

FOR SERVICE MANUALS
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DIGITAL STORAGE

OSCILLOSCOPE 4041 + 4040

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4041 DIGITAL STORAGE OSCILLOSCOPE

The Gould 4041 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 4041 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 (50 μ s/cm).

The output Option 4142 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 4144 is an IEEE 488 Data Bus interface and allows the 4041 to be used as part of an instrumentation system.

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Specification

Section 2

2.1 4041

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 time-base 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 ± 4 cm approx.

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

MISCELLANEOUS

Calibrator 1V pk/pk $\pm 1\%$ 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. 453853

OPTIONAL

Probe Kit PB12

A passive probe kit with switched x 1 and x 10 attenuations. With x 10 attenuation input impedance is 10M Ω //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

4143 HARD COPY (Optional)

The 4143 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 $\pm 3\%$. Output to input voltage (cal.) $\pm 3\%$.

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.

4142 DIGITAL INTERFACE (WITH HARD COPY)

In addition to the analogue outputs and controls specified for 4143, the 4142 provides a facility for parallel data transfer to and from the store and for remote readout and control of most of the functions of 4041. This can be used for direct interface to an I/O part of a microprocessor or data handling system or used via the Option 4144 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

4144 GPIB INTERFACE

With 4142 the 4144 unit provides full interface to the GPIB bus, IEEE488 or IEC625 to interrogate and/or control the 4041 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.

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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 conditions.

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 ($\pm 10\%$) 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 0.1 μ F 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 sector 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 0.2 μ s/cm in 1, 2, 5 steps. In Store modes, the lowest range is 5s/cm extending to the fastest range, 50 μ s/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 50 μ s/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 timebase 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 sensitivity 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 amplitude 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

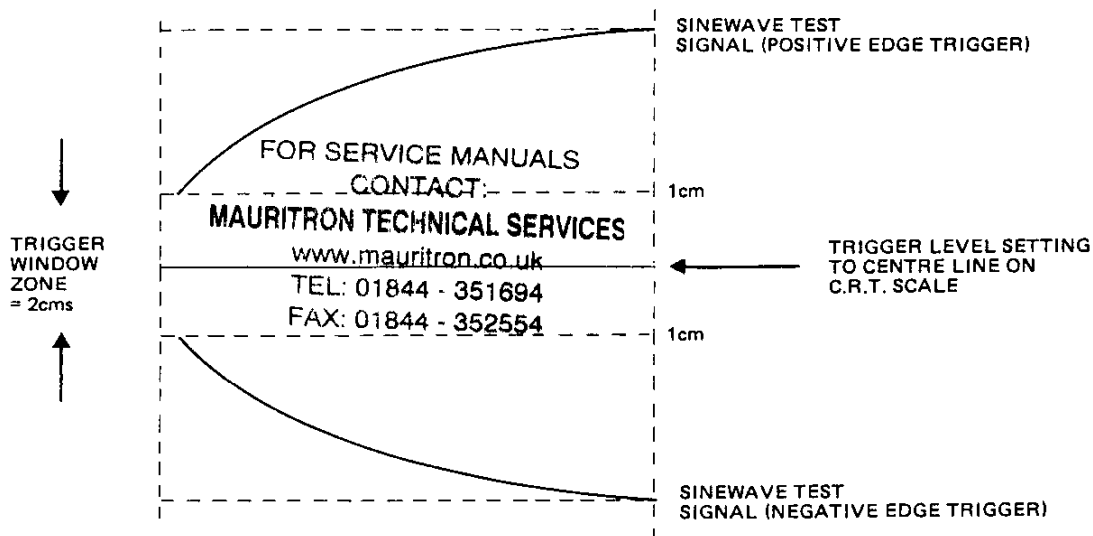


Fig. 3.1 Trig Window Operation

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 1M Ω /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 sector 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 sector 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 time-base 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 50 μ s/cm with full store capability on the display. If a faster range than 50 μ s/cm is selected, store acquisition will stop and the data acquired prior to this time will be displayed. The RANGE LIMIT i.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 (0.1 μ s 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 $2.5\mu\text{s}/\text{cm}$. TIME/CM rates up to $1\mu\text{s}/\text{cm}$ 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

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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 4041 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 then 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

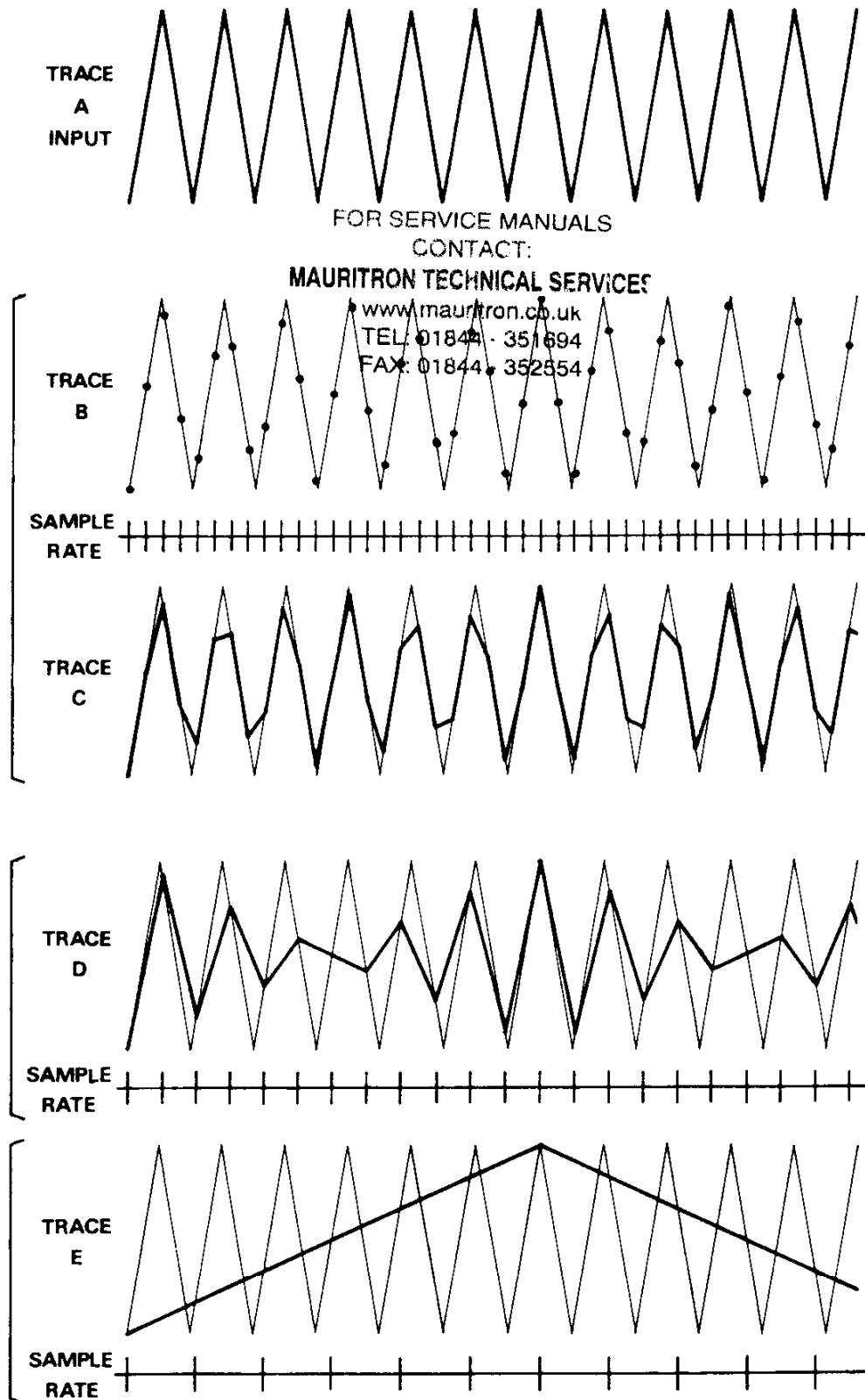


Fig. 3.3 Alias Effects

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 4041. 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 4041 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) occurring 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.

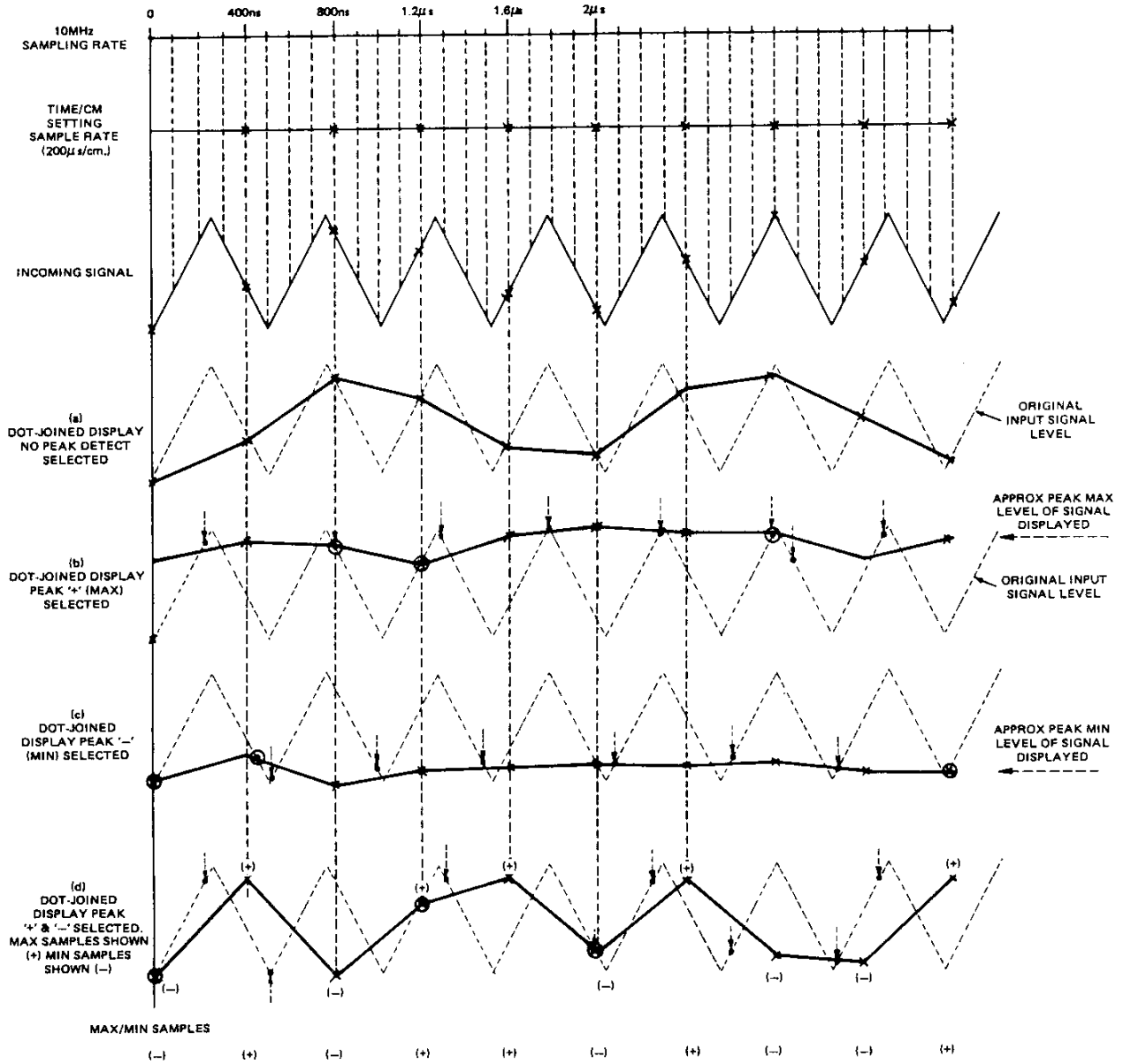
3.10.11 PLOT OUTPUT INTERFACE UNITS

The plot function is not available unless either the 4143 Plot Output option or the 4142 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 4142 contains circuitry common with the 4143 to provide a plot output, and also Interface circuitry which allows information to be written into and read out from the instrument store. The 4142 can interface directly to a dedicated digital system but it is normally used in conjunction with the 4144 to provide G.P.I.B. (IEEE 488) capability. The 4142 in addition to providing data transfer will also provide status information and control of the functions selected via the 4041. 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



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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 4142 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 4142 and the 4143 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 4144 unit is bolted to the top of the 4041 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 $\pm 2\%$ 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 $1M\Omega$ 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 $10M\Omega$ X10 probe. This reduces the input capacity (usually to a value of $\approx 10pF$) 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 off 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 I.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 I.e.d. should now light. Release the GND switch and the ARMED I.e.d. should go off, causing the TRIGGERED I.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 I.e.d. will go out and the STORED I.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 I.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 I.e.d. will go off and the STORED I.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 I.e.d. flashes and press the RELEASE button if the STORED I.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 I.e.d. should light. When the ground connection is removed the instrument should trigger, with the result that the ARMED I.e.d. will be switched off and the TRIGGERED I.e.d. will illuminate. At the end of a sweep acquisition the first HELD I.e.d. will illuminate to show that a trace has been stored, and the ARMED I.e.d. will light again awaiting the next trigger signal. The process will continue until four sweeps have been stored, denoted by the STORED I.e.d. and four indicating HELD I.e.d.'s. When the HELD I.e.d.'s are lit, the Post storage offset controls are enabled and adjustment of these controls should be observed to give about ± 4 cms 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 ROI.L. 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.

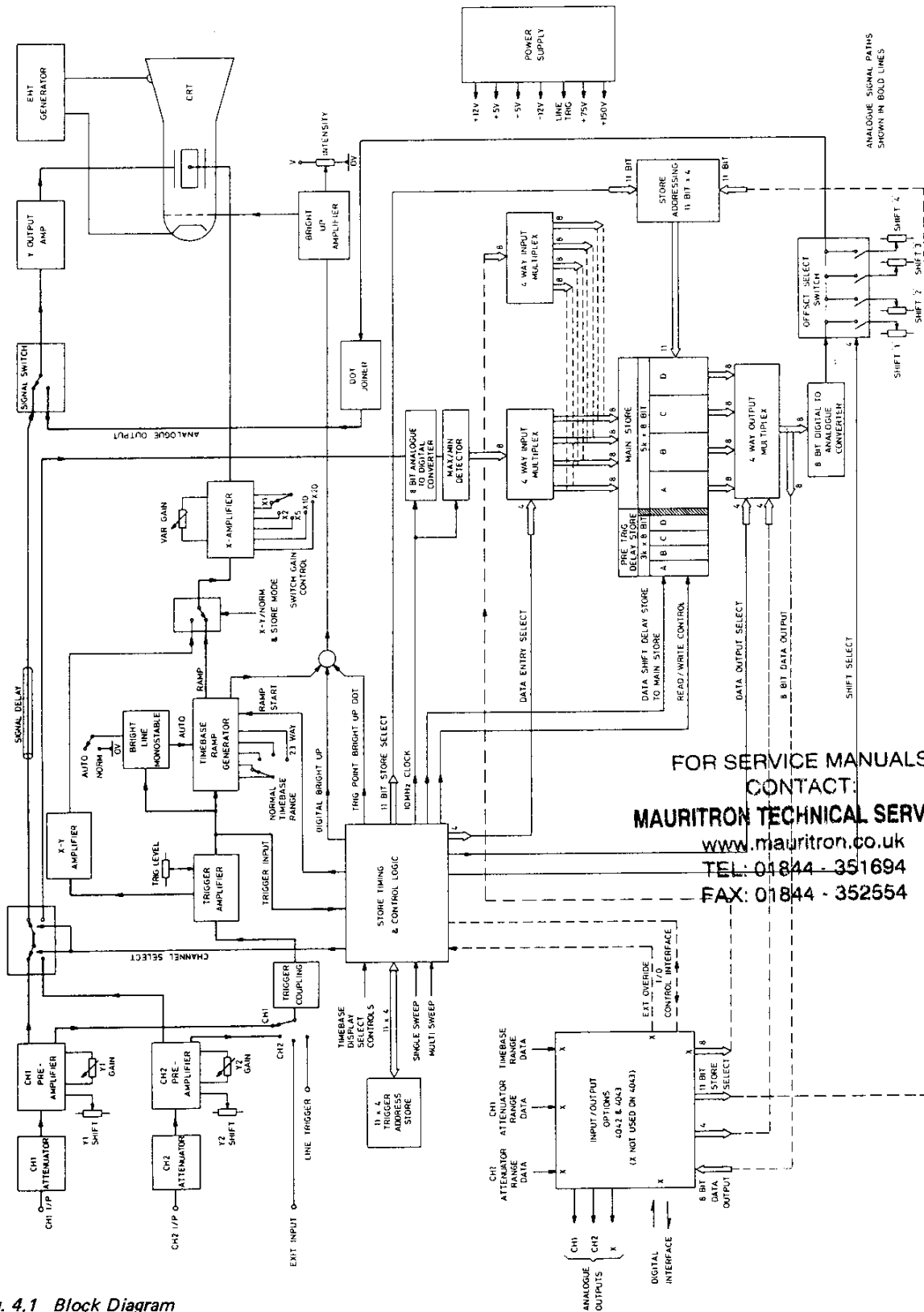
Next, capture a trace by use of the single shot facility. Press a trace hold, and the l.e.d. associated with the hold will light. The trace Offset may then be used to differentiate the split section of the stored display. Check either that a trigger signal is present or the Auto Bright Line function 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.



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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 $\div 1$, $\div 10$, $\div 100$ at a constant $1M\Omega/28pF$ 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 $500\mu s$ ($5K \times 100ns$) i.e. equivalent to a normal 10cm timebase sweep at $50\mu s/cm$. 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 to 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 or 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 $50\mu\text{s}/\text{cm}$ 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 4143 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 4142 has a digital interface system which

allows the output data from the store to be transmitted directly or via the 4144 onto an IEEE 488 data bus. Alternatively data may be generated remotely and entered into the main store as the address counter in the 4142 scans all its locations. The digital interface system

also allows the operating status of the 4041 to be read out or to be controlled. In the latter case the manual settings of most of the 4041 controls are over-ridden and it responds only to the external command.

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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	WHITE Dot
(When fitted)	

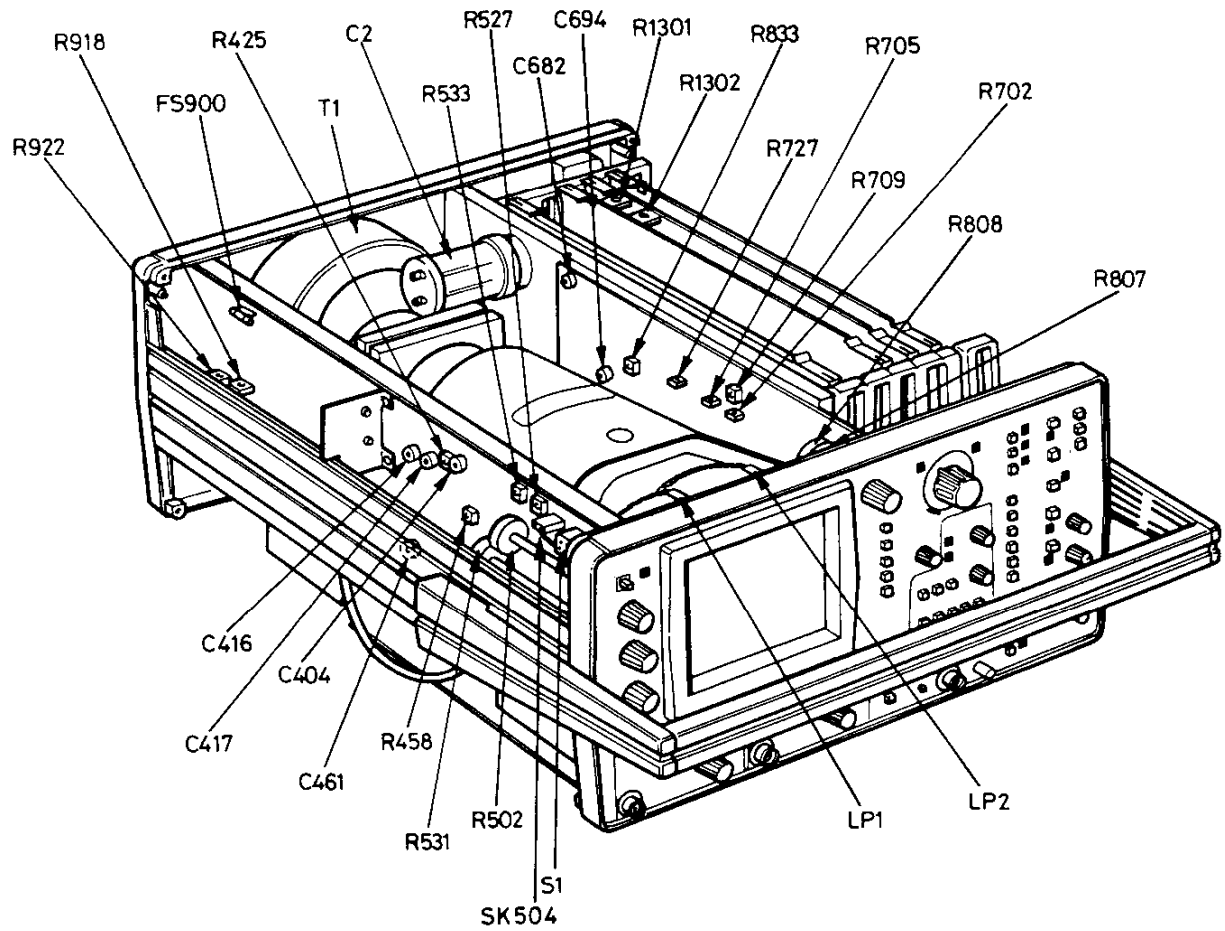
The ANALOGUE TO DIGITAL CONVERTER (ADC) is the nearest digital board to the centre panel. This is connected to the digital delay line which consists of several metres of wound coaxial cable attached to the centre panel. (Delay line not fitted from S/No. 2001).

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.

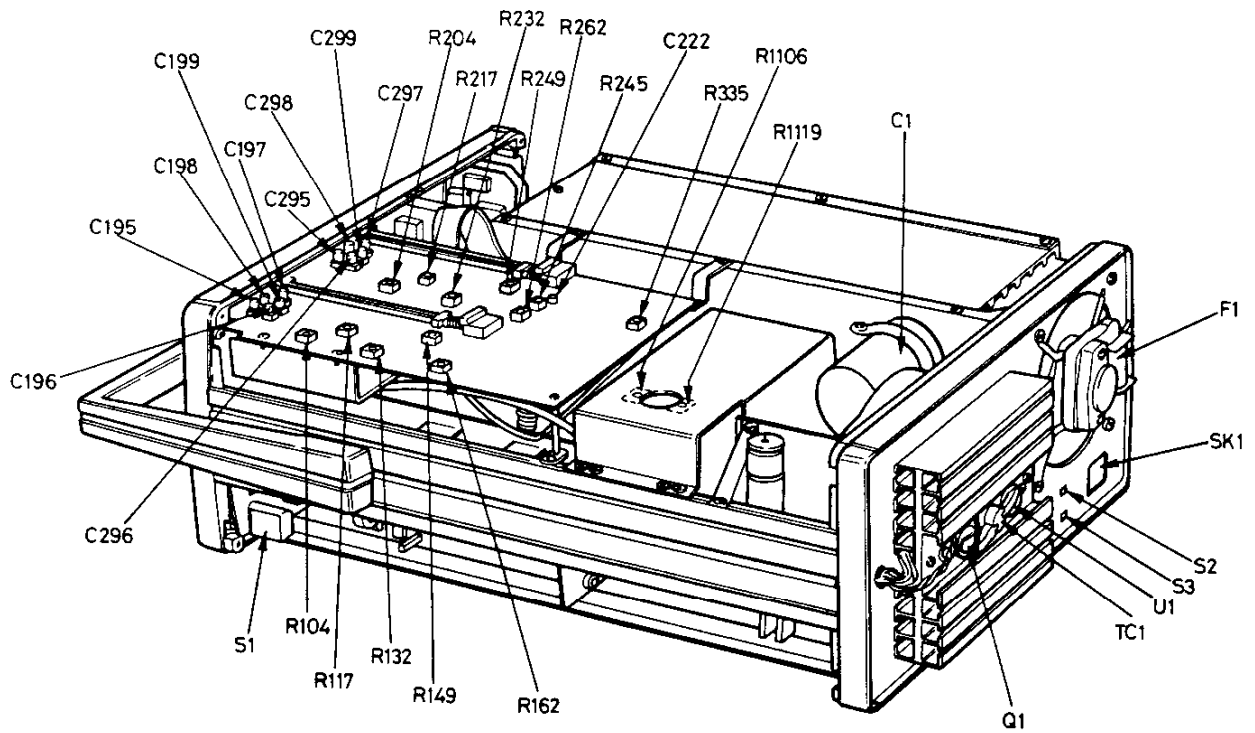
The INTERFACE board provides the means of connecting the store system with the front panel controls and the analogue circuitry. This board also incorporates the 10MHz/5MHz/2.5MHz clock generators, the Single/Multi sweep circuitry and part of the Trigger Jitter correction circuitry. It is situated fourth 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 4143 Plot Option board or the 4142 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.



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Fig. 5.1 Front View



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Fig. 5.2 Bottom View

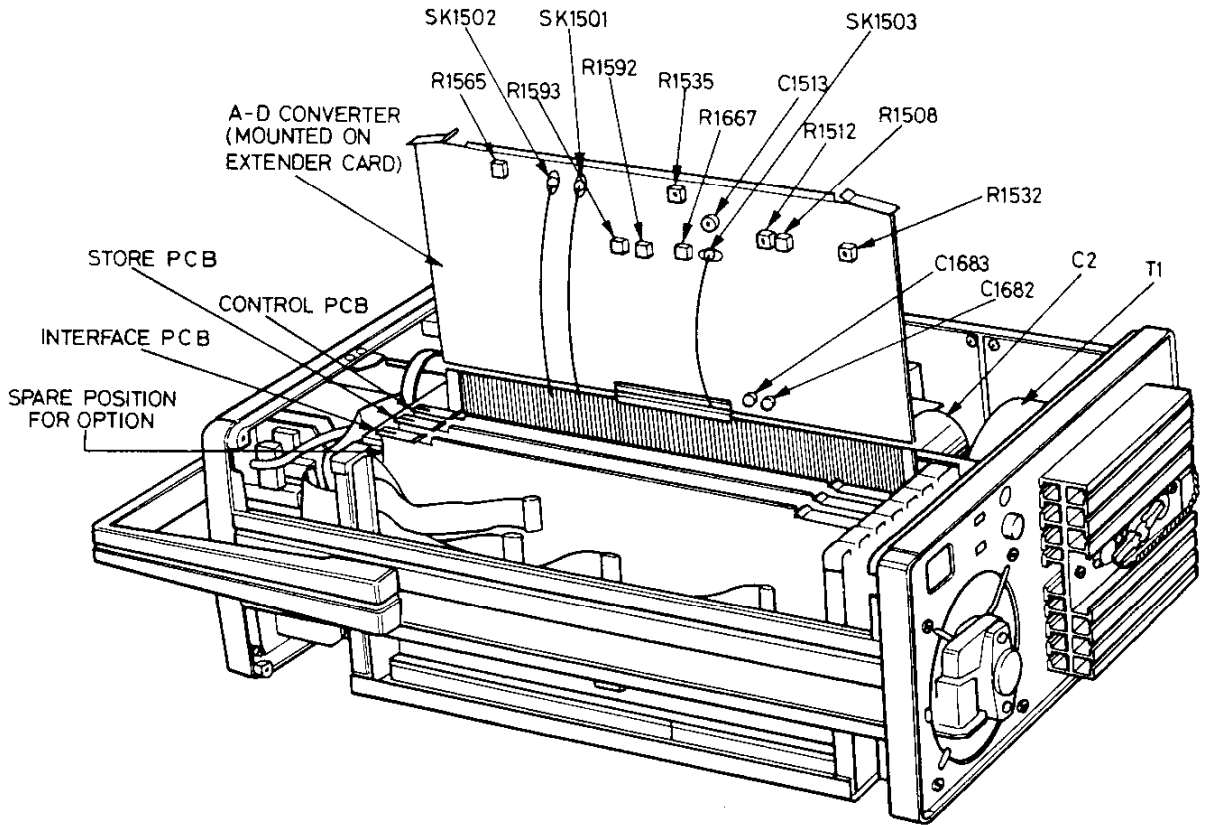


Fig. 5.3 Side View

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 1M Ω 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 50 Ω , 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 50 Ω with rise time of less than 2ns).
7. Voltage calibrator 1kHz squarewave generator with amplitude range of 2mV to 50V \pm 0.2%.
8. BNC-BNC connector lead.
9. 50 Ω BNC through-termination.
10. Capacitance standardiser 1M Ω /28pF.
11. Test oscilloscope 30MHz bandwidth \geq 5% accuracy, \leq 50mV/cm sensitivity with x 10 low capacitance probe.
12. Time mark generator 50ns to 1ms \pm 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 \pm 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 \pm 0.1V.
5. Connect the d.v.m. to pin 916 on the power supply board; set R922 to give -12.0V \pm 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 \pm 0.2V
PL1 (3)	+75V \pm 2V
PL1 (5)	+160 \pm 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 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 \pm 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 \pm 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 proceeding 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 0.2 μ s/cm. Apply a fast risetime squarewave with 1MHz repetition rate via a 50 Ω 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.

- Recheck the pulse response with a 100kHz square-wave.

5.3.16 Y AMPLIFIER BANDWIDTH

- Select CH1, DC coupled, 20mV/cm sensitivity. Connect a Constant Amplitude Sinewave Generator via a 50 Ω termination.
- 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.
- Similarly check the bandwidth on the 5mV, 10mV, 0.1V, and 1V ranges. All should be greater than 25MHz.
- Select 20mV/cm with x 5 magnification. Check that the bandwidth is greater than 8MHz with this combination.
- 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

- Select STORE T-Y mode, 50 μ s/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.
- Remove GND and HOLD. Apply a 10kHz square-wave 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

- Set the timebase to 0.1ms/cm, X1, AUTO trigger, and set the trigger LEVEL for a stable trace.
- 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.
- Repeat for X10 expansion, adjusting A.O.T. resistor R844 is necessary.

5.3.19 TRIGGER BALANCE

- Set the instrument to AC, CH1, Normal T-Y, 0.1ms/cm, positive slope and AUTO. Apply a 10kHz sine-wave 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.
- 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.

- Select CH2 as source, apply the sinewave to CH2 input, and repeat step 2, adjusting R262.

5.3.20 EXTERNAL X COMPENSATION

- Set the TRIGGER SOURCE to EXT, and TRIGGER COUPLING to DC. Select X-Y horizontal mode and CH2 vertical mode.
- 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.
- 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

- 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.
- 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.
- 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.
- Select 1 μ s/cm, and apply 1 μ s markers. Adjust R709 for one marker/cm.
- Select 1ms/cm and apply 1ms markers. Adjust R702 for one marker/cm.
- Using appropriate markers, check that all the time-base ranges from 0.5sec/cm to 0.2 μ s/cm are accurate to within $\pm 2\%$.
- Using 0.5 second markers, check that the RANGE LIMIT i.e.d. operates when 1, 2, & 5 sec/cm are selected, and that the displayed sweep rate remains at 0.5sec/cm.
- 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 $\pm 2\%$ apart respectively.
- Operate the VARIABLE X EXPAND control, and check that the UNCAL i.e.d. is lit. Check that the expansion range is greater than 2.5:1. Reset to cal.
- Select 0.2 μ s/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 $\pm 5\%$ over the entire sweep. Check also that the sweep is approximately linear when using the VARIABLE EXPAND control.
- 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 $\pm 1\%$ apart. Press the SPLIT DISPLAY 4 switch, and check that the markers are still 1cm $\pm 1\%$ apart. Clear Split Display.

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 \pm 10mV.
6. Monitor TP1502 and by means of R23 set "-ve ref" to 1.25V \pm 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 amplitude 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 50 μ S/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.

5.3.26 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 20 μ S/cm and ranges above this. Check that the RANGE LIMIT i.e.d. operates.

5.3.27 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.

5.3.28 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 \pm 10%.

5.3.29 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.

5.3.30 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.

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ABBREVIATIONS USED FOR COMPONENT DESCRIPTIONS

RESISTORS

CC	Carbon Composition	½W	10%	unless otherwise stated
CF	Carbon Film	¼W	5%	unless otherwise stated
MO	Metal Oxide	½W	2%	unless otherwise stated
MF	Metal Film	¼W	1%	unless otherwise stated
WW	Wire Wound	6W	5%	unless otherwise stated
CP	Control Potentiometer		20%	unless otherwise stated
PCP	Preset Potentiometer Type MPD, PC		20%	unless otherwise stated

CAPACITORS

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

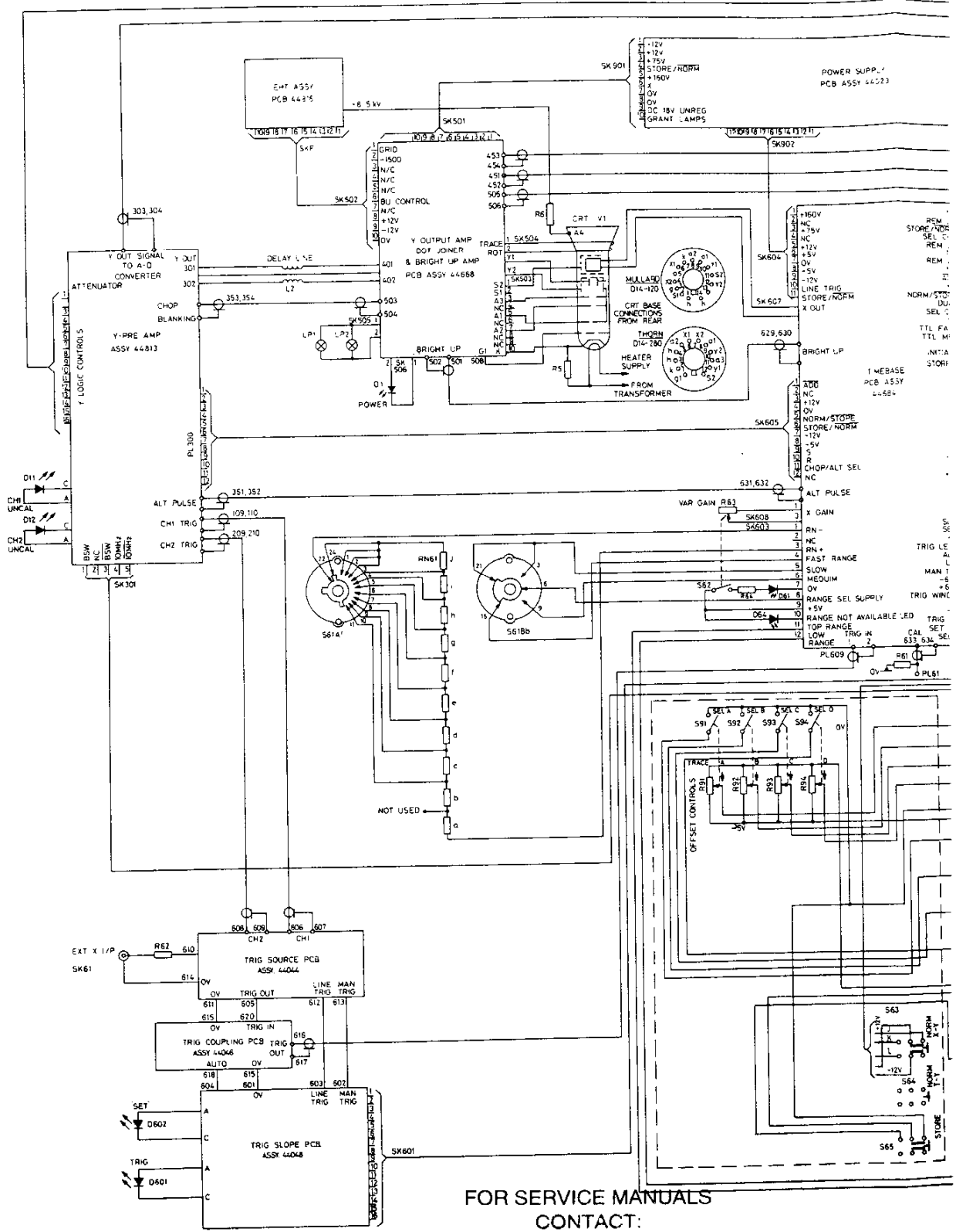
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Component List and Illustrations

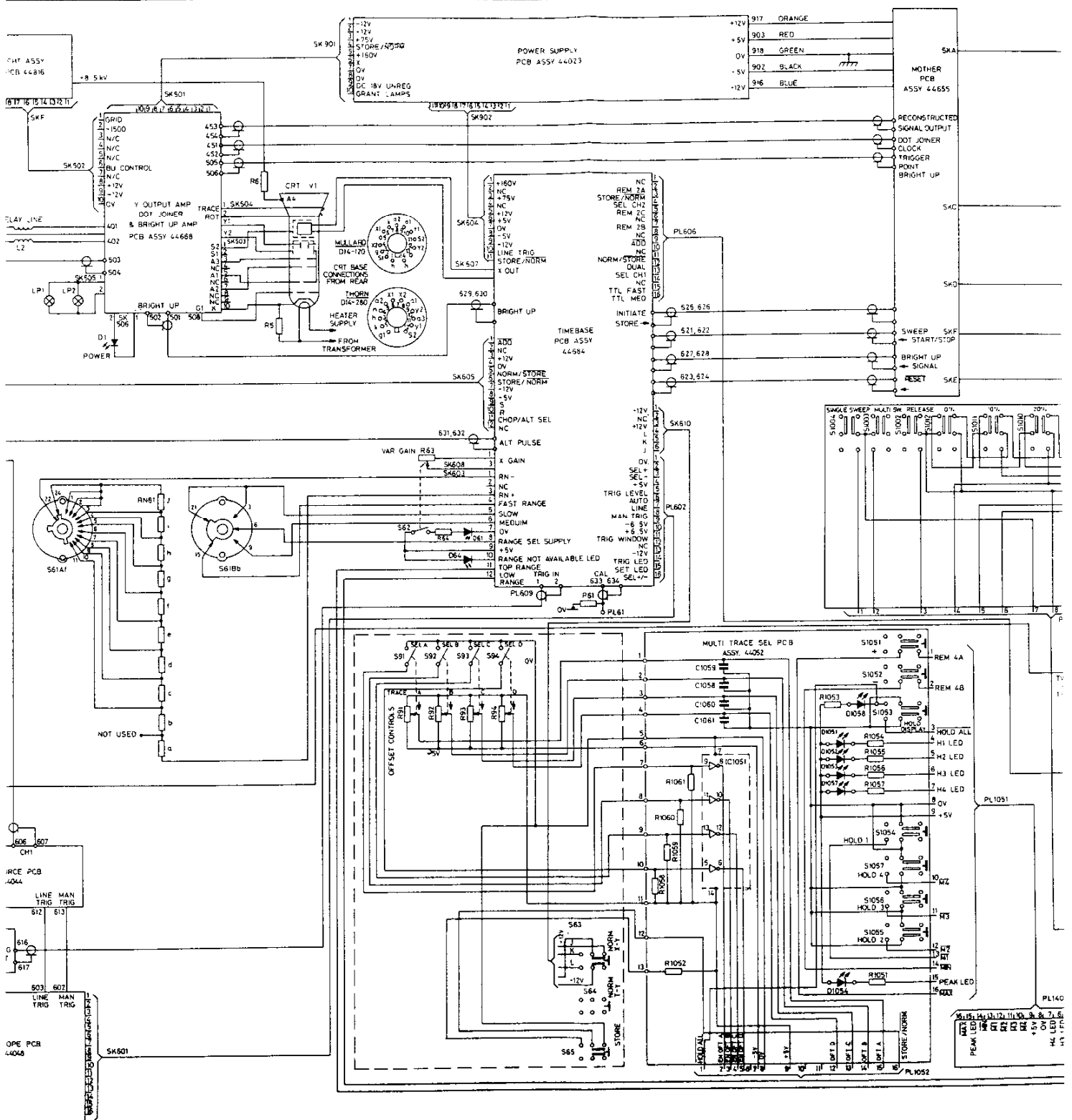
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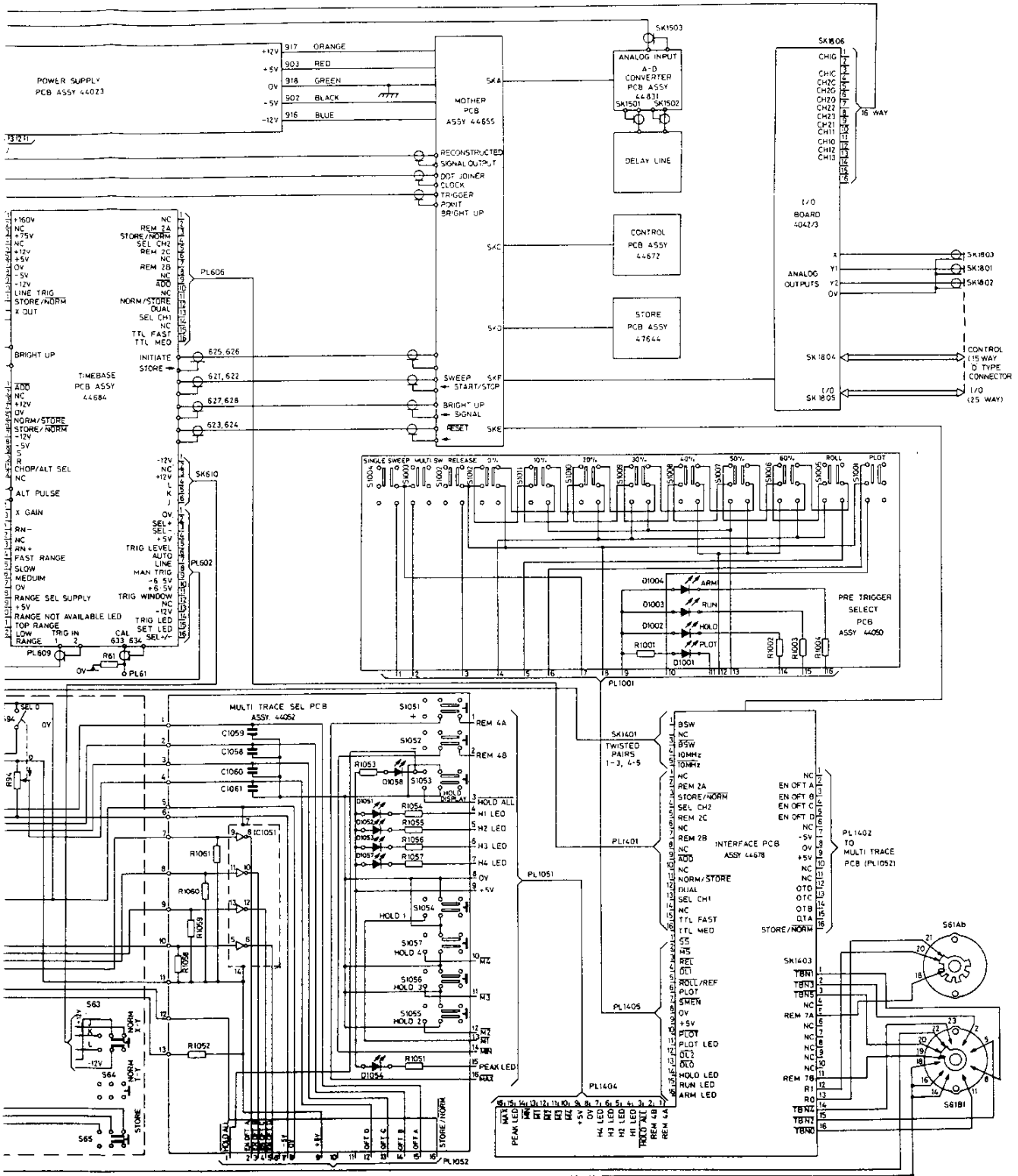
4041 INTERCONNECTIONS

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS						DIODES					
R5	100	CF			21819	D1		L.E.D. MV5153			43847
R6	1MΩ	CF			31840	D11		L.E.D. MV5153			43847
R61	1k1	MF			41874	D12		L.E.D. MV5153			43847
R62	22	CF			28710	D61		L.E.D. MV5153			43847
R63	2k2	CP			With S62 A4/452650	D64		L.E.D. MV5153			43847
R64	390	CF			28722	D1001		L.E.D. MV5153			43847
R91	10k	CP			With S91 A4/44786	D1002		L.E.D. MV5153			43847
R92	10k	CP			With S92 A4/44786	D1003		L.E.D. MV5153			43847
R93	10k	CP			With S93 A4/44786	D1004		L.E.D. MV5153			43847
R94	10k	CP			With S94 A4/44786	D1051		L.E.D. MV5153			43847
RN61		Resistor Network			A3/40103	D1052		L.E.D. MV5153			43847
R1001	330	CF			28721	D1053		L.E.D. MV5153			43847
R1002	330	CF			28721	D1054		L.E.D. MV5153			43847
R1003	330	CF			28721	D1057		L.E.D. MV5153			43847
R1004	330	CF			28721	D1058		L.E.D. MV5153			43847
R1051	330	CF			28721	INTEGRATED CIRCUITS					
R1052	47	CF			28714	U1051		74 LS05			36879
R1053	330	CF			28721	MISCELLANEOUS					
R1054	330	CF			28721	S61					44788
R1055	330	CF			28721	S62		With R63 A4/452650			
R1056	330	CF			28721	S63-65					A3/44793
R1057	330	CF			28721	S91		With R91 A4/44786			
R1058	1k	CF			21799	S92		With R92 A4/44786			
R1059	1k	CF			21799	S93		With R93 A4/44786			
R1060	1k	CF			21799	S94		With R94 A4/44786			
R1061	1k	CF			21799	S1001					A3/44794
CAPACITORS						S1002-1012					A3/44795
C1001	.01μF	CE(2)		250V	22395	S1051-1053					A3/44796
C1002	.01μF	CE(2)		250V	22395	S1054-1057					A3/44798
C1003	.01μF	CE(2)		250V	22395	L1					A3/32495
C1004	.01μF	CE(2)		250V	22395	L2					41996
C1005	.01μF	CE(2)		250V	22395	V1		Thorn D14-280GH			37571
C1006	.01μF	CE(2)		250V	22395			or Mullard D14-120GH			37569
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						



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Fig. 6.1 Interconnection Diagram

Component List and Illustrations

Section 6

4041 'Y' PREAMP & BEAM SWITCH

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS											
R11	10	CF			21793	R131	2k	MF	2		38601 S16
R12	10	CF			21793	R132	500	PCP			39232 Q18
R13	10	CF			21793	R133	56	CF			28715 N16
R14	10	CF			21793	R134	680	CF			28723 P18
R15	10	CF			21793	R135	56	CF			28715 N18
R16	10	CF			21793	R136	56	CF			28715 M15
R17	47	CF			28714	R137	680	CF			28723 Q18
R18	47	CF			28714	R138	56	CF			28715 P18
R19	15	CF			28708						
R20	15	CF			28708	R140	10	CF			21793 G3
R21	990k	MF	½	½W	31927	R141	56	CF			28715 L15
R22	990k	MF	½	½W	31927	R142	1k8	CF			28725 M13
R23	270	CF			28720	R143	1k3	MF			38597 M14
R24	270	CF			28720	R144	22	CF			28710 L15
R25	900k	MF	½	½W	31929						
R26	900k	MF	½	½W	31929	R146	75	MF	2		38567 L16
R27	330	CF			28721	R147	560	CF			21798 L13
R28	330	CF			28721	R148	560	CF			21798 K13
R29	220	CF			21796	R149	1k	PCP			39233 N13
R30	220	CF			21796	R150	10	CF			21793 F3
R31	700k	MF			44875	R151	160	MF	2		38575 J11
R32	700k	MF			44875	R152	330	MF	2		38582 L13
R33	470k	CC	10	¼W	4906	R153	330	MF	2		38582 K13
R34	470k	CC	10	¼W	4906	R154	680	CF			28723 M16
R35						R155	470	CF			21797 N16
R36						R156	22	CF			28710 N16
						R157	22	CF			28710 L16
V13	R100	8k2	CF		21808	R158	27	CF			28711 N17
X13	R101	8k2	CF		21808						
W15	R102	100k	CF		21819	R160	100	CF			21794 H12
W16	R103	300k	MF	½	44916	R161	1k	CF			21799 K16
V18	R104	100k	PCP		39269	R162	1k	PCP			39233 K18
V15	R105	10k	CF		21809	R163	68	CF			28716 L18
S18	R106	470	CF		21797	R164	1k2	CF			21800 J17
S17	R107	820	CF		28724	R165	750	MF	2		38591 H15
U17	R108	390k	CF		32358	R166	750	MF	2		38591 H15
B3	R109	56k	CF		28729	R167	1k5	CF			21801 J14
S16	R111	1k	CF		21799	R168	150	MF			38574 H14
V14	R112	10	CF		21793						
U13	R113	47	CF		28714	R170	100	CF			21794 H12
R15	R114	47	CF		28714	R171	27k	CF			21813 G15
S13	R115	68	CF		28716	R172	10k	CF			21809 J12
T15	R116	3k3	CF		21803	R173	10	CF			21793 J18
T15	R117	1k	PCP		39233	R174	100	CF			21794 E12
T17	R118	1k	CF		21799						
	R119	8k2	CF		21808	R176	100	CF			21794 E12
P13	R120	1k	CF		21799						
Q13	R121	470	CF		21797	R178	51	MF	2		38563 F12
R13	R122	220	MF	2	38578	R179	3k3	CF	A.O.T.		21803
R13	R123	220	MF	2	38578	R182	100	CF			21794 F12
P16	R124	100	CF		21794	R183	100	CF			21794 G12
	R125	4k7	CP		A4/44787	R184	100	CF			21794 F14
P15	R126	100	CF		21794	R185	100	CF			21794 F14
Q16	R127	75	CF		38567	R186	68	CF			28716 F14
R16	R128	2k2	CF		21802	R187	68	CF			28716 G14

Component List and Illustrations

Section 6

4041 'Y' PREAMP & BEAM SWITCH (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS (Cont.)											
G12	R188	82			MF	38568					
						R248	560	CF			21798 K4
						R249	1k	PCP			39233 N4
E12	R190	100			CF	21794					21793 F4
H12	R191	3k6		2	MF	38607					38575 J2
G12	R192	3k6		2	MF	38607				2	38582 L4
	R193	4k7			CP	A4/42203					38582 K4
Z17	R194	10k1		½	MF	37778					28723 M7
Z13	R195	111k		½	MF	37779					21797 N7
						R255	470	CF			28710 M7
						R256	22	CF			28710 M7
V3	R200	8k2			CF	21808					28710 L7
X3	R201	8k2			CF	21808					28711 M8
W6	R202	100k			CF	21819					
W6	R203	300k		½	MF	44916					21794 J3
V9	R204	100k			PCP	39269					21799 K7
V6	R205	10k			CF	21809					39233 K9
U8	R206	470			CF	21797					28716 L9
S8	R207	820			CF	28724					21800 H8
U8	R208	390k			CF	32358				2	38591 H6
D3	R209	56k			CF	28729				2	38591 H6
S7	R211	1k			CF	21799					21801 J5
V5	R212	10			CF	21793				2	38574 G4
U4	R213	47			CF	28714					
R6	R214	47			CF	28714					21794 J3
S3	R215	68			CF	28716					21813 G6
T6	R216	3k3			CF	21803					21809 J2
S6	R217	1k			PCP	39233					21793 J9
T8	R218	1k			CF	21799					21794 E9
	R219	8k2			CF	21808					
P4	R220	1k			CF	21799					21794 E9
Q4	R221	470			CF	21797					
R3	R222	220		2	MF	38578				2	38563 F9
R3	R223	220		2	MF	38578				A.O.T.	21803
P7	R224	100			CF	21794					21794 F9
	R225	4k7			CP	A4/44787					21794 G9
P6	R226	100			CF	21794					21794 F6
Q7	R227	75		2	MF	38567					21794 F6
R6	R228	2k2			CF	21802					28716 F6
						R286	68	CF			28716 G6
						R287	68	CF			28716 G6
S7	R231	2k		2	CF	38601				2	38568 G9
Q9	R232	500			PCP	39232					
N7	R233	56			CF	28715					21794 E9
P10	R234	680			CF	28723				2	38607 G9
N10	R235	56			CF	28715				2	38607 H9
M6	R236	56			CF	28715					A4/42203
P10	R237	680			CF	28723				½	37778 Z8
N10	R238	56			CF	28715				½	37779 Z4
G3	R240	10			CF	21793					21795 D11
L6	R241	56			CF	28715					21799 H10
M4	R242	1k8			CF	28725					21799 H9
M5	R243	1k3			MF	38597					21799 J9
L6	R244	22			CF	28710					21799 H12
J7	R245	100			PCP	39230					21798 F9
L7	R246	47			CF	28714					21798 F12
L4	R247	560			CF	21798					21793 H10
						R300	180	CF			
						R301	1k	CF			
						R302	1k	CF			
						R303	1k	CF			
						R304	1k	CF			
						R305	560	CF			
						R306	560	CF			
						R307	10	CF			

Component List and Illustrations

Section 6

4041 'Y' PREAMP & BEAM SWITCH (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS (Cont.)											
C13	R308	1k5	CF		21801	R376	2k7	CF			28726 B18
						R377	330	CF			28721 E14
D13	R311	1k5	CF		21801	R378	330	CF			28721 E14
A13	R312	2k2	CF		21802						
B13	R313	3k3	CF		21803	R381	1k	CF			21799 B15
B13	R314	2k2	CF		21802	R382	1k	CF			21799 B15
C13	R315	3k3	CF		21803						
B13	R316	100	CF		21794	R385	220	CF			21796 F16
C13	R317	100	CF		21794	R386	330	CF			28721 E17
B9	R318	100	MF	2	38570						
						RN1		Resistor Network		43135 or	43136
B9	R321	100	MF	2	38570	RN2		Resistor Network		43135 or	43136
B10	R322	100	MF	2	38570						
B10	R323	100	MF	2	38570						
CAPACITORS											
E6	R326	100	CF		21794	C11	4700pF	CE(2)			22393
D8	R327	27	CF		28711	C12	4700pF	CE(2)			22393
D8	R328	27	CF		28711	C13	0.1µF	CE(2)	400V		29495
D9	R329	270	CF	A.O.T.	28720	C14	0.1µF	CE(2)	400V		29495
	R330	4R7	CF		29433	C15	330pF	CE(2)			31293
B8	R331	270	CF		28720	C16	330pF	CE(2)			31293
B8	R332	330	MF	2	38582	C17	1.5pF	CE(3)			42398
B8	R333	51	MF	2	38563	C18	1.5pF	CE(3)			42398
B7	R334	1k8	CF		28725	C19	2.2pF	CE(3)			42400
B6	R335	50	CF		39267	C20	2.2pF	CE(3)			42400
E6	R336	1k	CF		21799	C21	47pF	CE(2)			29918
B4	R337	750	MF	2	38591	C22	47pF	CE(2)			29918
B5	R338	270	MF	2	38580	C23	5.6pF	CE(3)			42405
	R341	240	MF	2	38579	C24	5.6pF	CE(3)			42405
B5	R342	33	CF		28712	C25	4700pF	CE(2)			22393
D8	R343	6k8	CF		21807	C26	4700pF	CE(2)			22393
						C27	3.3pF	CE(2)			34529
B17	R350	2k7	CF		28726	C28	3.3pF	CE(2)			34529
G16	R351	220	CF		21796	C29	.01µF	CE(3)			42444
G16	R352	330	CF		28721	C30	.01µF	CE(3)			42444
						C31	.01µF	CE(3)			42444
C17	R355	560	CF		21798	C32	.01µF	CE(3)			42444
A14	R356	6k8	CF		21807	C33	.01µF	CE(3)			42444
B14	R357	10k	CF		21809	C34	.01µF	CE(3)			42444
A16	R358	2k7	CF		28726	C35	.01µF	CE(3)			42444
						C36	.01µF	CE(3)			42444
E17	R361	3k9	CF		21804	C37	.01µF	CE(3)			42444
A16	R362	2k7	CF		28726	C38	.01µF	CE(3)			42444
B14	R363	560	CF		21798						42444 C12
H17	R364	330	CF		28721	C100	.01µF	CE(3)			42444 W12
E19	R365	2k2	CF		21802	C101	.01µF	CE(3)			42444 U13
G18	R366	1k	CF		21799	C102	.01µF	CE(3)			42405 U16
G18	R367	220	CF		21796	C103	5.6pF	CE(3)			42444 W18
H18	R368	390	CF		28722	C104	.01µF	CE(3)			42444 W18
						C105	.01µF	CE(3)			42444 W18
						C106	22µF	E	25V		32181 U17
H18	R371	3k3	CF		21803	C107	.01µF	CE(3)			42444 U17
E18	R372	470	CF		21797	C108	.01µF	CE(3)			42444 S13
G18	R373	680	CF		28723	C109	33µF	E	16V		32173 R14
D17	R374	560	CF		21798						
D18	R375	3k3	CF		21803	C111	.01µF	CE(3)			42444 R12

Component List and Illustrations

Section 6

4041 'Y' PREAMP & BEAM SWITCH (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
CAPACITORS (Cont.)											
P16	C112	47pF	CE(3)		42416	C250	22μF	E		25V	32181 E4
P15	C113	47pF	CE(3)		42416						
Q16	C114		Not Fitted			C295	2/15pF	Trimmer			40554 AB7
Q19	C115	.01μF	CE(3)		42444	C296	2/5pF	Trimmer			40301 Y7
L13	C116	.01μF	CE(3)		42444	C297	2/5pF	Trimmer			40301 AB5
K13	C117	.01μF	CE(3)		42444	C298	2/15pF	Trimmer			40554 AB6
K17	C118	.01μF	CE(3)		42444	C299	2/10pF	Trimmer			40302 Y6
	C119	5n6	CE(3)		42441	C300	10nF	CE(3)			42444
M17	C120	100pF	CE(3)		42420	C301	47μF	E		25V	32182 F15
J15	C121	39pF	CE(3)		42415	C302	47μF	E		10V	32167 D14
J15						C303	.01μF	CE(3)			42444 D13
H15	C123	.01μF	CE(3)		42444	C304	47μF	E		25V	32182 E2
H16	C124	.01μF	CE(3)		42444	C305	.01μF	CE(3)			42444 A10
H17	C125	.01μF	CE(3)		42444	C306	.01μF	CE(3)			42444 B9
	C126	4p7	CE(2)	50V	36602	C307	.01μF	CE(3)			42444 B8
	C127	4p7	CE(2)	50V	36602	C308	.01μF	CE(3)			42444 B13
E3	C140	22μF		25V	32181	C311	.01μF	CE(3)			42444 C13
E4	C150	22μF	E	25V	32181	C312	.01μF	CE(3)			42444 D6
						C313	100pF	CE(3)			42420 D8
						C314	.01μF	CE(3)			42444
AB16	C195	2/15pF	Trimmer		40554						
Y16	C196	2/5pF	Trimmer		40301	C350	.01μF	CE(3)			42444 J18
AB14	C197	2/5pF	Trimmer		40301	C351	10μF	E		25V	32180 B18
AB15	C198	2/15pF	Trimmer		40554	C352	560pF	CE(3)			42429 G17
Y15	C199	2/10pF	Trimmer		40302	C353	560pF	CE(3)			42429 E18
V3	C200	.01μF	CE(3)		42444	C354	.01μF	CE(3)			42444 E16
X3	C201	.01μF	CE(3)		42444	C355	.01μF	CE(3)			42444 E16
U4	C202	.01μF	CE(3)		42444						
U7	C203	5.6pF	CE(3)		42405						
W9	C204	0.1μF	CE(3)		42444						
W9	C205	0.1μF	CE(3)		42444						
U8	C206	22μF	E	25V	32181						
U8	C207	.01μF	CE(3)		42444						
S4	C208	.01μF	CE(3)		42444						
R5	C209	33μF	E	16V	32173						
R3	C211	.01μF	CE(3)		42444						
P7	C212	47pF	CE(3)		42416						
P6	C213	47pF	CE(3)		42416						
Q7	C214		Not Fitted								
Q10	C215	.01μF	CE(3)		42444	Q200		AE37			40414 U5
L4	C216	.01μF	CE(3)		42444	Q201		AE13			31254 P7
K4	C217	.01μF	CE(3)		42444	Q202					
K8	C218	.01μF	CE(3)		42444	Q203		2N5771			38089 L5
C219	5n6	CE(3)			42441	Q204		2N5771			38089 K5
M8	C220	100pF	CE(3)		42420	Q205		2N5771			38089 N9
J5	C221	18pF	CE(3)		42411	Q206		2N5771			38089 L9
J6	C222	27pF	Trimmer		36273	Q207		AE13			31254 J4
H6	C223	.01μF	CE(3)		42444	Q208					H4
H7	C224	.01μF	CE(3)		42444						
H7	C225	.01μF	CE(3)		42444	Q300		BC212			70500 J10
	C226	4p7	CE(2)		36602	Q301		2N3906			21533 C7
	C227	4p7	CE(2)		36602	Q302		2N5771			38089 C10
E3	C240	22μF	E	25V	32181	Q303		2N5771			38089 C9
						Q304		2N5771			38089 C3

Component List and Illustrations

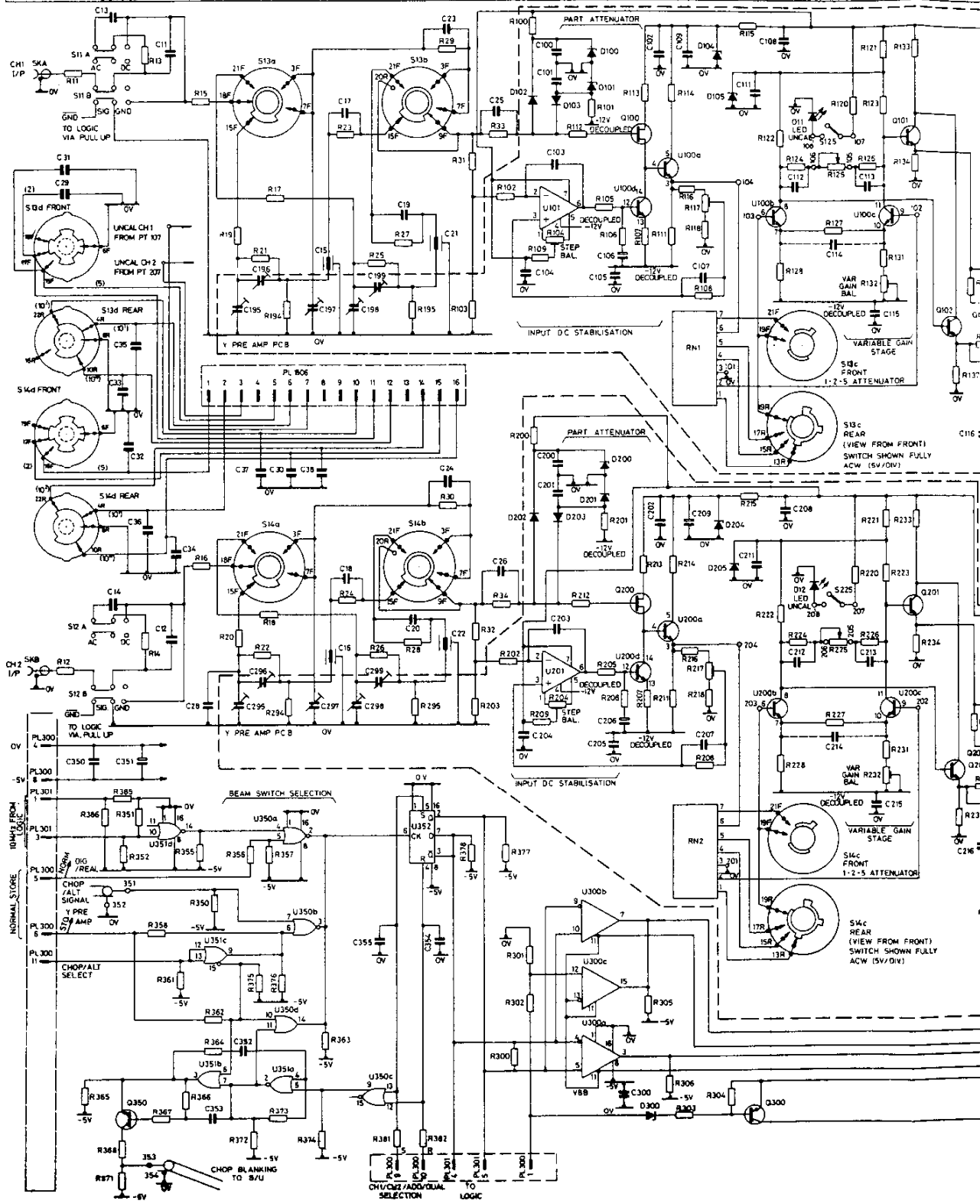
Section 6

4041 'Y' PREAMP & BEAM SWITCH (Cont.)

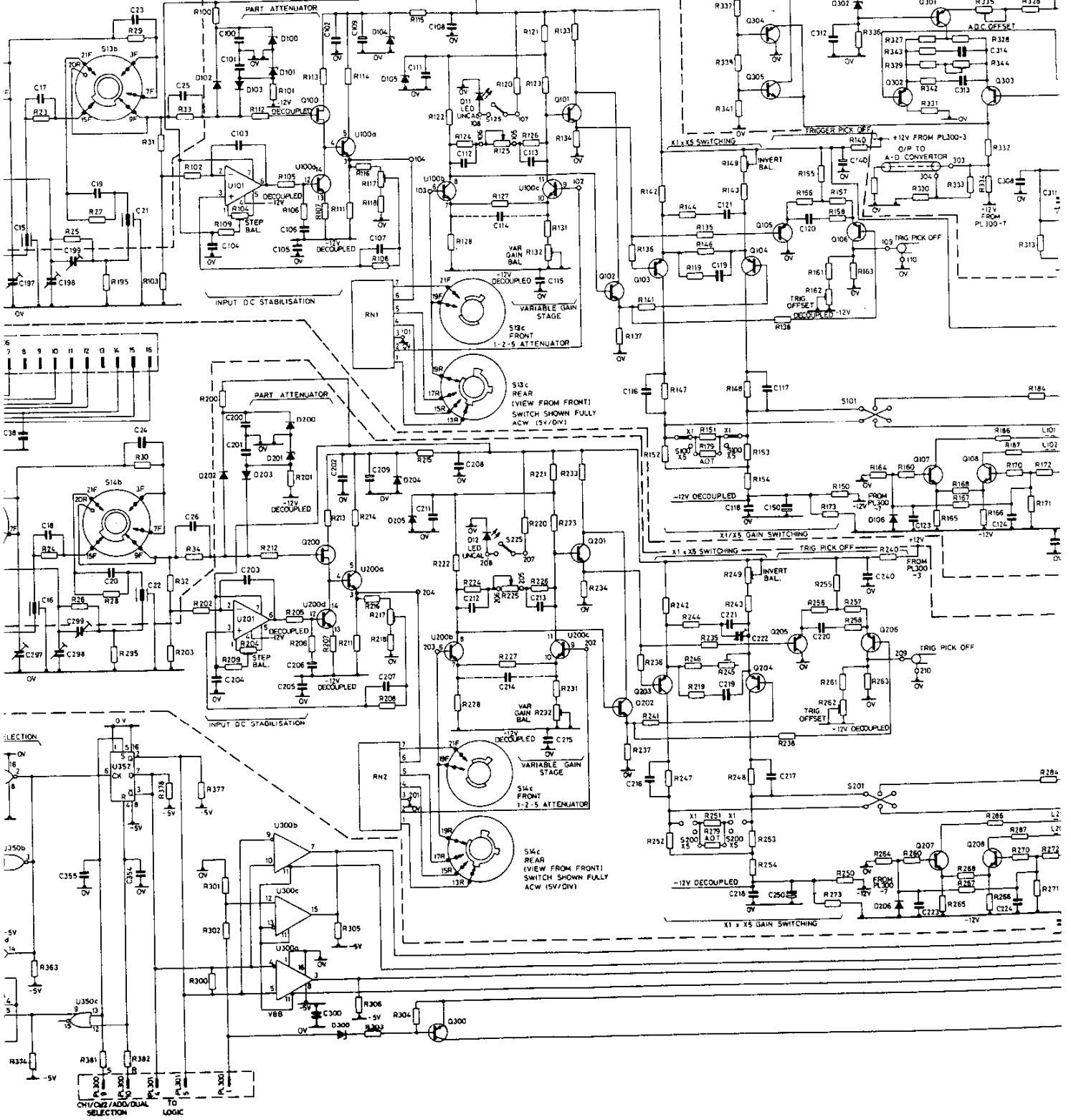
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TRANSISTORS (Cont.)											
B3	Q305	NPS2369			36625	U200		CA3086			42907 S6
						U201		LF355BN			42050 W7
G19	Q350	2N2640			31781	U202		CA3102E			44921 G7
						U300		MC10116			39244 G10
						U301		CA3086			42907 C11
DIODES											
W12	D100	3V3	ZENER		33923						
W12	D101	3V3	ZENER		33923	U350		MC10102			39243 D16
W15	D102		IN3595		29330	U351		MC10102			39243 G16
W13	D103		IN3595		29330	U352		MC10131			39246 D15
S13	D104	8V2	ZENER		33933						
R12	D105	4V7	ZENER		33927						
J16	D106	3V9	ZENER		33925	MISCELLANEOUS					
						S125					A4/44787
W3	D200	3V3	ZENER		33923	S225					A4/44787
W3	D201	3V3	ZENER		33923						
W6	D202		IN3595		29330	SKA					1222
W4	D203		IN3595		29330	SKB					1222
S4	D204	8V2	ZENER		33933						
Q3	D205	4V7	ZENER		33927						
J7	D206	3V9	ZENER		33925	INDUCTORS					
						L101		Ferrite Bead			26986
						L102		Ferrite Bead			26986
H9	D300	12V	ZENER		33937						
B9	D301	4V3	ZENER		33926	L201		Ferrite Bead			26986
D6	D302	3V	ZENER		33922	L202		Ferrite Bead			26986
B10	D303	4V3	ZENER		33926						
S15	U100		CA3086		42907	L300	1µH				41449 D2
W16	U101		LF355BN		42050						
G13	U102		CA3102E		44921						

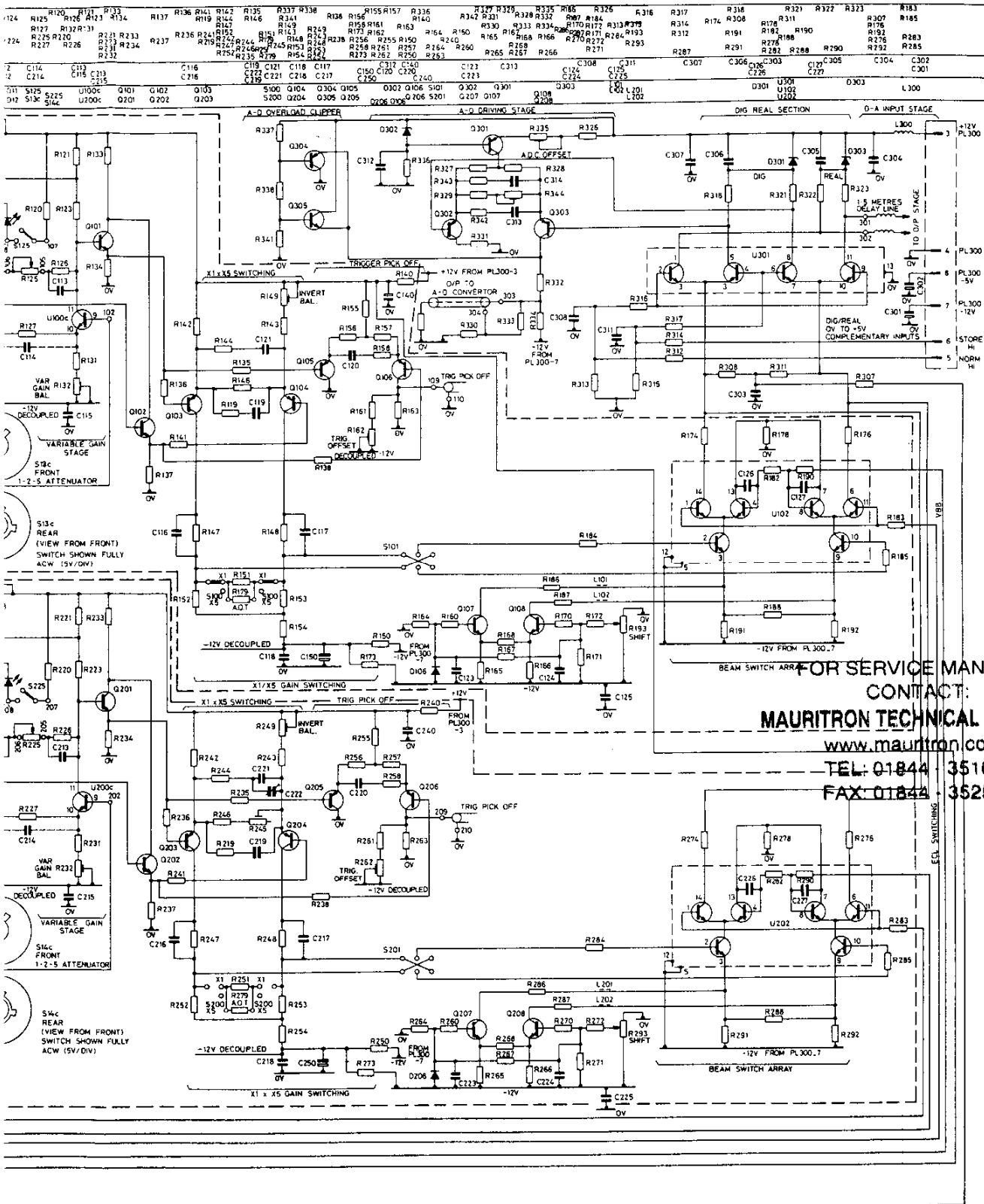
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 FAX: 01844 - 352554

R13	R15	R19	R21	R17	R23	R25	R27	R29	R31	R33	R100	R101	R113	R114	R116	R117	R115	R122	R174	R125	R126	R127	R128	R129	R130	R131	R132	R133	R134	R137																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
R14	R16	R18	R20	R22	R24	R26	R28	R30	R32	R34	R102	R103	R104	R105	R106	R107	R108	R109	R110	R111	R112	R113	R114	R115	R116	R117	R118	R119	R120	R121	R122	R123	R124	R125	R126	R127	R128	R129	R130	R131	R132	R133	R134	R137																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
R385	R352	R351	R361	R353	R350	R357	R354	R355	R356	R358	R359	R360	R362	R363	R364	R365	R366	R367	R368	R369	R370	R371	R372	R373	R374	R375	R376	R377	R378	R379	R380	R381	R382	R383	R384	R385	R386	R387	R388	R389	R390	R391	R392	R393	R394	R395	R396	R397	R398	R399	R400	R401	R402	R403	R404	R405	R406	R407	R408	R409	R410	R411	R412	R413	R414	R415	R416	R417	R418	R419	R420	R421	R422	R423	R424	R425	R426	R427	R428	R429	R430	R431	R432	R433	R434	R435	R436	R437	R438	R439	R440	R441	R442	R443	R444	R445	R446	R447	R448	R449	R450	R451	R452	R453	R454	R455	R456	R457	R458	R459	R460	R461	R462	R463	R464	R465	R466	R467	R468	R469	R470	R471	R472	R473	R474	R475	R476	R477	R478	R479	R480	R481	R482	R483	R484	R485	R486	R487	R488	R489	R490	R491	R492	R493	R494	R495	R496	R497	R498	R499	R500	R501	R502	R503	R504	R505	R506	R507	R508	R509	R510	R511	R512	R513	R514	R515	R516	R517	R518	R519	R520	R521	R522	R523	R524	R525	R526	R527	R528	R529	R530	R531	R532	R533	R534	R535	R536	R537	R538	R539	R540	R541	R542	R543	R544	R545	R546	R547	R548	R549	R550	R551	R552	R553	R554	R555	R556	R557	R558	R559	R560	R561	R562	R563	R564	R565	R566	R567	R568	R569	R570	R571	R572	R573	R574	R575	R576	R577	R578	R579	R580	R581	R582	R583	R584	R585	R586	R587	R588	R589	R590	R591	R592	R593	R594	R595	R596	R597	R598	R599	R600	R601	R602	R603	R604	R605	R606	R607	R608	R609	R610	R611	R612	R613	R614	R615	R616	R617	R618	R619	R620	R621	R622	R623	R624	R625	R626	R627	R628	R629	R630	R631	R632	R633	R634	R635	R636	R637	R638	R639	R640	R641	R642	R643	R644	R645	R646	R647	R648	R649	R650	R651	R652	R653	R654	R655	R656	R657	R658	R659	R660	R661	R662	R663	R664	R665	R666	R667	R668	R669	R670	R671	R672	R673	R674	R675	R676	R677	R678	R679	R680	R681	R682	R683	R684	R685	R686	R687	R688	R689	R690	R691	R692	R693	R694	R695	R696	R697	R698	R699	R700	R701	R702	R703	R704	R705	R706	R707	R708	R709	R710	R711	R712	R713	R714	R715	R716	R717	R718	R719	R720	R721	R722	R723	R724	R725	R726	R727	R728	R729	R730	R731	R732	R733	R734	R735	R736	R737	R738	R739	R740	R741	R742	R743	R744	R745	R746	R747	R748	R749	R750	R751	R752	R753	R754	R755	R756	R757	R758	R759	R760	R761	R762	R763	R764	R765	R766	R767	R768	R769	R770	R771	R772	R773	R774	R775	R776	R777	R778	R779	R780	R781	R782	R783	R784	R785	R786	R787	R788	R789	R790	R791	R792	R793	R794	R795	R796	R797	R798	R799	R800	R801	R802	R803	R804	R805	R806	R807	R808	R809	R810	R811	R812	R813	R814	R815	R816	R817	R818	R819	R820	R821	R822	R823	R824	R825	R826	R827	R828	R829	R830	R831	R832	R833	R834	R835	R836	R837	R838	R839	R840	R841	R842	R843	R844	R845	R846	R847	R848	R849	R850	R851	R852	R853	R854	R855	R856	R857	R858	R859	R860	R861	R862	R863	R864	R865	R866	R867	R868	R869	R870	R871	R872	R873	R874	R875	R876	R877	R878	R879	R880	R881	R882	R883	R884	R885	R886	R887	R888	R889	R890	R891	R892	R893	R894	R895	R896	R897	R898	R899	R900	R901	R902	R903	R904	R905	R906	R907	R908	R909	R910	R911	R912	R913	R914	R915	R916	R917	R918	R919	R920	R921	R922	R923	R924	R925	R926	R927	R928	R929	R930	R931	R932	R933	R934	R935	R936	R937	R938	R939	R940	R941	R942	R943	R944	R945	R946	R947	R948	R949	R950	R951	R952	R953	R954	R955	R956	R957	R958	R959	R960	R961	R962	R963	R964	R965	R966	R967	R968	R969	R970	R971	R972	R973	R974	R975	R976	R977	R978	R979	R980	R981	R982	R983	R984	R985	R986	R987	R988	R989	R990	R991	R992	R993	R994	R995	R996	R997	R998	R999	R1000



R21	R25	R27	R29	R31	R33	R35	R37	R39	R41	R43	R45	R47	R49	R51	R53	R55	R57	R59	R61	R63	R65	R67	R69	R71	R73	R75	R77	R79	R81	R83	R85	R87	R89	R91	R93	R95	R97	R99	R101	R103	R105	R107	R109	R111	R113	R115	R117	R119	R121	R123	R125	R127	R129	R131	R133	R135	R137	R139	R141	R143	R145	R147	R149	R151	R153	R155	R157	R159	R161	R163	R165	R167	R169	R171	R173	R175	R177	R179	R181	R183	R185	R187	R189	R191	R193	R195	R197	R199	R201	R203	R205	R207	R209	R211	R213	R215	R217	R219	R221	R223	R225	R227	R229	R231	R233	R235	R237	R239	R241	R243	R245	R247	R249	R251	R253	R255	R257	R259	R261	R263	R265	R267	R269	R271	R273	R275	R277	R279	R281	R283	R285	R287	R289	R291	R293	R295	R297	R299	R301	R303	R305	R307	R309	R311	R313	R315	R317	R319	R321	R323	R325	R327	R329	R331	R333	R335	R337	R339	R341	R343	R345	R347	R349	R351	R353	R355	R357	R359	R361	R363	R365	R367	R369	R371	R373	R375	R377	R379	R381	R383	R385	R387	R389	R391	R393	R395	R397	R399	R401	R403	R405	R407	R409	R411	R413	R415	R417	R419	R421	R423	R425	R427	R429	R431	R433	R435	R437	R439	R441	R443	R445	R447	R449	R451	R453	R455	R457	R459	R461	R463	R465	R467	R469	R471	R473	R475	R477	R479	R481	R483	R485	R487	R489	R491	R493	R495	R497	R499	R501	R503	R505	R507	R509	R511	R513	R515	R517	R519	R521	R523	R525	R527	R529	R531	R533	R535	R537	R539	R541	R543	R545	R547	R549	R551	R553	R555	R557	R559	R561	R563	R565	R567	R569	R571	R573	R575	R577	R579	R581	R583	R585	R587	R589	R591	R593	R595	R597	R599	R601	R603	R605	R607	R609	R611	R613	R615	R617	R619	R621	R623	R625	R627	R629	R631	R633	R635	R637	R639	R641	R643	R645	R647	R649	R651	R653	R655	R657	R659	R661	R663	R665	R667	R669	R671	R673	R675	R677	R679	R681	R683	R685	R687	R689	R691	R693	R695	R697	R699	R701	R703	R705	R707	R709	R711	R713	R715	R717	R719	R721	R723	R725	R727	R729	R731	R733	R735	R737	R739	R741	R743	R745	R747	R749	R751	R753	R755	R757	R759	R761	R763	R765	R767	R769	R771	R773	R775	R777	R779	R781	R783	R785	R787	R789	R791	R793	R795	R797	R799	R801	R803	R805	R807	R809	R811	R813	R815	R817	R819	R821	R823	R825	R827	R829	R831	R833	R835	R837	R839	R841	R843	R845	R847	R849	R851	R853	R855	R857	R859	R861	R863	R865	R867	R869	R871	R873	R875	R877	R879	R881	R883	R885	R887	R889	R891	R893	R895	R897	R899	R901	R903	R905	R907	R909	R911	R913	R915	R917	R919	R921	R923	R925	R927	R929	R931	R933	R935	R937	R939	R941	R943	R945	R947	R949	R951	R953	R955	R957	R959	R961	R963	R965	R967	R969	R971	R973	R975	R977	R979	R981	R983	R985	R987	R989	R991	R993	R995	R997	R999	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30	C31	C32	C33	C34	C35	C36	C37	C38	C39	C40	C41	C42	C43	C44	C45	C46	C47	C48	C49	C50	C51	C52	C53	C54	C55	C56	C57	C58	C59	C60	C61	C62	C63	C64	C65	C66	C67	C68	C69	C70	C71	C72	C73	C74	C75	C76	C77	C78	C79	C80	C81	C82	C83	C84	C85	C86	C87	C88	C89	C90	C91	C92	C93	C94	C95	C96	C97	C98	C99	C100	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	D20	D21	D22	D23	D24	D25	D26	D27	D28	D29	D30	D31	D32	D33	D34	D35	D36	D37	D38	D39	D40	D41	D42	D43	D44	D45	D46	D47	D48	D49	D50	D51	D52	D53	D54	D55	D56	D57	D58	D59	D60	D61	D62	D63	D64	D65	D66	D67	D68	D69	D70	D71	D72	D73	D74	D75	D76	D77	D78	D79	D80	D81	D82	D83	D84	D85	D86	D87	D88	D89	D90	D91	D92	D93	D94	D95	D96	D97	D98	D99	D100	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	Q41	Q42	Q43	Q44	Q45	Q46	Q47	Q48	Q49	Q50	Q51	Q52	Q53	Q54	Q55	Q56	Q57	Q58	Q59	Q60	Q61	Q62	Q63	Q64	Q65	Q66	Q67	Q68	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q90	Q91	Q92	Q93	Q94	Q95	Q96	Q97	Q98	Q99	Q100	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	S28	S29	S30	S31	S32	S33	S34	S35	S36	S37	S38	S39	S40	S41	S42	S43	S44	S45	S46	S47	S48	S49	S50	S51	S52	S53	S54	S55	S56	S57	S58	S59	S60	S61	S62	S63	S64	S65	S66	S67	S68	S69	S70	S71	S72	S73	S74	S75	S76	S77	S78	S79	S80	S81	S82	S83	S84	S85	S86	S87	S88	S89	S90	S91	S92	S93	S94	S95	S96	S97	S98	S99	S100	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12	U13	U14	U15	U16	U17	U18	U19	U20	U21	U22	U23	U24	U25	U26	U27	U28	U29	U30	U31	U32	U33	U34	U35	U36	U37	U38	U39	U40	U41	U42	U43	U44	U45	U46	U47	U48	U49	U50	U51	U52	U53	U54	U55	U56	U57	U58	U59	U60	U61	U62	U63	U64	U65	U66	U67	U68	U69	U70	U71	U72	U73	U74	U75	U76	U77	U78	U79	U80	U81	U82	U83	U84	U85	U86	U87	U88	U89	U90	U91	U92	U93	U94	U95	U96	U97	U98	U99	U100
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Fig. 6.2 'Y' Pre-amp & Beam Switch Circuit Diagram

Component List and Illustrations

Section 6

4041 Y O/P AMP & DOT JOINER

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

Component List and Illustrations

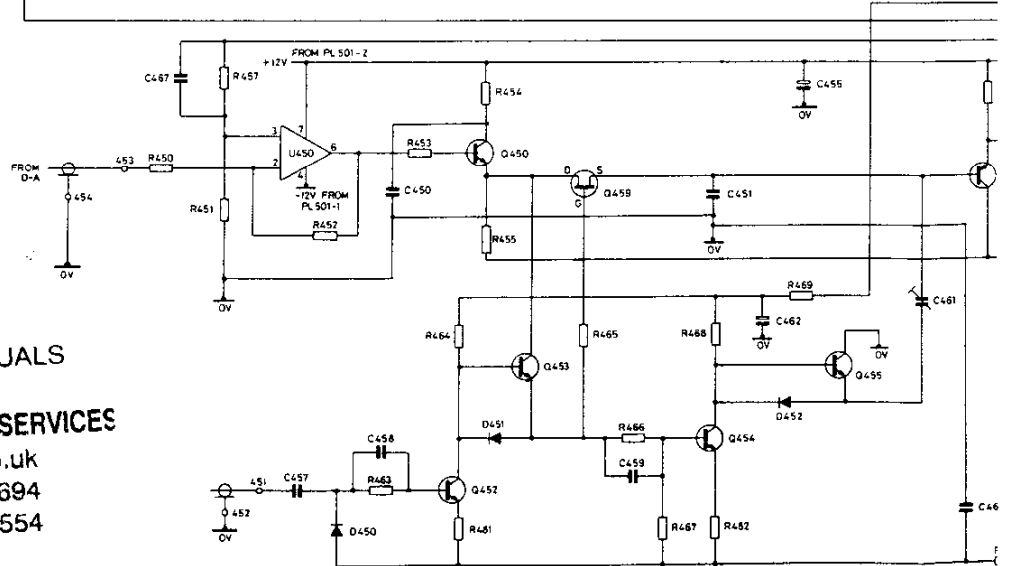
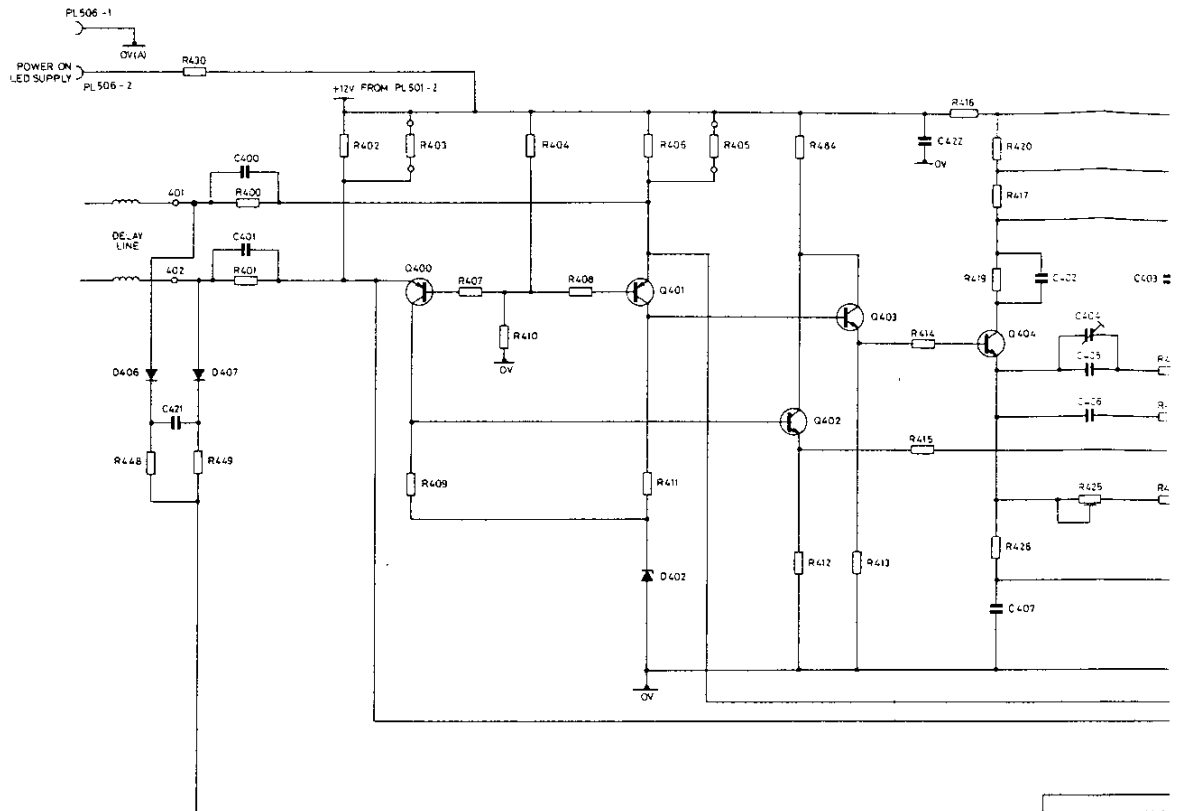
Section 6

4041 Y O/P AMP & DOT JOINER (Cont.)

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

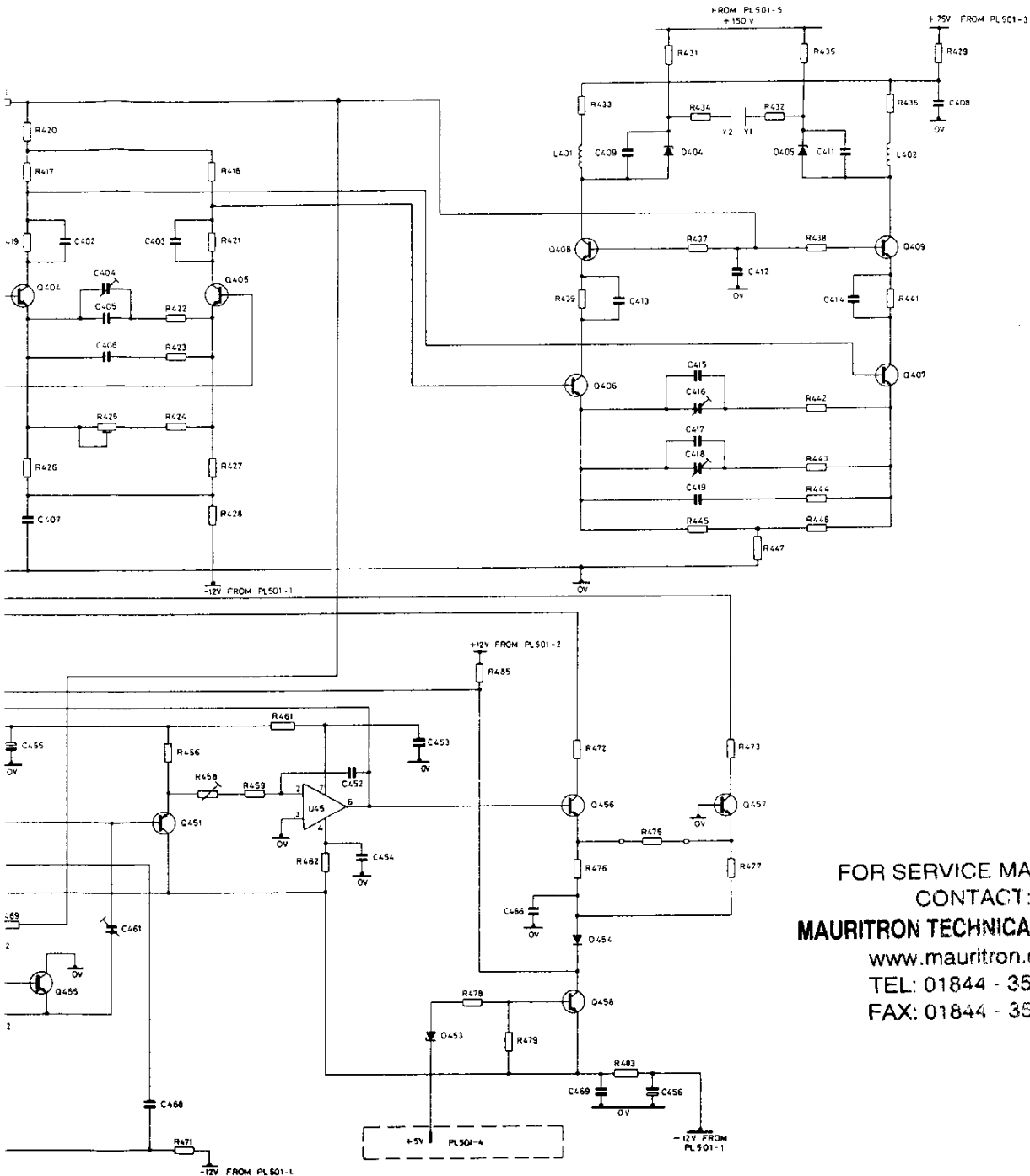
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	R430	R400	R407	R403	R407	R404	R408	R405	R405	R484	R417	R414	R415	R416	R420	R417	R419	R426	R41	R42	R43	R47	
RESISTORS	R448	R449	R401	R409	R457	R451	R410	R463	R453	R411	R454	R464	R481	R465	R466	R467	R468	R413	R482	R469			
CAPACITORS	C421	C400	C401	C467			C457	C450	C458			C459	C451	C462	C422		C407	C455	C407	C404	C405	C406	C403
MISCELLANEOUS	PL506	D406	D407	Q400			U450	D450	D451	Q401	Q402	Q450	Q451	Q453	Q499	Q402	Q403		D404	Q454	D452	Q495	Q451



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R420	R422	R418	R433	R431	R432	R435	R436	R429
R417	R425	R423	R439	R475	R437	R438	R442	
R419		R424				R442	R443	
R426		R456	R478	R473	R445	R473	R444	R441
		R471				R447	R445	
					R483			
							C411	C408
C407	C402	C404			C409	C415		
C455		C405			C413	C416	C414	
		C406				C417		
		C458			C454	C418		
Q404		Q405			Q408	Q404	D405	L402
Q455	Q451	U451	Q453	PL501	Q456	D454	Q409	Q407



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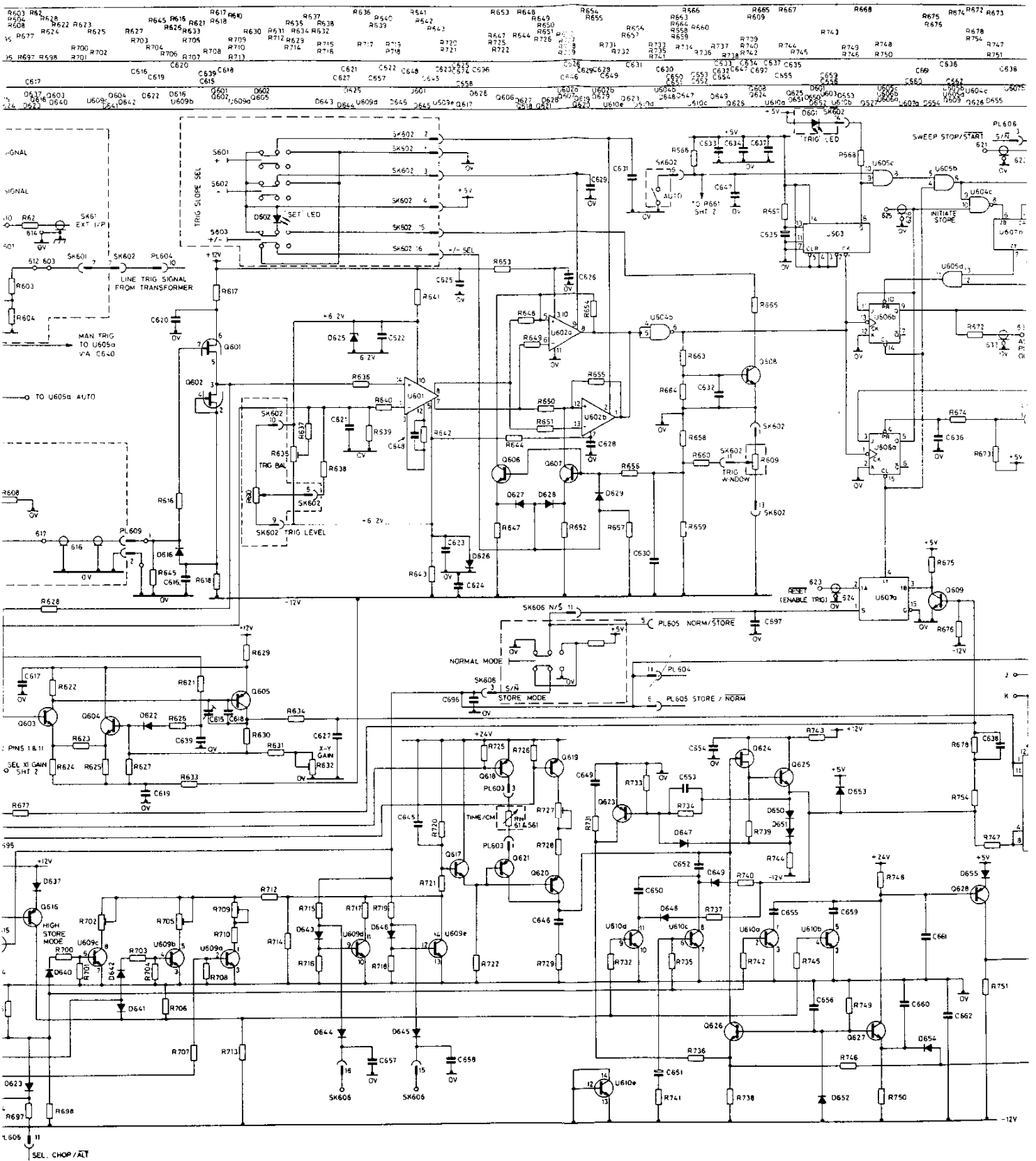
Fig. 6.3 'Y' Output Amplifier & Dot Joiner Circuit Diagram

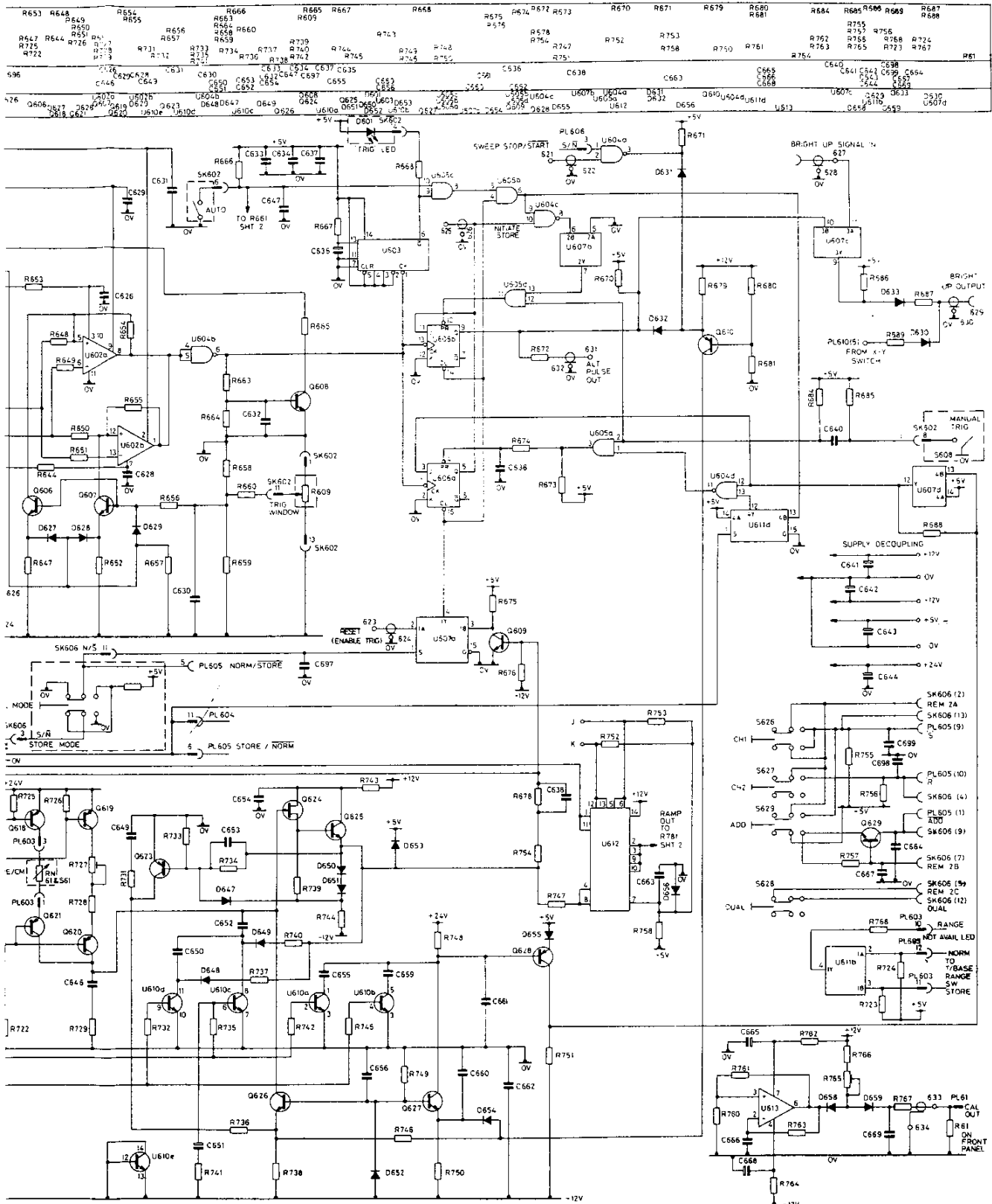
Component List and Illustrations

Section 6

4041 TIMEBASE

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS											
R601	820k	MF	2	½W	44726	R659	6k8	CF			21807 Z4
R602	82	CF			28717	R660	4k7	CF			21805 Z4
R603	8k2	CF			21808	R661	10k	CF			21809 AA12
R604	3k3	CF			21803						
R605	47	CF		1/8W	43146	R663	10k	CF			21809 Z6
R606	47	CF			28714	R664	10k	CF			21809 Z5
R607	220k	CF			21823	R665	330	CF			28721 Z6
R608	390k	MF	2		38656	R666	10k	CF			21809 W10
R609	22k	CP			A4/44784	R667	180k	CF			21822 AA11
R610	47k	CP			A4/452043	R668	330	CF			28721 W11
R611	390k	CP	2		38656	R670	1k2	CF			21800 V11
AF3	R616	100	CF		21794	R671	4k7	CF			21805 X9
AD4	R617	560	CF		21798	R672	1k8	CF			28725 W8
AF6	R618	10	CF		21793	R673	2k2	CF			21802 W11
AF12	R619	2k2	CF		21802	R674	470	CF			21797 X11
AF13	R620	3k3	CF		21803	R675	10k	CF			21809 W5
AF12	R621	47	CF		28714	R676	39k	CF			28728 R4
AF8	R622	680	CF		28723	R677	4k7	CF			21805 R3
AF7	R623	220	CF		21796	R678	12k	CF			21810 R3
AG7	R624	6k8	CF		21807	R679	1k3	MF	2		38597 V6
AF8	R625	6k8	CF		21807	R680	2k7	CF			28726 T4
AF11	R626	3k3	CF		21803	R681	270	CF			28720 T4
AF9	R627	12k	CF		21810	R684	4k7	CF			21805 W10
AF6	R628	100	CF		21794	R685	330k	CF			32357 W10
AD9	R629	10	CF		21793	R686	4k7	CF			21805 W8
AF9	R630	2k	MF	2	38601	R687	1k5	CF			21801 W8
AE11	R631	1k2	CF		21800	R688	22k	CF			21812 W7
AD11	R632	5k	CP		42156	R689	5k6	CF			21806 R2
AF12	R633	10	CF		21793	R690	1k8	CF		2½W	17823 J7
AC12	R634	82	CF		28717	R691	100k	CF			21819 AD13
AD4	R635	10k	PCP		39228	R692	27k	CF			21813 AC13
AD5	R636	100	CF		21794	R693	12k	CF			21810 AB12
AC5	R637	10k	CF		21809	R694	8k2	CF			21808 AB15
AC4	R638	10k	CF		21809	R695	12k	CF			21810 AB12
AC6	R639	220	CF		21796	R696	8k2	CF			21808 Z15
AC6	R640	100	CF		21794	R697	8k2	CF			21808 AG14
AD3	R641	180	CF		21795	R698	15k	CF			28727 Z15
AD6	R642	2k7	CF		28726						
AC5	R643	120	MO	2	½W	26746	R700	10k	CF		21809 Z14
AC8	R644	10	CF		21793	R701	22k	CF			21812 Z14
AF4	R645	10M	CF		32661	R702	10k	PCP			39228 W15
AA3	R647	1k2	MF	2		R703	10k	CF			21809 Z13
AC7	R648	220	CF		21796	R704	22k	CF			21812 Z14
AC8	R649	220	CF		21796	R705	10k	PCP			39228 W12
AC8	R650	220	CF		21796	R706	8k2	CF			21808 AB13
AC7	R651	220	CF		21796	R707	10k	CF			21809 X15
AA3	R652	1k2	MF	2		R708	22k	CF			21812 W15
AC7	R653	10	CF		21793	R709	10k	PCP			39265 U16
AA6	R654	15k	CF		28727	R710	3k9	CF			21804 W12
AA6	R655	15k	CF		28727	R712	6k2	MF	2		38613 W13
AA5	R656	100	CF		21794	R713	15k	CF			28727 Z13
Y4	R657	100k	CF		21819	R714	31k6	MF	0.5		44724 X13
Z4	R658	33k	CF		21814	R715	3k3	CF			21803 U14





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Fig. 6.4 Timebase Circuit Diagram 1

Component List and Illustrations

Section 6

4041 TIMEBASE (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS (Cont.)											
W14	R716	1k5			21801	R772	4k7	CF			21805 AH7
W13	R717	15k4		0.5	44723	R775	3k	MF	2		38605 F11
W13	R718	1k5			21801	R776	68k	CF			21816 F9
U13	R719	1k5			21801	R777	2k2	MF	2		38602 F10
R14	R720	6k81		0.5	44722	R778	10	CF			21793 L6
U13	R721	3k4		0.5	44721						
Q13	R722	68k			21816	R780	10	CF			21793 K8
AD10	R723	10k			21809	R781	47	CF			28714 M11
AD10	R724	10k			21809	R782	680	MF	2		38590 K12
S16	R725	8k2			21808	R783	130	MF	0.5		44718 M10
R15	R726	8k2			21808	R784	100	CF			21794 M11
T15	R727	100k			42158	R785	336	MF	0.5		44719 J11
T14	R728	300k		2	38653	R786	220	CF			21796 J11
Q12	R729	180			21795	R787	681	MF	0.5		44720 J10
						R788	820	CF			28724 J10
S6	R731	82			28717	R789	3k	MF	2		38605 F9
U10	R732	2k2			21802	R790	2k2	MF	2		38602 G9
S6	R733	12k			21810	R791	3k	MF	2		38605 F11
S8	R734	33k			21814	R792	130	MF	0.5		44718 M10
U9	R735	2k2			21802	R793	336	MF	0.5		44719 J10
U8	R736	1k			21799	R794	681	MF	0.5		44720 J9
R8	R737	470k			32330	R795	680	MF	2		38590 M9
U8	R738	620		2	38589	R796	2k2	MF	2		38602 F11
Q7	R739	1k2			21800	R797	390	MF	2		38584 F10
R8	R740	470k			32330						M9
U8	R741	47			28714	R799	22	CF			28710 P12
U9	R742	47k			21815						
P7	R743	390			28722	R801	68k	MF	2		38638 P16
Q6	R744	2k7			28726	R802	390k	CF			32358 P15
U10	R745	47k			21815	R803	39k	CF			28728 P15
U8	R746	330			28721	R804	20k	MF	2		38625 P15
Q9	R747	39			28713	R805	1k	CF			21799 AF14
S7	R748	680k			31839	R806	1k	CF			21799 P17
R3	R749	1k5			21801	R807	10k	} CP			A3/44789 AG14
Q5	R750	27k			21813	R808	10k				AE16
U6	R751	10k			21809						
P8	R752	22k			21812	R811	3k	MF	2		38606 N12
P8	R753	22k			21812	R812	3k	MF	2		38606 N13
Q5	R754	150			28719	R813	220	CF			21796 N13
AH5	R755	4k7			21805	R814	220	CF			21796 N14
AH6	R756	4k7			21805	R815	2k7	CF			28726 N14
Q3	R757	6k8			21807	R816	680	MF	2		38590 L15
P6	R758	4k7			21805	R817	680	MF	2		38590 L14
						R818	47	CF			28714 L12
						R819	47	CF			28714 L13
P5	R760	680			28723	R820	47	CF			28714 M12
L6	R761	3k3			21803						
L6	R762	220			21796						
P4	R763	15k			28727	R822	47	CF			28714 J14
L5	R764	220			21796	R823	47	CF			28714 H15
L2	R765	1k			39261	R824	8.2k	CF	A.O.T.		21805 H15
K3	R766	9k1		2	38617						
L3	R767	1k8			28725	R826	1k8	MF	2		38600 H16
AC13	R768	330			28721	R827	1k8	MF	2		38600 H16
						R828	12k	MF	2		38620 H12
AD9	R771	1k			21799	R829	12k	MF	2		38620 F12

Component List and Illustrations

Section 6

4041 TIMEBASE (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS (Cont.)											
H13	R832	390	CF		28722	C630	.01μF	CE(3)			42444 AA4
J13	R833	500	PCP		39232	C631	.01μF	CE(3)			42444 Y3
H12	R834	220	MF	2	38578	C632	.01μF	CE(3)			42444 Z5
J12	R835	220	MF	2	38578	C633	.01μF	CE(3)			42444 Z8
L15	R836	30k	MF	2	38629	C634	.01μF	CE(3)			42444 X6
M16	R837	11k	MF	2	38619	C635	1μF	E		63V	32193 AA9
F16	R838	5k6	MF	2	38612	C636	1500pF	CE(3)			42434 Z11
F15	R839	910	MF	2	38593	C637	.01μF	CE(3)			42444 W9
F15	R840	4k3	MF	A.O.T.	38609	C638	82pF	CE(3)			42419 R3
J16	R841	36k	MF	2	38631	C639	.01μF	CE(3)			42444 AD12
H16	R842	12k	MF	2	38620	C640	4700pF	CE(3)			42440 W10
J15	R843	2k	MF	2	38601	C641	22μF	E		25V	32181 U1
J16	R844	9k1	MF	A.O.T.	38617	C642	22μF	E		25V	32181 X4
						C643	47μF	E		10V	32167 R1
F13	R847	150k	CF		21821	C644	15μF	E		40V	32187 Q16
F14	R848	150k	CF		21821	C645	.1μF	CE(3)		100V	37018 Q14
B8	R849	47	CF		28714	C646	180pF	PS		160V	44725 U13
B15	R850	820	CF		28724	C647	.01μF	CE(3)			42444 V10
A11	R851	820	CF		28724	C648	5.6pF	CE(3)	0.5pF		42405 C3
B15	R852	220	CF		21796	C649	5.6pF	CE(3)			42405 Q5
B11	R853	220	CF		21796	C650	.022μF	CE(2)		100V	450118 R10
B9	R854	82k	MF	2	½W	28820	C651	33μF	E	16V	32173 U9
C13	R855	100	CF		21794	C652	2.2μF	PC			40853 R12
C13	R856	100	CF		21794	C653	56pF	CE(3)			42417 S7
A10	R857	62k	MF	2	½W	28817	C654	.01μF	CE(3)		42444 P11
B16	R858	62k	MF	2	½W	28817	C655	1μF	PE	100V	37389 T5
						C656	.01μF	CE(3)			42444 V11
D10	R861	10	CF		21793	C657	.01μF	CE(2)		50V	42569 AH6
E17	R862	10	CF		21793	C658	.01μF	CE(2)		50V	42569 AH6
E12	R863	1k5	CF		21801	C659	.01μF	PE		100V	39190 T8
D14	R864	1k5	CF		21801	C660	5.6pF	CE(3)			42405 Q4
						C661	100pF	PS	2½	63V	35912 T4
						C662	.01μF	CE(3)			42444 R4
						C663	.01μF	CE(3)			42444 N7
						C664	.01μF	CE(3)			42444 U3
						C665	33μF	E		16V	32173 N6
						C666	.1μF	CE(2)		100V	37018 P3
						C667	.01μF	CE(3)			42444 U3
						C668	33μF	E		16V	32173 P5
						C669	39pF	CE(3)			42415 L3
AE10	C615	3/45pF	Trimmer		43504	C670	39pF	CE(3)			42415 M10
AF6	C616	.01μF	CE(3)		42444	C671	15pF	CE(3)			42410 J11
AD8	C617	.01μF	CE(3)		42444	C672	5.6pF	CE(3)			42405 J10
AF10	C618	100pF	CE(3)	A.O.T.	42420	C673	1μF	T		50V	34895 M8
AF7	C619	.01μF	CE(3)		42444	C674	.1μF	CE(2)		35V	37018 Q14
AF6	C620	.01μF	CE(3)		42444	C675	.01μF	CE(3)		100V	42444 M16
AC6	C621	.01μF	CE(3)		42444	C676	.01μF	CE(3)			42444 P12
AD6	C622	.01μF	CE(3)		42444	C677	.01μF	CE(3)			42444 F16
AC5	C623	.01μF	CE(3)		42444	C678	.01μF	CE(3)			42444 J17
AC4	C624	.01μF	CE(3)		42444	C679	.01μF	CE(3)			42444 F12
AC4	C625	.01μF	CE(3)		42444	C680	2.2pF	CE(2)			44361 B16
AC7	C626	.01μF	CE(3)		42444	C681	2.2pF	CE(2)			44361 B15
AC12	C627	150pF	CE(3)		42422	C682	9pF	Trimmer			36272 B17
AC8	C628	.01μF	CE(3)		42444	C683	.01μF	CE(3)			42444 E17
Z3	C629	.01μF	CE(3)		42444	C684	.01μF	CE(2)		250V	22395 C14

Component List and Illustrations

Section 6

4041 TIMEBASE (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
CAPACITORS (Cont.)											
B11	C685	.1μF		250V	39199	Q642		BF469			38418 E14
D13	C686	.1μF		100V	37018	Q643		BF469			38418 E12
AD12	C687	.01μF			42444	Q644		BF470			38416 B14
D15	C688	.1μF		250V	39199	Q645		BF470			38416 B12
C11	C689	.01μF		250V	22395						
D10	C690	.01μF			42444	INTEGRATED CIRCUITS					
A12	C691	.01μF		250V	22395	U601		733			37394
C9	C692	2.2pF			44361	U602		1414			35682
B10	C693	2.2pF			44361	U603		74LS122			39238
E9	C694	9pF			43502	U604		74LS00			36730
F14	C695	56pF			42417	U605		74LS08			36467
W3	C696	.01μF			42444	U606		74LS112			36468
W3	C697	.01μF			42444	U607		74LS157			36735
W2	C698	.01μF			42444	U608		78L24ACZ			402045 X14
W2	C699	.01μF			42444	U609		CA3086			42907 T9
AH6	C700	.01μF			42444	U610		CA3086			42907
						U611		74LS157			36735
						U612		4066B			40044
						U613		709			40179
TRANSISTORS											
AF5	Q601		U412	Dual F.E.T.	452613						
AF5	Q602										
AE8	Q603		AE13	Matched Pair	31254	U615		CA3086			42907 K9
AG8	Q604					U616		CA3086			42907 G11
AE9	Q605		2N3906		21533	U617		741			36736
AA5	Q606		2N3904		24146						
Z5	Q607		2N3904		24146	U619		CA3086			42907 H15
Z6	Q608		BC182B		33205						
U3	Q609		2N3904		24146	DIODES					
V7	Q610		2N3906		21533	D601					43847
						D602					43847
AA15	Q613		BC212		29327						
AC14	Q614		2N3904		24246	D616		IN3595			29330 AF4
AC15	Q615		2N3904		24146	D617		IN4148			23802 AD9
Z12	Q616		BC212		29327	D618		IN4148			23802 F7
Q13	Q617		BC182B		33205	D619		IN4148			23802 N7
T17	Q618		BC214C		40348	D620		IN4148			23802 AE13
T15	Q619		BC214C		40348	D621		IN4148			23802 AE13
S14	Q620		BC214C		40348	D622		IN4148			23802 AF11
T13	Q621		BC214C		40348	D623		IN4148			23802 Y16
						D624		IN4148			23802 AG14
R6	Q623		2N3906		21533	D625		ZENER			33930 AD4
Q11	Q624		BF245A		38271	D626		ZENER			33930 AC5
Q9	Q625		MPS2369		36625	D627		IN4148			23802 AA4
U12	Q626		BC182B		40349	D628		IN4148			23802 AA4
R5	Q627		2N3904		24146	D629		IN4148			23802 AA4
T6	Q628		2N3906		21533	D630		IN4148			23802 W7
P3	Q629		2N3904		24146	D631		IN4148			23802 X9
AH7	Q630		BC212		29327	D632		IN4148			23802 W9
						D633		IN4148			23802 W8
G8	Q632		2N3904		24146	D634	18V	ZENER			33941 K7
						D635		IN4148			23802 K8
L14	Q636		2N3640		31781	D636		IN4148			23802 AB14
K14	Q637		2N3640		31781	D637		IN4148			23802 AB12
G17	Q638		2N3904		24146						
K15	Q639		2N3904		24146	D640		IN4148			23802 Z14
D16	Q640		MPS2369		36625	D641		IN4148			23802 Z13
E11	Q641		MPS2369		36625	D642		IN4148			23802 Z13

Component List and Illustrations

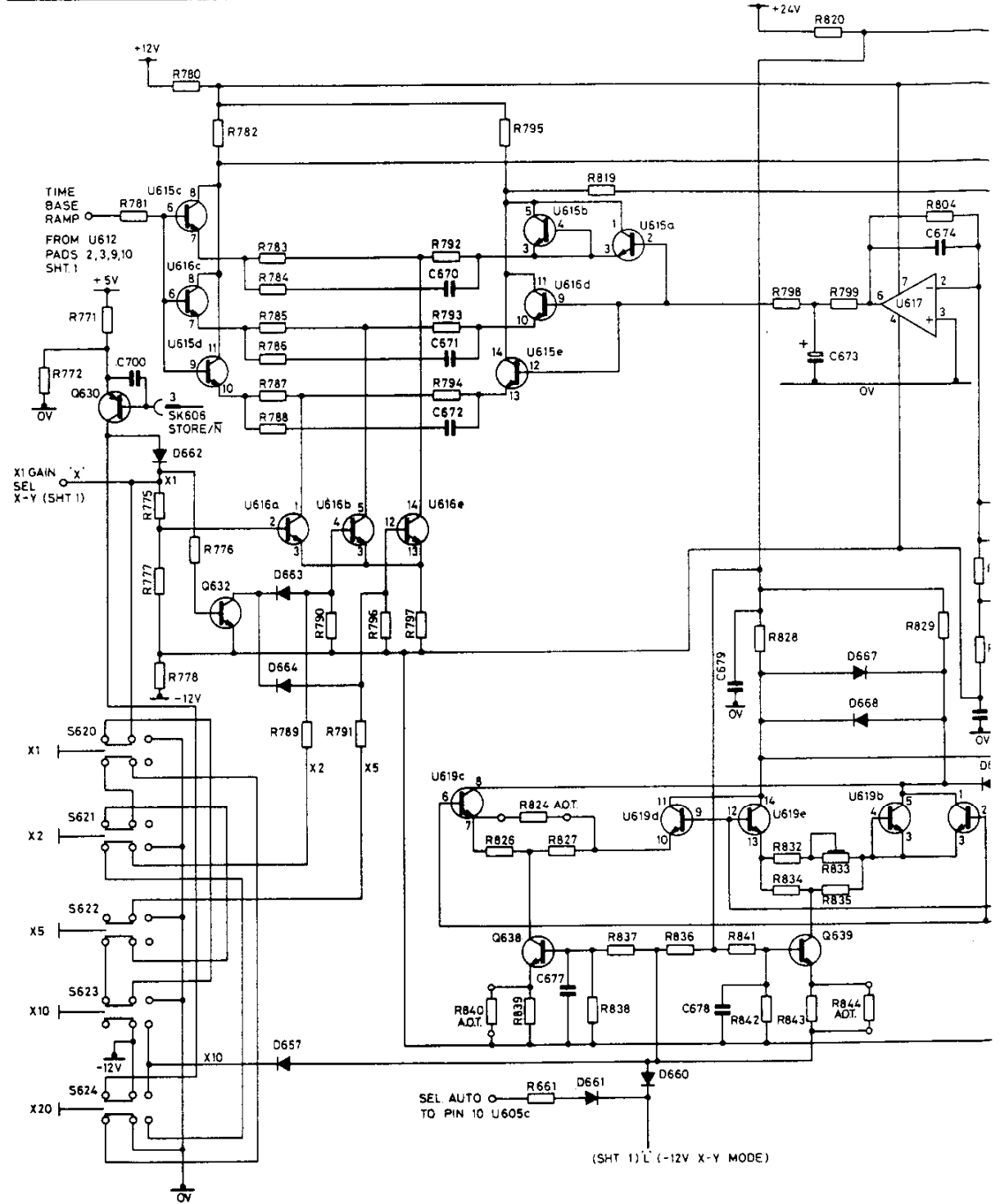
Section 6

4041 TIMEBASE (Cont.)

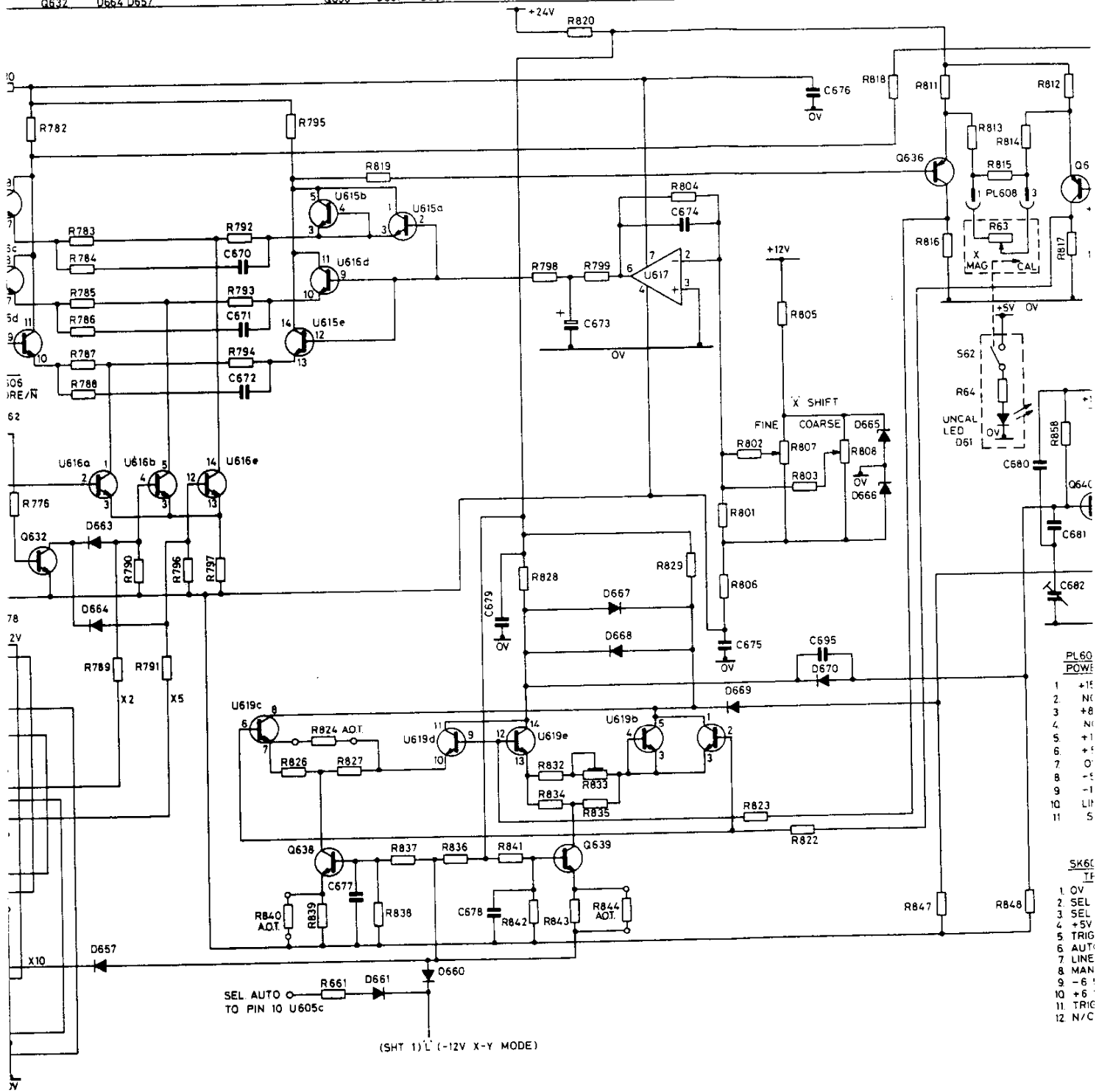
Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
DIODES (Cont.)											
U14	D643	IN4148			23802	D666	6V2	ZENER			33930 P16
U14	D644	IN4148			23802	D667		IN4149			1949 F13
U15	D645	IN4148			23802	D668		IN4149			1949 F14
U14	D646	IN4148			23802	D669		IN4149			1949 F13
Q6	D647	IN4148			23802	D670		IN4149			1949 F14
R9	D648	IN4148			23802	D671	4V7	ZENER			33927 B9
R9	D649	IN4148			23802	D672	6V8	ZENER			33931 E13
Q6	D650	IN4148			23802						
Q7	D651	IN4148			23802						
T4	D652	3V9 ZENER			33925	MISCELLANEOUS					
Q8	D653	IN4148			23802	S601-603					A3/44791
S4	D654	IN4148			23802	S604-608					A3/44797
U4	D655	IN4148			23802	S609-613					A3/44792
N6	D656	IN4148			23802						
M17	D657	IN4148			23802	S620-624					A3/44790
L4	D658	IN4148			23802	S626-629					A3/44799
L3	D659	IN4148			23802						
M16	D660	IN4148			23802	SK602					38001
AC14	D661	IN4148			23802						
AJ8	D662	IN4148			23802	SK606					38001
J9	D663	IN4148			23802	SK607					41393
F10	D664	IN4148			23802	SK608					41395
AF14	D665	6V2 ZENER			33930	SK609					402036

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	R780	R782	R783		R792	R795		R819		R798	R820	R799		R804
	R781	R775	R776	R784	R793	R794				R828				R829
	R771	R777		R785	R794					R832	R833			R8
	R772	R778		R786						R834	R835			R8
				R787						R842				
				R788	R789	R791				R844				
RESISTORS														
CAPACITORS	C700				C670	C671	C672		C677		C679	C678		C674
MISCELLANEOUS	Q630	U615c	U616c	U615d	U616b	U616e	U619c	U615b	U615d	U615a	U619d	U619e	Q639	D667
	D662	U616c	U615d	Q632	D663	D664	D657	U615b	U616d	Q638	D661	D660	U617	U619c



R780	R782	R783	R784	R785	R786	R787	R788	R789	R790	R791	R792	R793	R794	R795	R826	R824	R827	R838	R837	R836	R841	R832	R834	R833	R835	R842	R833	R844	R829	R801	R802	R807	R808	R803	R805	R823	R822	R818	R811	R813	R814	R815	R817	R858	R847	R848	C670	C671	C672	C677	C679	C678	C673	C674	C675	C676	C695	Q636	S62	C680	C682	Q637
U615c	U615d	U616a	U616b	U616e	U619c	U615b	U615d	U615e	U619a	U619d	U619e	Q639	D667	U619b	U619a	D669	D670	D665	D666	D61	S62	Q637																																								



PL60
POWER

1	+12V
2	N/C
3	+8V
4	N/C
5	+1V
6	+5V
7	0V
8	-5V
9	-1V
10	LIT
11	S

5K60
TUBE

1	0V
2	SEL
3	SEL
4	+5V
5	TRIG
6	AUT
7	LINE
8	MAN
9	-6V
10	+6V
11	TRIG
12	N/C

SEL AUTO TO PIN 10 U605c

(SHT 1) L (-12V X-Y MODE)

Component List and Illustrations

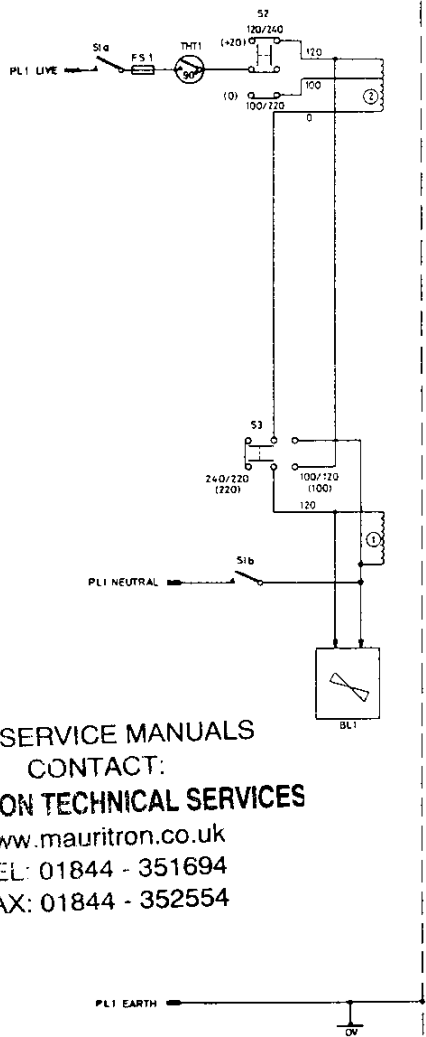
Section 6

4041 POWER SUPPLY

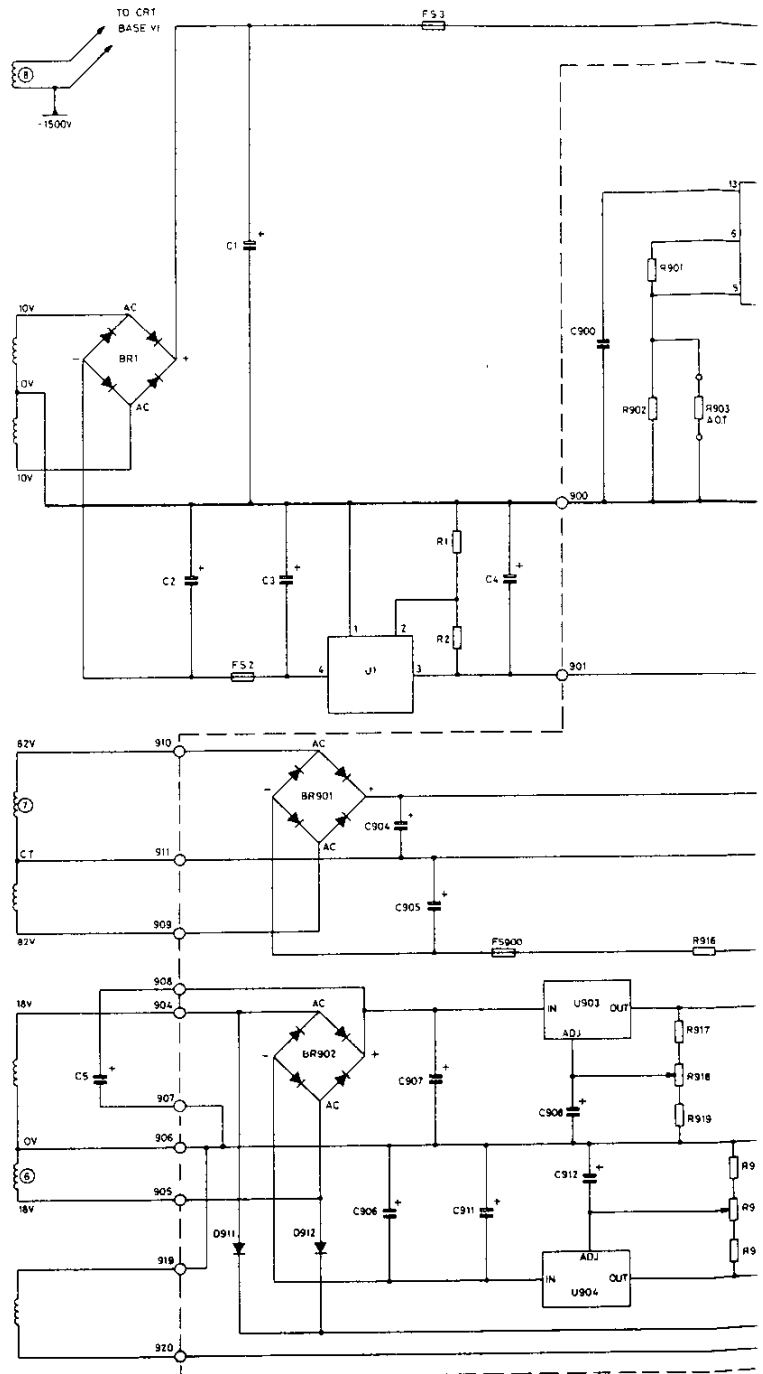
Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS											
R1	2k2	MF	2		38602	C909	1µF	T		35V	34895
R2	3k	MF	2		38605	C911	1µF	T		35V	34895
R900	470	CF			21797	C912	10µF	T		35V	35931
R901	2k	MF	2		38601	C913	1µF	T		35V	34895
R902	5k6	MF	2		38612	TRANSISTORS					
R903	47k	MF	2	A.O.T.	38634	Q1		2N6285			44836
R904	470	CF			21797	Q901		2N6504			44845
R905	10k	CF			21809	Q902		2N6400			44844
R906	1k	CF			21799	Q903		TIP30A			38415
R907	6k8	CF			21807	Q904		BC108			26110
R908	OR1	WW		6W	44897	INTEGRATED CIRCUITS					
R909	10	CF			21793	U1		uA79HG			44835
R911	2k7	MF	2		38604	U900		LM723			31651
R912	3k6	MF	2		38607	U901		MC3423P			43556
R913	10	CF			21793	U902		MC3423P			43556
R914	3k6	MF	2		38607	U903		LM317T			40731
R915	2k7	MF	2		38604	U904		LM337T			44842
R916	10	CF		½W	18526	DIODES					
R917	200	MF	2		38577	D901	6V8	ZENER			33931
R918	100	CP			36263	D902	33V	ZENER			33947
R919	2k	MF	2		38601	D911		IN4003			32771
R921	2k	MF	2		38601	D912		IN4003			32771
R922	100	CP			39263	MISCELLANEOUS					
R923	200	MF	2		38577	THT1		2455R-2-921			44900
R924	4k7	CF			21805	BR1		BY261-200			44832
R925	75k	MF	2	A.O.T.	38639	BR901		WO4			451795
R926	12k	MF	2		38620	BR902		VH148			36281
CAPACITORS											
C1	33000µF	E		16V	402029	T1					A/44829
C2	22000µF	T		16V	44833	BL1					44805
C3	1µF	T		35V	34895	S1					A4/36232
C4	1µF	T		35V	34895	S2					4069
C5	6800µF	E		25V A4/40766		S3					4069
C6	0.1µF	CE(2)		25V	36709	PL1					33787
C900	0.01µF	CE(2)		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						

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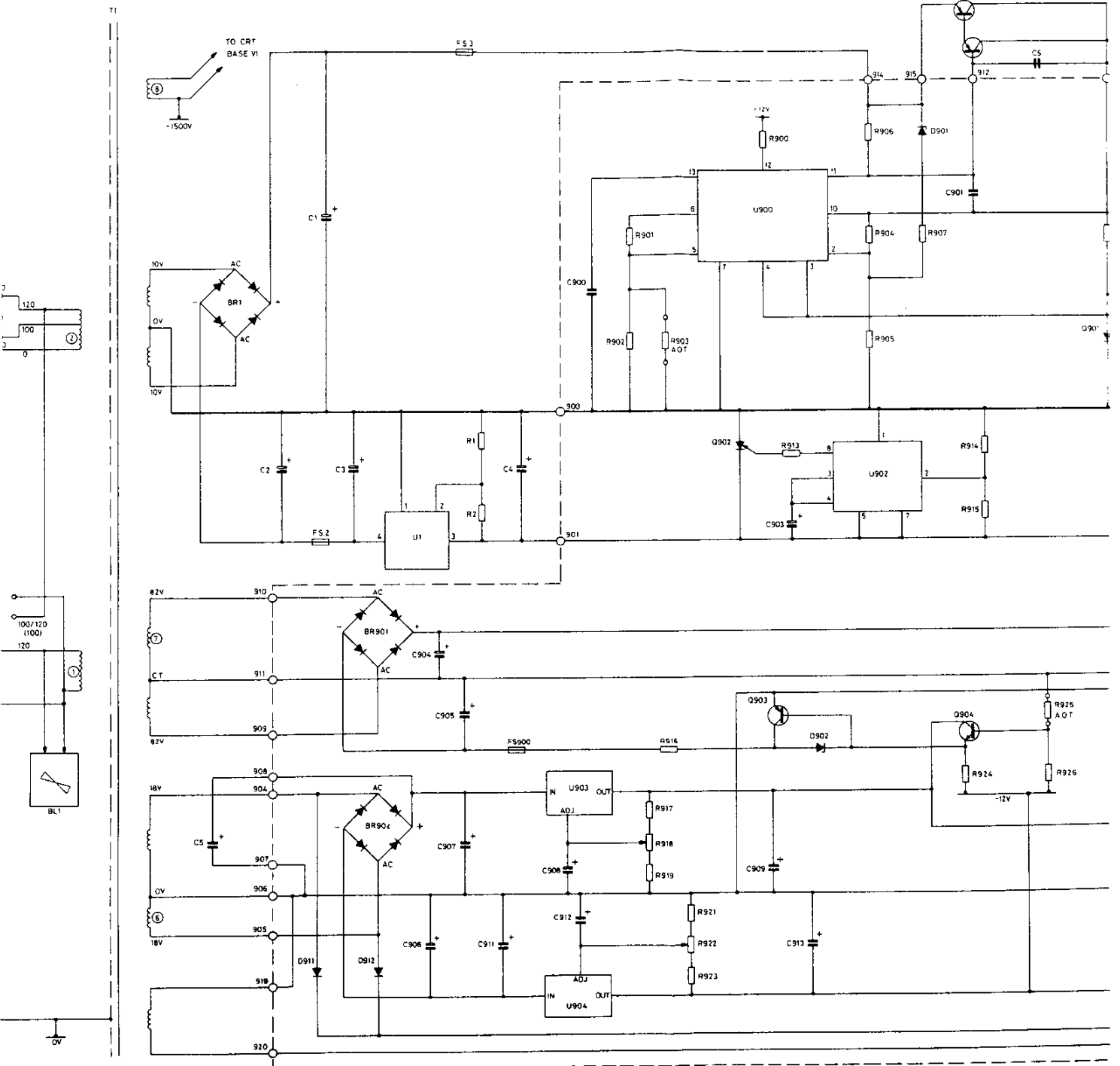
RESISTORS					R1	R2	R901	R902	R903	R904	R905	R906	R907	R908	R909	R910	R911	R912	R913	
CAPACITORS					C5	C2	C1	C3	C904	C905	C4	C900	C906	C907	C911	C908	C912			
MISCELLANEOUS					S2	S1	S3	BL1	T1	BR1	F52	D911	BR901	BR902	D912	U1	F53	F5900	U903	U904



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											R1	R901 R903 R916			R900		R906			R914			
											R2	R902 R917 R921			R913		R904 R905			R915 R924		R925 R926	
												R918 R922 R923											
C5	C2	C1	C3	C904	C905	C4	C900				C903						C901	C5					
				C906	C907		C911	C908	C912		C909	C913											
BL1	T1	BR1	FS2	BR901	BR902	U1	FS3	U903	U904	Q902	U900	Q903	Q902	U907	Q901	Q1	Q904	Q1					
											D911	D912	FS900										



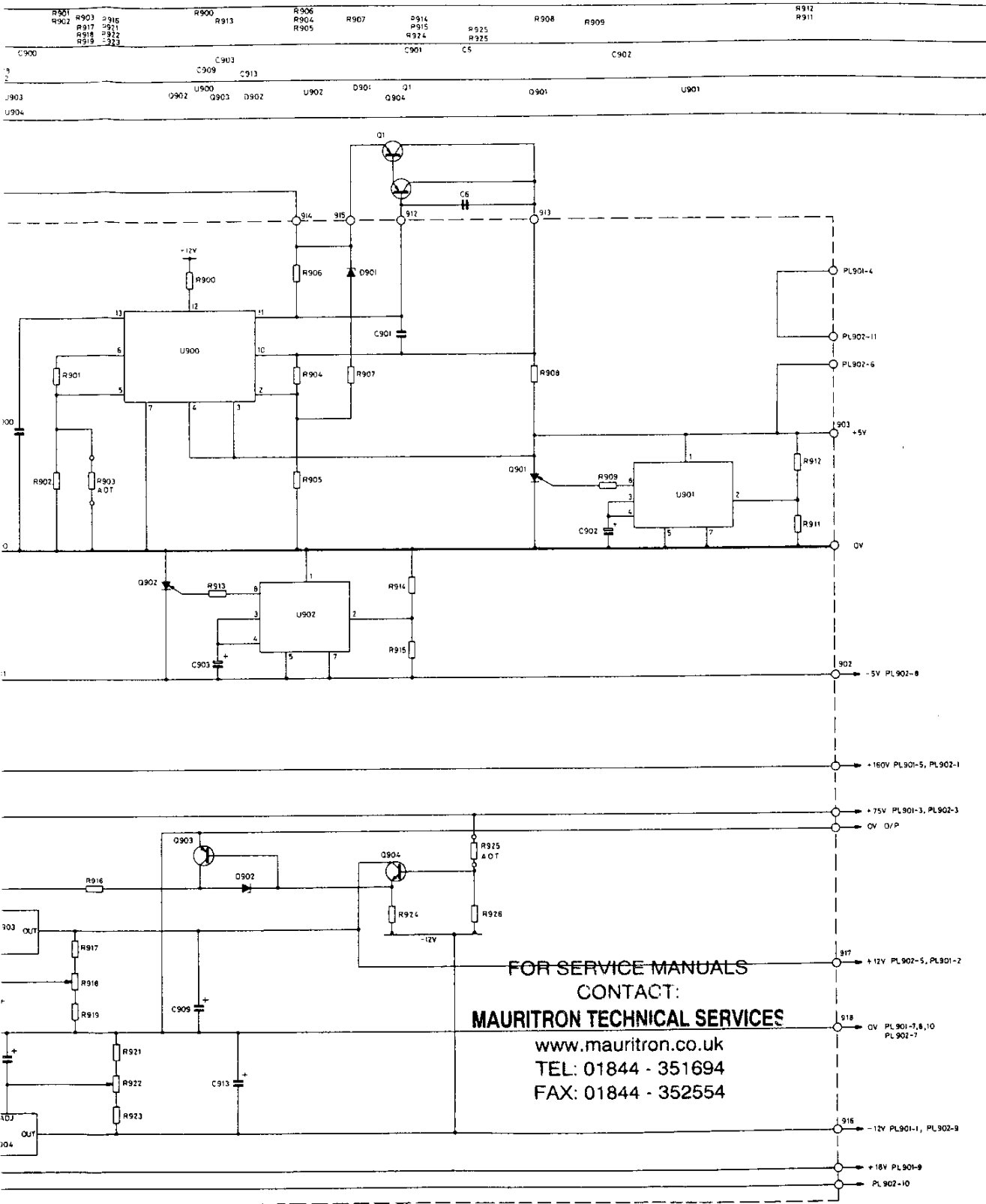


Fig. 6.6 Power Supply Circuit Diagram

Component List and Illustrations

Section 6

4041 STORE ASSY.

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS											
N1201	220 x 8	Resistor Network			44879	U1212		74LS163A			41086
N1202	330 x 8	Resistor Network			44880	U1213		74LS163A			41086
						U1214		74LS173			44396
R1209	1k	CF			21799	U1215		74LS173			44396
						U1216		74LS173			44396
R1211	1k	CF			21799	U1217		74LS173			44396
R1212	470	CF			21797	U1218		2114-1			450459
R1213	220	CF			21796	U1219		2114-1			450459
R1214	10k	CF			21809	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
INTEGRATED CIRCUITS											
U1201		2114-1			450459						
U1202		2114-1			450459						
U1203		2114-1			450459						
U1204		2114-1			450459						
U1205		2114-1			450459						
U1206		2114-1			450459						
U1207		2114-1			450459						
U1208		2114-1			450459						
U1209		74S00			34519						
U1210		74S00			33519						
U1211		74LS85			41081						

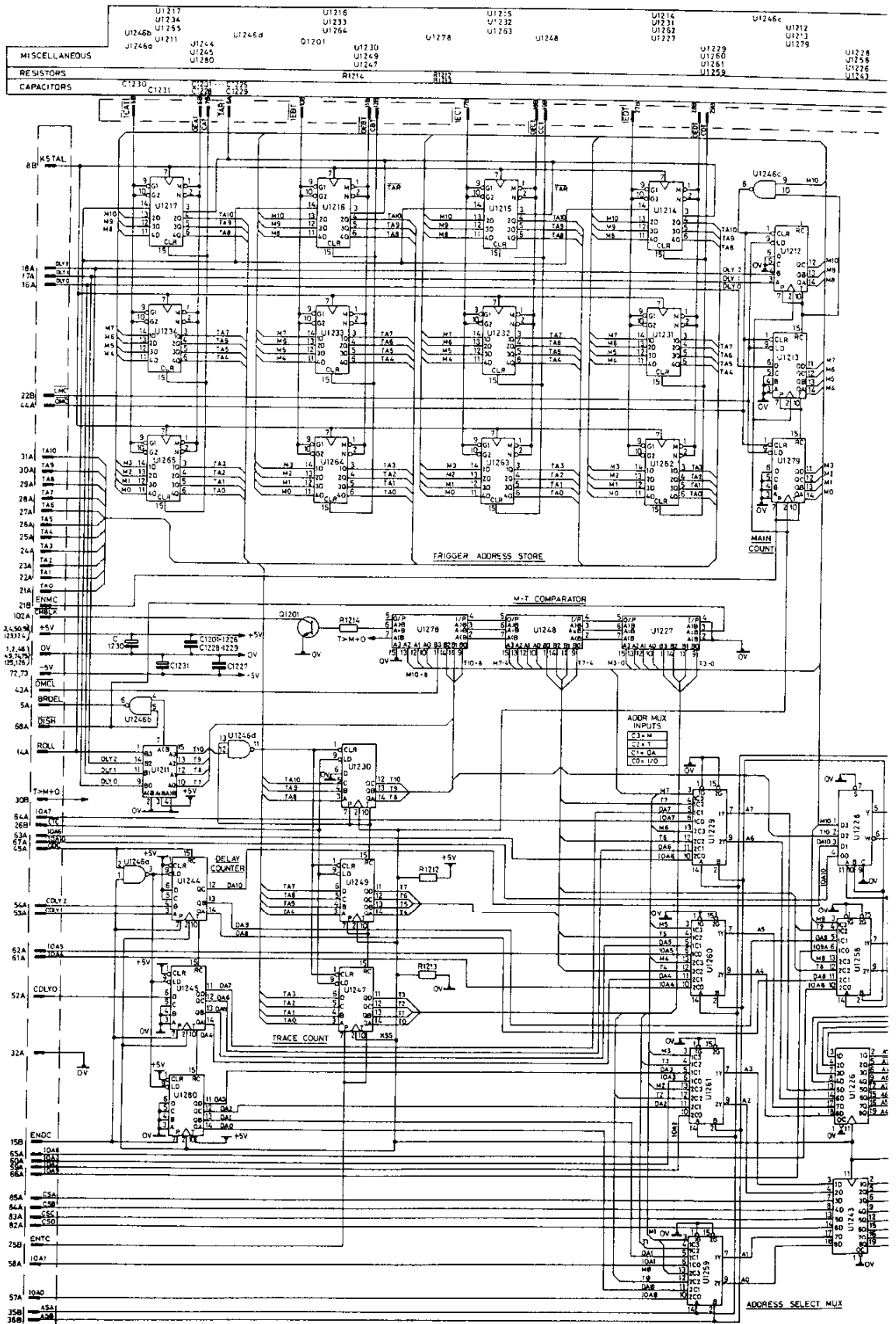
Component List and Illustrations

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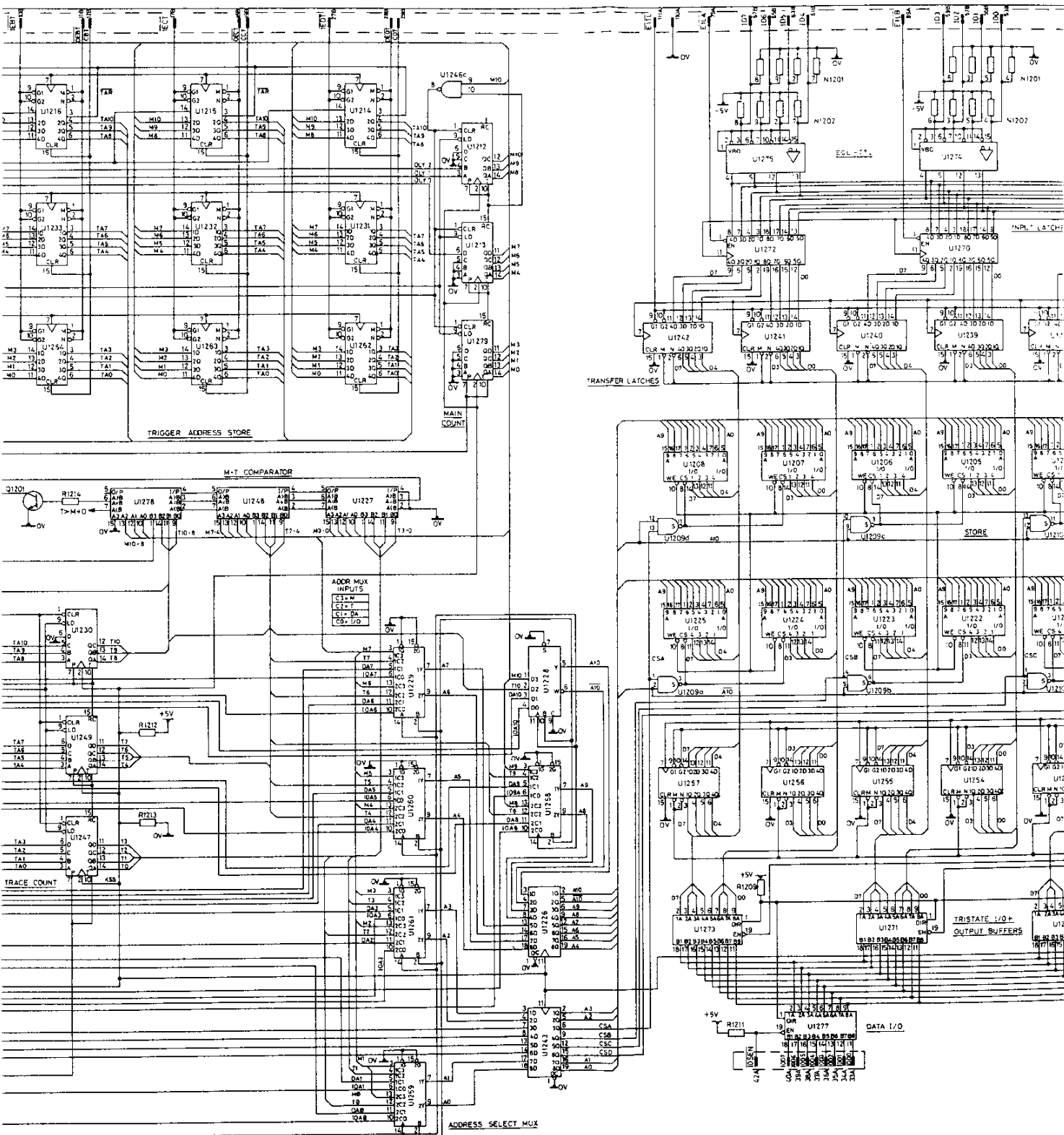
4041 STORE ASSY. (Cont.)

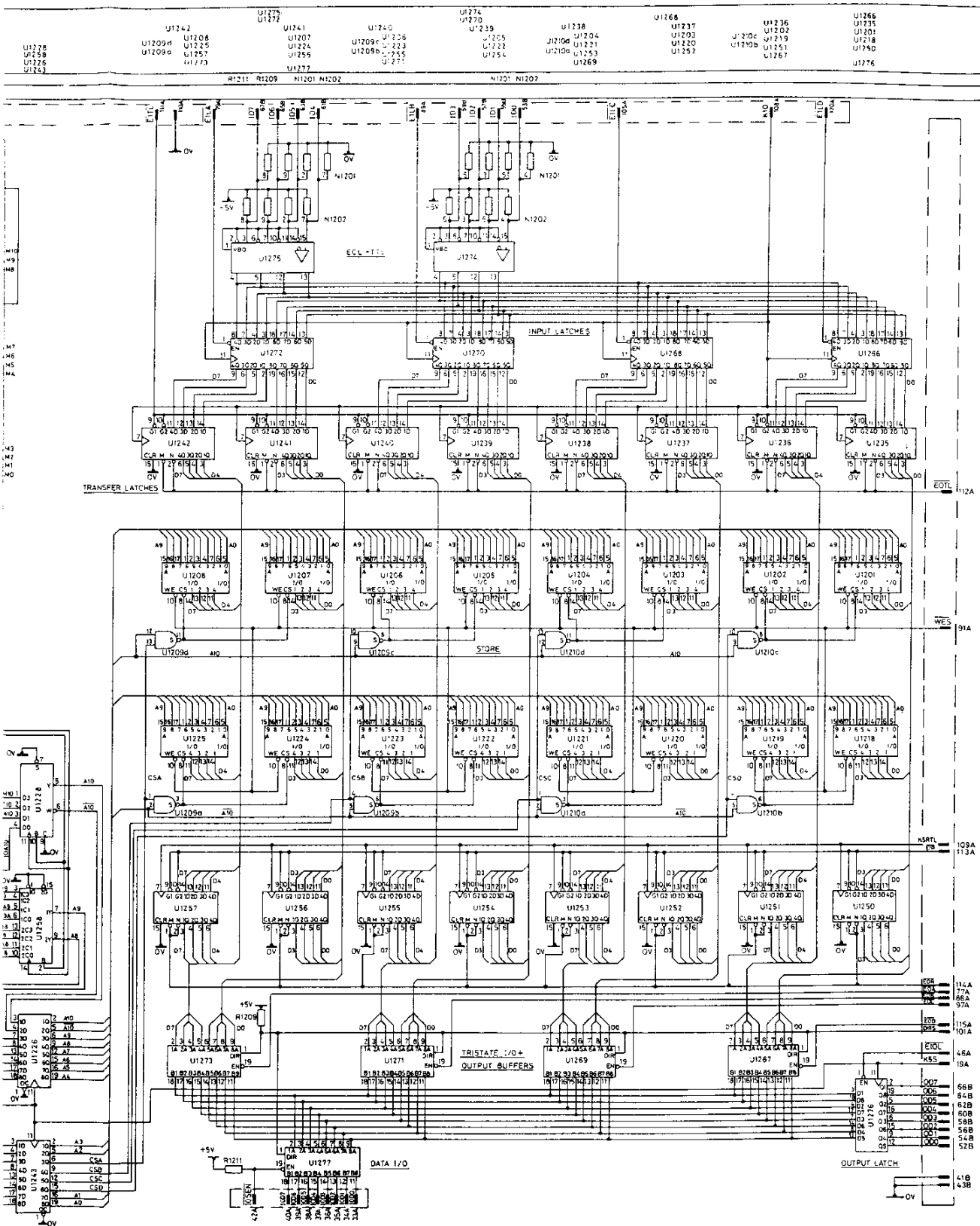
<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Tol %±</i>	<i>Rating</i>	<i>Part No</i>	<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Tol %±</i>	<i>Rating</i>	<i>Part No</i>
U1267		74LS245			44397	U1276		74LS377			42763
U1268		74LS377			42763	U1277		74LS245			44397
U1269		74LS245			44397	U1278		74LS85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

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U1216	U1215	U1214	U1246c	U1272	U1275	U1274	U1240	U1276	U1238
U1233	U1232	U1231	U1212	U1213	U1208	U1207	U1209c	U1209	U1205
U1264	U1263	U1262	U1211	U1210	U1205	U1204	U1209b	U1223	U1204
Q1201	U1230	U1278	U1248	U1227	U1229	U1228	U1209a	U1225	U1222
	U1249				U1256	U1255	U1257	U1256	U1254
	U1247				U1251	U1273	U1277	U1277	
					U1259				
R1214	R1211						R1211	R1209	N1201
							N1201	N1202	N1201
									N1201





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Fig. 6.7 Store Circuit Diagram

Component List and Illustrations

Section 6

4041 CONTROL P.C.B.

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

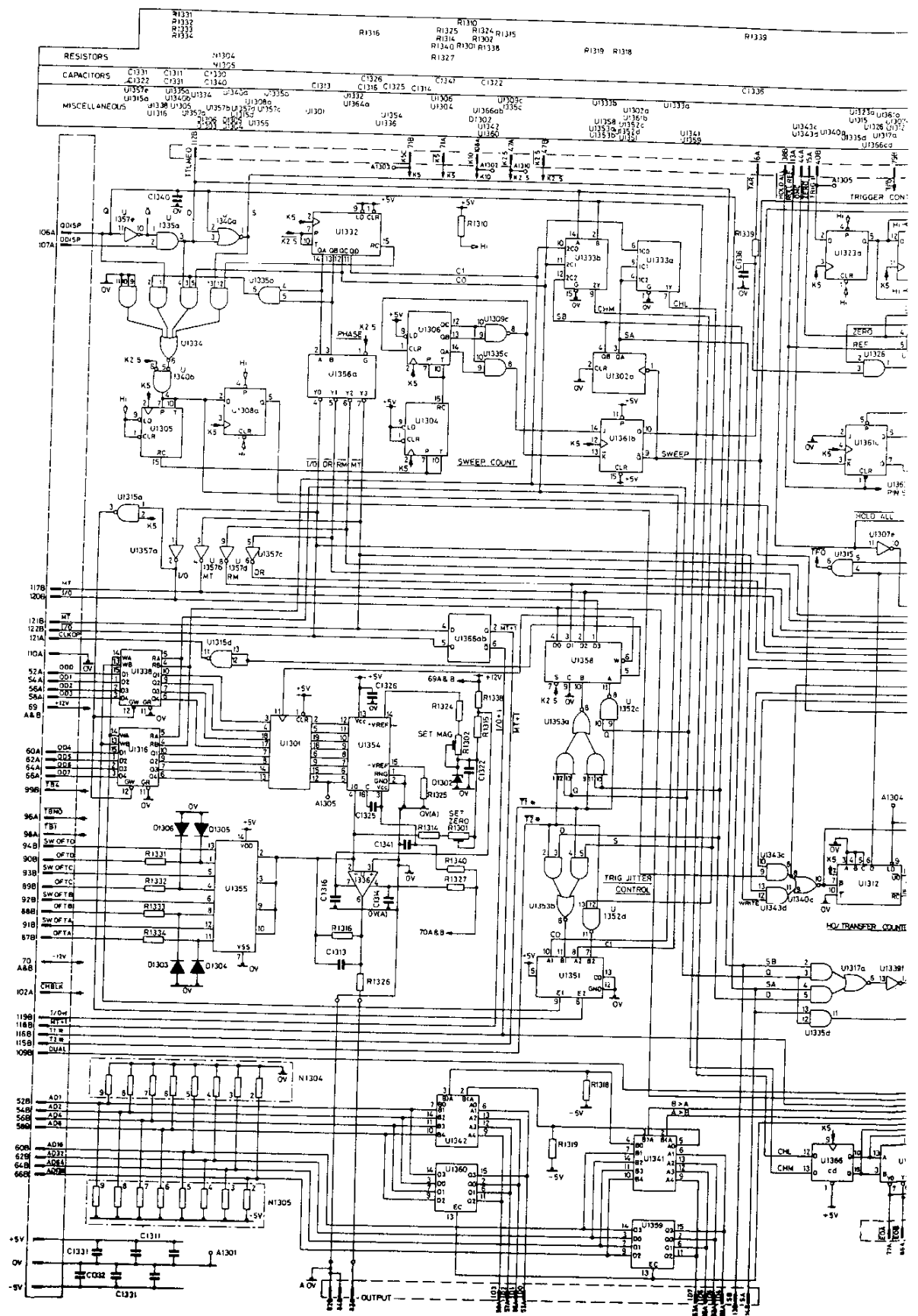
Component List and Illustrations

Section 6

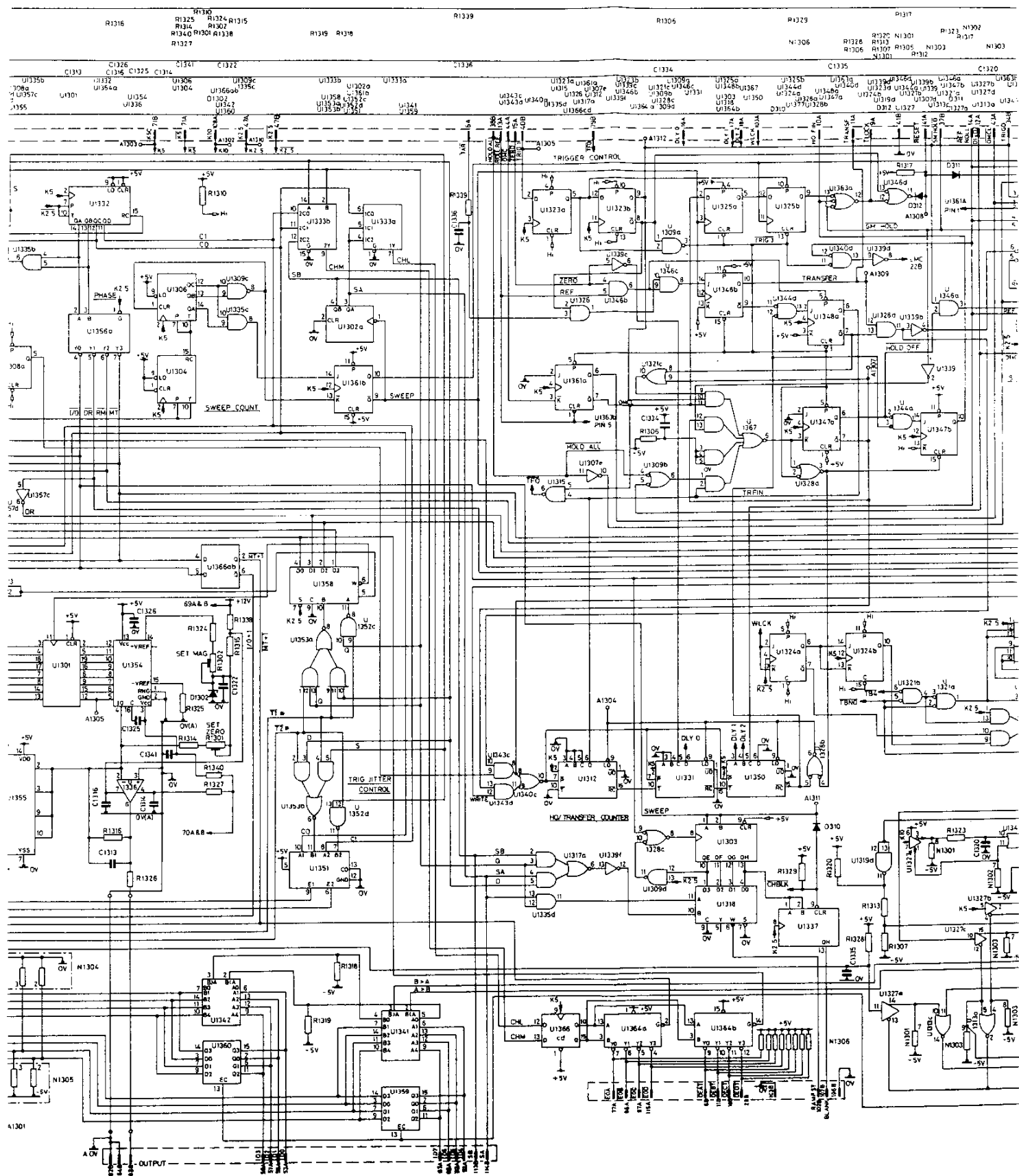
4041 CONTROL P.C.B. (Cont.)

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

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RESISTORS	CAPACITORS	MISCELLANEOUS
R1316, R1317, R1318, R1319, R1320, R1321, R1322, R1323, R1324, R1325, R1326, R1327, R1328, R1329, R1330, R1331, R1332, R1333, R1334, R1335, R1336, R1337, R1338, R1339, R1340, R1341, R1342, R1343, R1344, R1345, R1346, R1347, R1348, R1349, R1350, R1351, R1352, R1353, R1354, R1355, R1356, R1357, R1358, R1359, R1360, R1361, R1362, R1363, R1364, R1365, R1366, R1367, R1368, R1369, R1370, R1371, R1372, R1373, R1374, R1375, R1376, R1377, R1378, R1379, R1380, R1381, R1382, R1383, R1384, R1385, R1386, R1387, R1388, R1389, R1390, R1391, R1392, R1393, R1394, R1395, R1396, R1397, R1398, R1399, R1400, R1401, R1402, R1403, R1404, R1405, R1406, R1407, R1408, R1409, R1410, R1411, R1412, R1413, R1414, R1415, R1416, R1417, R1418, R1419, R1420, R1421, R1422, R1423, R1424, R1425, R1426, R1427, R1428, R1429, R1430, R1431, R1432, R1433, R1434, R1435, R1436, R1437, R1438, R1439, R1440, R1441, R1442, R1443, R1444, R1445, R1446, R1447, R1448, R1449, R1450, R1451, R1452, R1453, R1454, R1455, R1456, R1457, R1458, R1459, R1460, R1461, R1462, R1463, R1464, R1465, R1466, R1467, R1468, R1469, R1470, R1471, R1472, R1473, R1474, R1475, R1476, R1477, R1478, R1479, R1480, R1481, R1482, R1483, R1484, R1485, R1486, R1487, R1488, R1489, R1490, R1491, R1492, R1493, R1494, R1495, R1496, R1497, R1498, R1499, R1500	C1304, C1305, C1306, C1307, C1308, C1309, C1310, C1311, C1312, C1313, C1314, C1315, C1316, C1317, C1318, C1319, C1320, C1321, C1322, C1323, C1324, C1325, C1326, C1327, C1328, C1329, C1330, C1331, C1332, C1333, C1334, C1335, C1336, C1337, C1338, C1339, C1340, C1341, C1342, C1343, C1344, C1345, C1346, C1347, C1348, C1349, C1350, C1351, C1352, C1353, C1354, C1355, C1356, C1357, C1358, C1359, C1360, C1361, C1362, C1363, C1364, C1365, C1366, C1367, C1368, C1369, C1370, C1371, C1372, C1373, C1374, C1375, C1376, C1377, C1378, C1379, C1380, C1381, C1382, C1383, C1384, C1385, C1386, C1387, C1388, C1389, C1390, C1391, C1392, C1393, C1394, C1395, C1396, C1397, C1398, C1399, C1400, C1401, C1402, C1403, C1404, C1405, C1406, C1407, C1408, C1409, C1410, C1411, C1412, C1413, C1414, C1415, C1416, C1417, C1418, C1419, C1420, C1421, C1422, C1423, C1424, C1425, C1426, C1427, C1428, C1429, C1430, C1431, C1432, C1433, C1434, C1435, C1436, C1437, C1438, C1439, C1440, C1441, C1442, C1443, C1444, C1445, C1446, C1447, C1448, C1449, C1450, C1451, C1452, C1453, C1454, C1455, C1456, C1457, C1458, C1459, C1460, C1461, C1462, C1463, C1464, C1465, C1466, C1467, C1468, C1469, C1470, C1471, C1472, C1473, C1474, C1475, C1476, C1477, C1478, C1479, C1480, C1481, C1482, C1483, C1484, C1485, C1486, C1487, C1488, C1489, C1490, C1491, C1492, C1493, C1494, C1495, C1496, C1497, C1498, C1499, C1500	U1300, U1301, U1302, U1303, U1304, U1305, U1306, U1307, U1308, U1309, U1310, U1311, U1312, U1313, U1314, U1315, U1316, U1317, U1318, U1319, U1320, U1321, U1322, U1323, U1324, U1325, U1326, U1327, U1328, U1329, U1330, U1331, U1332, U1333, U1334, U1335, U1336, U1337, U1338, U1339, U1340, U1341, U1342, U1343, U1344, U1345, U1346, U1347, U1348, U1349, U1350, U1351, U1352, U1353, U1354, U1355, U1356, U1357, U1358, U1359, U1360, U1361, U1362, U1363, U1364, U1365, U1366, U1367, U1368, U1369, U1370, U1371, U1372, U1373, U1374, U1375, U1376, U1377, U1378, U1379, U1380, U1381, U1382, U1383, U1384, U1385, U1386, U1387, U1388, U1389, U1390, U1391, U1392, U1393, U1394, U1395, U1396, U1397, U1398, U1399, U1400, U1401, U1402, U1403, U1404, U1405, U1406, U1407, U1408, U1409, U1410, U1411, U1412, U1413, U1414, U1415, U1416, U1417, U1418, U1419, U1420, U1421, U1422, U1423, U1424, U1425, U1426, U1427, U1428, U1429, U1430, U1431, U1432, U1433, U1434, U1435, U1436, U1437, U1438, U1439, U1440, U1441, U1442, U1443, U1444, U1445, U1446, U1447, U1448, U1449, U1450, U1451, U1452, U1453, U1454, U1455, U1456, U1457, U1458, U1459, U1460, U1461, U1462, U1463, U1464, U1465, U1466, U1467, U1468, U1469, U1470, U1471, U1472, U1473, U1474, U1475, U1476, U1477, U1478, U1479, U1480, U1481, U1482, U1483, U1484, U1485, U1486, U1487, U1488, U1489, U1490, U1491, U1492, U1493, U1494, U1495, U1496, U1497, U1498, U1499, U1500



Component List and Illustrations

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4041 INTERFACE

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS											
R1401	22k	CF			21812	C1415	.01μF	CE(3)			42444
R1402	390	CF			28722	C1416	0.1μF	CE(3)			43498
R1403	1k	CF			21799	C1417	.01μF	CE(3)			42444
R1404	2k2	CF			21802	C1418	.01μF	CE(3)			42444
R1405	6k8	CF			21807	C1419	.01μF	CE(3)			42444
R1406	2k2	CF			21802	C1420	.01μF	CE(3)			42444
R1407	180	CF			21795	C1421	.01μF	CE(3)			42444
R1408	1k	CF			21799	C1422	.01μF	CE(3)			42444
R1409	100k	CF			21819	C1423	.01μF	CE(3)			42444
R1410	100k	CF			21819	C1424	.01μF	CE(3)			42444
R1411	1k	CF			21799	C1425	.01μF	CE(3)			42444
R1412	220k	CF			21823	C1426	.01μF	CE(3)			42444
R1413	100k	CF			21819	C1427	.01μF	CE(3)			42444
R1414	100k	CF			21819	C1428	.01μF	CE(3)			42444
R1415	1k	CF			21799	C1429	.01μF	CE(3)			42444
R1416	1k	CF			21799	C1430	.01μF	CE(3)			42444
R1417	1k	CF			21799	C1431	.01μF	CE(3)			42444
R1418	1k	CF			21799	C1432	.01μF	CE(3)			42444
R1419	47	CF			28714	C1433	150μF	E	6V3		32163
R1420	1k	CF			21799	C1434	.01μF	CE(3)			42444
R1421	1k	CF			21799	C1435	.01μF	CE(3)			42444
R1422	1k	CF			21799	C1436	.01μF	CE(3)			42444
R1423	390	CF			28722	C1437	.01μF	CE(3)			42444
R1424	390	CF			28722	C1438	.01μF	CE(3)			42444
R1425	39k	CF			28728	C1439	150μF	E	6V3		32163
R1426	3k3	CF			21803	C1440	.01μF	CE(3)			42444
R1427	1k	CF			21799	C1441	.01μF	CE(3)			42444
R1428	1M	CF			31840	C1442	.01μF	CE(3)			42444
R1429	47k	CF			21815	C1443	150μF	E	6V3		32163
R1430	47k	CF			21815	C1444	.01μF	CE(3)			42444
R1431	1k	CF			21799	C1445	.01μF	CE(3)			42444
R1432	2k2	CF			21802	C1446	10μF	T	35V		35931
R1433	120k	CF			21820	C1447	0.01μF	CE(3)			42444
R1434	470	CF			44222	C1448	.01μF	CE(3)			42444
R1435	1k	CF			21799	C1449	.047μF	CE(3)			43497
						C1450	.047μF	CE(3)			43497
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						
DIODES											
						D1401	6V2	ZENER			33930
						D1402	6V2	ZENER			33930
						D1403		BAT81			452036
						D1404		BAT81			452036
						D1405		IN4148			23802
						D1408		BAT81			452036
						D1450		BAT81			452036
						D1451		BAT81			452036
INTEGRATED CIRCUITS											
						U1401		74LS125			44390
						U1402		74LS04			36731
						U1403		74LS112			36468
						U1404		74LS00			36730
						U1405		74LS04			36731
						U1406		74LS02			41075
						U1407		74LS08			36467
						U1408		74LS125			44390

Component List and Illustrations

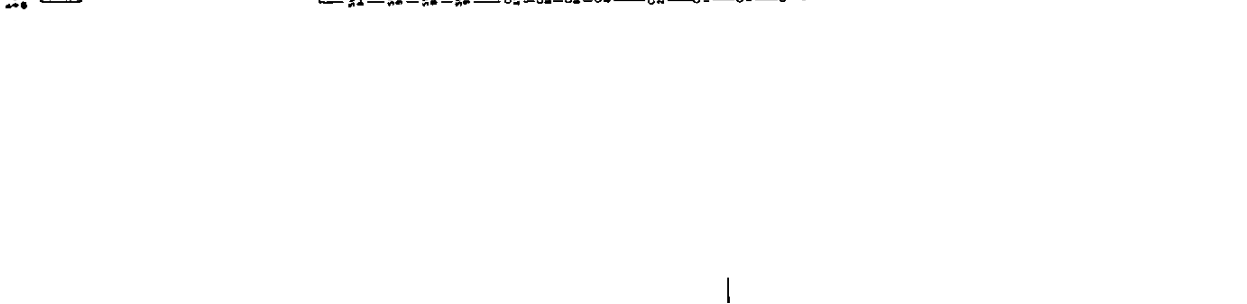
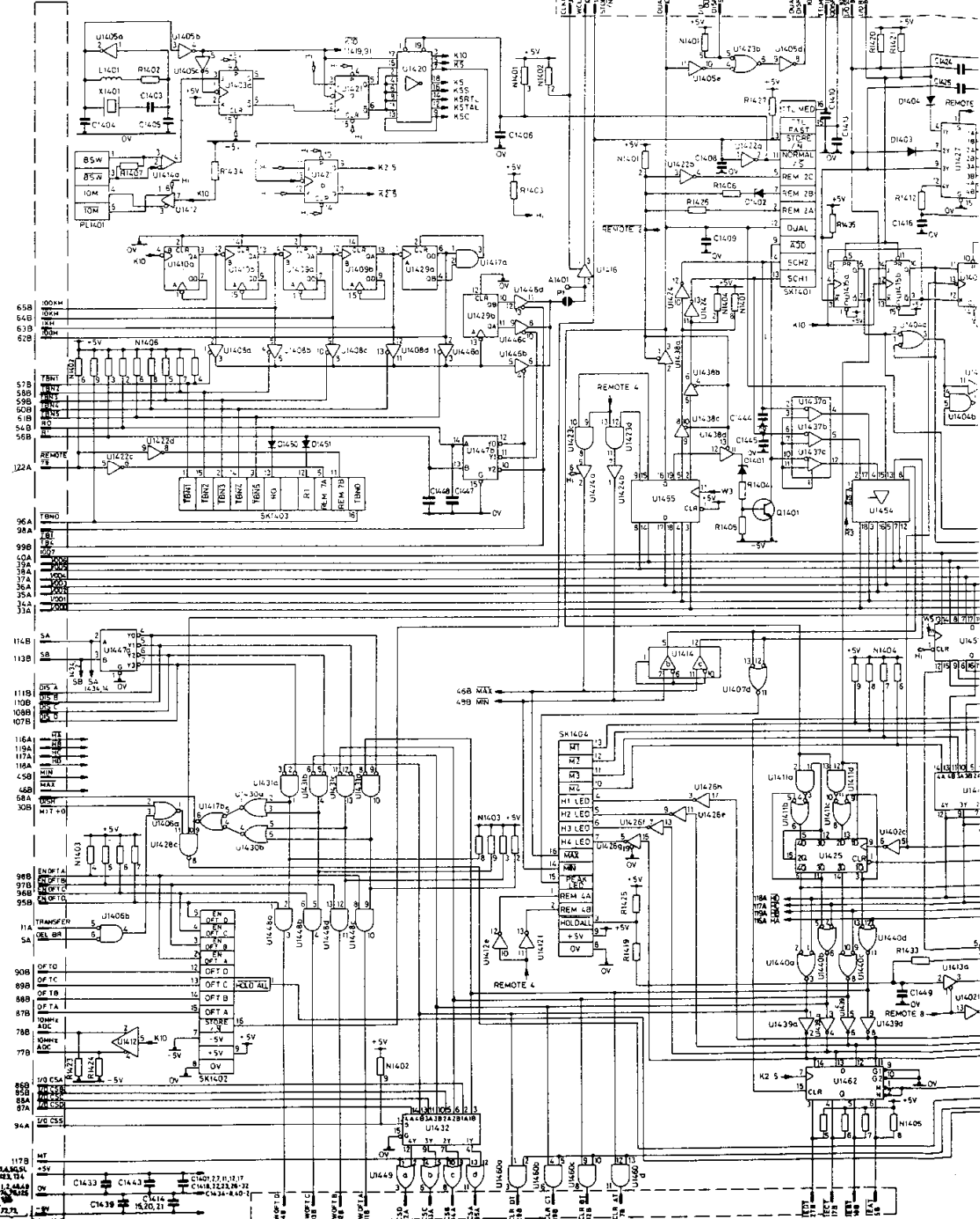
Section 6

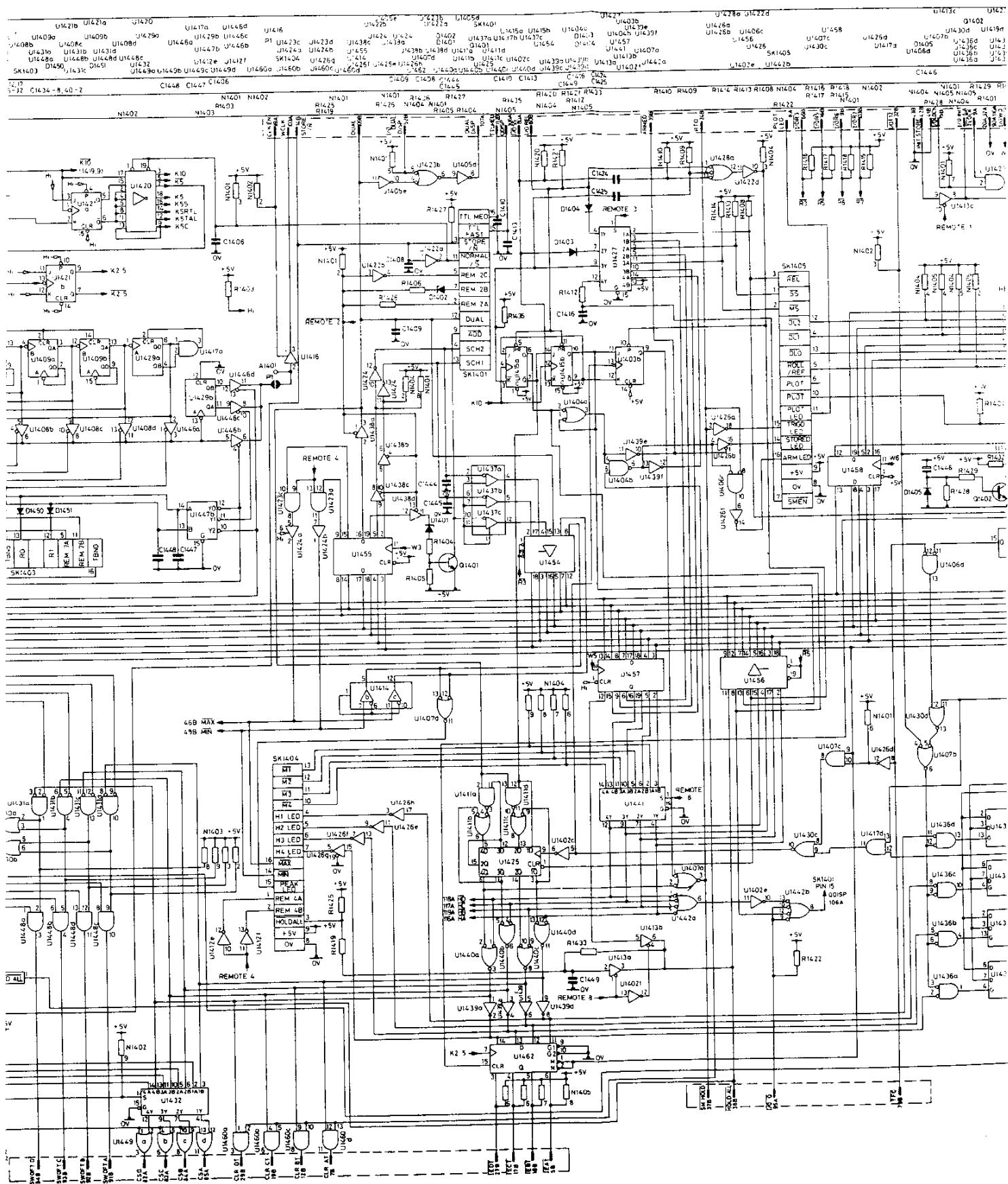
4041 INTERFACE (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
INTEGRATED CIRCUITS (Cont.)											
U1409		74LS390			43675	U1444		74LS379			44399
U1410		74LS390			43675	U1445		74LS85			41081
U1411		74LS00			36730	U1446		74LS125			44390
U1412		MC10124			44366	U1447		74LS139			44392
U1413		74LS125			44390	U1448		CD4081B			37694
U1414		MC10125			39245	U1449		74LS32			41080
U1415		74LS109			41082	U1450		74LS298			44377
U1416		74LS126			44391	U1451					
U1417		74LS08			36467	U1452		74LS244			43384
U1418		74LS75			44389	U1453		74LS273			41089
U1419		74LS175			36728	U1454		74LS244			43384
U1420		74S240			42794	U1455		74LS273			41089
U1421		74LS112			33447	U1456		74LS244			43384
U1422		74LS05			36879	U1457		74LS273			41089
U1423		74LS08			36467	U1458		74LS273			41089
U1424		MC10124			44366	U1459		74LS244			43384
U1425		74LS175			36728	U1460		74LS08			36467
U1426		74LS240			43382	U1461		74LS83			43671
U1427		74LS157			36735	U1462		74LS173			44396
U1428		74LS10			36867						
U1429		74LS393			41090						
U1430		74LS02			41075	MISCELLANEOUS					
U1431		74LS02			41075	Q1401		2N3904			24146
U1432		74LS157			36735	Q1402		2N3904			24146
U1433		74LS75			44389	Q1403		2N3904			24146
U1434		74LS153			36247						
U1435		74LS75			44389	SK1401					38001
U1436		74LS02			41075	SK1402					38001
U1437		MC10125			39245	SK1403					38001
U1438		74LS125			44390	SK1404					38001
U1439		74LS04			36731	SK1405					38001
U1440		74LS08			36467						
U1441		74LS157			36735	L1401	4.7µH				37560
U1442		74LS20			39236						
U1443		74LS157			36735	X1401		Crystal 10MHz			44893

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MISCELLANEOUS	U1401	U1402	U1403	U1404	U1405	U1406	U1407	U1408	U1409	U1410	U1411	U1412	U1413	U1414	U1415	U1416	U1417	U1418	U1419	U1420	U1421	U1422	U1423	U1424	U1425	U1426	U1427	U1428	U1429	U1430	U1431	U1432	U1433	U1434	U1435	U1436	U1437	U1438	U1439	U1440	U1441	U1442	U1443	U1444	U1445	U1446	U1447	U1448	U1449	U1450	U1451	U1452	U1453	U1454	U1455	U1456	U1457	U1458	U1459	U1460	U1461	U1462	U1463	U1464	U1465	U1466	U1467	U1468	U1469	U1470	U1471	U1472	U1473	U1474	U1475	U1476	U1477	U1478	U1479	U1480	U1481	U1482	U1483	U1484	U1485	U1486	U1487	U1488	U1489	U1490	U1491	U1492	U1493	U1494	U1495	U1496	U1497	U1498	U1499	U1500
CAPACITORS	C1404	C1405	C1406	C1407	C1408	C1409	C1410	C1411	C1412	C1413	C1414	C1415	C1416	C1417	C1418	C1419	C1420	C1421	C1422	C1423	C1424	C1425	C1426	C1427	C1428	C1429	C1430	C1431	C1432	C1433	C1434	C1435	C1436	C1437	C1438	C1439	C1440	C1441	C1442	C1443	C1444	C1445	C1446	C1447	C1448	C1449	C1450	C1451	C1452	C1453	C1454	C1455	C1456	C1457	C1458	C1459	C1460	C1461	C1462	C1463	C1464	C1465	C1466	C1467	C1468	C1469	C1470	C1471	C1472	C1473	C1474	C1475	C1476	C1477	C1478	C1479	C1480	C1481	C1482	C1483	C1484	C1485	C1486	C1487	C1488	C1489	C1490	C1491	C1492	C1493	C1494	C1495	C1496	C1497	C1498	C1499	C1500			
RESISTORS	R1401	R1402	R1403	R1404	R1405	R1406	R1407	R1408	R1409	R1410	R1411	R1412	R1413	R1414	R1415	R1416	R1417	R1418	R1419	R1420	R1421	R1422	R1423	R1424	R1425	R1426	R1427	R1428	R1429	R1430	R1431	R1432	R1433	R1434	R1435	R1436	R1437	R1438	R1439	R1440	R1441	R1442	R1443	R1444	R1445	R1446	R1447	R1448	R1449	R1450	R1451	R1452	R1453	R1454	R1455	R1456	R1457	R1458	R1459	R1460	R1461	R1462	R1463	R1464	R1465	R1466	R1467	R1468	R1469	R1470	R1471	R1472	R1473	R1474	R1475	R1476	R1477	R1478	R1479	R1480	R1481	R1482	R1483	R1484	R1485	R1486	R1487	R1488	R1489	R1490	R1491	R1492	R1493	R1494	R1495	R1496	R1497	R1498	R1499	R1500





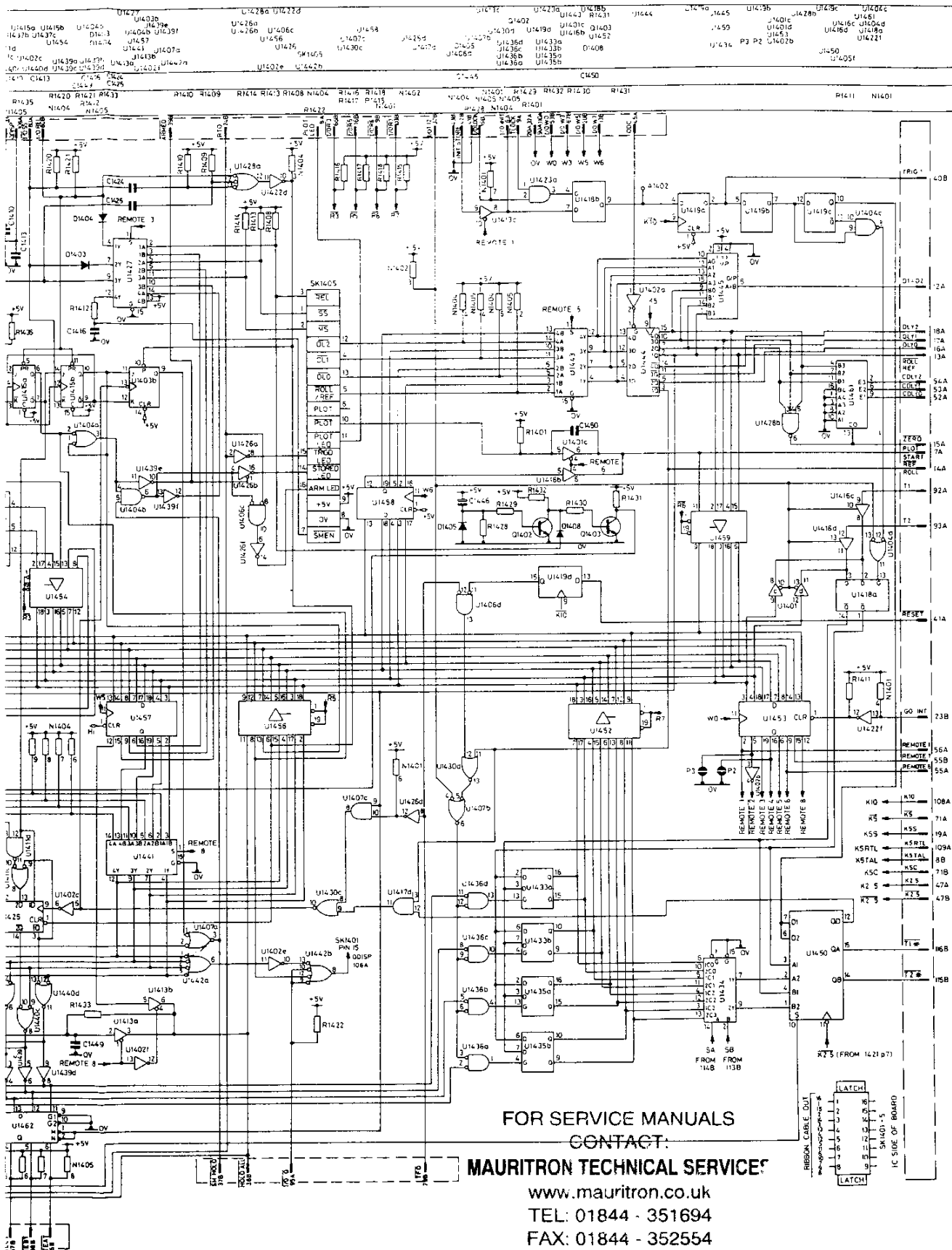


Fig. 6.9 Interface Circuit Diagram

Component List and Illustrations

Section 6

4041 A-D CONVERTOR

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
RESISTORS											
R1501	220	CF			21796	R1557	22	CF			28710
R1502	3k3	CF			21803	R1558	100	CF			21794
R1503	3k3	CF			21803	R1559	47	CF			28714
R1504	22	CF			28710	R1560	10	CF			21793
R1505	910	MF	2		38593	R1561	150	CF			28719
R1506	910	MF	2		38593	R1562	18	CF			28709
R1507	47	CF			28714	R1563	150	CF			28719
R1508	560	CF			21798	N1501	560x8	Resistor Network			39258
R1509	10	CF			21793	CAPACITORS					
R1510	1k8	CF			28725	C1501	10nF	CE(3)			42444
R1511	10	CF			21793	C1502	10nF	CE(3)			42444
R1512	22	CF			28710	C1503	10nF	CE(3)			42444
R1513	22	CF			28710	C1504	10nF	CE(3)			42444
R1514	130	MF	2		38573	C1505	5.6µF	CE(3)			42405
R1515	33	CF			28712	C1506	10nF	CE(3)			42444
R1516	1k	CF			21799	C1507	10nF	CE(3)			42444
R1517	10	CF			21993	C1508	10nF	CE(3)			42444
R1518	22	CF			28710	C1508	10nF	CE(3)			42444
R1519	330	CF			28721	C1509	10nF	CE(3)			42444
R1520	10	CF			21793	C1510	47µF	E		16V	32173
R1521	1k2	CF			21800	C1511	47µF	E		16V	32173
R1523	2k	PCP			40178	C1512	47µF	E		16V	32173
R1524	2k2	CF			21802	C1513	100nF	CE(3)			43498
R1525	9k1	MF	2		38617	C1514	100nF	CE(3)			43498
R1526	10k	MF	2		38618	C1515	100nF	CE(3)			43498
R1527	2k	PCP			40178	C1516	100nF	CE(3)			43498
R1528	1k	MF	2		38594	C1517	100nF	CE(3)			43498
R1529	10k	MF	2		38618	C1518	100nF	CE(3)			43498
R1530	10	CF			21793	C1519	100nF	CE(3)			43498
R1531	10	CF			21793	C1520	100nF	CE(3)			43498
R1532	150	CF			28719	C1521	100nF	CE(3)			43498
R1533	330	CF			28721	C1522	100nF	CE(3)			43498
R1534	500	PCP			39262	C1523	100nF	CE(3)			43498
R1535	2k2	MF	2		38602	C1524	120pF	CE(3)			42421
R1536	2k2	MF	2		38602	C1525	100nF	CE(3)			43498
R1538	330	CF			28721	C1526	10nF	CE(3)			42444
R1539	390	CF			28722	C1527	10µF	CE(3)			42408
R1540	390	CF			28722	C1528	22pF	CE(3)			42412
R1541	560	CF			21798	C1529	6.5/65pF	Trimmer			36091
R1542	560	CF			21798	C1530	10nF	CE(3)			42444
R1543	270	CF			28720	C1531	10nF	CE(3)			42444
R1544	100	CF			21794	C1533	10nF	CE(3)			42444
R1545	100	CF			21794	C1534	10nF	CE(3)			42444
R1546	270	CF			28720	C1535	68pF	CE(3)			42418
R1547	1k2	CF			21800	C1536	68pF	CE(3)			42418
R1548	5k	CP			42156	DIODES					
R1550	510	MF	2		38587	D1501		IN4148			23802
R1551	510	MF	2		38587	D1502		IN4148			23802
R1552	510	MF	2		38587	D1503		IN4148			23802
R1553	93k	CF	A.O.T.		21814	D1504	5V6	ZENER			33929
R1554	100k	CF	A.O.T.		21819	D1505	6V2	ZENER	IN813		40045
R1555	1k	CF			21799						
R1556	1k	CF			21799						

Appendix

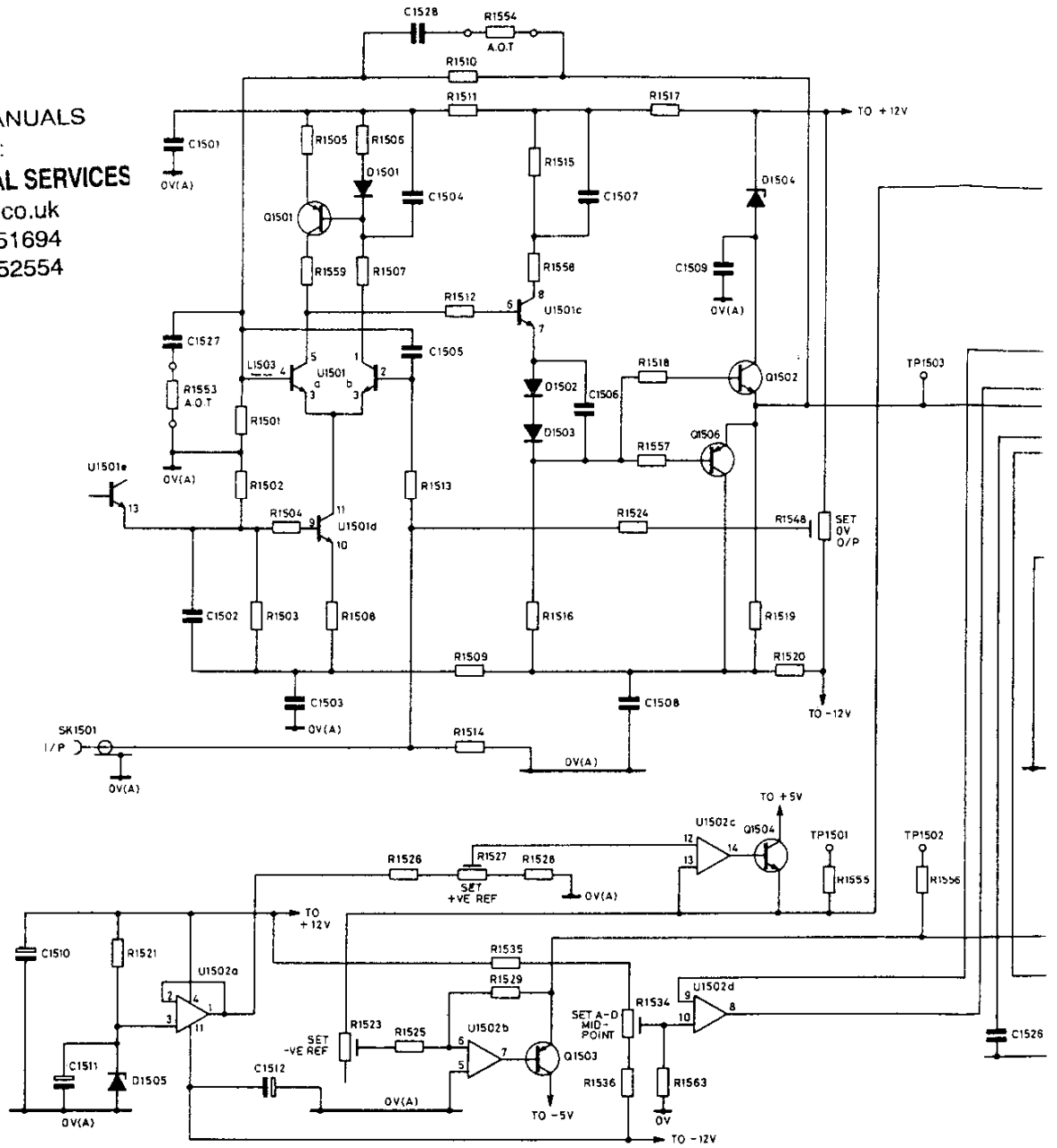
4041 A—D CONVERTOR (Cont.)

<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Tol %±</i>	<i>Rating</i>	<i>Part No</i>	<i>Ref</i>	<i>Value</i>	<i>Description</i>	<i>Tol %±</i>	<i>Rating</i>	<i>Part No</i>
TRANSISTORS											
Q1501		2N3640			31781	U1501		SL3145C			43980
Q1502		2N2369			23307	U1502		LF347			450908
Q1503		2N3906			21533	U1503		10315			451781
Q1504		2N3904			24146	U1504		10317			451782
Q1505		2N3906			21533	U1505		10116			39244
Q1506		2N5771			38089	U1506		10133			44367
						U1507		10133			44367
INTEGRATED CIRCUITS											
L1501	4μH	Choke			37560	MISCELLANEOUS					
L1502	4μH	Choke			37560	SK1501					36106
L1503		Ferrite Bead			29686						

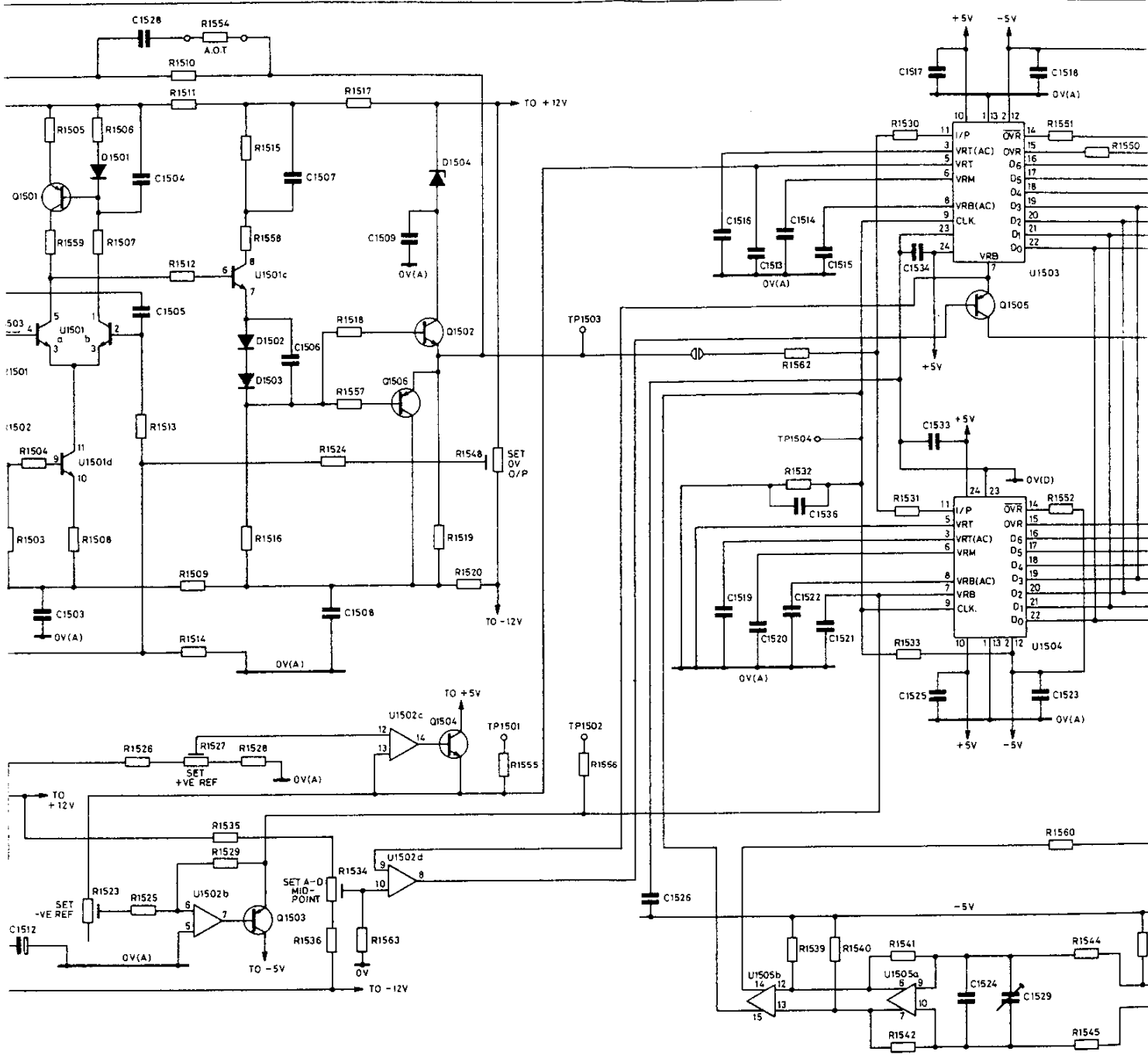
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RES.	R1553	R1501 R1502 R1503	R1504	R1559	R1507 R1508	R1513	R1510 R1511 R1512 R1509 R1514	R1554	R1515 R1508 R1506	R1517 R1518 R1557 R1524	R1519 R1520	R1548	
	R1521				R1523	R1526 R1527 R1525	R1535 R1529	R1528		R1534 R1536	R1563	R1555	R1556
CAPS.	C1510	C1511	C1501 C1527 C1502	C1503 C1512		C1528 C1504 C1505			C1507 C1508	C1508	C1509		C1527
MISC.		U1501+ SK1501	D1505	U1502a	L1503	Q1501 U1501a, b, d			D1502 D1503	U1502b U1502c, d	Q1506	D1504 Q1502 Q1504	

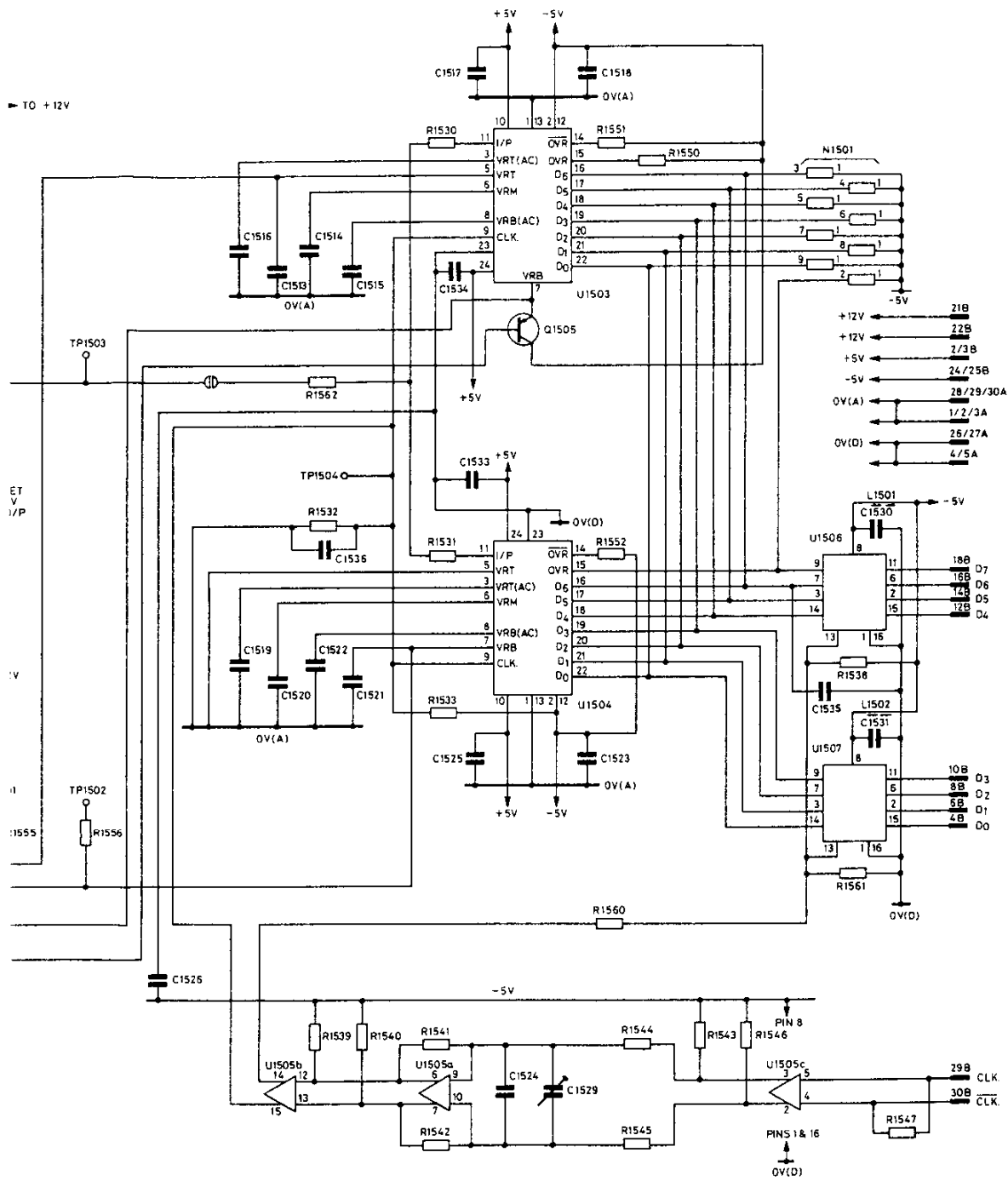
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R1504	R1505	R1506	R1507	R1508	R1510	R1511	R1512	R1514	R1515	R1516	R1517	R1518	R1519	R1520	R1548	R1555	R1556	R1562	R1532	R1530	R1531	R1533	R1551	R1552	R1550	
	R1523	R1526	R1527	R1525	R1528	R1529	R1535	R1524	R1536	R1534	R1537	R1538	R1539	R1540	R1541	R1542	R1543	R1544	R1545	R1546	R1547	R1548	R1549	R1550	R1551	R1552
C1503	C1512	C1528	C1504	C1505	C1507	C1506	C1508	C1509	C1507	C1506	C1509	C1526	C1516	C1513	C1514	C1515	C1536	C1517	C1534	C1525	C1533	C1524	C1529	C1518	C1523	
Q1501	D1501	D1502	D1503	D1504	U1502b	U1502c	U1503	U1502c.d	U1502c.d	U1504	U1502	Q1506	Q1502	Q1504	U1505b	U1505a	Q1505	U1503	U1504	U1503	U1504	U1503	U1504	U1503	U1504	U1503



	R1562 R1532	R1530 R1531 R1533	R1551 R1552	R1550	N1501 R1538 R1561							
R1556	R1539	R1540	R1541 R1542	R1560 R1544 R1545	R1543	R1546	R1547					
C1526	C1516 C1519	C1513 C1520	C1514 C1522	C1515 C1521	C1536	C1517 C1525	C1534 C1533	C1524	C1529	C1518 C1523	C1535	C1530 C1531
	U1505b	U1505a	Q1505	U1503 U1504	U1505c	U1506	L1501	U1507	L1502			



A.D.C. Circuit Diagram

Component List and Illustrations

Section 6

4041 TUBE SUPPLIES, BRIGHT UP & EHT

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

* (Fitted with Mullard Tube)

Component List and Illustrations

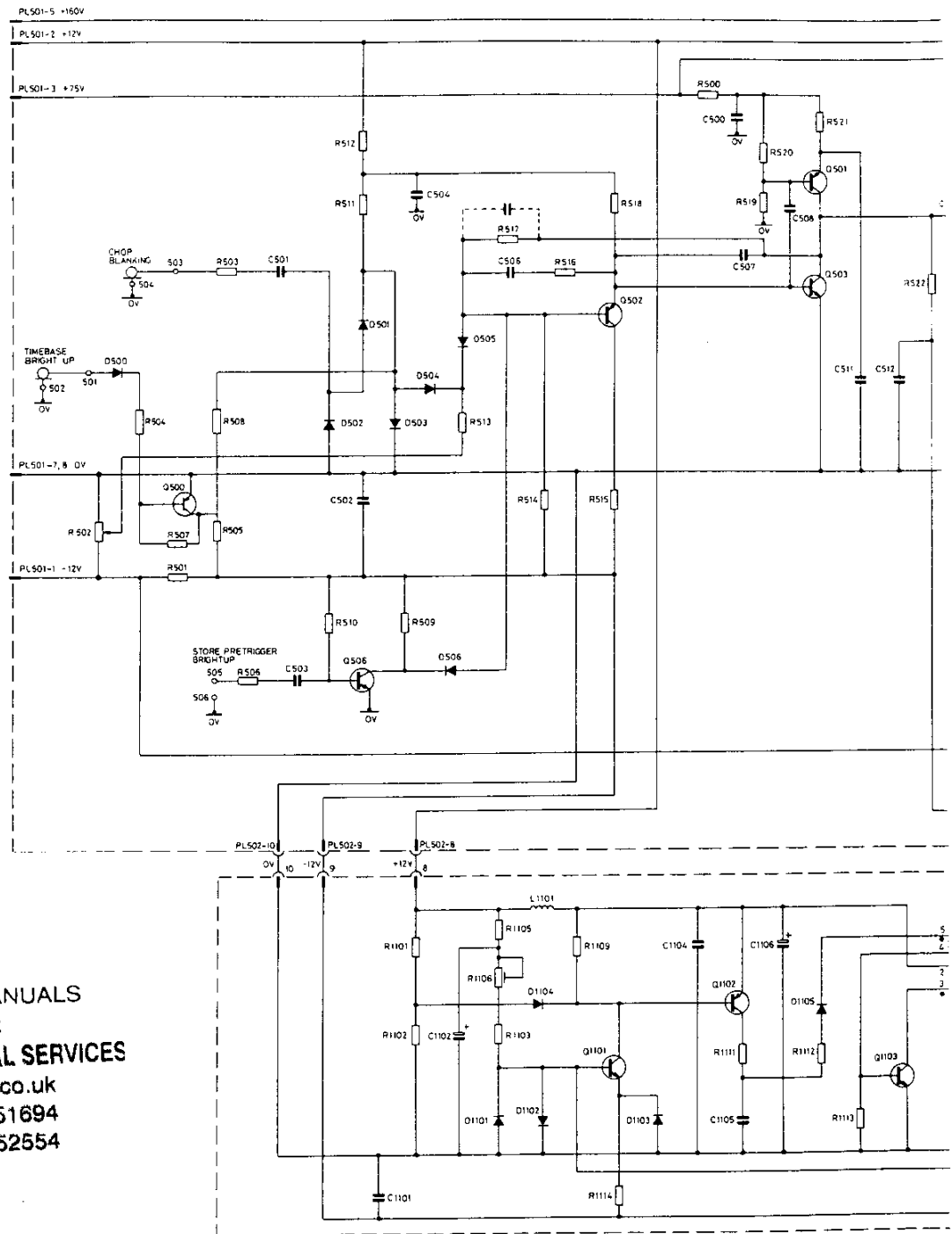
Section 6

4041 TUBE SUPPLIES, BRIGHT UP & EHT (Cont.)

Ref	Value	Description	Tol %±	Rating	Part No	Ref	Value	Description	Tol %±	Rating	Part No
DIODES											
D500		IN4148			23802	D1107		BY409			42356
D501		IN4148			23802	D1108		BY409			42356
D502		IN4148			23802	D1109		IN4148			23802
D503		IN4148			23802						
D504		IN4148			23802	D1111		BY409			42356
D505		IN4148			23802	D1112		BY409			42356
D506		IN4148			23802						
D507	6V2	ZENER			33930	D1114		IN5271			37557
D508	47V	ZENER			40049						
MISCELLANEOUS											
D511		IN4148			23802	T1101					A2/452238
D1101		IN4148			23802	L1101	150µH				35826
D1102		IN4148			23802	MPR1		Multiplier x6			A2/452246
D1103		IN4148			23802	PL504					41394
D1104		IN4148			23802	PL505					41391
D1105		IN4148			23802	PL506					41391

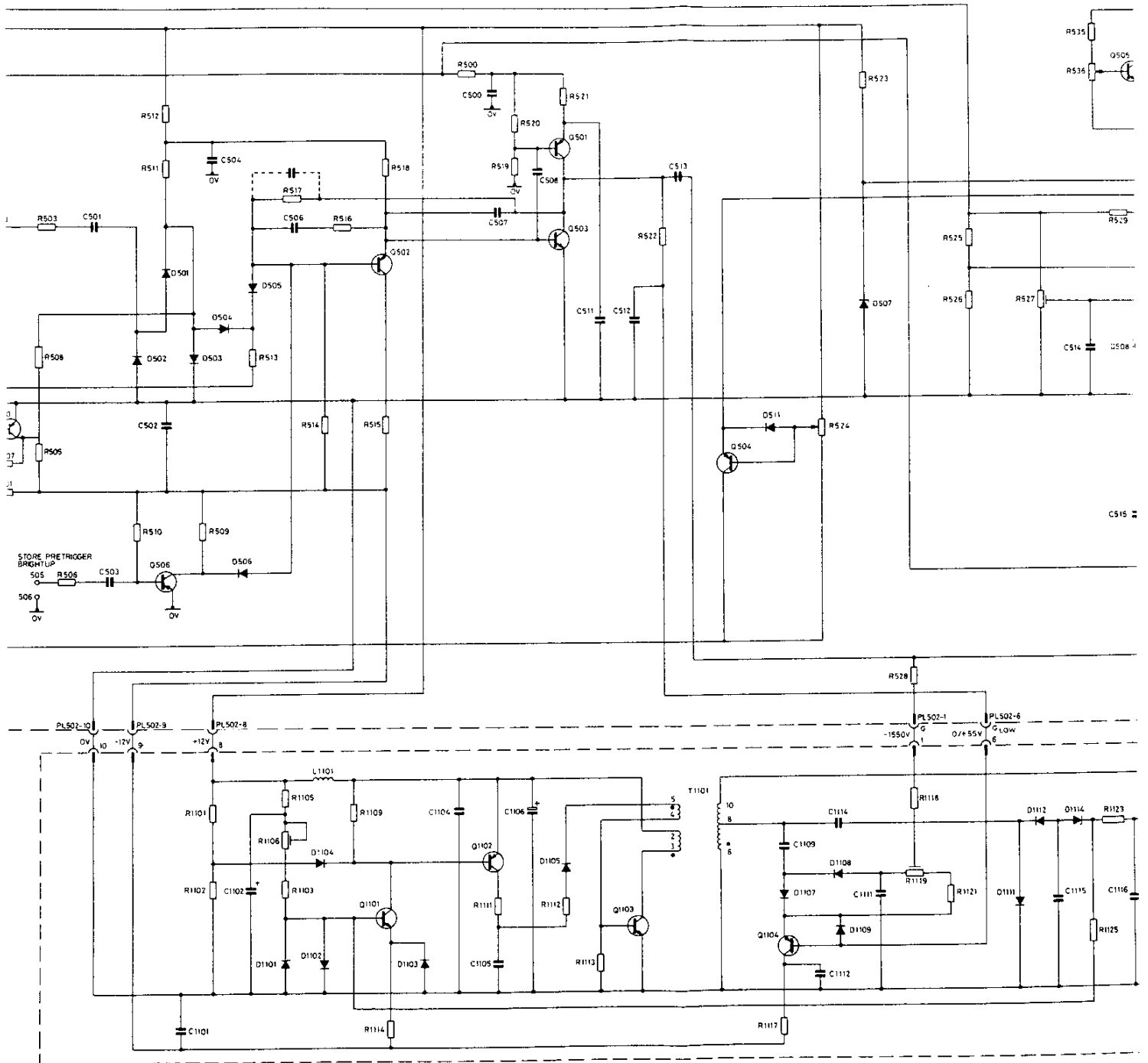
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	R501	R512	R517	R518	R500	R520	R521	
	R504	R511	R513	R515	R507	R519	R511	R512
RESISTORS	R502	R501	R509	R514	R506	R511	R512	R513
	R504	R507	R508	R505	R506	R509	R514	R515
CAPACITORS	C501	C502	C504	C506	C508	C508	C511	C512
	C503	C502	C504	C506	C508	C508	C511	C512
MISCELLANEOUS	D500	D500	D500	D502	D501	D504	D505	D506
	D500	D500	D500	D502	D501	D504	D505	D506
	D500	D500	D500	D502	D501	D504	D505	D506
	D500	D500	D500	D502	D501	D504	D505	D506



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R503	R512	R517	R518	R506	R520	R521	R523	R525	R535
R507 R508 R505	R510	R509	R516	R519	R518	R521	R524	R528	R536
R506	R511	R1101 R1102	R1105 R1106 R1103	R1109 R1114	P1111 C500 C501 C505	R1112 R1113	R1117	R1118 R1119	R1123
C501	C502	C1101	C504	C506	C508	C511	C512	C513	C514
C503	C507	C1107	C1102	C1104	C1105	C1109	C1112	C1114	C1115
D500	D502	D501	D504	D505	D1101	D1104	D1107	D1108	D1111
D506	D503	D506	D1102	D1103	Q101	Q102	Q103	Q104	Q105
Q505	Q506	Q503	Q1101	Q1103	Q1107	Q1105	Q1103	Q1101	Q1105
			L1101	L1104	L1107	L1105	TR1101	TR1101	TR1101
			D1101	D1102	D1107	D1105	Q1103	Q1101	Q1105
			D1101	D1102	D1107	D1105	Q1103	Q1101	Q1105
			D1101	D1102	D1107	D1105	Q1103	Q1101	Q1105



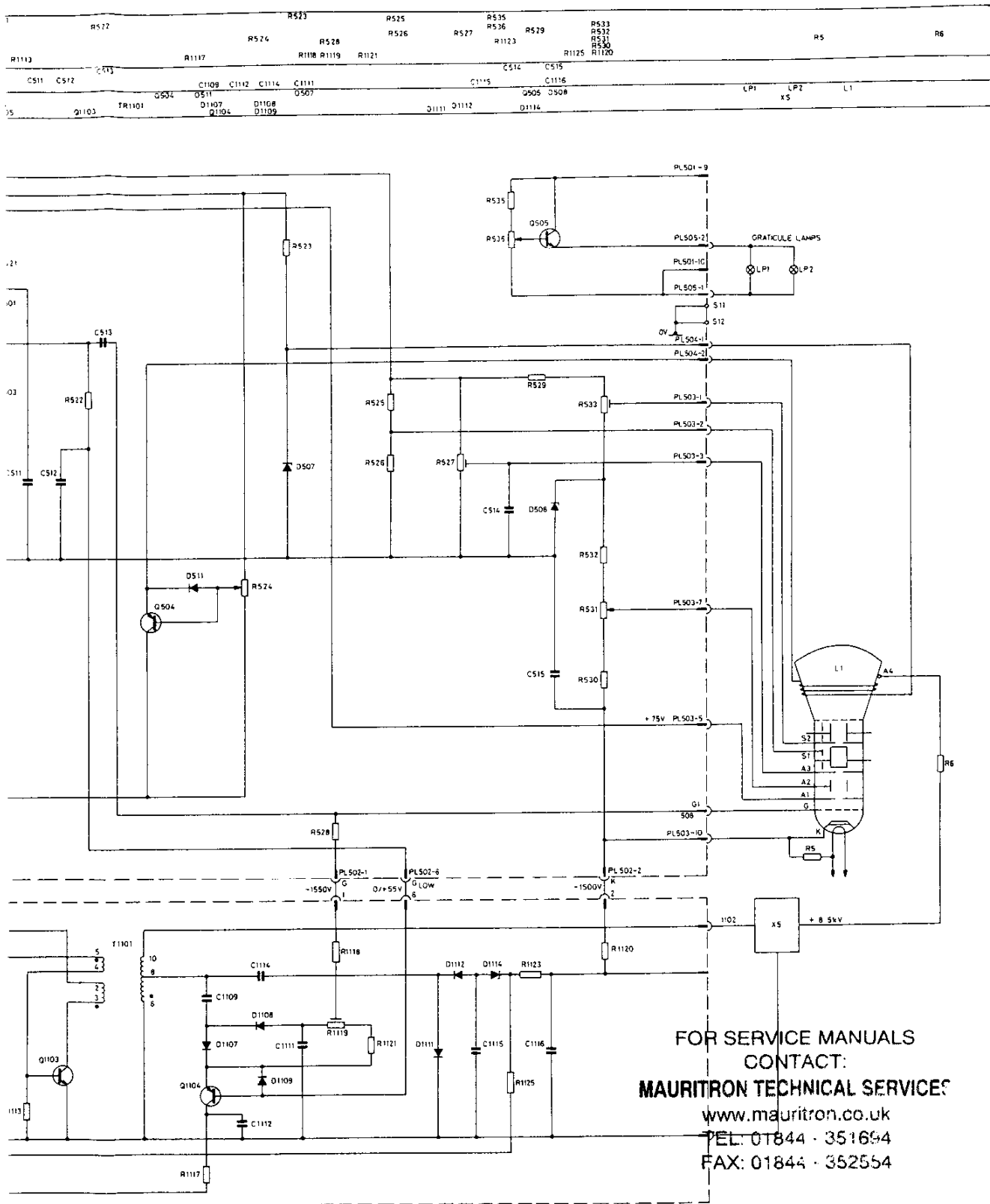


Fig. 6.13 Tube Supplies Bright Up & E.H.T. Circuit Diagram

Component List and Illustrations

Section 6

4041 MECHANICAL PARTS LIST

Ref. No.	Part No.	Description	Units	Ref. No.	Part No.	Description	Units
1	453823	Panel Front Blank)	1	39	12807	Fuse 5A	1
2	453824	Coverlay	1		12911	Fuse 10A	1
3	453813	Panel Rear	1	40	44771	Spacer Fan	1
4	453821	Side Support Bar	2	41	44805	Fan	1
5	453815	Corner Frame	3	42	33787	Socket Supply	1
6	44759	Bracket Support E.H.T. C.R.T.	1	43	7092	Clip Capacitor 1 3/8"	1
7	453839	Handle Assy.	1	44	20172	Clip Capacitor 1 5/8"	2
8	44777	Panel Attenuator	1	45	33016	M3 Washer Wavey	
9	44752	Panel Centre Support	1	46	33004	M4 Washer Plain	
10	44754	Bracket Support Y O/P P.C.B.	1	47	33028	M4 Stiff Nut	
11	44755	Bracket Support Logic P.C.B.	1	48	33044	M4 x 8 Pan Hd.	
12	44766	Bracket Power Supply P.C.B.	1	49	2135	Screw No. 6 x 3/8" Pan Hd.	
13	44767	Bracket 'Y' Amp P.C.B.	2	50	33038	M3 x 8 Pan Hd.	
14	44761	Guide P.C.B.	2	51	33003	M3 Washer Plain	
15	44409	Cradle C.R.T.	1	52	33094	M3 x 6 Taptite	
16	40677	Bracket Spacer	2	53	402004	M4 x 35	
17	453810	Bezel (C.R.T.)	1	54	33017	M4 Washer Wavey	
18	44406	Support (C.R.T.) Moulding	1	55	33069	M3 x 8 C'sk	
19	44780	Plate (P.C.B.) Mounting (Trig)	1	56	450194	No. 6-19-5/16 Plastite	
20	44779	Plate (P.C.B.) Mounting (Store)	1	57	450262	No. 8 x 22	
21	44776	Bracket Heatsink	1	58	44760	Spacer 9.5mm	6
22	44768	Heatsink	1	59	453816	Corner Frame	1
23	44772	Bracket Heatsink	1	60	40833	Terminal Earth	1
24	44770	Spacer	2	61	1222	Socket BNC 50Ω	3
25	43209	Screen Attenuator	2	62	453820	Bush 4mm	5
26	44765	Bracket (Switch Supply)	1	63	453431	Bezel (Pushbutton)	53
27	32626	Circlip	2	64	453432	Knob (Pushbutton)	53
28	450242	Spring	2	65	453769	Filter (C.R.T.)	1
29	453818	Cover Top	1	66	453440	21MM Knob R4-454	3
30	453819	Cover Bottom	1	67	453855	15MM Knob R2-324	4
31	453871	Trim Side	2	68	453856	15MM Knob R2-354	4
32	44762	P.C.B. Retainer	1	69	453436	10MM Knob R2-234	7
33	453809	Foot Bottom Cover	4	70	453444	21MM Cap W1-400	1
34	453814	Cover Rear	1	71	453442	10MM Cap W1-200	7
35	453811	Moulding Foot L/H	2	72	453443	15MM Cap W1-300	6
	453812	Moulding Foot R/H	2	73	40927	15MM Cap W1-303 (Red)	2
36	453870	Trim Side	2	74	43847	L.E.D. (Orange)	16
37	39097	Block Indexing	2	75	31229	Terminal Feed Thru'	1
38	38006	Fuse Holder	1	76	450922	L.E.D. (Green)	1

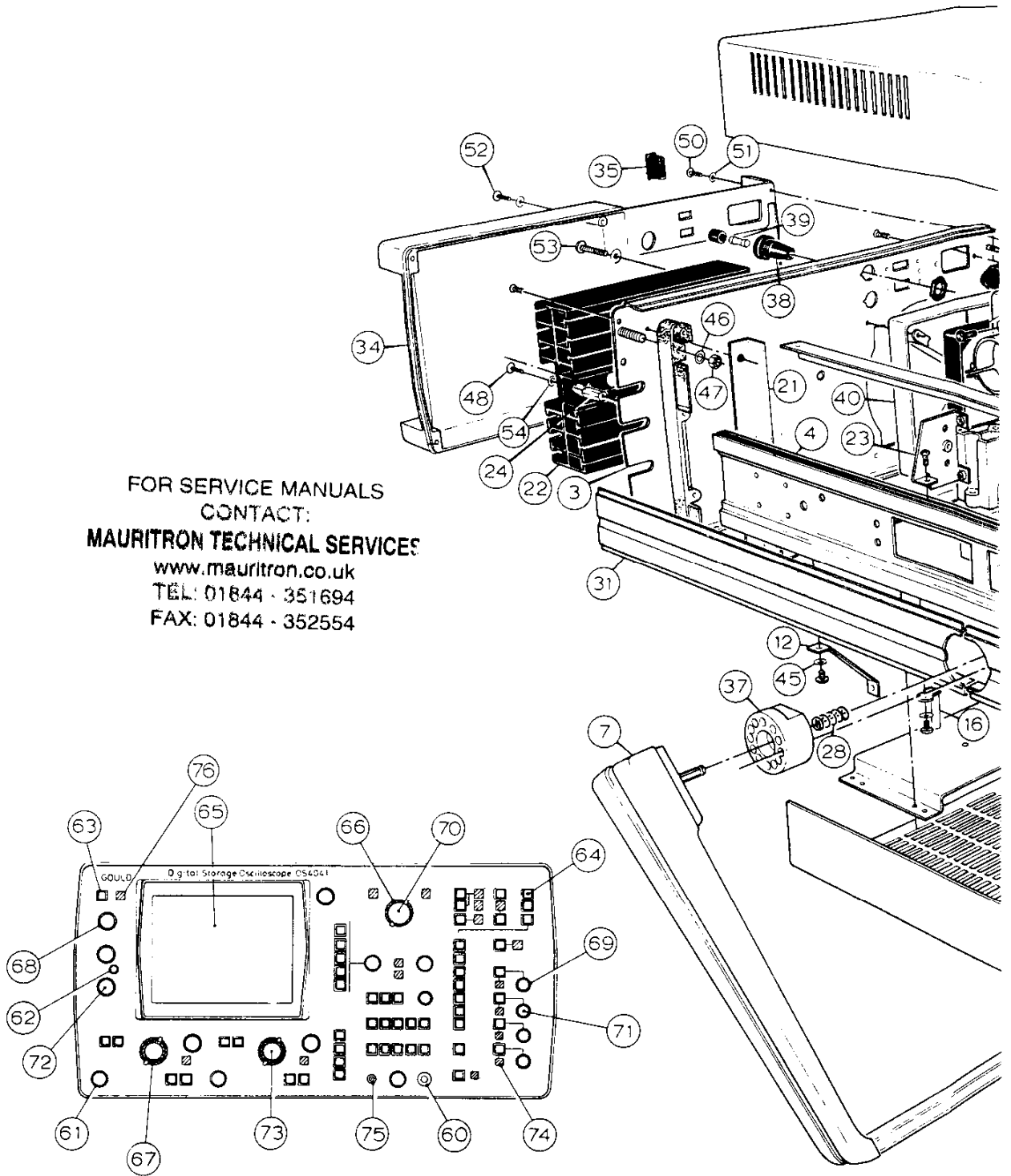
FOR SERVICE MANUALS
CONTACT:
MAURITRON TECHNICAL SERVICES

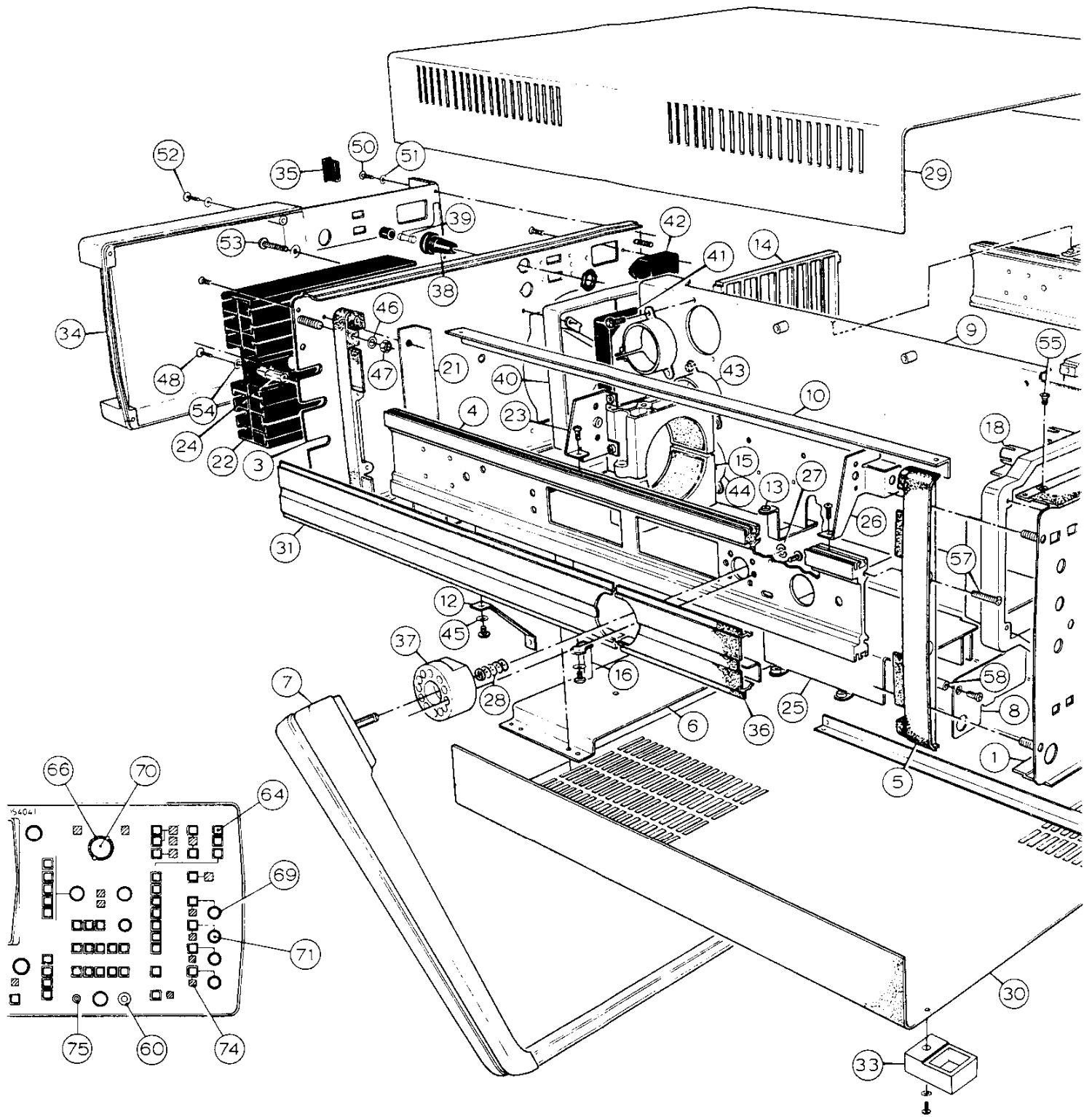
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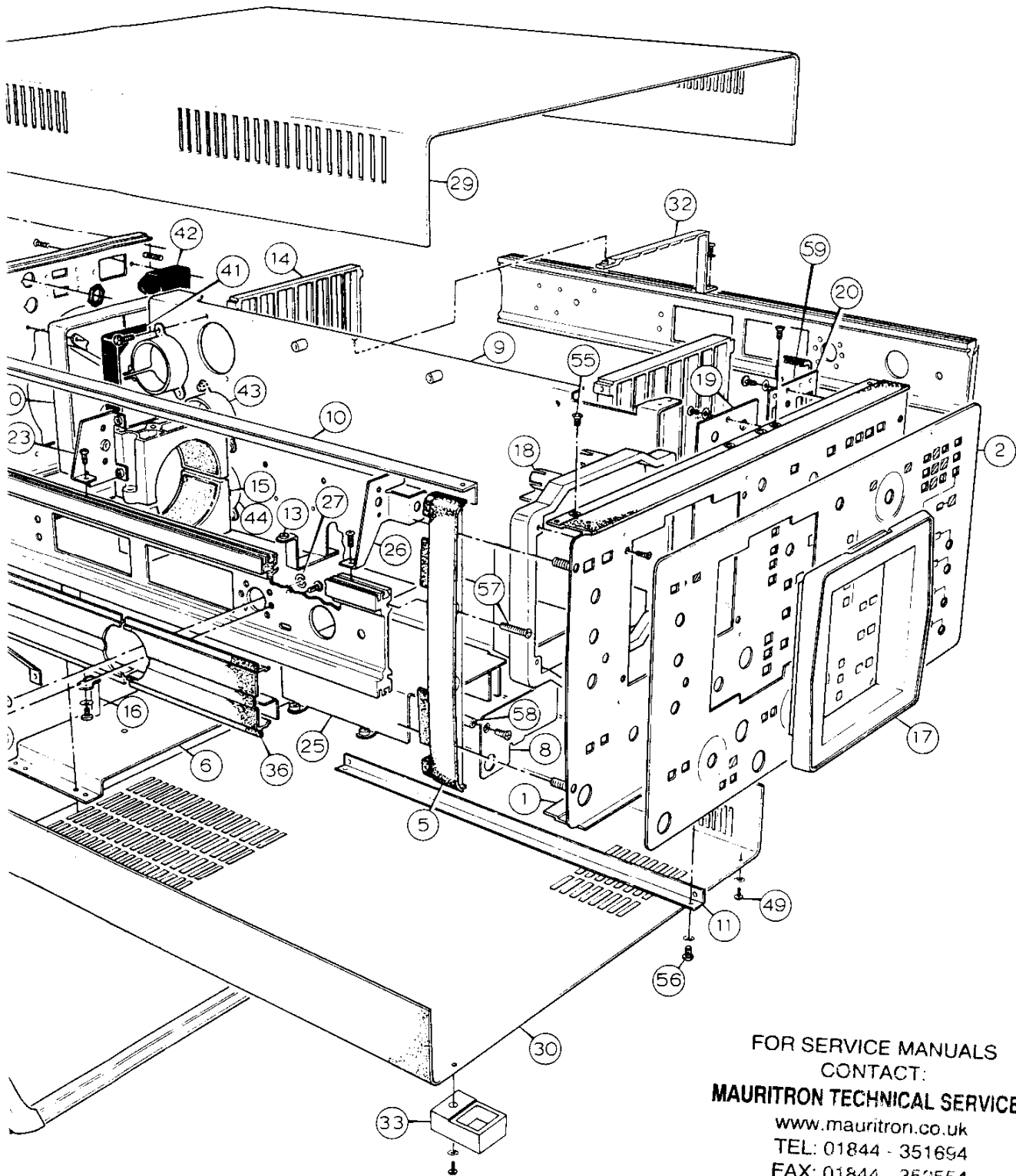


Fig. 6.14 Mechanical View Circuit Diagram

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

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

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

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

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

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

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

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

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

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