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Colin Hinson
In the village of Blunham, Bedfordshire.

DIGITAL STORAGE
OSCILLOSCOPE OS4040

Operators Manual

GOULD

Contents

SECTION	**1**	**Introduction**	4
SECTION	**2**	**Specification**	5
	2.1	OS4040	5
	2.2	Options	6
SECTION	**3**	**Operation**	8
	3.1	International Safety Warning	8
	3.2	Earthing	8
	3.3	Live Components	8
	3.4	Supplies	8
	3.5	Switching On	8
	3.6	Cooling	8
	3.7	C.R.T. Controls	8
	3.8	Y Channels Controls	8
	3.9	Timebase and Trigger	9
	3.10	Store Control	11
	3.11	Additional Facilities	18
	3.12	Functional Checks	18
SECTION	**4**	**Circuit Description**	22
	4.1	System Description	22
SECTION	**5**	**Maintenance**	25
	5.1	General	25
	5.2	Mechanical Assembly	25
	5.3	Calibration Procedure	21
SECTION	**6**	**Circuit Diagrams and Illustrations**	36
APPENDIX		**(Instruments from S/No. 2001)**	
SECTION	**7**	**Guarantee and Service**	73

ILLUSTRATIONS AND TABLES

Fig. 3.1	Trig. Window Operation	10
Fig. 3.2	Sample Density Table	12
Fig. 3.3	Alias Effects	14
Fig. 3.4	Time/cm Range and Input Signal Frequency Table	15
Fig. 3.5	Glitch Capture Table	16
Fig. 3.6	Sampling in Peak Detect Mode	17
Fig. 4.1	Block Diagram	21
Fig. 5.1	Front View	26
Fig. 5.2	Bottom View	27
Fig. 5.3	Side View	28
Fig. 5.4	A.D.C. Adjustments	32
Fig. 5.5	A.D.C. Beamswitch Waveforms	33
Fig. 6.1	Interconnection Diagram	36
Fig. 6.2	'Y' Pre-amp & Beam Switch Circuit Diagram	43
Fig. 6.3	'Y' Output Amplifier and Dot Joiner Circuit	45
Fig. 6.4	Timebase Circuit Diagram 1	47
Fig. 6.5	Timebase Circuit Diagram 2	51
Fig. 6.6	Power Supply Circuit Diagram	53
Fig. 6.7	Store Circuit Diagram	55
Fig. 6.8	Control Circuit Diagram	57
Fig. 6.9	Interface Circuit Diagram	59
Fig. 6.10	A.D.C. Circuit Diagram 1	61
Fig. 6.11	A.D.C. Circuit Diagram 2	65
Fig. 6.12	A.D.C. Circuit Diagram 3	67
Fig. 6.13	Tube Supplies Bright Up & E.H.T. Circuit Diagram	69
Fig. 6.14	Mechanical View	71

OS4040 DIGITAL STORAGE OSCILLOSCOPE

The Gould OS4040 operates both as a conventional Realtime Oscilloscope with a 25MHz bandwidth and also as a Digital storage instrument with a 10MHz maximum sampling rate.

The OS4040 is ideally suited for viewing transient waveforms e.g. in medical, dynamic testing, and pulse testing applications. The high Y sensitivity (1mV/cm) also provides the capability for viewing low level signals and the wide 25MHz bandwidth in Normal mode makes the instrument useful for a wide variety of Laboratory applications.

The primary modes 'Normal', 'Refreshed' and 'Roll' give an optimum choice when observing repetitive waveforms in realtime, low frequencies, transients, pretrigger information or long term phenomena. Digital storage offers many advantages notably the facility of pretrigger viewing, a flicker free simultaneous display of stored and realtime signals, without any deterioration of the stored display with time.

The 5K displayed store length provides high resolution when observing transients and up to 60% of the trace can display pretrigger information when required in Refreshed mode or 100% in Roll mode. Up to 50 times post storage X expansion is available to view in detail any part of the trace.

A particularly useful facility is the Split Display function where up to four independent traces may be individually held and displayed together or stored consecutively using the Multi Sweep facility. Each trace has a separate Y-offset control to permit Y shift after storage. Special circuitry has been incorporated to correct for X-axis jitter when the instrument is used in this mode.

A further feature is the Peak Detection circuit which is used, to enhance glitch capture when the instrument is used below its maximum store timebase speed (50μs/cm).

The output Option 4042 provides an analogue output suitable for X-Y or T-Y chart recorders and a digital interface to input or output data or control the majority of the oscilloscope functions externally.

Output option 4043 provides analogue output facilities only for X-Y and T-Y recorders. Output option 4044 is an IEEE 488 Data Bus interface and allows the OS4040 to be used as part of an instrumentation system.

2.1 OS4040

DISPLAY

CRT 8 x 10 rectangular.

EHT 10kV.

Graticule Internally illuminated with 8 x 10cm divisions and 2mm sub-divisions. Continually variable illumination.

VERTICAL DEFLECTION

Two identical input channels.

Bandwidth DC–25MHz (–3dB) in the normal mode.
2Hz to 25MHz (–3dB) AC coupled.
8MHz (–3dB) at x 5 gain.

Sensitivity 5mV/cm to 5V/cm in 1.2.5 sequence, 10 ranges.
Uncalibrated fine gain control >2.5:1
x 5 switched gain (1mV/cm).

Accuracy ±3% in calibrated positions (±5% at x 5 gain).

Input Impedance 1MΩ//28pF.

Input Coupling AC–DC–Ground.

Maximum Voltage 400V DC or pk AC.

Display Modes Channel 1 only.
Channel 2 only.
Channel 1 and Channel 2 dual trace.
In normal mode operation chop or alternate modes are selected automatically by the time/cm switch.
Add channel 1 and channel 2.
Invert switch selectable on both channels.

HORIZONTAL DEFLECTION

Normal Mode Sweep Rate 200ns/cm to 500ms/cm in 20 ranges (1.2.5 sequence).
(LED indication of slow speed range limit).

Accuracy ±3%.

Expansion Calibrated x 1, x 2, x 5, x 10 (x 10 ± 5% accuracy).
Continuously variable >2.5:1.

XY Mode (Normal only) X via channel 2

Accuracy ±5%

Phase Shift <3° at 500kHz.

Bandwidth 1Mhz.

Refreshed and Roll Modes Sweep Rate 50μs/cm 5s/cm in 16 ranges (1.2.5 sequence).
LED indication of high speed range limit.

Accuracy ±3%.

Expansion Calibrated x 1, x 2, x 5, x 10, x 20 continuously variable >2.5:1.

TRIGGER

Source CH1, CH2, EXT, LINE, MANUAL.

Coupling AC, DC, HF rej, LF rej.

Slope +, –, window (+ and –).

Level By manual control with selectable bright line (auto.).

Sensitivity Internal: 3mm to 3MHz.
10mm at 25MHz.
External: 30mV to 3MHz.
100mV at 25MHz.

Level Range ±5cm internal.
±500mV external.

Trigger window range 0.5 to 8cm internal approx.
50 to 800mV external approx.

Ext. input impedance 1MΩ//28pF.

Ext. input protection 400V pk max.

DIGITAL FACILITIES

Store Size 8K x 8 bit. 5120 x 8 bit display. 3072 x 8 bit pre-trigger.

Vertical Resolution 256 steps for >8cm approx. 30 steps/cm.

Horizontal Resolution Single trace 5120 for a complete scan (approx. 500 samples/cm).
Dual trace: Resolution is half that for single trace.
4 trace: Resolution is quarter that for single trace.

Sample Rate 10MHz (100ns/sample), single channel on 50μs/cm range.
5MHz (200ns/sample) on dual channel.
2.5MHz (400ns/sample) on split trace.
Reduces in proportion to timebase.
Accuracy ±0.01%.

Step Response (Fastest risetime) 100ns single trace, 200ns dual trace, 400ns on split trace.

Max. Storage Frequency 2.5MHz single trace.
1.25 MHz dual trace.

Dot Joining Linear interpolation between samples.

Peak Detection Glitch detection mode effective at timebase ranges below 50μs/cm. Displays maximum and/or minimum values of full 10MHz sample rate in place of actual data at entry time (Glitch Detection or Envelope).

DISPLAY MODES

Refreshed Stored data and display updated by triggered sweep.

Roll Stored data and display updated continually.

Single Sweep Freezes store at the end of a triggered sweep.

Multi-sweep Four successive triggered sweeps stored as split traces.

Hold Display Freezes store immediately.

Split Display Four trace display.
Four latching buttons hold one sample in four.

Post storage and offset control for each split trace ± 4cm approx.

Pre-Trigger Storage 100% in Roll mode. Selectable 0 to 60% in 10% steps in Refreshed mode.

MISCELLANEOUS

Calibrator 1V pk/pk ±1% at approx. 1kHz.

SUPPLIES

110, 120V; 220, 240V 45–64Hz, 150W.

MECHANICAL

Size 100mm x 410mm x 540mm.

Weight 16.5kg.

Temperature Range Operating 0–50°C. Full Spec. 15–35°C.

ACCESSORIES

Standard

Handbook. Pt. No. 451974.

OPTIONAL

Probe Kit PB12

A passive probe kit with switched x 1 and x 10 attenuations. With x 10 attenuation input impedance is 10MΩ//11pF.

Viewing Hood PN42224

Trolley TR7

General purpose oscilloscope trolley.

Protective Carrying Case PN450048

A strong carrying case which completely encloses the oscilloscope with three thicknesses of padded material covering the front panel.

Rack Mount Kit PN450046

Front Panel Cover PN450047

Extender Card, general PN 44923

Extender Card, ADC PN450397

Workshop Manual Pt. No. 44823.

2.2 OPTIONS

4043 HARD COPY (Optional)

The 4043 output unit provides analogue plot outputs suitable for X-Y or T-Y chart recorders.

ANALOGUE OUTPUT

Y Outputs – two channels via BNC connectors.

The outputs correspond to the display mode selected.

Single – outputs identical.

Dual – CH1, CH2.

4 Trace – outputs selected by 4 trace hold controls.

Amplitude 100mV per cm of screen height Bipolar with 0V corresponding to centre of screen.

Accuracy output voltage per cm of display ±3%. Output to input voltage (cal.) ±3%.

Bandwidth DC – 16kHz (–3dB).

READOUT RATE

Internal Clock Manual selection 20s/cm and 2s/cm. Remote selection via links on socket or TTL signals.
200s/cm to 50ms/cm in 1.2.5. sequence.

External Clock 0 to 300kHz, rephased by internal 625kHz clock.

CONTROLS

Plot Mode Manual (or Remote) start, autostart or continuous read-out.

Start-up Delay Delay from start command to initiation of read-out cycle. Range 100ms to 1 sec.

Inputs External plot Rate clock, TTL, positive edge active. External clock select, TTL, low level active. Remote start, TTL, negative edge active.

OUTPUTS

Contacts Isolated single pole contact closes from start command to end of read-out cycle.
Rating 100V DC 250mA DC, 10W DC.,
Isolation 400V Max.

Plot Marker TTL High commencing at the end of the delay, for the duration of the read-out cycle.

4042 DIGITAL INTERFACE (WITH HARD COPY)

In addition to the analogue outputs and controls specified for 4043, the 4042 provides a facility for parallel data transfer to and from the store and for remote readout and control of most of the functions of OS4040. This can be used for direct interface to an I/O part of a microprocessor or data handling system or used via the Option4044 for direct interface with a standard data bus.

Data transfer via simple handshake routine.

Latches provided for remote control function.

Read and Write Control
Stored data
Timebase range
Y mode
Refreshed/Roll
% Pre-trigger
Split trace
Hold
Single sweep
Multi-sweep
Release
Peak Detection max/min
Plot Start
Plot Mode

Write Only
Split Trace offset on/off
Split Trace blanking
Remote clock for data capture
Gate data capture (timebase hold

Read Only
Y sensitivity
Uncal
Store/Normal
Triggered/Stored
Plotting

4044 GPIB INTERFACE

With 4042 the 4044 unit provides full interface to the GPIB bus, IEEE488 or IEC625 to interrogate and/or control the OS4040 within an automated instrumentation system.

Mode

Listen only
Talk only
Talk/listen with local or remote operation following an independent controller.

Format

Data transfer, with or without corresponding X location information.

Binary
Octal
BCD
Hexadecimal

Coupling

Opto-coupling included to isolate ground of OS4040 from data bus ground and avoid earth-loop interference to oscilloscope measurements.

3.1 INTERNATIONAL SAFETY WARNING

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 to operate indoors, 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 conditons.

3.2 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 that the 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.

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.

3.3 LIVE COMPONENTS

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).

OPERATION

3.4 SUPPLIES

The instrument is normally despatched from the factory with the supply range switch on the rear panel set to the 240V (± 10%) range. Check that this is set correctly before connecting to the supply. Note that the correct fuse for the two high voltage ranges, 220V and 240V is a 2A Slo-Blo, size 20mm, Gould Part No. 450286. If the 120-100V ranges are selected, the fuse should be changed to a 4A Slo-Blo Gould Part No 44899.

NOTE: DO NOT CHANGE THE SUPPLY RANGE SWITCHES WITH THE INSTRUMENT CONNECTED TO THE SUPPLY.

3.5 SWITCHING ON

The instrument is switched on by pressing the POWER button, when the associated l.e.d. indicator will light. The button is self-locking and the instrument is switched off by pressing the button again.

3.6 COOLING

Since the instrument is provided with a cooling fan to provide forced air circulation it must not be operated with any restrictions over the air intakes below and at the side of the instrument or the exhaust vent at the rear. Note that the instrument must be operated within the specified supply frequency range (45-65Hz) in order that the cooling fan operates correctly.

3.7 C.R.T. CONTROLS

These controls are grouped to the left of the c.r.t. display.

Intensity	This is used to set optimum trace intensity depending on ambient lighting conditions.
Focus	Used to obtain finest possible trace width.
Scale	The non-illuminated c.r.t. Scale is easily visible under normal lighting conditions. Scale illumination is usually only required under low ambient light conditions or when a display is to be recorded photographically. The intensity will depend on the film speed, aperture and exposure time being used. The scale has 0, 10, 90, 100% lines marked to assist in rise time measurement.
Trace Rotate	This preset provides an adjustment of the trace azimuth to correct for the Earth's magnetic field and c.r.t. tolerances.

3.8 Y CHANNEL CONTROLS

The controls are grouped beneath the c.r.t. display. The input signal is applied to the CH1 or CH2 BNC input socket.

3.8.1 COUPLING

For direct connection of the input signal press the associated AC/DC push button switch to the DC (IN) position and the ground (GND) switch to the OUT position. For AC coupling of the input signal via an internal 0.1μF 400V capacitor the AC/DC switch is released, (OUT position).

NOTE. When examining low amplitude a.c. signals superimposed on a high d.c. level, the AC/DC switch should be set to AC and the sensitivity of the Y-amplifier increased to the level required.

To locate the baseline, push in the GND switch. With this setting, the input signal is disconnected from the Y-amplifier, and the amplifier is switched to ground.

3.8.2 SENSITIVITY

Set the VOLTS/CM switch to a suitable setting. To minimise pick up at sensitive settings, it is essential to ensure that the ground lead connection is close to the signal point.

The X5 GAIN push button may be used to supplement the attenuator on all ranges, and provides a maximum sensitivity setting of 1mV/cm. Note that when the X5 gain setting is used, the NORMAL mode Y-amplifier bandwidth drops to 8MHz.

When required the concentric VARIABLE control on the attenuator switch may be used to give fine gain adjustment. It has a range of approximately 3:1 so that its full adjustment overlaps the adjacent lower sensitivity range. When this control is at any position other than fully clockwise, the UNCAL l.e.d. illuminates to show that the amplifier is not at its calibrated gain setting.

3.8.3 INVERT

This push button switch reverses the polarity of the amplifier display on any attenuator range and may usefully be used with CH1 and CH2 ADD mode to provide a 2 input differential amplifier (see section 3.8.5).

3.8.4 SHIFT

For vertical shift of either trace, adjust the relevant Y-shift control (identified by vertical arrows).

3.8.5 Y MODE

The Vertical mode push button switches select either CH1 or CH2 individually, or CH1 and CH2 (DUAL display) or CH1 and CH2 (ADD). When DUAL is used CH1 and CH2 are beam-switched internally. The two channels are beam-switched by a chop signal at a rate of approximately 500KHz when the instrument is used at TIME/CM rates of 1ms/cm to 0.5s/cm in NORMAL mode. For higher timebase rates the channels are switched over at the end of each timebase sweep (alternate). The method of beam switching is selected automatically by the TIME/CM setting. The reason for using two beam switch modes is to reduce flicker at slow TIME/CM settings and remove chop oscillator signal alias effects at high TIME/CM settings.

ADD mode provides a means of summing the signals from each Y channel. The CH1 and CH2 Y-shift controls have a common effect on the trace in this mode.

3.9 TIMEBASE AND TRIGGER

The controls associated with the Timebase and Trigger facilities are grouped together on the right hand side of the c.r.t. display. The Trigger controls are all contained within the dark brown sectored area.

3.9.1 TIME/CM SWITCH

This control sets the horizontal axis timescale; for Normal mode operation ranges are available from 0.5s/cm to 0.2μs/cm in 1, 2, 5 steps. In Store modes, the lowest range is 5s/cm extending to the fastest range, 50μs/cm. If the TIME/CM switch is set to a position not available for the appropriate Normal or Store mode chosen, as indicated by the STORE ONLY or NORMAL ONLY sectors on the switch scale, then the RANGE LIMIT l.e.d. lights. In Normal mode when the TIME/cm switch is set to a lower speed than 0.5s/cm the timebase speed will remain at 0.5s/cm. In Store mode if the TIME/cm switch is set above 50μs/cm the store locks and holds the data present in the store before the range was exceeded.

3.9.2 X EXPAND

X Expansion is provided in calibrated settings from X1 to X10 in Normal mode and X1 to X20 in Store mode as selected on the 5 way push button bank. X20 expansion is only available in store mode (marked STORE ONLY). If X20 is selected in Normal mode, the X gain will remain in X10 expansion.

Variable expansion has a range in excess of 2.5:1 to provide overlap between the 1, 2, 5 steps on the X EXPAND push button switch settings. When the variable is turned away from the extreme anticlockwise position (marked CAL) the UNCAL warning l.e.d. above this control will illuminate.

When X10 expansion is used in the Normal mode with full X2.5 variable expansion, a maximum scan rate of about 8ns/cm is possible, however, linearity at this speed is not guaranteed to full Specification.

3.9.3 X SHIFT

The X Shift control, identified with the horizontal arrows, above the X Expand switch is used to centre the display or locate any part of the trace in the expanded position. This is a dual action control which provides coarse adjustment over the full shift range with a fine adjustment range for small angles of rotation.

3.9.4 TRIGGER SOURCES

The TRIGGER SOURCE push button bank selects one of the five signals, Internal CH1, Internal CH2, External, Line or Manual. The CH1, or CH2 internal signals are selected from a pick off on the CH1 and CH2 Y amplifier channels. The minimum Trigger threshold is 3mm of trace amplitude for internal CH1, CH2, except if the Y gain is in X5 mode when it is 1.5cm of trace amplitude.

When EXTERNAL trigger is selected the trigger signal is derived directly from the input b.n.c. socket directly below the push button. The minimum trigger threshold is 30mV p.p. for this input.

LINE trigger uses a signal from the power supply transformer to generate a trigger synchronised to the supply frequency. This mode is often useful when using the oscilloscope to identify or eliminate line frequency components of a signal; or, when used in conjunction

with signal sources such as frequency sweep generators synchronised to the supply frequency.

MANUAL trigger is a function which enables the time-base to be triggered manually each time the button is pressed. This facility will operate in both STORE and NORMAL modes, but is more useful in STORE mode by providing a means of manually updating the stored data. Note that the AUTO trigger mode causes repeated update of the store data in the absence of an acceptable trigger signal.

3.9.5 TRIGGER COUPLING

The TRIG COUPLING switch selects AC, DC, AC-LF REJECT or HF REJECT. The AC and DC positions are independent of the LF and HF reject functions and select wideband AC or DC trigger operation. The LF reference of AC coupling cuts off at approx. 10Hz. The LF Reject position limits the trigger sensitivity below approx. 10kHz. The LF Reject position limits the trigger senstivity below approx. 10kHz, while the HF Reject is AC coupled and limits sensitivity above 10kHz.

3.9.6 AUTO

The Auto switch is grouped with the trigger coupling bank and when selected in the absence of a valid trigger signal provides a continuous free run of the timebase in Normal mode and repeated store acquisition in Store mode. In Normal mode of operation, the function thus provides a 'bright line' display to assist in trace location. When operating in Auto, false triggering may occur if the trigger frequency is below 40Hz. If AUTO is not selected in Normal mode, an absence of trigger will cause the trace to blank. When store is selected, under the same conditions, the trace displayed will not update in REFRESHED mode and show the data already present in the store.

In ROLL mode the store will continuously update in the usual manner, awaiting trigger.

3.9.7 SLOPE SELECT AND TRIGGER LEVEL

The SLOPE + and – switches select either a positive-going edge or negative-going edge for the trigger signal. Clockwise adjustment of the TRIGGER LEVEL control moves the trigger point more positive or more negative according to whether + or – trigger slope is selected. When the instrument has been triggered, the TRIG l.e.d. will then illuminate continuously if the signal repetition rate is above 40Hz. It will be seen to flash at lower frequencies.

3.9.8 +/– SELECT AND TRIGGER WINDOW

The purpose of this function is to enable the instrument to trigger on either a positive or negative-going edge when the polarity of the signal stimulus is unknown, e.g. random noise spikes on a supply. The TRIGGER WINDOW control is used to produce a preset deadband over which trigger pulses are ignored. This WINDOW can be adjusted over a range of approx. 0.5 - 8cms on the c.r.t. The principle of operation can be illustrated with reference to an example and diagram, Fig. 3.1. In this case, it is required that the instrument should ignore signal spikes below 2cm in amplitide but should trigger on signals in excess of this. With +/– slope selected, the TRIGGER LEVEL is set to its central position and the WINDOW control to about the 2nd scale marking past zero. AC TRIG COUPLING is selected and AUTO bright line should be off. If the TRIGGER LEVEL is within the limits defined by the TRIGGER WINDOW the SET l.e.d. indicator will light. To test that the window limits have been set correctly insert a sinewave signal with a frequency below that required to display half of a cycle on the c.r.t. and adjust the WINDOW control so that the leading positive and negative-going edges commence 2cms apart.

Note that +/– slope trigger operation is intended for use in detecting one off events, if this function is used on a repetitive waveform the TIME/CM switch should

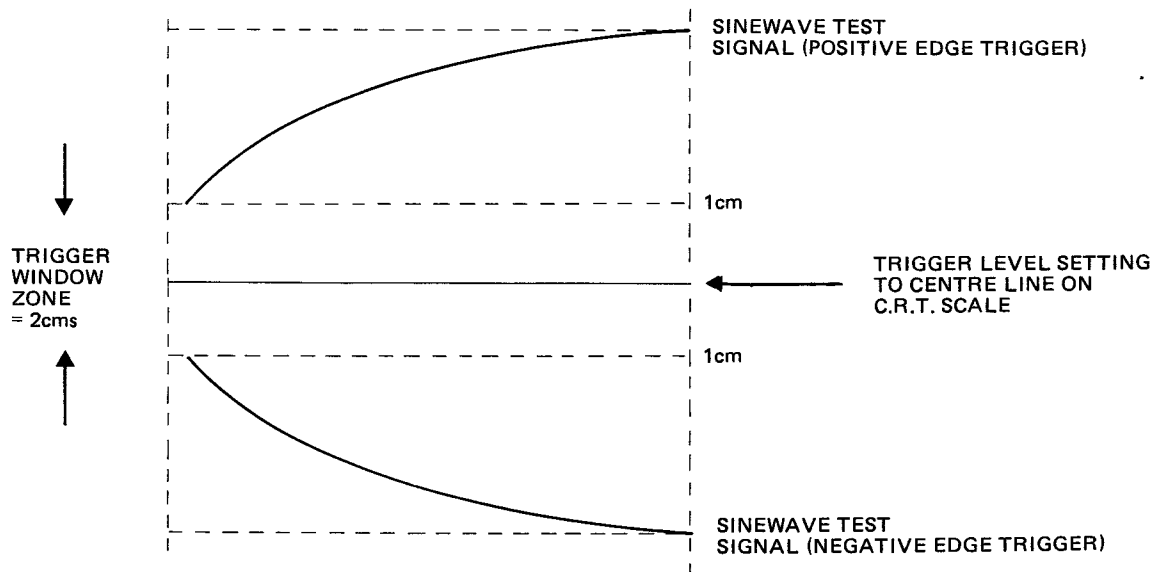


Fig. 3.1 Trig Window Operation

normally be set so that the timebase will complete a sweep substantially more rapidly than the repetition of the incoming waveform. If this is not done it is quite possible for the instrument to synchronise to only one trigger edge at certain signal frequencies and so appear as if the dual slope trigger is not working correctly.

3.9.9 NORMAL X-Y OPERATION

In Normal mode, the instrument may be used as an X-Y display by selecting the NORMAL X-Y push button in the top right-hand corner of the front panel. The source for the X signal is selected by the TRIGGER SOURCE switches, i.e. CH1, CH2, EXT or LINE. When using CH1 or CH2 for the X source, the X calibration follows the V/CM setting on the Y attenuator switches. The X-Y amplifier has been accurately calibrated to operate with CH2 and only approximate accuracy exists when coupled to CH1. When EXTERNAL is selected, input to the X amplifier is via the b.n.c. socket below the switch. The sensitivity is approximately 100mV/cm into 1MΩ/28pF. When LINE is selected, the input taken from the supply transformer provides a sinewave signal sufficient to cover approximately 10cms of horizontal deflection.

The AC and DC input coupling is available for X-Y operation, and also the LF and HF Reject filters. The selection of X-Y operation automatically switches the X amplifier to the X10 expand mode and so no other calibrated expansion is available, but the 2.5:1 variable expansion can be used if required. Note that since X10 expansion is used, an X offset may occur making it necessary to adjust the X SHIFT to bring the focussed spot to the centre of the screen.

3.10 STORE CONTROL

All controls associated with the storage facility are grouped together and distinguished by the mid-brown sectored area. Blue coding is used to denote storage functions. Normal and Store modes of operation are selected by the three push button switches with the functions NORMAL X-Y, NORMAL T-Y and STORE T-Y.

When the Store mode is selected, two operational functions of capture and display are available, REFRESHED and ROLL. These can be selected by the push button bank on the left side of the brown sectored area. REFRESHED mode is selected by any one of the 7 push buttons labelled 0 - 60% PRE TRIG. ROLL mode is selected by the button corresponding to 100% PRE TRIG. See also section (3.10.2).

3.10.1 REFRESHED MODE

If the instrument is displaying a trace in Normal mode, and the mode switch is changed to display REFRESHED, then the display would appear essentially unchanged. However, in both this mode and ROLL mode the display is limited by the 8 bit accuracy of the Analogue to Digital converter in the Y-direction and the 5K store size in the X-direction hence a small amount of step structure may be detected on the trace.

The display is triggered in the same way as in the Normal mode, but in the absence of trigger, (with AUTO bright line not selected) the previously stored trace is displayed continuously. This has the advantage of providing a flicker-free display even when low repetition rate signals are viewed. The display is updated (refreshed) by each trigger signal which occurs while the instrument is not engaged in updating the store. A further advantage over Normal operation is the availability of an extra 3 timebase ranges to display very slow sweep rates.

3.10.2 ROLL MODE

Selection of this display mode provides a form of free running timebase not found on a conventional oscilloscope. Incoming data is fed continuously to the store, with the latest data displayed on the right hand side of the trace. As the data is continuously updated, the older data moves progressively from right to left of the trace, to be finally erased and replaced when it reaches the left hand side of the trace. The appearance can be likened to that of a strip chart recorder viewed through a 10cm window.

As information is continuously written into store, prior to the trigger instant the store contains only pre trigger information. (hence the 100% PRE TRIG marking on the ROLL select switch). By using the SINGLE or MULTI SWEEP facilities (see section 3.10.6) pre-trigger information from transient signals may be stored and displayed. For detecting transient trigger signals the dual slope trigger, '+/−', and the trigger window facility may prove useful (see also section 3.9.8).

ROLL mode is ideally suited for viewing signals continuously at slow timebase rates. If this mode is used at high TIME/CM rates for 100% pre-trigger waveform storage of a fast incoming signal it is possible to produce a break-up effect on the live signal display. This is due to an alias effect between the display sweep rate and the incoming signal frequency, but will not affect any signal once stored in ROLL mode.

3.10.3 STORE DISPLAY RESOLUTION

ROLL and REFRESHED modes can be used over the TIME/CM ranges 5 sec/cm to 50μs/cm with full store capability on the display. If a faster range than 50μs/cm is selected, store acquisition will stop and the data acquired prior to this time will be displayed. The RANGE LIMIT l.e.d. will then illuminate to warn the operator of this condition. It is interesting to note that the maximum store TIME/CM setting can be calculated by multiplying the A–D conversion time (0.1μs for the 10MHz A–D used) by 500, corresponding to the full store number of bytes displayed/CM. Consequently, in order to obtain faster TIME/CM rates it is necessary to reduce the store resolution in the X-direction. Faster sweep rates can be achieved by using the X EXPAND

push buttons, noting that an extra X20 calibrated expansion is available for store mode operation giving a maximum rate of 2.5μs/cm. TIME/CM rates up to 1μs/cm can be achieved by using the 2.5:1 VARIABLE expansion control. However, the 500 byte/cm X display is not only limited by the X expansion setting. When DUAL Y channel operation is selected, half the total display store is allocated to each channel (2560 bytes) and when either MULTI-SWEEP or SPLIT DISPLAY are used only 1280 bytes are available for each of the 4 traces. The number of samples/cm can be checked by referring to the Fig. 3.2 which shows the X display resolution for each mode.

Display resolution in the Y direction remains at 8 bit (256 levels) for all settings of the V/CM switches, VERTICAL MODE switches or X5 Y-expansion switches. Approximately 30 levels/cm are displayed in the Y-direction, which allows a few samples to be displayed outside the 8cm graticule axis. Any signal peak which exceeds either of these Y-display limits will be instantly clipped and so displayed as a straight line section of trace outside the graticule area.

3.10.4 PRE TRIGGER SELECTION: REFRESHED & ROLL MODES

When the instrument is operated in Refreshed mode, a separate section of store called Delay Store is brought into use. This has a maximum capacity of approximately 3K bytes. It is updated continuously to retain pre-trigger data and the setting of the appropriate % PRE TRIGGER button determines how much of the 3K capacity is to be used. When a trigger signal arrives the Delay Store stops circulating, and data from it is transferred to the front section of the Main Store (5K bytes). Incoming data which follows the trigger signal point is then written directly into the remaining section of the Main Store. By this method it is possible to display in the Refreshed mode events which occur prior to the trigger signal. The position of the trigger event is indicated by the leading edge of a bright up dot on the c.r.t. trace. No bright up dot is provided if 0% PRE TRIG is selected in REFRESHED or 100% PRE TRIG in ROLL modes since these are at the beginning and end of trace positions, respectively, and the trigger point can easily be determined.

The stored trigger bright up point is not stored, hence if the PRE TRIGGER selection is changed during acquisition of e.g. 4 traces in Multi-Sweep mode, then the original trigger point will be lost. As the pre-trigger proportion is determined as percentage of trace length the position of the trigger point with respect to start of the trace is as follows:-

% PRE TRIG SELECTED	ACTUAL PRE TRIG POINT
10%	10.2mm
20%	20.4mm
30%	30.6mm
40%	40.9mm
50%	51.1mm
60%	61.4mm

When the instrument is used in Refreshed mode with Pre-trigger selected, it is necessary to fill the appropriate amount of Delay store with new data before a trigger is accepted and writing is allowed into Main Store. This is seen as a delay before new information appears on the trace, in particular when Single sweep and Multi sweep are used. This delay increases with increasing TIME/CM settings and increased Pre-trigger selection. For example, in Refreshed mode with 5sec/cm selected and 60% Pre-trigger a delay of 30 seconds would be experienced before the trace appeared to change. After this time, assuming that either a trigger signal was present, or the system was in AUTO the new data will appear instantaneously as the first 6cms of the trace, and further writing into main store will continue from that point.

3.10.5 HOLD DISPLAY

Operation of the HOLD DISPLAY button prevents change of the data held in store and the condition is

X EXPANSION	SINGLE	DUAL	QUAD/SPLIT TRACE
X 1	500	250	125
X 2	250	125	62.5
X 5	100	50	25
X10	50	25	12.5
X20	25	12.5	6.25
X50 (X20 with X 2.5 Variable)	10	5	2.5

Fig. 3.2 Sample/cm Density as a Function of X Expansion for Single, Dual, or Quad/Split Traces

indicated by an l.e.d. It can be used in Refreshed and Roll modes to instantaneously freeze the display if a feature of interest appears on the screen (This can also be achieved by operating MANUAL TRIGGER section 3.9.4). The action of the HOLD DISPLAY button overrides other controls and it can be of particular use in Roll mode if the store has not yet built up a full store of new data and is therefore not in a position to accept a trigger signal. Subsequently, the instrument can be used as a conventional oscilloscope in Normal mode but with the original stored data still available for display when the instrument is returned to a store mode. The HOLD DISPLAY button latches mechanically. To enable the instrument to be free to update the store as usual, the button should be pressed again to release.

3.10.6 SINGLE/MULTI SWEEP & RELEASE

The SINGLE SWEEP function operates in a similar manner to that of a conventional oscilloscope and will retain the next triggered sweep. Operation of the button in the REFRESHED mode will cause the ARMED l.e.d. to light, indicating that the relevant circuitry is primed. On receipt of a trigger signal, the TRIGGERED l.e.d. will light in place of the ARMED l.e.d. indicating that a storage sweep is in progress. At the end of the sweep the STORED l.e.d. will light indicating that the data is retained in the store. Further acceptance of trigger signals is prevented until the SINGLE SWEEP button is pressed again when the above capture sequence is repeated. Alternatively the RELEASE button may be pressed when REFRESHED operation is restored, responding to repeated trigger pulses.

When operating in the ROLL mode, the SINGLE SWEEP button causes the ARMED l.e.d. to come on while the display continues to roll. When trigger is received the display will be frozen immediately and the STORED l.e.d. will light. Operation of the SINGLE SWEEP button again will re-arm the circuitry for a repeat of the above sequence but a trigger will not be accepted until all the old data in the store has been replaced by new data.

The MULTI SWEEP function will store four sequential triggered traces in single channel mode or two successive pairs of traces in the DUAL channel mode, introducing the Split Display facility automatically. (see section 3.10.7). In DUAL channel mode traces 1 & 3 are allocated for CH1 and 2 & 4 for CH2. As each trace or pair of traces is held, the appropriate HELD l.e.d. will be seen to illuminate in the SPLIT DISPLAY sector of the front panel.

The sequence of the l.e.d. indication shows the function of Multi-sweep. In Single channel Refreshed Mode, the sequence will be Armed-Triggered-Armed with Split 1 (retained) - Triggered - Armed with Split 2 (retained) - Triggered - Armed with Split 3 (retained) - Triggered - Stored with Split 4 (retained).

Note that on slow storage rates, the OS4040 may appear inactive in the armed mode despite the presence of trigger signals but time must be allowed to up-date the data in the pre-trigger store in Refreshed and Main Store in Roll before a trigger can be accepted.

If either SINGLE SWEEP or MULTI SWEEP is pressed with AUTO selected, the instrument will immediately run through its appropriate routine of arming and storing.

3.10.7 SPLIT DISPLAY AND OFFSET FACILITY

The SPLIT DISPLAY section contains four self latching push buttons arranged in a vertical line, each of which can be used to freeze a trace and an associated l.e.d. indicates that the trace is held. This splitting is achieved by sharing the available store capacity of 5K samples between each of the four traces and the horizontal resolution is reduced accordingly. Once held, each trace can be offset or shifted vertically by the adjacent control which must be switched away from its fully anticlockwise off position.

A SPLIT function may be used to freeze a trace from either a live single or live dual channel display, or, alternatively, to separate a trace from a stored single or dual channel display. When a trace is held on a live display, this may be shifted by the appropriate Y-offset in the usual manner, while the remainder of the display continues to show live data and is not affected by the offset shift control. Similarly, data which has been acquired as the result of a stored single or dual trace may also be split and separated by using the hold buttons in conjunction with the offset shift controls. Each Split Display section has been allocated to a Y-channel when dual trace mode is used, CH1 to sections 1 and 3 and CH2 to sections 2 and 4. These are designated on the front panel DUAL CH1 or DUAL CH2. When a Single or Multi-sweep stored display is released by operation of the RELEASE or STORE buttons, any trace held by the SPLIT store hold buttons will be retained. This feature provides a useful reference when comparing held traces to live traces or other stored traces.

The Split Display facility may also be used in a similar way in conjunction with the Multi Sweep function. Multi sweep as described in section 3.10.6 will provide four equal sequential single sweeps when a single Y channel mode is used or two pairs of sequential sweeps for dual channel mode. These traces appear in ascending order 1 - 4 on single channel or in the order 1 and 3 (CH1), 2 and 4 (CH2) when dual channel is used. As each sweep is complete, the respective hold l.e.d. for each split trace illuminates to show that the trace is stored. Although these traces are stored, and will not change when new data is entered, the automatic holds can be cancelled by using the RELEASE button. If it is required to save any trace, the appropriate SPLIT button should be pressed. The trace than can be used as a reference against future stored traces when required.

3.10.8 TRIGGER JITTER CORRECTION

The digitisation of a waveform involves sampling at discrete intervals determined by the crystal clock so that

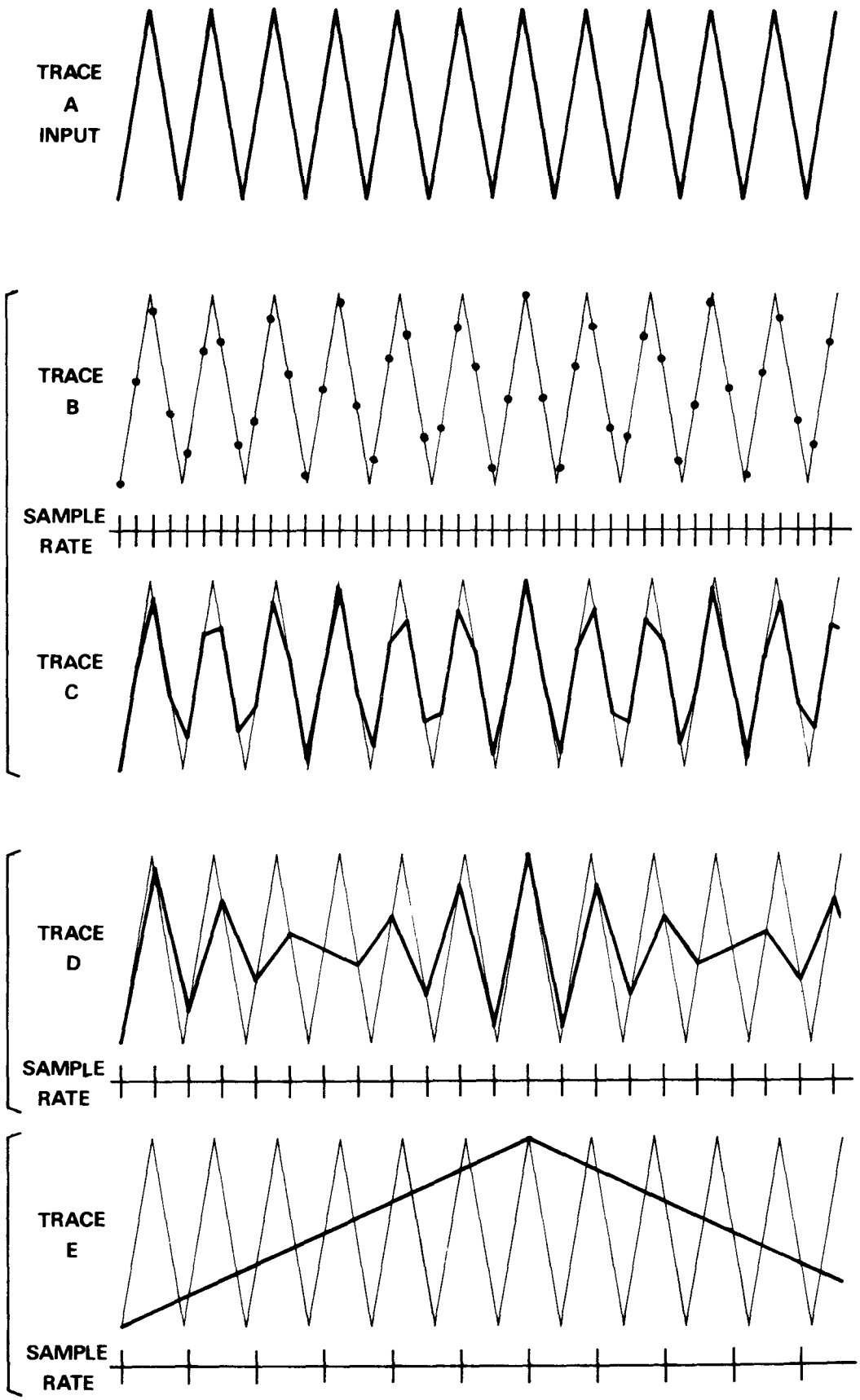


Fig. 3.3 Alias Effects

the first sample is not taken coincident with trigger but may be delayed by as much as one sample period. Thus the reconstructed waveform will show a time uncertainty or jitter of one sample period. On a single trace, however, this is only one part in 5K of the full trace and is not visible. It can be seen only on the fully expanded trace (x50) as 1% of the 10cm sweep, (1mm). Internal correction is applied to ensure that this level of jitter is not exceeded on dual or split trace modes although the sample spacing of each trace is increased two or four times.

3.10.9 ALIAS EFFECTS

In the Refreshed and Roll modes, the instrument uses a sampling system to examine the incoming waveform. Any such system can give misleading results known as alias effects if the input signal has a significant component with a frequency approaching or above the sampling frequency. Fig. 3.3. shows the effect of the sampling process on a triangular input waveform (trace A). Trace B shows the effect of sampling at a frequency close to four times that of the input if the display is formed by a series of dots. It will be seen that this can become a meaningless jumble. However, trace C shows the same sampled waveform reconstructed with the dot joining system employed in the OS4040. The display is formed by a series of straight lines, joining the successive sampled levels rather than a dot at each level, usually used on reconstructed displays. The dot joining approach is seen to retain the essential nature of the input waveform without ambiguity. This is particularly important since the actual horizontal dot density would be much closer than that shown in the diagram. However, if the sampling rate is reduced further, the essential nature of the waveform will be lost. Trace D shows the effect of a sampling rate close to half the input frequency and Trace E the effect when the frequencies are nearly equal. In the latter case, the display appears on the input form but at a reduced frequency. The frequency division is the principle on which sampling oscilloscopes operate, but can cause confusion in this case.

The OS4040 takes approximately 5000 samples per sweep. These are shared between both traces on dual channel and four traces when Multi-Sweep or Split Display are used. Assuming that the sampling rate should exceed the signal input frequency by a factor of about five, the following table shows the maximum frequency which can be viewed on each range.

The above table 3.4. shows the order of maximum input frequency allowable for each Timebase range which if exceeded may cause misleading displays. The actual amount of distortion depends on both the frequency and waveshape involved. Individual peaks of sinusoidal signals can be –3dB at a frequency of approx 10% above those shown above.

If alias effects are suspected, it is recommended that either the fastest TIME/CM range (50μs/cm) be selected, or alternatively, that the PEAK DETECTION facility be used (see sections 3.10.10 and 3.12.10). High speed repetitive signals are best viewed in normal mode if possible before comparison with a Refreshed trace.

3.10.10 PEAK DETECTION

This facility has two main functions. Firstly, it provides improved glitch capture performance when used at TIME/CM speeds below the 50μs/cm maximum for store mode, and secondly gives indication if the instrument is operating in a state of Alias signal capture (see section 3.10.9). The Peak Detection circuit is selected by two self latching push buttons one marked "+" and the other "–". When either button is pressed the l.e.d. between them lights to show that the Peak Detection

TIME/CM RANGE	SINGLE CHANNEL	DUAL CHANNEL	SINGLE TRACE OR MULTI SWEEP
50μs/cm	2MHz	1MHz	500kHz
0.1ms/cm	1MHz	500kHz	250kHz
0.2ms/cm	500kHz	250kHz	120kHz
0.5ms/cm	200kHz	100kHz	50Hz
1ms/cm	100kHz	50kHz	25Hz
2ms/cm	50kHz	25kHz	12kHz
5ms/cm	20kHz	10kHz	5kHz
10ms/cm	10kHz	5kHz	2.5kHz
20ms/cm	5kHz	2.5kHz	1kHz
50ms/cm	2kHz	1kHz	500Hz
0.1s/cm	1kHz	500Hz	250Hz
0.2s/cm	500Hz	250Hz	100Hz
0.5s/cm	200Hz	100Hz	50Hz
1s/cm	100Hz	50Hz	25Hz
2s/cm	50Hz	25Hz	10Hz
5s/cm	20Hz	10Hz	5Hz

Fig. 3.4 Time/cm Range and Input Signal Frequency

circuit has been selected. The button marked "+" selects peak values of positive transients and the button marked "–" selects negative transient peaks.

When the TIME/CM switch is set to 50μs/cm, the data is stored at the maximum 10MHz rate (100ns/sample). However, at slower TIME/CM rates the storage rate is reduced. e.g. at 1MHz only 1 sample in every 10 clock cycles is stored. The Peak Detection Circuit inspects the intervening samples which would normally be rejected and retains for storage the maximum value or minimum values of signals in each group. This enables the probability of capture of a 100ns glitch in single trace mode to be 100% even at the minimum TIME/CM speed of 5ns/cm. When MAX (+) and MIN (–) are selected together, the Peak Detection circuit alternates between maximum and minimum on alternate store samples. However, to avoid malfunction on dual and split trace modes which also switch functions on alternate samples, the max-min change is held on one sample in four and follows the sequence + – + – – + – + + – + – – + – + etc.

Because the detection circuit is time shared between MAX(+) and MIN(–) and between traces on dual and split trace modes the probability of capture of a single glitch on one trace reduces accordingly. Fig. 3.5 gives glitch capture probabilities for the 3 display modes (Single, Dual and Quad trace).

Display Mode	Probability with Peak + or – only	Probability with + & – peaks selected
Single Channel	100%	50%
Dual Channel	50%	25%
Quad Trace	Gives 25% Reduction in capture probability for each ¼ store hold used.	

Fig. 3.5 Probability of Capture of 100ns Glitch

The facility may be used to reveal Alias effects (see section 3.10.9) occuring when the instrument is used below its maximum TIME/CM rate.

If the instrument is operating in an alias condition, selection of either or both of the Peak Detector buttons will cause the displayed waveform to change its pattern. Selection of the "+" PEAK DETECT would display the maximum value samples, and the "–" PEAK DETECT minimum value samples. When both PEAK DETECT buttons are selected the displayed signal will alternate between the maximum and minimum values obtained from successive samples.

With reference to the diagram illustrated in Fig. 3.6, the major samples determined by the TIME/CM switch are shown by 'X'

Trace (a) shows the display produced without MAX/MIN selected, showing that the input waveform detail has become lost. Traces (b) and (c) illustrate the effect of selecting MAX or MIN where the trace approximates to a straight line indicating the peak maximum or minimum signal levels. Trace (d) shows the display obtained when MAX and MIN are selected together, and the +/– samples alternate in a fixed sequence.

An additional use of the MAX and MIN function is to display at slow sweep rates, the envelope of a higher frequency carrier signal if that carrier frequency is less than about 1MHz and so able to be followed by the full 10MHz conversion rate.

When the instrument is operated at high Y-sensitivities (e.g. 5mV/cm and X5 expansion) selection of the MAX and MIN function can have the effect of apparently increasing the amplifier noise and so causing thickening of the trace as it automatically displays the envelope of the signal.

3.10.11 PLOT OUTPUT INTERFACE UNITS

The plot function is not available unless either the 4043 Plot Output option or the 4042 Digital Interface and Plot option is fitted. These options will provide two channel outputs simultaneously for hard copy recording on X-Y or strip chart plotters.

Single or dual channel stored information is generated in analogue form by pressing momentary action PLOT button, which will cause the PLOT l.e.d. to illuminate showing that plotting is in progress.

When using Multi Sweep or Split Display, plot output is obtained two traces at a time, by selecting the required trace hold buttons. If one hold button is selected the plot output information will be identical on both CH1 and CH2 output sockets; and if two hold buttons are selected, the CH1 information will be selected by the uppermost hold button and CH2 information on the other. If three or more holds are active the plot l.e.d. will flash as a warning to show that plot is not permissible. Three modes of Plot output are available, MANUAL, AUTO and CONTINUOUS. Manual mode requires the plot button to be pushed each time an output is required. Auto mode will cause plot data to be output each time a single shot trace or pair of traces has been acquired and then automatically re-arm the Oscilloscope to capture more data when the plot is complete. Continuous mode allows captured data to be repeatedly plotted out, and may also be used as a means of waveform generation.

The 4042 contains circuitry common with the 4043 to provide plot output, and also Interface circuitry which allows information to be written into and read out from the instrument store. The 4042 can interface directly to a dedicated digital system but it is normally used in conjunction with the 4044 to provide G.P.I.B. (IEEE 488) capability. The 4042 in addition to providing data transfer will also provide status information and control of the functions selected via the OS4040. Controllable functions are TIME/CM, VERTICAL MODE, PEAK DETECTION, ROLL/REFRESHED MODES, PRE TRIGGER SELECTION, PLOT, SINGLE SHOT/MULTI SHOT ARM and RELEASE, and DISPLAY Holds. Status information only is read from the Y attenuator

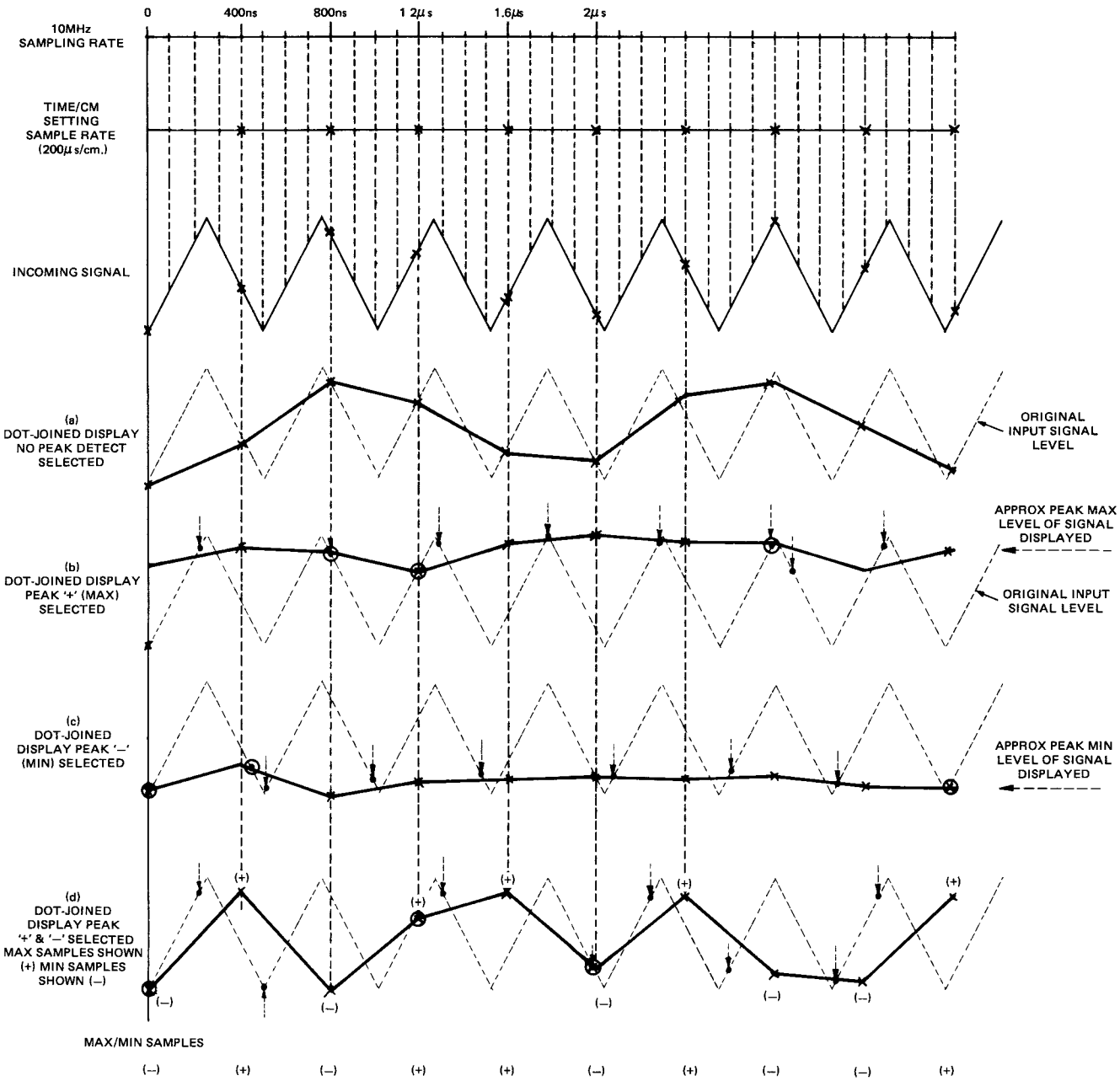


Fig. 3.6 Sampling in Peak Detect Mode

settings. Data from store and status control is read out or written in serial form on an 8 bit wide data bus on the 4042 using the handshake control to clock the data. Two address select lines MUX 1 and MUX 2 define the type of information requested, i.e. data or status, and in some cases, they require indirect addressing to select the particular data.

Both the 4042 and the 4043 are fitted as an extra circuit board in the instrument card frame. Access to the plot outputs and controls is by a small aperture on the right side of the instrument. The 4044 unit is bolted to the top of the 4040 and can if required be retrofitted.

Refer to the appropriate handbook supplement for full details of these options.

3.11 ADDITIONAL FACILITIES

3.11.1 CALIBRATOR SIGNAL

This is output as a 1V d.c. coupled positive-going square wave to an accuracy of ± 2% amplitude and at a frequency of approximately 1kHz. Shorting the CAL pin to the instrument chassis e.g. via the earth connector will produce a square wave current of approximately 1mA in the shorting link. This can be used for current probe calibration.

3.11.2 USE OF OPTIONAL 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 1MΩ shunted by approximately 28pF. The effective capacitance of the input lead must be added to this and the resultant impedance will sometimes load the signal source. Therefore it is advisable to use a 10MΩ X10 probe. This reduces the input capacity (usually to a value of ≙ 10pF) and increases the input resistance at the expense of the sensitivity. The probe contains a shunt RC network in series with the input and forms an attenuator with the input RC of the Y-channel. To obtain a flat frequency response it is necessary to adjust the capacitance of the probe to match the input capacity of the Y channel as follows:-

1. In the NORMAL MODE set the Y channel VOLTS/cm switch to 20mV/cm and the TIME/cm switch to 0.2ms/cm and obtain a triggered trace.
2. Connect the probe to the CAL 1V pin.
3. Set the adjustable capacitor in the probe tip or termination with a small trimming tool for a level response with no overshoot or undershoot visible on the display.

3.12 FUNCTIONAL CHECKS

This section describes a test routine which checks that the instrument is functioning correctly in its main modes of operation, and also provides examples of how to use and set the instrument.

3.12.1 NORMAL MODE

Switch on, and set the HORIZONTAL MODE switch to NORMAL. Next, set the instrument up to the following conditions:-

1. TIME/cm switch to 1ms/cm.
2. CH1 and CH2 attenuators to 0.2V/cm.
3. Select AUTO trigger and set the TRIGGER LEVEL control to mid range. Select '+' SLOPE.
4. Set CH1, CH2 Y shift controls and also the X shift control to a central position.
5. Set the VERTICAL MODE switches to DUAL and the CH1/CH2 input coupling switches to GROUND (GND).
6. Set the TRIGGER SOURCE switch to CH1 and the COUPLING switch to AC. HF REJECT or LF REJECT should not be selected.
7. SELECT X1, X EXPANSION and set the VARIABLE control to CAL.

Turn the INTENSITY control to the fully clockwise position and adjust the CH1 and CH2 shift controls to obtain two traces. Adjust the INTENSITY and FOCUS controls to provide a reasonable brightness display consistent with fine width traces. Adjust the TRACE ROTATE preset control with a screwdriver as necessary for the traces to be horizontal in the central area of the screen. Select CH2 display only and apply a sinewave of about 1kHz to CH2 input. Set the input coupling to DC and switch off the GROUND to the amplifier input. Adjust the input signal level or attenuator setting, to obtain about 5cms of vertical deflection, and using CH2 as trigger source input adjust the TRIGGER LEVEL control for a stable trace. The TRIG l.e.d. should be illuminated. Now switch of the AUTO bright line and check that the trace is still triggered. Turn the trigger level control until the trigger is lost and the trace should disappear. Now re-engage the AUTO and a free-running trace should re-appear. Reset the Trigger Level control for a stationary trace.

With the same signal (1kHz) fed to CH2 input and CH2 trigger source select NORMAL X-Y mode. Adjust the X shift control to obtain a trace which should have the same horizontal and vertical amplitude, thus forming an angle of 45° to the horizontal. Check that adjustment of the variable gain control adjusts the X gain. (The calibrated X expansion settings should have no effect). Now switch to CH1 Trigger Source input with CH1 input grounded and a vertical deflection only should be obtained.

3.12.2 REFRESHED MODE

With the oscilloscope in NORMAL MODE, obtain a stable display with a sinewave signal of approximately 1kHz and a TIME/cm setting of 1ms/cm. Switch to Store Mode and select 0% Pre-Trigger. (Refresh Mode). Check that the trace responds to the Y shift control.

Switch off the Auto function to disable the bright line and adjust the Trigger Level control until the Triggered l.e.d. indicator goes off. The oscilloscope should retain a display of the last signal on which it was triggered. This can be checked by removing the signal input and observing that the trace does not respond when the Y shift is adjusted. Reconnect the signal and adjust the Trigger level to obtain a Refreshed trace again. Now adjust the signal input frequency to about 100Hz, so that one complete cycle appears on the display. Check the operation of the 10% to 60% Pre-Trigger settings by observing the position of the bright up pip for each setting marking the point of trigger (It may be necessary to adjust the Intensity control to observe this). Each 10% setting should approximately coincide with a vertical graticule line if the X shift has been set so that the trace starts from the first left hand vertical. The position of the trigger point on the waveform, as indicated by the bright up pip, or, by the start of the trace when 0% Pre-trigger is selected, should remain the same for each Pre-Trigger setting. Change the frequency of the input signal to approximately 10Hz, disable the Auto bright line, (to avoid mistriggering) and adjust the TIME/cm switch to 50msec/cm. Switch to NORMAL mode and set the trigger level for a stable trace. Observe that the trace flicker disappears when the instrument is returned to the Refresh mode again.

3.12.3 X EXPANSION

Set the TIME/cm to 1ms/cm and insert a frequency of about 20kHz. Switch to Refresh mode and obtain a triggered display. Check that the X expansion ranges step correctly. There should be about 1 cycle displayed per cm on X20 expansion. Further adjustment of the variable control will give about 1 cycle for every 3cm. Note that there will be considerable reduction of trace brightness at full expansion. Adjust the INTENSITY control to compensate.

3.12.4 SINGLE SWEEP

Set the TIME/cm switch to a low speed to best observe the operating sequence, say, 0.5s/cm. Insert a low frequency sinewave of about 3Hz, select d.c. coupling on the Y-amplifier and Trigger input; switch off the Auto bright line function and adjust the Trigger level for a triggered trace. (The Trigger indicator will be observed to flash). Select 0% Pre-Trig Refreshed mode and then press the Y-input coupling GND switch. The instrument will be observed to carry on acquiring data until the rest of the store is full and then the trace will freeze. Now press the SINGLE SWEEP button. The ARMED l.e.d. should now light. Release the GND switch and the ARMED l.e.d. should go off, causing the TRIGGERED l.e.d. to light immediately and remain on while the store performs its acquisition. New data should now start to appear on the screen. At the end of the acquisition, the TRIGGERED l.e.d. will go out and the STORED l.e.d. will be observed to continuously illuminate, indicating that acquisition is complete. No new data can now be entered unless either the RELEASE button is pressed or another Single Sweep cycle is enabled. Note that pressing the SINGLE SWEEP button will re-arm the instrument without the necessity of pressing RELEASE first.

With the same input settings as for the previous test select 60% Pre-Trigger Refreshed mode. After pressing the ARM button the instrument requires about 3 seconds on this timebase range and delay setting to acquire sufficient data to fill the Pre-Trigger store before it is capable of accepting a trigger signal. After this period, when the GND switch is released to enter Y data the TRIGGERED l.e.d. will illuminate as with the previous test, except that the first 6cms of new data will appear instantaneously. Writing of new data will then continue across the screen until acquisition has been complete. The TRIGGERED l.e.d. will the go off and the STORED l.e.d. illuminate.

3.12.5 MULTI SWEEP

The Multi Sweep Arm and trigger procedure is similar to that described for Single Sweep in the previous section. If single channel is selected, 4 successive sweeps will be acquired, whereas if Dual channel is selected the 4 traces will be captured as two pairs. CH1 data will be displayed on traces 1 and 3 and CH2 data on 2 and 4. To demonstrate the operation set the TIME/cm switch to a slow speed say, 0.5ms/cm, single Y channel and insert a low frequency of about 3Hz. The Y-input and trigger coupling should be set to DC and the AUTO bright line should be off. Adjust the Trigger Level so that the TRIG l.e.d. flashes and press the RELEASE button if the STORED l.e.d. is on. Select 0% Pre-Trigger Refreshed mode and the display should be observed to update new data in the usual way. Next, ground the Y input and the data should freeze at the end of the store cycle. Press the MULTI SWEEP button and the ARMED l.e.d. should light. When the ground connection is removed the instrument should trigger, with the result that the ARMED l.e.d. will be switched off and the TRIGGERED l.e.d. will illuminate. At the end of a sweep acquisition the first HELD l.e.d. will illuminate to show that a trace has been stored, and the ARMED l.e.d. will light again awaiting the next trigger signal. The process will continue until four sweeps have been stored, denoted by the STORED l.e.d. and four indicating HELD l.e.d.'s. When the HELD l.e.d.'s are lit, the Post storage offset controls are enabled and adjustment of these controls should be observed to give about ± 4cms of shift to the relevant split trace. Note that Post Storage Offsets have the ability to bring over range waveforms into the graticule area which would normally be 'clipped' by the maximum and minimum limits in the A.D.C. and store system. When using Pre-Trigger delays other than 0% the instrument must allow time to enter data to its Delay store. This causes a delay on each sweep before the instrument will accept trigger (see section 3.12.4).

3.12.6 ROLL MODE

Switch the display mode to ROLL. Select a low sweep speed such as 1sec/cm. Select CH1 only, switch off the

AUTO function and offset the Trigger Level control to one end and ensure that all the HELD and STORED l.e.d.'s are off. Movement of the CH1 shift control will now be seen to draw a trace on the screen similar to a strip chart recorder, with the "pen" at the right side of the screen, and the trace moving towards the left at the sweep speed selected. The HOLD DISPLAY button can be used to arrest the display at any time.

3.12.7 SINGLE & MULTI SWEEP: ROLL MODE

In ROLL mode only 100% pre-trigger information is available, i.e. the point of trigger signifies the last event in the acquisition of each trace. To demonstrate the operation, connect a low frequency signal of about 3Hz, with timebase and trigger settings as for the previous test in section 3.12.6. Press the MANUAL TRIGGER button. This will disable all other trigger sources. Press the MULTI SWEEP button and the ARMED l.e.d. will switch on. The trace should continue to ROLL in absence of trigger. After allowing sufficient time for a complete trace of new data to build up press the MANUAL TRIGGER button. One trace should freeze. (Use the Post-Storage Offset controls if required to differentiate the traces). The ARMED indicator should now light again. After allowing sufficient time for a new complete trace of data to build up (about 10 sec) press MANUAL TRIGGER again and a second trace should lock. The process can be continued until all four traces are captured. The procedure for capture can be demonstrated in a similar way when Single Sweep is selected. If no trigger is present, selection of the AUTO function will cause the Multi Sweep capture sequence to run through automatically.

3.12.8 HOLD DISPLAY

Select ROLL mode, insert a low frequency signal and select a slow timebase frequency (e.g. 3Hz, 0.5sec/cm). Press the HOLD DISPLAY button and note that the display freezes immediately regardless of the Bright Line Auto function. Note also that when Hold Display is released, store writing will continue from the point on the trace where it was frozen. Hold Display will prevent further acquisition in either Roll or Refresh modes and can be employed usefully to hold the display in the middle of any capture sequence. Alternatively, any stored pattern, single or multi trace can be retained by the HOLD function while the instrument is used in the NORMAL mode. The stored pattern will be returned to the display when the STORED mode is selected.

3.12.9 SPLIT DISPLAY FACILITY

Operation of any of the Split Trace Hold buttons can be used to instantaneously freeze a trace while the rest of the display continues updating. Alternatively, a stored trace or pair of traces can be split up into four individual traces if all the Hold buttons are selected. To demonstrate the operation, select CH1 Refresh mode and insert a low frequency signal and timebase Range. Adjust the Trigger Level to obtain an updating display and press a Hold button to freeze a trace, this will be signified by the Held l.e.d. Adjust the relevant Post Storage Offset control to differentiate the held trace from the live data. Other traces may be held in a similar manner.

Next, capture a trace by use of the single shot facility. Press a trace hold, and the l.e.d. associated with the hold will light. The trace Offset may then be used to differentiate the split section of the stored display. Check either that a trigger signal is present or the Auto Bright Line function is selected and operate the RELEASE button. The held trace should remain whilst the rest of the display returns to the Refresh mode again.

3.12.10 PEAK DETECT

Peak Detect has two primary applications either as a means of enhancing glitch or fast transient detection or to detect an alias mode (see sections 3.10.9, 3.10.10 ALIAS EFFECT, PEAK DETECT).

To demonstrate the glitch detection enhancement, select a slow TIME/cm range e.g. 50ms/cm and single Y channel. Select also Refreshed mode and switch off AUTO Bright Line. Using a suitable pulse generator, insert a signal to the CH1 input consisting of square wave positive going pulses about 150ns wide and at a repetition rate of about 50Hz. Adjust the Trigger Level control to obtain a Refreshed display. Without the Peak Detect facility selected it will be observed that most of the pulses are missed or appear at reduced amplitude. Now press PEAK DETECT + and the l.e.d. indicator should light. All the peaks should now appear at about their maximum amplitude on the display (2.5/cm). Next, release PEAK DETECT '+' and press PEAK DETECT '–'. Again, many of the pulses will be missed, but if CH1 INVERT is pressed to invert the pulse waveform, then all the peaks will again appear. Referring back to NORMAL mode will demonstrate the advantage of this facility and digital storage, since the pulses will be very difficult to observe on the flickering display.

If the instrument is returned to the Refresh mode again and the PEAK DETECT '+' and '–' buttons are selected it will be observed that although there is improvement in glitch capture when compared to the situation without Peak Detect selected, about 50% of the pulses will be missed. Fig. 3.5 section 3.10.10 gives details of glitch capture probabilities. To demonstrate the alias detection mode, first switch off Peak Detect and with the timebase setting at 50ms/cm connect an input signal of about 10kHz. A sinewave alias signal should be displayed. (It may be necessary to adjust the input frequency for the best effect). If either Peak Detect '+' or '–' is selected, a maximum or minimum signal approximating to a line will be observed. If Peak Detect '+' and '–' are selected together, both the maximum and minimum will be observed, chopped by a rapid switching signal. If the timebase Range is now turned up to a much higher range e.g. 0.1ms/cm this alias mode will not occur, and the Peak Detection circuitry will have no effect on the display.

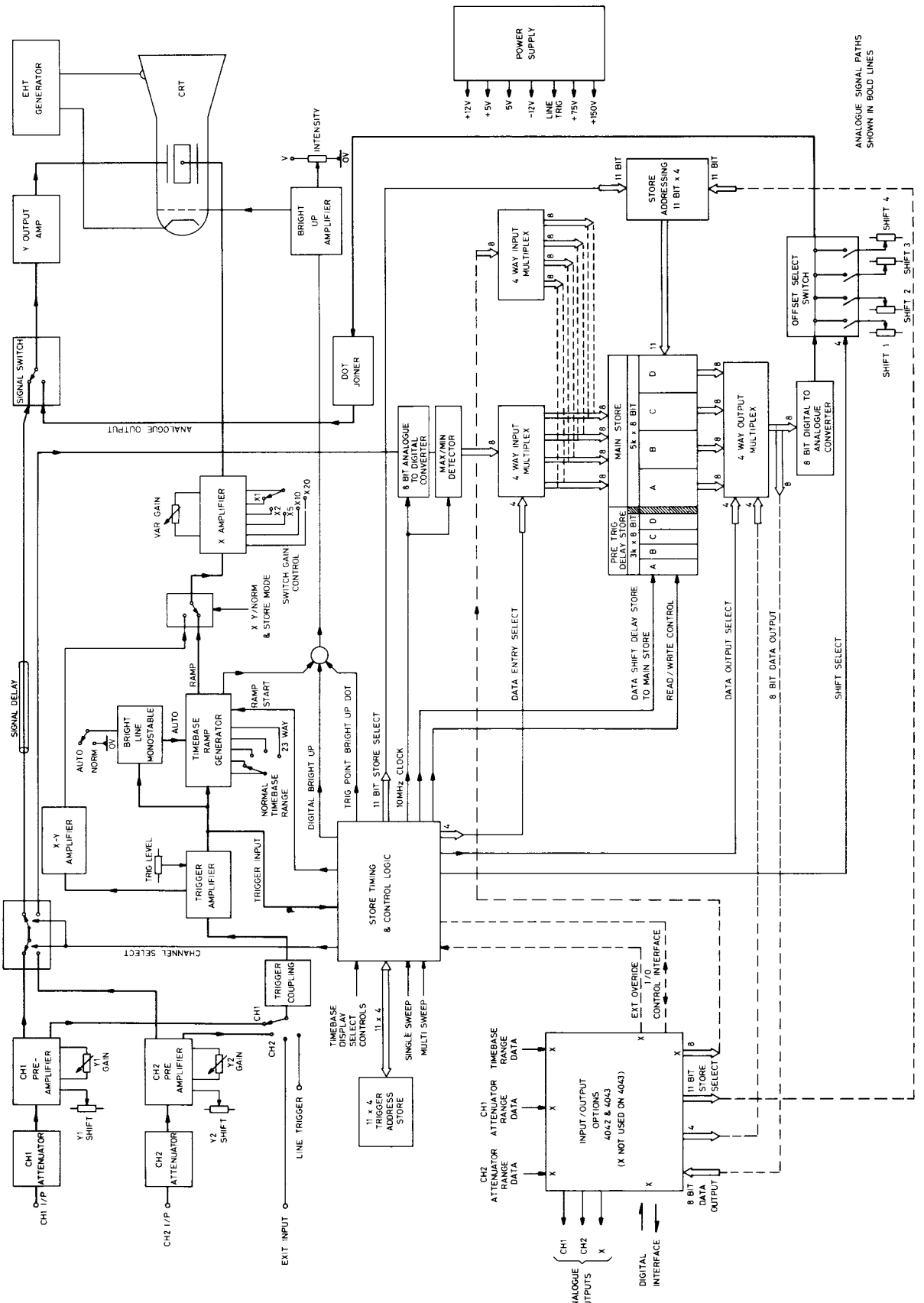


Fig. 4.1 Block Diagram

4.1 SYSTEM DESCRIPTION

When the NORMAL T-Y switch is selected, the instrument operates as a conventional oscilloscope. Referring to Fig. 4.1, input signals are applied to two identical pre-amplifiers via a switched attenuator network which provides decade division steps ÷ 1, ÷ 10, ÷ 100 at a constant 1MΩ/28pF input impedance. The 1, 2, 5 steps to fill in the remaining ranges in conjunction with the decade steps as provided by a second attenuator suitably buffered to operate at low impedance. Trigger pick off, x 5 gain select, invert and Y shift are all incorporated within the Pre-amplifier section. The trigger pick off point is taken from an amplifier stage before gain x 5, Invert and Y shift in order that these controls do not affect the trigger signal when adjusted. The outputs from the pre-amplifiers are applied to the beam switch which selects the appropriate amplifier CH1, CH2, when selected, or can be made to switch automatically between CH1 and CH2 when Dual channel is selected. Flicker is reduced at low timebase speeds in Dual channel mode by using a 500kHz signal to 'Chop' the signals but at high timebase speeds (>1ms/cm) the channels are switched over on alternate sweeps to prevent the chop waveform appearing on the trace.

The output from the beam switch is applied via the signal switch to the Y output amplifier which drives the vertical deflection plates of the c.r.t.

The signals from each Y Pre-amplifier trigger pick off are fed to the trigger source switch which also receives signals from the External input socket and a Supply frequency, Line signal from the mains transformer. The selected trigger signal is then conveyed to the trigger coupling network where AC/DC coupling is selected or the LF Reject and HF Reject filters can be applied. The trigger amplifier has a high gain, snap-action trigger circuit which converts this input signal to a square wave. Trigger action selected on rising edge (+) or falling edge (−) signals is achieved by inverting the trigger amplifier signals. A fast trigger edge, provided by the trigger amplifier, is sent to the timebase ramp generator to initiate a ramp signal.

The timebase will then ignore any other trigger signal until it has completed the ramp and returned to its original state. The ramp output then passes via the X-Y/NORM/STORE signal switch to the X amplifier which produces a horizontal scan on the c.r.t. A bright up pulse which lasts the duration of the ramp signal is sent from the timebase via a summing network to the Bright up amplifier. The bright up signal is amplified and used to control the grid of the c.r.t. in conjunction with the INTENSITY control. At the end of the ramp, the bright up is removed to blank the trace during fly-back and until the next trigger signal. The trigger pulses from the trigger amplifier are also sent to the bright line Monostable. This circuit has a dual function. It drives the TRIGGERED indicator when trigger pulses are present and inhibits the AUTO or bright line function which otherwise allows the timebase ramp generator to cycle automatically in the absence of trigger.

When NORMAL X-Y is selected, the timebase ramp generator is turned off and signals are applied to the X-amplifier from the X-Y amplifier via the X-Y/NORM & STORE MODE switch. The X-Y amplifier input is taken from a pick off point in the trigger amplifier, and hence the X-Y signal input is selected by the Trigger Source switch.

When STORE T-Y is selected, the digital modes are operative and the Y input signals are applied to the Analogue to Digital Converter, (ADC) instead of the Y Output Amplifier. The ADC samples the incoming signal every 100ns and converts each sample to an 8 bit (256 level) binary code and this output is entered via a 4 way multiplex system into the store,

The REFRESHED mode, without Pre-trigger selected, directly corresponds to Normal T-Y operation when a trigger signal initiates a sequence in the Timing and Control section to enter 5K of samples into the Main Store. On the fastest available digital range, these samples are entered into the store at the full 10MHz rate, and the store is filled in 500μs (5K x 100ns) i.e. equivalent to a normal 10cm timebase sweep at 50μs/cm. At slower Time/cm settings, the data entry rate into the store is divided accordingly. Once all addresses in the store have been filled, data entry is held. When Single Sweep mode is selected a triggered up-date of data is initiated only after a manual arm of the control circuit but in the Released mode, the store update is initiated immediately by the next trigger pulse. The latter corresponds to repeated triggered operation in the NORMAL mode.

Meanwhile an independent counter in the Control Logic cycles continuously to scan the main store, reading data out via a multiplexer into a D–A converter to re-construct the input waveform in a staircase or stepped form. A Dot Joiner provides linear interpolation between levels and this signal is sent ot the X-Y deflection system of the c.r.t. At the same time the Timebase ramp generator is triggered and sweeps at a fixed rate corresponding to the data read-out to provide a continuous display of the waveform held in the store. To avoid interference the data write and read functions are time sequenced to occur alternately.

When a Pre-trigger storage mode is selected, data from the ADC is fed continuously to all or part of the pre-trigger section of the store. On receipt of trigger this store is frozen and its contents are transferred into the corresponding front section of the main store. Subsequent data from the ADC is then directed to the remaining section of the main store.

For instance, at 20% of pre trigger, 1K of the available 3K pre-trigger store is employed. When data from this is entered into the first 1K of the main store, it represents 20% of the full 5K capacity and the subsequent data is entered from the end of this first 1K to fill the

full 5K of store for the remaining 80% of post storage trace.

In the display of this Pre-trigger mode, a pulse is sent from the control logic at the appropriate point in the sweep to provide a bright up dot signifying the point of trigger.

The main application of the ROLL mode is to view slow moving events and its operation is best understood at slow rates of data entry (Time/cm). In this mode, data from the ADC is entered continuously into the Main Store but each read-out scan is made to start from the next address beyond that at which data is being entered. The effect is then to display a full scan of captured waveform with the latest data or "now" at the end of the sweep, i.e. a continuous rolling display which does not require trigger. In the Single Sweep mode, data entry is halted immediately on receipt of trigger to retain a display of 100% pre-trigger.

In single channel mode (CH1 or CH2) the digitised signal level from the selected store is entered in sequence into all store locations and read-out or reconstruction of the signal follows the same sequence. In DUAL channel mode, the beam switch is reversed between each data entry into the store and thus CH1 and CH2 data is stored on alternate locations (data is entered in the equivalent of Chop mode in Normal operation) thus sections A and C of the multiplexed store correspond to one channel and sections B and D to the other. The readout sequence of dual channel data is to address all CH1 data and then all CH2 data, thus regenerating the two signals on alternate traces.

The principle of operating only on alternate locations in the store is extended to achieve the SPLIT display mode. When a split trace hold is selected, data entry is inhibited on one of the four store sections (e.g. the whole of section A) so that these addresses retain data from the previous trace. Similarly the store would retain other sections in the series A, B, C, D when other trace holds were selected.

Readout in this mode is organised into each of the 1 in 4 sections in turn, i.e. the regenerated display forms each of the 4 possible traces in sequence while the relevant post storage offset is added accordingly. This allows the generation of a 4 trace display, each stored at a different time and each following its own post storage shift.

As alternate store sections are allocated to CH1 and CH2 data in Dual trace operation, two of the split traces correspond to CH1 (Blocks A and C) and two to CH2 (Blocks B and D).

When Multi-Sweep is selected, the control circuitry automatically executes four triggered sweeps of data entry, retaining each of the split sections in turn, before inhibiting any further response to trigger until the system is re-armed.

As the 5K capacity of the main store is divided between two traces in Dual Channel mode or four traces in Multi-Sweep/Split trace mode. Thus there are 2.5K or 1.25K samples assigned for each replayed trace. The replay clock rate remains the same and hence the time-base sweep rate must be doubled or quadrupled accordingly.

The internal crystal clock is of course not synchronous with an incoming trigger signal and in single channel mode, the possible time variation between trigger and the next clock pulse to initiate data entry will cause the regenerated trace to be indeterminate in time (or to jitter by up to 1 sample (1 in 5K of trace or only 1mm of the 10cm trace on the full x 50 expansion). Additional storage of the trigger phase is provided in the control logic to ensure that this jitter does not increase by a factor of two or four in dual on four trace display modes but remains as 1mm maximum).

The ADC operates continuously at the full 10MHz on the data presented to it but at all timebase ranges slower than 50μs/cm the necessary division allows data storage of one sample in 2, 4, 10 etc. while the other samples are ignored. Thus a fast transient could be detected by the ADC but not be retained if it occurred between entries of data into the store.

When the MAX or MIN facility is selected, additional circuitry is brought into operation between the ADC and the store. In MAX, this examines each digitised sample or number from the ADC comparing it with the previous maximum number found since the last data entry to the store. If it is less it ignores the number but if more, it retains that number as its new maximum. When each data entry is called into the store it is the current maximum which is entered instead of the actual number from the ADC at that time. After each data entry the maximum number is reset to the current number, then to capture only the maximum during the period up to the next data entry. Thus any glitch is detected and its peak amplitude is recorded. Similarly when MIN is selected, the system responds to the minima which occur. When both MAX and MIN are selected the system is made to alternate between maximum and minimum detection on each data entry. Thus there is only a 50% chance of capturing a single unipolar transient but the system will respond well to follow the envelope of a modulated carrier signal where maximum and minimum occur between each data entry.

The control circuitry for the store operates on a time multiplex system which has a sequence of slots to allow data entry (into main or pre-trigger store), transfer from pre-trigger to main store and readout from main store. When the Plot Option 4043 is fitted, additional circuitry in that unit has access to the store within another dedicated time slot. An address counter in the option is caused to scan all main store locations at the specified plot rate and the output data from the store drives one or two DAC's (single or dual mode) which generate the necessary output signals. In addition the more comprehensive option 4042 has a digital interface system which

allows the output data from the store to be transmitted directly or via the 4044 onto an IEEE 488 data bus. Alternatively data may be generated remotely and entered into the main store as the address counter in the 4042 scans all its locations. The digital interface system also allows the operating status of the OS4040 to be read out or to be controlled. In the latter case the manual settings of most of the OS4040 controls are over-ridden and it responds only to the external command.

NOTE:- FOR SERIAL NOS. ABOVE 2001 REFER TO APPENDIX AT REAR OF MANUAL.

5.1 GENERAL

The instrument is electrically protected by four fuses as follows:-

1. The supply line fuse, FS1 mounted on the rear panel next to the supply voltage. The rating is 2A Slo-Blo (Part No. 4 50286) for 220/240 volt operation and 4A Slo-Blo (Part No. 44899) for 100/120 volt operation.
2. The +150V/+75V fuse FS900 mounted on the Power Supply board at the L.H.S. rear of the instrument see Fig. 5.1. Access is by removing the top cover (see section 5.2). The fuse rating is 250mA Fast Blow 500mA (Part No. 32338)
3. The +5V supply and –5V supply fuses are mounted side by side on the centre chassis plate near the EHT generator section see Fig. 5.2. Access to these fuses is gained by removing the bottom cover (see section 5.2). The +5V supply fuse is 10A FAST BLOW (Part No. 12991) and is situated nearer the rear of the instrument. The –5V supply fuse is 5A FAST BLOW (Part No 12807) and is situated nearer the front of the instrument.

5.2 MECHANICAL ASSEMBLY

5.2.1 LAYOUT

Figures 5.1, 5.2 & 5.3. illustrate the internal layout of the instrument and show the positions of the majority of preset components. These are accessible when the top and bottom covers have been removed. Each cover is held in position by four retaining screws.
DISCONNECT THE INSTRUMENT FROM THE SUPPLY BEFORE REMOVING THE COVERS.

WARNING – DANGEROUS HIGH VOLTAGES ARE EXPOSED WHEN THE COVERS ARE REMOVED AND THE INSTRUMENT MUST BE WORKED ON ONLY BY SUITABLY QUALIFIED PERSONNEL. NOTE ALSO THAT COMPONENTS IN THE C.R.T. SUPPLY CIRCUITRY MAY REMAIN CHARGED TO A HIGH VOLTAGE AFTER THE INSTRUMENT HAS BEEN SWITCHED OFF.

Warning labels of "DANGER HIGH VOLTAGE" are situated in areas of particular importance.

The POWER SUPPLY board contains the low voltage and 75V/150V power supplies, and is situated at the L.H.S. rear of the instrument next to the supply transformer. The output transistor for the +5V supply and the –5V regulator unit are mounted on the heatsink assembly at the rear of the instrument and connect to the power supply board.

The Y PREAMPLIFIER AND BEAM SWITCH assembly contains the input amplifiers and attenuators for both Y-channels. It is secured under the c.r.t. and has the Y signal delay line associated with it.

The EHT supply consists of the EHT oscillator board and the EHT multiplier unit. It is situated in a screening box below the neck of the c.r.t. and immediately behind the Y-PRE AMPLIFIER assembly.

The TIMEBASE BOARD carries the timebase ramp generator circuitry, trigger amplifier, X output amplifier and calibrator. It is mounted on the centre panel facing the c.r.t.

The Y OUTPUT AMPLIFIER board contains also the DOT JOINER, the BRIGHT UP AMPLIFIER and the c.r.t. control circuitry. It is mounted on the L.H.S. of the instrument adjacent to the c.r.t.

The digital section of the instrument is situated in a card frame unit on the R.H.S of the centre plate. All of the boards in this unit are connected by an edge connector system to the Mother board at the bottom of the unit.

Each circuit board in the card frame has a colour coded label attached to it, corresponding to a similar label on the card frame to assist with recognition and reassembly. The colour code is as follows:-

A-D converter	RED Dot
CONTROL BOARD	BLUE Dot
STORE BOARD	GREEN Dot
INTERFACE BOARD	YELLOW Dot
OPTIONS 4042, 4043 (When fitted)	WHITE Dot

The ANALOGUE TO DIGITAL CONVERTER (ADC) is the nearest digital board to the centre panel. This is connected to the digital delay line which consists of several metres of wound coaxial cable attached to the centre panel. (Delay line not fitted from S/No. 2001).

The CONTROL board contains the store system clocks, trigger control circuitry, MAX/MIN circuitry, data transfer/hold off counter and the Digital to Analogue Converter unit (DAC). It is fitted next to the ADC and is the second from centre in the card frame unit. (A space is left in the card frame between the ADC and the CONTROL board).

The STORE BOARD contains the Random Access Memory (RAM), the store address circuitry, the three address counters (Main, Trace & Delay counters), and the Trigger Address Store. The STORE board is the third from centre in the card frame unit and situated next to the control board.

The INTERFACE board provides the means of connecting the store system with the front panel controls and the analogue circuitry. This board also incorporates the 10MHz/5MHz/2.5MHz clock generators, the Single/Multi sweep circuitry and part of the Trigger Jitter correction circuitry. It is situated fourth from centre in the card frame unit, next to the store board.

A spare space and edge connector on the R.H.S. of the card frame is reserved for the OS4043 Plot Option board or the OS4042 Plot Output and digital I/O unit. These units have separate controls and input/output connectors fitted to a panel at the side of the instrument.

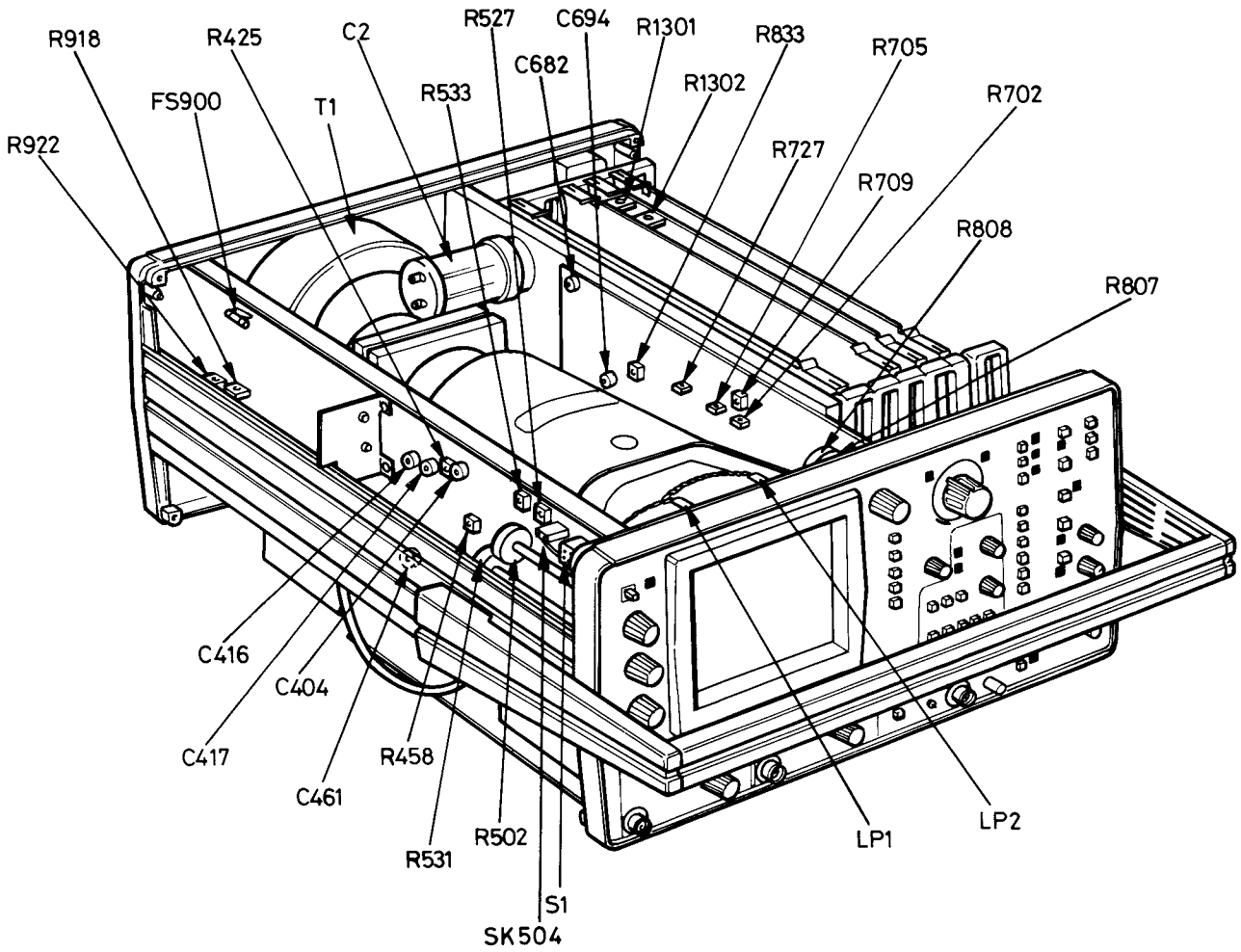


Fig. 5.1 Front View

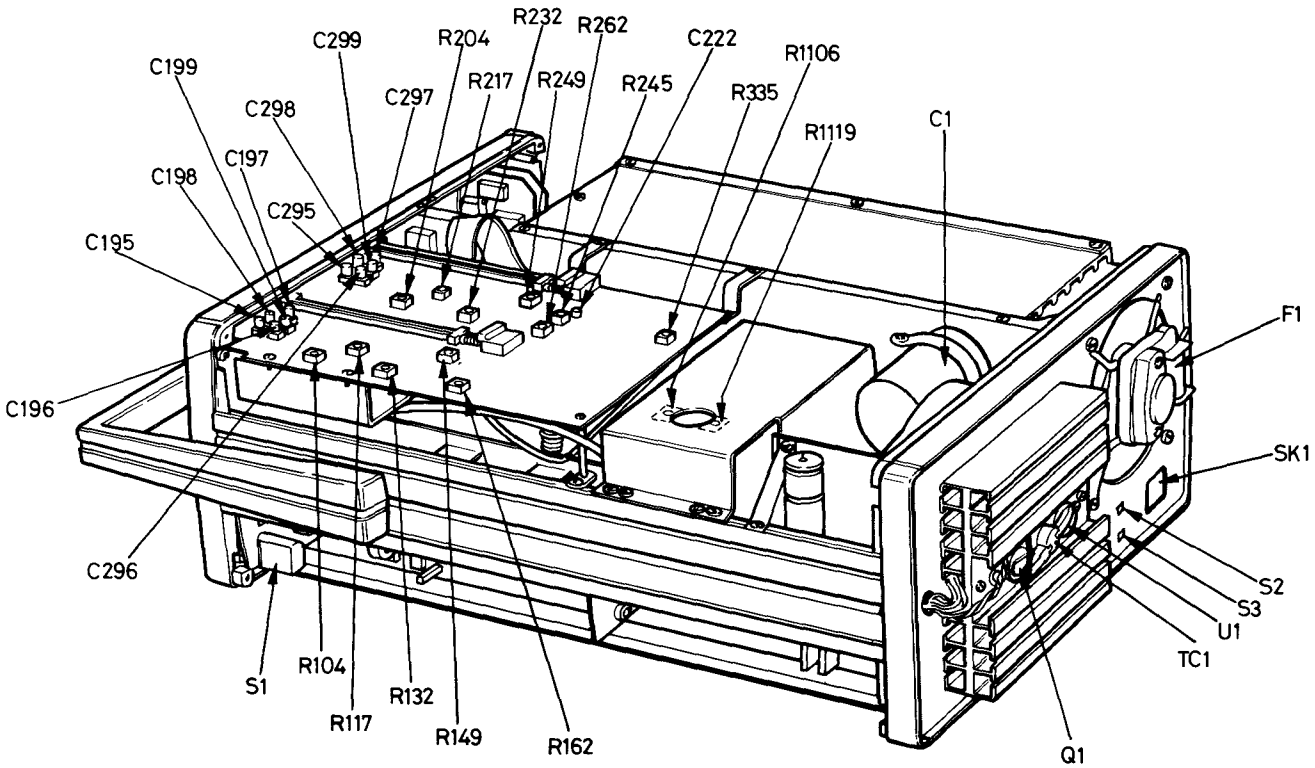


Fig. 5.2 Bottom View

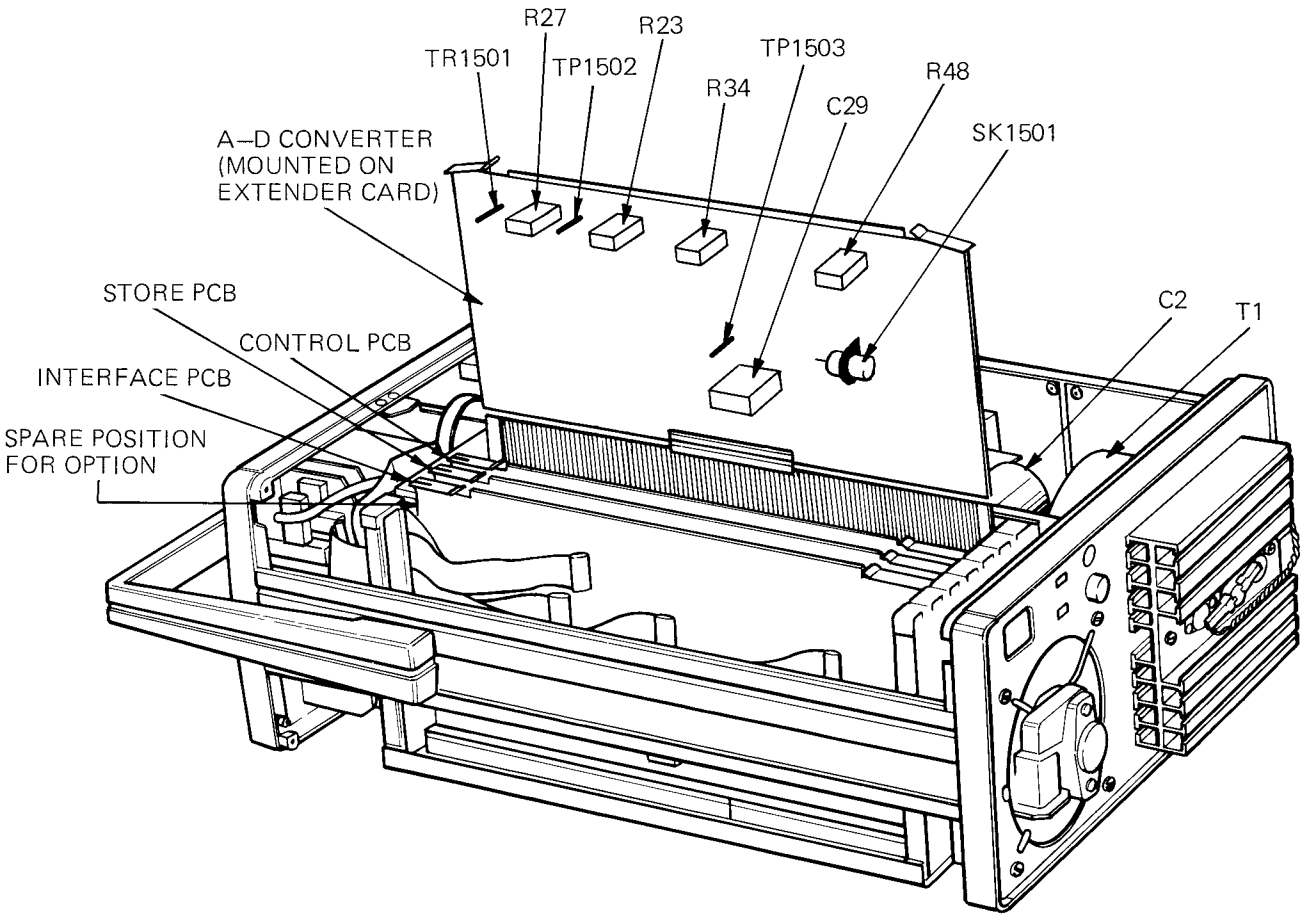


Fig. 5.3 Side View

There are also five small boards associated with the push button system of the front panel. Three of the boards are arranged in a tier system below the Timebase Range switch and perform the functions of selecting the trigger source, slope and coupling. They are fixed to an inner panel together with the timebase switch. The other two boards are mounted on the switches concerned with the store mode operation and provide an interconnection role to the Interface board. This forms another inner panel assembly together with the post storage offset controls.

The construction of the instrument has been arranged so that most of the individual boards and assemblies can be checked in situ and also to allow easy servicing when required.

5.3 CALIBRATION PROCEDURE

The calibration procedure is detailed below. Note that any calibration adjustments found necessary must not be made until a 15 minute warm-up period has elapsed. The locations of the various preset components are shown in Figs. 5.1, 5.2 and 5.3.

All measurements are made with respect to chassis 0V, except where stated.

5.3.1 TEST EQUIPMENT REQUIRED

1. Variable Autotransformer. Output voltage 95-260V at 5A with r.m.s. voltmeter.
2. Digital voltmeter with 1MΩ minimum input impedance, and accuracy within 0.1%.
3. High voltage probe for voltmeter, capable of operation up to 10kV.
4. Levelled R.F. sinewave generator, 500kHz to 50MHz with 50kHz reference frequency. Output amplitude 10mV to 5V pp into 50Ω, accuracy within 3%.
5. L.F. Sinewave generator.
6. Fast rise squarewave generator 100Hz to 1MHz (flat top squarewave with amplitude range 0.1V to 1V into 50Ω with rise time of less than 2ns).
7. Voltage calibrator 1kHz squarewave generator with amplitude range of 2mV to 50V ±0.2%.
8. BNC-BNC connector lead.
9. 50Ω BNC through-termination.
10. Capacitance standardiser 1MΩ/28pF.
11. Test oscilloscope 30MHz bandwidth ⩾5% accuracy, ⩽ 50mV/cm sensitivity with x 10 low capacitance probe.
12. Time mark generator 50ns to 1ms ±0.2%.
13. ADC Extender Board. PN 450397.

5.3.2 POWER SUPPLY VOLTAGES

1. Set the INTENSITY control to a minimum.
2. Set the SUPPLY VOLTAGE switches on the rear panel to suit the available supply. Check that the correct supply fuse has been fitted. Using the autotransformer, set the supply to the instrument to within ±2% of the selected nominal voltage.
3. Check that the POWER ON l.e.d. is lit, and that the SCALE control varies the graticule illumination.
4. Connect the d.v.m. to pin 917 on the power supply board; set R918 to give +12.0V ±0.1V.
5. Connect the d.v.m. to pin 916 on the power supply board; set R922 to give −12.0V ±0.1V.
6. Check that the +5V supply on pin 903 is between 4.8V and 5.2V. If necessary, change R903 (A.O.T.) to achieve this.
7. Check the following supply voltages:

pin 902	- 5.2V ±0.2V
PL1 (3)	+75V ±2V
PL1 (5)	+160 ±10V

If necessary, change R925 (A.O.T.) to bring the +75V supply within limits.

5.3.3 E.H.T. AND C.R.T. CUT OFF VOLTAGES

1. Remove the screen from the e.h.t. oscillator. BEWARE HIGH VOLTAGE.
2. Connect the d.v.m. via the high voltage probe to the cathode (positive band) of D1114. Adjust R1106 for −1500V.
3. Set the instrument to X-Y mode and centre the spot on the screen. Adjust the INTENSITY control for +8V at the junction of R522, C513 and R517 on the Y output p.c.b., then set R1119 for a just visible spot.
4. Replace the e.h.t. screen

5.3.4 SCALE ILLUMINATION

Check that both lamps are operating. Replace if showing signs of blackening. Check that their brilliance is fully variable.

5.3.5 TRACE ALIGNMENT, GEOMETRY AND ASTIGMATISM

1. Set the instrument to 1ms/cm, 50mV/cm, with trigger to AUTO, Y MODE to CH1, Normal T-Y mode.
2. Ground CH1 input and centre the trace. Adjust the TRACE ROTATE control for a horizontal trace. (It may be necessary to reverse SK504).
3. Set CH1 input to AC. Apply a 1MHz sinewave of approximately 400mV amplitude. Trigger the signal and adjust the GEOM preset R533 for the best compromise of the X and Y edges at the extreme edges of the graticule.
4. Apply a 1kHz sinewave of approximately 400mV amplitude. Trigger the waveform, and adjust the ASTIG preset R527 in conjunction with the FOCUS control for the finest trace at low intensity.
5. Recheck the geometry setting. Note that calibration of X and Y can be affected by the geometry setting, and it is important to check calibration when this has been changed.

5.3.6 Y AMPLIFIER ADJUSTMENTS

CHANNELS 1 & 2 – AC/DC EQUALISATION

1. Set the instrument to CH1 only, 10mV/cm sensitivity DC coupled, triggered from CH1 AC coupled, time-

base 5ms/cm, Normal T-Y mode.
2. Apply a 100Hz squarewave via a 28pF standardiser and adjust R117 for a flat top to the waveform.
3. Repeat for R217 on channel 2.

5.3.7 CHANNELS 1 & 2 – DC STEP ATTENUATOR BALANCE

1. Set to CH1 only, 20mV/cm sensitivity, input grounded, timebase free running (AUTO), Normal T-Y.
2. Centre the trace, and adjust R104 so that there is no trace movement when the attenuator is switched between 20mV/cm and 5mV/cm.
3. Repeat for CH2, adjusting R204.

5.3.8 CHANNELS 1 & 2 – VARIABLE GAIN BALANCE

1. Set the instrument as for 5.3.7 above.
2. Centre the trace and adjust R132 for no movement when the CH1 variable gain control is operated.
3. Repeat for CH2, adjusting R232.

5.3.9 CHANNELS 1 & 2 – INVERT BALANCE

1. Set the instrument as for 5.3.8. above.
2. Select x 5 gain magnification for both CH1 and CH2.
3. Centre the trace and adjust R149 so that there is no trace movement when the CH1 Invert switch is operated.
4. Check that operation of the CH1 x 5 switch causes no trace movement.
5. Repeat the procedure for CH2, adjusting R249.

5.3.10 CHANNELS 1 & 2 – SHIFT RANGE

Apply a sinewave signal to each channel in turn and set the amplitude for 8cm pk-pk display. Check that the traces can be shifted completely off the screen in each direction.

5.3.11 ADD MODE BALANCE

1. Set the instrument to DUAL mode, 20mV/cm sensitivity each channel, input grounded, timebase free running (AUTO) at 1ms/cm, Normal T-Y mode.
2. Centre both traces and the operate the ADD switch. If the trace moves from the centre of the screen by more than 1cm, remove R403 or R405 on the Y output p.c.b. to rectify the situation.

5.3.12 CHANNELS 1 & 2 – GAIN CALIBRATION

1. Set the instrument to CH1 only, 20mV/cm. Apply a 100mV peak to peak squarewave from an oscilloscope calibrator, set the timebase to a suitable speed and trigger the waveform. Adjust R425 for exactly 5cm peak to peak on the screen.
2. Check that the variable gain control reduces the display amplitude to between 1 and 2 cm, and is smooth in operation. Check that the UNCAL l.e.d. operates.
3. Set the instrument to 10mV/cm and apply a 50mV peak to peak squarewave from the calibrator. Check that a 5cm deflection is obtained, and reduce the input to 10mV pk-pk. Select x 5 gain magnification and check that the deflection is 5cms ±1.5mm.
4. Repeat step 1 for CH2, adjusting R245 on the Y preamp p.c.b.
5. Repeat steps 2 and 3 for CH2,

5.3.13 CHANNELS 1 & 2 – ATTENUATOR COMPENSATION

1. Select CH1 only 0.1V/cm, set the calibrator to give a 5cm pk-pk squarewave at 1kHz, and adjust C199 to give a square corner.
2. Select 1V/cm sensitivity, reset the calibrator and adjust C196 for a square corner.
3. Fit a 28pF capacitance standardiser in series with the input, select 10mV/cm sensitivity, reset the calibrator, and adjust C197 for a square corner.
4. Select 0.1V/cm and repeat, adjusting C198.
5. Select 1V/cm and repeat, adjusting C195.
6. Select CH2 only and repeat steps 1 – 5 above, adjusting C299, C296, C292, C298, and C295 respectively.

5.3.14 FUNCTIONAL CHECKS

CHANNELS 1 & 2 – ATTENUATOR ACCURACY

Using the calibrator, check all attenuator ranges on both channels for ±3% accuracy and square corner.

CHANNELS 1 & 2 – INVERT SWITCHES

1. Select CH1 only. Invert a 5cm squarewave and check that the amplitude does not change.
2. Repeat for CH2.

CHANNEL 1 & 2 – INPUT LEAKAGE

Select 1mV/cm sensitivity, using the x 5 switch. Check that when the input coupling is switched from DC to GND, the trace movement is less than 1mm on both channels.

5.3.15 Y AMPLIFIER PULSE RESPONSE

NOTE: If there is any reason to suspect that there are significant timebase h.f. calibration errors, these should be checked and rectified before proceding further, as the pulse response measurements will otherwise be invalid.

1. Centre the trimmer capacitors, C416, C417, C403.
2. Select CH1, DC coupled, 20mV/cm sensitivity, with the timebase at 0.2μs/cm. Apply a fast risetime squarewave with 1MHz repetition rate via a 50Ω termination, and adjust the level to give about 5cm pk-pk.
3. Adjust C416 on the Y Output p.c.b. to give the display squarewave a flat top.
4. Adjust C417 to optimise the squarewave corner.
5. Adjust C404 to optimise the squarewave edge. It may be necessary to adjust each trimmer several times to achieve the best compromise, paying particular attention to obtaining a square corner.
6. Select CH2, DC coupled, 20mV/cm sensitivity, and apply the same signal as for CH1. Adjust C222 for optimum squarewave shape and matching to CH1.
7. Check that the risetime is less than 14ns on both channels.

8. Recheck the pulse response with a 100kHz squarewave.

5.3.16 Y AMPLIFIER BANDWIDTH

1. Select CH1, DC coupled, 20mV/cm sensitivity. Connect a Constant Amplitude Sinewave Generator via a 50Ω termination.
2. Switch the reference frequency and adjust the output to give a 5cm pk-pk deflection. Increase the generator frequency until the amplitude drops to 3.5cm. The frequency should be greater than 25MHz.
3. Similarly check the bandwidth on the 5mV, 10mV, 0.1V, and 1V ranges. All should be greater than 25MHz.
4. Select 20mV/cm with x 5 magnification. Check that the bandwidth is greater that 8MHz with this combination.
5. Repeat steps 1–4 for CH2. Should the bandwidth prove inadequate, recheck the pulse response (section 5.3.15) paying particular attention to obtaining a square corner.

5.3.17 DOT JOINER ADJUSTMENT

1. Select STORE T-Y mode, 50μs/cm x 20. Set CH1 input to GND and apply HOLD. Adjust C461 on the Y output p.c.b. to give the 'cleanest' trace, free from ripples.
2 Remove GND and HOLD. Apply a 10kHz squarewave to the input and give a 4cm pk-pk waveform. Apply HOLD. Adjust R458 to give a square corner.

NOTE: These settings may be confused if the A.D.C. is out of adjustment.

TIMEBASE ADJUSTMENTS

5.3.18 X MEAN PLATE POTENTIAL

1. Set the timebase to 0.1ms/cm, X1, AUTO trigger, and set the trigger LEVEL for a stable trace.
2. Adjust the X shift control to bring the start of the trace to the centre of the screen. Using the test oscilloscope, check that the sweep start voltage on each plate lies between +65V and +75V. If necessary, change the A.O.T. resistor R840 to achieve this.
3. Repeat for X10 expansion, adjusting A.O.T. resistor R844 is necessary.

5.3.19 TRIGGER BALANCE

1. Set the instrument to AC, CH1, Normal T-Y, 0.1ms/cm, positive slope and AUTO. Apply a 10kHz sinewave of about 6cm pk-pk on the display, set the TRIGGER LEVEL to centre and the TRIGGER COUPLING to AC with CH1 as source. Adjust R635 so that the trigger point is central to the displayed waveform.
2. Set the TRIGGER COUPLING to DC, and adjust R162 on the Y Pre-amplifier p.c.b. for no trigger point movement between DC coupling and AC coupling.
3. Select CH2 as source, apply the sinewave to CH2 input, and repeat step 2, adjusting R262.

5.3.20 EXTERNAL X COMPENSATION

1. Set the TRIGGER SOURCE to EXT, and TRIGGER COUPLING to DC. Select X-Y horizontal mode and CH2 vertical mode.
2. Apply a 1kHz squarewave from the calibrator to both CH2 input and the EXT socket, and adjust the CH2 attenuator and the calibrator output to give two spots on the screen approximately 5cm apart and at 45° to the screen centre.
3. Adjust the trimmer capacitor C603 on the Trigger Source p.c.b. to give two clear spots on the screen. i.e. remove appearance of horizontal tail to the spot.

5.3.21 TIMEBASE CALIBRATION

1. Set the VERTICAL MODE to CH1 with input at DC, and the HORIZONTAL MODE to Normal T-Y, 0.1ms/cm, X1, with CH1 as TRIGGER SOURCE.
2. Apply 0.1ms markers from the time mark generator, trigger the waveform, and adjust R705 on the timebase p.c.b. and the X shift control so that the markers align with the 1cm graticule lines.
3. Using the markers and the X shift control, check that the trace length is between 10.6 and 11.4cm. If not, adjust the gain of the X output amplifier by changing the A.O.T. resistor R824.
4. Select 1μs/cm, and apply 1μs markers. Adjust R709 for one marker/cm.
5. Select 1ms/cm and apply 1ms markers. Adjust R702 for one marker/cm.
6. Using appropriate markers, check that all the timebase ranges from 0.5sec/cm to 0.2μs/cm are accurate to within ±2%.
7. Using 0.5 second markers, check that the RANGE LIMIT l.e.d. operates when 1, 2, & 5 sec/cm are selected, and that the displayed sweep rate remains at 0.5sec/cm.
8. Select 0.1ms/cm, X10 expansion, and apply 0.1ms markers. Adjust R833 until the markers are 10cm apart. Check that when X2 and X5 expansion are selected, the markers are 2cm and 5cm ±2% apart respectively.
9. Operate the VARIABLE X EXPAND control, and check that the UNCAL l.e.d. is lit. Check that the expansion range is greater than 2.5:1. Reset to cal.
10. Select 0.2μs/cm, X10 expansion, and apply 50ns markers. Adjust C682 and C684 for optimum accuracy and linearity over the whole sweep. Check that the accuracy is within ±5% over the entire sweep. Check also that the sweep is approximately linear when using the VARIABLE EXPAND control.
11. Select STORE T-Y, 1ms/cm, and apply 1ms markers Adjust R727 for one marker/cm. Select DUAL vertical mode, and check that the markers are still 1cm ±1% apart. Press the SPLIT DISPLAY 4 switch, and check that the markers are still 1cm ±1% apart. Clear Split Display.

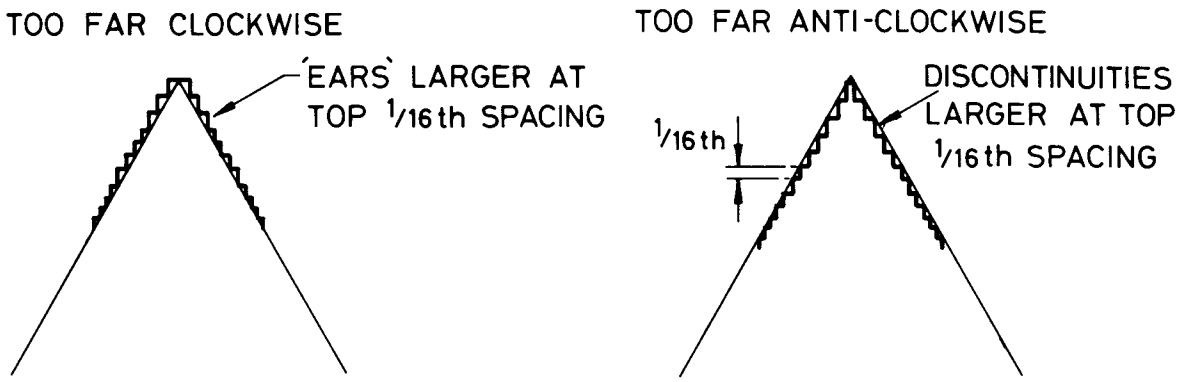


FIGURE (a) D.A.C. REFERENCE R1667

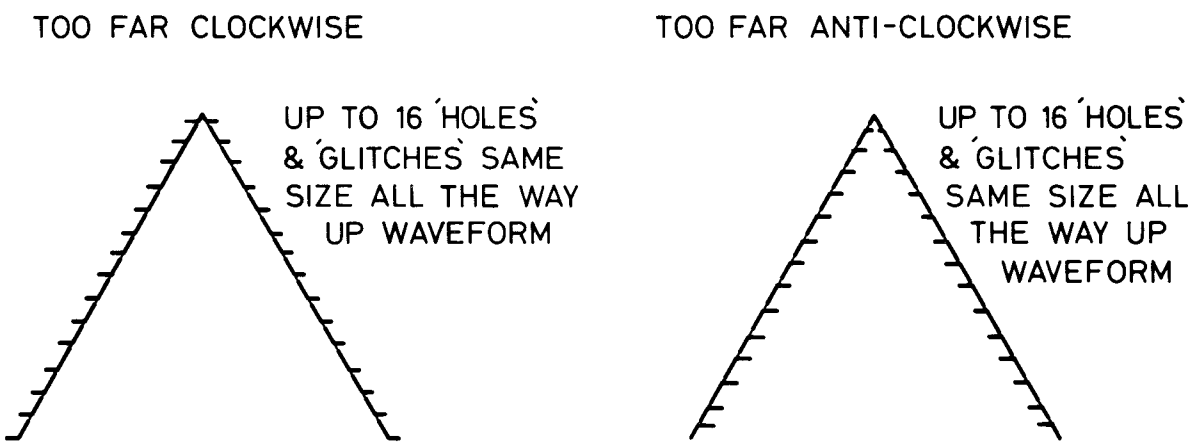


FIGURE (b) SECOND RANK OFFSET R1565

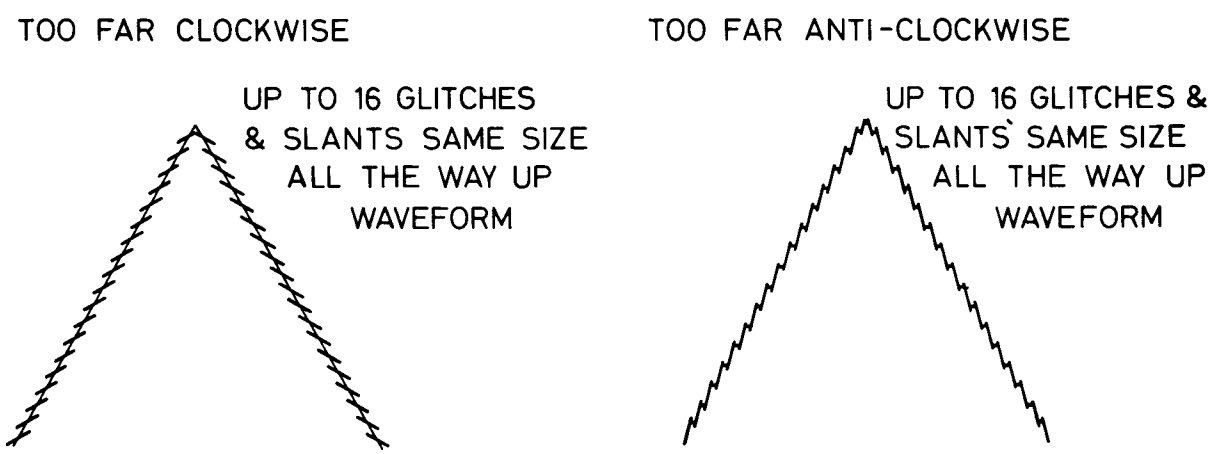


FIGURE (c) SECOND RANK REFERENCE R1592

Fig. 5.4 A.D.C. Adjustments

FIG. 5·5a

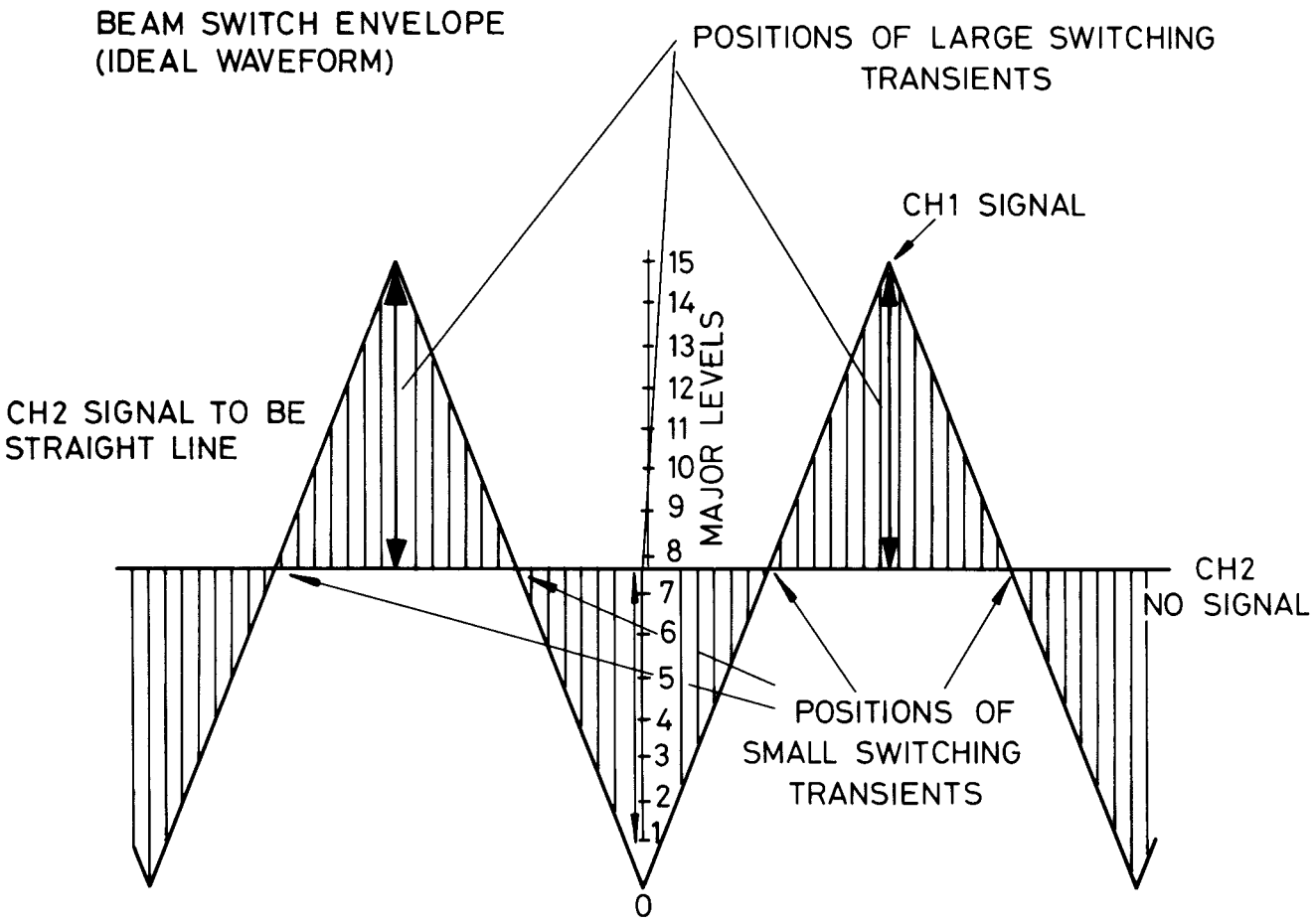


FIG. 5·5b

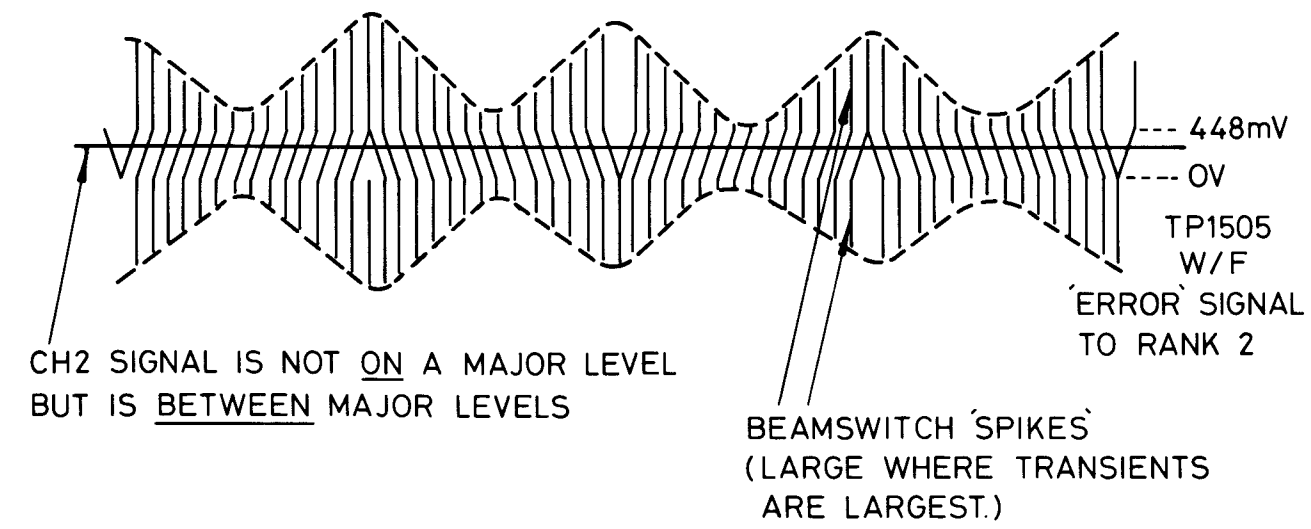


Fig. 5.5 A.D.C. Beamswitch Waveforms

5.3.22 ANALOGUE TO DIGITAL CONVERTOR (ADC)

D.C. Conditions

1. Use the ADC extender board (PN 450397) to gain access to the ADC board. Voltages should be measured with respect to 0V on the board.
2. Short pins 1523 and 1524 together.
3. Adjust R1593 to give +2.56V at TP1506.
4. Adjust R1592 to give +224mV at TP1507.
5. Set R1508 to give 0V at TP1502.
6. Set R1565 to give 0V at TP1505.
7. Remove the short from pins 1523 and 1524.

5.3.23 SLOPE AND STEP MATCHING

1. Select REFRESHED mode, 0% pre-trigger and CH1 display only. Set the Y sensitivity to 0.1V/cm and the Timebase range to 0.2ms/cm.
2. Apply a triangle wave signal of approx. 800mV p.p. amplitude and frequency 500Hz. Adjust the Trigger level to obtain a stable trace. A single cycle should be displayed.
3. Initially adjust R1565 for minimum step amplitude at the bottom of the waveform and R1667 for minimum step amplitude at the top of the waveform (see Figs. 5.4a, b).
4. Adjust R1592 to align the minor slopes with the signal trace (see Fig. 5.4c).
5. Repeat adjustments on R1565, R1667 and R1592 to obtain the best linearity on the trace.

5.3.24 LF/H.F. RESPONSE BALANCE AND DELAY LINE COMPENSATION

1. With the same conditions as for the previous test select DUAL trace, switch the CH2 input to GND and position the CH2 trace on the centre graticule line.
2. Connect the X10 probe of a test oscilloscope to TP1501. The test oscilloscope should have bandwidth limited to approx. 20–30MHz and have a flat overall response with the probe used. Adjust R1512 for an optimum straight line at the centre of the waveform envelope as shown in Fig. 5.5a with the test oscilloscope set to 0.1V/cm.
3. Set the test oscilloscope to 0.5V/cm and connect the probe to TP1502. Adjust R1532 for optimum response as in step 2.
4. Set the CH1 attenuator switch to 20mV/cm and apply a 100kHz fast rise squarewave signal to CH1 input at about 100mV p/p amplitude. Select CH1 only vertical mode. Connect the test oscilloscope to the delay line output (junction of R1554 and R1555) and adjust C1513 and R1535 to obtain a square corner with no 'hook' on the waveform.
5. Set the instrument up as for the previous tests 1 and 2 and with the test oscilloscope set to 50mV/cm and connected to the junction of R1554 and R1555 adjust the value of the select on test resistor R1548 for optimum straight line response as in Fig. 5.5a. Select CH1 mode only and adjust R1667 for minimum steps at the top of the waveform (see Fig. 5.4a).

5.3.25 BEAM SWITCH TIMING

1. Referring to Fig. 5.5b connect the test oscilloscope probe to TP 1505 and adjust C1682 for minimum beamswitch spikes on the waveform (visible as a 'haze' on the display).

5.3.26 ALIAS MODE TIMING

1. Set the vertical mode to CH1 and the Timebase to 50μs/cm. Then connect a 10.01MHz sinewave to CH1 input. Adjust the generator frequency by small amounts to obtain a trace with about 5 cycles displayed. Adjust C1683 for optimum sinewave shape. Note that since this is an alias waveform the trace will not be locked by trigger, and setting up can more easily be performed by repeated use of the single sweep facility.

5.3.27 FINAL ADJUSTMENTS

1. Select CH1 and apply an 800mV p.p. 500Hz triangle wave signal to CH1 input. Set the CH1 sensitivity to 0.1V/cm and the timebase range to 0.2ms/cm.
2. Recheck the adjustments of R1565, R1667 and R1592 as in test 3 & 4 of section 5.3.23.
3. Switch CH2 input to GND, select DUAL channel, and adjust R1512 by a small amount if necessary to give minimum crosstalk on CH2 display.
4. Adjust the Y2 shift between limits and check that the shift on the CH1 display is minimal. If not recheck step 3. If sampling steps >1 bit appear on the CH1 trace when CH2 shift is near limits recheck the adjustments as detailed in section 5.3.24.
5. Transfer the ramp waveform to give a CH2 display with CH1 input at GND and recheck tests 3 & 4 of this section.

5.3.28 FUNCTIONAL CHECKS

1. Check all timebase ranges in the REFRESHED mode, and ensure that the SINGLE SWEEP and MULTI SWEEP facilities are functioning correctly.
2. Check that a dual trace is obtained when DUAL is selected.
3. Press MULTI SWEEP and check that the four OFFSET controls function independently.
4. Using time markers or a low frequency waveform, check the action of the PRE TRIG delay switches and the ROLL switch.
5. Select 1ms/cm, and using a 100kHz signal, check the operation of the PEAK DET switches.
6. Select 20μs/cm and ranges above this. Check that the RANGE LIMIT l.e.d. operates.

5.3.29 X-Y GAIN AND PHASE

1. Select NORMAL X-Y mode with CH2 as TRIGGER SOURCE, DC coupled, and CH1 vertical mode.
2. Set CH2 to 20mV/cm, DC coupled, and apply a 160mV 1kHz squarewave signal to CH2, and adjust R632 for two spots on the screen, 8cm apart horizontally.

3. Select CH2 as the vertical source with 20mV/cm and DC coupling. Apply 5cm of 50kHz reference signal from an HF signal generator to the CH2 input. A 45° line trace should now be visible on the c.r.t.
4. Increase the frequency to 500kHz, and the line may be observed to open out and to an ellipse. Change the value of A.O.T. capacitor C618 for the ellipse to close to a line again. Check that the line does not separate more than 2mm for frequencies up to 500kHz.

5.3.30 INTERNAL CALIBRATOR

1. Briefly switch off the instrument, remove U613 on the timebase p.c.b., and switch on again.
2. Connect the d.v.m. to the 1V CAL pin, and adjust R765 on the timebase p.c.b. to give a 1.00V d.c. output.
3. Briefly switch off the instrument, replace U613 and switch on again. Confirm with an oscilloscope the presence of a squarewave at the CAL output, of frequency 1kHz ±10%.

5.3.31 DIGITAL TO ANALOGUE CONVERTER

The range of the DAC must be set up such that the trace can just be deflected off the screen (approx. 9cm).

1. Set the HORIZONTAL MODE to STORE T-Y, ROLL, with CH1 as vertical source and its input grounded. Rotate the Y shift control fully anti-clockwise to deflect the trace to its lower limit and adjust R1301 on the control p.c.b. to position the trace on the lower graticule line.
2. Apply a 100mV squarewave to CH1 input and set the CH1 attenuator switch to 20mV/cm. Adjust the Y shift control to obtain a 0.5cm display and then re-adjust R1301 to position the top of the displayed waveform on the lower graticule line.
3. Rotate the shift control fully clockwise and use R1302 to position the trace on the top graticule line. Reset the shift control to display a 0.5cm amplitude trace as before and re-adjust R1302 to set the lower edge of the display on the top graticule line.

5.3.32 SCALING AMPLIFIER

With a 5cm squarewave displayed in the Normal mode adjust R344 on the Y preamplifier p.c.b. to give no change in amplitude when switching from Normal to Store modes. Set R335 for no change in vertical position between the two display modes. Ensure that full coverage of the screen can be obtained in the STORE mode.

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 Potenitometer 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%	

OS4040 INTERCONNECTIONS

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R5	100	CF			21819
R6	1MΩ	CF			31840
R61	1k1	MF			41874
R62	22	CF			28710
R63	2k2	CP	With S62		A4/44785
R64	390	CF			28722
R91	10k	CP	With S91		A4/44786
R92	10k	CP	With S92		A4/44786
R93	10k	CP	With S93		A4/44786
R94	10k	CP	With S94		A4/44786
RN61		Resistor Network			A3/40103
R1001	330	CF			28721
R1002	330	CF			28721
R1003	330	CF			28721
R1004	330	CF			28721
R1051	330	CF			28721
R1052	47	CF			28714
R1053	330	CF			28721
R1054	330	CF			28721
R1055	330	CF			28721
R1056	330	CF			28721
R1057	330	CF			28721
R1058	1k	CF			21799
R1059	1k	CF			21799
R1060	1k	CF			21799
R1061	1k	CF			21799
CAPACITORS					
C1001	.01μF	CE(2)		250V	22395
C1002	.01μF	CE(2)		250V	22395
C1003	.01μF	CE(2)		250V	22395
C1004	.01μF	CE(2)		250V	22395
C1005	.01μF	CE(2)		250V	22395
C1006	.01μF	CE(2)		250V	22395
C1007	.01μF	CE(2)		250V	22395
C1008	.01μF	CE(2)		250V	22395
C1009	.01μF	CE(3)			42444
C1010	.01μF	CE(3)			42444
C1058	.01μF	CE(2)		250V	22395
C1059	.01μF	CE(2)		250V	22395
C1060	.01μF	CE(2)		250V	22395
C1061	.01μF	CE(2)		250V	22395

Ref	Value	Description	Tol %±	Rating	Part No
DIODES					
D1		L.E.D. MV5153			43847
D11		L.E.D. MV5153			43847
D12		L.E.D. MV5153			43847
D61		L.E.D. MV5153			43847
D64		L.E.D. MV5153			43847
D1001		L.E.D. MV5153			43847
D1002		L.E.D. MV5153			43847
D1003		L.E.D. MV5153			43847
D1004		L.E.D. MV5153			43847
D1051		L.E.D. MV5153			43847
D1052		L.E.D. MV5153			43847
D1053		L.E.D. MV5153			43847
D1054		L.E.D. MV5153			43847
D1057		L.E.D. MV5153			43847
D1058		L.E.D. MV5153			43847
U1051		74 LS05			36879
MISCELLANEOUS					
S61					44788
S62				With R63	A4/44785
S63–65					A3/44793
S91				With R91	A4/44786
S92				With R92	A4/44786
S93				With R93	A4/44786
S94				With R94	A4/44786
S1001					A3/44794
S1002–1012					A3/44795
S1051–1053					A3/44796
S1054–1057					A3/44798
L1					A3/32495
L2					41996
V1		Thorn D14–280GH			37571
		or Mullard D14–120GH			37569

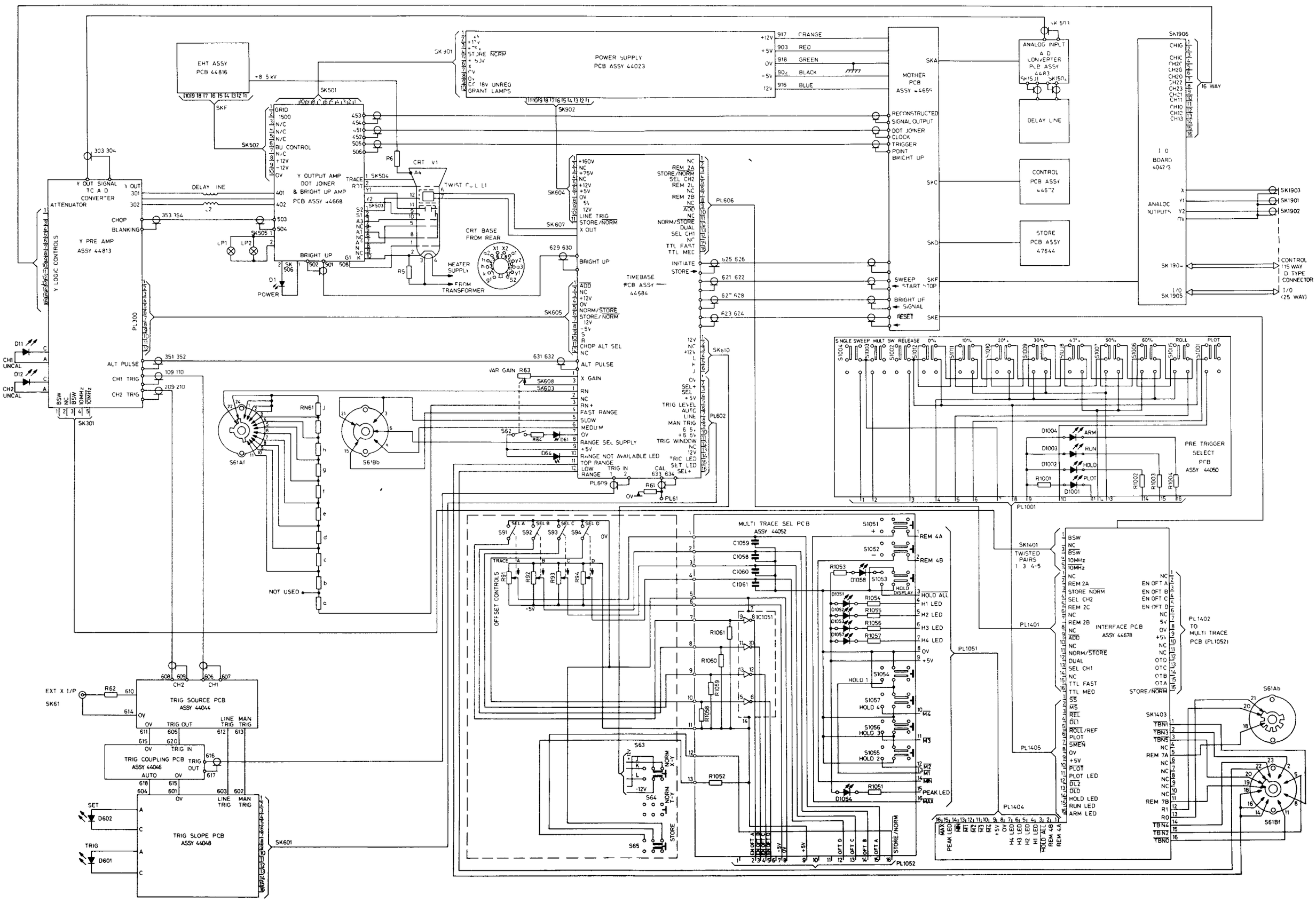


Fig. 6.1 Interconnection Diagram

OS4040 'Y' PREAMP & BEAM SWITCH

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R11	10	CF			21793
R12	10	CF			21793
R13	10	CF			21793
R14	10	CF			21793
R15	10	CF			21793
R16	10	CF			21793
R17	47	CF			28714
R18	47	CF			28714
R19	15	CF			28708
R20	15	CF			28708
R21	990k	MF	½	½W	31927
R22	990k	MF	½	½W	31927
R23	270	CF			28720
R24	270	CF			28720
R25	900k	MF	½	½W	31929
R26	900k	MF	½	½W	31929
R27	330	CF			28721
R28	330	CF			28721
R29	220	CF			21796
R30	220	CF			21796
R31	700k	MF			44875
R32	700k	MF			44875
R33	470k	CC	10	¼W	4906
R34	470k	CC	10	¼W	4906
R35					
R36					
R100	8k2	CF			21808
R101	8k2	CF			21808
R102	100k	CF			21819
R103	300k	MF	½		44916
R104	100k	PCP			39269
R105	10k	CF			21809
R106	470	CF			21797
R107	820	CF			28724
R108	390k	CF			32358
R109	56k	CF			28729
R111	1k	CF			21799
R112	10	CF			21793
R113	47	CF			28714
R114	47	CF			28714
R115	68	CF			28716
R116	3k3	CF			21803
R117	1k	PCP			39233
R118	1k	CF			21799
R120	1k	CF			21799
R121	470	CF			21797
R122	220	MF	2		38578
R123	220	MF	2		38578
R124	100	CF			21794
R125	4k7	CP			A4/44787
R126	100	CF			21794
R127	75	CF			38567
R128	2k2	CF			21802
R131	2k	MF	2		38601
R132	500	PCP			39232
R133	56	CF			28715
R134	680	CF			28723
R135	56	CF			28715
R136	56	CF			28715
R137	680	CF			28723
R138	56	CF			28715
R140	10	CF			21793
R141	56	CF			28715
R142	1k8	CF			28725
R143	1k3	MF			38597
R144	22	CF			28710
R146	75	MF	2		38567
R147	560	CF			21798
R148	560	CF			21798
R149	1k	PCP			39233
R150	10	CF			21793
R151	160	MF	2		38575
R152	330	MF	2		38582
R153	330	MF	2		38582
R154	680	CF			28723
R155	470	CF			21797
R156	22	CF			28710
R157	22	CF			28710
R158	27	CF			28711
R160	100	CF			21794
R161	1k	CF			21799
R162	1k	PCP			39233
R163	68	CF			28716
R164	1k2	CF			21800
R165	750	MF	2		38591
R166	750	MF	2		38591
R167	1k5	CF			21801
R168	150	MF			38574
R170	100	CF			21794
R171	27k	CF			21813
R172	10k	CF			21809
R173	10	CF			21793
R174	100	CF			21794
R176	100	CF			21794
R178	51	MF	2		38563
R179	3k3	CF	A.O.T.		21803
R182	100	CF			21794
R183	100	CF			21794
R184	100	CF			21794
R185	100	CF			21794
R186	68	CF			28716
R187	68	CF			28716

OS4040 'Y' PREAMP & BEAM SWITCH (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS (Cont.)					
R188	82	MF			38568
R190	100	CF			21794
R191	3k6	MF	2		38607
R192	3k6	MF	2		38607
R193	4k7	CP			A4/42203
R194	10k1	MF	½		37778
R195	111k	MF	½		37779
R200	8k2	CF			21808
R201	8k2	CF			21808
R202	100k	CF			21819
R203	300k	MF	½		44916
R204	100k	PCP			39269
R205	10k	CF			21809
R206	470	CF			21797
R207	820	CF			28724
R208	390k	CF			32358
R209	56k	CF			28729
R211	1k	CF			21799
R212	10	CF			21793
R213	47	CF			28714
R214	47	CF			28714
R215	68	CF			28716
R216	3k3	CF			21803
R217	1k	PCP			39233
R218	1k	CF			21799
R220	1k	CF			21799
R221	470	CF			21797
R222	220	MF	2		38578
R223	220	MF	2		38578
R224	100	CF			21794
R225	4k7	CP			A4/44787
R226	100	CF			21794
R227	75	MF	2		38567
R228	2k2	CF			21802
R231	2k	CF	2		38601
R232	500	PCP			39232
R233	56	CF			28715
R234	680	CF			28723
R235	56	CF			28715
R236	56	CF			28715
R237	680	CF			28723
R238	56	CF			28715
R240	10	CF			21793
R241	56	CF			28715
R242	1k8	CF			28725
R243	1k3	MF			38597
R244	22	CF			28710
R245	100	PCP			39230
R246	47	CF			28714
R247	560	CF			21798
R248	560	CF			21798
R249	1k	PCP			39233
R250	10	CF			21793
R251	160	MF	2		38575
R252	330	MF	2		38582
R253	330	MF	2		38582
R254	680	CF			28723
R255	470	CF			21797
R256	22	CF			28710
R257	22	CF			28710
R258	27	CF			28711
R260	100	CF			21794
R261	1k	CF			21799
R262	1k	PCP			39233
R263	68	CF			28716
R264	1k2	CF			21800
R265	750	MF	2		38591
R266	750	MF	2		38591
R267	1k5	CF			21801
R268	150	MF	2		38574
R270	100	CF			21794
R271	27k	CF			21813
R272	10k	CF			21809
R273	10	CF			21793
R274	100	CF			21794
R276	100	CF			21794
R278	51	MF	2		38563
R279	3k3	CF	A.O.T.		21803
R282	100	CF			21794
R283	100	CF			21794
R284	100	CF			21794
R285	100	CF			21794
R286	68	CF			28716
R287	68	CF			28716
R288	82	MF	2		38568
R290	100	CF			21794
R291	3k6	MF	2		38607
R292	3k6	MF	2		38607
R293	4k7	CP			A4/42203
R294	10k1	MF	½		37778
R295	111k	MF	½		37779
R300	180	CF			21795
R301	1k	CF			21799
R302	1k	CF			21799
R303	1k	CF			21799
R304	1k	CF			21799
R305	560	CF			21798
R306	560	CF			21798
R307	10	CF			21793

OS4040 'Y' PREAMP & BEAM SWITCH (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS (Cont.)					
R308	1k5	CF			21801
R311	1k5	CF			21801
R312	2k2	CF			21802
R313	3k3	CF			21803
R314	2k2	CF			21802
R315	3k3	CF			21803
R316	100	CF			21794
R317	100	CF			21794
R318	100	MF	2		38570
R321	100	MF	2		38570
R322	100	MF	2		38570
R323	100	MF	2		38570
R326	100	CF			21794
R327	27	CF			28711
R328	27	CF			28711
R329	270	CF	A.O.T.		28720
R330	4R7	CF			29433
R331	270	CF			28720
R332	330	MF	2		38582
R333	51	MF	2		38563
R334	1k8	CF			28725
R335	50				39267
R336	1k	CF			21799
R337	750	MF	2		38591
R338	270	MF	2		38580
R341	240	MF	2		38579
R342	33	CF			28712
R343	6k8	CF			21807
R350	2k7	CF			28726
R351	220	CF			21796
R352	330	CF			28721
R355	560	CF			21798
R356	6k8	CF			21807
R357	10k	CF			21809
R358	2k7	CF			28726
R361	3k9	CF			21804
R362	2k7	CF			28726
R363	560	CF			21798
R364	330	CF			28721
R365	2k2	CF			21802
R366	1k	CF			21799
R367	220	CF			21796
R368	390	CF			28722
R371	3k3	CF			21803
R372	470	CF			21797
R373	680	CF			28723
R374	560	CF			21798
R375	3k3	CF			21803
R376	2k7	CF			28726
R377	330	CF			28721
R378	330	CF			28721
R381	1k	CF			21799
R382	1k	CF			21799
R385	220	CF			21796
R386	330	CF			28721
RN1		Resistor Network		43135 or	43136
RN2		Resistor Network		43135 or	43136
CAPACITORS					
C11	4700pF	CE(2)			22393
C12	4700pF	CE(2)			22393
C13	0.1μF	CE(2)		400V	29495
C14	0.1μF	CE(2)		400V	29495
C15	330pF	CE(2)			31293
C16	330pF	CE(2)			31293
C17	1.5pF	CE(3)			42398
C18	1.5pF	CE(3)			42398
C19	2.2pF	CE(3)			42400
C20	2.2pF	CE(3)			42400
C21	47pF	CE(2)			29918
C22	47pF	CE(2)			29918
C23	5.6pF	CE(3)			42405
C24	5.6pF	CE(3)			42405
C25	4700pF	CE(2)			22393
C26	4700pF	CE(2)			22393
C27	3.9pF	CE(2)			34225
C28	3.9pF	CE(2)			34225
C100	.01μF	CE(3)			42444
C101	.01μF	CE(3)			42444
C102	.01μF	CE(3)			42444
C103	5.6pF	CE(3)			42405
C104	.01μF	CE(3)			42444
C105	.01μF	CE(3)			42444
C106	22μF	E		25V	32181
C107	.01μF	CE(3)			42444
C108	.01μF	CE(3)			42444
C109	33μF	E		16V	32173
C111	.01μF	CE(3)			42444
C112	47pF	CE(3)			42416
C113	47pF	CE(3)			42416
C114		Not Fitted			
C115	.01μF	CE(3)			42444
C116	.01μF	CE(3)			42444
C117	.01μF	CE(3)			42444
C118	.01μF	CE(3)			42444
C119	5.6μF	CE(3)			42441
C120	100pF	CE(3)			42420
C121	39pF	CE(3)			42415

OS4040 'Y' PREAMP & BEAM SWITCH (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
CAPACITORS (Cont.)					
C123	.01μF	CE(3)			42444
C124	.01μF	CE(3)			42444
C125	.01μF	CE(3)			42444
C126	4p7	CE(2)			36602
C127	4p7	CE(2)			36602
C140	22μF			25V	32181
C150	22μF	E		25V	32181
C195	2/15pF	Trimmer			40554
C196	2/5pF	Trimmer			40301
C197	2/5pF	Trimmer			40301
C198	2/15pF	Trimmer			40554
C199	2/10pF	Trimmer			40302
C200	.01μF	CE(3)			42444
C201	.01μF	CE(3)			42444
C202	.01μF	CE(3)			42444
C203	5.6pF	CE(3)			42405
C204	0.1μF	CE(3)			42444
C205	0.1μF	CE(3)			42444
C206	22μF	E		25V	32181
C207	.01μF	CE(3)			42444
C208	.01μF	CE(3)			42444
C209	33μF	E		16V	32173
C211	.01μF	CE(3)			42444
C212	47pF	CE(3)			42416
C213	47pF	CE(3)			42416
C214		Not Fitted			
C215	.01μF	CE(3)			42444
C216	.01μF	CE(3)			42444
C217	.01μF	CE(3)			42444
C218	.01μF	CE(3)			42444
C219	5.6μF	CE(3)			42441
C220	100pF	CE(3)			42420
C221	18pF	CE(3)			42411
C222	27pF	Trimmer			36273
C223	.01μF	CE(3)			42444
C224	.01μF	CE(3)			42444
C225	.01μF	CE(3)			42444
C226	4p7	CE(2)			36602
C227	4p7	CE(2)			36602
C240	22μF	E		25V	32181
C250	22μF	E		25V	32181
C295	2/15pF	Trimmer			40554
C296	2/5pF	Trimmer			40301
C297	2/5pF	Trimmer			40301
C298	2/15pF	Trimmer			40554
C299	2/10pF	Trimmer			40302
C300	10μF	CE(3)			42444
C301	47μF	E		25V	32182
C302	47μF	E		10V	32167
C303	.01μF	CE(3)			42444
C304	47μF	E		25V	32182
C305	.01μF	CE(3)			42444
C306	.01μF	CE(3)			42444
C307	.01μF	CE(3)			42444
C308	.01μF	CE(3)			42444
C311	.01μF	CE(3)			42444
C312	.01μF	CE(3)			42444
C313	100pF	CE(3)			42420
C314	.01μF	CE(3)			42444
C350	.01μF	CE(3)			42444
C351	10μF	E		25V	32180
C352	560pF	CE(3)			42429
C353	560pF	CE(3)			42429
C354	.01μF	CE(3)			42444
C355	.01μF	CE(3)			42444
Q100		AE37			40414
Q101		AE13			31254
Q102		AE13			31254
Q103		2N5771			38089
Q104		2N5771			38089
Q105		2N5771			38089
Q106		2N5771			38089
Q107		AE13			31254
Q108					
Q200		AE37			40414
Q201		AE13			31254
Q202		AE13			31254
Q203		2N5771			38089
Q204		2N5771			38089
Q205		2N5771			38089
Q206		2N5771			38089
Q207		AE13			31254
Q208					
Q300		BC212			70500
Q301		2N3906			21533
Q302		2N5771			38089
Q303		2N5771			38089
Q304		2N5771			38089
Q305		NPS2369			36625
Q350		2N2640			31781
DIODES					
D100	3V3	ZENER			33923
D101	3V3	ZENER			33923
D102		IN3595			29330
D103		IN3595			29330
D104	8V2	ZENER			33933

OS4040 'Y' PREAMP & BEAM SWITCH (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
DIODES (Cont.)					
D105	4V7	ZENER			33927
D106	3V9	ZENER			33925
D200	3V3	ZENER			33923
D201	3V3	ZENER			33923
D202		IN3595			29330
D203		IN3595			29330
D204	8V2	ZENER			33933
D205	4V7	ZENER			33927
D206	3V9	ZENER			33925
D300	12V	ZENER			33937
D301	4V3	ZENER			33926
D302	3V	ZENER			33922
D303	4V3	ZENER			33926
U100		CA3086			42907
U101		LF355BN			42050
U102		CA3102E			44921
U200		CA3086			42907
U201		LF355BN			42050
U202		CA3102E			44921
U300		MC10116			33449
U301		CA3086			42907
U350		MC10102			39243
U351		MC10102			39243
U352		MC10131			39246
MISCELLANEOUS					
S125					A4/44787
S225					A4/44787
SKA					1222
SKB					1222
INDUCTORS					
L101		Ferrite Bead FX1242			26986
L102		Ferrite Bead FX1242			26986
L201		Ferrite Bead FX1242			26986
L202		Ferrite Bead FX1242			26986
L300	1μH				41449

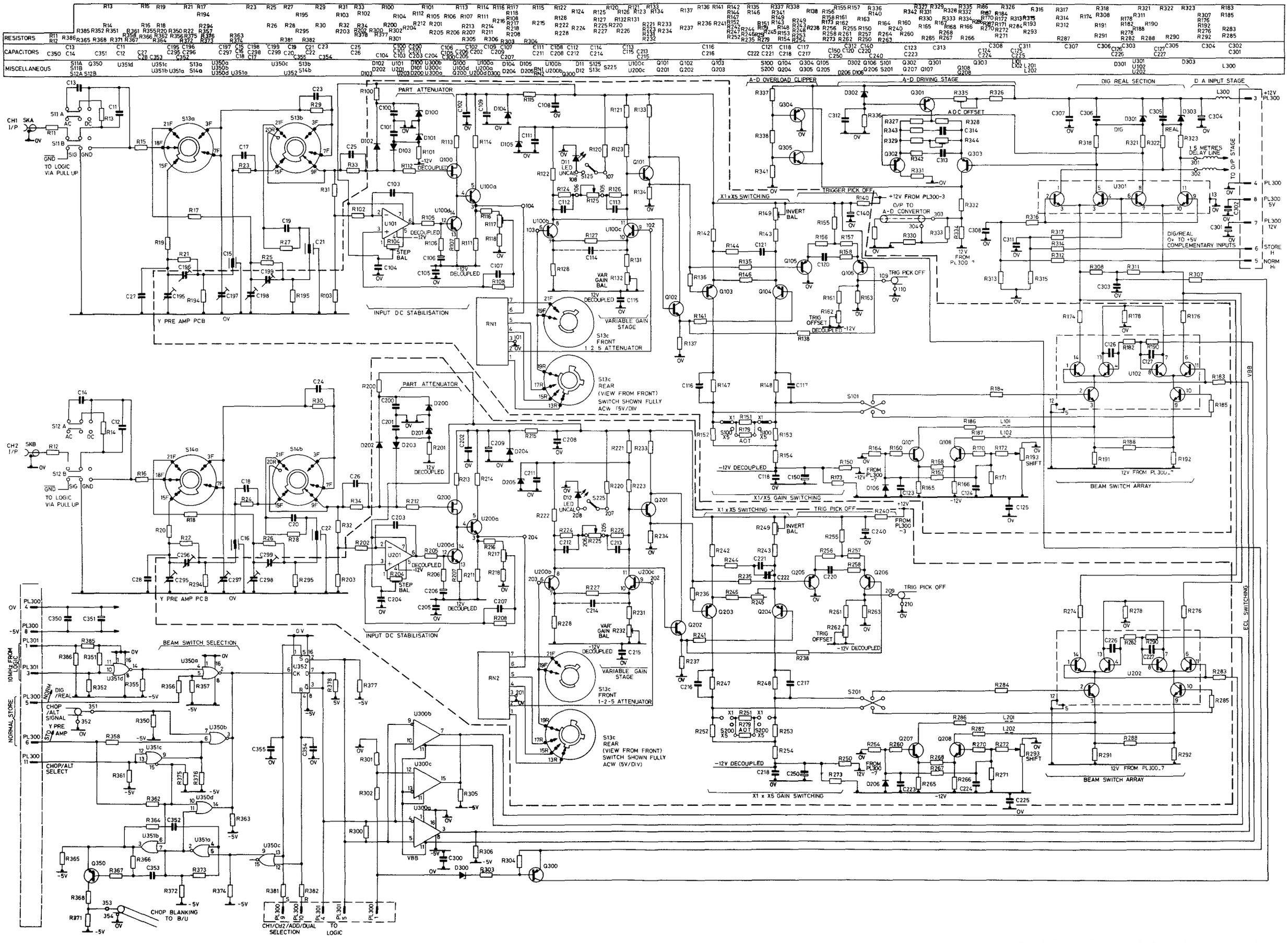


Fig. 6.2 'Y' Pre-amp & Beam Switch Circuit Diagram

OS4040 Y O/P AMP & DOT JOINER

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R400	100	MF	2		38570
R401	100	MF	2		38570
R402	1k2	MF	2		38596
R403	22k	CF	A.O.T.		21812
R404	1k2	MF	A.O.T.		38596
R405	22k	CF			21793
R406	1k2	MF	2		38596
R407	10	CF			21793
R408	10	CF			21793
R409	270	MF	2		38580
R410	1k1	MF	2		38595
R411	270	MF	2		38580
R412	820	CF			28724
R413	820	CF			28724
R414	47	CF			28714
R415	47	CF			28714
R416	10	CF			21793
R417	180	MF	2		38576
R418	180	MF	2		38576
R419	180	CF			21795
R420	150	MF	2		38574
R421	180	CF			21795
R422	33	CF			28712
R423	12k	CF			21810
R424	82	CF			28717
R425	50	PCP			39267
R426	2k	MF	2		38601
R427	2k	MF	2		38601
R428	10	CF			21793
R429	10	CF			21793
R430	1k	CF			21799
R431	82k	CF			21818
R432	100	CF			21794
R433	820	MO	5	2W	37548
R434	100	CF			37548
R435	82k	CF			21818
R436	820	MO	5	2W	37548
R437	47	CF			28714
R438	47	CF			28714
R439	27	CF			28711
R441	27	CF			28711
R442	330	CF			28721
R443	68	CF			28716
R444	1k	CF			21799
R445	33	CF			28712
R446	33	CF			28712
R447	82	CF			38568
R448	8k2	CF			21808
R449	8k2	CF			21808
R450	1k8	CF			28725
R451	1k8	CF			28725
R452	1k	CF			21799
R453	100	CF			21794
R454	680	CF			28723
R455	1k	CF			21799
R456	4k7	CF			21805
R457	1k	CF			21799
R458	10k	PCP			39265
R459	10k	CF			21809
R461	10	CF			21793
R462	10	CF			21793
R463	2k7	CF			28726
R464	8k2	CF			21808
R465	220	CF			21796
R466	4k7	CF			21805
R467	2k2	CF			21802
R468	8k2	CF			21808
R469	10	CF			21793
R471	10	CF			21793
R472	470	MF	2		38586
R473	470	MF	2		38586
R475	1k2	CF	A.O.T.		21800
R476	1k8	CF	2		38600
R477	1k8	CF	2		38600
R478	1k	CF			21799
R479	1k	CF			21799
R481	56	CF			28715
R482	56	CF			28715
R483	10	CF			21793
R484	56	CF			28715
R485	68K	CF			21816
CAPACITORS					
C400	8.2pF	CE(3)			42407
C401	8.2pF	CE(3)			42407
C402	0.01μF	CE(3)			42444
C403	.01μF	CE(3)			42444
C404	27pF	Trimmer			36273
C405	47pF	CE(3)			42416
C406	68pF	CE(3)			42418
C407	.01μF	CE(3)			42444
C408	.01μF	PE		100V	39190
C409	.01μF	CE(3)			42444
C411	.01μF	CE(3)			42444
C412	.01μF	CE(3)			42444
C413	.01μF	CE(3)			42444
C414	.01μF	CE(3)			42444
C415	27pF	CE(3)			42413
C416	45pF	Trimmer			36274
C417	45pF	Trimmer			36274
C418	47pF	CE(3)			42416
C419	120pF	CE(3)			42421
C421	1000pF	CE(3)			42432
C422	.01μF	CE(3)			42444

OS4040 Y O/P AMP & DOT JOINER (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
CAPACITORS (Cont.)					
C449	270pF	CE(3)			
C450	.01μF	CE(3)			42444
C451	680pF	PS			35917
C452	100pF	CE(3)			42420
C453	.01μF	CE(3)			42444
C454	.01μF	CE(3)			42444
C455	47μF	E		25V	32182
C456	47μF	E		25V	32182
C457	1500pF	CE(3)			42434
C458	47μF	CE(3)			42416
C459	22pF	CE(3)			42412
C461	2/10pF	Trimmer			43502
C462	47μF	E		25V	32182
C466	.01μF	CE(3)			42444
C467	82pF	CE(3)			42419
C468	.01μF	CE(3)			42444
C469	.01μF	CE(3)			42444
LAMPS					
L401	4.7μH				37560
L402	4.7μH				37560
Q400		2N3640			31781
Q401		2N3640			31781
Q402					
Q403		AE13			31254
Q404					
Q405					
Q406		ZTX327			39271
Q407		ZTX327			39271
Q408		MBD529			35840
Q409		MBD529			35840
Q450		BC108			26110
Q451		BC214C			36019
Q452		MPS2369			36625
Q453		MPS2369			36625
Q454		MPS2369			36625
Q455		MPS2369			36625
Q456		MPS2369			36625
Q457		MPS2369			36625
Q458		MPS2369			36625
Q459		E111			36028
DIODES					
D402	2V7	ZENER			33921
D404	27V	ZENER			33945
D405	27V	ZENER			33945
D406		IN4148			23802
D407		IN4148			23802
D450		IN4148			23802
D451		IN4148			23802
D452		IN4148			23802
D453	12V	ZENER			33937
D454		IN4148			23802
MISCELLANEOUS					
U450		LF356			39226
U451		LF356			39226

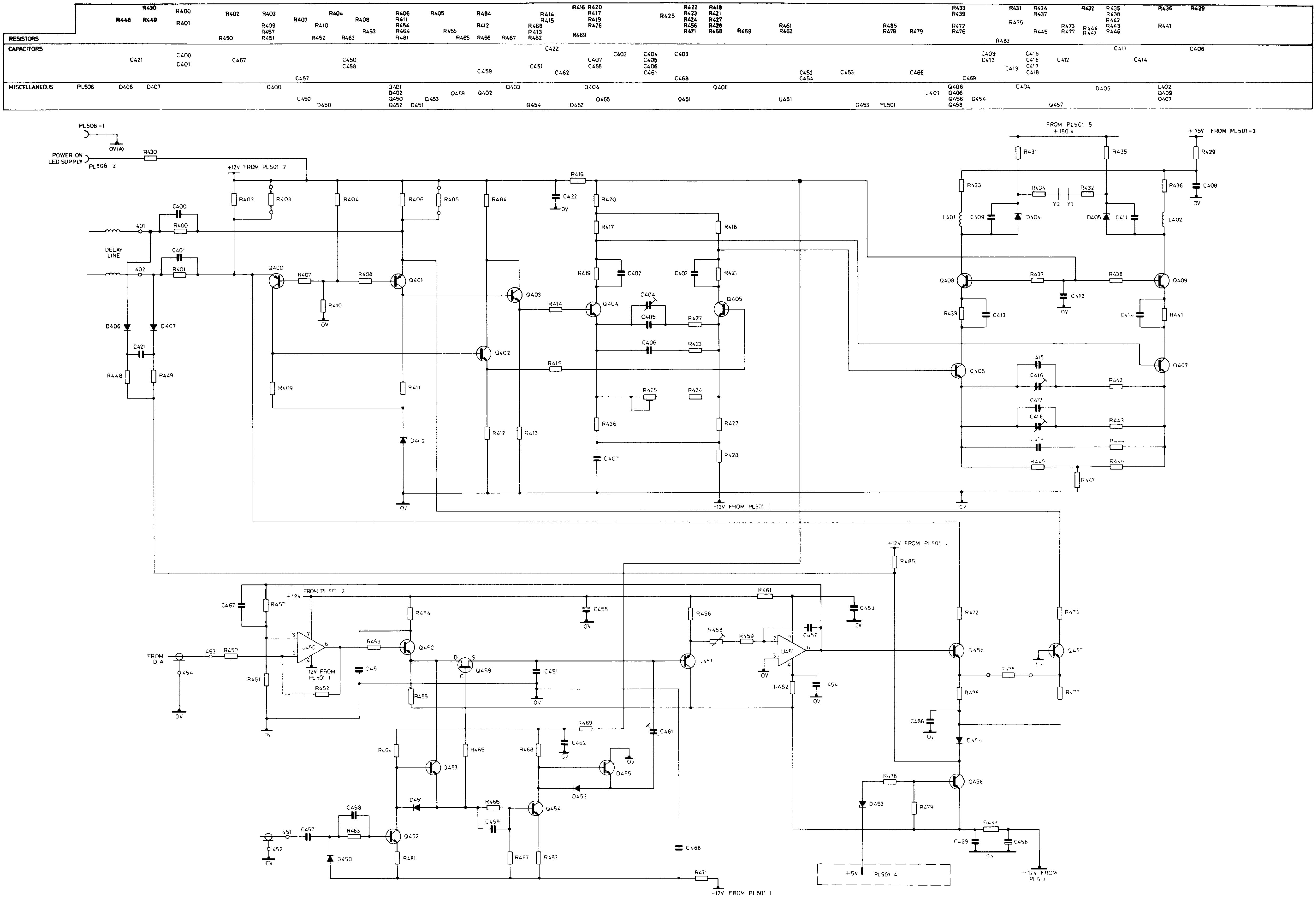


Fig. 6.3 'Y' Output Amplifier & Dot Joiner Circuit Diagram

OS4040 TIMEBASE

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R601	820k	MF	2	½W	44726
R602	82	CF			28717
R603	8k2	CF			21808
R604	3k3	CF			21803
R605	47	CF		1/8W	43146
R606	47	CF			28714
R607	220k	CF			21823
R608	390k	MF	2		38656
R609	22k	CP			A4/44784
R610	47k	CP			A4/452043
R611	390k	CF	2		38656
R616	100	CF			21794
R617	560	CF			21798
R618	10	CF			21793
R619	2k2	CF			21802
R620	3k3	CF			21803
R621	47	CF			28714
R622	680	CF			28723
R623	220	CF			21796
R624	6k8	CF			21807
R625	6k8	CF			21807
R626	3k3	CF			21803
R627	12k	CF			21810
R628	100	CF			21794
R629	10	CF			21793
R630	2k	MF	2		38601
R631	1k2	CF			21800
R632	5k	CP			42156
R633	10	CF			21793
R634	82	CF			28717
R635	10k	PCP			39228
R636	100	CF			21794
R637	10k	CF			21809
R638	10k	CF			21809
R639	220	CF			21796
R640	100	CF			21794
R641	180	CF			21795
R642	2k7	CF			28726
R643	120	MO	2	½W	26746
R644	10	CF			21793
R645	10M	CF			32661
R647	1k2	MF	2		38596
R648	220	MF			21796
R649	220	MF			21796
R650	220	MF			21796
R651	220	MF			21796
R652	1k2	MF	2		38596
R653	10	CF			21793
R654	15k	CF			28727
R655	15k	CF			28727
R656	100	CF			21794
R657	100k	CF			21819
R658	33k	CF			21814
R659	6k8	CF			21807
R660	4k7	CF			21805
R661	10k	CF			21809
R663	10k	CF			21809
R664	10k	CF			21809
R665	330	CF			28721
R666	10k	CF			21809
R667	180k	CF			21822
R668	330	CF			28721
R670	1k2	CF			21800
R671	4k7	CF			21805
R672	1k8	CF			28725
R673	2k2	CF			21802
R674	470	CF			21797
R675	10k	CF			21809
R676	39k	CF			28728
R677	4k7	CF			21805
R678	12k	CF			21810
R679	1k3	MF	2		38597
R680	2k7	CF			28726
R681	270	CF			28720
R684	4k7	CF			21805
R685	330k	CF			32357
R686	4k7	CF			21805
R687	1k5	CF			21801
R688	22k	CF			21812
R689	5k6	CF			21806
R690	1k8	CF		2½W	17823
R691	100k	CF			21819
R692	27k	CF			21813
R693	12k	CF			21810
R694	8k2	CF			21808
R695	12k	CF			21810
R696	8k2	CF			21808
R697	8k2	CF			21808
R698	15k	CF			28727
R700	10k	CF			21809
R701	22k	CF			21812
R702	10k	PCP			39228
R703	10k	CF			21809
R704	22k	CF			21812
R705	10k	PCP			39228
R706	8k2	CF			21808
R707	10k	CF			21809
R708	22k	CF			21812
R709	10k	PCP			39265
R710	3k9	CF			21804
R712	6k2	MF	2		38613
R713	15k	CF			28727
R714	31k6	MF	0.5		44724
R715	3k3	CF			21803

Fig. 6.4 Timebase Circuit Diagram 1

OS4040 TIMEBASE (Cont.)

RESISTORS (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
R716	1k5	CF			21801
R717	15k4	MF	0.5		44723
R718	1k5	CF			21801
R719	1k5	CF			21801
R720	6k81	MF	0.5		44722
R721	3k4	MF	0.5		44721
R722	68k	CF			21816
R723	10k	CF			21809
R724	10k	CF			21809
R725	8k2	CF			21808
R726	8k2	CF			21808
R727	100k	CF			42158
R728	300k	MF	2		38653
R729	180	CF			21795
R731	82	CF			28717
R732	2k2	CF			21802
R733	12k	CF			21810
R734	33k	CF			21814
R735	2k2	CF			21802
R736	1k	CF			21799
R737	470k	CF			32330
R738	620	MF	2		38589
R739	1k2	CF			21800
R740	470k	CF			32330
R741	47	CF			28714
R742	47k	CF			21815
R743	390	CF			28722
R744	2k7	CF			28726
R745	47k	CF			21815
R746	330	CF			28721
R747	39	CF			28713
R748	680k	CF			31839
R749	1k5	CF			21801
R750	27k	CF			21813
R751	10k	CF			21809
R752	22k	CF			21812
R753	22k	CF			21812
R754	150	CF			28719
R755	4k7	CF			21805
R756	4k7	CF			21805
R758	4k7	CF			21805
R760	680	CF			28723
R761	3k3	CF			21803
R762	220	CF			21796
R763	15k	CF			28727
R764	220	CF			21796
R765	1k	PCP			39261
R766	9k1	MF	2		38617
R767	1k8	CF			28725
R768	330	CF			28721
R771	1k	CF			21799
R772	4k7	CF			21805
R775	3k	MF	2		38605
R776	68k	CF			21816
R777	2k2	MF	2		38602
R778	10	CF			21793
R780	10	CF			21793
R781	47	CF			28714
R782	680	MF	2		38590
R783	130	MF	0.5		44718
R784	100	CF			21794
R785	336	MF	0.5		44719
R786	220	CF			21796
R787	681	MF	0.5		44720
R788	820	CF			28724
R789	3k	MF	2		38605
R790	2k2	MF	2		38602
R791	3k	MF	2		38605
R792	130	MF	0.5		44718
R793	336	MF	0.5		44719
R794	681	MF	0.5		44720
R795	680	MF	2		38590
R796	2k2	MF	2		38602
R797	390	MF	2		38584
R799	22	CF			28710
R801	68k	MF	2		38638
R802	390k	CF			32358
R803	39k	CF			28728
R804	20k	MF	2		38625
R805	1k	CF			21799
R806	1k	CF			21799
R807	10k	CP			A3/44789
R808	10k	CP			A3/44789
R811	3k	MF	2		38606
R812	3k	MF	2		38606
R813	220	CF			21796
R814	220	CF			21796
R815	2k7	CF			28726
R816	680	MF	2		38590
R817	680	MF	2		38590
R818	47	CF			28714
R819	47	CF			28714
R820	47	CF			28714
R822	47	CF			28714
R823	47	CF			28714
R824	8.2k	CF A.O.T.			21805
R826	2k7	MF	2		38604
R827	2k7	MF	2		38604
R828	12k	MF	2		38620
R829	12k	MF	2		38620

OS4040 TIMEBASE (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS (Cont.)					
R832	680	CF			28723
R833	500	PCP			39232
R834	330	MF	2		38582
R835	330	MF	2		38582
R836	30k	MF	2		38629
R837	11k	MF	2		38619
R838	5k6	MF	2		38612
R839	910	MF	2		38593
R840	6k8	CF	A.O.T.		21807
R841	36k	MF	2		38631
R842	12k	MF	2		38620
R843	2k	MF	2		38601
R844	12k	CF	A.O.T.		21810
R847	150k	CF			21821
R848	150k	CF			21821
R849	47	CF			28714
R850	820	CF			28724
R851	820	CF			28724
R852	220	CF			21796
R853	220	CF			21796
R854	82k	MF	2	½W	28820
R855	100	CF			21794
R856	100	CF			21794
R857	62k	MF	2	½W	28817
R858	62k	MF	2	½W	28817
R861	10	CF			21793
R862	10	CF			21793
R863	1k5	CF			21801
R864	1k5	CF			21801
CAPACITORS					
C601	12pF	CE(2)			22365
C602	15pF	CE(2)			22366
C603	27pF	Trimmer			36273
C604	.01µF	CE(2)		250V	22395
C605	.1µF	CE(2)		100V	37018
C606	47pF	CE(3)			42416
C607	82pF	CE(3)			41419
C615	3/45pF	Trimmer			43504
C616	.01µF	CE(3)			42444
C617	.01µF	CE(3)			42444
C618	100pF	CE(3)	A.O.T.		42420
C619	.01µF	CE(3)			42444
C620	.01µF	CE(3)			42444
C621	.01µF	CE(3)			42444
C622	.01µF	CE(3)			42444
C623	.01µF	CE(3)			42444
C624	.01µF	CE(3)			42444
C625	.01µF	CE(3)			42444
C626	.01µF	CE(3)			42444
C627	150pF	CE(3)			42422
C628	.01µF	CE(3)			42444
C629	.01µF	CE(3)			42444
C630	.01µF	CE(3)			42444
C631	.01µF	CE(3)			42444
C632	.01µF	CE(3)			42444
C633	.01µF	CE(3)			42444
C634	.01µF	CE(3)			42444
C635	1µF	E		63V	32193
C636	1500pF	CE(3)			42434
C637	.01µF	CE(3)			42444
C638	82pF	CE(3)			42419
C639	.01µF	CE(3)			42444
C640	4700pF	CE(3)			42440
C641	22µF	E		25V	32181
C642	22µF	E		25V	32181
C643	47µF	E		10V	32167
C644	15µF	E		40V	32187
C645	.1µF	CE(3)		100V	37018
C646	180pF	PS		160V	44725
C647	.01µF	CE(3)			42444
C648	10pF	CE(3)			42408
C649	5.6pF	CE(3)			42405
C650	.022µF	CE(2)		100V	450118
C651	33µF	E		16V	32173
C652	2.2µF	PC			40853
C653	56pF	CE(3)			42417
C654	.01µF	CE(3)			42444
C655	1µF	PE		100V	37389
C656	.01µF	CE(3)			42444
C657	.01µF	CE(2)		50V	42569
C658	.01µF	CE(2)		50V	42569
C659	.01µF	PE		100V	39190
C660	5.6pF	CE(3)			42405
C661	100pF	PS	2½	63V	35912
C662	.01µF	CE(3)			42444
C663	.01µF	CE(3)			42444
C664	.01µF	CE(3)			42444
C665	33µF	E		16V	32173
C666	.1µF	CE(2)		100V	37018
C667	.01µF	CE(3)			42444
C668	33µF	E		16V	32173
C669	39pF	CE(3)			42415
C670	39pF	CE(3)			42415
C671	15pF	CE(3)			42410
C672	5.6pF	CE(3)			42405
C673	1µF	T		50V	34895
C674	.1µF	CE(2)		35V	37018
C675	.01µF	CE(3)		100V	42444
C676	.01µF	CE(3)			42444
C677	.01µF	CE(3)			42444
C678	.01µF	CE(3)			42444
C679	.01µF	CE(3)			42444
C680	2.2pF	CE(2)			44361
C681	2.2pF	CE(2)			44361
C682	9pF	Trimmer			36272
C683	.01µF	CE(3)			42444
C684	.01µF	CE(2)		250V	22395

OS4040 TIMEBASE (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
CAPACITORS (Cont.)					
C685	.1μF	PE		250V	39199
C686	.1μF	CE(2)		100V	37018
C687	.01μF	CE(3)			42444
C688	.1μF	PE		250V	39199
C689	.01μF	CE(2)		250V	22395
C690	.01μF	CE(3)			42444
C691	.01μF	CE(2)		250V	22395
C692	2.2pF	CE(2)			44361
C693	2.2pF	CE(2)			44361
C694	9pF	Trimmer			43502
C695	56pF	CE(3)			42417
C696	.01μF	CE(3)			42444
C697	.01μF	CE(3)			42444
C698	.01μF	CE(3)			42444
C699	.01μF	CE(3)			42444
C700	.01μF	CE(3)			42444
Q601		J412-1 or	Dual F.E.T.		44703
Q602		J412-2		or	44704
Q603		AE13	Matched Pair		31254
Q604					
Q605		2N3906			21533
Q606		2N3904			24146
Q607		2N3904			24146
Q608		BC182B			33205
Q609		2N3904			24146
Q610		2N3906			21533
Q613		BC212			29327
Q614		2N3904			24246
Q615		2N3904			24146
Q616		BC212			29327
Q617		BC182B			33205
Q618		BC214C			40348
Q619		BC214C			40348
Q620		BC214C			40348
Q621		BC214C			40348
Q623		2N3906			21533
Q624		BF245A			38271
Q625		MPS2369			36625
Q626		BC182B			40349
Q627		2N3904			24146
Q628		2N3906			21533
Q629		2N3904			24146
Q630		BC212			29327
Q632		2N3904			24146
Q636		2N3640			31781
Q637		2N3640			31781
Q638		2N3904			24146
Q639		2N3904			24146
Q640		MPS2369			36625
Q641		MPS2369			36625
Q642		BF469			38418
Q643		BF469			38418
Q644		BF470			38416
Q645		BF470			38416
U601		733			37394
U602		1414			35682
U603		74LS122			39238
U604		74LS00			36730
U605		74LS08			36467
U606		74LS112			36468
U607		74LS157			36735
U608		78L24ACZ			402045
U609		CA3086			42907
U610		CA3086			42907
U611		74LS157			36735
U612		4066B			40044
U613		709			40179
U615		CA3086			42907
U616		CA3086			42907
U617		741			36736
U619		CA3086			42907
DIODES					
D601					43847
D602					43847
D616		IN3595			29330
D617		IN4148			23802
D618		IN4148			23802
D619		IN4148			23802
D620		IN4148			23802
D621		IN4148			23802
D622		IN4148			23802
D623		IN4148			23802
D624		IN4148			23802
D625		ZENER			33930
D626		ZENER			33930
D627		IN4148			23802
D628		IN4148			23802
D629		IN4148			23802
D630		IN4148			23802
D631		IN4148			23802
D632		IN4148			23802
D633		IN4148			23802
D634	18V	ZENER			33941
D635		IN4148			23802
D636		IN4148			23802
D637		IN4148			23802
D640		IN4148			23802
D641		IN4148			23802
D642		IN4148			23802

OS4040 TIMEBASE (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
DIODES (Cont.)					
D643		IN4148			23802
D644		IN4148			23802
D645		IN4148			23802
D646		IN4148			23802
D647		IN4148			23802
D648		IN4148			23802
D649		IN4148			23802
D650		IN4148			23802
D651		IN4148			23802
D652	3V9	ZENER			33925
D653		IN4148			23802
D654		IN4148			23802
D655		IN4148			23802
D656		IN4148			23802
D657		IN4148			23802
D658		IN4148			23802
D659		IN4148			23802
D660		IN4148			23802
D661		IN4148			23802
D662		IN4148			23802
D663		IN4148			23802
D664		IN4148			23802
D665	6V2	ZENER			33930
D666	6V2	ZENER			33930
D667		IN4149			1949
D668		IN4149			1949
D669		IN4149			1949
D670		IN4149			1949
D671	4V7	ZENER			33927
D672	6V8	ZENER			33931
MISCELLANEOUS					
S601–603					A3/44791
S604–608					A3/44797
S609–613					A3/44792
S620–624					A3/44790
S626–629					A3/44799
SK602					38001
SK606					38001
SK607					41393
SK608					41395
SK609					402036

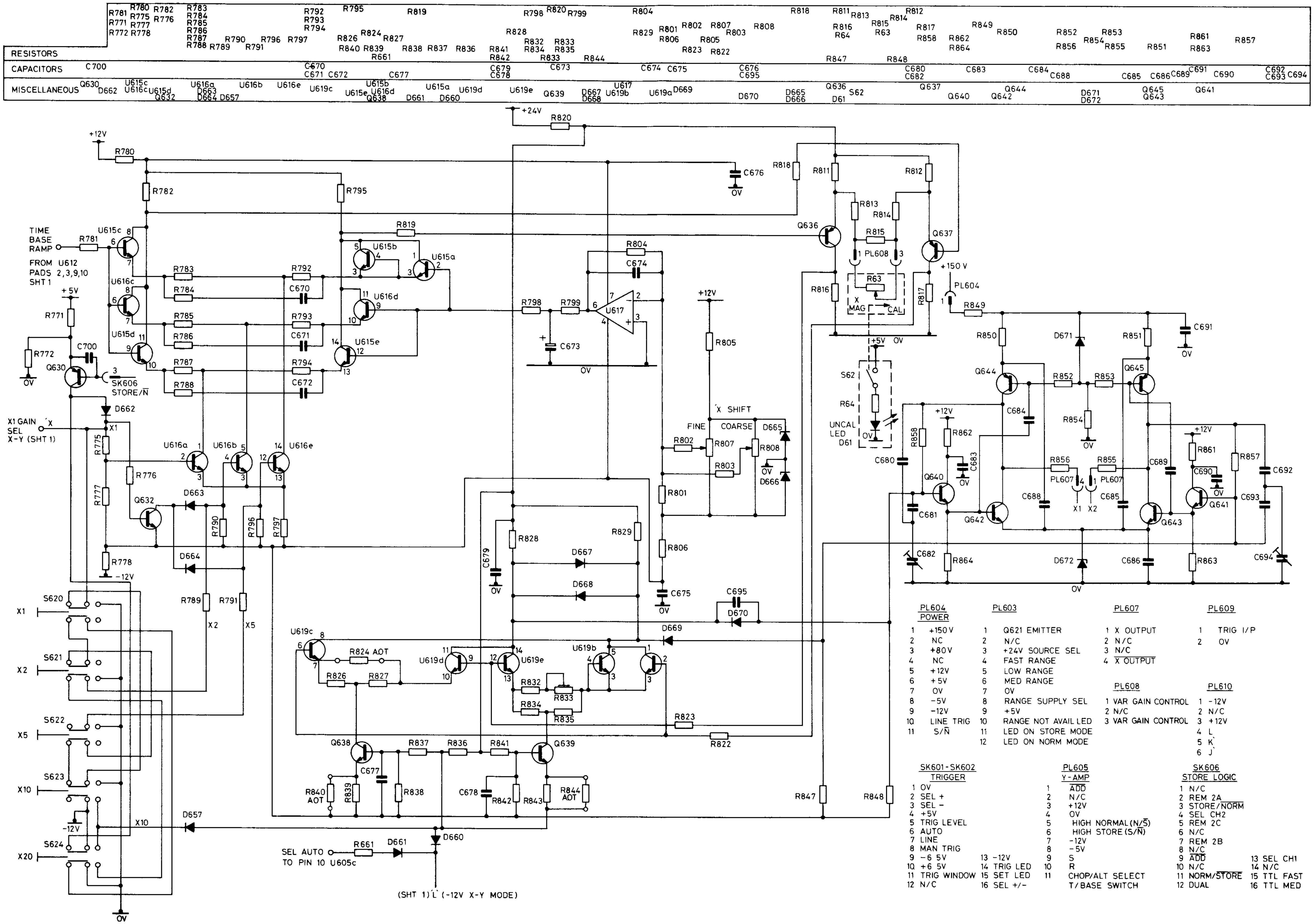


Fig. 6.5 Timebase Circuit Diagram 2

OS4040 POWER SUPPLY

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R1	2k2	MF	2		38602
R2	3k	MF	2		38605
R900	470	CF			21797
R901	2k	MF	2		38601
R902	5k6	MF	2		38612
R903	47k	MF	2	A.O.T.	38634
R904	470	CF			21797
R905	10k	CF			21809
R906	1k	CF			21799
R907	6k8	CF			21807
R908	OR1	WW		6W	44897
R909	10	CF			21793
R911	2k7	MF	2		38604
R912	3k6	MF	2		38607
R913	10	CF			21793
R914	3k6	MF	2		38607
R915	2k7	MF	2		38604
R916	10	CF		½W	18526
R917	200	MF	2		38577
R918	100	CP			36263
R919	2k	MF	2		38601
R921	2k	MF	2		38601
R922	100	CP			39263
R923	200	MF	2		38577
R924	4k7	CF			21805
R925	75k	MF	2	A.O.T.	38639
R926	12k	MF	2		38620

Ref	Value	Description	Rating	Part No
CAPACITORS				
C1	33000µF	E	16V	402029
C2	22000µF	T	16V	44833
C3	1µF	T	35V	34895
C4	1µF	T	35V	34895
C5	6800µF	E	25V	A4/40766
C6	0.1µF	CE(2)	25V	36709
C900	0.01µF		250V	22395
C901	0.01µF	CE(2)	250V	22395
C902	1µF	T	35V	34895
C903	1µF	T	35V	34895
C904	100µF	T	160V	44840
C905	150µF	T	160V	44912
C906	3300µF	E	25V	44578
C907	1µF	T	35V	34895
C908	10µF	T	35V	35931
C909	1µF	T	35V	34895
C911	1µF	T	35V	34895
C912	10µF	T	35V	35931
C913	1µF	T	35V	34895

Ref	Description	Part No
Q1	2N6285	44836
Q901	2N6504	44845
Q902	2N6400	44844
Q903	TIP30A	38415
Q904	BC108	26110
U1	uA79HG	44835
U900	LM723	31651
U901	MC3423P	43556
U902	MC3423P	43556
U903	LM317T	40731
U904	LM337T	44842

Ref	Value	Description	Part No
DIODES			
D901	6V8	ZENER	33931
D902	33V	ZENER	33947
D911		IN4003	32771
D912		IN4003	32771

Ref	Description	Part No
MISCELLANEOUS		
THT1	2455R-2-921	44900
BR1	BY261-200	44832
BR901	WO4	451795
BR902	VH148	36281
T1		A/44829
BL1		44805
S1		A4/36232
S2		4069
S3		4069
PL1		33787

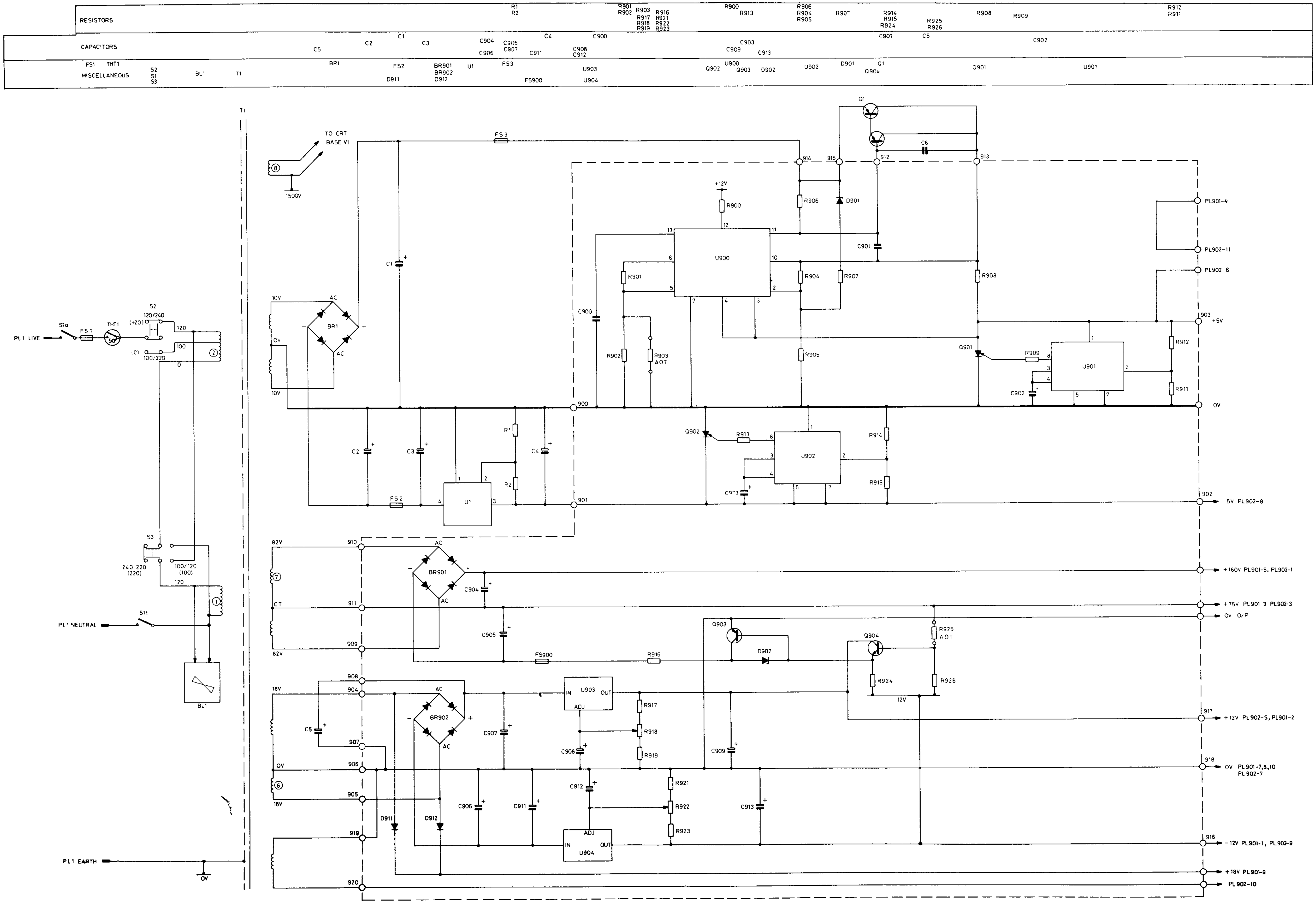


Fig. 6.6 Power Supply Circuit Diagram

OS4040 STORE ASSY.

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
N1201	220 x 8	Resistor Network			44879
N1202	330 x 8	Resistor Network			44880
R1209	1k	CF			21799
R1211	1k	CF			21799
R1212	470	CF			21797
R1213	220	CF			21796
R1214	10k	CF			21809
CAPACITORS					
C1201	.01μF	CE(3)			42444
C1202	.01μF	CE(3)			42444
C1203	.01μF	CE(3)			42444
C1204	.01μF	CE(3)			42444
C1205	.01μF	CE(3)			42444
C1206	.01μF	CE(3)			42444
C1207	.01μF	CE(3)			42444
C1208	.01μF	CE(3)			42444
C1209	.01μF	CE(3)			42444
C1210	.01μF	CE(3)			42444
C1211	.01μF	CE(3)			42444
C1212	.01μF	CE(3)			42444
C1213	.01μF	CE(3)			42444
C1214	.01μF	CE(3)			42444
C1215	.01μF	CE(3)			42444
C1216	.01μF	CE(3)			42444
C1217	.01μF	CE(3)			42444
C1218	.01μF	CE(3)			42444
C1219	.01μF	CE(3)			42444
C1220	.01μF	CE(3)			42444
C1221	.01μF	CE(3)			42444
C1222	.01μF	CE(3)			42444
C1223	.01μF	CE(3)			42444
C1224	.01μF	CE(3)			42444
C1225	.01μF	CE(3)			42444
C1226	.01μF	CE(3)			42444
C1227	.01μF	CE(3)			42444
C1228	.01μF	CE(3)			42444
C1229	.01μF	CE(3)			42444
C1230	150μF	E		6V3	32163
C1231	150μF	E		6V3	32163
U1201		2114-2			450459
U1202		2114-2			450459
U1203		2114-2			450459
U1204		2114-2			450459
U1205		2114-2			450459
U1206		2114-2			450459
U1207		2114-2			450459
U1208		2114-2			450459
U1209		74S00			34519
U1210		74S00			33519
U1211		74LS85			41081

Ref	Value	Description	Tol %±	Rating	Part No
U1212		74LS163A			41086
U1213		74LS163A			41086
U1214		74LS173			44396
U1215		74LS173			44396
U1216		74LS173			44396
U1217		74LS173			44396
U1218		2114-1			450459
U1219		2114-1			450459
U1220		2114-1			450459
U1221		2114-1			450459
U1222		2114-1			450459
U1223		2114-1			450459
U1224		2114-1			450459
U1225		2114-1			450459
U1226		74LS374			44398
U1227		74LS85			41081
U1228		74LS151			41085
U1229		74LS153			36247
U1230		74LS163A			41086
U1231		74LS173			44396
U1232		74LS173			44396
U1233		74LS173			44396
U1234		74LS173			44396
U1235		74LS173			44396
U1236		74LS173			44396
U1237		74LS173			44396
U1238		74LS173			44396
U1239		74LS173			44396
U1240		74LS173			44396
U1241		74LS173			44396
U1242		74LA173			44396
U1243		74S374			44398
U1244		74LS163A			41086
U1245		74LS163A			41086
U1246		74LS00			36730
U1247		74LS163A			41086
U1248		74LS85			41081
U1249		74LS163A			41086
U1250		74LS173			44396
U1251		74LS173			44396
U1252		74LS173			44396
U1253		74LS173			44396
U1254		74LS173			44396
U1255		74LS173			44396
U1256		74LS173			44396
U1257		74LS173			44396
U1258		74LS153			36247
U1259		74LS153			36247
U1260		74LS153			36247
U1261		74LS153			32647
U1262		74LS173			44396
U1263		74LS173			44396
U1264		74LS173			44396
U1265		74LS173			44396
U1266		74LS377			42763

OS4040 STORE ASSY. (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
U1267		74LS245			44397
U1268		74LS377			42763
U1269		74LS245			44397
U1270		74LS377			42763
U1271		74LS245			44397
U1272		74LS377			42763
U1273		74LS245			44397
U1274		MC10125			39245
U1275		MC10125			39245
U1276		74LS377			42763
U1277		74LS245			44397
U1278		74LS85			41081
U1279		74LS163A			41086
U1280		74LS163A			41086
MISCELLANEOUS					
Q1201		2N3904			24146

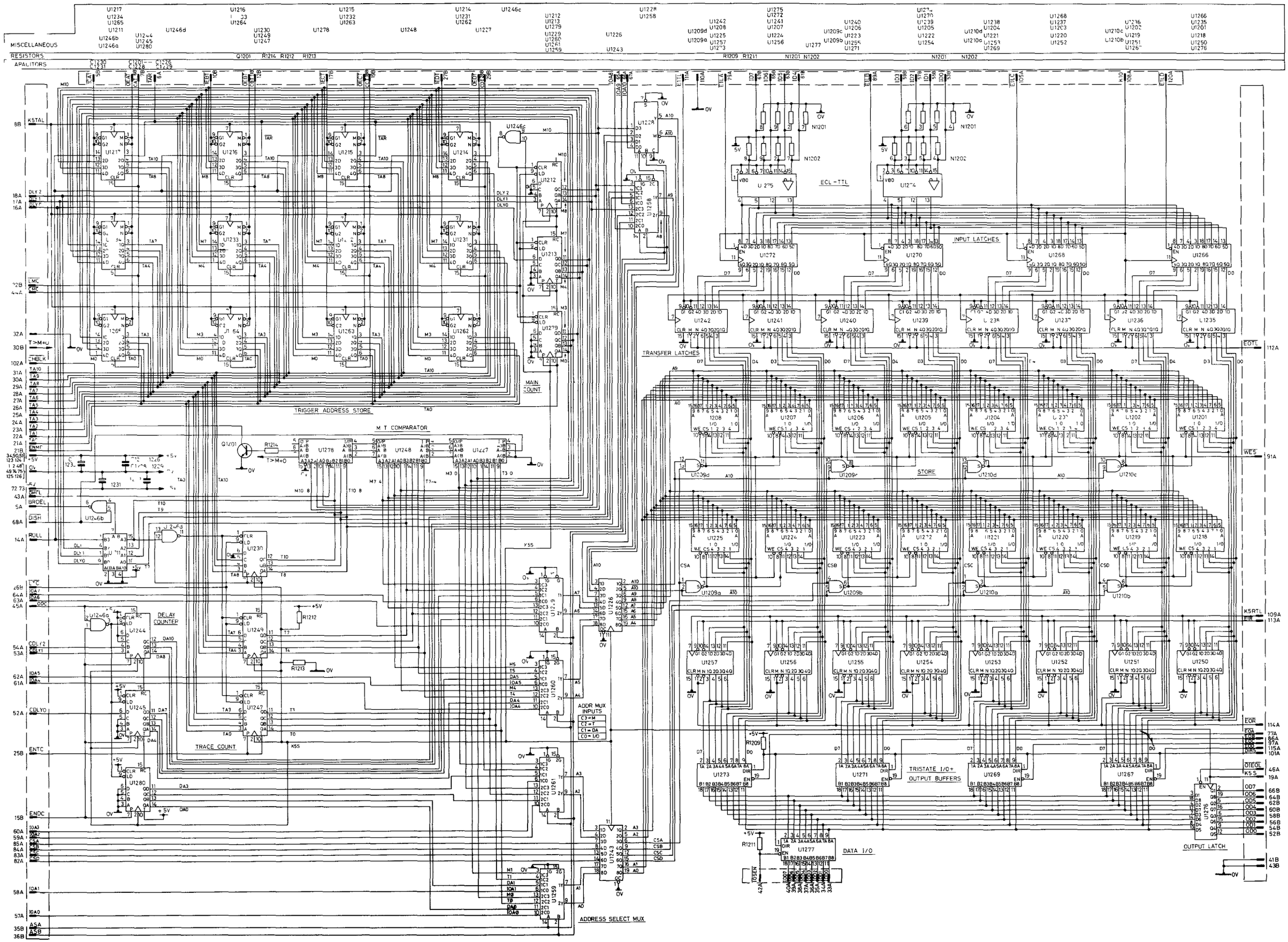


Fig. 6.7 Store Circuit Diagram

OS4040 CONTROL P.C.B.

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R1301	2k	PCP			40178
R1302	1k	PCP			39261
R1304	1k	CF			21799
R1305	39	CF			28713
R1306	6k8	CF			21807
R1307	390	CF			28722
R1308	390	CF			28722
R1309	390	CF			28722
R1310	1k	CF			21799
R1311	390	CF			28722
R1313	390	CF			28722
R1314	4k7	CF			21805
R1315	680	CF			28723
R1316	1k	CF			21799
R1317	4k7	CF			21805
R1318	560	CF			21798
R1319	560	CF			21798
R1320	560	CF			21798
R1321	3k9	CF			21804
R1322	2k7	CF			28726
R1323	560	CF			21798
R1324	2k2	CF			21802
R1325	2k7	CF			28726
R1326	100	CF			21794
R1327	100	CF			21794
R1328	1k	CF			21799
R1329	1k	CF			21799
R1330	560	CF			21798
R1331	4k7	CF			21805
R1332	4k7	CF			21805
R1333	4k7	CF			21805
R1334	4k7	CF			21805
R1335	1k	CF			21799
R1336	270	CF			28720
R1337	2k7	CF			28726
R1338	68	CF			28716
R1339	470	CF			21797
R1340	22	CF			28710
N1301	560 x 8	Resistor Network			39258
N1302	560 x 8	Resistor Network			39258
N1303	560 x 8	Resistor Network			39258
N1304	220 x 8	Resistor Network			44879
N1305	330 x 8	Resistor Network			44880
N1306	1k x 8	Resistor Network			44892
CAPACITORS					
C1301	.01µF	CE(3)			42444
C1302	.01µF	CE(3)			42444
C1303	150pF	CE(3)			42422
C1304	.01µF	CE(3)			42444
C1305	22pF	CE(3)			42412
C1306	.01µF	CE(3)			42444
C1307	.01µF	CE(3)			42444
C1308	.01µF	CE(3)			42444
C1309	.01µF	CE(3)			42444
C1310	.01µF	CE(3)			42444
C1311	.01µF	CE(3)			42444
C1312	.01µF	CE(3)			42444
C1313	330pF	CE(3)			42426
C1314	.01µF	CE(3)			42444
C1315	.01µF	CE(3)			42444
C1316	.01µF	CE(3)			42444
C1317	.01µF	CE(3)			42444
C1318	.01µF	CE(3)			42444
C1319	.01µF	CE(3)			42444
C1320	22pF	CE(3)			42414
C1321	.01µF	CE(3)			42444
C1322	.01µF	CE(3)			42444
C1323	.01µF	CE(3)			42444
C1324	.01µF	CE(3)			42444
C1325	150pF	CE(3)			42422
C1326	.01µF	CE(3)			42444
C1327	.01µF	CE(3)			42444
C1328	.01µF	CE(3)			42444
C1329	.01µF	CE(3)			42444
C1330	.01µF	CE(3)			42444
C1331	150µF	E		6V3	32163
C1332	150µF	E		6V3	32163
C1333	2700pF	CE(3)			42437
C1334	47µF	E			44883
C1335	.01µF	CE(3)			42444
C1336	2200pF	CE(3)			42436
C1337	.01µF	CE(3)			42444
C1338	.01µF	CE(3)			42444
C1340	.01µF	CE(3)			42444
C1341	.01µF	CE(3)			42444
DIODES					
D1301		BAT81			452036
D1302	5V6	ZENER			33929
D1303		BAT81			452036
D1304		BAT81			452036
D1305		BAT81			452036
D1306		BAT81			452036
D1307		BAT81			452036
D1310		BAT81			452036
D1311		BAT81			452036
D1312		BAT81			452036
U1301		74LS273			41809
U1302		74LS393			41090
U1303		74LS164			41087
U1304		74LS163A			41086
U1305		74LS163A			41086
U1306		74LS163A			41086

OS4040 CONTROL P.C.B. (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
U1307		74LS04			36731
U1308		74S74			36005
U1309		74LS00			36730
U1310		7425			44387
U1311		74LS27			41077
U1312		74LS669			44374
U1313		10102			39243
U1314		10102			39243
U1315		74LS00			36730
U1316		74LS670			44373
U1317		74LS51			43676
U1318		74LS151			41085
U1319		74S00			34519
U1320		74S109			40210
		or 74F109			451247
U1321		74LS02			41075
U1322		74S51			44371
U1323		74LS74			36732
U1324		74S109			40210
		or 74F109			451247
U1325		74LS74			36732
U1326		74S02			41075
U1327		MC10124			44366
U1328		74LS08			36467
U1329		MC10104			41064
U1330		10131			39246
U1331		74LS669			44374
U1332		74LS163A			41086
U1333		74LS133			36427
U1334		74LS54			44388
U1335		74LS08			36467
U1336		LF356			39226
U1337		74LS164			41087
U1338		74LS670			44373
U1339		74LS04			36731
U1340		74LS02			41075
U1341		MC10166			44368
U1342		MC10166			44368
U1343		74LS08			36467
U1344		74LS02			41075
U1345		74FOO			450569
U1346		74LS08			36467
U1347		74LS109			41082
U1348		74LS109			41082
U1349		10102			39243
U1350		74LS669			44374
U1351		74LS83			43671
U1352		74LS00			36730
U1353		74LS51			43676
U1354		MC1408			35683
U1355		MC14066B			40044
U1356		74LS139			44392
U1357		74LS04			36731
U1358		74F151			44386
U1359		MC10133			44367
U1360		MC10133			44367
U1361		74LS109			41802
U1362		74LS273			41089
U1363		74LS11			41076
U1364		74LS156			39237
U1365		74LS148			44393
U1366		74LS175			36728
U1367		74LS54			44388

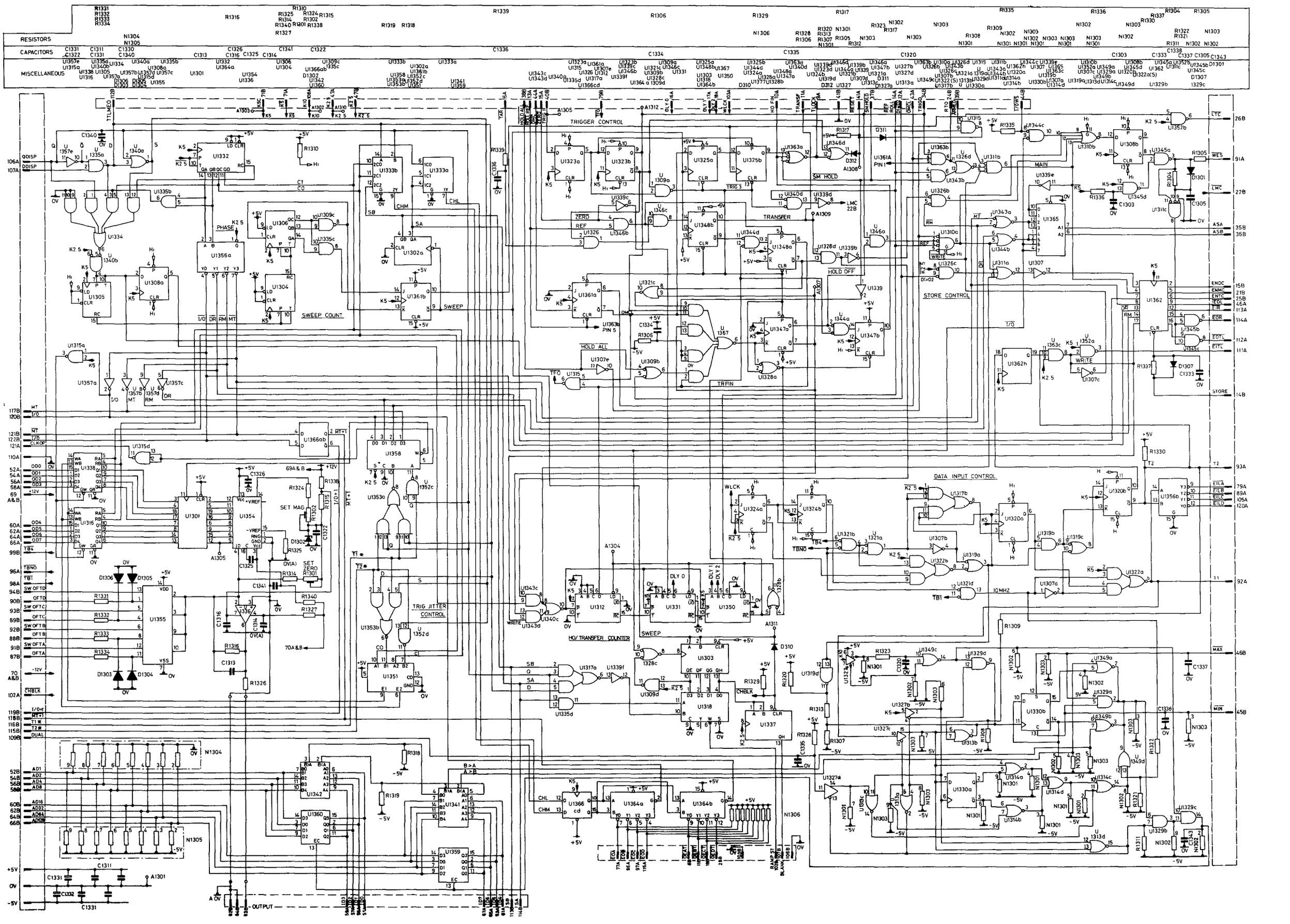


Fig. 6.8 Control Circuit Diagram

OS4040 INTERFACE

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R1401	22k	CF			21812
R1402	390	CF			28722
R1403	1k	CF			21799
R1404	2k2	CF			21802
R1405	6k8	CF			21807
R1406	2k2	CF			21802
R1407	180	CF			21795
R1408	1k	CF			21799
R1409	100k	CF			21819
R1410	100k	CF			21819
R1411	1k	CF			21799
R1412	220k	CF			21823
R1413	100k	CF			21819
R1414	100k	CF			21819
R1415	1k	CF			21799
R1416	1k	CF			21799
R1417	1k	CF			21799
R1418	1k	CF			21799
R1419	1k	CF			21799
R1420	1k	CF			21799
R1421	1k	CF			21799
R1422	1k	CF			21799
R1423	390	CF			28722
R1424	390	CF			28722
R1425	1k	CF			21799
R1426	3k3	CF			21803
R1427	1k	CF			21799
R1428	1M	CF			31840
R1429	47k	CF			21815
R1430	47k	CF			21815
R1431	1k	CF			21799
R1432	2k2	CF			21802
R1433	120k	CF			21820
R1434	470	CF			44222
R1435	1k	CF			21799
N1401	1k x 8	Resistor Network			44892
N1402	1k x 8	Resistor Network			44892
N1403	1k x 8	Resistor Network			44892
N1404	1k x 8	Resistor Network			44892
N1405	1k x 8	Resistor Network			44892
N1406	4k7 x 8	Resistor Network			39225
CAPACITORS					
C1401	.01µF	CE(3)			42444
C1402	.01µF	CE(3)			42444
C1403	15pF	CE(3)			42410
C1404	220pF	CE(3)			42424
C1405	150pF	CE(3)			42422
C1406	.01µF	CE(3)			42444
C1407	.01µF	CE(3)			42444
C1408	.01µF	CE(3)			42444
C1409	.01µF	CE(3)			42444
C1410	.01µF	CE(3)			42444
C1411	.01µF	CE(3)			42444
C1412	.01µF	CE(3)			42444
C1413	.01µF	CE(3)			42444
C1414	.01µF	CE(3)			42444
C1415	.01µF	CE(3)			42444
C1416	0.1µF	CE(3)			43498
C1417	.01µF	CE(3)			42444
C1418	.01µF	CE(3)			42444
C1419	.01µF	CE(3)			42444
C1420	.01µF	CE(3)			42444
C1421	.01µF	CE(3)			42444
C1422	.01µF	CE(3)			42444
C1423	.01µF	CE(3)			42444
C1424	.01µF	CE(3)			42444
C1425	.01µF	CE(3)			42444
C1426	.01µF	CE(3)			42444
C1427	.01µF	CE(3)			42444
C1428	.01µF	CE(3)			42444
C1429	.01µF	CE(3)			42444
C1430	.01µF	CE(3)			42444
C1431	.01µF	CE(3)			42444
C1432	.01µF	CE(3)			42444
C1433	150µF	E		6V3	32163
C1434	.01µF	CE(3)			42444
C1435	.01µF	CE(3)			42444
C1436	.01µF	CE(3)			42444
C1437	.01µF	CE(3)			42444
C1438	.01µF	CE(3)			42444
C1439	150µF	E		6V3	32163
C1440	.01µF	CE(3)			42444
C1441	.01µF	CE(3)			42444
C1442	.01µF	CE(3)			42444
C1443	150µF	E		6V3	32163
C1444	.01µF	CE(3)			42444
C1445	.01µF	CE(3)			42444
C1446	10µF	T		35V	35931
C1447	0.01µF	CE(3)			42444
C1448	0.01µF	CE(3)			42444
C1450	.047µF	CE(3)			43497
DIODES					
D1401	6V2	ZENER			33930
D1402	6V2	ZENER			33930
D1403		OA47			4468
D1404		OA47			4468
D1405		IN4148			23802
D1406		OA47			4468
D1407		OA47			4468
D1408		OA47			4468
U1401		74LS125			44390
U1402		74LS04			36731
U1403		74LS112			36468
U1404		74LS00			36730
U1405		74LS04			36731
U1406		74LS02			41075
U1407		74LS08			36467
U1408		74LS125			44390
U1409		74LS390			43675
U1410		74LS390			43675
U1411		74LS00			36730
U1412		MC10124			44366
U1413		74LS125			44390
U1414		MC10125			39245
U1415		74LS109			41082
U1416		74LS126			44391
U1417		74LS08			36467

OS4040 INTERFACE (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
U1418		74LS75			44389
U1419		74LS175			36728
U1420		74S240			42794
U1421		74LS112			33447
U1422		74LS05			36879
U1423		74LS08			36467
U1424		MC10124			44366
U1425		74LS175			36728
U1426		74LS240			43382
U1427		74LS157			36735
U1428		74LS10			36867
U1429		74LS393			41090
U1430		74LS02			41075
U1431		74LS02			41075
U1432		74LS157			36735
U1433		74LS75			44389
U1434		74LS153			36247
U1435		74LS75			44389
U1436		74LS02			41075
U1437		MC10125			39245
U1438		74LS125			41917
U1439		74LS04			36731
U1440		74LS08			36467
U1441		74LS157			36735
U1442		74LS20			39236
U1443		74LS157			36735
U1444		74LS379			44399
U1445		74LS85			41081
U1446		74LS125			41917
U1447		74LS139			44392
U1448		CD4081B			37694
U1449		74LS32			41080
U1450		74LS298			44377
U1451					
U1452		74LS244			43384
U1453		74LS273			41089
U1454		74LS244			43384
U1455		74LS273			41089
U1456		74LS244			43384
U1457		74LS273			41089
U1458		74LS273			41089
U1459		74LS244			43384
U1460		74LS08			36467
U1461		74LS83			43671
U1462		74LS173			44396
MISCELLANEOUS					
Q1401		2N3904			24146
Q1402		2N3904			24146
Q1403		2N3904			24146
SK1401					38001
SK1402					38001
SK1403					38001
SK1404					38001
SK1405					38001
L1401	4.7μH				37560
X1401		Crystal 10MHz			44893

Fig. 6.9 Interface Circuit Diagram

OS4040 A–D CONVERTER

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R1500	130	MF	2		38573
R1501	82	MF	2		38568
R1502	27	CF			28711
R1503	1k	CF			21799
R1504	5k6	CF			21806
R1505	5k6	CF			21806
R1506	560	CF			21798
R1507	100	CF			21794
R1508	200	PCP			39264
R1509	47k	CF			21721
R1510	22	CF			28710
R1511	100	CF			21794
R1512	500k	CP			42153
R1513	100	CF			21794
R1514	220	CF			21796
R1515	1k	CF			21799
R1516	560	MF	2		38588
R1517					
R1518	165	MF	1		450617
R1519	1k	CF			21799
R1520	47k	CF			21721
R1521	5k6	CF			21806
R1522	5k6	CF			21806
R1523	270	CF			28720
R1524	100	CF			21794
R1525	100	CF			21794
R1526	100	CF			21794
R1527	220	CF			21796
R1528	39	CF			28713
R1529	1k	CF			21799
R1530					
R1531	390	MF	1		41184
R1532					
R1533	33	MF			38558
R1534	560	CF	2		450433
R1535	2k2	MF	2		38602
R1536	2k2	MF	2		38602
R1537	56k	CF			28729
R1538	1k	CF			21799
R1539	5k6	CF			21806
R1540	3k3	CF			21803
R1541	5k6	CF			21806
R1542	560	CF			21798
R1543	100	CF			21794
R1544	100	CF			21794
R1545	100	CF			21794
R1546	220	CF			21796
R1547	560	MF	2		450433
R1548					
R1549	22	CF			28710
R1551	1k	CF			21799
R1552	3k3	CF			21803
R1553	47	MF	2		38562
R1554	100	MF	2		38570
R1555	100	MF	2		38570
R1556	200	MF	2		38577
R1557	68	MF	2		38566
R1558	1k	CF			21799
R1559	5k6	CF			21806
R1560	47	CF			43146
R1561	5k6	CF			21806
R1562	560	CF			21798
R1563	150	CF			28719
R1564	100	CF			21794
R1565	200k	PCP			42159
R1566	47k	CF			21721
R1567					
R1568	680	MF	2		38590
R1569	220	CF			21796
R1570	47	CF		1/8W	43146
R1571	470	CF			21797
R1572					
R1573	100	CF			21794
R1574	220	CF			21796
R1575	200	MF	2		38577
R1576	1k	CF			21799
R1577	5k6	CF			21806
R1578	100	CF			21794
R1579	5k6	CF			21806
R1580	22	CF			28710
R1581	560	CF			21798
R1582	100	CF			21794
R1583					
R1584	100	CF			21794
R1585	220	CF			21796
R1586	470	MF	2		38586
R1587	470	CF		½W	18546
R1588	33	MF			38558
R1589	1k2	CF			21800
R1590	33k	MF	1		450435
R1591	8k2	MF	1		450552
R1592	1k	PCP			39233
R1593	10k	PCP			39265
R1594	9	MF	0.25		37974
R1595	10	CF			21793
R1596	9	MF	0.25		37974
R1597	10	CF			21793
R1598	9	MF	0.25		37974
R1599	10	CF			21793
R1600	22k	MF	1		450436
R1601	9	MF	0.25		37974
R1602	10	CF			21793
R1603	9	MF	0.25		37974
R1604	10	CF			21793
R1605	9	MF	0.25		37974
R1606	10	CF			21793
R1607	9	MF	0.25		37974
R1608	10	CF			21793
R1609	9	MF	0.25		37974
R1610	10	CF			21793
R1611	9	MF	0.25		37974
R1612	10	CF			21793

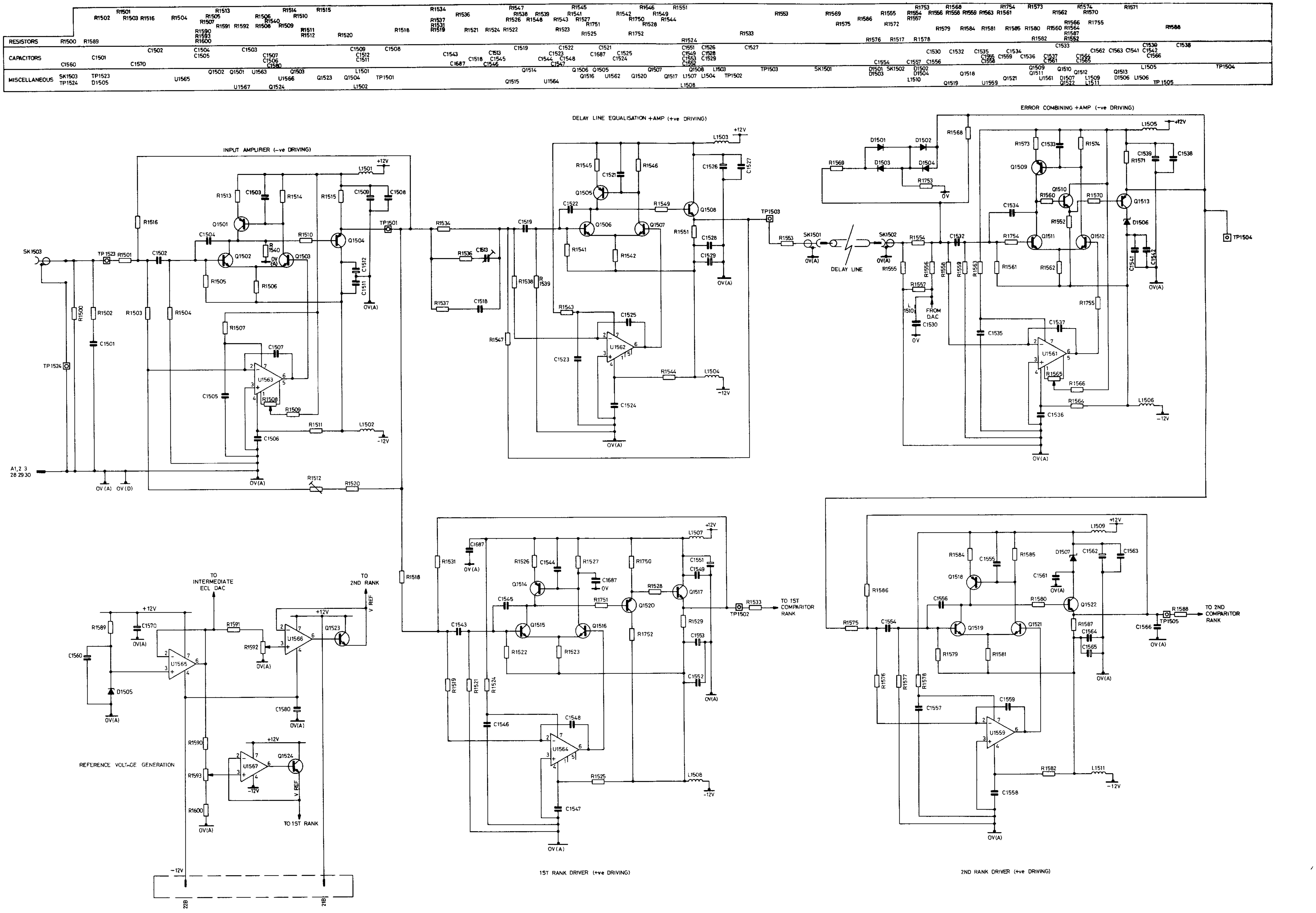


Fig. 6.10 A.D.C. Circuit Diagram 1

OS4040 A–D CONVERTER (Cont.)

RESISTORS (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
R1613	9	MF	0.25		37974
R1614	10	CF			21793
R1615	9	MF	0.25		37974
R1616	10	CF			21793
R1617	9	MF	0.25		37974
R1618	10	CF			21793
R1619	9	MF	0.25		37974
R1621	10	CF			21793
R1622	9	MF	0.25		37974
R1623	10	CF			21793
R1624	9	MF	0.25		37974
R1625	10	CF			21793
R1626	9	MF	0.25		37974
R1627	12	CF			28707
R1628	12	CF			28707
R1629	12	CF			28707
R1631	12	CF			28707
R1632	12	CF			28707
R1633	12	CF			28707
R1634	12	CF			28707
R1635	12	CF			28707
R1636	12	CF			28707
R1637	12	CF			28707
R1638	12	CF			28707
R1639	12	CF			28707
R1641	12	CF			28707
R1642	12	CF			28707
R1643	12	CF			28707
R1644	1k8	CF			28725
R1645	1k8	CF			28725
R1646	1k8	CF			28725
R1647	1k8	CF			28725
R1648	1k8	CF			28725
R1649	1k8	CF			28725
R1651	1k8	CF			28725
R1652	1k8	CF			28725
R1653	1k8	CF			28725
R1654	1k8	CF			28725
R1655	1k8	CF			28725
R1656	1k8	CF			28725
R1657	1k8	CF			28725
R1658	1k8	CF			28725
R1659	1k8	CF			28725
R1661	180	MF	2		38576
R1662	130	MF	2		38573
R1663	82	MF	2		38568
R1664	27	CF			28711
R1665	51	CF			32218
R1666	1k8	MF	1		450437
R1667	500	PCP			39262
R1668	2k	MF	2		38601
R1669	9	MF	0.25		37974
R1671	10	CF			21793
R1672	9	MF	0.25		37974
R1673	10	CF			21793
R1674	9	MF	0.25		37974
R1675	10	CF			21793
R1676	9	MF	0.25		37974
R1677	10	CF			21793
R1678	9	MF	0.25		37974
R1679	10	CF			21793
R1681	9	MF	0.25		37974
R1682	10	CF			21793
R1683	9	MF	0.25		37974
R1684	10	CF			21793
R1685	9	MF	0.25		37974
R1686	10	CF			21793
R1687	9	MF	0.25		37974
R1688	10	CF			21793
R1689	9	MF	0.25		37974
R1691	10	CF			21793
R1692	9	MF	0.25		37974
R1693	10	CF			21793
R1694	9	MF	0.25		37974
R1695	10	CF			21793
R1696	9	MF	0.25		37974
R1697	10	CF			21793
R1698	9	MF	0.25		37974
R1699	10	CF			21793
R1701	9	MF	0.25		37974
R1702	10	CF			21793
R1703	9	MF	0.25		37974
R1704	12	CF			38707
R1705	12	CF			28707
R1706	12	CF			28707
R1707	12	CF			28707
R1708	12	CF			28707
R1709	12	CF			28707
R1711	12	CF			28707
R1712	12	CF			28707
R1713	12	CF			28707
R1714	12	CF			28707
R1715	12	CF			28707
R1716	12	CF			28707
R1717	12	CF			28707
R1718	12	CF			28707
R1719	12	CF			28707
R1721	180	MF	2		38576
R1722	1k8	CF			28725
R1723	1k8	CF			28725
R1724	1k8	CF			28725

OS4040 A–D CONVERTER (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS (Cont.)					
R1725	1k8	CF			28725
R1726	1k8	CF			28725
R1727	1k8	CF			28725
R1728	1k8	CF			28725
R1729	1k8	CF			28725
R1731	1k8	CF			28725
R1732	1k8	CF			28725
R1733	1k8	CF			28725
R1734	1k8	CF			28725
R1735	1k8	CF			28725
R1736	1k8	CF			28725
R1737	1k8	CF			28725
R1738	82	MF	2		38568
R1739	130	MF	2		38573
R1740	150	CF			28719
R1743	100	CF			21794
R1744	150	CF			28719
R1750	1k2	CF			21800
R1751	56	CF			28715
R1752	39	CF			28713
R1753	1k2	CF			21800
R1754	47	CF			43146
R1755	47	CF			43146
N1500	1k 2 x 8	Resistor Network			44877
N1501	2k 7 x 8	Resistor Network			44878
N1502	1k 2 x 8	Resistor Network			44877
N1503	2k 7 x 8	Resistor Network			44878
N1504	1k 2 x 8	Resistor Network			44877
N1505	2k 7 x 8	Resistor Network			44878
N1506	1k 2 x 8	Resistor Network			44877
N1507	2k 7 x 8	Resistor Network			44878
N1508	560 x 8	Resistor Network			39258
N1509	560 x 8	Resistor Network			39258
N1510	560 x 8	Resistor Network			39258
N1511	560 x 8	Resistor Network			39258
N1512	560 x 8	Resistor Network			39258
N1513	560 x 8	Resistor Network			39258
N1514	560 x 8	Resistor Network			39258
N1515	560 x 8	Resistor Network			39258
N1516	560 x 8	Resistor Network			39258
N1517	560 x 8	Resistor Network			39258
N1518	560 x 8	Resistor Network			39258
N1519	560 x 8	Resistor Network			39258
N1520	560 x 8	Resistor Network			39258
N1521	560 x 8	Resistor Network			39258
N1522	560 x 8	Resistor Network			39258
N1523	560 x 8	Resistor Network			39258
N1524	560 x 8	Resistor Network			39258
N1525	560 x 8	Resistor Network			39258
N1526	560 x 8	Resistor Network			39258

Ref	Value	Description	Tol %±	Rating	Part No
CAPACITORS					
C1501	27pF	CE(2)			22369
C1502	0.1µF	CE(3)		50V	43498
C1503	0.1µF	CE(2)		25V	36709
C1504	4p7	CE(2)		50V	36602
C1505	.022µF	CE(2)		63V	44882
C1506	.022µF	CE(2)		63V	44882
C1507	120pF	CE(2)			22377
C1508	.01µF	CE(2)		250V	22395
C1509	33µF	E		16V	44884
C1511	.01µF	CE(2)		250V	22395
C1512	33µF	E		16V	44884
C1513	1.5/9pF	Trimmer			36272
C1518	100pF	CE(2)		100V	22376
C1519	0.1µF	CE(3)		50V	43498
C1521	0.1µF	CE(2)		25V	36709
C1522	4p7	CE(2)		50V	36602
C1523	.022µF	CE(2)		63V	44882
C1524	.022µF	CE(2)		63V	44882
C1525	120pF	CE(2)			22377
C1526	33µF	E		16V	44884
C1527	.01µF	CE(2)		250V	22395
C1528	.01µF	CE(2)		250V	22395
C1529	33µF	E		16V	44884
C1530	100pF	CE(3)			22376
C1532	0.1µF	CE(3)		50V	43498
C1533	0.1µF	CE(2)		25V	36709
C1534	6p8	CE(3)		50V	36604
C1535	.022µF	CE(2)		63V	44882
C1536	.022µF	CE(2)		63V	44882
C1537	120pF	CE(2)			22377
C1538	.01µF	CE(2)		250V	22395
C1539	33µF	E		16V	44884
C1540	18pF	CE(2)			22367
C1541	.01µF	CE(2)		250V	22395
C1542	33µF	E		16V	44884
C1543	0.1µF	CE(3)		50V	43498
C1544	0.1µF	CE(2)		25V	36709
C1545	5p6	CE(2)		50V	36603
C1546	.022µF	CE(2)		63V	44882
C1547	.022µF	CE(2)		63V	44882
C1548	120pF	CE(2)			22377
C1549	.01µF	CE(2)		250V	22395
C1551	33µF	E		16V	44884
C1552	.01µF	CE(2)		250V	22395
C1553	33µF	E		16V	44884
C1554	0.1µF	CE(3)		63V	43498
C1555	0.1µF	CE(2)		25V	36709
C1556	4p7	CE(2)		50V	36602
C1557	.022µF	CE(2)		63V	44882

OS4040 A–D CONVERTER (Cont.)

CAPACITORS (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
C1558	.022μF	CE(2)		63V	44882
C1559	120pF	CE(2)			22377
C1560	33μF	E		16V	44884
C1561	.01μF	CE(2)		250V	22395
C1562	33μF	E		16V	44884
C1563	.01μF	CE(2)		250V	22395
C1564	.01μF	CE(2)		250V	22395
C1565	33μF	E		16V	44884
C1566	5p6	CE(2)			22361
C1567	.022μF	CE(2)		63V	44882
C1568	.022μF	CE(2)		63V	44882
C1569	.022μF	CE(2)		63V	44882
C1570	33μF	E		16V	44884
C1571	.022μF	CE(2)		63V	44882
C1572	.022μF	CE(2)		63V	44882
C1573	.022μF	CE(2)		63V	44882
C1574	.022μF	CE(2)		63V	44882
C1575	.022μF	CE(2)		63V	44882
C1576	.022μF	CE(2)		63V	44882
C1577	.022μF	CE(2)		63V	44882
C1578	.022μF	CE(2)		63V	44882
C1579	.022μF	CE(2)		63V	44882
C1580	33μF	E		16V	44884
C1581	.022μF	CE(2)		63V	44882
C1582	.022μF	CE(2)		63V	44882
C1583	.022μF	CE(2)		63V	44882
C1584	.022μF	CE(2)		63V	44882
C1585	.022μF	CE(2)		63V	44882
C1586	47μF	E		10V	44883
C1587	47μF	E		10V	44883
C1588	.022μF	CE(2)		63V	44882
C1589	.022μF	CE(2)		63V	44882
C1591	.022μF	CE(2)		63V	44882
C1592	.022μF	CE(2)		63V	44882
C1593	.022μF	CE(2)		63V	44882
C1594	.022μF	CE(2)		63V	44882
C1595	10pF	CE(2)		50V	36606
C1596	10pF	CE(2)		50V	36606
C1597	10pF	CE(2)		50V	36606
C1598	10pF	CE(2)		50V	36606
C1599	10pF	CE(2)		50V	36606
C1601	10pF	CE(2)		50V	36606
C1602	10pF	CE(2)		50V	36606
C1603	10pF	CE(2)		50V	36606
C1604	10pF	CE(2)		50V	36606
C1605	10pF	CE(2)		50V	36606
C1606	10pF	CE(2)		50V	36606
C1607	10pF	CE(2)		50V	36606
C1608	10pF	CE(2)		50V	36606
C1609	10pF	CE(2)		50V	36606
C1611	10pF	CE(2)		50V	36606
C1612	.022pF	CE(2)		63V	44882
C1613	47μF	E		10V	44883
C1614	.022μF	CE(2)		63V	44882
C1615	.022μF	CE(2)		63V	44882
C1616	47μF	E		10V	44883
C1617	.022μF	CE(2)		63V	44882
C1618	.022μF	CE(2)		63V	44882
C1619	.022μF	CE(2)		63V	44882
C1620	47μF	E		10V	44883
C1621	.022μF	CE(2)		63V	44882
C1622	.022μF	CE(2)		63V	44882
C1623	47μF	E		10V	44883
C1624	.022μF	CE(2)		63V	44882
C1625	47μF	E		10V	44883
C1626	47μF	E		10V	44883
C1627	.022μF	CE(2)		63V	44882
C1628	.022μF	CE(2)		63V	44882
C1629	.022μF	CE(2)		63V	44882
C1631	.022μF	CE(2)		63V	44882
C1632	.022μF	CE(2)		63V	44882
C1633	.022μF	CE(2)		63V	44882
C1634	.022μF	CE(2)		63V	44882
C1635	.022μF	CE(2)		63V	44882
C1636	.022μF	CE(2)		63V	44882
C1637	.022μF	CE(2)		63V	44882
C1638	.022μF	CE(2)		63V	44882
C1639	.022μF	CE(2)		63V	44882
C1640	47μF	E		10V	44883
C1641	.022μF	CE(2)		63V	44882
C1642	.022μF	CE(2)		63V	44882
C1643	.022μF	CE(2)		63V	44882
C1644	.022μF	CE(2)		63V	44882
C1645	.022μF	CE(2)		63V	44882
C1646	.022μF	CE(2)		63V	44882
C1648	.022μF	CE(2)		63V	44882
C1649	.022μF	CE(2)		63V	44882
C1650	47μF	E		10V	44883
C1651	.022μF	CE(2)		63V	44882
C1652	.022μF	CE(2)		63V	44882
C1653	.022μF	CE(2)		63V	44882
C1654	10pF	CE(2)		50V	36606
C1655	10pF	CE(2)		50V	36606
C1656	10pF	CE(2)		50V	36606
C1657	10pF	CE(2)		50V	36606
C1658	10pF	CE(2)		50V	36606
C1659	10pF	CE(2)		50V	36606
C1661	10pF	CE(2)		50V	36606
C1662	10pF	CE(2)		50V	36606
C1663	10pF	CE(2)		50V	36606
C1664	10pF	CE(2)		50V	36606
C1665	10pF	CE(2)		50V	36606
C1666	10pF	CE(2)		50V	36606
C1667	10pF	CE(2)		50V	36606

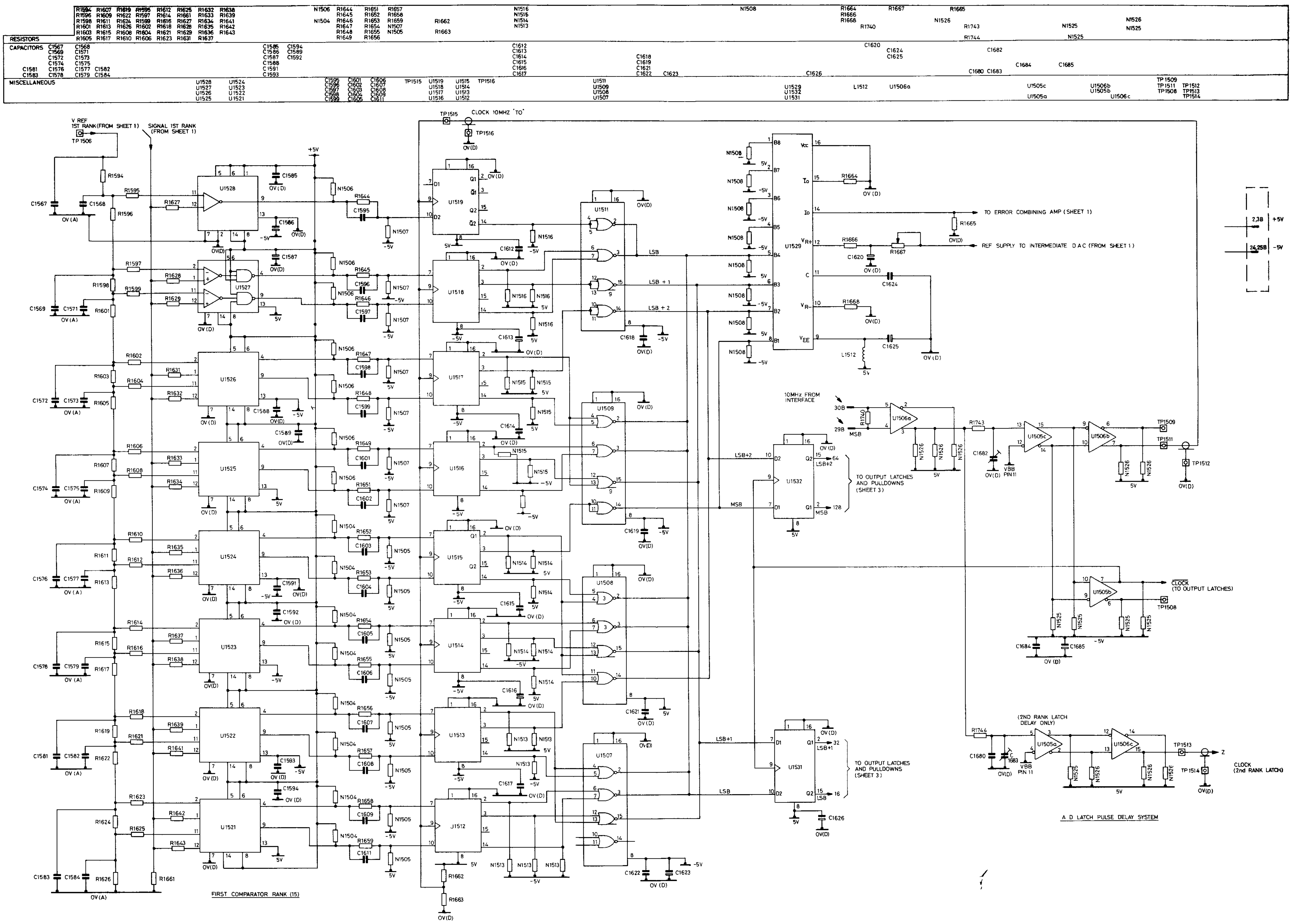


Fig. 6.11 A.D.C. Circuit Diagram 2

OS4040 A–D CONVERTER (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
CAPACITORS (Cont.)					
C1668	10pF	CE(2)		50V	36606
C1669	10pF	CE(2)		50V	36606
C1671	.022μF	CE(2)		63V	44882
C1672	47μF	E		10V	44883
C1673	.022μF	CE(2)		63V	44882
C1674	.022μF	CE(2)		63V	44882
C1675	47μF	E		10V	44883
C1676	.022μF	CE(2)		63V	44882
C1677	47μF	E		10V	44883
C1678	.022μF	CE(2)		63V	44882
C1679	.022μF	CE(2)		63V	44882
C1680	39pF	CE(2)		500V	22371
C1681	47μF	E		10V	44883
C1682	65pF	Trimmer			36091
C1683	65pF	Trimmer			36091
C1684	22μF	CE(2)			44882
C1685	47μF	E		10V	44883
C1686	10μF	T		35V	35931
C1687	.01μF	CE(2)			42569
INDUCTORS					
L1501	150μH				39214
L1502	150μH				39214
L1503	150μH				39214
L1504	150μH				39214
L1505	150μH				39214
L1506	150μH				39214
L1507	150μH				39214
L1508	150μH				39214
L1509	150μH				39214
L1510	Ferrite Bead FX1242				26986
L1511	150μH				39214
L1512	150μH				39214
Q1501		2N5771			38089
Q1502		2N2369			23307
Q1503		2N2369			23307
Q1504		2N5771			38089
Q1505		2N5771			38089
Q1506		2N2369			23307
Q1507		2N2369			23307
Q1508		ZTX327			39271
Q1509		2N5771			38089
Q1510		MPS2369			36625
Q1511		ZTX326A			41753
Q1512		ZTX326A			41753
Q1513		2N5771			38089
Q1514		2N5771			38089
Q1515		2N2369			23307
Q1516		2N2369			23307
Q1517		ZTX327			39271
Q1518		2N5771			38089
Q1519		2N2369			23307
Q1520		2N5771			38089
Q1521		2N2369			23307
Q1522		2N3866			27740
Q1523		BFY 50			29329
Q1524		BFY 50			29329
DIODES					
D1501		HP5082-2800			32671
D1502		HP5082-2800			32671
D1503		HP5082-2800			32671
D1504		HP5082-2800			32671
D1505	6V2	ZENER			40045
D1506	5V6	ZENER			33929
D1507	3V9	ZENER			33925
U1501		10103			39246
U1502		10103			39246
U1503		10103			39246
U1504		10103			39246
U1505		MC10216			39903
U1506		MC10216			39903
U1507		10102			39243
U1508		10102			39243
U1509		10102			39243
U1511		10102			39243
U1512		10103			39246
U1513		10103			39246
U1514		10103			39246
U1515		10103			39246
U1516		10103			39246
U1517		10103			39246
U1518		10103			39246
U1519		10103			39246
U1521		NE521			44886
U1522		NE521			44886
U1523		NE521			44886
U1524		NE521			44886
U1525		NE521			44886
U1526		NE521			44886
U1527		NE521			44886
U1528		NE521			44886
U1529		MC10318L			44887
U1531		10103			39246
U1532		10103			39246
U1533		NE521			44886
U1534		NE521			44886
U1535		NE521			44886
U1536		NE521			44886
U1537		NE521			44886
U1538		NE521			44886
U1539		NE521			44886
U1541		NE521			44886
U1542		10103			39246

OS4040 A–D CONVERTER (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
U1543		10103			39246
U1544		10103			39246
U1545		10103			39246
U1546		10103			39246
U1547		10103			39246
U1548		10103			39246
U1549		10103			39246
U1551		MC10101			41062
U1552		MC10101			41062
U1553		MC10101			41062
U1554		MC10101			41062
U1555		10102			39243
U1556		10102			39243
U1557		10102			39243
U1558		10102			39243
U1559		LF356			39226
U1561		LF355B			42050
U1562		LF355B			42050
U1563		LF356			39226
U1564		LF355B			42050
U1565		741			36736
U1566		741			36736
U1567		741			36736
MISCELLANEOUS					
SK1501					36105
SK1052					36105
SK1503					36105

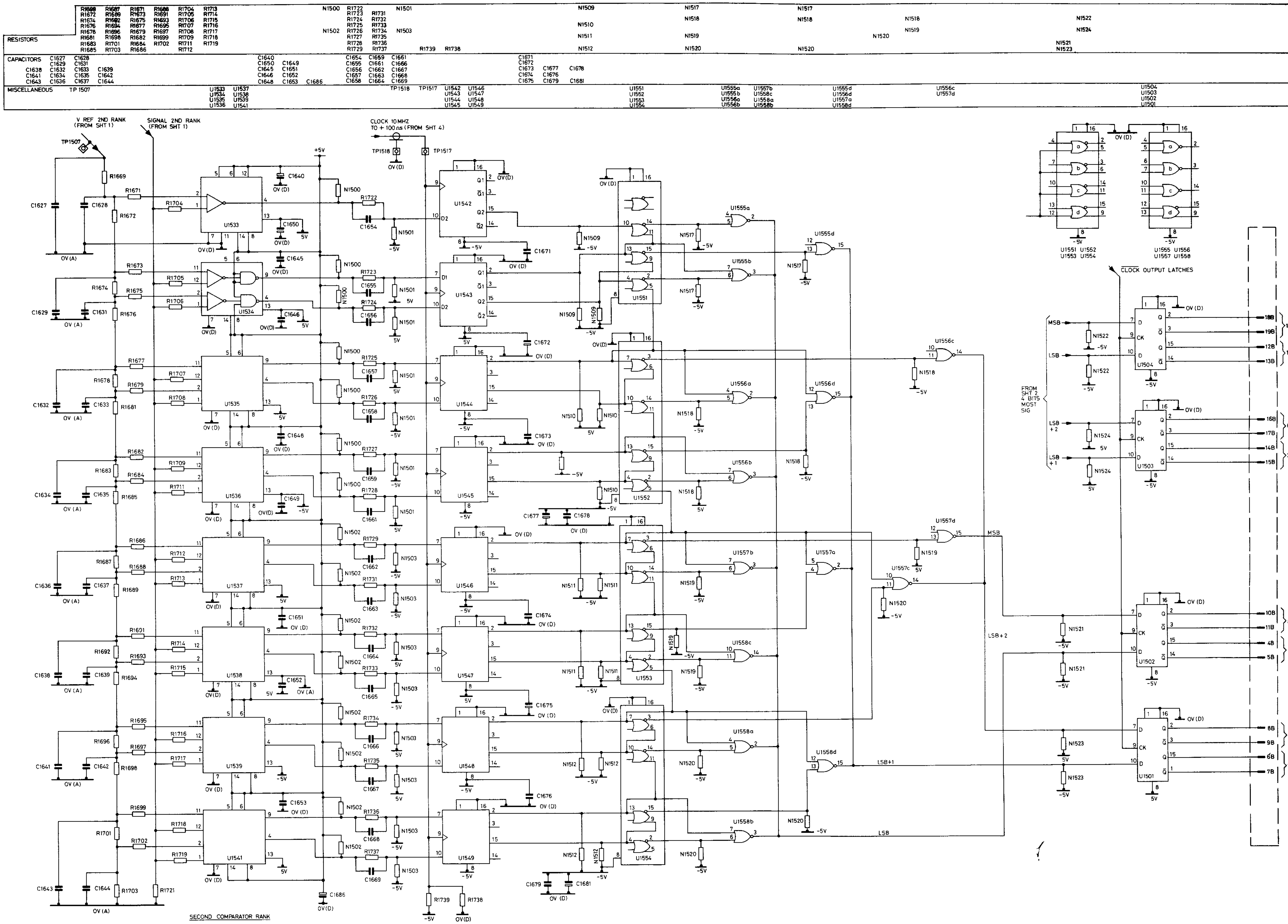


Fig. 6.12 A.D.C. Circuit Diagram 3

OS4040 TUBE SUPPLIES, BRIGHT UP & EHT

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R500	47	CF			28714
R501	10	CF			21793
R502	10k	CP			A4/44599
R503	39	CF			28713
R504	39	CF			28713
R505	1k	CF			21799
R506	1k	CF			21799
R507	1k5	CF			21801
R508	820	CF			28724
R509	22k	CF			21812
R510	100k	CF			21819
R511	2k7	CF			28726
R512	10	CF			21793
R513	5k6	CF			21806
R514	100k	CF			21819
R515	10	CF			21793
R516	100	CF			21794
R517	27k	CF			21813
R518	1k2	CF			21800
R519	68k	CF			21816
R520	10k	CF			21809
R521	1k8	CF			28725
R522	47k	CF			21815
R523	220	CF		½W	18542
R524	2k2	CP			A4/44598
R525	1M	CF			31840
R526	1M	CF			31840
R527	200k	PCP			39264
R528	1M	CF			31840
*R529	220k	CF			21823
*R530	1M8	CF			35752
R531	1M	CP			A4/44597
*R532	3M6	MG			452027
*R533	200k	PCP			39264
R535	150	CF			28719
R536	1k	CP			A4/44597
R1101	100	CF			21794
R1102	820	CF			28724
R1103	68k	CF			21816
R1105	22k	CF			21812
R1106	50k	PCP			39268
R1109	5k6	CF			21806
R1111	1k5	CF			21801
R1112	220	CF			21796
R1113	1k	CF			21799
R1114	8k2	CF			21808
R1117	100	CF			21794
R1118	10k	CF			21809
R1119	1M	PCP			39431
R1120	10k	CF			21809
R1121	15M	MG			40371
R1123	10k	CF			21809
R1125	15M	MG			40371
CAPACITORS					
C500	0.01µF	PE		100V	39130
C501	0.01µF	CE(3)			42444
C502	0.01µF	CE(3)			42444
C503	68pF	CE(3)			42418
C504	0.01µF	CE(3)			42444
C505		Printed on Board			
C506	56pF	CE(3)			42417
C507	2.2pF	CE(3)			42400
C508	0.01µF	PE		100V	39190
C511	0.1µF	CE(2)		100V	37018
C512	4700pF	CE(2)			22393
C514	0.1µF	PE		250V	39199
C515	3000pF	CE(2)		3kV	34381
C1101	0.01µF	CE(2)		250V	22395
C1102	22µF	E		25V	32181
C1104	0.1µF	CE(2)		100V	37018
C1105	0.1µF	CE(2)		250V	39199
C1106	220µF	E		16V	42757
C1109	470pF	CE(1)		4kV	43845
C1111	470pF	CE(1)		4kV	43845
C1112	0.01µF	CE(2)		250V	22395
C1114	4700pF	CE(1)		4kV	40562
C1115	4700pF	CE(1)		4kV	40562
C1116	4700pF	CE(1)		4kV	40562
Q500		2N5771			38089
Q501		BC450			40128
Q502		2N5771			38089
Q503		BC449			40129
Q504		BFX88			23337
Q505		BFY51			29329
Q506		2N3906			21533
Q1101		BC182B			33205
Q1102		BC212			29327
Q1103		2SC1173			36188
Q1104		BC212			29327

* (Fitted with Mullard Tube)

OS4040 TUBE SUPPLIES, BRIGHT UP & EHT (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No
DIODES					
D500		IN4148			23802
D501		IN4148			23802
D502		IN4148			23802
D503		IN4148			23802
D504		IN4148			23802
D505		IN4148			23802
D506		IN4148			23802
D507	6V2	ZENER			33930
D508	47V	ZENER			40049
D511		IN4148			23802
D1101		IN4148			23802
D1102		IN4148			23802
D1103		IN4148			23802
D1104		IN4148			23802
D1105		IN4148			23802
D1107		BY409			42356
D1108		BY409			42356
D1109		IN4148			23802
D1111		BY409			42356
D1112		BY409			42356
D1114		IN5271			37557
MISCELLANEOUS					
T1101					A2/44850
L1101	150μH				35826
PL504					41394
PL505					41391
PL506					41391

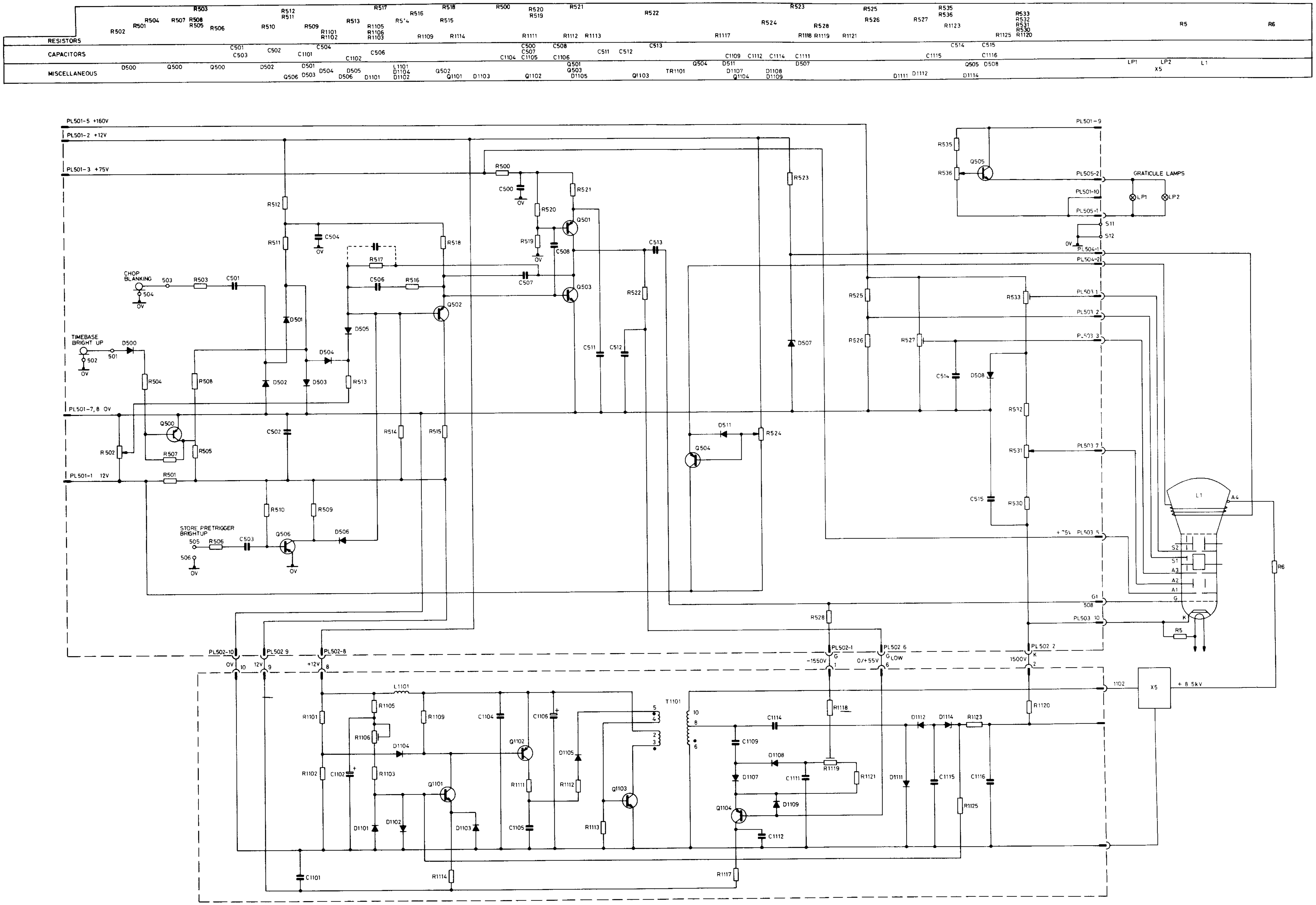


Fig. 6.13 Tube Supplies Bright Up & E.H.T. Circuit Diagram

OS4040 MECHANICAL PARTS LIST

Ref. No.	Part No.	Description	Units
1	44750	Panel Front Blank	1
2	44751	Coverlay	1
3	44809	Panel Rear	1
4	44753	Side Support Bar	2
5	44756	Corner Frame	4
6	44759	Bracket Support E.H.T. C.R.T.	1
7	40805	Handle Assy.	1
8	44777	Panel Attenuator	1
9	44752	Panel Centre Support	1
10	44754	Bracket Support Y O/P P.C.B.	1
11	44755	Bracket Support Logic P.C.B.	1
12	44766	Bracket Power Supply P.C.B.	1
13	44767	Bracket 'Y' Amp P.C.B.	2
14	44761	Guide P.C.B.	2
15	44409	Cradle C.R.T.	1
16	40677	Bracket Spacer	2
17	44405	Bezel (C.R.T.)	1
18	44406	Support (C.R.T.) Moulding	1
19	44780	Plate (P.C.B.) Mounting (Trig)	1
20	44779	Plate (P.C.B.) Mounting (Store)	1
21	44776	Bracket Heatsink	1
22	44768	Heatsink	1
23	44772	Bracket Heatsink	1
24	44770	Spacer	2
25	43209	Screen Attenuator	2
26	44765	Bracket (Switch Supply)	1
27	32626	Circlip	2
28	450242	Spring	2
29	44773	Cover Top	1
30	44774	Cover Bottom	1
31	44757	Trim Side	2
32	44762	P.C.B. Retainer	1
33	450302	Foot Bottom Cover	4
34	44585	Cover Rear	1
35	40815 / 41411	Foot Insert	2
36	39915	Trim Side	2
37	39097	Block Indexing	2
38	44830	Fuse Holder	1
39	12807	Fuse 5A	1
	12911	Fuse 10A	1
40	44771	Spacer Fan	1
41	44805	Fan	1
42	33787	Socket Supply	1
43	7092	Clip Capacitor 1 3/8"	1
44	20172	Clip Capacitor 1 5/8"	2
45	33016	M3 Washer Wavey	
46	33004	M4 Washer Plain	
47	33028	M4 Stiff Nut	
48	33044	M4 x 8 Pan Hd.	
49	2135	Screw No.6 x 3/8" Pan Hd.	
50	33038	M3 x 8 Pan Hd.	
51	33003	M3 Washer Plain	
52	33094	M3 x 6 Taptite	
53	402004	M4 x 35	
54	33017	M4 Washer Wavey	
55	33069	M3 x 8 C'sk	
56	450194	No. 6-19-4/16 Plastite	
57	450262	No. 8 x 22	
58	44760	Spacer 9.5mm	6
60	40833	Terminal Earth	1
61	1222	Socket B.N.C. 50Ω	3
62	40635	Bush 4mm	5
63	43256	Bezel (Push Button)	53
64	38407	Knob (Push Button)	53
65	44481	Filter (C.R.T.)	1
66	40410	21mm Knob R4-454	3
67	40922	15mm Knob R2-324	4
68	40923	15mm Knob R2-354	4
69	40408	10mm Knob R2-234	7
70	450026	21mm Cap W1-400	1
71	450025	10mm Cap W1-200	7
72	44549	15mm Cap W1-300	6
73	40927	15mm Cap (Red) W1-303	2
74	43847	L.E.D. (Orange)	17
75	31229	Terminal Feed Thru'	1

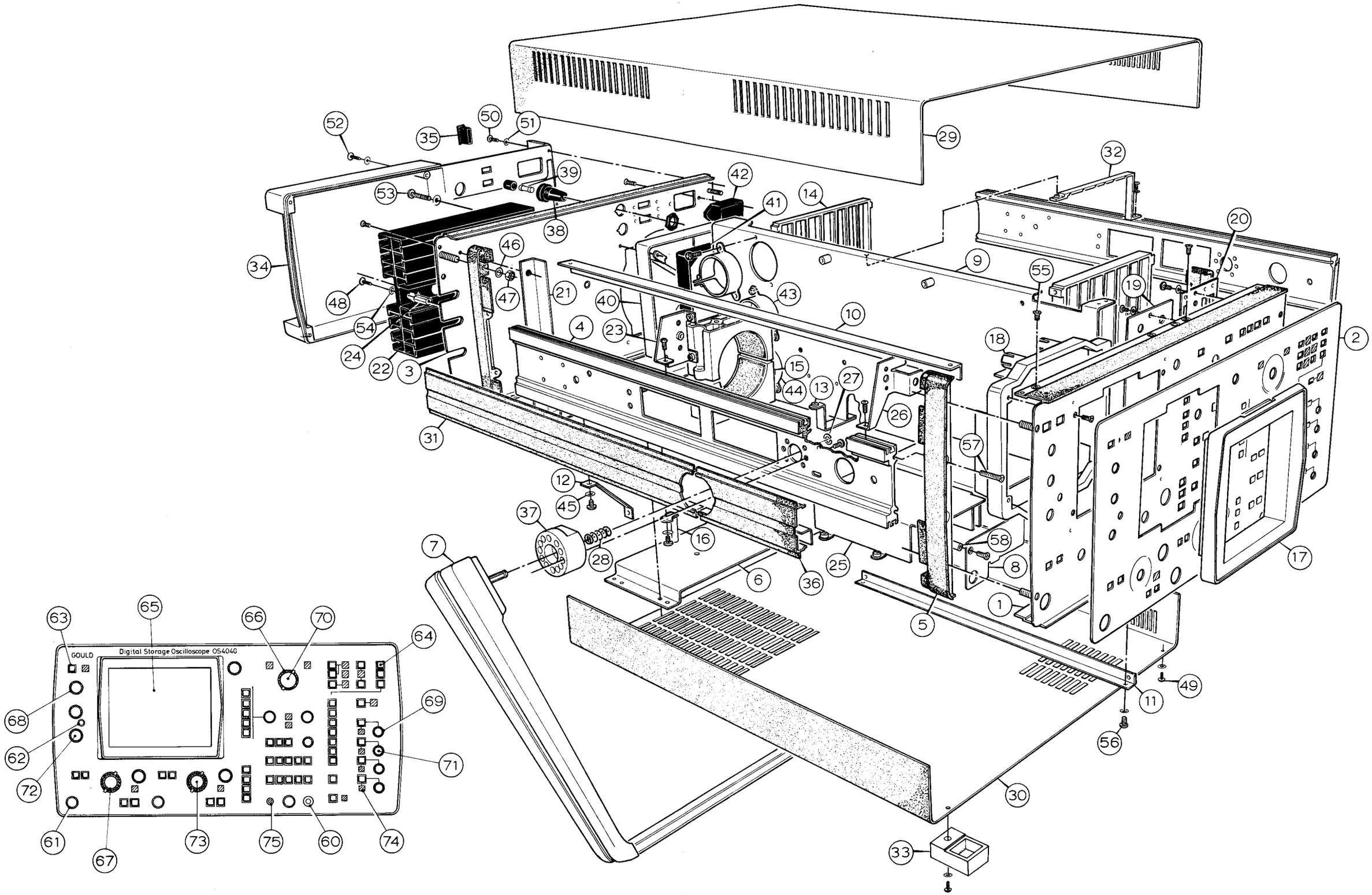


Fig. 6.14 Mechanical View Circuit Diagram

Guarantee and Service Facilities

Section 7

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 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.

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

Tel: 01-500 1000
Telex: 263785
Telegrams: Attenuate Ilford

WL 235 8 84 Issue 3

Manual Part Number 451974

Appendix

APPENDIX – FOR INSTRUMENTS FROM SERIAL NOS. 2001

The following items in the main body of the handbook no longer apply.

1. Figs. 5.3, 5.4, 5.5
2. Maintenance sections 5.3.22 to 5.3.27 inclusive.
3. ADC Circuit Diagrams and Component Lists Fig. 6.10, 6.11 and 6.12.

The appropriate new sections of text, circuit diagram and component lists are included in this appendix.

5.3.22 ANALOGUE TO DIGITAL CONVERTOR (ADC)

D.C. CONDITIONS

1. Use the extender board (Pt. No. 450397) to gain access to the ADC board. Voltages should be measured with respect to OV on the board.
2. Set the instrument to CH1, 20mV/cm sensitivity, input grounded, timebase free running (AUTO) at 1mS/cm, normal T-Y mode.
3. Remove the co-axial lead from socket SK1501 and monitor the voltage at TP1503 using a DVM set to 2V d.c.
4. Adjust R48 (set OV O/P) for zero volts at TP1503. Replace co-ax lead.
5. With DVM still set to 2V d.c. monitor TP1501 and by means of R27 set "+ ve ref" to 1.25V ±10mV.
6. Monitor TP1502 and by means of R23 set "- ve ref" to 1.25V ±10mV.

5.3.23 CLOCK TIMING ADJUSTMENT

1. Select REFRESHED mode, 0% pre-trigger and CH1 display only. Set Y sensitivity to 20mV/cm, store T-Y and timebase to 0.5mS/cm.
2. Apply a sine wave of approx. 120mV amplitude and frequency 1KHz. Adjust trigger to obtain a stable trace.
3. Adjust C29 to remove any random spikes which may appear on the waveform.

5.3.24 MIDPOINT STEP AND SLOPE ADJUSTMENT

1. Select REFRESHED mode, 0% pre-trigger and CH1 display only. Set Y sensitivity to 20mV/cm, Store T-Y and timebase to 0.5mS/cm.
2. Apply a triangle wave of approx. 120mV appli-tude and frequency 500Hz. Adjust trigger to obtain a stable trace.
3. Adjust R34 to remove the mid point step in the waveform. Increase sensitivity in X and Y directions if necessary to improve resolution of measurement.
4. Make small adjustments to R23 to ensure that sides of triangle are a straight line with no changes of slope on either side of the centre. Increase sensitivity as necessary to improve measurement resolution.

5.3.25 ADC DRIVE AMPLIFIER LF/HF RESPONSE

1. Select REFRESHED mode, 0% pre-trigger and DUAL trace mode. Set Y sensitivities to 20mV/cm. Store T-Y and timebase to 50μS/cm. Switch CH2 input to GND.
2. Apply a square wave of approx. 120mV amplitude and frequency of 10KHz.
3. Make adjustments to AOT resistors R53 and R54 to minimise the crosstalk into CH2.

   Remove ADC extender board and replace ADC direct into mainframe, recheck 5.3.23 and re-adjust C29 if necessary.

Appendix

A–D CONVERTER OS4040

Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS					
R1501	220	CF			21796
R1502	3k3	CF			21803
R1503	3k3	CF			21803
R1504	22	CF			28710
R1505	910	MF	±2		38593
R1506	910	MF	±2		38593
R1507	47	CF			28714
R1508	560	CF			21798
R1509	10	CF			21793
R1510	1k8	CF			28725
R1511	10	CF			21793
R1512	22	CF			28710
R1513	22	CF			28710
R1514	130	MF	±2		38573
R1515	33	CF			28712
R1516	1k	CF			21799
R1517	10	CF			21793
R1518	22	CF			28710
R1519	330	CF			28721
R1520	10	CF			21793
R1521	1k2	CF			21800
R1523	2k	PCP			40178
R1524	2k2	CF			21802
R1525	9k1	MF	±2		38617
R1526	10k	MF	±2		38618
R1527	2k	PCP			40178
R1528	1k	MF	±2		38594
R1529	10k	MF	±2		38618
R1530	10	CF			21793
R1531	10	CF			21793
R1532	150	CF			28719
R1533	330	CF			28721
R1534	500	PCP			39262
R1535	8k2	MF	±2		38616
R1536	8k2	MF	±2		38616
R1538	330	CF			28721
R1539	390	CF			28722
R1540	390	CF			28722
R1541	560	CF			21798
R1542	560	CF			21798
R1543	270	CF			28720
R1544	100	CF			21794
R1545	100	CF			21794
R1546	270	CF			28720
R1547	1k2	CF			21800
R1548	5k	CP			42156
R1550	510	MF	±2		38587
R1551	510	MF	±2		38587
R1552	510	MF	±2		38587
R1553	33k	CF	A.O.T.		21814
R1554	100k	CF	A.O.T.		21819
R1555	1k	CF			21799
R1556	1k	CF			21799
R1557	22	CF			28710
R1558	100	CF			21794
R1559	47	CF			28714
R1560	10	CF			21793
R1561	150	CF			28719
R1562	18	CF			28709
N1501	560x8	Resistor Network			39258
CAPACITORS					
C1501	10nF	CE(3)			42444
C1502	10nF	CE(3)			42444
C1503	10nF	CE(3)			42444
C1504	10nF	CE(3)			42444
C1505	5.6pF	CE(3)			42405
C1506	10nF	CE(3)			42444
C1507	10nF	CE(3)			42444
C1508	10nF	CE(3)			42444
C1509	10nF	CE(3)			42444
C1510	47µF	E		16V	32173
C1511	47µF	E		16V	32173
C1512	47µF	E		16V	32173
C1513	100nF	CE(3)			43498
C1514	100nF	CE(3)			43498
C1515	100nF	CE(3)			43498
C1516	100nF	CE(3)			43498
C1517	100nF	CE(3)			43498
C1518	100nF	CE(3)			43498
C1519	100nF	CE(3)			43498
C1520	100nF	CE(3)			43498
C1521	100nF	CE(3)			43498
C1522	100nF	CE(3)			43498
C1523	100nF	CE(3)			43498
C1524	33pF	CE(3)			42414
C1525	100nF	CE(3)			43498
C1526	10nF	CE(3)			42444
C1527	10pF	CE(3)			42408
C1528	22pF	CE(3)			42412
C1529	6.5/6pF	Trimmer			36091
C1530	10nF	CE(3)			42444
C1531	10nF	CE(3)			42444
C1532	33pF	CE(3)			42414
C1533	10nF	CE(3)			42444
C1534	10nF	CE(3)			42444
C1536	39pF	CE(3)			42415
DIODES					
D1501		IN4148			23802
D1502		IN4148			23802
D1503		IN4148			23802
D1504	5V6	ZENER			33929
D1505	6V2	ZENER IN813			40045
Q1501		2N3640			31781
Q1502		2N2369			23307
Q1503		BFX88			23337

Appendix

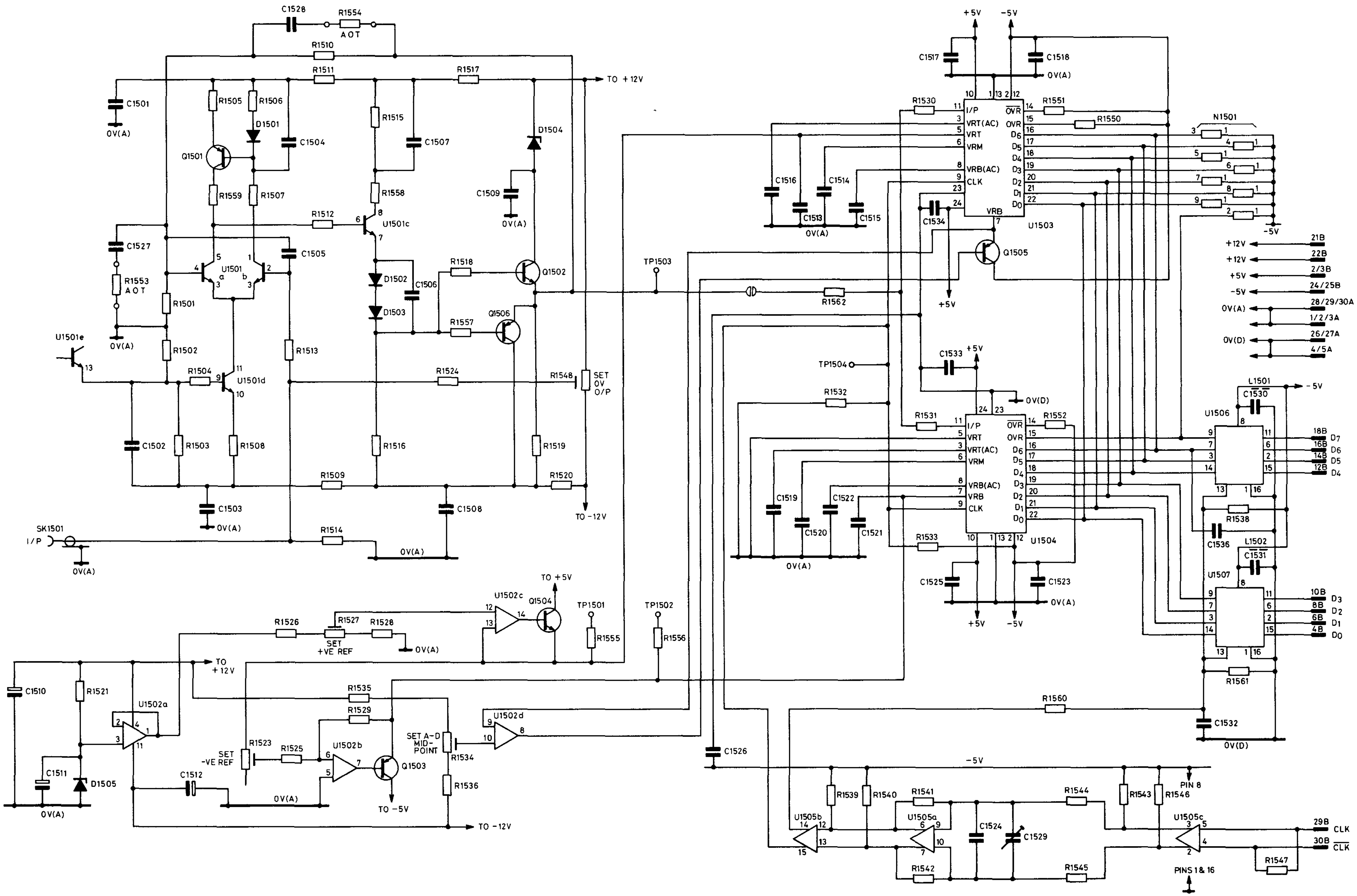
A–D CONVERTER OS4040 (Cont)

Ref	Value	Description	Tol %±	Rating	Part No
Q1504		BFY51			29329
Q1505		BFX88			23337
Q1506		2N5771			38089
U1501		SL3145C			43980
U1502		LF347			450908
U1503		10315			451781
U1504		10317			451782
U1505		10116			39244
U1506		10133			44367
U1507		10133			44367

MISCELLANEOUS

SK1501					36106
L1501	4uH	CHOKE			37560
L1502	4uH	CHOKE			37560

RES	R1521 R1553 R1501 R1502 R1503 R1504 R1505 R1559 R1506 R1507 R1508 R1523 R1513 R1526 R1525 R1510 R1511 R1512 R1509 R1514 R1527 R1535 R1529 R1554 R1515 R1558 R1516 R1528 R1517 R1518 R1557 R1524 R1534 R1536 R1519 R1520 R1548 R1555 R1556 R1562 R1532 R1539 R1540 R1530 R1531 R1533 R1541 R1542 R1551 R1552 R1550 R1560 R1544 R1545 R1543 R1546 N1501 R1538 R1561 R1547
CAPS	C1510 C1511 C1501 C1527 C1502 C1503 C1512 C1528 C1504 C1505 C1507 C1506 C1508 C1509 C1526 C1516 C1519 C1513 C1520 C1514 C1522 C1515 C1521 C1517 C1525 C1534 C1533 C1524 C1529 C1518 C1523 C1536 C1532 C1530 C1531
MISC	U1501e SK1501 D1505 U1502a Q1501 D1501 U1501a,b,d U1502b D1502 D1503 U1501c Q1503 U1502c,d Q1506 D1504 Q1502 Q1504 U1505b U1505a Q1505 U1503 U1504 U1505c U1506 U1507 L1501 L1502



A.D.C. Circuit Diagram