# 7151
# COMPUTING MULTIMETER
## MAINTENANCE MANUAL

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# 7151 COMPUTING MULTIMETER

## MAINTENANCE MANUAL

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CONTENTS

# Chapter 1 General

CHAPTER 1

## 1. GENERAL

The Solartron 7151 Computing Multimeter performs all common measurement functions, and offers: a library of programs; clock controlled measurements; and a programmable power-on status.

The instrument is suitable for general purpose bench work, or for use within a system where 7151 would be operated via one of its remote control interfaces. The interfaces provided are the IEEE 488 (1978) STD system and the RS232C V24 serial system.

## 2. SAFETY

The 7151 multimeter has been designed in accordance with the recommendations of IEC 348. To ensure the user's safety, and the continued safe operation of the instrument, it is advisable to fully observe the procedures and specifications given in the Operating Manual (Part No. 71510010).

An Earth wire is provided to ensure the user's safety. Therefore, if an extension mains cable is used, check that the Earth connection is maintained throughout the length of the extension.

When using 7151 on equipment which is capable of delivering high voltages (e.g. inductive circuitry giving high back emf's such as the secondary of a large mains transformer), it is most important that 7151's test leads are disconnected from the equipment before switched it off. This ensures that harmful back-emf's do not reach 7151. Care should always be exercised when handling the input leads, especially where high voltages are known to be present, or where high transients could occur.

Whenever it is likely that the safety of the instrument has been impaired - e.g. if it shows visible signs of damage, if it fails to perform correctly, or if the specifications have been exceeded in any way - it should be made inoperative and referred to a suitable repair depot. Any maintenance, adjustment or repair of the multimeter must be carried out by skilled personnel only, in accordance with the procedures and precautions detailed in this Maintenance Manual (part no. 71510011).

⚠ Wherever this symbol appears on the front or rear panel it is advisable to consult the appropriate section of the Operating Manual for further information.

## 3. SUMMARY OF OPERATION

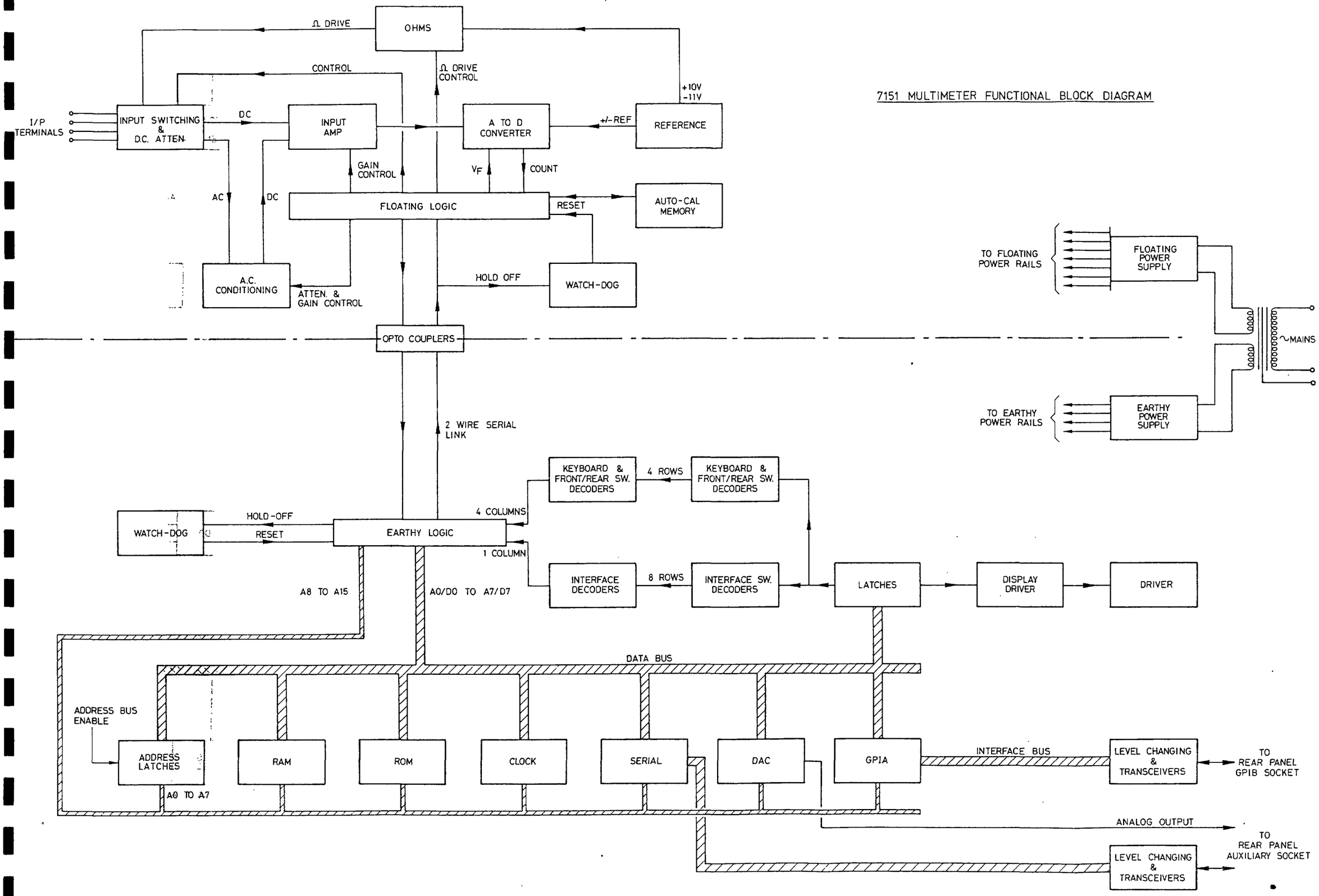
A schematic block diagram of the 7151 is shown in Fig. 1.1. 7151 is essentially a voltage measuring instrument which uses the pulse width technique of analog to digital conversion.

All inputs to the instrument are first converted to dc voltages before being passed to the input amplifier. This is simple enough for current (dc) and resistance, but ac inputs also undergo rms conversion to dc. All inputs are suitably scaled by the input amplifier and passed to the

analog to digital converter (ADC). With no input, the ADC produces two balanced pulse trains of mark space ratio 1:1. When an input is received, the mark-space ratios of the trains respond in an equal and opposite manner, proportional to the size of the input. These trains are then converted to a single end and gated into a reversible counter. The nett result is a pulse count proportional to the measure of the input.

The measuring circuits are controlled by what is termed the 'floating' logic and consists essentially of a 8-bit microprocessor with 'piggy-back' ROM. The other circuits of 7151 are organised in a bus arrangement which is controlled by the 'earthy' logic and consists essentially of another 8-bit microprocessor. Isolated communication between the floating and earthy logic is acheived by opto coupled serial links. It is the earthy logic which is responsible for effective control of measurements, processing, remote control, the real time clock, the displays, and so on.

7151 MULTIMETER FUNCTIONAL BLOCK DIAGRAM




7151 MULTIMETER FUNCTIONAL BLOCK DIAGRAM
FIG 1.1

# Chapter 2 Calibration Procedures

CHAPTER 2

# Setting-Up And Calibration Procedures

## General

These procedures enable the instrument to be set-up and calibrated to the factory despatch standards.

The procedures are categorised into the following sections:

1. Setting-up procedures
2. Initial calibration procedures
3. Final calibration procedures

## Safety

The instrument must be disconnected from the mains supply when dismantling it to gain access to the preset controls and also when it is being reassembled (see Chapter 4 for dissembly instructions).

When adjusting preset controls beware of high test voltages, the guard potential on the guard plate and also the mains input supply.

## Calibration Method

Owing to the automatic calibration circuits incorporated in 7151, it can only be calibrated by connecting it to a remote controller and then using the appropriate calibration commands. Alternatively, a calibration program can be used which is a much faster method of calibrating 7151. Solartron can supply, on tape cassettes, a calibration program for the more common types of controllers.

The user is advised to re-calibrate 7151 annually.

If the instrument's existing state of calibration is judged to be satisfactory, the user can simply re-write the existing calibration constants by sending the REFRESH command to 7151 once it is in the calibration mode.

## Calibration Source

It is recommended that the calibration source has an accuracy of at least two times better than the accuracy specified for the various 7151 functions. The 7151 specification is given in the Operating Manual and the important percentage accuracies are as follows:-

| | |
|---|---|
| DC Volts | 0.002% |
| DC Current | 0.02% |
| AC Volts | 0.05% |
| AC Current | 0.05% |
| Resistance | 0.002% |

## ENTERING CALIBRATION MODE

Insert a shorted 2.5mm jack plug into the rear panel CAL socket, causing the front panel CAL indicator to repeatedly flash. The short may be within the plug itself, or externally via a switch. The plug must remain fitted throughout the calibration, and can be removed after calibration is complete.

**Note:** Do not switch mains power on or off when the shorting plug is fitted, otherwise the internal calibration constants may be altered.

Using the controller, send the command CALIBRATE ON to 7151, putting it into the calibration mode. The CAL indicator should then be steady. Also displayed is the word, 'CAL'. Once the calibration mode has been selected, the following conditions apply:

| | | |
|---|---|---|
| (a) Three commands cannot be used: | TRIG | |
| | TRACK | 'OFF' status is adopted. |
| | NULL | 'OFF' status is adopted, all nulls being deleted. |
| (b) Four commands become available: | HI | |
| | LO | |
| | WRITE | |
| | REFRESH | for refreshing existing cal. constants. |

## CALIBRATING MEASUREMENT RANGE

Using the controller, select the function and range to be calibrated by sending the appropriate MODE and RANGE commands.

7151 must then be supplied with two precisely known reference inputs (non-negative) one at approximately nominal full scale (referred to as the Hi point), and one at approximately zero (referred to as the Lo point). in the case of ac ranges the Lo point should not be less than approximately 5% of nominal full scale rather than zero. This ensures that all inputs are within the optimum part of 7151's linear range.

After a reference input is applied, 7151 must be informed of the precise value of the input. This is achieved by using the HI command for a Hi point, and the LO command for a Lo point. These commands must be accompanied by an integer argument number, of up to six digits in length, which expresses the applied input in terms of 5 x 9's count.

An integer value of 200000 corresponds to nominal full scale for any range.

For example, applying 2V on the 2V range, enter 200000
applying 20V on the 20V range, enter 200000
applying 5V on the 200V range, enter 005000

Apply the Hi point input to 7151 for the requisite function/range.

For example, 2.00843V on 2V dc range.

Using the controller, send the HI command to 7151.

For example, HI200843.

7151 responds by displaying 'Hi Pt' for about 1.5 seconds, during which time it measures the applied reference input. When finished, the instrument displays (and outputs) its measured count, e.g. 214576. It is of no consequence if the displayed count differs from the applied input.

Repeat the above procedure for the Lo point. For example, reference = 0V (short circuit), and send the LO command. For example LO0 (leading zeroes need not be specified).

Having specified the Hi point and Lo point (in any order), send the command WRITE to 7151 (no argument required). This causes the calibration constants for the selected range/function to be calculated and stored in memory. If successful, the message 'Good' is displayed. If unsuccessful, an error message will be displayed and output to the controller.

Repeat the above instructions for each function/range to be calibrated.

## RESTORING THE MEASUREMENT FUNCTIONS

Using the controller, send 7151 the command CALIBRATE OFF. The CAL indicator will then flash indicating that the CAL shorting plug is still fitted.

Withdraw the CAL shorting plug. The CAL indicator should then be invisible, the instrument being ready for normal use.

## SUMMARY

(a) Insert CAL shorting plug (2.5mm) in rear panel socket.
(b) Select the calibration mode by sending the CALIBRATE ON command.
(c) Select the requisite function and range to be calibrated and perform the calibration sequence. Repeat for each range/function to be calibrated.
(d) De-select the calibration mode by sending the CALIBRATE OFF command.
(e) Remove CAL plug.

## Setting-Up Procedures

### DC Power Supply Checks

Measure the dc supplies on PCB1 and PCB2 at the output pins of the appropriate regulator IC's. Tolerances of the most important supplies, mains voltage 240V, follow:

| | |
|---|---|
| floating 15V unregulated | between 20.7V and 21.6V |
| floating 15V regulated | 15 ± 0.75V |
| floating 5V unregulated | between 8.8V and 9.1V |
| floating 5V regulated | 5 ± 0.25V |
| earthy 5V unregulated | between 9.5V and 9.8V |
| earthy 5v regulated | 5 ± 0.25V |

### Display Checks

The contrast of the display can be adjusted by means of RV301. Make the digits appear as black as possible but without introducing slurring when a reading changes.

### Keyboard Checks

The following sequence exercises all 16 keys.

| Key Press | Display Response |
|---|---|
| FILT 2 press minimum | "FILT" on/off<br>Finish with "FILT" off |
| I~ | mA~ |
| I=== | mA=== |
| KΩ | KΩ |
| V~ | V~ |
| V=== | V=== |
| AUTO 2 ptesses minimum | "AUTO" on/off |
| ∇ | Check for downranging |
| Δ | Check for upranging |
| LOCAL | "GPIB nm" where nm is address value. |
| NULL 2 presses minimuim | "NULL" on/off |
| 6 x 9 2 presses minimum | "6 x 9" on/off |
| TRACK 2 presses minimum | "HOLD" on/off |
| SAMPLE with "HOLD" asserted | "HOLD" goes out briefly and returns. |
| COMPUTE | "NO PROG" |
| MENU | "PROBES?" |

Initial Calibration Procedures
Test Equipment

1. General purpose DMM.

2. General purpose oscilloscope

3. Controller, e.g. Commodore PET fitted with BASIC III or BASIC IV firmware.

4. Calibrator, e.g. Fluke 5101 fitted with GPIB interface.

5. ACV Calibrator, e.g. Hewlett-Packard 745.

6. ACV High Voltage Amplifier e.g. Hewlett-Packard 746.

7. Capacitor 0.1µF polypropylene attached to a twin 4mm banana plugs (3/4" centres).

Switch on 7151 and allow to warm up for at least one hour before calibration.

The initial calibration procedures are detailed in the following tables:

| Table No. | Procedure |
|---|---|
| 2.1 | Initial calibration, DC Volts |
| 2.2 | Initial calibration, Resistance |
| 2.3 | Initial calibration, Current |
| 2.4 | Initial calibration, AC Volts |

Please Note: The limits of error expressed in the following tables are those adhered to by the factory for a new instrument. As an instrument 'ages', components become more noisy or their tolerances increase. Therefore, when calibrating a used instrument, it may be necessary to accept limits of error that are marginally higher than those listed in these pages. However, the instrument should always conform to the commercial specification (see Operating Manual) after calibration.

Table 2.1 Initial Calibration, DC Volts

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 1 | Configure the rear panel interface switches and connect the controller to 7151. Do not insert the calibration Key Jack yet. FRONT/REAR switch to 'FRONT'. | | | | |
| 2 | | | | | |
| 3 | | | Power on | | |
| 4 | | | Insert Calibration Key Jack | | |
| 5 | 2VDC | s/c link VHI-VLO front | Adjust RV3. DVM between link & ROME | ± 100 µV | I/P amp gross offset null. |
| 6 | 2VDC | s/c VHI-VLO Front | Check display for scatter | 3 adjacent values | 2V range noise test. The reading may jump every 10 secs at drift-correct. |
| 7 | 0.2VDC | o/c | Check reading | 0 ± 100µV | Input current measurement. Value may be exceeded at drift-correct. |
| 8 | 2VDC | 4V< plus overload < -100V | Measure C4 with DMM referred to ROME | +3.90 +3.05 | Positive input-clamp test (D6) |
| 9 | 2VDC | -4V< minus overload < -100V | As above | -3.05 -3.90 | Negative input-clamp test (D26) |
| 10 | 2VDC | ±1.99999V alternatively | Adjust RV1 CAL BAL | + and - equal within 1 bit | Cal. Bal Adjustment Use continuous drift-correct (Y1). |
| 11 | 2VDC | +1.99999V & 0.00000V | Do calibration routine over the interface | | +2V set-up |
| 12 | 0.2VDC | 0.199999V & 0.00000V | Do calibration routine over the interface | | +2V set-up. Use the calibrator to deliver 0 volt. |
| 13 | 20VDC | +19.9999V & 0.00000V | Do calibration routine over the interface | | +20V set-up. |

Table 2.1 Cont.

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 14 | 200VDC | +199.999V & 0.00000V | Do calibration routine over the interface | | +200V set-up. |
| 15 | 1kVDC | +10000.00V & 0.00V | Do calibration routine over the interface | | +1kV Set-up. The Calibrator LO and the 7151 LO input should be mains grounded. Check that the spark-gap does not operate. Apply for 1 minute and check that the reading does not drift more than 2 bits. |
| 16 | | | Exit Cal Mode | | |
| 17 | 2VDC | +1.00000V<br>-1.00000V | Measure | ±2 bits pos-neg error | Linearity. Change polarity changing over inputs. |

Table 2.2 Initial Calibration, Resistance

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 1 | 20kΩ | DMM between I- and LO | Measure current from -I. DMM set to current. | 100±5μA | |
| 2 | 200kΩ | As above | As above | 10.0 ± 0.5μA | |
| 3 | 2MΩ | As above | As above | 1.0 ± 0.5μA | |
| 4 | 2kΩ | 1.00000kΩ and 1Ω | Do calibration using the interface | | 2KΩ range set up |
| 5 | 20kΩ | 10.0000kΩ and 1Ω | Do calibration using the interface | | 20KΩ range set up. |
| 6 | 200kΩ | 100.000kΩ and 1Ω | Do calibration using the interface | | 200KΩ range set up. |
| 7 | 2MΩ | 1.00000MΩ and 1Ω | Do calibration using the interface | | 2MΩ range set up 0.1μF in parallel will reduce scatter caused by series mode interference. |
| 8 | 20MΩ | 10.0000MΩ and 1Ω | Do calibration using the interface | | 20MΩ range set up. 0.1μF in parallel will reduce scatter. |
| 9 | 2MΩ | DMM across 7150 HI & LO | Measure the o/c volts from Ω source. | +5.2V ± 1V | Ω source positive clamp. |
| 10 | 2MΩ | 240VAC / 50 Hz | Apply VHI-VLO 10 seconds. | | Ohms overload test |
| 11 | 2MΩ | 1.00000MΩ | Check after test 9 | 1.00000MΩ ±100 bits | Survival check for damage after test 10. |
| 12 | DV Auto | +1 kV applied 5 times | Check display | ± 10 bits | 1kV step input test. LO and GUARD must connect to LO of Cal. and also to mains ground. 7151 must uprange withou power restarts. It is permissible that the spark-gap operates. |

Table 2.3 Initial Calibration, Current

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 1 | DC A | +1.00000A & open circuit | Calibrate over the bus | | 1 Ampere Set-up. |
| 2 | AC A | 400 Hz 1.99999A & 0.19999A | Calibrate over the bus | | 2 Ampere Set-up. |
| 3 | | | Exit Cal Mode | | |
| 5 | DC AC | +1.99999A | Measure voltage at current front sockets with a DMM. | 0.80 volt | Burden |

Table 2.4 Initial Calibration, AC Volts

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 1 | VAC various ranges | s/c | Adjust RV2 for minimum @ TP3 | ±150 bits referred to 0V | IC15 offset null adjust. Use DMM to monitor TP3 Transformer lamination to be mains-grounded. The lowest figure possible is required; if necessary by error-sharing among the ranges. |
| 2 | 20VAC | 19.9999V 400Hz | Note reading | | |
| 3 | 20VAC | 19.9999V 50kHz | Adjust CV1 & R10 for flat response | Value at test '2' ±0.010V | Attenuator HF trim. 100 bit limit applies when a dummy lid is fitted. |
| 4 | 0.2VAC | 0.199999V & 0.019999V 400Hz | Calibrate over the bus. | | 0.2V LF Set-up Fluke 5101. |
| 5 | 2VAC | 1.99999V & 0.19999V 400Hz | Calibrate over the bus. | | 2V LF Set-up |
| 6 | 20VAC | 19.9999V & 1.9999V 400Hz | Calibrate over the bus. | | 20V Set-up |
| 7 | 200VAC | 199.999V & 19.999V 400Hz | Calibrate over the bus. | | 200V Set-up |
| 8 | 1kVAC | 750.00V & 199.99V 400Hz | Calibrate over the bus. | | 1 kV Set-up |
| 9 | | | Exit Cal Mode | | |
| 10 | 0.2VAC | 30KHz 0.199999V | Check | 0.199999V ± .000120V | |
| 11 | 0.2VAC | 10KHz 0.199999V | Check | 0.199999V ± .000096V | |

Table 2.4 Cont.

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 12 | 2VAC | 10kHz 1.99999V | Check | 1.99999V ± .00096V | |
| 13 | 2VAC | 30kHz 1.99999V | Check | 1.99999V ± .00120V | |
| 14 | 20VAC | 30kHz 19.9999V | Check | 19.9999V ± 0.0120V | |
| 15 | 20VAC | 10kHz 19.9999V | Check | 19.9999V ± .0096V | |
| 16 | 200VAC | 10kHz 199.999V | Check | 199.999V ± .096V | |
| 17 | 200VAC | 30kHz 199.999V | Check | 199.999V ± 0.120V | |
| 18 | 1kVAC | 10kHz 750.00V | Check | 750.00V ± 0.46V | |
| 19 | 1kVAC | 30kHz 750.00V | Check | 750.00V ± 0.70V | |
| 20 | 0.2VAC | s/c | Check | 150µV | s/c zero. Trasnsformer laminations to be mains-grounded. |
| 21 | 2VAC | 10Hz 2.00000V | Check | 2.00000V ± 0.01456V | |
| 22 | 2VAC | 20Hz 2.00000V | Check | 2.00000V ± 0.00416V | |
| 23 | 2VAC | 40Hz 2.00000V | Check | 2.00000V ± 0.00096V | |
| 24 | 2VAC | 100Hz 2.00000V | Check | 2.00000V ± 0.00880V | |
| 25 | 2VAC | 100kHz 0.19999V | Check | 0.199999V ± 0.000880V | |
| 26 | 20VAC | 100kHz 20.0000V | Check | 20.0000V ± 0.0880V | |
| 27 | 200VAC | 100kHz 200.000V | Check | 200.000V ± 0.880V | |

Table 2.4 Cont.

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 24 | 2VAC Auto | 750V/400Hz applied 5 times | Check | 750.00 ± 0.46V | 750VAC Autorange test. Lo and GUARD must connect to LO of Calibrator and also mains ground. 7151 must uprange with no signs of distress. |

## Final Calibration Procedures

7151 should be fully cased and placed in a 20°C environment for at least four hours and switched on for at least two hours prior to final calibration. GUARD and LO should be mains-grounded to minimise series-mode interference. For this reason, use of the screened leads is essential for HI Ω measurement.

Note that the four screws which retain the top section of the case must be fully tightened to make the case screening effective.

The final calibration procedures are detailed in the following tables:

| Table No. | Procedure |
|---|---|
| 2.5 | Final calibration, DC Volts |
| 2.6 | Final calibration, Resistance |
| 2.7 | Final calibration, AC Volts |
| 2.8 | Final calibration, Current |
| 2.9 | Final calibration, Recheck |
| 2.10 | Other Checks |

Table 2.5 Final Calibration, DC Volts

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 1 | 0.2VDC | +0.100000V & 0.000000V | Calibrate over the bus | | 200mV range Cal. zero volts to be commanded from Calibrator. |
| 2 | 2VDC | +1.9999V & 0.000000V | Calibrate over the bus | | 2V range Cal. zero volts from Calibrator on its 2 volt range. |
| 3 | 20VDC | +19.9999V & 0.000000V | Calibrate over the bus | | 20V range Cal. zero volts from Calibrator on its 20 volt range. |
| 4 | 200VDC | +199.999V & 0.000000V | Calibrate over the bus | | 200V range Cal. zero volts from Calibrator. |
| 5 | 1kVDC | +1000.00V & 0.00V | Calibrate over the bus. | | 1kV range Cal. |

Table 2.6 Final Calibration, Resistance

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 1 | 2KΩ | 1KΩ & 1Ω | Do calibration over the bus | | 4 terminal connection |
| 2 | 20kΩ | 10kΩ & 1Ω | Do calibration over the bus | | 4 terminal connection to be used. |
| 3 | 200kΩ | 100kΩ & 1Ω | Do calibration over the bus | | |
| 4 | 2MΩ | 1MΩ & 1Ω | Do calibration over the bus | | Use screened lead |
| 5 | 20MΩ | 10MΩ & 1Ω | Do calibration over the bus | | Use screened lead |

Table 2.7 Final Calibration, AC Volts

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 1 | 0.2VAC | 0.199999V & 0.0199999V 400Hz | Do calibration over the bus | | |
| 2 | 2VAC | 1.99999V & .19999V @ 400Hz | Do calibration over the bus | | |
| 3 | 20VAC | 19.9999V & 1.9999V @ 400Hz | Do calibration over the bus | | |
| 4 | 200VAC | 199.999V & 19.999V @ 400Hz | Do calibration over the bus | | |
| 5 | 1kVAC | 750.00V & 199.99V 400Hz | Do calibration over the bus | | |

Table 2.8 Final Calibration, Current

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 1 | 2ADC | 1.00000A and o/c | Do calibration over the bus | | |
| 2 | 2A AC | 1.99999A & 0.19999A 400Hz | Do calibration over the bus | | |

Table 2.9 Final Calibration Recheck (Filter In)

| TEST | RANGE & MODE | INPUT | LIMITS |
|---|---|---|---|
| 1 | 2ADC | 1.00000A | 20 bits |
| 2 | 2AAC | 1.9999A/400Hz | 100 bits |
| 3 | 2kΩ | 1.00000KΩ | 4 bits |
| 4 | 20kΩ | 10.0000kΩ | 4 bits |
| 5 | 200kΩ | 100.000kΩ | 5 bits |
| 6 | 2MΩ | 1.00000MΩ | 5 bits |
| 7 | 20MΩ | 10.0000MΩ | 40 bits |
| 8 | 0.2VAC | 0.199999V 400Hz | 100 bits |
| 9 | 2VAC | 1.99999V 400Hz | 100 bits |
| 10 | 20VAC | 19.9999V 400Hz | 100 bits |
| 11 | 200VAC | 199.999V 400Hz | 100 bits |
| 12 | 1k VAC | 750.00V 400Hz | 46 bits |
| 13 | 0.2VAC | 1Ω (short circuit) | 250 bits |
| 14 | 20VAC | 19.9999V 50kHz | 300 bits |
| 15 | 0.2VDC | +0.199999V | 6 bits |
| 16 | 2VDC | +1.99999V | 6 bits |
| 17 | 20VDC | +19.9999V | 6 bits |
| 18 | 200VDC | +199.999V | 6 bits |
| 19 | 1 kVDC | +1000.00V | 4 bits |
| 20 | 1 kVDC | -10000.00V | 4 bits |
| 21 | 200VDC | -199.999V | 6 bits |
| 22 | 20VDC | -19.9999V | 6 bits |
| 23 | 2VDC | -1.99999V | 6 bits |
| 24 | 0.2VDC | -0.199999V | 6 bits |

Table 2.10 Other Checks

| TEST | RANGE & MODE | INPUT | ACTION | LIMITS | COMMENTS |
|---|---|---|---|---|---|
| 1 | | 1.5kV max. | Do flash test | | Safety test to IEC 348. Refer to Solartron Specification 09/00/105.02. Power switch ON. |
| 2 | DC Auto | See Fig.2.1 | Check Display | 0 + 500µV | DC Common Mode Rejection 120dB. |
| 3 | AC Auto | See Fig.2.2 | Check Display | 0 ± 340µV | AC Common Mode Rejection 120dB. |
| 4 | | 25 Ampere 5 seconds | Perform earth continuity test | 0.5Ω | |
| 5 | | | Fit mains fuses appropriate to supply voltage. | 250mA SLO BLO or 100mA SLO-BLO | |
| 6 | | 1.5kV rms | Flash Test LO to Earth. | | As Test 1. |

Figure 2.1 DC Common Mode Rejection

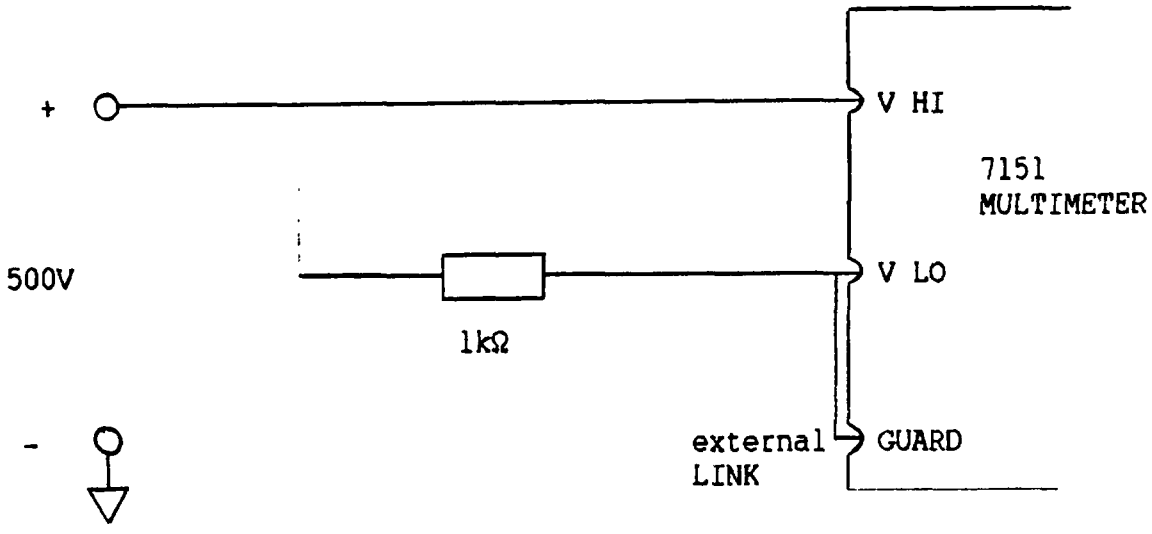
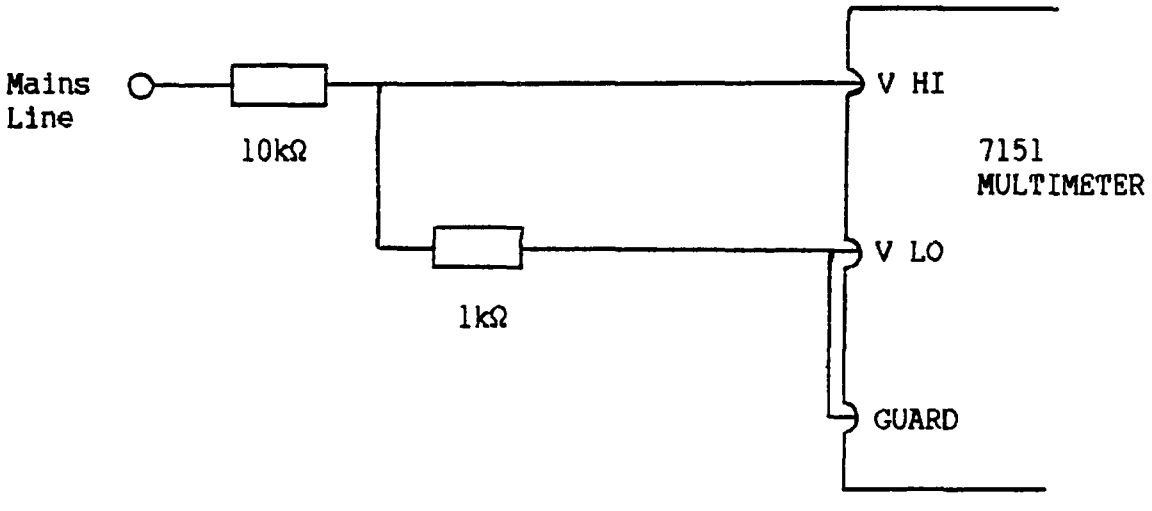



Figure 2.2 AC Common Mode Rejection



# Chapter 3 Dismantling & Reassembly

CHAPTER 3
DISMANTLING AND REASSEMBLY

## 3.1 GENERAL

The 7151 must be disconnected from the mains supply before proceeding with these instructions.

## 3.2 DISMANTLING

1. Pivot the carrying handle to the rear of the case. Pull out the handle lugs from the pivot points on each side of the case and remove the handle.

2. Remove the four screws from the bottom of the case and then withdraw the top section of the case to expose the copper track side of PCB 1.

3. Compress the two plastic snap fasteners, located on the right hand side of PCB 1 (as viewed from the unit front) to release the pcb. Pivot the pcb outwards to gain access to the board components and to expose the screening pcb and the mains transformer.

4. Remove the two screws from the holes located in the mains transformer laminations and withdraw the complete instrument assembly from the bottom section of the case. PCB 2 can now be accessed by unclipping the plastic stand-off fasteners which retain the screening board to PCB 2.

5. At the left of the front panel assembly, remove the self-tapping screw which secures the front panel assembly to a clip on PCB 2. Unplug the front panel assembly from PCB 2.

6. To gain access to PCB 3, remove the six screws which secure the pcb to the front panel. Note that PCB 3 remains attached to the front panel by the keyboard ribbon cable.

## 3.3 REASSEMBLING

1. Fit PCB 3 to the front assembly using the six screws.

2. Carefully plug the front panel assembly into PCB 2. Check that all of the connecting pins on the front panel assembly are correctly inserted into the socket pins on PCB 2.

3. Fit the self-tapping screw which secures the front panel assembly to PCB 2.

4. Attach the screening pcb to PCB 2 by use of the plastic stand-off fasteners.

5. Insert the complete instrument assembly into the bottom section of the case. Insert the two screws into the holes on the mains transformer laminations and tighten to secure the bottom section of the case.

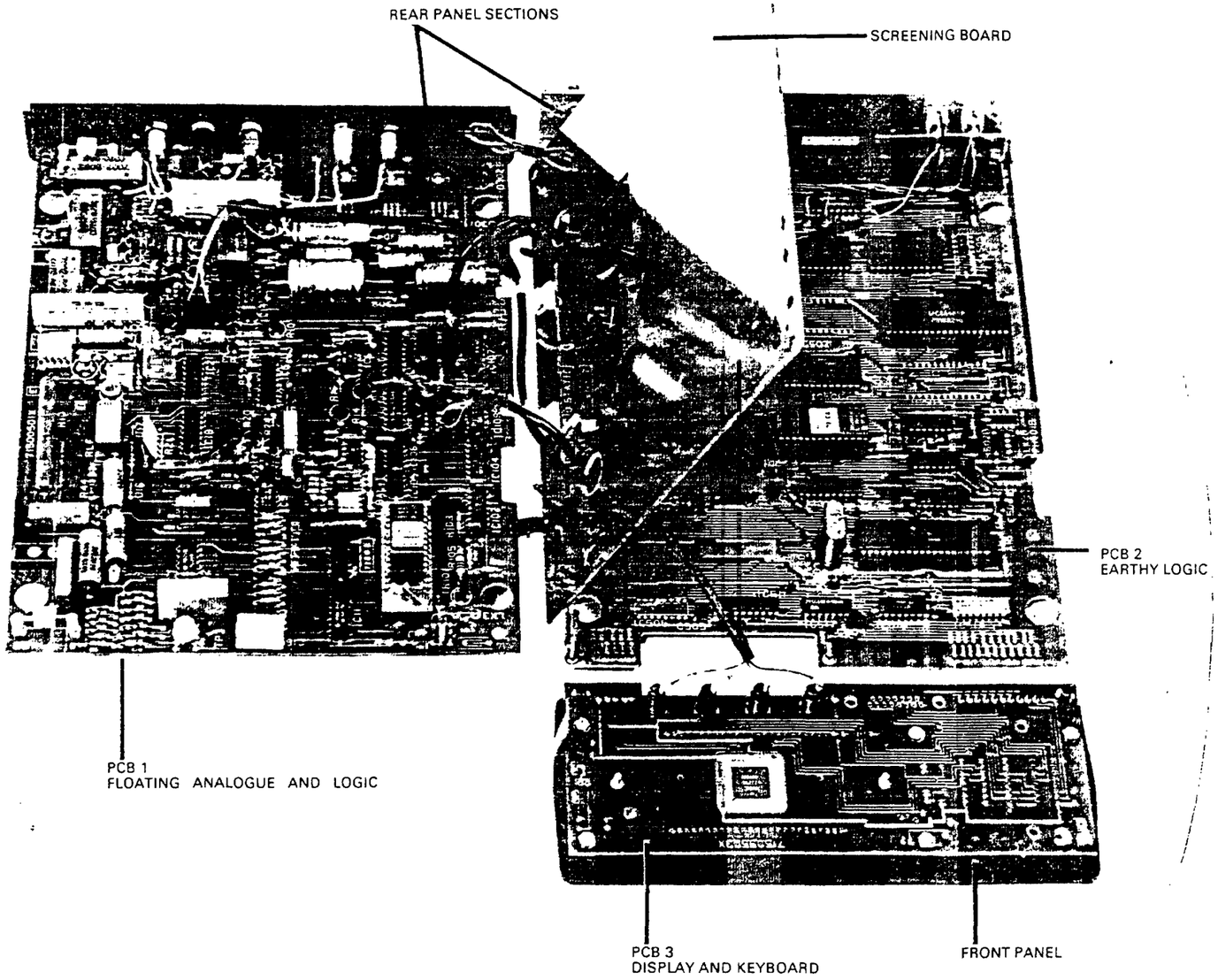
6. Secure PCB 1 by use of the two plastic snap fasteners located on the right hand side of the pcb.

7. Dress the cables on the top of the screening board clear of the holes in the board which locate the extended lugs in the top section of the case.

8. Insert the top section of the case onto the instrument assembly and secure the top section to the bottom section by the four screws inserted into the bottom section of the case.

   NOTE: It is important that these four screws are fully tightened otherwise the case screening is made ineffective and consequently the ac calibration could be impaired.

9. Fit the handle by lining up the locating lugs on the handle with the pivot points on each side of the case and then press the handle lugs into the pivoting points on the case.




The instrument pictured is not 7151, but a similar instrument and is intended only to show the functional assembly.

7151 DISMANTLED
FIG 3.1

## Chapter 4 Circuit Descriptions & Diagrams

# CHAPTER 4 CIRCUIT DESCRIPTIONS AND DIAGRAMS

## 1. GENERAL

All multimeter inputs are at some stage processed by the Analog to Digital Converter (ADC) whose operating range is limited to ±2.6V. The range of measurement is extended beyond this figure by scaling all inputs to the 2V range. For example, a 200V input scaled by a factor of 0.01 would be seen by the ADC as only 2V. Non-dc inputs must of course undergo conversion to dc as well as attenuation and scaling.

## 2. MEASUREMENT OF VOLTAGE, DC

The dc voltage input attenuator consists of the resistors R1A to R1D. The attenuator is switched by FETs TR7, TR8, and relay RLK in response to range control inputs from the floating logic. The attenuator setting, x1, x0.01, x0.001 depends upon the selected voltage range, i.e.

| Range(V) | Attenuation | Circuit Path |
|---|---|---|
| 0.2, 2 | x1 | Direct to input amp. via RLB |
| 20, 200 | x0.01 | RLK, TR7, with RLB open |
| 1000 | x0/001 | RLK, TR8, with RLB open |

The attenuated outputs are then amplified by the input amplifier, whose gain is arranged to be x1 or x10 to ensure satisfactory scaling at the ADC.

Input switching - The dc voltage inputs to the input amplifier are selected via the series FET TR7 and the shunt FET TR6. With TR5 on, TR6 is off, and vice versa.

TR6 is switched on during ac (voltage or current) measurement, during dc current measurement, and during 'drift correct'.

## 3. MEASUREMENT OF AC VOLTAGE

For Vac operations, inputs are first scaled to the 2V range by the ac signal conditioning circuits and then converted into a dc voltage.

AC inputs are subject to the ac input attenuator which is switched by IC18, TR1, TR2, and by the op. amp. IC15. It's gain is set, via IC18 to be either x1 or x10. For inputs on the 2V range, no conditioning is required; quad analog switch IC18 selects the gain of IC15 (via the matched resistors R21A and R21B) to be set at unity, with inputs to the amplifier passed through RLA, RLE and RLF contacts. The overall circuit gain for other input ranges is selected by TR1 and IC18 in response to range and control inputs from the floating logic.

| Range(V) | Attenuation | Amp. I/P(V) | Gain | Amp O/P(V) |
|---|---|---|---|---|
| 0.2 | x1 | 0.2 | x10 | 2 |
| 2 | x1 | 2 | x1 | 2 |
| 20 | x0.01 | 0.2 | x10 | 2 |
| 200 | x0.01 | 2 | x1 | 2 |
| 1000 | x0,001 | 1 | x1 | 1 |

The AC to DC conversion is performed by the true rms to dc converter IC21. The maximum 2V output from this IC is switched to the dc input amplifier IC1 via the shunt input FET TR6 and via quad analog switch IC5.

## 4. MEASUREMENT OF RESISTANCE

This is achieved by measuring the voltage developed across the unknown resistance when a known current is passed through it. The resultant voltage is then measured by the dc voltage measurement circuit.

### Current Generator Circuit

IC3 is a precision operational amplifier to which is connected the +10V supply from the reference circuit. The other amplifier input is the +11V reference. Thus IC3 drives TR3, maintaining a 1V differential across the resistors R73, R74, R75 and R15. Control inputs from the logic circuitry switch this resistor chain (via TR4, TR9, and RLD) to define four test currents. The test currents for the various ranges are:

| Nominal Range | Test Current |
|---|---|
| 20MΩ | 100nA |
| 2MΩ | 1µA |
| 200kΩ | 10µA |
| 20kΩ | 100µA |
| 2kΩ | 100µA |

When checking 4-wire measurement circuits ensure that all current available at the Hi ohms source terminal is returned via the Lo ohms source terminal.

For the ranges other than 20MΩ, the logic control, via IC2, also switches in the resistor chain R7, R27 and R56 which is connected between the Lo ohms source terminal and the -3.1V reference. This part of the circuit acts as a calibrated current sink for the test current generator.

Protection of the resistance measurement circuit is provided by resistor R4 (22k) which is in series with both the I+ and V+ input terminals. Diodes D2 and D25 limit the voltage of TR3 and R4 to between +5.3V and -2.6V.

## 5. MEASUREMENT OF CURRENT

This is achieved by measuring the potential produced across a known resistance when the unknown current passes through it. The voltage obtained can be measured by the dc input amplifier directly or for ac inputs, via the AC-DC converter.

### DC Current Input

Resistor R3 is a 0.1Ω shunt through which the current to be measured flows. The potential across R3 is switched to the dc input amplifier IC1 via the quad switch IC5 and shunt FET TR6. The gain of IC1 is set to x10 for dc current; the amplifier output is thus correctly scaled on the 2V range for A to D conversion.

### AC Current Input

For ac inputs, the potential across resistor R3 is switched, via the quad switch IC18 and FET TR2, to the ac operational amplifier IC15. The gain of IC15 is set to x10 for ac current inputs; thus the inputs to the AC to DC converter are scaled to the 2V range. After AC to DC conversion, the output voltage is switched to the dc input amplifier via the quad switch IC5 and shunt FET TR6.

Protection agains excessive current is by the 2A fuse, F1.

## 6. INPUT AMPLIFIER

Input amplifier IC1 is a precision FET input operational amplifier. Signals for IC1 are firstly amplified by the dual FET pre-amplifier, TR13, whose bias is provided by transistor TR14 and diode D7.

Inputs to the pre-amplifier are selected either by switching on TR5 (series FET) or TR6 (shunt FET) depending on the selected multimeter function. For dc measurement functions (including resistance) TR5 conducts; for ac functions, or during drift corrections, TR6 conducts.

The gain of the pre-amplifier is controlled by IC2 in response to range control signals from the floating logic. IC2 is a quad analog switch connected across IC1 feedback resistors R18 and R19. The switching of IC2 sets the overall gain of the pre-amplifier and IC1 to be x1 or x10 depending on the selected input range or measurement function. The gain settings can be summarised as follows:

| | Range (V) | Gain |
|---|---|---|
| for DC | 0.2 | x10 |
| voltage | 2 | x1 |
| ranges | 20 | x10 |
| | 200 | x1 |
| | 1000 | x1 |

| | Range (mA) | Gain |
|---|---|---|
| for DC current range | 2000 | x10 |

| | Range (mA) | Gain |
|---|---|---|
| for AC current range | 2000 | x1 |

## 7. DRIFT CORRECTION

A 'drift correct' is necessary in order to compensate for any drift originating in the input amplifier or from the ADC. Typically, drift results from component aging or temperature fluctuations.

During a drift correct cycle, the input amplifier is isolated from any measured input (series FET TR5 off) and connected to signal 0V (shunt FET TR6 on). With zero input to the amplifier, any resultant count is then due to drift. This is subsequently subtracted from a measurement count to provide a final count (i.e. result) free from error.

## 8. INPUT PROTECTION

Protection against voltage overload of the input amplifer is by spark-gap SG2 (1400V nominal) which is connected across the VHI and VLO terminals. Resistors R9 and R25 form a current limiter, and diodes D6 and D26 limit series inputs to the amplifier to ±2.6V.

## 9. ANALOGUE TO DIGITAL CONVERTER (ADC)

This circuit converts the analogue output from the input amplifier into digital pulses. These are used to gate clock into a reversible counter in the MPU, IC103, to produce a count proportional to the measured input.

**The Integrator**
The integrator, IC8 has the following inputs connected to its summing point:

1. The input to be measured
2. The forcing waveform
3. + reference or - reference

With zero input applied to the multimeter and a 300Hz forcing square waveform applied continuously to the integrator, the output is driven alternately positive and negative through the thresholds of the comparators IC9 and IC10.

The states of the two comparators are followed by the bistable, IC11 which synchronises the transistors to a clock. The outputs from IC11 control the analogue switch IC16 which switch the + and - reference supplies (through 0V) to the integrator input. This closed loop feedback arrangement ensures that the output is always dynamically balanced about zero.

The synchronised output of the bistable, IC11, is also NANDed by IC17 and passed to IC103 where the pulses are counted.

## 10. REFERENCE SUPPLY

This circuit generates the +10V and +11V supplies for the ohms current generator and the + and -3.1V supplies for the ADC. The reference diode, D20, together with the resistor network R38, R42, R17 and RV1, ensures the input to IC4 is held at 3.1V. D20 also forms the + reference supply, via IC6a and IC16, for the ADC. The output of IC4 forms the -3.1V reference supply.

All references are with respect to the 0V ROME.

The + reference voltage is also used as the input to IC6b. This is an amplifier which drives a current through R14, R57 and R16 in order to maintain the reference at balance. The resistor chain is tapped to provide the +10V and +11V reference voltages for the ohms current generator.

## 11. FLOATING LOGIC

This circuit includes the floating logic microprocessor (MPU), IC103. This IC communicates with the earthy logic MPU via a 2-wire optically coupled serial link. The circuit can be considered to have four separate functions:

1. Controls range and mode switching on the analogue pcb.
2. Generates the forcing waveform for the ADC.
3. Counts the pulsed output from the ADC.
4. Stores calibration constants and checksum for use during auto-cal procedures.

Note: The circuit automatically resets to a known state in the event of a system lockout.

### 11.1 Analogue Control Lines

These MPU outputs are connected to drivers, comparators and bi-lateral switches on the analogue pcb. The outputs, via their respective switching devices, correctly configure the circuits for the selected multimeter range and function.

### 11.2 Forcing Waveform

The "timer-out" signal from the MPU is a 300Hz waveform which is used to generate the forcing waveform for the A to D converter. The TTL level signal is converted into a 0 to 8V square wave by the bi-lateral switch IC5 in the analog circuit.

### 11.3 Counting Circuit

Timer-in is an input to the MPU which is derived from the ADC. The input is a single, clock synchronised pulse-train; the pulse widths indicating alternatively, the length of time the + and - reference voltages were applied in order to balance the integrator. Within the MPU, these pulses are used to gate clock into a reversible counter to produce a nett count proportional to the measured input.

### 11.4 Non-Volatile Memories

IC's 105 and 106 are EAROMs which hold the automatic calibration program for the multimeter and the calibration constants for each mode/range selected.

### 11.5 Reset Watchdog

This circuit causes the floating MPU to be reset in the event of system lockout. The circuit operation is similar to that described for the earthy logic reset circuit (page 2.11).

A 1.2288 MHz clock derived output from the MPU is divided by a 12-bit binary counter IC 107. The 300Hz (3.33ms period) output from this IC is counted by the 4-bit counter, IC108.

The serial link TX DATA line from the earthy MPU, is also connected to IC108. This input holds off the RESET output unless the RX DATA line is inactive for more than 26.664ms (8x period).

With the RESET line active, bistable IC112 (see ADC) is also reset, thus MPU pin 8 (TIMER IN) is set to a logic 1 state. Pins 8, 9, and 10 are set to this state at initialisation.

## 12. EARTHY LOGIC

This includes the microprocessor set, the remote control interfaces, the watch-dog reset circuitry, the analog to digital converter (analog output), clock and the interface switch decoders.

MPU set

This consists of IC 212 : 8 bit MPU
IC 207 : 16K x 8 bit ROM
IC 208 : 8K x 8 bit RAM

### 12.1 GPIB Interface

This consists of IC 203 : general purpose interface adaptor
IC 202 : octal transceiver
IC 201 : octal transceiver

IC 203 consists essentially of 15 registers, 7 of which can be written into by the MPU and, depending on the state of control lines R/W and RS0 to RS2, 8 can be read by the MPU.

The transceivers IC201 and 202 are bidirectional and consist of eight driver/receiver pairs each. Each driver/receiver is enabled by a send/receive input (T/R1 and T/R2) with the disabled output forced to a high impedance state. All GPIB signals are TTL level.

### 12.2 RS232 Interface

This consists of IC 204 : RS232 interface adaptor
IC 218 : RS232 line driver
IC 219 : RS232 line receiver

IC204 is essentially a reversible 8 to 1 line decoder for the transmission and reception of data via the TxD and RxD lines. IC218 and 219 serve to buffer and level-shift the various signals to/from RS232 levels (±12V).

### 12.3 Analog Output

This is generated by the 8-bit digital to analog converter, IC205. The voltage between the Hi and Lo lines should bot exceed +10V, or be less than 0V.

### 12.4 Address Decoders

The MPU addresses the various bus connected devices and the watch-dog reset circuitry via the decoder, IC209. The ROM, IC207, is addressed separately by the A15 (inverted) address line.

### 12.5 Clock

IC206 is a real time clock which is responsible for generating accurate time signals for the MPU and provides control signals for other circuits. The clock frequency is factory adjusted to exactly 32.768kHz. If the frequency is to be checked, test probes must not be placed directly across the crystal as this will produce a false reading. Instead, the frequency should be measured at IC206/pin 21 where it is suitably buffered and divided by four. i.e. 8.1920kHz±0.1Hz. The frequency can be adjusted with C217.

Whilst the instrument is switched-off, standby power is supplied to IC206 (pin 22) by the back-up battery, BAT 201 (approx. 4.5V).

## 12.6 Reset Watchdog

This resets the MPU and the display in the event of a system lockout. A 0.6144MHz clock derived output from the MPU is further divided by the 12-bit binary counter IC216. The 150Hz (6.6ms period) resultant output is checked by the counter, IC217.

## 12.7 Display and Keyboard

This circuit has two main functions:

1. to decode display and command data
2. to transfer keyboard selections to the MPU

## 12.8 Display

The display circuit includes custom LCD X301. At switch-on, the display undergoes selt-test for approx. 2 secs. The display is of the matrix type where it takes both column and row signals to activate particular segments (see diagram of display layout). The display is driven by pulses that alternate about 0V; this ensures that the crystals do not become permanently polarised.

The driver for the display is IC301 and is serially interfaced with the 'earthy' logic via pins 8→13. With CS (chip select), data can be sent on the serial input (SI) line. A data bit is sent for every +ve going transition of SCK; on the eight on, the BUSY line is made low until the IC is ready to accept more data.

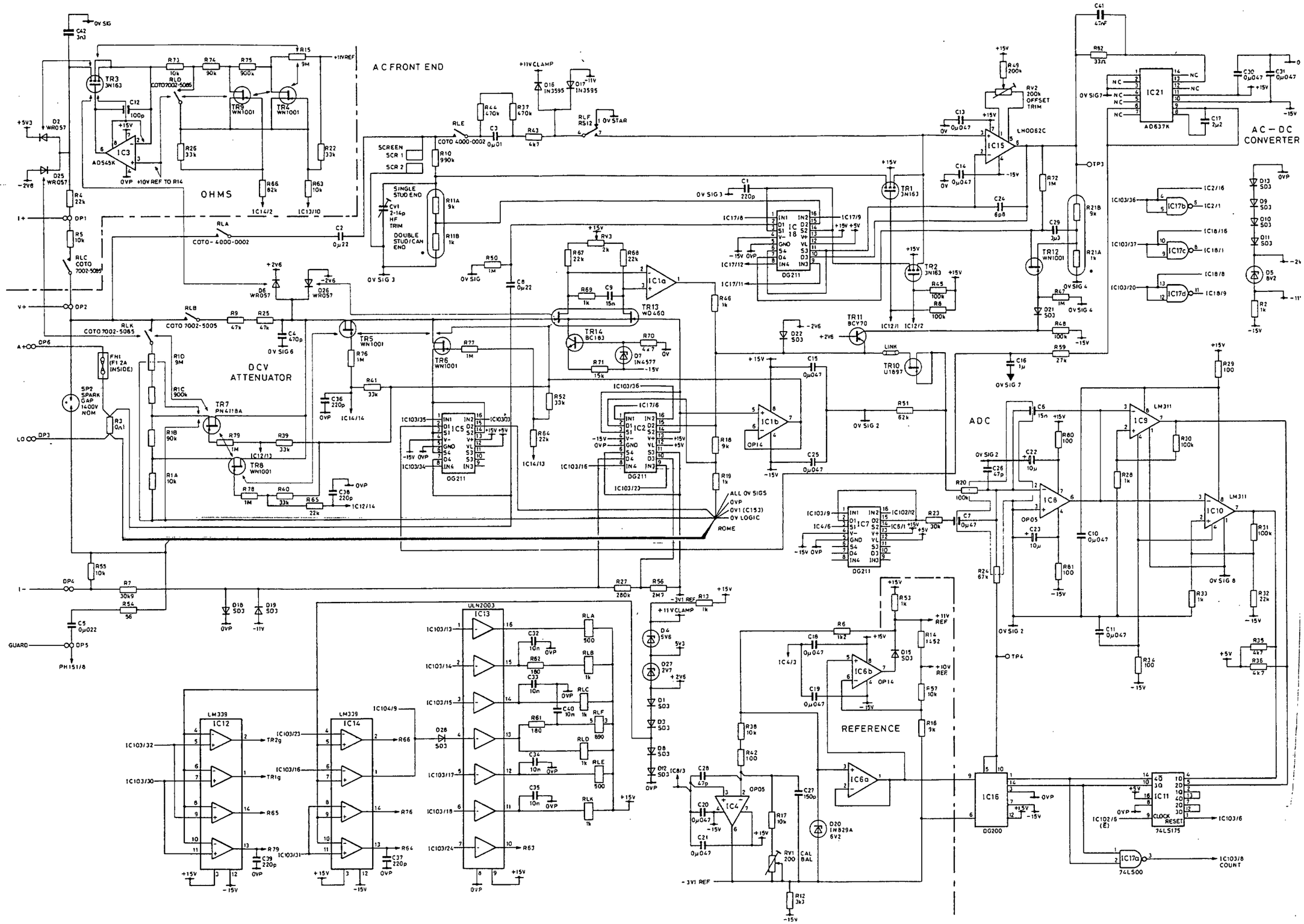
The serial input may just be data for display, in which case the control data (C/D) line remains in its active low state. However, for driver commands, such as blanking or flashing the display, C/D is set to active high.

## 12.9 Keyboard

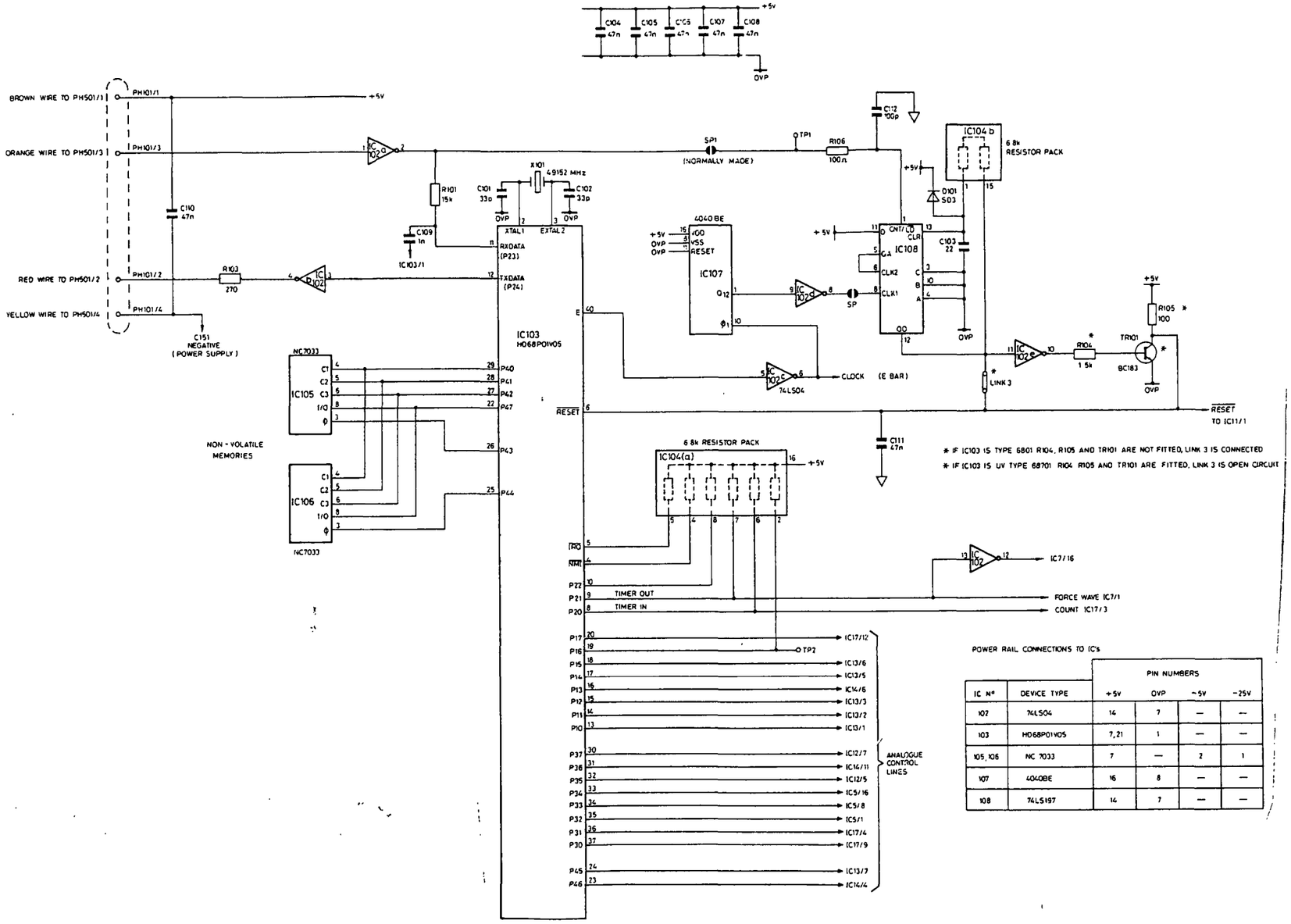
The (vertical) column outputs from the keyboard are connected directly to the MPU and, with no selections made, held in the logic 1 state via pull-up resistors on the earthy logic pcb. Keyboard (horizontal) rows are scanned via output latch IC210 and BCD-to-decimal decoder, IC302.

## 12.10 Power Supplies

Both PCB1 and PCB2 have on-board power-supply regulation, supplied by a common mains transformer. The display board logic derives its power from the regulated 5V supply of PCB2 whilst the display backlighting power is derived from PCB2's unregulated 5V supply. The -25V supply of PCB1 can only be enabled by insertion or a shorted CAL plug, and is required to re-program the calibration constants held in the EAROMs (ICs 105 & 106).



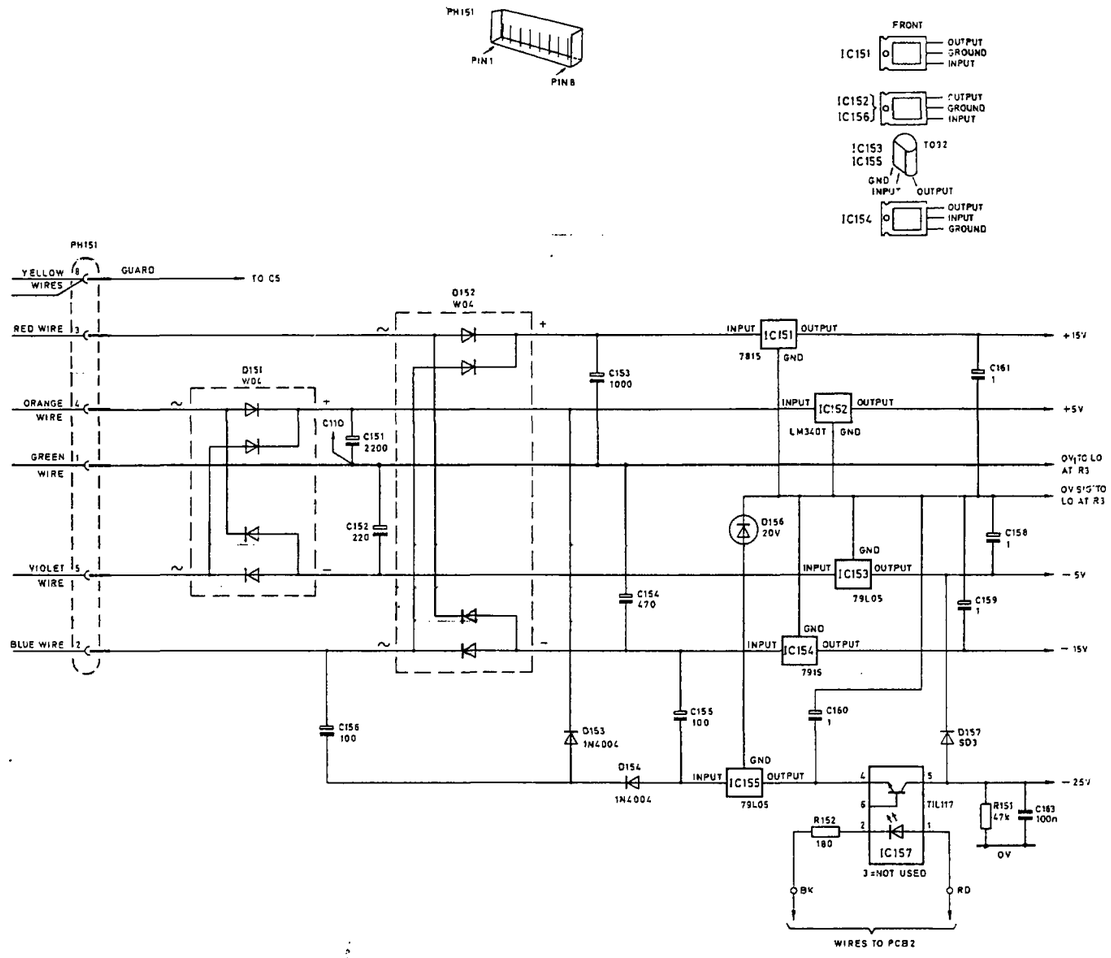

PCB1, SHT 1 OF 3, FLOATING ANALOGUE
DIAGRAM 4.1



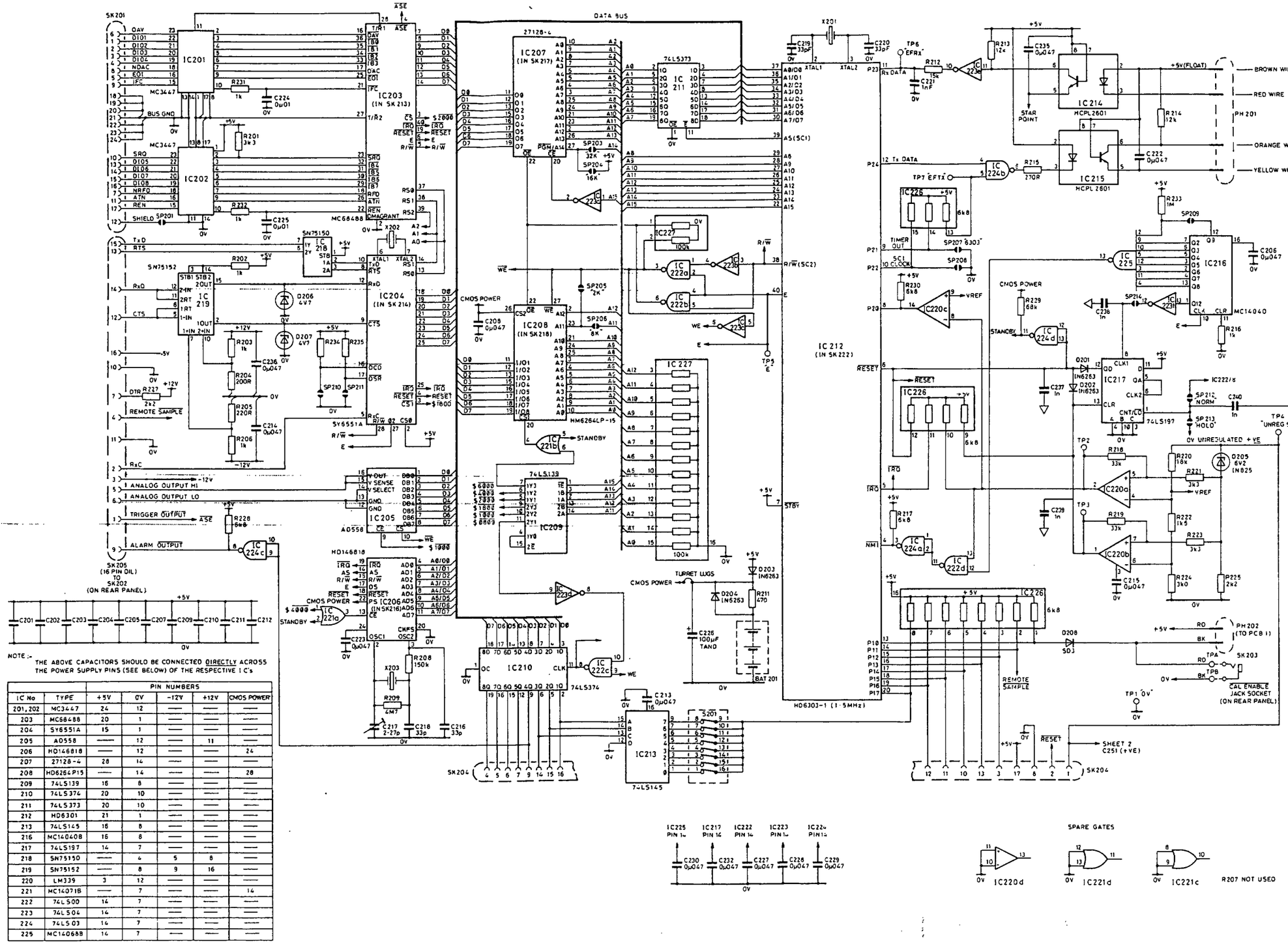

POWER RAIL CONNECTIONS TO IC's

| IC N° | DEVICE TYPE | PIN NUMBERS | | | |
|---|---|---|---|---|---|
| | | +5V | OVP | −5V | −25V |
| 102 | 74LS04 | 14 | 7 | — | — |
| 103 | H068P01W05 | 7, 21 | 1 | — | — |
| 105, 106 | NC 7033 | 7 | — | 2 | 1 |
| 107 | 4040BE | 16 | 8 | — | — |
| 108 | 74LS197 | 14 | 7 | — | — |

PCB1, SHT 2 OF 3, FLOATING ANALOGUE
DIAGRAM 4.2



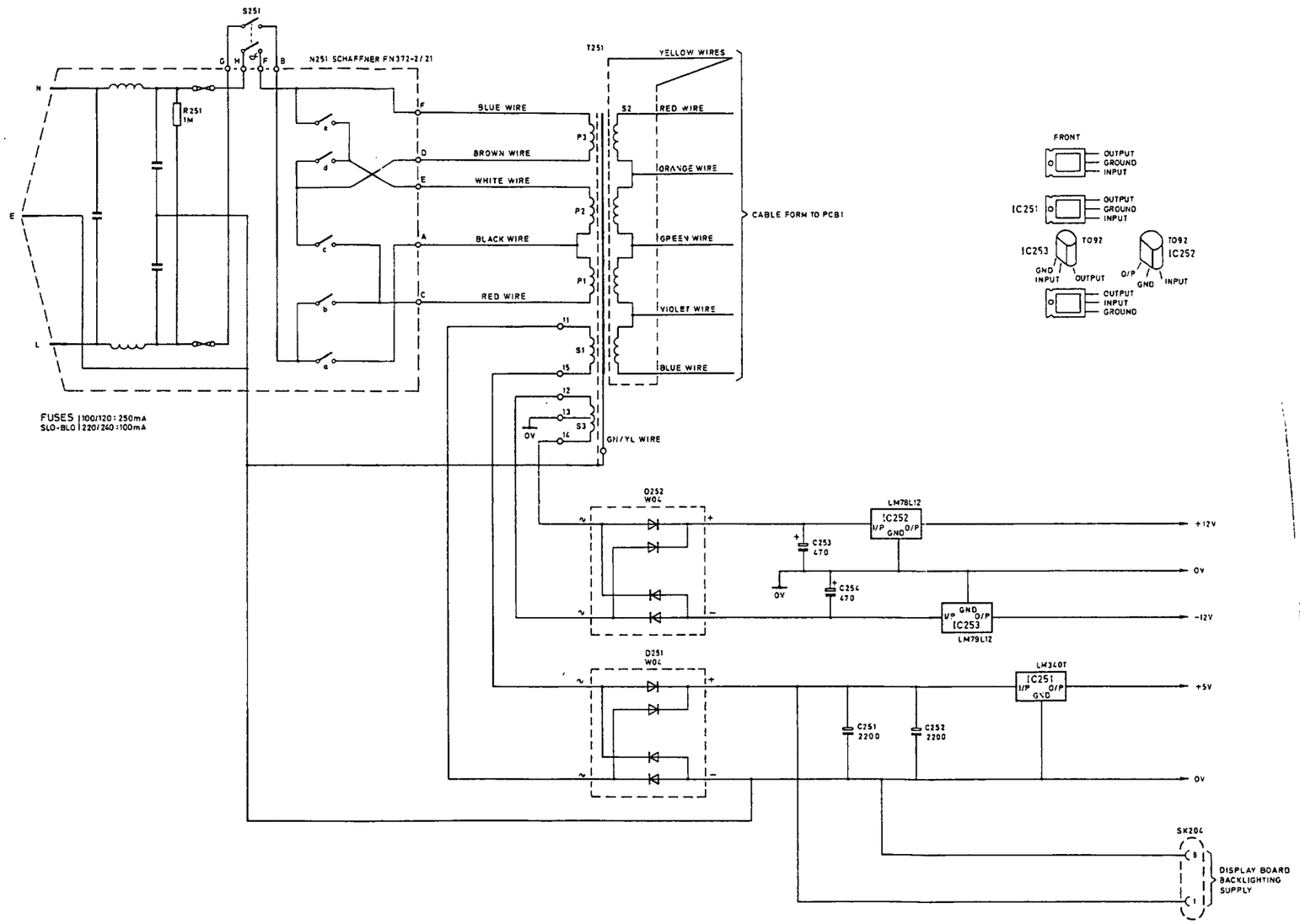

FLOATING ANALOGUE POWER SUPPLIES
DIAGRAM 4.3



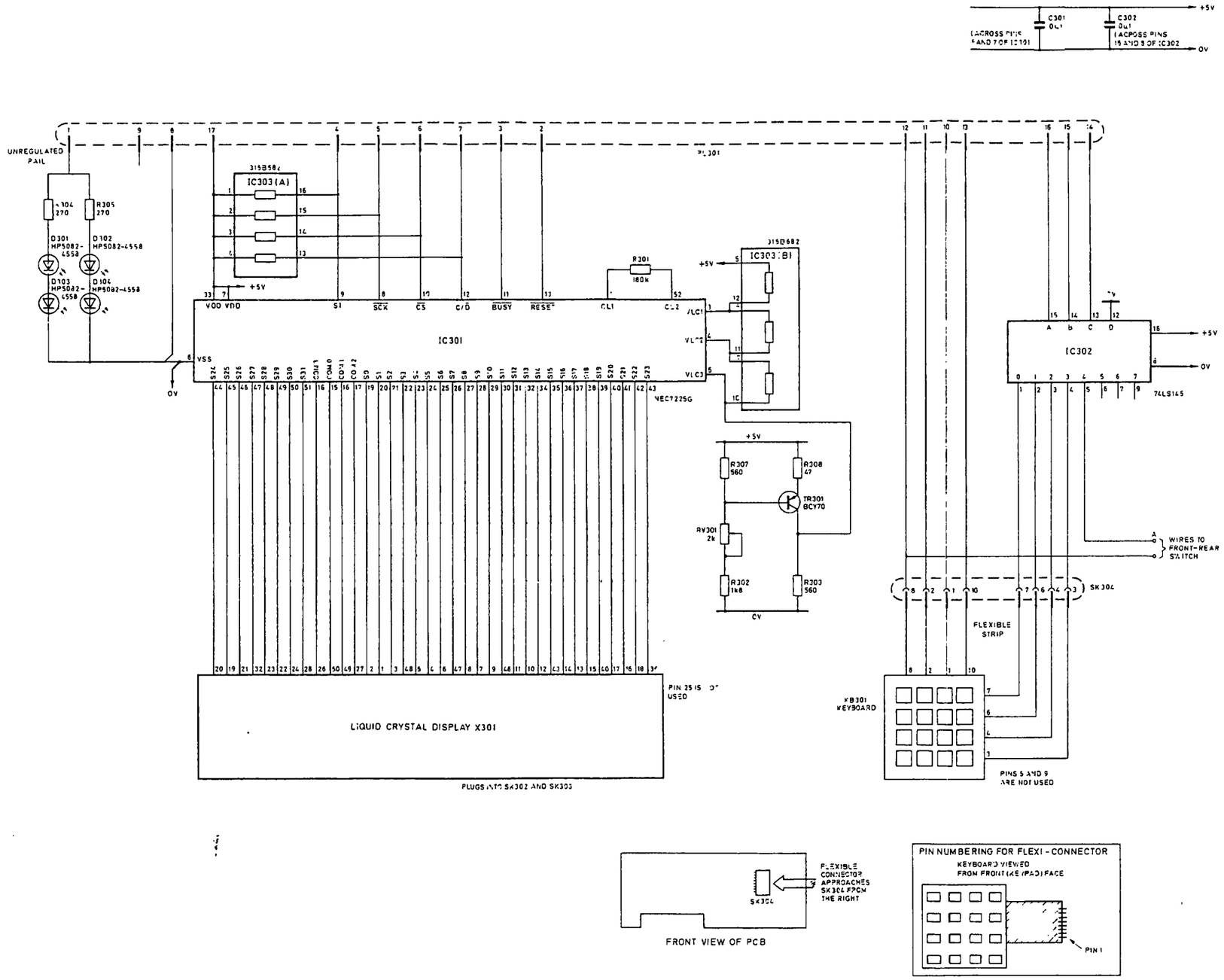

NOTE :- THE ABOVE CAPACITORS SHOULD BE CONNECTED DIRECTLY ACROSS THE POWER SUPPLY PINS (SEE BELOW) OF THE RESPECTIVE I C's

| | | PIN NUMBERS | | | | |
|---|---|---|---|---|---|---|
| IC No | TYPE | +5V | 0V | -12V | +12V | CMOS POWER |
| 201, 202 | MC3447 | 24 | 12 | — | — | — |
| 203 | MC68488 | 20 | 1 | — | — | — |
| 204 | SY6551A | 15 | 1 | — | — | — |
| 205 | AD558 | — | 12 | — | 11 | — |
| 206 | HD146818 | — | 12 | — | — | 24 |
| 207 | 27128-4 | 28 | 14 | — | — | — |
| 208 | HD6264P15 | — | 14 | — | — | 28 |
| 209 | 74LS139 | 16 | 8 | — | — | — |
| 210 | 74LS374 | 20 | 10 | — | — | — |
| 211 | 74LS373 | 20 | 10 | — | — | — |
| 212 | HD6301 | 21 | 1 | — | — | — |
| 213 | 74LS145 | 16 | 8 | — | — | — |
| 216 | MC140408 | 16 | 8 | — | — | — |
| 217 | 74LS197 | 14 | 7 | — | — | — |
| 218 | SN75150 | — | 4 | 5 | 8 | — |
| 219 | SN75152 | — | 8 | 9 | 16 | — |
| 220 | LM339 | 3 | 12 | — | — | — |
| 221 | MC14071B | — | 7 | — | — | 14 |
| 222 | 74LS00 | 14 | 7 | — | — | — |
| 223 | 74LS04 | 14 | 7 | — | — | — |
| 224 | 74LS03 | 14 | 7 | — | — | — |
| 225 | MC14068B | 14 | 7 | — | — | — |

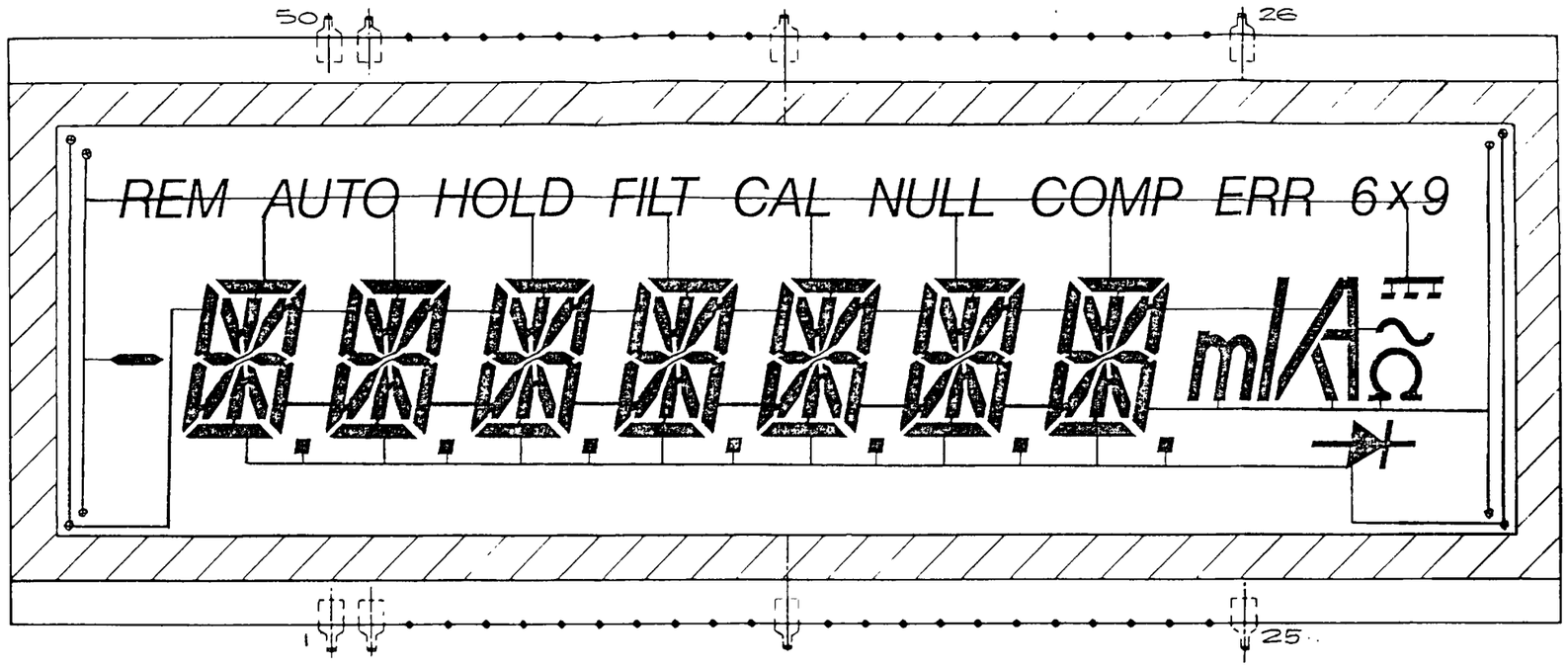
PCB2, EARTHY LOGIC
DIAGRAM 4.4



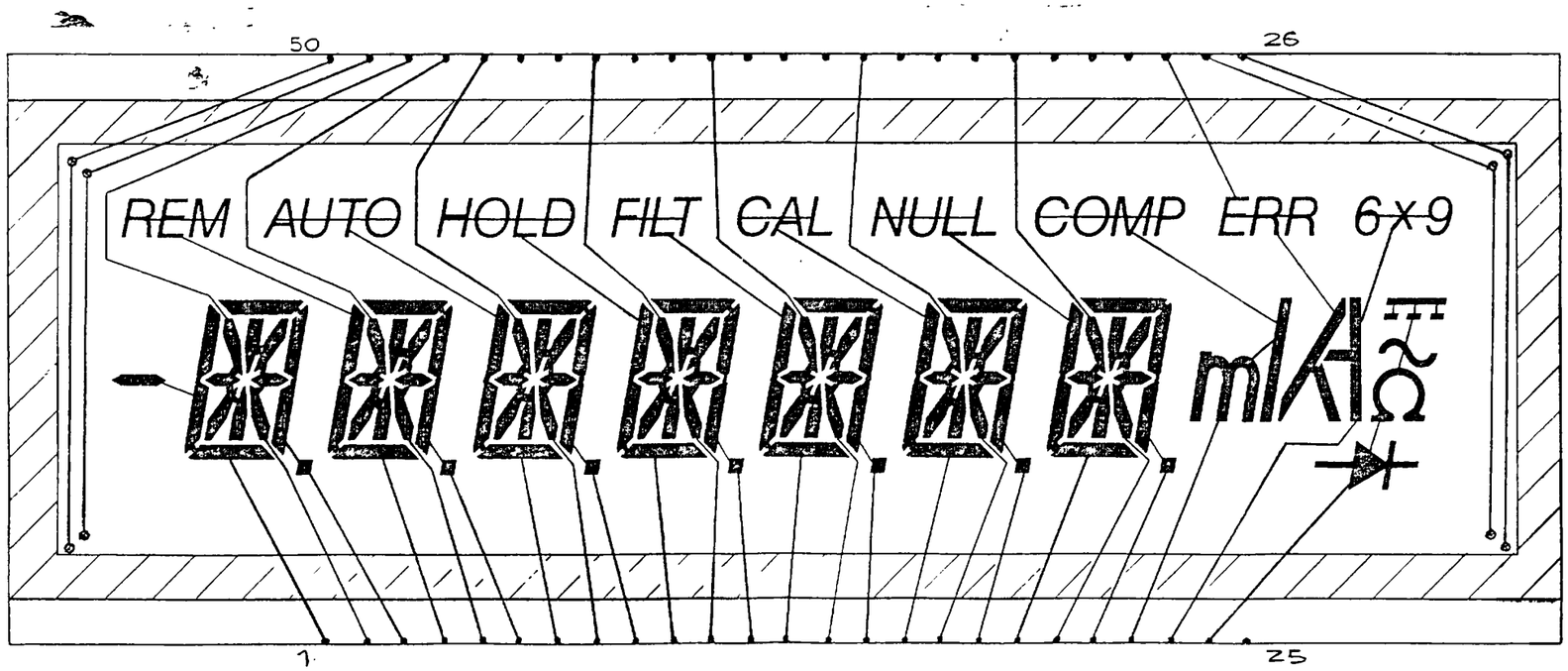

EARTHY LOGIC POWER SUPPLIES (& MAINS POWER)
DIAGRAM 4.5




PCB3, DISPLAY AND KEYBOARD
DIAGRAM 4.6



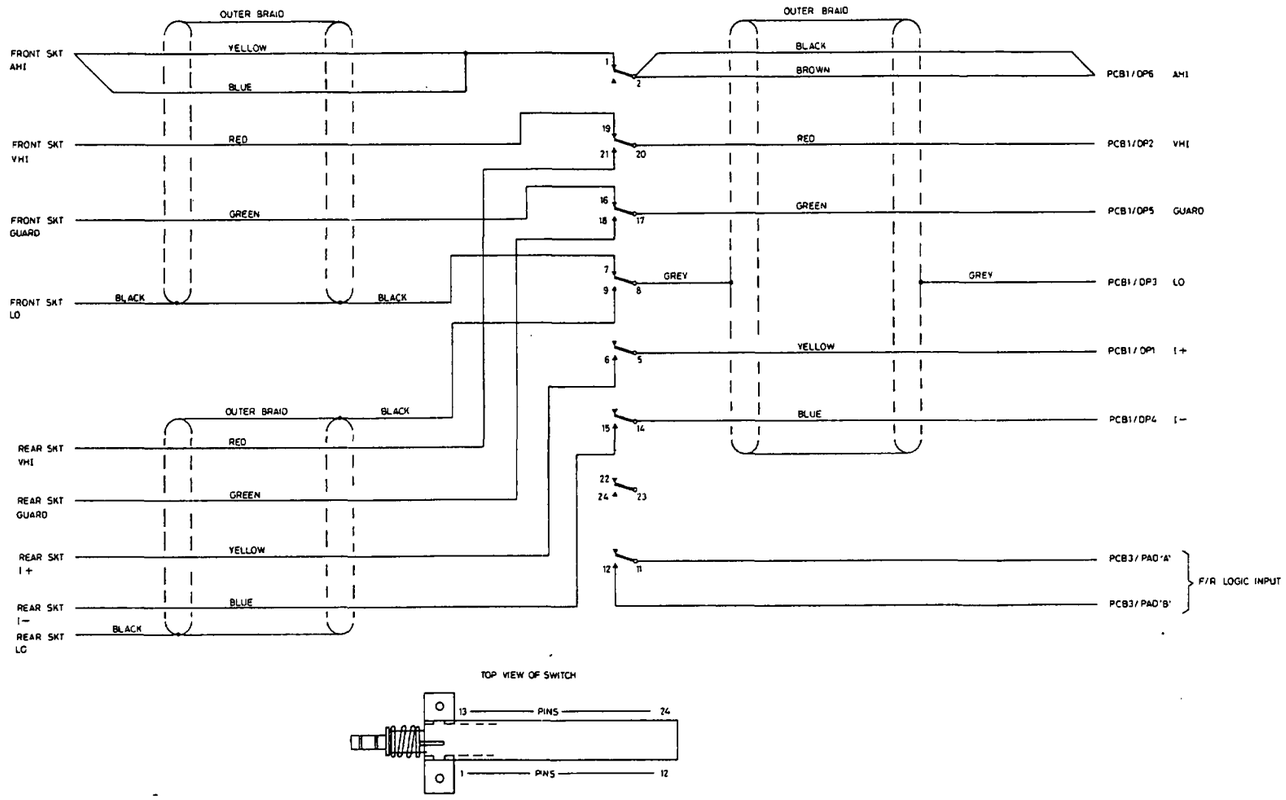

backplane




segment plane

⊗ = crossover

DISPLAY WIRING
DIAGRAM 4.7







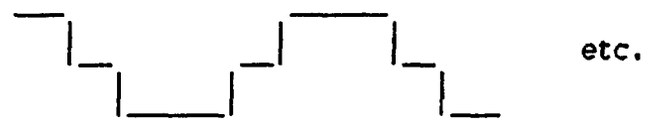
FRONT/REAR SWITCH WIRING
DIAGRAM 4.8

# Chapter 5 Fault Diagnosis Guide

| Symptom | Possible Fault | Procedure |
|---|---|---|
| Instrument 'dead' | No mains power | A good check is to look for the display backlights. If no lights check fuses and supply voltages. |
| Fuses keep blowing | Rectifier, regulator or smoothing capacitor faulty. | Correct current drawn from the mains for 240V on 240V setting: approx 60mA, for 120V on 120V setting: approx 120mA. Under fault conditions (regulator blown) current may typically be in order of 500mA. Look for correct output from each regulator IC. |
| 'Fail 1' displayed at power-up | Communication breakdown between floating and earthy logic | Check opto-couplers IC214 & IC215, IC102, and the connecting wires and plugs (to PCB 1). Look for activity on the TX and RX lines. |
| 'Fail 2' displayed at power-up | Problem with Real-time clock IC206, possibly caused by battery BAT201 being discharged. | Leave 7151 switched on for 24 Hrs, displaying 'Fail 2', to recharge battery (or fit a good replacement). Switch off and on again. If 'Fail 2' still displayed, switch off, remove turret lug link (if no link, remove battery) and momentarily short IC206 pin 22 to 0V to reset the chip. Also check that pin 21 is exactly 8.192kHz (derived from X203). |
| Amps range 'does not work' | 2A fuse on rear panel blown. | Check fuse. |
| Display inoperative | Poor connections between display and IC301, or of the header PL301 in socket SK204. | Remake all connections and verify 100% contact. Look for the following shaped waveform on the IC301 outputs S0→S31:  Also check the control lines of IC301 (e.g. ensure that RESET is not 'stuck'). |
| Display 'sluggish' or too faint | Display not correctly driven | Check setting of RV301 (see P2.5). |
| 7151 doesn't perform 'correctly' via remote control, i.e. perhaps occasional errors occur. | Poor contacts in switch S201, or fault in interface chips, IC201, 202, 203 (for GPIB) or IC218, 219, 204 (for RS232). | Toggle switches S201 to clear their contacts and set as required. If no improvement check chips by substitution. In the case of the GPIB, ensure that the correct cables are being used, and disconnect all instruments other than the controller to verify if 7151 is faulty. |

| Symptom | Possible Fault | Procedure |
|---|---|---|
| After calibrating 7151, it is still out of calibration. | New cal. constants haven't been stored in IC105 & 106. | Check that -25V is produced by IC157 pin 5 when the CAL plug is fitted, and that it reaches IC105 & 106 pin 1. |

Very often a fault will not fall into one of the above categories and it can be very difficult to decide where to start looking. However, for PCB1 and PCB2 there are some basic checks that can be carried out to help narrow the search.

| Board | Check |
|---|---|
| PCB 1 | All power supplies are within tolerance (see Chapter 2).<br><br>Waveform E at IC103 pin 40 is 1.2288 MHz.<br><br>TX and RX of data from PCB 2 (via opto couplers) on IC103 pins 11 & 12. It is sufficient just to look for activity on the signal lines.<br><br>Forcing waveform of 300 Hz is generated by IC103 pin 9. Reference voltages at IC16 pins 9 & 6 should be 3.1V and -3.1V respectively.<br><br>Waveform at TP4 (IC 16 pin 10) should look like:<br><br>  etc.<br><br>$\overline{\text{RESET}}$ from IC 103 pin 6 for activity. |
| PCB 2 | All power supplies.<br><br>Waveform E at IC212 pin 40 is 1.2288MHz.<br><br>TX and RX of data from PCB 1 (via opto couplers) on IC212 pins 11 & 12. It is sufficient just to look for activity on the signal lines.<br><br>$\overline{\text{RESET}}$ from IC212 pin 6 for activity.<br><br>Pin 21 of IC206 (Real time clock) should be exactly 8.192kHz. |

# Chapter 6 Parts Lists & Component Layout

CHAPTER 6

# PARTS LISTS AND LAYOUT DIAGRAMS

## INTRODUCTION

This section contains component layout diagrams and detailed parts lists for each of the three printed circuit boards and the front and rear panels. When ordering spare parts, it is essential to quote the instrument serial number located on the rear panel as well as the full description of the item given in the appropriate parts list.

A description of the abbreviations used in the parts list is given as follows:

## COMPONENT PARTS LIST ABBREVIATIONS

### CIRCUIT REFERENCES

| | |
|---|---|
| B | Battery |
| C | Capacitor |
| D | Diode |
| FS | Fuse |
| IC | Integrated Circuit |
| L | Inductor |
| LK | Link |
| PL | Plug |
| R | Resistor |
| RL | Relay |
| S | Switch |
| SK | Socket |
| T | Transformer |
| TP | Terminal Post (or Test Point) |
| TR | Transistor |
| X | Other Components |

Also Used:

| | |
|---|---|
| RV | Variable Resistor |

### COMPONENT TYPES

Fixed Resistors

| | |
|---|---|
| CACP | Carbon Composition |
| MEFM | Metal Film |
| MEGL | Metal Glaze |
| MEOX | Metal Oxide |
| POWW | Power Wirewound |
| PRWW | Precision Wirewound |
| TKFM | Thick Film |

Capacitors

| | |
|---|---|
| ALME | Aluminimum Electrolytic |
| CARB | Polycarbonate |
| CERM | Ceramic |
| ESTF | Polyester Foil |
| ESTM | Polyester Metallised |
| PTFE | PTFE |
| TAND | Tantalum Dry |

Variable Resistors

| | |
|---|---|
| CMPM | Cermet Preset Multiturn |

PCB 1 (71510501) Floating Logic and Analogue

| Cct. Ref. | General Description | | | | Solartron Part No. |
|---|---|---|---|---|---|
| R1 | CAD1776 | | | TKFM | |
| R2 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R3 | 0.1 | | 0.5% | PRWW | 160300506 |
| R4 | 22k | 3W | 5% | MEGL | 176442200 |
| R5 | 10k | 0.5W | 10% | CACP | 172341000 |
| R6 | 1.2k | 0.125W | 0.5% | MEFM | 192731202 |
| R7 | 30.9k | 0.125W | 0.25% | MEFM | 192843094 |
| R8 | 100k | 0.25W | 5% | MEOX | 198651000 |
| R9 | 47k | 3W | 2% | MEGL | 175244700 |
| R10 | 990k | 2W | 0.5% | MEFM | 160400487 |
| R11 | 9k+1k | 0.2W | 0.1% | TKFM | 160400582 |
| R12 | 3.3k | 0.25W | 5% | MEOX | 195633300 |
| R13 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R14 | 1452 } | matched | 0.25% | | 169617201 |
| R15 | 9k } | pair | | | |
| R16 | CAD1776 | | | TKFM | 160400583 |
| R17 | 10k | 0.125W | 0.5% | MEFM | 192741002 |
| R18 | 9k | matched | | | |
| R19 | 1k | pair | 0.25% | | 169617001 |
| R21 | 9k+1k | 0.2W | 0.1% | TKFM | 160400582 |
| R20 | 100k } | matched | | | |
| R24 | 67k } | pair | 0.25% | | 169617101 |
| R22 | 33k | 0.25W | 5% | MEOX | 195643300 |
| R23 | 30k | 0.125W | 0.5% | MEFM | 192743002 |
| R25 | 47k | 3W | 2% | MEGL | 175244700 |
| R26 | 33k | 0.25W | 5% | MEOX | 195643300 |
| R27 | 280k | 0.125W | 0.25% | MEFM | 192852804 |
| R28 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R29 | 100 | 0.25W | 5% | MEOX | 195621000 |
| R30 | 100k | 0.25W | 5% | MEOX | 195651000 |
| R31 | 100k | 0.25W | 5% | MEOX | 195651000 |
| R32 | 22k | 0.25W | 5% | MEOX | 195642200 |
| R33 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R34 | 100 | 0.25W | 5% | MEOX | 195621000 |
| R35 | 4.7k | 0.25W | 5% | MEOX | 195634700 |
| R36 | 4.7k | 0.25W | 5% | MEOX | 195634700 |
| R37 | 470k | 0.5W | 10% | CACP | 172354700 |
| R38 | 10k | 0.125W | 0.5% | MEFM | 192741002 |
| R39 | 33k | 0.25W | 5% | MEOX | 195643300 |
| R40 | 33k | 0.25W | 5% | MEOX | 195643300 |

PCB 1 (cont.)

| Cct. Ref. | | General Description | | | Solartron Part No. |
|---|---|---|---|---|---|
| R41 | 33k | 0.25W | 5% | MEOX | 195643300 |
| R42 | 100 | 0.125W | 0.5% | MEFM | 192721002 |
| R43 | 4.7k | 3W | 5% | MEOX | 193734700 |
| R44 | 470k | 0.5W | 10% | CACP | 172354700 |
| R45 | 100k | 0.25W | 5% | MEOX | 195651000 |
| R46 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R47 | 1M | 0.5W | 5% | MEOX | 193561000 |
| R48 | 100k | 0.25W | 5% | MEOX | 195651000 |
| R49 | 200k | 0.125W | 0.5% | MEFM | 192752002 |
| R50 | 1M | 0.25W | 0.5% | MEFM | 198261002 |
| R51 | 62k | 0.125W | 0.5% | MEFM | 192746202 |
| R52 | 33k | 0.25W | 5% | MEOX | 195643300 |
| R53 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R54 | 56 | 0.25W | 5% | MEOX | 195615600 |
| R55 | 10k | 0.5W | 10% | CACP | 172341000 |
| R56 | 2.7M | 0.25W | 10% | CACP | 172062700 |
| R57 | 10k | 0.125W | 0.5% | MEFM | 192741004 |
| R59 | 27k | 0.125W | 0.5% | MEFM | 192742702 |
| R61 | 180 | 0.25W | 5% | MEOX | 195621800 |
| R62 | 180 | 0.25W | 5% | MEOX | 195621800 |
| R63 | 10k | 0.25W | 5% | MEOX | 195641000 |
| R64 | 22k | 0.25W | 5% | MEOX | 195642200 |
| R65 | 22k | 0.25W | 5% | MEOX | 195642200 |
| R66 | 82k | 0.25W | 5% | MEOX | 195648200 |
| R67 | 22k | 0.125W | 0.5% | MEFM | 192742202 |
| R68 | 22k | 0.125W | 0.5% | MEFM | 192742202 |
| R69 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R70 | 4.7k | 0.125W | 0.5% | MEFM | 192734702 |
| R71 | 15k | 0.125W | 0.5% | MEFM | 192741502 |
| R72 | 1M | 0.5W | 5% | MEOX | 193561000 |
| R73 | 10k | 0.2W | 0.25% | PRWW | 160300505 |
| R74 | 90k | 0.2W | 0.01% | PRWW | 160300438 |
| R75 | 900k | 0.3W | 0.25% | PRWW | 160300504 |
| R76 | 1.0M | 0.25W | 10% | CACP | 172061000 |
| R77 | 1.0M | 0.25W | 10% | CACP | 172061000 |
| R78 | 1.0M | 0.25W | 10% | CACP | 172061000 |
| R79 | 1.0M | 0.25W | 10% | CACP | 172061000 |
| R80 | 100 | 0.25W | 5% | MEOX | 195621000 |
| R81 | 100 | 0.25W | 5% | MEOX | 195621000 |
| R82 | 33 | 0.125W | 0.5% | MEFM | 192713302 |

PCB 1 (cont.)

| Cct. Ref. | General Description | | | | Solartron Part No. |
|---|---|---|---|---|---|
| R101 | 15k | 0.25W | 5% | MEOX | 195641500 |
| R103 | 270 | 0.25W | 5% | MEOX | 195622700 |
| R104 | 1.5k | 0.25W | 5% | MEOX | 195631500 |
| R105 | 100 | 0.5W | 1% | MEOX | 195421000 |
| R106 | 100 | 0.25W | 5% | MEOX | 195621000 |
| R151 | 47k | 0.25W | 5% | MEOX | 195644700 |
| R152 | 180 | 0.25W | 5% | MEOX | 195621800 |
| RV1 | 200 | 0.5W | 10% | multiturn cermet preset | 130922000 |
| RV2 | 200k | 0.5W | 10% | multiturn cermet preset | 110016220 |
| RV3 | 2k | 0.5W | 10% | multiturn cermet preset | 130932000 |
| RLA | relay | COTO 4000-0002 | | | 301203400 |
| RLB | relay | COTO 7002-5005 | | | 301203300 |
| RLC | relay | COTO 7002-5085 | | | 301203500 |
| RLD | relay | COTO 7002-5086 | | | 301203600 |
| RLE | relay | COTO 4000-0002 | | | 301203400 |
| RLF | relay | RS12 | | | 300652190 |
| RLK | relay | COTO 7002-5085 | | | 301203500 |
| C1 | 200pF | 500V | 20% | CERM | 241322200 |
| C2 | 0.22µF | 400V | 20% | ESTM | 226152200 |
| C3 | 10nF | 1000V | 10% | ESTF | 222841000 |
| C4 | 470pF | | | | 208100201 |
| C5 | 22nF | 400V | 10% | ESTF | 222342200 |
| C6 | 15nF | 100V | 10% | ESTM | 225441500 |
| C7 | 0.47µF | 100V | 10% | ESTM | 225454700 |
| C8 | 0.22µF | 100V | 10% | ESTM | 225452200 |
| C9 | 15nF | 400V | 10% | ESTF | 222341500 |
| C10 | 47nF | 25V | 25% | CERM | 241944700 |
| C11 | 47nF | 25V | 25% | CERM | 241944700 |
| C12 | 100pF | 160V | 20% | CARB | 208900004 |
| C13 | 47nF | 25V | 25% | CERM | 241944700 |
| C14 | 47nF | 25V | 25% | CERM | 241944700 |
| C15 | 47nF | 25V | 25% | CERM | 241944700 |
| C16 | 1µF | 100V | 10% | ESTM | 225461000 |
| C17 | 2.2µF | 100V | 10% | ESTM | 225462200 |
| C18 | 47nF | 25V | 25% | CERM | 241944700 |
| C19 | 47nF | 25V | 25% | CERM | 241944700 |
| C20 | 47nF | 25V | 25% | CERM | 241944700 |
| C21 | 47nF | 25V | 25% | CERM | 241944700 |
| C22 | 10µF | 25V | 20% | TAND | 208700108 |
| C23 | 10µF | 25V | 20% | TAND | 208700108 |
| C24 | 6.8pF | 500V | 20% | CERM | 241306800 |

PCB 1 (cont.)

| Cct. Ref. | | | General Description | | | Solartron Part No. |
|---|---|---|---|---|---|---|
| C25 | 47nF | 25V | 25% | CERM | | 241944700 |
| C26 | 47pF | 500V | 20% | CERM | | 241314700 |
| C27 | 150pF | 500V | 20% | CERM | | 241321500 |
| C28 | 47pF | 500V | 20% | CERM | | 241314700 |
| C29 | 3.3µF | 100V | 10% | ESTM | | 225463300 |
| C30 | 47nF | 25V | 25% | CERM | | 241944700 |
| C31 | 47nF | 25V | 25% | CERM | | 241944700 |
| C32 | 10nF | 25V | 25% | CERM | | 241941000 |
| C33 | 10nF | 25V | 25% | CERM | | 241941000 |
| C34 | 10nF | 25V | 25% | CERM | | 241941000 |
| C35 | 10nF | 25V | 25% | CERM | | 241941000 |
| C36 | 220pF | 500V | 20% | CERM | | 241322200 |
| C37 | 220pF | 500V | 20% | CERM | | 241322200 |
| C38 | 220pF | 500V | 20% | CERM | | 241322200 |
| C39 | 220pF | 500V | 20% | CERM | | 241322200 |
| C40 | 10nF | 25V | 25% | CERM | | 241941000 |
| C41 | 47nF | 25V | 25% | CERM | | 241944700 |
| C42 | 3.3nF | - | - | - | | 208100207 |
| C101 | 33pF | 500V | 20% | CERM | | 241313300 |
| C102 | 33pF | 500V | 20% | CERM | | 241313300 |
| C103 | 22µF | 16V | 20% | TAND | | 208700106 |
| C104 | 47nF | 25V | 25% | CERM | | 241944700 |
| C105 | 47nF | 25V | 25% | CERM | | 241944700 |
| C106 | 47nF | 25V | 25% | CERM | | 241944700 |
| C107 | 47nF | 25V | 25% | CERM | | 241944700 |
| C108 | 47nF | 25V | 25% | CERM | | 241944700 |
| C109 | 1nF | 500V | 20% | CERM | | 241331000 |
| C110 | 47nF | 25V | 25% | CERM | | 241944700 |
| C111 | 47nF | 25V | 25% | CERM | | 241944700 |
| C112 | 100pF | 500V | 20% | CERM | | 241321000 |
| C151 | 2200µF | 16V | - | ALME | | 273392200 |
| C152 | 220µF | 16V | - | ALME | | 273382200 |
| C153 | 1000µF | 40V | - | ALME | | 273791000 |
| C154 | 470µF | 40V | - | ALME | | 273784700 |
| C155 | 100µF | 25V | - | ALME | | 273581000 |
| C156 | 100µF | 25V | - | ALME | | 273581000 |
| C158 | 1µF | 35V | 20% | TAND | | 266061000 |
| C159 | 1µF | 35V | 20% | TAND | | 266061000 |
| C160 | 1µF | 35V | 20% | TAND | | 266061000 |
| C161 | 1µF | 35V | 20% | TAND | | 266061000 |
| C163 | 100nF | 50V | 20% | CERM | multilayer | 208450140 |

PCB 1 (cont.)

| Cct. Ref. | General Description | | | | Solartron Part No. |
|---|---|---|---|---|---|
| CV1 | 2-14pF | | | PTFE | 290060030 |
| D1 | SD3 | | | | 300522160 |
| D2 | WR0 57 | | | | 300525770 |
| D3 | SD3 | | | | 300522160 |
| D4 | BZY 88 | 5.6V Zener | 5% | 400mW | 300521450 |
| D5 | BZY88 | 8.2V Zener | 5% | 400mW | 300521330 |
| D6 | WR0 57 | | | | 300525770 |
| D7 | IN4577 | | | | 300525050 |
| D8 | SD3 | | | | 300522160 |
| D9 | SD3 | | | | 300522160 |
| D10 | SD3 | | | | 300522160 |
| D11 | SD3 | | | | 300522160 |
| D12 | SD3 | | | | 300522160 |
| D13 | SD3 | | | | 300522160 |
| D15 | SD3 | | | | 300522160 |
| D16 | IN3595 | | | | 300523590 |
| D17 | IN3595 | | | | 300523590 |
| D18 | SD3 | | | | 300522160 |
| D19 | SD3 | | | | 300522160 |
| D20 | IN829A reference | 6.2V Zener | | 400mW | 300525400 |
| D21 | SD3 | | | | 300522160 |
| D22 | SD3 | | | | 300522160 |
| D25 | WRO 57 | | | | 300525770 |
| D26 | WRO 57 | | | | 300525770 |
| D27 | BZY88 | 20V Zener | 5% | 400mW | 300523790 |
| D28 | SD3 | | | | 300522160 |
| D101 | SD3 | | | | 300522160 |
| D151 | W04 | | | | 300524700 |
| D152 | W04 | | | | 300524700 |
| D153 | IN4004 | | | | 300522070 |
| D154 | IN4004 | | | | 300522070 |
| D156 | BZY88 | 20V Zener | 5% | 400mW | 300523790 |
| D157 | SD3 | | | | 300522160 |
| TR1 | 3N163 | | | | 300554530 |
| TR2 | 3N163 | | | | 300554530 |
| TR3 | 3N163 | | | | 300554530 |
| TR4 | WN1001 | | | | 300555770 |
| TR5 | WN1001 | | | | 300555770 |
| TR6 | WN1001 | | | | 300555770 |
| TR7 | PN4118A | | | | 300555880 |
| TR8 | WN1001 | | | | 300555770 |

PCB 1 (cont.)

| Cct. Ref. | | General Description | Solartron Part No. |
|---|---|---|---|
| TR9 | WN1001 | | 300555770 |
| TR10 | U1897 | | 300553800 |
| TR11 | BCY70 | | 300553590 |
| TR12 | WN1001 | | 300555770 |
| TR13 | WD460 | | 300555820 |
| TR14 | BC183 | | 300555590 |
| TR101 | BC183 | | 300555590 |
| IC1 | OP14 | Op. Amp (matched with IC6) | 510091360 |
| IC2 | DG211 | Quad analog SPST switch | 510091180 |
| IC3 | AD545K | Precision FET Op. Amp | 51009074l |
| IC4 | OPO5 | Op Amp | 510091130 |
| IC5 | DG211 | Quad Analog SPST switch | 510091180 |
| IC6 | OP14 | Op. Amp (matched with IC1) | 510091360 |
| IC7 | DG211 | Quad Analog SPST switch | 510091180 |
| IC8 | OPO5 | Op Amp | 510091130 |
| IC9 | LM311 | Voltage Comparator | 510091280 |
| IC10 | LM311 | Voltage Comparator | 510091280 |
| IC11 | 74LS175 | Quad D-type Flip-Flop | 510003170 |
| IC12 | LM399 | Quad O/Collector Comparator | 510090490 |
| IC13 | ULN2003 | 7-Channel Buffer | 510004980 |
| IC14 | LM339 | Quad O/Collector Comparator | 510090490 |
| IC15 | AD528J | FET Op. Amp | 510090380 |
| IC16 | DG200 | Dual Analog Switch | 510091170 |
| IC17 | 74LS00 | Quad Dual I/P Nand Gate | 510002000 |
| IC18 | DG211 | Quad Analog SPST switch | 510091460 |
| IC19 | AD637K | Rms to dc Converter | 510091460 |
| IC102 | 74LS04 | Hex Inverters | 510002690 |
| IC103 | HD68P01V05 | Microprocessor | 510006250 |
| IC104 | 6.8kΩ | Resistor pack | 160400569 |
| IC105 | NC7033 | | 510005150 |
| IC106 | NC7033 | | 510005150 |
| IC107 | 4040 BE | 12 stage ripple counter | 510001820 |
| IC108 | 74LS197 | 4 bit binary counter | 510005750 |
| IC151 | 7815CKC | 15V 0.5A pos. volt reg. | 510090320 |
| IC152 | LM340T5 | 5V 0.5A pos. volt reg. | 510090500 |
| IC153 | 79L05ACZ | 5V 0.1A neg. volt reg. | 510090950 |
| IC154 | 7915 | 15V 0.5A neg. volt reg. | 510090330 |
| IC155 | 79L05ACZ | 5V 0.1A neg. volt reg. | 510090950 |
| IC157 | TIL117 | Opto transistor | 300540240 |
| SG1 | Ceramic surge voltage protector, 1400V | | 300011470 |

PCB 1 (cont.)

| Cct. Ref. | General Description | Solartron Part No. |
|---|---|---|
| FH1 | 20mm x 5mm Fuseholder | 360206040 |
| - | 20mm x 5m 2A Fuse | 360106150 |
| PH151 | 8-way header, 0.1" pitch | 352308060 |
| X101 | 4.9152MHz crystal, 30pF 0.01% | 300810590 |
| TP1 | Test hook | 355400760 |
| TP2 | Test hook | 355400760 |
| TP4 | Test hook | 355400760 |

| Cct. Ref. | General Description | Solartron Part No. |
|---|---|---|
| SK201 | Auxiliary Socket (with ribbon) | 71510205B |
| SK202 | GPIB Socket | 352524320 |
| SK203 | CAL Socket | 352501740 |
| | Fuse, 2A Fast blow | 360106150 |
| | Fuse, 250mA slow blow | |
| | Fuse, 100mA slow blow | 360106260 |

PCB 2 (71510502)

| Cct. Ref. | General Description | | | | Solartron Part No. |
|---|---|---|---|---|---|
| R201 | 3.3k | 0.25W | 5% | MEOX | 195633300 |
| R202 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R203 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R204 | 220 | 0.25W | 5% | MEOX | 195622200 |
| R205 | 220 | 0.25W | 5% | MEOX | 195622200 |
| R206 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R208 | 150k | 0.25W | 5% | MEOX | 195651000 |
| R209 | 4.7m | 0.25W | 10% | CACP | 172064700 |
| R211 | 470 | 0.25W | 5% | MEOX | 195624700 |
| R212 | 15k | 0.25W | 5% | MEOX | 195641500 |
| R213 | 12k | 0.25W | 5% | MEOX | 195641200 |
| R214 | 12k | 0.25W | 5% | MEOX | 195641200 |
| R215 | 270 | 0.25W | 5% | MEOX | 195622700 |
| R216 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R217 | 6.8k | 0.25W | 5% | MEOX | 195636800 |
| R218 | 68k | 0.25W | 5% | MEOX | 195646800 |
| R219 | 33k | 0.25W | 5% | MEOX | 195643300 |
| R220 | 18k | 0.25W | 5% | MEOX | 195641800 |
| R221 | 3.3k | 0.25W | 5% | MEOX | 195633300 |
| R222 | 1.5k | 0.25W | 5% | MEOX | 195631500 |
| R223 | 3.3k | 0.25W | 5% | MEOX | 195633300 |
| R224 | 3k | 0.25W | 5% | MEOX | 195633000 |
| R225 | 2.2k | 0.25W | 5% | MEOX | 195632200 |
| R227 | 2.2k | 0.25W | 5% | MEOX | 195632200 |
| R228 | 6.8k | 0.25W | 5% | MEOX | 195636800 |
| R229 | 68k | 0.25W | 5% | MEOX | 195646800 |
| R230 | 6.8k | 0.25W | 5% | MEOX | 195636800 |
| R231 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R232 | 1k | 0.25W | 5% | MEOX | 195631000 |
| R233 | 1M | 0.5W | 5% | MEOX | 193561000 |
| R234 | 6.8k | 0.25W | 5% | MEOX | 195636800 |
| R235 | 6.8k | 0.25W | 5% | MEOX | 195636800 |
| R251 | 1M (on rear panel) | | | | 172361000 |
| C201 through C215 | 47nF | 40V | 25% | CERM | 241944700 |
| C216 | 33pF | 500V | 20% | CERM | 241313300 |
| C217 | 2-27pF (variable) film | | | | 290030280 |
| C218 | 33pF | 500V | 20% | CERM | 241313300 |
| C219 | 33pF | 500V | 20% | CERM | 241313300 |
| C220 | 33pF | 500V | 20% | CERM | 241313300 |

PCB 2 (cont)

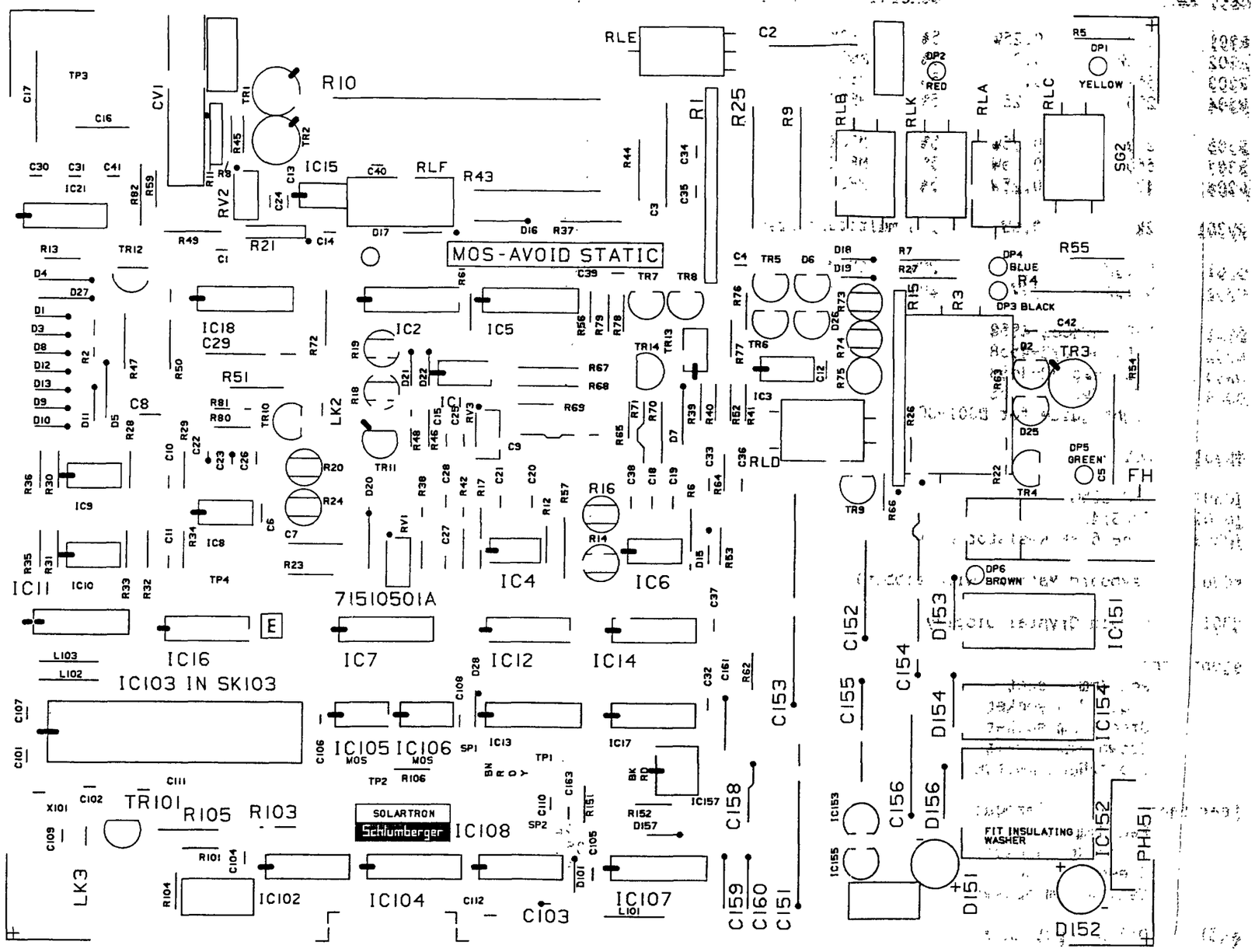
| Cct. Ref. | General Description | | | | Solartron Part No. |
|---|---|---|---|---|---|
| C221 | 1nF | 500V | 20% | CERM | 241331000 |
| C222 | 47nF | 25V | 25% | CERM | 241944700 |
| C223 | 47nF | 25V | 25% | CERM | 241944700 |
| C224 | 10nF | 100V | 10% | ESTF | 227041000 |
| C225 | 10nF | 100V | 10% | ESTF | 227041000 |
| C226 | 100µF | 10V | 20% | TAND | 265481000 |
| C227 | 47nF | 25V | 25% | CERM | 241944700 |
| C228 | 100nF | 50V | 20% | CERM (multilayer) | 208450140 |
| C229 | 47nF | 40V | 25% | CERM | 241944700 |
| C230 | 47nF | 40V | 25% | CERM | 241944700 |
| C232 | 47nF | 40V | 25% | CERM | 241944700 |
| C235 | 47nF | 40V | 25% | CERM | 241944700 |
| C236 | 47nF | 40V | 25% | CERM | 241944700 |
| C237 | 1nF | 500V | 20% | CERM | 241331000 |
| C238 | 1nF | 500V | 20% | CERM | 241331000 |
| C239 | 1nF | 500V | 20% | CERM | 241331000 |
| C240 | 100pF | 500V | 20% | CERM | 241321000 |
| C251 | 2200µF | 16V | | ALME | 273392200 |
| C252 | 2200µF | 16V | | ALME | 273392200 |
| C253 | 470µF | 40V | | ALME | 273784700 |
| C254 | 470µF | 40V | | ALME | 273784700 |
| D201 | 1N6263 | | | | 300525650 |
| D202 | 1N6263 | | | | 300525650 |
| D203 | 1N6263 | | | | 300525650 |
| D204 | 1N6263 | | | | 300525650 |
| D205 | 1N825 | | | | 300523050 |
| D206 | 4.7V Zener | | | | 300521470 |
| D207 | 4.7V Zener | | | | 300521470 |
| D208 | SD3 | | | | 300522160 |
| D251 | W04 | Bridge Rectifier | | | 300524700 |
| D252 | W04 | Bridge Rectifier | | | 300524700 |
| SW201 | 8-way Interface configuring switch | | | | 375000600 |
| BAT201 | 3.6V Battery | | | | 800400210 |
| X201 | 4.9152MHz Crystal | | | | 300810590 |
| X202 | 1.8432MHz Crystal | | | | 300810460 |
| X203 | 32.768kHz Crystal | | | | 300810640 |
| PH201 | 4-way Header | | | | 352304080 |
| PH202 | 2-way Header | | | | 352302080 |
| TP1→7 | Test Hook | | | | 355400760 |

PCB 2 (cont)

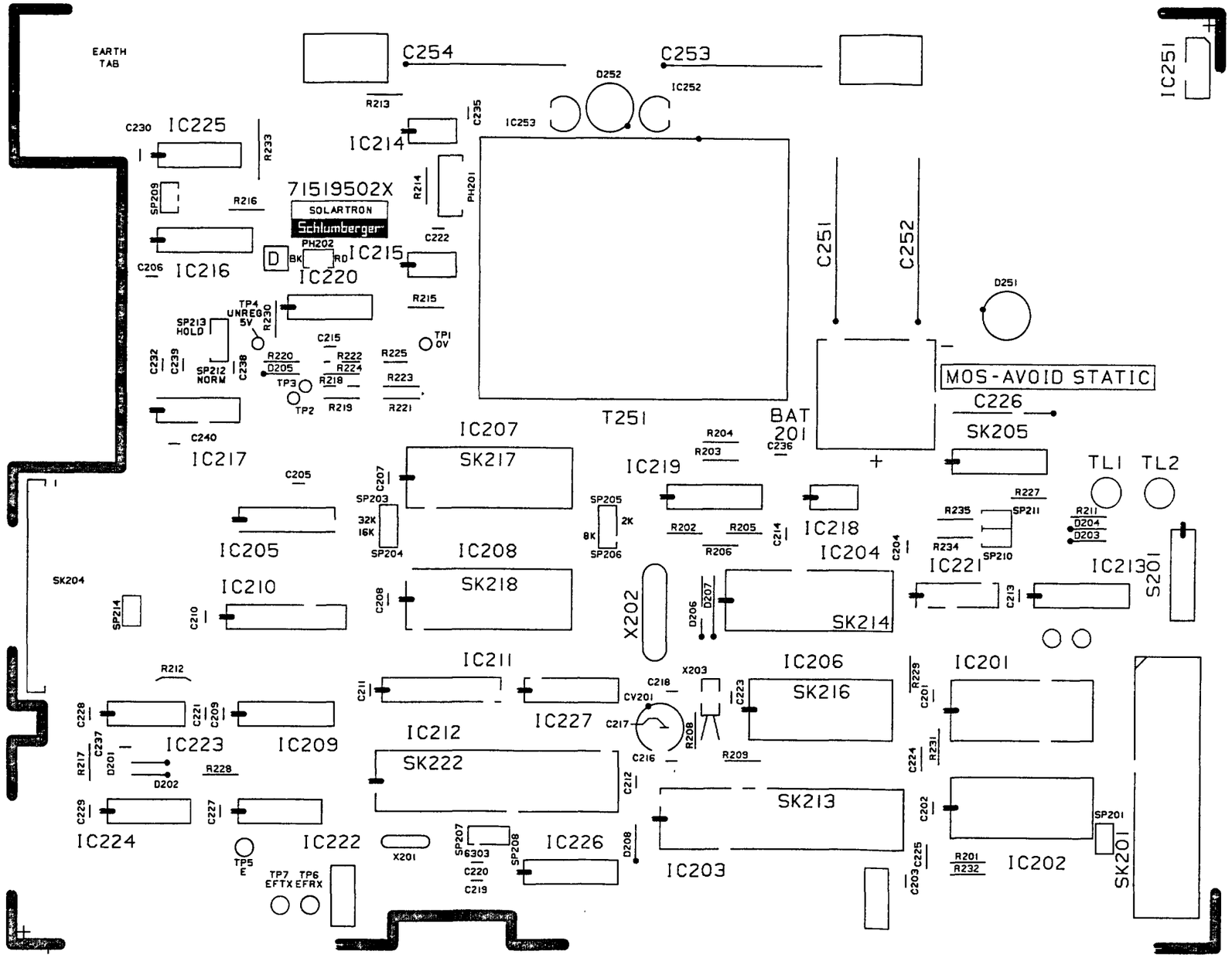
| Cct. Ref. | | General Description | | | Solartron Part No. |
|---|---|---|---|---|---|
| IC201 | MC3447 | 8 way tranceivers | | | 510005700 |
| IC202 | MC3447 | 8 way tranceivers | | | 510005700 |
| IC203 | MC68488 | GPIB Interface adaptor | | | |
| IC204 | SYP6551A | RS232 interface | | | 510006090 |
| IC205 | AD558 | 8 bit digital to analog converter | | | 510091430 |
| IC206 | HD146818 | Real time clock | | | 510006300 |
| IC208 | HM6264P15 | 64k static RAM | | | 510006500 |
| IC209 | 74LS139 | 2 to 4 line decoder | | | 510002960 |
| IC210 | 74LS374 | Octal latch/Flip-flop | | | 510004390 |
| IC211 | 74LS373 | Octal tri-state latch | | | 510004870 |
| IC212 | HD6303 | 8-bit microprocessor | | | |
| IC213 | 74LS145 | BCD to decimal decoder/driver | | | 510004990 |
| IC214 | HCPL2601 | Opto-coupled transistor | | | 300540260 |
| IC215 | HCPL2601 | Opto-coupled transistor | | | 300540260 |
| IC216 | MC14040B | 12-stage ripple counter | | | 510001820 |
| IC217 | 74LS197 | 4-bit binary counter | | | 510005750 |
| IC218 | SN75150 | RS232 line driver | | | 510005250 |
| IC219 | SN75152 | RS232 line receiver | | | |
| IC220 | LM339 | Quad O/Collector comparator | | | 510090490 |
| IC221 | MC14071B | Quad dual i/p OR gate | | | 510001680 |
| IC222 | 74LS00 | Quad dual i/p Nand Gate | | | 510002000 |
| IC223 | 74LS04 | Hex inverters | | | 510002690 |
| IC224 | 74LS03 | Quad dual i/p Nand gate | | | 510004140 |
| IC223 | MC14068B | 8-input Nand gate | | | 510002630 |
| IC226 | 6.8k | Resistor pack | | | 160400569 |
| IC227 | 100k | Resistor pack | | | 160400598 |
| IC251 | LM240T5 | 5V | 0.5A | pos. volt reg. | 510090500 |
| IC252 | 78L12 | 12V | 0.1A | pos. volt reg. | 510090450 |
| IC253 | 79L12 | 12V | 0.1A | neg. volt reg. | 510090460 |

PCB 3 (71510503) Display Board

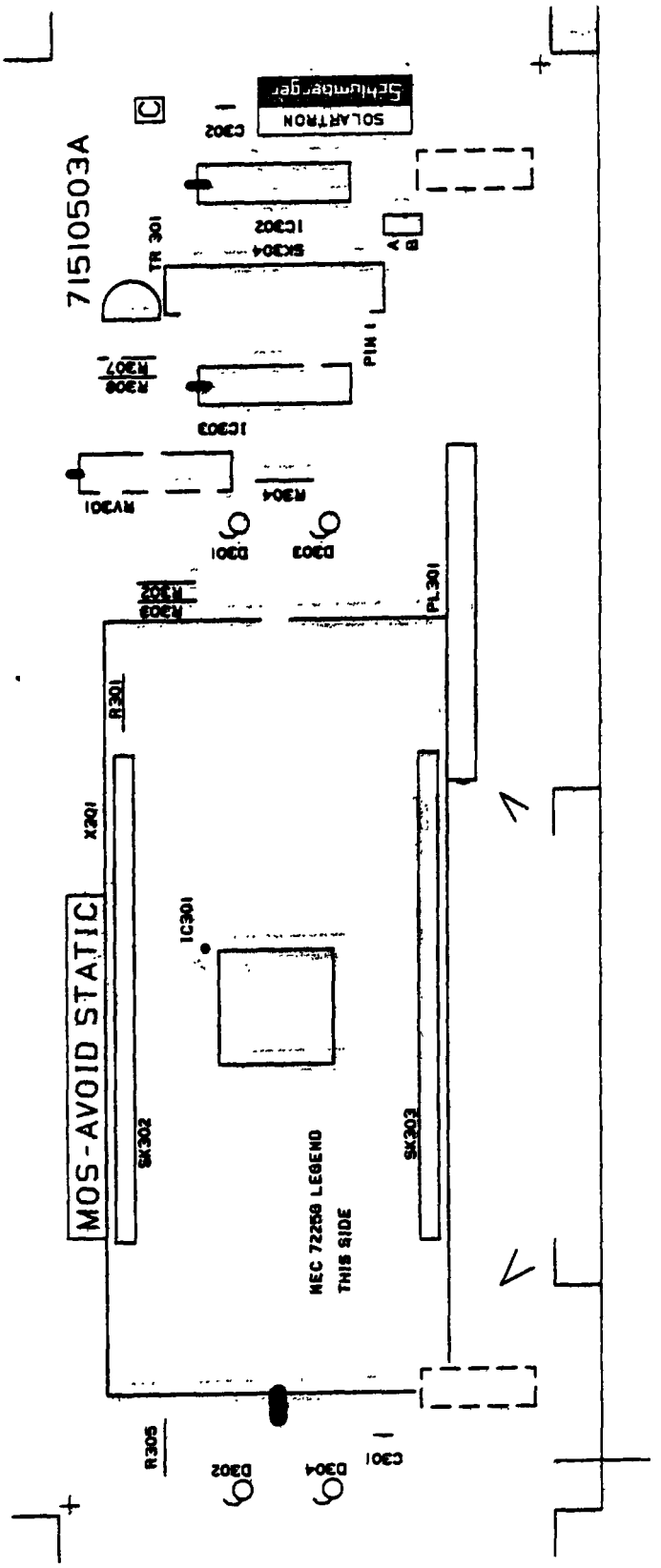
| Cct. Ref. | General Description | | | | Solartron Part No. |
|---|---|---|---|---|---|
| R301 | 180k | 0.25W | 5% | MEOX | 195651800 |
| R302 | 1.8k | 0.25W | 5% | MEOX | 195631800 |
| R303 | 560 | 0.25W | 5% | MEOX | 195625600 |
| R304 | 270 | 0.25W | 5% | MEOX | 195622700 |
| R305 | 270 | 0.25W | 5% | MEOX | 195622700 |
| R307 | 560 | 0.25W | 5% | MEOX | 195625600 |
| R308 | 47 | 0.25W | 5% | MEOX | 195614700 |
| RV301 | 2k | 0.5W | 10% multiturn preset | | 130632000 |
| C301 | 0.1µF | 50V | 20% | CERM | 208450140 |
| C302 | 0.1µF | 50V | 20% | CERM | 208450140 |
| D301 | LED, HP5082-4558 | | | | 300750270 |
| D302 | LED, HP5082-4558 | | | | 300750270 |
| D303 | LED, HP5082-4558 | | | | 300750270 |
| D304 | LED, HP5082-4558 | | | | 300750270 |
| | light guide for D301→304 | | | | 71502035B |
| TR301 | BCY70 | | | | 300553590 |
| IC301 | NEC7225G | | | | 510005890 |
| IC302 | 74LS145 | | | | 510004990 |
| IC303 | 316B 6.8k Resistor pack | | | | 192136800 |
| KB301 | Keyboard Matrix (with ribbon) | | | | |
| X301 | Liquid Crystal Display | | | | 71512000 |
| Front Panel | | | | | |
| | Red 4mm socket | | | | 352501470 |
| | Black 4mm socket | | | | 352501480 |
| | Green 4mm socket | | | | 352501490 |
| | Brown 4mm socket | | | | 352501750 |
| | Front/Rear switch | | | | 71517001 |
| Rear Panel & Miscellaneous | | | | | |
| | Red 4mm socket | | | | 352501470 |
| | Black 4mm socket | | | | 352501480 |
| | Green 4mm socket | | | | 352501490 |
| | Yellow 4mm socket | | | | |
| N251 | Mains input unit | | | | 550001480 |
| S251 | Mains switch | | | | 375500020 |
| T251 | Mains Transformer | | | | 309618901 |




PCB 1 COMPONENT LAYOUT
FIG 6.1




PCB 2 COMPONENT LAYOUT
FIG 6.2




PCB 3 COMPONENT LAYOUT
FIG 6.3