

FOR SERVICE MANUALS  
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DIGITAL STORAGE  
OSCILLOSCOPE OS1420  
Instruction | Manual

For Service Manuals  
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The Gould OS1420 provides a combination of Digital Storage and Real-time facilities, and caters for measurements from DC to 20MHz with a flicker-free display of a full cycle down to 0.002Hz. The digital method of storage provides many advantages, notably the facilities for pretrigger viewing and the ability to store a waveform indefinitely.

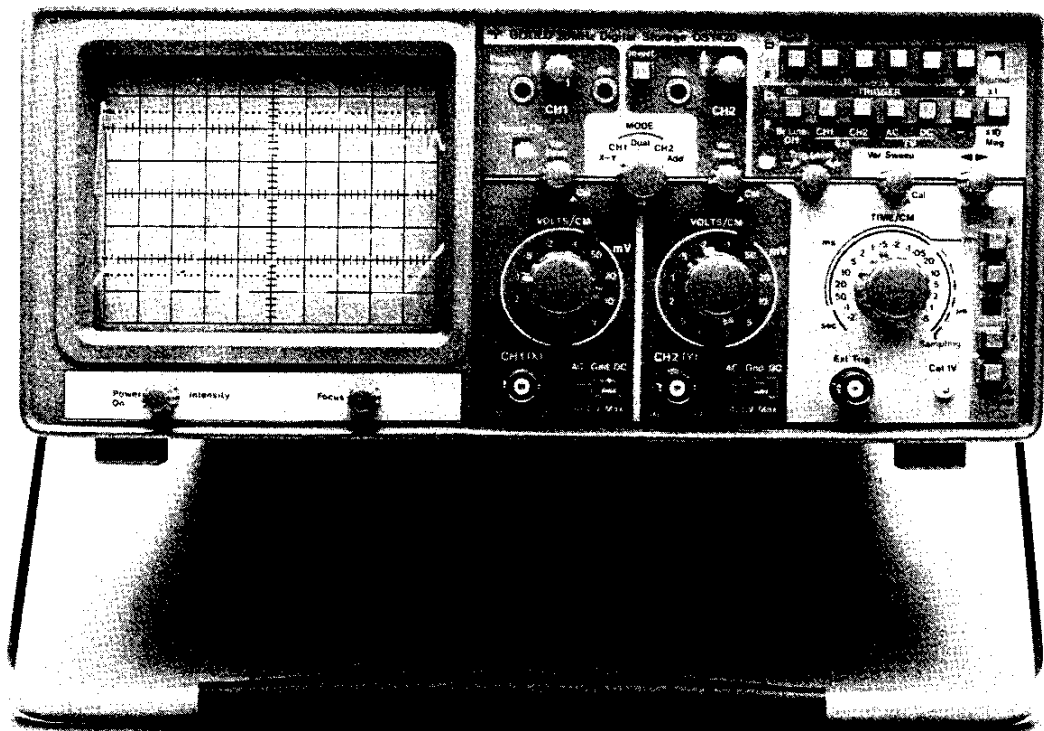
It features two identical input channels with a maximum sensitivity of 2mV/cm and a bandwidth from DC up to 20MHz. The channels may be displayed separately or together in both STORE and the conventional NORMAL modes. The ability to display the sum or difference of the channels and an X-Y mode operation are available in NORMAL mode. The timebase ranges from 0.005 $\mu$ s/cm to 0.25/cm in NORMAL mode with additional ranges down to 50s/cm in STORE mode. A x 10 facility expands the upper limit to 50ns/cm. In NORMAL and certain of the STORE modes, inde-

pendent variable sensitivity and separate controls are provided.

The trigger facilities available are comprehensive, with DC and AC coupling available and a bright-line-free run facility to enable true location in the absence of a trigger. An active TV sync. separator is provided for viewing video waveforms.

Many additional facilities are provided with the OS1420 such as a plot option fitted as standard, a 1KHz calibrator, a DC coupled Z modulation input and a trace rotation control.

The instrument is readily portable and the use of an uncommitted logic array has reduced both the number of components and board area. This has additional benefits in terms of reliability, power consumption and ease of maintenance.



Amendment for OS1420 Instruction Manual.

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Specification

Para. Trigger 'Sensitivity'

Amend as follows:-

Line 1 2mm to read 3mm  
Line 3 2mm to read 3mm  
Line 5 100mV to read 150mV  
Line 6 400mV to read 600mV  
Line 7 100mV to read 150mV  
Line 8 400mV to read 600mV

Para. Display Modes.

Dual Trace

Line 3 0.2ns to read 0.2ns/cm  
Line 5 0.2ns to read 0.2ns/cm

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## DISPLAY

**CRT** 8 x 10cm rectangular mono-accelerator

**EHT** 2kV (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** ±3%.

**Variable Sensitivity** >2-5:1 range allows continuous adjustment of sensitivity 2mV/cm to 25V/cm.

**Input Impedance:** 1MΩ/28pF.

**Input Coupling** DC-GND-AC.

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

## HORIZONTAL DEFLECTION

**Normal Mode Sweep Rate** 0.5μs/cm to 0.2sec/cm, 18 ranges in 1-2-5 sequence

**Accuracy** ±3% (to 200ns/cm).

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

**Store Modes Sweep Rate** 0.5μs/cm to 50sec/cm, 25 ranges in 1-2-5 sequence.

**Accuracy** ±3% (to 200ns/cm).

**Variable Sweep** >2.5:1 allows continuous coverage from 0.5μs/cm to 50μs/cm (sampling only).

**X Expansion** X10 push button gives fastest speed of 50ns/cm. Accuracy ±3% (50ns ±5%).

## TRIGGER

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

**Source** Internal CH1 or CH2 External.

**Slope** Positive or negative.

**Coupling** DC, AC or TV (active sync separator with line/frame selected by timebase switch between 50 and 100μs/cm).

**Sensitivity** Internal: DC coupled 2mm to 2MHz, 1cm to 20MHz.

AC coupled 2mm, 10Hz - 2MHz.

1cm, 4Hz - 20MHz.

External: DC coupled 100mV to 2MHz,

400mV to 20MHz.

AC coupled 100mV, 10Hz to 2MHz.

400mV, 4Hz to 20MHz.

**External Input Impedance** 100kΩ/10pF.

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

## DISPLAY MODES

**Single trace** CH1 or CH2.

**Dual trace** In Normal, Chopped or Alternate Modes automatically selected by the timebase switch. Between 0.5μs/cm and 0.2ns/cm the Alternate Mode is selected whilst on ranges slower than 0.2ns/cm Chop Mode is selected. The chop frequency is 500kHz. (In store modes simultaneous capture).

**Add** CH1 and CH2 added to give the algebraic sum of the two channel inputs (Normal mode only).

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

**X-Y** CH1 input gives X deflection and CH2 input gives Y deflection. (Normal mode only).

## ADDITIONAL FACILITIES

**Calibrator** 1V ±2% square wave at approx. 1kHz.

**Z Mod Input** DC coupled, 2V visible mod.

Sensitivity +40V cut off sensitivity.

Input impedance 10kΩ/10pF approx.

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

## DIGITAL FACILITIES

**Store Size** 1024 x 8-bits per channel.

**Vertical Resolution** 1 in 256 approx. 30 steps/cm.

**Horizontal Resolution** 1 in 1024 approx. 100 samples/cm. (0.05ms/cm range on Dual is 50 samples/cm).

**Expansion** X10 reduces the resolution by ten on all ranges.

**Sample Rate:** 2MHz (0.5μs) reducing in proportion with timebase.

**Dot Joining** Linear interpolation between samples.

## DISPLAY MODES

**Roll** Stored data and display updated continually. (timebase ranges 50sec/cm to 0.05ms/cm).

**Refreshed** Stored data and display updated by triggered sweep. (timebase ranges 50sec/cm to 0.05ms/cm).

**Sampling** Stored data and display updated from trigger point in single shot mode.

**Single Shot** Freezes store at end of triggered sweep.

**Display Hold** Freezes store immediately.

**Pretrigger Storage** Available in Roll mode only, switchable from 0%, 25%, 75% and 100% of full store pre-trigger.

## PLOT OUTPUT

Analogue output of the stored display.

**Y Output** Channel 1 or Channel 2 selected by Plot 1 or Plot 2 push switch for the respective channel via 4mm socket. Amplitude 100mV/cm (nominal).

# Specification

# Section 2

**X Output** X ramp via 4mm socket.  
Amplitude 100mV/cm (nominal).

**Output Sweep Rate** Selected by Time/cm (main timebase) range 50sec/cm to 50ms/cm in 1–2–5 sequence.

**Output Impedances** 100Ω.

**Pen Lift Output** High output to indicate penlift. TTL open collector. Maximum Voltage 15V. Maximum Sink Current 8mA.

**Supply** 100V, 120V, 220V and 240V ±10%.  
45 to 400Hz, 40VA approx.

**Safety** Designed for IEC 348 Cat 1.

**Operating Temperature Range** 0 to 50°C (+15°C to 35°C for full accuracy).

**Dimensions** 140 x 305 x 460mm.  
(5.5") x (12.0") x (18.1")

**Weight** 6kg approx.

**Accessories Supplied** Handbook PN 450770.  
Mains Lead PN 402001

## Optional Accessories

**Probe Kit PB12**  
A passive probe kit with switched X1 and X10 attenuators.  
X10 attenuation input impedance is 10MΩ/11.5pF.

**Probe Kit PB13**  
A X10 passive probe with 1.5m of cable. Input impedance 10m/11.5pF.

**Probe Kit PB17**  
A X100 passive probe with 1.5m of cable.  
Input impedance 100MΩ//4.5pF.  
Working voltage 1.5kV inc pk a.c.

**Viewing Hood** PN450401  
**Front Panel Cover** PN450240  
**Rack Mount Kit** PN450070

**Trolley** Type TR7 General Purpose

**Protective Carrying Case** PN42610 – A strong case which completely encloses the oscilloscope with 3 thicknesses of padded material covering the front panel.

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## 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.

## EARTHING

The instrument must be operated with a protective earth 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 earth 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 earth 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 earth 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 OS1420 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 OS1420 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 OS1420 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:
  - Set NORM/STORE switch to NORM.
  - 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 $\mu$ 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 centralise the trace on the screen.
6. Adjust the TRACE ROTATE preset control if necessary to align the trace with the centre 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 OS1420 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 $\mu$ 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 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 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 elapsed 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. In the STORE mode some of the display modes are not available. These will be indicated in the relevant paragraph.

#### 3.4.1 SINGLE CHANNEL

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.

#### 3.4.2 DUAL CHANNEL

For dual trace simultaneous display of both Y inputs against the timebase, this switch should be set to DUAL.

In the NORMal operating mode, two modes of beam switching are used and are 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 0.5 $\mu$ s/cm. At the slower rates from 0.2s/cm to 0.5ms/cm the chop mode operates at approx. 500kHz.

In the STORE mode the display is beamswitched alternately at a fixed rate of 200Hz.

#### 3.4.3 ADD

In the ADD mode, which is only available in the NORMAL operating 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 the 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.

In the STORE mode, the ADD position of the MODE switch is equivalent to the CH2 position.

#### 3.4.4 X-Y

In the X-Y mode, which is only available in NORMAL operating 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.

In the STORE mode selection of X-Y is equivalent to the selection of CH1.

### 3.5 TIMEBASE AND X-EXPANSION

The calibrated sweep speed of the internal timebase is determined by the setting of the TIME/CM switch and additionally in STORE mode by the ms-s button. When this button is in, the milliseconds section of the TIME/CM switch is converted to seconds, for example 1ms/cm becomes 1s/cm. In NORMAL operation and in STORE mode on the SAMPLING section of the TIME/CM switch, the sweep rate may be varied by the VARIable SWEEP control, enabling intermediate sweep rates between the calibrated ranges to be obtained.

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.

The + – button selects the slope, positive or negative going, which causes triggering when the signal passes through the level set by the TRIGGER LEVEL control. Presence of a TRIGGER signal is indicated by the associated TRIGGER l.e.d. This will flash at low trigger repetition rates and remain on at faster rates. 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 AC coupling, the low frequency sensitivity reduces to 1cm pk/pk at about 2Hz.

The Ext Trig input impedance is approx. 100k $\Omega$ /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 ('BR 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 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 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 $\mu$ s/cm and line trigger is automatically selected at fast sweep rates from 50 $\mu$ s/cm. The trigger polarity should be selected for the polarity of the synch. pluses. At least 2mm pk/pk of synch. pulse amplitude is required with internal triggering, or 0.25V with external.

Summarising 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, AC or DC.
- (b) Select the trigger slope + or – and adjust the trigger level control to obtain a trace which is triggered at the required point.

## 3.7 STORE CONTROL

STORE mode is selected by depressing the NORM/STORE button. The various STORE modes are selected by operation of the buttons on the right hand side of the NORM/STORE control, and by the buttons on the right hand side of the TIME/CM switch. All controls associated with the STORE mode are labelled in blue.

### 3.7.1 NORM/STORE

With this button out, NORMAL operation is obtained. The instrument behaves like a conventional 20MHz oscilloscope. All controls associated with STORE mode have no effect.

With the button in, STORE mode is selected and the display is produced by the reading out of a digital store. Acquisition of data for this store, and the subsequent display of this data is controlled by the controls labelled in blue.

### 3.7.2 ROLL/REFRESH

Selection of ROLL provides a form of free running timebase not found on a conventional oscilloscope. Incoming data is fed continuously to the store. As the display is thus updated, the trace appears to be moving or rolling to the left, in appearance, similar to the view through a 10cm window of a strip chart recorder trace.

As information is being continuously written into the store, at a trigger instant the store will only contain pretrigger information. Thus by using the single shot facility (see 3.7.3, 3.7.5) pre-trigger information even for transient signals may be stored and displayed.

The rate of rolling is controlled by the TIME/CM switch and ms–s button. At high roll speeds the display becomes meaningless to the user, so for the top three ranges of roll mode, 0.2ms/cm, 0.1ms/cm, 0.05ms/cm, the display is blanked while information is stored in the memory. Once the information has been acquired ready for display, the store is read out once, and then, if release mode has been selected, the store is again updated and the display again blanked; the cycle of acquisition then display repeating until an alternative mode is selected. If trigger signals are not present and BRIGHT LINE is off the display will be blank on these three ranges until a trigger signal is present. The display on these three ranges still has a pretrigger facility in the released roll mode. Roll mode can be used on ranges 50sec/cm up to 0.05ms/cm.

If REFRESH is selected, the display obtained is similar to that obtained on a conventional oscilloscope but with the advantage of flicker-free operation at low timebase speeds. The display updates from the left hand side of the screen on receipt of a trigger as in conventional operation. If the instrument is in single shot mode (see 3.7.5) or the trigger is not present the display retains indefinitely the information captured on the previous sweep until a trigger is received in released mode or the instrument is rearmed. On the top three ranges of the TIME/CM switch for which refresh is applicable

0.2ms/cm, 0.1ms/cm, 0.05ms/cm, the display is blanked while the store is filled and then read out once when the acquisition is complete; this cycle repeating if in released mode, or if in single shot mode readout is then continuous. As in roll mode the display will be blanked if a trigger signal is not present, unless the display has been held or stored. Refresh mode is only used on ranges of 50s/cm to 0.05ms/cm of the TIME/CM switch.

### 3.7.3 PRETRIGGER/25% + 75%

These two buttons select the amount of pretrigger required when using the Roll mode single shot facility (see 3.7.2 and 3.7.5). With both buttons out, 0% PRETRIGGER is selected, with only the 25% button depressed 25% PRETRIGGER is selected, similarly for the 75% button, and with both buttons depressed 100% PRETRIGGER is selected.

The amount of pretrigger selected determines the percentage of the display which is acquired before the trigger point, and hence the position of the trigger point on the display. For example, if a trace is stored with 25% Pretrigger selected, the trigger point is 2.5cm from the left hand side of the display, the first 2.5cm of the display is pretrigger information, and the last 7.5cm is posttrigger information.

Pretrigger as mentioned earlier is available in the roll single shot mode, but on the three top ranges of the TIME/CM switch for which roll is available, 0.2ms/cm, 0.1ms/cm and 0.05ms/cm, the pretrigger facility is available in the released roll mode also (see 3.7.2 and 3.7.4). On these ranges a 'refresh' type display is obtained but with the position of trigger point being selected by these buttons.

### 3.7.4 RELEASE

Operation of this button puts the instrument into its continuous acquisition mode. In ROLL this means that the display 'rolls' continuously and ignores triggers except on the ranges 0.2ms/cm 0.1ms/cm and 0.05ms/cm (see 3.7.2). In REFRESH the display updates until the display is filled with new information and then updating ceases until a trigger is received. The display will again begin updating from the left hand side of the screen. This cycle of refreshing the display, then awaiting a trigger, repeats indefinitely in the released refresh mode.

Release does not separate on timebase ranges of 20μs/cm to 0.5μs/cm.

### 3.7.5 ARM

This button when operated initiates the single shot storage facility of this instrument. On arming, in ROLL mode, the trace will roll across the screen, and the ARMED/STORED l.e.d. will begin flashing.

When a trigger is received the l.e.d. will cease flashing and switch off. Meanwhile the trace continues rolling, and after the required amount of pretrigger information is obtained, the instrument will accept a trigger, and when the required amount of post trigger information has

been acquired the trace will cease rolling and the ARMED/STORED l.e.d. comes on continuously. The display will not now alter unless rearmed, or put into release mode by operating the release button. In refresh, operation of the ARM button stops the display updating if currently occurring and initiates flashing of the ARMED/STORED l.e.d. On receipt of a trigger the display will begin updating from the left hand side of the screen and the l.e.d. will cease flashing. When the display has been fully refreshed the STORED l.e.d. will come on. This display will now not alter unless rearmed or released.

In this single shot mode of operation there is an extra facility, SAMPLING, available on timebase ranges 20μs/cm to 0.5μs/cm. By using a repetitive sampling method it is possible to digitise waveforms which are repetitive in nature, up to the full bandwidth of the oscilloscope. Operation of ARM will blank the previous display and initiate a store cycle.

The store is then updated, one store location per channel per sweep of the timebase. During this process a dot is displayed which moves across the screen as the store is filled. Lack of triggers will cause the dot to halt and the TRIGGER l.e.d. to extinguish until triggers are again present. Once the store is full the stored l.e.d. will come on and a display of the stored waveform will occur until rearmed. Note that RELEASE, PLOT 1, PLOT 2 have no effect of these timebase ranges.

### 3.7.6 ms-s

When this button is out the TIME/CM milliseconds ranges remain correct. However, when the button is depressed this multiplies the TIME/CM millisecond ranges by one thousand converting the millisecond/cm ranges to second/cm. It has no effect on other timebase ranges.

### 3.7.7 PLOT 1 PLOT 2

These two buttons initiate the plotting of the channel selected, PLOT 1 initiating a plot of the CH1 display, and similarly PLOT 2 initiating plot of CH2. Plot can only be initiated if a display is STORED (see 3.7.5) or DISPLAY HOLD is operated (see 3.7.8) and the TIME/CM switch is set on a milliseconds/cm range. The plotting speed is then a one-thousandth of the reciprocal of the TIME/CM range selected, for example a selection of 0.2ms/cm on the TIME/CM switch gives a plotting speed of  $\frac{1}{0.2} \times 1000$  cm/ms which is 5cm/s,

0.2  
The plot X and Y outputs are on the back panel of the instrument. A penlift signal is also available which is an open collector TTL o/p that goes high to indicate a pen lift if required.

### 3.7.8 DISPLAY HOLD

Operation of the DISPLAY HOLD freezes the display so that no further modification of the display can occur.

It can be used in ROLL mode to freeze the display if a feature of interest appears on the screen. Alternatively it can lock the display in REFRESH mode. Once the trace is frozen it can be plotted using PLOT 1 or PLOT 2 as required.

When the button is released, the instrument returns to a RELEASE mode. Hence operating HOLD will clear and ARM condition.

It should be noted that movement of the function switches after a display has been locked can disturb the display, particularly shifting the start point of the trace.

### 3.8 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 $\mu$ s and the output impedance is approx. 470 $\Omega$ , 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. Z mod.

This socket on the rear panel allows modulation of the brightness. The input is d.c. coupled into approx. 10k $\Omega$ /10pF. The sensitivity at normal brightness setting 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.

#### 3. 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 $\mu$ 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.

#### 4. Camera.

A camera may be used with the oscilloscope to record waveforms. This facility is particularly useful at slow timebase sweep rates. Suitable camera utilising 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.

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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.
800	—	999	Digital Storage Board and associated components.
1100	—	1199	Function Switch Board and associated components.
1200	—	1299	Auxiliary Power Supply Board and associated components.
1300	—	1399	Pick off Board and associated components.
1400	—	1499	Plot switch Board and associated components.

#### 4.1 GENERAL

With the NORMAL/STORE button out the instrument behaves as a conventional oscilloscope. 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 1.2.5 sequence to cover the ranges from 2mV/cm to 0.1V/cm and a  $\times 100$  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 CH1 or the CH2 signal to be applied 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 or chop between CH1 and CH2 levels during the sweep.

A signal from the multivibrator also blanks the trace during each switching transition. 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.

When the NORM/STORE button is in the instrument becomes a digital storage oscilloscope. The output of the Y dot joiner is routed through to the Y output amplifier. Analogue signals from the Y preamp are picked off, buffered, then fed into two sample and hold circuits. The outputs of the sample and holds are beamswitched into the Analogue to Digital Converter (ADC). This produces an 8 bit binary code representing the amplitude of the instantaneous signal input at 500 nanosecond intervals. The data produced is loaded into the store under control of the timing logic. The store can hold 2048 8 bit words and the data is entered at such a rate that the information contained in each of the two 1024 bytes of memory represents one complete sweep of each channel.

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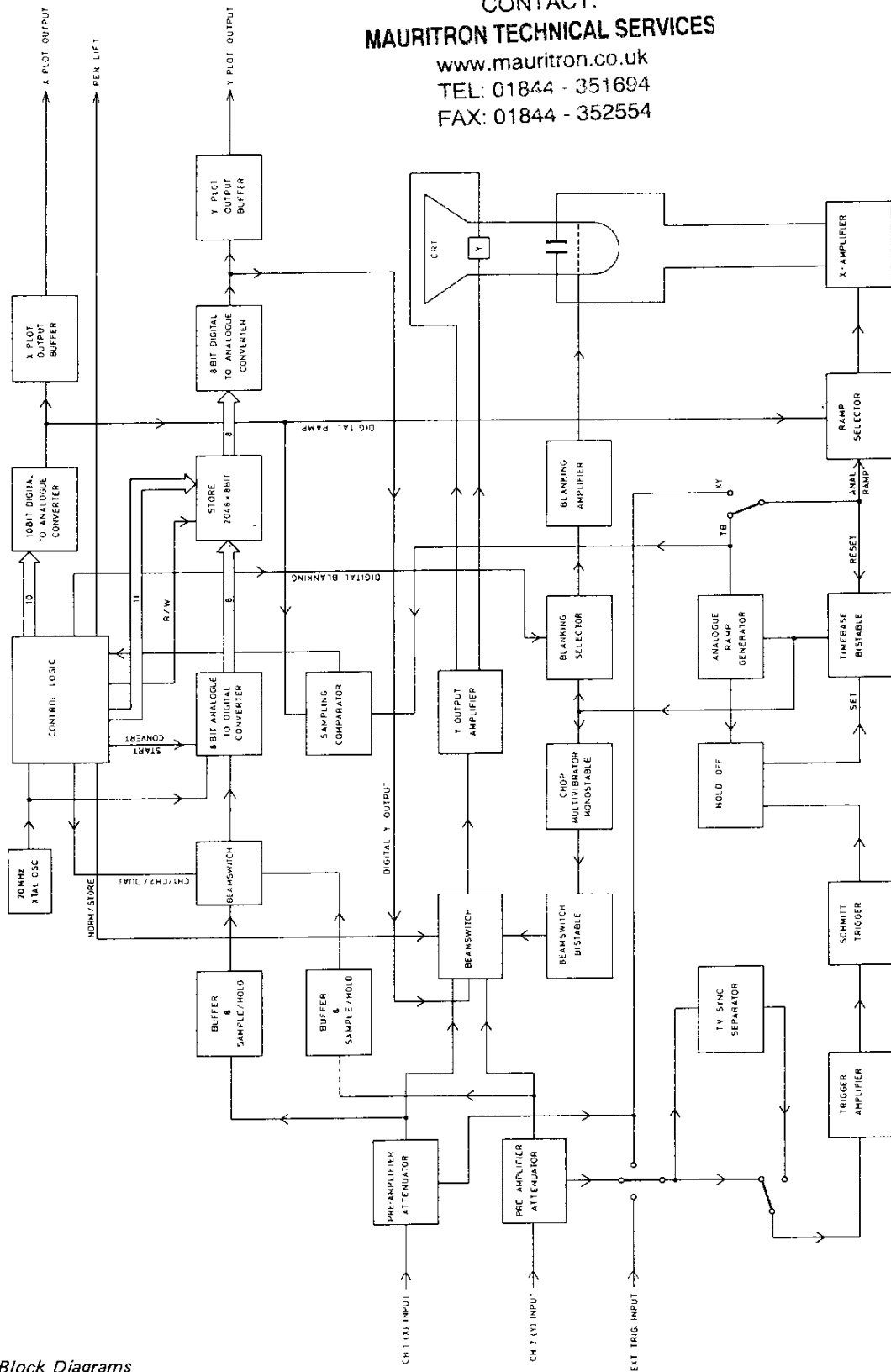


Fig. 1 Block Diagrams

This data is then read out (non destructively) at a fixed rate and reconstructed as an analogue signal by the Digital to Analogue Converter (DAC), and applied to the Y output to give a continuous display of the store contents. Since the output of the DAC is in the form of discrete levels a dot joiner is included to join these levels and provide a continuous display.

In all the digital storage modes the timebase sweep is controlled by a ten bit counter which provides an increasing ten bit code which is reconstructed by a ten bit DAC and dot joiner to give an analogue ramp. This ramp is synchronised to the readout of the Y data from the store. This ramp is used to display the two sections of 1024 bytes of store alternately, or just one section if in a single channel mode, the lower 1024 bytes containing CH1 data, and the upper 1024 bytes CH2 information. The trigger is now entirely dissociated from the timebase since the latter runs continuously. The function of the trigger now is, in REFRESH to initiate a write cycle, during which a screen full of new information is entered into the store, and in ROLL to define the amount of pretrigger and post trigger information held in the store.

The trigger is still used to produce an analogue ramp: this is used by the sampling mode circuitry used to digitise repetitive waveforms on the top six ranges of the TIME/CM switch, and it defines the rate at which data is loaded into the store. In ROLL and REFRESH the rate at which data is entered into the store is defined by a programmable digital divider which divides the master 20MHZ clock under control of the TIME/CM switch to provide 100 data samples per cm unexpanded on the display. This is also the resolution obtained in the SAMPLING mode. Expansion of the display is carried out in the X amplifier by analogue means and this gives a resolution of 10 samples/cm.

#### 4.2 THE Y AMPLIFIERS AND BEAM SWITCH

These circuits are shown in Fig. 7, Fig. 10.

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, 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 outputs from IC301 (CH1) and IC351 (CH2) are then split. High impedance amplifiers buffer the signals to the Analogue to Digital Converter (ADC) and convert the differential signals to single ended outputs (see Analogue to Digital Converter). The differential outputs also feed R316 and R317, which provide defined signal currents to the beamswitch, and these 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 changover switch, S301, which reverses the output signals from IC351 in the INVERT mode.

The signal currents from IC301, and IC351 are fed into a 3 way beamswitch with the stored signal from the Digital to Analogue Converter (DAC). The beamswitch is formed by diodes, D301, D302, D303, D304, D351, D352, D353, D354, D811, D812, D813, D814. In NORMAL mode the output of inverter U826e is low, switching off Q806 and Q807, it also takes the junctions of D811 and D813 low, diverting the signal currents from R823 and R824 reverse biasing D812, D814. The junctions of D301, D302 and D351, D352 are then both under control of IC501b. The bistable controls the beamswitching of the two Y channels into the Y output amplifier (see 4.5 Mode Control Circuits). In STORE mode the output of the inverter U826e is high. This forces the junctions of D301, D302 and D351, D352 low via Q806, Q807, diverting the Y preamplifier signal from the Y output amplifier.

At the same time, the junction of D811, D813 is taken high, forward biasing D812 and D814 and allowing the

signal from the Y DAC to drive the bases of TR401 and TR402 in the Y output amplifier. The outputs from the differential shunt feedback amplifier stage formed by TR401 and TR402, are fed to the ground 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 TRIGGER CIRCUITS

These circuits are shown in Figs. 8 and 10.

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  $-11\text{V}$  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, S262a is open and TR603 is cut off. However, at speeds of  $100\mu\text{s}/\text{cm}$  and slower, R608 is connected to  $+11\text{V}$  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.

The output of IC602 is used by the timebase generator (see next section).

### 4.4 ANALOGUE TIMEBASE GENERATOR AND X 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 ( $+4.5\text{V}$ ), turning on TR261 via R507 and R262, holding the input, and hence the output of the operational amplifier, IC261 at  $0\text{V}$ . 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  $0.5\text{ms}/\text{cm}$  and slower, S262c connects R263 to  $+11\text{V}$ . 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 the 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 towards  $0\text{V}$  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. When the o/p of IC601c is low it indicates the presence of a trigger signal. Q815 is then switched on, lighting Trigger i.e.d. D1.

This free run condition can be inhibited by operation of the BRIGHT LINE OFF switch S501 which takes the junctions of D509 and D505 low via R562.

The output of the ramp generator IC251 is fed to the analogue multiplexer U821b. The other input of the multiplexer comes from the output of the sample and hold U830 in the digital ramp generator (see digital ramp generator). In NORMAL mode the ramp output from IC261 is selected by the output of U826e going low. The ramp is then buffered by U827, a unity gain buffer amplifier, and drives the X output amplifier via R821 and C820. In STORE mode, the output of the digital ramp generator is selected and as in NORMAL mode

drives the X output amplifier via amplifier U827, R539, and C515.

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 and 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.8) and the NORM/STORE button S.

S261 defines the state of three control lines L1, L2, L3. The state of these control lines is then further defined by the gating U822a, f, d, e, U823a, b, c, d U832a, b, c, U833a, d. The outputs of this gating DL1, DL2, DL3 are level shifted by Q808, Q809, Q810, and these outputs drive the mode control circuitry.

In NORMAL mode, the state of DL1, DL2, DL3 follow L1, L2, L3 but in STORE mode these outputs do not follow L1, L2, and L3 (see table below).

### NORMAL MODE

DISPLAY MODE S261		L1	L2	L3	DL1	DL2	DL3	IC501b	
X-Y		+11V	0	+11V	+11V	0	+11V	Q	5
CH1	FOR SERVICE MANUALS	0	+11V	0	0	+11V	0	L	H
DUAL	CONTACT:	+11V	+11V	0	+11V	+11V	0	SWITCHING	
CH2	www.mauritron.co.uk	+11V	0	0	+11V	0	0	L	H
ADD	TEL: 01844 - 351694	0	0	0	0	0	0	H	H
	FAX: 01844 - 352554								

### STORE MODE

DISPLAY MODE S261		L1	L2	L3	DL1	DL2	DL3	IC501b	
X-Y		11V	0	+11V	+11V	0	0	L	H
CH1		0	+11V	0	+11V	0	0	L	H
DUAL		+11V	+11V	0	+11V	0	0	L	H
CH2		+11V	0	0	+11V	0	0	L	H
ADD		0	0	0	+11V	0	0	L	H



Section 4.2 described the action of beamswitching diodes, D301 to D304, D351 to D354 and D811 to D814, and as mentioned then in NORMal mode the diodes D301, D302 and D351, D352 are controlled by the outputs of beam switch bistable, IC501b. In the CH1 mode, DL1 is low 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, DL1 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 DL1 and DL2 are low 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, DL1, DL2, and DL3 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, DL3 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  $\times 10$  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-up of the trace.

In the Dual mode, both DL1 and DL2 are held at +11V so that the beam switch bistable, IC501b, 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 disabled.

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,

DL1 or DL2 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.

In the STORE mode DL1, DL2, DL3, as shown in the table above, force all selections on S261 to be effectively CH2. The beamswitch bistable, IC501b then behaves as described above for this mode.

However, since both outputs from the Y preamplifiers are disabled the beamswitch bistable does not control the input to the Y amplifier, and the Y amplifier is driven by the Y DAC.

#### 4.6 THE ANALOGUE TO DIGITAL CONVERTER

These circuits are shown in Fig. 9, 10.

As described in Section 4.2 the differential CH1 and CH2 Y Preamplifier outputs are picked off and converted into a single output on the pick-off board.

The CH1 outputs of IC301 are fed into a differential amplifier formed by Q1301, Q1302, whose gain is adjusted by R1329. On the normal DSO ranges, 50ms/cm to 0.5ms/cm Q1355 is turned on by the output of U805a. This output only goes high for timebase ranges of 20 $\mu$ s/cm to 0.5 $\mu$ s/cm. Q1356, when switched on connects C1351 across the roll off capacitor C1302, producing an high frequency roll off of approximately 1MHz.

A sample of the shift amount set by R315 is also differentially amplified by U1301a. The gain of this stage is adjusted by R1323 and the offset by R1325, adjustment of these two presets enables matching of the shift signals and the Y signals. The output of U1301a is added into the output of the differential amplifier Q1301 and Q1302. The resultant signal is buffered by emitter follower Q1304.

The circuitry of CH2 is identical to that for CH1. The circuit references for CH2 can be obtained by adding 50 to those of CH1, except for the CH1 components R1311, R1329, R1328, R1312, C1309, C1351, Q1355. The corresponding CH2 components for these are R1327, R1377, R1376, R1326, C1357, C1353 and Q1353.

The outputs of the emitter followers, Q1304 for CH1, Q1354 for CH2, drive a sample-and-hold.

The output Q1304 feeds the sample gate formed by D801, D802, D803 and D804. Normally the diodes, D803, D804 are held reverse biased by the zener diodes, D803 and D804. The control circuitry produces a 50ns sample pulse, when a conversion is required at the output of U803c. This pulse is amplified and converted into a differential signal by a long tail pairs, Q803 and Q804. The

differential output of Q803, Q804 is applied to T801 pulsing the Shottky diodes D804 and D803 on for the duration of the sample pulse. These diodes conduct and allow C803 to follow the analogue input from Q1304. When the sampling pulse ends the capacitor holds the instantaneous value of the input. The diodes have a very low leakage and the hold capacitor C803 is buffered by a very high impedance amplifier formed by Q801a, b and Q802. The capacitor therefore has a low droop rate and the output of the amplifier will be held for long enough for the successive approximation converter (SAC) to convert the analogue signal accurately into a digital representation.

The sample-and-hold for CH2 behaves in exactly the same way as outlined above for CH1, with all circuit references being 9XX instead of 8XX (except U803c).

The two sample-and-holds hold the value of analogue signal at the sampling instant and their outputs are beamswitched by the switch formed by Q803 and Q804. The beamswitch is controlled by the Q  $\bar{Q}$  outputs of the bistable U835a. The Q high, Q805 is switched off and D909 is reverse biased. Hence Q905 is conducting and the output of the CH2 sample-and-hold is presented to the input of the SAC. With the Q output low the CH1 output is routed to the SAC. The D input to the bistable is the CH1 signal from U831. (see Section 4.7 for details of timings). This is clocked by the Start Convert signal from U803b, delayed by U801a, b by approximately 10ns, which initiates the conversion cycle of the SAC U815. The SAC has a 20MHz Xtal oscillator to control its internal logic. This is formed by U801f, U801e, C847, R867, R868 and XL801. The output of this oscillator is gated by U805b, so that the clock can be disabled externally and by the NORM/STORE button, thus reducing the amount of breakthrough in NORMal mode. If the 20MHz clock is disabled and external clock can be used via U802a.

The SAC conversion cycle is initiated as stated above by Start Convert. The conversion takes 9 20MHz clock cycles, i.e. 450ns, and it takes approximately 50ns for Start Convert to initiate the conversion. The complete conversion cycle takes 500ns. At the end of the conversion cycle the digital word representing the analogue input is latched onto the D0-D7 outputs. The SAC will nominally produce a code of 00000000 for an analogue input of 0V and 11111111 for -0.5V the reference level input. However to compensate for the variation in gain of the pick-off buffer amplifier and sample-and-hold, the reference input to the SAC can be adjusted by R842 to -0.5V  $\pm$  0.1V. This ensures that a CH1 or CH2 input signal that should cause a full screen deflection produces a range of codes from the ADC of 00000000 to 11111111.

### 4.7 TIMING AND CONTROL LOGIC

The timing signals used by the SAC are produced by the relatively high speed logic circuits around U807, a four bit decade counter. This counter is clocked by the

20MHz clock. Outputs QA, QB, and QC which is inverted by U829d feed gate U805c which resets the bistable U806b on a count of three. This reset takes the Q output high. When the count reaches eight, QD goes high, clocking the bistable U806b, taking Q output low. Thus the WE input to U831 is high from a count of three to eight, which is a period of time of 250ns.

A counter output of eight is detected by U804a, the output of which goes low. On the next ninth clock this low is clocked through bistable U806a producing a positive going edge on the Q output. On the tenth clock the Q output remains low. This output therefore is a 50ns pulse that occurs on a count of nine of the counter U807. This pulse passes through two inverting gates U802c, U803b and is further delayed by U801a and U801b. This pulse clocks bistable U835d and also initiates a conversion cycle of the S.A.C.

The QD output of the counter goes high on a count of eight and low on a count of ten, producing a 100ns pulse to U831 at a 2MHz repetition rate.

The LD input on Pin 9 of U807 is driven by U804c. One input of this gate will high when RESET STORED and/or STORED (PIN 3 U831) are low. The other input of this gate will be high when RESCH1 (Pin 51 U831) is high. RESCH1 is driven high by U835b which is clocked by EWRITE (Pin 50 U831). The reset input of this bistable is controlled by the TIME/CM SWITCH. A four bit code, D1, D2, DIV2, DIV5 is derived from this switch, from a double wafer on the pick-off board (See Fig. 9). The outputs are as shown in the table below:

TIMEBASE SPEED SELECTED	DIV2	TIMEBASE CODE			
		DIV5	D1	D2	
50ms/cm	1	0	0	0	
20	0	1	0	0	
10	0	0	1	0	
5	1	0	1	0	
2	0	1	1	0	
1	0	0	0	1	
0.5	1	0	0	1	
0.2	0	1	0	1	
0.1	0	0	1	1	
0.05	1	0	1	1	
20 $\mu$ s/cm	1	1	1	1	
10	1	1	1	1	
5	1	1	1	1	
2	1	1	1	1	
1	1	1	1	1	
0.5	1	1	1	1	

The output of gate U805a is high for all but the top six ranges when an all ones code is detected. This output is inverted by U826c. The output of this inverter is the

SAMPLE signal. When SAMPLE is low, this takes the output of U809b high and hence the reset input of U835b low forcing RESCH1 high.

SAMPLE controls the selector formed by U802d, U802b and U803c. When SAMPLE is low, the Q output of U806a is routed through to the SAMPLE AND HOLDS, via U802c and U803b. U806a hence controls the sampling of the input signals, the sample pulse being the same width and timing on the clock to the beamswitch bistable U835a described earlier in this section. When SAMPLE is high the sample pulse is derived from the outputs of U904a. Again the pulse is approximately 50ns wide but its occurrence is controlled by the sampling circuitry described later (Section 4.11).

The waveforms described above are shown in Fig. 4.

#### 4.8 STORE CONTROL

The data from the ADC is stored in a 2048 x 8 static random access memory. The timing signals controlling the writing of data into this store are produced by U831, an uncommitted logic array (U.L.A.). This U.L.A. produces a Read/Write control signal  $\overline{\text{NMWE}}$  (see Fig. 5 for timing). This signal consists of double pulses, each 250ns in length at a rate determined by the TIME/CM switch by the Sampling Pulse produced by U904a (see Section 4.11 for descriptions of relevant circuitry. This signal latches the data from the ADC into a TRISTATE buffer U816 and controls the Output Enable line of this buffer. When  $\overline{\text{NMWE}}$  goes low the data held in this latch appear on the outputs Q0 to Q7. Simultaneously the output buffers of the memory are put into a high impedance state by this signal eliminating contention on the data bus. Meanwhile U831 has produced a write address on lines A0 to A9 (U831 PINS 39, 38, 37, 36, 35, 34, 32, 31, 30, 29). For the first of the two negative going pulses of  $\overline{\text{NMWE}}$  A10 (U831 PIN 28) is low and when  $\overline{\text{NMWE}}$  goes high again the data held in the buffer is stored in the address selected by A0-A9 and A10. When  $\overline{\text{NMWE}}$  goes low a second time, the new data from the ADC is latched into the buffer and again the stores' data lines go to high impedance. The lines A0-A9 still contain the same write address but A10 now has gone high so the new data is stored into the upper half of the store. When  $\overline{\text{NMWE}}$  remains high in this way CH1 and CH2 data is stored at a rate selected by the  $\overline{\text{NMWE}}$  signal into their respective halves of the store.

When  $\overline{\text{NMWE}}$  goes high the second time, the memory buffers are enabled and the stores will contain data from the address selected by A0-A10. Within the U.L.A. data lines, the write address is incremented after the second write. Reading of this data is again controlled by the U.L.A. U831. On all ranges below 0.2ms/cm reads are interleaved with writes of a 200kHz rate. Thus the address lines A0-A9 contain alternatively a write 'slot' and a read 'slot', each 'slot' lasting 2.5 $\mu$ s, enabling continuous reading and writing to occur. For the 3 ranges above 0.5ms/cm, the store is completely filled with new

data, writing prevented and store read out. This process repeats, so that a complete write followed by a complete read occurs continuously, unless in a single shot mode when reads continue indefinitely after a complete write cycle.

The read and writes are interleaved continuously at 200kHz. rate so that for each new read 'slot' there is a new read address. This address is presented to the store which then places on its data lines the data contained at this address. At the end of the read slot RWCLK goes low, latching the Read Data into latch U819. The output of this latch drives the DIGITAL TO ANALOGUE CONVERTER (see section 4.9). Note that in Roll mode, for ranges of the TIME/CM below 0.2ms/cm the read address will increment by two if a write has occurred in the previous write slot. This causes the continuous 'rolling' effect visible on the display in this mode.

The waveforms associated with the store control circuitry described above are shown in Fig. 5.

Once a 'read' of the lower 1024 addresses of the store is complete, A10 goes high for the next 1024 'read' slots so that the upper half of the store is read.

The writing to and reading from the two halves of store are controlled by the DISPLAY MODE switch, S261. The three signal lines L1, L2, L3 derived from this switch are decoded and level shifted by gates, U822a, d, f, b and U823b, c, d. (see table in Section 4. for L1, L2, L3 codes). This gating produces two signals NCH1, and NCH2. NCH1 is low if X-Y or CH1 is selected and NCH2 is low if CH2 or ADD is selected on the MODE switch. If both lines are high, Dual channel operation is selected. The operation of the Dual Channel mode has been described earlier in this section.

If however either NCH1, or NCH2 is low the U.L.A. U831, forces line A10 to the memory low for NCH1 low and high for NCH2 low. Thus writing and reading of only the relevant half of the store occurs. One of the  $\overline{\text{NMWE}}$  double pulses is also inhibited if either CH1 or CH2 is low, 'NCH1 low' inhibiting the first of the two pulses enabling only relevant information from the A.D.C. to be latched into the store and its latch. The beamswitch bistable is also controlled by NCH1, and NCH2. If NCH1 goes low, the bistable is RESET and the beamswitch forced over to CH1, and vice versa if NCH2 goes low.

The process of converting and storing data has been described above. However, the selection of when a write cycle should occur and the associated operating mode are controlled by ARM RELEASE, 25% and 75% PRETRIGGER, ROLL/REFRESH and DISPLAY HOLD. ARM AND RELEASE control and when the data is captured in a single shot mode or in a continuous mode. The ARM button S1101 initiates a single shot acquisition of data. S1101 when operated, takes low the reset input of bistable, U814C, producing a low on the output R892 and R893 introducing hysteresis onto the reset input. The bistable

output is inverted by U826d, and the resultant high level triggers one half of dual monostable, U1101, via input 2B, and allows timer, U1102, to oscillate at a period of 2Hz, set by R1107, R1106, R1108 and C1104, causing i.e.d. D1101, to flash at this rate. The time constant of this half of dual monostable, U1101, is set by C1102 and R1105 to be 100 $\mu$ s, and so on triggering, the Q output of this monostable will go low for 100 $\mu$ s. This negative going 100 $\mu$ s pulse arms the ULA U831. If the STORED output of this device was high, it will now go low. If REFRESH is selected by pushing in the ROLL/REFRESH button, the address lines of the U.L.A., during the write slots as described earlier in this section, remain at zero, until a trigger occurs. TRIGGER signals are disabled initially on ARM by latch, U835a. The latch is held set by S1101 and the  $\bar{Q}$  output is low, disabling U812a and preventing triggers passing through this gate. When S1101 is released, the set input of U838a goes high after the length of the time constant set by C854 and R872. When the TRIG input next goes low it resets U838a taking the  $\bar{Q}$  output high, enabling gate U812a and allowing triggers to reach U813a. When not in SAMPLING mode, the output of U805a is high, taking PIN1 of U813a high and PIN 11 low. The output of U812a will then be inverted by U813a, and triggers the U.L.A. when the TRIG input goes high. The output of U813a also drives U812b. The other input of this gate is high, again since RELEASE is high, taking low the output of U826f and forcing the output of U812c high. The inverted TRIG signal will thus take low the SET input of bistable U814c, forcing high the Q output, and low the output of U826d. This will take high the RESET on timer U1102 resetting the output, and switching off Q1101. The i.e.d. D1101 will extinguish.

Once the U.L.A. has received a trigger signal, the write addresses will increment from zero, at a rate determined by the TIME/CM switch, and at each successive store location, data from the ADC will be stored, as described earlier. When all 1024 store locations in each half or in one half of the store have been updated, the stored output of U831 will go high, taking low the output of U8046, high the output of U809a, and low the output of U829e. The STORED LED D1101 on the functions switch board will now light indicating that acquisition of data has now ceased and the display is now stored.

The operation of ARM in the ROLL mode is essentially as described above except that the write addresses begin incrementing immediately after the ARM to U831, and the ULA U831 ignores TRIG signals. When a sufficient amount of data has been entered into the store to satisfy the pretrigger requirements, the U.L.A. will now accept a TRIG signal. When the required amount of post trigger information has been stored, writing will cease and the STORED output of the U.L.A. will go high, as in REFRESH. As data is written into the store the read address increments so that an increasing offset occurs between the Read Address to the STORE

and the address lines to the DAC, U818, causing a 'rolling' effect on the display. The display ceases rolling when the STORED indication occurs, since writing ceases.

When ARM is operated, it also clocks bistable, U836a. The D input of this bistable is driven by gate, U824a. If the TIME/CM switch is selecting ranges 0.05ms/cm, 0.1ms/cm and 0.2ms/cm, the output of either U833b or U833c will be low, taking high the output of U824a. If ROLL mode is selected the output of U824c will be low, again forcing high the output of U824a. The output of U824a therefore indicates that either one of the three timebase ranges mentioned above, or ROLL mode has been selected by S1105. Therefore the Q output of bistable U836a will be low if ARM is operated and the output of U824a is high, forcing high the output of U824b, selecting ROLL mode to the U.L.A. until RELEASE or RESET or hold goes low, when the output of U824b will follow the state of the ROLL/REFRESH signal from S1105.

Operation of the RELEASE button triggers monostable, U1101, on the function switch board. The monostable has a time constant of 100 $\mu$ s set by R1104 and C1101. The monostable will thus produce a negative-going 100 $\mu$ s pulse which clears the STORED condition and resets U836a which enables the ROLL/REFRESH signal to the U.L.A. to follow the ROLL/REFRESH button. In refresh, the operation of RELEASE essentially enables continuous recycling of the write cycle described above for ARM. The write address holds at zero until a trigger occurs, at which point, the write address begins incrementing, data being stored in each successive location. When the STORE has been filled with new data, writing ceases until another trigger is received when the writing process begins again. This cycle repeats indefinitely until the operating mode is altered.

In ROLL after operation of the RELEASE button, the write addresses to the store begin incrementing immediately, new data being stored at each location in succession. Again as in the ARMED mode the read address to the store increments by one extra count after each write, causing the rolling effect on the display. The write process occurs continuously and is unaffected by the TRIGGER signal, and the display as a result will roll continuously, new data appearing on the right-hand end of the screen and rolling across the screen to the left-hand side.

On the top three ranges of the TIME/CM switch for which ROLL and REFRESH are applicable, 0.2ms/cm, 0.1ms/cm and 0.05ms/cm, the display is blanked while data is being acquired and then after acquisition is complete the new data is displayed. The rolling effect on both ARM and RELEASE is therefore not present on these ranges. However data is acquired in exactly the same fashion as described above.

The amount of pretrigger information stored in ROLL mode is controlled by the two button 25%, 75% PRE-

TRIGGER. When both buttons, S1103 and S1104, are out the signals PER 25 and PER 75 are both low, and with either S1103 or S1104 operated the relevant signals PER 25 or PER 75 will go high to indicate 25% or 75% PRETRIGGER has been selected. With both switches operated both signals will go high indicating 100% PRETRIGGER selected. These two control signals PER 25 and PER 75 are used by the U.L.A. U831, to control the acquisition of data with respect to the trigger point. If REFRESH mode is selected control signals PER 25 and PER 75 will both be low, indicating 0% PRETRIGGER, regardless of the state of the two PRETRIGGER buttons, S1105 forcing a low output from both S1103 and S1104.

Operation of Display hold freezes the display, holding the information present on the screen. When the DISPLAY HOLD button, S1404 is out, the set input of bistable U814b is high, and the reset input is low. The Q output of U814b is therefore low, taking the output of U826b high. The D input of U836b is thus high and so when DACIO of U831 goes high, halfway through a read cycle the Q output will be clocked high, producing a low of the output of U824d, and taking N HOLD on U831 and one input of U809c high. The U.L.A. U831 will take a high level as indicating a NOT HOLD signal. The NMWE signals will reach the memory enabling data to be written to the STORE as described earlier.

If DISPLAY HOLD is operated, i.e. pushed in, the set input of U814b will go low and the reset input will now be high taking the  $\bar{Q}$  output high. The D input of U836b will go low and when DAC 10 next goes high, during a read cycle the Q output will go low. This produces, a positive clock edge at U836a, latching either the state of the ROLL/REFRESH, or if the TIME/CM switch is on the ranges 0.2ms/cm, 0.1ms/cm and 0.05ms/cm, as described earlier. The N HOLD input of U831 is taken low, freezing the write address produced by the U.L.A. for the memory, preventing further locations in the store being updated. Gate U809c is also disabled driving high NMWE, and hence preventing data being altered at the current write address.

#### 4.9 DIGITAL TO ANALOGUE CONVERTER

The Y data present on the output of latch, U834, is converted into an analogue form by U820, a monolithic eight bit digital to analogue converter. A reference current is fed into this device and the  $I_o$  and  $\bar{I}_o$  outputs produce a differential current output proportional to the product of this reference current and the digital code present on its data inputs D0 to D7. Resistors, R886 and R887, set a reference current of 1mA, giving  $I_o$  and  $\bar{I}_o$  a range of 0→1mA depending on the digital code selected. The reference current is derived from a 6V2 voltage reference formed by Zener Diode D821 and R885 decoupled by C859. Approximately one quarter of the  $I_o$  and  $\bar{I}_o$  currents are fed into the differential amplifiers, U827a and U827d, which convert the currents into a voltage output of approx. +280mV. A time constant of 1 $\mu$ s, set by C822 R830 and R831, is

applied to this differential output. This matches the time constant of the digital ramp generator, and provides a dot joining effect on the display, the dot moving linearly between the data points, though the brightness increases non-linearly as the dot moves between the data points. An adjustment of the relative d.c. offset of the differential Y output signals is provided by R829 enabling the two Y output signals to be balanced. The outputs of this amplifier is fed into Y beamswitch via R823, R824, R371, R372 as described in section 4.2.

#### 4.10 DIGITAL RAMP GENERATOR

The U.L.A. provides a linearly incrementing address bus DAC1 to DAC10 to drive a 10 bit digital to analogue converter (DAC). The lines DAC1 to DAC10 increment from 0 to 1024 as the Y data is read out of the store, 0 corresponding to the left hand edge of the screen, and 1024 the right hand edge of the display. These ten signals are fed into U818, a monolithic 10 bit D.A.C. This produces the differential current outputs  $I_o$  and  $\bar{I}_o$  which represents the product of the digital word on the data inputs and the reference current into the device. The reference current is set at 1mA by R845 and R846 which are connected to 0V(A) and the 6V2 voltage reference mentioned in the previous section.

The current  $\bar{I}_o$  which flows to U818 pin 2 derives from R844, the difference current feeding into R847. The voltage of 0 to +1V generated across R847 is buffered by the unity gain buffer, U825b (see Plot section 4.12).

The  $I_o$  current output of U818 pin 4 is fed to amplifier, U825a, which converts it to a voltage output. The gain of this amplifier is set by preset, R834. A time constant of 1 $\mu$ s on the output is set by R833, R822 and C821 to match the time constant in the Y D.A.C. output amplifier (a small analogue ramp is added into the amplifier input in sampling if necessary. See 4.11) The output of the D.A.C. has a glitch at the changeover of the m.s.b. To reduce this a sample of the m.s.b. is fed into the inverting input of the output amplifier via R849 and C830. The output of the amplifier drives one input of the multiplexer U821b via R833. The other input of this multiplexer is the analogue ramp output from IC261. When NORMal is selected the analogue ramp is fed through to the X output amplifier, and in STORE mode the digital ramp is fed to the X output amplifier, U826e controlling the multiplexer.

The U.L.A. U831 produces a digital blanking signal which lasts for the first four counts of the count on lines DAC1 to DAC10, i.e. 20 $\mu$ s wide. This digital blanking signal is multiplexed with the analogue blanking signal from TR507 collector. In NORMal mode, the analogue blanking signal is selected and in STORE mode the digital blanking signal is selected, the selected signal driving the Bright-up amplifier described in section 4.13, which provides blanking of the display when the c.r.t. beam flies back from the right hand side of the screen to the left hand side.

#### 4.11 SAMPLING

These circuits are shown in Figs. 10.

On the top six ranges, 20 $\mu$ s/cm to 0.5 $\mu$ s/cm, a repetitive sampling method is used to obtain a digital representation of the input waveform.

This technique uses the analogue ramp described in Section 4 and the digital ramp generator formed by U831 and U818 described in Section 4.10.

The aim of this technique is to obtain 1024 samples of the waveform in the time, selected by the TIME/CM switch, necessary to sweep 10.24cm across the screen. In the following discussion a TIME/CM selection of 1 $\mu$ s/cm will be used to illustrate this technique. The time taken to sweep 10.24cm is, using this figure of 1 $\mu$ s/cm, 10.24 $\mu$ s. If we need 1024 samples of the waveform in this time, the samples must be taken at intervals of 10ns. Now the analogue timebase ramp must have the necessary slope to sweep the beam across 10.24cm of display in 10.24 $\mu$ s. If the amplitude of the ramp required to produce 10.24cm of deflection is A Volts, this slope is A/10240 V/ns. Therefore if the samples are taken at intervals of 10ns, this corresponds to a voltage interval of  $\frac{A}{10,240} \times 10$ , or  $\frac{A}{1024}$  Volts

The slow ramp level in fact must increment at A/1024 Volt intervals to produce 10.24cm of display at full scale. Hence a comparator driven by the fast analogue ramp, (which starts at a defined point on the input waveform) and the output of the digital ramp, will produce pulses every time the fast ramp crosses the slow ramp. If the slow ramp after every crossing, increments by one level, i.e. A/1024V, the crossing point will increment at intervals of 10ns. If a sample of the input waveform is taken at each crossing the required objective of taking a sample at 10ns intervals from the trigger point is achieved, each successive sample occurring on successive fast ramps. The circuitry necessary to implement the above method will now be described in detail.

The sampling process is initiated by operating the ARM button. This takes low the reset on U814C, producing a high on the output of U826d. This will enable U812d, allowing the TRIG signals from ICS01a pin 5 in the analogue timebase circuitry to clock counter U902. This TRIG signal goes high at the beginning of fast ramp and low during the fast ramp holdoff. Since U812d inverts the TRIG signal the counter is clocked at the end of the fast ramp.

To ensure that the slow ramp starts above the fast ramp, and hence ensure that the comparator will produce a positive going output, a Start-up circuit is incorporated which offsets the slow ramp until a crossing is obtained.

When the instrument is armed, the Q output of bistable, U904a, is low, and bistable U904b is reset. Counter U902 is then enabled by the Q output of U904b so that the counter will increment at the end of each fast ramp.

R921, R922, R923, R924, R925, R926 on the outputs of this counter produce a current into R836 on the non inverting input of amplifier, U825a, proportional to the count on the counter. Therefore as the counter increments, the output of U825a will be offset in a positive direction. The output of U818 is, at this time, constant and the data input from DAC1 to DAC10 is zero. The line DAC1 to DAC10 are incremented by the TRIG signal to the U.L.A. U831 which, at this time, are disabled at gate U813b pin 9, by the output of U904b.

When the output of amplifier, U825, is offset sufficiently so that the non inverting input of comparator, U903, is at a higher level than the lowest point of the fast analogue ramp, which is fed into the inverting input of this comparator from the output of IC261, the comparator will produce a positive going edge at its output. This output is fed back into the non-inverting input via R919 to ensure a sufficient amount of hysteresis at the switching point, preventing oscillation at this point. This positive-going output clocks a 'high' through bistable, U904a. The D input of this bistable has a time constant ensuring that for a short time after an ARM, the D input remains low, so that comparator crossings are ignored until the D.A.C., U818, has settled. The Q output of the bistable, U904a, will go high, once the comparator has produced a positive edge, and the D input has gone high. The Q output of U904a remains high for approx. 50ns after the Q output has gone high, producing a 50ns pulse at the output of U804d. As described in section 4.6, this pulse drives the sample and holds at the inputs to the SAC beamswitch. The Q output of U904a going high clocks bistable U904b, producing a high on the Q output, and a low on the Q output.

The enable to counter, U902, goes low, the counter stops incrementing, holding a fixed offset on the output of U825a U831 pin 47. Note that the TRIG input to U813 pin 10 has a time constant formed by C853 and R871. This ensures that the positive going output of U813b is delayed by approximately 2 $\mu$ s after the fast ramp finishes. This positive going output causes the D.A.C. outputs of U831 to increment, thus increasing the level of the slow ramp at U903 pin 2. When that fast ramp rises again, the comparator produces another positive going edge, delayed by one sample interval from the previous edge. Meanwhile when the fast ramp reset, and TRIG went low, bistable U904a was reset, and so this edge from the comparator will clock U904a and so produce another sample pulse. This sequence of events will repeat until 1024 sample pulses have been produced and the output of D.A.C. U818 has reached its maximum value. At this point the STORED output of U831 will go high. This produces a low at the input U808c setting flip-flop, U814c, disabling the clock input to counter, U902, taking low the D input of U904a and resetting U904b. The output of U809a will also go high, resetting counter, U902, and driving low the output of U82e, which switches on the STORED L.E.D. D1 101. The U.L.A. U831, outputs (DAC1 to DAC10) now increment at the read rate as described section 4.10.

The 1024 negative-going sample pulses which are produced by U804d during the sampling process, not only drive the sample-and-holds in the A.D.C. but also initiate a conversion and store cycle for each sample taken that initiates conversion of the samples and then ensures the data produced by the A.D.C. is stored correctly.

In the Sampling mode, the output of U805a is low, taking high the output of U826c, this being the SAMPLE signal.  $\overline{\text{SAMPLE}}$ , the reverse of this signal, is produced by U826a. U804d produces the 50ns sample pulses. When SAMPLE is high, these pulses are gated through U801c U803d and U803c to the sample-and-hold circuitry (described in Section 4.6). These pulses are inverted by U809b which is enabled in SAMPLE, and again inverted by U829c, and resets bistable, U835b, taking low the Q output. The Q output was previously high, and so the  $\overline{\text{LD}}$  input of counter U807 was low, presetting the counter outputs to 7, the value determined by the A,B,C,D, preset inputs. The Q outputs of U835b going low clears the LD input on U807, and so on the next 20MHz clock, the counter will increment to a count of eight. Referring to Fig. 5, the counter and associated circuits will produce a WE signal at the  $\overline{\text{Q}}$  output of U806b, a MHZCLK to U831 pin 54 and a Start convert signal to the SAC U815, as described in Section 4.7.

The timing logic will produce four start convert pulses, four write enables and four MHZCLK signals, at which point a positive edge is produced by U831 pin 50, clocking bistable U835b so that the Q output returns high, setting the  $\overline{\text{LD}}$  input of U807, which presets the counter to a count of 7 and holds the count until  $\overline{\text{LD}}$  returns high.

As the timing logic produced these pulses, U831 produces an A10 signal to determine which half of the store is to be written, an address on lines A0 to A9 to determine which location is to be written and a  $\overline{\text{NMWE}}$  signal which writes the data into the store. A10 is clocked low by the first of the MHZCLK input to U831, and alternates after each MHZCLK ending high after the fourth MHZCLK signal. Address lines A0-A9 remain constant for the whole of this cycle and increments only when the TRIG input to U831 goes high, at the end of each analogue ramp,  $\overline{\text{NMWE}}$  is delayed and inverted version of the WE input to U831, hence four of these signals occurs, each going low 50ns approximately after A10 changes, latching the address on the store address bus into the store. When  $\overline{\text{NMWE}}$  returns high 250ns later, the data at the store data bus is latched into the store. The data latch U816, latches data from S.A.C. U815, and enables its output buffers when  $\overline{\text{NMWE}}$  goes low, so that the memory receives new data from the A.D.C.

This cycle repeats for each of the 1024 sample pulses, with A0 to A9 incrementing after each cycle when TRIG goes high. After a full store of data is acquired, the STORED signal from U831 goes high, as described earlier, ending the data acquisition. Reading of this data will now continue until another single shot capture is requested via the ARM button.

#### 4.12 PLOT

A plot facility is provided as standard on this instrument which enables a waveform captured on either CH1 or CH2 is plotted on an X-Y or T-Y pen recorder.

Plot for CH1 is initiated by generating the PLOT1 button. The set input of bistable, U814a, is taken low, and the reset taken high driving the Q output high. When the button is released, the Q output will remain low. The Q output going high initiates the plot mode for CH1 via the PLOT 1 input of the U.L.A. 831. The PLOT output of U831 will go high, thus switching the analogue multiplexer U821a so that the output of U821b is routed through to the X ramp output, and after the first four Y data samples have been read out enables the output of U827c to pass through multiplexer, U821c, to the plot Y output. The plot signal is inverted by U829a which will switch on the PLOT L.E.D. on the front panel and also drive into the A input of monostable, U828a. The B input driven by the TSTMON output of U831 is already high, and the monostable fires, driving high the Q output, and low the  $\overline{\text{Q}}$  output for approx. 500ms, the period set by R852 and C838. The CEP input of counter, U807, is taken low and so the counter halts, holding up the plot operation 500ms. The set input of bistable, U838b, is driven low for 500ms, taking high the Q output, and taking low the penlift via open collector gate U832d. After 500ms plot continues and the data is readout from the store and reconstructed by DAC U820. The current output of U820 is converted into a bipolar voltage output by amplifier U827c, at approx. an output level of 100mV/cm.

The X ramp output is produced by D.A.C. U818, in synchronism with Y data readout. One of the current outputs of this D.A.C. drives amplifier, U825b, which converts this current into unipolar, voltage output at a level of approximately 100mV/cm. When the data has been plotted TSTMON pin 18 of U831, having been low during the plotting, returns high. The A input of U828 is still low at this time and so U828 is retriggered, again halting counter, U807, for 500ms, holding the Plot outputs at the last point plotted. The reset input of U8 will also go low for 500ms, taking high the penlift output, U832d. After 500ms the plot mode will be disabled and the display will return to the normal readout rate.

Operation of PLOT 2 is the same as PLOT 1, bistable U814d being replaced by U814a in the above description.

#### 4.13 POWER SUPPLIES AND C.R.T. CIRCUITS

Circuits for the power supplies are shown in Figs. 10, 11. The following D.C. supplies are generated in the power supply circuits from secondary windings on the supply transformer, T.1.

+ 210V, + 11V, + 12V, + 7V, + 5V, - 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. An additional 5V line is generated in the timebase from the + 11V line by IC552 (Fig. 8).

The incoming a.c. supply from the supply connector, PLM, is switched by S1 and fuse protected 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 supplies +11V, +7V, -5V (used on the main p.c.b. assembly), and -11V 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 unstabilised supply across C704 defined at -11V by that stabiliser, the positive side is applied to the series regulator, IC702, which takes up all variation in the unstabilised 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 +12V, +5V and -5V supplies are derived from secondary windings on T1 of 14V, 8.5V and 8.5V respectively. The 14V output is bridge-rectified by D1205, D1206, D1207 and D1208 and smoothed by C1204 and C1205. A 12V regulator U1202 provides a regulated supply of 12V, which is decoupled by C1206. The +5V and -5V supplies are produced in a similar manner, the relevant components being D1201, D1202, D1203, D1204, C1201, C1202, U1201, C1203 and D1209, D1210, D1211, D1212, C1207, C1208, U1203 and C1209.

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. -200V with respect to 0V by the series zener diode, D706, which is returned to the stabilised cathode potential of -1850V. Subsequent variations in the unstabilised 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 stabilising 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 OS1400 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 signal from the blanking selector, U813a, which in NORMAL provides bright-up during each timebase sweep with blanking of each chop transition if appropriate, and in STORE mode provides bright-up on each readout sweep. 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.

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## 5.1 GENERAL

Fig. 2 and 3 show the internal location of the major components, subassemblies and preset controls. No regular maintenance is required apart from the 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 C.R.T. 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 Cast (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 Cast (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 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 centre 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 centre 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 whilst 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 IV 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 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 earthing 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.

- (g) Removal of the Pick-off Board

If access to the pick-off board for repair or maintenance is required, the D.S.O. p.c.b. can be easily removed. First remove all plugs and sockets from the D.S.O. board and then lift the board clear of the 3 supporting hinges taking care not to catch the trailing cable assemblies. This clears the area around the Pick-off Board, which is supported by two pillars on the edge near the c.r.t. and the switch wafer on the opposite side. Unscrew the nuts securing the wafer onto the switch shaft and slide the board off the two pillars and this shaft, taking care not to damage the wiring under this board. Remove the socket from the lower edge of the board and from the 16 pin DIL SKT next to the switch wafer on the reverse of this board. The board may now be lifted clear.

### 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-stabilised 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, whilst the line load is connected to the forward pin.

The +12V +5V, -5V supplies for the DSO board may be monitored on the D.S.O. board at PLPP pins 1 to 6.

#### Normal Operating Conditions

Unless otherwise specified the controls are set for single channel operation with the trace centred 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. The NORMal switch should be set to NORMal unless otherwise specified.

- (a) Supplies Unregulated

30V DC across C704 from 25 r.m.s. secondary voltage  
268V DC across C705 from 210 r.m.s. secondary voltage  
2.5kV DC across C711 + C712 from 950V r.m.s. secondary voltage

12V DC across C1201 from 8.5V r.m.s. secondary voltage  
20V DC across C1204 from 14V r.m.s. secondary voltage  
12V DC across C1207 from 8.5V r.m.s. secondary voltage

#### Stabilised

+210V	± 21V	} From auxiliary supply board
+11V	± 0.5V	
+7V	± 0.4V - 0.6V	
-5V	-10.4V, - 0.6V	
-11V	± 0.5V	
+12V	± 0.6V	
+5V	± 0.25V	
-5V	±0.25V	

- (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

HANDBOOK AMENDMENT, OS300, OS1400, OS1420 SERIES

Note to Section 5.4

The unstabilised EHT voltage is a function of the peak-to-peak supply voltage and is thus waveform dependent. Operation of the set via a variable or other transformer may introduce peak clipping of the supply to the set and cause subsequent errors in checking or re-setting the EHT stabiliser range. (R725 according to section 5.4b above).

To check the effect of introducing a variable transformer to drive the set, first operate the set directly from the supply and note the supply voltage and the collector voltage of TR707.

Then operate the set via the variable transformer and adjust the supply voltage to the set to give the same voltage on TR707. Any difference in the supply voltage as measured represents a limitation of the variable transformer.

For example:-

Assume that when operating directly from the supply, the supply is measured as 250V and the voltage on TR707 as 430V.

Then on operation of the set through a variable transformer, the output of that transformer into the set is measured as 265V when adjusted to give the same 430V on TR707. The difference of 15V is a result of the impedance of the variable transformer. The input to the set should be adjusted to 240V + 15V, (i.e. 255V) to check or set the voltage on TR707 to 405V.

The voltage on TR707 can have an error of + 20V before any stabilisation problem occurs. Note that adjustment of R725 changes the stabilised EHT voltage and subsequent full re-calibration of the set is required. The stabilised EHT voltage should be  $-1850V \pm 5\%$

E.JG. SALMON

10.8.83

(Attachment to Memo)

# Maintenance

# Section 5

U827a	+3.9V	70mV/cm	With NORM /STORE
U827d	+3.9V	70mV/cm	switch in STORE
Test Point	D.C. Level	Sensitivity	
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	+11.5V	6.8V/cm each side	

### (c) Analogue 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.	65mV/cm each side
	+3.5V on Int D.C.	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, ±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)
Test Point	Signal
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)
U831 pin 52	Switching signal +5.0V to 0V (STORE selected on NORM/STORE switch)
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

### (h) Analogue to Digital Converter

For following measurements set instrument into STORE mode at 0.5ms/cm.

Test Point	D.C. Level	Sensitivity
Q1302 Collector		65mV/cm
Q1304 Emitter	0V	65mV/cm
U1301a pin 1		65mV/cm
D804, D803 Junction	0V	65mV/cm
Q802 Emitter	-0.25V	65mV/cm
Q805, Q905 Base		
U815 Pin 16	-0.25V	65mV/cm
Pin 2	50ns pulse	0 4V signal
Pin 18	20MHz Clk.Switching	0 4V

## (i) Control and Timing Logic

Instrument in STORE mode at 0.5ms/cm

Test Point	Signal (TTL Levels 1 = TTL high level 0 = TTL low level)
------------	--

U807 pin 9	1
U804a pin 3	50ns Negative-going pulse
U805c pin 8	50ns Negative-going pulse
U806a pin 6	50ns Positive-going pulse
U801e pin 10	20MHz Clock
U802a pin 3	20MHz Clock
U8066 pin 8	2MHz Clock with even mark/space
U803c pin 8	50ns Positive-going pulse
U807 pin 11	100ns Positive-going pulse
U807 pin 7	1

## (j) Store Control

Instrument in STORE mode at 0.5ms/cm

Test Point	Signal (TTL logic levels 1 = TTL high level 0 = TTL low level)
------------	--

U831 pin 46	1
U831 pin 48	200kHz clock even mark/space
U831 pin 27	Two 250ns Negative-going pulses every 5 $\mu$ s
U831 pin 47	1 during ramp 0 during hold-off
U831 pin 52	20 $\mu$ s positive-going pulse every 5ms
U831 pin 18	5 $\mu$ s negative-going pulse every 5ms
U817 pin 21	Same as U831 pin 27
U816 pin 1	
U816 pin 11	2 250ns positive-going pulse every 5 $\mu$ s

## (k) Digital to Analogue Converter

Instrument in STORE mode at 0.5ms/cm

Test Point	Signal (TTL logic levels unless otherwise specified)
------------	--

U834 pin 11	200kHz clock
U819 pin 11	200kHz clock
U820 pin 13	+6.2V
U827a pin 1	3.9V D.C. level Sensitivity 70mV/cm
U827d pin 14	3.9V D.C. level Sensitivity 70mV/cm

## (l) Digital Ramp Generator

Instrument in STORE mode at 0.5ms/cm

Test Point	Signal
U831 pin 23	200Hz clock with even mark/space

Test Point	Signal
U825a pin 1	200Hz ramp from 0V to 3.5V
U830a pin 8	200kHz clock with even mark/space
U830a pin 5	200Hz ramp from 0V to 3.5V

## (m) Sampling Circuitry

Instrument in STORE mode at 20 $\mu$ s/cm

Test Point	Signal
U903 pin 1	2.5V analogue ramp at sweep rate selected on TIME/CM switch
U903 pin 2	2.5 digital ramp at 200Hz rate
U903 pin 4	0 to 4V when slow ramp crosses fast ramp
U804d pin 11	50ns pulses at Trigger rate, when updating the Store, after ARM, before STORED indication lights.

## 5.4 SETTING UP PROCEDURE

The following procedure details the adjustments necessary to recalibrate the OS1420 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.

Set instrument initially in NORMAL mode.

### a. Test Equipment

1. Multirange Test Meter including 2.5kV capability at 20k $\Omega$ /V.
2. Variable Autotransformer, output voltage 100-170V 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 $\Omega$ , 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 E.H.T.

Set the incoming a.c. supply via the auto-transformer to the nominal centre 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 +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 centre 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 anticlockwise. 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 centre line. Adjust the Trace Rotation preset control to align the trace with the centre 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 centred 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 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. to 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 Equalisation

Select 100mV/cm on CH1 with the Variable Sensitivity control set fully anticlockwise 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 $\mu$ 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. to pk. at 50kHz. Increase the frequency and check that the loss of amplitude is less than 3dB at 20MHz (3.5cm pk. to pk.).

## o. Calibrator

Monitor a calibrated 1V pk. to pk. square wave input and set the sensitivity and variable sensitivity controls for a full 8cm pk. to pk. display. Disconnect the external input and connect the Y input to the OS1420 Calibrator output. Adjust R641 for a similar 8cm signal amplitude.

## p. Adjustment of the Y D.A.C. output.

Apply a 100mV square wave input to CH1 and set the CH1 attenuator to 10mV/cm. Set STORE mode, and operate the RELEASE control with the TIME/CM switch set to 0.5ms/cm. Adjust R829 to centre the display on the screen. Adjust R821 so that the upper and lower levels of the display are just on screen at both the upper and lower edge of the screen.

## q. Adjustment of the A.D.C.

Select STORE mode, CH1 input coupling to DC, TIME/CM switch to 0.5ms/cm, and set DISPLAY MODE switch to CH1. Apply a 100mV/cm signal to CH1 and select 20mV/cm on the attenuators. Adjust R842

so that the display waveform is 5cm in amplitude.

r. Adjustment of pickoff board

Set CH1 input coupling switch to GND. Ensure CH1 trigger is selected and BRIGHT LINE is On. Set NORMAL mode, and 0.5ms/cm on the TIME/CM switch. Adjust the CH1 Y shift control to centre the trace on the display. Switch to STORE mode. If a trace displacement occurs, adjust R1325 to bring the trace back to the centre of the screen. Switch back to NORMAL mode and display TRACE to the upper edge of the screen. Return back to STORE mode and adjust R1323 set the trace at the upper edge of the screen, if necessary.

Select DUAL mode on the DISPLAY MODE switch.

Set CH1 and CH2 input coupling to DC. Select a 100mV square wave input for both CH1 and CH2.

Set the attenuator to 20mV/cm. Observe the levels of the two displayed waveforms and adjust R1377 so that the amplitudes of both CH1 and CH2 are identical.

Select CH2 on the DISPLAY MODE switch and set the CH2 input coupling to GND. Set BRIGHT LINE ONE, CH2 TRIGGER and NORMAL mode. Adjust the CH2 Y shift control to centre the trace on the screen. Switch

to STORE mode and adjust R1374 to centre the trace again. Return to NORMAL mode, and shift the trace up to the upper edge of the display. Switch back to STORE mode and adjust R1373 so that the trace is at the upper edge of the screen.

s. Adjustment of Sampling Circuitry

Select 20 $\mu$ s/cm on the TIME/CM switch. Set the NORM NORMAL/STORE button to STORE, select CH1 on the DISPLAY MODE switch, and CH1 TRIGGER. Set BRIGHT LINE ON and CH1 input coupling to GND.

Set R838 fully anticlockwise. Remove U902 and connect pin 12 of the socket to +5V and Pins 11, 7, 6, 5, 4, 3 to ground. Operate the ARM control. The display will now go blank. Adjust R838 until a trace appears. R838 should be set as near the point which initiates a trace as possible.

Replace U902.

t. Digital Timebase adjustment

Apply 1ms markers to CH1 input. Set the TIME/CM switch to 0.1ms. Select STORE mode and operate the RELEASE button. Obtain a centred triggered trace and adjust R834 to obtain 1cm spacing between the markers.

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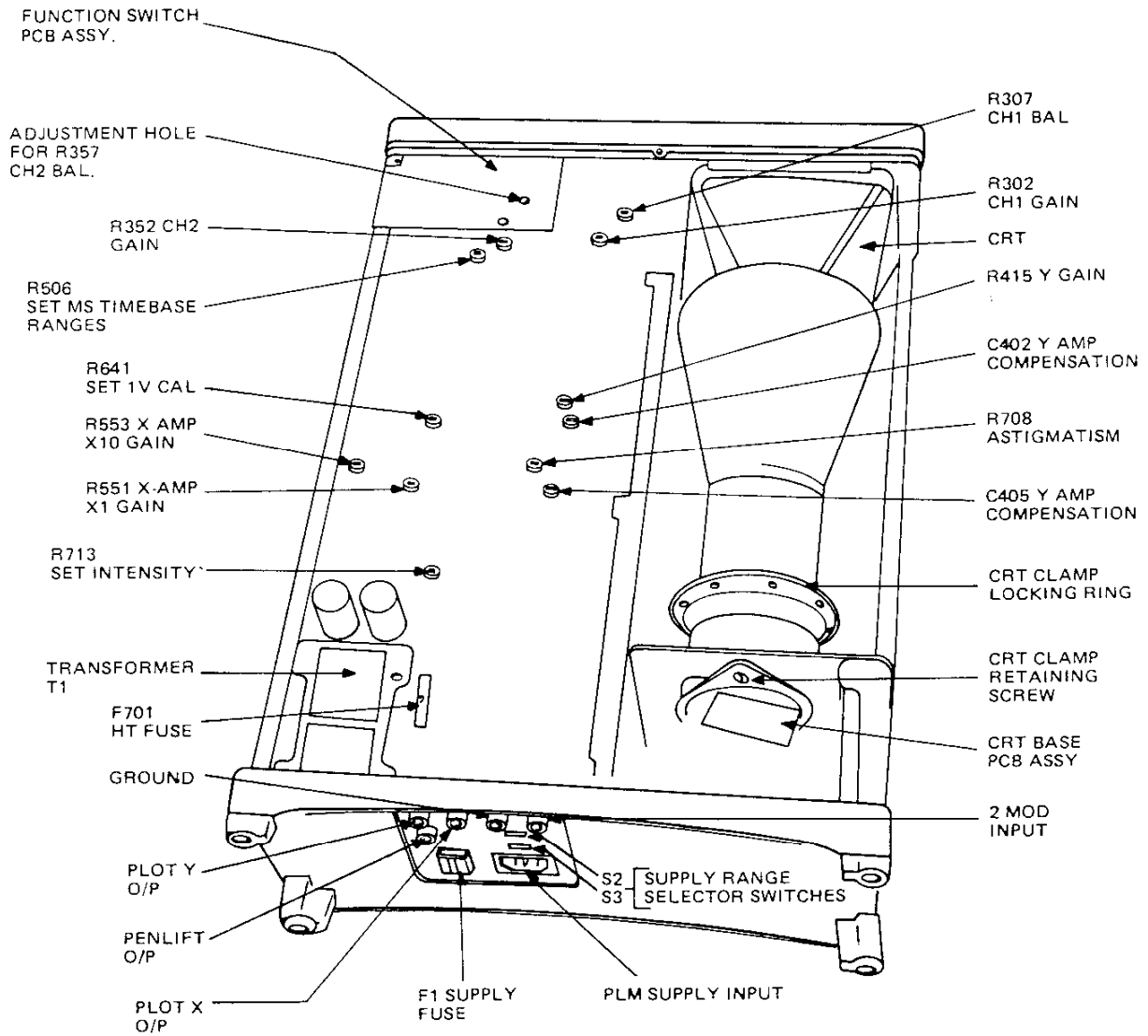
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Fig. 2 Internal Assembly — Top View

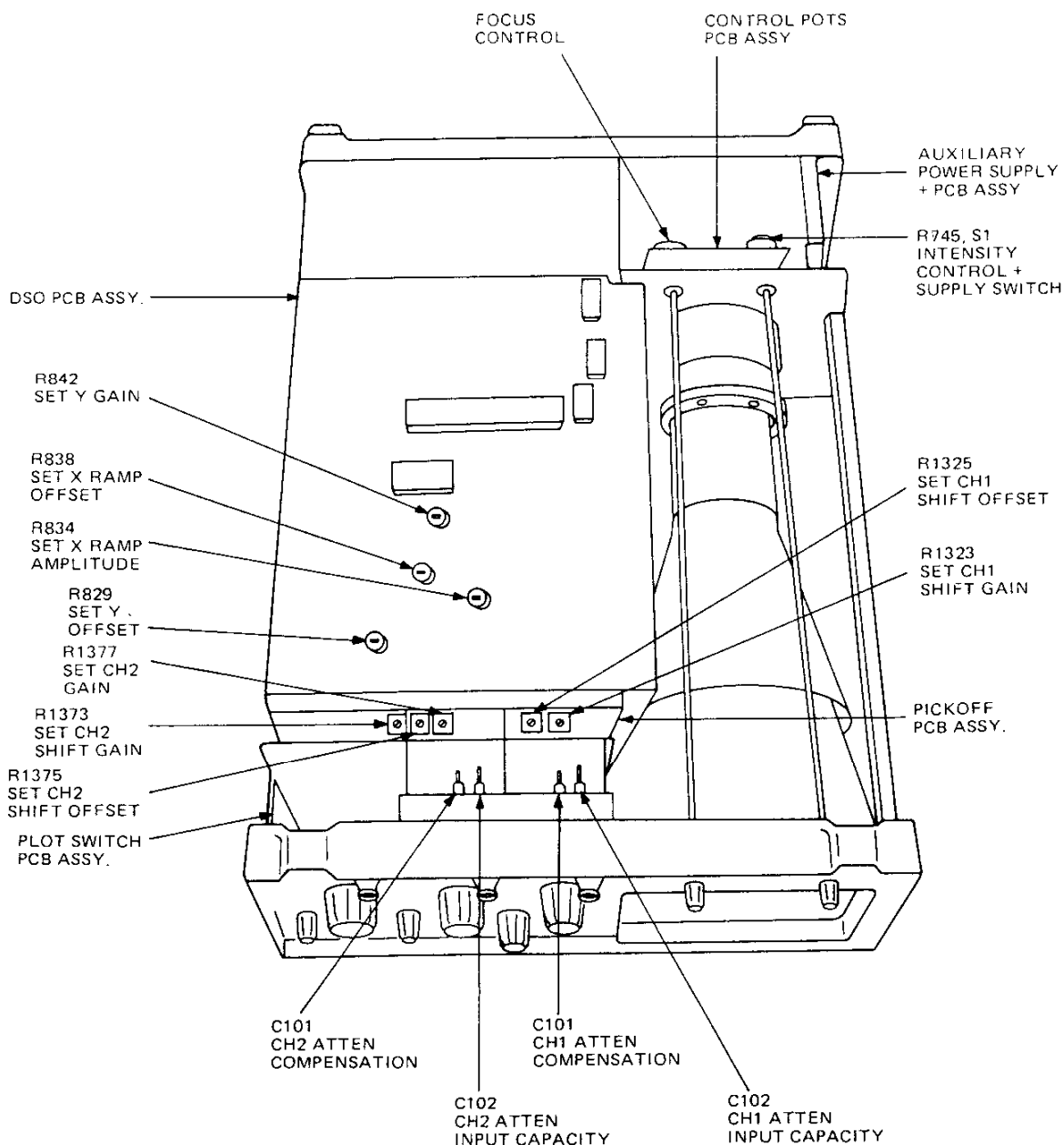


Fig. 3 Internal Assembly – Bottom View

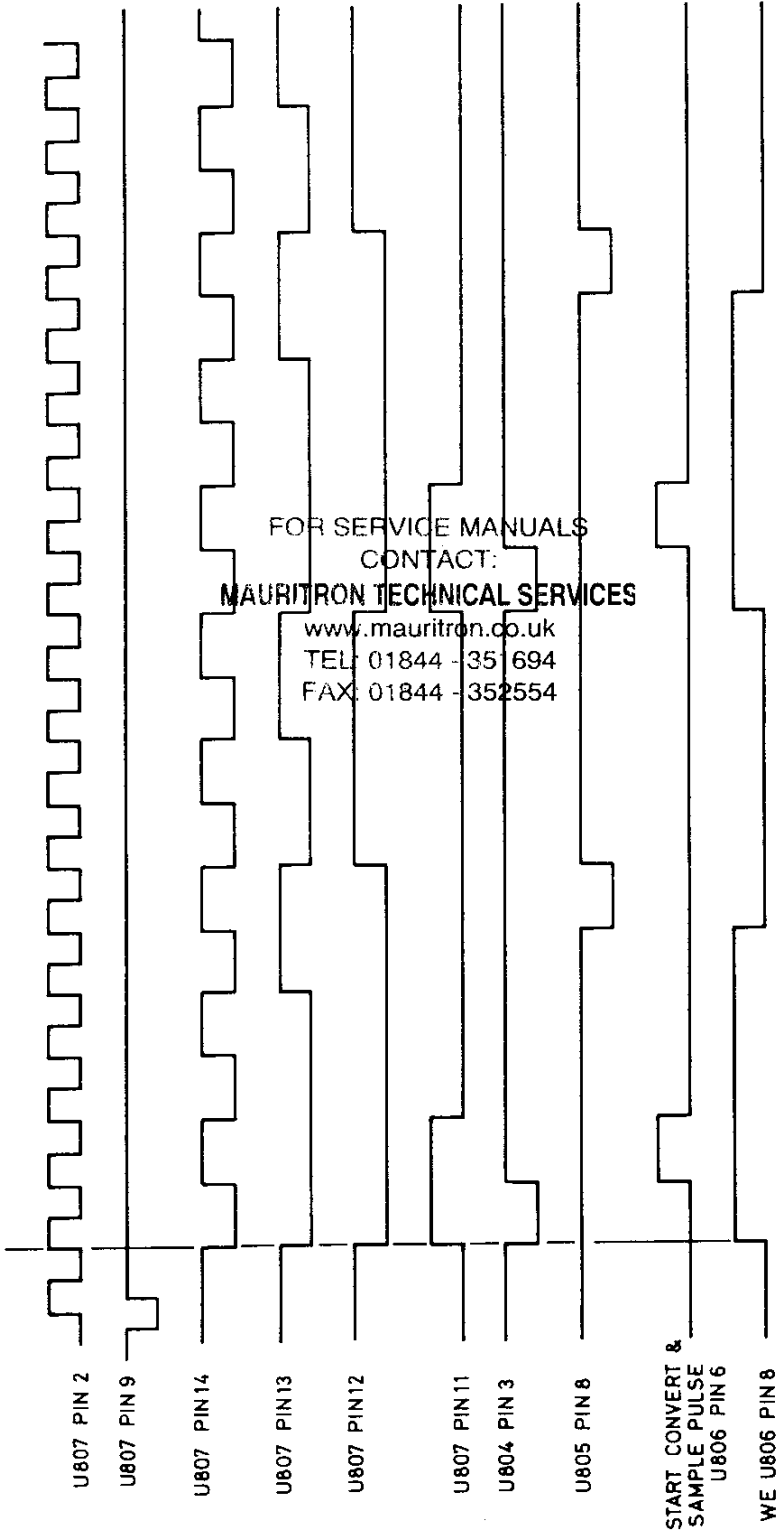
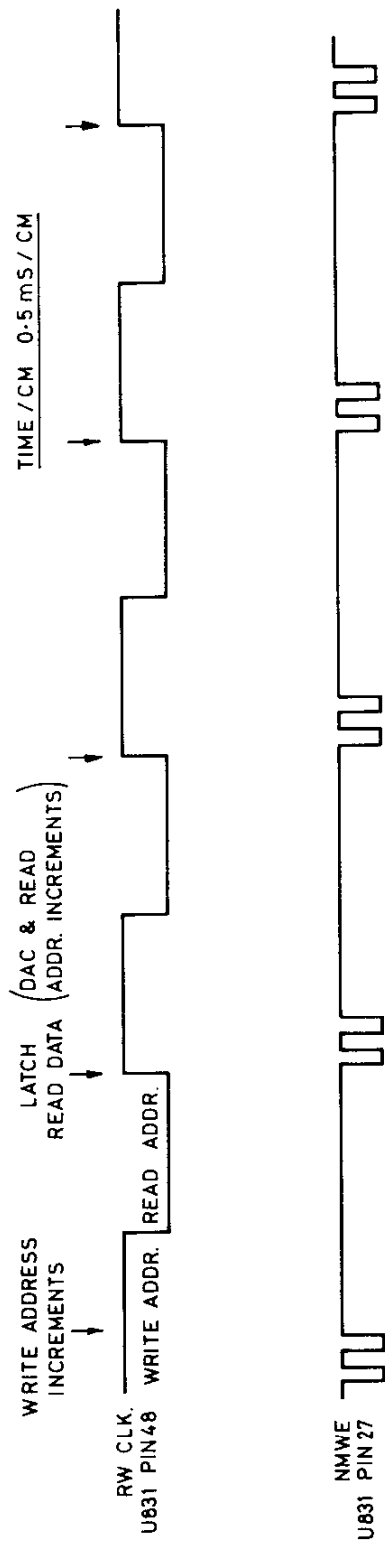


Fig. 4 Control & Timing Logic Waveforms



IN ROLL MODE WHEN WRITE ADDRESS INCREMENTS  
THE NEXT READ ADDRESS INCREMENTS BY TWO.

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Fig. 5 Store Control Waveforms

## ABBREVIATIONS USED FOR COMPONENT DESCRIPTIONS

### RESISTORS

CC	Carbon Composition	½W	10%	unless otherwise stated
CF	Carbon Film	¼W	5%	unless otherwise stated
MO	Metal Oxide	½W	2%	unless otherwise stated
MF	Metal Film	¼W	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	±10%	unless otherwise stated
CE(3)	Ceramic	50V		unless otherwise stated
SM	Silver Mica			
PF	Plastic Film		±10%	unless otherwise stated
PS	Polystyrene			
PE	Polyester		±10%	unless otherwise stated
PC	Polycarbonate			
E	Electrolytic (Aluminium)		+50%	
			-10%	
T	Tantalum		+50%	
			-10%	

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# Component List and Illustrations

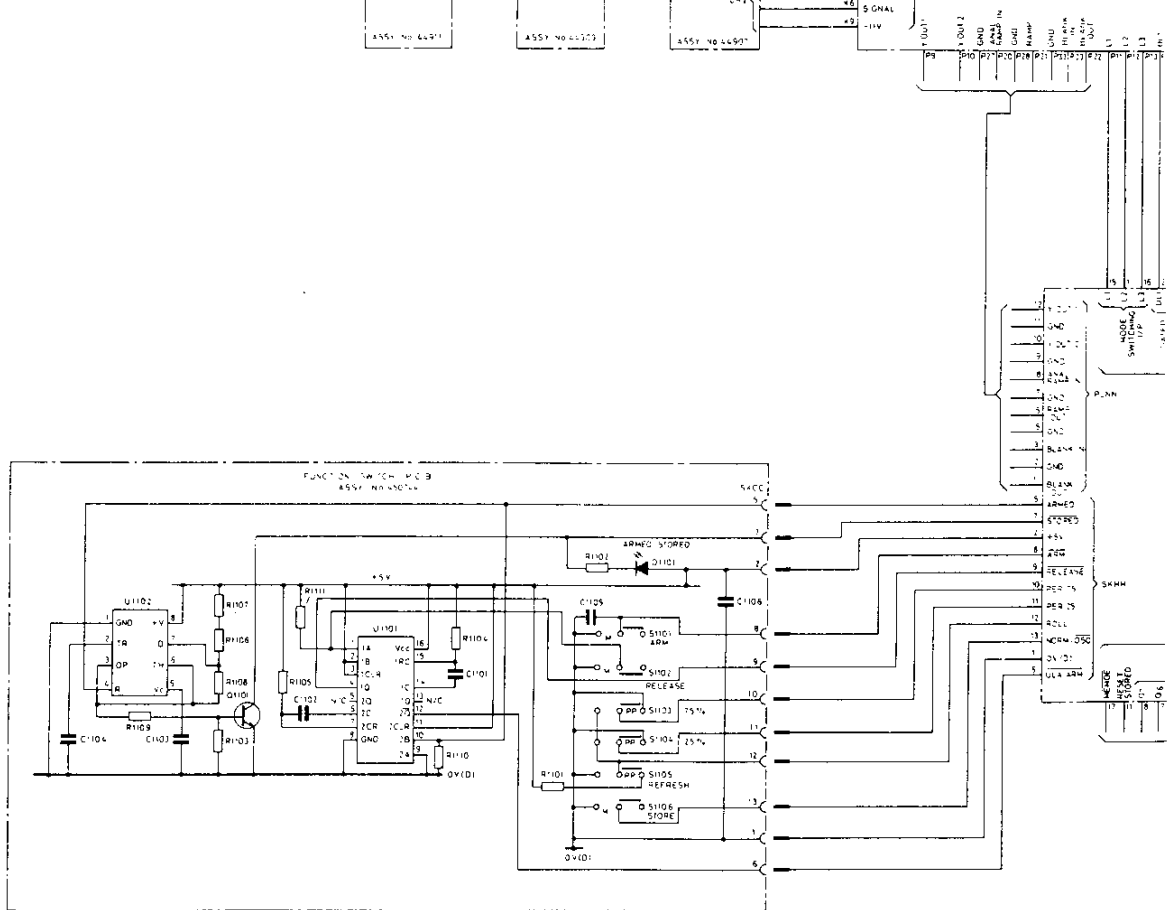
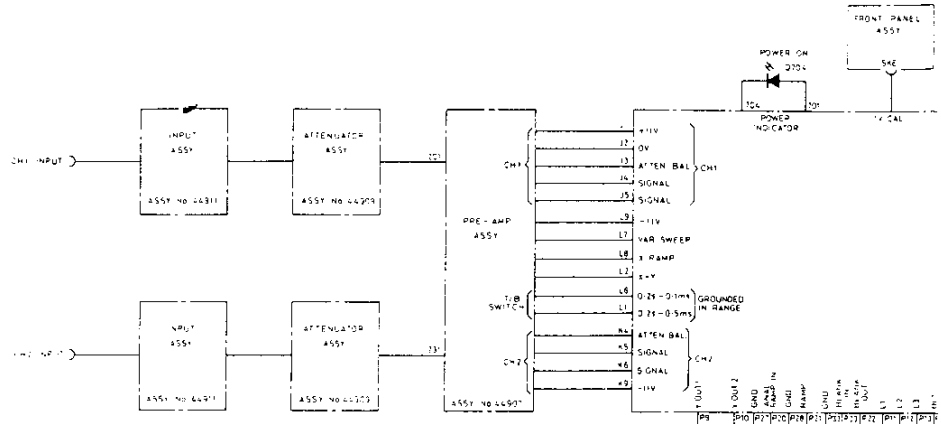
# Section 6

## INTERCONNECTION DIAGRAM

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
<b>RESISTORS</b>											
R1101	1k	CF			21799	C1106	10nF	CE(3)			450548
R1102	390	CF			28722						
R1103	4k7	CF			21805	<b>DIODES</b>					
R1104	10k	CF			21809	D1101					
R1105	10k	CF			21809						
R1106	270k	CF			21256	D1401					
R1107	330k	CF			32357						
R1108	470k	CF			32330	Q1101		MPS2369			36625
R1109	4k7	CF			21805						
						U1101		74C221			451267
R111	10k	CF			21809	U1102		ICM7555IPA			451317
<b>CAPACITORS</b>						<b>MISCELLANEOUS</b>					
C1101	10nF	CE(3)		25V	450548	S1101					
C1102	10nF	CE(3)		25V	450548	-1106					
C1103	10nF	CE(3)		25V	450548						
C1104	470nF	CE(3)			43500	S1401					
C1105	100nF	CE(3)			43498	-1404					

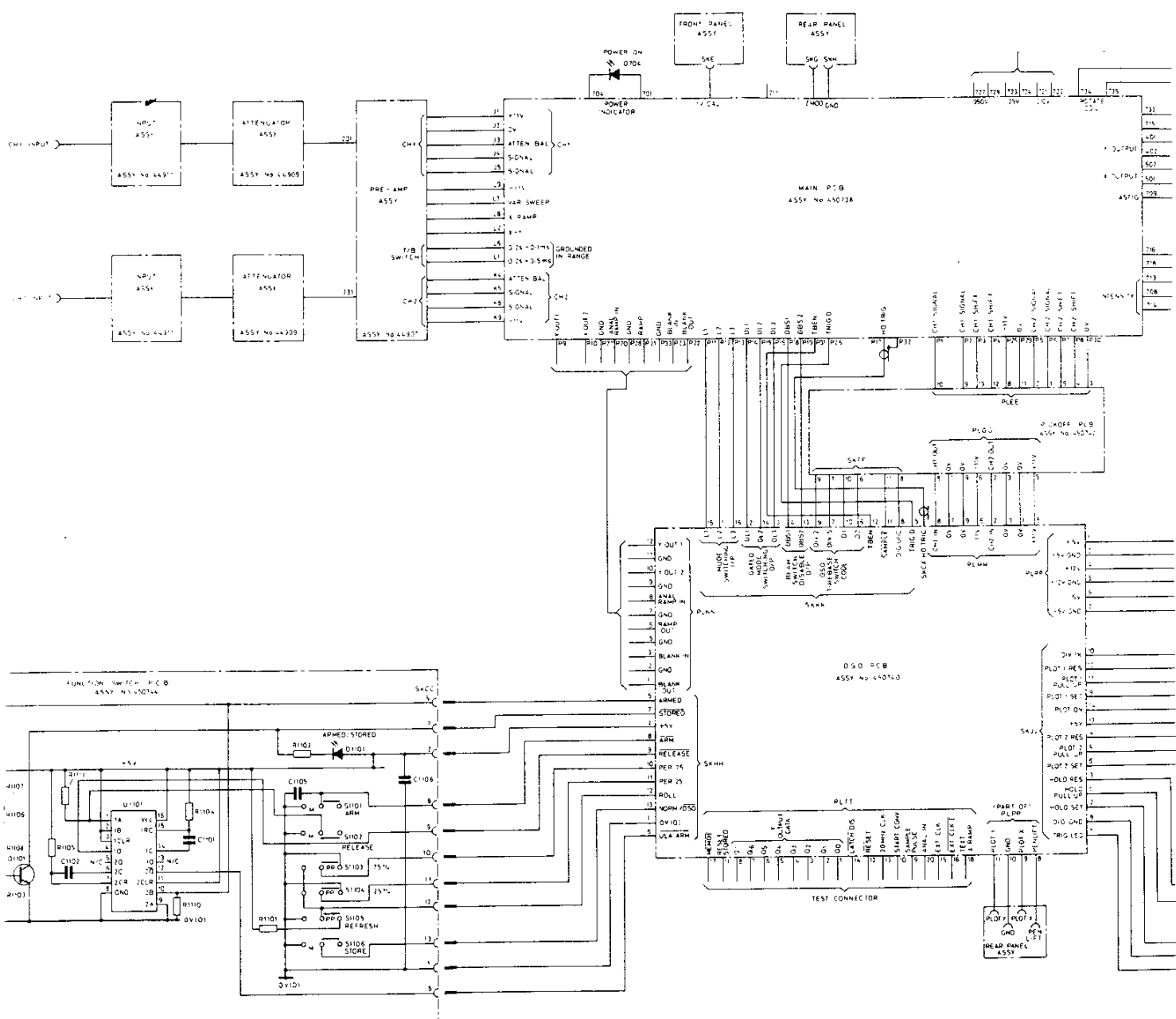
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RESIS	R1103	R1107 R1108 R1109 R1101	R1105	R1111	R1104 R1112	R1102 R1101
CAPS	C1104	C1103	C1102	C1101	C1105	C1106
WISC	U1107	D1101	U1101	S1101 S1102 S1103 S1104 S1105 S1106	D1101	SKCC D1104 SKE



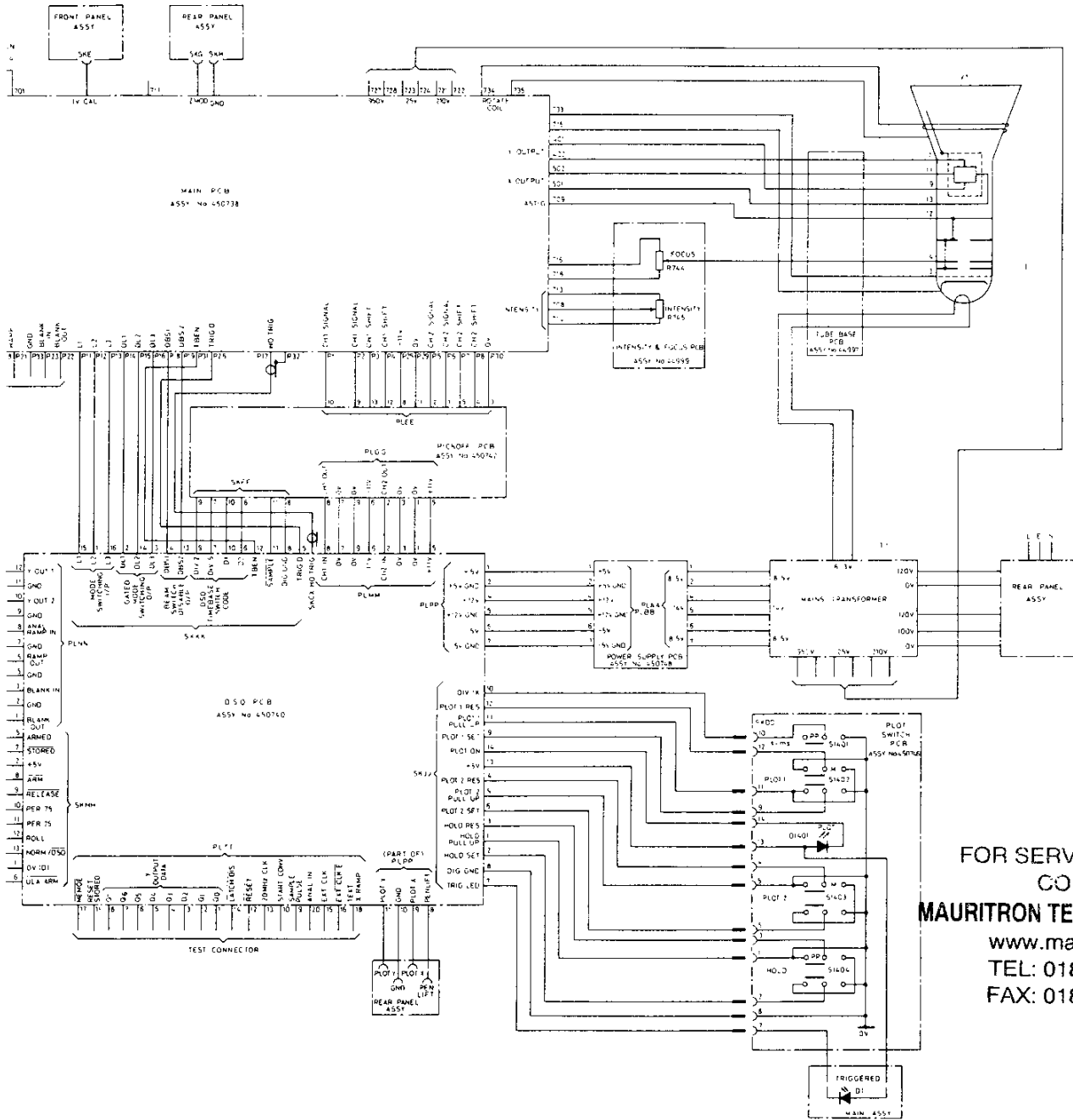
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U107	R1105	R1101	R1102	R1102	R1101				
U108									
U101									
C1102	C1101		C1105		C1106				
			D1101		SXCC		D104	SWE	SXG SXH





R744 R745		S400		S1401 S1402 S1403 S1404	VI
SKE	S4G S4H				
01					



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Fig. 6 Interconnection Diagrams

# Component List and Illustrations

# Section 6

## Y AMP, TIMEBASE & TRIGGER

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
<b>RESISTORS</b>											
R1	47	CF			28714	R270	4k7	CP			A3/451369
R2	47	CF			28714	R271	2k2	CP			451370
						R272	47k	CF		1/8W	44242
R101	27	CF			28711	R273	8k2	CF		1/8W	44234
						R274	2k2	CP			451370
R103	22	CF			28710						
						R301	10k	PCP			44959
R133	22	CF			28710	R302	220	PCP			36262
R151	82k	CF		1W	19060	R306	1k	CF			21799
						R307	10k	PCP			36267
R201	1k8	CF			28725	R308	22k	CF			21812
R202	10	CF			21793	R309	120	CF	2		38572
						R311	10	CF			21793
R204	1k5	CF			21801	R312	10	CF			21793
R205	3k3	CF			21803	R313	100	CF			21794
R206	47	CF			28714	R314	100	CF			21794
R207	470k	CC			4906	R315	4k7	CP			A3/451371
R208	150	CF			28719	R316	3k3	MF	2		38606
						R317	3k3	MF	2		38606
R210	820	CF			28724	R318	7k5	CF			40297
R211	510	CF			29434	R319	7k5	CF			40297
R212	820	MF	2		38592						
R213	820	MF	2		38592	R351	10k	PCP			44959
R214	1k5	MF	2		38598	R352	220	PCP			36262
R215	1k5	MF	2		38598						
R216	180	CF			21795	R356	1k	CF			21799
R217	4k7	CP			451368	R357	10k	PCP			36267
						R358	22k	CF			21812
						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	3k3	CF			21803	R365	4k7	CP			A3/451371
R236	47	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	R401	2k2	MF	2		38602
R241	510	CF			29434	R402	2k2	MF	2		38602
R242	820	MF	2		38592	R403	2k2	CF			21802
R243	820	MF	2		38592	R404	2k2	CF			21802
R244	1k5	MF	2		38598	R405	2k7	MF			38604
R245	1k5	MF	2		38598	R406	47	CF			28714
R246	180	CF			21795	R407	2k7	MF	2		38604
R247	4k7	CP			451368	R408	1k5	CF			21801
						R409	1k5	CF			21801
R261	10	CF			21793	R410	1k8	CF			28725
R262	470	CF			21797	R411	1k8	CF			18553
R263	4k7	CF			21805	R412	390	MF	2		38584
						R413	1k8	CF		½W	18553
R265	1k	CF			21799	R414	390	MF	2		38584
R266	1k	CF			21799	R415	100	PCP			36261
R267	10	CF			21793	R416	47	CF			28714
R268	100	CF			21794	R417	150	MF	2		38574
R269	47k	CP			A3/451367						

# Component List and Illustrations

# Section 6

## Y AMP, TIMEBASE & TRIGGER (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
<b>RESISTORS (Cont.)</b>											
R418	270	MO			26742	R532	180	CF			21795
R419	10	CF			21793	R533	1k2	CF			21800
						R534	6k8	CF			21807
R421	10	CF			21793	R535	680	CF			28723
R422	270	MO			26742	R536	10	CF			21793
R423	100	CF			21794	R537	10	CF			21793
R424		A.O.T.				R538	10	CF			21793
R425	100	MF	2		38570	R539	470	CF			21797
R426	120	CF			28718						
R427	120	CF			28718	R541	1k8	CF			28725
R428	22	CF			28710	R542	47	CF			28714
R429	39k	CF		1W	19056						
						R544	470	CF			21797
R432	22	CF			28710	R545	2k7	CF	A.O.T.		28726
R433	47	CF			28714	R546	6k8	CF			21807
R434	47	CF	5		28714	R547	2k2	CF			21802
						R548	8k2	CF			21808
R437	100	CF			21794	R549	6k8	CF			21807
R438	100	CF			21794						
R439	270	CF		1W	19036	R551	1k	PCP			36264
R440	270	CF		1W	19036	R552	5k6	CF			21806
R441	270	CF		1W	19036	R553	4k7	PCP			36266
R442	2k2	MO	5		44986	R554	680	CF			28723
R443	2k2	MO	5		44986	R555	47	CF			28714
R444	47	CF			28714	R556	2k7	CF			28726
R445	47	CF			28714	R557	1k8	CF			28725
						R558	10	CF			21793
R503	470	CF			21797	R559	100	CF			21794
R504	56k	CF			28729	R560	68k	CF			21816
R505	27k	CF			21813	R561	100	CF			21794
R506	10k	PCP			36267	R562	10k	CF			21809
R507	4k7	CF			21805	R563	390	CF		½W	18545
R508	4k7	CF			21805	R564	33k	CF			21814
R509	33k	CF			21814	R565	2k2	CF			21802
R510	10	CF			21793	R566	100k	MO			28822
R511	10k	CF			21809	R567	390	CF		½W	18545
R512	33k	CF			21814	R568	22k	CF			21812
R515	5k6	CF			21806	R569	510	MF	2		38587
R514	1k5	CF			21801	R570	15k	CF	A.O.T.		28727
R515	1k5	CF			21801	R571	820	CF			28724
R516	1k	CF			21799	R572	22k	CF			21812
R517	22k	CF			21812	R573	4k7	CF			21805
R518	22k	CF			21812	R574	12k	CF		1W	19051
R519	3k9	CF			21804	R575	12k	CF		1W	19051
R520	10k	CF			21809	R576	10k	MO	5		44987
R521	1k	CF			21799	R577	10k	MO	5		44987
R522	2k2	CF			21802						
R523	4k7	CF			21805	R600	22k	CF			21812
R524	3k9	CF			21804	R601	27k	CF			21813
R525	2k2	CF			21804						
R526	3k9	CF			21802	R603	3k3	CF			21803
R527	680	CF			28723	R604	4k7	CF			21805
R528	680	CF			28723	R605	2k2	CF			21802
R529	1k	CF			21799	R606	27k	CF			21813
R530	56	CF			28715	R607	2k2	CF			21802

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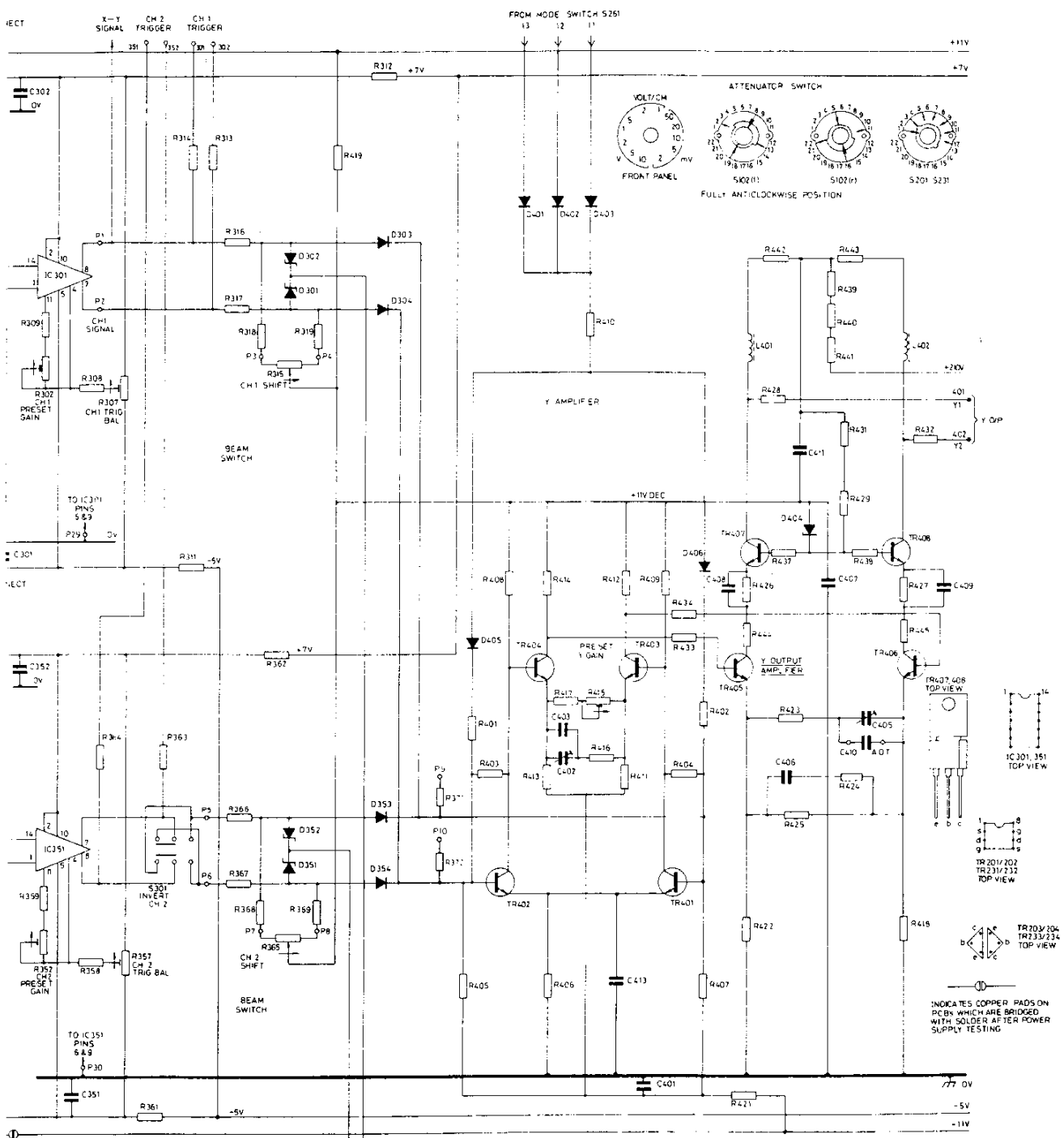
## Y AMP, TIMEBASE & TRIGGER (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
<b>RESISTORS (Cont.)</b>											
R608	4k7	CF			21805	C133			A.O.T.		
R609	470	CF			21797						
R610	10	CF			21793	C135	100nF	PE		400V	44966
R611	680	CF			28723						
R612	680	CF			28723	C151	6.8pF	SM		500V	22362
R613	68k	CF			21816						
R614	10	CF			21793	C201	10µF	E		25V	32180
R615	12k	CF			21810	C202	2.2nF	CE(2)			22389
R616	470	CF			21797	C204	1nF	CE(3)			42432
R617	2k7	CF			28726						
R618	47k	CF			21815	C231	10µF	E		25V	32180
R619	3k3	CF			21803	C232	10nF	CE(3)		25V	450548
R620	1M	CF			31840	C233	2.2nF	CE(2)			22389
R621	3k3	MF			21803	C234	1nF	CE(3)			42432
R622	1k8	CF			28725						
R623	220k	CF			21823	C237	10nF	CE(3)		25V	450548
R624	10	CF			21793						
R625	1M	CF			31840	C263	12nF	PS		63V	450536
R626	1M	CF			31840	C264	1µF	PE		100V	41743
R627	680k	CF			31839	C265	10nF	CE(3)		25V	450548
R628	1M	CF			31840	C266	10nF	CE(2)		100V	37018
R629	1M	CF			31840	C267	10nF	CE(3)		25V	450548
R630	100k	CF			21819	C268	10nF	CE(3)		25V	450548
R631	33k	CF			21814						
R632	300k	MF	2		38653	C301	10nF	CE(3)		25V	450548
R633	18k	CF			21811	C302	10nF	CE(3)		25V	450548
R634	6k8	CF			21807						
R635	10	CF			21793	C351	10nF	CE(3)		25V	450548
R636	68k	CF			21816	C352	10nF	CE(3)		25V	450548
R637	2k2	CF			21802						
R638	3k9	CF			21804	C401	10nF	CE(3)		25V	450548
R639	10k	CF			21809	C402	10/65pF	TRIMMER			30286
R640	39k	CF			28728	C403	15pF	CE(3)			42410
R641	2k2	PCP			36265	C404	120pF	CE(3)			42421
R642	56k	CF		½W	19058	C405	1065/pF	TRIMMER			30286
R643	470	CF			21797	C406			A.O.T.		
R644	3k3	CF			21803	C407	100nF	CE(2)		100V	37018
R645	10k	CF			21809	C408	3.3nF	CE(3)			42438
						C409	3.3nF	CE(3)			42438
RN101		RESISTOR NETWORK			A3/43194						
RN201		RESISTOR NETWORK			A3/44651	C411	5.6nF	CE(2)		500V	22394
						C412	15pF	CE(3)	A.O.T.		42410
						C413	1nF	CE(3)		50V	42432
RN231		RESISTOR NETWORK			A3/44651						
RN261		RESISTOR NETWORK			A3/38692	C501	220nF	PE		100V	44370
						C502	1nF				42432
						C503	10nF	CE(3)		25V	450548
						C504	10nF	CE(3)		25V	450548
<b>CAPACITORS</b>											
C101	1/6pF	TRIMMER			450510	C506	10pF	CE(3)			42408
C102	1/6pF	TRIMMER			450510	C507	10nF	CE(3)		25V	450548
C103		A.O.T.				C508	10nF	CE(3)		25V	450548
C104	680pF	PC			40631	C509	100µF	E		16V	450582
C105	100nF	CE(2)		400V	44966	C510	560pF	CE(3)			42429
C106	6.8pF	CE(2)			22362	C511	3.3nF	CE(3)			42438

RES15	R103 R133	R1	R2	RN01	RN101a,b,c	R207	R237	R215	R214	R204	R245	R242	RN201a-1	RN231a-1	R208	Q238	R211	R213	R241	R243	R210	R212	R202	R232	R240	R201	R231	R205	R206	R216	R217	R246	R247	R301	R306	R351	R352	R353	R354	R355	R356	R357	R358	R359	R360	R361	R362	R363	R364	R365	R366	R367	R368	R369	R370	R371	R372	R373	R374	R375	R376	R377	R378	R379	R380	R381	R382	R383	R384	R385	R386	R387	R388	R389	R390	R391	R392	R393	R394	R395	R396	R397	R398	R399	R400	R401	R402	R403	R404	R405	R406	R407	R408	R409	R410	R411	R412	R413	R414	R415	R416	R417	R418	R419	R420	R421	R422	R423	R424	R425	R426	R427	R428	R429	R430	R431	R432	R433	R434	R435	R436	R437	R438	R439	R440	R441	R442	R443	R444	R445	R446	R447	R448	R449	R450	R451	R452	R453	R454	R455	R456	R457	R458	R459	R460	R461	R462	R463	R464	R465	R466	R467	R468	R469	R470	R471	R472	R473	R474	R475	R476	R477	R478	R479	R480	R481	R482	R483	R484	R485	R486	R487	R488	R489	R490	R491	R492	R493	R494	R495	R496	R497	R498	R499	R500	R501	R502	R503	R504	R505	R506	R507	R508	R509	R510	R511	R512	R513	R514	R515	R516	R517	R518	R519	R520	R521	R522	R523	R524	R525	R526	R527	R528	R529	R530	R531	R532	R533	R534	R535	R536	R537	R538	R539	R540	R541	R542	R543	R544	R545	R546	R547	R548	R549	R550	R551	R552	R553	R554	R555	R556	R557	R558	R559	R560	R561	R562	R563	R564	R565	R566	R567	R568	R569	R570	R571	R572	R573	R574	R575	R576	R577	R578	R579	R580	R581	R582	R583	R584	R585	R586	R587	R588	R589	R590	R591	R592	R593	R594	R595	R596	R597	R598	R599	R600	R601	R602	R603	R604	R605	R606	R607	R608	R609	R610	R611	R612	R613	R614	R615	R616	R617	R618	R619	R620	R621	R622	R623	R624	R625	R626	R627	R628	R629	R630	R631	R632	R633	R634	R635	R636	R637	R638	R639	R640	R641	R642	R643	R644	R645	R646	R647	R648	R649	R650	R651	R652	R653	R654	R655	R656	R657	R658	R659	R660	R661	R662	R663	R664	R665	R666	R667	R668	R669	R670	R671	R672	R673	R674	R675	R676	R677	R678	R679	R680	R681	R682	R683	R684	R685	R686	R687	R688	R689	R690	R691	R692	R693	R694	R695	R696	R697	R698	R699	R700	R701	R702	R703	R704	R705	R706	R707	R708	R709	R710	R711	R712	R713	R714	R715	R716	R717	R718	R719	R720	R721	R722	R723	R724	R725	R726	R727	R728	R729	R730	R731	R732	R733	R734	R735	R736	R737	R738	R739	R740	R741	R742	R743	R744	R745	R746	R747	R748	R749	R750	R751	R752	R753	R754	R755	R756	R757	R758	R759	R760	R761	R762	R763	R764	R765	R766	R767	R768	R769	R770	R771	R772	R773	R774	R775	R776	R777	R778	R779	R780	R781	R782	R783	R784	R785	R786	R787	R788	R789	R790	R791	R792	R793	R794	R795	R796	R797	R798	R799	R800	R801	R802	R803	R804	R805	R806	R807	R808	R809	R810	R811	R812	R813	R814	R815	R816	R817	R818	R819	R820	R821	R822	R823	R824	R825	R826	R827	R828	R829	R830	R831	R832	R833	R834	R835	R836	R837	R838	R839	R840	R841	R842	R843	R844	R845	R846	R847	R848	R849	R850	R851	R852	R853	R854	R855	R856	R857	R858	R859	R860	R861	R862	R863	R864	R865	R866	R867	R868	R869	R870	R871	R872	R873	R874	R875	R876	R877	R878	R879	R880	R881	R882	R883	R884	R885	R886	R887	R888	R889	R890	R891	R892	R893	R894	R895	R896	R897	R898	R899	R900	R901	R902	R903	R904	R905	R906	R907	R908	R909	R910	R911	R912	R913	R914	R915	R916	R917	R918	R919	R920	R921	R922	R923	R924	R925	R926	R927	R928	R929	R930	R931	R932	R933	R934	R935	R936	R937	R938	R939	R940	R941	R942	R943	R944	R945	R946	R947	R948	R949	R950	R951	R952	R953	R954	R955	R956	R957	R958	R959	R960	R961	R962	R963	R964	R965	R966	R967	R968	R969	R970	R971	R972	R973	R974	R975	R976	R977	R978	R979	R980	R981	R982	R983	R984	R985	R986	R987	R988	R989	R990	R991	R992	R993	R994	R995	R996	R997	R998	R999	R1000
CAP	C103	C105	C102	C101	C104	C257	C203	C233	C235	C205	C102	C301	C231	C232	C204	C234	C302	C301	C352	C352																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
MISC	SKA	SKB	S101	S102	S101	S102	D203	D202	D231	D232	D233	D201	TR201	TR231	TR204	TR234	TR203	TR233	TR202	TR232	S201	S231	S232	S233	S234	S235	S236	S237	S238	S239	S240	S241	S242	S243	S244	S245	S246	S247	S248	S249	S250	S251	S252	S253	S254	S255	S256	S257	S258	S259	S260	S261	S262	S263	S264	S265	S266	S267	S268	S269	S270	S271	S272	S273	S274	S275	S276	S277	S278	S279	S280	S281	S282	S283	S284	S285	S286	S287	S288	S289	S290	S291	S292	S293	S294	S295	S296	S297	S298	S299	S300	S301	S302	S303	S304	S305	S306	S307	S308	S309	S310	S311	S312	S313	S314	S315	S316	S317	S318	S319	S320	S321	S322	S323	S324	S325	S326	S327	S328	S329	S330	S331	S332	S333	S334	S335	S336	S337	S338	S339	S340	S341	S342	S343	S344	S345	S346	S347	S348	S349	S350	S351	S352	S353	S354	S355	S356	S357	S358	S359	S360	S361	S362	S363	S364	S365	S366	S367	S368	S369	S370	S371	S372	S373	S374	S375	S376	S377	S378	S379	S380	S381	S382	S383	S384	S385	S386	S387	S388	S389	S390	S391	S392	S393	S394	S395	S396	S397	S398	S399	S400	S401	S402	S403	S404	S405	S406	S407	S408	S409	S410	S411	S412	S413	S414	S415	S416	S417	S418	S419	S420	S421	S422	S423	S424	S425	S426	S427	S428	S429	S430	S431	S432	S433	S434	S435	S436	S437	S438	S439	S440	S441	S442	S443	S444	S445	S446	S447	S448	S449	S450	S451	S452	S453	S454	S455	S456	S457	S458	S459	S460	S461	S462	S463	S464	S465	S466	S467	S468	S469	S470	S471	S472	S473	S474	S475	S476	S477	S478	S479	S480	S481	S482	S483	S484	S485	S486	S487	S488	S489	S490	S491	S492	S493	S494	S495	S496	S497	S498	S499	S500	S501	S502	S503	S504	S505	S506	S507	S508	S509	S510	S511	S512	S513	S514	S515	S516	S517	S518	S519	S520	S521	S522	S523	S524	S525	S526	S527	S528	S529	S530	S531	S532	S533	S534	S535	S536	S537	S538	S539	S540	S541	S542	S543	S544	S545	S546	S547	S548	S549	S550	S551	S552	S553	S554	S555	S556	S557	S558	S559	S560	S561	S562	S563	S564	S565	S566	S567	S568	S569	S570	S571	S572	S573	S574	S575	S576	S577	S578	S579	S580	S581	S582	S583	S584	S585	S586	S587	S588	S589	S590	S591	S592	S593	S594	S595	S596	S597	S598	S599	S600	S601	S602	S603	S604	S605	S606	S607	S608	S609	S610	S611	S612	S613	S614	S615	S616	S617	S618	S619	S620	S621	S622	S623	S624	S625	S626	S627	S628	S629	S630	S631	S632	S633	S634	S635	S636	S637	S638	S639	S640	S641	S642	S643	S644	S645	S646	S647	S648	S649	S650	S651	S652	S653	S654	S655	S656	S657	S658	S659	S660	S661	S662	S663	S664	S665	S666	S667	S668	S669	S670	S671	S672	S673	S674	S675	S676	S677	S678	S679	S680	S681	S682	S683	S684	S685	S686	S687	S688	S689	S690	S691	S692	S693	S694	S695	S696	S697	S698	S699	S700	S701	S702	S703	S704	S705	S706	S707	S708	S709	S710	S711	S712	S713	S714	S715	S716	S717	S718	S719	S720	S721	S722	S723	S724	S725	S726	S727	S728	S729	S730	S731	S732	S733	S734	S735	S736	S737	S738	S739	S740	S741	S742	S743	S744	S745	S746	S747	S748	S749	S750	S751	S752	S753	S754	S755	S756	S757	S758	S759	S760	S761	S762	S763	S764	S765	S766	S767	S768	S769	S770	S771	S772	S773	S774	S775	S776	S777	S778	S779	S780	S781	S782	S783	S784	S785	S786	S787	S788	S789	S790	S791	S792	S793	S794	S795	S796	S797	S798	S799	S800	S801	S802	S803	S804	S805	S806	S807	S808	S809	S810	S811	S812	S813	S814	S815	S816	S817	S818	S819	S820	S821	S822	S823	S824	S825	S826	S827	S828	S829	S830	S831	S832	S833	S834	S835	S836	S837	S838	S839	S840	S841	S842	S843	S844	S845	S846	S847	S848	S849	S850	S851	S852	S853	S854	S855	S856	S857	S858	S859	S860	S861	S862	S863	S864	S865	S866	S867	S868	S869	S8																								



D309 R302 R359 R352	R308 R307 R354 R357	R361 R351	R311 R314 R313	R316 R317 R366 R367	R319 R362 R368 R365	R419 R312	R408 R403 R405	R413 R406	R414 R417 R416	R410 R415 R411 R407	R402 R409 R404 R422	R426 R423 R425	R428 R437 R424	R442 R444	R443 R439 R440 R441	R431 R429 R438 R418	R432 R427	R445	
C302 C301 C352	C351		S301	D302 D301 D351	D303 D304 D354	D405	C401 C402 C403 TR402	C407 C413	C408	C401 C413	C408	C411	C407 C406	C405 C410	C409				
IC301 IC351							TR402 TR403 TR401												



No 450738  
 TO BEAM SWITCH FROM IC501(b) 2  
 TO BEAM SWITCH FROM IC501(b) 0

FOR SERVICE MANUALS  
 CONTACT:  
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Fig. 7 Y Amplifier Circuit Diagram

# Component List and Illustrations

# Section 6

## Y AMP, TIMEBASE & TRIGGER (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No	
<b>CAPACITORS (Cont.)</b>												
C512	6.5nF	CE(2)			22394	TR231		DUAL F.E.T.			44704	
C513	100µF	E		16V	450582	TR232						
C514	120pF	CE(3)			42421	TR233						
C515	150pF	CE(3)			42422	TR234			AE38	44627		
C516	150pF	CE(3)			42422							
C520	10µF	E		25V	32180	TR261		ZTX313			40788	
						TR262		BC547B			44951	
						TR263		BC558C			44952	
						TR264		BC558C			44952	
C601	220nF	PE		250V	39201							
C602	100pF	CE(3)			42420							
C603	2.2µF	E		63V	32194	TR401		BF371			36275	
C604	2.2µF	E		100V	450593	TR402		BF371			36275	
C605	22pF	CE(3)			42412	TR403		BF371			36275	
C606	100nF	CE(2)		100V	37018	TR404		BF371			36275	
C607	100nF	CE(2)		100V	37018	TR405		ZTX313			40788	
C608	220nF	PE		100V	44370	TR406		ZTX313			40788	
C609	100nF	CE(2)		100V	37018	TR407		BF468			40056	
C610	10nF	CE(3)		25V	450548	TR408		BF468			40056	
C611	22pF	CE(3)			42412							
C612	100nF	CE(2)		100V	37018	TR501		BC547B			44951	
C613	10nF	CE(3)		25V	450548	TR502		MPS2369			36625	
C614	47pF	CE(3)			42416	TR503		MPS2369			36625	
C615	100nF	CE(2)		100V	37018	TR504		BC547B			44951	
C616	10nF	CE(3)		25V	450548	TR505		2N3904			24146	
C617	47nF	CE(2)		100V	39192	TR506		BC558C			44592	
C618	47nF	CE(2)		100V	39192	TR507		BC557B			44590	
C619	100pF	CE(3)			42420	TR508		BC557B			44950	
C620	10nF	CE(3)		25V	450548	TR509		BC547B			44951	
C621	10nF	CE(3)		25V	450548							
C622	2.2µF	E			32194	TR511		2N3904			24146	
C623	3.3pF	CE(3)			36600	TR512		2N3906			21533	
						TR513		NSD459			40054	
C701	10nF	CE(3)		25V	450548	TR514		NSD459			40054	
C702	2.2nF	PE		4kV A4/44990		TR515		BF393			450226	
C703	2.2nF	PE		4kV A4/44990								
C704	1000µF	E		40V	44992	TR601		BC558C			44952	
C705	33µF	E		350V	44991	TR602		BC558C			44952	
						TR603		BC547B			44951	
C708	10µF	E		25V	32180	TR605		BC557B			44950	
C709	2.2nF	PE		4kV A4/44990		TR605		2N3904			24146	
C710	10µF	E		25V	32180	TR606		2N3904			14146	
C711	100nF	PE		1.5kV	40075	TR607		2N3906			21533	
C712	100nF	PE		1.5kV	40075							
C713	220nF	PE		100V	44370	TR701		TJ630			44953	
C714	10nF	CE(3)		25V	450548	TR702		BFR86B			44954	
C715	220nF	PE		100V	44370	TR703		BFR86B			44954	
C716	10nF	CE(3)		25V	450548	TR704		BC558C			44952	
C717	56pF	CE(3)			42417							
C718	22pF	CE(3)	A.O.T.		42412	TR706		BC547B			44951	
C719	5.6nF	CE(2)			22394	TR707		BUX87			44955	
<b>TRANSISTORS</b>						TR709		BC328			38414	
TR201	}	DUAL F.E.T.			44704							
TR202							TR711		BC558C			44952
TR203							TR712		TIP29A			38419
TR204	}	AE38			44627	TR713		TIP112			40591	



# Component List and Illustrations

# Section 6

## OS1400/1420 Y AMP, TIMEBASE & TRIGGER (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
<b>TRANSISTORS (Cont.)</b>											
TR714		BC547B			44951	D601		IN4148			23802
TR715		BC557B			44950	D602		IN4148			23802
TR716		2N6518			36472	D603		IN4148			23802
<b>DIODES</b>											
D201		IN3595			29330	D604		IN4148			23802
D202		IN3593			29330	D605	5V6	ZENER			33929
D203	6V8	ZENER			33931	D606		IN4148			23802
D231		IN3595			29330	D607		IN4148			23802
D232		IN3595			29330	D608		IN4148			23802
D233	6V8	ZENER			33931	D609	47V	ZENER			40049
D231		IN3595			29330	D610		IN4148			23802
D232		IN3595			29330	D611		IN4148			23802
D233	6V8	ZENER			33931	<b>INTEGRATED CIRCUITS</b>					
D301		ZC2811H			40352	IC261		LF351			40130
D302		ZC2811H			40352	IC301		LM733CN			40084
D303		IN4148			34701	IC351		LM733CN			40084
D304		IN4148			34701	IC501		74LS74N			36732
D351		ZC2811H			40352	IC552		LM78L05 ACZ			40406
D352		ZC2811H			40352	IC601		MC3401P			40061
D353		IN4148			34701	IC602		LM710CN			40083
D354		IN4148			34701	IC701		MC78L12 ACP			40060
D401		IN4148			23802	IC702		LM341P15			40059
D402		IN4148			23802	<b>MISCELLANEOUS</b>					
D403		IN4148			23802	L401	15µH				44993
D404	5V1	ZENER			33928	L402	15µH				44993
D405		IN4148			34701	S1		WITH R745			A4/44461
D406		IN4148			34701	S2					A4/4069
D501		IN4148			23802	S3					A4/4069
D502		OA47			4468	S101					A4/44965
D503		IN4148			23802	S102					44978
D504		IN4148			23802	S131					A4/44965
D505		IN4148			23802	S201					450294
D506		IN4148			23802	S231					450294
D507		IN4148			23802	<b>FOR SERVICE MANUALS</b>					
D508		IN4148			23802	<b>CONTACT:</b>					
D509		IN4148			23802	<b>MAURITRON TECHNICAL SERVICES</b>					
D510		IN4148			23802	S261					A4/44476
D511		IN4148			23802	S262					A4/450760
D512		IN4148			23802	S301		www.mauritron.co.uk			A4/38729
D513		IN4148			23802	TEL: 01844 - 351694					
D514		IN4148			23802	FAX: 01844 - 352554					
D515		IN4148			23802	S501					A4/38728
D516		IN4148			23802	-506					A4/38728
D517		IN4148			23802	S507					A4/38729
D518		IN4148			23802						
D519		IN4148			23802						
D520		IN4148			23802						
D521	6V2	ZENER			33930						
D522		IN4148			23802						
D523		IN4148			23802						
D524		ZC2811H			40352						
D525		ZC2811H			40352						

# Component List and Illustrations

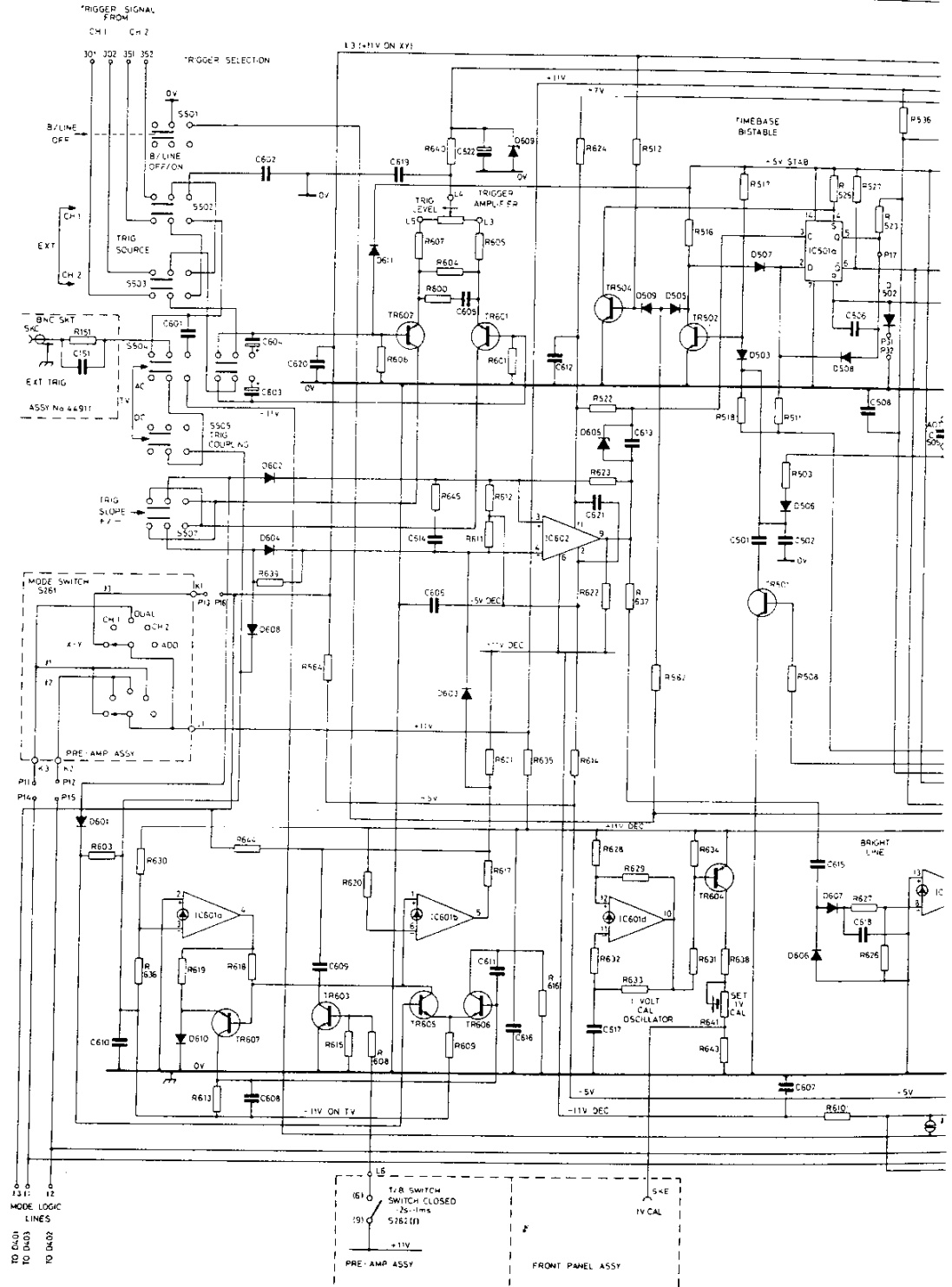
## Section 6

### Y AMP, TIMEBASE & TRIGGER (Cont.)

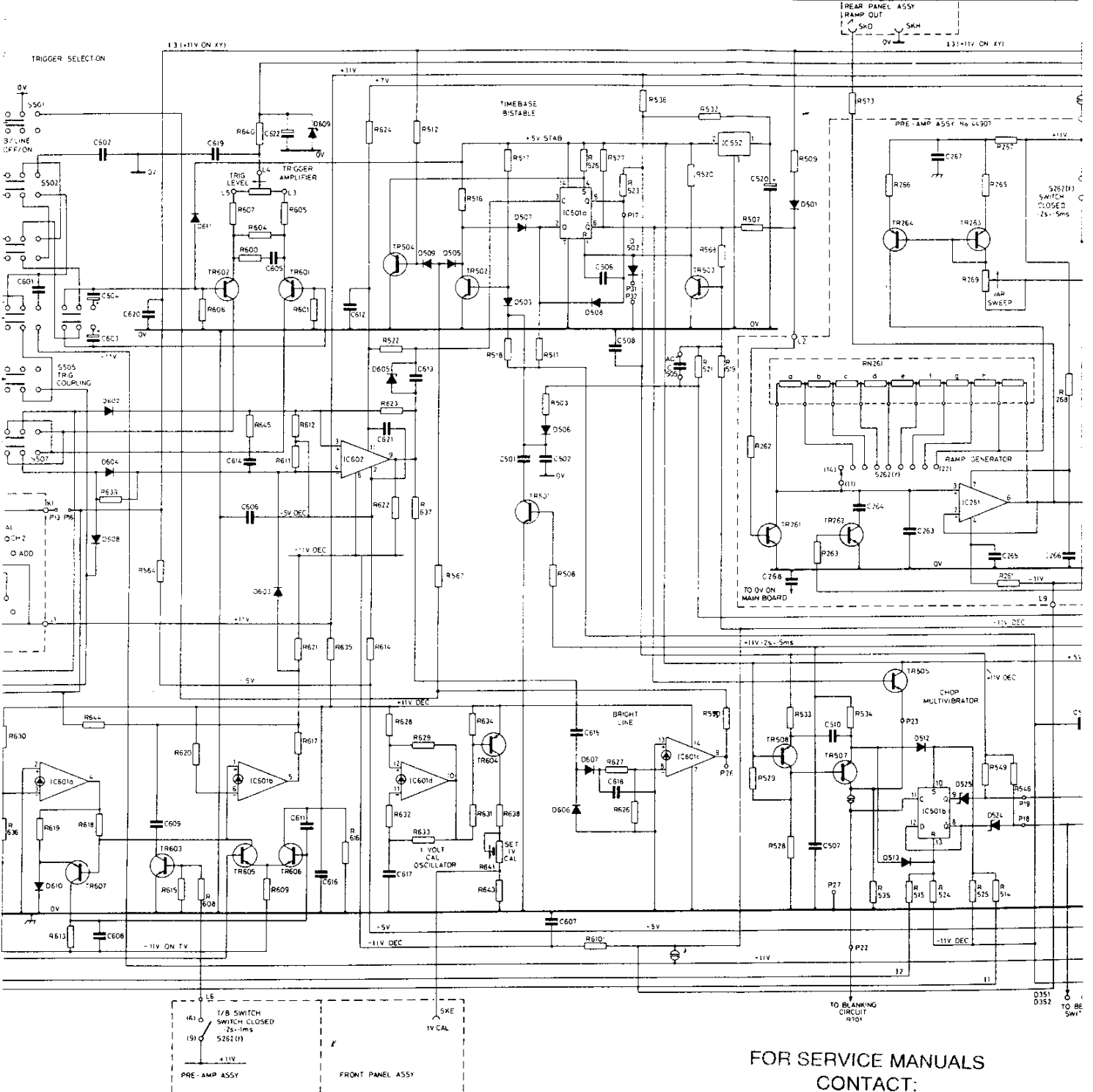
<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Tol %±</i>	<i>Rating</i>	<i>Part No</i>	<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Tol %±</i>	<i>Rating</i>	<i>Part No</i>
MISCELLANEOUS (Cont.)											
SKA					1222	SKE					31229
SKB					1222						
SKC					1222	F1	{	250mA	FOR 250V SUPPLY		33684
SKD					37293			500mA	FOR 110V SUPPLY		33685

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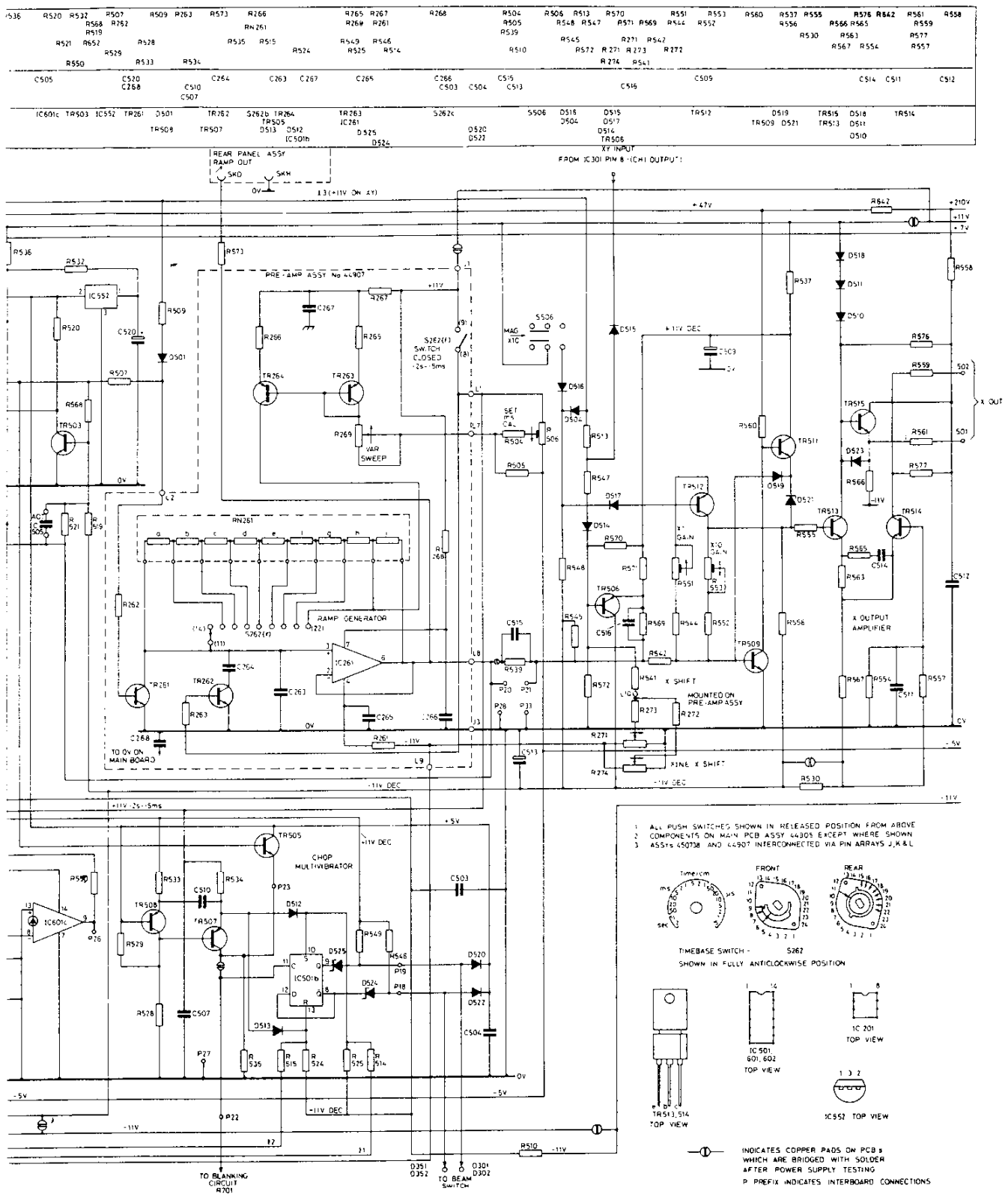
RESIS	R151	R630	R639	R644	R654	R606	R607	R604	R605	R601	R624	R522	R512	R516	R517	R518	R511	R503	R526	R527	R523	R538	
CAP	C151	C610	C601	C604	C608	C609	C614	C605	C622	C611	C616	C612	C613	C501	C607	C502	C515	C505	C508	C518			
MISC	S261	S501	S502	S503	S504	S505	S507	S508	S509	S510	S511	S512	S513	S514	S515	S516	S517	S518	S519	S520	S521	S522	
	D601	D602	D603	D604	D605	D606	D607	D608	D609	D610	D611	D612	D613	D614	D615	D616	D617	D618	D619	D620	D621	D622	
	TR601	TR602	TR603	TR604	TR605	TR606	TR607	TR608	TR609	TR610	TR611	TR612	TR613	TR614	TR615	TR616	TR617	TR618	TR619	TR620	TR621	TR622	



R639	P564	P606	R640	R605	R601	R624	R522	R512	R516	R517	R511	R503	R526	R527	R523	P536	R520	P532	R507	R509	R263	R573	R266	R765	R267	R268											
R644	R615	R620	R607	R604	R605	R624	R623	R637	R552	R634	R508	R508	R627	R627	R627	R626	R521	P568	R262	R578	R535	R515	R524	R543	R546	R544											
R619	R618	R513	C501	C620	C619	C605	C623	C616	C612	C613	C501	C502	C506	C508	C505	R550	R533	R534	C520	C264	C263	C267	C265	C266	C501												
C604	C603	C608	C509	C614	C606	C617	C617	C617	C617	C617	C501	C502	C506	C508	C505	R550	R533	R534	C520	C264	C263	C267	C265	C266	C501												
S501	S503	S504	D602	D604	D608	D611	TR602	TR601	D603	D609	IC602	TR604	D605	D509	D505	TR602	D501	D501	IC501a	D508	D502	IC601c	TR601	D501	TR602	S262b	TR604	TR605	D513	D512	IC501b	D515	IC161	D515	S262c		
IC601b	TR607	TR607	TR603	TR603	TR603	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606	TR605	TR606



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# Component List and Illustrations

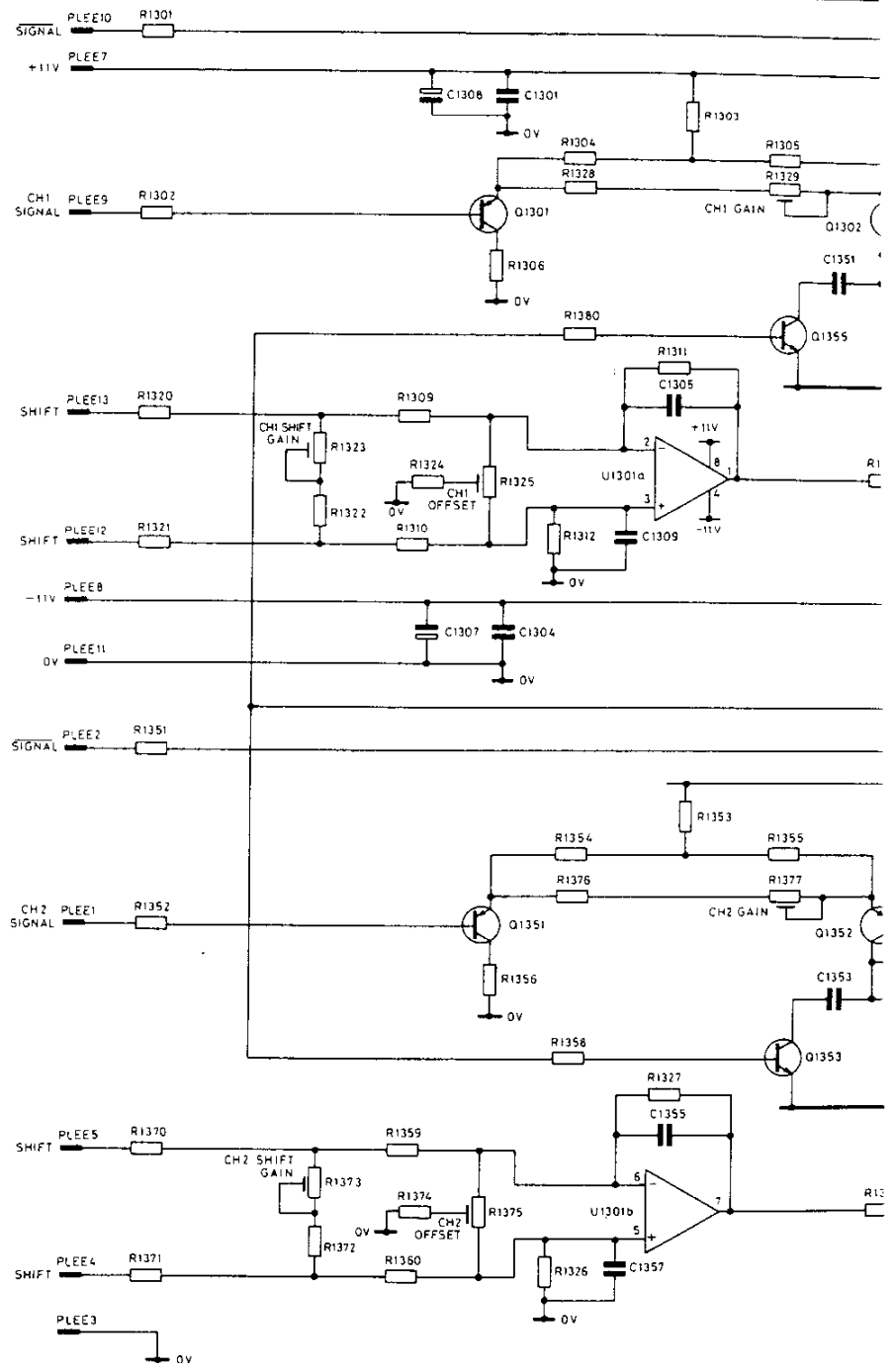
# Section 6

## PICK-OFF CIRCUIT

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
<b>RESISTORS</b>											
R1301	47	CF			28714	R1374	220k	CF			21823
R1302	47	CF			28714	R1375	100k	CP			42167
R1303	1k	CF			21799						
R1304	150	CF			28719	R1376	470	CF			21797
R1305	150	CF			28719	R1377	1k	CP			35898
R1306	270	CF			28720						
R1307	270	CF			28720	R1380	4k7	CF			21811
R1309	15k	CF			28727	<b>CAPACITORS</b>					
R1310	15k	CF			28727	C1301	10nF	CE(3)		25V	450548
R1311	100k	CF			21819	C1302					
R1312	100k	CF			21819	C1304	10nF	CE(3)			450548
R1314	1k5	CF			21801	C1305	100nF	CE(3)			43498
R1316	3k3	CF			21803	C1206	10nF	CE(3)		25V	450548
R1317	47	CF			28714	C1307	10µF	E		25V	32180
R1318	220	CF			21796	C1308	10µF	E		25V	32180
R1319						C1309	100nF	CE(3)			43498
R1320	18k	CF			21811	C1310	10nF	CE(3)		25V	450548
R1321	18k	CF			21811	C1351	270pF	CE(3)			42425
R1322	22k	CF			21812	C1352					
R1323	47k	CP			42166	C1353	270pF	CE(3)			42425
R1324	220k	CF			21823						
R1325	100k	CP			42167	C1355	100nF	CE(3)			43498
R1326	100k	CF			21819	C1356	10nF	CE(3)		25V	450548
R1327	100k	CF			21819	Q1301		2N5771			38089
R1351	47	CF			28714	Q1302		2N5771			38089
R1352	47	CF			28714	Q1304		MPS2369			36625
R1353	1k	CF			21799	Q1351		2N5771			38089
R1354	220	CF			21796	Q1352		2N5771			38089
R1355	220	CF			21796	Q1353		MPS2369			36625
R1356	270	CF			28720	Q1354		MPS2369			36625
R1357	270	CF			28720	Q1355		MPS2369			36625
R1358	4k7	CF			21811						
R1359	15k	CF			28727						
R1360	15k	CF			28727	<b>DIODES</b>					
R1364	1k5	CF			21801	D1301		IN4148			23802
R1366	3k3	CF			21803	D1351		IN4148			23802
R1367	47	CF			28714	U1301		I.C. TL082			451262
R1368	220	CF			21796						
R1369						<b>MISCELLANEOUS</b>					
R1370	18k	CF			21811	S1301					A4/450761
R1371	22k	CF			21812	SKFF					38001
R1372	22k	CF			21812						
R1373	47k	CP			42166						

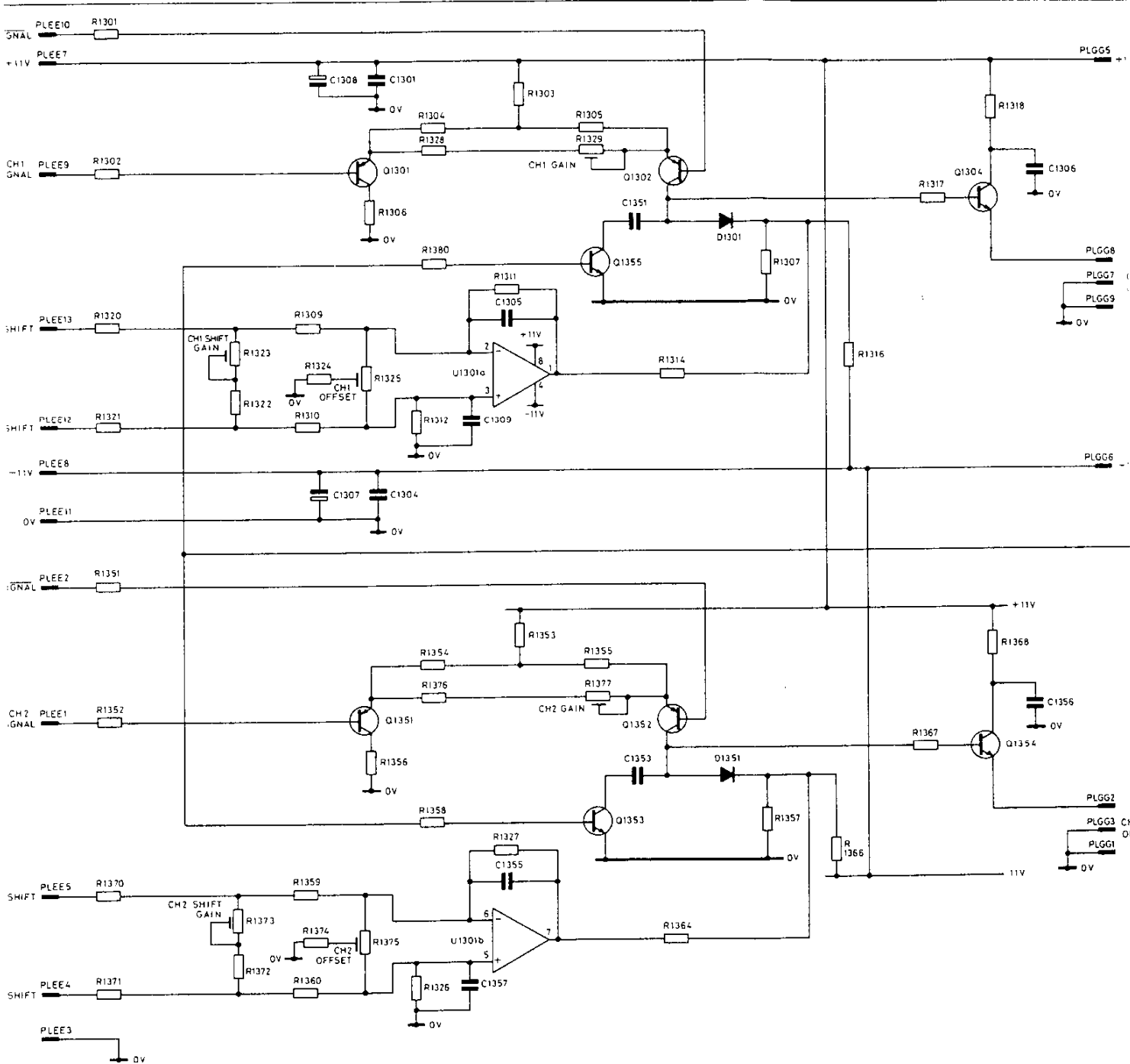
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RESIS	R1301 R1303 R1320 R1321 R1351 R1352 R1370 R1371	R1323 R1322 R1373 R1372	R1309 R1324 R1310 R1319 R1374 R1350	R1306 R1325 R1356 R1375	R1304 R1312 R1314 R1326 R1358 R1328	R1303 R1311 R1329 R1353 R1327	R1305 R1355	R1305 R1353	R1305 R1355	R1351 R1353
CAPS			C1308 C1307	C1301 C1304	C1309 C1357	C1305 C1355	C1351	C1353		
MISC				Q1301 Q1351	U1301a U1301b	Q1302 Q1355	Q1355 Q1353	Q1353	Q1353	Q1353



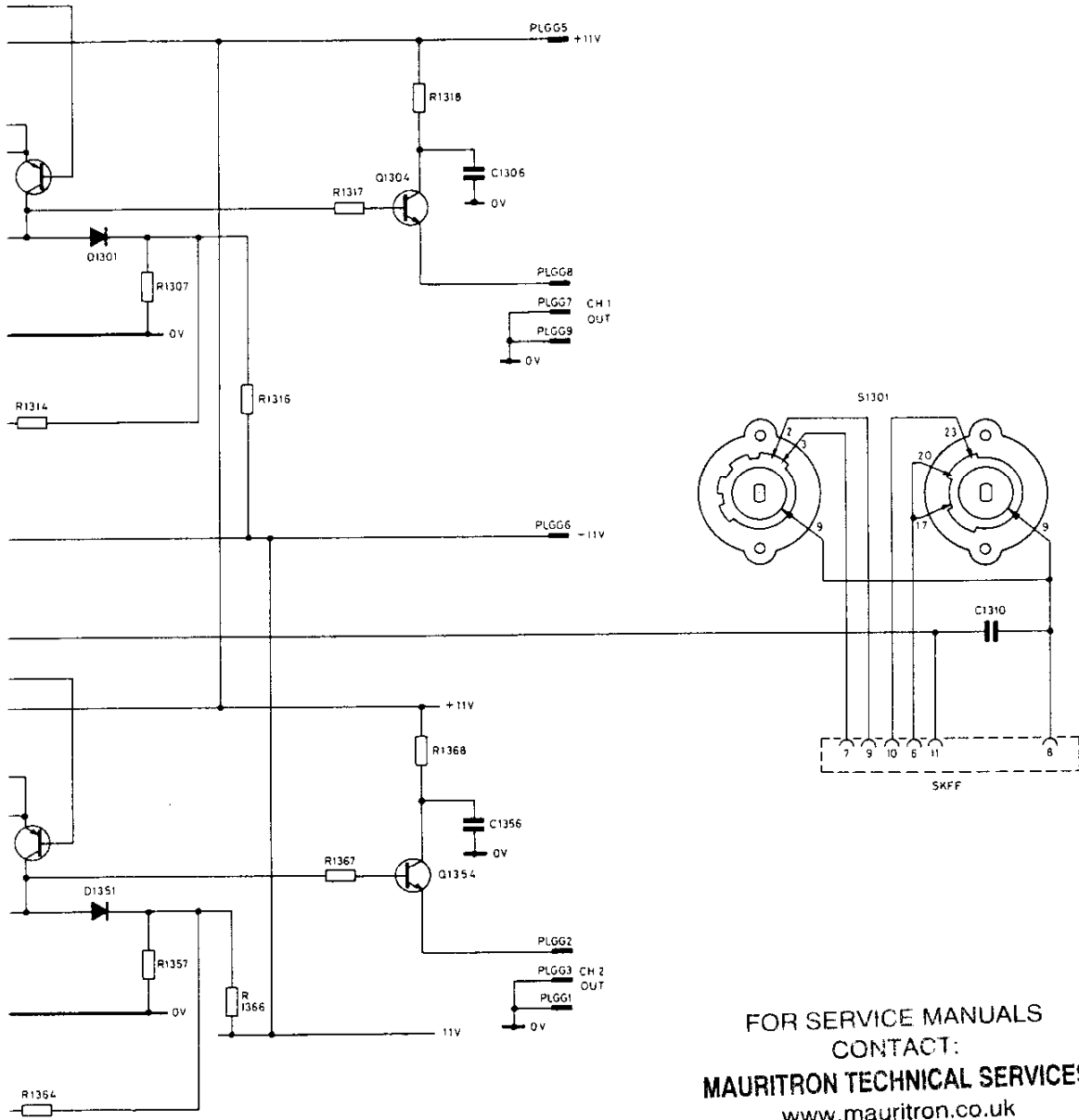
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R1301	R1323	R1309	R1306	R1304	R1303	R1305	R1307	R1316	R1317	R1318
R1302	R1322	R1324	R1325	R1326	R1329	R1325	R1314	R1316	R1317	R1318
R1320	R1310	R1315	R1316	R1317	R1318	R1319	R1314	R1316	R1317	R1318
R1321	R1373	R1374	R1375	R1376	R1377	R1378	R1364	R1366	R1367	R1368
R1351	R1372	R1372	R1372	R1372	R1372	R1372	R1364	R1366	R1367	R1368
R1352										
R1370										
R1371										





R1314	R1307	R1316	R1317	R1318	
R1364	R1357	R1356	R1367	R1368	
		C1306 C1356		C1310	
Q1302 Q1352	D1301 D1351	Q1304 Q1354		S1301 SKFF	



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Fig. 9 Pickoff Circuit Diagram

# Component List and Illustrations

# Section 6

## OS1420 D.S.O. CIRCUIT

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
<b>RESISTORS</b>											
R801	100	CF			21794	R857	22k	CF			21812
R802	10k	CF			21809	R858	22k	CF			21812
R803	2k2	CF			21802	R859	22k	CF			21812
R804	47	CF			28714	R860	5k6	CF			21806
R805	5k6	CF			21806	R861	22k	CF			21812
R807	1k8	CF			28725	R863	15k	CF			28727
R808	100	CF			21794	R864	15k	CF			28727
R809	1k	CF			21799	R865	4k7	CF			21805
R810	1k	CF			21799	R866	4k7	CF			21805
R811	390	CF			28722	R867	680	CF			28723
R812	10	CF			21793	R868	680	CF			28723
R813	10	CF			21793	R869	18k	CF			21811
R814	100	CF			21794						
R815	47	CF			28714	R871	220	CF			21796
R816	820	CF			28724	R872	47k	CF			21815
R817	5k6	CF			21806	R873	1k	CF			21799
R818	1k5	CF			21801	R874	47k	CF			21815
R819	3k9	CF			21804						
R820	6k8	CF			21807	R880	100	CF			21794
R821	10k	CP			36267	R881	15k	CF			28727
R822	180	CF			21795	R882	15k	CF			28727
R823	3k	MF	5		38605	R883	7k5	MF	2		38615
R824	3k	MF	5		38605	R884	7k5	MF	2		38615
R825	3k9	CF			21804	R885	560	CF			21798
R826	3k9	CF			21804	R886	6k2	MF	2		38613
R827	5k6	CF			21806	R887	6k2	MF	2		38613
R828	5k6	CF			21806						
R829	470	CP			36263	R891	10k	CF			21809
R830	220	CF			21796						
R831	220	CF			21796	R901	100	CF			21794
R832	100	CF			21794	R902	10k	CF			21809
R833	820	CF			28724	R903	2k2	CF			21802
R834	470	CP			36263	R904	47	CF			28714
R835	1k5	CF			21801	R905	5k6	CF			21806
R836	1k5	CF			21801						
R837	18k	CF			21811	R907	1k8	CF			28725
R838	10k	CP			36267	R908	100	CF			21794
R839	18k	CF			21811	R909	1k	CF			21799
R840	560	CF			21798	R910	1k	CF			21799
R841	5k6	CF			21806	R911	390	CF			28722
R842	220	CP			36262	R912	470	CF			21797
R843	390	CF			28722	R913	120	MF	2		38572
R844	6k2	MF	2		38613						
R845	6k2	MF	2		38613	R915	120	MF	2		38572
R846	6k2	MF	2		38613	R916	1k2	MF	2		38596
R847	620	MF	2		38589	R917	120	MF	2		38572
R848	18k	CF			21811	R918	1k2	MF	2		38596
R849	22k	CF			21812	R919	10k	CF			21809
R850	100k	CF			21819	R920	4k7	CF			21805
R851	330	CF			28721	R921	330k	CF			32357
R852	100k	CF			21819	R922	5M6	CF			33260
R853	18k	CF			21811	R923	2M7	CF			30758
R854	330	CF			28721	R924	1M5	CF	10		40729
						R925	680k	CF			31839
R856	22k	CF			21812	R926	150k	CF			21821

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### OS1420 D.S.O. CIRCUIT (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
<b>RESISTORS (Cont.)</b>											
N801	10k	Resistor Network			450452	C853					
N802	10k	Resistor Network			450452	C854	47nF	CE(3)			43497
N803	4k7	Resistor Network			39225	C855	100nF	CE(3)			43498
N804	10k	Resistor Network			450452	C856	2.2µF	E		63V	32194
<b>CAPACITORS</b>											
C801						C857	10µF	E		25V	32180
C802						C858	100nF	CE(3)			43498
C803	220pF	CE(2)			35914	C859	10nF	CE(3)		25V	450548
C804	10nF	CE(3)		25V	450548	C860	100nF	CE(3)			43498
C805	10nF	CE(3)		25V	450548	C861	10nF	CE(3)		25V	450548
C806	10µF	E		25V	32180	C862	100nF	CE(3)			43498
C807	10µF	E		25V	32180	C863	10nF	CE(3)		25V	450548
C809	10µF	E		25V	32180	C864	1nF	CE(3)			42432
C810	10µF	E		25V	32180	C865	10nF	CE(3)		25V	450548
C811	10nF	CE(3)		25V	450548	C901					
C812	10µF	E		25V	32180	C902					
C813	10nF	CE(3)		25V	450548	C903	220pF	CE(2)			35914
C814	10µF	E		25V	32180	C904	10nF	CE(3)		25V	450548
C815	10nF	CE(3)		25V	450548	C905	10nF	CE(3)		25V	450548
C816	10µF	E		25V	32180	C907					
C818	10nF	CE(3)		25V	450548	C908					
C819	10nF	CE(3)		25V	450548	C909	10nF	CE(3)		25V	450548
C821	1nF	CE(3)			42432	C910	47nF	CE(3)			43497
C822	2.2nF	CE(3)			42436	C911	220pF	CE(3)			42424
C823	100nF	CE(3)			43498	<b>DIODES</b>					
C824	10nF	CE(3)		25V	450548	D801	2V7	ZENER			33921
C825	10nF	CE(3)		25V	450548	D802	2V7	ZENER			33921
C826	1nF	CE(3)			42432	D803		ZC2811H			40352
C829	100pF	CE(3)			42420	D804		ZC2811H			40352
C830	5.6pF	CE(3)			42405	D805		IN4148			23802
C831	100nF	CE(3)			43498	D806		IN4148			23802
C832	100nF	CE(3)			43498	D807		IN4148			23802
C833	10nF	CE(3)		25V	450548	D808		IN4148			23802
C834	100nF	CE(3)			43498	D809		IN4148			23802
C836	10nF	CE(3)			450548	D810					
C837	100nF	CE(3)			43498	D811		IN4148			23802
C838	10µF	E		25V	32180	D812		IN4148			23802
C839						D813		IN4148			23802
C841	10nF	CE(3)		25V	450548	D814		IN4148			23802
C842	10nF	CE(3)		25V	450548	D815	3V9	ZENER			33925
C843	10nF	CE(3)		25V	450548	D816	3V9	ZENER			33925
C844	10nF	CE(3)		25V	450548	D817	6V2	ZENER			40045
C845	10nF	CE(3)		25V	450548	D818		IN4148			23802
C846	10nF	CE(3)		25V	450548	D819	3V9	ZENER			33925
C847	47pF	CE(3)			42416	D820	3V9	ZENER			33925
C848	10nF	CE(3)		25V	450548	D821	6V2	ZENER			40045
C849	10nF	CE(3)		25V	450548	D822		IN4148			23802
C850	10nF	CE(3)		25V	450548	D823		0A47			4468
C851	10nF	CE(3)		25V	450548	D824		0A47			4468
C852	10nF	CE(3)		25V	450548	D825		0A47			4468
						D826		0A47			4468
						D827		0A47			4468
						D828		0A47			4468
						D829		IN4148			23802

# Component List and Illustrations

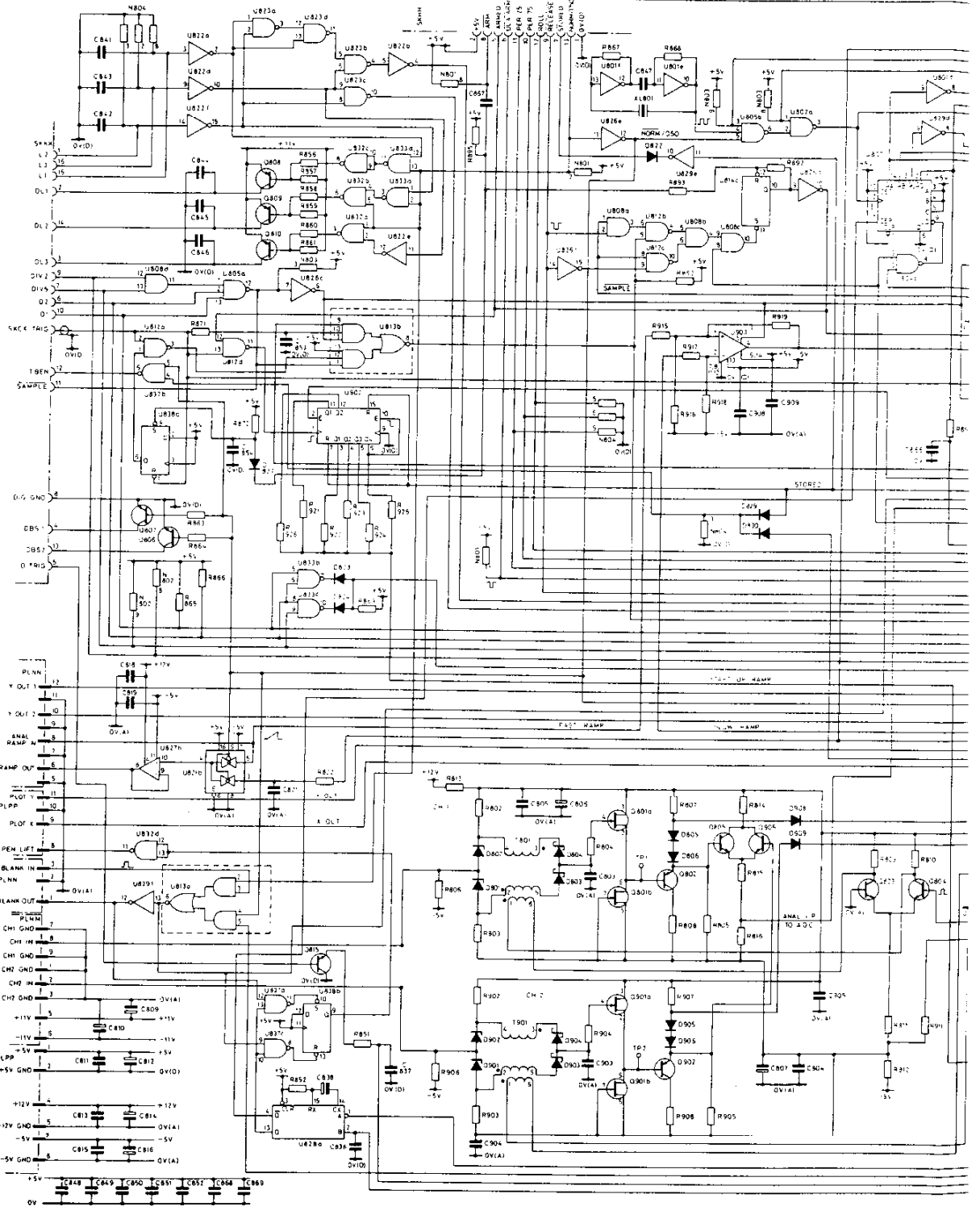
# Section 6

## D.S.O. CIRCUIT (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
<b>DIODES (Cont.)</b>											
D830		IN4148			23802	U812		4011			34953
						U813		74LS51			43676
D901	2V7	ZENER			33921	U814		4044			44024
D902	2V7	ZENER			33921	U815		TCD1001J			450682
D903		ZC2811H			40352	U816		74SC374			451265
D904		ZC2811H			40352	U817		HM6116P-3			450683
D905		IN4148			23802	U818		DAC10			451264
D906		IN4148			23802	U819		74C374			451266
						U810		DAC08			450686
D909		IN4148 :			23802	U821		4053			41891
						U822		4049			36200
Q801		DUAL FET			44704	U823		4011			34953
Q802		2N5771			38089	U824		74C00			451282
Q803		MPS2369			36625	U825		TL082			451262
Q804		MPS2369			36625	U826		4049			36200
Q805		MPS2369			36625	U827		TL084			451261
Q806		2N3906			21533	U828		74LS123			41084
Q807		2N3906			21533	U829		74ALS04			451301
Q808		2N3906			21533						
Q809		2N3906			21533	U831		MT7009-1			450600
Q810		2N3906			21533	U832		74LS26			44362
Q811		MPS2369			36625	U833		4011			34953
Q812		MPS2369			36625	U834		74C374			451266
Q813		MPS2369			36625	U835		74ALS74			451308
Q814		MPS2369			36625	U836		74C74			451290
Q815		2N3906			21533	U837		74C00			451282
						U838		74C74			451290
Q901		DUAL FET			44704						
Q902		2N5771			38089	U902		4520			450914
Q903		MPS2369			36625	U903		NE521			44886
Q904		MPS2369			36625						
Q905		MPS2369			36625	U904		74ALS74			451308
U801		74ALS04			451301						
U802		74ALS00			451299	<b>MISCELLANEOUS</b>					
U803		74ALS00			451299	T801					A4/450687
U804		74LS00			36730	T901					A4/560687
U805		74LS10			36867	XL801		CRYSTAL 20MHz			450688
U806		74ALS74			451308						
U807		74LS162			450681	SKHH					450771
U808		4081			37694	SKJJ					450771
U809		74LS00			36730	SKKK					38001

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RESIS	N404	R851 R852 R853	R854 R855 R856	R857 R858 R859	R860 R861 R862 R863 R864 R865 R866	R867 R868 R869 R870 R871 R872 R873 R874 R875 R876 R877 R878 R879 R880 R881 R882 R883 R884 R885 R886 R887 R888 R889 R890 R891 R892 R893 R894 R895 R896 R897 R898 R899 R900 R901 R902 R903 R904 R905 R906 R907 R908 R909 R910 R911 R912 R913 R914 R915 R916 R917 R918 R919 R920 R921 R922 R923 R924 R925 R926 R927 R928 R929 R930 R931 R932 R933 R934 R935 R936 R937 R938 R939 R940 R941 R942 R943 R944 R945 R946 R947 R948 R949 R950 R951 R952 R953 R954 R955 R956 R957 R958 R959 R960 R961 R962 R963 R964 R965 R966 R967 R968 R969 R970 R971 R972 R973 R974 R975 R976 R977 R978 R979 R980 R981 R982 R983 R984 R985 R986 R987 R988 R989 R990 R991 R992 R993 R994 R995 R996 R997 R998 R999 R1000	R999 R1000 R1001 R1002 R1003 R1004 R1005 R1006 R1007 R1008 R1009 R1010 R1011 R1012 R1013 R1014 R1015 R1016 R1017 R1018 R1019 R1020 R1021 R1022 R1023 R1024 R1025 R1026 R1027 R1028 R1029 R1030 R1031 R1032 R1033 R1034 R1035 R1036 R1037 R1038 R1039 R1040 R1041 R1042 R1043 R1044 R1045 R1046 R1047 R1048 R1049 R1050 R1051 R1052 R1053 R1054 R1055 R1056 R1057 R1058 R1059 R1060 R1061 R1062 R1063 R1064 R1065 R1066 R1067 R1068 R1069 R1070 R1071 R1072 R1073 R1074 R1075 R1076 R1077 R1078 R1079 R1080 R1081 R1082 R1083 R1084 R1085 R1086 R1087 R1088 R1089 R1090 R1091 R1092 R1093 R1094 R1095 R1096 R1097 R1098 R1099 R1100	R1100 R1101 R1102 R1103 R1104 R1105 R1106 R1107 R1108 R1109 R1110 R1111 R1112 R1113 R1114 R1115 R1116 R1117 R1118 R1119 R1120 R1121 R1122 R1123 R1124 R1125 R1126 R1127 R1128 R1129 R1130 R1131 R1132 R1133 R1134 R1135 R1136 R1137 R1138 R1139 R1140 R1141 R1142 R1143 R1144 R1145 R1146 R1147 R1148 R1149 R1150 R1151 R1152 R1153 R1154 R1155 R1156 R1157 R1158 R1159 R1160 R1161 R1162 R1163 R1164 R1165 R1166 R1167 R1168 R1169 R1170 R1171 R1172 R1173 R1174 R1175 R1176 R1177 R1178 R1179 R1180 R1181 R1182 R1183 R1184 R1185 R1186 R1187 R1188 R1189 R1190 R1191 R1192 R1193 R1194 R1195 R1196 R1197 R1198 R1199 R1200	R1200 R1201 R1202 R1203 R1204 R1205 R1206 R1207 R1208 R1209 R1210 R1211 R1212 R1213 R1214 R1215 R1216 R1217 R1218 R1219 R1220 R1221 R1222 R1223 R1224 R1225 R1226 R1227 R1228 R1229 R1230 R1231 R1232 R1233 R1234 R1235 R1236 R1237 R1238 R1239 R1240 R1241 R1242 R1243 R1244 R1245 R1246 R1247 R1248 R1249 R1250 R1251 R1252 R1253 R1254 R1255 R1256 R1257 R1258 R1259 R1260 R1261 R1262 R1263 R1264 R1265 R1266 R1267 R1268 R1269 R1270 R1271 R1272 R1273 R1274 R1275 R1276 R1277 R1278 R1279 R1280 R1281 R1282 R1283 R1284 R1285 R1286 R1287 R1288 R1289 R1290 R1291 R1292 R1293 R1294 R1295 R1296 R1297 R1298 R1299 R1300	R1300 R1301 R1302 R1303 R1304 R1305 R1306 R1307 R1308 R1309 R1310 R1311 R1312 R1313 R1314 R1315 R1316 R1317 R1318 R1319 R1320 R1321 R1322 R1323 R1324 R1325 R1326 R1327 R1328 R1329 R1330 R1331 R1332 R1333 R1334 R1335 R1336 R1337 R1338 R1339 R1340 R1341 R1342 R1343 R1344 R1345 R1346 R1347 R1348 R1349 R1350 R1351 R1352 R1353 R1354 R1355 R1356 R1357 R1358 R1359 R1360 R1361 R1362 R1363 R1364 R1365 R1366 R1367 R1368 R1369 R1370 R1371 R1372 R1373 R1374 R1375 R1376 R1377 R1378 R1379 R1380 R1381 R1382 R1383 R1384 R1385 R1386 R1387 R1388 R1389 R1390 R1391 R1392 R1393 R1394 R1395 R1396 R1397 R1398 R1399 R1400	R1400 R1401 R1402 R1403 R1404 R1405 R1406 R1407 R1408 R1409 R1410 R1411 R1412 R1413 R1414 R1415 R1416 R1417 R1418 R1419 R1420 R1421 R1422 R1423 R1424 R1425 R1426 R1427 R1428 R1429 R1430 R1431 R1432 R1433 R1434 R1435 R1436 R1437 R1438 R1439 R1440 R1441 R1442 R1443 R1444 R1445 R1446 R1447 R1448 R1449 R1450 R1451 R1452 R1453 R1454 R1455 R1456 R1457 R1458 R1459 R1460 R1461 R1462 R1463 R1464 R1465 R1466 R1467 R1468 R1469 R1470 R1471 R1472 R1473 R1474 R1475 R1476 R1477 R1478 R1479 R1480 R1481 R1482 R1483 R1484 R1485 R1486 R1487 R1488 R1489 R1490 R1491 R1492 R1493 R1494 R1495 R1496 R1497 R1498 R1499 R1500	R1500 R1501 R1502 R1503 R1504 R1505 R1506 R1507 R1508 R1509 R1510 R1511 R1512 R1513 R1514 R1515 R1516 R1517 R1518 R1519 R1520 R1521 R1522 R1523 R1524 R1525 R1526 R1527 R1528 R1529 R1530 R1531 R1532 R1533 R1534 R1535 R1536 R1537 R1538 R1539 R1540 R1541 R1542 R1543 R1544 R1545 R1546 R1547 R1548 R1549 R1550 R1551 R1552 R1553 R1554 R1555 R1556 R1557 R1558 R1559 R1560 R1561 R1562 R1563 R1564 R1565 R1566 R1567 R1568 R1569 R1570 R1571 R1572 R1573 R1574 R1575 R1576 R1577 R1578 R1579 R1580 R1581 R1582 R1583 R1584 R1585 R1586 R1587 R1588 R1589 R1590 R1591 R1592 R1593 R1594 R1595 R1596 R1597 R1598 R1599 R1600	R1600 R1601 R1602 R1603 R1604 R1605 R1606 R1607 R1608 R1609 R1610 R1611 R1612 R1613 R1614 R1615 R1616 R1617 R1618 R1619 R1620 R1621 R1622 R1623 R1624 R1625 R1626 R1627 R1628 R1629 R1630 R1631 R1632 R1633 R1634 R1635 R1636 R1637 R1638 R1639 R1640 R1641 R1642 R1643 R1644 R1645 R1646 R1647 R1648 R1649 R1650 R1651 R1652 R1653 R1654 R1655 R1656 R1657 R1658 R1659 R1660 R1661 R1662 R1663 R1664 R1665 R1666 R1667 R1668 R1669 R1670 R1671 R1672 R1673 R1674 R1675 R1676 R1677 R1678 R1679 R1680 R1681 R1682 R1683 R1684 R1685 R1686 R1687 R1688 R1689 R1690 R1691 R1692 R1693 R1694 R1695 R1696 R1697 R1698 R1699 R1700	R1700 R1701 R1702 R1703 R1704 R1705 R1706 R1707 R1708 R1709 R1710 R1711 R1712 R1713 R1714 R1715 R1716 R1717 R1718 R1719 R1720 R1721 R1722 R1723 R1724 R1725 R1726 R1727 R1728 R1729 R1730 R1731 R1732 R1733 R1734 R1735 R1736 R1737 R1738 R1739 R1740 R1741 R1742 R1743 R1744 R1745 R1746 R1747 R1748 R1749 R1750 R1751 R1752 R1753 R1754 R1755 R1756 R1757 R1758 R1759 R1760 R1761 R1762 R1763 R1764 R1765 R1766 R1767 R1768 R1769 R1770 R1771 R1772 R1773 R1774 R1775 R1776 R1777 R1778 R1779 R1780 R1781 R1782 R1783 R1784 R1785 R1786 R1787 R1788 R1789 R1790 R1791 R1792 R1793 R1794 R1795 R1796 R1797 R1798 R1799 R1800	R1800 R1801 R1802 R1803 R1804 R1805 R1806 R1807 R1808 R1809 R1810 R1811 R1812 R1813 R1814 R1815 R1816 R1817 R1818 R1819 R1820 R1821 R1822 R1823 R1824 R1825 R1826 R1827 R1828 R1829 R1830 R1831 R1832 R1833 R1834 R1835 R1836 R1837 R1838 R1839 R1840 R1841 R1842 R1843 R1844 R1845 R1846 R1847 R1848 R1849 R1850 R1851 R1852 R1853 R1854 R1855 R1856 R1857 R1858 R1859 R1860 R1861 R1862 R1863 R1864 R1865 R1866 R1867 R1868 R1869 R1870 R1871 R1872 R1873 R1874 R1875 R1876 R1877 R1878 R1879 R1880 R1881 R1882 R1883 R1884 R1885 R1886 R1887 R1888 R1889 R1890 R1891 R1892 R1893 R1894 R1895 R1896 R1897 R1898 R1899 R1900	R1900 R1901 R1902 R1903 R1904 R1905 R1906 R1907 R1908 R1909 R1910 R1911 R1912 R1913 R1914 R1915 R1916 R1917 R1918 R1919 R1920 R1921 R1922 R1923 R1924 R1925 R1926 R1927 R1928 R1929 R1930 R1931 R1932 R1933 R1934 R1935 R1936 R1937 R1938 R1939 R1940 R1941 R1942 R1943 R1944 R1945 R1946 R1947 R1948 R1949 R1950 R1951 R1952 R1953 R1954 R1955 R1956 R1957 R1958 R1959 R1960 R1961 R1962 R1963 R1964 R1965 R1966 R1967 R1968 R1969 R1970 R1971 R1972 R1973 R1974 R1975 R1976 R1977 R1978 R1979 R1980 R1981 R1982 R1983 R1984 R1985 R1986 R1987 R1988 R1989 R1990 R1991 R1992 R1993 R1994 R1995 R1996 R1997 R1998 R1999 R2000
CAPS	C841 C842 C843 C844 C845 C846 C847 C848 C849 C850 C851 C852 C853 C854 C855 C856 C857 C858 C859 C860 C861 C862 C863 C864 C865 C866 C867 C868 C869 C870 C871 C872 C873 C874 C875 C876 C877 C878 C879 C880 C881 C882 C883 C884 C885 C886 C887 C888 C889 C890 C891 C892 C893 C894 C895 C896 C897 C898 C899 C900 C901 C902 C903 C904 C905 C906 C907 C908 C909 C910 C911 C912 C913 C914 C915 C916 C917 C918 C919 C920 C921 C922 C923 C924 C925 C926 C927 C928 C929 C930 C931 C932 C933 C934 C935 C936 C937 C938 C939 C940 C941 C942 C943 C944 C945 C946 C947 C948 C949 C950 C951 C952 C953 C954 C955 C956 C957 C958 C959 C960 C961 C962 C963 C964 C965 C966 C967 C968 C969 C970 C971 C972 C973 C974 C975 C976 C977 C978 C979 C980 C981 C982 C983 C984 C985 C986 C987 C988 C989 C990 C991 C992 C993 C994 C995 C996 C997 C998 C999 C1000															
M.I.C	U807 U808 U809 U810 U811 U812 U813 U814 U815 U816 U817 U818 U819 U820 U821 U822 U823 U824 U825 U826 U827 U828 U829 U830 U831 U832 U833 U834 U835 U836 U837 U838 U839 U840 U841 U842 U843 U844 U845 U846 U847 U848 U849 U850 U851 U852 U853 U854 U855 U856 U857 U858 U859 U860 U861 U862 U863 U864 U865 U866 U867 U868 U869 U870 U871 U872 U873 U874 U875 U876 U877 U878 U879 U880 U881 U882 U883 U884 U885 U886 U887 U888 U889 U890 U891 U892 U893 U894 U895 U896 U897 U898 U899 U900 U901 U902 U903 U904 U905 U906 U907 U908 U909 U910 U911 U912 U913 U914 U915 U916 U917 U918 U919 U920 U921 U922 U923 U924 U925 U926 U927 U928 U929 U930 U931 U932 U933 U934 U935 U936 U937 U938 U939 U940 U941 U942 U943 U944 U945 U946 U947 U948 U949 U950 U951 U952 U953 U954 U955 U956 U957 U958 U959 U960 U961 U962 U963 U964 U965 U966 U967 U968 U969 U970 U971 U972 U973 U974 U975 U976 U977 U978 U979 U980 U981 U982 U983 U984 U985 U986 U987 U988 U989 U990 U991 U992 U993 U994 U995 U996 U997 U998 U999 U1000															





R805	R810	R815	R820	R825	R830	R835	R840	R845	R850	R855	R860	R865	R870	R875	R880	R885	R890	R895	R900	R905	R910	R915	R920	R925	R930	R935	R940	R945	R950	R955	R960	R965	R970	R975	R980	R985	R990	R995																																																																																																																																																																	
U801	U802	U803	U804	U805	U806	U807	U808	U809	U810	U811	U812	U813	U814	U815	U816	U817	U818	U819	U820	U821	U822	U823	U824	U825	U826	U827	U828	U829	U830	U831	U832	U833	U834	U835	U836	U837	U838	U839	U840	U841	U842	U843	U844	U845	U846	U847	U848	U849	U850	U851	U852	U853	U854	U855	U856	U857	U858	U859	U860	U861	U862	U863	U864	U865	U866	U867	U868	U869	U870	U871	U872	U873	U874	U875	U876	U877	U878	U879	U880	U881	U882	U883	U884	U885	U886	U887	U888	U889	U890	U891	U892	U893	U894	U895	U896	U897	U898	U899	U900	U901	U902	U903	U904	U905	U906	U907	U908	U909	U910	U911	U912	U913	U914	U915	U916	U917	U918	U919	U920	U921	U922	U923	U924	U925	U926	U927	U928	U929	U930	U931	U932	U933	U934	U935	U936	U937	U938	U939	U940	U941	U942	U943	U944	U945	U946	U947	U948	U949	U950	U951	U952	U953	U954	U955	U956	U957	U958	U959	U960	U961	U962	U963	U964	U965	U966	U967	U968	U969	U970	U971	U972	U973	U974	U975	U976	U977	U978	U979	U980	U981	U982	U983	U984	U985	U986	U987	U988	U989	U990	U991	U992	U993	U994	U995	U996	U997	U998	U999	U1000

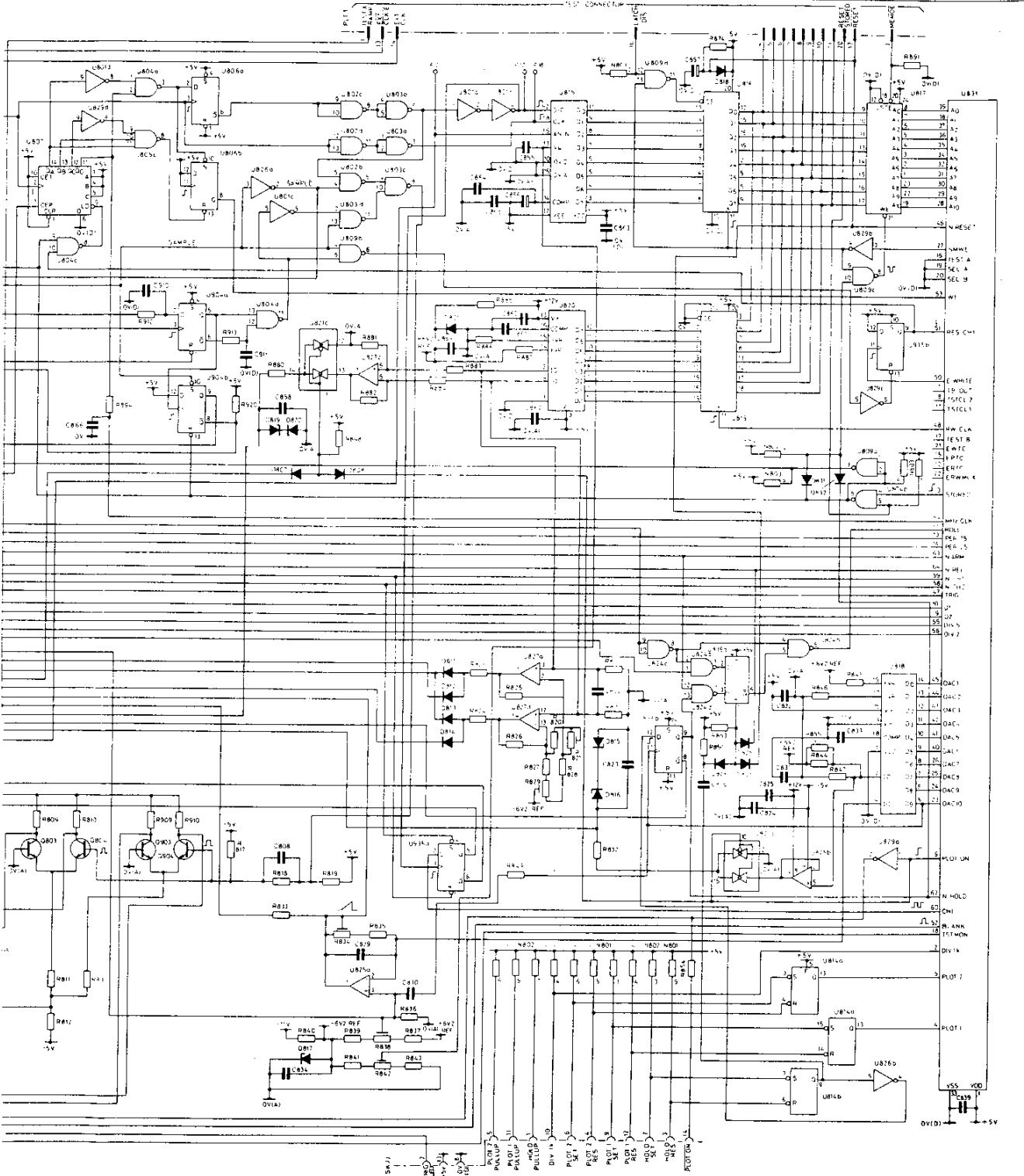


Fig. 10 Digital Storage Circuit Diagram  
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# Component List and Illustrations

# Section 6

## POWER SUPPLY AND CRT

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
<b>RESISTORS</b>											
R701	1k	CF			21799	RN720		RESISTOR NETWORK			A3/44608
R702	680	CF			28723						
R703	10k	CF		1W	2882	<b>DIODES</b>					
R704	22k	CF			21812	D701		IN4148			23802
R705	5k6	CF			21806	D702		IN4148			23802
R706	470	CF			21797	D704		L.E.D.			43847
R707	8k2	CF			21808	D705		BAX17			402022
R708	220k	PCP			36270	D706	150V	ZENER			37559
R710	2k2	CF			21802	D708		IN4148			23802
						D709	200V	ZENER			40052
R713	470k	PCP			36271	D711	9V1	ZENER			33934
R714	1M	CF		½W	18588	D712	5V1	ZENER			33928
R715	680k	CF			31839	D713		IN4148			23802
R716	33M	MG	5	½W	43008	D714		IN4148			23802
R717	33M	MG	5	½W	43008	D715	200V	ZENER			40052
R718	22k	CF	10		3433	D716	200V	ZENER			40052
R719	18k	CF		½W	18565	D717	200V	ZENER			40052
R721	180	CF		½W	18541	D718	12kV				44550
R722	1k	CF			21799	D719	12kV				44550
R723	2k2	CF			21802	D720		IN4148			23802
R724	5k6	CF			21806	D721		BAX17			402022
R725	47k	PCP			38261	D722		IN4004			450266
R726	33k	MF	2		38630	D723		IN4004			450266
R727	150	CF			28719	D724		IN4004			450266
R728	68	CF			28716	D725		IN4004			450266
R729	680	CF			28723	D726		IN4004			450266
R730	1k	CF			21799	D727		IN4004			450266
R731	10k	MF	2		38618	D728		IN4004			450266
R732	47k	CF			21815	D729		IN4004			450266
R733	22k	CF	10		3433	D730	200V	ZENER			40052
R734	68	CF	A.O.T.		28716	<b>MISCELLANEOUS</b>					
R735	1k5	CF			21801	V1		MULLARD 56825GY			
R736	1k	CF			21799			NORMAL VERSION			44932
R737	10k	PCP			44959	T1					451429
R738	180	MF	2		38576						456020
R739	47	CF		½W	18534	SKG					37293
R741	5k6	CC	5		2363	SKH					37293
R742	220k	MF	2		38650	PLM					44960
R743	33M	MG	5	½W	43008	F701	125mA				450551
R744	1M	CP			A4/44460						
R745	10k	CP	WITH S1		A4/44461						
R746	82k	CF			21818						
R747	120k	CF			21820						
R748	100k	CF			21819						

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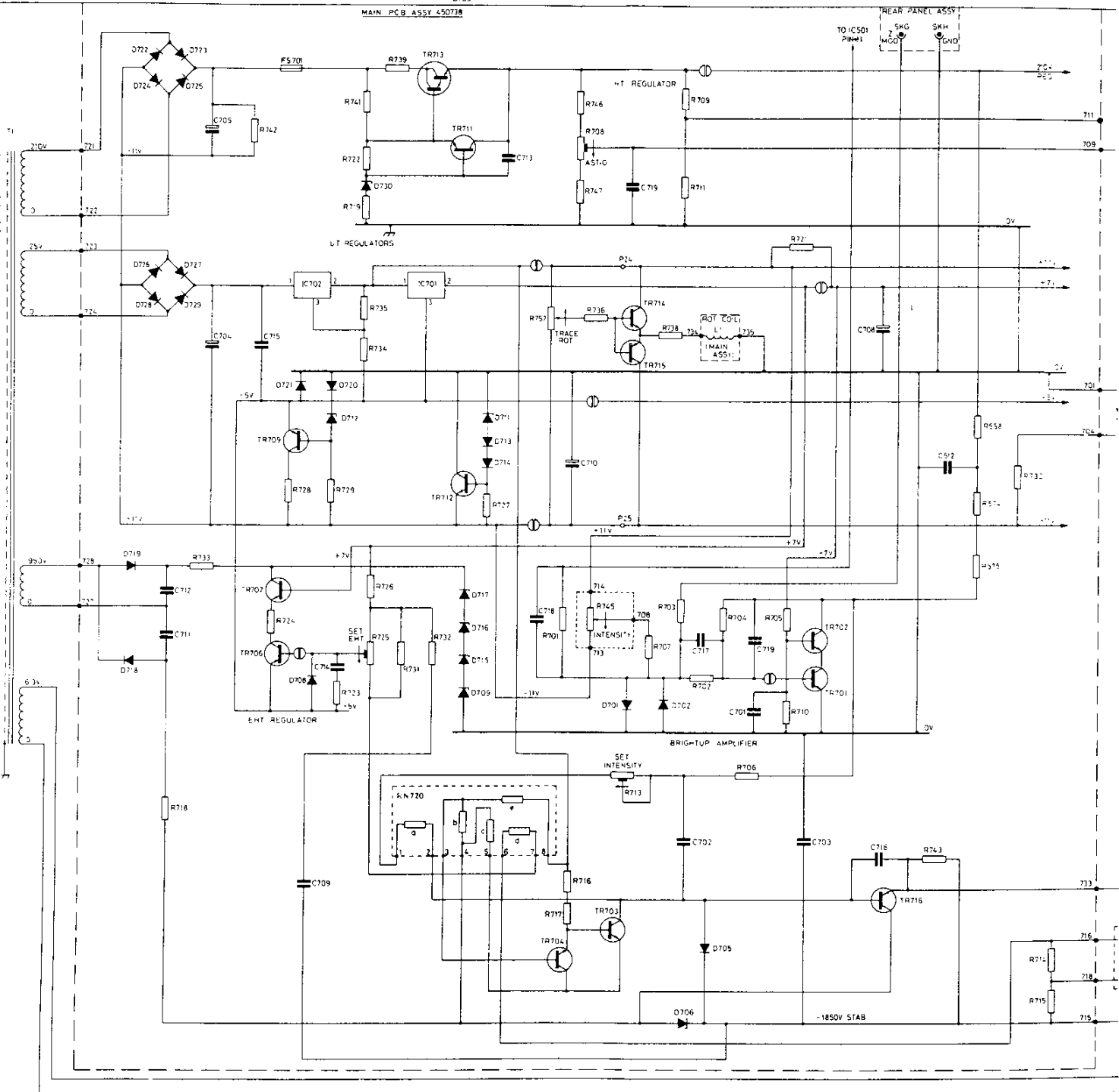




R718	R733	R742	R728	R729	R722	R739	RM720a-e	R727	R757	R716	R746	R738	R709	R704	R721	R743	R558	R730
		R724	R723		R719	R734			R701	R717	R708	R703	R711	R707	R705		R574	
					R735	R726	R731	R732			R747				R710		R575	
					R725						R745							P714
																		P715

C712	C705	C715	C709	C714		C713	C718	C710	C719	C717	C703	C708	C512
C711	C704											C716	

D719	D722	D723	F5701	D721	D720	D730	TR713	TR711	D711	TR714	L'	TR702	SKG	SKH
D716	D724	D725		TR705	D717		IC701	TR712	D713	D701	D702	TR701		
				TR707	D708				D716	TR703	D705			
				TR706					D715		D706	TR716		
									D709					





# Component List and Illustrations

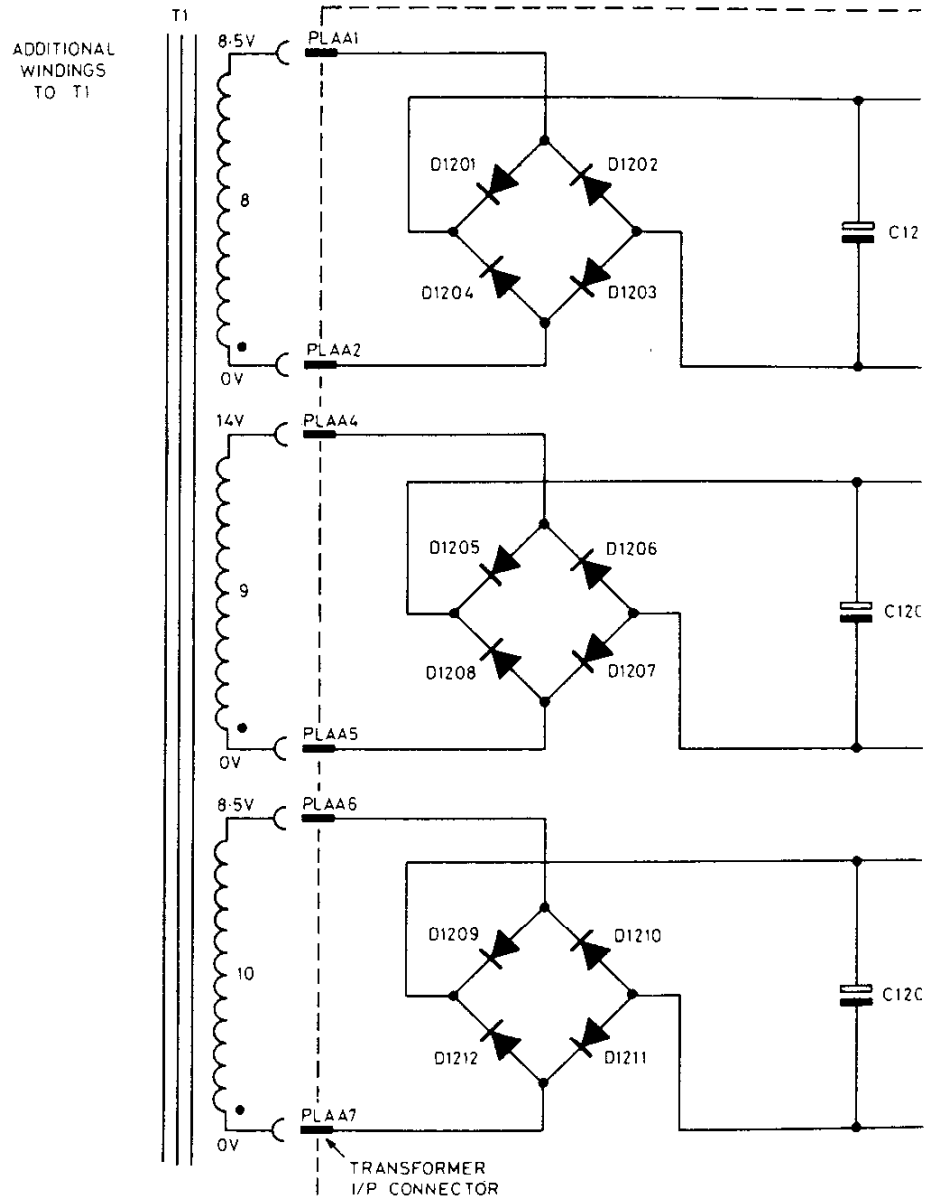
# Section 6

## AUXILIARY POWER SUPPLY

<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Tol %±</i>	<i>Rating</i>	<i>Part No</i>	<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Tol %±</i>	<i>Rating</i>	<i>Part No</i>
<b>CAPACITORS</b>											
C1201	6800µF	E		16V	450796	D1203		IN4003			23462
C1202	2.2µF	T		35V	35930	D1204		IN4003			23462
C1203	2.2µF	T		35V	35930	D1205		IN4003			23462
C1204	4700µF	E		25V	38893	D1206		IN4003			23462
C1205	2.2µF	T		35V	35930	D1207		IN4003			23462
C1206	2.2µF	T		35V	35930	D1208		IN4003			23462
C1207	4700µF	E		16V	450795	D1209		IN4003			23463
C1208	2.2µF	T		35V	35930	D1210		IN4003			23463
C1209	2.2µF	T		35V	35930	D1211		IN4003			23463
						D1212		IN4003			23463
<b>DIODES</b>											
D1201		IN4003			23462	U1201		7805			36176
D1202		IN4003			23462	U1202		7812			36178
						U1203		7905			36182

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CAPS.		C1201 C1204 C1207
MISC.	T1	D1201 - D1212



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C1201  
C1204  
C1207

C1202  
C1205  
C1208

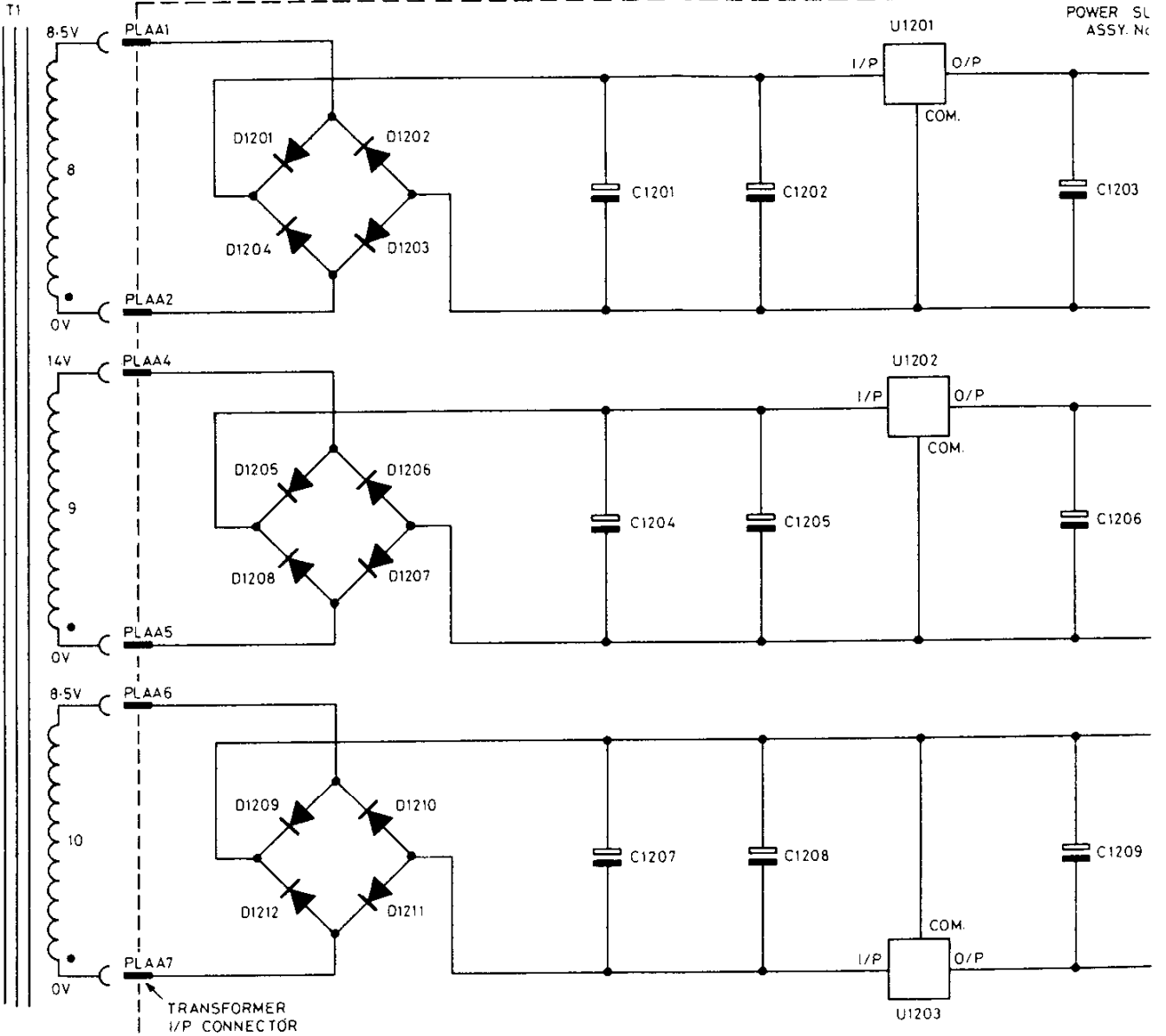
C1203  
C1206  
C1209

T1

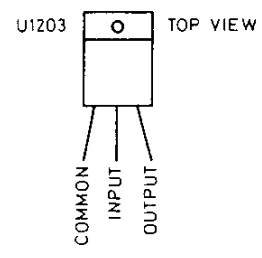
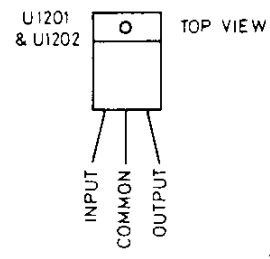
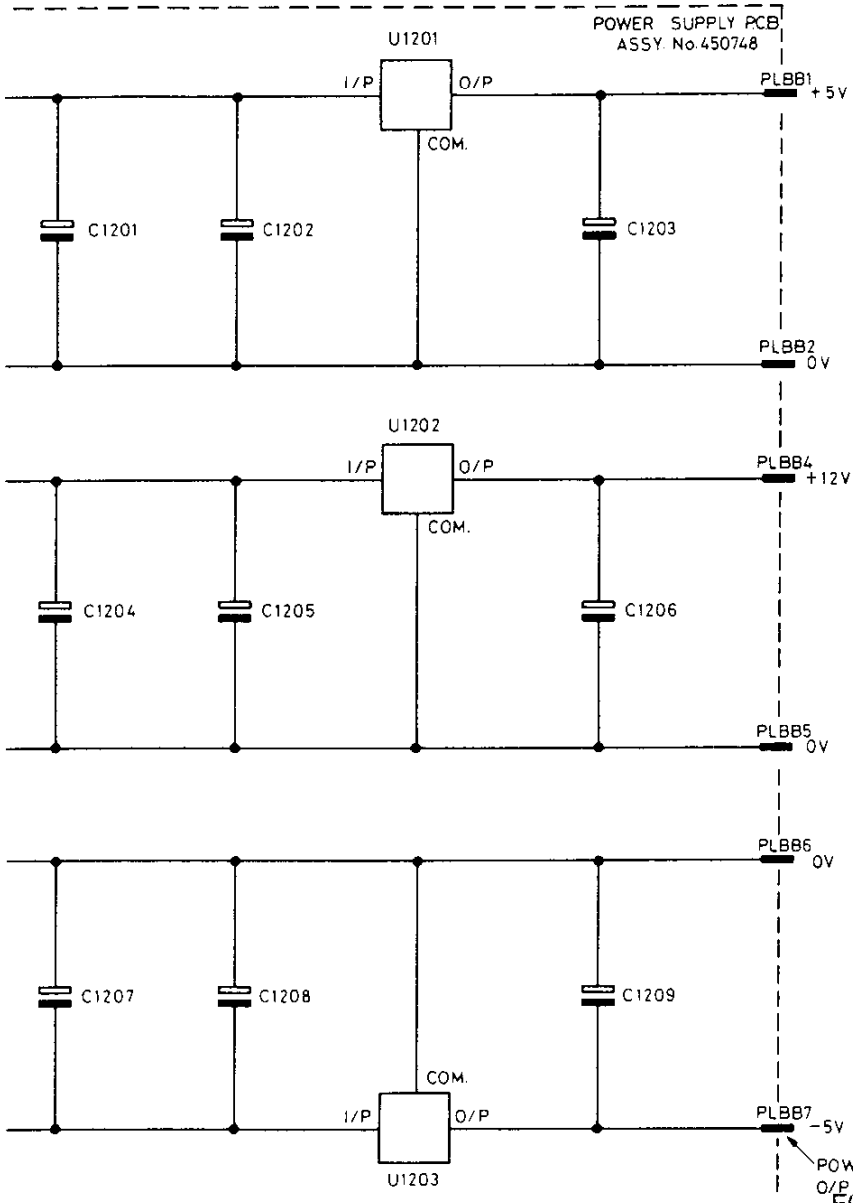
D1201 - D1212

U1201  
U1202  
U1203

ADDITIONAL  
WINDINGS  
TO T1



C1201 C1204 C1207	C1202 C1205 C1208	C1203 C1206 C1209
U1201 U1202 U1203		



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Fig. 12 Auxiliary Power Supply

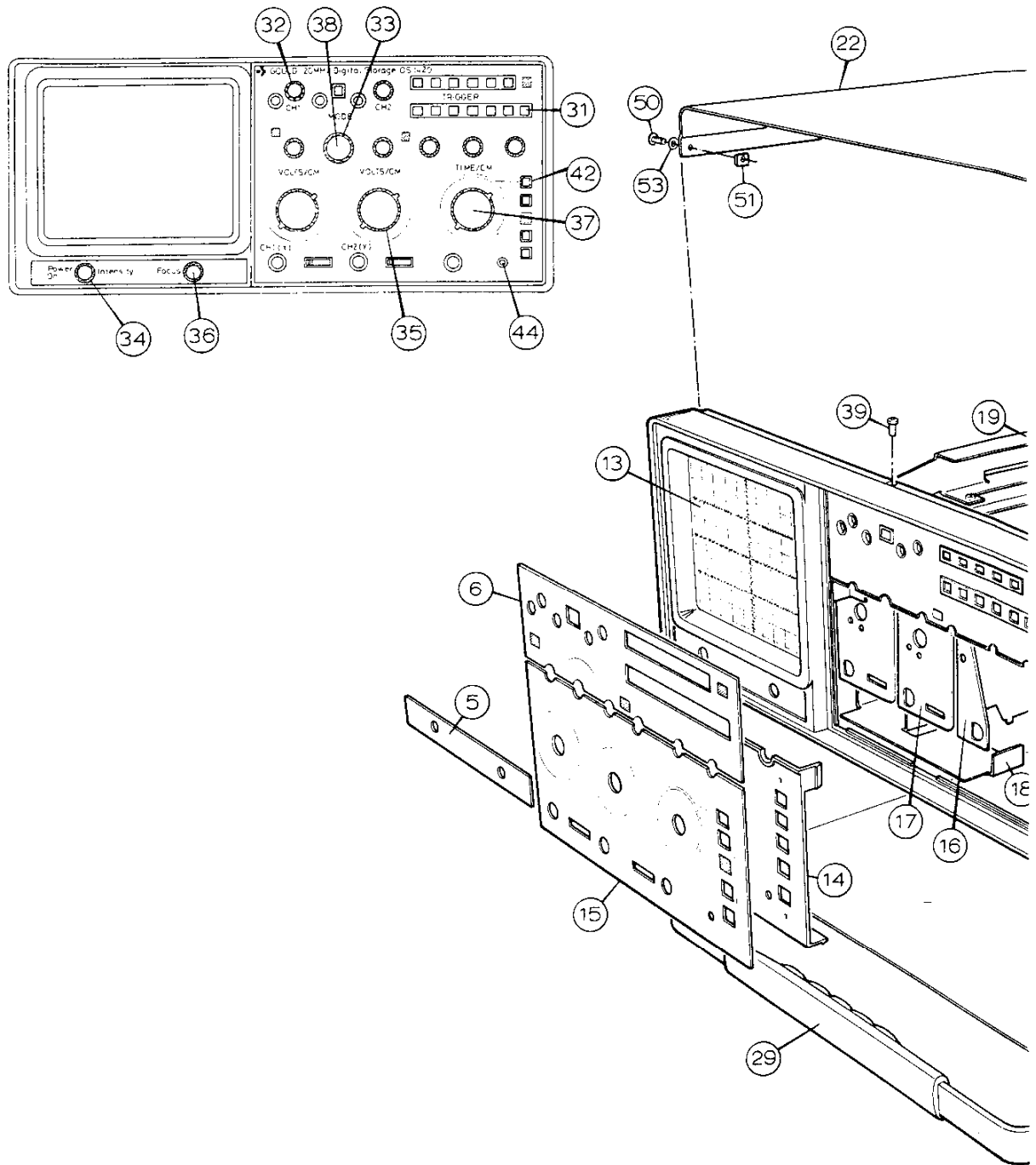
# Component List and Illustrations

# Section 6

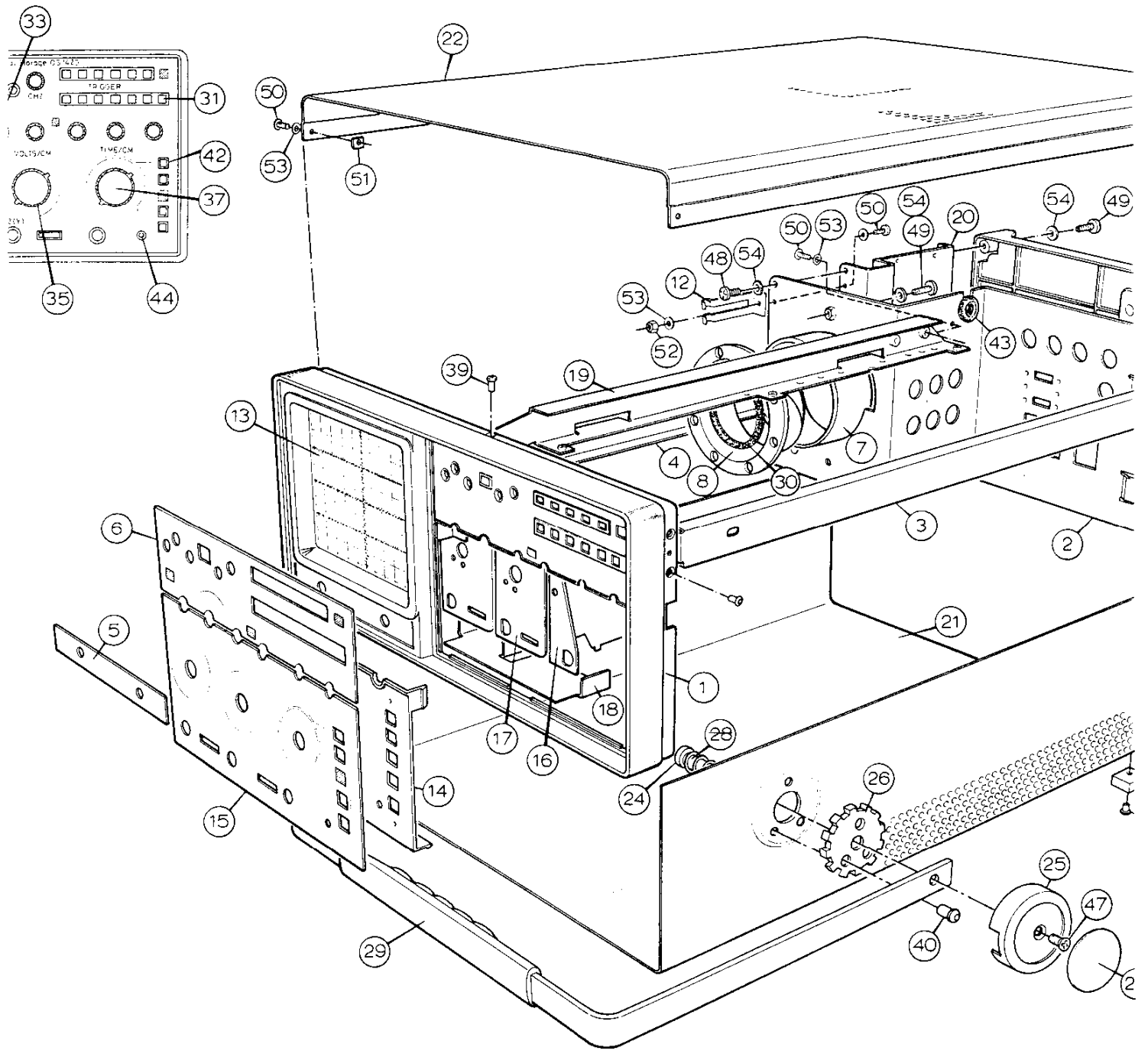
<i>Ref</i>	<i>Description</i>	<i>Part No</i>
1	Frame/Panel Moulding	451068
2	Panel Rear	451595
3	Support Side (Long)	450730
4	Side Support (Short)	450043
5	Coverlay Focus/Brill	450754
6	Coverlay Pushbuttons	450731
7	Clamp C.R.T. (Moulding)	450009
8	Base C.R.T. (Moulding)	450008
9	Cover Rear (Moulding)	44969
10	Holder Fuse	40068
11	Connector Supply	44960
12	Earth Spring	44984
13	Graticule Blue	44964
14	Panel Front	44478
15	Coverlay	450732
16	Screen Timebase	44972
17	Screen Attenuator	44973
18	Screen B.N.C. Sockets	450089
19	Heatsink	450648
20	Heatsink (Aux Power Supply)	450752
21	Case Bottom	450768
22	Case Top	450769
23	Button Handle	36681
24	Spindle Moulded	44470
25	Cover Handle	44471
26	Base Handle	44472
27	Foot	36329
28	Spring	44568
29	Handle Assy	44469
30	Washer C.R.T.	44963
31	Knob – Pushbutton	38407
32	Knob 10mm 'D' Type	402009
33	Knob 15mm 'D' Winged	402010
34	Knob R2–234	40408
35	Knob R4–454 (21mm)	40410
36	Cap W1–208	44957
37	Cap W1–400	44958
38	Cap W1–300	44959
39	'POP' Rivet	450690
40	Rivet .2" Long	12862
41	Rivet .29" Long	29426
42	Bezel	43256
43	Grommet	382
44	Terminal	24159
45	Fuse 500mA	33685
46	Fuse 250mA	33684
47	Screw M4 x 12 C'sk Hd.	33077
48	Screw M4 x 8 Pan Hd.	33044
49	Screw M4 x 10 Pan Hd.	33045
50	Screw M3 x 8 Pan Hd.	33038
51	Nut M3 Sq.	41407
52	Nut M3	33023
53	Washer M3 Wavey	33016
54	Washer M4 Wavey	33017

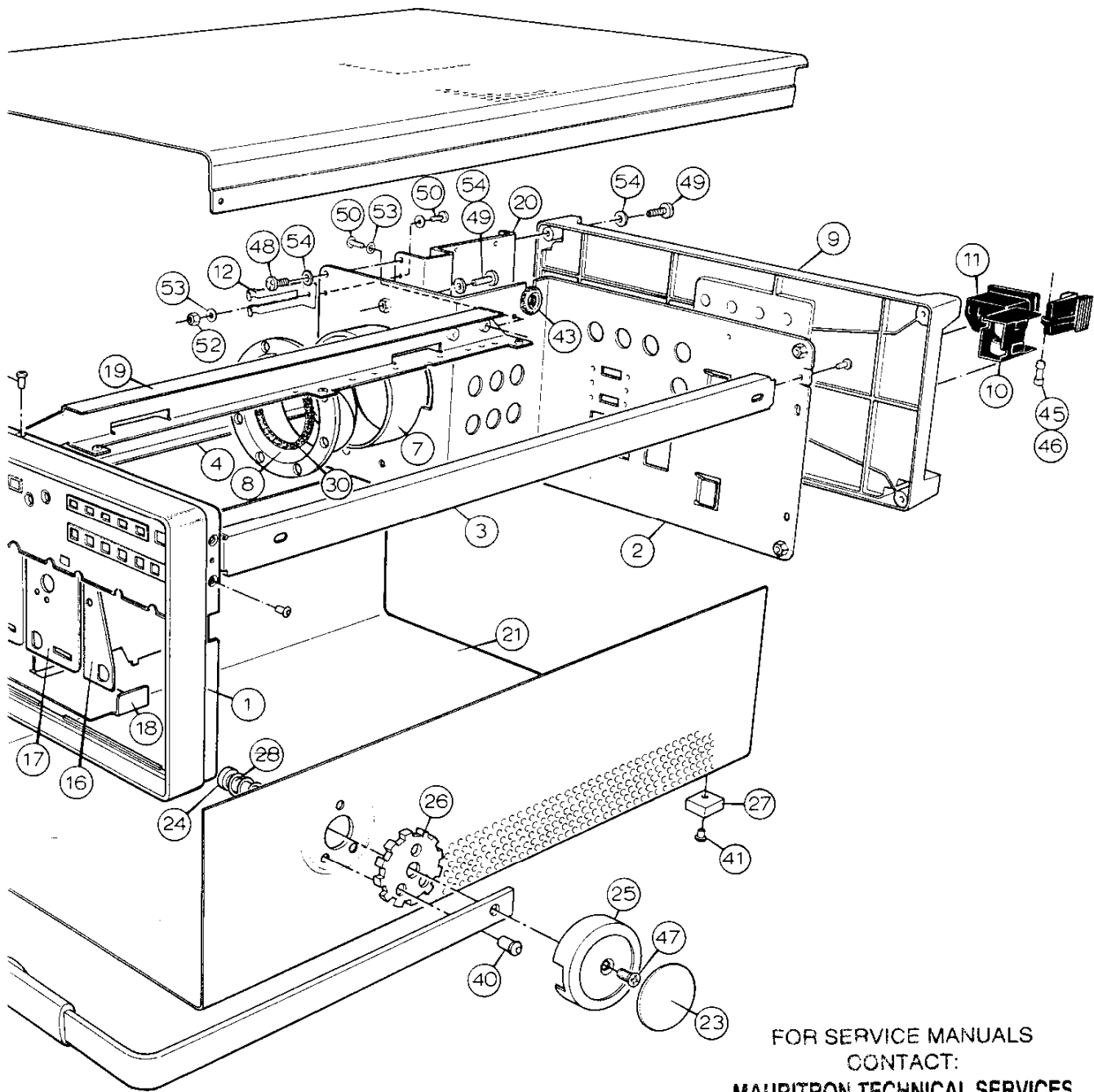
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Fig. 13 Mechanical View Circuit Diagram

This instrument is guaranteed for a period of two years from its delivery to the purchaser, covering faulty workmanship and replacement of defective parts other than cathode ray tubes and batteries (where fitted). Cathode ray tubes are subject to the manufacturers guarantee. This assumes fair wear and tear and usage in the specified environment and does not cover routine recalibrations and mechanical adjustments.

We maintain comprehensive after sales facilities and the instrument should be returned to our factory for servicing if this is necessary. The type and serial number of the instrument should always be quoted, together with full details of any fault and service required.

Equipment returned for servicing must be adequately packed, preferably in the box in which the instrument was supplied and shipped with transportation charges

Service Dept.,  
Roebuck Road,  
Hainault,  
Essex,  
IG6 3UE

Tel: 01-500 1000

Telex: 263785

Telegrams: Attenuate Ilford

prepaid. We accept no responsibility for instruments arriving damaged. Should the cause of failure during the guarantee period be due to misuse or abuse of the instrument, or if the guarantee has expired the repair will be put in hand without delay and charged unless other instructions are received.

Our Sales, Service and Engineering Departments are ready to assist you at all times.

The Service Department can provide maintenance and repair information by telephone or letter, if required.

Note: Please check fuses before returning instruments for service and ensure that any 13 Amp mains plugs fitted are removed. To prevent possible transit damage, we regret that mains plugs cannot be returned.

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