. Variable Autotransformer, output voltage 100-270V at 5A.
3. Sine/square wave signal generator, 10Hz to 100kHz, 20mV - 5V.
4. Source of voltage and time calibration signals, such as Bradley Oscilloscope Calibrator type 192.
5. Square wave generator, 500kHz, 100mV into 50 Ω , rise time less than 50ns with square corner and flat top.
6. RF Sinewave, Constant Amplitude Signal Generator. 25mV to 5V pk/pk 50kHz to 15MHz.
7. 10:1 passive probe (PB12 or PB13).

b. Set EHT.

Set the incoming a.c. supply via the auto transformer to the nominal center voltage of the selected range. Set to mid brilliance on the c.r.t. Monitor the collector voltage of TR707. Adjust R725 for this voltage to be +405V $\pm$ 5V. Remove the voltmeter. The instrument may now be operated directly from the uncontrolled supply.

c. Set Intensity Range.

Set to X-Y mode with inputs grounded and center the spot on the screen. Monitor the collector voltage of TR702. Adjust the intensity control for this voltage to be +15V and then adjust R713 for the intensity of the spot to be near cut off. Remove the voltmeter.

d. Astigmatism

Display a mid-frequency sinusoidal signal in the normal sweep mode on one channel, approx. 2cm pk to pk and 4cm period. Set the Variable sensitivity control fully counterclockwise. Set to a fairly low brilliance and adjust both the Focus control and R708 (Astig.) for the sharpest trace over the whole of its length. Reset the Variable sensitivity to Cal.

e. Trace Rotation

Ground the input and set the horizontal trace to the center line. Adjust the Trace Rotation preset control to align the trace with the center graticule line.

f. Input Balance

Select CH1 and with the input grounded, adjust the preset Bal control for no vertical movement of the trace between the 0.1V/cm and the 0.2V/cm ranges. Repeat for CH2.

g. Trigger Balance

Set R357 for no vertical movement of the channel 2 trace when Invert is selected. Connect a sinusoidal input, AC coupled, to CH1 and set the trace for about 5cm pk to pk signal and one cycle displayed. Adjust R307 such that there is no change of trigger point as the Trigger Coupling is switched between AC and DC. Note that the relevant shift control may have to be operated to return the trace to the centre of the screen when R357 or R307 are adjusted.

h. Timebase Calibration

Ensure that the Variable Sweep is set fully clockwise to Cal. Apply 0.1ms calibrated time markers to either channel input. Set the timebase to 0.1ms/cm and obtain a centered triggered trace. Apply X10 Magnification and set R553 for 10cm spacing between the time markers.

Return to X1 Magnification and set R551 for 1cm spacing between markers.

Apply 1ms/cm time markers and set the timebase to 1ms/cm. Set R506 for 1cm spacing between the time markers.

All other timebase ranges can be checked for accuracy.

i. X-Y Calibration

Ensure that the CH1 Variable Sensitivity control is set fully clockwise to Cal. Select X-Y and apply a calibrated 100mV square wave to Channel 1 input. Select 20mV/cm Ground Channel 2. Set R302 for a 5cm horizontal trace length.

j. Channel 1 Calibration

Select CH1. With 100mV input at 20mV/cm as i. above, set R415 for a 5cm vertical amplitude signal.

All other sensitivity ranges can be checked for accuracy.

k. Ensure that the CH2 Variable Sensitivity control is set fully clockwise to Cal. Transfer the 100mV calibration signal to channel 2 and set to display that channel at 20mV/cm. Set R352 for a 5cm vertical amplitude signal.

All other sensitivity ranges can be checked for accuracy.

l. Attenuator Compensation

Apply a square wave input to CH1 at approx. 1V pk/pk and 1kHz. Select 0.2V/cm and adjust C101 on the CH1 attenuator assembly to obtain a square-topped displayed pulse. Access is through the screw driver/trim tool hole in the pre-amplifier board.

Repeat for CH2.

m. Input Capacitance Equalization

Select 100mV/cm on CH1 with the Variable Sensitivity control set fully counterclockwise and monitor a 10V 1kHz square wave via a 10:1 probe. Adjust the capacitive compensation of the probe for a flat-topped displayed pulse. Select 200mV/cm, reset the Variable Sensitivity to Cal and adjust C102 for a similar flat top to the pulse. Access is through the screw driver/trim tool hole in the pre-amplifier board.

Repeat for channel 2.

n. Pulse Response and Bandwidth

Monitor a fast rise square wave input signal to examine the edge in detail on the 20mV/cm and 0.5 μ s/cm ranges.

Adjust C405 for a flat top following the transition and C402 for the optimum corner to the pulse.

Connect a constant amplitude sinusoidal generator and set the input for 5cm pk/pk at 50kHz. Increase the frequency and check that the loss of amplitude is less than 3dB at 20MHz (>3.5cm pk/pk).

o. Calibrator

Monitor a calibrated 1V pk/pk square wave input and set the sensitivity and variable sensitivity controls for a full 8cm pk/pk display. Disconnect the external input and connect the Y input to the OS300 Calibrator output. Adjust R641 for a similar 8cm signal amplitude.

SPARES ORDERING

When ordering spare parts, always give the following information:

- 1) Instrument model number
- 2) Serial number
- 3) Gould part number
- 4) Schematic reference number
- 5) Description of part

NOTE: All part numbers shown in this manual shall be prefixed with AD2, i.e., 37898 should be AD237898.

In its program of developing new and better products, Gould may make changes in component types and other parts. In most cases these components will be interchangeable with those in instruments already in the field. However, where necessary, minor modifications may be required. Contact your Gould Service Center for advice.

Most components have internationally available equivalents.

ABBREVIATIONS USED FOR COMPONENT DESCRIPTIONS

RESISTORS

CC	Carbon Composition	$\frac{1}{2}W$	10%	unless otherwise stated
CF	Carbon Film	$\frac{1}{4}W$	5%	unless otherwise stated
MO	Metal Oxide	$\frac{1}{2}W$	2%	unless otherwise stated
MF	Metal Film	$\frac{1}{4}W$	1%	unless otherwise stated
WW	Wire Wound	6W	5%	unless otherwise stated
CP	Control Potentiometer		20%	unless otherwise stated
PCP	Preset Potentiometer Type MPD, PC		20%	unless otherwise stated

CAPACITORS

CE(1)	Ceramic		+80%	
			-25%	
CE(2)	Ceramic	500V	$\pm 10\%$	unless otherwise stated
CE(3)	Ceramic	50V		unless otherwise stated
SM	Silver Mica			
PF	Plastic Film		$\pm 10\%$	unless otherwise stated
PS	Polystyrene			
PE	Polyester		$\pm 10\%$	unless otherwise stated
PC	Polycarbonate			
E	Electrolytic (Aluminium)		+50%	
			-10%	
T	Tantalum		+50%	
			-10%	

Component List and Illustrations

Section 6

NOTE: When ordering, all part numbers shown in this manual shall be prefixed with AD2, i.e., 37898 should be AD237898.

CIRCUIT COMPONENTS LIST FOR OS300

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS											
R101	22	CF			28710	R301	10k	PCP			44959
						R302	220	PCP			36262
R103	22	CF			28710						
R133	22	CF			28710	R306	1k	CF			21799
						R307	10k	PCP			36267
R151	100k	CF		1W	19061	R308	22k	CF			21812
						R309	120	CF	2		38572
R201	1k8	CF			28725	R311	10	CF			21793
R202	10	CF			21793	R312	10	CF			21793
						R313	100	CF			21794
R204	1k5	CF			21801	R314	100	CF			21794
R205	4k7	CF			21805	R315	4k7	CP		A4/450060	
R206	47	CF			28714	R316	3k3	MF	2		38606
R207	470k	CC			4906	R317	3k3	MF	2		38606
R208	150	CF			28719	R318	7k5	CF			40297
						R319	7k5	CF			40297
R210	820	CF			28724						
R211	510	CF			29434	R351	10k	PCP			44959
R212	820	MF	2		38592	R352	220	PCP			36262
R213	820	MF	2		38592						
R214	1k5	MF	2		38598	R356	1k	CF			21799
R215	1k5	MF	2		38598	R357	10k	PCP			36267
R216	180	CF			21795	R358	33k	CF			21812
R217	4k7	CP			44980	R359	120	MF	2		38572
R231	1k8	CF			28725	R361	10	CF			21793
R232	10	CF			21793	R362	10	CF			21793
						R363	100	CF			21794
R234	1k5	CF			21801	R364	100	CF			21794
R235	4k7	CF			21805	R365	4k7	CP		A4/450060	
R236	4k7	CF			28714	R366	3k3	MF	2		38606
R237	470k	CC			4906	R367	3k3	MF	2		38606
R238	150	CF			28719	R368	7k5	CF			40297
						R369	7k5	CF			40297
R240	820	CF			28724						
R241	510	CF			29434	R401	2k2	MF	2		38602
R242	820	MF	2		38592	R402	2k2	MF	2		38602
R243	820	MF	2		38592	R403	2k2	CF			21803
R244	1k5	MF	2		38598	R404	2k2	CF			21802
R245	1k5	MF	2		38598	R405	2k7	MF	2		38604
R246	180	CF			21795	R406	47	CF			28714
R247	4k7	CP			44980	R407	2k7	MF	2		38604
						R408	1k5	CF			21801
R261	10	CF			21793	R409	1k5	CF			21801
R262	470	CF			21797	R410	1k8	CF			28725
R263	4k7	CF			21805	R411	1k8	CF		½W	18553
						R412	390	MF	2		38584
R265	1k	CF			21799	R413	1k8	CF		½W	18553
R266	1k	CF			21799	R414	390	MF	2		38584
R267	10	CF			21793	R415	100	PCP			36261
R268	100	CF			21794	R416	47	CF			28714
R269	47k	CP			44477	R417	150	MF	2		38574
R270	4k7	CP			44981	R418	270	MO			26742
R271	2k2	CP			44982	R419	10	CF			21793

Component List and Illustrations

Section 6

NOTE: When ordering, all part numbers shown in this manual shall be prefixed with AD2, i.e., 37898 should be AD237898.

OS300 (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS (Cont.)											
R421	10	CF			21793	R534	6k8	CF			21807
R422	270	MO			26742	R535	1k	CF			21799
R423	82	CF			28717	R536	10	CF			21793
R424		A.O.T.				R537	10	CF			21793
						R538	10	CF			21793
R426	120	CF			28718	R539	470	CF			21797
R427	120	CF			28718						
R428	22	CF			28710	R541	10k	CF			21809
R429	39k	CF		1W	19056	R542	47	CF			28714
R432	22	CF			28710	R544	470	CF			21797
R433	47	CF			28714	R545	3k	MF	2		38605
R434	47	CF			28714	R546	6k8	CF			21807
						R547	2k2	CF			21802
R437	100	CF			21794	R548	8k2	CF			21808
R438	100	CF			21794	R549	6k8	CF			21807
R439	270	CF		1W	19036						
R440	270	CF		1W	19036	R551	1k	PCP			36264
R441	270	CF		1W	19036	R552	12k	CF			21810
R442	2k2	MO	5		44986	R553	4k7	PCP			36266
R443	2k2	MO	5		44986	R554	680	CF			28723
R444	47	CF			28714	R555	47	CF			28714
R445	47	CF			28714	R556	2k7	CF			28726
						R557	1k8	CF			28725
R503	470	CF			21797	R558	10	CF			21793
R504	56k	CF			28729	R559	100	CF			21794
R505	27k	CF			21813	R560	68k	CF			21816
R506	10k	PCP			36367	R561	100	CF			21794
R507	4k7	CF			21805	R562	10k	CF			21809
R508	4k7	CF			21805	R563	390	CF		½W	18545
R509	33k	CF			21814	R564	33k	CF			21814
R510	10	CF			21793	R565	2k2	CF			21802
R511	10k	CF			21809	R566	100k	MO			28822
R512	33k	CF			21814	R567	390	CF		½W	18545
R513	5k6	CF			21806	R568	22k	CF			21812
R514	1k5	CF			21801	R569	510	MF		¼W	38587
R515	1k5	CF			21801	R570	18k	CF			21811
R516	1k	CF			21799	R571	820	CF			28724
R517	22k	CF			21812	R572	22k	CF			21812
R518	22k	CF			21812	R573	4k7	CF			21805
R519	3k9	CF			21804	R574	12k	CF		1W	19051
R520	2k2	CF			21802	R575	12k	CF		1W	19051
R521	1k	CF			21799	R576	10k	MO	5		44987
R522	2k2	CF			21801	R577	10k	MO	5		44987
R523	4k7	CF			21805						
R524	3k9	CF			21804	R600	22k	CF			21812
R525	3k9	CF			21804	R601	10k	CF			21809
R526	2k2	CF			21802						
R527	680	CF			28723	R603	3k3	CF			21803
R528	680	CF			28723	R604	4k7	CF			21805
R529	1k	CF			21799	R605	2k2	CF			21802
R530	56	CF			28715	R606	10k	CF			21809
						R607	2k2	CF			21802
R532	180	CF			21795	R608	4k7	CF			21805
R533	1k2	CF			21800	R609	470	CF			21797

Component List and Illustrations

Section 6

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OS300 (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS (Cont.)											
R610	10	CF			21793	R721	180	CF		½W	18541
R611	680	CF			28723	R722	1k	CF			21799
R612	680	CF			28723	R723	2k2	CF			21802
R613	68k	CF			21816	R724	5k6	CF			21806
R614	10	CF			21793	R725	47k	PCP			38261
R615	12k	CF			21810	R726	33k	MF	2		38630
R616	470	CF			21797	R727	150	CF			28719
R617	2k7	CF			28726	R728	68	CF			28716
R618	47k	CF			21815	R729	680	CF			28723
R619	3k3	CF			21803	R730	1k	CF			21799
R620	1M	CF			31840	R731	10k	CF	2		38618
R621	3k3	CF			21803	R732	47k	CF			21815
R622	1k8	CF			28725	R733	22k	CF	10		3433
R623	270k	CF			32356	R734	68	CF			28716
R624	10	CF			21793	R735	1k5	CF			21801
R625	1M	CF			31840	R736	1k	CF			21799
R626	1M	CF			31840	R737	10k	PCP			44959
R627	680k	CF			31839						
R628	1M	CF			31840	R739	47	CF		½W	18534
R629	1M	CF			31840						
R630	100k	CF			21819	R741	5k6	CC	5	1W	2363
R631	33k	CF			21814	R742	220k	MF	2		38650
R632	300k	CF	2		38653	R743	33M	MG	5	½W	43008
R633	15k	CF			28727	R744	1M	CP			A4/44460
R634	6k8	CF			21807	R745	10k	CP	With S1		A4/44461
R635	10	CF			21793	R746	82k	CF			21818
R636	68k	CF			21816	R747	120k	CF			21820
R637	2k2	CF			21802	R748	100k	CF			21819
R638	3k9	CF			21804						
R639	10k	CF			21809	RN101		Resistor Network			A3/43194
R640	39k	CF			28728						
R641	2k2	PCP			36265	RN201		Resistor Network			A3/44651
R642	56k	CF		½W	19058						
R643	470	CF			21797	RN231		Resistor Network			A3/44651
R644	3k3	CF			21803						
R645	10k	CF			21809	RN261		Resistor Network			A3/38692
R701	1k	CF			21799	RN720		Resistor Network			A3/44608
R702	680	CF			28723						
R703	10k	CF		1W	2882	CAPACITORS					
R704	22k	CF			21812	C101	6pF	Trimmer			29421
R705	5k6	CF			21806	C102	6pF	Trimmer			29421
R706	470	CF			21797	C103			A.O.T.		
R707	5k6	CF			21806	C104	680pF	PC			40631
R708	220k	PCP			36270	C105	0.1µF	CE(2)		400V	44966
						C106	6.8pF	CE(2)			22362
R710	2k2	CF			21802						
						C133			A.O.T.		
R713	470k	PCP			36271						
R714	1M	CF		½W	18588	C135	0.1µF	PE		400V	44966
R715	680k	CF			31839						
R716	33M	MG	5	½W	43008	C151	2.2pF	SM			815
R717	33M	MG	5	½W	43008						
						C201	10µF	E		25V	32180
R719	18k	CF		½W	18565	C202	CE(3)	0.01µF		50V	42444

Component List and Illustrations

Section 6

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OS300 (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
CAPACITORS (Cont.)											
C203	5600pF	CE(2)			22394	C605	22pF	CE(3)			42412
C204	1000pF	CE(2)			42432	C606	0.1μF	CE(2)		100V	37018
						C607	0.1μF	CE(2)		100V	37018
C231	10μF	E		25V	32180						
C232	0.01μF	CE(3)			42444	C609	0.1μF	CE(2)		100V	37018
C233	5600pF	CE(2)			22394	C610	0.01μF	CE(3)			42444
						C611	22pF	CE(3)			42412
C237	0.01μF	CE(3)			42444	C612	0.1μF	CE(2)		100V	37018
						C613	0.01μF	CE(3)			42444
C263	1200pF	PS		63V	37455	C614	47pF	CE(3)			42416
C264	1μF	PE		100V	41743	C615	0.1μF	CE(2)		100V	37018
C265	0.01μF	CE(3)			42444	C616	0.01μF	CE(3)			42444
C266	0.01μF	CE(2)		100V	37018	C617	0.047μF	CE(2)		100V	39192
C267	0.01μF	CE(3)			42444	C618	0.047μF	CE(2)		100V	39192
C268	0.01μF	CE(3)			42444	C619	100pF	CE(3)			42420
						C620	0.01μF	CE(3)			42444
C301	0.01μF	CE(3)			42444						
C302	0.01μF	CE(3)			42444	C622	2.2μF	E			32194
C351	0.01μF	CE(3)			42444	C701	0.01μF	CE(3)			42444
C352	0.01μF	CE(3)			42444	C702	2200pF	PE		4kV A4/44990	
						C703	2200pF	PE		4kV A4/44990	
C401	0.01μF	CE(3)			42444	C704	1000μF	E		40V	44992
C402	27pF	Trimmer			32519	C705	33μF	E		350VA3/44991	
C403	47pF	CE(3)			42416						
C404	120pF	CE(3)			42421	C708	10μF	E		25V	32180
C405	10/65pF	Trimmer			30286	C709	2200pF	PE		4kV A4/44990	
C406		A.O.T.				C710	10μF	E		25V	32180
C407	0.1μF	CE(2)		100V	37018	C711	0.1μF	PE		1.5kV	40075
C408	5600pF	CE(3)			42441	C712	0.1μF	PE		1.5kV	40075
C409	5600pF	CE(3)			42441	C713	0.22μF	PE		100V	44370
						C714	0.01μF	CE(3)			42444
C411	5600pF	CE(2)			22394	C715	0.22μF	PE		100V	44370
C412		A.O.T.				C716	0.01μF	CE(3)			42444
						C717	56pF	CE(3)			42417
C501	0.22μF	PE		100V	44370	C718	22pF	CE(3)			42412
C502	1000pF	CE(3)			42433	C719	5600pF	CE(2)			22394
C503	0.01μF	CE(3)			42444						
C504	0.01μF	CE(3)			42444	TRANSISTORS					
						TR201	Dual F.E.T.				44704
C506	10pF	CE(3)			42408	TR202					
C507	0.01μF	CE(3)			42444	TR203					
C508	0.01μF	CE(3)			42444	TR204					
C509	0.01μF	CE(3)			42444		AE38				44627
C510	560pF	CE(3)			42429						
C511	3300pF	CE(3)			42438						
C512	5600pF	CE(2)			22394						
						TR231	DUAL F.E.T.				44704
C514	120pF	CE(3)			42421	TR232					
C515	150pF	CE(3)			42422	TR233					
C516	150pF	CE(3)			42422	TR234					
							AE38				44627
C601	0.22μF	PE		250V	39201						
C602	100pF	CE(3)			42420						
C603	2.2μF	E		63V	32194						
C604	2.2μF	E		63V	32194						
						TR261	MPS2369	Selected			44953
						TR262	BC547B				
						TR263	BC558C				
						TR264	BC558C				
						TR401	BF371				36275
						TR402	BF371				36275

Component List and Illustrations

Section 6

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OS300 (Cont.)

Ref	Value	Description	Part No	Ref	Value	Description	Part No
TRANSISTORS (Cont.)							
TR403		BF371	36275	D301		IN4148	23802
TR404		BF371	36275	D302		IN4148	23802
TR405		AE13	31254	D303		IN4148	23802
TR406		AE13	31254	D304		IN4148	23802
TR407		BF468	40056				
TR408		BF468	40056	D351		IN4148	23802
				D352		IN4148	23802
TR501		BC547B	44951	D353		IN4148	23802
TR502		MPS2369	36625	D354		IN4148	23802
TR503		MPS2369	36625				
TR504		BC547B	44951	D401		IN4148	23802
TR505		2N3904	24146	D402		IN4148	23802
TR506		BC558C	44952	D403		IN4148	23802
TR507		BC557B	44950	D404	5V1	ZENER	33928
TR508		BC557B	44950	D405		IN4148	34701
TR509		BC547B	44951	D406		IN4148	34701
TR511		2N3904	24146	D501		IN4148	23802
TR512		2N3904	21533				
TR513		NSD459	40054	D503		IN4148	23802
TR514		NSD459	40054	D504		IN4148	23802
TR515		BF393	450226	D505		IN4148	23802
TR601		BC558C	44952	D507		IN4148	23802
TR602		BC558C	44952	D508		IN4148	23802
TR603		BC547B	44951	D509		IN4148	23802
TR604		BC557B	44950				
TR605		2N3904	24146	D511		IN4148	23802
TR606		2N3904	24146	D512		IN4148	23802
TR607		2N3906	21533	D513		IN4148	23802
				D514		IN4148	23802
TR701		MPS2369	44953	D515		IN4148	23802
TR702		BFR86B	44954	D516		IN4148	23802
TR703		BFR86B	44954	D517		IN4148	23802
TR704		BC558C	44952	D518		IN4148	23802
				D519		IN4148	23802
TR706		BC547B	44951	D520		IN4148	23802
TR707		BUX87	44955				
				D522			
TR709		BC328	38414				
TR711		BC558C	44952				
TR712		TIP29A	38419	D522		IN4148	23802
TR713		TIP112	40519	D523		IN4148	23802
TR714		BC547B	44951				
TR715		BC557B	44950	D601		IN4148	23802
TR716		2N6518	36472	D602		IN4148	23802
				D603		IN4148	23802
				D604		IN4148	23802
DIODES							
D201		IN3595	29330	D605	5V1	ZENER	33928
D202		IN3595	29330	D606		IN4148	23802
D203	6V8	ZENER	33931	D607		IN4148	23802
				D608		IN4148	23802
D231		IN3595	29330	D609	4V7	ZENER	40049
D232		IN3595	29330	D610		IN4148	23802
D233	6V8	ZENER	33931	D611		IN4148	23802

Component List and Illustrations

Section 6

NOTE: When ordering, all part numbers shown in this manual shall be prefixed with AD2, i.e., 37898 should be AD237898.

OS300 (Cont.)

Ref	Value	Description	Part No	Ref	Value	Description	Part No
DIODES (Cont.)				MISCELLANEOUS			
D701		IN4148	23802	L401	15μH		44993
D701		IN4148	23802	L402	15μH		44993
D704		L.E.D.	43847	V1	{	Mullard 56825GY	
D705		BAX17	402022			Normal Version	44932
D706	150V	ZENER	37559			Mullard 56825GM	
						Long Persistence	44933
D708		IN4148	23802	T1			
D709	200V	ZENER	40052				A1/44961
D711	9V1	ZENER	33934			With R745	
D713		IN4148	23802	S1			A4/44461
D714		IN4148	23802	S2			A4/4069
D715	200V	ZENER	40052	S3			A4/4069
D716	200V	ZENER	40052	S101			A4/44965
D717	200V	ZENER	40052	S102			44978
D718	12kV		44550	S131			A4/44965
D719	12kV		44550				
D720		IN4148	23802	S201			40048
D721		BAX17	402022				
D722		IN4004	450266	S231			40048
D723		IN4004	450266				
D724		IN4004	450266	S261			A4/44476
D725		IN4004	450266	S262			A4/44979
D726		IN4004	450266				
D727		IN4004	450266	S301			A4/38729
D728		IN4004	450266				
D729		IN4004	450266	S501/506			A4/38728
D730	200V	ZENER	40052	S507			A4/38729
INTEGRATED CIRCUITS				SKA			1222
IC261		LF351	40130	SKB			1222
				SKC			1222
IC301		LM733CN	40084	SKD			37293
				SKE			31229
IC351		LM733CN	40084				
IC501		74LS74N	Not Motorola	SKG			37293
			36732	SKH			37293
IC552		LM78LO5	40406	PLM			44960
IC601		MC3401P	40061				
IC602		LM710CN	40083	F1	250mA	For 250V Supply	33684
					500mA	For 110V Supply	33685
IC701		MC78L12 ACP	40060	F701	100mA		39258
IC702		LM351P15	40059				

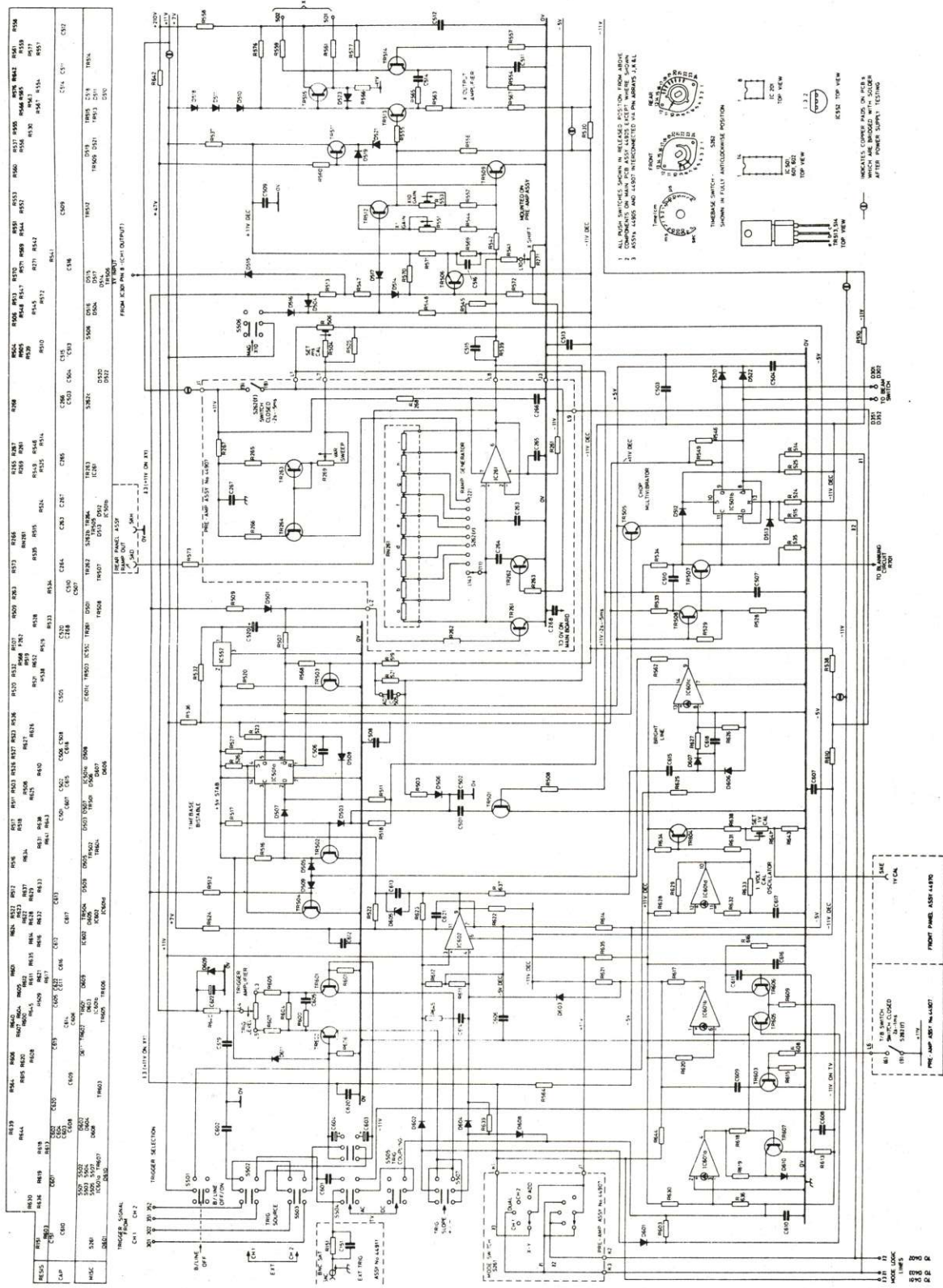
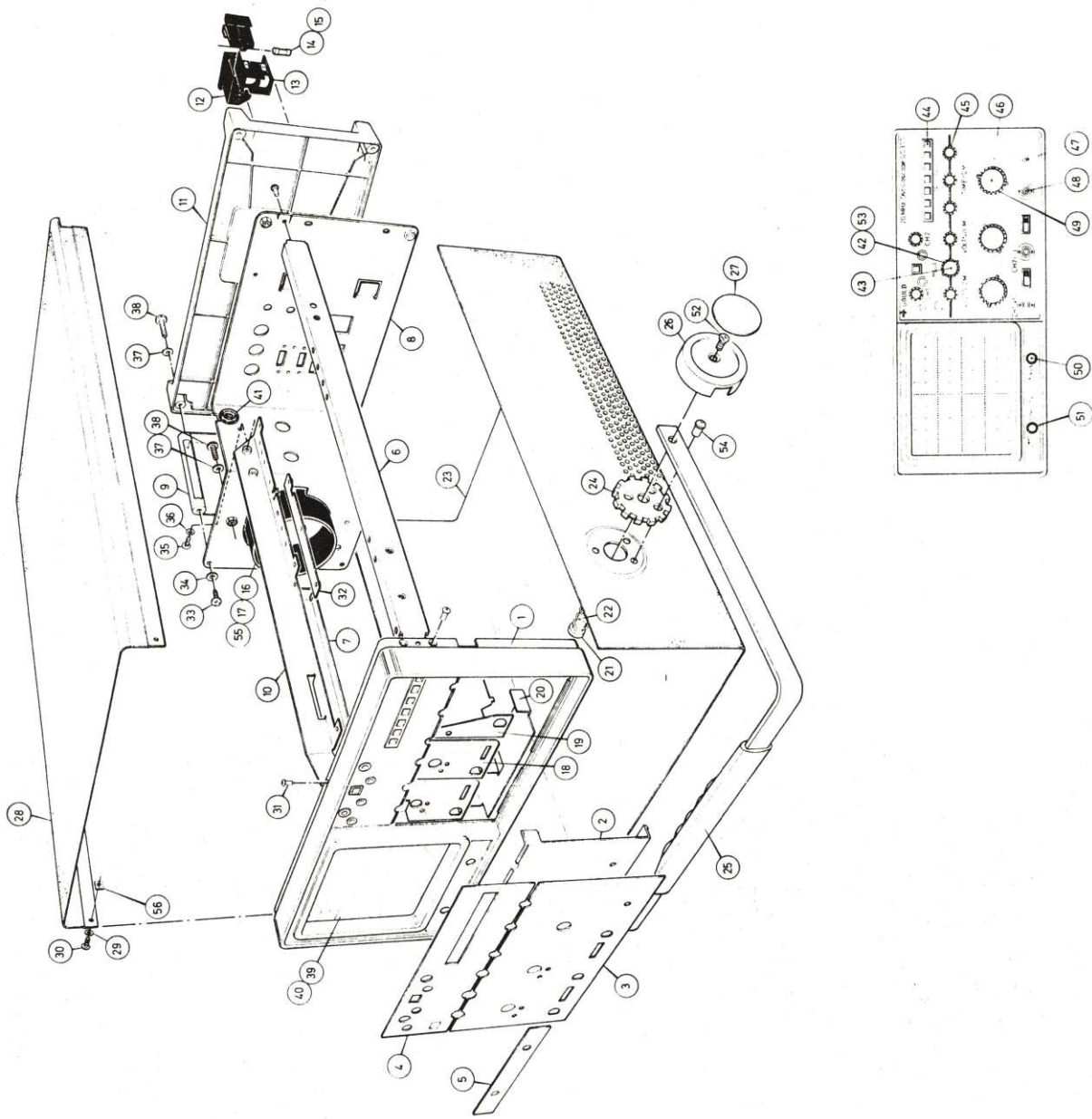


Fig. 5 Timebase and Trigger Circuit Diagram



Ref.	Part No.	Description	No. Off
1	A0/44581	Frame/Panel Moulding	1
2	A1/44478	Panel Front Moulding	1
3	A2/44975	Coverlay - Switches	1
4	A2/44976	Coverlay - Push Buttons	1
5	A3/44974	Coverlay - Focus/Brill	1
6	A2/402007	Side Support	1
7	450043	Panel Rear	1
8	A2/44457	Support Moulding	1
9	A1/41401	Heatsink	1
10	A2/44466	Rear Cover	1
11	A1/44969	Connector Supply	1
12	44960	Fuse Holder	1
13	40068	Fuse 250mA 250V	1
14	33684	Fuse 500mA 110V	1
15	or 33685	Base C.R.T. Moulding	1
16	A2/450008	Clamp C.R.T. Moulding	1
17	A2/450009	Screen Attenuator	2
18	A3/44973	Screen Timebase	1
19	A3/44972	Screen B.N.C.	1
20	A3/450089	Spindle Moulded	2
21	A4/44470	Spring	2
22	A4/44568	Case Bottom	1
23	A1/44467	Base Handle	1
24	A3/44472	Handle Assy.	1
25	A1/44469	Cover Handle	2
26	A3/44471	Button Handle	2
27	A4/36681	Case Top	1
28	A1/44468	M3 Plain Washer	3
29	33016	Screw M3 X 8 Pan Hd.	3
30	33095	Pop Rivet	7
31	29426	Clamp Heatsink	1
32	A3/450090	Screw M4 X 8 Pan Hd.	4
33	33044	Washer M4 Wavey	6
34	33017	Screw M3 X 6 Pan Hd.	2
35	33037	M3 Wavey Washer	2
36	33016	Washer M4 Plain	10
37	33004	Screw M4 X 10 Pan Hd.	5
38	33045	Graticule Blue	1
39	A3/44964	Graticule Amber	1
40	44967	Grommet	4
41	382	Knob 15mm 'D' Winged	1
42	A4/402010	Cap 15mm	1
43	44549	Knob - Push Button	8
44	A3/38407	Knob 10mm 'D'	7
45	A4/402009	Cap 21mm	3
46	44958	Terminal Feed Through	1
47	31229	Socket B.N.C. 50Ω	3
48	1222	Knob 21mm Winged	3
49	40410	Cap 10mm	9
50	44957	Knob 10mm	2
51	40408	Screw M4 X 12 C'SK	2
52	33077	Bush Heyco 1/4 Dia	1
53	36253	Rivet Pop	6
54	12862	Washer C.R.T.	1
55	A4/44963	Square Nut M3	2
56	41407		

Fig. 7 Mechanical View

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