7061 &7062 SYSTEMS VOLTMETERS

MAINTENANCE MANUAL

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Schlumberger

Schlumberger Technologies, Instruments Division,
Victoria Road, Farnborough, Hampshire, England GU14 7PW
Telephone: Farnborough (0252) 544433 Telex: 858245 Schlmf

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1 INTRODUCTION

This chapter contains the theory of operation for the 7061 and 7062 Systems Voltmeters. The theory is presented as a simplified block diagram description, followed by a circuit description. As the 7061 and 7062 voltmeters have identical circuits, all circuit diagrams included in this manual are valid for both instruments. The difference between the 7061 and 7062 exists primarily at the software level. The two are identical in performance specification. Both include the same functions which may be fully operated from a remote controller. While the 7061 can access all functions and programs at its front panel, the 7062 has a simplified front panel which controls only measurement functions and is designed for dedicated systems use. Both may be calibrated, either from the front panel, or via the interface. Except where noted, all references to 7061 also apply to 7062.

Early issue voltmeters were fitted with PCBs 3 and 5, instead of PCBs 13 and 15 as fitted to current issues. PCB 13 contains some components over and above those found on PCB 3. Use is made of these only if the Status Monitor Option 70616B, is to be installed. PCB 15, unlike PCB 5, contains circuitry which permit AC + DC voltage and current measurements to be made. In most other respects the two sets of boards are identical; thus in the following descriptions, reference is made only to PCBs 13 and 15. For completeness however, cicuit and components layout diagrams for PCBs 3 and 5 are included in Chapter 6 of this manual.

2 SIMPLIFIED BLOCK DIAGRAM DESCRIPTION (Fig 1.12)

2.1 GENERAL DESCRIPTION

The 7061 System Voltmeter contains four printed circuit boards (PCBs) which contain the electronic circuitry. Additional option boards may also be fitted.

All inputs to the instrument are converted to a dc voltage level and then transformed into time analog pulse trains on PCB 15. On PCB 13, the analog pulse trains are digitised into discrete, equal length time units, which are counted and passed to the display board, PCB 1, for display. The display provides a numerical indication of the input value measured.

2.2 PCB 15 SIMPLIFIED DESCRIPTION

The inputs, received from either the front or rear panel, are passed to the input switching, dc input attenuator and current shunt for conversion into a dc voltage. AC inputs are converted to dc levels by the true rms ac convertor and attenuator. Once the signals have been converted they are passed to the input amplifier.

In conjunction with the ranging circuit, the input amplifier scales the dc level for processing by the integrator. The gain of the input amplifier is controlled by the scaling resistor network of the ranging circuit.

The integrator converts the analog input into a digital output. The applied input voltage to the integrator is converted into time periods on two pulse trains, '+ glug' and '-glug'. The width difference of these glug pulses is directly proportional to the magnitude of the input voltage. The + and - glug pulses are passed to the floating logic circuit and the output, to counters on PCB 13.

The reference circuit provides reference voltages to the integrator, ohms current source and other circuits. These reference voltages are used in the integrator to maintain the input at 0V. The Force Wave drive input to the integrator is a square wave generated by the reference circuit. This square wave is applied to the input of the integrator as a reference waveform. Feedback of the integrator output is controlled by clock pulses from the floating logic.

The ohms current source provides a current source for use when measuring resistance. Current is passed to the input switching circuit via the HI output, whilst the LO output is used to sink the return current.

The floating power supply provides the stabilised voltages for the analog board.

The floating logic decodes the commands received from the front panel keyboard via PCB 13. In addition, information received from PCB 13 is decoded and passed to other circuits. Relay and FET drive signals are decoded and passed to the appropriate circuit. Interconnection between PCB 15 and PCB 13 is achieved by a ribbon cable between PL801 on PCB 15 and PL401 on PCB 13.

2.3 PCB 13 SIMPLIFIED DESCRIPTION

The microprocessor with associated memory forms the main control circuit of the instrument. The microprocessor provides all the facilities for processing with communication over an eight line data bus. The sixteen line address bus controls data transfer between the microprocessor and other circuits.

Input and output interfacing facilities are provided by the general input/output circuit. This circuit contains the interfaces for the keyboard, display and external units. The external (GPIB) interface provides an IEEE 488 compatible interface which allows data exchange between the 7061 and external devices. Ribbon cables are used to connect PCB 13 to the display and keyboard.

When a key is pressed, a software command causes the input/output circuit to generate an output to the beeper.

External Trigger inputs from the rear panel are received by the input/output circuit and the Trigger Complete signal is output from the input/output circuit to the rear panel.

The glug counter and latches circuit converts the incoming + Glug and - Glug pulses and transfers the count data into two data bus latches. When the circuit generates a FIRQ signal, the microprocessor reads the contents of the latches.

The floating input/output circuit provides the interface between PCB 13 and PCBs 15 and 8. The 49.152MHz clock input is divided and output to other circuits.

The 49.152MHz clock is phase locked to the mains frequency and control signals are passed to PCB 8 to maintain the accuracy of the clock.

Power supplies for PCB 1, PCB 13 and PCB 8 are produced from the mains input by the power supply on PCB 13.

2.4 PCB 8 SIMPLIFIED DESCRIPTION

PCB 8 generates a clock at 49.152MHz which is phase locked to the frequency of the mains input to ensure accuracy of measurement. This 49.152MHz clock is used as the source of other clock frequencies within the instrument.

2.5 PCB 1 SIMPLIFIED DESCRIPTION

The display PCB allows processed data to be displayed digitally and for the front panel annunciators to be illuminated on selection of the appropriate function key.

3 CIRCUIT DESCRIPTION

3.1 INTRODUCTION

The three main PCBs, PCB 1, PCB 13 and PCB 15 are described with the aid of functional block diagrams and text. PCB 8 is described as part of the floating input/output and clock.

The description of the two main PCBs, PCB 13 and PCB 15 is divided into a series of functional areas.

Circuit diagrams and component layout diagrams for the PCBs are contained in Chapter 6 of the manual.

4 PCB 1 DISPLAY BOARD

This PCB allows processed data to be digitally displayed and the front panel annunciators to be illuminated on selection of the appropriate function keys. A simplified block diagram of the display circuit is shown in Fig 1.1.

Processed data enters the board via PL1, pins 14 to 21, and is applied to octal D flip-flops IC1 and IC2; both clocked by DSPDAT. On the rising edge of the clock signal the data is transferred to their Q outputs and fed to both the annunciator and the display circuits.

The Q outputs of IC1 and IC2 are applied to the D inputs of IC5, IC6, IC7 and IC8 respectively. ICs 5 to 8 are controlled by the BLANK signal from pin 24 of PL1 such that, when BLANK goes to logic 0, a rising clock edge causes the D inputs to be transferred to the Q outputs to light the LED annunciators. IC5 and IC6 are clocked by one Q output of IC13. IC7 and IC8 are clocked by the other Q output.

IC13 is driven by the serial data output from the display drivers. The serial data is applied to the D1 input of IC13 and transferred, upon a rising edge of the clock signal CHRCLK (pin 23 of PL1), to the Q1 output. The inverse of the data signal also appears at the Q1 output and is used directly to clock ICs 7 and 8. The Q1 output is applied to the D2 input of the second stage of IC13. On the next rising clock edge, the inverse of the original IC13 input appears at the Q2 output and is used to clock ICs 5 and 6.

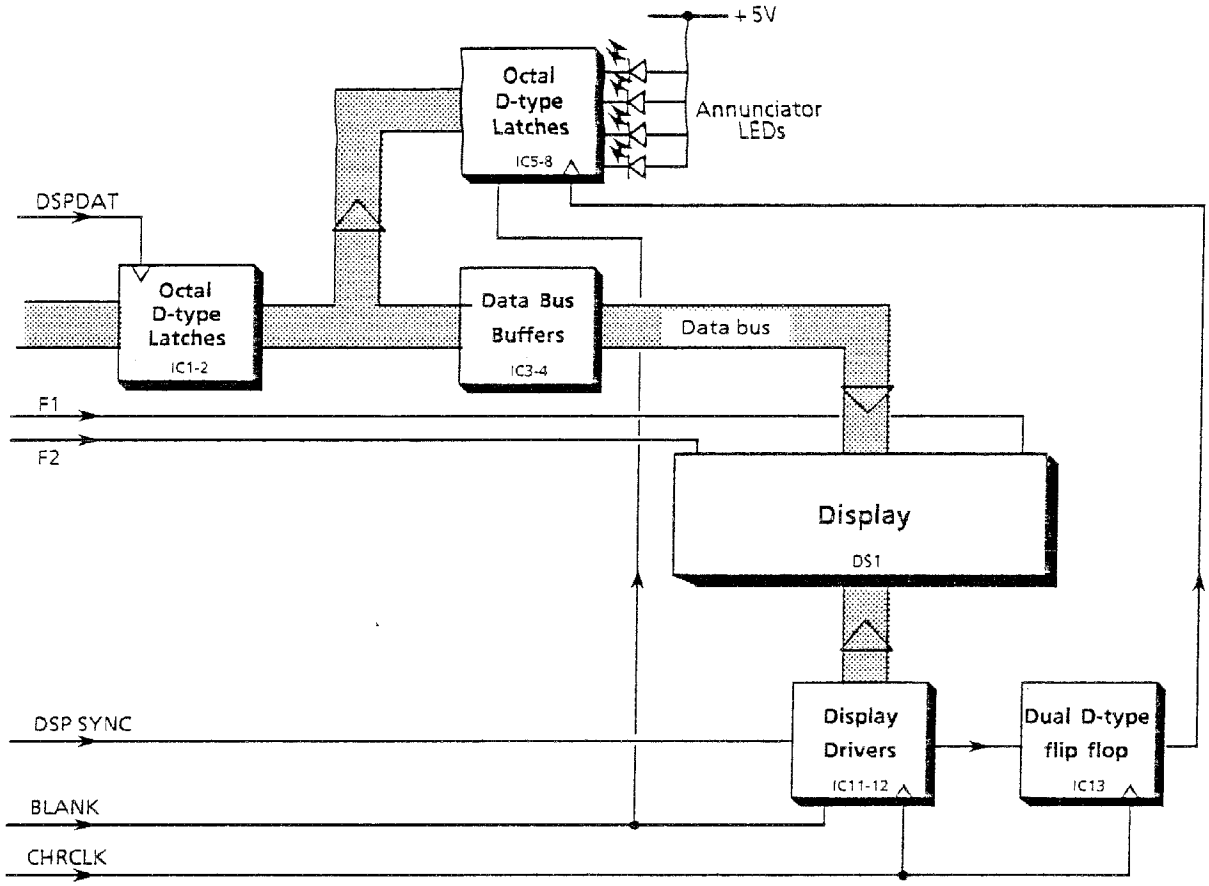


Fig 1.1 *Display, Simplified Block Diagram*

IC5 to IC8 are used to drive the annunciators indicated in Table 1. 1. The annunciator LEDs D1 to D26 have also been listed in the correct order corresponding to each annunciator.

Table 1.1 *Annunciators*

IC No.	ANNUNCIATOR
8 LEDs D20-D26	NULL, LISTEN, RATIO, CHAN, DIGITS, SQR, LOCAL
7 LEDs D12-D19	I, Ω, ⎓, ~, TRUE Ω, TALK, AUTO RANGE, FILTER
6 LEDs D4-D11	RESET, TIMER, SCAN, DELAY, PROBE, PROGS, HIST, V,
5 LEDs D1-D3	TRACK, TRIG, MENU

The Q outputs from IC1 and IC2 are applied, via buffers IC3 and IC4, to the display, DS1. This display is controlled, via its grid inputs, by display drivers IC11 and IC12.

DSP SYNC is applied to the serial data input of IC11. On a rising edge of the CHRCLK clock signal, DSP SYNC is transferred to IC11's internal shift registers. When the BLANK signal falls to logic 0, the data signal is passed out of the device, via its parallel output pins, to the grid inputs (G1 to 10) of DS1.

Serial data output from IC11 is applied to the serial data input pin of IC12. IC12 operates in exactly the same fashion as IC11 except that there is a delay, with respect to IC11, of one clock pulse. The parallel outputs from IC12 are applied to the grid inputs (G11 to 20) of DS1. Serial data output from IC12 is applied to the D1 input of IC13.

Refer to Figure 1-2. The anode inputs to DS1, i.e. inputs a thru n, plus '.' and ',' (semi-colon) - denote which segment of the display digits is to be lit. The grid inputs denote which of the twenty digits are to be lit.

DS1 lights when the grid and anode inputs are positive with respect to the filament inputs. F1 and F2 supply the filament inputs to DS1.

CAUTION: The outputs of IC11 and IC12 are rated at 40V maximum. Care must be taken when probing these ICs not to connect an output to an input pin as the inputs are rated at only 5.5V maximum.]

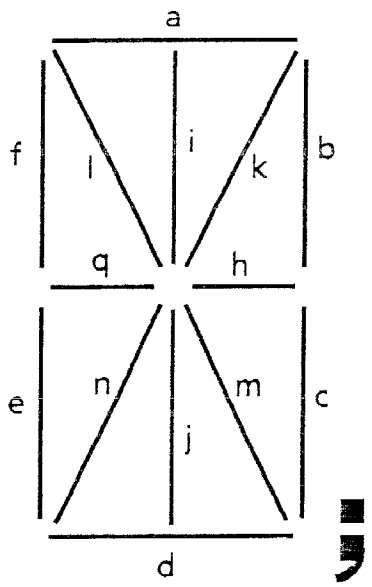


Fig 1.2 *Display Segment*

5 *PCB 13 (DIGITAL BOARD) AND PCB 8 (OSCILLATOR)*

5.1 INTRODUCTION

A block diagram of PCBs 13 and 8 is shown in Fig 1.13. The sheet numbers referred to on this block diagram are the sheet numbers of the appropriate circuit diagram which are contained in Chapter 6.

5.2 MPU AND MEMORY

The 68B09 microprocessor (Fig 6.7, Sheet 1), which controls the earthy logic boards has access to the following areas of memory:

32K bytes of ROM (ICs 106 and 107)
16K bytes of RAM (ICs 110 and 112)
2K bytes of EAROM (IC113) that holds the calibration constants.

Fig 6.3 also includes the power fail detect circuit block described in para 5.2.3. A simplified block diagram of the microprocessor circuit is shown in Fig 1.3.

5.2.1 Microprocessor

The microprocessor contains all the functions required for multi-instruction processing: an arithmetic and logic unit, instruction decode and address registers, and an instruction register. The microprocessor can store its own state during an interrupt service routine by holding the contents of the program counter and its registers on the stack part of memory. On completion of the routine the microprocessor returns to the original program at the point where it was interrupted. The instruction cycle of the microprocessor is set by an 8MHz crystal oscillator clock (Xtal 101), and the microprocessor 'E' clock runs at 2MHz.

The read/write (R/W) signal determines the direction of data flow between the microprocessor and its peripherals. When R/W is at logic 1 a read cycle is selected: when at logic 0 a write becomes operative.

A bus request BREQ input (DMA) is disabled by setting pin 33 to logic 1.

A logic 0 on the memory ready (MRDY) input stretches the E and Q clock signals to allow extension of data access times. This enables the microprocessor to interface with slow memory chips.

The interrupt request IRQ from the peripheral devices is initiated by asserting logic 0 on the IRQ pin of the microprocessor. The microprocessor recognises the request after it has executed the current instruction, provided the interrupt mask bit in the condition code register is not set.

The Non-Maskable Interrupt (NMI) is recognised by the microprocessor as soon as the NMI line goes to logic 0. The interrupt is used as a power-failure sensor, asserted by IC117(a) which forms part of the power fail detect circuitry. Except forthe fact that it cannot be masked, the NMI interrupt sequence is similar to IRQ. After completing its current instruction, the microprocessor stacks its registers and fetches the starting address, in which is stored the vector address, of the NMI interrupt service routine.

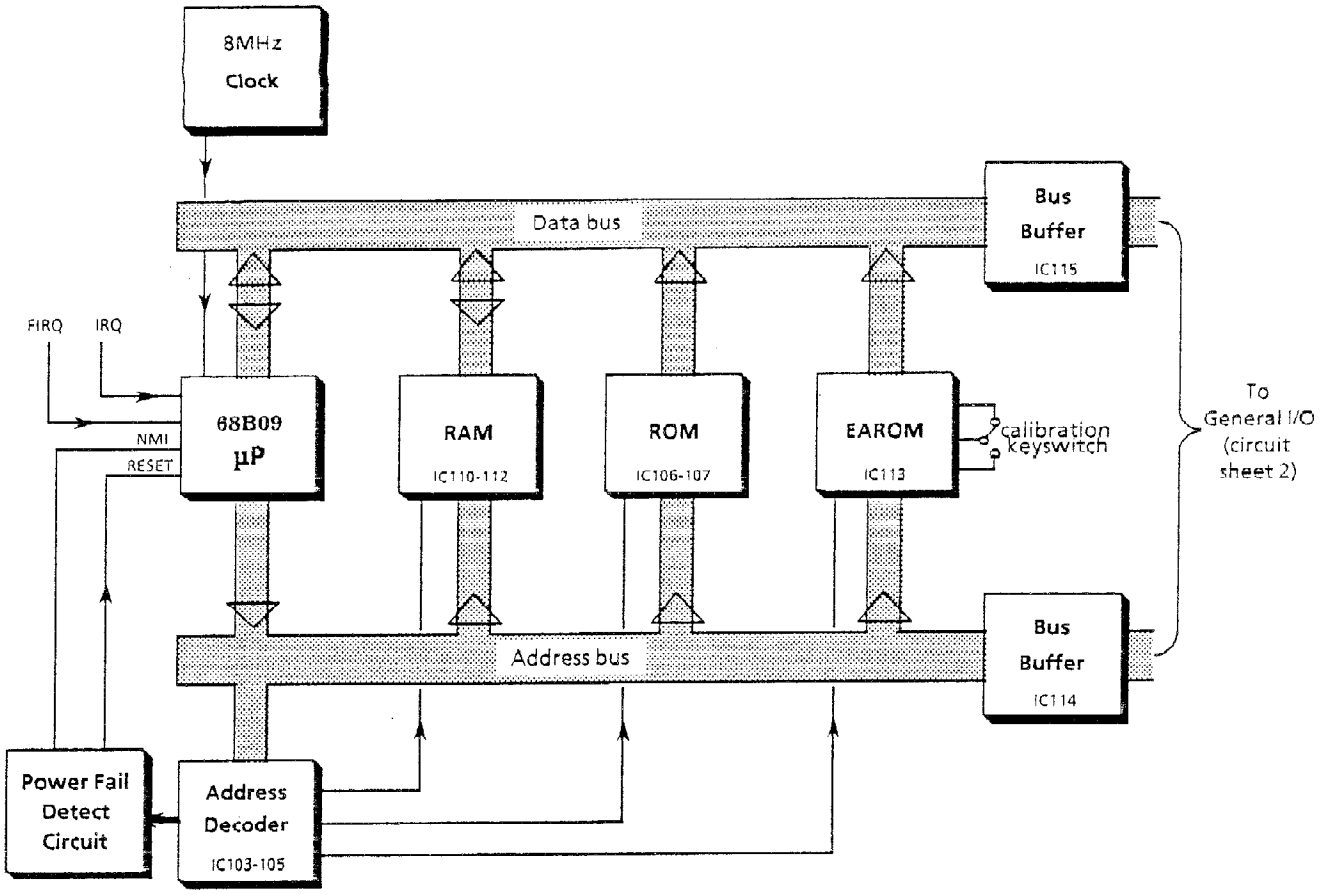


Fig 1.3 *MPU and Memory, Simplified Block Diagram*

A logic 0 FIRQ interrupt signal to the microprocessor is initiated by the falling edge of the -Glug signal at the end of a GLUG cycle. At the same time the contents of the f/2f counters (ICs 305, 306 and 307, circuit sheet 3) are latched into the two data bus buffers (ICs 308 and 309). The FIRQ signal stays low until the GLUG counter data is pulled onto the data bus from the bus buffers and stored in memory. This occurs when the microprocessor reads locations $0300 and $0400.

The reset interrupt RESET is used following 'power on' to reach an initialising program that sets up system starting conditions. Since it is normally used only in start-up mode, there is no reason to save the microprocessor contents on the stack. The reset line is asserted by IC117(b) in the power fail detect circuit.

On power down the NMI source line is used as a power failure sensor device, ensuring an orderly power down sequence. When the power rail voltage drops to a given level the NMI input will signal the microprocessor to do a checksum of data in the RAMs before the reset voltage level is reached. On reset the RAM protect line from the collector of TR101 goes low, isolating all the battery-backed CMOS RAMs to protect the data.

During the power up sequence the RESET remains low and the NMI (low) level is ignored as an interrupt. When the power rail voltage reaches a certain level the NMI line goes high and the RAMs are enabled. When full power has been restored the microprocessor is enabled and a checksum comparison is made to test the validity of the RAM data.

The 16 line (A0 to A15) address bus controls data transfer between the microprocessor set, input/output interfaces, memories and peripherals. The address and data buses are fully buffered by octal bus driver/receiver ICs 114 and 115

5.2.2 Address Decoders

The address decode circuit provides enable signals for the memory, interface, GLUG counter, and analog circuits. ICs 103(a) and 104 decode the address line to select slower access memory so the microprocessor is slowed by the 'slomem' command causing the stretching of the E pulse by approximately 50%, this is achieved by ICs 119(a), 102(a) and 121(a). ICs 103(b) and 118(c), (d) use address lines A13, A14 and A15 to generate logic 0 enable signals to ROM ICs 106 and 107, and RAM ICs 111 and 112. IC103(b) is enabled by a logic 0 signal from address line A15. The 2- to 4-line decoder IC103(a) uses address lines A11, A12 to generate logic 0 enable signals to the EAROM IC113 and the RAM IC110. The lower order address lines A8 to A10 are decoded by ICs 104, 105 to generate enable signals for the input/output interface devices PIA, GPIB, Keyboard and Display.

The two pages of ROM held in IC107 are selectable by a low level signal from the PIA output port 7, via the ROMSEL line.

The memory map (Fig 1.4) shows how the memory address space has been divided.

IC113 is an EAROM for non-volatile memory. This memory is used for storing the calibration constants and its 'write enable' line is switched by a keyswitch to stop the constants being overwritten except when in the 'cal mode'.

5.2.3 Power Fail Detect Circuit

In the power fail detect circuit block the op. amp. ICs 117(a) and 117(b) are used as comparators monitoring the voltage levels at their inputs. On full power supply the non-inverting inputs of ICs 117(a), (b) are at 2.8V, set by zener diode D106. Resistors R102, 103 and 104, act as a potential divider, setting the potential of the inverting inputs of IC117(a) and IC117(b) at a value dependent on the state of TR102 and the charge on C114.

As the power rail voltage falls, a level is reached where the voltage difference across the inputs of IC117(a) is zero, switching the output to low. This is the source of the NMI signal to the microprocessor. As the power rail voltage continues to drop, the voltage difference across the inputs of IC117(b) will then become zero, producing an output low level RESET signal to the microprocessor.

Transistor TR101 is switched off by comparator IC117(c) when the output of IC117(b) goes low. This produces the RAM protect line signal from the emitter of TR101 which disables all the RAMs.

The remaining part of this circuit block, which incorporates an FET TR102 and capacitor C114, functions as a watchdog. As the circuit is powered up, the capacitor C114 begins to charge up across the supply voltage rails. At the same time the FET TR102 is continually being switched on and off by a series of negative pulses from the Yo output pin of decoder IC105. The overall effect is to discharge the capacitor each time it begins to charge up from the supply rails, and so prevent a RESET voltage level being reached.

If the microprocessor fails then pulses stop flowing into the base of TR102 and the capacitor continues to charge up until a RESET occurs. The feedback loop, via inverter IC119(c), causes the capacitor to discharge when the RESET line goes low.

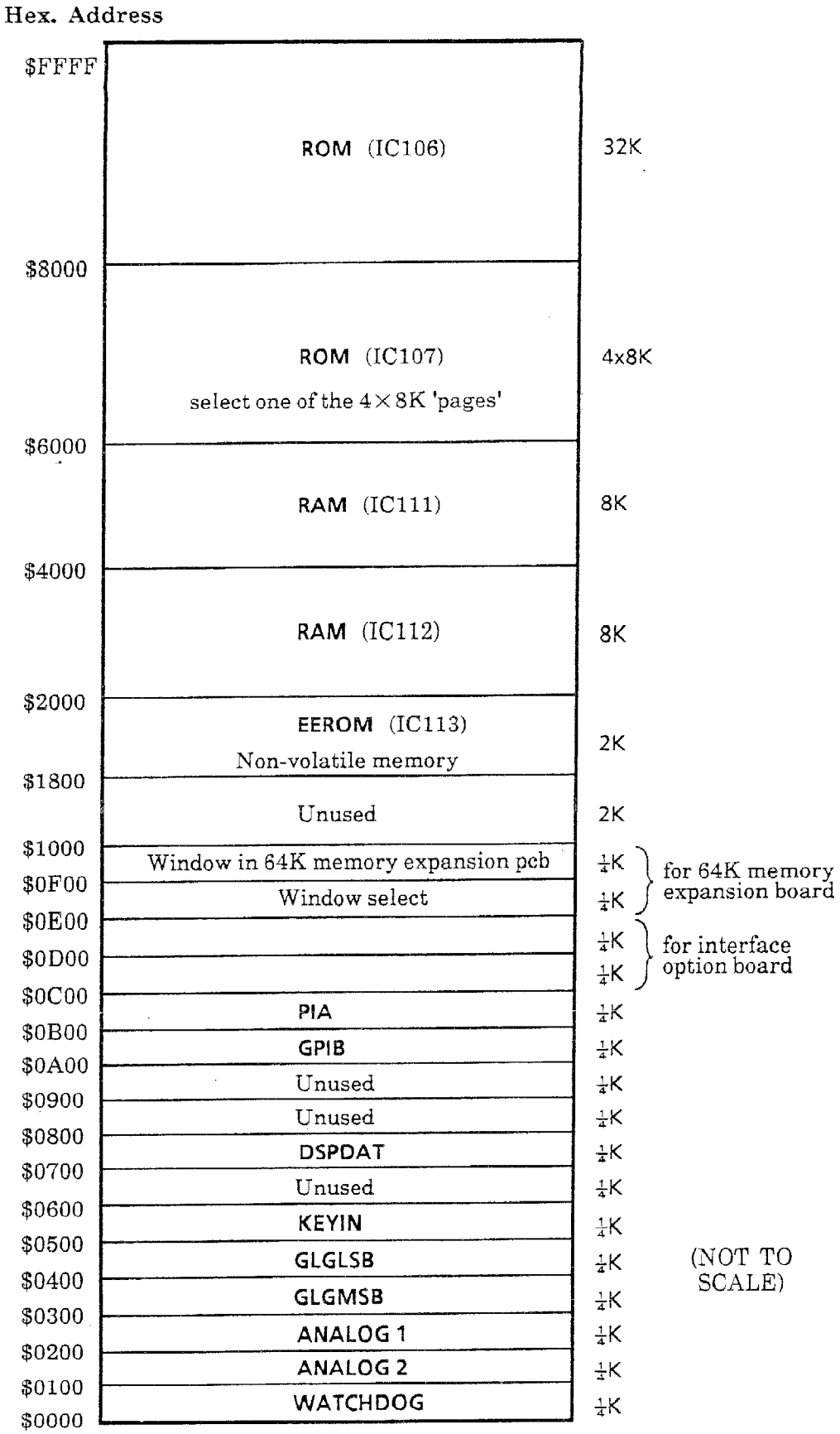


Fig 1.4 *Microprocessor, Memory and Address Map*

5.2.4 Test Points

The following test points listed in Table 1.2 are provided to assist in printed circuit board fault finding.

Table 1.2 *MPU and Memory, Test Points*

TEST POINT (TP)	SIGNAL
101	RESET
102	NMI
103	E
104	R/W
105	OE
106	WE
107	FIRQ
108	IRQ

5.3 GENERAL INPUT/OUTPUT

The general input/output circuit block (PCB 13, circuit sheet 2 - Fig 6.4) incorporates a Peripheral Interface Adaptor (PIA) (a general purpose input/output device), the General Purpose Interface Bus (GPIB), Display and Keyboard interfaces. This circuit sheet also includes the two expansion sockets PL201 and PL202 arranged in parallel on board 13 for connection to the digital option boards. A simplified block diagram of the general I/O circuit is shown in Fig 1.5 .

5.3.1 GPIB Interface

The GPIB interface permits data exchange between the voltmeter and any suitable external device conforming to IEEE 488 1978 (standard digital interface for programmable instrumentation). The interface provides full talk/listen and talk only functions. The GPIB address of the voltmeter is set from the front panel. (Refer to the 7061/62 Operating Manual, Chapter 5, for details of setting the GPIB address).

The microprocessor enables the GPIB chip (IC205) by sending address $0400 which pulls pin 3 low. Control of the bidirectional data lines D0-D7, which allow 8-bit ASCII data transfer between the microprocessor and the GPIB chip, is effected using the handshake lines (NDAC, NRFD, and DAV) and the bus management lines (ATN, IFC, EOI, SRQ, and REN). The bus management lines are used to manage the orderly flow of information across the interface. They are listed below in order of significance:

Interface Clear (IFC)- a system controller signal which sets the interface system to an initial condition.

Remote Enable (REN)- a system controller signal which sets device to remote control.

Attention (ATN)- a controller command. When ATN is active, devicesmonitor the data lines for addressing or an interface command.

End or Identity (EOI)- signals end of message and in conjunction with ATN executes a parallel polling sequence.

Service Request (SRQ)- a device signal which indicates to the controller that a device needs attention.

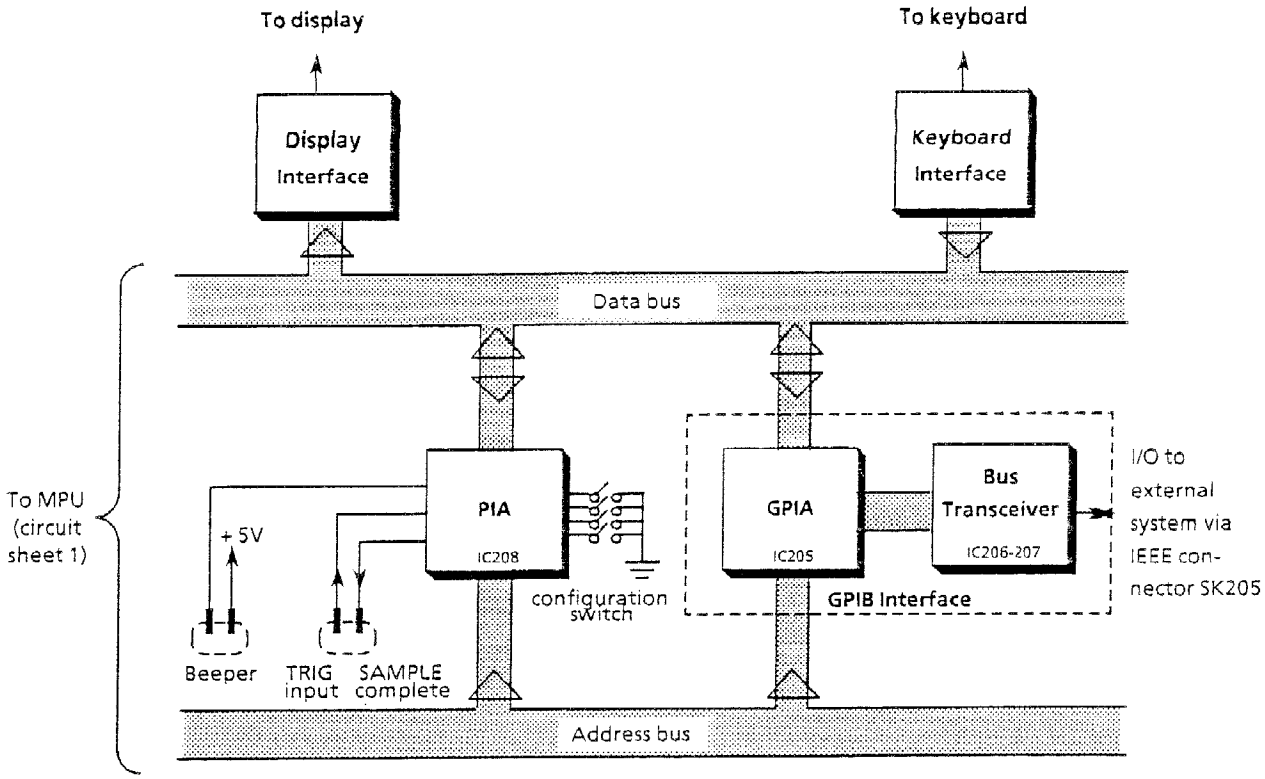


Fig 1.5 *General I/O, Simplified Block Diagram*

The three handshake lines (DAV, NRFD, NDAC) allow the proper transfer of each data byte on the bus between talkers and listeners. NRFD (Not Ready for Data) is high to indicate that all listeners are ready for data. A talker indicates that 'data is valid' by putting DAV (Data Valid) low and the transfer begins when NRFD falls low. Upon the reception of valid data by all listeners NDAC (Not Data Accepted) goes high indicating that the data has been accepted by all listeners.

The GPIB in the 7061 conforms to the following sub-functions within the standard, as listed on the rear panel:

SH1	Source Handshake
AH1	Acceptor Handshake
T5	Basic Talker, Serial Poll, Talk Only Selectable, unaddressed if MLA (My Listener Address)
TE0	No Extended Talker capability
L4	Basic Listener, no Listen Only mode, unaddressed if MLA (My Listener Address)
LE0	No Extended Listener capability
SR1	Complete Service Request capability
RL1	Complete Remote/Local capability, with Local Lock-Out
PP2	Parallel Poll with Local Configuration
DC1	Complete Device Clear Capability, including Selective Device Clear
C0	No Controller capability
DT0	No Device Trigger capability
E1	Open collector Drivers

Register Select lines RS0, RS1, RS2, when used in conjunction with the register access and direction of data transfer lines R/W and WE, allow the microprocessor to access the internal registers of the GPIB chip.

The handshake and management lines and all data lines are connected to the 24-way GPIB socket SK205 via bus transceivers IC206 and IC207.

5.3.2 Keyboard Interface

The keyboard consists of pressure activated keys, configured in a 5x6 bit matrix in memory, via the keyboard connector PL204. In the keyboard interface circuitry a logic 0 pulse 'scans' the keyboard from the output of a BCD-to-decimal decoder IC201. The input signals KB1, KB2 and KB4 originate from the DSPCLK clock input signal via a 5 counter (lower half of IC203). The microprocessor reads the keyboard data lines BD0-BD7 on the enable KEYIN address signal $0500 to find which key has been activated; this results in a data line being pulled low.

5.3.3 Display Interface

In the display interface circuitry, the microprocessor writes 2 bytes to the display via the display data lines BD0-BD7 on pulling the DSPDAT line low by sending address $0700. The CHRCLK, BLANK, and DSP SYNC signals all originate from the DSPCLK signal which is synchronised to GLUG cycle counts. The upper half of IC203 acts as a 25 counter, counting every twenty-fifth pulse of the DSPCLK signal. This produces the synchronisation pulses (DSP SYNC) which sets the illumination rate sequence of the 20-display digits. The CHRCLK and BLANK signals, which are clocked out of the D-type flip-flop IC204(a), are dependent on the condition of the RESET and KEYIN lines. When gate IC209(a) receives a FIRQ, the keyboard display is made blank (via FET TR201) to allow new count data to be displayed.

The display clock is at the frequency of the FIRQ and the display update takes 25 clocks to complete. The microprocessor addresses KEYIN to read the Keypad data and reset IC204(a) and DISPDAT to update the display. The CHRCLK is used to select the next character for update, by clocking the shift register. IC203 selects the keyboard columns and also counts 25 DSPCLK pulses. After 25 clock pulses the output of IC211(b) selects the first digit on the display for update and signals the microprocessor through IC202 to restart the sequence. The CHRCLK through IC209(a) and TR201 blanks the display during update.

5.3.4 Peripheral Interface Adaptor

The PIA (IC208) enables the MPU to interface with external circuitry.. The MPU-PIA connections consist of 8-bidirectional data lines (D0-D7) and various control lines.

RS1, RS0 are the 'Register Select' inputs for selecting a specific register in the PIA. The microprocessor uses these address lines and the R/W to write into the PIA's internal registers.

When the RESET input is pulled low by a signal from the power fail detect circuitry (circuit sheet 1), the registers in the PIA are reset to their initial values.

IRQA/B interrupt request outputs enable the PIA to interrupt the MPU when necessary.

The interrupt control line CB1, which receives a 50Hz clock input signal, is used to maintain the real time clock. The PIA chip is enabled by a logic low address $0800 from the microprocessor, thus allowing data to flow between the microprocessor and the PIA on the data lines.

The external interface side of the PIA includes two 8-bit bidirectional buses PB0-PB7 PA0-PA7. Address switches LFS1, LFS0 in the PIA configuration switch S201 select a line frequency of 50Hz, 60Hz, or 400Hz, depending on the mains frequency used. (Refer to the 7061/62 Operating Manual, Chapter 1, for the configuration switch settings.) The address switch PB7 selects an eight 4-pole or sixteen 2-pole input channel configuration for the scanner option board.

The beeper signal on output port PB2 is software driven (short beep for valid key press, long beep for invalid key press).

External 'TRIG' input and 'TRIG COMP' output BNC sockets (located on the rear panel of the instrument) use TTL signal levels.

The trigger input to CA1 of the PIA is a debounce input causing an interrupt on a +ve or -ve going edge of the trigger pulse. In the debounce circuitry, transistor TR202 remains off with capacitor C202 fully charged in the absence of an input. The +ve or -ve going edge (dependant on the setting of PB output of the PIA) of an external trigger pulse will switch on TR202 and discharge the capacitor. The relatively long time constant of the CR

combination ensures that any secondary contact closure 'glitches' from the triggering pulse are filtered out. For rapid triggering, a non-rebounce input is fed into CA2 of the PIA. Output port PB1 provides the 'TRIG COMP' signal. This output, via inverter IC209(c), is normally high but pulses low after completion of the measurement sequence.

The diode-resistor arrangement at the socket inputs limit the TRIG input/output signals to a range of 0-5V.

5.4 GLUG COUNTERS AND LATCHES

The GLUG counter circuit block (PCB 13, circuit sheet 3 - Fig 6.5) counts the incoming +GLUG and -GLUG pulses, produced by the comparators at the ADC output, and transfers the count data into two data bus latches until the latch contents are read by the microprocessor on a FIRQ signal. A simplified block diagram of the GLUG counter and latches is shown in Fig 1.6.

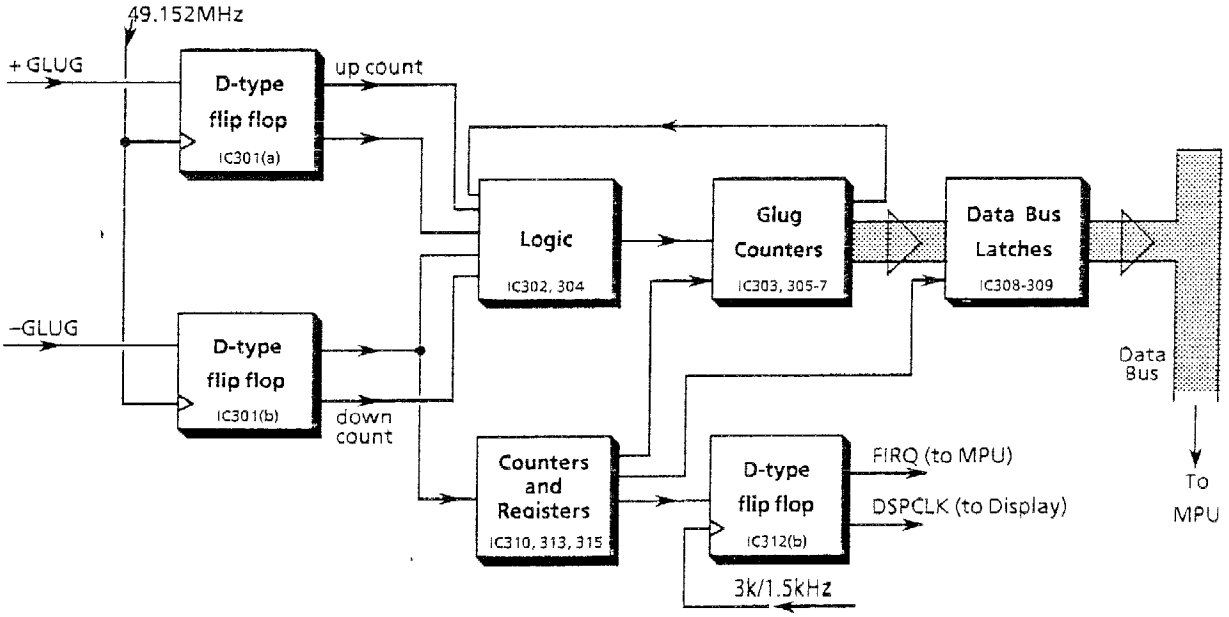


Fig 1.6 *Glug Counters and Latches, Simplified Block Diagram*

5.4.1 GLUG Digitisation

The master D-type flip-flops (ICs 301(a) and 301(b) are both clocked by the same 49.152MHz clock signal. On a positive edge of the clock signal the data input to IC301(a) is sampled and clocked on the Q output. The resulting effect is to digitise the *incoming analog +GLUG signal to a 20ns time grid. Each 'count up' signal digit from* the Q output can then be clocked into a digital counter. In the same way the incoming -GLUG signal is digitised by IC301(b), producing a series of 'count down' digits which can also be clocked into the digital counter. The master flip-flops also enable the counters when the 'count up' or 'count down' signal appears at their Q output.

Test points TP301 and TP302 can be used to monitor the +GLUG and -GLUG changes respectively.

5.4.2 f/2f Counter Chain

The 16-bit counter chain comprises of two 1-bit counters IC303(a) and 303(b), two 4-bit counters IC305 and IC306, and a 6-bit counter IC307. The first 1-bit counter IC303(a) represents the LSB of the 16-bit count.

This counter chain, known as the f/2f counter, is equivalent to a 16-bit up/down synchronous counter by using two clocking frequencies f(49.152MHz) and 2f. When both GLUG pulses are low a frequency f is applied; when the +GLUG pulse is high 2f is applied, and when the -GLUG pulse is high f is not applied. Although all the counters are clocked by the same frequency of 49.152MHz the effect of doubling the clock frequency is achieved by by-passing the LSB counter IC303(a). This makes the output count frequency equal to the input clock frequency instead of half the value. The condition for using f, 2f, or zero clock inputs depends not only on state of the up/down count input pulses from the master D-types but also on the current state of the Q outputs from the two 1-bit counters.

The logic gate decode circuits IC302 and IC304 enables the 1-bit counters. For example while the +GLUG pulse is high and the -GLUG pulse is low then the decoder IC302 will disable the first 1-bit counter and effect a clocking frequency of 2f to the counter chain.

5.4.3 GLUG Latches

The purpose of the lower section of the GLUG counter circuit block is to clear the counters at the end of a GLUG cycle, i.e. 'up count' followed by a 'down count', transfer the contents of the counter to the two octal data bus latches, and initialise the counter in readiness for the next GLUG input when the microprocessor reads the contents of the latches by sending addresses $0300 and $0400.

On the falling edge of the -GLUG pulse (at the end of a GLUG cycle) the counter IC310 receives a clock pulse and produces an output signal on pin 11. This signal, which allows an 8-GLUG cycle to be counted, is selected by the 2-way selector IC424 (on the A input) if a 4-digit measurement display is chosen. This corresponds to an ADC forcing wave frequency of 24kHz. Alternatively, if a 5- 6- or 7-digit measurement display is chosen, an ADC forcing wave frequency of 1.5kHz is used and the software FIRQ rate is set at 1. 5kHz, enabling the microprocessor to count in single GLUG cycles. In this case the selector switch selects the B input, thus by-passing IC310.

The positive output which signals the end of a GLUG cycle(s) count is delayed for 280ns by shift register IC313 before the counters and data bus latches are reset. This allows time for the contents of the counter to be transferred into two data bus latches and read by the microprocessor on a FIRQ signal.

Shift register IC315 acts as a watchdog for the counting circuitry. It is clocked by 3kHz/1.5kHz pulses (depending on the display chosen) which causes a signal to rapidly shift along successive outputs. Normally this 'running' signal is reset by a GLUG count pulse before it can reach the 4Q output. If the counting circuit should fail, however, and the signal reaches output 4Q, the 3k/1. 5kHz clock pulses to the flip-flop IC312(b) will shut down FIRQ and stop the display clock DSPCLK. The error message GLUG DEATH is displayed.

5.4.4 Test Points

The following test points shown in Table 1.3 are provided to assist in printed circuit board fault finding.

Table 1.3 *GLUG Counters and Latches, Test Points*

TEST POINT (TP)	SIGNAL
301	+GLUG
302	-GLUG
303	LATCH RESULT
304	CLR COUNTER

5.5 FLOATING I/O AND CLOCK

The floating I/O and clock circuit block (PCB 13, circuit sheet 4 - Fig 6.6) shows the floating I/O part of printed circuit board 13, and also includes the smaller oscillator PCB 8 which is mounted directly on board 13. A simplified block diagram of the floating I/O and clock circuit is shown in Fig 1.7.

5.5.1 Clock Oscillator (PCB 8)

Printed circuit board 8 is a high frequency oscillator circuit which provides a clock signal of nominal frequency 49.152MHz. This signal is phase-locked to the 50Hz/60Hz/400Hz mains frequency signal by the clock control output of phase comparator (IC426) when COMP IN and SIG IN (mains frequency signal) differ. The dc output of the comparator fine tunes the oscillator circuit through the Varicap diode D101. The oscillator frequency is brought within the range of the comparator by adjusting L101. The 10Vac mains signal derived from the secondary winding of the mains transformer (PCB 13, circuit sheet 5), passes from the floating side to the earthy side via two opto-coupler isolators, IC416 and IC417 (Fig 6.7).

The phase-locked oscillator may be replaced by a crystal oscillator if required. See 'Options', Chapter 5.

5.5.2 Clock Divider

The fundamental clock signal of 49.152MHz passes through a series of dividers to produce various clocking frequencies for other parts of the circuit.

The upper half of synchronous counter IC420 acts as a $\div 2$ counter, producing a 24.576MHz signal at its QA output. This frequency is used to clock shift register IC313 in the GLUG control circuitry (circuit sheet 3).

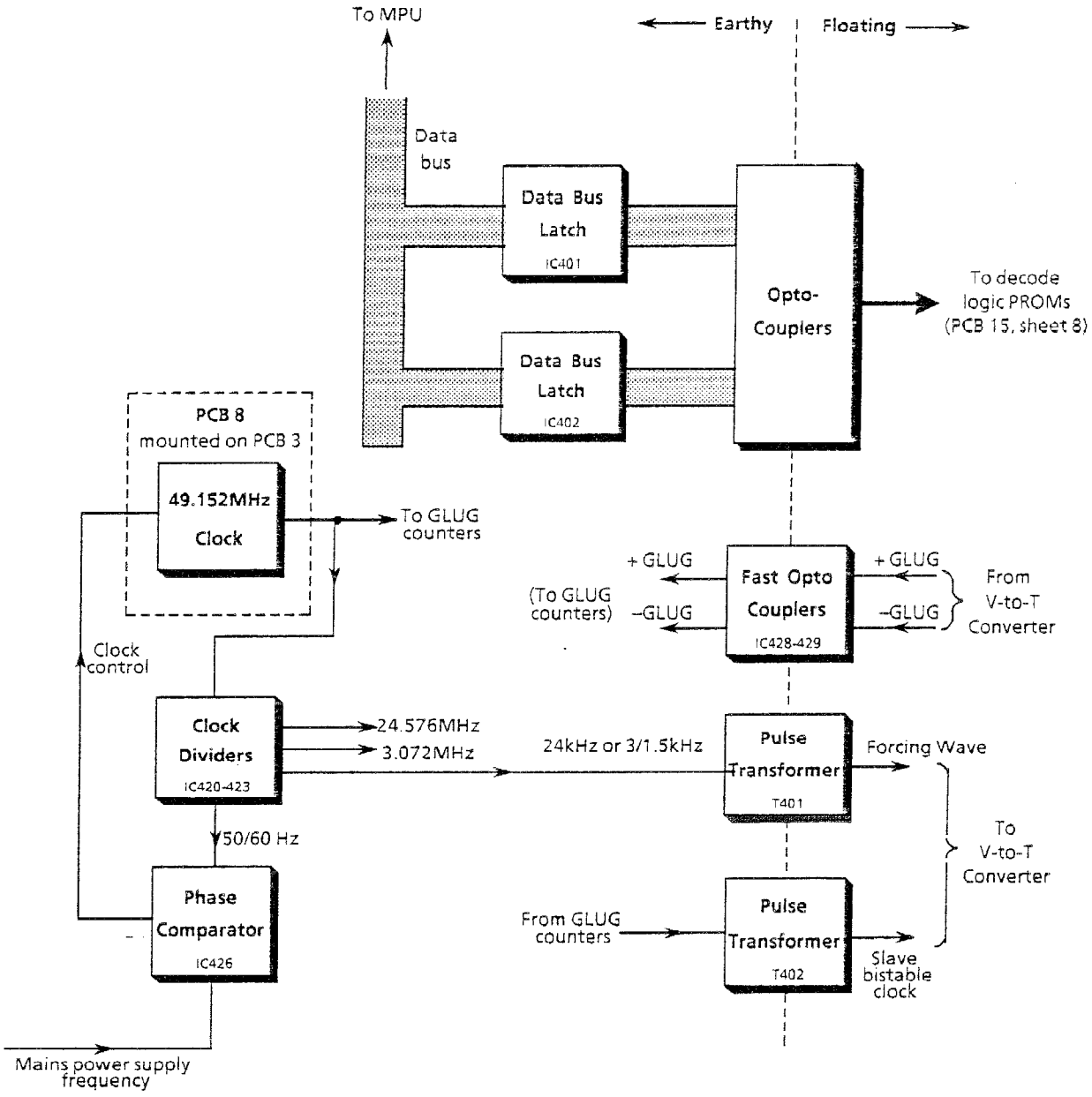


Fig 1.7 *Floating I/O and Clock, Simplified Block Diagram*

The lower half of IC420 acts as a ÷8 counter, producing a 3.072MHz clock signal for divider IC421, for further frequency division. IC421 provides the ADC forcing square wave drive signal of frequency 24kHz (if a 4-digit display is chosen) or 3/1.5kHz (if a 5-, 6- or 7-digit display is chosen). Selection of the 3kHz or 1. 5kHz rate is made by bridging the appropriate split-pad SP403 or SP404.

The 24kHz signal at the Q7 output of IC421 is also used to drive the display filaments by causing rapid FET switching across the primary windings of transformer T501 (PCB 13, circuit sheet 5 - Fig 6.7).

The 3kHz signal fed into the next counter (IC422) is divided down by 5 to output 600Hz at 1QD (which is fed to IC423) and then divided by 5 again to output 120Hz at 2QD. IC423 then further divides the 600Hz signal to 100Hz. Both the 100Hz and 120Hz signals are fed into a ganged 4-pole selector (IC425), configured by the line frequency select inputs LFS0 and LFS1. The line frequency is set from the PIA configuration switch (PCB 13, sheet 2). The selected frequency (100Hz or 120Hz) is then passed through a further divider (IC203) to provide the 50/60Hz COMP IN signal.

The two forcing wave drive signals are fed into a data selector IC424. If the A/B control line is pulled high, for a 5-, 6- or 7-digit display, then the 24kHz signal is passed via pulse transformer T401 and clocks the D-type flip flop IC418(a). This generates a square forcing waveform of frequency 24kHz. If a 4-digit display is chosen, A/B is pulled low by a logic 0 pulse on data bus buffer IC401, pin 12, thus allowing the 3/1.5kHz signal to pass to IC418(a) instead of the 24kHz signal.

5.5.3 Floating I/O

This circuit also shows a line of opto-couplers and pulse transformers which isolate the Earthy and Floating sides of the circuit. The microprocessor writes one byte into each of the octal data bus buffers which is transferred via the opto-couplers to the four logic decode PROMs which then produce the decoded signal for the relay/FET switching analog circuitry.

The lower right part of the circuit shows transfer of the +GLUG and -GLUG signal from the analog circuitry on the floating side to the digital counting circuitry on the earthy side.

5.5.4 Test Points

The following test points shown in Table 1.4 are provided to assist in printed circuit board fault finding.

Table 1.4 *Floating Input/Output and Clock, Test points*

TEST POINT (TP)	SIGNAL
101 (PCB 8)	49.152MHz clock
402	Control clock
403	50/60Hz COMP IN
404	50/60Hz MAINS IN
405	Mains frequency

5.6 *POWER SUPPLY*

The power supply circuit (Fig 6.7, Sheet 5) produces the floating power for the analog circuits and earthy power for the logic circuits. It includes a mains transformer, a noise reducing filter, two mains fuses FS1, FS2 and a Schaffner voltage selector roller block. The selector can be set for different mains voltage ranges (nominal 50Hz or 60Hz) of 100V, 120V, 220V or 240V by operating switches a to e. (Refer to the maintenance section of this manual for details of setting the voltage selector and accessing the mains fuses.)

5.6.1 Earthy Power Supply

Part of the secondary windings of the transformer connect to PCB 15 floating power supply, via socket SK901. The remaining part of the windings provide the voltage supply rails for the digital circuitry in PCB 13, via socket SK1.

A bridge rectifier D502 full-wave rectifies the stepped down ac mains signal. The rectified output is smoothed by capacitors C501, C502, and applied either to four +5V regulators IC501-504 along the five voltage supply lines d, a, b, c and e respectively, or left unregulated at +9V. While the mains supply remains on, the 3.6V back-up battery B501 is by-passed but kept on trickle charge. During a power-down sequence (or mains failure) the NiCd back-up battery holds the +5Vc supply line at 3.6V, which is sufficient to maintain the CMOS RAM ICs in the MPU and memory (Fig 6.3).

On each supply line test points are provided for checking the dc voltage (see Table 1.5). The direct ±10Vac output from bridge rectifier D501 is used to provide the mains frequency SIG IN for the clock phase comparator (Fig 6.6).

In the lower part of the secondary windings the stepped down ac voltage is applied to the bridge rectifier D504, via voltage doubling capacitors C505, C506. The rectified output is smoothed by C507 and applied to a 5V regulator IC505. This 5V is added to the 35V across the zener diode D505 to give the +40V required for the Display Drivers. The unregulated +32V and -32V supply lines for the expansion sockets on PCB13 (Fig 6.4) are produced by bridge rectifier D506. Test points are provided on each voltage supply line.

The isolated section in the upper right part of this circuit drives the display filaments, switch FETs TR501, TR502 at a 24kHz rate across the transformer primary to produce 6.3V between the filament signal lines F1, F2. The third FET TR503 and associated circuitry functions as a watchdog on start up.

5.6.2 Test Points

The following test points shown in Table 1.5 are provided to assist in printed circuit board fault finding

Tabel 1.5 *Power Supply, Test points*

TEST POINT (TP)	SIGNAL
501	+5Va
502	+5Vb
503	+5Vc
504	+5Ve
505	+40V
506	32V (unreg.)
507	-32V (unreg.)
508	0V (digital ground)
509	+5Vd

6 PCB 15 (ANALOG BOARD)

6.1 INTRODUCTION

A block diagram of PCB 15 is shown in Fig 1.14. The sheet numbers referred to on this block diagram are the sheet numbers of the appropriate circuit diagram which are contained in Chapter 6.

6.2 INPUT SWITCHING, DC VOLTS ATTENUATOR AND CURRENT

As the A-to-D convertor is capable of handling dc volts only, regardless of the measurement being taken, the signal conditioning circuits convert all inputs to a suitable dc voltage level. Once converted, the input signal is applied to the amplifier, the gain of which is determined by the range on which the voltmeter is operating.

6.2.1 Input Switching

The input switching circuit (Fig 6.9, Sheet 1) includesthe three measurement input channel sockets: two of the measurement inputs (5-way Fischer sockets) are of the same channel (channel 0), but one of the inputs (SK1) is located on the front panel and the other (SK2) on the rear panel of the instrument. A push switch, S1, on the front panel, allows the user to select either front or rear channel 0 input, to be used for measurement. The third input (5-way Switchcraft socket SK3), called the reference input, is used as a fast systems input since its reduced protection offers faster settling times. There is also available a pair of 4mm current input terminals TL1, TL2 on the rear panel, which are fuse protected (2A max.).

An additional 8 (or 16) input channel option board (PCB 7) can be incorporated in the instrument (refer to Chapter 5, 'Options'). Disconnect pins DP1 to DP5 are used to connect the inputs from the scanner board.

The voltmeter input signal, from either the front or rear panel connector, can be fed to various combinations of relays and resistors, depending on the measurement function selected by the user. For measurement of resistance, the resistor is energised by the ohms current source (Fig 6.9, Sheet 6) via the I lines. The relay RL10 specially operates for the 10M range, using the internal +10V reference source to energise the test resistor. For this measurement both relays RL1, RL2 are closed simultaneously. The closure of relay RL2 directs the energising current from the +10V REF supply to the test resistor connected to the input socket SK1/SK2. The closure of the relay RL1 enables the voltage developed across the test resistor to be applied to the input of the dc amplifier. The input switching relay coils RL1 to RL10 are driven by an array of darlington drivers on the switching decode logic lines (Fig 6.9, Sheet 8). The drivers are controlled by four PROMs which decode the signals from data bus buffers on the earthy side.

6.2.2 DC Volts Attenuator

The dc volts attenuator resistors R3 and R4 protect the 0.2V, 2V and 20V measurement ranges, whilst resistors R1A, R1B, R1C attenuate this input from channel 0 on the 100V and 1kV measurement ranges. Signals in the higher voltage measurement range are switched through to the input of the dc amplifier (Fig 6.9, Sheet 2) by the FET switch TR1. The ac input signals are fed into the ac to dc conversion circuit block (Fig 6.9, Sheet 7) and converted into a dc level for input to the dc amplifier via FET switch TR3. The bootstrap line is used to apply a suitable voltage level to the FETs, enabling them to switch on or off depending on the mode selected. Opto couplers ICs 1-3 are used

to convert voltage levels from the darlington drivers to bootstrap levels. Clamping diodes D1 limit the amplifier input to 22V.

6.2.3 DC Input

There are two paths for dc voltage input:

a. For voltages in the range ±20V the inputs pass via R3, R4 and RL1 (when energised) to the dc amplifier.

b. Other voltage inputs are passed via RL2 and attenuated by R1, R2 through TR2 to the dc amplifier.

Overvoltage protection is provided by spark gap SG1.

6.2.4 Current Input

Current input paths are as follows:

a. DC current - Through FS1 and R8. The voltage drop across R8 is passed via RL9 (energised) and switched by TR2 to the dc amplifier.

b. AC current - As for dc current up to TR2, then via C1 to the AC-DC converter.

6.2.5 Ohms

Constant currents for ohms measurements are switched through RL8 to the input sockets.

6.2.6 Reference Input

Reference inputs are passed from the rear mounted input socket through relays to the appropriate input path. On dc, the reference input is not attenuated and is therefore limited to the maximum of the 20V range.

6.2.7 +10 Volt Reference

The +10V reference voltage produced by the reference circuit is used for measuring high resistance values by the conductance method, i.e. the reference voltage is applied across R1A, B and E with the unknown resistance in series. The voltage drop across the unknown resistance is measured by the dc circuit.

The switching voltage for FETs TR1, 2 and 3 is referenced to the bootstrap voltage and this in turn tracks the input potential. Screening of the input paths is also taken to the bootstrap voltage to minimise capacitance. The command lines for TR1, 2 and 3 are isolated by the opto-couplers IC1, 2 and 3.

6.3 DC INPUT AMPLIFIER

All input signals, however derived, are applied to this circuit which is the last in the signal conditioning chain. In conjunction with the dc ranging circuit (Fig 6.9, Sheet 3) the signal is scaled to a suitable level of processing by the A-to-D convertor. The dc input amplifier is shown in Fig 6.9, Sheet 2.

IC401 in this circuit is the main gain amplifier. The transistor output stage level shifts the signal as required to drive the integrator input (Fig 6.9, Sheet 4). On the 10V range the amplifier circuitry acts as a unity gain buffer, giving a very high input impedance and low output impedance.

TR410-414 and TR403-406 are commutator FETs which alternate the positions of the matched FETs in TR412; the offset voltage at the input of the amplifier is averaged

out. The commutation drive is derived from the digital board PCB13. The signals at A and B are complementary square waves at 1.5kHz (mains locked) for 4 digits (Vdc, ohms and Idc ranges) and 50/60Hz for 5/6/7/digits and Vac ranges.
The bootstrap amplifier (IC402) provides an appropriate voltage level to drive some of the switching FETs in the dc ranging circuit block. It acts as a low output impedance unity gain voltage follower producing an output which faithfully follows the input to the input amplifier.

The feedback path for IC401 is switched by TR101, 102 or 103 to give the amplifier a gain of X1, X10 and X100.

The input circuit of the amplifier is a double FET with the input from the attenuator going to one gate and the feedback to the other gate. The source current for the double FET TR412 is kept constant by TR416, the Diode D409 on its base and R421. The dc balance of the circuit is obtained by adjusting the value of resistors R419 or R420. Normally only one of these two resistors would be fitted and the other replaced with a wire link. This adjustment is carried out on initial set up and should only need to be adjusted when TR412 or IC401 has been changed.

Drift in the circuit is overcome by continuously switching over the input and the feedback input to TR412 and IC401. As long as each result is made up of an equal number of readings in both positions then any offset in the circuit will be eliminated, even offsets due to drift. The frequency of the switching is at 50/60Hz (supply freq.) or 1.5kHz when the integration is set to 4 nines.

6.3.1 DC Input Amplifier Test Points

The following test points are provided to assist in printed circuit board fault finding:

TP401 Commutator drive A

TP401 Commutator drive B

6.4 DC RANGING

The dc ranging circuit is shown in Fig 6.9, Sheet 3.

The gain of the main input amplifier is controlled by the scaling resistor network in this circuit, which also provides an additional measurement of input amplifier protection, relative to bootstrap. The FET switches are switched on by the Vdc ranging signals derived from the floating logic decode circuitry (Fig 6.9, Sheet 8). The bootstrap amplifier sets the correct switch-on levels for the FETs. The three scaling lines provide a direct, 10 and 100 scaling of the amplifier output signal.

This circuit also shows the main floating 0V star 'anchor' point on the analog board, TP101.

Test point 101 (0V Star Cove) is located on Fig 6.9, Sheet 3.

6.5 INTEGRATOR

The integrator circuit is shown in Fig 6.9, Sheet 4. A simplified circuit is shown at Fig 1.9. This circuit block performs Analog-to-Digital Conversion, the applied voltage level at the integrator input being converted to time periods on two 'pulse trains' called + GLUG and -GLUG. The width difference of these GLUG pulses are directly proportional to the magnitude of the input voltage. The + GLUG and -GLUG pulses

are used to gate clock into an f/2f counter chain which produces a net count proportional to the measured input voltage.

The integrator has a virtual earth maintained at its input. With the input kept at 0V and a forcing square wave applied continuously to the input, the integrator output ramps up and down through the threshold levels of the two comparators (IC203). If the input is kept at zero the ramp waveform is symmetrical about the comparator reference level and the +GLUG and -GLUG signals have the same mark space ratio. The waveforms are shown in Fig 1.10.

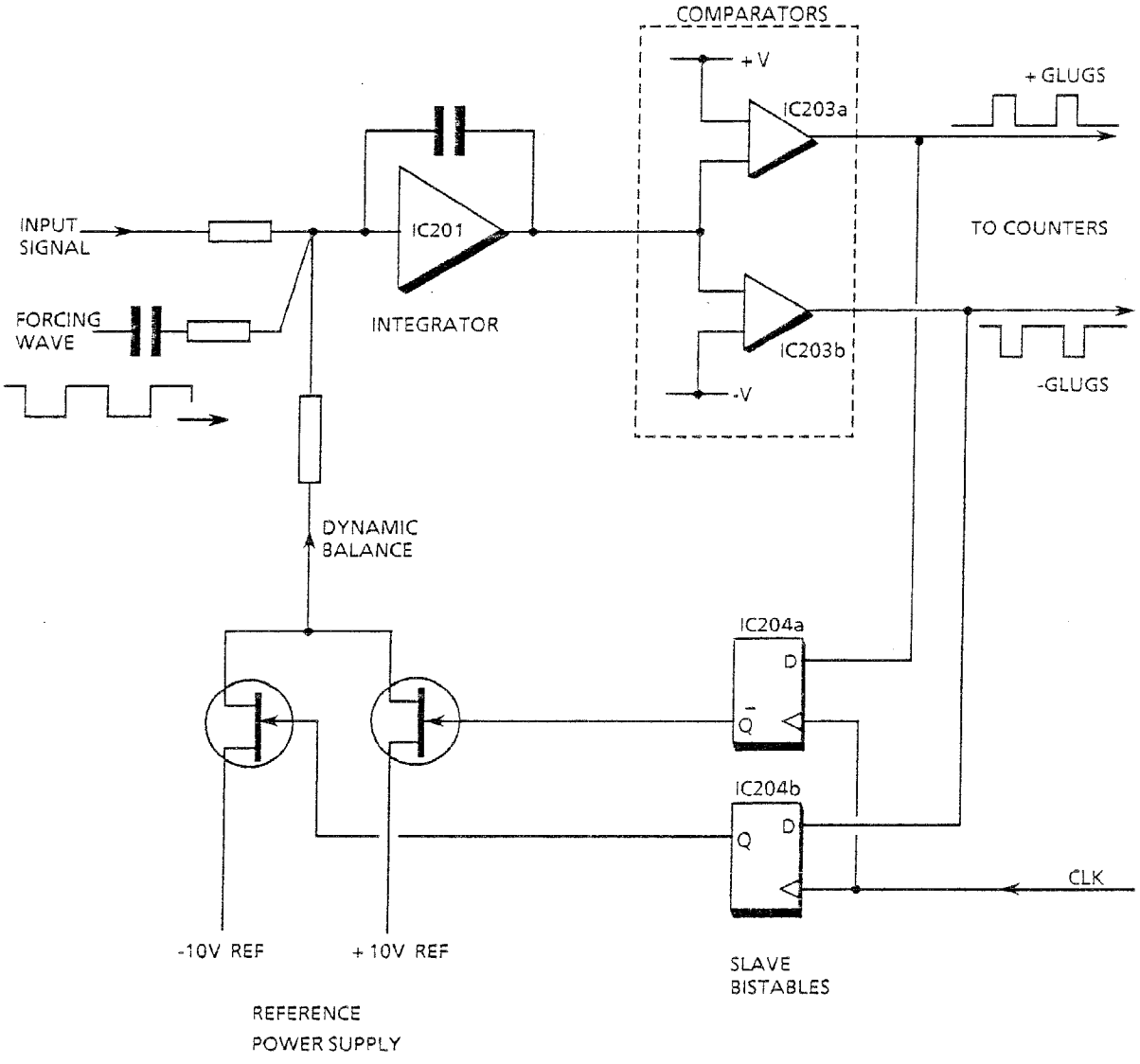
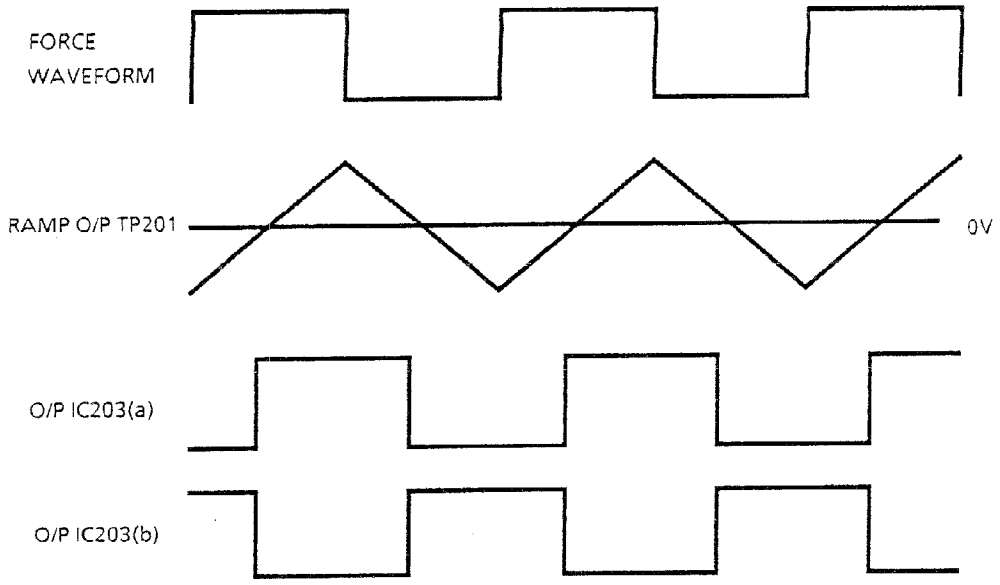
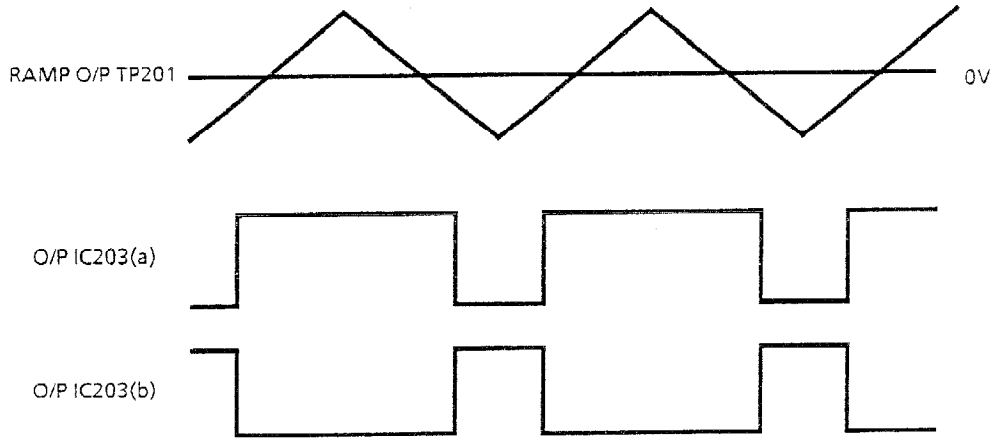


Fig 1.9 *Integrator, Simplified Circuit*

For an input signal other than zero the ramp waveform changes and causes a corresponding difference in the GLUG mark-space ratios. The +GLUG and -GLUG signals are then fed into the GLUG counter. The waveforms are shown in Fig 1.10.



(A) Integrator kept at zero



(B) Integrator input other than zero

Fig 1.10 *Integrator Waveforms*

From Fig 1.9 and 1.10 it can be seen that if a dc input goes positive, the output waveform of IC203a and b would change in mark/space ratio, i.e. IC203a positive section becomming wider and IC203b positive section becomming narrower. The opposite would occur if the input went negative. These output pulses from the comparators (+ and -GLUG) are used to control the counters on PCB 13.

In practice IC203b is biased slightly negative, giving a short delay between the switching of one comparator to the other. During this delay the reference voltage is enabled. Fig 1.11 shows the effect of the reference voltage on the waveforms. The waveform at TP201 is the ramp output flattened by the effect of switching in the reference voltage. The reference waveform shows the effect of the slight negative bias to IC203b.

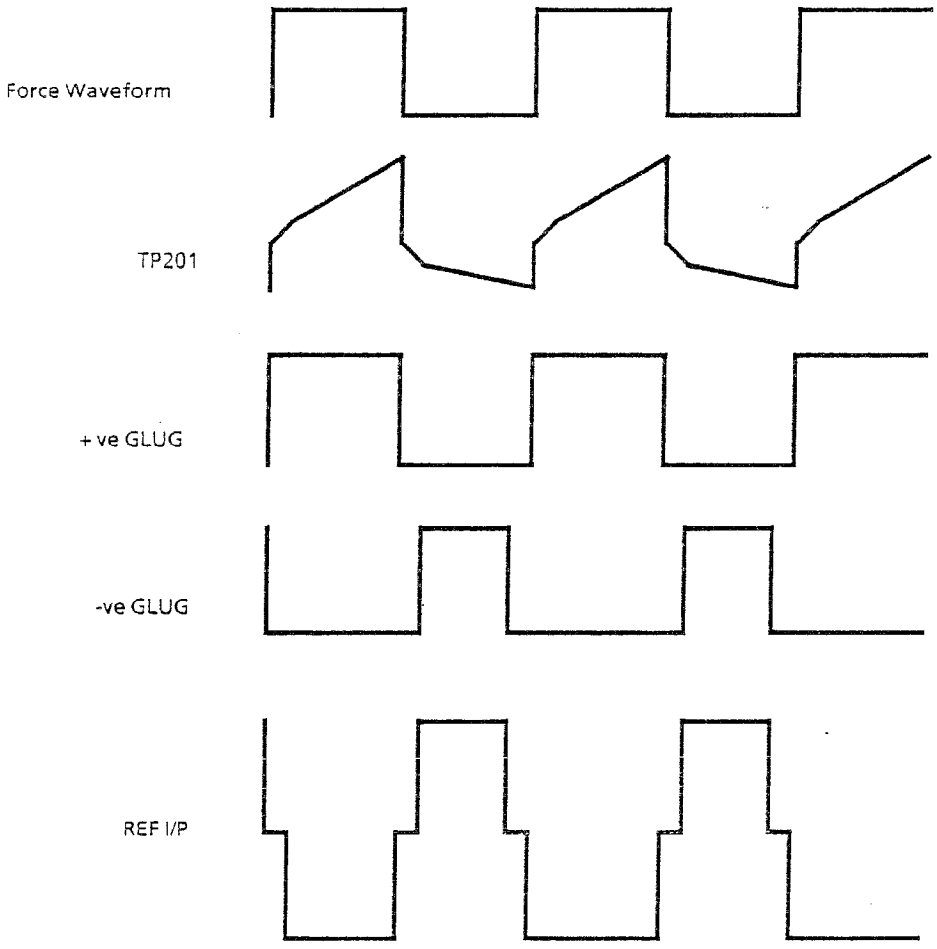


Fig 1.11 *Integrator Waveforms with Reference Voltage Applied*

The state of the comparator outputs are followed by the two slave bistables which clock the signal through the two GLUG FET drivers, controlling the +10V and -10V reference switches alternatively (through 0V) to the integrator input. This closed loop feedback arrangement ensures that the integrator output will always remain dynamically balanced about zero. Any tendency to drift is automatically corrected as it would otherwise cause an offset in the ramp waveform.

6.5.1 Test Points

The following test points shown in Table 1.6 are provided to assist in printed circuit board fault finding.

Table 1.6 *Integrator, Test Points*

TEST POINT (TP)	SIGNAL
201	Integrator output
202	-Glug drive
203	+Glug drive
204	+Glug
205	0V
206	-Glug

6.6 REFERENCE

The reference circuit is shown in Fig 6.9, Sheet 5. This circuit block generates the highly stable +10V and -10V reference voltages for the A-to-D convertor and for the ohms current source. The low impedance reference sources are located at the star points.

The +10V reference is produced by IC301 and TR301 with R303 and zener diode D301. D301 is the precision reference diode within the voltmeter and it provides an accurate voltage of 6.15V to the input of IC301. The gain of the circuit is set by R303 a and b to give an output of +10 volts at TP301. This +10V is inverted by IC302 and TR302 with R302a and b to produce the -10V. IC301 buffers the reference source and IC302 and R302 a, b determine the zero of the A-to-D convertor, as they are used to centre the reference voltages. The 10V Zener ensures that at power-up the reference circuit starts up in the correct direction. (N.B. This circuit has two stable operating states).

IC303 switches between +10V and -10V to generate the forcing waveform for the integrator.

6.6.1 Test Points

The following test points shown in Table 1.7 are provided to assist in printed circuit board fault finding.

Table 1.7 *Reference, Test Points*

TEST POINT (TP)	SIGNAL
301	+10V ref
302	-10V ref
303	0V

6.7 OHMS CURRENT SOURCE

The ohms current source circuit is shown in Fig 6.9, Sheet 6. True 4-terminal resistance measurements are made with the 7061/62, since the current source is floating with an independent power supply. Using this measurement technique, resistance is measured by passing a known current through the unknown resistance and measuring the voltage developed across it. The resistance current source generated by this circuit block is fed into the input switching circuit via input I Hi. The second input I Lo is used to sink the return current.

This circuit produces three constant current of 10 microamps, 100 microamps and 1 milliamp. The +10V, -10V Reference is applied across a network of precision resistors R602, R603 and R604. As a result, a stable voltage of 5V is developed across R603. IC602 compares this voltage with the voltage across its inverting input, across resistors R605, R606 and R607. Once of these voltages are switched in response to the current range 10 microamps, 100 microamps or 1 milliamp, selected from the logic decode circuit.

The open circuit voltage at the output is limited by TR603 and D603, 604. On ranges below 2 Megohms, IC605b shorts across D604 reducing the open circuit voltage to a maximum of 15V. On the 2 Megohms range the maximum voltage is 26V. TR602 limits the reverse voltage and D602 protects against applied voltages. The low current path is via R612, 611 and 610, switched in by the current range selection to the -10V reference.

The output from IC602 varies the drive to the he FET, keeping the energising current to the unknown resistance at a constant value.

6.8 AC TRUE RMS CONVERTOR

The ac to dc convertor located within the input switching circuit converts the ac input into a dc voltage representing the rms value of the input, which is then applied to the input dc amplifier. Fig 6.9, Sheet 7. shows the circuit of the AC True RMS Convertor.

The input ac signal attenuator provides signal attenuation of 1000, 100, or 1, depending on the voltage range. Attenuation is achieved through relay switching which determines the signal path. The buffer amplifier provides a high input impedance which does not significantly load the attenuator. It also provides a x1 or x10 gain depending on the nominal voltage range.

Module IC702 with its associated components performs the true rms-to-dc conversion, producing a dc output in the range of 0 to 2V. The buffer stage is IC701 and its feedback circuit. The dc balance of IC701 is set by RV701, this is adjusted on production test and should only need adjusting on component failure. The gain of the circuit is switched by IC703b (X1, X10), IC702 is an rms-to-dc convertor. It is fed by the buffer amp and produces a corresponding dc output which is fed into the dc input amp. Relay 705 switches in an extra filter circuit around IC702 when the filter is switched in on the front panel.

The voltage developed across the current shunt resistor (R8) for rms current is fed to the buffer circuit through IC703a and RL704. The buffer gain is X10 for the one current range. TR5 short circuits to produce the RMS (AC + DC) current value.

The input to the buffer amp is peak protected to +-15V by D701 and D702. R705 reduces the current when the diodes fire.

Test point TP701 provides a test aid for use during fault finding. This test point is on the output of the rms-to-dc convertor IC702.

6.9 FLOATING LOGIC

The floating logic circuit is shown in Fig 6.9, Sheet 8. The main function of the floating logic circuit is that of decoding the front panel commands associated with measurement Mode (function), Channel and Range. the circuit is floating with respect to supply 0V. Data transfer from the data bus latches (Figure 5-6.) on the Earthy side is achieved by means of opto-couplers. The four PROMs decode the information sent from the data bus when address by the microprocessor and this decoded logic drives the appropriate relay/FET switches in the analog circuitry.

Also shown on the floating logic circuit is a 16 way socket SK802, which connects the appropriate scanner control lines to the scanner option board (see Chapter 5).

6.10 FLOATING POWER SUPPLY

The floating power supply circuit is shown in Fig 6.9, Sheet 9. This circuit generates the floating power for the analog circuits of PCB 15.

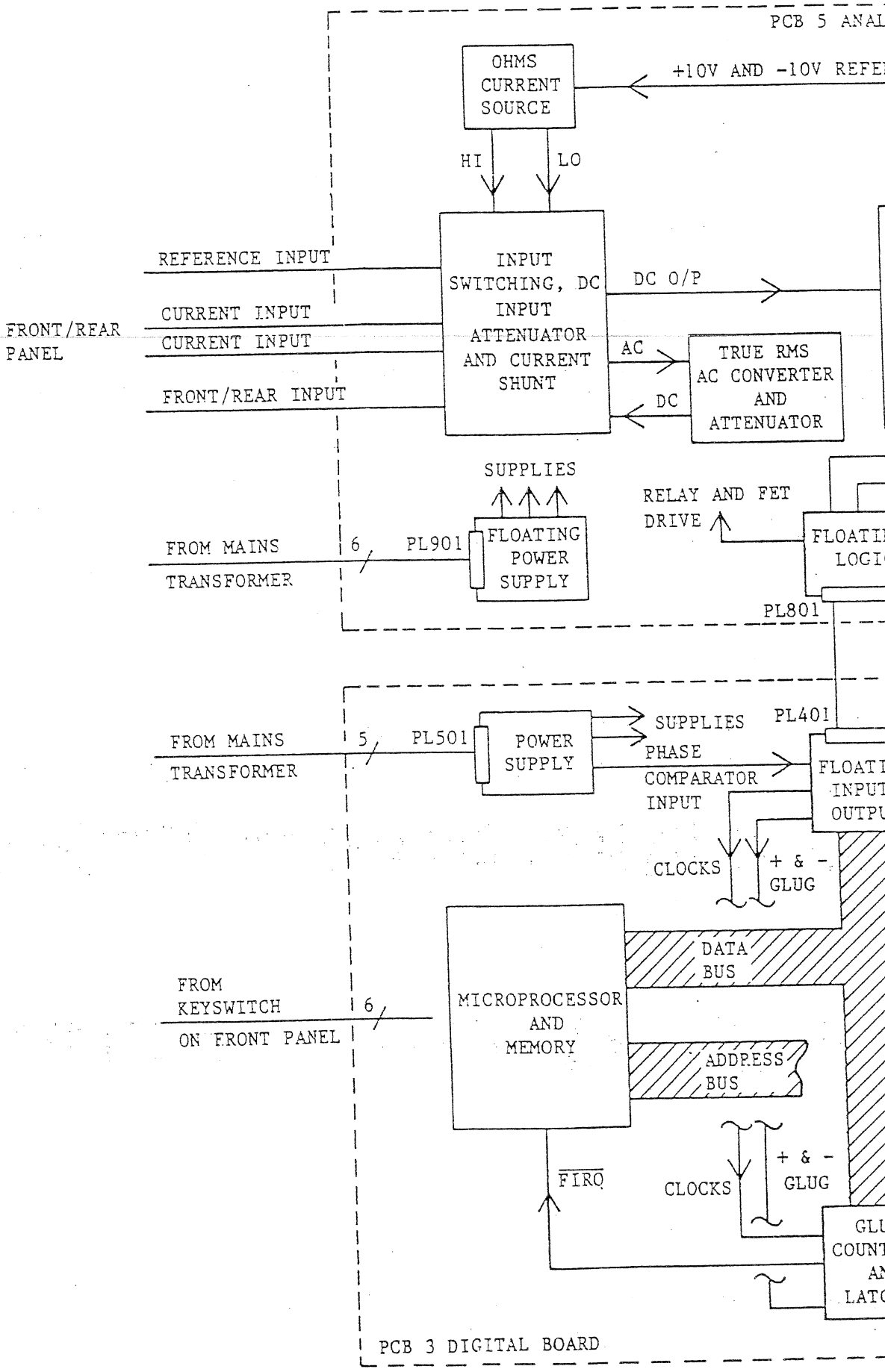
The dc supply rails are produced from the floating secondary windings of a mains transformer, via bridge rectifiers and the appropriate voltage regulators.

6.10.1 Test Points

The following test points shown in Table 1.8 are provided to assist in printed circuit board fault finding.

Table 1.8 *Floating Power Supply,Test Points*

TEST POINT (TP)	SIGNAL
901	+36V
902	+15V
903	0VP
904	-15V
905	-36V
906	+5VF
907	0VP


PCB 5 ANAL
OHMS CURRENT SOURCE
+10V AND -10V REFE
HI
LO
REFERENCE INPUT
CURRENT INPUT
CURRENT INPUT
FRONT/REAR INPUT
FRONT/REAR PANEL
INPUT SWITCHING, DC INPUT ATTENUATOR AND CURRENT SHUNT
DC O/P
AC
DC
TRUE RMS AC CONVERTER AND ATTENUATOR
SUPPLIES
RELAY AND FET DRIVE
FLOATI LOGI
FROM MAINS TRANSFORMER
6
PL901
FLOATING POWER SUPPLY
PL801
FROM MAINS TRANSFORMER
5
PL501
POWER SUPPLY
SUPPLIES
PHASE COMPARATOR INPUT
PL401
FLOATI INPUT OUTPU
CLOCKS
+ & - GLUG
DATA BUS
FROM KEYSWITCH ON FRONT PANEL
6
MICROPROCESSOR AND MEMORY
ADDRESS BUS
FIRQ
CLOCKS
+ & - GLUG
GLU COUNT AN LATC
PCB 3 DIGITAL BOARD

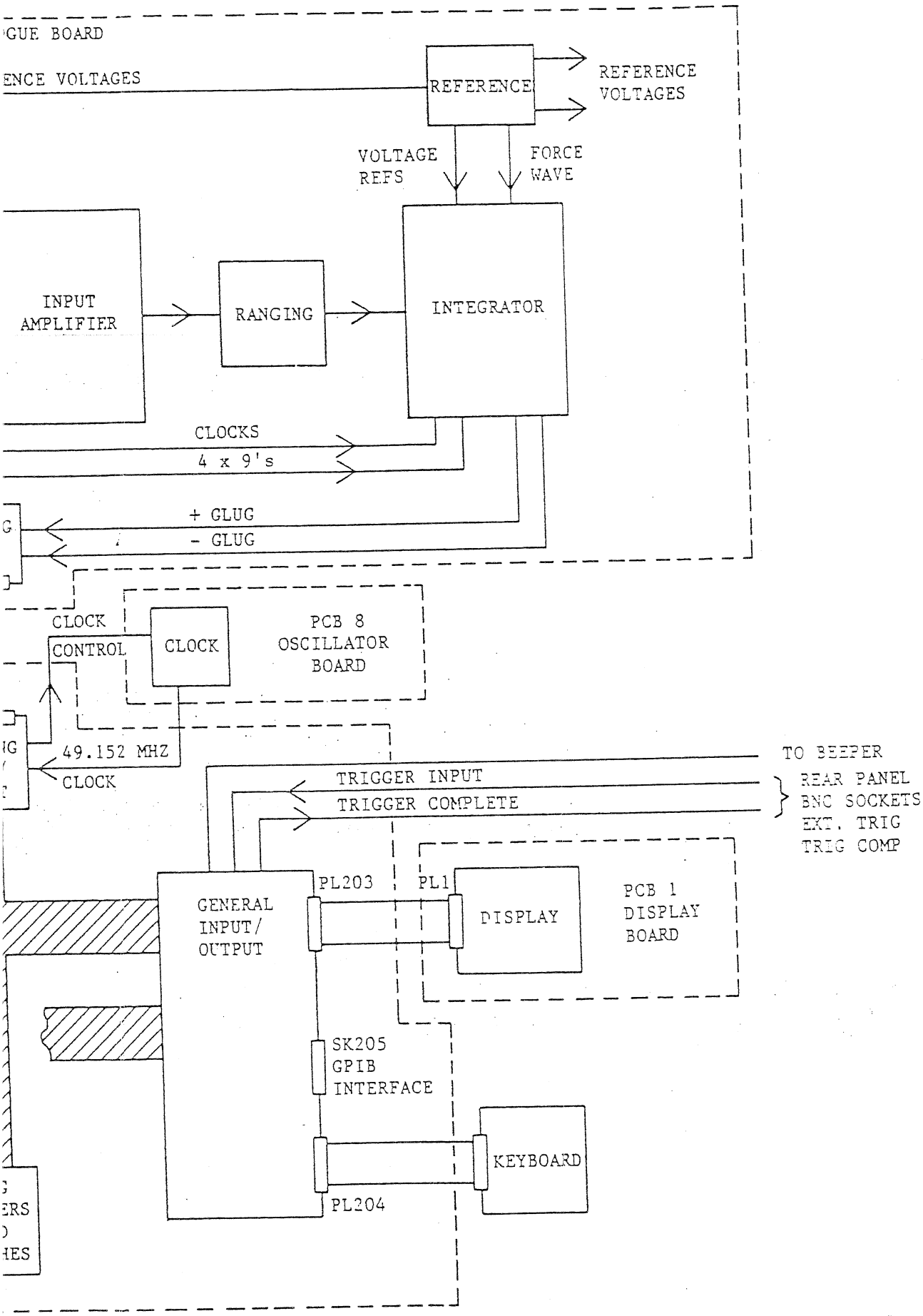
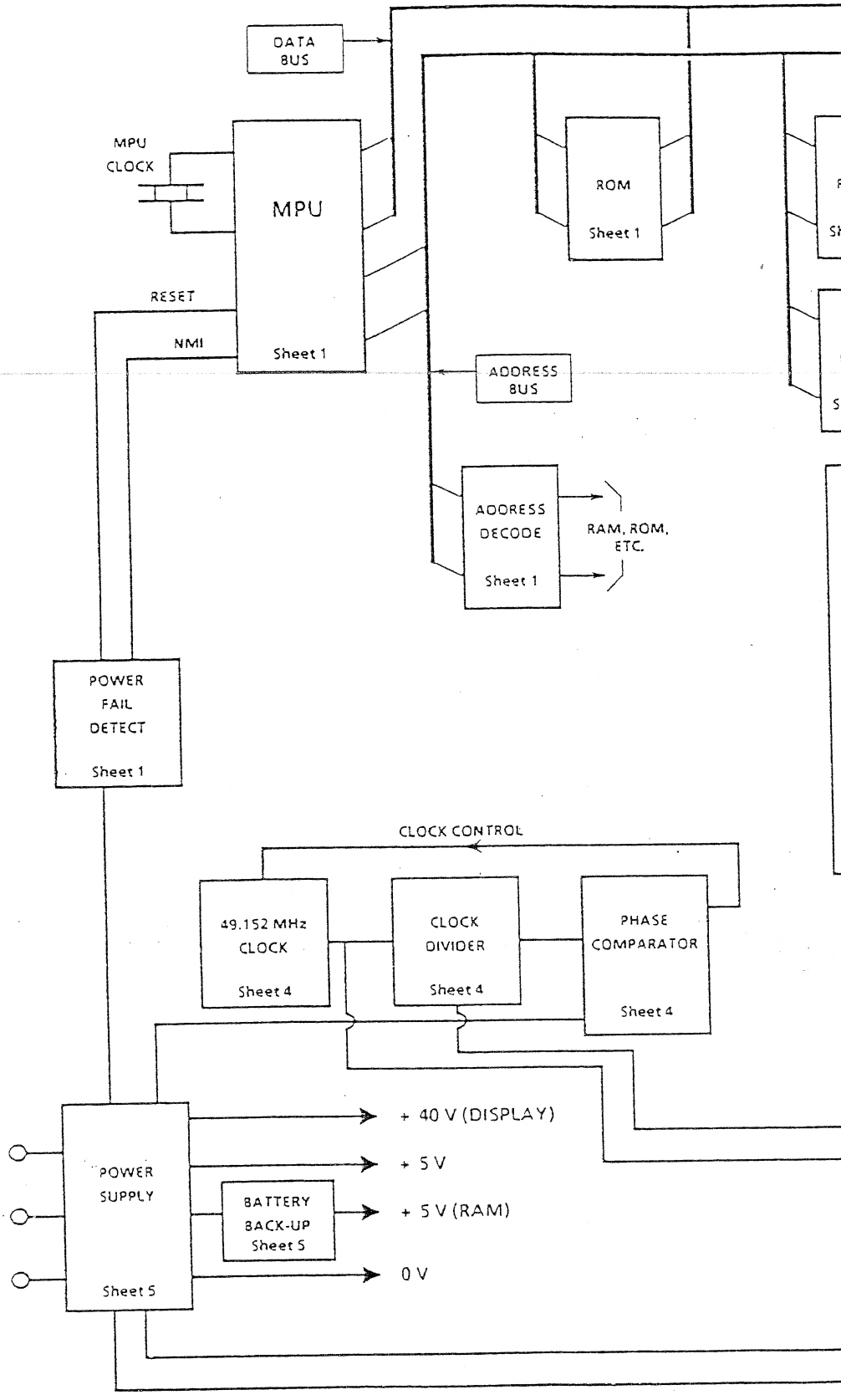


Fig 1-12 *7061 System Voltmeter Simplified Block Diagram*



N.B. Sheet numbers indicate circuit sheets containing the item.

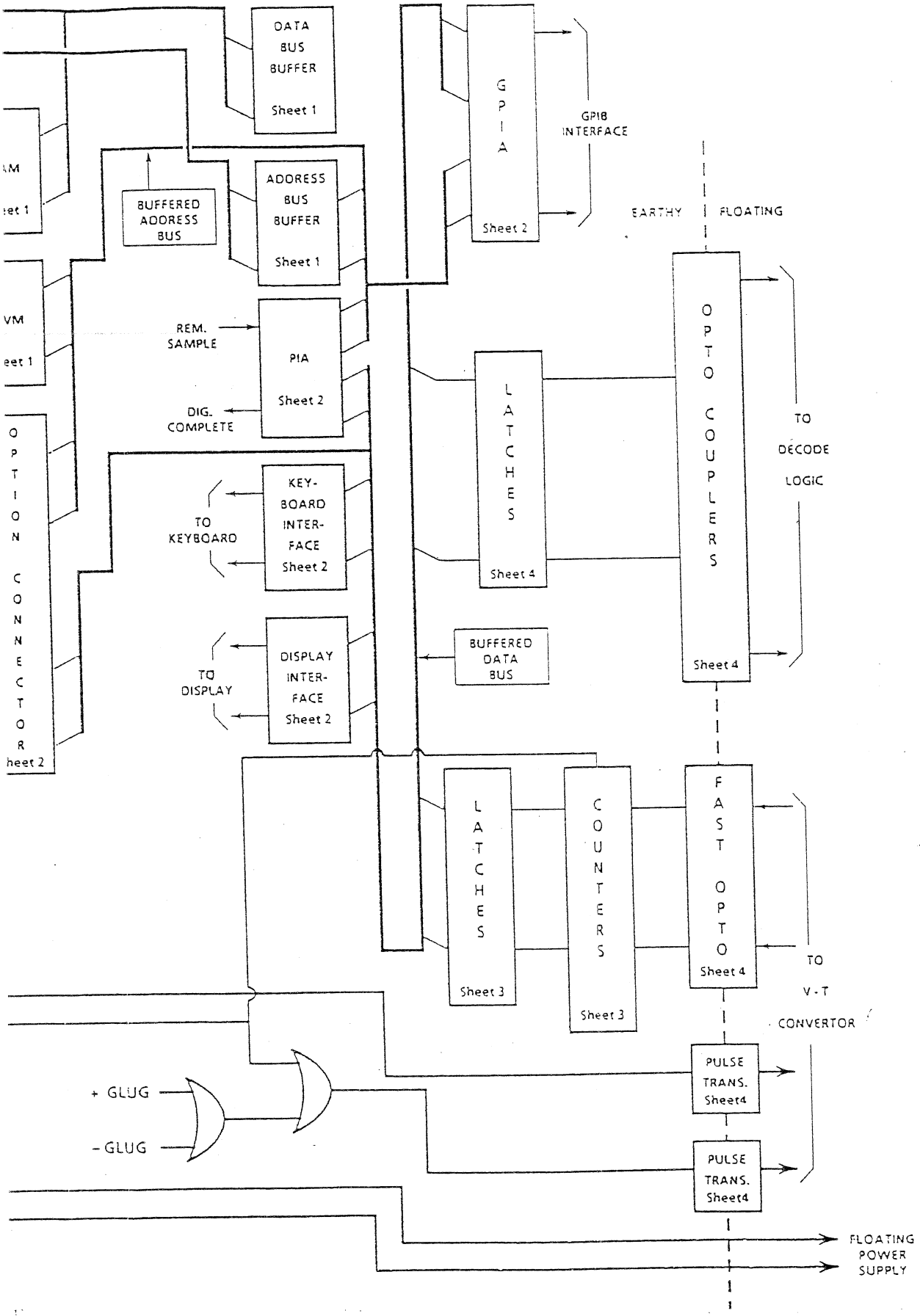
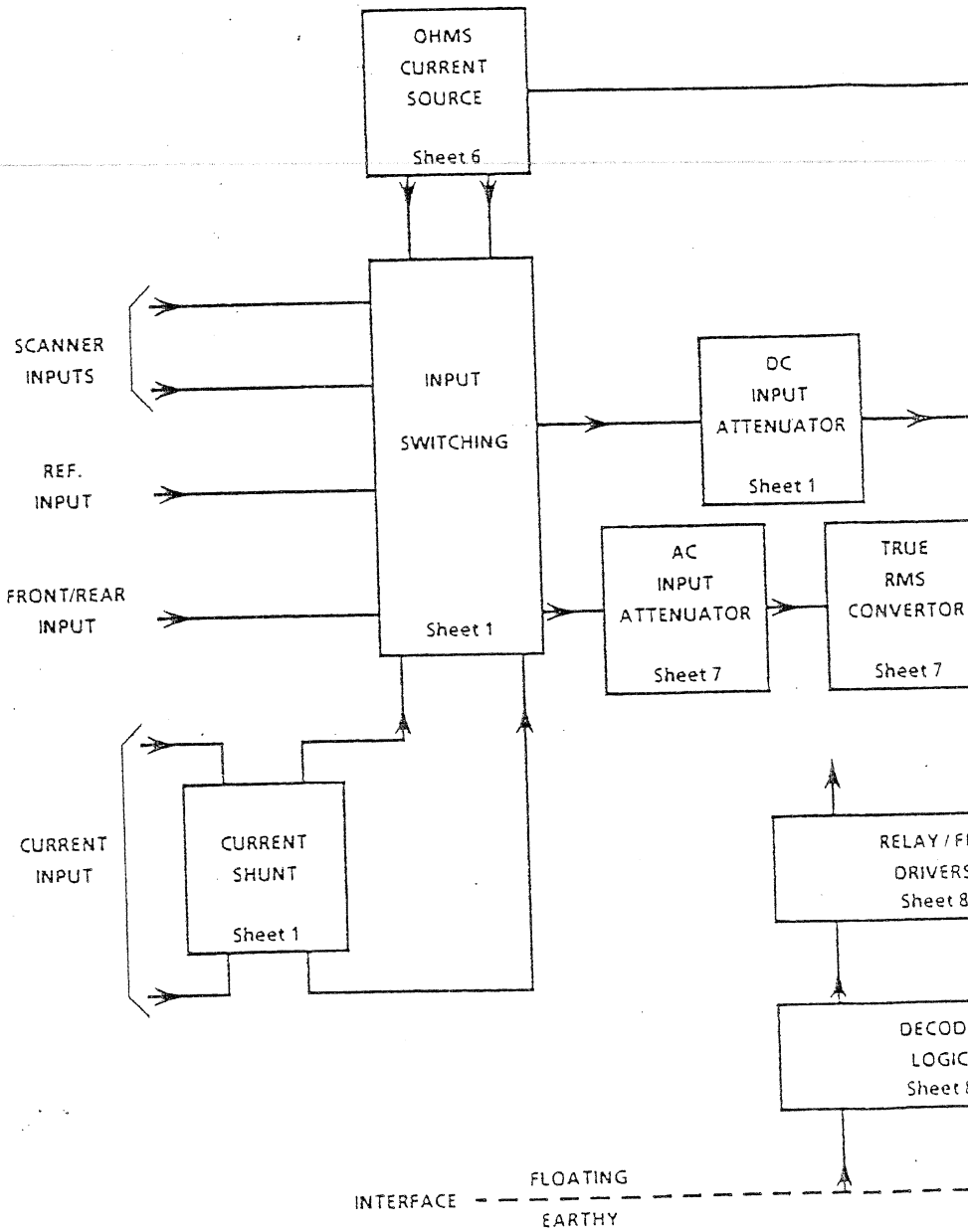


Fig 1-13 *PCB13 and PCB8 Block Diagrams*



N.B. Sheet numbers indicate circuit sheets containing the item.

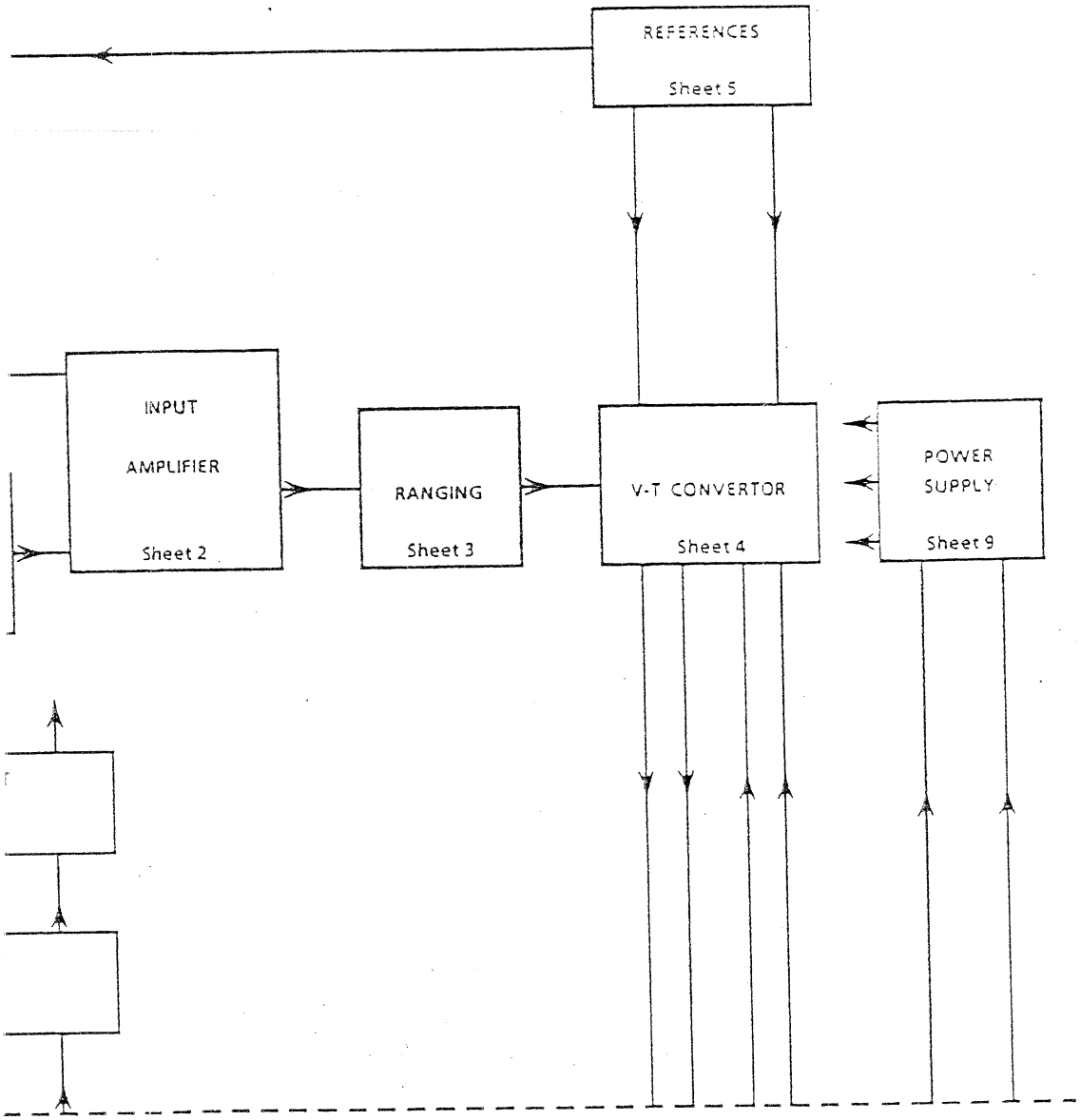


Fig 1-14 *PCB15 Block Diagram*

Chapter 2
Maintenance

Tables

Illustrations

1 INTRODUCTION

This chapter contains information on General Maintenance, a Performance Verification test, Troubleshooting information, Calibration procedures, Disassembly procedures, Repair and Replacement procedures, Reassembly procedures and a Test After Repair procedure. The performance verification test is performed on power up by the microprocessor and if a failure message is displayed the troubleshooting information can be used to aid fault diagnosis to a particular PCB or circuit on a PCB.

The instrument should be calibrated on an annual basis or on completion of any repair which required the top or bottom cover to be removed.

2 GENERAL MAINTENANCE

2.1 CLEANING INSTRUCTIONS

Periodically (at least every 90 days) clean the instrument to remove dust, grease and other contaminants using the following procedure:

1. Switch OFF the instrument at the MAINS switch located on the rear panel.
2. Disconnect the line power cord from the rear of the instrument.
3. Clean the external casing and the front and rear panels using a soft cloth moistened with a mild solution of detergent and water.
4. Reconnect the line power cord at the rear of the instrument.
5. Switch ON the instrument at the MAINS switch located on the rear panel.

2.2 INSPECTION

The instrument should be examined for obvious signs of damage and the following items should be checked:

1. Mechanical damage to the instrument.
2. Presence of all cover securing screws.
3. Presence of all securing screws on rear panel mounted components.
4. Damaged pins or bodies of connectors.
5. Condition of carrying handle.

Ensure that the voltage selector is set to the correct setting and that fuses of the correct type and value are fitted to the instrument (Section 2.4).

If there are no obvious signs of damage to the instrument and the voltage setting and fuses are correct proceed as follows:

1. Connect the mains lead to the rear panel input.

2. Switch ON the instrument at the rear panel MAINS switch.

3. Check that the display reads either '7061 INITIALISED' or '7061 RESUMED'. Any other message indicates an error and reference should be made to the troubleshooting information.

If there are obvious signs of damage or the instrument displays an error message, repairs should be completed before using the instrument.

2.3 VOLTAGE SELECTION

A mains input unit (illustrated in Fig 2.1) is located on the rear panel of the instrument. The selector setting should be set as listed in Table 2.1.

Table 2.1 *Voltage Selection*

MAINS VOLTAGE VARIATION RANGE	VOLTAGE SELECTOR SETTING REQUIRED
90 to 110V	100V
108 to 132V	120V
198 to 242V	220V
216 to 264V	240V

The voltage setting selected is visible through the aperture of the mains input unit. To adjust the voltage selected, proceed as follows:

1. Ensure the instrument is switched OFF at the MAINS switch on the rear panel.

2. Disconnect the mains input lead from the mains input unit on the rear panel.

3. Lever open the hinged flap with a screwdriver.

4. Lift out the voltage selector roller block and refit with the selected voltage value facing outward.

5. Close the flap securely, checking that the selected voltage value is visible through the aperture.

6. Reconnect the mains input lead.

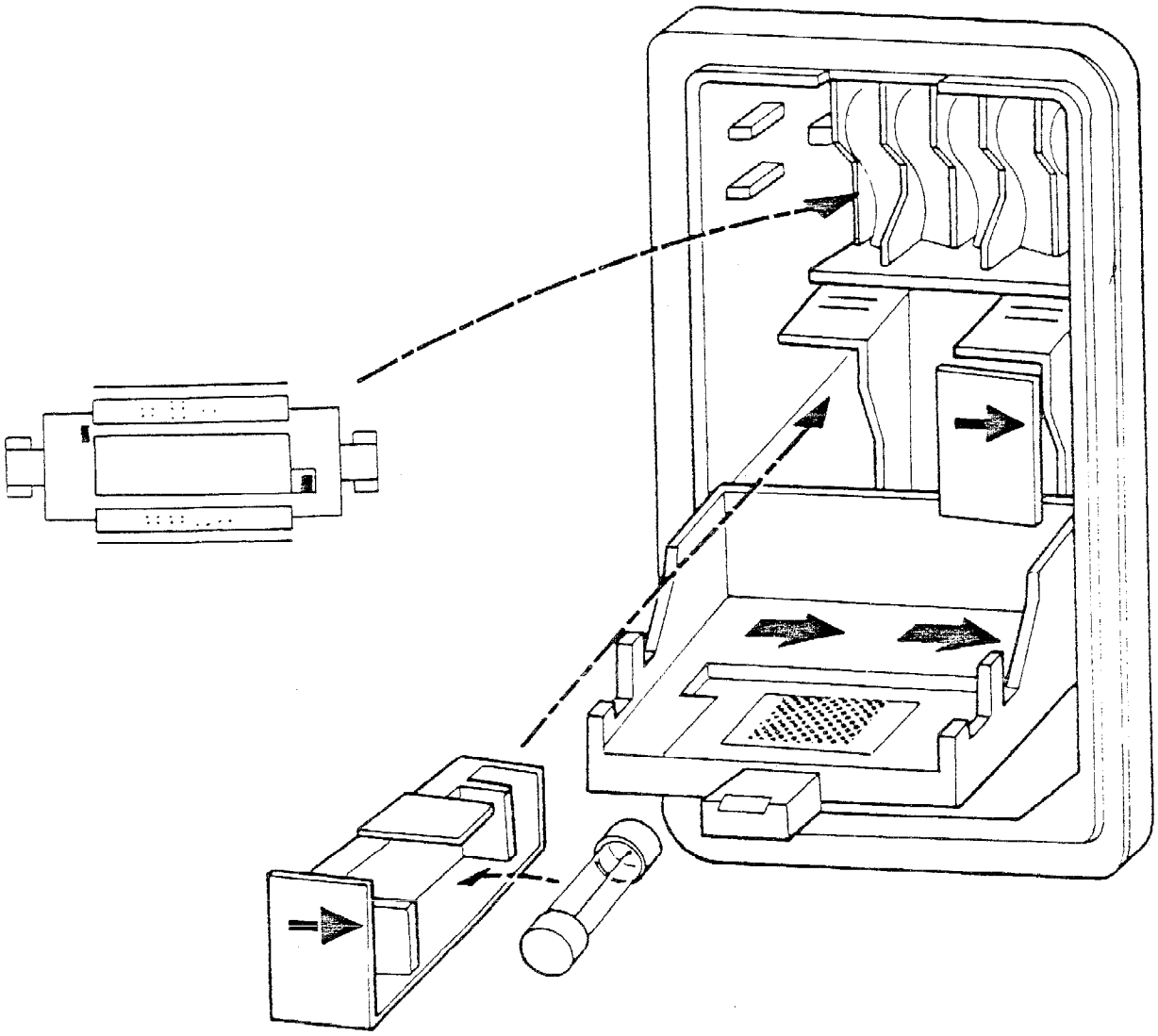


Fig 2.1 *Mains Input Unit*

2.4 FUSES

The instrument has two line fuses and a current protection fuse. The line fuses are located inside the power input unit on the rear panel. The 2A current protection fuse is located on the rear panel current input block.

The value of the line fuses depend upon the voltage selection. Table 2.2 refers.

Table 2-2 *Mains Input Fuses*

VOLTAGE SELECTION	FUSE VALUE	FUSE TYPE
100V or 120V	400mA	SLO-BLO 20mm x 5mm Cartridge
220V or 240V	200mA	SLO-BLO 20mm x 5mm Cartridge

Live and Neutral inputs are fused in the mains input unit of the instrument. To change the line fuses proceed as follows:

1. Ensure the instrument is switched OFF at the rear panel MAINS switch.
2. Disconnect the mains input lead from the mains input unit on the rear panel.
3. Lever open the hinged flap of the mains input unit (See Fig 2.1).
4. Withdraw the fuseholder from the power input unit.
5. Remove the fuse from the fuseholder.
6. Fit replacement fuse in the fuseholder.
7. Refit the fuseholder in the power input unit, taking care to ensure that the arrowheads marked on the fuse holder align with those on the flap.
8. Close the flap securely.
9. Reconnect the DVM power cordd.

The 2A current protection fuse may be replaced by unscrewing the fuse cap, removing the fuse, fitting a replacement fuse and refitting the fuse cap.

3 PERFORMANCE VERIFICATION

3.1 INTRODUCTION

A self test routine which is initiated during power-up checks the operation of the instrument. Error messages are displayed on the front panels and in the event of an error being detected the troubleshooting information will aid fault diagnosis. In addition to the self test routine, the user can verify performance by the use of a manual test routine described in sub-secton 3.3.

3.2 SELF TEST

The self test check is initiated automatically on power-up of the instrument.* To perform the self test proceed as follows:

1. Connect the mains input lead to the mains input unit.
2. Switch ON the instrument at the mains switch on the rear panel.
3. Observe the front panel display message.
4. If the instrument is operational, the display will read either '7061 INITIALISED' or '7061 RESUMED'. Error messages are listed in Table 2.3. If no message is displayed, check the mains input and repeat steps 2. and 3. If no message is displayed refer to the troubleshooting information.

Table 2.3 *Error Messages*

MESSAGE DISPLAYED	NOTES
ROM FAILED	Refer to troubleshooting
RAM FAILED	Refer to troubleshooting
CAL NOT DONE	Carry out calibration
GLUG DEATH †	Refer to troubleshooting

*If the DVM is fitted with 'Mate' (CIIL Software) ROMS, the Self Test is not carried out automatically but may be requested by the user. On request, the following tests will be carried out:

RAM test
ROM test
Non-volatile memory (NVM) test
1V, dc range, analog test (Reading must be 0.000V ± 2000 digits)
10V,dc range, analog test (Reading must be 1 0.000V ± 2000 digits)

If Self Test Option 70616A is fitted to the DVM, the above tests, plus 28 additional analog tests may be carried out. For details of these analog tests, refer to Chapter 1, Section 5.4, of the 7061 Operating Manual.

† The message 'ADC FAIL' replaces 'GLUG DEATH' if 'Mate' ROMS are fitted.

3.3 MANUAL PERFORMANCE TEST

The test equipment required for the performance tests is listed in Table 2.4.

Table 2.4 *Test Equipment Required for Manual Performance Test*

TEST EQUIPMENT	RECOMMENDED INSTRUMENT
DC Voltage Source	Fluke 5440B
AC Voltage Source	Fluke 5215A
Resistors - 1 Kilohm, 10 Kilohm, 1 Megohm and 10 Megohm	+/- 1% Tolerance
Certified Digital Voltmeter	Schlumberger 7061

To carry out the performance tests, switch ON the instrument to be tested and proceed as follows:

1. Input clamp

   Select Vdc, 10V range. Apply an input of +21 volts and then -21 volts through a current measuring DVM. Check that the input current is less than +/- 20 microamps.

2. Input impedance

   Select 10Vdc range. Apply an input of +10 volts dc and note the reading. Insert a 10 Megohm +/- 1% resistor in series with the high lead and allow the reading to settle. This reading should be within the range 0.999 to 1.001 times the original reading.

3. Open circuit ohms voltage

   Connect another DVM with input impedance of $\geq\geq$ 10 Megohms, set to Vdc, autorange, across the input of the DVM under test.

   Switch the DVM under test to the 10 kilohm range. The reading on the other DVM should be between 10 and 14 volts.

   Switch the DVM under test to the 1 Megohm range. The reading on the other DVM should be between 21 and 25 volts.

4. Linearity check

   Select the 10Vdc range.

   Apply accurately known dc voltages of +/- 4.75V, 9.5V, 14.25V and 19.0V.

   Check that all readings are scaled 1:2:3:4 and that the scaling is within the specification 5ppm. rdg +/- 2ppm F.S.

5. Input current

Select the 0.1Vdc range and short circuit the input.

Press the 'NULL' button.

Remove the short circuit and apply a screened 1 Megohm resistor to the input. The reading should be less than 50 microvolts. Select 4 digit operation. The reading should now be less than 2 millivolts.

6. AC frequency response

Select the 10Vac range, filter in, 5 digits.

Apply an input of 10Vac at 1kHz and note the reading.

Increase the frequency to 50kHz. The reading should now be 50 + /- 5 digits higher than the reading at 1kHz.

7. DC common mode rejection

Select Vdc, autorange. Connect a 1 Megohm resistor between input low and high and apply 500Vdc between the high terminal and ground (mains earth). The reading on the 7061 should fall to less than 50 millivolts.

8. AC common mode rejection

Select Vdc autorange. Apply 240Vac, common mode, by connecting a 1 kilohm resistor across the low and high input terminals, then applying the 240Vac between high and ground (mains earth). The reading on the 7061 should not exceed 100 microvolts.

9. Ohms protection

Select the 10 kilohm range. Apply a 10 kilohm +/- 1% resistor and note the reading on the 7061. Remove the 10 kilohm resistor and replace it with a 1 kilohm resistor. Apply 240Vac between high and ground (mains earth) for 10 seconds. Remove the 1 kilohm resistor. Now apply the 10 kilohm resistor. The reading on the 7061 should be within 5 bits of the previous measurement. Select the true ohms range and the reading should remain within 10 bits of the first reading.

10. 1000V input check

Select Vac autorange. Apply a 750V rms 1kHz step voltage and check that the 7061 reaches the 1000V range correctly, displaying a steady reading without overload indications.

If the instrument fails to meet the performance criteria, carry out calibration or repair the instrument.

4 CALIBRATION (7061 and 7062)

Note: Reference must be made to Chapter 4, AC frequency response settings, *before attempting a calibration.*

4.1 INTRODUCTION

Calibration should be performed at yearly intervals or after any repair which requires the top or bottom covers to be removed.

The recommended test equipment is listed in Table 2.5. If the recommended equipment is not available, replacements with equivalent specifications may be used.

Table 2.5 *Test Equipment Required for Calibration*

TEST EQUIPMENT	RECOMMENDED INSTRUMENT
DC Voltage source traceable to National Standards within 5 ppm	Fluke 5440B
AC Voltage source traceable to National Standards within 100 ppm	Fluke 5200 with 5215A
Resistors traceable to NationalStandards within 5 ppm	Fluke 5450A
DC current source traceable to National Standards within 100 ppm	Fluke 5100A
AC current source traceable to National Standards within 100 ppm	Fluke 5100A

4.2 PREPARATION

The following procedure should be performed on the instrument to be calibrated:

1. Install the DVM in a temperature stable environment at 20(23, U. S.) +/- 1 deg. C.

2. Switch ON, wait 10 seconds then press RESET followed by the ENTER key.

3. Allow 3 hours minimum for the DVM to reach operating temperature.

Notes ...

If it becomes necessary to abort any of the following calibrate commands, this can be achieved by pressing the MENU key at any time during the key press sequence.

When the instrument is recalibrated, the limits of error quoted in the specification will apply relative to the standards that were used for this calibration.

4.3 7061 CALIBRATION

4.3.1 Zero Calibration

Perform the following:

a. Set the FRONT/REAR switch to FRONT.

b. Short circuit the FRONT INPUT and the REF. INPUT at the rear of the instrument.

c. Set the CAL/NORMAL switch to CAL.

d. Select 10Vdc range.

e. Allow the reading to settle for a minimum of 20 seconds and then perform the key sequences listed in Table 2.6.

f. Repeat step (e) for the following ranges in turn, 1V, 0.1V, 1000V and 100V.

Note ...
Each calibration cycle takes approximately 15 seconds.

g. Zero calibration is now complete.

Table 2.6 7061 *Zero Calibration Key Sequence*

KEY	RESULTING DISPLAY
MENU	Reading
RESET	CALIBRATE
ENTER	ZERO
ENTER	CAL IN PROGRESS
	READY
	Reading

4.3.2 Resistance Calibration

Perform the following:

a. Select the OHMS mode of operation

b Select the 0.1 kilohm range and connect the input in a four terminal configuration to a 0.1 kilohm resistor.

c Perform the sucession of range chsnges/input changes/key selections listed in Table 2.7.

Note..
Allow 20 seconds settling time for the ranges up to 100 kilohm and at least one minutes settling time for the 1000 and 10,000 kilohm ranges.

d. Resistance calibration is now complete.

Table 2.7 *7061 Resistance Calibration*

RANGE	INPUT (nominal)	KEY PRESS SEQUENCE					
		1	2	3	4	5#	6
0.1 Kohm	0.1 Kohm	MENU	RESET	ENTER	HIGH	= value	ENTER
1.0 Kohm	1.0 Kohm	MENU	RESET	ENTER	HIGH	= value	ENTER
10 Kohm	10 Kohm	MENU	RESET	ENTER	HIGH	= value	ENTER
100 Kohm	100 Kohm	MENU	RESET	ENTER	HIGH	= value	ENTER
1000 Kohm	1000 Kohm	MENU	RESET	ENTER	HIGH	= value	ENTER
10000 Kohm	OPEN CIRCUIT	MENU	RESET	ENTER	OPEN*		ENTER
10000 Kohm	10000 Kohm	MENU	RESET	ENTER	HIGH	= value	ENTER

\# The value of the known resistor can be between 0.75 and 2.1 times the nominal value. This value should be entered on key press 5 in the sequence.

* The HIGH/OPEN option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

4.3.3 DC Voltage Calibration

Perform the following:

a Select VOLTS DC, mode of operation.

b Select the 1.0Vdc range and connect the input to a nominal 1.0Vdc source.

c Perform the succession of range changes/input changes/key selections listed in table 2.8.

d. DC voltage calibration is now complete.

Note..
Allow at least 30 seconds settling time for all inputs.

The frequency of all inputs should be 1kHz

Table 2.8 *7061 DC Voltage Calibration*

RANGE	INPUT (nominal)	KEY PRESS SEQUENCE					
		1	2	3	4*	5#	6
1.0 Vdc	1.0 Vdc	MENU	RESET	ENTER	HIGH	= value	ENTER
0.1 Vdc	0.1 Vdc	MENU	RESET	ENTER	HIGH	= value	ENTER
10 Vdc	10 Vdc	MENU	RESET	ENTER	HIGH	= value	ENTER
100 Vdc	100 Vdc	MENU	RESET	ENTER	HIGH	= value	ENTER
1000 Vdc	1000 Vdc	MENU	RESET	ENTER	HIGH	= value	ENTER

* The HIGH/OPEN option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

\# The value of the known voltage can be between 0.75 and 2.1 times the nominal value. This value should be entered on key press 5 in the sequence.

4.3.4 AC Voltage Calibration

Perform the following:

a. Select VOLTS AC, 5 DIGIT mode of operation.

b. Select the 0.1Vac range and connect the input to a nominal 0.01Vac, 1kHz source.

c. Using a flat bladed screwdriver, loosen the four dzus fasteners securing the top cover by turning them a quarter turn anti-clockwise.

d. Remove top cover by lifting the rear upwards until the dzus fasteners are clear, then slide cover backwards to clear the lip on the front of the cover.

e. Allow approximately 20 minutes for the instrument to stabilise.

f. Perform the succession of range changes/input changes/key selections listed in Table 2.9.

Note ...
Allow at least 30 seconds settling time for all inputs.

The frequency of all inputs should be 1kHz

Table 2.9 *7061 AC Voltage Calibration*

RANGE	INPUT (nominal)	KEY PRESS SEQUENCE					
		1	2	3	4*	5#	6
0.1 Vac	0.01 Vac	MENU	RESET	ENTER	LOW	= value	ENTER
0.1 Vac	0.1 Vac	MENU	RESET	ENTER	HIGH	= value	ENTER
1.0 Vac	0.1 Vac	MENU	RESET	ENTER	LOW	= value	ENTER
1.0 Vac	1.0 Vac	MENU	RESET	ENTER	HIGH	= value	ENTER
10 Vac	1.0 Vac	MENU	RESET	ENTER	LOW	= value	ENTER
10 Vac	10 Vac	MENU	RESET	ENTER	HIGH	= value	ENTER
100 Vac	10 Vac	MENU	RESET	ENTER	LOW	= value	ENTER
100 Vac	100 Vac	MENU	RESET	ENTER	HIGH	= value	ENTER
1000 Vac	100 Vac	MENU	RESET	ENTER	LOW	= value	ENTER
1000 Vac	750 Vac	MENU	RESET	ENTER	HIGH	= value	ENTER

* The HIGH/LOW option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

\# The value of the known voltage can be between 0.75 and 2.1 times the nominal value. This value should be entered on key press 5 in the sequence.

To adjust the HF AC ATTENUATOR proceed as follows:

a Select the 10Vac range.

b Connect an input of 10Vac at 50kHz

c Using an insulated trimmung tool adjust CV701 on PCB 15, Fig 2.2 (refer to Fig 2.3 for location CV701 on PCB 5), for a reading of 10.0100 plus or minus 5 digits.

d Replace top cover but do not secure.

e Check the reading has remained at 10.0100 plus .or minus 5 digits.. If the reading is out of tolerance, remove the top cover and repeat steps c) to e). Continue to repeat until the reading is within tolerance with the top cover in position.

f Replace top cover by fitting lip under front moulding and secure with dzus fasteners.

g Tighten dzus fasteners by turning a quater turn clockwise.

h AC voltage calibration is now complete.

4.3.5 AC + DC Voltage Calibration

Perform the following:

a. Select VOLTS AC + DC, 5 DIGIT mode of operation.

b. Select the 0.1Vac range and connect the input to a nominal 0.01Vac, 1kHz source.

c. Using a flat bladed screwdriver, loosen the four dzus fasteners securing the top cover by turning them a quarter turn anti-clockwise.

d. Remove top cover by lifting the rear upwards until the dzus fasteners are clear, then slide cover backwards to clear the lip on the front of the cover.

e. Allow approximately 20 minutes for the instrument to stabilise.

f. Perform the succession of range changes/input changes/key selections listed in Table 2.10.

Note ...
Allow at least 30 seconds settling time for all inputs.

The frequency of all inputs should be 1kHz

Table 2.10 *7061 AC+DC Voltage Calibration*

RANGE	INPUT (nominal)	KEY PRESS SEQUENCE					
		1	2	3	4*	5#	6
0.1 Vac+dc	0.01 Vac	MENU	RESET	ENTER	LOW	= value	ENTER
0.1 Vac+dc	0.1 Vac	MENU	RESET	ENTER	HIGH	= value	ENTER
1.0 Vac+dc	0.1 Vac	MENU	RESET	ENTER	LOW	= value	ENTER
1.0 Vac+dc	1.0 Vac	MENU	RESET	ENTER	HIGH	= value	ENTER
10 Vac+dc	1.0 Vac	MENU	RESET	ENTER	LOW	= value	ENTER
10 Vac+dc	10 Vac	MENU	RESET	ENTER	HIGH	= value	ENTER
100 Vac+dc	10 Vac	MENU	RESET	ENTER	LOW	= value	ENTER
100 Vac+dc	100 Vac	MENU	RESET	ENTER	HIGH	= value	ENTER
1000 Vac+dc	100 Vac	MENU	RESET	ENTER	LOW	= value	ENTER
1000 Vac+dc	750 Vac	MENU	RESET	ENTER	HIGH	= value	ENTER

* The HIGH/LOW option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

\# The value of the known voltage can be between 0.75 and 2.1 times the nominal value. This value should be entered on key press 5 in the sequence.

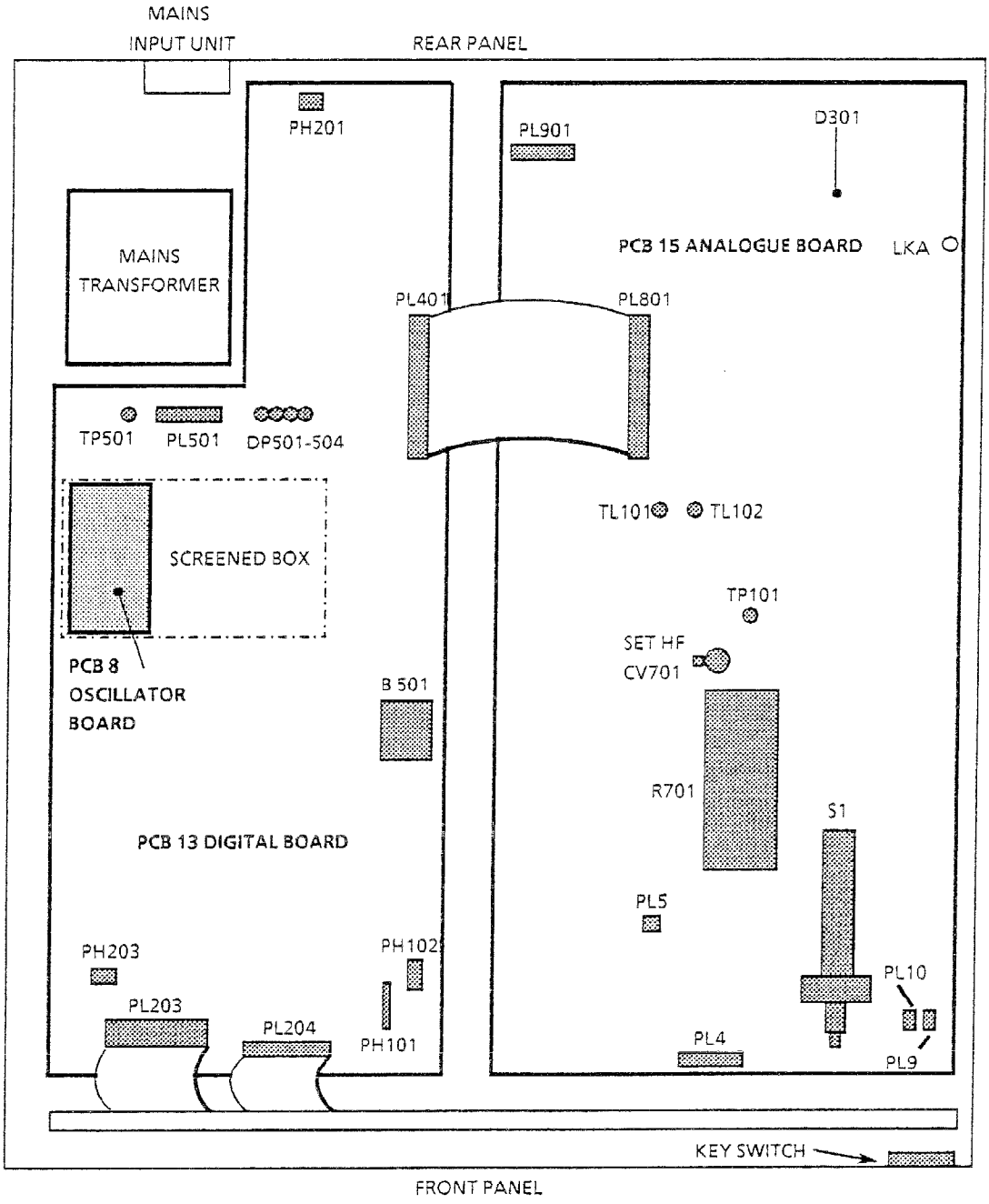


Fig 2.2 *Adjustment of CV701 on PCB1 5*

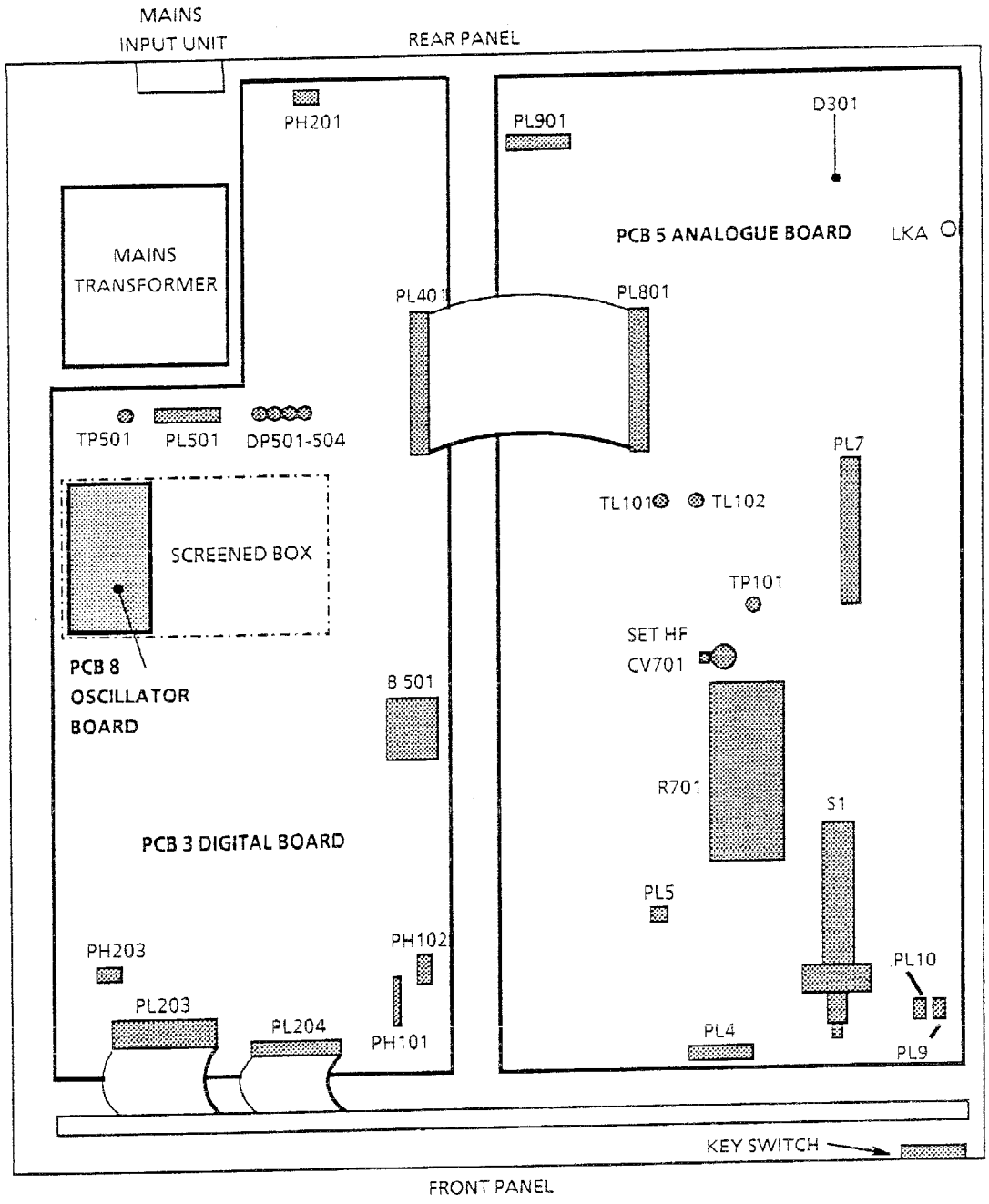


Fig 2.3 *Adjustment of CV701 on PCB 5*

4.3.6 DC Current Calibration

Perform the following:

a. Select CURRENT DC, 6 DIGIT mode of operation.

b. Connect a known current of 1000 milliamps dc to the rear input terminals.

c. Allow 30 seconds for the input to settle.

d. Perform the key sequences listed in Table 2.11.

e. DC current calibration is now complete.

Table 2.11 *7061 DC Current Calibration*

KEY PRESS SEQUENCE				
1	2	3	4	5
MENU	RESET	ENTER	Value #	ENTER

The value of the known current can be between 750 milliamps and 2100 milliamps.

4.3.7 AC Current Calibration

Perform the following:

a. Select CURRENT AC, 5 DIGIT mode of operation.

b. Connect a known current of 100 milliamps, 1kHz to the rear input terminals.

c. Perform the succession of input changes/key presses listed in Table 2.12.

d. AC current calibration is now complete.

Note ...
Allow at least 30 seconds settling time for each input.

Table 2.12 *7061 AC Current Calibration*

INPUT (Nominal)	KEY PRESS SEQUENCE					
	1	2	3	4*	5#	6
100mA 1000mA	MENU MENU	RESET RESET	ENTER ENTER	LOW HIGH	= value = value	ENTER ENTER

* The HIGH/LOW option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

\# The value of the known current can be between 0.75 and 2.1 times the nominal value.

This value should be entered on key press 5 in the sequence.

4.3.8 AC + DC Current Calibration

Perform the following:

a. Select CURRENT AC + DC, 5 DIGIT mode of operation.

b. Connect a known current of 100 milliamps, 1kHz to the rear input terminals.

c. Perform the succession of input changes/key presses listed in Table 2.13.

d. AC + DC current calibration is now complete.

Note ...
Allow at least 30 seconds settling time for each input.

Table 2.13 *7061 AC+DC Current Calibration*

INPUT (Nominal)	KEY PRESS SEQUENCE					
	1	2	3	4*	5#	6
100mA 1000mA	MENU MENU	RESET RESET	ENTER ENTER	LOW HIGH	= value = value	ENTER ENTER

* The *HIGH/LOW* option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

\# The value of the known current can be between 0.75 and 2.1 times the nominal value.

This value should be entered on key press 5 in the sequence.

4.3.9 Calibrate Refresh

During any calibration cycle, the complete non-volatile memory contents may be 'refreshed using the REFRESH command. This command refreshes the contents of the non-volatile memory from the instrument's internal RAM and should only be used infrequently, i.e. at approximately six monthly intervals.

To refresh the non-volatile memory, perform the key sequences listed in Table 2.14.

Table 2.14 *7061 Calibrate Refresh*

KEY	RESULTING DISPLAY LEGEND
MENU	reading
RESET	CALIBRATE
ENTER	ZERO
	DATE
	REFRESH
ENTER	

Note ...

This command takes approximately 20 seconds to execute.

4.3.10 Calibrate Date

This command initially indicates the date of final calibration of the instrument in the factory. The date of calibration should be entered by performing the key sequences listed in Table 2-15.

Table 2.15 *7061 Calibrate Date*

KEY	RESULTING DISPLAY LEGEND
MENU	reading
RESET	CALIBRATE
ENTER	ZERO
	DATE
ENTER	

The new date is entered using the numeric keypad on the right of the instrument front panel, followed by the ENTER key.

When the instrument is recalibrated, the limits of error quoted in the specification will apply relative to the standards that were used for this calibration

4.4 7062 CALIBRATION

4.4.1 Zero Calibration

Perform the following:

a. Set the FRONT/REAR switch to FRONT.

b. Short circuit the FRONT INPUT and the REF. INPUT at the rear of the instrument.

c. Set the CAL/NORMAL switch to CAL.

d. Select 10Vdc range.

e. Allow the reading to settle for a minimum of 20 seconds and then perform the key sequences listed in Table 2.16.

f. Repeat step (e) for the following ranges in turn, 1V, 0.1V, 1000V and 100V.

Note ...
Each calibration cycle takes approximately 15 seconds.

g. Zero calibration is now complete.

Table 2.16 *7062 Zero Calibration Key Sequence*

KEY	RESULTING DISPLAY LEGEND
RESET	INITIALISE
	CALIBRATE
ENTER	ZERO
ENTER	CAL IN PROGRESS
	READY
	Reading

4.4.2 Resistance Calibration

Perform the following:

a. Select the OHMS mode of operation.

b. Select the 0.1 kilohm range and connect the input in a four terminal configuration to a 0.1 kilohm resistor.

c. Perform the succession of range changes/input changes/ key selections listed in Table 2.17.

d. Resistance calibration is now complete.

Note ...
Allow 20 seconds settling time for ranges up to 100 kilohm and at least one minutes settling time for the 1000 and 10,000 kilohm ranges.

Table 2.17 *7062 Resistance Calibration*

RANGE	INPUT (nominal)	KEY PRESS SEQUENCE					
		1	2	3	4	5#	6
0.1 Kohm	0.1 Kohm	RESET	ENTER	ENTER	HIGH	= value	ENTER
1.0 Kohm	1.0 Kohm	RESET	ENTER	ENTER	HIGH	= value	ENTER
10 Kohm	10 Kohm	RESET	ENTER	ENTER	HIGH	= value	ENTER
100 Kohm	100 Kohm	RESET	ENTER	ENTER	HIGH	= value	ENTER
1000 Kohm	1000 Kohm	RESET	ENTER	ENTER	HIGH	= value	ENTER
10000 Kohm	OPEN CIRCUIT	RESET	ENTER	ENTER	OPEN*		ENTER
10000 Kohm	10000 Kohm	RESET	ENTER	ENTER	HIGH	= value	ENTER

\# The value of the known resistor can be between 0.75 and 2.1 times the nominal value. This value should be entered on key press 5 in the sequence.

* The HIGH/OPEN option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

4.4.3 DC Voltage Calibration

Perform the following:

a. Select VOLTS DC mode of operation.

b. Select the 1.0Vdc range and connect the input to a nominal 1.0Vdc source.

c. Perform the succession of range changes/input changes/ key selections listed in Table 2.18.

d. DC voltage calibration is now complete.

Note ..
Allow at least 30 seconds settling time for all ranges.

Table 2.18 *7062 DC Voltage Calibration*

RANGE	INPUT (nominal)	KEY PRESS SEQUENCE				
		1	2	3*	4#	5
1.0 Vdc	1.0 Vdc	RESET	ENTER	HIGH	= value	ENTER
0.1 Vdc	0.1 Vdc	RESET	ENTER	HIGH	= value	ENTER
10 Vdc	10 Vdc	RESET	ENTER	HIGH	= value	ENTER
100 Vdc	100 Vdc	RESET	ENTER	HIGH	= value	ENTER
1000 Vdc	1000 Vdc	RESET	ENTER	HIGH	= value	ENTER

* The HIGH/OPEN option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

\# The value of the known voltage can be between 0.75 and 2.1 times the nominal value.

This value should be entered on key press 5 in the sequence.

4.4.4 AC Voltage Calibration

Perform the following:

a. Select VOLTS AC, 5 DIGIT mode of operation.

b. Select the 0.1Vac range and connect the input to a nominal 0.01Vac, 1kHz source.

c. Using a flat bladed screwdriver, loosen the four dzus fasteners securing the top cover by turning them a quarter turn anti-clockwise.

d. Remove top cover by lifting the rear upwards until the dzus fasteners are clear, then slide cover backwards to clear the lip on the front of the cover.

e. Allow approximately 20 minutes for the instrument to stabilise.

f. Perform the succession of range changes/input changes/key selections listed in Table 2.19.

Note ...
Allow at least 30 seconds settling time for all inputs.

The frequency of all inputs should be 1kHz.

Table 2.19 *7062 AC Voltage Calibration*

RANGE	INPUT (nominal)	KEY PRESS SEQUENCE				
		1	2	3*	4#	5
0.1 Vac	0.01 Vac	RESET	ENTER	LOW	= value	ENTER
0.1 Vac	0.1 Vac	RESET	ENTER	HIGH	= value	ENTER
1.0 Vac	0.1 Vac	RESET	ENTER	LOW	= value	ENTER
1.0 Vac	1.0 Vac	RESET	ENTER	HIGH	= value	ENTER
10 Vac	1.0 Vac	RESET	ENTER	LOW	= value	ENTER
10 Vac	10 Vac	RESET	ENTER	HIGH	= value	ENTER
100 Vac	10 Vac	RESET	ENTER	LOW	= value	ENTER
100 Vac	100 Vac	RESET	ENTER	HIGH	= value	ENTER
1000 Vac	100 Vac	RESET	ENTER	LOW	= value	ENTER
1000 Vac	750 Vac	RESET	ENTER	HIGH	= value	ENTER

* The HIGH/LOW option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

\# The value of the known voltage can be between 0.75 and 2.1 times the nominal value.

This value should be entered on key press 5 in the sequence.

To adjust the HF AC ATTENUATOR proceed as follows:

a. Select the 10Vac range.

b. Connect an input of 10Vac at 50kHz.

c. Using an insulated trimming tool adjust CV701 on PCB 5 (Refer to Fig 2.2 for location of CV701 on PCB 5) for a reading of 10.0100 plus or minus 5 digits.

d. Replace top cover but do not secure.

e. Check the reading has remained at 10.0100 plus or minus 5 digits. If the reading is out of tolerance, remove the top cover and repeat steps (c) to (e). Continue to repeat until the reading is within tolerance with the top cover in position.

f. Replace top cover by fitting lip under front moulding and secure with dzus fasteners.

g. Tighten dzus fasteners by turning a quarter turn clockwise.

h. AC voltage calibration is now complete.

4.4.5 AC + DC Voltage Calibration

Perform the following:

a. Select VOLTS AC + DC, 5 DIGIT mode of operation.

b. Select the 0.1Vac range and connect the input to a nominal 0.01Vac, 1kHz source.

c. Using a flat bladed screwdriver, loosen the four dzus fasteners securing the top cover by turning them a quarter turn anti-clockwise.

d. Remove top cover by lifting the rear upwards until the dzus fasteners are clear, then slide cover backwards to clear the lip on the front of the cover.

e. Allow approximately 20 minutes for the instrument to stabilise.

f. Perform the succession of range changes/input changes/key selections listed in Table 2.20.

Note ...
Allow at least 30 seconds settling time for all inputs.

The frequency of all inputs should be 1kHz.

Table 2.20 *7062 AC + DC Voltage Calibration*

RANGE	INPUT (nominal)	KEY PRESS SEQUENCE				
		1	2	3*	4#	5
0.1 Vac	0.01 Vac	RESET	ENTER	LOW	= value	ENTER
0.1 Vac	0.1 Vac	RESET	ENTER	HIGH	= value	ENTER
1.0 Vac	0.1 Vac	RESET	ENTER	LOW	= value	ENTER
1.0 Vac	1.0 Vac	RESET	ENTER	HIGH	= value	ENTER
10 Vac	1.0 Vac	RESET	ENTER	LOW	= value	ENTER
10 Vac	10 Vac	RESET	ENTER	HIGH	= value	ENTER
100 Vac	10 Vac	RESET	ENTER	LOW	= value	ENTER
100 Vac	100 Vac	RESET	ENTER	HIGH	= value	ENTER
1000 Vac	100 Vac	RESET	ENTER	LOW	= value	ENTER
1000 Vac	750 Vac	RESET	ENTER	HIGH	= value	ENTER

* The HIGH/LOW option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

\# The value of the known voltage can be between 0.75 and 2.1 times the nominal value.

This value should be entered on key press 5 in the sequence.

To adjust the HF AC ATTENUATOR proceed as follows:

a. Select the 10Vac range.

b. Connect an input of 10Vac at 50kHz.

c. Using an insulated trimming tool adjust CV701 on PCB 5 (Refer to Fig 2.2 for location of CV701 on PCB 15) for a reading of 10.0100 plus or minus 5 digits.

d. Replace top cover but do not secure.

e. Check the reading has remained at 10.0100 plus or minus 5 digits. If the reading is out of tolerance, remove the top cover and repeat steps (c) to (e). Continue to repeat until the reading is within tolerance with the top cover in position.

f. Replace top cover by fitting lip under front moulding and secure with dzus fasteners.

g. Tighten dzus fasteners by turning a quarter turn clockwise.

h. AC + DC voltage calibration is now complete.

4.4.6 DC Current Calibration

Perform the following:

a. Select CURRENT DC, 6 DIGIT mode of operation.

b. Connect a known current of 1000 milliamps dc to the rear input terminals.

c. Allow 30 seconds for the input to settle.

d. Perform the key sequences listed in Table 2.21.

e. DC current calibration is now complete.

Table 2.21 *7062 DC Current Calibration*

KEY PRESS SEQUENCE				
1	2	3	4	5
MENU	RESET	ENTER	Value #	ENTER

The value of the known current can be between 750 milliamps and 2100 milliamps.

4.4.7 AC Current Calibration

Perform the following:

a. Select CURRENT AC, 5 DIGIT mode of operation.

b. Connect a known current of 100 milliamps, 1kHz to the rear input terminals.

c. Perform the succession of input changes/key presses listed in Table 2.22.

d. AC current calibration is now complete

Note ...
Allow at least 30 seconds settling time for each input.

Table 2.22 *7062 AC Current Calibration*

INPUT (Nominal)	KEY PRESS SEQUENCE				
	1	2	3*	4#	5
100mA 1000mA	RESET RESET	ENTER ENTER	LOW HIGH	= value = value	ENTER ENTER

* The HIGH/LOW option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

\# The value of the known current can be between 0.75 and 2.1 times the nominal value.

This value should be entered on key press 5 in the sequence.

4.4.8 AC + DC Current Calibration

Perform the following:

a. Select CURRENT AC + DC, 5 DIGIT mode of operation.

b. Connect a known current of 100 milliamps, 1kHz to the rear input terminals.

c. Perform the succession of input changes/key presses listed in Table 2.23.

d. AC current calibration is now complete

Note ...
Allow at least 30 seconds settling time for each input.

Table 2.23 *7062 AC + DC Current Calibration*

INPUT (Nominal)	KEY PRESS SEQUENCE				
	1	2	3*	4#	5
100mA 1000mA	RESET RESET	ENTER ENTER	LOW HIGH	= value = value	ENTER ENTER

* The HIGH/LOW option is obtained by the use of the ↑ ↓ (skip) keys to the right of the display.

\# The value of the known current can be between 0.75 and 2.1 times the nominal value.

This value should be entered on key press 5 in the sequence.

4.4.9 Calibrate Refresh

During any calibration cycle, the complete non-volatile memory contents may be 'refreshed using the REFRESH command. This command refreshes the contents of the non-volatile memory from the instrument's internal RAM and should only be used infrequently, i.e. at approximately six monthly intervals.

To refresh the non-volatile memory, perform the key sequences listed in Table 2.24.

Table 2.24 *7062 Calibrate Refresh*

KEY	RESULTING DISPLAY LEGEND
RESET ↓ ENTER ↓ ↓ ENTER	INITIALISE CALIBRATE ZERO DATE REFRESH

Note ...
This command takes approximately 20 seconds to execute.

4.4.10 Calibrate Date

This command initially indicates the date of final calibration of the instrument in the factory. The date of calibration should be entered by performing the key sequences listed in Table 2-25.

Table 2.25 *7062 Calibrate Date*

KEY	RESULTING DISPLAY LEGEND
RESET ↓ ENTER ↓	INITIALISE CALIBRATE ZERO DATE

The new date is entered using the numeric keypad on the right of the instrument front panel, followed by the ENTER key.

5 TROUBLESHOOTING

5.1 INTRODUCTION

Troubleshooting information for the 7061 consists of a series of text and flow charts. *For details of how to disassemble the isntrument refer to Disassembly procedures.*

On power-up the instrument performs a self-test check and any faults found are reported via front panel error messages.

5.2 TROUBLESHOOTING SEQUENCE

Switch ON the instrument and observe the front panel. If the instrument is operational, the display will read '7061 INITIALISED' or '7061 RESUMED'. Error messages and suggested actions are listed in Table 2.26. If the display is blank, check input fuses and check input power supply.

Table 2.26 *Error Messages*

MESSAGE DISPLAYED	ACTION
ROM FAILED	Check IC106 and 107 on PCB 13.
RAM FAILED	Check IC111 and 112, and decode IC103 on PCB 13
CAL NOT DONE	Check IC113 on PCB 13. Carry out calibration.
GLUG DEATH	Refer to Sub-Section 5.3.

5.3 GLUG DEATH

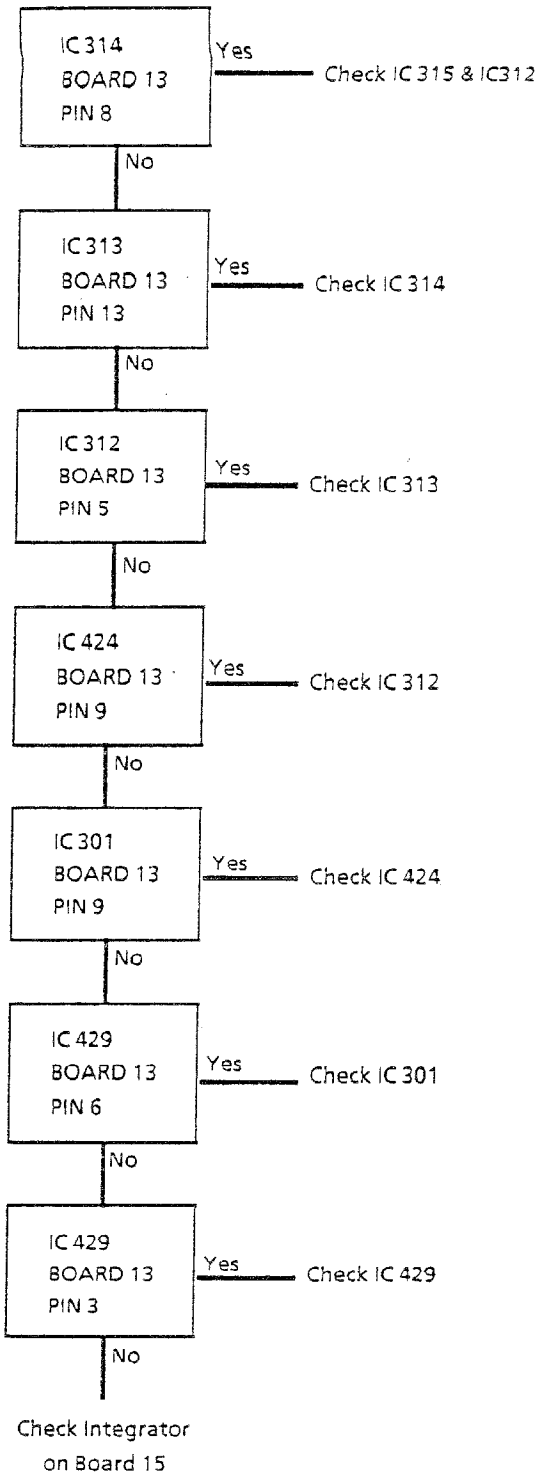
If the display indicates 'GLUG DEATH' (or 'ADC FAIL' if 'Mate' PROMS are fitted) carry out the following:

1. Select VOLTS DC, 5 DIGIT mode of operation.
2. Select the 10Vdc range.
3. Short circuit the input to the instrument.
4. Using an oscilloscope, check for a pulse of approximately 1. 5kHz at the locations indicated in Fig 2.4.

5.4 INTEGRATOR CHECK

The integrator circuit is a loop and it is therefore difficult to pinpoint specific faults without a number of checks. The basic operation of the circuit can be checked as follows:

1. Select VOLTS DC, 5 DIGIT mode of operation.
2. Select 10Vdc range and short circuit the input to the instrument.
3. Ensure that the link between TL101 and TL102 is made.
4. Using an oscilloscope measure the waveforms present on test points TP204 and TP206.



(Refer to Sub-Section 5.3)

Fig 2.4 *Glug Death Checks*

5. The waveform should be as shown in Fig 2.5.

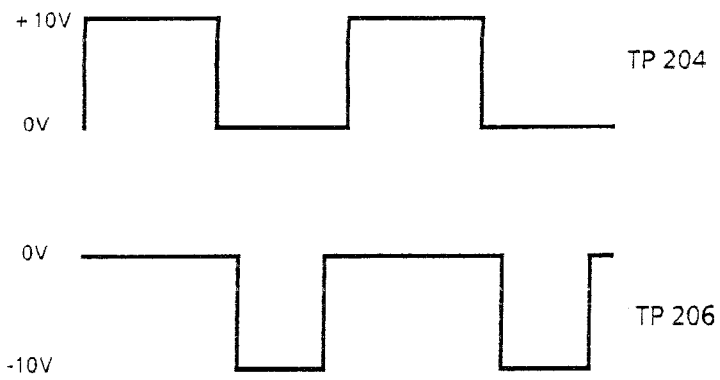


Fig 2.5 *Waveform on Test Points TP204 and TP206*

6. The positive and negative waveforms should be approximately the same width. If the amplitude of either pulse is incorrect, check the reference inputs on TP301 (+10V) and TP302 (-10V). If either of these inputs is incorrect, check the Reference circuit.

7. If no waveform is present, check the Force Wave input on C212. This should be a square wave at 1.5kHz with an amplitude of + and -10V as shown in Fig 2.6. If this square wave is not present check IC303.

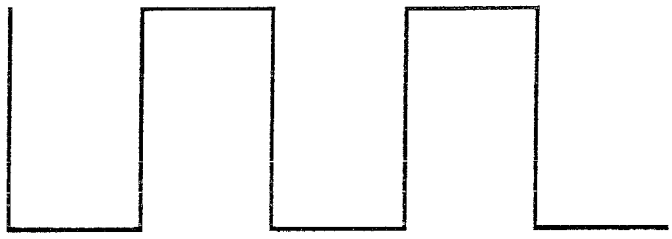


Fig 2.6 *Force Wave Input*

Additional checks of the integrator circuit require the removal of TR201-204 in order to break the loop. These additional checks are therefore intended for workshop use and should only be undertaken if no replacement PCB is available.

Remove TR201-204 and using an oscilloscope check the integrator circuit output at TP201. The waveform should be as shown in Fig 2. 7.

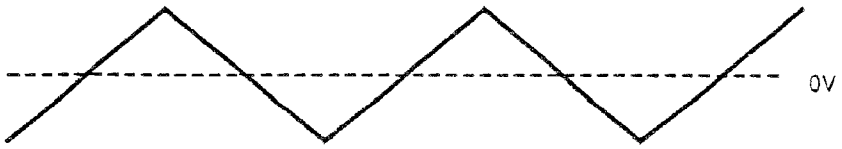


Fig 2.7 *Ramp Output at TP201*

If the waveform on TP201 is incorrect, the most likely cause is a fault in IC201 on IC202.

If the waveform on TP201 is correct, further circuit checks are required. The ramp waveform is passed to comparators IC203A and IC203B. With both comparators biased at 0V the outputs should be as shown in Fig 2.8.

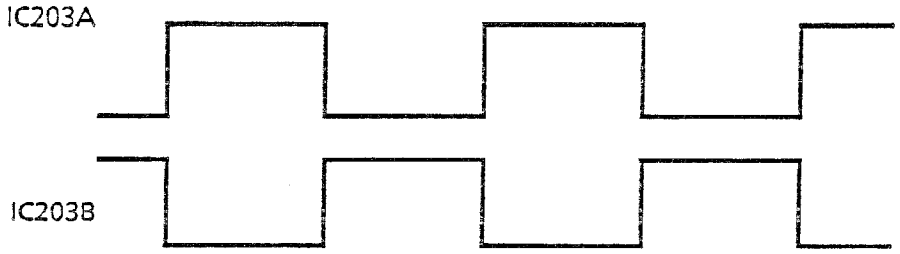


Fig 2.8 *Output From Comparators*

If the waveforms are incorrect, change the IC. If these waveforms are correct, continue by checking the remaining circuit components, i.e. IC204, TR205, 206, 207 and 208 until the faulty component is located. When the faulty component has been replaced, refit TR201-204 and recheck circuit operation as previously described.

5.5 RAM CHECKSUM

During power-up the microprocessor compares the RAM checksum with the stored checksum and if the two are not identical the display will indicate 'INITIALISED' instead of the expected 'RESUMED'. There are three possible reasons for this fault:

1. Possible Fault - the battery voltage (B501) has fallen too low to maintain the RAM.

   Cure - charge the battery by running the instrument for 24 hours. If this fails to cure the fault change the battery and check the charging circuit.
2. Possible Fault - RAM failure.

Cure - Check RAM, IC111 and 112 and if necessary replace.

3. Possible Fault - power fail circuit fault.

   Cure - Check the operation of IC117 and D106. Check R102, 103 and 104. Check the unregulated voltage on TP510 on PCB 3. This voltage should be greater than +9V. If this voltage is low, check the mains supply and D501.

5.6 INPUT AMPLIFIER AND DC RANGING CHECK

If the input amplifier on PCB 5 is suspected as being faulty, perform the following:

1. Select VOLTS DC, 10V range.
2. Set the FRONT/REAR switch to FRONT.
3. Connect an input of between 0 and 20V to the input.
4. Using a voltmeter, check the voltage across TL101(+) and TP101. The voltage should be approximately the same as the input voltage.
5. Change the input voltage to between 0 and 2V.
6. Select 1Vdc range.
7. The voltage on the voltmeter should follow the input and have a gain of 10.
8. Change the input voltage to between 0 and 200 millivolts.
9. Select 0.1Vdc range.
10. The voltage on the voltmeter should follow the input and have a gain of 100.

If any of the checks fails, the gain switching components IC101, 102 and 103 and FET's TR101, 102 and 103 should be checked.

If all ranges checked are incorrect, check IC401, TR412 and the associated components.

If only one range of those checked is correct, the correct range probably contains the faulty switching component.

Note ...
To avoid errors from other circuits, the link between TL101 and TL102 may be broken during the testing of the input amplifier.

6 DISASSEMBLY

6.1 INTRODUCTION

These instructions provide the information necessary to remove all the main assemblies of the instrument. The instrument general view is shown in Fig 2.9.

The instrument layout is shown in Figs 2.2 or 2.3

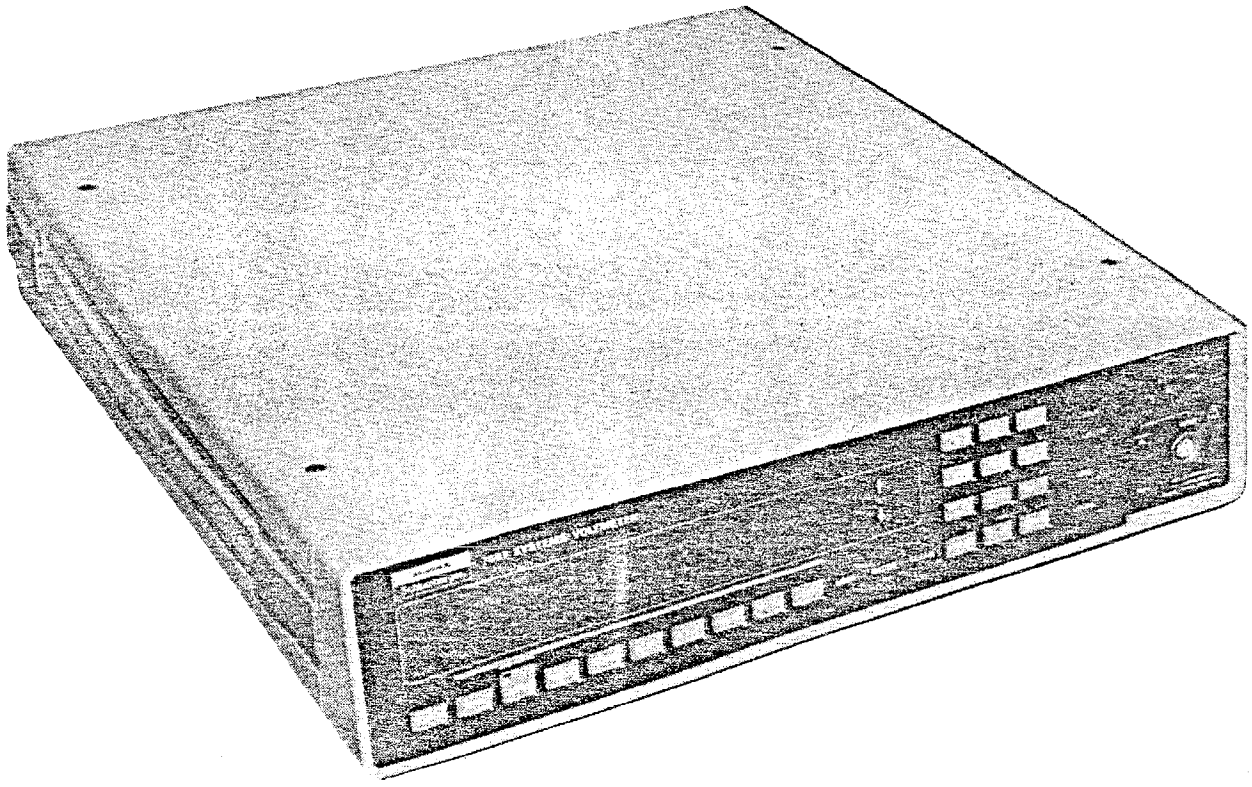


Fig 2.9 *7061 Systems Voltmeter; General View*

6.2 TOP AND BOTTOM COVER REMOVAL (FIG 2.10)

To remove the top cover proceed as follows:

1. Using a flat blade screwdriver loosen the four dzus fasteners by turning them a quarter turn anticlockwise.

2. Remove the cover by lifting the rear upwards until the dzus fasteners are clear, then slide the cover backwards to clear the lip on the front of the cover.

To remove the bottom cover proceed as follows:

1. Turn the instrument upside down so that the bottom cover is uppermost.

2. Using a flat blade screwdriver loosen the four dzus fasteners by turning them a quarter turn anticlockwise.

3. Remove the bottom cover by lifting the rear upwards until the dzus fasteners are clear, then slide the cover backwards to clear the lip on the front.

Note ...
All the removal procedures require the removal of the top and bottom cover and therefore this procedure has not been repeated in individual removal procedures.

6.3 FRONT PANEL REMOVAL (FIG 2.11)

To remove the front panel proceed as follows:

1. Disconnect PL203 and PL204 from PCB 3.

2. Remove three M3 screws which secure the front panel assembly to the front moulding.

3. The front panel keyboard may now be withdrawn from the front of the moulding.

6.4 PCB 1 (DISPLAY BOARD) REMOVAL (FIG 2.11)

Remove the front panel keyboard as previously described in Sub-Section 6.3. Remove six M3 screws and crinkle washers which secure the PCB to the switch assembly. PCB 1 may now be removed.

6.5 SWITCH ASSEMBLY REMOVAL

Remove the front panel keyboard and PCB 1 as detailed in Sub Section 6.3 and 6.4. The switch assembly may now be separated from the six spacers and three brackets.

6.6 BEEPER REMOVAL (FIG 2.11)

To remove the Beeper proceed as follows:

1. Disconnect PL203 from PCB 3.

2. Remove two M2 screws and crinkle washers securing the beeper to the front moulding. The beeper may now be removed from the front moulding.

6.7 FRONT PANEL COMPONENT REMOVAL (FIG 2.11)

In addition to removing the keyboard and beeper, it is possible to remove the keyswitch and the front input socket.

To remove the keyswitch proceed as follows:

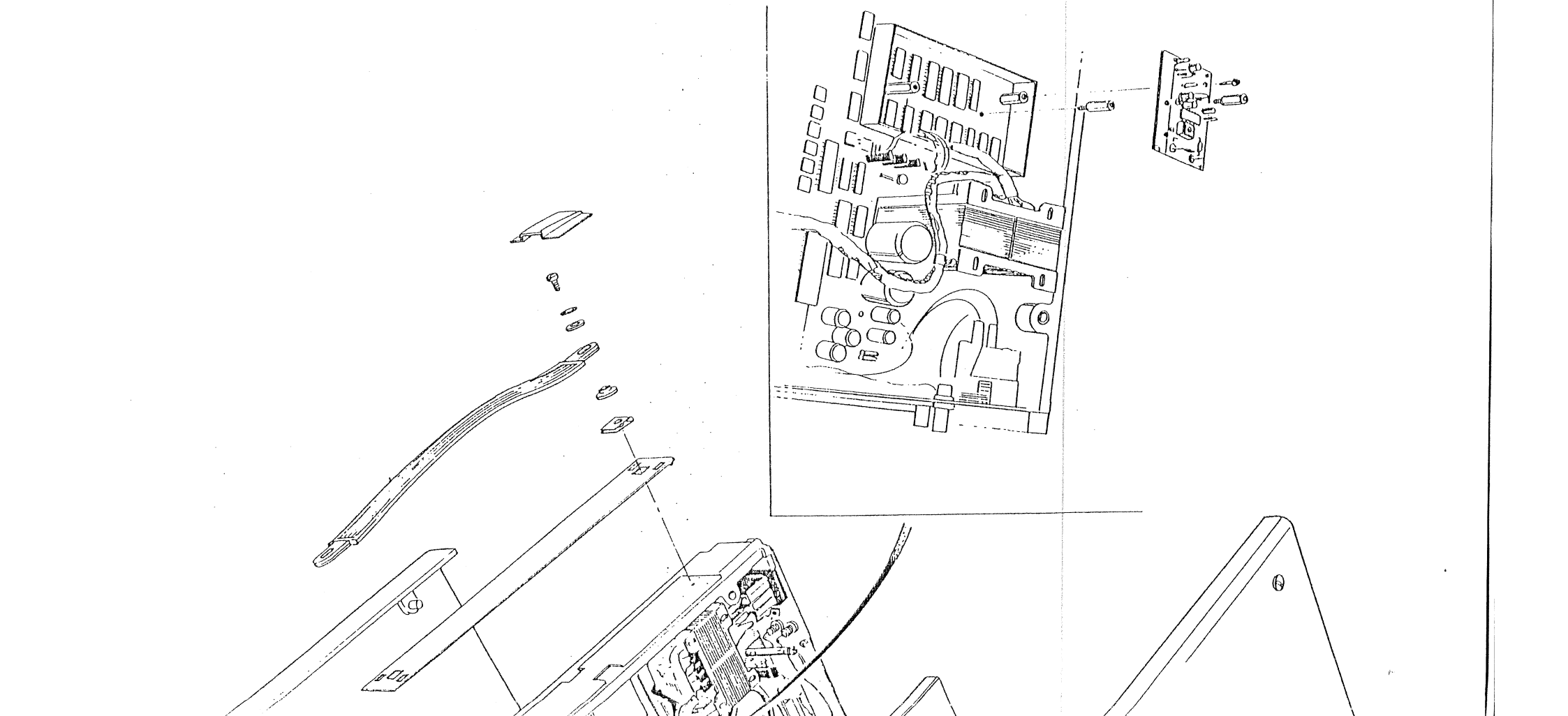
1. Disconnect PL203, PL204 and PH203 on PCB 3.
2. Remove two M4 screws securing the front moulding to the chassis.
3. Remove the plastic FRONT/REAR switch extender by gently levering off with a flat bladed screwdriver.
4. The front moulding may now be moved forward away from the chassis, allowing access to the keyswitch.
5. Remove the five connectors from the rear of the keyswitch, taking note of each connection (see Figure 2-18. for connections).
6. Remove 'boot' which secures the keyswitch to the front moulding.
7. The keyswitch may now be removed.

To remove the front input socket (SK1) proceed as follows:

1. Perform steps 1 to 4 described above.
2. Unsolder the five wires from the rear of the socket, taking note of each connection for use in reassembly.
3. Unscrew the nut which secures the socket to the front moulding.
4. The input socket may now be withdrawn from the front moulding.

6.8 REAR PANEL AND REAR PANEL COMPONENT REMOVAL (FIG 2.12)

To replace rear panel components the rear panel can be loosened from the chassis by removing seven screws as indicated on Fig 2.12. For most tasks it is not necessary to remove the rear panel; removal of the seven screws allows the rear panel to be tilted away from the chassis and this eases access to the rear panel components.



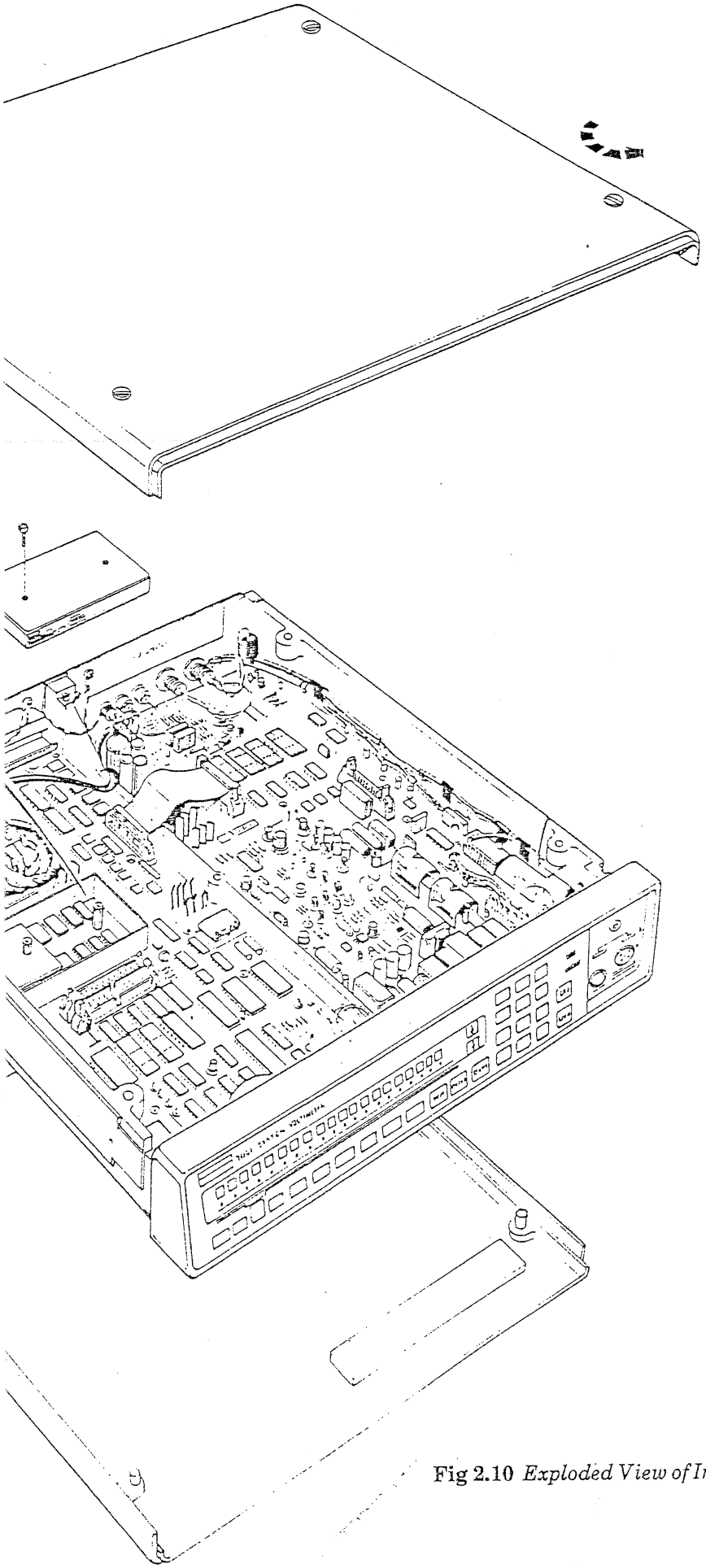
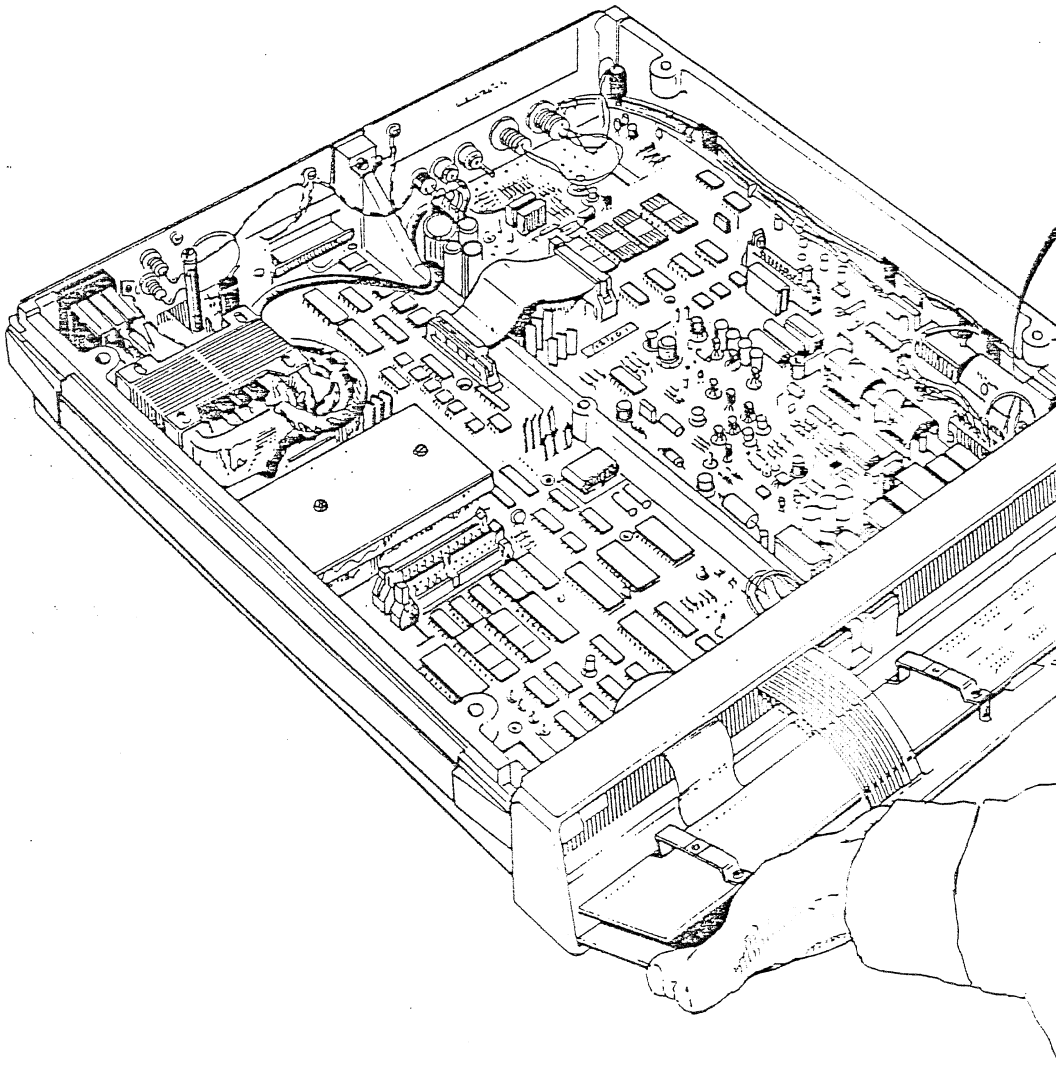


Fig 2.10 *Exploded View of Instrument*



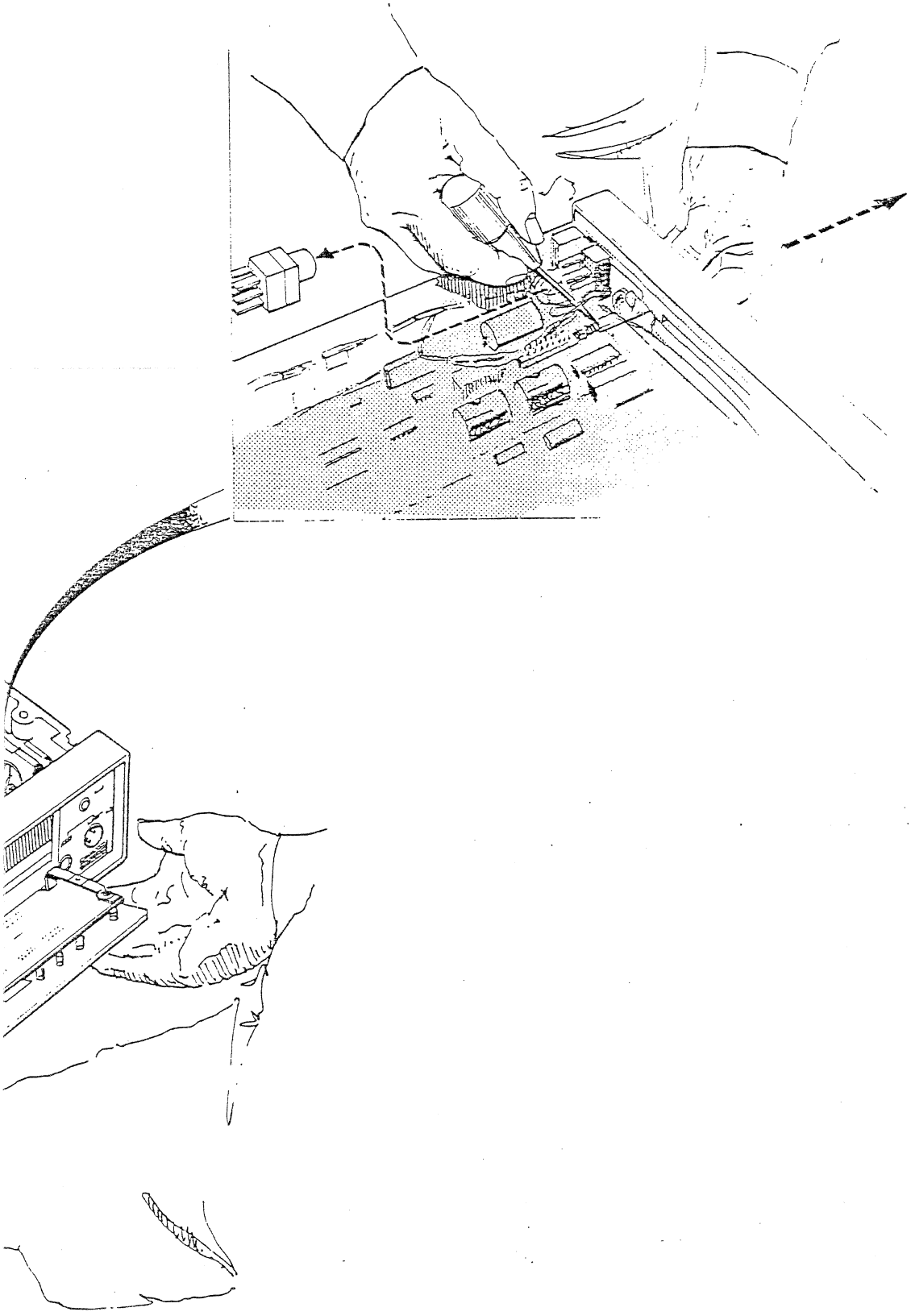


Fig 2.11 *Exploded View of Instrument Showing Front Panel Removal*

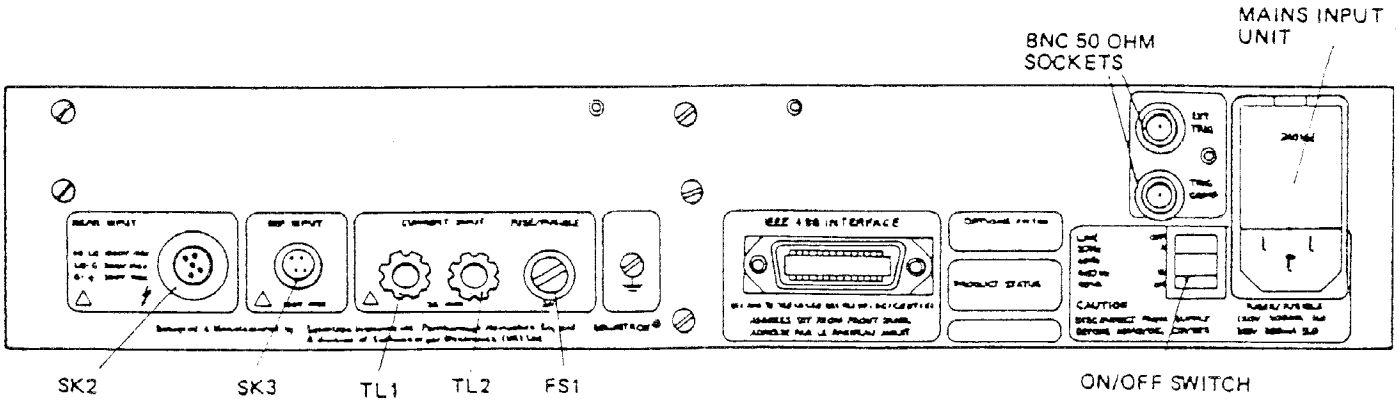


Fig 2.12 *Rear Panel*

To remove the rear input socket (SK2) proceed as follows:

1. Unsolder the five wires from the rear of the socket, taking note of each connection for use in reassembly.

2. Unscrew the nut which secures the socket to the rear panel.

3. The input socket may now be withdrawn from the rear panel.

To remove the reference input socket (SK3) proceed as follows:

1. Unsolder the five wires from the rear of the socket, taking note of each connection for use in reassembly.

2. Unscrew the nut which secures the socket to the rear panel.

3. The reference input socket may now be withdrawn from the rear panel.

To remove the current input terminals (TL1 or TL2) proceed as follows:

1. Unsolder the single wire from the rear of the terminal.

2. Remove the nut and washer securing the terminal to the rear panel.

3. The terminal may now be withdrawn from the rear panel.

Note ...
The procedure applies to both TL1 and TL2.

To remove the fuseholder for FS1, the 2A current protection fuse proceed as follows:

1. Unsolder the two wires on the rear of the fuseholder.
2. Remove the nut which secures the fuseholder to the rear panel.
3. The fuseholder may now be withdrawn from the rear panel.

To remove the EXT TRIG or TRIG COMP (50 ohm BNC) sockets proceed as follows:

1. Unsolder the single wire from the rear of the socket.
2. Unscrew the nut which secures the connector to the rear panel.
3. The BNC socket may now be withdrawn from the rear panel.

To remove the ON/OFF switch proceed as follows:

1. Unsolder the four wires from the rear of the switch, taking note of the connections for use during reassembly.
2. Remove the boot which secures the switch to the rear panel.
3. The switch may now be removed from the rear panel.

To remove the mains input unit proceed as follows:

1. Remove the nine connectors from the rear of the mains unit, taking note of the connections for use during reassembly.
2. Using a screwdriver, gently lever the mains unit away from the rear panel. Do not use force, gentle pressure applied successively at the top and bottom of the mains input unit is sufficient to withdraw the unit away from the rear panel.

If it is necessary to remove the rear panel as an assembly, all the rear panel components should be removed as previously described. Disconnect all earth leads from the rear panel. The rear panel may now be removed from the chassis.

An alternative method of rear panel removal follows:

1. Remove the seven screws as indicated on Fig 2.12.
2. Unsolder the wires from the rear input socket, reference input socket, current input terminals, fuseholder, EXT TRIG socket, TRIG COMP socket and from the ON/OFF switch. Note the connections for use during reassembly.
3. Disconnect the connectors from the mains input unit, making notes of the connections for use during reassembly.
4. Disconnect the earth leads by removing securing screws.
5. The rear panel may now be removed from the chassis.

6.9 PCB 8 (OSCILLATOR BOARD) REMOVAL (Fig 2.10)

PCB 8 is located in a screened box mounted on PCB 13. To remove PCB 8 proceed as follows:

1. Remove two screws securing the cover of the screened box.
2. Remove the cover from the screened box.
3. Remove spacer from screened box.
4. Remove two screws which secure PCB 8 to PCB13.
5. PCB 8 may now be removed by lifting away from the locating pins.

6.10 PCB 13 (DIGITAL BOARD) REMOVAL (Fig 2.10 and 2.11)

To remove PCB 13 it is necessary to tilt the front panel moulding forward in order to allow the PCB to be lifted clear of the chassis. Proceed as follows:

1. Disconnect PL203, PL204 and PH203 on PCB 13.
2. Remove two M4 screws securing the front moulding to the chassis.
3. Remove the plastic FRONT/REAR switch extender by gently levering off with a flat bladed screwdriver (see Fig 2.11).
4. Tilt the front moulding away from the chassis.
5. Disconnect PH101, PH102, PH201, PL401 and PL501 on PCB 13.
6. Unsolder two earth tags DP501 and DP504 from PCB 13.
7. Remove earth tag from rear panel by unscrewing the securing screw.
8. Remove PCB 8 as described in Sub-Section 6.9.
9. Remove the four screws with washers and the two stanchions with washers which secure the PCB to the chassis.
10. PCB 13 may now be removed by withdrawing the PCB upwards and towards the front of the instrument.

6.11 PCB 15 (ANALOGUE BOARD) REMOVAL (Fig 2.10 and 2.11)

To remove PCB 5, carry out the procedure described in Sub-Section 6. 10 steps (1) to (4) to tilt the front moulding. Proceed as follows:

1. Disconnect PL901, PL801, PL4, PL9 and PL10 on PCB 15.
2. Disconnect earth lead from centre of rear panel.
3. Unsolder the 12 wires on the FRONT/REAR switch S1. Make notes of the connections for use during reassembly.

4. Remove the eight screws and crinkle washers which secure the PCB to the chassis.

5. The PCB may now be removed by lifting from the front and withdrawing the PCB towards the centre of the instrument.

6.12 MAINS TRANSFORMER REMOVAL (Fig 2.13)

To remove the Mains Transformer proceed as follows:

1. Disconnect PL901 on PCB 15.

2. Disconnect PL501 on PCB 13.

3. Disconnect five connectors from the transformer to the mains input unit, noting the connections for use during reassembly.

4 Remove the earth tag from the transformer by unscrewing securing screw.

5. Turn the instrument on its side and whilst supporting the transformer with one hand, remove the four screws and washers which secure the transformer to the chassis (see Figure 2-13.).

6. The transformer may now be removed from the instrument.

6.13 HANDLE REMOVAL (Fig 2.10)

To remove the handle proceed as follows:

1. Remove the handle trim on each side of the handle.

2. Remove the two screws, crinkle washers, plain washers and support plate from the handle.

3. The handle can now be removed.

6.14 BATTERY REMOVAL

To remove the battery (B501) proceed as follows:

1. Locate battery on PCB 13 (see Fig 2.2 or 2.3).

2. Unsolder connections at each end of battery.

3. Remove battery from instrument.

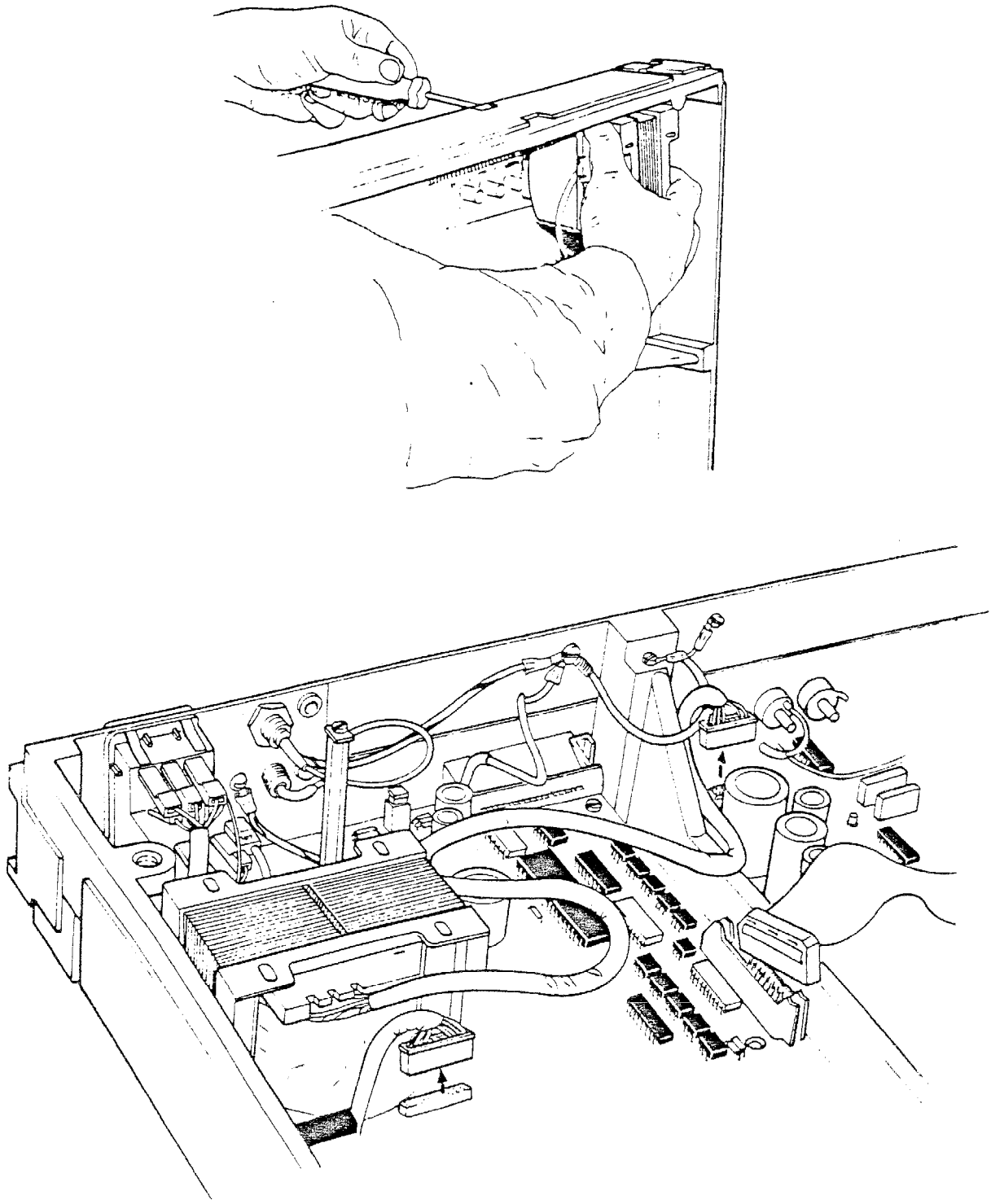


Fig 2.13 *Mains Transformer Removal*

6.15 CHASSIS AND MOULDING REPLACEMENT

In the event of catastrophic damage to the unit, i.e. severe mechanical damage to the front moulding or to the chassis, the instrument chassis and moulding may be replaced.

To replace the front moulding (shown in Fig 2.11) proceed as follows:

1. Carry out the procedures detailed in Sub-Section 6.2 and 6.3. The front panel keyboard must now be removed from the front moulding.
2. Remove the beeper as detailed in Sub-Section 6.5.
3. Remove the remaining front panel components, i.e. the keyswitch and front input socket as detailed in Sub-Section 6.7.
4. Remove the two cable clips securing the front input loom to the moulding.
5. The front moulding may now be removed and replaced.

To replace the chassis (shown in Fig 2.14) proceed as follows:

1. Remove PCB 8, PCB 13 and PCB 15 as detailed in Sub-Sections 6.9, 6.10 and 6.11.
2. Remove the mains transformer unit as detailed in Sub-Section 6. 12.
3. Remove the rear panel assembly as detailed in Sub-Section 6.8 (Alternative Method).
4. Remove the front moulding as detailed in Para 2-120.
5. Remove the four cable clips securing the looms to the right hand side of the chassis.
6. Remove the two cable clamps securing the loom to the right hand side of the chassis.
7. Remove the handle as detailed in Sub-Section 6.13.
8. The chassis may now be replaced

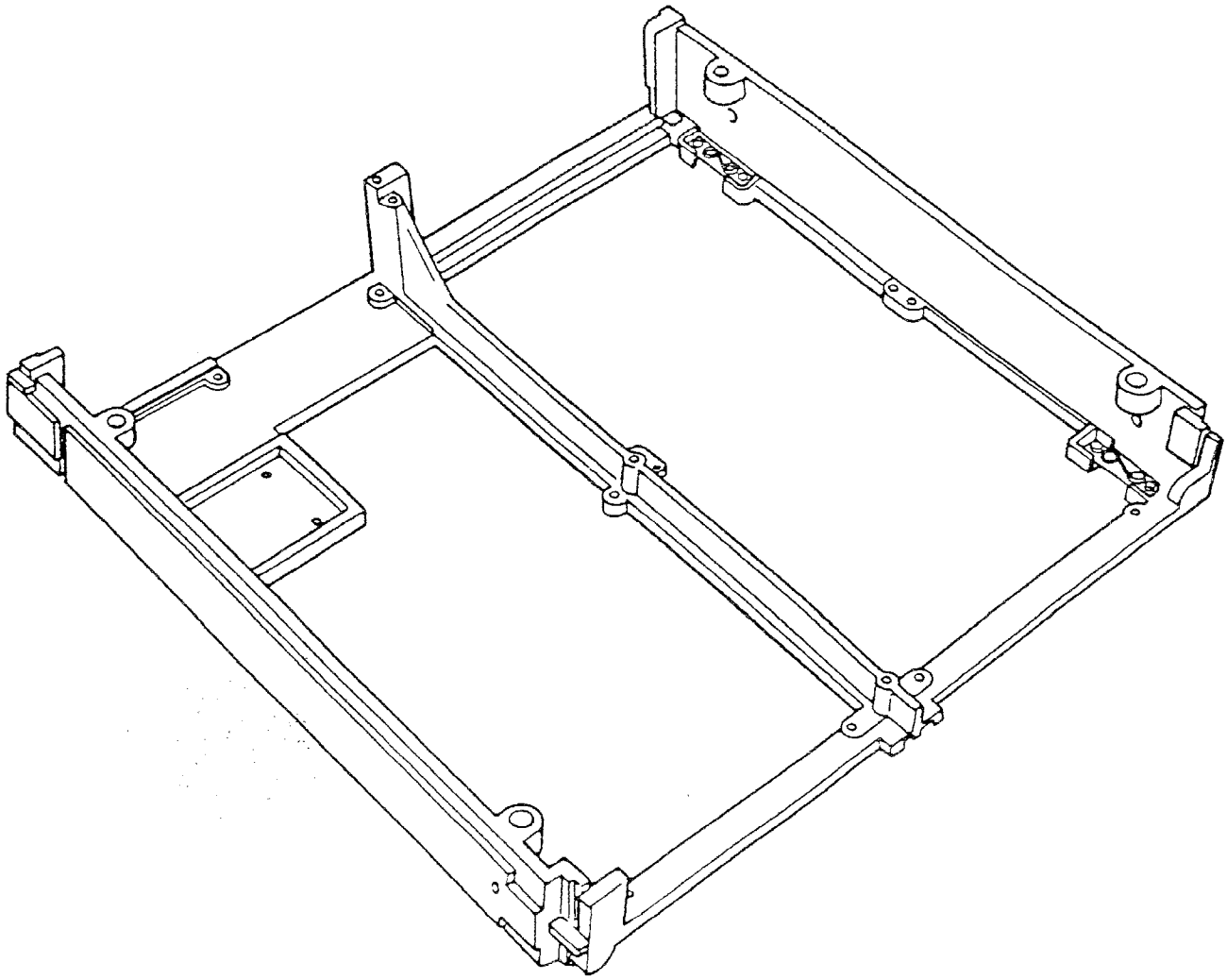


Fig 2.14 *Chassis*

7 REPAIR

7.1 GENERAL

Repairs should be carried out in accordance with the appropriate servicing policy.

Should it be necessary to replace PCB 13 or to replace components on any of the PCBs great care must be taken to avoid damage to the boards.

If components are replaced, ensure that the replacement component is of the correct type and tolerance.

7.2 REFERENCE DIODE REPLACEMENT

Should it be necessary to replace the reference diode D301 on PCB 15, the replacement diode must be set-up to obtain the best temperature coefficient (TC). After replacing D301 proceed as follows:

1. On PCB 5 solder bridge LKA and check that LKB, LKC and LKD are open.
2. Run the instrument in a temperature controlled cabinet at 15 degrees Celsius for three hours.
3. Connect an input of 10Vdc from a known source of accuracy of less than 5 ppm.
4. Select VOLTS DC, 5 DIGIT mode of operation.
5. Select the 10Vdc range and record the displayed reading as result 'A'.
6. Increase the temperature controlled cabinet to 35 degrees Celsius.
7. Run the instrument for a further three hours at 35 degrees Celsius.
8. After three hours record the displayed reading as result 'B'.

The temperature coefficient of the diode is calculated using the following formula:

$$TC = \frac{B-A}{20} * 10\ 6 \text{ microvolts per degree Celsius.}$$

Using the information in Table 2.25, set the links for the correct diode current (see Fig 2.15).

To achieve a positive TC, increase the diode current by approximately 200 microamps ppm. To achieve a negative TC reduce the diode current.

Table 2.27 DIODE D301 TC SET-UP

D	LKA	LKB	LKC	LKD
9.233mA	0	0	0	0
8.901mA	0	0	0	1
8.656mA	0	0	1	0
8.363mA	0	0	1	1
8.052mA	0	1	0	0
7.798mA	0	1	0	1
7.609mA	0	1	1	0
7.382mA	0	1	1	1
7.328mA	1	0	0	0
7.117mA	1	0	0	1
6.960mA	1	0	1	0
6.770mA	1	0	1	1
6.560mA	1	1	0	0
6.394mA	1	1	0	1
6.267mA	1	1	1	0
6.112mA	1	1	1	1

1 = Link open 0 = Link closed

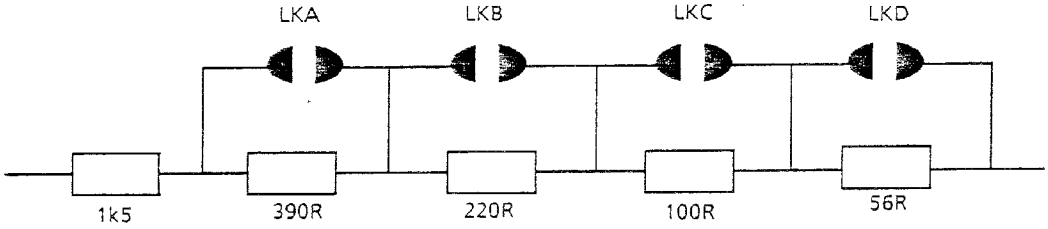


Fig 2.15 *Reference Diode D301 Links*

8 REASSEMBLY

8.1 GENERAL

Reassembly is in the reverse order of disassembly. Care must be taken to ensure connectors and wires removed during disassembly are replaced correctly. As a guide to reassembly the connection information is included in this section.

8.2 PCB 15 REPLACEMENT

Replace the PCB in the instrument and secure the board to the chassis with the eight screws and crinkle washers. Proceed as follows:

1. Resolder the 12 wires on the FRONT/REAR switch S1 in accordance with Fig 2.16.

2. Reconnect control lead to centre of rear panel.

3. Reconnect PL901, PL801, PL4, PL9 and PL10 on PCB 5.

4. Reconnect PL203, PL204 and PH203 on PCB 3.

5. Replace the plastic FRONT/REAR switch extender.

6. Secure front moulding to chassis by replacing two M4 screws.

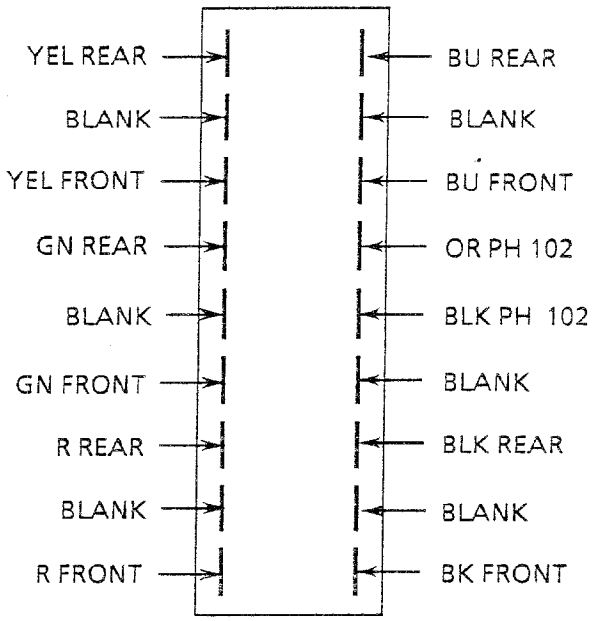


Fig 2.16 *Front/Rear Switch Wiring*

8.3 PCB 13 REPLACEMENT

Replace the PCB in the chassis and secure with four screws and washers and two stanchions and washers. Proceed as follows:

1. Reconnect PH101, PH102, PH201, PL401 and PL501 on PCB 13.

2. Resolder two earth tags DP501 and DP504 to PCB 13.

3. Reconnect earth tag to rear panel securing screw.

4. Replace the plastic FRONT/REAR switch extender.

5. Secure front moulding to chassis by replacing two M4 screws.

8.4 PCB 8 REPLACEMENT

To replace PCB 8 proceed as follows:

1. Replace PCB 8 on PCB 13 making sure locating pins and spacers are in position.
2. Secure the PCB to PCB 13 by two screws.
3. Replace screened box cover, ensuring space is correctly fitted to PCB 13.
4. Replace two screws and secure the cover to the PCB.

8.5 PCB 1 REPLACEMENT

To replace PCB 1 proceed as follows:

1. Secure PCB 1 to the switch assembly using six M3 screws and washers.
2. Refit front panel keyboard to the front moulding ensuring that the brackets are correctly mounted as shown in Fig 2.17.
3. Secure the keyboard using three M3 screws and washers.
4. Reconnect PL203 and PL204 on PCB 13.

8.6 FRONT AND REAR PANEL COMPONENT REPLACEMENT

Reassembly of front and rear panel components is the reverse of disassembly and reference should be made to the appropriate instructions as necessary. In order to assist reconnection, wiring diagrams are included for the keyswitch, mains input unit, ON/OFF switch, input sockets and the reference input socket.

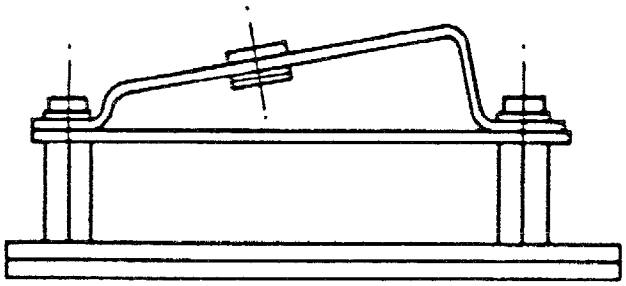


Fig 2.17 *PCB 1 Replacement*

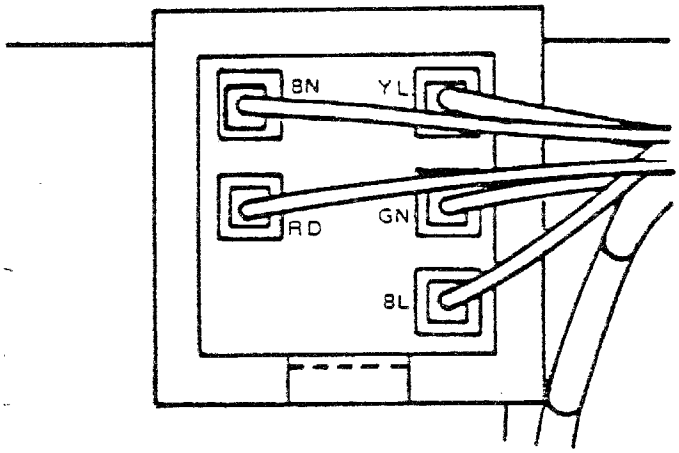


Fig 2.18 *Keyswitch Wiring*

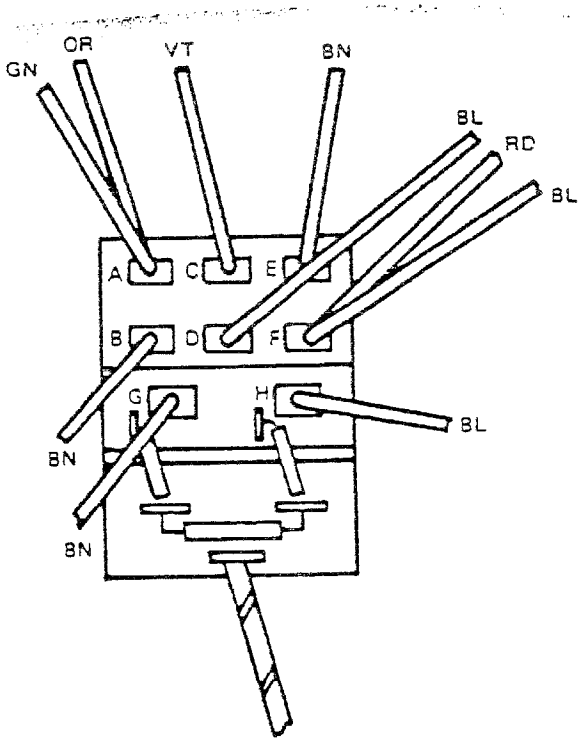


Fig 2.19 *Power Input Unit Wiring*

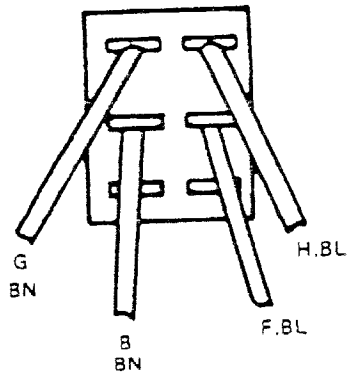


Fig 2.20 *ON/OFF Switch Wiring*

Fig 2.21 *Input Socket Wiring*

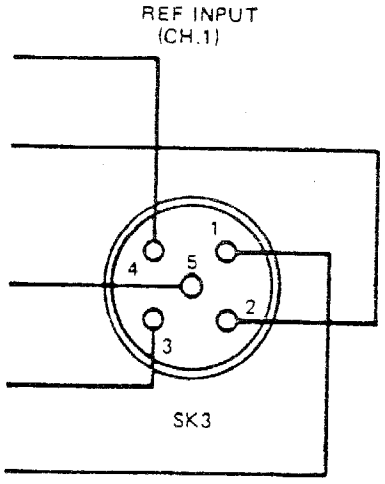


Fig 2.22 *Reference Input Socket Wiring*

9 TEST AFTER REPAIR

9.1 GENERAL

After any repair which required the top or bottom covers to be removed, the instrument must be calibrated as detailed in Section 4, Calibration.

After calibration the instrument should be tested as detailed in Sub-Section 3.3, Manual Performance Test.

Chapter 3
List of Replaceable Parts

Tables *Page*

Illustrations

1 INTRODUCTION

This section contains information on the parts which can be replaced on the 7061 and 7062 Systems Voltmeters.

The components that make up each assembly are referenced with an item number or circuit reference which corresponds to a Schlumberger Instruments, Farnborough, (SI) part number.

2 ORDERING SPARE PARTS

Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from Schlumberger Instruments, Farnborough, by quoting the SI part number. Where no MFG part number is shown components are only available from Schlumberger Instruments, Farnborough.

When ordering spare parts, it is essential to quote the instrument serial number which is located on the rear panel of the instrument. A full description of the component required should also be supplied.

3 EXPLODED VIEWS

Figures 3.1 and 3.2 show the major assemblies of the instrument. Parts identified in these illustrations are listed in Table 3.1 and 3.2. A list of consumable items such as nuts, washers and screws is detailed in Table 3.3.

4 PCB PARTS LISTS

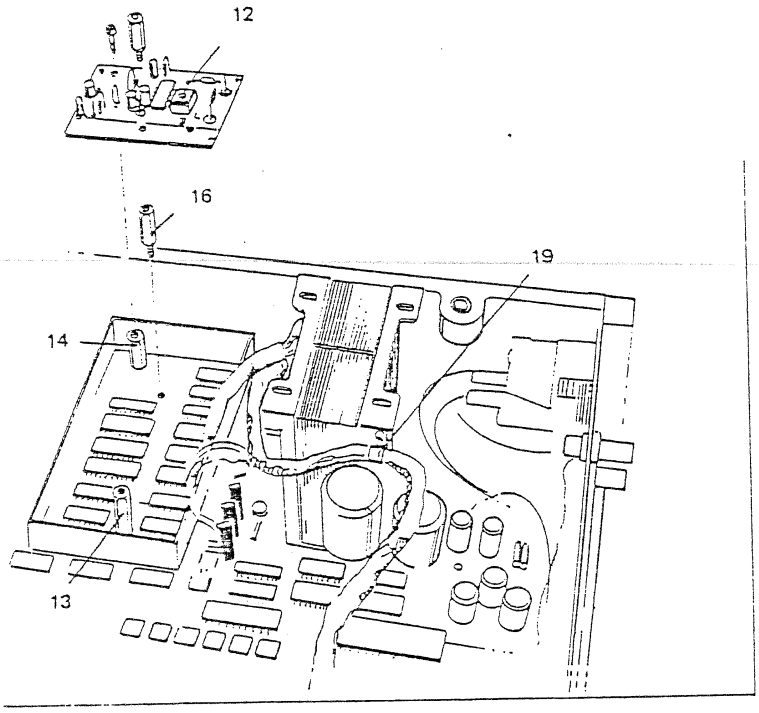
Parts lists for the individual PCBs are presented in Table 3.4 thru 3. 46. These tables include parts lists for PCBs 3 and 5 which, in current instruments, have been replaced by PCBs 13 and 15 respectively,

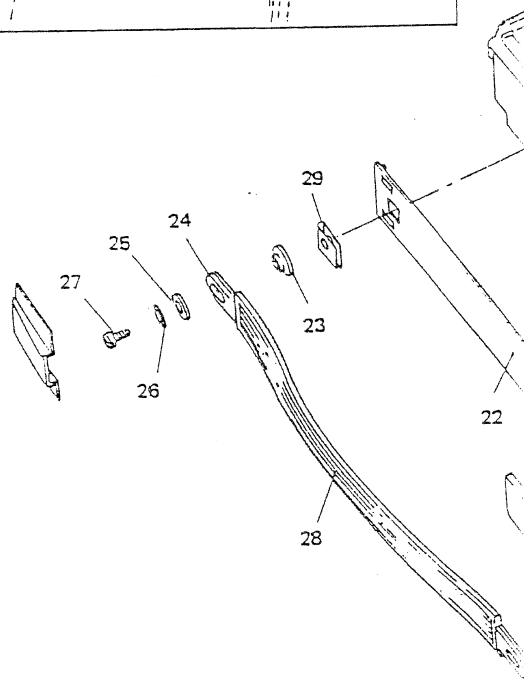
Table 3.1 PARTS SHOWN ON EXPLODED VIEW No. 1 - FIGURE 3. 1

ITEM	DESCRIPTION	SI PART NO.	*MFG* FED SUPPLY CODE	*MFG* PART NO. OR TYPE	PLISN
1	Front Moulding Assembly	70610004A			A0121
2	Panel Rear Assembly	70610005A			A0117
3	PCB 3 Assembly †	70610503X			C0001
4	PCB 5 Assembly †	70610505Y			D0001
5	Chassis	70810208A			A0110
6	Transformer to PCB 3 Lead	70810217A			A0004
7	Display Keyboard Assembly	70610006A *			A0118
8	Transformer	309620001			A0047
9	Chassis to PCB 5 Lead	70610222A			A0084
10	Cable Assembly 26 Way	70610211A			A0083
11	Pillar	70752249A			A0003
12	PCB 8 Assembly	70610508X			E0001
13	Spacer Long	12862019X			A0045
14	Spacer Short	70612006A			A0086
15	Lid	70612004A			A0085
16	Pillar	70612018A			A0002
17	Cable Clip Self Adhesive	412090440			A0055
18	Cable Clamp	412090520			A0056
19	P- clip	412001030			A0053
20	Top Cover	70810007A			A0119
21	Bottom Cover	70610008A			A0120
22	Support Plate	70602024A			A0038
23	Spacer	70602025A			A0039
24	Handle, Inner	70602029A			A0040
25	Washer Crinkle M4	411129020			A0035
26	Washer Plain M4	411029020			A0033
27	Screw M4 Pan Head	406804100			A0036
28	PVC Handle	70602030A			A0041
29	Captive Nut M4 4	12006760			A0054

† On later issue DVMs, PCB 3 is replaced by PCB 13 and PCB 5, by PCB15

* On 7062 this Part No. is 70620006A


12
16
19
14
13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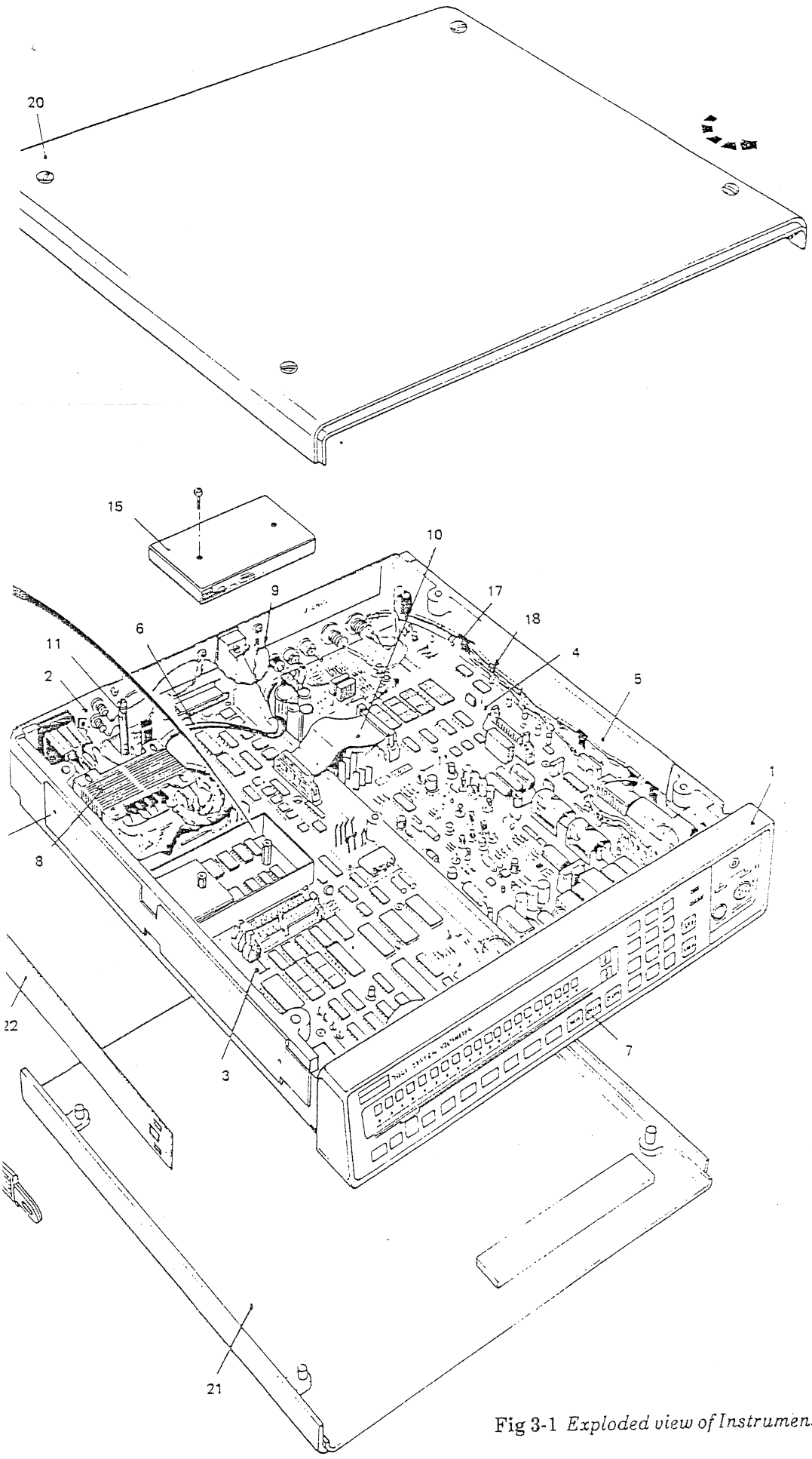


Fig 3-1 *Exploded view of Instrument*

Table 3.2 PARTS SHOWN ON EXPLODED VIEW No. 2 - FIG 3.2

ITEM	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
1	Earth Stud to PCB 3	70610208A			A0015
2	Earth Lead	70610209A			A0016
3	PCB 3 to BNC	70610210A			A0017
4	Reference Input	70610218A			A0022
5	Rear Loom	70610217A			A0021
6	Socket 5 Way Fixed	352505040			A0067
7	Mains Switch	375500030			A0011
8	Mains Selector (Input Unit)	550001480			A0081
9	Fuselink 200mA	360106280			A0098
10	Fuselink 2A	360106150			A0071
11	Fuseholder	360206030			A0072
12	Socket BNC 50 Ohm	352101300			A0066
13	Resistor 1 Megohm	172361000	50139	EB	A0065
14	Beeper	300950030			A0023
15	Keyswitch Support	70812001A			A0122
16	Keyswitch Label	70812005A			A0123
17	Keyswitch	376100130			A0058
18	Spring	71502041A			A0010
19	Front Input Loom	70610215A			A0019
20	Bracket	70812007A			A0027
21	Spacer	70812008A			A0028
22	Switch Assembly	70610207B			A0082
23	PCB 1 Assembly	70610501X			B0001

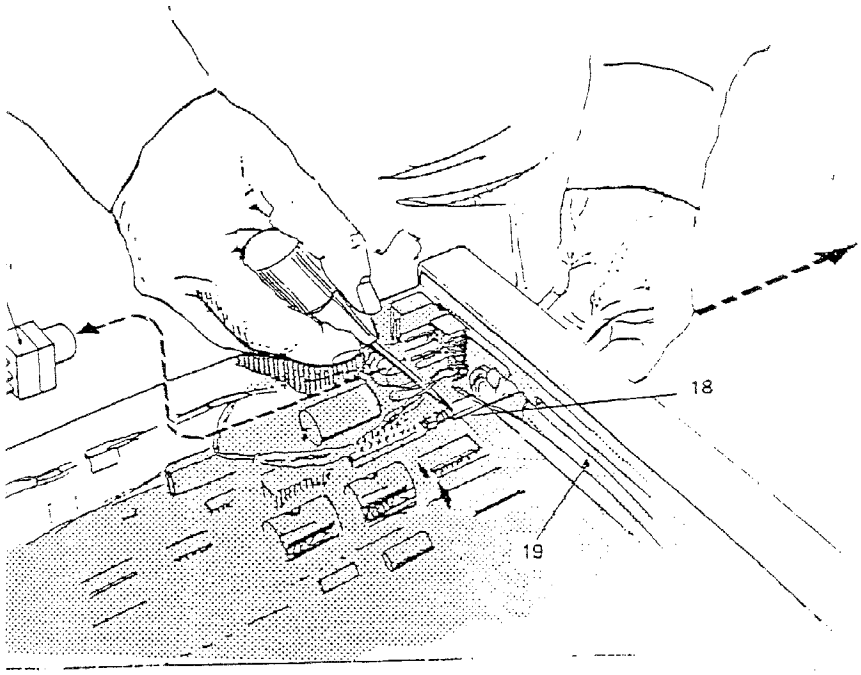


Fig 3-2 *Exploded view of Instrument Showing Front Panel Removal*

COMPONENTS PARTS LIST ABBREVIATIONS

CIRCUIT REFERENCE

B	-	Battery	R	-	Resistor (Ω)
C	-	Capacitor (μF)	RL	-	Relay
CSR	-	Thyristor	RNL	-	Non Linear Resistor (Ω)
D	-	Diode	RV	-	Variable Resistor (Ω)
FS	-	Fuse	S	-	Switch
IC	-	Integrated Circuit	SK	-	Socket
L	-	Inductor	T	-	Transformer
LP	-	Lamp (including Neon)	TP	-	Terminal Post (or Test Point)
LK	-	Link	TR	-	Transistor
MSP	-	Mains Selector Panel	X	-	Other Components
PL	-	Plug			

COMPONENT TYPES

Fixed Resistors:

Carbon Composition	CACP
Carbon Film	CAFM
Cracked Carbon	CKCA
Metal Film	MEFM
Metal Oxide	MEOX
Metal Glazed	MEGL
Power Wirewound	POWW
Precision Wirewound	PRWW
Temperature Sensitive	TEMP
Thick Film	TKFM
Thin Film	TNFM
Voltage Sensitive	VOLT

Variable Resistors:

Carbon Front Panel Multiturn	CAFM
Carbon Front Panel Single Turn	CAFS
Carbon Preset Multiturn	CAPM
Carbon Preset Single Turn	CAP
Cermet Front Panel Multiturn	CMFM
Cermet Front Panel Single Turn	CMF
Cermet Preset Multiturn	CMPM
Cermet Preset Single Turn	CMP
Wirewound Front Panel Multiturn	WWFM
Wirewound Front Panel Single Turn	WWF
Wirewound Preset Multiturn	WWPM
Wirewound Preset Single Turn	WWPS

Capacitors:

Air	AIR
Aluminium Electrolytic	ALME
Aluminium Solid	ALMS
Polycarbonate	CARB
Ceramic	CERM
Polyester Foil	ESTF
Polyester Metallised	ESTM
Glass	GLAS
Mica	MICA
Metallised Lacquer	MLAC
Paper Foil	PAPF
Paper Metallised	PAPM
PTFE	PTFE
Polypropylene Film	PYLN
Polystyrene	STYR
Tantalum Dry	TAND
Tantalum Foil	TANF
Tantalum Wet	TANW

Table 3.3 MISCELLANEOUS PARTS

DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
Nut M3	410031010			A0052
Captive Nut No. 4	412006720			A0054
Captive Nut No. 8	412006770			A0063
Screw No. 4 x .5 Self Tapping	408811020			A0050
Screw No. 4 x .31 Self Tapping	408811420			A0051
Screw M3 x 6 P/H ST/ST	406803061			A0031
Screw M3 x 6 P/H	406803060			A0048
Screw M4 x 20 P/H	406804200			A0049
Screw No. 8 x .5 ST	408811600			A0061
Screw M2 x 6 Ch. Hd.	406602060			A0059
Screw M3 x 8 P/H	406803080			A0060
Screw M3 x 8 P/H ST/ST	406803081			A0073
Screw M4 x 12 P/H	406804120			A0032
Washer M4 Crinkle	411129020			A0035
Washer M3 Crinkle	411129010			A0034
Washer M2 Crinkle	411129050			A0109
Washer M2 Plain	411029060			A0062
Washer M3 Int. Store	411350030			A0075
Washer M3 Plain	411029010			A0074
Washer	70602010A			A0091
Foot Left Hand	429900203			A0089
Foot Right Hand	429900302			A0090
Tilt Bar	70602020A			A0092
Foot Inserts	429900101			A0081

Table 3.4 PCB 1 PARTS LIST, DISPLAY

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R1-3	CACP 10k 1/2 W 10%	172041000	50139	CB	B0003
C1	CERM 100n 40V +80% -20%	208450140			B0004
C2-5	CERM 47n 12V 20%	241744700			B0006
C6-7	CERM 100n 40V +80% -20%	208450140			B0004
C8	CERM 330p	241323300			B0005
IC1-2	74 HC 374N	510006690	04713	MC74HC374N	B0014
IC3-4	UDN 6118	510005710	7E682	UDN6118A	B0012
IC5-8	74 HC 374N	510006690	04713	MC74HC374N	B0014
IC9-10	RESISTOR D.I.L. PACK 150 1/16 W 2%	160400587	50139	316A-151	B0002
IC11-12	UCN 481 DA	510005180	4S837	UCN4810A	B0011
IC13	74 HC 74N	510006590	04713	MC74HC74N	B0013
D1-26	LED	300750280			B0009
DS1	DISPLAY (VFD) FG209M	300730460			B0008
PL1	PLUG 26-WAY	351326030			B0017
	STICK-ON FEET	420310260	5W380	SJ5012-BLACK	B0010
	PCB 1 ASSY.	70610501X			B0001
	PAD MOUNTING	300584220			B0007
	PCB MACHINING	70619501A			B0015
	CABLE ASSY.	70810203A			B0016

Table 3.5 PCB 13 PARTS LIST, MPU AND MEMORY

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R101	MEFM 680 1/4 W 5%	195326800	14674	NK4	F0013
R102	MEFM 18k 1/4 W 5%	195341800	14674	NK4	F0024
R103	MEFM 1k5 1/4 W 5%	195331500	14674	NK4	F0016
R104	MEFM 2k2 1/4 W 5%	195332200	14674	NK4	F0018
R105	MFM 3k3 1/4 W 5%	195333300	14674	NK4	F0019
R106	MEFM 68k 1/4 W 5%	195346800	14674	NK4	F0026
R107	MEFM 3k3 1/4 W 5%	195333300	14674	NK4	F0019
R108	MEFM 33k 1/4 W 5%	195343300	14674	NK4	F0025
R109	MEFM 3k9 1/4 W 5%	195333900	14674	NK4	F0020
R110	MEFM 1k 1/4 W 5%	195331000	14674	NK4	F0014
R111	MEFM 4k7 1/4 W 5%	195334700	14674	NK4	F0021
R112	MEFM 6k8 1/4 W 5%	195336800	14674	NK4	F0022
R113	MEFM 2k2 1/4 W 5%	195332200	14674	NK4	F0018
R114	1M	172061000	50139	CB	F0006
R115	CACP 1k 1/4 W 5%	172031000	50139	CB	F0005
R116	MEFM 1k 1/4 W 5%	195331000	14674	NK4	F0014
R118	MEFM 6k8 1/4 W 5%	195336800	14674	NK4	F0022
R119-120	MEFM 1k2 1/4 W 5%	195331200	14674	NK4	F0015
C101	TAND 4µ7 35V 20%	208700109			F0036
C104-113	CERM 47n 25V -25 + 50%	241744700			F0041
C114	TAND 33 20V 20%	265873300			F0044
C115	CERM 100p 500V 20%	241321000			F0037
C116	CERM 47n 25V -25 + 50%	241944700			F0041
C117	TAND 22 16V 20%	208700106			F0035
C118	CERM 1n 500V -20 + 40%	241331000			F0038
IC101	68 B09	510005121	04713	MC68B09P	F0098
IC102	L500	510002000	4S837	SN74LS00N	F0088
IC103	F139	510005880	34148	F74FL139PC	F0101
IC104-105	F138	510005870	34148	F74FL138PC	F0100
IC106-107	27C256	510007970	61802	TC57256D-25	F0126
IC111-112	6264 LP-12	510006501	3P025	HM6264LP-12	F0105
IC113	2816A	510007240			F0119
IC114	LS 245	510004560	4S837	SN74LS245N	F0096
IC115	LS 244	510004500	4S837	SN74LS244N	F0095
IC116	RESISTOR PACK 6k8 1/8 W 2%	160400569	50139	316A-682	F0002
IC118	LS 00	510002000	4S837	SN74LS00N	F0088
IC119	LS 04	510002690	4S837	SN74LS04N	F0090
IC120	RESISTOR PACK 2k2	160400637	50139	316A-222	F0003
IC121	LS 74	510002600	4S837	SN74LS74AN	F0089

(Contd.)

Table 3.5 PCB 13 PARTS LIST, MPU AND MEMORY *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
TR101	BCY 70	300553590	04713	BCY70	F0056
TR102	VN 10 KM	300555860			F0058
D101-105	SD3	300522160			F0048
D106	IN 825 (Zener) 6V2 400mW 5%	300523050	04713	IN825	F0049
X101	CRYSTAL 8MHz	300810700			F0067
TP101-108	TEST POINT	355400760			F0077
PH101	POST HEADER 6-WAY	352306090	00779	280372-2	F0071
PH102	POST HEADER 2-WAY	352302080	00779	280370-2	F0070
TL101-102	TERMINAL LUG	355500430			F0078
	D.I.L. SOCKET 28-WAY 6 OFF	300585160			F0062
	D.I.L. SOCKET 40-WAY	300585190			F0063

Table 3.6 PCB 13 PARTS LIST, GENERAL I/O

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R201	MEOX 100 ½ W 1%	195421000	14674	NK5	F0027
R202	MEFM 10k	195341000	14674	NK4	F0023
R203	MEFM 1k	195331000	14674	NK4	F0014
R204	MEFM 10k	195341000	14674	NK4	F0023
R205	MEFM 10k	195341000	14674	NK4	F0023
R206	MEOX 100 ½ W 1%	195421000	14674	NK5	F0027
R207	MEFM 10k	195341000	14674	NK4	F0023
R208-211	MEOX 6k8	195336800	14674	NK4	F0022
C201	CERM 1n	241331000			F0038
C202	TAND 4µ7 10V	265364700			F0042
C203-207	CERM 47n	241944700			F0041
IC201	LS 145	510004990	4S837	SN74LS145N	F0097
IC202	HC 244	510006660	04713	MC74HC244N	F0109
IC203	HC 390	510007530	04713	MC74HC390N	F0125
IC204	HC 74	510006590	04713	MC74HC74N	F0107
IC205	9914A	510007250	4S837	TMS9914ANL	F0120
IC206	75160 AN	510007200	4S837	SN75160AN	F0117
IC207	75161 AN	510007210	4S837	SN75161AN	F0118
IC208	63 B21	510006711	3P025	HD63B21P	F0111
IC209	HC 132	510006950	04713	MC74HC132N	F0112
IC210	RESISTOR PAK 6k8 1/8W 2%	160400569	50139	316A-682	F0002
IC211	LS 86	510002800	4S837	SN74LS86AN	F0091
TR201	VN10KM	300555860			F0058
TR202	BC 107	300553320	04713	BC107A	F0055
TR203	MPSA13	300554560	04713	MPS-A13	F0057
D201-4	SD3	300522160			F0048
SW201	D.I.L. SWITCH 6-POLE	375000570	59610	09 22200 03	F0081
PH201	POST HEADER 2-WAY	352302080	00779	280370-2	F0070
PH203	POST HEADER 2-WAY	352302080	00779	280370-2	F0070
PL201-202	RIBBON PLUG 40-WAY	352340110	5W380	3432-6302	F0075
PL203	RIBBON PLUG 26-WAY	352326110	5W380	3429-6302	F0073
PL204	PLUG BERGSTIK 15-WAY	352336070			F0074

(continued)

Table 3.6 PCB 1 PARTS LIST, GENERAL I/O *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
SK205	GPIB SOCKET (RIGHT ANGLE)	352524350			F0076
	D.I.L. SOCKET 20-WAY 2 OFF	300585220			F0064
	D.I.L. SOCKET 40-WAY 2 OFF	300585190			F0063

Table 3.7 PCB 13 PARTS LIST GLUG COUNTER AND LATCHES

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R301	MEFM 4k7 1/4W 1%	195334700	14674	NK4	F0021
R303-306	MEFM 4k7 1/4W 1%	195334700	14674	NK4	F0021
R307	MEFM 6k8 1/4W 1%	195336800	14674	NK4	F0022
C301-314	CERM 47n 25V -25% +50%	241944700			F0041
IC301	F7	510006000	04713	MC74F74N	F0102
IC302	F64	510007470	34148	F74F64PC	F0121
IC303	F74	510006000	04713	MC74F74N	F0102
IC304	F64	510007470	34148	F74F64PC	F0121
IC305	F161	510007480	34148	F74F161APC	F0122
IC306	LS161	510004160	4S837	SN74LS161AN	F0092
IC307	LS393	510004470	4S837	SN74LS393N	F0094
IC308-309	LS374	510004390	4S837	SN74LS374N	F0093
IC310	HC161	510007000	04713	MC74HC161N	F0115
IC312	HC 74	510006590	04713	MC74HC74N	F0107
IC313	F164	510007490	18324	N74F164N	F0123
IC314	HF00	510006520	04713	MC74HF00N	F0106
IC315	HC174	510006630	04713	MC74HC174N	F0108
TP301-304	TEST POINT	355400760			F0077

Table 3.8 PCB 13 PARTS LIST, FLOATING I/O AND CLOCK

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R412-413	MEFM 2k2 1/4W 5%	195332200	14674	NK4	F0018
R414-415	MEFM 6k8 1/4W 5%	195336800	14674	NK4	F0022
R416-417	MEFM 270 1/4W 5%	195322700	14674	NK4	F0010
R418-419	MEFM 330 1/4W 5%	195323300	14674	NK4	F0011
R420	MEFM 1k 1/4W 5%	195331000	14674	NK4	F0014
R421-422	MEFM 270 1/4W 5%	195322700	14674	NK4	F0010
R423	MEFM 2k2 1/4W 5%	195332200	14674	NK4	F0018
R424-425	MEFM 4k7 1/4W 1%	195334700	14674	NK4	F0021
R426-429	MEFM 6k8 1/4W 5%	195336800	14674	NK4	F0022
C406-415	CERM 47n 25V -25% + 50%	241944700			F0041
C416-417	CERM 0.1µ 50V -20% + 80%	208450140			F0029
C419-420	CERM 10n 25V -25% + 50%	241941000			F0044
C422	ALME 47µ 10V	208600244			F0030
C423	CERM 100p 500V 20%	241321000			F0037
IC401-402	HC 374	510006690	04713	MC74HC374N	F0110
IC403-417	TIL 117	300540240	4S837	TIL117	F0053
IC418	LS 74	510002600	4S837	SN74LS74AN	F0089
IC419	LS 00	510002000	4S837	SN74LS00N	F0088
IC420	F161	510007480	34148	F74F161APC	F0122
IC421	HC 4040	510007040	04713	MC74HC4040N	F0116
IC422	HC 390	510007530	04713	MC74HC390N	F0125
IC423	HC 161	510007000	04713	MC74HC161N	F0115
IC424	HC 157	510006980	04713	MC74HC157N	F0114
IC425	HC 153	510006970	04173	MC74HC153N	F0113
IC426	CD 4046	510005690	04713	MC14046BCP	F0099
IC427	F 374	510006190	34148	F74F374PC	F0104
IC428-429	HCPL 2601	300540260	5B017	HCPL2601	F0054
IC430	F 04	510007500	34148	F74F04PC	F0124
IC431	F 86	510006010	34148	F74F86PC	F0103
IC432	HC 132	510006950	04713	MC74HC132N	F0112
IC434	Resistor Network 1k 1.5W 2% (15 OFF)	160400644	50139	316A-102	F0004
IC435	Resistor Network 6.8k 1.5W 2% (15 OFF)	160400569	50139	316A-682	F0002
D401-2	Diode PIV75 IDC 0.075	300522160		SD3	F0048
D404	Diode PIV75 IDC 0.075	300522160		SD3	F0048

(Contd.)

Table 3.8 PCB 13 PARTS LIST, FLOATING I/O AND CLOCK *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
TP401-402	TRANSFORMER 76614/4HV	303050010			F0068
PL401	RIBBON PLUG 26-WAY	352326110	5W380	3429-6302	F0073
TP401-405	TEST POINT	355400760			F0077

Table 3.9 PCB 13 PARTS LIST, POWER SUPPLY

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R501	MEFM 470R 1/4W 1%	195324700	14674	NK4	F0012
R504	MEFM 470k 1/4W .5%	192754702	50139	FC55	F0007
R505	MEFM 22 1/4W 1%	195312200	14674	NK4	F0009
C501	ALME 10,000µ 16V	208600284	7E682	80D103P016JC2	F0033
C502	ALME 3,300µ 16V	208600286	54473	ECET16R332SW	F0034
C503	CERM 0.1µ 50V -20% + 80%	208450140			F0029
C504	TAND 33µ 10V 20%	265473300	50139	316A-102	F0043
C505-507	ALME 47µ 40V	208600261	7E682	672D476H40CD2	F0031
C508	ALME 220µ 40V	208600262	54473	ECEA1GV221SC	F0032
C509	ALME 220µ 40V	208600262	54473	ECEA1GV221SC	F0032
C510-511	TAND 1µ 35V 20%	266061000			F0045
C512-513	CERM 47n 25V -25% + 50%	241944700			F0041
C514	CERM 10n 25V -25% + 50%	241941000			F0040
C515	CERM 1n 500V -20% + 40%	241331000			F0038
C516	CERM 22n 25V -20% + 50%	241842200			F0039
C517	TAND 1µ 35V 20%	266061000			F0045
C518	TANT 22µ 16V 20%	208700106			F0035
IC501-505	7805CT	510090500	4S837	UA7805CKC	F0128
TR501-503	VNO300M	300556300			F0059
D501	RECTIFIER KBU4B	300510340	04713	MDA97042	F0046
D502-503	IN6263	300525650	4S837	TIL117	F0053
D504	WO4	300524700			F0059
D505	Zener 30V	300521430			F0047
D506	WO4	300524700			F0059
D509	LED, HLMP-3316	300750190			F0061
D510-513	Diode PIV75 IDC 0.075	300522160		SD3	F0048
T501	TRANSFORMER (RM6)	309620201			F0069
B501	Nicd battery 3V6 0.09AL	800400210			F0135
PL501	8 WAY PLUG	352308060	00779	280373-2	F0072

(continued)

Table 3.9 PCB 13 PARTS LIST, POWER SUPPLY (Contd.)

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
TP501-509	TEST POINT	355400760			F0077
FOR ICI 2,3,4	HEATSINKS	300584940			F0061
DP501-504	DISCONNECT PINS	355900550			F0084

Table 3.10 PCB 13 PARTS LIST, 70615A OPTION PRE- FITTED PARTS

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R601	MEFM 10k 1/8W 0.5%	192741002			F0023
R602	MEFM 1k5 1/8W 0.5%	192731502			F0024
R603	MEFM 220k 1/8W 0.5%	192752202			F0025
R604	MEFM 470 1/4W 1.0%	195324700			F0012
R605	MEFM 10k 1/4W 1%	195341000			F0026
D601	Diode	300522160		SD3	F0048
IC117	Comp.Quad. O.C. O/P	510090490		LM339 Equiv	F0127

Table 3.11 PCB 8 PARTS LIST, OSCILLATOR (MOUNTED ON PCB 13)

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
	PCB 8 ASSY.	70610508X			E0001
	SPREADER (TO18)	300584030			E0020
	PAD MOUNTING	300584220			E0021
	SOCKET PV 1-WAY	352501680	00779	85861-4	E0023
	PCB 8	70619508X			E0026
R101	MEFM 330k 1/8W .5%	192753302	50139	FC55	E0002
R102	MEFM 100k 1/4W 1%	195351000	14674	NK4	E0008
R103	MEFM 10k 1/4W 1%	195341000	14674	NK4	E0007
R104	MEFM 100k 1/4W 1%	195351000	14674	NK4	E0008
R106	MEFM 1k 1/4W 1%	195331000	14674	NK4	E0006
R107-108	MEFM 180 1/4W 1%	195321800	14674	NK4	E0004
R109	MEFM 220 1/4W 1%	195322200	14674	NK4	E0005
R110	MEOX 10 1/4W 1%	195311000	14674	NK4	E0003
C101	TAND 22µ 16V	208700106			E0010
C102	TAND 1µ 35V	266061000			E0015
C103	CERM 47p	208450200			E0009
C104-106	CERM 47n	241944700			E0014
C107	CERM 1n	241331000			E0012
C108	CERM 47n	241944700			E0014
C109	CERM 10n	241941000			E0013
C110	TAND 4µ7 35V 20%	208700109			E0011
IC101	MC1648	510007550	04713	MC1648P	E0025
TR101-102	ZN2906A	300554500	34148	2N2906A	E0019
TR103	ZN2369	200552390	34148	2N2369	E0018
D101	MV2115	300525310	04713	MV2115	E0017
D102	OA47	300520850			E0016
L101	220n	305030490			E0022
TP101	TEST POINT	355400760			E0024

Table 3.12 PCB 15 PARTS LIST, INPUT SWITCHING DC VOLTS ATTENUATOR AND CURRENT

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R1 (A-C)	MATCHED SET 3M3	169609102			G0009
R2	MATCHED SET 100k05 0.1%				
R3-5	MEGL 47k 3W 2%	175244700			G0015
R6	MEFM 1M 1/4W 5%	198261002	50139	FC65	G0062
R7	56R	192715602	50139	FC55	G0016
R8	PRWW 0.1 .5%	160300506			G0003
R9-11	MEOX 47k 1/2W 1%	195444700	14674	NK5	G0060
R12-14	MEFM 820R 1/4W 1%	195328200	14674	NK4	G0043
R15-16	MEFM 47k	192744702	50139	FC55	G0031
R17	MEFM 100k	192751002	50139	FC55	G0033
R18-19	MEFM 10k 1/8W .5%	192741001	50139	FC55	G0026
R20-26	NOT USED				
R27	MEFM 10k 1/8W 5%	192741001	50139	FC55	G0026
C1	ESTM 0.22µ 100V 10%	225452200			G0077
C2	ESTF 22n 400V 10%	208450143			G0064
C3-6	CERM 10n 25V -25% + 50%	241941000			G0089
IC1-3	TIL117	300540240	4S837	TIL117	G0116
TR1-3	WN1001	300555770			G0125
TR4	2N2904A	300551670	04713	2N2904A	G0117
TR5	3N170	300555270	04713	3N170	G0123
D1	D PAD 1	300525930			G0115
D2-3	BZY88 22V	300523680			G0110
RL1	RELAY 2 POLE 250nV1,000V 10 13	300652290			G0210
RL2	RELAY - 500V 10 13	300652260			G0142
RL3	RELAY 2 POLE 250nV 250V 10 13	300652270			G0143
RL4	RELAY 2 POLE - 1,000V 10 13	300652230			G0140
RL5	RELAY - 1,200V 10 9	300652320			G0145
RL6	RELAY 2 POLE 250nV1,000V 10 13	300652290			G0210
RL7-8	RELAY 2 POLE - 1,000V 10 13	300652230			G0140
RL9	RELAY 2 POLE 250nV 250V 10 13	300652270			G0143
RL10	RELAY 300V 10 13	300652250			G0141

(Contd.)

Table 3.12 PCB 15 PARTS LIST, INPUT SWITCHING DC VOLTS ATTENUATOR AND CURRENT *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
SG1	SPARK GAP 1,400V	300011470			G0096
DP1-5	DISCONNECT PIN	355900550	00779	151585-9	G0155
PL4	6 WAY AMP HEADER	352306090	00779	380372-2	G0150
PL5-6	2 WAY AMP HEADER	352302080	00779	280370-2	G0149
PL8	2 WAY AMP HEADER	352302080	00779	280370-2	G0149
PL9-10	FAST ON	355901490	00779	341329-1	G0156
S1	SWITCH 6 POLE	377000410			G0157

Table 3.13 PCB 15 PARTS LIST, DC INPUT AMPLIFIER

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R401	MEFM 15k 1/4W 1%	195341500	14674	NK4	G0052
R402-403	MEFM 30k 1/8W 0.5%	192743002	50139	FC55	G0029
R405-406	MEFM 10k 1/4W 1%	195341000	14674	NK4	G0050
R407	MEFM 27k 1/4W 1%	195342700	14674	NK4	G0054
R408	MEFM 4k7 1/4W 1%	195334700	14674	NK4	G0049
R409	MEFM 100 1/4W 1%	195321000	14674	NK4	G0039
R410	MEFM 1k5 1/4W 1%	195331500	14674	NK4	G0046
R411	MEFM 47R 1/4W 1%	195314700	14674	NK4	G0038
R412	MEFM 12k 1/4W 1%	195341200	14674	NK4	G0051
R413	MEFM 1k6 1/8W 0.5%				
R414	MEFM 12k 1/8W 0.5%	192741202	50139	FC55	G0028
R415	MEFM 820R 1/4W 5%	195328200	14674	NK4	G0043
R417	MEFM 4k7 1/4W 1%	195334700	14674	NK4	G0049
R418	MEFM 47R 1/4W 1%	195314700	14674	NK4	G0038
R419	MEFM A.O.T.				
R420	MEFM A.O.T.				
R421	MEFM 10k 1/8W 0.5%	192741002	50139	FC55	G0027
R422-426	MEFM 10k 0.25W 1%	195341000	14674	NK4	G0050
R427	MEFM 470R 0.25W 1%	195324700	14674	NK4	G0041
R430-431	MEFM 680R 0.125W 0.5%	192726804	50139	FC55	G0022
R432-433	MEFM 4k7 0.25W 1%	195334700	14674	NK4	G0049
R434	MEFM 10k 0.025W 1%	195341000	14674	NK4	G0050
R435	MEFM 33k 0.025W 1%				
C401	ESTM 0µ1 100V 10%	225451000			G0076
C404	CERM 10n 25V -25%, +50%	241941000			G0089
C405	CERM 47n 12V +50, -25%	241744700			G0088
C406-407	CERM 1n 500V -20, +40%	241331000			G0087
C408	ESTM 0µ1 100V 10%	225451000			G0076
C409	STYR 1n 500V 10%	210331000			G0069
C410	ESTF 10n 400V 10%	222341000	7E682	192P	G0070
C412	TAND 33µ 20V 20%	265873300			G0093
IC401	OP27	510091511	4U077	OP27EZ	G0190
IC402	LF356N	510091320	04713	LF356N	G0188
IC403	74HC04	510006540	04713	MC74HC04N	G0175
IC404	TIL117	300540240	4S837	TIL117	G0116

(Contd.)

Table 3.13 PCB 15 PARTS LIST, DC INPUT AMPLIFIER *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
TR401-402	2N2484	300552860	04713	2N2484	G0118
TR403-406	PN4117A	300555950			G0129
TR407	2N2904A	300551670	04713	2N2904A	G0117
TR408	BFX34	300554540	34148	BFX34	G0122
TR409	2N2904A	300551670	04713	2N2904A	G0117
TR410-411	PN4117A	300555950			G0129
TR412	WD460	300555820			G0126
TR413-414	PN4117A	300555950			G0129
TR416	2N484	300552860	04713	2N2484	G0118
TR418-421	2N2484	300552860	04713	2N2484	G0118
TR422	BFX34	300554540	34148	BFX34	G0122
TR423	2N2904A	300551670	04713	2N2904A	G0117
D401	BZY88 5V6 0.4W 5%	300521450			G0102
D402	BZY88 6V8 0.4W 5%	300522540			G0107
D403-404	SD3	300522160			G0106
D405	BZY88 22V 0.4W 5%	300523680			G0110
D406	BZY88 7V5 0.4W 5%	300521460			G0103
D407	BZY88 2V7 0.4W 5%	300523870			G0111
D409	BZY88 5V6 0.4W 5%	300521450			G0102
D411	BZY88 4V 0.4W 5%	300521470			G0104
TP401-402	TEST POINT	355400760			G0153
	TURRET LUGS	355500430			G0154

Table 3.14 PCB 15 PARTS LIST, D C RANGING

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
(R101	PRWW SET 18k	169617801			G0010
(R102	2k22				
(R103	18k				
(R104	2k				
R105-107	MEFM 47k 1/8W	195344700	14674	NK4	G0055
R108-110	MEFM 8201/4W 1%	195328200			G0043
R113	MEFM 1k8 1/8W 0.5%	192731802	50139	FC55	G0025
IC101-103	TIL 117	300540240	4S837	TIL117	G0116
TR101-103	WN1001	300555770			G0125
TR104	2N2904A	300551670	04713	2N2904A	G0117
DP6	DISCONNECT PIN	355900550	00779	151585-9	G0155
TL101-102	TURRET LUG	355500430			G0154
TP101	TEST POINT	355400760			G0153

Table 3.15 PCB 15 PARTS LIST, INTEGRATOR

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
(R201 (R202A, (R202B	P.W.W. 300k P.W.W. PAIR 100k	169618801		M/Set	G0013
R203	MEFM 10k 1/8W 0.5%	192741001	50139	FC55	G0026
R204-205	MEFM 1k 1/4W 1%	195331000	14674	NK4	G0044
R206-207	MEFM 100k 1/4W 1%	195351000	14674	NK4	G0056
R208-209	MEFM 10k 1/8W 0.5%	192741001	50139	FC55	G0026
R210	MEFM 10k 1/4W 1%	195341000	14674	NK4	G0050
R211	MEFM 560 1/4W 1%	195325600	14674	NK4	G0042
R212	MEFM 10k 1/4W 1%	195341000	14674	NK4	G0050
R213	MEFM 560 1/4W 1%	195325600	14674	NK4	G0042
R214-215	MEFM 470 1/8W 0.5%	192724702	50139	FC55	G0021
R217-218	MEFM 22k 1/4W 1%	195342200	14674	NK4	G0053
R219-220	MEFM 2k2 1/4W 1%	195332200	14674	NK4	G0046
R221	MEFM 39k 1/8W 0.5%	192743902	50139	FC55	G0030
R222	MEFM 150k 1/8W 0.1%	195351500	14674	NK4	G0057
R223	MEOX 10k 1/4W 5%				
R224	MEFM 10 1/4W 1%	195311000	14674	NK4	G0036
R225	MEFM 75k 1/8W 5%				
R227	MEOX 470 1/2W 1%	195424700	14674	NK5	G0059
R228-229	MEOX 1k 1/4W 1%	195331000	14674	NK4	G0044
R230	MEOX 330 1/4W 1%	195323300	14674	NK4	G0040
R231	MEFM 470 1/4W 1%	195324700	14674	NK4	G0041
C201	PYLN 22N 400V	208900003			G0068
C202	ESTM 470n 100V 10%	225454700			G0079
C203	ESTM 68n 100V 10%	225446800			G0075
C204	CERM 150p 500V 20%	241321500			G0085
C205	ESTM 10n 100V 10%	225441000			G0073
C208-209	CERM 10n 500 -25 +50%	241941000			G0089
C210-211	CERM 220p 500 +40%,-20%	241322200			G0086
C212	ESTM 22n 100V 10%	225442200			G0074
C213	TANT 33µ 10V 10%	265373300			G0091
C214-215	ESTM 100n 100V 10%	225451000			G0076

(Contd.)

Table 3.15 PCB15 PARTS LIST, INTEGRATOR *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
C216-219	CERM 47n 25V -25% +50%	241944700			G0090
C220-221	CERM 47p 500V 20%	241314700			G0083
C223	TANT 15p 20V 10	265871500			G0092
C224	CERM 100n 50V -20% +80%	208450140			G0063
IC201	ICL 7650	510091120			G0183
IC202	LM301	510091270	4S837	LM301AN	G0186
IC203	LM319N	510091640	27014	LM319N	G0191
IC204	74F74	510006000	04713	MC74F74N	G0174
TR201-202	WM222	300555940			G0128
TR203-204	VP1008L	300556330			G0130
TR205-206	BCY70	300553590	04713	BCY70	G0120
TR207-208	VN10	300555860			G0127
D201-202	SD3	300522160			G0106
D204-205	Zener 7V5 .4W 5%	300521460			G0103
D206	Zener 5V1	300521310			G0099

Table 3.16 PCB 15 PARTS LIST, REFERENCE

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R301	1k5				
R302A/B	PREC MEFM MATCHED PAIR 44k 1%	169607702			G0008
R303A/B	PREC MEFM MATCHED PAIR 3k85 0.1% TINNED COPPER WIRE LINK	169618002			G0011
R306	MEFM 470R 1/2W 1%	195424700	14674	NK5	G0059
R307-308	MEFM 100R 1/4W 1%	195321000	14674	NK4	G0039
R309-310	MEFM 1k 1/8W .5%	192731002	50139	FC55	G0023
R311	MEFM 390R 1/8W 1/2W	192723902	50139	FC55	G0020
R312	MEFM 220R 1/8W 0.5%%	192722202	50139	FC55	G0019
R313	MEFM 470R 1/2W 1%	195424700	14674	NK5	G0059
C301	CERM 47n 25V -25% +50%	241944700			G0090
C304	CERM 47n 25V -25% +50%	241944700			G0090
IC301	0P05CP	510091130	4U077	OP-05CP	G0184
IC302	0P05CP	510091130	4U077	OP-05CP	G0184
IC303	DG301	510091110	34371	HI1-301-5	G0182
TR301	BC107	300553320	04713	BC107A	G0119
TR302	BCY70	300553590	04713	BCY70	G0120
D301	Zener 6.15V				
D302	Zener 10V	300522760			G0108
TP301-302	TEST POINT	355400760			G0153
TP305	TEST POINT	355400760			G0153

Table 3.17 PCB 15 PARTS LIST, OHMS CURRENT SOURCE

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R601	MEFM 47k 1/8W 0.5%	192744702	50139	FC55	G0031
R602	MEFM 75k 1/8W 0.5%	192747501	50139	FC55	G0032
R603-607	PR.MEFM/WW 25k + 100k + 5k + 50k + 500k	169618101		M/SET	G0012
R607	PRWW 500k				
R608	MEFM 1k 1/4W 1%	195331000	14674	NK4	G0044
R609	P.T.C. 1k	161000030	50157	180Q10232	G0007
R610	MEFM 10k 1/8W 0.5%	192741002	50139	FC55	G0027
R611	MEFM 110k 1/8W 0.5%	192751101	50139	FC55	G0034
R612	MEFM 1M 1/4W .5%	198261002	50139	FC65	G0062
R613	MEFM 12k 1/8W 1%	195341200	14674	NK4	G0051
R614	MEFM 3k3 1/4W 1%	195333300	14674	NK4	G0047
R651	MEFM 10k 1/4W 1%	195341000			G0050
R652	MEFM 820 1/4W 1%	195328200			G0043
R653	MEFM 10k 1/4W 1%	195341000			G0050
R654-655	MEFM 820 1/4W 1%	195328200			G0043
R656-659	MEFM 10k 1/4W 1%	195341000			G0050
C601	CERM 100p 500V	241321000			G0084
C602-603	ESTM 100n 100V	225451000			G0074
C605	CERM 100n 50V	208450140			G0063
C606	CERM 100p 500V	241321000			G0084
IC601	LM201	510091271	4S837	LM201AN	G0187
IC602	ICL7650	510091120			G0183
IC603-605	DG211	510091180			G0185
IC606-608	TIL 117	300540240	4S837	TIL117	G0116
TR601	TRANS 3N163 + SHORTING CLIP	300554530	8S956	3N163	G0121
TR602-603	TRANS WN807	300555380			G0124

(Contd.)

Table 3.17 PCB 15 PARTS LIST, OHMS CURRENT SOURCE *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
D601	Zener 6V2 400mW 5%	300521240			G0097
D602	IN4007	300524990	04713	1N4007	G0114
D603	Zener 10V 400mW 5%	300522760			G0108
D604	Zener 13V 400mW 5%	300523920			G0112
D605	Zener 18V 400mW 5%	300521300			G0098
D606-607	Zener 5V1 400mW 5%	300521310			G0099
D731	Diode I/Reg. 50V 4m7	300526040			G0196
FOR IC 602	14-PIN D.I.L. SOCKET	300585340			G0135

Table 3.18 PCB 15 PARTS LIST, AC / AC + DC TRUE RMS CONVERTOR *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R701	RES. M.F. 990k	160300516	6B214	MS313N	G0006
R702A-B	RES. CADDOCK 9k/1k 0.2W 0.1%	160400582	6B214	T912B-1K-050-01	G0005
R703-704	RES. COMP 470k 1/2W 10%	172354700	50139	EB	G0014
R705	RES. P.T.C. 1k	161000030	50157	180Q10232	G0007
R706	RES. MEFM 1M 1/2W 1%	195461000	14674	NK5	G0061
R707A-B	RES. CADDOCK 9k/1k 0.2W 0.1%	160400582	6B214	T912B-1K-050-01	G0005
R708	RES. MEFM 75R 1/8W 0.5%	192715602	50139	FC55	G0017
R709	RES. MEFM 200k 1/8W 0.5%	192752002	50139	FC55	G0035
R710	RES. MEFM 100k 1/4W 1%	195351000	14674	NK4	G0056
R712	THERMISTOR PTC 600@0°C 1k5@50°C	161000030			G0007
R731	RES.MEFM 10k 4W 5%	176241000			G0197
R732	RES.CACP 220M 1/2W 10%	172372200			G0205
R734	RES. MEFM 965k 1/4W 0.5%	160400530			G0206
R735	RES. MEFM 10k 1/4W 0.5%	192741002			G0027
R737	RES. MEFM 8.2k 1/4W 1%	195338200			G0207
R739	RES. MEFM 1k 1/4W 0.5%	192731002			G0023
R740	RES. MEFM 220k 1/4W 1%	195322200			G0208
RV701	RES. VAR 100k 1/2W 10%	130951000	4D600	ET24W	G0002
RV702	RES.VAR 50 1/2W 20%	130915000			G0209

(Contd.)

Table 3.18 PCB 15 PARTS LIST, AC / AC + DC TRUE RMS CONVERTOR *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
C701	CAP. ESTM 0M22 400V 20%	226152200			G0081
C702	CAP. ESTF 10n 1.000 10%	222841000			G0071
C703	CAP. CERM 6p8 500V 20%				
C704	CAP. ESTF 3M3 100V 10%	225463300			G0080
C705	CAP. CERM 47N 25V -25 +50%	241944700			G0090
C706	CAP. 47n	241944700			G0198
C707	CAP. 22n	227034700			G0199
C708	CAP. 47n	241944700			G0198
C709	CAP. 47n	241944700			G0198
C710	CAP. ESTM 4µ7 63V 10%	225164700			G0072
C711	CAP. ESTM 0µ33 10%	225453300			G0078
C712-714	CAP. CERM 10n	241941000			G0089
C720	CAP. ESTM 2µ2 63V 10%	225162200			G0201
C731	CAP.ESTM 0µ22 63V 10%	208200159			G0200
C732	CAP. TAND 4µ7 35V 20%	208700109			G0202
C733	CAP. CERM 10p 500V 20%	241311000			G0082
C734	CAP. TAND 22µ 16V 20%	208700106			G0203
C735	CAP. TAND 10µ 25V 20%	208700108			G0204
CV701-723*	TRIMMER CAP 0.5-7p	290060080			G0095
IC701	I.C. LN0062	510090380	6Z045	AD52&J	G0178
IC702	I.C. AD637K	510091460	6Z045	AD637KN	G0189
IC703	I.C. DG211	510091180			G0185

(Contd.)

Table 3.18 PCB 15 PARTS LIST, AC / AC + DC TRUE RMS CONVERTOR *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
TR701 TR731	3N170 BFY90	300555270 300553890*	04713	3N170	G0123
D701-702 D731	Diode 1N3595 Diode 50V I.Reg.	300523590	34148	1N3595	G0109
RL701	Reed 1-Pole N/O 500VDC 1/2A	300652320			G0145
RL702	Reed 1-Pole C/O Hi-speed 20W	300652030	61058	RS-5V	G0138
RL703-704	Reed 1-Pole N/O 1/2A Sw.	300652210			G0139
RL705	Reed 1-Pole N/O 1/4A Sw.	300652000			G0137
RL706	Reed 1-Pole N/O 360VDC	300652260			G0142
RL707	Reed 1-Pole N/O 5V 1/4A	300652000			G0137
PL701	26-WAY PLUG	352326110	5W380	3429-6302	G0152
TP701	TEST POINT	355400760			G0153
FOR IC701 FOR IC702	8-PIN D.I.L. BASE 14-PIN D.I.L. BASE	300585340			G0135

Table 3.19 PCB15 PARTS LIST, FLOATING LOGIC

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R801	MEFM 10k 0.25W 1%	195341000	14674	NK4	G0050
IC801-804	UV ROM 2716	510003080	4S837	TMS2516	G0172
IC805-808	ULN 2003A	510004980	4S837	ULN-2003AN	G0173
D801	BZY88 10V 400mW 5%	300521430			G0101
PL801	26 WAY PLUG (FIXED)	352326110	5W380	3429-6302	G0152
SK802	16 PIN D.I.L. BASE	300584860			G0132
	24 PIN D.I.L. BASE	300584910			G0133

Table 3.20 PCB 15 PARTS LIST, FLOATING POWER SUPPLY

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R901	MEFM 39R 0.25W 1%	195313900	14674	NK4G0037	G0211
C901-902	ALME 220µ 40V	208600262	54473	ECEA1GV221SC	G0065
C904	ALME 1,000µ 40V	208600263	54473	ECEA1HV102SU	G0066
C905	TAND 1µ 35V 20%	266061000			G0094
C906	ALME 1,000µ 40V	208600263	54473	ECEA1HV102SU	G0066
C907	TAND 1µ 35V 20%	266061000			G0094
C908-909	ALME 220µ 40V	208600262	54473	ECEA1GV221SC	G0065
C911	ALME 3,300µ 16V	208600286	54473	ECET16R332SN	G0067
C912-914	TAND 1µ 35V 20%	266061000			G0094
IC901	7815CT +15V	510090320	4S837	UA7815CKC	G0176
IC902	7915CT -15V	510090330	4S837	UA7915CKC	G0177
IC903	7805CT +5V	510090500	4S837	UA7805CKC	G0179
IC904	78L12 +12V	510090520	4S837	UA7812CKC	G0180
IC905	79L12 -12V	510090530	4S837	UA7912CKC	G0181
D901	BRIDGE W04	300524700	8S956	W04	G0113
D902-905	1N4004	300522070	04713	1N4004	G0105
D906	BRIDGE W04	300524700	8S956	W04	G0113
D907-908	Zener 8V2 400mW 5%	300521330			G0100
FOR IC901-903	HEATSINK	300584940			G0134
TP901-907	TEST POINT	355400760			G0153
PL901	8 WAY AMP HEADER	352308060	00779	280373-2	G0151

Table 3.21 PCB 15 PARTS LIST, MISCELLANEOUS

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
	PCB 5 ASSEMBLY	70610505Y	-		G0001
	RESISTOR 1.5k	160300516	05591	5E10D	G0004
R701	(TABLE 3.17)				
	RESISTOR SET	169618801			G0013
	RESISTOR 56R	192715602	50139	FC55	G0016
R708	(TABLE 3.17)				
R312	(TABLE 3.15)				
R311	(TABLE 3.15)				
	RESISTOR 1.5k	192731502	50139	FC55	G0024
R18,R19	(TABLE 3.11)				
	RESISTOR 3.9k	195333900	14674	NK4	G0048
	RESISTOR 150k	195351500	14674	NK4	G0057
	RESISTOR 270	195422700	14674	NK5	G0058
	CAPACITOR 22n	208450143			G0064
	CAPACITOR 10p	241311000			G0082
	CAPACITOR 100p	241321000			G0084
D1	(TABLE 3.11)				
TR701	(TABLE 3.17)				
	PAD TRANSISTOR	300584090			G0131
	MICA WASHER SOT93	300585430			G0136
	RELAY CR - 7002 - 5082	300652300			G0144
	RELAY	300652550			G0146
	RELAY CORE 31000154	300652560			G0147
	RELAY CORE 70035070	300652570			G0148
	SCREW M2	406602060			G0158
	SCREW M3 x 8mm	406803080			G0159
	SCREW M3 x 10mm	406803100			G0160
	NUT FULL M3	410031010			G0161
	M2 NUT HEX x FULL	410031060			G0162
	WASHER CRINKLE x 13	411129010			G0164
	WASHER CRINKLE x 12	411129050			G0165
	LABEL LIGHTNING FLASH	420880470			G0166
	SLEEVING POLYPENC E	429500210			G0167
	WASHER INS	470110100			G0168

(Contd.)

Table 3.21 PCB 15 PARTS LIST, MISCELLANEOUS *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
	BEAD CERAMIC SMALL	470120030			G0169
	BEAD CERAMIC	470120040			G0170
	SPACER CERAMIC	470120100			G0171
	PCB 5 SHORTING LINK	70610226A			G0192
	PCB 5 MODIFICATION	70614411A			G0193
	PCB 5	70619505X			G0194
	SCREEN	71512013A			G0195

Table 3.22 MAIN FRAME COMPONENTS

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
SK1	SOCKET 5 WAY (S/F)	352105010			A0114
SK2	SOCKET 5 WAY (S/F)	352105010			A0114
SK3	SOCKET 5 WAY (SWITCHCRAFT)	352505040			A0067
SK4	6 WAY AMP "PLUG"	351506100			A0115
SK5-8	2 WAY AMP "PLUG"	351502080			A0116
TL1	BINDING POST RED	355100670			A0069
TL2	BINDING POST BLACK	355100650			A0068
FS1	FUSE 2A FUSE HOLDER	360106150			A0071

Table 3.23 PCB 3 PARTS LIST, GLUG COUNTER AND LATCHES

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R301	MEFM 4k7 1/4W 1%	195334700	14674	NK4	C0021
R303-306	MEFM 4k7 1/4W 1%	195334700	14674	NK4	C0021
R307	MEFM 6k8 1/4W 1%	195336800	14674	NK4	C0022
C301-314	CERM 47n 25V -25% +50%	241944700			C0041
IC301	F7	510006000	04713	MC74F74N	C0102
IC302	F64	510007470	34148	F74F64PC	C0121
IC303	F74	510006000	04713	MC74F74N	C0102
IC304	F64	510007470	34148	F74F64PC	C0121
IC305	F161	510007480	34148	F74F161APC	C0122
IC306	LS161	510004160	4S837	SN74LS161AN	C0092
IC307	LS393	510004470	4S837	SN74LS393N	C0094
IC308-309	LS374	510004390	4S837	SN74LS374N	C0093
IC310	HC161	510007000	04713	MC74HC161N	C0115
IC312	HC 74	510006590	04713	MC74HC74N	C0107
IC313	F164	510007490	18324	N74F164N	C0123
IC314	HC00	510006520	04713	MC74HC00N	C0106
IC315	HC174	510006630	04713	MC74HC174N	C0108
TP301-304	TEST POINT	355400760			C0077

Table 3.24 PCB 3 PARTS LIST, FLOATING I/O AND CLOCK

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R412-413	MEFM 2k2 1/4W 5%	195332200	14674	NK4	C0018
R414-415	MEFM 6k8 1/4W 5%	195336800	14674	NK4	C0022
R416-417	MEFM 270 1/4W 5%	195322700	14674	NK4	C0010
R418-419	MEFM 330 1/4W 5%	195323300	14674	NK4	C0011
R420	MEFM 1k 1/4W 5%	195331000	14674	NK4	C0014
R421-422	MEFM 270 1/4W 5%	195322700	14674	NK4	C0010
R423	MEFM 2k2 1/4W 5%	195332200	14674	NK4	C0018
R424-425	MEFM 4k7 1/4W 1%	195334700	14674	NK4	C0021
R426-429	MEFM 6k8 1/4W 5%	195336800	14674	NK4	C0022
C406-415	CERM 47n 25V -25% + 50%	241944700			C0041
C416-417	CERM 0.1µ 50V -20% + 80%	208450140			C0029
C419-420	CERM 10n 25V -25% + 50%	241941000			C0044
C422	ALME 47µ 10V	208600244			C0030
C423	CERM 100p 500V 20%	241321000			C0037
IC401-402	HC 374	510006690	04713	MC74HC374N	C0110
IC403-417	TIL 117	300540240	4S837	TIL117	C0053
IC418	LS 74	510002600	4S837	SN74LS74AN	C0089
IC419	LS 00	510002000	4S837	SN74LS00N	C0088
IC420	F161	510007480	34148	F74F161APC	C0122
IC421	HC 4040	510007040	04713	MC74HC4040N	C0116
IC422	HC 390	510007530	04713	MC74HC390N	C0125
IC423	HC 161	510007000	04713	MC74HC161N	C0115
IC424	HC 157	510006980	04713	MC74HC157N	C0114
IC425	HC 153	510006970	04173	MC74HC153N	C0113
IC426	CD 4046	510005690	04713	MC14046BCP	C0099
IC427	F 374	510006190	34148	F74F374PC	C0104
IC428-429	HCPL 2601	300540260	5B017	HCPL2601	C0054
IC430	F 04	510007500	34148	F74F04PC	C0124
IC431	F 86	510006010	34148	F74F86PC	C0103
IC432	HC 132	510006950	04713	MC74HC132N	C0112
IC434	Resistor Network 1k 1.5W 2% (15 OFF)	160400644	50139	316A-102	C0004
IC435	Resistor Network 6.8k 1.5W 2% (15 OFF)	160400569	50139	316A-682	C0002
D401-2	SD3	300522160			C0048
D404	SD3	300522160			C0048

(Contd.)

Table 3.24 PCB 3 PARTS LIST, FLOATING I/O AND CLOCK *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
TP401-402	TRANSFORMER 76614/4HV	303050010			C0068
PL401	RIBBON PLUG 26-WAY	352326110	5W380	3429-6302	C0073
TP401-405	TEST POINT	355400760			C0077

Table 3.25 PCB 3 PARTS LIST, POWER SUPPLY

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R501	MEFM 470R 1/4W 1%	195324700	14674	NK4	C0012
R504	MEFM 470k 1/4W .5%	192754702	50139	FC55	C0007
R505	MEFM 22 1/4W 1%	195312200	14674	NK4	C0009
C501	ALME 10,000µ 16V	208600284	7E682	80D103P016JC2	C0033
C502	ALME 3,300µ 16V	208600286	54473	ECET16R332SW	C0034
C503	CERM 0.1µ 50V -20% + 80%	208450140			C0029
C504	TAND 33µF 10V 20%	265473300	50139	316A-102	C0043
C505-507	ALME 47µF 40V	208600261	7E682	672D476H40CD2	C0031
C508	ALME 220µF 40V	208600262	54473	ECEA1GV221SC	C0032
C509	ALME 220µF 40V	208600262	54473	ECEA1GV221SC	C0032
C510-511	TAND 1µ 35V 20%	266061000			C0045
C512-513	CERM 47nF 25V -25% + 50%	241944700			C0041
C514	CERM 10nF 25V -25% + 50%	241941000			C0040
C515	CERM 1nF 500V -20% + 40%	241331000			C0038
C516	CERM 22nF 25V -20% + 50%	241842200			C0039
C517	TAND 1µ 35V 20%	266061000			C0045
C518	TANT 22µ 16V 20%	208700106			C0035
IC501-505	7805CT	510090500	4S837	UA7805CKC	C0128
TR501-503	VNO300M	300556300			C0059
D501	RECTIFIER KBU4B	300510340	04713	MDA97042	C0046
D502-503	IN6263	300525650	4S837	TIL117	C0053
D504	WO4	300524700			C0059
D505	Zener 30V	300521430			C0047
D506	WO4	300524700			C0059
D509	LED, HLMP-3316	300750190			C0061
D510-513	SD3	300522160			C0048
T501	TRANSFORMER (RM6)	309620201			C0069
B501	Nicd battery 3V6 0.09AL	800400210			C0135
PL501	8 WAY PLUG	352308060	00779	280373-2	C0072

(Contd.)

Table 3.25 PCB 3 PARTS LIST, POWER SUPPLY *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
TP501-509	TEST POINT	355400760			C0077
FOR ICI 2,3,4	HEATSINKS	300584940			C0061
DP501-504	DISCONNECT PINS	355900550			C0084

Table 3.26 PCB 8 PARTS LIST, OSCILLATOR (MOUNTED ON PCB 3)

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
	PCB 8 ASSY.	70610508X			E0001
	SPREADER (TO18)	300584030			E0020
	PAD MOUNTING	300584220			E0021
	SOCKET PV 1-WAY	352501680	00779	85861-4	E0023
	PCB 8	70619508X			E0026
R101	MEFM 330k 1/8W .5%	192753302	50139	FC55	E0002
R102	MEFM 100k 1/4W 1%	195351000	14674	NK4	E0008
R103	MEFM 10k 1/4W 1%	195341000	14674	NK4	E0007
R104	MEFM 100k 1/4W 1%	195351000	14674	NK4	E0008
R106	MEFM 1k 1/4W 1%	195331000	14674	NK4	E0006
R107-108	MEFM 180 1/4W 1%	195321800	14674	NK4	E0004
R109	MEFM 220 1/4W 1%	195322200	14674	NK4	E0005
R110	MEOX 10 1/4W 1%	195311000	14674	NK4	E0003
C101	TAND 22µ 16V	208700106			E0010
C102	TAND 1µ 35V	266061000			E0015
C103	CERM 47p	208450200			E0009
C104-106	CERM 47n	241944700			E0014
C107	CERM 1n	241331000			E0012
C108	CERM 47n	241944700			E0014
C109	CERM 10n	241941000			E0013
C110	TAND 4µ7 35V 20%	208700109			E0011
IC101	MC1648	510007550	04713	MC1648P	E0025
TR101-102	ZN2906A	300554500	34148	2N2906A	E0019
TR103	ZN2369	200552390	34148	2N2369	E0018
D101	MV2115	300525310	04713	MV2115	E0017
D102	OA47	300520850			E0016
L101	0.22µ	305030490			E0022
TP101	TEST POINT	355400760			E0024

Table 3.27 PCB 5 PARTS LIST, INPUT SWITCHING DC VOLTS ATTENUATOR AND CURRENT

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R1 (A-c)	MATCHED SET 3M3	169609102			D0009
R2	MATCHED SET 100k05 0.1%				
R3-5	MEGL 47k 3W 2%	175244700			D0015
R6	MEFM 1M 1/4W 5%	198261002	50139	FC65	D0062
R7	56R	192715602	50139	FC55	D0016
R8	PRWW 0.1 .5%	160300506			D0003
R9-11	MEOX 47k ½W 1%	195444700	14674	NK5	D0060
R12-14	MEFM 820R 1/4W 1%	195328200	14674	NK4	D0043
R15-16	MEFM 47k	192744702	50139	FC55	D0031
R17	MEFM 100k	192751002	50139	FC55	D0033
R18-19	MEFM 10k 1/8W 0.5%	192741001	50139	FC55	D0026
R20-26	NOT USED				
R27	MEFM 10k 1/8 W 5%	192741001	50139	FC55	D0026
C1	ESTM 0.22µ 100V 10%	225452200			D0077
C2	ESTF 22n 400V 10%	208450143			D0064
C3-6	CERM 10n 25V -25% + 50%	241941000			D0089
IC1-3	TIL117	300540240	4S837	TIL117	D0116
TR1-3	WN1001	300555770			D0125
TR4	2N2904A	300551670	04713	2N2904A	D0117
TR5	3N170	300555270	04713	3N170	D0123
D1	D PAD 1	300525930			D0115
D2-3	BZY88 22V	300523680			D0110
RL1	RELAY 2 POLE 250nV1,000V 10 13	~~300652290~~ 300652550			D0196
RL2	RELAY - 500V 10 13	300652260			D0142
RL3	RELAY 2 POLE 250nV 250V 10 13	300652270			D0143
RL4	RELAY 2 POLE - 1,000V 10 13	300652230			D0140
RL5	RELAY - 1,200V 10 9	300652320			D0145
RL6	RELAY 2 POLE 250nV1,000V 10 13	300652290			D0196
RL7-8	RELAY 2 POLE - 1,000V 10 13	300652230			D0140
RL9	RELAY 2 POLE 250nV 250V 10 13	300652270			D0143
RL10	RELAY 300V 10 13	300652250			D0141

(Contd.)

Table 3.27 PCB 5 PARTS LIST, INPUT SWITCHING DC VOLTS ATTENUATOR AND CURRENT *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
SG1	SPARK GAP 1,400V	300011470			D0096
DP1-5	DISCONNECT PIN	355900550	00779	151585-9	D0155
PL4	6 WAY AMP HEADER	352306090	00779	380372-2	D0150
PL5-6	2 WAY AMP HEADER	352302080	00779	280370-2	D0149
PL8	2 WAY AMP HEADER	352302080	00779	280370-2	D0149
PL9-10	FAST ON	355901490	00779	341329-1	D0156
S1	SWITCH 6 POLE	377000410			D0157

Table 3.28 PCB 5 PARTS LIST, DC INPUT AMPLIFIER

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R401	MEFM 15k 0.025W 1%	195341500	14674	NK4	D0052
R402-403	MEFM 30k 0.125W 0.5%	192743002	50139	FC55	D0029
R405-406	MEFM 10k 0.25W 1%	195341000	14674	NK4	D0050
R407	MEFM 27k 0.25W 1%	195342700	14674	NK4	D0054
R408	MEFM 4k7 0.25W 1%	195334700	14674	NK4	D0049
R409	MEFM 100 0.25W 1%	195321000	14674	NK4	D0039
R410	MEFM 1k5 0.25W 1%	195331500	14674	NK4	D0046
R411	MEFM 47R 0.25W 1%	195314700	14674	NK4	D0038
R412	MEFM 12k 0.25W 1%	195341200	14674	NK4	D0051
R413	MEFM 1k6 0.125W 0.5%				
R414	MEFM 12k 0.125W 0.5%	192741202	50139	FC55	D0028
R415	MEFM 820R 0.25W 5%	195328200	14674	NK4	D0043
R417	MEFM 4k7 0.25W 1%	195334700	14674	NK4	D0049
R418	MEFM 47R 0.25W 1%	195314700	14674	NK4	D0038
R419	MEFM A.O.T.				
R420	MEFM A.O.T.				
R421	MEFM 10k 0.125W 0.5%	192741002	50139	FC55	D0027
R422-426	MEFM 10k 0.25W 1%	195341000	14674	NK4	D0050
R427	MEFM 470R 0.25W 1%	195324700	14674	NK4	D0041
R430-431	MEFM 680R 0.125W 0.5%	192726804	50139	FC55	D0022
R432-433	MEFM 4k7 0.25W 1%	195334700	14674	NK4	D0049
R434	MEFM 10k 0.025W 1%	195341000	14674	NK4	D0050
R435	MEFM 33k 0.025W 1%				
C401	ESTM 0µ1 100V 10%	225451000			D0076
C404	CERM 10n 25V -25%, +50%	241941000			D0089
C405	CERM 47n 12V +50, -25%	241744700			D0088
C406-407	CERM 1n 500V -20, +40%	241331000			D0087
C408	ESTM 0µ1 100V 10%	225451000			D0076
C409	STYR 1n 500V 10%	210331000			D0069
C410	ESTF 10n 400V 10%	222341000	7E682	192P	D0070
C412	TAND 33µ 20V 20%	265873300			D0093
IC401	OP27	510091511	4U077	OP27EZ	D0190
IC402	LF356N	510091320	04713	LF356N	D0188
IC403	74HC04	510006540	04713	MC74HC04N	D0175
IC404	TIL117	300540240	4S837	TIL117	D0116

(Contd.)

Table 3.28 PCB 5 PARTS LIST, DC INPUT AMPLIFIER *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
TR401-402	2N2484	300552860	04713	2N2484	D0118
TR403-406	PN4117A	300555950			D0129
TR407	2N2904A	300551670	04713	2N2904A	D0117
TR408	BFX34	300554540	34148	BFX34	D0122
TR409	2N2904A	300551670	04713	2N2904A	D0117
TR410-411	PN4117A	300555950			D0129
TR412	WD460	300555820			D0126
TR413-414	PN4117A	300555950			D0129
TR416	2N484	300552860	04713	2N2484	D0118
TR418-421	2N2484	300552860	04713	2N2484	D0118
TR422	BFX34	300554540	34148	BFX34	D0122
TR423	2N2904A	300551670	04713	2N2904A	D0117
D401	BZY88 5V6 0.4W 5%	300521450			D0102
D402	BZY88 6V8 0.4W 5%	300522540			D0107
D403-404	SD3	300522160			D0106
D405	BZY88 22V 0.4W 5%	300523680			D0110
D406	BZY88 7V5 0.4W 5%	300521460			D0103
D407	BZY88 2V7 0.4W 5%	300523870			D0111
D409	BZY88 5V6 0.4W 5%	300521450			D0102
D411	BZY88 4V 0.4W 5%	300521470			D0104
TP401-402	TEST POINT	355400760			D0153
	TURRET LUGS	355500430			D0154

Table 3.29 PCB 5 PARTS LIST, D C RANGING

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
(R101 (R102 (R103 (R104	PRWW SET 18k 2k22 18k 2k	169617801			D0010
R105-107	MEFM 47k 1/4W	195344700	14674	NK4	D0055
R111-112	MEFM 47k 1/8W	192744702	50139	FC55	D0031
R113	MEFM 1k8 1/8W 0.5%	192731802	50139	FC55	D0025
IC101-103	TIL 117	300540240	4S837	TIL117	D0116
TR101-103	WN1001	300555770			D0125
TR104	2N2904A	300551670	04713	2N2904A	D0117
DP6	DISCONNECT PIN	355900550	00779	151585-9	D0155
TL101-102	TURRET LUG	355500430			D0154
TP101	TEST POINT	355400760			D0153

Table 3.30 PCB 5 PARTS LIST, INTEGRATOR

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
(R201	P.W.W. 300k	169618801		M/SET	D0013
(R202A,	P.W.W. 100k				
(R202B	P.W.W. 100k				
R203	MEFM 10k 1/8W 0.5%	192741001	50139	FC55	D0026
R204-205	MEFM 1k 1/4W 1%	195331000	14674	NK4	D0044
R206-207	MEFM 100k 1/4W 1%	195351000	14674	NK4	D0056
R208-209	MEFM 10k 1/8W 0.5%	192741001	50139	FC55	D0026
R210	MEFM 10k 1/4W 1%	195341000	14674	NK4	D0050
R211	MEFM 560 1/4W 1%	195325600	14674	NK4	D0042
R212	MEFM 10k 1/4W 1%	195341000	14674	NK4	D0050
R213	MEFM 560 1/4W 1%	195325600	14674	NK4	D0042
R214-215	MEFM 470 1/8W 0.5%	192724702	50139	FC55	D0021
R217-218	MEFM 22k 1/4W 1%	195342200	14674	NK4	D0053
R219-220	MEFM 2k2 1/4W 1%	195332200	14674	NK4	D0046
R221	MEFM 39k 1/8W 0.5%	192743902	50139	FC55	D0030
R222	MEFM 150k 1/8W 0.1%	195351500	14674	NK4	D0057
R223	MEOX 10k 1/4W 5%				
R224	MEFM 10 1/4W 1%	195311000	14674	NK4	D0036
R225	MEFM 75k 1/8W 5%				
R227	MEOX 470 1/2W 1%	195424700	14674	NK5	D0059
R228-229	MEOX 1k 1/4W 1%	195331000	14674	NK4	D0044
R230	MEOX 330 1/4W 1%	195323300	14674	NK4	D0040
R231	MEFM 470 1/4W 1%	195324700	14674	NK4	D0041
C201	PYLN 22N 400V	208900003			D0068
C202	ESTM 470n 100V 10%	225454700			D0079
C203	ESTM 68n 100V 10%	225446800			D0075
C204	CERM 150p 500V 20%	241321500			D0085
C205	ESTM 10n 100V 10%	225441000			D0073
C208-209	CERM 10n 500 -25 +50%	241941000			D0089
C210-211	CERM 220p 500 +40%,-20%	241322200			D0086
C212	ESTM 22n 100V 10%	225442200			D0074
C213	TANT 33µ 10V 10%	265373300			D0091
C214-215	ESTM 100n 100V 10%	225451000			D0076

(Contd.)

Table 3.30 PCB5 PARTS LIST, INTEGRATOR *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
C216-219	CERM 47n 25V -25% +50%	241944700			D0090
C220-221	CERM 47p 500V 20%	241314700			D0083
C223	TANT 15p 20V 10	265871500			D0092
C224	CERM 100n 50V -20% +80%	208450140			D0063
IC201	ICL 7650	510091120			D0183
IC202	LM301	510091270	4S837	LM301AN	D0186
IC203	LM319N	510091640	27014	LM319N	D0191
IC204	74F74	510006000	04713	MC74F74N	D0174
TR201-202	WM222	300555940			D0128
TR203-204	VP1008L	300556330			D0130
TR205-206	BCY70	300553590	04713	BCY70	D0120
TR207-208	VN10	300555860			D0127
D201-202	SD3	300522160			D0106
D204-205	Zener 7V5 .4W 5%	300521460			D0103
D206	Zener 5V1	300521310			D0099

Table 3.31 PCB 5 PARTS LIST, REFERENCE

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R301	1k5				
R302A/B	PREC MEFM MATCHED PAIR 44k 1%	169607702			D0008
R303A/B	PREC MEFM MATCHED PAIR 3.85k 0.1% TINNED COPPER WIRE LINK	169618002			D0011
R306	MEFM 470R 1/2W 1%	195424700	14674	NK5	D0059
R307-308	MEFM 100R 1/4W 1%	195321000	14674	NK4	D0039
R309-310	MEFM 1k 1/8W 0.5%	192731002	50139	FC55	D0023
R311	MEFM 390R 1/8W 0.5%	192723902	50139	FC55	D0020
R312	MEFM 220R 1/8W 0.5%	192722202	50139	FC55	D0019
R313	MEFM 470R 1/2W 1%	195424700	14674	NK5	D0059
C301	CERM 47n 25V -25% +50%	241944700			D0090
C304	CERM 47n 25V -25% +50%	241944700			D0090
IC301	0P05CP	510091130	4U077	OP-05CP	D0184
IC302	0P05CP	510091130	4U077	OP-05CP	D0184
IC303	DG301	510091110	34371	HI1-301-5	D0182
TR301	BC107	300553320	04713	BC107A	D0119
TR302	BCY70	300553590	04713	BCY70	D0120
D301	Zener 6.15V				
D302	Zener 10V	300522760			D0108
TP301-302	TEST POINT	355400760			D0153
TP305	TEST POINT	355400760			D0153

Table 3.32 PCB 5 PARTS LIST, OHMS CURRENT SOURCE

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R601	MEFM 47k 1/8W 0.5%	192744702	50139	FC55	D0031
R602	MEFM 75k 1/8W 0.5%	192747501	50139	FC55	D0032
R603-607	PR.MEFM/WW 25k + 100k + 5k + 50k + 500k	169618101		M/SET	D0012
R607	PRWW 500k				
R608	MEFM 1k 1/4W 1%	195331000	14674	NK4	D0044
R609	P.T.C. 1k	161000030	50157	180Q10232	D0007
R610	MEFM 10k 1/8W 0.5%	192741002	50139	FC55	D0027
R611	MEFM 110k 1/8W 0.5%	192751101	50139	FC55	D0034
R612	MEFM 1M 1/4W .5%	198261002	50139	FC65	D0062
R613	MEFM 12k 1/8W 1%	195341200	14674	NK4	D0051
R614	MEFM 3k3 1/4W 1%	195333300	14674	NK4	D0047
R651	MEFM 10k 1/4W 1%	195341000			D0050
R652	MEFM 820 1/4W 1%	195328200			D0043
R653	MEFM 10k 1/4W 1%	195341000			D0050
R654-655	MEFM 820 1/4W 1%	195328200			D0043
R656-659	MEFM 10k 1/4W 1%	195341000			D0050
C601	CERM 100p 500V	241321000			D0084
C602-603	ESTM 100n 100V	225451000			D0074
C605	CERM 100n 50V	208450140			D0063
C606	CERM 100p 500V	241321000			D0084
IC601	LM201	510091271	4S837	LM201AN	D0187
IC602	ICL7650	510091120			D0183
IC603-605	DG211	510091180			D0185
IC606-608	TIL 117	300540240	4S837	TIL117	D0116
TR601	TRANS 3N163 + SHORTING CLIP	300554530	8S956	3N163	D0121
TR602-603	TRANS WN807	300555380			D0124

(Contd.)

Table 3.32 PCB 5 PARTS LIST, OHMS CURRENT SOURCE *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
D601	Zener 6V2 400mW 5%	300521240			D0097
D602	IN4007	300524990	04713	1N4007	D0114
D603	Zener 10V 400mW 5%	300522760			D0108
D604	Zener 13V 400mW 5%	300523920			D0112
D605	Zener 18V 400mW 5%	300521300			D0098
D606-607	Zener 5V1 400mW 5%	300521310			D0099
FOR IC 602	14 PIN D.I.L. SOCKET	300585340			D0135

Table 3.33 PCB 5 PARTS LIST, TRUE RMS AC CONVERTOR

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R701	RES. M.F. 990k	160300516	6B214	MS313N	D0006
R702A-B	RES. CADDOCK 9k/1k .2W .1%	160400582	6B214	T912B-1K-050-01	D0005
R703-704	RES. COMP 470k 0.5W 10%	172354700	50139	EB	D0014
R705	RES. P.T.C. 1k	161000030	50157	180Q10232	D0007
R706	RES. MEFM 1M 0.5W 1%	195461000	14674	NK5	D0061
R707A-B	RES. CADDOCK 9k/1k 0.2W .1%	160400582	6B214	T912B-1K-050-01	D0005
R708	RES. MEFM 75R 1/8W .5%	192715602	50139	FC55	D0017
R709	RES. MEFM 200k 1/8W .5%	192752002	50139	FC55	D0035
R710	RES. MEFM 100k 1/4W 1%	195351000	14674	NK4	D0056
RV701	RES. VAR 100k 0.5W 10%	130951000	4D600	ET24W	D0002
C701	CAP. ESTM 0M22 400V 20%	226152200			D0081
C702	CAP. ESTF 10n 1.000 10%	222841000			D0071
C703	CAP. CERM 6p8 500V 20%				
C704	CAP. ESTF 3M3 100V 10%	225463300			D0080
C705	CAP. CERM 47N 25V -25 +50%	241944700			D0090
C706	CAP. 47N	241944700			D0198
C707	CAP. 22N	227034700			D0199
C708	CAP. 47N	241944700			D0198
C709	CAP. 47N	241944700			D0198
C710	CAP. ESTM 4M7 63V 10%	225164700			D0072
C711	CAP. ESTM 0M33 10%	225453300			D0078
C712-714	CAP. CERM 10n	241941000			D0089
CV701	TRIMMER CAP 0.5-7p	290060080			D0095
IC701	I.C. LN0062	510090380	6Z045	AD528J	D0178
IC702	I.C. AD637K	510091460	6Z045	AD637KN	D0189
IC703	I.C. DG211	510091180			D0185

(Contd.)

Table 3.33 PCB 5 PARTS LIST, TRUE RMS AC CONVERTOR *(Contd.)*

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
TR701	3N170	300555270	04713	3N170	D0123
D701-702	DIODE 1N3595	300523590	34148	1N3595	D0109
RL701	RELAY - 1m200V 10				
RL702	RELAY RS5	300652030	61058	RS-5V	D0138
RL703-704	RELAY - 200V	300652210			D0139
RL705	RELAY D.I.L.	300652000			D0137
PL701	26 WAY PLUG	352326110	5W380	3429-6302	D0152
TP701	TEST POINT	355400760			D0153
FOR IC701	8 PIN D.I.L. BASE				
FOR IC702	14 PIN D.I.L. BASE	300585340			D0135

Table 3.34 PCB 5 PARTS LIST, FLOATING LOGIC

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R801	MEFM 10k 0.25W 1%	195341000	14674	NK4	D0050
IC801-804	UV ROM 2716	510003080	4S837	TMS2516	D0172
IC805-808	ULN 2003A	510004980	4S837	ULN-2003AN	D0173
D801	BZY88 10V 400mW 5%	300521430			D0101
PL801	26 WAY PLUG (FIXED)	352326110	5W380	3429-6302	D0152
SK802	16 PIN D.I.L. BASE	300584860			D0132
	24 PIN D.I.L. BASE	300584910			D0133

Table 3.35 PCB 5 PARTS LIST, FLOATING POWER SUPPLY

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R901	MEFM 39R 0.25W 1%	195313900	14674	NK4D0037	D0197
C901-902	ALME 220µ 40V	208600262	54473	ECEA1GV221SC	D0065
C904	ALME 1,000µ 40V	208600263	54473	ECEA1HV102SU	D0066
C905	TAND 1µ 35V 20%	266061000			D0094
C906	ALME 1,000µ 40V	208600263	54473	ECEA1HV102SU	D0066
C907	TAND 1µ 35V 20%	266061000			D0094
C908-909	ALME 220µ 40V	208600262	54473	ECEA1GV221SC	D0065
C911	ALME 3,300µ 16V	208600286	54473	ECET16R332SN	D0067
C912-914	TAND 1µ 35V 20%	266061000			D0094
IC901	7815CT +15V	510090320	4S837	UA7815CKC	D0176
IC902	7915CT -15V	510090330	4S837	UA7915CKC	D0177
IC903	7805CT +5V	510090500	4S837	UA7805CKC	D0179
IC904	78L12 +12V	510090520	4S837	UA7812CKC	D0180
IC905	79L12 -12V	510090530	4S837	UA7912CKC	D0181
D901	BRIDGE W04	300524700	8S956	W04	D0113
D902-905	1N4004	300522070	04713	1N4004	D0105
D906	BRIDGE W04	300524700	8S956	W04	D0113
D907-908	Zener 8V2 400mW 5%	300521330			D0100
FOR IC901-903	HEATSINK	300584940			D0134
TP901-907	TEST POINT	355400760			D0153
PL901	8 WAY AMP HEADER	352308060	00779	280373-2	D0151

Table 3.36 PCB 5 PARTS LIST, MISCELLANEOUS

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
	PCB 5 ASSEMBLY	70610505Y			D0001
	RESISTOR 1.5k	160300516	05591	5E10D	D0004
R701	(TABLE 3.17)				
	RESISTOR SET	169618801			D0013
	RESISTOR 56R	192715602	50139	FC55	D0016
R708	(TABLE 3.17)				
R312	(TABLE 3.15)				
R311	(TABLE 3.15)				
	RESISTOR 1.5k	192731502	50139	FC55	D0024
R18,R19	(TABLE 3.11)				
	RESISTOR 3.9k	195333900	14674	NK4	D0048
	RESISTOR 150k	195351500	14674	NK4	D0057
	RESISTOR 270R	195422700	14674	NK5	D0058
	CAPACITOR 22n	208450143			D0064
	CAPACITOR 10p	241311000			D0082
	CAPACITOR 100p	241321000			D0084
D1	(TABLE 3.11)				
TR701	(TABLE 3.17)				
	PAD TRANSISTOR	300584090			D0131
	MICA WASHER SOT93	300585430			D0136
	RELAY CR - 7002 - 5082	300652300			D0144
	RELAY	300652550			D0146
	RELAY CORE 31000154	300652560			D0147
	RELAY CORE 70035070	300652570			D0148
	SCREW M2	406602060			D0158
	SCREW M3 x 8mm	406803080			D0159
	SCREW M3 x 10mm	406803100			D0160
	NUT FULL M3	410031010			D0161
	M2 NUT HEX x FULL	410031060			D0162
	WASHER CRINKLE x 13	411129010			D0164
	WASHER CRINKLE x 12	411129050			D0165
	LABEL LIGHTNING FLASH	420880470			D0166
	SLEEVING POLYPENC E	429500210			D0167
	WASHER INS	470110100			D0168

(Contd.)

Table 3.20 PCB 5 PARTS LIST, MISCELLANEOUS (Contd.)

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
	BEAD CERAMIC SMALL	470120030			D0169
	BEAD CERAMIC	470120040			D0170
	SPACER CERAMIC	470120100			D0171
	PCB 5 SHORTING LINK	70610226A			D0192
	PCB 5 MODIFICATION	70614411A			D0193
	PCB 5	70619505X			D0194
	SCREEN	71512013A			D0195

Chapter 4
General Information

1 INTRODUCTION

This section contains general information including the recommended tools required for servicing the instrument.

2 TOOLS FOR SERVICE AND SET-UP

The recommended tools for service and set-up are listed in Table 4. 1.

Table 4.1 RECOMMENDED TOOLS

TOOL	TYPE
Soldering Iron (2)	1 x 30 Watt, 1 x 40 Watt 2.3mm chisel head bit 3.0mm chisel head bit
Desoldering Tool	Anti static
Trimming Tool	Insulated trimmer for potentiometer
Trimming Tool 4mm	Insulated trimmer for coil cores
Flat Bladed Screwdrivers (3)	4" x 1/4" 4" x 5/16" 4" x 3/8"
Box Spanners (3)	1/4" x 5/6" Whitworth M3 17mm
Spanners (1 Set)	Open ended M2.5 to M6
Posidrive Screwdrivers (1 Set)	Blade sizes 0, 1 and 2
Wire cutters	1 pair Flush cutters
Pliers	1 pair Snipe nose. Jaw length 120mm
Station	1 Anti static station

3 STORAGE

The instrument should be stored complete with the battery B501 connected. Should the battery require charge after storage, the instrument should be run for 24 hours.

4 7061/62 TEST SPECIFICATION

4.1 INITIAL CHECKS

4.1.1 Proms

Check the DVM has the following PROMS:

27C256 (×2) fitted as IC106 and IC107 on PCB 13
2764 (×4) fitted as IC801, IC802, IC803, IC804 on PCB 15

PCB 13 IC 106 = 7061 36XX
PCB 13 IC 107 = 7061 37XX
PCB 15 IC 801 = 7061 51XX
PCB 15 IC 802 = 7061 52XX
PCB 15 IC 803 = 7061 53XX
PCB 15 IC 804 = 7061 54XX where XX is the status and issue of the PROM.

4.1.2 Split Pads

The split pads (SPs) should have the following allocation at this stage;

PCB 13 **SPs Open:** 601, 201, 202*, 403.
102, 103†, 202, 203, 301, 302, 303, 401, 402, 405, 501, 502,
SPs Closed: 503, 504, 505, 506, 507, 508, 509, 602, 603.

* 7061 only. SP202 is closed if 7062
†SP 103 is closed if MPU type 68B109 fitted

PCB 15 **SPs Open:** 2‡, 401.
SPs Closed: 1‡, 201, 202, 901, 902, 903, 904, 906. Link also, LKA

‡ Assumes PCB 15 is fitted with PROMS type 2716. If type 2764are fitted, close SP1 and open SP2

4.1.3 Switch Position

SW 201 on PCB 13 should be set as shown;

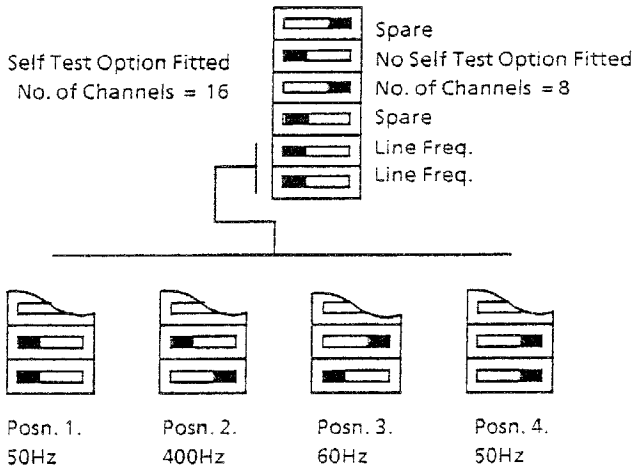


Fig. 4.1 *Configuration Switch Settings*

4.2 PSU AND DIGITAL CHECKS

4.2.1 Power Up

The voltage selector should be set to 240V. Connect the 7061/2 power input to a variac with 240V setting. Switch on the 7061/2 when the display should show all the display segments and LED indicators.

4.2.2 Keyboard

Check the keyboard operation by pressing each key and listening for a beep.

4.2.3 Voltage Selector Checks

With the mains supply set to 240V, measure the voltage at SP507 wrt TP508. This should be 9V ±1V.

Reduce the mains supply to 220V and change the voltage selector to 220V. The voltage at SP507 should again be 9V ±1V. Now change the fuses to 400mA and repeat with 120V on the 120V setting and 100V on the 100V setting. The voltage at SP507 should still be 9V ±1V. Replace the fuses with 200mA and return to the 240V setting.

4.2.4 Rail Checks

Reduce the mains supply to 215V and measure the rails shown below, checking that they are stabilised and within limits:

	Rail	Test Point	Limit
PCB 3	+5VA	TP501	+5V ±0.25V
wrt TP 508	+5VB	TP502	+5V ±0.25V
	+5VC	TP503	+4.5V ±0.5V
	+5VD	TP509	+5V ±0.25V
	+5VE	TP504	+5V ±0.25V
PCB 3	+40V	TP505	+41V ±2V
wrt TP508	+32V unregulated	TP506	+27 to +37V
	-32V unregulated	TP507	-27 to -37V
PCB 5	+36V	TP901	+35V ±2V
wrt TP903	+15V	TP902	+15V ±1V
	-15V	TP904	-15V ±1V
	-36V	TP905	-35V ±2V
	+5V	TP906	+5V ±0.25V

Repeat the rail checks with the mains supply at 265V. Now switch off the 7061/2 and measure the voltage at TP503 wrt TP508. It should be 4V ±0.5V. Power up the 7061/2 on 240V.

4.2.4 External Trigger Check

Connect an oscilloscope to the TRIG COMPLETE socket and a sample switch to the EXT TRIG socket. Select TRACK, 4 digits, and check that a pulse of about 4µsec can be seen on the oscilloscope.

Now select TRIG on the front panel and check that the pulse occurs when the sample switch is operated.

4.2.5 Clock Adjustment

Monitor the voltage at TP402 PCB 3 wrt TP508. Adjust the core of L401 on PCB 3 until the voltage settles to +3.0V ±0.2V.

4.3 ANALOGUE CHECKS

4.3.1 Input Amplifier Offset Adjustment

Select* Vdc, 10V range, 6 digits. The display should show 0.00000 ±10 bits. Fit an input lead to the front socket and connect high to low. Measure the voltage at link TL101 wrt TP101, noting polarity.

Use the table below to decide which resistance value must be used to minimise the amplifier offset. If the readings are positive then fit the resistance between the R420 Lugs. If negative then use the R419 Lugs.

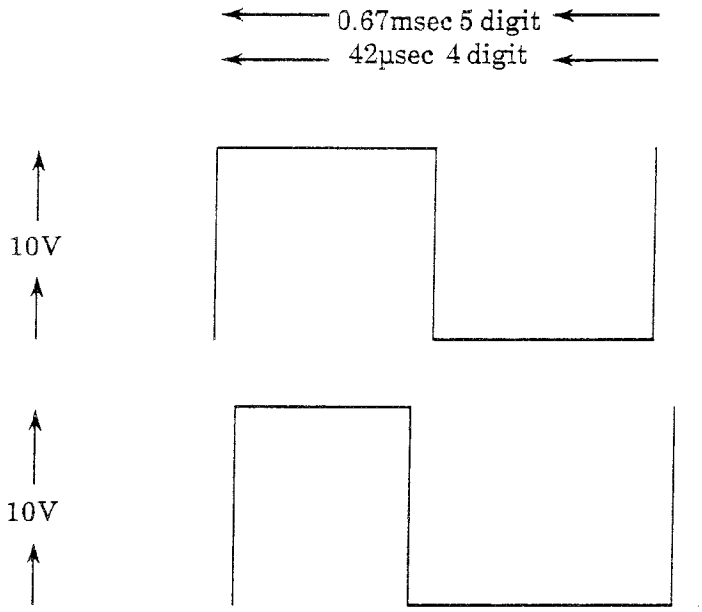
Voltage at TL101, 102	Resistance
0 - 3mV	Links
3 - 5.5mV	12
5.5 - 8.5mV	22
8.5 - 11.5mV	33
11.5 - 14mV	47
14 - 17mV	56
17 - 20mV	68
20 - 23mV	82
23 - 25mV	91
25 - 27.5mV	100
27.5 - 30mV	110
30 - 33mV	120

Power up and select: Vdc, 10V. The voltage at TL101 should now settle to ±4mV. Now solder a link between TL101 and TP102 and bridge the split pad SP 401 to allow commutation of the input amplifier. Select Vdc, 0.1V with input high and low connected together. The 7061/2 display should read 0 ±20µV.

4.3.2 Glugs

Using a double beam oscilloscope, trigger one trace from the + ve edge of the negative glug at TP206 on PCB 5. Use the second trace to look at the positive glug at TP204 on PCB 5.

Check the timing for the 5 digit and 4 digit rates of operation called up from the front panel.
Glug zero time: 3 - 5µ sec 4 digit10 - 15µ sec, 5 digit



Glug zero time: 10-15 µsec (5 digits)
3-5 µsec (4 digits)

4.3.3 AC Zero Offset Adjustment

Select Vac, auto, and measure the voltage level at the output of IC701 pin 6 (R708 end). Use a 10kΩ resistance in series with the high measurement lead. Adjust RV701 on PCB 5 for a reading of less than 200µV.

4.4 PERFORMANCE CHECKS

4.4.1 Input Clamp

Select Vdc, 10V range. Apply an input of +21 volts and then -21 volts through a current measuring DVM. Check that the input current is less than +/-20nA.

4.4.2 **Input Impedance**

Select 10Vdc range. Apply an input of +10 volts dc and note the reading. Insert a 10 Megohm +/- 1% resistor in series with the high lead and allow the reading to settle. This reading should be within the range 0.9999 to 1.0001 times the original reading.

4.4.3 **Open circuit ohms voltage**

Connect another DVM with input impedance of $\geq\geq$ *10Megohms, set to* Vdc, autorange, across the input of the DVM under test.

Switch the DVM under test to the 10 kilohm range. The reading on the other DVM should be between 10 and 14 volts.

Switch the DVM under test to the 1 Megohm range. The reading on the other DVM should be between 21 and 25 volts.

4.4.4 **Input Current**

Select the 0.1Vdc range and short circuit the input.

Press the 'NULL' button.

Remove the short circuit and apply a screened 1 Megohm resistor to the input. The reading should be less than 50 microvolts. Select 4 digit operation. The reading should now be less than 2 millivolts.

4.4.5 **AC/ AC + DC frequency response 1V Range**

Select 1Vac Range, filter in, 5 digits.
Apply an input of 1V at 1kHz and note the reading. Change the input frequency to 100kHz and note the reading. If the two recorded values differ, adjust RV702. Note the reading and repeat the procedure if neccessary until the difference is less than ± 5 digits.

4.4.6 **AC/ AC + DC frequency response 0.1V Range**

Select 0.1 Vac range, filter in,5 digits
Apply an input of 100mV at 1kHz and note the reading. Change the input frequency to 100kHz and note the reading. If the two recorded values differ, adjust CV731. Note the reading and repeat the procedure if neccessary until the difference is less than ± 5

4.4.7 **AC/ AC + DC frequency response 10V Range**

Select the 10V range, filter in, 5 digits.

Apply an input of 100mV at 1kHz and note the reading. Change the input frequency to 50kHz and note the reading. Adjust CV702 on PCB 5 until the reading is 50 ± 5 digits higher than the 1kHz reading.

4.4.8 **DC Common Mode Rejection**

Select: Vdc, Autorange. Connect a 1M resistance between input low and high and apply 500V dc between the high terminal and ground (mains earth). The reading on the 7061/2 should fall to less than 50mV.

4.4.9 **AC Common Mode Rejection**

Select: Vdc, Autorange. Apply 240V ac, common mode, by connecting a 1K resistor across the low and high input terminals, then applying the 240V ac between high and ground (mains earth). The reading on the 7061/2 should not exceed ± 100µV.

4.5 60Hz OPERATION

If the 7061/2 is required for 60Hz operation, then carry out the following procedure:

1. Remove the DVM top cover and SET the front two rockers on SW201 to the 60Hzposition (Fig 4.1 refers).

2. Change the mains fuses to 400mA and set the voltage selector to 120V.

3. Power up the 7061/2 from a 120V 60Hz supply and check that the voltage measured at TP402 wrt to TP508 is 3V ±0.5V.

4. Remove connections and refit the cover.

Chapter 5
7061Options

1 INTRODUCTION

This chapter contains information on the option boards which may be installed in the 7061 and 7062 Systems Voltmeters. The chapter includes installation instructions parts lists, circuit diagrams and component layout diagrams where applicable.

When an option has been installed, a self-adhesive sticker identifying that option, should be affixed to the rear panel. Labels are supplied with each option kit.

SAFETY.
Before removing covers prior to installing, or removing components, first ensure that the DVM is switched off.

The options available are as follows:

70612A; Scanner Option
70613A; Memory Expansion Option
70615A; Mate (CIIL) Software Option
70616A; Self-test Option
70616B; Status Monitor Relay Option
70616C; Crystal Clock Option

To install any of the above options, it will first be necessary to remove the top, or top and bottom covers, of the DVM. Details are given in Chapter 2, Section 6.2.

Notes. 1. Early issue DVMs were fitted with PCBs 3 and 5 rather than PCBs 13 and 15. The Status Monitor Relay Option, 70616B, can only be installed in a unit fitted with a PCB 13.

2. The Scanner Option, 70612A and Self-test Option 70616A, cannot both be installed in the same instrument.

2 70612A; SCANNER OPTION (PCB 7)

The Scanner Option provides an additional eight input connectors on the instrument. These connectors can be configured as either eight 4-pole, or sixteen 2-pole channels.

Configuration for either 8 or 16 channels, is made via switch S201 on PCB 13. The additional BNC input connectors are located on a separate panel at the rear of the DVM. The mode decode and channel decode circuitry is shown on Sheet 2 of Fig.5.4. All mode switching reed relay coils, RL1 to RL7, are energised through a darlington array.

2.1 INSTALLATION

Refer to Fig. 5.4

The Scanner Option board, PCB 7, is fitted above PCB 15 at the rear of the instrument. PCB 7 connects to PCB 15 via a ribbon cable from SK1 to SK 802 on PCB 15.

To install the option:

1. Remove top and bottom covers.
2. Remove three screws from the small panel to the rear of PCB 15; disconnect the yellow/green ground wire and remove the panel.
3. Insert two hankbushes on PCB 15 (see diagram). Secure hankbushes to PCB 15 with screws offered up from the underside of the board.
4. Fit the ribbon cable connector, from SK1 on the option board, to SK802 on PCB 15.
5. Position the option board onto the hankbushes and secure with top screws.
6. Position the option panel to the rear of board 15 and secure using existing screws.
7. Reconnect ground wire to rear panel.
8. Connect-up the wires from the option board to board 15 as follows:

    a. Thin pink wire, to DP2
    b. Pink wire (No. 7) to DP1
    c. White wire (No.2) to DP3
    d. Blue wire, to DP5
    e. Yellow wire, to DP4
    f. Three black wires, to DP6

7. Refit top and bottom covers.

PARTS LIST; 70612A SCANNER OPTION (PCB 7)

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
IC174HC139	510006610				H0001
IC274LS145	510004990				H0002
IC374HC00	510006520				H0003
IC474HC04	510006540				H0004
IC574HC02	510006530				H0005
IC6ULN2003A	510004980				H0006
IC79D8-CC	300526010				H0007
D1	Zen. 30V 5%	300521430			H0008
SK1	16-Pin DIL. Socket	300584860			H0009
C1	CAP. CERM 47n	241944700			H0010
RL1	2- Pole 0.25A 150Vdc	300652270			H0011
RL2	2- Pole 0.5A 250Vdc	300652230			H0012
RL3-4	2- Pole 0.25A 250Vdc	300652270		H0013	
RL5-7	2- Pole 0.5A 250Vdc	300652230		H0014	
RL12-19	2- Pole 0.5A 350Vdc	300652440			H0015
RL22-29	2- Pole 0.5A 250Vdc CR 7102-0 1000	300652450			H0016
DP0-46	DISCONNECT PIN	355900550			H0017

3 70613A; MEMORY EXPANSION OPTION (PCB 2)

The 70613A Memory Expansion Option provides the user with additional storage for up to 7000 extra measurements.

The 70613A Memory Expansion Option board provides an additional 64K RAM, ICs 1 through 8. In practical terms this will give the user an extra 7000-deep memory history file. The board is complete with a 40-way ribbon cable connector which plugs into one of the expansion sockets located on PCB 13. This board incorporates an optional 3.6V Ni-Cad battery back- up (B1) for the CMOS RAMs.

3.1 INSTALLATION

Refer to Fig. 5.4

The Memory Expansion Option board, PCB 2, is installed above PCB 13 at the front of the instrument. PCB 2 is connected to PCB 13 via a ribbon cable from SK1 on the option board, to PL201 on PCB 13.

To install the option:

1. Remove top and bottom covers.
2. Locate three hankbushes on the topside of PCB 13 (see diagram). Secure hankbushes to PCB 13 with screws offered up from underside of the board.
3. Insert the two plastic hinges in the holes on PCB 13 (see diagram) and 'snap' into position.
4. Fix the option board to the other ends of the hinges in a similar manner to that described step 3. above.
5. Position the option board onto the hankbushes and secure using the top screws.
6. Connect the free end of the ribbon connector on the option PCB, to PL 201 on PCB 13.
7. Replace top and bottom covers.

Table 5.2 PCB 2 PARTS LIST; 70613A MEMORY EXPANSION OPTION

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R1	MEOX 10k 1/4W5%	195641000			I0001
R2	MEOX 470 1/4W 5%	195624700			I0002
C1-6	CERM 47n	241944700			I0003
C7	TAND 33µ 10V	265473300			I0004
IC1-8	6264LP-15	510006500			I0005
IC9	HC138	510006420			I0006
1C10	HC374	510006690			I0007
IC11	HC00	510006520			I0008
IC12	HC04	510006540			I0009
D1	1N6263	300525650			I0010
B1	NCL BATTERY 3V6	800400210			I0011

4 70615A; MATE (CIIL) SOFTWARE OPTION

This software permits the DVM to be used in a 'MATE' environment, using CIIL as an alternative to its own native language.

With this option, the 'native' PROMS, ICs 106 and 107, are replaced by 'native / CIIL' (Mate) PROMS .

4.1 INSTALLATION

To install the option:

1. Remove DVM top cover.
2. Remove existing ICs106 and 107 from board 13.
3. Fit Mate option ICs106 and 107.
4. Affiix the adhesive label, which includes the PROM serial numbers, to the inside of the DVM case (adjacent to ICs 106 and 107).
5. Replace top cover.

Table 5.3 PARTS LIST; 70615A MATE (CIIL) SOFTWARE OPTION

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
IC 106	PROM	70615256AA			J0001
IC 107	PROM	70615257AA			J0002
LABEL	IC'106	70615A56AA			J0003
LABEL	IC107	70615A57AA			J0004

5 70616A; SELF TEST OPTION

The 70616A Self-test Option permits 28 analogue tests to be carried out in addition to the 3 digital and 2 analogue tests provided in the standard instrument.

The 28 tests are carried out on the DC voltage, AC voltage, AC + DC voltage and Resistance measurement circuits of the instrument. These additional tests, with other information on the 70616A Option, are fully described in Chapter 1 of the 7061 Operating Manual.

5.1 INSTALLATION

Refer to Fig. 5.3

The Self-test Option board, PCB 17, is installed above PCB 15 at the rear of the instrument. PCB 17 connects to PCB 15 via a ribbon cable from SK1 on PCB 17 to SK 802 on PCB 15. Other wire connections are via disconnect pins (see Step 8. below).

To install the option:

1. Remove DVM top and bottom covers.
2. Disconnect the yellow/green ground wire from the small rear panel, adjacent to board 15.
3. Remove the three screws from this panel and lift off the panel.
4. Insert two hankbushes in board 15 (see diagram). Secure the hankbushes to PCB 15 with screws, offered up through the underside of the board.
5. Connect ribbon connector from SK1 on the option board to SK802 on PCB 15.
6. Position the option board onto the hankbushes and secure with top screws.
7. Refit the rear panel and reconnect the ground wire.
8. Make the following connections from the option board to PCB 15:
   a. Wire No. 1; to DP1
   b. Wire No. 3; to DP3
   c. Red wire; to DP2
   d. Yellow wire; to DP4
   e. Blue wire; to DP5
9. Refit top and bottom covers.

Table 5.4 PARTS LIST; 70616A SELF TEST OPTION

CIRCUIT REF	DESCRIPTION	SI PART NO.	*MFG* FED SUPPLY CODE	*MFG* PART NO. OR TYPE	PLISN
R31	MEFM 68k 1/8W 0.5%	192746802			K0001
R32	PRWW 82k 0.1W 0.1%	160300531			K0002
R33	PRWW 10k 0.1W 0.1%	160300530			K0003
R34	MEFM 27k 1/8W 0.5%	192742702			K0004
R35	MEFM 12k 1/8W 0.5%	192741202			K0005
R36	PRWW 1k5 70mW 0.1%	160300516			K0005
R37	PRWW 6k 0.1W 0.1%	160300529			K0006
C31	ESTM 15n 100V 10%	225441500			K0007
C32	CERM 10n 25V-25+50%	241941000			K0008
C33	CERM 47n 25V-25+50%	241944700			K0009
D1	Zen.12V 0.4W 5%	300521480		BZX79-C12	K0010
D31		300526540		LM385Z-1.2V	K0011
IC32	EPROM (8×8K)	510006280		HN482764G-3	K0012
IC33	7-Chan. Buff.	510004980		ULN-2003AN	K0013
IC34	G.P. Timer	510002530		SN72555L	K0014
IC35	Dual D-type F.Flop	510006590		CD74HC74E	K0015
IC36	Quad.SPST An. Sw.	510091630		DG308ACJ	K0016
RL31	1-pole 200Vdc 0.5A	300652250		Reed	K0017
RL32,RL33	1-pole 500Vdc 0.5A	300652300		Reed	K0018
RL34	1-pole 200Vdc 0.5A	300652250		Reed	K0019
RL35	2-pole 250Vdc 0.5A	300652230		Reed	K0020
SK1	Socket, 16-pin	300584860			K0021

6 70616B; STATUS MONITOR RELAY OPTION

This option permits monitoring of the the DVM's internal temperature and microprocessor status. No additional PCB is fitted; the components and wiring necessary to install the option are simply added to existing hardware.

IC601 (Fig 5.1) with a 10mV/°C output, monitors the DVM's internal temperature. The IC will cause the relay RL601 to be de-energised if the unit reaches an internal temperature of 70°C. If the processor fails then the signal PROC FAIL [*NOT*] causes RL601 to de-energise. RL601 contacts are across pins of SKT 9, which is located on the rear panel.

6.1 INSTALLATION

Refer to Fig. 5.3

The Status Monitor Relay Option,70616B, can only be installed in a unit having a PCB 13 (rather than a PCB 3). PCB 13 is supplied with some optional components already installed.

To install the option:

1. Remove the DVM top and bottom covers.
2. Remove the small blank panel located to the rear of PCB 13.
3. In place of the blank panel, fit the option panel which includes a 'D-type' cannon socket plus option wiring, with SK601 at its free end.
4. Remove the copper link from IC601 location on PCB13 to permit fitment of the IC.
5. Fit the following option components to PCB 13:

   a. TR601 (See Note)
   b. IC 601 (See Note)
   c. RL601

5. Connect socket SK601 to PH601. To ensure correct connections when fitting the socket, have the 'open' side facing the front of the instrument.
6. Secure option wiring to the DVM moulding where indicated, using the 'P' clip and adhesive cable retainer.
3. Refit top and bottom covers.

Note. IC601 is circular in shape and TR601, rectangular.

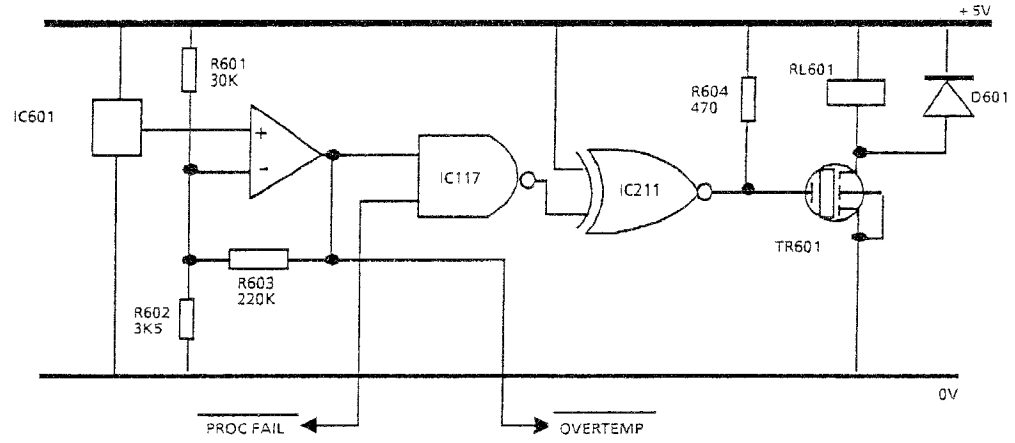


Fig 5.1 *Status Monitor Relay Circuit*

Table 5.5 PARTS LIST; 70615A STATUS RELAY MONITOR OPTION

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
D601	Diode, PIV 75V	300522160		SD3	L0001
IC601	Temp. Sens.	510091840		LM35	L0002
RL601	Relay 30Vdc 2Adc max	300652400		1-Pole C/O	L0003
SK601	Post Header 4-way	352304080			L0004
TR601	FET	300555860		VN10KN	L0005

Note. The 70615A Option uses some additional components which are pre-fitted to PCB 13; for details, refer to Chapter 3 Table 3.10.

7 70616C; CRYSTAL CLOCK OPTION

The 70616C Crystal Clock Option replaces the existing 49.152 MHz, frequency-locked oscillator with a crystal oscillator.

Note. Installing this option will effect the series mode rejection and other characteristics of the DVM. Full details are given in Chapter 1 of the 7061 Operating Manual.

7.1 INSTALLATION

To install the option:

1. Remove DVM top cover.
2. Remove the two screws securing the RF screen to PCB 13.
3. Remove the hankbush and screw which secure the existing PCB 8 to PCB 13.
4. Carefully lift PCB 8 from the three 'berg' type connector pins.
5. Locate and secure replacement (option) board in the same position.
6. Refit RF screen.
7. Refit top cover.

Note. The component layout for the Crystal Clock Option components is similar to that of existing PCB 8 (containing frequency-locked oscillator) except that crystal X101 is fitted in IC101 position. Refer to Chapter 6, Figure 6.4

Table 5.6 PARTS LIST; 70616C CRYSTAL CLOCK OPTION

CIRCUIT REF	DESCRIPTION	SI PART NO.	MFG FED SUPPLY CODE	MFG PART NO. OR TYPE	PLISN
R110	MEFM 10 0.25W ±1%	195311000			M0001
C105,108	CERM 47n 25V +50-25%	241944700			M0002
C110	TAND 4μ7 35V ±20%	208700109			M0003
X101	Crystal Oscillator	300811170			M0004

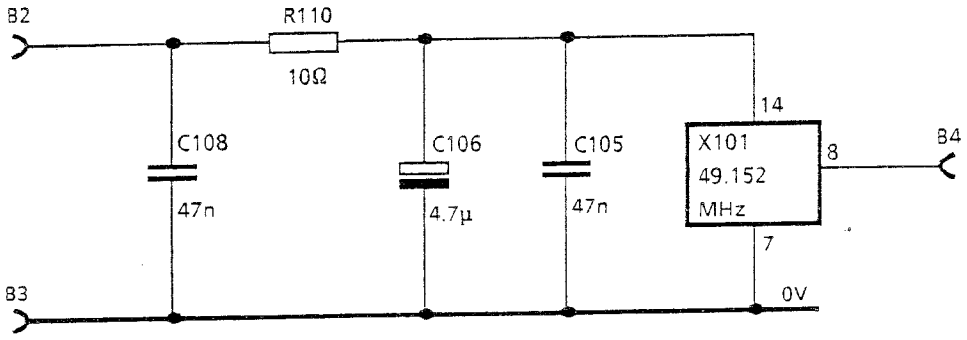


Fig 5.2 *Crystal Clock Circuit*

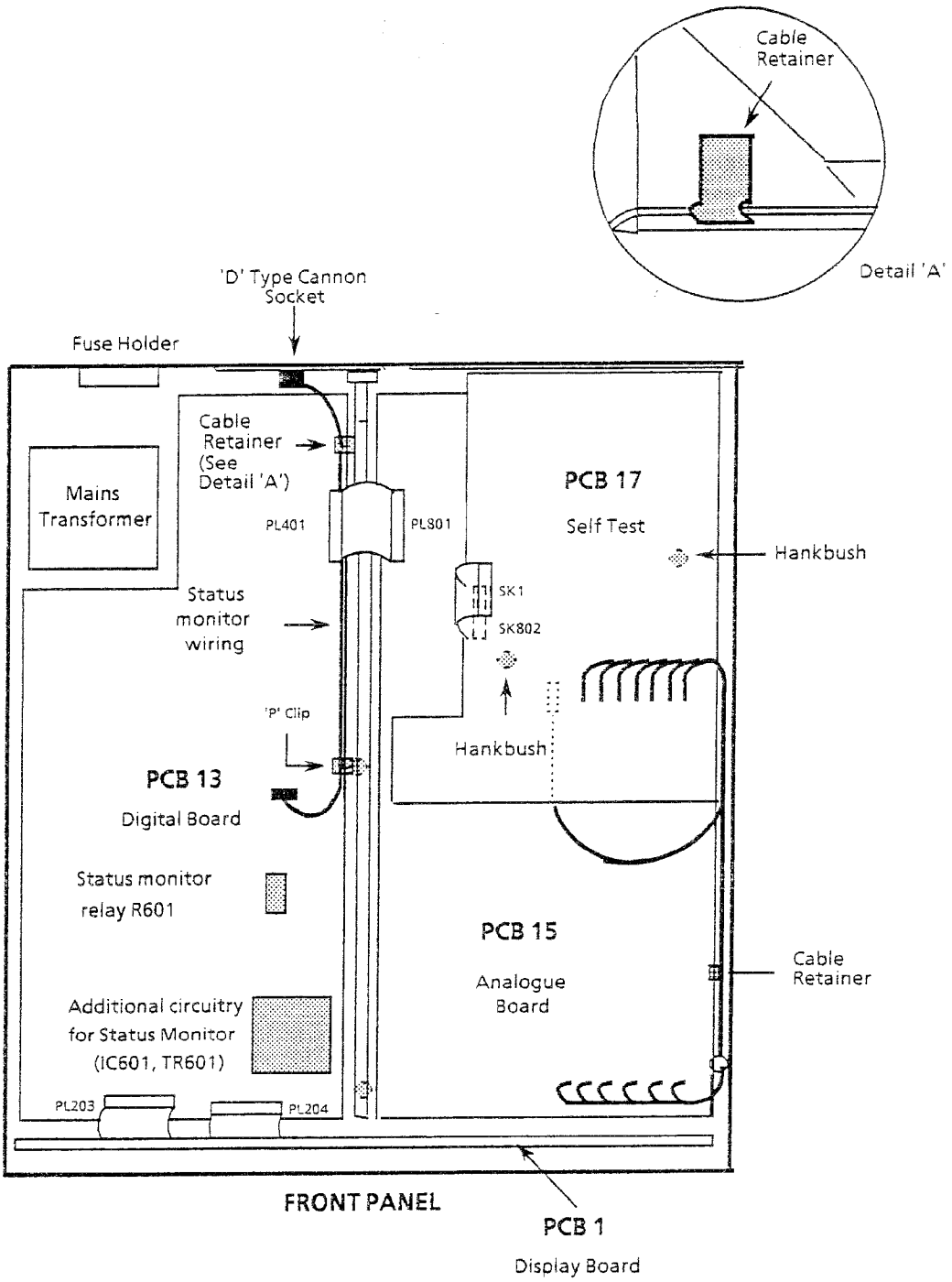


Figure 5.3 *Location; 70616A and 70616B Parts*

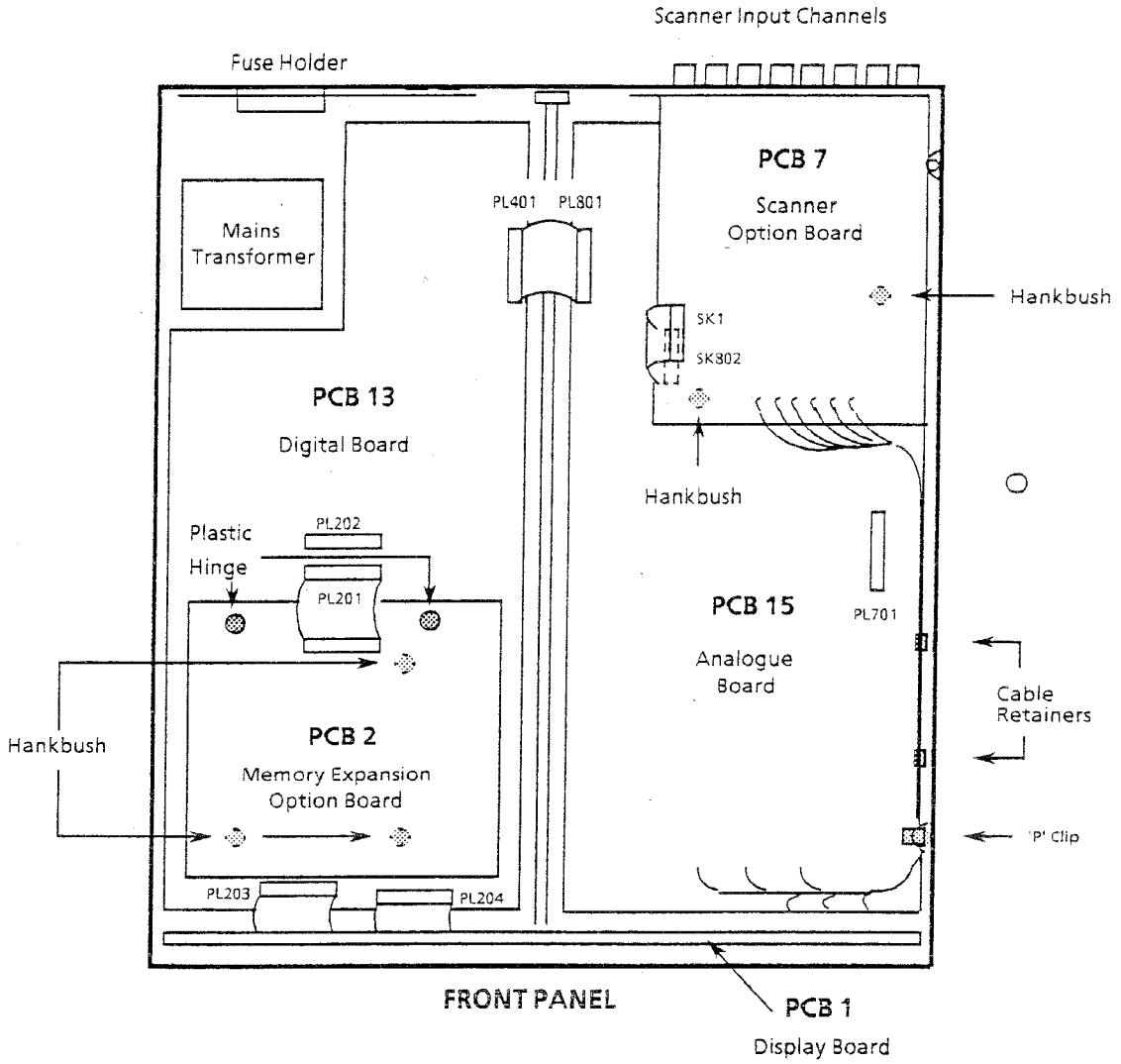


Figure 5.4 *Location; 70612A and 70613A Parts*

Chapter 6
Schematic Diagrams

This Chapter contains the circuit and component layout diagrams for the 7061.
Note that either boards 3 and 5, or boards 13 and 15 are fitted.