6425

Precision Component Analyzer

MAINTENANCE MANUAL

WAYNE KERR

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CONTENTS

(continued)

CONTENTS - Continued

(continued)

CONTENTS - Continued

(continued)

CONTENTS - Continued

ILLUSTRATIONS

(continued)

ILLUSTRATIONS - Continued

1 INTRODUCTION

This Manual provides maintenance information on Precision Component Analyzer 6425 and circuit descriptions of the four plug-in options available: RS232C, GPIB Interface, Handler Interface and Analog Output. A separate handbook (TP212) provides operating instructions.

The 6425 is a sophisticated instrument and its internal circuits should not be adjusted except by suitably qualified personnel with access to the test equipment and Standard components specified.

2 SYSTEM DESCRIPTION

2.1 MICROPROCESSOR CONTROL

All functions of the system are under the direct control of a microprocessor (MPU). Each automatic cycle of operations includes an interrogation of the keypad selections - the keys do not operate directly on the measurement circuits. The MPU then controls these circuits to obtain comparative voltages for the Unknown and Standard impedances under the selected test conditions. By resolving these voltages into orthogonal components, and subsequent computation, the selected type of readout information is used to update the CRT display.

The MPU polls the keyboard (and GPIB - IEEE) as a background task. When any change is detected, the measurement is aborted and the input instruction serviced. If an ac measurement is required, it runs through a sequence of 6 or 8 operations, according to the type of measurement and the Speed selected. The operations involve the selection of the Standard and Unknown voltages and the appropriate reference signal for a phase-sensitive detector (psd). The MPU also selects the integration time used for A-D conversion. On completion of the sequence, the selected parameters are computed, trim corrections applied, and the display updated. Write to the display occurs only when changes are needed, and then only to those areas needing update. Further details are in section 2.3 and in the section 'Screen Display Character Generation'(2.6).

2.2 BASIC MEASUREMENT

Refer to Fig 2.1. The guard amplifier produces a feedback current through the Standard resistor, Rs, exactly matching the current through the component under test, Zu. A single measurement channel is switched electronically to measure the corresponding two voltages produced, Es and Eu. Resolution of these into in-phase and quadrature components, and subsequent computations, provides the required information for the display.

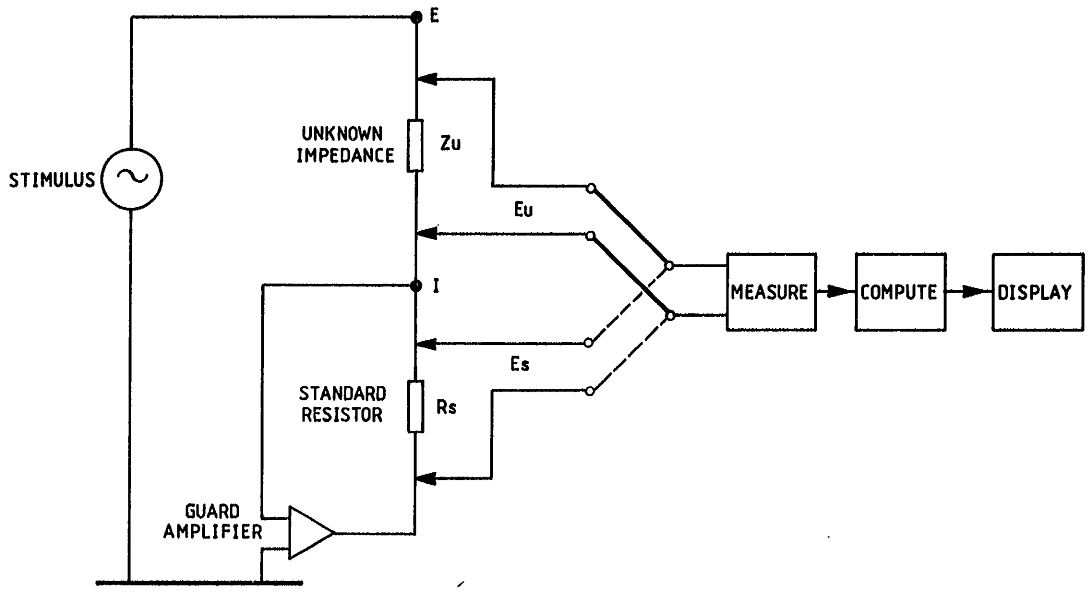


Fig 2.1 Basic Measurement

2.3 MEASUREMENT SEQUENCE

On voltage-drive ranges (3-8), the current-derived signal Es is measured first, followed by the Unknown voltage Eu. This order is reversed on current-drive ranges (1 & 2).

In the measurement channel, the psd resolves the signal to be measured, with respect to a reference signal of the same frequency as the drive signal.

The psd reference signal has four phase settings (0 - 3) separated by precise 90° shifts. Their phase relationship to the drive signal is, however, arbitrary. The orthogonal outputs of the psd are fed to the A-D converter.

The sequence for ac measurements on ranges 3-8, at NORMAL or FAST speeds, is:

Select Es
Settling delay (frequency-dependent)
Measure with psd phase 2
" " " " 0
" " " " 1
" " " " 3
Select Eu
Settling delay
Measure with psd phase 3
" " " " 0
Compute results
Output to display/output option

On repetitive measurements, Es is selected after the sixth measurement and the results computed and output during the subsequent Es settling delay.
The key polling sequence also checks whether each A/D conversion is complete.

If an overload occurs at any point, the sequence is aborted and auto-ranging started. With Hold selected, the sequence continuously restarts and RANGE ERROR is reported.

On SLOW speed, both Es and Eu are measured at all four psd phases (ie 8 measurements).

2.4 OVERALL SYSTEM

Refer to the Block Diagram, Fig. 2.4, which shows seven circuit boards:

Memory
CPU & TV
Synthesiser
Signal Source
20V Bias
Bridge
Detector

Not shown on Fig. 2.4 are the Mother board (into which the above are fitted), the power supply sub-chassis nor any of the optional plug-in boards. Because circuit functions are interdependent (one board serving more than one purpose) the descriptions are given under the following headings:

	Section
DIGITAL SYSTEM	2.5
SCREEN DISPLAY CHARACTER GENERATION	2.6
ADDRESS MAPS	2.7
Memory Map	2.7.1
I/O Map	2.7.2
FREQUENCY GENERATION	2.8
Fixed Dividers	2.8.1
Programmable Dividers	2.8.2
Staircase Generator	2.8.3
SOURCE SIGNAL DERIVATION	2.9
AC Level Selector	2.9.1
Programmable Filter (Source)	2.9.2
Output Amplifier	2.9.3
Source Resistance Selection	2.9.4
BRIDGE CIRCUITS	2.10
Neutralizer	2.10.1
Range Selection	2.10.2
UNKNOWN SIGNAL PROCESSING	2.11
Gain Selection	2.11.1
Programmable Filter (Detector)	2.11.2
Overload Detector	2.11.3
PSD, & PSD Reference Generator	2.11.4

Locations of the circuit elements referred to in these texts are stated, frequently, by board names. Component reference numbers themselves, however, are a general guide to their location:

Prefix	0	Chassis
	1	Synthesiser
	2	Memory (Mk I and Mk II) (Also RS232C Option)
	3	CPU & TV
	4	Keyboard
	5	Signal Source
	7	Power Supplies
	8	Bridge
	9	Detector
	10	Mother board
	16	20V Bias
	17	GPIB & Handler Interface Option
	18	Analog Output Option

2.5 DIGITAL SYSTEM

Block Diagram - Fig. 2.4.
CPU & TV Circuit Diagram - Fig. 6.2.
Memory Board Circuit Diagrams - Figs. 6.4 & 6.6.
Keyboard Circuit Diagram - Fig. 6.8

The digital system is based on a Z80 MPU, (IC305, CPU & TV board), operating with a 2.13MHz clock, which is connected via buffers to a 16-bit address bus and an 8-bit bi-directional data bus. These connect to the memory circuits, the screen display generator, synthesiser and A-D control circuits, and to the external interface Option slots.

The Z80 (CPU) has two modes of addressing external devices. These are (a) memory mapping and (b) I/O mapping.

(a) Memory mapping uses the whole of the address bus and hence can address 64k bytes. The address is qualified by the $\overline{\text{MREQ}}$ strobe. A Read ($\overline{\text{RD}}$) or Write ($\overline{\text{WR}}$) function is defined by the appropriate strobe to qualify the data.

(b) I/O mapping uses only half the address bus (AB0-AB7) and hence can only address 256 bytes. The address is qualified by the $\overline{\text{IORQ}}$ strobe. The $\overline{\text{RD}}$ and $\overline{\text{WR}}$ strobes qualify the data as above.

In the 6425, the hardware is addressed in both modes, according to its function. Detailed address maps are in section 2.7.

The Eprom address decoder, (IC213/214, Memory board), provides 10 x 4k blocks for 2732 memories (MkI Memory boards) or 4 x 16k blocks for 27128 memories (MkII Memory boards).

A separate 1k block decoder, IC216, is provided for RAM and memory-mapped hardware. The top 1k block is used for hardware and also feeds the page enable line $\overline{\text{ENF}}$ on the option connector. The next 1k block down ($\overline{\text{SEN}}$) is used for the screen circuits (see separate description) with the working RAM below this. The top 1k block is further decoded (IC217) to provide 6 memory-mapped enable lines to the hardware ($\overline{\text{MEN}}$ 0-5).

The top 1k of RAM is non-volatile, using CMOS devices with a 3V Lithium primary cell back-up. At power-up, these devices change over to the internal 5V supply via D204 and D205. TR200, 203, 204 hold off the enable lines to the non-volatile RAM until internal power supplies have been established, and normal microprocessor operation is ensured.

To permit operation of slow hardware blocks, a wait state is generated whenever the hardware or screen is addressed (IC 306, CPU & TV board).

To minimize digital noise pickup, the data and address buses are not routed to the analog measurement areas (signal source, detector, bridge, 20V bias). MPU inputs from this area (ANI 4-7) feed to a common input port (IC218) located on the Memory board. MPU outputs to the analog area are I/O mapped and are routed via IC301 to a special 'quiet' data bus (ANO 0-7) which is inactive except during an I/O write. Decoded enable lines ($\overline{\text{OEN}}$ 0-7) provide for up to 8 latches to be connected to this bus.

All the above inputs and outputs are at TTL logic levels, level shifting for CMOS gates or heavy-duty relays being provided locally as required.

The keyboard drive has 4 latched addresses and 4 data lines which are decoded into 10 rows x 4 columns. The keys are polled periodically during the measurement sequence at times when any resulting digital noise pickup would be unimportant to measurement accuracy.

Power-on Reset (approx 200ms pulse) is provided by IC332. This can also be triggered during fault-finding by an internal master reset button located on the CPU & TV board. Additionally, IC337 generates a master reset (without delay) whenever the +5V digital supply falls below 4.75V, which helps to maintain the data integrity of the non-volatile RAM under supply drop-out conditions.

2.6 SCREEN DISPLAY CHARACTER GENERATION

Screen Display Generator Block Diagram - Fig. 2.5.
CPU & TV Circuit Diagram - Fig. 6.2.

The screen display circuits, located on the CPU & TV board, generate separate horizontal sync, vertical sync and video signals, all at TTL levels, which are routed to the CRT drive circuits. A non-interlaced horizontal raster is used, with a line frequency of 16.0kHz and frame frequency of 54.98Hz.

The microprocessor addresses the screen as 21 rows of 38 adjacent character cells, although the display area is only 19 rows of 37 characters. Each character cell is 8 dots wide x 12 lines high. A single byte describing the content of each character cell is stored in each of 798 (21 x 38) screen RAM locations (IC317, 318). From these, any one of 256 standard characters can be selected for display in each character cell.

The character PROMS (IC324, IC325) contain the patterns of light and dark dots making up each character, and each location in either PROM stores one horizontal line of information. Address lines A0 to A3 select the 12 lines forming each character, while address lines A4 to A11 select from the 256 different characters.

Each of the two PROMS contains a different character set, one or the other being selected by IC321.

The display is generated by sequentially scanning the address lines of the screen RAM and the character PROM. The resulting patterns of 8 horizontal dots at a time are loaded into a shift register (IC323) and clocked out to the display by a 6.4MHz dot clock.

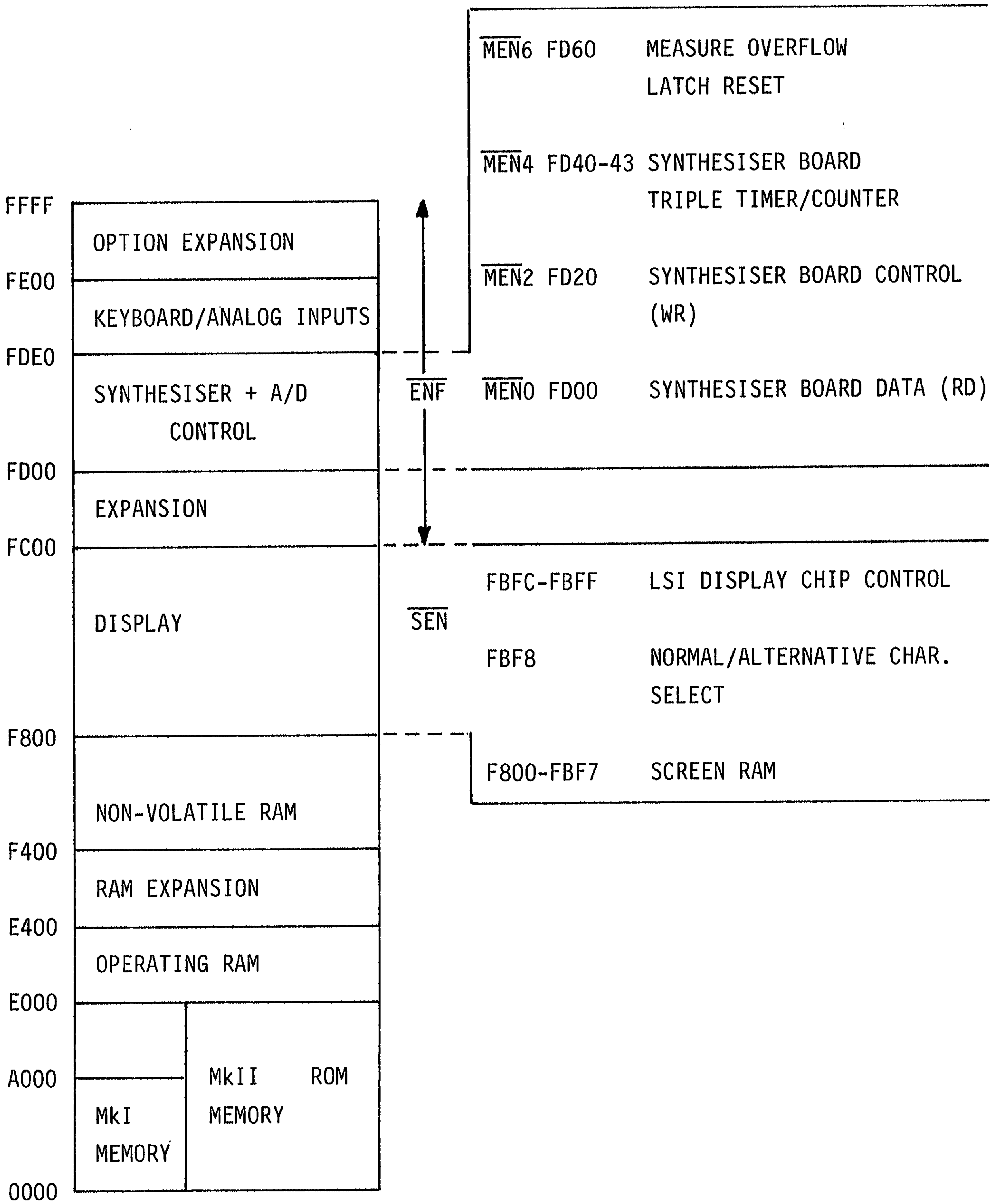
Scanning of the address lines, generation of sync pulses and cursor control are all handled by an LSI chip (IC312) which is initialized at power-up by the microprocessor. To avoid interfering with the display, the processor can write to the screen RAM only during line or frame flyback. If it attempts to write at any other times, a wait state is generated by the control logic.

During screen RAM updating, the RAM address lines are switched from IC312 to the processor address bus, by means of data multiplexers IC314-316.

2.7 ADDRESS MAPS

2.7.1 Memory Map

HEX ADDRESS 6425 MNEMONIC



2.7.2 I/O Map

(see circuit description for detailed hardware truth tables)

HEX ADDRESS		
FF	EXPANSION	
86	20V BIAS	$\overline{\text{OEN}}$ 6
85	CONTROL	$\overline{\text{OEN}}$ 5
84	DETECTOR CONTROL	$\overline{\text{OEN}}$ 4
83	NEUTRALIZER CONTROL	$\overline{\text{OEN}}$ 3
82	BRIDGE CONTROL	$\overline{\text{OEN}}$ 2
81	SIGNAL SOURCE CONTROL	$\overline{\text{OEN}}$ 1
80	AC LEVEL CONTROL	$\overline{\text{OEN}}$ 0
	OPTION EXPANSION	
40	HANDLER INTERFACE OPTION	
30	ANALOG OPTION	
20	GPIB OPTION	
10	RS232C OPTION	
00		

2.8 FREQUENCY GENERATION

2.8.1 Fixed Dividers (located on Synthesiser board)

Circuit Diagram - Fig. 6.10.

The fixed dividers provide the CPU and video clock frequencies by division from the 38.4MHz crystal oscillator IC132. IC104b and IC106 form ÷2 and ÷3 stages respectively to produce the 6.4MHz screen clock SCK. A further division by 3 (IC105b and IC107c) provides the 2.133MHz processor clock PCK.

2.8.2 Programmable Dividers (located on Synthesiser board)

The 42 drive frequencies (20Hz to 300kHz) are initially generated at 16fo (ie 320Hz to 4.8MHz). Frequencies from 1.6MHz (= 16 x 100kHz) upwards are generated directly by the dividers IC108 and IC109a, the required output frequency being selected by data multiplexer IC110.

Frequencies below 1.6MHz are provided by counter 2 of the programmable triple timer counter IC103, using as its clock the selected output frequency from IC110. IC111 forms a 2-way switch, selecting either the direct or divided 16fo signal for further processing by the Staircase Generator.

2.8.3 Staircase Generator (located on Synthesiser board)

The 16fo clock is used to generate an eight level, 16 time sample approximate sinewave by analog summing of the output of the bidirectional shift register IC114. The register is arranged to generate a cyclic bit pattern of increasing logic ones followed by decreasing logic ones. The summing amplifier IC130 has weighted inputs to give the required approximate sine amplitude at S1 for each time sample generated by the register.

Control counter IC113 provides a binary code for each time sample. At count 0 the register is loaded with 1000 0000 with S0, S1 held at logic one. At the 9th time sample the register direction is reversed, and on reaching the 15th sample the register is re-loaded. IC115 with IC116 decodes the 0, 9th and 15th time samples for shift left/right control of the register via latch IC123a.

2.9 SOURCE SIGNAL DERIVATION

2.9.1 AC Level Selector (Signal Source board)

Circuit Diagram - Fig. 6.12.

The stepped ac drive signal (at TP03) is received by the multiplying DAC IC503 which, with the range amplifier IC505a, sets the ac level between 10mV and 5V. The preset R506 adjusts the maximum drive level (set at 1.2kHz).

The processor control signals are received via the quiet analog bus at the octal latch IC501. Bits 0 to 5 set the signal over a 50-step range. Bits 6 and 7 set the range amplifier accordingly to give:

AC Level Range	IC501 pin number		Range Amp Gain
	12	9	
0 to 500mV	1	1	x1
520mV to 1V	0	1	x2
1.05 to 2.5V	1	0	x5
2.6 to 5.0V	0	0	x10

Pin 2 of latch IC502 provides a signal inhibit function, via level shifter TR516 and range selector IC504. This function operates only during dc bias charge or discharge periods (see section 2.10). At all other times pin 2 is at logic high, giving 0V at IC504 pin 6.

2.9.2 Programmable Filter (Signal Source board)

IC506 & IC507 form a state variable low-pass filter which provides initial filtering of the drive signal at the output IC507b (TP04). Additional filtering is provided by a similar filter in the detector circuit.

The corner frequencies are adjusted from the processor by selecting the required integrator C & R values via the analog multiplexers IC509a & b and the reed relays RL501 & RL502. The settings for the Signal Source filter (which are interleaved with the Detector Filter settings) are as follows:

Frequency Range	IC 502 pin number 6	9	15	12
20Hz	0	1	1	1
25 - 50Hz	0	1	1	0
60 - 120Hz	0	1	0	1
150 - 300Hz	0	1	0	0
400 - 800Hz	1	0	1	1
1kHz - 2kHz	1	0	1	0
2.5 - 5kHz	1	0	0	1
6 - 12kHz	1	0	0	0
15 - 30kHz	1	1	1	1
40 - 75kHz	1	1	1	0
100 - 300kHz	1	1	0	1

2.9.3 Output Amplifier (Signal Source board)

TR501 through to TR512 form a conventional audio power amplifier with a nominal gain of 2.5 times. TR510, 512 provide safe area protection for the output transistors, allowing at least 200mA peak current at normal operating voltages. Excessive transient voltages accidentally fed into the E terminal of the Analyzer are clamped to a safe level by D512, D513, with D505, D506, D508, D509 providing reverse blocking whenever the clamped transients exceed the amplifier supply rails. The ac output is coupled to the Bridge circuits via the capacitor bank C24 to C33 to permit application of dc bias at the E terminal. The power amplifier output is biased to -0.5V nominal to polarize these capacitors in the absence of bias.

2.9.4 Source Resistance Selection

Relay RL503 and associated driver circuit TR513 TR514 selects 2Ω/50Ω source resistance depending on the range requirements selected by the processor auto-range routine. The 2Ω resistor is located on the Bridge board and is increased to 50Ω by switching R558/559 in series on the Signal Source.

The truth table for these functions is as follows:

Range No	Source R	IC502 pin 19
1 - 2	50Ω	0
3 - 5	2Ω	1
6 - 8	50Ω	0

2.10 BRIDGE CIRCUITS

Circuit Diagram - Fig. 6.14.

Components to be measured are connected between the E (signal source) and I (current sense) terminals. The action of the virtual-ground guard amplifier IC801 forces the current at the I terminal to flow through one of four standard resistors (R821 to R824), selected according to measurement range by IC802, RL801, RL802. TR801 to TR806 form an output current booster used with the 10-ohm and 640-ohm Standards. This circuit incorporates simple constant-current overload protection (D809 to D812 with R847, R848). D801 to D804 protect the guard amplifier against normal input overloads. Additional protection is provided by FS801 mounted on the Bridge board; this will not normally blow except under exceptional fault conditions.

IC805 and IC806 form a differential amplifier feeding the ac detector circuits. To perform ac impedance measurements, the amplifier input is alternately connected (via IC804) to measure the voltages across the Unknown component (Eu) or the Standard resistor (Es). For each connection, a series of two or four complex measurements is made (see section 2.3), the microprocessor computing the required measurement parameter from the results. The amplifier output appears at TP01 on the Detector board.

TR809 to TR811 form a wideband buffer to isolate the switching action of IC804 from the measurement leads. TR811 is a bootstrap follower driving both the collector of TR809 and its bias divider, maintaining a high input impedance at all frequencies. The output of this buffer feeds two hf phase trim networks. The main phase trim network comprises R810, R811 and the input capacitance of the signal selector/amplifier combination. IC804 selects this network whenever the 10Ω, 640Ω or 5k12 Standard resistors are in use, the phase lag introduced being adjusted on test to balance that due to the stability capacitor (C816, 817, 818, 844) connected across each Standard resistor. When the 40k96 Standard is in use, the alternative network R808, R809, C808 is selected by IC804, being adjusted to compensate for the self-capacitance of the Standard resistor.

DC blocking is provided for each ac signal input, the input time-constants being kept equal. As a result, low-frequency phase errors cancel out when the impedance calculations are performed. During bias charge or discharge periods, the output of blocking capacitor C810 is clamped by TR812 to voltage divider R895, R896. This is adjusted on test to equal the normal dc input voltage of the wideband follower. The operation of this clamp minimizes circuit settling time after application or removal of dc bias.

The truth table for the signal select control lines is as follows (all settings apply with 1V or 100mA signal levels selected):

Range/ Function	Signal Select	Standard Resistor	IC810 Pin Numbers 19	5	16	6	IC811 Pin 12
1-4	Es	10Ω	1	1	0	1	1
5-6	Es	640Ω	0	1	0	1	1
7	Es	5k12	1	0	0	1	1
8	Es	40k96	0	0	1	0	1
	Eu	x	x	x	1	1	1
Bias charge/ discharge	x	x	x	x	x	x	0

2.10.1 Neutralizer (part of Bridge board)

For operation at high frequencies (3kHz to 300kHz) the loop gain of the guard amplifier is increased by the action of the neutralizer circuit (IC812 to IC816). Without this circuit, the loop gain is progressively reduced by the current flowing in the compensation capacitor C821. The voltage feeding this capacitor (IC801 pin 8) is scaled by the resistor chain R830-R837, inverted by the video amplifier IC813 (nominal gain -5), further scaled by resistor chain R856 to R860 and integrated by IC816, which is connected in feedforward mode to minimize hf phase errors. The resulting output voltage is applied to either R827 or R828, producing a current which cancels that flowing in C821 at the chosen operating frequency only. For each frequency-setting the scaling attenuators are altered by the MPU to maintain this cancellation. The preset control R874 compensates for the tolerances in C821, C834 and the gain of IC813. The control truth table for the neutralizer circuit is as follows:

Freq (kHz)	IC811 pin number				
	2	19	5	16	6
≦2	0	0	0	1	1
2.5/3	0	1	0	0	1
4	0	0	0	0	1
5	1	0	0	0	1
6	1	1	0	0	1
8	0	0	1	0	1
10	1	0	1	0	1
12	1	1	1	0	1
15	0	1	1	1	1
20	0	0	1	1	1
25	1	0	1	1	1
30	1	1	1	1	1
40	0	0	0	0	0
50	1	0	0	0	0
60	0	1	1	0	0
75	0	0	1	0	0
100	1	0	1	0	0
120	1	1	1	0	0
150	0	1	1	1	0
200	0	0	1	1	0
300	1	1	1	1	0

2.10.2 Range Selection (Bridge board & Detector board)

Bridge Board Circuit Diagram - Fig. 6.14.
Detector Board Circuit Diagram - Fig. 6.16.

Impedance measurement range is selected by choice of Standard resistor together with a precision x8 attenuator located on the Detector board. For ac levels ≧250mV or 25mA, eight ranges are available. Below these levels, the settings are altered to increase the detector input levels, and only 6 ranges are available. The various settings used are detailed in the table.

RANGE SELECTION

AC MEASUREMENTS			HIGH LEVEL ≧250mV/25mA			LOW LEVEL <250mV/25mA		
Range No.	Impedance Coverage(Ω)	Max Level	Standard Resistor	Es gain	Eu gain	Standard Resistor	Es gain	Eu gain
1	<1.25	100mA	10Ω	x1	x8	-	-	-
2	1.25-10	100mA	10Ω	x1	x1	10Ω	x8	x8
3	10-80	1V	10Ω	x1	x1	10Ω	x8	x8
4	80-640	5V	10Ω	x8	x1	640Ω	x1	x8
5	640-5k12	5V	640Ω	x1	x1	640Ω	x8	x8
6	5k12-41k	5V	640Ω	x8	x1	5k12	x8	x8
7	41k-328k	5V	5k12	x8	x1	40k96	x8	x8
8	>328k	5V	40k96	x8	x1	-	-	-

2.11 UNKNOWN SIGNAL PROCESSING

2.11.1 Gain Selection (Detector board - Fig. 6.16.)

Amplifiers IC903, IC904a with the analog multiplexers IC902a, b and c form a programmable gain stage by selection of feedback ratio at IC902c and forward attenuation at IC902b and IC902a. The x8 ratio is of high accuracy and is used as part of the range selection routines. The other two sections are used only to compensate for drive level variations. With Range Hold and Range 3 selected from the keyboard the following truth table applies:

Gain Ratio			Signal Level	IC901 pin number		
				19	16	15
x8	x4.5	x2.2	0 - 60mV	0	0	0
x8	x4.5	x1	70 - 140mV	0	0	1
x8	x1	x2.2	150 - 240mV	0	1	0
x1	x4.5	x2.2	250 - 520mV	1	0	0
x1	x4.5	x1	540mV - 1.1V	1	0	1
x1	x1	x2.2	1.12 - 2.35V	1	1	0
x1	x1	x1	2.4 - 5.0V	1	1	1

2.11.2 Programmable Filter (Detector board)

Amplifiers IC904b, IC907a and IC907b, with analog multiplexers IC908a and IC908b, form a state variable low-pass filter with corner frequencies interleaved with the Source Programmable Filter (see Source board description). The combination of the two filters maintains effective harmonic filtering at all frequencies. The detector filter settings are:

Frequency Range	IC901 pin number			
	9	6	5	2
20 - 30Hz	0	1	1	0
40 - 80Hz	0	1	0	1
100 - 200Hz	0	1	0	0
250 - 500Hz	1	0	1	1
600 - 1200Hz	1	0	1	0
1.5 - 3kHz	1	0	0	1
4 - 8kHz	1	0	0	0
10 - 20kHz	1	1	1	1
25 - 50kHz	1	1	1	0
60 - 120kHz	1	1	0	1
150 - 300kHz	1	1	0	0

The detector filter output appears at TP02 on the Detector board.

Any dc present at the filter output is removed by the selectable ac coupling. The shorter time-constant is selected for faster settling time, when the measurement frequency is 250Hz or above, via junction FET TR905.

2.11.3 Overload Detector (Detector board)

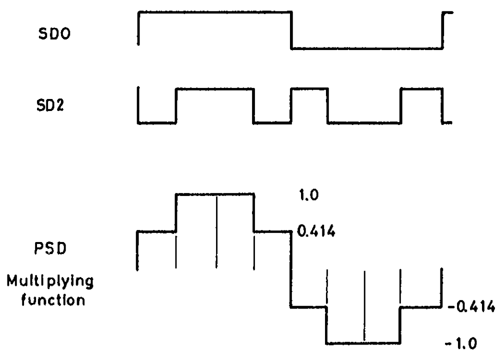
The overload detector monitors the peak signal entering the Detector circuit (5V rms max) and the level at the PSD input (1V rms max) by comparators IC914a and b respectively. If an overload occurs, the output is latched (IC914c).

The measurement cycle comprises 6 or 8 A-D conversions and, at the end of each, the processor reads the latch before setting $\overline{MSR}$ high, which resets the latch. If an overload has occurred during the previous A-D conversion, the processor will abort the measurement cycle and immediately enter the auto-range routine.

2.11.4 PSD, & PSD Reference Generator (Detector & Synthesiser boards)

Detector Circuit Diagram - Fig. 6.16.
Synthesiser Circuit Diagram - Fig. 6.10.

The phase-sensitive detector (PSD) employs a 4-level multiplying reference signal which contains no harmonics below the seventh. Hence the PSD rejects low-order odd harmonics as well as all even harmonics. The reference signal is made up from the sum of two waveforms SD0 and SD2:

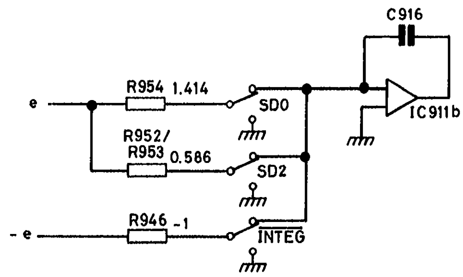


SD0 and SD2 can be generated in 4 different phase positions and are derived from clock signals of 16, 4 and 2x the measure frequency fo by the gating circuits IC118 and IC119. The gated waveforms are synchronized with the Staircase Generator at the output latches IC121 a and b to remove propagation delay variations. The PSD drive waveforms are enabled only during the integration period of each A-D conversion.

The processor selects the appropriate phase position via control lines PP0 and PP1 according to the following table:

Octal Latch IC102 Output			
PP1 P2	PP0 P19	Phase	
0	0	0°	0
0	1	90°	1
1	0	180°	2
1	1	270°	3

The PSD drive signals are received at the PSD (located on the Detector board) via buffers TR901 - TR903 and drive IC910 which serves as a two-pole change-over analog switch. (SD0 and SD2 in diagram).



The signal current to the A-D integrator IC911b is modulated by the selection of R954, R952/R953 or neither.

Dual polarity operation is obtained by biasing the circuit to 50% of fsd during the A-D integration period. This bias is derived from the 5V reference voltage, inverted by IC911a, which also provides a phase-inverted measure signal to the PSD to provide full-wave rather than half-wave detection. The effect of this is to cancel 1f noise and to improve suppression of switching transients. The multiplied signal is fed directly into the analog to digital converter integrator as a current, which avoids amplifier slew-rate distortion at the fast switching edges.

2.12 A-D CONVERSION

The A-D converter comprises a digital control section located on the Synthesiser board (component prefix 1) and an analog section on the Detector board (component prefix 9). Once triggered by the microprocessor, the A-D conversion process proceeds unsupervised, and on completion it waits to be polled by the microprocessor, as part of the keyboard polling routine. Each measurement cycle comprises 6 separate A-D conversions (8 with SLOW speed selected), with different signal and/or PSD phase selections. See section 2.3.

The A-D converter uses the charge balancing technique, where the signal is summed with the reference during the integration period. The reference signal is switched on and off as required to maintain the integrator output close to zero. During integration, the integrator output oscillates about zero, the measure counter being enabled whenever the reference signal is on.

At the end of the integration period, the PSD is switched off and the reference current is left on to take the integrator output to an arbitrary negative level outside the band of oscillation, giving a final accurate conversion count.

2.12.1 Measure Counter (Synthesiser circuit)

Synthesiser Circuit Diagram - Fig. 6.10.

The A-D counter uses a 20-bit measure counter chain. The most significant 16 bits are provided by counter 0 within the programmable triple timer counter IC103. IC105a and IC104a prescale the 16-bit counter to provide the remaining 5 (least significant) bits. The counter chain is clocked directly by the 38.4MHz master clock and enabled by the $\overline{\text{MSR}}$ control line from the processor being active with the INTEGRATION control signal (see 2.12.3). On a long measurement the counter chain may overflow. This is detected by latch IC123b to inform the processor. The overflow is noted in software and the latch is reset before the next overflow can occur via the $\overline{\text{MEN3}}$ line.

2.12.2 Measure Timer (Synthesiser circuit)

Synthesiser Circuit Diagram - Fig. 6.10.

Integration times are set by the user via the Fast, Medium and Slow measure modes. The processor loads counter 1 (in one-shot mode) of the triple timer counter IC103 with the appropriate binary number to give a time-out within a whole number of measure periods. When enabled by the RUN control line (from the A-D control circuit) the counter gate IC103 p14, becomes logic high and the counter counts down. On reaching zero count, output 1, (IC103 pin 13) becomes a logic high, resetting the $\overline{\text{INTEG}}$ latch IC120b at the next rising edge of the synchronizing signal.

2.12.3 A-D Conversion Timing (Synthesiser & Detector boards)

Synthesiser Circuit Diagram - Fig. 6.10.
Detector Circuit Diagram - Fig. 6.16.

The following description of the A-D conversion process should be read with reference to the timing diagram, Fig 2.2.

The MPU initiates a measurement by setting $\overline{\text{MSR}}$ low, which enables the RUN latch IC122b and resets the zero crossing comparator IC913. The RUN latch becomes set on the next measure signal period via the SYNC flip-flop IC122a, which generates a clock waveform at measure frequency in phase with the Staircase Generator. The RUN latch in turn enables the INTEGRATOR latch IC120b which in turn enables the PSD drive latches IC121a and b. The RUN and INTEGRATOR control lines activate the analog switch IC912, setting the A-D converter to measure mode by opening the integrator capacitor shorting switch (IC912, S4, D4). The A-D Offset reference (which is routed through the PSD full-wave inverting stage IC911a, R946) is also enabled at IC912, S1, D2.

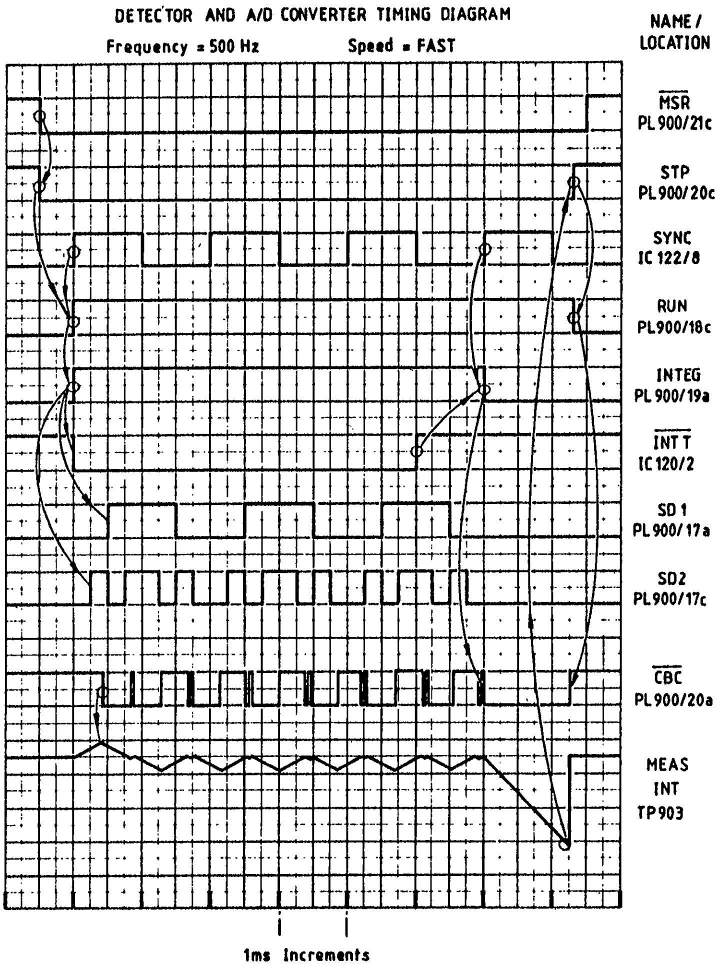


Fig. 2.2 Timing Diagram

The HIGH/LOW monitor compares the integrator output with OV, sending an error status signal (H/L) to the CHARGE BALANCE CONTROL circuit IC109b, IC124, IC120a, IC127. The charge balance control generates two 2.34kHz clocks with duty cycles of 15/16 and 1/16 at IC124 outputs. At the start of each charge balance period, the appropriate waveform is selected by the sampling circuit IC120a, IC127 depending on the status of the H/L line for the predominantly on or off reference current at the A-D converter.

IC135 selects a higher charge balance clock frequency, for measurement frequencies between 600Hz and 1.5kHz, giving improved measurement accuracy.

The CBC and $\overline{\text{CBC}}$ control lines are generated at IC133 latch which is synchronized with the master clock to remove timing errors. The reference current is switched into the integrator summing junction by IC912, S3, D3 via R947.

At the end of the integration time-out (generated within the programmable timer counter IC103), the D input at IC120b INTEGRATOR latch becomes high.

The next measure sync period toggles the INTEGRATOR latch, inhibiting further PSD and CBC drive. The $\overline{\text{INTEG}}$ line remains high, holding the reference current switch IC912, S3, D3 on. The integrator output is forced -ve until the zero crossing comparator IC913 latches, sending a STOP signal to reset the RUN latch IC122b, this in turn resetting the INTEGRATOR latch IC120b to switch off the reference current to the integrator. The RUN line becoming low informs the MPU that conversion is complete and $\overline{\text{MSR}}$ is set high to reset the A/D converter. The $\overline{\text{MSR}}$ line may be set high at any time by the MPU if a measurement is to be aborted.

2.13 20V BIAS UNIT

Block Diagram - Fig. 2.4
Circuit Diagram - Fig. 6.18

The 20V Bias circuit consists of a programmable 0 - 20V dc supply which is connected, via a rear panel link, to a 1kΩ resistor (R1617) feeding the output connection of the Signal Source circuit. The user may omit the link for safety, or alternatively an external supply may be connected in place of the link, when the bias becomes the sum of the internal and external voltages. For rapid charging and discharging, the 1kΩ resistor is short-circuited by the processor (RL02/1), ac drive and measurements being inhibited during these periods (identified by the display "DC VOLTAGE NOT SET"). At other times the dc voltage across R1617 is monitored to detect voltage errors due to excess leakage current or connection of undischarged capacitors. A second relay (RL1601) connects R1617 to ground (via R1616) when Bias Off is selected, bypassing the rear panel link. This is also used as a discharge path when an external supply is in use, as most external supplies cannot sink reverse currents.

2.13.1 Programmable Voltage Source

IC1601a with its complementary output stages (TR1601 - TR1606) form a virtual ground amplifier. IC1605 is a multiplying DAC providing a programmable current which flows in the feedback resistor (R1614 - R1615) to give a defined voltage at the Bias Link connector PL1602. TR1601 and TR1604 provide 1A current limiting during charging or discharging, the circuit being protected against connection of charged capacitors by R1607, D1603, D1604, D1612, D1626. The output stage operates from a single polarity unregulated supply (designated +20V) with TR1609 providing a continuous -50mA bleed to maintain linear operation close to zero output.

The reference input to IC1605, derived from IC1603 and divider chain R1638 - R1640, is switched by the multiplexer IC1604 to provide three output voltage ranges, corresponding to steps of 0.1, 0.2 or 0.5V. IC1605 provides fine setting over a 50-step range (6 data inputs, binary weighted).

2.13.2 Status Comparators

Two sections of quad comparator IC1608 monitor the voltage across the rear panel link, using 4-terminal connections to eliminate wiring drop. Presence of an external supply is detected by a positive link voltage >100mV (ANI5 goes low). Absence of the link is detected if Bias ON is attempted; this generates a negative link voltage (ANI7 goes low).

The other two sections of IC1608 form a window comparator, monitoring the voltage across R1607 during charge or discharge periods. When charge/discharge is complete, this voltage falls within the comparator window (pins 13/14 go high). Similarly, the voltage across R1616 (used for discharge only) is monitored by one section of IC1602 (pin 2 goes high). A second section of IC1602 (pin 1 output) gates these two outputs with the RL1602 drive signal, the resulting output appearing at ANI4 during charge/discharge periods only (High = bias correct).

2.13.3 Hold Comparator

IC1601b is connected as a differential amplifier sensing the voltage across R1617. The ac component appearing when measurements are enabled is removed by the filter R1622, R1623, C1605, C1606, the resulting dc error voltage being detected by separate Low and High comparators (IC1602 pins 13 and 14). The dc threshold for these comparators increases with total dc bias (R1624, R1628), allowing for the effect of resistor tolerances in the differential amplifier. To improve settling time, the filter resistors are bypassed during charge/discharge (RL1602/2 and RL1603/1). The two comparator outputs are combined and gated by sections of IC1609, appearing at ANI4 during 'bias hold' periods only (High = bias correct).

When switching off bias after a sustained application, dielectric storage in the output blocking capacitor of the Signal Source circuit causes a gradual increase in dc output level. To compensate for this, TR1611 provides a 2.5mA current bleed, turned on as necessary by the High comparator via TR1610. This circuit may continue to cycle for a minute or two after turning bias off. The resulting narrow pulses on ANI4 are normally ignored by software timing, except when measurement of capacitors >5000μF increases the dielectric storage effect. During charge/discharge periods the High comparator is held off (via D1622) inhibiting this current bleed.

The Bias Control truth table is given on the next page.

Bias Control Truth Table

	IC1606 Pin No.			IC1607 Pin No.						
	10	7	2	19	15	12	9	6	5	2
Bias OFF	0	0	0	0	0	0	0	0	0	0
Bias ON Charge/Discharge	1	X	X	0	X	X	X	X	X	X
Bias ON Hold	1	X	X	1	X	X	X	X	X	X
Level Setting (Bias ON)										
x1 Range 0.0V	1	0	0	X	0	0	0	0	0	0
x1 Range 0.1V	1	0	0	X	0	0	0	0	0	1
x1 Range 0.2V	1	0	0	X	0	0	0	0	1	0
x1 Range 0.4V	1	0	0	X	0	0	0	1	0	0
x1 Range 0.8V	1	0	0	X	0	0	1	0	0	0
x1 Range 1.6V	1	0	0	X	0	1	0	0	0	0
x1 Range 3.2V	1	0	0	X	1	0	0	0	0	0
x1 Range 5.0V	1	0	0	X	1	1	0	0	1	0
x2 Range 10.0V	1	0	1	X	1	1	0	0	1	0
x5 Range 20.0V	1	1	0	X	1	1	0	0	1	0

2.14 POWER SUPPLIES/GROUNDING

Power Supplies Circuit Diagram - Fig. 6.20.

IMPORTANT See Notes on Fig. 2.3.

The power supply unit comprises analog supplies, a 5-volt supply and a floating bias supply (see Fig. 2.3). Additionally, there are 12V regulators, bias control circuits and local supply regulators. Although the designs of these individual circuits are based on conventional principles, it is essential that no ground (or return) paths are introduced additional to those in the diagram. Failure to observe this will introduce loops that could seriously affect proper operation of the Analyzer.

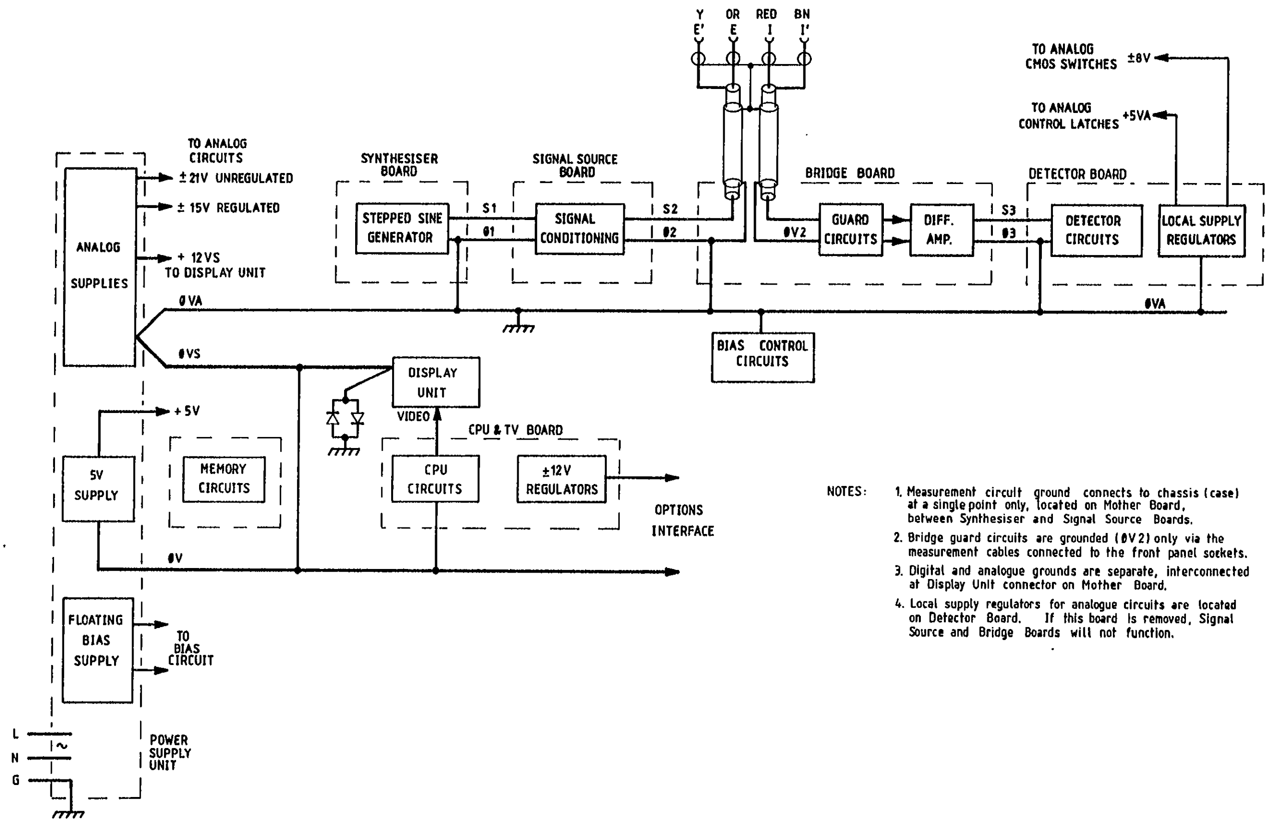


Fig. 2.3 Grounding and Power Supplies

2.15 RS232C INTERFACE OPTION (SIO OUTPUT)

Circuit Diagram - Fig. 6.26.

The card address is set up on switches S201 and S202. Gates IC200, IC201, IC203 provide an output when a matching address occurs on the address bus.

The data bus is connected to the UART IC208 via buffers IC205, IC206. The baud rate and data characteristics are set on switch S203, which is connected to the bus via IC207.

The serial data and control interface with IC208 is via buffers and the two-pole switches of S204. These switches permit the interchange of the data and handshake lines so that the Analyzer can operate as the computer or the peripheral end of the RS232C link.

2.16 GPIB/HANDLER INTERFACE OPTION

GPIB/Handler Interface Option, Circuit Diagram - Fig. 6.28.

IC1708 Decodes the I/O address to produce a high at IC1712 pin 12 when the board is accessed.

When SW1702 is not fitted, the card has a default address range of 10 to 17 Hex. When used as a Handler Interface option, SW1702 is fitted and the address range becomes 30 to 37 Hex.

IC1712 & IC1709 delay the decoded select by one cycle of 'CLOCK' to produce the chip select (CS) for IC1701.

The data strobe for IC1701 (02) is produced by gating together read ($\overline{\text{RD}}$) and write ($\overline{\text{WR}}$) pulses and delaying by one cycle of 'CLOCK'.

On a read from or write to IC1701, the internal registers are selected by RS0 to RS2 and data is coupled to/from the option bus by IC1707. IC1707 is made active by the same signal as $\overline{\text{CS}}$, and its direction determined by $\overline{\text{RD}}$.

When a read from register 4 of IC1701 is attempted, an enable is produced at $\overline{\text{ASE}}$ which in turn enables IC1706 and couples SW1701 to the option bus. By this means the user set Device address and talk only bit are read by the processor.

IC1702 to IC1705 are tristatable drivers which convey signals between the Output port SK1702 and the GPIA IC1701.

IC1701 may be configured under software control to generate an interrupt in response to certain IEEE bus events. The interrupt is sent to the processor by the open collector driver IC1711, its output appearing at pin 8.

At power-up, the microprocessor performs a read at bit 7 of register 3 of IC1701, to establish the presence of a GPIB and/or Handler Interface option in the instrument.

2.17 ANALOG OUTPUT OPTION

Analog Output Option, Circuit Diagram - Fig. 6.30.

The Analog Output option provides two dc output voltages, derived from two rectangular-wave signals under software control, in addition to four TTL input and four TTL output lines.

IC1801 performs the initial address decoding, the output on pin 6 going high whenever I/O addresses 020H - 027H are selected.

The first half of IC1802 decides whether the address relates to the analog circuits (addresses 020H - 023H) or the digital circuits (024H - 027H). If analog, the on-chip decoding of IC1804 is used. If digital, the second half of IC1802 is used to determine whether a Read or Write has been performed. A Write will generate a pulse to IC1806 which will store the current state of the data bus. The output of IC1806 is buffered by half of IC1803 to provide the digital output port. A Read will cause the outputs of the second half of IC1803 to be enabled, allowing the data bus to reflect the logic states of the Input port. At the same time TR1801 will be enabled, pulling data line D7 low, which is used by the microprocessor to determine the presence of an Analog Output option at power-up.

IC1804 contains three software-programmable timers. The first of these is used as a rate generator, generating a 347Hz rectangular wave (pin 10). The other two timers each take this base frequency and act as programmable monostable flip-flops, generating variable pulse-width signals. These signals will normally be 0-5V TTL and are used to switch the analog switch IC1807 between 0V and a negative reference of -6.3 to -7.2 volts.

The resulting negative-going rectangular signals feed into 3-pole low-pass filters (IC1808 and IC1809). Each filter contains an inverting stage to convert the output to a positive-going dc level, and each incorporates pre-set offset and scale adjustments to compensate for circuit tolerances. These may be adjusted and the circuit performance verified as follows, using built-in test software.

1 With the Analog Output board fitted and Main Index selected, the option ANALOG SET should be displayed. (Failure for this to show implies that address decoding or one of the data lines has failed). Select ANALOG SET, set the ANALOG ON/OFF to OFF, and set the UPPER OFF LEVEL to MIN. Connect a DVM on 1V dc range to TP2(+ve) and TP1. Set the output voltage to between -1mV and 1mV by adjusting R1810 (upper zero).

2 Set the UPPER OFF LEVEL to MAX. Set the output voltage to between 0.999 and 1.001V by adjusting R1824 (upper scale).

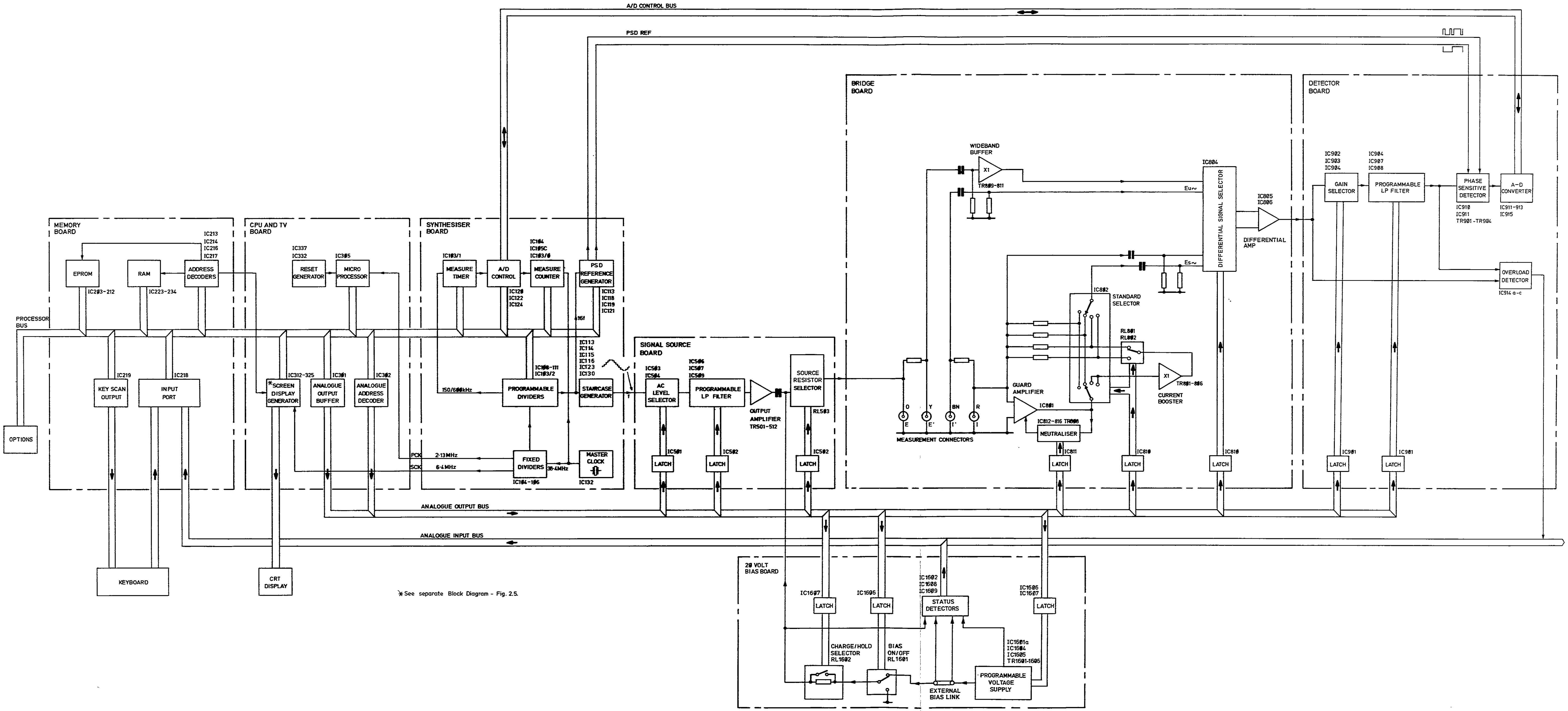
3 Set the UPPER OFF LEVEL to MID. Switch the DVM to an rms ac range and check that the ripple is less than 10mV rms.

4 Select Code 0.65. Set DVM to 2V dc range. Using the ▲ and ▼ keys, step the output voltage from 0.0V to 1.0V dc, checking that the dc output voltage is within ±1mV of the value displayed on the Analyzer at each step.

5 Connect the DVM between TP3 (+ve) and TP1 and repeat steps 1 to 4, setting LOWER instead of UPPER and adjusting R1815 for zero and R1814 for scale.

6 Connect an oscilloscope between TP2 (signal) and TP1 (ground). Select 200mV/div and 20ms/div. Select Main Index, followed by Code 0.6. Overshoot on the 10Hz square-wave should be less than 100mV, and the settling time less than 35ms.

7 Transfer the oscilloscope signal input to TP3 and repeat step 6. Remove the DVM and oscilloscope.



* See separate Block Diagram - Fig. 2.5.

Fig. 2.4
Block Diagram
DV/25741/A

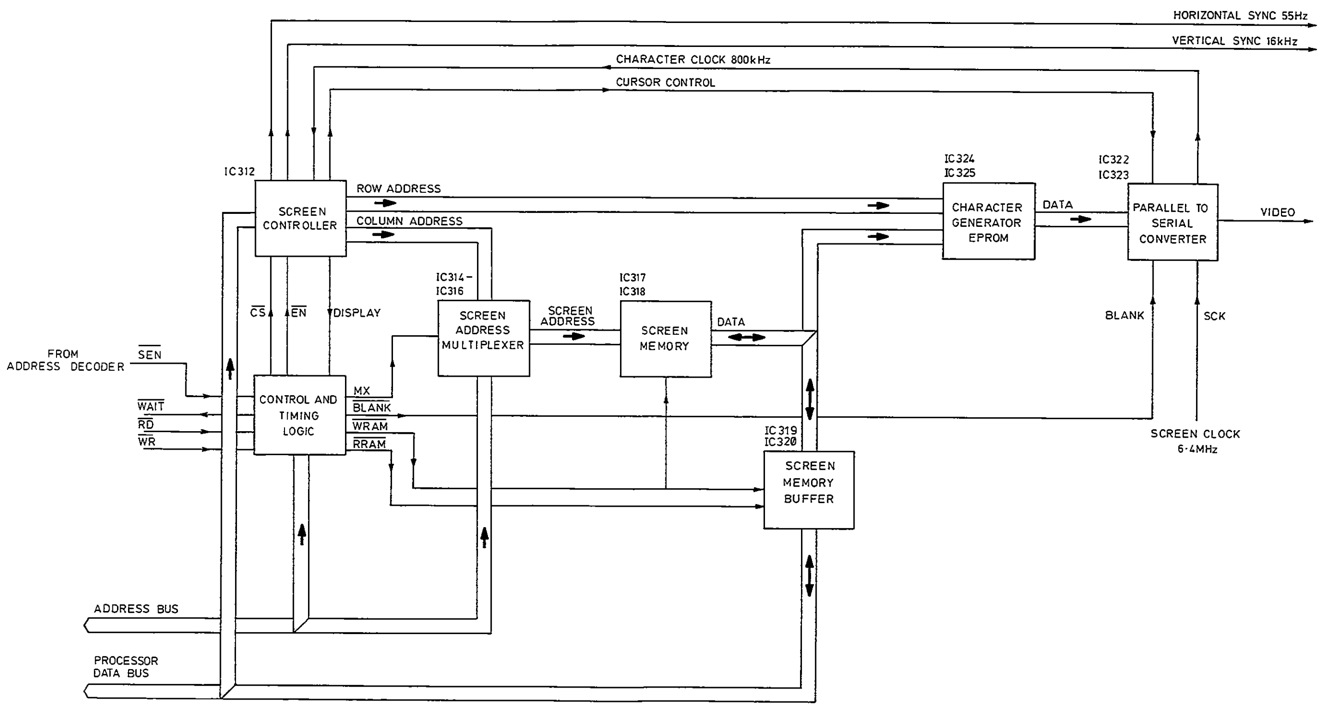


Fig. 2.5

Screen Display Generator - Block Diagram

DV/25739/A

3 DISMANTLING

WARNINGS

Safety goggles should be worn when handling cathode-ray tubes. Also, the inherent capacitance of the crt can retain a very high voltage charge for several minutes after the instrument has been switched off: this should be shorted to chassis before any work is done on the display circuits.

For personal safety, and to prevent possible damage to components, always allow 1 or 2 minutes from switch-off for reservoir capacitors to discharge. Check that all rail potentials have decayed before working on the circuits.

On rear lip of the top cover, turn 2 screws (using a 4mm a/f wrench, or screwdriver, according to type fitted) counter-clockwise until a resistance is felt (do NOT attempt to remove them). Raise rear lip slightly and push the cover forward to clear front lip. Remove cover. A similar procedure applies for removal of the bottom cover, if this is necessary.

To release the board retaining plate, remove 2 screws holding the plate to 2 round pillars, and lift this edge to lower the 'outer' end of the plate, clearing it away from 2 studs. The 6 front boards are now accessible.

With top and bottom covers removed, 4 screws are visible which can be removed to release the front panel. To remove rear panel, power transformer screws must also be removed (see Power Supply Unit removal on next page). DO NOT remove front and rear panels at one time or the assembly will collapse. The position of the pcbs and other major items is shown in Fig. 3.1.

Access to individual boards is obtained as follows:

CPU & TV - straight pull.

Memory - remove the 64-way connector, raise board some 10cm and push the locking tabs open to release the 10-way header plug. The board can now be withdrawn. (To replace the header plug, push until it clicks into position).

Synthesiser - straight pull.

Bridge - raise the board until the 8-way screened measurement connector can be held across its ends for removal. The board can now be removed with its screening plate attached.

Detector - straight pull (board with its screening plate).

Signal Source - " " " " " " "

Keyboard - remove front panel. Unsolder leads to Trigger socket (or remove socket). Remove 7 nuts to separate the Keyboard.

20V Bias - first remove CPU & TV, Memory and Synthesiser boards (as described above). Remove 20-way ribbon connector from Mother board. From the 20V Bias board, remove the 2-pin Molex connector (with leads to Bias Link). Using a 2.5mm a/f wrench between the heat-sink fins, remove the two hexagon-socket screws holding the board mounting bracket to the rear panel. When free, disconnect the flying lead 3-pin Molex from the Power Supply board.

Power Supply Board - remove 3 Molex connectors from the Board (1 to reservoir capacitors, 1 to power transformer and 1 to Bias board), and the flying-lead with Molex from the Mother board. Use a wrench (as just described for 20V Bias board) to free board bracket from back panel.

Option boards - the top cover of the Analyzer, and the board retaining plate, must be removed when inserting or removing option boards. Usually, it will also be necessary to remove the Detector and/or Signal Source boards. Options are held by 2 captive screws (top and bottom of their panels) and have 64-way connectors mating to their inside edge.

Display Unit - see WARNING at beginning of section 3. Remove the 6-way Molex connector from Mother board (the connector on the Display Unit varies with supplier). From inside the Analyzer, remove four screws from the base and one (on most models) from the top corner bracket. The complete unit can now be withdrawn.

Power Supply Unit - this is bolted to the rear panel and the two items should not be separated. To obtain access to the Power Supply Unit, remove the bottom cover. This exposes 2 screws into power transformer. Remove these and the 4 screws holding the rear panel to the main framework. Before separating the rear panel, remove connectors as necessary and separate one end of the on/off switch rod (twist to break adhesive bond). Unless previously removed, the rear panel will carry with it the Power Supply and 20V Bias boards, together with any Options.

Re-assembly is the reverse of the procedures above. Always check that the connectors are correctly positioned and securely fitted; in some instances this must be done before the board is re-fitted to the Analyzer.

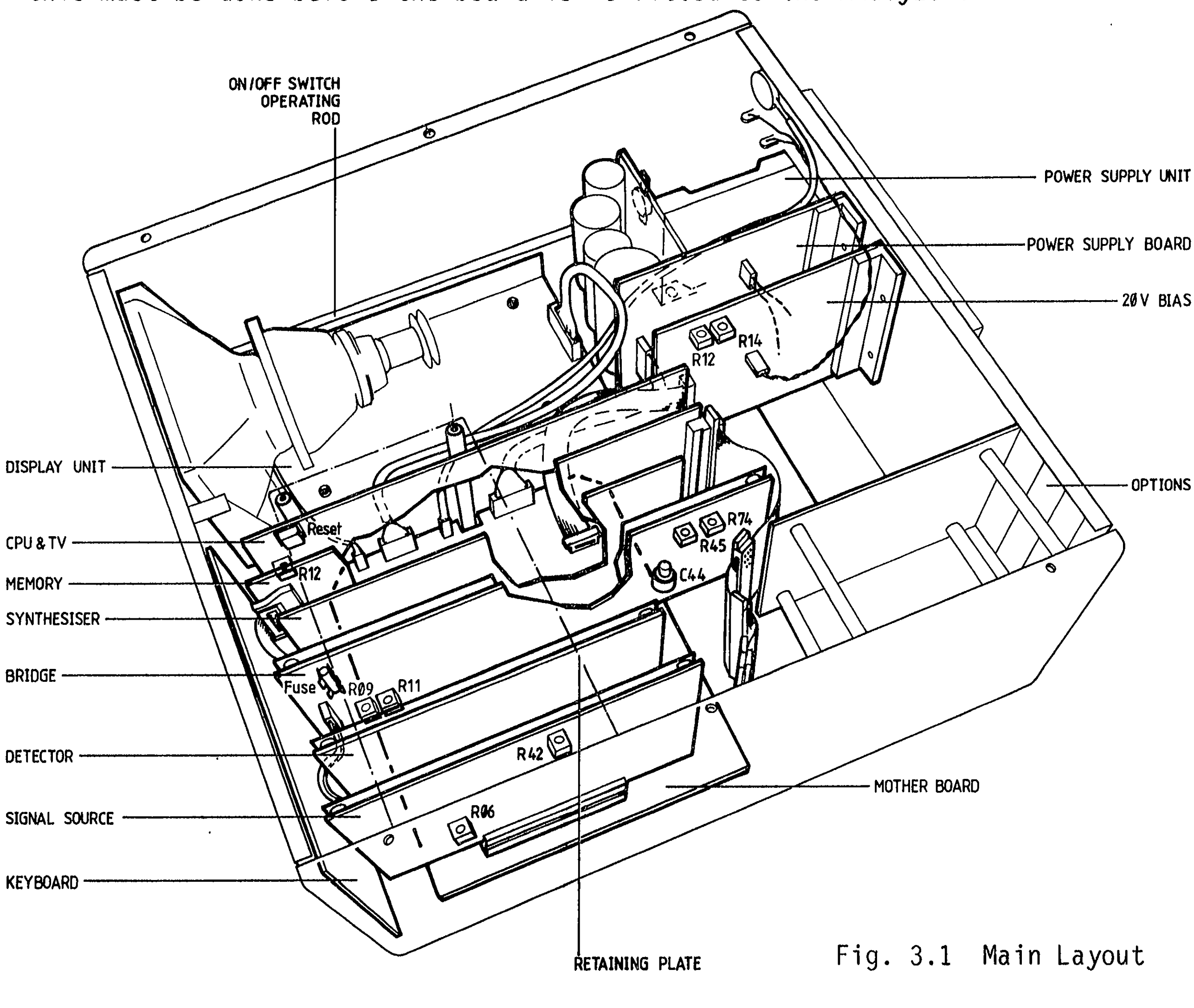


Fig. 3.1 Main Layout

4		TEST EQUIPMENT REQUIRED
4.1	Current Meter	To measure dc currents of 10µA ±1µA, 250mA ±1mA. Multimeter set to dc current range
4.2	DC Voltmeter	To measure dc voltages of 0-50mV, resolution ±1mV. Multimeter set to measure dc volts
4.3	AC Voltmeter	To measure ac voltages in the frequency range 20Hz to 300kHz. Average or rms responding, rms sine-wave calibrated Level range 0.5mV - 10mV, accuracy ±3% 10mV - 5V, accuracy ±0.1% Bandwidth 1MHz (or use item 4.4) Screened input lead, terminated BNC plug
4.4	Low-pass Filter	To reduce bandwidth of AC Voltmeter to 1MHz nominal for levels below 10mV. See Fig. 4.0 for suitable circuit
4.5	Frequency Counter	To measure 8kHz to ±0.001%
4.6	Oscilloscope	Input sensitivity range 10mV/div to 1V/div. Bandwidth >1MHz
4.7	10Ω Resistor	Connected across BNC plug. Value measured at plug: 10Ω ±0.1%
4.8	500µF Capacitor	Connected across BNC plug. Electrolytic or tantalum type, low voltage working, +ve end to centre pin of plug. Value of series capacitance measured at 20Hz: 500µF ±10%
4.9	100Ω Resistor	Wire-ended. Rating 5W. Value 100Ω ±1%

4.10	Standards	Screened, 4-terminal Standards terminated in four BNC connectors. See Fig. 4.2 for details of wiring. Screens isolated from Ground.
	R Values	Known values are relative to S/C. 1.00Ω ±1%. Known value ±0.005% 10.00Ω ±1%. " " ±0.005% 80.00Ω ±1%. " " ±0.005% 640.0Ω ±1%. " " ±0.005% 5.12kΩ ±1%. " " ±0.005% 470Ω ±1%.
	C Values	Known values are relative to O/C. 385pF ±1%. Known value (at 10kHz) ±0.005%. * 3.08nF ±1%. " " (at 100Hz & 10kHz) ±0.005%. * 24.6nF ±1%. " " (at 100Hz & 10kHz) ±0.005%. * 43 or 47pF silver mica or gas-filled. Value and dissipation factor known to ±0.005% at 10kHz. * 20nF ±2.5%. Polystyrene. D factor at 10kHz <0.0001
4.11	Extender Board	Single Eurocard size fitted with DIN 41612 64-way a/c indirect connectors
4.12	Variac	100VA minimum rating
4.13	DC Supply	30V 1A variable supply
4.14	Voltage Source	Floating 140mVdc source (eg battery & resistive divider network), accuracy ±5mV with 1kΩ load (Fig. 4.1)
4.15	Capacitor	100μF, 35V, terminated in 2 BNC plugs

* Silver mica capacitors, dissipation factor known to ±0.005% at 100Hz & 10kHz. Alternatively, a separate polystyrene capacitor of known low dissipation factor may be used in addition, in which case only the C value of the silver mica Standard is required to be known.

4.16 Test Lead — Screened 50Ω lead with two BNC connectors for Oscilloscope/Counter/DC "Link"

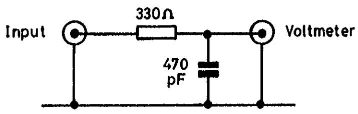


Fig. 4.0 Low-pass Filter

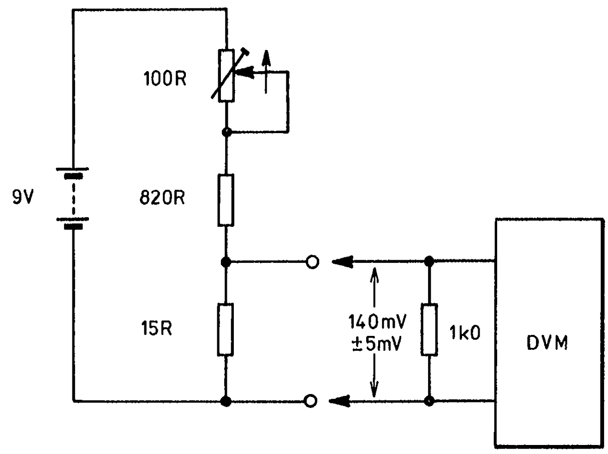


Fig. 4.1 Voltage Source

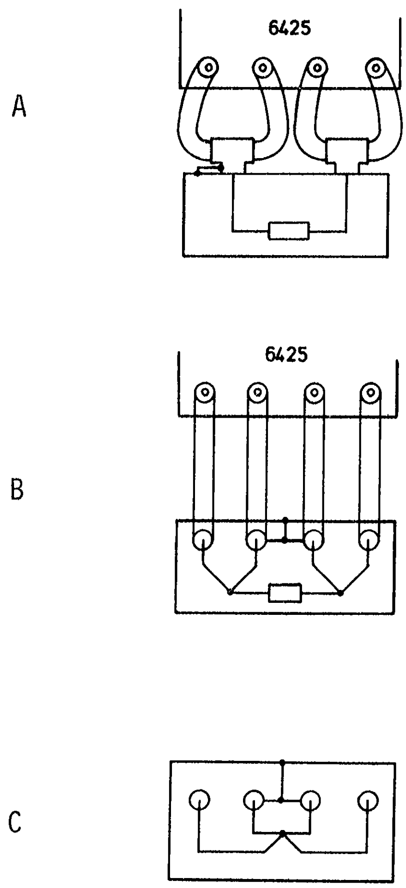


Fig. 4.2 Screened Standards

<u>Notes on Standards (see Fig. 4.2)</u>

Connections to 6425 should always be 4-terminal. (A & B).

Leads to screened boxes must be 4-terminal for low impedance Standards, with Red and Orange outers linked at box end and connected to box itself. Yellow and Brown outers O/C at box end. (B).

All R Standards, also the 20nF and 24.6nF Standards, must be 4-terminal (B). Lower-value capacitance Standards may be 3-terminal (A) or 4-terminal (B). With 3-terminal Standards, use BNC T-pieces at box end to convert to 4-terminal connections to 6425. (A).

C shows a 4-terminal short circuit.

5 SETTING-UP PROCEDURES

5.1 BATTERY REPLACEMENT

Life of the Lithium battery used in the non-volatile RAM circuits is normally greater than ten years. When replacement is necessary, remove the Memory Board (see section 3) and the old battery, and break the link between TP02 and TP03. Connect the Current Meter (item 4.1) across these test points (+ve to TP02). Fit the replacement battery, taking care to ensure the correct polarity. The CMOS RAM standby current should not exceed 10µA. Remove the meter, replace the link between TP02 and TP03, and refit the Memory Board, ensuring that the Keyboard connector (SK201) is inserted correctly.

5.2 POWER INPUT

Ensure that the rear panel Bias Link is fitted. Verify the supply voltage setting and ensure that the correct supply fuse is fitted. Link the inners of the red and orange measurement connectors. Connect the instrument to the ac supply via the Variac (item 4.12). Set this to the local nominal voltage, switch on and check that the yellow LED indicator is illuminated.

When the CRT display is visible, select Main Index and NORMAL. Set Bias to 10V and turn it ON. The message 'DC VOLTAGE NOT SET' should appear. This test draws maximum bias current (short-circuit condition) and confirms satisfactory operation of the power supply. Use the Variac to set the input voltage to the Analyzer to the low limit (207V for 230V instruments, 103V for 115V instruments). Use the DC Voltmeter (item 4.2) to check dc voltage levels at the regulator board output pins. Pin numbers and acceptable limits are in Table 5.0.

WARNING

> The dc bias short-circuit current of 1A causes R1607 at the top of the 20V Bias board to run very hot. Take care to avoid touching it, and keep measurement leads away to prevent damage. Switch Bias OFF except when making measurements.

On completion of these checks, remove the Bias Link.

Table 5.0 Internal Supply Tolerances

Output	Nominal	+Pin	-Pin	Limits
*Logic Supply	5.2V	1	2	4.92-5.43
Bias Supply	20.0V	PL02/2	PL02/1	18 - 23
Power Amp Supply (+ve)	+21V	5	8	19.3-24.0
Screen Supply	+12V	6	8	11.4-12.6
Analog +ve Supply	+15V	7	8	14.25-15.75
Analog -ve Supply	-15V	8	10	14.25-15.75
Power Amp Supply	-21V	8	11	19.0 - 25.0

* R710 (value 12R, 33R, 47R or 56R ±5%) is selected during manufacture to achieve correct output voltage. Increasing R710 increases output voltage.

5.3 VOLTAGE TRIP SETTING

Switch off the ac power, remove the CPU & TV Board and connect the DC Voltmeter across TP1 and TP2 (+ve). Refit the Board via Extender Board (item 4.11). Remove the Variac and connect the Analyzer to the ac supply. Switch on. The Voltmeter should read between 4.75 and 4.80V. If necessary, adjust R312. Remove the Voltmeter and re-fit the CPU & TV Board directly to the Analyzer.

5.4 DISPLAY

The Analyzer has an OEM CRT drive circuit. Consequently, setting details and locations of preset controls vary according to manufacturer. Horizontal and Vertical Sync. do not normally need adjustment but, if required, consult the appropriate Appendix.

5.5 BRIGHTNESS

Switch on. Set the Brightness control on the rear panel fully clockwise. Adjust the preset Contrast control on the CRT drive board for maximum brightness of the display without serious defocussing. If necessary, also adjust the preset Brill control until the background level is just invisible. Check operation of the rear-panel Brightness control and set to a normal level.

5.6 ALIGNMENT

Using the keyboard, enter Code 0.2, then press Enter to obtain the CRT test pattern. If miskeying occurs, press Clear and repeat. The centre line on the test pattern should be horizontal. If necessary, slacken the clamp screw on the deflection coil assembly, rotate as appropriate, and retighten the clamp.

If the display height is incorrect, adjust the preset Height or V. Amp control on the CRT drive board.

If the display width is incorrect, adjust the ferrite slug in the Width or H. Amp inductor. Use the correct tool when making this adjustment, or the slug may be damaged.

If the overall display is not centralized, adjust the two shift ring magnets on the deflection coil assembly.

The combined use of these last three adjustments should result in a display pattern which is centralized and approximately fills the screen.

5.7 PIN-CUSHION ADJUSTMENT

If appreciable pin-cushion distortion occurs, the procedure for minimizing it may differ on some models. Do not make any adjustments unless substantial correction is necessary.

If the deflection unit has bar magnets for pin-cushion correction, adjust these by bending them forward and towards the CRT to obtain straight vertical edges on the display pattern. Then adjust ring magnets on the pegs around the display coils, rotating them as necessary to obtain horizontal top and bottom edges on the display. Each of the magnet positions affects one corner or one edge of the display. In the corners of the display it may not be possible to obtain straight horizontal and vertical lines simultaneously on

the test pattern, in which case always adjust for best possible horizontal straightness.
After adjustment, the magnets should be re-locked with suitable cement.

5.8 LINEARITY AND POSITION ADJUSTMENT

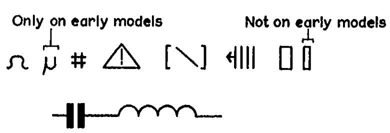
Check the displayed pattern for reasonable horizontal linearity. If obvious differences exist between cell widths at the centre and edges of the display, slacken the deflection coil clamp screw and adjust the linearity sleeve forwards or backwards. Check the display rotation before retightening the clamp.

The vertical spacing between the key legends should correspond exactly to the printed line spacing. If necessary, carefully adjust the display height to achieve this. The display should fill the screen with all details clearly visible: if necessary, make further slight adjustments to the shift ring magnets and width inductor. When set correctly, the key legends should appear in the lower half of their display "windows", when viewed from a position approximately 60cm directly in front of the CRT. If necessary, adjust the linearity presets in conjunction with the height control to obtain this condition for all keys simultaneously. (These presets are labelled Gen. Lin, Bott. Lin or F. Lin.)

Finally, adjust the Focus control for best possible focus at the 4 corners of the test pattern.

5.9 CHARACTER GENERATOR

5.9.1 To test the correct operation of the Character Generator circuits, press Main Index followed by Code 0.1 then Enter. Two versions will be displayed of each upper case letter, lower case letter, numeral and punctuation mark, the lower version being enclosed between two lines. Ensure that these two versions match exactly. The lower line of the display should read



NOTE 'Prom 1' displayed in top righthand corner.*

* Not applicable to some early models.

5.9.2 Press the Enter key to obtain a display of all large-size characters, these being constructed mosaic-wise from special character shapes. Ensure that each character is displayed correctly.

5.9.3* Press Enter. Note 'Prom 2' displayed in top righthand corner. Display should show characters as in 5.9.1, omitting the capacitor.

5.9.4* Press Enter. Large characters should be displayed as in 5.9.2.

5.9.5* Press Enter. Two columns of Bar Graphs should be displayed, the righthand column showing a centre mark. The length of the bar shown should increase from just under 50% at the top of the screen to about 60% at the bottom.

5.9.6 Press Main Index, followed by CONNECTIONS, and ensure all circuit symbols are displayed correctly.

5.10* RAM AND KEYBOARD TESTS

Press Main Index, followed by Code 0.3, then Enter to perform a self-test on the normal (volatile) RAM and the screen RAM.
If no failures occur, the instrument will return to the previous set up conditions. Otherwise a message will appear giving the location of the failure.

Press Code 0.4, then Enter to obtain a Keyboard test pattern. Press each key in turn, finishing with Main Index, to ensure correct operation without bouncing. Press Main Index again to exit from this test.

If it is required to check the Trigger socket, connect the lead or fixture normally used. Press Code 0.4 again, then Enter. Operate the switch on the lead or fixture and check that the effect is the same as pressing the Trigger button on the Analyzer.

5.11 EPROM TEST

Press Code 0.5, Enter, to perform self-test of the main software EPROMS. A cyclic redundancy signature is obtained for each EPROM in turn and its status displayed on the screen. Press Main Index to exit from test.

* Not applicable to some early models

5.12 TEST CONDITIONS

Press Main Index and select NORMAL.
Select Hold, Rep and Norm.
Press Code 6 and Enter to set the Analyzer to range 6.
Select C, R and Parallel.

5.13 SIGNAL SOURCE BOARD

Set frequency to 8.0kHz, level to 10mV ac, bias to 0.0Vdc and select Bias OFF.

Using the screened lead (item 4.16), connect the Oscilloscope to the orange measurement terminal. With range 6 retained, check that the display on the Oscilloscope is a sinewave of approximately 30mV p-p, with a dc error not exceeding ±10mV. Some hf noise is permitted, not exceeding 30mV p-p, with an Oscilloscope bandwidth of 20MHz.

5.13.1 Bias Setting and Power-Up Check

Switch power off. While monitoring the output on the Oscilloscope, switch on the power. After the initial spike (lasting about 0.5 seconds), the output should remain within ±100mV before returning to the previous signal conditions. Previously selected display settings should be retained. Switch power off. Connect the DC Voltmeter between TP01 (+ve) and TP02 on the Signal Source board. Switch power on. The DC Voltmeter reading should be 50mV ±10mV. If necessary, adjust Set Bias (preset R542) on the Signal Source board.

Connect the Frequency Counter (item 4.5) to the yellow measurement terminal. Set level to 1.00V ac. The frequency reading should be between 7999.2 and 8000.8Hz.

Switch the Analyzer on and off a number of times and check that the non-volatile display settings are retained. A self-check is performed at power-up and any corruption causes the display to revert to the Main Index mode, with an indication of the memory area that has failed.

5.13.2 Level Setting

Ensure Hold is selected. Key Code 5, Enter, to select range 5. Set level to 1V ac. Set frequency to 1.2kHz. Using a screened lead, connect the AC Voltmeter to the yellow measurement terminal. Check that the reading is 1.00V ±0.5%. If necessary, adjust Set Level (preset R506).

Set the level to each of the following values and check that the Voltmeter reading is always within the specified limits.

10, 20, 30, 40, 70, 80mV	±2mV
150, 160mV	±3mV
310, 320, 500mV	±5mV
2.5V	2.4625 - 2.5375V
5.0V	4.925 - 5.075V

5.13.3 Source Impedance

Reset level to 1.00Vac. Temporarily replace the Oscilloscope by a 10Ω 0.1% resistor (item 4.7). The AC Voltmeter reading should be between 800 and 820mV. Press Code 1 and Enter to select range 1. The level display should change from 1.00V to 100mA and the AC Voltmeter should read between 812 and 855mV. Remove the 10Ω resistor and reconnect the Oscilloscope.

5.13.4 Frequency Response

Press Code 3, Enter, to select range 3. Select 20Hz and then step upwards through each frequency in turn. At each step, check the Oscilloscope display for a sine wave of approximately the correct frequency and ensure that the AC Voltmeter reading is between the following limits:

20 & 25Hz	0.95 - 1.05V
30Hz - 120kHz	0.975 - 1.025V
150kHz	0.965 - 1.035V
200kHz	0.94 - 1.06V
300kHz	0.90 - 1.10V

The value of C507 (33, 36 or 39pF) is selected during manufacture to achieve the 150kHz to 300kHz values.

5.13.5 Output Coupling Capacitor

Select 20Hz. Replace the Oscilloscope by a 500µF capacitor (item 4.8). The level should not fall below 0.9V. Disconnect the capacitor, AC Voltmeter and Counter.

5.14 BRIDGE BOARD

5.14.1 Bias Setting

Switch off power, and connect DC Voltmeter (item 4.2) between TP01(+ve) and TP02 on the Bridge board. Switch power on and check that the Voltmeter reading is 50mV ±10mV. If necessary, adjust Set Bias (preset R845). Transfer the DC Voltmeter to TP03 and TP04* on the Bridge Board. The reading should be 0V ±10mVdc. If necessary, adjust R896. Switch off power, and disconnect DC Voltmeter.

5.14.2 Neutralizer Tuning

Connect the AC Voltmeter (item 4.3) to the brown measurement terminal, using a screened lead (item 4.16). If the Voltmeter has a bandwidth exceeding 1MHz, insert the Low-pass Filter (item 4.4) in the input lead, close to the Voltmeter. Connect the 5.12kΩ Standard (see 4.10) between the red and orange measurement terminals.

Set frequency to 60kHz, level to 3.00Vac, and select Hold and Rep. Key in Code 6, Enter, to select range 6. If Range No. is not displayed, turn it on by keying Code 9, Enter.

Key in Code 7, Enter, to select range 7. This should cause the reading to blank and RANGE ERROR message to appear. The Voltmeter reading should be less than 4.0mV. If necessary, adjust Set Neutralizer (preset R874) on the Bridge board for minimum Voltmeter reading.

* On Bridge boards before issue G, TP03 and TP04 are not fitted. The two measurement points are:
- (i) The junction of R895 and R896 (fitted in position R814 and TR813 respectively).
- (ii) The junction of R813 and R868.

Using the ▼ key, step the frequency downwards to 2kHz. At each step, check that the Voltmeter reading does not exceed the following limits:

40 - 60kHz	4.0mV	
30kHz	2.2mV	
15 - 25kHz	2.0mV	If necessary, the Low-pass Filter
3.0 - 12kHz	0.9mV	bandwidth may be reduced by a factor of
2.0 - 2.5kHz	3.0mV	10 for frequencies of 20kHz and below

Set frequency to 75kHz. The Analyzer should automatically select range 6. Using the ▲ key, check at each frequency up to 300kHz that the Voltmeter reading does not exceed 1.35mV. If necessary, re-adjust R874 to bring all readings within limits. Note that if the first part of this test is to be repeated, range 7 must be re-selected after setting the frequency to 60kHz or below.

5.14.3 Range 1 Input Impedance

With the test equipment connected as for the previous test, replace the 5.12kΩ Standard by a short-circuit between the inners of the red and orange measurement terminals. Key in Code 1, Enter, to select range 1. The drive level should change to 100mA. Set the frequency to 20kHz and check that the Voltmeter reading does not exceed 30mV. Disconnect the AC Voltmeter.

5.15 DETECTOR

5.15.1 Attenuators and DC Level

Using a suitable test probe, connect Oscilloscope to TP02 on the Detector board, making the ground connection to the Detector board screen plate mounting screw. Connect the 640Ω Standard. Enter Code 4 to select range 4.

Set frequency to 1.0kHz, level to 5.00Vac and speed to Fast. The Oscilloscope should display a sinusoidal signal, switching rapidly between two levels. The larger level should be between 1.9 and 2.5V p-p.

Repeat this test with levels of 2.35V, 1.1V, 520mV and 140mV. Some dc shift may occur as the level is reduced. Ensure that the combined peak signal + dc shift does not exceed ±4V total when the level is set to 140mV.

5.15.2 Filters

Set level to 2.35Vac. Set frequency to the following values in turn, in each case ensuring that the larger displayed level is between 1.9 and 2.5V p-p.

30Hz	1.2kHz	50kHz
80Hz	3.0kHz	120kHz
200Hz	8.0kHz	300kHz
500Hz	20kHz	

5.15.3 A-D Converter Waveform

Set speed to Norm and frequency to 40kHz. Transfer the Oscilloscope probe to TP03 on the Detector board. Set the Oscilloscope sensitivity to 1V/division, dc-coupled, and the timebase to 5ms/division.

Connect the timebase synchronizing input to TP04 and adjust the Oscilloscope to trigger on the -ve going edge of the TTL level pulse present at this point. The Oscilloscope will now display the charge balancing waveforms of the A-D converter. A complete measurement sequence comprises 6 separate measurements, each giving slightly different waveforms and these will appear in succession superimposed on one another. Each waveform should comprise an initial period of 40ms (50ms for 60Hz instruments) during which the voltage oscillates between a maximum of 3.2V and a minimum of 1.8V. The voltage should then fall in approximately 1.5ms to between 0 and -0.2V before returning to 2.5V for 1ms and then repeating (see Fig. 5.1).

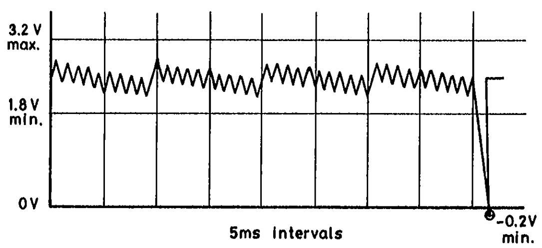


Fig. 5.1 A-D Converter Waveform

Set frequency to 15kHz and ensure these timings are maintained.

Set frequency to 1kHz. The voltage should now oscillate at twice the previous frequency and the amplitude of these oscillations should be half of their original value.

Set speed to Fast and check that the initial charge-balancing period changes to 5ms.

Set speed to Slow and change timebase setting to 20ms/division.

The Slow sequence comprises 4 measurements at 200ms and 4 measurements at 100ms. Set frequency to 100kHz and check that these timings become 100ms and 50ms respectively.

Disconnect the Oscilloscope.

5.15.4 Overload Detectors

Select Slow and set frequency to 1.5kHz. With Hold selected, enter Code 5 to select range 5.

Connect the 470Ω Standard between the red and orange measurement terminals.

Set level to 0.92Vac and check that measurement result is blanked.

Inspect the 'measure busy' asterisk (screen top left) and check that it blinks regularly at a rate of approximately 1 per second.

Set level to 1.10Vac and check that the regular blinking is replaced by either a faster irregular blink or a steady asterisk.

Set frequency to 20Hz, check that result is blanked, and that asterisk blinks at a rate of 1 per second.

Set level to 4.3Vac and check that faster blinking or a steady asterisk occurs.

5.16 ACCURACY TESTS

IMPORTANT. Do not attempt any part of these checks unless the test equipment and all the Standards are available. In particular, HF Phase adjustments are inter-dependent: do NOT perform either 5.16.3 or 5.16.10 unless both operations can be completed. It is also vitally important that all trimming operations are made with any connecting leads arranged exactly as they will be for measurement checks. If the leads are changed or moved in any way, the trimming operation must be repeated.

Trimming removes the effect of shunt impedances on high-impedance ranges and series impedance on low-impedance ranges. If Standards are only 2-terminal, the outside connectors must be removed completely (this applies to high impedances: on low-impedance ranges, 4-terminal connections are essential).

Connect the short screened leads that are to be used for connecting Standards.

5.16.1 Initial Trim - O/C

Key in Code 9.1, Enter, to clear down the non-volatile memory. Select NORMAL and set speed to Slow. Set frequency to 10kHz. Select C, G, Parallel and Rep.

Key in Code 9, Enter, to obtain a display of the currently selected measurement range. This should be 8.

Check that the residual capacitance reading does not exceed 8.8pF, with parallel conductance reading not exceeding ±10nS.

Press Trim O/C followed by Trigger to initiate the Auto-Trim process. When this is complete (allow 10-15 seconds), the display should show 0.0fF ±2fF and 0.0nS ±0.04nS.

5.16.2 Initial Trim - S/C

Connect a 4-terminal short circuit (see Fig. 4.2). The Analyzer should Auto-range to range 1, the drive level changing to 100mA.

Select L, R and Series.

Check that the residual inductance and resistance readings do not exceed 350nH and 20mΩ respectively.

Press Trim S/C followed by Trigger. When the Auto-Trim process is complete, the display should show 0.0nH ±0.4nH and 0μohm ±30μohms.

5.16.3 HF Phase (ranges 1-6)

Select Hold and key Code 4, Enter, to select range 4.

Set speed to Slow and connect the 80Ω Standard, ensuring that the leads are not moved (the slightest movement will cause a greater change than the 0.1μH permitted).

The series inductance reading should be exactly 0.00μH. If necessary, adjust HF Phase (R811) on the Bridge board.

Set frequency in turn to 30kHz, 100kHz and 300kHz. In each case, the inductance reading should not exceed ±0.1μH.

5.16.4 Measurement Speed Correlation

Re-set frequency to 10kHz and note exact resistance reading. Select Fast. The inductance reading should be 0.0μH and the repeated resistance readings should not vary by more than 0.02Ω, each reading being within 0.02Ω of the value noted.

Select Norm. The inductance reading should be 0.0μH and the repeated resistance readings should not vary by more than 0.005Ω, each reading being within 0.005Ω of the value noted.

5.16.5 System Linearity & Distortion

Repeat the O/C Trim and S/C Trim procedures (see 5.16.1 and 5.16.2). Select Auto, C, D, Parallel and Slow. If range number is not displayed, key Code 9, Enter.

Connect the 20nF Polystyrene Standard.

Set frequency to 10kHz and check that range 5 has been selected. Note the exact C and D readings.

Set frequency to 12kHz and use the ▼ key to step the frequency downwards to 1.5kHz. At each step, check that:

a) range 5 remains selected

b) the change in C reading from the noted value, and the change in C reading from the previous step, do not exceed the limits shown in Table 5.1

c) the D reading, and the change in D reading from the previous step, do not exceed the limits shown in Table 5.1.

Note: The value of C818 (1nF, 1n2 or 1n5) is selected during manufacture to achieve correct D readings on range 5. If it needs to be changed, repeat 5.16.3 and the above tests (5.16.5).

Set frequency to 1kHz. Check that range 6 has been selected, and note the exact C reading. Repeat the above test, stepping frequency from 1.5kHz down to 200Hz, and applying the test limits shown in Table 5.2.

Set frequency to 150Hz. Check that range 7 has been selected, then select Hold and note the exact C reading. Repeat the above test, stepping frequency from 200Hz down to 20Hz, and applying the test limits shown in Table 5.3. Ignore RANGE ERROR which shows at 20Hz.

Set frequency to 20kHz and select Auto. Check that range 4 has been selected, and note the exact C reading. Set frequency to 12kHz and use the ▲ key to step the frequency upwards to 100kHz. At each step, check that range 4 remains selected, and that the changes in C and D readings conform to the limits shown in Table 5.4 as for previous tests.

Set frequency to 120kHz. Check that range 3 has been selected, then select 100kHz and note the exact C reading. Repeat the above test, stepping frequency from 100kHz to 300kHz and applying the test limits shown in Table 5.5.

Table 5.1 (Range 5)

FREQUENCY (kHz)	C LIMIT (±nF)	D LIMIT(±)
12	.002	.0004
10	Reference	.00035
8	.0020	.00030
6	.0020	.00030
5	.0020	.00030
4	.0020	.00025
3	.0025	.00025
2.5	.0030	.00025
2	.0040	.00025
1.5	.0040	.00025

Table 5.2 (Range 6)

FREQUENCY (Hz)	C LIMIT (±nF)	D LIMIT(±)
1.5k	.0020	.00025
1.2k	.0020	.00025
1.0k	Reference	.00025
800	.0020	.00025
600	.0020	.00025
500	.0020	.00025
400	.0020	.00025
300	.0030	.00030
250	.0040	.00030
200	.0040	.00030

Table 5.3 (Range 7)

FREQUENCY (Hz)	C LIMIT (±nF)	D LIMIT(±)
200	.0020	.00030
150	Reference	.00035
120	.0020	.00040
100	.0020	.00040
80	.0025	.00045
60	.0030	.00055
50	.0040	.00060
40	.0040	.00070
30	.0060	.00090
25	.0080	.00100
20	.0100	.00120

Table 5.4 (Range 4)

FREQUENCY (kHz)	C LIMIT (±nF)	D LIMIT(±)
12	.002	.0004
15	.002	.0004
20	Reference	.0005
25	.006	.0008
30	.006	.0010
40	.008	.0014
50	.010	.0020
60	.015	.0020
75	.015	.0025
100	.020	.0030

Table 5.5 (Range 3)

FREQUENCY (kHz)	C LIMIT (±nF)	D LIMIT(±)
100	Reference	.0030
120	.03	.004
150	.03	.004
200	.04	.005
300	.08	.008

5.16.6 S/C Trim Interpolation

Re-connect the 4-terminal short circuit as in Fig. 4.2.

If the range number is not displayed, key Code 9, Enter.

Select Auto, Z, Vac and Slow.

Check that range 1 has been selected.

Set frequency to 10kHz and level to 100mA.

During this test, and 5.16.7, ensure that the leads are not moved.

Press Trim S/C, followed by Trigger, to initiate the Auto-Trim process. When this is complete, set frequency to 20Hz and then step through to 10kHz. At each frequency, check that the Z reading does not exceed the following values:

20Hz - 50Hz	250μohms
60Hz - 5kHz	125μohms
6kHz	150μohms
8kHz	200μohms
10kHz	50μohms

Set level and frequency as shown below and, for each combination, check that the Z reading does not exceed the value shown:

Level (mA)	Frequency	Impedance	Range
25	20 Hz	250 μohms	1
25	10kHz	80 μohms	1
5	20 Hz	1.00mohm	2
5	10kHz	0.40mohm	2

Select L, R and series. Set level to 100mA.

Step frequency from 12kHz to 300kHz. At each frequency ensure that the L and R readings do not exceed the following values (Range 1 selected):

FREQ (kHz)	L max (±nH)	R max (±mΩ)
12	4.0	0.30
15	4.0	0.38
20	4.0	0.50
25	4.0	0.63
30	4.0	0.75
40	4.0	1.00
50	4.0	1.25
60	4.0	1.50
75	4.0	1.90
100	4.0	2.50
120	4.0	3.0
150	4.0	3.8
200	4.0	5.0
300	4.0	7.5

At 300kHz only, repeat this test with level set to 25mA (test limits ±4nH and ±7.5mΩ) and with level set to 5mA (test limits ±20nH and ±38mΩ).

5.16.7 Low Impedance Accuracy (10kHz)

After performing the previous test, select Hold.

Set frequency to 10kHz and level to 100mAac.

Select each of the following range and Standard combinations in turn, using the corresponding Code no. to select each range. In each case, ensure that the R reading corresponds to the known Standard value, within the tolerance shown, and that the L reading does not exceed the tolerance and limits shown. Ignore RANGE ERROR which appears on range 2 with 1Ω selected.

Range No	Standard	R Tolerance	L Limit*		
			Min		Max
1	1Ω	±.0004Ω (±0.4mΩ)	+25	to	+35nH
2	1Ω	±.0004Ω (±0.4mΩ)	+23.5	to	+36.5nH
2	10Ω	±.002Ω	-5	to	+45nH
3	10Ω	±.002Ω	-5	to	+45nH
3	80Ω	±.024Ω	-230	to	+270nH
4	80Ω	±.024Ω	-0.05μH	to	+0.05μH
4	640Ω	±.200Ω	-3.5μH	to	+2.6μH

Level Vac	Range No.	Standard (ohms)	R Tolerance (ohms)	L Limit*	
				Min	Max
5.00	4	640	0.24	-4.0μH	+3.1μH
2.35	4	640	0.24	-4.0μH	+3.1μH
520mV	4	640	0.24	-4.0μH	+3.1μH
140mV	4	640	0.24	-4.0μH	+3.1μH
50mV	4	640	0.24	-4.0μH	+3.1μH

5.16.8 Low Impedance Accuracy (100Hz)

Set level to 1.00Vac.
Select range 1 and check that level changes to 100mAac.
Set frequency to 100Hz, then repeat the whole of section 5.16.7 with the following test limits:

Range No	Standard	R Tolerance	L Limit
1	1Ω	±.0004Ω (±.4mΩ)	±0.50μH
2	1Ω	±.0004Ω (±.4mΩ)	±0.5μH
2	10Ω	±.002Ω	±5.00μH
3	10Ω	±.002Ω	±5.0μH
3	80Ω	.024Ω	±40μH
4	80Ω	.024Ω	±40μH
4	640Ω	.20Ω	±305μH

* Figures quoted assume Standard resistors have a self-inductance of 20nH relative to reference S/C except that, in the case of the 640-ohm resistor, a self-capacitance of 1pF is assumed. Other Standards may differ.

Level Vac	Range No	Standard (ohms)	R Tolerance (ohms)	L Limit (µH)
5.00	4	640	0.24	±355
2.35	4	640	0.24	±355
520mV	4	640	0.24	±355
140mV	4	640	0.24	±355
50mV	4	640	0.24	±355

5.16.9 O/C Trim Interpolation

Remove all connections from the measurement sockets.

If the range number is not visible, key Code 9, Enter.

Select Auto, Y, Iac and Slow.

Set frequency to 10kHz and level to 5.00V.

Check that range 8 has been selected.

Press Trim O/C, followed by Trigger, to initiate the Auto-Trim process. When this is complete, set frequency to 20Hz and then step through to 10kHz. At each frequency, check that the Y (admittance) reading does not exceed the following limits:

Frequency	Admittance (nS)
20-50 Hz	0.20
60-1k Hz	0.10
1.2kHz	0.12
1.5kHz	0.15
2 kHz	0.20
2.5kHz	0.25

Frequency	Admittance (nS)
3kHz	0.10
4kHz	0.40
5kHz	0.50
6kHz	0.60
8kHz	0.80
10kHz	1.00

Level (mV)	Frequency	Admittance (nS)	Range
250	20 Hz	0.2	8
250	10kHz	1.0	8
50	20 Hz	1.0	7
50	10kHz	5.0	7

Select C, G and Parallel. Set level to 5.00V.

Step frequency from 12kHz to 300kHz. At each frequency, check that correct range is selected and that the C and G readings do not exceed the following values:

FREQ (kHz)	RANGE	C Max	G Max
12	7	±10fF	±0.9nS
15	7	±25fF	±2.4nS
20	7	±25fF	±3.2nS
25	7	±25fF	±4.0nS
30	7	±25fF	±4.5nS
40	7	±25fF	±6.0nS
50	7	±25fF	±8nS
60	7	±10fF	±5nS
75	6	±0.05pF	±100nS
100	6	±0.05pF	±30nS
120	6	±0.05pF	±0.15μS
150	6	±0.05pF	±0.19μS
200	6	±0.05pF	±0.25μS
300	6	±0.05pF	±0.19μS

Level (mV)	Frequency (kHz)	Range	C Max	G Max
250	60	7	±50fF	±20nS
250	300	6	±0.1pF	±0.19μS
50	60	6	±0.40pF	±150nS
50	300	5	±0.80pF	±1.5μS

5.16.10 High Impedance Accuracy (10kHz)

NOTE: If separate Standard capacitors are available for D factor measurements, select these whenever a D measurement is required throughout test clauses 5.16.10 and 5.16.13. Use the Silver Mica Standards for all measurements of C value.

After performing the previous test, select Hold, C, D and Parallel.

Set frequency to 10kHz and level to 1.00Vac.

Select range 7 and connect the 385pF Standard capacitor.

The D reading should correspond exactly with the known D value of the capacitor at 10kHz, with a variation due to measurement noise not exceeding ±0.00005. If necessary, adjust Range 7 Phase (C844) on the Bridge board.
Check that the C reading is within ±0.15pF of the known Standard value.
Disconnect the brown and yellow measurement leads at the Analyzer end. If the Standard is 4-terminal, connect all four outers together at the Standard end of the leads. Check that the change in C reading does not exceed ±0.04pF and that the change in D reading does not exceed ±0.00015.
Re-connect the brown and yellow measurement leads to the Analyzer and, if the four outers were linked at the Standard end, remove the link.

Select each of the following range and Standard combinations in turn, using the corresponding Code No. to select each range. In each case, check that the C and D readings correspond to the known Standard values within the tolerances shown.

Range No	Standard	C Tolerance	D Tolerance
6	385pF	±0.17pF	±.00045
6	3.08nF	±0.0012nF	±.00040
5	3.08nF	±0.0014nF	±.00045
5	24.6nF	±0.010nF	±.00040

With range 5 held, connect the 640Ω Standard. Select C, R and Parallel.

Check that the R reading corresponds to known Standard value ±0.20Ω with a C reading between the limits -6.5 to +8.5pF. (See footnote on page 5-19).

5.16.11 High Impedance Accuracy (100Hz)

With settings retained from the previous test, set frequency to 100Hz. Select each of the following range and Standard combinations in turn. In each case, check that the R reading corresponds to known Standard value within tolerance shown, with a +ve or -ve C reading not exceeding the limit shown.

Range No	Standard	R Tolerance	C Max
5	640Ω	±0.20Ω	0.75nF
5	5.12kΩ	±0.0016kΩ	0.09nF
6	5.12kΩ	±0.0016kΩ	93pF

Select C, D and Parallel.

Select the following range and Standard combinations in turn.

In each case, check that the C and D readings correspond to the known Standard values within the tolerances shown. Ignore the RANGE ERROR message which appears for the first and third measurements.

Range No	Standard	C Tolerance	D Tolerance
6	24.6nF	±.011nF	±.00045
7	24.6nF	±.010nF	±.00040
7	3.08nF	±.0014nF	±.00045

5.16.12 Range 8 Accuracy (High Frequency)

Connect the 43pF (or 47pF) Standard between the Red and Orange measurement sockets.

Set the frequency to 10kHz and the level to 1.00Vac.

Select C, G, Parallel, Hold and Slow.

Select measurement range 8.

Temporarily disconnect the Red measurement lead at the Standard end and perform an O/C trim.

Check that the C reading does not exceed ±2fF and that the G reading does not exceed ±0.04nS. Re-connect the Red measurement lead and select C, D.

The D reading should correspond exactly with the known D value of the Standard, with a variation due to measurement noise not exceeding ±0.00005. If necessary, adjust Range 8 Phase (R809) on the Bridge board.

Note: The value of R808 (1k3, 2k2, 3k0) is selected during manufacture to centralise the range of R809. If it needs to be changed, repeat the O/C trim before adjusting R809.

Check that the C reading is within ±0.022pF of the known Standard value.

5.16.13 Range 8 Accuracy (Low Frequency)

Set the frequency to 100Hz and the level to 1.00Vac.

Remove all connections from the measurement sockets and perform an O/C trim.

Check that the C reading does not exceed ±0.02pF and that the G reading does not exceed ±0.01nS.

Connect the 3.08nF Standard. Check that the C and D readings are within ±0.0012nF and ±0.00040, respectively, of the known values. Disconnect the Standard.

5.17 20V BIAS BOARD

5.17.1 Voltage Setting

Ensure that the Bias link is fitted to the Analyzer. Select Code 9.1, Main Index, Normal, 10kHz, Rep and Bias ON.

Connect DVM (Item 4.2) between bias link +ve and screen of Orange socket. Set Bias to 0.0V. When the DC VOLTAGE NOT SET message has extinguished, check that the DVM reading is 0 ±5mV. If necessary, adjust R1612.

Set Bias to 20V. When the DC VOLTAGE NOT SET message has extinguished, check that the DVM reading is 20V ±0.02V. If necessary, adjust R1614.

Repeat these last two tests until both conditions are met.

Connect the DVM between centre and ground of Orange socket.

Set bias to each of the following values in turn and check that every reading lies within the limits shown.

SETTINGS	MINIMUM	MAXIMUM
5 V	4.84	5.16
10 V	9.74	10.26
20 V	19.54	20.46
0.0V	-0.060	0.060
0.1V	0.038	0.162
0.2V	0.136	0.264
0.3V	0.234	0.366
0.4V	0.332	0.468
0.7V	0.626	0.774
0.8V	0.724	0.876
1.5V	1.41	1.59
1.6V	1.51	1.69
3.1V	2.98	3.22
3.2V	3.08	3.32

Select Bias OFF.

5.17.2 Hold Filter

Select 20Hz and connect BNC link between Red and Orange sockets.
Check that the DC VOLTAGE NOT SET message does not come on during the next few seconds.

Remove the BNC link.

5.17.3 Hold Threshold

Connect Bias link +ve to inner of Orange socket.

Select Hold, and key in Code 4, Enter, to select range 4.

Select 10kHz, 2.6Vdc and Bias ON.

Check that the DC VOLTAGE NOT SET message is extinguished and that no other messages appear.

Insert the 140mV source (Item 4.14) between the Bias link and the Orange socket (positive to socket).

Check that DC VOLTAGE NOT SET appears and extinguishes cyclically.

Select 7.4Vdc on Analyzer and check that DC VOLTAGE NOT SET does not show.

Remove the 140mV source, reconnecting the Bias link to the Orange socket.

Check that DC VOLTAGE NOT SET remains extinguished.

Select Bias OFF and disconnect the link.

5.17.4 Leakage Current

Connect the 640-ohm Standard.

Select 2.3Vdc and Bias ON.
Check that DC VOLTAGE NOT SET extinguishes within a few seconds. The message will periodically re-appear and extinguish as the bias level is corrected.

Select Bias OFF.

5.17.5 Measurement Accuracy

Connect the 20nF Standard.

Select Code 9.1, Normal, 20Vdc, Slow, C, D and Trigger.

Note the C and D readings.

Select Bias ON and Trigger in quick succession.
When new readings appear, check that they are within 0.002nF and 0.0001 of those readings noted without Bias applied.

Select Rep.
Disconnect the 20nF Standard.

5.17.6 Dielectric Storage

With 20Vdc still applied, select 10mVac and connect the 100µF Capacitor between inners of Red and Orange sockets (positive to Orange).

Connect Oscilloscope to Yellow socket with screen as reference. Set Oscilloscope to 20mV/division, 2ms/division, dc coupled.

Select Bias OFF.
Check that once the Bias level has initially fallen to 0V, the dc level shown on the oscilloscope does not exceed ±80mV during the following ten seconds and, furthermore, that during the same ten seconds the DC VOLTAGE NOT SET message does not re-appear.

Remove 100µF capacitor and oscilloscope.

5.17.7 Link Status Detector

Select 0.1Vdc and remove Bias link.

Select Bias ON and check that BIAS LINK NOT FITTED and Bias OFF messages appear.

5.17.8 External Bias Supply

Connect DVM between Bias link positive (+) and inner of Orange measurement socket (-).

Select 20Vdc.

Observing polarity, replace the Bias link with the external DC Supply set to 30V ±0.1V as displayed on DVM.

Check that EXTERNAL BIAS SUPPLY message appears.

Select Bias ON.

Wait for the DC VOLTAGE NOT SET message to extinguish.

Check that the DVM reads between -1.06V and +1.06V.

Select Bias OFF.

Remove External DC Supply and replace Bias link.

6 COMPONENTS LIST

6.1 CPU & TV PCB

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R300	4k7			SIL N/W	Hitech L109
R301	4k7	5		Film	Mullard SFR25
R302	100R	5		Film	Mullard SFR25
R303	1k0	5		Film	Mullard SFR25
R304	1k0	5		Film	Mullard SFR25
R305	2k2			SIL N/W	Hitech L109
R306	1k0	5		Film	Mullard SFR25
R307	560R	5		Film	Mullard SFR25
R308	470R	5		Film	Mullard SFR25
R309	470R	5		Film	Mullard SFR25
R310	1k2	5		Film	Mullard SFR25
R311	1k2	5		Film	Mullard SFR25
R312	20k			Cermet	A. Bradley E4A203
R313	39k	5		Film	Mullard SFR25
R314	1k0	5		Film	Mullard SFR25
C300	220µ		10V	Electrolytic	Mullard 031 34221
C301	1n	-20,+80	500V	Ceramic Disc	ITT CD08/K2
C302	220p	20	500V	Ceramic Disc	ITT CD08/K1
C303	220p	20	500V	Ceramic Disc	ITT CD08/K1
C304	100n		63V	Ceramic Disc	Siemens B37449
C305	100n		63V	Ceramic Disc	Siemens B37449
C306	100n		63V	Ceramic Disc	Siemens B37449
C307	100n		63V	Ceramic Disc	Siemens B37449
C308	100n		63V	Ceramic Disc	Siemens B37449
C309	100n		63V	Ceramic Disc	Siemens B37449
C310	100n		63V	Ceramic Disc	Siemens B37449
C311	100n		63V	Ceramic Disc	Siemens B37449
C312	100n		63V	Ceramic Disc	Siemens B37449
C313	100n		63V	Ceramic Disc	Siemens B37449
C314	100n		63V	Ceramic Disc	Siemens B37449
C315	100n		63V	Ceramic Disc	Siemens B37449
C316	100n		63V	Ceramic Disc	Siemens B37449
C317	100n		63V	Ceramic Disc	Siemens B37449
C318	100n		63V	Ceramic Disc	Siemens B37449
IC300	LM78-L12-ACZ			Regulator	National
IC301	DM81LS95N				National
IC302	SN74LS138N				Texas
IC303	SN74LS26N				Texas
IC304	LM79-L12-ACZ			Regulator	National
IC305	Z80 CPU PS				Zilog
IC306	SN74LS74AN				Texas
IC307	SN74LS245N				Texas
IC308	SN74LS244N				Texas
IC309	SN74LS244N				Texas
IC310	SN74LS244N				Texas
IC311	SN74LS09N				Texas
IC312	MC6845P				Motorola
IC313	SN74LS76N				Texas

(CPU & TV PCB - Continued)

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
IC314	SN74LS157N				Texas
IC315	SN74LS157N				Texas
IC316	SN74LS157N				Texas
IC317	P2114A-6				Intel
IC318	P2114A-6				Intel
IC319	SN74LS244N				Texas
IC320	SN74LS373N				Texas
IC321	SN74LS74AN				Texas
IC322	SN74LS161AN				Texas
IC323	SN74LS166N				Texas
IC324	Programmed				WK DV4/25673 item 35
IC325	Programmed				WK DV4/25673 item 36
IC326	Not fitted				
IC327	SN74LS32N				Texas
IC328	SN74LS08N				Texas
IC329	SN74LS00N				Texas
IC330	SN74LS132N				Texas
IC331	SN74LS00N				Texas
IC332	SN74LS132N				Texas
IC333	SN74LS32N				Texas
IC334	SN74LS02N				Texas
IC335	SN74LS04N				Texas
IC336	SN74LS04N				Texas
IC337	LM311N				National
D300	1N4002			Diode	I.R.
D301	BZX79 C5V6			Diode	Mullard
TR300	2N2369A			Transistor	Mullard
PL301	64-way Indirect Male Connector				Vero 17-2876D
S300	MDP	Switch	69955B		ITT

6.2 MEMORY BOARD MkI PCB

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R200	1k0	5		Film	Mullard SFR25
R201	4k7			SIL N/W	Hitech 4019
R202	4k7			SIL N/W	Hitech 4019
R203	4k7			SIL N/W	Hitech 4019
R204	47k	5		SIL N/W	Hitech 4019
R205	100R			Film	Mullard SFR25
R206	4k7	5		Film	Mullard SFR25
R207	4k7	5		Film	Mullard SFR25
R208	1k0	5		Film	Mullard SFR25
R209	1k0	5		Film	Mullard SFR25
R210	2k7	5		Film	Mullard SFR25
R211	10k	5		Film	Mullard SFR25
R227	4k7	5		Film	Mullard SFR25
R232	4k7	5		Film	Mullard SFR25
C200	10µ		25V	Electrolytic	Mullard 030 36109
C201	100n			Ceramic Disc	Siemens B37449
C202	10µ		25V	Electrolytic	Mullard 030 36109
C203- C212 inc	100n			Ceramic Disc	Siemens B37449
C213	22µ		10V	Tantalum Bead	ITT TAG 22/10V
C214- C218 inc	100n			Ceramic Disc	Siemens B37449
C219	47p	10	500V	Ceramic Disc	ITT CD08/WK
IC200	SN74LS245N				Texas
IC201	SN74LS09N				Texas
IC202	SN74LS09N				Texas
IC203- IC212 inc				Programmed	WK DV4/25673 items 4-13 inc.
IC213	SN74LS138N				Texas
IC214	SN74LS139N				Texas
IC215	SN74LS00N				Texas
IC216	SN74LS138N				Texas
IC217	SN74LS138N				Texas
IC218	DM81LS96N				National
IC219	SN74LS175N				Texas
IC220	SN74LS08N				Texas
IC221	SN74LS32N				Texas
IC222	SN74LS32N				Texas
IC223	P2114A-6				Intel
IC224	P2114A-6				Intel
IC233	µPD444/6514				NEC
IC234	µPD444/6514				NEC
IC235	LM78L05ACZ				National
PL200	64-way Indirect Male Connector				Vero 17-2876D
PL202	64-way Indirect Male Connector				Vero 17-2876D

6.3 MEMORY BOARD MkII PCB

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R200	1k0	5		Film	Mullard SFR25
R201	4k7			SIL N/W	Hitech L109
R202	4k7			SIL N/W	Hitech L109
R203	4k7			SIL N/W	Hitech L109
R204	47k	5		Film	Mullard SFR25
R205	100R	5		Film	Mullard SFR25
R206	4k7	5		Film	Mullard SFR25
R207	4k7	5		Film	Mullard SFR25
R208	1k0	5		Film	Mullard SFR25
R209	1k0	5		Film	Mullard SFR25
R210	2k7	5		Film	Mullard SFR25
R211	10k	5		Film	Mullard SFR25
R212	39R	5		Film	Mullard SFR25
R227	4k7	5		Film	Mullard SFR25
R232	4k7	5		Film	Mullard SFR25
C200	10µ		25V	Electrolytic	Mullard 030 36109
C201	100n			Ceramic Disc	Siemens B37449
C202	10µ		25V	Electrolytic	Mullard 030 36109
C203	100n			Ceramic Disc	Siemens B37449
C204	Not fitted				
C205	100n			Ceramic Disc	Siemens B37449
C206	100n			Ceramic Disc	Siemens B37449
C207	100n			Ceramic Disc	Siemens B37449
C208	100n			Ceramic Disc	Siemens B37449
C209	100n			Ceramic Disc	Siemens B37449
C210	100n			Ceramic Disc	Siemens B37449
C211	100n			Ceramic Disc	Siemens B37449
C212	100n			Ceramic Disc	Siemens B37449
C213	22µ		10V	Tantalum Bead	ITT TAG 22/10V
C214	100n			Ceramic Disc	Siemens B37449
C215	100n			Ceramic Disc	Siemens B37449
C216	100n			Ceramic Disc	Siemens B37449
C217	100n			Ceramic Disc	Siemens B37449
C218	100n			Ceramic Disc	Siemens B37449
C219	47p	10	500V	Ceramic Disc	ITT CD08/WK
C220	1n0	20	500V	Ceramic Disc	ITT CD08/MK2
IC200	SN74LS245N				Texas
IC201	SN74LS09N				Texas
IC202	SN74LS09N				Texas
IC203	Programmed				WK DV4/25673 item 24
IC204	Programmed				WK DV4/25673 item 25
IC205	Programmed				WK DV4/25673 item 26
IC206	(Reserved for expansion)				
IC214	SN74LS139N				Texas
IC215	SN74LS00N				Texas
IC216	SN74LS138N				Texas
IC217	SN74LS138N				Texas
IC218	DM81LS96N				National

(MEMORY BOARD MkII PCB - Continued)

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
IC219	SN74LS175N				Texas
IC220	SN74LS08N				Texas
IC221	SN74LS32N				Texas
IC222	SN74LS32N				Texas
IC223	P2114A-6				Intel
IC224	P2114A-6				Intel
IC233	μPD444/6514				NEC
IC234	μPD444/6514				NEC
IC235	LM78L05ACZ				National
D200	BZX79 C3V0			Diode	Mullard
D201	1N4148			Diode	Mullard
D202	Not fitted				
D203	Not fitted				
D204	1N4148			Diode	Mullard
D205	1N4148			Diode	Mullard
D206	1N4148			Diode	Mullard
TR200	BC183			Transistor	Texas
TR201	Not fitted				
TR202	Not fitted				
TR203	BC183			Transistor	Texas
TR204	BC183			Transistor	Texas
B200	BR-2/3A-1P			Battery	National (Dubilier)
PL200	64-way Indirect Male Connector				Vero 17-2876D
PL202	64-way Indirect Male Connector				Vero 17-2876D

6.4 KEYBOARD PCB

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
C400	100n		63V	Ceramic	Siemens B37449
IC400	SN74LS145N				Texas
S400 to S432 inc.	Switch 75-120-002		Black		Preh
SK401	Socket				Rendar R322-180.00

6.5 FRONT PANEL

D1001 LED HLMP/3401 Hewlett Packard

PL1004 Insulated Bulkhead Connector LX04-0503-22005N Belling Lee
PL1005 Insulated Bulkhead Connector LX04-0503-22005N Belling Lee
PL1006 Insulated Bulkhead Connector LX04-0503-22005N Belling Lee
PL1007 Insulated Bulkhead Connector LX04-0503-22005N Belling Lee

6.6 KME LEAD ASSEMBLY

Connector Lead Assembly (KME to Mother Board) To WK Drg. DV3/25649

6.7 REAR PANEL

R001	1k0	Lin.	CE8S Bush	F5 Spindle	Radiohm P20C
C001	22,000μ	Elec.	16V	071 15223	Mullard
C002	6,800μ	Elec.	40V	071 17682	Mullard
C003	10,000μ	Elec.	40V	071 17103	Mullard
C004	2,200μ	Elec.	40V	071 17222	Mullard
FS001	Fuse 1A SB 20mm			L2080A	Belling-Lee
PL001	CEE22 Appliance Inlet				Rendar R470,300.00
S001	Power Switch (inc. bracket) MU 1999 MMS				Lipa Isostat
S002	2-pole Slide Switch				Rendar R530,040.00
S003	Thermostat 5004-013-068				Airpax
SK002	Black Terminal L1568				Belling-Lee
SK003	Red Terminal L1568				Belling-Lee
T001	Transformer				WK 4-385-5570

6.8 SYNTHESISER PCB

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R102	510R	1	100ppm	Metal Film	Allen Bradley FC55
R103	510R	1	100ppm	Metal Film	Allen Bradley FC55
R104	510R	1	100ppm	Metal Film	Allen Bradley FC55
R105	510R	1	100ppm	Metal Film	Allen Bradley FC55
R106	510R	1	100ppm	Metal Film	Allen Bradley FC55
R107	510R	1	100ppm	Metal Film	Allen Bradley FC55
R108	510R	1	100ppm	Metal Film	Allen Bradley FC55
R109	620R	1	100ppm	Metal Film	Allen Bradley FC55
R110	13k0	0.1	50ppm	Metal Film	Allen Bradley FC55
R111	Not fitted				
R112	6k8	0.1	50ppm	Metal Film	Allen Bradley FC55
R113	95R3	1	100ppm	Metal Film	Allen Bradley FC55
R114	4k99	0.1	50ppm	Metal Film	Allen Bradley FC55
R115	20R	2		Metal Oxide	Electrosil TR4
R116	4k64	0.1	50ppm	Metal Film	Allen Bradley FC55
R117	95R3	1	100ppm	Metal Film	Allen Bradley FC55
R118	4k99	0.1	50ppm	Metal Film	Allen Bradley FC55
R119	Not fitted				
R120	6k8	0.1	50ppm	Metal Film	Allen Bradley FC55
R121	Not fitted				
R122	13k0	0.1	50ppm	Metal Film	Allen Bradley FC55
R123	Not fitted				
R124	47R	5		Film	Mullard SFR25
R125	Not fitted				
R126	47R	5		Film	Mullard SFR25
R127	220R	5		Film	Mullard SFR25
R128	1k0			SIL N/W	Hitech L109
R129	1k	5		Film	Mullard SFR25
R130	1k	5		Film	Mullard SFR25
R131	1k	5		Film	Mullard SFR25
R132	Not fitted				
R133	1k	5		Film	Mullard SFR25
R134	1k	5		Film	Mullard SFR25
R135	47R	5		Film	Mullard SFR25
R136	4k7	5		Film	Mullard SFR25
R137	1k	5		Film	Mullard SFR25
C101	100n		63V	Ceramic Disc	Siemens B37449
C102	100n		63V	Ceramic Disc	Siemens B37449
C103	100n		63V	Ceramic Disc	Siemens B37449
C104	100n		63V	Ceramic Disc	Siemens B37449
C105	100n		63V	Ceramic Disc	Siemens B37449
C106	100n		63V	Ceramic Disc	Siemens B37449
C107	Not fitted				
C108	100n		63V	Ceramic Disc	Siemens B37449
C109	220µ		16V	Electrolytic	Dubilier CEA22016
C110	4n7	-20,+80	500V	Ceramic Disc	ITT CD10/K3
C111	270p	20	500V	Ceramic Disc	ITT CD08/K1
C112	1n	-20,+80	500V	Ceramic Disc	ITT CD08/K2
C113	1n	-20,+80	500V	Ceramic Disc	ITT CD08/K2
C114	220n	20	100V	Polyester	Wima MKS4
C115	Not fitted				
C116	100n		63V	Ceramic Disc	Siemens B37449

(SYNTHESISER PCB - Continued)

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
C117	100n		63V	Ceramic Disc	Siemens B37449
C118	100n		63V	Ceramic Disc	Siemens B37449
C119	100n		63V	Ceramic Disc	Siemens B37449
C120	100n		63V	Ceramic Disc	Siemens B37449
C121	100n		63V	Ceramic Disc	Siemens B37449
C122	Not fitted				
C123	Not fitted				
C124	220µ		16V	Electrolytic	Dubilier CEA22016
C125	47p	10	500V	Ceramic Disc	ITT CD08/WK
IC101	DM81LS95N				National
IC102	SN74LS373N				Texas
IC103	P8253				Intel
IC104	SN74S112N				Texas
IC105	SN74LS393N				Texas
IC106	SN74LS76N				Texas
IC107	SN74LS86N				Texas
IC108	SN74LS390N				Texas
IC109	SN74LS393N				Texas
IC110	SN74LS251N				Texas
IC111	SN74LS00N				Texas
IC112	CD4040BE				R.C.A.
IC113	74F161PC				Fairchild
IC114	SN74198N				Texas
IC115	SN74LS26N				Texas
IC116	SN74LS02N				Texas
IC117	SN74LS05N				Texas
IC118	SN74LS266N				Texas
IC119	N74F86N				Signetics
IC120	SN74LS74AN				Texas
IC121	SN74LS74AN				Texas
IC122	SN74LS74AN				Texas
IC123	MC74F74N				Motorola
IC124	SN74LS260N				Texas
IC125	SN74LS02N				Texas
IC126	SN74LS04N				Texas
IC127	SN74LS38N				Texas
IC128	Not fitted				
IC129	Not fitted				
IC130	LF357N				National
IC131	µA78-05-UC				Fairchild
IC132	38.4MHz	±0.01%		Crystal Oscillator	MF Electronics M1100
IC133	SN74S74N				Texas
IC134	SN74LS245N				Texas
IC135*	SN74LS00N				Texas
D101	1N4148			Diode	I.R.
D102	1N4148			Diode	I.R.
PL101	64-way Indirect male connector				Vero 17-2876D

* Not fitted on Mk1 Synthesiser Boards.

6.9 SIGNAL SOURCE

Ref	Value	Tol(%)	Rating	Type (new)	Supplier & Type No.
R501	2k0	2		Metal Oxide	Welwyn MR4
R502	1k8	2		Metal Oxide	Welwyn MR4
R503	1k	5		Film	Mullard SFR25
R504	1k	5		Film	Mullard SFR25
R505	1k5	2		Metal Oxide	Welwyn MR4
R506	2k0	10		Var. Cermet	Allen Bradley E4A
R507	3k3	0.25	50ppm	Metal Film	Allen Bradley FC55
R508	825R	0.25	50ppm	Metal Film	Allen Bradley FC55
R509	4k7	5		Film	Mullard SFR25
R510	4k7	5		Film	Mullard SFR25
R511	4k7	5		Film	Mullard SFR25
R512	4k7	5		Film	Mullard SFR25
R513	3k3	0.25		Metal Film	Allen Bradley FC55
R514	3k3	0.25		Metal Film	Allen Bradley FC55
R515	2k21	0.1	25ppm	Metal Film	Allen Bradley FC55
R516	2k21	0.1	25ppm	Metal Film	Allen Bradley FC55
R517	1k65	0.1	25ppm	Metal Film	Allen Bradley FC55
R518	1k65	0.1	25ppm	Metal Film	Allen Bradley FC55
R519	1k74	1	100ppm	Metal Film	Allen Bradley FC55
R520	1k74	1	100ppm	Metal Film	Allen Bradley FC55
R521	5k11	1	100ppm	Metal Film	Allen Bradley FC55
R522	5k11	1	100ppm	Metal Film	Allen Bradley FC55
R523	18k7	1	100ppm	Metal Film	Allen Bradley FC55
R524	18k7	1	100ppm	Metal Film	Allen Bradley FC55
R525	28k	1	100ppm	Metal Film	Allen Bradley FC55
R526	28k	1	100ppm	Metal Film	Allen Bradley FC55
R527	Not fitted				
R528	Not fitted				
R529	3k0	1	100ppm	Metal Film	Allen Bradley FC55
R530	100k	5		Film	Mullard SFR25
R531	100k	5		Film	Mullard SFR25
R532	Not fitted				
R533	7k5	1	100ppm	Metal Film	Allen Bradley FC55
R534	1k2	2		Metal Oxide	Welwyn MR4
R535	270R	2		Metal Oxide	Welwyn MR4
R536	680R	5		Film	Mullard SFR25
R537	33k	2		Metal Oxide	Welwyn MR4
R538	33k	2		Metal Oxide	Welwyn MR4
R539	3k3	2		Metal Oxide	Welwyn MR4
R540	100R	5		Film	Mullard SFR25
R541	2k0	2		Metal Oxide	Welwyn MR4
R542	2k0	10		Var. Cermet	Allen Bradley E4A
R543	1k0	2		Metal Oxide	Welwyn MR4
R544	Not fitted				
R545	12k	5		Film	Mullard SFR25
R546	22R	5		Film	Mullard SFR25
R547	22R	5		Film	Mullard SFR25
R548	Not fitted				
R549	Not fitted				
R550	68k	2		Metal Oxide	Welwyn MR4
R551	68k	2		Metal Oxide	Welwyn MR4
R552	680R	2		Metal Oxide	Welwyn MR4
R553	680R	2		Metal Oxide	Welwyn MR4

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R554	2R2	1	100ppm	Metal Film	Welwyn MFR4
R555	2R2	1	100ppm	Metal Film	Welwyn MFR4
R556	100R	5		Film	Mullard SFR25
R557	100R	5		Film	Mullard SFR25
R558	47R	1		Wire Wound	Welwyn W21
R559	1R0	5		Film	Mullard SFR25
R560-R564	Not fitted				
R565	1k	5		Film	Mullard SFR25
R566	12k	5		Film	Mullard SFR25
R567	4k7	5		Film	Mullard SFR25
R568	4k7	5		Film	Mullard SFR25
R569	1k3	2		Metal Oxide	Welwyn MR4
R570	8R2	5		Film	Mullard SFR25H
R571	8R2	5		Film	Mullard SFR25H
R572	Not fitted				
R573	Not fitted				
R574	2R2	5		Film	Mullard SFR25H
R575	2R2	5		Film	Mullard SFR25H
R576	Not fitted				
R577	10R	5		Film	Mullard SFR25
R578	Not fitted				
R579	Not fitted				
R580	4R7	5		Film	Mullard SFR25
C501	33p	1p	160V	Polystyrene	Suflex HS
C502	100μ		10V	Electrolytic	Mullard 035-54101
C503	Not fitted				
C504	56p	2.5	160V	Polystyrene	LCR FSC
C505	10μ		50V	Electrolytic	Mullard 035-90008
C506	33p	1p	160V	Polystyrene	Suflex HS
C507	36p	1p	160V	Polystyrene	Suflex HS
C507AOT	33p	1p	160V	Polystyrene	Suflex HS
C507AOT	39p	1p	160V	Polystyrene	Suflex HS
C508	100n		63V	Ceramic	Siemens B37449
C509	Not fitted				
C510	4n04	1	63V	Polycarbonate	MFD OPR 4n04F63
C511	4n04	1	63V	Polycarbonate	MFD OPR 4n04F63
C512	165n	1	63V	Polycarbonate	MFD OPR 165nF63
C513	165n	1	63V	Polycarbonate	MFD OPR 165nF63
C514	100p	1	160V	Polystyrene	LCR FSC
C515	100p	1	160V	Polystyrene	LCR FSC
C516	2n2	2.5	160V	Polystyrene	LCR FSC
C517	Not fitted				
C518	Not fitted				
C519	220μ		16V	Electrolytic	Mullard 035-55221
C520	220μ		16V	Electrolytic	Mullard 035-55221
C521	10p	10	500V	Ceramic	ITT CD08/KCG
C522	100n		63V	Ceramic	Siemens B37449
C523	100n		63V	Ceramic	Siemens B37449
C524	1000μ		63V	Electrolytic	ECC SMVB
C525	1000μ		63V	Electrolytic	ECC SMVB
C526	1000μ		63V	Electrolytic	ECC SMVB
C527	1000μ		63V	Electrolytic	ECC SMVB

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
C528	1000µ		63V	Electrolytic	ECC SMVB
C529	1000µ		63V	Electrolytic	ECC SMVB
C530	1000µ		63V	Electrolytic	ECC SMVB
C531	1000µ		63V	Electrolytic	ECC SMVB
C532	1000µ		63V	Electrolytic	ECC SMVB
C533	1000µ		63V	Electrolytic	ECC SMVB
C534	15p	10	500V	Ceramic	ITT CD08/KCG
C535	10n	20	400V	Polyester	Wima MKS4 PCM10
C536	100n		63V	Ceramic	Siemens B37449
C537	100n		63V	Ceramic	Siemens B37449
C538	Not fitted				
C539	100n		63V	Ceramic	Siemens B37449
C540	100n		63V	Ceramic	Siemens B37449
C541	100n		63V	Ceramic	Siemens B37449
C542	100n		63V	Ceramic	Siemens B37449
C543	100n		63V	Ceramic	Siemens B37449
C544	47µ		25V	Electrolytic	Mullard 035-56479
C545	47µ		25V	Electrolytic	Mullard 035-56479
IC501	SN74LS273N				Texas
IC502	SN74LS273N				Texas
IC503	DAC-08ED				Analog Devices
IC504	CD4052BE				RCA*
IC505	LF412				National
IC506	LF351N				National
IC507	LF412				National
IC508	SN74LS26N				Texas
IC509	CD4052BE				RCA*
D501	1N4148			Diode	I.R.
D502	Not fitted				
D503	1N4148			Diode	I.R.
D504	1N4148			Diode	I.R.
D505	1N4148			Diode	I.R.
D506	1N4148			Diode	I.R.
D507	1N4148			Diode	I.R.
D508	1N4002			Diode	I.R.
D509	1N4002			Diode	I.R.
D510	1N4002			Diode	I.R.
D511	1N4002			Diode	I.R.
D512	ICTE-45			Transient Suppressor	General Semiconductor
D513	ICTE-45			Transient Suppressor	General Semiconductor
D514	BZX79 C12			Zener Diode	Mullard
D515	1N4002			Diode	I.R.
D516	BZX79 C3V3			Zener Diode	Mullard
D517	Not fitted				
D518	1N4148			Diode	I.R.
D519	1N4148			Diode	I.R.
D520	Not fitted				
D521	BZX79 C5V6			Zener Diode	Mullard

* Only alternative : National

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
TR501	BC184			Transistor	Texas
TR502	BC184			Transistor	Texas
TR503	BC450			Transistor	Motorola
TR504	BC182			Transistor	Texas
TR505	BC449			Transistor	Motorola
TR506	BD231			Transistor	Mullard
TR507	BD230			Transistor	Mullard
TR508	BC450			Transistor	Motorola
TR509	BC449			Transistor	Motorola
TR510	BC214			Transistor	Texas
TR511	BC214			Transistor	Texas
TR512	BC184C			Transistor	Texas
TR513	BC212			Transistor	Texas
TR514	BC214			Transistor	Texas
PL501	64-way Indirect male connector				Vero 17-2876D
RL501	Relay DIL E-2A-5V-D				ERG
RL502	Relay DIL E-2A-5V-D				ERG
RL503	Relay 24V G-2R-217PV				Omron

6.10 BRIDGE BOARD

R801-804	Not fitted				
R805	100R	5		Film	Mullard SFR25H
R806	100R	5		Film	Mullard SFR25
R807	Not fitted				
R808 AOT	2k2/1k3/3k0	2%		Metal Oxide	Electrosil TR4
R809	1k0	10		Var. Cermet	Allen Bradley E4A102
R810	1k2	2		Metal Oxide	Electrosil TR4
R811	1k0	10		Var.Cermet	Allen Bradley E4A102
R812	Not fitted				
R813	3M3	5		Metal Glaze	Mullard VR25
R814-818	Not fitted				
R819	150R	5		Film	Mullard SFR25
R820	150R	5		Film	Mullard SFR25
R821	40k96	0.01		Metal Film	Vishay S102J
R822	5k12	0.01		Metal Film	Vishay S102J
R823	640R	0.01		Metal Film	Vishay S102J
R824	10R	+0.04 -0		Metal Film	Vishay S102J
R825 AOT	27k	5		Film	Mullard SFR25
R826	47R	5		Film	Mullard SFR25
R827	6k2	0.5	50ppm	Metal Film	Allen Bradley FC55
R828	680k	0.5	50ppm	Metal Film	Allen Bradley FC55
R829	10k	5		Film	Mullard SFR25
R830	30k	1	50ppm	Metal Film	Allen Bradley FC55
R831	330R	0.25	50ppm	Metal Film	Allen Bradley FC55
R832	300R	5		Film	Mullard SFR25
R833	270R	0.25	50ppm	Metal Film	Allen Bradley FC55

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R834	560R	5		Film	Mullard SFR25
R835	210R	0.25	50ppm	Metal Film	Allen Bradley FC55
R836	750R	5		Film	Mullard SFR25
R837	270R	0.25	50ppm	Metal Film	Allen Bradley FC55
R838	4k7	5		Film	Mullard SFR25
R839	3M3	5		Metal Glaze	Mullard VR25
R840	3M3	5		Metal Glaze	Mullard VR25
R841	3M3	5		Metal Glaze	Mullard VR25
R842	Not fitted				
R843	4k3	5		Film	Mullard SFR25
R844	100R	5		Film	Mullard SFR25
R845	2k0	10		Var. Cermet	Allen Bradley E4A202
R846	100k	5		Film	Mullard SFR25
R847	15R	5		Film	Mullard SFR25
R848	15R	5		Film	Mullard SFR25
R849	100R	5		Film	Mullard SFR25
R850	22k	5		Film	Mullard SFR25
R851	150R	5		Film	Mullard SFR25H
R852	150R	5		Film	Mullard SFR25H
R853	10k	5		Film	Mullard SFR25
R854	10k	5		Film	Mullard SFR25
R855	10k	5		Film	Mullard SFR25
R856	1k05	0.25	50ppm	Metal Film	Allen Bradley FC55
R857	150R	0.25	50ppm	Metal Film	Allen Bradley FC55
R858	49R9	0.25	50ppm	Metal Film	Allen Bradley FC55
R859	180R	5		Film	Mullard SFR25
R860	120R	5		Film	Mullard SFR25
R861	4k7			SIL Network	Hitech L109
R862	470R	0.25	50ppm	Metal Film	Allen Bradley FC55
R863	470R	0.25	50ppm	Metal Film	Allen Bradley FC55
R864	470R	0.25	50ppm	Metal Film	Allen Bradley FC55
R865	470R	0.25	50ppm	Metal Film	Allen Bradley FC55
R866	8k2	1	50ppm	Metal Film	Allen Bradley FC55
R867	2R0	1		Wire Wound	Welwyn W22
R868	22R	5		Film	Mullard SFR25
R869	100R	5		Film	Mullard SFR25
R870	100R	5		Film	Mullard SFR25
R871	100R	5		Film	Mullard SFR25
R872	100R	5		Film	Mullard SFR25
R873	Not fitted				
R874	20k	10		Var. Cermet	Allen Bradley E4A203
R875	1k3	2		Metal Oxide	Electrosil TR4
R876	2k0	2		Metal Oxide	Electrosil TR4
R877	390k	1	50ppm	Metal Film	Allen Bradley FC55
R878	130k	2		Metal Oxide	Electrosil TR4
R879	33k	1	50ppm	Metal Film	Allen Bradley FC55
R880	22k	2		Metal Oxide	Electrosil TR4
R881	6k2	2		Metal Oxide	Electrosil TR4
R882	2k7	5		Film	Mullard SFR25
R883	10R	5		Film	Mullard SFR25
R884	1k5	2		Metal Oxide	Electrosil TR4
R885	4M7	10		Film	Mullard SFR25
R886	2M2	10		Film	Mullard SFR25
R887	10R	5		Film	Mullard SFR25
R888-890	Not fitted				
R891	47k	5		Film	Mullard SFR25

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R892	10k	5		Film	Mullard SFR25
R893	8R2	5		Film	Mullard SFR25H
R894	8R2	5		Film	Mullard SFR25H
R895	15k	5		Film	Mullard SFR25
R896	1k0	10		Var. Cermet	Allen Bradley E4A102
R897	10R	5		Film	Mullard SFR25
R898	10R	5		Film	Mullard SFR25
C801-802	Not fitted				
C803	100μ		10V	Electrolytic	Mullard 035 54101
C804	47μ		10V	Electrolytic	Mullard 035 54479
C805	Not fitted				
C806	Not fitted				
C807	330p	2.5	160V	Polystyrene	LCR FSC
C808	82p	1p	160V	Polystyrene	Suflex HS
C809	Not fitted				
C810	470n	5	400V	Polyester	Wima MKS4
C811	Not fitted				
C812	470n	5	100V	Polyester	Wima MKS4
C813	Not fitted				
C814	470n	5	100V	Polyester	Wima MKS4
C815	470n	5	100V	Polyester	Wima MKS4
C816	82p	1p	160V	Polystyrene	Suflex HS
C817	4n7	2.5	160V	Polystyrene	LCR FSC
C818	1n0 AOT	2.5	160V	Polystyrene	LCR FSC
C819	100n		63V	Ceramic	Siemens B37449
C820	100n		63V	Ceramic	Siemens B37449
C821	10p	5	500V	Ceramic	Thompson CSF. GLC604
C822	220n	20	100V	Polyester	Wima MKS4
C823	Not fitted				
C824	100n		63V	Ceramic	Siemens B37449
C825	100n		63V	Ceramic	Siemens B37449
C826	1μ		100V	Electrolytic	Mullard 035 59108
C827	1μ		100V	Electrolytic	Mullard 035 59108
C828	Not fitted				
C829	220μ		16V	Electrolytic	Mullard 035 55221
C830	220μ		16V	Electrolytic	Mullard 035 55221
C831	4p7	0.5p	500V	Ceramic	ITT CD08/DAG
C832	4p7	0.5p	500V	Ceramic	ITT CD08/DAG
C833	470p	20	500V	Ceramic	ITT CD08/K1
C834	68p	2.5	160V	Polystyrene	LCR FSC
C835	100n		63V	Ceramic	Siemens B37449
C836	100n		63V	Ceramic	Siemens B37449
C837	100n		63V	Ceramic	Siemens B37449
C838	47μ		25V	Electrolytic	Mullard 035 56479
C839	100n		63V	Ceramic	Siemens B37449
C840	47μ		25V	Electrolytic	Mullard 035 56479
C841	47μ		25V	Electrolytic	Mullard 035 56479
C842	47μ		25V	Electrolytic	Mullard 035 56479
C843	100n		63V	Ceramic	Siemens B37449
C844	2-10p				Jackson Bros. 5750 HPC
C845	Not fitted				
C846	100n		63V	Ceramic	Siemens B37449
C847	100n		63V	Ceramic	Siemens B37449

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
C848	100n		63V	Ceramic	Siemens B37449
C849	Not fitted				
C850	100n		63V	Ceramic	Siemens B37449
C851	100n		63V	Ceramic	Siemens B37449
C852	100n		63V	Ceramic	Siemens B37449
C853	100n		63V	Ceramic	Siemens B37449
IC801	TL070CP				Texas
IC802	CD4052BE				RCA*
IC803	Not fitted				
IC804	CD4052BE				RCA*
IC805	TL072CP				Texas
IC806	NE5534N				Signetics
IC807	SN74LS26N				Texas
IC808	SN74LS26N				Texas
IC809	SN74LS26N				Texas
IC810	SN74LS273N				Texas
IC811	SN74LS273N				Texas
IC812	CD4052BE				RCA*
IC813	LM733CN				National
IC814	TL071CP				Texas
IC815	CD4052BE				RCA*
IC816	TL070CP				Texas
IC817	LM339N				National
D801	1N4006			Diode	I.R.
D802	1N4006			Diode	I.R.
D803	1N4148			Diode	I.R.
D804	1N4148			Diode	I.R.
D805	1N4006			Diode	I.R.
D806	Not fitted				
D807	1N4006			Diode	I.R.
D808	Not fitted				
D809	BZX79 C3V6			Diode	Mullard
D810	1N4148			Diode	I.R.
D811	BZX79 C3V6			Diode	Mullard
D812	1N4148			Diode	I.R.
D813	BZX79 C7V5			Diode	Mullard
D814	BZX79 C7V5			Diode	Mullard
D815	1N4006			Diode	I.R.
D816	Not fitted				
D817	1N4006			Diode	I.R.
D818	1N4006			Diode	I.R.
D819	Not fitted				
D820	1N4006			Diode	I.R.
D821	1N4006			Diode	I.R.
D822	1N4006			Diode	I.R.
D823	1N4006			Diode	I.R.
D824	1N4006			Diode	I.R.
D825	1N4006			Diode	I.R.
D826	1N4006			Diode	I.R.
D827	1N4148			Diode	I.R.
D828	1N4006			Diode	I.R.
D829	1N4006			Diode	I.R.

* Only alternatives: SGS or National

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
TR801	BC212			Transistor	Texas
TR802	BC214			Transistor	Texas
TR803	BC182			Transistor	Texas
TR804	BC212			Transistor	Texas
TR805	BD229			Transistor	Mullard
TR806	BD228			Transistor	Mullard
TR807	Not fitted				
TR808	BC212			Transistor	Texas
TR809	BC184C			Transistor	Texas
TR810	BC184			Transistor	Texas
TR811	BC214			Transistor	Texas
TR812	J113			Transistor	Siliconix
FS801	Fuse	20 x 5mm	1.6A		Belling Lee L1427B
PL801	64-way Indirect Male Connector				Vero 17-2876D
RL801	DIL Relay E-1A-5V-D				ERG
RL802	DIL Relay E-1A-5V-D				ERG
RL803	DIL Relay E-1A-5V-D				ERG
TP01	Terminal Assembly				Vero 20-2137D
TP02	Terminal Assembly				Vero 20-2137D
TP03	Terminal Assembly				Vero 20-2137D
TP04	terminal Assembly				Vero 20-2137D

6.11 DETECTOR PCB

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R901	700R	0.005		Film	Vishay S102J
R902	100R	0.005		Film	Vishay S102J
R903	91R	1	100ppm	Metal Film	Allen Bradley FC55
R904	3k4	1	100ppm	Metal Film	Allen Bradley FC55
R905	390R	1	100ppm	Metal Film	Allen Bradley FC55
R906	348R	1	100ppm	Metal Film	Allen Bradley FC55
R907	3k09	1	100ppm	Metal Film	Allen Bradley FC55
R908	887R	1	100ppm	Metal Film	Allen Bradley FC55
R909	680R	5		Film	Mullard SFR25
R910	2k4	0.1	25ppm	Metal Film	Allen Bradley FC55
R911	2k4	0.1	25ppm	Metal Film	Allen Bradley FC55
R912	2k2	0.1	25ppm	Metal Film	Allen Bradley FC55
R913	2k2	0.1	25ppm	Metal Film	Allen Bradley FC55
R914	3k74	1	100ppm	Metal Film	Allen Bradley FC55
R915	3k74	1	100ppm	Metal Film	Allen Bradley FC55
R916	10k7	1	100ppm	Metal Film	Allen Bradley FC55
R917	10k7	1	100ppm	Metal Film	Allen Bradley FC55
R918	38k3	1	100ppm	Metal Film	Allen Bradley FC55
R919	38k3	1	100ppm	Metal Film	Allen Bradley FC55
R920	57k6	1	100ppm	Metal Film	Allen Bradley FC55
R921	57k6	1	100ppm	Metal Film	Allen Bradley FC55
R922	330R	5		Film	Mullard SFR25
R923	330R	5		Film	Mullard SFR25
R924	4k7	2		SIL N/W	Hitech L109
R925	2R2	5		Film	Mullard SFR25H
R926	2R2	5		Film	Mullard SFR25H
R927	4k7	2		Metal Oxide	Welwyn MR4
R928	4k7	2		Metal Oxide	Welwyn MR4
R929	100k	5		Film	Mullard SFR25
R930	100k	5		Film	Mullard SFR25
R931	1k0	2		SIL N/W	Hitech L109
R932	1k0	2		SIL N/W	Hitech L109
R933	10k	5		Film	Mullard SFR25
R934	Not fitted				
R935	3k9	5		Film	Mullard SFR25
R936	Not fitted				
R937	1k5	5		Film	Mullard SFR25
R938	3k6	1	100ppm	Metal Film	Allen Bradley FC55
R939	1k5	1	100ppm	Metal Film	Allen Bradley FC55
R940	10k	5		Film	Mullard SFR25
R941	18k	2		Metal Oxide	Welwyn MR4
R942	22k	2		Metal Oxide	Welwyn MR4
R943	33k	5		Film	Mullard SFR25
R944	10k	5		Film	Mullard SFR25
R945	Not fitted				
R946	47k	0.25	50ppm	Metal Film	Allen Bradley FC55
R947	30k	0.25	50ppm	Metal Film	Allen Bradley FC55
R948	51k	0.25	50ppm	Metal Film	Allen Bradley FC55
R949	64k9	0.25	50ppm	Metal Film	Allen Bradley FC55
R950	12k7	1	100ppm	Metal Film	Allen Bradley FC55
R951	330R	5		Film	Mullard SFR25
R952	20k	0.5	50ppm	Metal Film	Allen Bradley FC55
R953	Not fitted				
R954	8k25	0.5	50ppm	Metal Film	Allen Bradley FC55

(DETECTOR PCB - Continued)

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R955	3k3	5		Film	Mullard SFR25
R956	6k2	5		Film	Mullard SFR25
R957	1k3	2		Metal Oxide	Welwyn MR4
R958	1k5	2		Metal Oxide	Welwyn MR4
R967	1k8	1	100ppm	Metal Film	Allen Bradley FC55
R968	3k3	1	100ppm	Metal Film	Allen Bradley FC55
R969	1k	5		Film	Mullard SFR25
R970	22k	5		Film	Mullard SFR25
C901	47µ		25V	Electrolytic	Mullard 035/56479
C902	47µ		25V	Electrolytic	Mullard 035/56479
C903	470µ		16V	Electrolytic	Mullard 035/55471
C904	470µ		16V	Electrolytic	Mullard 035/55471
C905	470µ		16V	Electrolytic	Mullard 035/55471
C906	330n	10	100V	Polyester	Wima MKS4
C907	56p	1p	160V	Polystyrene	Suflex HS
C908	91p	1p	160V	Polystyrene	Suflex HS
C909	91p	1p	160V	Polystyrene	Suflex HS
C910	4n04	1	63V	Polycarbonate	MFD OPR4n04F63
C911	4n04	1	63V	Polycarbonate	MFD OPR4n04F63
C912	165n	1	63V	Polycarbonate	MFD OPR165nF63
C913	165n	1	63V	Polycarbonate	MFD OPR165nF63
C914	1µ2	1	63V	Polycarbonate	MFD OPR1200nF63
C915	300n	1	63V	Polycarbonate	MFD OPR300nF63
C916	47n	2.5	30V	Polystyrene	LCR FSC
C917	330p	10	500V	C. Disc	Thomson CSF-G GLB604 Y5P
C918	100p	10		Ceramic Disc	ITT CD08 N3300
C919	220p	10		Ceramic Disc	ITT CD08/4700
C920	100n		63V	Ceramic Disc	Siemens B37449
C921	100n		63V	Ceramic Disc	Siemens B37449
C922	100n		63V	Ceramic Disc	Siemens B37449
C923	100n		63V	Ceramic Disc	Siemens B37449
C924	1n0	20		Ceramic Disc	ITT CD08 K2
C925	100n		63V	Ceramic Disc	Siemens B37449
C926	100n		63V	Ceramic Disc	Siemens B37449
C927	10n		40V	Ceramic Disc	ITT TD08K3
C928	4n7	10	63V	C. Disc	Roederstein ROZ 767FA
IC901	SN74LS273N				Texas
IC902	CD4053BE				RCA*
IC903	NE5534N				Signetics
IC904	LF353N				National
IC905	SN74LS26N				Texas
IC906	SN74LS26N				Texas
IC907	LF412CN				National
IC908	CD4052BE				RCA*
IC909	µA7805-UC				Fairchild
IC910	SD5001N				Signetics

* Only alternatives: National, SGS

(DETECTOR PCB - Continued)

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
IC911	TL072CP				Texas
IC912	DG211CJ				Siliconix
IC913	LM339N				National
IC914	LM339N				National
IC915	9495CJ				Teledyne
IC916	µA7808-UC				Fairchild
D901	1N4148			Diode	
D902	1N4148			Diode	
D905	1N4148			Diode	
D906	1N4148			Diode	
D907	1N4148			Diode	
D908	1N4148			Diode	
D909	1N4148			Diode	
TP01	Terminal Assy 20-2137D				Vero
TP02	Terminal Assy 20-2137D				Vero
TP03	Termianl Assy 20-2137D				Vero
TP04	Terminal Assy 20-2137D				Vero
TR901	VN2222L		FET	Transistor	Siliconix
TR902	VN2222L		FET	Transistor	Siliconix
TR903	VN2222L		FET	Transistor	Siliconix
TR904	VN2222L		FET	Transistor	Siliconix
TR905	J113		FET	Transistor	Siliconix
PL900	64-way Indirect Male Connector				Vero 17-2876D
RL901	Relay DIL E-2A-5V-D				ERG
RL902	Relay DIL E-2A-5V-D				ERG

6.12 20V BIAS BOARD

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R1601	390R	5		Film	Mullard SFR25
R1602	560R			Film	Piher PR01
R1603	0.68R	5		Wire Wound	Welwyn W21
R1604	390R	5		Film	Mullard SFR25
R1605	560R	5		Film	Piher PR01
R1606	0.68R	5		Wire Wound	Welwyn W21
R1607	10R	5		Wire Wound	Welwyn W24
R1608	2k7	5		Film	Mullard SFR25
R1609	820R	5		Film	Mullard SFR25
R1610	120R	5		Film	Mullard SFR25H
R1611	120R	5		Film	Mullard SFR25H
R1612	20k			Preset Cermet	Spectrol 63X
R1613	6M8	5		Metal Glaze	Mullard VR37
R1614	20k			Preset Cermet	Spectrol 63X
R1615	51k	1	50ppm	Metal Film	Welwyn MFR4
R1616	27R	5		Wire Wound	Welwyn W21
R1617	1k0	5		Wire Wound	Welwyn W21
R1618	120k	0.25	25ppm	Metal Film	Allen Bradley FC55
R1619	120k	0.25	25ppm	Metal Film	Allen Bradley FC55
R1620	82k	0.25	25ppm	Metal Film	Allen Bradley FC55
R1621	82k	0.25	25ppm	Metal Film	Allen Bradley FC55
R1622	3k3	1	50ppm	Metal Film	Welwyn MFR4
R1623	3k3	1	50ppm	Metal Film	Welwyn MFR4
R1624	470k	1	50ppm	Metal Film	Welwyn MFR4
R1625	2M7	5		Metal Glaze	Mullard VR25
R1626	2M7	5		Metal Glaze	Mullard VR25
R1627	13k	1	50ppm	Metal Film	Allen Bradley FC55
R1628	470k	1	50ppm	Metal Film	Welwyn MFR4
R1629	13k	1	50ppm	Metal Film	Allen Bradley FC55
R1630	4k7	5		Film	Mullard SFR25H
R1631	27k	5		Film	Mullard SFR25
R1632	27k	5		Film	Mullard SFR25
R1633	39k	5		Film	Mullard SFR25
R1634	12k	5		Film	Mullard SFR25
R1635	18k	5		Film	Mullard SFR25
R1636	4k7	2		S.I.L.N/W	Hitech L109
R1637	1k0	5		Film	Mullard SFR25
R1638	1k0	0.25	25ppm	Metal film	Allen Bradley FC55
R1639	1k0	0.25	25ppm	Metal film	Allen Bradley FC55
R1640	3k0	0.25	25ppm	Metal Film	Allen Bradley FC55
R1641	9k1	5		Film	Mullard SFR25
R1642	9k1	5		Film	Mullard SFR25
R1643	10k	5		Film	Mullard SFR25
R1644	10k	1	50ppm	Metal Film	Welwyn MFR4
R1645	1k0	5		Film	Mullard SFR25
R1646	3M9	5		Film	Mullard SFR25
R1647	1M8	5		Film	Mullard SFR25
R1648	5M6	5		Metal Glaze	Mullard VR25
R1649	4k7	5		Film	Mullard SFR25H
R1650	5k6	5		Film	Mullard SFR25
R1651	33k	5		Film	Mullard SFR25
R1652	1M8	5		Film	Mullard SFR25
R1653	120k	5		Film	Mullard SFR25
R1654	120k	5		Film	Mullard SFR25
R1655	470k	5		Film	Mullard SFR25

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R1656	4M7	5		Film	Mullard SFR25
R1657	12k	5		Film	Mullard SFR25
R1658	2k7	5		Film	Mullard SFR25
R1659	22R	5		Film	Mullard SFR25
R1660	1k8	5		Film	Mullard SFR25
C1601	100n		63V	Ceramic Disc	Siemens B37449
C1602	100n		63V	Ceramic Disc	Siemens B37449
C1603	680n	10	100V	Polyester	Wima MKS4
C1604	1n	20	500V	Ceramic Disc	ITT CD08/K2
C1605	22μ	20	25V	Tantalum Bead	ITT TAG 22/25
C1606	22μ	20	25V	Tantalum Bead	ITT TAG 22/25
C1607	100n		63V	Ceramic Disc	Siemens B37449
C1608	100n		63V	Ceramic Disc	Siemens B37449
C1609	100n		63V	Ceramic Disc	Siemens B37449
C1610	22p	10	500V	Ceramic Disc	ITT CD08/TH (N470)
C1611	100μ		63V	Electrolytic	Mullard 035-58101
C1612	100n		63V	Ceramic Disc	Siemens B37449
C1613	100n		63V	Ceramic Disc	Siemens B37449
C1614	100n		63V	Ceramic Disc	Siemens B37449
C1615	100n		63V	Ceramic Disc	Siemens B37449
C1616	100n		63V	Ceramic Disc	Siemens B37449
C1617	Not fitted				
C1618	100μ		63V	Electrolytic	Mullard 035-58101
C1619	100n		63V	Ceramic Disc	Siemens B37449
C1620	100n		63V	Ceramic Disc	Siemens B37449
C1621	100n		63V	Ceramic Disc	Siemens B37449
IC1601	LF412CN				National
IC1602	LM339AN				National
IC1603	μA7805UC				Fairchild
IC1604	CD4052BCN				National
IC1605	ADDAC08ED				Analog Devices
IC1606	SN74LS175N				Texas
IC1607	SN74LS273N				Texas
IC1608	LM339N				National
IC1609	SN74LS26				Texas
D1601	BZX79 C15V0			Diode	Mullard
D1602	BZX79 C15V0			Diode	Mullard
D1603	1N4002			Diode	Mullard
D1604	1N4002			Diode	Mullard
D1605	1N4002			Diode	Mullard
D1606	BZX79 C22V0			Diode	Mullard
D1607	1N4002			Diode	Mullard
D1608	BZX79 C22V0			Diode	Mullard
D1609	BZX79 C10V0			Diode	Mullard
D1610	1N4002			Diode	Mullard
D1611	1N4002			Diode	Mullard
D1612	1N4148			Diode	Mullard
D1613	BZX79 C4V7			Diode	Mullard
D1614	BZX79 C6V8			Diode	Mullard
D1615	1N4148			Diode	Mullard

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
D1616	1N4148			Diode	Mullard
D1617	1N4148			Diode	Mullard
D1618	BZX79 C4V7			Diode	Mullard
D1619	1N4148			Diode	Mullard
D1620	1N4148			Diode	Mullard
D1621	1N4148			Diode	Mullard
D1622	1N4148			Diode	Mullard
D1623	1N4148			Diode	Mullard
D1624	BZX79 C11C0			Diode	Mullard
D1625	1N4148			Diode	Mullard
D1626	1N4148			Diode	Mullard
TR1601	BC212			Transistor	Texas
TR1602	BC212			Transistor	Texas
TR1603	BD204			Transistor	Mullard
TR1604	BC182			Transistor	Texas
TR1605	BC182			Transistor	Texas
TR1606	BD203			Transistor	Mullard
TR1607	VN2222LM			Transistor	Siliconix
TR1608	VN2222LM			Transistor	Siliconix
TR1609	BD228			Transistor	Mullard
TR1610	BC184			Transistor	Texas
TR1611	BC449			Transistor	Texas
RL1601	Relay, 24-volt coil				Omron G2R-217PV
RL1602	Relay, 24-volt coil				Omron G2R-217PV
RL1603	Relay				ERG E-1A5VD

6.13 POWER SUPPLY PCB

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R701	120R	0.5	100ppm	Metal Film	Allen Bradley FC55
R702	348R	0.5	100ppm	Metal Film	Allen Bradley FC55
R703	100R	0.5	100ppm	Metal Film	Allen Bradley FC55
R704	1k1	0.5	100ppm	Metal Film	Allen Bradley FC55
R705	120R	0.5	100ppm	Metal Film	Allen Bradley FC55
R706	1k0	0.5	100ppm	Metal Film	Allen Bradley FC55
R707	1k1	0.5	100ppm	Metal Film	Allen Bradley FC55
R708	100R	0.5	100ppm	Metal Film	Allen Bradley FC55
R709	33R	2		Metal Oxide	Welwyn MR4
R710	12R	5	AOT	Film	Mullard SFR25
"	33R	5	AOT	Film	Mullard SFR25
"	47R	5	AOT	Film	Mullard SFR25
"	56R	5	AOT	Film	Mullard SFR25
C705	220µF		16V	Electrolytic	Mullard 03555221
C706	220µF		16V	Electrolytic	Mullard 03555221
C707	220µF		16V	Electrolytic	Mullard 03555221
C708	220µF		16V	Electrolytic	Mullard 03555221
C709	220µF		16V	Electrolytic	Mullard 03555221
C710	33µF		16V	Electrolytic	Mullard 03555339
C711	33µF		16V	Electrolytic	Mullard 03555339
C712	33µF		16V	Electrolytic	Mullard 03555339
C713	330n	20	100V	Polyester	Wima MKS4
C714	330n	20	100V	Polyester	Wima MKS4
C715	330n	20	100V	Polyester	Wima MKS4
IC701	LM350K				National
IC702	LM350K				National
IC703	LM317T				National
IC704	LM337T				National
D701	VHE 605			Diode	Varo
D702	VHE 605			Diode	Varo
D703	VHE 605			Diode	Varo
D704	VHE 605			Diode	Varo
D705	30S1			Diode	I.R.
D706	30S1			Diode	I.R.
D707	30S1			Diode	I.R.
D708	30S1			Diode	I.R.
D709	MR751			Diode	Motorola
D710	MR751			Diode	Motorola
D711	MR751			Diode	Motorola
D712	MR751			Diode	Motorola
D713	1KAB10		Block Rectifier		I.R.
D714	1N4002			Diode	Mullard
D715	1N4002			Diode	Mullard
D716	1N4002			Diode	Mullard
D717	1N4002			Diode	Mullard
D718	1N4002			Diode	Mullard
D719	1N4002			Diode	Mullard
D720	1N4002			Diode	Mullard
D721	1N4002			Diode	Mullard
FS701	5 x 20mm Fuse			5AT	Belling-Lee L2080A

6.14 MOTHER BOARD PCB

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R1001	270R	5		Film	Mullard SFR25
SK1001	64-way Indirect Connector				Panduit 100-964-433
SK1002	64-way Indirect Connector				Panduit 100-964-433
SK1003	64-way Indirect Connector				Panduit 100-964-433
SK1004	64-way Indirect Connector				Panduit 100-964-433
SK1005	64-way Indirect Connector				Panduit 100-964-433
SK1006	64-way Indirect Connector				Panduit 100-964-433

6.15 CRT SUB-ASSEMBLY

D1002	1N5817	Motorola
D1003	1N5817	Motorola

Cathode Ray Tube:

MkI	(No implosion protection)	C822P4	NEC
MkII	(With implosion protection)	C8M47P4-SB	NEC
CRT	Drive Module:	MB12/20/18/090/5/FA/TTL	KME

6.16 RS232C INTERFACE OPTION

R200	2k2	5	0.3W	Film	Mullard SFR25
R201	220R	5	2.5W	Wirewound (when fitted)	Welwyn W21
R202	220R	5	2.5W	Wirewound (when fitted)	Welwyn W21
R203	3k	5	0.3W	Film	Mullard SFR25
R204	47R	5	2.5W	Wirewound (when fitted)	Welwyn W21
R205	75k	5	0.3W	Film	Mullard SFR25
R206	47R	5	2.5W	Wirewound (when fitted)	Welwyn W21
R207	47R	5	2.5W	Wirewound (when fitted)	Welwyn W21
R208	2k7	5	0.3W	Film	Mullard SFR25
R209	1M	5		Film (when fitted)	Mullard SFR25
R210	x4k7			Resistor Network	VTM 560-1
R211	x4k7			Resistor Network	VTM 560-1

(RS232C INTERFACE OPTION - Continued)

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
C200	100n		63V	Ceramic Disc	Siemens B37449
C201	10μ		25V	Electrolytic	Mullard 015-16109
C202	100n		63V	Ceramic Disc	Siemens B37449
C203	10μ		25V	Electrolytic	Mullard 015-16109
C204	100n		63V	Ceramic Disc	Siemens B37449
C205	100n		63V	Ceramic Disc	Siemens B37449
C206	100n		63V	Ceramic Disc	Siemens B37449
C207	100n		63V	Ceramic Disc	Siemens B37449
C208	100n		63V	Ceramic Disc	Siemens B37449
C209	100n		63V	Ceramic Disc	Siemens B37449
C210	100n		63V	Ceramic Disc	Siemens B37449
C211	100n		63V	Ceramic Disc	Siemens B37449
C212	100n		63V	Ceramic Disc	Siemens B37449
C213	100n		63V	Ceramic Disc	Siemens B37449
C214	100n		63V	Ceramic Disc	Siemens B37449
C215	10p	1p	160V	Polystyrene (when fitted)	Suflex HS
C216	47p	2.5	160V	Polystyrene (when fitted)	LCR FSC
C217	390p	2.5	160V	Polystyrene	LCR FSC
C218	390p	2.5	160V	Polystyrene	LCR FSC
C219	390p	2.5	160V	Polystyrene	LCR FSC
C220	390p	2.5	160V	Polystyrene	LCR FSC
C221	220n		10V	Ceramic Disc	Erie 811T10V
TR200	BC184				Texas
TR201	BC184				Texas
TR202	2N3053				RCA
IC200	SN74LS136N				Texas
IC201	SN74LS136N				Texas
IC202	SN74LS10N				Texas
IC203	SN74LS136N				Texas
IC204	SN74LS04N				Texas
IC205	DM81LS95N				National
IC206	DM81LS95N				National
IC207	DM81LS95N				National
IC208	INS8250				National
IC209	DS1488N				National
IC210	DS1489N				National
S201	Switch, DIL, 16 pin				ERG SDS 8
S202	Switch, DIL, 16 pin				ERG SDS 8
S203	Switch, DIL, 16 pin				ERG SDS 8
S204	Switch, DIL, 12 pin				ERG SCS 6
SK201	25-way Indirect Female Connector				McMurdo DB-25-S-N
PL201	64-way Indirect Male Connector				Vero 17-2876D

6.17 GPIB/HANDLER INTERFACE OPTION

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R1	4k7	2		SIL N/W	Hitech L109
R2	1k0	2		SIL N/W	Hitech L109
C1	10µ		25V		ITT TAG 10/25V
C2- C13 inc	100n		63V	Ceramic Disc	Siemens B37449
C14	220n		10V	Ceramic Disc	ITT (811T) T016
C15	220p	20		Ceramic Disc	ITT CD08/K1
IC1	MC68488P				Motorola
IC2	MC3448A				Motorola
IC3	MC3448A				Motorola
IC4	MC3448A				Motorola
IC5	MC3448A				Motorola
IC6	74LS244N				Texas
IC7	74LS245N				Texas
IC8	74LS136N				Texas
IC9	74LS02N				Texas
IC10	74LS14N				Texas
IC11	74LS05N				Texas
IC12	74LS74AN				Texas
PL1	64-way Indirect Male Connector				Vero 17-2876D
SK2	24-way Indirect Female Connector				Amphenol 57-20240/2
SW1	16-pin DIL Switch				Spectra SDS8 (ERG)
SW2	16-pin DIL Switch				Spectra SDS8 (ERG)

6.18 ANALOG OUTPUT OPTION

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R1802	4k7	5		Film	Mullard SFR25
R1805	4k7	5		Film	Mullard SFR25
R1806	560R	5		Film	Mullard SFR25
R1807	180k	1	25ppm	Metal Film	Allen Bradley FC55
R1808	180k	1	25ppm	Metal Film	Allen Bradley FC55
R1809	22k	1	25ppm	Metal Film	Allen Bradley FC55
R1810	20k	10		Cermet	Spectrol 63XENDMT
R1811	4M7	5		Metal Glaze	Mullard VR37
R1812	10k	5		Film	Mullard SFR25
R1813	22k	1	25ppm	Metal Film	Allen Bradley FC55
R1814	10k	10		Cermet	A. Bradley E4A103
R1815	20k	10		Cermet	Spectrol 63XENDMT
R1816	4M7	5		Metal Glaze	Mullard VR37
R1817	10k	5		Film	Mullard SFR25
R1818	47R	5		Film	Mullard SFR25
R1819	47R	5		Film	Mullard SFR25
R1820	100k	1	25ppm	Metal Film	Allen Bradley FC55
R1821	100k	1	25ppm	Metal Film	Allen Bradley FC55
R1822	100k	1	25ppm	Metal Film	Allen Bradley FC55
R1823	100k	1	25ppm	Metal Film	Allen Bradley FC55
R1824	10k	10		Cermet	A. Bradley E4A103
R1825	10k	5		Film	Mullard SFR25
R1826	10R	5		Film	Mullard SFR25
R1827	10R	5		Film	Mullard SFR25
C1801	100n		63V	Ceramic Disc	Siemens B37449
C1802	100n		63V	Ceramic Disc	Siemens B37449
C1803	100n		63V	Ceramic Disc	Siemens B37449
C1804	100n		63V	Ceramic Disc	Siemens B37449
C1805	33n	5	250V	Polyester	Wima MKS4
C1806	150n	5	100V	Polyester	Wima MKS4
C1807	150n	5	100V	Polyester	Wima MKS4
C1808	33n	5	250V	Polyester	Wima MKS4
C1809	10μ		25V	Tantalum Bead	ITT/STC TAG10/25V
C1810	10μ		25V	Tantalum Bead	ITT/STC TAG10/25V
C1811	68n	5	250V	Polyester	Wima MKS4
C1812	68n	5	250V	Polyester	Wima MKS4
C1813	220n		10V	C. Disc, Transcap	ITT/STC TD16 K3
C1814	47p	10	500V	Ceramic Disc	ITT/STC CDC 8/WK
C1815	100n	20	100V	Ceramic Disc	ITT/STC 8131M-100-0104
C1816	100n	20	100V	Ceramic Disc	ITT/STC 8131M-100-0104
IC1801	SN74LS85-N				Texas
IC1802	SN74LS139-N				Texas
IC1803	SN74LS244-N				Texas
IC1804	P8253				Intel
IC1805	SN74LS04-N				Texas
IC1806	SN74LS 75-N				Texas
IC1807	CD4053BCN				National
IC1808	LF412CN				National
IC1809	LF412CN				National
D1801	LM329CZ				National

(ANALOG OUTPUT OPTION - Continued)

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
TR1801	VN2222L FET				Siliconix
PL1802	15-way Male Connector				Hunter (2E) 08P15L0.5
SK1801	64-way Indirect Male Connector				Vero 17.28760
SK1802	15-way Indirect Female Connector				Hunter (2E) 08S015W0.5

Kelvin clip lead set	1605	(standard item)
4-terminal lead set	1505	(optional extra)
Low capacity clip leads (pair)	D10642B	" "
Chip component clip lead	1605A	" "
Chip probe lead set	1905A	" "
4-terminal component fixture	CF1005	" "

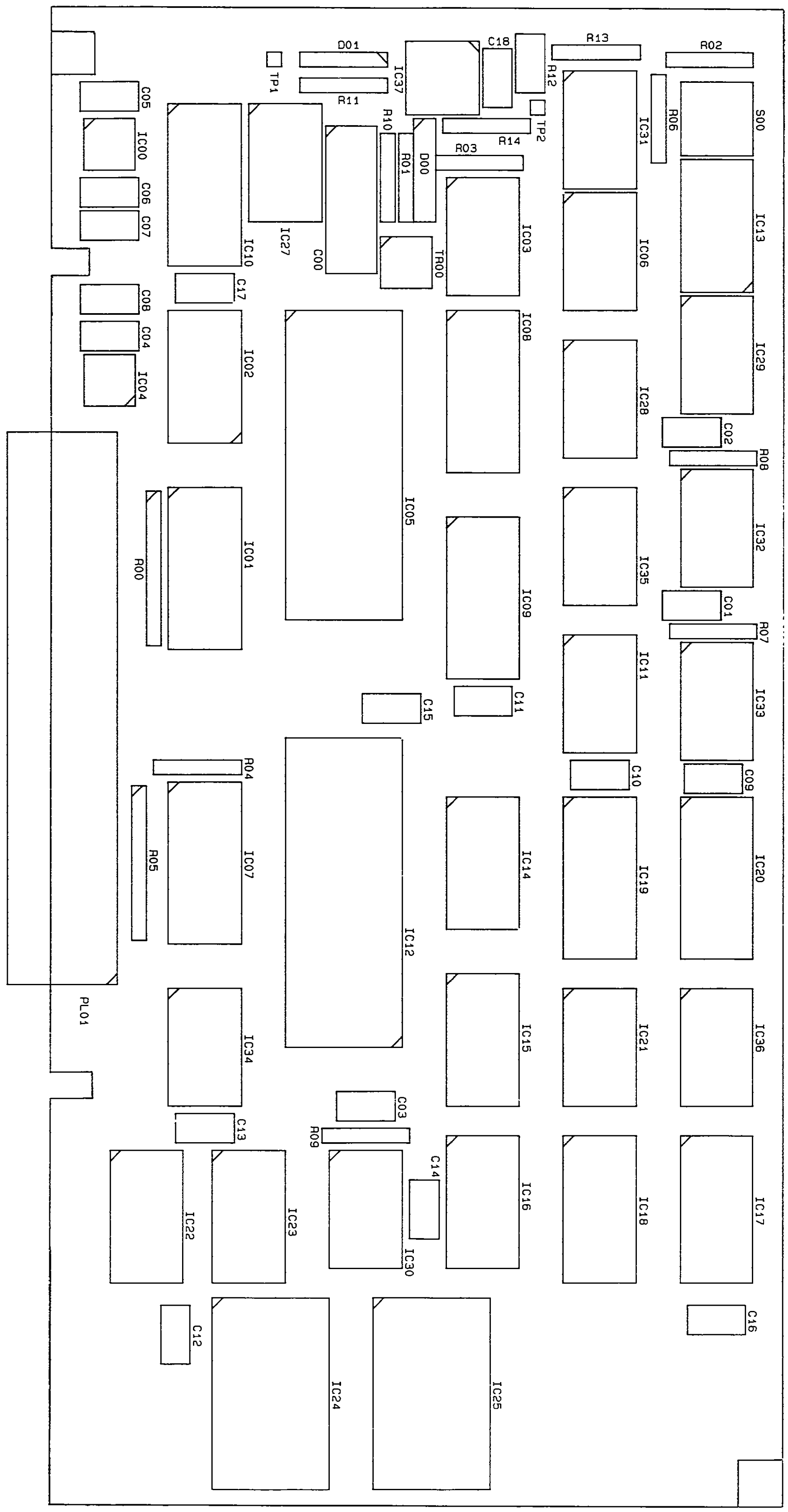


Fig. 6.1
CPU & TV
PCB Layout

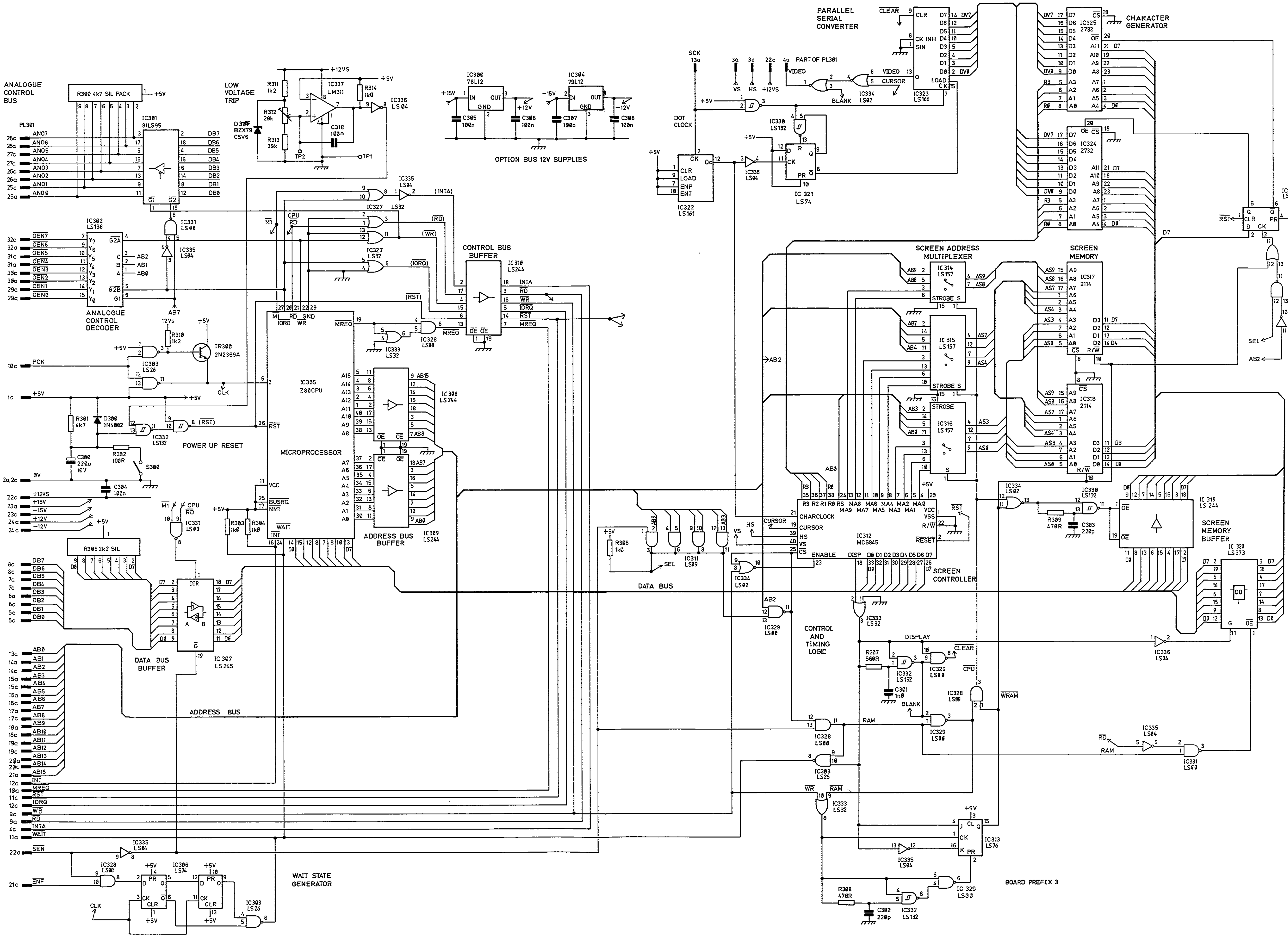


Fig. 6.2

CPU & TV - Circuit Diagram

DV1/25518/P2

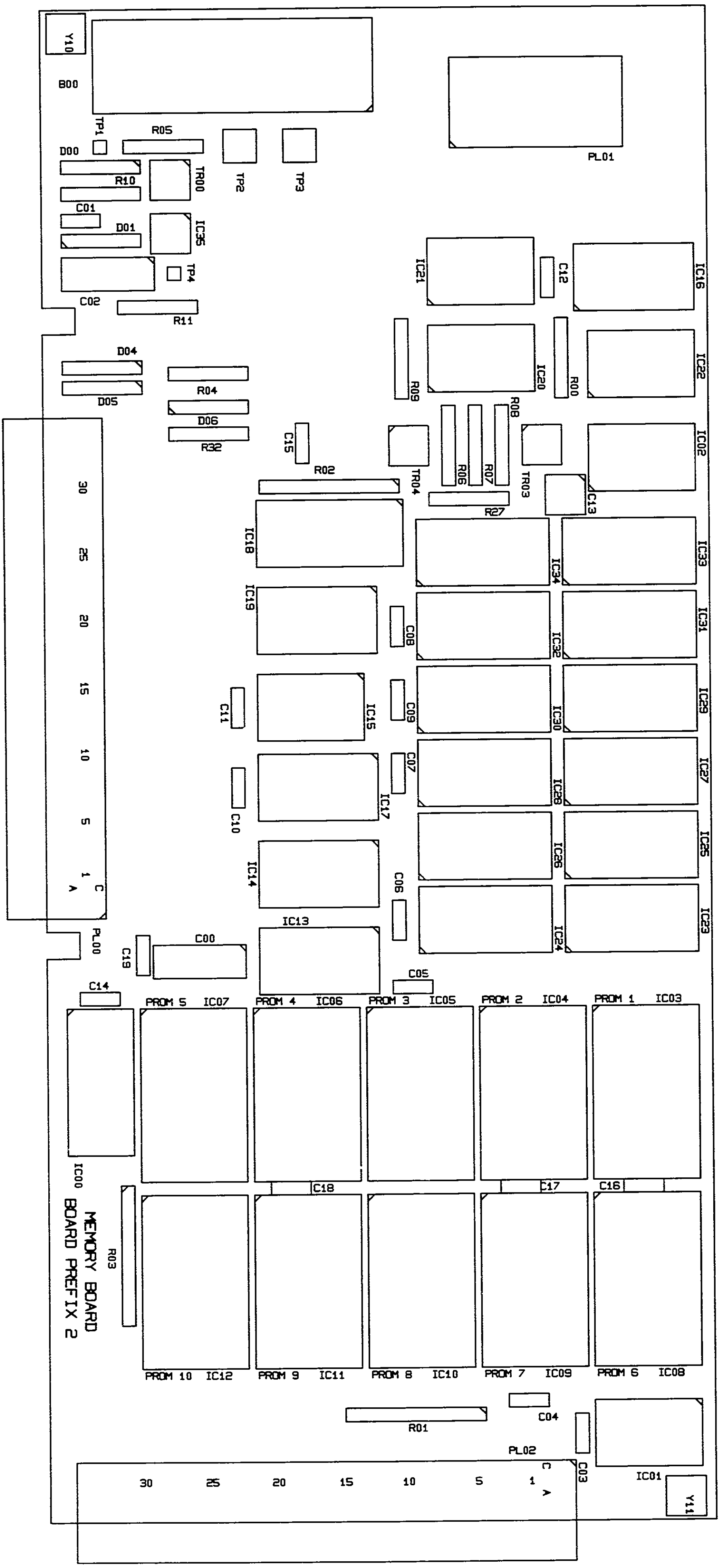
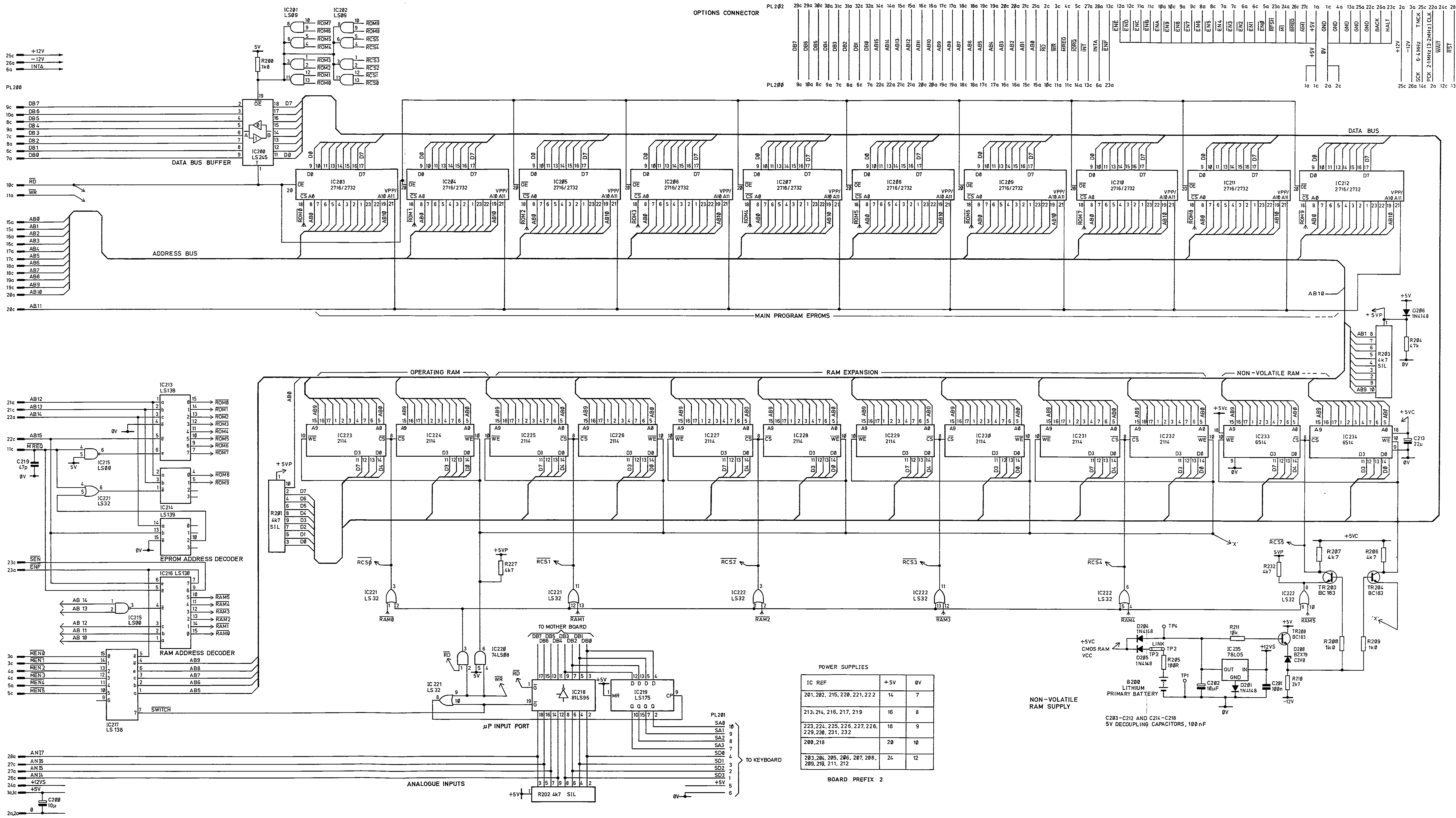


Fig. 6.3
Memory MkI
PCB Layout



POWER SUPPLIES

IC REF	+5V	ØV
2Ø1, 2Ø2, 215, 22Ø, 221, 222	14	7
213, 214, 216, 217, 219	16	8
223, 224, 225, 226, 227, 228, 229, 23Ø, 231, 232	18	9
2ØØ, 218	2Ø	1Ø
2Ø3, 2Ø4, 2Ø5, 2Ø6, 2Ø7, 2Ø8, 2Ø9, 21Ø, 211, 212	24	12

BOARD PREFIX 2

Fig. 6.4

Memory MkI - Circuit Diagram

DV1/25511/P2

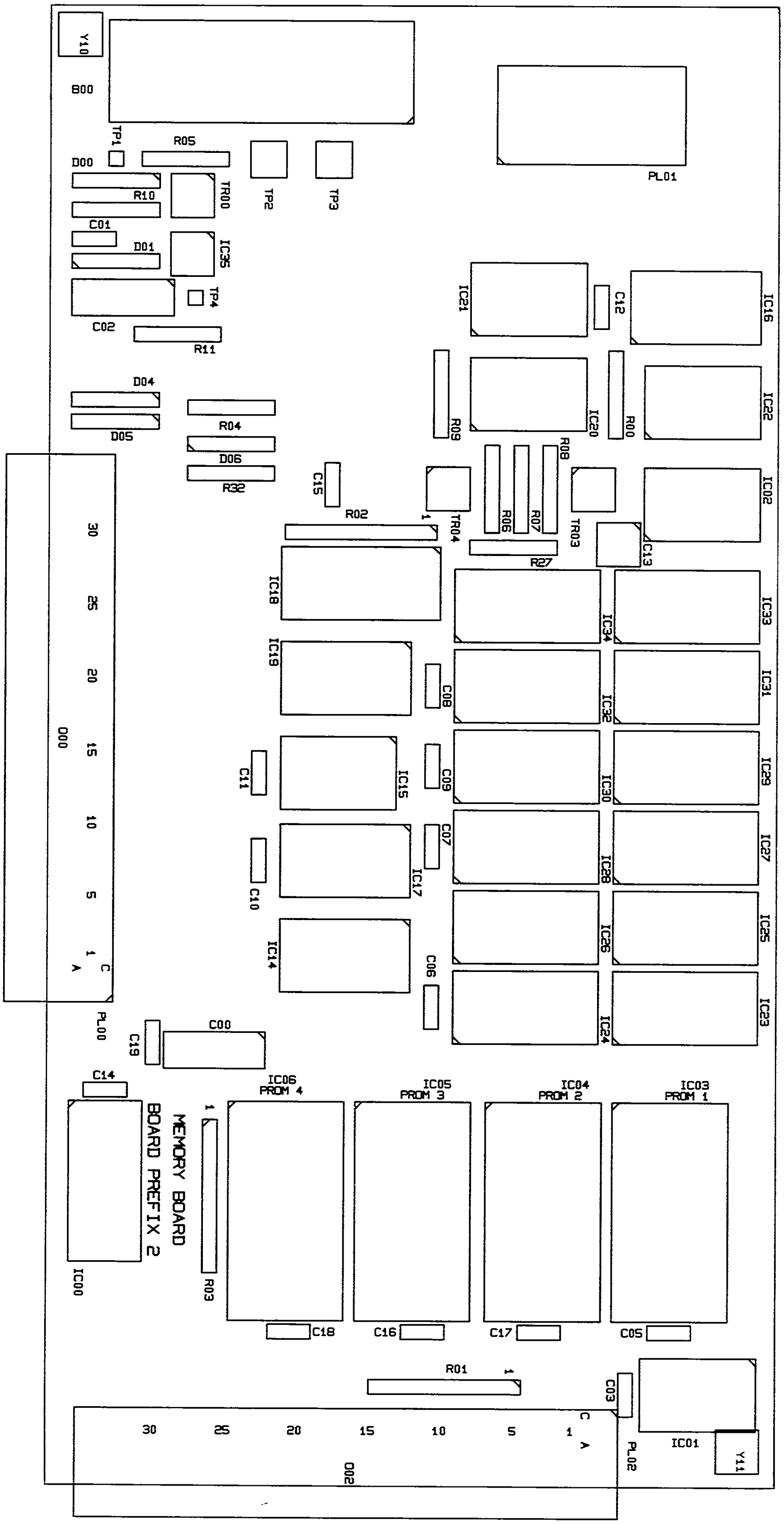
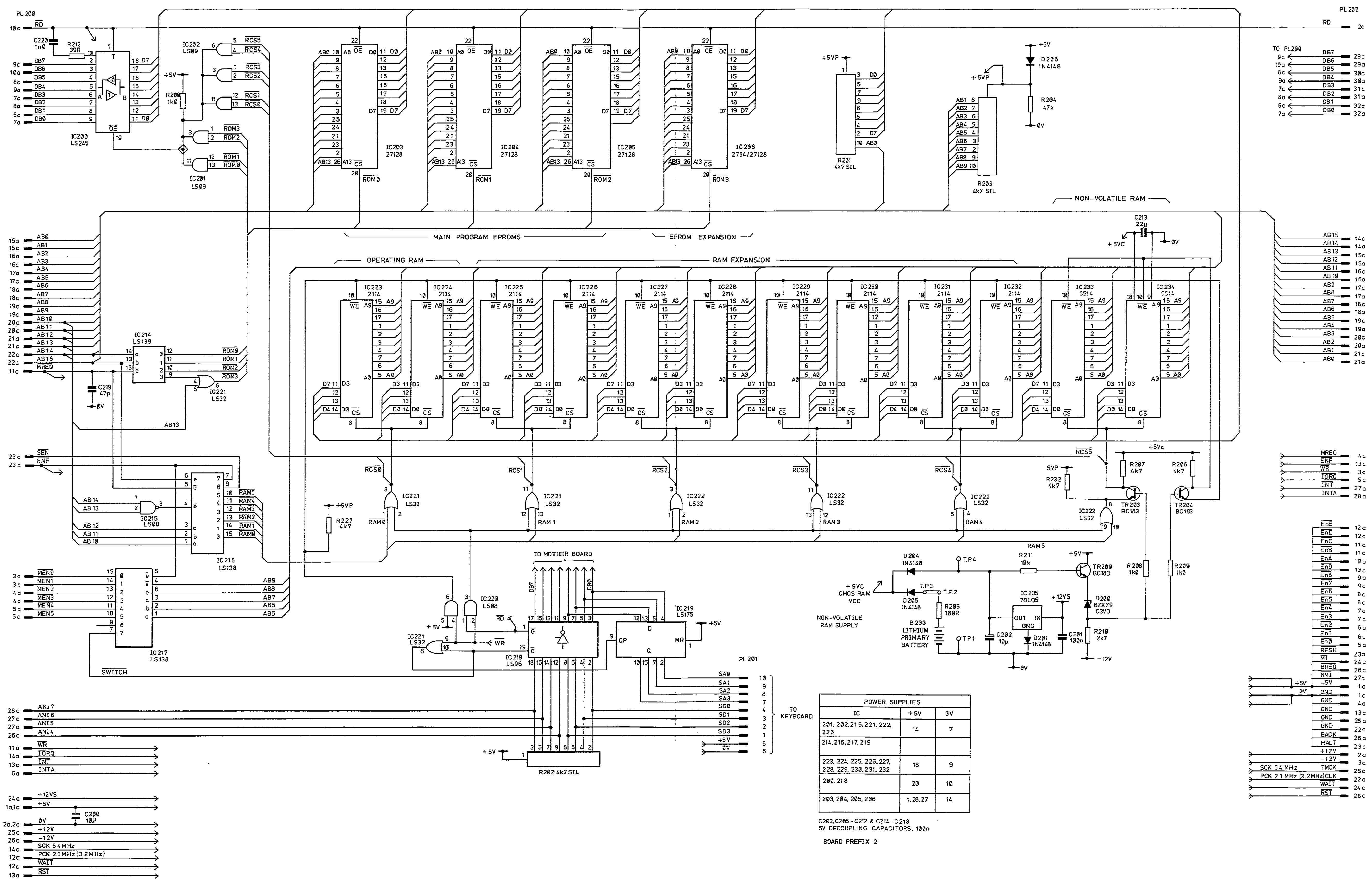


Fig. 6.5
Memory MkII
PCB Layout



POWER SUPPLIES		
IC	+5V	0V
201, 202, 215, 221, 222, 220	14	7
214, 216, 217, 219		
223, 224, 225, 226, 227, 228, 229, 230, 231, 232	18	9
200, 218	20	10
203, 204, 205, 206	1, 28, 27	14

C203, C205 - C212 & C214 - C218
5V DECOUPLING CAPACITORS, 100n

BOARD PREFIX 2

Fig. 6.6

Memory MkII - Circuit Diagram

DV1/25670/P2

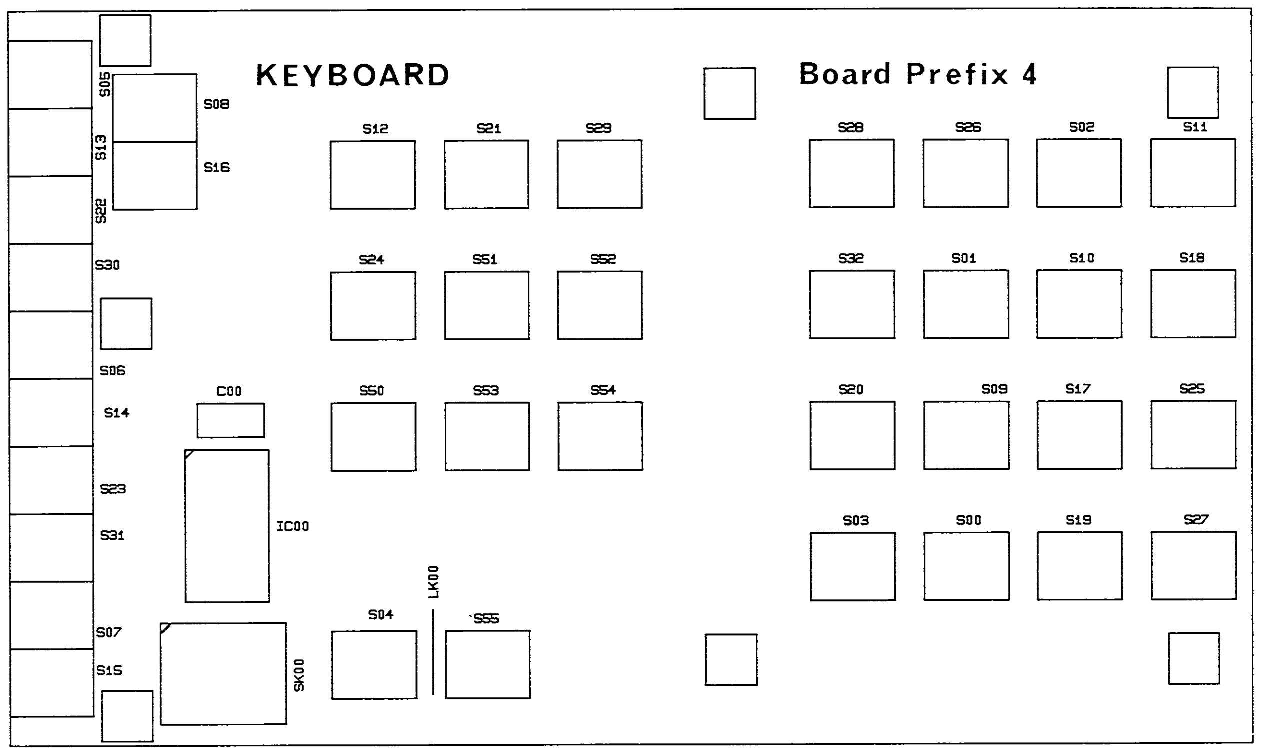


Fig. 6.7 Keyboard - PCB Layout

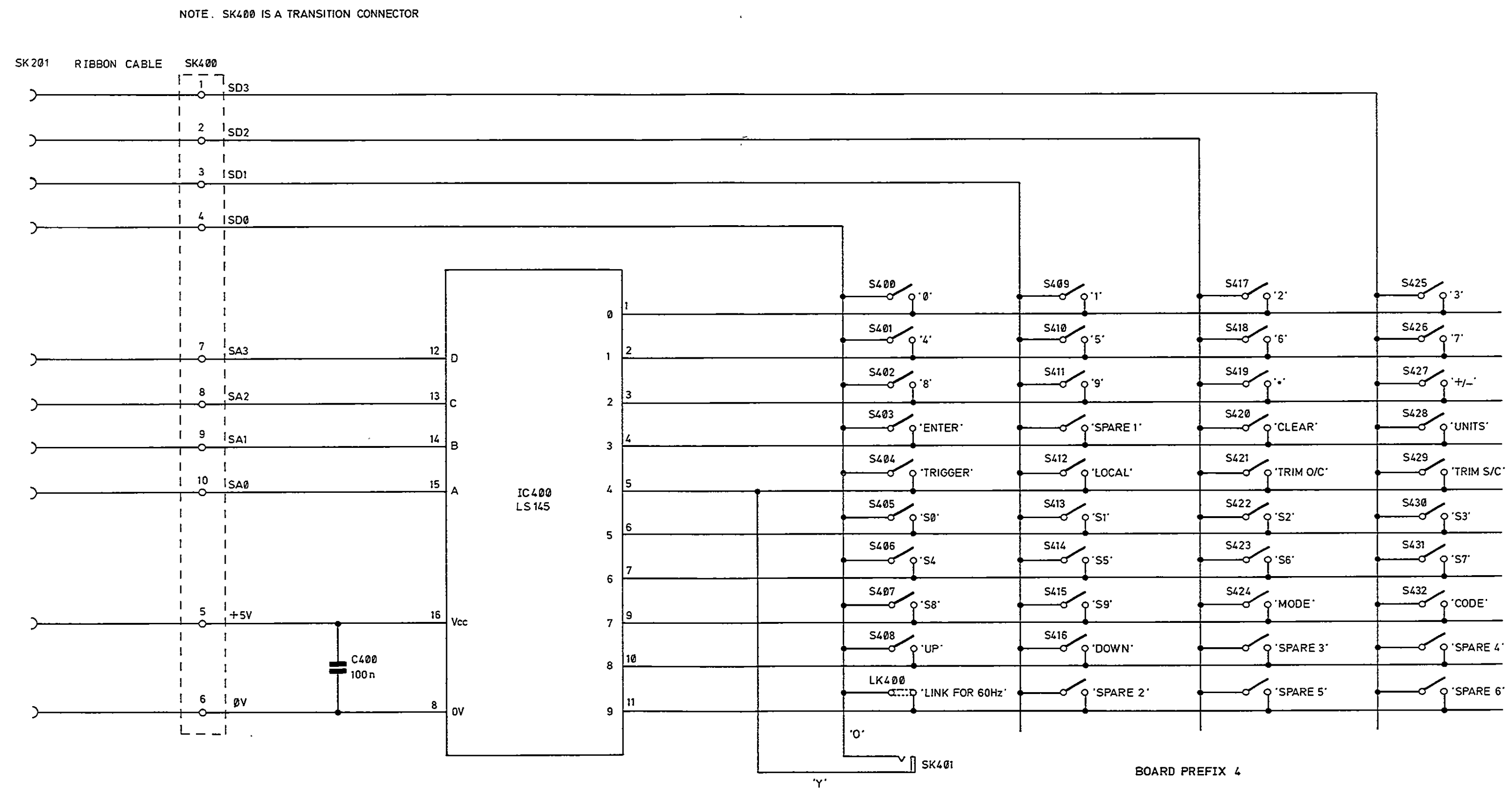


Fig. 6.8
Keyboard - Circuit Diagram
DV2/25521/P1

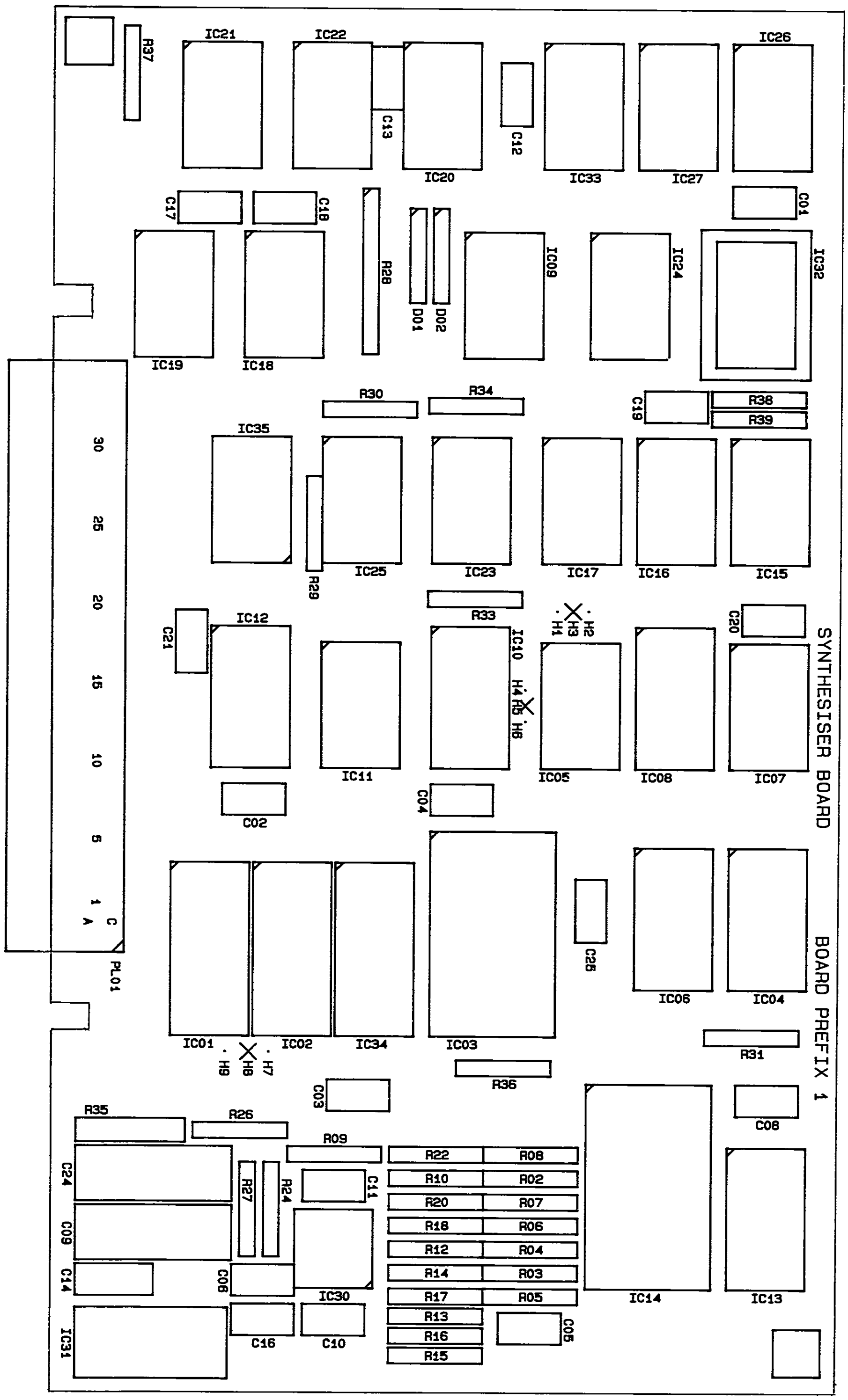


Fig. 6.9 Synthesiser - PCB Layout

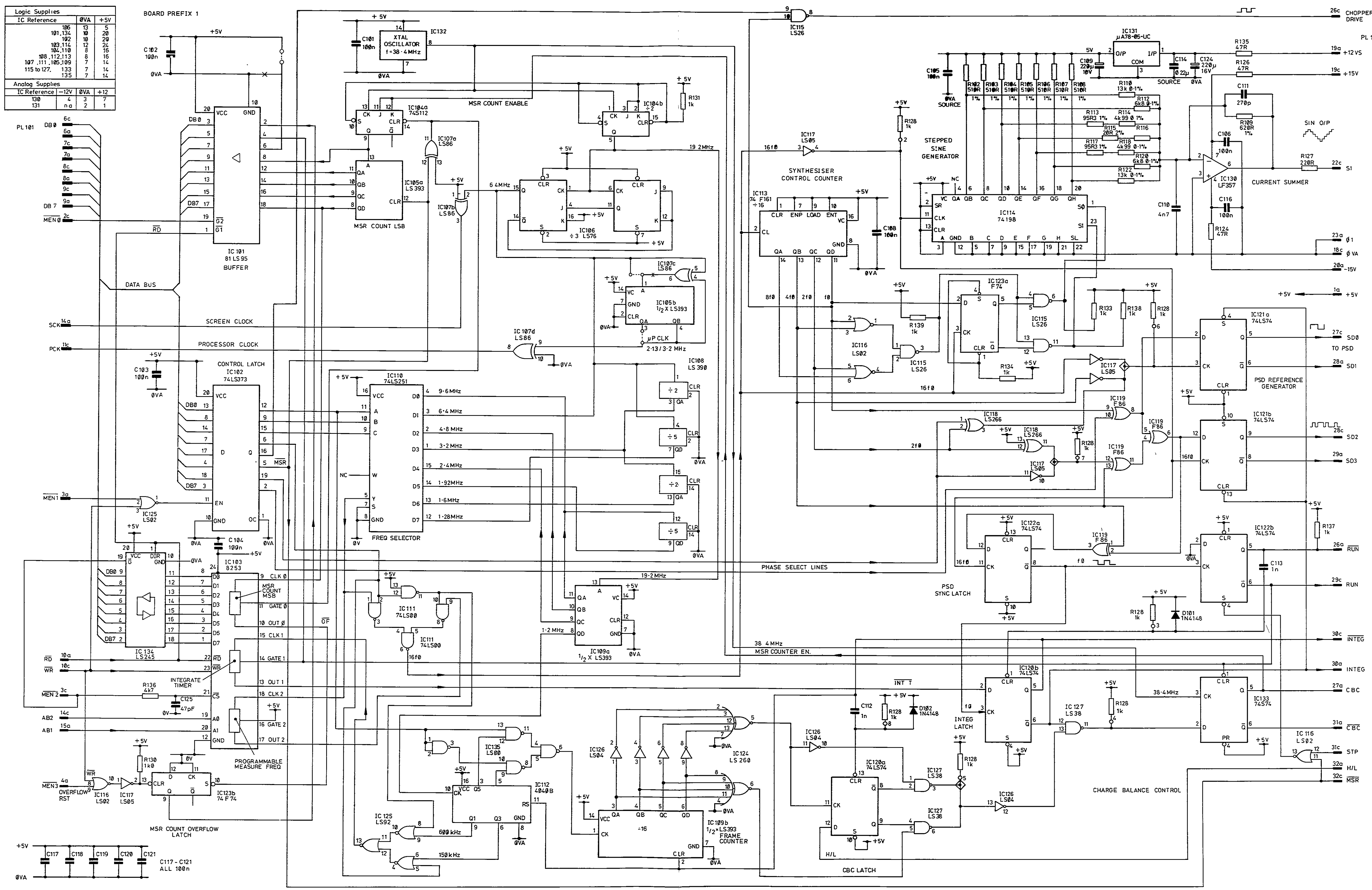


Fig. 6.10

Synthesiser - Circuit Diagram

DV1/25508/P4

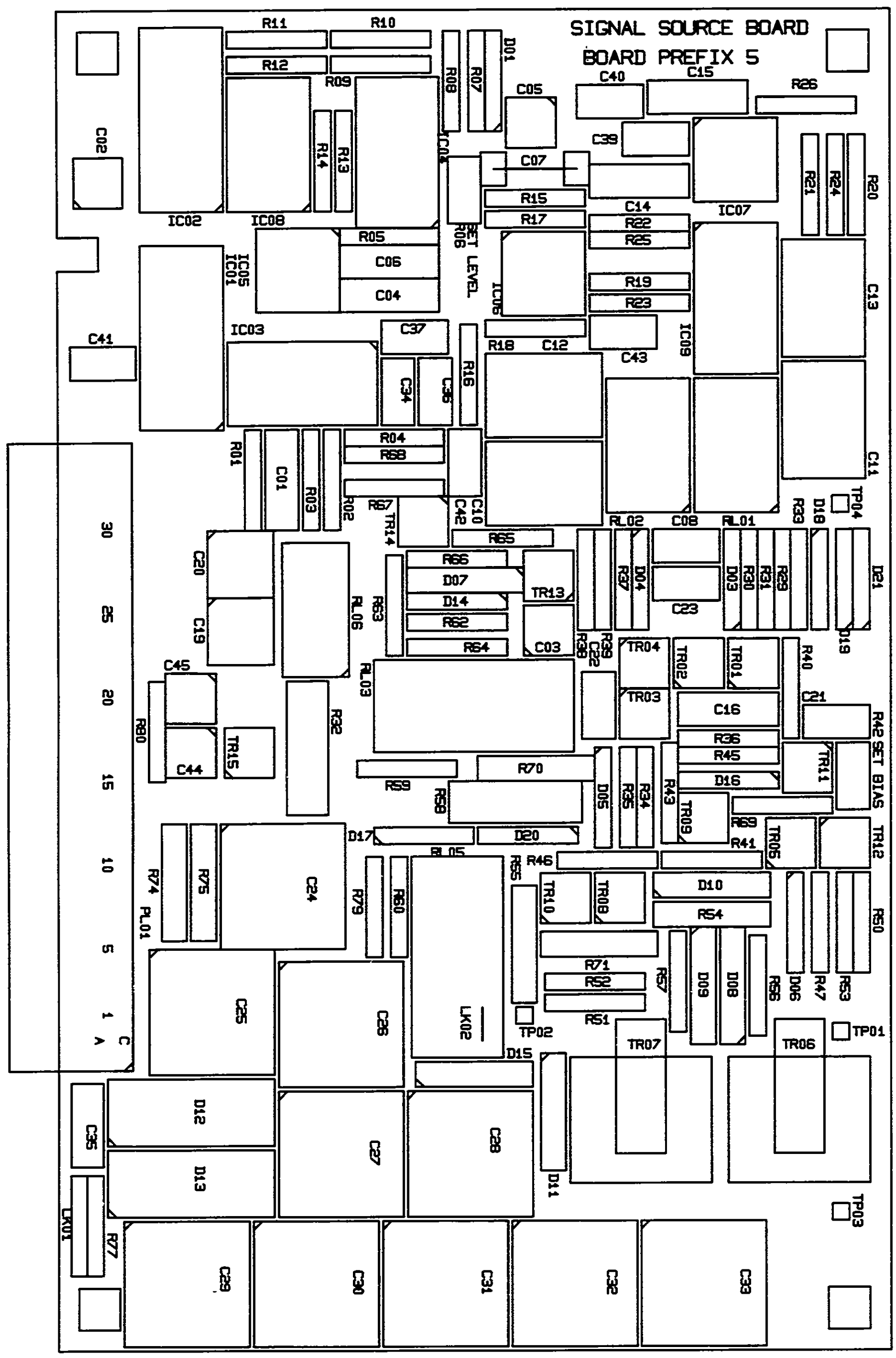
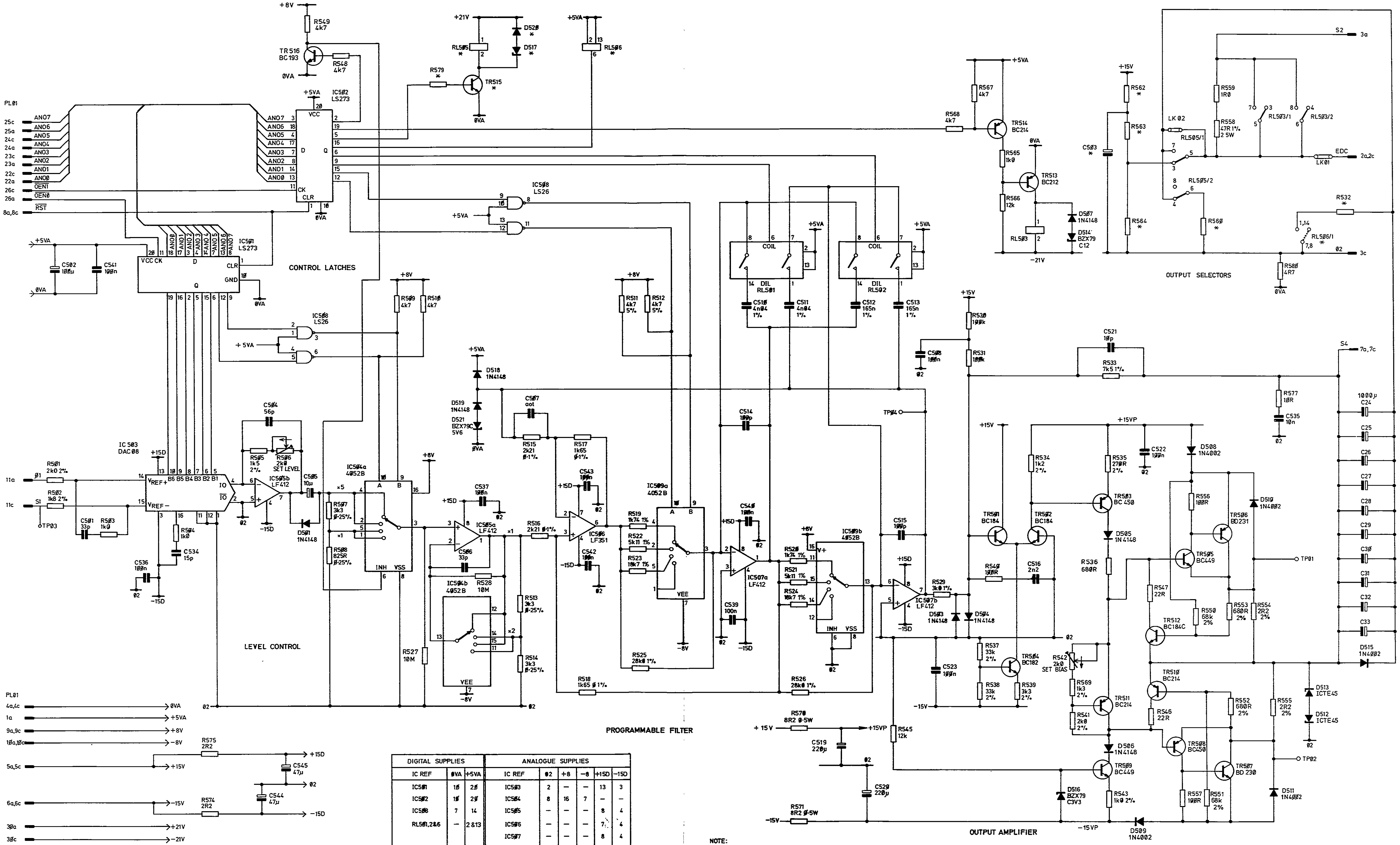


Fig. 6.11 Signal Source - PCB Layout



DIGITAL SUPPLIES		
IC REF	ØVA	+5VA
IC5Ø1	1Ø	2Ø
IC5Ø2	1Ø	2Ø
IC5Ø8	7	14
RL5Ø1,2&6	—	2 &13

ANALOGUE SUPPLIES					
IC REF	Ø2	+8	−8	+15D	−15D
IC5Ø3	2	—	—	13	3
IC5Ø4	8	16	7	—	—
IC5Ø5	—	—	—	8	4
IC5Ø6	—	—	—	7	4
IC5Ø7	—	—	—	8	4
IC5Ø9	8	16	7	—	—

NOTE:
COMPONENTS MARKED * NOT FITTED TO THIS BOARD
BOARD PREFIX 5

Fig. 6.12
Signal Source - Circuit Diagram
DV1/25680/E

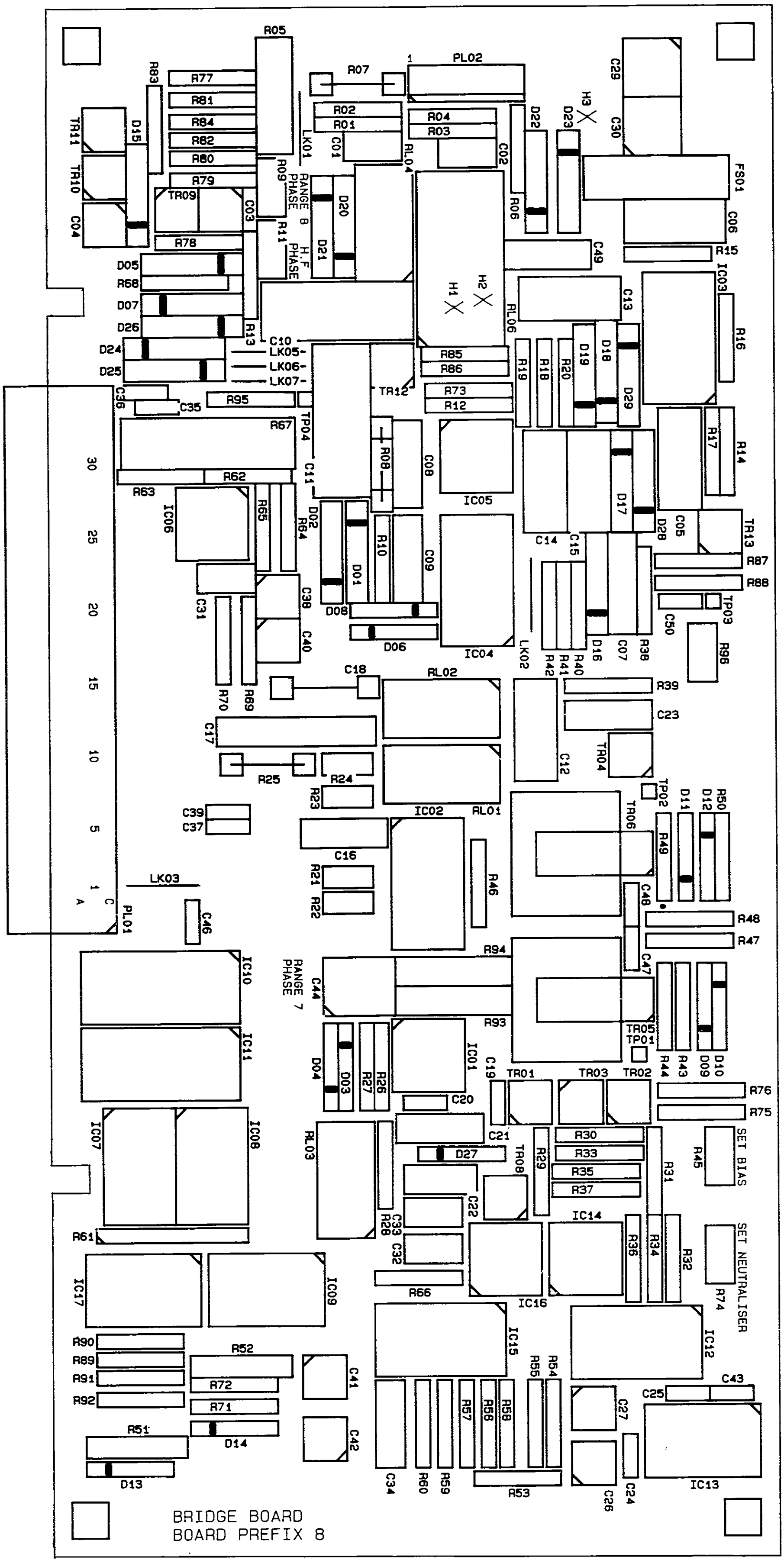
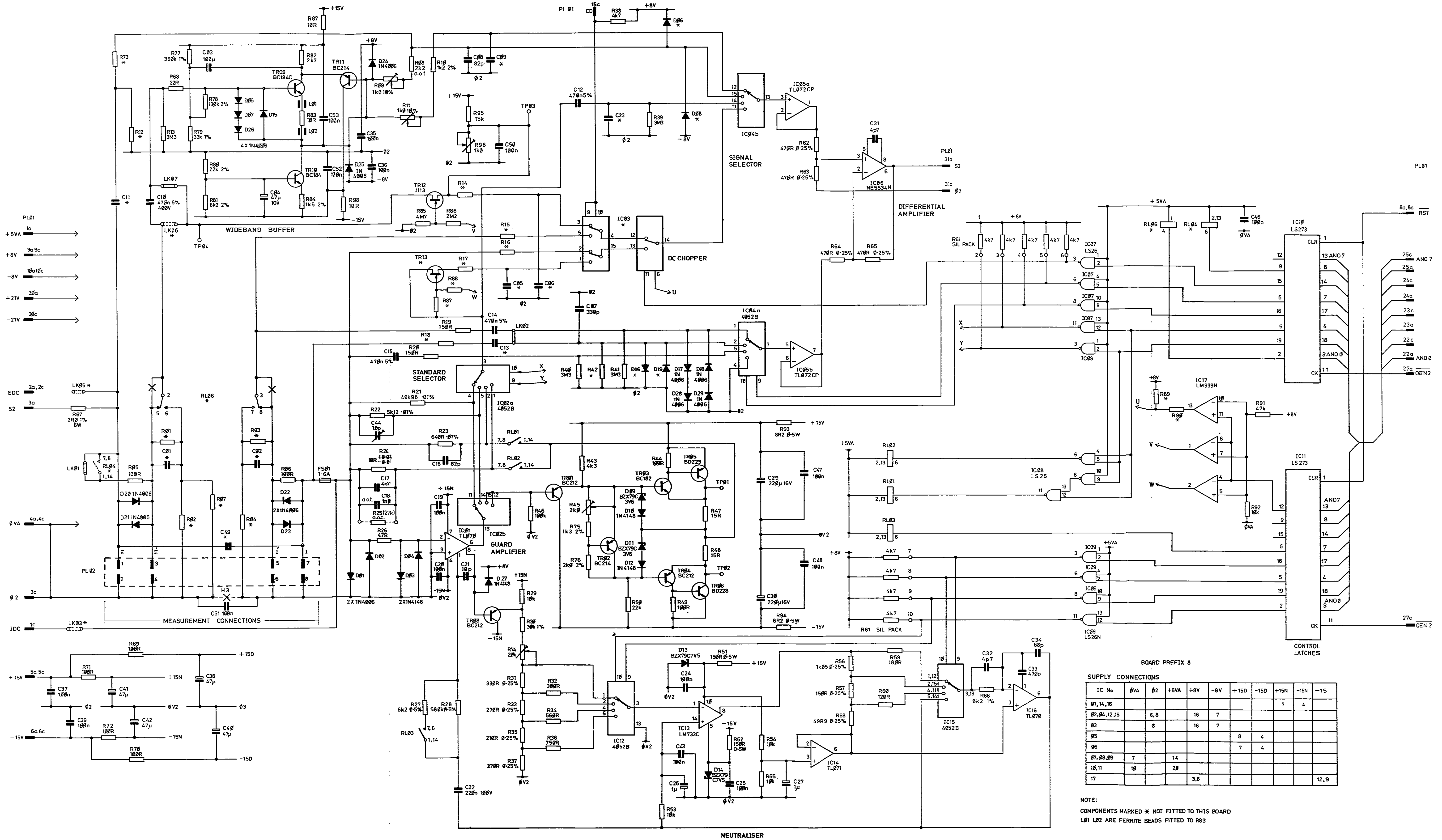


Fig. 6.13
Bridge Board
PCB Layout



BOARD PREFIX 8

SUPPLY CONNECTIONS

IC No	ØVA	Ø2	+5VA	+8V	-8V	+15D	-15D	+15N	-15N	-15
Ø1,14,16								7	4	
Ø2,Ø4,12,15		6,8		16	7					
Ø3		8		16	7					
Ø5						8	4			
Ø6						7	4			
Ø7,Ø8,Ø9	7		14							
1Ø,11	1Ø		2Ø							
17				3,8						12,9

NOTE:

COMPONENTS MARKED * NOT FITTED TO THIS BOARD

LØ1 LØ2 ARE FERRITE BEADS FITTED TO R83

Fig. 6.14

Bridge Board - Circuit Diagram

DV1/25683/I

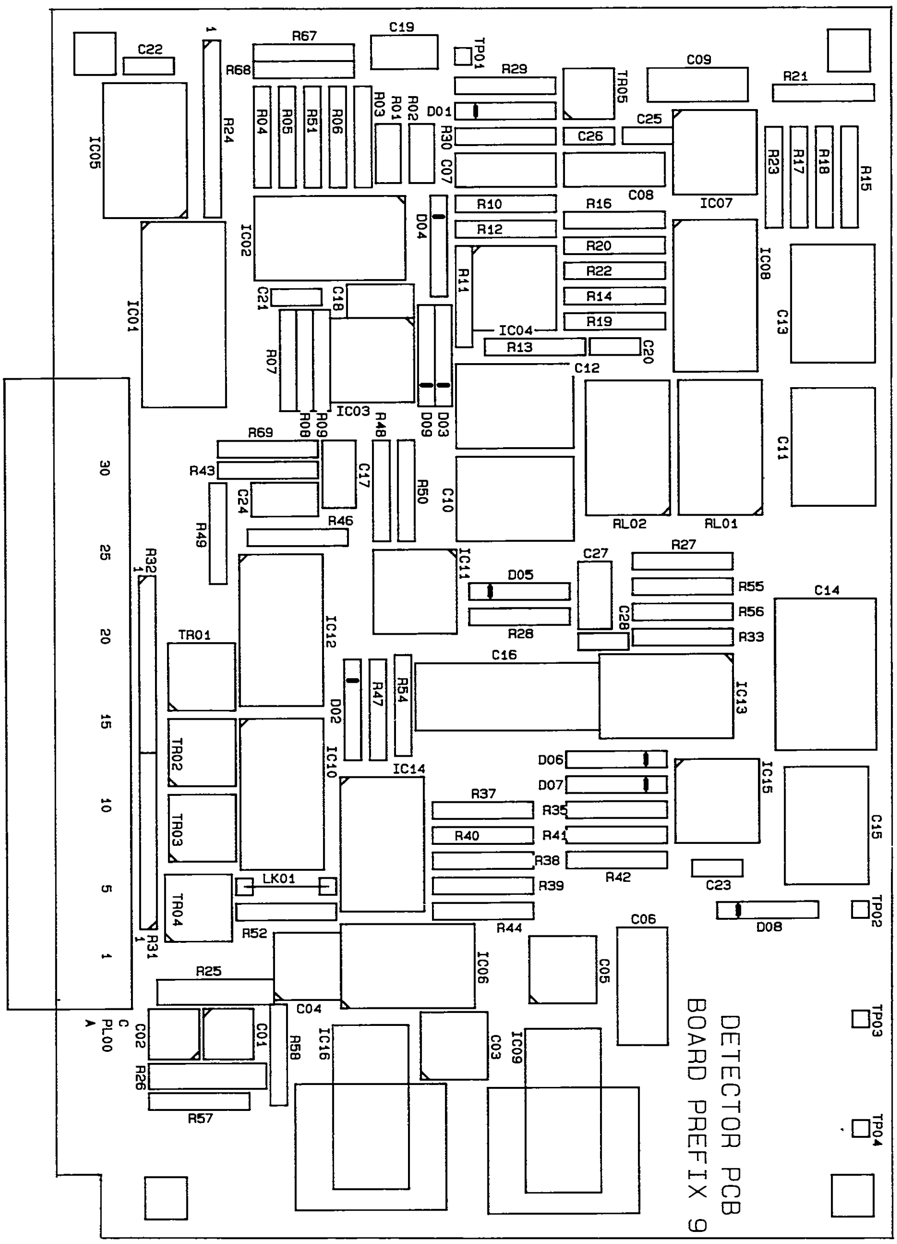
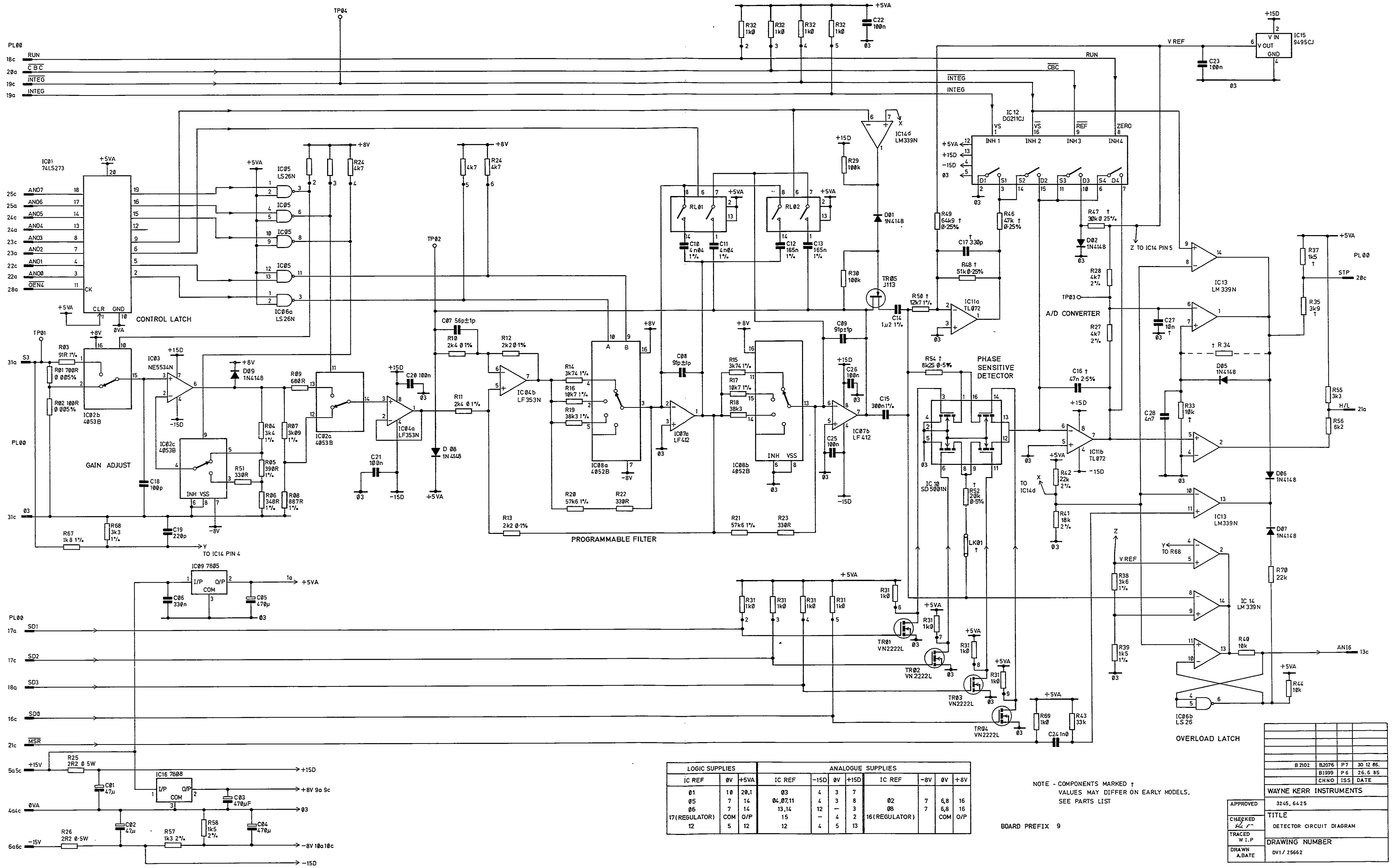


Fig. 6.15   Detector - PCB Layout



LOGIC SUPPLIES			ANALOGUE SUPPLIES							
IC REF	ØV	+5VA	IC REF	−15D	ØV	+15D	IC REF	−8V	ØV	+8V
Ø1	1Ø	2Ø,1	Ø3	4	3	7				
Ø5	7	14	Ø4,Ø7,11	4	3	8	Ø2	7	6,8	16
Ø6	7	14	13,14	12	—	3	Ø8	7	6,8	16
17(REGULATOR)	COM	O/P	15	—	4	2	16(REGULATOR)		COM	O/P
12	5	12	12	4	5	13				

	CHNO	ISS	DATE
B 2102	B2076	P7	30 12 86.
	B1999	P6	26.6 85

WAYNE KERR INSTRUMENTS
3245, 6425
APPROVED
CHECKED
TRACED W.I.P
DRAWN A.BATE
TITLE: DETECTOR CIRCUIT DIAGRAM
DRAWING NUMBER: DV1/25662

Fig. 6.16
Detector - Circuit Diagram
DV1/25662/P7

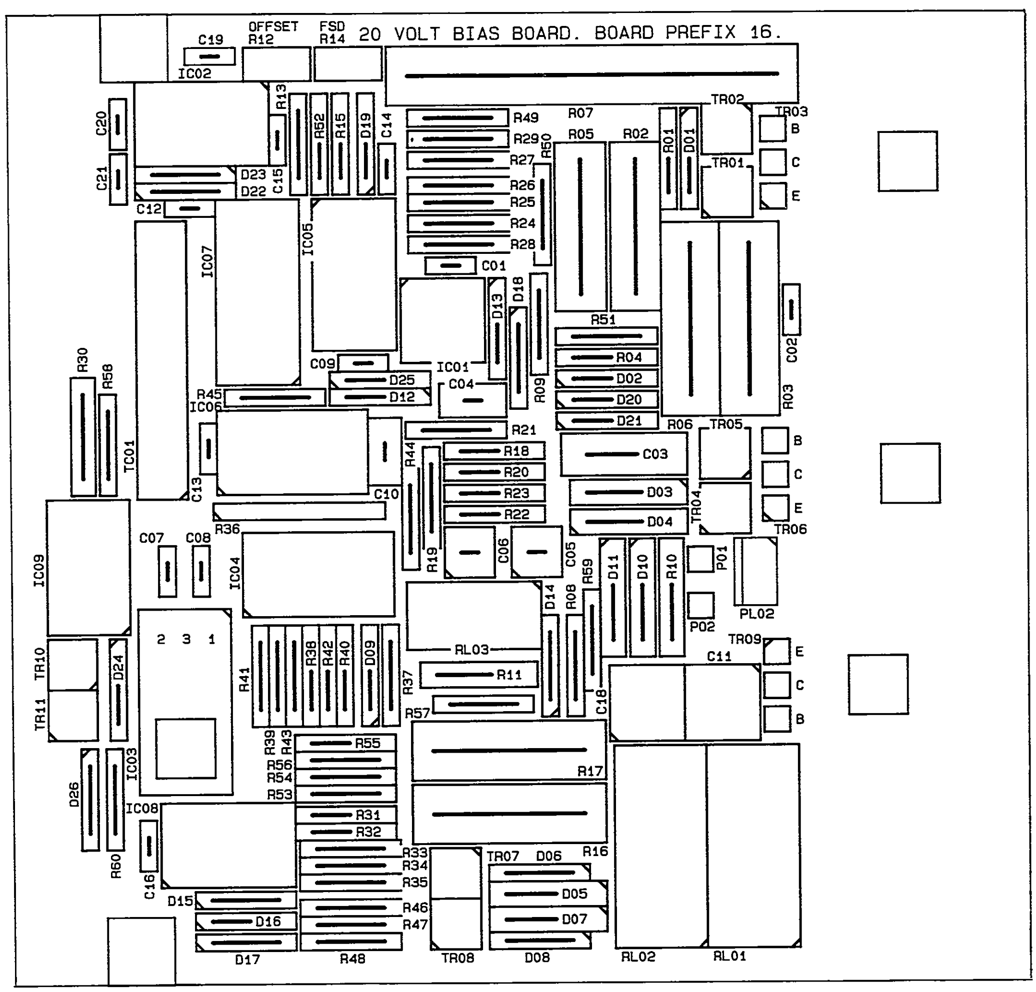
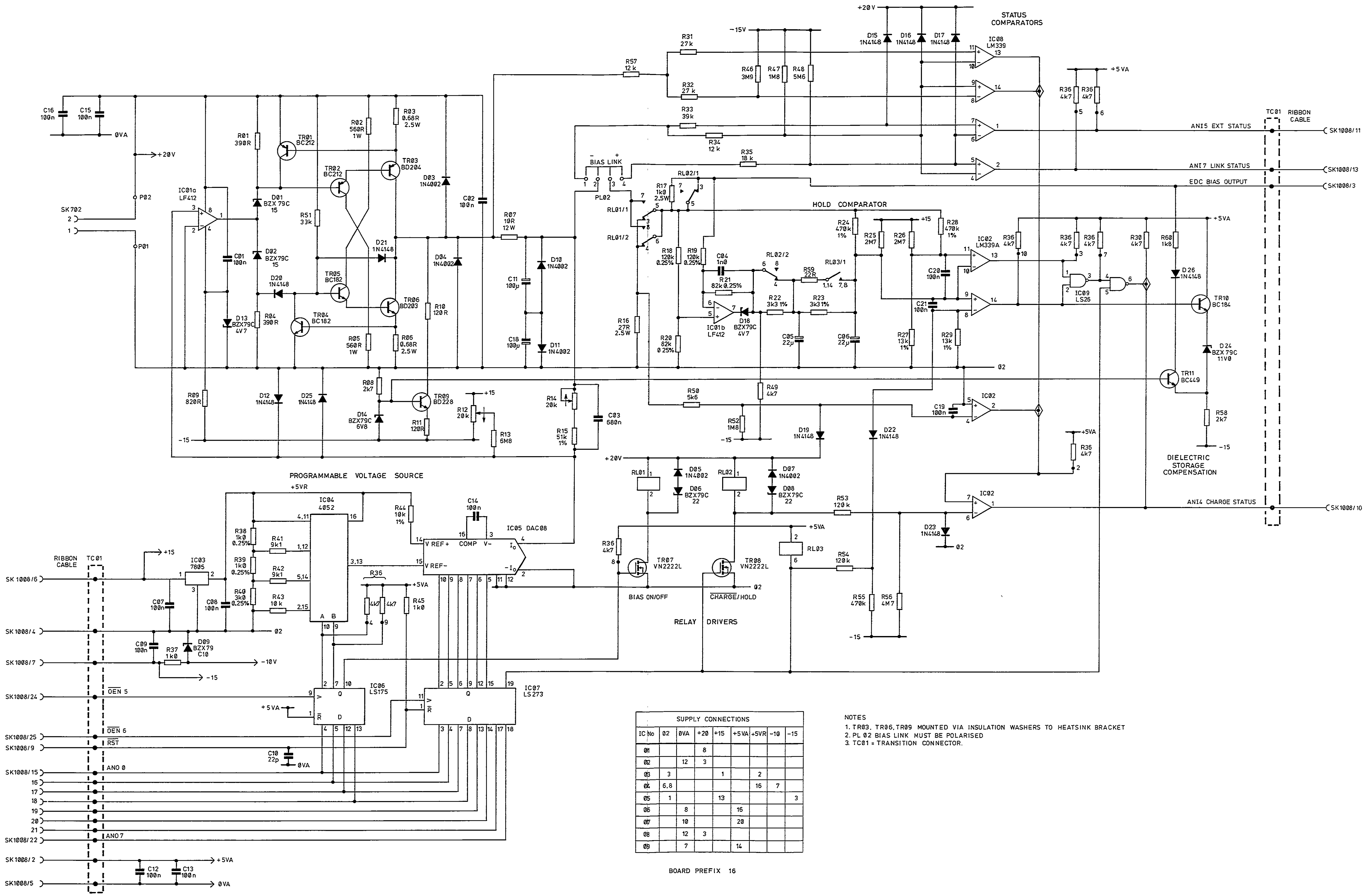


Fig. 6.17   20V Bias - PCB Layout



SUPPLY CONNECTIONS								
IC No	02	0VA	+20	+15	+5VA	+5VR	-10	-15
01			8					
02		12	3					
03	3			1		2		
04	6,8					16	7	
05	1			13				3
06		8			16			
07		10			20			
08		12	3					
09		7			14			

BOARD PREFIX 16

NOTES
1. TR03, TR06, TR09 MOUNTED VIA INSULATION WASHERS TO HEATSINK BRACKET
2. PL 02 BIAS LINK MUST BE POLARISED
3. TC01 = TRANSITION CONNECTOR.

Fig. 6.18

20V Bias - Circuit Diagram

DV1/25690/H

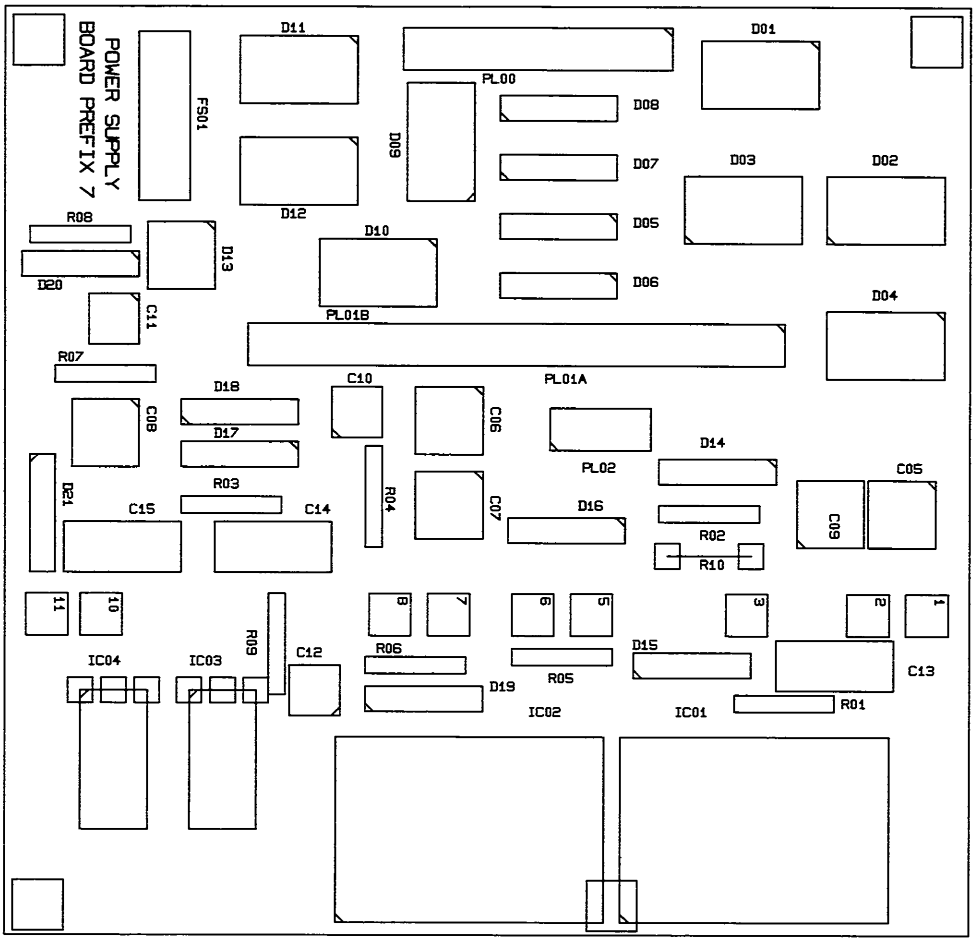


Fig. 6.19   Power Supplies - PCB Layout

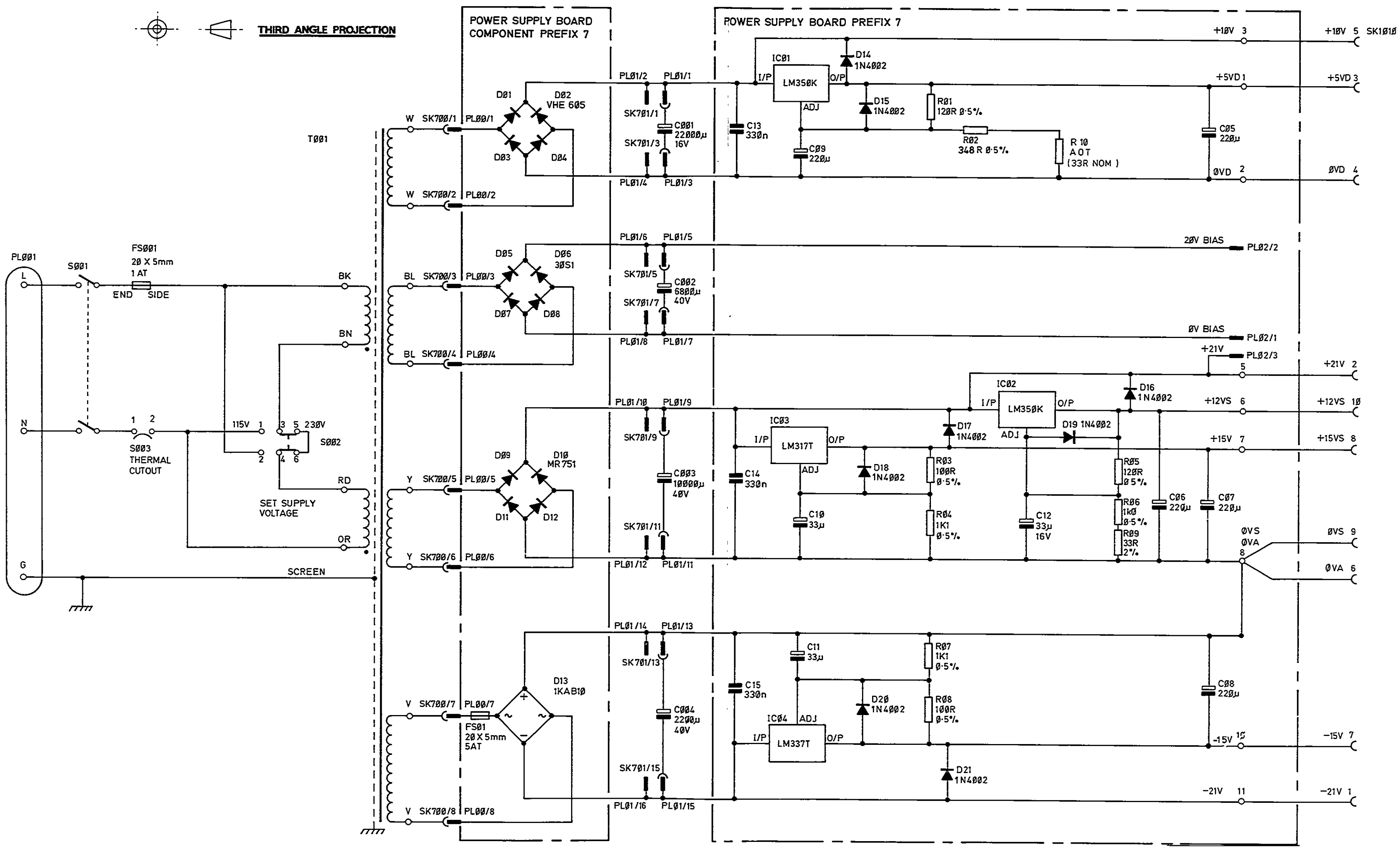


Fig. 6.20

Power Supplies - Circuit Diagram

DV1/25530/P5

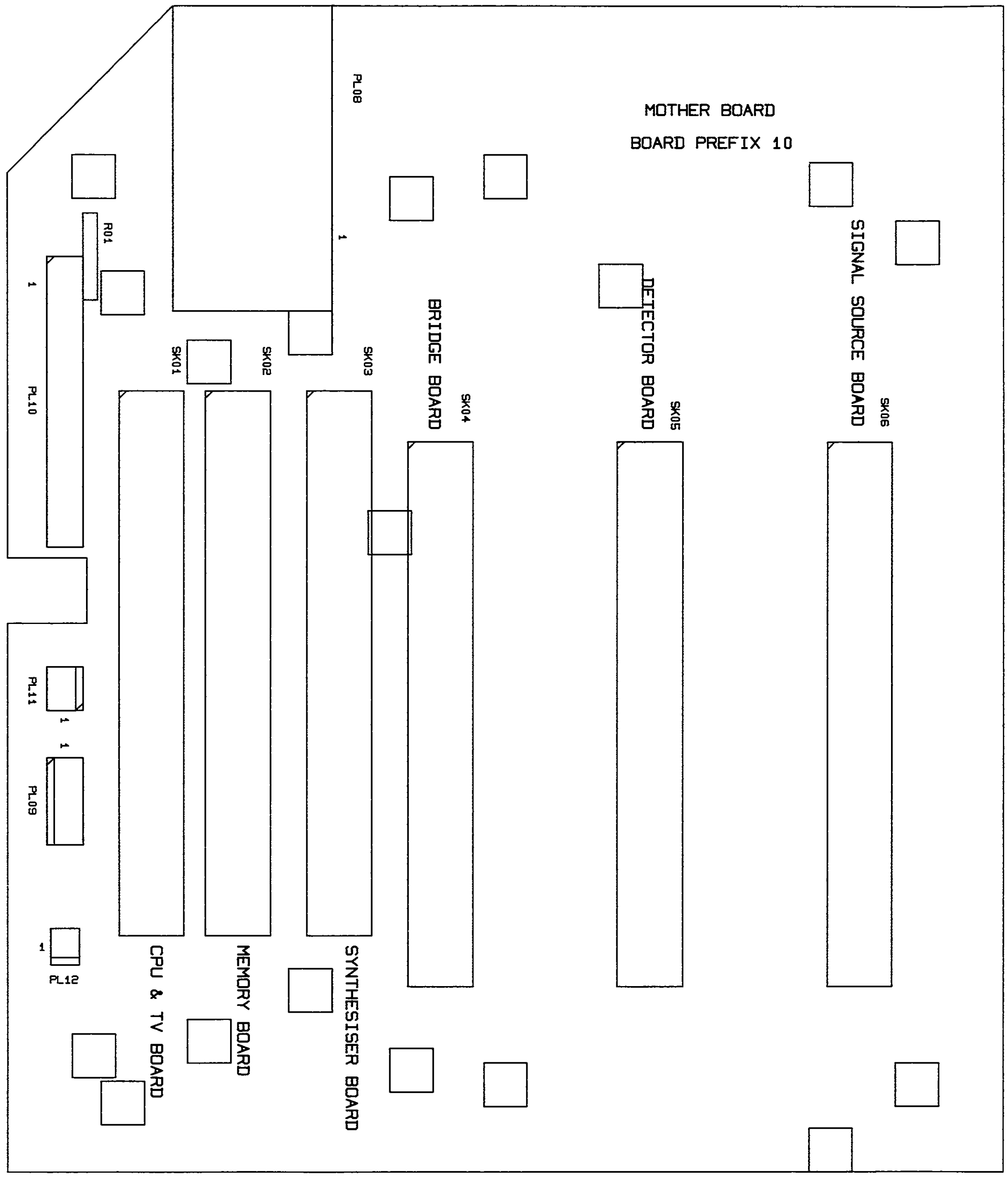


Fig. 6.21 Mother Board - PCB Layout

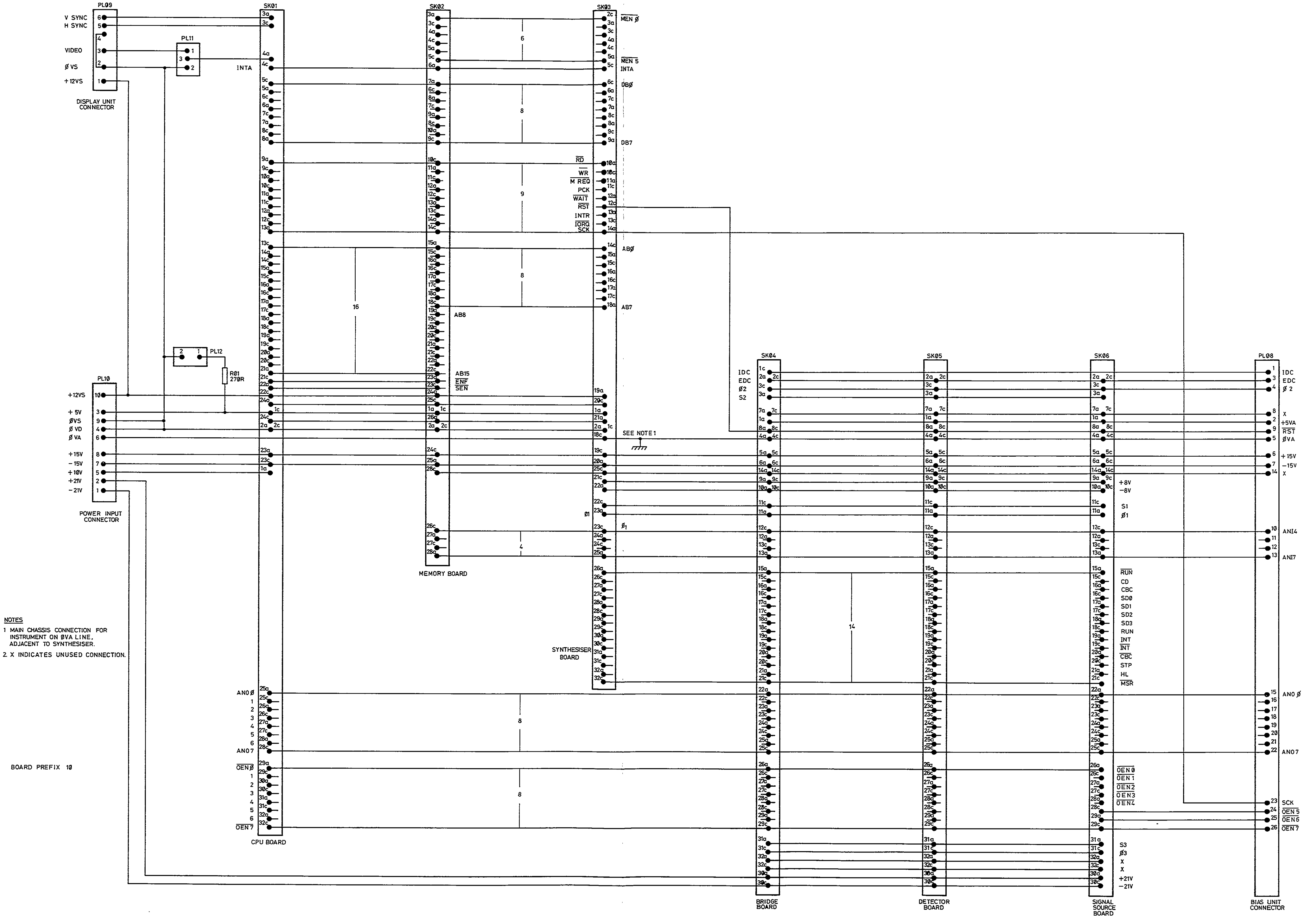


Fig. 6.22

Mother Board - Circuit Diagram

DV1/25514/P1

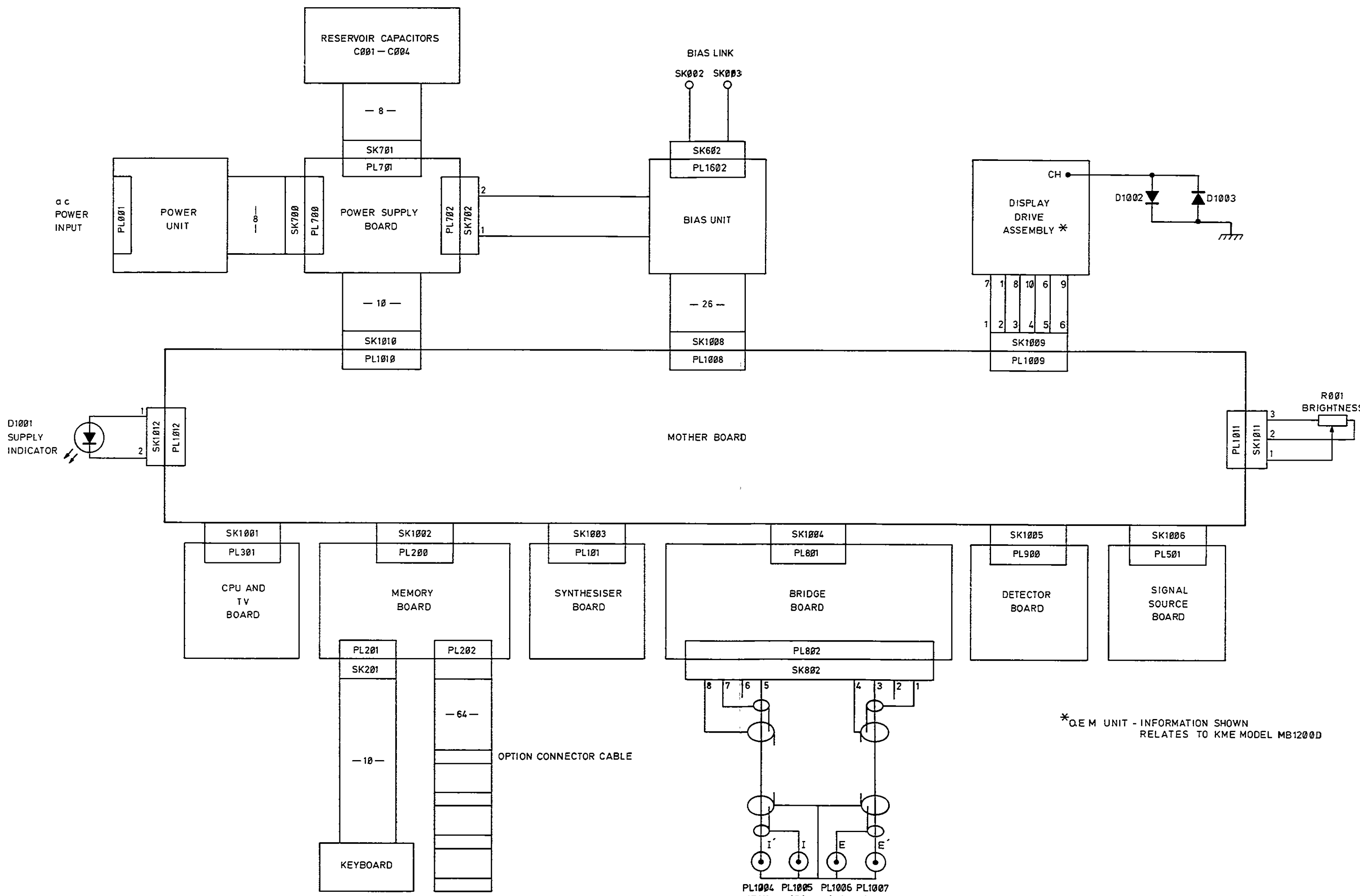
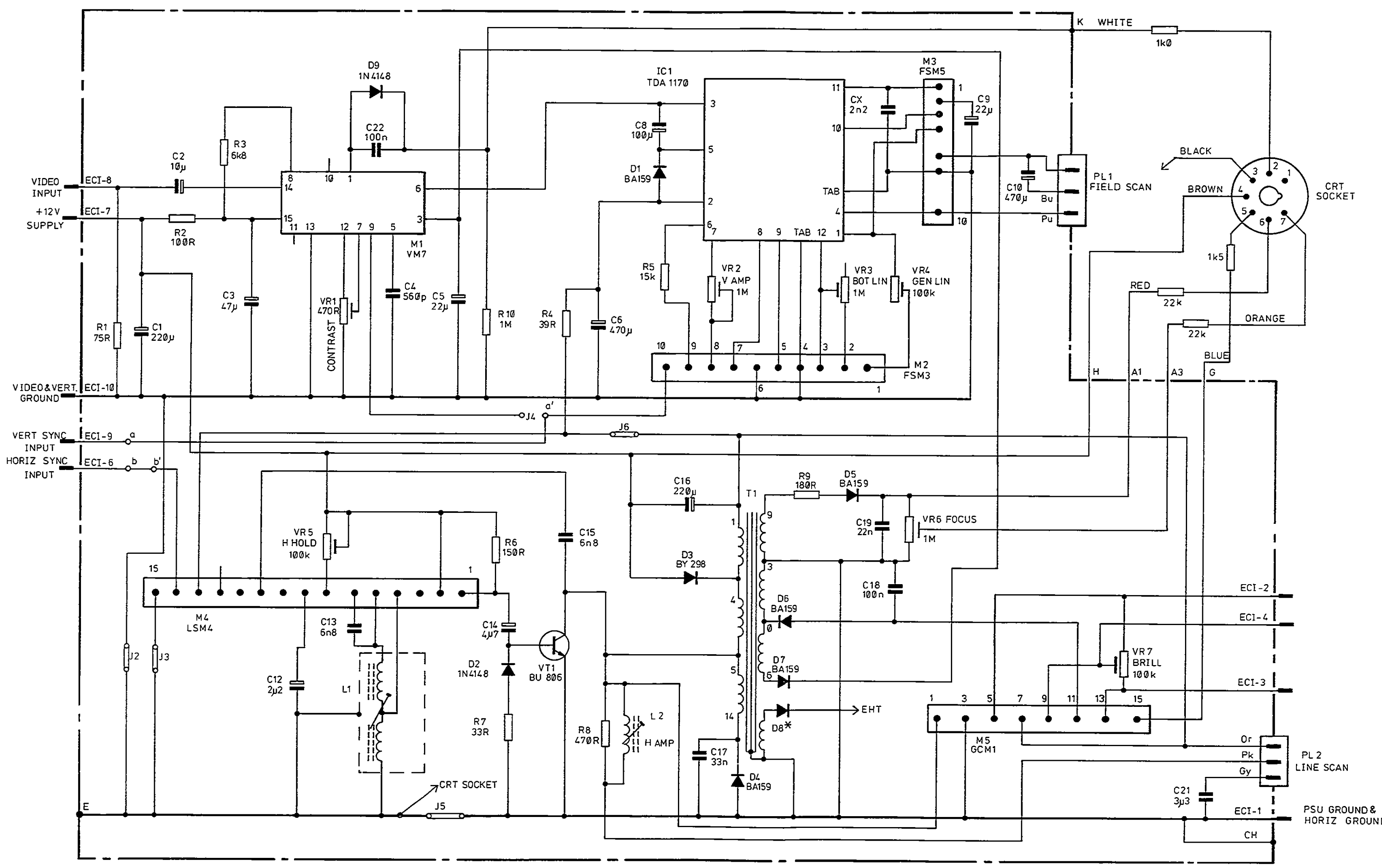


Fig. 6.23

Interconnections

DV/25740/P1



*D8 INTEGRAL PART OF T1

Fig. 6.24

KME CRT Drive Board - Circuit Diagram

DV/25736/A

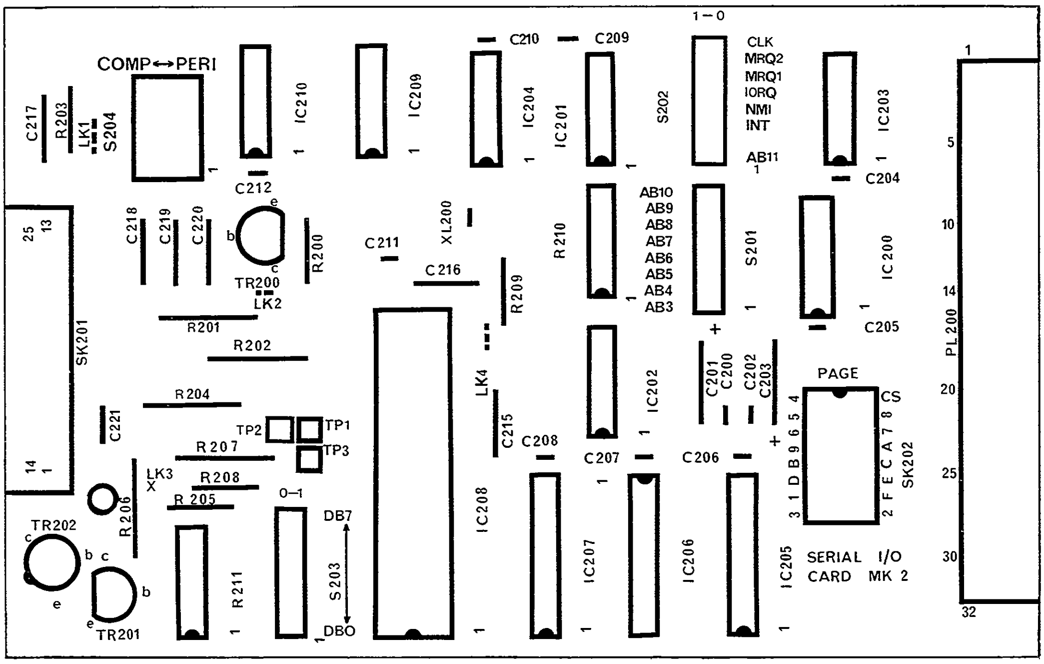


Fig. 6.25 RS232C Option - PCB Layout

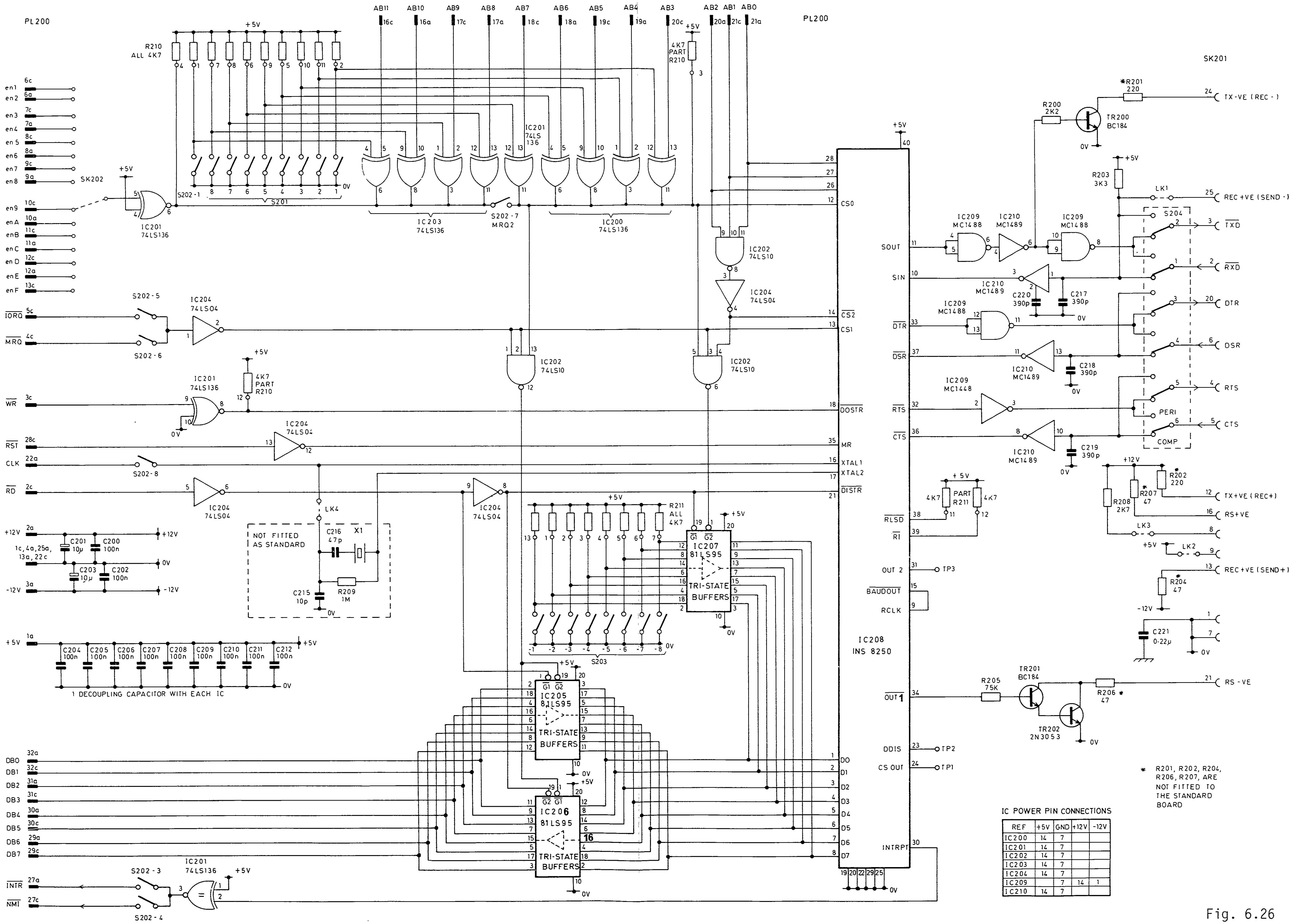


Fig. 6.26

RS232C Option - Circuit Diagram

D02/24228/E

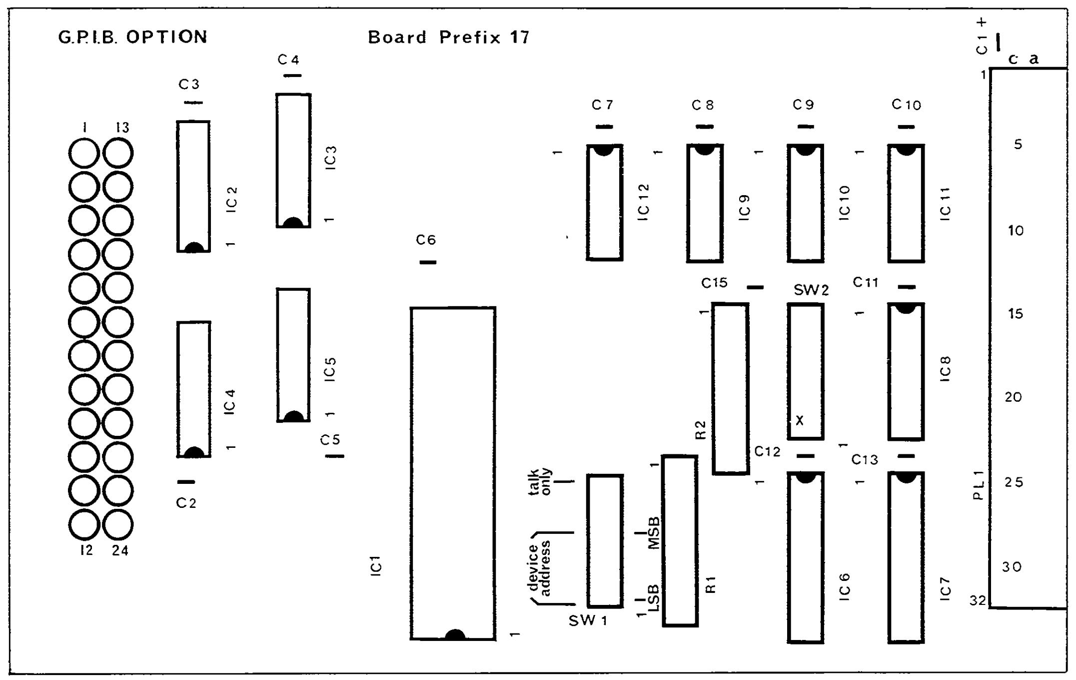


Fig. 6.27 GPIB/Handler Interface Option - PCB Layout

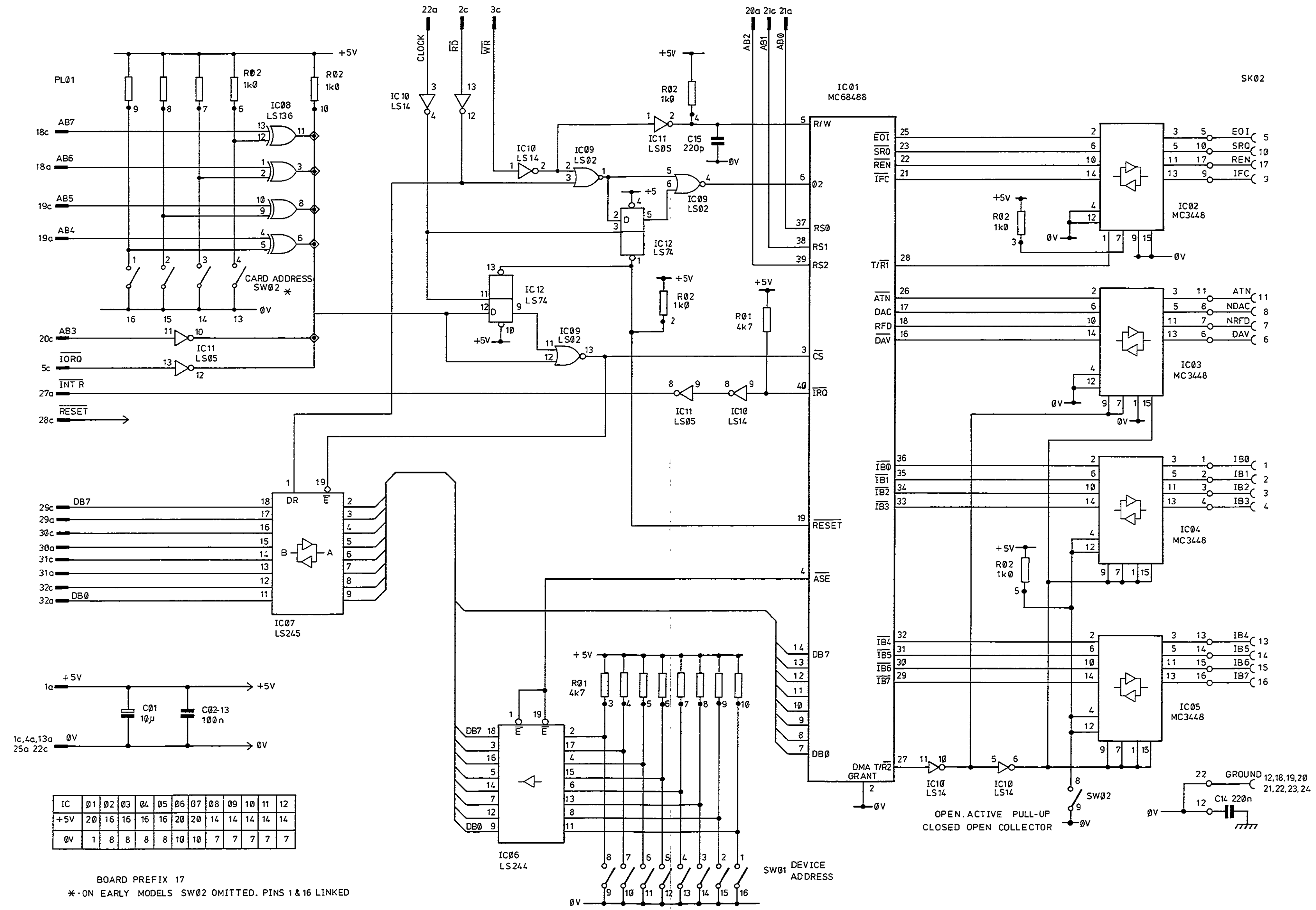


Fig. 6.28
GPIB/Handler Interface Option - Cct. Dia.
DV2/25694/P2

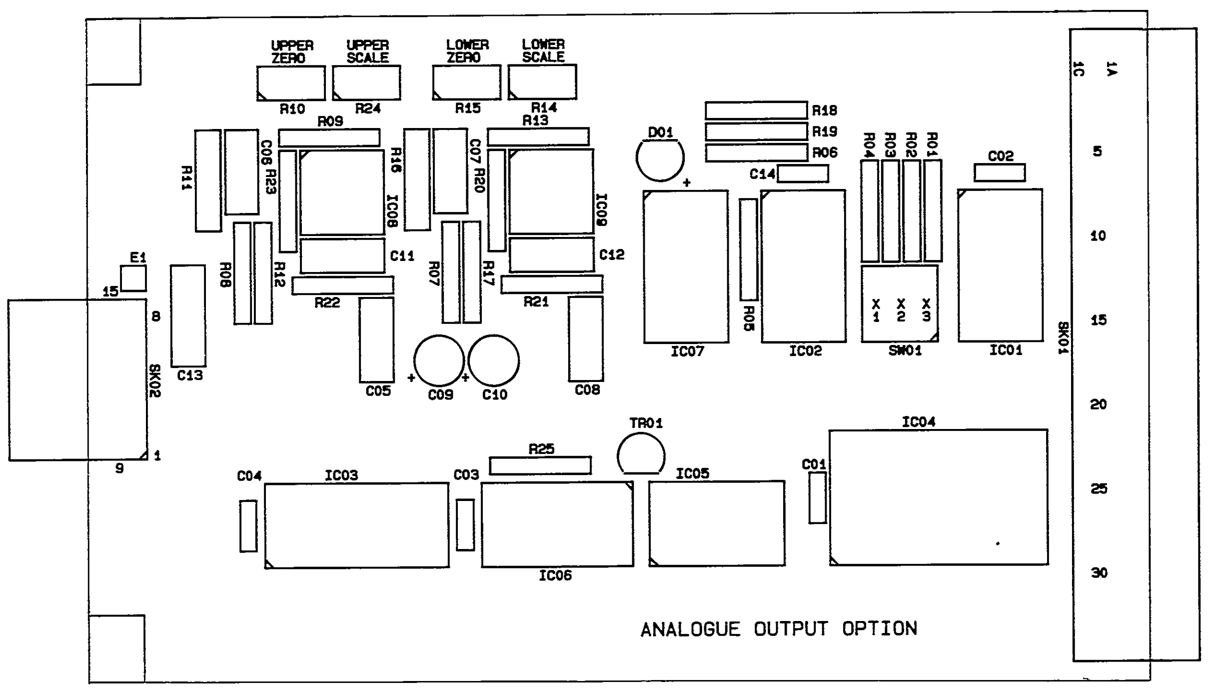
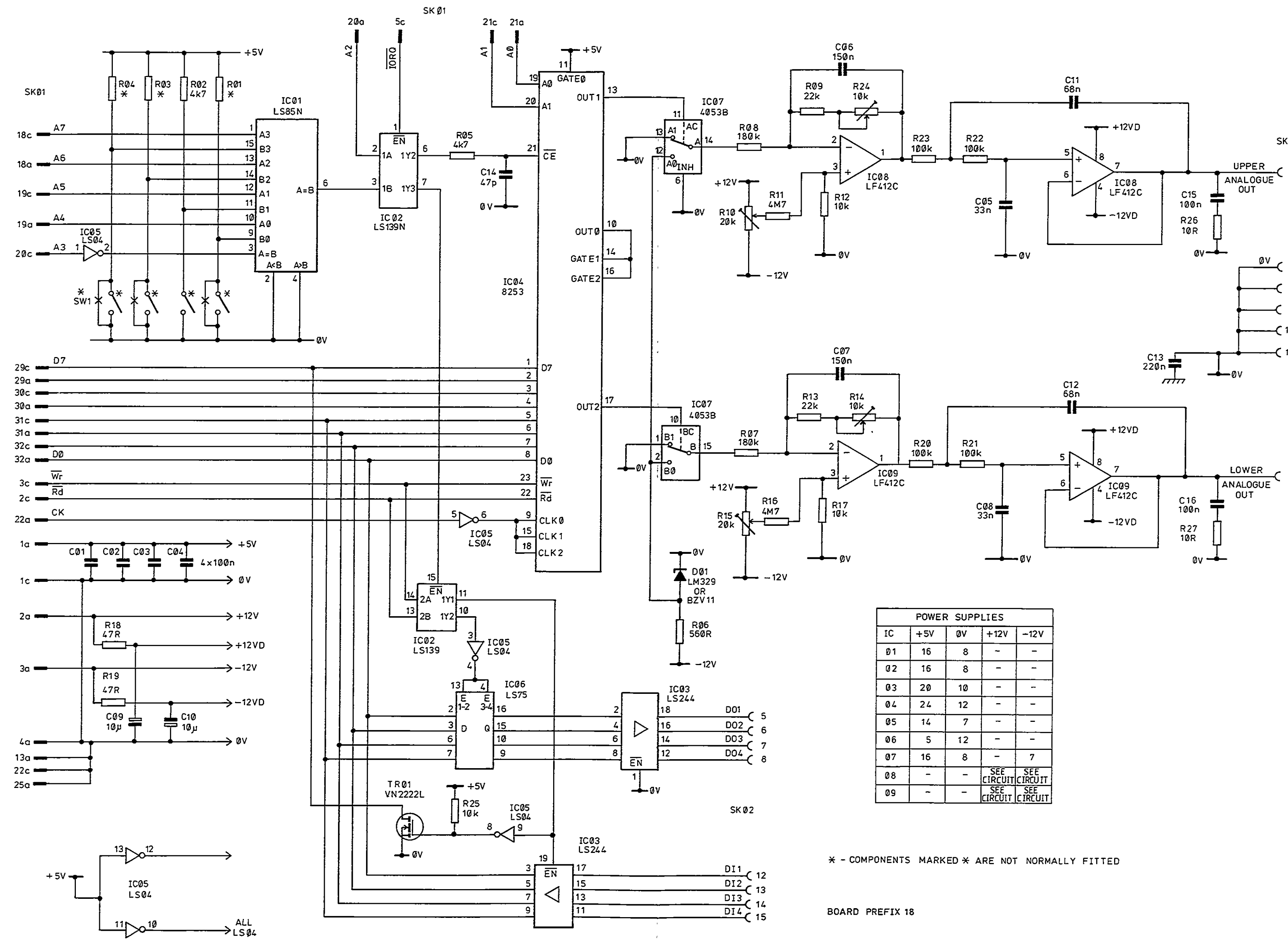


Fig. 6.29 Analog Output Option - PCB Layout



POWER SUPPLIES				
IC	+5V	ØV	+12V	−12V
Ø1	16	8	–	–
Ø2	16	8	–	–
Ø3	2Ø	1Ø	–	–
Ø4	24	12	–	–
Ø5	14	7	–	–
Ø6	5	12	–	–
Ø7	16	8	–	7
Ø8	–	–	SEE CIRCUIT	SEE CIRCUIT
Ø9	–	–	SEE CIRCUIT	SEE CIRCUIT

Fig. 6.30

Analog Output Option - Circuit Diagram

DV1/25705/D

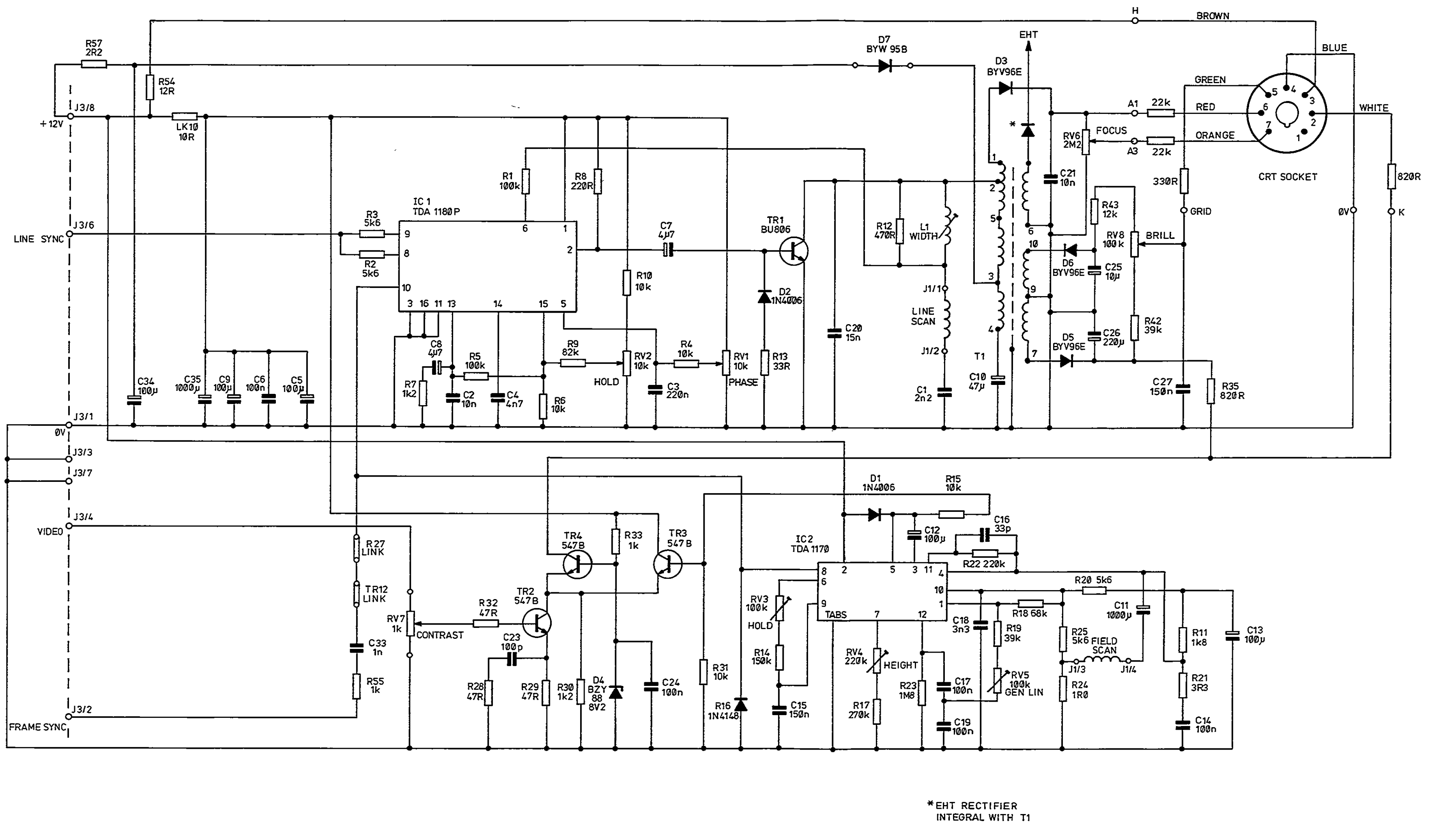


Fig. 6.31

Nevin CRT Drive Board - Circuit Diagram

DV/25744

APPENDIX A

KME CRT DRIVE BOARD (MODEL MB1200 D)

A.1 CIRCUIT DESCRIPTION

Circuit Diagram - Fig. 6.24 (page 6-53).

WARNING

> At no time should the CRT Drive Board be run without the flashover protection system fully connected, (the crt base socket), otherwise extensive damage may result and, because high voltages are generated within the unit, no attempt should be made by unskilled personnel to service a unit whilst it is switched on.

Design of the CRT Drive circuit is based on thick-film hybrid technology. Normally, if a hybrid becomes faulty, the board would be replaced. Note that the links and jumpers shown on the circuit diagram are applicable to the TTL mode of operation used in the 6425. (The board has provision for an alternative - composite - mode of operation).

Video amplification is provided by M1, with the gain set by Contrast control VR1, and the video signal drives the crt cathode via C22/D9 and a 1k flashover protection resistor.

The frame timebase is based on IC1 with hybrids M2 and M3, control of vertical amplitude and linearity being provided by VR2, VR3 and VR4. Frame flyback blanking is fed from IC1 pin 3 to M1 pin 6. The frame circuit operates from the boosted supply at IC1 pin 2, derived from the line output transformer, T1.

The line timebase is a Hartley oscillator utilizing M4, L1 and C13, with horizontal hold control VR5. A rectangular pulse at M4 pin 1 is ac-coupled to line output transistor VT1. Primary of the line output transformer is connected to D3 and D4 to provide the boosted rail supply for the frame timebase (referred to in the previous paragraph).

High voltage for focus and A1 of the crt is generated by D5/C19, while D6/C18 derive the negative supply for the brightness control circuit M5 with VR7. M5 also provides line flyback blanking and spot suppression at switch-off. A 68-volt positive supply for the video amplifier is produced by D7/C5. Note that the eht rectifier, D8, is integral with the line output transformer.

The crt socket incorporates spark-gap protection on each of the pins. The ground connection of the spark-gap is pin 3, which is connected directly to the metallized bulb of the crt. Under flashover conditions, very large currents may flow momentarily to ground, and diodes D1002/D1003 (Fig. 6.23: diodes not fitted on some early models) prevent these entering the digital circuits and possibly corrupting the MPU.

A.2 TEST EQUIPMENT REQUIRED
(Where Horizontal or Vertical Sync. require adjustment).

i) Oscilloscope with 10MΩ input probe.

ii) Copper-bladed trimming tool.

A.3 INITIAL CONTROL SETTING

Ensure that PL1, PL2, CRT base, EHT lead, CRT metallizing and 10-way connector are all correctly engaged.

Connect the oscilloscope probe to the cathode (positive) end of D2 and set the vertical and horizontal deflection factors to 2V/cm and 10μs/cm respectively.

Apply dc input and drive signals.

A.4 HORIZONTAL AND VERTICAL HOLD

If there is no horizontal lock, adjust VR5 (H. Hold) until the picture locks in. The exact position of the control does not matter at this stage and will be set accurately later.

If adjustment of VR5 cannot achieve horizontal lock, then put it at the mechanical centre of its travel and adjust the core of L1 with the copper bladed trim tool until the picture is locked.

Vertical lock is preset by resistor R5 and should not require adjustment. Should it be necessary, R5 may be removed and a 100k variable resistor connected across R5 pads and adjusted for vertical lock. The value of the variable should then be measured and the nearest preferred value of fixed resistor soldered into position R5. At this stage all other adjustments should be left until the mark-space ratio of the waveform observed at D2 cathode is verified to be within limits or is adjusted to be so.

A.5 DRIVE PULSE MARK/SPACE RATIO

The waveform observed on the Oscilloscope will be rectangular with a duration equal to the horizontal repetition rate and the negative part of it should lie in the region of 19-21μs. The amplitude will be approximately 7V peak to peak. If the negative duration is wrong then the core of L1 should be adjusted with the copper-bladed trimming tool to give a duration of 20μs. If adjustment of the core causes the monitor to go out of horizontal sync then VR5 must be re-adjusted. Alignment of L1 is valid only with the timebase in lock.

When the mark/space ratio is correct, the centre frequency of the line discriminator circuit is adjusted to give maximum pull-in range as follows:

Short-circuit line sync to ground and rotate VR5 to give a floating picture, i.e. out of but nearly in lock.
Releasing the short will cause the picture to jump into a horizontal lock with the data central in the raster ±1 character space. Absolute centering may then be achieved by slight re-adjustment of VR5.

It cannot be too highly stressed that the above procedure is the only allowable one, and no deviations are permitted if correct and continued operation of the Analyzer is to be achieved. Under no circumstances must the core of L1 be used as either a horizontal phase or hold adjustment. Once the coil has been aligned it should never need touching again.

APPENDIX B

NEVIN CRT DRIVE BOARD (MODEL DDF 5 Mk II)

B.1 CIRCUIT DESCRIPTION

Circuit Diagram - Fig. 6.31 (page 6-61)

The function of this board is similar to that described in Appendix A except that integrated circuits are used in place of hybrids.

WARNING

> At no time should the CRT Drive Board be run without the flashover protection system fully connected, (the crt base socket), otherwise extensive damage may result and, because high voltages are generated within the unit, no attempt should be made by unskilled personnel to service a unit whilst it is switched on.

Because the circuit board is common to several different applications, a few components are located in positions which have inapplicable silk screening (for example there is a diode fitted in the location "R16").

B.2 SETTING-UP PROCEDURE

The operations described in sections 5.4 to 5.8 inclusive should be read in conjunction with the text below. The procedure to be used will depend on whether the display tube or the drive board has been disturbed.

1 Set the Brilliance control (RV8) on the drive board to maximum.

2 Adjust Width (L1) so that both edges of the raster are visible.

3 Adjust Phase (RV1) to centralize the cross-hatch pattern on the raster.

4 Re-set Width, and reduce Brilliance to the normal level.

5 The Nevin board has a Hold control (RV3) which can be adjusted if any frame slip occurs.

B.3 NEVIN CRT DRIVE BOARD - COMPONENTS LIST

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
R1	100k	2	0.33W	Film	Mullard SFR25
R2	5k6	2	0.33W	Film	Mullard SFR25
R3	5k6	2	0.33W	Film	Mullard SFR25
R4	10k	2	0.33W	Film	Mullard SFR25
R5	100k	2	0.33W	Film	Mullard SFR25
R6	10k	2	0.33W	Film	Mullard SFR25
R7	1k2	2	0.33W	Film	Mullard SFR25
R8	22R	2	0.5W	Film	Mullard SFR30
R9	82k	2	0.33W	Film	Mullard SFR25
R10	10k	2	0.33W	Film	Mullard SFR25
R11	1k8	2	0.33W	Film	Mullard SFR25
R12	470R	2	0.5W	Film	Mullard SFR30
R13	33R	2	0.33W	Film	Mullard SFR25
R14	150k	2	0.33W	Film	Mullard SFR25
R15	10k	2	0.33W	Film	Mullard SFR25
R16	(See diodes)				
R17	270k	2	0.33W	Film	Mullard SFR25
R18	68k	2	0.33W	Film	Mullard SFR25
R19	39k	2	0.33W	Film	Mullard SFR25
R20	5k6	2	0.33W	Film	Mullard SFR25
R21	3R3	2	0.33W	Film	Mullard SFR25
R22	220k	2	0.33W	Film	Mullard SFR25
R23	1M8	2	0.33W	Film	Mullard SFR25
R24	1R0	2	0.33W	Film	Mullard SFR25
R25	5k6	2	0.33W	Film	Mullard SFR25
R26	Not fitted				
R27	(Link)				
R28	47R	2	0.33W	Film	Mullard SFR25
R29	47R	2	0.33W	Film	Mullard SFR25
R30	1k2	2	0.33W	Film	Mullard SFR25
R31	10k	2	0.33W	Film	Mullard SFR25
R32	47R	2	0.33W	Film	Mullard SFR25
R33	1k	2	0.33W	Film	Mullard SFR25
R34	Not fitted				
R35	820R	2	1.6W		Mullard PR37
R42	39k	2	0.33W	Film	Mullard SFR25
R43	12k	2	0.33W	Film	Mullard SFR25
R54	12R	2	0.33W	Film	Mullard SFR25
R55	1k0	2	0.33W	Film	Mullard SFR25
R56	Not fitted				
R57	2R2	5	2.5W	Wire Wound	
LK10	10R	2	0.33W	Film	Mullard SFR25
RV1	10k	Phase		Preset	Piher PT10V
RV2	10k	Line Hold		Preset	Piher PT10V
RV3	100k	Frame Hold		Preset	Piher PT10V
RV4	220k	Height		Preset	Piher PT10V
RV5	100k	General Linearity		Preset	Piher PT10V
RV6	2M2	Focus		Preset	Piher PT10V
RV7	1k0	Contrast		Preset	Piher PT10V
RV8	100k	Brilliance		Preset	Piher PT10V

(NEVIN CRT DRIVE BOARD - Continued)

Ref	Value	Tol(%)	Rating	Type	Supplier & Type No.
C1	2µ2	10	100V	Polyester	Wima MK54
C2	10n		63V		Wima FK52100V
C3	22n		63V	Decoupling	Wima R2
C4	4n7	1	160V	Polyester axial	Mullard 42S
C5	100µ		16V	Rad Al El	
C6	100n		63V	Decoupling	Siemens B37449
C7	4µ7		35V	Rad Al El	
C8	4µ7		35V	Rad Al El	
C9	100µ		16V	Rad Al El	
C10	47µ		63V	Rad Al El	
C11	1000µ		16V	Rad Al El	
C12	100µ		16V	Rad Al El	
C13	100µ		16V	Rad Al El	
C14	100n		63V	Decoupling	Siemens B37449
C15	150n	10	100V		Mullard 2222-363-25154
C16	33p	2	100V	Cer. Plate	Mullard 2222-683-58339
C17	100n		100V	High Stab.	Siemens B32560
C18	3n3		63V		Wima FK52100V
C19	100n		100V	High Stab.	Siemens B32560
C20	15n		400V		Wima FKC-32
C21	10n		1kV	Ceramic Disc	
C22	Not fitted				
C23	100p	2	100V	Cer. Plate	Mullard 2222
C24	100n		63V	Decoupling	Siemens B37449
C25	10µ		100V	Rad Al El	
C26	220µ		63V	Rad Al El	
C27	150n	10	100V		Mullard 2222-363-25154
C33	1n		63V		Evox MMKO 5
C34	4µ7		16V	Rad Al El	Gelec AE4-7R16
C35	1000µ		16V	Rad Al El	
IC1	TDA 1180P			Line I.C.	SGS
IC2	TDA 1170S			Frame I.C	SGS
D1	1N4006			Diode	Mullard
D2	1N4006			Diode	Mullard
D3	BYV 96E			Diode	Mullard
D4	BZY 88 C8V2 DO35			Zener Diode	Mullard
D5	BYV 96E			Diode	Mullard
D6	BYV 96E			Diode	Mullard
D7	BYW 95B			Diode	Mullard
R16	1N4148			Diode	Mullard
TR1	BU806			Transistor	Mullard
TR2	BC547B			Transistor	Mullard
TR3	BC547B			Transistor	Mullard
TR4	BC547B			Transistor	Mullard
J1	4-way Straight Post Header				Amp 640456-4
J3	8-way Straight Post Header				Amp 640456-8
T1	Line Output Transformer				Philips AT2240/16

7 SUPPORT & SERVICES

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