7010 HIGH SPEED COMPONENT TESTER

PART 2

SERVICE/MAINTENANCE MANUAL

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1 INTRODUCTION

This text provides service information on High Speed Component Tester 7010, including the optional Maths Co-Processor and the GPIB / Handler board. The Operating Instructions should be referred to before maintenance is undertaken.

The 7010 is a sophisticated, precision instrument and the internal circuits should not be adjusted except by suitably qualified personnel with access to the test equipment and Standard components specified.

Certain components require handling precautions to avoid being damaged by static electricity discharge. Such components are identified by *STATIC* in the Components List.

Users are referred to the SAFETY clauses which appear at the front of the Operating Instructions.

2 CIRCUIT DESCRIPTIONS

2.1 SYSTEM OVERVIEW

2.1.1 Microprocessor Control

A single microprocessor (CPU) controls the signal source and measurement circuits, computes the measurement results and formats the data for output to the display module, the bin handler port, the GPIB port or the RS232C port.

Each measurement comprises a sequence of six or more A/D conversions, with different hardware settings controlled by the CPU. After each sequence, the unknown value is computed and formatted according to the selected functions, these instrument settings being stored in non-volatile battery backed-up RAM.

Prioritised interrupts are generated from several sources (see Table 2.1). In general, any interrupt occurring during a measurement sequence is serviced immediately, but any resulting change to instrument settings will not be implemented until that sequence is complete.

A watchdog counter is reset periodically during normal CPU operation. If a crash occurs for any reason, this counter generates a non-maskable interrupt to restart the system.

2.1.2 Interrupts

Table 2.1 Interrupts

SOURCE	MEANING	PROCESSOR ACTION
A/D convertor	Conversion complete	Test overload status, read result, set up next conversion or calculate results.
GPIB port	GPIB bus activity	Poll GPIB chip to identify activity, service as necessary.
RS232C port - 1	Input buffer full	Read data byte.
- 2	Output buffer empty	Output next data byte if available.
- 3	Handshake change	Inhibit/Enable data outputs.
Keyboard	Key is pressed	Poll to identify key.
Display module	Ready for data	Output next data byte if available.
Handler port	Remote trigger	Store trigger status until end ofpresent measure sequence.

2.1.3 Basic Measurement

Refer to Fig. 2.1. The high gain guard amplifier produces a feedback current through the Standard resistor, exactly matching the current through the unknown component, here shown as Cx. The resulting two voltages, Es and Eu, are routed alternately to a common measurement channel. Measurement frequencies of 1kHz or 10kHz are processed directly, but signals at 100kHz or 1MHz are down converted by the ultra-linear differential mixer. The phase and amplitude relationships of the original signals are accurately preserved during this down conversion process. The resulting signals pass to the range amplifier which incorporates precision attenuators for impedance range selection. The following phase-sensitive detector (PSD) resolves the signals into in-phase and quadrature components which are measured in sequence by the A/D converter and passed to the CPU for computation.

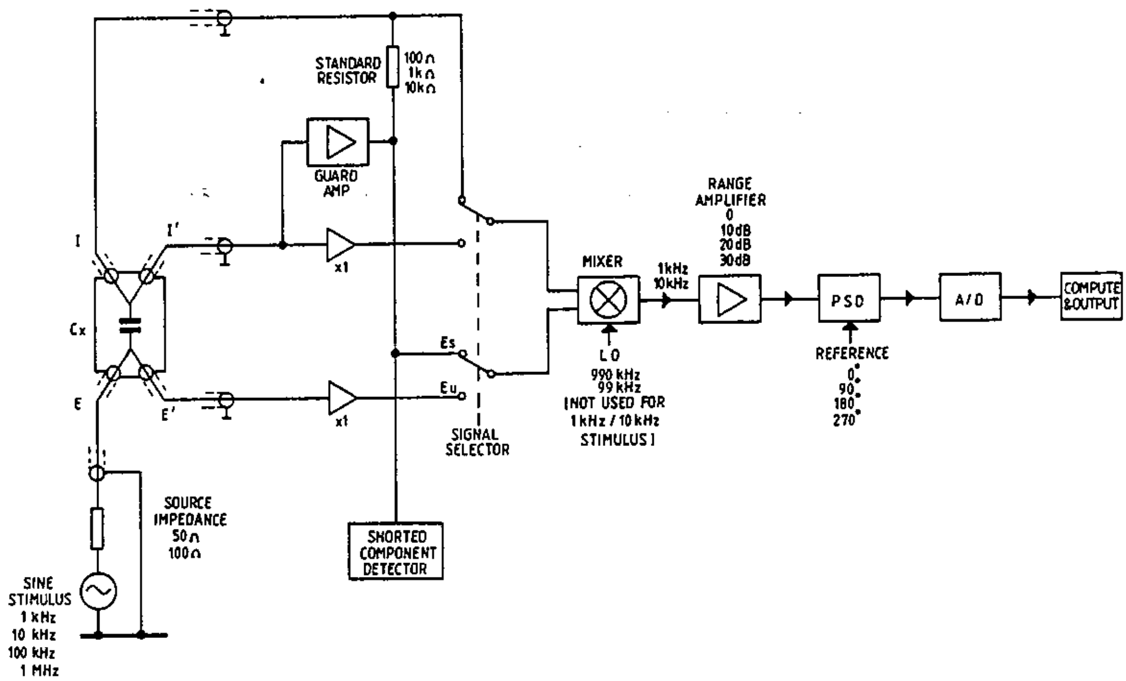


Fig. 2.1 Theory of Operation

2.1.4 Range Selection

The instrument has up to 12 measurement ranges as detailed in the Operating Instructions, section 6.2. The signal source impedance (Rsce), Standard resistor (Rstd) and gain settings used for each combination of frequency, drive level and range are detailed in tables 2.2, 2.3 and 2.4 (overleaf).

Table 2.2 - 1kHz Ranges

Drive Level		1.0V/0.5V			0.3V			0.1V		
Range	Rsce	Gain Eu	Es	Rstd	Gain Eu	Es	Rstd	Gain Eu	Es	Rstd
0	100	31.6	1	100						
1	100	10	1	100	31.6	3.16	100			
2	100	3.16	1	100	10	3.16	100	31.6	10	100
3	100	1	1	100	3.16	3.16	100	10	10	100
4	50	1	1	100	3.16	3.16	100	10	10	100
5	50	1	3.16	100	3.16	10	100	10	31.6	100
6	50	1	1	1k	3.16	3.16	1k	10	10	1k
7	50	1	3.16	1k	3.16	10	1k	10	31.6	1k
8	50	1	1	10k	3.16	3.16	10k	10	10	10k
9	50	1	3.16	10k	3.16	10	10k	10	31.6	10k
A	50	1	10	10k	3.16	31.6	10k			
B	50	1	31.6	10k						

Table 2.3 - 10kHz Ranges

Drive Level		1.0V/0.5V			0.3V			0.1V		
Range	Rsce	Gain Eu	Es	Rstd	Gain Eu	Es	Rstd	Gain Eu	Es	Rstd
0	100	31.6	1	100						
1	100	10	1	100	31.6	3.16	100			
2	100	3.16	1	100	10	3.16	100	31.6	10	100
3	100	1	1	100	3.16	3.16	100	10	10	100
4	50	1	1	100	3.16	3.16	100	10	10	100
5	50	1	3.16	100	3.16	10	100	10	31.6	100
6	50	1	1	1k	3.16	3.16	1k	10	10	1k
7	50	1	3.16	1k	3.16	10	1k	10	31.6	1k
8	50	1	10	1k	3.16	31.6	1k			
9	50	1	31.6	1k						

Table 2.4 - 100kHz & 1MHz Ranges

Drive Level		1.0V/0.5V			0.3V			0.1V		
Range	Rsce	Gain Eu	Es	Rstd	Gain Eu	Es	Rstd	Gain Eu	Es	Rstd
0	100	31.6	1	100						
1	100	10	1	100	31.6	3.16	100			
2	100	3.16	1	100	10	3.16	100	31.6	10	100
3	100	1	1	100	3.16	3.16	100	10	10	100
4	50	1	1	100	3.16	3.16	100	10	10	100
5	50	1	3.16	100	3.16	10	100	10	31.6	100
6	50	1	10	100	3.16	31.6	100			
7	50	1	31.6	100						

2.1.5 Measurement Sequence

On current-drive ranges, (0-3), the current-derived signal Es is measured first, followed by the Unknown voltage Eu. This order is reversed on voltage-drive ranges (4-B).

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, only approximate, phase 1 being aligned within 15° of the drive signal zero-crossing immediately before the start of each measurement sequence.

The sequence for measurements on ranges 4-B at FAST or MAX speeds is:

Select gain
Select Eu (drive signal)
Settling delay
Align psd reference
Measure with psd phase 1
" " " " 2
Select Es
Select gain
Settling delay
Measure with psd phase 1
" " " " 2
" " " " 3
" " " " 0
Compute results
Output to display/output device

On repetitive measurements, Eu is selected after the sixth measurement and the results are computed and output during the subsequent settling delay. 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.

If a short-circuited component is connected on a voltage driven range, there will be no signal for psd phase alignment, and the resulting time out has the same effect as an overload. In addition, the shorted component detector shown on Fig. 2.1 will prevent the Es signal from being selected if it is outside the linear signal range of the following amplifier. This minimises the recovery time required following a short-circuit or low-impedance component when sorting at high speed.

Note that, for some of the slower speed settings, some or all of this measurement sequence is repeated, the results being averaged to improve display resolution.

2.2 DIGITAL SYSTEM

Digital Board Circuit Diagram	Figs. 6.2 & 6.3
Power Supply Circuit Diagram	Fig. 6.4
GPIB / Handler Circuit Diagram	Fig. 6.6

2.2.1 CPU & Clock

The digital system is based on a Z80 CPU, (IC4, Fig. 6.3), operating at 5.814MHz, derived from a crystal oscillator (IC1).

The Z80 is connected directly to its program EPROMs (IC15, IC16, IC72) and data RAMs (IC13, IC14) and via data buffers (IC9, IC10, IC12) to other peripheral devices. The non-buffered address and data busses are designated A0-A15 and D0-D7 respectively, and the buffered busses AB0-AB7 and DB0-DB7. Note that only 8 address lines are buffered: the buffered busses are for I/O (Input/Output) only, and use a reduced (8-bit) address space.

2.2.2 Memory Decoding

IC8-1 to IC8-4 provides decode for the various memory functions: by ORing MREQ, IORQ, RD and WR (equivalent to negative logic AND), Memory Read (IC8-1), Memory Write (IC8-4), I/O Read (IORD, IC8-3) and I/O Write (IOWR, IC8-2) are formed.

Memory addressing is paged to extend the available space beyond 64kbytes. Both EPROM and RAM are paged as shown in the memory map below.

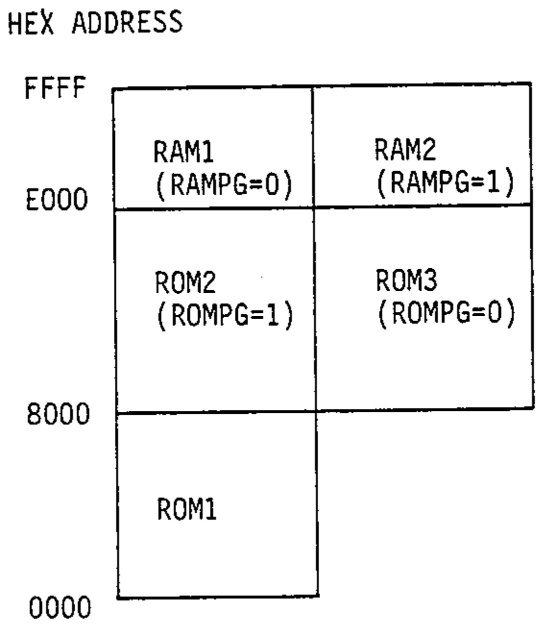


Fig. 2.2 Memory Map

PROM 1 (IC15) is addressed whenever A15 is low (pin 20) and a memory read occurs (pin 22 low). Address decoding for PROMs 2 & 3 (IC16, IC72) is provided by IC73. The PROMs are selected individually by ROMPG, derived from IC30 pin 15 (Fig. 6.2). IC73-3 also provides address decoding, via TR4, to RAM 1 & 2 (IC13, IC14, Fig. 6.3). The RAMs are selected individually by RAMPG, derived from IC30 pin 14 (Fig. 6.2). TR3-TR5, TR10 and associated components allow for battery back-up of the RAMs. Write and Chip select are controlled by TR3, TR4, both switching off when +5V falls, preventing data corruption during power-up / power-down. Back-up is provided by BAT1, a non-rechargeable lithium battery designed to last more than ten years.

2.2.3 I/O Decoding

I/O addresses are decoded by IC11 (Fig. 6.3), to produce the I/O address map shown below:

ADDRESS	DEVICE			
00-0F	Front-panel Controller	PIO, IC31 (Fig. 6.3)*		
10-1F	Measurement Controller	PIO, IC45 (Fig. 6.2)*		
20-2F	Measurement Controller	8255, IC30 (Fig. 6.2)		
30-3F	Counter/Timer	8254, IC23 (Fig. 6.2)		
40-4F	RS232 Controller	DART, IC17 (Fig. 6.3)*		
50-5F	{ Option Switch (Read) { Watchdog (Write)	LATCH, IC29 (Fig. 6.3) TIMER, IC28 (Fig. 6.3)		
60-6F	Maths Co-Processor	8231, IC6 (Fig. 6.3)		
70-7F	Unused			
80-8F	Bin Handler	PIO, IC1	*	**
90-EF	Unused		**	
F0-FF	GPIB Controller	9914, IC17	**	

* = Interrupt device (see text)

** = On GPIB / Handler PCB, controlled by IC2

Fig. 2.3 I/O Address Map

E^2PROM IC63 (Fig. 6.2) is a serial input/output device, with a capacity of 1kbits, which is used to store calibration data. It is driven from the measurement control PIO IC45, port B 4-7.

2.2.4 Front Panel Control

The front-panel (A: Display, and B: Keyboard) is controlled by IC31, IC32, IC6 and associated components.

A: <u>Display</u>

The display module is an OEM unit incorporating a microcontroller and a vacuum fluorescent display. It cannot normally be serviced, apart from replacement of the display itself which is a plug-in item. It is fed with unregulated power via PL14 (Digital Circuit Diagram Fig. 6.4). Pins 1 & 2 provide a nominal +42V dc supply, with pins 3, 4 & 5 providing a floating centre-tapped ac supply, 6Vrms nominal. LK1 and series resistors R86, R87 allow these voltages to be changed to accommodate displays from different manufacturers. Fuses F3, F4, F5 located on the Digital Board provide protection against short-circuit faults.

PL13 provides the +5V logic supply and the data input which is controlled by port A of IC31 (Fig. 6.3). Port A is configured as an output, with ARDY and $\overline{ASTB}$ providing handshake capability, an interrupt being generated whenever $\overline{ASTB}$ (= $\overline{BUSY}$) goes high. IC56-3 and IC56-4 provide pulse-shaping required by the display module. The timing diagram is shown below.

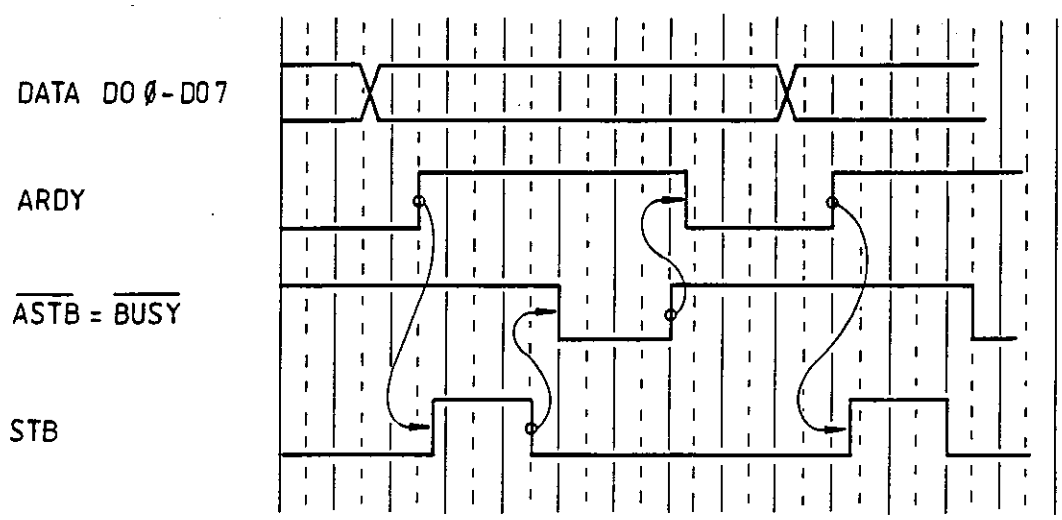


Fig. 2.4 Display Timing

B: Keyboard

The Keyboard is controlled by IC32 and Port B of IC31, (Fig. 6.3) and is connected as shown in Fig. 6.7 (Keyboard PCB Circuit Diagram). B0-B3 (IC31) are configured as inputs, and B4-B7 as outputs. In normal operation, B3-B7 will be low, and the inputs I1-I9 of IC32 (a priority encoder) will be pulled high by R30. When any key is pressed, one of I1-I9 connects to one of B4-B7, and is pulled low. The appropriate binary code (negative logic) appears on the outputs Y0-Y3 of IC32, and on B0-B3 of IC31. This is configured to generate an interrupt when any key is pressed. The interrupt service polls the keys by setting each of B4-B7 low in turn and reads the data (B0-B3) to identify which key is pressed.

2.2.5 Serial Interface (RS232C)

A Serial Interface is provided as standard, giving Remote Control or a Printer Output. This is controlled by IC17 (Fig. 6.3) and associated components. Two connectors are fitted, wired in parallel but with different pin allocations, providing DTE or DCE functions. Note that the pin numbers shown for PL7 and PL8 on Fig. 6.3 do not correspond to the RS232 rear panel connectors. See Interconnection Diagram Fig. 6.8 for details.

IC18 and IC19 provide the RS232 outputs and inputs respectively. In addition, IC22 acts as an input for an optional 20mA current-loop interface, with LK3 able to provide a current source and LK5 a current drain if required. Similarly, IC21 and TR1 provide an equivalent output, LK4 providing the current source and LK6 the current drain.

Full handshaking is provided: if not required, pins 4 and 5 on the DTE, or 8 and 20 on the DCE, must be connected together. This connection must be made for current-loop interface as no handshaking is available.

The Baud-rate clock (BD/RTE) is provided by one section of the programmable divider IC23 pin 17 (Fig. 6.2) and operates from 110 to 19200 baud.

2.2.6 Maths Co-Processor (Option)

The Optional Maths Co-Processor is IC6 (Fig. 6.3). If fitted, the measurement speed is increased, as it enables calculations to be made at a faster rate. Its presence is automatically checked at power-up, to simplify its installation. It functions as a standard processor peripheral, with the exceptions that its clock is a divided-down version of the processor clock, and it is connected to the WAIT input of the Z80. These exceptions are necessary as it will not operate at the full processor clock speed. Pin 24 provides a ready signal ($\overline{\text{END}}$) that is monitored by pin 10 of PIO IC45 (Fig. 6.2).

2.2.7 Watchdog Timer

IC28 (Fig. 6.3) is reset periodically by the CPU writing to address 50. If a software crash occurs, IC28 times out and resets the CPU via IC27-3.

2.2.8 Option Links

A set of option links (LK8 - Fig. 6.3) is used to indicate the state of the hardware, in the case of board modifications etc. It is read at power-up by IC29 which is at the same address as the watchdog timer. These links have been factory set to correspond to the boards provided and should not be altered.

2.2.9 GPIB / Handler PCB (Option)

The Circuit Diagram is shown on Fig. 6.6.

The option card is installed by connecting its flying lead into PL19 on the Digital Board, connecting the flying leads from the rear-panel into PL30 and PL31 and screwing the board down.

The option card provides (A) GPIB functions for both remote-control and printer, and (B) bin-handler operation.

A: The GPIB controller is IC17 (TMS 9914), providing all the GPIB functions. It is located at address F0, decoded by IC2. It provides an interrupt signal GPINT to the Digital Board, where it is accessed by the PIO IC45, as the 9914 does not support Z80 interrupts.

IC18 and IC19 are the GPIB drivers for the data and control busses respectively. The bus connector plugs into PL20. Note that the pin numbers shown for PL20 do not correspond to the IEEE 488 rear panel connector. See Interconnection Diagram (Fig. 6.8) for details. IC18 normally provides standard totem-pole outputs, but LK1 may be fitted to give open-collector outputs where the 7010 is used in a system requiring parallel-poll operation. (Although the 7010 does not support parallel-poll operation, all instruments must have open-collector outputs if parallel-polling is used in the system. In practice parallel-polling is rarely used).

B: The bin-handler functions are controlled by IC1, Z80 PIO, and associated circuitry. It is located at address 80, decoded by IC2. SW1 is not normally fitted but allows an extended address range for future expansion.

Port A controls the bin output - A0 to A4 represent the selected bin number coded in binary, the selected output being enabled by A5 going low. Port B controls the handshake lines $\overline{\text{TRG}}$ and $\overline{\text{BUSY}}$. The $\overline{\text{TRIGGER}}$ input for SORT measurements is PL31 pin 27. It is normally active low but may be converted to active high by setting SW6 2/B to B. D1, R9 and C32 provide debouncing of the input. An optional opto-isolator may be fitted with SW6 3/C set to C, at location IC14 for a current sourcing input or at IC15 for a current sinking input.

To current-limit the opto-isolator input (eg when driving it from a voltage source), SW6 1/A can be set to the A position, putting R6 in series with the input. SW6 4/D can be set to D to provide a current source/sink if a passive output is fitted to the handler, and opto-isolation is required on the 7010.

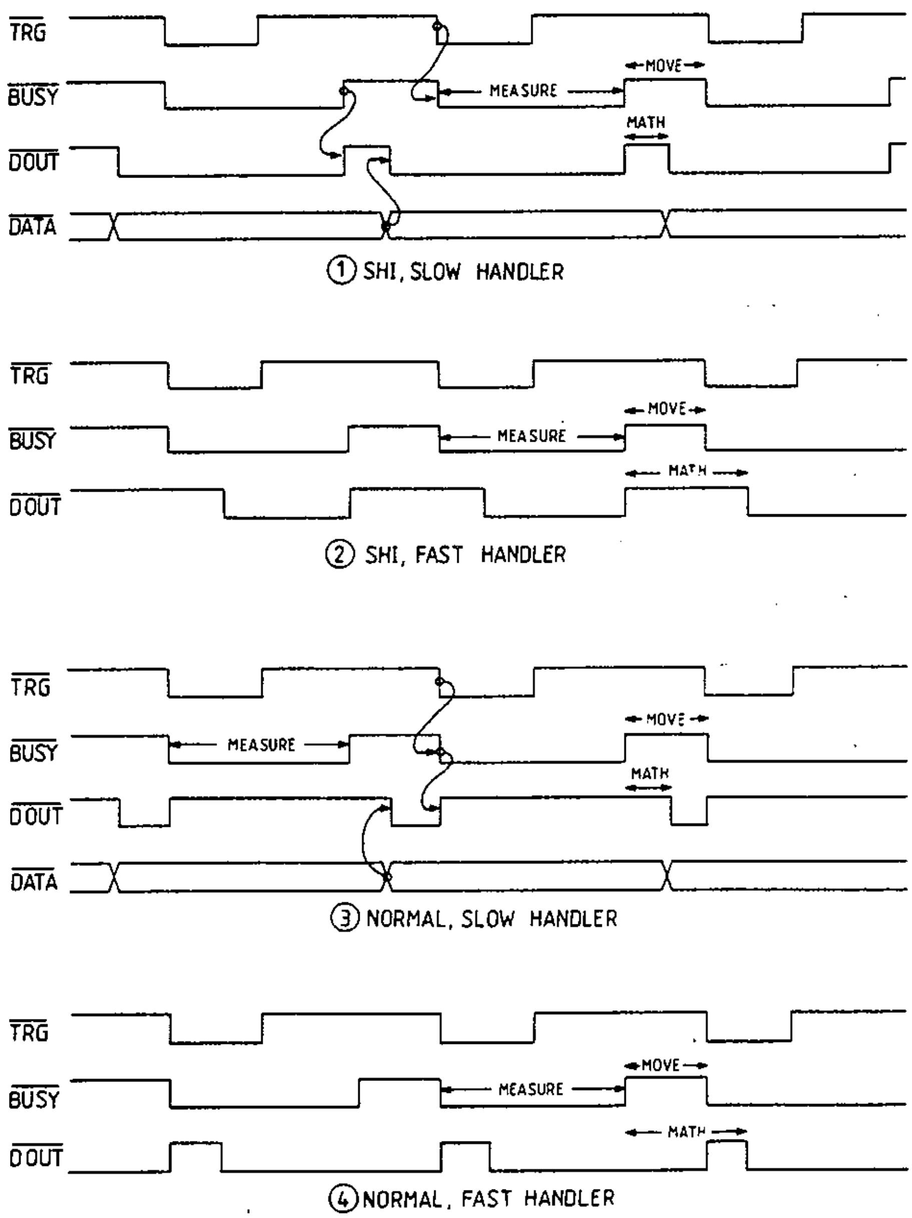
The $\overline{\text{BUSY}}$ output is PL31 pin 29, and is set when the 7010 is performing a measurement. It is normally active low, reversed by SW5/B. An opto-isolator, IC16, may be fitted, by setting SW5/C. A pull-up output resistor is normally fitted, disconnected by setting SW5/4.

The DATA Ready output ($\overline{\text{DOUT}}$) is PL31 pin 35, and is set when bin data is ready. It is normally active low, reversed by SW7/B. An opto-isolator, IC13, may be fitted, by setting SW7/C. A pull-up output resistor is normally fitted, disconnected by setting SW7/4.

The bin outputs BIN0 to BINB are set to indicate the bin for the measured component. They are normally active low, reversed by replacing IC3 - IC6 with 74HCT138's. Pull-up resistors are provided by resistor networks R7 and R8, which may be unplugged if not required. Single-pole reed relays RL1 to RL30 are optional, switches SW8-SW11 being set to OFF when these are fitted or ON when they are omitted.

The most common use of relays is to provide electrical isolation, the pull-up resistor being removed and the common ON connection VN being connected via SW2 to an external reference VE(PL31 pin 1). However, several non-isolated configurations are available, the relays giving high current operation and/or logic level shifting. These options are described in detail in the Operating Instructions, page 11-9, section 11.3. SW2 and SW4 provide the necessary re-routing of the common relay ON connection (VN) and the pull-up voltage (VF) respectively. When isolated operation is not required, the VE line may be used to supply power to external logic if required, the appropriate voltage being selected by SW3.

Two different handshake timing conventions are available: SHI (corresponds to existing Wayne Kerr products) or NORMAL (corresponds to industry standard). These are set by SW5 A or SW5 1 respectively. The corresponding timings are shown below.



DATA = BIN 0-27, A, B.

Fig. 2.5 Bin Handler Interface Timing

2.2.10 Interrupt Structure

As indicated earlier, interfacing between the CPU and its peripherals is largely controlled by interrupts. The peripherals generate interrupts under certain conditions (see Table 2.1) and request service from the CPU. Their priority is controlled by the IEI/IEO daisy-chain between the devices, the lowest priority having its IEI connected to +5V, the next having its IEI connected to the IEO of the previous device and so on. The final device does not have its IEO connected. This gives the following priority structure:

HIGHEST	IC45	Measurement PIO
	IC17	Serial Interface
	IC13	Front Panel PIO
LOWEST	IC1	Handler PIO

When a device requires servicing, it checks that its own IEI is high and, if so, it generates an interrupt, and sets its own IEO low. This sets IEI for the next device low, disabling its interrupts. This in turn sets its IEO low, and so on, disabling the interrupts for all successive devices. After the interrupt has been serviced, the device causing the interrupt will set its IEO high, enabling interrupts for all successive devices.

From the above mechanism, it can be determined which device is causing an interrupt, by examining its IEI and IEO lines. If the IEI is low, the interrupting device has a higher priority. It it is high, and its IEO is high, it is a device of lower priority. If, however, IEI is high and IEO is low, this device is generating the interrupt.

2.3 MEASUREMENT SYSTEM (see Block Diagram Fig. 6.9)

2.3.1 Source Signal Generation

Digital Circuit Diagram Fig. 6.2
Analogue Circuit Diagram " 6.11

Frequency Selection

The 64MHz crystal oscillator (IC60, Fig. 6.2) feeds a series of fixed dividers, producing an input to IC41-1 at 8x selected frequency. Frequency selection is controlled by signals FA1 and FB1 from IC30 pins 11 & 10 respectively, connected to the drive signal multiplexer (IC39). The truth table for FA1 and FB1 is as follows:

FB1	FA1	Freq
0	0	1MHz
0	1	100kHz
1	0	10kHz
1	1	1kHz

The divided outputs from IC41-1 feed the analogue multiplexer IC65, whose output is a four-level stepped waveform at the source frequency Fo. The levels, set by resistors R31, R32 and R33, are such that the output waveform contains insignificant levels of harmonics below the 7th. This waveform is buffered by the FET follower TR6, operating with TR2 as a current source, and feeds via PL16 and a coaxial cable to the Analogue Board (PL21). Note that the OV rail associated with these circuits (OVS) is at Analogue Board ground potential, being connected via the screen of this coaxial cable. If the cable is disconnected, for example during fault-finding, R39 provides continued operation for these circuits.

A programmable filter located on the Analogue Board (IC1, 2, 3, 4) converts the stepped waveform into a low distortion signal which drives the measurement circuits. At 1kHz, 10kHz and 100kHz, IC3 and IC4 operate as active low-pass filters with corner frequencies selected by multiplexers IC1 and IC2. At 1MHz, passive LC filtering is employed (L2 and L3 with C3 + C6, C13 + C14), and IC3, IC4 operate as unity gain buffers. In each case the filters are underdamped, giving a peak response at the working frequency. Tolerances in signal levels between the four frequencies are removed during test by selecting the value of R171 or R172 (10kHz, 100kHz) and adjusting L2 or L3 (1MHz).

The frequency select multiplexers operate from a decoupled, locally regulated 5V supply and are controlled directly by FA and FB. These are derived from FA1 and FB1 by filtering (R107, R108 Digital Board, C4, C108 Analogue Board).

Drive Level

Attenuator R156 + R18 to R21 provides four drive levels, selected by the multiplexer IC5 This is controlled by LA and LB, derived from

IC30 (Digital Board) pins 13 and 12 respectively, filtered by R105, R106 (Digital Board), and C20, C21 (Analogue Board). The truth table for LA and LB is as follows:

LB	LA	Level
0	0	0.1V
0	1	0.3V
1	0	0.5V
1	1	1.0V

IC6 is a high slew rate op. amp. which with TR6 forms a low distortion output amplifier, with a nominal gain of 2.2 preset by R26. TR6 operates in class A with TR2 providing a 20mA current source.

Source Resistance

The resulting ac signal drives the E terminal via the source resistors R34, R35, R163 and dc blocking capacitors C30, C31 connected back-to-back. On voltage driven ranges (see tables 2.2 - 2.4) R163 is shorted by RL12, which is an all position mercury-wetted relay with a 5V coil. This is controlled by the signal SS derived from IC30 (Digital Board) pin 25, as follows:

SS	Source Resistance
0	100 ohms (RL12 open)
1	50 ohms (RL12 closed)

Protection

The output amplifier is protected against connection of charged capacitors to the instrument by D2 and D3, which clamp the output to ±6.5V supplies derived from surge arrestor diodes D4 and D5.

DC Bias

External dc bias is applied to the E terminal via R32, which is protected by the series PTC R33. This has a cold resistance of approximately 100ohms, but if the measurement terminals are short-circuited with an applied bias voltage above 50V, it rapidly heats up and changes to a high resistance state. This protection is self-resetting on removal of the short-circuit or the bias voltage.

2.3.2 Bridge Circuits

Analogue Circuit Diagram Fig. 6.11
Digital Circuit Diagram " 6.2

Measurement Standards

Components to be measured are connected between the E (signal source) and I (current sense) terminals, with the voltage at each end of the unknown component sensed by the E' and I' terminals respectively. The I/V converter shown on the Block Diagram comprises a high gain feedback amplifier IC9 with output transistor TR14 and switched Standard resistors R56, R57 and R58. The action of this amplifier is to force the current flowing in the selected Standard resistor to exactly balance the unknown current at the I terminal, such that no voltage appears at the I' terminal. The Standard resistors are selected by RL5 to RL10, which are dry reed relays operating in pairs with their coils connected in series. They are controlled by IVA and IVB derived from IC30 (Digital Board) pins 16 and 17 respectively, filtered by R103, R104 (Digital Board) and C61, C130 (Analogue Board). The truth table is as follows:

IVB	IVA	Standard Resistor
0	0	Not used
1	0	100ohm (RL5 + RL6)
0	1	1kohm (RL7 + RL8)
1	1	10kohm (RL9 + RL10)

The capacitors C56, C57, C58 connected across each Standard resistor are necessary to maintain h.f. stability. At the frequencies where each Standard is used, they introduce small and stable phase errors which are removed by the calibration software.

Protection

The I and I' inputs are protected against connection of charged capacitors by back-to-back diodes D13, D14 and D33 to D36. The impedance of the measurement cables at 1MHz produces levels up to 200mV peak at the I input, requiring two diodes in series to avoid measurement errors. These diodes have no series limiting resistors and are therefore protected by fuses FS2 and FS6 on the instrument rear panel. (See Interconnection Diagram Fig. 6.8).

Tuning

At 1MHz only, the loop gain of the guard amplifier IC9 is increased by parallel resonating its compensation capacitor. This capacitor comprises trimmer C55 connected in parallel with approx. 20pF within IC9 itself. These are resonated by L5 driven from TR13 and the temperature compensation network R59 - R62 with R149. Note that both C55 and L5 are selected low t.c. components and should only be replaced by equivalent parts, otherwise the temperature compensation will not track correctly.

This resonating circuit is enabled and disabled by RL11, the drive for which is decoded from the frequency control lines FA, FB by IC7-1.

R179 maintains dc operation of the guard amplifier if the I and I' connections are separated between measurements. The shunt capacitor C161 is necessary to maintain h.f. stability under these conditions. At frequencies other than 1MHz, C160 is added in parallel by the CMOS switch IC31-1. This is controlled by the same decoded signal as RL11.

Wideband Buffer

The signal at the E' terminal is buffered by TR3, which is a low-noise vhf transistor operating as an emitter follower, with TR4 providing a 10mA current source. Input protection is provided by D9, D10, D28 and D29 clamping to the ±6.5V surge arrestor zeners, R43 and L4 providing steady-state and fast-edge current limiting. D26 and D15 provide additional protection against fast initial voltage transients. TR3 has ferrite beads fitted to its base and collector leads to prevent parasitic oscillations. If TR3 is replaced, ensure that the specified grade of ferrite is used in these locations.

Signal Selector

The differential voltages across the unknown component Cx and the standard resistor Rs, (Eu and Es respectively) are selected alternately by closing RL1 + RL4, or RL2 + RL3, respectively. These are all-position mercury-wetted reed relays selected for their fast operating speed and long life characteristics. Their control signals Es and Eu are derived from IC30 (Digital Board) pins 20 and 21, filtered by R110, R114 (Digital Board) and C62, C63 (Analogue Board).

The blocking capacitors C47 and C48 absorb any difference in dc potential between IC9 or TR3 outputs and the inputs of the following vhf emitter followers TR5 or TR6. This voltage is stored on the capacitors when the corresponding relay is open which minimises any switching transients. R51 and R52 provide a high impedance leakage path which maintains this stored voltage during idle periods.

Overload Detectors

The instantaneous voltages feeding the blocking capacitors C47, C48 are monitored by two window detectors (IC10) which set one of two latches (IC11) if either voltage exceeds the range ±4V. If, for example, a shorted component is connected with the 1kohm Standard selected, the resulting ±10V square-wave at TP13 will set $\overline{ESOL}$ low and prevent the CPU from closing RL2 + RL3. $\overline{ESOL}$ and $\overline{EUOL}$ are read by IC45 (Digital Board) pins 13 and 12, the latches being reset by $\overline{RSOL}$ going low (IC45 pin 8).

2.3.3 Signal Processing

Analogue Circuit Diagram	Fig.	6.12
Digital Circuit Diagram	"	6.2

Mixer

The buffered signals from TR5 and TR6 (Analogue Circuit Fig. 6.11) feed the differential mixer IC17, (Fig. 6.12) which is a quad D-MOS FET switch operating in the current steering mode. Signal input currents via R76 and R77, are switched between the inputs of IC12 and IC13 at local oscillator frequency, which is 1.016kHz below 100kHz or 10.16kHz below 1MHz. The resulting difference frequency signals are amplified by IC12 and IC13 and extracted differentially by IC14. Component matching throughout this circuit maintains true differential input sensing, R76 and R77 being deliberately mismatched to compensate for TR5 and TR6 operating at different dc currents. The sum frequency signal from the mixer is absorbed by C84, C86, C87 and C90, with additional 2MHz traps formed by L7 + C83 and L8 + C85. Any remaining ripple is removed by the passive filter R102, L9, C109.

Mixer Drive

The local oscillator drive (LO) is derived from a 63.35MHz crystal oscillator (IC61 on Digital Board) which feeds a series of fixed dividers located on the Digital Board. A square-wave signal at 4 x LO frequency is selected by one section of IC40 and feeds via PL11 and a coaxial cable to the Analogue Board (PL23, Fig. 6.12). A further ÷4 stage (IC16) feeds the gating circuit IC18 to generate the fast make-before-break drive required for high mixer linearity. When operating at 1kHz or 10kHz, IC16 is reset to disable the mixer drive. This puts two sections of IC17 permanently ON (pins 5-8 and pins 13-16) giving normal differential amplifier operation.

Range Attenuator

The filtered mixer output feeds the precision ranging attenuator with outputs selected by the CMOS multiplexer IC20-2. This operates from locally regulated ±8.2V supplies, and its control inputs are level shifted by the open collector gate IC19. IC19 also inverts the control signals GA and GB, derived from IC30 (Digital Board) pins 22, 23. The following truth table applies to the non-inverted signals. See also the range settings given in tables 2.2 - 2.4.

GB	GA	Relative Gain
0	0	1.0 (IC20 pin 4)
0	1	3.16 (IC20 pin 2)
1	0	10 (IC20 pin 5)
1	1	31.6 (IC20 pin 1)

Detector Amplifier & Overload Detector

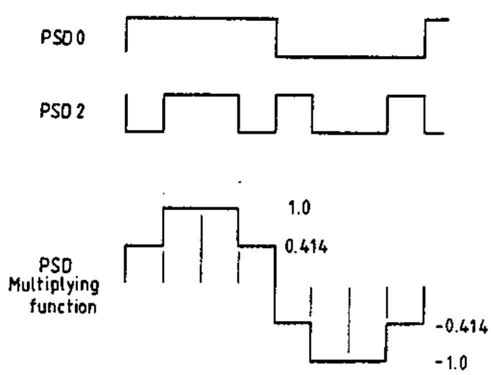
The following amplifier (IC22) has two gain settings, selected by IC21-2 corresponding to mixer and non-mixer operation. IC19-2 provides a level shifted control signal (FB inverted).

FB	Relative Gain
0	1.58 (IC21 pin 1)
1	1.0 (IC21 pin 2)

Input to the detector amplifier IC23-2 is via an ac coupling (C111) having a defined short time-constant which minimises the settling time required for any switching transients. The resulting gain reduction at 1kHz is compensated by C158 and R176. The ac level at this point also feeds the overload detector IC25-1 which sets latch IC24-1/IC24-2 if the peak level exceeds 1.25V. C156 prevents spurious operation due to digital noise spikes. The overload latch is reset at the beginning of each A/D conversion cycle by the negative edge of $\overline{MSR}$, differentiated by C112.

2.3.4 PSD and Reference Generator

The phase-sensitive detector (PSD) employs a four-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, PSD0 and PSD2:

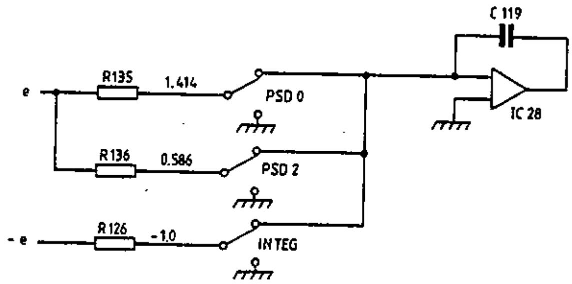


This composite signal has four relative phase settings derived from the ring counter IC46 on the Digital Board. The drive signal for IC46 is derived from the 64MHz clock by division for 1kHz and 10kHz operation. For 100kHz or 1MHz it is derived from a secondary mixer IC62 driven from ÷2 versions of the 64MHz and 63.35MHz clocks. L1, C38, C46 form a low-pass filter to extract the difference frequency signal which is converted to a square-wave by comparator IC44. The Measurement System Block Diagram Fig. 6.9 clarifies this arrangement.

As explained previously, the absolute phase of the PSD reference is aligned at the start of each measurement sequence. IC3-2 on the Digital Board is reset by the CPU, (via IC45 pin 29), which clears counters IC41, IC46 and enables (via PHE) the zero-crossing detector IC25-2 on the Analogue Board. At the next zero-crossing of the signal, PHR goes high, setting IC3-2 and enabling the counters.

Propagation delay differences between the four phase settings are eliminated by IC50 on the Digital Board which is continuously clocked at 16 x PSD drive frequency.

The PSD drive signals are received at the PSD (located on the Analogue Board, Fig. 6.12) via buffers IC30 - 2, 3, 5, 6, driving IC27 which serves as a two-pole change-over analogue switch (PSD0 and PSD2 in diagram).



The signal current to the A/D integrator IC28 is modulated by the selection of R135, R136 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 IC23-1, 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 analogue to digital convertor integrator as a current, which avoids amplifier slew-rate distortion at the fast switching edges.

2.3.5 A/D Converter

The A/D converter comprises a control section located on the Digital Board (Circuit diagram Fig. 6.2) and an analogue section on the Analogue Board (Circuit diagram Fig. 6.12). Once triggered by the microprocessor, the A/D conversion process proceeds unsupervised, generating an interrupt on completion. Each measurement cycle comprises six or more separate A/D conversions with different signal and/or PSD phase selections. See section 2.1.5.

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 positive level outside the band of oscillation, giving a final accurate conversion count.

The 24-bit measure counter comprises IC53-2, IC54, IC64-2, and IC59-2 with section 1 of the triple timer/counter IC23 providing the 16 least significant bits. It is driven directly by the 64MHz clock IC60 and is active whenever CBC is low.

The integration period, which always equals an integral number of psd reference periods, is timed by section 0 of IC23, clocked at approximately 320kHz from IC39 pin 9 (shown as 'Charge Balance Clock' on the block diagram). The output from IC23 pin 10 is then synchronised to the psd reference frequency by IC58-1 and aligned with the psd reference signals by IC50-3 (generates INTEG and $\overline{\text{INTEG}}$).

The following description of the A/D conversion process should be read with reference to the timing diagram (Fig. 2.6).

After vector alignment is achieved, the CPU initiates a measurement by setting $\overline{\text{MSR}}$ high, then low (IC45 pin 30). This resets the latch IC58-2 (pin 9) (via IC7-6) and the circuit waits for the next rising edge of the synchronising square-wave from IC47 pin 9. This sets the latch IC58-1 (pin 5), enabling the psd drive waveforms setting INTEG and RUN high and enabling the integrate timer IC23 pin 10. This activates the analogue measurement by opening the integrator capacitor shorting switch (IC26-3, Analogue Board) and closing the analogue switch IC26-2.

During the integrate period (INTEG = high) the HIGH/LOW comparator IC25-3 on the Analogue Board monitors the integrator output, sending an error status signal H/$\overline{\text{L}}$ to the charge balance control circuit formed by IC51 and IC52 (Digital Board, Fig. 6.2). The charge balance control generates a waveform at 1/8 x Charge Balance Clock frequency, which has a duty cycle of either 1/8 or 7/8, at IC51 pin 8. At the start of each charge balance period the appropriate waveform is selected, depending on the status of the H/$\overline{L}$ line, giving a predominantly ON or OFF reference current at the A/D converter.

The CBC control line is generated at IC53-1 latch (pin 7) which is synchronised with the 64MHz clock to remove timing errors. This signal controls IC26-1 on the Analogue Board, switching the reference current into the integrator summing junction.

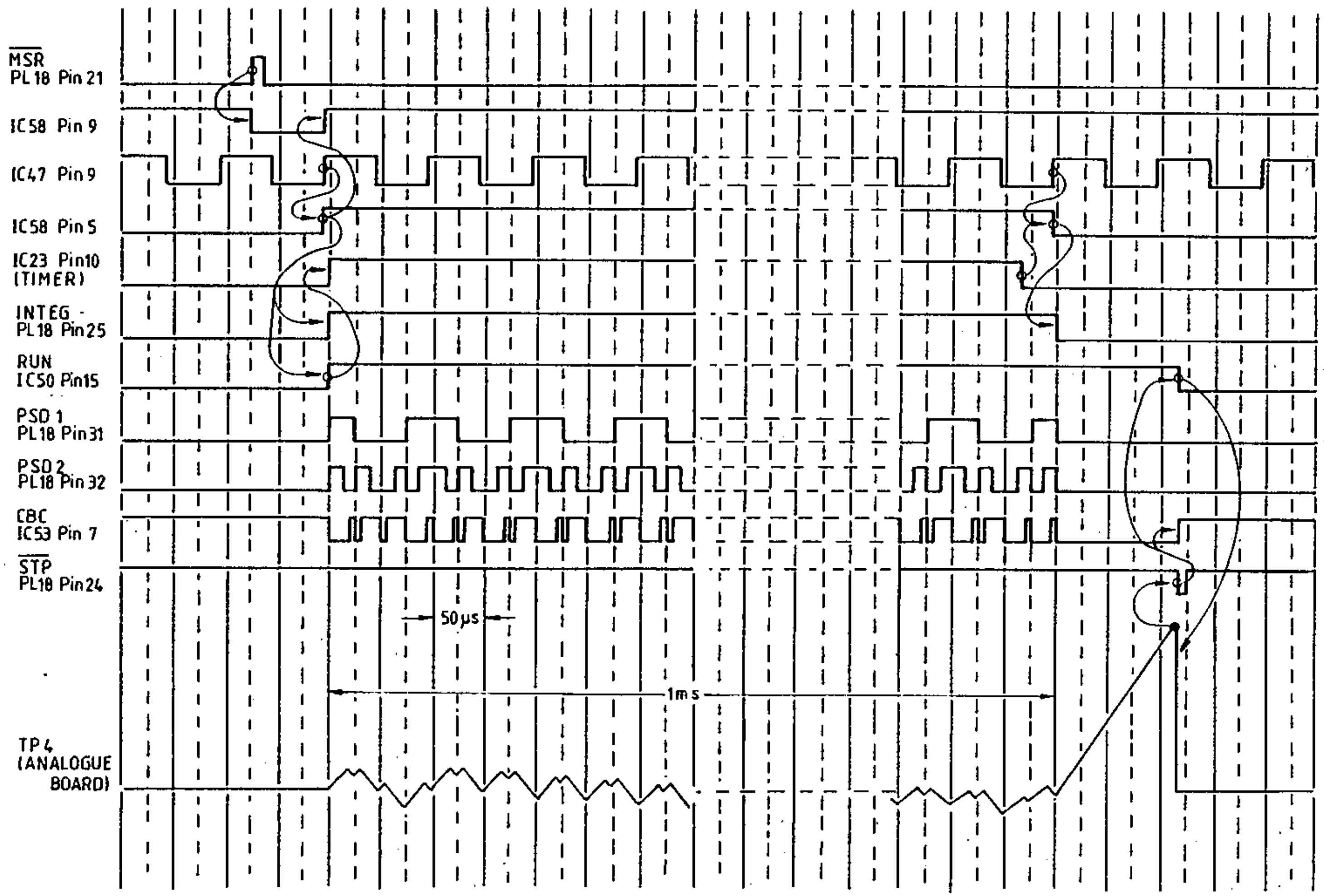
At the end of the integration time-out (from IC23 pin 10), the D input of the INTEG latch IC58-1 goes high. The end of the next sync. period toggles the INTEG latch, inhibiting further PSD and CBC drive. The CBC line remains low, holding the reference current ON with the measure counter enabled. The integrator output is forced +ve until the final conversion comparator IC29 (Analogue Board) latches, resetting IC50-4 (RUN) aperiodically and stopping the conversion. A signal to IC45 pin 14 generates an interrupt, to signal that the conversion is complete, the measure count being read during the following service routine. The measure counter is reset by $\overline{\text{MSR}}$ going high at the start of the next conversion.

2.4 POWER SUPPLIES (Circuit Diagram - Digital Board Fig. 6.4)

The linear power supplies provide unregulated power to the display module (see section 2.2.4/A), regulated supplies of +12V, -12V and +5V to the digital circuits, and separately regulated +12V and -12V supplies to the analogue circuits. Power supply components are located on the Digital Board, with the exception of the Supply Transformer, the +5V supply rectifier BR3 and 5V series regulator TR10.

The regulated supply outputs may be isolated for test purposes by removing the link from TSK1. With the link in place TSK1 forms a convenient test point for checking voltage and ripple levels.

Separate IC regulators (IC68 - IC71) provide the analogue and digital ±12V supplies. To minimise noise pick-up on the analogue supplies, IC68 and IC69 have their reference ground and output decoupling capacitors returned directly to a star point chassis connection adjacent to PL18, the Analogue



TYPICAL A/D CONVERSION, 10 kHz MAXIMUM SORT SPEED

Fig. 2.6 A/D Converter Timing Diagram

Board ribbon connection. Note that this is the only direct chassis connection to the Analogue Board, the screening box having insulated mountings and an hf ground connection via C1 (see Interconnection Diagram Fig. 6.8).

The +5V regulator is rated at 3Amps output and incorporates foldback current limiting (0 3Amps into a shorted load). R75 sets the output voltage, R116 sets the foldback limit current.

The master reset pulse for the CPU and digital circuits originates from TR7, which is turned on by the voltage across the +5V series regulator. R62 and C16 delay this pulse, which feeds IC56-1 and IC56-2 (Digital Board Circuit Diagram, Fig. 6.3) to produce complementary RST and $\overline{RST}$ signals. If the incoming ac supply falls too low, TR7 turns off and D11 rapidly restores the reset condition until power is re-established. S2 provides a manual reset function for use during testing.

2.5 NOISE FILTERING (see Interconnection Diagram, Fig. 6.8)

The 7010 is designed to operate reliably in an electrically noisy environment. In addition to the filtered power inlet PL1, all measurement and data input/output connections are fitted with common mode chokes. These are the ferrite toroid CH3 on the measurement leads and the ferrite slabs CH4, CH5, CH6, CH7 on the rear panel data sockets. Note that for these to operate correctly, the connectors themselves are in each case electrically insulated from the mounting panel.

3 DISMANTLING

3.1 Removal of the instrument top cover (two screws each side) provides access to the component side of the Analogue and Digital Circuit Boards. If the optional GPIB / Handler Board is fitted, obscuring part of the Digital Board, it can be removed by disconnecting two ribbon connectors from its surface, the flying connector from the Digital Board, and then removing the six retaining screws. Access to the underside of the Digital Board is obtained by inverting the instrument, and removing the bottom cover (two screws each side).

3.2 If the Digital Board is to be removed, first invert the instrument, remove the bottom cover, and remove the two small screws from the side rail (near front right, viewed from below). These hold the two metal blocks associated with IC68/69 and IC70/71, respectively, shown protruding on the pcb layout (Fig. 6.1). Return the instrument to its normal position, and remove the single screw which holds the hard-wired rectifier block (BR3). There are ten connectors to be freed (eleven including the one to the optional GPIB / Handler Board). The Digital Board is held in position by seven nuts, five nylon pillars and one hexagonal metal pillar (note the location of this one, which must be re-fitted in the same position). When lifting out the Digital Board, check to see if an earth tag is present (not a loose item on later models). If so, ensure that it is correctly positioned when replacing the board.

3.3 The Analogue Board, together with its screening box, is insulated from the main case. If the complete assembly must be removed, the ceramic 220nF capacitor (C1) must be disconnected from the underside. To remove only the circuit board, first detach all five connectors - one of which is on the Digital Board and, before this one can be freed, two screws securing the ribbon cable clamp associated with the ferrite common-mode choke CH8 must be removed. Then remove the seven nuts which secure the Analogue Board.

3.4 To transfer the sub-assembly of the four BNC connectors from the front panel to the rear panel, undo two nuts from the sub-assembly and two from the rear blanking panel. Remove the tie-wrap holding the single CMR choke to a cross-bar, and transpose the locations of the two panels (ensuring that the connector with the yellow '4' sleeve is at the BIAS end of the four rear holes). Tie the CMR choke to a convenient supporting bar and tighten the four nuts.

3.5 The procedure for replacing any boards removed is the reverse of the sequences just given for their removal. Ensure that all connectors are correctly located and properly secured.

4 TEST EQUIPMENT REQUIRED

Item 1	Variac	100VA 50/60Hz Range 0 to 240V
2	DC Voltmeter	To measure 3V to 12.5V, accuracy ±0.1%
3	DC Ammeter	To measure up to 320mA, accuracy ±2%
4	DC Resistance Meter	To measure 0-500 ohms, accuracy ±5%
5	AC Voltmeter	To measure sinusoidal signals 1kHz to 1MHz, level range 0.1V to 1.0V, accuracy ±1%. Screened input connector suitable for use with x1 oscilloscope probe or similar.
6	Oscilloscope	2 channels with x1 probes (Rin = 1MΩ) + single x10 probe (Rin = 10MΩ) Input sensitivity 5mV/division to 2V/division Bandwidth (with probes) 10MHz minimum Timebase range 0.5μsec to 1 sec / division Vertical deflection accuracy ±3% Horizontal deflection accuracy ±3%
7	Computer Terminal (VDU)	To EIA Standard RS232C, with interconnecting lead as shown in Fig. 5.2.
8	Component Fixture	Wayne Kerr type 1006
9	Transfer Standard Kit	Wayne Kerr type 7010 TSK

10 Axial leaded components to fit 1006 fixture as follows:

Metal film resistors	100Ω	±1%	(t.c. ±25ppm/°C or better)
	330Ω	±2%	(t.c. ±200ppm/°C)
Polystyrene or polypropylene capacitors	100pF	±5%	
	1.8nF	±1%	

Item 11 Calibration Standards

Screened 4-terminal Standards terminated in four BNC connectors, screens isolated from ground. See Fig. 4.1 for details of wiring.

Calibration Setting

The following Standards are required to reset the calibration on an instrument.

Capacitors: All values measured with respect to reference open-circuit.

5nF	±1%	Silver mica or sealed polystyrene. Dissipation factor known to ±0.00005 at both 1kHz and 10kHz.
1nF	±1%	Silver mica or sealed polystyrene. Dissipation factor known to ±0.00005 at 10kHz.
500pF	±1%	Silver mica or sealed polystyrene. Dissipation factor known to ±0.00005 at 10kHz.
100pF	±1%	Gas-filled, silver mica or other stable construction. Capacitance known to ±0.005% and dissipation factor known to ±0.00005 at 10kHz.

Resistors: Measured with respect to reference short-circuit.

100 ohms	±1%	Bulk foil construction (Vishay S102 or equivalent). Value at dc or 1kHz known to ±0.005%.
1k ohm	±2%	Metal film or bulk foil construction. Self capacitance not exceeding 1.0pF

Accuracy Checks

The following Standards are required to perform full accuracy checks on a calibrated instrument.

Capacitors: All values measured with respect to reference open-circuit.

5nF ±1% Silver mica or sealed polystyrene. Dissipation factor known to ±0.00005 at both 1kHz and 10kHz.

1.88nF ±1% Silver mica or other stable construction. Value known to ±0.005% and dissipation factor known to ±0.00005 at 1kHz, value known to ±0.005% at 10kHz.

1.0nF ±1% Silver mica or other stable construction. Value known to ±0.005% and dissipation factor known to ±0.00005 at both 1kHz and 10kHz.

500pF ±1% Silver mica or other stable construction. Value known to ±0.005% and dissipation factor known to ±0.00005 at both 1kHz and 10kHz.

Resistors: These should all be bulk film construction (Vishay S102 or similar). For the following values, the resistance at dc or 1kHz, and the series inductance at 10kHz, measured with respect to the reference short-circuit, should be known to the uncertainty indicated.

Value (±1%)	Resistance uncertainty	Inductance uncertainty
3.16 ohms	±0.005%	±2.5nH
10.0 ohms	±0.005%	±8nH
31.6 ohms	±0.005%	±25nH
100 ohms	±0.005%	±80nH
316 ohms	±0.005%	±250nH
1.0k ohms	±0.005%	±0.8μH
3.16k ohms	±0.005%	±2.5μH

For the following values, the resistance at dc or 1kHz, and the parallel capacitance relative to the reference open-circuit, should be known to the uncertainty indicated.

Value (±1%)	Resistance uncertainty	Capacitance uncertainty
10k ohms	±0.005%	±0.8pF
31.6k ohms	±0.005%	±0.25pF

Notes on Standards

Always make screened 4-terminal connections to Standards (Fig. 4.1, A & B).

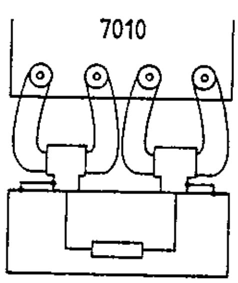
Screened leads should be 1m long (±10cm), preferred cable type RG174A or RG174 A/U.

The outers of all four leads must be connected together at the Standard end, and connected to the outer screen of the Standard.

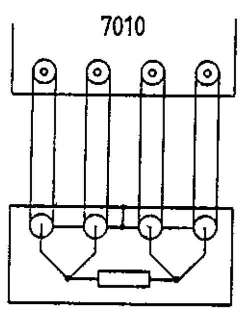
Resistance Standards up to 1kΩ must be 4-terminal (Fig. 4.1, B). Capacitance Standards and higher value resistance Standards may be 3-terminal (A) or 4-terminal (B). With 3-terminal Standards, use BNC T-pieces at the Standard end of the cables to convert to 4-terminal.

Fig. 4.1,C shows a 4-terminal short-circuit.

A



B



C

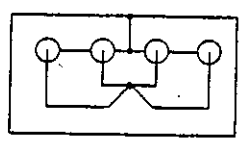


Fig. 4.1 Screened Standards - Wiring

The reference open-circuit must provide linking between I' and I (Brown to Red) and E to E' (Orange to Yellow), with all four cable outers connected together as above.

Item 12 GPIB / Handler Board (Option)

The following additional test equipment is required to test this option when it is fitted.

Handler Interface: Bin output test unit constructed as per Fig. 5.3.

IEEE 488 Controller having a shell program suitable for control of talker/listener equipment conforming to the general requirements of specification IEEE 488.2

5(A) SETTING-UP PROCEDURE - CIRCUIT ADJUSTMENTS

5.1 INITIAL SETTINGS

Ensure that the rear panel Bias Link is fitted. Verify the supply voltage setting and ensure that the correct supply fuse is fitted.

5.2 LITHIUM BATTERY CONDITION

Life of the Lithium battery used in the non-volatile RAM circuits is normally greater than ten years. With no power connected to the instrument, remove the top cover and measure the voltage across BAT1.* If this is less than 3.0 volts, the battery should be replaced using the following procedure.

Remove the instrument bottom cover and the old battery. Break the link LK2. Fit the new battery, taking care to ensure correct polarity. Using an oscilloscope fitted with a x10 scope probe (item 6), monitor the dc voltage at the cathode end of D5. Scale the oscilloscope input for an overall 1 volt per division and set the 0V position such that +5V will be well on the screen. Set timebase to 1 sec/division.

Apply power to the instrument, and switch ON. Observe +5V on oscilloscope while switching power OFF. The voltage normally drops smoothly to +4 volts or so within a few seconds, then decays downwards much more slowly. It should not decay below +3 volts within 10 seconds from the +4 volt point, otherwise RAM standby leakage current is excessive.

At 3 volts, switch power ON and observe that the supply returns to +5 volts without any drop before rising.

Disconnect oscilloscope and power connections. Ensure battery voltage exceeds 4.0 volts, then re-fit LK2 and instrument bottom cover.

* Components referred to in the text are annotated on Fig. 6.1 (Digital Board) and Fig. 6.10 (Analogue Board).

5.3 POWER SUPPLY CHECKS

Connect the instrument to the ac supply via the Variac (item 1). Set this to low supply limit (207V for 230V setting, 103V for 115V setting) and switch on power. After approximately 2 seconds, the display should illuminate, the nature of the displayed data depending on the previous usage of the instrument, which is normally retained. The message 'Previous set-up lost' indicates a fault in the non-volatile RAM.

5.3.1 Regulated Supplies

Connect the common lead of dc voltmeter (item 2) to the Digital Board mounting bolt adjacent to PL12 (the ribbon feed to the keyboard). Verify the dc voltages at the power supply test link TSK1 as follows:

Supply	Pin Number	Voltage Limits	
+5V Digital	3 - 12	+4.9	+5.1
+12V Digital	4 - 11	+11.64	+12.36
-12V Digital	5 - 10	-11.64	-12.36
+12V Analogue	6 - 9	+11.64	+12.36
-12V Analogue	7 - 8	-11.64	-12.36

If necessary, adjust R75 to set the +5V supply.

Replace the dc voltmeter by the dc ammeter (item 3) and measure the +5V short-circuit current. This should be 300 ±20 mA. If necessary, adjust R116 to set this.

Remove the ammeter.

5.3.2 Display Module Supplies

These unregulated supplies do not normally require checking. The following data is provided for fault-finding only.

Provision is made for modules containing vacuum fluorescent displays manufactured by Itron or by Futaba. The standard module WAY205G2 incorporates an Itron display.

'On load' voltages at low supply voltage limit should be as follows:
50/60 Hz ac supply (PL14 pin 3 - 5, pin 4 = centre tap)

ITRON	(R86, 87 in circuit)	5.2Vrms
FUTABA	(R86, 87 linked)	5.4Vrms

Unregulated dc supply (PL14 pin 2 - 1):

ITRON	(LK1 = default position)	40Vdc
FUTABA	(LK1 = alternative position)	34Vdc

Note that each of the above supplies is short-circuit protected by 250mA fuses F3 - F5, located on the Digital Board.

5.4 MEMORY CLEAR

Switch power ON and, when display appears, press the keys 'Code 9.1 Enter' in sequence. After a short pause, the display should blank, to be replaced by the message 'Previous set-up lost' or the display

→ C D Par 1kHz 1.0v (where → represents the cursor)

If no display appears at power on, proceed as follows:

Press the keys Enter/Local and 9 simultaneously and, while holding them pressed, press and release the master reset button S2 on the Digital Board. After 2 seconds, release the keys, which should have the same effect as Code 9.1 above.

5.5 MICROPROCESSOR RESET

With the instrument powered from the Variac, press 'Meas SetUp2' key. Display should change to → Max Auto (where → represents the cursor). Reduce the supply until the display extinguishes, then increase it gradually to minimum setting as before. The same display should re-appear within 2 seconds. A blanked or changing display, or the message 'Previous set-up lost' indicates a fault condition. For the remaining tests the Variac is not required and the instrument may be powered directly.

5.6 DISPLAY

Press keys 'Code .1 Enter' and ensure all display characters are intact. Press any key a total of four times to check the remainder of the character set in sequence. Press any key to exit this test.

5.7 KEYBOARD

Press keys 'Code .4 Enter'. The display instructions will ask for each button in turn to be pressed and will return the message 'O.K' if the button was detected correctly and, at the end, the message 'Keyboard O.K' will be displayed.

5.8 EPROMS

Press keys 'Code .5 Enter' to perform CRC test on EPROM 1. After a few seconds, the display should show 'PASS' and the appropriate CRC signature. Press any key to repeat test for EPROM 2 and then for EPROM 3. Press any key to exit this test.

5.9 RAM

Press keys 'Code .3 Enter' to test the RAM non-destructively. The display will show PASS or FAIL for each RAM chip.

5.10 E^2PROM

Press keys 'Code .2 Enter' to test the E^2PROM. The display will show E^2PROM followed by PASS 1 or FAIL 1. Press any key to exit this test.

5.11 CO-PROCESSOR

If the high speed option is fitted (IC6), check it by pressing keys 'Code .7 Enter'. The display will show 'Co-processor PASS' or 'Co-processor FAIL' or 'Chip not fitted'. Press any key to exit this test.

5.12 WATCHDOG

Press keys 'Code .6 Enter' to test the watchdog circuit. The message 'Testing watchdog' will appear. If the watchdog is operating correctly, this message will vanish after 2 seconds, to be replaced by the Meas SetUp1 or Meas SetUp2 display.

5.13 MEASUREMENT CONNECTION

Attach Component Fixture 1006 to the measurement terminals, observing the connector colour coding. Use the dc resistance meter (item 4) to measure between the 'Bias' terminal of the fixture and chassis. Ensure dc resistance is 500 ±50 ohms.

5.14 BASIC MEASUREMENT

Fit 100 ohm resistor (item 10) to the fixture. Press Meas SetUp1 key, move the cursor to point at 'D' and use 'select' key to obtain 'C + R Par' measurement function. Press Meas SetUp2 key, move the cursor to point at 'Auto' and use 'select' key to obtain 'Hold 4' function. Press Clear key followed by 3 to select and hold measurement range 3.

Press Meas key and hold to obtain a continuously flashing asterisk. The display should show a capacitance value close to zero, resolution ±0.1nF, and approximate resistance value, resolution ±.01 ohm (or ±.005 ohm if reading is below 100 ohms).

Press Meas SetUp1 key, move cursor to point at frequency and select '10kHz'. Repeat measurement as above. In this case capacitance resolution should be ±0.01nF.

Repeat this for frequencies of 100kHz and 1MHz. These should at this stage show a negative capacitance reading of 120-160pF, with resolution of ±1pF and ±0.1pF respectively.

5.15 SIGNAL SOURCE GENERATION

Reselect 1kHz and press Meas key. Set Oscilloscope (item 6) to 1V per division, ac coupled, with timebase setting 0.5ms per division.

Check TP8 on the Analogue Board, which should show a stepped 1kHz waveform with levels of approximately ±0.95V and ±2.3V.

Check signal at Bias end of fixture, which should show a 1kHz sinewave approximately 1.4V pk-pk. Select 10kHz, press Meas and ensure this level is maintained. Repeat this for 100kHz and 1MHz, then reselect 1kHz.

5.16 SOURCE IMPEDANCE SELECTION

Press Meas SetUp2 key and select range 4 (key Clear, 4). Check that signal level increases to approximately 1.9V pk-pk.

5.17 DETECTOR GAIN / MIXER FUNCTION

Check 1kHz sinewave at TP3 on the Analogue Board. This should be approximately 2.5V pk-pk. Select 100kHz and press Meas. TP3 should show 1kHz (±2%) at the same level (within ±2%).

Press Meas SetUp1, move cursor to point at level, select 0.1V and press Meas. Waveform at TP3 should be unchanged.

Repeat this for 0.3V level. Reselect 1.0V.

5.18 PSD DRIVE

Set the frequency to 10kHz. Pres Meas SetUp2, move cursor to point at speed and select Slow. Press and hold Meas to obtain repetitive slow measurements.

Set oscilloscope to 2V/division, dc coupled with timebase set to 20 μs/division. Check that waveform at IC27 pin 3 (Analogue Board) is a clean 0-5V square wave with a 100μs period. (The phase of this waveform changes periodically and some care may be necessary to obtain satisfactory timebase triggering. Use of trigger hold-off may be beneficial). Repeat this test at IC27 pin 14. Also check at IC27 pins 6 and 11 for the correct distortion-cancelling Walsh waveform. This is shown as PSD2 in section 2.3.4.

5.19 A/D CONVERTER OPERATION

Set oscilloscope timebase to 0.2ms/division and connect to TP4 on Analogue Board. Key in 'Code .85 Enter' to test the A/D Converter. Adjust the oscilloscope triggering level to obtain a waveform similar to the bottom trace of Fig. 2.6. During the 1ms charge balancing period the voltage will oscillate up and down but should remain between ±0.8V. The final conversion ramp should reach a maximum level of approximately 5.2 volts within <0.15 ms.

Change timebase setting to 5ms/division, select Max speed (Meas SetUp2) and press Meas to obtain repetitive measurements. The correct sequence comprises six A/D conversions, with different charge balance patterns, each 5ms long, with a 2.5ms pause between the 2nd and 3rd conversion. By using dc-coupled +ve slope triggering, and carefully adjusting the trigger level, it should be possible to observe at least five of these conversions, which should all conform to the levels stated above.

5.20 Es/Eu TIMING

Fit 330 ohm resistor (item 10) to fixture. Connect channel 1 of oscilloscope to TP7 on the Analogue Board and channel 2 to IC30 pin 20 on the Digital Board. Set channel 2 sensitivity to 1V per division, dc coupled.

Set timebase to 0.5ms/division, triggering on the rising edge of the channel 2 waveform.

Channel 1 should show a sinewave approx. 9V pk-pk followed by a sinewave approx. 3V pk-pk. Ensure that zero signal exists for at least 0.2ms between these two.

Reset oscilloscope to trigger on negative edge, to show sinewave switching from 3V pk-pk to 9V pk-pk. Again ensure zero signal exists for at least 0.2ms between these two.

If either condition is not met, a fault in relay RL3 or RL4 is indicated. Disconnect the oscilloscope.

5.21 OVERLOAD DETECTOR

Press Meas SetUp2 and select range 6. Press Meas key, ensure display shows 'Range Error'.

5.22 SHORT CIRCUIT DETECTOR

Press Meas SetUp2 and select range 9, repetitive measurements. With the oscilloscope, probe IC11 pin 6 (Analogue Board) which should be at +5V. Refit 100 ohm resistor to fixture and ensure IC11 pin 6 changes to 0V with repetitive +5V pulses between 100 and 200µs wide.

5.23 STABILITY CAPACITOR SWITCHING

WARNING: This test could damage the CMOS switch IC31 unless normal antistatic precautions are observed.

Using dc resistance meter (item 4), ensure continuity (<500Ω) exists between pins 12 and 14 of IC31. Select 1MHz, press Meas and ensure open circuit condition is selected.

5(B) SETTING-UP PROCEDURE - CALIBRATION

5.24 INITIAL SOAK

Replace top cover without fitting retaining screws. Leave the instrument switched on for a minimum of 1 hour in a steady ambient temperature of 23 ±2°C, free from draughts.

5.25 SIGNAL SOURCE LEVEL

Fit 100pF capacitor (item 10) to fixture. Using ac voltmeter (item 5) fitted with x1 probe, measure the voltage at the Bias end of this component, grounding the probe to the stainless bar on the fixture.

Set 7010 to 'C D Par 1kHz 1.0V' (Meas SetUp1) and 'Slow Hold 6' (Meas SetUp2). Press Meas key.

Ensure level (displayed on voltmeter) is exactly 1.000V (± 1mV). If necessary, briefly slide off top cover and adjust R26 (at back left on Analogue Board).

Select 1MHz test frequency and press Meas. Ensure voltmeter displays 1.000V ±3mV. If the voltage lies outside these limits, briefly slide off the cover and, using correct tool, adjust L2 or L3 on the Analogue Board.

Select 0.1V test level and verify voltmeter reading is 100mV ±2mV. Repeat for 0.3V and 0.5V with test limits of ±6mV and ±10mV respectively.

5.26 GUARD AMPLIFIER BALANCE (1MHz)

Fit 1.8nF capacitor (item 10) to fixture. Connect Oscilloscope (item 6) fitted with x1 probes to monitor the voltage at each end of this component, grounding both probes to the stainless bar on the fixture. It is important that this ground connection is made at the end of the bar away from the Bias marking (see Fig.5.1).

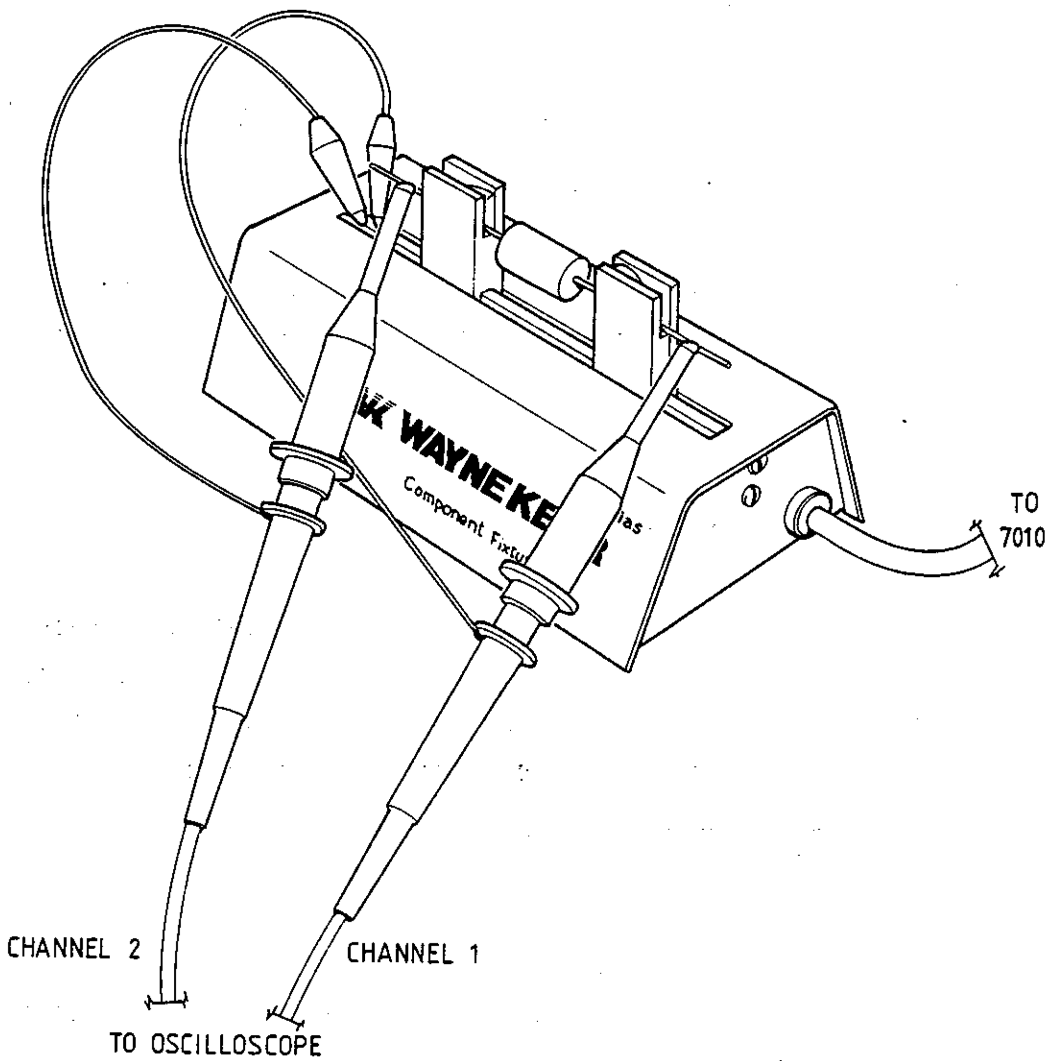


Fig. 5.1 Setting Guard Amplifier Balance

Set 7010 to 'C D Par 1MHz 1.0V' (Meas SetUp1) and 'Slow Hold 3' (Meas SetUp2). Press Meas key. Set oscilloscope timebase to 0.5µs/division and synchronise to the 2.8V pk-pk sinewave on channel 1. With channel 2 sensitivity set to 5mV/division the display should show an almost pure 2nd harmonic (2MHz) signal, well below 5mV pk-pk. Any unwanted 1MHz signal is indicated by successive peaks in the 2MHz signal being of unequal height. If either the +ve or -ve peaks show more than 0.5mV inequality, briefly slide off top cover and using an insulated tool adjust trimmer C55 and/or R61 on the Analogue Board to establish correct balance.

5.27 SIGNAL SOURCE DISTORTION

Select measurement range 4 (Meas SetUp2). The waveform displayed on channel 2 will normally show increased distortion. Ensure that the peak-peak level of this signal does not exceed 7mV.

5.28 GUARD AMPLIFIER GAIN (100kHz)

Select 100kHz frequency (Meas SetUp1) and range 3 (Meas SetUp2). Press Meas key. Replace the 1.8nF capacitor by a short-circuit and synchronise oscilloscope to 100kHz signal on channel 2. Ensure that this is essentially sinusoidal with amplitude not exceeding 16mV pk-pk.

NOTE - STORED CALIBRATION DATA

The E²PROM IC63 stores calibration data which is specific to each instrument. Provided that this data has not been lost and that no component changes have been made to the Analogue Board, the calibration data should remain valid for several years. In this case, proceed to section 5.30 (Accuracy Tests). If calibration data has become corrupted, or the test limits of section 5.32 or 5.33 are not met, new calibration values may be generated by using the Calibration Adjustment procedure which follows. Do not attempt to carry out this procedure unless all the necessary Standard components (item 11 in section 4) are available, each with 1kHz/10kHz calibration figures as defined, traceable to National or International Standards.

5.29 CALIBRATION ADJUSTMENT (See important NOTE on previous page)

The 7010, fully tested up to this point, must be left switched on for three hours with covers fitted in an ambient temperature of 23 ±2 degrees C and free from draughts. If following on immediately from the previous section then this time may be reduced to two hours.

5.29.1 Connections

Use 1 metre-long cables (see notes on Standard construction)* to connect calibration Standards to 7010 under test. Calibration Standards must be isolated from ground at all times except for the connections via the coaxial cables.

5.29.2 Trim

Press 'calibrate' key to obtain a display 'Open Fixture, Key 1'. Connect reference open-circuit to measurement leads and press key 1. If 'O/C FAIL Retry = Key 1' appears, check all connections are correctly made and repeat. Correct display is 'Short Fixture, Key 2'.

Connect reference short-circuit to measurement leads and press key 2. If 'S/C FAIL Retry = Key 2' appears, check all connections are correctly made and repeat. Correct display is 'Connect Std, Key 3'. Cancel this message by pressing 'Meas SetUp 1'.

5.29.3 Measured Values

Ensure required ambient conditions are met before proceeding. If the software version is not known, press 'Code 0.11, Enter' to display the version number.

Connect 5nF Standard to measurement leads, and press 'Code 987.6, Enter' to obtain the message 'Test 1 D = '.

Key in the known value of 10kHz D factor for the 5nF capacitor, followed by Enter. The display will echo each character as it is keyed and errors may be corrected by pressing Clear and re-keying.

* Section 4, item 11 - Notes on Standards

The built-in calibration routine performs checks to ensure that the measured values are reasonable. If they appear to be out of limits, the display will show 'Test 1 D = Fail'. Otherwise the required calibration constants will be calculated and stored and the message 'Test 2 D = ' will be displayed.

Repeat this procedure for all seven tests shown in the table below. The measurement range in use is shown here for information only. Note when keying-in resistance or capacitance values the units should not be entered, but 100pF and 500pF require the use of the 'p' multiplier. Test 6 needs no values to be entered, simply press Enter. (The 1kΩ resistor provides an accurate zero phase reference at 1kHz).

For software versions 3.11 and earlier, the sequence of tests 4 and 5 should be reversed.

On successful completion of test 7, the display will change to CALIBRATION COMPLETE.

TEST	STANDARD VALUE	UNITS / VALUE	FREQ Hz	RANGE IN USE
1	5nF	Enter D value (.000XXX)	10k	6/7
2	1nF	Enter D value (.000XXX)	10k	8
3	500pF	Enter D value (.000XXX)	10k	9
4	100R	Enter value (100.XXX)	1k	4
5	100pF	Enter value (100.XXX p)	10k	9
6	1.0k	Enter no value	1k	6
7	5nF	Enter D value (.000XXX)	1k	8

Immediately following on from the Calibration procedure, check that the calibration data has been correctly stored by making measurements corresponding to each test in the table above. Select 'C D Par' or 'C R Par' with '1kHz 1.0V' or '10kHz 1.0V' as appropriate. Meas SetUp2 should be set to 'Slow' and 'Hold' with the range number shown in each case.

For each test except 1 and 6 the reading should correspond to the value which was keyed in within ±2 displayed digits. For test 1 with range 6 selected the reading should be low by 8 ±2 digits. With range 7 selected the reading should be high by 2 ±2 digits. For test 6 the parallel capacitance should not exceed ±2pF.

5(C) SETTING-UP PROCEDURE - PERFORMANCE CHECKS

5.30 ACCURACY TESTS

These tests should be performed in a stable ambient temperature of 23 ± 2°C, the 7010 having been operating for a minimum of 1 hour with all covers in place before commencing. Use 1 metre long cables to connect the calibration Standards to the 7010. Calibration Standards must be isolated from ground at all times except for the connections via the coaxial cables.

5.31 TRIM

Press 'calibrate' key to obtain a display 'Open Fixture, Key 1'. Connect reference open-circuit to measurement leads and press key 1. If 'O/C FAIL Retry = Key 1' appears, check all connections are correctly made and repeat. Correct display is 'Short Fixture, Key 2'.

Connect reference short-circuit to measurement leads and press key 2. If 'S/C FAIL Retry = Key 2' appears, check all connections are correctly made and repeat. Correct display is 'Connect Std, Key 3'. Cancel this message by pressing 'Meas SetUp 1'.

5.32 1kHz TESTS

For each test shown in Table 5.1, select measurement parameters indicated, test signal '1kHz 1.0V', with Meas SetUp2 set to 'Slow' and 'Hold' with the range number indicated.

Connect the appropriate Standard as indicated and verify that 7010 readings correspond to the known values for the Standard in use within the limits shown in the table.

TABLE 5.1 TEST CONDITIONS AND LIMITS FOR 1kHz

MEAS SET UP 1			RANGE	STANDARD	ALLOWED LIMITS	
MAJ	MIN	SER PAR	NUMBER	VALUE	QUAD	REAL
L	R	S	0	S/C	±7nH	± 60µ ohms
L	R	S	0	3.16	±75nH	±.0010 ohms
L	R	S	1	10	±240nH	±.0025 ohms
L	R	S	2	31.6	±750nH	±.007 ohms
L	R	S	3	31.6	±750nH	±.005 ohms
L	R	S	3	100	±2.4µH	±.015 ohms
L	R	S	4	100	±2.4µH	±.010 ohms
L	R	S	4	316	±7.5µH	±.05 ohms
L	R	S	5	316	±7.5µH	±.07 ohms
L	R	S	5	1.0k	±30µH	±.25 ohms
L	R	S	6	1.0k	±24µH	±.25 ohms
L	R	S	6	3.16k	±75µH	±.00085k ohms
L	R	S	7	3.16k	±75µH	±.00095k ohms
C	R	P	7	10k	±3.5pF	±.0030k ohms
C	R	P	8	10k	±3.5pF	±.0030k ohms
C	D	P	8	5nF	-	±0.0001 D
C	R	P	8	31.6k	±1.1pF	±.0095k ohms
C	R	P	9	31.6k	±1.1pF	±.0108k ohms
C	D	P	9	5nF	-	±0.0002 D
C	D	P	A	1.88nF	±.00066nF	±0.0002 D
C	D	P	A	500pF	±.175pF	±0.0002 D
C	D	P	B	500pF	±.175pF	±0.0002 D
C	G	P	B	O/C	± 8fF	±.09nS

fF = 0.001pF

5.33 10kHz TESTS

Repeat section 5.32 procedure but with frequency set to 10kHz at 1.0V and using table 5.2.

TABLE 5.2 TEST CONDITIONS AND LIMITS FOR 10kHz

MEAS SET UP 1			RANGE	STANDARD	ALLOWED LIMITS	
MAJ	MIN	SER PAR		VALUE	QUAD	REAL
L	R	S	0	S/C	±1nH	± 60μ ohms
L	R	S	0	3.16	±7.5nH	±.001 ohms
L	R	S	1	10	±24nH	±.003 ohms
L	R	S	2	31.6	±75nH	±.01 ohms
L	R	S	3	31.6	±75nH	±.01 ohms
L	R	S	3	100	±240nH	±.03 ohms
L	R	S	4	100	±240nH	±.03 ohms
L	R	S	4	316	±750nH	±.10 ohms
L	R	S	5	316	±750nH	±.10 ohms
L	R	S	5	1.0k	±2.4μH	±.30 ohms
L	R	S	6	1.0k	±2.4μH	±.30 ohms
L	R	S	6	3.16k	±7.5μH	±.001k ohms
C	D	P	6	5nF	-	±0.00015 D
C	D	P	7	5nF	-	±0.00015 D
L	R	S	7	3.16k	±7.5μH	±.001k ohms
C	D	P	8	1.88nF	±.0006nF	NO VALUE
C	D	P	8	1.0nF	±.0003nF	±0.00015 D
C	D	P	8	500pF	±.15pF	±0.00015 D
C	D	P	9	500pF	±.15pF	±0.00015 D
C	G	P	9	O/C	±6fF	±.50nS

fF = 0.001pF

5.34 REDUCED LEVEL OPERATION

Repeat trimming routine of section 5.31. Select frequency of 1kHz. Repeat section 5.32 procedure using the ranges and level settings shown in table 5.3.

TABLE 5.3 TEST CONDITIONS AND LIMITS FOR REDUCED LEVEL

MEAS SET UP 1				RANGE	STANDARD VALUE	ALLOWED LIMITS	
MAJ	MIN	SER PAR	LEVEL			QUAD	REAL
L	R	S	0.1	2	S/C	±.07μH	±0.6m ohms
L	R	S	0.1	9	31.6k	±1.8pF	±0.12k ohms
C	G	P	0.1	9	0/C	±.08pF	±0.90nS
L	R	S	0.3	9	31.6k	±1.8pF	±0.12k ohms
L	R	S	0.5	9	31.6k	±1.8pF	±0.12k ohms

5.35 INCREASED SPEED OPERATION

Select 'L R Ser 1kHz 1.0V' and 'Slow Hold 4'. Connect the 100Ω Standard and pres Meas for continuous measurements. Observe the 100 ohms reading varies by less than ±0.001 ohm from average.

Select 'Med ...', press Meas and observe a faster measurement repetition rate. Similarly for 'Fast' for a faster rate and finally 'Max'.

Observe the 100 ohms reading (on Max speed) varies by less than ±0.01 ohms from the same average.

5.36 HIGH FREQUENCY LINEARITY

Disconnect leads from 7010 and replace by 1006 Fixture. To ensure consistent low contact resistance, pre-condition the fixture by sliding both measurement jaws from end to end several times. Then position them together approximately in the middle of the fixture.

5.37 TRIM AND TRANSFER CALIBRATION

Press 'calibrate' key to obtain a display 'Open Fixture, Key 1'. Press key 1 to initiate open circuit trim routine. On completion display will show 'Short Fixture, Key 2'. Fit encapsulated short circuit 7010 LSC from the Transfer Standard Kit (item 9), inserting leads to full extent. Press key 2 to initiate short circuit trim routine. On completion display will show 'Connect Std, Key 3'. Remove short circuit from fixture.

Fit the encapsulated Transfer Standard 7010 LTS to the fixture. Avoid transferring any heat to the capacitor element by handling only the housing. Do not touch the lead-out wires at all and keep handling to a minimum. Press key 3 to initiate transfer calibration routine. On completion display will show 'CALIBRATION COMPLETE'. Extinguish this message by pressing Meas SetUp1.

5.38 TRANSFER CALIBRATION ACCURACY

Select 'C D Par 10kHz 1.0V', and 'Slow Auto'. Press Meas key to obtain repetitive measurements and note C value. Note that this will vary slowly with time if the Standard has received any heat. In this case allow it to stabilise until reading variations are no greater than ±1 digit, and record average value.

Select 100kHz frequency and repeat repetitive measurements. Ensure that C reading is lower than 10kHz value by .002pF ±3 digits and that D reading is between .00003 and .00009.

Check 10kHz reading to ensure no drift, then select 1MHz frequency and repeat. Ensure C reading is lower than 10kHz value by .01pF ±.003pF and that D reading is between .00000 and .00006.

5.39 MIXER LINEARITY

With '1MHz 1.0V' selected, press Meas SetUp2 and select 'Hold 6'. Select repetitive measurements and record the average values for both the C and D readings.

Change level to 0.5V and reselect repetitive measurements. Under these conditions, variations between successive readings will be significant, but ensure that the changes in the average C and D readings, from the 1.0V values, do not exceed ±.02pF and ±.0002, respectively.

Remove Transfer Standard from fixture and adjust jaw spacing to suit 1.8nF capacitor (item 10). Fit this capacitor to fixture using minimum of handling to avoid heating the capacitor.

Select 100kHz 1.0V, repetitive measurements. Ensure C reading is not drifting, allowing time for the temperature to stabilise if necessary. Record average readings for both C and D.

Change level to 0.5V and reselect repetitive measurements. As before, observe the changes in the average C and D readings which, in this case, should not exceed ±.00012nF and ±.00006, respectively.

5.40 RS232C OPERATION

Connect the RS232C terminal (item 7) to the DTE connector. To perform a full test including handshake, the connecting lead should be arranged to include a Handshake Disable switch as shown in Fig. 5.2. Set this switch to 'NORMAL' (pins 4 and 5 of DTE connector linked). Make no connection to the DCE connector at this stage.

Press 'Code 14 Enter' and observe the message 'GPIB = XX' where XX is a number. If XX is less than 31 then press 'Clear 33 Enter' to activate the RS232 port.

Press 'Code 13.0 Enter' which will indicate the baud rate selection. Match that of the terminal, using the 'select' button.

Cursor down to set up matching data bits, Stop and Parity bits using the left-right cursor buttons and 'select'.

Exit the routine by pressing Meas SetUp 1.

If necessary, connect 1006 fixture to 7010 and fit 100 ohm resistor.

Type the following string into the terminal:

L;R;SER;FREQ 1000;SPD MAX;HOLD 4;MEAS?

followed by <RETURN>. (Note that this string contains 3 embedded spaces).

The 7010 should make a single measurement, returning the inductance and resistance values to the terminal as well as to the display.

Press Enter/Local key to restore front panel control. Check that the contents of Meas SetUp1 and Meas SetUp2 correspond to the data in the set up string above.

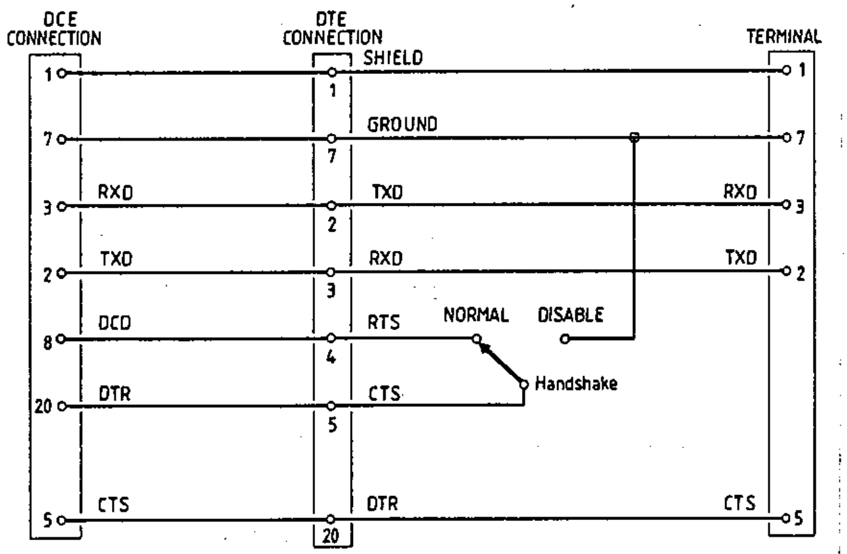


Fig. 5.2 RS232C Interconnections Diagram

Set Handshake switch to 'DISABLE', change resistor to 330 ohms and type into terminal the string

MEAS? followed by <RETURN>

There should be no change to display on terminal.
Set Handshake switch to 'NORMAL', and observe new measured values returned to terminal as before.

Disconnect lead from DTE socket, connect to DCE socket as detailed in Fig. 5.2. Repeat the foregoing sections completely including the handshake disable test.

5.41 GPIB / HANDLER BOARD (OPTION)

The following sections should be performed only if the 7010 under test is fitted with the GPIB / Handler Option.

5.41.1 GPIB Remote Control

This can be tested only if a GPIB Controller with a suitable shell program for controlling talker/listener equipment is available.

Connect Controller to IEEE 488 socket on 7010. Key in 'Code 14 Enter' on 7010 to obtain the display 'GPIB = XX' where XX is the GPIB address of the 7010. Set this to suit the shell program by keying 'Clear YY Enter' where YY is the required address between 0 and 30.

If necessary, connect 1006 fixture to 7010 and fit 100 ohm resistor.

Using the shell program, send the following command string to the 7010.

C;R;PAR;FREQ 10E3;SPD MED;AUTO;MEAS?

This should cause the 7010 to perform a measurement, returning a result string to the Controller (assuming the 7010 is addressed to talk). The form of the result string will be (for example)

1 E-12, 100.456

representing C value 1pF followed by R value 100.456 ohms.

5.41.2 Bin Handler Output

To perform a full functional test on this interface socket, a test circuit as shown in Fig. 5.3 is required. Connect this test circuit to the socket marked 'Handler' on the instrument rear panel.

The Handler Port can be reconfigured in several ways to suit different handler characteristics. Full details are given in the Operating Instructions, sections 11.1 to 11.3. All common configurations can be tested directly by the following procedure.

5.41.3 Bin Output Lines

If no relays are fitted (sockets RL1 - RL30 on GPIB / Handler Board), the outputs are not isolated. Set switch on test circuit to NON-ISOLATED.

If relays are fitted to some or all of the sockets, the common connection (VN) will be connected to one of the internal supplies, or connected to pin 1 of the connector to give isolated operation. Check the setting of SW2 on the GPIB / Handler Board as follows:

SW2 Setting	Selection	Test circuit switch setting
1	-12V	NON-ISOLATED
2	0V	NON-ISOLATED
3	+5V	Cannot test
4	+12V	Cannot test
5	VE*	ISOLATED

* For isolated operation, SW3 also should be set to position 8.

Ensure that IC3 to IC6 on the option board are type 74HCT238 for normal operation. If type 74HCT138 has been substituted, polarity will be inverted.

Key in 'Code 0.75 Enter' to activate handler test software, and verify that the test circuit LED's illuminate from Bin 0 to Bin B in turn.

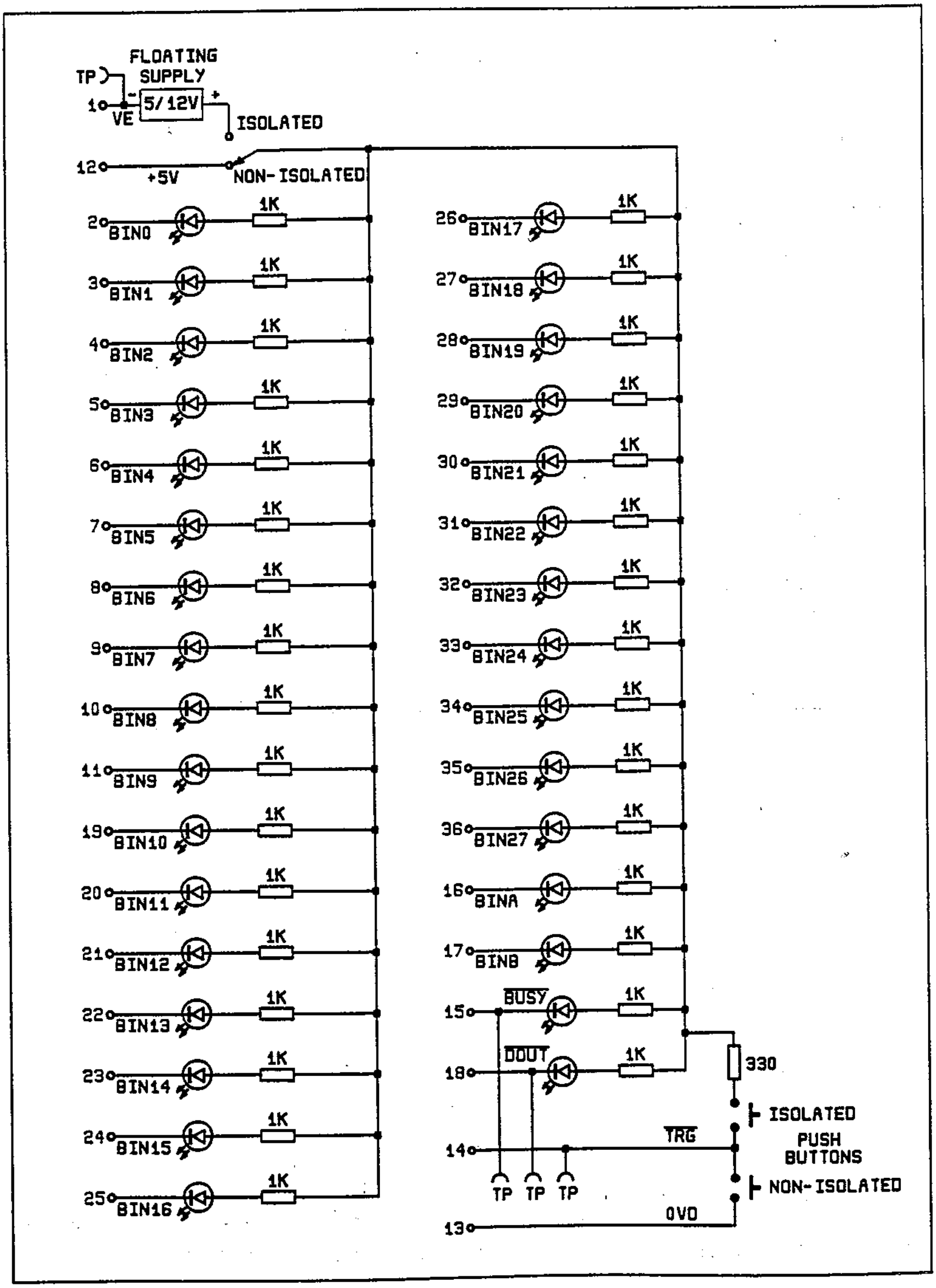


Fig. 5.3 Bin Output Test Circuit

If relays are fitted in some locations only, LED's corresponding to unpopulated bins will not light.

For inverted polarity, LED's will normally be on and selected Bin will extinguish in turn.

5.41.4 Handshake Outputs

If opto-isolators are fitted at IC13 and IC16 on the GPIB / Handler Board, handshake outputs will be isolated. Ensure SW2 (VN) is set to position 5 and SW3 (VE) is set to position 8. In this case, set switch on test circuit to ISOLATED. Otherwise set switch to NON-ISOLATED.

Check timing setting by inspecting first pole of SW5 (BUSY). This may be Normal (set to 1) or SHI (Set to A).

Check polarity setting by inspecting second pole of SW5 (BUSY) and SW7 (DOUT). Each of these may be Normal (set to 2) or Inverted (set to B).

Connect channel 1 of oscilloscope (item 6) to $\overline{\text{BUSY}}$ test point on test circuit, and channel 2 to $\overline{\text{DOUT}}$ test point. Ground the oscilloscope to 0V (chassis) for NON-ISOLATED switch setting, or to the VE test point on the test circuit for the ISOLATED switch setting. Set oscilloscope controls as follows:

CH1 and CH2 sensitivity	2V / division
Timebase	50µs / division
Trigger	Normal, CH1

If BUSY polarity is normal (SW5, 2) use +ve edge triggering.
" " " " inverted (SW5, B) use -ve edge triggering.

With Code 0.75 selected from previous test, observe CH1 ($\overline{\text{BUSY}}$). This should show a high-level pulse (3.5 - 5V) approx. 220µs long for normal polarity setting, or a low-level pulse for inverted polarity.

Observe CH2 ($\overline{\text{DOUT}}$). For normal timing (SW5, 1) this should show a low-level pulse approximately 135µs long ending synchronously with CH1. This will be a high-level pulse for inverted polarity (SW7, B). For SHI timing (SW5, A) this pulse should be 85µs long starting synchronously with CH1.

Press any front-panel key to halt test software. Disconnect oscilloscope.

5.41.5 Trigger Input

If an opto-isolator is fitted at IC14 on the GPIB / Handler Board, trigger input will be isolated. Ensure SW2 (VN) is set to position 5 and SW3 (VE) is set to position 8. In this case set switch on test circuit to ISOLATED.

If an opto-isolator is fitted at IC15 with the above SW2 and SW3 settings, reversed input current polarity is required. Set switch on test circuit to ISOLATED and reverse polarity of floating supply from that indicated on Fig. 5.3.

If neither socket is populated, set switch on test circuit to NON-ISOLATED.

Check polarity setting by inspecting second pole of SW6 (TRG). This may be Normal (set to 2) or Inverted (set to B).

Press 'Select Readout' key and use 'select' key to obtain 'Bin number only'. Press 'Sort' key and ensure that a sort measurement is triggered, indicated by a brief * display followed by the selected bin number. (With no measurement leads connected, the display will show 'Bin 0 Range Error', regardless of Bin Setup details).

Key in ' Code 8 Enter' to enable the handler port.

Press and release either the ISOLATED or NON-ISOLATED PUSH BUTTONS on the test circuit, as appropriate. For normal polarity, (SW6, 2) a sort measurement should be triggered on pressing the button. For inverted polarity (SW6, B) the trigger should occur on releasing the button.

6 COMPONENTS LIST

6.1 7010 Digital Board EJ1/27242 Iss.P8

Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
BAT1	BATTERY LITHIUM				BR-2/3A1P	NATIONAL
BR1	DIODE BRIDGE				1KAB20E	I/R
BR2						
BR3	DIODE BRIDGE				26MB 5A	I/R
C1	CERAMIC	100n		63V	B37449	SIEMENS
C2						
C3						
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C13						
C14						
C15	ELECTROLYTIC	15000u	20%	16V	054-55153	PHILIPS
C16	ELECTROLYTIC	2u2	20%	63V	035-58228	PHILIPS
C18	CERAMIC	100n		63V	B37449	SIEMENS
C19	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C20	POLYSTYRENE	100p	1.5%	63V	SUF710	SUFLEX
C21	ELECTROLYTIC	220u	20%	16V	035-55221	PHILIPS
C22	ELECTROLYTIC	1500u	20%	25V	035-56152	PHILIPS
C23						
C24	ELECTROLYTIC	10u	20%	50V	035-90008	PHILIPS
C25	ELECTROLYTIC	1u	20%	63V	035-58108	PHILIPS
C26	ELECTROLYTIC	10u	20%	50V	035-90008	PHILIPS
C27	ELECTROLYTIC	1u	20%	63V	035-58108	PHILIPS
C28	ELECTROLYTIC	10u	20%	50V	035-90008	PHILIPS
C29	ELECTROLYTIC	1u	20%	63V	035-58108	PHILIPS
C30	ELECTROLYTIC	10u	20%	50V	035-90008	PHILIPS
C31	ELECTROLYTIC	1u	20%	63V	035-58108	PHILIPS
C32	ELECTROLYTIC	22u	20%	63V	035-58229	PHILIPS
C33	ELECTROLYTIC	10u	20%	50V	035-90008	PHILIPS
C34	CERAMIC	100n		63V	B37449	SIEMENS
C35						
C36						
C37						
C38	POLYSTYRENE	560p	5%	63V	SUF710	SUFLEX
C39	CERAMIC	100n		63V	B37449	SIEMENS
C40	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C41	CERAMIC	100n		63V	B37449	SIEMENS
C42	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C43	CERAMIC	100n		63V	B37449	SIEMENS
C44						

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
C45	CERAMIC	10p	5%	500V	GLC604	THOMSON CSF
C46	POLYSTYRENE	560p	5%	63V	SUF710	SUFLEX
C47	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C48	CERAMIC	100n		63V	B37449	SIEMENS
C49	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C50	CERAMIC	100n		63V	B37449	SIEMENS
C52	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C53	ELECTROLYTIC	22u	20%	63V	035-58229	PHILIPS
C54	CERAMIC	100n		63V	B37449	SIEMENS
C55						
C56						
C57						
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C60						
C61						
C62						
C63						
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C103						
C104						
C105						
C106						
C107						
C108						
C109	CERAMIC	470p	5%	100V	VK20C0G	VITRAMON
C110						

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	Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
	C111	ELECTROLYTIC	10u	20%	50V	035-90008	PHILIPS
	D1	DIODE REFERENCE	5.0V			LM336Z-5.0	LINEAR TECHNOLOGY
	D2						
	D3	DIODE				1N4148	PHILIPS
	D4						
	D5						
	D7	DIODE ZENER	3.9V			BZX79-C3V9	PHILIPS
	D8	DIODE ZENER	7.5V			BZX79-C7V5	PHILIPS
	D9	DIODE				1N4148	PHILIPS
	D10	DIODE				1N4002	PHILIPS
	D11	DIODE				1N4148	PHILIPS
	D12						
	D13						
	D14	DIODE ZENER	6.2V			BZX79-C6V2	PHILIPS
	D15	DIODE				1N4002	PHILIPS
	D16						
	D17						
	D18						
	D19						
	D20						
	D21						
	D22	DIODE				1N4148	PHILIPS
	F3	FUSE	PICOFUSE		250mA	275-250	LITTELFUSE
	F4						
	F5						
	IC1	CRYSTAL OSC. (DIL)	5.814MHz			GBS205-5.814	ECM
STATIC	IC2	INTEGRATED CIRCUIT				74ACT00PC	FAIRCHILD
STATIC	IC3	INTEGRATED CIRCUIT				CD74HC74E	RCA
STATIC	IC4	INTEGRATED CIRCUIT	(Z80 CPU)			Z0840006PSC	ZILOG
STATIC	IC5	INTEGRATED CIRCUIT				CD74HCT08E	RCA
STATIC	IC7	INTEGRATED CIRCUIT				CD74HC04E	RCA
STATIC	IC8	INTEGRATED CIRCUIT				CD74HCT32E	RCA
STATIC	IC9	INTEGRATED CIRCUIT				74AC244PC	FAIRCHILD
STATIC	IC10	INTEGRATED CIRCUIT				CD74HCT373E	RCA
STATIC	IC11	INTEGRATED CIRCUIT				CD74HC138E	RCA
STATIC	IC12	INTEGRATED CIRCUIT				CD74HCT244E	RCA
STATIC	IC13	INTEGRATED CIRCUIT				TC5564PL-20	TOSHIBA
STATIC	IC14						
STATIC	IC15	INTEGRATED CIRCUIT	(PROGRAMMED)			uPD27C256-15	NEC
STATIC	IC16						
STATIC	IC17	INTEGRATED CIRCUIT	(Z80 DART)			Z0847006PSC	ZILOG
	IC18	INTEGRATED CIRCUIT				DS1488N	NATIONAL
	IC19	INTEGRATED CIRCUIT				DS1489N	NATIONAL
	IC21	INTEGRATED CIRCUIT				CNY17-3	G/E
	IC22						

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	Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
STATIC	IC23	INTEGRATED CIRCUIT				P8254-5	INTEL
STATIC	IC24	INTEGRATED CIRCUIT				CD74HCT244E	RCA
STATIC	IC25	INTEGRATED CIRCUIT				CD74HCT04E	RCA
STATIC	IC26	INTEGRATED CIRCUIT				CD74HC00E	RCA
STATIC	IC27	INTEGRATED CIRCUIT				CD74HC04E	RCA
STATIC	IC28	INTEGRATED CIRCUIT				CD74HC4020E	RCA
STATIC	IC29	INTEGRATED CIRCUIT				CD74HC373E	RCA
STATIC	IC30	INTEGRATED CIRCUIT				P8255A-5	INTEL
STATIC	IC31	INTEGRATED CIRCUIT	(Z80 PIO)			Z0842006PSC	ZILOG
STATIC	IC32	INTEGRATED CIRCUIT				CD74HC147E	RCA
STATIC	IC33	INTEGRATED CIRCUIT				74ACT74PC	FAIRCHILD
STATIC	IC34	INTEGRATED CIRCUIT				CD74HC390E	RCA
STATIC	IC35	INTEGRATED CIRCUIT				SN74AC74N	TEXAS
STATIC	IC36	INTEGRATED CIRCUIT				CD74HC390E	RCA
STATIC	IC37	INTEGRATED CIRCUIT				SN74AC74N	TEXAS
STATIC	IC38	INTEGRATED CIRCUIT				CD74HC390E	RCA
STATIC *STATIC*	IC39 IC40	INTEGRATED CIRCUIT				74AC153PC	FAIRCHILD
STATIC	IC41	INTEGRATED CIRCUIT				CD74HC4520E	RCA
STATIC	IC42	INTEGRATED CIRCUIT				CD74HCT86E	RCA
	IC44	INTEGRATED CIRCUIT				LM311N	NATIONAL
STATIC	IC45	INTEGRATED CIRCUIT	(Z80 PIO)			Z0842006PSC	ZILOG
STATIC	IC46	INTEGRATED CIRCUIT				CD74HC74E	RCA
STATIC	IC47	INTEGRATED CIRCUIT				74AC153PC	FAIRCHILD
STATIC	IC48	INTEGRATED CIRCUIT				CD74HC10E	RCA
STATIC	IC49	INTEGRATED CIRCUIT				CD74HC08E	RCA
STATIC	IC50	INTEGRATED CIRCUIT				CD74HC175E	RCA
STATIC	IC51	INTEGRATED CIRCUIT				CD74HC00E	RCA
STATIC	IC52	INTEGRATED CIRCUIT				CD74HC74E	RCA
STATIC	IC53	INTEGRATED CIRCUIT				74ACT109PC	FAIRCHILD
STATIC	IC54	INTEGRATED CIRCUIT				SN74AC74N	TEXAS
STATIC	IC56	INTEGRATED CIRCUIT				CD74HCT132E	RCA
STATIC	IC57	INTEGRATED CIRCUIT				CD74HC00E	RCA
STATIC	IC58	INTEGRATED CIRCUIT				CD74HC74E	RCA
STATIC	IC59	INTEGRATED CIRCUIT				CD74HC393E	RCA
	IC60	CRYSTAL OSC. (DIL)	64.0MHz			GBS205-64.0	ECM
	IC61	CRYSTAL OSC. (DIL)	63.350MHz			GBS205-63.35	ECM

7010 Digital Board EJ1/27242 Iss.P8

	Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
STATIC	IC62	INTEGRATED CIRCUIT				CD74HCT86E	RCA
STATIC	IC63	INTEGRATED CIRCUIT				NMC9346N	NATIONAL
STATIC	IC64	INTEGRATED CIRCUIT				CD74HC74E	RCA
STATIC	IC65	INTEGRATED CIRCUIT				CD74HC4051E	RCA
	IC67	INTEGRATED CIRCUIT				LM324N	NATIONAL
	IC68	VOLTAGE REGULATOR				LM337T	NEC
	IC69 IC70	VOLTAGE REGULATOR				LM317T	NEC
	IC71	VOLTAGE REGULATOR				LM337T	NEC
STATIC	IC72	INTEGRATED CIRCUIT	(PROGRAMMED)			uPD27C256-15	NEC
STATIC	IC73	INTEGRATED CIRCUIT				CD74HCT10E	RCA
	L1	INDUCTOR	820u	5%		WD-WEE-820	NYTRONICS
	PL7 PL8	CONNECTOR	26 WAY	IDC		IDH26PK1-S3-TG	ROBINSON NUGENT
	PL11	CONNECTOR	3 WAY			MKS3733-1-0-303	STOCKO
	PL12	CONNECTOR	14 WAY	IDC		IDH14PK1-S3-TG	ROBINSON NUGENT
	PL13	CONNECTOR	26 WAY	IDC		IDH26PK1-S3-TG	ROBINSON NUGENT
	PL14	CONNECTOR	5 WAY			MKS3735-1-0-505	STOCKO
	PL15	CONNECTOR	3 WAY			MLSS156-3	PANDUIT
	PL16	CONNECTOR	3 WAY			MKS3733-1-0-303	STOCKO
	PL17	CONNECTOR	11 WAY			MLSS156-11	PANDUIT
	PL18 PL19	CONNECTOR	34 WAY	IDC		IDH34PK1-S3-TG	ROBINSON NUGENT
	R1 R2	FILM	56R	5%	0.25W	SFR25	PHILIPS
	R3	FILM	4K7	5%	0.25W	SFR25	PHILIPS
	R4 R5 R6	FILM	10K	5%	0.25W	SFR25	PHILIPS
	R7 R8 R9 R10	FILM	330R	5%	0.25W	SFR25	PHILIPS
	R11	FILM	47R	5%	0.25W	SFR25	PHILIPS
	R12	NETWORK	4K7	2%		4610X-101-472	BOURNS
	R13	NETWORK	10K	2%		4610X-101-103	BOURNS
	R14 R15	NETWORK	4K7	2%		4610X-101-472	BOURNS
	R18 R19 R20 R21	FILM	10K	5%	0.25W	SFR25	PHILIPS
	R22	FILM	100R	5%	0.25W	SFR25	PHILIPS
	R23	FILM	10K	5%	0.25W	SFR25	PHILIPS

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
R24	FILM	10K	5%	0.25W	SFR25	PHILIPS
R25						
R26						
R27						
R28						
R29	FILM	2K2	5%	0.25W	SFR25	PHILIPS
R30	NETWORK	10K			4610X-101-103	BOURNS
R31	METAL FILM	470R	0.1%	25ppm	H4	HOLSWORTHY
R32	METAL FILM	665R	0.1%	25ppm	H4	HOLSWORTHY
R33	METAL FILM	470R	0.1%	25ppm	H4	HOLSWORTHY
R34	FILM	390R	5%	0.25W	SFR25	PHILIPS
R35	FILM	3K3	5%	0.25W	SFR25	PHILIPS
R36	FILM	1K5	5%	0.25W	SFR25	PHILIPS
R37	FILM	100R	5%	0.25W	SFR25	PHILIPS
R38	FILM	560R	5%	0.25W	SFR25	PHILIPS
R39	FILM	22R	5%	0.25W	SFR25	PHILIPS
R40	FILM	560R	5%	0.25W	SFR25	PHILIPS
R41	FILM	4K7	5%	0.25W	SFR25	PHILIPS
R42						
R43	FILM	1K0	5%	0.25W	SFR25	PHILIPS
R44						
R47	FILM	10K	5%	0.25W	SFR25	PHILIPS
R48	FILM	2K7	5%	0.25W	SFR25	PHILIPS
R49	FILM	100R	5%	0.25W	SFR25	PHILIPS
R50	FILM	47K	5%	0.25W	SFR25	PHILIPS
R51	FILM	4K7	5%	0.25W	SFR25	PHILIPS
R52						
R55	FILM	10K	5%	0.25W	SFR25	PHILIPS
R56	FILM	100K	5%	0.25W	SFR25	PHILIPS
R57	FILM	10K	5%	0.25W	SFR25	PHILIPS
R58						
R59	METAL FILM	390R	1%	100ppm	H4	HOLSWORTHY
R60	METAL FILM	4K7	1%	100ppm	H4	HOLSWORTHY
R61	FILM	3K3	5%	0.25W	SFR25	PHILIPS
R62	FILM	470K	5%	0.25W	SFR25	PHILIPS
R63	FILM	100R	5%	0.25W	SFR25	PHILIPS
R64	FILM	4K7	5%	0.25W	SFR25	PHILIPS
R65	FILM	22R	5%	1.0W	PR37	PHILIPS
R66	METAL FILM	5K1	1%	100ppm	H4	HOLSWORTHY
R67	FILM	47K	5%	0.25W	SFR25	PHILIPS
R68	FILM	10K	5%	0.25W	SFR25	PHILIPS

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
R69	METAL FILM	100R	1%	100ppm	H4	HOLSWORTHY
R70	FILM	100R	5%	0.25W	SFR25	PHILIPS
R71	FILM	1K0	5%	0.25W	SFR25	PHILIPS
R72	FILM	1K8	5%	0.25W	SFR25	PHILIPS
R73	FILM	47K	5%	0.25W	SFR25	PHILIPS
R74	METAL FILM	56K	1%	100ppm	H4	HOLSWORTHY
R75	PRESET CERMET	20K	10%		E28203	ALLEN BRADLEY
R76	METAL FILM	1K0	1%	100ppm	H4	HOLSWORTHY
R77	WIRE WOUND	0R033	5%	4W	KN350-8-4W	VTM
R78	METAL FILM	1K3	1%	100ppm	H4	HOLSWORTHY
R79	METAL FILM	150R	1%	100ppm	H4	HOLSWORTHY
R80	METAL FILM	2K15	1%	100ppm	H4	HOLSWORTHY
R81	METAL FILM	249R	1%	100ppm	H4	HOLSWORTHY
R82	METAL FILM	2K15	1%	100ppm	H4	HOLSWORTHY
R83	METAL FILM	249R	1%	100ppm	H4	HOLSWORTHY
R84	METAL FILM	1K3	1%	100ppm	H4	HOLSWORTHY
R85	METAL FILM	150R	1%	100ppm	H4	HOLSWORTHY
R86 R87	FILM	3R3	5%	0.25W	SFR25	PHILIPS
R88	FILM	100R	5%	0.25W	SFR25	PHILIPS
R89	FILM	560R	5%	0.25W	SFR25	PHILIPS
R90	FILM	47R	5%	0.25W	SFR25	PHILIPS
R91 R92 R93	FILM	10K	5%	0.25W	SFR25	PHILIPS
R95	FILM	100K	5%	0.25W	SFR25	PHILIPS
R96	FILM	470K	5%	0.25W	SFR25	PHILIPS
R97	FILM	2K2	5%	0.25W	SFR25	PHILIPS
R98	FILM	5K6	5%	0.25W	SFR25	PHILIPS
R100 R101 R102	NETWORK	47K			4610X-101-473	BOURNS
R103 R104 R105 R106 R107	FILM	4K7	5%	0.25W	SFR16	PHILIPS
R108	FILM	470R	5%	0.25W	SFR25	PHILIPS
R110 R111	FILM	4K7	5%	0.25W	SFR16	PHILIPS
R112	FILM	470R	5%	0.25W	SFR25	PHILIPS
R114 R115	FILM	4K7	5%	0.25W	SFR16	PHILIPS

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	Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
	R116	PRESET CERMET	20K	10%		E2B203	ALLEN BRADLEY
	R117 R118	FILM	4K7	5%	0.25W	SFR25	PHILIPS
	S2	SWITCH	BLACK			75-120-002	PREH
STATIC	TR1	TRANSISTOR	FET			2N7000	SILICONIX
	TR2 TR3 TR4 TR5	TRANSISTOR	NPN			BC183	TEXAS
STATIC	TR6	TRANSISTOR	FET			J112	SILICONIX
	TR7	TRANSISTOR	PNP			BC212	TEXAS
	TR8	TRANSISTOR	NPN			BSR50	PHILIPS
	TR9	TRANSISTOR	NPN			BC183	TEXAS
	TR10	TRANSISTOR	NPN			2N2369A	PHILIPS

6.2 7010 Bin Handler/GPIB Option board EJ1/27268

	Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
	C1	CERAMIC	100n		63V	B37449	SIEMENS
	C2						
	C3						
	C4						
	C5						
	C6						
	C7						
	C8						
	C9						
	C10						
	C11						
	C12						
	C13						
	C14						
	C15						
	C16						
	C17						
	C18						
	C19						
	C20						
	C21						
	C22						
	C23						
	C24						
	C25						
	C26						
	C27						
	C28						
	C29						
	C30						
	C31						
	C32						
	C33	ELECTROLYTIC	10u	20%	50V	035-90008	PHILIPS
	C35	CERAMIC	100n		63V	B37449	SIEMENS
	C36						
	C37						
	D1	DIODE				1N4148	PHILIPS
STATIC	IC1	INTEGRATED CIRCUIT	(Z80 PIO)			Z0842006PSC	ZILOG
STATIC	IC2	INTEGRATED CIRCUIT				CD74HC138E	RCA
STATIC	IC3	INTEGRATED CIRCUIT				CD74HCT238E	RCA
STATIC	IC4						
STATIC	IC5						
STATIC	IC6						
STATIC	IC7	INTEGRATED CIRCUIT				CD74HCT14E	RCA
	IC8	INTEGRATED CIRCUIT				ULN2003AN	TEXAS
	IC9						
	IC10						
	IC11						
	IC12						
	*IC13	INTEGRATED CIRCUIT				CNY17-3	GE
	*IC14						
	*IC15						
	*IC16						
	IC17	INTEGRATED CIRCUIT				TMS9914ANL	TEXAS
	IC18	INTEGRATED CIRCUIT				SN75160BN	TEXAS
	IC19	INTEGRATED CIRCUIT				SN75161BN	TEXAS
STATIC	IC20	INTEGRATED CIRCUIT				CD74HC04E	RCA
	PL20	CONNECTOR	26 WAY	IDC		IDH26PK1-S3-TG	ROBINSON NUGENT
	PL31	CONNECTOR	40 WAY	IDC		IDH40PK1-S3-TG	ROBINSON NUGENT

COMPONENTS MARKED THUS * ARE OPTIONS NOT FITTED TO STANDARD BOARD.

7010 Bin Handler/GPIB Option board EJ1/27268

Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
R1	FILM	120R	5%	0.25W	SFR25	PHILIPS
R2						
R3	FILM	4K7	5%	0.25W	SFR25	PHILIPS
R4						
R5						
R6	FILM	330R	5%	0.25W	SFR25	PHILIPS
R7	NETWORK	4K7	2%		316-A-472	ALLEN BRADLEY
R8						
R9	FILM	27K	5%	0.25W	SFR25	PHILIPS
R10	FILM	120R	5%	0.25W	SFR25	PHILIPS
R11	FILM	10K	5%	0.25W	SFR25	PHILIPS
R12						
*RL1	RELAY	DRY REED 1P			161A-2	ASTRALUX
*RL2						
*RL3						
*RL4						
*RL5						
*RL6						
*RL7						
*RL8						
*RL9						
*RL10						
*RL11						
*RL12						
*RL13						
*RL14						
*RL15						
*RL16						
*RL17						
*RL18						
*RL19						
*RL20						
*RL21						
*RL22						
*RL23						
*RL24						
*RL25						
*RL26						
*RL27						
*RL28						
*RL29						
*RL30						
*SW1	SWITCH DIL	8 WAY			SDS8-023	ERG
SW2	SWITCH DIL	8 WAY			DS16C 1-8	ERG
SW3						
SW4						
SW5	SWITCH DIL	4 WAY C/O			SCS-4-023	ERG
SW6						
SW7						
SW8	SWITCH DIL	8 WAY			SDS8-023	ERG
SW9						
SW10						
SW11						

COMPONENTS MARKED THUS * ARE OPTIONS NOT FITTED TO STANDARD BOARD.

6.3 7010 Keyboard PCB Assembly EJ2/27249 Iss.P1

Ref.	Description	Type No.	Supplier
-	KEYBOARD PCB ISS C	4-701-7248	WK
-	KEYBOARD CABLE ASSY	5-701-7283	WK
S1	SWITCH BLACK	75-120-002	PREH
S2			
S3			
S4			
S5			
S6			
S7			
S8			
S9			
S10			
S11			
S12			
S13			
S14			
S15			
S16			
S17			
S18			
S19			
S20			
S21			
S22			
S23			
S24			
S25			
S26			
S27			
S28			

6.4 7010 Analogue Board EJ1/27245 ISS.P7

Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
C1	CERAMIC	100n		63V	B37449	SIEMENS
C2						
C3	POLYSTYRENE	300p	1%	63V	SUF710	SUFLEX
C4	CERAMIC	100n		63V	B37449	SIEMENS
C5						
C6	POLYSTYRENE	100p	1.5%	63V	SUF710	SUFLEX
C7	CERAMIC	100n		63V	B37449	SIEMENS
C8	POLYSTYRENE	1n8	1%	63V	SUF710	SUFLEX
C9	CERAMIC	100n		63V	B37449	SIEMENS
C11						
C12						
C13	POLYSTYRENE	300p	1%	63V	SUF710	SUFLEX
C14	POLYSTYRENE	100p	1.5%	63V	SUF710	SUFLEX
C15	CERAMIC	100n		63V	B37449	SIEMENS
C16	POLYSTYRENE	1n8	1%	63V	SUF710	SUFLEX
C17	CERAMIC	100n		63V	B37449	SIEMENS
C19						
C20						
C21						
C22						
C23						
C24						
*C25	CERAMIC	10p	5%	500V	GLC604	THOMSON CSF
	*(ONLY FITTED IF IC6 IS ALTERNATIVE TYPE MC30480)					
C26	CERAMIC	100n		63V	B37449	SIEMENS
C27						
C28						
C29	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C30	ELECTROLYTIC	22u	20%	250V	SMVB	NIPPON C/CON
C31						
C32	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C33						
C34						
C35						
C36						
C37	POLYESTER	2u2	10%	250V	34441225	PHILIPS
C38	POLYCARBONATE	1u	5%	250V	PMC2R	RECSAM
C39	CERAMIC	100n		63V	B37449	SIEMENS
C40						
C41	CERAMIC	22p	5%	100V	GEC605	THOMSON CSF
C42	CERAMIC	100n		63V	B37449	SIEMENS
C43	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C44	CERAMIC	100n		63V	B37449	SIEMENS
C45						
C47	ELECTROLYTIC	10u	20%	50V	035-90008	PHILIPS
C48						
C49	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
C50 C52	CERAMIC	100n		63V	B37449	SIEMENS
C53	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C54	CERAMIC	100n		63V	B37449	SIEMENS
C55	TRIMMER	1p-14p			60-0727-15014-000	TRONSER
C56	CERAMIC	150p	5%	100V	VP31COG	VITRAMON
C57	CERAMIC	100p	5%	100V	GEC607	THOMSON CSF
C58	CERAMIC	47p	5%	100V	GEC606	THOMSON CSF
C59 C60	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C61 C62 C63 C64 C65 C66 C67 C68 C69	CERAMIC	100n		63V	B37449	SIEMENS
C70	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C71	CERAMIC	100n		63V	B37449	SIEMENS
C72	POLYCARBONATE	1u	5%	250V	PMC2R	RECSAM
C73	CERAMIC	22p	5%	100V	GEC605	THOMSON CSF
C74	CERAMIC	100n		63V	B37449	SIEMENS
C75	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C76 C77	CERAMIC	100n		63V	B37449	SIEMENS
C78	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C79 C80	ELECTROLYTIC	100u	20%	25V	035-56101	PHILIPS
C81	CERAMIC	100n		63V	B37449	SIEMENS
C82	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C83	POLYSTYRENE	2n7	1%	63V	SUF710	SUFLEX
C84	POLYSTYRENE	4n7	5%	63V	SUF710	SUFLEX
C85	POLYSTYRENE	2n7	1%	63V	SUF710	SUFLEX
C86	POLYSTYRENE	4n7	5%	63V	SUF710	SUFLEX
C87	POLYSTYRENE	470p	1%	63V	SUF710	SUFLEX
C88 C89	CERAMIC	47p	5%	100V	GEC606	THOMSON CSF
C90	POLYSTYRENE	470p	1%	63V	SUF710	SUFLEX
C91	NOT FITTED					
C92	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C93	ELECTROLYTIC	10u	20%	50V	035-90008	PHILIPS
C94	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
C95						
C96						
C97	CERAMIC	100n		63V	B37449	SIEMENS
C98						
C99						
C100						
C101						
C102						
C103						
C104	CERAMIC	47p	5%	100V	GEC606	THOMSON CSF
C106	CERAMIC	100n		63V	B37449	SIEMENS
C107						
C108						
C109	POLYCARBONATE	100n	2%	100V	MKC4	WIMA
C111						
C112	CERAMIC	1n	10%	500V	GEB605	THOMSON CSF
C113	CERAMIC	100n		63V	B37449	SIEMENS
C114						
C115						
C116						
C119	POLYSTYRENE	6n8	1%	63V	SUF710	SUFLEX
C120	POLYPROPOLENE	1n	5%	63V	FKP2	WIMA
C121	CERAMIC	4n7	50%	500V	GEY604	THOMSON CSF
C122	CERAMIC	47p	5%	100V	GEC606	THOMSON CSF
C126	CERAMIC	100n		63V	B37449	SIEMENS
C127						
C128						
C129						
C130						
C131						
C132						
C133						
C134	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C135						
C136	CERAMIC	100n		63V	B37449	SIEMENS
C137						
C138						
C139						
C140						
C141						
C142						
C143						
C144						
C145	ELECTROLYTIC	10u	20%	50V	035-90008	PHILIPS
C146	CERAMIC	470p	5%	100V	VP31COG	VITRAMON
C147	CERAMIC	22p	5%	100V	GEC605	THOMSON CSF
C148	CERAMIC	100n		63V	B37449	SIEMENS
C149	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C150	CERAMIC	100n		63V	B37449	SIEMENS
C151	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS
C152	CERAMIC	100n		63V	B37449	SIEMENS
C153	ELECTROLYTIC	47u	20%	25V	035-56479	PHILIPS

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
C154 C155	CERAMIC	100n		63V	B37449	SIEMENS
C156	CERAMIC	220p	10%	500V	GLB604	THOMSON CSF
C157	CERAMIC	100n		63V	B37449	SIEMENS
C158	POLYCARBONATE	1n5	2%	100V	FKC2	WIMA
C159	CERAMIC	33p	10%	500V	CD08/WK	ITT/STC
C160	CERAMIC	150p	5%	100V	VP31COG	VITRAMON
C161	CERAMIC	33p	5%	100V	VP31COG	VITRAMON
C162	CERAMIC	100n		63V	B37449	SIEMENS
C163	CERAMIC	150p	5%	100V	VP31COG	VITRAMON
C164	CERAMIC	10p	5%	500V	GLC604	THOMSON CSF
D1	DIODE ZENER	7.5V	5%	0.4W	BZX79-C7V5	PHILIPS
D2 D3	DIODE				1N4006	PHILIPS
D4 D5	DIODE ZENER CLAMP	5.0V	5%		ICTE-5	GEN. SEM.
D7 D8 D9 D10	DIODE				1N4006	PHILIPS
D11 D12	DIODE				1N4148	PHILIPS
D13 D14	DIODE				1N4006	PHILIPS
D15 D16 D17 D18 D19	DIODE				1N4148	PHILIPS
D20	DIODE				1N4148	PHILIPS
D21 D22	DIODE ZENER	8.2V	5%	0.4W	BZX79-C8V2	PHILIPS
D24	DIODE				1N4148	PHILIPS
D25	DIODE REFERENCE				LT1029CZ	LINEAR TECH.
D26 D27	DIODE				1N4148	PHILIPS
D28 D29	DIODE				1N4006	PHILIPS
D30	DIODE				1N4148	PHILIPS
D31 D32 D33 D34 D35 D36	DIODE				1N4006	PHILIPS
D37	DIODE ZENER	7.5V	5%	0.4W	BZX79-C7V5	PHILIPS
D38	DIODE				1N4148	PHILIPS

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	Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
	D39	DIODE ZENER	3.3V	5%	0.4W	BZX79-C3V3	PHILIPS
	D40 D41 D42	DIODE				1N4148	PHILIPS
STATIC *STATIC*	IC1 IC2	INTEGRATED CIRCUIT				CD4052BE	RCA
STATIC *STATIC*	IC3 IC4	INTEGRATED CIRCUIT				MC34081P	MOTOROLA
STATIC	IC5	INTEGRATED CIRCUIT				CD4052BE	RCA
STATIC	IC6	INTEGRATED CIRCUIT				MC34080P	MOTOROLA
STATIC	IC7	INTEGRATED CIRCUIT				CD74HC02E	RCA
	IC8	INTEGRATED CIRCUIT				ULN2003AN	TEXAS
	IC9	INTEGRATED CIRCUIT				NE5534AN	SIGNETICS
	IC10	INTEGRATED CIRCUIT				LM339N	NATIONAL
STATIC	IC11	INTEGRATED CIRCUIT				CD74HC00E	RCA
	IC12 IC13 IC14	INTEGRATED CIRCUIT				NE5534AN	SIGNETICS
	IC15	VOLTAGE REGULATOR	5.0V			LM78L05ACZ	NATIONAL
STATIC	IC16	INTEGRATED CIRCUIT				SN74AC74N	TEXAS
STATIC	IC17	INTEGRATED CIRCUIT				SD5001N	SIGNETICS
STATIC	IC18	INTEGRATED CIRCUIT				74AC00PC	FAIRCHILD
	IC19	INTEGRATED CIRCUIT				SN74LS26N	TEXAS
STATIC	IC20	INTEGRATED CIRCUIT				CD4052BE	RCA
STATIC	IC21	INTEGRATED CIRCUIT				CD4053BE	RCA
	IC22	INTEGRATED CIRCUIT				NE5534AN	SIGNETICS
	IC23	INTEGRATED CIRCUIT				NE5532N	NATIONAL
STATIC	IC24	INTEGRATED CIRCUIT				CD74HC00E	RCA
	IC25	INTEGRATED CIRCUIT				LM339N	NATIONAL
STATIC	IC26	INTEGRATED CIRCUIT				CD4053BE	RCA
STATIC	IC27	INTEGRATED CIRCUIT				SD5001N	SIGNETICS
	IC28	INTEGRATED CIRCUIT				HA3 2625	HARRIS
	IC29	INTEGRATED CIRCUIT				LM311N	NATIONAL
STATIC	IC30	INTEGRATED CIRCUIT				CD74HC04E	RCA
STATIC	IC31	INTEGRATED CIRCUIT				CD4053BE	RCA
	L1	INDUCTOR	2u7			SC10	SIGMA
	L2 L3	INDUCTOR ASSY.	ADJUSTABLE			4-701-7250	WAYNE KERR
	L4	INDUCTOR	8u2			SC10	SIGMA
	L5	INDUCTOR	820u	5%		71.30-8200J	JAHRE

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
L7 L8	INDUCTOR	2u2			SC10	SIGMA
L9	INDUCTOR	220u			SC04	SIGMA
PL21	CONNECTOR	3 WAY			MKS3733-1-0-303	STOCKO
PL22	CONNECTOR	8 WAY			MKS3738-1-0-808	STOCKO
PL23 PL24	CONNECTOR	3 WAY			MKS3733-1-0-303	STOCKO
PL3	CONNECTOR	8 WAY			MKS3738-1-0-808	STOCKO
R1	METAL FILM	357K	0.5%	50ppm	H4	HOLSWORTHY
R2	METAL FILM	39K2	0.5%	50ppm	H4	HOLSWORTHY
R3	METAL FILM	4K02	0.5%	50ppm	H4	HOLSWORTHY
R4	METAL FILM	301K	0.5%	50ppm	H4	HOLSWORTHY
R5	METAL FILM	30K1	0.5%	50ppm	H4	HOLSWORTHY
R6	METAL FILM	2K8	0.5%	50ppm	H4	HOLSWORTHY
R7	METAL FILM	931R	0.5%	50ppm	H4	HOLSWORTHY
R8	METAL FILM	200R	0.1%	25ppm	H4	HOLSWORTHY
R10	METAL FILM	158R	0.5%	100ppm	H4	HOLSWORTHY
R11	METAL FILM	348K	0.5%	50ppm	H4	HOLSWORTHY
R12	METAL FILM	30K1	0.5%	50ppm	H4	HOLSWORTHY
R14	METAL FILM	301K	0.5%	50ppm	H4	HOLSWORTHY
R15	METAL FILM	30K1	0.5%	50ppm	H4	HOLSWORTHY
R16	METAL FILM	2K7	0.5%	50ppm	H4	HOLSWORTHY
R18	METAL FILM	750R	0.5%	50ppm	H4	HOLSWORTHY
R19 R20	METAL FILM	300R	0.5%	100ppm	H4	HOLSWORTHY
R21	METAL FILM	150R	0.5%	25ppm	H4	HOLSWORTHY
R23	FILM	470R	5%	0.25W	SFR25	PHILIPS
R24	FILM	680R	5%	0.25W	SFR25	PHILIPS
R25	METAL FILM	1K3	1%	100ppm	H4	HOLSWORTHY
R26	PRESET CERMET	500R	10%		E28501	ALLEN BRADLEY
R27	METAL FILM	2K0	1%	100ppm	H4	HOLSWORTHY
R28 R29	FILM	330R	5%	0.25W	SFR25	PHILIPS
R30	FILM	10R	5%	0.25W	SFR25	PHILIPS
R31	METAL FILM	470R	1%	100ppm	H4	HOLSWORTHY
R32	WIRE WOUND	390R	5%	6W	W22	WELWYN
R33	THERMISTOR	(PTC)			2322-661-15693	PHILIPS
R34 R35	WIRE WOUND	120R	1%	2.5W	W21	WELWYN
R36	FILM	5K1	5%	0.25W	SFR25	PHILIPS

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
R37						
R38	FILM	360R	5%	0.25W	SFR25	PHILIPS
R39	FILM	200R	5%	0.25W	SFR25	PHILIPS
R40	FILM	33R	5%	0.25W	SFR25	PHILIPS
R41						
R42	METAL FILM	36K	1%	100ppm	H4	HOLSWORTHY
R43	WIRE WOUND	68R	5%	2.5W	W21	WELWYN
R44	FILM	22R	5%	0.25W	SFR25	PHILIPS
R45	METAL FILM	6K49	1%	100ppm	H4	HOLSWORTHY
R46	FILM	430R	5%	0.25W	SFR25	PHILIPS
R47	METAL FILM	1K8	1%	100ppm	H4	HOLSWORTHY
R48	METAL FILM	820R	1%	100ppm	H4	HOLSWORTHY
R49	METAL FILM	270R	1%	100ppm	H4	HOLSWORTHY
R50	FILM	68R	5%	0.25W	SFR25	PHILIPS
R51	FILM	1M5	5%	0.25W	SFR25	PHILIPS
R52						
R53	FILM	33R	5%	0.25W	SFR25	PHILIPS
R54	FILM	100R	5%	0.25W	SFR25	PHILIPS
R55	FILM	47R	5%	0.25W	SFR25	PHILIPS
R56	METAL FILM	100R	0.005%		S102L	VISHAY
R57	METAL FILM	900R	0.005%		S102L	VISHAY
R58	METAL FILM	9K0	0.005%		S102L	VISHAY
R59	THERMISTOR	(NTC)			KED101CY	STC
*R60	METAL FILM	40R2	1%	100ppm	H4	HOLSWORTHY
	*VALUE FITTED IF IC9 IS ALTERNATIVE TYPE (TEXAS)					
*R60	METAL FILM	33R	1%	100ppm	H4	HOLSWORTHY
	*VALUE FITTED IF IC9 IS STANDARD TYPE (SIGNETICS)					
R61	PRESET CERMET	500R	10%		E2B501	ALLEN BRADLEY
R62	METAL FILM	340R	1%	100ppm	H4	HOLSWORTHY
R63	METAL FILM	4K7	1%	100ppm	H4	HOLSWORTHY
R64						
R65						
R66	FILM	4K7	5%	0.25W	SFR25	PHILIPS
R67	FILM	1K8	5%	0.25W	SFR25	PHILIPS
R68	FILM	4K7	5%	0.25W	SFR25	PHILIPS
R69	FILM	1K8	5%	0.25W	SFR25	PHILIPS
R70	FILM	470R	5%	0.25W	SFR25	PHILIPS
R71	FILM	100K	5%	0.25W	SFR25	PHILIPS
R72	FILM	68R	5%	0.25W	SFR25	PHILIPS

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
R73	FILM	22R	5%	0.25W	SFR25	PHILIPS
R74	FILM	10K	5%	0.25W	SFR25	PHILIPS
R75	FILM	270R	5%	0.25W	SFR25	PHILIPS
R76	METAL FILM	1K0	0.1%	25ppm	H4	HOLSWORTHY
R77	METAL FILM	976R	0.1%	25ppm	H4	HOLSWORTHY
R78	METAL FILM	1K8	1%	100ppm	H4	HOLSWORTHY
R79	METAL FILM	820R	1%	100ppm	H4	HOLSWORTHY
R80	METAL FILM	2K7	0.5%	50ppm	H4	HOLSWORTHY
R81	METAL FILM	270R	1%	100ppm	H4	HOLSWORTHY
R82	FILM	33R	5%	0.25W	SFR25	PHILIPS
R83	METAL FILM	3K9	0.25%	100ppm	H4	HOLSWORTHY
R84 R85 R86 R87	METAL FILM	200R	0.1%	25ppm	H4	HOLSWORTHY
R88	METAL FILM	3K9	0.25%	100ppm	H4	HOLSWORTHY
R89 R90 R91 R92	FILM	33R	5%	0.25W	SFR25	PHILIPS
R93 R94	FILM	2K2	5%	0.25W	SFR25	PHILIPS
R95	NETWORK	22K	2%		4610X-101-223	BOURNS
R96	FILM	1K2	5%	0.25W	SFR25	PHILIPS
R97	FILM	6K8	5%	0.25W	SFR25	PHILIPS
R98 R99	FILM	2K7	5%	0.25W	SFR25	PHILIPS
R100	FILM	22K	5%	0.25W	SFR25	PHILIPS
R101	METAL FILM	1K0	0.5%	100ppm	H4	HOLSWORTHY
R102	FILM	47R	5%	0.25W	SFR25	PHILIPS
R104	METAL FILM	1K479	0.005%		S102L	VISHAY
R105	METAL FILM	467R7	0.005%		S102L	VISHAY
R107	METAL FILM	147R9	0.005%		S102L	VISHAY
R109	METAL FILM	68R4	0.005%		S102L	VISHAY
R113	METAL FILM	1K0	0.5%	100ppm	H4	HOLSWORTHY
R114	METAL FILM	576R	0.5%	100ppm	H4	HOLSWORTHY
R115	METAL FILM	12K	0.5%	100ppm	H4	HOLSWORTHY
R116	METAL FILM	1K6	1%	100ppm	H4	HOLSWORTHY
R118	METAL FILM	48K7	0.5%	100ppm	H4	HOLSWORTHY
R119	FILM	12K	5%	0.25W	SFR25	PHILIPS
R120	FILM	4K7	5%	0.25W	SFR25	PHILIPS

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
R121	FILM	330R	5%	0.25W	SFR25	PHILIPS
R122	FILM	10K	5%	0.25W	SFR25	PHILIPS
R123	METAL FILM	14K	0.25%	25ppm	H4	HOLSWORTHY
R124	METAL FILM	34K8	0.25%	25ppm	H4	HOLSWORTHY
R125 R126	METAL FILM	12K7	0.25%	25ppm	H4	HOLSWORTHY
R135	METAL FILM	8K25	0.5%	25ppm	H4	HOLSWORTHY
R136	METAL FILM	20K	0.5%	25ppm	H4	HOLSWORTHY
R137	FILM	12K	5%	0.25W	SFR25	PHILIPS
R138	FILM	10K	5%	0.25W	SFR25	PHILIPS
R139	METAL FILM	15K8	0.25%	25ppm	H4	HOLSWORTHY
R141	METAL FILM	4K7	1%	100ppm	H4	HOLSWORTHY
R142	FILM	2K2	5%	0.25W	SFR25	PHILIPS
R143	FILM	100K	5%	0.25W	SFR25	PHILIPS
R144	FILM	1K0	5%	0.25W	SFR25	PHILIPS
R145	METAL FILM	4K7	1%	100ppm	H4	HOLSWORTHY
R146	FILM	1K0	5%	0.25W	SFR25	PHILIPS
R147	FILM	2K7	5%	0.25W	SFR25	PHILIPS
R148	FILM	100R	5%	0.25W	SFR25	PHILIPS
R149	METAL FILM	100R	1%	100ppm	H4	HOLSWORTHY
R150	FILM	1K0	5%	0.25W	SFR25	PHILIPS
R151	FILM	680R	5%	0.25W	SFR25	PHILIPS
R153	FILM	68R	5%	0.25W	SFR25	PHILIPS
R154	FILM	330K	5%	0.25W	SFR25	PHILIPS
R155	FILM	1K0	5%	0.25W	SFR25	PHILIPS
R156	METAL FILM	2K15	1%	100ppm	H4	HOLSWORTHY
R157	FILM	68R	5%	0.25W	SFR25	PHILIPS
R158	FILM	270R	5%	0.25W	SFR25	PHILIPS
R159	METAL FILM	9K53	0.5%	100ppm	H4	HOLSWORTHY
R160	METAL FILM	3K24	0.5%	50ppm	H4	HOLSWORTHY
R161	FILM	220R	5%	0.25W	SFR25	PHILIPS
R162	NETWORK	100K	2%		4610X-101-104	BOURNS
R163	WIRE WOUND	56R	1%	2.5W	W21	WELWYN
R164 R165	FILM	330R	5%	0.25W	SFR25	PHILIPS
R166	FILM	10R	5%	0.25W	SFR25	PHILIPS
R167	FILM	470R	5%	0.25W	SFR25	PHILIPS
R168	FILM	220R	5%	0.25W	SFR25	PHILIPS

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Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
R169	METAL FILM	16K2	0.5%	100ppm	H4	HOLSWORTHY
R170	METAL FILM	1K0	0.5%	100ppm	H4	HOLSWORTHY
*R171	FILM (AOT)	330K	5%	0.25W	SFR25	PHILIPS
*R171	FILM (AOT)	360K	5%	0.25W	SFR25	PHILIPS
*R171	FILM (AOT)	390K	5%	0.25W	SFR25	PHILIPS
*R171	FILM (AOT)	470K	5%	0.25W	SFR25	PHILIPS
*R171	FILM (AOT)	560K	5%	0.25W	SFR25	PHILIPS
*R172	FILM (AOT)	33K	5%	0.25W	SFR25	PHILIPS
*R172	FILM (AOT)	36K	5%	0.25W	SFR25	PHILIPS
*R172	FILM (AOT)	39K	5%	0.25W	SFR25	PHILIPS
*R172	FILM (AOT)	47K	5%	0.25W	SFR25	PHILIPS
*R172	FILM (AOT)	56K	5%	0.25W	SFR25	PHILIPS
R173	FILM	1K8	5%	0.25W	SFR25	PHILIPS
R174 R175	FILM	220R	5%	0.25W	SFR25	PHILIPS
R176	METAL FILM	18K	1%	100ppm	H4	HOLSWORTHY
R177	METAL FILM	510R	1%	100ppm	H4	HOLSWORTHY
R178	METAL FILM	1K2	1%	100ppm	H4	HOLSWORTHY
R179	FILM	5K6	5%	0.25W	SFR25	PHILIPS
R180 R181	FILM	1K0	5%	0.25W	SFR25	PHILIPS
R182	FILM	220R	5%	0.25W	SFR25	PHILIPS
R183	FILM	330R	5%	0.25W	SFR25	PHILIPS
RL1 RL2 RL3 RL4	RELAY SIL	WET REED		1 POLE	MSS4/A05	GI CLARE
RL5 RL6 RL7 RL8 RL9 RL10 RL11	RELAY SIL	DRY REED		1 POLE	161A-2 1LH-2	ASTRALUX
RL12	RELAY SIL	WET REED		1 POLE	MSS4/A05	GI CLARE
TR1 TR2	TRANSISTOR	NPN			BC184	TEXAS
TR3	TRANSISTOR	NPN			BF240	MOTOROLA
TR4	TRANSISTOR	NPN			BC184	TEXAS
TR5 TR6	TRANSISTOR	NPN			BF240	MOTOROLA
TR7 TR8	TRANSISTOR	NPN			BC184	TEXAS
TR9	TRANSISTOR	PNP			BC214	TEXAS

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	Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
STATIC	TR10	TRANSISTOR	FET			2N7000	SILICONIX
	TR12 TR13 TR14 TR15	TRANSISTOR	NPN			BC184	TEXAS
	SCREENING BEAD (USED WITH TR3, TR5, TR6)					FX1242	PHILIPS

6.5 7010 Transformer Module Assembly

Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
PL1	POWER INLET, FILTERED				L2131C/S	BELLING-LEE
SK17	CONNECTOR, 11-WAY				CE156F20-1	PANDUIT
SW1	POWER SWITCH (ON/OFF)				NE15	TOKO
SW2	SLIDE SWITCH (115V/230V) DPDT				S-5022CD03-0	STACKPOLE
T1	POWER TRANSFORMER				4-701-7246	WK

6.6 7010 Main Assembly

Ref	Type	Value	Tol(%)	Rating	Type No.	Supplier
C1	CERAMIC	220n		10V	TD161/WK3	ITT/STC
CH4	FERRITE SLAB				2643163951*	FAIR-RITE
CH5	" "				"	"
CH6	" "				"	"
CH7	" "				"	"
CH8	" "				"	"
FS1 (115V)	FUSE, SLOW BLOW	20x5mm		800mA-T	L2080/A	BELLING-LEE
FS1 (230V)	FUSE, SLOW BLOW	20x5mm		400mA-T	L2080/A	BELLING-LEE
FS2	FUSE, QUICK BLOW	20x5mm		1.6A		LITTELFUSE
FS6	" " "	"		"		"
SK5	TERMINAL 4mm SOCKET BLACK				E6020/1	BELLING-LEE
SK15	SOCKET 3-WAY				CE156F 20-3-D	PANDUIT
SK24	SOCKET 3-WAY				MKF17363.1.0.303	STOCKO
TR10	POWER TRANSISTOR				BD536	PHILIPS
DIGITAL PCB ASSY					5-701-7242	WK
ANALOG " "					5-701-7245	"
KEYBOARD " "					5-701-7249	"
RS232 CABLE ASSY (DET 1) (DCE)					5-701-2971	"
" " " (DET 2) (DTE)					5-701-2972	"
TRANSFORMER MODULE ASSY					5-701-7274	"
DISPLAY DATA CABLE ASSY					5-701-7270	"
DISPLAY POWER CABLE ASSY					5-701-7271	"
BNC PLATE ASSY					5-701-7272	"
SCREENED CONNEXN. CABLE ASSY					5-701-7275	"
IEEE CABLE ASSY					5-701-7284	"
HANDLER CABLE ASSY					5-701-7296	"
VACUUM FLUORESCENT DISPLAY MODULE					4-701-7286	"

* TWO SLABS REQUIRED FOR EACH CHOKE - TYPE NO. REFERS TO ONLY ONE SLAB.

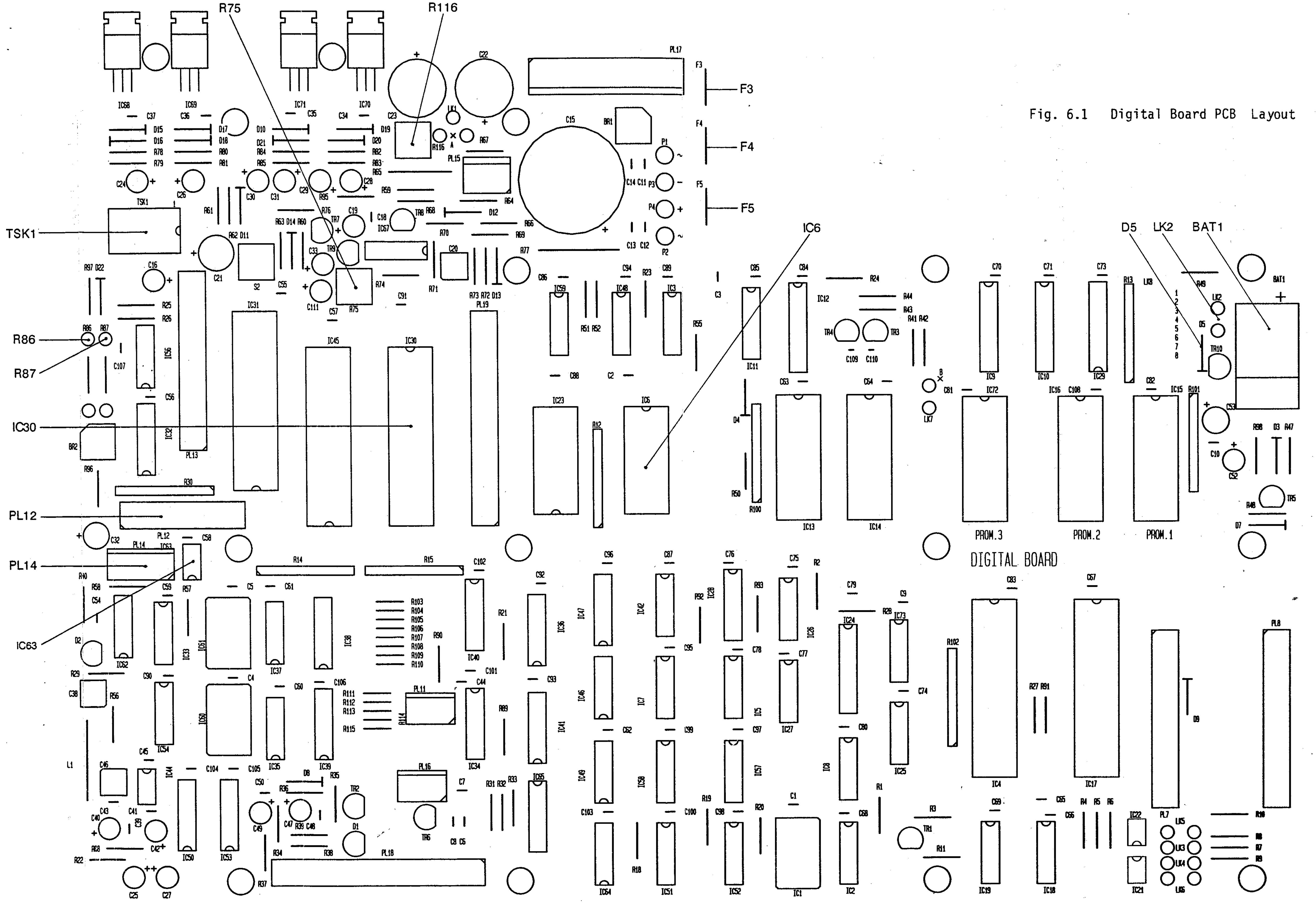


Fig. 6.1 Digital Board PCB Layout

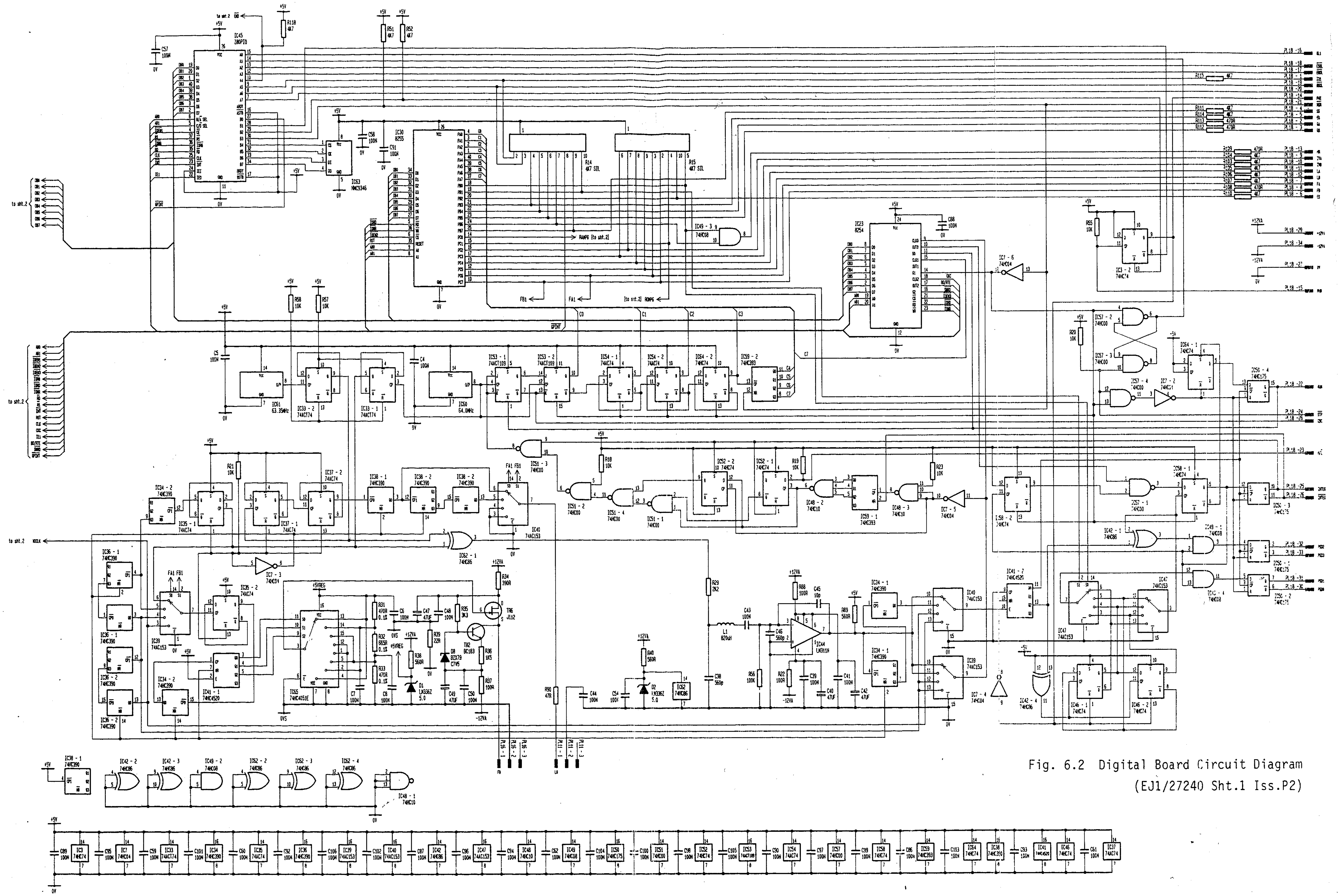


Fig. 6.2 Digital Board Circuit Diagram
(EJ1/27240 Sht.1 Iss.P2)

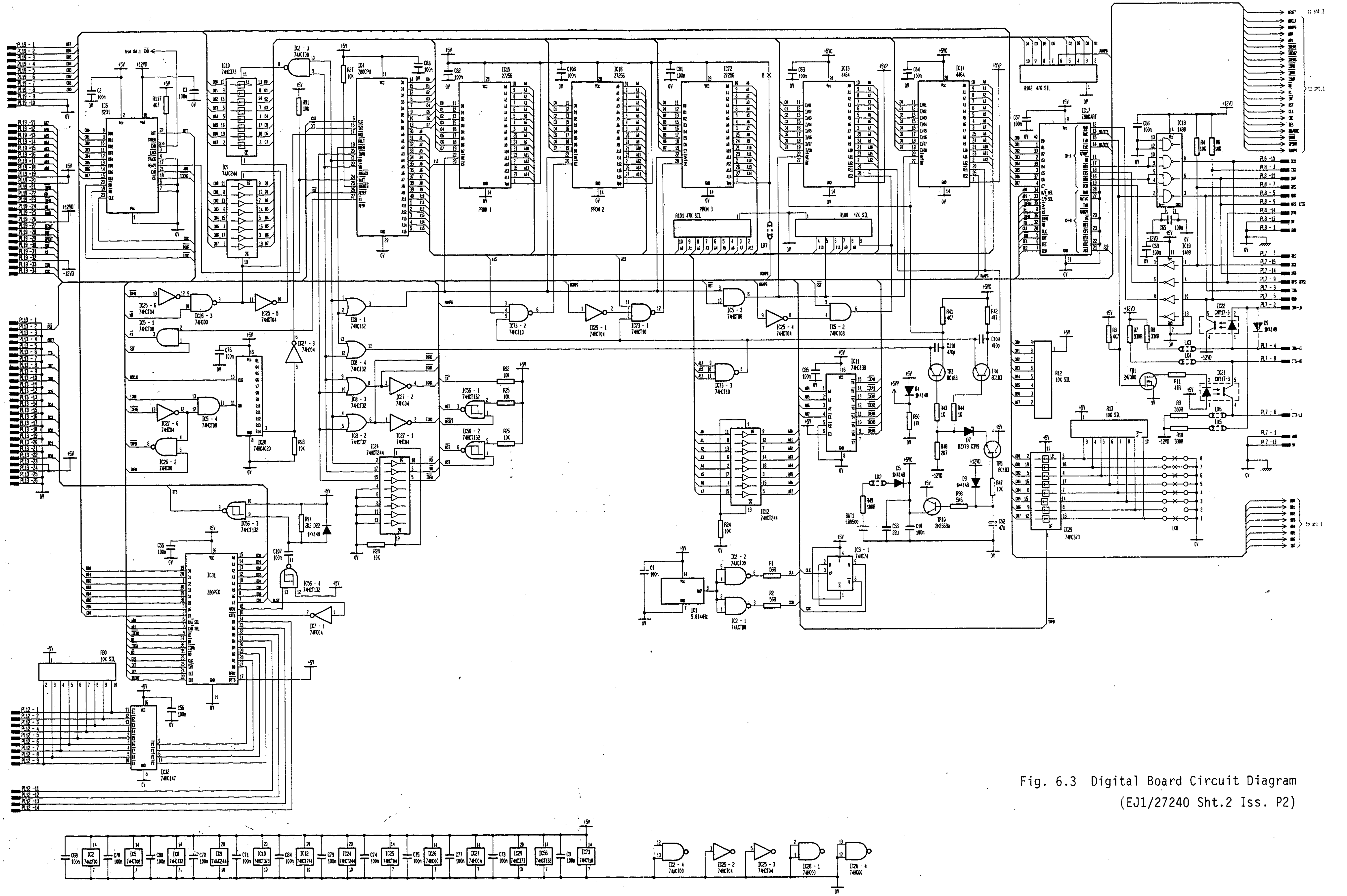


Fig. 6.3 Digital Board Circuit Diagram
(EJ1/27240 Sht.2 Iss. P2)

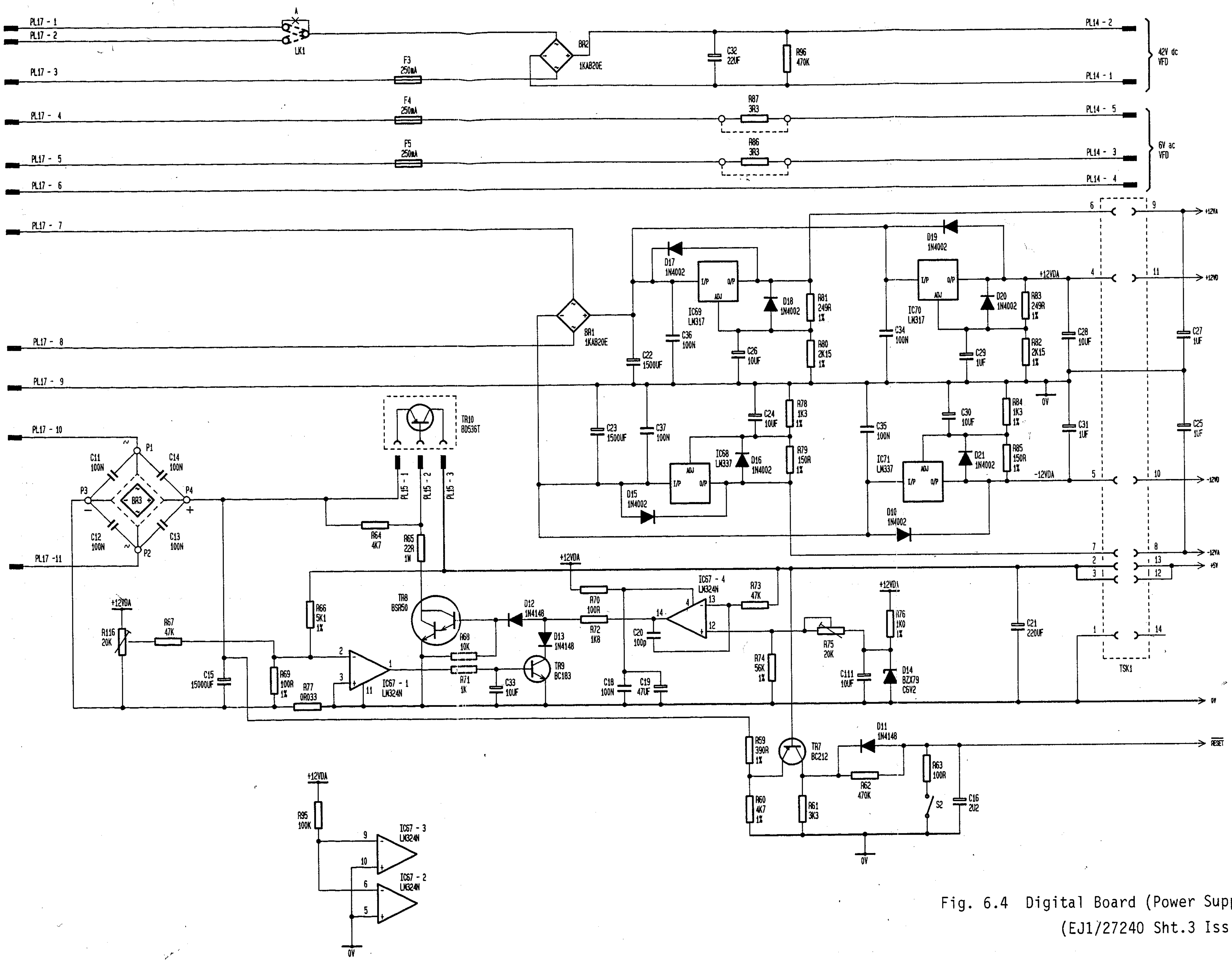
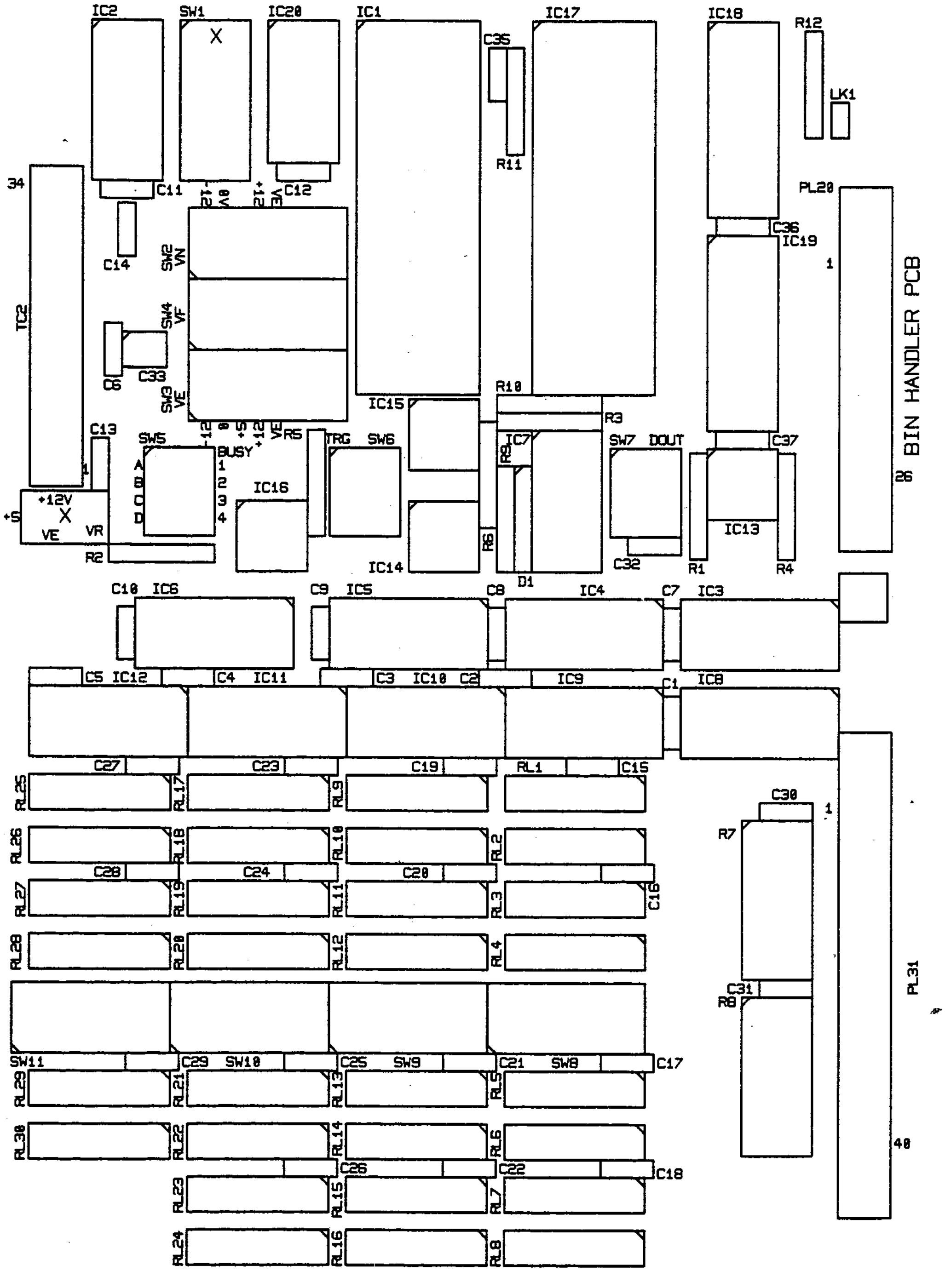


Fig. 6.4 Digital Board (Power Supply)
(EJ1/27240 Sht.3 Iss.P2)



Bin Handler PCB - showing switch locations

Fig. 6.5 GPIB / Handler PCB Layout

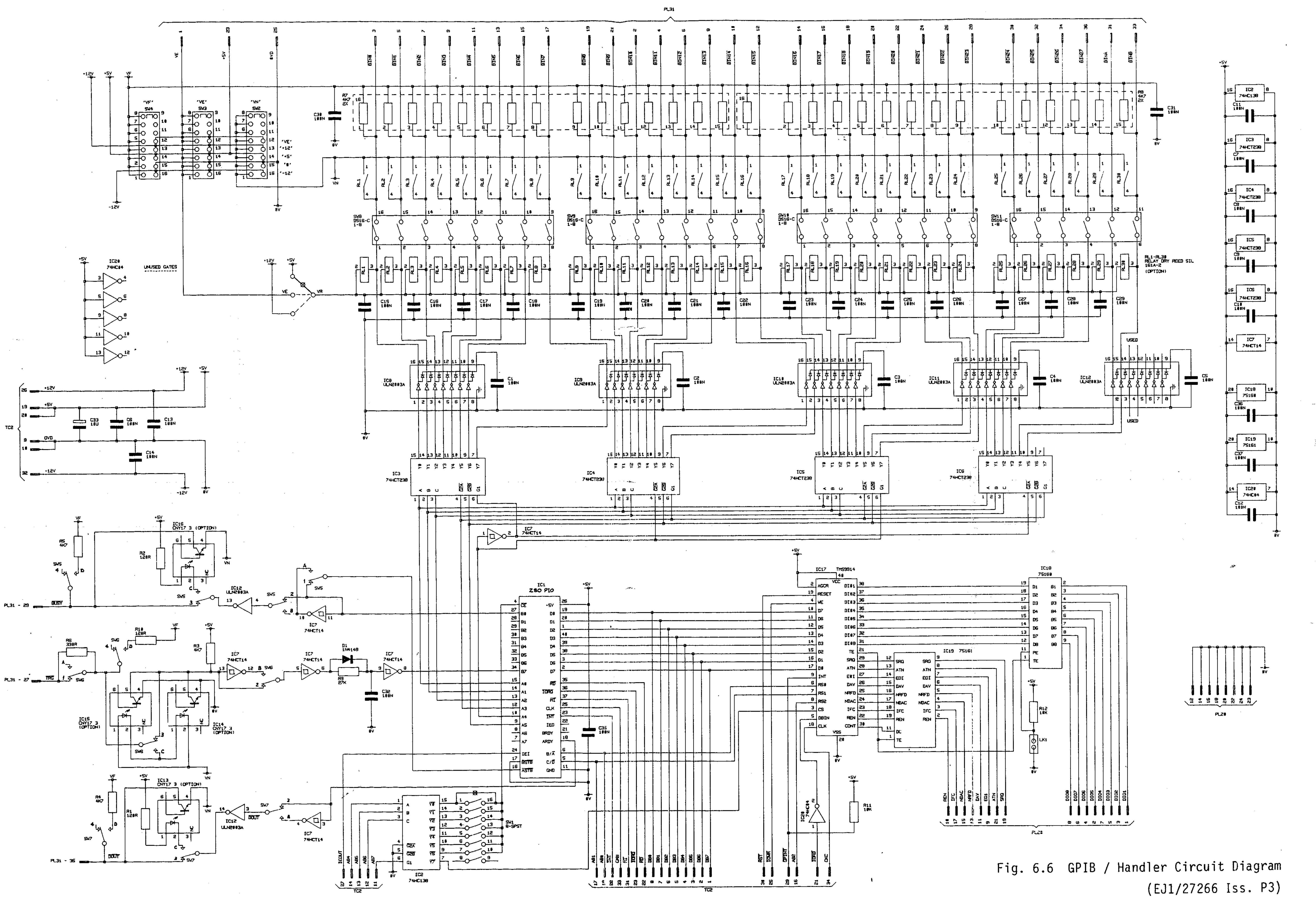


Fig. 6.6 GPIB / Handler Circuit Diagram
(EJ1/27266 Iss. P3)

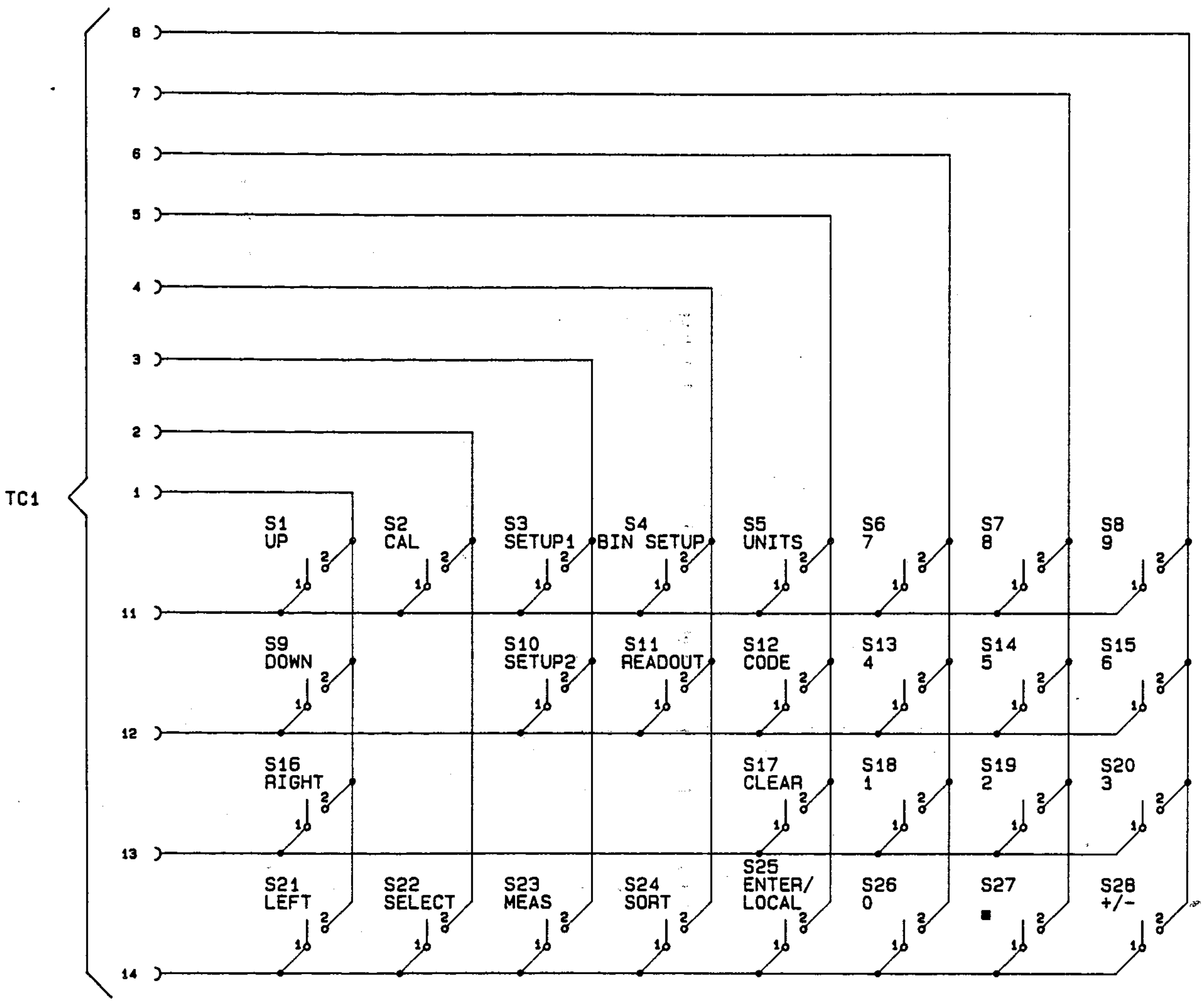
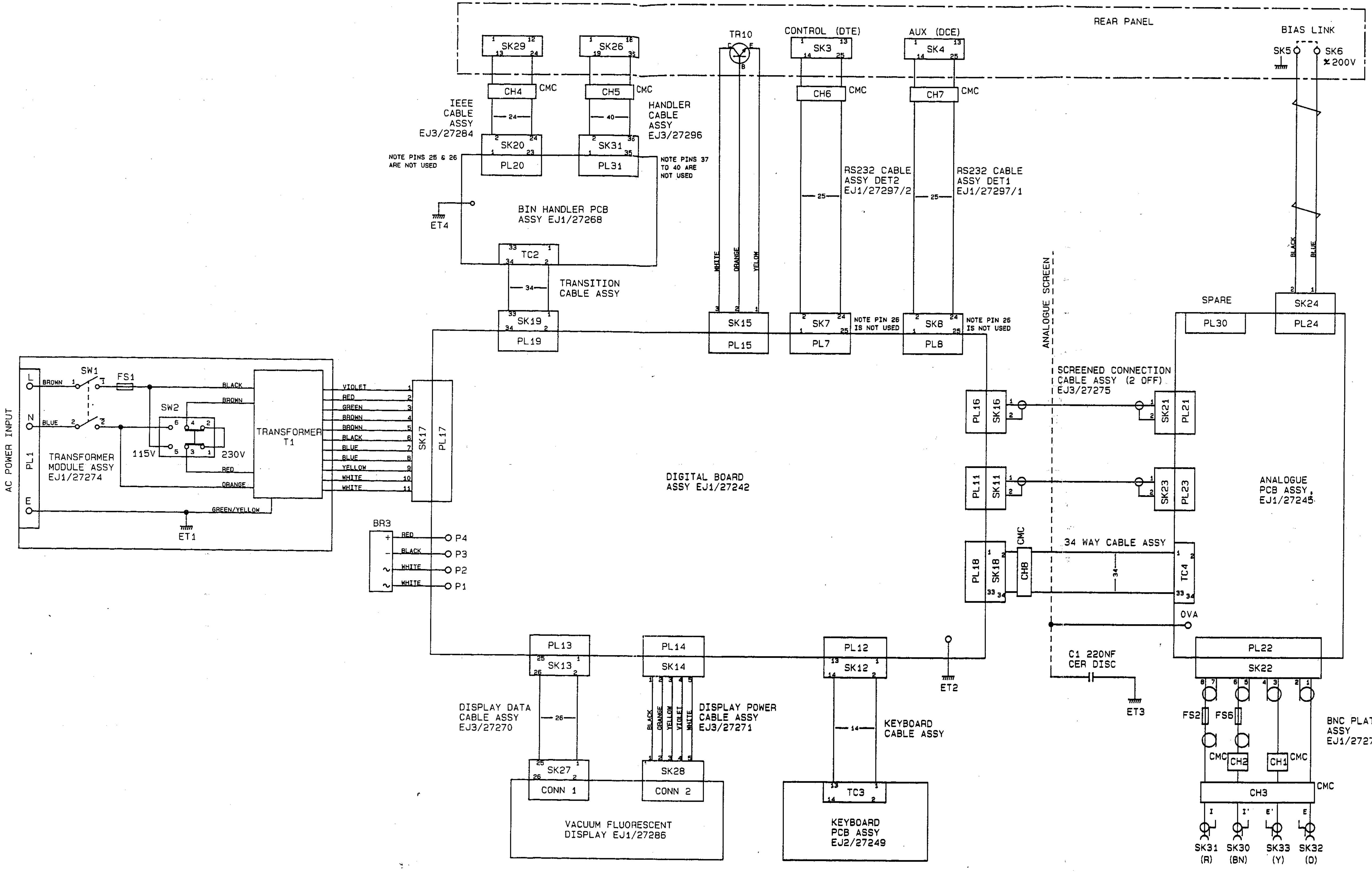


Fig. 6.7 Keyboard PCB Circuit Diagram
(EJ1/27247 Iss.A)

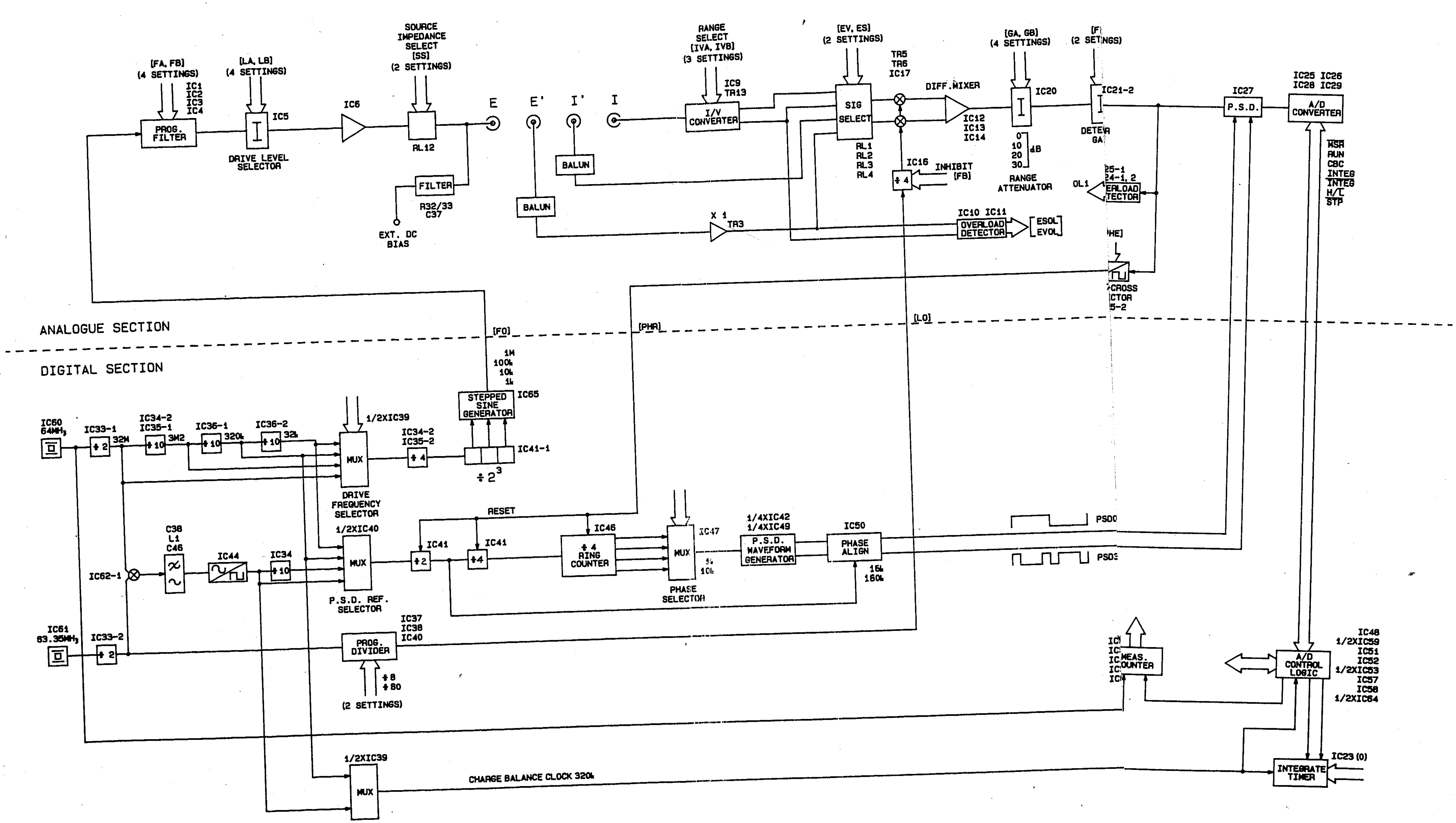


NOTES:

1. CMC = 'COMMON MODE CHOKE'.
2. ALL BNC SOCKETS ARE ISOLATED FROM THE CHASSIS.

Fig. 6.8 Interconnection Diagram (EJ1/27287 Iss. D)

7010 MEASUREMENT SYSTEM BLOCK DIAGRAM.



ig. 6.9 Measurement System - Block Diagram
(EJ1/27314 Iss. B)

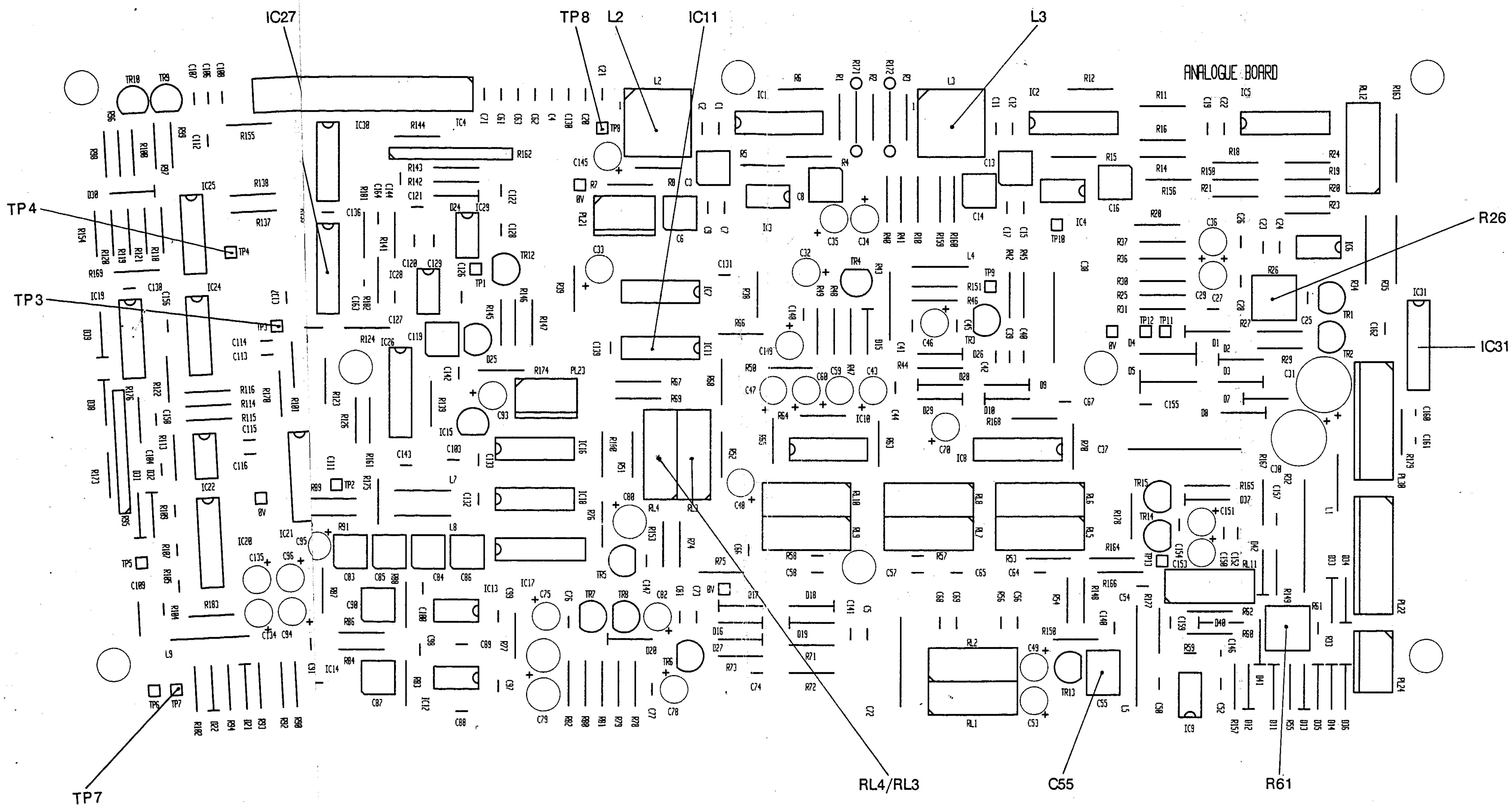
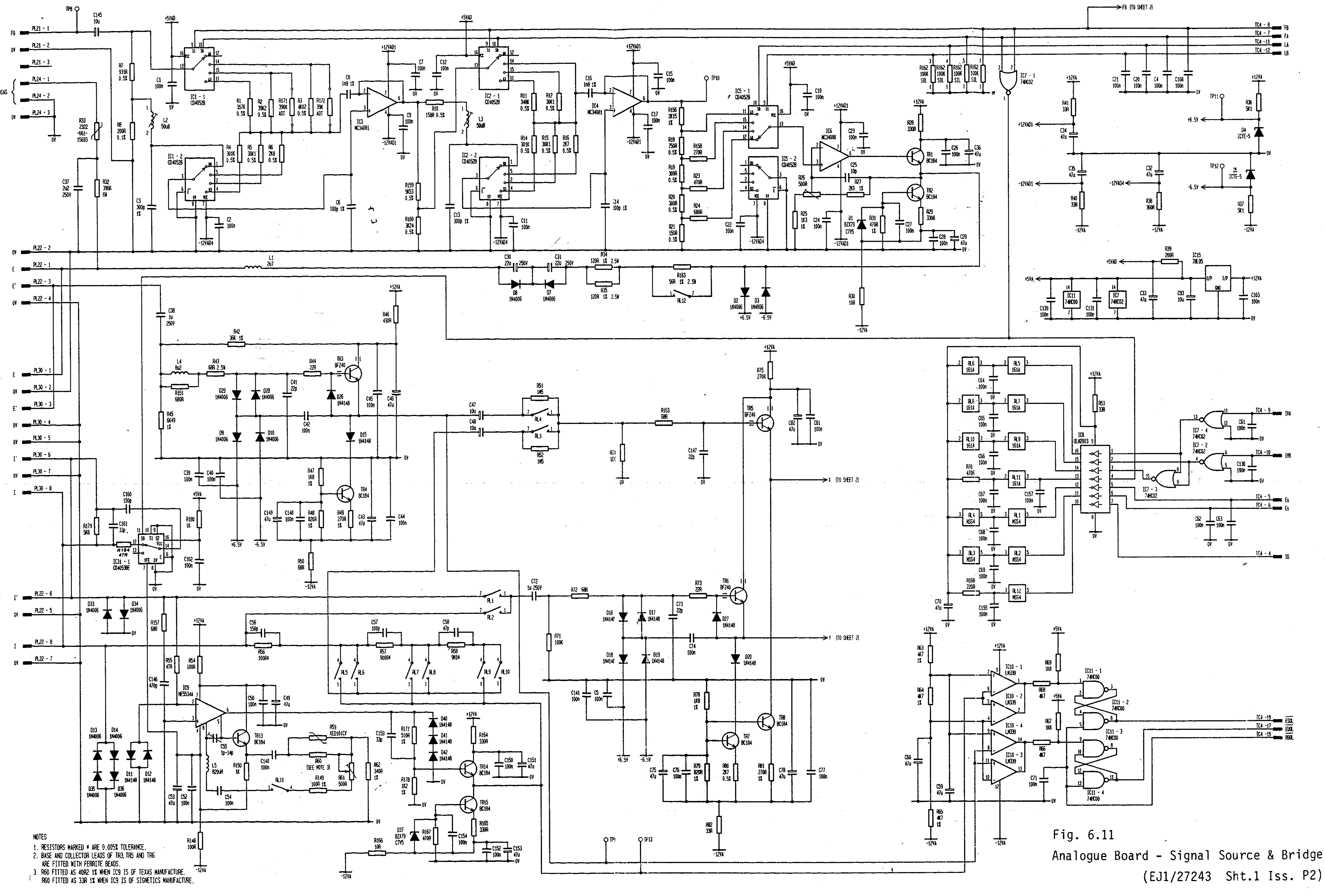


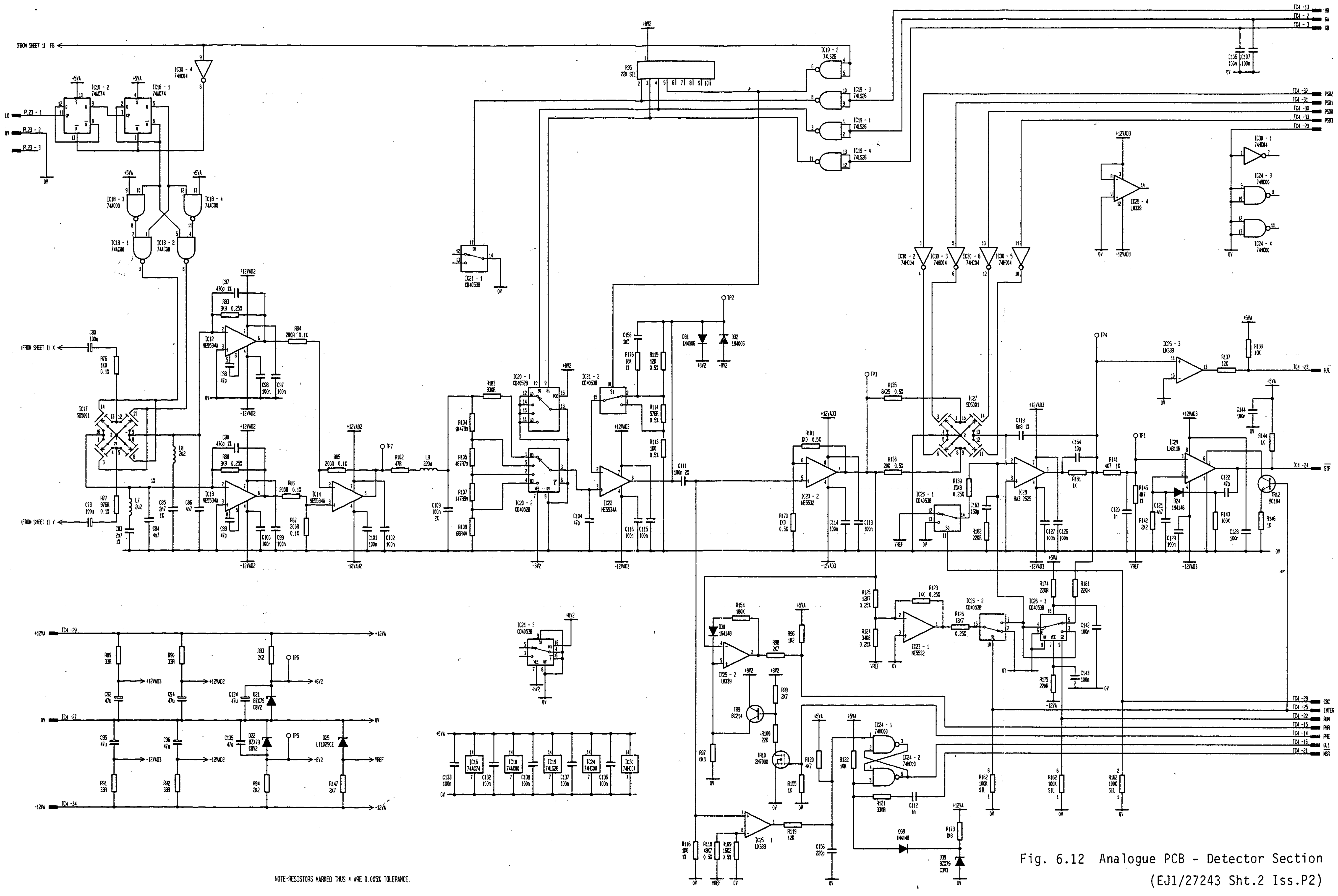
Fig. 6.10 Analogue Board PCB Layout



NOTES

1. RESISTORS MARKED * ARE 0.005% TOLERANCE.
2. BASE AND COLLECTOR LEADS OF TR3, TR5 AND TR6 ARE FITTED WITH FERRITE BEADS.
3. R60 FITTED AS 40R2 1% WHEN IC9 IS OF TEXAS MANUFACTURE. R60 FITTED AS 33R 1% WHEN IC9 IS OF SIGNETICS MANUFACTURE.

Fig. 6.11
Analogue Board - Signal Source & Bridge
(EJ1/27243 Sht.1 Iss. P2)



NOTE-RESISTORS MARKED THUS * ARE 0.005% TOLERANCE.

Fig. 6.12 Analogue PCB - Detector Section
(EJ1/27243 Sht.2 Iss.P2)